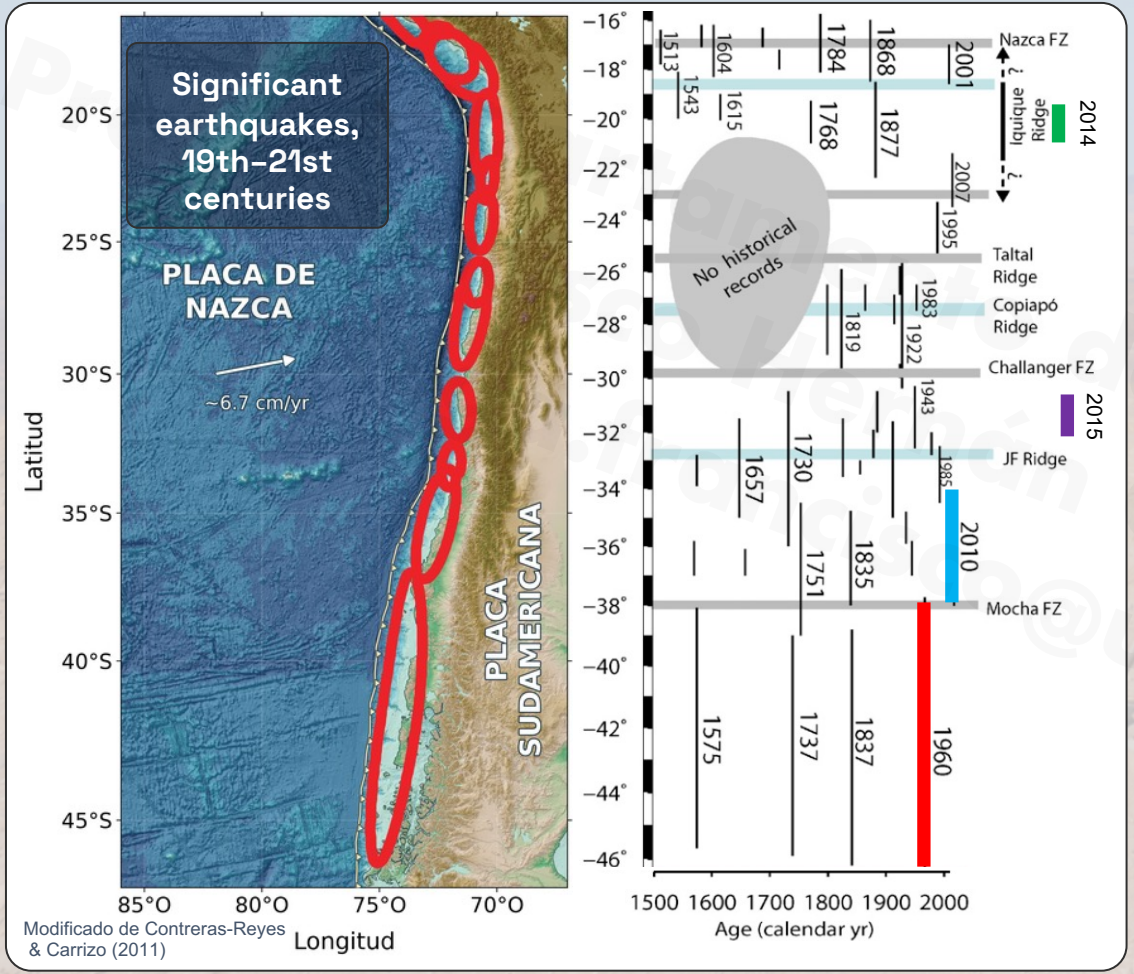

geo sismos
GeoSismos: Daily PPP-AR Processing of the Chilean GNSS Network
IGS Bias and Ambiguity Resolution (BAR) Virtual Meeting
Francisco Ortega-Culaciati
Department of Geophysics – FCFM – University of Chile
DATA OBSERVATORY
CSN
CENTRO SISMOLÓGICO NACIONAL
UNIVERSIDAD DE CHILE
fcfm
Ingeniería Matemática
FACULTAD DE CIENCIAS
FÍSICAS Y MATEMÁTICAS
UNIVERSIDAD DE CHILE
fcfm
Geofísica
FACULTAD DE CIENCIAS
FÍSICAS Y MATEMÁTICAS
UNIVERSIDAD DE CHILE

Three Mw > 8 earthquakes since 2010

geosismos



The 1960 Valdivia earthquake (Mw 9.5) is the largest instrumentally recorded on Earth.

Mw > 8.0 earthquakes since 2010

- Maule (Mw 8.8) 2010
- Iquique (Mw 8.2) 2014
- Illapel (Mw 8.3) 2015

High seismogenic and tsunamigenic potential
→ We need to understand Earthquake Generation
→ Seismic Cycle

