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Modelling methane using improved prior emissions and transport model

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Use of atmospheric chemistry-transport models (ACTMs) for interpreting sources and sinks of methane (CH_4) requires accurate representation of transport in the both troposphere and stratosphere, and quantification of hydroxyl (OH) radicals mainly in the troposphere and OH distribution between the two hemispheres (measured as the north-south (NH/SH) OH ratio).

We have developed a new generation ACTM based on the Model for Interdisciplinary Research On Climate Earth System Model (MIROC, version 4.0), which is an upgrade from the CCSR/NIES/FRCGC AGCM5.7b that used pressure-sigma vertical coordinate system. The MIROC-ACTM follows hybrid coordinate system in vertical (pressure-sigma in near the Earth's surface and gradually changing to pressure in the stratosphere). This implementation clearly improves the representation of age-of-air in the lower stratosphere region and above, and slight reduction in the convective transport in the tropical region, compared to the AGCM5.7b-ACTM.

The MIROC4-ACTM simulations produce better agreement with sulphur hexafluoride (SF_6) observations at the surface sites (NOAA/ESRL/HATS) and aircraft campaigns (HIPPO), compared to those using the ACGM5.7b-ACTM. The simulations of methyl chloroform (CH_3CCl_3) are used for validating global-mean OH abundance and a reconfirmation of the NH/SH OH ratio to be close 1.

We have also incorporated the CH_4 emissions the latest releases of (1) anthropogenic emission inventory by The Emissions Database for Global Atmospheric Research (EDGAR, version 4.3.2), (2) simulated fluxes of CH_4 from wetlands, rice paddies and soil oxidation by a process-based ecosystem model VISIT (Vegetation Integrative Simulator for Trace Gases).

These advancement in MIROC4-ACTM system produces key improvements in matching the a priori XCH_4 in comparison with the Greenhouse gases observing satellite (GOSAT) observations, e.g., meridional gradients in XCH_4 over the extra-tropical latitudes. This is mainly due to the improved representation of CH_4 vertical profiles in the stratosphere and mesosphere.

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