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Validation of a methane remote sensing approach with in situ observations of emissions from natural marine hydrocarbon seeps

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The sources and sinks of methane, an important greenhouse gas, are poorly constrained. Remote sensing techniques can significantly improve our understanding of sources and sinks. Field and labortory studies used spectral and in-situ chemical measurements of methane emissions from natural marine seepage and radiative transfer calculations to test the feasibility of remote sensing from the AVIRIS platform on this marine source. Numerical MODTRAN simulations showed that although most of the spectral region between 2200 and 2340 nm is sensitive to CH_4 it is only mildly sensitive to interference from H_2O vapor. Repeated transects of an intense marine seep area were conducted and flame ion detector (FID) measurements made of the methane plume. Based on a Gaussian plume model of observations, methane column abundances were calculated and showed values of 0.5 g/m^2 to a downwind distance of 70 m. MODTRAN calculations showed that this was well above the noise equivalent detection level of AVIRIS. During a separate field study, three FIDs at 2.2, 3.6, and 5 m above the sea surface recorded methane concentrations as high as 200 ppm while transecting an active seep area. Contemporaneously, spectra were obtained with a field spectrometer. Several plumes were identified from the FID data. A clear relationship was shown between the presence of methane plumes along the incident pathlength and the presence of methane absorption features in spectra, while methane absorption features above atmospheric background were not observed outside the plumes.