Multi-Filter Rotating Shadow Band Radiometer (MFRSR-379)
Raw Count Calibration 2004 February.

Fred Denn

The Yankee Environmental Systems Inc., Multi-Filter Rotating Shadow Band Radiometer (MFRSR-379) has been located at the Mauna Loa Observatory (MLO) island of Hawaii for several periods between 1998 January and 2003 February to perform calibration measurements. These measurements are used to calculate the Top Of Atmosphere (TOA) values as measured by MFRSR-379. The TOA results of these raw count measurements are present here. A discussion follows the results table.

Date of measurements, 1998 February through 2004 November.
Applicable period, 1998 January through present.
NOTE: U95=2.0*standard_deviation

The results are on page 2.

Results

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

Mean Value TOA Results
Period 1, before 1998 December 21.

Wavelength	Top of Atmosphere value	Standard deviation
416.7 nm	11716 counts	83 counts
502.0 nm	8170 counts	94 counts
616.2 nm	7852 counts	30 counts
671.2 nm	3817 counts	22 counts
870.7 nm	8505 counts	34 counts
940.2 nm	11582 counts	65 counts

Mean Value TOA Results
Period 2, 1998 December 21 to 2001 April 4.

Wavelength	Top of Atmosphere value	Standard deviation
416.3 nm	9817 counts	155 counts
497.3 nm	5767 counts	97 counts
613.6 nm	5912 counts	94 counts
672.5 nm	10083 counts	147 counts
868.8 nm	8850 counts	127 counts
938.7 nm	14041 counts	1026 counts

Mean Value TOA Results
Period 3, 2001 April 4 to present.

Wavelength	Top of Atmosphere value	Standard deviation
415.0 nm	10154 counts	334 counts
495.9 nm	6910 counts	139 counts
614.2 nm	6643 counts	105 counts
670.7 nm	11563 counts	161 counts
868.3 nm	10572 counts	118 counts
939.0 nm	15362 counts	1106 counts

Filters

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

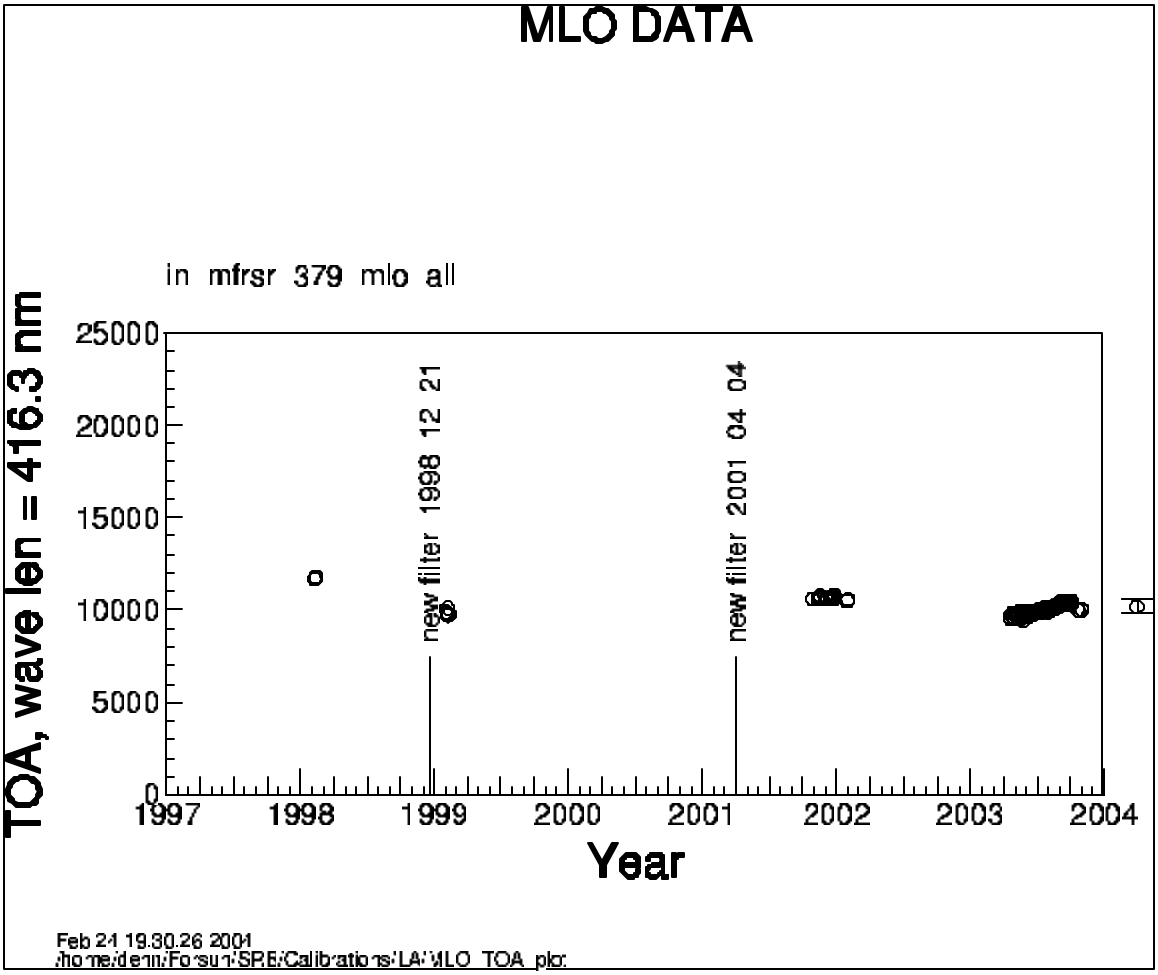

Figure 1. Graphical display of filter changes and data collection periods. The circles are the Langley determined Top Of Atmosphere values. The filter changes are marked by vertical lines and the lines are dated.

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. At 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.

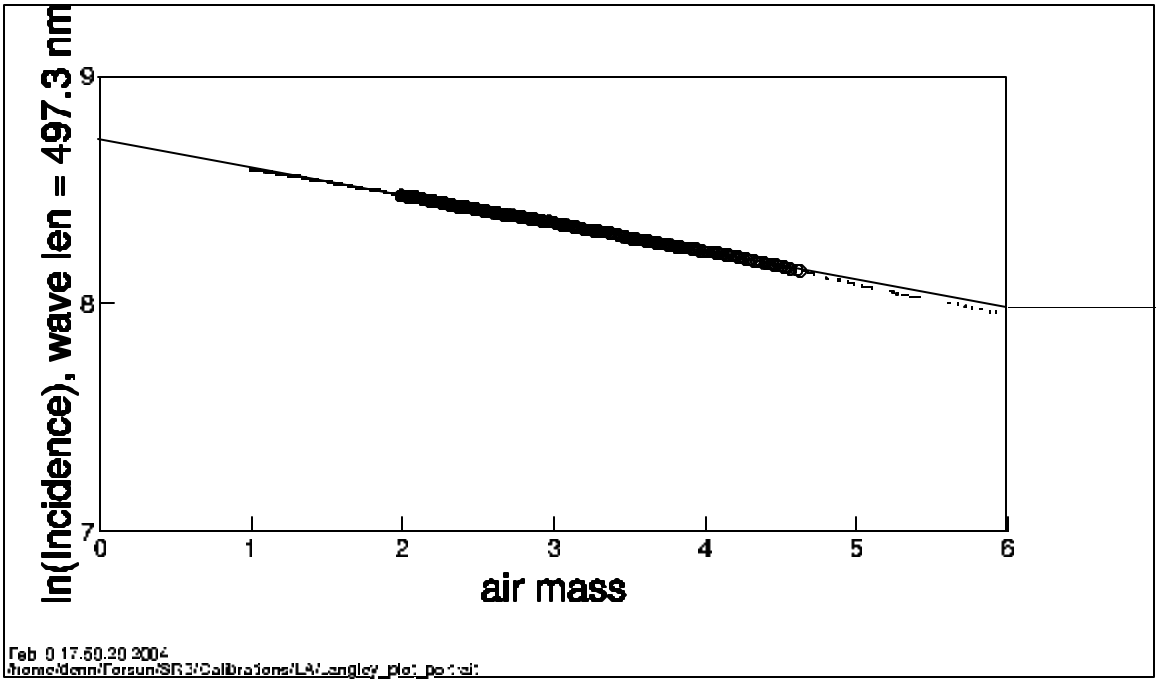

Figure 2. An example of Langley analysis. The vertical axis is the log of the direct beam irradiance. The horizontal axis is the atmospheric path length, in atmospheric path length units. The symbols and dots are the logs of the direct beam irradiance. A straight line is fit to this data and extrapolated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

Spectral Response

Figure 3 is an example of the spectral response of MFRSR-379. These measurements were provided by the manufacturer.

