Multi-Filter Rotating Shadow Band Radiometer (MFRSR-244)
Raw Count Calibration 2004 February.

Fred Denn

The Yankee Environmental Systems Inc., Multi-Filter Rotating Shadow Band Radiometer (MFRSR-244) has been located at the Mauna Loa Observatory (MLO) island of Hawaii for several periods between 2002 February and 2004 January to perform calibration measurements. These measurements are used to calculate the Top Of Atmosphere (TOA) values as measured by MFRSR-244. The TOA results of these raw count measurements are present here. A discussion follows the results table.

Date of measurements, 2002 January through 2004 February.
Applicable period, 2000 October through 2004 March.
NOTE: U95=2.0*standard_deviation

Mean Value TOA Results

Wavelength	Top of Atmosphere value	Standard deviation
415.0 nm	10015 counts	195 counts
496.7 nm	6112 counts	135 counts
613.9 nm	5990 counts	104 counts
671.1 nm	9989 counts	90 counts
866.1 nm	9381 counts	72 counts
937.0 nm	13936 counts	1149 counts

Interpolated Results Next Page.

Monthly Interpolated TOA Results

A line has also been fit through the available MLO TOA data. The coefficients are presented below for each wavelength.

Wavelength	slope	Intercept	Standard Error
415.0 nm	-203	10163	168
496.7 nm	-189	6251	98
613.9 nm	-171	6116	62
671.1 nm	30	9967	89
866.1 nm	30	9358	71
937.0 nm	949	13241	1057

Application
(For each given wavelength)

TOA(decimal year) = (decimal year – 2002)*slope + intercept

It is recommended that the values obtained for 2002 May be used for the period 2000 October through 2002 May, and the value obtained for 2004 February be used for time periods after that, rather than a linear extrapolation outside of those dates.

Filters

The wavelengths filters have been changed as necessary during the life of the instrument. A graphical representation of the filter changes and MLO measurement periods is presented in Figure 1.

