

## ALINE/LALINET NETWORK STATUS

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### ABSTRACT

The Latin American Lidar Network, ALINE a.k.a LALINET is a federation lidar network established in 2008 which became a member of GALION/GAW program in 2013. Currently the network consists of 9 operational stations with the perspective of two more stations to be included. The network today covers more than 18 million Km<sup>2</sup> and spans in latitude from -52° to 21° and in longitude from -78° to -47°. It should cover a larger area in the future as planned with the inclusion of more active stations.

### 1. INTRODUCTION

LALINET is a federation lidar network established in 2013 as a member of GALION for 4D aerosol observation related to topics such as long-term climatic trends, identification of aerosols in the atmosphere and their optical properties and monitoring of long range transport, such as dust, volcanic ashes and biomass burning onto South America. Initially before its establishment the network organized itself via biennial meetings that have been taking place every two years since 2001. These meetings were initially created to nucleate the laser remote sensing groups in South and Central America. Among the participants we highlight the presence of experts and observers from other groups in the

world. With the engagement of the groups and setup of informal agreements new insights and scientific activities have been released such as pre-workshop introductory courses on atmospheric science and lidar fundamentals. The scientific drives for the network are those connected to characterize the temporal-spatial distribution of aerosols and their variations on a regional and continental scale. On a local scale the aerosol plumes are used to study the atmospheric dynamics acting as planetary boundary layer tracers and also to help in validating models and satellite observation products [1]. LALINET's most recent efforts are focused in establishing a standard measurement protocol and in improving a dataset common algorithm for data processing to be shared among all participating stations and adding more stations to the present network.

**Table 1.** ALINE/LALINET lidar stations.

Lidar system	City/Country	Coordinates
ba-BA-AR	Bariloche / Argentina	41.15°S 71.16°W
not applicable	Camagüey / Cuba	21.4°N 77.8°W
co-CEFOP-UDEC	Concepción/Chile	36.84°S 73.02°W
cr-CR-AR	Comodoro Rivadavia/ Argentina	43.24°S 65.33°W
ma-MA	Manaus / Brazil	2.89°S 59.97°W
me-LOA-UNAL	Medellin/ Colombia	6.26°N 75.58°W
ne-NE-AR	Neuquén/ Argentina	38.59°S 68.15°W
pa-LIPAZ	La Paz / Bolivia	16.54°S 68.07°W
sp-CLA-IPEN-MSP-LIDAR-I	São Paulo / Brazil	23.56°S 46.74°W
sp-CLA-IPEN-II	São Paulo / Brazil	Variable

## 2. NETWORK WORKSHOPS

The biennial meetings that have been taking place every two years since 2001, when the workshops were initially created to nucleate the laser remote sensing groups in South and Central Americas. To achieve such goal, experts and observers from other groups in the world were invited at each edition. With the engagement of the groups and informal agreements being made new insights and scientific activities have been implemented, as

pre-workshop introductory courses on atmospheric science and lidar fundamentals.

The network workshops have been held at most of the sites of the original teams (except Arecibo). Altogether 7 editions of this meeting have happened – Cuba(2001,2003); Colombia(2005); Brazil (2007); Argentina (2009); Bolivia (2011); Chile (2013) – with a scheduled workshop to happen in Cuba, in April 2015. These meetings have steered most of the LALINET activities until the last edition when additional technical workshops were created to help in establishing measurement and data analysis protocols.

The I Workshop on Lidar Inversion Algorithms for LALINET were held in Concepción, Chile, from 10 to 13 March 2014. The main goal of this first workshop was to compare the inversion algorithms for elastic backscatter lidars from each Latin-American Lidar group in order to develop a uniform, unified and improved algorithm.

