Constraining Aerosol Properties with Ground-based Lidar and other Remote Sensing Techniques

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Lidars are versatile instruments for measuring aerosols but are limited by only measuring light scattered from a single angle for a given altitude, which is usually 180° backscattered light. Because the amount of backscattered light compared to the total scattered and absorbed light varies greatly with particle size, shape, and composition, the retrieval of aerosol properties is usually underdetermined by the data. Multiple wavelengths, polarizations, and Raman channels can be used to reduce the problem but there are still limitations. Conversion of lidar backscatter to more useful quantities like extinction often relies on the assumption of an extinction to backscatter ratio known as the "Lidar Ratio". This assumption is especially necessary under the low background stratospheric conditions where direct measurement of extinction by Raman lidar is not possible. Examples of three volcanic eruptions, Kasatochi, Sarychev, and Nabro, are shown using backscatter profiles with two laser wavelengths as an example. Evolution of the plumes can be seen as the plumes diffuse with time. Added constraints of the aerosol properties can be achieved with the addition of a bistatic receiver located at some distance from the lidar. The second receiver measures scattered light at angles less than 180°. The improvement of the aerosol property retrieval errors with this additional data are examined.

Averages of lidar aerosol profiles heavily weight the profiles to any clouds that are present during the observations. Simply using the median instead of the average gives a much better representation of the aerosols. The median profile fits an exponential function remarkably well over two or three scale heights with a value of 2.5 km. The water vapor scale height is 2.1 km and the molecular scale height is 9.1 km over Mauna Loa Observatory (MLO).

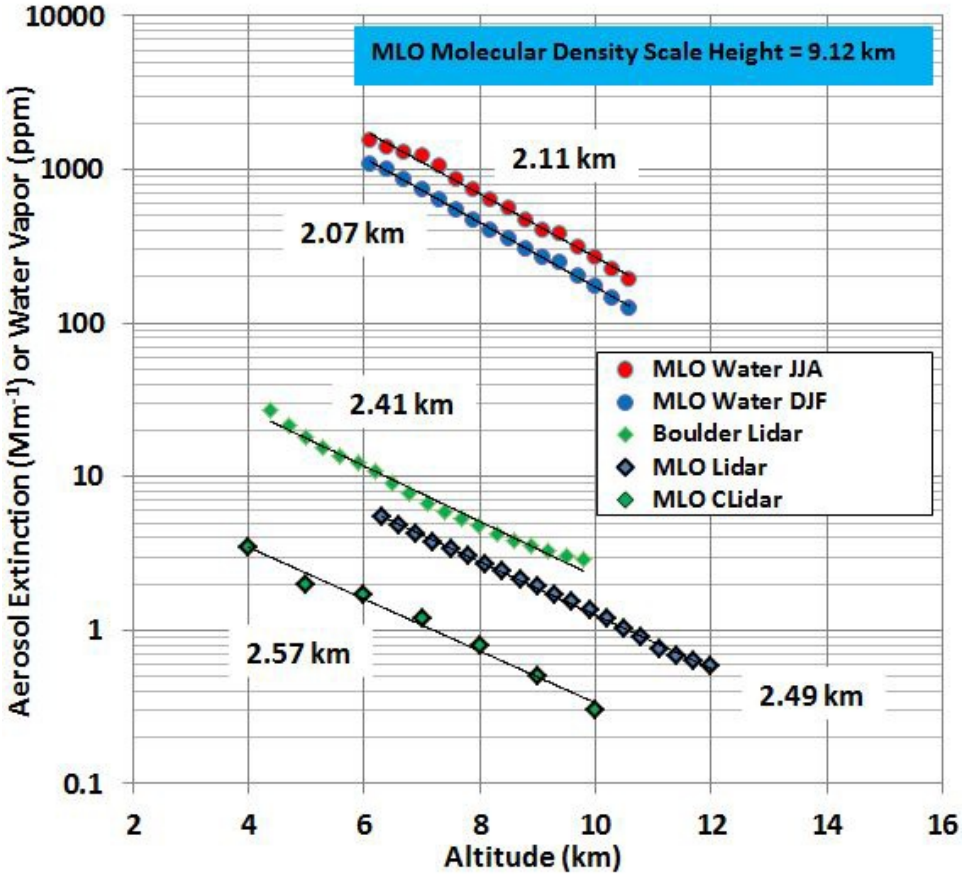

Figure 1. Scale heights for aerosols, water vapor, and molecular density are shown for MLO. The aerosol scale height for Boulder, CO is also shown. At MLO aerosol profiles were measured independently by the lidar and Clidar.