

The April 2015 eruption of Calbuco volcano, Southern Chile

**7th WMO Volcanic ash Seminar
October 2015
Anchorage**



**Gobierno
de Chile**

Álvaro Amigo +

D. Bertin, L. Lara, F. Bucchi, C. Cardona

National Network for Volcanic Surveillance
Geological Survey of Chile
SERNAGEOMIN



I. The national network for volcano surveillance (RNVV)

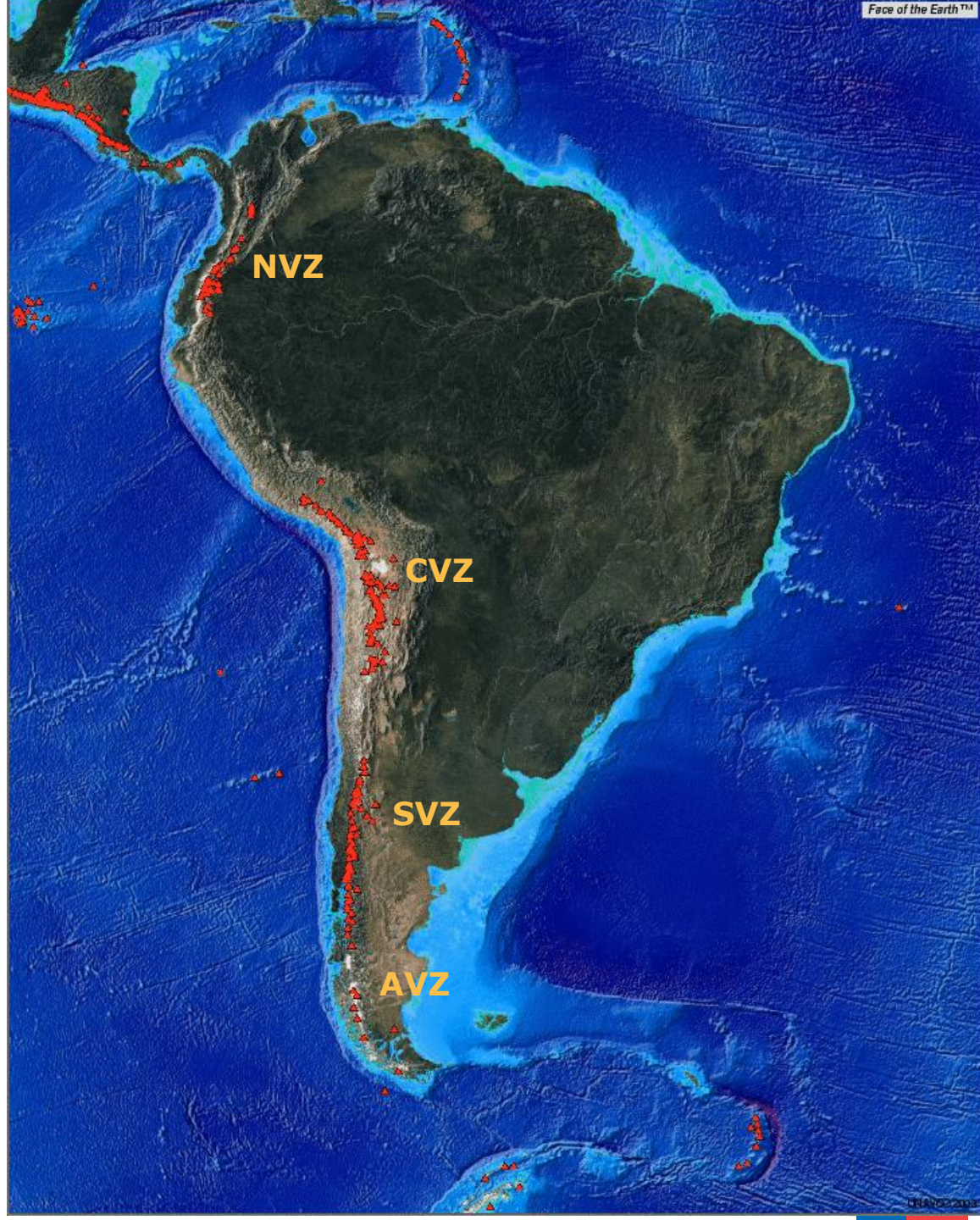
II. Calbuco eruption 2015

In Chilean territory there are **89** volcanoes geologically active (Easter Island is considered but not volcanoes in Antarctica)

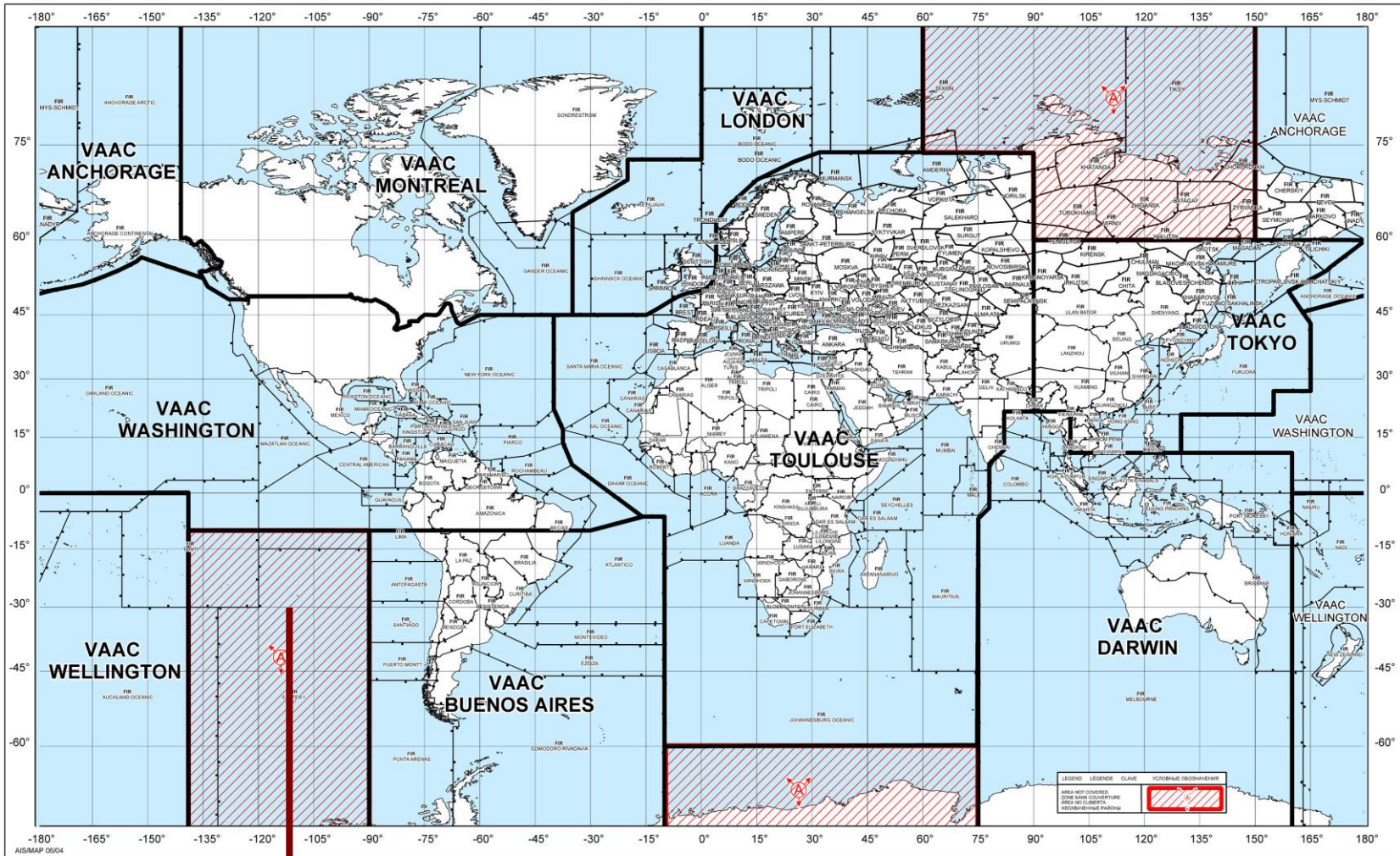
Roughly **16%** of the continental territory is directly threatened by volcanic eruptions and even **ca. 50%** could be affected in some way.

Since the **XVIth** century, more than **400** volcanic events (minor eruptions and hydrothermal explosions included) have been reported.

A significant (VEI>3) eruption occurs each **8-10** years in Chile.

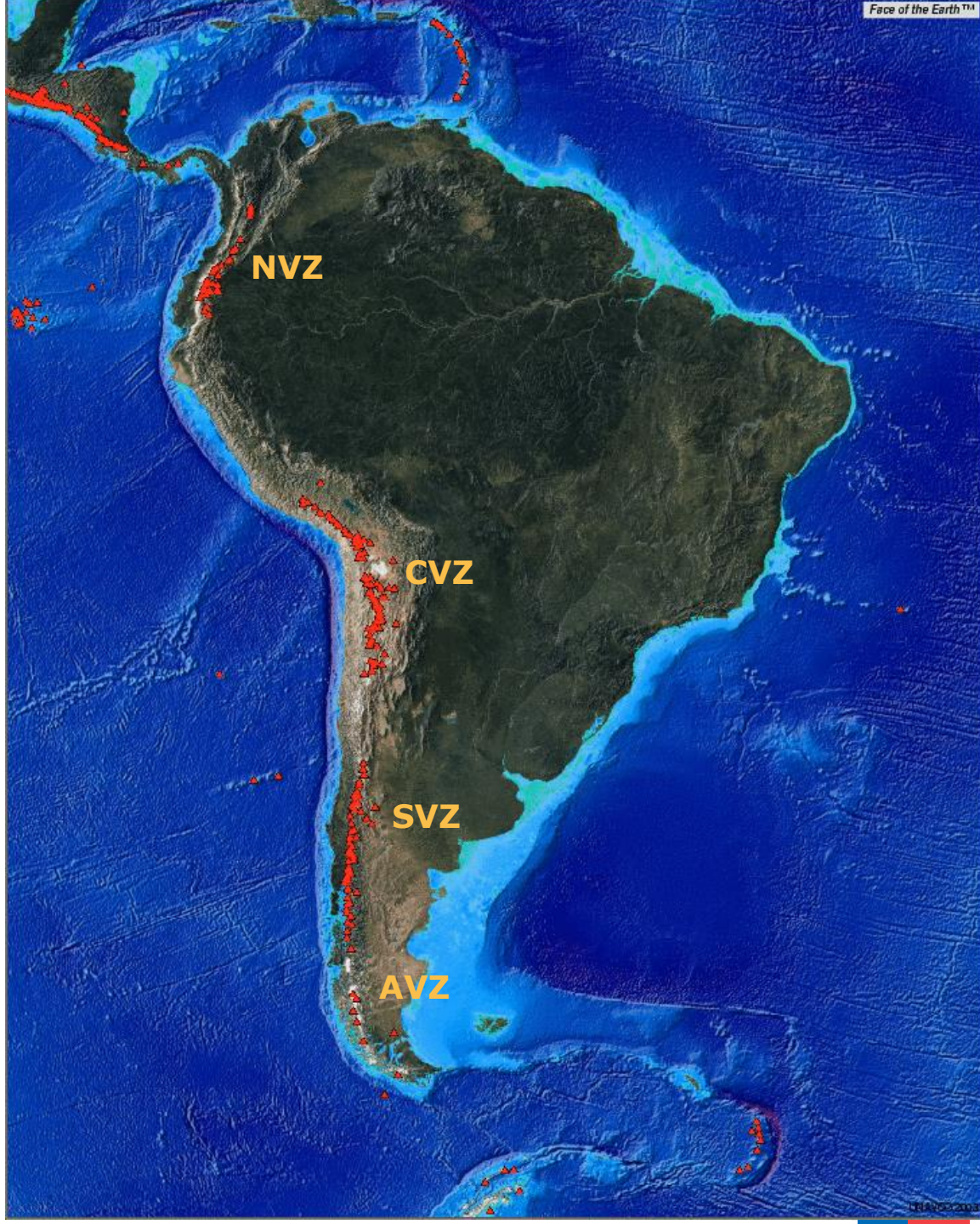


CURRENT STATUS OF ICAO VOLCANIC ASH ADVISORY CENTRES (VAAC) - AREAS OF RESPONSIBILITY
 SITUATION ACTUELLE DES CENTRES OACI D'AVIS DE CENDRES VOLCANIQUES (VAAC) - ZONES DE RESPONSABILITÉ
 ESTADO ACTUAL DE LOS CENTROS DE AVISOS DE CENIZAS VOLCÁNICAS (VAAC) DE LA OACI - ÁREAS DE RESPONSABILIDAD
 СУЩЕСТВУЮЩЕЕ РАСПРЕДЕЛЕНИЕ КОНСУЛЬТАТИВНЫХ ЦЕНТРОВ ИКАО ИО ВУЛКАНИЧЕСКОМУ ПЕПЛУ (VAAC) - РАЙОНЫ ОТВЕТСТВЕННОСТИ



