



INVENTARIO NACIONAL DE GLACIARES

2018

IANIGLA



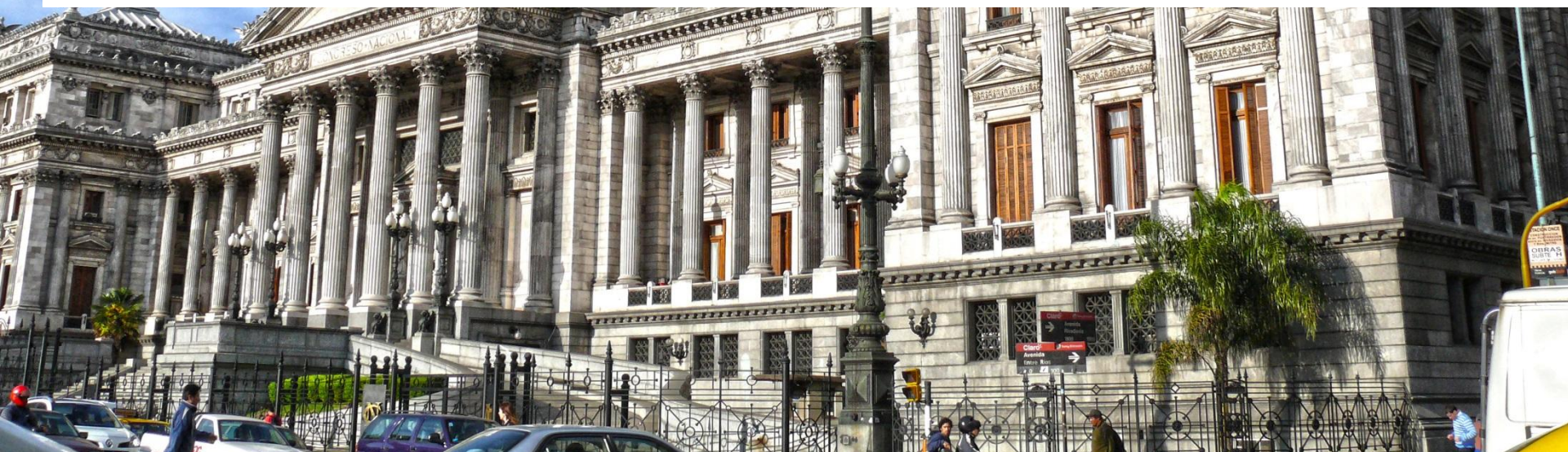
CONICET

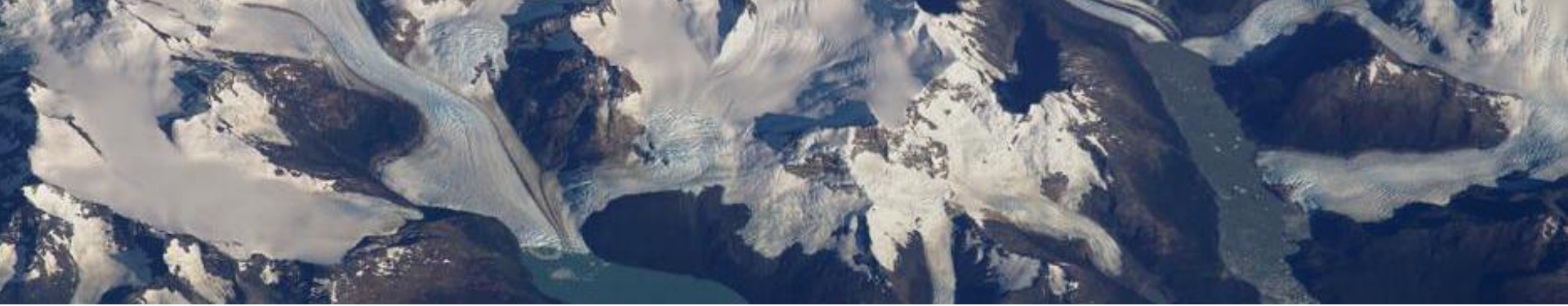
U.N. CUYO
GOBIERNO
DE MENDOZA

Mariano Masiokas, Lidia Ferri, Laura Zalazar, Pierre Pitte, Lucas Ruiz, Mariano Castro, Hernán Gargantini, Melisa Giménez, Gustavo Costa, Rodolfo Crimi, Ricardo Villalba



On October 2010, the Argentinean Senate approved the Law 26639 for the “Preservation of Glaciers and Periglacial Environments”





✓ This National law considers glaciers and periglacial features as strategic water reserves

✓ Declared these reserves as public goods

✓ One important outcome of this law was the creation of the National Glacier Inventory (NGI) to identify and map all the glacier and periglacial landforms that act as strategic water reserves in the Argentinean Andes

✓ The inventory was assigned to the Argentinean Institute for Snow, Ice and Environmental Research (IANIGLA) in collaboration with the National Secretary of Environment and Sustainable Development

What is included in the inventory

- Clean ice glaciers
- Debris-covered glaciers
- Permanent snow patches
- Rock glaciers

Area $\geq 0,01 \text{ km}^2$



Methods

The NGI was largely based on remote sensing techniques and datasets
 The methodology followed international guidelines (e.g. from GLIMS)
 for the development of glacier inventories

Tipo de glaciar	Resolución espectral	Resolución espacial	Método
<p data-bbox="19 478 483 585">Glaciares descubiertos y manchones de nieve</p> 	<p data-bbox="511 478 782 514"><u>Multiespectrales</u></p> <ul style="list-style-type: none"> <li data-bbox="608 542 695 578">Alos <li data-bbox="608 614 705 649">Aster <li data-bbox="608 678 724 714">Spot 4 <li data-bbox="608 742 724 778">Spot 5 <li data-bbox="608 806 743 842">Landsat 	<p data-bbox="946 478 1062 514"><u>Media</u></p> <ul style="list-style-type: none"> <li data-bbox="946 542 1091 578">10x10m <li data-bbox="946 614 1226 649">15x15m (visible) <li data-bbox="946 678 1091 714">20x20m <li data-bbox="946 742 1091 778">10x10m <li data-bbox="946 806 1381 842">30x30m (visible-IRC-IRM) 	<p data-bbox="1516 478 1912 514">Extracción automática</p> <p data-bbox="1516 542 1932 635">Clasificación supervisada por objetos</p> <p data-bbox="1516 664 1903 699">Índice de nieve (NSDI)</p> 
<p data-bbox="19 1013 473 1120">Glaciares de escombros y glaciares cubiertos</p> 	<p data-bbox="511 1013 830 1106"><u>Multiespectrales o pancromáticas</u></p> <ul style="list-style-type: none"> <li data-bbox="608 1135 859 1170">HRC (CBERS2) <li data-bbox="608 1206 743 1242">SPOT 5 <li data-bbox="608 1270 840 1306">Prism (ALOS) 	<p data-bbox="946 1013 1023 1049"><u>Alta</u></p> <ul style="list-style-type: none"> <li data-bbox="946 1149 1130 1185">2,5 x 2,5m <li data-bbox="946 1213 1246 1249">2,5x2,5m y 5x5m <li data-bbox="946 1278 1130 1313">2,5 x 2,5m 	<p data-bbox="1516 1013 1903 1049">Digitalización manual</p> 

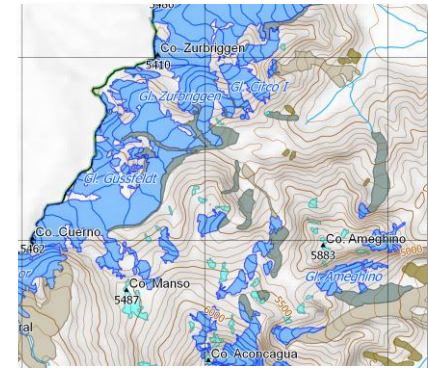
Methods

But also included field campaigns to verify the mapping and classification of ice masses

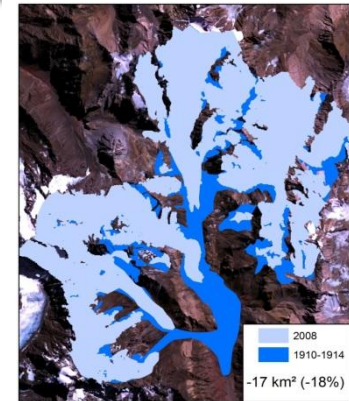


The NGI project includes three types of studies

Level 1: Identification, mapping and characterization of all ice masses that act as water reserves in the country



Level 2: Assessment of recent glacier fluctuations on selected areas along the Argentinean Andes



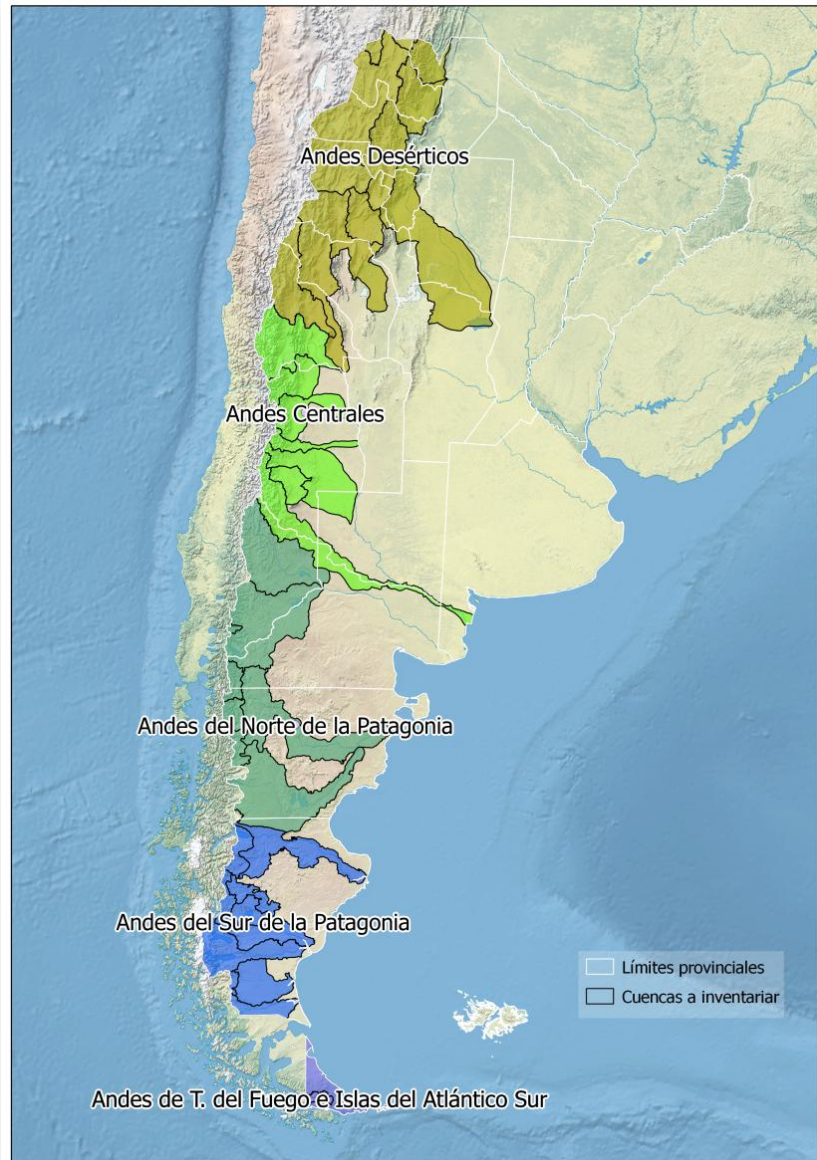
Level 3: mass balance, meteorological and hydrological studies in selected glaciers in different regions of the Andes

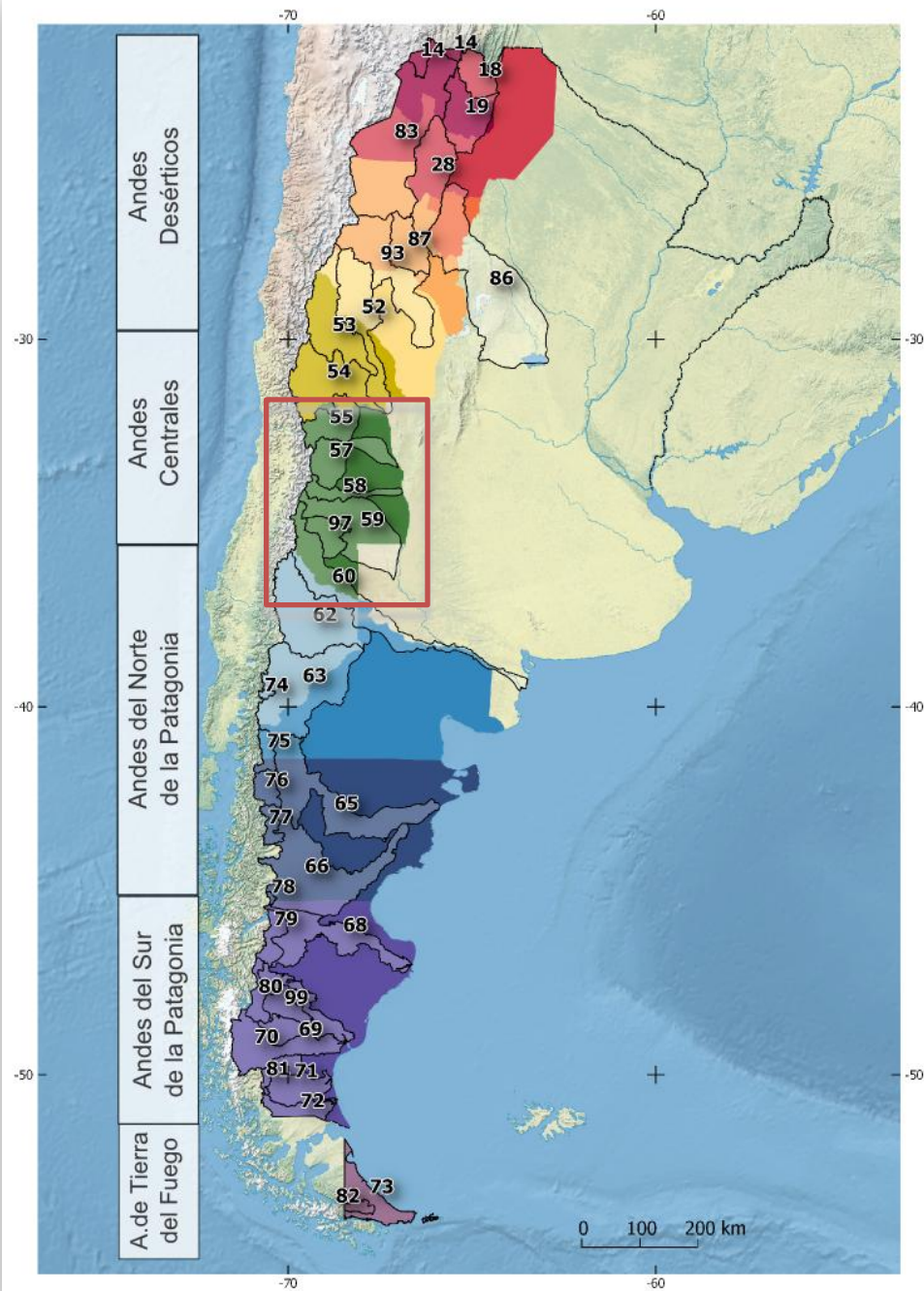


Geographical organization

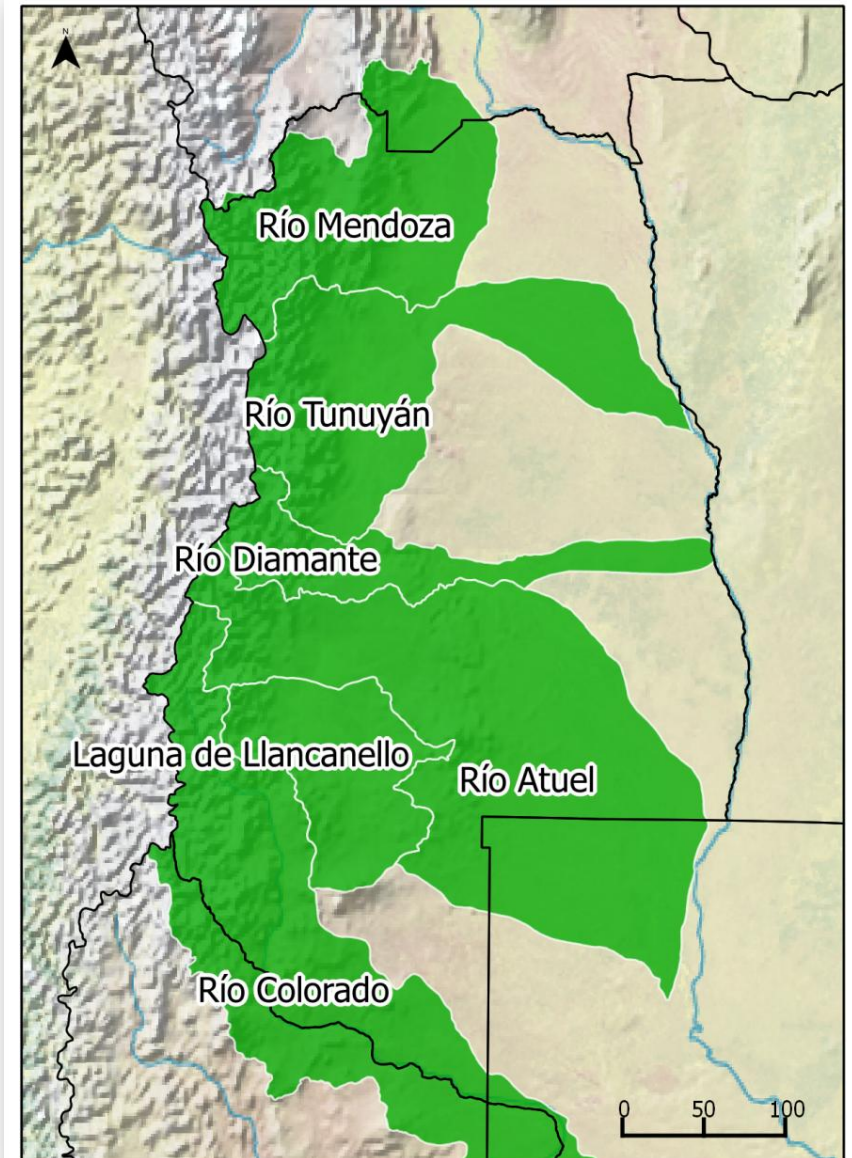
Due to the large extent of the Andes and the wide range of environments and conditions, the NGI was also organized in five major regions:

