

A Lidar Network in Latin America in the context of GALION.

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ABSTRACT

Lidars have demonstrated their capability for studying the atmosphere. The most prominent applications are measurements of ozone, aerosol, contaminants, temperature, water vapor and winds. During more than a decade the development of regional lidar networks has been taking place. The current effort of the WMO through the GAW Program to organize the GAW Aerosol Lidar Observation Network (GALION) is a logical and necessary step in that direction aimed to the addition of aerosol lidar information to the current flux of meteorological information feeding the regional and national Meteorological Services. Outputs from the GALION meeting held in Hamburg, Germany, in March 2007 will be briefly described. In that context the paper will analyze the ongoing effort to create a Lidar Network in Latin America. Progress and difficulties will be discussed. A strategy will be presented on how to combine the national and regional interests of the current and future lidar teams in Latin America. This strategy is based on promoting the combined upgrade of the current lidar sites, the creation of new ones and the increase of applications of the lidar derived measurements both in research and in meteorological services. Special attention is being paid to capacity building. Coordinated actions by the Latin American lidar teams are being conducted.

1. INTRODUCTION

Lidars still are in a process of development, mainly with the use of new technological achievements. But many of the current techniques have reached a degree of maturity that ensures a set of important applications. That is the case of the aerosol optical and spatial properties measurements. The use of multiple lidars, arranged in networks, to provide local/regional coverage of the aerosol physical properties distributions is a reality today.

There are still several important issues which require a lot of work. For example, providing to modelers and

end-users the properties measured by lidars in a format and magnitude they can conveniently employ. In the same direction making that community of end-users aware of what can they expect from current lidar capabilities. There is, for example, current research on the synergy of lidar and sunphotometers, but this field is far from being completely explored.

None of those challenges, and the many others not mentioned, can be addressed properly by individual groups. The current status of the human knowledge, and the globalization phenomenon with noticeable incidence also in the sciences, demand a global approach to these challenges. In these conditions the development of regional networks has been taking place. Very recently the Global Atmospheric Watch Program (GAW) launched an initiative to develop a global lidar network for aerosols measurements.

The leaders of the lidar teams in Latin America have been aware of this process. Almost a decade ago we began to build a lidar community in Latin America, developing the scientific and technical lidar capacities in the region. We are facing now a critical moment for the possible creation of a lidar network in the region. In this context we have jointly developed a strategy for achieving this goal.

2. REGIONAL NETWORKS

The creation of regional networks has been a logical step in the development and application of lidar technology and research. They have been growing in the regions of greater economic development because of the crucial role of funding. But this is not an absolute requirement. There is for example the case of EARLINET (European Aerosol Research Lidar Network), supported initially from the European Commission funds. After the end of the period of funding the European lidar community has managed to keep EARLINET working, combining local resources with European opportunities of minor funds. In that context they have developed EARLINET-ASOS [1].

Several other regional networks are currently operating. These are listed in Table 1, with the links to their websites.

EARLINET	http://www.earlinet.org/
European Aerosol Research Lidar NETwork	
CIS-LINET	http://www.cis-linet.basnet.by/
Community of Independent States Lidar NETwork	
AD-NET	http://www-lidar.nies.go.jp/AD-Net/
Asian Dust and aerosol researchers NETwork	
MPLNET	http://mplnet.gsfc.nasa.gov/
Micro Pulse Lidar NETwork GSFC, NASA	
REALM	http://alg.umbc.edu/REALM/
Regional East Atmospheric Lidar Mesonet	

Table 1: Existing lidar networks and their websites.

3. LIDARS IN LATIN AMERICA

Five lidar groups exist currently in Latin America and at least three others are in development. From the year 2001 to the present regular exchanges and contacts have been taking place among these groups. A common goal has been found: the creation of a lidar network in the region. The achievement of this goal is seen as a process of integration of existing lidar projects and the establishment of new ones. [2].

In the current situation we can identify both limiting and favoring conditions. Among the limiting conditions are the disparities in the current lidar systems, the different levels of expertise and qualification among the teams as well as, in most cases, the very low level of local funding. On the other side the favorable conditions are the recognized expertise and experience at international level of some teams and the presence of young researchers and graduate students mainly from local Universities. A determining factor is the common idea of the necessity of cooperation between the existing lidar teams.

No.	Dates	City	Country
I	6 - 8 March 2001	Camagüey	Cuba
II	17-21 February 2003	Camagüey	Cuba
III	11 - 15 July 2005	Popayan	Colombia
IV	17-23 June 2007	Ilhabela	Brazil

Table 2: Dates and places of the Workshops on Lidar Measurements in Latin America.

