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VARIABILITY OF LOW LATITUDE IONOSPHERIC ELECTRODYNAMICS

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Abstract. The Earth's ionosphere is strongly affected by the ionospheric plasma drifts driven by local and global lower and upper atmospheric processes and by the solar wind-magnetospheric dynamo. The low the low latitude ionosphere has been studied for over four decades using mostly ground-based measurements in the American sector and theoretical and numerical models. Over the last decade extensive ground-based observations and satellite measurements have provided more detailed information on the global climatology and on the spatial and short term (times scales shorter than a month) variability of low latitude electrodynamics processes. In this talk, we will discuss the recent results on the variability of low latitude plasma drifts and spread F during geomagnetic quiet and disturbed times derived from ground-based and satellite observations.

1 INTRODUCTION

Electrodynamic plasma drifts control the distribution and composition of the plasma in the low latitude ionosphere and ionosphere and protonosphere, drive the equatorial electrojet and control the development of the Appleton ionization anomaly and the generation of plasma E- and F-region plasma density structures and waves with a large range of scale sizes. The accurate specification of the temporal and spatial variability of ionospheric plasma drifts constitutes one of the main challenges for the development of improved forecasting of ionospheric weather and of processes that can strongly affect the performance of space-based systems.

Low latitude ionospheric plasma drifts and currents have been the subject of intense experimental studies using extensive ground-based radar, ionosonde and magnetometer observations. Global low latitude ionospheric electrodynamic in-situ measurements were carried out between the middle 1970s and early 1980s on board the low inclination AE-E and San Marco satellites and the high inclination DE-2 satellite. These measurements confirmed the strong longitudinal dependence of the low latitude ionospheric plasma density, drifts and currents.

Over the last decade, satellite missions have provided more detailed information on the electrodynamics and plasma structure in the low latitude ionosphere. These missions have used the DMSP, IMAGE, TIMED, ROCSAT-1, DEMETER, CHAMP, TOPEX and the C/NOFS satellites. These satellite observations have been complemented by coordinated global ground-based radio and radar, and optical measurements.

2 RESULTS AND SUMMARY

Ion drift measurements on board the ROCSAT-1 were used to develop a quiet time solar cycle, season, and longitude dependent model for the equatorial vertical plasma drifts. The longitudinal dependence shown by these measurements is much stronger than reported previously. The IMAGE and ROCSAT-1 and TOPEX satellite data show strong signatures of wave number four daytime during equinox and June solstice. The evening prereversal enhancement of the equatorial vertical plasma drifts has largest longitudinal variation during December solstice. The longitudinal variation of the evening prereversal velocity peaks determined by ROCSAT-1 measurements is in excellent agreement with that of the equatorial spread F inferred from CHAMP and DMSP satellite measurements. Ground-based and recent using the DMSP, ROCSAT and CHAMP satellite studies have determined the altitude, season, solar cycle and longitude dependent climatology of equatorial spread F and plasma depletions. The fundamental questions on the electrodynamics of the low latitude ionosphere are now centered on its very strong short- term (periods a few hours to about a month) variability during geomagnetic quiet and active conditions. Several studies have examined the possible effects semidiurnal tides, of gravity and planetary waves and of solar wind-magnetosphere dynamo and storm-time winds on the equatorial plasma drifts and on the plasma density distribution and generation of plasma structures and waves. They have identified periods of occurrence of planetary wave effects with periods of two to about 16 days. More recently, strong lunar semidiurnal effects have been identified on equatorial vertical plasma drifts during arctic winter sudden stratospheric warming events.

In this presentation, we briefly review the climatology of low latitude electrodynamic plasma drifts and then discuss recent results and fundamental questions on their short-term variability. Finally, we highlight some near future initiatives which should significantly improve the forecasting of low latitude ionospheric weather.