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Multiscale Natural Gas Emissions Observations of the San Juan, NM Coal Mine: Inversion Using Plume and Neural Network Models

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Methane (CH_4) is a potent greenhouse gas; therefore, accurate measurement of its sources is important for climate research. Because of the diversity of methane sources, identifying and apportioning different sources is essential. We demonstrate our ability characterize a specific source using top-down atmospheric observations downwind of a coal mine vent shaft, a large natural gas source, in San Juan, NM. To facilitate a field campaign in December of 2020, a mobile platform was developed to make simultaneous in situ observations of methane and ethane (C_2H_6) with an Aeris mid-IR spectrometer and wind velocities with a Trisonica mini 3-D anemometer. Total column methane was also measured during the campaign using an EM27/SUN mobile solar Fourier transform spectrometer (FTS) and compared with column methane and ethane measured in March of 2013 using higher resolution FTS instruments at a TCCON station near the site[1]. Our in situ data shows a unique and stable C_2H_6:CH_4 ratio of 1-2% in the vent plume that agrees well with the 1.5% ratio measured by the TCCON FTS instruments in 2013, demonstrating that consistent attribution can be made using both in situ and remote methods. Furthermore, we infer the mass flux of methane and ethane from the vent shaft using a simple plume dispersion model and multiple measurements around the vent shaft. This direct source inversion is compared to results from a trained neural network code we have developed for source location and quantification (ALFaLDS)[2]. Our results demonstrate how multiscale measurements, inverse modeling, and machine learning can be used to better attribute and constrain methane emissions.

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