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Mobile Optical Remote Sensing for quantification of Ammonia and Methane emissions from Dairy Farms in California.

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Solar occultation flux (SOF) and Mobile extractive FTIR (MeFTIR) are techniques used for over 20 years to quantify industrial emissions of VOCs, CH_4, and others, from refineries in the USA, Europe, and Asia. Here, they were combined to assess methane (CH_4) and ammonia (NH_3) from concentrated animal feeding operations (CAFOs) in the San Joaquin Valley (SJV), California. SOF and MeFTIR were used to measure NH_3 column, and ground concentrations of NH_3 and CH_4, respectively. SOF retrieves the gas column concentration from the solar spectra using a solar track, directing the light to a FTIR spectrometer, while crossing the gas plume. Subsequently, a direct flux approach combines the retrieved columns with wind information to obtain the mass fluxes of ammonia. In this survey, the wind information was acquired by a wind LIDAR, which measures wind speed and direction in the interval of 10 – 300 m. On the other hand, Methane emissions were quantified using a unique indirect flux approach by combining the estimated ammonia fluxes and the NH_3:CH_4 ratios measured from the ground concentration using MeFTIR.

Two field campaigns performed in spring and autumn studied emissions from 14 single dairy CAFOs. The daily emissions from the single farms averaged 96.4 ± 38.4 $kg_{NH3}\,h^{-1}$and 411 ± 185.4 $kg_{CH4}h^{-1}$, respectively, for NH_3 and CH_4 with the corresponding emission factors (EF) per animal unit of 11.3 ± 3.8 $g_{NH3}h^{-1}AU^{-1}$and 50.3 ± 24.1 $g_{CH4}h^{-1}AU^{-1}$. The uncertainty of ammonia measurements was 17 % in a standard confidence interval (CI) and 37 % in a 95 % CI, with the largest uncertainty associated with the wind measurements. Furthermore, the methane uncertainty estimations averaged 27 % in a standard CI, and 52 % in a 95 % CI, dominated by the ammonia fluxes uncertainty. Comparison between Annual or daily EFs obtained by SOF to other quantification approaches, have to take into consideration the SOF measurement conditions, day-time and sunny weather, due to their effects on the NH_3 emissions. The study contributed to develop the knowledge of dairy CAFOs emission, and to strengthen the role of optical remote sensing techniques, bridging the gap between satellites and stationary measurement approaches.