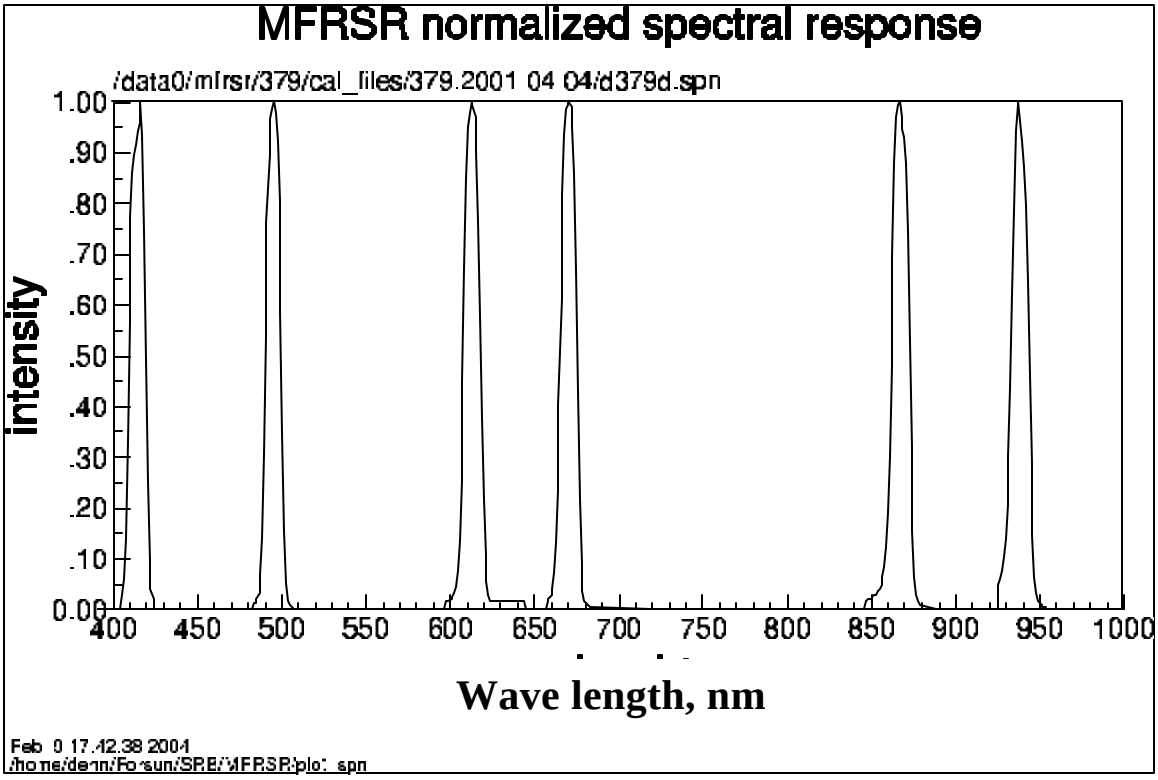

Figure 3. An example of normalized spectral response data for the 6 MFRSR-379 narrow-band channels. Nominally 416, 497, 613, 672, 868 and 938 nm. This data is from the 2000 February filter change.

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. A horizontal line representing the mean is displayed on each figure.

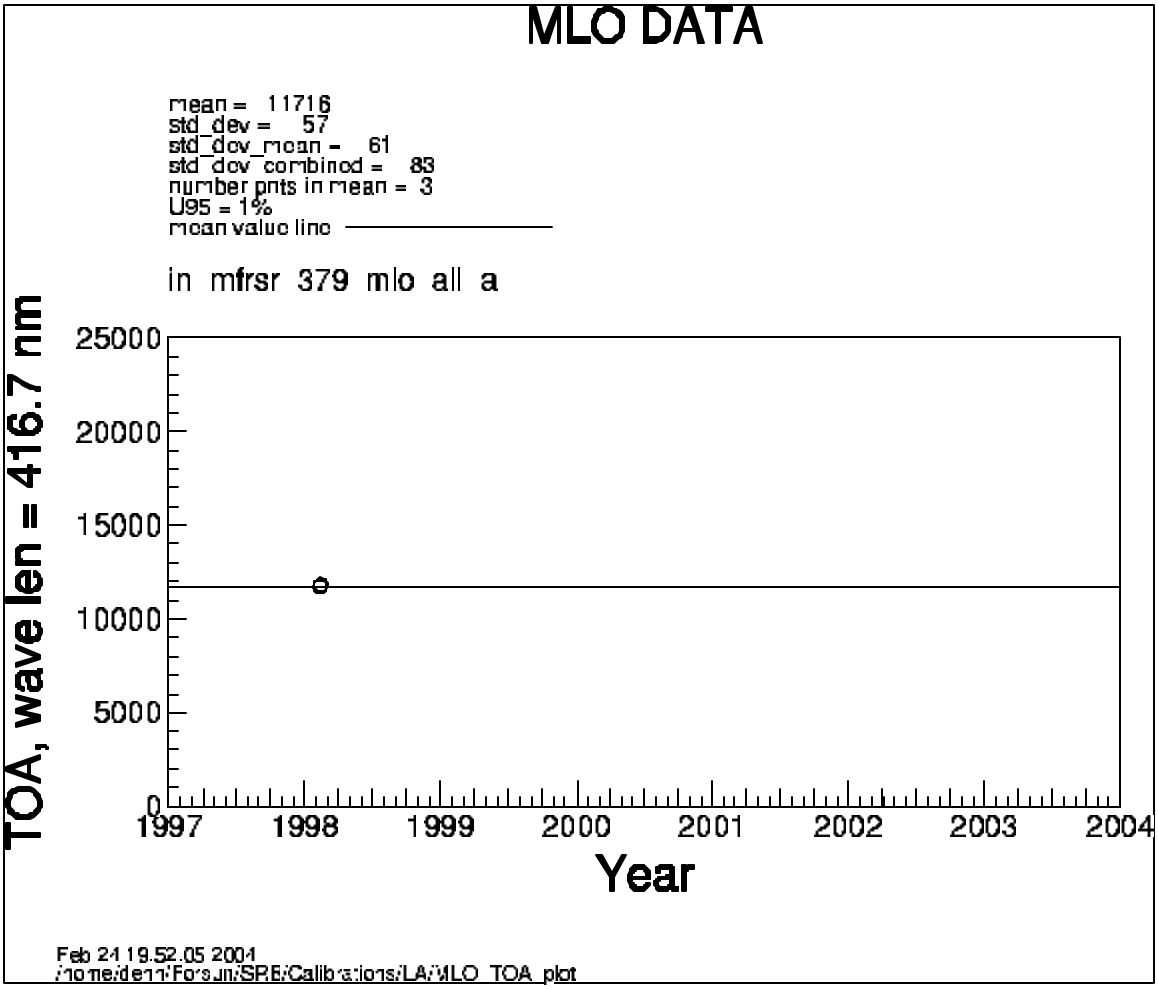

Figure 4a. Period 1, MLO TOA data collected during year 1998 for wavelength 416.7 nm.

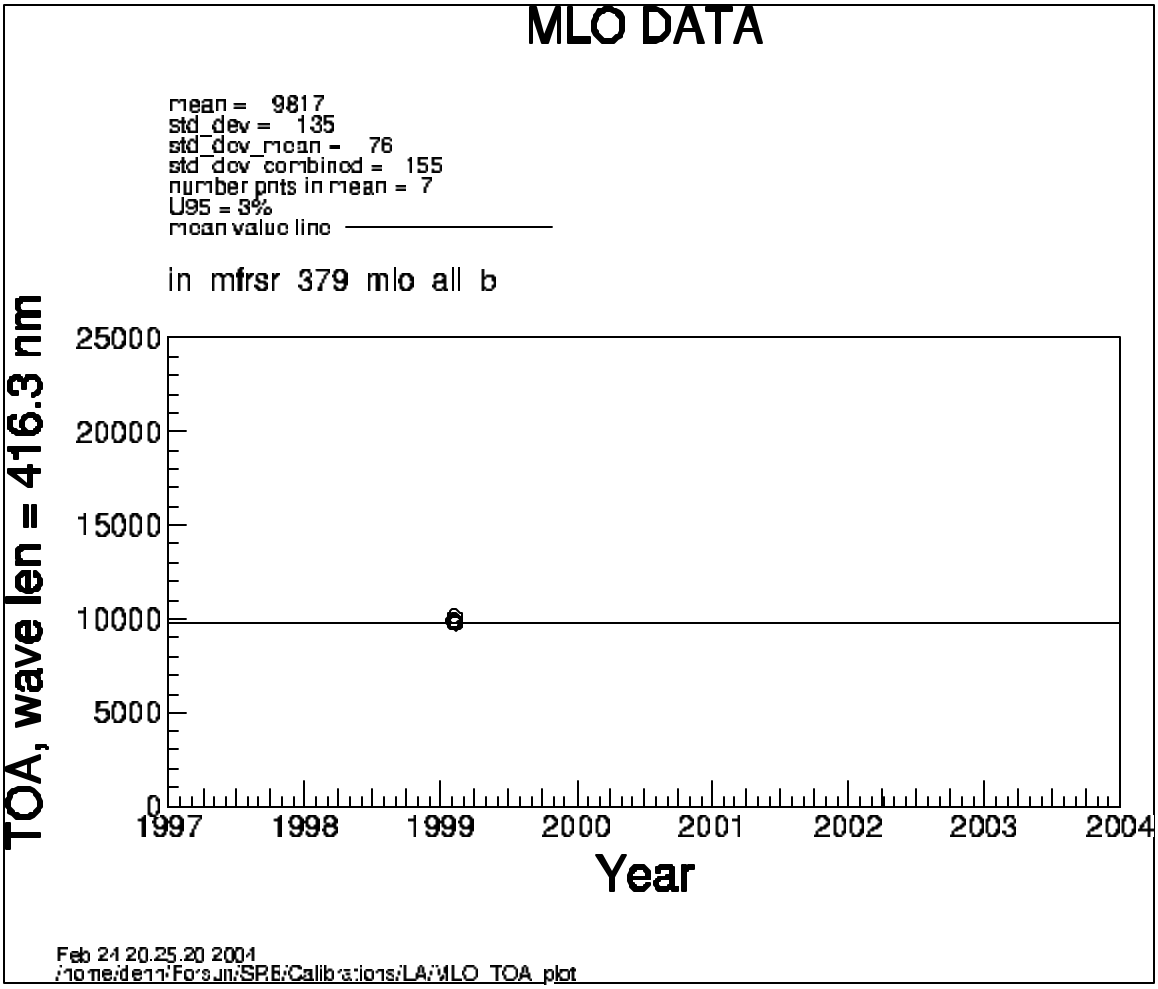

Figure 4b. Period 2, MLO TOA data collected during year 1999 for wavelength 416.3 nm.

