**TITLE:** NOAA Backscatter Studies

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**ACCOMPLISHMENTS:**

In the past year NOAA has measured and analyzed another year's worth of backscatter over Boulder, Colorado. The average profile for the past year (Fig. 1) was computed from 80 observations of backscatter spread throughout the year, using NOAA's $CO_2$ coherent lidar operating at a wavelength of 10.59 $\mu$m. The seasonal averages (Fig. 2) show a familiar trend -- highest backscattering in spring (perhaps due to Asian dust or biomass burning) and lowest backscattering in fall. The 1990 average profile was not significantly different from the 1988 or 1989 profiles, except that it displays a slight increase in the upper troposphere, perhaps due to the Redoubt volcano.

A manuscript has been reviewed, modified, and resubmitted to Applied Optics on the observations of backscatter made from slopes of the Mauna Loa volcano in Hawaii over a 24-day period in fall, 1988. In that paper, a technique to better analyze backscatter observations with dropouts is presented, called the "inferred" technique. There was indication in the Hawaii data of a "background" mode of aerosol backscatter, similar to that reported by Rothermel, Bowdle, Vaughn and Post for NOAA's and RSRE's 1981-1984 backscatter data using a different method of analysis. However, that mode does not appear to be present when the 1981-1984 NOAA observations are reanalyzed with the inferred technique.

In October 1989 and May 1990 the NOAA lidar was used at NASA Ames to validate backscatter measurements being made by JPL's pulsed lidar (9.25 $\mu$m) and MSFC's CW lidars (9.11 and 10.59 $\mu$m) aboard NASA's DC-8 aircraft. These efforts, in NOAA's opinion, were crucial to the success of the 2nd GLOBE survey mission, having first identified instrument problems during the 1st mission, and then helping to confirm proper instrument performance during the 2nd mission. A NOAA observer was also aboard the DC-8 for the first two legs of the 2nd mission to aid the mission scientists in evaluating onboard lidar systems' performance.

Another accomplishment in 1990 was the refining of NOAA's backscatter processing program (BETA) to enable the calculation of gaseous absorption effects based on rawindsonde measurements, as well as by using atmospheric models. A NOAA Technical Memorandum on the revised BETA program is in press, describing in addition the entire procedure NOAA uses to process, archive, manipilate, and analyze the backscatter data gathered under this research effort. These procedures (and the necessary software) were developed under previous years' NASA funding.

NOAA participated in two intercomparisons of aerosol measuring instruments near Boulder, called FRLAB (Front Range Lidar, Aircraft, and Balloon experiment). The instruments were NOAA's $CO_2$ and ruby lidars, their King Air-mounted PMS probes and nephelometer, and the University of Wyoming's balloon-borne backscatter sonde. Intercomparison of all the data sources is possible using Mie theory, and preliminary results are encouraging. Ultimately, it is hoped that scaling factors can be developed to tie together historical records of the various instruments.

Finally, considerable effort was put into developing a multi-agency science proposal to NASA headquarters (MACAWS) to work with both JPL and NASA Marshall to produce an airborne Doppler lidar facility for the DC-8. This would enable NASA to make major contributions to dynamical science in large field campaigns such as STORM and GCIP.

**CURRENT FOCUS:**

NOAA continues to make routine backscatter observations at 10.59 $\mu m$ near Boulder at the rate of 1-2 per week, and to process and archive those data. Comparisons of lidar backscatter with Mie predicted backscatter for thermally-conditioned particle size measurements in the 1988 Hawaii data are commencing, as well as studies on the representativeness of the Mauna Loa observatory samplers under upslope and downslope flows.

**PLANS:**

Routine observations of backscatter will continue to increase the climatological data base, and to help put future airborne and satellite observations of backscatter into context. Depending on funding of the MACAWS proposal, these observations may be curtailed for 6-12 months to implement hardware changes to the NOAA lidar. FRLAB intercomparisons will continue, with a publication likely in about 1 year. Studies on the representativeness of the observatory samplers at Mauna Loa will be published as well.

**PUBLICATIONS:**

1. Post, M.J. and R.E. Cupp, "$CO_2$ lidar backscatter profiles over Hawaii during fall, 1988," submitted to Appl. Opt.

2. Menzies, R.T. and M.J. Post, "GLOBE Backscatter: Climatologies and mission results," Proc. SPIE Symp. on High Power Lasers, 20-25 Jan., 1990, Los Angeles, CA.

3. Rothermel, J., D.A. Bowdle, J.M. Vaughn, and M.J. Post, "Evidence of a tropospheric aerosol backscatter background mode," Appl. Opt., 28, 1040-1042 (1989).

4. Post, M.J., " Atmospheric purging of El Chichon debris," J. Geophys. Res., 91(D4), 5222-5228 (1986).

5. Post, M.J., "Aerosol backscattering profiles at $CO_2$ wavelengths: the NOAA data base," Appl. Opt. 23, 2507-2509 (1984).

