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

L. Mingari[1,2], M. A. Salles[2], E. Collini[2,3], A. Folch[4], D. Rodriguez[2], K. Bolzi[2], M. S. Lopardo[2], and L. Otero[5]

1. Instituto de Física de Buenos Aires - CONICET
2. Servicio Meteorológico Nacional, Argentina
3. Servicio de Hidrografía Naval, Argentina
4. Barcelona Supercomputing Center, Barcelona, España
5. CEILAP (CITEFA-CONICET)/CONAE, Argentina

PUERTO VARAS, CHILE 2016
Cities on Volcanoes 9

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 inflow 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 (Russo 1953). In the upper sector it is common to find out oysters, scallops, bryozoans, mollusks, and cetacean teeth levels on which it is also common to find silicified wood (Sciutto et al. 2008). Grain-size distribution (GSD) analysis showed a symmetric unimodal distribution, 125-250 µm being the mode.

Colhé Huapi lake in the media

9 May 2016 (http://tn.com.ar)

"A plane has been found on a dry lake in Chubut that disappeared 52 years ago"

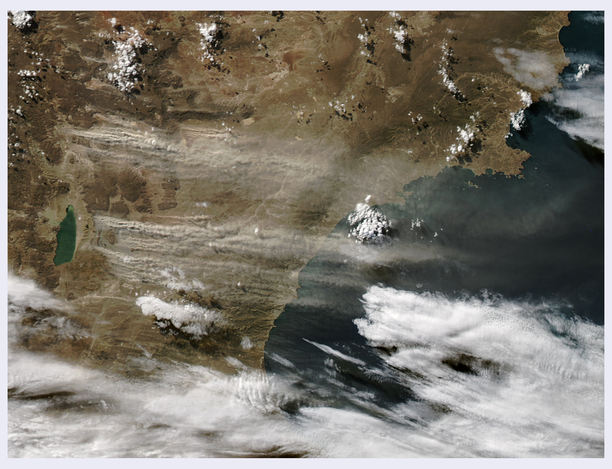
"In the last 20 years the lake Colhué Huapi lost half of its surface and the erosion destroy everything in its path"

24 April 2016 (http://www.elpatagonico.com)

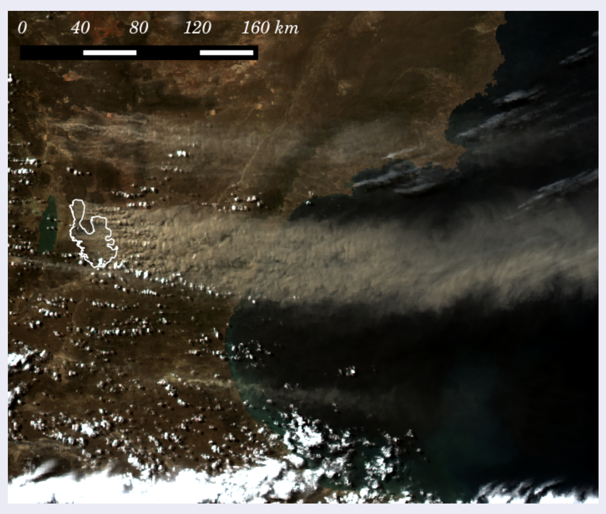
Observations

MODIS imagery

Previous episodes of wind-blown dust in Patagonia:



