National Aeronautics and Space Administration

Coupled Atmosphere-Surface Retrievals for Visible/Shortwave Infrared Imaging Spectroscopy

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Program: Topic

Project Objectives:

•Develop fast and accurate radiative transfer model for VSWIR imaging spectroscopy applications

•Use optimal estimation theory to simultaneously retrieve atmospheric and surface properties

•Perform simulation-based uncertainty quantification to assess retrieval error distribution

•Develop methodology for simultaneous spatial (multi-pixel) retrievals

FY18/19 Results:

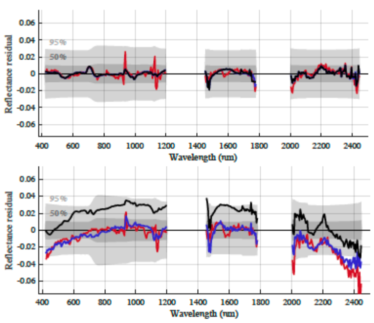

Figure 1: Spectral reflectance residuals for two different scenes from the AVIRIS-NG India campaign. The red lines denote traditional sequential surface/atmosphere retrievals, while the blue and black lines denote optimal estimation retrievals using a stock rural aerosol model and a mixture of three aerosol types, respectively. The shaded regions show 50% and 95% posterior predicted uncertainty slopes.

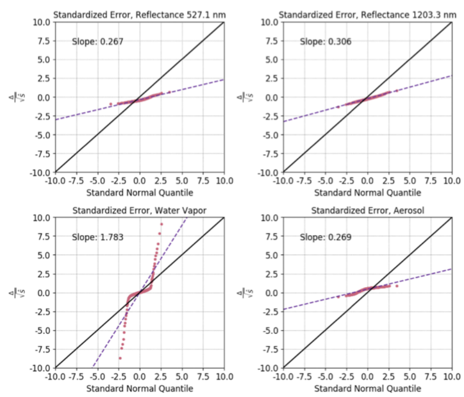

Figure 2: Simulation experiments can assess realized retrieval error against reported uncertainty. Quantile-quantile plots for a sample experiment show that surface retrieval errors (top) perform as expected; water vapor retrieval errors (bottom left) are more variable and non-Gaussian.

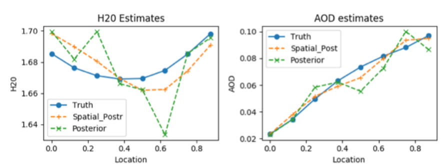

Figure 3: Retrievals of (left) H2O and (right) aerosol optical depth (AOD) over eight spatially contiguous pixels using (green) standard and (orange) spatial retrievals. The blue lines represent the truth.

Benefits to NASA and JPL (Significance of Results):

Improve Current State of the Art

•Utilizes spectrally resolved information.
•Properly accounts for atmosphere-surface coupling.
•Provides error estimates and quantifies uncertainties.
•Accounts for spatial coherence.

Enable Missions/Science

•Applies JPL investment in radiative transfer/optimal estimation/uncertainty quantification to new science domain (VSWIR imaging spectroscopy).
•Puts JPL at a significant competitive advantage for future imaging spectroscopy missions (EV-I, EV-S, Decadal Survey, Planetary and Exoplanetary atmospheric characterization missions.
•Effort will yield insight into aerosol conditions in AVIRIS-NG India campaign, an important benchmark dataset.
•Algorithmic advances would be incorporated into standard AVIRIS-NG Science Data System.

Publications:

Thompson, D. R., V. Natraj, et al. (2018), Optimal Estimation for Imaging Spectrometer Atmospheric Correction, Remote Sens. Environ., 216, 355-373.

Bue, B. D., D. R. Thompson, V. Natraj, et al. (2019), Neural Network Radiative Transfer for Imaging Spectroscopy, Atmos. Meas. Tech., 12(4), 2567–2578.

Thompson, D. R., V. Natraj, et al. (2019), A Unified Approach to Estimate Land and Water Reflectances with Uncertainties for Coastal Ocean Imaging Spectroscopy, Remote Sens. Environ., 231, 111198.

Thompson, D. R., V. Natraj, A. J. Braverman, et al. (2019), Optimal Estimation of Spectral Surface Reflectance in Challenging Atmospheres, Remote Sens. Environ., 232, 111258.

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Poster No. RPC-046