To download the Seismic Cycle animations go to

https://github.com/frortega/Seismic-Cycle-Animations/

Or scan the QR code below



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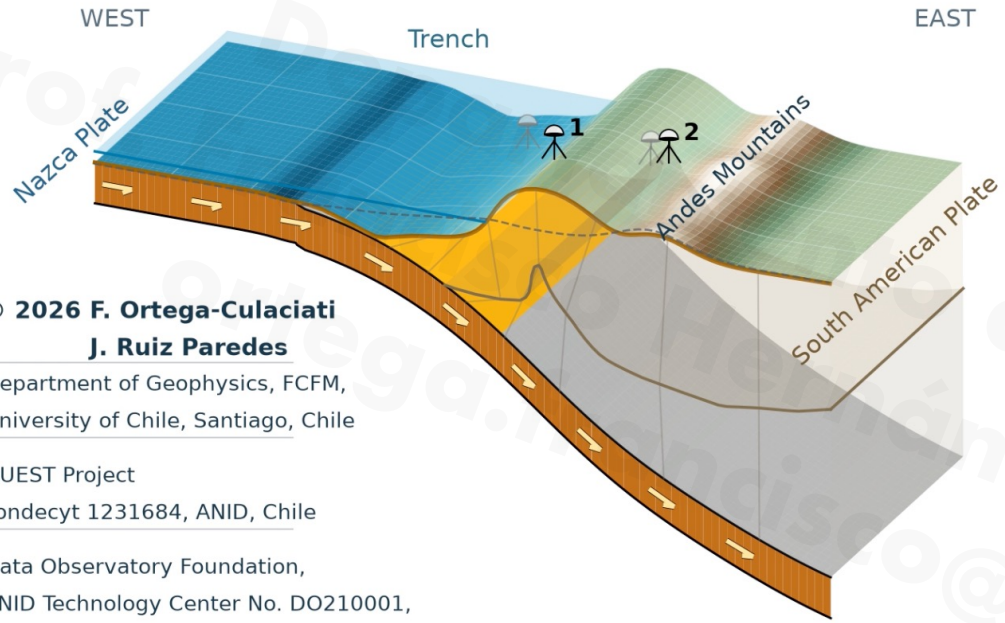
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DATA OBSERVATORY

THE SEISMIC CYCLE

SUBDUCTION ZONE



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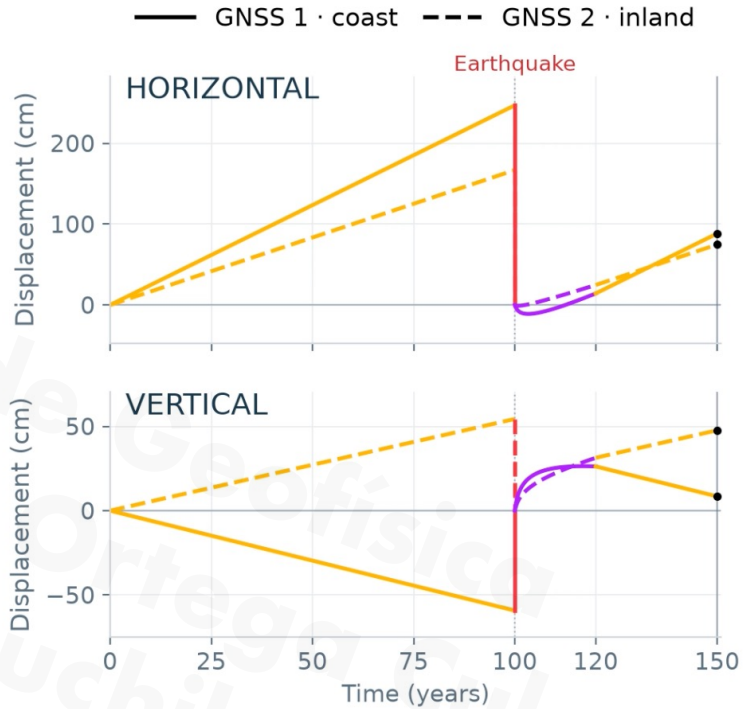
J. Ruiz Paredes

Department of Geophysics, FCFM,
University of Chile, Santiago, Chile

QUEST Project
Fondecyt 1231684, ANID, Chile

Data Observatory Foundation,
ANID Technology Center No. DO210001,
Santiago, Chile

GNSS STATION DISPLACEMENT





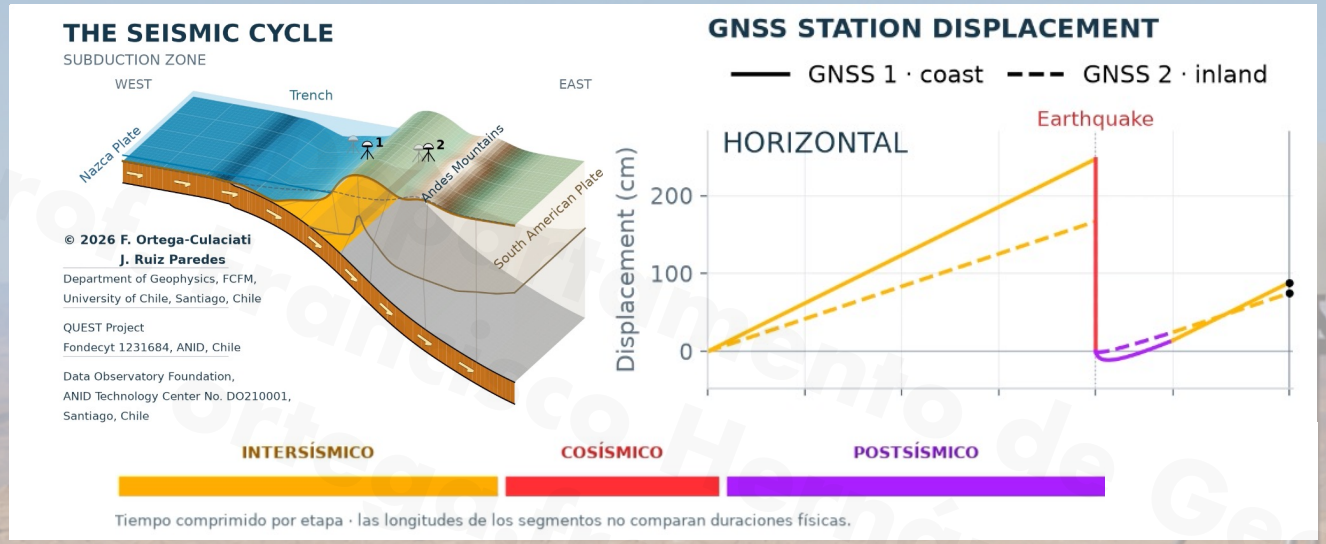
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Ministerio de Ciencia, Tecnología, Conocimiento e Innovación
Gobierno de Chile