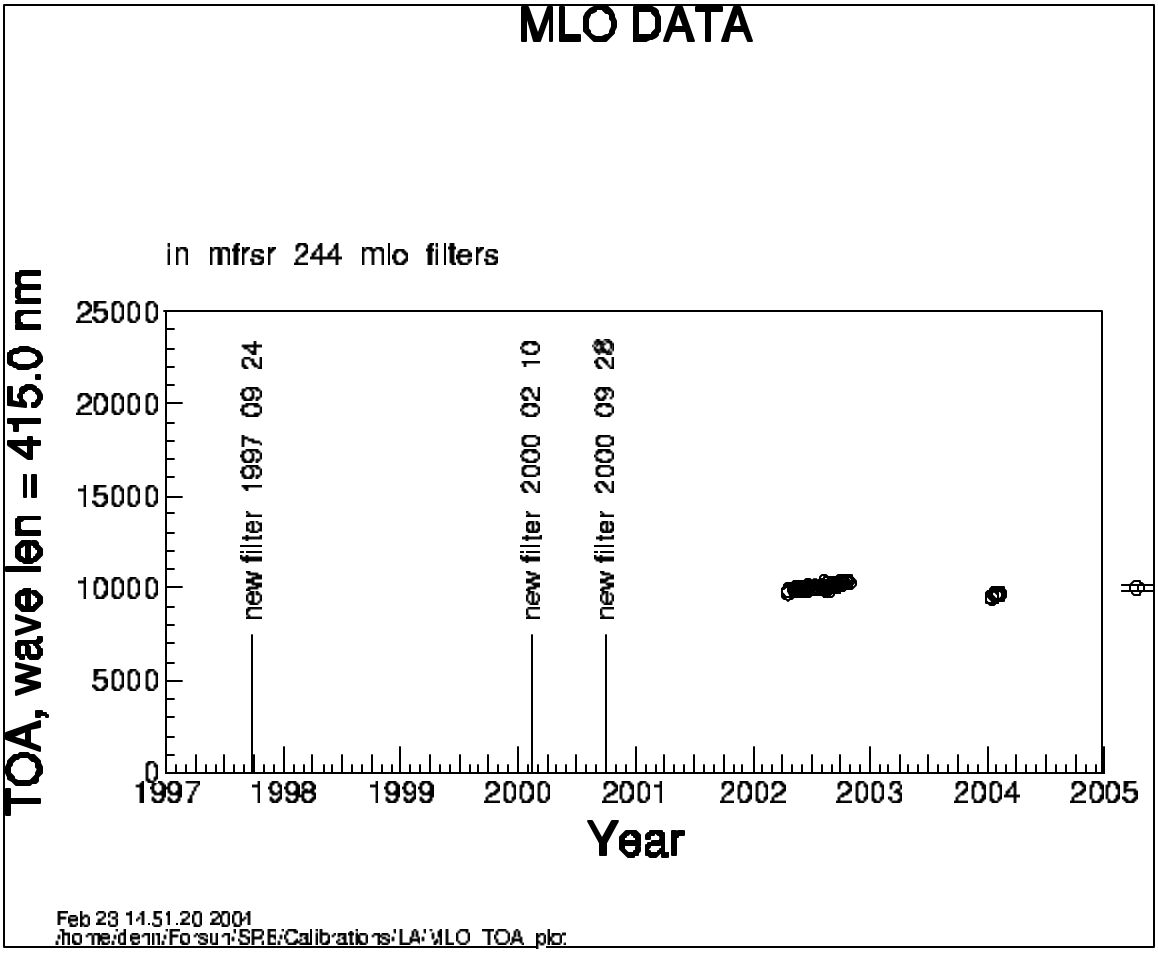

Figure 1. Graphical display of filter changes and MLO data collection periods. The circles are the Langley determined Top Of Atmosphere values. The filter changes are marked by the vertical lines which are dated.

Langley Analysis

Langley analysis consists of determining the irradiance as the sun rises or sets. Sunrise periods are preferred because the afternoon atmosphere is less stable due to solar heating. During these periods the direct beam irradiances are measured at one minute or smaller intervals. The atmospheric path lengths are calculated (directly overhead is defined as an atmospheric path length of 1 regardless of the measurement location). A straight line is fit to the log of the irradiance (y value) and the atmospheric path length (x value). This straight line is then extrapolated zero atmospheric path lengths. This extrapolated value is the Langley determined Top Of Atmosphere value. The range of atmospheric path lengths chosen here is 2 to 5. Below 2, the data points are too numerous and will unduly influence the fit. The maximum of 5 was chosen because a similar analysis has been preformed on data collected at the Clouds and Earth's Radiant Energy System (CERES) Ocean Validation Experiment (COVE) Site. COVE data for atmospheric path lengths greater than 5 are unusable because of haze. A sample plot of Langley analysis is shown in Figure 2.

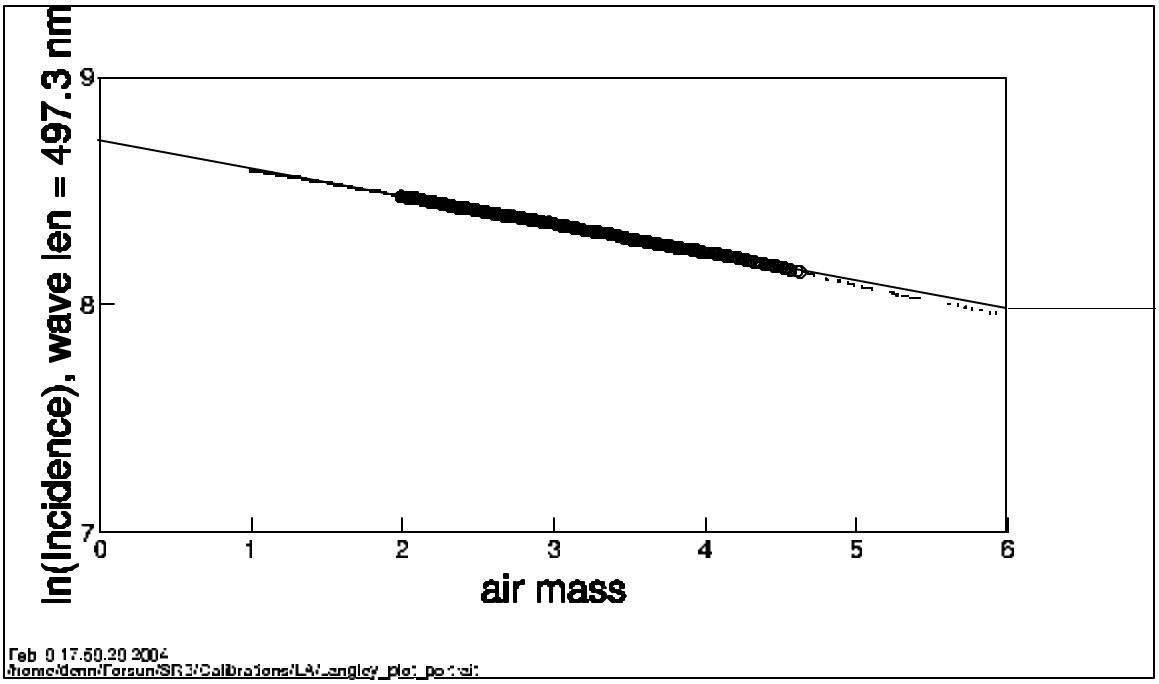

Figure 2. An example of Langley analysis. The vertical axis is the log of the direct beam irradiance. The horizontal axis is the atmospheric path length, in atmospheric path length units. The symbols and dots are the logs of the direct beam irradiance. A straight line is fit to this data and extrapolated to zero atmospheric path lengths.

