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New aspects of thermospheric and ionospheric responses to high latitude forcing revealed by satellite observations

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The neutral mass density N and electron density Ne at 400 km height measured by CHAMP, and ion densities at 600 km and 840 km heights measured by ROCSAT and DMSP reveal some new aspects of the thermospheric and ionospheric responses to the high latitude forcing during the main phase (MP) and recovery phase (RP) of geomagnetic storms. (1) During short and steady MPs, high latitude thermosphere undergoes impulsive responses due to high rate of energy input, which generates fast equatorward surges (or waves) and winds that reach the equator within 1.5 to 3 hours; fast rate of change of Dst produces strong eastward penetration electric fields (PEFs); and the two together produce strong and sharp positive ionospheric storms centered at around +/-30° magnetic latitudes, with sever density depletions around the equatorial F region (400 km and 600 km heights) and density enhancements in the topside ionosphere (840 km height). (2) During RPs when severe negative ionospheric storms occur at low and mid latitudes due to the chemical effects of the thermospheric storms, positive ionospheric storms occur around the equator. Physical mechanisms of these new aspects are presented based on basic principles and model calculations.