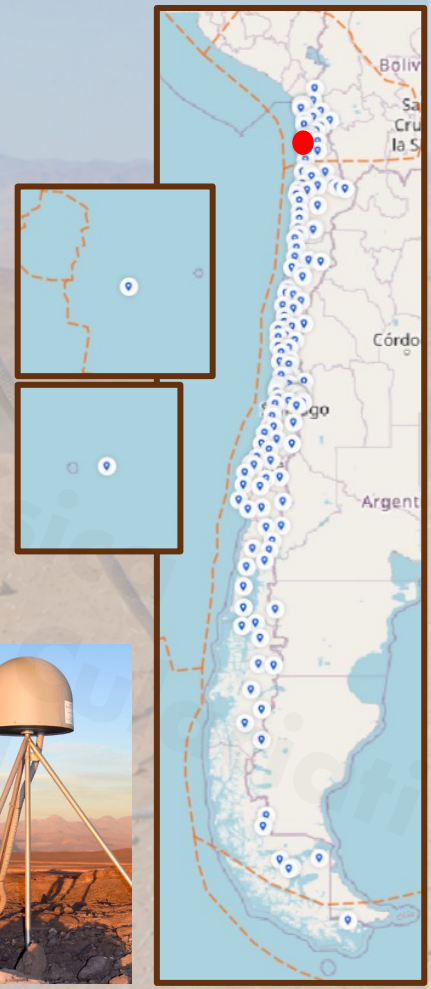
ANID Agencia Nacional de Investigación y Desarrollo
Gobierno de Chile

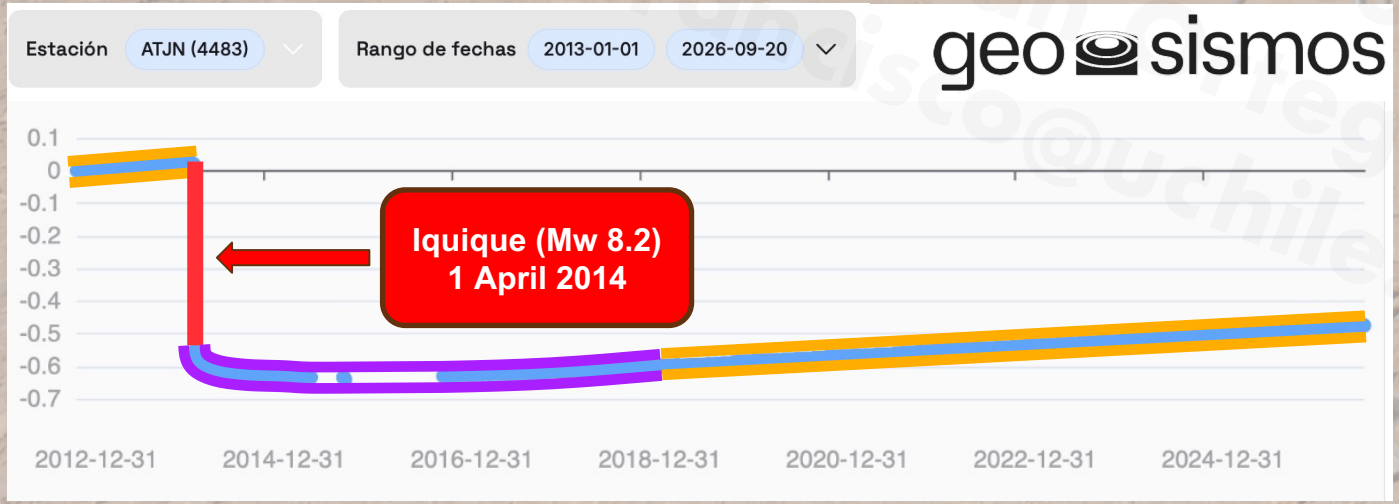
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DO DATA OBSERVATORY

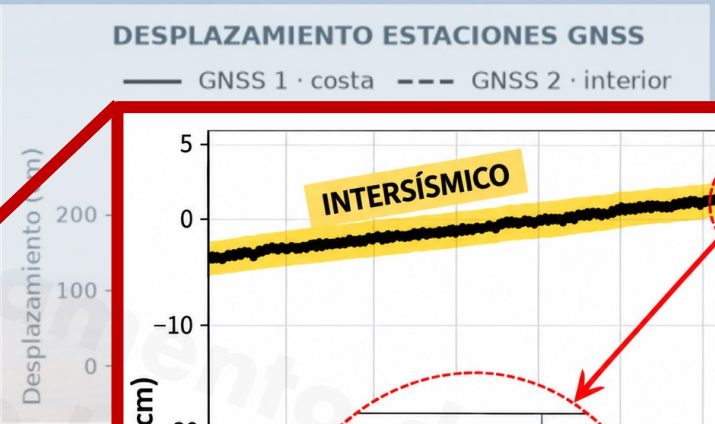

THE SEISMIC CYCLE
SUBDUCTION ZONE
WEST
Trench
EAST
Nazca Plate
Andes Mountains
South American Plate
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J. Ruiz Paredes
Department of Geophysics, FCFM, University of Chile, Santiago, Chile
QUEST Project
Fondecyt 1231684, ANID, Chile
Data Observatory Foundation, ANID Technology Center No. DO210001, Santiago, Chile
GNSS STATION DISPLACEMENT
GNSS 1 · coast
GNSS 2 · inland
HORIZONTAL
Earthquake
Displacement (cm)
200
100
0
INTERSÍSMICO
COSÍSMICO
POSTSÍSMICO
Tiempo comprimido por etapa · las longitudes de los segmentos no comparan duraciones físicas.