The algorithm evaluation and improvement was based on the analysis of three simulated lidar datasets and a comparison with the expected results. The first dataset was provided by the Institute for Tropospheric Research (iFT), Leipzig – Germany, and corresponds to the data used in the EARLINET. The second dataset was a modification of the first one, to include different levels of noise. The third dataset was another modification to include a cloud. As a result of the comparison, a standard for the retrieval of the particle backscatter from elastic lidar data was defined. Matlab and Mathematica routines for doing these calculations were prepared, which are being implemented to be used by all stations in the network.

## 3. INSTRUMENTAL INVENTORY

Most of the LALINET systems are not series-produced instruments and, therefore, present large differences in configuration and capabilities, in that condition efforts are being made to provide a network harmonization and, as a result, it is mandatory to have means of system optimization. A review of the current instrumental status of all LALINET systems was done and analyzed in detail in order to assess the potential performance of the network and to detect networking weaknesses. In this process it was detected that procedures must be done to achieve as much as

possible unattended systems to improve temporal coverage and to reduce the manpower needed, which in turn should have repercussions on the disposition devoted on data analysis. The number of emitted wavelengths should increase in order to achieve the triad 355+532+1064 nm, with the aim to improve the spectral capabilities of LALINET and be able to detect these channels that are the minimum lidar wavelengths to derive particle microphysical properties by combination with sun-photometer data. Besides, no 3+2 systems are available to extract microphysical properties by inversion method with regularization. At present, the Nd:YAG laser is the workhorse for the lidar community but there is no preference in the laser model (almost any LALINET lidar is based on a different laser models). Because almost 90% of LALINET systems emit laser radiation at 355 nm, almost 90% at 532 nm and 80% at 1064 nm, only 80% of LALINET systems emit simultaneously at these three wavelengths therefore limiting the number final products that can be derived from part of the lidar systems. It is expected that the results of this diagnostic will bring benefits to both the existing stations and to the new groups, and will help the improvement of the overall quality of the aerosol data products derived from LALINET for contributing to the scientific knowledge.

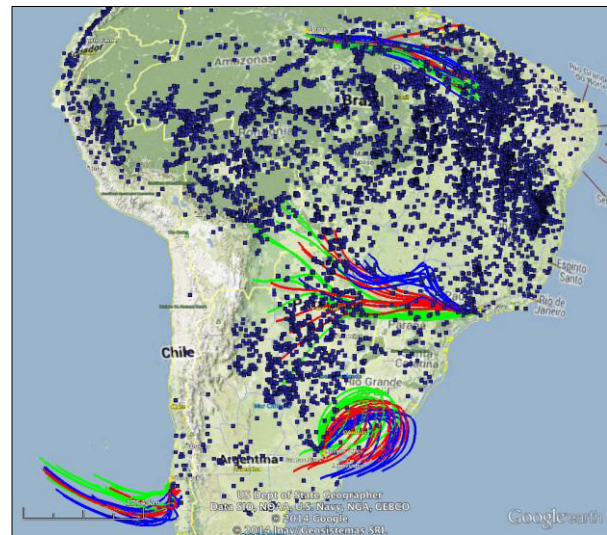
#### 4. PILOT CAMPAIGN

A pilot campaign was carried out during Sep 10-14<sup>th</sup> 2012, which was representative as many biomass-burning activities occur during this period of the year. This pilot campaign was the first coordinated effort to perform simultaneous lidar measurements in Latin America. The difficulties involved in the coordination of such simultaneous measurements were mainly due to (1) reduced manpower, (2) manually operated lidar stations, and (3) weather permitting conditions. This effort allowed us to establish some common network standards such as molecular cross-section and the same methodology for retrieving particle backscatter from elastic lidar data.

