



EL TIEMPO DE LOS ARGENTINOS

Activities and challenges to face the detection of volcanic ash at SMN

by Estela A. Collini

The Research and Development Interinstitutional group

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COMPONENTS

ON PROGRESS:

- **VORHISE** database
- **Working together with SEGEMAR**
- **REMOTE SENSING**
- **INSTRUMENTS**
- **MODELING CALBUCO**
- **ENSEMBLES/ASSIMILATION**
- **RESUSPENSION**
- **Experimental Operational Product**
- **MANAGEMENT PROTOCOL for VOLCANIC HAZARDS**

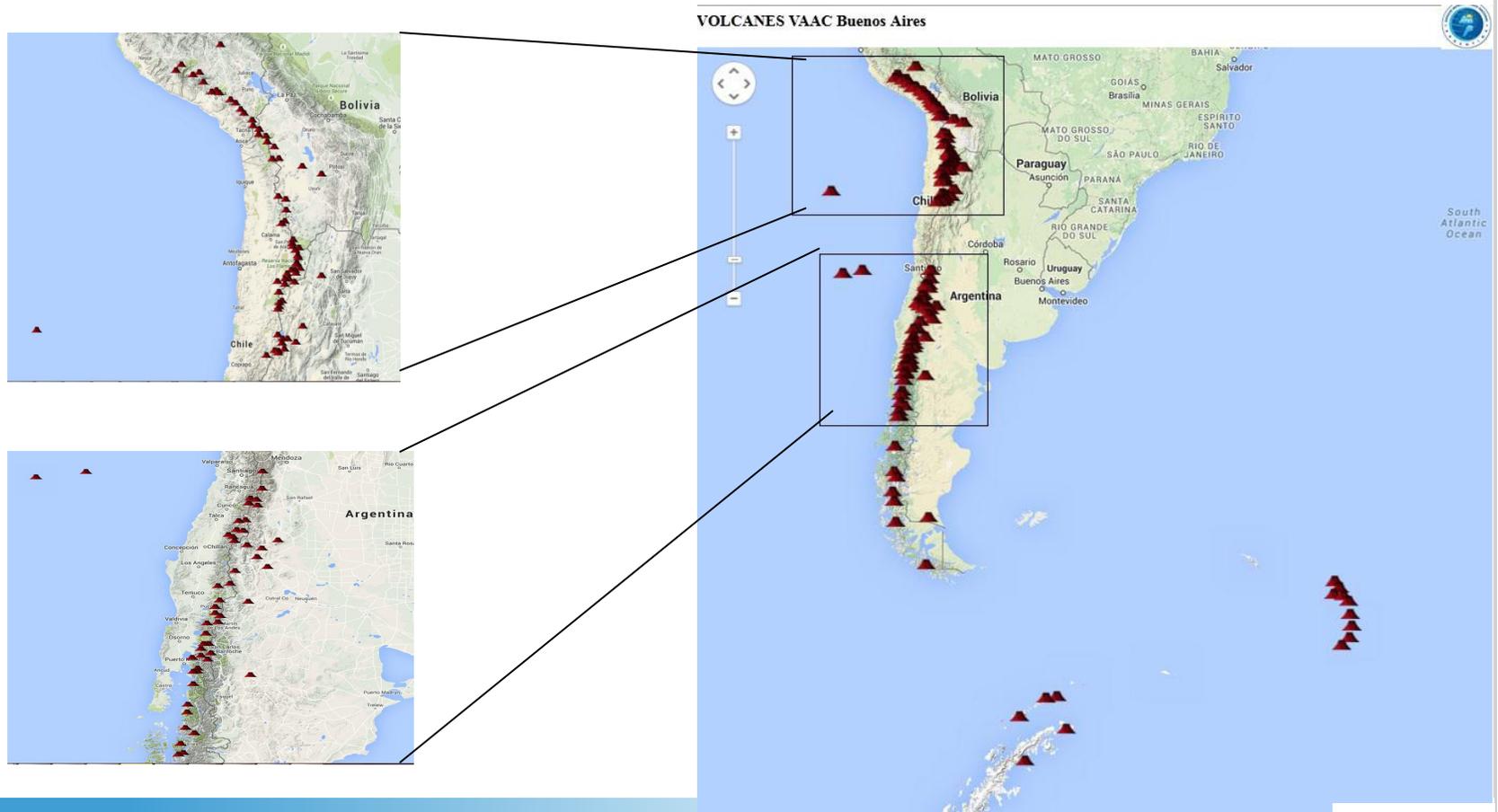
FUTURE CHALLENGES:

- **VOLCANIC ASH Deposits Catalog**
- **HAZARD SCENARIOS**



VORHISE: Volcanes activos de la Región y su HIStoria Eruptiva data base

GOAL: To concentrate and systematize the documentation needed for the initialization of the dispersion models as well as the construction of eruptive scenarios



VORHISE, Farias C. et al., 2014

VORHISE: Volcanes activos de la Región y su HIStoria Eruptiva data base

VORHISE

Main tasks:

- Inclusion of the ranking of volcanoes based on their risk
- Compilation and load of geological and vulcanological documentation

Exchanges:

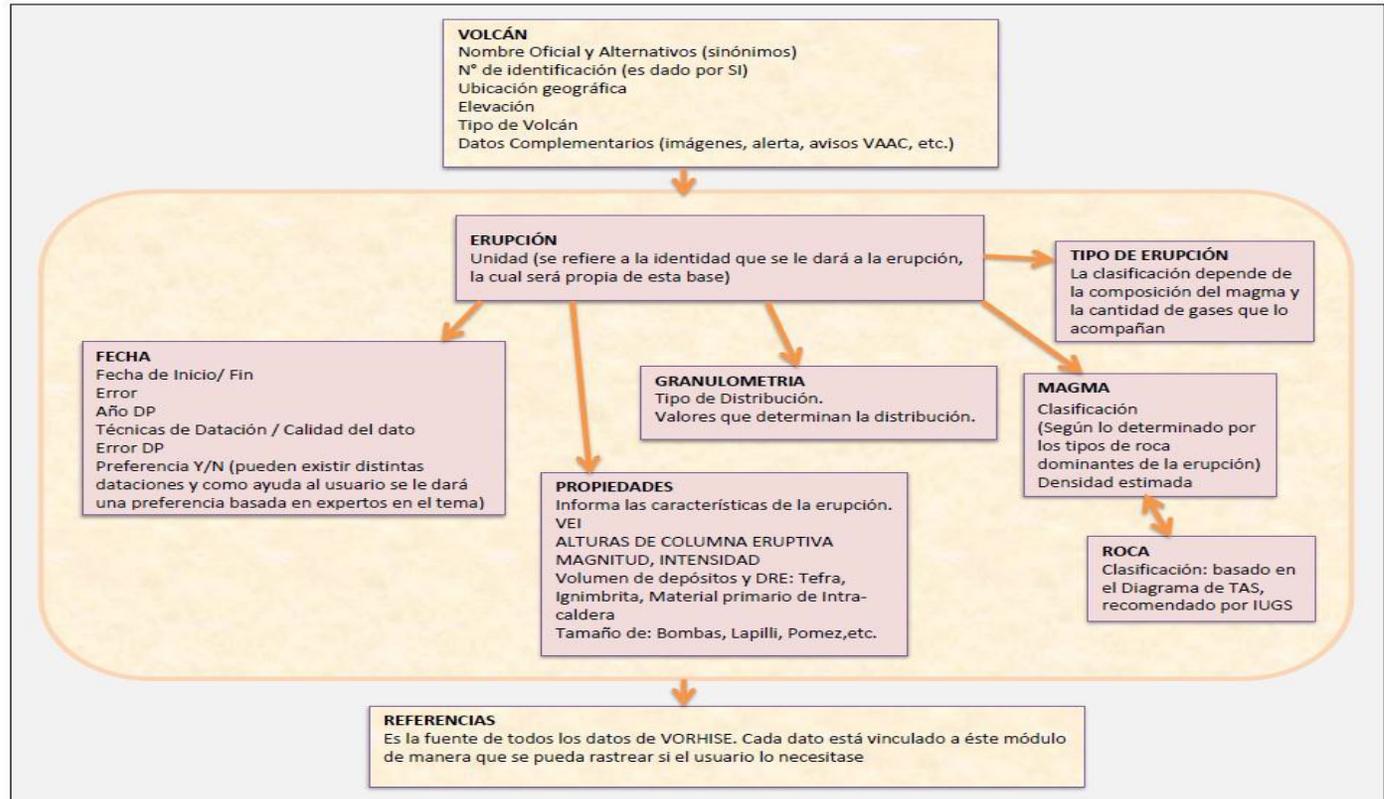
- **SEGEMAR** (Servicio Geológico Minero de Argentina, Observatorio Volcánico de Argentina)
- **Smithsonian Institution (USA)**
- **Instituto Geográfico Nacional (Argentina)**
- **University of Bristol (UK)**



