WINDS OF WINTER: SOLAR WIND DRIVEN PARTICLE PRECIPITATION CAN AFFECT NORTHERN WINTER CLIMATE

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Solar wind drives the electromagnetic variability of the near-Earth space. During the declining phase of the solar cycle long-lived high-speed solar wind streams (HSSs) are commonly observed at Earth's orbit. The HSSs efficiently accelerate magnetospheric particles to higher energies and enhance energetic particle precipitation (EEP) into the atmosphere. Electrons from tens to hundreds of keV precipitate down to the mesosphere and upper stratosphere, where they can create nitrogen and hydrogen oxides.

During winter, nitrogen oxides have enhanced lifetime in the polar night. They can descend down to the mid-stratosphere and destroy ozone, which leads to cooling of the high-latitude stratosphere. This enhances the meridional temperature gradient and westerly winds, thus accelerating the polar vortex. This mechanism is successfully modeled by chemistry-climate models. Dynamical changes in the stratosphere can descend down to the troposphere. During strong polar vortex, the northern annular mode (NAM) is anomalously positive. Positive NAM enhances westerly winds at mid-latitudes and encloses the cold arctic air into the polar region. Enhanced westerlies bring warm and moist air from Atlantic to the Northern Eurasia causing positive temperature anomalies. At the same time negative temperature anomalies are observed in the Northern Canada and Greenland.

We have found that the positive NAM pattern is systematically preferred during the declining phase of the solar cycle at least since the late 19th century. There is a positive relation between precipitating electron fluxes in winter. We have also shown that the quasi-biennial oscillation (QBO) of equatorial winds strongly modulate this relation at high latitudes. These results give strong evidence that solar wind related effect do affect the tropospheric winter climate at high northern latitudes.