Sección Especial: 37th AMASON / Special Section: 37th AMASON
Aerosols in the Atmosphere

AERONET-RIMA calibration facility: Accuracy assessment of sky radiances in Autilla del Pino (Palencia-Spain)

Estación de calibración de AERONET-RIMA: Evaluación de la calidad de las medidas de radiancia de cielo en Autilla del Pino

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ABSTRACT:

Since 2006, RIMA network has a calibration facility for the Cimel sun photometers (intercomparison site at Autilla del Pino, Palencia). The calibration process and network management are carried out by the Atmospheric Optics Group of Valladolid University (GOA-UVa). This fact allows our group to run a large number of data from different co-located Sun photometers (Cimel-318). The comparison of radiance measurements has a special interest due to its importance in the inversion procedures. Differences between most of the sun photometers were under 5%, for direct comparison between sun-photometers since 2006, which is Aeronet acceptance limit. However, some discrepancies over this limit were found in some channels, especially in the aureole range and at 90º of almucántar angle. Problems in the pointing system are thought to be the causes of the differences at aureole range. Two new measurements have been implemented to evaluate and to improve the accuracy of pointing system in sun photometers: matrix and cross measurements. Errors at 90º at almucántar angle have been associated with old collimators. Aeronet network is installing new collimators so as reduce the differences.

Keywords: Aeronet, Radiance, Sun-Photometer, Pointing System.

RESUMEN:

Desde el año 2006, la red RIMA tiene una estación de calibración para fotómetros solares Cimel (estación de intercomparación en Autilla del Pino, Palencia). Tanto el proceso de calibración como el mantenimiento de la red es llevado a cabo por el Grupo de Óptica Atmosférica de la Universidad de Valladolid (GOA-UVa). Este hecho ha permitido a nuestro grupo administrar un gran número de datos de diferentes fotómetros solares (Cimel-318) midiendo en la misma estación. Este hecho, permite realizar una comparación de medidas de radiancia, las cuales poseen una relevancia especial en el procedimiento de inversión dentro de la red Aeronet. Las diferencias encontradas en la mayoría de los fotómetros estuvieron por debajo del 5%, para las comparaciones realizadas desde el año 2006, que es el límite aceptado por la red Aeronet. Sin embargo, se han observado algunas discrepancias por encima de este límite, especialmente en el rango de la aureola y a 90º de ángulo de almucántar. El motivo asociado a las diferencias en la aureola han sido los problemas de apuntamiento. Dos nuevos medidas han sido implementadas para evaluar y mejorar el apuntamiento en los fotómetros solares: medidas matriz y cruz. Por otro lado, se ha comprobado que los errores a 90º en el ángulo del almucántar son debidos a viejos colimadores. La red Aeronet está instalando nuevos colimadores para reducir las diferencias.

Palabras clave: Aeronet, Radiancia, Fotómetros Solares, Sistema de Apuntamiento..

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1. Introduction

In the context of Aeronet network [1] and regarding the aerosol products calculated by the inversion of radiance measurements, there have been found several disagreements. One of them is the significant discrepancy found between inversions from almucantar and principal plane data. This disagreement has been related to errors in radiance measurements associated to technical questions. These errors affect in different ways depending on the measurement, for example, principal plane scenario is very sensitive to an error in the pointing system, while in almucantar measurement the pointing error is highly corrected by the means of left and right measures. Therefore to guarantee good products from the radiance inversion a good evaluation over radiance measurements is needed.

