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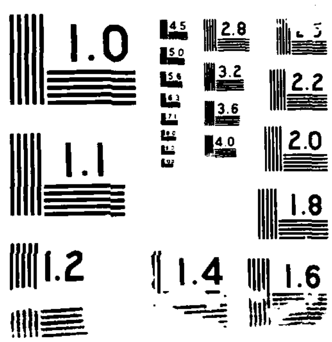
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A TIME SERIES ANALYSIS OF
ENERGETIC ELECTRON FLUXES
(1.2 - 16 MeV)
AT GEOSYNCHRONOUS ALTITUDE

THESIS

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AFIT/GSO/ENS-ENP/86D-1

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THESIS

Presented to the Faculty of the School of Engineering
of the Air Force Institute of Technology
Air University
In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Space Operations

Michael P. Halpin, B.S.
Major, USAF

December 1986

Preface

The person knowledgeable of the general subject of this thesis will perhaps notice a very marked similarity to two other theses accomplished at AFIT by prior students who also had an interest in the correlations between the solar wind, the interplanetary magnetic field (IMF), and geosynchronous energetic electron count rates (fluxes). These were the work of Captains Warren Smith and Douglas McCormick of previous GSO classes 83 and 84. In this study, new data were gathered and analyzed but, rather than using the classical methods of Smith and McCormick, the more refined method of Time Series Analysis as described by Box and Jenkins (1976) was used in an attempt to derive models for the energetic electron fluxes (Box and Jenkins, 1976). It is hoped that at least some of the models derived as a result of this thesis may be used to more successfully predict the level of energetic electron activity with sufficient lead time to allow efficient control of the many satellites we have operating in this energetic particle-filled region of space. Moreover, this thesis has been another attempt to show that some relationship exists between the IMF, the solar wind, and the energetic electron fluxes.

Perhaps the greatest thing one learns from taking on a project such as this is not just simply a few facts about the subject matter. On the contrary, what one "learns" for certain is the virtually ingraspable enormity of physical processes at work in the universe for which God has given us only a few keys to try to understand. In short, I have indeed had a humbling experience in composing this study.

Even more humbling is the realization of the incredible amount of stored knowledge that those who have helped me in this endeavor command at their mere fingertips. Major Joe Litko is a brilliant man whose near instantaneous and extremely accurate recollections of the Box and Jenkins time series details never ceased to amaze me. Concerning Major Jim Lange, I can only sing similar praises. His knowledge of the physics of the space environment is astounding. I am indeed greatly indebted for the continuing patience and help of these two individuals. I am also obliged to give my thanks to Mr. Jim Ware, the AFIT School of Engineering computer consultant for his much needed help in transfering raw data from tapes to files in my personal computer accounts. This enabled me to comfortably analyze the data in ways I am used to. Anyone who has

had the misfortune of having to deal with reading data off a tape knows what I'm talking about. Mr. Ware made the data reading process a virtual ease for me with his great command of the computer systems at AFIT. Thanks also goes to Dr. Ray Klebesadel of the Los Alamos National Laboratory and Ms. Billie Dolen and Mr. Ralph Post of the National Space Science Data Center for their very courteous and concerned help in providing the raw data for this project.

On the home front, where would I be without the comfort and restoration of my loving wife, Jennifer? Even in my darkest moments she was able to help me keep my eyes focused on the goal and gave me reassurances that I was capable of completeing this project.

Finally, thanks be to the Lord. May I ever and always be His instrument and a part of His plan for good works.

Michael P. Halpin

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Abstract

This project used a Box and Jenkins time series analysis of energetic electron fluxes measured at geosynchronous orbit in an effort to derive prediction models for the flux in each of five energy channels. In addition, the technique of transfer function modeling described by Box and Jenkins was used in an attempt to derive input-output relationships between the flux channels (viewed as the output) and the solar wind speed or interplanetary magnetic field (IMF) north-south component, B_z, (viewed as the input). The transfer function modeling was done in order to investigate the theoretical dynamic relationship which is believed to exist between the solar wind, the IMF B_z, and the energetic electron flux in the magnetosphere. The models derived from the transfer function techniques employed were also intended to be used in the prediction of flux values.

The results from this study indicate that the energetic electron flux changes in the various channels

are dependent on more than simply the solar wind speed or the IMF B_z. Also, most of the time series models developed here (for both the individual energetic electron channels by themselves and those developed through transfer functions) were not suitable for use in prediction, since the standard error of the forecasts made using these models was unacceptably high. However, a few of the models did merit possible consideration for use in prediction of fluxes. These were the individual time series models for the 6.6 - 9.7 MeV channel. In addition, the transfer function models developed using the solar wind as an input and the 6.6 - 9.7 MeV channel as an output may be of possible use. The channel containing electrons with energies between 9.7 - 16 MeV was also related to the solar wind via a transfer function with a reasonable forecast standard error. Finally, most of the transfer function models derived with the solar wind considered as the input to a given channel resulted in delay parameters of about 2 days between the input change in solar wind velocity and the observed output change in electron flux which supports findings from prior studies.

A TIME SERIES ANALYSIS OF ENERGETIC ELECTRON FLUXES (1.2-16 MeV) AT GEOSYNCHRONOUS ORBIT

I. Introduction

Background

In the years immediately after World War II and the capture of various German secret plans for rockets from their launch complex at Peenemunde on the Baltic coast, the imagination of the scientific community began to be taken with the possibilities for space exploration inherent in such devices as the V-2 which could zoom to altitudes many miles higher than had ever been previously achieved. Indeed, Dr. James Van Allen of the University of Iowa conducted a 1958 experiment with a V-2 spinoff, the Jupiter, which like its parent was developed by von Braun (Boyd, 1974:28). Van Allen put together a small package for the Explorer I satellite in which he installed Geiger counters in the Jupiter's payload and then helped launch it into space to continue the high altitude cosmic ray studies which he was then conducting (Glasstone, 1965:543). To Van Allen's surprise, he found that the term "space" apparently was a misnomer at least in the near-earth sense. The Geiger counters recorded very high amounts of energy which caused a great bewilderment in the scientific community as to the energy's source. The Van Allen belts, as they are now called, are regions of very intense energy particles which extend from altitudes about 500 miles above the earth's equator to over 40,000 miles. Thus, man began to realize that this area of "space" (the magnetosphere) isn't just empty but is literally filled with these tiny, high energy particles.

But what are these particles, and where do they come from? A good portion of them are energetic electrons and protons which have become trapped in the earth's magnetosphere. It is believed that many of these particles are produced by solar disturbances, carried outward from the sun by the solar wind, and then deposited into the magnetosphere by a little understood mechanism which allows the Interplanetary Magnetic Field (IMF) to "link" up with the earth's magnetic field (Akasofu, 1983:179). Thus, the particles of the solar wind are allowed to enter the magnetosphere where they are subsequently accelerated and become "trapped" along the earth's magnetic field lines. The kinetic energy of these particles is very large which implies that they are extremely fast moving. The energies of the particles which will be dealt with in this study are in the range of 1 to 16 MeV. One MeV is 10^6 electron volts where an electron volt is equal to approximately 1.6 x 10^{-19} joules of kinetic energy. Taking into consideration the very small masses involved, it should be apparent that the velocities of these protons and electrons are extremely high in order to produce energies of the magnitudes cited above. Indeed, with regard to the energetic electrons which will be studied here, the electrons must be considered in a relativistic sense, since their velocity may approach and in some cases nearly equal the speed of light (3 x 10^8 meters/sec).

The next question concerns what the implications are for our operations in space given all these particles in the near earth space environment. The implications are many. They can, for example, cause difficult problems for our spacecraft deployed in geosynchronous earth orbits inside the magnetosphere. High levels of flux (defined as the measured number of particles passing through a unit area per unit of time) of these small energetic masses can cause such maladies as: (1) spurious event sensing of surveillance satellites, (2) uncommanded tumbling motions of the satellite, (3) degraded sensor and/or electronics capabilities due to particle energy absorption over a long period of time, (4) alterings of satellite surface coatings such that the satellite's operating temperature is increased above the optimum, and (5) radiation sickness, cancer, or gene mutation for astronauts traveling for any extended periods in such conditions (Lange, 1982:III-D-21,22; Spjeldvik and Rothwell, 1983:113).

Since it is imperative that we have satellites operating within the Van Allen belts in the geosynchronous region of space (approximately 22,700 miles altitude) for communications, surveillance, and exploration, and since the exact mechanism for the changes in flux of these energetic particles in the Van Allen belts is not well understood, statistical methods are used in an attempt to help explain particle behavior. Having some ability to predict when changes in flux levels might occur is a very desirable goal since such a capability would allow (given sufficient lead time) more efficient control of satellites which might be exposed to potentially harmful flux levels. For example, in the event of a forecast particle substorm, sensitive satellite subsystems might be turned off so as to avoid the deleterious effects of increased flux levels much as a personal computer owner might turn off his system at the onset of a thunderstorm to avoid the potential for damage due to lightning strikes. Thus, many statistical studies of these energetic particle fluxes have focused on classical methods such as correlation analysis or analysis of variance (ANOVA) in attempts to link measured particle flux levels (recorded by a number of satellites which the US currently has in geosynchronous orbit) with other magnetospheric parameters which are also measurable by our satellites or at ground stations. The idea is that if a given magnetospheric or solar wind parameter can be used with sufficient lead time (say one to two days) to predict an increase in particle flux, then the parameter may be used as a basis for satellite command and control decisions.

One of the key areas of interest has been the belief on the part of many geophysicists that there is a relationship between changes in the solar wind velocity, the north-south component of the solar wind (or interplanetary) magnetic field (IMF), and the levels of flux of energetic electrons in the magnetosphere (Paulikas and Blake, 1978:2,10). Studies of note which have made attempts to correlate such parameters via the classical methods mentioned above are those of Smith (1983) and McCormick (1984). Smith, employing data from June 1979 to April 1982, used a correlation analysis and

ANOVA of solar wind speed, IMF, and energetic electron flux level data and concluded that there was only a <u>weak</u> correlation (largest value of $R^2 = 0.2582$ when two-day old solar wind data used) between solar wind speed readings and energetic electron flux levels (Smith, 1983:42-50). Also, no significant correlations between the IMF north-south (B_z) component and e^- flux levels were noted (Smith, 1983:54). McCormick, with the same data set, used methods similar to those of Smith and came to virtually identical conclusions, but he also found that solar wind correlations with increased flux levels were slightly higher when the IMF north-south component was negative (ie, more southward oriented). To elaborate, R^2 values were 0.269 and 0.313 respectively for the correlations between <u>squared</u> two day old solar wind speed values and energetic electron flux values from the two lowest electron flux channels of 1.2 - 1.8 MeV and 3.4 - 4.9 MeV. These R^2 values were attained <u>only</u> when the IMF north-south (B_z) component was negative during the same time at which the solar wind speed was measured (McCormick, 1984:51-63). This tended to support existing ideas that a southward oriented B_z component of the IMF seems to result in more enhanced flux levels (Potemra, 1983:279).

Despite these sometimes discouraging results, the scientific community continues to believe that some sort of relationship exists between the IMF B_z, the solar wind, and the energetic electron fluxes, and further study in this area seems warranted (Paulikas and Blake, 1978:1). In fact, a number of other studies have very much established that a statistical relationship does exist when electron fluxes of lower energy are involved (Su and Konradi, 1979:25).

Objectives of the Research

A comparatively new and unused method of statistical analysis for data taken over a long time period is that of Time Series Analysis such as that described by Box and Jenkins (1976). With the advent of very powerful computers and the availability of statistical programs such as the BMDP Statistical Software package, the capability to do analyses like that of Box and Jenkins now exists. Therefore, the objectives of this research will be twofold. First, a Box and Jenkins time series analysis of energetic electron flux data will be performed in an attempt to define models which may be used to predict changes in flux levels. As stated earlier, such models might allow the prediction of potentially dangerous fluxes with sufficient lead time to allow better control of affected spacecraft. Second, since one of the main concerns of the geophysical/astrophysical community is in the linkage between the solar wind velocity, the north-south (B_z) component of the IMF, and the changes in flux levels of energetic e^-, an attempt will also be made in this study to <u>relate</u> these <u>entities</u> <u>via</u> <u>time</u> <u>series</u> <u>transfer</u> <u>functions</u>. The scope of this study will be limited to data taken in the time period between April 1982 and May 1986, a period somewhat longer than that in the studies by Smith and McCormick. It should be emphasized that some of this data may be discarded due to the way in which a time series analysis is conducted. The finer details of a time series analysis as described by Box and Jenkins will be presented in the Detailed Methodology section of this report.

<u>Overview</u>

This report includes a literature review of articles on geosynchronous particle flux and its implications (Chapter II), data preparation and use of computers (Chapter III), a detailed look at the Box and Jenkins time series analysis (Chapter IV), a presentation of results (Chapter V), and finally, appropriate conclusions and recommendations (Chapter VI).

II. Literature Review

One of the most obvious points concerning a literature review in the general field of magnetospheric phenomena is the abundance of articles. This is due in part to the commissioning in the mid-1970s of the International Magnetospheric Survey (IMS) "in which a coordinated effort was made to understand magnetospheric processes" (Russell and Southwood, 1982:vii). The IMS was created by a group of concerned geophysicists who felt that more research was needed concerning the magnetosphere. The coordination of the many projects resulting from the multinational commitment to the IMS has been and continues to be carried out at the level of the participating scientists from each nation. The result of the IMS has been a virtual (and much needed) flood of research projects and interest in the magnetosphere and its mechanics.

One of the best publications for finding literature on magnetospheric processes is the space physics portion (blue colored volumes) of the Journal of Geophysical Research. This is a monthly publication which is filled with the studies of the world's leading space physicists. Many of the articles cited here came from this journal.

The way in which one chooses to conduct a literature review of the magnetosphere is dependent on the specific project concerns. In this case, it was decided to look at articles and books associated with the general theme of the interactions between the IMF, the solar wind, and the flux levels of energetic particles observed in the magnetosphere. Also, were it not for the fact that these energetic particles pose difficult problems for our spacecraft, one might easily surmise that the intensity of research in this area would be somewhat lessened. Consequently, reviews of articles concerning the difficulties of space operations in the magnetosphere along with ways of predicting hazardous conditions there also seem appropriate.

Magnetospheric Interactions

A generally accepted theory is that the particle energy flux in the magnetosphere is greatly controlled by an as yet undetailed mechanism whereby the interplanetary magnetic field lines link with the earth's magnetic field lines. According to Nishida, extensive examinations of both ground based and space based observations have led us to believe that the energy supplied to the magnetosphere "proceeds mainly by reconnection between the lines of force of the IMF and the geomagnetic field" (Nishida, 1983:185). When this occurs, vast amounts of energy in the form of particles carried along by the solar wind are allowed to enter the magnetosphere where subsequently these particles are accelerated to extreme speeds and become trapped along the earth's field lines. Paulikas and Blake, in an earlier study of 11 years of data on electron fluxes at geosynchronous orbit, found that the "efficiency of coupling" between these solar wind particles and the magnetosphere is apparently controlled by the "IMF direction as well as the solar wind velocity" (Paulikas and Blake, 1978:2).

Part of the problem in developing a deeper understanding of the processes controlling the rate of energy inflow to the magnetosphere has to do with the vastness of space itself. According to Baker, the very great distances involved make it extremely difficult to "probe the system concurrently at enough different points to truly understand the complex relationships between its different parts" (Baker, 1982b:5917). Su and Konradi, in an earlier paper, were in agreement and stated that "the observations made by a single spacecraft so far fail to resolve the temporal and spatial variations of the environment" (Su and Konradi, 1979:23). Nevertheless, by correlating data from different satellites located in different parts of the magnetosphere and by systematically moving these probes so as to sample different areas, the work of understanding the processes continues. An example of such a study was that conducted by Baker in which he and co-workers developed a model of energetic particles at geosynchronous orbit by studying and analyzing the data sent back from six different satellites at different points in the magnetosphere during the occurence of a substorm on July 29, 1977 (Baker, 1982b).

Regardless of the actual mechanisms controlling the rate of energetic particle inflow, it is widely held that the solar wind is the driving force behind the inflow and holds the secrets to further understanding. In a recent study of high energy magnetospheric protons, Baker et al noted from their work that increases in energetic electron intensities (above 0.2 MeV) track closely with the solar wind velocity (Baker, 1979:7149). They also noted that virtually all substorms are accompanied by some observable injection of electrons with energies > 30 KeV. In a different article, Baker stated flatly that the dynamics of the magnetosphere "may be effectively discussed in terms of energy input from the solar wind into the magnetosphere" (Baker, 1982b:5917). Nishida again echoed this feeling in a later report (Nishida, 1983:185).

Still another facet in understanding the interactions is the part played by the north-south (B_z) component of the IMF. Numerous studies have shown that increases in energetic particle flux seem to correlate well with a negative (or southward oriented) B_z. Researchers involved in such studies included McPherron who in observations of substorms found that the growth phase of these storms occurred during southward oriented B_z components of the measured IMF (McPherron et al, 1973:3131). Studies conducted by Russell in the following year came to the same conclusions (Russell et al, 1974:1108). Moreover, a 1977 study by Caan and others again reached the same conclusions regarding the onset of substorms following a prolonged (two hours or more) southward turning of the IMF B_z (Caan et al, 1977:4837). More recently, statements by Akasofu and Baker on this subject only serve to emphasize the unanimity of the geophysical community concerning the appropriateness of this theory. In a 1983 paper, Akasofu wrote,

> . . . it has been found that the north-south component of the solar wind (or interplanetary) magnetic field is one of the most important parameters which link solar wind disturbances and magnetospheric disturbances. . . Thus, it is

> crucial to understand the physical causes of theta (the north-south component of the solar wind magnetic field) and its time variations in linking solar wind disturbances and magnetospheric disturbances (Akasofu, 1983:179,181).

Baker was more to the point when in a later article that same year he stated,

> . . . a southward IMF ($B_z < 0$) gives rise to enhanced magnetospheric activity, while a prolonged northward IMF ($B_z > 0$) is followed by quiet geomagnetic conditions (Baker and others, 1983:6230).

There are many more geophysicists in the available articles who are of the same beliefs.

Another point is also brought out in the literature and bears mentioning here. In a study to determine the effects of the solar wind on magnetospheric dynamics, Paulikas and Blake noted that increases in the solar wind <u>velocity</u> as well as the aforementioned southward oriented IMF correlated with increases in the numbers of energetic electrons in the magnetosphere (Paulikas and Blake, 1978:2). In fact, they were so adamant regarding the significance of the solar wind velocity that they went on to state that the "velocity of the solar wind is the most important parameter in organizing the flux levels of energetic electrons in the outer magnetosphere" (Paulikas and Blake, 1978:16). As part of their study they also showed that increases in the flux levels of energetic electrons (> 3.9 MeV) correlated well with approximately 2 day old solar wind speed data. Specifically,

> Starting about a day or two after the solar wind stream first reaches the earth, the fluxes build up in correlation with the increasing velocity of the solar wind (Paulikas and Blake, 1978:11).

This is in general agreement with the findings of Smith and McCormick who, as noted in Chapter 1, found some amount of correlation between two day old solar wind speed data and increased flux levels.(Smith, 1983 and McCormick, 1984). One interesting side light to the Paulikas and Blake paper has to do with their observation that the most marked variability of higher energy electron fluxes is associated with the 27 day solar rotation period (Paulikas and Blake, 1978:22). This is a characteristic which will clearly present itself when the results of the analysis are presented later on in this report.

Thus one can summarize the literature that surrounds the interaction aspect with three observations: (1) the solar wind is the energy provider, (2) the IMF linkage with the geomagnetic field is the key which apparently turns the energy flow on and off, and (3) the solar wind velocity, perhaps more than any other parameter, is a good indicator of the amount of energy available for inflow to the magnetosphere.

Operational Hazards

In a 1979 study, Grajek and Mcpherson stated that "a significant number of satellite operating anomalies are due to differential charging of spacecraft surfaces and resultant discharges" (Grajek and McPherson, 1979:769). They went on to observe that though most of these anomalies have had little impact on the spacecraft mission, some have been serious enough to result in total failure of the spacecraft power system (Grajek and McPherson, 1979:769). A separate study of the Van Allen belts in 1983 detailed some of the possible anomalies such as "detector malfunction and degradation, optical system degradation, memory system alteration, and control system malfunction or failure" (Spjeldvik and Rothwell, 1983:113). The study also cited the possible biological effects and implications for manned space operations (Spjeldvik and Rothwell, 1983:113). The main measure of damage done by penetrating energetic radiation or particles is radiation dosage or rads which is a unit of energy defined as the deposition of 6.25×10^7 MeV in 1 gram of material. According to Spjeldvik and Rothwell, one of the major concerns is "the on-orbit lifetime of microelectronic devices that are designed to a specific level of radiation 'hardness' (such as 10^4-10^5 rad)" which dictates a "trade-off between orbit choice and system lifetime" (Spjeldvik and Rothwell, 1983:114). Since just a single energetic electron of the type analyzed in this study may carry as much as 16 MeV, it is easy to see why space operations in the magnetosphere can not be taken lightly. In addition, the study noted that the upper limit for human tolerance to such radiation is only about 500 rads (lethal) while lesser amounts can cause serious biological damage (such as gene ıtation or cancer) (Spjeldvik and Rothwell, 1983:121).

Therefore, given that man has found it necessary to operate spacecraft in the magnetosphere for a host of reasons, it will behoove us all to understand as much about magnetospheric processes as possible and to develop relationships for the prediction of such events so that sufficient lead time is available for spacecraft control. To a great extent, the practical approach up till now has been the observation of significant magnetospheric events and the correlation of these with measured geophysical parameters.

Prediction Methods

Numerous studies have been conducted for determining the correlations between events observed in the magnetosphere and measured parameters. An example of one of these studies attempted to prove or disprove previous correlations between such things as observed spacecraft anomalies and local time, geomagnetic activity, the day of the week, and the season (Grajek and McPherson, 1979). The study concluded that the anomalies are, with 99.997% confidence, dependent upon geomagnetic activity as measured by the index D_{ST} where D_{ST} is a measure of the equatorial disturbance produced by magnetic storms (Grajek and McPherson, 1979:774). Su and Konradi also derived a model for particle flux intensities at geosynchronous altitude using a third order polynomial curve of best fit for their available data concerning particles of the energy range 70 - 41,000 eV (Su and Konradi, 1979:27). During their study they also showed that geosynchronous particle flux intensities correlated well enough with the auroral electrojet (AE) index to indicate a definite causal relationship, while the flux intensities did not correlate well with the geomagnetic planetary (K_P) index (Su and Konradi, 1979:26,27).

Others have taken the approach of trying to directly include characteristics of the solar wind in their representations of magnetospheric processes. In a 1983 paper, Akasofu derived an equation for total energy output rate of the magnetosphere which contained, among other factors, the solar wind velocity and the square of the overall solar wind magnetic field magnitude (Akasofu, 1983:176). McCormick pointed out that this approach considered the magnetosphere to be a "driven" system rather than an "unloading system where substorms occur from energy accumulated in the magnetosphere and (are) released by some instability" (McCormick, 1984:16). Crooker and others after looking at six-month and yearly solar wind speed averages found a high correlation with geomagnetic activity and subsequently suggested that the product of the southward component of the IMF and the square (or higher power) of the solar wind velocity seemed to correlate well with geomagnetic activity (Crooker et al, 1977:1933-1936).

Alas, there are many theories concerning ways to predict particle flux in the magnetosphere, but as yet there is no universally acceptable way to predict, much less describe, magnetospheric processes. Perhaps Paulikas and Blake summed up the hopes of many space researchers when they stated:

> . . . it seems clear that the present results already offer some hope of both short-term and long-term prediction of the energetic electron radiation in the outer magnetosphere if a sufficiently accurate prediction of the parameters of the solar wind are available (Paulikas and Blake, 1978:33).

With the hope of deriving prediction models for energetic electron flux in the magnetosphere based on the Box and Jenkins time series analysis methods along with the same hope for deriving a relationship between the flux and the IMF/solar wind speed via transfer functions, let us go on to consider how the data were prepared.

III. Data, Software, and Computers

Data

The data for this project were supplied by two sources. The Los Alamos National Laboratory and the satellite 1979-053 were the source of one set of the data. The National Space Science Data Center through readings from the IMP 8 and ISEE 3 satellites was the other.

The Los Alamos data was originally sent on a magnetic tape and contained, among ten variables, daily average values of five energetic electron flux level channels covering the time period from April 1982 to May 1986. The details of the orientation of satellite 1979-053 and its sensors which record the flux values are available from Baker et al. The five channels mentioned contain measurements for flux levels (count rates) in the ranges of 1.2 - 1.8 Mev, 3.4 - 4.9 MeV, 4.9 - 6.6 MeV, 6.6 - 9.7 MeV, and 9.7 - 16 MeV. Two different detector packages aboard the satellite collected this data. The lowest energy channel (1.2 - 1.8 MeV) was collected by a solid state detector. Henceforth, this channel's data shall be referred to as the SEESSD data channel (where "SEE" is an acronym for spectrometer for extended electron measurements and

"SSD" stands for solid state detector) (Baker et al, 1982a:83). The last four channels were collected by the other onboard detector and will be referred to henceforth as the SEEI, SEEII, SEEIII, and SEEIV data channels respectively. One point which should be made is that the flux values measured are simply the count rates which are not the same as the standard units for flux levels (particles per unit area per unit time). However, the correlation between count rates and the standard units is direct, so the measured count rates may be used in an analysis just as the data converted to standard units could be used.

Regarding the second set of data supplied by the National Space Science Data Center (NSSDC), once again, the data were sent on a magnetic tape referred to commonly by the NSSDC as the "Omni Tape". This tape, in addition to containing the pertinent values for solar wind speed and the IMF components, contained readings of no less than 37 different parameters. The big difference between this data and that supplied by Los Alamos, however, was that the Omni Tape contained hourly readings of all these different parameters over a period stretching from April 1981 to April 1985. This meant that the data in its raw form was contained in a five megabyte file with much of the information irrelevant to this study. Consequently, a computer program had to be written to allow compression of the original Omni Tape supplied into a more manageable file containing daily averages. This was done in order to synchronize daily average values for the solar wind speed and IMF with the daily average readings contained on the Los Alamos tape for the energetic electron fluxes. Though the NSSDC obtains their Omni Tape data from a total of 17 different satellites, the majority of the readings for the solar wind speed and the IMF component values come from the IMP 8 (for International Magnetospheric Probe) and ISEE 3 (for International Sun-Earth Explorer) spacecraft. The ISEE project is a joint NASA-European Space Agency effort to study the outer magnetosphere (von Rosenvinge, 1982:1). Once again, details concerning spacecraft orbital parameters and instrumentation are available from McCormick (McCormick, 1984:7) and King (King, 1982:10-20).

Overview

As a first action, both tapes were read into personal files on the CDC Cyber 6000 and SSC Unix VAX 11/780 computers at AFIT. Next, due to the intractable nature of the data contained on the Omni Tape, its data was compressed into daily averages and then saved in a different file. The Los Alamos data for the energetic electron fluxes (count rates) was already in this daily form. A separate file containing time synchronized solar wind speed, IMF B_z, and energetic electron flux values was also created to allow transfer function modeling. Once this was accomplished, analyses of the data began. The BMDP Statistical Software package used in this study was available on both systems. Also, files were transferable between the two computers. The availability of both systems for this project helped reduce time delays when one system was busy. This was helpful in that many analyses were necessary with a great deal of iterative interactions on the part of the author.

Detailed Preparations

As explained earlier, the data for this study were obtained from LANL and NSSDC in the form of tapes. The LANL tape contained the data for daily average count rates in five different energetic electron energy ranges (or channels). This tape was obtained first and was delivered to the AFIT school of engineering computer consultant who was able to successfully load the tape on the school's tape drive unit in the computer terminal room. Using a program to transfer data from a tape file to a disk file in the SSC's memory, the consultant then transfered the data to a personal file on the SSC which was subsequently copied by the author to enable later analysis via BMDP. The data supplied by LANL are explained in more detail in an article by Baker (Baker, 1982a:82-90).

The data supplied by the NSSDC (Omni Tape) also came in magnetic tape form. The problem with this file was its great size (approximately 5.2 megabytes). The process followed for "getting" the data from this tape was somewhat different from that followed for the LANL tape. The tape was loaded on the school's tape drive unit in the computer room. However, since its size was too great to be accommodated in a personal file, the consultant loaded it into a general purpose directory of the SSC's memory. This directory is purged every 48 hours, but its availability allowed the author enough time to write a small FORTRAN program which could access the data from the Omni Tape (as written in the general purpose directory) and then compress it into daily (24 hour) averages. Once this was done, the size of the new file was reduced by 1/24, and this made it manageable and small enough to be stored in the author's personal SSC account. All daily average parameters (from the original 37) not seen to be of any use to this study were discarded in order to further reduce the size of the file. For completeness program readom, a listing of the FORTRAN program written to compress the Omni Tape, is included in Appendix A of this report. Adequate comments are available within the program listing to enable the reader to understand what was done to actually read and compress the NSSDC data. Details of the data contained on the Omni Tape are contained in a separate set of articles (von Rosenvinge, 1982:1-9 and King, 1982:11-20).

A set of particulars concerning each tape's generation also accompanied them in the mail. This was both helpful and necessary in each case, since without knowledge of the format of the information on each tape, the writing of a program to read the data would have been impossible.

In order to perform a time series analysis using transfer functions, it was necessary to write another FORTRAN program which could read values from the NSSDC file (solar wind/IMF values) and the LANL file (electron flux values) and then store these values in a single time synchronized data file. This was required so that computation of the cross correlation functions required in transfer function modeling could take place. Only the values from overlapping days of the two files were read and stored, since the cross correlation between two time series only makes sense if the series are synchronized in time. Thus, progam combol read and stored 706 combined cases of data from May 8, 1983 to April 12, 1985. This encompassed approximately the last two years of the NSSDC data on solar wind speed and IMF and the middle two years of the LANL data on the energetic electron flux. This was more than sufficient to perform a suitable transfer function analysis. A copy of program combol is also included in Appendix B.

Missing Values

Some important points concerning the data should be mentioned which have a direct bearing on this study. On both tapes some data were naturally missing. This is of course due to the inherent problems with trying to obtain satellite readings via sensors which can malfunction. Missing data can have serious implications for a time series analysis which may only be accomplished on a set of equally spaced (in time) readings. To remedy this problem, two different methods were used. Regarding the energetic electron data (the tape from LANL), missing values were estimated by BMDP program AM, "Description and Estimation of Missing Data" using the SINGLE method whereby "a value for a variable is estimated by regressing that variable on the variable with which it is most highly correlated" (Dixon et al, 1985:217-234). This seemed like a logical method since the data contained five different electron flux channels with at least some amount of presumable correlation between the channels. The use of program AM was possible because there was a total of only 32 days over the four year period covered by the data where missing values occurred. Also, the smaller size of the LANL file made it easy to apply program AM. The majority of these missing values were in August of 1982 (17 were missing) which was subsequent cause for disregarding the data from 1982 for this study. The estimated values provided by program AM were then substituted into the data set to allow analysis.

The NSSDC data, however, presented a slightly different problem. The massive size of the Omni Tape made its data intractable as far as using BMDP program AM. Therefore, the author decided that the best way to handle missing data on the Omni Tape was to allow program readom to store the last computed daily average as the new daily average if an entire day's set of hourly readings was missing. Also, if only part of one day's hourly readings was available for averaging (say only 10 hourly readings instead of the usual 24 for one day), then those readings which were available were averaged and taken to be the daily average value. Again, only in the case where an entire day's set of hourly readings was missing was the previous day's average substituted. With the data set filled in, the analysis could begin. The data files along with the BMDP instruction files were easily transfered back and forth between the SSC and the Cyber.

Discarded Data

One final point should be made. As mentioned earlier in this chapter, only about the last three years of the data from the LANL tape were used. This was due to the fact that the LANL tape contained the majority of its missing values (17 out of 32) in the first year of the data (eg., in 1982). Thus, to reduce the effect of substitution of estimated missing values, this data was discarded. In addition, since the LANL data ended on May 6, 1986, it was decided to discard all data up to May 8, 1983 which allowed the analysis of precisely the last three years of the data (1095 days). It was felt that the analysis of the most recent data would allow the development of the most accurate and up to date time series models.

In the case of the Omni Tape, only the last two years were used for the transfer function modeling (May 1983 to April 1985) because this gave the maximum overlap of the LANL data. The reader will recall from earlier discussions that time synchronized data from two series is necessary in order to do transfer function modeling. The overlap occurred between the dates mentioned above and was more than adequate to perform the analysis.

With regard to the actual data which was used, Appendix C is a FORTRAN program which was composed to write out all the pertinent data utilized in this study. Appendix D is the result of this program: a complete listing of the data.

Software and Computers

BMDP2T, the "Box-Jenkins Time Series Analysis", was the program used to perform all the analyses (Dixon and others, 1985:639-660). The initial step in running BMDP2T is to compose a small computer program containing the necessary instructions to perform a basic examination of the data (Dixon and others, 1985:640). The stored data files are accessed by either including them directly as part of the instruction file (as called for on the Cyber) or by accessing them external to the instruction file via a data file identification statement (as called for on the SSC). The basic examination exhibits the data for each time series in a graph of the daily flux values over time (a time plot). In addition, it performs an initial calculation of the autocorrelation and partial autocorrelation functions of the data so as to help define an initial guess at a prediction model. Such terms as "autocorrelation function" along with the details of the Box and Jenkins time series analysis methods will be given later on in the Detailed Methodology chapter of this paper. For now, it is sufficient for the reader to understand that this type of analysis combines a certain amount of precision with an equal amount of "art" and "gut feeling". Said more formally, although this method does have some "hard rules", its application to real data involves some interpretation. Time series analysis is an iterative and time consuming method. The prediction models derived from a time series analysis are not obtained by a definite set of procedures. Moreover, there may be more than one model which is appropriate for the data depending on the total history or extent of the data which is used. Time series models are always subject to updating when new data becomes available to add to the history of the series.

Two computer systems were used in this research. The CDC Cyber 6000 provides the fastest processing capability regardless of the task (usually no more than 30 seconds), but it is a bit more restrictive than the SSC Unix system which has better manipulative and naming capabilities for files. The BMDP Statistical Software package is readily available on both systems. The current BMDP manual is the 1985 reprinting (Dixon and others, 1985). Documentation for the BMDP programs as implemented on either system is available. For the SSC, a file named bmdp.doc (documentation file) is made available to the user when the entire set of BMDP programs is initially accessed. This file contains helpful information concerning how to actually run a given BMDP program. Included are tips to increase memory size (RAM) alotted for each program so that all appropriate processing may be performed as necessary. This one particular feature was utilized often due to the size of the data sets involved along with the amount of processing. A file similar to the bmdp.doc file is also available for the Cyber implementation of BMDP. The on-duty computer consultant can obtain a hard copy of this file for anyone desiring it as well as show the user how to access the BMDP software on either the Cyber or the SSC.

IV. Detailed Methodology

The Box and Jenkins Method

The book entitled *Time Series Analysis: Forecasting and Control* by G.E.P. Box and G.M. Jenkins (1976) is the backbone for the analysis in this report. The basic ideas in a time series analysis are presented in the first chapter of this book (Box and Jenkins, 1976:1-19). As compared to its more classical statistical counterparts, this method is relatively unknown. Therefore, a few of the fundamental ideas in time series analysis will be discussed along with some of the models which form a framework for a time series forecast function. In addition, the reader will be made aware of how a time series transfer function is derived. Those with a deeper interest in the workings of the Box and Jenkins method are strongly urged to obtain a copy of the text for their own perusal.

Time Series

A series of recorded values of a given random variable taken at equally spaced intervals of time is a *discrete time series*. Since many entities in the world can be termed random variables, analysts thus have the opportunity to record periodic values of these entities and study them as they behave over time (ie., in a time series).

A time series analysis has three important "areas of application" as mentioned in the introductory chapter. Two of these have direct bearing upon this study and are noted as

> (1) The forecasting of future values of time series from current and past values.
> (2) The determination of the transfer function of a system--the determination of a dynamic input-output model that can show the effect on the output of a system subject to inertia, of any given series of inputs (Box and Jenkins, 1976:1).

Recalling the introduction, the reader will note that the objectives of this study were to derive prediction (forecasting) models for energetic electron flux and also to derive relationships (transfer functions) between the IMF B_z, the solar wind speed, and the energetic electron flux. This second objective is undertaken with the IMF or the solar wind speed viewed as the input series and the energetic electron flux in any given channel viewed as the output. As noted by Box and Jenkins, a good forecast function can provide the basis for correct planning and control (Box and Jenkins, 1976:1). In this particular case, a good forecast function would allow optimal control of spacecraft and sensors which may be exposed to predicted dangerous levels of energetic electron flux. Also, a valid transfer function would help to establish more firmly the theoretical relationship between the IMF, the solar wind, and the energetic electron flux.

Fundamentals

A random variable (rv) of interest whose values have been recorded over equispaced intervals of time might be designated as z. If we denote the present time as t, then z_t represents the currently recorded value for the rv of interest. Similarly, one might denote the last recorded value of z prior to the current value as z_{t-1}. The value recorded two time periods prior to the current would be z_{t-2} and so on. The elapsed time period between which the readings of the variable are made can take on any value. Often times, it will be dictated by the apparatus used to measure the variable (in this case, the time between satellite sensor measurements of the energetic electron flux, the IMF component values, and the solar wind speed). The important point is that the individual discrete readings of the variable must be equispaced over time.

What is sought, then, is a forecast of the value of the variable at some future time t+1. One might denote this forecast as $\hat{z}_t(1)$ where $\hat{z}$ (pronounced zee-hat) is the estimate of the series' value at time t+1. According to Box and Jenkins, the objective is to derive a forecast function such that "the mean square of the deviations $z_{t+1} - \hat{z}_t(1)$ between the actual and forecasted values is as small as possible for each lead time 1" (Box and Jenkins, 1976:2).

In addition, it is necessary to specify the accuracy of each forecast function so that "the risks associated with decisions based upon forecasts may be calculated" (Box and Jenkins, 1976:2). These accuracies are typically specified by calculating probability limits (confidence intervals) on either side of each forecast value (Box and Jenkins, 1976:2). Thus, if one desired an estimate for the energetic electron flux two days in the future based upon the present history of the data, the forecast model employed might yield a value (with arbitrary units) of, say, 3.6 +/- 1.2 where the 1.2 on either side of the estimated 3.6 might represent the standard error for the estimate. This being the case, the given estimate along with the stated +/- 1.2 standard error interval would represent a confidence interval (or probability limits) for the estimate of approximately 68%. A 95% confidence interval estimate would then be represented by (approximately) 3.6 +/- 2.4. Obviously, if one desires a greater accuracy, then the confidence interval for the estimate has to become broader. In addition, the farther into the future that a prediction is desired, the broader the confidence interval for such an estimate will be.

To draw a parallel between what has been discussed thus far and the data presented here for analysis, Figure 1 is shown below. In it is a plot

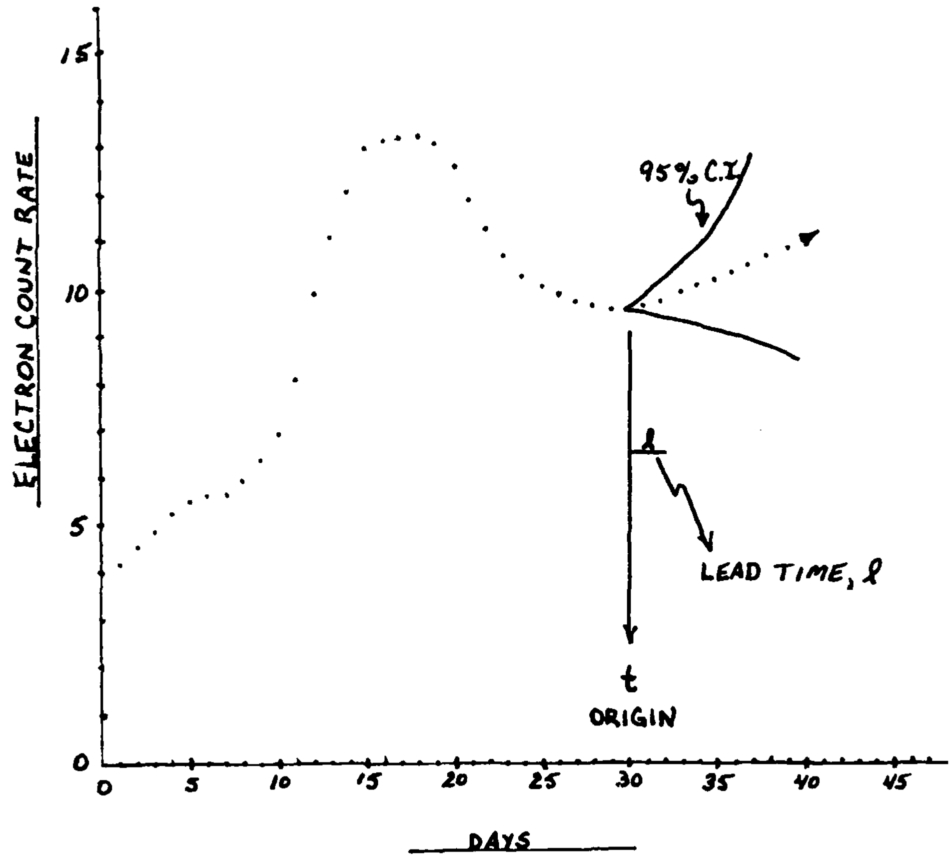


Fig 1. Hypothetical Time Series Plot
(Box and Jenkins, 1976:2)

of a hypothetical time series for energetic electron flux readings recorded over a period of 30 days. If the present time is t, then what is desired is an estimate of the series' value at time t+l where l is perhaps two days hence. Note that the confidence intervals shown illustrate that the farther into the future one estimates, the broader the confidence interval becomes. Likewise, the greater the specified accuracy of the estimate at any desired time in the future, the broader the interval.

