
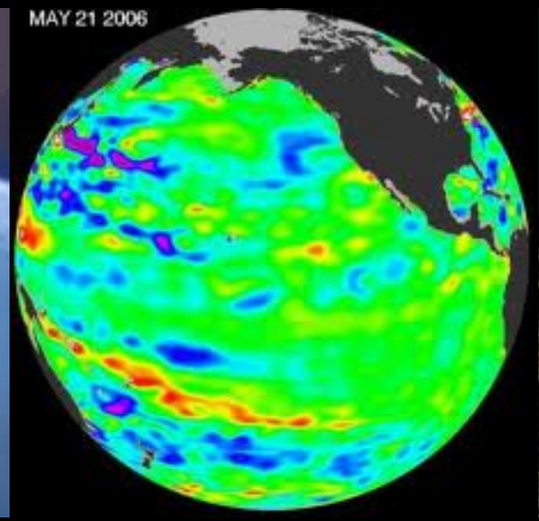


Hyperspectral remote sensing

Imaging Spectroscopy

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University of Virginia
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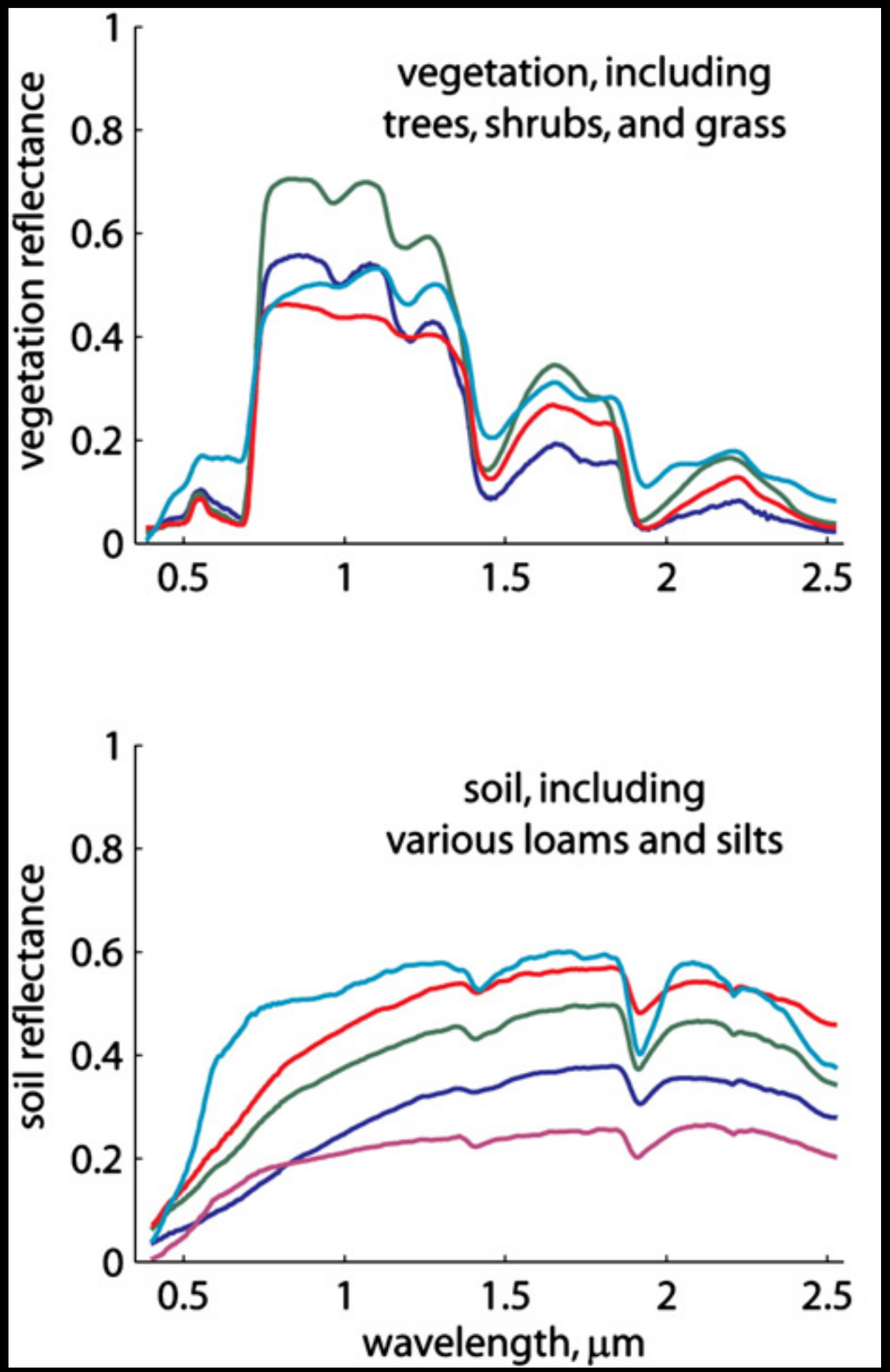
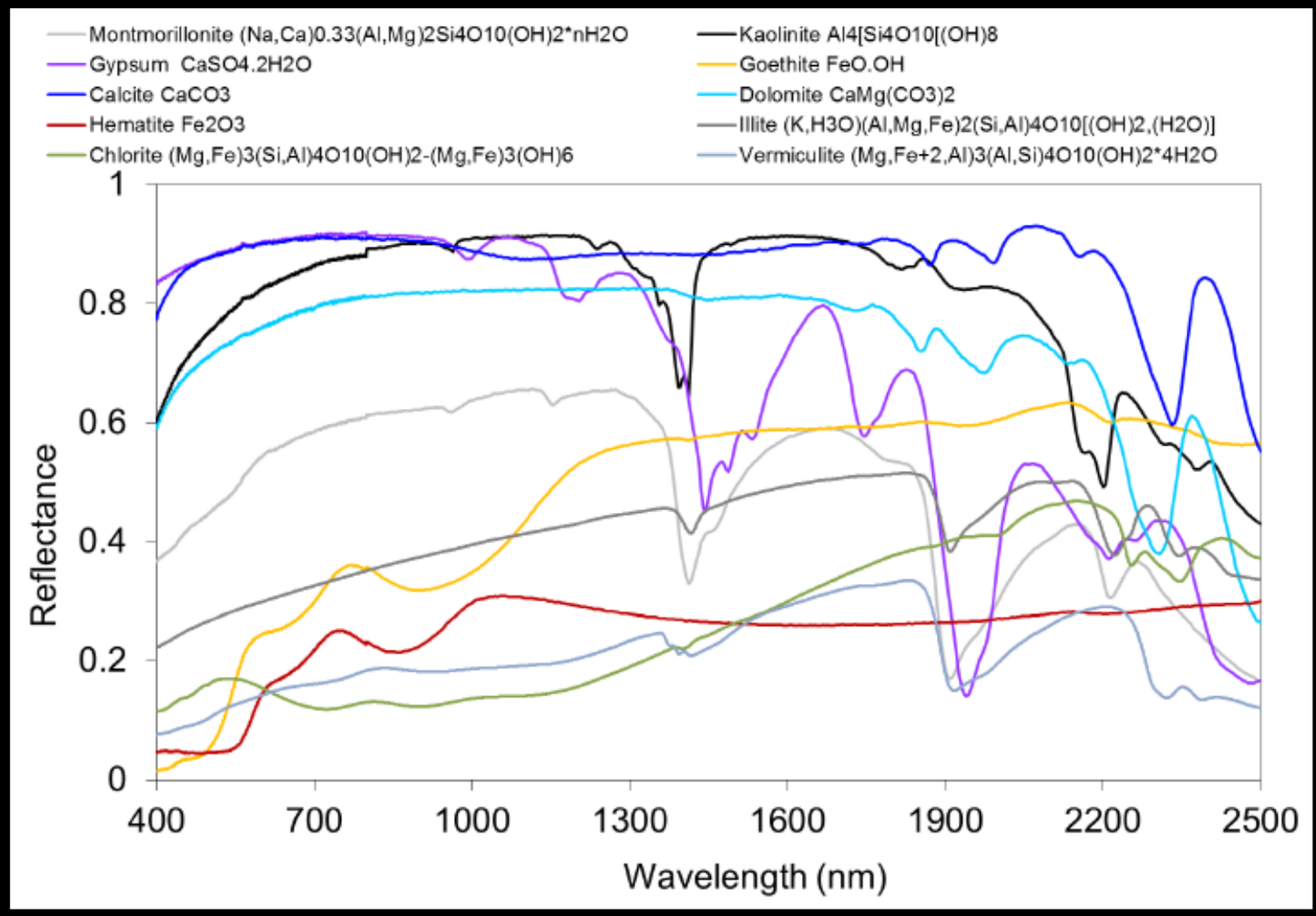
390 Clark Hall

