

High resolution mapping of methane emissions using the next generation Airborne Visible/Infrared Imaging Spectrometer (AVIRIS-NG)

Thorpe, A. K.¹, Thompson, D. R.¹, Frankenberg, C.², Aubrey, A. D.¹, Bue, B. D.¹, Green, R. O.¹, Boardman, J. W.³, Eastwood, M. L.¹, Helmlinger, M. C.¹, Nolte, S.H.¹, Mccubin, I. B.¹, Roberts, D. A.⁴, and AVIRIS-NG team¹

¹Jet Propulsion Laboratory, California Institute of Technology
²California Institute of Technology
³Analytical Imaging and Geophysics LLC
⁴University of California, Santa Barbara





- AVIRIS-NG (Next generation Airborne Visible/Infrared Imaging Spectrometer)
 - Pushbroom sensor
 - 36° field of view
 - 380 to 2,510 nm
 - 5 nm spectral resolution
 - 427 spectral channels



Green et al., 1998



High resolution absorptions





- High resolution absorptions
- AVIRIS and AVIRIS-NG require convolving to instrument lineshape function





Two related techniques

Retrieval techniques for airborne imaging of methane concentrations using high spatial and moderate spectral resolution: application to AVIRIS

A. K. Thorpe^{1,2}, C. Frankenberg², and D. A. Roberts¹

¹Department of Geography, University of California, Santa Barbara, Santa Barbara, California, USA ²Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA

Real-time remote detection and measurement for airborne imaging spectroscopy: a case study with methane

D. R. Thompson¹, I. Leifer², H. Bovensmann³, M. Eastwood¹, M. Fladeland⁴, C. Frankenberg¹, K. Gerilowski³, R. O. Green¹, S. Kratwurst³, T. Krings³, B. Luna⁴, and A. K. Thorpe¹ ¹Jet Propulsion Laboratory, California Institute of Technology, CA, USA ²Bubbleology Research International, Solvang, CA, USA ³Institute of Environmental Physics, University of Bremen, Bremen, Germany ⁴NASA Ames Research Center, Moffett Field, CA, USA Atmospheric Measurement Techniques



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Rocky Mountain Oilfield Testing Center (RMOTC) near Casper, WY





Rocky Mountain Oilfield Testing Center (RMOTC) near Casper, WY







At each release point (X-N, X-C, X-S):





- Variable CH₄ flux rates
 - 100-5,000 scfh

Standard cubic feet CH₄ per hour (scfh)	Cubic meters CH₄ per hour	Kilaton CH₄ per year
5,000	141.58	0.89
2,500	70.79	0.44
2,000	56.63	0.36
1,000	28.32	0.18
500	14.16	0.09
100	2.83	0.02

- AVIRIS-NG flights
 - Flyovers at different altitudes

Above ground level (AGL, km)	Spatial resolutio n (m)
3.80	3.6
2.00	1.9
1.10	1.0
0.58	0.5
0.43	0.4



55 flights (over 7 experiment days, 20-26 June 2013)





Methane plume examples: Similar altitude, different fluxes

2,000 scfh (56.6 m³/h), 0.58 km AGL





Methane plume examples: Similar altitude, different fluxes

2,000 scfh (56.6 m³/h), 0.58 km AGL





500 scfh (14.2 m³/h), 0.43 km AGL



(Thorpe et al., submitted)



Methane plume examples: Variable altitude, same flux (2,000 scfh, 56.6 m³/h)

0.58 km AGL







Methane plume examples: Variable altitude, same flux (2,000 scfh, 56.6 m³/h)

0.58 km AGL



1.00 km AGL







Methane plume examples: Variable altitude, same flux (2,000 scfh, 56.6 m³/h)



(Thorpe et al., submitted)



Real time methane mapping

• Effort lead by David Thompson, support by Brian Bue and Joe Boardman

Next Generation Data Capture System (NGDCS)





Real time methane mapping

• Effort lead by David Thompson, support by Brian Bue and Joe Boardman

Next Generation Data Capture System (NGDCS)



Real time CH₄ plume mapping



(Thompson et al., 2015)



Recent campaigns

 Garfield County, CO (natural gas extraction using hydraulic fracturing)



- Bakersfield, CA (enhanced recovery of oil using steam injection)
 - P.I. Ira Leifer



- Four Corners, CO NM (coal bed CH₄)
 - P.I. Christian Frankenberg





Methane from produced water tank (natural gas extraction using hydraulic fracturing)



(Aubrey et al., 2015)



Methane from "Frac tanks" for produced water tank



(Aubrey et al., 2015)



- Quantitative CH₄ retrievals algorithms developed for AVIRIS-NG
- Controlled release experiment allowed testing AVIRIS-NG CH₄ sensitivity
 - Plumes observed for flights between 0.43 and 3.80 km above ground level
 - AVIRIS-NG detected CH₄ plumes for fluxes as low as 3.4 m³/h
- AVIRIS-NG capable of detecting fugitive CH₄ emission sources in existing oil and gas fields



- JPL:
 - Sarah Lundeen and AVIRIS-NG team
 - Simon Hook and Bill Johnson (thermal camera)
- Chevron:
 - Andrea Steffke, et al. (controlled release experiment)
- NASA:
 - Jack Kaye (Four Corners campaign)