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Attribution of the accelerating increase in atmospheric methane during 2010–2018 by inverse analysis of GOSAT observations

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We conduct a global inverse analysis of 2010–2018 GOSAT satellite observations to better understand the factors controlling atmospheric methane and its accelerating increase over the 2010–2018 period. The inversion optimizes anthropogenic methane emissions and their 2010–2018 trends on a 4°×5° grid, monthly regional wetland emissions, and annual hemispheric concentrations of tropospheric OH (the main sink of methane). We use an analytical solution to the Bayesian optimization problem that provides closed-form estimates of error covariances and information content for the solution. We verify our inversion results with independent methane observations from the TCCON and NOAA networks. Our inversion successfully reproduces the interannual variability of the methane growth rate inferred from NOAA background sites. We find that prior estimates of fuel-related emissions reported by individual countries to the United Nations are too high for China (coal) and Russia (oil/gas), and too low for Venezuela (oil/gas) and the U.S. (oil/gas). We show large 2010–2018 increases in anthropogenic methane emissions over South Asia, tropical Africa, and Brazil, coincident with rapidly growing livestock populations in these regions. We do not find a significant trend in anthropogenic emissions over regions with large production or use of fossil methane, including the U.S., Russia, and Europe. Our results indicate that the peak methane growth rates in 2014–2015 are driven by low OH concentrations (2014) and high fire emissions (2015), while strong emissions from tropical (Amazon and tropical Africa) and boreal (Eurasia) wetlands combined with increasing anthropogenic emissions drive high growth rates in 2016–2018. Our best estimate is that OH did not contribute significantly to the 2010–2018 methane trend other than the 2014 spike, though error correlation with global anthropogenic emissions limits confidence in this result.