VORHISE, Farias C. et al., 2014

VORHISE: Volcanes activos de la Región y su HIStoria Eruptiva data base

VORHISE conceptual diagram



VORHISE must include volcano location, ID number, type/height; and for each recorded eruption, the dates and/or the duration of the activity, height/s column/s eruptive/s, granulometric characteristics and parameters of shape of the ash emitted by volcanoes, explosivity index (VEI), volume, petrographic and geochemical characteristics of the material erupted, among other relevant data.



VORHISE, Farias C. et al., 2014

OBJECTIVES

Identify the volcanoes with higher RISK to the country

RAPID RISK ASSESSMENT

Based on NVEWS methodology (National Volcanic Early Warning System - USGS, Ewert et al., 2005). Applied by SERNAGEOMIN (Lara et al.: NVEWS-Chile)

Hazard and Exposure are characterized from the evaluation of different factors, obtaining a Risk Value.

$$R = P \times E$$

R: Risk, H: Hazard, E: Exposure

It will include the entire Hazard and Exposure factors and all the volcanoes that could affect Argentina, located in Argentina as well as Chile-Argentina border

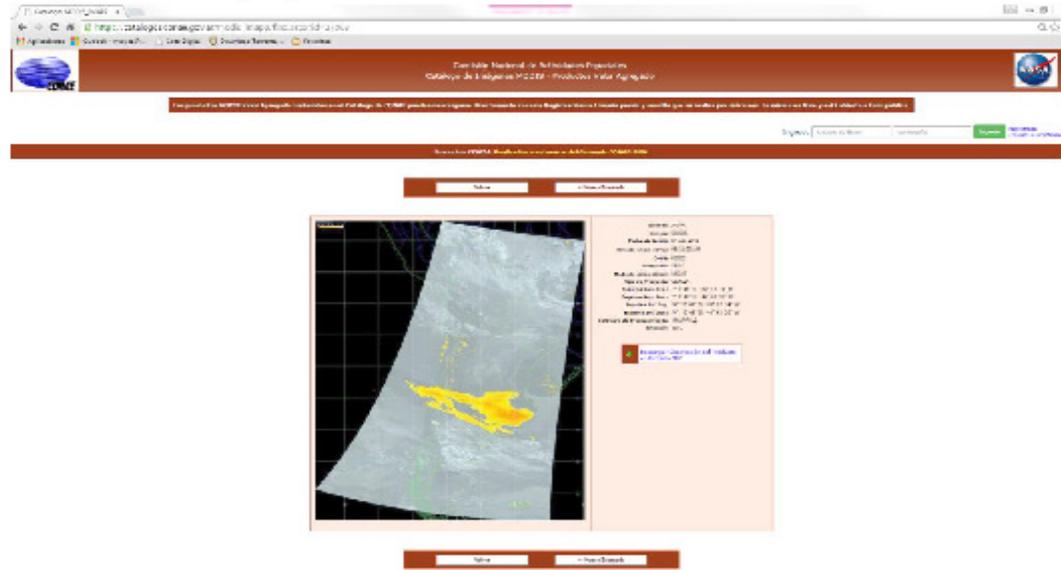


Elissondo M.; Farias C.; work in progress

REMOTE SENSING

Operational implementation of the concept of reverse absorption

Volcanic ash clouds detected on the basis of MODIS in near real time
(BT11 μm – BT12 μm) < $\sim -1.0^\circ\text{K}$



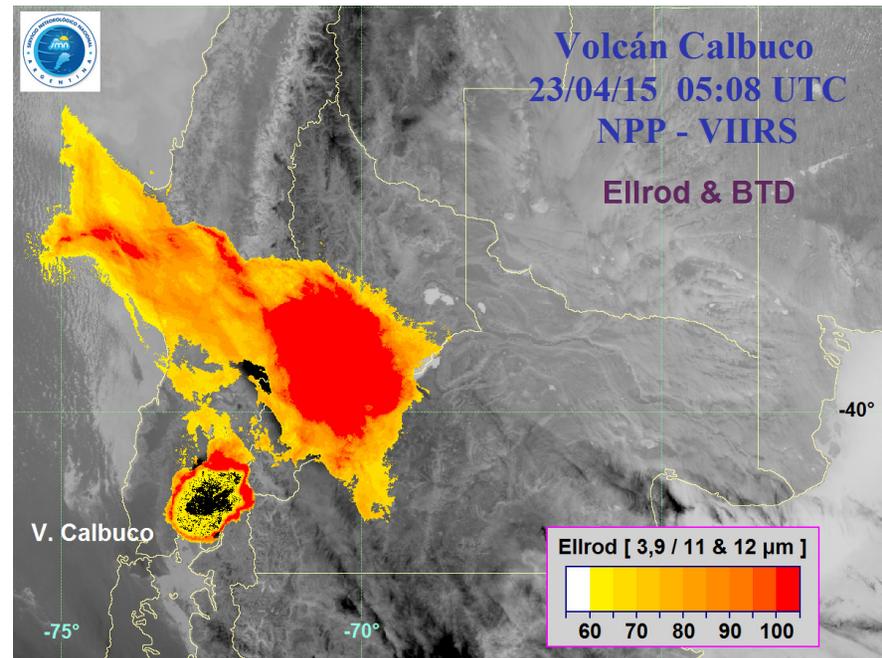
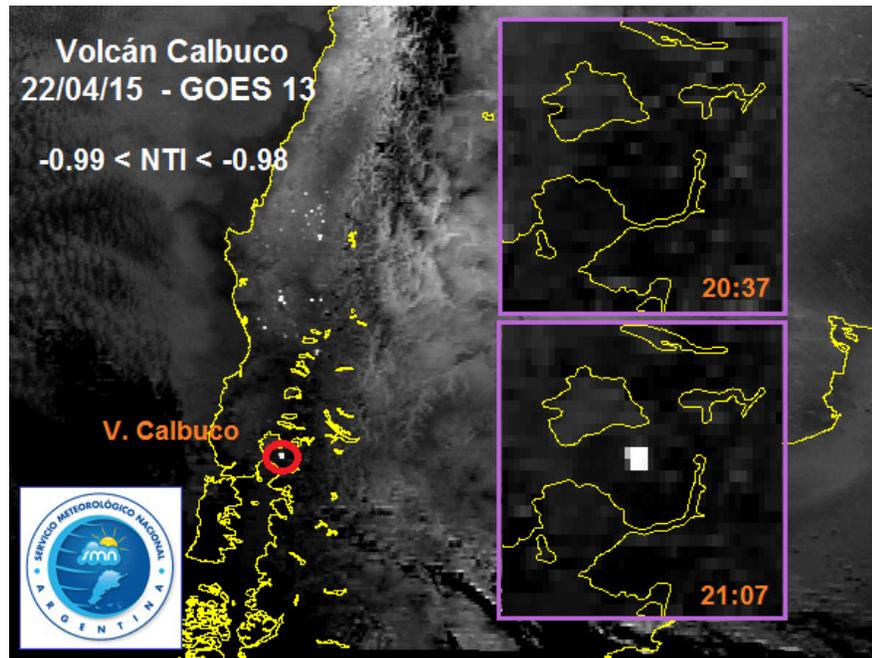
http://catalogos.conae.gov.ar/modis_imapp/

