

## SPALINET: The Spanish and Portuguese aerosol lidar network

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**ABSTRACT:** To extend and reinforce the action of the EARLINET-ASOS project, a network of Spanish and Portuguese aerosol lidars (SPALINET) was created. In the first three years of the project six out of the ten systems have been successfully intercompared, seven elastic algorithms have also been validated and six Raman algorithms are currently being validated. Now the network focuses on future scientific objectives aiming at performing coordinated measurements.

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### 1. INTRODUCTION

Satellite-based lidars (GLAS, on board of ICESAT (2003), CALIOP, on board of CALIPSO (2006)) offer a global coverage of the aerosol spatial distribution but

with revisit times on the order of at least ten days. Coordinated terrestrial lidar networks offer simultaneously the temporal and vertical high resolution of each individual instruments and the spatial sampling of an extensive geographic zone.

EARLINET (European aerosol research lidar network to establish an aerosol climatology) [1] was created in May 2000. It has been endorsed since March 2006 by the coordinated action EARLINET-ASOS from the European Union and is currently totalizing 27 stations. The main objective of EARLINET-ASOS is to improve the EARLINET infrastructure resulting in a better spatial and temporal coverage of the observations, continuous quality control, and fast availability of standardized data products. The lidars from EARLINET present a great variety of characteristics [2] and one of the specific objectives of EARLINET-ASOS is to optimize instruments and define advanced lidars. To concentrate their efforts onward this objective, the Spanish lidar community created in 2007 a Spanish lidar network. Since mid-2009 the network also includes two Portuguese lidar stations.

## 2. THE SPANISH AND PORTUGUESE AEROSOL LIDAR NETWORK

The Spanish and Portuguese aerosol lidar network ([www.lidar.es/spalinet/en](http://www.lidar.es/spalinet/en)) is an initiative from the three Spanish groups involved in EARLINET-ASOS. It aims at promoting the use of lidar instruments and data among the Spanish and Portuguese scientific community [3]. The mains goals of the network are:

- Extend and reinforce the actions of EARLINET-ASOS;
- Form a nucleus for stimulating the Spanish and Portuguese lidar community;

- Promote the participation of new groups for improving the spatial coverage of aerosol vertical measurements on the Iberian Peninsula territory.

A total of 10 research centers or universities are participating:

- Universitat Politècnica de Catalunya (41.39N, 2.11E, Barcelona, BAR);
- Centro de Investigaciones Energéticas Medioambientales y Tecnológicas (40.46N, 3.72W, Madrid, MAD);
- Universidad de Granada (37.18N, 3.58W, Granada, GRA);
- Universidad de La Laguna (28.48N, 16.32W, La Laguna, LLA);
- Instituto Nacional de Técnica Aeroespacial (28.47N, 16.23W, Santa Cruz de Tenerife, SCT);
- Universitat de València (39.5N, 0.38W, Valencia, VAL);
- Universidad de Murcia (38.02N, 1.15W, Murcia, MUR);
- Universidad Politécnica de Cartagena (37.37N, 0.57W, Cartagena, CAR);
- Universidad de Algarve (37.05N, 7.97W, Faro, FAR);
- Centro de Geofísica de Évora (38.57N, 7.91W, Évora, EVO).

The main characteristics of the lidars involved in SPALINET are summarized in Table 1 and their geographical distribution is shown in Figure 1.

	Lidar stations									
	BAR	MAD	GRA	LLA	SCT	VAL	MUR	CAR	FAR	EVO
Lidar model	Lab.	Lab.	Raymetrics LR321-D400	Eridan LSA-2c	SES Inc. MPL-3	CIMEL Elec. CAML CE370-2	Lab.	Elight UV11	Lab.	Listar GmbH PollyXT
1064 – Elastic	160	-	110	100	-	-	1000	-	110	180
532 – Elastic	160	100	65 <sup>a</sup>	50	0.01 <sup>b</sup>	0.004	500	-	110	110 <sup>c</sup>
355 – Elastic	-	-	60	-	-	-	250	-	-	60
266 – Elastic	-	-	-	-	-	-	110	-	-	-
390-399 – Elastic	-	-	-	-	-	-	Yes	Yes	-	-
255-290 – Elastic	-	-	-	-	-	-	Yes	Yes	-	-
607 – Raman	Yes	Yes	Yes	-	-	-	Yes	-	-	Yes
387 – Raman	-	-	Yes	-	-	-	Yes	-	-	Yes
407 – Raman	-	-	Yes	-	-	-	Yes	-	-	-
PRF (Hz)	10	20	10	10	2500	4600	10	20	10	20
Scanning capability	Yes	Yes	-	Yes	Yes	-	Yes	Yes	-	-
Overlap (km)	0.25	~0.4	0.3	~0.3	1.5		0.2-2	~0.3	1	0.5
Max range (km)	50	15	60-90	10	60	5	50	5	10	61

<sup>a</sup> p and s polarization components are detected.