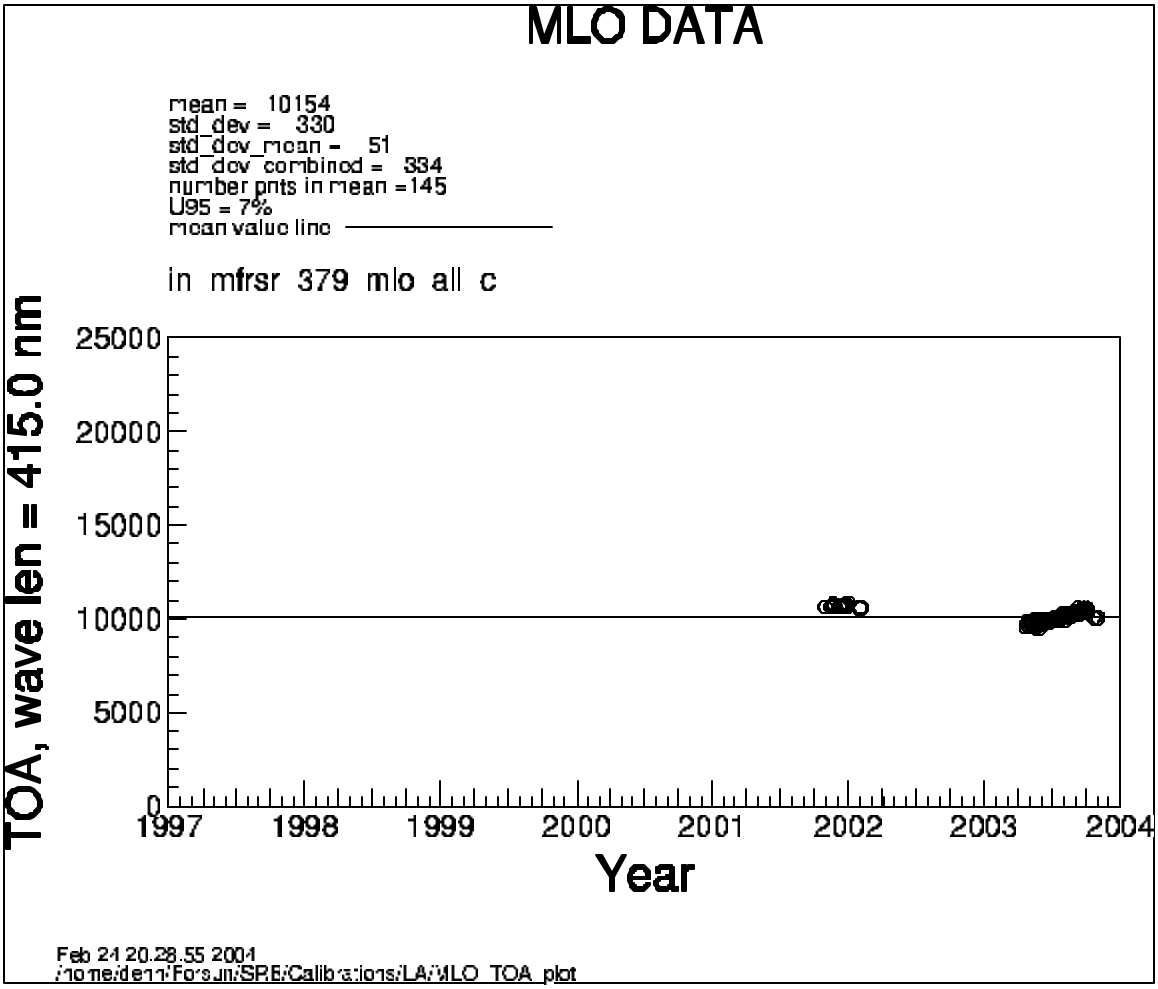

Figure 4c. Period 3, MLO TOA data collected during years 2001 through 2003 for wavelength 415.0 nm.

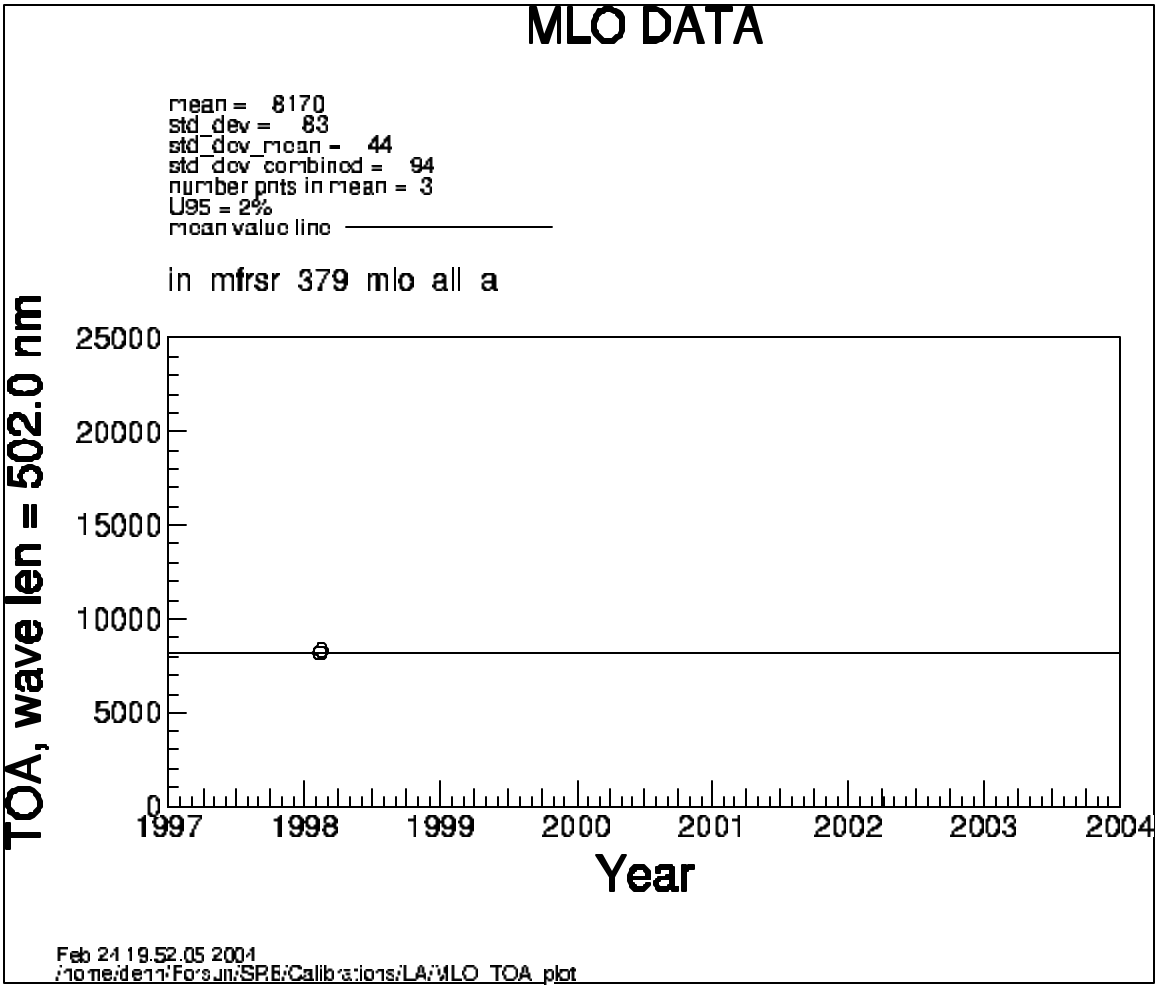

Figure 5a. Period 1, MLO TOA data collected during year 1998 for wavelength 502.0 nm.

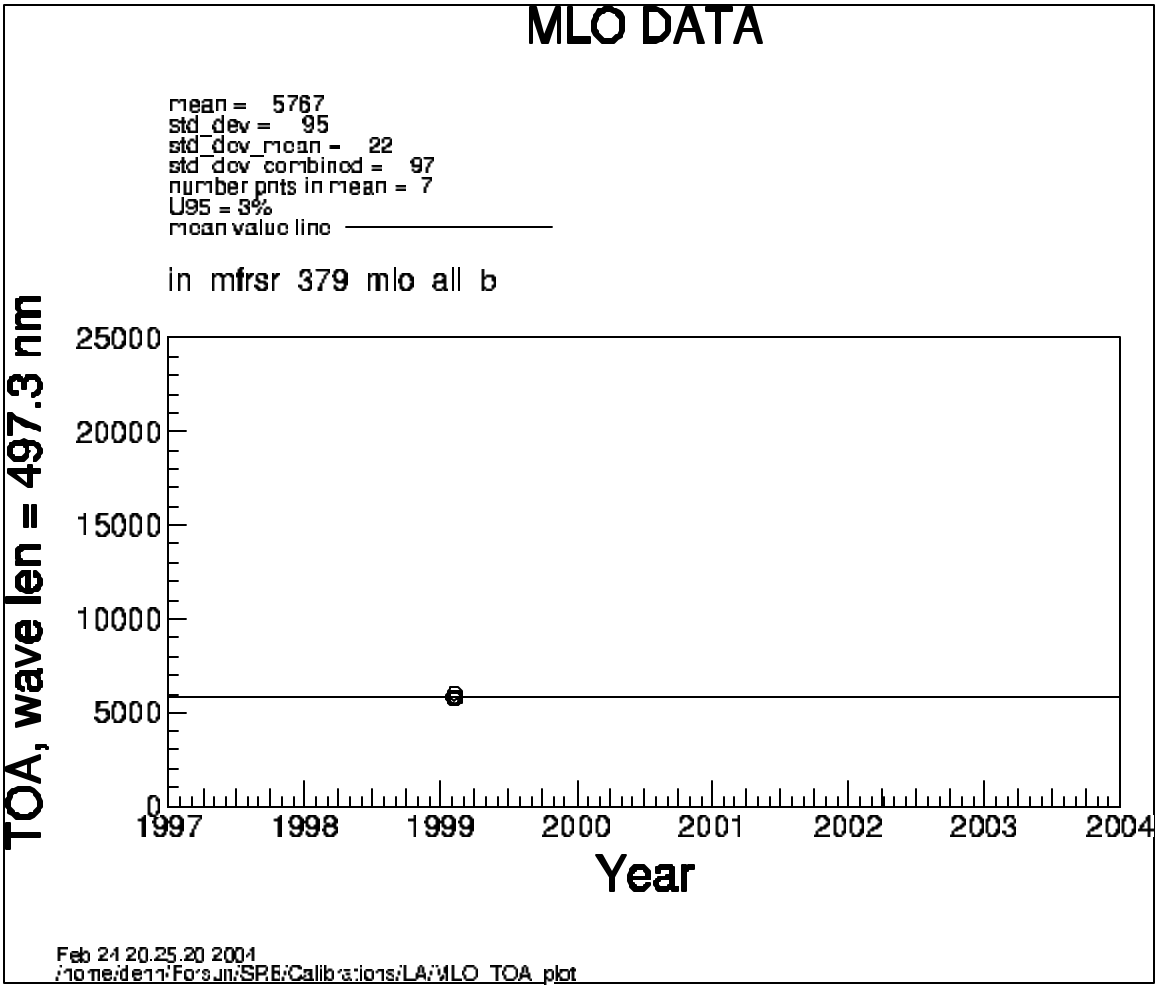

Figure 5b. Period 2, MLO TOA data collected during year 1999 for wavelength 497.3 nm.