Spectral Response

Figures 3 is an example of the spectral response of MFRSR-244. These measurements were provided by the manufacturer.

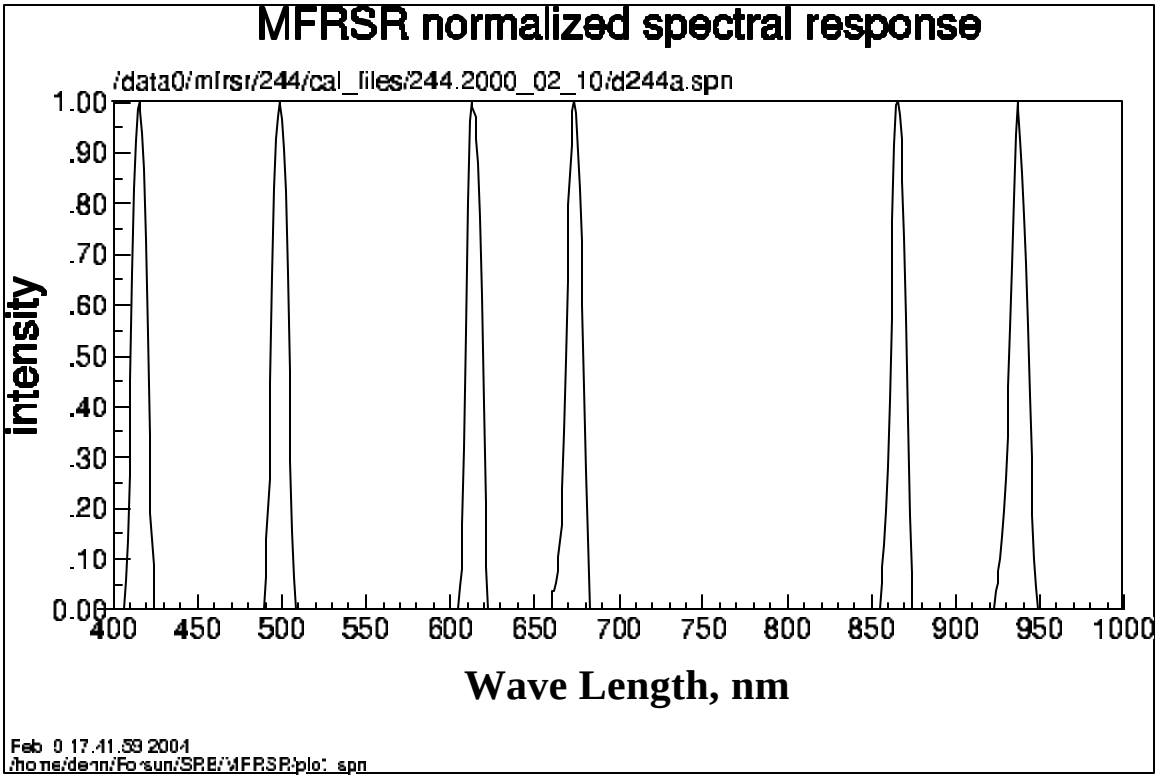

Figure 3. An example of normalized spectral response data for the 6 MFRSR-244 narrow-band channels. Nominally 416, 497, 613, 672, 868 and 938 nm. This data is from the 2000 February filter change.

Top Of Atmosphere Results

Figures 4 through 9 show the TOA results for each wavelength. The mean and standard deviation of the TOA values are determined. Another parameter, 'std_dev_mean', comes from the Langley fit for each point and is the mean of these points. This mean is then combined with the standard deviation of the TOA values using the root some square method to get 'std_dev_combined'. These values are displayed in each figure in the left column above the plot. The column to the right (red) displays the slope and intercept for a straight line fit to the data, as well as a 'combined std error' which is equivalent to the 'std dev combined'. A horizontal line representing the mean is displayed on each figure. The least squares fit line is also displayed; it is red and has diamonds on it.