Message

Monitoring and volcanological studies should be a multi-national effort





I. The national network for volcano surveillance (RNVV)

- ***“After 100 years and 100 latitude degrees apart”***
- **Southern Andes Volcano Observatory (OVDAS)**

II. Calbuco eruption 2015

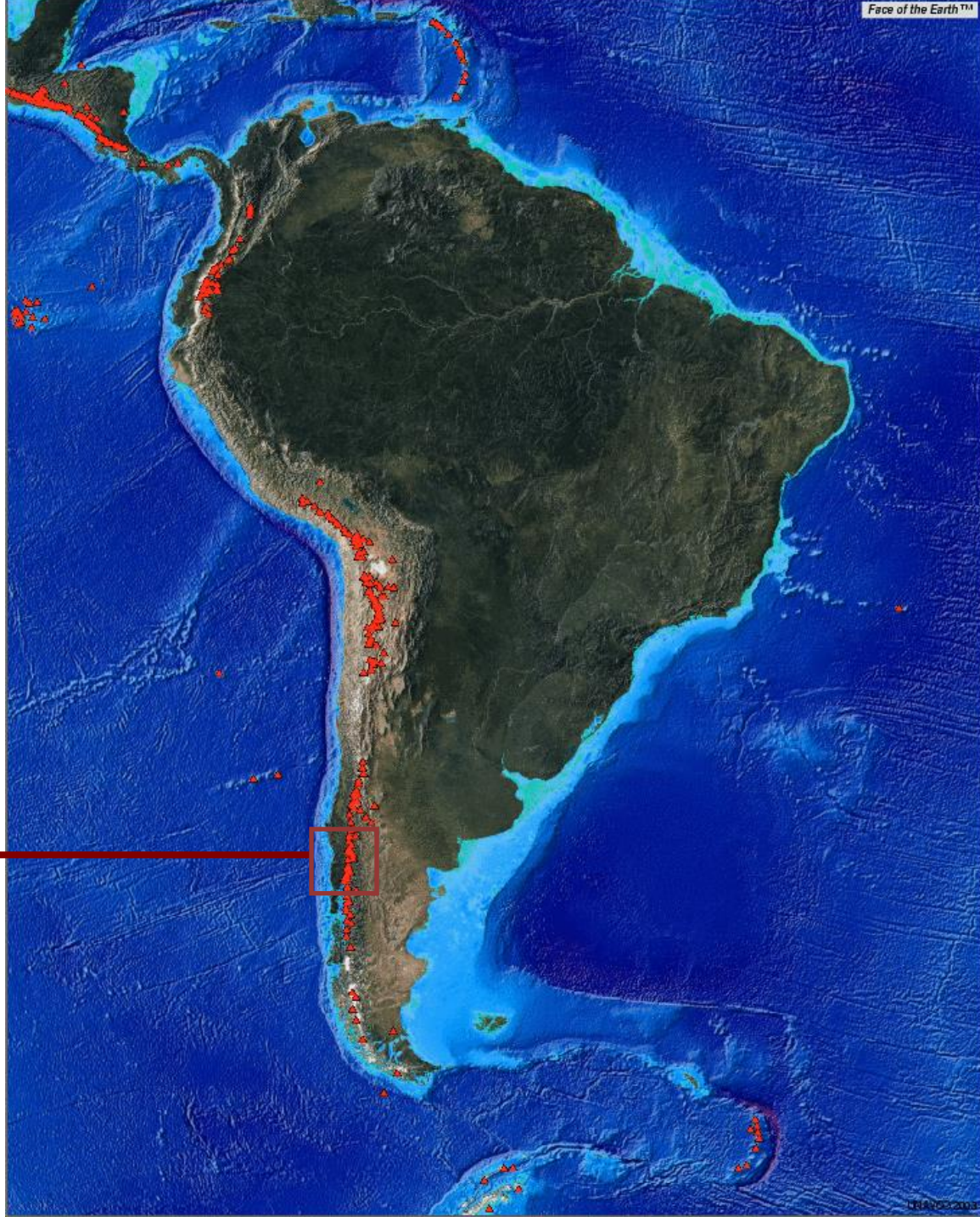


In 1996 the Volcano Observatory of the Southern Andes (OVDAS) was created.



At the beginning of 2008, only six volcanoes were monitored in semi real time:

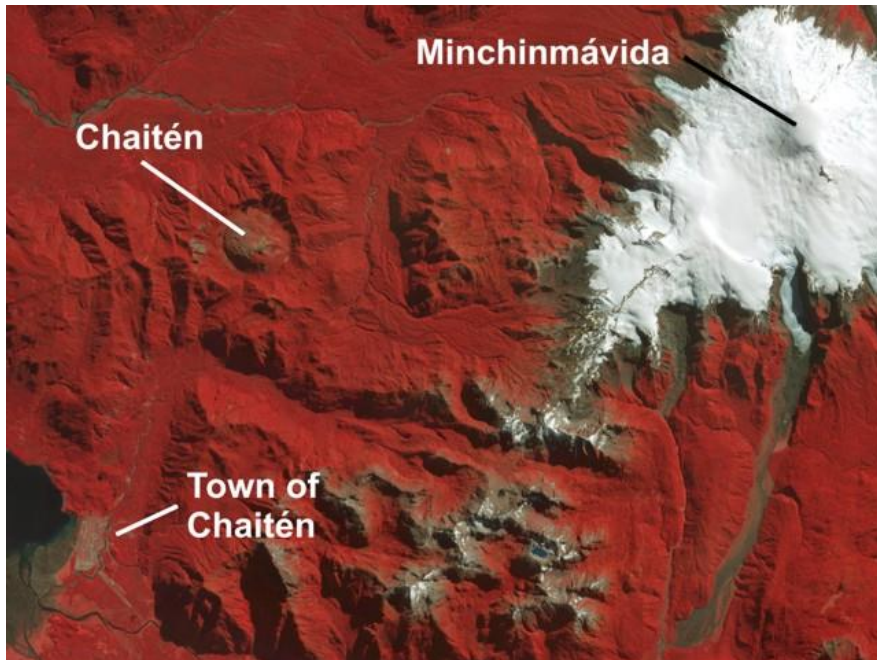
Lonquimay (1)
Llaima (2 + 3) – erupting!
Villarrica (2)
Mocho-Choshuenco (1)
Osorno (1)
Calbuco (1)



Chaitén eruption: May 2008

Earthquakes felt near Chaitén town late on April 30th, 2008 provided the first warning of increasing volcanic activity in the area....

At that time, very little was known about Chaitén volcano and it was unmonitored.





On May 2nd, 2008, the volcano erupted.

Downwind ash fall extended 1000 km to the coast of Argentina. On multiple occasions ash from the eruption disrupted air traffic in South America.

Full evacuation of the town by ship (around 5,000 people)

Native forest was destroyed by directed blasts on the flanks of the volcano.

On May 11th, moderate to heavy rains generated lahars and devastated Chaitén town.



On May 8th, the U.S. Government offered to send a VDAP team (*Volcano Disaster Assistance Program*) to help SERNAGEOMIN install real-time seismic monitoring

Chaitén volcano is



**.... our Mount St. Helens:
Birth of a new volcano hazards
program**

The 2008-2009 eruption of Chaitén volcano focused the attention of the Chilean Government on volcano hazards which resulted in a new national network for volcano surveillance and hazard assessment program.



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Since 2009, SERNAGEOMIN is building real-time monitoring networks and also generating geological knowledge at Chile's highest-risk volcanoes.



Chaitén volcano is



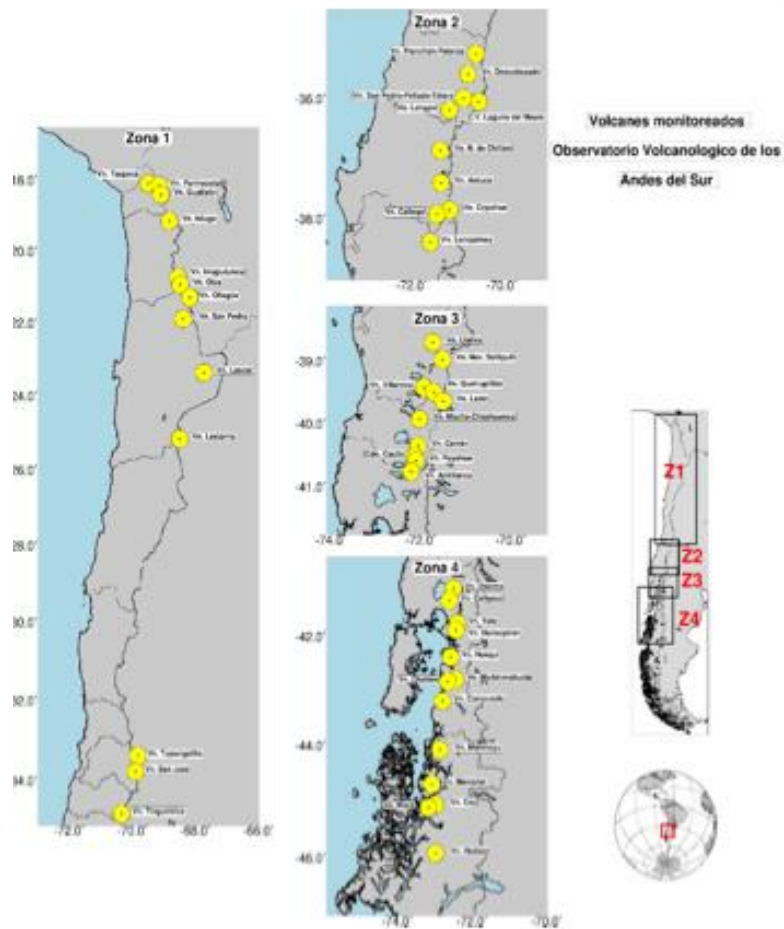
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The mission of this program is to improve the country's preparation and capacity to mitigate effects of volcanic eruptions on people and economy.




