How Cities Breathe: Ground-Referenced, Airborne Hyperspectral Imaging Precursor Measurements To Space-Based Monitoring

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Abstract: Interpreting human-induced carbon emissions requires satellite data, but current missions cannot resolve many anthropogenic sources. Fundamental advances in space-based remote sensing are needed. The CAMB project (Communicating Anthropogenic Methane: Bremen) evaluates new airborne and satellite platforms for detecting large and small human causes of greenhouse gases. Here, we describe recent airborne and satellite measurements of sources and sinks of CO2 and CH4 in Southern California to establish a baseline for spaceborne measurements, and present opportunities and challenges for space-based remote sensing of large and small emissions.

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Hyperspectral Imaging: Land Use and String Trace Gas Sources

High Resolution-Romote Sensing: Trace Gas Column-Abundance

Key-urban reference considerations include traffic and access, meteorology, boundary layer exchange to building or open sources, atmospheric transport and profile monitoring, and spatial resolution.

Land Use Reference (ancillary data)

Key considerations for developing land use data include spatial resolution, boundaries due to high complexity and spurious emissions.

Applications in surface, air, and remote sensing data

Airborne Shortwave Infrared (AVIRIS) and Thermal Infrared (SEBASS) Methane Imaging Spectroscopy in the LA Basin

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CO2 and Methane Experiment “COMEX”

COMEX will calibrate / validate plume inverse-model derivation of greenhouse gas source emissions for future remote sensing satellite missions (HyspIRI and CarbonSat) that use Short Wave InfraRed absorption features for trace gas retrievals.

HyspIRI ER2 with AVIRIS swath maps sources, MAMAP methane and carbon dioxide (Bremen) CIRPS, in situ GHS (Ames), atmospheric characterization Malo Tir methane (Aerospase) H211 in situ methan and carbon dioxide (Ames) Surface – AMOS Surveyor and MACLab – Temporal GHS, trace gas characterization, and satellite data comparison

Landuse

HyspIRI Hyperspectral AVIRIS Level II Product surface emissivity, surface reflectance, product (8 TIR Bands) Hyperspectral TIR multispectral Level I product (6 TIR Bands) Hyperspectral SWIR/TIR multispectral product (8 TIR Bands)

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CarbonSat

Global CO2, CH4, etc, from space

Complementary Satellites

HyspIRI

The HyspIRI mission includes two instruments mounted on a satellite in Low Earth Orbit:

• Imaging spectrometer measuring from the visible to short wave infrared (380 nm to 2100 nm) in 64 spectral bands.
• Multispectral imager measuring from 12 to 16 bands at finer resolution.
• SWIR and TIR instruments have 40 km spatial resolution on Earth.

Main Points

COMEX will combine airborne, surface, TIR and SWIR imaging spectroscopy and high spectral resolution spectroscopy for greenhouse gas source derivation from a network of sites in California. COMEX is part of the broader HyspIRI campaign, with a focus on the Los Angeles megacity. Combined airborne and surface reference data are richer for source identification and characterization of the complex urban environment. Sensitivity and insights could be derived from analyzing hyperspectral imaging data for Los Angeles land use during the COMEX campaign. Combined TIR and SWIR provides improved land-use characterization.