Since 2006, the Atmospheric Optics Group of the University of Valladolid is responsible for the management, the maintenance and the calibration of the instruments within RIMA (Iberian network for aerosol measurements). This network acts as part of the international AERONET network, which counts with a total of around 300 stations all over the world. Calibration procedure has two stages: radiance calibration with an integrating sphere in the Optic Laboratory of GOA in the Valladolid University and the irradiance calibration by intercomparison with master photometers in the field Calibration platform of Autilla del Pino (Palencia). During this second stage the photometers are sited together for one or two months and, even though they are in their irradiance calibration phase, they also do radiance measurements. This fact is very useful in order to compare the radiance measurements and evaluate the differences between the photometers

2. RIMA facility in Autilla del Pino

The field calibration platform of Rima network is operational since summer 2007 and is located in the rural village of Autilla del Pino, 7 km away from Palencia town (Spain). The facility is situated in one of the station for meteorological measurements belonging to AEMET (Spanish Meteorological Agency). The geographical area has special conditions to install a platform to carry out sun-photometer calibration works, because it is a very clean area far from polluted regions, with a fully unobstructed view to the horizon, and presents 200 days per year under cloudless conditions.

The geographical area is situated on the North-central flat plateau of the Iberian Peninsula (Region of Castilla y León) which in average has 850 m.a.s.l. The region presents a Continentalized Mediterranean climate. This climate is similar to a typical Mediterranean climate, but with more extreme temperatures characteristics of a continental climate: Winters are long and cold, with average temperatures around 4°C. Summers are short and warm with an average temperature of 20°C. The three or four summer months are very dry, typical of a Mediterranean climate. Rain average is only 450 millimetres annually. The low aerosol charge is given by a mean of 0.12 for the aerosol optical depth at 440 nm and the value of the Angstrom coefficient is 1.3 (dst=0.15).

2.1. Most common situation: Clean continental aerosol

The Iberian Peninsula is highly affected by the North Atlantic Anticyclone. During this situation (Fig. 1), the registered aerosol in Autilla del Pino is continental type. It has low turbidity with aerosol optical depth at 440 nm below 0.1 and high Angstrom parameter above 1. Normally it is associated with cloudless days, which result in perfect conditions for sun-photometer calibration.

2.2. Desert dust events

Because of its geographical position near the North African continent, the Iberian Peninsula is frequently affected by African air masses loaded of mineral dust particles (Fig. 2). These intrusions entail the episodes with largest aerosol load over the Iberian Peninsula [3,4]. Although in southern Spain, desert dust intrusions are more frequent than in the northern areas, these areas also have a high aerosol load as can be seen analyzing the data of Palencia station [5], which is sited 7 km from Autilla del Pino. This analysis shows that around 10% of the days, the area registers desert dust episodes. It presents high turbidity with high values of aerosol optical depth at 440 nm and low Angstrom parameter because of the large volume of coarse mode particles.

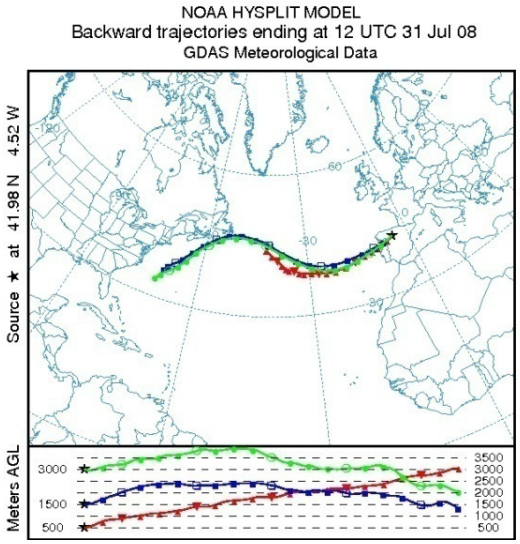

Fig. 1: The most common situation at Autilla del Pino, when it is under the effect of North Atlantic Anticyclone (Azores high).