OVDAS



Red Nacional de Vigilancia Volcánica del Sernageomin

Estado del Volcán	Actividad	Observación	Alerta	Estado	Observación	Alerta	Estado	Observación	Alerta	Estado	Observación	Alerta	Estado	Observación	Alerta	Estado	Observación	Alerta	
Activo	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Inactivo	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Total	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
213										128									
Estaciones de vigilancia										Servidores de datos									






Seismology (12)
Geodesy (12)
Infrasound (1)
Magnetometry (2)
Gas and water sampling
Gravimetry
Webcams (3)



Very high level monitoring


- 1. Láscar**
 - 2. Tupungatito**
 - 3. Descabezado Grande -Quizapu**
 - 4. Nevados de Chillán**
 - 5. Antuco**
 - 6. Llaima**
 - 7. Villarrica**
 - 8. Mocho-Choshuenco**
 - 9. Puyehue-Cordón Caulle**
 - 10. Calbuco**
 - 11. Michinmahuida**
 - 12. Chaitén**
 - 13. Hudson**
- 

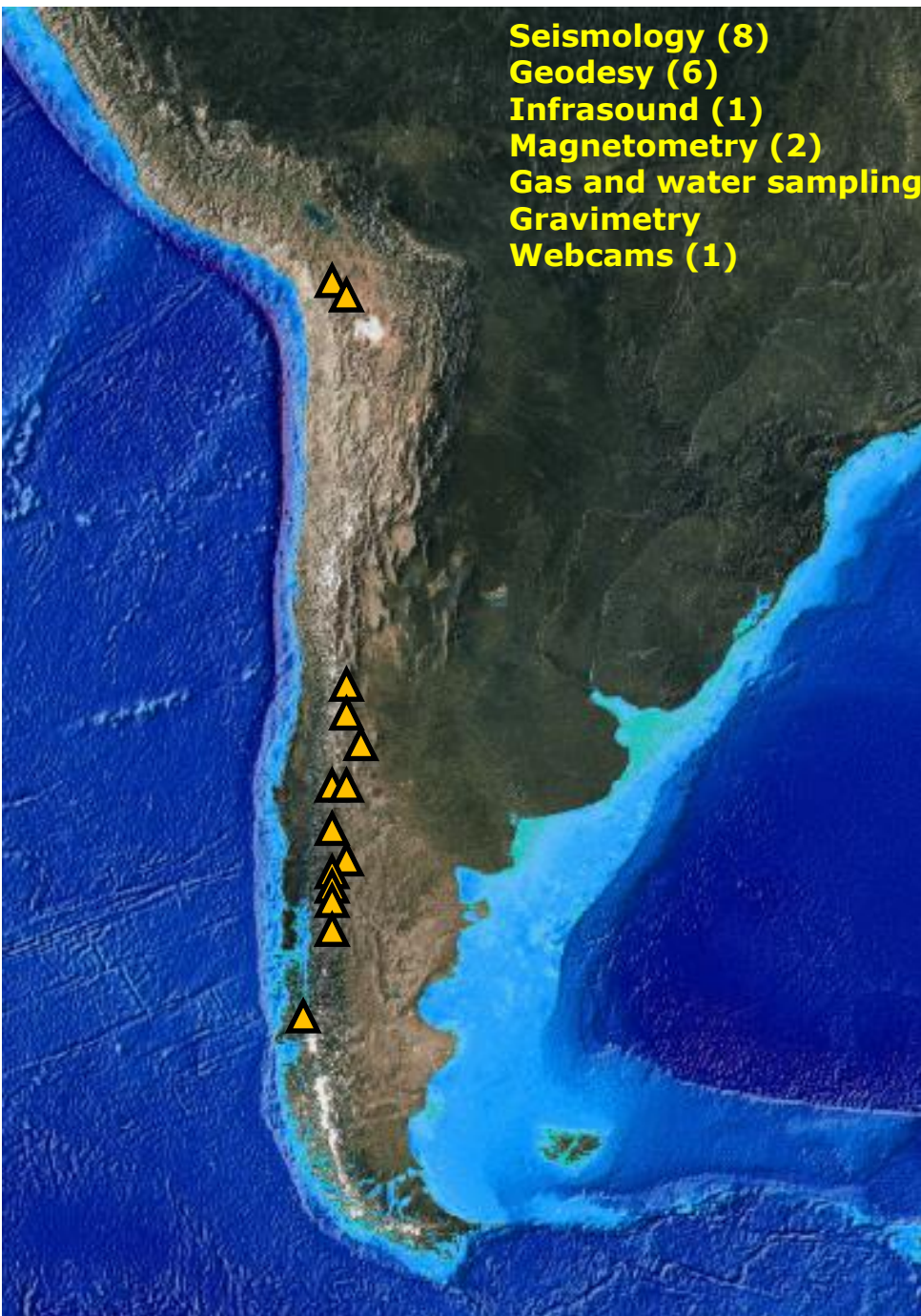


Seismology (12)
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Very high level monitoring

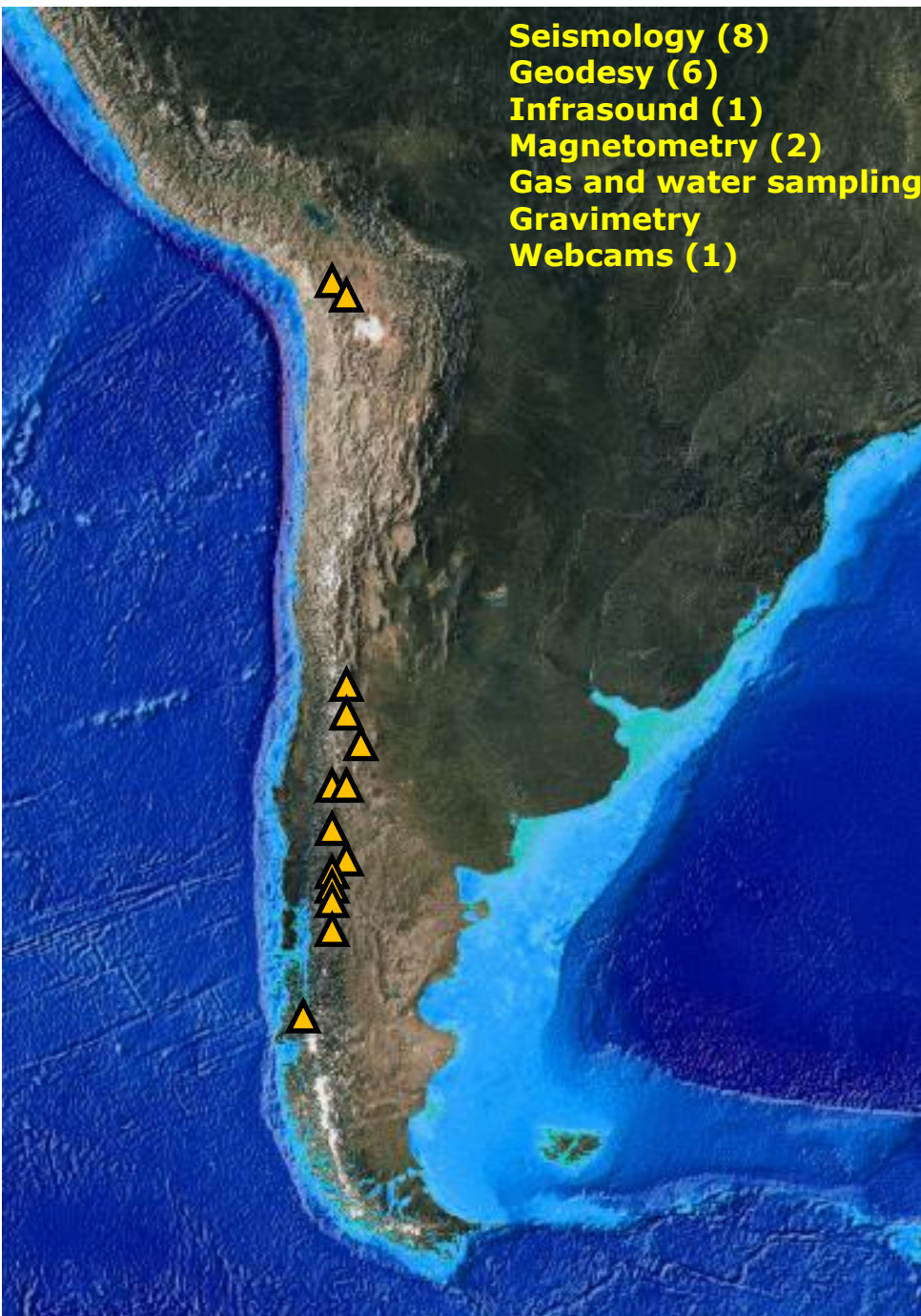
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 10. **Calbuco**
 11. Michinmahuida
 12. **Chaitén**
 13. **Hudson**
- 

A satellite-style map of Chile showing the coastline and inland terrain. Yellow triangles indicate the locations of 14 monitoring stations along the coast. The triangles are distributed from the north to the south, with a higher concentration in the central region. The ocean is shown in shades of blue, and the land is in shades of brown and green.

Seismology (8)
Geodesy (6)
Infrasound (1)
Magnetometry (2)
Gas and water sampling
Gravimetry
Webcams (1)

High level monitoring

1. Taapaca
2. Parinacota
3. San José
4. Planchón-Peteroa
5. Laguna del Maule
6. Callaqui
7. Copahue
8. Lonquimay-Tolhuaca
9. Sollipulli
10. Carrán- Los Venados
11. Casablanca-Antillanca
12. Osorno
13. Yate-Hornopirén-Apagado
14. Macá - Cay



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High level monitoring

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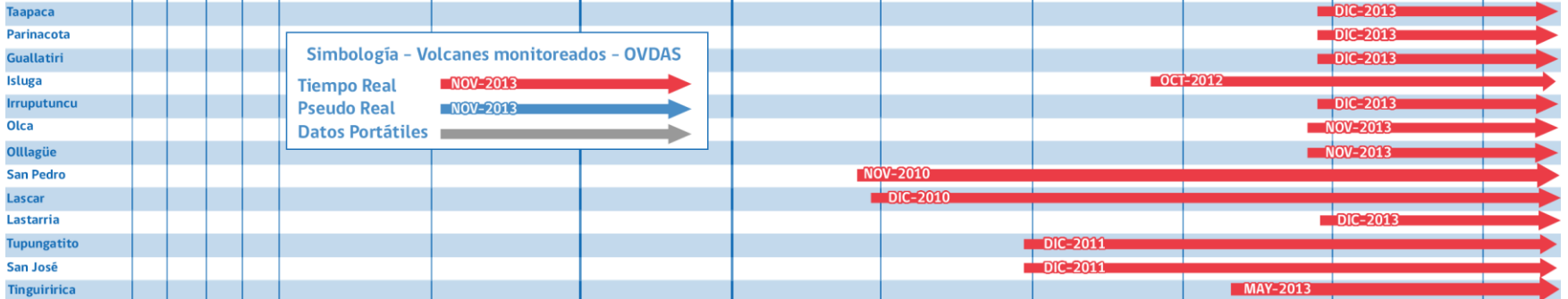
Seismology (base level)
Geodesy (base level)



