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A novel MFRSR radiometer calibration approach for accurate aerosol optical depth retrieval: application to urban and maritime test sites.

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The MultiFilter Rotating Shadowband Radiometer (MFRSR) is a ground-based instrument widely used for atmospheric aerosol study.
It uses a system of independent detectors and an automated rotating shadow-band technique to measure global and diffuse solar irradiances at six shortwave wavelength (usually between 400 and 950 nm) with a 10 nm band-pass. It also has a broadband solar channel from 300 to 1100 nm. The direct irradiances for each different wavelength are calculated as the difference between global and diffuse irradiances. To obtain reliable values of spectral irradiance and aerosol optical depth an accurate calibration procedure is required.
The MFRSR calibration algorithm is based on Langley regression. The Langley method evaluates the variation of the natural logarithm of direct normal irradiance at the surface with optical mass, assuming the aerosol optical depth constant during the measurements period. Usually the calibration measurements are made in high mountain sites where optimal conditions to apply Langley method are present. However instruments displacement is sometimes impossible and in situ calibration is then necessary. In particular, when the measurements are made in urban sites, the hypothesis of constant optical depth can be extremely critical.
A novel calibration method, based on an algorithm which identifies and selects Langley plots with a point distribution that satisfy appropriate selection criteria, has been developed. MFRSR data analysis program provides the number of points for Langley plot regression and their standard deviation, optical depth and V0 (voltage related to solar irradiance at the top of atmosphere) values corrected for Earth-Sun distance. The V0 values are selected imposing particular conditions (different for each wavelength) on optical depth and standard deviation regression points. Then, V0 monthly mean, the running moving average on three months and the standard deviation for each one are calculated. The approach presented is applied to obtain spectral calibration constants values for monthly datasets. These values are used for spectral optical thickness retrieval in the same time period.
To validate the new calibration approach the measurements of two MFRSR operating at the Department of Physics of the University of Rome Sapienza (urban site) and one at the central Mediterranean ENEA Base of Lampedusa (maritime site), have been considered.
The calibration analysis for the MFRSR in Rome and in Lampedusa for the time period 2006-2009 are presented. Optical depth values obtained from calibrated data analysis for the two radiometers in Rome are also compared in order to validate the calibration algorithm for the urban site.