Global Ionospheric Response Observed by COSMIC Satellites during the January 2009 Stratospheric Sudden Warming Event

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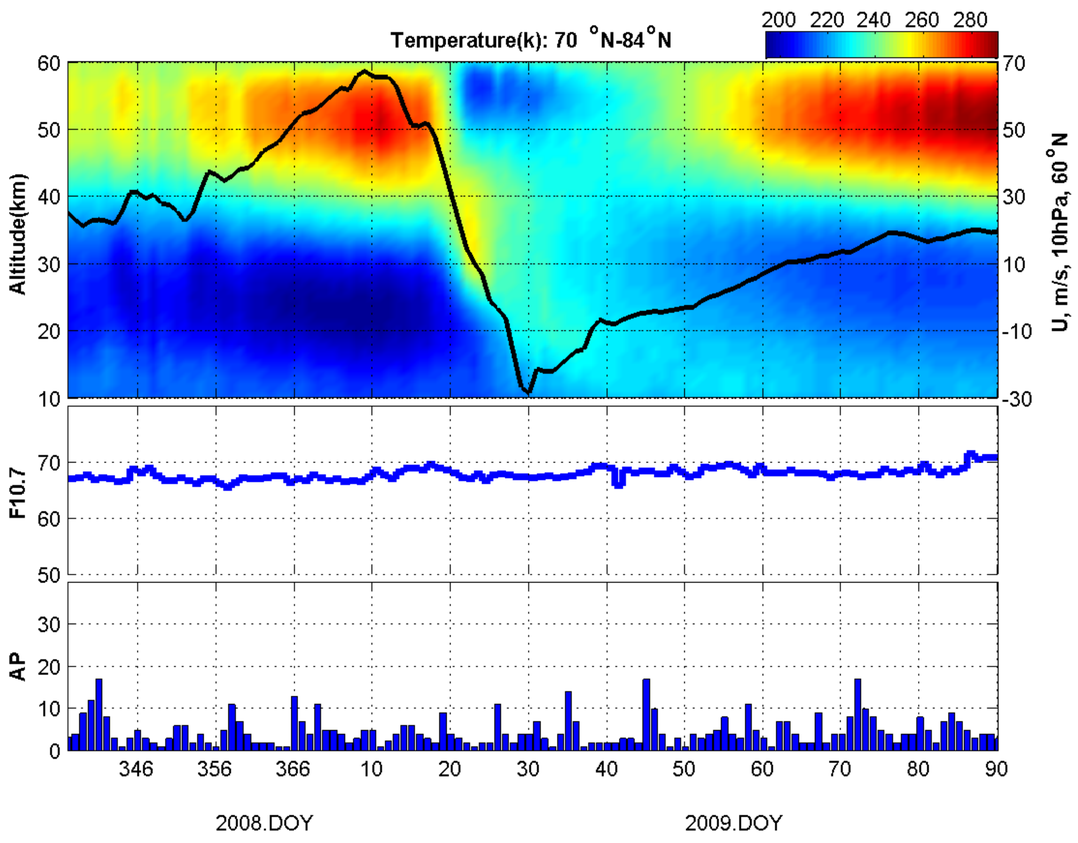
1. Introduction

- ✓ Meteorological energy sources are thought to be the important contributors to ionospheric day-to-day variability. Stratospheric Sudden Warming (SSW) is one such typical phenomena that couples the stratosphere, middle and low altitude thermosphere (MLT), and upper atmosphere and ionosphere together.
- ✓ A SSW is an event where the polar vortex of westerly (eastwards) winds in the Northern winter hemisphere abruptly slows down (minor SSW) or even reverses direction (major SSW), accompanied by a rise of stratospheric temperature by several tens of kelvins.
- ✓ Some observations and modeling results have shown that the ionosphere can have dramatic changes during and after a SSW event.
- ✓ A major SSW event occurred during January of 2009, when the solar and geomagnetic activities were extremely low. It provides a good opportunity to study the variability of the ionosphere resulting from changes in the lower atmosphere.

