Interannual variations in VOC flux estimates inferred from OMI formaldehyde columns through 2005-2013

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Introduction and methods

We use an inverse modeling scheme constrained by formaldehyde columns retrieved from the Ozone Monitoring Instrument (OMI) to improve the biogenic and pyrogenic NMVOC emission estimates for the period between 2005 and 2013. To this purpose, we employ the IMAGESv2 global chemistry-transport model and its adjoint module (Stavrakou et al. 2015). The MEGAN-MOHICAN-v2 updated model is used as bottom-up inventory for biogenic emissions (Stavrakou et al., 2014) and fire fluxes are taken from the GFEDv3 inventory (van der Werf et al., 2010). The inversions are realized per month and monthly emissions are derived per emission category and for every model grid.

The inversion results are compared to independent inventories, ground-based measurements and fire counts

Optimized emission fluxes averaged 2005-2013

Interannual variability

- Low interannual variability in biogenic emissions
- The variability is reduced in the tropics and increased in temperate regions
- Enhanced variability in MEGAN-MACC, low in GUESS, ES

Strongest decreases in isoprene emissions over tropical regions and over N. America
Flux increases in isoprene emissions during heat waves in Europe and Russia
MEGAN-MACC and GUESS-ES are about a factor 2 higher, pointing to the large uncertainty associated to this source category

Over regions where small fires (agricultural or deforestation) are dominant, the updated emissions present a better correlation with MODIS fire counts

Seasonal variations

- Over N. Africa emissions are strongly decreased at the fire season peak and slightly increased at the end of the fire season

Conclusions

- Global reduction of emissions by 12% (6) and 13% (4)
- Strongest decrease in Tropics, slight increase in Europe and Russia
- Interannual variability reduced in Tropics and increased over temperate regions
- Independent inventories exhibit often large deviations from top-down fluxes
- Strongest decrease in N. Africa and in S. America
- Interannual variability reduced in most regions
- Inferred changes are generally well in line with the independent inventories

References

Online datasets: http://www.aeronomie.be/en/Research/Modelling/Experiments/OMI伟正式deck/Global_Emission_data_portal (April 2016) based on OMI HCHO observations from the NASA Goddard Space Flight Center, primarily in the 170-190 nm wavelength range. The MOZART-4 model simulates and predicts the atmospheric chemistry of the Earth's troposphere and stratosphere, with a focus on the representation of tropospheric chemistry. The MOZART-4 model is a chemical transport model that uses a grid-based approach to simulate the transport and transformation of atmospheric species. The model is used to study the effects of human activities on the Earth's climate and to understand the interactions between the chemical and physical processes that govern the composition of the atmosphere.

Notes: This research was supported by the Belgian Science Policy Office through the ACROSAT project (2014-2017) and by the European Space Agency (ESA) through the GlobEmission project (2011-2013). Based on the comparison of the observed and modeled formaldehyde columns with independent inventories, the strongest decreases in biogenic emissions are observed in N. Africa and S. America, while the strongest increases are observed in Russia and Russia. The interannual variability in emissions is reduced in the Tropics and increased over temperate regions. The seasonal variations show that emissions are generally lower during the fire season and increase towards the end of the fire season.