Servicio Meteorológico Nacional
Argentina

Quantitative Volcanic Ash Information at the Buenos Aires VAAC: Developments and Tests to achieve the Initial Operating Capabilities.

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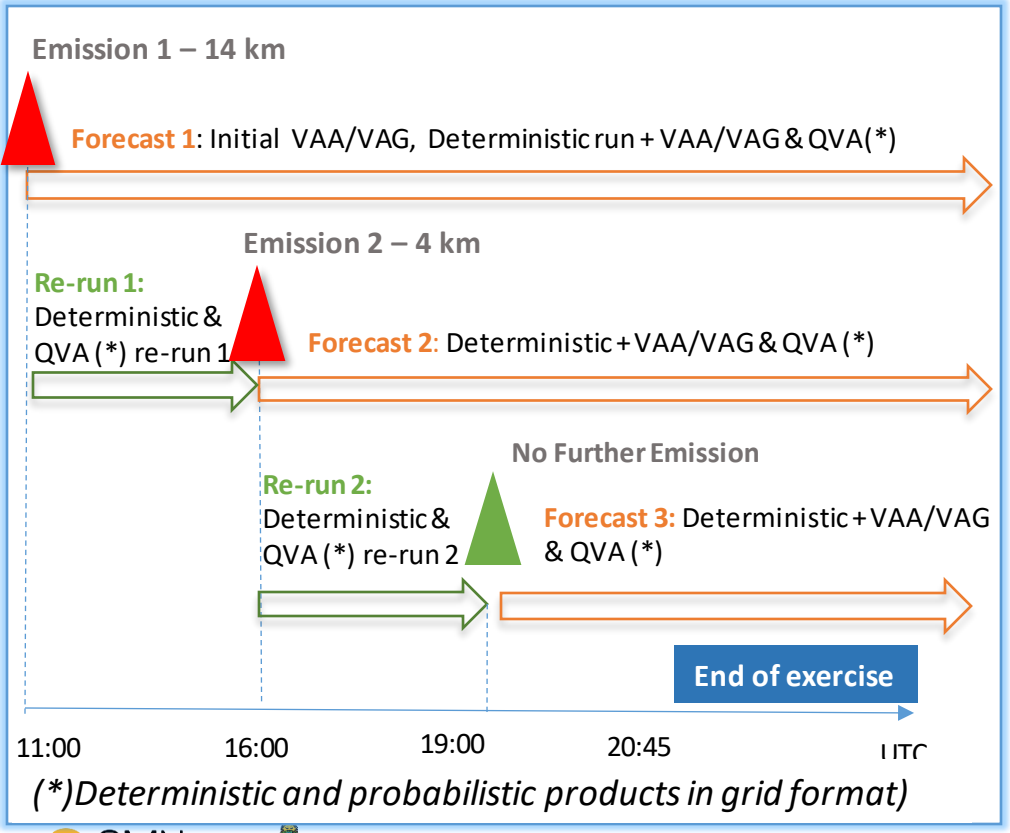
FALL3D model in VAAC Buenos Aires

- FALL3D is an Eulerian model for atmospheric passive transport and deposition of volcanic ash (tephra) and other substances (Folch et al. 2020).
- Since 2009 we run the FALL3D model, several degree and PhD theses were done in collaboration with Dr. Arnau Folch (BSC/CSIC) and also used the model in real-time.
- To produce QVA information we are working with FALL3D-v8.1 model (Folch et al., 2021).
- Version 8.1 includes the capability to consider uncertainties in the Eruption

  Source Parameters, particle properties, and meteorological fields to produce ensemble-based runs.
- FALL3D ensemble post-processing produces mean, spread, and relative frequency of exceeding user-defined thresholds for ash mass loading and concentration.
- During the last two years and in order to achieve QVA information complying with the Initial Operational Capabilities required by ICAO, some tests were performed in collaboration with other institutions.