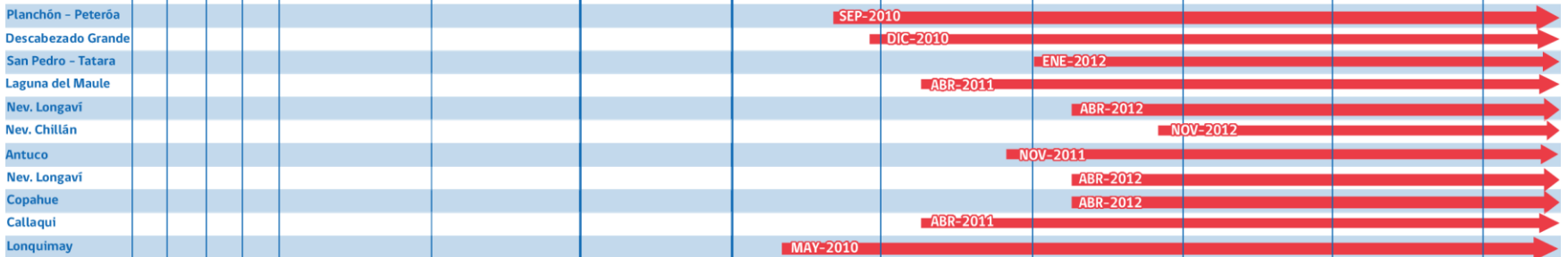
Low level monitoring

1. Guallatiri
2. Isluga
3. Irruputuncu
4. Olca
5. Ollagüe
6. San Pedro
7. Lastarria
8. Tinguiririca
9. Tatara-San Pedro
10. Nevado de Longaví
11. Quetrupillán
12. Lanín
13. Huequi
14. Corcovado-Yanteles
15. Melimoyu
16. Mentolat

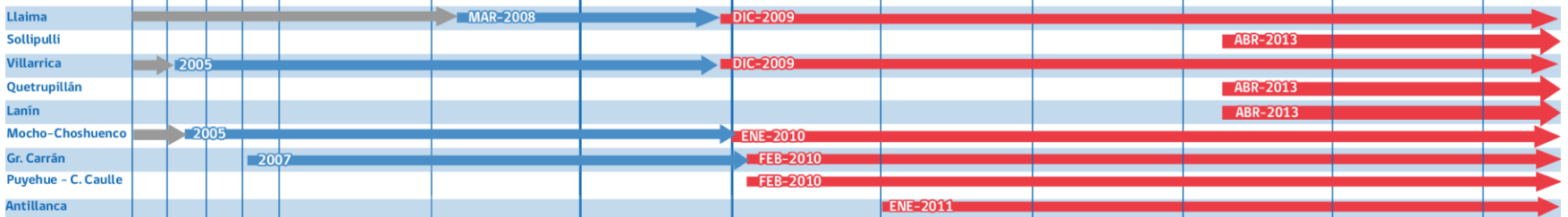
ZONA 1



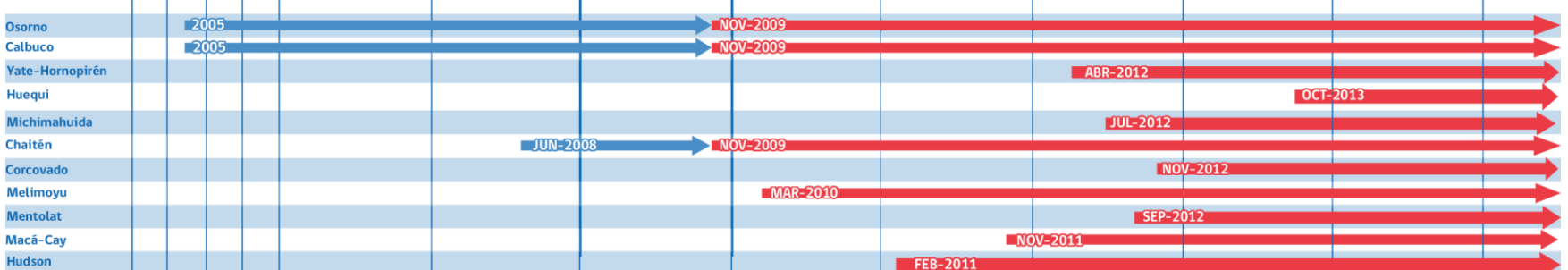
ZONA 2



ZONA 3



ZONA 4



Simbología - Volcanes monitoreados - OVDAS

- Tiempo Real → (Red arrow)
- Pseudo Real → (Blue arrow)
- Datos Portátiles → (Grey arrow)

Puyehue- Cordón Caulle eruption, June 4th 2011

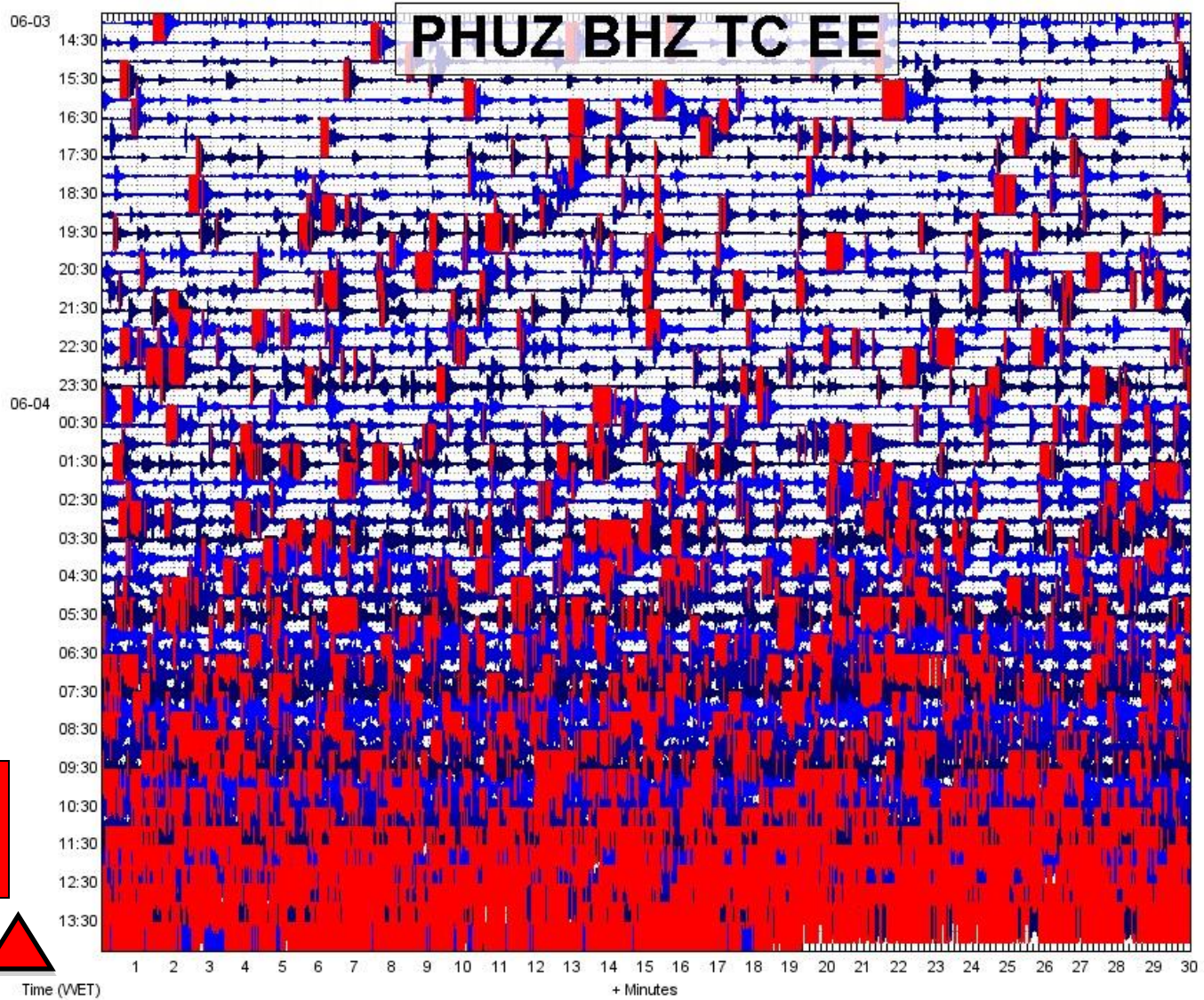


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© JC Gedda-2011

SEISMICITY 03 & 04 JUNE - 2011



YELLOW
Alert level



RED
Alert level



Reporte Especial de Actividad Volcánica No 27
Región de Los Ríos
Complejo Volcánico Puyehue – Cordón Caulle
04 de junio de 2011