Direct access to end users, e.g. SMN
Geo-portal of volcanic ash products



Toyos G. and G. Pujol, 2014

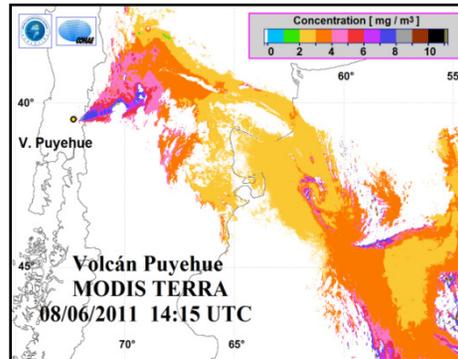
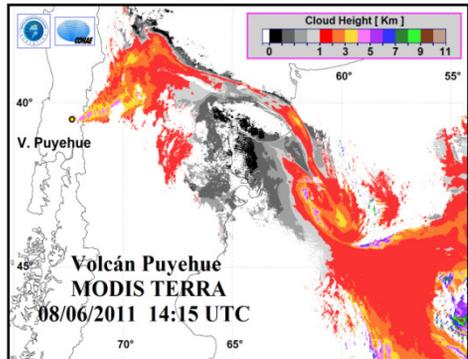
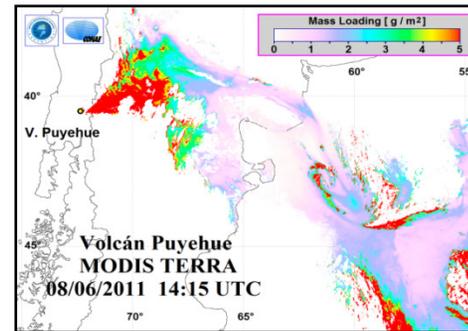
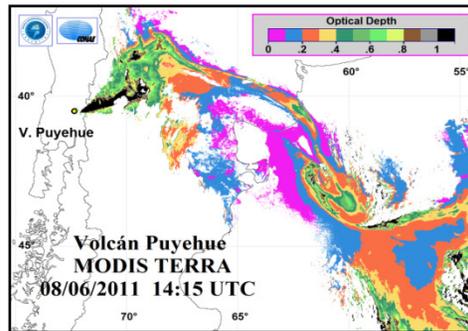
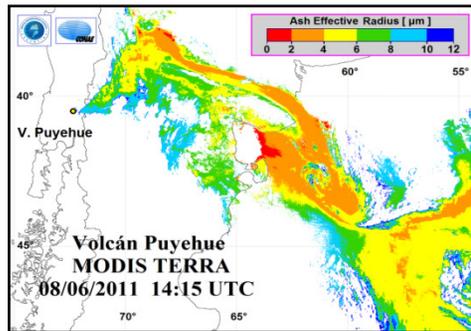
REMOTE SENSING



Pujol G., 2015

REMOTE SENSING

Ash effective radius, optical depth, mass loading, cloud height, concentration



Pujol G., 2015

INSTRUMENTS

- **Particle Counter (MetOne; TOPAS)**
- **LIDAR**
- **Thermo Model FH62 C14**



INSTRUMENTS/MetOne

MetOne similar TOPAS: particle counter instrument installed al Bariloche Airport since Setember 2011



The plan is to install a ToPAS o similar at each LIDAR location



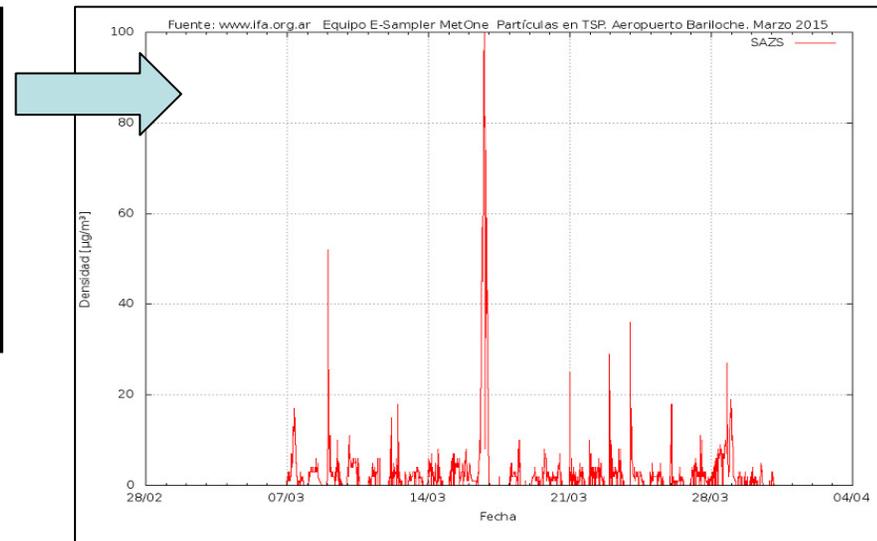
Fernández M., 2015

INSTRUMENTS/MetOne



The resuspension plume travels 90 km to reach Bariloche

This image shows the reduction of visibility at Bariloche airport on 16 March 2015, caused by the aeolian remobilization of the volcanic ash deposits from the Cordón Caulle 2011 eruption. The phenomenon lasted all during the day . Nevertheless the airport remains operational.



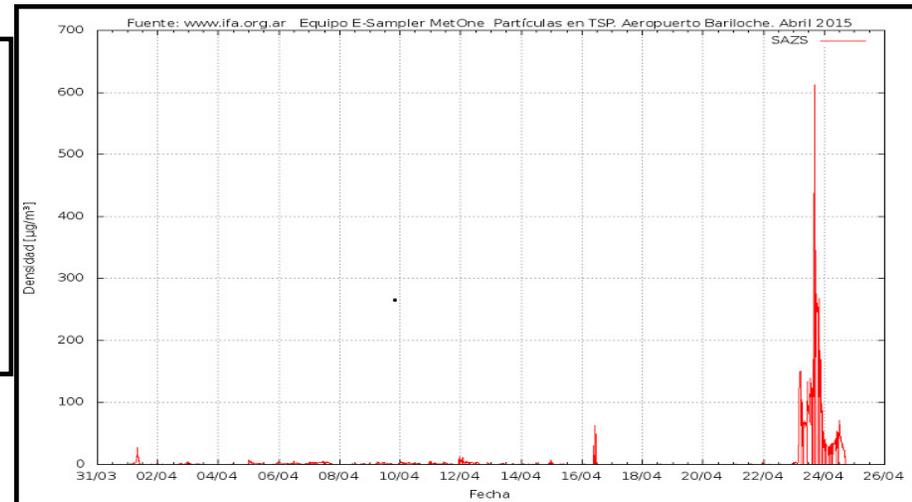
Fernández M., 2015

INSTRUMENTS/MetOne

This image shows the reduction of visibility at Bariloche airport on 24 April 2015, caused by the aeolian remobilization of the volcanic ash deposits from the Calbuco recent eruption.



