



Satellite images uncertainty: eruption or resuspension? The importance of the multidisciplinary approach. The case of June 13th, 2015 Ojos del Salado false volcanic eruption

Collini E.A.^{1,4}, Mingari L.^{2,4}, Reckziegel F.³, Bustos E.³, Baez W.³, Andrioli M.⁴, Folch A.⁵, Alexander P.², and Viramonte J.G.³

The INSTITUTIONS

- 1 Servicio de Hidrografía Naval (SHN), Argentina
- 2 CONICET-DF/FCEyN-UBA, Argentina
- 3 INENCO-GEONORTE – UNSa-CONICET, Argentina
- 4 Servicio Meteorológico Nacional (SMN), Argentina
- 5 Barcelona Supercomputing Center (BSC), Barcelona, España



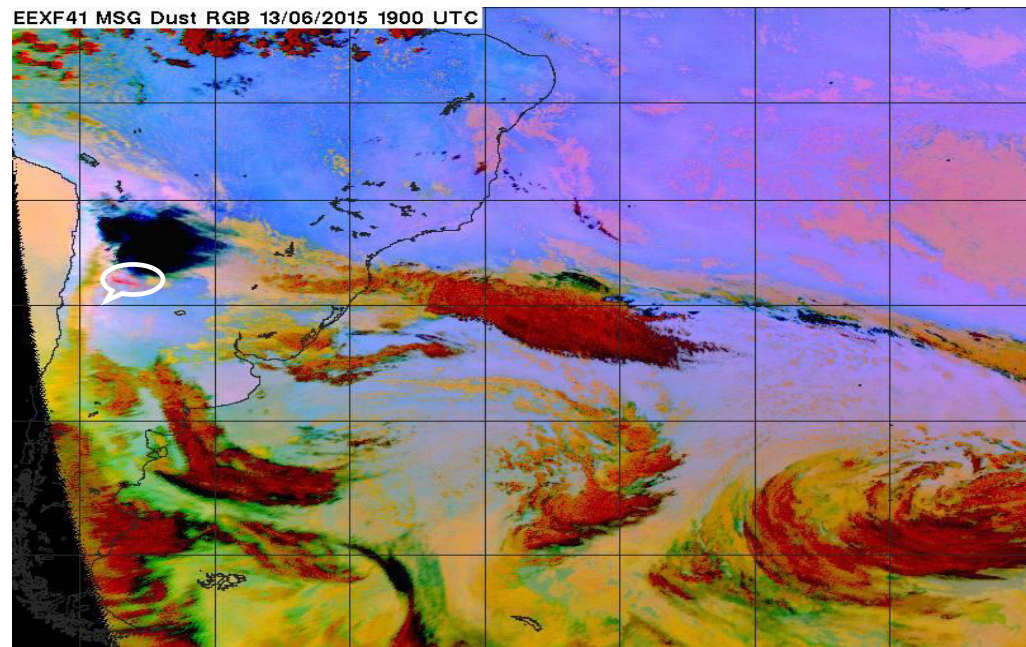
Satellite images uncertainty: eruption or resuspension? The importance of the multidisciplinary approach. The case of June 13th, 2015 Ojos del Salado false volcanic eruption



INTRODUCTION

On June 13th, 2015 an eruption from Nevados Ojos del Salado volcano (6,879 m), located on the Chile/Argentina border, was reported. 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.

This suspicious eruption 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)



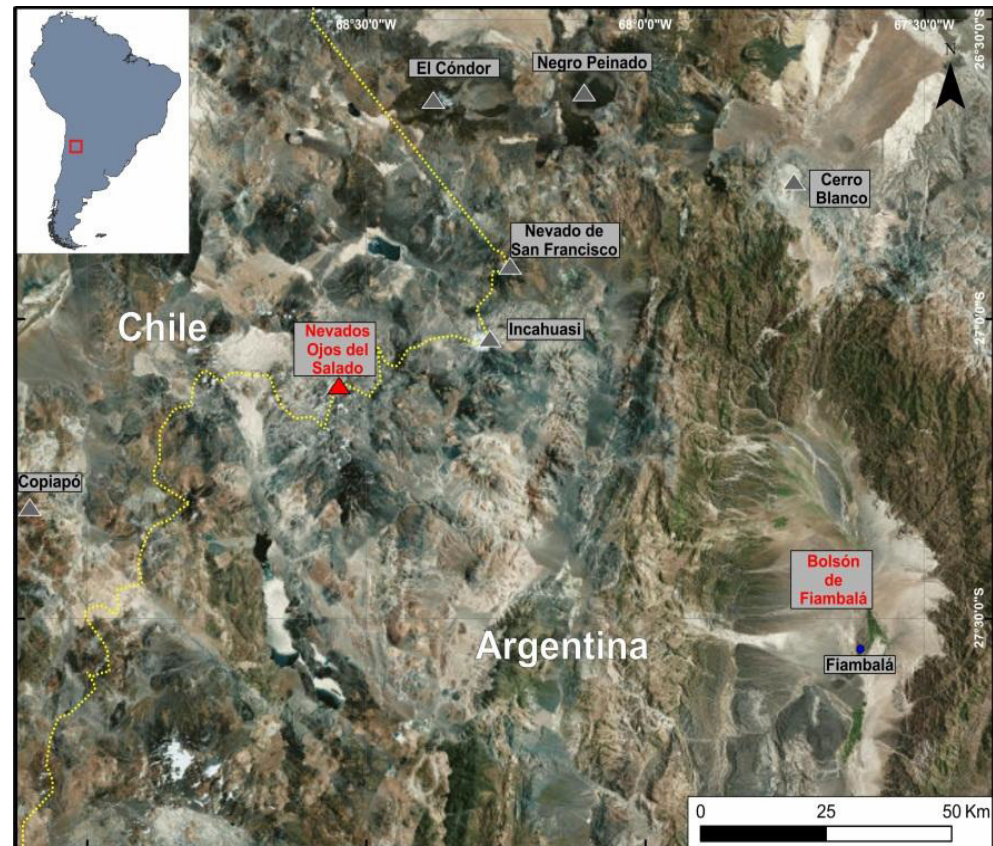
Satellite images uncertainty: eruption or resuspension? The importance of the multidisciplinary approach. The case of June 13th, 2015 Ojos del Salado false volcanic eruption



INTRODUCTION

This event was then analyzed with the collaboration of a solid group that specializes in Central Andes volcanoes.

We arrived to the conclusion that this phenomenon was caused due to resuspension of ancient pyroclastic deposits from the "Bolsón de Fiambalá", located near to the Ojos del Salado volcanic complex

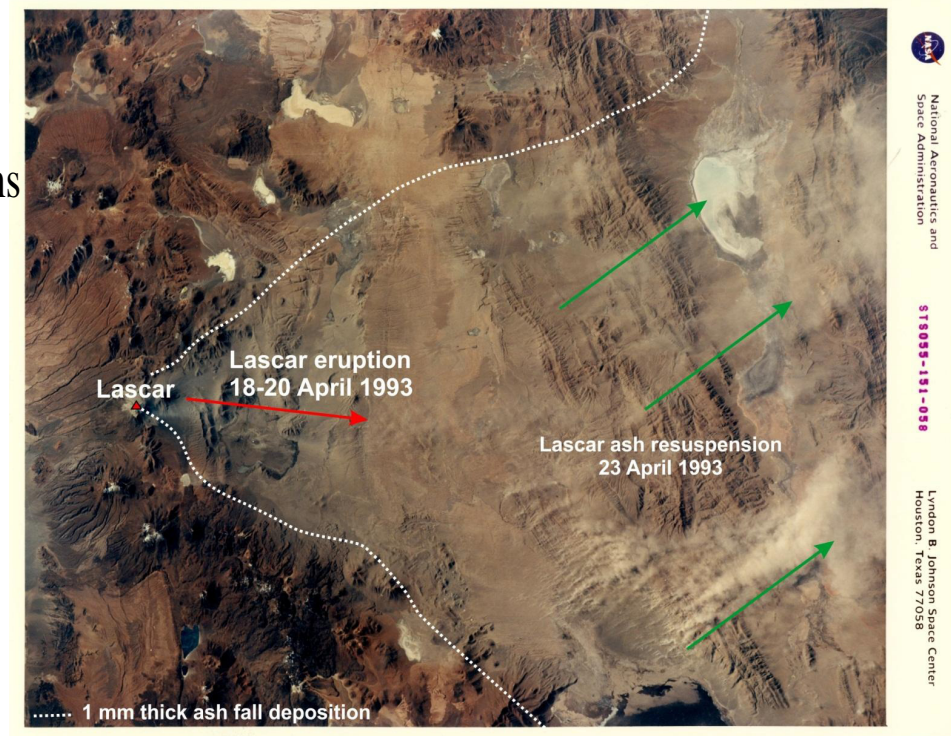


Satellite images uncertainty: eruption or resuspension? The importance of the multidisciplinary approach. The case of June 13th, 2015 Ojos del Salado false volcanic eruption



BACKGROUND

The continuous N-S band of arid and semi-arid terrains extending from the coast of Peru to the coast of Patagonia constitutes an area of dust sources. Particularly, an important dust activity has been identified in the dry areas of the Puna and the Altiplano of Perú, Bolivia and Chile [3].



Given the considerable volcano activity in the Central Andes, remobilization events arising from ancient as well as recent volcanic ash deposits are common in this region. The picture on the right shows ash remobilization at La Puna in 1993, a few days after the Lascar eruption. It should be noted that during the eruption of the Lascar volcano the plume moves to the SE, while lifted ash moves to the NW.



Satellite images uncertainty: eruption or resuspension? The importance of the multidisciplinary approach. The case of June 13th, 2015 Ojos del Salado false volcanic eruption



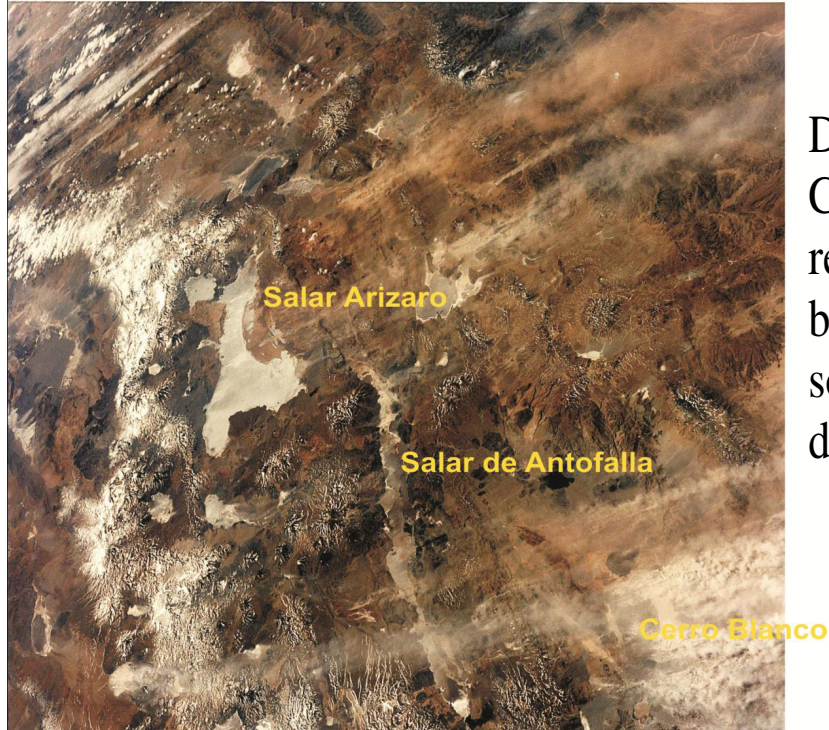
BACKGROUND



National Aeronautics and
Space Administration

S-08-31-0858

Lyndon B. Johnson Space Center
Houston, Texas 77058



Dust storms are frequent phenomena of the Southern Central Andes, which are produced by the remobilization of a variety of superficial material, being the Cerro Blanco deposits one of the main sources. As an example, the picture on the left shows a dust megastorm in the vicinity of Cerro Blanco

Earth observations during space shuttle mission STS - 55: Columbia's mission to planet earth (April 26 - May 6, 1993)

ARTICLE in GEOCARTO INTERNATIONAL 10:67-79 · FEBRUARY 1995

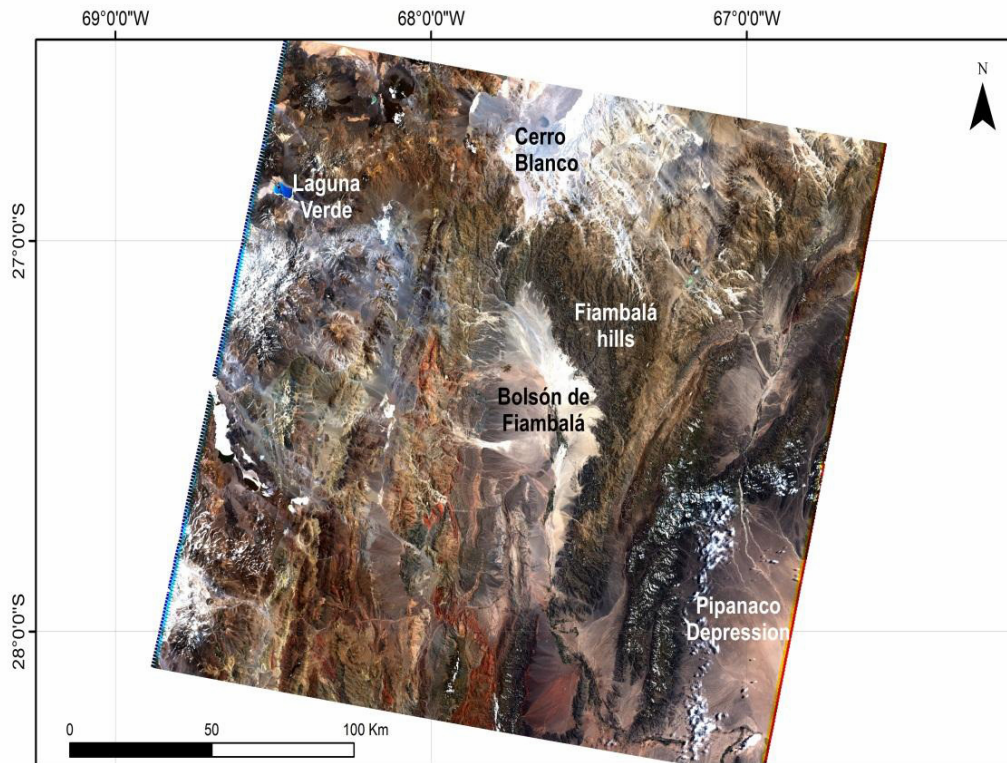


Satellite images uncertainty: eruption or resuspension? The importance of the multidisciplinary approach. The case of June 13th, 2015 Ojos del Salado false volcanic eruption



GEOLOGY

The dunes of the “Bolsón de Fiambalá” are mainly product of the eolian reworked pyroclastic materials originated from the Cerro Blanco strong eruption which occurred about 4500 years ago. That was one of the greatest eruption of the Central Andes during the Holocene. The pyroclastic material remobilized on June 13th, 2015 corresponds to the “Bolsón de Fiambalá” deposit.