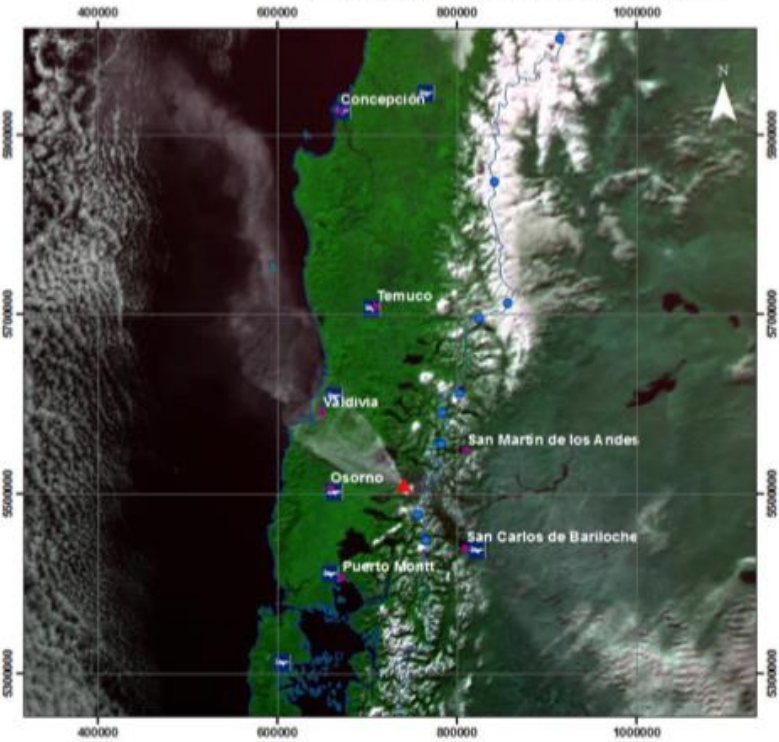
Hora del reporte: 10:30 hora local

**3 hours
before the
eruption
onset !**

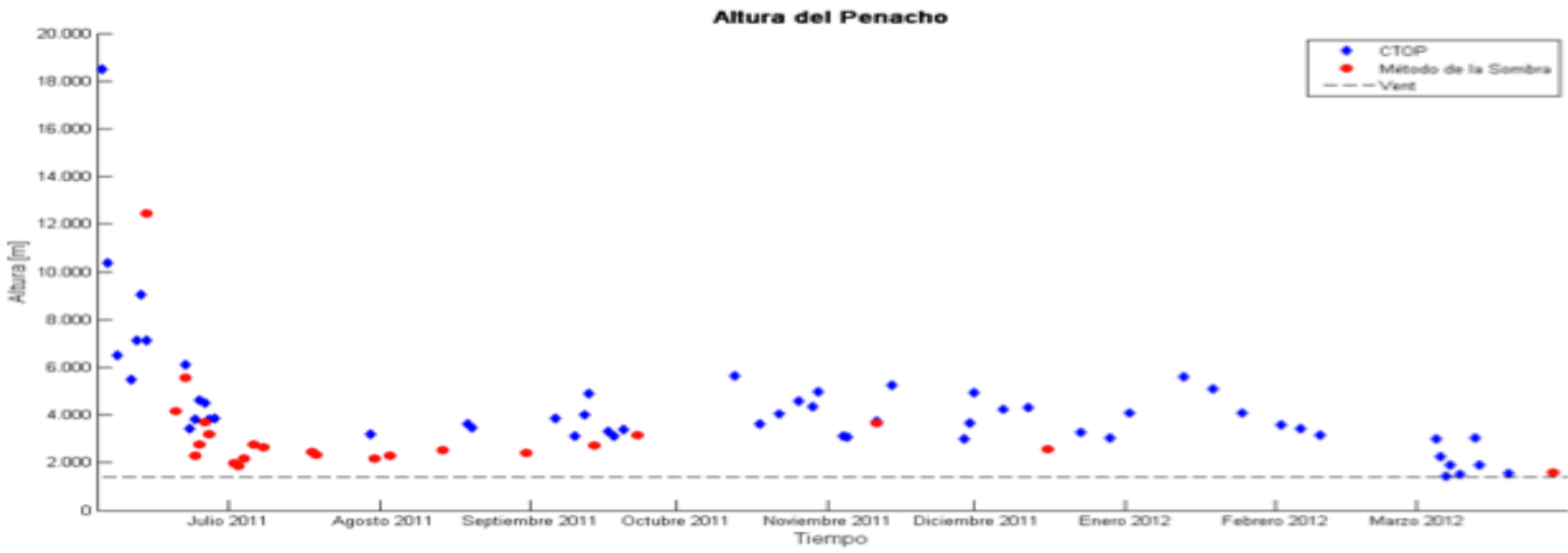
El Servicio Nacional de Geología y Minería (SERNAGEOMIN) - Observatorio Volcanológico de los Andes del Sur (OVDAS), informa que el proceso sísmico en el Complejo Volcánico indica la inminencia de una erupción en las próximas horas. La actividad sísmica ha evolucionado al registro de un temblor espasmódico de alta energía, conformado por señales relacionadas en su mayoría, con la dinámica de fluidos al interior de los conductos volcánicos (Tipo Híbrido y Largo Periodo), localizados en el edificio del Cordón Caulle, en un rango de profundidades entre 1-4 km. En la últimas 6 horas se registraron en promedio 230 sismos por hora, de los cuales 12 eventos presentaron magnitudes (M_L) mayores a 4.0, 50 eventos, mayores a 3.0; el 50 % de los eventos registrados tienen magnitudes (M_L) mayores a 2.0. Se destaca el sismo registrado a las 8:36 hora local con una magnitud (M_L) igual a 4.4.

Pobladores de la región reportaron haber sentido sismos de manera constante en las horas de la noche de ayer y en la mañana de hoy.

Por tanto, el nivel de la alerta volcánica cambia a Nivel 5 – ROJO: INMINENCIA DE UNA ERUPCIÓN EN HORAS /DÍAS.

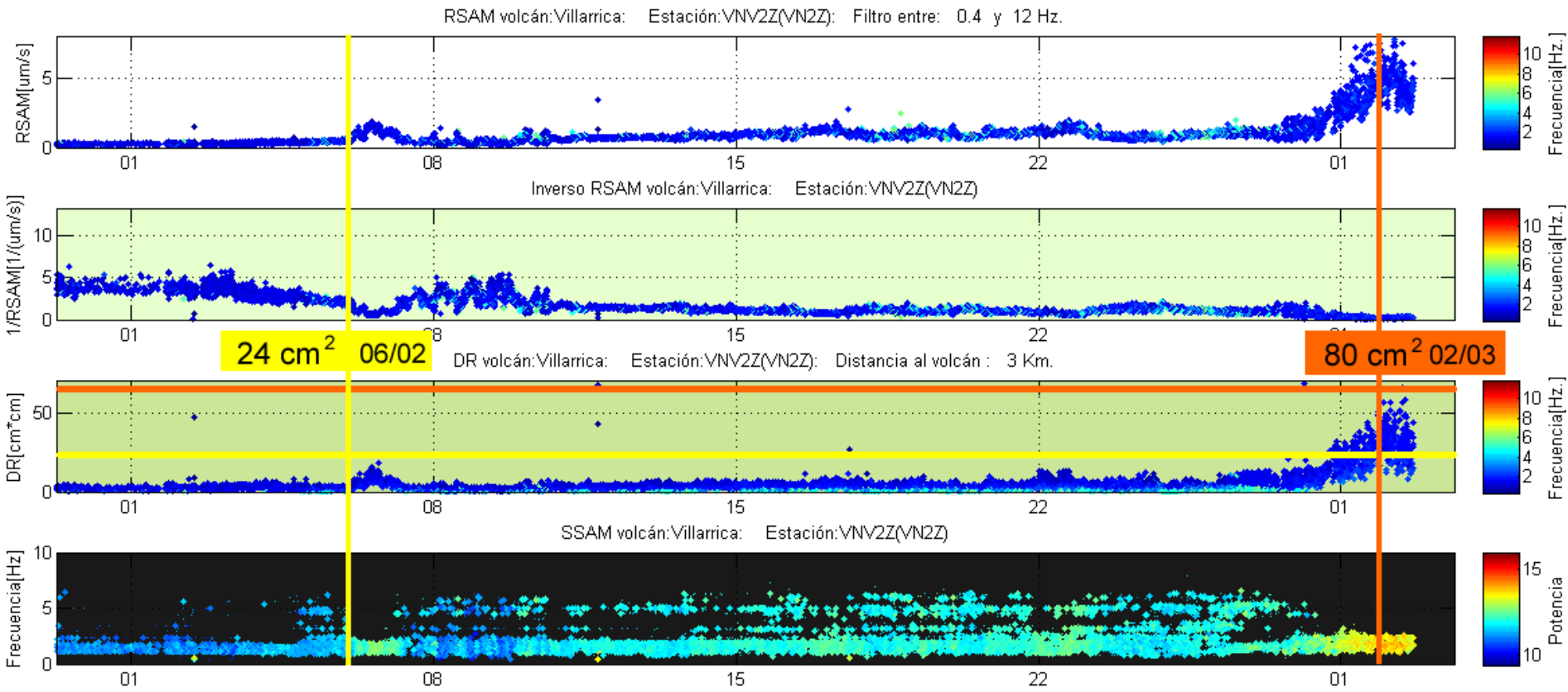


© F. Negroni



Villarrica eruption, March 3rd 2015



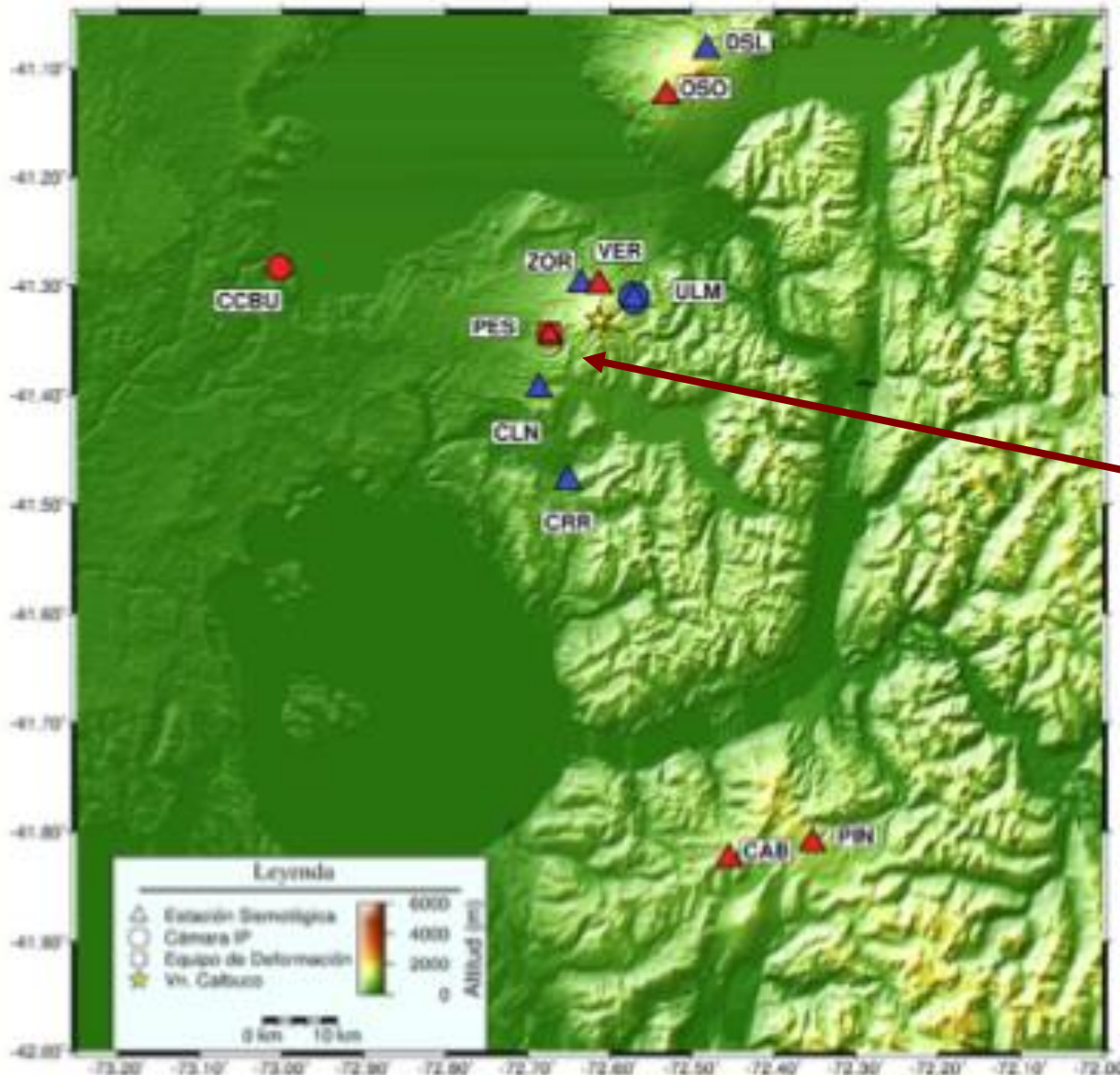
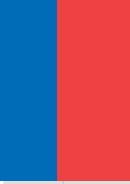