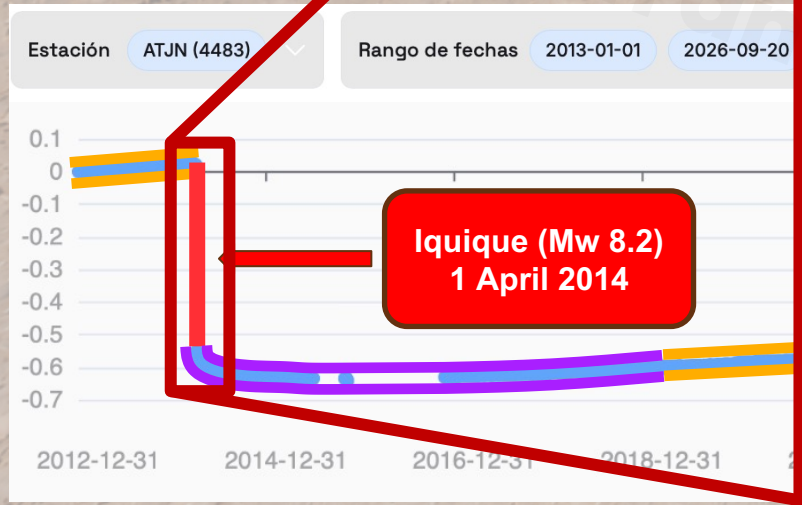
geo sismos


Bolivi
Sa
Cru
la S
Córdo
go
Argent


Estación
ATJN (4483)
Rango de fechas
2013-01-01
2026-09-20
geo sismos
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
Iquique (Mw 8.2)
1 April 2014
2012-12-31
2014-12-31
2016-12-31
2018-12-31
2020-12-31
2022-12-31
2024-12-31





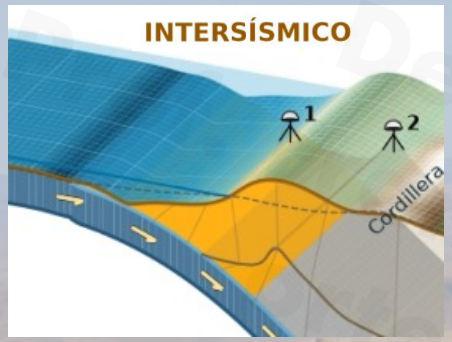


Iquique (Mw 8.2)
1 April 2014

Prof. Francisco Ortega Culaciati
Departamento de Geofísica
francisco@ing.uchile.cl

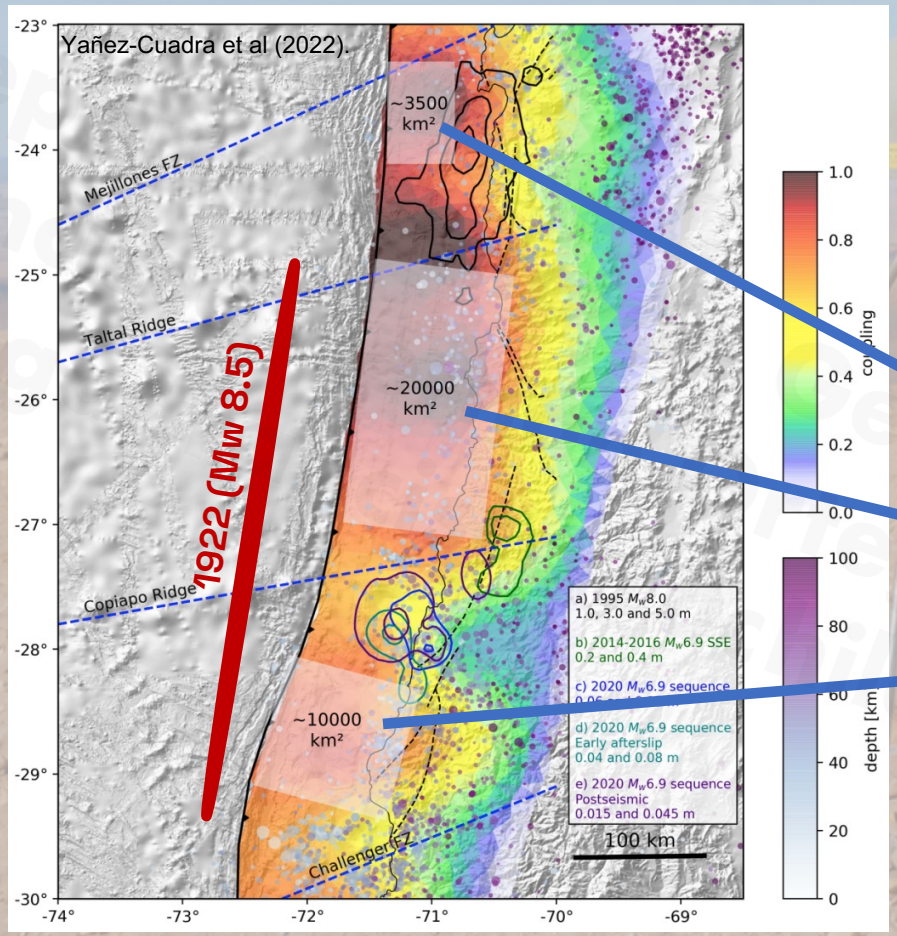
Interseismic → Locked Plates

geosismos



We infer the distribution of interplate coupling
or
slip deficit

Plates are more locked in some places than in others



Seismogenic Potential

Slip deficit since 1922

Mw 7.9

Mw 8.3

Mw 8.1

Where, how big ~~PREDICTION~~

Building GNSS Time Series

geosismos

Automatic positioning software for ~160 stations:

1. Raw data in RINEX format from the CSN network



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→ Local database

2. Data curation.
- GFZRNX (Nischan, 2016).
- Automated RINEX quality control.
- Data format normalization.
- RINEX resampled from 1 Hz (CSN) to 30 s for daily processing.

3. Local mirror of precise products.
- Orbits, clocks and biases: Wuhan rapid; IGSR03 when available.
- Global Ionosphere Maps (IGS).
- VMF3 (TU Wien, Austria).
- FES2004 (ocean tide loading).