EVSC 4010/7010 Week 11

Revisit spectra of vegetation and rocks

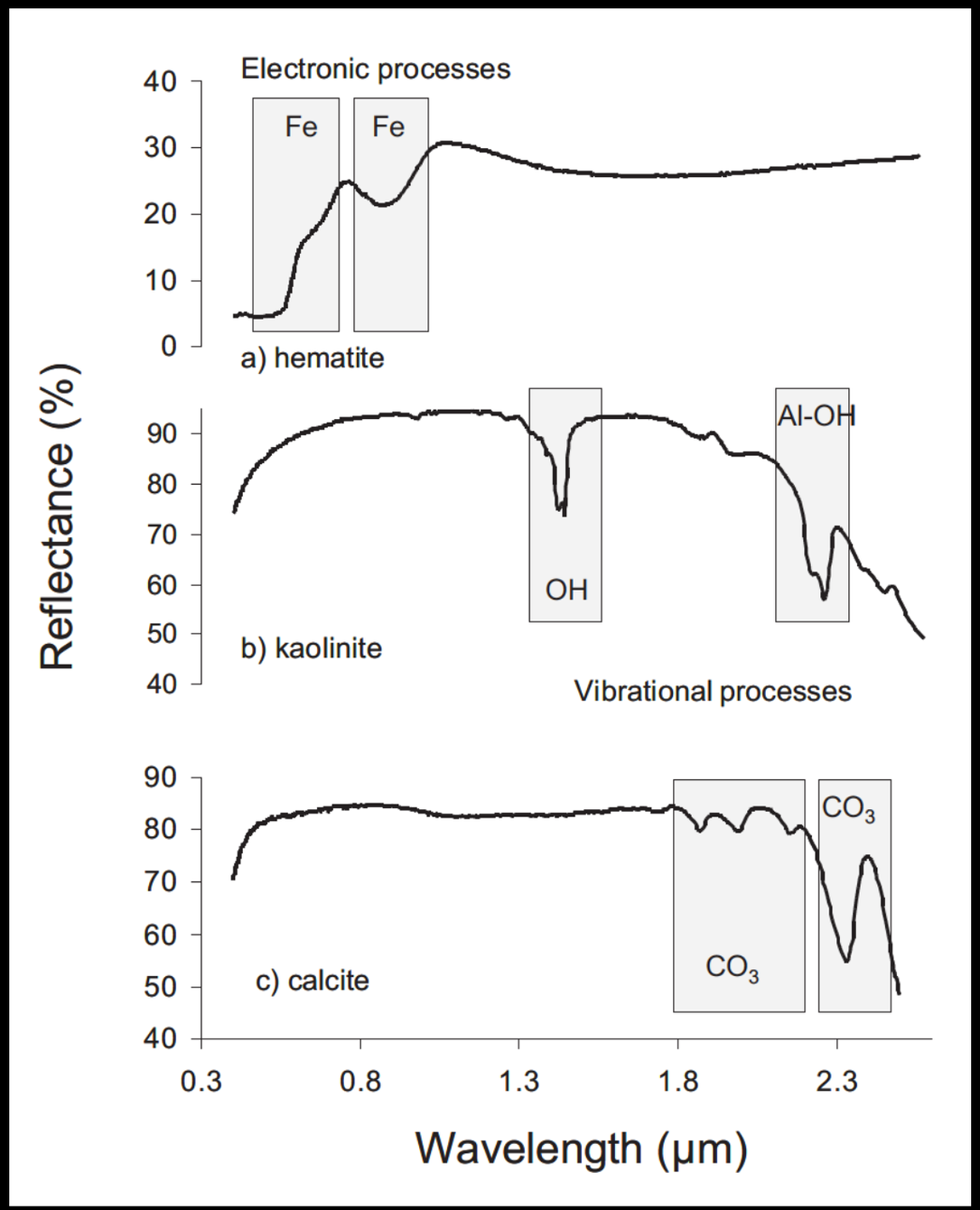


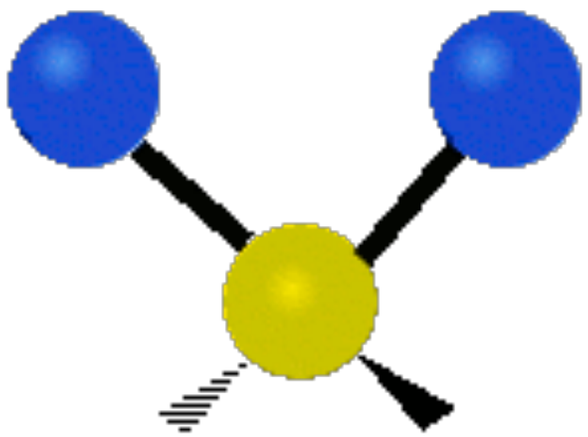


Spectra of minerals

Causes of absorption features in rock spectra

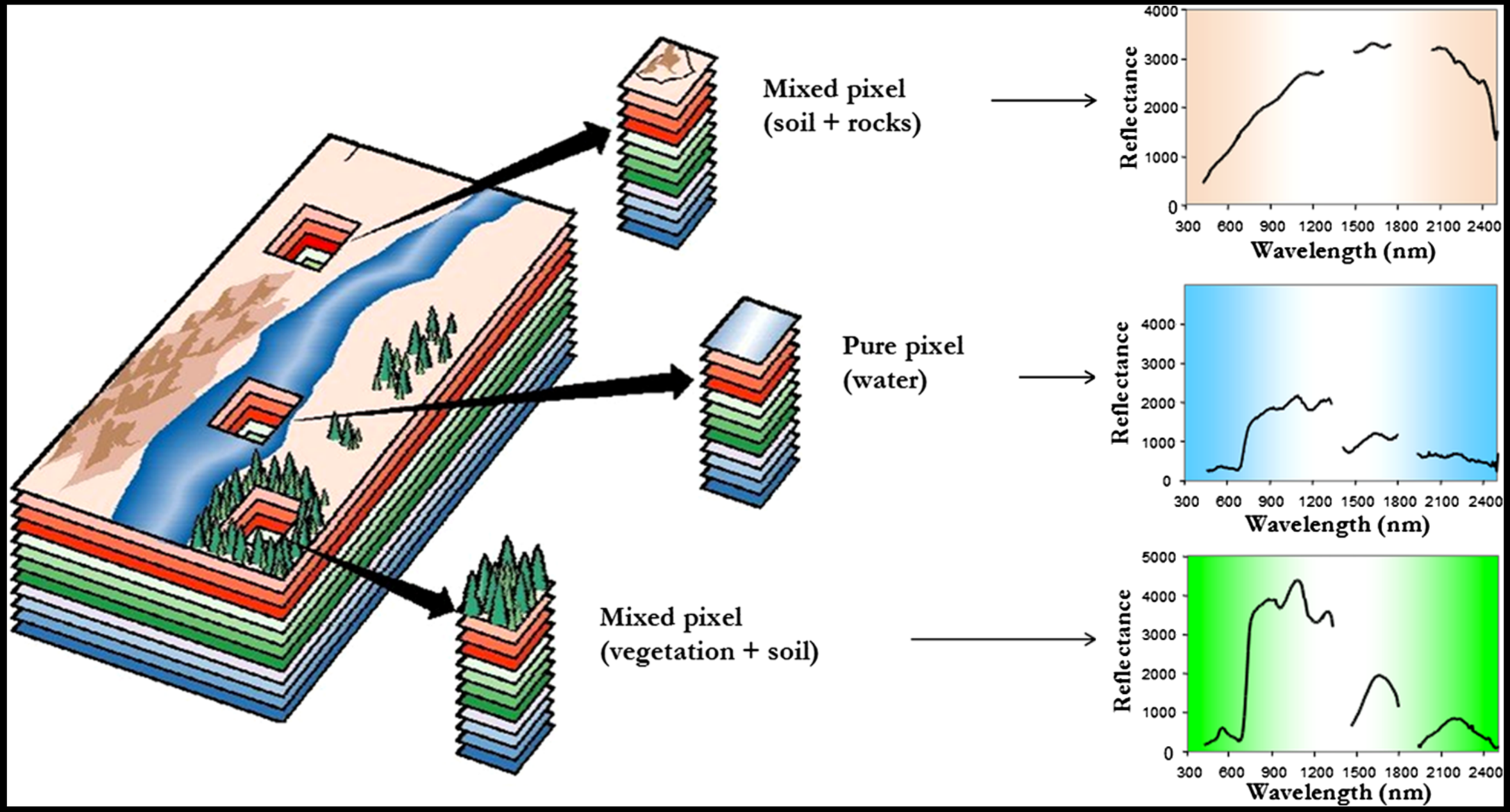
Electronic processes or Vibrational processes



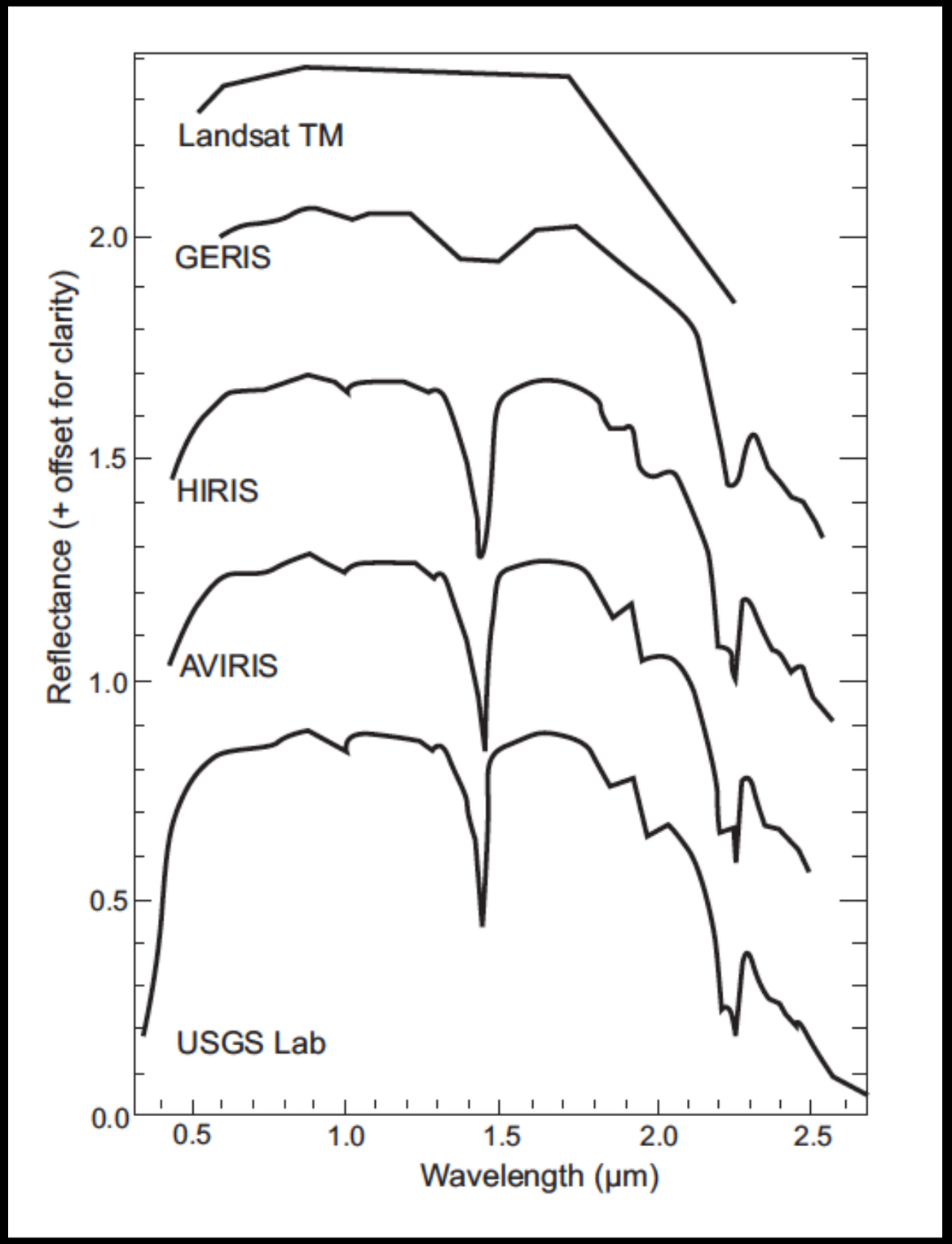


Imaging Spectroscopy

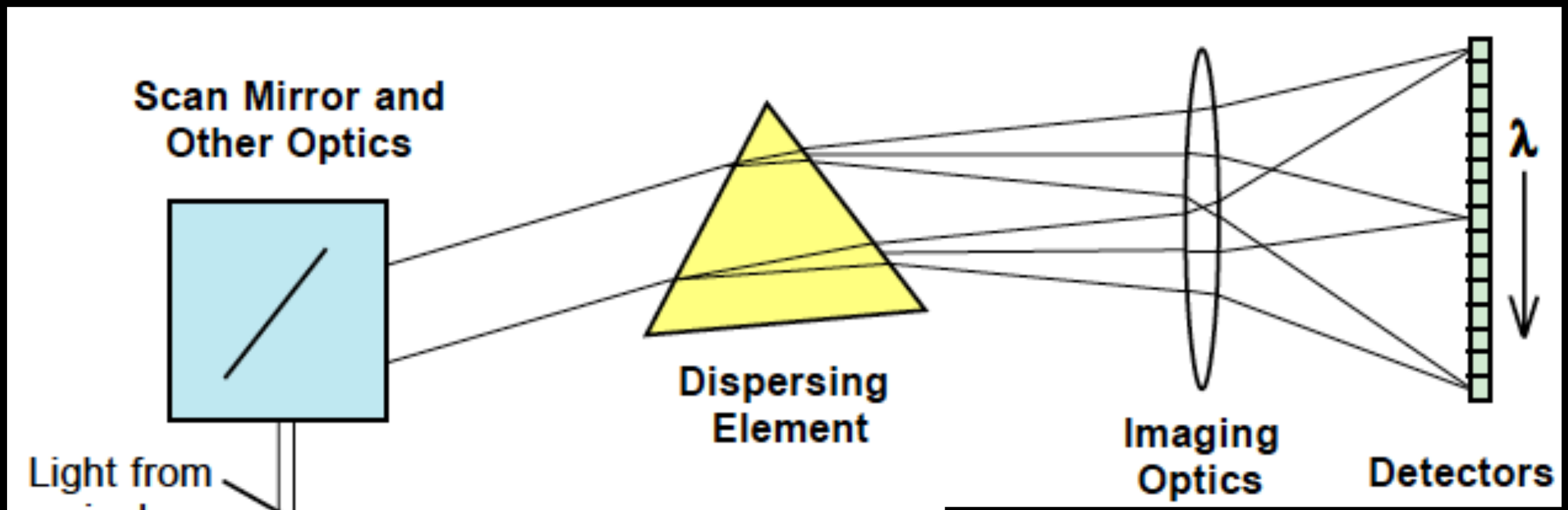
Image Cube

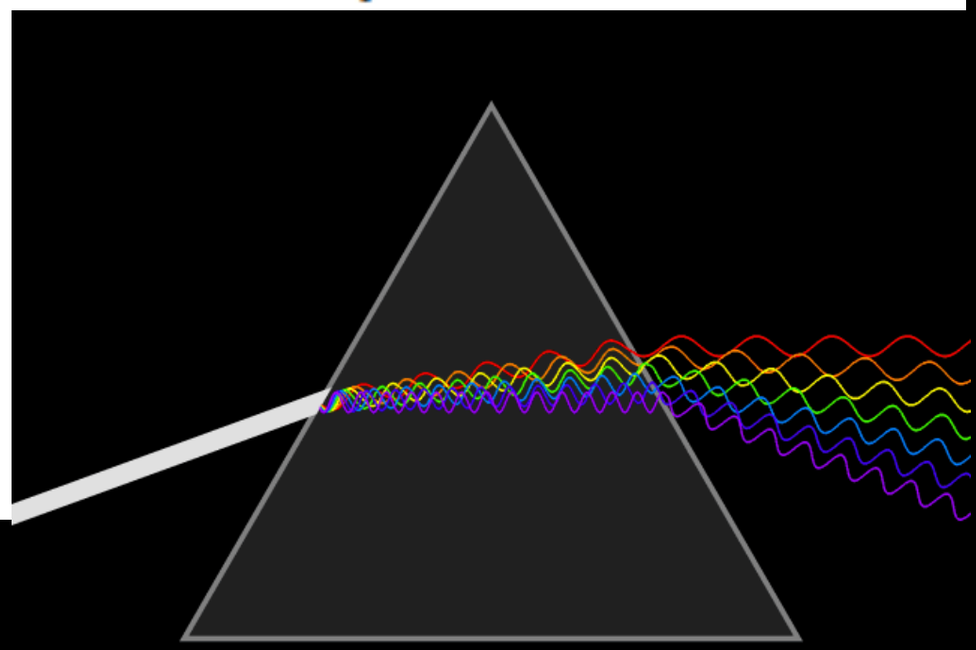


Hyperspectral vs Multispectral



How does an imaging spectrometer work?

