

LIDAR COMMUNITY IN LATIN AMERICA: A DECADE OF CHALLENGES AND SUCCESSES

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ABSTRACT

A retrospective view of the build-up and evolution of the lidar community in Latin America is presented. Regular workshops providing exchange opportunities between Latin American lidar teams and facilitating contacts worldwide are highlighted. Sustained by an informal agreement between the leaders of a small number of initial lidar teams, its formalization is still pending. The contribution of the international community in helping to maintain the workshops every two years, leading to the development of local scientific capacities and the publication of the papers presented is noteworthy. Clear and precise goals have been maintained throughout the years, guaranteeing success. Efforts have been dedicated to capacity building mainly with the pre-workshop courses. Exchanges of students and scientists in the region and with the rest of the world contribute to increasing local lidar scientific expertise. The increase from 5 lidar teams and 3 prospective sites in 2001 to 9 teams, with 3 sites building lidars and 3 more in the design phase by 2011 demonstrate the results. Two of the new sites in 2011 are directly linked to agreements reached at the workshops. This has been an endeavour conducted by Latin-American scientists with the valuable assistance of the international lidar community. Records of all the six workshops held so far are available at a website.

1. INTRODUCTION

At the beginning of the XXI century only five lidar projects were operating in Latin America [1]. A little more than a decade later this number has doubled and several new lidars are under construction or being designed. This increase has been notably supported by an initiative promoted by Latin American scientists

with the support of scientists all over the world. The core of this effort has been the implementation of biennial workshops. The present article presents a retrospective view of the challenges confronted and the achievements reached.

2. THE WORKSHOP SERIES: CHALLENGES

The organization, fundraising and implementation of the six workshops already held (between the 1st workshop in 2001 and the most recent, in 2011) have been sustained by an informal agreement between the leaders of the five lidar teams existing in 2001 plus the leaders of the new lidar projects in Bolivia and Colombia.

One important challenge to our initiative has been its coincidence in time with increasing economic difficulties worldwide, leading to the current crisis. Despite this situation, the leaders of the lidar community have managed to conduct an intensive search for funds for maintaining the workshops.

The 1st Workshop, held in Camagüey Cuba, was conceived with two main goals: promoting communication and cooperation among the existing lidar teams and planning future joint research in the region [1, 2, 3]. Following the success of the first workshop, a third goal emerged: the stimulation of regional capacity building in lidar research [4]. The 2nd Workshop, also held in Camagüey Cuba, confirmed the relevance of regular information exchanges, creating an opportunity for the discussions of possible cooperation among researchers from Bolivia and a representative of the European Space Agency (both attending the workshop). That particular exchange later led to the setup of a new lidar project in Bolivia [5]. The

workshop also allowed us to test the feasibility and the importance of conducting pre-workshop courses on lidar technology and applications in scientific research. This activity has been replicated during all the following workshops held to date. The lidar courses have provided students and young scientists a unique opportunity of learning not available before in Latin America and other regions of the world.

The development of a lidar project in Colombia has also been facilitated by the workshops. Initial exchanges of Colombian researchers with colleagues from within the region and worldwide, took place during the cited 2nd workshop. The 3rd workshop held in Popayán, Colombia, created an opportunity for attendees to learn about the real capabilities and needs of the Colombian researchers. Further actions and exchanges were held at the following workshops allowing the project to be introduced at the 5th workshop held in Buenos Aires [6].

The workshops have been held at almost all the sites of the original teams (except Arecibo) plus the first two lidar projects created by this initiative. Table 1 summarizes the information about the workshops already held. The next workshop, in 2013, will be held at the University of Concepción, Chile, a new lidar site currently in the design and construction stage. The implementation of this new lidar facility clearly demonstrates the advances achieved in the development of lidar projects in Latin America.

Table 1: Workshop information: Year, Location, number of attendees and presentations. Captions: LA: Latin America; RW: Rest of the World; ST: Students; OR: Oral presentations; PO: Posters. (Oral presentations includes lectures.)

WMLA (Year)	Place	Attendees				Papers	
		LA	RW	Total	ST	OR	PO
I (2001)	Camagüey, Cuba	9	14	23	5	14	5
II (2003)	Camagüey, Cuba	13	12	25	13	25	2
III (2005)	Popayán, Colombia	25	6	52	26	25	6
IV (2007)	Ilhabela, Brazil	30	12	42	20	29	16
V (2009)	Buenos Aires, Argentina	42	23	65	21	31	31
VI (2011)	La Paz, Bolivia	52	12	64	32	21	15

The support received from the European Space Agency (ESA) for conducting the workshops regularly has been highly relevant. Beginning with the 2nd workshop in 2003, ESA has contributed with funds to all the workshops already held. Dr. Errico Armandillo, researcher and member of the ESA Directorate Staff, has been the only non-Latin American scientist attending all of the workshops. He has been actively

engaged also as member of the International Organizing Committees in the organization of the workshops. He has also participated in the Awards Committees and contributing with his expertise and experience in all the related activities.

3. ACHIEVEMENTS

The information in table 1 documents the generally increasing trend in the number of attendees and presentations. Highly significant is the fact that the number of students attending the workshops typically represents around the 50 % of all the participants, showing the success of the sustained effort in capacity building that has been made throughout the last decade.

The development of two new lidar projects (La Paz, Bolivia and Medellin, Colombia) has been facilitated by the workshops. The initial exchanges leading to the agreements reached later for developing both projects, took place during the workshops.

The series of workshops has been made possible not only by the strong commitment of the leaders of the lidar teams, but also as a result of the dedication and personal efforts of the other team members. This unselfish cooperation and dedication has created strong bonds among the members of the lidar community in Latin America. In fact today a sense of scientific community exists among the Latin American lidar researchers.

