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Effect of Solar Wind Dynamic Pressure on Rossby Wave Propagation and Breaking

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Observational evidences are provided that the solar wind dynamic pressure (Psw) may influence stratospheric and tropospheric winter circulation in the Northern Hemisphere (NH) through a perturbation on the North Atlantic Oscillation (NAO) or on the Northern Annular Mode (NAM). When solar activity is high, the solar wind effect becomes mostly zonal and projects on the NAM. When solar activity is low, the solar wind effect becomes more localized. A positive solar wind dynamic pressure signal in the NAM propagates downward from the upper stratosphere to the surface under high solar conditions in winter and a negative signal descends into the lower stratosphere in spring. Significant perturbations on winter mean temperatures, winds and sea-surface pressure are observed in Jan-Mar mean. Possible perturbations of the solar wind dynamic pressure on Eliassen-Palm (EP) fluxes as well as synoptic wave breaking near the tropopause are also examined. We found that the signals in zonal wind and temperature fields are closely associated with downward propagation of EP fluxes and their anomalous divergence and convergence. The winter signal in EP-fluxes under high solar condition is controlled by a modulation of northward EP-flux, causing flow acceleration at high latitudes and deceleration at mid-latitudes. The negative solar wind dynamic pressure signal in the NAM in spring under low solar conditions is primarily governed by stronger upward EP-flux, meaning that higher solar wind dynamic pressure leads to an anomalously warmer polar region and/or earlier onset of final warmings in spring. The detected behaviour of EP-fluxes is consistent with the well-established quasi-geostrophic Transformed Eulerian-mean Theorem and and synoptic wave breaking leads to a NAM-like meridional circulation dipoles, suggesting that solar wind perturbation of Rossby waves is the main driver for the solar wind dynamic pressure signal seen in the zonal-mean flow reported previously by Lu et al. (2008).