Notice that the word "probability" is used in the above discussion. This is because a time series model is a probabilistic or <u>stochastic</u> model as opposed to a deterministic model. In a stochastic model, one calculates "the <u>probability</u> of a future value lying between two specified limits" (Box and Jenkins, 1976:7). It is also important to note that the <u>actual</u> time series recorded is just one of an infinite number of possible series which could have been generated by the given stochastic model for the series (Box and Jenkins, 1976:7).

<u>Categories of Processes</u>

Generally, there are two different classes of time series models. <u>Stationary</u> models derive their name from the fact that the series they represent tend to be in equilibrium about a constant, never-changing, mean level (Box and Jenkins, 1976:7). A <u>nonstationary</u> model, however, is used to represent a series (also called a process) where there is no natural mean or equilibrium point (Box and Jenkins, 1976:7). As will be explained later, a given time series usually reveals whether or not it is stationary when its autocorrelation function is plotted. If the autocorrelations decrease quickly as the lag, k, increases, the series is considered stationary. In all the cases studied here, the series were stationary. A particularly wide class of processes which "provides a range of models, stationary and non-stationary, that adequately represent many of the time series met in practice" is known as the autoregressive-integrated moving average processes or ARIMA processes (Box and Jenkins, 1976:8).

<u>Operators and Assumptions</u>

In describing the primary time series models, it is necessary to discuss a couple of the basic operators used. Perhaps the two most important are the backward shift operator denoted by B and the backward difference operator denoted by ∇ (pronounced "del"). These two operators are defined as follows:

$$Bz_t = z_{t-1}$$

and

$$B^m z_t = z_{t-m}$$

$$\nabla z_t = z_t - z_{t-1}$$

$$= (1 - B)z_t$$

and

$$\nabla^m z_t = z_t - z_{t-m}$$

Note that the backward difference operator can be represented in terms of the backward shift operator. Also, the parameter m may be thought of as the "power" of the operator.

In addition to these basic operators, the time series models used by Box and Jenkins view the output of any given time series as being generated from an input series of independent shocks, a_t, with the shocks being random drawings from a fixed normal distribution of mean zero and variance σ_a^2. "Such a sequence of random variables a_t, a_{t-1}, a_{t-2},... is called a white noise process by engineers" (Box and Jenkins, 1976:8). When the model for the series under study is finally fitted, the white noise represents the residuals or the differences between the actual series values and those which the model would predict at the same points in time at which the actual series values were recorded. This sequence of random white noise numbers is transformed into the observed output time series, z_t, by another operator known as a linear filter, $\psi(B)$ where B is again the backshift operator and the notation $\psi(B)$ indicates that varying powers of backshifting are used throughout the operator. For example, one might represent a time series of interest by the model

$$z_t = \mu + \psi(B)a_t \qquad (1)$$

where the filter, $\psi(B)$, is

$$\psi(B) = 1 + \psi_1 B + \psi_2 B^2 + \ldots$$

A finite or infinite/convergent set of parameters ψ_1, ψ_2, ... is said to classify the process as stationary. In this case, the value μ is thus the natural mean or equilibrium point for the process under study. If the set of parameters is infinite and not convergent however, then the process is said to be nonstationary, and in this case, μ is only a "reference point for the level of the process" (Box and Jenkins, 1976:8-9).

Specific Models

An autoregressive model for a time series is expressed "as a finite, linear aggregate of previous values of the process and a shock a_t" (Box and Jenkins, 1976:9). If the values of a process are z_t, z_{t-1}, z_{t-2}, ... as before and the deviations of each of these values from the mean, μ, are represented by $\tilde{z}_t$, $\tilde{z}_{t-1}$, $\tilde{z}_{t-2}$, ... then an autoregressive (AR) model of order p is represented by

$$\tilde{z}_t = \phi_1\tilde{z}_{t-1} + \phi_2\tilde{z}_{t-2} + \ldots + \phi_p\tilde{z}_{t-p} + a_t \qquad (2)$$

which as the reader will note, is simply a regression equation where the value $\tilde{z}_t$ is regressed on previous values of itself. The term a_t is analogous to the error term in a regression and in this context represents the random shock input in the current time period. Thus, the reason for the name autoregressive becomes apparent (Box and Jenkins, 1976:9). The autoregressive operator may then be defined as

$$\phi(B) = 1 - \phi_1 B - \phi_2 B^2 - \ldots - \phi_p B^p$$

and in doing so, the autoregressive model above may be rearranged and "written economically" so that

$$\phi(B)\tilde{z}_t = a_t \text{ (Box and Jenkins, 1976:9)}$$

As Box and Jenkins point out, it is not difficult to see that the autoregressive model, (2), is a special case of the linear filter model, (1), discussed previously (Box and Jenkins, 1976:10). To show this, the z terms on the right hand side of (2) may be progressively replaced with their expanded values according to the model. For instance, the term $\tilde{z}_{t-1}$ on the right side of (2) may be replaced and thereby eliminated by substituting

$$\tilde{z}_{t-1} = \phi_1\tilde{z}_{t-2} + \phi_2\tilde{z}_{t-3} + \ldots + \phi_p\tilde{z}_{t-p-1} + a_{t-1}$$

Similar substitutions for $\tilde{z}_{t-2}$, and so on will eventually yield an infinite series in the a's (Box and Jenkins, 1976:10). Having made all the substitutions, one can thus see that not only is

$$\phi(B)\tilde{z}_t = a_t$$

as already pointed out, but also

$$\tilde{z}_t = \psi(B)a_t \qquad (3)$$

Therefore, it is obvious that

$$\psi(B) = \phi^{-1}(B) \qquad \text{(Box and Jenkins, 1976:10)}$$

The reader will note that the utility of using $\phi(B)$ over $\psi(B)$ in model development stems from the fact that while

$\psi(B)$ has an infinite number of terms, $\phi(B)$ is economically represented by just p terms.

Whereas the autoregressive model could express $\tilde{z}_t$ as the sum of an infinite series of weighted shock values shown in Eq (3) above, the <u>moving average</u> model expresses z_t as the sum of a <u>finite</u> series of weighted shocks. The model is thus expressed as

$$\tilde{z}_t = a_t - \theta_1 a_{t-1} - \theta_2 a_{t-2} - \ldots - \theta_q a_{t-q} \quad (4)$$

and is called a <u>moving average process of order q</u> or MA. The MA operator is thus defined as

$$\theta(B) = 1 - \theta_1 B - \theta_2 B^2 - \ldots - \theta_q B^q$$

and the MA model may thus be written more succinctly as

$$\tilde{z}_t = \theta(B)a_t \quad (5) \qquad \text{(Box and Jenkins, 1976:10)}$$

The <u>mixed autoregressive-moving average</u> (ARMA) model is used to achieve greater flexibility in the fitting of models to a given time series (Box and Jenkins, 1976:11). This model consists of the addition of the terms from the right side of Eq (4) to those from the right side of Eq (2) to yield

$$\tilde{z}_t = \phi_1 z_{t-1} + \ldots + \phi_p z_{t-p} + a_t - \theta_1 a_{t-1} - \ldots - \theta_q a_{t-q} \quad (6)$$

or

$$\phi(B)z_t = \theta(B)a_t \qquad (7)$$

For discrete data such as this study will analyze, the transfer function between an output time series, Y_t, and an input time series, X_t, may be effectively represented by a difference equation involving backward shift operators which operate on both the input and the output series (Box and Jenkins, 1976:13). This type of representation is given as

$$\begin{aligned}(1 - \delta_1 B - \ldots - \delta_r B^r)Y_t &= (\omega_0 - \omega_1 B - \ldots - \omega_s B^s)X_{t-b} + a_t \\ &= (\omega_0 B^b - \omega_1 B^{b+1} - \ldots \\ &\qquad - \omega_s B^{b+s})X_t + a_t \qquad (8)\end{aligned}$$

or

$$\begin{aligned}\delta(B)Y_t &= \omega(B)B^b X_t \\ &= \Omega(B)X_t\end{aligned}$$

where the parameter b is the number of time periods (dead-time or pure-delay) between the input value and its observed effective output. The parameters r and s express the order of the left side and right side operators in the above difference equation and a_t is a random noise component. Another way of stating the relationship is that Y_t and X_t are linked by a linear filter such that

$$Y_t = v_0X_t + v_1X_{t-1} + v_2X_{t-2} + \ldots + a_t \quad (9)$$

or

$$Y_t = v(B)X_t + a_t$$

where v(B) is the <u>transfer</u> <u>function</u> and can be stated more explicitly as

$$v(B) = v_0 + v_1B + v_2B^2 + \ldots \quad (10)$$

Thus v(B) is simply a ratio of the right side operator of order s and the left side operator of order r in the difference equation (8). The reader should take note of the fact that for an input-output relationship in which the dead-time between the input and its observed output is equal to b time periods, the first b weights in equation (10) (eg., v_0, v_1, ... , v_{b-1}) are zero (Box and Jenkins, 1976:14).

With regard to the data available for this study, it is hoped that a model of the types discussed here will fit. The tasks thus implied with respect to the objectives listed in the introduction to this report are as follows:

(1) Develop, if possible, a time series model of the type AR, MA, or ARMA for each of the energetic electron channels discussed.
(2) Use the developed models to make forecasts of the flux values and compare these forecast values to the actual values to assess the model's utility in prediction.
(3) Develop models of the same type for solar wind and IMF B_z in an attempt to show that the solar wind speed or the IMF B_z (considered as inputs) are related to the energetic electron flux levels (considered as outputs) via a transfer function.

Deducing the Model

The "precise steps" to be followed in deriving these models have so far not been mentioned. As stated in the Chapter III, the Box and Jenkins method combines a certain amount of precision with an equal amount of art. The "precision" in deriving the appropriate model(s) comes with the determination of the autocorrelation and partial autocorrelation functions. The "art" comes in the form of how well one can deduce the type of model from these special functions. Deducing the model is an iterative and time consuming process which involves close scrutiny of these functions as many models are fitted to the data until eventually (and hopefully) one of the fitted models leads to a reasonably small set of residuals.

Thus, a necessary first step is the determination of the autocorrelation functions for the time series of interest. For a series with N discrete values, the kth lag autocorrelation is defined as

$$r_k = C_k/C_0 \qquad (11)$$

where

$$C_k = \frac{1}{N}\sum_{t=1}^{N-k}(z_t - \bar{z})(z_{t+k} - \bar{z}), \quad k = 0,1,2,\ldots,K \qquad (12)$$

is an estimate of the autocovariance at lag k, and $\bar{z}$ is the mean of the time series (Box and Jenkins, 1976:32). The lag (k) has to do with the number of time periods between recorded values in the process. For instance, if the series of interest consists of 1000 daily readings (eg., readings taken precisely 24 hours apart), then the autocorrelation at lag k = 2 days would consist of the sum of all autocovariances of readings which lag each other by exactly two days (C_2) divided by the sum of all autocovariances which lag each other by exactly zero days (C_0). The reader may also note that C_0 is nothing more than the simple variance of all the observations. Thus, the autocorrelations for any lag from zero on up to N - 1 may be calculated by the formulas (11) and (12). The display of these autocorrelations in a bar chart showing the computed values plotted against progressively higher lags forms what is commonly refered to as the <u>autocorrelation function</u>.

Figure 2 is an example of such a chart. The autocorrelation function along with a nearly identical illustration of the partial autocorrelation function (Figure 3), form the fundamental tools in the iterative procedure of identifying the model which fits a given time series. Whereas the shape of the autocorrelation function allows a guess as to the type of model which should be entertained (eg., AR, MA, ARMA, etc.) the <u>partial autocorrelation function</u> is used to help determine the <u>order</u> of the model. Box and Jenkins liken the use of the partial autocorrelation function to that of "deciding on the number of independent variables to be included in a multiple regression" (Box and Jenkins, 1976:64). They also include a detailed discussion of how to obtain the partial autocorrelation function (Box and Jenkins, 1976:64-65). Basically, the partial autocorrelation function shows the autocorrelation at higher lags after the effects of variables up to a certain lag have been regressed out. Therefore, the partial at lag 4 is the autocorrelation at lag 4 having accounted for the effects of lag 1, 2, and 3.

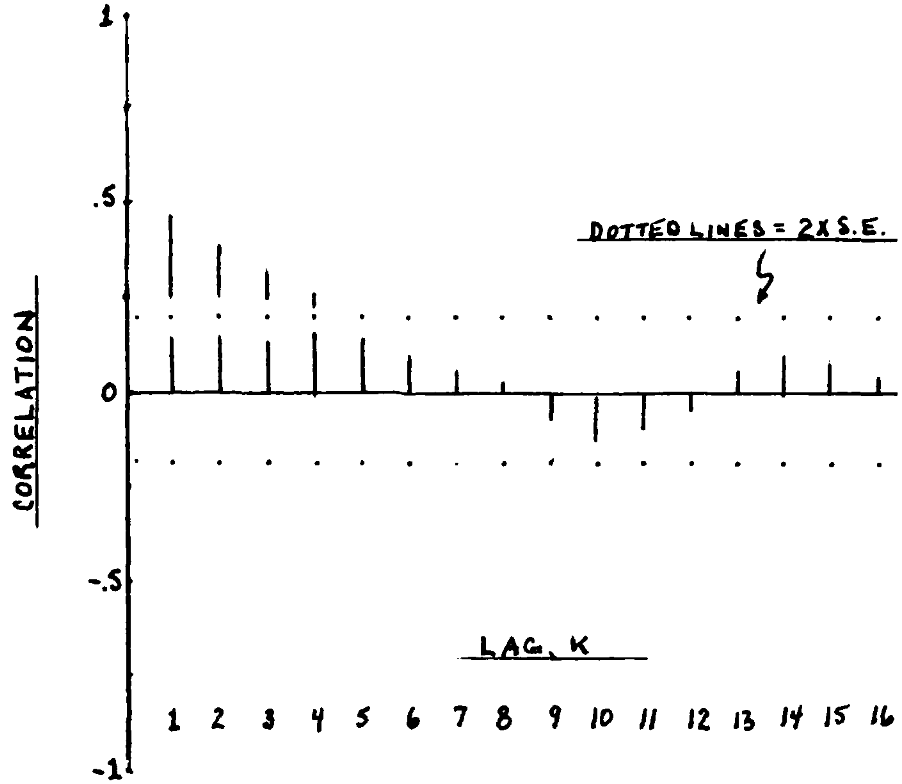


Fig 2. Example Autocorrelation Function

An example to clarify the above discussion is justified. Referring to Figure 2, let the assumption be that the autocorrelation function shown represents a time series which is under study. One can see that the locus of points formed by an imaginary curve connecting the tops of the charted values has a shape which is characteristic of some sort of exponential function. According to Box and Jenkins, this is a classic

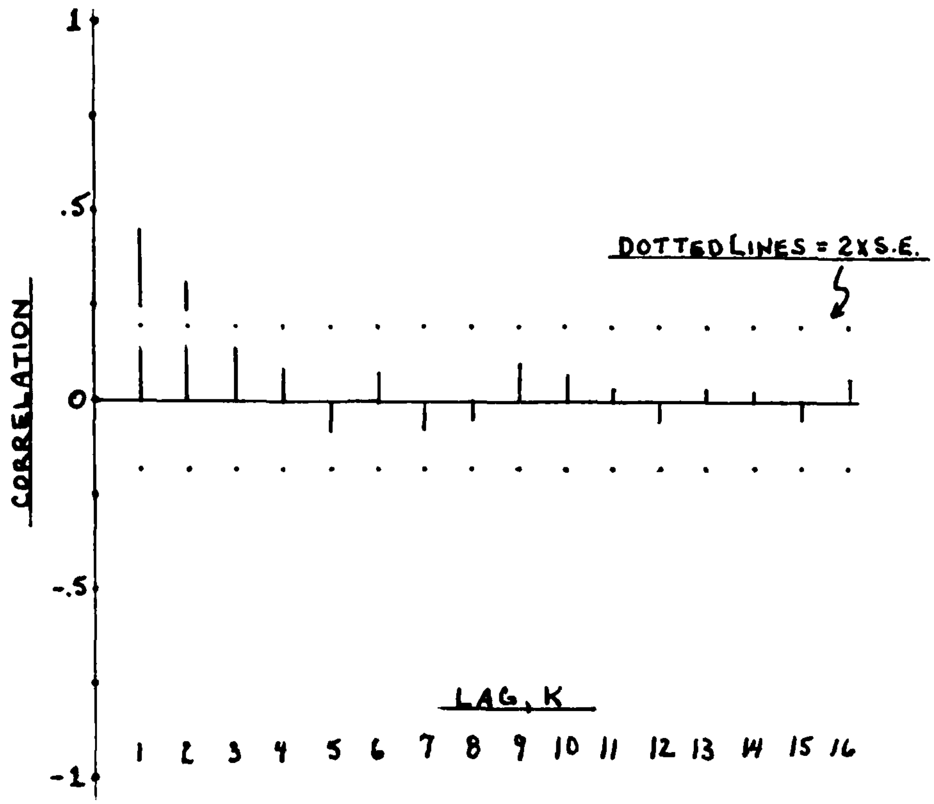


Fig 3. Example Partial Autocorrelation Function

indication of an autoregressive process. Notice also that the values of the autocorrelations drop off rapidly as the lag, k, increases. This is indicative of a stationary process as was discussed earlier in this chapter. Thus, the general type of model has been deduced. The problem remaining is to specify the order of the model.

One point should be made before determining the order. Box and Jenkins give formulas for calculating the <u>standard error</u> of the autocorrelation or partial autocorrelation at any chosen lag (Box and Jenkins, 1976:34,65). Twice the standard error is chosen as the level of significance for any calculated autocorrelation or partial autocorrelation value. In other words, if the computed correlation value for any given lag k does not exceed twice the standard error, then that correlation is effectively regarded as having a value of zero. Again referring to Figure 2 and 3, the dotted lines on each bar chart reflect twice the standard error at each lag. Observe that even though noticeable values have been computed past the second lag on the partial autocorrelation plot, in terms of the indicated standard error they are insignificant and thus are regarded as zero. In viewing the partial autocorrelation function (Figure 3), one can see that the function shows a definite cutoff after the lag k = 2 indicating that the process being analyzed is very likely a second order series. This being the case, the model would be initially estimated as AR(2) and would thus have the form

$$\tilde{z}_t = \phi_1 \tilde{z}_{t-1} + \phi_2 \tilde{z}_{t-2} + a_t$$

Similar procedures are followed for all time series. The shape and character of the autocorrelation and partial autocorrelation functions are thus the determining factors in the initial guess as to the model type. Box and Jenkins devote chapter 6 to the discussion of how to identify the type of model along with estimating its parameters (ϕ_1 and ϕ_2 in this case) (Box and Jenkins, 1976:171-207).

The reader may now be wondering how the parameters of the entertained model are calculated. As already stated, a significant amount of detail is contained in the text regarding model parameter estimation (Box and Jenkins, 1976:187-193,208-284). Let it suffice to say that a modern statistical software package such as BMDP allows the estimation of these parameters with a minimum of effort (Dixon and others, 1985:644-645). The main task of the analyst is to merely decide on the type and order of model he/she would like to fit to the data.

<u>Model Checking</u>

After the model is identified and its parameters estimated, the model must then be tested to see whether a good fit has indeed occurred. If the fit is good, then the model may be retained for forecasting. If not, then a new model must be entertained and likewise tested. This process continues until a good fit is obtained. Box and Jenkins refer to the testing of the model as "model diagnostic checking" (Box and Jenkins, 1976:285-299). One of two methods they describe to do diagnostics is that of displaying "the autocorrelation function of the residuals" (Box and Jenkins, 1976:285).

Earlier in this chapter, it was stated that the time series models of Box and Jenkins employ a white noise process (a series of normal shocks with mean zero and variance σ_a^2). In so doing, this white noise is transformed into a model which adequately represents the series under study by linear filtering. The model thus derived can be rearranged so that estimated values of the originally input white noise process may then be computed. When this is done, the estimated white noise (or shocks) are designated as a_t and are also called the residuals (Box and Jenkins, 1976:289). The plot of the autocorrelation function of these residuals is one of the primary methods used to diagnose the adequacy of the model. If the autocorrelations of the residuals are significant at any lag, then a better model can most likely be found. The text suggests ways to use the residual autocorrelations to implement a better model (Box and Jenkins, 1976:298-299). If they are insignificant, then the model is adequate and may be used for forecasting. Again, twice the standard error determines the significance of the computed autocorrelation at each lag. This method is easily accomplished with the BMDP package and used exclusively in this study.

To recap, the building of a time series model is an iterative process (Box and Jenkins, 1976:19). In most cases, a five step process takes place:

(1) The general class of models is postulated. A plot of the actual time series may reveal the type of model to the "practiced eye".
(2) The initial model to be entertained is then identified from the autocorrelation and partial autocorrelation functions.
(3) The parameters of the entertained model are estimated.
(4) The model is diagnostically checked by examining the autocorrelation of the residuals computed from the newly fitted model with its estimated parameters.
(5) If the model's residuals are insignificant, the model may be used for forecasting. If not, a new model must be suggested based on the residual autocorrelation plot examination and steps 2 through 5 reaccomplished until a suitable model is found.

Transfer Function Models

As discussed earlier, a transfer function links the output time series of a given dynamic system with the input time series to that system. From this perspective, one may be better able to understand the actual dynamics of the system in a purely mathematical sense if not in the physical sense. Such mathematical insights are almost certain to eventually lead to better physical understanding as well.

Box and Jenkins go into considerable detail on the subject of transfer function modeling in chapters 10 and 11 of their text (Box and Jenkins, 1976:335-420). In perhaps their best illustration of how a transfer function model is formed, they exhibit the necessary steps in an example problem concerning the output of carbon dioxide (CO_2) from a gas furnace which has influential inputs of air and methane (CH_4) (Box and Jenkins, 1976:381-386). In a very fortunate coincidence, the BMDP manual, in discussing their own example problem to illustrate transfer function modeling, uses the same gas furnace problem of Box and Jenkins (Dixon and others, 1985:650-655). Thus the reader is able to match the logic used in forming the computer solution to the problem with the theoretical logic contained in Box and Jenkins. For this reason, further discussion of transfer function modeling will be limited to the main tool of analysis in this method which is the <u>cross correlation function</u>. The reader desiring more detail on transfer function modeling is therefore urged to obtain a copy of Box and Jenkins and the BMDP manual.

Just as the autocorrelation and partial autocorrelation functions yield much information about a given single time series, the cross correlation function reveals much about the relation between any two time series. A cross correlation between two time series may be appropriate at any time one believes that the two interact in some sort of a dynamic system. As brought out in the literature review, this is the belief concerning the energetic electron flux levels and the solar wind speed/IMF B_z. Formulae for determining the cross correlation at any desired lag between any two dynamically related time series are contained in the text, and the reader will notice that they are very similar to those given for determining the autocorrelations (Box and Jenkins, 1976:374). These formulae are as follows:

$$r_{xy}(k) = c_{xy}(k)/s_x s_y \qquad (13)$$

where

$$c_{xy}(k) = \frac{1}{n}\sum_{t=1}^{n-k}(x_t - \overline{x})(y_{t+k} - \overline{y}) \quad k = 0,1,2,\ldots \qquad (14)$$

or

$$c_{xy}(k) = \frac{1}{n}\sum_{t=1}^{n+k}(y_t - \overline{y})(x_{t-k} - \overline{x}) \quad k = 0,-1,-2,\ldots \qquad (15)$$

In equation (13), $r_{xy}(k)$ is the cross correlation at lag k between an input series x and an output series y. The term c_{xy} is the cross covariance between the two series, and equations for obtaining it are shown in (14) and (15) where n stands for the number of pairs of series values (x_t, y_t) and $\bar{x}$ and $\bar{y}$ are the respective series means.

Once the cross correlations at each lag are determined, they are plotted in a bar chart which is very similar to Figures 2 and 3 shown earlier in this chapter. This plot is referred to as the <u>cross correlation function</u>. From this chart the model is tentatively identified. An estimation of the dead-time parameter, b, may be made directly from the cross correlation function along with estimates of the parameters r and s from the difference equation (8). The parameter b is usually set equal to the value for the first positive lag at which a significant cross correlation occurs. Thus, if the first significant cross correlation for two dynamically connected series occurs at lag k=2, then b is set equal to 2. The model estimation and final identification process then proceeds iteratively as it did for the single series models.

One final point which should be made is that the method of transfer function modeling used by BMDP2T is that of "prewhitening the input" (Box and Jenkins, 1976:379-380). This method essentially recognizes that two series which are dynamically related also have an element of noise involved. Thus, any output series modeled from a related input series is influenced not only by the input but by noise as well. The amount of noise present in the model can thus be an indicator of how deeply related any two series are. Said another way, the greater the noise component, the less influence the input has on the output series. This noise component is modeled in the transfer function models determined in this study. Also, and perhaps more importantly, the prewhitening method is used since it can provide initial rough estimates of the v_k parameters of the transfer function equation (10) (Box and Jenkins, 1976:380). With these initial rough estimates, the model fitting procedure can usually be implemented in a more efficient manner.

BMDP Examples

Appendix E of this report contains three example time series analysis problems as performed using program

BMDP2T. Example 1 was done on the SSC, while Example 2 and Example 3 were done on the CYBER.

Example 1 is typical of the early stages of identification of a model for any given time series. In this particular run, energetic electron channel SEEI is analyzed, and the plot of the autocorrelation and partial autocorrelation functions indicate a stationary series with autoregressive tendencies. In explanation, the autocorrelation function decreases rather quickly as the lag, k, increases, while the partial autocorrelation function has a definite cutoff after lag k = 2 (page 138). This would indicate a probable best fit of an AR model with first and second order terms. However, the analyst, not being seasoned in the "art" of time series analysis, decided to attempt to fit an AR model with first and 27th order terms as shown in the ARIMA paragraph on page 139 of Appendix E. On the page 140, the results of the attempted fit yield a model with estimated parameters of 0.7856 and 0.1039 (by the backcasting method). The reader will notice that the T-RATIO of the first order is very high (23.16) indicating that the model should most definitely contain a first order AR term. However, the T-RATIO of the 27th order is only 1.91 indicating that perhaps this parameter is inappropriate. Nevertheless, if one believes in the validity of the parameters as estimated, the model would be

$$(1 - 0.7856B - 0.1039B^{27})\tilde{z}_t = a_t$$

where $\tilde{z}_t$ represents the current estimated deviation of SEEI from the series mean. Using the plot of the autocorrelations of the residuals, a_t, resulting from the attempted fit of the model (page 141), the reader can see that the fit is inappropriate since the residuals show significant (ie., greater than two standard errors) autocorrelations at lags k = 1, 2, and 4. Thus, the analyst should try to fit a model which better explains the data. The best guess of the author would be, as stated earlier, an AR model with first and second order terms. This iterative identification process is an illustration of the "art" of time series analysis. The person with a better of grasp of this kind of analysis will be able to converge to a more appropriate model in a fewer number of tries.

Example 2 (page 144) is much the same as Example 1. Here the series under study is energetic electron channel SEEIII. The analyst has already examined the autocorrelation and partial autocorrelation functions of the series and thus has decided to spare computer processing time by not including the autocorrelation functions in the analysis. In the ARIMA paragraph on page 145, an attempt is made to fit an ARMA model with AR terms of first and 27th order along with an MA term of first order. Using the parameters estimated by the backcasting method, the model is

$$(1 - 0.9850B - 0.1701B^{27})\tilde{z}_t = (1 + 0.1227B)a_t$$

The fit of this model is somewhat better than that of Example 1 as evidenced by the lesser number and magnitude of the significant autocorrelations of the residuals (page 147). The analyst may want to accept the fitted model or reiterate and attempt to fit a different one. A forecast of future values is also made (page 148) based upon the model as estimated above. The reader can see that the standard error of the forecast is 0.02037 for the initial day. It should also be noted that the standard error increases as one attempts to forecast farther into the future. The analyst may also use the forecast paragraph to check the accuracy of the fitted model by requesting that the forecasting take place over a period for which actual series values are available. In the example, days 345 through 365 have actual values which may be compared to the forecast values.

Example 3 is a transfer function model visualizing the IMF B_z component as the input series and the SEESSD channel as the resulting output. The important point to note here is that the plot of the cross correlations (page 153) shows only one significant value at lag $k = 1$. Thus, the analyst might surmise a very simple transfer function model with the delay parameter, b, set equal to 1 and parameters r and s (the left side and right side orders of the difference equation (8)) both equal to zero. Hence, (r,s,b) would be (0,0,1). The analyst would then use the procedure described in Chapter 10 of Box and Jenkins to derive initial estimates of of the operators $\delta(B)$ and $\omega(B)$ (Box and Jenkins, 1976:345-351). With these initial estimates, BMDP2T is then run interactively in a series of trial and error steps until a suitable model is identified (Dixon and others, 1985:650-656). The iterative part of developing a transfer function model is mainly contained in deriving a good model for the input series and for the noise component. Also, as discussed in Box and Jenkins, there may be more than one transfer function model. That is to say, r, s, and b may be set equal to other values and other models may be fit with equally good (or poor) results (Box and Jenkins, 1976:387). The final transfer function model derived here and used to obtain the forecasts on page 161 is

$$Y_t = -24.01BX_t + (1/(1 - 0.6125B - 0.1973B^{27}))a_t$$

The terms in parentheses represent the noise portion of the model. The first term on the right hand side represents that portion of the output series (where Y_t is the output or SEESSD in this case) which may be explained directly by the input series (where X_t is the input series or IMF B_z).

Again, the interested reader is strongly advised to obtain a copy of both the text and the BMDP manual in order to fully grasp the time series analysis procedures. The results of the Box and Jenkins method as applied to the data received will now be presented.

V. Results

Individual Channel Models

Tables I - IV beginning on the next page summarize the time series analysis results for each of the energetic electron channels. In other words, the series of discrete daily average values from each channel (SEESSD, SEEI, SEEII, and SEEIII) were separately analyzed in order to try to fit an appropriate model to each individual channel.

The first thing the reader will notice is that no individual models for SEEIV are included. The reason for this is simply that the data in the SEEIV channel did not lend itself to this type of analysis. SEEIV contains recorded values of energetic electron count rates in the range of 9.7 - 16 MeV. An initial examination of the SEEIV data over the last 765 days (from April 84 until May 86) revealed that the autocorrelations were effectively zero at all lags save one: At lag k = 35, the computed autocorrelation was 0.199 which was significant. Likewise, the computed partial autocorrelations were all effectively zero except at lag k = 35 where the computed value was once again 0.199. The fact that nothing could be said about the SEEIV data due to the lack of any identifiable

TABLE I

Suggested Models for the SEESSD Channel (1.2 - 1.8 MeV)

Data Length	Suggested Model	S.E.
100 days (Jan 86-May 86)	$(1 - .8250B - .1776B^{27})z_t = (1 + .4401B)a_t$	157.49/ 174.29
365 days (May 85-May 86)	$(1 - .7470B - .2329B^{27})z_t = (1 + .2727B)a_t$	227.34/ 241.04

Approximate series mean = 224.49

pattern in the autocorrelations meant that this data, by itself, could not be analyzed via time series analysis. However, transfer function modeling of this channel was possible and will be shown later. The reader will recall that the autocorrelation functions are the primary tool in identifying a series model. With no values other than zero, identification becomes impossible. Sample autocorrelation and partial autocorrelation functions for all the energetic electron channels are included in Appendix F.

In examining Table I, the reader will notice that a couple of different models are identified. The first model is an AR1,27 MA1 representation of the SEESSD channel over the last 100 days of the available data (27 Jan 86 - 6 May 86). The second model is a similar representation of the last year of the data (7 May 85 - 6 May 86). These two models represent the "best fits" that the author was able to identify in terms of (1) the least residual mean square values and (2) the smallest forecast standard errors. In both cases, the plot of the autocorrelation function of the residuals showed a good fit (no significant correlations at any lag). Many other models were fitted to the data with varying degrees of success which were all less than that achieved by the two models listed. The column entitled "S.E." represents the forecast standard error for the given model. In Table I, two such values are shown per model. The reason for this is to illustrate that a given model can achieve varying amounts of effectiveness at predicting the series values depending upon where the initial point of forecast takes place. In the case of the 100 day model, two different requests for forecasting (predictions) were made. The one which resulted in a S.E. of 157.49 began at the 80th day of the 100 days of data while the other which yielded an S.E. of 174.29 began at the 71st day. The forecasts were requested beginning at these particular days in order to allow the available SEESSD series values to be compared to the values predicted by the models. Similarly, the 365 day model resulted in an S.E. of

227.34 and 241.04 for requested forecasts beginning at the 350th and 200th days of the data respectively. The approximate series mean for each of the channels is shown at the bottom of each of Tables I - IV. This is shown in order to give the reader an idea of the magnitude of the forecast standard error as compared to the mean series value. These means are only approximate since they were initially determined over the entire 4 years of data originally presented for analysis by LANL. Thus, the mean of each series will change depending on the amount of data (number of days) to which a model is fit. It was assumed here that the means of the lesser series do not vary substantially from those determined for the entire four years of the data. This is a reasonable assumption since each of the series for SEESSD, SEEI, SEEII, and SEEIII appear to be stationary (ie., the mean does not vary considerably over time).

The models shown in Tables II - IV are displayed in a similar manner to those in Table I and thus represent the best models for the SEEI, SEEII, and SEEIII channels. As in the case of the SEESSD channel, each of the models for the other three channels appears to be best represented by some type of ARMA model. Indeed, a closer look reveals that almost without exception each of the models for the different channels contains autoregressive terms of first and 27th order along with a moving average term of first order. In each of the tables, the term z_t should be taken to

TABLE II

Suggested Models for the SEEI Channel (3.4 - 4.9 MeV)

Data Length	Suggested Model	S.E.
100 days (Jan 86-May 86)	$(1 - .7975B - .0973B^{26} - .0421B^{27})z_t = (1 + .0959B)a_t$	.336
365 days (May 85-May 86)	$(1 - .6243B - .0806B^{26} - .0844B^{27})z_t = (1 + .4623B)a_t$	1.598

Approximate series mean = 1.05

TABLE III

Suggested Models for the SEEII Channel (4.9 - 6.6 MeV)

Data Length	Suggested Model	S.E.
100 days (Jan 86-May 86)	$(1 - .9240B)z_t = (1 - .2931B)a_t$	.1195
365 days (May 85-May 86)	$(1 - .7043B)z_t = (1 - .7043B)a_t$	.1203

Approximate series mean = .1458

TABLE IV

Suggested Models for the SEEIII Channel (6.6 - 9.7 MeV)

Data Length	Suggested Model	S.E.
100 days (Jan 86-May 86)	$(1 - .9932B - .1222B^{27})z_t = (1 + .1307B)a_t$	.0167
365 days (May 85-May 86)	$(1 - .9850B - .1701B^{27})z_t = (1 + .1227B)a_t$	.0204

Approximate series mean = 14.01

mean the current value of the stated energetic electron channel as it deviates from the overall series mean. This term was explained in the previous chapter.

Transfer Function Models

The results of the transfer function modeling are presented in Tables V - XVII. Tables V - VIII contain models suggested for each of the energetic electron channels using the entire extent of the available cross correlated data (706 days or from 8 May 83 to 12 Apr 85). The models include those for which the solar wind as well as the IMF B_z component is considered as the input series. The output series is always considered to be the stated channel. Thus, in each of the suggested models in these tables, the term y_t denotes the output series current value (the channel) and the term x_t denotes the input series (either the B_z

component or the solar wind). The term associated with a_t represents the noise component in the model. Tables IX - XII are duplicates of V - VIII except that the models shown only represent data covering the last 200 days of cross correlation (25 Sep 84 - 12 Apr 85). Tables XIII - XVI are once again the same except that they only represent some 70 days worth of cross correlated data. Tables XVII and XVIII are special in that they identify transfer function models for the SEEIV channel based on a solar wind input. As stated earlier in this chapter, an individual series model for the SEEIV channel was not identifiable. Each of the tables exhibits the r, s, and b values used in the original difference equation along with the standard error of the forecasts. The r, s, and b values were explained in Chapter 4. As is evident from the tables, many of the models contain delay parameters equal to one day, though some have delays which differ significantly from one.

Table V may be used in illustration. The models for the B_z and solar wind inputs are as shown. The r, s, and b used initially were (0,0,1) and (1,2,1) respectively. The forecast standard errors for the models shown are 186.91 and 187.36.

TABLE V

Transfer Function Models for the SEESSD Channel
706 days (8 May 83 - 12 Apr 85)

Input	Suggested Model
B_z	$y_t = -14.96Bx_t + (1/(.5434B + .1911B^{27}))a_t$ $(r,s,b) = (0,0,1)$ S.E. = 186.91
Solar Wind	$y_t = ((.3342B + .1372B^2 - .2040B^3)/(1 + .9981B))x_t + (1/(1 - .5578B - .1878B^{27}))a_t$ $(r,s,b) = (1,2,1)$ S.E. = 187.36

TABLE VI

Transfer Function Models for the SEEI Channel
706 days (8 May 83 - 12 Apr 85)

Input	Suggested Model
B_z	$y_t = -.083Bx_t + (1/(1 - .5589B - .1431B^3 - .1091B^{24} - .2387B^{27}))a_t$ $(r,s,b) = (0,0,1)$ S.E. = 1.307
Solar Wind	$y_t = ((.0020B^2 - .0013B^4)/(1 + .9998B))x_t + (1/(1 - .5680B - .0444B^2 - .1951B^3 + .1515B^4 - .1906B^{27}))a_t$ $(r,s,b) = (1,3,1)$ S.E. = 1.497

TABLE VII

Transfer Function Models for the SEEII Channel
706 days (8 May 83 - 12 Apr 85)

Input	Suggested Model
B_z	$y_t = -.0088Bx_t + (1/(1 - .6468B - .1165B^3 - .1950B^{27}))a_t$ $(r,s,b) = (0,0,1)$ S.E. = .1699
Solar Wind	$y_t = .0002B^2x_t + (1/(1 - .6974B + .1173B^2 - .1039B^3 - .1604B^{27}))a_t$ $(r,s,b) = (0,0,2)$ S.E. = .1689

TABLE VIII

Transfer Function Models for the SEEIII Channel
706 days (8 May 83 - 12 Apr 85)

Input	Suggested Model
B_z	$y_t = (-.0713B^5 + .1351B^6)x_t + (1/(1 - .3434B -.1771B^2 - .1551B^3 + .1935B^4))a_t$ $(r,s,b) = (1,1,5)$ S.E. = 2.058
Solar Wind	$y_t = ((-.0023B^7 - .0023B^8)/(1 - .6482B))x_t + (1/(1 - .3343B - .1813B^2 - .1504B^3 + .1911B^4))a_t$ $(r,s,b) = (1,1,7)$ S.E. = 2.196

TABLE IX

Transfer Function Models for the SEESSD Channel
200 days (25 Sep 84 - 12 Apr 85)

Input	Suggested Model
B_z	$y_t = -24.01Bx_t + (1/(1 - .6125B - .1973B^{27}))a_t$ $(r,s,b) = (0,0,1)$ S.E. = 189.13
Solar Wind	$y_t = ((.6749B - .4985B^3)/(1 - .9107B))x_t + (1/(1 - .5735B))a_t$ $(r,s,b) = (1,2,1)$ S.E. = 201.25

TABLE X

Transfer Function Models for the SEEI Channel
200 days (25 Sep 84 - 12 Apr 85)

Input	Suggested Model
B_z	$y_t = -.2078Bx_t + (1/(1 - .4547B - .0881B^3 - .0876B^{21} - .3046B^{27}))a_t$ $(r,s,b) = (1,2,1)$ S.E. = 1.556
Solar Wind	$y_t = ((.0026B - .0047B^3)/(1 - .9334B))x_t + (1/(1 - .4937B - .2745B^3 + .2193B^4 - .1864B^{27})a_t$ $(r,s,b) = (1,3,1)$ S.E. = 1.546

TABLE XI

Transfer Function Models for the SEEII Channel
200 days (25 Sep 84 - 12 Apr 85)

Input	Suggested Model
B_z	$y_t = -.0115Bx_t + (1/(1 - .5718B - .3042B^3 + .2504B^4 - .3065B^{26}))a_t$ $(r,s,b) = (0,0,1)$ S.E. = .1889
Solar Wind	$y_t = .0006B^2x_t + (1/(1 - .5061B - .2915B^3 + .1598B^4 - .3445B^{27}))a_t$ $(r,s,b) = (0,0,2)$ S.E. = .1810

TABLE XII

Transfer Function Models for the SEEIII Channel
200 days (25 Sep 84 - 12 Apr 85)

Input	Suggested Model
B_z	Parameter estimation terminated, no apparent model.
Solar Wind	$y_t = .0022B^9x_t + (1/(1 - .8535B + .1603B^2 - .0439B^6 + .3125B^{13} - .4784B^{14}))a_t$ $(r,s,b) = (0,0,9)$ S.E. = 1.221

TABLE XIII

Transfer Function Models for the SEESSD Channel
B_z = 70 days (30 Oct 83 - 7 Jan 84)
Solar Wind = 71 days (1 Feb 85 - 12 Apr 85)

Input	Suggested Model
B_z	No significant cross correlations, no apparent model.
Solar Wind	$y_t = .2161B^3x_t + (1/(1 - .7991B))a_t$ $(r,s,b) = (0,0,3)$ S.E. = 163.42

TABLE XIV

Transfer Function Models for the SEEI Channel
B_z = 70 days (30 Oct 83 - 7 Jan 84)
Solar Wind = 71 days (1 Feb 85 - 12 Apr 85)

Input	Suggested Model
B_z	No significant cross correlations, no apparent model.
Solar Wind	$y_t = .0005B^2x_t + (1/(1 - .7357B + .2114B^2))a_t$ $(r,s,b) = (0,0,2)$ S.E. = 1.218

TABLE XV

Transfer Function Models for the SEEII Channel
B_z = 70 days (30 Oct 83 - 7 Jan 84)
Solar Wind = 71 days (1 Feb 85 - 12 Apr 85)

Input	Suggested Model
B_z	$y_t = (-.0191B^{11} + .0453B^{12})x_t + (1/(.6368B - .1913B^4))a_t$ $(r,s,b) = (0,1,11)$ S.E. = .1244
Solar Wind	$y_t = ((.0007B^3 - .0010B^6)/(1 + .3376B))x_t + (1/(1 - .5547B))a_t$ $(r,s,b) = (1,4,2)$ S.E. = .1446

TABLE XVI

Transfer Function Models for the SEEIII Channel
B_z = 70 days (30 Oct 83 - 7 Jan 84)
Solar Wind = 71 days (1 Feb 85 - 12 Apr 85)

Input	Suggested Model
B_z	No significant cross correlations, no apparent model.
Solar Wind	$y_t = (.00009B^2 + .00005B^3 + .00003B^4)x_t + (1/(1 - .3589B + .2715B^2 - .4446B^{25} - .4600B^{27}))a_t$ $(r,s,b) = (0,2,2)$ S.E. = .0136

TABLE XVII

Transfer Function Models for the SEEIV Channel
200 days (25 Sep 84 - 12 Apr 85)

Input	Suggested Model
B_z	No significant cross correlations, no apparent model.
Solar Wind	$y_t = (.00016B^9 - .000012B^{10})x_t + (1/(1 - .7571B + .0728B^2 + .0810B^5 - .1919B^{15} + .0701B^{20}))a_t$ $(r,s,b) = (0,1,9)$ S.E. = .0932

TABLE XVIII

Transfer Function Models for the SEEIV Channel
B_z = 70 days (30 Oct 83 - 7 Jan 84)
Solar Wind = 71 days (1 Feb 85 - 12 Apr 85)

Input	Suggested Model
B_z	No significant cross correlations, no apparent model.
Solar Wind	$y_t = (.00005B^2 - .00003B^4)x_t + (1/(1 - .7078B - .2644B^{27})a_t$ $(r,s,b) = 0,2,2)$ S.E. = .01846

Additional data concerning the autocorrelation and partial autocorrelation functions of the two input series (the IMF B_z and the solar wind speed) are contained in Appendix G. These ACFs and PACFs were used to identify the input series necessary for the initial part of the transfer function modeling as accomplished by the prewhitening method. Both of these input series were shown to be AR(1) processes. Also, Appendix H is a listing of the 70 day cross correlation functions between these input series and the various energetic electron channels (output series) so that the reader may better grasp the procedures for identifying the r, s, and b values in transfer function modeling.

