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Use of GNSS/GPS for calibrating ESR/SKYNET and AERONET Sun-sky radiometers: a multi-instruments approach to retrieve the precipitable water vapor content performing measurements comparability

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The estimation of the trace gases as the precipitable water vapor content (W) with high temporal and spatial resolution is of great interest in both meteorological and climatological studies. Several methodologies based on remote sensing techniques have been recently developed, in order to obtain accurate and frequent measurements of this atmospheric parameter. Among them, the relative low cost and easy deployment of sun-sky radiometers, or sun-photometers, operating in several international networks, allowed the development of automatic estimations of W from these instruments with high temporal resolution. However, the great problem of this methodology is the estimation of the sun-photometric calibration parameters. The objective of this paper is to validate a new methodology based on the hypothesis that the calibration parameters characterizing the atmospheric transmittance at 940 nm are dependent on vertical profiles of temperature, air pressure and moisture typical of each measurement site. To obtain the calibration parameters some simultaneously seasonal independent measurements of W taken over a large range of solar zenith angle and covering a wide range of W, are needed. In this work yearly GNSS/GPS dataset were used for obtaining a table of photometric calibration constants and the methodology was applied and validated in three European ESR-SKYNET network sites, characterized by different atmospheric and climatic conditions: Rome, Valencia and Aosta. Results were validated against the GNSS/GPS and AErosol Robotic NETwork (AERONET) W estimations. In both the validations the agreement was very high with a percentage RMSD of about 6%, 13% and 8% in the case of GPS intercomparison at Rome, Aosta and Valencia, respectively, and of 8% in the case of AERONET comparison in Valencia.
Analysing the results by W classes, the present methodology was found to clearly improve W estimation at low W content when compared against AERONET in term of %Bias, bringing the agreement with the GPS (considered the reference one), from a %Bias of 5.76 to 0.52.