ZONAL WIND OBSERVATIONS DURING A GEOMAGNETIC STORM

N. J. Miller and N. W. Spencer
Laboratory for Atmospheres
NASA/Goddard Space Flight Center
Greenbelt, MD 20771

In situ measurements taken by the Wind and Temperature Spectrometer (WATS) onboard the Dynamics Explorer 2 spacecraft during a geomagnetic storm display zonal wind velocities that are reduced in the corotational direction as the storm intensifies. The data were taken during November 24-26, 1982 within the altitudes 275-475 km in the dusk local time sector equatorward of the auroral region. Characteristic variations in the value of the Dst index of horizontal geomagnetic field strength are used to monitor the storm evolution. The detected global rise in atmospheric gas temperatures indicates the development of thermospheric heating. Concurrent with that heating, reductions in corotational wind velocities were measured equatorward of the auroral region. Just after the sudden commencement, while thermospheric heating is intense in both hemispheres, eastward wind velocities in the northern hemisphere show reductions ranging from 500 m/s over high latitudes to 30 m/s over the geomagnetic equator. After 10 hours storm time, while northern thermospheric heating is diminishing, wind velocity reductions, distinct from those initially observed, begin to develop over southern latitudes. In the latter case, velocity reductions range from 300 m/s over the highest southern latitudes to 150 m/s over the geomagnetic equator and extend into the northern hemisphere. The observations highlight the interhemispheric asymmetry in the development of storm effects detected as enhanced gas temperatures and reduced eastward wind velocities. Zonal wind reductions over high latitudes can be attributed to the storm induced equatorward spread of westward polar cap plasma convection and the resulting plasma-neutral collisions. However, those collisions are less significant over low latitudes; so zonal wind reductions over low latitudes must be attributed to an equatorward extension of a thermospheric circulation pattern disrupted by high latitude collisions between neutrals transported via eastward winds and ions convecting westward.