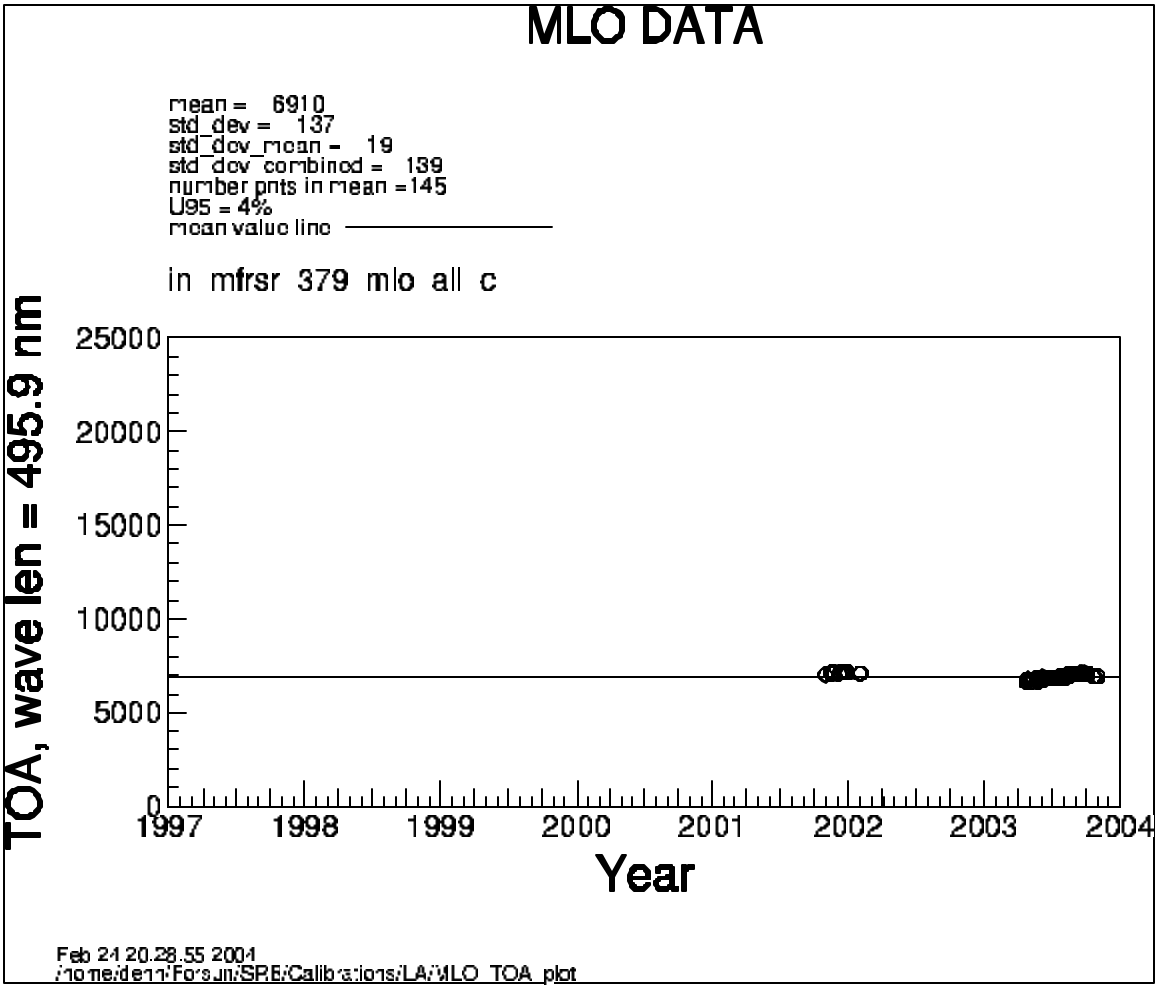

Figure 5c. Period 3, MLO TOA data collected during years 2001 through 2003 for wavelength 495.9 nm.

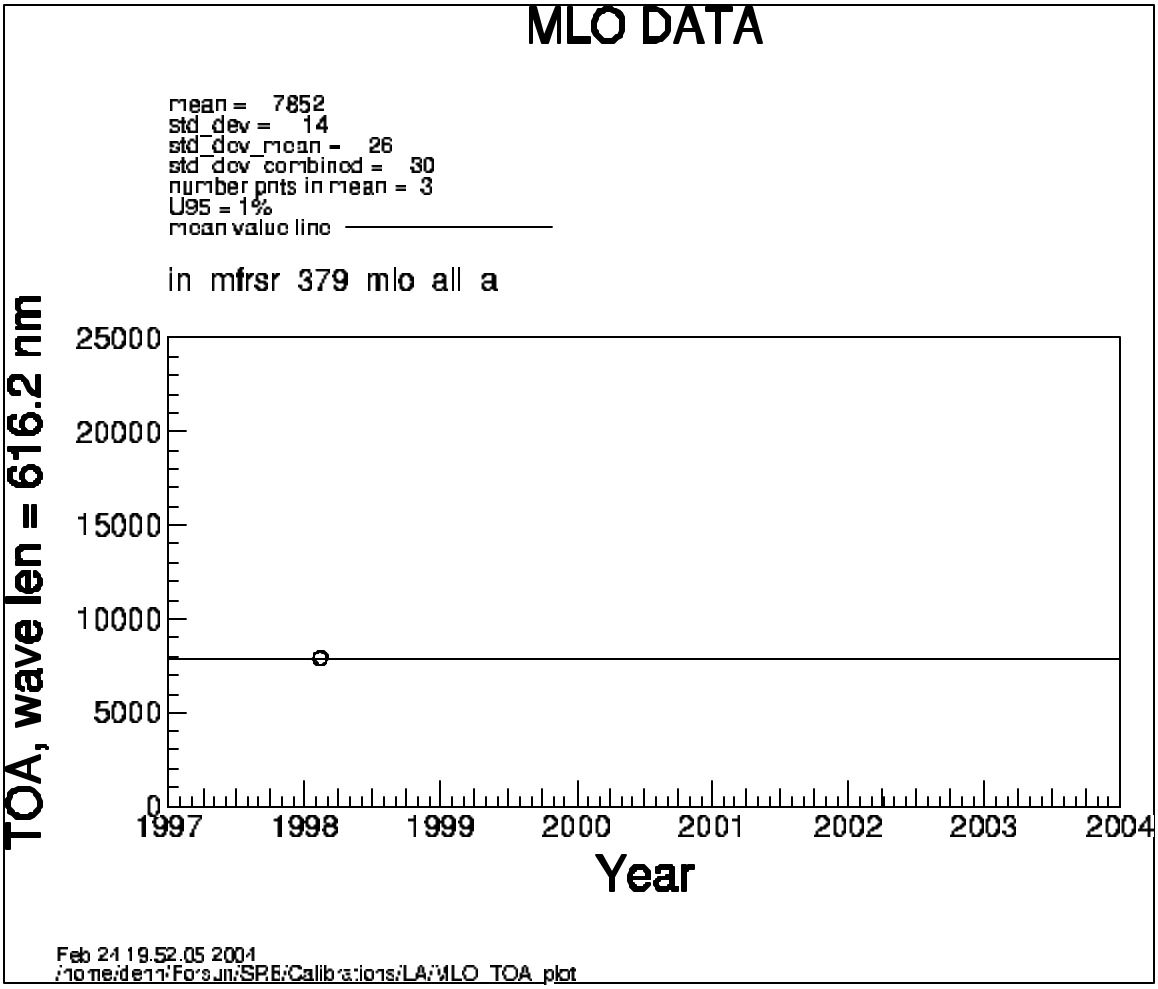

Figure 6a. Period 1, MLO TOA data collected during year 1998 for wavelength 616.2 nm.