Discussion

Apart from the time series models developed in this study, good support for some of the results obtained in prior studies of energetic electron flux is evident. Perhaps the two best examples of this are (1) the fact that a large positive autocorrelation showed up very consistently near lag k = 27 in the ACFs of the lowest three energetic electron channels studied (SEESSD, SEEI, SEEII), and (2) the delay factor for many of the transfer function models was on the order of one to two days. Finding (1) above is in good agreement with McCormick who stated in his conclusions that "whatever processes affect electron fluctuations in the three lowest channels are different from those affecting the two highest channels" (McCormick, 1984:62,63). In addition, it supports the findings of Paulikas and Blake who noted the variability of energetic electron fluxes associated with the 27 day solar rotation period Paulikas and Blake, 1978:22). Finding (2) is also in harmony with McCormick's finding that the electron fluxes in the SEESSD, SEEI, and SEEII channels showed a weak but evident correlation with one and a half to two-day old solar wind speed data. (McCormick, 1984:62). Moreover, Paulikas and Blake are in agreement with this delay factor (Paulikas and Blake, 1978:11). Most of these previous findings were mentioned in Chapter II of this report.

Referring to the individual series models, Tables I - IV seem to suggest mixed amounts of success in using time series analysis. With regard to Table I, the best models identified yielded a forecast standard error which is undoubtedly too great to make these models of any practical use. A 95% confidence interval for a prediction one day in the future using either of the two models listed would be an extremely broad interval of about 3 to 4 times the mean value of the series itself. One should bear in mind that the standard error of the forecasts depends somewhat upon where (ie., beginning on what day) the requested forecast is made as is illustrated by the two different standard errors listed for each model in Table I. Still, this appears to render the models unacceptable. A more reasonable model would give a 95% CI of, say, no more than half of the mean value of the series. With this in mind, it then appears that the models in Tables II and III are likewise of little value.

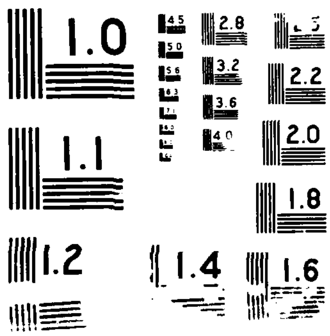
The results shown in Table IV, however, offer some hope. As shown, the models for the SEEIII channel both yielded very small forecast standard errors (.0167 and .0204 for the 100 day and the 365 day models respectively) as compared to their respective series means. This would appear to make them of possible future use, but one must keep in mind the data as it appeared in this channel. The SEEIII values were characterized by fairly constant count rates (usually about 0.12 - 0.15) except on a few rare occasions where the count rate skyrocketed to values such as 1417.89 which was the highest value recorded in this series. Outliers such as this can have a marked effect on the series mean and standard deviation and thus make a given model seem more appropriate than it may in fact be. In truth, with the exception of the few outliers in the SEEIII channel, one might very well be able to forecast the next two days of count rates for SEEIII simply by "eyeballing" the past data and noting that, for the most part, it varies little from day to day.

Many of the transfer function models are likewise of doubtful utility. In fact, it seems that the standard error for the forecasts based on any given transfer function model was often times as much or greater than that of the individual series models. Again, bearing in mind the series means and the forecast standard errors indicated, it appears that the 706 day models shown in Tables V, VI, and VII are not useful. Once again though, the models for the SEEIII channel (Table VIII) have acceptable standard errors as compared to the series mean and thus may be of some possible value in prediction.

The exact same set of statements may be said in regard to the 200 day models (Tables IX - XII). Once again the 200 day model for the SEEIII channel (based on a solar wind input) possessed a small standard error as compared to the mean value of the SEEIII channel. The reader will note that a transfer function model for the SEEIII channel using the IMF B_z as the input was not identifiable. The computer terminated parameter estimation due to estimates of the parameters "becoming too highly correlated".

In recognition of the fact that quite a bit of the input series data had to be estimated (ie., the data from the NSSDC on the solar wind and IMF B_z contained many missing values), it was felt that perhaps the transfer function models were not getting a fair chance at success. Thus, a further examination of the data was done in an effort to determine a "stretch" of erough consecutive days of unestimated data so as to make the transfer function models less susceptible to any bias caused as a result of all the estimated values. For the IMF B_z data, the longest stretch of "clean" data which could be cross correlated with the energetic electron channels occurred during the dates from 30 Oct 83 to 7 Jan 84 (70 days). For the solar wind, the longest stretch occurred between 1 Feb 85 to 12 Apr 85 (71 days). The results of the transfer function models using these days' B_z and solar wind values are given in Tables XIII - XVI. As is evident, results using this "unbiased data" were only marginally better than those when the data containing estimated values were used. And, once again, the transfer function model for the SEEIII channel offered the most possible usefulness. The reader may note that in three cases, models were not

AD-A194 360 A TIME SERIES ANALYSIS OF ENERGETIC ELECTRON FLUXES (12 2/3
- 16 MEV) AT GEOS (U) AIR FORCE INST OF TECH
WRIGHT-PATTERSON AFB OH SCHOOL OF ENGI M P HALPEN
UNCLASSIFIED DEC 86 AFIT/GSO/ENS-ENP/86D-1 F/G 22/1 NL


1.0
2.8
3.2
2.2
3.6
1.1
2.0
1.8
1.2
1.4
1.6

identifiable due to lack of any significant cross correlations between the input series and the stated energetic electron channel. In all three cases, this occurred when the B_z component was used as the input series. This again offers some support for the findings of McCormick who noted that little correlation existed between the IMF B_z and the energetic electron fluxes (McCormick, 1984:63).

Tables XVII and XVIII represent the only identified way of modeling the SEEIV channel. In both cases, no model could be identified using the IMF B_z as the input. However, when the solar wind was assumed as the input, some models of possible usefulness were obtained as the standard error of the forecasts was small when compared to the series mean. Once again, the same things which were said about the behavior of the SEEIII channel may also be said about the SEEIV channel: The series contains outliers. Therefore, careful use of these models is in order.

VI. Conclusions and Recommendations

Conclusions

This study had some measurable "positives" to report. First, it reinforced previous findings that changes in the levels of energetic electron flux lag solar wind speed changes by one to two days. This was brought out by the fact that many of the suggested transfer function models had delay parameters (b) of 1 or 2 which indicates that the output (the given electron channel) lags the input (the solar wind or the IMF B_z) by a one to two day time period. Second, the fact that the autocorrelation functions of the three lowest energy channels (in addition to that of the solar wind) showed a strong positive autocorrelation around the lag k = 27 definitely supports previous findings that the solar rotation cycle plays a considerable part in the makeup of the solar wind plasma and, consequently, in the changes in energetic electron flux. A closer inspection of the ACFs shows that a buildup of autocorrelations at lags just before the k = 27 day point occurs followed generally by a "builddown" in the autocorrelations after this point. A possible theory on the reason for this is the surmised existence of a "hot spot" of the sun which emits greater than average amounts of plasma and which slowly moves across the solar surface while the sun rotates. Third, the fact that the three lowest energy channels displayed this 27 day lag trend while the higher channels did not gives support to previous findings that the lower energetic electron channels appear to behave differently from the higher energy channels. Thus, the control mechanisms for the lower energy channels seem to differ from those of the higher channels.

Of less positive note, it seems that the entire methodology of time series analysis did not apply as well as had been hoped to the data presented for study. This might lead one to become disconsolate with regard to the Box and Jenkins method. However, some qualifications which affected the analysis have to be emphasized.

First, it should be recognized that the data were anything but consistent. The LANL data on the energetic electron count rates were by far the best with regard to consistency. Of the data from LANL actually used, only 15 days worth of missing values had to be estimated. However, this was far less than the data from the NSSDC on the solar wind and IMF B_z which contained stretches of days at a time where no values were posted. The fact that data were missing at all can only tend to have adverse effects on the analysis.

Second, there is the iterative or "artful" nature of time series analysis which must be considered. The Box and Jenkins method, as presented in BMDP, requires that the user interact with the program in what is frequently a very long and time consuming set of processes before a model is finally identified. The user must master the art of examining the autocorrelation and partial autocorrelation functions to unmask the true behavior of a given time series. Obviously, the more experience one has at this sort of thing, the quicker the process of identifying the appropriate model becomes. The same may be said more emphatically of transfer function modeling. Mastery of the secrets held in the cross correlation function between a given input and output series is of the utmost importance. Without it, an attempt to derive a transfer function model may be doomed from the start. In the transfer function modeling process as presented in BMDP, the user is required many trial and error interactions. Initially, assuming significant cross correlations exist between the two series, a guess at r, s, and b may be made and the appropriate estimates of the difference equation parameters (all figured by hand) must be input into the computer. The computer will further refine these estimates or else "throw them out entirely". When this occurs, the user is forced to make a new guess at r, s, and b and refigure new parameter estimates. Also, a great deal of the time spent in transfer function modeling consists of trying to iteratively determine the noise portion of the model (ie., the part attached to a_t). In addition, one is reminded in Box and Jenkins that for transfer function modeling, there is not necessarily one unique model (Box and Jenkins, 1976:387). Therefore, despite the fact that the model one may derive seems poor (or even good), the analysis, if carried out a different way, might well yield more favorable results. Different surmisals of the r, s, and b parameters can, for instance, lead to different models. In short, there is often too much left to the skills (and whims) of the user and not enough left to the computer, at least as far as the BMDP implementation is concerned. Until a more precise way of performing a time series analysis is developed so as to remove a lot of the "art", this method may well be scorned by many when, in fact, it may have the potential of modeling a given equispaced series of values very accurately.

Third, one must consider the physical processes at work in the magnetosphere. As has already been brought out in the literature, the interactions between the solar wind, the IMF, and the energetic electron fluxes are anything but trivial. Therefore in this respect, the results of this study are definitely in support of this non-simplistic theory, since most of the transfer functions derived here seem to indicate that the fluxes depend quite heavily on something other than just the solar wind and the IMF B_z. If the solar wind and the B_z component were the sole drivers of the energetic electron fluxes, then one would suspect that the forecast standard errors in all the transfer function models would, on the whole, be considerably less than what they turned out to be. Put simply, there is more at work in the magnetosphere with regard to energetic electron flux than is reflected here.

Recommendations

Notwithstanding the somewhat disappointing results of the model fitting attempted in this study, the author continues to believe in the Box and Jenkins method and also that it has utility with regard to the further study of energetic electron fluxes and the magnetosphere in general. If nothing else, even with data that contained many missing values, the various time series studied here indicate a good capability to be modeled by the Box and Jenkins method. This is supported by the fact that so many of the autocorrelation and partial autocorrelation functions exhibit what appear to be "classic" time series model tendencies. Moreover, support is offered by the models themselves. For instance, an examination of BMDP Example #3 in Appendix E shows that the forecasts made by the model are at least attempting to follow the trends of the actual values (page 162). Thus, it is recommended that time series analyses of such data continue to be carried out in the future. One possibility for shortening the long iterations involved in the BMDP implementation of the method is the development and use of more sophisticated software which will eliminate some or all of the guessing involved on the part of the user and make the method more the application of a precise set of steps which yields a very accurate model. From consultations with advisors and peers, it is the understanding that such computer software may be on the horizon. If so, it would definitely be to the advantage of the person doing a time series analysis to use such programs.

With regard to future data, it would be most helpful if it could somehow be made more consistent and required less by way of estimation of missing values.

This is truly an ideal, however, and the author realizes that it is almost as difficult to predict when a satellite sensor is about to malfunction as it is to predict electron fluxes. If "cleaner" data could be obtained, the possibility of doing a time series analysis based on hourly readings might be an interesting undertaking if the improved software spoken of above could also be used. If such a computer program were to yield an extremely accurate model for, say, a transfer function between the solar wind and the SEEIV channel utilizing hourly data, it might be more plausible to ask for (and rely on) a prediction 24 - 48 hours (time periods) in the future. The reader will recall that usually such predictions carry with them a very high standard error.

Additionally, nothing can help the potential user of the Box and Jenkins method more than a solid foundation in the material as presented in the text. As a minimum, a prior graduate level course in time series analysis is recommended.

Finally, with regard to the models derived here, only those with an acceptably small forecast standard error should be considered for use. The reader is reminded that time series modeling is not a static process in that as new data is recorded, the model should be updated to reflect the series' latest trends.

Appendix A: FORTRAN Program to Read the LANL Data

Appendix A: FORTRAN Program to Read the LANL Data

```
      program readom
c
c     This program was written so that the data on the
c     Omni Tape could be compressed into a more
c     manageable file of daily averages.  The really
c     important variables are the variables for the
c     solar wind velocity (v) and those
c     having to do with the IMF (bxe,bye,bze,bym,bzm).
c     Note that some variables have been declared as
c     integers and some as real depending on how the
c     NSSDC specified their individual formats on the
c     Omni Tape (eg., I2 or F6.2, etc.).
c     Note also that the last 20 real variables
c     beginning with the variable aptsi are the averages
c     of their respective variables which we are
c     interested in (eg., aptsi is the average of ptsi,
c     av is the average solar wind velocity, etc.).
c
      integer  flag,yr,day,hr,brn,idimf,idsw,ptsi,ptsp,
     *kp,c9,r,dst,nn(20),dread

      real b,f,thb,phb,bxe,bye,bze,bym,bzm,sigb,sigf,
     *sigbx,sigby,sigbz,t,n,v,phv,thv,sigt,sign,sigv,
     *sigphv,sigthv,
     *ss(20),
     *aptsi,aptsp,akp,ac9,ar,adst,ab,af,athb,aphb,
     *abxe,abye,abze,abym,abzm,at,an,av,aphv,athv
c
c     The character variable junk was introduced as a
c     variable into which any miscellaneous data records
c     which do not contain numerical characters could be
c     read and discarded.  For the data set given, this
c     occured only once:  on the 10th hour of the 338th
c     day of 1982, a row of asterisks was present.
c     Thus, this data were discarded by having it read
c     into the variable junk.
c
      character junk
c
c     The general purpose directory tmp contained the
c     raw Omni Tape data (hourly readings amounting to a
c     5 megabyte file).  The file name containing the
c     raw data was file3.  Consequently, we must
c     open this file in order to manipulate the data.
c     Also, the file swdat must be opened in order to
c     read in the newly averaged data.
```

```
c     The file swdat will be the compressed and more
c     manageable file.
c
      open(2,file='/tmp/file3')
      open(3,file='swdat')
c
c     The following are small routines to set the
c     summing variables back
c     to zero at the beginning of a new day.
c

5     do 6   kk=1,20
         ss(kk) = 0.0
6     continue

7     do 8   kk=1,20
         nn(kk) = 1
8     continue


c
c     The variable dread is a conditional termination
c     variable for the program.
c
      dread = 0
10    if(dread.eq.1) goto 200
c
c     The following are the format statement and read
c     statement that are used to read the raw data from
c     the file file3.
c

11    format(i1,i2,i3,i2,i4,2i2,2i3,14f6.2,f8.0,
     *f5.1,3f6.1,f8.0,f5.1,3f6.1,i2,i1,i4,i5)
c
c     Note that the original raw data on the Omni Tape
c     contained 37 different variables, many of which
c     are superfluous to this study.
c
      read(2,11)
     *flag,yr,day,hr,brn,idimf,idsw,
     *ptsi,ptsp,b,f,thb,phb,bxe,bye,bze,bym,
     *bzm,sigb,sigf,sigbx,
     *sigby,sigbz,t,n,v,phv,thv,sigt,sign,sigv,
     *sigphv,sigthv,kp,c9,r,dst
c
c     The averaging subroutines are called for the
c     various variables which have now been read in.
c     These subroutines simply add the
c     newly read variable to the previous sum of the
```

```
c     same variable and calculate a new average.  The
c     subroutine is called for each
c     hourly reading until the last reading of the day
c     is read in.  At that time, the daily average value
c     is computed and read into the file swdat as the
c     average value for that variable for that day.
c
      call avgi(ptsi,nn(1),ss(1),aptsi)
      call avgi(ptsp,nn(2),ss(2),aptsp)
      call avgi(kp,nn(3),ss(3),akp)
      call avgi(c9,nn(4),ss(4),ac9)
      call avgi(r,nn(5),ss(5),ar)
      call avgi(dst,nn(6),ss(6),adst)
      call avgr(b,nn(7),ss(7),ab)
      call avgr(f,nn(8),ss(8),af)
      call avgr(thb,nn(9),ss(9),athb)
      call avgr(phb,nn(10),ss(10),aphb)
      call avgr(bxe,nn(11),ss(11),abxe)
      call avgr(bye,nn(12),ss(12),abye)
      call avgr(bze,nn(13),ss(13),abze)
      call avgr(bym,nn(14),ss(14),abym)
      call avgr(bzm,nn(15),ss(15),abzm)
      call avgr(t,nn(16),ss(16),at)
      call avgr(n,nn(17),ss(17),an)
      call avgr(v,nn(18),ss(18),av)
      call avgr(phv,nn(19),ss(19),aphv)
      call avgr(thv,nn(20),ss(20),athv)
c
c     The 23rd hour of the day is the last reading on
c     any given day.  Thus at this time, the data must
c     be finally averaged and then written into the file
c     swdat.  A total of 22 variables will be written
c     into the new file.
c
      if(hr.eq.23) then
15    format(i2,1x,i3,1x,2(f5.1,1x),f4.1,1x,
     *f3.1,1x,2(f6.1,1x),
     *9(f6.2,1x),f8.0,1x,f5.1,1x,3(f6.1,1x))
        write(3,15)
     *  yr,day,aptsi,aptsp,akp,ac9,
     *  ar,adst,ab,af,athb,aphb,abxe,abye,
     *  abze,abym,abzm,
     *  at,an,av,aphv,athv
      endif
c
c     The following is the subroutine used to close the
c     files when all the data from file3 has finally
c     been read and written.  Note that this routine
c     sets the termination variable dread equal to the
```

```
c       program termination value of 1.
c
        if(hr.eq.23.and.day.eq.101.and.yr.eq.85) then
           close(2)
           close(3)
           dread = 1
        endif
c
c       The one data record which contained miscellaneous
c       "junk" is identified with the routine below.
c       This data is to be discarded.  This statement was
c       unique to the data provided.
c
        if(hr.eq.10.and.day.eq.338.and.yr.eq.82) then
            read(2,16) junk
16          format(a180)
        endif
c
c       A series of "if" statements to ascertain if the
c       last original raw data record has been read.
c       Again, the values used in these 3 statements are
c       unique to the data provided.
c
        if(hr.eq.23.and.day.ne.101.and.yr.ne.85) goto 5
        if(hr.eq.23.and.day.eq.101.and.yr.ne.85) goto 5
        if(hr.eq.23.and.day.ne.101.and.yr.eq.85) goto 5
        goto 10

200     end
c
c       These are the actual subroutines used for
c       averaging.  Note that any variables which have a
c       value of zero are not used in computing the final
c       daily average.  This is because zero was
c       designated by the NSSDC as the value for a
c       variable when its actual value was "missing" or
c       indeterminate.
c
        subroutine avgi(x,nx,sx,ax)
        real sx,ax
        integer x,nx

        if (x.ne.0) then
          sx = x + sx
          ax = sx/nx
          nx = nx + 1
        endif

        end
```

```
subroutine avgr(x,nx,sx,ax)
real x,sx,ax
integer nx
if (x.ne.0) then
  sx = x + sx
  ax = sx/nx
  nx = nx + 1
endif

end
```

Appendix B: FORTRAN Program Combining LANL and NSSDC Data

Appendix B: FORTRAN Program Combining LANL and NSSDC Data

```
      program combo1
c
c     This program was written to read the values in the
c     files formed from the LANL data (energetic elec-
c     tron flux) and the NSSDC data (solar wind speed/
c     IMF values) in order to form one single time
c     synchronized data file for the purposes of
c     performing transfer function analysis as described
c     in Box and Jenkins.  The name of the LANL file
c     is "EEDAT3" while the name used for the NSSDC file
c     was "swdat".
c
c     In the following lists of variables, day, date,
c     abzm (the average daily Bz component expressed
c     in Geocentric Solar Magnetospheric or GSM units),
c     av (the average daily solar wind velocity in
c     km/sec), and SEESSD, SEEI, SEEII, SEEIII, SEEIV
c     (the various channels of energetic electron flux)
c     are the variables of interest despite the fact
c     that others were copied into the new time synch-
c     ronized file.  The other variables were either
c     superfluous or declared for convenience in execu-
c     ting this program.
c
      integer yr,day,grp,date,pts,count,
              rep,doi,poi,i(15),k,j1,j2
      real    aptsi,aptsp,akp,ac9,ar,adst,ab,af,
     *        athb,aphb,abxe,abye,abze,abym,abzm,
     *        at,an,av,aphv,athv,
     *        GAMIII,
     *        SEEIII,GAMII,GAMIV,SEEI,SEEII,SEEIV,SEESSD
      character junk1,junk2
c
c     The variables count and rep are counter variables
c     used to control execution of this program.  The
c     variables doi and poi stand for "day of interest"
c     and "port of interest".  The 127th day of the file
c     containing the solar wind and IMF data (file
c     "swdat") represents May 8 which is the first day
c     (matched to the file containing the energetic
c     electron flux data, "EEDAT3") of sw/IMF values
c     which should be copied.  May 8, 1983 is the first
c     day of data from file "EEDAT3".  File "swdat" has
c     data for days prior to this so all its data
c     prior to this date is unecessary since no
```

```
c       cross correlations can be performed on it
c       without data for similar days from file "EEDAT3".
c       The parameter poi is a variable to name the port
c       through which a file is copied (a FORTRAN
c       particular when writing a file of data to a new
c       file).  Variables j1 and j2 are also counters.
c
        count = 0
        rep = 1
        doi = 127
        poi = 4
        j1 = 0
        j2 = 0
c
c       Variable i is an array used to name the particu-
c       lar dates in file "EEDAT3" where missing values of
c       variables of no interest to this study will have
c       to be read.  Thus, when the program determines
c       that one of these dates is the date of the data
c       being read, it will read the data according to
c       a different format.  In so doing, it will use
c       the character variables junk1 and junk2 to read
c       in the missing values of these useless variables.
c       Without this caveat in the program, the creation
c       of the new single time synchronized file could not
c       proceed.  Notice that there are 15 dates on which
c       missing values of superfluous variables occur.
c       The other 17 dates where missing values occurred
c       were in August 1982.  The reader will recall from
c       Chapter III that the data up until May 8, 1983
c       from LANL was discarded partly for this reason (so
c       many missing values in one month).  Also, discard-
c       ing data up to May 8, 1983 left exactly three
c       years (1095 days) which could be analyzed.  This
c       was felt to be more than enough data for analysis.
c
        i(1) = 830523
        i(2) = 830524
        i(3) = 830526
        i(4) = 840216
        i(5) = 840217
        i(6) = 840218
        i(7) = 840620
        i(8) = 840718
        i(9) = 841015
        i(10) = 841016
        i(11) = 841030
        i(12) = 841031
        i(13) = 841101
```

```
      i(14) = 841102
      i(15) = 841103
c
c     The following statements open the relevant files.
c     File "CCFL0" is the name given to the new single
c     file containing combined, time synchronized
c     sw/IMF and energetic electron flux data.  The
c     reader will notice that later on in the program
c     two other files ("CCFL1" and "CCFL2") were also
c     created.  These were initially thought to be
c     necessary for the analysis but in fact were not.
c     The name "CCFL0" is the author's acronym for
c     "cross correlation file with 0 days lag".
c     In other words, "CCFL0" represents a file of
c     data from both "swdat" and "EEDAT3" which is
c     time synchronized (ie., has zero days lag).
c
      open (2,file = 'swdat')
      open (3,file = 'EEDAT3')
      open (4,file = 'CCFL0')

      date = 830508

 5    read (2,10) yr,day,aptsi,aptsp,akp,
     *              ac9,ar,adst,ab,af,athb,
     *              aphb,abxe,abye,abze,abym,
     *              abzm,at,an,av,aphv,athv
c
c     File "swdat" is read first since it has all
c     the excess data at the start which must be
c     discarded (ie., all data up until May 8, 1983).
c
 10   format (i2,1x,i3,1x,2(f5.1,1x),f4.1,1x,f3.1,1x,
     *          2(f6.1,1x),9(f6.2,1x),
     *          f8.0,1x,f5.1,1x,3(f6.1,1x))

c
c     We continue to read data from "swdat" but
c     not copy it until May 8, 1983 rolls around.
c     This is the first day of data from file "EEDAT3".
c     When we finally reach this date, data from both
c     "swdat" and "EEDAT3" begins to be copied into
c     the file "CCFL0".
c
      if (yr.eq.83.and.day.eq.doi) then
          count = 1
      endif

      if (count.lt.1) goto 5
```

```
c
c      Continue to read data without copying until
c      reaching the appropriate date.
c
c      The following do loop takes care of reading
c      in the appropriate values on those days when
c      missing values for superfluous variables in
c      file "EEDAT3" occur.
c      As mentioned earlier, without this the program
c      could not read all the data.  Notice that when
c      the data is read this way, character variables
c      junk1 and junk2 are assigned values for what
c      would normally be the unused variables pts and
c      GAMII (see statement 13 below).
c
       do 12 k=1,15
            if (date.eq.i(k)) then
                 j2 = k
                 k = 15
 10              read (3,11) grp,date,junk1,SEEIII,
     *                       junk2,SEEI,
     *                       SEEII,SEEIV,SEESSD
 11              format (i2,2x,i6,5x,a2,1x,
     *                   f7.4,a7,3(f6.4,1x),f8.4)
            endif
 12    continue

            if (j2.gt.j1) goto 16
c
c      Statement 13 is the normal read statement used
c      to read data from file "EEDAT3".  Statement 10
c      above is only used on the 15 particular dates
c      where missing values occur.
c
 13    read (3,15) grp,date,pts,SEEIII,
     *             GAMII,GAMIII,GAMIV,
     *             SEEI,SEEII,SEEIV,SEESSD

 15    format (i2,2x,i6,5x,i2,4x,f6.4,
     *         3x,f7.4,3x,f7.4,2x,f8.4,4x,
     *         f6.4,4x,f6.4,4x,f6.4,2x,f8.4)
c
c      Statement 16 begins the sequence where the data
c      values from both "EEDAT3" and "swdat" are actually
c      written into the new time synchronized file.
c
 16    j1 = j2
       if (count.eq.1) then
            write (poi,17) date,abxe,abye,abze,
```

```
     *                          abym,abzm,av,SEESSD,
     *                          SEEI,SEEII,SEEIII,SEEIV
 17        format (i6,1x,5(f6.2,1x),f6.1,1x,
     *             f8.4,1x,2(f6.4,1x),f7.4,1x,f6.4)
      endif
c
c     The following list of statements are termination
c     statements.  The last day for which time synch-
c     ronized data may be obtained is April 12, 1985.
c     This is the last day of data occurring in file
c     "swdat" and thus represents the last day for
c     which we wish to write down values into the new
c     file.  April 12, 1985 corresponds to day 101 in
c     the creation of file "CCFL0".  It corresponds to
c     day 100 and day 99 in the creation of files
c     "CCFL1" and "CCFL2" respectively.  These last two
c     files were not used in the analysis.  "EEDAT3"
c     contains data for dates after April 12, 1985, but
c     since "swdat" does not, we have copied as many
c     values as we can for the purposes of transfer
c     function modeling.
c
      if (yr.eq.85.and.day.eq.101.and.rep.eq.1) then
           count = 0
           j1 = 0
           j2 = 0
           close (2)
           close (3)
           close (4)
           rep = 2
      endif
c
c     If we have not read the last day, then rep re-
c     mains equal to 1 and we continue to read by re-
c     turning to statement 5 to iterate the process.
c     If we have read the last value, then rep is set
c     equal to 2 (see the "if" statement above), and
c     the new file is closed.  We then proceed on to
c     create and fill data files "CCFL1" and "CCFL2"
c     in the same manner as we did "CCFL0".
c
      if (rep.eq.1) goto 5
      if (count.eq.1) goto 20

      if (rep.eq.2) then
           open (2,file = 'swdat')
           open (3,file = 'EEDAT3')
           open (7,file = 'CCFL1')
           doi = 126
```

```
          poi = 7
     endif

20   if (yr.eq.85.and.day.eq.100.and.rep.eq.2) then
          count = 0
          j1 = 0
          j2 = 0
          close (2)
          close (3)
          close (7)
          rep = 3
     endif
     if (rep.eq.2) goto 5
     if (count.eq.1) goto 25

     if (rep.eq.3) then
          open (2,file = 'swdat')
          open (3,file = 'EEDAT3')
          open (8,file = 'CCFL2')
          doi = 125
          poi = 8
     endif

25   if (yr.eq.85.and.day.eq.99.and.rep.eq.3) then
          close (2)
          close (3)
          close (8)
          rep = 4
     endif

     if (rep.eq.3) goto 5

     end
```

Appendix C: FORTRAN Program to Write Out All Pertinent Data

Appendix C: FORTRAN Program to Write Out All Pertinent Data

```
      PROGRAM DATSHO
C
C       THIS PROGRAM WRITES OUT ALL THE DATA FOR EACH OF THE
C       DAILY AVERAGE VALUES RECORDED FOR:
C       SOLAR WIND, BZ, SEESSD SEEI, SEEII, SEEIII, AND
C       SEEIV.  THE BEGINNING DATE IS MAY 8, 1983.  NOTICE
C       THAT VALUES FOR THE SOLAR WIND AND BZ COMPONENT END
C       ON 12 APR 85.  THIS 706 DAYS REPRESENTS THE EXTENT
C       OF THE CROSS-CORRELATABLE DATA BETWEEN THE SOLAR WIND/
C       BZ CONSIDERED AS INPUTS AND THE INDIVIDUAL ELECTRON
C       FLUX CHANNELS CONSIDERED AS OUTPUTS FOR TRANSFER
C       FUNCTION MODELING.
C
      INTEGER  DATE, COUNT
      REAL     ABZM, AV, SEESSD, SEEI, SEEII, SEEIII, SEEIV
      CHARACTER  JUNK1, JUNK2, JUNK3

      COUNT = 1
      OPEN (2, FILE = 'CCFLO')
      OPEN (3, FILE = 'EEDAT3')

5     READ (2,10) DATE, JUNK1, ABZM, AV, SEESSD, SEEI, SEEII,
     *SEEIII, SEEIV
10    FORMAT (I6,A29,F6.2,1X,F6.1,1X,F8.4,1X,2(F6.4,1X),F7.4,1X,F6.4)

      IF (COUNT.EQ.1) THEN
        WRITE (6,11)
11      FORMAT (3X,'DATE',6X,'BZ',4X,'SWVEL',3X,'SEESSD',4X,'SEEI',
     *          4X,'SEEII',3X,'SEEIII',3X,'SEEIV',/)
      ENDIF

      COUNT = COUNT + 1
      WRITE (6,12) DATE, ABZM, AV, SEESSD, SEEI, SEEII, SEEIII, SEEIV
12    FORMAT (2X,I6,2X,F6.2,2X,F6.1,2X,F8.4,2X,F6.4,2X,F6.4,2X,
     *           F7.4,2X,F6.4)
      IF (COUNT.GE.45) THEN
        COUNT = 1
      ENDIF

      IF (DATE.LT.850412) GOTO 5
      CLOSE (2)

13    READ (3,15) JUNK1, DATE
15    FORMAT (A4,I6)
```

```
      IF (DATE.LT.860412) GOTO 18

17    READ (3,20) JUNK1, DATE, JUNK2, SEEIII, JUNK3, SEEI, SEEII,
     *            SEEIV, SEESSD

20    FORMAT (A4,I6,5X,A2,4X,F6.4,A34,2(F6.4,4X),F6.4,2X,F8.4)
      IF (COUNT.EQ.1) THEN
         WRITE (6,22)
22       FORMAT (3X,'DATE',6X,'BZ',4X,'SWVEL',3X,'SEESSD',4X,'SEEI',
     *           4X,'SEEII',3X,'SEEIII',3X,'SEEIV',/)
      ENDIF

      COUNT = COUNT + 1
      WRITE (6,25) DATE, SEESSD, SEEI, SEEII, SEEIII, SEEIV
25    FORMAT (2X,I6,18X,F8.4,2X,F6.4,2X,F6.4,2X,F7.4,2X,F6.4)

      IF (COUNT.GE.45) THEN
         COUNT = 1
      ENDIF

      IF (DATE.NE.860506) GOTO 17

      CLOSE (3)
      END
```

Appendix D: Listing of All Pertinent Data

Appendix D: Listing of All Pertinent Data

DATE	BT	SWVEL	SEESSI	SEEI	SEEII	SEEIII	SEEIV
830508	0.29	477.8	236.5678	0.4055	0.0642	0.0944	0.2052
830509	2.50	474.2	136.5375	0.4118	0.0609	0.0919	0.2050
830510	3.48	464.6	344.5045	1.0250	0.0900	0.0981	0.2151
830511	0.59	518.2	11.8411	0.0590	0.0397	0.0787	0.1890
830512	-1.02	671.1	110.8706	0.3389	0.0557	0.0787	0.1815
830513	-1.02	671.1	282.7434	1.4832	0.1232	0.0968	0.1880
830514	-1.02	671.1	429.1737	3.0454	0.2541	0.0953	0.1935
830515	-1.02	671.1	396.3473	2.7705	0.2319	0.0945	0.1939
830516	-1.02	671.1	374.1903	3.3052	0.3017	0.0981	0.1937
830517	-1.02	495.6	143.9721	1.0575	0.1227	0.0828	0.1802
830518	2.68	450.8	60.4168	0.5044	0.0692	0.0799	0.1794
830519	2.37	410.4	80.2263	0.5334	0.0722	0.0916	0.1897
830520	3.63	389.4	187.6782	2.0617	0.2474	0.0968	0.2010
830521	5.82	557.5	3.6556	0.0399	0.0377	0.0816	0.1868
830522	-3.05	591.8	31.3407	0.1020	0.0433	0.0800	0.1849
830523	-2.25	585.2	80.7859	0.4593	0.0611	0.0826	0.1925
830524	-1.33	614.2	184.3976	0.9290	0.1586	28.4798	0.2353
830525	5.95	648.0	184.4024	0.9290	0.1586	28.4781	0.2354
830526	5.95	648.0	55.8152	0.7328	0.1268	0.0938	0.1961
830527	5.95	648.0	184.4120	0.9291	0.1586	28.4747	0.2350
830528	5.95	648.0	70.4957	0.2067	0.0541	0.0895	0.1979
830529	5.95	648.0	152.8007	0.6294	0.0790	0.0949	0.2034
830530	0.86	391.3	119.9056	0.4777	0.0782	0.0925	0.2019
830531	0.79	420.6	20.3335	0.0931	0.0428	0.0894	0.1998
830601	-0.86	432.6	22.8509	0.0924	0.0469	0.0791	0.2046
830602	0.82	460.7	23.5162	0.0708	0.0431	0.0846	0.1934
830603	0.31	502.0	34.9108	0.1309	0.0518	0.0915	0.2055
830604	0.51	438.9	45.3721	0.1657	0.0538	0.0890	0.2035
830605	0.89	440.9	55.9589	0.1887	0.0535	0.0889	0.2040
830606	2.72	517.3	55.6194	0.1645	0.0518	0.0365	0.1995
830607	2.72	517.3	29.4189	0.0874	0.0464	0.0865	0.1999
830608	2.72	517.3	30.8373	0.0895	0.0465	0.0856	0.2035
830609	2.72	517.3	15.6942	0.0588	0.0423	0.0831	0.1938
830610	2.72	517.3	4.6172	0.0436	0.0404	0.0813	0.1905
830611	2.72	357.0	15.6687	0.0478	0.0422	0.0829	0.1924
830612	2.72	365.2	4.9617	0.0425	0.0408	0.0835	0.1914
830613	-2.81	555.7	8.6462	0.0436	0.0391	0.0804	0.1897
830614	0.84	463.5	87.8682	0.0699	0.0462	0.0973	0.1999
830615	-2.03	427.9	63.2878	0.0922	0.0495	0.0905	0.2068
830616	0.35	385.0	95.5263	0.1760	0.0507	0.0917	0.2050
830617	0.73	439.8	63.6880	0.1429	0.0462	0.0895	0.2019
830618	0.08	601.3	24.3370	0.0740	0.0444	0.0867	0.2045
830619	-1.73	592.4	73.4869	0.1330	0.0463	0.0898	0.2031
830620	-1.73	476.1	190.6555	0.4659	0.0594	0.0949	0.2054

DATE	BZ	SWVEL	SEESSD	SEEI	SEEII	SEEIII	SEEIV
830621	-1.73	476.1	163.2236	0.4717	0.0665	0.0924	0.2108
830622	-1.73	476.1	244.5261	0.5865	0.0644	0.0928	0.2065
830623	-1.73	476.1	176.3921	0.6379	0.0701	0.0888	0.2053
830624	-0.39	392.2	119.8399	0.5659	0.0734	0.0928	0.2064
830625	0.09	357.8	273.1826	1.7312	0.1023	0.1012	0.2139
830626	0.70	407.4	125.2135	0.3403	0.0505	0.0903	0.2068
830627	0.26	443.0	67.3353	0.2273	0.0506	0.0882	0.2027
830628	0.48	477.3	100.8528	0.3518	0.0625	0.0919	0.2053
830629	0.84	420.7	41.0516	0.0925	0.0453	0.0873	0.2034
830630	1.26	411.8	12.4443	0.0545	0.0438	0.0875	0.2037
830701	-0.32	393.5	48.8261	0.1317	0.0471	0.0906	0.2049
830702	-0.32	393.5	58.2352	0.1195	0.0472	0.0919	0.2063
830703	-0.32	393.5	33.7165	0.0997	0.0458	0.0873	0.2065
830704	-0.32	393.5	24.0561	0.0522	0.0456	0.0878	0.2161
830705	-0.32	393.5	20.3643	0.0629	0.0465	0.0904	0.2129
830706	-0.32	363.9	8.3975	0.0534	0.0444	0.0891	0.2075
830707	-0.88	445.8	14.3057	0.0544	0.0455	0.0900	0.2120
830708	1.37	442.5	22.7939	0.0577	0.0445	0.0914	0.2103
830709	-0.39	455.3	19.5251	0.0672	0.0447	0.0916	0.2097
830710	0.78	465.0	51.3236	0.0929	0.0512	0.0947	0.2170
830711	0.60	399.7	57.6838	0.1071	0.0505	0.0969	0.2178
830712	2.07	401.5	43.1700	0.1060	0.0494	0.0926	0.2120
830713	-1.34	555.4	98.2269	0.0975	0.0515	0.0957	0.2176
830714	-1.34	555.4	125.5243	0.1024	0.0518	0.0985	0.2204
830715	-1.34	555.4	183.3351	0.1814	0.0548	0.0996	0.2223
830716	-1.34	555.4	3.7769	0.0461	0.0437	0.0904	0.2115
830717	-1.34	555.4	51.7207	0.0723	0.0479	0.0916	0.2141
830718	-1.34	555.4	56.9284	0.1151	0.0471	0.0916	0.2172
830719	-1.01	555.4	212.0317	0.3193	0.0575	0.0994	0.2205
830720	1.48	479.7	286.5022	0.6035	0.0700	0.1026	0.2249
830721	-1.03	463.1	279.4203	0.5114	0.0692	0.1013	0.2271
830722	-0.12	405.3	124.2042	0.5023	0.0627	0.0947	0.2181
830723	4.49	421.4	4.2854	0.0436	0.0416	0.0828	0.1954
830724	-3.85	443.1	21.2244	0.0676	0.0437	0.0883	0.2055
830725	-0.45	515.9	96.5466	0.1123	0.0489	0.0910	0.2123
830726	0.10	451.5	271.1768	0.3819	0.0628	0.1011	0.2233
830727	0.10	451.5	252.7928	0.3332	0.0601	0.0997	0.2240
830728	0.10	451.5	72.4116	0.1126	0.0504	0.0935	0.2153
830729	0.10	451.5	52.2086	0.0873	0.0476	0.0912	0.2150
830730	0.10	451.5	59.7341	0.1151	0.0483	0.0930	0.2161
830731	0.10	451.5	115.6035	0.1639	0.0527	0.0952	0.2246
830801	-0.66	372.2	192.3115	0.3452	0.0611	0.1051	0.2320
830802	-0.66	427.2	5.6579	0.0460	0.0452	0.0936	0.2132
830803	2.66	564.2	4.6918	0.0476	0.0423	0.0893	0.2095