<sup>b</sup> The center wavelength is 523 nm.

<sup>c</sup> Total and cross polarization components are detected.

Table 1. Characteristics of the lidars involved in SPALINET.



Figure 1. Geographical distribution of the lidars involved in SPALINET. Circles and squares indicate transportable and fixed systems, respectively. The black color indicates the systems involved in EARLINET.

### 3. RESULTS FROM THE FIRST THREE YEARS

Table 2 summarizes all the intercomparison exercises performed so far and their results.

#### 3.1 Intercomparison at the hardware level

So far, 6 systems have been intercompared successfully at the hardware level. One system (MUR) participated in an intercomparison field campaign but did not fulfill the quality criteria due to inherent acquisition slowness. The Murcia system will realize a new field campaign once the system's acquisition module has been improved. The intercomparison of the last three systems (CAR, FAR and EVO) is planned for spring/summer 2010.

The intercomparison was made in terms of normalized distance, an indicator of signal similarity, and in terms of backscatter coefficient. The deviations of all optical coefficients intercompared (compared to the Barcelona system) fell within the maximum allowed values fixed by EARLINET [2]. More details about the successful intercomparisons can be found in Sicard et al. [4].

#### 3.2 Intercomparison at the software level: elastic algorithm

All groups (except Cartagena and the Portuguese groups) inverted with their own algorithm the aerosol backscatter profiles at 355, 532, and 1064 nm from a set of profiles of simulated elastic lidar signals under two atmospheric conditions (cases) and three situations (stages). The deviation of the inverted backscatter coefficient compared to the true value was less than 10 % in the more realistic stage (no information about the atmosphere was provided) and less than 1 % when the lidar ratio profiles was provided.

#### 3.3 Intercomparison at the software level: Raman algorithm

Six groups performed the intercomparison of Raman algorithms during 2009. Preliminary results show that at 532 nm all algorithms are able to retrieve both extinction and backscatter coefficients with the accuracy fixed by EARLINET. At 355 the deviations respect to the solution are greater. The extinction can be fairly well retrieved in the PBL and in a lofted layer at 3.6 – 4 km. The backscatter coefficient is not so well retrieved: four of the algorithms do not fulfill the criteria fixed by EARLINET neither in the PBL, nor in the lofted layer.

Intercomparison exercise	Date	Lidar stations									
		BAR	MAD	GRA	LLA	SCT	VAL	MUR	CAR	FAR	EVO
Intercomparison at the hardware level	06/2006 – 05/2008	$\beta_{1064}$ $\beta_{532}$ $\alpha_{532}$	$\beta_{532}$ $\alpha_{532}$	$\beta_{532}$ $\beta_{1064}$	$\beta_{532}$	$\beta_{523}$	$\beta_{532}$	TBR	TBM	TBM	TBM
Intercomparison of elastic algorithms	2008	ok	ok	ok	ok	ok	ok	ok	TBM	TBM	TBM
Intercomparison of Raman algorithms	2009	ok	ok	ok	ok			ok		TBM	Ok

Table 2. Results of all the intercomparison exercises. The first line shows the wavelengths intercompared. “TBR” and “TBM” stand for “To Be Repeated” and “To Be Made”, respectively. The grey cells indicate that the lidar station does not use the Raman algorithm.

### 4. OBSERVATIONAL APPROACH AND FUTURE OF SPALINET

The activities of SPALINET are driven by common scientific objectives which cover fields such as aerosol aging, transport, radiative forcing, with a special emphasis on desert dust whose intrusions over the Canary Islands and the Iberian Peninsula are more frequent than ever.

SPALINET aims at acting as a single tool for performing coordinated measurements over the entire territory covered by the network or a part of it. Field campaigns can be fixed by the network's own scientific objectives or in response to national or international projects.

In the present and in the near future some lidar stations of SPALINET are involved in EARLINET at a

continental scale and in CALIPSO [5] Cal/Val exercise at a global scale.

In a shorter time frame some SPALINET lidar stations have been involved in EMEP [6] (European Monitoring and Evaluation Programme) and are currently taking part in the ChArMEX project [7] (Chemistry-Aerosol Mediterranean Experiment).

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