In this graphic three Calbuco eruptive events can be observed.
The maximum detected value was about 650 mcgrs/m³
Even if this value doesn't restrict the airnavigation, a temporary closing of the airport due to low visibility took place



Fernández M., 2015

INSTRUMENTS/LIDAR



A real-time aerosol monitoring network in development

The main properties of the aerosols focusing on source areas, types of aerosols, transportation, and seasonal variation will be studied

- CEILAP – December 2003
- Bariloche – February 2012
- C. Rivadavia – October 2012
- R. Gallegos – July 2013
- Neuquén – December 2014
- Aeroparque – February 2015
- Punta Arenas – March 2016
- Córdoba
- Tucumán

PE MD
31554/11

Ministerio de Defensa
Presidencia de la Nación

SAVERNet
South America Environment Risk Network
Argentina Chile Japan

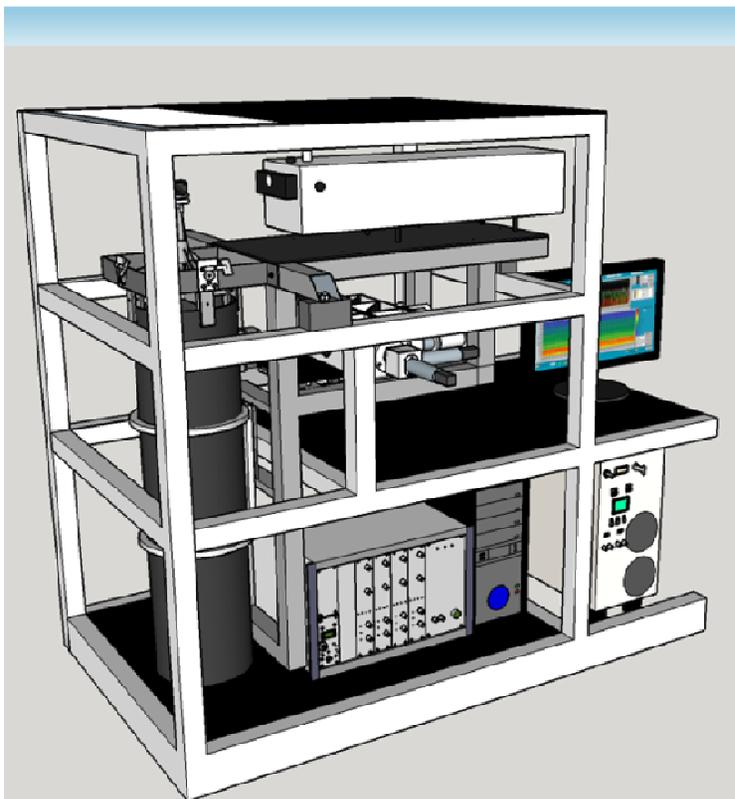
Ministerio de Defensa
Presidencia de la Nación



Ristori P. et al., 2015

INSTRUMENTS/LIDAR

MD31554/ 11 and SAVERNet Project : Lidar Container Design and Construction



Multiwavelength Lidar System Concept

Emission at 355, 532 and 1064 nm

Reception:

355 nm co and cross-polarized channels

532 nm co and cross-polarized channels

1064 nm channel

384 nm and 607 nm N₂ Raman channels

408 nm H₂O Raman channel

High Spectral Resolution capabilities for daytime extinction observations (JST and JICA contributions to Buenos Aires and Córdoba sites)

Aluminum structure to hold the whole system and protect the components

Iron structure to reduce thermal effects and keep the critical optical elements aligned

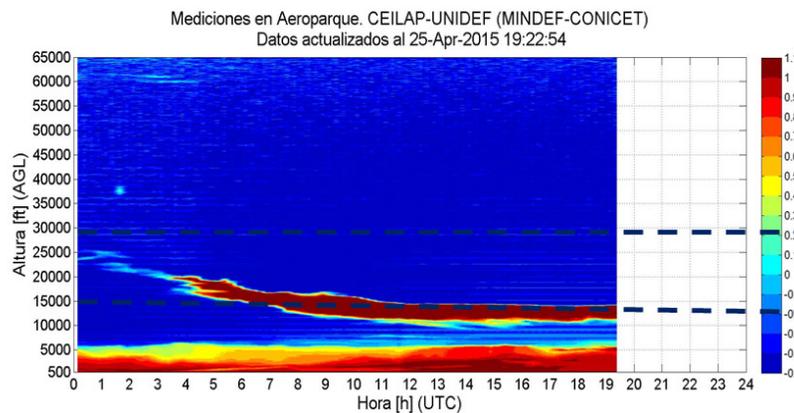


Ristori P. et al., 2015

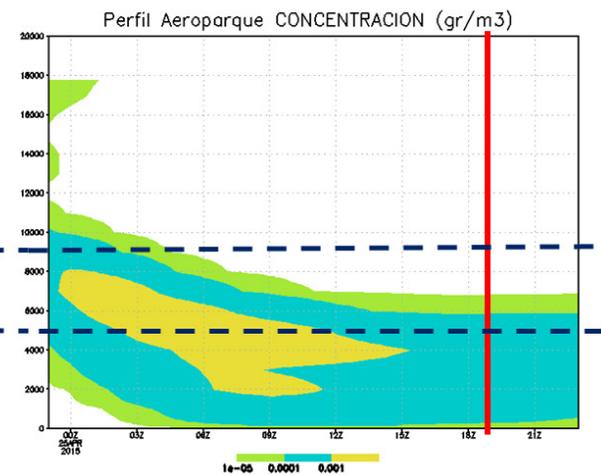
The Calbuco Volcanic Eruption

Fall3d vs Lidar measurements

LIDAR Dorrego - Observation



Ash concentration forecast
Initialized on 24 April 2015
Valid for 25 April 00Z to 26 April 00Z



Buenos Aires, First Episode. Direct Volcanic Plume

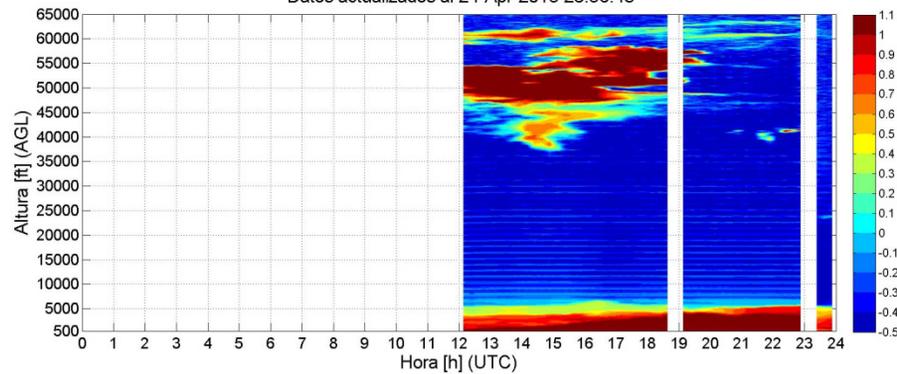
Fuente:
Lic. M.S. Osores (CONICET-CONAE-SMN)
Dra. Estela Collini (SHN-SMN)



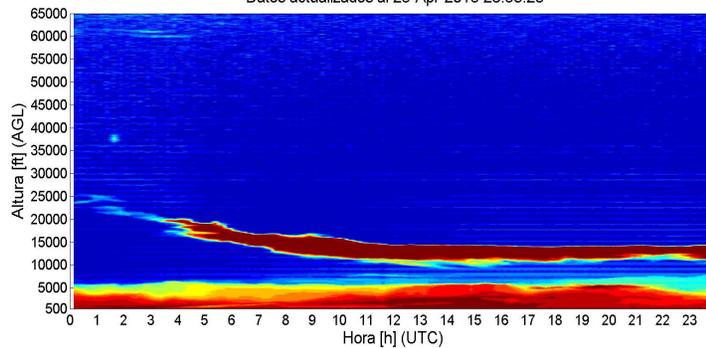
INSTRUMENTS/LIDAR

The Calbuco Volcanic Eruption

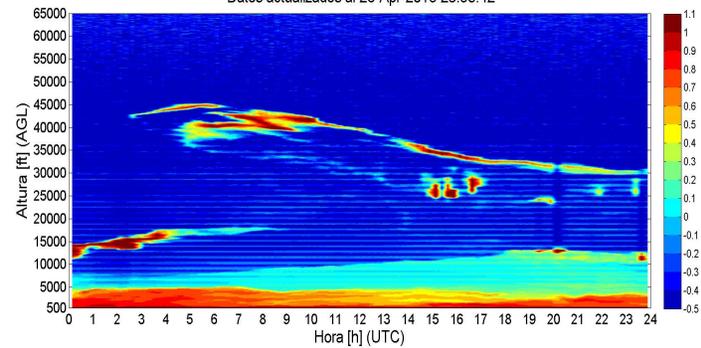
Mediciones en Aeropuerto. CEILAP-UNIDEF (MINDEF-CONICET)
Datos actualizados al 24-Apr-2015 23:56:48



