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Transport of NOx created by energetic particle precipitation from the mesosphere-lower thermoshere to the stratosphere

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In the Arctic winters of 2005-2006 and 2008-2009 we observed that energetic particle precipitation (EPP) can have a significant impact on the middle atmosphere even during times of low geomagnetic activity. Stratospheric EPP-created NOx (EPP-NOx) mixing ratios were well above average in both winters, while the level of EPP leading up to the stratospheric NOx enhancements was low. These increases in stratospheric EPP-NOx mixing ratios have been attributed to unusually strong descent in the middle atmosphere that transported EPP-NOx created under normal EPP levels in the mesosphere and lower thermosphere (MLT) to the stratosphere. Once in the stratosphere, NOx has the potential to affect ozone and, therefore, temperature and winds. In order to reproduce the variability of middle atmospheric effects of EPP in general climate models (GCMs)--and thus elucidate the factors controlling the transport of EPP-NOx from the MLT to the stratosphere--we must be able to reproduce the dynamics that give rise to exceptional descent in the middle atmosphere. Since gravity waves are the primary forcing controlling mesospheric descent, it is critical that their parameterization in GCMs be optimally tuned to represent middle atmosphere dynamics. In this study, we assess the gravity wave parameterization in version 4 of the Whole Atmosphere Community Climate Model (WACCM4) with respect to reproducibility of dynamical features that are relevant to the transport of EPP-NOx.