

AEROSOLS OBSERVATIONS WITH A NEW LIDAR STATION IN PUNTA ARENAS, CHILE

Boris Barja^{1*}, Felix Zamorano¹, Pablo Ristori², Lidia Otero², Eduardo Quel², Nobuo Sugimoto³
Atsushi Shimizu³ and Jorge Santana⁴.

¹*Atmospheric Research Laboratory (LIA), University of Magallanes, Punta Arenas, Chile.
email:bbarja@gmail.com

²*Division Lidar, CEILAP (UNIDEF-CONICET). Buenos Aires, Argentina.*

³*National Institute for Environmental Studies (NIES). Tsukuba. Ibaraki, Japan.*

⁴*Institute of Astronomy, Geophysics and Atmospheric Sciences (IAG). University of São Paulo, Brazil.*

ABSTRACT

A tropospheric lidar system was installed in Punta Arenas, Chile (53.13°S, 70.88°W) in September 2016 under the collaboration project SAVERNET (Chile, Japan and Argentina) to monitor the atmosphere. Statistical analyses of the clouds and aerosols behavior and some cases of dust detected with lidar, at these high southern latitude and cold environment regions during three months (austral spring) are discussed using information from satellite, modelling and solar radiation ground measurements.

1 INTRODUCTION

Atmospheric particles as aerosols and clouds have a great influence on the climate, weather and daily human life. Aerosols have important influences on human health, air quality and climate changes. Their concentrations in the atmosphere have significantly increased since the preindustrial times [e.g. 1]. Their capacity to scatter and absorb solar radiation and work as cloud condensation nuclei, allows atmospheric aerosols to affect atmospheric radiation and dynamics [e.g. 2]. Also, atmospheric aerosols can be a major component of haze pollution, reducing atmospheric visibility and being dangerous to human health [3]. Another type of aerosol recognized as an important component of the climatic system is the dust. Dust can travel large distances across the earth surface and affects all of Earth's climatic zones from the tropics to the poles [4]. Specifically, high latitude dust produced particularly by glacial and periglacial processes in the high and cold regions have attracted little research attention despite increasing evidence that local and regional high-latitude dust emissions can affect the climatic system [e.g. 5].

On the other hand, clouds a component of the atmosphere that affect the solar and terrestrial radiation and the energy balance in the climatic system. Clouds are a very important issue around the Antarctic continent. Clouds around and in Antarctica region are amongst the least well observed due to the remote environment [6].

From the last statements the importance to conduct measurements of aerosols and clouds with ground based instruments around high latitudes regions is evident.

With the objective to long term monitoring the aerosols and clouds in the atmosphere a tropospheric lidar system was installed in the Atmospheric Research Laboratory belonging to University of Magallanes in the city of Punta Arenas, Chile (53.13°S, 70.88°W) during September 2016 under the collaboration project Savernet - South American Environment Risk Network (Chile, Japan and Argentina) [7].

In the following, the characteristics of lidar system are reported. Preliminary results of three first months of measurements are presented in Sect. 3, from September to December of 2016 (austral spring) with some cases of dust detected with lidar. Results and discussions using information from solar radiation ground measurements, data HYSPLIT back trajectories and Navy Aerosol Analysis and Prediction System (NAAPS) Global Aerosol Model results are presented in Sect. 4 to evaluate the source of the measured dust, followed by conclusions in Sect. 5.

2 METHODOLOGY

The lidar system installed in the measurement site of Atmospheric Research Laboratory, University of Magallanes (53.13°S, 70.88°W) is a Multi-wavelength Raman Depolarization Aerosol lidar.

It was installed through the Savernet Project [7]. Details about the lidar system are summarized in Table 1 and detailed information is given in [7]. A laser (Continuum Surelite II – 10Hz), was used as the energy source, the acquisition system from Licel is operating at 20 MSPS and controlled by a computer. The emission – reception configuration is coaxial. The beams are not expanded since low divergence is not desired for this instrument with the tropospheric measurements objective. The light is oriented by a fused silica prism. Three wavelengths are sensed in the spectrometric box: 1064 nm, 532 nm and 355 nm; polarization is available in the UV and visible channels. Also Raman signals are measured at 384 nm, 408 nm and 607 nm. The observation protocol consists in 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.

Table 1 Summarized characteristics of the Multi-wavelength Raman Depolarization Aerosol lidar installed in Punta Arenas.

Emission	Continuum Surelite II – 10Hz 3 wavelength (1064, 532, and 355 nm)
Reception	Telescope 20 cm diameter. 1064 nm, Polarization (532 and 355 nm) Raman (384 nm, 408 nm and 607 nm)
Acquisition	Licel system operating at 20 MSPS

In the present work we are using only information from the 1064 and 532 nm channels, the signals from these channels were used to obtain the attenuated backscatter coefficient at 1064 and 532 nm, the volume depolarization ratio and the dust and sphere extinction coefficients for the 532 nm channel. These quantities are processed with the used algorithm in AD-Net [8, 9]. The lidar ratio used during the processing was 50 sr, the value used for the AD-Net network for dust studies.