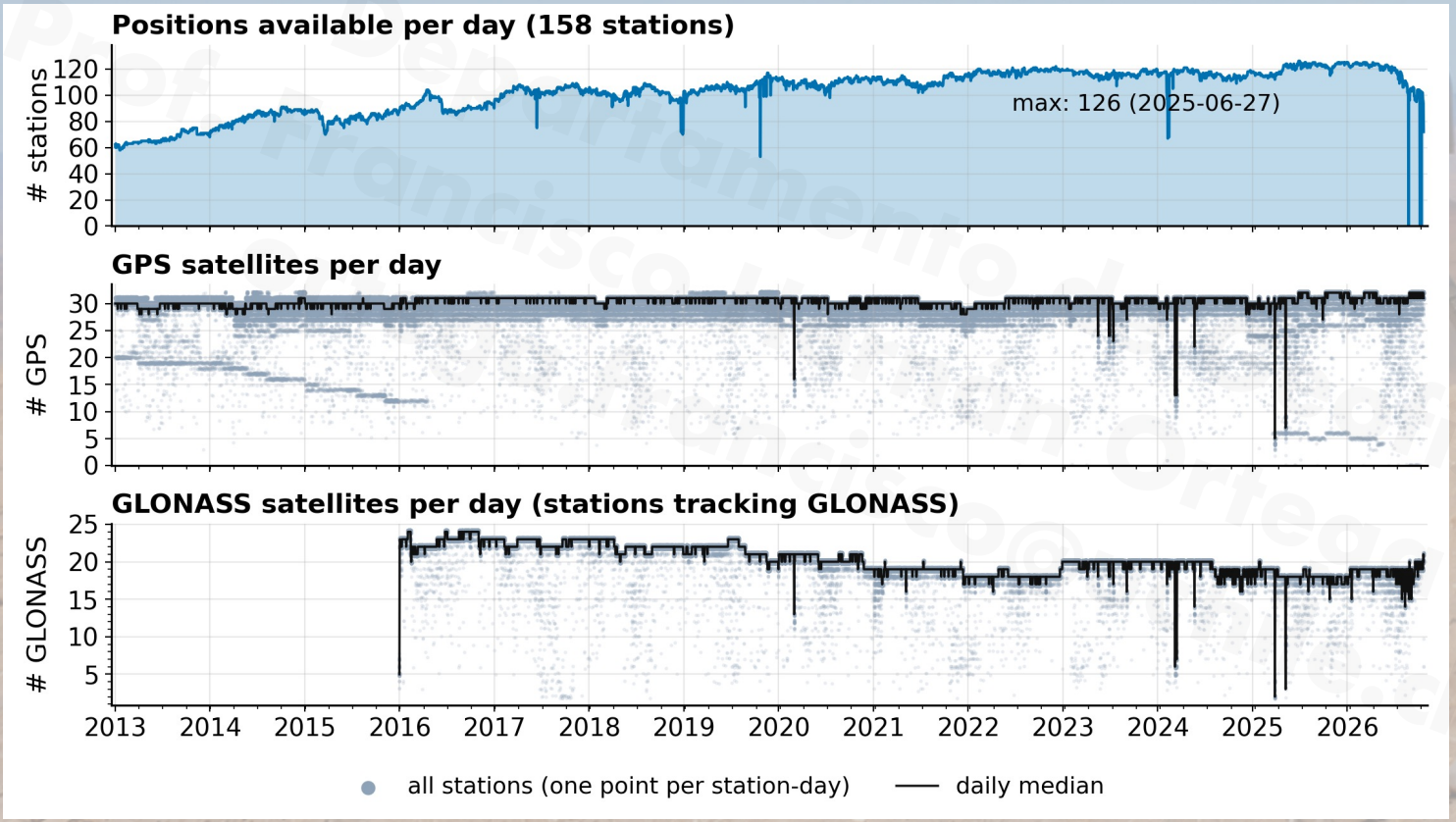
4. RINEX processing
We wrap PRIDE PPP-AR (Geng et al., 2019).→ Daily solutions.

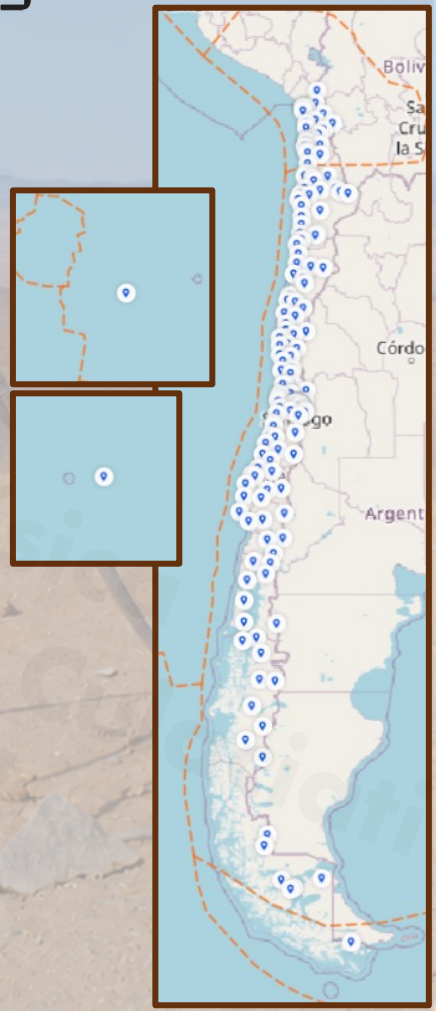
PRIDE Lab
Positioning Radars to Image & Decipher the Earth

5. Daily GNSS station time series.
- Reference frame aligned to IGS20.
- ENU displacement time series (East, North, Up).
- Outlier detection and uncertainty from repeatability.

