National Aeronautics and Space Administration

Earth Explorer: Ozone and Trace Gases

Principal Investigator: Nathaniel Livesey (329); Co-Investigators: Jessica Neu (329), Felix Seidel Caprez (329), Vivienne Payne (329), Michelle Santee (329), Kevin Bowman (329), Carl Percival (329), Kazuyuki Miyazaki (329), Thomas Pagano (382), Stanley Sander (320)

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Strategic Focus Area: Earth System Explorer - Strategic Initiative Leader: Sabrina M Feldman

Objectives

Recognizing that:

1. The 2017 Earth Science Decadal Survey (DS) recommended an "Ozone and Trace Gases" (OTG) opportunity be included in the "Earth Science Explorer" (ESE) program.
2. Multiple complementary approaches for observing atmospheric composition from space exist.

Our objectives for this first year include:

1. Compile and prioritize relevant science questions and objectives from the DS and elsewhere as appropriate.
2. Formulate candidate approaches to making measurements that address these questions, bearing in mind the capabilities of state-of-the-art technologies and of observing systems in the Program of Record (PoR).

Approach and results

Science questions

- We have developed ~30 science questions covering a range of topics.
- Two of the common themes that emerged are discussed in the remainder of this poster.

Constraining the abundance of tropospheric OH

- The OH radical is the "atmospheric detergent" governing the lifetimes of many pollutants.
- Although critical to much of atmospheric chemistry, its abundance in the troposphere cannot be measured from space.
- However, measurements of other trace gases can be used to constrain model estimates of OH.
- Preliminary work (Figure 1) shows how assimilation of data from existing sensors affects model OH estimates.
- Future work will prioritize and identify requirements for observations of other species that better improve OH estimates.

Measurements of Biogenic Volatile Organic Compounds (BVOCs)

- BVOCs, mostly generated by trees when under stress, play a critical but poorly understood role in tropospheric ozone formation.
- Global observations are needed to advance our understanding of the role played by BVOCs and to improve predictive capability.
- The infrared spectrum is rich in signatures of BVOCs (Figure 2)
- We have developed various point designs for an "Infrared Composition Atmospheric Sounder" (INCAS) instrument concept to deliver global observations of BVOCs (Figure 3).

Significance and benefits to JPL

- The proposed work lays the groundwork for future JPL-led or JPL-participating proposals to NASA's new Earth System Explorer (ESE) program.
- This work cements JPL's strong role in OTG-related observations by developing concepts for next-generation sounders that fill identified gaps in established knowledge and the expected observations from the Program of Record (PoR).
- The concepts developed may also be suitable for proposal to other opportunities, including those under the Earth Venture program.

Background

- Anthropogenic influences on atmospheric composition are the main drivers of global environmental change and have major impacts on human and ecosystem health.
- A major challenge in Earth System Science is to improve predictive capability for atmospheric composition on the timescales associated with climate forcings and feedbacks and those required for air quality forecasts.
- Atmospheric composition is affected by many processes, including surface emissions and deposition, horizontal and vertical transport, photochemistry, interactions with aerosols and clouds, impacts of lightning and solar/cosmic particles, transport between the various atmospheric layers, and transport/mixing and chemical processing within those layers.
- All these processes take place in different domains (boundary layer, free troposphere, upper troposphere, stratosphere), and no single measurement technique is capable of probing them all.

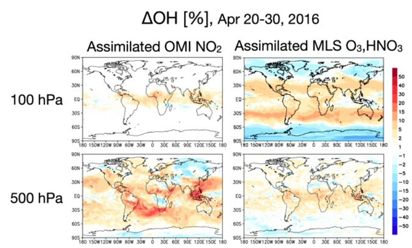

Figure 1: Changes in model-estimated OH abundance at two different pressure levels (rows) resulting from the assimilation of column NO_2 from OMI (left) and O_3 and HNO_3 profiles from MLS (right).

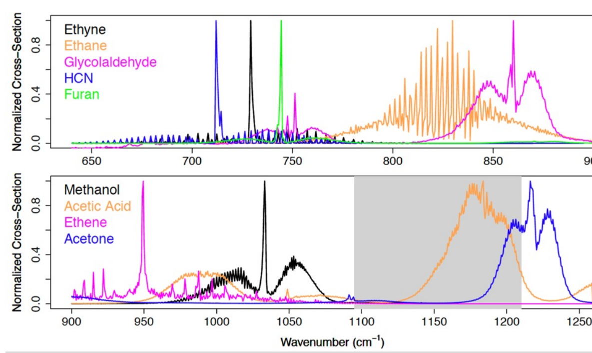

Figure 2: Spectral signatures of target BVOC species. Plot shows the normalized absorption cross sections for various BVOCs as a function of wavenumber (range equivalent to roughly 8–15μm).

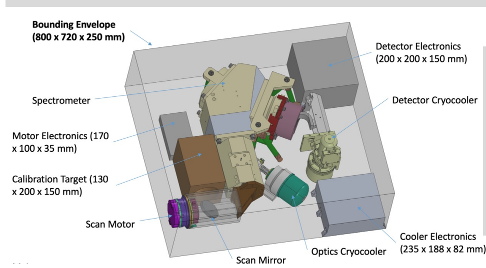

Figure 3: Illustration of a "traditional" single-order INCAS instrument design.

Publications: None as yet.

PI/Task Mgr. Contact Information:
Email: Nathaniel.J.Livesey@jpl.nasa.gov

National Aeronautics and Space Administration
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California
www.nasa.gov

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