12 May 2013
MODIS-AQUA



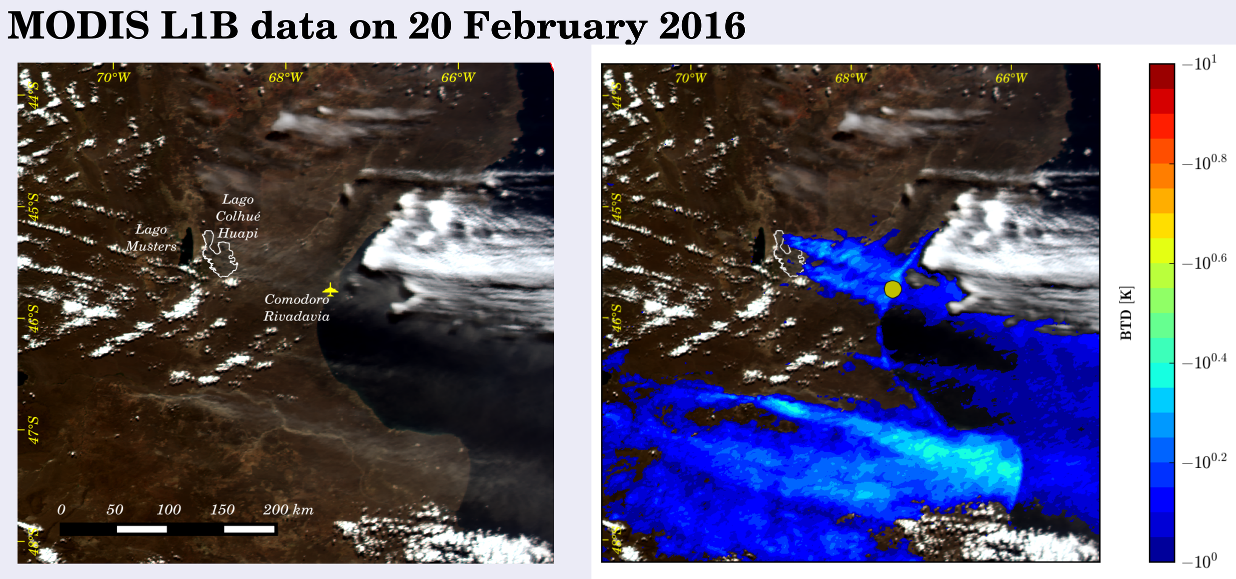
3 November 2016
MODIS-AQUA

MODIS L1B data on 20 February 2016

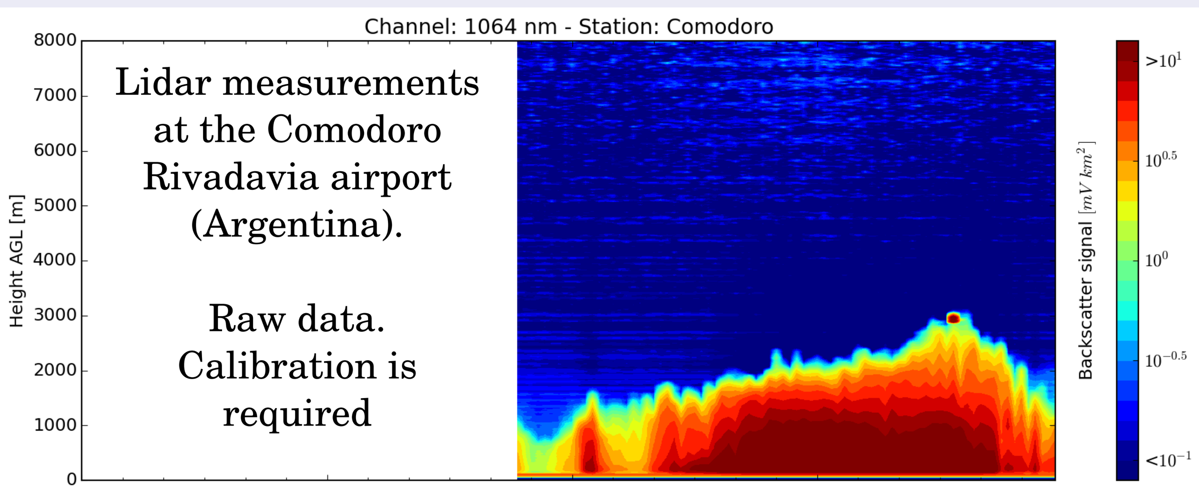
Brightness temperature difference (BTD):
BT31-BT32

B31: 11.03 µm
B32: 12.02 µm

MODIS image shows dust blowing from the lake Colhué Huapi and other sources in the Patagonia.