Mediciones en Aeropuerto. CEILAP-UNIDEF (MINDEF-CONICET)
Datos actualizados al 25-Apr-2015 23:58:28



Mediciones en Aeropuerto. CEILAP-UNIDEF (MINDEF-CONICET)
Datos actualizados al 26-Apr-2015 23:58:42



Ristori P. et al., 2015

INTRUMENTS/THERMO Model FH62 C14

Air Quality Monitoring automatic network of the Ciudad de Buenos Aires (CABA), Argentina



CO, NO-NO₂-NO_x, O₃, PM₁₀
Córdoba station



CO, NO-NO₂-NO_x, PM₁₀
Parque Centenario station



CO, NO-NO₂-NO_x, SO₂-H₂S,
PM₁₀ La Boca station



Mayol L., 2014

INTRUMENTS/THERMO Model FH62 C14

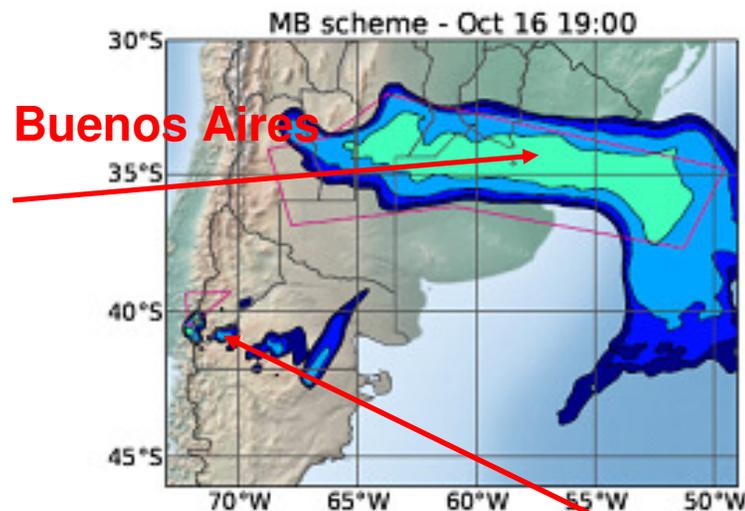
October 14-18, 2011 re-suspended VA outbreak episode in Argentina

Re-suspended ash clouds are injected at low atmospheric levels and very fine ash can be transported, affecting:

- Vast areas in-situ and downwind
- All means of transportation - disrupts aviation activity-
- Air quality



Buenos Aires "J. Newbery" domestic airport, 1.400 km from the v. complex, 10-16-2011



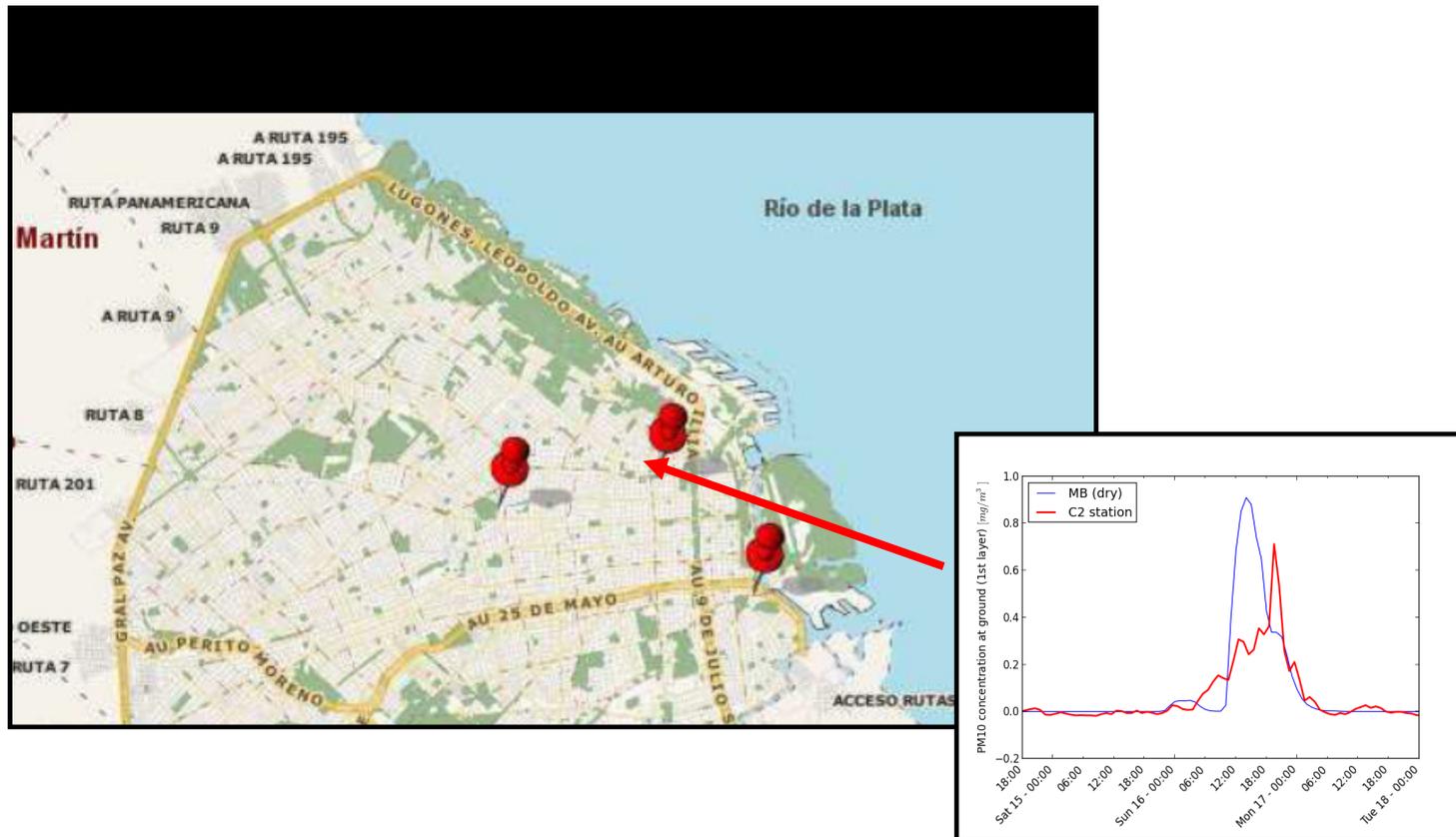
Volcanic complex and deposit



Folch A. et al., 2014

INTRUMENTS/THERMO Model FH62 C14

October 14-18, 2011 re-suspended VA outbreak episode in Argentina. Measurements vs. FALL3D model resuspension forecast at Avenue Córdoba station in the Ciudad de Buenos Aires (CABA).



Folch A. et al., 2014

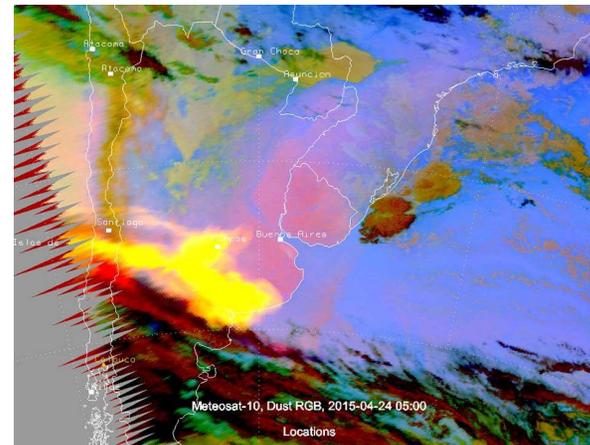
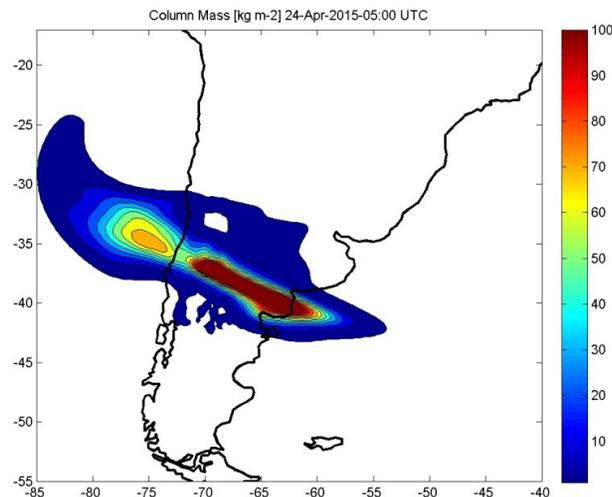
Modeling the Calbuco eruption (April 2015)

Quasi-Operational support from I+D Group-SMN-CONICET-CONAE-SHN

Deterministic forecasts, using FALL3D dispersion model and meteorological fields from WRF-ARW (SHN-SMN), were ran during the Calbuco eruption.