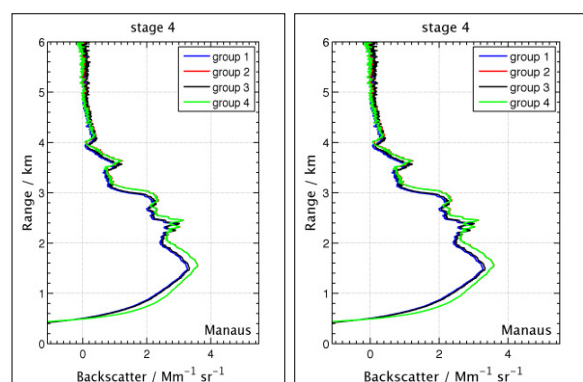
#### 5. CONCLUSIONS

LALINET (<http://lalinet.org>) is a Latin American coordinated lidar network focused on the

vertically-resolved monitoring of the particle optical properties distribution (i.e. particle backscatter and extinction profiles) over Latin America, as well as other atmospheric species such as ozone and water vapor. This federative lidar network started on voluntary basis in 2001 and was officially recognized by WMO in 2013.



**Figure 1** Fires (dark blue) detected by INPE algorithm (<http://www.inpe.br/queimadas/>) using AQUA/MODIS satellite data from September 10th to 14th 2012 are shown. Lines correspond to 48 h HYSPLIT back trajectories (<http://ready.arl.noaa.gov/HYSPLIT.php>) starting at the time selected for each station and altitude of maximum backscatter (Fig. 3). Trajectories were calculated in ensemble mode using GDAS meteorological data.



**Figure 2** Particle backscatter coefficients (Mm-1 sr-1) obtained by each group participating in the analysis of data from the Pilot Campaign. Left: São Paulo and right: Manaus. No overlap correction was applied at this stage.

The network is developing measurement and data analysis protocols and aims to establish some seasonal intensive campaigns in order to provide representative dataset from a region in the globe which still is underrepresented in terms of atmospheric and climatic data available with special interest in aerosol probing and its specification through active remote sensing.

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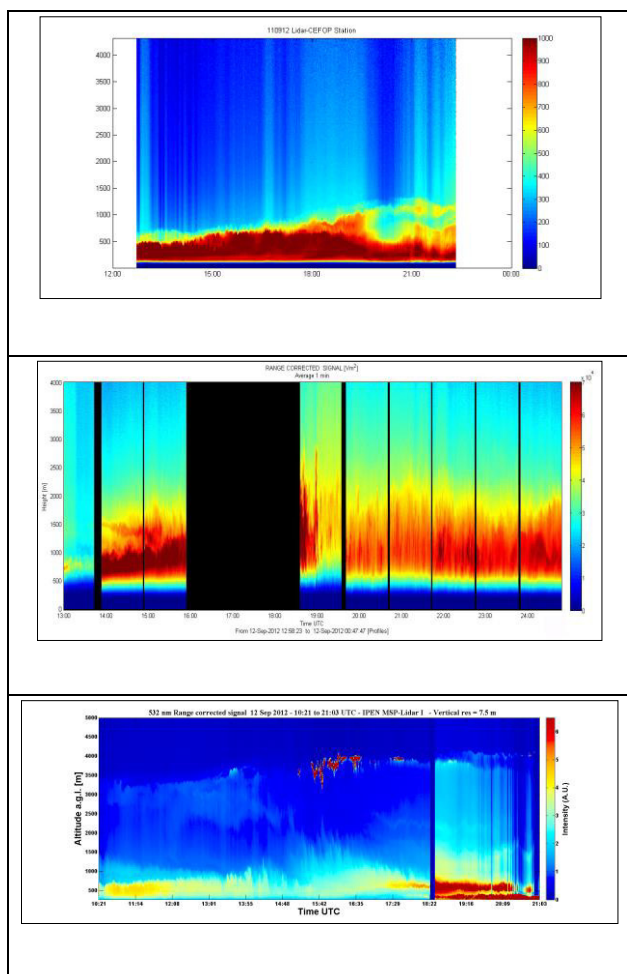


Figure 3 – Quicklook panel for some of the stations running a coordinated campaign in 2012. From top to bottom: co-CEFOP-UDEC, and sp-CLA-IPEN-MSP-LIDAR-I.

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