The European SKYRAD users network package (ESR.pack): validation of the aerosol optical depth in comparison to AERONET

V. Estellés[1,2], M. Campanelli[3], T. Smyth[4], M.P. Utrillas[2] and J.A. Martínez-Lozano[2]

[1]Dept. Física Fundamental, Universidad de La Laguna (Spain); [2]Dept. Física de la Terra, Universitat de València (Spain);
[3]Institute of Atmospheric Sciences and Climate, CNR (Italy); [4]Plymouth Marine Laboratory (United Kingdom)

Introduction

Aerosols play an important role in the Earth radiative balance and consequently on global warming. However, our understanding of their optical and radiative properties is low. In order to estimate their properties, the sky – sun radiometric technique is the most accurate, accessible and wide spread in the world. In spite of its availability, for climate studies the WMO recommends to employ only data provided by networks with recognized quality standards. Nowadays, two of these international networks are up: **AERONET** and **SKYNET**.

Figure 1.
AERONET is mainly distributed in North America and Europe, and uses the Cimel CE318 as standard.

SKYNET is mainly present in eastern Asia, and holds the Prede POM01 radiometer as standard.

What ESR is?

The European Skyrad users network (also EuroSkyRad or ESR) has been started in November 2010 as a Colaboration Agreement between 10 different groups from European universities and research institutes.

On a first level, ESR is being constituted as a federated network of SKYNET, involving Prede radiometers in Europe and the Mediterranean region, whose data will be analyzed by SKYNET for homogeneity. But in addition, ESR is also developing its own software package (**ESR.pack**) for the analysis of both Cimel and Prede data. On a second level, ESR provides a platform for the synergistic study of both AERONET and SKYNET networks, involving not only Prede but Cimel radiometers, and applying the ESR package indistinctly to Cimel CE318 and Prede POM sky – sun radiometers.

This study addresses the validation of the ESR package, by analysing the performance of the new processing algorithm (*dsproc*) in comparison to AERONET aerosol optical depth retrievals. The application of the same code to both radiometers allow us to determine the relative performance of them too.

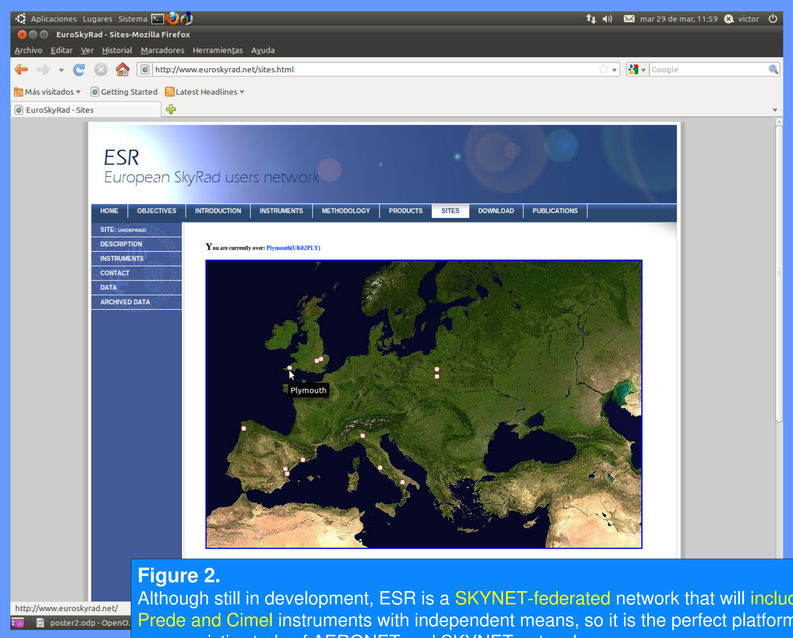

Figure 2.
Although still in development, ESR is a SKYNET-federated network that will include Prede and Cimel instruments with independent means, so it is the perfect platform for a synergistic study of AERONET and SKYNET networks.

Methodology

DATA BENCH
3 years of data obtained from two collocated CE318 and POM01 radiometers.

CALIBRATION
To avoid calibration differences, the CE318 calibration was transferred to the POM.

ALGORITHM
The *dsproc* code has been implemented in two different modes:
Mode 1 is composed of adapted Skyrad 4.2 subroutines.
Mode 2 implements alternative and more accurate algorithms.

	Mode 1	Mode 2
Solar position	Skyrad 4.2.	Blanco-Muriel (2001)
Refraction correction	No	Michalsky (1988)
Optical mass	Single, plane parallel	Multiple; Gueymard (2001)
Rayleigh scattering	Fröhlich and Shaw (1980) Young (1981)	Bodhaine (1999)
Ozone absorption	Skyrad 4.2.	Gueymard (2001)
Vapor absorption	No	Gueymard (2001)
NO_2 absorption	No	Gueymard (2001)
Filter convolution	Gaussian functions and filter transmittance profiles	
Water vapor	Bruegge (1992); Halthore (1997)	
Temperature	Compensated (generic or experimental termal coefficients)	
Ångström exponent	Ratio of wavelength pairs	Linear regression
Meteorological input	Pressure and ozone	Pressure, ozone, NO_2, water vapor and temperature

Results

ESR.PACK versus AERONET for CE318 (N~15000)

Mode	λ (nm)	rmsd(%)	rmsd	U95
1	340	14.5	0.0279	0.0463
	380	8.8	0.0163	0.0321
	440	7.4	0.0130	0.0257
	500	8.0	0.0108	0.0215
	675	9.9	0.0098	0.0190
	870	10	0.0086	0.0172
	1020	16	0.0102	0.0193
	Alfa	21	0.25	0.49
	WV (cm)	41	0.68	1.17
2	340	2.7	0.0052	0.0102
	380	2.3	0.0043	0.0077
	440	1.2	0.0021	0.0042
	500	1.6	0.0022	0.0037
	675	1.7	0.0017	0.0032
	870	1.0	0.0008	0.0013
	1020	3.1	0.0020	0.0039
	Alfa	2.4	0.03	0.06
	WV (cm)	8.6	0.16	0.32

POM01 versus CE318 – AERONET (N~5000)

Mode	λ(nm)	rmsd(%)	rmsd	U95
2	440	2.5	0.0045	0.0087
	500	2.2	0.0035	0.0070
	675	3.2	0.0033	0.0062
	870	2.9	0.0027	0.0051
	1020	5.9	0.0042	0.0083
	Alfa	2.6	0.03	0.05
	WV (cm)	5.5	0.10	0.14

Conclusions

- Mode 2 results are within the instrument precision, or AERONET uncertainty for a master instrument (~ 0.003).
- Mode 1 results are within AERONET uncertainty for field instruments (~0.02).
- Cimel and Prede radiometers obtain equivalent AOD when processed with the same ESR package (RMSD ~ 0.003 – 0.005).
- Prede and AERONET differences are also minimum (0.003 – 0.004).
- Improvements on columnar water vapor are expected, once the current AERONET methodology is implemented.

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Contact information

For more information about ESR activities and results, please email at vestelle@uv.es or visit us at: http://www.euroskyrad.net (website still under development!).

Universidad de La Laguna

ISAC

PML Plymouth Marine Laboratory