2. COSMIC Data

- ✓ COSMIC consists of six identical micro-satellites launched on April of 2006. The primary instruments are GPS RO receivers. Each spacecraft utilizes 4 GPS antennas: two occultation antennas for 50-Hz tracking for atmospheric profiling in an open-loop (OL) mode, and two single patch antennas for 1-Hz tracking for precise orbit determination (POD) and ionospheric profiling . These payloads are managed by the University Corporation for Atmospheric Research (UCAR) and the raw observations are processed by the COSMIC Data Analysis and Archive Center (CDAAC) both in near real-time and post-processing.
- ✓ Both neutral temperature profile during 10-60 km and electron density profile during 100-800 km are used in this research.

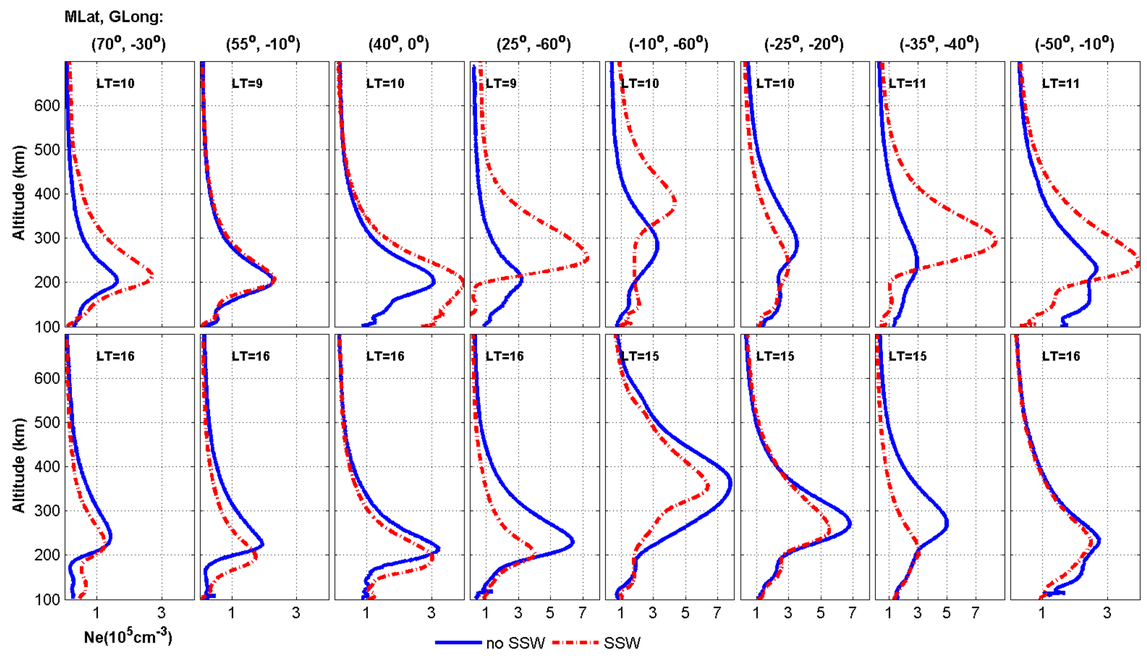
2009 SSW

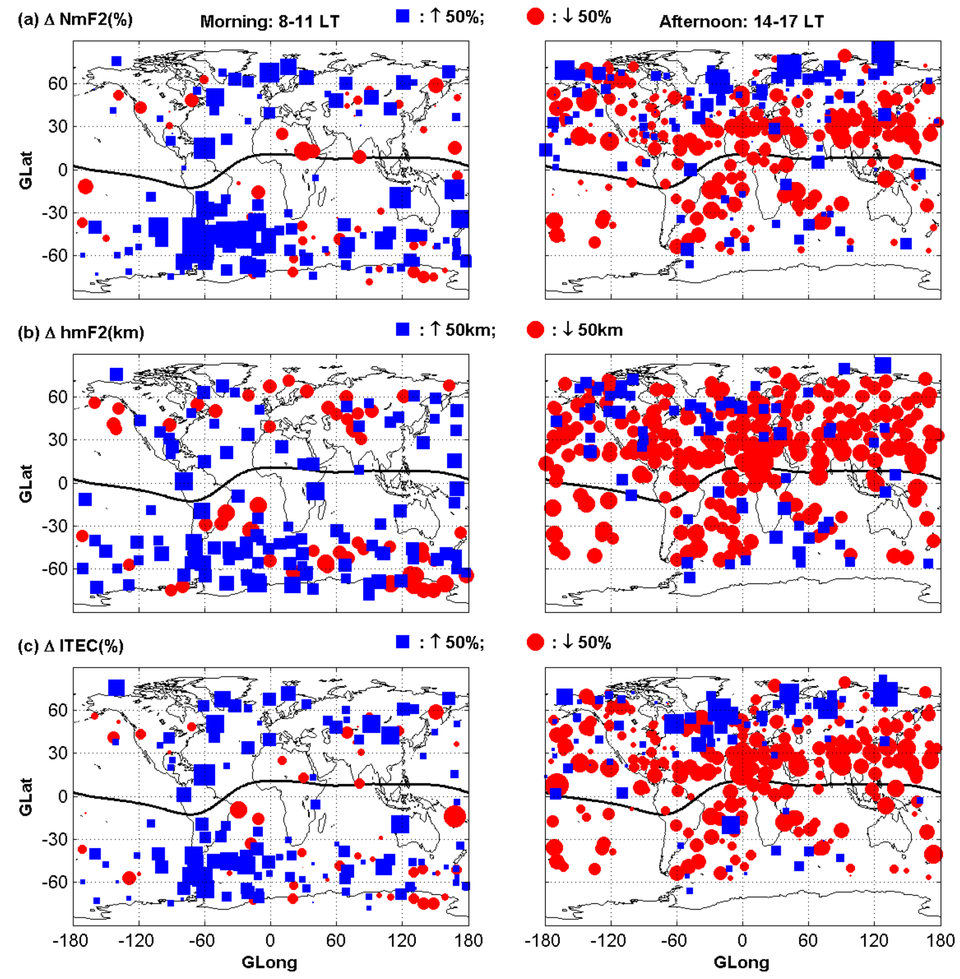


3. Analysis Method

- ✓ January 15-19 was chosen as a reference (non-SSW) period and January 26-28 as the SSW period. The COSMIC observed EDPs are then binned into geomagnetic latitude, longitude and local time cells with the intervals of 5 degree, 10 degree, and 1 hour, respectively, for both no-SSW and SSW days. If there are observed EDPs during both non-SSW days and SSW days for the same cell, then it is considered as a case. Additionally, local times ranges of 8-11 and 14-17 hours were chosen to represent the morning and afternoon sectors, respectively. There are totally 481 cases, including 160 cases in the morning and 321 in the afternoon.

