Natural Emissions in Africa : Improved Quantification using a Joint Inversion of TROPOMI NO_2 and HCHO Columns in the MAGRITTE CTM and Evaluation

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Abstract

The Earth system and its climate are largely regulated by land-biosphere-atmosphere interactions with tropical ecosystems being the most dynamic and yet most poorly understood. Africa plays a crucial role for atmospheric composition, primarily due to the large amounts of biogenic volatile organic compounds (BVOCs) released by vegetation. BVOCs are key drivers of tropospheric chemistry and climate, with impacts on ozone, fine particles and the methane lifetime. However, large uncertainties exist in the current estimates of both BVOC fluxes, mainly due to the large biological diversity, flaws in the monitoring of tree cover, and the paucity of direct observations. Another large source of uncertainty stems from natural NOx emissions over Africa, from soils and lightning. These two sources together account for 25% of the global total NOx emission, but their share over Africa is much higher (40%), based on current estimates. Due to the significance of the natural sources of NOx and VOCs and their large uncertainties, this study aims to an improved appraisal of these sources using inverse modelling of TROPOMI observations. Given the intricate interplay between NOx and VOCs, we design a novel inversion setup relying on a concomitant use of TROPOMI HCHO and NO_2 column data in order to simultaneously optimize VOC and NOx emissions. We provide top-down monthly estimates of natural NOx and BVOC emissions over Africa at a resolution of 0.5° using an inverse modelling framework built on the chemistry-transport model MAGRITTEv1.1 and its adjoint. The a priori and optimized fluxes are subsequently evaluated against an extensive compilation of in situ soil NO flux measurements from literature, in situ NO_2 observations from the INDAAF network, upper-tropospheric NO_2 mixing ratios based on cloud-sliced TROPOMI columns, and isoprene columns retrieved by the CrIS satellite sensor.

Early Career Scientist

NO, I am not an early career scientist.

IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations