IRS2012-202
International Radiation Symposium 2012
Dahlem Cube, Berlin, Germany, 06 – 10 August 2012

Can a Spatially Unresolved 3D Mix of Clouds and Aerosols by Disentangled for Remote Sensing Purposes using Multi-Angular Polarized Radiance Observations?

A.B. Davis (1), M.J. Garay (1), F. Xu (1), C. Emde (2), and A. Marshak (3)

(1) Jet Propulsion Laboratory / California Institute of Technology, Pasadena, Ca, United States (anthony.b.davis@jpl.nasa.gov, +1-818-393-4619), (2) Ludwig Maximilians University, Munich, Germany, (3) NASA - Goddard Space Flight Center, Greenbelt, Md, United States

Aerosols have been identified as one of the most significant sources of uncertainty in predictive climate modeling, and this translates to a challenge for the atmospheric remote sensing community. Part of this challenge is to characterize the aerosol well-enough to separate its anthropogenic and natural components. This situation is exacerbated by the fact that it is in fact the complex interactions of aerosols with clouds (so-called "indirect effects") that most need to be better understood. In sharp contrast, the current operational procedure in aerosol remote sensing is to work only with pixels that are as far away as possible from clouds (to minimize cloud adjacency effects) and that are the most likely to be free of contamination by unresolved cloud. This down-selection process will lead at best to a reasonably good characterization of the aerosols responsible for the so-called "direct" radiative effect on climate.

NASA's Glory mission was poised to take aerosol remote sensing to levels of accuracy that would significantly improve climate modeling. Unfortunately, it failed at launch in 2011 (but hopefully will have a prompt re-flight). Glory's innovative observational approach was, in essence, to mine photon state space almost exhaustively. That is, to use the Aerosol Polarimetry Sensor (APS) instrument to project every detected photon onto its spectral, directional, and polarization dimensions in its inherent space of possible quantum mechanical eigen-states. We will explore the possibility of using this comprehensive optical measurement scheme to determine aerosol quantity and quality in the close vicinity of clouds. This capability would make aerosol remote sensing directly applicable to cloud-aerosol interaction studies, which can only be done at present (with certain limitations) using active lidar techniques.

Now, the potential vulnerability for Glory's APS data exploitation is that its spatial resolution is only $\sim$6 km at nadir, and its footprint becomes an elongated ($\sim 6\times 20$ km^2) ellipse for the most oblique views. So one must worry about 3D radiative transfer effects unfolding in this region and, to a lesser extent, about net radiative fluxes coming from its spatial environment. To provide the cloud screening—as well as assistance to any attempt at cloud-aerosol unmixing—Glory also has two mono-spectral intensity-only Cloud Cameras (CCs) that look straight down at a broader scene with $\sim$0.5 km resolution.

At this point, we will use a state-of-the-art 3D vector (polarized) radiative transfer model to simulate Glory observations (APS and CCs) and preliminary unmixing algorithms based on 1D vector radiative transfer modeling. This modeling toolbox will enable us to perform an objective error quantification. We fully anticipate that this will show a degraded accuracy with respect to pure aerosol (or cloud) cases. Yet, in view of the difficult aerosol-cloud-climate science questions to be addressed, this degraded accuracy may still be useful.