Directly attributing methane and carbon dioxide emissions using the next generation Airborne Visible/Infrared Imaging Spectrometer (AVIRIS-NG)

Thorpe, A. K.[1], Frankenberg, C.[1,2], Thompson, D. R.[1], Duren, R.M.[1], Bue, B. D.[1], Green, R. O.[1], Roberts, D.A.[3], Dennison, P.E.[4], Ayasse, A.[3]

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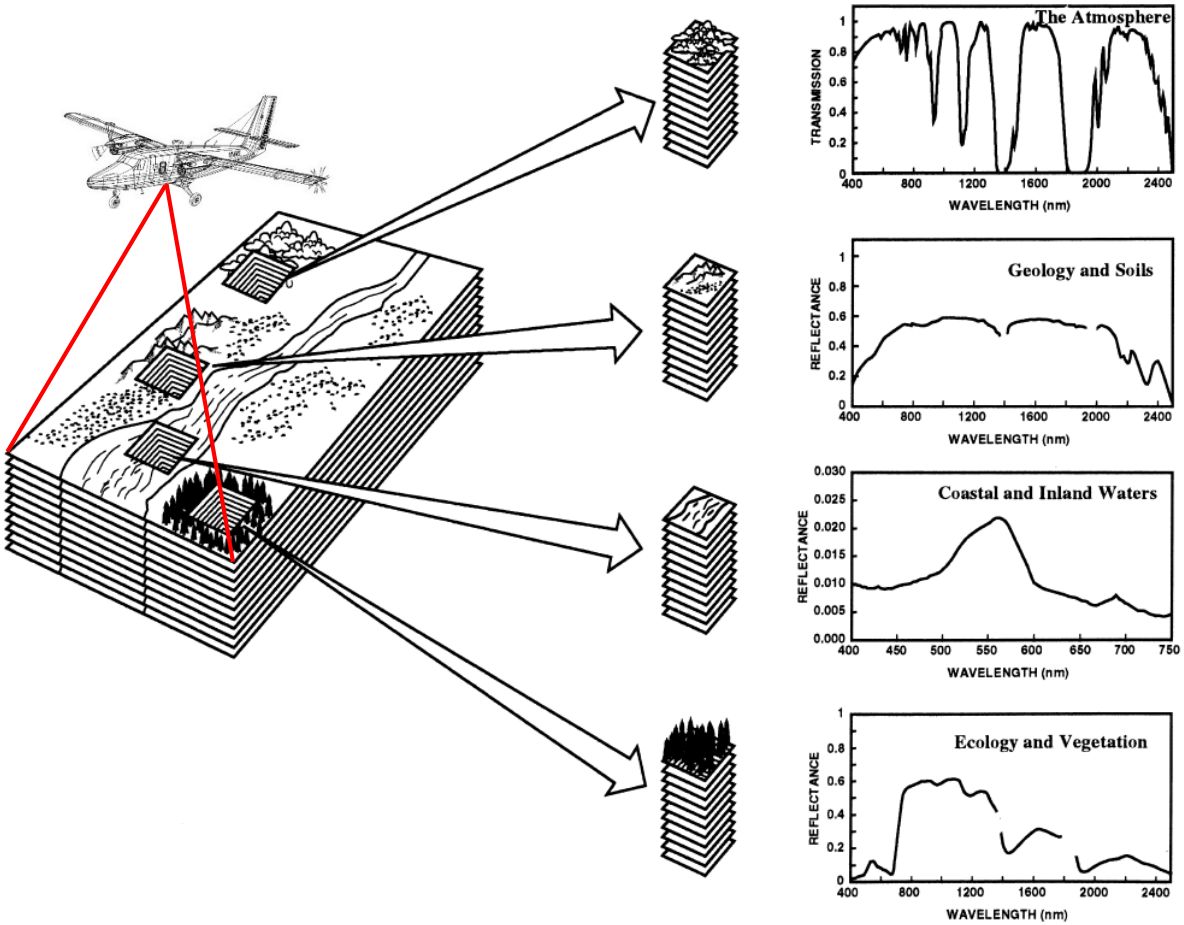
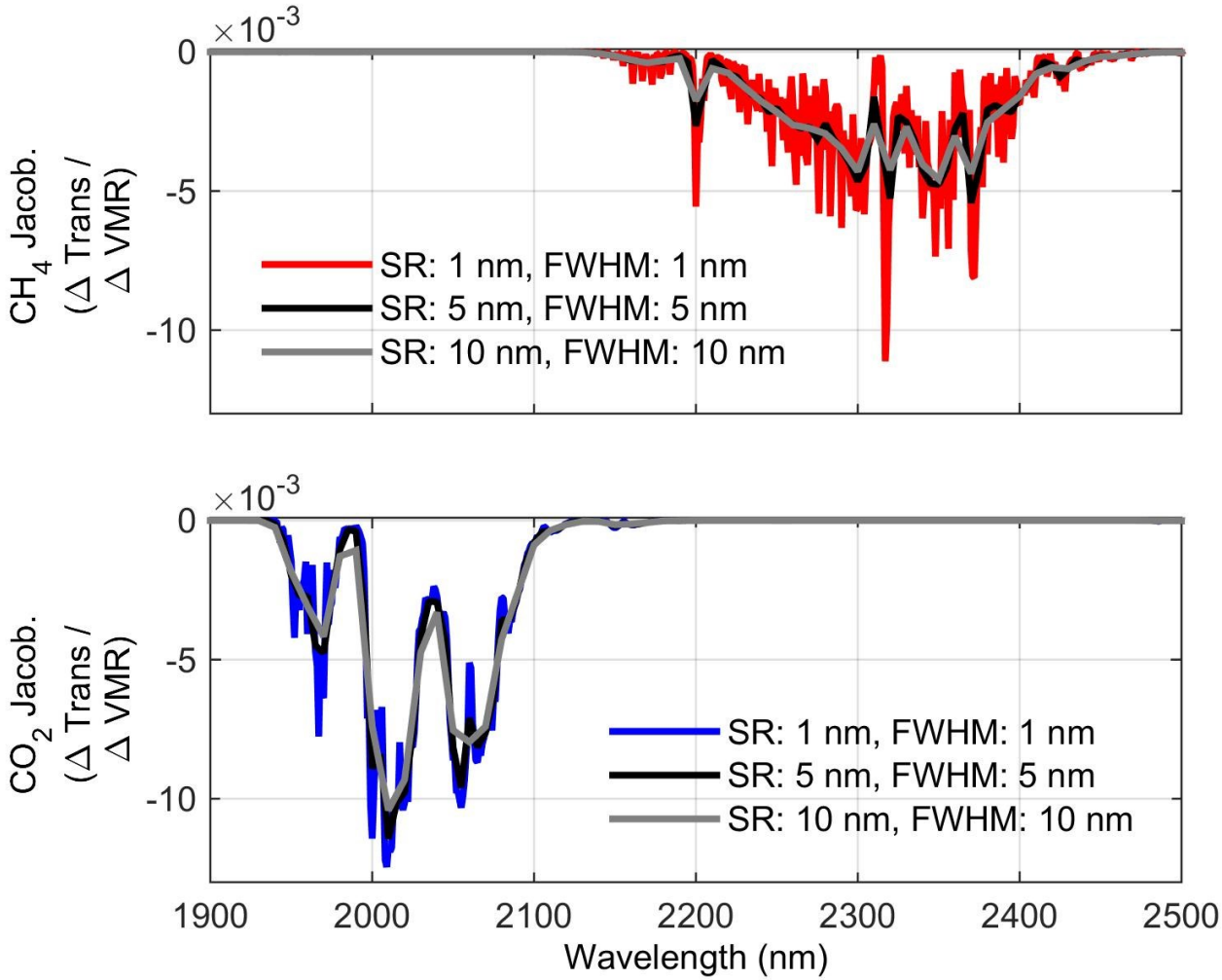
- AVIRIS-NG (Next generation Airborne Visible/Infrared Imaging Spectrometer)
  - Pushbroom sensor
  - 36° field of view
  - 380 to 2,510 nm
  - 5 nm spectral resolution
  - 427 spectral channels



CH_4 and CO_2 absorption features

- CH_4 and CO_2 absorption features



CH_4 and CO_2 mapping with AVIRIS-NG

- Two related techniques

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

Atmospheric Measurement Techniques Open Access

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

Atmospheric Measurement Techniques Open Access

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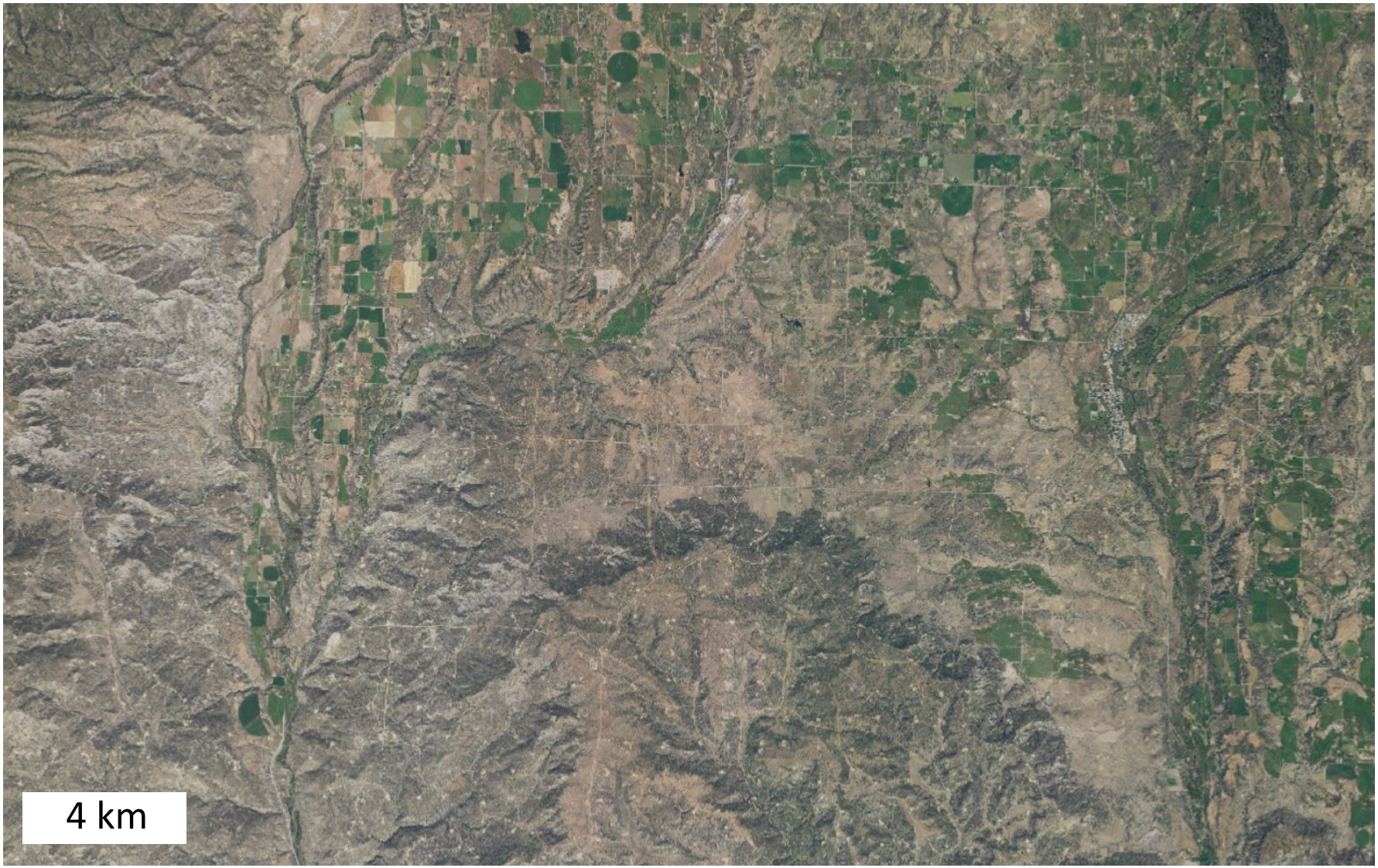
Study sites

