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# THE EFFECTS OF MAGNETIC STORM PHASES ON F-LAYER IRREGULARITIES FROM AURORAL TO EQUATORIAL LATITUDES

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# COMPARISON OF F-LAYER IRREGULARITIES DURING PERIODS OF HIGH AND LOW SOLAR FLUX

## EQUATORIAL STUDIES

The review of equatorial data relative to F-layer irregularities continued during this period with an emphasis in this quarter on determining the effects of localized effects on the generation of F-region irregularities. The study compares initially for one month TEC and scintillation data for Manila, the Philippines, Palehua, Hawaii Tepei, Taiwan , and Osan, Korea all in the Pacific Sector. For some periods in 1980 and 1981, all the data are available. The initial study will be the data set for July 1980.

We are working on airglow depletion data taken in Brazil over a span of years which include years of both high and low solar flux. The initial analysis is almost completed and will be described in the next quarterly report.

## HIGH LATITUDE STUDIES

We have analyzed the data provided by Dr. Leonard Kersley of the University College of Aberystwyth, Wales and his group. Data from several periods of interest in the low sunspot years of 1985 and 1986 has been contoured. The data available for the study of contrasting low and high solar flux years includes that from the University College data set taken in Kiruna, Sweden as well as other data taken in Goose Bay, Labrador. We also have access to equatorial observations for these dates. Evaluation of data sets has included new analysis as well as the utilization of older data, much of it at this date merely reduced.

## PROPOSED PRESENTATION

We are preparing the following material to be put into an abstract for the Ionospheric Effects Symposium.

## THE SUNSPOT CYCLE AND "AURORAL" F LAYER IRREGULARITIES

J. Aarons, L. Kersley (University College of Wales) and A.S. Rodger (British Antarctic Survey)

The use of the word "aurora" for many different observations at high latitudes has limited the concepts involved; this is particularly true for F region irregularities. Observations setting the position of the auroral oval are made with the 5577 Å green line emitted predominantly at E layer heights. Starkov and Feldstein have shown that the change in position of the auroral oval for constant Kp, as a function of sunspot cycle, is of the order of one degree difference between sunspot maximum and sunspot minimum. However irregularities in the F region do not have the same behavior as the auroral 100 km observations and for the same magnetic index show large differences in position as a function of solar flux.

The data from Goose Bay, Labrador observing from 67° to 70° Corrected Geomagnetic Latitude indicate that the occurrence of scintillation at 250 MHz during a year of low solar flux (1986) is enormously reduced compared to the occurrence for the same magnetic conditions during a year of high solar flux (1980). Data from the low altitude orbiting Transit satellites taken in Lerwick, Scotland indicate that the scintillation boundary for low K values, moves equatorwards of the order of 4 to 10 degrees (depending on arbitrary values of scintillation level chosen) as sunspot maximum is approached. For example the October-November periods of 1987 shows the 10-20% occurrence of scintillation of moderate level at 65 degrees of corrected geomagnetic latitude for 1987 and 53 degrees for the higher flux year of 1988. Higher occurrence of 20%-30% levels of scintillation show a change of 4 degrees for the same comparison.

Using a shorter time scale, an earlier unpublished study of scintillations (Hawkins, 1974) during extended quiet periods for a year of relatively high to moderate sunspot numbers (127 and 89) showed that as the days of low magnetic activity continued the mean scintillation index also decreased.

Scintillation intensity is a function both of the disturbing mechanism and the ambient electron density. Changes in electron density has been proposed as the dominant mechanism for changes in high latitude irregularity intensity. The contrary evidence against the use of electron density as the predominant parameter has two aspects i.e. that scintillations maximize during the night when electron density is lower. In addition during certain phases of many magnetic storms, the intensity of the irregularities increases yet the local F-layer electron density decreases. This may lead to the formulation of two mechanisms, one for the conditions of low solar flux and quiet magnetic conditions and the second for mechanisms operating during magnetic storms.

A second paper is being prepared for presentation at the Ionospheric Effects Symposium with Dr. Charles Rush of National Telecommunications and Information Administration. The abstract and title follow:

**THE EFFECTS OF SCINTILLATION ON 136-150 MHz EARTH-SPACE PROPAGATION PATHS**

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A large amount of synchronous satellite-to-ground data has been taken at 136 MHz on a global scale; this data base can be applied to understanding the ionospheric effects on the use of the frequency band 136-150 MHz for low Earth orbit (LEO) satellite-to-ground systems. Such LEO-based systems have been proposed for position determination and low data rate transfer services. Understanding the ionospheric irregularities particularly at F layer heights, will provide information to system designers and users regarding possible effects on the systems imposed by the capriciousness of the ionosphere. It will also allow for the design of modulation methods to minimize the impact of the phase and amplitude fading on system performance.

The data base has four components in its global structure i.e. equatorial, middle latitude, auroral, and polar. Most dramatic is the high occurrence of fading within 5 degrees of the magnetic equator and the very deep fading in the anomaly region of the magnetic equator. The anomaly region, several degrees wide in latitude and 15

degrees from the magnetic equator, has shown a high occurrence of deep fades greater than 20 dB, particularly during years of high sunspot numbers. At times fades of 50 dB in signals at this frequency have been reported in the anomaly region. The middle latitudes show the least impact of scintillations with fading levels mostly of the order of several dB and even that of low occurrence. The auroral region shows very deep fading when magnetic storms occur. The affected area is difficult to define in latitude for the scintillation studies since at times the latitudes showing significant fading can descend to areas south of Washington, D.C., for example. The auroral region shows a high occurrence of fading of the order of 20 dB during magnetic activity and during years of high sunspot number. The polar region can be only mildly affected by fading (during years of low sunspot activity during the daytime) but can have very deep fades during years of high sunspot activity - and the fading in those years can be continuous.

Occurrence patterns, correlation with magnetic and solar activity, fading spectra are all part of the literature and a general outline of the available data will be presented. The potential impact of scintillation on the performance of LEO-based radio systems will be discussed and the effects at 400 MHz will be noted.

## PUBLICATIONS

Refereed Paper Accepted for Publication

Aarons, J., Longitudinal Morphology of Equatorial F Layer Irregularities Relevant to their Occurrence. Accepted for publication December 1992 by Space Science Reviews