- A) Desert Andes**
- B) Central Andes**
- C) North Patagonian Andes**
- D) South Patagonian Andes**
- E) Andes of Tierra del Fuego**

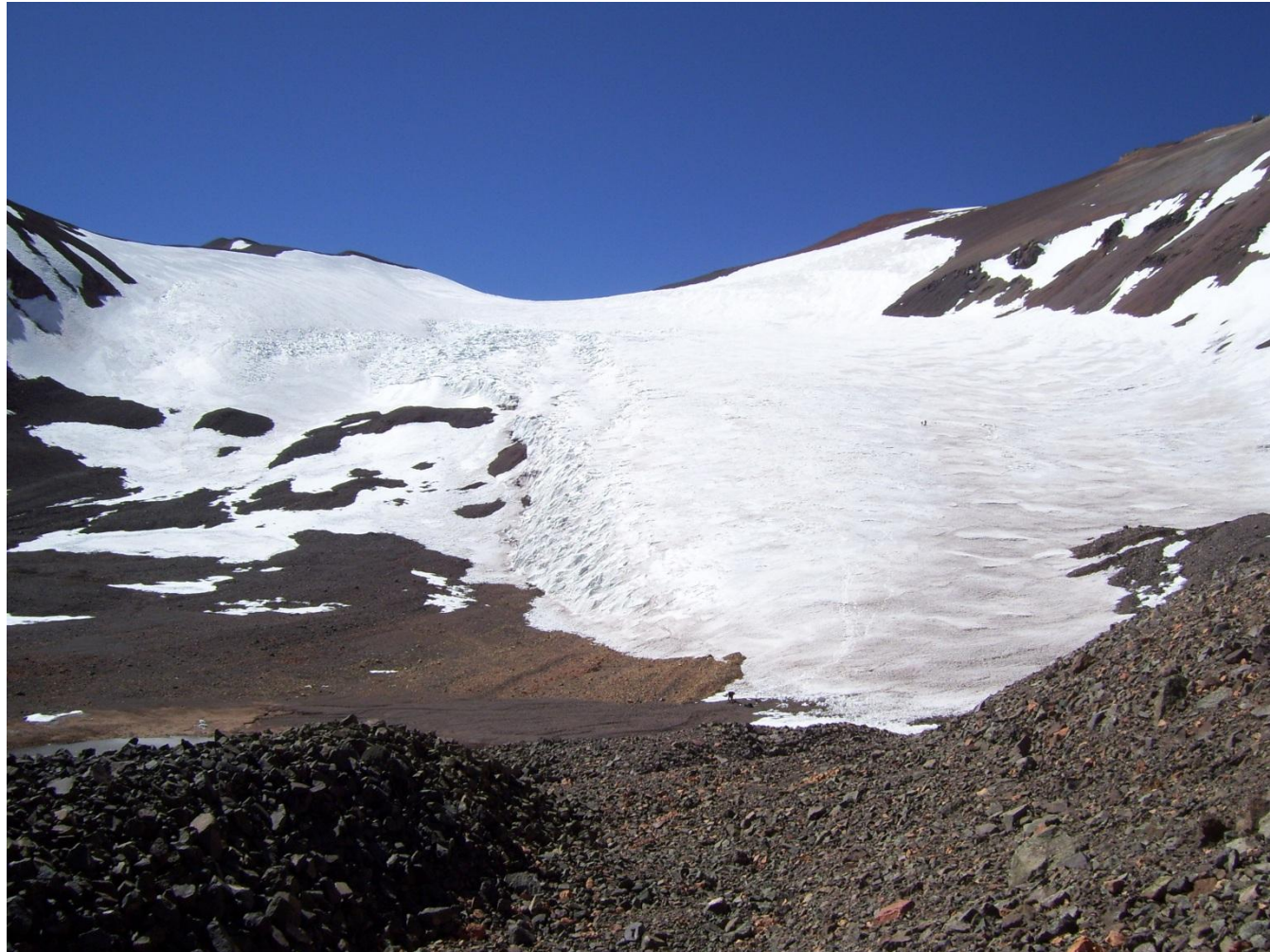
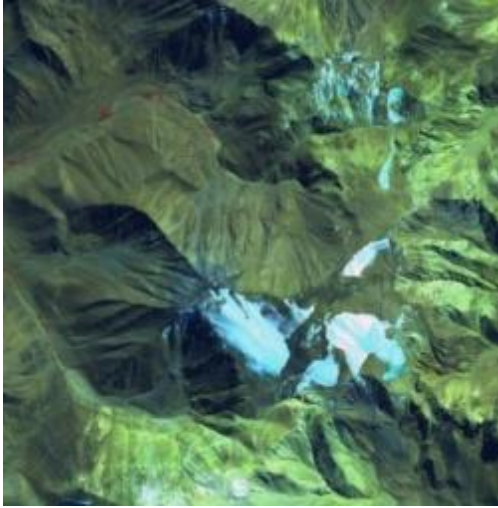




Within these regions the inventories were performed considering hydrological basins or specific sectors

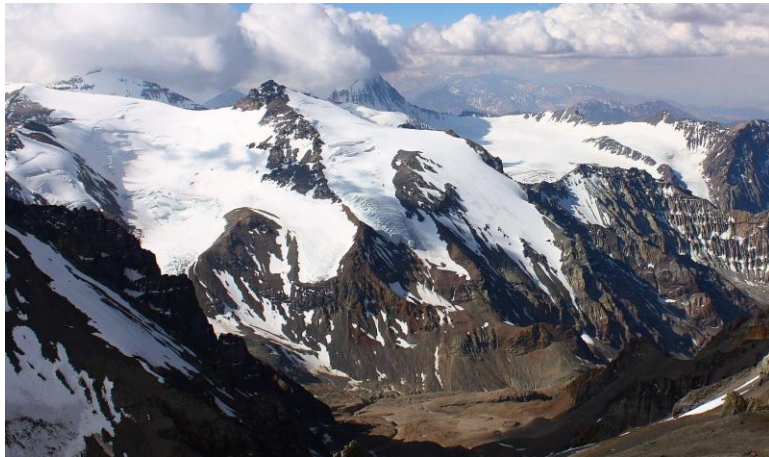


Desert Andes (21°- 31°S)

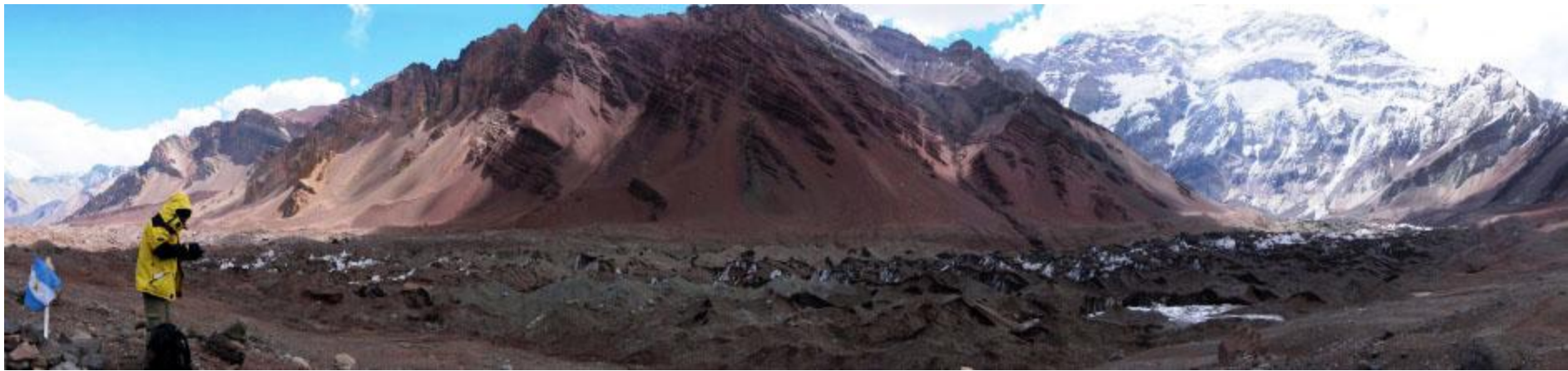
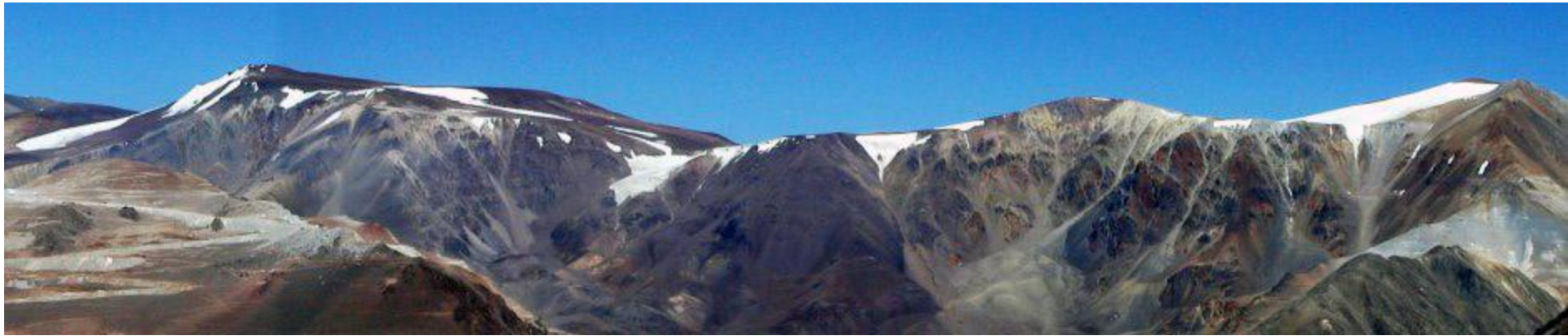




Central Andes (31°- 35°S)





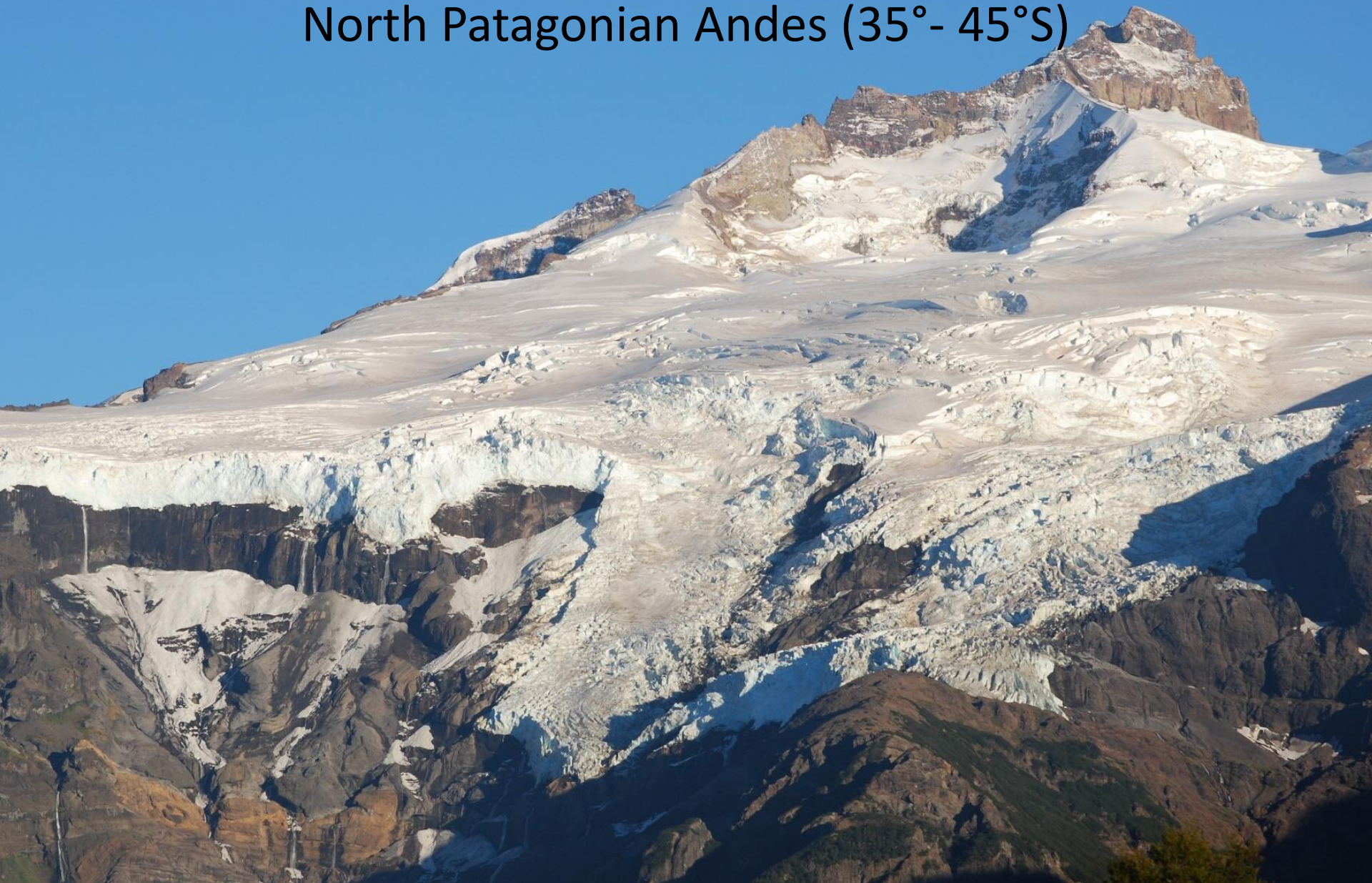




Glaciar de escombros Morenas Coloradas

Fuente: D. Trombotto IANIGLA

North Patagonian Andes (35°- 45°S)



