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Methane leak or false positive? An automated probabilistic treatment of detected emissions from oil and gas facilities in multi-spectral satellite imagery at continental scale.

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Satellite observations are an important tool in large emission event detection and global monitoring of methane emissions from oil and gas facilities, but current satellite-based methods face significant uncertainty. One of the major sources of uncertainty is a high rate of false positives. Current methods to mitigate false positive rates typically involve manual inspection of plume imagery, a time-consuming process which introduces human error. The Sentinel-2 multispectral satellite is widely used in global methane observation, as methane enhancements can be identified by a signal in shortwave infrared bands 11 and 12. However, physical, biological and other anthropogenic processes can have a similar spectral signature, leading to a high rate of false positives. We present an empirical False Discovery Rate approach for quantifying the false positive probability for a given candidate plume. Imagery data is divided into a near-to-well set (within 200m of oil and gas infrastructure) and a far-from-well control set (between 400m-1200m away from oil and gas infrastructure), which is conservatively assumed to consist entirely of false positives. With these datasets, we define the probability of a false positive given proximity to oil and gas infrastructure as a function of plume quality and distance to infrastructure. The results from this approach are shown for a case study over the contiguous United States, where we found a strong relationship between the selected plume quality metrics, distance to infrastructure and the false positive probability. We also identified significant differences in plume characteristics between the near-to-well and far-from-well datasets. This work presents a more efficient and data-driven false positive algorithm, which can significantly reduce the manual step in false positive identification, resulting in larger scale deployment and data processing of satellite-based methane emission monitoring.