Saturation and parabolic efects of Langley Calibration at different altitude levels

Abstract

The performance of the well-known Langley plot technique, used for the calibration of ground-based sunphotometers, has been investigated at three observatory sites of different altitudes. All solar measurements were collected using a portable LED-type sunphotometer programed to a constant measurement protocol to allow direct comparison between different days and sites. Our results show that evaluation on the correlation R-value and slope AOD-value alone is not robust enough to guarantee a good Langley plot. Statistical analysis on global, diffuse and direct component also fails to select a perfect Langley plot within a pool of data available. Instead, examination on the evolution of diffuse component and direct component against global component actually provides a good representation of the performance of Langley plot. Diurnal evolution of diffuse component and direct component was found closely matching to the global component in a similar increasing trend. Our results also highlighted two important effects that greatly govern the performance of Langley plot, which are saturation effect and parabolic effect. Saturation effect occurs for the state when little to no more signal increase can be legibly reflected on Langley plot. It is dominant in low airmass region where the change of airmass is relatively too small for the increase in signal detected by the sunphotometer. Parabolic effect is preceding effect of signal saturation and becomes severely erroneous when high air masses are included in Langley plot.