4.1.8. Stratospheric Aerosols

At MLO in early 1998, both the ruby and Nd:YAG (neodymium doped yttrium aluminum garnet type laser) lidars were moved into the new Network for the Detection of Stratospheric Change (NDSC) building. The NDSC has three rooms devoted to the CMDL lidar program that are used as a control room, a laser room, and a telescope room. The entire optical structure was redesigned to house the lasers and the telescopes more compactly. The optical rails extend through the wall to rigidly tie the telescopes and lasers together. Separating the telescopes from the lasers reduced the signal-induced noise on some of the detectors. The new facilities are far better for maintaining the equipment and developing new measurements. The move was accomplished in about 2 weeks because the hatches were installed previously. The Nd:YAG laser required a service call to get the power back to specification.

The ruby lidar signal strength was severely reduced in the new configuration. After exchanging several of the components, the signal was still too weak for reasonable data. Since the backscatter at 694 nm can be interpolated from the Nd:YAG backscatter measured at 532 nm and 1064 nm more accurately then the actual ruby lidar measurement, it was decided to end the ruby lidar measurement. Over 1 year (44 measurements) of overlapping data showed the interpolated and measured 694 nm backscatter agreed to a few percent, well within the 20% error of the ruby lidar data.

A grant from the NOAA National Environmental Satellite, Data, and Information Service (NESDIS) was received for the rescue of the ruby lidar database. Although the integrated aerosol data were available, the individual profiles (over 700 measurements) were in various formats and could not be analyzed consistently. The database will be standardized and errors will be estimated. The data can then be submitted to the NDSC archive for use by other researchers. Interactive Data Language (IDL) software was acquired under the grant to use for the lidar temperature analysis. A temperature analysis by the Jet Propulsion Laboratory (JPL) lidar group, written in IDL and well researched, will be used for the reanalysis of the temperature record.

The background conditions in the stratospheric aerosol [*Barnes and Hofmann*, 1997] that began in 1996 at MLO continued through 1999. Figure 4.5 shows (a) the quasi-biennial oscillation (QBO) winds, (b) the backscatter from the upper part of the stratospheric aerosol layer (25-33 km), and (c) the backscatter from the total stratospheric layer (15.8-33 km). The total layer is dominated by the 16 to 22-km region. The 4 years (1996-1999) show a clear annual cycle in the total layer, peaking in the winter. The winter peak coincides with the doubling of the vertical transport of air through the tropical tropopause [*Rosenlof and Holton*, 1993] during the winter compared to the summer months. It is not clear if the winter peak in the aerosols is consistent with the stronger vertical transport. Although this would mean that more sulfur-rich air would enter the stratosphere during the winter, the residence time necessary for aerosol formation would be shorter.

There is no clear QBO effect in the total aerosol layer. Both the easterly and westerly phases have about the same yearly averages, 1.1×10^{-4} per steridian (sr^{-1}). However, a QBO effect is discernable in the upper part of the layer. During the westerly phase, the aerosol loading is a factor of two less than during the easterly phase. This is consistent with the lofting of the aerosol layer during the easterly phase when the tropical stratospheric reservoir is sequestered from mixing with midlatitude air.

In Boulder a new stratospheric aerosol lidar was built and installed in one of CMDL's rooftop domes in August 1999. The lidar uses a single, electronically gated photomultiplier tube and a 61 cm telescope (152 cm focal length), similar to the ones at MLO. A much smaller Nd:YAG, frequency doubled laser (Big Sky Lasers) is used for the 532 nm source. A multi-channel scaler data acquisition board is used, and the MLO software was modified for the Boulder configuration. The lower tropopause at Boulder increases the dynamic range needed to profile the entire stratospheric layer on one channel. Preliminary measurements at Boulder show that there is often no clear lower boundary of the layer in contrast to the case at MLO. This makes the interpretation of the data more difficult.

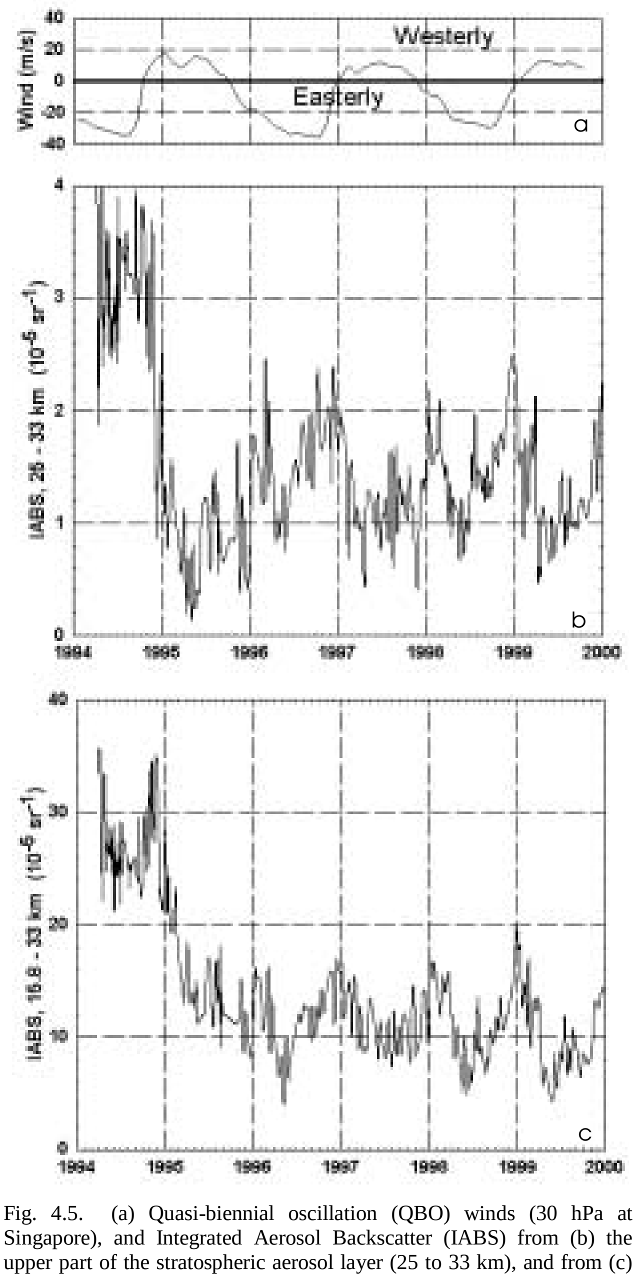

Fig. 4.5. (a) Quasi-biennial oscillation (QBO) winds (30 hPa at Singapore), and Integrated Aerosol Backscatter (IABS) from (b) the upper part of the stratospheric aerosol layer (25 to 33 km), and from (c) the total stratospheric layer (15.8 to 33 km) observed over MLO.