Global methane emissions derived from two years of TROPOMI observations: Sensitivity to OH and missing sources

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Abstract

The rate of increase in atmospheric methane (CH_4) has accelerated in recent years, reaching 15 ppb/yr in 2020, with causes that are not well understood. Given methane's potent global warming potential (85x that of CO_2 on a 20-year timescale), this indicates a crucial need to better understand its current budget. Near-global high-precision methane column observations from the TROPOMI satellite sensor offer a major advance for mapping methane fluxes. Here we combine two years of TROPOMI data with the GEOS-Chem adjoint model in a 4D-Var framework to optimize global methane emissions at high spatial resolution. The inversions converge on distinct sets of solutions depending on whether methane loss rates are also simultaneously optimized or not. Findings thus show that even with the dense TROPOMI coverage, methane budget inferences remain sensitive to the prior assumptions for OH. The ensemble of solutions adheres to a close linear relationship between the derived global source and sink terms, with each distinct result successfully improving the simulation of globally-available in-situ data. Solutions with methane loss rates treated as a hard constraint exhibit the best consistency with remote OH and CO measurements and with the background seasonal cycle in methane. We further employ multiple inversion formalisms to test the solution sensitivity to the assumed prior emissions. This presentation will explore the derived emission adjustments in terms of their implications for methane flux drivers and potential missing sources.

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