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Model sensitivity to MACC anthropogenic and biogenic emissions: Global simulations and evaluation for reactive gases

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The EU projects MACC (Monitoring Atmospheric Composition and Climate, 2009-2011) and MACC-II (2011-2014) prepare for the operational Global Monitoring for Environment and Security (GMES) atmospheric core service which is envisaged to start in 2014. Besides global service lines for greenhouse gases and aerosols, emphasis is put also on global monitoring and forecasting of reactive gases. The MACC reanalysis and forecast simulations benefit from the multi-sensor approach for data assimilation of ozone, CO and NO_2 observations. Currently the Integrated Forecast System (IFS) of the European Centre for Medium-range Weather Forecasts (ECMWF) is coupled to the chemical transport model MOZART-3 to represent in detail the chemical conversion as well as major source and sink processes.

A global emission inventory for reactive gases has been developed as part of the MACC project. Based upon the ACCMIP emissions for the year 2000 these emissions are extrapolated for years after 2000 with the Representative Concentration Pathway RCP8.5 scenario and extended for VOCs and several other species. This inventory composes the MACCity anthropogenic emission inventory (Granier et al. 2011).
During the MACC project it became apparent that using the MACCity emissions in reanalysis simulations for recent years led to an underestimation of CO concentrations in the Northern Hemisphere when compared to independent observations. In order to give insight into the reasons for this behavior we conducted MOZART offline simulations for the year 2008 to test the sensitivity of the chemical transport model to the varying emissions. Therefore we ran MOZART with different sets of emissions: 1. MACCity emissions, 2. The GEMS/RETRO emission inventory, 3. MACCity emissions, but with increased traffic CO emissions. While using the emission inventory developed in the RETRO and GEMS projects gives quite reasonable tropospheric concentrations for the key species, the MACCity emissions are too low, particularly during NH winter. Increasing the MACCity CO traffic emissions by a factor of 2.5 results in a much better representation of surface and satellite observations for most parts of the world. This points to a significant underestimation of traffic CO emissions in the MACCity emission inventory, which is potentially amplified by an unrealistic emission reduction 2000-2010 in the RCP8.5 scenario.
Biogenic emissions used in MOZART for MACC come from the MEGANv3 emission database. We will also show the impact of using an alternative emission inventory for Europe (NATAIR) on reactive gases for the global scale.

References:
Granier, C. et al. (2011). Evolution of anthropogenic and biomass burning emissions of air pollutants at global and regional scales during the 1980–2010 period, Climatic Change, doi: 10.1007/s10584-011-0154-1