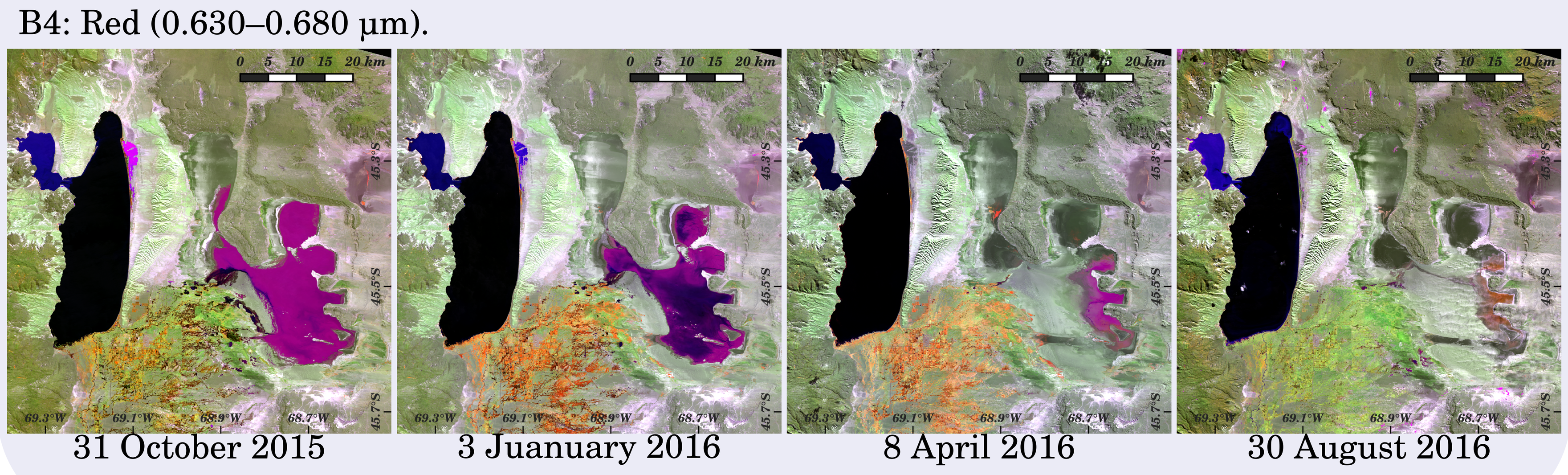
Lidar Measurements - Comodoro Rivadavia station



Lidar signal

LANDSAT 8 imagery

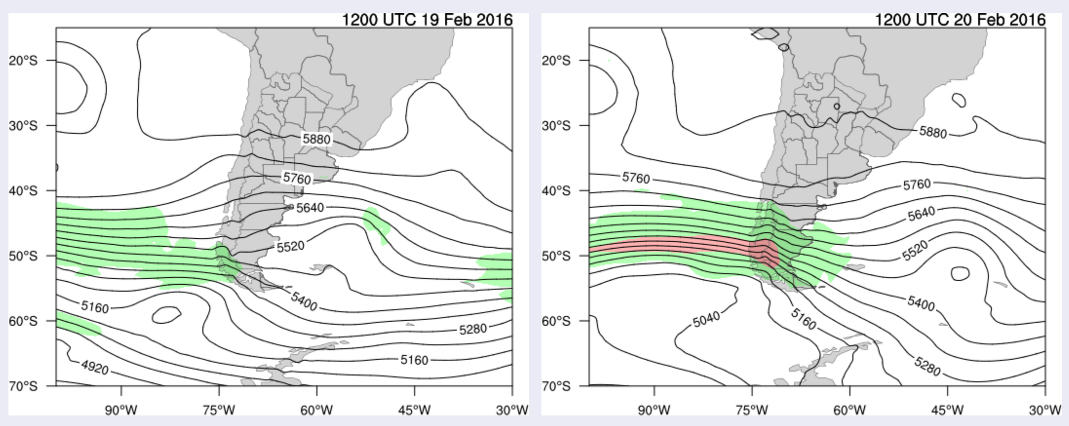
A prolonged drought caused a depleted water level during the last 5 years. This situation has become particularly evident in recent months. Sequence of LANDSAT 8 images. False-color band combinations B5-B6-B4. This band combination is good for picking out land from water:
B5: Near Infrared (0.845–0.885 µm),
B6: Shortwave infrared (1.560–1.660 µm), and
B4: Red (0.630–0.680 µm).



