

## ENHANCED ER-2 AND DC-8 LIDAR OBSERVATIONS IN TOGA/COARE

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The Tropical Ocean Global Atmosphere/Coupled Ocean Atmosphere Response Experiment (TOGA/COARE) was a large scale international experiment with the overall objective to study the formation and maintenance of the western tropical Pacific warm pool. An element of the experiment was an investigation of the radiative properties, forcing and remote sensing of tropical high clouds. The primary elements of the tropical cloud radiation experiment were observations by the NASA ER-2 and DC-8 high altitude research aircraft in January and February of 1993. Lidar observations from both the ER-2 and DC-8 were an essential part of the experiment.

The technology and operational characteristics of the ER-2 cloud and aerosol lidar (CALIS) and the DC-8 visible and near infrared lidar (VIRL) were significantly improved for the TOGA/COARE project. The CALIS instrument is a Nd:YAG based backscatter lidar. For the system transmitter, the former flashlamp pumped laser has been replaced by a custom built diode pumped Nd:YAG laser of 200 mJ pulse energy and 20 Hz pulse repetition frequency (PRF), both double the parameters of the former transmitter. The diode pumped laser reduced power requirements and weight for the CALIS system, but most importantly the reliability of the system was greatly increased. The data system of the CALIS instrument has been also upgraded. The current data system employs 8 mm data tape storage, and in addition to reducing size and weight the data record time was increased to ten hours. Four channels are recorded with 20 MHz sampling. The data system reliability was also improved. As before the CALIS is a fully autonomous in its operation.

The VIRL instrument has been previously employed for lidar measurements with Raman

shifting down conversion from the Nd:YAG fundamental frequency to obtain backscatter measurements at 1.54  $\mu\text{m}$  in addition to 1.06 and 0.53  $\mu\text{m}$ . For the TOGA/COARE deployment, an Optical Parametric Oscillator (OPO) was used instead of the Raman cell for down conversion. The intent was to obtain backscatter measurement in the 2.1  $\mu\text{m}$  wavelength region. Major technical obstacles were encountered for use of the OPO down conversion, but backscatter observations at 2.046  $\mu\text{m}$  were obtained. The primary application of the VIRL instrument for the TOGA/COARE experiment were to obtain high resolution cloud structure measurements. The instrument employs a 50 Hz 300 mJ Nd:YAG laser and a 40 cm aperture receiver, and extensive high quality measurements were realized which include polarization data at the 1.06  $\mu\text{m}$  wavelength. The VIRL system operates in both the zenith and nadir mode from the DC-8 aircraft.

Over 300 hours of high altitude lidar observations were acquired during the TOGA/COARE experiment. On both the ER-2 and DC-8 the lidar measurements were combined with multisensor atmospheric radiation measurements and other remote sensing observations. A unique aspect of the experiment was that for a large fraction of the measurements the ER-2 and DC-8 aircraft were directly coordinated. During much of the time lidar and other observations of tropical high clouds were obtained simultaneously from both above and below. The data are currently being employed to study radiative heating and cooling factors in tropical cirrus and to investigate the overall the atmospheric radiation balance. Initial results are to be presented.

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