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AEROSOLS MONITORING NETWORK TO CREATE A VOLCANIC ASH RISK MANAGEMENT SYSTEM IN ARGENTINA AND CHILE

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ABSTRACT

Two main decisions were made in Argentina to mitigate the impact of the recent volcanic activity in de country basically affected by the presence of volcanic ash in the air and deposited over the Argentinean territory. The first one was to create a risk management commission were this risk between others were studied, and second to develop new ground based remote sensing technologies to be able to identify and inform the risk close to the airports. In addition the Japanese government program for Science and Technology joint Research Partnership between Argentina, Chile and Japan for Sustainable Development (SATREPS) accepted to fund this cooperation due to the potential future utilization of the research outcomes to the benefit of the society. This work present the actual achievements and expected advance of these projects that try to joint efforts between national and international agencies as well as countries on behalf of a better understanding of the risks and a joint collaboration on the mitigation of suspended ashes impact over the aerial navigation.

1. INTRODUCTION

The intense volcanic activity in the Andes Mountain Range affecting Argentina and Chile as for example Chaitén (2008), Puyehue Cordón Caulle (2011), Copahue (2014), Villarrica (2015), had an important impact in the Argentinean and Chilean society by means of the activation of diverse risk management protocols at both sides of the Andes Mountain Range, like evacuation of vulnerable regions, and in some cases the suspension for several days to months of the aerial navigation as mentioned on the previous ILRC meeting [1]. At that meeting only Bariloche Station was installed (Feb 2, 2012). Eyjafjallajökull eruption major consequence in the Argentinean region was the introduction of quantitative evaluation criteria based on threshold concentrations to decide which aerial space to close. Then several studies and developments were done in Argentina to model [2] and to detect volcanic ashes. Actually the network has new stations: Comodoro Rivadavia (CDR) on Oct 12, 2012; Neuquén (NQN) Dec 12, 2013, Río Gallegos (RGL) Jul 1, 2014 and Aeroparque (AEP) Feb 2, 2015. All these stations, are installed inside the Airports or very close to it (<1km). A last station was also installed at the Lidar Division (CEILAP) which is intended to be not only a transportable station but also a station where to test the updates before being sent to the sites and a training place for operators and researchers.

2. THE SPECIAL PROJECT MD 31554/11

After the eruption of Puyehue Cordón Caulle volcano the Ministry of the Defense in Argentina proposed to finance the construction of an aerosol monitoring network at the Lidar Division to be operated by the National Weather Service (NWS) (dependent of this Ministry) which is responsible of the regional Volcanic Ash Advisory Center (VAAC) at Buenos Aires covering the region (South of 10ºS and between 10ºW and 90ºW).

This project consisted on designing upgradable and transportable aerosol monitoring stations to be placed at different places to be designed. They were built in a 20 feet maritime container (figure 1) adapted to work as a laboratory. Half of the inner space has a multi-wavelength lidar (355 nm, 532 nm and 1064 nm) and the second half contains a room were the UPS, computers and acquisition systems of the complementary instruments were placed. Those instruments are installed at the rooftop of the container. They were initially a CIMEL Sunphotometer part of the AERONET network, a nephelometer to measure TSP, PM_{10}, $PM_{2.5}$ and PM_1; a weather station, a broadband, UVA and UVB pyranometers, and a 7 channel Radiometer. These systems are part to a single and indivisible network. Further updates of the Project were done to include vibro-rotational Raman channels (384 nm, 408 nm and 607 nm) and depolarization channels for both UV and visible elastic wavelengths (except for the actual fiber-based design at Bariloche Station as seen on [3]). Other complementary equipment is also planned to be added is a multi-axes DOAS unit.

Figure 1: Aerosol Monitoring Station: Left: Lidar Container. Right: Lidar unit

Part of this project consist on creating the lidar operation capacity at the NWS stations were the lidars are placed and at the NWS sites were part data will be processed and analyzed.

3. THE SATREPS "SAVER.Net" PROJECT

This project complements in several ways the MD31554/11 project. The previous project intended to transfer technology from one institution to another in one country. In this case those institutions are partners on a common research involving three different countries in strong collaboration. It must also be noticed that social point of view is the most important one. The most ambitious goal is to contribute the global community developing a social management system for environmental risk in South America, concerning suspended volcanic ash risk. From the scientific and technological point of view the project increase the number of monitoring stations adding a third multi-wavelength and depolarization Raman lidar station at Punta Arenas in southernmost region of Chilean Patagonia as seen on figure 2, as well as two new monitoring sites containing iodine cell-based HSRL's and based on [4]. These last stations are an important contribution from NIES to the Lidar Division at CEILAP and the whole members and Institutions integrating this project. The complementing instrumentation is similar to the one mentioned in the previous project. The lidar and container design will be similar but it is intended to improve some construction details based on the current acquired experience.