← Feb 2015 → Mar 2015

Calbuco eruption, April 22nd 2015



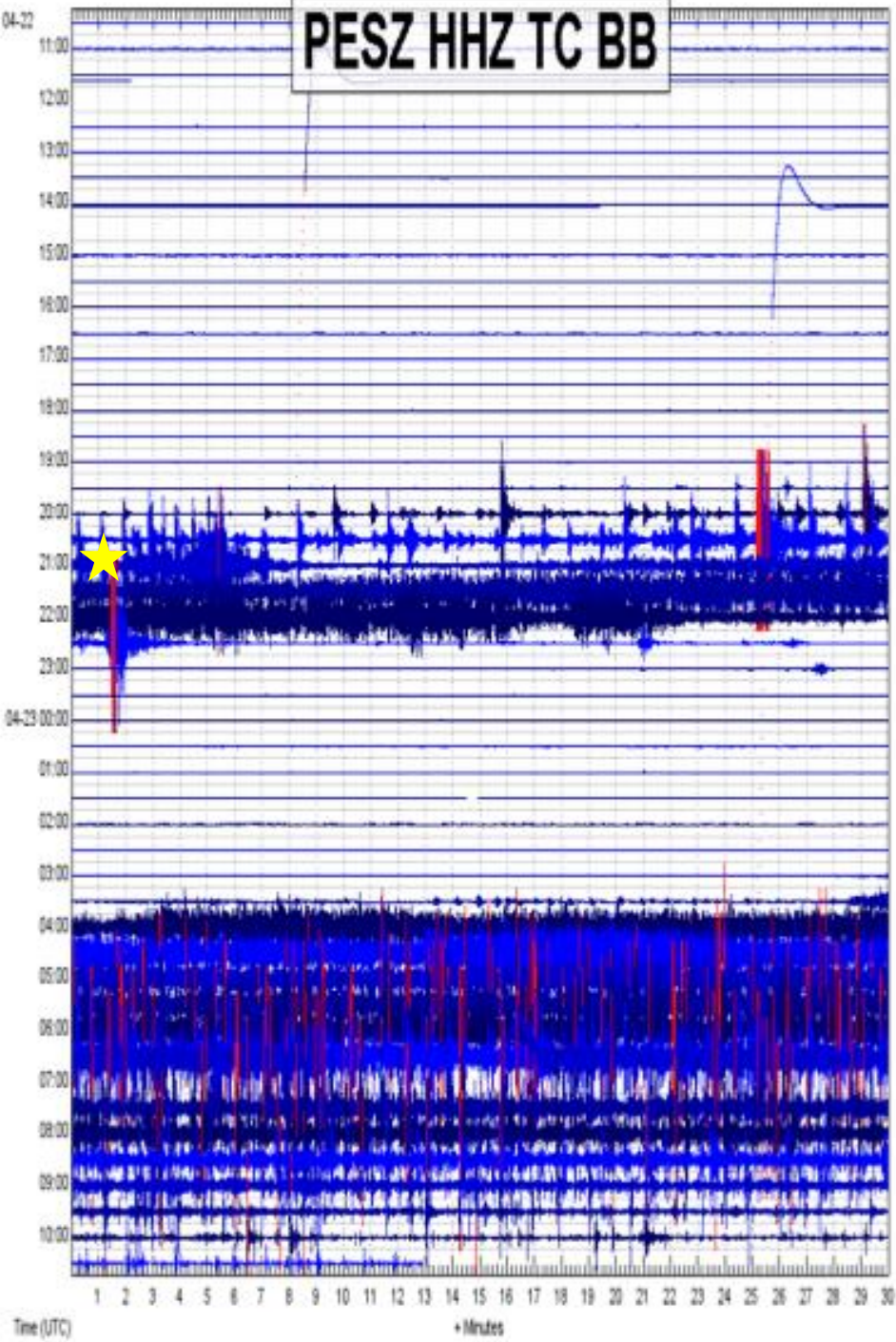
Current monitoring network for Calbuco volcano



**Broadband seismic station working fine.
5 km from the volcano**

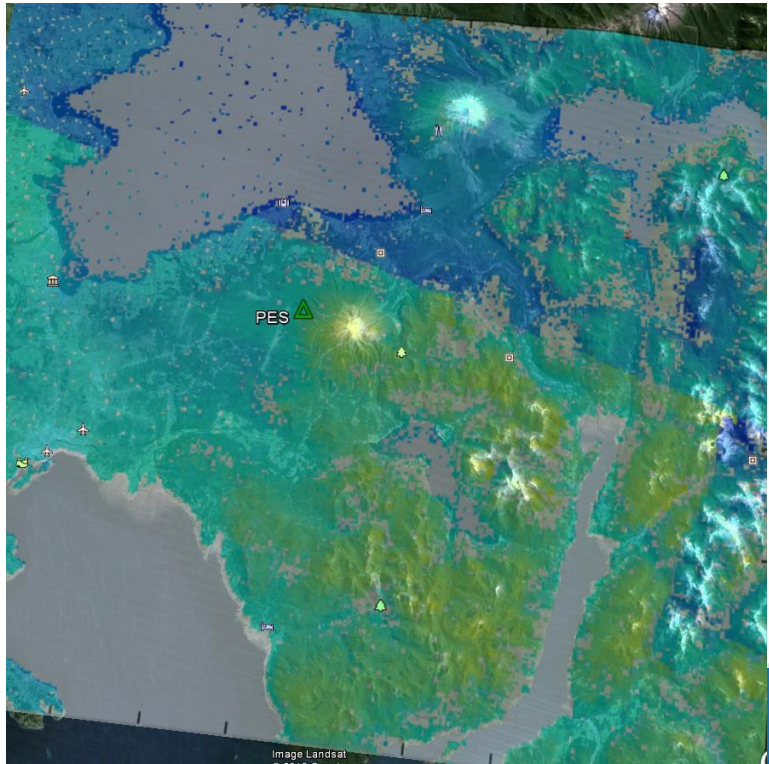


PESZ HHZ TC BB

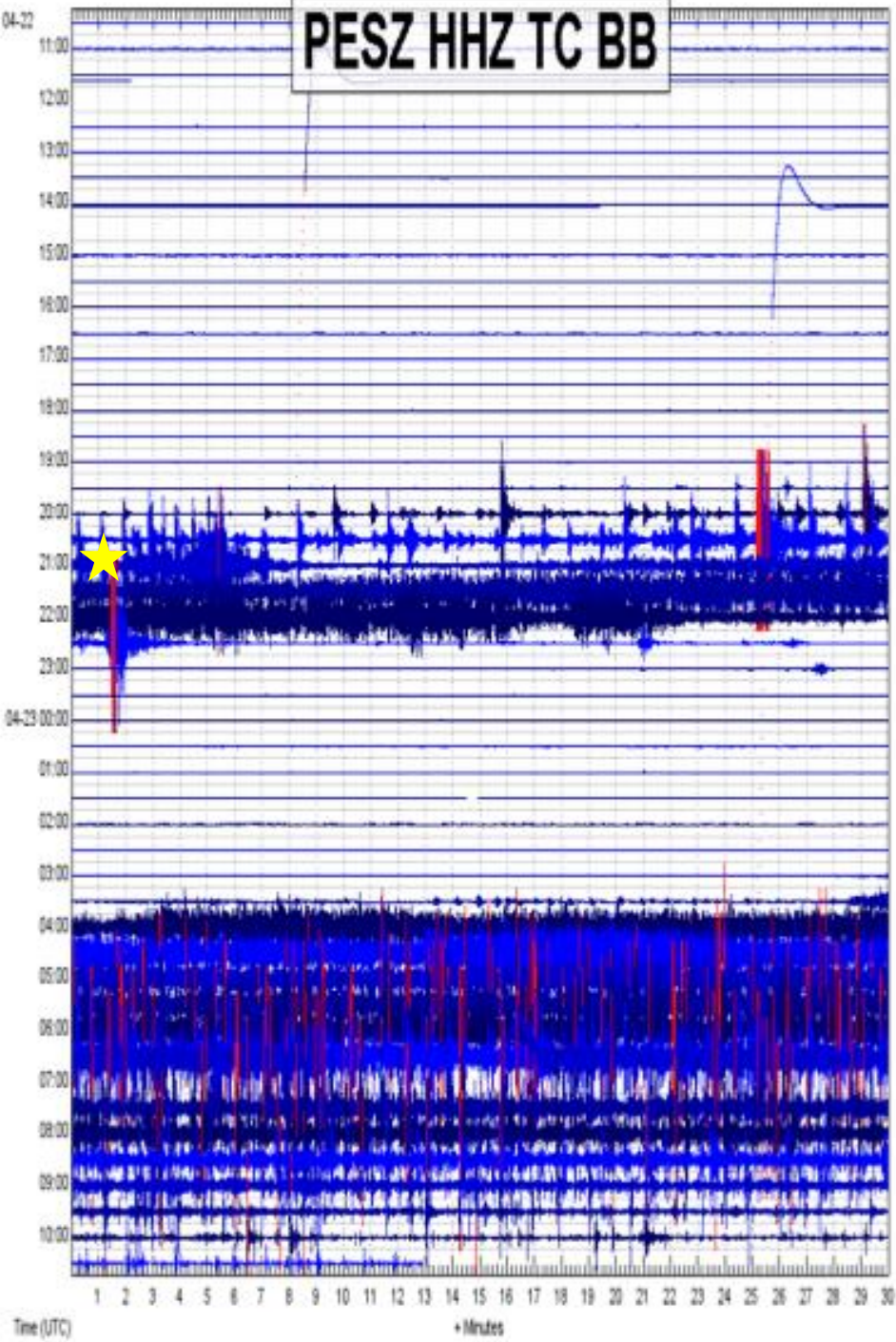


Seismicity:
2,9 hrs before the eruption:
Low energy seismic swarm
2,5 hs before the eruption:
fluids movement
10 min before the eruption:
Clear precursor

Pre-eruptive deformation:
Not detected (interferogram
28th mar-21st apr!).
Provided by M. Pritchard



PESZ HHZ TC BB



Seismicity:

2,9 hrs before the eruption:

Low energy seismic swarm

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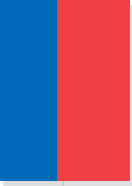
Not detected (interferogram 28th mar-21st apr!).

Provided by M. Pritchard

Message

Need of a real multi-parametric network

Column height. From local observations and satellite imagery available (CIMMS, Volcanic Clouds email list, Simon Carn, Fred Prata)



First pulse. GOES 22/04/2015 – 21:38 UTC
Column height: 15.0 ± 0.5 km a.s.l.

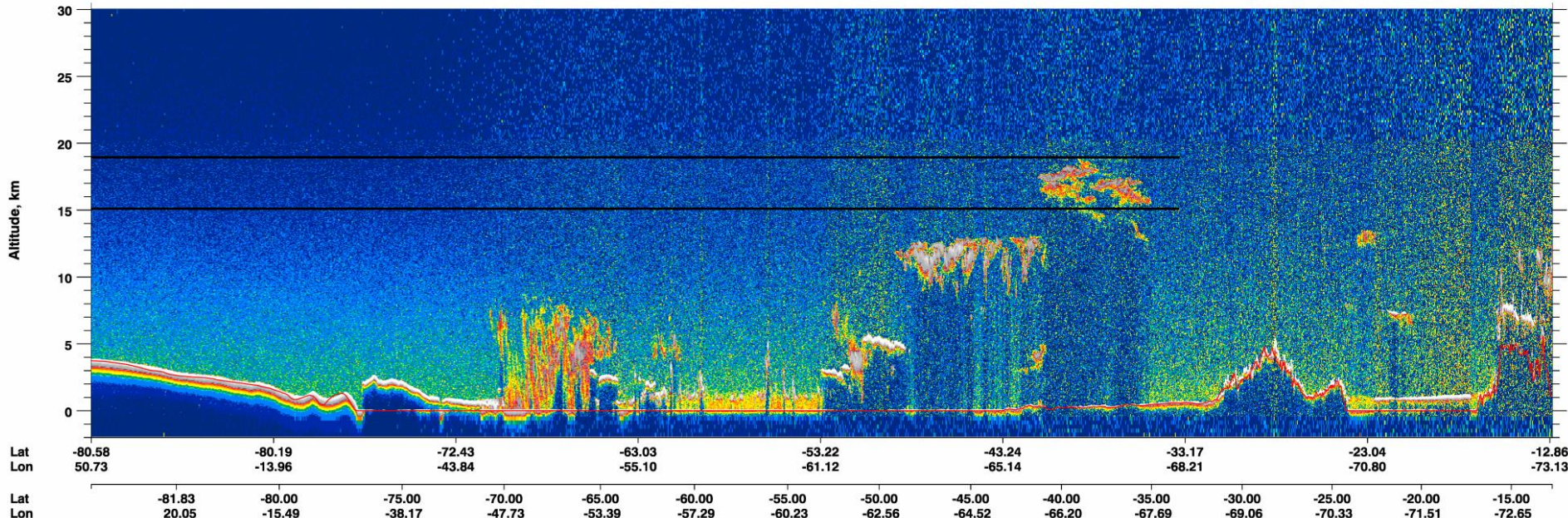


Really important during the first hours of the eruption.