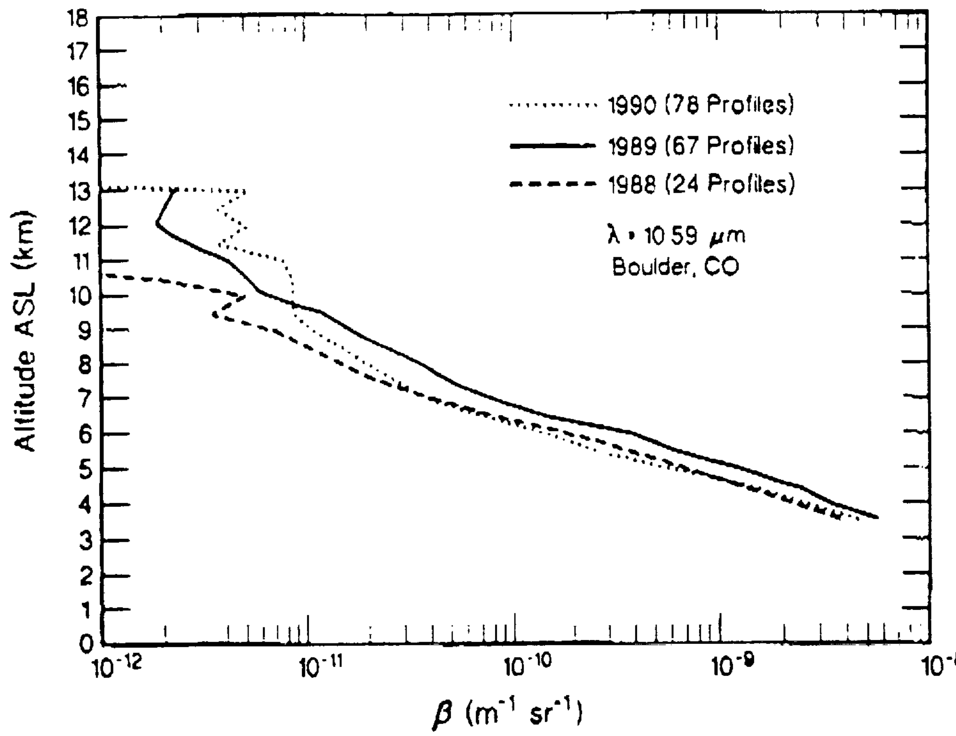


Fig. 1. Yearly averaged profiles of aerosol backscatter at $\lambda = 10.59\ \mu m$ over Boulder, Colorado, for 1988-90.

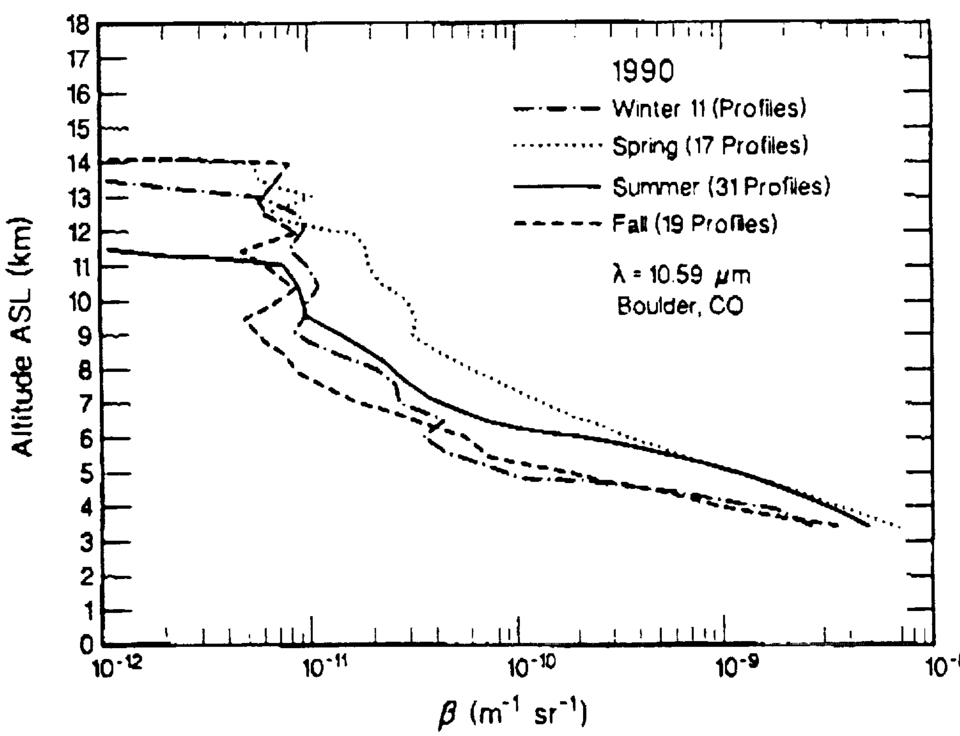


Fig. 2. 1990 seasonal averages of aerosol backscatter observed at $\lambda = 10.59\ \mu m$ over Boulder, Colorado.