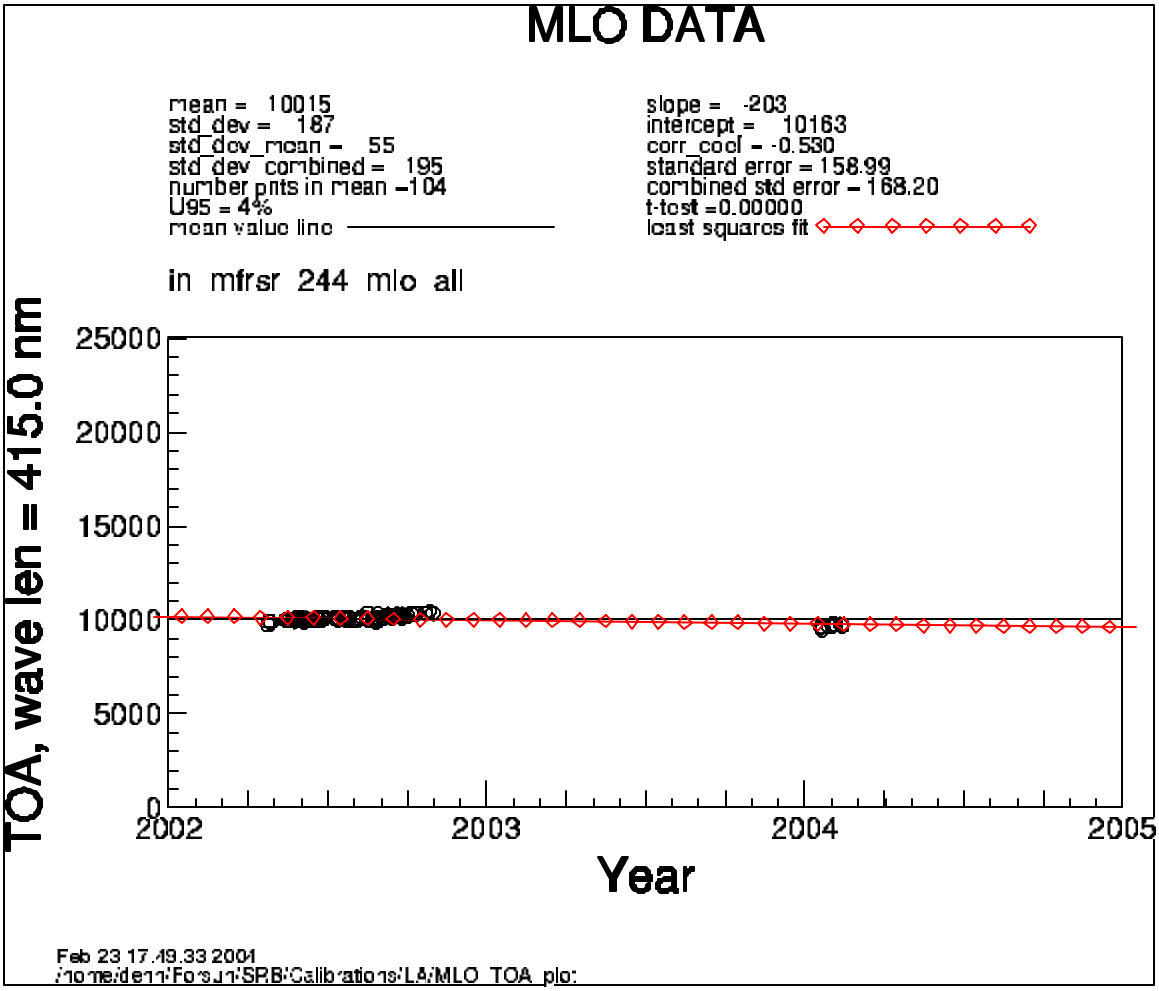

Figure 4. MLO TOA data collected during years 2002 through 2004 for wavelength 415.0 nm.