Among the different needs identified, the importance of building on existing capabilities and to provide training to scientists at each of the existing and prospective sites has received most attention and effort. This has been

realized throughout a series of regular meetings. Beginning in 2001 Workshops on Lidar Measurements in Latin America have been conducted every two years [3]. Table 2 lists the dates and places where the four already conducted took place.

The workshops have successfully reached the proposed goals. They have been very effective in promoting communication and cooperation between scientists in lidar research in Latin America and with colleagues from other parts of the world. Another result is the facilitation of the education and capacity building of the students/young scientists related to lidar research. Also they have been a unique environment for promoting and planning future lidar research projects in the region, including the future creation of the network [4].

4. GALION

The Global Atmospheric Watch Program (GAW) was established in 1989. GAW focuses on global networks for GHGs, ozone, UV, aerosols, selected reactive gases, and precipitation chemistry. GAW coordinates activities and data from 24 Global, ~200 Regional, and many contributing stations. The new GAW Strategic Plan 2008-2015 has among its goals “*Establishing a GAW aerosol lidar network in cooperation with existing networks and interested research groups*” [5].

A WMO Experts Meeting on the implementation of GALION was held between 27 and 29 March, 2007 at the Max-Planck-Institut für Meteorologie, Hamburg, Germany. The joint work of the experts during the meeting and further exchanges via e-mail produced a white paper on the implementation of GALION [6]. The draft version was approved in a recent session of the GAW Scientific Advisory Group and is under final review by the experts.

GALION’s objective has been clearly defined: A long-term monitoring program on a global scale of aerosol vertical distribution combining different types of simultaneous data from lidar instruments. GALION will be based on an agreed cooperation between existing aerosol lidar networks and individual lidar stations. It will support and coordinate global coverage by ground-based aerosol lidar through the implementation of standardized instruments at selected observatories in cooperation with experienced research groups.

Participation in GALION will take place either via regional networks or via National Hydrological and Meteorological Services. Network Development will take place both by incorporation of existing lidar sites as well as the creation of new sites.

It is expected that GALION will provide rapid access products to be integrated in chemical forecast systems, to be used for boundary layer height characterization and for aerosol property characterization in different layers.

The predominant approach in the short term is to collect, archive and make available vertical aerosol backscatter extinction profiles. These profiles will be provided to modelers and other end users. They will also serve to generate a multi-annual monthly aggregate profile for climatology studies. In the medium/long-term it is expected to expand the collected information with profiles of optical properties, such as backscatter and extinction coefficients, at selected wavelengths, lidar ratio and Ångström coefficients. Also microphysical properties (e.g., effective radius, refractive index, number density) are among the products envisaged to be produced by GALION.

The synergy between lidars, sunphotometers and satellite instruments will play an important role in GALION. In this sense the combination on the same site of lidar and sunphotometers is encouraged.

A fundamental activity for GALION will be capacity building. It will be necessary in the process of GALION development to upgrade some stations and create new ones. For such stations it will be necessary to provide training to already existing or new personnel. The combination of short courses, training, and workshops is part of the planned strategy. Also it will be desirable to develop network/regional lidar training centers where it will be useful and possible.

5. LATIN AMERICAN STRATEGY

The implementation of GALION will lead to the development of the existing lidar sites and the creation of new ones. It will represent a unique opportunity for the development of the existing lidar networks in general and in particular for the creation of the Latin America Lidar Network. That was one of the subjects discussed during the Discussion Session of the IV Workshop on Lidar Measurements in Latin America, on June 2007 Ilhabela, Brazil [4]. There was a general agreement that the participation of Latin American existing lidar groups in GALION should be encouraged. Moreover, the implementation of GALION and the creation and development of the Latin America Lidar Network (LALINET) should be very interrelated. In this sense the intended strategy combines both goals.

5.1 Creation of the Network

The members of the lidar community in Latin American are agreed that the creation of the network is necessary. Up to the present we have been working under a "gentleman's agreement". There has been an almost complete fulfillment of all the agreements reached under this status, showing the strong commitment of the lidar community in our region. But as was discussed in the IV Workshop it is necessary to make the effort to constitute an official Latin American body of the network under the umbrella of one scientific institution in the region. In this respect an agreement was reached

to draft the organizational rules for the network operation.

