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Modeling sensitivity of biogenic VOC emissions to environmental factors

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Summary

Global inventory of biogenic VOC emissions MEGAN-MACC (REF) has been created using the model MEGANv2.1 (Guenther et al., 2012). Emissions of the main chemical species emitted by vegetation were estimated on monthly basis for the period of 1980 – 2010. The global BVOC emission total is dominated by isoprene (69% of global total). Further, we present three sensitivity isoprene emission inventories. Dataset SM accounts for impact of soil moisture deficiency on isoprene emission. In dataset titled SW a simplified calculation of PAR (Photosynthetically Active Radiation) input variable has been used assuming that PAR equals to 1/4 of incoming short-wave radiation. In dataset CRU, we replaced the MERRA meteorological fields (used for the reference as well as for SM and SW datasets) by the meteorological inputs from the CRU-NCEP reanalysis. These variations in driving environmental factors resulted in substantial changes of isoprene global total which decreased by 50% in SM, increased by 16% in SW and decreased by 27% in CRU sensitivity model runs when compared to the reference.

Isoprene emission dataset MEGAN-MACC

Isoprene with simplified calculation of PAR variable (SW)

Isoprene emissions (CRU-REF) / mg.m⁻².day⁻¹

Isoprene emissions (SW-REF) / mg.m⁻².day⁻¹

Isoprene based on CRU meteorology (CRU)

Comparison of the datasets

Isoprene emissions (SW-REF) / mg.m⁻².day⁻¹

Isoprene emissions (CRU-REF) / mg.m⁻².day⁻¹

More information


MEGAN model setup

• emission potentials in the form of high resolution gridded maps (Guenther et al., 2012)
• vegetation distribution described by 16 PFT categories consistent with Community Land Model v4 (Lawrence and Chase, 2007)
• Leaf Area Index 8-day values from global retrievals of MODIS (Yuan et al., 2011)
• meteorological driving fields

Comparison of annual mean PAR (W.m⁻²) from MERRA dataset (a), PAR calculated as: 1/4 of dawn-dusk short-wave radiation (b) and PAR derived from the global satellite data (c). Data provided by Pinker et al., University of Maryland. Shown is a comparison for the year 2005.

Isoprene with simplified calculation of PAR variable (SW)

Differences in annual zonal means of a) temperature and b) photosynthetically active radiation (PAR) between the CRU and MERRA datasets (2000-2009).

Acknowledgement

Presented work has been supported by the European project MACC-II (http://www.gmes-atmosphere.eu).

Isoprene with soil moisture effect factor (SM)

Isoprene emissions (SM-REF) / mg.m⁻².day⁻¹

Relative decrease of emission due to SM factor

EMission SM = Emission REF * γ_SM,iso

Calculation of soil moisture effect factor

γ_SM,iso = (θ - θw)/Δθ

PML_isoprene = 1

PMSL_isoprene = (θ - θw)/Δθ

PML_isoprene = 0

• Δθ volumetric water content [m³/m³]
• θw wilting point
• γ_SM empirical parameter

Guenther et al., 2008

Relative composition of global BVOC emissions

expressed as emission of isoprene

3% 2% 6% 1% 11% 2% 2% 13% 4% 3% 1% 62% 9% 11% 3% 1%

Differences in annual global totals of isoprene emissions between the reference and sensitivity model runs. Presented are the absolute differences, as well as the relative decrease of emissions to the reference. Isoprene is the main BVOC emitted from vegetation; however, its density, especially in tropical regions, is much more pronounced in the reference and SM datasets. Application of the the soil moisture activity factor leads to dramatic decrease of isoprene emissions in the tropics. The location of emitting regions in the CRU dataset is similar to the reference, however, the sources are less active, mainly in the south-tropical region.