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Radar data from Jicamarca, Peru and phase fluctuation data from Arequipa, Santiago and Kourou were used to study the occurrence and intensity of phase fluctuations of GPS signals. In the study of 14 days of campaign equatorial data, there was a longitudinal separation of 5.5 degrees between the overhead field line at the radar site at Jicamarca and the overhead field line at Arequipa. At times thin layers were shown on the radar but plumes appeared to develop to the east showing a lack of correlation even over small distances. We have started a study to relate GPS phase fluctuations at the equator with the Bz component of a high latitude magnetogram; for this initial study there was a lack of correlation between magnetic activity and phase fluctuation but more complex studies involving a larger data base and more attention to ambient conditions will be instituted in the future.

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

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USE OF THE DATA BASE OF IGS AND RADAR DATA

A relatively new data source from a large number of stations throughout the world has been available for studies of both high and equatorial latitude irregularity development, i.e., the International GPS Service for Geodynamics (IGS). To explore this resource a program of using the data base has been developed at the Center for Space Physics of Boston University.

Thirty second values of phase differences were measured between the 1.2 Ghz and the 1.6 GHz signals of each GPS satellite recorded. With the data set consisting of 30 second samples, thus limiting spectral characteristics, we have chosen to call our data phase fluctuations. It should be noted that the apparent velocity of the propagation path plays a role in the meaning of a one minute sample. For one mid-latitude site for example speed ranged from 200 to 400 meters per second for an elevation of 10 degrees to less than 100 meters per second from 50* to 70* of elevation. Irregularities of the order of a few kilometers are thus sampled.

Measurements of differential phase scintillations were made at high latitudes by Kersley et al., 1995. In those studies, the phase differences between 150 and 400 MHz were used with the NNSS series of 1000 km satellites to determine the occurrence patterns of phase scintillation. In those studies the data was digitized at rapid rates thus allowing the spectrum of phase scintillations to be determined.

Using the difference between 30 second samples of Total Electron Content from individual Global Position System satellites, comparisons were made with several types of ground measurements during the MISETA period, September 23 - October 7, 1994. Phase fluctuations occurred when radar returns were noted and were not seen when there were no coherent radar returns. Depletion of 6300 A emission correlated with phase fluctuations. Attempts to use high latitude Bz magnetometer excursions failed to account for day to day variations in irregularity activity.

The radar data we have used were taken with the 50 MHz Jicamarca radar. We have concentrated on the coherent backscatter returns from F layer irregularities. The radar data from Kodeki (1995) showed an unusual range of types of returns. Several plumes were observed. One on October 3 showed returns to 1400 km of altitude. There were several nights of thin layers and finally nights of no F layer return.

For specific dates, we have compared radar behavior with phase fluctuation results. The longitudinal separation between the overhead field line at Jicamarca and the overhead field line at Arequipa is 5.5*; the distance between field lines is 600 km. Using a wind velocity of 100 meters per second, it would take approximately 1 hour 40 minutes for the wind to bring irregularities developed at the longitude of Jicamarca to the field line of Arequipa. It appears that some thin layers did not extend greatly in longitude. Some thin layers at Jicamarca were in contrast with plumes at Arequipa. Overhead fixed vertical radars have limited application to forecasting. The conclusion must be that even at the short distance of 5.5* there is considerable difference in day to day occurrence of irregularities.

There was a comparison of phase fluctuations from Arequipa, Peru and Fortaleza, Brazil, both at the same dip latitude. The difference in longitude along the dip latitude lines between Arequipa and Fortaleza even using the high velocity of 100 meters/second means a passage of many hours. The development of irregularities over 33* degrees of longitude for this relatively short period of observation can be summarized as follows: During the October 3rd period both Arequipa and Fortaleza showed strong phase fluctuations. During the nights when only thin layers developed there were difference in occurrence of the phase fluctuations.

MAGNETIC DISTURBANCES

In an effort to relate radar and phase fluctuations to magnetic variations, we have assembled the Bz component of the high latitude Igloolik Magnetometer Site of the MAACS; this has the following coordinates Geographic: 69*N 80*W, Corrected Geomagnetic 79.5* N -8.7* UT of Noon MLT 17:20 The basic pattern of this magnetometer was similar to those at lower latitudes for excursions of Bz. Continuity of data was the reason for not using lower latitude sites. We concentrated on 0-12 UT hours.

There was a lack of correlation of magnetic activity and phase fluctuation in the October 4-7 time period. There does not appear to be direct input of the magnetic field variations as far as the day to day changes are noted.

USES OF GPS DATA SETS FOR EQUATORIAL STUDIES

In an attempt to fully utilize the GPS data, we have developed 3D maps of Total Electron Content as a function of local time and latitude. The intensity of amplitude scintillation in the equatorial anomaly region is the product of electron density in the F layer in this region and the turbulence that produces the irregularities along the field lines at great distances. Essentially the latter forcing function is in the dynamics within the plume. Two conditions are necessary for strong amplitude scintillation in the anomaly region i.e. a disturbance extended in altitude over the magnetic equator and high electron density in the sunset to post-sunset time period in the anomaly region.

An important area of study relative to forecasting and understanding the day to day changes in the anomaly will be to determine the following origin or the following variation in the anomaly.

a. Temporal development of the region; absence of development of the anomaly and its causation.

b. Latitude of maximum; rate of change of TEC with latituide towards and away from the magnetic equator

ANOMALY REGION-MIDDLE LATITUDE IONOSPHERIC STUDIES

While we have pointed out the variation of the effective latitude of the anomaly region, we have not studied it. The importance of this region is seen in recent studies of 4 GHz signals at a variety of latitudes encompassing the anomaly latitudes and the lower middle latitudes. Can the intensity and time variations of the anomaly region be used in forecasting equatorial scintillation? Our aim is to see what effect the anomaly region movements have on scintillation activity and intensity.

PUBLICATION

The paper by J. Aarons, L. Kersley, and A.S. Rodger "The sunspot cycle and "auroral" F layer irregularities appeared in Radio Science 30, 631-638, May-June 1995

THE ONR AASERT PROGRAM IN UPPER ATMOSPHERE AND IONOSPHERIC PHYSICS

Ms. Colerico has continued in her study of ground based imaging observations of equatorial irregularities using data taken by the Boston University imager in Arequipa, Peru. She has assisted Dr. Aarons in a comparison study between TEC and scintillation measurements taken from GPS satellites and optical observations of Spread-F plumes taken at the imager site in Peru. There is a high correlation between the occurrence of scintillation activity and the passage of Spread-F plumes through the satellite's path. Some results from this comparison were presented in the AGU poster paper by Aarons, Mendillo, and Yantosca at the Spring 1995 AGU meeting in Washington, D.C. . Ms. Colerico has continued her research into the 6300A airglow feature which moves from north to south through the field of view of the Arequipa imager. This feature is referred to as the "Brightness Wave". This newly discovered phenomenon is being studied thru comparing coincident FPI measurements and optical observations of the "Brightness Wave". There are suggestions that the "Brightness Wave" may be related to the Midnight Temperature Maximum (MTM). The passage of the "Brightness Wave" correlates well with local minimums in the zonal winds, abatements/reversals of the meridional winds, and a local maximum in temperature all of which are consistant with the effect of the MTM on the neutral winds. These results were presented by Ms. Colerico in an oral presentation at the CEDAR meeting and a poster paper at the IUGG meeting both held in Boulder, Colorado in June 1995.

Ms. Colerico is also monitoring the Goose Bay imager. A site visit is being planned for a later date in order to update the imager's control software.