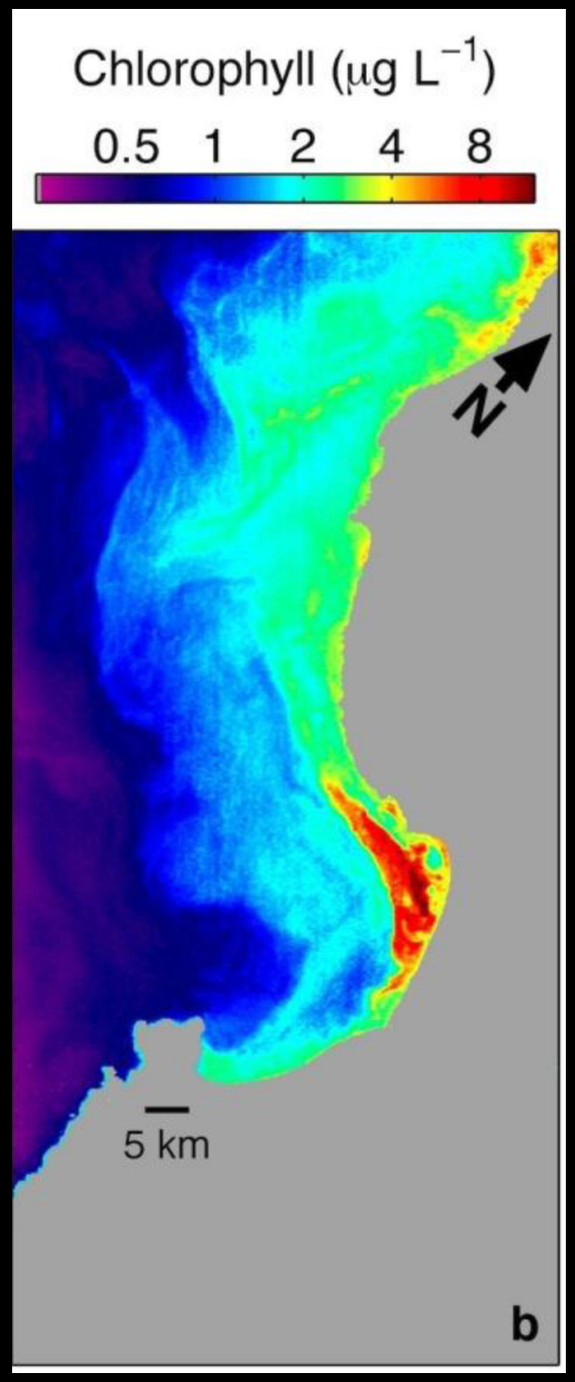




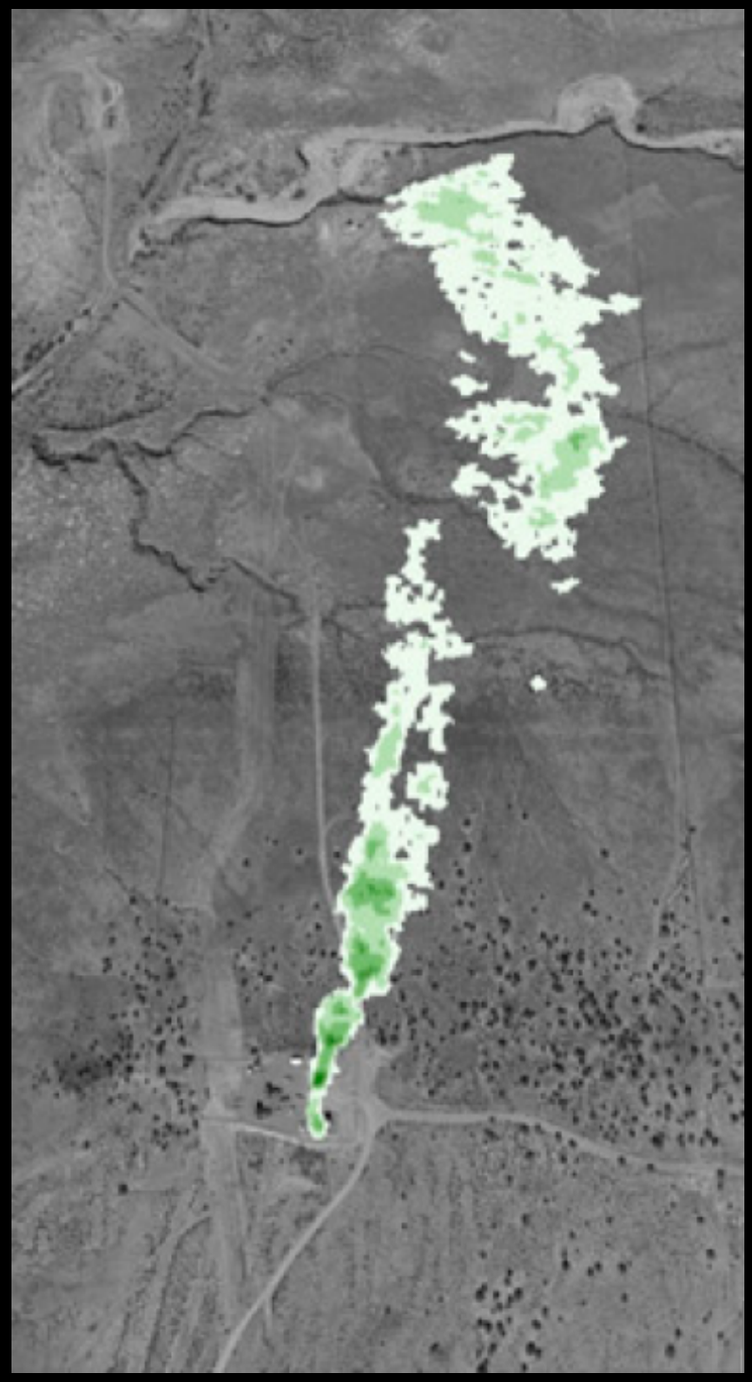
MicroImages.com

Hyperspectral Remote Sensing Case Studies

Plants



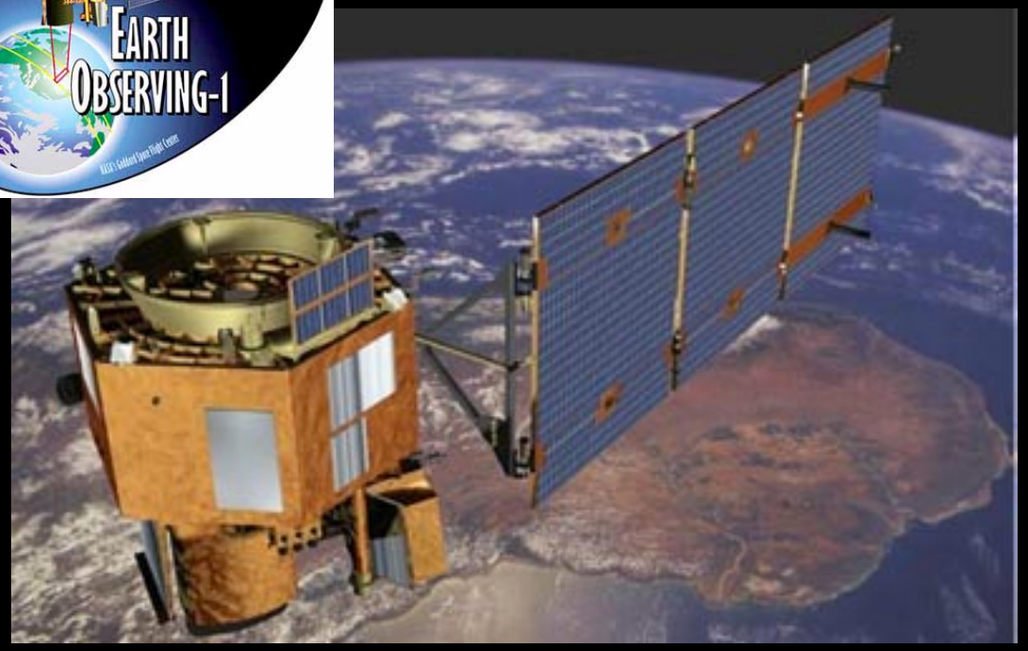
Ocean

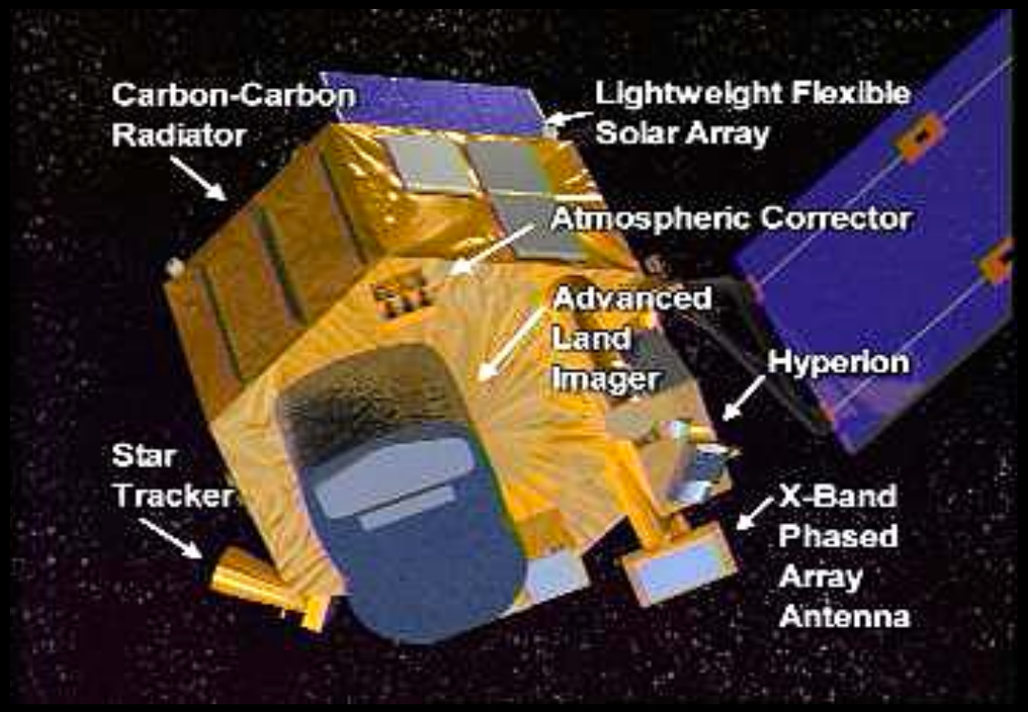


Atmosphere

Imaging spectroscopy sensors

Earth Observing-1 by USGS





EO-1 Hyperion

- Three sensors onboard: Hyperion, Advanced Land Imager, and the Atmospheric corrector
- Hyperion is an imaging spectrometer: 220 bands from 0.4 um to 2.5 um; the spectral res is around 11 nm. Spatial resolution: 30 meters.

