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Energetic particle precipitation signatures in meteorological surface temperature observations?

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Recent model studies have suggested that the Odd Nitrogen, NO_x, created by Energetic Particle Precipitation (EPP) and the consequent ozone loss through catalytic loss cycles could have an effect on stratospheric and tropospheric (e.g. surface level) temperatures. According to the model studies, these effects could potentially be comparable to the effects induced by the solar cycle at high latitudes. Significant mesospheric and stratospheric NO_x enhancements have been observed during times of high solar activity (e.g. during Solar Proton Events). NO_x can also be transported from high altitudes (mesosphere-lower thermosphere), where it's created by energetic particle precipitation (protons and electrons), down to the stratosphere. Once in the stratosphere, the catalytic ozone loss cycles involving NO_x are important to the general stratospheric ozone balance.

Using meteorological datasets of the global sea-level temperatures from the European Centre for Medium Range Weather Forecast (ECMWF) and the UK Met Office, we select observational data from years with high geomagnetic activity (i.e. enhanced EPP into the atmosphere) and compare to those with low geomagnetic activity (i.e. low EPP). The resulting surface temperature patterns indicate an agreement with model results investigating EPP effects on climate. The possible effects of volcanic eruptions, as well as the solar cycle, the El Nino-Southern Oscillation and the North Atlantic Oscillation, on the observations are also considered.