Network Statistics

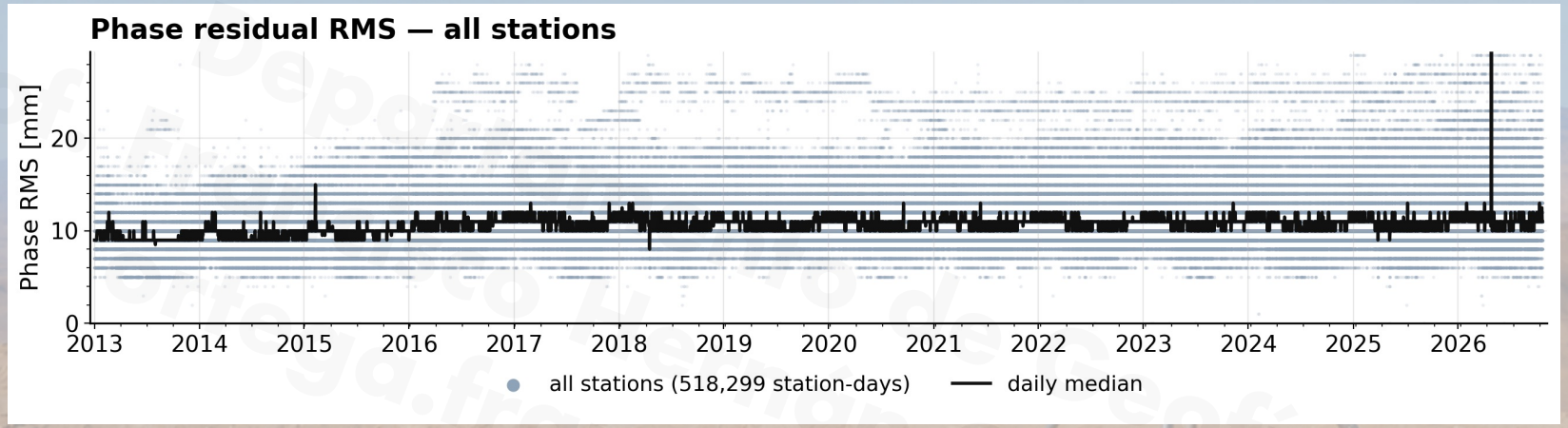
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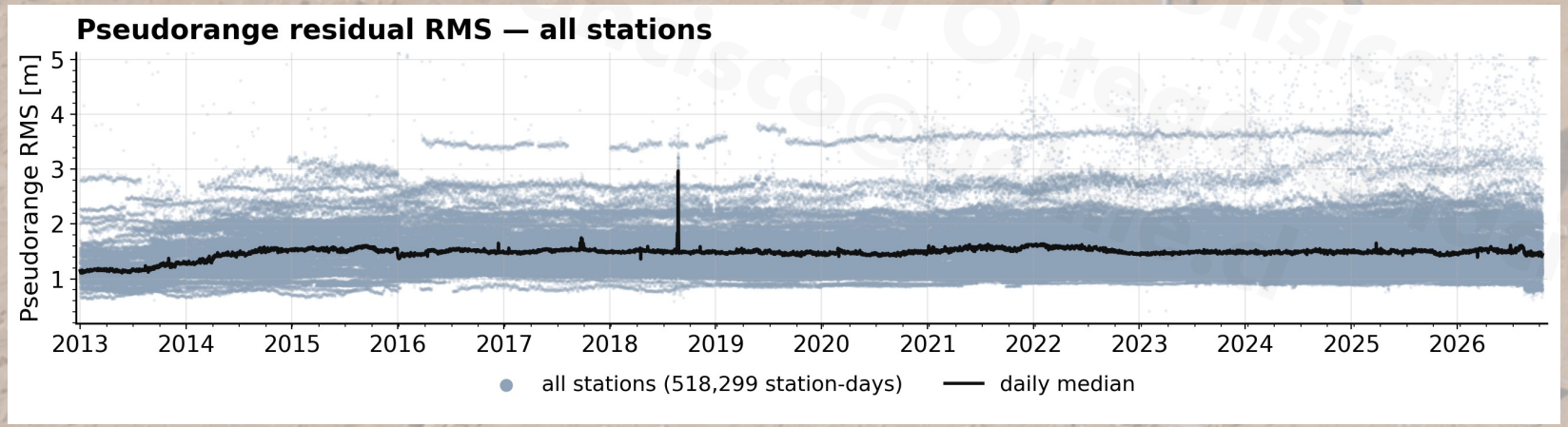