- Four Corners, CO NM
  - Coal bed CH_4
  - P.I. Christian Frankenberg
  - (Frankenberg et al., 2016)

- Bakersfield and LA Basin, CA
  - Oil & Gas, Landfills
  - P.I. Ira Leifer
  - (Thompson et al., 2015)

- Aliso Canyon, CA
  - Natural gas leak
  - P.I. Riley Duren
  - (Thompson et al., 2016)

Motivation



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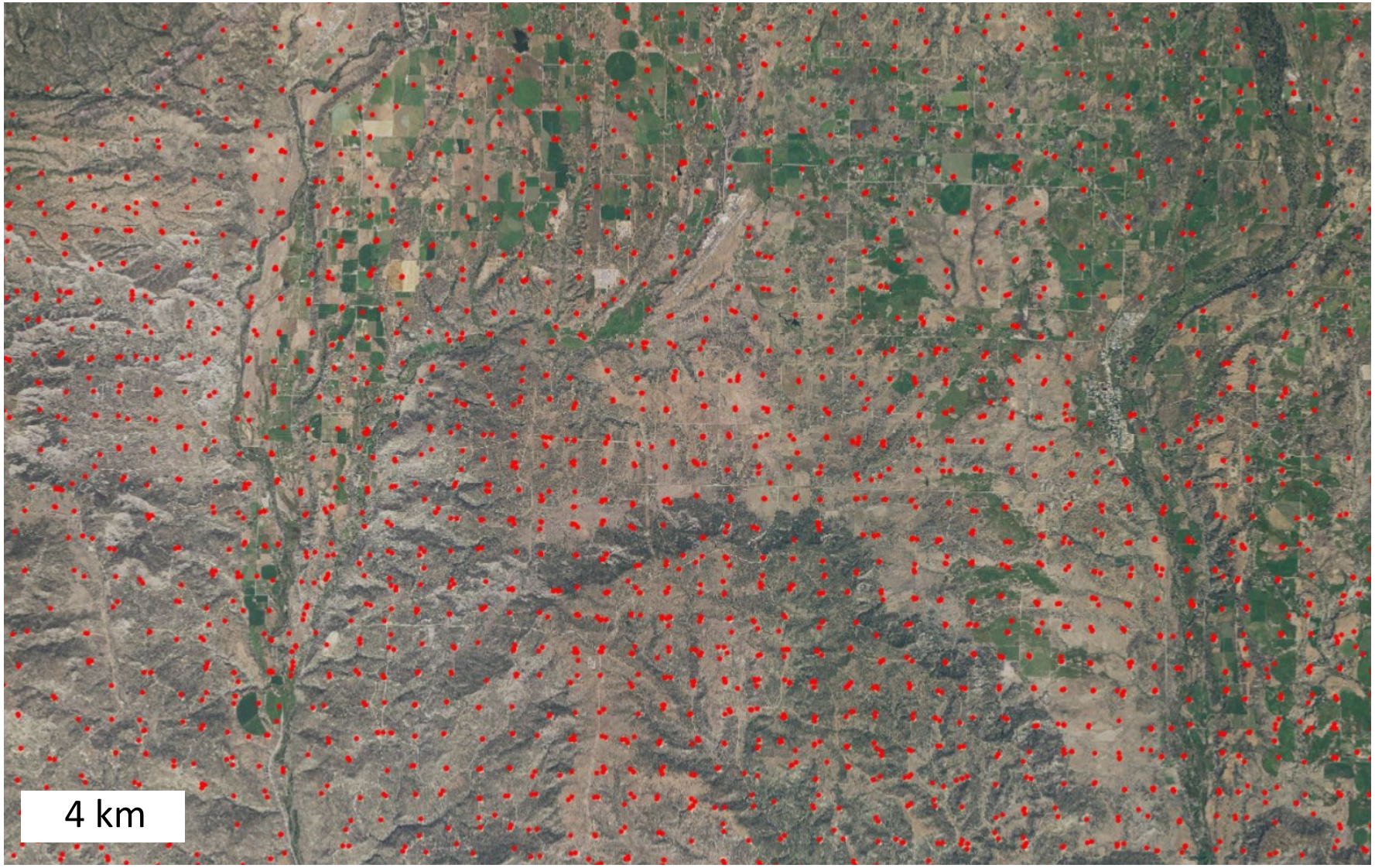

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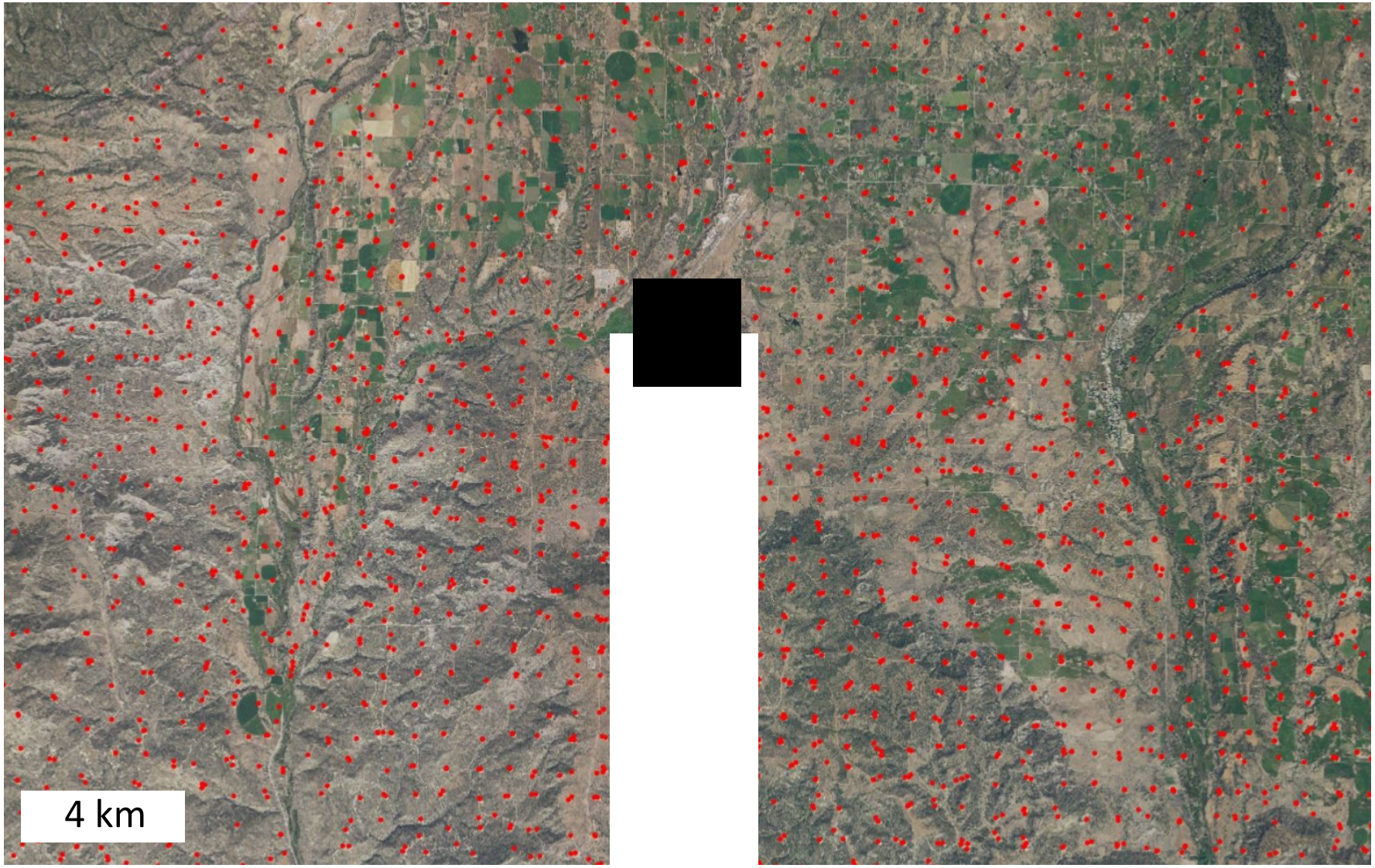
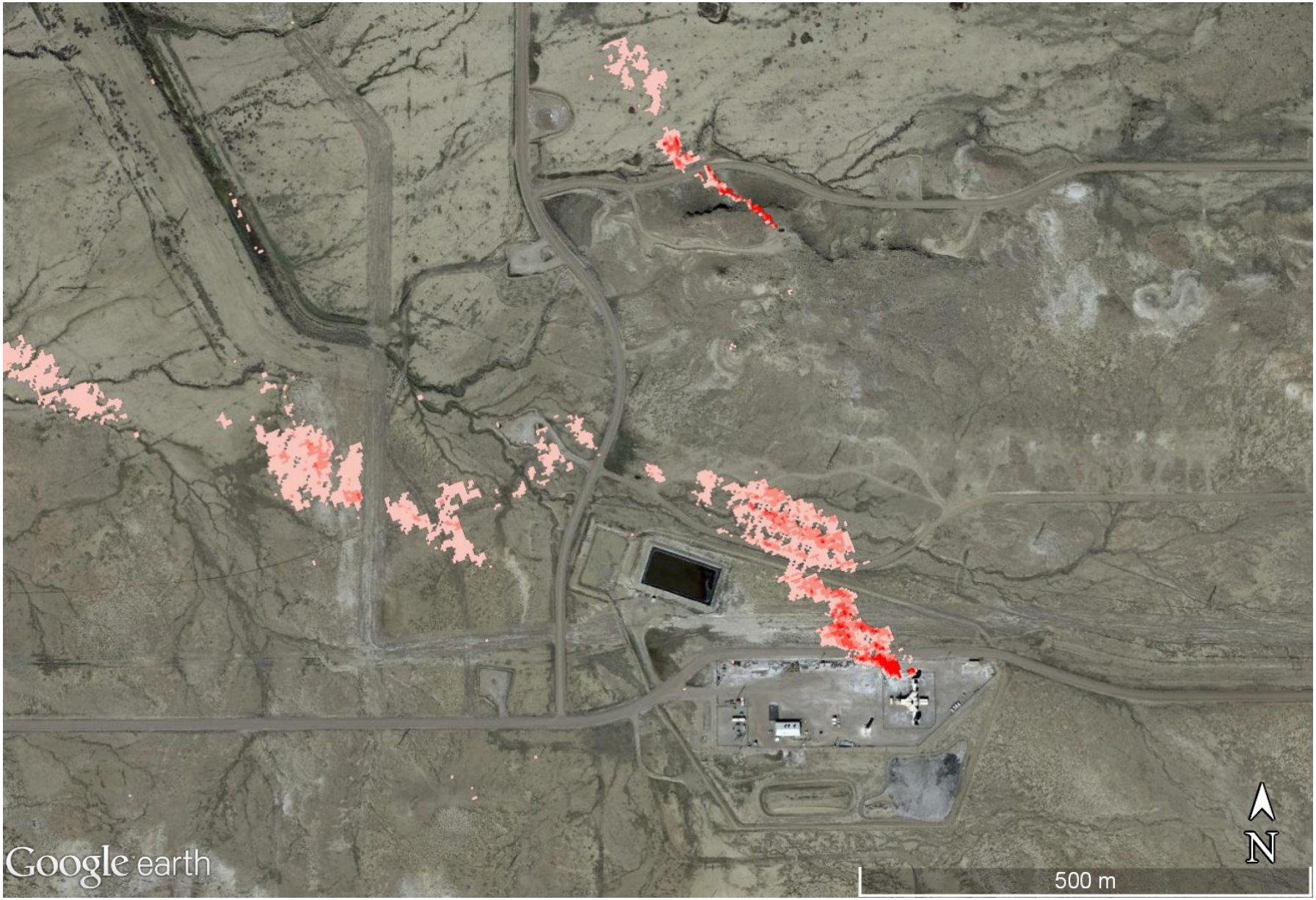


