Final Report for the NASA Grant
"Satellite Studies of Storm-Time Thermospheric Winds"
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In this project we have studied the climatology and storm-time dependence of longitude-averaged mid- and low-latitude thermospheric neutral winds observed by the WINDII instrument on board the UARS satellite. This satellite is in a circular, 57° inclination orbit at a height of 585 km; the orbit precesses at a rate of 5° per day. WINDII is a Michelson interferometer that measures Doppler shifts of the green line (557.7 nm) and red line (630.0 nm) airglow emissions at the Earth's limb, covering latitudes up to 72°.

We studied the mid- and low-latitude disturbance winds using the methodology outlined by *Fejer et al.* [2000] and *Emmert et al.* [2001]. In this procedure, the perturbation winds are obtained by removing local time, season, solar cycle and orbital dependent quiet time ($Kp<3$) winds. In *Emmert et al.* [2001] and *Emmert* [2001], we used these data to study and model empirically the latitudinal dependence of the longitudinally averaged daytime F region disturbance winds. This study showed that the measured winds are in poor agreement with results from the empirical Horizontal Wind Model-93 during the entire daytime period. There were also important discrepancies between the WINDII data and the results from the NCAR TIEGCM, particularly at mid-latitudes.

We have presented the first detailed study of the seasonal and altitudinal variations of the mid- and low-latitude daytime disturbance thermospheric winds over the 90-275 km height range (*Emmert et al.*, 2002). Our results, indicate that: (1) The daytime perturbation winds are generally equatorward and westward, and decrease toward the magnetic equator; (2) The zonal and meridional components decrease sharply below 120 km and are essentially insignificant below 100 km; and (3) The seasonal dependence is strongest in the early morning sector. This study also showed that the height and storm-time dependence of these perturbation winds begin to develop after 3-9 hr, and tend to saturate 12-24 hr after storm onset; seasonal effects are generally important only after storm times greater than 6-12 hr. One of the most striking characteristics of the low latitude disturbance winds is the large eastward perturbation of the zonal component which maximizes at the magnetic equator and vanishes at magnetic latitudes of about 20°.

Fejer [2002] presented a review of low latitude storm time electrodynamic drifts as determined by radar and satellite observations. This work pointed out the complex dependence of low latitude disturbance dynamo drifts on perturbation winds. *Fejer* [2004] examined the present understanding of solar wind-magnetosphere effect on the electrodynamics of the middle and low latitude ionosphere.

We have done the first extensive study of the nighttime quiet and disturbance winds using WINDII data from different altitudes [*Emmert et al.*, 2004]. In this case, we have used a more extensive data set (version 5.11) than previously available (version 4.98). We showed that the nighttime zonal winds in the 225-275 km height range are predominantly westward, with strongest effects extending from dusk at 70° to midnight at 45°. At low latitudes, the zonal winds change from westward to eastward at dawn. The meridional perturbed winds are mostly equatorward above 40° and after 0300 MLT. In the midnight sector, the meridional winds are poleward below 40° during low and moderate solar flux conditions; near solar maximum they are largely equatorward throughout the night. Figure 1 illustrates the behavior of the daytime and nighttime WINDII perturbation winds for $Kp \geq 3$, which shows very similar results from the northern and southern hemispheres (from *Emmert et al.*, 2004).

References:

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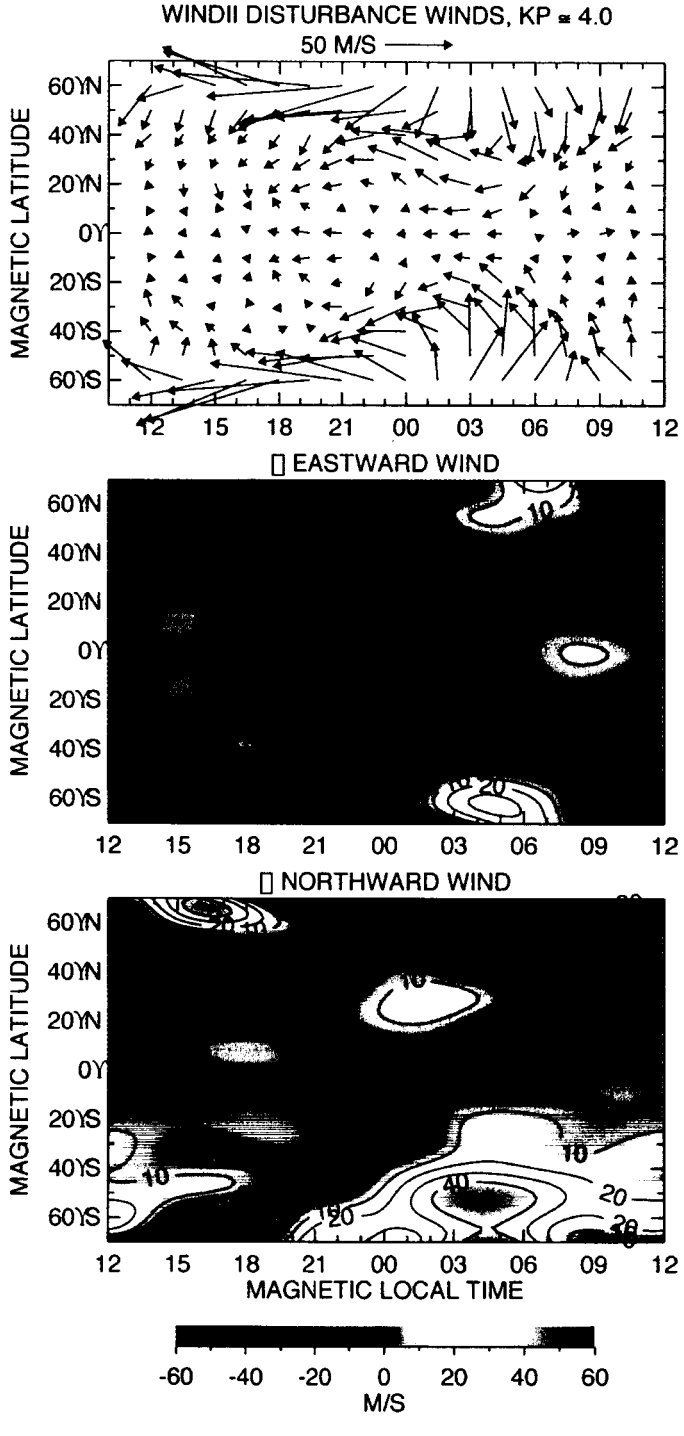
WINDII DISTURBANCE WINDS, KP = 4.0
50 M/S
60°N
40°N
20°N
0°
20°S
40°S
60°S
MAGNETIC LATITUDE
12 15 18 21 00 03 06 09 12
EASTWARD WIND
10
20
NORTHWARD WIND
10
40
20
MAGNETIC LOCAL TIME
-60 -40 -20 0 20 40 60
M/S

Figure 1