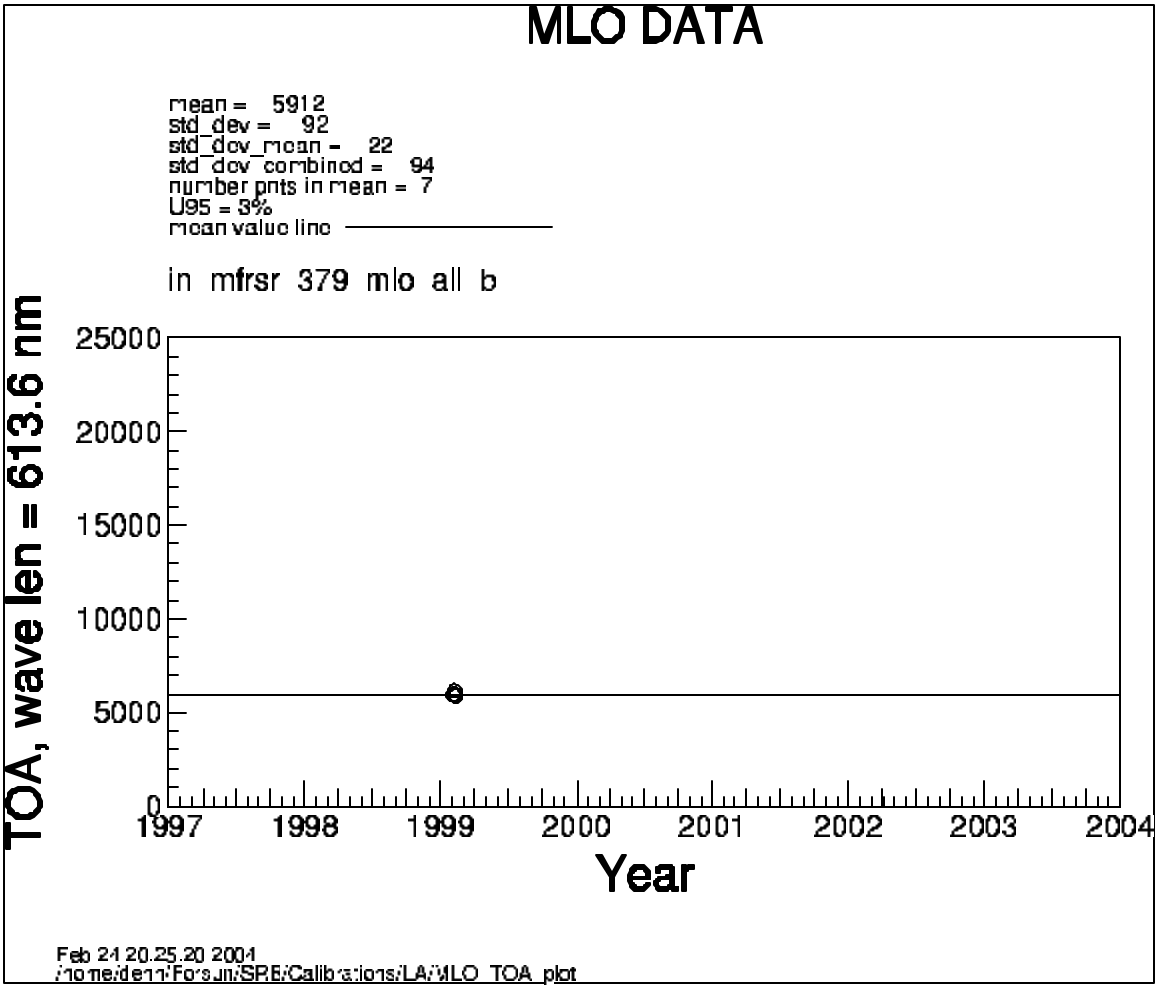

Figure 6b. Period 2, MLO TOA data collected during year 1999 for wavelength 613.6 nm.

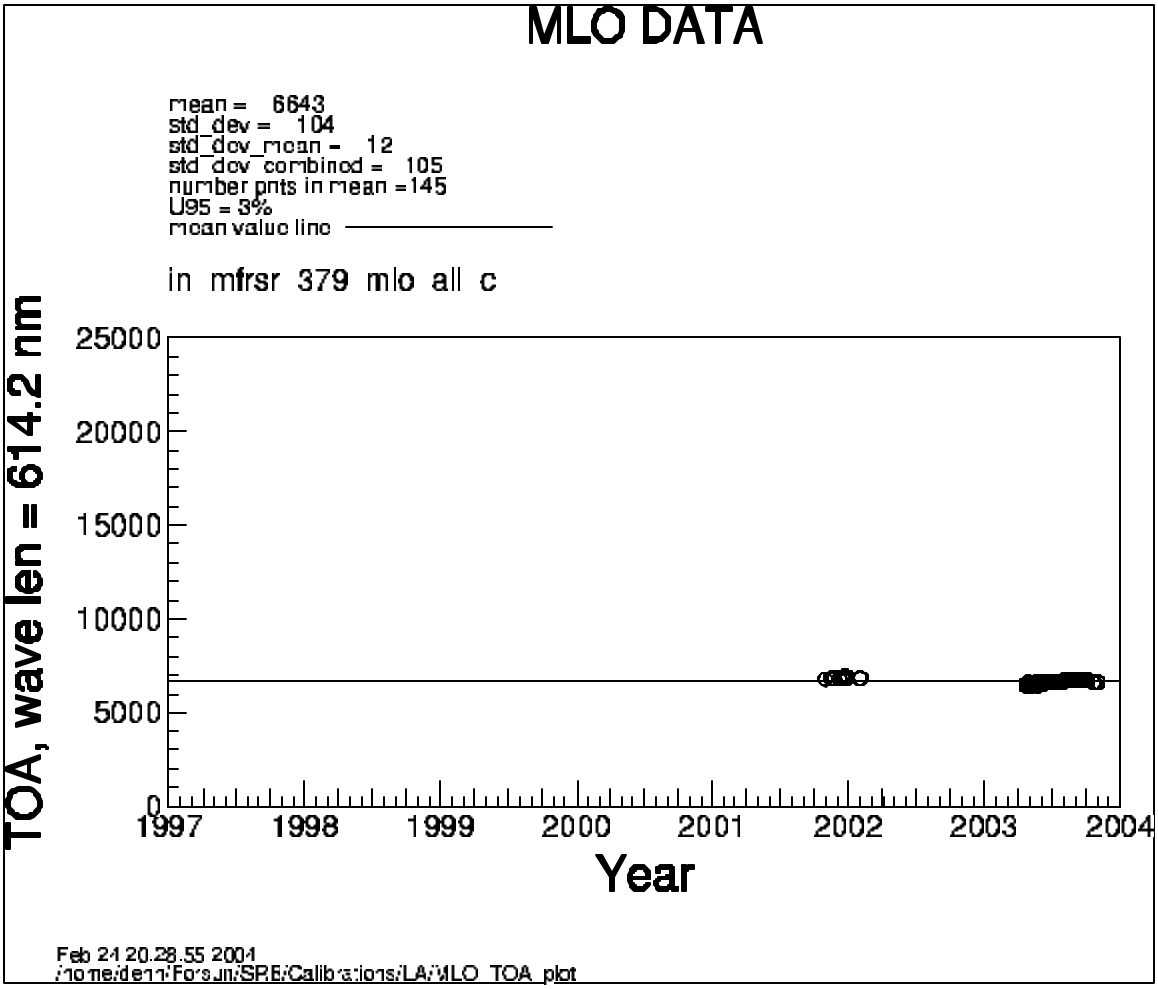

Figure 6c. Period 3, MLO TOA data collected during years 2001 through 2003 for wavelength 614.2 nm.

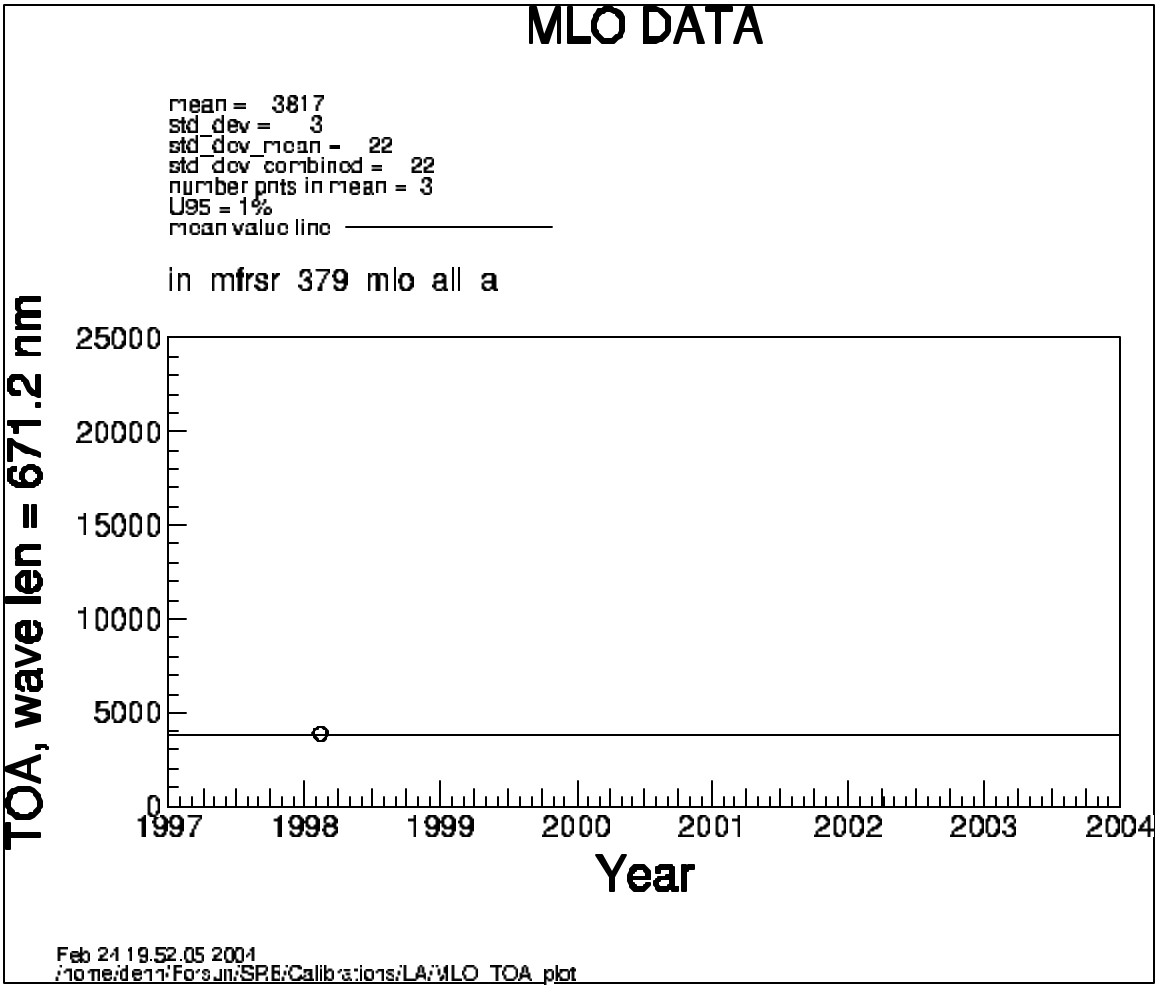

Figure 7a. Period 1, MLO TOA data collected during year 1999 for wavelength 671.2 nm.