Network Statistics

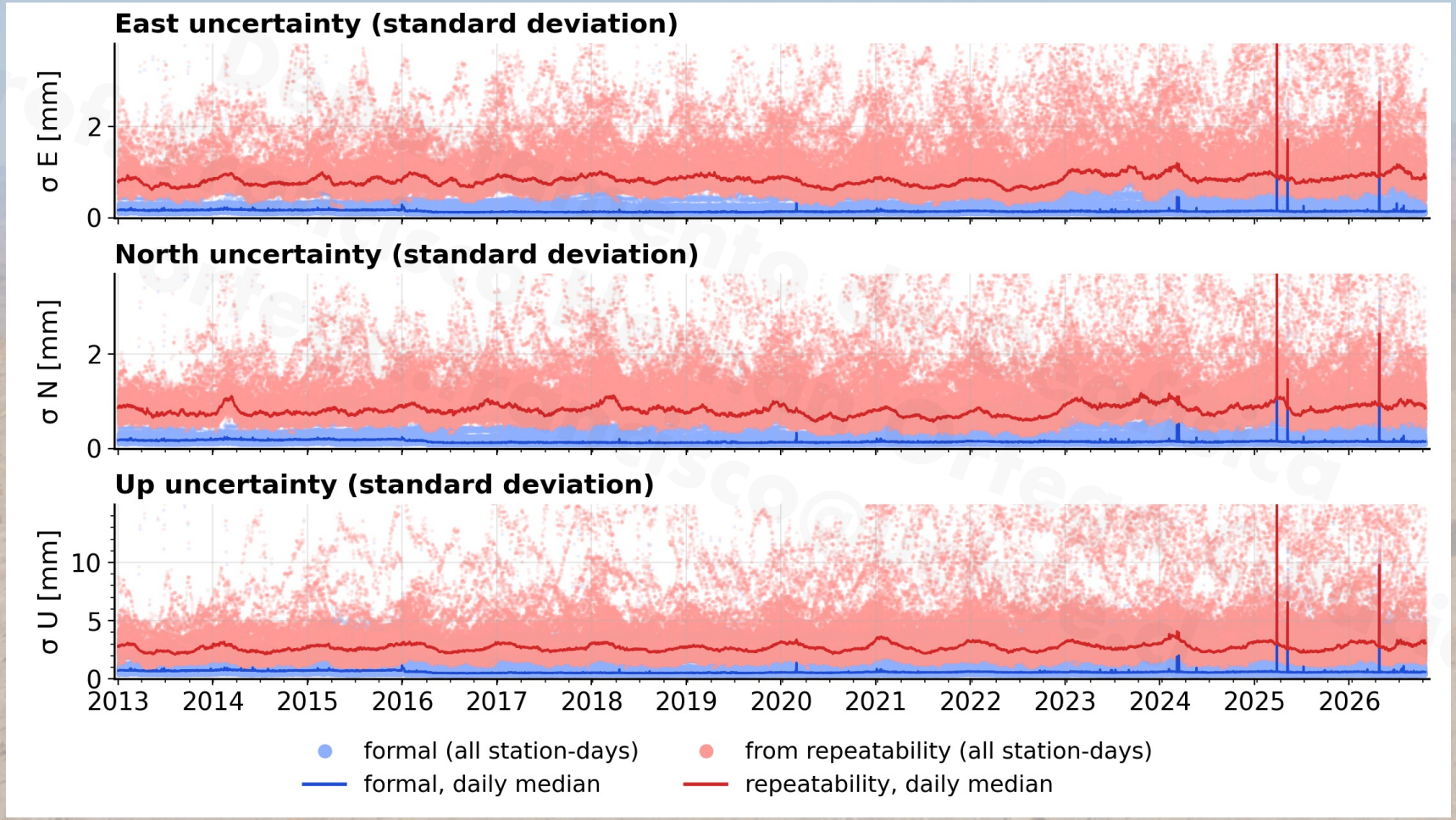
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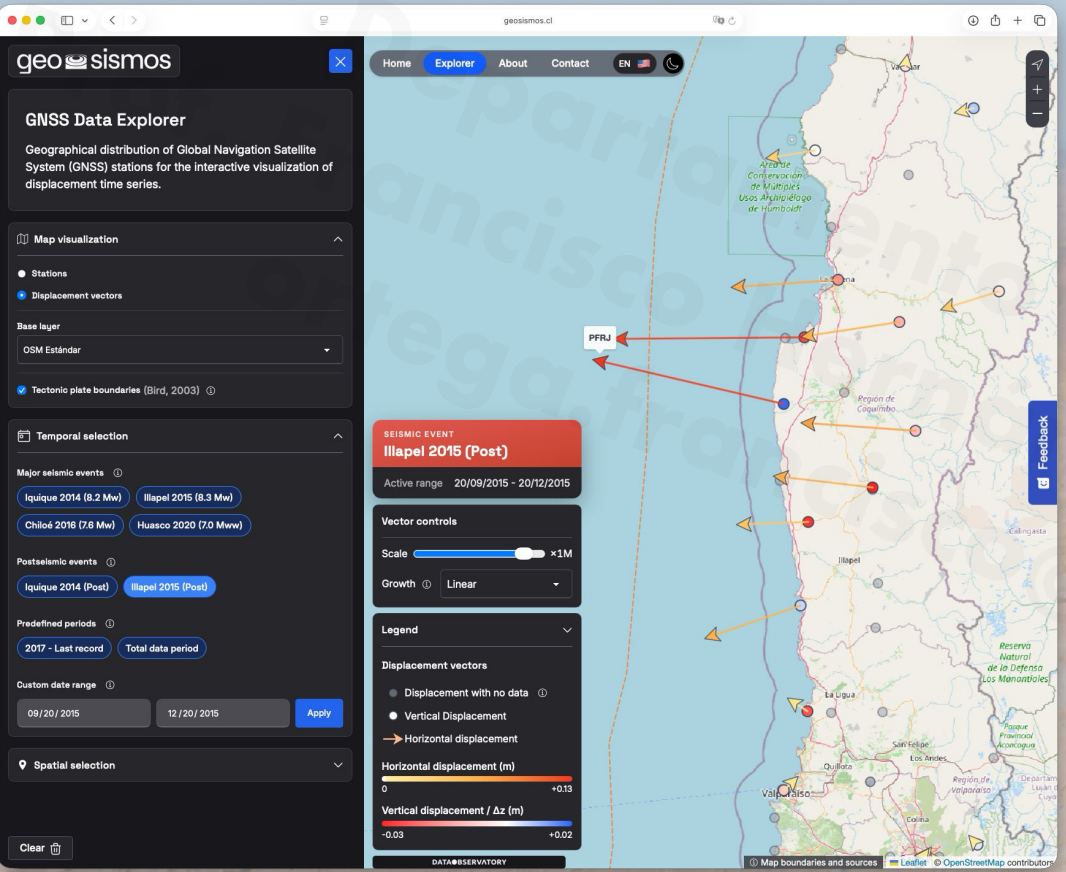