First exercise of QVA production - December 2021

Exercise timeline

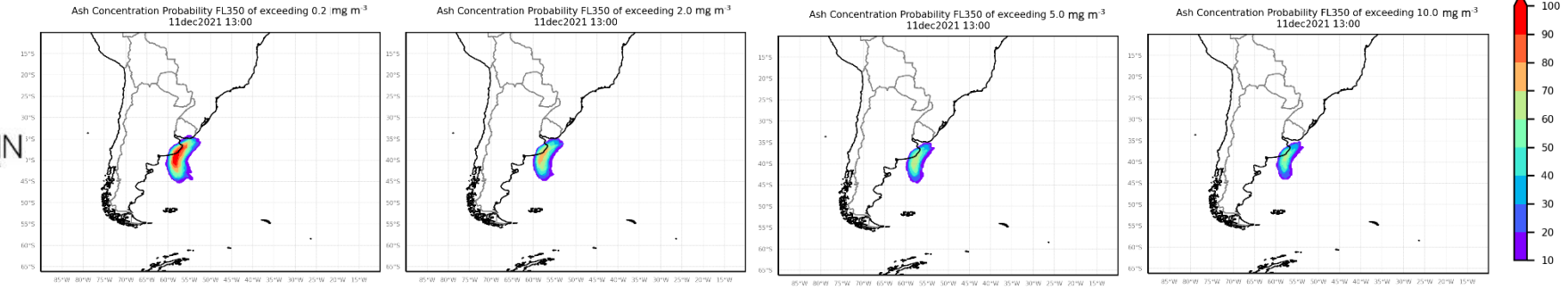


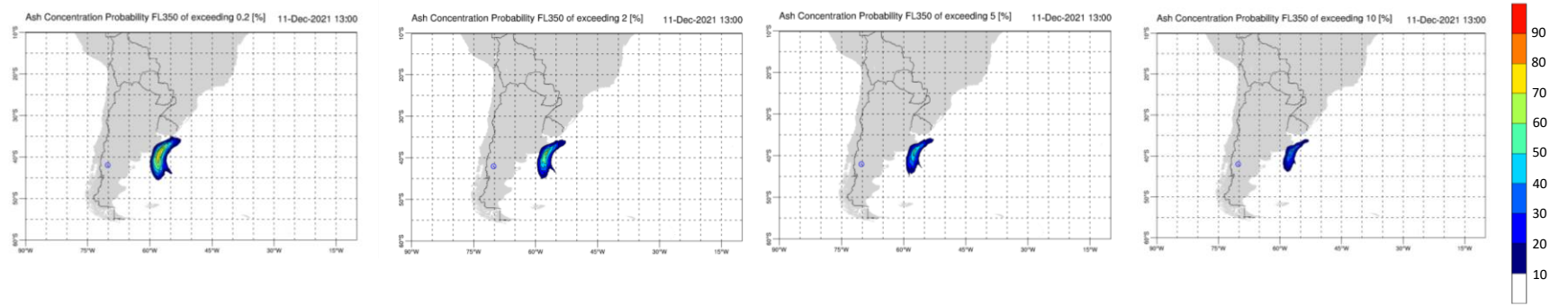
Model	FALL3D 8,1 (Folch et al., 2020)	
Meteorological fields	GFS 0,25 (cycles 06,12,18)	
Horizontal Resolution	0,25°	0,15°
Vertical resolution (top 20 km)	20 layers	50 layers
Temporal resolution	1 hour	1 hour
Ensemble members	20 (H, emission shape, V)	48
Hardware	100 cores	2304 cores
24 hours forecast	17 minutes (forecast) 6 minutes (Re-run)	19 minutes

First exercise of QVA production - December 2021

At every time step:

- 48 Ash concentration charts of probability of exceeding thresholds (12 vertical layers x 4 thresholds)
- 12 Ash concentration (Deterministic)