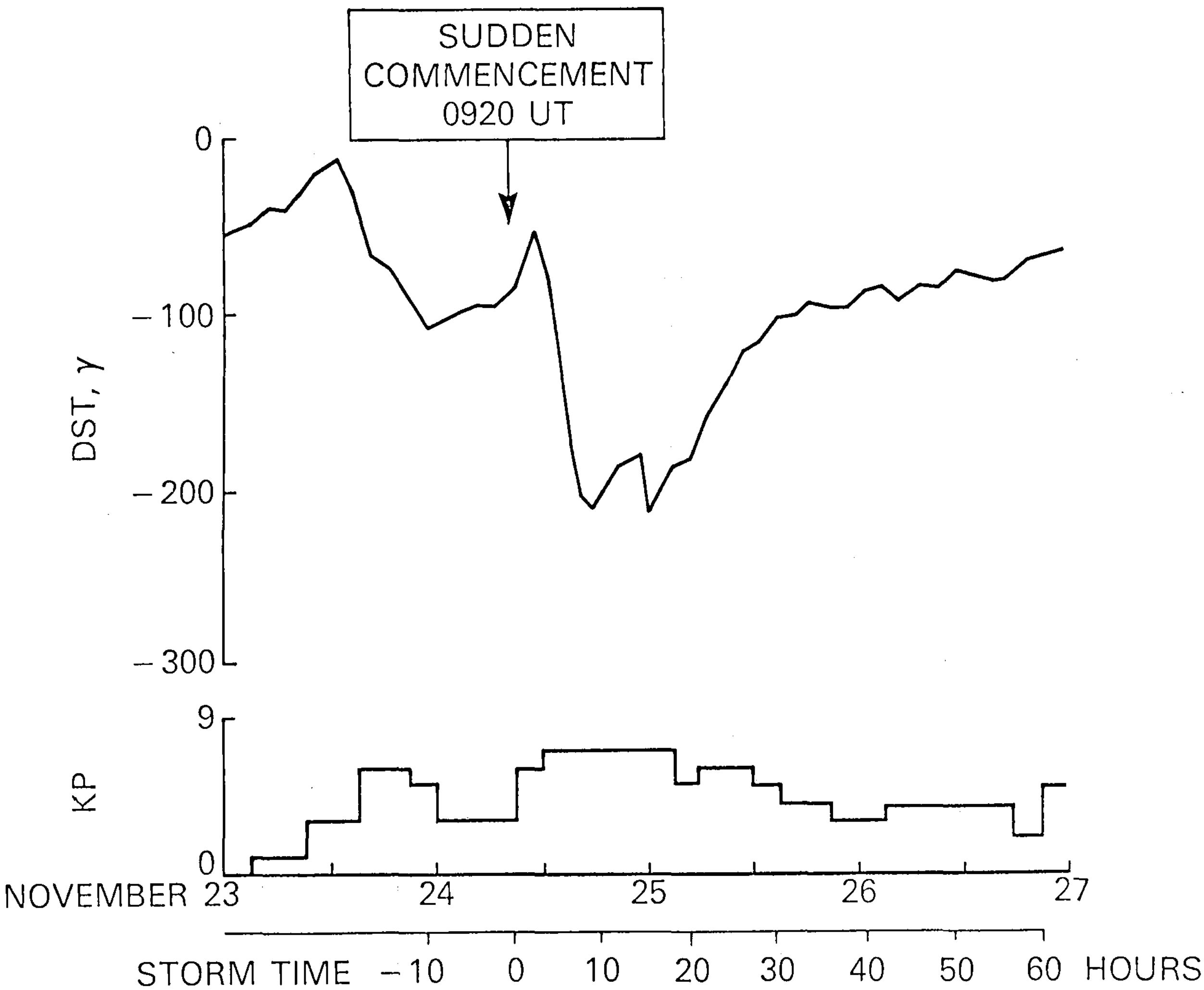

Figure 1. Magnetic characteristics of the period November 24-26, 1982. The Dst index decreases to -218γ at 1800 UT on the 24th; the three-hourly Kp index reaches 7 near 1400 UT on the 24th and remains there until after 0300 UT on the 25th. Storm time is measured from the time of the sudden commencement.