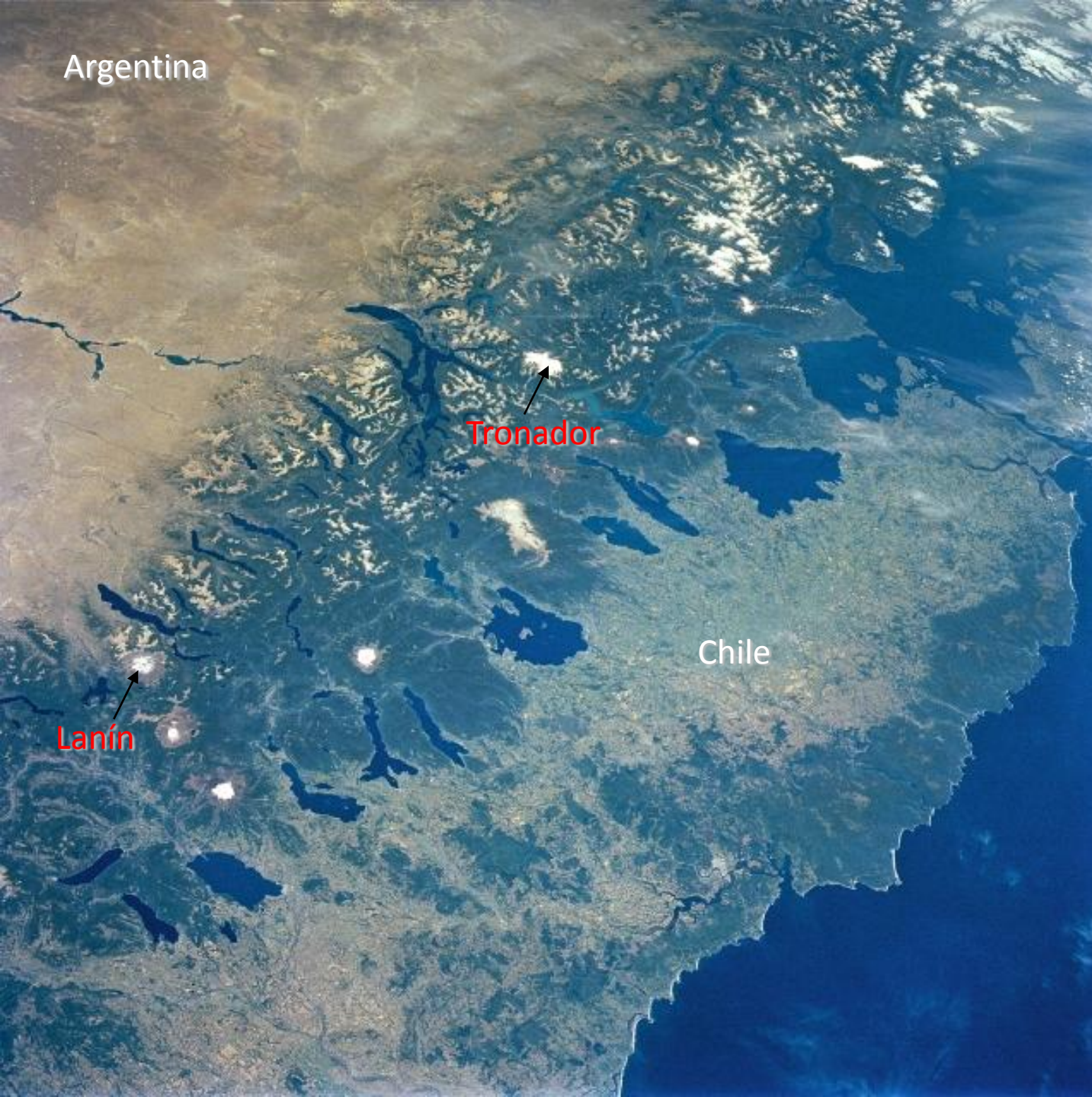
Monte Tronador

Argentina

Tronador

Lanín

Chile



Volcán Lanín



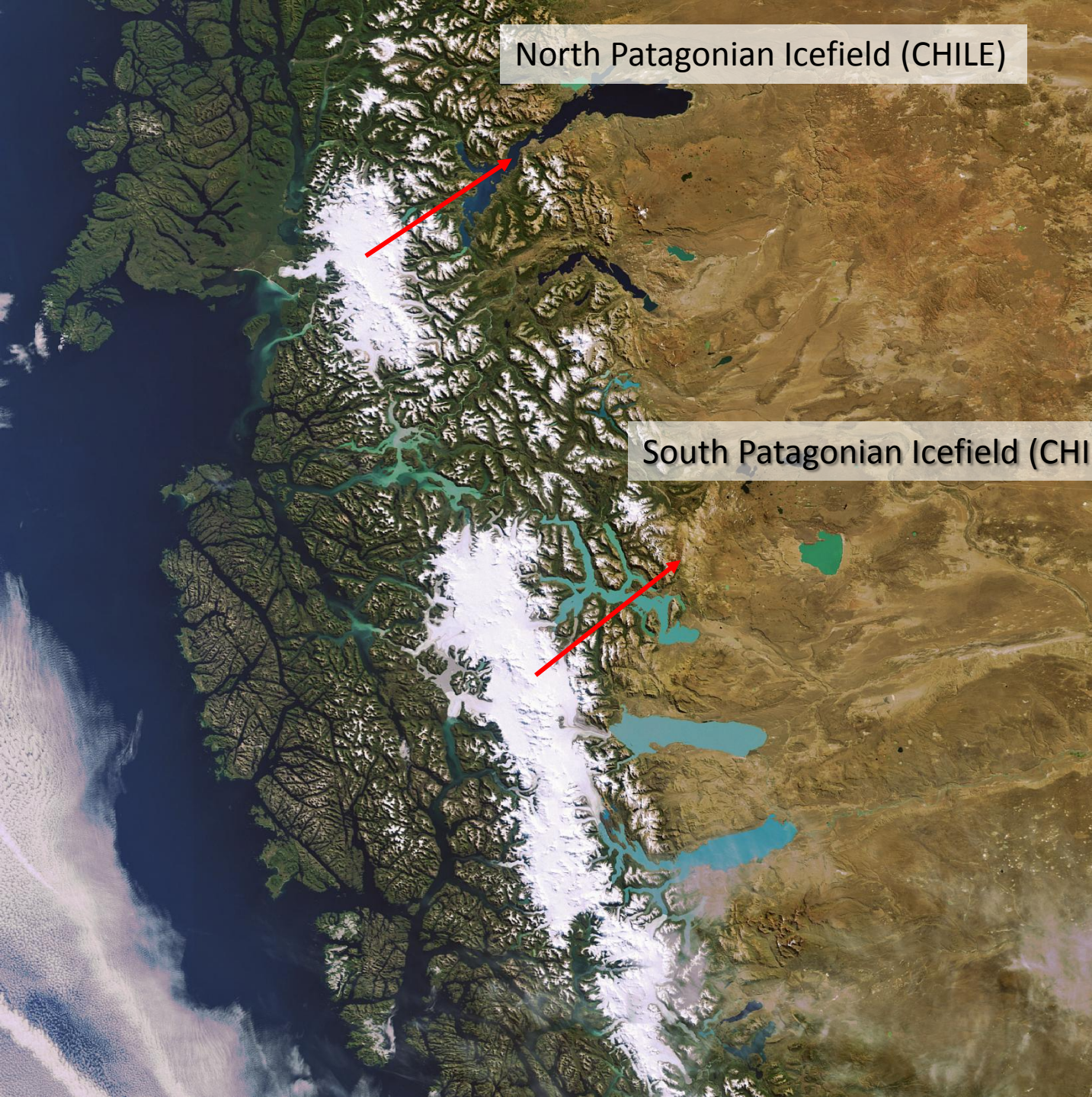
South Patagonian Andes (45°- 52°S)



Glaciar Upsala

North Patagonian Icefield (CHILE)

South Patagonian Icefield (CHILE-ARGENTINA)





Perito Moreno glacier





Tierra del Fuego (52° - 55°S)



TIERRA DEL FUEGO

Cordón Martial



Ushuaia

Cerro Alvear



Glaciar Vinciguerra





Cerros Grande, Solo, cordón del Torre y cordón del Fitz Roy

Aproximación al Chaltén. Provincia de Santa Cruz

**The first National Glacier Inventory
was published in May 2018**

www.glaciaresargentinos.gob.ar



Co. Reichert

5138

Gl. de las Vacas

Co. Cúpula de Güssfeldt

5486

R. de las Vacas

Co. Zurbruggen

5410

Gl. de las Vacas

Gl. de las Vacas

Gl. Zurbruggen Gl. Circo I

3500

5000

4500

5000

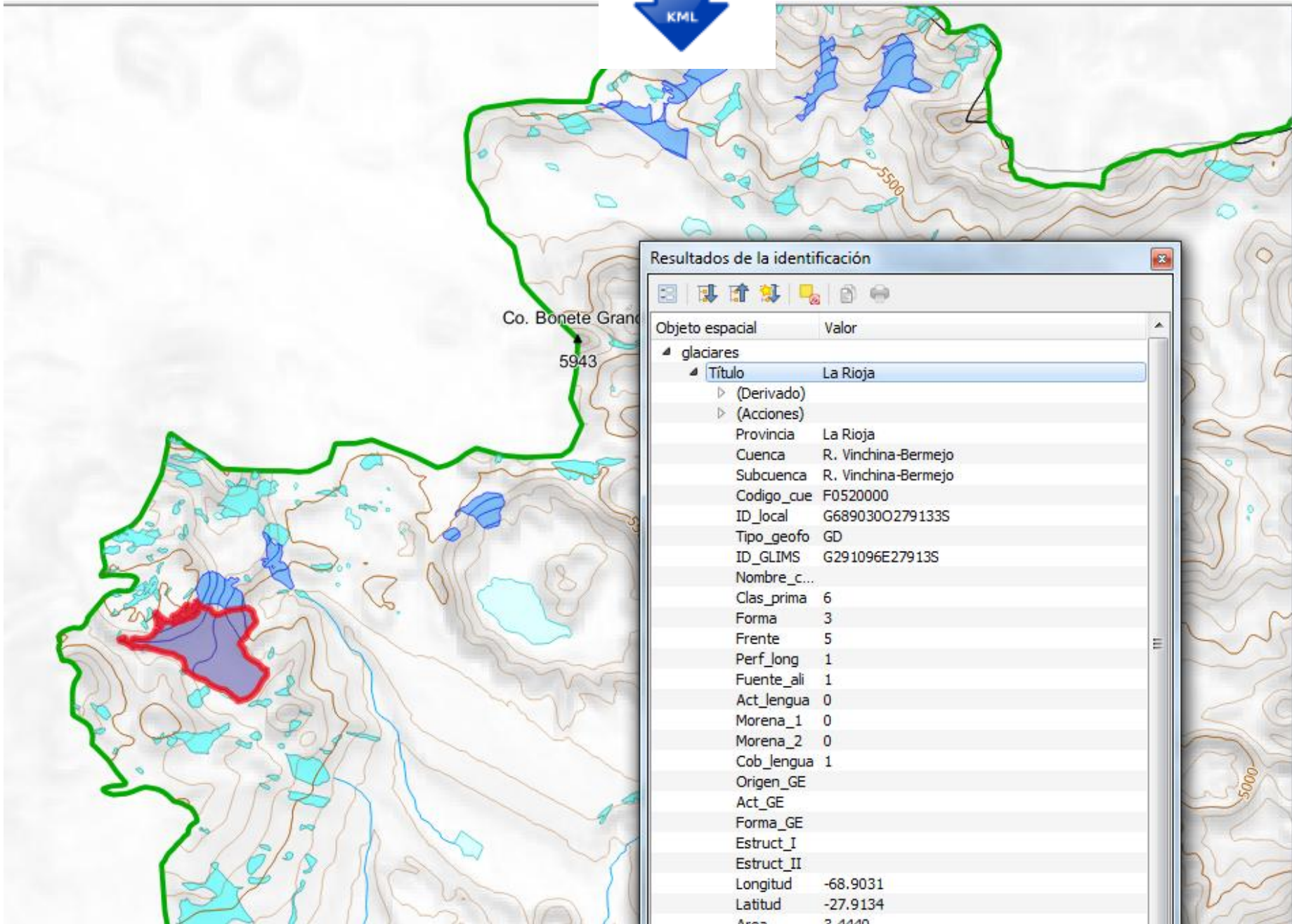
Gl. Güssfeldt

Co. Ameghino

5883

nes-Superior

NGI database



Maps

INVENTARIO NACIONAL DE GLACIARES

IANIGLA U.N.CUYO GOBIERNO DE MENDOZA
 COXICET SECRETARÍA DE AMBIENTE Y DESARROLLO SUSTENTABLE DE LA NACIÓN

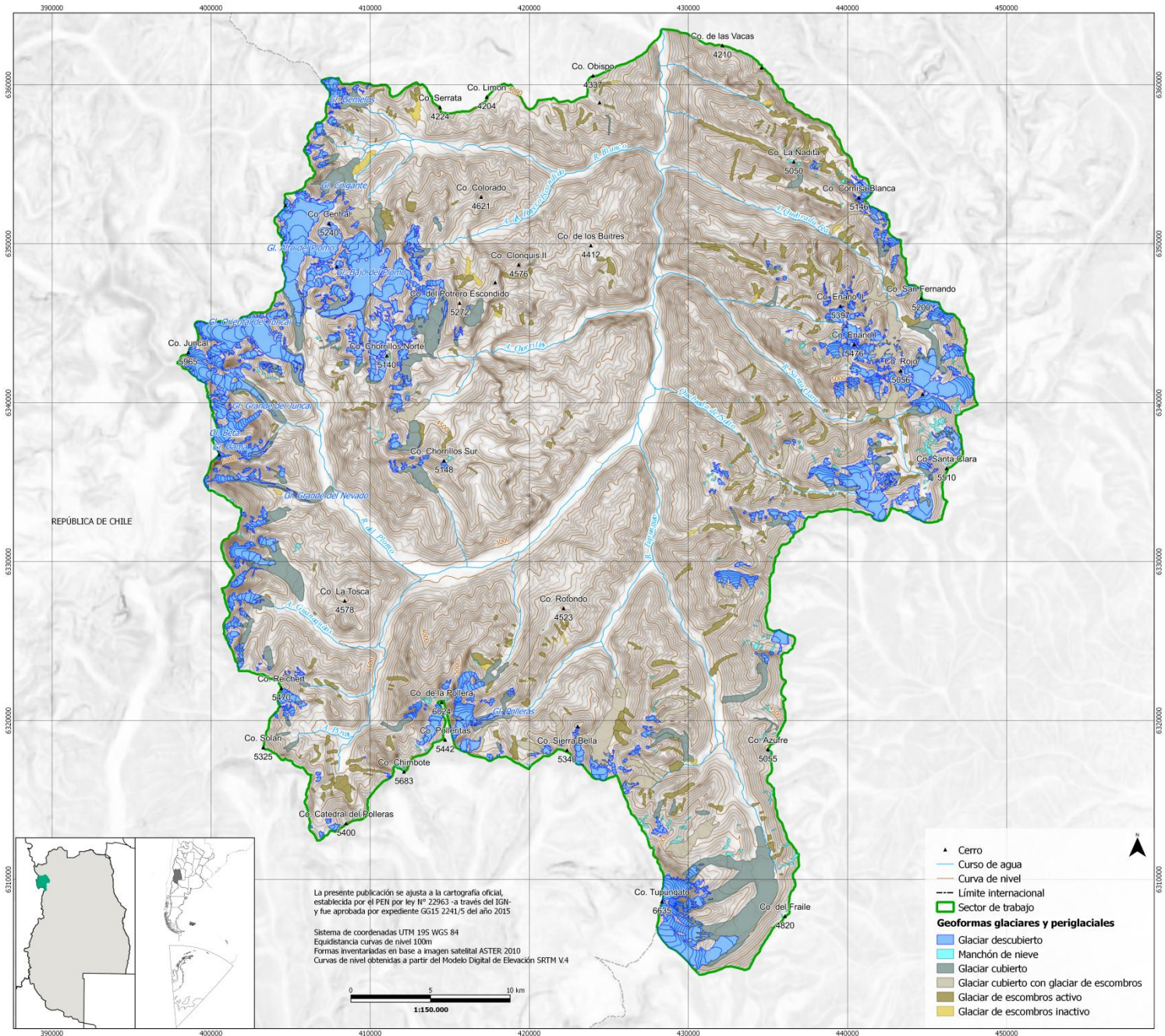
Cuenca del río Mendoza

Subcuenca del río Tupungato
 Provincia de Mendoza

Fecha de elaboración: Diciembre 2015



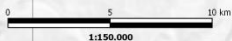
Glaciar Tupungato, subcuenca río Tupungato (Foto: Pablo Betancourt)



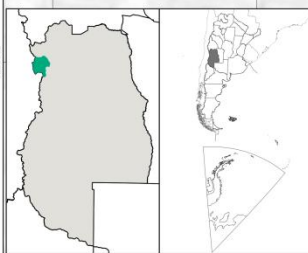
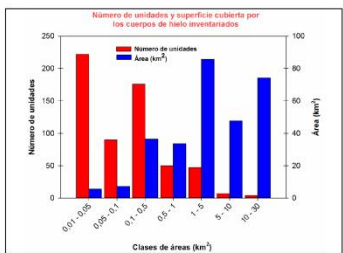
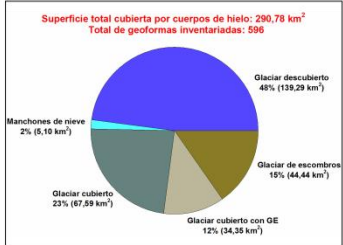
REPÚBLICA DE CHILE

La presente publicación se ajusta a la cartografía oficial, establecida por el PEN por ley Nº 22963 -a través del IGN- y fue aprobada por expediente GG15 2241/5 del año 2015

Sistema de coordenadas UTM 19S WGS 84
 Equidistancia curvas de nivel 100m
 Formas inventariadas en base a imagen satelital ASTER 2010
 Curvas de nivel obtenidas a partir del Modelo Digital de Elevación SRTM V4



- ▲ Cerro
 - Curso de agua
 - Curva de nivel
 - - - Límite internacional
 - ▭ Sector de trabajo
- Geoformas glaciares y periglaciales**
- Glaciar descubierto
 - Manchón de nieve
 - Glaciar cubierto
 - Glaciar cubierto con glaciar de escombros
 - Glaciar de escombros activo
 - Glaciar de escombros inactivo





Reports and maps
are available for 69
basins and sub-basins
along the Andes



Informe de las subcuencas
de los ríos de las Cuevas
y de las Vacas
Cuenca del río Mendoza

Provincia de Mendoza



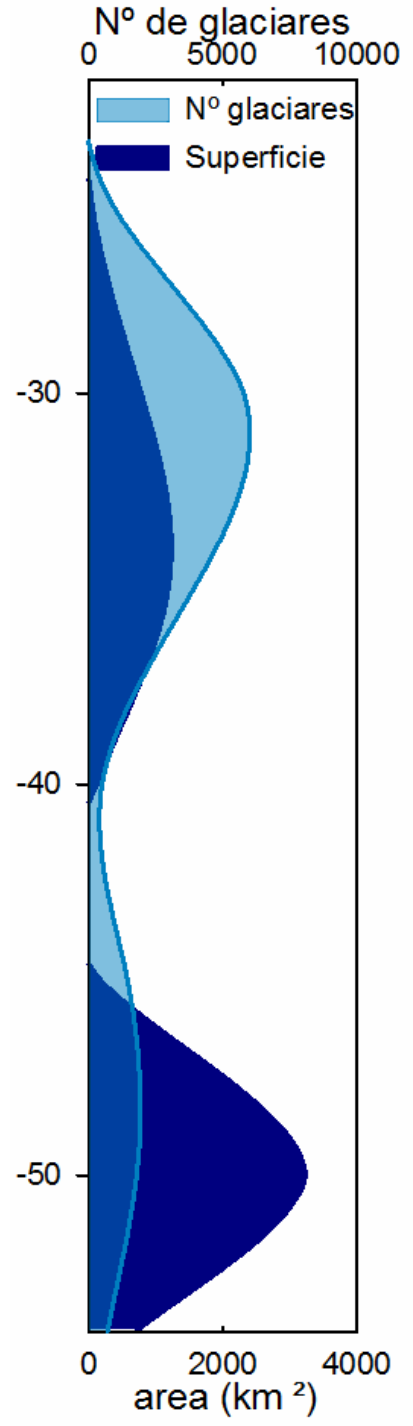
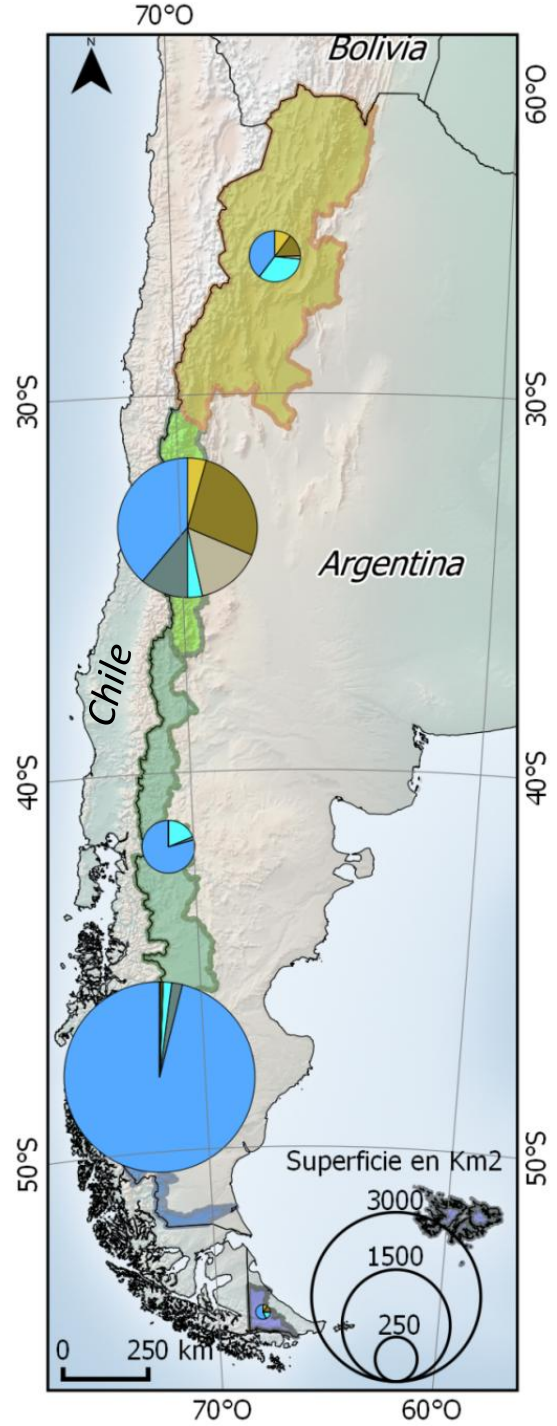
National totals