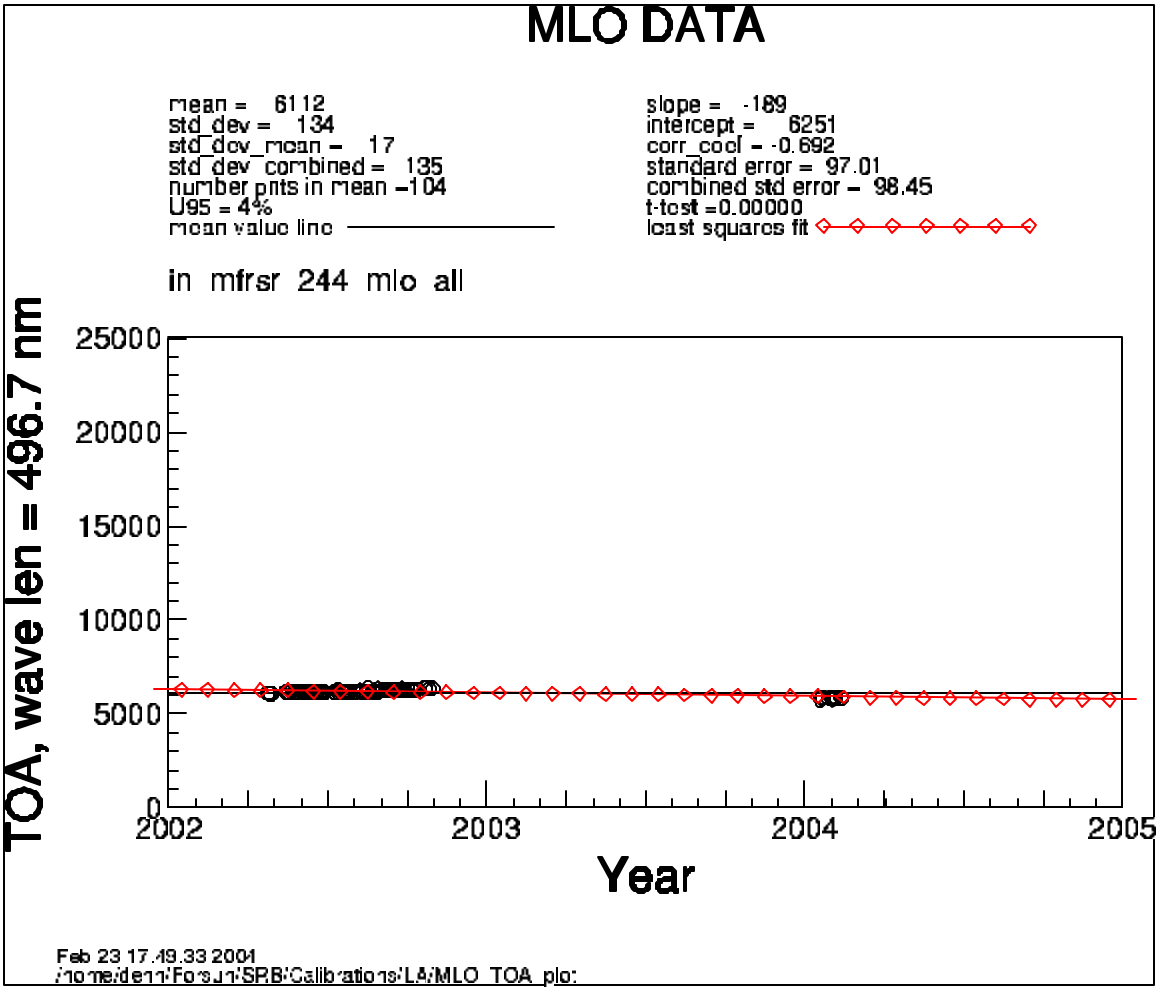

Figure 5. MLO TOA data collected during years 2002 through 2004 for wavelength 496.7 nm.