Imaging spectroscopy sensors

Earth Observing-1 by USGS

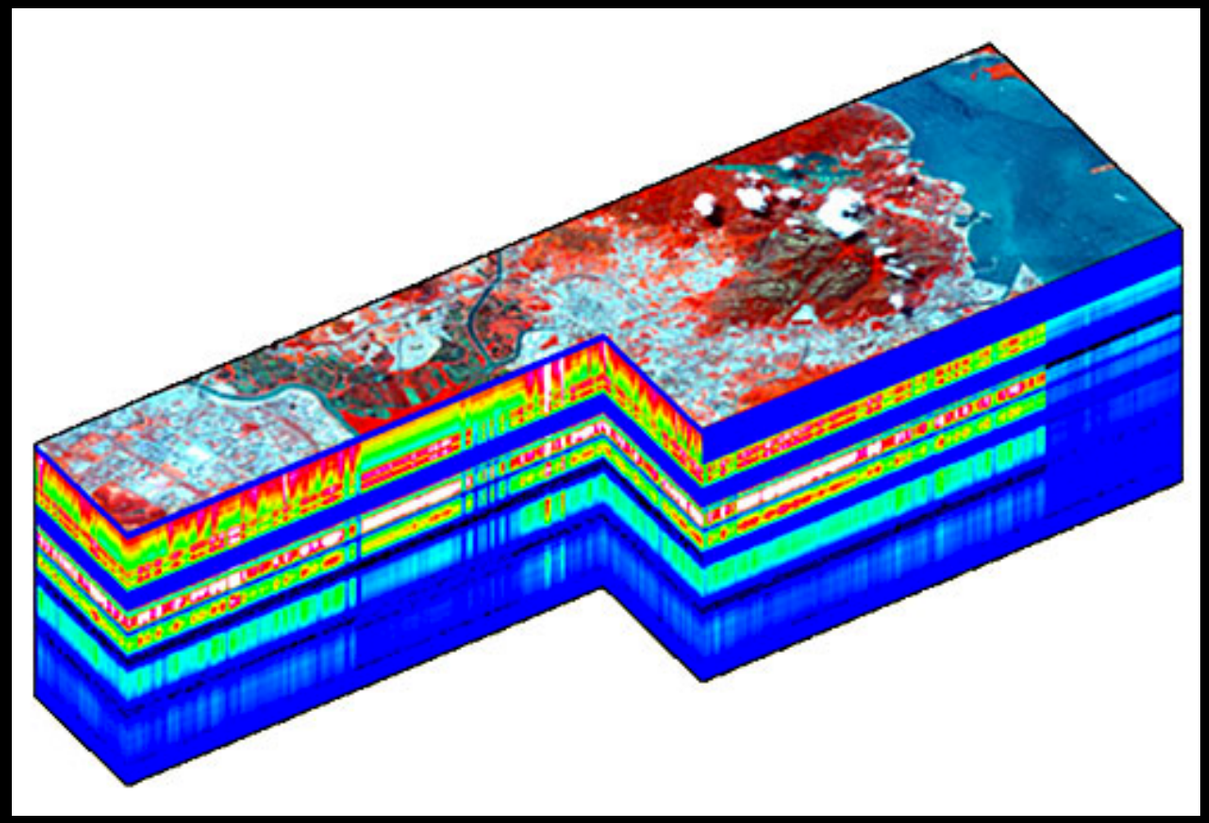
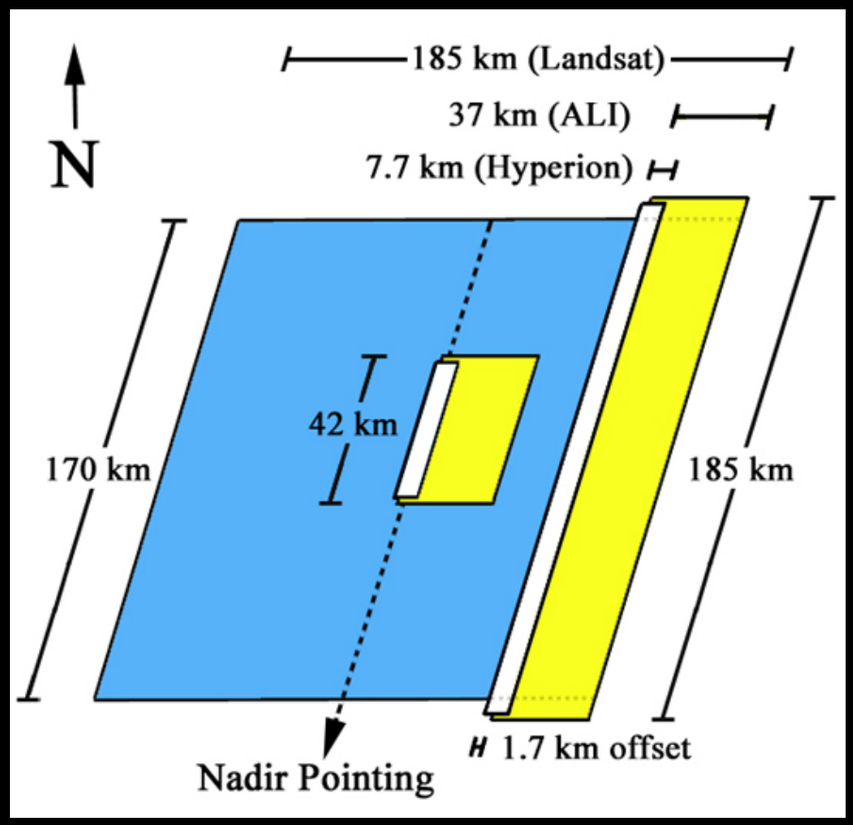


Image cube from Hyperion

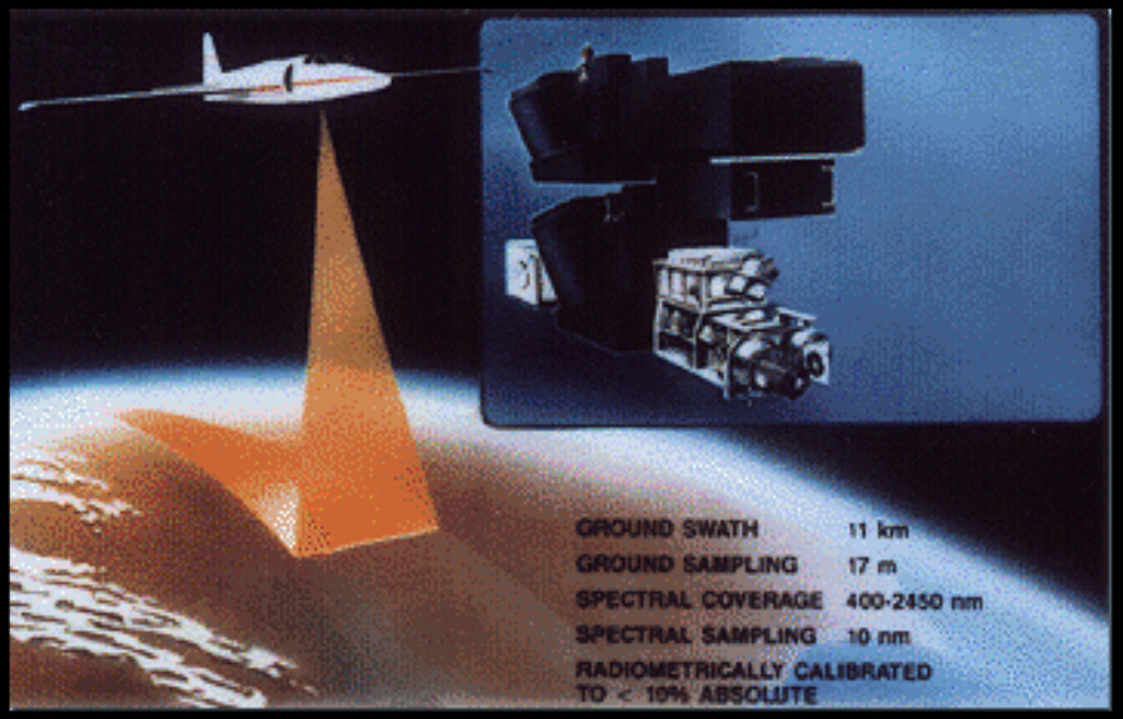


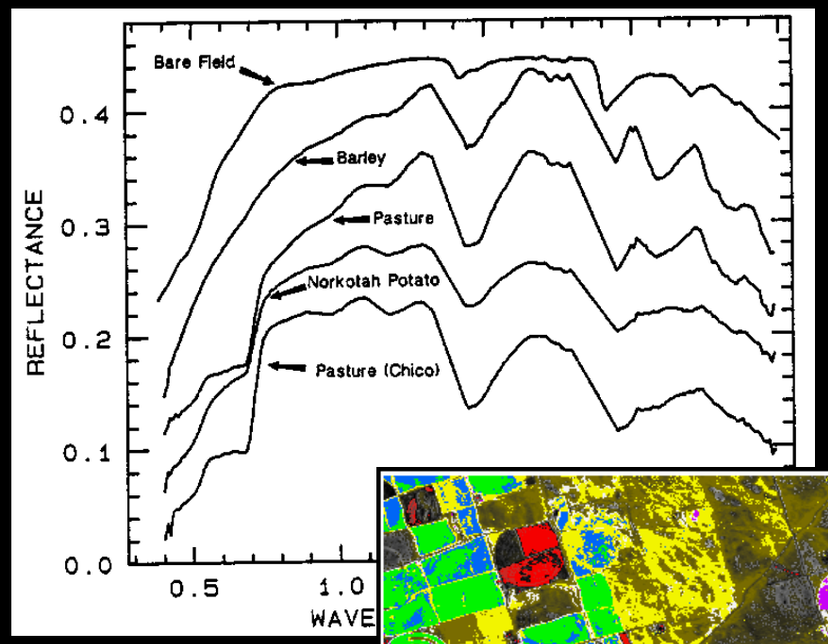
Comparing the FOV

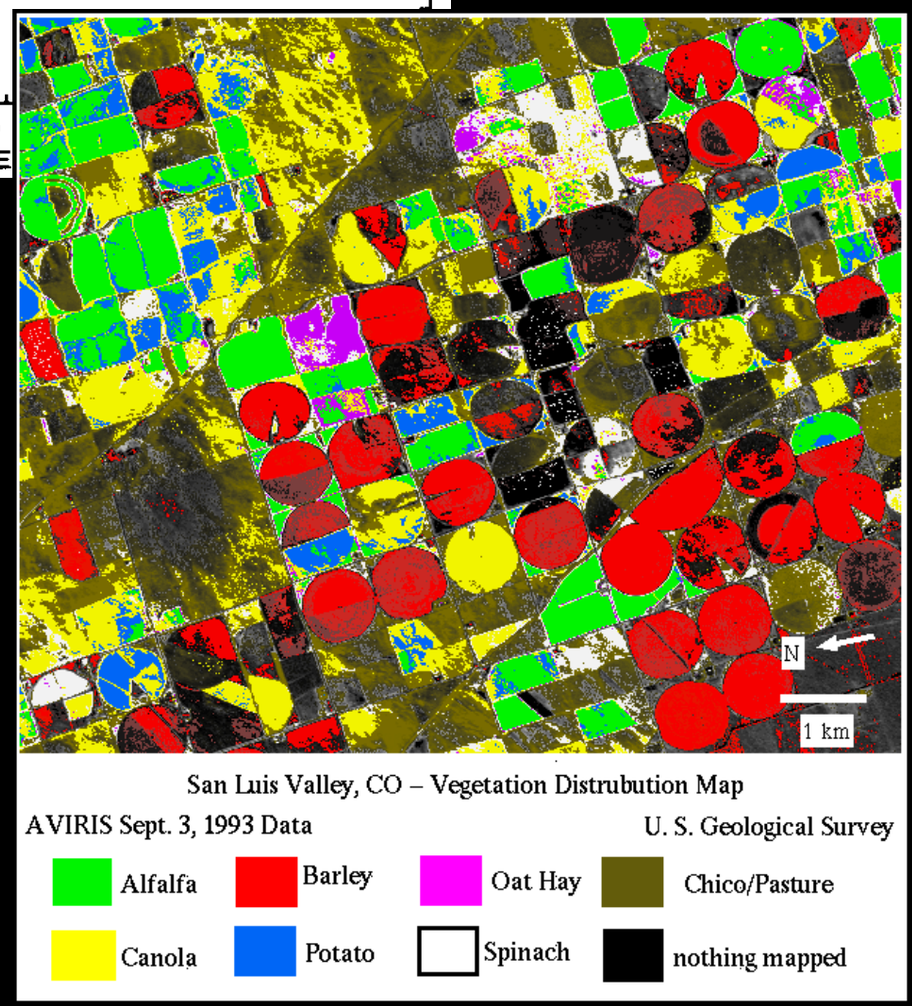
- Hyperion has a much narrower FOV comparing with ALI and Landsat TM.
- Both Hyperion and ALI can point to the target from nadir or from the side. The latter covers a larger area.

