Sensitivity of the Isotopic Composition of Atmospheric Methane to Oxidant Fields in the GEOS Model

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The isotopic composition of methane provides valuable information on methane sources and their trends, but oxidation reactions also alter the isotopic composition, complicating the interpretation of the isotopic ratios. We use the Goddard Earth Observing System (GEOS) global atmospheric model to simulate the global distribution and temporal evolution of atmospheric methane and its isotopic composition. The simulation shows reasonable agreement with the spatial distribution observed at NOAA GMD surface sites, although the interhemispheric gradient of $\delta^{13}C$ is underestimated. This underestimate is also present in comparison with aircraft observations from the Atmospheric Tomography (ATom) mission. Since $^{13}CH_4$ and $^{12}CH_4$ have different loss rates with respect to OH and chlorine, we use the model to investigate the sensitivity of the isotopic composition to OH and chlorine. We find that using a chlorine field simulated by the GEOS-Chem model, which increases tropospheric chlorine concentrations relative to our base simulation, has little effect on total methane but has a large effect on the isotopic ratio. Inclusion of spatially-varying $\delta^{13}C$ values for wetland emissions also improves the comparison to GMD observations.

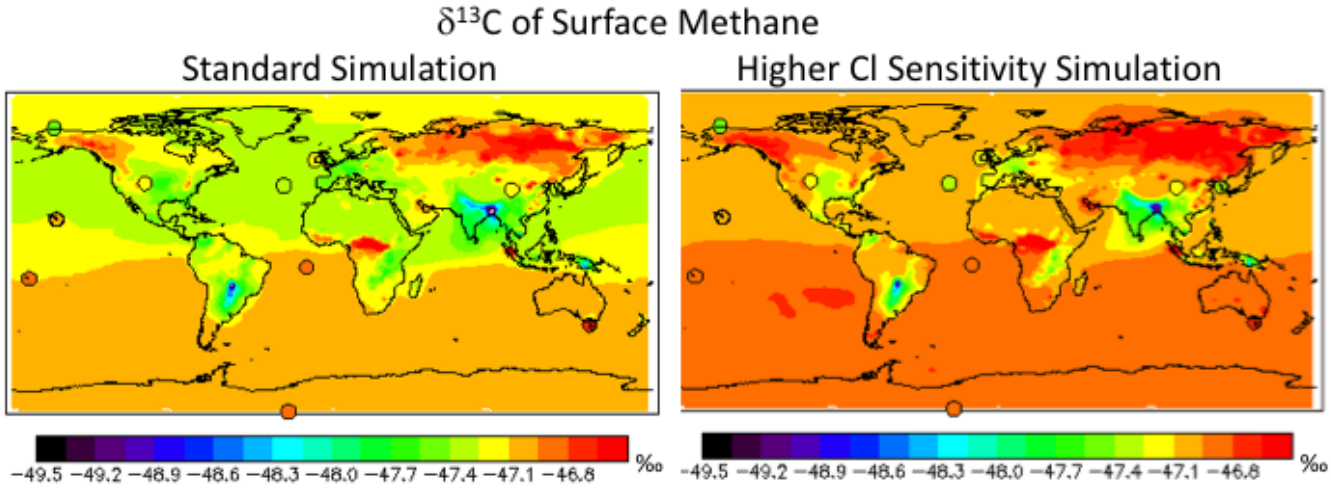

Figure 1. The January 2005 $\delta^{13}C$ of methane observed at GMD sites (circles) is overplotted on the surface $\delta^{13}C$ simulated by the GEOS model. The simulations used chlorine concentrations from the GMI (left) and GEOSChem (right) chemical mechanisms.