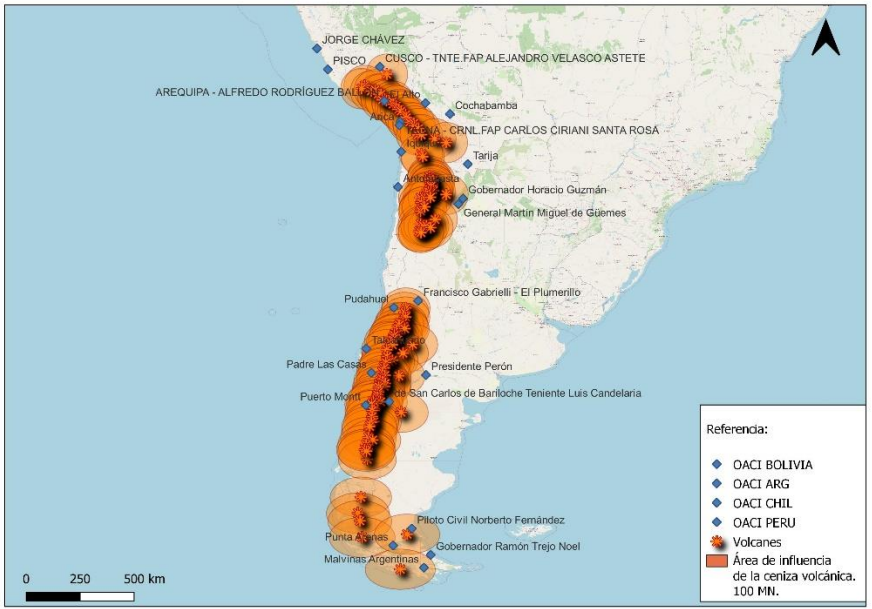
The differences in resolution and number of members explain the differences

Criteria for issuing QVA analysis in VAAC Buenos Aires AoR

Guidance on the criteria for issuing QVA by a VAAC: Vertical extent of ash cloud to at least FL 300, and/or ash cloud within (or expected to move within) approximately 100 nm of a commercial aerodrome, or when requested by ACC or airline operator. Exceptions for quality control assessment and discretion by the VAAC.

Considering:

- Aerodromes from FASID table AOP in VAAC BA AoR
- Volcanoes within 100 nm from aerodromes



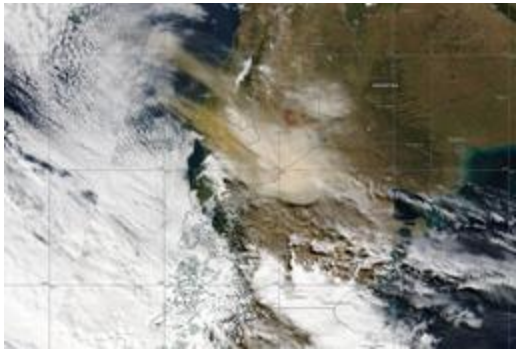
63/144 (44%) of the volcanoes in VAAC Buenos Aires AoR has at least one commercial aerodrome within 100 nm.

QVA test for Calbuco eruption

On 22nd to 23rd April 2015 Calbuco Volcano (Chile) erupted, and produced column heights that reached 15-20 km height (Vidal et al., 2017).

This eruption was modeled with FALL3D-8.1 and compared with polar satellite and in-situ data.