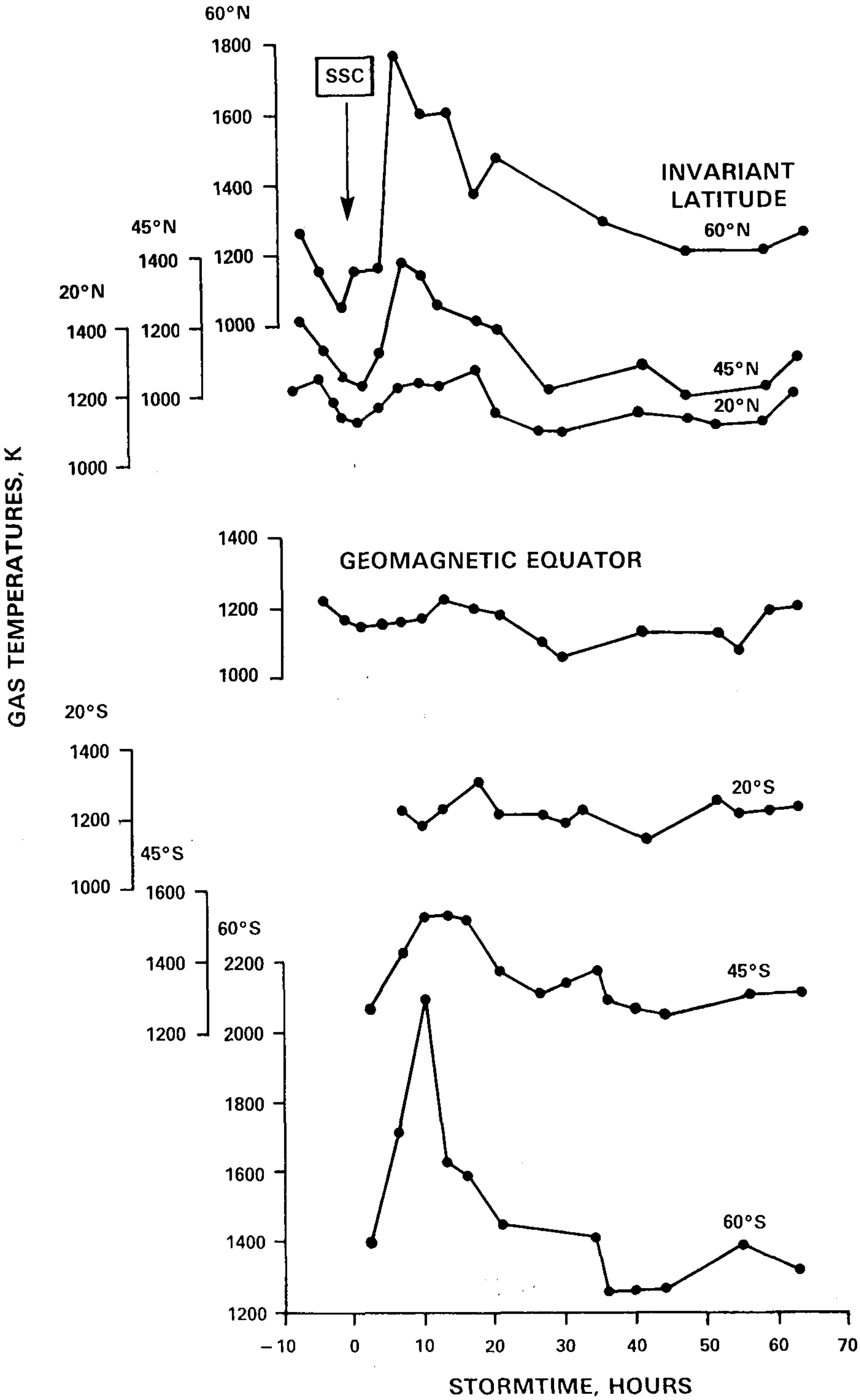

Figure 2. Gas temperatures measured by the WATS instrument in the dusk local time sector within the altitude range 275-475 km. The effects of thermospheric heating appear between 0-20 hours storm time over all dusk latitudes equatorward of 60° invariant latitude. The temperature rises 660° K over 60°N invariant latitude but only 70° K over ghe geomagnetic equator.

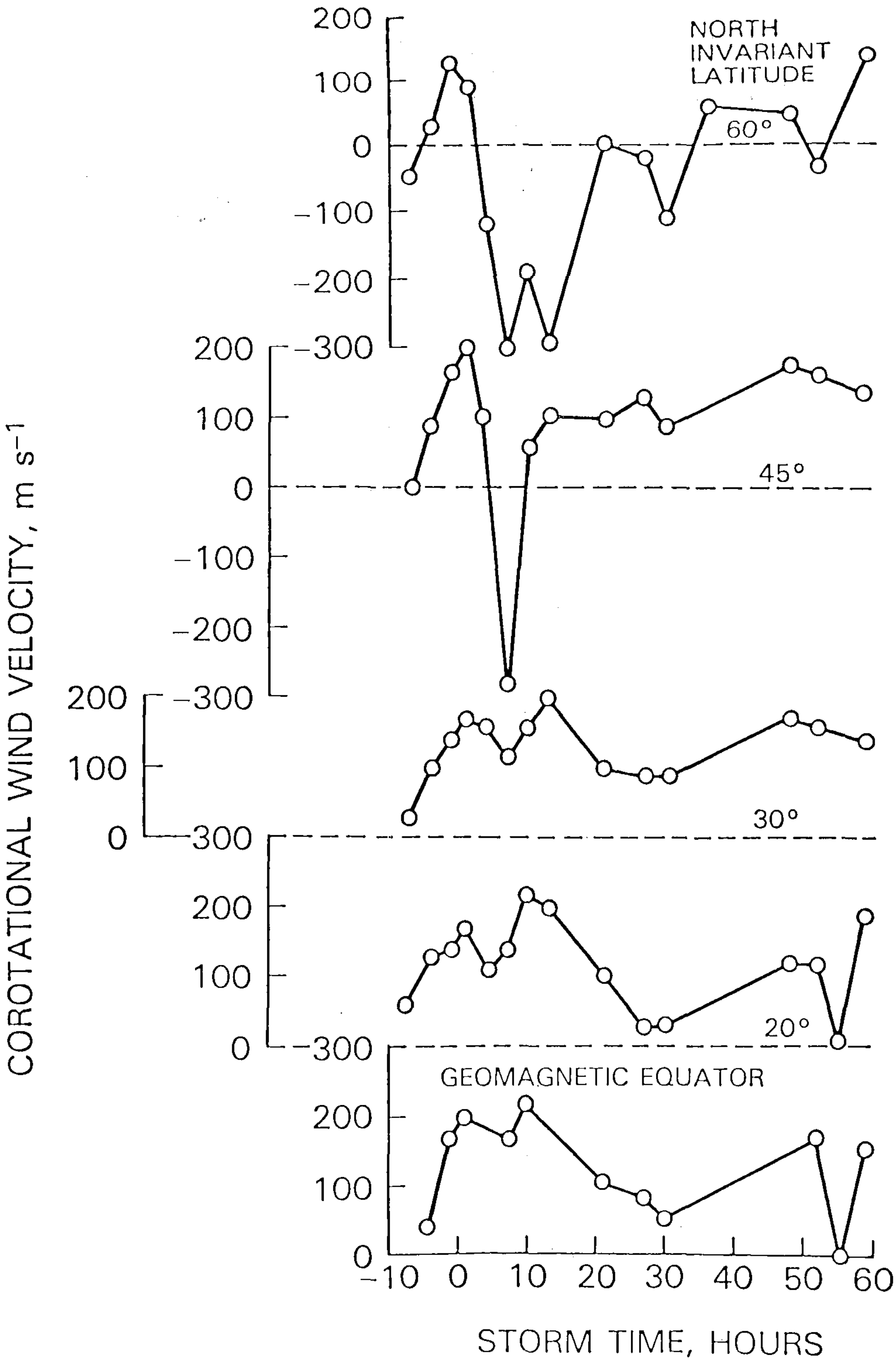

Figure 3. Zonal wind velocities measured over northern latitudes by the WATS instrument at the same time as the measurements represented in Figure 2. Velocities are relative to the corotation velocity, hence zero means corotation. Over all northern latitudes equatorward of 60° invariant latitude, velocities display a decrease in value immediately after the sudden commencement.

