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Predicting Ammonia Plume Presence at Feedlots in the San Joaquin Valley from VSWIR Spectroscopy of the Land Surface

Industrial-scale livestock farms, or Concentrated Animal Feeding Operations (CAFOs), are a major source of air pollutants including ammonia, methane, and hydrogen sulfide. Ammonia in particular is a major contributor to rural air pollution that is released from the breakdown of livestock effluent. Mitigating regional air pollution through improved waste management practices is only possible if emissions can be accurately monitored. However, ammonia is challenging to measure directly due to its short atmospheric lifetime and lack of VSWIR spectral signature.

Here we investigate the potential for spectroscopic imaging of the CAFO land surface to predict the presence of detectable ammonia emissions. Data from the Hyperspectral Thermal Emission Spectrometer (HyTES) instrument were found to clearly identify plumes of ammonia emitted by specific feedlots. Plume presence or absence was then tied to pixel-level reflectance spectra from the Earth Surface Mineral Dust Source (EMIT) instrument. Random forest classification models were found to predict ammonia plume presence/absence from VSWIR reflectance alone with an accuracy in the range of 70% to 80%. Our conclusions are limited by the limited number of feedlots overflown by HyTES (n=96), the time gap between HyTES and EMIT data, and potential difficulty in comparing feedlots in different regions.

While only tested over a modest area, our results suggest that ammonia plume presence/absence may be predictable on the basis of surface features identifiable from VSWIR reflectance alone. Further investigation could focus on more comprehensive model validation, including characterization of the land surface processes and spectral signatures associated with feedlot surfaces with and without observable ammonia plumes. If generalizable, these results suggest that EMIT data may in some circumstances be used to predict the presence of ammonia emission plumes at feedlots in other areas, potentially enabling broader accounting of feedlot ammonia emissions.