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Yoram Kaufman, Lorraine Remer, Bo-Cai Gao

1.0 Aerosol Models

At the end of 1994 we had developed an aerosol model for sulfate aerosol from analysis of the ground-based sun/sky radiometer data of SCAR-A. This model consists of five lognormals of fixed radius and standard deviation which vary in volume according to the aerosol optical thickness. Two of the modes represent the aerosols resulting from gas-to-particle conversion and cloud processes, respectively. Most of the optics in the model are determined by the relative strengths of these two modes as the aerosol optical thickness changes. Also at the end of 1994 we discovered a flaw in the inversion algorithim which calculates aerosol volume distribuiton from sky radiances. At both the smallest and largest radii the inversion overcompensates for boundary conditions which force the distribution to be zero beyond the resolved range of particle sizes. This creates an appearance of an abundance of unphysically small and large particles. However, this is a minor flaw in that the inversion retrieves a size distribution which accurately reflects the correct optical properties of the aerosol even though the size distribution itself is in error.

During the first three months of 1995 we continued to refine the sulfate aerosol model by developing a correction to the flaw in the inversion and by validating the model results with data. In addition, we used a similar methodology to develop an aerosol model for smoke aerosol by analyzing data from the sun/sky radiometer network in the Brazilian biomass burning region.

To correct the inversion flaw we match the single-scattering radiance calculated from the flawed volume size distribution for the first 40 degrees to that of a lognormal distribution in a look-up table. The reasoning is that the inversion must gives us the correct optics for the first 40 degrees. We then correct the volume of the distribution by keeping constant the optical properties (aerosol single scattering spectral path radiance) before and after the adjustment. The result of the correction is a physically realistic volume size distribution with the same optics as measured by the instrument. We validated this model by comparing model-generated sky radiances to those measured directly by the sun/sky radiometers and we get excellent agreement.

Using a similar methodology, we developed an aerosol model for smoke aerosol. The resulting model is less complex than that of the sulfate aerosol. We find a good fit to the volume size distributions with only three modes, not five. There is a single accumulation mode for smoke which has constant sized particles for a wide range of optical thicknesses. The smoke model was also validated by finding an excellent agreement between model-generated sky radiances and those measured directly by the sun/sky radiometers.

The modal radii suggested by our models agree well with previous ground-based in situ observations. However, the standard deviations or modal widths of our model tend to be larger than previously observed. We are now in the process of comparing our SCAR-A volume size distribution retrievals to airborne in situ measurements of the Univ. of Washington C131A aircraft. Qualitatively the initial comparisons look very promising; however, again the inverted size distributions tend to be wider than the in situ measurements.

2.0 Planning for SCAR-B

We progressed quickly in planning SCAR-B during the first quarter of 1995. The following are some important milestones to which we have contributed:

- Completion of the SCAR-B Mission Plan. This document describes the scientific objectives and a broad plan outlining how these objectives will be met by the integration of the three different aircrafts, ground researchers, satellite analyses and sun/sky radiometer network. Also included in this document is a detailed description of the logistics involved.
- Completion of the SCAR-B Detailed Plan. This document describes four specific scenarios: 1) cloud free mixed aerosol 2) aerosol-cloud interaction 3) individual fires 4) large scale variability of aerosol. In each scenario, the roles of each research group is outlined and the necessary measurements and analysis specified.
- Joint US-Brazilian planning meeting at Williamsburg VA. At this meeting, the continuing diplomatic difficulties were discussed (since resolved) and preliminary plans were introduced and discussed. In subsequent informal discussions in the days following the formal meeting outstanding issues were identified, some resolved and some left as action items.
- Preparation of the Aircraft Operations Map. A map indicated the limits of the aircraft operations in Brazil and coastal ocean was delivered to headquarters. The aircraft operations area was divided into 5 sectors corresponding to different scientific objectives such that we may comply with the Brazilian airforce request to announce in advance in what sector will we fly on any particular day.
- Inclusion of AVIRIS. Permission and funding was sought and secured to bring AVIRIS to Brazil. AVIRIS provides an important additional data collection ability.

Several issues concerning SCAR-B remain unresolved. The exact procedure on daily mission planning is dependent on meteorological forecasting and information coming over the World Wide Web. Accessing this data and interacting with the mission meteorologist will need to be tested at the final planning meeting in Brasilia in June. The C-131A still needs to identify appropriate landing sites near the locations of interest.

3.0 SCAR-C Data Analysis

3.1 MAS calibration

There are three separate calibrations being performed on the SCAR-C MAS data, the visible channels, the thermal channels at background temperatures and the thermal channels at high fire temperatures. To calibrate the visible channels NASA / Ames personnel used the NASA / Ames integrating sphere characterized by John Cooper of NASA / GSFC. The resulting visble channel calibration was used in an intercomparison with AVIRIS flying on the same mission. The results of the intercomparison show that MAS agrees with AVIRIS in calibration slope but that there are offsets between the two instruments. The offset is insignificant at 0.55 µm, but as much as 0.05 in reflectance units at 0.87 µm. In all future analysis of SCAR-C data we intend to adjust the MAS data to AVIRIS values.

The background temperature calibration is proceeding well by using the onboard calibration procedure. Results are promising. However, the high temperature calibration is disappointing. Initially we had hoped to calibrate for fire temperatures by using a hotplate technique developed by Jim Brass at NASA / Ames. Unfortunately this techniqure produced unusable results. We are trying to extrapolate the onboard calibration procedure to the higher temperatures but are uncertain of our accuracy.

Calibration is still in progress, although we are pessimistic about ever retrieving fire temperature from the thermal channels.

3.2 Fire Analysis

We have begun analysis of the Quinault fire which is a prescribed fire that sent a well-defined smoke plume over the ocean. There are eight ER-2 observations of this fire over a two hour period. We have related the size of the fire to the amount of smoke by plotting both quantities as a function of time. We intend to continue this analysis by including fire temperature as well as fire size, and also to analyze the many other fires observed during SCAR-C. The goal is to relate fire characteristics to emissions. Eventually we will integrate our findings with those measured in situ by the Univ. of Washington's C-131A aircraft.

There is a difficulty in proceeding. Because of the inaccuracies in determining fire temperature from the poorly calibrated thermal channels we are proceeding the fire temperature analysis by using the 1.6 µm channel which is calibrated by intercomparison with AVIRIS. Currently a theoretical sensitivity study is underway to determine how sensitive the 1.6 µm channel is to fires at the MAS pixel resolution.

4.0 Attendance Chapman Conference

Yoram Kaufman and Lorraine Remer attended and presented papers at the Chapman Conference on Biomass Burning in Williamsburg VA in March. The time there was also spent attending a SCAR-B planning meeting and an informal SCAR-C data analysis workshop. These formal meetings plus the informal discussions with many collaborators were important and acted to advance both the SCAR-B planning and organize the SCAR-C analysis.