Four Corners

Four Corners

Four Corners



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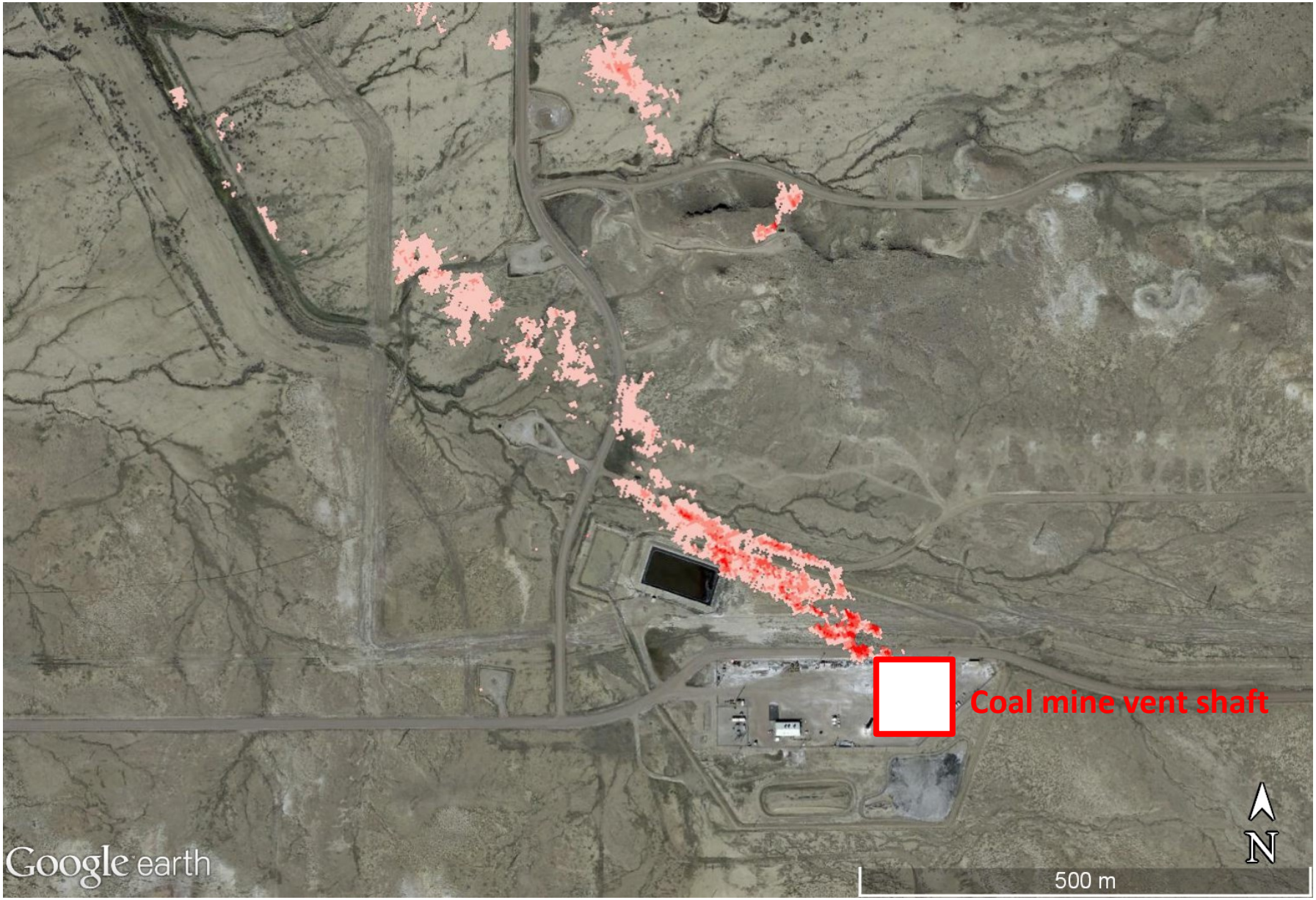

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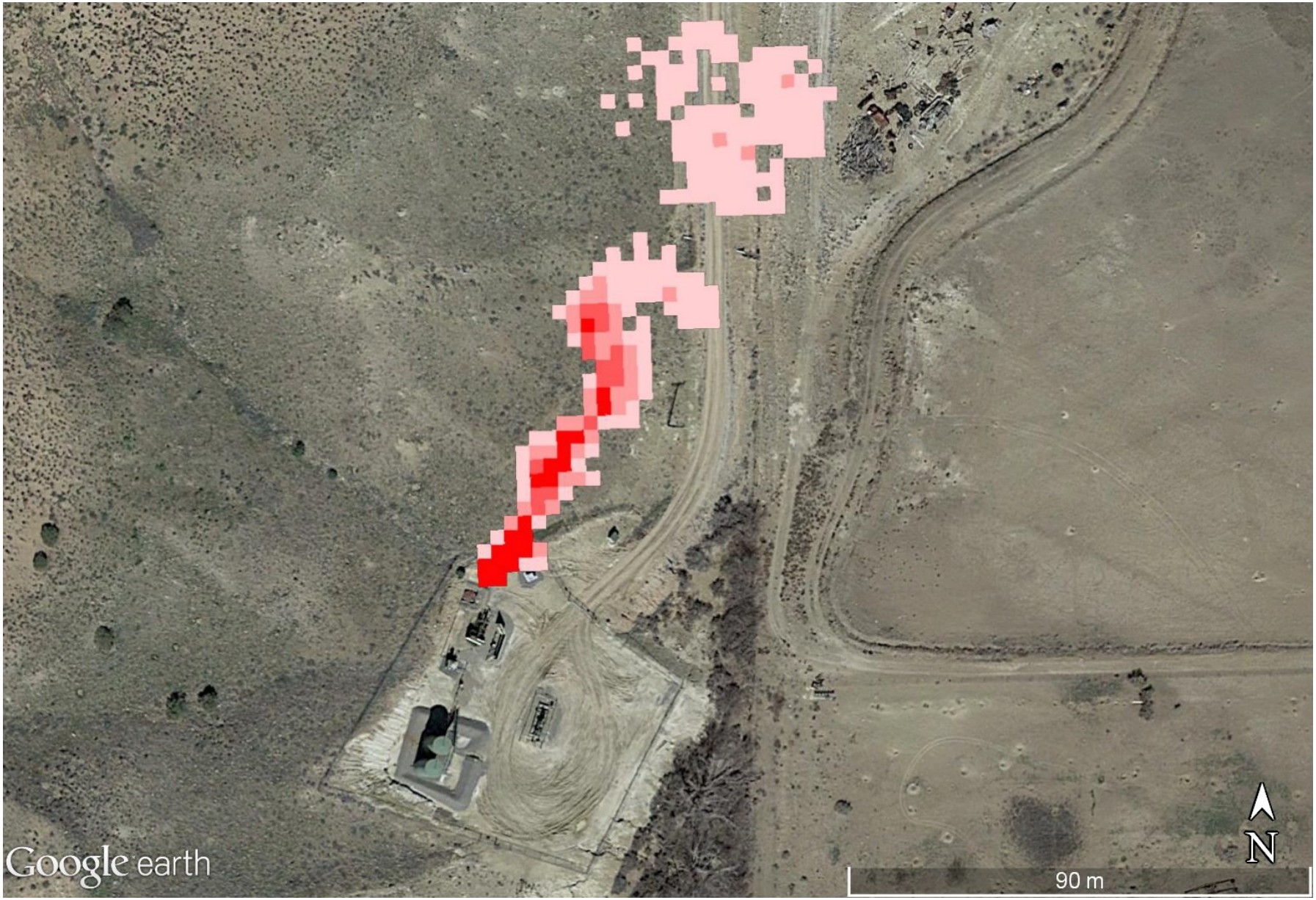

