FUGITIVE EMISSION FROM FOSSIL FUEL PRODUCTION WITH IMAGING SPECTROSCOPY MEASUREMENTS

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HyspIRI workshop Pasadena, CA, 24-26 Aug 2010
THANKS TO THE ENABLING SUPPORT

1 University of California, Santa Barbara
2 Jet Propulsion Laboratory
3 NASA HQ
4 US Geologic Survey
5 University of Utah
6 NOAA
8 University of California, Davis

And critical enabling support from
Methane – Stable until 1700s

Dlugokencky et al. A Long-term Perspective on Recent Increases in Atmospheric CH4 Abundance, Global Monitoring annual Conference, 18-19 May 2020, Boulder CO.
Methane is a greenhouse gas with 72 times the Global Warming Potential of carbon dioxide on a 20-year time horizon. (IPCC4, Ch2, Fig.2.22, 2007)
Methane is a greenhouse gas with **26 times the Global Warming Potential of carbon dioxide** on a 100-year time horizon. (IPCC4, Ch2, Fig.2.21, 2007)
Methane – Human Sources

http://www.asiapacificpartnership.org/pdf/CFE/meeting_seoul/workshop_presentations/09_M2M-APP_CFETF.pdf
Figure 1 a) Showing absorption coefficients for methane (blue) and carbon dioxide (red) calculated from HITRAN 2004 (Rothman et al., 2005)

Figure 1 b) Transmission spectra of methane and carbon dioxide calculated using MODTRAN 4.3 (Berk et al., 1999) for one airmass and concentrations of 1.8 and 380 ppm for methane and carbon dioxide, respectively
AVIRIS Modtran Simulations

For darker surfaces, path radiance becomes more important

Residual Analysis

Detection Limit ~11.8 ppm, 1-km layer
Detection Limit ~very low

Dark surfaces have high detection limits.
Methane

- Total: $580 \pm 50$ Tg yr$^{-1}$
- Ancient: 104 Tg yr$^{-1}$
- Fossil Fuel Industry: 50 Tg yr$^{-1}$
- Seepage: 50 – 85 Tg yr$^{-1}$
- Marine Seepage: 20-30 Tg yr$^{-1}$
Total Hydrocarbon Plume from Trilogy Seep
MODTRAN calculated residuals show AVIRIS can observe methane for typical Coal Oil Point seep field emissions and sea surface albedos.
AVIRIS methane residual approach (Roberts et al. 2010)

- Imagery complications (clouds, surface patterns, etc.)
- Assumes fixed path length
Equinox (June 19), solar noon, ER2

AVIRIS radiance at 2288 nm (CH$_4$ absorption band)

~300 km$^2$ coverage
BAND RATIO ANALYSIS OF METHANE PLUMES

AVIRIS radiance at 2288 nm (CH$_4$ absorption band)

~300 km$^2$ coverage

Band ratio plume

Platform Habitat; 4/7/2010

Thermal

High Contrast Thermal

Methane

Cold water outflow from platform
Gulf offshore oil facilities and pipelines
F070812r3 (3.4m pixels): flare at Platform Holly (x419, y7065 unrotated)
F070812r11_sc01 (4.3m pixels): flare at Platform Holly (x491,y7875 unrotated)

Platform Holly

RGB (SWIR-G-B)
US Fossil Fuel Production

Red - Gas, Green - oil, Yellow - both
Strong Methane Anomalies co-located with production

Prevailing Gulf winds from east

Preliminary
Marine hydrocarbon seep fields provide an ideal natural laboratory to understand, investigate, and validate petroleum related processes.