**Upper Tropospheric Water Vapor Measurements with Raman Lidar at MLO**

J.E. Barnes[1], and H. Voemel[2]

[1]NOAA Climate Monitoring and Diagnostics Laboratory, Mauna Loa Observatory, P.O. Box 275, Hilo HI 96721; 808-933-6965, E-mail: John.E.Barnes@noaa.gov
[2]Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder 80309

Water vapor has been measured by lidar at Mauna Loa Observatory (MLO) with the addition of two Raman scattering detector channels and a 74-cm telescope mirror. To detect water molecules with the 532-nm green wavelength of the Nd:YAG laser, two Raman-scattered wavelengths are used, 607 nm from nitrogen and 660 nm from water. The nitrogen signal is proportional to air density and the ratio of the water signal to the nitrogen signal is proportional to the water vapor mixing ratio: $H_2O$ (mixing ratio) = Constant $\times$ ($H_2O$ signal)/($N_2$ Signal). The calibration constant was determined by balloonborne measurements using the CMDL frostpoint hygrometer, a Vaisala radiosonde with a Humicap-H humidity sensor, and a Snow White (a commercial thermoelectric frostpoint hygrometer). The analysis includes Rayleigh extinction corrections. The difference of the extinction corrections of the returning signals due to wavelength dependence are less than 1% at MLO. Experimentally, the most important requirement of the system is to reject the much more intensely scattered light at 532 nm. The MLO system uses three filters for a rejection factor of $1 \times 10^9$. Because of the small water vapor signals, the detector errors of signal-induced noise and saturation are negligible. The noise source limiting the performance is background light at the water vapor wavelength that becomes worse when the moon is visible in the sky. The observations started February 14, 2002, and there have been 93 observations through April 9, 2004.

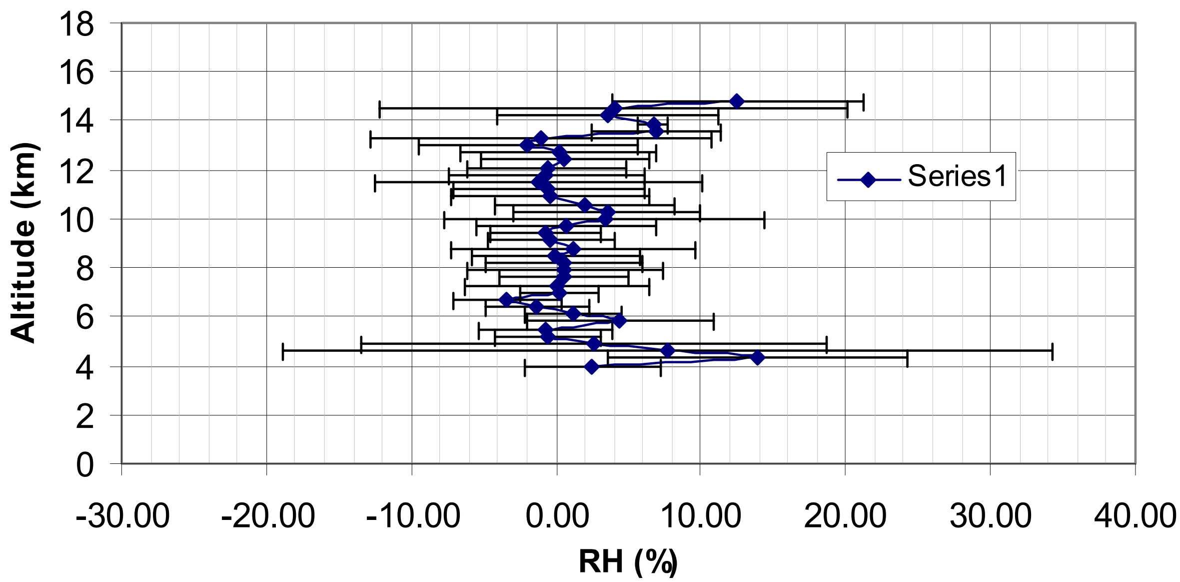


Figure 1. Summary of calibration results of the lidar by balloon flights. Most of the balloon measurements are from Vaisala RS × 80-H humidity sensors, although some frostpoint hygrometer results are also included. The error bars indicate one standard deviation of the difference between the balloon sonde and the lidar. Between 5 and 13 km the average deviation is 6.3%. Above 13 km the known bias of the sonde is seen (due to cold temperatures) by the systematic difference with the lidar.