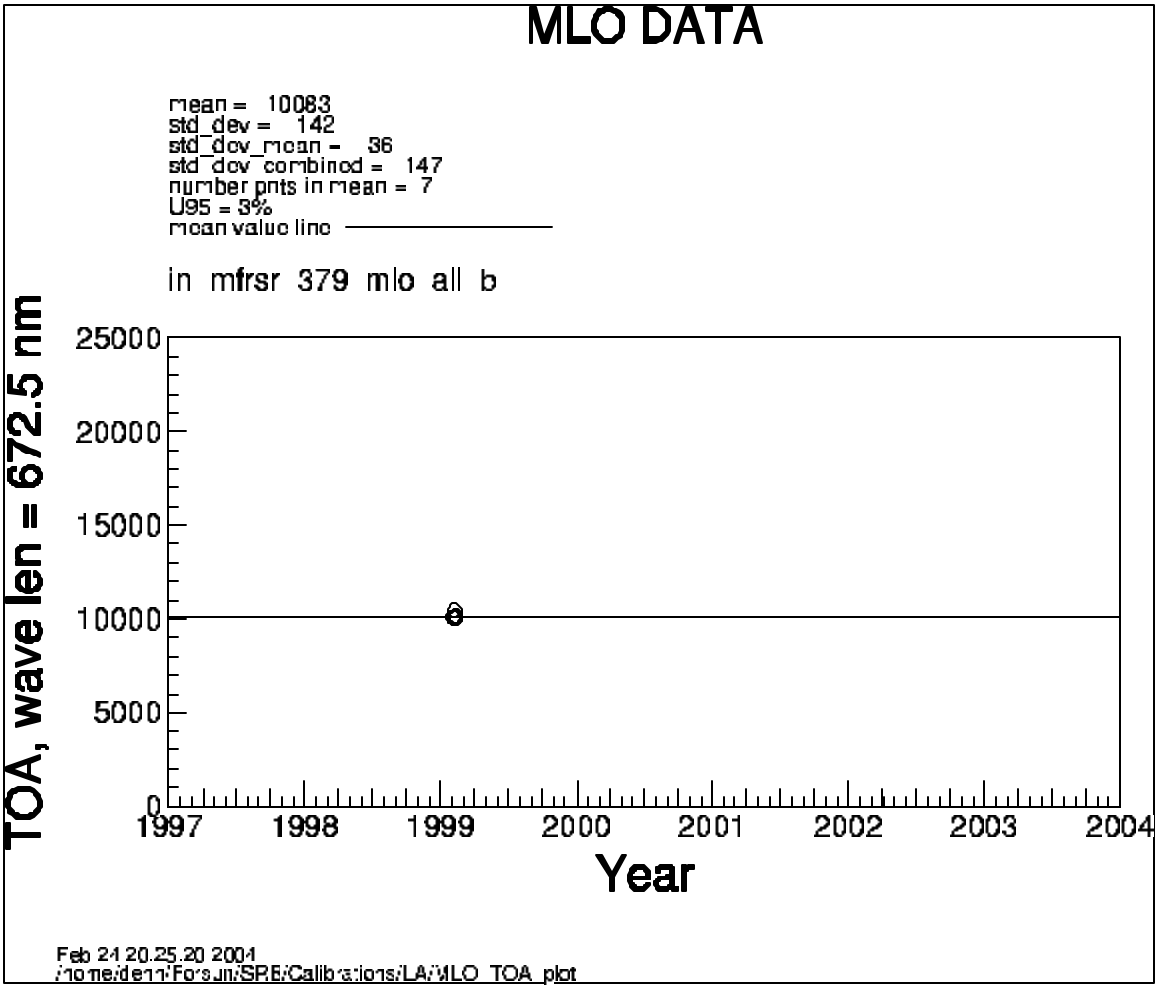

Figure 7b. Period 2, MLO TOA data collected during year 1999 for wavelength 672.5 nm.

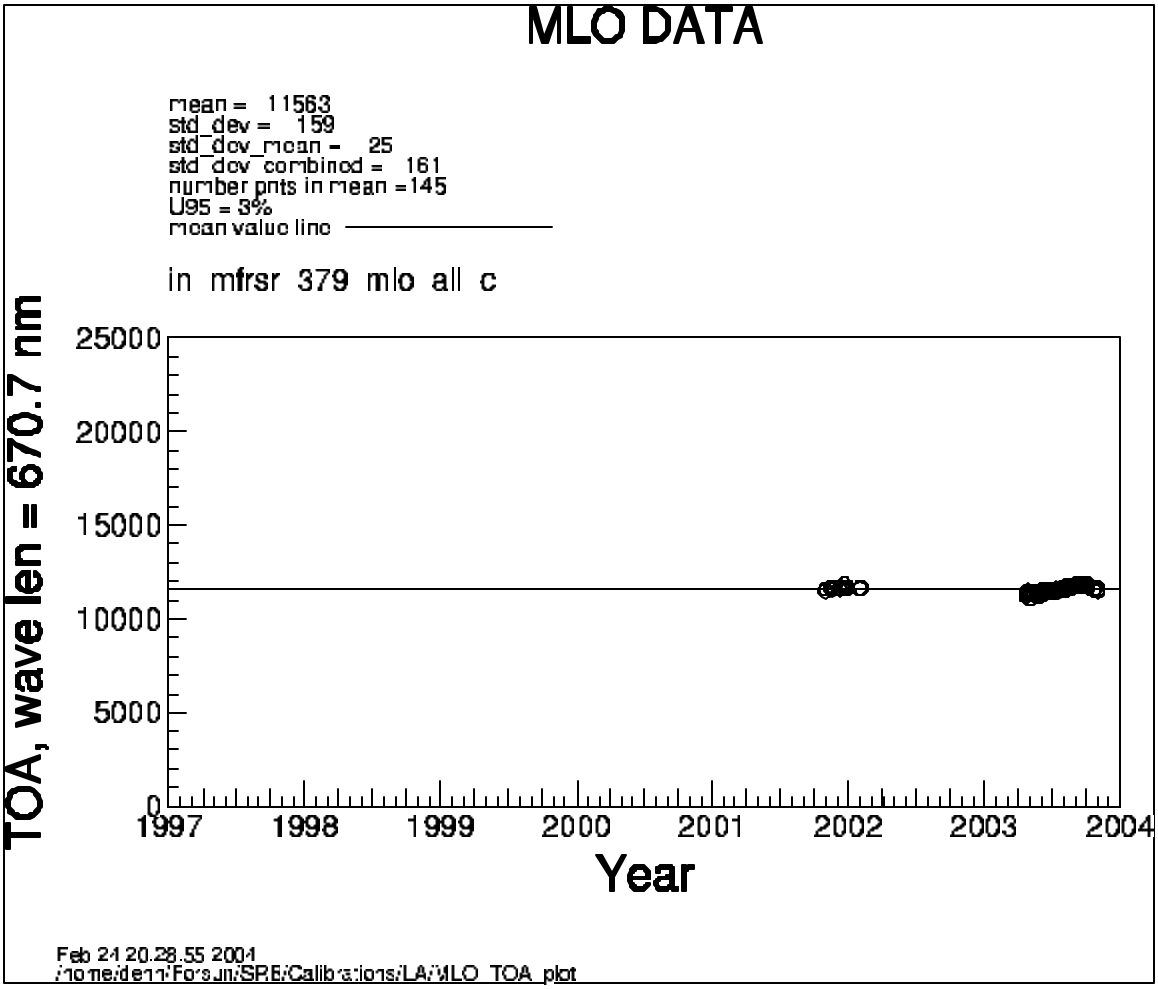

Figure 7c. Period 3, MLO TOA data collected during years 2001 through 2003 for wavelength 670.7 nm.

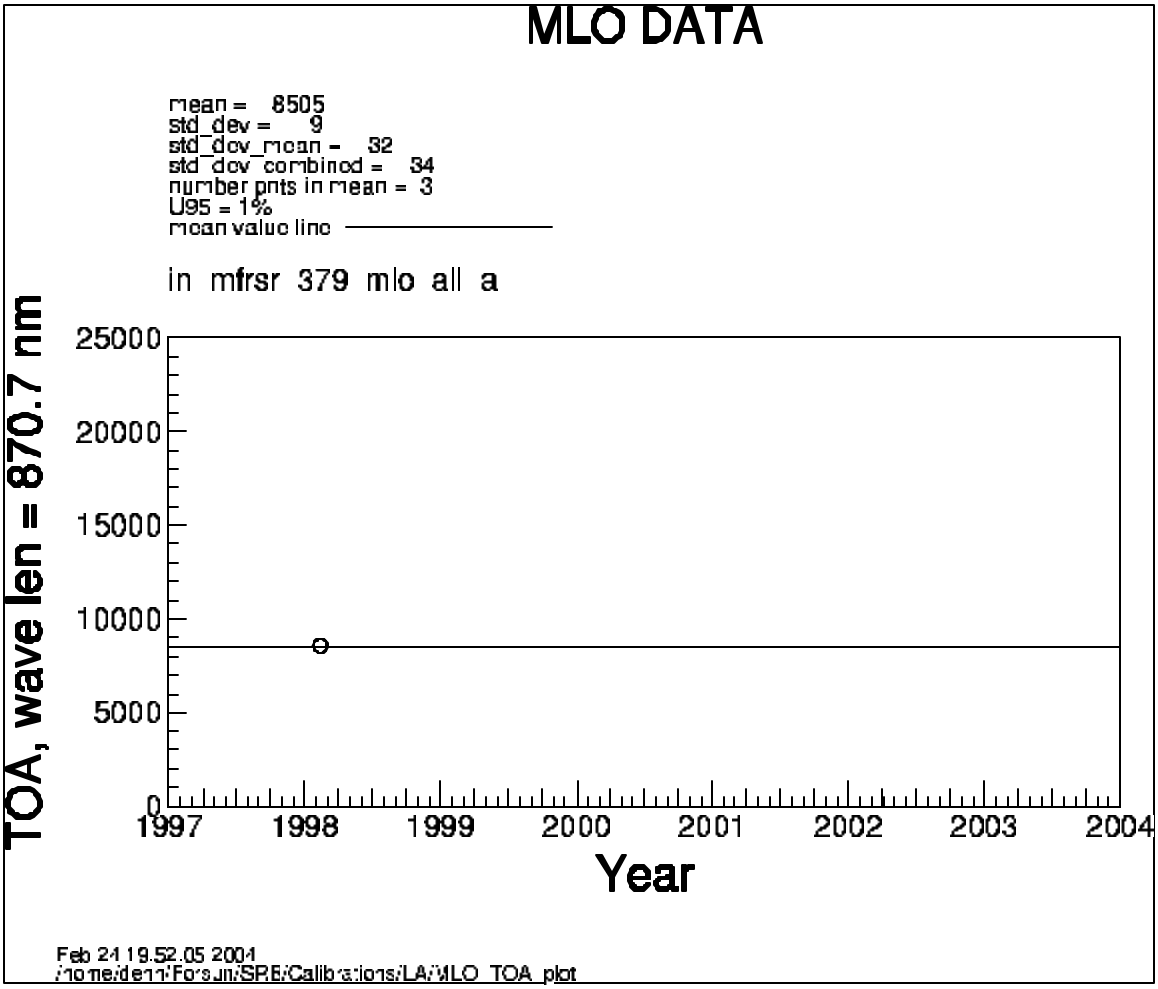

Figure 8a. Period 1, MLO TOA data collected during year 1998 for wavelength 870.7 nm.