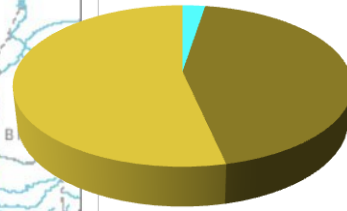
16078 ice bodies

5768 km² in surface area

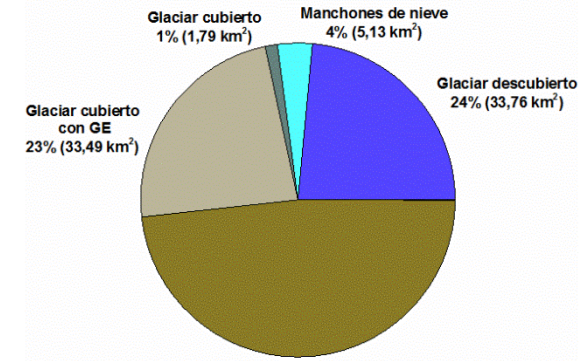
- Glaciar descubierto
- Glaciar cubierto
- Manchón de nieve
- Glaciar cubierto con GE
- Glaciar de escombros activo
- Glaciar de escombros inactivo

- Glaciar descubierto
- Glaciar cubierto
- Manchón de nieve
- Glaciar cubierto con GE
- Glaciar de escombros activo
- Glaciar de escombros inactivo

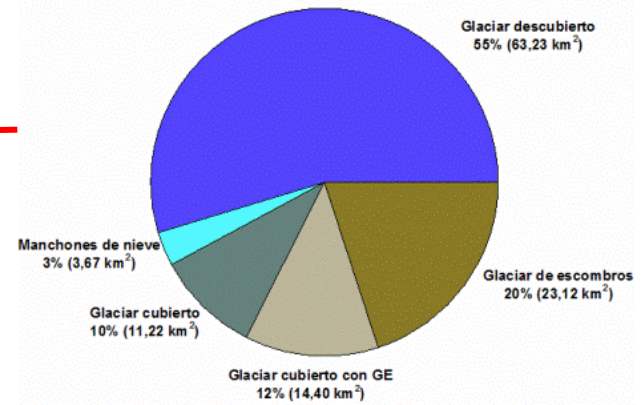




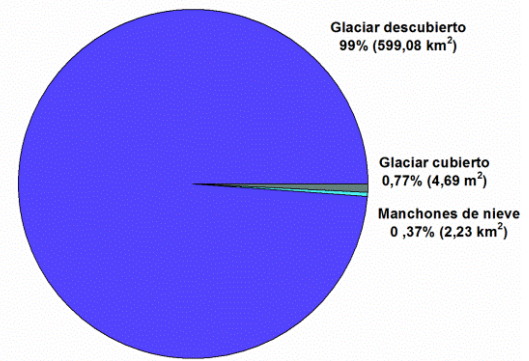
Superficie total cubierta por cuerpos de hielo: 143,39 km²
Total de geoformas inventariadas: 854

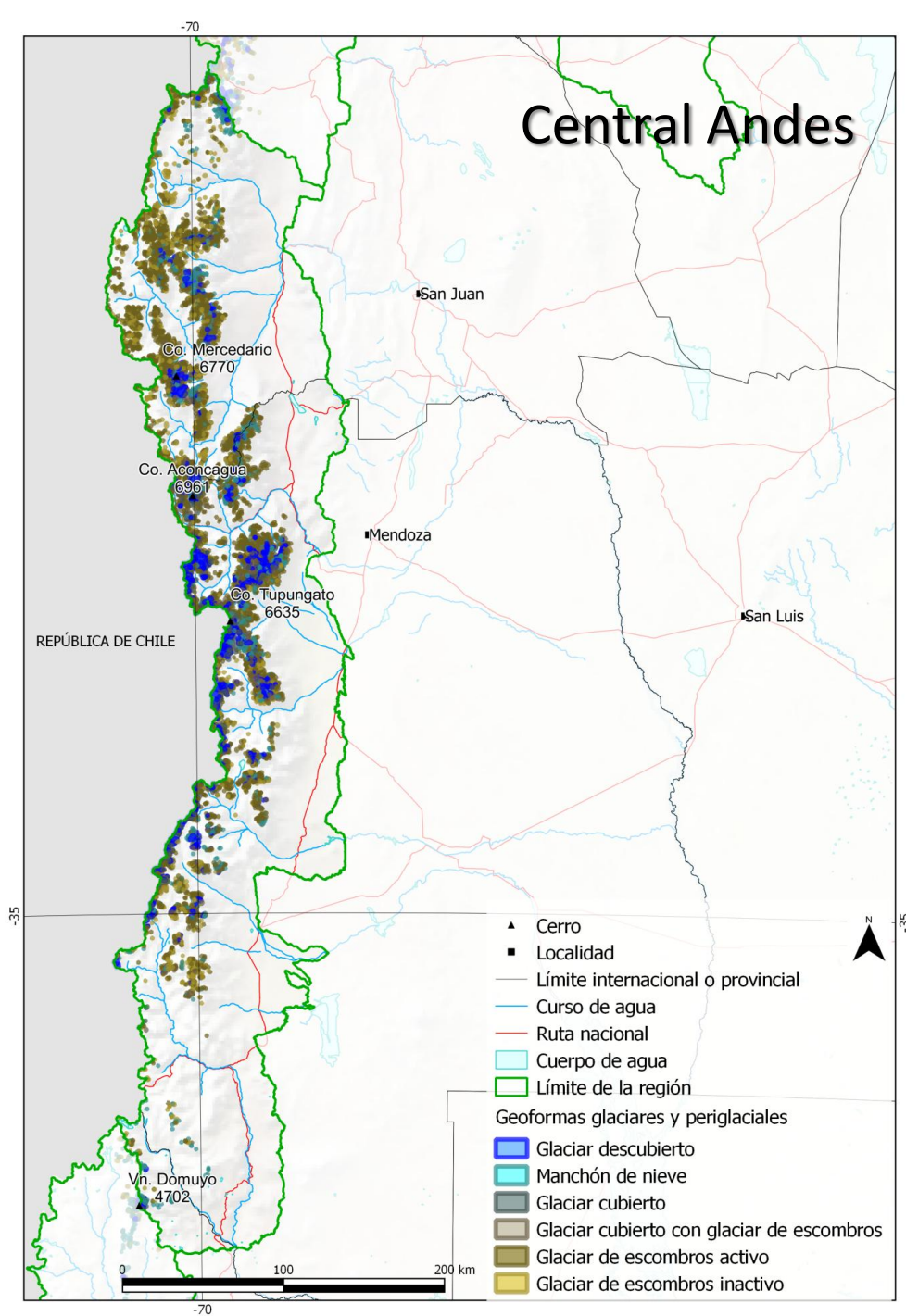
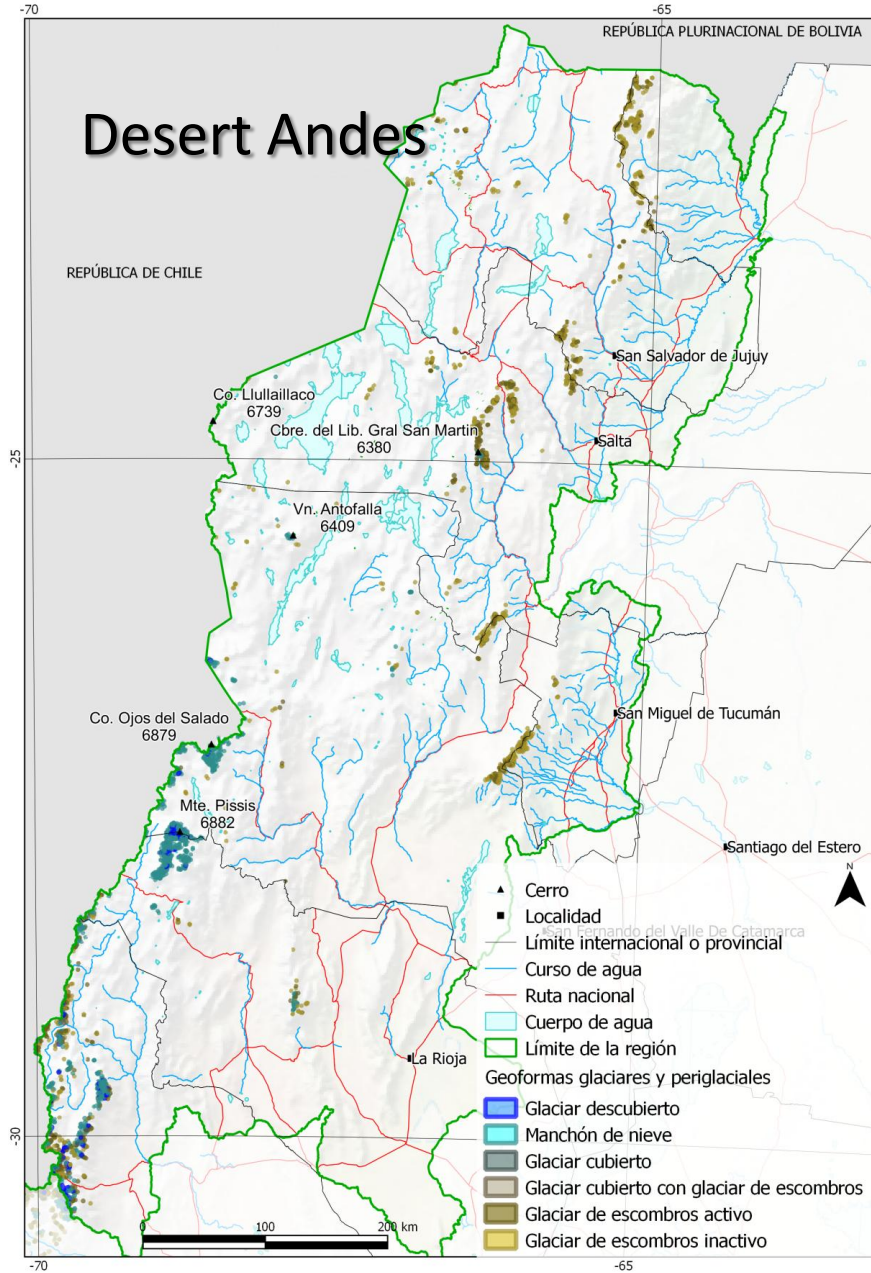


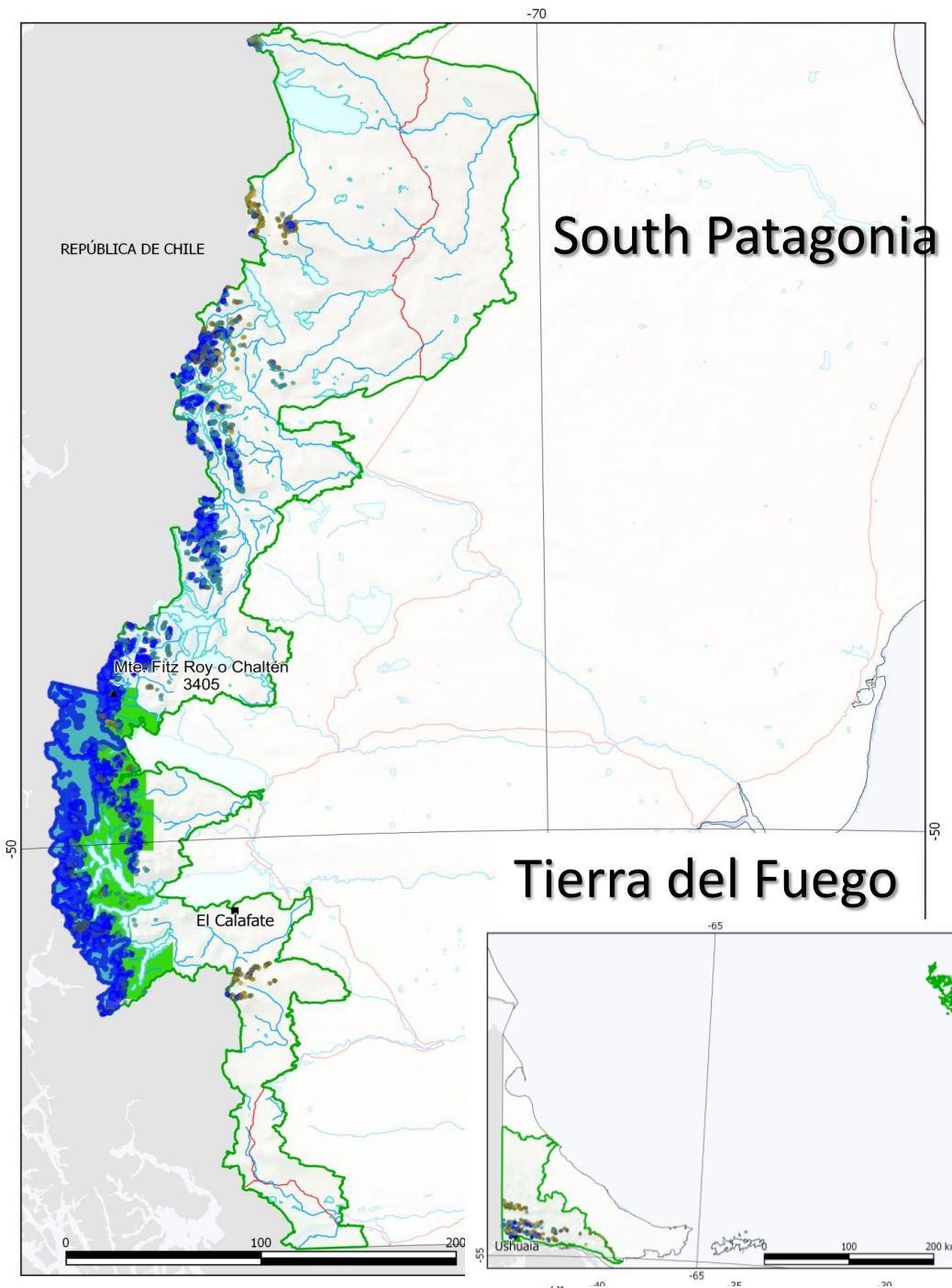
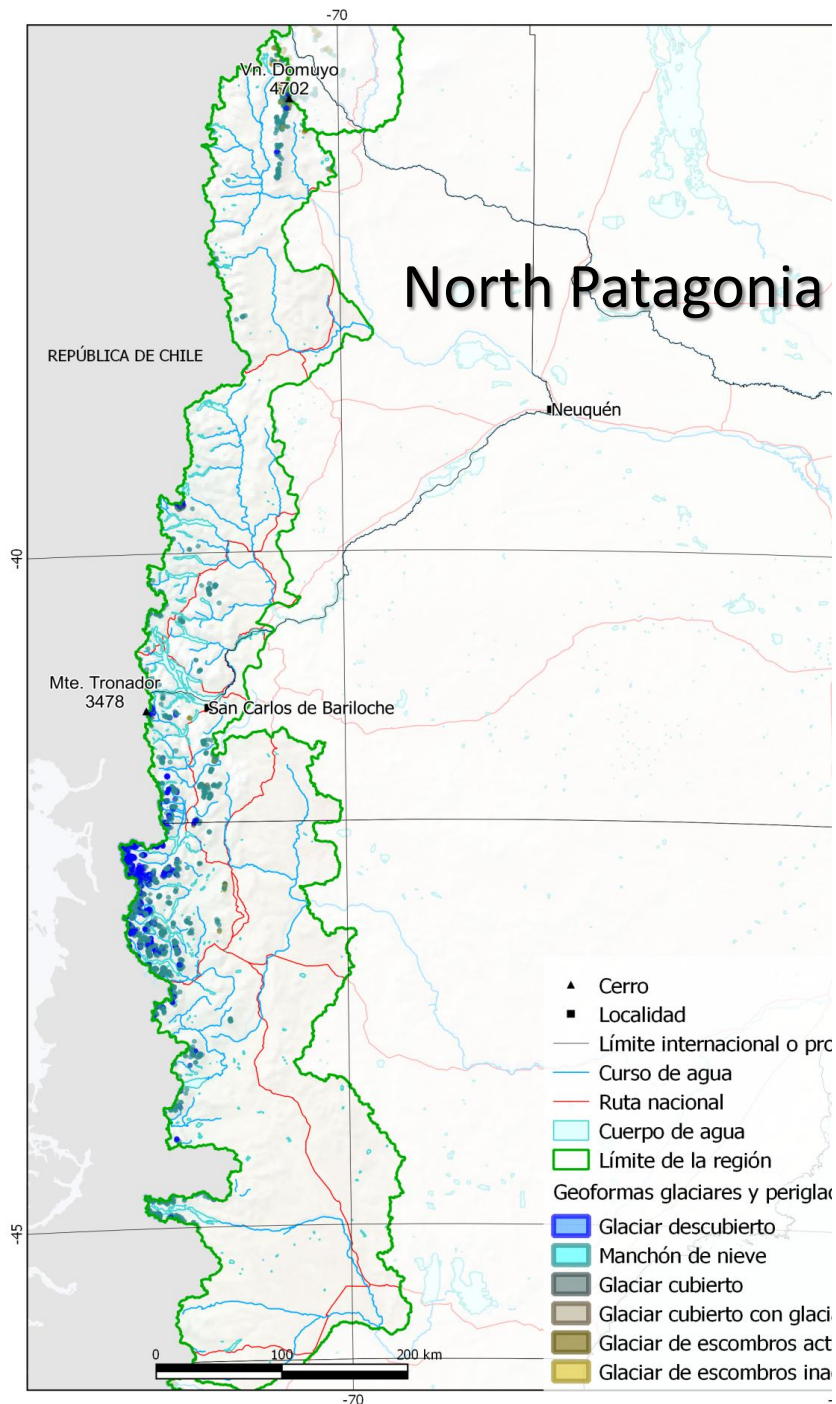
Superficie total cubierta por cuerpos de hielo: 115,63 km²
Total de geoformas inventariadas: 389