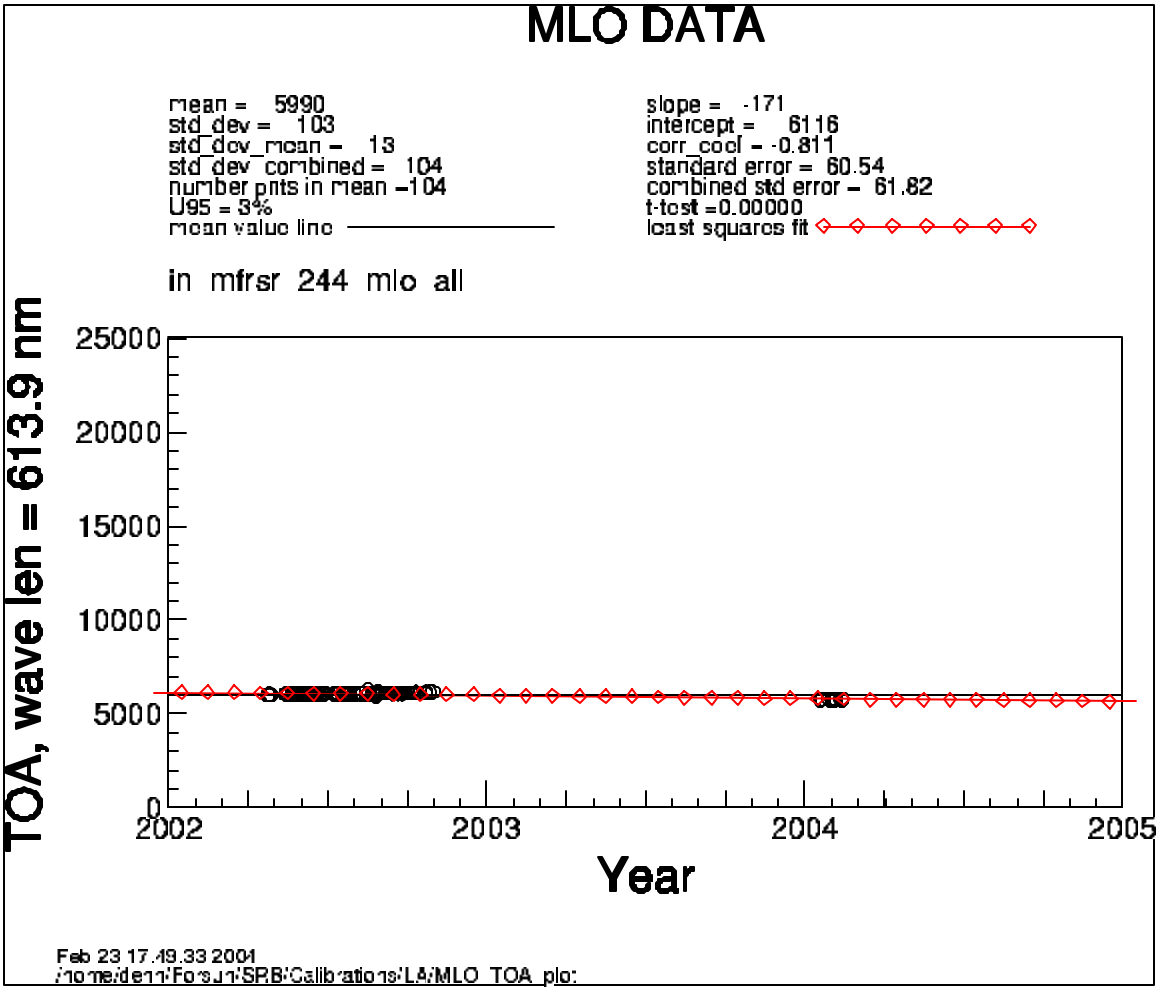

Figure 6. MLO TOA data collected during years 2002 through 2004 for wavelength 613.9 nm.