The pyroclastic material from Cerro Blanco emerges partly as a primary deposit and partly as a result of eolic rework. At the NW corner of the image appears the ignimbrita “Laguna Verde” which is older than the deposit, and due to its lithologic characteristics it is not a source of dust. It should be mentioned that both exhibit a similar spectral response due to the resemblance in the composition. The western border of the Pipanaco depression, on the SE corner of the image, does not encompass similar material to the “Bolsón de Fiambalá”.



Satellite images uncertainty: eruption or resuspension? The importance of the multidisciplinary approach. The case of June 13th, 2015 Ojos del Salado false volcanic eruption

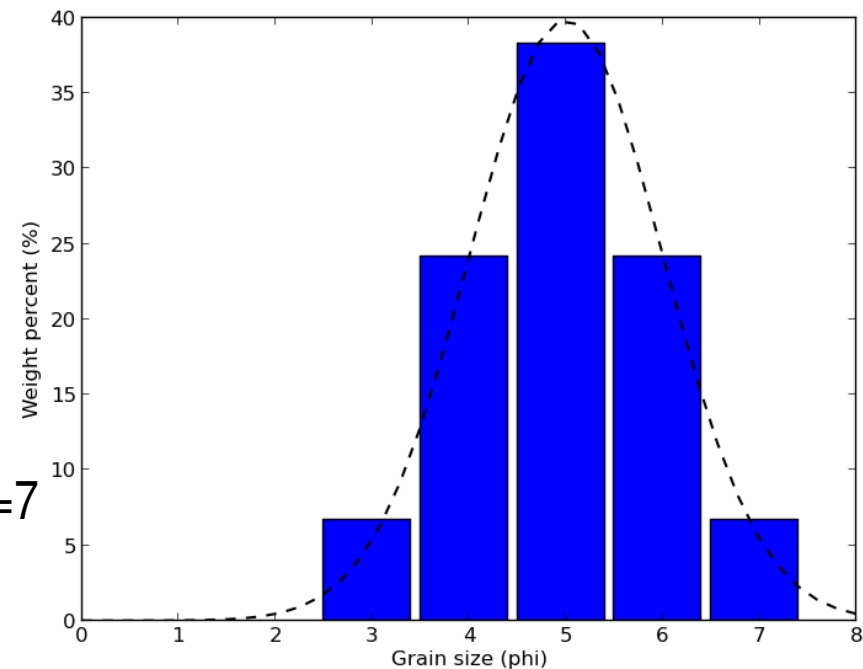


ERUPTION RUN/ Volcanological Input

Firstly, we analyze this as an eruption event, and run the FALL3D [1] in eruption mode using one of the nine eruptive centers Nevados Ojos del Salado as a vent (27.109S, 68.541W, elevation: 6879 m).

Granulometry:

- Supposing a phreatomagmatic eruption (Viramonte, personal comm.)
- Log-Normal distribution
- Parameters: $\phi_{\text{mean}} = 5$ and $\sigma = 1$
- Five particle classes between $\phi = 3$ and $\phi = 7$
- Sulfur dioxide (10%)

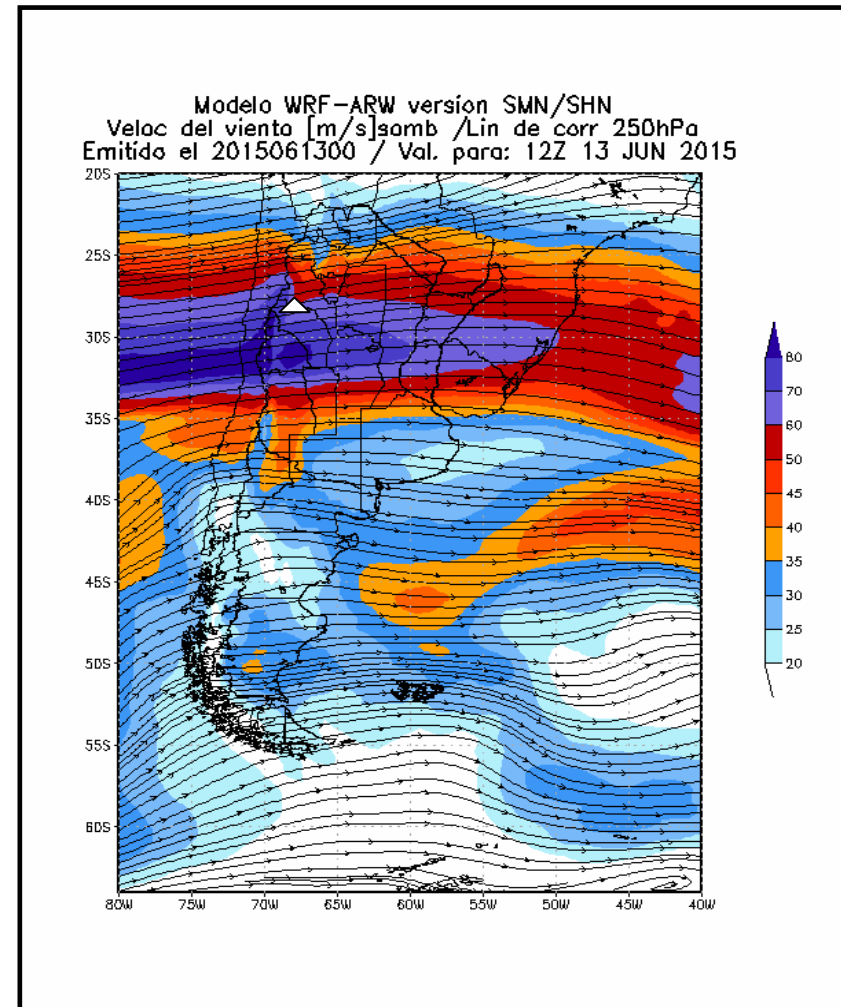


Satellite images uncertainty: eruption or resuspension? The importance of the multidisciplinary approach. The case of June 13th, 2015 Ojos del Salado false volcanic eruption



ERUPTION RUN/Meteorological Driver

- WRF-ARW used as the meteorological driver
- Operational configuration
- Horizontal resolution: 24 km
- 38 vertical levels
- Initial and boundary conditions:
1° Global Forecast System (GFS)



Satellite images uncertainty: eruption or resuspension? The importance of the multidisciplinary approach. The case of June 13th, 2015 Ojos del Salado false volcanic eruption

RESUSPENSION RUN/MODELLING

In the case of FALL3D resuspension run the choice of a suitable scheme depends on data availability

- a) The most complex schemes (e.g. Marticorena MB, Shao and Lu SH) require good data input on thickness and granulometry at the VA deposit; (Model tends to overestimate concentration near the VA deposit sites).
- b) The simplest schemes (e.g. Westphal WE) are more suitable in case of uncertainty of thickness and granulometry