Superficie total cubierta por cuerpos de hielo: 606 km²
Total de geoformas inventariadas: 194

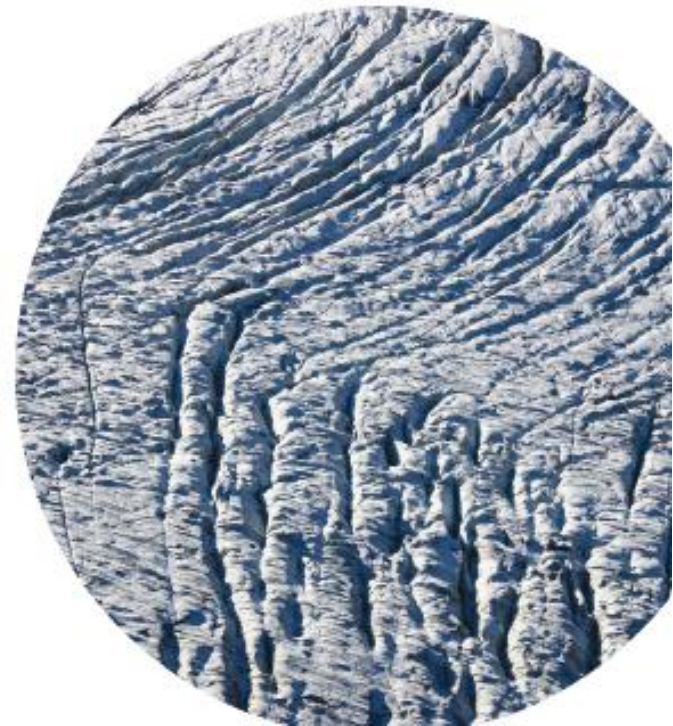
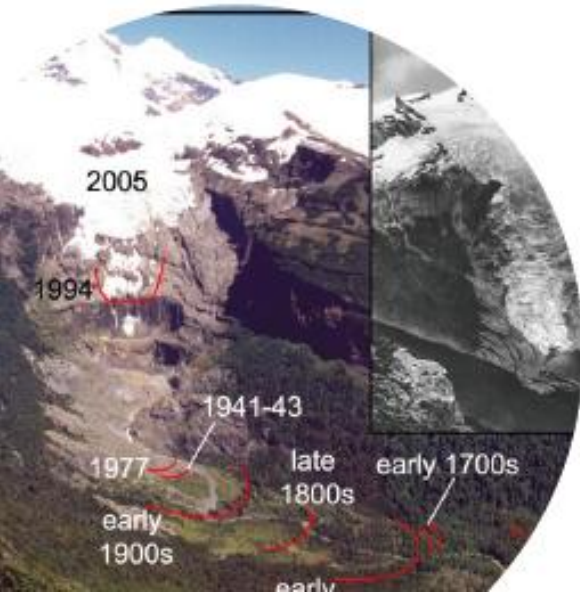






Next steps

- Publication of Level 1 results in the scientific literature, dissemination of results, incorporation of NGI data on scientific analyses
- **Initiation of Level 2 studies (fluctuations of glaciers)**
- Continuation and expansion of Level 3 studies now including rock glacier sites





**INVENTARIO
NACIONAL
DE GLACIARES**

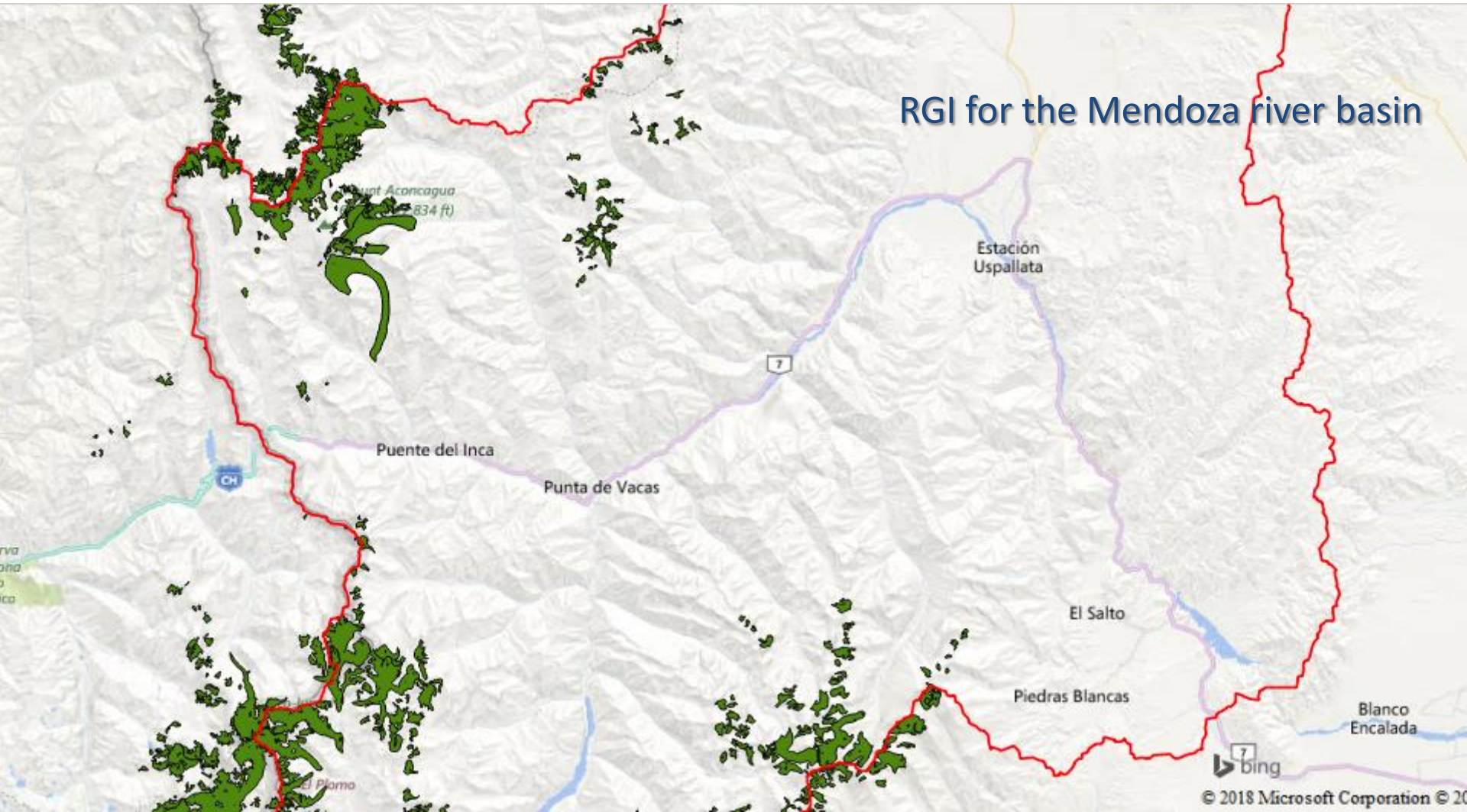
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Some applications of the results

Comparison with the Randolph Glacier Inventory



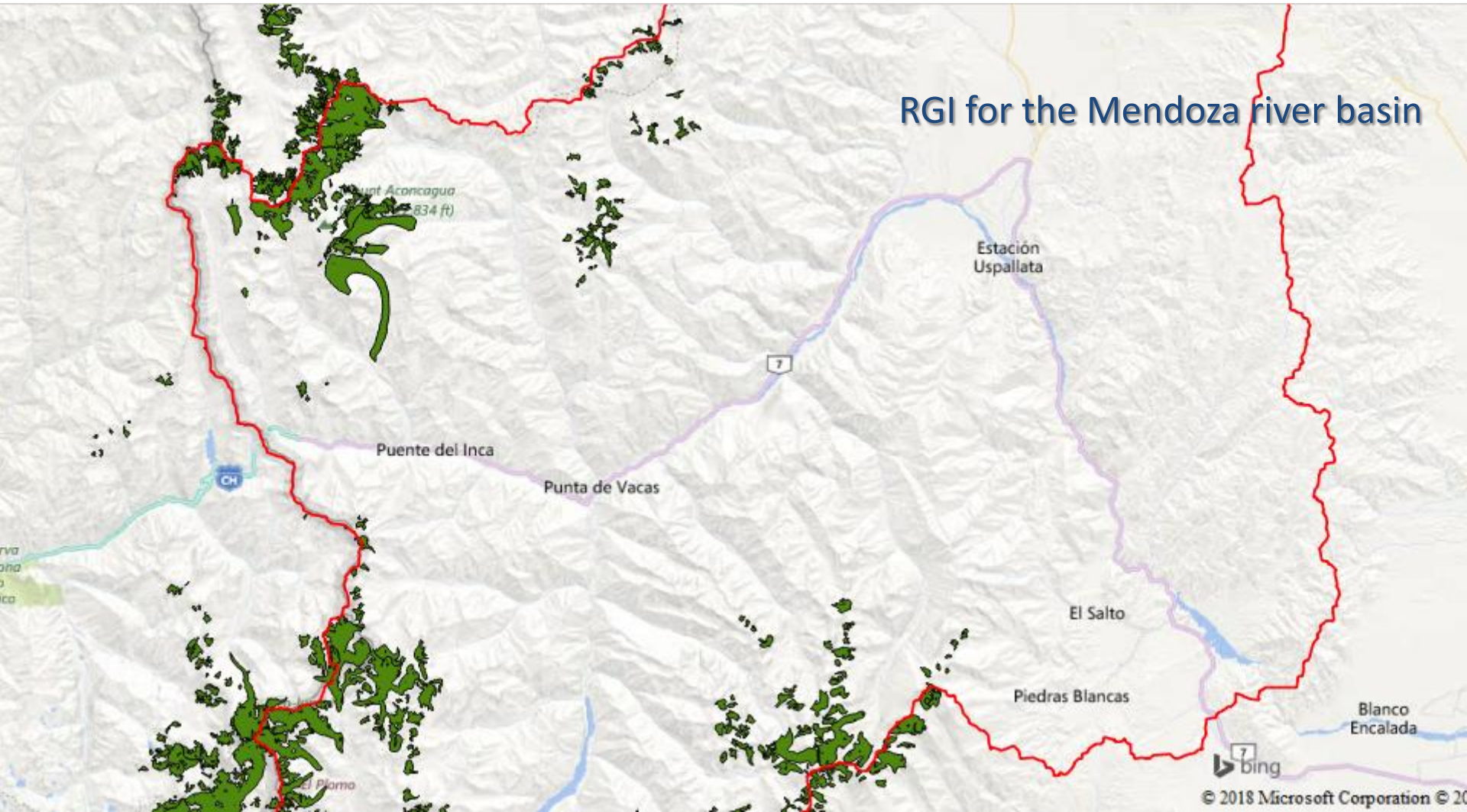
A map of South America with the outlines of the continent and its countries. Red dots are scattered across the mountainous regions, primarily the Andes, indicating the locations of glaciers. The dots are most densely packed in the southern part of the continent, particularly in Chile and Argentina, and also form a significant line through the central Andes in Peru and Bolivia. There are also some scattered dots in the northern Andes of Colombia and Venezuela.

Randolph Glacier Inventory, GLIMS

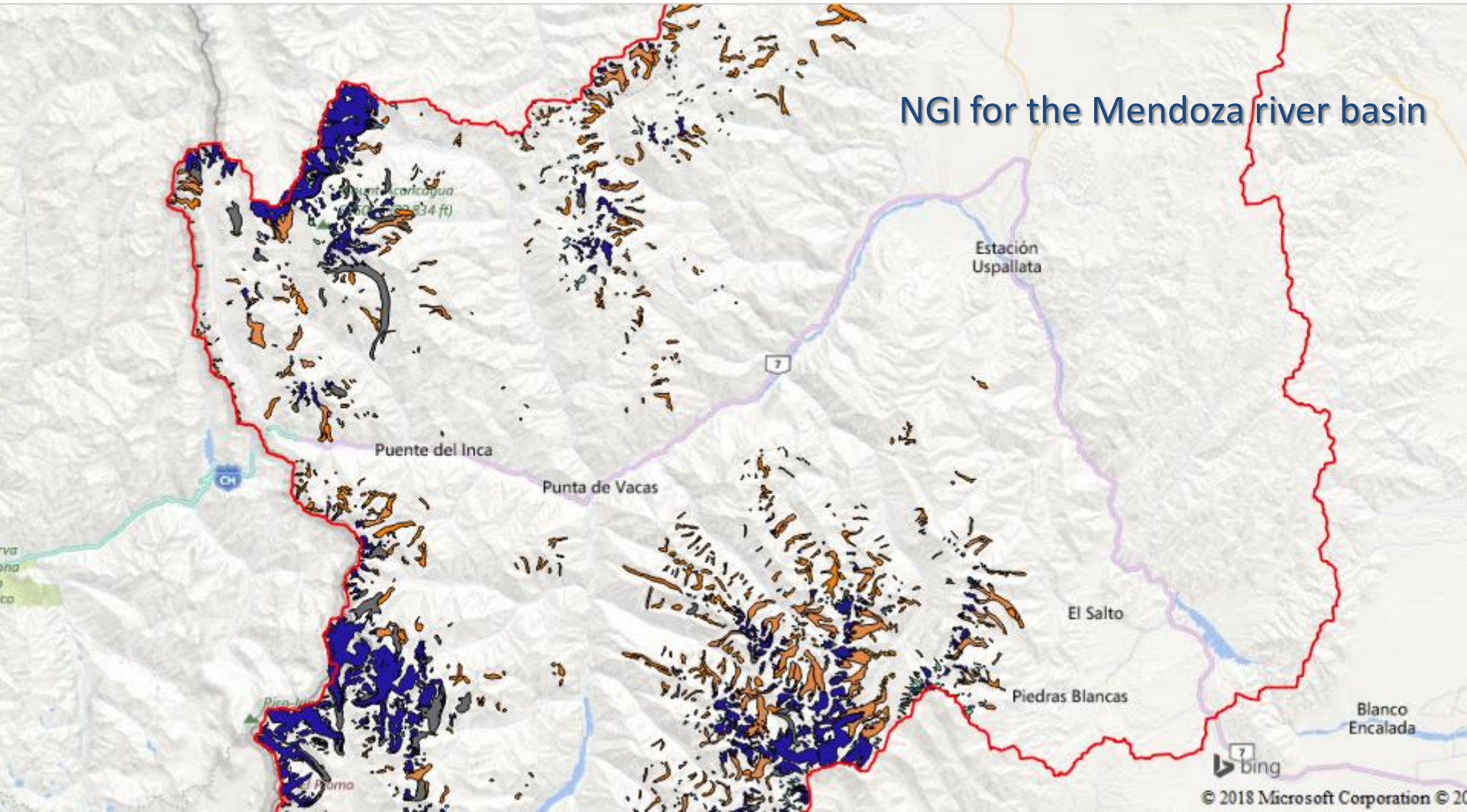
Regularly updated and freely available for the entire Andes