Imaging spectroscopy sensors

AVIRIS-Airborne Visible/Infrared Imaging Spectrometer

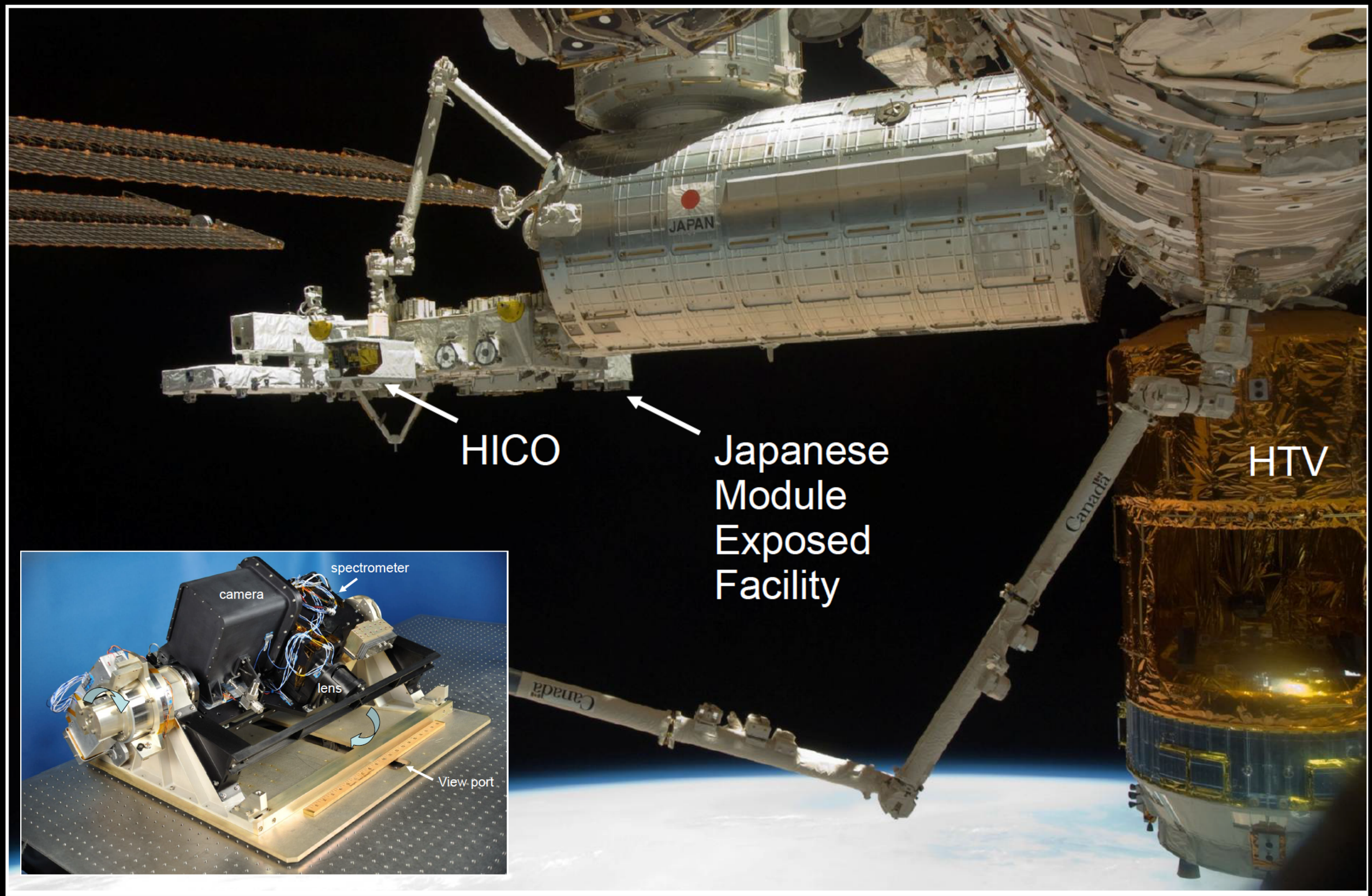






- Ground horizontal FOV (swath): 11 km
- ~220 bands from 0.4 um to 2.5 um
- Spatial res: 17 m

Hyperspectral Imager for Coastal Ocean (HICO)