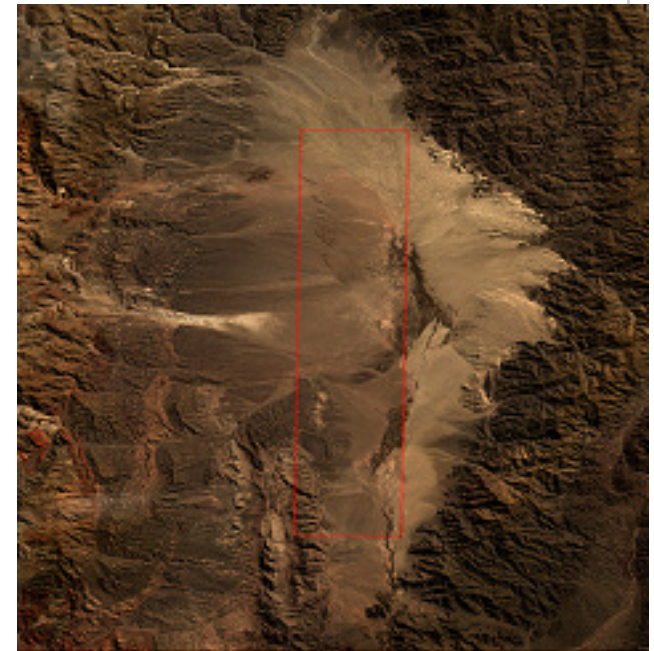
Satellite images uncertainty: eruption or resuspension? The importance of the multidisciplinary approach. The case of June 13th, 2015 Ojos del Salado false volcanic eruption



RESUSPENSION RUN/Emission source

We performed a resuspension run with the FALL3D [1,2] Model considering a set of potential emission sources delimited by a simplified region

In the image it is outlined the “Bolsón de Fiambalá” bottom, which is the emission or deflation area that feeds the Tatón dunes on the East. These dunes climb over the Fiambalá hills and constitute the main storage area.



Bolsón de Fiambalá aprox 27.6667° S, 67.6167° W



Satellite images uncertainty: eruption or resuspension? The importance of the multidisciplinary approach. The case of June 13th, 2015 Ojos del Salado false volcanic eruption

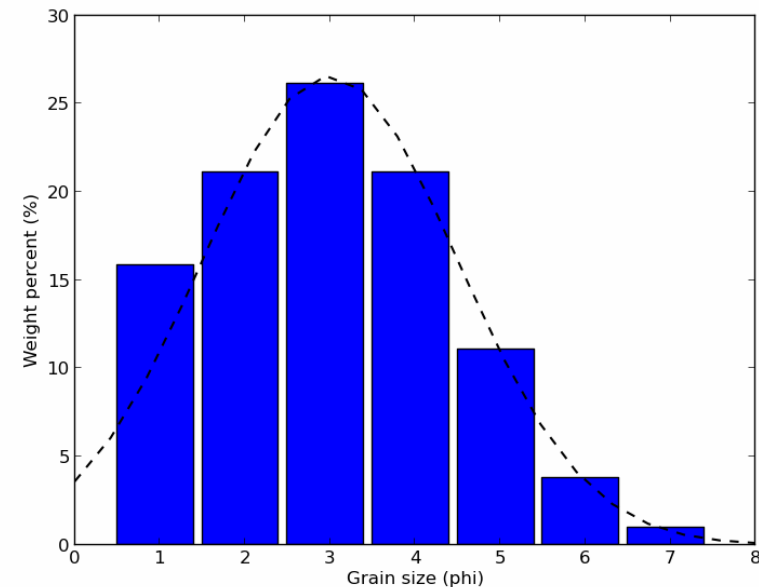


RESUSPENSION RUN/Volcanological Input

Granulometry:

- Log-Normal distribution
- Parameters: $\phi_{\text{mean}} = 3$ and $\sigma = 1.5$
- Seven particle classes between $\phi = 1$ and $\phi = 7$

This is a field granulometry, determined from the existing remobilized deposits



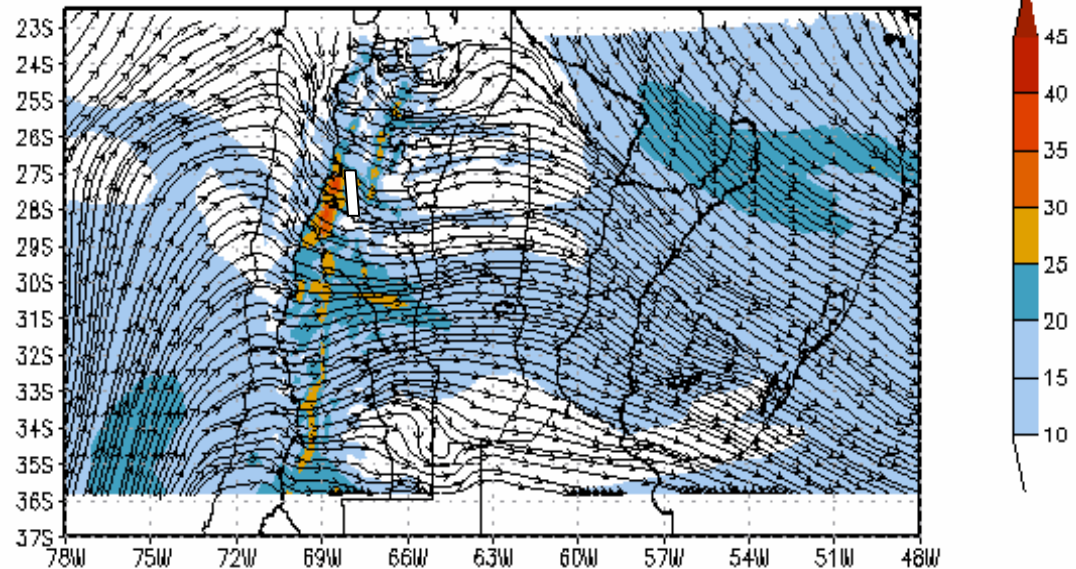
Satellite images uncertainty: eruption or resuspension? The importance of the multidisciplinary approach. The case of June 13th, 2015 Ojos del Salado false volcanic eruption



RESUSPENSION RUN/Meteorological Driver

- WRF-ARW used as the meteorological driver
- Operational configuration
- Horizontal resolution: 12 km
- 38 vertical levels
- Initial and boundary conditions:
0.5° Global Forecast System (GFS)

Modelo WRF-ARW version SMN/SHN
Veloc del viento [m/s] /Lin de corr 700hPa
Emitido el 2015061306 / Val. para: 15Z 13 JUN 2015

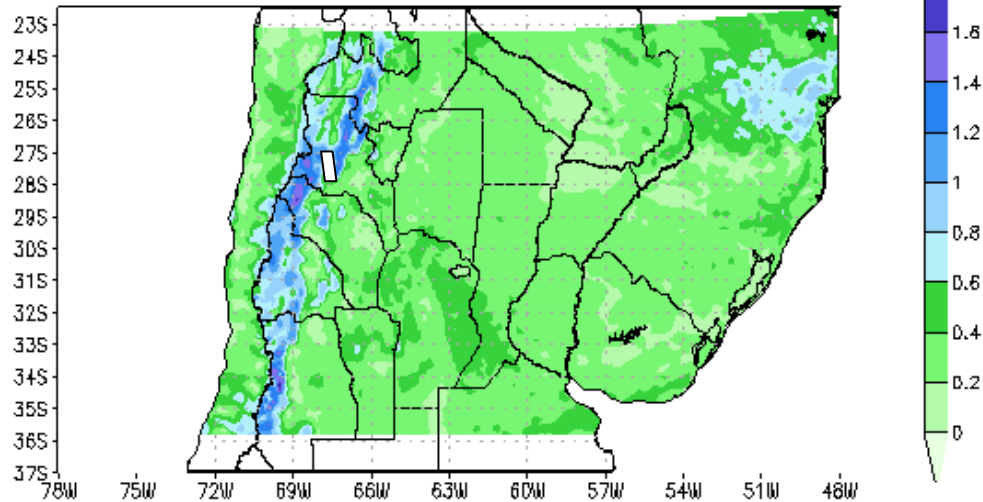


Satellite images uncertainty: eruption or resuspension? The importance of the multidisciplinary approach. The case of June 13th, 2015 Ojos del Salado false volcanic eruption



RESUSPENSION RUN/Meteorological Driver

Modelo WRF-ARW version SMN/SHN
Veloc fric [m/s]somb
Emitido el 2015061306 /Val. para: 15Z 13 JUN 2015



- FALL3D Emission flux is calculated according to Marticorena scheme [1,2], friction velocity dependent
- The emission is possible when the friction velocity exceeds a critical value of around 0.4-0.8 m/s



Satellite images uncertainty: eruption or resuspension? The importance of the multidisciplinary approach. The case of June 13th, 2015 Ojos del Salado false volcanic eruption



RESUSPENSION RUN/SEVIRI

The SEVIRI images were processed using python packages from PyTROLL project.

The DUST product is a RGB algorithm using brightness temperature from IR 8.7, 10.8 y 12um. After a GAMMA correction was applied.

The Dust RGB image composite:

Channels	Temp.	Gamma
IR12.0 - IR10.8	-4 to 2 K	1
IR10.8 - IR8.7	0 to 15 K	2.5
IR10.8	261 to 289 K	1



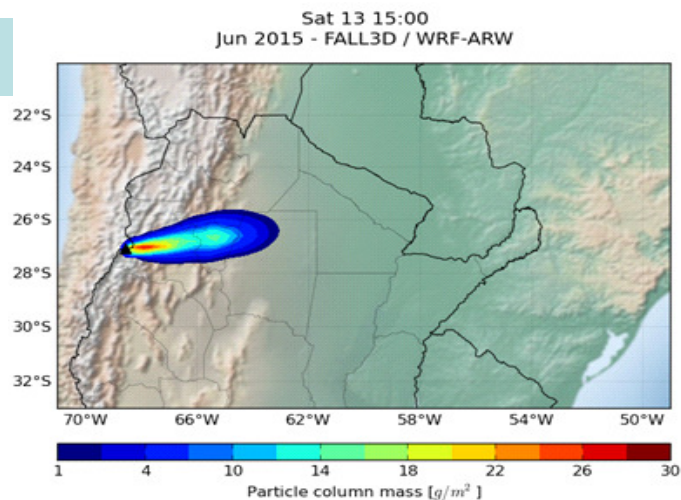
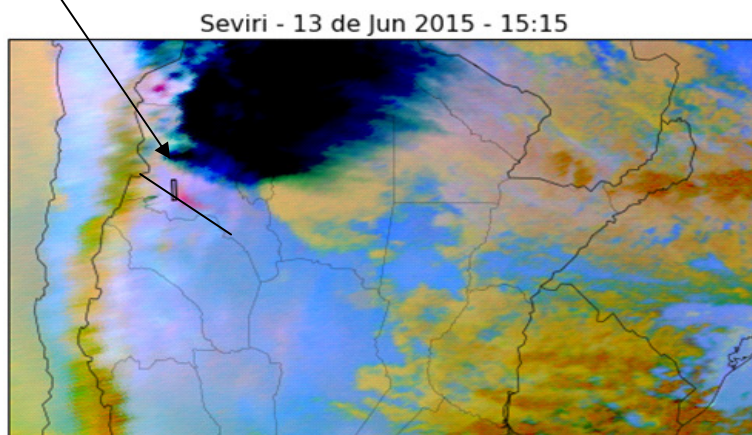
Satellite images uncertainty: eruption or resuspension? The importance of the multidisciplinary approach. The case of June 13th, 2015 Ojos del Salado false volcanic eruption



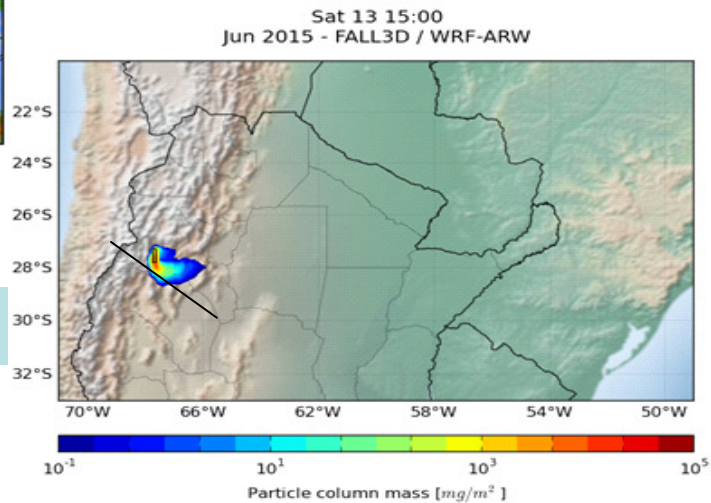
RESULTS/ Initial Time

Emission source

Eruption Run



Resuspension Run



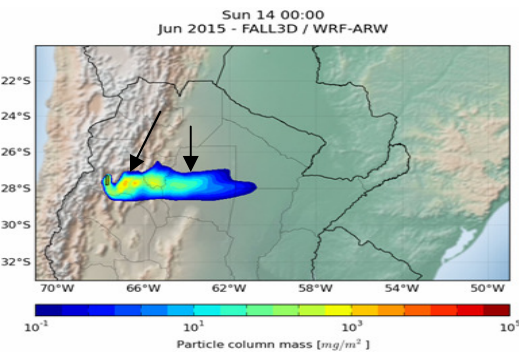
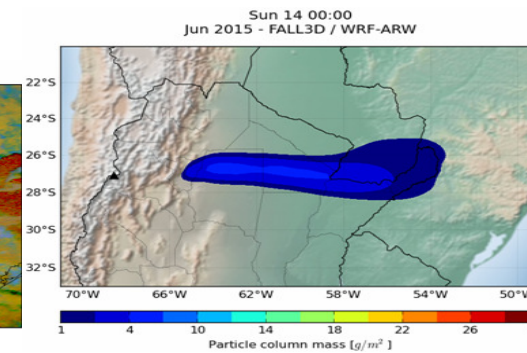
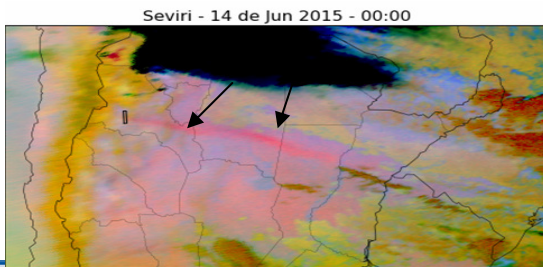
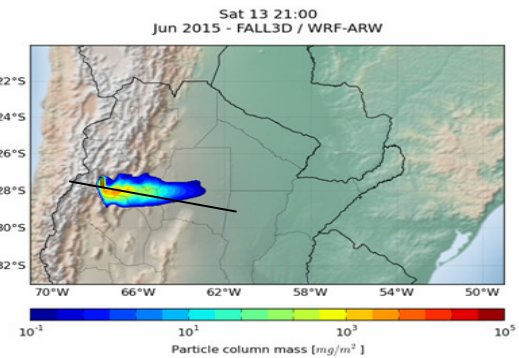
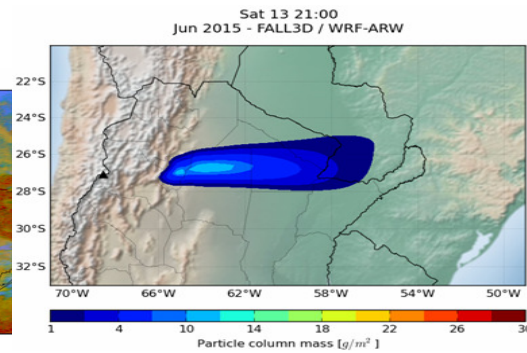
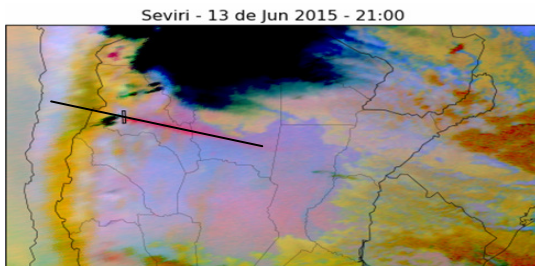
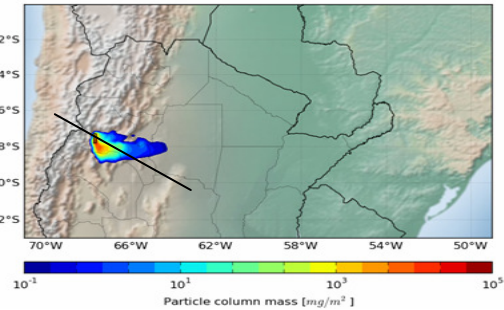
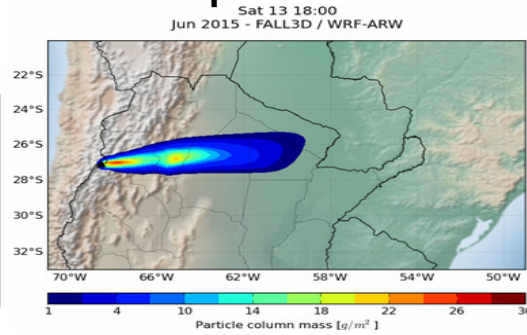
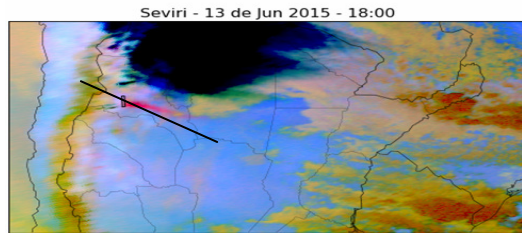
Satellite images uncertainty: eruption or resuspension? The importance of the multidisciplinary approach. The case of June 13th, 2015 Ojos del Salado false volcanic eruption