Methodology for discriminating between dust and spherical aerosols is based in the depolarization of the lidar signal [8, 9]. So we can determine the extinction coefficient component and make a preliminary analysis of the presence and predominance of the dust particles, spherical

particles or mixture of both particles types. Spherical particles are related with aerosols from contamination and sea salt aerosols.

For the analysis of some cases of dust and spherical particles we used information of observation and modelling from the National Research Laboratory (NRL) aerosol page. Modelling was the NAAPS (Navy Aerosol Analysis and Prediction System) Global Aerosol Model. Also we used the NOAA's HYSPLIT atmospheric transport and dispersion modeling system to show the origin of the air mass that arrives to the site during the days of studied measurements [10].

3 RESULTS

We can see in Figure 1, five panels showing the time series of attenuated backscatter coefficient for 532 nm (first box), the volume depolarization ratio for 532 nm (second box), the attenuated backscatter coefficient for 1064 nm (third box), these three first boxes show the altitude until 18 km. The fourth and fifth boxes show the dust and spherical extinction coefficients for 532 nm until an altitude of 9 km. In these last two boxes we can see the color gray to show no measurements. These graphics correspond for the September month of 2016. Similar graphics (not showed) were obtained for the remaining months of the spring season of 2016 (October, November and December).

These graphics show the high frequency of clouds during the measurement period. It was also possible to determine the presence of dust and spherical aerosols over Punta Arenas. We can see in Figure 1, in the fourth box the presence of dust particles during the days of 23 and 24 September 2016, with values of the dust extinction coefficient around 0.1 km^{-1} almost up to 2 km of altitude. During these days there are lower values of the spherical extinction coefficient. So the contribution of the dust aerosol to the site is significantly higher than that of the spherical aerosols.

In Figure 1, we can see also a higher contribution of spherical particle aerosols with lower contribution from dust particles during the days 16 and 17 September 2016. We are looking in more detail in these days.

