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Response of the lower atmosphere to changes in the global atmospheric electric circuit associated with solar wind variability

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The existence of a meteorological response in the polar regions to fluctuations in the interplanetary magnetic field (IMF) component By is well established. More controversially, there is evidence to suggest that this Sun–weather coupling occurs via the global atmospheric electric circuit (GEC). In this talk I present further evidence of the solar wind's influence on the polar troposphere, communicated via the GEC. In particular, our recent results show a response to IMF By throughout the Antarctic troposphere within about 1-5 days, and indications of a resulting delayed influence on the lower stratosphere. We observe an increase in the response time with increasing altitude which is suggestive of an upward propagation of the influence of the solar-wind-induced variability on the lower troposphere. These results are in contrast to the observed slower downward propagation of meteorological effects, from the stratosphere to the lower troposphere, due to mechanisms associated with solar variability involving ultra-violet radiation or energetic particle precipitation.

It has been assumed that the meteorological response to fluctuations in IMF By maximizes at high latitudes and is negligible at low and mid-latitudes, because the perturbation by the IMF is concentrated in the polar regions. We demonstrate, however, a previously unrecognized influence of IMF By on mid-latitude surface pressure. The difference between the mean surface pressures during times of high positive and high negative IMF By possesses a statistically significant mid-latitude wave structure similar to atmospheric Rossby waves. Our results show that a mechanism that is known to produce atmospheric responses to the IMF in the polar regions is also able to modulate pre-existing weather patterns at mid-latitudes. The amplitude of the effect is comparable to typical initial analysis uncertainties in ensemble numerical weather prediction so could have an important effect, via the nonlinear evolution of atmospheric dynamics, on critical atmospheric processes.