DATE	BZ	SWVEL	SEESSP	SEEI	SEEII	SEEIII	SEEIV
830804	0.86	531.6	28.5173	0.0561	0.0472	0.0905	0.2145
830805	1.32	405.3	49.3099	0.0753	0.0522	0.0954	0.2205
830806	2.85	367.6	43.3183	0.0729	0.0475	0.0919	0.2081
830807	2.69	333.2	17.5633	0.0502	0.0434	[illegible]	0.2031
830808	2.69	333.2	8.2698	0.0508	0.0442	0.0847	0.2012
830809	2.69	333.2	9.8932	0.0563	0.0442	0.0885	0.2035
830810	2.69	333.2	15.7431	0.0669	0.0429	0.0856	0.2051
830811	2.69	333.2	47.1030	0.1110	0.0475	0.0903	0.2092
830812	2.69	333.2	3.6526	0.0454	0.0426	0.0874	0.2083
830813	-0.63	542.5	22.4241	0.0648	0.0477	0.0920	0.2208
830814	1.05	509.7	132.0583	0.1283	0.0531	0.0996	0.2260
830815	0.24	491.2	183.3936	0.1504	0.0553	0.1000	0.2279
830816	0.06	427.3	250.4874	0.2351	0.0599	0.1034	0.2288
830817	1.34	381.2	38.4445	0.0813	0.0480	0.0914	0.2171
830818	1.78	351.4	212.9304	0.5943	0.0715	0.1060	0.2284
830819	3.17	355.6	135.3966	0.3975	0.0619	0.1001	0.2272
830820	-0.71	422.1	5.9777	0.0468	0.0455	0.0902	0.2145
830821	-0.71	422.1	8.6153	0.0476	0.0435	0.0901	0.2132
830822	-0.71	422.1	31.0290	0.0736	0.0478	0.0906	0.2234
830823	-0.71	422.1	42.9739	0.1049	0.0494	0.0925	0.2205
830824	-0.71	422.1	106.6274	0.2878	0.0587	0.0961	0.2222
830825	-0.71	422.1	180.5868	0.7948	0.0840	0.1035	0.2355
830826	-0.60	581.4	399.9948	1.9240	0.1498	0.1129	0.2362
830827	0.71	490.4	777.2976	5.5075	0.4246	0.1363	0.2643
830828	-1.46	415.6	310.0828	2.2563	0.2198	0.1111	0.2327
830829	0.36	371.9	53.2053	0.3127	0.0590	0.0918	0.2152
830830	0.62	635.3	6.8942	0.0510	0.0437	0.0863	0.2107
830831	-0.23	639.9	166.2012	0.2020	0.0558	0.0986	0.2262
830901	0.70	582.8	196.4010	0.3766	0.0628	0.1024	0.2312
830902	0.70	515.0	282.1411	0.6869	0.0770	0.1073	0.2378
830903	0.70	515.0	250.7995	0.7646	0.0816	0.1066	0.2415
830904	0.70	515.0	292.0909	1.1802	0.1048	0.1090	0.2393
830905	0.70	515.0	235.4409	0.6026	0.0821	0.1067	0.2365
830906	0.70	515.0	86.8791	0.2012	0.0546	0.0982	0.2292
830907	0.70	515.0	21.3002	0.0832	0.0467	0.0939	0.2255
830908	2.10	362.0	5.9497	0.0523	0.0466	0.0961	0.2249
830909	2.49	528.0	6.2765	0.0494	0.0460	0.0927	0.2251
830910	0.79	534.0	44.6622	0.0618	0.0514	0.0974	0.2275
830911	0.73	510.5	155.8239	0.1067	0.0566	0.1039	0.2339
830912	-0.15	465.8	96.7901	0.1413	0.0519	0.0995	0.2275
830913	-0.59	403.4	126.4273	0.2093	0.0565	0.1014	0.2318
830914	1.34	372.1	105.0611	0.1573	0.0535	0.0963	0.2267
830915	2.33	375.1	7.0178	0.0500	0.0444	0.0915	0.2230
830916	2.33	375.1	13.6484	0.0567	0.0469	0.0914	0.2212

DATE	BZ	SWVEL	SEBSSP	SEEI	SEEII	SEEIII	SEEIV
830917	2.33	375.1	175.0748	0.3911	0.0620	0.1000	0.2300
830918	2.33	375.1	253.5108	0.5594	0.0733	0.1054	0.2372
830919	2.33	375.1	27.8209	0.0894	0.0483	0.0933	0.2209
830920	-1.37	489.5	269.5759	0.6867	0.0808	0.1069	0.2364
830921	-1.37	430.5	698.4154	1.9262	0.1425	0.1268	0.2585
830922	-0.66	382.2	356.9766	1.1473	0.0961	0.1105	0.2420
830923	-0.75	323.7	629.8430	3.5511	0.2139	0.1313	0.2609
830924	1.41	380.6	225.0540	0.9161	0.0948	0.1079	0.2397
830925	2.41	580.0	11.2239	0.0600	0.0469	0.0936	0.2209
830926	1.54	663.2	112.1104	0.2117	0.0551	0.0981	0.2277
830927	0.59	625.7	433.6756	0.8814	0.0887	0.1153	0.2502
830928	0.59	625.7	583.2333	1.5415	0.1149	0.1240	0.2583
830929	0.59	625.7	280.9175	0.7566	0.0806	0.1115	0.2455
830930	0.59	625.7	505.0337	3.1832	0.2404	0.1215	0.2607
831001	0.59	625.7	337.1849	1.3829	0.1210	0.1126	0.2446
831002	0.59	625.7	11.2763	0.0602	0.0458	0.0953	0.2232
831003	-2.88	427.2	82.0711	0.1806	0.0523	0.0998	0.2293
831004	-1.50	426.0	17.6032	0.0761	0.0492	0.0948	0.2283
831005	2.64	458.5	25.7346	0.0723	0.0487	0.0965	0.2253
831006	2.31	459.1	10.7290	0.0504	0.0459	0.0956	0.2251
831007	1.83	551.7	29.5990	0.0572	0.0489	0.0959	0.2301
831008	1.33	558.1	42.8985	0.0664	0.0491	0.0951	0.2238
831009	1.46	504.7	61.6628	0.0809	0.0520	0.0982	0.2293
831010	1.96	408.2	72.4207	0.1250	0.0517	0.0983	0.2294
831011	1.96	408.2	84.5935	0.1106	0.0525	0.0998	0.2297
831012	1.96	408.2	82.9764	0.1255	0.0531	0.0989	0.2322
831013	1.96	408.2	5.2966	0.0489	0.0461	0.0933	0.2247
831014	1.96	408.2	13.8164	0.0534	0.0478	0.0951	0.2263
831015	-0.90	409.7	92.8338	0.1428	0.0508	0.1014	0.2268
831016	-0.80	385.3	98.9013	0.2360	0.0555	0.0986	0.2343
831017	-4.22	424.0	20.5290	0.0774	0.0475	0.0944	0.2256
831018	-3.77	488.4	35.9681	0.1054	0.0475	0.0940	0.2274
831019	0.02	464.5	344.3532	0.7599	0.0990	0.1153	0.2486
831020	0.52	389.4	546.9635	2.5230	0.2271	0.1278	0.2603
831021	1.55	450.4	305.3996	1.7729	0.1640	0.1121	0.2420
831022	0.30	560.6	98.1038	0.1764	0.0533	0.0996	0.2328
831023	0.30	510.4	134.7237	0.2478	0.0580	0.0976	0.2300
831024	0.30	510.4	282.6889	0.6840	0.0770	0.1103	0.2460
831025	0.30	510.4	444.0351	1.0826	0.1035	0.1235	0.2657
831026	0.30	510.4	545.8427	2.3992	0.1944	0.1270	0.2693
831027	0.30	510.4	617.8358	2.9352	0.2180	0.1309	0.2624
831028	2.70	334.8	234.5580	0.7747	0.1087	0.1101	0.2432
831029	-2.24	505.0	24.7020	0.0744	0.0478	0.0904	0.2204
831030	-2.31	480.2	191.8190	0.3017	0.0814	[illegible]	[illegible]

DATE	BZ	SWVEL	SEESSD	SEEI	SEEII	SEEIII	SEEIV
831031	-0.67	411.3	199.6836	0.5826	0.0732	0.1101	0.2468
831101	-1.73	370.3	127.0907	0.3452	0.0622	0.1054	0.2435
831102	2.82	611.9	13.2441	0.0587	0.0481	0.0987	0.2375
831103	1.39	605.9	53.7797	0.0732	0.0526	0.1032	0.2289
831104	1.45	532.4	77.5977	0.1185	0.0534	0.1043	0.2425
831105	1.21	532.4	116.8316	0.1934	0.0607	0.1118	0.2432
831106	2.25	532.4	158.9537	0.2866	0.0639	0.1058	0.2435
831107	-1.23	532.4	50.6835	0.0994	0.0522	0.0962	0.2281
831108	-2.97	532.4	23.9970	0.0580	0.0468	0.0919	0.2238
831109	-1.62	589.1	82.2664	0.1600	0.0511	0.0949	0.2228
831110	-1.10	574.8	270.4604	0.5886	0.0749	0.1065	0.2364
831111	4.25	590.3	107.2401	0.4689	0.0648	0.0936	0.2190
831112	-3.83	490.3	54.8620	0.1577	0.0512	0.0912	0.2145
831113	-2.74	415.5	36.4082	0.1052	0.0486	0.0946	0.2211
831114	-1.10	478.8	110.6407	0.3547	0.0607	0.1031	0.2293
831115	1.58	535.9	98.6521	0.4022	0.0634	0.1022	0.2345
831116	0.14	622.8	166.9456	0.3532	0.0681	0.1023	0.2357
831117	0.53	735.0	307.0937	1.0932	0.1060	0.1096	0.2411
831118	0.34	735.0	594.0546	1.9180	0.1552	0.1216	0.2574
831119	1.05	735.0	609.1188	2.4430	0.1901	0.1246	0.2605
831120	0.17	735.0	827.3979	3.6066	0.2750	0.1376	0.2705
831121	0.36	735.0	767.1244	3.7039	0.2723	0.1415	0.2786
831122	0.78	469.3	836.2339	4.6821	0.3699	0.1487	0.2854
831123	1.57	385.9	419.1855	4.1379	1.0926	0.1979	0.3287
831124	-0.72	370.5	314.9636	1.0887	0.1309	0.1154	0.2504
831125	-1.07	444.4	77.0917	0.1306	0.0549	0.0973	0.2369
831126	-1.26	440.0	123.2007	0.2365	0.0575	0.1044	0.2372
831127	0.72	405.1	101.5761	0.1952	0.0590	0.1033	0.2441
831128	2.22	448.2	42.4152	0.1278	0.0548	0.1013	0.2414
831129	1.47	618.2	19.2049	0.0739	0.0498	0.1041	0.2426
831130	0.68	618.2	115.4216	0.1257	0.0559	0.1068	0.2459
831201	0.90	618.2	278.6878	0.3173	0.0651	0.1172	0.2518
831202	1.27	618.2	320.9668	0.4582	0.0736	0.1159	0.2580
831203	1.65	618.2	361.7669	0.6689	0.0842	0.1222	0.2647
831204	1.14	618.2	327.3109	0.7183	0.0887	0.1223	0.2562
831205	-0.86	421.7	60.4529	0.0357	0.0538	0.1029	0.2385
831206	-1.65	595.6	54.1124	0.1102	0.0530	0.1042	0.2368
831207	-1.11	610.7	331.9057	0.6205	0.0748	0.1187	0.2550
831208	0.36	523.4	30.6406	3.3498	0.2054	0.1524	0.2997
831209	3.56	441.4	891.6741	4.5244	0.2699	0.1439	0.2890
831210	0.13	422.8	268.4093	1.3646	0.1215	0.1119	0.2450
831211	-0.49	460.8	8.7918	0.0557	0.0472	0.0950	0.2252
831212	0.62	562.2	36.4771	0.0689	0.0487	0.0961	0.2271
831213	0.10	643.8	175.2748	0.2484	0.0590	0.1039	0.2341

DATE	BZ	SWVEL	SEESSD	SEEI	SEEII	SEEIII	SEEIV
831214	-0.41	643.8	507.8288	1.2235	0.1067	0.1176	0.2534
831215	-0.25	643.8	328.8929	1.3885	0.1197	0.1155	0.2519
831216	-0.25	643.8	516.6509	1.9891	0.1749	0.1296	0.2649
831217	-0.25	643.8	798.1637	4.6481	0.3521	0.1426	0.2842
831218	1.54	387.3	455.7874	2.2605	0.1972	0.1240	0.2625
831219	1.26	407.8	71.1982	0.2106	0.0603	0.1020	0.2399
831220	0.80	445.3	103.3243	0.2877	0.0634	0.1097	0.2449
831221	-0.52	388.5	106.4787	0.3521	0.0678	0.1068	0.2429
831222	-1.18	381.3	46.1835	0.1101	0.0529	0.1038	0.2424
831223	-0.28	406.9	28.1788	0.0857	0.0528	0.0978	0.2382
831224	1.20	384.2	28.7490	0.0902	0.0530	0.0990	0.2428
831225	-0.15	395.5	13.5209	0.0595	0.0513	0.1054	0.2415
831226	0.39	399.2	27.9449	0.0732	0.0512	0.1045	0.2422
831227	-0.05	399.2	100.8805	0.1488	0.0580	0.1098	0.2443
831228	0.26	399.2	69.8345	0.1082	0.0572	0.1073	0.2494
831229	-0.43	393.2	202.7693	0.2180	0.0667	0.1185	0.2611
831230	-2.19	557.0	66.0959	0.1153	0.0551	0.1077	0.2452
831231	-2.84	512.4	226.9893	0.3531	0.0680	0.1139	0.2514
840101	-2.84	500.1	139.5037	0.3319	0.0618	0.1130	0.2481
840102	-2.84	533.1	137.8207	0.4489	0.0700	0.1123	0.2539
840103	-2.84	443.9	200.0558	0.4647	0.0717	0.1166	0.2536
840104	2.77	514.9	26.1700	0.0833	0.0511	0.1054	0.2337
840105	-0.08	598.5	176.9655	0.1698	0.0592	0.1088	0.2442
840106	-0.46	548.4	673.3968	1.0154	0.1006	0.1382	0.2922
840107	-0.99	346.2	976.6953	2.0987	0.1438	0.1576	0.3107
840108	-0.99	346.2	111.9968	2.6622	0.1647	0.1672	0.3207
840109	-0.99	346.2	755.2965	1.9205	0.1436	0.1464	0.2979
840110	-0.99	346.2	135.0891	0.2142	0.0635	0.1160	0.2554
840111	-0.99	346.2	9.8865	0.0607	0.0535	0.1079	0.2489
840112	0.23	397.9	56.7255	0.0834	0.0569	0.1158	0.2589
840113	-0.77	406.3	72.5513	0.0891	0.0568	0.1124	0.2534
840114	-0.57	409.6	14.2393	0.0611	0.0544	0.1126	0.2504
840115	-0.32	390.9	36.0768	0.0737	0.0567	0.1120	0.2524
840116	-0.64	359.8	30.8138	0.0655	0.0544	0.1072	0.2507
840117	-0.34	349.6	13.9477	0.0589	0.0536	0.1085	0.2506
840118	-1.05	324.9	11.4719	0.0563	0.0522	0.1083	0.2463
840119	-1.88	372.6	4.9582	0.0535	0.0529	0.1084	0.2504
840120	-1.88	372.6	35.4529	0.0632	0.0579	0.1149	0.2515
840121	-1.88	372.6	25.5090	0.0575	0.0523	0.1087	0.2524
840122	-1.89	372.6	42.5949	0.0643	0.0549	0.1074	0.2554
840123	-1.88	372.6	42.3541	0.0692	0.0552	0.1100	0.2570
840124	4.79	394.9	40.5292	0.0545	0.0553	0.1097	0.2526
840125	-2.61	366.1	20.0452	0.0562	0.0521	0.1050	0.2454
840126	-2.17	373.1	7.4132	0.0543	0.0522	0.1045	0.2492

DATE	BZ	SWVEL	SEESSI	SEEI	SEEII	SEEIII	SEEIV
840127	-0.94	385.5	5.8702	0.0549	0.0537	0.1084	0.2515
840128	0.99	483.5	6.8249	0.0523	0.0513	0.1065	0.2513
840129	1.08	491.8	10.4035	0.0544	0.0505	0.1013	0.2427
840130	-0.36	671.2	81.5937	0.1238	0.0540	0.1040	0.2435
840131	0.58	668.6	283.6094	0.4902	0.0732	0.1131	0.2562
840201	0.73	658.8	354.4764	0.9795	0.0960	0.1229	0.2630
840202	0.73	658.8	403.9552	1.1240	0.1031	0.1278	0.2699
840203	0.73	658.8	31.8193	0.0993	0.0517	0.1022	0.2279
840204	0.73	658.8	10.0612	0.0570	0.0480	0.0988	0.2339
840205	0.73	658.8	32.8101	0.0907	0.0515	0.1017	0.2270
840206	-0.10	398.2	87.3635	0.1818	0.0595	0.1079	0.2483
840207	0.48	394.6	41.1644	0.0976	0.0551	0.1065	0.2475
840208	-0.51	391.7	142.3114	0.2823	0.0658	0.1160	0.2608
840209	-0.47	428.0	66.9102	0.1093	0.0555	0.1064	0.2508
840210	-2.81	416.6	90.7658	0.1551	0.0570	0.1091	0.2487
840211	-2.53	430.8	65.6594	0.0987	0.0554	0.1083	0.2450
840212	-0.18	395.1	138.9470	0.1535	0.0611	0.1169	0.2603
840213	-6.37	392.1	34.2986	0.0873	0.0498	0.1030	0.2361
840214	-6.37	392.1	82.1503	0.2044	0.0556	0.1033	0.2413
840215	-6.37	392.1	48.4983	0.1556	0.0546	0.1048	0.2427
840216	-6.37	392.1	88.5640	0.3162	0.0935	0.1585	0.3596
840217	-6.37	457.7	230.8326	1.0715	0.1437	11.7252	1.1250
840218	-0.57	437.2	230.8374	1.0716	0.1437	11.7234	1.1251
840219	0.38	412.6	230.8421	1.0716	0.1437	11.7217	1.1252
840220	3.82	414.0	13.3758	0.0722	0.0509	0.1046	0.2333
840221	-1.09	463.5	29.2731	0.0741	0.0534	0.1049	0.2424
840222	0.26	428.5	45.3264	0.0777	0.0548	0.1076	0.2474
840223	0.50	437.7	29.7743	0.0641	0.0515	0.1048	0.2414
840224	2.53	560.5	34.3807	0.0673	0.0509	0.1006	0.2386
840225	1.16	434.8	54.2461	0.0938	0.0546	0.1092	0.2457
840226	0.39	386.5	27.3344	0.0653	0.0505	0.1041	0.2414
840227	0.39	386.5	13.2964	0.0595	0.0503	0.0987	0.2316
840228	0.39	386.5	36.5885	0.0720	0.0510	0.1008	0.2336
840229	0.39	386.5	40.4755	0.0699	0.0518	0.1013	0.2349
840301	-1.58	544.2	22.3254	0.0585	0.0495	0.0972	0.2271
840302	-0.95	681.7	98.1633	0.2392	0.0553	0.0970	0.2241
840303	-1.20	592.9	554.5409	1.6796	0.1266	0.1223	0.2523
840304	0.32	467.1	648.0546	3.4300	0.2262	0.1323	0.2670
840305	2.10	406.5	481.4972	3.5431	0.7833	0.1847	0.3220
840306	-1.33	551.6	213.7771	1.3684	0.1145	0.1082	0.2423
840307	-1.21	538.0	182.6439	0.4261	0.0658	0.1025	0.2368
840308	-1.26	545.4	397.5177	1.4383	0.1141	0.1172	0.2482
840309	0.32	475.5	146.9993	1.1759	0.1265	0.1058	0.2355
840310	0.32	475.5	190.8641	0.9703	0.0971	0.1056	0.2373

DATE	BZ	SWVEL	SEESSI	SEEI	SEEII	SEEIII	SEEIV
840311	0.32	475.5	216.6232	0.8144	0.0911	0.1094	0.2462
840312	0.32	475.5	72.8002	0.2874	0.0619	0.1105	0.2262
840313	0.32	475.5	25.3811	0.0814	0.0495	0.0938	0.2344
840314	2.09	431.3	21.3311	0.0902	0.0604	0.1113	0.2548
840315	3.41	405.5	24.5600	0.1138	0.0544	0.1024	0.2401
840316	2.14	395.6	9.7768	0.0620	0.0493	0.0970	0.2329
840317	0.97	470.6	12.9580	0.0603	0.0473	0.0942	0.2282
840318	0.80	498.8	37.1234	0.0718	0.0489	0.0987	0.2364
840319	0.31	504.5	290.2417	0.2564	0.0654	0.1163	0.2534
840320	1.49	371.7	337.4520	0.4057	0.0708	0.1198	0.2555
840321	0.94	343.2	226.7966	0.2895	0.0629	0.1113	0.2459
840322	-2.37	441.9	16.2245	0.0591	0.0472	0.0948	0.2239
840323	-2.37	441.9	21.9223	0.0763	0.0474	0.0944	0.2189
840324	-2.37	441.9	26.2175	0.0829	0.0482	0.0948	0.2193
840325	-2.37	441.9	32.2076	0.0843	0.0458	0.0969	0.2262
840326	1.13	565.1	64.9681	0.1082	0.0526	0.1003	0.2319
840327	-2.42	493.1	94.9908	0.1649	0.0526	0.0975	0.2225
840328	-3.99	562.2	71.8393	0.2256	0.0515	0.0930	0.2161
840329	-0.77	675.5	193.2357	0.5759	0.0763	0.0975	0.2279
840330	-1.19	663.7	165.1121	0.8817	0.0982	0.0975	0.2271
840331	-1.30	539.2	493.1260	2.3014	0.1917	0.1204	0.2481
840401	-2.69	570.9	189.9978	1.6871	0.1723	0.1052	0.2297
840402	-2.69	570.9	211.7041	2.1744	0.2220	0.1069	0.2288
840403	-4.02	570.9	487.5990	4.4023	0.4841	0.1312	0.2438
840404	-2.71	647.7	756.4777	8.9857	0.8694	0.1573	0.2565
840405	-2.71	647.7	357.2335	2.9559	0.3305	0.1204	0.2332
840406	-2.71	647.7	809.0072	7.4300	0.8655	0.1659	0.2702
840407	-2.71	647.7	421.5092	4.2801	0.4779	0.1301	0.2391
840408	-2.71	647.7	103.0418	1.3676	0.1782	0.1013	0.2238
840409	-2.71	647.7	36.4212	0.2845	0.0619	0.0955	0.2184
840410	-0.10	647.7	43.9906	0.6320	0.1335	0.0998	0.2240
840411	-0.10	647.7	97.7905	0.5744	0.0846	0.1003	0.2313
840412	-0.10	647.7	132.2853	0.7089	0.1091	0.1039	0.2361
840413	-0.10	647.7	11.1036	0.0618	0.0477	0.0973	0.2248
840414	11.41	647.7	18.7878	0.1386	0.0545	0.0990	0.2292
840415	11.41	647.7	18.3118	0.0638	0.0494	0.0998	0.2323
840416	-1.52	647.7	20.1350	0.0800	0.0498	0.0983	0.2263
840417	-1.52	647.7	17.6089	0.0748	0.0501	0.1016	0.2297
840418	-1.52	647.7	7.5718	0.0558	0.0485	0.0993	0.2269
840419	-1.52	647.7	5.4059	0.0520	0.0474	0.0957	0.2243
840420	-1.52	647.7	26.8115	0.0787	0.0496	0.0965	0.2295
840421	-0.09	558.5	97.2781	0.2225	0.0665	0.1048	0.2367
840422	0.83	445.0	161.1068	0.2815	0.0759	0.1114	0.2459
840423	0.83	445.0	128.2010	0.2711	0.0727	0.1094	0.2442

DATE	BZ	SWVEL	SEESSP	SEEI	SEEII	SEEIII	SEEIV
840424	1.00	445.0	26.5909	0.0672	0.0521	0.0994	0.2341
840425	-3.34	445.0	13.2240	0.1513	0.0928	0.1249	0.2403
840426	-3.72	445.0	148.6642	2.0717	0.7248	0.4132	0.3453
840427	-1.33	533.8	298.6903	1.3784	0.3613	0.2004	0.2595
840428	-1.33	533.8	774.4427	3.4992	0.2776	0.1556	0.2478
840429	-1.33	533.8	39.3608	5.2853	0.3139	0.1515	0.2639
840430	-1.33	533.8	98.7328	6.0495	0.3098	0.1540	0.2783
840501	-1.33	533.8	456.3110	2.0570	0.1350	0.1195	0.2305
840502	-1.33	533.8	327.2597	2.0885	0.1883	0.1196	0.2387
840503	0.69	474.8	366.1742	3.4422	0.3385	0.1247	0.2374
840504	-1.84	458.2	161.1268	0.6010	0.0734	0.1050	0.2295
840505	-3.20	400.4	128.3955	0.2701	0.0573	0.1034	0.2284
840506	0.81	362.4	36.7974	0.1561	0.0527	0.1023	0.2275
840507	2.60	335.3	91.5988	0.4279	0.0589	0.1075	0.2311
840508	4.86	371.1	103.5002	0.4574	0.0661	0.1026	0.2279
840509	0.15	385.0	36.2406	0.1385	0.0518	0.0983	0.2227
840510	2.12	434.0	11.8988	0.0541	0.0459	0.0963	0.2201
840511	6.25	464.8	9.2150	0.0512	0.0453	0.0923	0.2066
840512	6.25	418.9	5.5503	0.0468	0.0437	0.0924	0.2115
840513	6.25	418.9	9.0273	0.0477	0.0448	0.0964	0.2146
840514	6.25	418.9	10.6299	0.0533	0.0484	0.0994	0.2191
840515	6.25	418.9	15.5008	0.0539	0.0461	0.0962	0.2191
840516	6.25	418.9	26.6945	0.0648	0.0479	0.1007	0.2255
840517	3.53	538.5	11.1762	0.0555	0.0444	0.0918	0.2049
840518	-0.42	471.8	10.1852	0.0535	0.0460	0.0929	0.2100
840519	-0.44	454.1	39.4121	0.1112	0.0473	0.0931	0.2133
840520	-0.78	483.8	80.2955	0.1149	0.0518	0.1002	0.2205
840521	-2.23	541.3	31.2427	0.1534	0.0518	0.0994	0.2228
840522	-1.63	590.1	362.9964	1.4700	0.1128	0.1132	0.2375
840523	0.52	636.2	621.6406	4.1070	0.2812	0.1274	0.2510
840524	2.19	635.6	475.0843	3.3244	0.2731	0.1157	0.2409
840525	2.19	635.6	158.5559	0.7110	0.0756	0.1003	0.2257
840526	2.19	635.6	210.1347	1.0432	0.1021	0.1061	0.2192
840527	2.19	635.6	464.4539	2.7071	0.1960	0.1248	0.2506
840528	-1.63	480.0	323.2195	1.5239	0.1251	0.1132	0.2395
840529	-0.86	438.1	164.1316	0.5700	0.0704	0.1039	0.2245
840530	3.81	418.5	64.5959	0.3225	0.0595	0.0976	0.2219
840531	2.66	418.5	19.4648	0.1268	0.0514	0.1016	0.2225
840601	1.70	334.5	63.7952	0.4468	0.0671	0.1037	0.2338
840602	-0.76	390.5	36.3593	0.1131	0.0503	0.1007	0.2255
840603	-0.44	471.5	37.2352	0.1522	0.0519	0.0989	0.2222
840604	-0.70	566.8	26.8641	0.0680	0.0483	0.1095	0.2183
840605	-1.23	588.7	92.2160	0.1435	0.0526	0.1031	0.2319
840606	-1.23	588.7	156.2100	0.2307	0.0554	0.1059	0.2311

DATE	BZ	SWVEL	SEESSE	SEEI	SEEII	SEEIII	SEEIV
840607	-1.23	588.7	129.9914	0.1922	0.0556	0.1056	0.2312
840608	-1.23	588.7	192.9457	0.4599	0.0657	0.1069	0.2373
840609	-1.23	588.7	43.7022	0.1052	0.0509	0.1024	0.2289
840610	-0.59	656.0	216.7139	0.2214	0.0596	0.1194	0.2428
840611	0.40	587.6	600.4174	0.5800	0.0919	0.1294	0.2643
840612	0.08	512.3	659.7035	0.9450	0.0975	0.1373	0.2670
840613	0.32	365.5	579.0411	1.0772	0.0959	0.1363	0.2695
840614	0.07	367.1	377.3713	0.6673	0.0897	0.1239	0.2631
840615	1.78	490.5	74.4494	0.1341	0.0541	0.1045	0.2381
840616	-0.22	646.8	74.1187	0.1388	0.0549	0.1028	0.2289
840617	1.39	530.1	143.3897	0.2233	0.0574	0.1051	0.2337
840618	1.39	509.8	84.0062	0.1980	0.0546	0.1013	0.2265
840619	1.39	509.8	126.4588	0.1946	0.0549	0.1036	0.2278
840620	1.39	509.8	113.4334	0.2436	0.0580	0.0950	0.2375
840621	1.39	509.8	232.7680	1.0775	0.1431	11.0268	1.1621
840622	1.39	509.8	542.5692	3.5022	0.2316	0.1322	0.2631
840623	1.39	509.8	565.5732	7.3005	0.5081	0.1324	0.2608
840624	1.12	453.7	65.1381	0.2589	0.0582	0.1062	0.2361
840625	0.32	408.2	66.5555	0.2664	0.0615	0.1077	0.2399
840626	0.60	408.0	109.9318	0.3920	0.0696	0.1095	0.2436
840627	-0.69	379.6	78.7414	0.1637	0.0565	0.1068	0.2425
840628	-4.56	376.3	14.0224	0.0669	0.0477	0.1021	0.2341
840629	2.12	442.6	7.1928	0.0523	0.0492	0.1002	0.2285
840630	-2.33	504.3	79.3223	0.0817	0.0530	0.1052	0.2341
840701	-2.33	504.3	112.6738	0.1244	0.0546	0.1062	0.2375
840702	-2.33	504.3	86.6237	0.0975	0.0533	0.1031	0.2358
840703	-2.33	504.3	138.8681	0.1451	0.0546	0.1064	0.2367
840704	-2.33	504.3	112.4972	0.1416	0.0545	0.1033	0.2331
840705	-2.33	572.5	124.6674	0.1597	0.0578	0.1092	0.2392
840706	-0.47	541.3	154.7901	0.2073	0.0592	0.1122	0.2411
840707	0.16	514.0	204.5325	0.2585	0.0635	0.1161	0.2515
840708	-0.20	451.6	241.4356	0.2353	0.0630	0.1188	0.2544
840709	-0.26	434.6	163.1024	0.1798	0.0589	0.1121	0.2522
840710	-1.20	427.7	118.4210	0.1393	0.0558	0.1060	0.2360
840711	-2.80	382.9	80.8242	0.0983	0.0549	0.1030	0.2350
840712	1.35	404.4	19.1828	0.0642	0.0488	0.0946	0.2290
840713	1.41	419.0	4.2970	0.0497	0.0465	0.0946	0.2237
840714	1.41	419.0	135.9740	0.3468	0.0610	0.1053	0.2354
840715	1.41	419.0	478.2426	1.2106	0.1034	0.1230	0.2593
840716	1.41	419.0	559.9037	2.6790	0.1679	0.1245	0.2627
840717	1.41	419.0	939.4742	5.7021	0.3803	0.1469	0.2824
840718	1.41	419.0	928.7066	4.3364	0.3085	0.1412	0.2913
840719	1.06	419.0	233.2374	1.0789	0.1430	10.8574	1.1711
840720	-0.20	554.5	696.7854	6.5673	2.0402	0.2855	0.3957

DATE	BZ	SWVEL	SEESSP	SEEI	SEEII	SEEIII	SEEIV
840721	1.07	529.9	710.2981	2.9836	2.6231	0.2896	0.3949
840722	1.65	454.6	710.7416	5.5401	1.0653	0.2000	0.3396
840723	0.77	413.4	905.1847	8.2695	0.7093	0.1674	0.2905
840724	1.65	445.5	162.4967	0.5072	0.0780	0.1079	0.2417
840725	0.50	403.0	112.7585	0.2966	0.0646	0.1027	0.2314
840726	0.50	308.8	17.3805	0.0964	0.0500	0.0966	0.2272
840727	0.50	308.8	28.0916	0.0791	0.0493	0.0949	0.2257
840728	0.50	308.8	28.1458	0.0703	0.0496	0.0969	0.2275
840729	0.50	308.8	72.9209	0.1212	0.0548	0.1016	0.2298
840730	0.50	308.8	189.8442	0.2614	0.0661	0.1092	0.2434
840731	-1.65	392.4	154.6724	0.2139	0.0608	0.1052	0.2358
840801	-2.12	592.6	31.7613	0.0636	0.0496	0.0939	0.2279
840802	-0.56	607.1	805.5638	1.8103	0.1245	0.1389	0.2817
840803	-1.02	530.6	306.2339	3.4434	0.1891	0.1637	0.3134
840804	-0.84	491.9	935.3943	3.3852	0.1915	0.1501	0.2936
840805	-0.76	460.5	578.9531	9.9773	0.5281	0.1857	0.3313
840806	-0.58	397.0	35.4731	4.4055	0.7043	0.2085	0.3614
840807	-0.63	347.2	408.2106	0.9244	0.6899	0.1864	0.3275
840808	-1.47	344.0	110.0014	0.2024	0.0613	0.1065	0.2453
840809	-1.47	344.0	88.0228	0.1564	0.0549	0.1051	0.2428
840810	-1.47	344.0	27.6241	0.0785	0.0520	0.1041	0.2435
840811	-1.47	344.0	12.0340	0.0563	0.0509	0.1044	0.2403
840812	-1.47	344.0	16.0790	0.0592	0.0512	0.1035	0.2410
840813	2.32	425.1	74.8473	0.0835	0.0545	0.1073	0.2479
840814	-0.06	414.6	47.6978	0.0764	0.0514	0.1048	0.2425
840815	1.48	568.2	166.5823	0.1523	0.0580	0.1083	0.2484
840816	0.54	525.7	285.3130	0.2825	0.0672	0.1168	0.2553
840817	1.11	497.1	557.2972	0.8296	0.0885	0.1319	0.2757
840818	2.87	435.0	610.8335	1.0756	0.0984	0.1382	0.2856
840819	0.86	398.7	518.6164	1.1281	0.1011	0.1331	0.2737
840820	0.86	398.7	38.0973	0.1030	0.0541	0.1061	0.2477
840821	0.86	398.7	57.4382	0.1638	0.0578	0.1116	0.2494
840822	0.86	398.7	58.6682	0.2358	0.0595	0.1132	0.2536
840823	0.86	398.7	16.6621	0.0781	0.0519	0.1003	0.2425
840824	0.86	398.7	6.6562	0.0524	0.0481	0.1015	0.2372
840825	-1.69	398.7	104.5318	0.1170	0.0551	0.1047	0.2463
840826	-1.21	442.0	247.1872	0.2352	0.0636	0.1152	0.2565
840827	-2.25	464.1	155.3522	0.2081	0.0594	0.1104	0.2491
840828	-0.63	608.6	83.5577	0.0988	0.0534	0.1060	0.2435
840829	0.80	569.5	564.8046	1.3519	0.1097	0.1321	0.2758
840830	-1.84	484.8	18.2476	3.5639	0.1941	0.1580	0.3047
840831	1.37	407.3	672.7576	3.1989	0.1998	0.1415	0.2891
840901	1.37	310.0	315.0660	1.7815	0.1584	0.1297	0.2649
840902	1.37	310.0	152.1864	0.6237	0.0301	0.1131	0.2551

DATE	PC	SWVEL	SEESSI	SEEI	SEEII	SEEIII	SEEIV
840903	1.37	310.0	51.9340	0.1871	0.0691	0.1065	0.2499
840904	1.37	310.0	10.8300	0.0771	0.0596	0.1032	0.2419
840905	1.37	310.0	37.2010	0.1810	0.0554	0.1020	0.2363
840906	-0.56	310.0	275.2691	0.9946	0.1399	0.1165	0.2569
840907	1.62	410.0	342.3694	1.3632	0.1719	0.1225	0.2584
840908	4.94	401.8	427.1530	3.1328	0.2852	0.1341	0.2647
840909	2.41	478.1	274.3305	0.6577	0.0911	0.1153	0.2617
840910	0.53	702.1	143.5957	0.4275	0.0734	0.1112	0.2551
840911	0.49	693.9	453.5367	1.0391	0.1041	0.1307	0.2729
840912	0.52	635.0	487.8800	1.0487	0.1051	0.1315	0.2786
840913	2.93	614.9	994.2604	2.8085	0.1793	0.1604	0.3087
840914	2.93	614.9	61.1532	4.3661	0.2810	0.1599	0.3111
840915	2.93	614.9	966.8851	4.2315	0.2843	0.1611	0.3111
840916	2.93	614.9	445.4474	1.8700	0.1576	0.1318	0.2732
840917	2.93	614.9	448.0508	2.3083	0.2086	0.1372	0.2777
840918	2.93	614.9	707.6599	5.7569	0.4912	0.1581	0.2931
840919	-0.87	522.3	58.5614	0.4342	0.0887	0.1087	0.2458
840920	-0.68	448.5	225.4315	0.2329	0.0639	0.1120	0.2547
840921	-0.46	460.2	383.4935	0.7006	0.0802	0.1221	6.6021
840922	-0.23	462.9	317.5739	0.6457	0.0766	0.1205	0.2643
840923	-2.38	643.9	76.3074	0.2481	0.0590	0.1025	0.2426
840924	-0.49	751.4	941.1225	6.0505	0.4564	0.1578	0.2911
840925	-0.72	680.0	603.8993	5.0378	1.2639	0.2135	0.3335
840926	-2.21	685.0	46.9794	4.3674	1.4728	0.2041	0.3010
840927	-2.21	685.0	781.5458	9.2272	1.0231	0.1796	0.2892
840928	-2.21	685.0	27.8259	9.1128	0.9936	0.1929	0.3033
840929	-2.21	685.0	396.5352	4.9359	0.7368	0.1819	0.2727
840930	-2.21	685.0	286.2962	2.0504	0.2092	0.1282	0.2663
841001	-2.21	685.0	414.4194	5.7008	0.7369	0.1663	0.2708
841002	-1.20	336.0	238.4428	1.6975	0.2316	0.1270	0.2617
841003	1.79	372.7	16.5669	0.0729	0.0524	0.1051	0.2441
841004	1.99	368.9	8.4053	0.0641	0.0516	0.1061	0.2440
841005	2.25	356.0	11.4484	0.0648	0.0518	0.1045	0.2409
841006	1.20	403.3	7.7531	0.0549	0.0476	0.0953	0.2269
841007	3.00	556.3	14.7853	0.0640	0.0492	0.1018	0.2416
841008	0.97	698.3	183.6185	0.2446	0.0636	0.1126	0.2511
841009	0.97	710.5	291.1329	0.4274	0.0726	0.1191	0.2627
841010	0.97	710.5	710.3834	2.2427	0.1570	0.1428	0.2919
841011	0.97	710.5	797.6239	2.8777	0.2009	0.1496	0.2909
841012	0.97	710.5	124.0873	5.3760	0.3607	0.1696	0.3063
841013	0.97	710.5	98.1200	5.8271	0.3872	0.1692	0.3134
841014	-1.80	536.0	367.0674	7.1343	0.5042	0.1857	0.3340
841015	-0.65	471.3	985.9666	6.6835	0.4991	0.1966	0.3115
841016	-1.40	458.8	234.6602	1.0833	0.1425	10.3441	1.1984

