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First space-based derivation of the global atmospheric methanol emission fluxes

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This work provides improved global methanol emission estimates, in particular for the largest methanol source, the terrestrial biosphere, and for biomass burning. To this purpose, one complete year of spaceborne measurements of tropospheric methanol columns retrieved for the first time by the thermal infrared sensor IASI aboard the MetOp satellite are compared with distributions calculated by the IMAGESv2 global chemistry-transport model. Two model simulations are performed using a priori biogenic methanol emissions either from the new MEGANv2.1 emission model, which is based on net ecosystem flux measurements, or from a previous parameterization based on net primary production by Jacob et al. (2005). A significantly better model performance in terms of both amplitude and seasonality is achieved through the use of MEGANv2.1 in most world regions, with respect to IASI data, and to surface- and air-based methanol measurements, even though important discrepancies over several regions are still present. As a second step of this study, we combine the MEGANv2.1 and the IASI column abundances over continents in an inverse modelling scheme based on the adjoint of the IMAGESv2 model to generate an improved global methanol emission source. The global optimized source totals 187 Tg/yr with a contribution of 100 Tg/yr from plants, only slightly lower than the a priori MEGANv2.1 value of 105 Tg/yr. Large decreases with respect to the MEGANv2.1 biogenic source are inferred over Amazonia and Indonesia, and more moderate reductions are recorded in the eastern US and central Africa. On the other side, the biogenic source is found to strongly increase in the arid and semi-arid regions of central Asia (up to a factor of 5) and western US (factor of 2), probably due to a source of methanol specific to these ecosystems which is unaccounted for in the MEGANv2.1 inventory. Detailed comparisons of the model with a number of aircraft and surface observations of methanol show that the satellite-derived methanol emissions improve significantly the agreement with the independent data, giving thus credence to the IASI dataset.