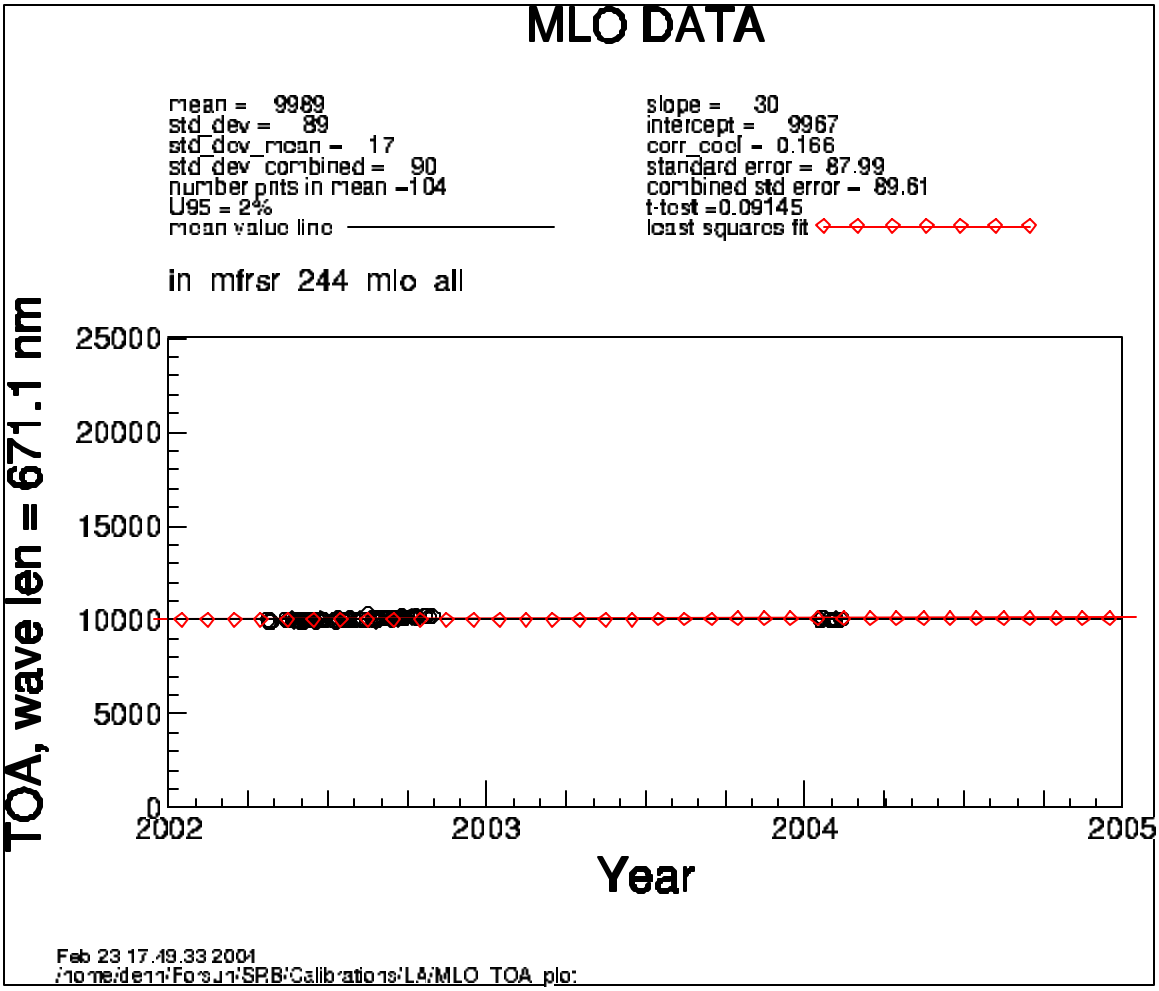

Figure 7. MLO TOA data collected during years 2002 through 2004 for wavelength 671.1 nm.

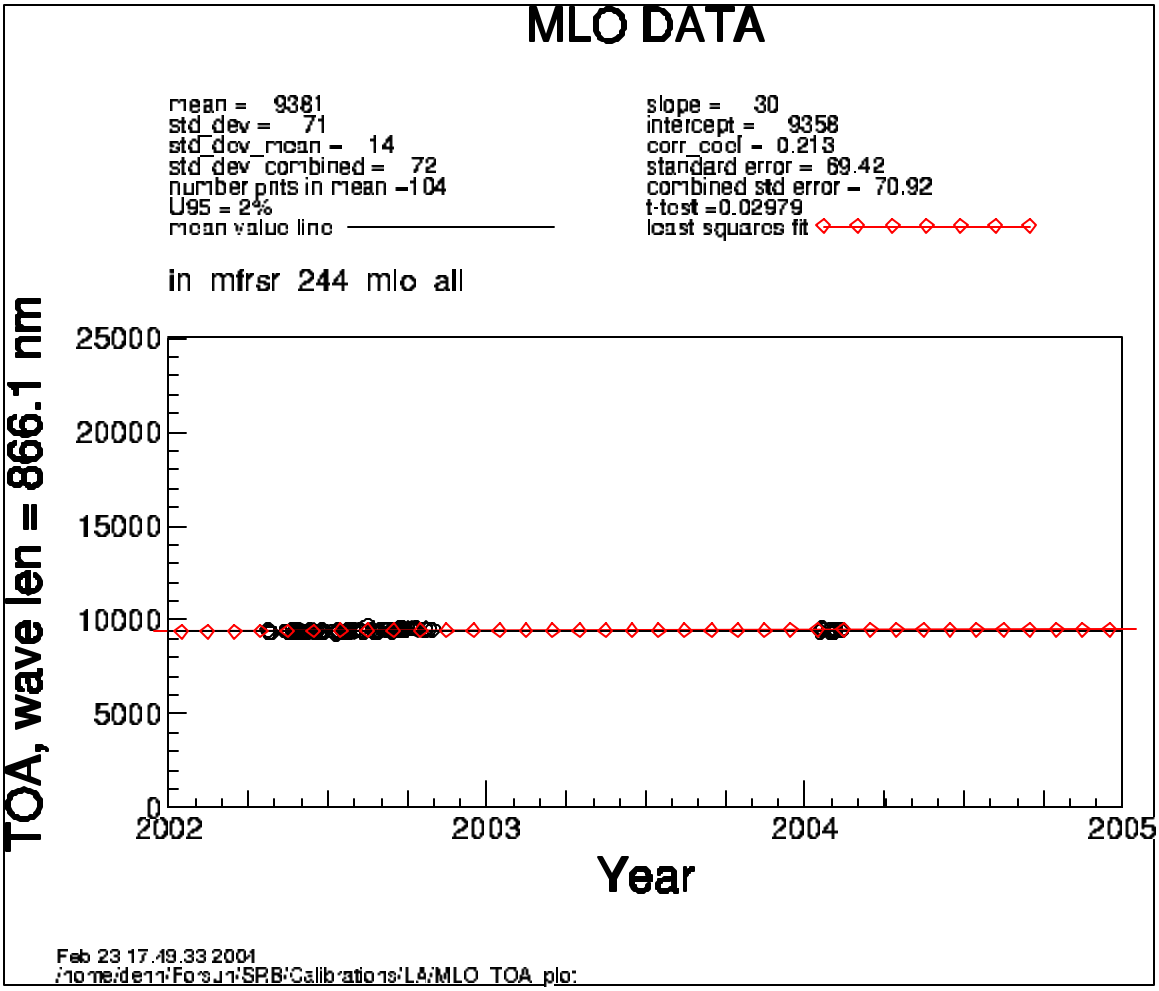

Figure 8. MLO TOA data collected during years 2002 through 2004 for wavelength 866.1 nm.