Estimation of the mass flow rate as input parameter for ash dispersion models.

VONA report must be sent to the aeronautical agency

532 nm Total Attenuated Backscatter, $\text{km}^{-1} \text{sr}^{-1}$ UTC: 2015-04-23 18:22:40.2 to 2015-04-23 18:45:13.5 Version: 3.30 Expedited



Effects: Ash (tephra) fall and roof collapses



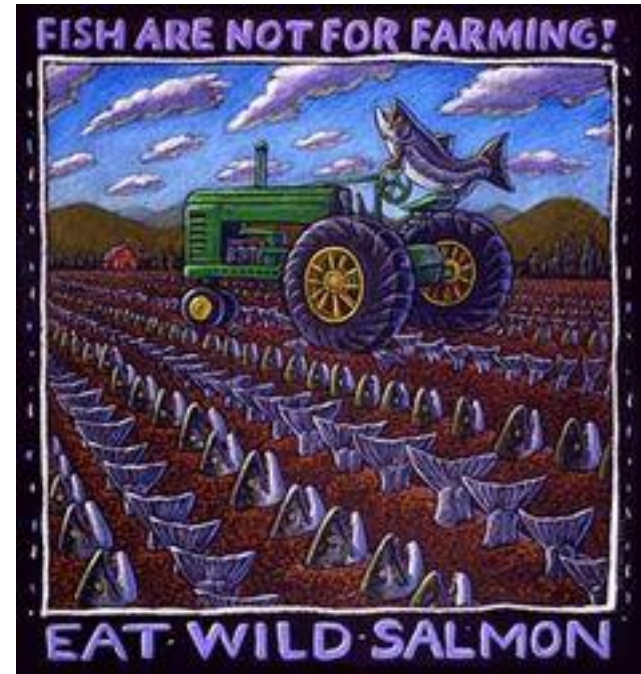
Effects: Lahars and pyroclastic flows



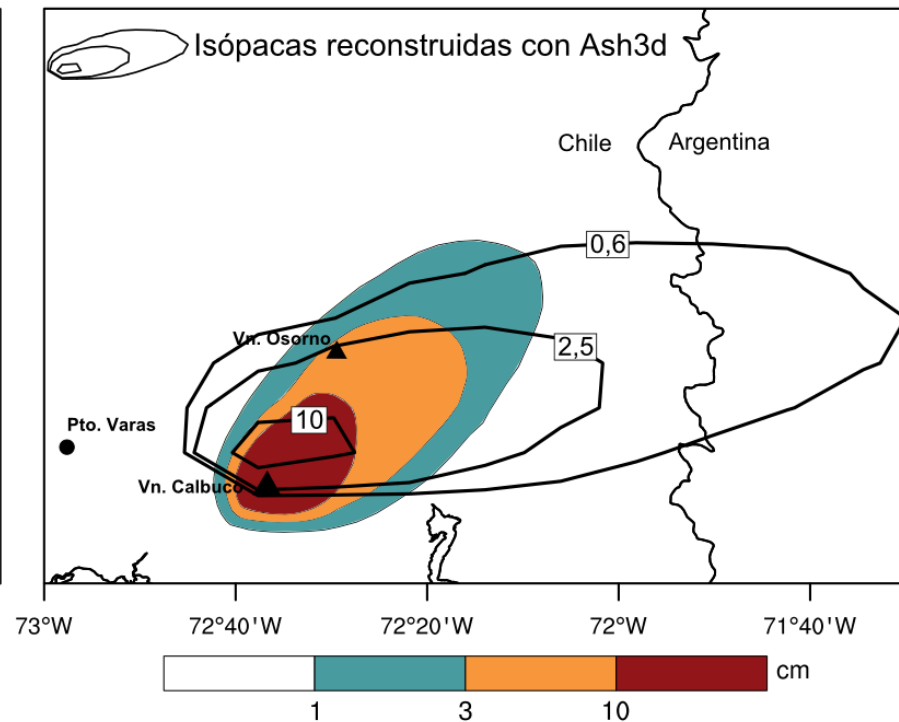
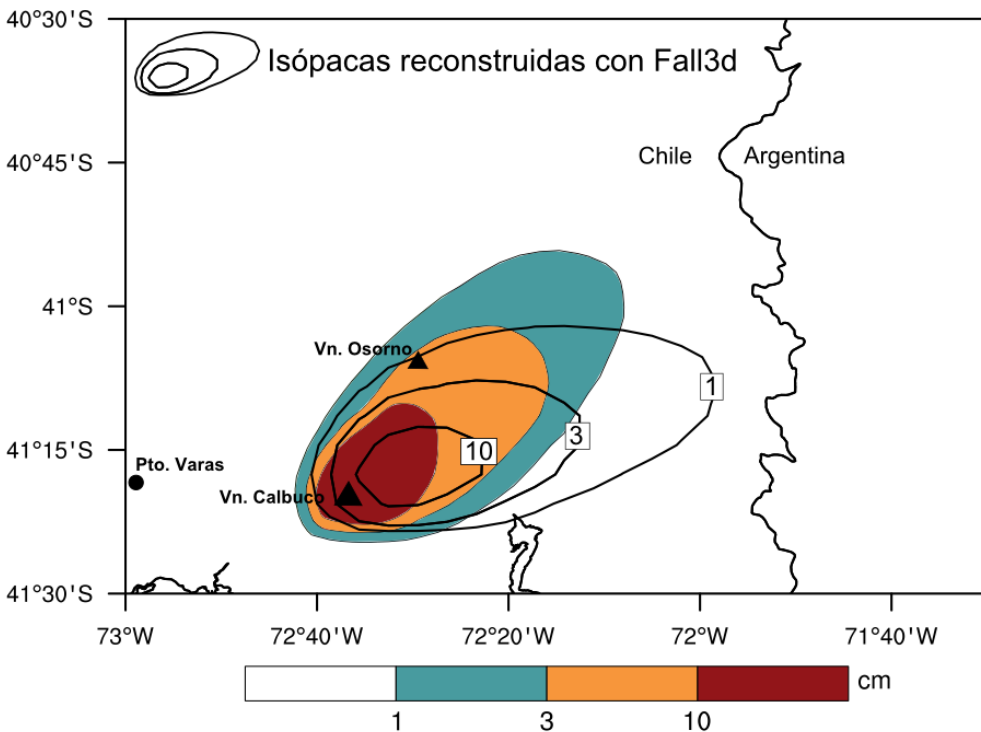
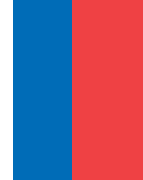
Effects: Ash (tephra) fall and roof collapses