Residual ash from previous eruptive pulses was included in the following forecast simulations, reprocessing the previous 24 hours with more accurate column heights (i.e using Restart). Plume height estimations were based on satellite images combining with radiosondes data, and SERNAGEOMIN reports.

Simulation using restart on 23rd to forecast 24th at 00 UTC (24 hrs)



from EUMETSAT



Osores M. S. et al. , 2016

ENSEMBLE Forecasts System (work on progress)

With the aim of quantify uncertainty in ash dispersion forecasts, a **PhD is under development** on ensemble forecasting and data assimilation (M.S. Osores).

This is a collaborative work between different institutions. Using the computational facilities of the Research Centre for Sea and Atmosphere at the University of Buenos Aires (CIMA-CONICET-UBA) and Marenostum at the Barcelona Supercomputing Center from Spain.



We use an stochastic expansion based on the Polynomial Chaos Expansion theory (Wiener, 1938) (i.e combination of multivariate orthogonal polynomials bases) to generate a surrogate model and perform hundreds of evaluations with lower computational cost. The code is developed in Python.



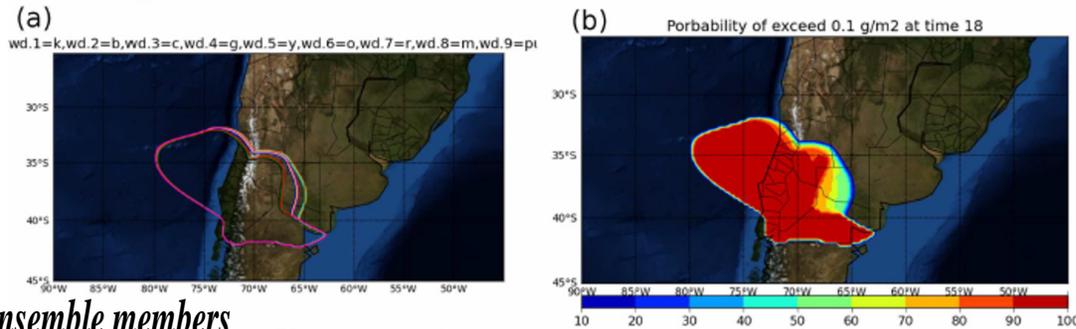
Osores M.S. et al.

ENSEMBLE Forecasts System (work in progress)

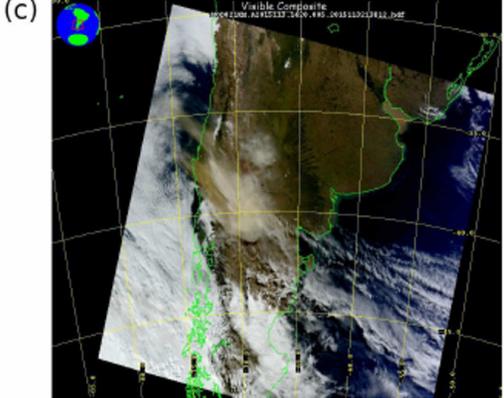
Example of the ensemble forecast system for the of Calbuco eruption.

The ensemble was initialized on 24 April 2015 with the volcanological parameters: Column height: [13 km ; 17 km] and TGSD mean [3□;4□]. Assuming uniform PDFs.

Gauss quadrature points using (Legendre) polynomials of 3rd order ($3^2=9$ members).



Column mass ensemble members (>0.1 kg/m2)



Probability of exceed 0.1 kg/m2 from 100 evaluations of the Surrogate Model (25 April 15 UTC)

MODIS image



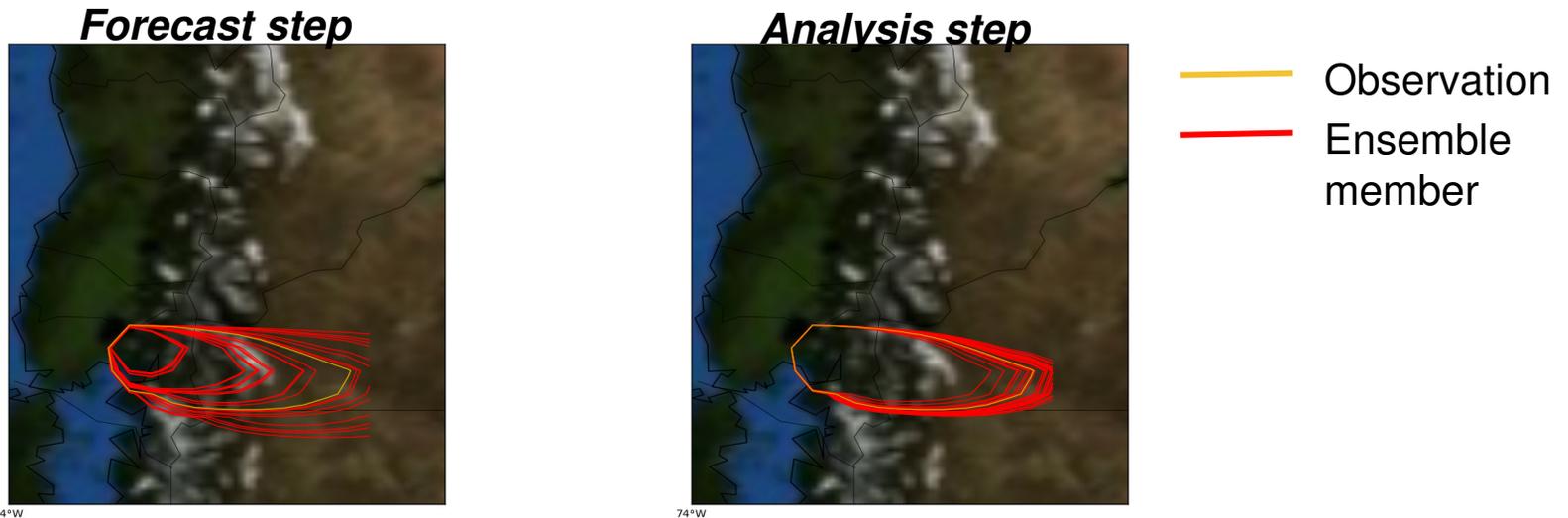
Osores M.S. et al.



Data Assimilation (work on progress)

In order to improve initial conditions (i.e volcanological parameters and current state of the ash cloud) to perform the following forecast, data assimilation techniques are being evaluated as a part of M.S Osores PhD.