DATE	BZ	SWVEL	SEESSD	SEEI	SEEII	SEEIII	SEEIV
841017	1.13	364.8	234.6650	1.0833	0.1425	10.3423	1.1994
841018	1.15	392.9	5.0792	0.0564	0.0517	0.1021	0.2442
841019	-2.27	552.7	129.0053	0.2366	0.0592	0.1095	0.2473
841020	-0.55	726.3	747.5139	4.7316	0.3596	0.1441	0.2786
841021	-0.86	715.2	228.2435	0.4935	0.9487	0.1910	0.3124
841022	2.30	703.0	595.2448	6.3987	1.5023	0.2317	0.3328
841023	2.30	703.0	141.0585	0.8710	1.0354	0.1977	0.3109
841024	2.30	703.0	132.8678	2.1664	1.2066	0.2058	0.3102
841025	2.30	703.0	58.6963	8.8784	1.8925	0.2789	0.3735
841026	2.30	703.0	117.7140	1.6517	0.2805	0.1239	0.2434
841027	2.65	414.2	165.0843	3.3321	0.5933	0.1512	0.2492
841028	0.45	454.7	202.0982	5.4452	1.0325	0.1866	0.2592
841029	0.14	405.3	97.2613	1.2754	0.1923	0.1182	0.2492
841030	1.54	364.0	57.5894	0.7474	0.1474	0.1173	0.2603
841031	1.76	349.0	234.7321	1.0835	0.1425	10.3181	1.1997
841101	5.84	453.5	235.0674	1.0845	0.1424	10.1971	1.2062
841102	8.27	500.6	235.0674	1.0835	0.1425	10.1954	1.2062
841103	1.96	572.7	235.0674	1.0845	0.1424	10.1971	1.2062
841104	2.39	572.7	235.0674	1.0846	0.1424	10.1954	1.2062
841105	2.39	572.7	183.1481	0.1958	0.0627	0.1169	0.2553
841106	2.39	572.7	199.6639	0.2746	0.0657	0.1173	0.2586
841107	2.39	572.7	159.0099	0.2638	0.0652	0.1195	0.2564
841108	2.39	572.7	147.5693	0.1363	0.0613	0.1123	0.2529
841109	2.39	572.7	192.9507	0.2495	0.0631	0.1130	0.2543
841110	2.84	634.5	247.6573	0.3165	0.0673	0.1166	0.2625
841111	0.72	581.0	285.5954	0.4195	0.0738	0.1224	0.2635
841112	1.17	540.6	161.7752	0.3198	0.0668	0.1168	0.2555
841113	1.17	540.6	133.0825	0.3645	0.0689	0.1135	0.2534
841114	2.59	441.7	111.4039	0.1947	0.0583	0.1085	0.2467
841115	-1.83	513.6	21.3140	0.0762	0.0507	0.1011	0.2369
841116	-6.42	576.0	85.4704	0.4511	0.0794	0.1061	0.2450
841117	-6.42	576.0	598.2737	6.5855	0.5330	0.1938	0.3307
841118	-6.42	576.0	371.1382	9.7925	0.7955	0.1962	0.3170
841119	-6.42	576.0	510.8710	3.3648	1.2100	0.2237	0.3307
841120	-6.42	576.0	556.6871	0.8128	0.8191	0.1965	0.3281
841121	-6.42	576.0	878.1363	8.4434	0.7404	0.1772	0.2981
841122	-0.42	496.9	330.7316	2.2672	0.2154	0.1338	0.2646
841123	-0.42	496.9	270.8994	2.1856	0.3233	0.1410	0.2680
841124	-0.42	496.9	367.9759	3.6690	0.5635	0.1604	0.2689
841125	0.47	376.0	236.8218	2.3391	0.3695	0.1433	0.2645
841126	0.47	376.0	60.5795	0.1998	0.0664	0.1128	0.2545
841127	1.53	376.0	70.1465	0.4517	0.1044	0.1179	0.2575
841128	0.42	376.0	61.7584	0.3765	0.0845	0.1133	0.2527
841129	4.16	376.0	24.8612	0.1730	0.0661	0.1101	0.2552

DATE	BZ	SWVEL	SEPSSI	SEEI	SEEII	SEEIII	SEEIV
841130	4.16	376.0	13.8331	0.0945	0.0517	0.1080	0.2415
841201	4.16	376.0	101.2490	0.1187	0.0612	0.1170	0.2565
841202	4.16	376.0	62.6510	0.0875	0.0559	0.1092	0.2452
841203	4.16	376.0	446.1147	0.5454	0.0767	0.1228	0.2581
841204	4.16	376.0	326.5432	0.6994	0.0807	0.1243	0.2629
841205	0.10	707.1	361.6308	0.9742	0.0955	0.1268	0.2714
841206	0.08	644.0	886.9927	2.6297	0.1839	0.1543	0.2929
841207	-0.19	635.2	741.2852	2.8107	0.1919	0.1423	0.2992
841208	-0.57	635.2	964.6821	4.0155	0.2598	0.1719	0.3166
841209	-0.57	635.2	861.5584	3.7093	0.2414	0.1633	0.3206
841210	1.27	368.5	557.2236	2.4619	0.2023	0.1432	0.2856
841211	-1.44	562.5	191.9280	0.5519	0.0853	0.1182	0.2582
841212	0.83	521.6	62.2337	0.1079	0.0574	0.1119	0.2502
841213	0.83	521.6	104.0566	0.1146	0.0575	0.1116	0.2501
841214	0.83	521.6	293.3018	0.2818	0.0701	0.1229	0.2648
841215	0.83	521.6	479.8995	0.6726	0.0867	0.1349	0.2744
841216	0.83	521.6	312.5101	0.4379	0.0744	0.1225	0.2661
841217	-0.52	521.6	643.2272	1.3805	0.1121	0.1385	0.2870
841218	-0.49	598.7	282.4524	3.7688	0.2362	0.1771	0.3255
841219	-0.58	469.4	555.9530	4.7805	0.2953	0.2007	0.3596
841220	-1.51	401.3	577.4872	5.9143	0.3700	0.2044	0.3602
841221	1.14	398.0	627.3108	2.8222	0.2118	0.1451	0.2964
841222	0.03	408.5	58.0347	0.1204	0.0576	0.1103	0.2517
841223	-1.10	445.0	10.7553	0.0563	0.0530	0.1036	0.2451
841224	0.64	445.0	61.7885	0.0928	0.0581	0.1129	0.2549
841225	3.95	320.6	29.7314	0.0677	0.0539	0.1095	0.2509
841226	3.95	320.6	16.2548	0.0605	0.0518	0.1052	0.2461
841227	3.95	320.6	32.0501	0.0690	0.0532	0.1082	0.2479
841228	3.95	320.6	249.9883	0.2571	0.0673	0.1213	0.2592
841229	3.95	320.6	393.0954	0.5095	0.0765	0.1281	0.2788
841230	3.95	619.3	765.9006	1.5993	0.1202	0.1453	0.2917
841231	3.95	661.6	768.5547	1.9921	0.1382	0.1454	0.2924
850101	3.95	724.1	467.5444	1.8427	0.1449	0.1362	0.2714
850102	3.95	682.9	303.7992	1.0191	0.1085	0.1273	0.2739
850103	3.95	682.9	793.8506	1.9083	0.1637	0.1540	0.2944
850104	3.95	453.0	924.7980	2.8859	0.2206	0.1590	0.3155
850105	3.95	424.6	548.8491	1.9472	0.1653	0.1391	0.2955
850106	3.95	424.6	171.7523	0.2654	0.0723	0.1213	0.2571
850107	3.95	424.6	180.0259	0.3767	0.0741	0.1167	0.2660
850108	3.95	424.6	77.1919	0.2306	0.0658	0.1133	0.2608
850109	3.95	424.6	121.5396	0.1813	0.0597	0.1129	0.2591
850110	3.95	424.6	855.5011	1.5252	0.1250	0.1550	0.3016
850111	0.92	655.5	803.1394	1.7332	0.1329	0.1520	0.3092
850112	1.32	629.0	974.5895	2.5763	0.1675	0.1654	0.3179

DATE	BZ	SWVEL	SEESSI	SEEI	SEEII	SEEIII	SEEIV
850113	0.57	574.4	973.1761	3.6460	0.2218	0.1651	0.3218
850114	-0.60	574.4	999.0406	4.5013	0.2741	0.1699	0.3199
850115	0.99	446.5	518.3029	2.2621	0.1500	0.1347	0.2925
850116	0.36	484.7	203.0687	0.7731	0.0690	0.1215	0.2681
850117	-0.10	412.1	184.7342	0.7658	0.0875	0.1216	0.2639
850118	0.57	370.2	45.6031	0.2027	0.0649	0.1115	0.2580
850119	-0.54	342.5	86.2874	0.4023	0.0773	0.1152	0.2569
850120	-0.54	342.5	63.3030	0.2495	0.0693	0.1132	0.2554
850121	-0.54	342.5	78.2433	0.2468	0.0684	0.1133	0.2597
850122	-0.54	342.5	15.6787	0.0587	0.0564	0.1079	0.2525
850123	-0.54	600.0	47.7974	0.0860	0.0550	0.1103	0.2530
850124	-0.10	469.3	176.6067	0.1863	0.0670	0.1236	0.2687
850125	6.75	479.0	191.2083	0.2278	0.0627	0.1164	0.2548
850126	1.65	409.8	139.8997	0.2255	0.0631	0.1118	0.2466
850127	-2.52	399.7	48.2095	0.0690	0.0557	0.1100	0.2466
850128	-4.72	490.0	46.5021	0.0948	0.0533	0.1063	0.2464
850129	-2.42	481.1	200.3278	0.6910	0.0839	0.1222	0.2673
850130	0.81	469.3	512.2911	1.9704	0.1592	0.1358	0.2862
850131	-0.55	417.3	463.0419	1.9725	0.1475	0.1380	0.2841
850201	-0.55	417.3	337.8270	1.2648	0.1093	0.1300	0.2781
850202	-0.55	417.3	306.3029	1.4144	0.1337	0.1303	0.2761
850203	-0.55	417.3	608.1980	3.7692	0.2897	0.1442	0.2940
850204	-0.55	417.3	520.8087	4.2241	0.3293	0.1453	0.3054
850205	-0.55	529.8	65.0849	0.3064	0.0709	0.1117	0.2577
850206	2.31	529.8	38.6712	0.0872	0.0547	0.1068	0.2510
850207	1.62	675.5	295.1098	0.3172	0.0721	0.1261	0.2717
850208	0.25	647.4	502.4382	0.7589	0.0895	0.1356	0.2904
850209	0.71	593.1	382.1718	1.2338	0.1049	0.1331	0.2823
850210	2.66	665.0	581.5863	2.4078	0.1683	0.1452	0.2951
850211	0.93	627.4	633.6258	3.0455	0.2253	0.1491	0.3010
850212	0.71	559.2	810.8228	3.3673	0.2741	0.1648	0.3268
850213	1.02	510.3	831.9723	4.7919	0.3904	0.1655	0.3308
850214	1.02	510.3	347.0404	1.3927	0.1463	0.1310	0.2839
850215	1.02	510.3	242.3249	0.8622	0.1077	0.1288	0.2776
850216	1.02	510.3	311.7280	1.8292	0.1920	0.1319	0.2848
850217	1.02	485.0	172.0926	0.7171	0.1005	0.1224	0.2741
850218	1.55	438.1	14.1167	0.3680	0.0952	0.1177	0.2672
850219	0.88	391.3	37.8612	0.7063	0.1067	0.1145	0.2641
850220	-2.24	331.0	24.5211	0.1168	0.0589	0.1115	0.2638
850221	-2.57	376.0	24.6671	0.0982	0.0594	0.1165	0.2640
850222	-0.77	364.9	20.9095	0.0838	0.0579	0.1128	0.2618
850223	-1.81	349.3	26.8773	0.0764	0.0570	0.1139	0.2650
850224	-1.79	412.3	6.8921	0.0596	0.0541	0.1098	0.2582
850225	-1.56	424.2	49.7695	0.0775	0.0572	0.1122	0.2597

DATE	BZ	SWVEL	SEESSI	SEEI	SEEII	SEEIII	SEEIV
850226	-2.42	375.5	48.7117	0.0761	0.0581	0.1147	0.2554
850227	-2.42	375.5	36.0171	0.0749	0.0571	0.1112	0.2657
850228	-2.42	375.5	110.0336	0.1716	0.0606	0.1163	0.2691
850301	-2.42	375.5	222.4541	0.4592	0.0759	0.1271	[illegible]
850302	1.34	598.0	326.9134	0.8003	0.0897	0.1294	0.2648
850303	1.65	604.0	234.9399	0.5975	0.0902	0.1244	[illegible]
850304	2.43	462.4	231.4010	0.7187	0.0953	0.1279	0.2754
850305	1.22	659.7	173.5347	0.4921	0.0772	0.1272	[illegible]
850306	1.97	701.0	378.2263	0.8363	0.0995	0.1294	[illegible]
850307	1.68	760.6	429.0356	0.9491	0.1039	0.1341	[illegible]
850308	1.45	694.6	766.8057	3.5889	0.2699	0.1577	0.3114
850309	0.93	504.6	323.2904	9.2491	0.7062	0.2007	0.3535
850310	5.60	465.0	348.4363	3.2427	1.2118	0.2188	0.3421
850311	5.60	465.0	72.1522	0.2236	0.0927	0.1161	0.2612
850312	5.60	465.0	75.1244	0.4149	0.0762	0.1135	0.2612
850313	5.60	465.0	18.6538	0.1004	0.0566	0.1125	0.2616
850314	-1.03	383.0	24.4017	0.1264	0.0588	0.1138	0.2620
850315	1.23	466.4	8.9149	0.0607	0.0537	0.1107	0.2593
850316	0.93	454.7	12.5553	0.0675	0.0557	0.1113	0.2601
850317	1.12	404.0	29.5768	0.0857	0.0590	0.1145	0.2691
850318	-0.82	393.2	11.7745	0.0638	0.0562	0.1131	0.2625
850319	-1.67	375.8	12.8501	0.0602	0.0546	0.1094	0.2628
850320	1.19	363.4	17.2438	0.0617	0.0575	0.1114	0.2646
850321	0.11	331.8	16.1537	0.0631	0.0563	0.1110	0.2655
850322	0.53	333.2	7.3158	0.0595	0.0572	0.1156	0.2673
850323	-0.55	318.2	6.0041	0.0575	0.0548	0.1137	0.2630
850324	-0.55	318.2	4.3811	0.0562	0.0548	0.1112	0.2626
850325	-0.55	318.2	3.9757	0.0579	0.0535	0.1120	0.2650
850326	-0.55	318.2	4.3546	0.0551	0.0538	0.1108	0.2584
850327	-2.63	327.4	3.6204	0.0558	0.0546	0.1106	0.2584
850328	2.38	376.9	3.0909	0.0566	0.0556	0.1095	0.2619
850329	2.33	405.4	3.7493	0.0580	0.0571	0.1136	0.2651
850330	2.54	435.1	19.6132	0.0615	0.0580	0.1143	0.2694
850331	3.39	492.5	8.3199	0.0580	0.0557	0.1119	0.2654
850401	1.08	582.0	3.4146	0.0514	0.0546	0.1099	0.2669
850402	1.08	692.5	66.3900	0.0735	0.0598	0.1157	0.2690
850403	1.08	644.1	360.9408	0.3222	0.0810	0.1331	0.2951
850404	1.08	589.5	739.3507	1.0454	0.1116	0.1659	0.3044
850405	1.08	553.8	772.7992	1.5073	0.1235	0.1640	0.3359
850406	1.08	553.8	799.3716	2.0656	0.1490	0.1702	0.3411
850407	1.08	553.8	93.7434	0.1501	0.0644	0.1232	0.2794
850408	1.08	553.8	57.0671	0.1386	0.0621	0.1196	0.2772
850409	1.08	438.3	28.9246	0.0739	0.0572	0.1164	0.2790
850410	1.08	433.0	50.5119	0.0779	0.0593	0.1190	0.2767

DATE	BZ	SWVEL	SEBSSD	SEBI	SEBII	SEBIII	SEBIV
850411	1.08	477.5	42.9496	0.0807	0.0615	0.1206	0.2742
850412	1.09	469.1	62.8717	0.1176	0.0652	0.1246	0.2900
850413			82.6152	0.1729	0.0669	0.1266	0.2825
850414			116.1099	0.1493	0.0646	0.1255	0.2825
850415			81.0242	0.1495	0.0656	0.1252	0.2839
850416			57.5142	0.0980	0.0605	0.1234	0.2783
850417			35.9637	0.0755	0.0599	0.1215	0.2802
850418			55.1824	0.0891	0.0629	0.1259	0.2854
850419			10.2484	0.0597	0.0567	0.1158	0.2733
850420			5.6966	0.0547	0.0553	0.1111	0.2644
850421			44.5212	0.2207	0.0653	0.1168	0.2684
850422			149.5794	0.7759	0.1159	0.1272	0.2856
850423			334.6781	1.3693	0.1443	0.1370	0.2948
850424			333.9201	1.6086	0.1572	0.1477	0.3023
850425			387.6622	1.9593	0.1697	0.1435	0.2999
850426			83.5531	0.2692	0.0652	0.1108	0.2493
850427			172.4058	0.5695	0.0735	0.1118	0.2446
850428			193.6247	1.4132	0.1825	0.1124	0.2398
850429			152.9477	1.0986	0.1226	0.1146	0.2438
850430			77.0905	0.8475	0.1357	0.1149	0.2477
850501			27.6922	0.1054	0.0564	0.1176	0.2472
850502			120.9975	0.2376	0.0660	0.1129	0.2604
850503			227.0148	0.4756	0.0815	0.1190	0.2698
850504			165.7690	0.2751	0.0669	0.1190	0.2690
850505			52.2372	0.2382	0.0727	0.1145	0.2692
850506			48.7417	0.1147	0.0594	0.1153	0.2666
850507			46.6031	0.1129	0.0609	0.1167	0.2700
850508			43.3752	0.1452	0.0611	0.1170	0.2673
850509			19.3634	0.0690	0.0568	0.1121	0.2643
850510			10.8347	0.0663	0.0576	0.1187	0.2706
850511			15.3406	0.0651	0.0575	0.1170	0.2691
850512			8.3345	0.0605	0.0554	0.1146	0.2693
850513			14.8606	0.0667	0.0583	0.1169	0.2730
850514			4.4752	0.0592	0.0565	0.1179	0.2745
850515			16.2300	0.0604	0.0559	0.1158	0.2705
850516			59.1014	0.0758	0.0604	0.1191	0.2773
850517			20.0846	0.0644	0.0570	0.1193	0.2737
850518			9.7911	0.0591	0.0581	0.1165	0.2713
850519			3.9184	0.0587	0.0587	0.1177	0.2764
850520			2.8543	0.0608	0.0596	0.1209	0.2922
850521			3.3998	0.0597	0.0581	0.1195	0.2816
850522			4.4134	0.0608	0.0599	0.1219	0.2812
850523			5.1982	0.0600	0.0601	0.1200	0.2830
850524			4.4961	0.0607	0.0614	[illegible]	0.2920

DATE	BZ	SWVEL	SEESSE	SEEI	SEEII	SEEIII	SEEIV
850525			4.2090	0.0599	0.0593	0.1194	0.2783
850526			4.3002	0.0588	0.0578	0.1171	0.2787
850527			7.2409	0.0635	0.0606	0.1227	0.2841
850528			9.7236	0.0651	0.0594	0.1221	0.2893
850529			5.5385	0.0626	0.0599	0.1221	0.2874
850530			6.4009	0.0659	0.0638	0.1240	0.2884
850531			4.1216	0.0604	0.0601	0.1180	0.2830
850601			6.3153	0.0585	0.0589	0.1183	0.2778
850602			54.4520	0.0727	0.0629	0.1274	0.2882
850603			90.2567	0.0834	0.0675	0.1287	0.2969
850604			55.6228	0.0731	0.0621	0.1273	0.2836
850605			29.8984	0.0649	0.0604	0.1224	0.2850
850606			9.7924	0.0593	0.0582	0.1187	0.2758
850607			118.2839	0.1077	0.0653	0.1273	0.2869
850608			95.0725	0.1778	0.0665	0.1253	0.2917
850609			147.2381	0.3874	0.0743	0.1297	0.2906
850610			141.1535	0.1923	0.0677	0.1248	0.2875
850611			209.7101	0.3698	0.0760	0.1294	0.2974
850612			437.5824	0.9058	0.0987	0.1483	0.3078
850613			456.6597	1.4198	0.1217	0.1525	0.3266
850614			116.3140	0.2269	0.0652	0.1307	0.3027
850615			169.3583	0.3625	0.0784	0.1314	0.2948
850616			42.7678	0.1294	0.0660	0.1276	0.2950
850617			33.0527	0.1203	0.0656	0.1259	0.2905
850618			19.4851	0.0681	0.0606	0.1240	0.2823
850619			26.1073	0.0778	0.0638	0.1264	0.2929
850620			17.1960	0.0742	0.0611	0.1220	0.2840
850621			11.1866	0.0723	0.0604	0.1187	0.2829
850622			13.7543	0.0691	0.0619	0.1245	0.2835
850623			8.7151	0.0685	0.0592	0.1216	0.2835
850624			7.3900	0.0701	0.0629	0.1242	0.2848
850625			13.3375	0.0862	0.0590	0.1179	0.2845
850626			23.3168	0.0818	0.0611	0.1214	0.2836
850627			121.4709	0.1534	0.0686	0.1290	0.2910
850628			66.1696	0.1020	0.0633	0.1233	0.2869
850629			233.9606	0.3042	0.0765	0.1355	0.3007
850630			354.0147	0.6815	0.0911	0.1459	0.3070
850701			78.9412	0.1458	0.0674	0.1285	0.2921
850702			98.6462	0.2035	0.0719	0.1259	0.3022
850703			150.1100	0.4464	0.0842	0.1350	0.3070
850704			21.3999	0.0761	0.0574	0.1175	0.2809
850705			72.7435	0.1044	0.0625	0.1234	0.2862
850706			236.6770	0.3104	0.0742	0.1225	0.2969
850707			428.3557	1.0678	0.1050	0.1476	[illegible]

DATE	ED	SWVEL	SEESSI	SEEI	SEEII	SEEIII	SEEIV
850708			818.6738	2.2598	0.1650	0.1740	0.3350
850709			616.2460	2.0351	0.1598	0.1684	0.3445
850710			727.6400	3.6100	0.2474	0.1780	0.3444
850711			157.4796	0.8107	0.1107	0.1235	0.2954
850712			85.9040	0.2637	0.0660	0.1162	0.2095
850713			213.5669	0.6256	0.0830	0.1236	0.2791
850714			87.9351	0.3080	0.0689	0.1215	0.2735
850715			708.4595	3.0264	0.1954	0.1680	7.1199
850716			85.5039	8.7911	0.4683	0.1933	0.3600
850717			211.9707	0.5944	0.0883	0.1360	0.2926
850718			175.8679	0.4416	0.0787	0.1309	0.2943
850719			287.9275	0.5853	0.0860	0.1392	0.4751
850720			301.1668	0.7409	0.0974	0.1435	0.3134
850721			118.8429	0.2359	0.0729	0.1292	0.2965
850722			110.8537	0.3979	0.0778	0.1297	0.2964
850723			24.1796	0.1040	0.0619	0.1201	0.2851
850724			31.1936	0.1007	0.0630	0.1219	0.2860
850725			45.5564	0.0892	0.0628	0.1263	0.2896
850726			112.3856	0.1762	0.0694	0.1294	0.2967
850727			184.9409	0.3289	0.0753	0.1331	0.2051
850728			274.1722	0.4803	0.0871	0.1411	0.3115
850729			326.9473	0.5686	0.0893	0.1486	0.3203
850730			132.9214	0.2286	0.0702	0.1283	0.2916
850731			32.5911	0.0955	0.0594	0.1189	0.2787
850801			152.7215	0.2811	0.0708	0.1270	0.2578
850802			223.3760	0.3751	0.0785	0.1324	0.2903
850803			357.1899	0.7458	0.0982	0.1473	0.3124
850804			546.1469	1.1441	0.1105	0.1650	0.3133
850805			764.2014	2.6444	0.1755	0.1774	0.3420
850806			751.5192	2.4876	0.1700	0.1841	0.3540
850807			346.5358	0.8818	0.1066	0.1462	0.3084
850808			78.2761	0.2003	0.0713	0.1266	0.2937
850809			60.3367	0.1210	0.0676	0.1267	0.2932
850810			25.4305	0.0807	0.0603	0.1221	0.2834
850811			32.8004	0.0969	0.0639	0.1290	0.2999
850812			22.4294	0.0852	0.0602	0.1210	0.2965
850813			4.0082	0.0577	0.0560	0.1212	4.8584
850814			543.6551	1.1686	0.1142	0.1529	0.3192
850815			825.8046	2.3924	0.1693	0.1752	0.3386
850816			350.6109	0.9839	0.1044	0.1483	0.3141
850817			388.3256	0.8564	0.0942	0.1468	0.3163
850818			152.5599	0.7224	0.0871	0.1327	0.3014
850819			138.2944	0.3296	0.0740	0.1324	0.3007
850820			113.9978	0.2730	0.0709	0.1308	0.2963

DATE	BZ	SWVEL	SEESSD	SEEI	SEEII	SEEIII	SEEIV
850821			207.5400	0.4647	0.0934	0.1396	0.3081
850822			209.1777	0.4735	0.0902	0.1369	0.3026
850823			669.6134	1.9641	0.1615	0.1579	0.3354
850824			529.7751	1.3347	0.1232	0.1628	0.3341
850825			37.0343	0.1411	0.0644	0.1266	0.2927
850826			50.5888	0.1286	0.0666	0.1255	0.2938
850827			82.6192	0.1238	0.0648	0.1269	0.2943
850828			164.3920	0.1724	0.0717	0.1340	0.2982
850829			240.4725	0.3366	0.0796	0.1372	0.2991
850830			441.1464	0.8818	0.1054	0.1574	0.3163
850831			44.5041	0.1076	0.0620	0.1231	0.2871
850901			114.7793	0.2667	0.0751	0.1375	0.3065
850902			260.3091	0.8600	0.1040	0.1476	0.3203
850903			334.1283	0.9737	0.1078	0.1515	0.3231
850904			353.7156	1.2182	0.1259	0.1544	0.3304
850905			197.4968	0.7739	0.1041	0.1450	0.3179
850906			40.7174	0.1097	0.0656	0.1306	0.2995
850907			7.6278	0.0641	0.0610	0.1257	0.2978
850908			14.1384	0.0660	0.0630	0.1262	0.2985
850909			23.5899	0.0694	0.0613	0.1226	0.298[illegible]
850910			69.0698	0.0920	0.0648	0.1314	0.3032
850911			174.8101	0.1784	0.0735	0.1382	0.3123
850912			160.5024	0.1913	0.0740	0.1404	0.3166
850913			164.8553	0.1842	0.0746	0.1407	0.3188
850914			22.6247	0.0727	0.0621	0.1238	0.3012
850915			3.6805	0.0584	0.0654	0.1310	0.3069
850916			95.0488	0.1138	0.0669	0.1321	0.3050
850917			455.0642	0.4789	0.0960	0.1630	0.3267
850918			709.2010	1.3322	0.1319	0.1759	0.3639
850919			87.8466	0.2132	0.0677	0.1301	0.2976
850920			286.1552	0.3903	0.0825	0.1401	0.3122
850921			320.0055	0.8112	0.0947	0.1446	0.3208
850922			740.0520	2.1408	0.1604	0.1705	0.3557
850923			517.9929	1.6987	0.1467	0.1607	0.6581
850924			447.1563	2.3045	0.1927	0.1695	0.3353
850925			276.6996	0.7371	0.0994	0.1468	0.3196
850926			579.2537	1.7565	0.1612	0.1745	0.3460
850927			762.2559	2.8584	0.2132	0.1831	0.3657
850928			615.5533	2.1125	0.1640	0.1767	0.3540
850929			688.3818	3.8269	0.2754	0.1784	0.3655
850930			850.1644	5.3706	0.3697	0.2012	0.3971
851001			554.6694	2.3532	0.1340	0.1690	0.3711
851002			242.9973	0.9723	0.1165	0.1446	0.3151
851003			42.5928	0.1822	0.07[illegible]	0.12[illegible]	0.3034

DATE	RZ	SWVEL	SEESSD	SEEI	SEEII	SEEIII	SEEIV
851004			5.6245	0.0614	0.0613	0.1264	0.3002
851005			45.9420	0.1076	0.0620	0.1262	0.2998
851006			832.6728	3.3734	0.2253	0.1765	0.3551
851007			585.6230	8.4733	0.5424	0.2360	0.4194
851008			195.1833	5.7377	1.0905	0.2923	0.4640
851009			226.2078	5.7260	2.1193	0.3006	0.4943
851010			736.6350	6.6455	1.4784	0.2847	0.4437
851011			100.5311	0.2744	0.0772	0.1362	0.3078
851012			59.4001	0.2251	0.0705	0.1349	0.3098
851013			175.1964	0.4707	0.0829	0.1423	0.3117
851014			222.7244	0.4752	0.0883	0.1452	0.3181
851015			125.1821	0.3364	0.0779	0.1368	0.3137
851016			181.8630	0.3465	0.0773	0.1426	0.3162
851017			287.5163	0.4143	0.0887	0.1468	0.3267
851018			136.7514	0.2723	0.0735	0.1388	0.3151
851019			513.9333	0.7831	0.1103	0.1671	0.3464
851020			828.7290	1.6656	0.1675	0.1896	0.3814
851021			469.3183	1.2626	0.1350	0.1641	0.3458
851022			98.6132	0.1643	0.0720	0.1429	0.3101
851023			470.1825	0.6705	0.1053	0.1714	0.3463
851024			459.5151	0.8707	0.1113	0.1609	0.3434
851025			344.8286	0.6266	0.1012	0.1574	0.3404
851026			188.9425	0.4433	0.0919	0.1531	0.3354
851027			311.3256	0.9383	0.1224	0.1601	0.3419
851028			127.5457	0.2510	0.0797	0.1458	0.3193
851029			45.9771	0.1070	0.0681	0.1357	0.3039
851030			4.0212	0.0654	0.0656	0.1350	0.3162
851031			5.5642	0.0681	0.0656	0.1355	0.3089
851101			9.1739	0.0664	0.0640	0.1338	0.3099
851102			21.5432	0.0703	0.0657	0.1342	0.3118
851103			191.7515	0.1927	0.0775	0.1468	0.3268
851104			982.0961	1.2127	0.1377	0.2016	0.3947
851105			699.5004	1.2807	0.1254	0.1808	0.3656
851106			243.7546	0.6416	0.0900	0.1553	0.3335
851107			264.7381	0.5282	0.0893	0.1557	0.3384
851108			241.3829	0.6654	0.0976	0.1506	0.3298
851109			102.0878	0.1712	0.0743	0.1429	0.3198
851110			96.6271	0.1290	0.0725	0.1441	0.3209
851111			180.1557	0.2178	0.0809	0.1523	0.3316
851112			172.5565	0.2459	0.0815	0.1501	0.3336
851113			44.2855	0.0882	0.0661	0.1390	0.3141
851114			30.0637	0.0775	0.0654	0.1379	0.3095
851115			179.3899	0.1595	0.0782	0.1474	0.3251
851116			538.8126	0.5149	0.1030	0.1768	0.3574

DATE	BZ	SWVEL	SEESSP	SEEI	SEEII	SEEIII	SEEIV
851117			414.3850	0.4782	0.0983	0.1621	0.3473
851118			177.4758	0.2243	0.0781	0.1457	0.3271
851119			254.9924	0.4044	0.0898	0.1571	0.3384
851120			262.5045	0.5715	0.0931	0.1611	0.3419
851121			150.4235	0.2767	0.0807	0.1518	0.3291
851122			60.7163	0.0982	0.0727	0.1462	0.3281
851123			68.7736	0.1395	0.0763	0.1495	0.3326
851124			63.2332	0.1488	0.0752	0.1474	0.3289
851125			43.3223	0.1190	0.0729	0.1448	0.3296
851126			25.2462	0.0840	0.0680	0.1446	0.3254
851127			16.7363	0.0722	0.0678	0.1410	0.3169
851128			66.0998	0.0894	0.0753	0.1463	0.3312
851129			67.0343	0.1009	0.0713	0.1440	0.3244
851130			175.3078	0.2560	0.0775	0.1543	0.3313
851201			984.8569	1.5015	0.1529	0.2093	9.0211
851202			371.0925	0.7043	0.1016	0.1638	0.3491
851203			834.8508	2.3215	0.1786	0.1934	0.3896
851204			506.2756	1.3363	0.1372	0.1750	0.3636
851205			187.5587	0.4364	0.0905	0.1581	0.3404
851206			243.1387	0.9520	0.1087	0.1655	0.3524
851207			191.8690	0.6964	0.0972	0.1589	0.3353
851208			126.5041	0.2812	0.0841	0.1556	0.3181
851209			70.4771	0.1637	0.0785	0.1503	0.3312
851210			43.3459	0.1138	0.0710	0.1432	0.3226
851211			29.0247	0.0869	0.0706	0.1456	0.3190
851212			68.2619	0.1123	0.0734	0.1473	0.3280
851213			24.2000	0.0839	0.0683	0.1416	0.3175
851214			140.2845	0.1420	0.0786	0.1536	0.3343
851215			369.1897	0.2516	0.0936	0.1684	0.3511
851216			428.1408	0.3623	0.0994	0.1760	0.3618
851217			119.5074	0.1118	0.0766	0.1542	0.3327
851218			90.8697	0.1062	0.0769	0.1520	0.3287
851219			69.0152	0.1689	0.0711	0.1413	0.3178
851220			116.1646	0.1671	0.0773	0.1503	0.3178
851221			174.8899	0.3635	0.0870	0.1570	0.3315
851222			195.8406	0.3163	0.0849	0.1543	0.3374
851223			146.0607	0.2207	0.0806	0.1535	0.3360
851224			27.0859	0.0776	0.0707	0.1427	0.3214
851225			17.6773	0.0762	0.0700	0.1439	0.3242
851226			37.8846	0.0914	0.0724	0.1483	0.3304
851227			42.9585	0.0889	0.0695	0.1459	0.3257
851228			67.2219	0.1107	0.0714	0.1404	0.3153
851229			138.3240	0.1934	0.0811	0.1535	0.3336
851230			330.8318	0.4486	0.0875	0.1580	[illegible]

DATE	EC	SWVEL	SEESSP	SEEI	SEEII	SEEIII	SEEIV
851231			901.0352	1.9677	0.1676	[illegible]	[illegible]
860101			755.3288	2.2590	[illegible]	[illegible]	[illegible]
860102			24.27[illegible]	3.7009	[illegible]	[illegible]	[illegible]
860103			412.2094	5.4890	[illegible]	[illegible]	[illegible]
860104			393.1720	[illegible]	0.5790	0.2425	0.4304
860105			216.8599	7.9459	0.5509	0.2000	1.0107
860106			608.1573	5.0139	0.4716	0.1802	0.3687
860107			66.8608	0.0929	0.0712	0.1460	0.3240
860108			157.2783	0.1500	0.0822	0.1580	0.3288
860109			352.3887	0.3002	0.0967	0.1701	0.3519
860110			143.8157	0.1615	0.0802	0.1561	0.3379
860111			223.6698	0.2820	0.0893	0.1665	0.3500
860112			165.3522	0.2117	0.0856	0.1593	0.3404
860113			118.5711	0.1856	0.0803	0.1546	0.3373
860114			76.3317	0.1541	0.0797	0.1526	0.3342
860115			43.8961	0.1135	0.0744	0.1464	0.3325
860116			17.1293	0.0811	0.0711	0.1474	0.3285
860117			17.2557	0.0787	0.0709	0.1447	0.3219
860118			10.0397	0.0708	0.0677	0.1409	0.3171
860119			10.3231	0.0697	0.0704	0.1384	0.3184
860120			5.6771	0.0637	0.0654	0.1368	0.3090
860121			21.3216	0.0761	0.0646	0.1366	0.3078
860122			70.7506	0.0840	0.0688	0.1382	0.3106
860123			210.3506	0.1786	0.0797	0.1485	0.3236
860124			690.6239	0.8132	0.1137	0.1959	0.3579
860125			455.5797	1.1099	0.1119	0.1646	0.3407
860126			319.0968	0.5946	0.1010	0.1591	0.6598
860127			407.2978	0.8201	0.1050	0.1617	0.3403
860128			999.0785	2.7040	0.2091	0.2034	0.3860
860129			738.9543	7.7203	0.4804	0.2527	0.4611
860130			573.9995	6.9938	0.4452	0.2504	0.4459
860131			729.5627	8.8391	0.5869	0.2646	0.4595
860201			574.2798	9.9016	0.7201	0.2643	0.4524
860202			659.0290	4.1573	0.4124	0.1939	0.3689
860203			374.7841	2.5414	0.3359	0.1698	0.3451
860204			264.3569	1.2609	0.2053	0.1654	0.3431
860205			187.9661	0.9605	0.1715	0.1575	0.3400
860206			111.0884	0.7420	0.1916	0.2114	0.3745
860207			25.4355	0.2218	0.1375	0.1839	0.3264
860208			91.6344	0.4604	0.0918	0.1235	0.2683
860209			36.4915	0.1706	0.0682	0.1095	0.2492
860210			44.5956	0.2979	0.0998	0.1244	0.2722
860211			110.2774	0.4607	0.0995	0.1275	0.2754
860212			109.3230	0.1783	0.0651	0.1210	0.2727

DATE	BC	SWVEL	SEESSD	SEEI	SEEII	SEEIII	SEEIV
860213			831.9343	2.1724	0.1527	0.1663	0.3456
860214			707.6456	2.8497	0.2461	0.2196	0.3745
860215			420.0558	2.0544	0.1834	0.1573	0.3003
860216			391.7810	2.9195	0.3360	0.1470	0.2960
860217			183.9081	1.0423	0.1639	0.1316	0.2810
860218			48.3821	0.1256	0.0602	0.1182	0.2711
860219			75.1698	0.1838	0.0666	0.1234	0.2777
860220			41.1743	0.1122	0.0618	0.1210	0.2754
860221			66.2223	0.1181	0.0649	0.1250	0.2866
860222			280.3640	0.2710	0.0824	0.1409	0.3070
860223			567.4124	1.2964	0.1219	0.1599	0.3265
860224			64.6458	2.9596	0.2311	0.2041	0.3882
860225			461.5604	4.8787	0.3282	0.2306	0.4213
860226			233.2737	6.0389	0.4105	0.2130	0.4034
860227			974.3854	4.7552	0.3577	0.2056	0.3819
860228			660.6248	3.6639	0.3172	0.1784	0.3449
860301			297.8015	1.6004	0.1750	0.1551	0.3175
860302			279.8955	1.3175	0.1525	0.1512	0.3239
860303			352.3002	5.0322	0.7346	0.1916	0.3290
860304			167.6465	0.6603	0.1088	0.1410	0.3150
860305			199.3438	1.4770	0.2029	0.1468	0.3166
860306			63.3244	0.2071	0.0578	0.1315	0.3009
860307			99.3302	0.1566	0.0683	0.1306	0.3021
860308			213.4366	0.6049	0.0903	0.1396	0.3075
860309			197.4989	0.6674	0.0979	0.1325	0.2896
860310			544.0297	4.6521	0.3093	0.1600	0.3227
860311			711.6551	5.4215	0.3620	0.1739	0.3391
860312			210.2005	1.0369	0.1230	0.1368	0.3002
860313			33.7488	0.0901	0.0586	0.1231	0.2849
860314			41.8412	0.0908	0.0624	0.1261	0.2956
860315			34.8689	0.0949	0.0623	0.1253	0.2932
860316			45.6402	0.0856	0.0633	0.1291	0.2967
860317			51.7143	0.1065	0.0639	0.1300	0.3029
860318			48.0447	0.0904	0.0643	0.1281	0.2991
860319			71.7350	0.1022	0.0663	0.1328	0.3090
860320			88.6467	0.1345	0.0724	0.1363	0.3189
860321			28.7168	0.0780	0.0608	0.1285	0.3009
860322			104.7850	0.1304	0.0685	0.1307	0.3047
860323			165.9279	0.1644	0.0736	0.1377	0.3119
860324			137.0872	0.2069	0.0710	0.1347	0.3033
860325			235.2775	0.4311	0.0834	0.1464	0.3134
860326			506.6770	1.1256	0.1219	0.1639	0.3497
860327			395.5760	0.8894	0.1054	0.1559	0.3312
860328			561.3150	1.4499	0.1418	0.1673	[illegible]

DATE	BC	SWVEL	SEESSD	SEEI	SEEII	SEEIII	SEEIV
860329			407.2204	1.0387	0.1222	0.1585	0.3349
860330			236.8583	0.8584	0.1071	0.1510	0.3294
860331			180.2203	0.6585	0.0998	0.1407	0.3217
860401			119.3902	0.3756	0.0842	0.1412	0.3171
860402			105.7562	0.4482	0.0953	0.1420	0.3174
860403			34.0527	0.1260	0.0693	0.1344	0.3109
860404			42.8514	0.1826	0.0736	0.1421	0.3216
860405			56.4321	0.2725	0.0758	0.1379	0.2985
860406			19.9337	0.0966	0.0701	0.1383	0.3177
860407			15.2751	0.0784	0.0655	0.1349	0.3151
860408			12.9174	0.0844	0.0659	0.1295	0.3165
860409			5.8188	0.0696	0.0668	0.1332	0.3150
860410			10.8256	0.0669	0.0655	0.1314	0.3096
860411			23.1654	0.0753	0.0687	0.1385	0.3163
860412			25.8039	0.0691	0.0639	0.1331	0.3106
860413			13.2699	0.0689	0.0677	0.1367	0.3137
860414			18.5467	0.0694	0.0658	0.1341	0.3179
860415			5.5622	0.0653	0.0642	0.1294	0.3145
860416			8.2890	0.0679	0.0666	0.1354	0.3176
860417			8.7771	0.0693	0.0678	0.1352	0.3161
860418			10.0942	0.0673	0.0671	0.1323	0.3180
860419			7.3609	0.0644	0.0624	0.1332	0.3140
860420			11.0364	0.0691	0.0665	0.1350	0.3154
860421			11.5644	0.0702	0.0671	0.1379	0.3206
860422			7.0411	0.0646	0.0649	0.1342	0.3160
860423			9.7012	0.0683	0.0665	0.1350	0.3205
860424			31.2800	0.0769	0.0679	0.1360	0.3184
860425			28.3760	0.1228	0.0753	0.1405	0.3271
860426			26.2116	0.1012	0.0733	0.1409	0.3263
860427			23.6217	0.0948	0.0712	0.1424	0.3263
860428			4.9680	0.0685	0.0660	0.1364	0.3225
860429			15.7443	0.0721	0.0683	0.1421	0.3288
860430			26.9121	0.0769	0.0712	0.1419	0.3327
860501			24.5988	0.0761	0.0701	0.1421	0.3217
860502			8.8463	0.0666	0.0646	0.1334	0.3203
860503			66.2500	0.2120	0.0734	0.1423	0.3189
860504			113.8567	0.3066	0.0799	0.1474	0.3295
860505			106.8020	0.1375	0.0777	0.1448	0.3300
860506			6.6490	0.0727	0.0666	0.1333	0.3155

