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A multi-tiered methane analytic framework for constraining budgets, point source attribution, and anomalous event detection

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Methane emissions monitoring is rapidly expanding with increasing coverage of surface, airborne, and satellite instruments. However, no single methane instrument or observing strategy can both close emission budgets and pinpoint point sources on regional to global scales. Instead, we present a multi-tiered data analytics system that synthesizes information across various instruments into a single analytic framework. We highlight an example in Los Angeles, where we combine surface measurements from the Los Angeles megacities project, mountaintop measurements from the CLARS-FTS instrument, airborne AVIRIS-NG point source emission estimates, and TROPOMI total column retrievals into a single analytic framework. Surface, mountaintop, and satellite measurements are assimilated into a methane flux inverse model to constrain basin-wide emissions and pinpoint sub-basin methane hotspots. We show an example of a large urban landfill, whose anomalous emissions were detected by the inverse system, and validated using AVIRIS-NG methane plume maps. This general approach of quantifying both methane area and point source emissions is an avenue not just for closing regional to global scale budgets, but also for understanding which emission sources dominate the budget (i.e., so called methane super-emitters). We finally show how this multi-tiered analytic framework can be improved with future satellite missions, and present examples of unexpectedly large methane emissions that were detected by a new generation of satellite imaging spectrometers.