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Poster
MethaneSAT XCH4 observations offer an unprecedented combination of scale (sweep scans over 200 km x 200 km targets), resolution (~110 m x 400 m), and precision (~2 – 4 ppb @ 1.5 km2). They provide a unique opportunity for the comprehensive characterization of regional methane emissions, including detection and quantification of large (> 200 kg/hr) point sources and mapping of aggregate and area sources. However, this opportunity brings with it challenges that stress the current state of the art in methane emissions quantification from remote sensing. This presentation is a focused discussion of these challenges and the approaches that the MethaneSAT team has taken to address them.

While established algorithms exist for the quantification of point sources and mapping aggregate and area sources, these algorithms must be combined carefully to maximize their utility and ensure accurate accounting of total regional emissions. Our approach is staged – we start with point source detection and quantification using the divergence integral method, then remove the enhancement due to point sources from the observations, then quantify aggregate and area sources using an inverse model with a Jacobian from the Stochastic Time-Inverted Lagrangian Transport (STILT) model.

Because of the large scale and high resolution of MethaneSAT XCH4 data, the concept of a background concentration must be expanded to a boundary inflow concentration. The boundary inflow concentration is a field of XCH4 concentrations across the domain, composed of the constant background, mesoscale variations, and plumes originating outside the domain. We estimate the boundary inflow concentration with an inverse model that isolates variations in XCH4 that can be explained by fluxes outside of the domain.

MethaneAIR, the airborne precursor to MethaneSAT, has flown over 70 research flights between 2019 and 2023. We have used MethaneAIR data to develop, test, and validate the emissions quantification algorithms that will be used for MethaneSAT. Point source estimation has been validated by comparison with a blind controlled release experiment, but aggregate and area source quantification validation is a challenge. We have implemented and compared independent modeling approaches and tested for agreement.

Addressing these challenges will enable the MethaneSAT team deliver an operational emissions quantification product that will provide actionable and timely data to a spectrum of stakeholders.
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