

## REMOTE SENSING OF SMOKE, CLOUDS, AND RADIATION USING AVIRIS DURING SCAR EXPERIMENTS

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### 1. INTRODUCTION

During the past two years, researchers from several institutes joined together to take part in two SCAR experiments. The SCAR-A (Sulfates, Clouds And Radiation - Atlantic) took place in the mid-Atlantic region of the United States in July, 1993. Remote sensing data were acquired with the Airborne Visible Infrared Imaging Spectrometer (AVIRIS), the MODIS Airborne Simulator (MAS), and a RC-10 mapping camera from an ER-2 aircraft at 20 km. In situ measurements of aerosol and cloud microphysical properties were made with a variety of instruments equipped on the University of Washington's C-131A research aircraft. Ground based measurements of aerosol optical depths and particle size distributions were made using a network of sunphotometers. The main purpose of SCAR-A experiment was to study the optical, physical and chemical properties of sulfate aerosols and their interaction with clouds and radiation. Sulfate particles are believed to affect the energy balance of the earth by directly reflecting solar radiation back to space and by increasing the cloud albedo.

The SCAR-C (Smoke, Clouds And Radiation - California) took place on the west coast areas during September - October of 1994. Sets of aircraft and ground based instruments, similar to those used during SCAR-A, were used during SCAR-C. Remote sensing of fires and smoke from AVIRIS and MAS imagers on the ER-2 aircraft was combined with a complete in situ characterization of the aerosol and trace gases from the C-131A aircraft of the University of Washington and the Cesna aircraft from the U. S. Forest Service.

The comprehensive data base acquired during SCAR-A and SCAR-C will contribute to a better understanding of the role of clouds and aerosols in global change studies. The data will also be used to develop satellite remote sensing algorithms from MODIS on the Earth Observing System.

### 2. PRELIMINARY RESULTS

The AVIRIS data acquired during SCAR-A have been used in the intercomparison of radiometric calibrations among AVIRIS, MAS, and Landsat TM5. The AVIRIS data have also been used in developing an operational algorithm for retrieving aerosol optical depths from MODIS visible and near-IR channels. In this MODIS algorithm, the 2.13- $\mu\text{m}$  MODIS channel is used to find areas covered by dark, green vegetation. The MODIS channels at 0.47 and

0.65  $\mu\text{m}$  are then used to derive aerosol optical depths over vegetated areas (Kaufman and Sendra, 1988).

Figures 1a and 1b show how the AVIRIS data can be used to improve algorithms for retrieving tropospheric aerosols. In Fig. 1a, an AVIRIS 0.557- $\mu\text{m}$  image acquired over an area in North Carolina on July 22, 1993 during SCAR-A is shown. Surface features were blurred. At first, we thought the whole image was covered by thin cirrus clouds. In Fig. 1b, a 1.372- $\mu\text{m}$  image over the same area is shown. The 1.372- $\mu\text{m}$  channel sees only the upper portion of the atmosphere; cirrus clouds and contrails from a twin engine aircraft are sharply delineated. Only the lower portion of the image was covered by thin cirrus clouds. The upper portion was actually covered by a dense haze layer with an optical depth (at 0.55  $\mu\text{m}$ ) of approximately 1.0, based on ground based sunphotometer observations. By applying a cirrus mask derived from the 1.372- $\mu\text{m}$  image to the 0.557- $\mu\text{m}$  image, areas of cirrus can be eliminated from the 0.557- $\mu\text{m}$  image, so that a better retrieval of tropospheric aerosol optical depths can be made.

### 3. DISCUSSION

Although we have received many AVIRIS data sets measured during SCAR-A, we are still in the very early stage of analyzing these data sets. We hope to fly AVIRIS during SCAR-B to be conducted in Brazil in August - September of 1995.

### 4. ACKNOWLEDGMENTS

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### 5. REFERENCES

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Fig. 1: 0.557- $\mu\text{m}$  and 1.372- $\mu\text{m}$  AVIRIS images acquired over an area in North Carolina on July 22, 1993 during the SCAR-A (Sulfate, Cloud, And Radiation - Atlantic) experiment. Surface features in the 0.557- $\mu\text{m}$  image are blurred because of large amount of haze in the lower atmosphere. The 1.372- $\mu\text{m}$  image sees the thin cirrus clouds and aircraft contrails and does not see the lower level haze layer.