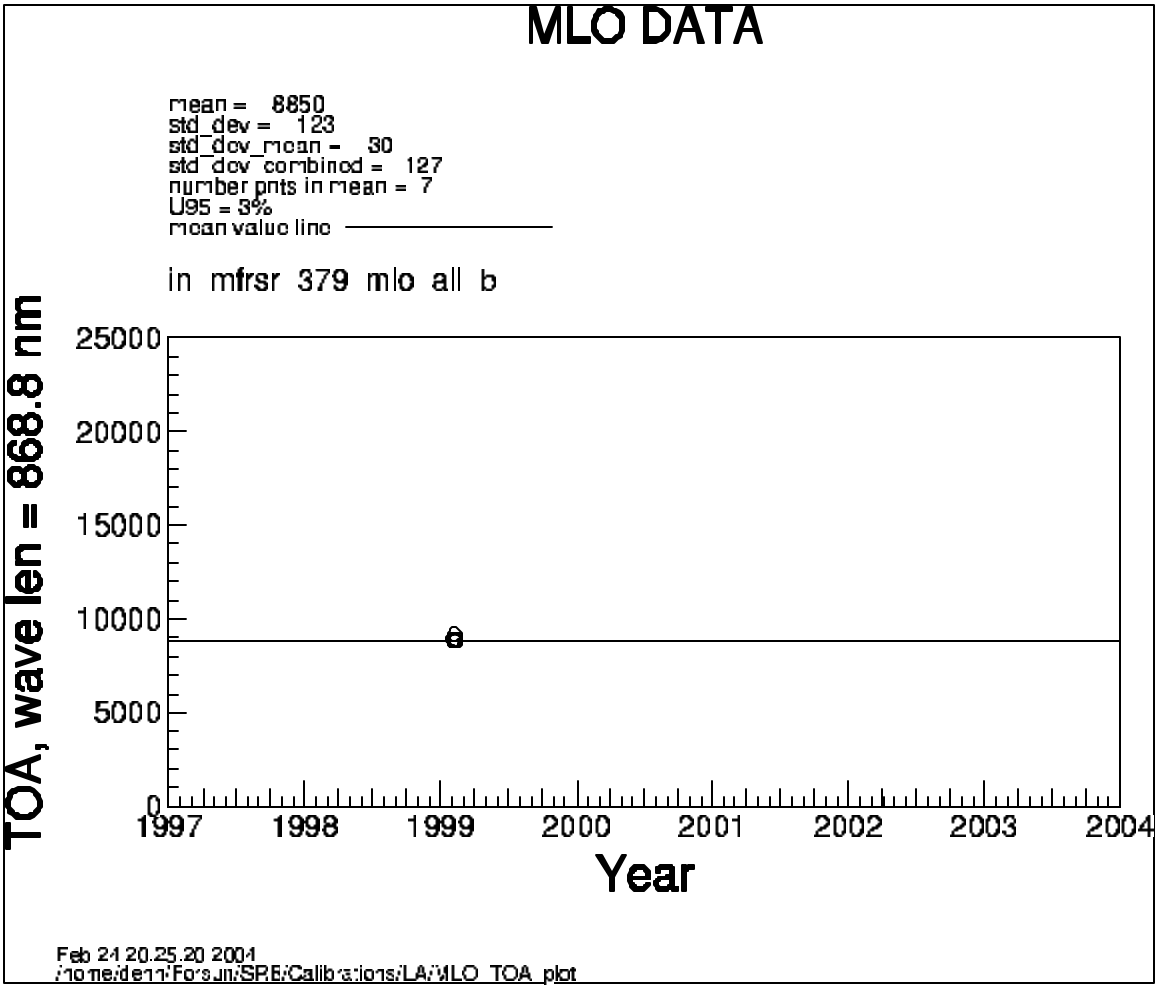

Figure 8b. Period 2, MLO TOA data collected during year 1999 for wavelength 868.8 nm.

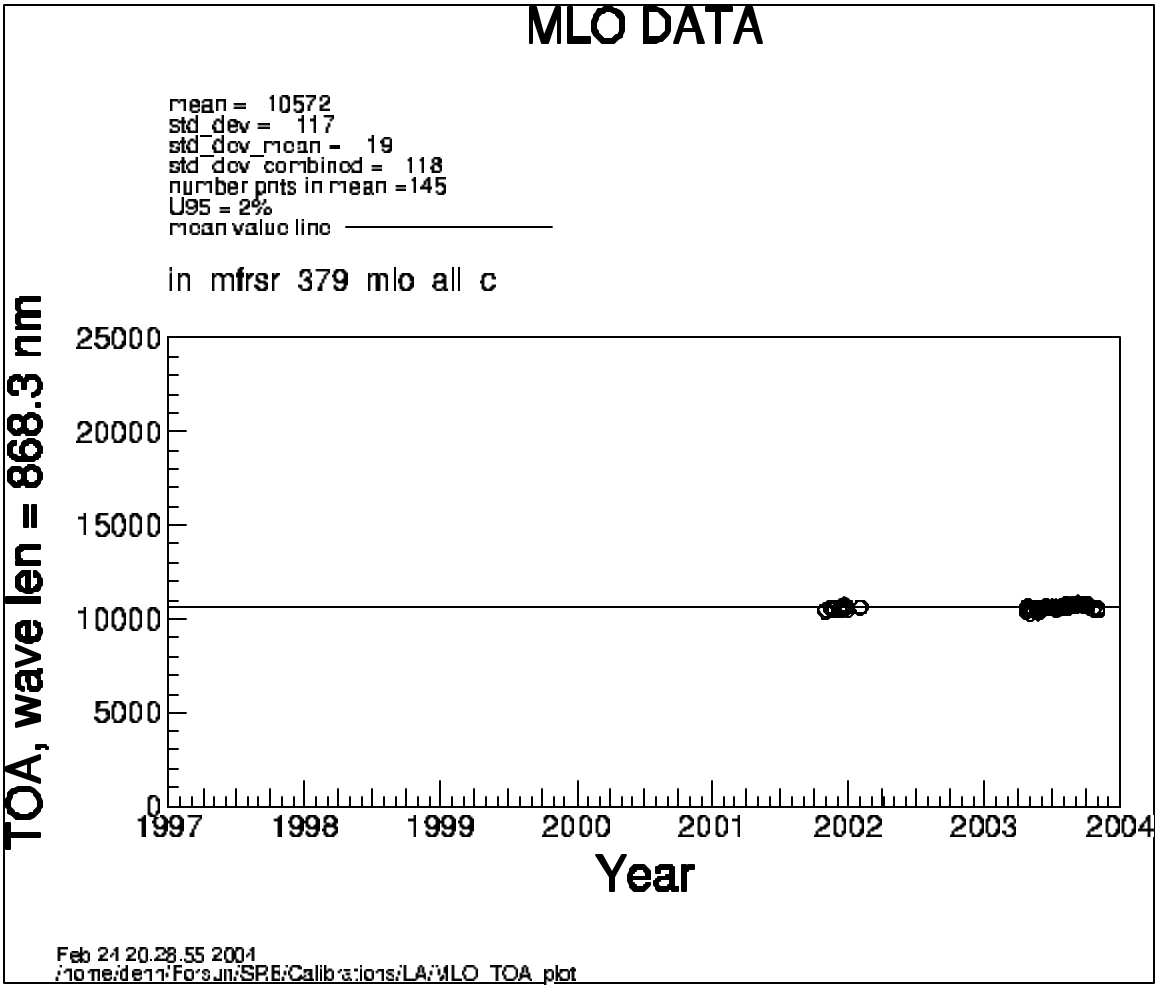

Figure 8c. Period 3, MLO TOA data collected during years 2001 through 2003 for wavelength 868.3 nm.

