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The empirical relationship between satellite-derived tropospheric NO_2 and fire radiative power and possible implications for fire emission rates of NO_x

Stefan F. Schreier (1,3), Andreas Richter (1), Johannes W. Kaiser (2), Dmitry Schepaschenko (3), Anatoly Shvidenko (3), Andreas Hilboll (1), and John P. Burrows (1)

(1) University of Bremen, Institute of Environmental Physics, Bremen, Germany (schreier@iup.physik.uni-bremen.de), (2) Max Planck Institute for Chemistry, Mainz, Germany, (3) International Institute for Applied Systems Analysis, Laxenburg, Austria

Vegetation fires across the globe have various impacts on Earth systems such as the atmosphere and biosphere. Every year, large quantities of biomass in different ecosystems are burned, either started by lightning strikes or caused by humans. Consequently, a considerable amount of trace gases (e.g. NO_x) and aerosols is released into the atmosphere. As nitrogen oxides (NO_x) affect atmospheric chemistry, air quality, and climate, a quantification of the total emissions is needed. Although several approaches have been developed for the estimation of NO_x emissions from fires, they still suffer from large uncertainties.

We present a simple statistical approach to estimate fire emission rates (FERs) of NO_x based on the linear relationship between satellite-observed tropospheric NO_2 vertical columns (TVC NO_2) and fire radiative power (FRP). While the great advantage of the method is the spatial coverage of FERs and the application to various biomes and regions, the uncertainties in the two retrieved parameters can lead to uncertainties in the FERs.

In general, the approach performs well for the tropical and subtropical regions where both the number and the spatial extent of vegetation fires are rather large throughout the fire season. However, due to the smaller number of fires and the patchy spatial occurrence, the estimation of FERs is more complicated in the boreal regions. Nevertheless, it is possible to derive FERs for some characteristic regions in the North American and Eurasian part of the boreal forest biome.

The estimated FERs of NO_x for the dominating types of vegetation burned are lowest for open shrublands, savannas, and boreal forest (0.28–1.03 g NO_x s^{-1} MW^{-1}) and highest for croplands and woody savannas (0.82–1.56 g NO_x s^{-1} MW^{-1}). Interestingly, there are large regional discrepancies of up to 40 % observed for evergreen broadleaf forest and boreal forest. Possible explanations for these regional discrepancies are discussed.