RESULTS/Development

Eruption Run

Resuspension Run



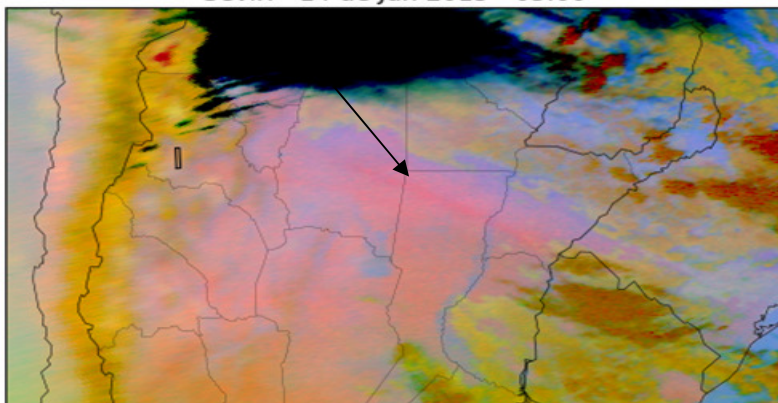
Satellite images uncertainty: eruption or resuspension? The importance of the multidisciplinary approach. The case of June 13th, 2015 Ojos del Salado false volcanic eruption



RESULTS/Final Time

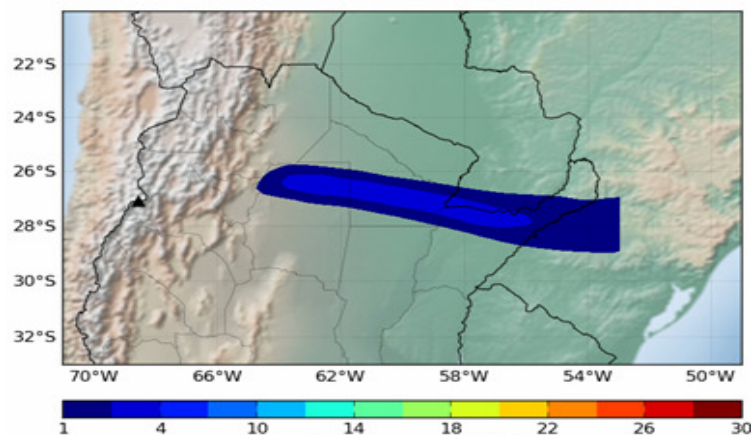
Eruption Run

Seviri - 14 de Jun 2015 - 03:00

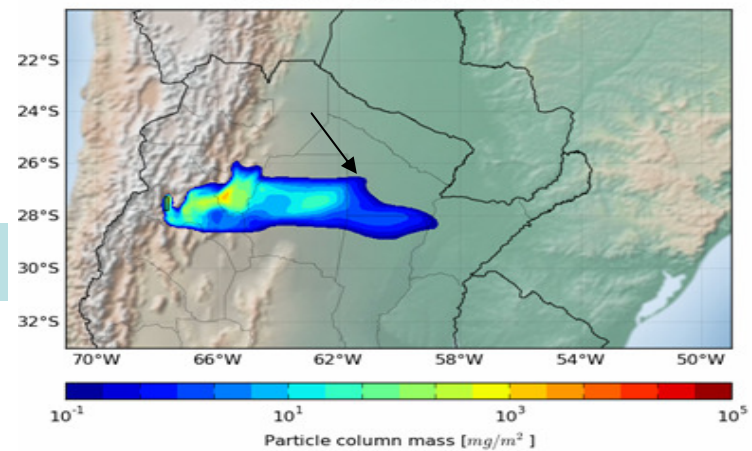


Resuspension Run

Sun 14 03:00
Jun 2015 - FALL3D / WRF-ARW



Sun 14 03:00
Jun 2015 - FALL3D / WRF-ARW



Satellite images uncertainty: eruption or resuspension? The importance of the multidisciplinary approach. The case of June 13th, 2015 Ojos del Salado false volcanic eruption



CONCLUSIONS/FUTURE PLANS

- ❖ The complexity of the event, considered as a purely meteorological case by VAAC Buenos Aires' operators at first sight, triggered a full thorough investigation that involved researchers from five Institutions of Argentina and Spain, achieving surprising results.
- ❖ Cases like the successful VAAC London – VAAC Buenos Aires' collaboration will be enhanced and facilitated in the near future by a Volcanic Ash Advisory Center (VAAC) Common webpage focused on the sharing of relevant information/products amongst the 9 (nine) VAACs around the world.



Satellite images uncertainty: eruption or resuspension? The importance of the multidisciplinary approach. The case of June 13th, 2015 Ojos del Salado false volcanic eruption



CONCLUSIONS/FUTURE PLANS

- ❖ There is a considerable amount of pyroclastic deposits along the Andes and they are the source of frequent ash/dust storms or remobilization processes that could be masked as an eruption.
- ❖ One of the main conclusions from this experiment is the strong need of a multidisciplinary approach in order to be conclusive.
- ❖ The next step is to perform experiments increasing the spatial resolution of the meteorological driver and consequently of the FALL3D, in order to better simulate the whole area of emission of the “Bolsón de Fiambalá”.