AQUA for 23/04/2015 at 18:35 UTC

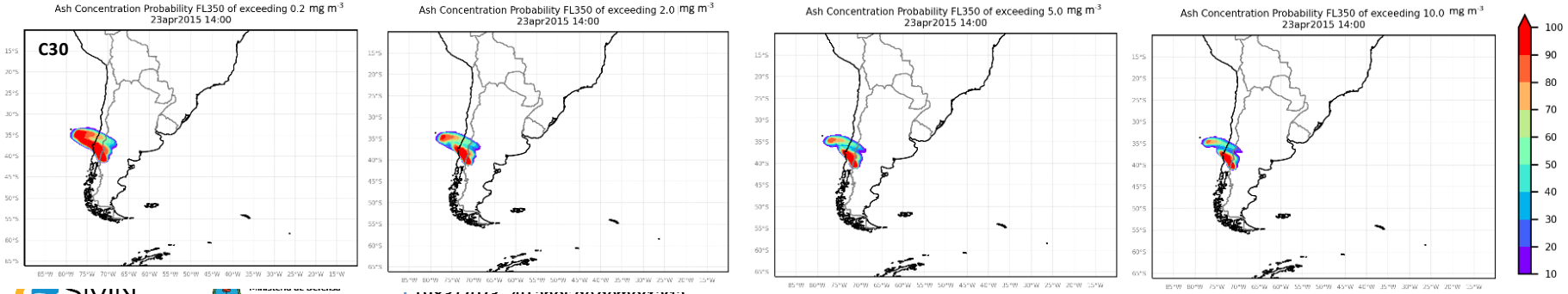


Meteorological Driver: GFS 0.25 (00, 6, 12,18 UTC cycles)

Members: 20

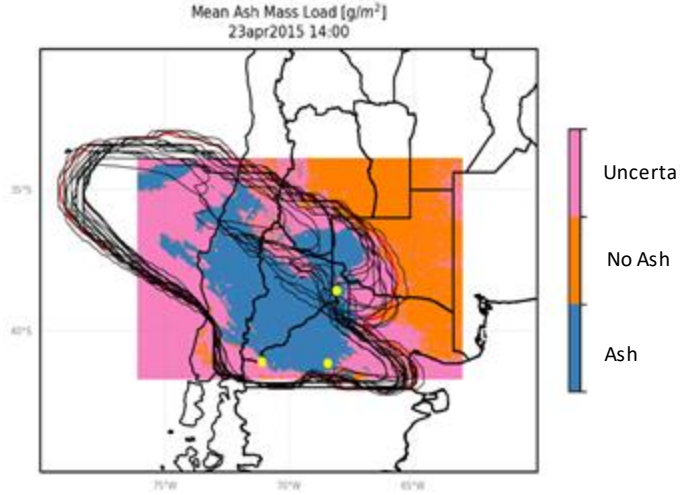
Parameters	C10	C20	C30
H (rel)	10%	20%	30%
Suzuki-A (abs)	2		
Wind (rel)	20%		

Based on previous sensitivity studies (Osores, 2017)



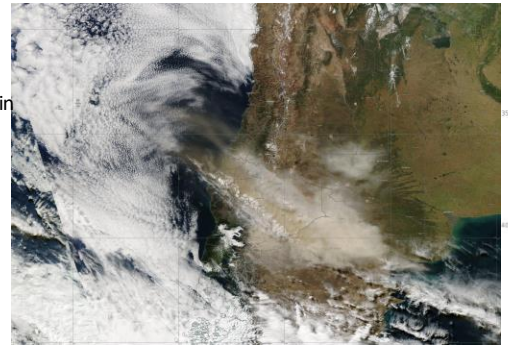
Osores et al., 2022

QVA test for Calbuco eruption

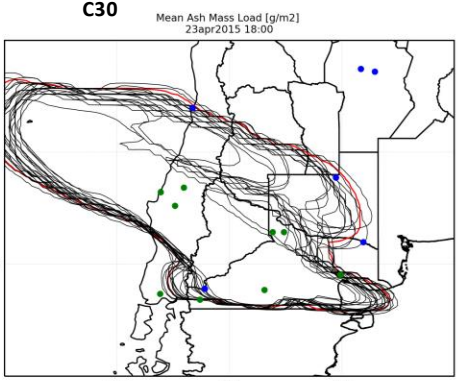


(Satellite classification Rodriguez et al., 2018)

