Geophysical Research Abstracts
Vol. 18, EGU2016-7336, 2016
EGU General Assembly 2016

Atmospheric nitrogen deposition to the northwestern Pacific: seasonal variation and source attribution

Yuanhong Zhao (1), Lin Zhang (1), Yuepeng Pan (2), Yuesi Wang (2), Fabien Paulot (3), and Daven Henze (4)

(1) Department of Atmospheric and Oceanic Science, School of Physics, Peking University, Beijing, China , (2) State Key Laboratory of Atmospheric Boundary Layer Physics and Atmospheric Chemistry (LAPC), Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing , China, (3) Program in Atmospheric and Oceanic Sciences, Princeton University, Princeton, USA, (4) Department of Mechanical Engineering, University of Colorado, Boulder, Colorado, USA

Rapid Asian industrialization has lead to increased atmospheric nitrogen deposition downwind threatening the marine environment. We present an analysis of the sources and processes controlling atmospheric nitrogen deposition to the northwestern Pacific, using the GEOS-Chem global chemistry model and its adjoint model at 1/2°× 2/3° horizontal resolution over the East Asia and its adjacent oceans. We focus our analyses on the marginal seas: the Yellow Sea and the South China Sea. Asian nitrogen emissions in the model are 28.6 Tg N a-1 as NH3 and 15.7 Tg N a-1 as NO_x. China has the largest sources with 12.8 Tg N a-1 as NH3 and 7.9 Tg N a-1 as NO_x; the much higher NH3 emissions reflect its intensive agricultural activities. We improve the seasonality of Asian NH3 emissions; emissions are a factor of 3 higher in summer than winter. The model simulation for 2008-2010 is evaluated with NH3 and NO_2 column observations from satellite instruments, and wet deposition flux measurements from surface monitoring sites. Simulated atmospheric nitrogen deposition to the northwestern Pacific ranges 0.8-20 kg N ha-1 a-1, decreasing rapidly downwind the Asian continent. Deposition fluxes average 11.9 kg N ha-1 a-1 (5.0 as reduced nitrogen NHx and 6.9 as oxidized nitrogen NO_y) to the Yellow Sea, and 5.6 kg N ha-1 a-1 (2.5 as NHx and 3.1 as NO_y) to the South China Sea. Nitrogen sources over the ocean (ship NO_x and oceanic NH3) have little contribution to deposition over the Yellow Sea, about 7% over the South China Sea, and become important (greater than 30%) further downwind. We find that the seasonality of nitrogen deposition to the northwestern Pacific is determined by variations in meteorology largely controlled by the East Asian Monsoon and in nitrogen emissions. The model adjoint further points out that nitrogen deposition to the Yellow Sea originates from sources over China (92% contribution) and the Korean peninsula (7%), and by sectors from fertilizer use (24%), power plants (22%), and transportation (18%). Deposition to the South China Sea shows source contribution from Mainland China (64%), Taiwan (21%), and the rest 15% from the Southeast Asian countries and oceanic NH3 emissions. The adjoint analyses also indicate that reducing Asian NH3 emissions would increase NO_y dry deposition to the Yellow Sea (28% offset annually), limiting the effectiveness of NH3 emission controls.