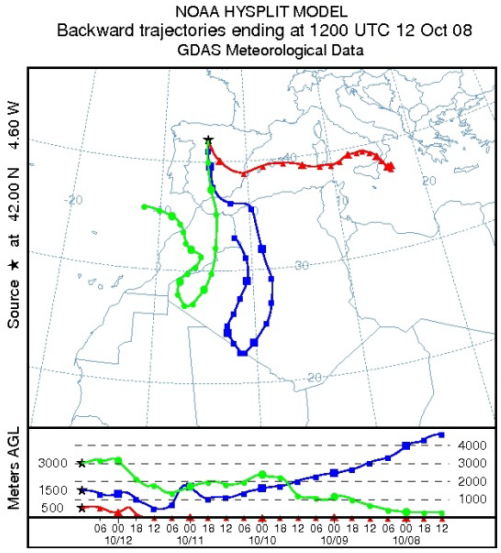

Fig. 2: Air masses coming from North African to Autilla del Pino during desert dust events.

2.3. Biomass burning events.

Due to the large number of fires in the Iberian Peninsula, biomass burning events are registered in the station, especially in the summer. Nevertheless, they only represent the 1% of the days. This type of aerosol presents high values for the aerosol optical depth and for the Angstrom parameter, so it can be easily discerned from desert dust events just by the Angstrom parameter.

2.4. Almucantar measurements for different scenarios

As it has been previously indicated radiance measurements, almucantars in AERONET network, are used to calculate aerosol features such as the single scattering albedo or the aerosol size distribution. As it was indicated, Autilla station registers different aerosol events, which can be use to observe the radiance attributes for different scenarios; Accordingly, in Fig. 3, normalized radiances, at four wavelengths (440 nm, 670 nm, 870 nm and 1020 nm) are shown for a desert dust and biomass burning events, which were registered in Autilla del Pino at the same solar zenith angle (75º) and with the same aerosol optical depth at 440 nm (0.26).

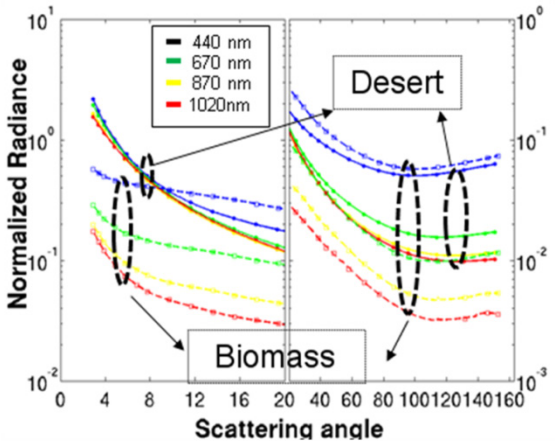

Fig. 3: Normalized radiance comparison between desert dust (2009-11-19) and biomass burning (2009-10-02) events measured in Autilla del Pino at same SZA (75º) and with the same AOD_{440}(0.26).

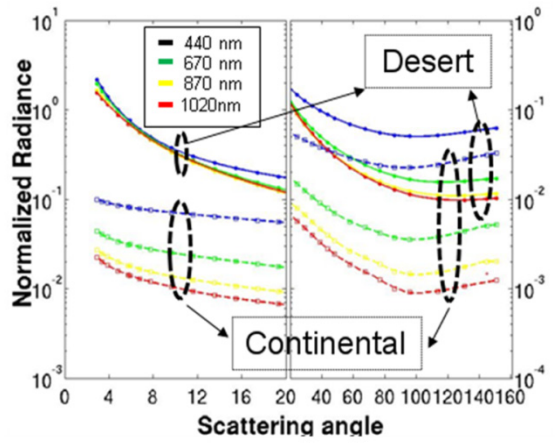

Fig. 4. Normalized radiance comparison between desert dust (2009-11-19) and clean continental (2009-10-15) events measured in Autilla del Pino at same SZA (75º).

The main difference between them is that while all radiance measurements, not matter the channel, are very close for the desert dust event they are spread for the biomass burning. This result is even more noticeable for aureole values where largest particles, which are less wavelength dependent, have more influence. Also, normalized radiance measurements in desert dust event are higher than the ones in the biomass burning in the aureole region though they get more equal as the scattering angle is increased.

On the other hand, in Fig. 4, the normalized radiance for clean continental case is compared, instead of the biomass burning, with normalized radiance for desert dust event.

