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Solar Fourier Transform Spectrometry in mid-near infrared and visible-ultraviolet to monitor greenhouse gas and co-emitted pollutant emissions from Four Corners, NM power plants

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Agreements to limit greenhouse gas emissions require scientifically valid methods for monitoring and validating anthropogenic emissions. However, the task of monitoring CO_2emissions is difficult because relatively small increases need to be detected against CO_2's variable and large background concentrations. To ensure fair compliance, remotely sensed measurements and an understanding of the atmospheric transport of CO_2 from the sources are required. We hypothesize that CO_2 from various natural and anthropogenic sources can be distinguished and tracked by monitoring co-emitted gases (e.g. NO_2, SO_2, and CO) and isotopomers (e.g.$^{13}CO_2$). The ratio of a co-emitted species to CO_2 depends on fuel composition and combustion process and thus varies by energy sector. These ratios provide an independent method to quantify CO_2 emissions. Their low backgrounds, their large perturbations from energy activities, and our ability to measure them precisely make them sensitive probes to attribute sources, especially when emission ratios of multiple species are used concurrently. This strategy of observing emission ratios of co-emitted species to derive regional and source-specific baselines and CO_2 fluxes is being tested in the Four Corners region of northwestern New Mexico. The semi-arid ecology in the region has a weak natural carbon cycle, facilitating our goal of dissection of anthropogenic sector-specific sources. The net Four Corners and San Juan power plant emissions are the largest point source of CO_2 and NO_X in North America. The Four Corners plant produces much more NO_X than the San Juan power plant, while their energy and CO_2 outputs, and coal used, are similar. This difference offers us a unique opportunity to test discrimination methods. While their CO_2 signals remain elusive for current satellites, their NO_2plumes have recently been resolved from space. All of this makes the site an ideal test bed.

Los Alamos National Laboratory has deployed a solar tracking Fourier Transform Spectrometer in San Juan County, NM to monitor regional scale greenhouse gas and pollution from two power plants. Our system, deployed 12/2010, is part of the Total Column Carbon Observing Network (https://tccon-wiki.caltech.edu/Sites/Four_Corners). It has Aluminum optics, InSb, InGaAs and Si detectors and CaF_2 and quartz beam splitters allowing it to cover the mid-near ir and uv-vis regions. There are also in-situ instruments measuring CO_2 and CH_4 (Picarro Cavity Ringdown), CO, NO_X, SO_2, O_3 and aerosols in the boundary layer, as well as CIMEL monitoring aerosols in the column. We are executing a systematic and coordinated observational, satellite validation and modeling program. We will present analysis of new observations and develop signature relations between air pollutants and CO_2 for attributions. Satellite measurements are also analyzed over Four Corners and have revealed that recent environmental upgrades have reduced NO_X emissions, verifying bottom up inventories. A coordinated field campaign is planned, which will interrogate the power plant plume and regional dynamics and chemistry. Modeling using the plants' reported emissions will be compared with observations to test the veracity of our approach. Early modeling, satellite analyses and measurements will be presented.