4. Results





Magnetic Latitude		MLat<=30°		30° <MLat<60°		MLat>=60°		Total	
Local Time		Morning	Afternoon	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon
Average	△NmF2(%)	44(26)	-36(-31)	45(35)	-26(-17)	33(28)	-22(-10)	42(31)	-29(-21)
Value (All)	△hmF2(km)	33(30)	-30(-29)	33(27)	-19(-17)	36(16)	-16(-15)	33(27)	-24(-21)
	△ITEC(%)	28(24)	-33(-32)	37(28)	-24(-20)	33(24)	-22(-17)	33(25)	-28(-24)

5. Conclusion

- ✓ During 2009 SSW event, the peak density (NmF2), peak height (hmF2), and ionospheric total electron content (ITEC) increase in the morning hours and decrease in the afternoon globally for 80% of the casesNmF2, hmF2, and ITEC during SSW days, on average, increase 42%, 33 km, and 33% in the morning and decrease 29%, 24 km, and 28% in the afternoon, respectively..
- ✓ The ionospheric response in low-middle latitude and equatorial regions during SSW can be explained by the modulated electric field vertical drift resulting from the interaction between planetary waves and tides through E-region dynamo, whereas the ionospheric variations at middle and high latitude during SSW might also be attributed to the direct propagation of planetary wave and tides from the lower atmosphere to the ionospheric F2 region.
- ✓ Planetary wave is an important source of ionospheric weather especially during winter time.