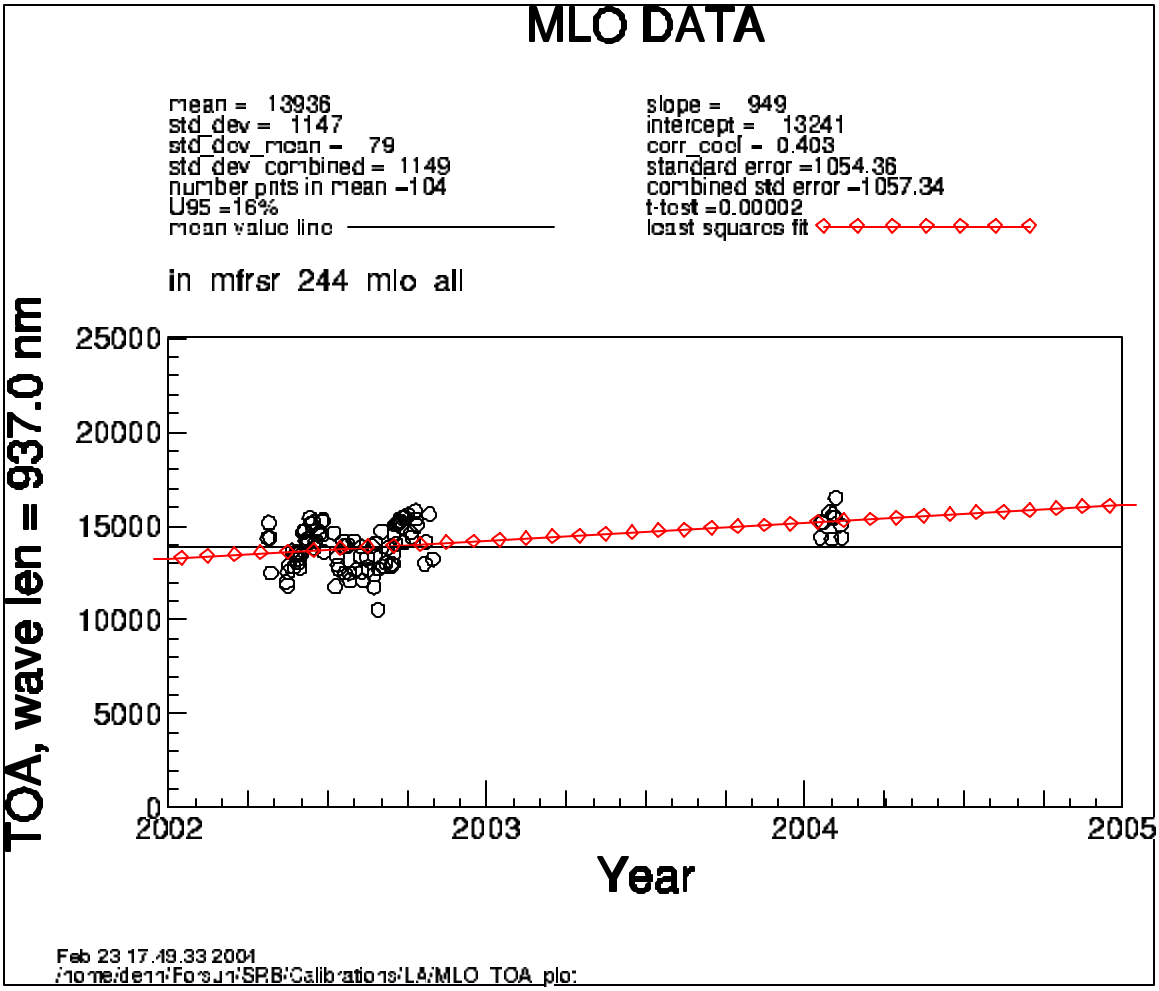

Figure 9. MLO TOA data collected during year 2002 for wavelength 937.0 nm. This is a water vapor absorption wavelength, therefore the Langley TOA extrapolation does not work well.

Results

The final results of this analysis are presented here and at the beginning of the report.

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