31 October 2015 | 3 Juanuary 2016 | 8 April 2016 | 30 August 2016

Numerical Simulations

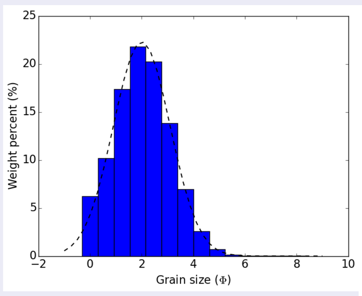
Synoptic situation: GFS Dataset

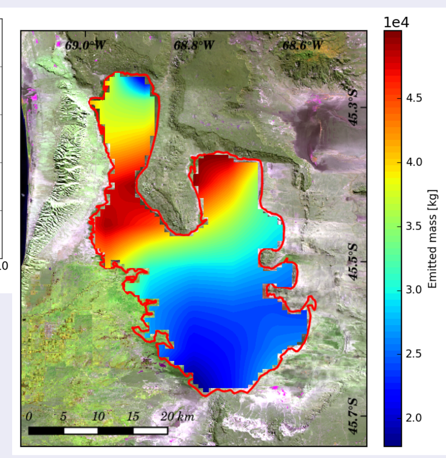


The figures show the evolution of a strong gradient geopotential height pattern at 500 hPa. The National Meteorological Service (SMN) from Argentina, forecast strong winds developing wind storm with large gusts from the West over the whole Santa Cruz Province.