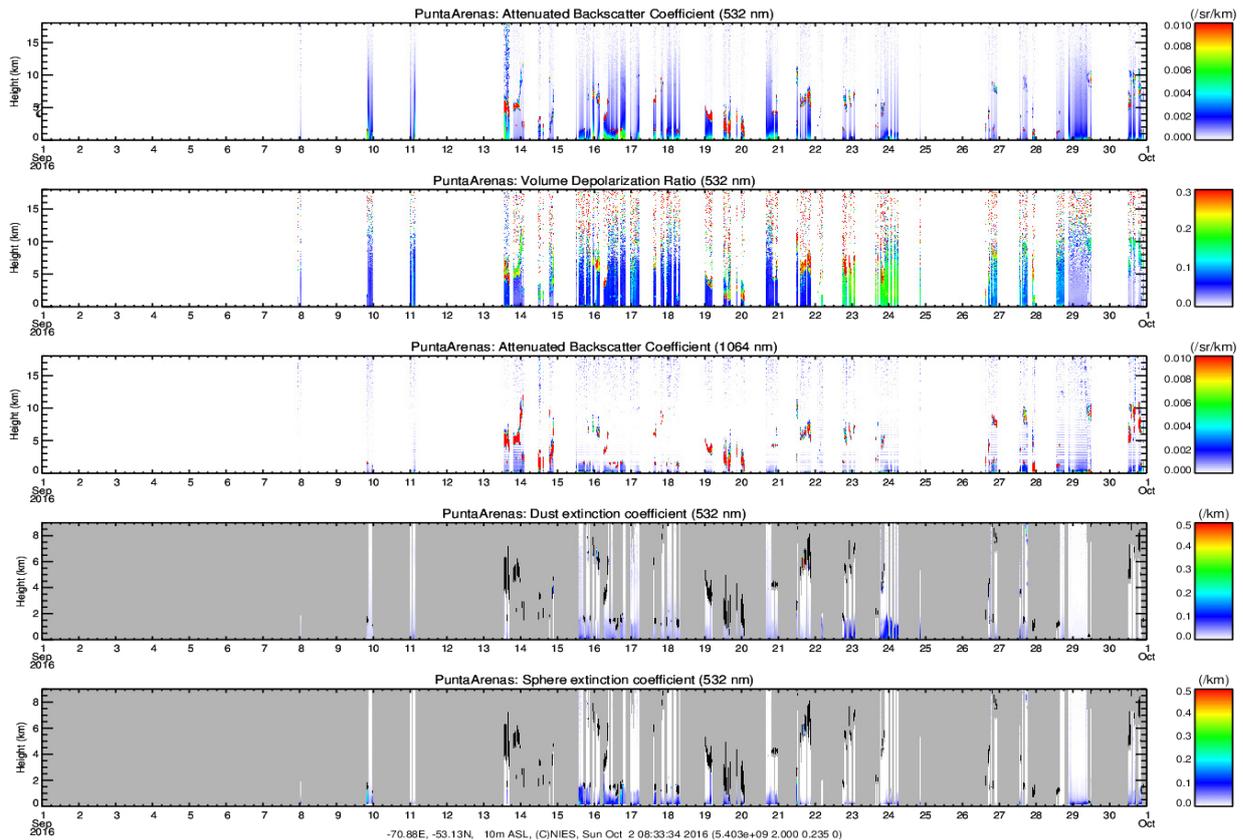


Figure 1 Time Series of Attenuated backscatter coefficient for 1064 and 532 nm, volume depolarization ratio for 532 nm and dust and spherical extinction coefficient at 532 nm (first, second, third and fourth panel respectively), during the month of 2016.

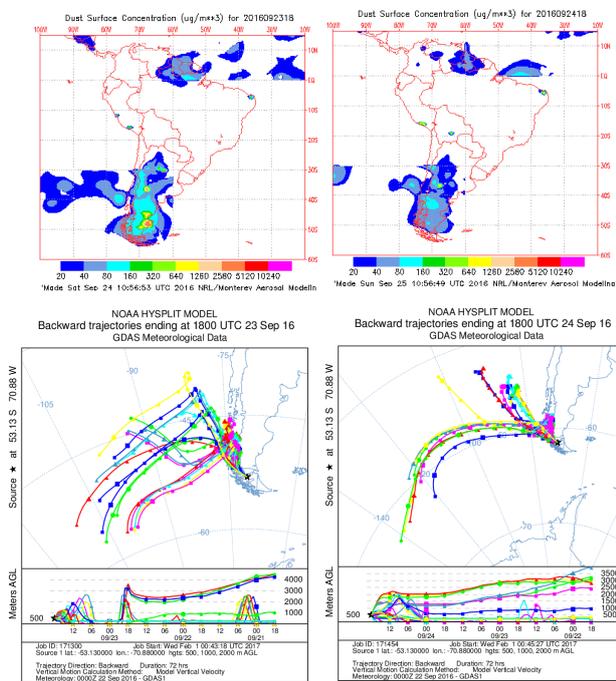


Figure 2 NAAPS forecasting analysis and HYSPLIT for the days 23 and 24 September 2016 at 18:00 UTC.

In the lower panels of the Figure 2 with the HYSPLIT backward trajectory we can see the

higher input from the continent in the lower altitudes of the atmosphere, denoting the possible contribution of the regional dust to our site of measurements. The high dust concentration at our site is noted in the upper panels of the Figure 2 with values between $40 \mu\text{g}/\text{m}^3$ and $80 \mu\text{g}/\text{m}^3$. These values of concentration were obtained from the NAAPS forecasting analysis for the September 23 and 24, 2016.

The NAAPS model for the days 15 and 16 September shows no dust. The HYSPLIT back trajectories indicate the origin of the air masses measured at the site to be over the Ocean at all altitudes. So there is a difference between these two days with different origins of the air masses showing different contribution to the aerosols measured in the site.

We select another day from the NAAPS forecasting model with presence of high levels of concentration of dust in surface near to 160 micrograms per meter cubic. This situation occurs during the day of October 7, 2016, and similar conditions stay during the next two days. Figure 3 show the NAAPS analysis for this day in the left

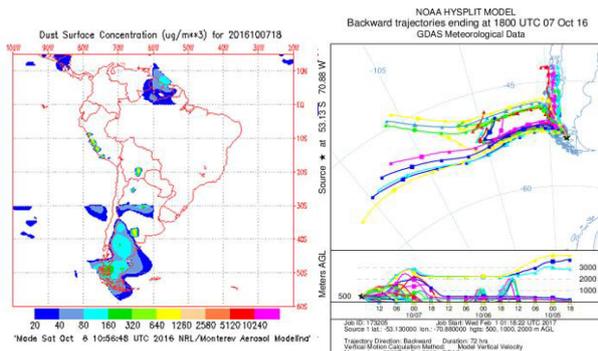


Figure 3 NAAPS forecasting analysis and HYSPLIT for the days 07 October 2016 at 18:00 UTC.

panel and the right panel shows the HYSPLIT back trajectories for the same date.

There is evidence of the presence of dust in our site from the modeling results but lidar signals show low contribution of dust during this day.

4 CONCLUSIONS

We show the first results of measurements with lidar in Punta Arenas during 2016. The analysis of the Mie channels shows that there is possible to determine the dust and spherical aerosols in agreement with other information in surface. But there are other days that there is no coincidence between the two sources of information.

So there is needed to make future improvement to the analysis of lidar signals in our site, tuning the method from the AD-Net to our location.

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