The number of new lidar projects started in the last 2 years, 5, is equal to the total number existing ten years ago. These are listed, in Table 2, which demonstrates the rapid increase in lidar research in our region, facilitated no doubt by the existence of the workshops. Four of the projects are in countries with a tradition in lidar research (Brazil and Argentina), which are becoming strong nuclei of lidar activity; and which can be expected to serve in the near future as support for maintaining current development. The other two new lidar projects, in Mexico and Chile, represent an expansion of the number of Latin American countries engaged in lidar research.

Several of the current leaders and researchers in the new lidar projects attended workshops as students and participated in pre-workshop courses. Among these people, several met the scientists who provided the fellowships for their graduate and postgraduate studies at one of the workshops. Incentivising contacts between young graduates and senior scientists in this way constitutes one of the successful capacity building actions conducted during the past decade.

The geographical distribution of the current lidar projects in Latin America is shown in figure 1. Ten lidar projects are currently operative. Four others are in

the design phase and two more (at the Pontificia Universidad Católica del Perú and the Universidad de Zulia, Venezuela) have expressed an interest in building lidar systems. Unfortunately a lack of funds keeps the lidar project at the GOAC, Camagüey, Cuba inoperative. The GOAC maintains its expertise in processing and analyzing lidar data, currently conducting research using CALIPSO measurements.

Table 2: New lidar projects in Latin America.

Institution	Country	Location	Type	Status
Universidad de Concepción	Chile	36° S; 73° W	Tropospheric elastic	Building testing
Universidade de Sao Paulo	Brazil	3° S; 60° W	UV-Raman Lidar	Design, Building
Universidade Federal de Pelotas	Brazil	32° S; 52° W	Tropospheric elastic	Design, Building
Benemérita Universidad Autónoma de Puebla	México	19° N; 98° W	Tropospheric, elastic	Design, Building
CEILAP Estación Bariloche	Argentina	41° S; 71° W	Rayleigh-Raman lidar	Operational (volcanic ash)

Publishing the results of the scientific research conducted in the third world countries represents, in many cases, a challenge, because of the scarcity of resources. Beginning with the 3rd workshop the attendees have had the possibility of publishing their papers in the *Óptica Pura y Aplicada* (OPA), peer reviewed Journal of the Optical Society of Spain (http://www.sedoptica.es/Menu_Volumenes/Revista.html). This has been possible thanks to the contribution of the Grupo de Óptica Atmosférica, University of Valladolid, Spain, lead by Dr. Angel de Frutos. A total of 55 papers have been published in OPA from the III, IV and V workshops. Currently 10 articles are been submitted to OPA for the peer-review process from the presentations made at the VI workshop held in La Paz, Bolivia, September 24th to October 3rd, 2011. Extended abstracts of the presentations made at the VI workshop will be published in the *Revista Boliviana de Física* (<http://www.fiumsa.edu.bo/rbf/>). Records of all the six workshops already held are kept by GOAC on its webpage (<http://www.lidar.camaguey.cu>).

The Latin American lidar community has also achieved international recognition. It is represented by one Latin American scientist in the ICLAS - International Coordination Group on Laser Atmospheric Studies (<http://iclas.hamptonu.edu/>) and also in GALION – GAW Aerosol Lidar Observation Network (<http://alg.umbc.edu/galion/>). In the latter case, the Latin American lidar teams have been included in GALION, providing another opportunity for potential funding in the future, according to availability of resources [7].

4. THE WAY AHEAD

The analysis of the discussions held at the open session of the VI workshop last year in La Paz confirmed the main conclusions of the former two workshops discussed in a pair of articles presented at the 24 and 25 ILRC [7, 8] by the leaders of the lidar projects. The core of our strategy should be to maintain the three main goals that have guided our efforts during more than a decade. Particular emphasis should be given to the aspects summarized as follow:

- Formalizing the Latin-American Lidar Network (LALINET)
- Enhancement of capacity building activities
- Maintaining the regular series of workshops biennially
- Promoting the development of research and applications making use of the synergy between lidar and sunphotometer measurements.

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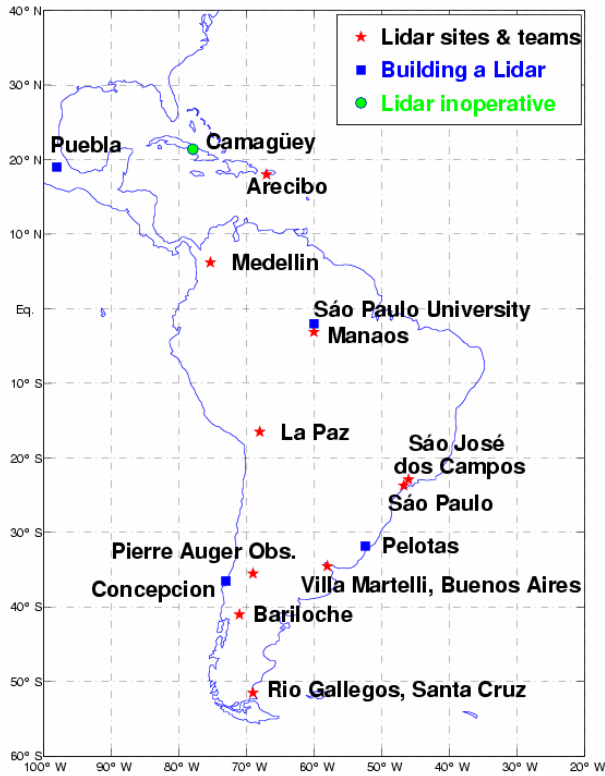
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Latin American Lidar Sites as March 2012.

Figure 1. Current lidar stations.