

“Volume Closure”: A Next Step in Validating Our Interpretation of Atmospheric Observations by Satellites?

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We in the satellite remote sensing community have come up with quite a number of “retrieval algorithms.” These are aimed at interpreting the radiances measured by Earth-viewing satellites in terms of atmospheric properties, such as the amount and type of particles suspended in the air. Since aerosol retrieval is an under-determined problem, assumptions are routinely made about properties of the underlying surface, scene variability, and aerosol vertical distribution. Prior knowledge is applied to constrain the range of aerosol properties considered by the retrieval.

Quantitatively testing the validity of these algorithms, under a range of natural conditions, is proving to be a major challenge. The most ambitious approaches involve surface stations, ships, and aircraft carrying an array of direct sampling and remote sensing devices intended to characterize the surface and atmosphere as the satellite flies overhead. These field campaigns typically last about a month, during which fundamental questions about experiment design, spatial and temporal sampling, and the degree to which particular meteorological conditions are representative of other times and places, are debated as flight decisions are being made. Practical considerations must be folded in, such as restricted waters and air space, and altitude and flight duration limits. Once the data are collected, the debate continues, focusing on how best to analyze, and how to interpret, the results.

“Column Closure” represents a conceptual advance in satellite aerosol retrievals that developed in the mid 1990s. The idea is to collect and interpret the field measurements with the goal of obtaining characteristic surface and atmospheric properties over a region sampled by the satellite. From these characteristics, the net radiation at the top and bottom of the atmosphere can be calculated. The net radiative flux at the top and bottom of the atmosphere is measured as well, and the comparison between the measured and calculated fluxes is used as an indication of the degree to which the environment has been well-characterized.

For the new generation of satellite instruments, such as the Multi-angle Imaging SpectroRadiometer (MISR) that flies aboard NASA’s Terra satellite, the calibration is so good that spatial variability, even over “uniform” ocean sites several kilometers in size, must be taken into account. In planning for the ACE-Asia and CLAMS field campaigns, which took place in April and July 2001, we extended the Column Closure idea to “Volume Closure,” aimed at characterizing the variability of the surface and atmospheric radiative properties along with the representative values. Experiment designs included high-temporal-sampling with surface and airborne radiometers, and “stacked L” flight trajectories. This talk will describe what we were able to measure, will describe how we are planning to analyze the results, and will ask for thoughts about how we might do better.