Appendix E: BMDP Example Problems

Page

Appendix E: BMDP Example Problems

BMDP Example Problem #1

Computer: SSC
Data set used: SHEEDATYR (7 May 85 - 6 May 86)
Model fit attempted: AR1,27
Poor model

```
BMDP2T - BOX-JENKINS TIME SERIES ANALYSIS

Mon Aug  4 16:56:30 1986

 /PROBLEM     TITLE IS 'GEOSYNCH ENERGETIC ELECTRON TIME SERIES'.

 /INPUT       VARIABLES ARE 10.
              FORMAT IS FREE.
              FILE IS SHEEDATYR.
              RECL = 95.
 /VARIABLE    NAMES ARE DATE,PTS,SEEIII,GAMI,GAMIII,GAMIV,SEEI,
                        SEEII,SEEIV,SEESSD.
 /END

NUMBER OF CASES READ. . . . . . . . . . . . . . .     365

      ALL CASES ARE COMPLETE.

    THE BLOCKING IS ACROSS ALL VARIABLES.


  ACF         VARIABLE IS SEEI.
              MAXLAG IS 60./


FIRST CASE NUMBER TO BE USED      =            1
LAST CASE NUMBER TO BE USED       =          365
NO. OF OBS. AFTER DIFFERENCING    =          365
MEAN OF THE (DIFFERENCED) SERIES  =       0.9742
STANDARD ERROR OF THE MEAN        =       0.1212
T-VALUE OF MEAN (AGAINST ZERO)    =       8.0405
```

AUTOCORRELATIONS

1- 12	.76	.43	.20	.05	0.0	0.0	.02	.05	.07	.07	.06	.06
ST.E.	.05	.08	.10	.09	.09	.09	.09	.09	.09	.09	.09	.09
13- 24	.04	.02	.02	.01	-.01	-.03	-.06	-.06	-.06	-.05	-.03	.02
ST.E.	.08	.09	.09	.09	.09	.09	.09	.09	.09	.09	.09	.09
25- 36	.08	.13	.15	.12	.08	.05	0.0	-.02	-.03	-.05	-.06	-.06
ST.E.	.09	.09	.09	.09	.09	.09	.09	.09	.09	.09	.09	.09
37- 48	-.05	-.03	-.03	-.04	-.04	-.07	-.08	-.08	-.08	-.08	-.08	-.10
ST.E.	.09	.09	.09	.09	.09	.09	.09	.09	.09	.09	.09	.09
49- 60	-.11	-.09	-.06	-.03	.01	.04	.05	.03	0.0	-.02	-.05	-.07
ST.E.	.09	.09	.09	.09	.09	.09	.09	.09	.09	.09	.09	.09

PLOT OF AUTOCORRELATIONS

```
           -1.0 -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8  1.0
LAG   CORR. +----+----+----+----+----+----+----+----+---------+
                                     I
  1   0.758                       +  IXX+XXXXXXXXXXXXXXXX
  2   0.429                      +   IXXX+XXXXXXX
  3   0.200                      +   IXXX+X
  4   0.050                      -   IX  +
  5  -0.003                      +   I   +
  6   0.000                      +   I   +
  7   0.017                      +   I   +
  8   0.049                      +   IX  +
  9   0.067                      +   IXX +
 10   0.075                      +   IXX +
 11   0.063                      +   IXX +
 12   0.057                      +   IX  +
 13   0.042                      +   IX  +
 14   0.020                      +   I   +
 15   0.022                      +   IX  +
 16   0.009                      +   I   +
 17  -0.013                      +   I   +
 18  -0.035                      +  XI   +
 19  -0.062                      + XXI   +
 20  -0.061                      + XXI   +
 21  -0.057                      +  XI   +
 22  -0.053                      +  XI   +
 23  -0.027                      +  XI   +
 24   0.018                      +   I   +
 25   0.085                      +   IXX +
 26   0.134                      +   IXXX+
```

```
27   0.146                        +    IXXXX
28   0.119                        +    IXXX+
29   0.079                        +    IXX +
30   0.050                        +    IX  +
31   0.004                        +    I   +
32  -0.022                        +  XI    +
33  -0.032                        +  XI    +
34  -0.054                        +  XI    +
35  -0.053                        +  XI    +
36  -0.061                        + XXI    +
37  -0.049                        +  XI    +
38  -0.029                        +  XI    +
39  -0.033                        +  XI    +
40  -0.036                        +  XI    +
41  -0.044                        +  XI    +
42  -0.067                        + XXI    +
43  -0.091                        + XXI    +
44  -0.083                        + XXI    +
45  -0.079                        + XXI    +
46  -0.076                        + XXI    +
47  -0.073                        + XXI    +
48  -0.097                        + XXI    +
49  -0.107                        +XXXI    +
50  -0.090                        + XXI    +
51  -0.064                        + XXI    +
52  -0.025                        +  XI    +
53   0.012                        +    I   +
54   0.037                        +    IX  +
55   0.053                        +    IX  +
56   0.035                        +    IX  +
57  -0.001                        +    I   +
58  -0.023                        +  XI    +
59  -0.046                        +  XI    +
60  -0.068                        + XXI    +

 PACF        VARIABLE IS SEEI.
             MAXLAG IS 60./

FIRST CASE NUMBER TO BE USED       =           1
LAST CASE NUMBER TO BE USED        =         365
NO. OF OBS. AFTER DIFFERENCING     =         365
MEAN OF THE (DIFFERENCED) SERIES   =      0.9742
STANDARD ERROR OF THE MEAN         =      0.1010
T-VALUE OF MEAN (AGAINST ZERO)     =      9.64[illegible]
```

PARTIAL AUTOCORRELATIONS

```
 1- 12      .76 -.35  .07 -.03  .09 -.02  .02  .05 -.01  .04 -.04  .08
 ST.E.      .05  .05  .05  .05  .05  .05  .05  .05  .05  .05  .05  .05

13- 24     -.06  .02  .02 -.06  .01 -.06 -.01  .01 -.04  0.0  .03  .05
 ST.E.      .05  .05  .05  .05  .05  .05  .05  .05  .05  .05  .05  .05

25- 36      .08  .03  .02 -.02  .03  .01 -.07  .05 -.06 -.03 -.02 -.03
 ST.E.      .05  .05  .05  .05  .05  .05  .05  .05  .05  .05  .05  .05

37- 48      .03 -.04 -.03  0.0 -.03 -.04  .01  0.0 -.02  0.0 -.03 -.05
 ST.E.      .05  .05  .05  .05  .05  .05  .05  .05  .05  .05  .05  .05

49- 60      .02 -.02  .01  .02 -.01  .04 -.01 -.03 -.01  .01 -.04 -.02
 ST.E.      .05  .05  .05  .05  .05  .05  .05  .05  .05  .05  .05  .05
```

PLOT OF PARTIAL AUTOCORRELATIONS

```
           -1.0 -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8  1.0
LAG   CORR. +----+----+----+----+----+----+----+----+----+----+
                                     I
  1   0.758                       +  IXX+XXXXXXXXXXXXXXX
  2  -0.348                 XXXXXX+XXI  +
  3   0.075                       +  IXX+
  4  -0.035                       +XXI  +
  5   0.090                       +  IXX+
  6  -0.016                       +  I  +
  7   0.023                       +  IX +
  8   0.047                       +  IX +
  9  -0.010                       +  I  +
 10   0.039                       +  IX +
 11  -0.041                       + XI  +
 12   0.076                       +  IXX+
 13  -0.061                       +XXI  +
 14   0.021                       +  IX +
 15   0.023                       +  IX +
 16  -0.063                       +XXI  +
 17   0.012                       +  I  +
 18  -0.057                       + XI  +
 19  -0.009                       +  I  +
 20   0.014                       +  I  +
 21  -0.040                       + XI  +
 22   0.004                       +  I  +
 23   0.031                       +  IX +
 24   0.054                       +  IX +
 25   0.083                       +  IXX+
```

```
26   0.016                     +  I  +
27   0.019                     +  I  +
28  -0.020                     + XI  +
29   0.025                     +  IX +
30   0.012                     +  I  +
31  -0.073                     +XXI  +
32   0.046                     +  IX +
33  -0.059                     + XI  +
34  -0.025                     + XI  +
35  -0.018                     +  I  +
36  -0.034                     + XI  +
37   0.033                     +  IX +
38  -0.035                     + XI  +
39  -0.032                     + XI  +
40   0.004                     +  I  +
41  -0.030                     + XI  +
42  -0.043                     + XI  +
43   0.008                     +  I  +
44   0.001                     +  I  +
45  -0.019                     +  I  +
46  -0.004                     +  I  +
47  -0.030                     + XI  +
48  -0.054                     + XI  +
49   0.021                     +  IX +
50  -0.027                     + XI  +
51   0.012                     +  I  +
52   0.022                     +  IX +
53  -0.013                     +  I  +
54   0.045                     +  IX +
55  -0.009                     +  I  +
56  -0.034                     + XI  +
57  -0.008                     +  I  +
58   0.010                     +  I  +
59  -0.039                     + XI  +
60  -0.025                     + XI  +

 ARIMA      VARIABLE IS SEEI.
            AROR = '(1),(27)'./

THE COMPONENT HAS BEEN ADDED TO THE MODEL

THE CURRENT MODEL HAS
OUTPUT VARIABLE = SEEI
INPUT  VARIABLE = NOISE


 ESTIMATION  RESIDUAL = RESEEI./
```

FIRST CASE NUMBER TO BE USED : 1
LAST CASE NUMBER TO BE USED : 365

ESTIMATION BY CONDITIONAL LEAST SQUARES METHOD

RELATIVE CHANGE IN RESIDUAL SUM OF SQUARES LESS THAN 0.1000e-04

SUMMARY OF THE MODEL

OUTPUT VARIABLE -- SEEI
INPUT VARIABLES -- NOISE

VARIABLE	VAR. TYPE	MEAN	TIME	DIFFERENCES
SEEI	RANDOM		1- 365	

PARAMETER	VARIABLE	TYPE	FACTOR	ORDER	ESTIMATE	ST. ERR.	T-RATIO
1	SEEI	AR	1	1	0.7856	0.0339	23.15
2	SEEI	AR	2	27	0.1040	0.0545	1.91

RESIDUAL SUM OF SQUARES = 836.986938
DEGREES OF FREEDOM = 335
RESIDUAL MEAN SQUARE = 2.498468

ESTIMATION BY BACKCASTING METHOD

RELATIVE CHANGE IN RESIDUAL SUM OF SQUARES LESS THAN 0.1000e-04

SUMMARY OF THE MODEL

OUTPUT VARIABLE -- SEEI
INPUT VARIABLES -- NOISE

VARIABLE	VAR. TYPE	MEAN	TIME	DIFFERENCES
SEEI	RANDOM		1- 365	

PARAMETER	VARIABLE	TYPE	FACTOR	ORDER	ESTIMATE	ST. ERR.	T-RATIO
1	SEEI	AR	1	1	0.7856	0.0339	23.16
2	SEEI	AR	2	27	0.1039	0.0545	1.91

RESIDUAL SUM OF SQUARES = 836.987366
DEGREES OF FREEDOM = 335
RESIDUAL MEAN SQUARE = 2.498470

(BACKCASTS EXCLUDED)

```
 ACF        VARIABLE IS RESRE1.
            MAXLAG IS 60./


FIRST CASE NUMBER TO BE USED     =          29
LAST CASE NUMBER TO BE USED      =         365
NO. OF OBS. AFTER DIFFERENCING   =         337
MEAN OF THE (DIFFERENCED) SERIES =      0.2017
STANDARD ERROR OF THE MEAN       =      0.0853
T-VALUE OF MEAN (AGAINST ZERO)   =      2.3652


AUTOCORRELATIONS

  1- 12     .24 -.15 -.12 -.17 -.10 -.03 -.02  .04  .03  .05 -.02  .02
  ST.E.     .05  .06  .06  .06  .06  .06  .06  .06  .06  .06  .06  .06

 13- 24     .02 -.05  .03  .02  0.0  0.0 -.05 -.01  0.0 -.03 -.02 -.03
  ST.E.     .06  .06  .06  .06  .06  .06  .06  .06  .06  .06  .06  .06

 25- 36     .06  .05 -.02  .01 -.01  .05 -.02 -.02  .02 -.03 -.01 -.03
  ST.E.     .06  .06  .06  .06  .06  .06  .06  .06  .06  .06  .06  .06

 37- 48    -.03  .04 -.01  0.0  .03 -.03 -.03 -.02 -.01  .01  .02 -.03
  ST.E.     .06  .06  .06  .06  .06  .06  .06  .06  .06  .06  .06  .06

 49- 60    -.06 -.02 -.02  0.0  .02  .02  .07  .05 -.03 -.01 -.02 -.02
  ST.E.     .06  .06  .06  .06  .06  .06  .06  .06  .06  .06  .06  .06

PLOT OF AUTOCORRELATIONS

          -1.0 -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8  1.0
LAG   CORR. +----+----+----+----+----+----+----+----+----+----+
                                     I
  1   0.238                       +  IXX+XXX
  2  -0.155                      X+XXI  +
  3  -0.124                       XXXI  +
  4  -0.172                      X+XXI  +
  5  -0.097                       +XXI  +
  6  -0.027                       + XI  +
  7  -0.025                       + XI  +
  8   0.038                       +  IX +
  9   0.029                       +  IX +
 10   0.051                       +  IX +
 11  -0.021                       + XI  +
 12   0.024                       +  IX +
```

```
13   0.022          +  IX +
14  -0.050          + XI  +
15   0.031          +  IX +
16   0.018          +  I  +
17  -0.003          +  I  +
18   0.001          +  I  +
19  -0.063          +XXI  +
20  -0.014          +  I  +
21  -0.002          +  I  +
22  -0.032          + XI  +
23  -0.018          +  I  +
24  -0.025          + XI  +
25   0.057          +  IX +
26   0.056          +  IX +
27  -0.021          + XI  +
28   0.007          +  I  +
29  -0.006          +  I  +
30   0.054          +  IX +
31  -0.019          +  I  +
32  -0.022          + XI  +
33   0.021          +  IX +
34  -0.028          + XI  +
35  -0.014          +  I  +
36  -0.033          + XI  +
37  -0.031          + XI  +
38   0.039          +  IX +
39  -0.010          +  I  +
40   0.004          +  I  +
41   0.031          +  IX +
42  -0.027          + XI  +
43  -0.030          + XI  +
44  -0.018          +  I  +
45  -0.007          +  I  +
46   0.008          +  I  +
47   0.025          +  IX +
48  -0.027          + XI  +
49  -0.058          + XI  +
50  -0.024          + XI  +
51  -0.022          + XI  +
52  -0.001          +  I  +
53   0.017          +  I  +
54   0.020          +  I  +
55   0.067          +  IXX+
56   0.045          +  IX +
57  -0.029          + XI  +
58  -0.014          +  I  +
59  -0.017          +  I  +
60  -0.024          + XI  +
```

```
END

NUMBER OF INTEGER WORDS OF STORAGE USED IN PRECEDING    PROBLEM    7048
CPU TIME USED      22.750 SECONDS

BMDP2T - BOX-JENKINS TIME SERIES ANALYSIS

Mon Aug  4 17:02:42 1986
```

Computer: CYBER
Data set used: Last two years of EEDAT
Model fit attempted: AR 1,27 MA 1
Good model

```
1PAGE   1 BMDP2T

BMDP2T - BOX-JENKINS TIME SERIES ANALYSIS
BMDP STATISTICAL SOFTWARE, INC.
1964 WESTWOOD BLVD. SUITE 202
(213) 475-5700
PROGRAM REVISED APRIL    1982
MANUAL REVISED -- 1981
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TO SEE REMARKS AND A SUMMARY OF NEW FEATURES FOR
THIS PROGRAM, STATE NEWS. IN THE PRINT PARAGRAPH.

THIS VERSION OF BMDP HAS BEEN CONVERTED FOR USE ON
CDC 6000 AND CYBER SERIES COMPUTERS BY
BMDP PROJECT, VOGELBACK COMPUTING CENTER
NORTHWESTERN UNIVERSITY
2129 SHERIDAN ROAD
EVANSTON, ILLINOIS 60201
(312) 492-3681

RELEASED AUGUST 1983 FOR FTN5 COMPILERS

EXECUTED ON 86/10/11.AT 20.09.13.


PROGRAM CONTROL INFORMATION
/PROBLEM   TITLE IS 'GEOSYNCH ENERGETIC ELECTRON DATA'.
/INPUT     VARIABLES ARE 11.
           FORMAT IS FREE.
           RECLEN=97.
/VARIABLE  NAMES ARE PERIOD,DATE,PTS,SEEIII,
                     GAMI,GAMIII,GAMIV,SEEI,SEEII,
                     SEEIV,SEESSD.
/TRANSFORM DELETE = 1 TO 730.
/END

PROBLEM TITLE IS
GEOSYNCH ENERGETIC ELECTRIN DATA

NUMBER OF VARIABLES TO READ IN. . . . . . . . .      11
NUMBER OF VARIABLES ADDED BY TRANSFORMATIONS. .       0
```

```
TOTAL NUMBER OF VARIABLES . . . . . . . . . . . .          11
NUMBER OF CASES TO READ IN. . . . . . . . . . . . TO END
CASE LABELING VARIABLES . . . . . . . . . . . .
MISSING VALUES CHECKED BEFORE OR AFTER TRANS. . NEITHER
BLANKS ARE. . . . . . . . . . . . . . . . . . . MISSING
INPUT UNIT NUMBER . . . . . . . . . . . . . . .          5
REWIND INPUT UNIT PRIOR TO READING. . DATA. . .        NO
NUMBER OF WORDS OF DYNAMIC STORAGE. . . . . . .   39998

***** TRAN     PARAGRAPH IS USED *****
1PAGE   2 BMDP2T  GEOSYNCH ENERGETIC ELECTRON DATA

VARIABLES TO BE USED
     1 PERIOD  2 DATE   3 PTS    4 SEEIII      5 GAMI
     6 GAMIII  7 GAMIV  8 SEEI   9 SEEII      10 SEEIV
    11 SEESSD
INPUT FORMAT IS
FREE
MAXIMUM LENGTH DATA RECORD IS   97 CHARACTERS.

NUMBER OF CASES READ. . . . . . . . . . . . . . .    1095
   CASES WITH USE SET TO NEGATIVE VALUE . . . .       730
      REMAINING NUMBER OF CASES . . . . . . . . .     365
1PAGE   3 BMDP2T  GEOSYNCH ENERGETIC ELECTRON DATA


 ARIMA      VARIABLE IS SEEIII.
           AROR = '(1),(27)'.
           MAOR = '(1)'./

THE COMPONENT HAS BEEN ADDED TO THE MODEL

THE CURRENT MODEL HAS
OUTPUT VARIABLE = SEEIII
INPUT  VARIABLE = NOISE
1PAGE   4 BMDP2T  GEOSYNCH ENERGETIC ELECTRON DATA


ESTIMATION  RESIDUAL = RESSEEIII./


 ESTIMATION BY CONDITIONAL LEAST SQUARES METHOD

RELATIVE CHANGE IN RESIDUAL SUM OF SQUARES LESS THAN  .1000E-04

SUMMARY OF THE MODEL

OUTPUT VARIABLE -- SEEIII
INPUT VARIABLES -- NOISE
```

```
VARIABLE  VAR. TYPE  MEAN      TIME     DIFFERENCES

SEEIII     RANDOM              1- 365

PARAMETER VARIABLE   TYPE  FACTOR  ORDER ESTIMATE   ST. ERR.  T-RATIO
      1  SEEIII       MA      1      1     -.1223     .0553     -2.21
      2  SEEIII       AR      1      1      .9851     .0096    102.81
      3  SEEIII       AR      2     27      .1694     .0545      3.11

RESIDUAL SUM OF SQUARES  =          .130532
DEGREES OF FREEDOM       =              334
RESIDUAL MEAN SQUARE     =          .000391


ESTIMATION BY BACKCASTING METHOD

RELATIVE CHANGE IN RESIDUAL SUM OF SQUARES LESS THAN  .1000E-04


SUMMARY OF THE MODEL

OUTPUT VARIABLE -- SEEIII
INPUT VARIABLES -- NOISE

VARIABLE  VAR. TYPE  MEAN      TIME     DIFFERENCES

SEEIII     RANDOM              1- 365


PARAMETER VARIABLE   TYPE  FACTOR  ORDER ESTIMATE   ST. ERR.  T-RATIO
      1  SEEIII       MA      1      1     -.1227     .0547     -2.24
      2  SEEIII       AR      1      1      .9850     .0045    218.90
      3  SEEIII       AR      2     27      .1701     .0543      3.13

RESIDUAL SUM OF SQUARES  =          .130532 (BACKCASTS EXCLUDED)
DEGREES OF FREEDOM       =              334
RESIDUAL MEAN SQUARE     =          .000391
1PAGE   5 BMDP2T  GEOSYNCH ENERGETIC ELECTRON DATA
```

```
ACF          VARIABLE IS RESRETIL./

NUMBER OF OBSERVATIONS              =          3[illegible]
MEAN OF THE (DIFFERENCED) SERIES    =          .0017
STANDARD ERROR OF THE MEAN          =          .0010
T-VALUE OF MEAN (AGAINST ZERO)      =         1.6901

AUTOCORRELATIONS

  1- 12   -.03 -.16 -.07 -.15 -.13 -.01 -.01  .07  0.0  .01 -.02 -.02
  ST.E.    .05  .05  .05  .05  .06  .06  .06  .06  .06  .06  .06  .06

 13- 24    .12 -.06 -.01 -.01  0.0 -.04  .01  .01  .03 -.03 -.08 -.07
  ST.E.    .06  .06  .06  .06  .06  .06  .06  .06  .06  .06  .06  .06

 25- 36    08  .11 -.02  0.0  .04 -.01 -.07  .07  .05  0.0 -.04 -.05
  ST.E.    .06  .06  .06  .06  .06  .06  .06  .06  .06  .06  .06  .06


PLOT OF AUTOCORRELATIONS

          -1.0  -.8  -.6  -.4  -.2   .0   .2   .4   .6   .8  1.0
LAG   CORR. +----+----+----+----+----+----+----+----+----+----+
                                     I
  1   -.026                        + XI  +
  2   -.155                      X+XXI  +
  3   -.075                        +XXI  +
  4   -.151                      X+XXI  +
  5   -.132                       XXXI  +
  6   -.014                        +  I  +
  7   -.011                        +  I  +
  8    .075                        +  IXX+
  9   -.005                        +  I  +
 10    .011                        +  I  +
 11   -.024                        + XI  +
 12   -.020                        + XI  +
 13    .118                        +  IXXX
 14   -.061                        +XXI  +
 15   -.005                        +  I  +
 16   -.011                        +  I  +
 17   -.002                        +  I  +
 18   -.040                        + XI  +
 19    .009                        +  I  +
 20    .009                        +  I  +
 21    .035                        +  IX +
 22   -.025                        + XI  +
 23   -.079                        +XXI  +
 24   -.074                        +XXI  +
```

```
25    .090                              +  IXX+
26    .114                              +  IXXX
27   -.022                              + XI  +
28    .004                              +  I  +
29    .044                              +  IX +
30   -.015                              +  I  +
31   -.071                              +XXI  +
32    .071                              +  IXX+
33    .052                              +  IX +
34    .001                              +  I  +
35   -.042                              + XI  +
36   -.084                              +XXI  +
1PAGE   6 BMDP2T  GEOSYNCH ENERGETIC ELECTRON DATA


FORECAST    CASES = 24.
            START = 345./


 FORECAST ON VARIABLE SEEIII   FROM TIME PERIOD   345

PERIOD          FORECASTS       ST. ERR.        ACTUAL
  345             .12734         .02037         .13540
  346             .12504         .03040         .13520
  347             .12386         .03760         .13230
  348             .12352         .04356         .13020
  349             .12151         .04861         .13500
  350             .12201         .05305         .13790
  351             .12453         .05702         .13420
  352             .12073         .06063         .13500
  353             .12124         .06394         .13600
  354             .11836         .06699         .14050
  355             .11581         .06982         .14090
  356             .11300         .07247         .14240
  357             .11136         .07494         .13640
  358             .11018         .07727         .14210
  359             .10759         .07946         .14190
  360             .10763         .08153         .14210
  361             .10566         .08349         .13340
  362             .10449         .08535         .14230
  363             .10270         .08711         .14740
  364             .10177         .08879         .14490
  365             .10003         .09003         .13330
  366             .09859         .09191
  367             .09682         .09330
  368             .09557         .09475


STANDARD ERROR =  .203740E-01 (BY CONDITIONAL METHOD  )
```

```
1PAGE    7 BMDP2T  GEOSYNCH ENERGETIC ELECTRON DATA

END/

NUMBER OF INTEGER WORDS OF STORAGE USED IN PRECEDING PROBLEM   [illegible]
CPU TIME USED   11.754 SECONDS
1PAGE    8 BMDP2T

BMDP2T - BOX-JENKINS TIME SERIES ANALYSIS
EXECUTED ON 86/10/11.AT 20.09.27.

PROGRAM CONTROL INFORMATION

NO MORE CONTROL LANGUAGE.

PROGRAM TERMINATED
```

BMDP Example Problem #[illegible]

Computer: CYBER
Data set used: CCFLO
Transfer Function Model

```
1PAGE   1 BMDP2T


BMDP2T - BOX-JENKINS TIME SERIES ANALYSIS
BMDP STATISTICAL SOFTWARE, INC.
1964 WESTWOOD BLVD. SUITE 202
(213) 475-5700
PROGRAM REVISED APRIL    1982
MANUAL REVISED -- 1981
COPYRIGHT (C) 1982 REGENTS OF UNIVERSITY OF CALIFORNIA

TO SEE REMARKS AND A SUMMARY OF NEW FEATURES FOR
THIS PROGRAM, STATE NEWS. IN THE PRINT PARAGRAPH.


THIS VERSION OF BMDP HAS BEEN CONVERTED FOR USE ON
CDC 6000 AND CYBER SERIES COMPUTERS BY
BMDP PROJECT, VOGELBACK COMPUTING CENTER
NORTHWESTERN UNIVERSITY
2129 SHERIDAN ROAD
EVANSTON, ILLINOIS 60201
(312) 492-3681

RELEASED AUGUST 1983 FOR FTN5 COMPILERS

EXECUTED ON 86/10/19.AT 10.50.33.


PROGRAM CONTROL INFORMATION

 /PROBLEM     TITLE IS 'GEOSYNCH EE TIME SERIES,
              TRANSFER FUNC FROM SOLAR WIND, IMF BZ'.
 /INPUT       VARIABLES ARE 12.
              FORMAT IS FREE.
              RECL = 90.
 /VARIABLE    NAMES ARE DATE,ABXE,ABYE,ABZE,
                      ABYM,ABZM,AV,SEESSD,SEEI,
                      SEEII,SEEIII,SEEIV.
 /TRANSFORM   DELETE = 1 TO 506.
 /END

PROBLEM TITLE IS
GEOSYNCH EE TIME SERIES, TRANSFER FUNC FROM SOLAR WIND, IMF BZ
```

```
NUMBER OF VARIABLES TO READ IN. . . . . . . . .        12
NUMBER OF VARIABLES ADDED BY TRANSFORMATIONS. .         0
TOTAL NUMBER OF VARIABLES . . . . . . . . . . .        12
NUMBER OF CASES TO READ IN. . . . . . . . . . . .TO END
CASE LABELING VARIABLES . . . . . . . . . . . .
MISSING VALUES CHECKED BEFORE OR AFTER TRANS. . NEITHER
BLANKS ARE. . . . . . . . . . . . . . . . . . . MISSING
INPUT UNIT NUMBER . . . . . . . . . . . . . . .         5
REWIND INPUT UNIT PRIOR TO READING. . DATA. . .        NO
NUMBER OF WORDS OF DYNAMIC STORAGE. . . . . . .     49996
***** TRAN     PARAGRAPH IS USED *****
1PAGE   2 BMDP2T  GEOSYNCH EE TIME SERIES, TRANSFER FUNC FROM SOLAR WIND, IMF BZ


VARIABLES TO BE USED
     1 DATE     2 ABXE     3 ABYE     4 ABZE     5 ABYM
     6 ABZM     7 AV       8 SEESSI   9 SEEI    10 SEEII
    11 SEEIII     12 SEEIV
INPUT FORMAT IS
FREE
MAXIMUM LENGTH DATA RECORD IS   90 CHARACTERS.

NUMBER OF CASES READ. . . . . . . . . . . . . .       706
   CASES WITH USE SET TO NEGATIVE VALUE . . . .       506
      REMAINING NUMBER OF CASES . . . . . . . .       200
1PAGE   3 BMDP2T  GEOSYNCH EE TIME SERIES, TRANSFER FUNC FROM SOLAR WIND, IMF BZ


  ARIMA       VARIABLE IS ABZM.
              ABOR = '(1)'.
              CENTERED./

THE COMPONENT HAS BEEN ADDED TO THE MODEL

THE CURRENT MODEL HAS
OUTPUT VARIABLE = ABZM
INPUT  VARIABLE = NOISE
1PAGE   4 BMDP2T  GEOSYNCH EE TIME SERIES, TRANSFER FUNC FROM SOLAR WIND, IMF BZ



  ESTIMATION  RESIDUAL = RX.
              METHOD IS CLS./



ESTIMATION BY CONDITIONAL LEAST SQUARES METHOD

RELATIVE CHANGE IN EACH ESTIMATE LESS THAN  .1000E-03
```

```
SUMMARY OF THE MODEL

OUTPUT VARIABLE -- AEDM
INPUT VARIABLES -- NOISE

VARIABLE  VAR. TYPE  MEAN      TIME    DIFFERENCES

AEDM       RANDOM    REMOVED  1- 200

PARAMETER VARIABLE   TYPE  FACTOR  ORDER ESTIMATE   ST. ERR.  T-RATIO
     1  AEDM         AR      1      1      .7423     .0475     15.62

RESIDUAL SUM OF SQUARES  =       517.550969
DEGREES OF FREEDOM       =              198
RESIDUAL MEAN SQUARE     =         2.613894
1PAGE   5 BMDP2T  GEOSYNCH EE TIME SERIES, TRANSFER FUNC FROM SOLAR WIND, IMF EZ



  FILTER       VARIABLE IS SEESSD.
               RESIDUAL = RY./

RESIDUAL MEAN SQUARE     =     45593.047731

VARIABLE SEESSD   IS FILTERED, RESULTS ARE STORED IN VARIABLE RY
1PAGE   6 BMDP2T  GEOSYNCH EE TIME SERIES, TRANSFER FUNC FROM SOLAR WIND, IMF EZ



  CCF          VARIABLES ARE RX, RY.
               MAXLAG IS 10./


EFFECTIVE NUMBER OF CASES =  199

CORRELATION         OF RX          AND RY        IS     .00

CROSS CORRELATIONS OF RX      (I) AND RY      (I+K)

  1- 10     -.19  .06 -.06  .10  .11  .05  .09 -.05  .10 -.03
  ST.E.      .07  .07  .07  .07  .07  .07  .07  .07  .07  .07

CROSS CORRELATIONS OF RY      (I) AND RX      (I+K)

  1- 10     -.04  .07  .01 -.05  .06  .05  .02 -.01 -.07  .04
  ST.E.      .07  .07  .07  .07  .07  .07  .07  .07  .07  .07
```

TRANSFER FUNCTION WEIGHTS

LAG	SCCF(X(I),Y(I+K)) *SY/SX	*SX/SY	SCCF(Y(I),X(I+K)) *SY/SX	*SX/SY
0	.52241	.00003	.52241	.00003
1	-24.77278	-.00142	-5.77467	-.00033
2	8.57492	.00049	8.59414	.00049
3	-7.94904	-.00046	1.77053	.00010
4	12.56537	.00072	-6.46692	-.00037
5	14.97775	.00086	8.51527	.00049
6	7.12679	.00041	6.33562	.00036
7	11.63571	.00067	2.17164	.00012
8	-7.21447	-.00041	-1.13360	-.00006
9	13.06466	.00075	-9.24338	-.00053
10	-3.49978	-.00020	4.87125	.00028

WHERE X(I) IS THE FIRST SERIES, Y(I) THE SECOND SERIES, SX THE STANDARD ERROR OF X(I), AND SY THE STANDARD ERROR OF Y(I)

1PAGE 7 BMDP2T GEOSYNCH EE TIME SERIES, TRANSFER FUNC FROM SOLAR WIND, IMF BZ

PLOT OF CROSS CORRELATIONS

```
          -1.0  -.8  -.6  -.4  -.2   .0   .2   .4   .6   .8  1.0
LAG  CORR. +----+----+----+----+----+----+----+----+----+----+
                                     I
-10   .037                      +    IX  +
 -9  -.070                      + XXI    +
 -8  -.009                      +    I   +
 -7   .016                      +    I   +
 -6   .048                      +    IX  +
 -5   .064                      +    IXX +
 -4  -.049                      +   XI   +
 -3   .013                      +    I   +
 -2   .065                       +   IXX+
 -1  -.044                       +  XI  +
  0   .004                       +   I  +
  1  -.188                     XX+XXI   +
  2   .065                       +   IXX+
  3  -.06[illegible]                      + XXI    +
  4   .0[illegible]5                      +    IXX +
  5   .11[illegible]                      +    IXXX+
  6   .[illegible]54                      +    IX  +
  7   .0[illegible]                      +    IXX +
  8  -.0[illegible]                      +   XI   +
  9   .0[illegible]                      +    IXX +
```

```
 1(   -.02?                          * XI  *
1PAGE   8 BMDP2T  GEOSYNCH BE TIME SERIES, TRANSFER FUNC FROM SOLAR WIND, IMF BZ

 ARIMA        VARIABLE IS SBESSD.
              CENTERED./

THE COMPONENT HAS BEEN ADDED TO THE MODEL

THE CURRENT MODEL HAS
OUTPUT VARIABLE = SBESSD
INPUT  VARIABLE = NOISE
1PAGE   9 BMDP2T  GEOSYNCH BE TIME SERIES, TRANSFER FUNC FROM SOLAR WIND, IMF BZ

 INDEP        VARIABLE IS ABZM.
              UPORDERS = '(1)'.
              UPVALUES = -24.77278./

THE COMPONENT HAS BEEN ADDED TO THE MODEL

THE CURRENT MODEL HAS
OUTPUT VARIABLE = SBESSD
INPUT  VARIABLE = NOISE    ABZM
1PAGE  10 BMDP2T  GEOSYNCH BE TIME SERIES, TRANSFER FUNC FROM SOLAR WIND, IMF BZ


  ESTIMATION  RESIDUALS = RYX.
              METHOD IS CLS./


ESTIMATION BY CONDITIONAL LEAST SQUARES METHOD

RELATIVE CHANGE IN RESIDUAL SUM OF SQUARES LESS THAN  .1000E-04


SUMMARY OF THE MODEL

OUTPUT VARIABLE -- SBESSD
INPUT VARIABLES -- NOISE    ABZM

VARIABLE  VAR. TYPE  MEAN      TIME     DIFFERENCES

SBESSD     RANDOM    REMOVED  1- 200

ABZM       RANDOM             1- 200
```

```
PARAMETER VARIABLE   TYPE  FACTOR  ORDER ESTIMATE  ST. ERR.  T-RATIO
     1  ABZM          UP      1       1     -8.531   7.6249    -1.12

RESIDUAL SUM OF SQUARES  =  14710279.871337
DEGREES OF FREEDOM       =               198
RESIDUAL MEAN SQUARE     =      74294.342785
1PAGE  11 BMDP2T  GEOSYNCH BZ TIME SERIES, TRANSFER FUNC FROM SOLAR WIND, IMF BZ

  ACF        VARIABLE IS EYX./

NUMBER OF OBSERVATIONS            =          199
MEAN OF THE (DIFFERENCED) SERIES =        4.9694
STANDARD ERROR OF THE MEAN        =       19.3187
T-VALUE OF MEAN (AGAINST ZERO)    =         .2572


AUTOCORRELATIONS

  1- 12      .65  .42  .20  .12  .01 -.09 -.10 -.12 -.02  .02  .06  .04
  ST.E.      .07  .10  .10  .11  .11  .11  .11  .11  .11  .11  .11  .11

 13- 24      .06  .05 -.03 -.07 -.10 -.09 -.12 -.04 -.01  0.0  .05  .08
  ST.E.      .11  .11  .11  .11  .11  .11  .11  .11  .11  .11  .11  .11

 25- 36      .17  .24  .28  .28  .22  .19  .12  .08  .06  .06  .03  .04
  ST.E.      .11  .11  .12  .12  .12  .12  .13  .13  .13  .13  .13  .13

PLOT OF AUTOCORRELATIONS

         -1.0  -.8  -.6  -.4  -.2   .0   .2   .4   .6   .8  1.0
LAG   CORR. +----+----+----+----+----+----+----+----+----+----+
                                     I
  1    .646                      +   IXX+XXXXXXXXXXXXX
  2    .423                     +    IXXXX+XXXXXX
  3    .201                     +    IXXXXX
  4    .122                     +    IXXX +
  5    .013                     +    I    +
  6   -.091                     +  XXI    +
  7   -.104                     + XXXI    +
  8   -.120                     + XXXI    +
  9   -.019                     +    I    +
 10    .024                     +    IX   +
 11    .062                     +    IXX  +
 12    .042                     +    IX   +
 13    .061                     +    IXX  +
 14    .054                     +    IX   +
 15   -.031                     +   XI    +
 16   -.070                     +  XXI    +
```

```
17   -.100                    + XXXI    +
18   -.092                    +  XXI    +
19   -.117                    + XXXI    +
20   -.043                    .    XI    +
21   -.010                    +     I    +
22    .001                    +     I    +
23    .050                    +     IX   +
24    .083                    +     IXX  +
25    .169                    +     IXXXX+
26    .237                   +      IXXXXXX
27    .273                   -      IXXXXX+X
28    .282                   +      IXXXXX+X
29    .221                   +      IXXXXXX
30    .185                   +      IXXXXX+
31    .120                   +      IXXX   +
32    .077                   +      IXX    +
33    .062                   +      IXX    +
34    .059                   +      IX     +
35    .062                   +      IXX    +
36    .041                   +      IX     +
1PAGE  12 BMDP2T  GEOSYNCH EE TIME SERIES, TRANSFER FUNC FROM SOLAR WIND, IMF BZ


 PACF       VARIABLE IS EYX./

NUMBER OF OBSERVATIONS              =          199
MEAN OF THE (DIFFERENCED) SERIES =         4.9694
STANDARD ERROR OF THE MEAN         =        19.3187
T-VALUE OF MEAN (AGAINST ZERO)     =          .2572


PARTIAL AUTOCORRELATIONS

 1- 12     .65  .01 -.13  .07 -.09 -.12  .06 -.05  .14  .02 -.01 -.03
 ST.E.     .07  .07  .07  .07  .07  .07  .07  .07  .07  .07  .07  .07

13- 24     .04 -.02 -.12  .01  0.0 -.02 -.04  .11 -.02 -.05  .03  .02
 ST.E.     .07  .07  .07  .07  .07  .07  .07  .07  .07  .07  .07  .07

25- 36     .12  .17  .03  .09 -.02  .01  0.0  .03  [illegible]  .01  .00 -.01
 ST.E.     .07  .07  .07  .07  .07  .07  .07  .07  .07  .07  .07  .07
```

```
PLOT OF PARTIAL AUTOCORRELATIONS

          -1.0 -.8  -.6  -.4  -.2   .0   .2   .4   .6   .8  1.0
LAG   CORR. +----+----+----+----+----+----+----+----+----+----+
                                     :
  1    .646                       +  IXX+XXXXXXXXXXXXX
  2    .009                       +  I  +
  3   -.130                       XXXI  +
  4    .086                       +  IXX+
  5   -.094                       +XXI  +
  6   -.120                       XXXI  +
  7    .059                       +  IX +
  8   -.048                       + XI  +
  9    .136                       +  IXXX
 10    .020                       +  I  +
 11   -.012                       +  I  +
 12   -.027                       + XI  +
 13    .036                       +  IX +
 14   -.020                       +  I  +
 15   -.123                       XXXI  +
 16    .019                       +  I  +
 17    .000                       +  I  +
 18   -.025                       + XI  +
 19   -.042                       + XI  +
 20    .112                       +  IXXX
 21   -.017                       +  I  +
 22   -.052                       + XI  +
 23    .086                       +  IXX+
 24    .021                       +  IX +
 25    .121                       +  IXXX
 26    .167                       +  IXX+X
 27    .031                       +  IX +
 28    .092                       +  IXX+
 29   -.016                       +  I  +
 30    .011                       +  I  +
 31   -.002                       +  I  +
 32    .025                       +  IX +
 33    .095                       +  IXX+
 34    .008                       +  I  +
 35    .030                       +  IX +
 36   -.011                       +  I  +
1PAGE  13 BMDP2T  GEOSYNCH EE TIME SERIES, TRANSFER FUNC FROM SOLAR WIND, IMF BZ

 ARIMA        VARIABLE IS SEESSD.
              CENTERED.
              AROR = '(1,27)'./

THE COMPONENT HAS BEEN ADDED TO THE MODEL
```

```
THE CURRENT MODEL HAS
OUTPUT VARIABLE = SEESSD
INPUT  VARIABLE = NOISE    ABZM
1PAGE  14 BMDP2T  GEOSYNCH EE TIME SERIES, TRANSFER FUNC FROM SOLAR WIND, IMF BZ

  ESTIMATION  RESIDUALS = RYX./

ESTIMATION BY CONDITIONAL LEAST SQUARES METHOD

RELATIVE CHANGE IN RESIDUAL SUM OF SQUARES LESS THAN  .1000E-04

SUMMARY OF THE MODEL

OUTPUT VARIABLE -- SEESSD
INPUT VARIABLES -- NOISE    ABZM

VARIABLE  VAR. TYPE  MEAN      TIME     DIFFERENCES

SEESSD     RANDOM    REMOVED  1- 200

ABZM       RANDOM             1- 200

PARAMETER VARIABLE    TYPE  FACTOR  ORDER ESTIMATE    ST. ERR.  T-RATIO
     1  SEESSD        AR       1       1      .7033     .0524    13.42
     2  SEESSD        AR       1      27      .1339     .0528     2.53
     3  ABZM          UP       1       1    -15.83    8.1434    -1.94

RESIDUAL SUM OF SQUARES  =   5434316.344292
DEGREES OF FREEDOM       :              169
RESIDUAL MEAN SQUARE     =     32155.718014


ESTIMATION BY BACKCASTING METHOD

RELATIVE CHANGE IN RESIDUAL SUM OF SQUARES LESS THAN  .1000E-04


SUMMARY OF THE MODEL

OUTPUT VARIABLE -- SEESSD
INPUT VARIABLES -- NOISE    ABZM

VARIABLE  VAR. TYPE  MEAN      TIME     DIFFERENCES

SEESSD     RANDOM    REMOVED  1- 200

ABZM       RANDOM             1- 200
```

```
PARAMETER VARIABLE   TYPE  FACTOR  ORDER ESTIMATE    ST. ERR.  T-RATIO
     1  SEESSI        AR      1      1      .6155     .0479    12.76
     2  SEESSI        AR      1     27      .1971     .0482     4.09
     3  ABCM          UP      1      1    -24.01     7.0925    -3.19

RESIDUAL SUM OF SQUARES  =   5578891.596103 (BACKCASTS EXCLUDED)
DEGREES OF FREEDOM       =              169
RESIDUAL MEAN SQUARE     =      33011.195794
1PAGE  15 BMDPST  GEOSYNCH EE TIME SERIES, TRANSFER FUNC FROM SOLAR WIND, IMF BZ


  ACF          VARIABLE IS RYX.
               MAXLAG IS 36./

NUMBER OF OBSERVATIONS            =          200
MEAN OF THE (DIFFERENCED) SERIES  =        -.8012
STANDARD ERROR OF THE MEAN        =       14.1529
T-VALUE OF MEAN (AGAINST ZERO)    =        -.0566

AUTOCORRELATIONS

  1- 12     -.01  .06 -.10  .06  0.0 -.11 -.04 -.14  .06  .02  .11  .02
  ST.E.      .07  .07  .07  .07  .07  .07  .07  .07  .07  .07  .07  .08

 13- 24      .05  .10 -.06 -.02 -.08  .01 -.03  .02  .07 -.01  .05 -.01
  ST.E.      .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08

 25- 36      .04  .03 -.09  .03 -.04  .02  0.0  0.0  .02  .04  .1   .02
  ST.E.      .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08
PLOT OF AUTOCORRELATIONS

            -1.0  -.8  -.6  -.4  -.2   .0   .2   .4   .6   .8  1.0
LAG   CORR. +----+----+----+----+----+----+----+----+----+----+
                                       I
                                       I
  1   -.013                         +  I  +
  2    .065                         +  IXX+
  3   -.104                         XXXI  +
  4    .065                        +   IXX +
  5   -.001                        +   I   +
  6   -.113                        +XXXI   +
  7   -.043                        +  XI   +
  8   -.135                        +XXXI   +
  9    .062                        +   IXX +
 10    .020                        +   I   +
 11    .112                        +   IXXX+
 12    .018                        +   I   +
 13    .052                        +   IX  +
 14    .105                        +   IXXX+
 15   -.056                        +  XI   +
```

```
16   -.022                        +  XI   +
17   -.081                        + XXI   +
18    .008                        +   I   +
19   -.090                        + XXI   +
20    .031                        +   IX  +
21    .075                        +   IXX +
22   -.012                        +   I   +
23    .051                        +   IX  +
24   -.006                        +   I   +
25    .035                        +   IX  +
26    .088                        +   IXX +
27   -.088                        + XXI   +
28    .034                        +   IX  +
29   -.043                        +  XI   +
30    .065                        +   IXX +
31   -.001                        +   I   +
32   -.004                        +   I   +
33    .016                        +   I   +
34    .042                        +   IX  +
35    .102                        +   IXXX+
36    .025                        +   IX  +
1PAGE  16 BMDP2T  GEOSYNCH EE TIME SERIES, TRANSFER FUNC FROM SOLAR WIND, IMF BZ


  ARIMA       VARIABLE IS ABZM.
              AROR = '(1)'.
              ARVALUES = 0.7423.
              CENTERED./

THE COMPONENT HAS BEEN ADDED TO THE MODEL

THE CURRENT MODEL HAS
OUTPUT VARIABLE = ABZM
INPUT  VARIABLE = NOISE    ABZM
1PAGE  17 BMDP2T  GEOSYNCH EE TIME SERIES, TRANSFER FUNC FROM SOLAR WIND, IMF BZ
PSIWEIGHT   MAXPSI = 40./

  24 PSI-WEIGHTS ARE STORED.
1PAGE  18 BMDP2T  GEOSYNCH EE TIME SERIES, TRANSFER FUNC FROM SOLAR WIND, IMF BZ


  ERASE       MODEL./

UNIVARIATE TIME SERIES MODEL ERASED
1PAGE  19 BMDP2T  GEOSYNCH EE TIME SERIES, TRANSFER FUNC FROM SOLAR WIND, IMF BZ
```

```
  ARIMA      VARIABLE IS SBBSSD.
             ARDE = '(1,27)'.
             ARVALUES = 0.6125,  0.1970.
             CENTERED./

THE COMPONENT HAS BEEN ADDED TO THE MODEL

THE CURRENT MODEL HAS
OUTPUT VARIABLE = SBBSSD
INPUT  VARIABLE = NOISE
1PAGE  20 BMDP2T  GEOSYNCH EE TIME SERIES, TRANSFER FUNC FROM SOLAR WIND, IMF BZ


  INDEP      VARIABLE IS ABZM.
             UPORDERS = '(1)'.
             UPVALUES = -24.01.
             CENTERED./

THE COMPONENT HAS BEEN ADDED TO THE MODEL

THE CURRENT MODEL HAS
OUTPUT VARIABLE = SBBSSD
INPUT  VARIABLE = NOISE    ABZM
1PAGE  21 BMDP2T  GEOSYNCH EE TIME SERIES, TRANSFER FUNC FROM SOLAR WIND, IMF BZ

  FORECAST   CASES = 30.
             START = 171./


 FORECAST ON VARIABLE SBBSSD   FROM TIME PERIOD   171

PERIOD        FORECASTS      ST.  ERR.       ACTUAL
  171          67.26424     189.12573      24.40170
  172         269.91766     221.78217       8.31490
  173         214.72861     232.85505      12.55530
  174         193.19551     236.87563      29.57690
  175         173.39074     238.36649      11.77450
  176         206.66543     238.92339      12.85010
  177         204.17370     239.13198      17.24380
  178         111.97103     239.21019      16.15370
  179         144.80542     239.23952       7.31580
  180         125.66970     239.25053       6.00410
  181         154.55765     239.25465       4.38110
  182         157.30364     239.25620       3.97570
  183         152.44244     239.25678       4.55460
  184         164.00170     239.25700       3.52040
  185         241.25144     239.25708       3.09090
```