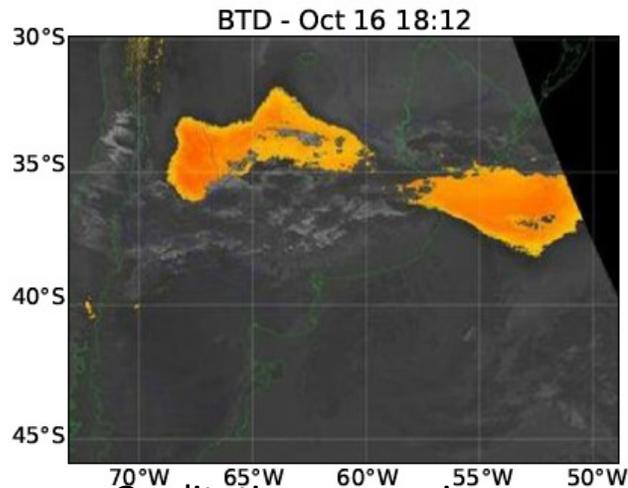
Following the works of Rochoux et al., (2015) and Madankan et al., (2012), some tests were performed using FALL3D and Ensemble Kalman Filter (EnKF) and synthetic satellite observations (i.e a model run), to constrain vertical column heights and the mean of the Total Grain Size Distribution, assuming Gaussian PDFs. This is in early stages of development.... Example of a EnKF cycle.



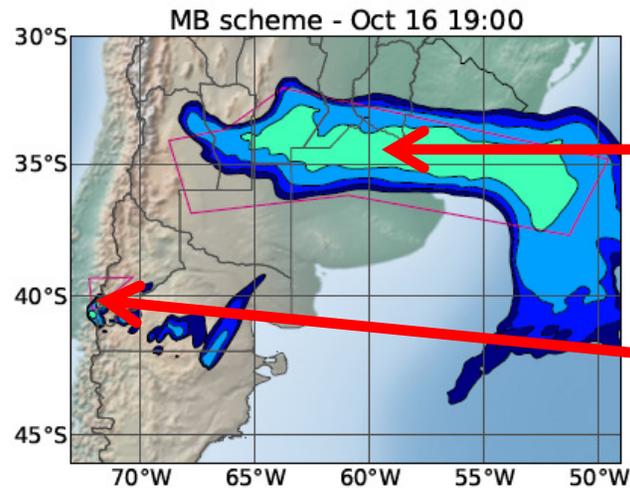
RESUSPENSION

October 14-18, 2011 re-suspended VA outbreak episode in Argentina

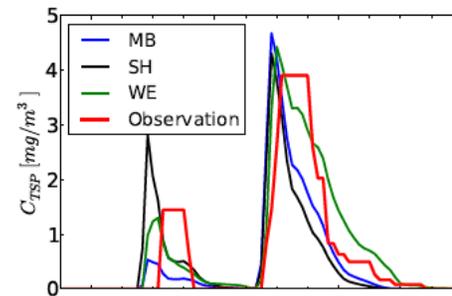
FALL3D applied to the re-suspension episode of Oct. 2011, as a test case.



Qualitative comparison
with satellite image
(BTD algorithm - MODIS)



Concentration:
Model vs. Observation
(Santa Rosa city example)



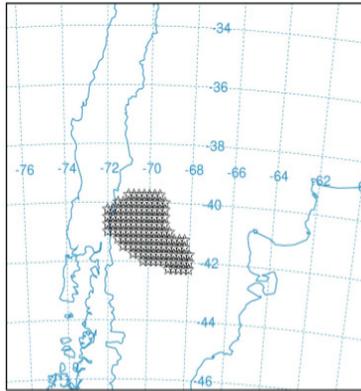
Column mass of re-suspended ash



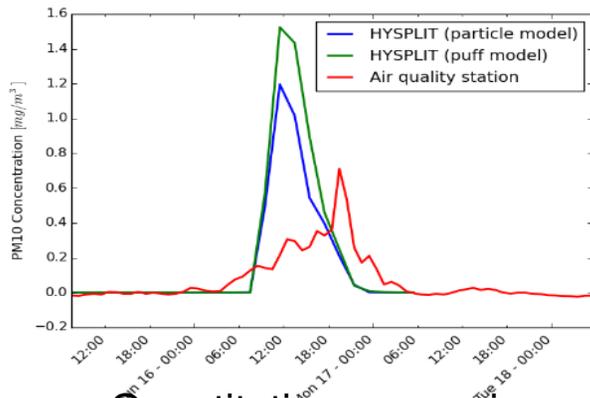
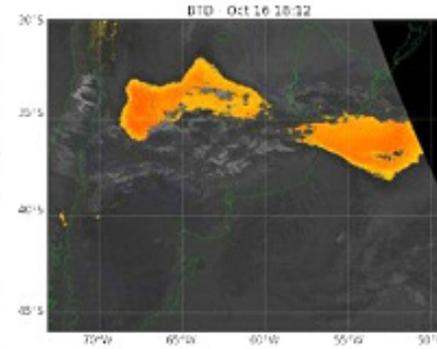
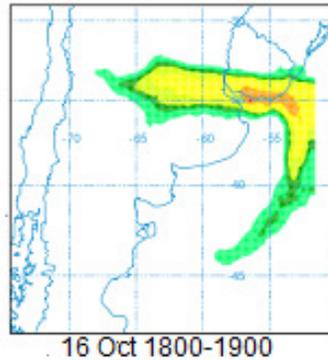
Folch A. et al., 2014; Mingari et al., 2014

RESUSPENSION

Modelling the 14-18 October, 2011 outbreak episode with HYSPLIT



Potential Sources Distribution



Quantitative comparison with air quality data

- Computational time is appropriate for operational use
- Different configurations were tested
- The dust storm module was used



Mingari L. et al., 2014

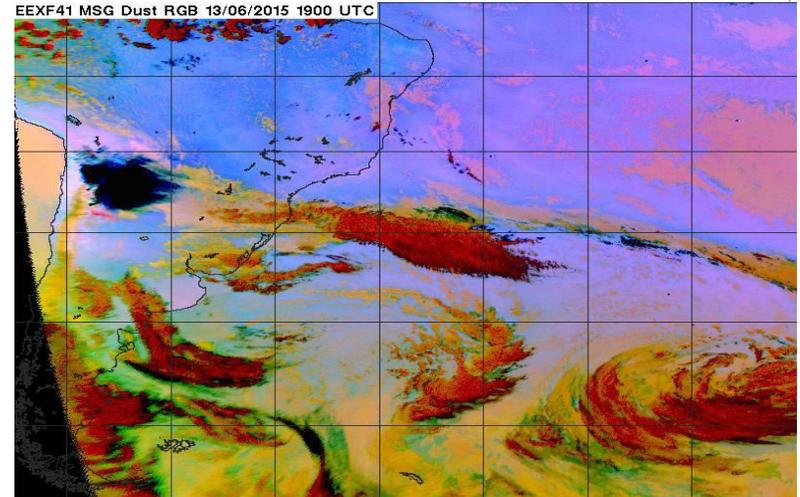
RESUSPENSION

On June 13th, 2015 an eruption from Nevados Ojos del Salado volcano (6,879 m), located on the Chile/Argentina border, was detected by VAAC London and immediately reported to VAAC Buenos Aires, within the frame of the ongoing initiatives to foster improved inter-VAAC collaboration. (VAAC: Volcanic Ash Advisory Center, ICAO-WMO)

The satellite images showed a “plume” being emitted for around 6 to 9 hours since 13/15UTC. It was detected using Red-Green-Blue satellite channel splitting techniques from the SEVIRI sensor on board of METEOSAT 10.

A multidisciplinary group start to work on this, and finally arrive to the conclusion that it was a resuspension event from the **Bolsón de Fiambalá** bottom.

The **BF** it is one, among the large amount of pyroclastic deposits along the Andes, which are sources of frequent ash/dust storms or remobilization processes that could be masked as an eruption.