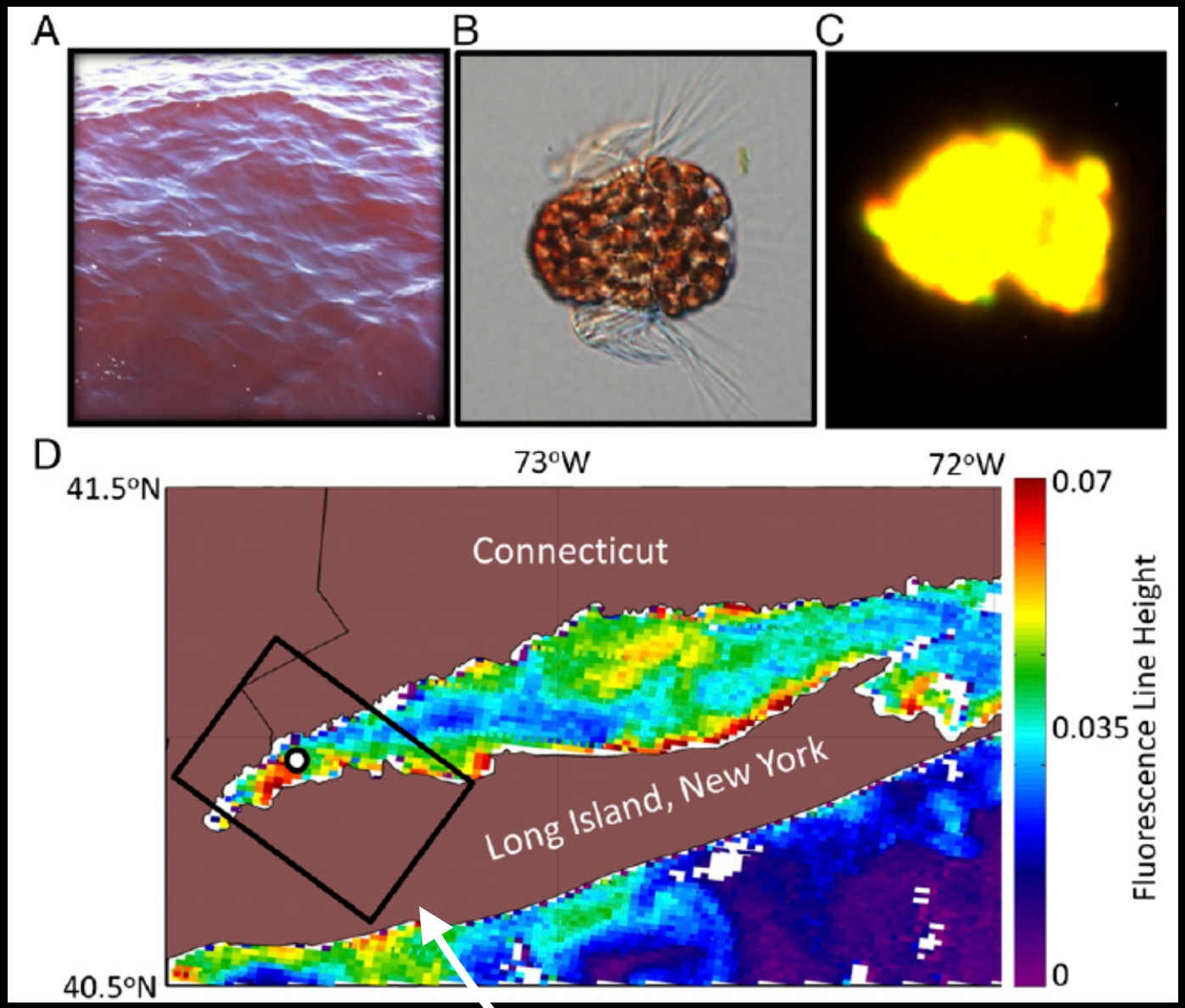
Examples from HICO

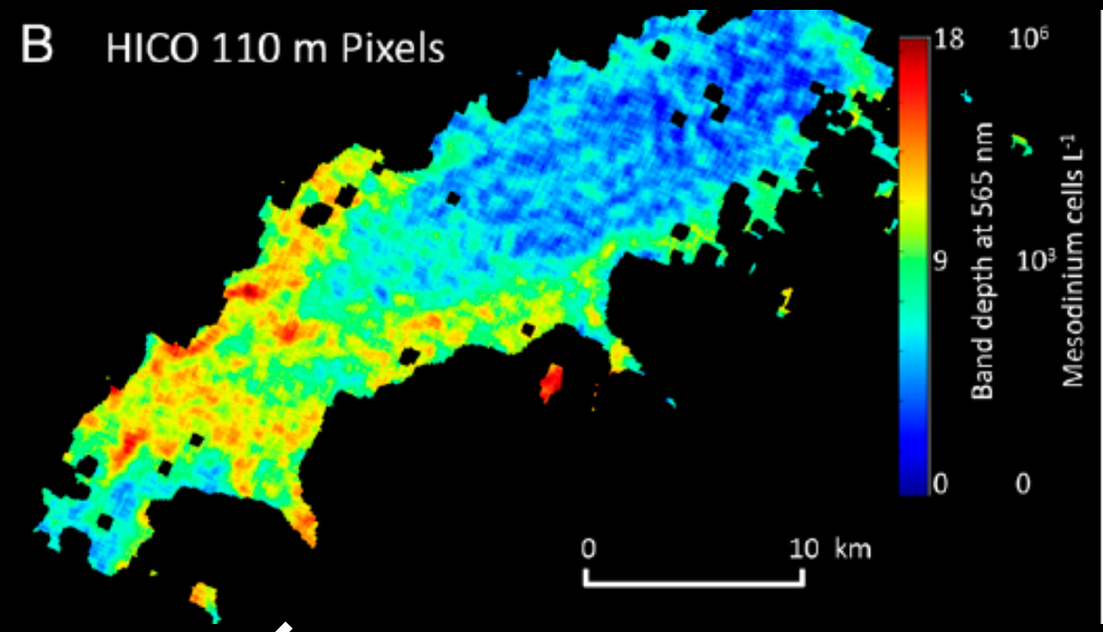
Hong Kong

New Zealand

Examples from HICO

M. rubrum

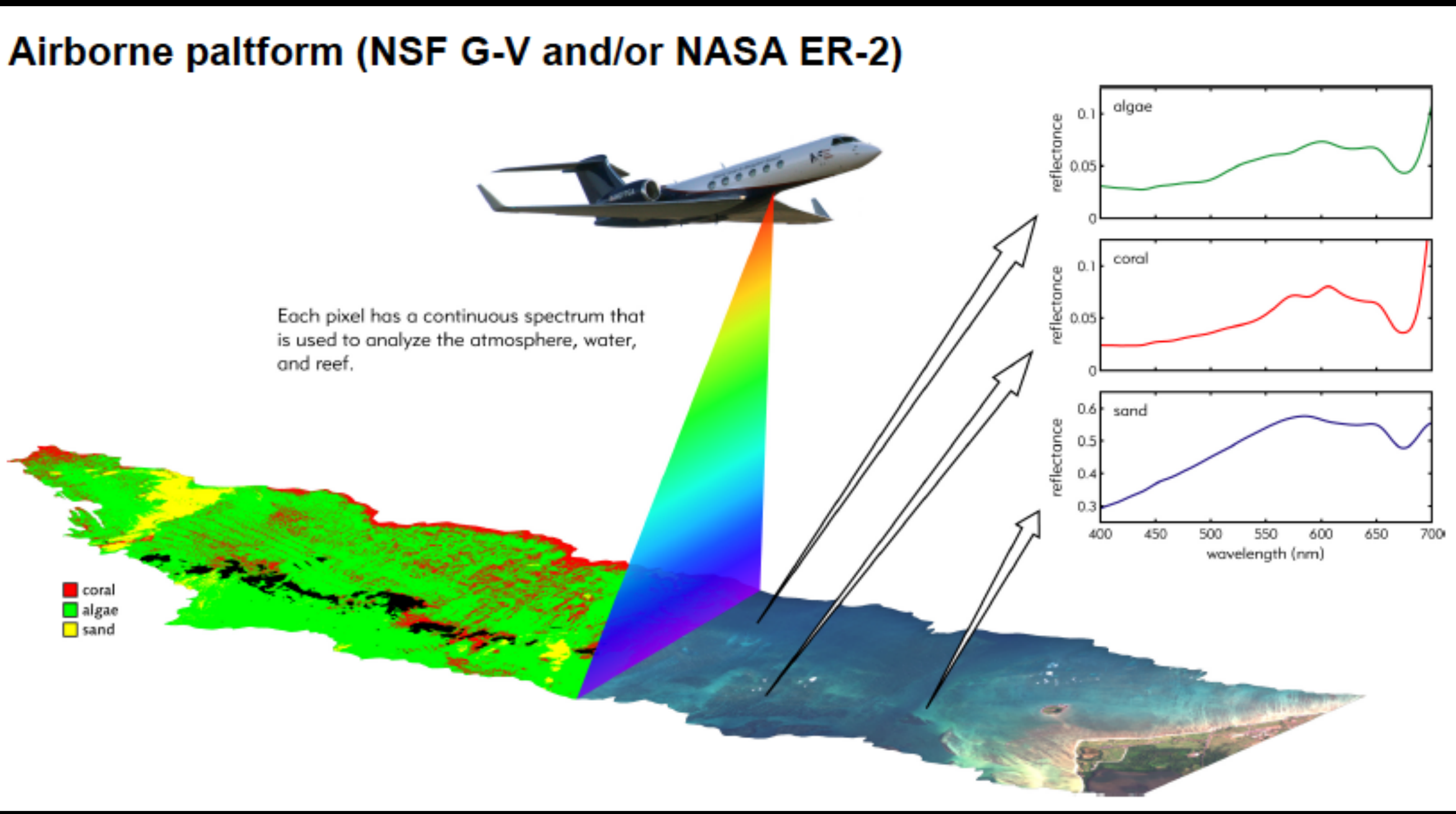




Dieerson et al. PNAS 2015

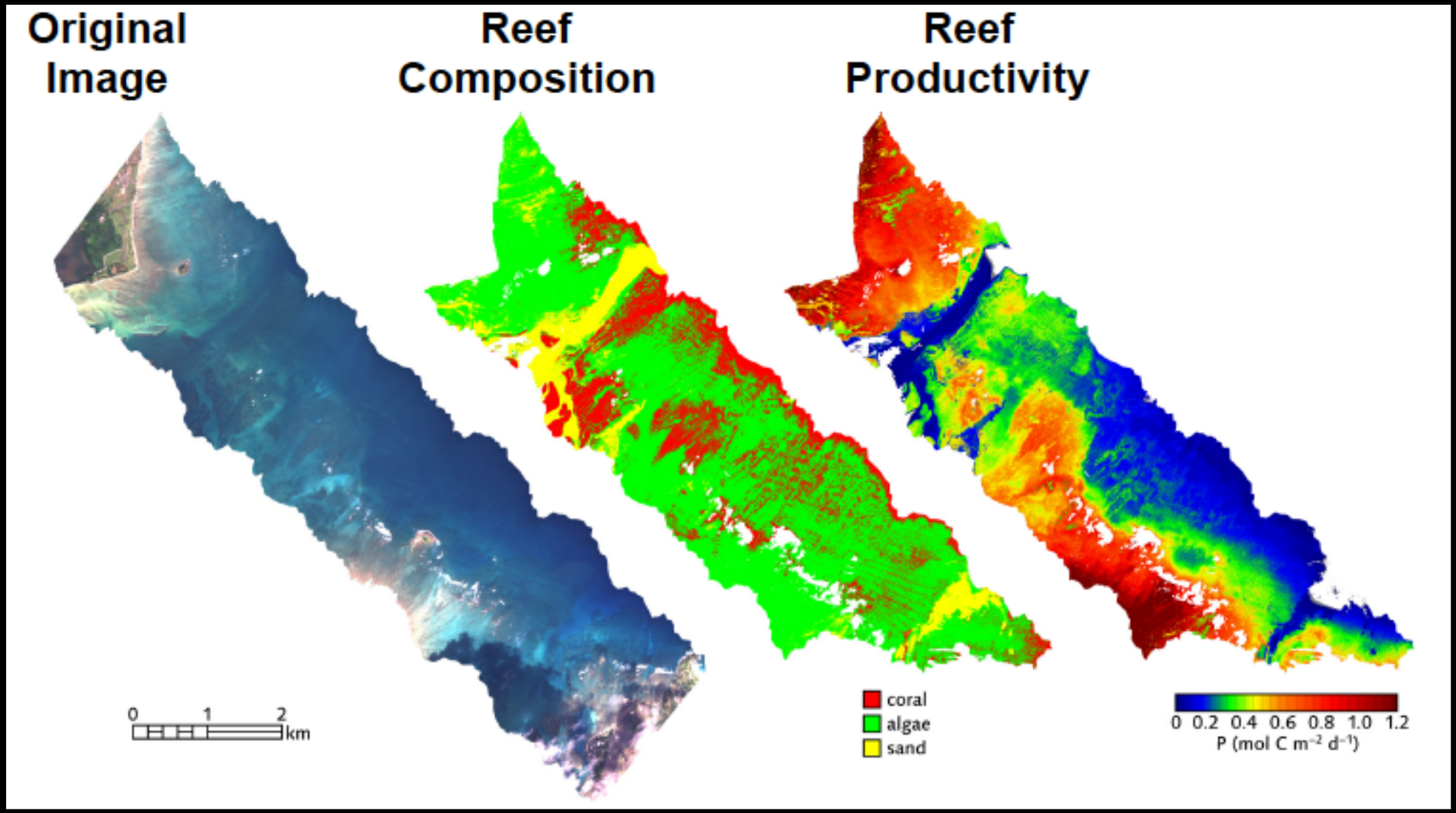
CORAL

COral Reaf Airborne Laboratory



CORAL

COral Reaf Airborne Laboratory

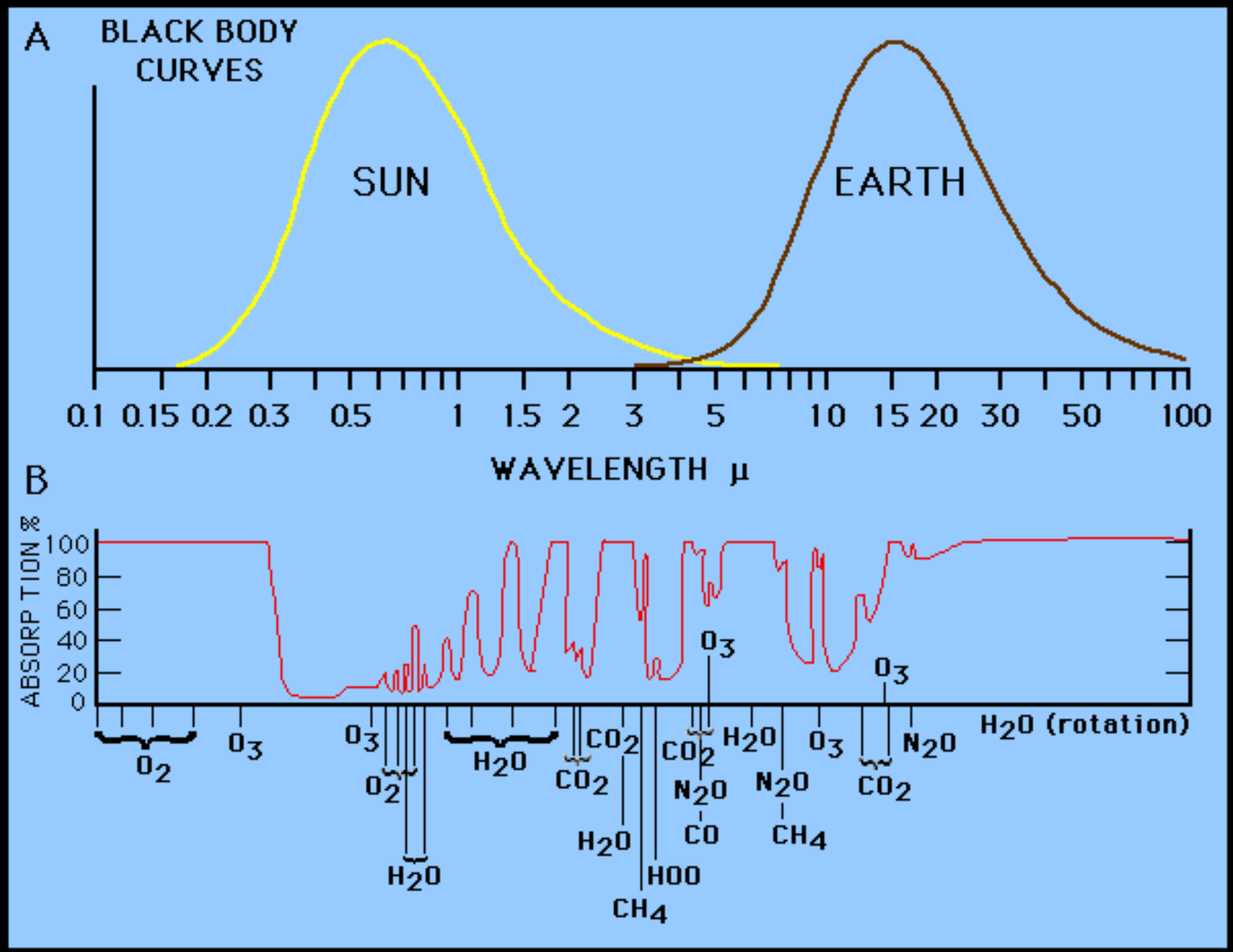


Remote Sensing of Trace Gases

- CO_2: anthropogenic greenhouse gases
- CH_4: a greenhouse gas
- N_2O: a greenhouse gas
- Ozone: protect us from UV radiation
- SO_2: Acid rain

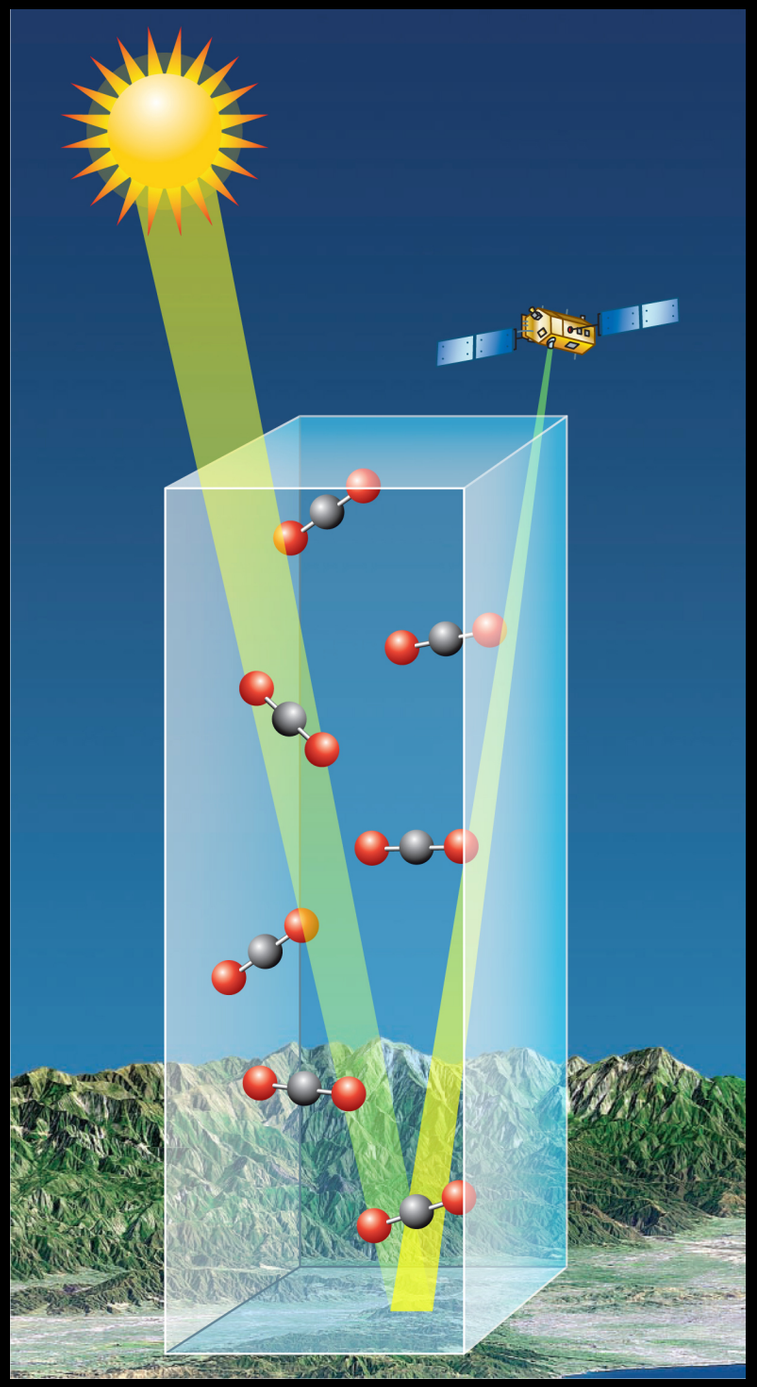
- What are the requirement?
  - Spatial: trace gases are well mixed
  - Temporal: depends on the lifetime of gases and the source
  - Spectral: 10 nm? 1 nm? <1 nm?

