Geophysical Research Abstracts
Vol. 17, EGU2015-3486, 2015
EGU General Assembly 2015

Solar-wind-driven changes to the ionospheric electric potential lead to changes in tropospheric temperature and geopotential height

Mai Mai Lam, Gareth Chisham, and Mervyn P. Freeman
British Antarctic Survey, Space Weather and Atmospheric Coupling, Cambridge, United Kingdom (maimailam7@gmail.com)

There are a large number of responses, on the day-to-day timescale, of the dynamics of the troposphere to regional changes in the downward current of the global atmospheric electric circuit (GEC). They provide compelling evidence that, via the GEC, the solar wind plays a role in influencing surface weather and climate. We use reanalysis data to estimate the altitude and time lag dependence of one such response – the Mansurov effect. This effect was first observed as a correlation between the duskward component B_y of the interplanetary magnetic field (IMF) and surface pressure anomalies in Antarctica. Additionally, we have more recently shown that the polar Mansurov effect can affect mid-latitude atmospheric planetary waves, the amplitude of the effect being comparable to typical initial analysis uncertainties in ensemble numerical weather prediction. Here we shed light on the origins of the polar surface effect by examining the correlation between IMF B_y and geopotential height anomalies throughout the Antarctic troposphere and lower stratosphere. We find that the correlation is highly statistically significant within the troposphere, and not so in the stratosphere. The peak in the correlation occurs at greater time lags at the tropopause ($\sim$ 6 – 8 days) and in the mid troposphere ($\sim$ 4 days) than in the lower troposphere ($\sim$ 1 day). This supports a mechanism involving the action on lower tropospheric clouds of the GEC, modified by variations in the solar wind (through modulations of the spatial variation in ionospheric potential). The increase in time lag with increasing altitude is consistent with the upward propagation by conventional atmospheric processes of the solar wind-induced variability in the lower troposphere. This is in contrast to the downward propagation of atmospheric effects to the lower troposphere from the stratosphere due to solar variability-driven mechanisms involving ultraviolet radiation or energetic particle precipitation. We also find a correlation between IMF B_y and the tropospheric air temperature anomaly, which is of lower statistical significance than the geopotential height effect described above. Up to altitudes of 3 km, the anomalies in air temperature are related to the geopotential height by the environmental lapse rate, and therefore considered to be real and to be part of the Mansurov effect. The mean air temperature anomaly across Antarctica associated with the Mansurov effect is up to 0.8 K.