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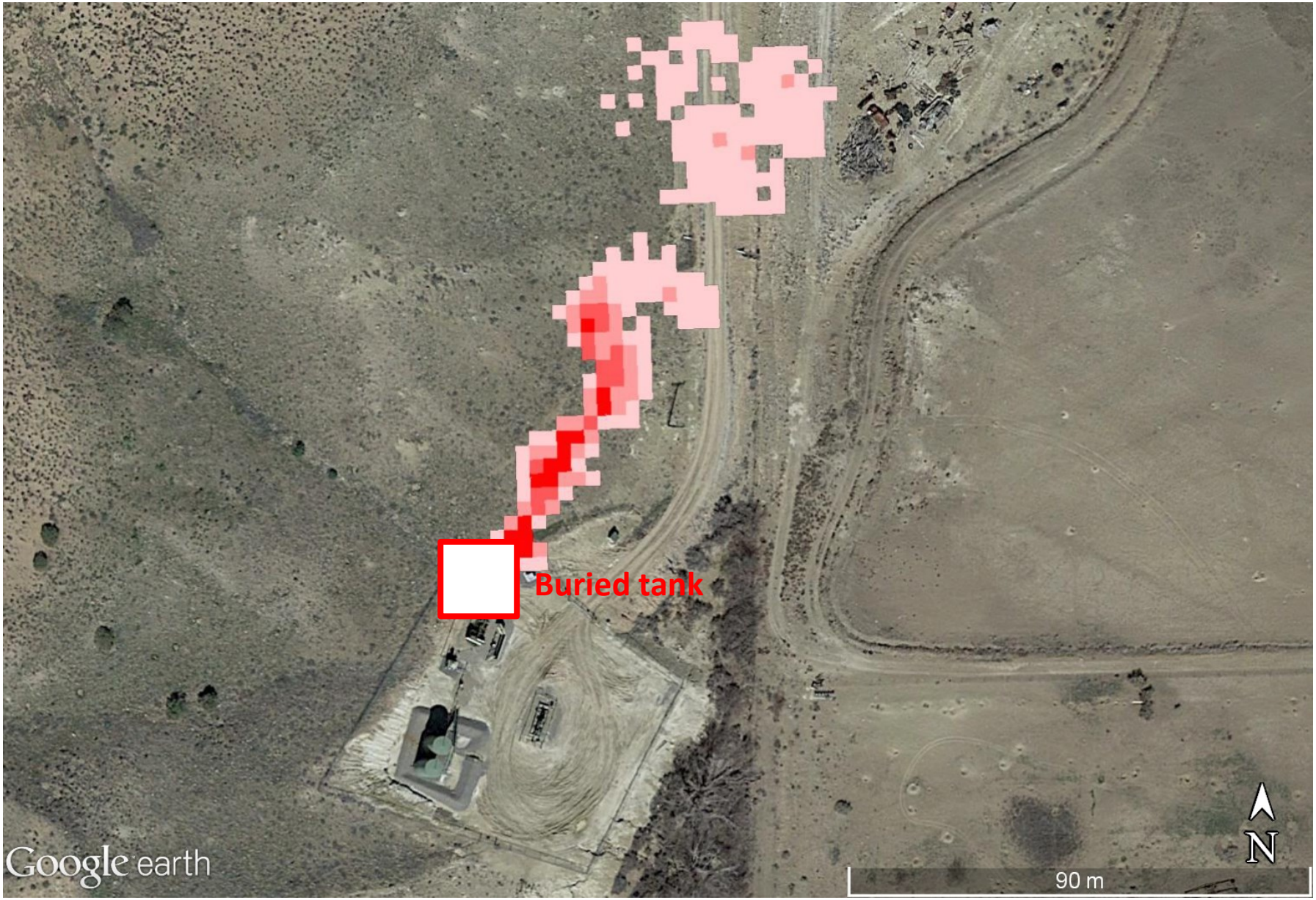

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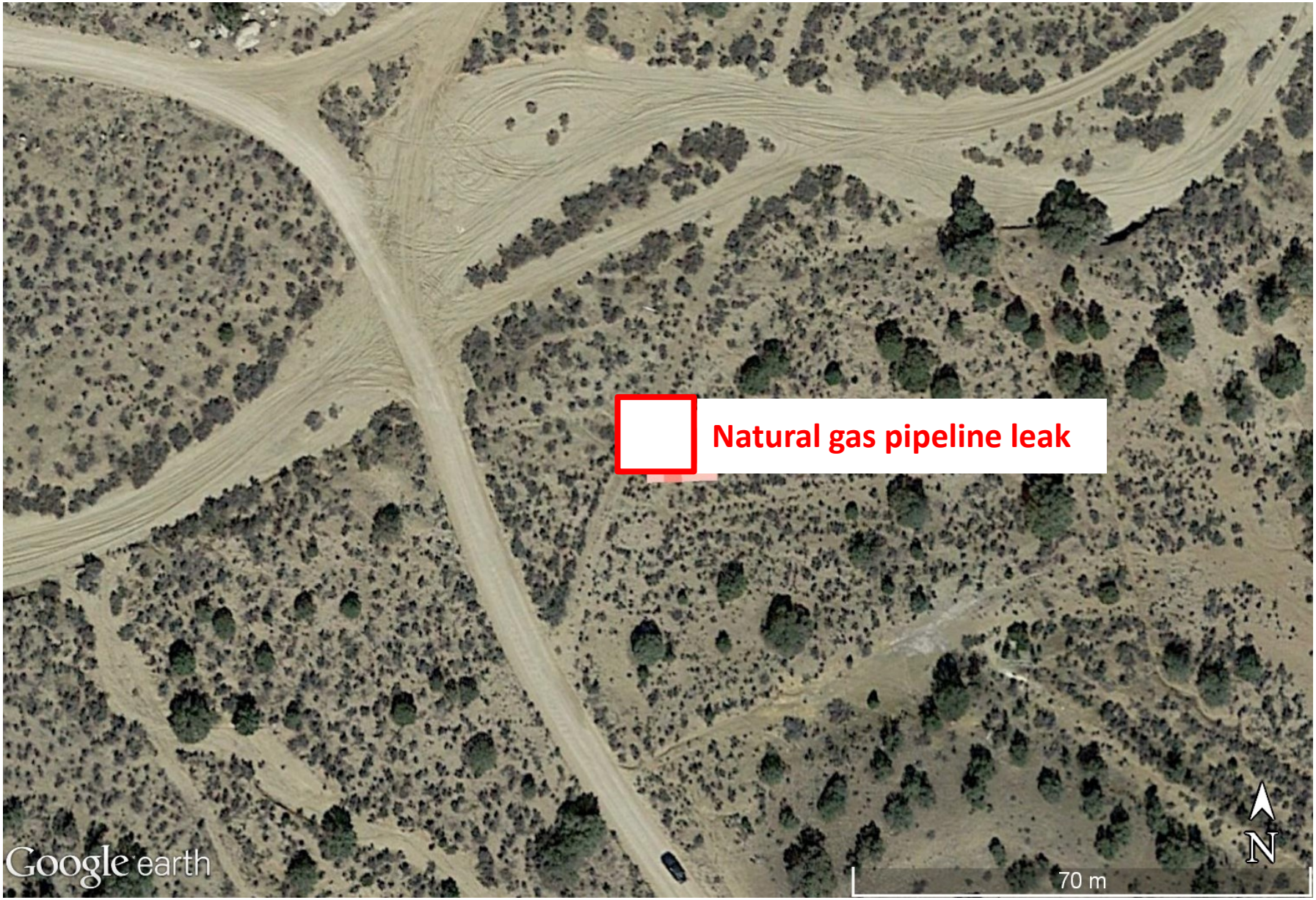

