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

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## EQUATORIAL AND MIDDLE LATITUDE STUDIES

We continued with the comparison of scintillation and total electron content data from a chain of stations in the Pacific. The study which uses records and data of TEC and scintillation for Manila, the Philippines, Palehua, Hawaii, Lunping, Taiwan, and Osan, Korea has lead to the need for studying the F-layer irregularities at lower and middle latitudes. The equatorial anomaly region is said to encompass regions plus and minus 15° from the geomagnetic equator. Yet there are Faraday fluctuations and irregularities above these latitudes with data seeping in from Puerto Rico, Korea and several stations in Japan, Taiwan, and China. We have started to look into this phenomena from the viewpoint of developing (for starters) what the morphology of this region is. We have prepared a paper for the January meeting of URSI which seeks to outline some puzzling data. The abstract follows:

### DAY TO DAY VARIATIONS OF EQUATORIAL IRREGULARITIES

Jules Aarons

#### ABSTRACT

Although the general pattern of equatorial F-layer irregularities as a function of latitude, longitude, and geophysical conditions is in hand, the day to day variations are still difficult to evaluate. The forcing functions for day to day variations appear to be neutral winds and electric field conditions. The data indicate that at times in "the irregularity season", irregularities are produced day after day. However nights of irregularities are at other times followed by one or more nights with an absence of irregularities.

For the equatorial region, using scintillation data at 136 MHz, we have correlated the occurrence of irregularities at several stations along a relatively narrow range of longitudes at various latitudes in the Pacific sector. The sites used are in the Philippines, Taiwan, and Korea. The correlation of daily occurrence was poor. For example at magnetically quiet times there are irregularities noted at a station such as Osan, Korea (dip latitude 30°) with little irregularity activity at Manila (dip latitude 5°), relatively close in longitude.

For latitudes somewhat higher than the anomaly region, the problem arises of separating polewards effects of the equatorial plumes and the equatorwards motion of irregularity development originating in the auroral region during severe magnetic storms.

A possibility exists for the generation of another class of F-layer irregularities at mid-latitudes with a body of data from Japan, Port Moresby, Osan, and Palehua, Hawaii. This is suggestive that at least in the Pacific region there is a low latitude generation of irregularities distinct from equatorial or auroral mechanisms.

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## TRAVEL

Dr. Jules Aarons travelled to Cambridge, England to work with Mr. Alan Rodger of the British Antarctic Survey on joint studies of F-layer irregularities. (September 8-October 1, 1993). With its network of ionospheric sounders and radars in the southern hemisphere, the British Antarctic Survey has been able to do studies which fit into the program being developed at Boston University on F-layer irregularities. At Boston University we have been able to work with observations and data from many Northern Latitude stations. Thus a comparison could be made on simultaneous effects in the Northern and Southern Hemisphere of various parameters.

A. Rodger and Dr. Aarons have written a series of papers on F-layer irregularities as observed by many techniques (incoherent radar, optical, scintillations etc.). During the stay in Cambridge, auroral region studies were completed. A paper which had been given at the Ionospheric Effects Symposium was revised; this paper has been invited for submission for publication by the editors of the special issue of Radio Science on the IES. New diagrams were planned, some additional studies of high latitude electron density variations were pursued during this time. In addition future programs were outlined. Basically the paper, being prepared with Dr. L. Kersley of the University College of Wales, seeks to show the enormous changes produced by the solar cycle of the so-called auroral region of F-layer irregularities. The region affected by the irregularities shrinks towards the pole during years of low sunspot numbers when magnetic conditions are quiet. In years of low sunspot numbers, the region reaches and moves equatorward of the low altitude (E layer) auroral oval.

Dr. Aarons attended the AGARD Symposium on Multiple Mechanism Propagation Paths; Their Characterization and Influence on System Design. The meeting was held from October 4-7, 1993. There were many areas of studies presented ranging from problems in HF transmission and OTH detection to millimeter propagation. In these areas contributions were made by both European and U.S. authors.

One area of interest to Dr. Aarons was the UK concept of developing means for using the 2-200 MHz range of frequencies to find the best path for the particular requirement; these are studies done under the sponsorship of military programs in the U.K. Since all transmissions will eventually be contributions to a bit stream, it should not make any difference whether HF or VHF is used. With handshakes to determine transmission viability, the bit stream could be put on any channel. Packaging, adaptive error-control sequences, vagaries of propagation were all considered. French groups were also interested in coding and in propagation; they proposed amplifying the use of ionosondes.

There were also interesting aspects of equatorial studies. In recent OTH observations made both in the U.S. and in Australia, it was found that F-layer ionospheric irregularities in the equatorial anomaly latitudes south of the magnetic equator were producing clutter on OTH units located in Northern states in the U.S. This related to the paper presented at the symposium on equatorial and high latitude F layer irregularities and ways of mitigating their effect. The approach in the paper was that system users, if they understood the morphology of these regions and the characteristics of the irregularity structures, could minimize the fading produced by these structures. The work done recently at Boston University on latitudes somewhat above the equatorial region was quite relevant to this problem.

The fact that there were diverse presentations allowed the individual scientist to

develop a greater interest and some expertise in areas beyond my field.

The travel was sponsored in part by ONR with payment for the transportation thru AGARD funds.

## **AASERT PROGRAM IN UPPER ATMOSPHERE AND IONOSPHERIC PHYSICS**

Ms. Colerico started her ASSERT fellowship in August 1993 and is now a full-time graduate student in the Electrical, Systems, and Computer Engineering M.S. program while being a graduate research assistant in the Center for Space Physics. Her initial research duties involve working with low latitude imaging observations made on Wake Island and mapping the 6300 A airglow features to the ALTAIR radar observing plane near the geomagnetic equator. This will allow us to conduct the first comprehensive investigation of the latitude-altitude characteristics of equatorial plasma depletions using simultaneous optical and radar means.

### **THE ONR SPONSORED ALL-SKY IMAGER**

The fabrication of an all-sky imager for installation at Goose Bay is complete. All components are complete, and assembly and testing are about to begin. Installation is still planned for the period November-January to allow for some data during the upcoming auroral winter season.