Effects: Lahars and pyroclastic flows

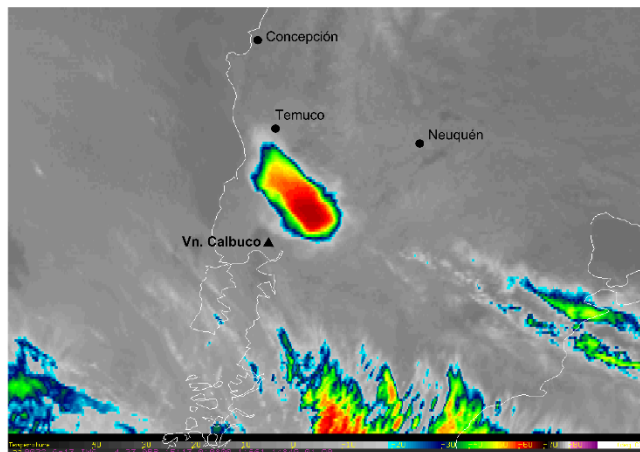


Ash (tephra) dispersion, fallout and arrival times

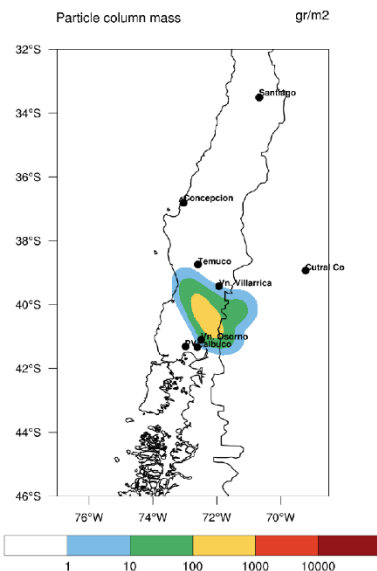


Ash (tephra) dispersion, fallout and arrival times

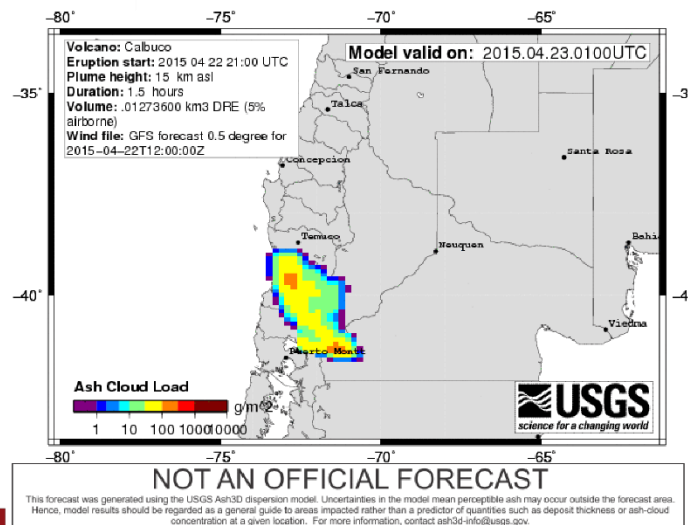
GOES13 - 23 abril 2015 - 01:08 UTC



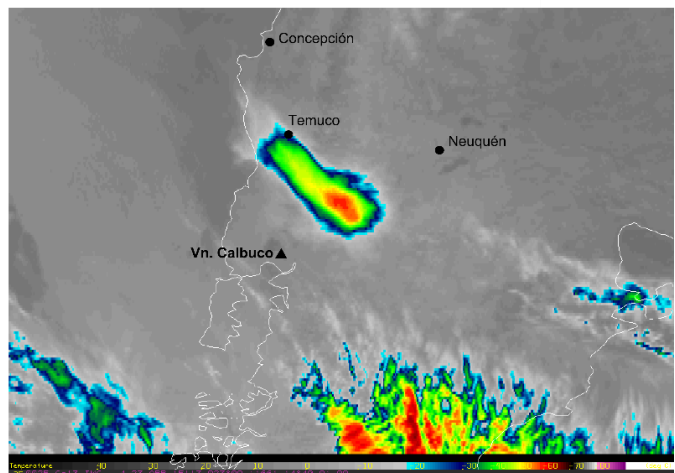
Fall3d - 23 abril 2015 - 01:00 UTC



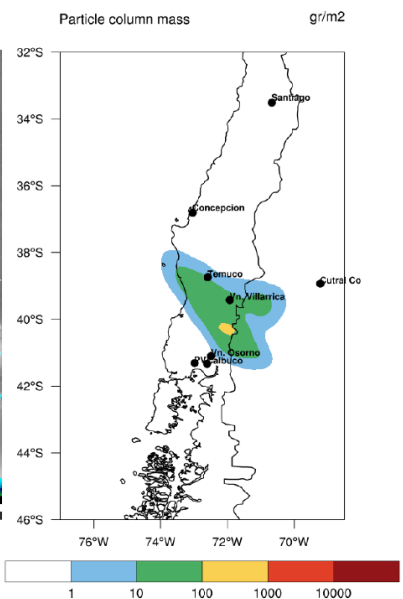
Ash3D - 23 abril 2015 - 01:00 UTC



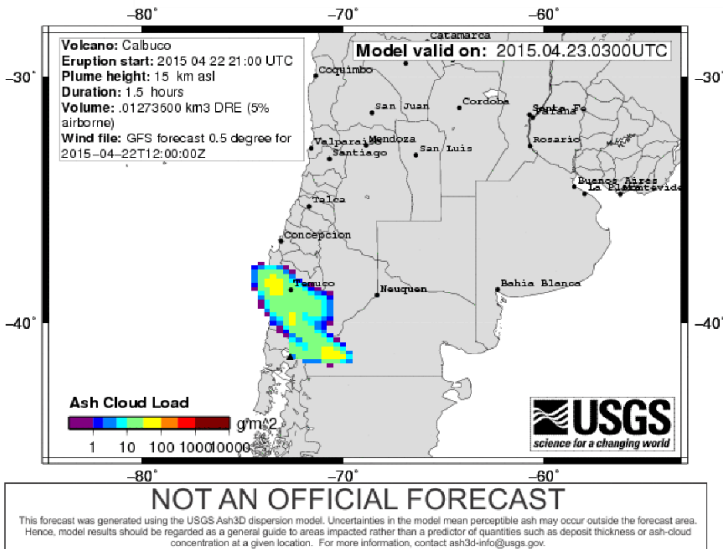
GOES 13 - 23 abril 2015 - 02:38 UTC



Fall3d - 23 abril 2015 - 03:00 UTC



Ash3d - 23 abril 2015 - 03:00 UTC



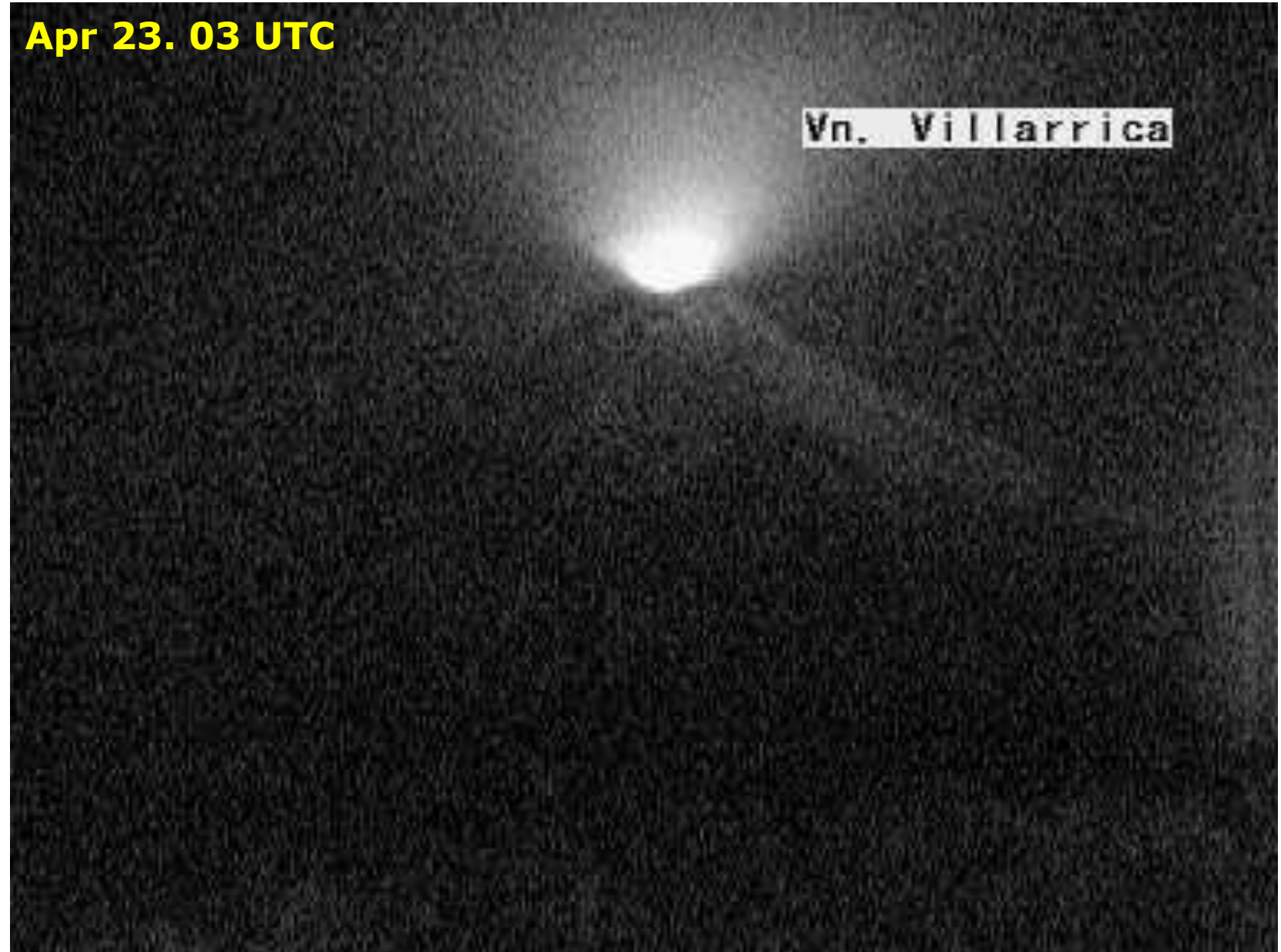
Apr 23. 02 UTC

Vn. Villarrica



Apr 23. 03 UTC

Vn. Villarrica



Apr 23. 04 UTC

**First pulse arrived in
Villarrica 7 hrs after the
eruption start
(Apr 22. 21 UTC)**

Vn. Villarrica

Apr 23. 10 UTC

Vn. Villarrica



Apr 23. 11 UTC

**Same with the 2nd pulse
(Apr 23. 04 UTC)**

Vn. Villarrica



Apr 23. 19 UTC

Vn. Villarrica



Apr 23. 20 UTC

Vn. Villarrica



Apr 23. 21 UTC

Vn. Villarrica



Apr 23. 22 UTC

Vn. Villarrica





Hudson 1991
4 - 5 km³



Chaitén 2008
0,5 - 1 km³



Cordón Caulle 2011
0,5 - 1 km³



Calbuco 2015
0,3 km³



Láscar 1993
0,1 km³



Villarrica 2015
< 0,1 km³



Lonquimay 1989
< 0,1 km³



Hudson 1991
4 - 5 km³



Chaitén 2008
0,5 - 1 km³



Cordón Caulle 2011
0,5 - 1 km³ C



Calbuco 2015
0,3 km³



Láscar 1993
0,1 km³

Message

Variety of magma compositions, eruptive styles, eruption size and duration. Also different precursory activity.



Villarrica 2015
< 0,1 km³



Lonquimay 1989
< 0,1 km³

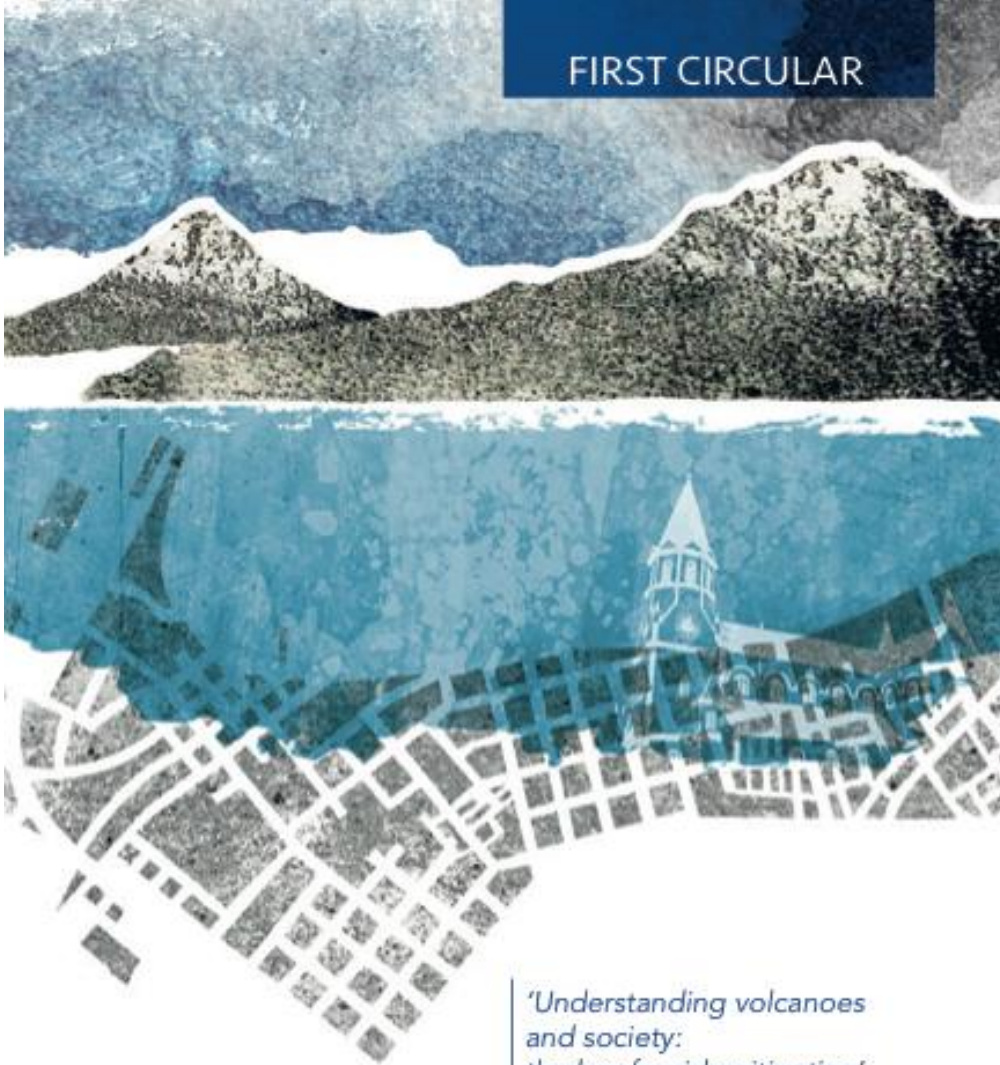


I. The national network for volcano surveillance (RNVV)

II. Calbuco eruption 2015

III. Bonus

FIRST CIRCULAR



*'Understanding volcanoes
and society:
the key for risk mitigation'*



**CITIES ON
VOLCANOES 9**

Puerto Varas - Chile

November 20 - 25, 2016



***Meeting in Chile -Puerto Varas-
next year!***

***A conduit for exchange of ideas
and experience and promote
multi-disciplinary applied
research, involving the
collaboration of physical and
social scientists and city officials***