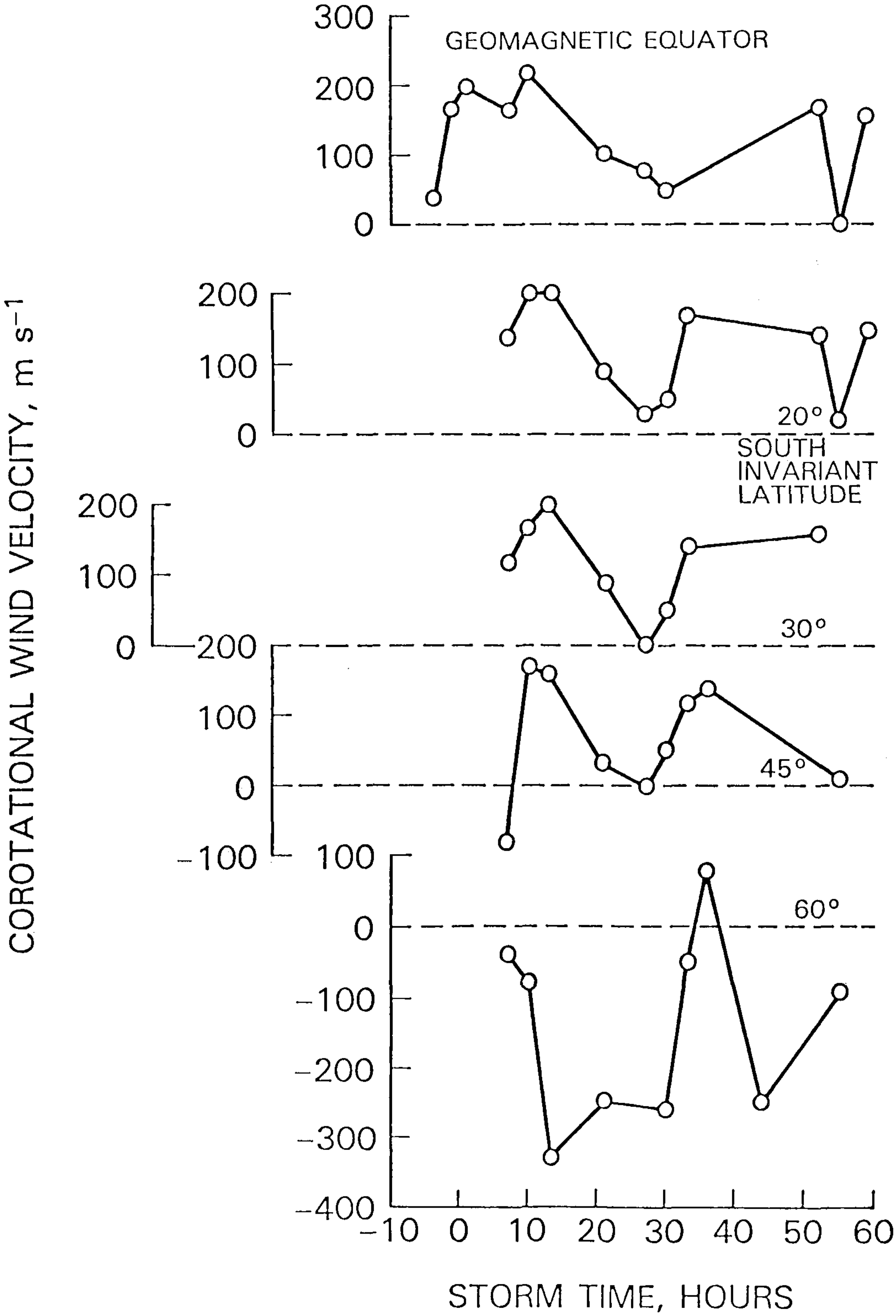

Figure 4. Zonal wind velocities measured as in Figure 3 but over southern latitudes. After 20 hours storm time the data display a velocity decrease that affects the zonal wind over latitudes from 60° south invariant latitude to 20° north invariant latitude.