Some applications of the results

Comparison with the Randolph Glacier inventory

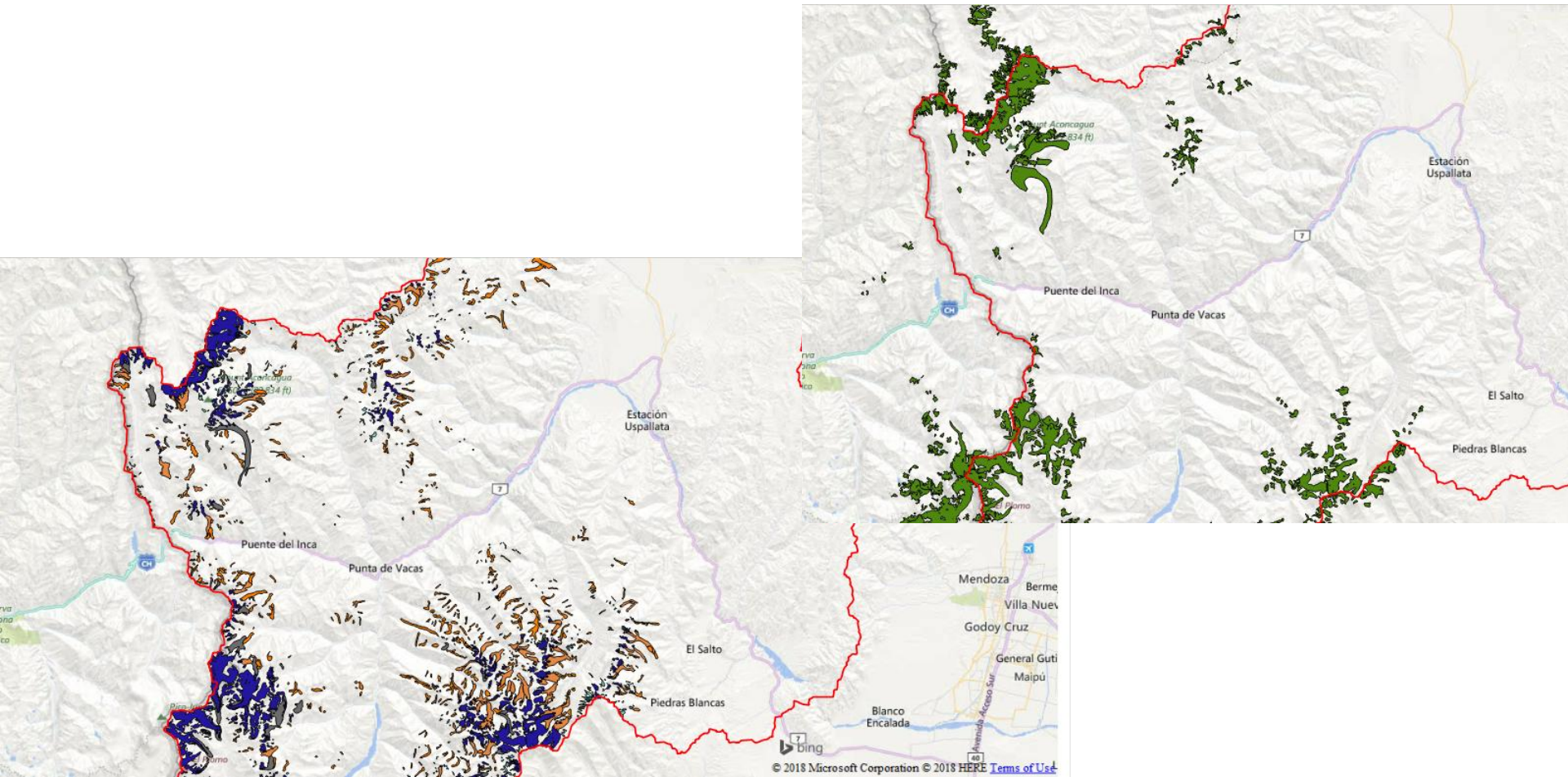


Some applications of the results

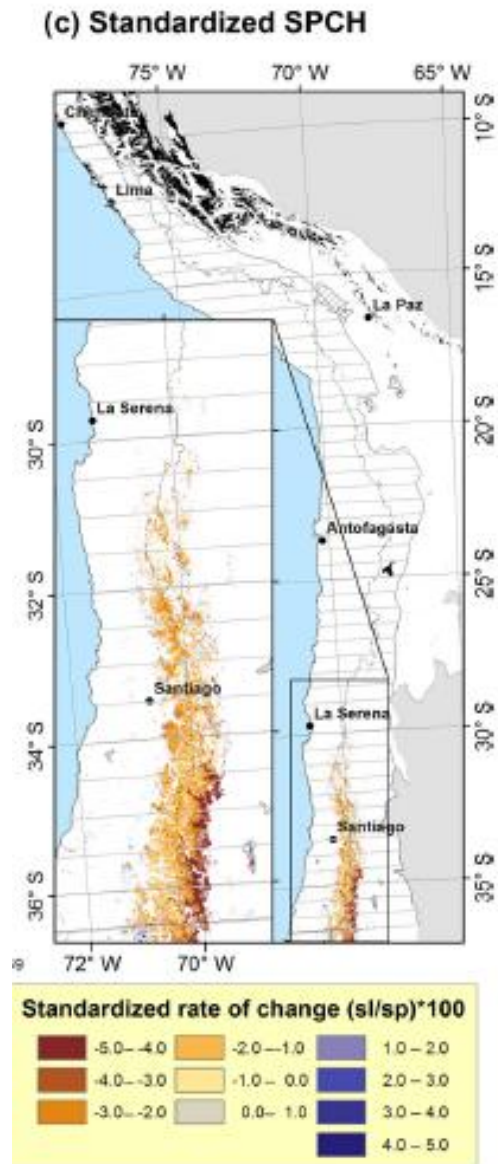
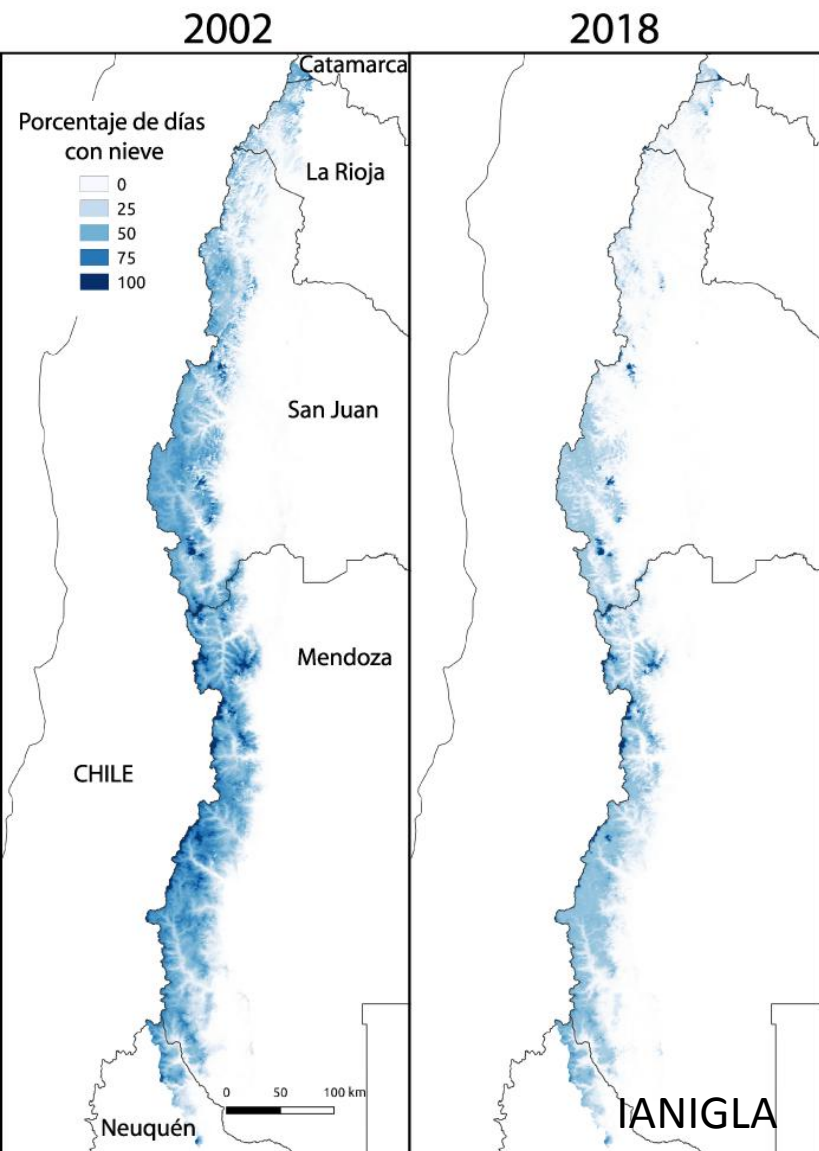


Some applications of the results

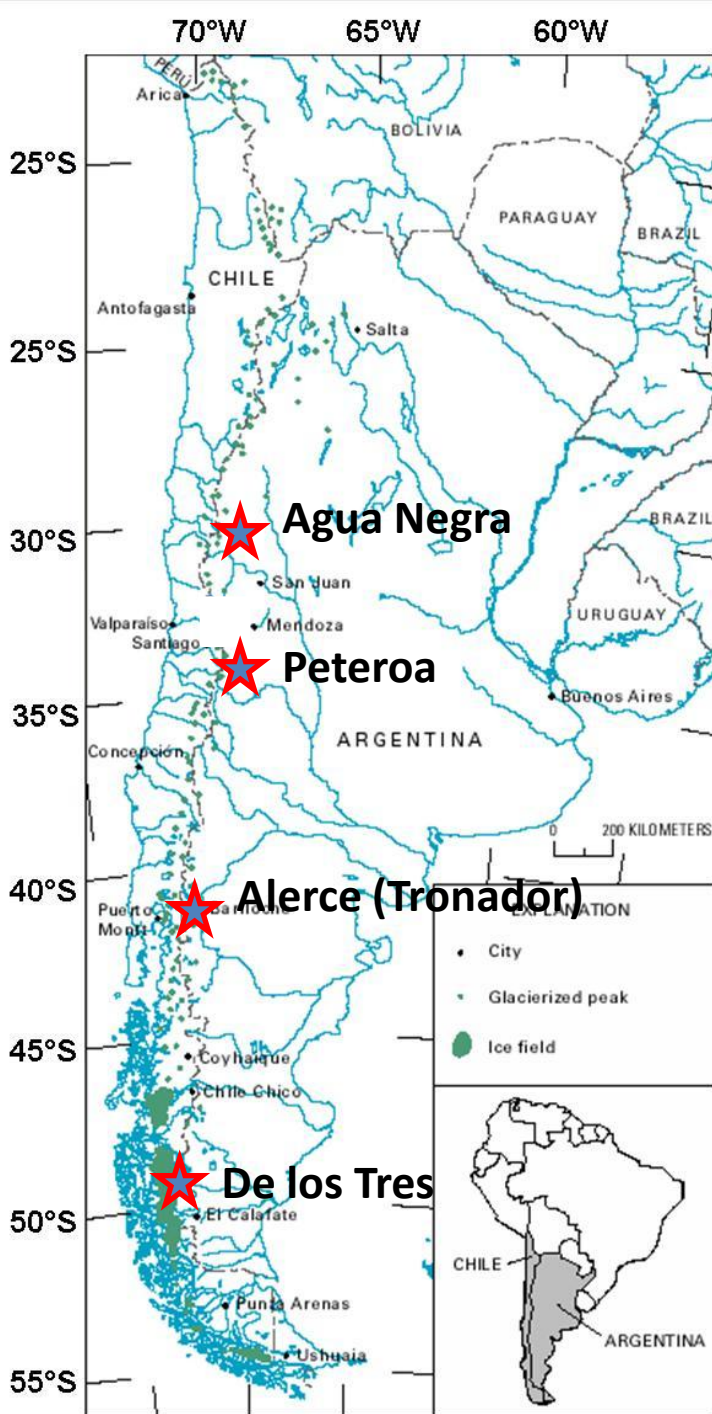
Together with improved estimates of the hydrological contribution of glaciers to a given basin, the inclusion of rock glaciers in these national initiatives could also help improve global inventories such as the RGI



Improved hydrological assessments of mountain water availability are particularly relevant on the Argentinean (drier) side of the central Andes, where the recent lack of snow is particularly noteworthy



Saavedra et al. 2016



As part of Level 3 of the NGI, we started a program to monitor the mass balance and hydro-meteorological variations of four selected glaciated sites along the Andes in Argentina

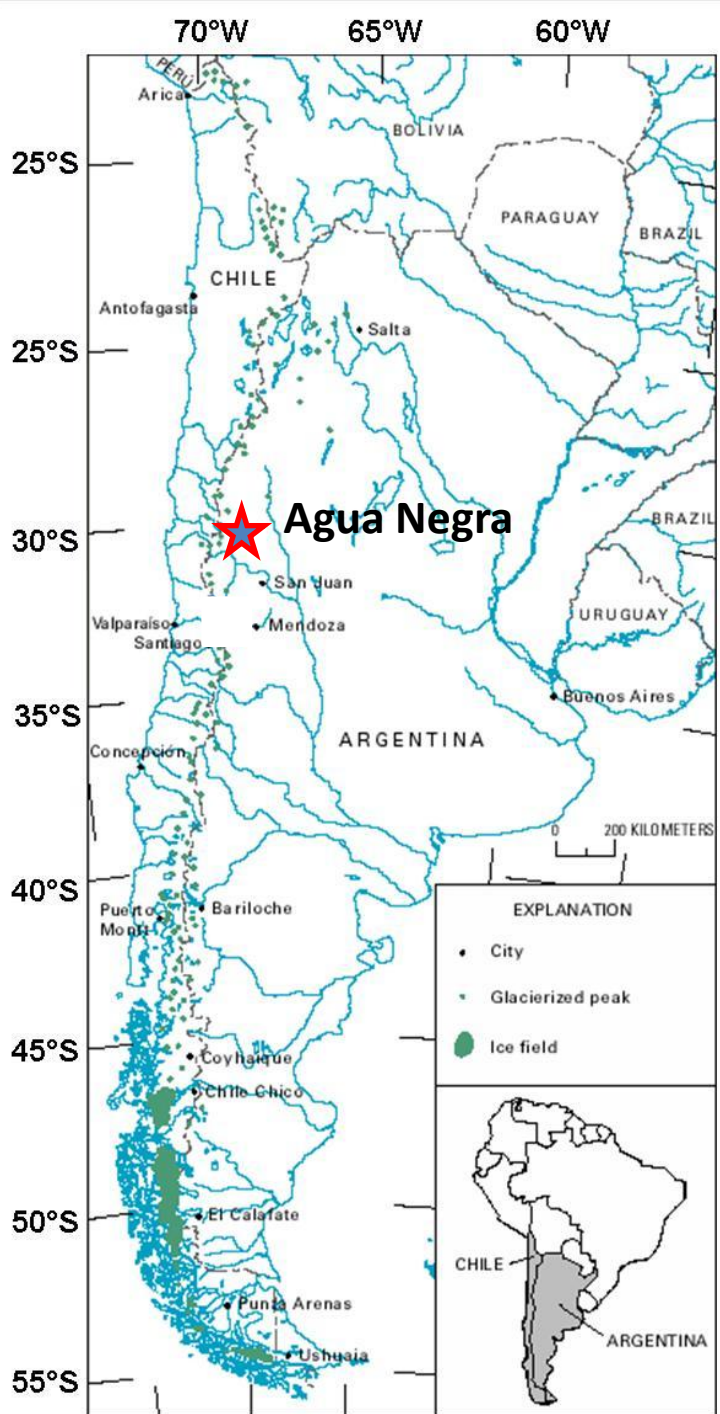
Nivel 3 del ING

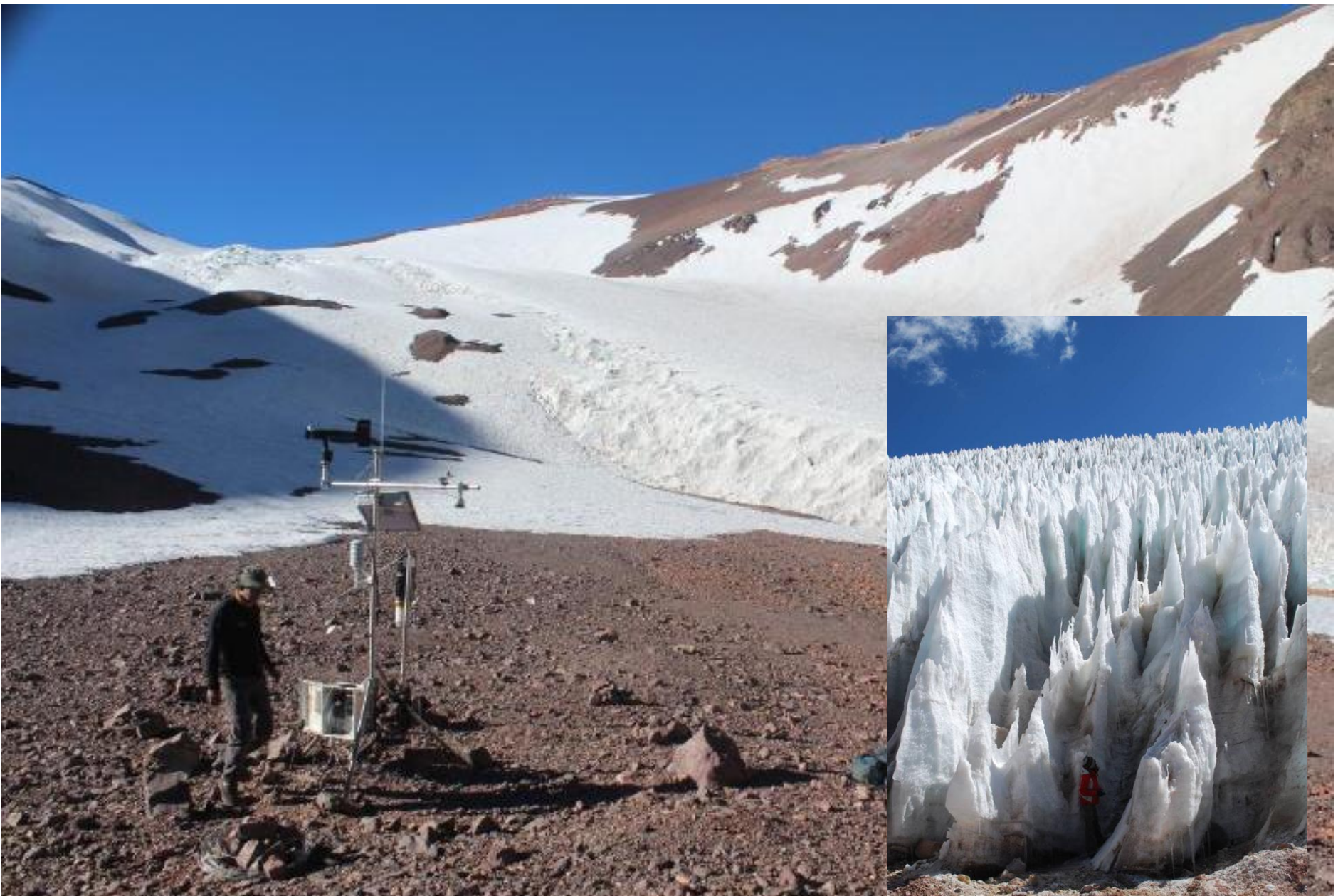
Calicata en el glaciar De los Tres. Santa Cruz, 2013. Foto: JP. Scarpa

