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Thermal and dynamic regimes of the auroral mesosphere inferred from the meteor radar and ionozonde observations

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Wind and temperature in the polar mesosphere-lower thermosphere (MLT) region are observed by the Sodankyla meteor radar, which is located in the vicinity of the southern edge of the stratospheric polar vortex and also close to the equatorial boundary of the auroral oval in the ionosphere. At 90 km height, the seasonal pattern is formed by the cold summer (100) and warm winter (200). The mean zonal winds are characterized with summer westward flow of about 30 m/s at 80-90 km heights and the eastward flow above 90 km. In winter the flow is eastward at all heights. The meridional winds are dominated by winter poleward flow and summer equatorward flow, with a jet core of about 15 m/s located slightly below 90 km. The structure observed corresponds to the polar branch of the seasonal inter-hemispheric circulation. The systematically varying winds are mostly the semidiurnal tides up to 40 m/s. Under conditions of low solar activity, pronounced sudden mesospheric cooling linked to major stratospheric warming (SSW) is observed, while no SSW-related thermal signatures are detected in the mesosphere during the solar maximum years. The mesospheric temperature minimum occurs 1 day ahead of the SSW maximum, and the cooling is almost of the same magnitude as the corresponding warming (~50 K). The reversal of mesospheric wind is also observed.
A rapid-run ionosonde continuously operates at the same site since 2007. Quasi periodic oscillations of the F-layer height with a period from several minutes to hours which are related to the travelling ionospheric disturbances caused by atmospheric gravity waves (AGW) are revealed. Long term variations of the AGW amplitudes depend on seaon, solar and geomagnetic activity. At the shorter time scales, wave penetration to the ionospheric heights is affected by the underlying atmosphere. While the mesospheric temperature reaches its minimum in the course of SSW, the amplitude of ionospheric AGW with periods of 10–60 min decay abruptly. The longer period waves are not affected. The effect is explained by selective filtering and increased atmospheric turbulence near the mesopause thermal inversion layer.