Satellite images uncertainty: eruption or resuspension? The importance of the multidisciplinary approach. The case of June 13th, 2015 Ojos del Salado false volcanic eruption



CONCLUSIONS/FUTURE PLANS

- ❖ Compilation of ash volcanic deposits (ancient and recent) to be included in our database **VORHISE** (**VO**lcanes activos de la **Re**gión y su **HIS**toria **E**ruptiva)
- ❖ Compilation of resuspension events
- ❖ Use of more complex schemes emission
- ❖ Improve characterization of deposits



Satellite images uncertainty: eruption or resuspension? The importance of the multidisciplinary approach. The case of June 13th, 2015 Ojos del Salado false volcanic eruption



REFERENCES

1. Folch, A., Costa, A. y Macedonio, G. 2009. FALL3D: a computational model for transport and deposition of volcanic ash, *Computers and Geosciences*, 35: 1334–1342
2. Folch, A., Mingari, L., Osores, M.S. and Collini, E. 2013. Modeling volcanic ash resuspension—application to the 14–18 October 2011 outbreak episode in Central Patagonia, Argentina. *Natural Hazards and Earth System Sciences*, 14, 119-133.
3. Gaiero, D. M., L. Simonella, S. Gassó, S. Gili, A. F. Stein, P. Sosa, R. Becchio, J. Arce, and H. Marelli, (2013), Ground/satellite observations and atmospheric modeling of dust storms originating in the high Puna-Altiplano deserts (South America): Implications for the interpretation of paleoclimatic archives, *J. Geophys. Res. Atmos.*, 118, 3817–3831



Satellite images uncertainty: eruption or resuspension? The importance of the multidisciplinary approach. The case of June 13th, 2015 Ojos del Salado false volcanic eruption



ACKNOWLEDGMENTS

The WRF/ARW-FALL3D resuspension mode run in a server installed at the Servicio Meteorológico Nacional (SMN) of Argentina with funds from the Argentinean Project PIDDEF 41/10: “Pronóstico del tiempo para estudios de vulnerabilidad e impacto socioeconómico”.

The FALL3D eruption mode run at Mendieta Cluster from CCAD-UNC, which is part of SNCAD-MinCyT, Argentina.

The images from Seviri were provided by Diego Souza from National Institute for Space Research (INPE), Center for Weather Forecast and Climate Studies (CPTEC), Satellite Division and Environmental Systems (DSA), Brazil.



Satellite images uncertainty: eruption or resuspension? The importance of the multidisciplinary approach. The case of June 13th, 2015 Ojos del Salado false volcanic eruption



RESUSPENSION/Research underway



This is the emission region that in case of strong winds we think is the main source of emission and whose modeling is underway.



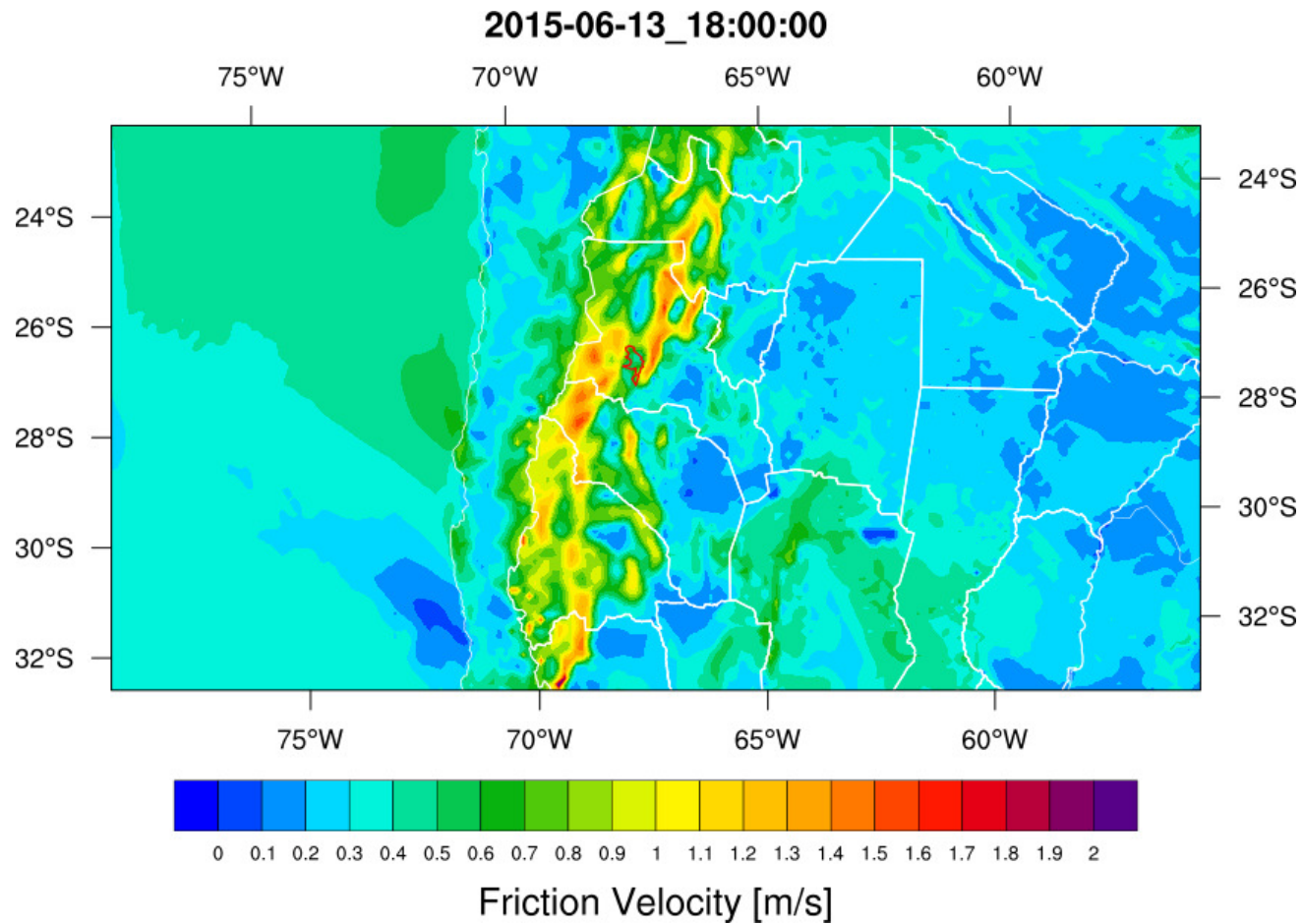
Satellite images uncertainty: eruption or resuspension? The importance of the multidisciplinary approach. The case of June 13th, 2015 Ojos del Salado false volcanic eruption



RESUSPENSION/Research underway

Nesting in WRF

“Bolsón de Fiambalá” case



Satellite images uncertainty: eruption or resuspension? The importance of the multidisciplinary approach. The case of June 13th, 2015 Ojos del Salado false volcanic eruption

