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









Atmos. Chem. Phys., 10, 107-119, 2010
www.atmos-chem-phys.net/10/107/2010/


# Lightning $NO_x$ emissions over the USA constrained by TES ozone observations and the GEOS-Chem model

L. Jourdain[1,*], S. S. Kulawik[1], H. M. Worden[2], K. E. Pickering[3], J. Worden[1], and A. M. Thompson[4]

[1]Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109, USA

[2]National Center for Atmospheric Research, P.O. Box 3000 Boulder, CO 80307, USA

[3]NASA Goddard Space Flight Center, Greenbelt, MD 20771 USA

[4]Department of Meteorology, Pennsylvania State University, University Park, PA 16802,USA

[*]now at: Laboratoire de Physique et Chimie de l'Environnement et de l'Espace et Université d'Orléans, Orléans, France

Abstract. Improved estimates of $NO_x$ from lightning sources are required to understand tropospheric $NO_x$ and ozone distributions, the oxidising capacity of the troposphere and corresponding feedbacks between chemistry and climate change. In this paper, we report new satellite ozone observations from the Tropospheric Emission Spectrometer (TES) instrument that can be used to test and constrain the parameterization of the lightning source of $NO_x$ in global models. Using the National Lightning Detection (NLDN) and the Long Range Lightning Detection Network (LRLDN) data as well as the HYPSLIT transport and dispersion model, we show that TES provides direct observations of ozone enhanced layers downwind of convective events over the USA in July 2006. We find that the GEOS-Chem global chemistry-transport model with a parameterization based on cloud top height, scaled regionally and monthly to OTD/LIS (Optical Transient Detector/Lightning Imaging Sensor) climatology, captures the ozone enhancements seen by TES. We show that the model's ability to reproduce the location of the enhancements is due to the fact that this model reproduces the pattern of the convective events occurrence on a daily basis during the summer of 2006 over the USA, even though it does not well represent the relative distribution of lightning intensities. However, this model with a value of 6 Tg N/yr for the lightning source (i.e.: with a mean production of 260 moles NO/Flash over the USA in summer) underestimates the intensities of the ozone enhancements seen by TES. By imposing a production of 520 moles NO/Flash for lightning occurring in midlatitudes, which better agrees with the values proposed by the most recent studies, we decrease the bias between TES and GEOS-Chem ozone over the USA in July 2006 by 40%. However, our conclusion on the strength of the lightning source of $NO_x$ is limited by the fact that the contribution from the stratosphere is underestimated in the GEOS-Chem simulations.

Final Revised Paper (PDF, 1951 KB) Discussion Paper (ACPD)

Citation: Jourdain, L., Kulawik, S. S., Worden, H. M., Pickering, K. E., Worden, J., and Thompson, A. M.: Lightning $NO_x$ emissions over the USA constrained by TES ozone observations and the GEOS-Chem model, Atmos. Chem. Phys., 10, 107-119, 2010. Bibtex EndNote Reference Manager