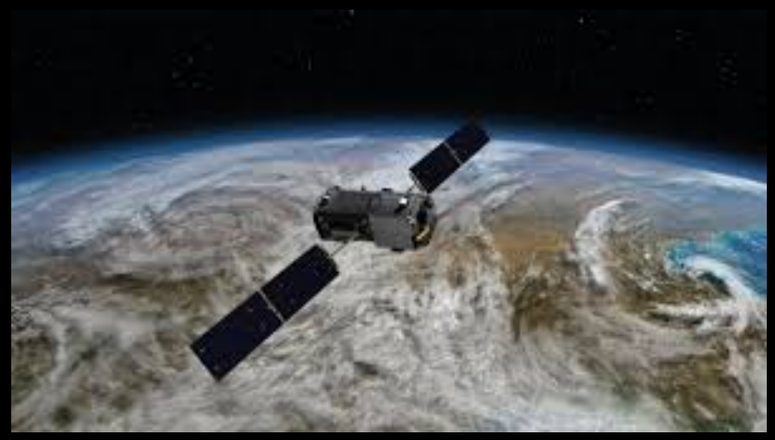
Trace gas absorption features



http://eesc.columbia.edu/courses/ees/climate/lectures/radiation_hays/

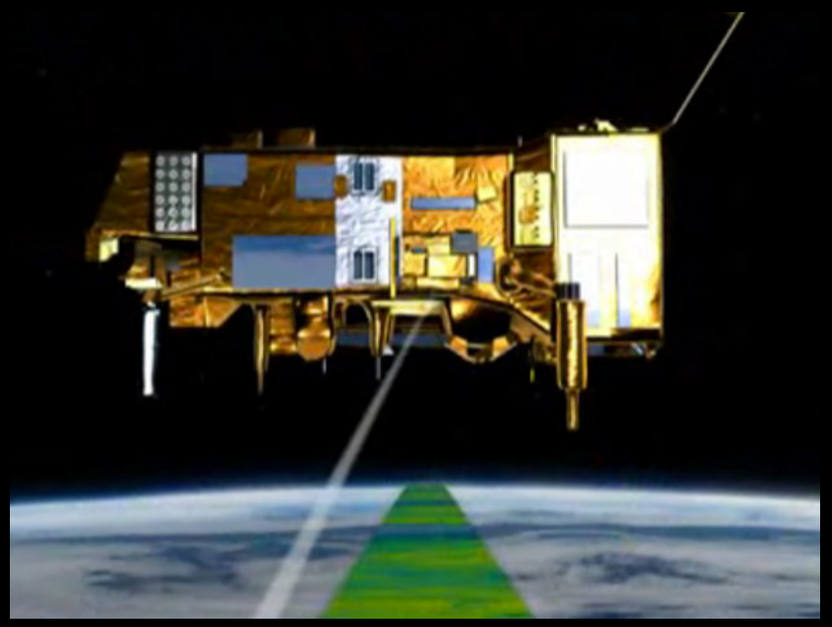
Sensors that measure trace gases





OCO-2

(Orbital Carbon Observatory 2)



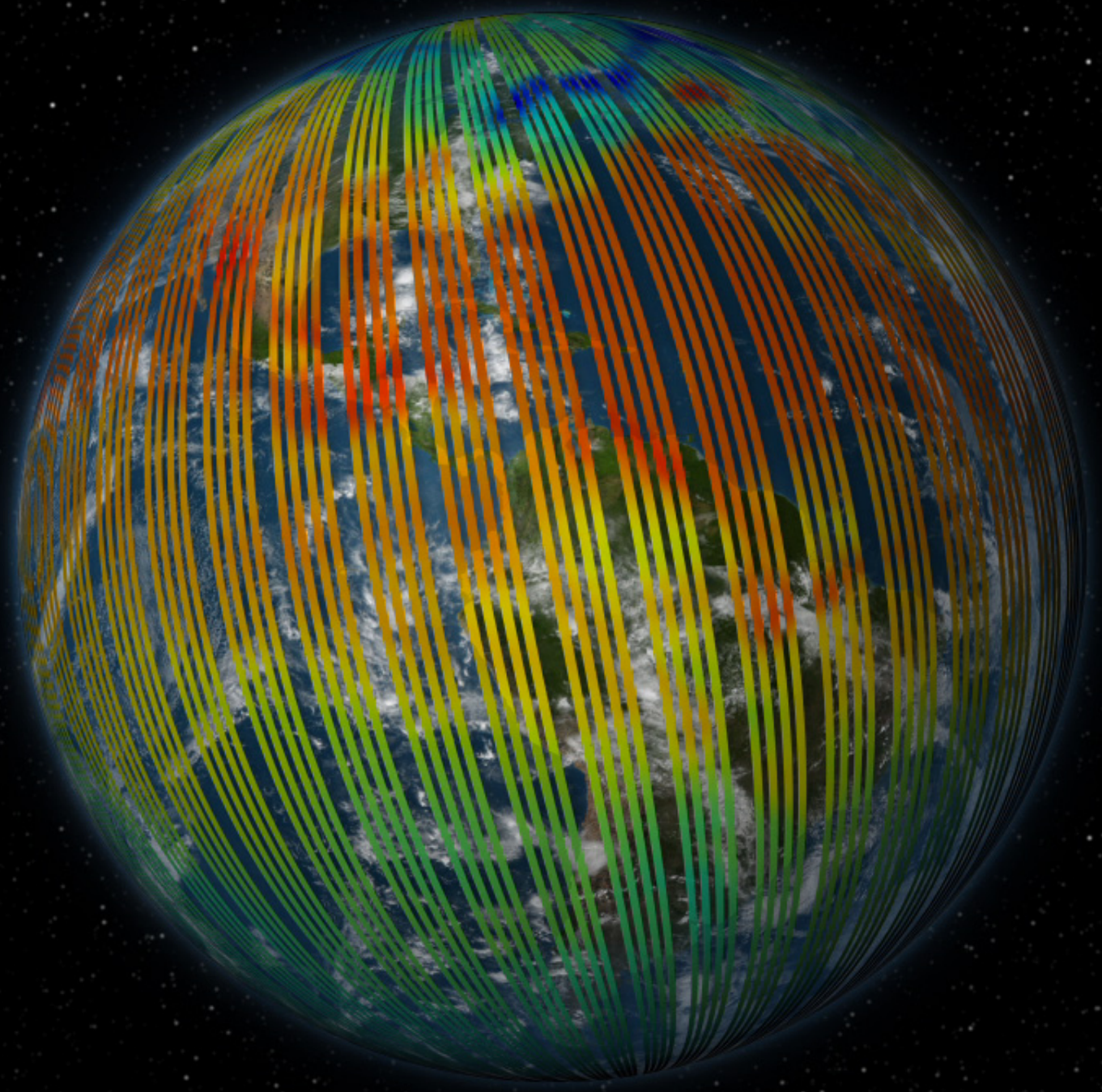
GOME-2

(Global Ozone Monitoring Experiment 2)

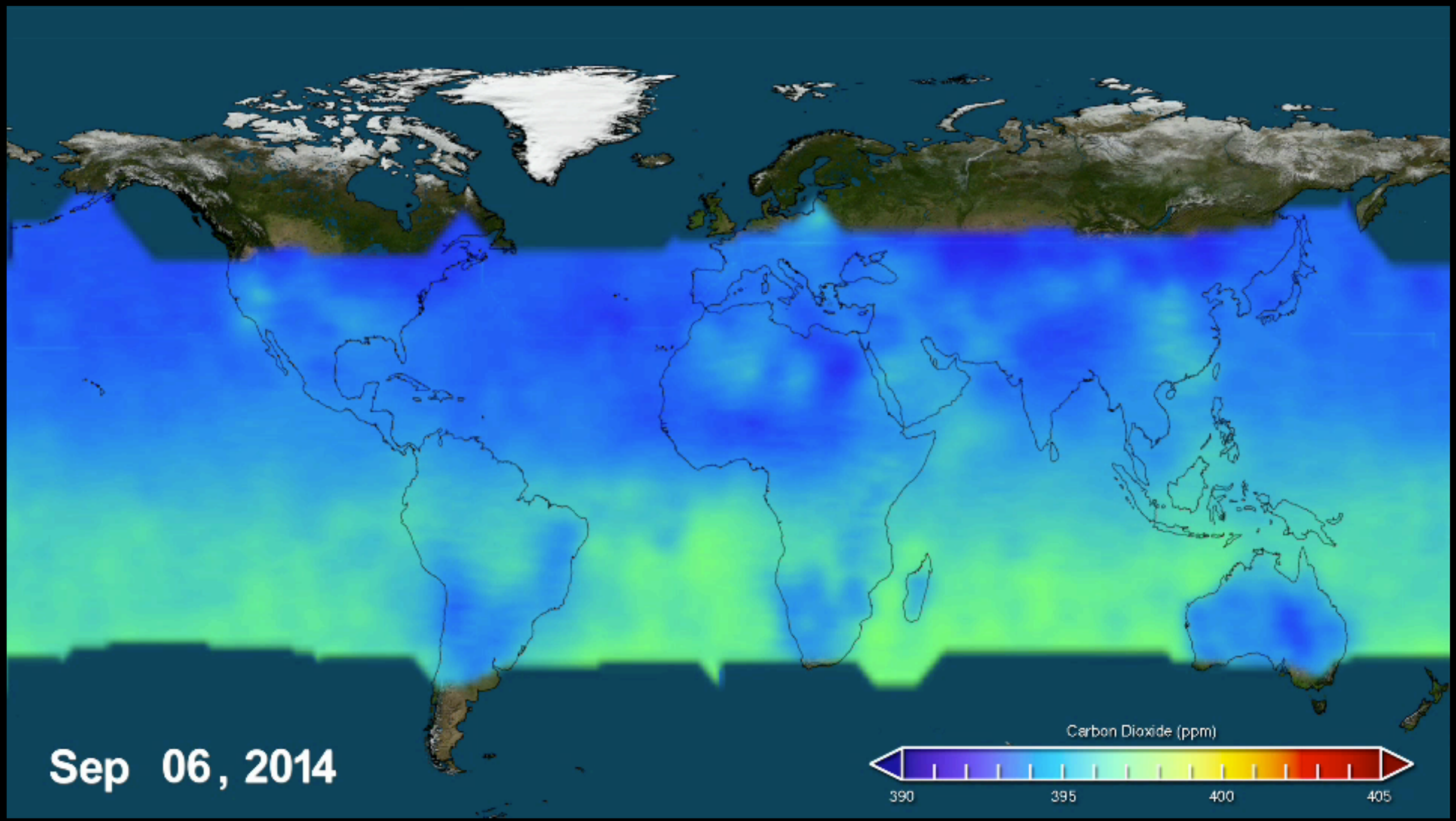
- GOSAT
- OMI/Aqua
- MOPITT/Terra
- AIRS/Aqua
- SCHIAMACHY

OCO-2 ground tracks

100000 measurements daily

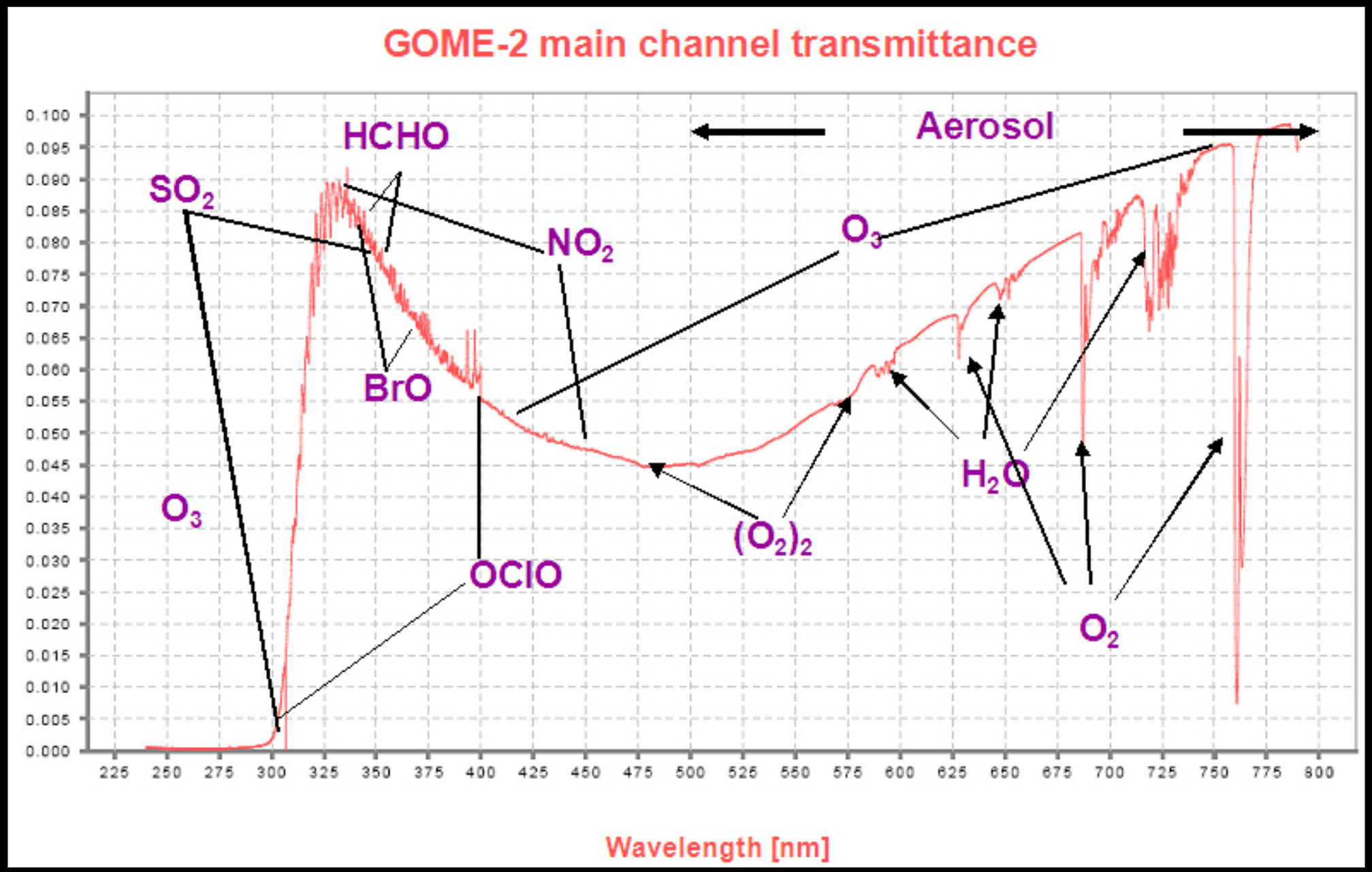


CO_2 map from OCO-2 (2014-2015)