Accumulation at glaciar de los Tres
(south Patagonia)

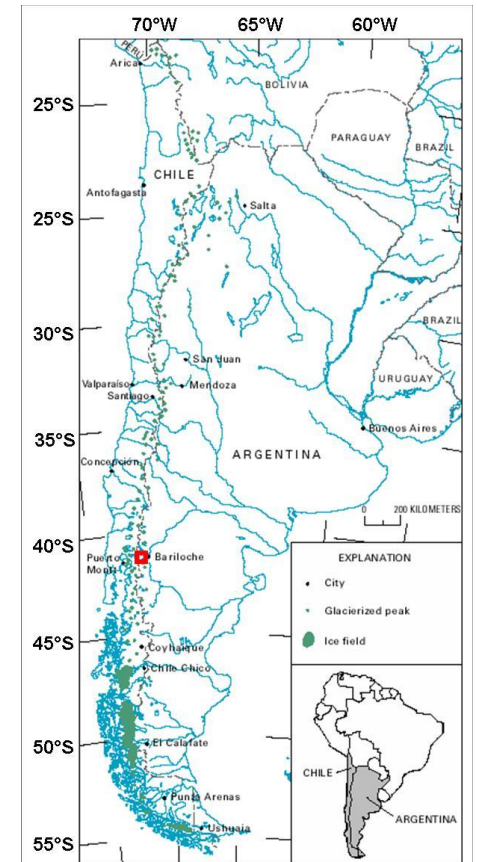


Installation of ablation stake at glaciar
Alerce (north Patagonia)



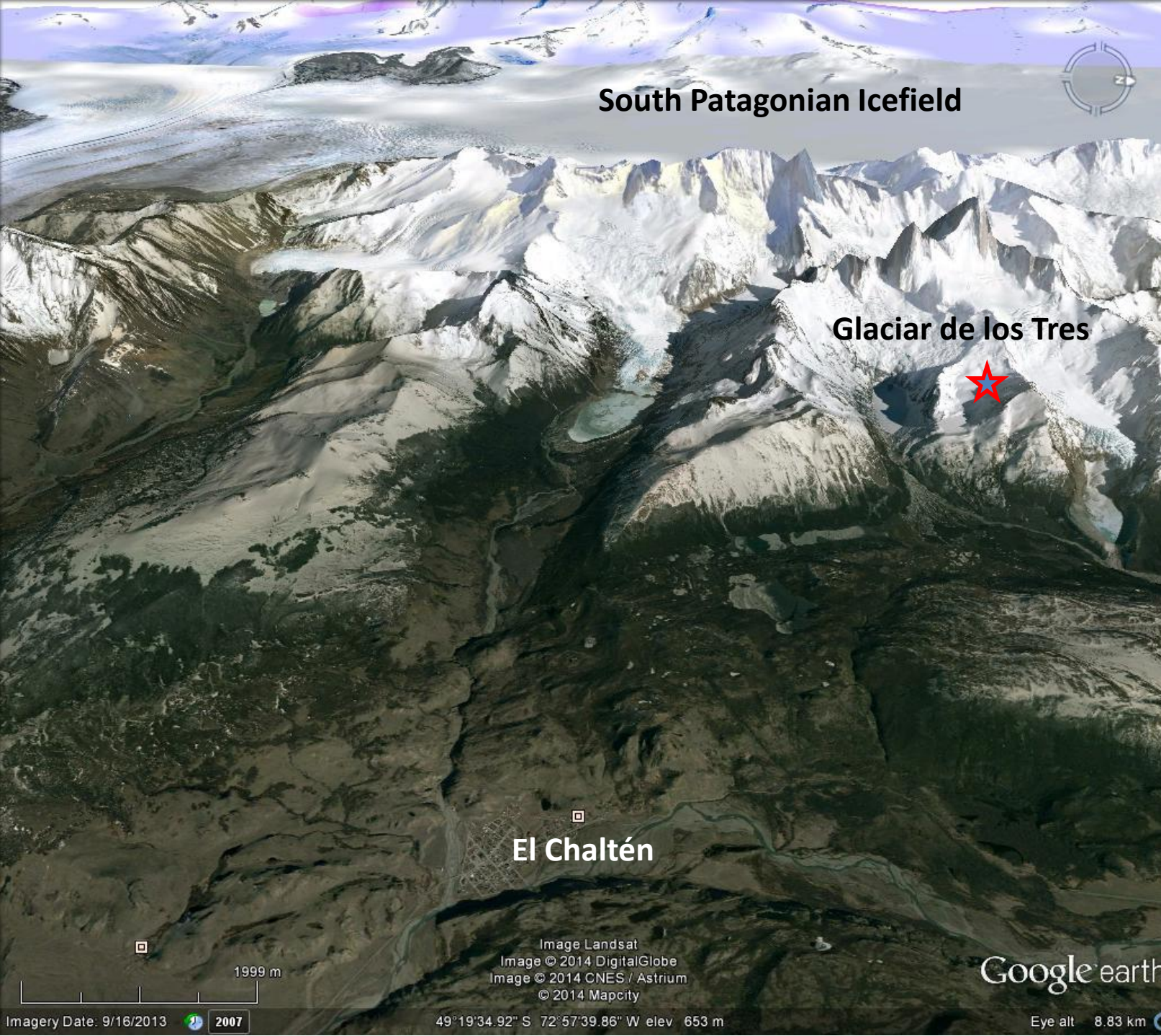


Monte Tronador (41°S) North Patagonian Andes



AWS La Almohadilla





South Patagonian Icefield

Glaciar de los Tres

El Chaltén

De los Tres

Google earth

Imagery Date: 9/16/2013 2007

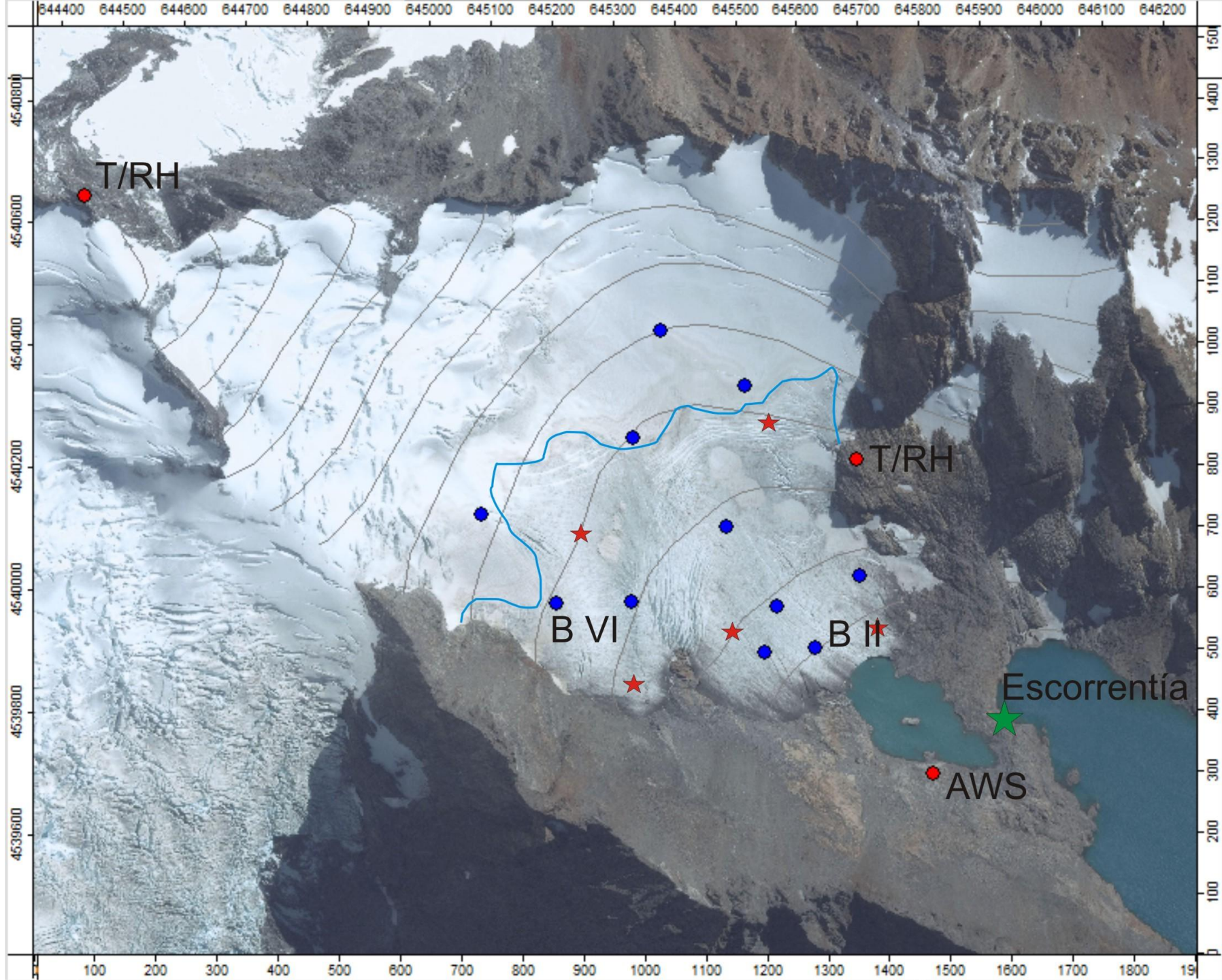
49°19'34.92" S 72°57'39.86" W elev 653 m

Eye alt 8.83 km

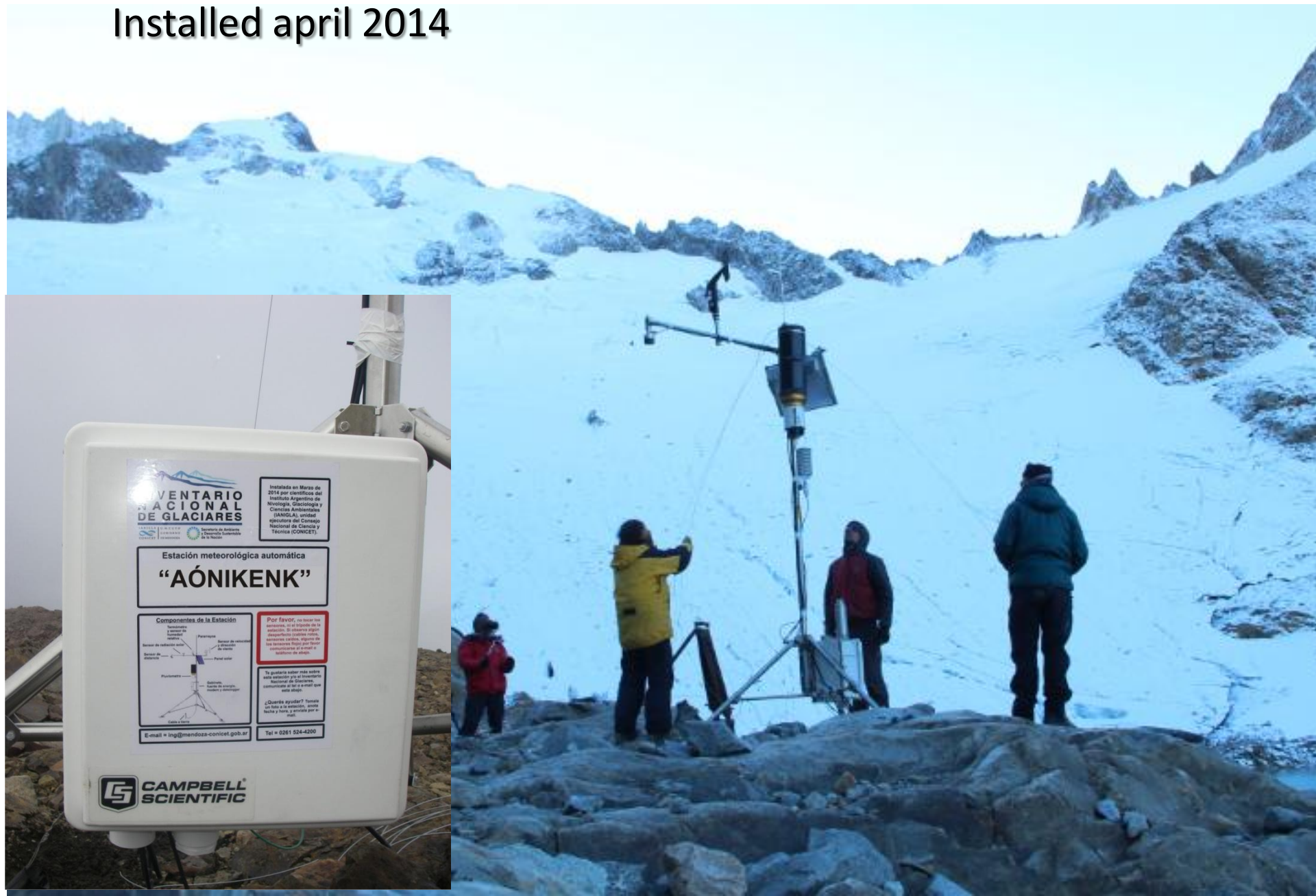


Cerro Fitz Roy

Glaciar de los Tres



AWS Aónikenk, Glaciar de los Tres Installed april 2014



INVENTARIO NACIONAL DE GLACIARES
Instalada en Marzo de 2014 por científicos del Instituto Argentino de Nivología, Glaciología y Ciencias Ambientales (IANIGLA), unidad ejecutiva del Consejo Nacional de Ciencia y Tecnología CONICET.

Estación meteorológica automática
“AÓNIKENK”



Por favor, no tocar los sensores, ni el triángulo de la estación. Si observa alguno de los siguientes problemas, algunos de los técnicos del IANIGLA por favor comunicarse al e-mail o teléfono de abajo.

Si necesita saber más sobre esta estación y el Instituto Argentino de Nivología, Glaciología y Ciencias Ambientales, comuníquese al tel o e-mail que está abajo.

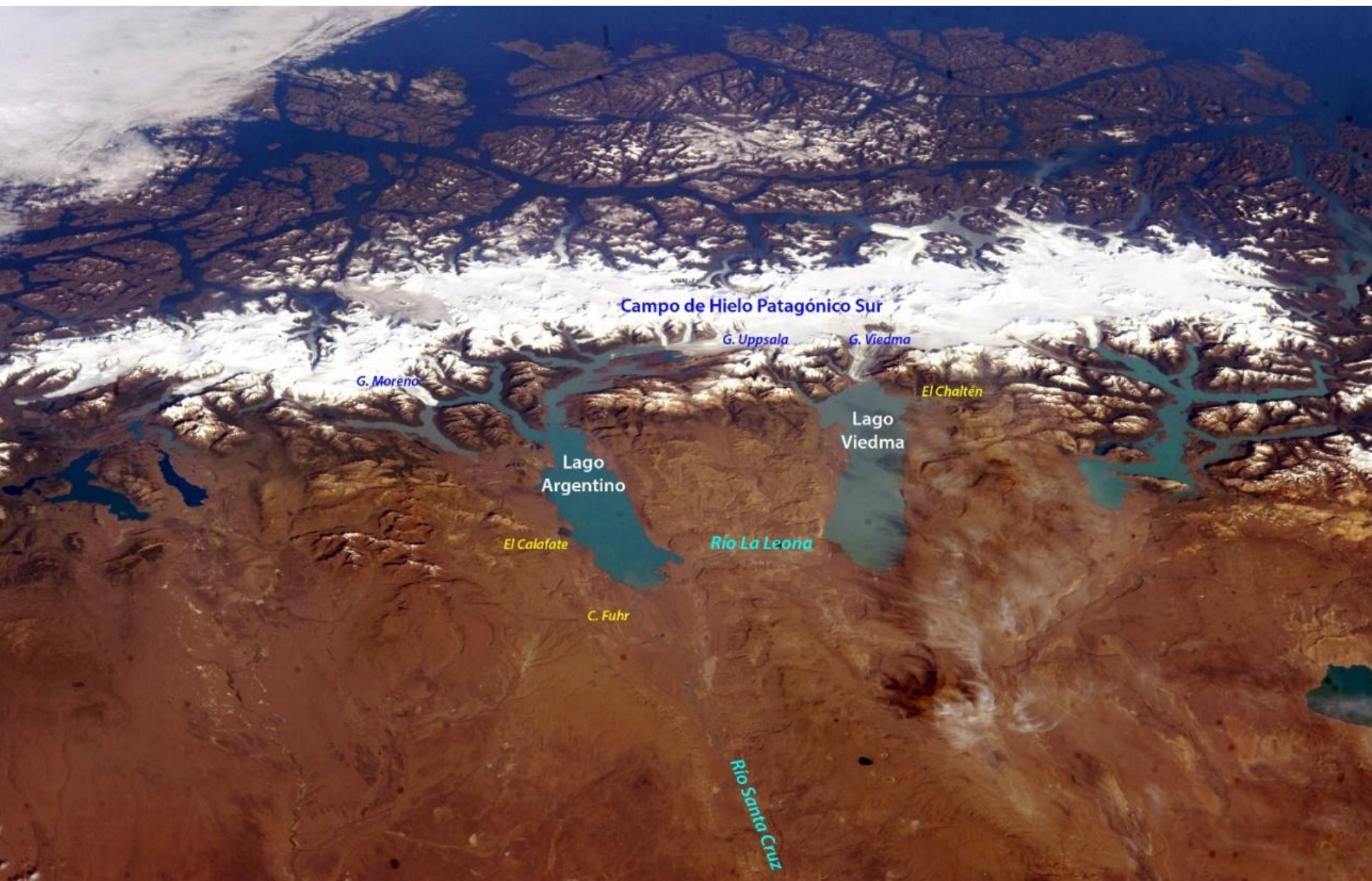
¿Quieres ayudar? Tenés un día a la estación, trae leche y fruta, y avísale por e-mail.