AQUA Modis - 23Apr2015 - 18:35 UTC



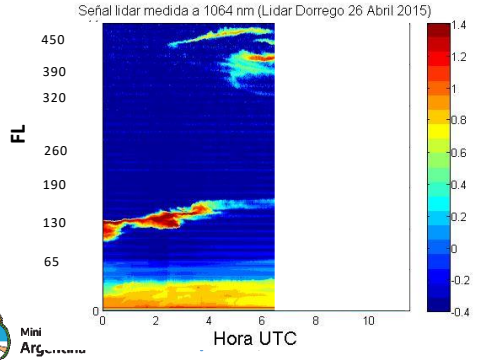
C30



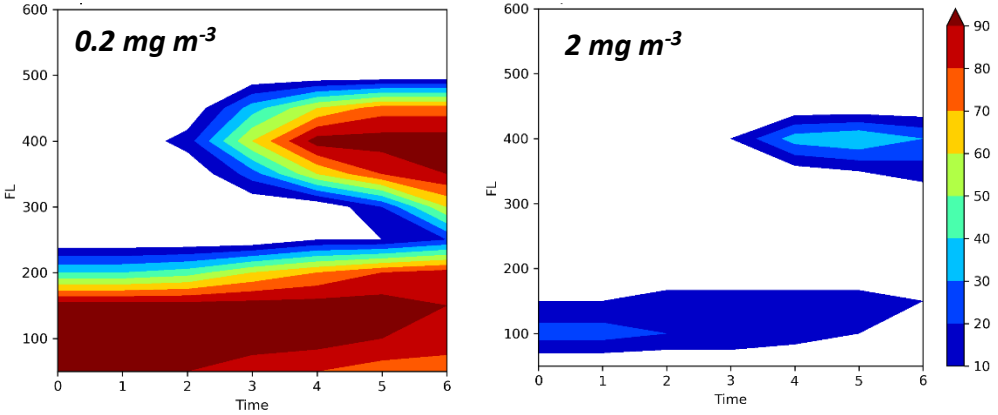
Osores et al., (2022)

Ash mass load members (0,2 g m-2 black contours), Mean ash mass load 0,2 g m-2 red contours), SYNOP - smoke or va (point green) and- dust or haze/fog (point blue)

LIDAR image Provided by Pablo Ristori from CITEDEF



Ash Concentration relative frequency of exceeding the threshold



Osores et al., (in prep)

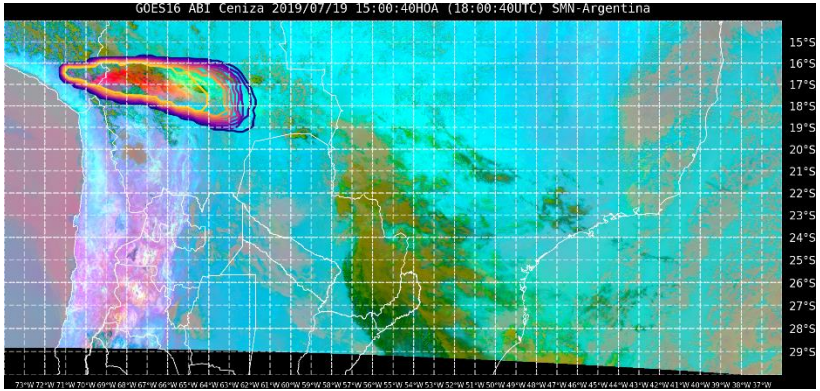
QVA test for Ubinas eruption

On 19th July 2019 Ubina Volcano (Perú) erupted, and produced column heights that reached 16-18 km height.

This eruption was modeled with FALL3D 8.1 and compared with GOES-16 and NOAA-20 satellite images.