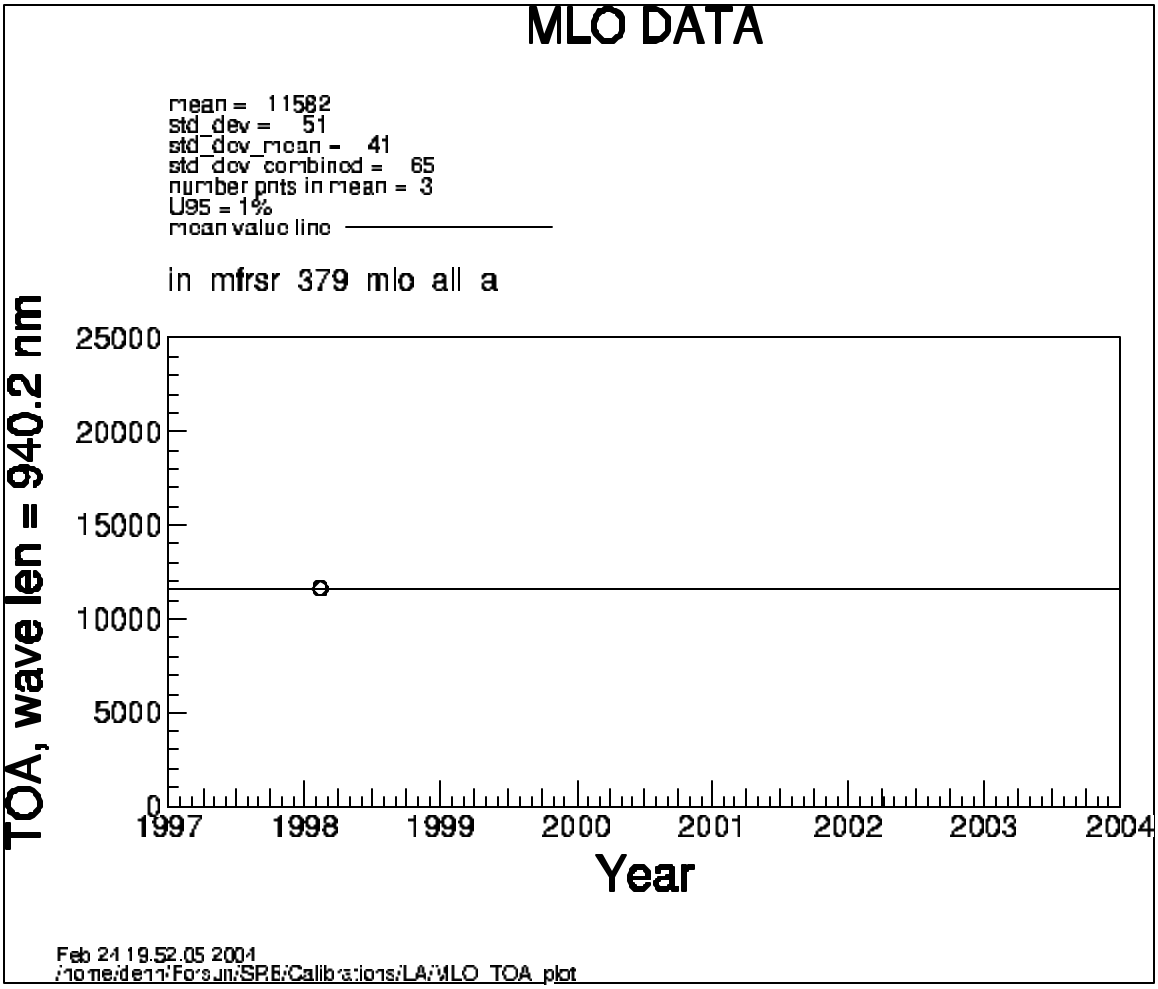

Figure 9a. MLO TOA data collected during year 1998 for wavelength 940.2 nm. This is a water vapor absorption wavelength, therefore the Langley TOA extrapolation does not work well.

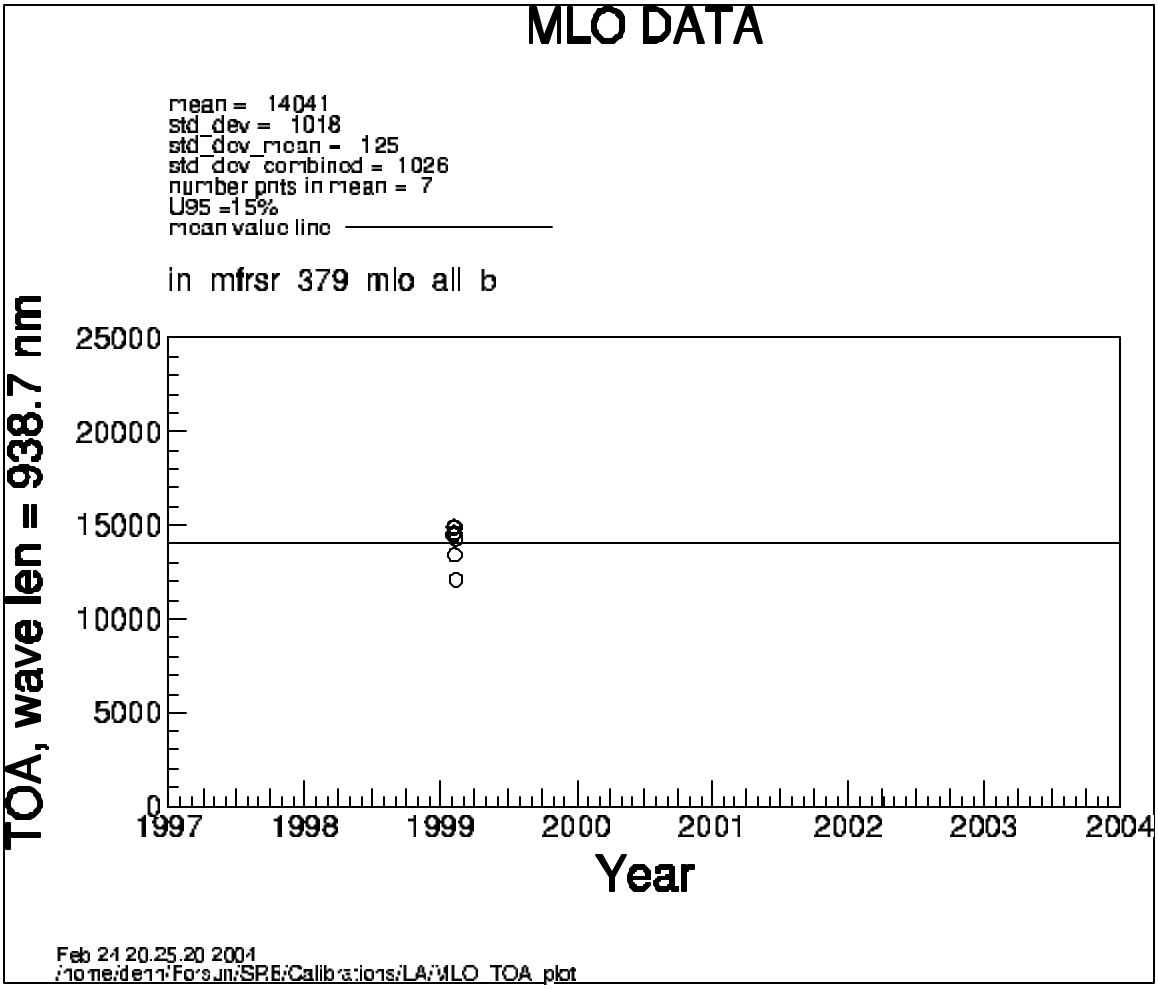

Figure 9b. MLO TOA data collected during year 1999 for wavelength 938.7 nm. This is a water vapor absorption wavelength, therefore the Langley TOA extrapolation does not work well.

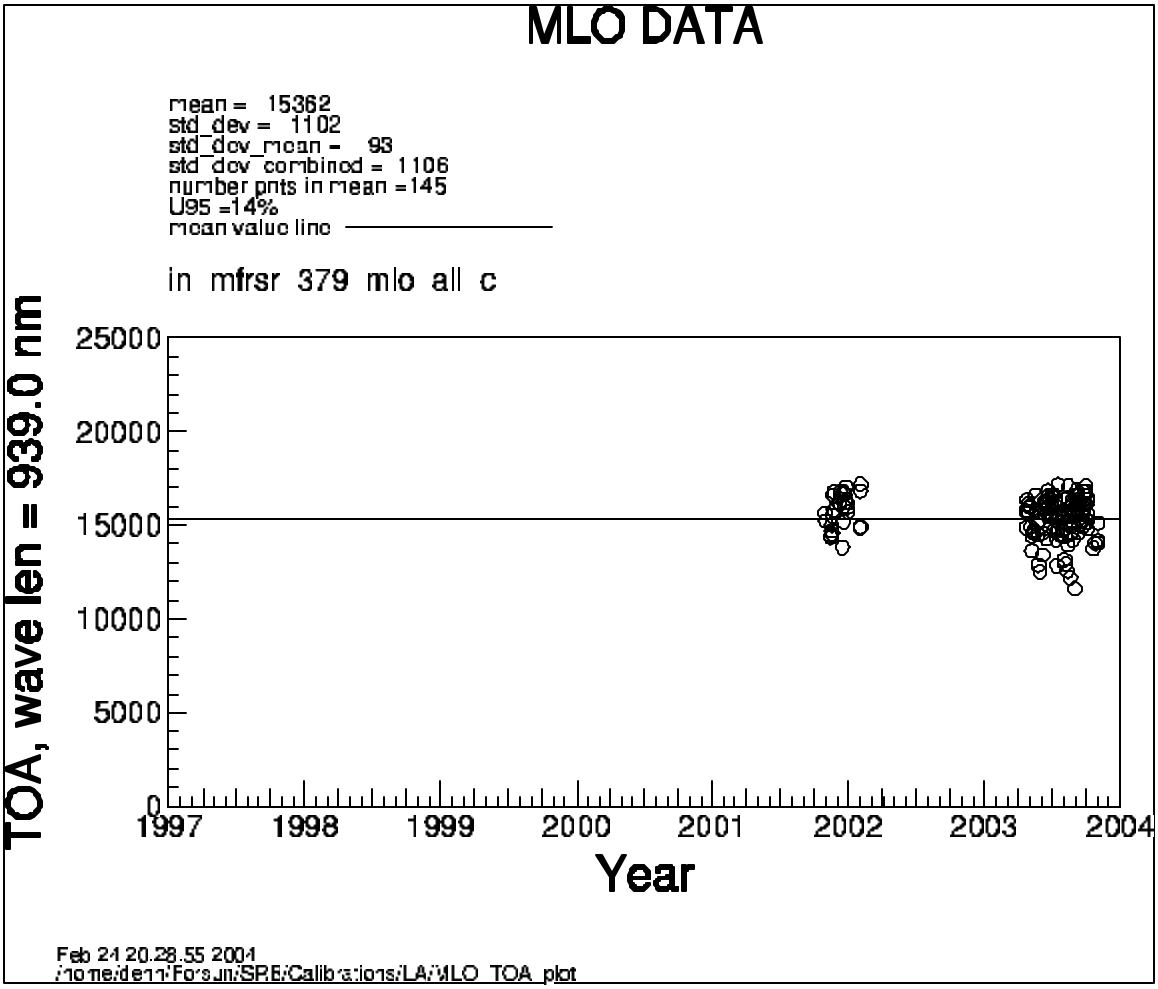

Figure 9c. MLO TOA data collected during years 2001 through 2003 for wavelength 939.0 nm. This is a water vapor absorption wavelength, therefore the Langley TOA extrapolation does not work well.

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