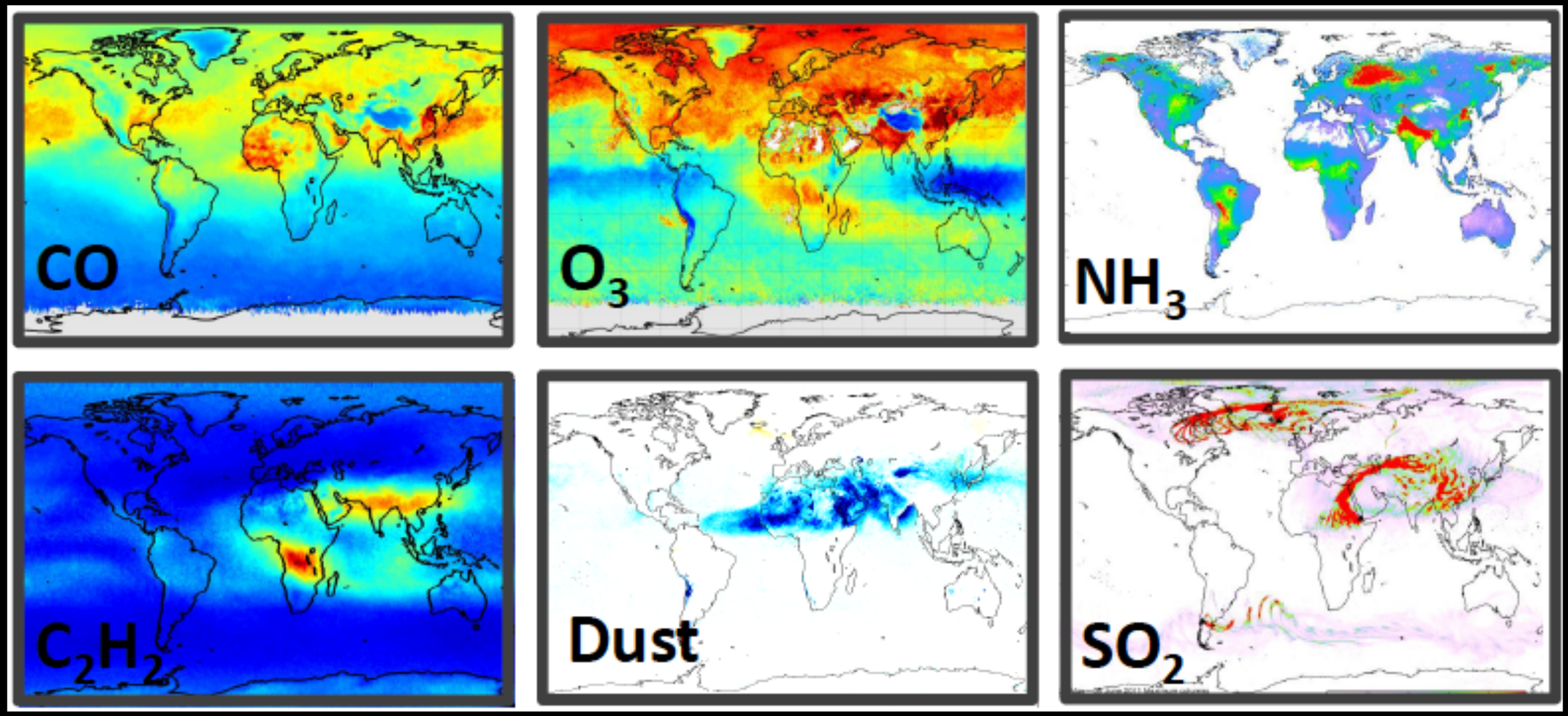
GOME-2

Measures multiple greenhouse gases



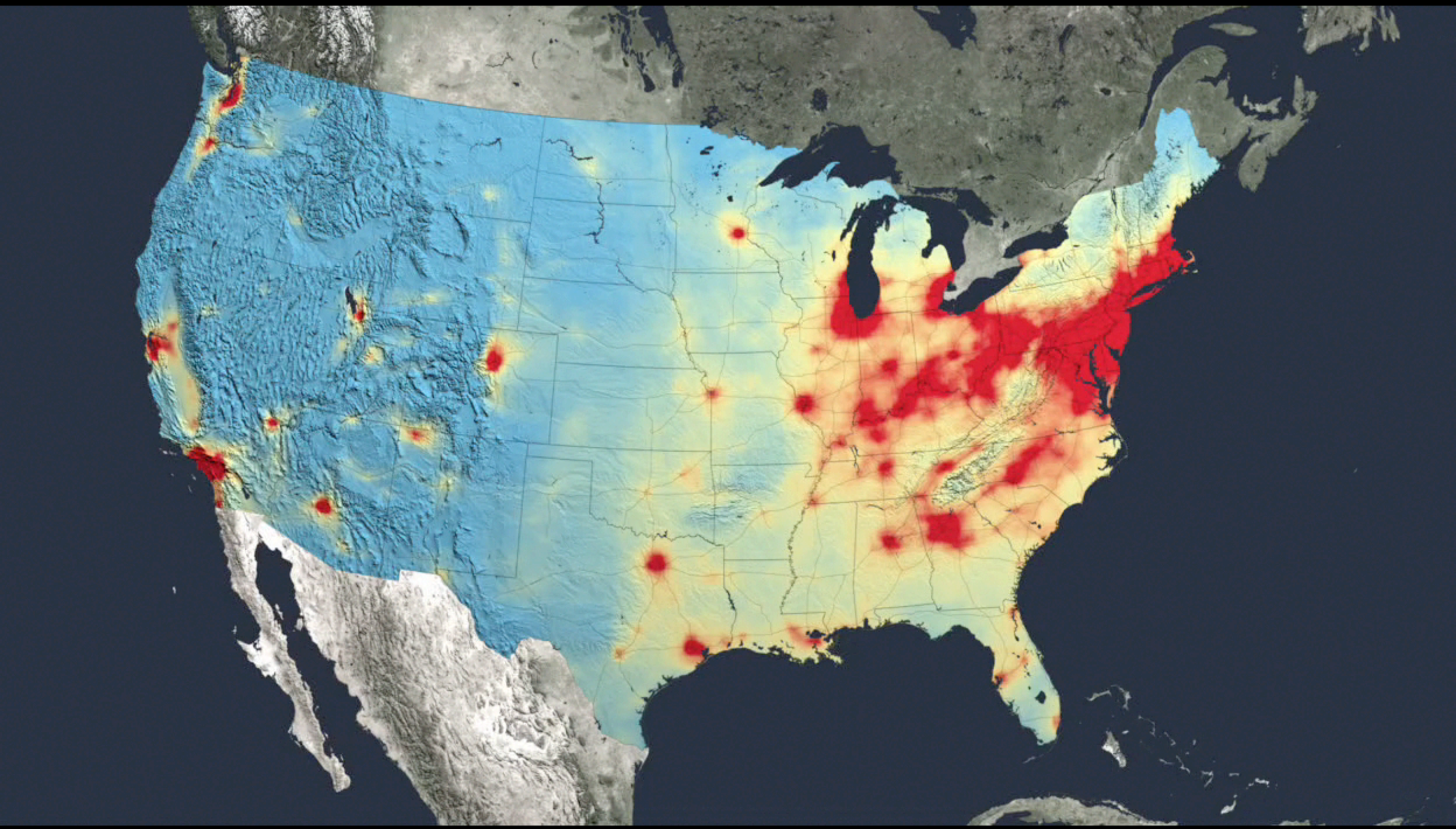
GOME-2

Measures multiple greenhouse gases

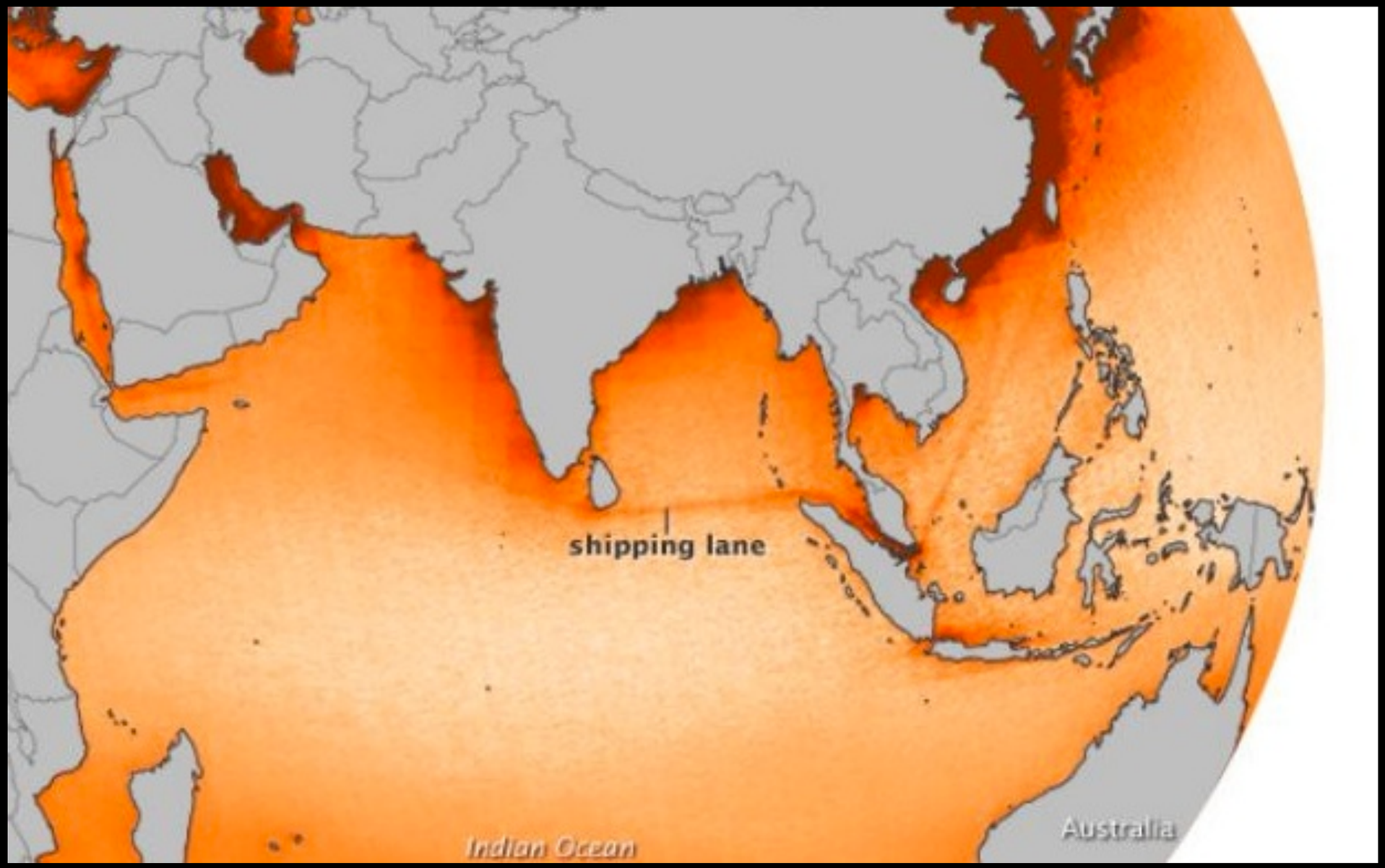


Nitrous Dioxide from 2005 to 2011

Aqua OMI - Ozone Monitoring Instrument



NO_2 from ships



Recap

- Mechanism: the absorption features
- Hyperspectral: high spectral resolution; MANY bands!
- We we can see from space?
  - Biodiversity;
  - Algal bloom;
  - Biomass burning;
  - Ozone hole;
  - Volcano eruptions;
- What we cannot measure?
  - Radioactivity (e.g., Fukushima) — UV radiation
  - Short life-time gases — require high temporal res.
  - Small scale events — we need ground observations!