E-mail = ing@mendoza-conicet.gov.ar Tel = 0261 524-4200





Proposal for an integrated hydro-meteorological monitoring system in the upper Santa Cruz river basin



Cuenca del Río Santa Cruz

Leyenda

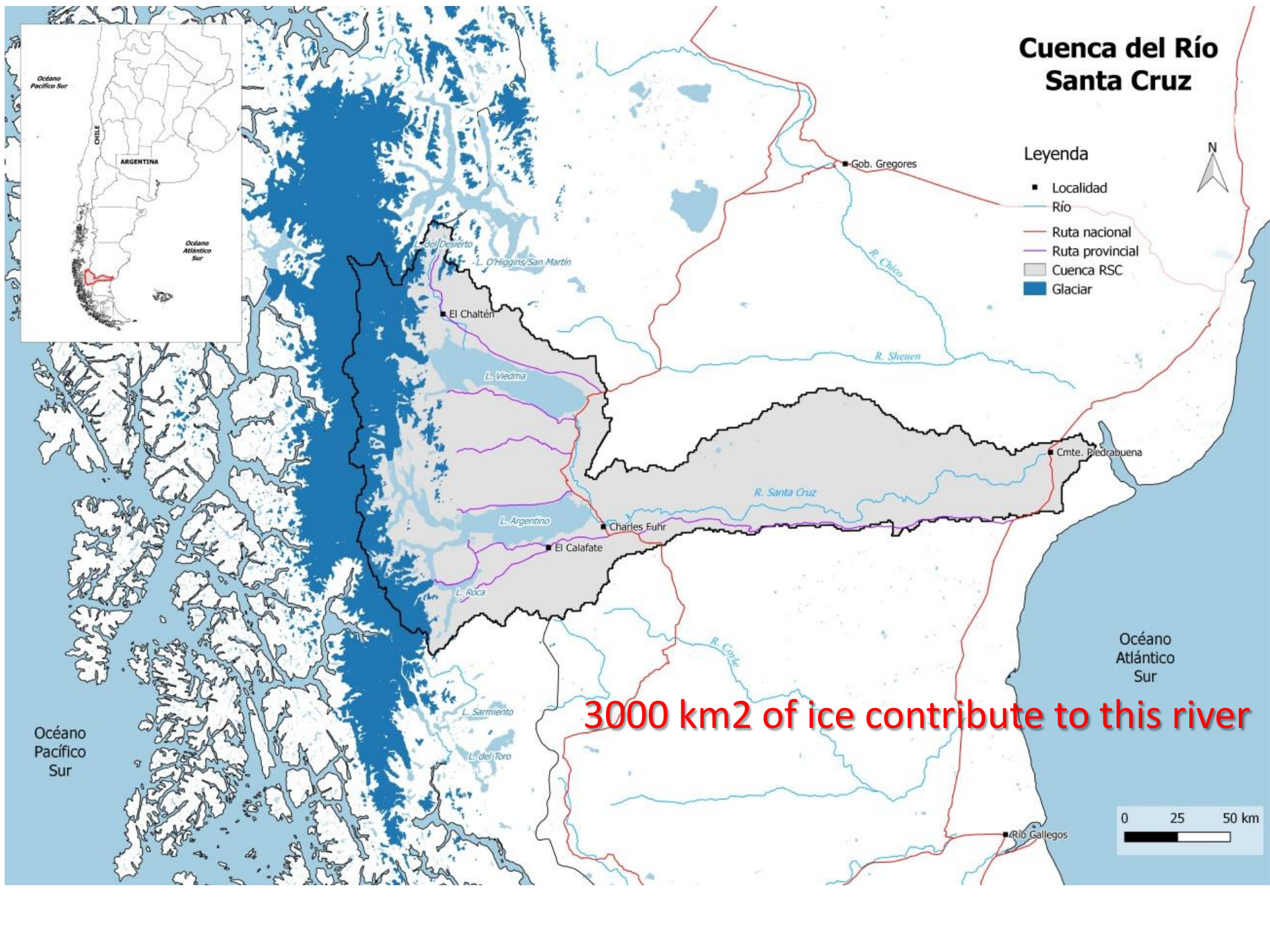
- Localidad
- Río
- Ruta nacional
- Ruta provincial
- Cuenca RSC
- Glaciar



Océano Pacífico Sur

Océano Atlántico Sur

3000 km² of ice contribute to this river



Real time meteorological monitoring of the upper Mendoza river basin



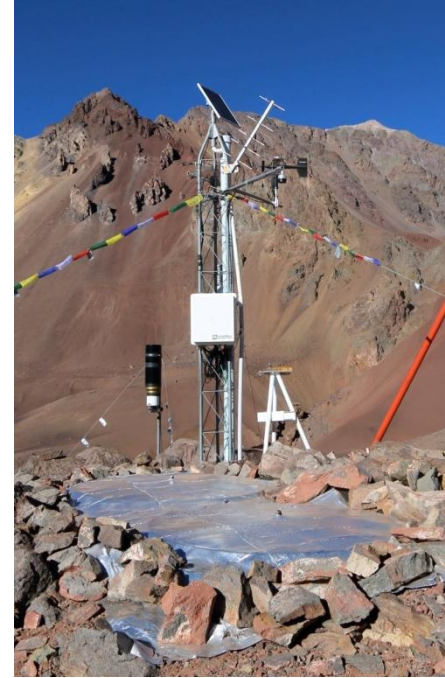
 Installed and transmitting hourly data

 To be installed this Spring



Cristo Redentor ($32,8251^{\circ}\text{S}$, $70,0703^{\circ}\text{O}$, 3840 msnm)

Plaza de Mulas -
Aconcagua ($32,6539^{\circ}\text{S}$,
 $70,0651^{\circ}\text{O}$, 4370 msnm)



Morenas Coloradas ($32,8251^{\circ}\text{S}$, $70,0531^{\circ}\text{O}$, 3347 msnm)



Las Cuevas ($32,8130^{\circ}\text{S}$, $70,0531^{\circ}\text{O}$, 3190 msnm)



¡Muchas Gracias!



The sporadic GLOF created by glaciar Perito Moreno has a noticeable impact on the Santa Cruz river



<http://www.youtube.com/watch?v=Dfl4DAthkYQ>

YouTube^{AR} 



6:51 / 13:27



Glaciar Perito Moreno Ruptura 1988 Dvx.avi



Southern Patagonia's Perito Moreno Glacier, Lake Argentino, and Santa Cruz River hydrological system: An overview

Andrea I. Pasquini*, Pedro J. Depetris

CICTERRA (CONICET-Universidad Nacional de Córdoba), Avenida Vélez Sarsfield 1611, X5016GCA Córdoba, Argentina

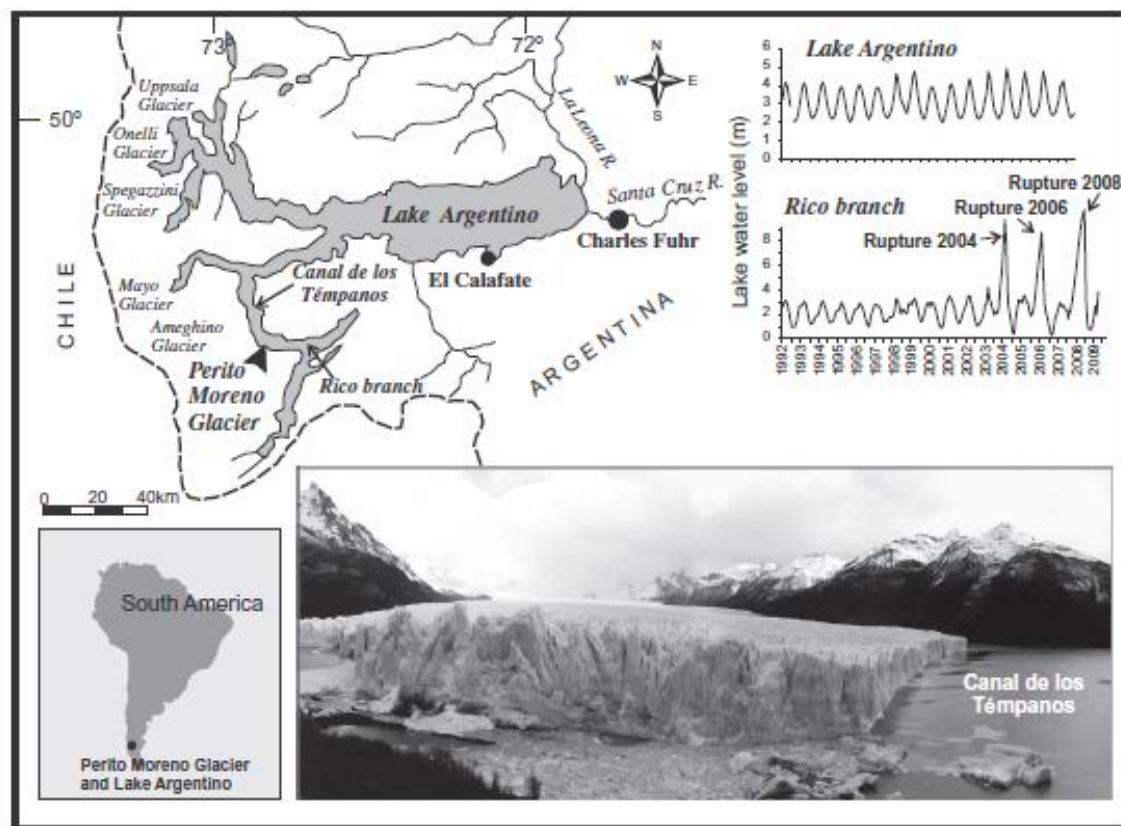
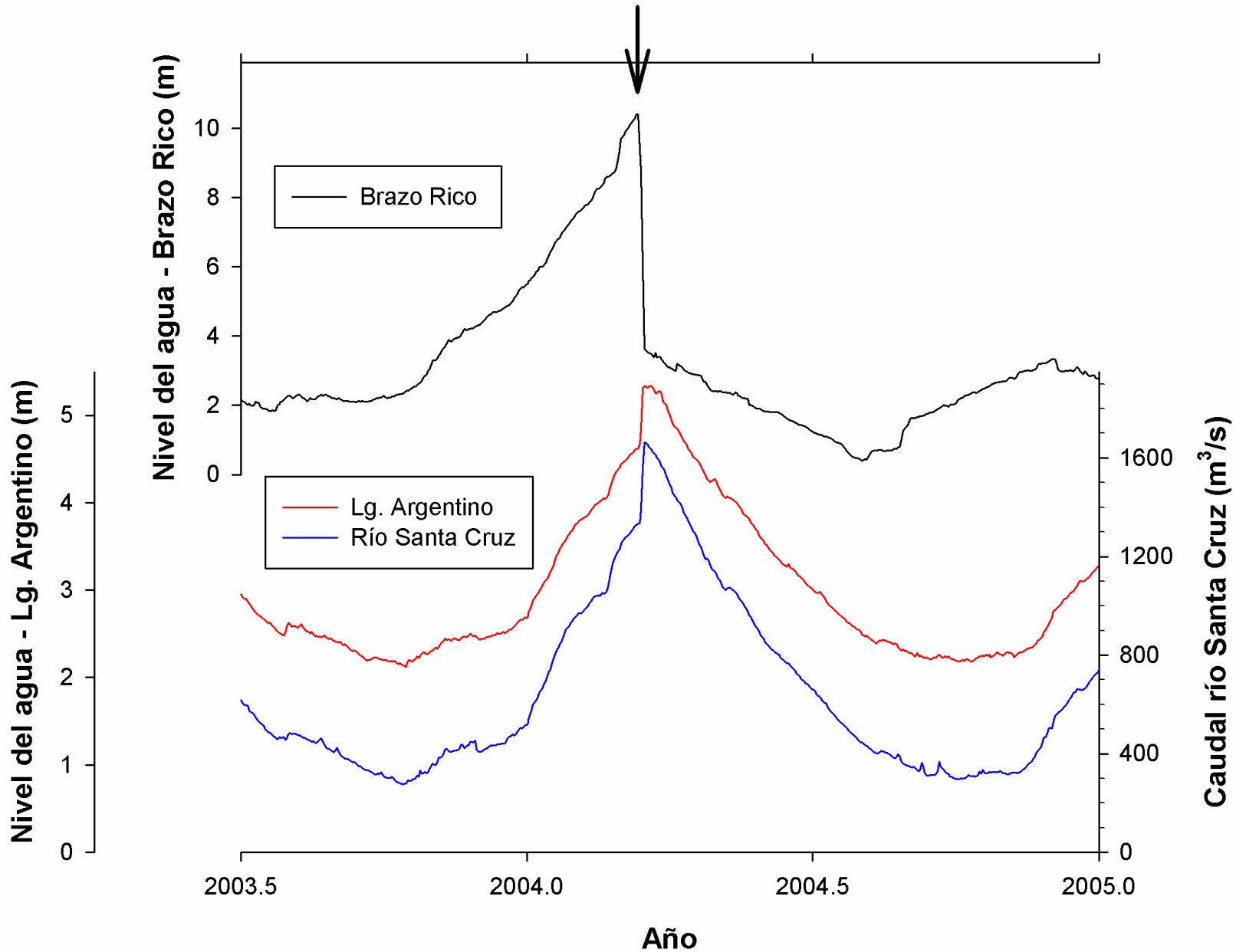
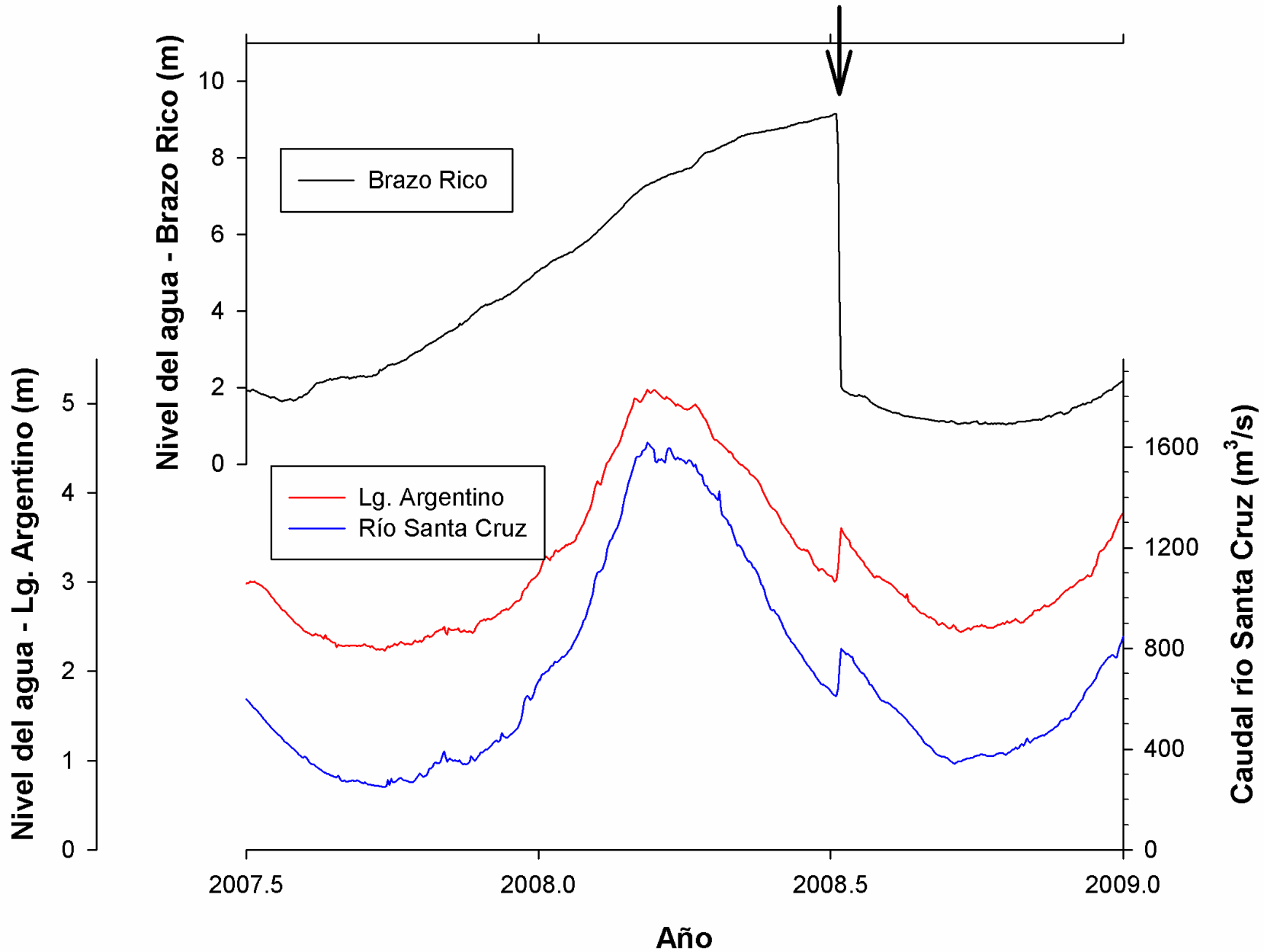


Fig. 1. A picture of the Perito Moreno Glacier terminus, a map of the hydrological system integrated by the glacier, Lake Argentino, and the head waters of the Santa Cruz River. South America's map (lower left side) shows the location of the area in the southern Argentine Andes. The inset on the upper right hand corner shows the water level gage height variability (period 1992–2009) at the Rico branch (notice the water level reached behind the ice dam during the last 3 ruptures), and the corresponding modulated level in Lake Argentino.

Ruptura del 14 de marzo de 2004



Ruptura del 9 de julio de 2008



Impacto del GLOF del 16-17 de febrero de 1988