Four Corners

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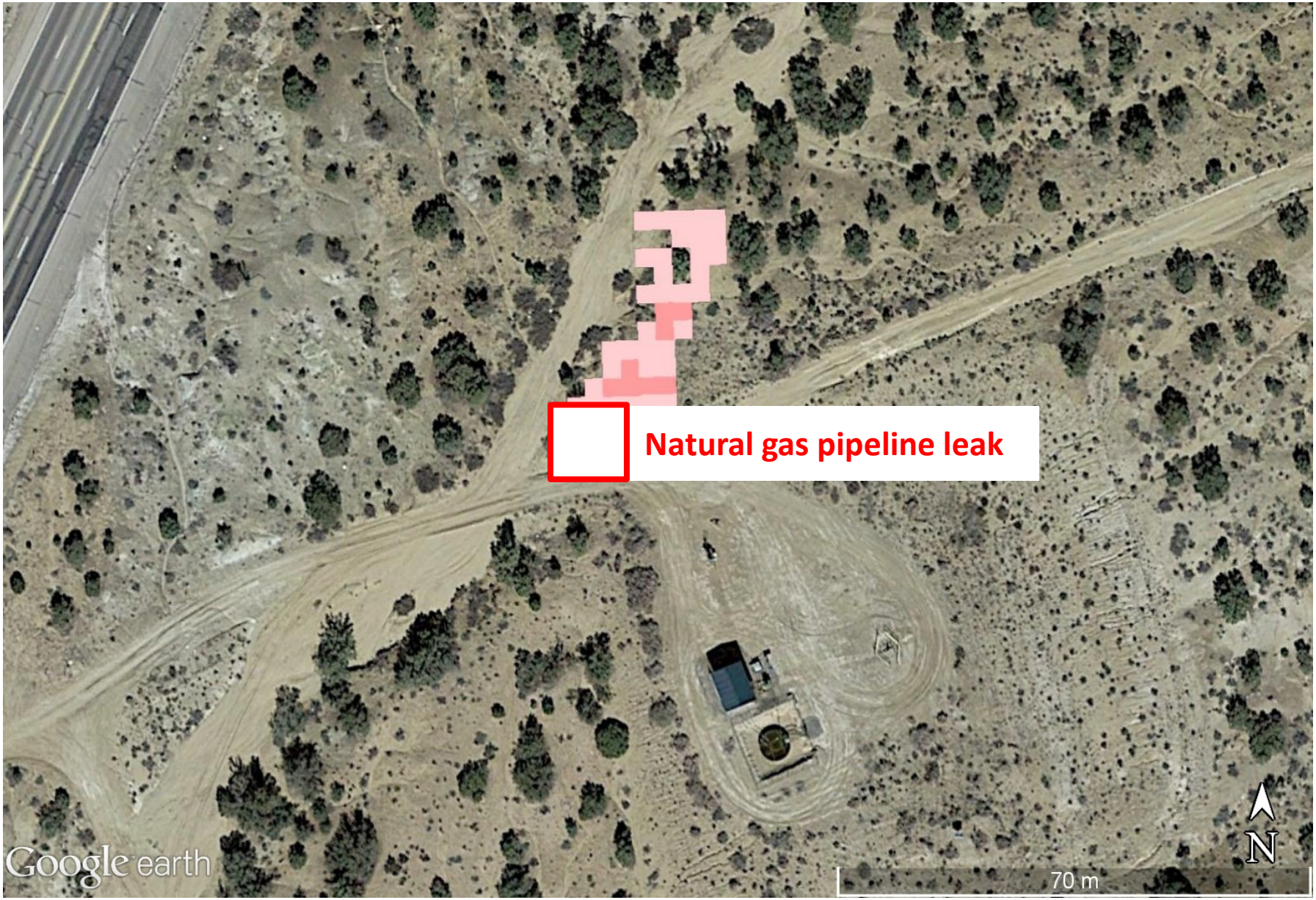
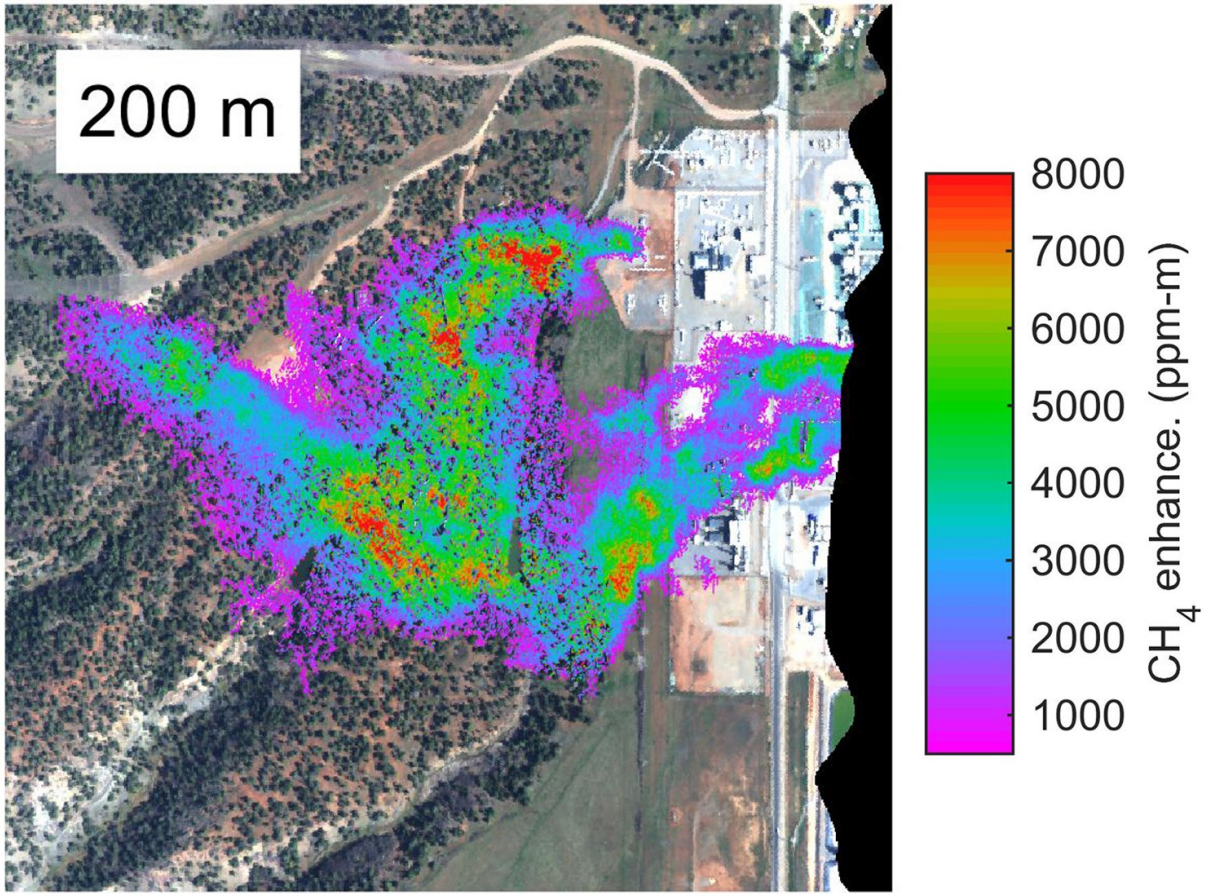
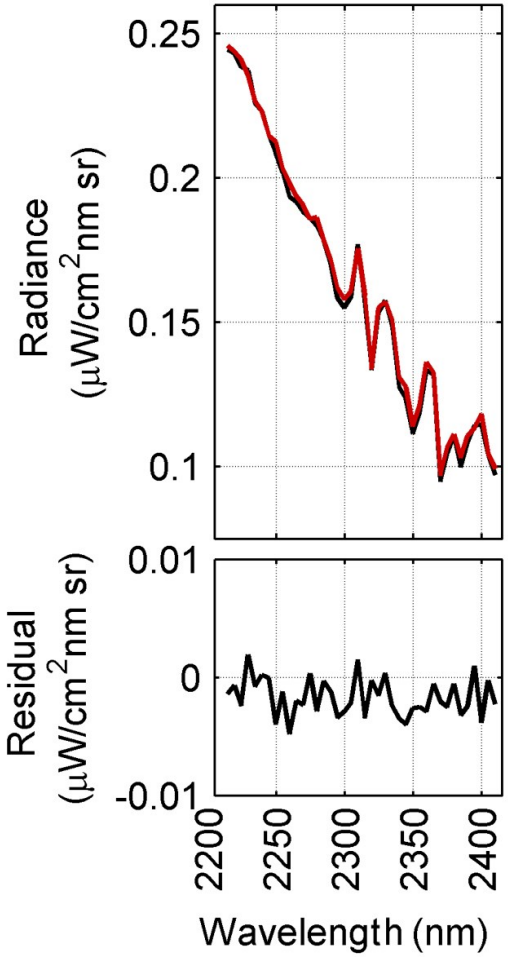
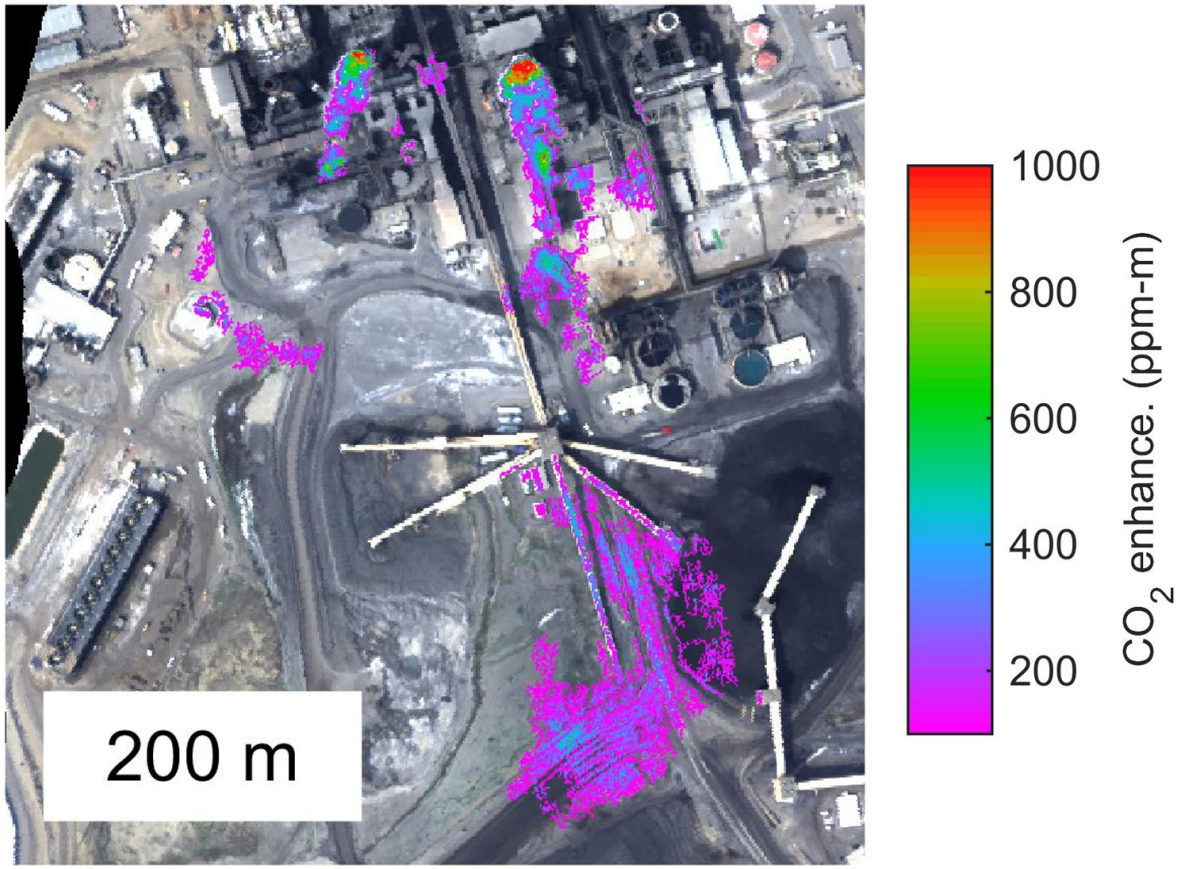