186	181.50450	239.25713	3.74910
187	185.97911	239.25713	10.61000
188	195.90108	239.25713	8.31990
189	177.03241	239.25713	3.41460
190	268.05719	239.25713	66.39000
191	303.21836	239.25713	360.94090
192	390.61474	239.25713	739.35070
193	355.15530	239.25713	772.79300
194	335.93435	239.25713	799.37160
195	291.77327	239.25713	93.74340
196	265.31102	239.25713	57.06710
197	237.96124	239.25713	28.92480
198	230.80034	242.14948	50.51190
199	234.99035	246.42809	42.94960
200	237.37395	249.97904	62.67170

STANDARD ERROR = 189.126 (BY CONDITIONAL METHOD)
1PAGE 22 BMDP2T GEOSYNCH EB TIME SERIES, TRANSFER FUNC FROM SOLAR WIND, IMF BZ

END/

NUMBER OF INTEGER WORDS OF STORAGE USED IN PRECEDING PROBLEM 5988
CPU TIME USED 9.070 SECONDS

1PAGE 23 BMDP2T

BMDP2T - BOX-JENKINS TIME SERIES ANALYSIS
EXECUTED ON 86/10/19.AT 10.50.47.

PROGRAM CONTROL INFORMATION

NO MORE CONTROL LANGUAGE.

PROGRAM TERMINATED

Appendix F: ACFs and PACFs of the Energetic Electron Channel Series

Appendix F: ACFs and PACFs of the Energetic Electron Channel Series

ACF VARIABLE IS [illegible]

```
NUMBER OF OBSERVATIONS            =        [illegible]
MEAN OF THE (DIFFERENCED) SERIES  =        205.60[illegible]
STANDARD ERROR OF THE MEAN        =          8.8395
T-VALUE OF MEAN (AGAINST ZERO)    =         23.2595
```

AUTOCORRELATIONS

1- 12	.59	.42	.25	.12	.09	.02	-.01	-.05	0.0	.01	.04	.05
ST.E.	.04	.05	.05	.06	.06	.06	.06	.06	.06	.06	.06	.06
13- 24	.06	.07	.07	.04	.02	-.01	-.04	.02	.03	.04	.06	.15
ST.E.	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	[illegible]
25- 36	.22	.28	.32	.29	.23	.18	.13	.10	.07	.06	.03	0.0
ST.E.	.06	.06	.06	.06	.06	.07	.07	.07	.07	.07	.07	.07

PLOT OF AUTOCORRELATIONS

```
          -1.0  -.8  -.6  -.4  -.2  .0   .2   .4   .6   .8  1.0
LAG   CORR. +----+----+----+----+----+----+----+----+----+----+
                                     I
  1    .594                         + IX+XXXXXXXXXXXXX
  2    .416                         + IX+XXXXXXXX
  3    .248                        +  IXX+XXX
  4    .124                        +  IXXX
  5    .085                        +  IXX+
  6    .018                        +  I  +
  7   -.012                        +  I  +
  8   -.055                        + XI  +
  9   -.004                        +  I  +
 10    .012                        +  I  +
 11    .039                        +  IX +
 12    .053                        +  IX +
 13    .052                        +  IX +
 14    .067                        +  IXX+
 15    .075                        +  IXX+
 16    .043                        +  IX +
 17    .022                        +  IX +
 18   -.010                        +  I  +
 19   -.042                        + XI  +
 20    .016                        +  I  +
 21    .033                        +  IX +
 22    .040                        +  IX +
 23    .078                        +  IXX+
 24    .148                        +  IXX+X
 25    .225                        +  IXX+XXX
 26    .282                        +  IXX+XXXX
 27    .316                        +  IXX+XXXXX
 28    .260                        +  IXX+XXX
 29    .231                        +  IXX+XXX
 30    .180                        +  IXX+XX
 31    .131                        +  IXXX
 32    .104                        +  IXXX
 33    .072                        +  IXX+
 34    .065                        +  IXX+
 35    .025                        +  IX +
 36   -.00[illegible]                        +  I  +
```

DATE VARIABLE IS [illegible]

NUMBER OF OBSERVATIONS = [illegible]
MEAN OF THE (DIFFERENCED) SERIES = [illegible]
STANDARD ERROR OF THE MEAN = [illegible]
T-VALUE OF MEAN (AGAINST ZERO) = 21.[illegible]

PARTIAL AUTOCORRELATIONS

1- 12	.59	.10	-.05	-.05	.04	-.05	-.02	-.05	.03	.01	.02	.01
ST.E.	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
13- 24	.02	.02	.03	-.04	0.0	-.03	-.03	[illegible]	.02	-.01	.06	.12
ST.E.	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
25- 36	.11	.09	.09	-.01	.04	.01	.01	.03	.03	.03	-.04	-.04
ST.E.	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04

PLOT OF PARTIAL AUTOCORRELATIONS

```
             -1.0  -.8  -.6  -.4  -.2   .0   .2   .4   .6   .8  1.0
LAG   CORR.  +----+----+----+----+----+----+----+----+----+----+
                                       I
  1    .594                          + IX+XXXXXXXXXXXXX
  2    .099                          + IXX
  3   -.052                          +XI +
  4   -.050                          +XI +
  5    .040                          + IX+
  6   -.049                          +XI +
  7   -.018                          + I +
  8   -.047                          +XI +
  9    .092                          + IXX
 10    .003                          + I +
 11    .024                          + IX+
 12    .010                          + I +
 13    .017                          + I +
 14    .017                          + I +
 15    .025                          + IX+
 16   -.043                          +XI +
 17   -.002                          + I +
 18   -.027                          +XI +
 19   -.031                          +XI +
 20    .101                          + IX+X
 21    .019                          + I +
 22   -.006                          + I +
 23    .063                          + IXX
 24    .120                          + IX+X
 25    .114                          + IX+X
 26    .094                          + IXX
 27    .059                          + IXX
 28   -.007                          + I +
 29    .036                          + IX+
 30    .011                          + I +
 31    .010                          + I +
 32    .030                          + IX+
 33    .027                          + IX+
 34    .034                          + IX+
 35   -.041                          +XI +
 36   -.043                          +XI +
```

ACF   VARIABLE IS SEE[illegible]

NUMBER OF OBSERVATIONS	=	[illegible]
MEAN OF THE (DIFFERENCED) SERIES	=	1.4[illegible]
STANDARD ERROR OF THE MEAN	=	.1033
T-VALUE OF MEAN (AGAINST ZERO)	=	12.7[illegible]

AUTOCORRELATIONS

1- 12	.73	.40	.25	.10	.01	-.02	-.02	-.02	-.01	.01	.01	.02
ST.E.	.04	.05	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06
13- 24	.03	.04	.07	.10	.08	.01	-.03	-.03	-.04	-.04	.01	.0[illegible]
ST.E.	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06
25- 36	.15	.21	.25	.22	.17	.11	.02	-.02	-.03	-.04	-.05	-.04
ST.E.	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06

```
                              ACF   VARIABLE IS SEE1

                              PLOT OF AUTOCORRELATIONS

            -1.0  -.8  -.6  -.4  -.2   .0   .2   .4   .6   .8  1.0
LAG   CORR.  +----+----+----+----+----+----+----+----+----+----+
                                       I
  1    .733                          + IX+XXXXXXXXXXXXXXXX
  2    .425                         +  IXX+XXXXXXXX
  3    .249                         +  IXX+XXX
  4    .095                         +  IXX+
  5    .012                         +  I  +
  6   -.017                         +  I  +
  7   -.021                         + XI  +
  8   -.019                         +  I  +
  9   -.010                         +  I  +
 10    .015                         +  I  +
 11    .013                         +  I  +
 12    .017                         +  I  +
 13    .033                         +  IX +
 14    .041                         +  IX +
 15    .073                         +  IXX+
 16    .099                         +  IXX+
 17    .078                         +  IXX+
 18    .013                         +  I  +
 19   -.029                         + XI  +
 20   -.028                         + XI  +
 21   -.033                         + XI  +
 22   -.039                         + XI  +
 23    .010                         +  I  +
 24    .084                         +  IXX+
 25    .151                         +  IXX+X
 26    .208                         +  IXX+XX
 27    .252                         +  IXX+XXX
 28    .221                         +  IXX+XXX
 29    .171                         +  IXX+X
 30    .112                         +  IXXX
 31    .023                         +  IX +
 32   -.025                         + XI  +
 33   -.034                         + XI  +
 34   -.040                         + XI  +
 35   -.050                         + XI  +
 36   -.039                         + XI  +
```

PACF VARIABLE IS SEE[illegible]

NUMBER OF OBSERVATIONS	=	[illegible]
MEAN OF THE (DIFFERENCED) SERIES	=	1.4[illegible]
STANDARD ERROR OF THE MEAN	=	[illegible]
T-VALUE OF MEAN (AGAINST ZERO)	=	[illegible]

PARTIAL AUTOCORRELATIONS

1- 12	.73	-.24	[illegible]	-.17	.06	-.02	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ST.E.	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
13- 24	0.0	.02	.07	.01	-.04	[illegible]	.03	[illegible]	[illegible]	.01	[illegible]	[illegible]
ST.E.	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
25- 36	.06	.08	[illegible]	-.06	.05	-.06	-.06	.02	.01	[illegible]	[illegible]	[illegible]
ST.E.	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04

[illegible] VARIABLE IS [illegible]

PLOT OF PARTIAL AUTOCORRELATIONS

```
          -1.0 -.8  -.6  -.4  -.2   .0   .2   .4   .6   .8  1.0
LAG   CORR. +----+----+----+----+----+----+----+----+----+----+
                                     I
  1    .733                        + IX+XXXXXXXXXXXXXXXX
  2   -.243                    XXXX+XI +
  3    .088                        + IXX
  4   -.146                      XX+XI +
  5    .059                        + IX+
  6   -.024                        +XI +
  7    .026                        + IX+
  8   -.023                        +XI +
  9    .020                        + I +
 10    .030                        + IX+
 11   -.043                        +XI +
 12    .046                        + IX+
 13    .005                        + I +
 14    .022                        + IX+
 15    .088                        + IXX
 16    .012                        + I +
 17   -.042                        +XI +
 18   -.081                        XXI +
 19    .029                        + IX+
 20    .023                        + IX+
 21   -.034                        +XI +
 22    .013                        + I +
 23    .075                        + IXX
 24    .092                        + IXX
 25    .058                        + IX+
 26    .078                        + IXX
 27    .075                        + IXX
 28   -.055                        +XI +
 29    .047                        + IX+
 30   -.057                        +XI +
 31   -.057                        +XI +
 32    .021                        + IX+
 33    .005                        + I +
 34    .001                        + I +
 35   -.025                        +XI +
 36    .023                        + IX+
```

ACF VARIABLE IS SERI[illegible]

```
NUMBER OF OBSERVATIONS              =        76[illegible]
MEAN OF THE (DIFFERENCED) SERIES    =        .15[illegible]
STANDARD ERROR OF THE MEAN          =        .0[illegible]
T-VALUE OF MEAN (AGAINST ZERO)      =        17.[illegible]
```

AUTOCORRELATIONS

1- 12	.71	.43	.30	.14	.06	.03	.01	-.01	-.01	.01	0.0	0.0
ST.E.	.04	.05	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06
13- 24	.01	.01	.03	.05	.04	0.0	-.02	-.01	0.0	.01	.07	.13
ST.E.	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06
25- 36	.18	.24	.28	.24	.20	.14	.06	.02	.01	-.02	-.04	-.04
ST.E.	.06	.06	.06	.06	.06	.06	.06	.07	.07	.07	.07	.07

```
                  ACF   VARIABLE IS S[illegible]

                  PLOT OF AUTOCORRELATIONS

             -1.0 -.8  -.6  -.4  -.2   .0   .2   .4   .6   .8  1.0
LAG   CORR.  +----+----+----+----+----+----+----+----+----+----+
                                       I
  1   .765                           + IX+XXXXXXXXXXXXXXXX
  2   .435                          +  IXX+XXXXXXXX
  3   .299                          +  IXX+XXXX
  4   .142                          +  IXX+X
  5   .060                          +  IX +
  6   .033                          +  IX +
  7   .010                          +  I  +
  8  -.008                          +  I  +
  9  -.011                          +  I  +
 10   .008                          +  I  +
 11   .000                          +  I  +
 12  -.005                          +  I  +
 13   .011                          +  I  +
 14   .012                          +  I  +
 15   .029                          +  IX +
 16   .046                          +  IX +
 17   .041                          +  IX +
 18   .003                          +  I  +
 19  -.022                          + XI  +
 20  -.005                          +  I  +
 21  -.003                          +  I  +
 22   .014                          +  I  +
 23   .065                          +  IXX+
 24   .127                          +  IXXX
 25   .180                          +  IXX+X
 26   .242                          +  IXX+XXX
 27   .282                          +  IXX+XXXX
 28   .238                          +  IXX+XXX
 29   .196                          +  IXX+XX
 30   .145                          +  IXX+X
 31   .061                          +  IXX+
 32   .020                          +  I  +
 33   .005                          +  I  +
 34  -.015                          +  I  +
 35  -.037                          + XI  +
 36  -.036                          + XI  +
```

PACF VARIABLE IS SEE11

```
NUMBER OF OBSERVATIONS           =          765
MEAN OF THE (DIFFERENCED) SERIES =        .1509
STANDARD ERROR OF THE MEAN       =        .0086
T-VALUE OF MEAN (AGAINST ZERO)   =      17.5608
```

PARTIAL AUTOCORRELATIONS

1- 12	.71	-.13	.09	-.15	.06	-.01	.01	-.03	.01	.04	-.04	[illegible]
ST.E.	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
13- 24	.02	0.0	.04	0.0	0.0	-.07	.01	.04	-.01	.04	.08	.10
ST.E.	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
25- 36	.08	.11	.06	-.05	.04	-.04	-.04	.01	0.0	0.0	-.04	.12
ST.E.	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04

PACF VARIABLE IS SEF[illegible]

PLOT OF PARTIAL AUTOCORRELATIONS

```
          -1.0 -.8  -.6  -.4  -.2   .0   .2   .4   .6   .8  1.0
LAG  CORR. +----+----+----+----+----+----+----+----+----+----+
                                    :
  1   .705                        + IX+XXXXXXXXXXXXXXXX
  2  -.125                       X+XI +
  3   .085                        + IXX
  4  -.153                      XX+XI +
  5   .058                        + IX+
  6  -.006                        + I +
  7   .008                        + I +
  8  -.025                        +XI +
  9   .009                        + I +
 10   .036                        + IX+
 11  -.039                        +XI +
 12   .011                        + I +
 13   .018                        + I +
 14  -.004                        + I +
 15   .044                        + IX+
 16   .001                        + I +
 17  -.004                        + I +
 18  -.067                        XXI +
 19   .007                        + I +
 20   .045                        + IX+
 21  -.012                        + I +
 22   .040                        + IX+
 23   .061                        + IXX
 24   .098                        + IXX
 25   .063                        + IXX
 26   .109                        + IX+X
 27   .061                        + IXX
 28  -.047                        +XI +
 29   .041                        + IX+
 30  -.039                        +XI +
 31  -.041                        +XI +
 32   .012                        + I +
 33   .002                        + I +
 34  -.004                        + I +
 35  -.036                        +XI +
 36   .018                        + I +
```

ACF VARIABLE IS SPEED1.

NUMBER OF OBSERVATIONS = 765
MEAN OF THE (DIFFERENCED) SERIES = .2560
STANDARD ERROR OF THE MEAN = .0412
T-VALUE OF MEAN (AGAINST ZERO) = 6.4255

AUTOCORRELATIONS

1- 12	.53	.32	.21	.10	-.01	-.01	-.01	-.01	-.01	-.01	-.01	-.01
ST.E.	.04	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05
13- 24	-.01	.10	.21	.21	.21	.21	.10	-.01	-.01	-.01	-.01	-.02
ST.E.	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05
25- 36	-.02	-.02	-.02	.11	-.01	-.01	-.01	-.01	-.01	-.01	-.01	-.01
ST.E.	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05

```
                              ACF   VARIABLE IS SERIII

                              PLOT OF AUTOCORRELATIONS

           -1.0  -.8  -.6  -.4  -.2   .0   .2   .4   .6   .8  1.0
LAG   CORR. +----+----+----+----+----+----+----+----+----+----+
                                     .
                                     .
  1    .535                        + IX+XXXXXXXXXX
  2    .316                        + IX+XXXXXX
  3    .205                        + IX+XXX
  4    .097                        + IXX
  5   -.012                        + I +
  6   -.011                        + I +
  7   -.010                        + I +
  8   -.010                        + I +
  9   -.010                        + I +
 10   -.011                        + I +
 11   -.012                        + I +
 12   -.013                        + I +
 13   -.014                        + I +
 14    .097                        + IXX
 15    .208                        + IX+XXX
 16    .209                        + IX+XXX
 17    .210                       +  IXX+XX
 18    .210                       +  IXX+XX
 19    .100                       +  IXXX
 20   -.010                       +  I   +
 21   -.011                       +  I   +
 22   -.013                       +  I   +
 23   -.014                       +  I   +
 24   -.015                       +  I   +
 25   -.016                       +  I   +
 26   -.016                       +  I   +
 27   -.017                       +  I   +
 28    .107                       +  IXXX
 29   -.014                       +  I   +
 30   -.014                       +  I   +
 31   -.013                       +  I   +
 32   -.012                       +  I   +
 33   -.011                       +  I   +
 34   -.010                       +  I   +
 35   -.010                       +  I   +
 36   -.011                       +  I   +
```

PACF VARIABLE IS [illegible]

NUMBER OF OBSERVATIONS	=	[illegible]
MEAN OF THE (DIFFERENCED) SERIES	=	.[illegible]
STANDARD ERROR OF THE MEAN	=	.040[illegible]
T-VALUE OF MEAN (AGAINST ZERO)	=	[illegible].42[illegible]

PARTIAL AUTOCORRELATIONS

1- 12	.53	.04	.02	-.05	-.08	.04	.01	.01	-.[illegible]	-.[illegible]	0.0	0.0
ST.E.	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
13- 24	0.0	.15	.15	.03	.04	.04	-.08	-.08	.04	.02	.02	-.02
ST.E.	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
25- 36	-.02	0.0	.01	.20	-.21	0.0	-.05	-.05	-.[illegible]	-.01	.03	-.01
ST.E.	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04

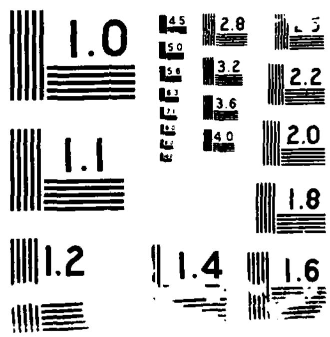
```
                         PACF   VARIABLE IS SEE[illegible]

                       PLOT OF PARTIAL AUTOCORRELATIONS

        -1.0  -.8  -.6  -.4  -.2   .0   .2   .4   .6   .8  1.0
LAG   CORR. +----+----+----+----+----+----+----+----+----+----+
                                   I
  1    .535                      + IX+XXXXXXXXXXX
  2    .042                      + IX+
  3    .029                      + IX+
  4   -.045                      +XI +
  5   -.064                      XXI +
  6    .039                      + IX+
  7    .005                      + I +
  8    .006                      + I +
  9   -.007                      + I +
 10   -.013                      + I +
 11   -.002                      + I +
 12   -.004                      + I +
 13   -.003                      + I +
 14    .153                      + IX+XX
 15    .153                      + IX+XX
 16    .025                      + IX+
 17    .042                      + IX+
 18    .040                      + IX+
 19   -.077                      XXI +
 20   -.075                      XXI +
 21    .036                      + IX+
 22    .019                      + I +
 23    .018                      + I +
 24   -.013                      + I +
 25   -.024                      +XI +
 26   -.002                      + I +
 27    .012                      + I +
 28    .20[illegible]                      + IX+XXX
 29   -.210                   XXX+XI +
 30   -.003                      + I +
 31   -.046                      +XI +
 32   -.049                      +XI +
 33   -.007                      + I +
 34   -.012                      + I +
 35    .03[illegible]                      + IX+
 36   -.009                      + I +
```

AD-A194 360 A TIME SERIES ANALYSIS OF ENERGETIC ELECTRON FLUXES (1.2 - 16 MEV) AT GEOS (U) AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL OF ENGI M P HALPEN 3/3

UNCLASSIFIED DEC 86 AFIT/GSO/ENS-ENP/86D-1 F/G 22/1 NL


1.0
1.1
1.2
1.4
1.6
1.8
2.0
2.2
2.8
3.2
3.6
4.0
4.5
5.0

ACF VARIABLE IS SFFIV

```
NUMBER OF OBSERVATIONS             =        768
MEAN OF THE (DIFFERENCED) SERIES   =     1.7100
STANDARD ERROR OF THE MEAN         =      .3840
T-VALUE OF MEAN (AGAINST ZERO)     =     1.7390
```

AUTOCORRELATIONS

1- 12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ST.E.	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
13- 24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ST.E.	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
25- 36	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	.20	0.0
ST.E.	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04

```
                        ACF    VARIABLE IS SEEIV

                        PLOT OF AUTOCORRELATIONS

              -1.0  -.8  -.6  -.4  -.2   .0   .2   .4   .6   .8  1.0
LAG   CORR.   +----+----+----+----+----+----+----+----+----+----+
                                         I
  1   -.002                            + I +
  2   -.002                            + I +
  3   -.002                            + I +
  4   -.003                            + I +
  5   -.003                            + I +
  6   -.003                            + I +
  7   -.003                            + I +
  8   -.003                            + I +
  9   -.003                            + I +
 10   -.003                            + I +
 11   -.003                            + I +
 12   -.003                            + I +
 13   -.003                            + I +
 14   -.003                            + I +
 15   -.003                            + I +
 16   -.003                            + I +
 17   -.003                            + I +
 18   -.003                            + I +
 19   -.003                            + I +
 20   -.003                            + I +
 21   -.002                            + I +
 22   -.003                            + I +
 23   -.003                            + I +
 24   -.003                            + I +
 25   -.002                            + I +
 26   -.002                            + I +
 27   -.003                            + I +
 28   -.003                            + I +
 29   -.001                            + I +
 30   -.003                            + I +
 31   -.003                            + I +
 32   -.003                            + I +
 33   -.003                            + I +
 34   -.003                            + I +
 35    .199                            + IX+XXX
 36   -.003                            + I +
```

PACF VARIABLE IS SEE[illegible]

NUMBER OF OBSERVATIONS	=	[illegible]
MEAN OF THE (DIFFERENCED) SERIES	=	1.7[illegible]
STANDARD ERROR OF THE MEAN	=	.984[illegible]
T-VALUE OF MEAN (AGAINST ZERO)	=	1.7[illegible]

PARTIAL AUTOCORRELATIONS

1- 12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ST.E.	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
13- 24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ST.E.	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
25- 36	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	.20	0.0
ST.E.	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04

PACF   VARIABLE IS SEED

PLOT OF PARTIAL AUTOCORRELATIONS

```
             -1.0  -.8  -.6  -.4  -.2   .0   .2   .4   .6   .8  1.0
 LAG    CORR. +----+----+----+----+----+----+----+----+----+----+
                                         I
   1    -.002                          + I +
   2    -.002                          + I +
   3    -.003                          + I +
   4    -.003                          + I +
   5    -.003                          + I +
   6    -.003                          + I +
   7    -.003                          + I +
   8    -.003                          + I +
   9    -.003                          + I +
  10    -.003                          + I +
  11    -.003                          + I +
  12    -.003                          + I +
  13    -.003                          + I +
  14    -.003                          + I +
  15    -.003                          + I +
  16    -.003                          + I +
  17    -.003                          + I +
  18    -.003                          + I +
  19    -.003                          + I +
  20    -.003                          + I +
  21    -.002                          + I +
  22    -.003                          + I +
  23    -.003                          + I +
  24    -.003                          + I +
  25    -.003                          + I +
  26    -.003                          + I +
  27    -.003                          + I +
  28    -.003                          + I +
  29    -.001                          + I +
  30    -.003                          + I +
  31    -.003                          + I +
  32    -.003                          + I +
  33    -.003                          + I +
  34    -.003                          + I +
  35     .199                          + IX-XXX
  36    -.002                          + I +
```

Appendix G: ACFs and PACFs of the IMF B_z and the Solar Wind Series

Appendix G: ACFs and PACFs of the IMF B_z and the Solar Wind Series

ACF VARIABLE IS BZ

```
NUMBER OF OBSERVATIONS            =      [illegible]
MEAN OF THE (DIFFERENCED) SERIES  =       .3811
STANDARD ERROR OF THE MEAN        =       .0831
T-VALUE OF MEAN (AGAINST ZERO)    =      4.5841
```

AUTOCORRELATIONS

1- 12	.63	.41	.30	.23	.17	.09	.06	.05	0.0	-.07	-.11	-.14
ST.E.	.04	.05	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06
13- 24	-.15	-.14	-.11	-.09	-.10	-.08	-.04	-.01	-.02	.04	.05	[illegible]
ST.E.	.06	.06	.05	.06	.06	.06	.06	.06	.06	.06	.06	.06
25- 36	.04	.10	.12	.12	.10	.11	.12	.08	.02	-.01	-.01	-.02
ST.E.	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06

```
                              ACF          VARIABLE IS B1

PLOT OF AUTOCORRELATIONS

             -1.0  -.8  -.6  -.4  -.2   .0   .2   .4   .6   .8  1.0
LAG   CORR.  +----+----+----+----+----+----+----+----+----+----+
                                         I
  1    .633                            + IX+XXXXXXXXXXXXXX
  2    .414                            + IX+XXXXXXXX
  3    .296                           +  IXX+XXXX
  4    .227                           +  IXX+XXX
  5    .171                           +  IXX+X
  6    .089                           +  IXX+
  7    .057                           +  IX +
  8    .047                           +  IX +
  9    .003                           +  I  +
 10   -.069                           +XXI  +
 11   -.113                           XXXI  +
 12   -.142                          X+XXI  +
 13   -.154                          X+XXI  +
 14   -.137                           XXXI  +
 15   -.112                           XXXI  +
 16   -.089                           +XXI  +
 17   -.104                           XXXI  +
 18   -.077                           +XXI  +
 19   -.037                           + XI  +
 20   -.013                           +  I  +
 21   -.017                           +  I  +
 22    .035                           +  IX +
 23    .046                           +  IX +
 24    .031                           +  IX +
 25    .041                           +  IX +
 26    .100                           +  IXX+
 27    .123                           +  IXXX
 28    .121                           +  IXXX
 29    .104                           +  IXXX
 30    .111                           +  IXXX
 31    .127                           +  IXXX
 32    .082                           +  IXX+
 33    .021                           +  IX +
 34   -.011                           +  I  +
 35   -.013                           +  I  +
 36   -.021                           + XI  +
```

PACF VARIABLE IS B,

NUMBER OF OBSERVATIONS	=	700
MEAN OF THE (DIFFERENCED) SERIES	=	.0911
STANDARD ERROR OF THE MEAN	=	[illegible]
T-VALUE OF MEAN (AGAINST ZERO)	=	4.5841

PARTIAL AUTOCORRELATIONS

1- 12	.63	.02	.04	.03	0.0	-.06	.02	.01	-.06	-.03	-.04	-.05
ST.E.	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
13- 24	-.03	.01	.01	0.0	-.05	.04	.03	.01	-.02	.08	-.03	-.04
ST.E.	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
25- 36	.03	.10	0.0	.01	0.0	.03	.03	-.04	-.05	-.03	.01	0.0
ST.E.	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04

PACF VARIABLE IS E_t

PLOT OF PARTIAL AUTOCORRELATIONS

```
             -1.0 -.8  -.6  -.4  -.2   .0   .2   .4   .6   .8  1.0
LAG   CORR.  +----+----+----+----+----+----+----+----+----+----+
                                       .
                                       .
  1    .633                          + IX+XXXXXXXXXXXXXX
  2    .024                          + IX+
  3    .042                          + IX+
  4    .032                          + IX+
  5    .004                          + I +
  6   -.061                          XXI +
  7    .018                          + I +
  8    .015                          + I +
  9   -.056                          +XI +
 10   -.089                          XXI +
 11   -.044                          +XI +
 12   -.051                          +XI +
 13   -.031                          +XI +
 14    .014                          + I +
 15    .014                          + I +
 16   -.001                          + I +
 17   -.053                          +XI +
 18    .036                          + IX+
 19    .031                          + IX+
 20    .007                          + I +
 21   -.024                          +XI +
 22    .079                          + IXX
 23   -.030                          +XI +
 24   -.035                          +XI +
 25    .031                          + IX+
 26    .098                          + IXX
 27    .005                          + I +
 28    .013                          + I +
 29    .002                          + I +
 30    .023                          + IX+
 31    .034                          + IX+
 32   -.039                          +XI +
 33   -.050                          +XI +
 34   -.028                          +XI +
 35    .005                          + I +
 36   -.002                          + I +
```

ACF VARIABLE IS [illegible]

NUMBER OF OBSERVATIONS = [illegible]
MEAN OF THE (DIFFERENCED) SERIES = [illegible]
STANDARD ERROR OF THE MEAN = [illegible]
T-VALUE OF MEAN (AGAINST ZERO) = [illegible]

AUTOCORRELATIONS

1- 12	.78	.55	.36	.22	.09	0.0	[illegible]	[illegible]	-.02	.05	.12	.16
ST.E.	.04	.06	.06	.07	.07	.07	.07	.07	.07	.07	.07	.07
13- 24	.17	.13	.09	.04	-.03	-.10	-.12	-.12	-.11	-.06	0.0	.09
ST.E.	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
25- 36	.21	.29	.30	.25	.17	.10	.05	-.02	-.06	-.09	-.11	-.09
ST.E.	.07	.07	.07	.07	.08	.08	.08	.08	.08	.08	.08	.08

ACF   VARIABLE IS SOLAR WIND

PLOT OF AUTOCORRELATIONS

```
           -1.0  -.8  -.6  -.4  -.2   .0   .2   .4   .6   .8  1.
LAG   CORR.  +----+----+----+----+----+----+----+----+----+----+
                                      I
  1    .778                         + IX+XXXXXXXXXXXXXXXX
  2    .545                        +  IXX+XXXXXXXXXX
  3    .365                        +  IXX+XXXXXX
  4    .219                        +  IXX+XX
  5    .086                        +  IXX+
  6    .002                        +  I  +
  7   -.053                        + XI  +
  8   -.064                        +XXI  +
  9   -.021                        + XI  +
 10    .053                        +  IX +
 11    .118                        +  IXXX
 12    .104                        +  IXX+X
 13    .171                        +  IXX+X
 14    .125                        +  IXXX
 15    .093                        +  IXX+
 16    .039                        +  IX +
 17   -.035                        + XI  +
 18   -.097                        +XXI  +
 19   -.124                        XXXI  +
 20   -.122                        XXXI  +
 21   -.105                        XXXI  +
 22   -.063                        +XXI  +
 23    .001                        +  I  +
 24    .093                        +  IXX+
 25    .213                        +  IXX+XX
 26    .288                       +   IXXX+XXX
 27    .304                       +   IXXX+XXXX
 28    .250                       +   IXXX+XX
 29    .174                       +   IXXXX
 30    .103                       +   IXXX+
 31    .051                       +   IX  +
 32   -.016                       +   I   +
 33   -.063                       + XXI   +
 34   -.090                       + XXI   +
 35   -.110                       +XXXI   +
 36   -.086                       + XXI   +
```

[illegible] VARIABLE IS S[illegible]

NUMBER OF OBSERVATIONS = [illegible]
MEAN OF THE (DIFFERENCED) SERIES = [illegible]
STANDARD ERROR OF THE MEAN = 4.[illegible]
T-VALUE OF MEAN (AGAINST ZERO) = [illegible]

PARTIAL AUTOCORRELATIONS

1- 12	.78	-.15	-.02	-.05	-.09	.01	-.02	.14	.10	.03	.04	.03
ST.E.	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
13- 24	-.03	-.09	.05	-.06	-.06	-.01	.01	.02	-.01	.03	.05	.11
ST.E.	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
25- 36	.16	.03	.01	-.09	-.02	.01	.03	-.05	.01	-.04	-.08	.02
ST.E.	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04

PACF   VARIABLE IS SOLAR WIND

PLOT OF PARTIAL AUTOCORRELATIONS

```
         -1.0  -.8  -.6  -.4  -.2   .0   .2   .4   .6   .8  1.0
LAG   CORR. +----+----+----+----+----+----+----+----+----+----+
                                     I
  1    .778                         + IX+XXXXXXXXXXXXXXXXX
  2   -.150                       XX+XI +
  3   -.017                         + I +
  4   -.051                         +XI +
  5   -.088                         XXI +
  6    .010                         + I +
  7   -.032                         +XI +
  8    .043                         + IX+
  9    .095                         + IXX
 10    .087                         + IXX
 11    .037                         - IX-
 12    .029                         + IX+
 13   -.034                         +XI +
 14   -.087                         XXI +
 15    .046                         + IX+
 16   -.064                         XXI +
 17   -.055                         +XI +
 18   -.014                         + I +
 19    .007                         + I +
 20    .031                         + IX+
 21   -.015                         + I +
 22    .031                         + IX+
 23    .053                         + IX+
 24    .111                         + IX+X
 25    .159                         + IX+XX
 26    .030                         + IX+
 27    .007                         + I +
 28   -.093                         XXI +
 29   -.019                         + I +
 30    .012                         + I +
 31    .026                         + IX+
 32   -.049                         +XI +
 33    .012                         + I +
 34   -.037                         +XI +
 35   -.082                         XXI -
 36    .025                         + IX-
```

Appendix H: CCFs of the 70 Day Transfer Function Models

Appendix H: CCFs of the 70 Day Transfer Function Models

```
 ARIMA      VARIABLE IS ABZM.
            ARCE = '(1)'.
            CENTERED./

THE COMPONENT HAS BEEN ADDED TO THE MODEL
THE CURRENT MODEL HAS
OUTPUT VARIABLE = ABZM
INPUT  VARIABLE = NOISE


 ESTIMATION  RESIDUALS  = RX.
            METHOD IS CLS./


ESTIMATION BY CONDITIONAL LEAST SQUARES METHOD

RELATIVE CHANGE IN RESIDUAL SUM OF SQUARES LESS THAN  .1000E-04


SUMMARY OF THE MODEL

OUTPUT VARIABLE -- ABZM
INPUT VARIABLES -- NOISE

VARIABLE  VAR. TYPE  MEAN      TIME     DIFFERENCES

ABZM       RANDOM    REMOVED  1-  70


PARAMETER VARIABLE   TYPE  FACTOR  ORDER ESTIMATE       ST. ERR.
T-RATIO
      1  ABZM         AR      1       1     .2982          .1141
2.61

RESIDUAL SUM OF SQUARES  =       162.838822
DEGREES OF FREEDOM       =               68
RESIDUAL MEAN SQUARE     =         2.394689


 FILTER     VARIABLE IS SEESSD.
            RESIDUALS = RY./

RESIDUAL MEAN SQUARE     =     39781.905634

VARIABLE SEESSD   IS FILTERED, RESULTS ARE STORED IN VARIABLE RY
```

```
CCF           VARIABLES ARE RX, RY.
              MAXLAG IS 15./

EFFECTIVE NUMBER OF CASES =   69

CORRELATION        OF RX          AND RY        IS     .12

CROSS CORRELATIONS OF RX      (I) AND RY      (I+K)

  1- 12     .05  .04 -.01 -.02  .03 -.10 -.08 -.07 -.09 -.19  0.0 -.08
  ST.E.     .12  .12  .12  .12  .13  .13  .13  .13  .13  .13  .13  .13

 13- 15    -.02 -.01  .04
  ST.E.     .13  .13  .14

CROSS CORRELATIONS OF RY      (I) AND RX      (I+K)

  1- 12     .12  .02 -.02 -.05  .05  .12  .09  .10  .17  .17  .18  .06
  ST.E.     .12  .12  .12  .12  .13  .13  .13  .13  .13  .13  .13  .13

. 13- 15   -.09 -.12 -.08
  ST.E.     .13  .13  .14
```

