A dust event in Patagonia: Lidar observations, satellite data and modeling

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Abstract

On 20 February 2016, mineral dust aerosols were detected using a ground-based lidar system located at Comodoro Rivadavia airport (Argentina). The true-color images from the Moderate Resolution Imaging Spectroradiometer (MODIS) on board AQUA satellite showed a dust cloud carried by strong westerly winds sweeping across the Patagonia. We concluded that the dust blew out of the shallow “Lago Colhué Huapi” (Colhué Huapi lake). This lake suffers from the lack of enough inflows due to the scarce precipitation and the water intake constructions in the surrounding area. The soil desiccation and the larger area of the sediments exposed to the wind erosion around the lake Colhué Huapi along with the strong winds of the region created favorable conditions for the dust storm on 20 February 2016. Studies on the lake Colhué Huapi showed that the geological profile presents two layers: the lowest pyroclastic-sedimentary and the higher of volcanic characteristics (vulcanites).

In this work, we conducted numerical simulations of the dust outbreak on 20 February 2016 using the resuspension mode of the WRF-ARW/FALL3D modeling system. The potential emission sources are determined by the Colhué Huapi lake area using a total grain size distribution (TGSD) based on field campaigns. The results are compared with the lidar measurements and satellite imagery. This study shows the importance of ground-based remote sensing instruments to detect dust/volcanic ash plumes. The development of algorithms for quantitative comparisons is the next step to achieve a more accurate assessment of these events.

Colhué Huapi lake

Geological Setting

Geological studies show that the sediments around the lake Colhué Huapi are mainly composed of fine to medium grained, friable glauconitic sandstones with a characteristic green color and argillaceous and sandstone intercalations with paler green towards the base (Ruoso 1853). In the upper sector it is common to find outcrops, scree slopes, breccias, mollusks, and oyster teeth levels on which it is also common to find silicified wood (Scicciuto et al. 2008). Grain-size distribution (GSD) analysis showed a symmetric unimodal distribution, 125-250 µm being the mode.

A prolonged drought caused a depleted water level during the last 5 years. This situation has become particularly evident in recent months. Sequence of LANDSAT 8 images. False-color band B32: 12.02 µm B31: 11.03 µm BT31-BT32 difference (BTD): Brightness temperature dust/volcanic ash plumes. The development of algorithms for quantitative study shows the importance of ground-based remote sensing instruments to detect results are compared with the lidar measurements and satellite imagery. This area using a total grain size distribution (TGSD) based on field campaigns. The potential emission sources are determined by the Colhué Huapi lake in the media “In the last 20 years the lake Colhué Huapi lost half of its surface and the erosion destroy everything in its path”

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Observations

Previous episodes of wind-blow dust in Patagonia:

<table>
<thead>
<tr>
<th>Date</th>
<th>MODIS imagery</th>
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<tbody>
<tr>
<td>12 May 2013</td>
<td>MODIS-AQUA</td>
</tr>
<tr>
<td>3 November 2016</td>
<td>MODIS-AQUA</td>
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<table>
<thead>
<tr>
<th>Date</th>
<th>MODIS L1B data on 20 February 2016</th>
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Lidar Measurements - Comodoro Rivadavia station

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<tr>
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<tbody>
<tr>
<td>31 October 2015</td>
<td>Raw data. Calibration is required</td>
</tr>
<tr>
<td>3 January 2016</td>
<td>Lidar signal</td>
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LANDSAT 8 imagery

A prolonged drought caused a depleted water level during the last 5 years. This situation has become particularly evident in recent months. Sequence of LANDSAT 8 images. False-color band combinations B5-B6-B4. This band combination is good for picking out land from water:

B5: Near Infrared (0.845–0.885 µm),
B6: Shortwave infrared (1.560–1.660 µm), and
B4: Red (0.630–0.680 µm).

Numerical Simulations

Synoptic situation: GFS Dataset

The figures show the evolution of a strong gradient geopotential height pattern at 500 hPa. The National Meteorological Service (SMN) forecast strong winds developing wind storm with large gusts from the West over the whole Santa Cruz Province.

In our modeling strategy, the potential emission sources are determined by the lake Colhué Huapi. The lake contour is provided by the Instituto Geográfico Nacional (IGN). The emission rate of windblown dust is computed using the Shao scheme with the FALL3D dispersal model. The emission scheme depends on the grain size distribution (left panel). Mineral dust is emitted mainly from the north of the lake (right panel).

Lidar observations, satellite data and modeling

Sweeping across the Patagonia.

“…a dust event that would allow the identification of its source”

References

2. Russo, A. (1953): Levantamiento geológico al norte de Pico Salamanca entre el mar y la Pampa del Castillo, Salamanca y Malaspina; escala 1:100.000 YPF (Inedito), 20 p., Buenos Aires.
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L. Mingari thanks CONICET for their PhD fellowship. The WRF-ARW/FALL3D modeling system ran in a server installed at the SMN with funds from the Argentinean project PIDDEF 41/10: “Proyectos de tiempo para estudios de vulnerabilidad e impactos socioeconómicos”.

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