As in the case of Fig. 4, normalized radiances for the clean continental aerosol seem to be expanded in contrast to the ones for the desert dust event. In fact, normalized radiances from biomass burning and clean continental have the same shape but the first one is one order of magnitude larger. That is explained because of its greater number of particles: while for the biomass burning, represented in Fig. 3, the aerosol optical depth at 440 nm was 0.26 for the clean continental aerosol was 0.03.

3. Radiance comparison between sun photometers

3.1. Comparison results

As it was previously commented, measured radiance with different photometers at the same time in Autilla del Pino station were analyzed by using CAELIS system (control management of RIMA). Firstly, through a complex query to CAELIS database, the radiance data from those photometers under comparison were selected whenever the measurement time difference between them was less than 10 seconds. Secondly, a cloud screening filter was applied: all those radiance data not fulfilling Aeronet inversion requirements were eliminated (symmetry criteria [6])

Almost all two by two comparisons showed differences around 1-2% which taking into the account that the sphere used for radiance calibration assures a radiance error under 5%

was a good result. However, there were found two major disagreements at aureole range and at 90º of almucántar angle.

In order to illustrate both discrepancies, Fig. 4 and Fig. 5 show two comparisons between sun-photometers in Autilla del Pino station. Although sun photometer calibration time lasts between one and two months there are always two masters to carry out the calibrations running for a longer period of around six months. Obviously, master comparisons are the most robust examples and they will be used to illustrate the general results: in Figs. 4 and 5, six months comparison between masters #25 and #352 (more than 400 almucantars passing Aeronet criteria) and between masters #383 and #421 (more than 200 almucantars passing Aeronet criteria) are represented.

Both figures show differences below 5%, which is the limit established for radiance calibration, but at 90º, almucantar angle, in the second comparison, where for 1020 nm channel radiance differences slightly overpass this 5% limit. The discrepancy at 90º only occurs in some cases and it has been associated to a problem with old sun- photometer collimators which, due to unwanted reflections, introduce some light in the system at 90º. To avoid this problem, AERONET network has already started to changed old collimators for new ones.

On the other hand, in all the comparisons, there is a change of tendency for aureole values, being the error bigger for shorter angles. The error in the shorter angles has been related to a pointing error of the tracking system. Regarding this issue and in collaboration with CIMEL, we are analyzing data from two new measurement scenarios that have been developed to check the pointing error.

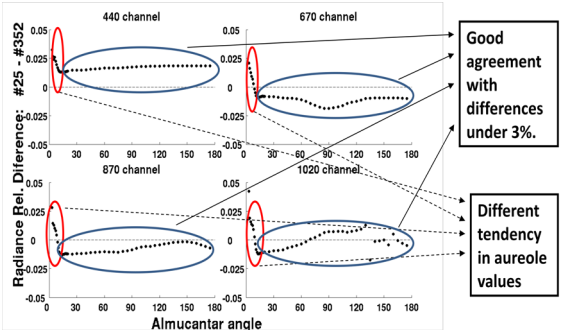

Fig. 5. Relative radiance differences between collocated photometers #25 and #352, measuring in Autilla del Pino from 2009-06-15 to 2010-01-15.

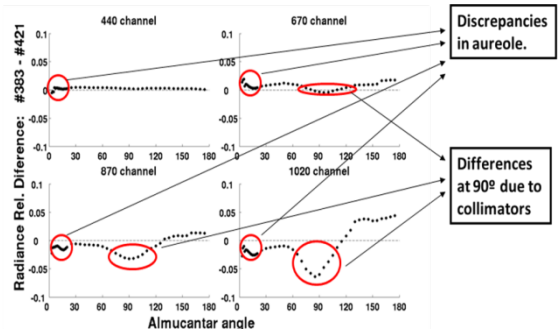

Fig. 5. Relative radiance differences between collocated photometers #383 and #421, measuring in Autilla del Pino from 2009-06-15 to 2010-01-15.

Acknowledgments

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