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Evaluating the Utility of Satellite Observations for Improving Bottom-Up National Emission Inventories: Application to Colombia

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Methane is a potent greenhouse gas, and detailed understanding of its contributions from different countries and source sectors is necessary for climate action. Livestock is the dominant anthropogenic methane source, but bottom-up estimates of its emissions have high uncertainties. Inversions of satellite observations of atmospheric methane can offer valuable top-down information, but the related uncertainties need to be carefully characterized. Colombia has a large proportion of methane from livestock, and past work over the region has identified discrepancies between bottom-up and top-down emissions estimates, particularly for the livestock sector. Here, we explore this discrepancy in detail by quantifying 2023 methane emissions in Colombia and the contributions from different sectors at up to ~12 km × 12 km resolution including error characterization using an analytical inversion ensemble of TROPOMI and GOSAT satellite observations of atmospheric methane. We also assess the potential of future Carbon-I satellite observations to further reduce uncertainties in emissions. We show that choices in the inversion setup, including the number of state vector elements and the prior emission inventories, have a significant impact on emission estimates. The high resolution of our inversion results allows us to relate our emission estimates to bottom-up processes. Results demonstrate the ability of satellite observations of methane to improve our process-based understanding of methane emissions in Colombia.