Collini E. et al., 2015

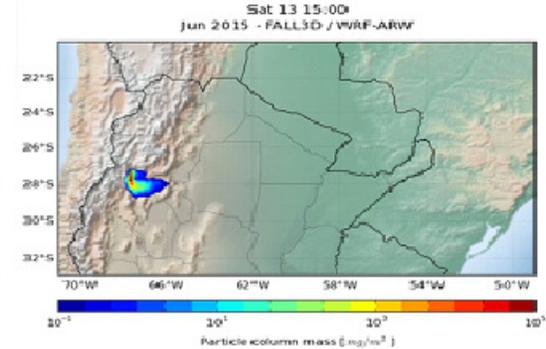
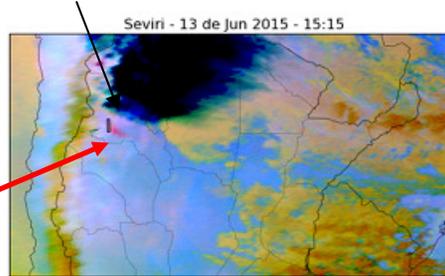
RESUSPENSION

We performed a resuspension run with the FALL3D Model considering a set of potential emission sources delimited by a simplified region

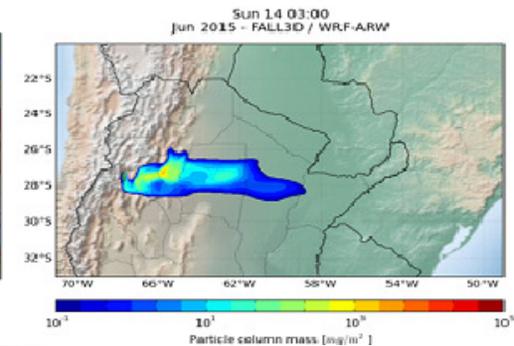
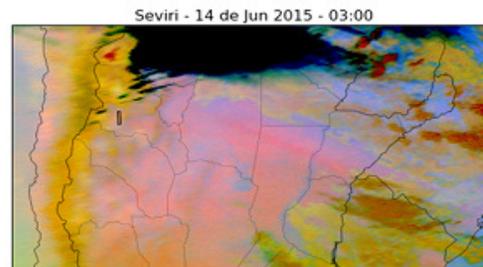
Bolsón de Fiambalá aprox 27.6667° S, 67.6167° W



Initial time

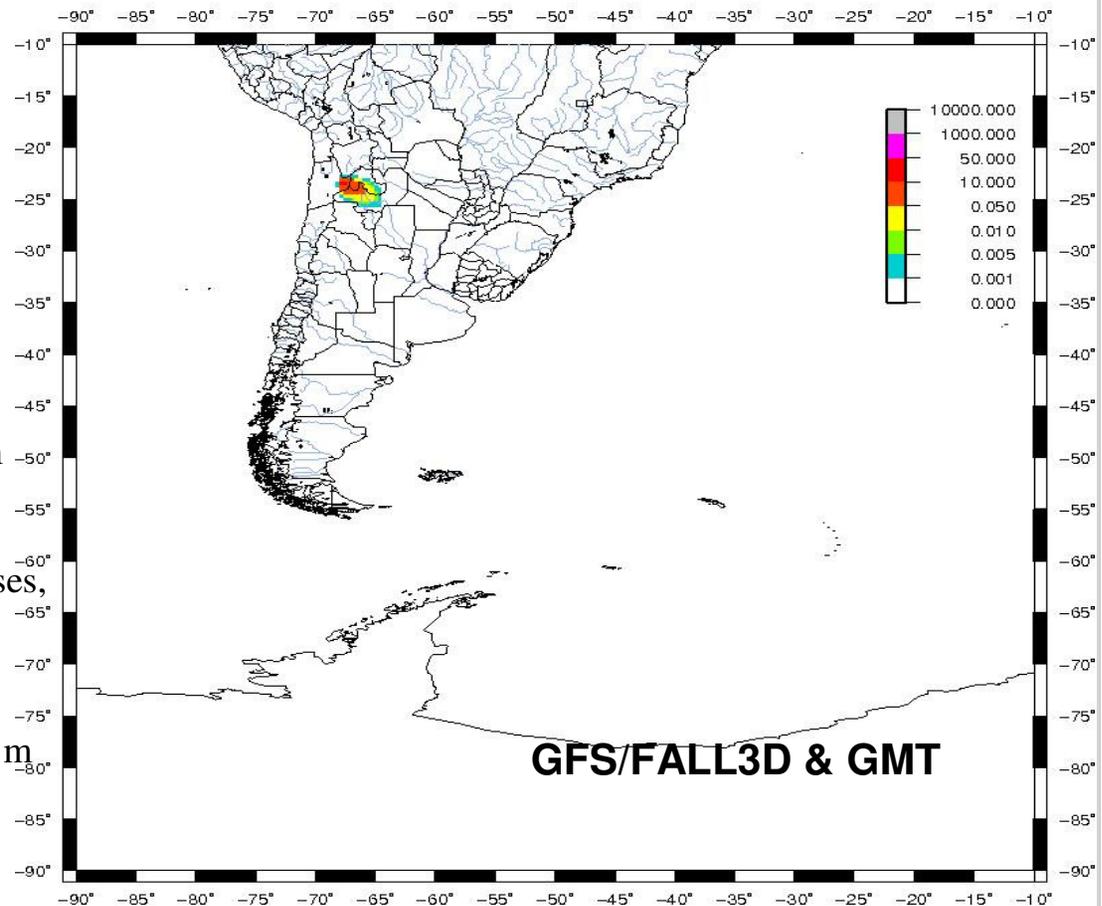


Final time



Experimental Operational Product

Lascar 22abr2016-0300-UTC LOAD kg/m²



SIMULATION (example)

LASCAR volcano:
(lat, lon) = (-23.37, -67.73); Vent height = 5592m

Granulometry:
April 1993 Plinian eruption: GAUSSIAN 5 classes,
Mean=2.1, Desv = 0.7

SUZUKI:
WOODHOUSE estimation; plume height: 10000 m



Salles M.A.; Farias C.



MANAGEMENT PROTOCOL for VOLCANIC HAZARDS

Argentine Interagency Volcanic Ash Information management protocol

• **Project Source:** Ministerio de Ciencia, Tecnología e Innovación Productiva, • National Agencies involved: SEGEMAR, SMN; CONAE; CONICET; IGN; among others

User: Subsecretaría de Protección Civil y Abordaje Integral de Emergencias y Catástrofes, Ministerio de Seguridad.

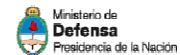
• **Main objective:** to articulate the scientific, technological and administrative capacities of all agencies involved for a better management of the hazardous situations posed by the presence of VA in the Argentinian territory in order to improve all administration levels of decision making processes.

• **Specific objectives:**

- Provide thorough information on the volcanos and the level of threat of an eruption;
- Catalog of active volcanos
- Monitor the threat of an eruption and provide VA forecasts (from dispersion and transport models), to determine potentially affected areas
- Isopach maps and VA deposit forecast
- Water & Air quality assessment in the affected areas
- Efficient warning



COMISION de RIESGO, MINCYT, ARGENTINA



Future CHALLENGES

- Create eruption/re-suspension **VA HAZARD SCENARIOS**. The maps will depict the probability of the presence of VA, its concentration in the atmosphere and the thickness of its ground deposits exceeding certain given thresholds.
- This cartography will combine the most probable vulcanological scenarios for the more explosive volcanos combined with the typical regional synoptic situations.
- **VOLCANIC ASH Deposits Catalog**



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Mingari, L, T. Schonholz, E. COLLINI, F. Reckziegel y M. Suaya: Aplicación del modelo HYSPLIT para el estudio y pronóstico de episodios de resuspensión de cenizas volcánicas, XIX Congreso Geológico Argentino, Córdoba, 2 al 6 de junio, 2014, Argentina. Modalidad: Poster



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MANY THANKS



INSTRUMENTS/THERMO Model FH62 C14

Measurements of respirable suspended particulate matter (PM10) from the EPA Air Quality Monitoring Stations Network. This network consists of three stations located at the northeast (C1, Parque Centenario), downtown (C2, Córdoba), and southwest (C3, La Boca) of CABA. The instruments installed at these stations are the Thermo Model FH62 C14, which continuously measure the mass concentration of particulate utilizing a beta rays attenuation technique. The instruments meet US and International Particulate Monitoring Regulations and are US EPA certified to agree with the international air quality regulations.

<http://www.buenosaires.gob.ar/agenciaambiental/monitoreoambiental/>

