PACE/HyspIRI COMPLEMENTARY MISSION APPLICATIONS:
Improving Hazard Assessment and Aviation Safety

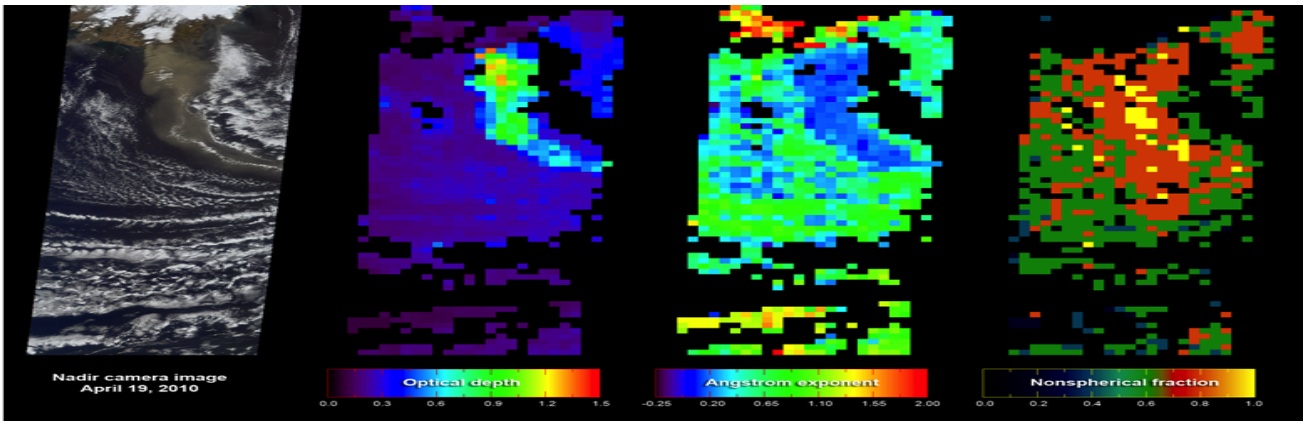

Figure 1. An example of MISR air mass mapping applied to the Eyjafjalljökull Volcano Ash Plume on April 19th, 2010. The four panels show successive information content (true color, optical depth, size, and sphericity) obtained from retrievals using multi-spectral, multi-angle MISR data (courtesy of Ralph Kahn and the MISR Team). This is similar to the information content of the multi-angle multi-spectral polarimeter planned for PACE.

Application Question/Issue

Aviation operations can be significantly impacted by volcanic ash as evident from the recent Eyjafjallajökull volcano in Iceland (April 2010). Knowledge of the location, amount, and evolution of the volcanic plume and its ash content will enable timely and accurate hazard assessment/avoidance and enhance aviation safety after volcanic eruptions.

Who Cares and Why?

Volcanic plumes consist of Sulfur Dioxide (SO_2) and volcanic ash which is predominantly composed of silicates with a melting point (~1100^{o}C) far below typical turbine engine full thrust temperatures of ~ 1400^{o}C. Aircraft flight through high concentrations of volcanic ash will fuse molten silicate onto turbine blades and guide vanes leading to transient flame out, and possibly engine failure. According the International Civil Aviation Organization (ICAO), more than 100,000 commercial flights were cancelled during the Eyjafjallajökull's 2010 volcanic eruption and over $5 billion in global GDP was lost due to what eventually became the largest shut-down of European air traffic since World War II.

Needed Measurements

An ICAO task force recommended the use of satellite-based observations to guarantee safety while avoiding the unnecessary closure of immense portions of airspace. The closure of air space during the 2010 eruption of Eyjafallajökull was based on forecasts rather than satellite observations of ash. Satellite measurements will help to initialize and/or validate such forecasts. Measurements of volcanic plumes, plume height, ash and SO_2 concentrations, and the ability to discriminate between clouds of volcanic ash and meteorological (water/ice) clouds are needed. Some of these measurements are needed both day and night for the development of advisories directly or as inputs to model simulations from which such advisories will be developed.

The NASA Response

Measurements, similar to the information content of Figure 1 above, that would identify the ash particle size and concentration (from a **Multi-angle Multi-spectral Polarimeter on PACE**), and the ability to discriminate between water/ice clouds and volcanic plumes (from **HyspIRI**) would form **a complementary data** set and provide the relevant Volcanic Ash Advisory Centers (VAACs) **sufficient actionable information** for hazard avoidance during volcanic eruptions. The Eyjafjallajökull plume was observed by many satellite sensors including OMI, MISR, MODIS, SEVIRI, ASTER, AIRS, and CALIPSO. The MODIS instruments (in low earth orbit on the Terra and Aqua satellites) and the SEVIRI instrument (on METEOSAT in geostationary orbit) tracked the geographic transport of the ash plume and estimated its height and ash particle size. HyspIRI Thermal Infra-Red (TIR) measurements will provide us with similar capabilities. The MISR instrument on the Terra satellite, provided critical information that allowed mapping the height of distinct plumes over the North Atlantic. Multi-angle aerosol measurements on board PACE would enable plume heights to be derived in a manner similar to those employed using MISR. Additionally polarization measurements aboard PACE would enable separation of volcanic ash from sulfate aerosols. The ability to obtain these data and develop timely advisories results in a direct societal benefit.

Comments? Thoughts?

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