Another agreement was to prepare a draft proposal for the next call of the Ibero-American Program for Science and Technology Development (CYETD in its Spanish acronym) in parallel to the effort to officially create the network. This proposal will be aimed at creating working groups among the members of the lidar community in Latin America to address particular issues of the network. They will concentrate on standardizing measurements, processing algorithms and quality control, as well as the archiving rules and policies.

There is a perspective for the creation of a Spanish Lidar Network [7]. Because of the strong bonds between Latin America and Spain, in particular in the CYTED program, this could be a unique opportunity for broadening the proposal for creating an Ibero-American Lidar Network. Preliminary contacts with the coordinators of the future Spanish network have been taking place.

5.2 Enhancement of Capacity Building

One important goal is maintaining and enhancing the capacity building activities already conducted. In this respect the participation of young scientists and students in the Workshops will be maintained and stimulated. Lectures and conferences on lidar basics and advances will continue to be conducted during the Workshops. It is also very important to encourage the incorporation of graduate students from countries with no lidar groups to existing lidar groups in other countries in Latin America. Such exchange will provide a unique opportunity for training students and young scientists and transferring know-how with regional resources. It will also allow the reinforcement of the exchanges among the groups and the establishment of regular contacts.

An important action will be the organization of Lidar Summer Schools in Latin America. They will complement the lectures and conferences held at the workshops. The measurements of aerosols with sunphotometers will also be the subject of lectures and practical work. Special emphasis will be devoted to the synergetic use of lidar and sunphotometer measurements. Lecturers will be experts in lidar and sunphotometry both from Latin America and the rest of the world.

The Workshops Website will host three new pages. The first will host links to calls for proposals and opportunities, both from the region and from international organizations and institutions. Another page will contain links to the most relevant lidar literature. The last will have links to the regional and international opportunities for graduate and undergraduate fellowships in the area of lidar. The information for keeping the pages updated will be

contributed by members of the lidar community both in Latin America and in the rest of the world.

The access to specialized literature will also be a focus of attention. It is a goal to resuscitate the proposal for Book Donations originated in the suggestion made during the 23rd ILRC (Nara July 2006) by Dr. Raymond Hoff. He proposed to the International Lidar Community to contribute to our future network with the donation of books needed by our lidar teams. A list of the most needed books has been drawn-up by the leaders of the lidar groups in Latin America.

5.3. Continuation of the series of Workshops

The workshop series has been the core of the development of the Latin American lidar community. These regular exchanges had become necessary for an important part of the community. They provide a unique opportunity for scientific exchanges, development of joint research projects, arranging scientist and students visits, both with colleagues from Latin America or from the rest of the world.

Because of their role in developing our community the workshop series will continue. We will preserve the core of activities already regular in the workshops, but we envisage others aimed at broadening the possibilities for exchanges.

The V Workshop on Lidar Measurements in Latin America will take place in Argentina in 2009. The homepage for the Workshop Series, with information about the former meetings is available [3]. Information about the next Workshop in will be posted soon.

5.4 Incorporating sun photometer measurements

From the five existing lidar groups three already have sunphotometers installed and a third one will be installed soon. One of the prospective sites has developed a simple handheld sunphotometer. In Argentina sunphotometers are installed at Villa Martelli (Buenos Aires province) and Rio Gallegos [8, 9] sites both from AERONET/NASA and also at Marambio (64° 14' S, 56° 37' W) under a joint agreement between CEILAP, the Argentinean National Meteorological Service and the Antarctic Institute from Argentina. In the last place it will operate during the summers [10]. In Brazil a sunphotometer is installed at IPEN, São Paulo [11]. In Bolivia two sunphotometers, from AERONET-NASA, are installed since three years in La Paz and Santa Cruz, operated by LFA-UMSA. Data from these location as well as, occasionally, from the mount of Chacaltaya (5420 m asl) are available [12]. In Colombia a tropospheric Lidar is under construction by the Grupo de Láseres y Espectroscopia, Universidad Nacional de Colombia-Sede Medellín, and a simple sunphotometer has been build by the graduate students of the Universidad del Cauca, Popayán, [13, 14]. In Camagüey, Cuba a sunphotometer will be installed by

the middle of the year as part of joint research project with the University of Valladolid, Spain [15].

6. SUMMARY

The lidar teams in Latin America are committed to the development of the lidar community in the region and to the future development of the regional lidar network. We have been implementing a long term strategy to achieve those goals. In the current particular moment several possibilities have appeared to intensify and accelerate the fulfillment of our objectives. Upon our joint effort we have counted during almost a decade with the generous contribution of several institutions and individuals. We urge the international lidar community to joint our effort and to advance together in the frame of GALION.

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