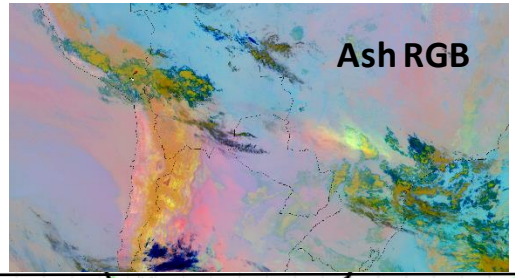
19jul2019 16:00 UTC

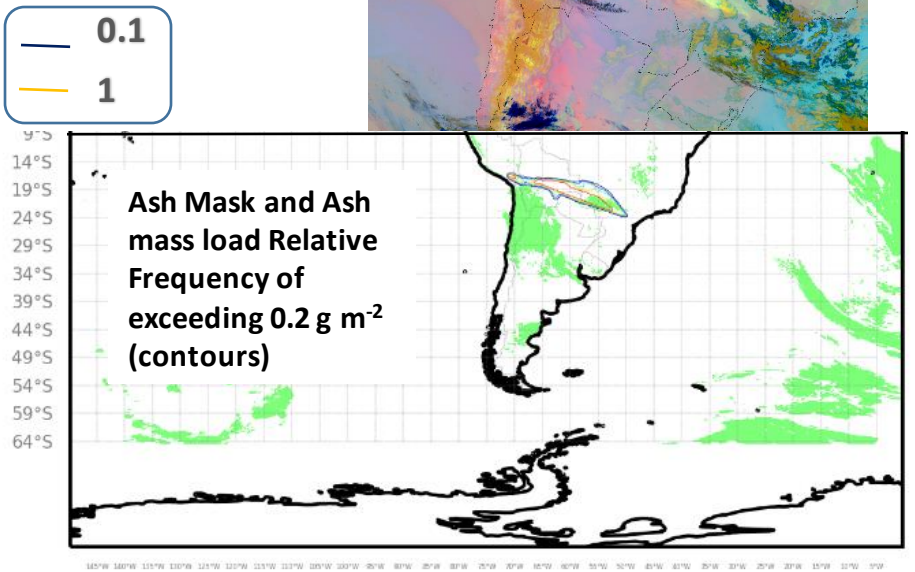
Ash mass load Relative Frequency of exceeding 0.2 g m^{-2} (contours)



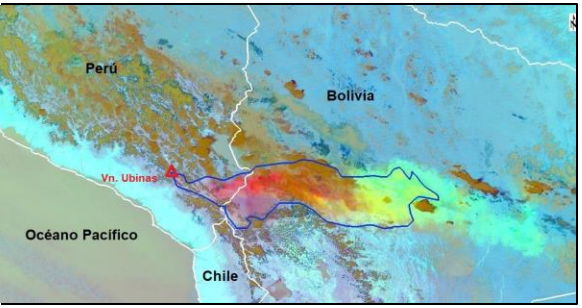
Osores et al., (2023)

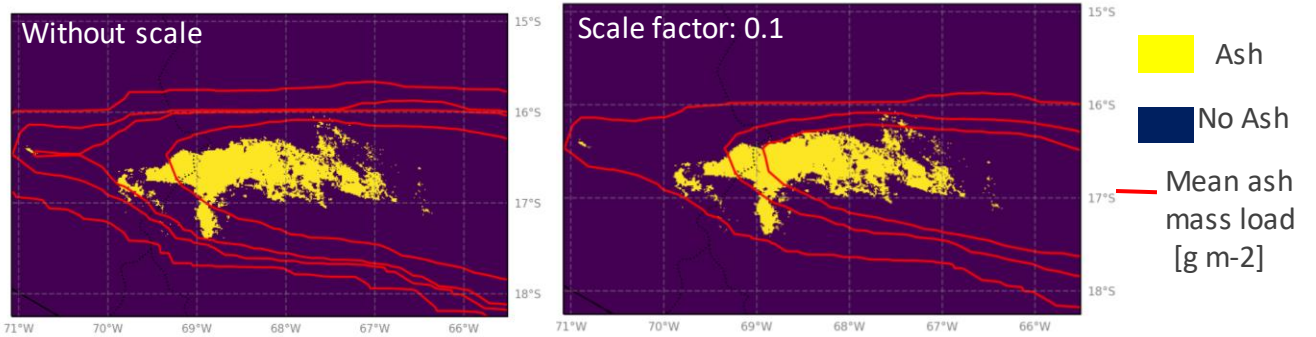
20 July 06:00 UTC





QVA test for Ubinas eruption





	Mean Ash Mass Load ≥ 0.2 g m^{-2}				Ash Mass Load relative Frequency of exceed. 0.2 g m-2
Scale	**Accuracy**	**Bias**	**POD**	**FAR**	**Brier Score**
1	0.52	8.69	1	0.88	0.37
0.1	0.69	5.91	0.98	0.83	0.13

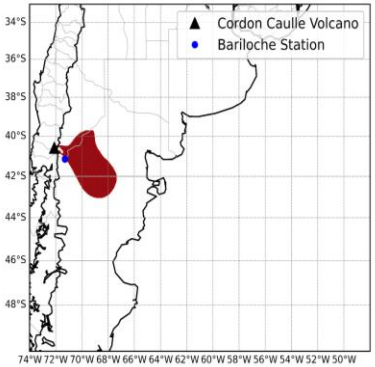
ACC perfect=1
POD perfect=1
FAR perfect=0
BIAS perfect=1
Brier Score perfect =0

All the indexes, particularly FAR and BIAS, are skewed due to the lack of a filter for uncertain pixels due to the presence of a meteorological cloud.