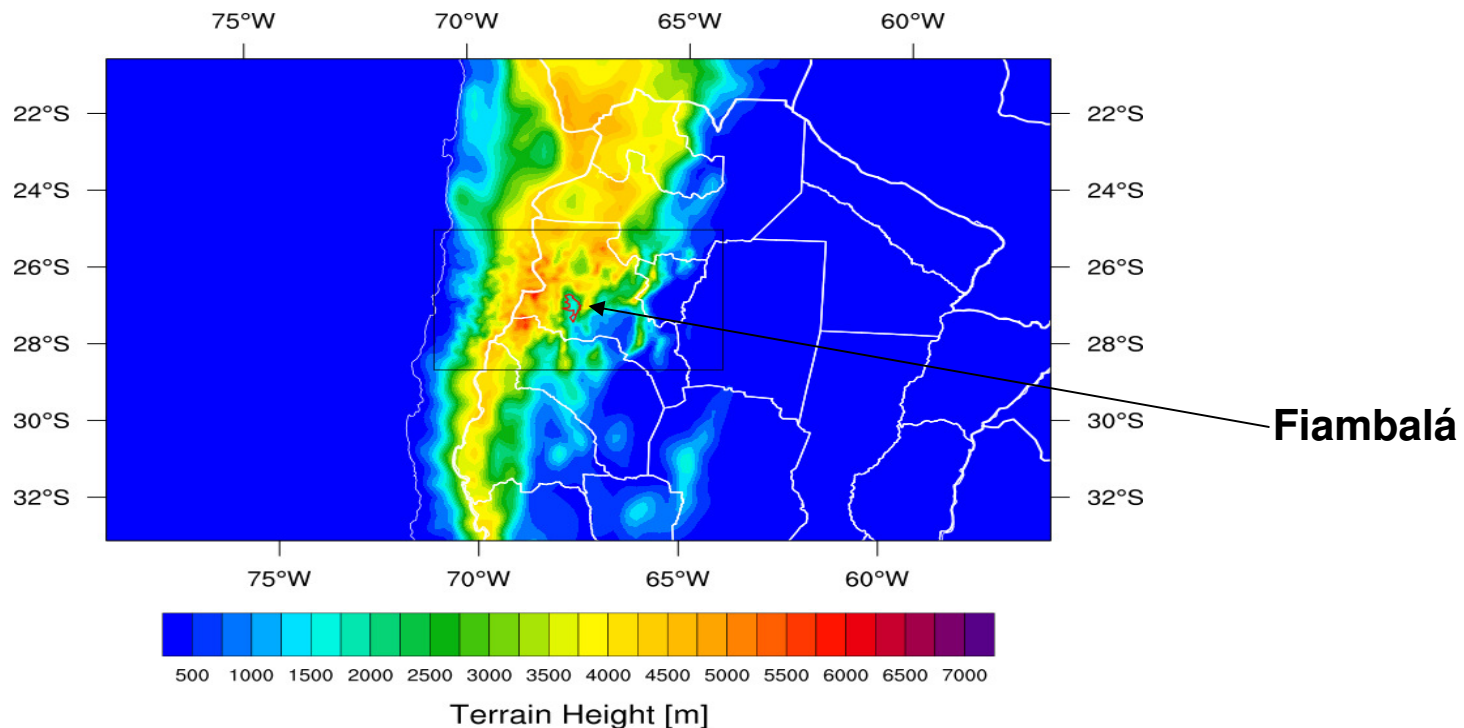


RESUSPENSION/Research underway/Nested Model Run

High resolution for a smaller domain around the “Bolsón de Fiambalá” (6 km-resolution)

Two-way nesting: Information exchange between the large domain and the nested domain is two-way

Multiple input files: each domain with a full input data file



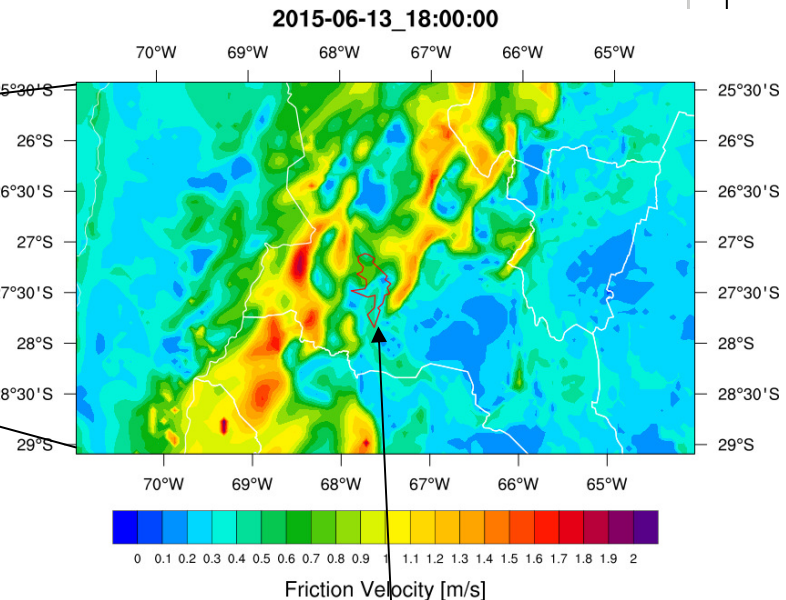
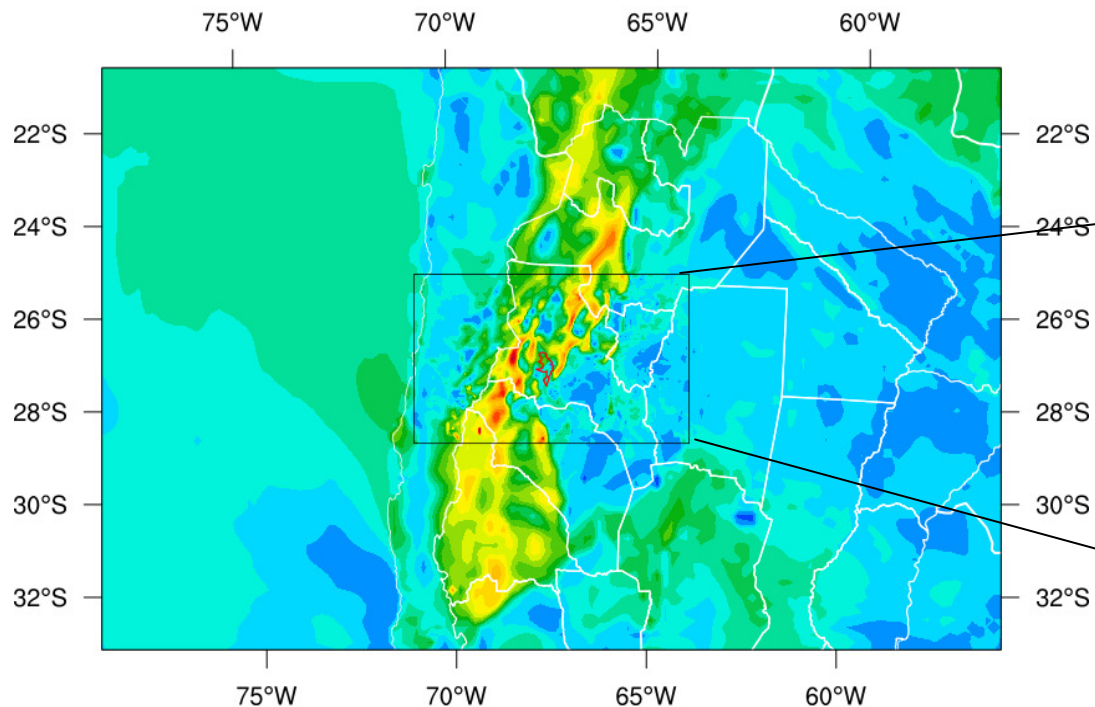
Satellite images uncertainty: eruption or resuspension? The importance of the multidisciplinary approach. The case of June 13th, 2015 Ojos del Salado false volcanic eruption



RESUSPENSION/Research underway/Nested Model Run

2015-06-13_18:00:00 - 2015-06-13_18:00:00

Inner-most domain (6km)



More detail in the potential emission area!



Satellite images uncertainty: eruption or resuspension? The importance of the multidisciplinary approach. The case of June 13th, 2015 Ojos del Salado false volcanic eruption



MANY THANKS



Satellite images uncertainty: eruption or resuspension? The importance of the multidisciplinary approach. The case of June 13th, 2015 Ojos del Salado false volcanic eruption