From the point of view of data analysis SAVER.Net will start learning from AD-NET experience implementing their algorithms [5] but it is expected a fast and growing collaboration by learning from other inversion algorithms developed in the lidar community [6] and also creating new capabilities by its own focused on local aerosol conditions and volcanic ash behavior. I must be noticed at this point that one of the most important problems with volcanic ash in Patagonia is ash deposits after a main eruption being lifted and transported by the wind several kilometers away from their origin.

Figure 2: Aerosol Monitoring Station locations. From CEILAP to Aeroparque the stations are already installed along the period Feb/2012 to Feb/2015. The new stations are being built at CEILAP, except Punta Arenas which will be partially built at Chile

A second aspect of this project is the development of a UV risk management system but this exceeds the scope of this paper.

4. THE LIDAR SYSTEMS AT THE STATIONS

All the lidar systems were built inside an aluminum frame as seen on figure 3. All the parts that need to be perfectly aligned (laser, telescope and spectroscopic box) are interconnected using a metal frame that is at the time attached to the aluminum frame via shock absorber units (figure 4-a). Inside this, the telescope and polychromator units are air coupled using a diaphragm at the telescope focal plane (figure 4-b). The light is then collimated and the wavelengths sent using hi-pass beamsplitters to the photomultipliers (Hamamatsu H10721-110 or -20). The optical paths are identical. The infrared radiation passes unaltered to the detection unit (Licel APD).

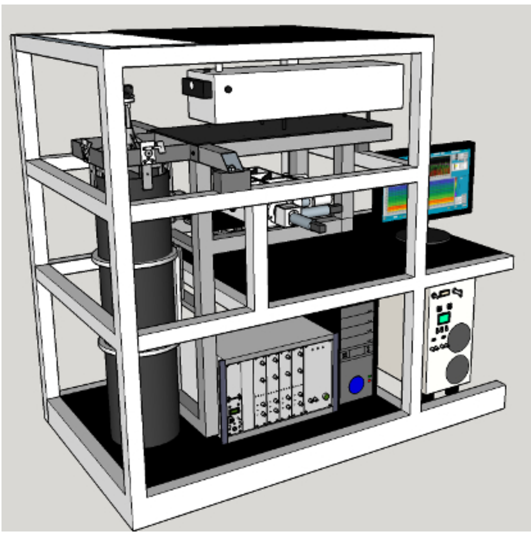

Figure 3: Diagram for Multi-wavelength Raman Depolarization Aerosol lidar.

Figure 4-c shows the aluminum frame were the laser (Continuum Surelite I – 30Hz), the energy source, the acquisition system (Licel operating at 20 MSPS) and the computer are placed. The output alignment unit (figure 4-d) has a coaxial configuration. The beams are not expanded since low divergence is not desired for this instrument. The light is oriented by a fused silica prism. The manual alignment is quite precise (angular sensitivity of the prism below 1.67 mrad per turn) and no telescope obstruction is done by the alignment procedure.

The observation protocol consists on acquiring 3 minutes of lidar signals every 15 minutes on a 24 h/day basis. The data is actually being sent for analysis and fast visualization to CEILAP and NIES.

Basic changes on the HSRL version consists on changing the lasers to the seeded version (NP-Photonics) of Surelite II-10Hz spectrally tuned to match a specific absorption line of a heated Iodine cell using acousto-optical modulators to improve the wavelength tuning [4].

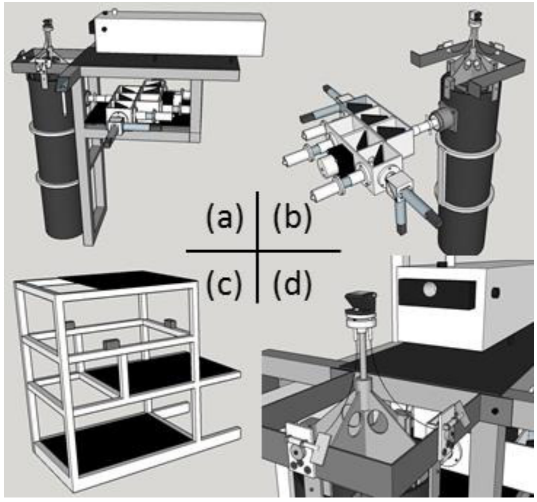

Figure 4: Parts of the Multi-wavelength Raman Depolarization Aerosol lidar. (a) Iron Frame, (b) Telescope and spectroscopic box (c) Aluminum frame, (d) laser alignment unit

5. CONCLUSIONS

This work shows the evolution of the Aerosol monitoring network based on lidars and other instrumentation to provide risk management capabilities inside the Argentina and the southern region of Chile. This network is intended to contribute to ALINE/LALINET and GALION. The synergy of the projects MD 31554/11 and SAVER.Net made possible a fast evolution of the network in a short period of time however this network is still growing and will need some time before reaching the intended maturity.

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