Polar Northern Hemisphere Middle Atmospheric Influence due to Energetic Particle Precipitation in January 2005

Charles H. Jackman (NASA Goddard Space Flight Center, Greenbelt, MD, U.S.A.)

Energetic Particle Precipitation (EPP) Impact Team
Cora E. Randall and Xiaohua Fang (Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO, U.S.A.), Peter F. Bernath (University of York, United Kingdom), Bernd Funke and Manuel Lopez-Puertas (Instituto de Astrofisica de Andalucia, CSIC, Granada, Spain), Stefan Versick and Gabriele P. Stiller (Karlsruhe Institute of Technology, IMK-ASF, Germany), Allan J. Tylka (Space Science Division, Naval Research Laboratory, Washington, DC, U.S.A.), Daniel R. Marsh, Francis M. Vitt, and Rolando R. Garcia (Atmospheric Chemistry Division, National Center for Atmospheric Research, Boulder, CO, U.S.A.), Eric L. Fleming (NASA Goddard Space Flight Center, Greenbelt, MD, U.S.A.)

Solar eruptions and geomagnetic activity led to energetic particle precipitation in early 2005, primarily during the January 16-21 period. Production of OH and destruction of ozone have been documented due to the enhanced energetic solar proton flux in January 2005 [e.g., Verronen et al., Geophys Res. Lett., 33, L24811, doi:10.1029/2006GL028115, 2006; Seppala et al., Geophys. Res. Lett., 33, L07804, doi:10.1029/2005GL025571, 2006]. These solar protons as well as precipitating electrons also led to the production of NOx (NO, NO2). Our simulations with the Whole Atmosphere Community Climate Model (WACCM) show that NOx is enhanced by 20-50 ppbv in the polar Northern Hemisphere middle mesosphere (~60-70 km) by January 18. Both the SCISAT-1 Atmospheric Chemistry Experiment (ACE) NOx measurements and Envisat Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) nighttime NO2 observations show large increases during this period, in reasonable agreement with WACCM predictions. Such enhancements are considerable for the mesosphere and led to simulated increases in polar Northern Hemisphere upper stratospheric odd nitrogen (NOy) of 2-5 ppbv into February 2005. The largest ground level enhancement (GLE) of solar cycle 23 occurred on January 20, 2005 with a neutron monitor increase of about 270 percent [Gopalswamy et al., 29th International Cosmic Ray Conference, Pune, 00, 101-104, 2005]. We found that protons of energies 300 to 20,000 MeV, not normally included in our computations, led to enhanced stratospheric NOy of less than 1 percent as a result of this GLE. The atmospheric impact of precipitating middle energy electrons (30-2,500 keV) during the January 16-21, 2005 period is also of interest, and an effort is ongoing to include these in WACCM computations. This presentation will show both short- and longer-term changes due to the January 2005 energetic particle precipitation.