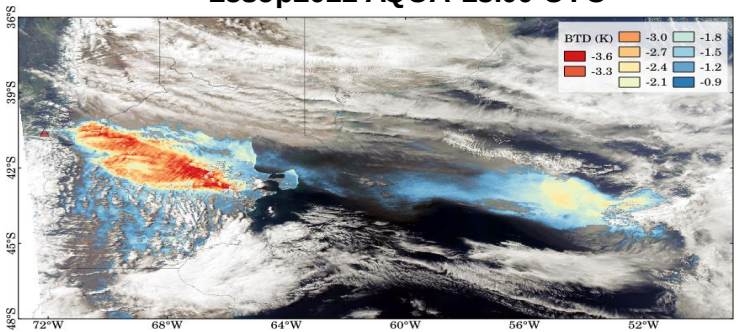
Osores et al., (2023)

R&D Cordón Caulle - Resuspension

On 24 to 25 September 2011 a resuspension event occurred due to the remobilization of the deposits of the Cordon Caulle Volcano (Chile). This event was modeled with FALL3D and compared with AQUA satellite.

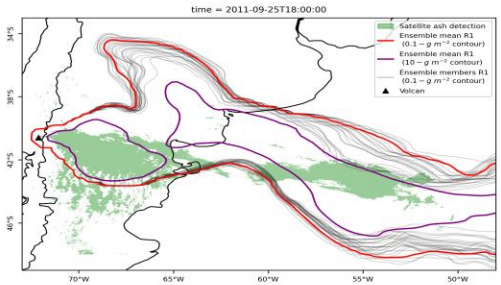


25sep2011 AQUA 18:00 UTC

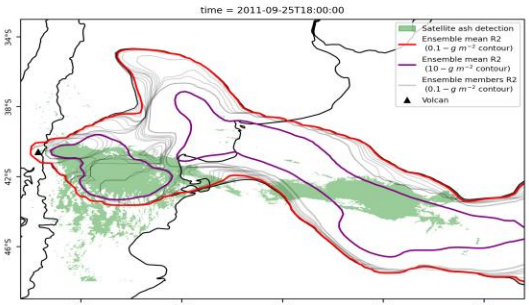


Experiments	U (m s^{-1})	V (m s^{-1})	u*$_{th}$ (m s^{-1})
R1			
R2			
R3			

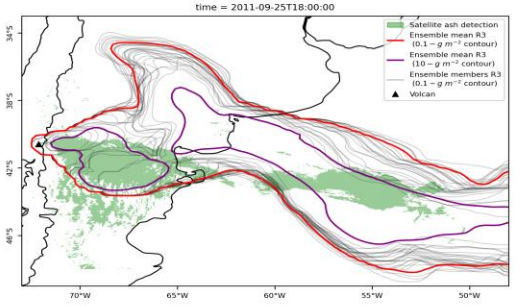
R1



R2



R3



Vazquez et al., (2022) - Phd co-directed with Dr. Leonardo Mingari

Next steps to produce QVA in Nov 2024

- Adquisition of a new cluster to run the model
- Adequate the output to the final IOC requirements, such as layer concentration instead of concentration at certain level
- IWXXM production
- Forecasters training
- Users workshop

R&D

- Improve satellite classification including meteorological cloud classification.
- Improve numerical results using satellite and ground data in an objective base.
- Include more sophisticated and realistic emission schemes wich will introduce more variability to the ensemble
- Analyze the sensitivity of the new pertubed parameters

Thanks for your attention

Questions?

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