TRANSFER FUNCTION WEIGHTS

LAG	SCCF(X(I),Y(I+K)) *SY/SX	SCCF(X(I),Y(I+K)) *SX/SY	SCCF(Y(I),X(I+K)) *SY/SX	SCCF(Y(I),X(I+K)) *SX/SY
0	17.24733	.00104	17.24733	.00104
1	6.42417	.00039	15.81012	.00095
2	4.74262	.00029	2.29382	.00014
3	-1.02395	-.00006	-2.87243	-.00017
4	-3.05419	-.00018	-6.14518	-.00037
5	10.08572	.00061	6.74932	.00041
6	-13.26092	-.00080	14.99674	.00090
7	-10.01070	-.00060	11.13831	.00067
8	-8.72463	-.00053	12.46527	.00075
9	-11.09453	-.00067	22.01650	.00133
10	-24.37040	-.00147	22.53590	.00136
11	-.52309	-.00003	23.66686	.00142
12	-10.47852	-.00063	8.16840	.00049
13	-3.00012	-.00018	-11.23285	-.00068
14	-.79805	-.00005	-15.72921	-.00095
15	5.69383	.00034	-10.90109	-.00066

WHERE X(I) IS THE FIRST SERIES, Y(I) THE SECOND SERIES, SX THE STANDARD ERROR OF X(I), AND SY THE STANDARD ERROR OF Y(I)

CCF for IMF B_z and SEESSI

PLOT OF CROSS CORRELATIONS

```
          -1.0 -.8  -.6  -.4  -.2   .0   .2   .4   .6   .8  1.0
LAG   CORR. +----+----+----+----+----+----+----+----+----+----+
                                     I
-15   -.085                   +    XXI      +
-14   -.122                   +   XXXI      +
-13   -.087                   +    XXI      +
-12    .063                    +     IXX   +
-11    .184                    +     IXXXXX+
-10    .175                    +     IXXXX +
 -9    .171                    +     IXXXX +
 -8    .097                    +     IXX   +
 -7    .086                    +     IXX   +
 -6    .116                    +     IXXX  +
 -5    .052                    +     IX    +
 -4   -.048                    +    XI     +
 -3   -.022                    +    XI     +
 -2    .018                    +     I     +
 -1    .123                    +     IXXX  +
  0    .134                    +     IXXX  +
  1    .050                    +     IX    +
  2    .037                    +     IX    +
  3   -.008                    +     I     +
  4   -.024                    +    XI     +
  5    .078                    +     IXX   +
  6   -.103                    +  XXXI     +
  7   -.078                    +   XXI     +
  8   -.068                    +   XXI     +
  9   -.086                    +   XXI     +
 10   -.189                    +XXXXXI     +
 11   -.004                    +     I     +
 12   -.081                    +   XXI     +
 13   -.023                   +     XI      +
 14   -.006                   +      I      +
 15    .044                   +      IX     +
```

```
FILTER      VARIABLE IS SEEI.
            RESIDUALS = RY./

RESIDUAL MEAN SQUARE     =          .995024

VARIABLE SEEI     IS FILTERED, RESULTS ARE STORED IN VARIABLE RY


CCF         VARIABLES ARE RX, RY.
            MAXLAG IS 15./


EFFECTIVE NUMBER OF CASES =   69

CORRELATION        OF RX          AND RY          IS     .21

CROSS CORRELATIONS OF RX      (I) AND RY      (I+K)

  1- 12     .01 -.05 -.05  .03  .11  .03 -.02  .03 -.08 -.19 -.05 -.05
  ST.E.     .12  .12  .12  .12  .13  .13  .13  .13  .13  .13  .13  .13

 13- 15    -.13 -.09  .03
  ST.E.     .13  .13  .14

CROSS CORRELATIONS OF RY      (I) AND RX      (I+K)

  1- 12     .19  0.0 -.02 -.02  .04  .09  .03  .09  .18  .22  .21  .04
  ST.E.     .12  .12  .12  .12  .13  .13  .13  .13  .13  .13  .13  .13

 13- 15    -.14 -.19 -.13
  ST.E.     .13  .13  .14
```

TRANSFER FUNCTION WEIGHTS

	SCCF(X(I),Y(I+K))		SCCF(Y(I),X(I+K))	
LAG	*SY/SX	*SX/SY	*SY/SX	*SX/SY
0	.13700	.32957	.13700	.32957
1	.00813	.01955	.12439	.29905
2	-.03207	-.07711	-.00058	-.00140
3	-.03019	-.07259	-.01555	-.03738
4	.02199	.05289	-.00975	-.02345
5	.07196	.17303	.02309	.05546
6	.01973	.04743	.05624	.13524
7	-.01563	-.03758	.05928	.14254
8	.02169	.05217	.05730	.13778
9	-.05234	-.12587	.11599	.27890
10	-.12414	-.29851	.14483	.34826
11	-.03319	-.07982	.13744	.33049
12	-.01282	-.03082	.02401	.05772
13	-.08438	-.20291	-.09298	-.22359
14	-.05672	-.13640	-.12446	-.29929
15	.02156	.05184	-.08615	-.20717

WHERE X(I) IS THE FIRST SERIES, Y(I) THE SECOND SERIES, SX THE STANDARD ERROR OF X(I), AND SY THE STANDARD ERROR OF Y(I)

CCF for IMF B_z and SEEI

```
PLOT OF CROSS CORRELATIONS

          -1.0 -.8  -.6  -.4  -.2  .0   .2   .4   .6   .8  1.0
LAG   CORR. +----+----+----+---------+----+----+----+----+----+
                                     -
                                     .
-15   -.134                   +   XXXI      +
-14   -.193                   + XXXXXI      +
-13   -.144                   +  XXXXI      +
-12    .037                    +     IX    +
-11    .213                    +     IXXXXX+
-10    .225                    +     IXXXXXX
 -9    .183                    +     IXXXX +
 -8    .089                    +     IXX   +
 -7    .092                    +     IXX   +
 -6    .087                    +     IXX   +
 -5    .036                    +     IX    +
 -4   -.015                    +     I     +
 -3   -.024                    +    XI     +
 -2   -.001                    +     I     +
 -1    .193                    +     IXXXXX+
  0    .213                    +     IXXXXX+
  1    .013                    +     I     +
  2   -.050                    +    XI     +
  3   -.047                    +    XI     +
  4    .034                    +     IX    +
  5    .112                    +     IXXX  +
  6    .031                    +     IX    +
  7   -.024                    +    XI     +
  8    .034                    +     IX    +
  9   -.081                    +   XXI     +
 10   -.192                    +XXXXXI     +
 11   -.051                    +    XI     +
 12   -.020                    +     I     +
 13   -.131                   +   XXXI      +
 14   -.088                   +    XXI      +
 15    .030                   +      IX     +
```

```
FILTER      VARIABLE IS SEEII.
            RESIDUALS = RY./

RESIDUAL MEAN SQUARE     =          .016695

VARIABLE SEEII    IS FILTERED, RESULTS ARE STORED IN VARIABLE RY


 CCF        VARIABLES ARE RX, RY.
            MAXLAG IS 15./


EFFECTIVE NUMBER OF CASES =   69

CORRELATION         OF RX          AND RY        IS     .13

CROSS CORRELATIONS OF RX      (I) AND RY      (I+K)

  1- 12     .04 -.01 -.02  .07  .05  .02 -.04  .12 -.09 -.21 -.29  .32
  ST.E.     .12  .12  .12  .12  .13  .13  .13  .13  .13  .13  .13  .13

 13- 15    -.17 -.08 -.14
  ST.E.     .13  .13  .14

CROSS CORRELATIONS OF RY      (I) AND RX      (I+K)

  1- 12     .04 -.04 -.09  .01  .12  .09  .05  .08  .12  .16  .16 -.02
  ST.E.     .12  .12  .12  .12  .13  .13  .13  .13  .13  .13  .13  .13

 13- 15    -.14 -.15 -.09
  ST.E.     .13  .13  .14
```

TRANSFER FUNCTION WEIGHTS

LAG	SCCF X(I),Y(I+K)) *SY/SX	*SX/SY	SCCF(Y(I),X(I-K)) *SY/SX	*SX/SY
0	.01567	2.24640	.01567	2.24640
1	.00295	.42242	.00310	.44441
2	-.00087	-.12533	-.00305	-.43693
3	-.00169	-.24156	-.00745	-1.06813
4	.00606	.86849	.00088	.12557
5	.00383	.54862	.00961	1.37739
6	.00207	.29638	.00769	1.10207
7	-.00308	-.44200	.00457	.65594
8	.01035	1.48312	.00630	.90272
9	-.00769	-1.10281	.01008	1.44478
10	-.01783	-2.55647	.01361	1.95145
11	-.02406	-3.44902	.01302	1.86645
12	.02707	3.88153	-.00208	-.29774
13	-.01438	-2.06086	-.01170	-1.67686
14	-.00671	-.96248	-.01226	-1.75830
15	-.01135	-1.62682	-.00776	-1.11309

WHERE X(I) IS THE FIRST SERIES, Y(I) THE SECOND SERIES, SX THE STANDARD ERROR OF X(I), AND SY THE STANDARD ERROR OF Y(I)

CCF for IMF Bz and [illegible]

PLOT OF CROSS CORRELATIONS

```
          -1.0  -.8  -.6  -.4  -.2   .0   .2   .4   .6   .8  1.0
LAG  CORR.  +----+----+----+----+----+----+----+----+----+----+
                                     I
-15  -.093                   +    XXI     +
-14  -.147                   +  XXXXI     +
-13  -.140                   +  XXXXI     +
-12  -.025                    +    XI    +
-11   .156                    +      IXXXX +
-10   .163                    +      IXXXX +
 -9   .121                    +      IXXX +
 -8   .075                    +      IXX  +
 -7   .055                    +      IX   +
 -6   .092                    +      IXX  +
 -5   .115                    +      IXXX +
 -4   .010                    +      I    +
 -3  -.089                    +   XXI    +
 -2  -.036                    +    XI    +
 -1   .037                    +      IX   +
  0   .188                    +      IXXXXX+
  1   .035                    +      IX   +
  2  -.010                    +      I    +
  3  -.020                    +    XI    +
  4   .073                    +      IXX  +
  5   .046                    +      IX   +
  6   .025                    +      IX   +
  7  -.027                    +    XI    +
  8   .124                    +      IXXX +
  9  -.092                    +   XXI    +
 10  -.214                    +XXXXXI    +
 11  -.288                   X+XXXXXI    +
 12   .324                    +      IXXXXX+XX
 13  -.172                   +  XXXXI     +
 14  -.080                   +    XXI     +
 15  -.136                   +   XXXI     +
```

```
 FILTER     VARIABLE IS SEEIII.
            RESIDUALS = RY./

RESIDUAL MEAN SQUARE    =          .000225

VARIABLE SEEIII   IS FILTERED, RESULTS ARE STORED IN VARIABLE RY


 CCF        VARIABLES ARE RX, RY.
            MAXLAG IS 15./


EFFECTIVE NUMBER OF CASES =   69

CORRELATION        OF RX          AND RY         IS     .17

CROSS CORRELATIONS OF RX      (I) AND RY      (I+K)

  1- 12     .02 -.01 -.04  .06  .08 -.03 -.07  .05 -.10 -.17 -.18  .18
  ST.E.     .12  .12  .12  .12  .13  .13  .13  .13  .13  .13  .13  .13

 13- 15    -.12 -.11 -.04
  ST.E.     .13  .13  .14

CROSS CORRELATIONS OF RY      (I) AND RX      (I+K)

  1- 12     .19 -.05 -.14 -.03  .10  .13  .02  .08  .10  .22  .15  0.0
  ST.E.     .12  .12  .12  .12  .13  .13  .13  .13  .13  .13  .13  .13

 13- 15    -.15 -.20 -.10
  ST.E.     .13  .13  .14
```

TRANSFER FUNCTION WEIGHTS

LAG	CCF(X(I),Y(I+K)) *SY/SX	CCF(X(I),Y(I+K)) *SX SY	CCF(Y(I),X(I+K)) *SY/SX	CCF(Y(I),X(I+K)) *SX SY
0	.00163	17.35507	.00166	17.35507
1	.00016	1.70932	.00180	19.80890
2	-.00010	-1.05971	-.00053	-5.60809
3	-.00042	-4.42532	-.00134	-14.20331
4	.00059	6.33617	-.00028	-3.00017
5	.00055	5.87743	.00096	10.22470
6	-.00027	-2.88377	.00130	13.91736
7	-.00064	-6.86513	.00017	1.83434
8	.00048	5.06501	.00076	8.05138
9	-.00100	-10.68439	.00096	10.27352
10	-.00162	-17.24604	.00217	23.11200
11	-.00178	-18.97704	.00175	18.60920
12	.00179	19.07811	-.00003	-.30253
13	-.00121	-12.87591	-.00142	-15.09815
14	-.00107	-11.40583	-.00189	-20.16544
15	-.00042	-4.50083	-.00100	-10.64196

WHERE X(I) IS THE FIRST SERIES, Y(I) THE SECOND SERIES, SX THE STANDARD ERROR OF X(I), AND SY THE STANDARD ERROR OF Y(I)

CCF for IMF B_z and SFEIII

```
PLOT OF CROSS CORRELATIONS

        -1.0  -.8  -.6  -.4  -.2   .0   .2   .4   .6   .8  1.0
LAG  COEF. +----+----+----+----+----+----+----+----+----+----+

-15   -.103                  +   XXXI      +
-14   -.195                  + XXXXXI      +
-13   -.146                  +  XXXXI      +
-12   -.003                   +     I     +
-11    .180                   +     IXXXXX+
-10    .224                   +     IXXXXXX
 -9    .100                   +     IXX   +
 -8    .078                   +     IXX   +
 -7    .018                   +     I     +
 -6    .134                   +     IXXX  +
 -5    .099                   +     IXX   +
 -4   -.029                   +    XI     +
 -3   -.138                   +  XXXI     +
 -2   -.054                   +    XI     +
 -1    .192                   +     IXXXXX+
  0    .168                   +     IXXXX +
  1    .017                   +     I     +
  2   -.010                   +     I     +
  3   -.043                   +    XI     +
  4    .061                   +     IXX   +
  5    .057                   +     IX    +
  6   -.028                   +    XI     +
  7   -.066                   +   XXI     +
  8    .049                   +     IX    +
  9   -.103                   +  XXXI     +
 10   -.167                   + XXXXI     +
 11   -.184                   +XXXXXI     +
 12    .185                   +     IXXXXX+
 13   -.125                  +   XXXI      +
 14   -.110                  +   XXXI      +
 15   -.044                  +     XI      +
```

```
 FILTER      VARIABLE IS SEEIV.
             RESIDUALS = RY./

RESIDUAL MEAN SQUARE     =          .000026

VARIABLE SEEIV    IS FILTERED, RESULTS ARE STORED IN VARIABLE RY


 CCF         VARIABLES ARE RX, RY.
             MAXLAG IS 15./


EFFECTIVE NUMBER OF CASES =   69

CORRELATION        OF RX          AND RY        IS     .20

CROSS CORRELATIONS OF RX      (I) AND RY      (I+K)

  1- 12      0.0  0.0 -.07  .08  .09 -.03 -.09  .03 -.12 -.12 -.14  .14
  ST.E.      .12  .12  .12  .12  .13  .13  .13  .13  .13  .13  .13  .13

 13- 15    -.12 -.09 -.04
  ST.E.      .13  .13  .14

CROSS CORRELATIONS OF RY      (I) AND RX      (I-K)

  1- 12      .23 -.05 -.16 -.04  .10  .11  .01 -.01  .03  .19  .17 -.01
  ST.E.      .12  .12  .12  .12  .13  .13  .13  .13  .13  .13  .13  .13

 13- 15    -.16 -.19 -.10
  ST.E.      .13  .13  .14
```

TRANSFER FUNCTION WEIGHTS

LAG	SCCF(X(I),Y(I+K)) *SY/SX	*SX/SY	SCCF(Y(I),X(I+K)) *SY/SX	*SX/SY
0	.00219	19.01547	.00219	19.01547
1	.00005	.39192	.00249	21.66936
2	.00004	.33089	-.00057	-4.96128
3	-.00073	-6.35314	-.00169	-14.69445
4	.00085	7.40493	-.00044	-3.82058
5	.00094	8.13439	.00107	9.30792
6	-.00029	-2.50574	.00115	10.03192
7	-.00098	-8.52418	.00007	.62559
8	.00029	2.55164	-.00008	-.65329
9	-.00124	-10.73600	.00098	8.50349
10	-.00129	-11.21067	.00209	18.15729
11	-.00154	-13.38780	.00182	15.81787
12	.00149	12.91103	-.00011	-.91725
13	-.00126	-10.96165	-.00169	-14.73027
14	-.00097	-8.42227	-.00203	-17.64397
15	-.00039	-3.39267	-.00105	-9.12247

WHERE X(I) IS THE FIRST SERIES, Y(I) THE SECOND SERIES, SX THE STANDARD ERROR OF X(I), AND SY THE STANDARD ERROR OF Y(I)

CCF for IMF B_y and SPEED

```
PLOT OF CROSS CORRELATIONS

          -1.0 -.8  -.6  -.4  -.2   .0   .2   .4   .6   .8  1.0
LAG   CORR. +----+----+----+----+----+----+----+----+----+----+
                                     I
-15   -.098                   +    XXI      +
-14   -.189                   + XXXXXI      +
-13   -.158                   +  XXXXI      +
-12   -.010                    +     I     +
-11    .170                    +     IXXXX +
-10    .195                    +     IXXXXX+
 -9    .091                    +     IXX   +
 -8   -.007                    +     I     +
 -7    .007                    +     I     +
 -6    .108                    +     IXXX  +
 -5    .100                    +     IXX   +
 -4   -.041                    +    XI     +
 -3   -.158                    + XXXXI     +
 -2   -.053                    +    XI     +
 -1    .232                    +     IXXXXXX
  0    .204                    +     IXXXXX+
  1    .004                    +     I     +
  2    .004                    +     I     +
  3   -.068                    +   XXI     +
  4    .079                    +     IXX   +
  5    .087                    +     IXX   +
  6   -.027                    +    XI     +
  7   -.091                    +   XXI     +
  8    .027                    +     IX    +
  9   -.115                    +  XXXI     +
 10   -.120                    +  XXXI     +
 11   -.144                    + XXXXI     +
 12    .138                    +     IXXX  +
 13   -.118                   +   XXXI      +
 14   -.090                   +    XXI      +
 15   -.036                   +     XI      +
```

```
 ARIMA       VARIABLE IS AV.
             ARORD = '(1)'.
             CENTERED./
THE COMPONENT HAS BEEN ADDED TO THE MODEL

THE CURRENT MODEL HAS
OUTPUT VARIABLE = AV
INPUT  VARIABLE = NOISE


 ESTIMATION  RESIDUALS  = RX.
             METHOD IS CLS./


ESTIMATION BY CONDITIONAL LEAST SQUARES METHOD

RELATIVE CHANGE IN EACH ESTIMATE LESS THAN  .1000E-03


SUMMARY OF THE MODEL

OUTPUT VARIABLE -- AV
INPUT VARIABLES -- NOISE

VARIABLE  VAR. TYPE  MEAN      TIME     DIFFERENCES

AV         RANDOM    REMOVED  1-  71


PARAMETER VARIABLE   TYPE  FACTOR  ORDER ESTIMATE        ST. ERR.
T-RATIO
      1  AV           AR      1      1      .8327          .0662
12.57

RESIDUAL SUM OF SQUARES  =    267796.403915
DEGREES OF FREEDOM       =               69
RESIDUAL MEAN SQUARE     =      3881.107303


 FILTER      VARIABLE IS SEESST.
             RESIDUALS = RY./

RESIDUAL MEAN SQUARE     =     20230.824699

VARIABLE SEESST   IS FILTERED, RESULTS ARE STORED IN VARIABLE RY
```

```
CCF         VARIABLES ARE RX, RY.
            MAXLAG IS 15./

EFFECTIVE NUMBER OF CASES =   70

CORRELATION        OF RX          AND RY        IS     .11

CROSS CORRELATIONS OF RX      (I) AND RY      (I+E)

  1- 12     .23  .26  .29 -.03  .16  .04 -.18 -.03 -.15 -.1[illegible] -.04 -.[illegible]
  ST.E.     .12  .12  .12  .12  .12  .13  .13  .13  .13  .13  .13  .13

 13- 15    -.07 -.04 -.01
  ST.E.     .13  .13  .13

CROSS CORRELATIONS OF RY      (I) AND RX      (I+E)

  1- 12    -.05  .01  .04  .05  .03 -.10  .02  .01 -.04 -.11 -.04 -.05
  ST.E.     .12  .12  .12  .12  .12  .13  .13  .13  .13  .13  .13  .13

 13- 15    -.06  .08 -.08
  ST.E.     .13  .13  .13
```

TRANSFER FUNCTION WEIGHTS

	SCCF(X(I),Y(I+K))		SCCF(Y(I),X(I+K	
LAG	*SY/SX	*SX/SY	*SY/SX	*SX/SY
0	.27773	.04111	.27773	.04111
1	.60608	.08971	-.14008	-.02073
2	.66810	.03889	.02108	.00312
3	.75781	.11216	.09624	.01424
4	-.08774	-.01299	.12262	.01815
5	.41413	.06130	.06828	.01011
6	.10190	.01508	-.26208	-.03879
7	-.47299	-.07001	.04831	.00715
8	-.22466	-.03328	.01420	.00210
9	-.40081	-.05933	-.11429	-.01692
10	-.34056	-.05041	-.28235	-.04179
11	-.10616	-.01571	-.09514	-.01408
12	-.07602	-.01125	-.14287	-.02115
13	-.18833	-.02787	-.15903	-.02354
14	-.09610	-.01422	.20099	.02975
15	-.03737	-.00553	-.20725	-.03068

WHERE X(I) IS THE FIRST SERIES, Y(I) THE SECOND SERIES, SX THE STANDARD ERROR OF X(I), AND SY THE STANDARD ERROR OF Y(I)

CCF for Solar wind and SEESSI

PLOT OF CROSS CORRELATIONS

```
          -1.0 -.8  -.6  -.4  -.2   .0   .2   .4   .6   .8  1.0
LAG   CORR. +----+----+----+----+----+----+----+----+----+----+
                                     I
-15   -.080                   +    XXI      +
-14    .077                   +      IXX    +
-13   -.061                    +   XXI     +
-12   -.055                    +    XI     +
-11   -.037                    +    XI     +
-10   -.109                    +  XXXI     +
 -9   -.044                    +    XI     +
 -8    .005                    +     I     +
 -7    .019                    +     I     +
 -6   -.101                    +  XXXI     +
 -5    .026                    +     IX    +
 -4    .047                    +     IX    +
 -3    .037                    +     IX    +
 -2    .008                    +     I     +
 -1   -.054                    +    XI     +
  0    .107                    +     IXXX  +
  1    .233                    +     IXXXXXX
  2    .257                    +     IXXXXXX
  3    .292                    +     IXXXXX+X
  4   -.034                    +    XI     +
  5    .159                    +     IXXXX +
  6    .039                    +     IX    +
  7   -.182                    +XXXXXI     +
  8   -.087                    +   XXI     +
  9   -.154                    + XXXXI     +
 10   -.131                    +  XXXI     +
 11   -.041                    +    XI     +
 12   -.029                    +    XI     +
 13   -.072                    +   XXI     +
 14   -.037                   +     XI      +
 15   -.014                   +      I      +
```

```
 FILTER      VARIABLE IS SEEI.
             RESIDUALS = EY./

RESIDUAL MEAN SQUARE      :         1.001000

VARIABLE SEEI     IS FILTERED, RESULTS ARE STORED IN VARIABLE EY


 CCF         VARIABLES ARE RX, RY.
             MAXLAG IS 15./


EFFECTIVE NUMBER OF CASES =   70

CORRELATION        OF RX          AND RY        IS    -.20

CROSS CORRELATIONS OF RX       (I) AND RY      (I+K)

  1- 12      .20  .32  .21  .10 -.25  .21  .17 -.21 -.13 -.09 -.05  .06
  ST.E.      .12  .12  .12  .12  .12  .13  .13  .13  .13  .13  .13  .13

 13- 15      .03 -.09 -.02
  ST.E.      .13  .13  .13

CROSS CORRELATIONS OF RY       (I) AND RX      (I+K)

  1- 12     -.09 -.05  .07  .10 -.17  .10  .06 -.03 -.05 -.11  .01 -.01
  ST.E.      .12  .12  .12  .12  .12  .13  .13  .13  .13  .13  .13  .13

 13- 15     -.06  .04 -.02
  ST.E.      .13  .13  .13
```

TRANSFER FUNCTION WEIGHTS

LAG	SCCF(X(I),Y(I+K)) *SY/SX	*SX/SY	SCCF(Y(I),X(I+K)) *SY/SX	*SX/SY
0	-.00419	-9.96864	-.00419	-9.96864
1	.00418	9.95424	-.00194	-4.61691
2	.00646	15.37227	-.00105	-2.50526
3	.00436	10.37493	.00152	3.62023
4	.00206	4.89085	.00215	5.11054
5	-.00520	-12.37819	-.00345	-8.21165
6	.00439	10.44747	.00198	4.70534
7	.00343	8.15340	.00127	3.03118
8	-.00436	-10.36712	-.00061	-1.44978
9	-.00276	-6.56623	-.00118	-2.80621
10	-.00176	-4.18948	-.00234	-5.55918
11	-.00097	-2.31229	.00028	.66033
12	.00128	3.04568	-.00017	-.40553
13	.00064	1.51892	-.00120	-2.86510
14	-.00189	-4.49396	.00090	2.15073
15	-.00047	-1.11263	-.00048	-1.14934

WHERE X(I) IS THE FIRST SERIES, Y(I) THE SECOND SERIES, SX THE STANDARD ERROR OF X(I), AND SY THE STANDARD ERROR OF Y(I)

PLOT OF CROSS CORRELATIONS

```
          -1.0  -.8  -.6  -.4  -.2   .0   .2   .4   .6   .8  1.0
LAG   CORR. +----+----+----+----+----+----+----+----+----+----+
                                     I
-15   -.024                   +     XI      +
-14    .044                   +      IX     +
-13   -.059                    +    XI     +
-12   -.008                    +     I     +
-11    .014                    +     I     +
-10   -.114                    +  XXXI     +
 -9   -.058                    +    XI     +
 -8   -.030                    +    XI     +
 -7    .062                    +     IXX   +
 -6    .096                    +     IXX   +
 -5   -.168                    + XXXXI     +
 -4    .105                    +     IXXX  +
 -3    .074                    +     IXX   +
 -2   -.051                    +    XI     +
 -1   -.095                    +   XXI     +
  0   -.204                    +XXXXXI     +
  1    .204                    +     IXXXXX+
  2    .315                    +     IXXXXX+XX
  3    .213                    +     IXXXXX+
  4    .100                    +     IXXX  +
  5   -.254                    XXXXXXI     +
  6    .214                    +     IXXXXX+
  7    .167                    +     IXXXX +
  8   -.213                    +XXXXXI     +
  9   -.135                    +  XXXI     +
 10   -.086                    +   XXI     +
 11   -.047                    +    XI     +
 12    .062                    +     IXX   +
 13    .031                    +     IX    +
 14   -.032                   +    XXI      +
 15   -.023                   +     XI      +
```

```
 FILTER      VARIABLE IS SBEII.
             RESIDUALS = RY./

RESIDUAL MEAN SQUARE     =          .024945

VARIABLE SBEII    IS FILTERED. RESULTS ARE STORED IN VARIABLE RY


 CCF         VARIABLES ARE RX, RY.
             MAXLAG IS 15./


EFFECTIVE NUMBER OF CASES =   70

CORRELATION        OF RX          AND RY         IS    -.17

CROSS CORRELATIONS OF RX      (I) AND RY      (I+K)

  1- 12    -.08  .33  .26  .05  .03 -.20  .28  .14 -.33 -.05 -.02 -.03
  ST.E.     .12  .12  .12  .12  .12  .13  .13  .13  .13  .13  .13  .13

 13- 15     .09  0.0 -.11
  ST.E.     .13  .13  .13

CROSS CORRELATIONS OF RY      (I) AND RX      (I+K)

  1- 12    -.06 -.03  .14 -.13  .01  .10 -.02 -.[illegible] -.03 -.05 -.04  .02
  ST.E.     .12  .12  .12  .12  .12  .13  .13  .[illegible]  .13  .13  .13  .13

 13- 15    -.06  .01 -.01
  ST.E.     .13  .13  .13
```

TRANSFER FUNCTION WEIGHTS

LAG	CCOR(X(I),Y(I+K)) *SY/SX	*SX/SY	CCOR(Y(I),X(I+K)) *SY/SX	*SX/SY
0	-.00044	[illegible]	-.00044	[illegible]
1	-.00014	[illegible]	-.00014	[illegible]
2	[illegible]	[illegible]	-.00009	-13.67845
3	.00065	[illegible]	.00036	56.66092
4	.00012	18.29070	[illegible]	[illegible]
5	.00008	12.57259	.00002	[illegible]
6	-.00067	-103.47849	.00026	40.05864
7	.00072	111.57536	-.00005	-8.10037
8	.00034	53.59599	-.00003	-4.34291
9	-.00085	-131.85773	-.00009	-13.36425
10	-.00013	-19.47069	-.00012	-18.26139
11	-.00006	-9.14531	-.00009	-14.51965
12	-.00007	-10.65153	.00005	7.62975
13	.00023	35.65978	-.00015	-22.81577
14	.00001	1.41485	.00004	5.59812
15	-.00027	-42.23735	-.00004	-5.69105

WHERE X(I) IS THE FIRST SERIES, Y(I) THE SECOND SERIES, SX THE STANDARD ERROR OF X(I), AND SY THE STANDARD ERROR OF Y(I)

CCF for Solar Wind and [illegible]

PLOT OF CROSS CORRELATIONS

```
            -1.0  -.8  -.6  -.4  -.2   .0   .2   .4   .6   .8  1.0
LAG   CORR.  +----+----+----+----+----+----+----+----+----+----+
                                         I
-15   -.014                    +         I         +
-14    .014                    +         I         +
-13   -.059                     +       XI        +
-12    .019                     +        I        +
-11   -.037                     +       XI        +
-10   -.048                     +       XI        +
 -9   -.034                     +       XI        +
 -8   -.011                     +        I        +
 -7   -.021                     +       XI        +
 -6    .102                     +        IXXX     +
 -5    .009                     +        I        +
 -4   -.132                     +     XXXI        +
 -3    .144                     +        IXXXX    +
 -2   -.035                     +       XI        +
 -1   -.056                     +       XI        +
  0   -.175                     +    XXXXI        +
  1   -.056                     +       XI        +
  2    .329                     +        IXXXXX+XX
  3    .255                     +        IXXXXXXX
  4    .046                     +        IX       +
  5    .032                     +        IX       +
  6   -.292                    X+XXXXXXI          +
  7    .233                     +        IXXXXX+X
  8    .130                     +        IXXXX    +
  9   -.334                   XX+XXXXXXI          +
 10   -.049                     +       XI        +
 11   -.023                     +       XI        +
 12   -.027                     +       XI        +
 13    .090                     +        IXX      +
 14    .004                    +         I         +
 15   -.107                    +     XXXI          +
```

```
 FILTER      VARIABLE IS SEEIII.
             RESIDUALS = RY./

RESIDUAL MEAN SQUARE     =           .000270

VARIABLE SEEIII   IS FILTERED, RESULTS ARE STORED IN VARIABLE RY


 CCF         VARIABLES ARE RX, RY.
             MAXLAG IS 15./


EFFECTIVE NUMBER OF CASES =   70

CORRELATION        OF RX          AND RY        IS    -.15

CROSS CORRELATIONS OF RX      (I) AND RY      (I+E)

  1- 12     .09  .46  .29  .11 -.01 -.19  .24 -.01 -.35 -.08 -.04 -.04
  ST.E.     .12  .12  .12  .12  .12  .13  .13  .13  .13  .13  .13  .13

 13- 15     .04 -.04 -.08
  ST.E.     .13  .13  .13

CROSS CORRELATIONS OF RY      (I) AND RX      (I+E)

  1- 12    -.07 -.01  .11 -.06 -.06  .06  .01 -.04 -.02 -.06 -.08  0.0
  ST.E.     .12  .12  .12  .12  .12  .13  .13  .13  .13  .13  .13  .13

 13- 15    -.05  .01 -.02
  ST.E.     .13  .13  .13
```

TRANSFER FUNCTION WEIGHTS

LAG	SCCF(X(I),Y(I+K)) *SY/SX	*SX.SY	SCCF(Y(I),X(I+K)) *SY/SX	*SX,SY
0	-.00004	-557.22520	-.00004	-557.22820
1	.00002	345.03445	-.00002	-258.34425
2	.00012	1752.94110	-.00000	-37.77947
3	.00008	1087.46988	.00003	416.53924
4	.00003	417.24312	-.00001	-210.61234
5	-.00000	-20.24466	-.00002	-235.22776
6	-.00005	-716.83016	.00001	213.51534
7	.00006	912.54635	.00000	42.79133
8	-.00000	-32.34764	-.00001	-162.04084
9	-.00009	-1321.47477	-.00001	-73.60908
10	-.00002	-298.71936	-.00002	-228.34886
11	-.00001	-139.99961	-.00002	-301.17763
12	-.00001	-135.18685	-.00000	-15.76626
13	.00001	151.29790	-.00001	-191.65939
14	-.00001	-162.07944	.00000	39.86271
15	-.00002	-284.91273	-.00000	-68.05244

WHERE X(I) IS THE FIRST SERIES, Y(I) THE SECOND SERIES, SX THE STANDARD ERROR OF X(I), AND SY THE STANDARD ERROR OF Y(I)

CCF for Solar Wind and SEEIII

PLOT OF CROSS CORRELATIONS

```
            -1.0 -.8  -.6  -.4  -.2   .0   .2   .4   .6   .8  1.0
LAG   CORR. +----+----+----+----+----+----+----+----+----+---------+
                                     I
-15   -.018                   +      I      +
-14    .011                   +      I      +
-13   -.051                    +    XI     +
-12   -.004                    +     I     +
-11   -.079                    +   XXI     +
-10   -.080                    +   XXI     +
 -9   -.019                    +     I     +
 -8   -.043                    +    XI     +
 -7    .011                    +     I     +
 -6    .058                    +     IX    +
 -5   -.082                    +   XXI     +
 -4   -.056                    +    XI     +
 -3    .110                    +     IXXX  +
 -2   -.010                    +     I     +
 -1   -.068                    +   XXI     +
  0   -.147                    + XXXXI     +
  1    .091                    +     IXX   +
  2    .462                    +     IXXXXX+XXXXXX
  3    .287                    +     IXXXXX+X
  4    .110                    +     IXXX  +
  5   -.005                    +     I     +
  6   -.189                    +XXXXXI     +
  7    .241                    +     IXXXXXX
  8   -.009                    +     I     +
  9   -.348                 XXX+XXXXXI     +
 10   -.079                    +   XXI     +
 11   -.037                    +    XI     +
 12   -.036                    +    XI     +
 13    .040                    +     IX    +
 14   -.041                   +     XI      +
 15   -.075                   +    XXI      +
```

```
 FILTER      VARIABLE IS SEEIV.
             RESIDUALS = RY./

RESIDUAL MEAN SQUARE     =          .00028[illegible]

VARIABLE SEEIV    IS FILTERED, RESULTS ARE STORED IN VARIABLE RY


 CCF         VARIABLES ARE RX, RY.
             MAXLAG IS 15./


EFFECTIVE NUMBER OF CASES =   70

CORRELATION        OF RX          AND RY        IS    -.12

CROSS CORRELATIONS OF RX      (I) AND RY      (I+K)

  1- 12     .15  .42  .26  .09 -.01 -.05  .15 -.09 -.29 -.09 -.05  0.0
  ST.E.     .12  .12  .12  .12  .12  .13  .13  .13  .13  .13  .13  .13

 13- 15     .01 -.04 -.06
  ST.E.     .13  .13  .13

CROSS CORRELATIONS OF RY      (I) AND RX      (I+K)

  1- 12    -.03 -.06  .18 -.04 -.07  .03 -.01 -.01 -.0[illegible] -.09 -.06 -.02
  ST.E.     .12  .12  .12  .12  .12  .12  .13  .13  .13  .13  .13  .13

 13- 15     0.0  .03 -.04
  ST.E.     .13  .13  .13
```

TRANSFER FUNCTION WEIGHTS

LAG	SCCF(X(I),Y(I+K)) *SY/SX	SCCF(X(I),Y(I+K)) *SX/SY	SCCF(Y(I),X(I+K)) *SY/SX	SCCF(Y(I),X(I+K)) *SX/SY
0	-.00003	-437.02456	-.00003	-437.02456
1	.00004	551.92268	-.00002	-334.21850
2	.00011	1537.17671	-.00002	-306.28552
3	.00007	967.05784	.00004	585.73900
4	.00003	347.53209	-.00001	-140.69056
5	-.00000	-27.79294	-.00002	-262.10206
6	-.00001	-187.72069	.00001	124.30921
7	.00004	542.41028	-.00000	-22.77830
8	-.00002	-319.59358	-.00000	-19.33229
9	-.00008	-1047.55819	-.00001	-120.96443
10	-.00002	-316.49679	-.00002	-317.51343
11	-.00001	-175.76318	-.00002	-235.75233
12	-.00000	-5.72133	-.00001	-84.05070
13	.00000	38.24121	-.00000	-2.22640
14	-.00001	-151.77093	.00001	110.36804
15	-.00002	-207.36667	-.00001	-157.72481

WHERE X(I) IS THE FIRST SERIES, Y(I) THE SECOND SERIES, SX THE STANDARD ERROR OF X(I), AND SY THE STANDARD ERROR OF Y(I)

CCF for Solar Wind And SEEI

PLOT OF CROSS CORRELATIONS

```
          -1.0  -.8  -.6  -.4  -.2   .0   .2   .4   .6   .8  1.0
LAG   CORR. +----+----+----+----+----+----+----+----+----+----+
                                     I
-15   -.043                   +     XI      +
-14    .033                   +      IX     +
-13   -.001                    +     I     +
-12   -.023                    +    XI     +
-11   -.064                    +   XXI     +
-10   -.067                    +   XXI     +
 -9   -.033                    +    XI     +
 -8   -.005                    +     I     +
 -7   -.009                    +     I     +
 -6    .034                    +     IX    +
 -5   -.072                    +   XXI     +
 -4   -.039                    +    XI     +
 -3    .160                    +     IXXXX +
 -2   -.056                    +    XI     +
 -1   -.091                    +   XXI     +
  0   -.119                    +  XXXI     +
  1    .151                    +     IXXXX +
  2    .419                    +     IXXXXX+XXXX
  3    .264                    +     IXXXXX+X
  4    .095                    +     IXX   +
  5   -.003                    +     I     +
  6   -.051                    +    XI     +
  7    .148                    +     IXXXX +
  8   -.087                    +   XXI     +
  9   -.286                   X+XXXXXI     +
 10   -.086                    +   XXI     +
 11   -.048                    +    XI     +
 12   -.002                    +     I     +
 13    .010                    +     I     +
 14   -.041                   +     XI      +
 15   -.057                   +     XI      +
```

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VITA

Major Michael P. Halpin was born on 18 November 1951 in Albuquerque, New Mexico. He graduated from high school there in 1969 and briefly attended the University of New Mexico before accepting an appointment to the United States Air Force Academy in June 1970. In June 1974, he graduated from USAFA with a Bachelor of Science degree in Civil Engineering and received a commission in the USAF. Subsequent to this, Major Halpin attended pilot training at Reese AFB, Texas where he was awarded his wings in September 1975. Major Halpin flew heavy aircraft including the KC-135 and E-3A AWACS. While stationed at Tinker AFB, Oklahoma, he completed the requirements for another Bachelor of Science degree, this time in Petroleum Engineering in May 1983. Major Halpin entered the School of Engineering, Air Force Institute of Technology, in May 1985.

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Thesis Chairmen: Joseph Litko, Major, USAF
James Lange, Major, USAF

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19. Abstract (continued)

This project used a Box and Jenkins time series analysis of energetic electron fluxes measured at geosynchronous orbit in an effort to derive prediction models for the flux in each of five energy channels. In addition, the technique of transfer function modeling described by Box and Jenkins was used in an attempt to derive input-output relationships between the flux channels (viewed as the output) and the solar wind speed or interplanetary magnetic field (IMF) north-south component, B_z, (viewed as the input). The transfer function modeling was done in order to investigate the theoretical dynamic relationship which is believed to exist between the solar wind, the IMF B_z, and the energetic electron flux in the magnetosphere. The models derived from the transfer function techniques employed were also intended to be used in the prediction of flux values.

The results from this study indicate that the energetic electron flux changes in the various channels are dependent on more than simply the solar wind speed or the IMF B_z. Also, most of the time series models developed here (for both the individual energetic electron channels by themselves and those developed through transfer functions) were not suitable for use in prediction, since the standard error of the forecasts made using these models was unacceptably high. However, a few of the models did merit possible consideration for use in prediction of fluxes. These were the individual time series models for the 6.6 - 9.7 MeV channel. In addition, the transfer function models developed using the solar wind as an input and the 6.6 - 9.7 MeV channel as an output may be of possible use. The channel containing electrons with energies between 9.7 - 16 MeV was also related to the solar wind via a transfer function with a reasonable forecast standard error. Finally, most of the transfer function models derived with the solar wind considered as the input to a given channel resulted in delay parameters of about 2 days between the input change in solar wind velocity and the observed output change in electron flux which supports findings from prior studies.

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