Title: Integrating MODTRAN6 into the Plume Tracker Data Analysis Toolkit: A Progress Report

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Topic Preference: retrievals of geophysical parameters, trace constituents, MOD6 development

Infrared remote sensing is a vital tool for the study of volcanic plumes and clouds, and radiative transfer (RT) modeling is required to derive the sulfur dioxide (SO_2), sulfate aerosol (SO_4), and silicate ash (pulverized rock) content of plumes and clouds from measurements of scene radiance. In the thermal infrared (TIR), we must account for the temperature, emissivity, and elevation of the surface beneath the plume, plume altitude and thickness, and local atmospheric temperature and humidity. Our knowledge of these parameters is never perfect, and interactive mapping allows us to evaluate the impact of these uncertainties on our estimates of plume composition.

The Jet Propulsion Laboratory (JPL) is collaborating with Spectral Sciences, Inc. (SSI) to develop high-performance RT modeling tools to map volcanic plumes based on multispectral image data. The foundations for our new tools are the Plume Tracker toolkit, developed at JPL, and MODTRAN RT model, developed by SSI. Plume Tracker provides a graphical user interface (GUI) that integrates MODTRAN-based retrieval procedures for surface temperature, surface emissivity, and plume gas concentrations with interactive utilities to visualize and analyze input data and output data products.

Building on the previous version of Plume Tracker, which is based on a custom (JPL) API to an outdated version of MODTRAN, we are developing Plume Tracker V.6, based on the MODTRAN6 RT model. The integration of MOD6 results in many improvements to Plume Tracker, including:

- More accurate band models and treatment of scattering
- Chemical plume option – flexibility in plume composition and geometry
- Multiple Spectral Resolution Options: 0.1, 1, 5, 20 cm-1 bins
- Modeling the VSWIR and TIR radiance of heterogeneous (mixed gas + particulate) plumes

Plume Tracker gains access to the full suite of RT modeling capabilities through the MOD6 API, the first API developed and maintained by SSI. Through a contract with JPL, SSI has developed an IDL Wrapper to the API that enables direct, object-based, communication of data between Plume Tracker and MOD6.

Plume Tracker's retrieval procedures require multiple calls (> 20) to MODTRAN per observed spectrum, or image pixel, and the efficient communication of data is necessary for high performance. To further improve performance, we have implemented a hash table strategy to cache the input parameters and atmospheric transmission and radiance spectra from prior runs of MODTRAN, and re-use the cached spectra in retrieval procedures based on similarities between the cached input parameters and inputs required for the retrievals, and reconstruction of top-of-the-atmosphere radiance, based on variations in surface temperature and emissivity, to increase the re-use of the cached spectra. We will report on our efforts to preserve these performance-enhancement strategies while integrating the powerful new modeling capabilities provided by MODTRAN6.