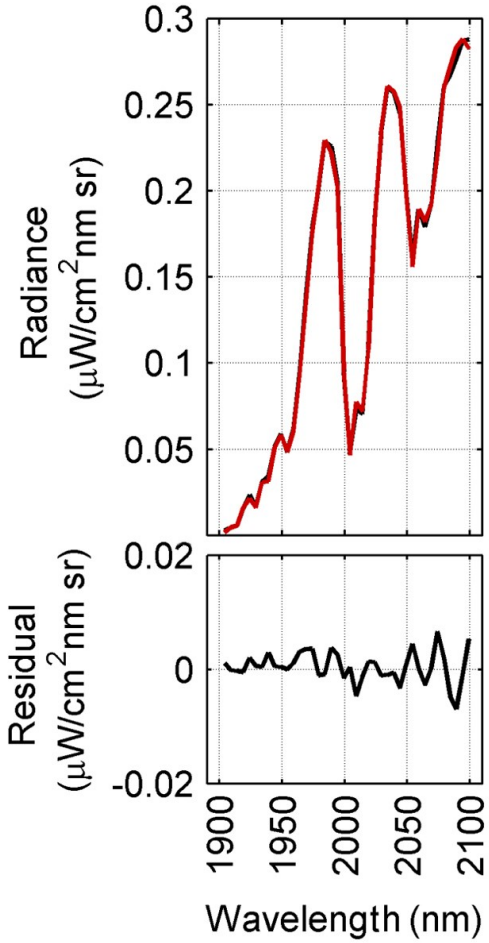
- CH_4 retrieval fits





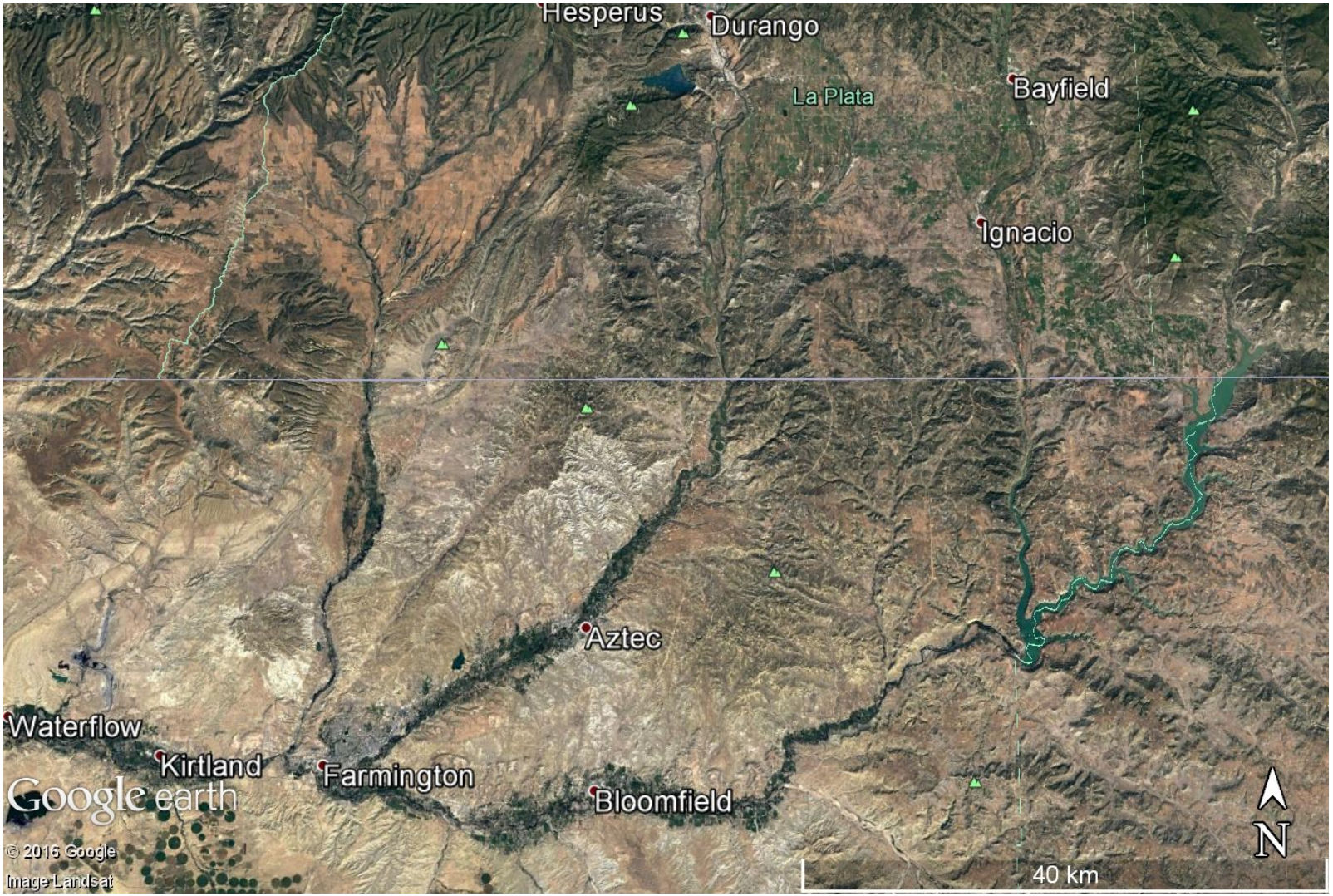
- CO_2 retrieval fits





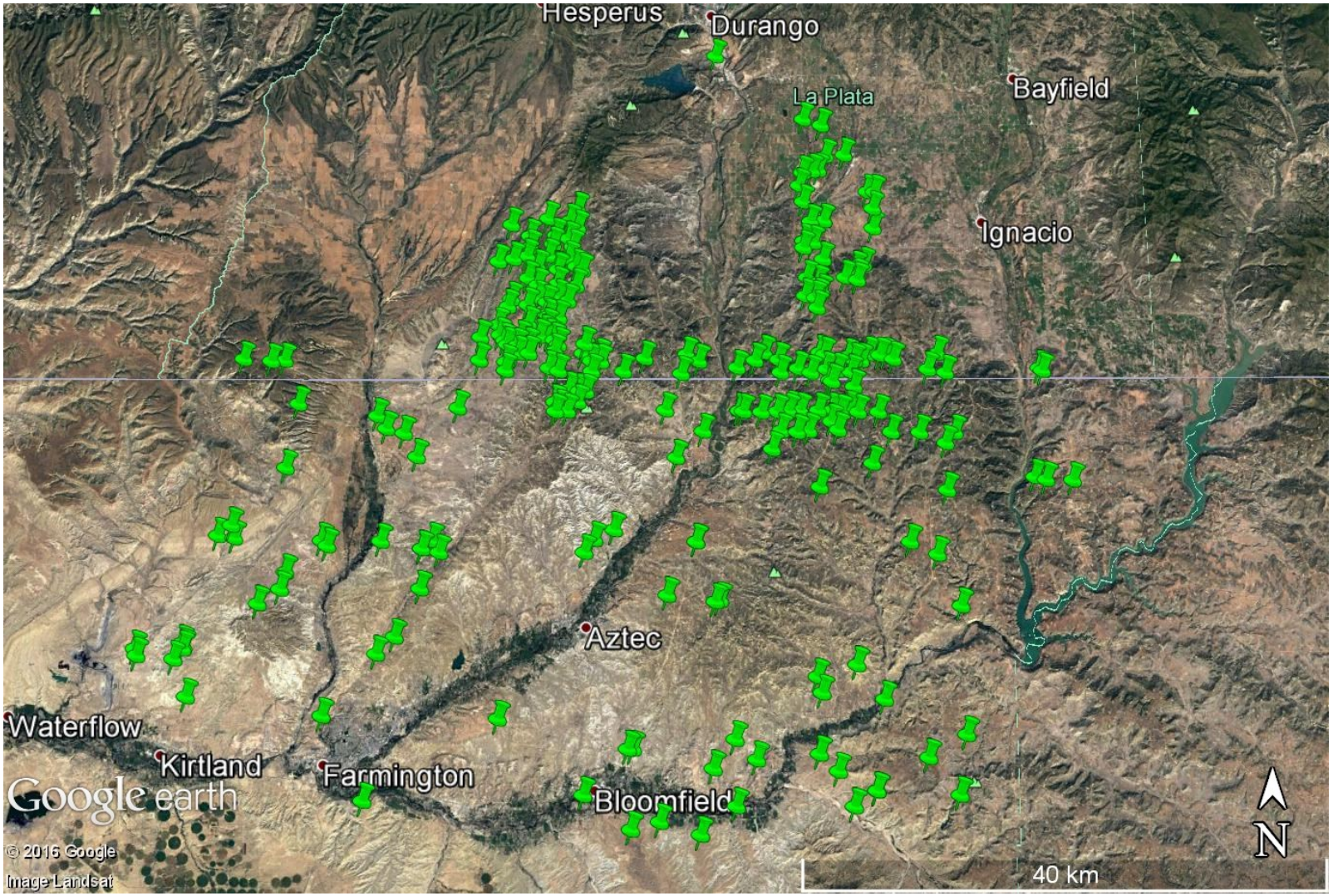
Four Corners

- Study site



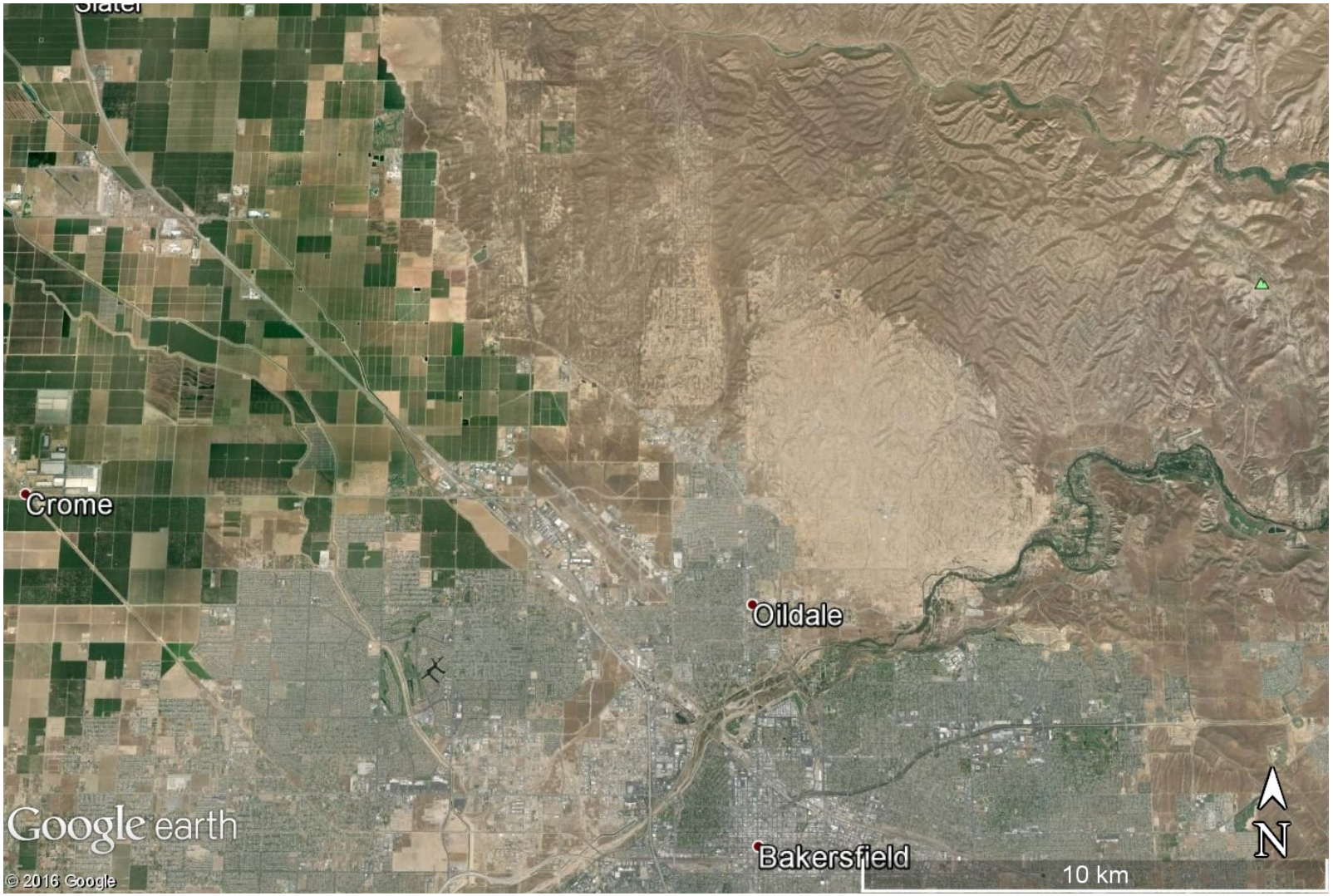
Four Corners

- Observed CH_4 plumes



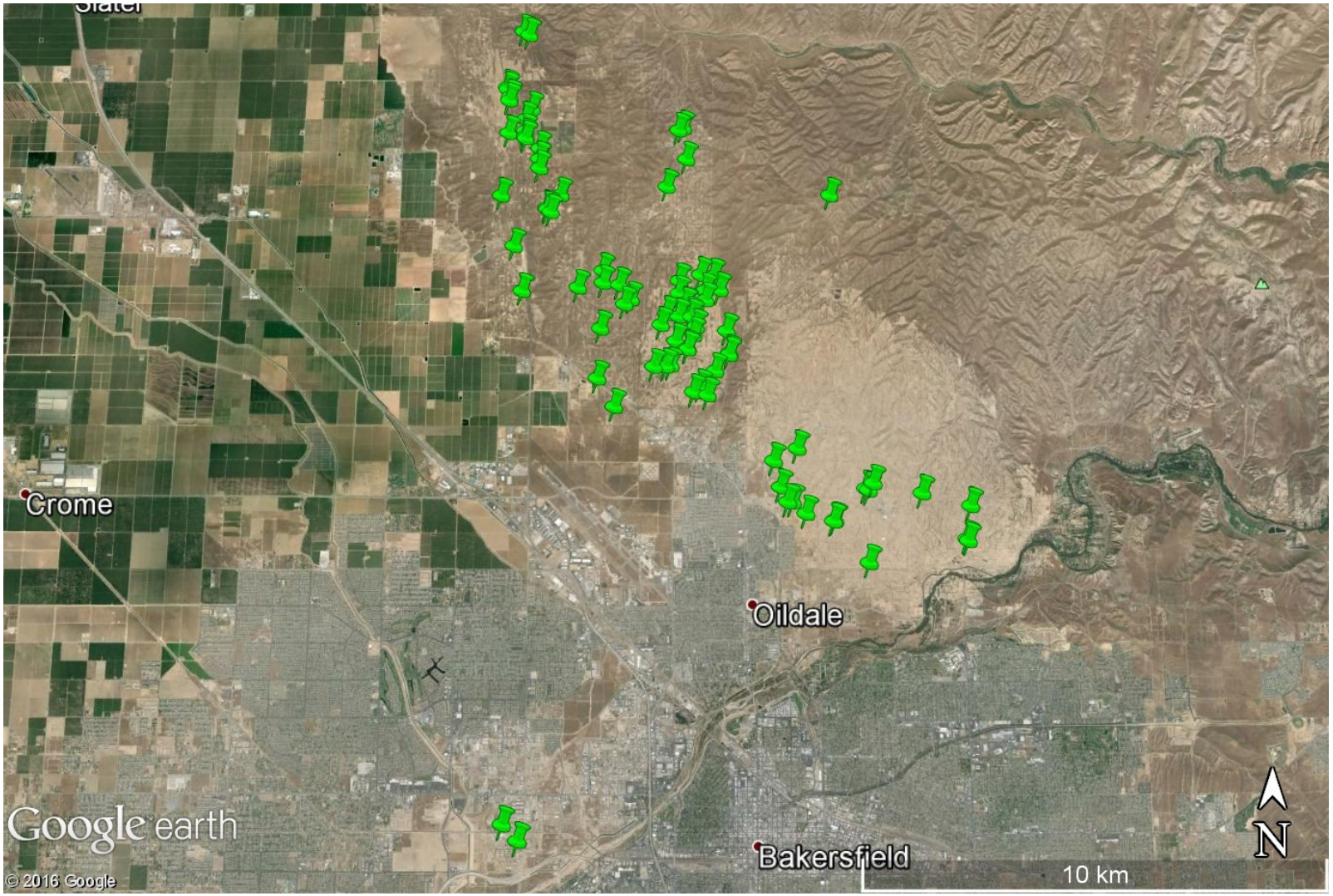
Bakersfield

- Study site

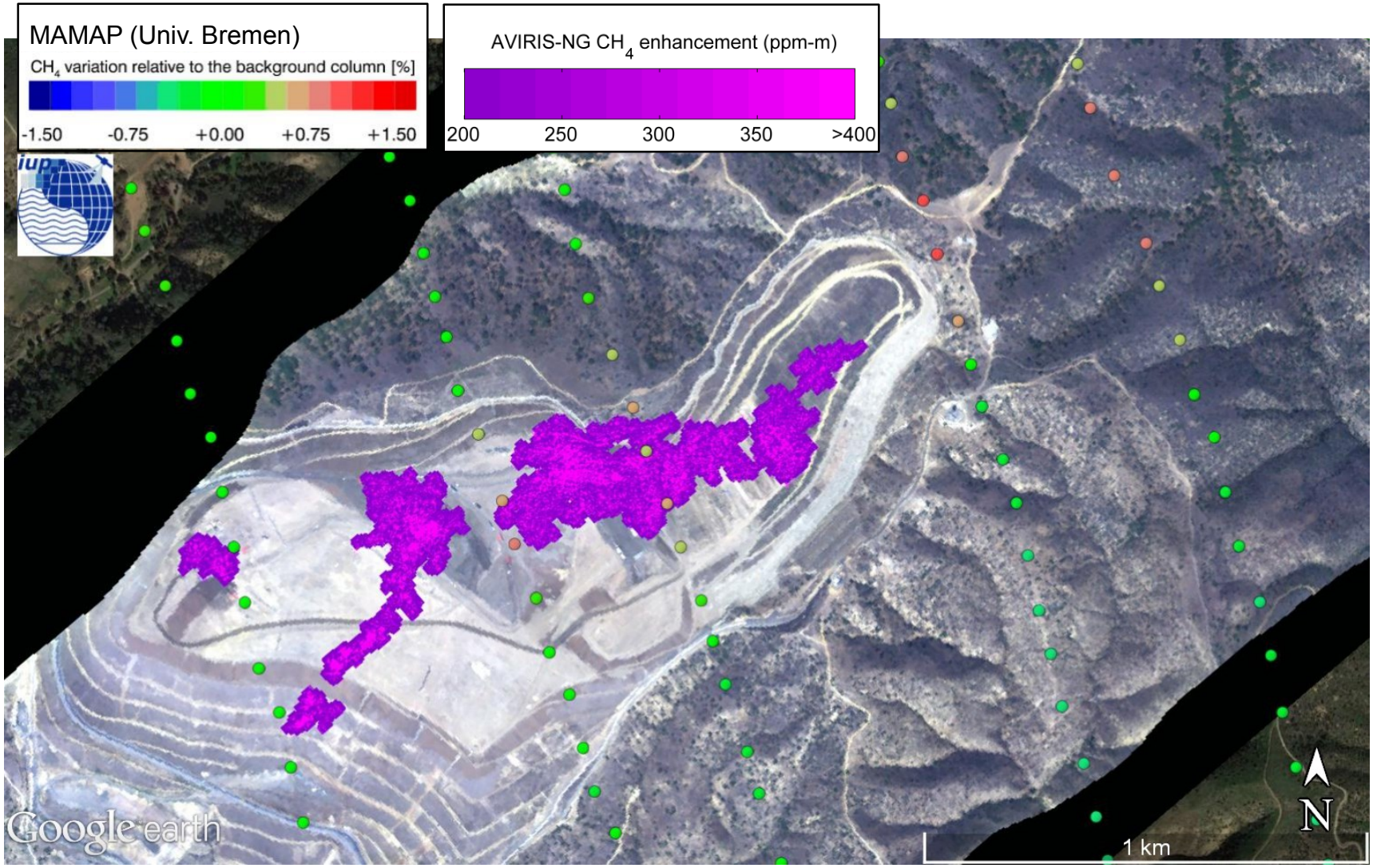


Bakersfield

- Observed CH_4 plumes



- CH_4 from Olinda Landfill



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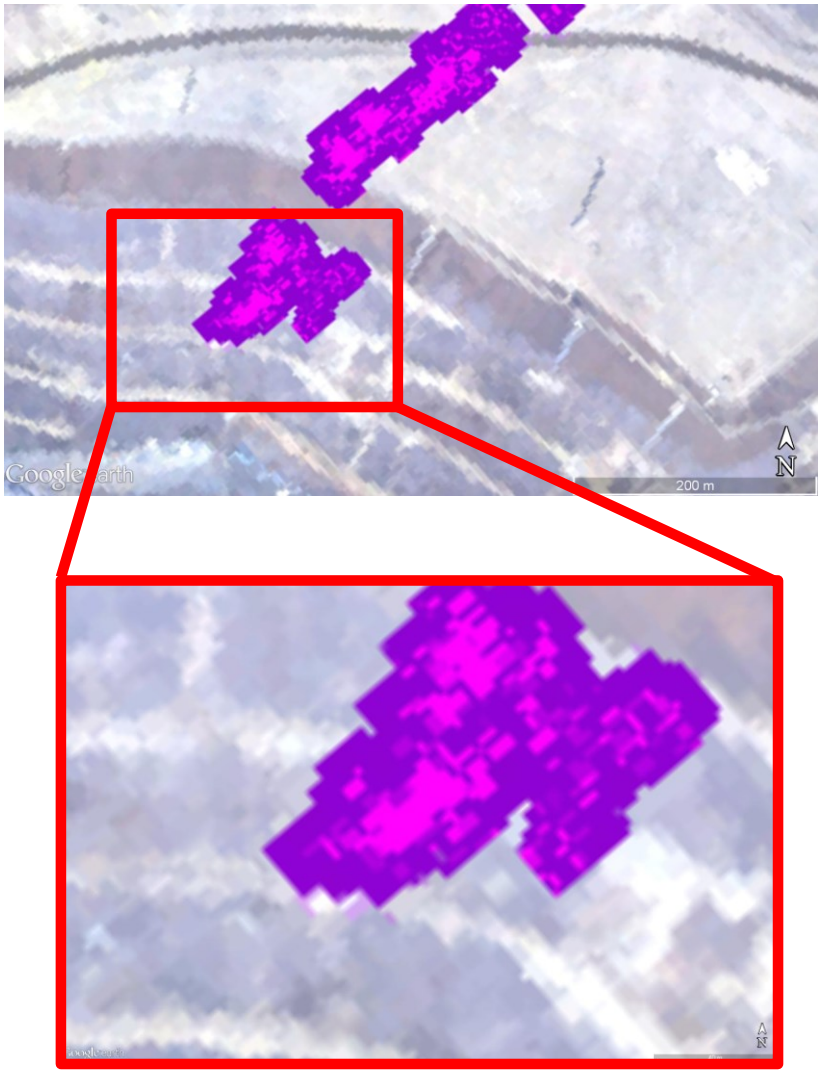
