Atmospheric Chemistry and Physics
An Interactive Open Access Journal of the European Geosciences Union

Atmos. Chem. Phys., 10, 1739-1757, 2010
www.atmos-chem-phys.net/10/1739/2010/

Impact of energetic particle precipitation on stratospheric polar constituents: an assessment using monitoring and assimilation of operational MIPAS data

A. Robichaud[1], R. Ménard[1], S. Chabrillat[2], J. de Grandpré[1], Y. J. Rochon[3], Y. Yang[3], and C. Charette[1]

[1]Atmospheric Science and Technology Directorate, Environment Canada, 2121 Trans-Canada Highway, H9P 1J3, Dorval (Québec), Canada

[2]Belgium Institute for Space Aeronomy, Avenue Circulaire 3, 1180, Bruxelles, Belgium

[3]Atmospheric Science and Technology Directorate, Environment Canada, 4905 Dufferin Street, M3H 5T4, Toronto, Ontario, Canada

Abstract. In 2003, strong energetic particle precipitation (EPP) events occurred producing massive amounts of ionization which affected the polar region significantly perturbing its chemical state down to the middle stratosphere. These events and their effects are generally left unaccounted for in current models of stratospheric chemistry and large differences between observations and models are then noted. In this study, we use a coupled 3-D stratospheric dynamical-chemical model and assimilation system to ingest MIPAS temperature and chemical observations. The goal is to gain further understanding of assimilation and monitoring processes during EPP events and their impacts on the stratospheric polar chemistry. Moreover, we investigate the feasibility of assimilating valid "outlier" observations associated with such events. We use *OmF* (Observation minus Forecast) residuals as they filter out phenomena well reproduced by the model (such as gas phase chemistry, transport, diurnal and seasonal cycles) thus revealing a clear trace of the EPP. Inspection of *OmF* statistics in both passive (without chemical assimilation) and active (with chemical assimilation) cases altogether provides a powerful diagnostic tool to assess the model and assimilation system. We also show that passive *OmF* can permit a satisfactory evaluation of the ozone partial column loss due to EPP effects. Results suggest a small but significant loss of 5–6 DU (Dobson Units) during an EPP-IE (EPP Indirect Effects) event in the Antarctic winter of 2003, and about only 1 DU for the SPE (Solar Proton Event) of October/November 2003. Despite large differences between the model and MIPAS chemical observations (NO_2, HNO_3, CH_4 and O_3), we demonstrate that a careful assimilation with only gas phase chemistry included in the model (i.e. no provision for EPP) and with relaxed quality control nearly eliminated the short-term bias and significantly reduced the standard deviation error of the constituents below 1 hPa.

Final Revised Paper (PDF, 5212 KB) Discussion Paper (ACPD)

Citation: Robichaud, A., Ménard, R., Chabrillat, S., de Grandpré, J., Rochon, Y. J., Yang, Y., and Charette, C.: Impact of energetic particle

precipitation on stratospheric polar constituents: an assessment using monitoring and assimilation of operational MIPAS data, Atmos. Chem. Phys., 10, 1739-1757, 2010. Bibtex EndNote Reference Manager