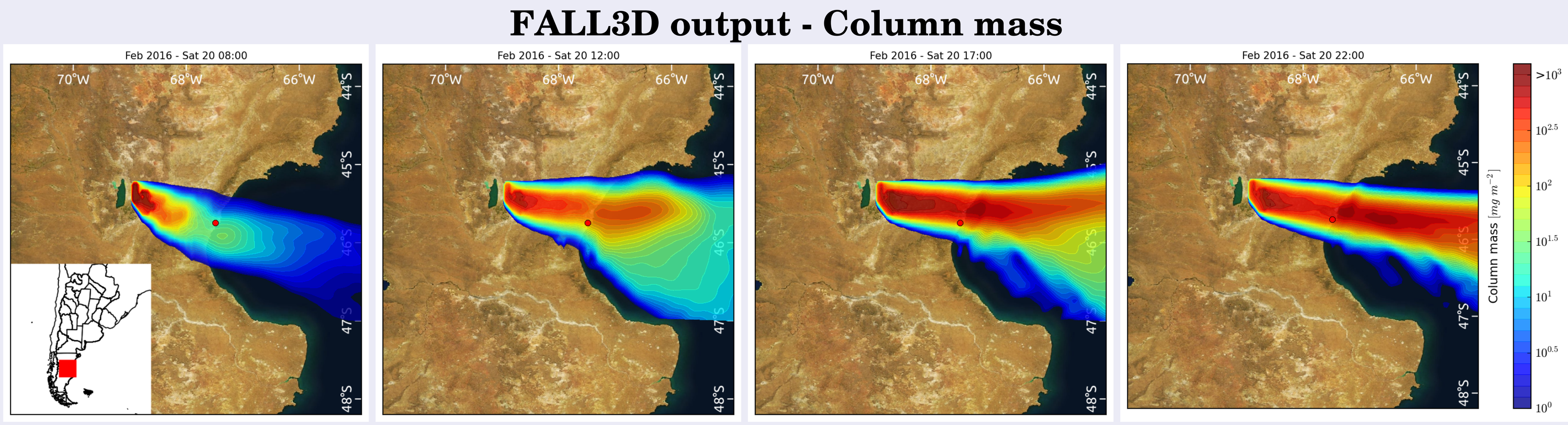
Emission sources

In our modeling strategy, the potential emission sources are determined by the area of the lake Colhué Huapi. The lake contour is provided by the Instituto Geográfico Nacional (IGN). The emission rate of windblown 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).



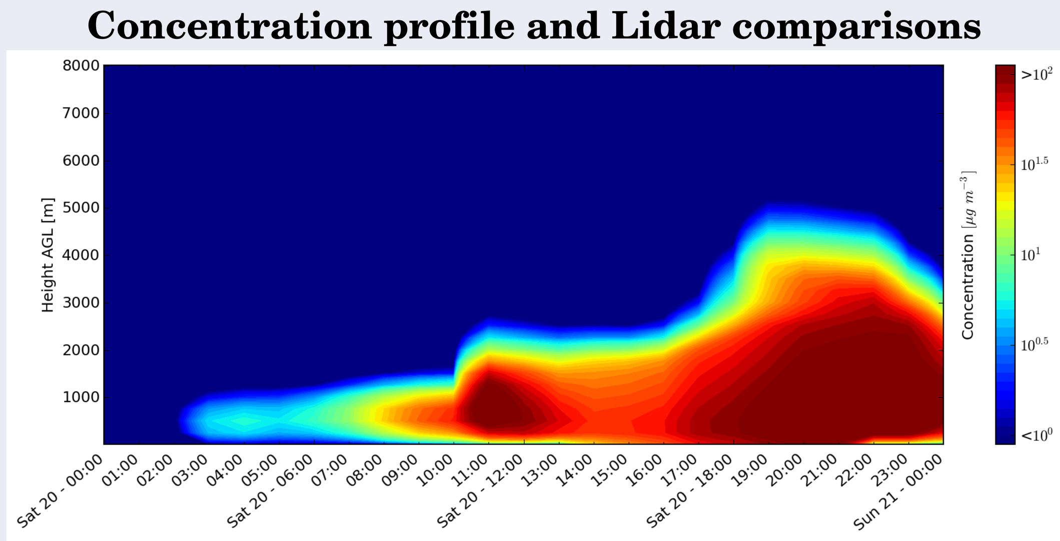


FALL3D output - Column mass



Concentration profile and Lidar comparisons

Modeled concentration



A good agreement with lidar measurements is obtained!

References

1. Castro, L.N., Scasso, R.A., Branzani, A. y Zubillaga, M.S. (2010): Los nivelesglauconítico de la formación Salamanca, Chubut: Su efectividad agronómica como fuente alternativa de fertilizante potásico. Revista de la Asociación Geologica Argentina, 66 (3): 391-398.
2. Russo, A. (1953): Levantamiento geologico 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.
3. Sciutto, J.C., Cesari, O. y Iantanos, N. (2008): Hoja Geologica 4569-IV, Escalante, provincia del Chubut. Instituto de Geologia y Recursos Minerales. Servicio Geologico Minero Argentino, Boletin 351, 76 p., Buenos Aires.
4. Llanos E., Behr S., Gonzalez J., Colombani E., Buono G. and Escobar, J.M.: Informe de las Variaciones del Lago Colhué Huapi mediante sensores remotos y su relacióncon las precipitaciones. Grupo Gestión Ambiental EEA Chubut.

Ackwonledgments

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: "Pronóstico del tiempo para estudios de vulnerabilidad e impacto socioeconómico".