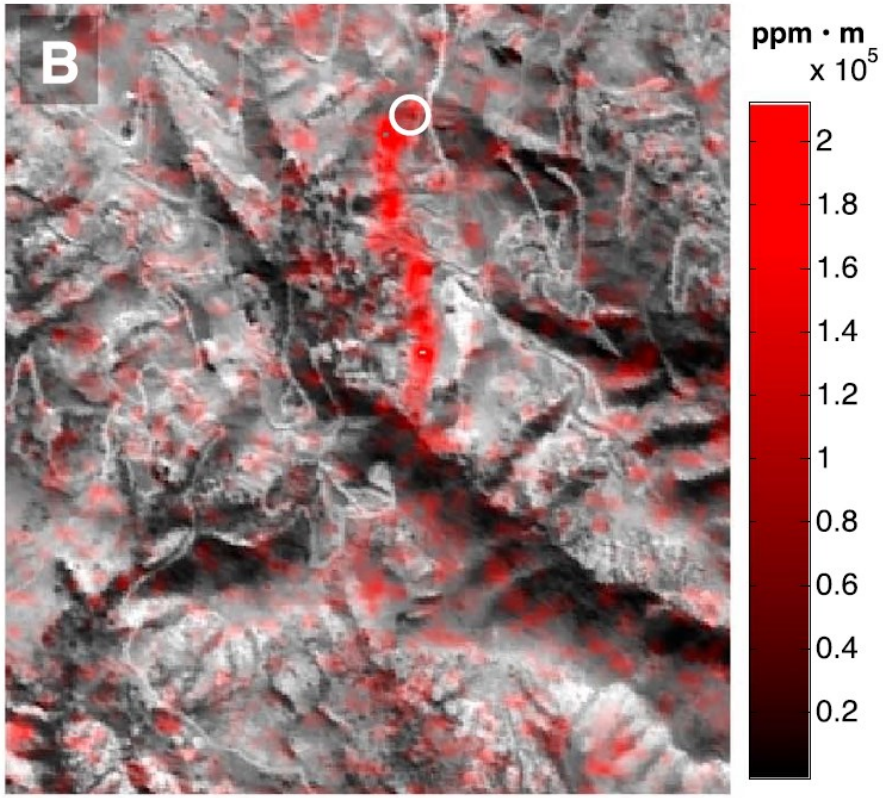


Aliso Canyon

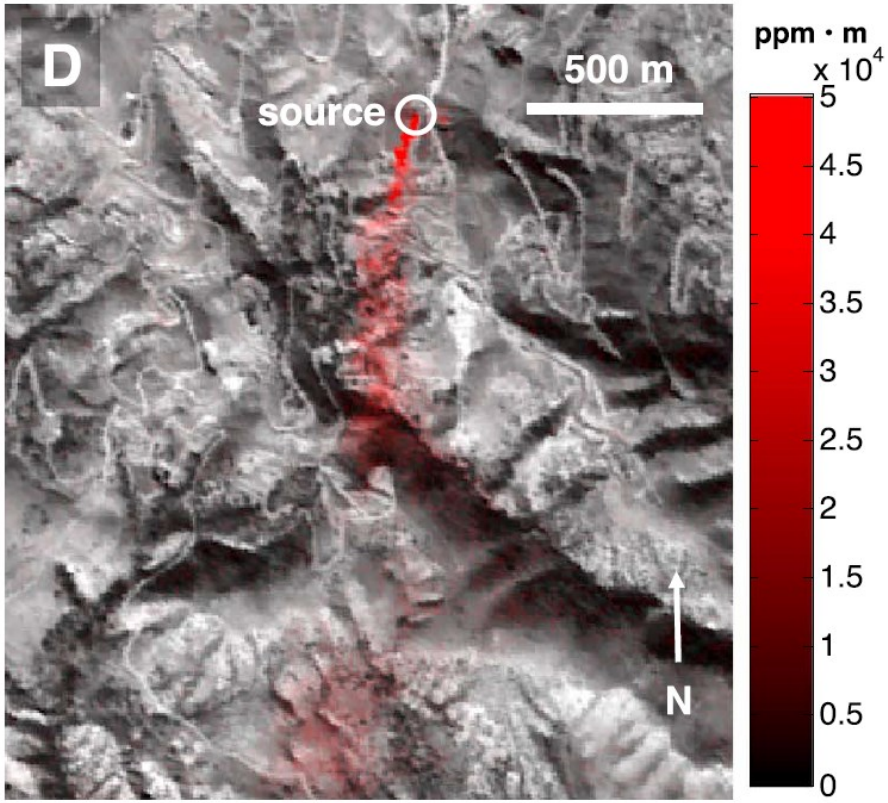
- AVIRIS Classic observed Aliso Canyon natural gas leak

- Orbital Hyperion instrument also observed CH_4 plume

Hyperion: 1/1/16, 16:39 UTC
Low Earth orbit

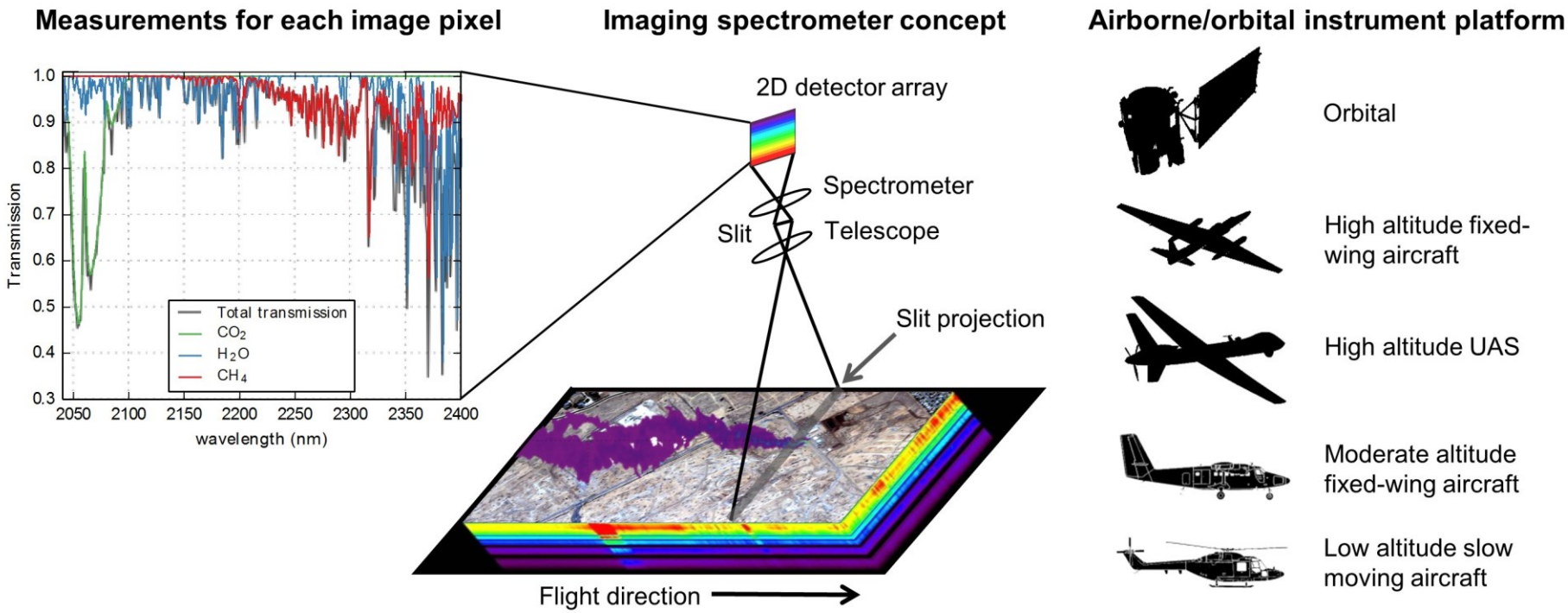


AVIRIS-C: 1/12/16, 20:25 UTC
6.6 km above ground level



Future instrument design

- 1 nm spectral resolution for improved gas sensitivity
- Quantitative mapping of CH_4, CO_2, H_2O, CO, N_2O
- NRC RFI #2: Understanding anthropogenic methane and carbon dioxide point source emissions (Duren et al., 2016)



Conclusions

- AVIRIS-NG permits quantitative mapping of CH_4 and CO_2 emissions
- Hundreds of CH_4 plumes were observed as part of campaigns in Four Corners (CO, NM) and Bakersfield (CA)
- Offers the potential to better understanding partitioning of anthropogenic and natural emission sources
- A dedicated instrument for greenhouse gas mapping would offer:
  - Improved gas sensitivity
  - Quantitative mapping of CH_4, CO_2, H_2O, CO, N_2O
  - Flexible instrument platform (aircraft/orbital)