Network Statistics

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GeoSismos Web Interface



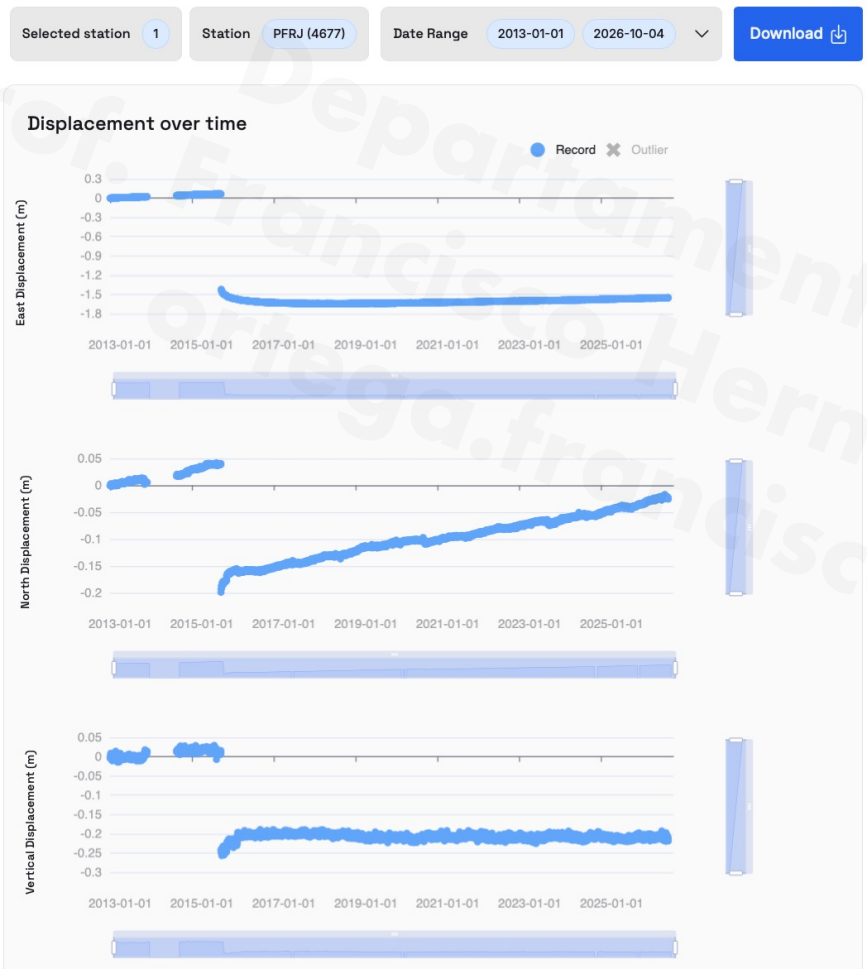
Current products

Easy data visualization

Daily time series for each GNSS station (one position per day).

Quality control and uncertainty quantification.

GeoSismos Web Interface



Current products

Easy data visualization

Daily time series for each GNSS station (one position per day).

Quality control and uncertainty quantification.

PLANNED

- Precise static coseismic displacements in the GeoSismos earthquake database.

- Trajectory models for all time series (automatic).

geosismos

Planned products

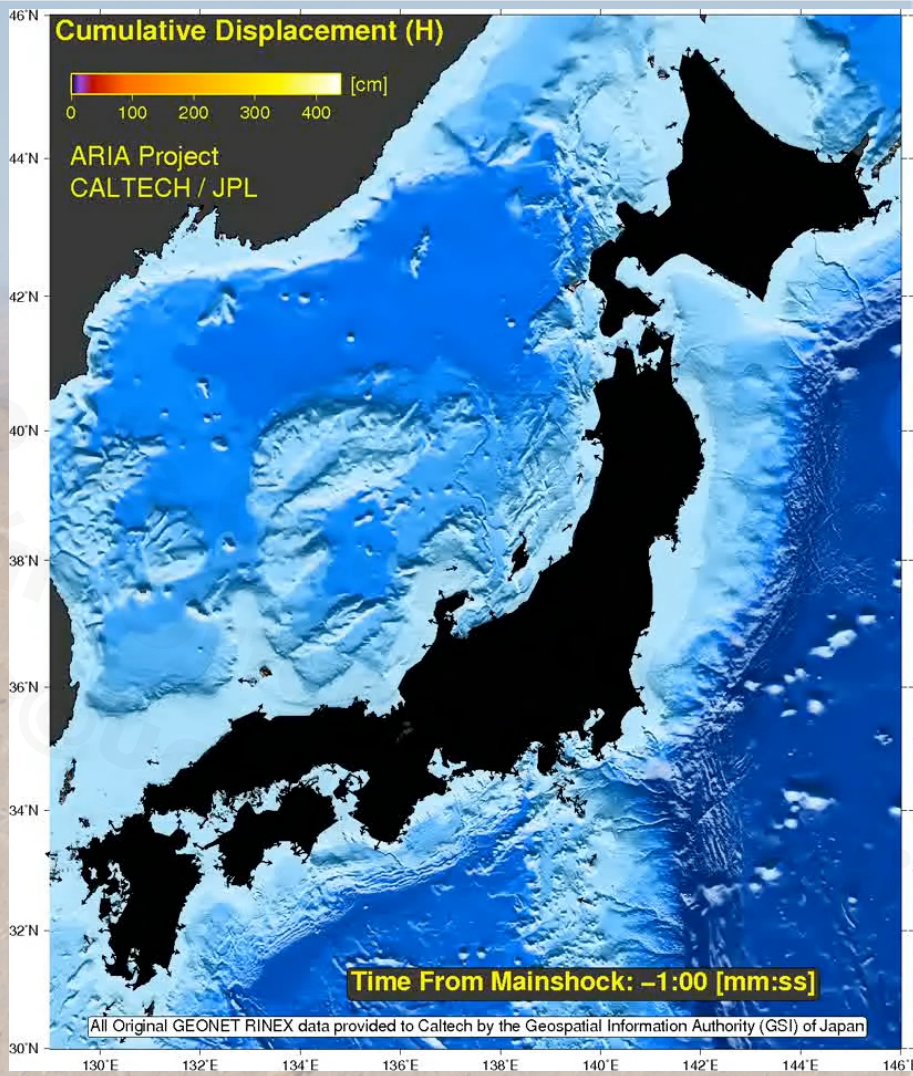
High-rate (1 Hz) time series → earthquake seismograms.

EXAMPLE:

GNSS displacements from the 2011 Tohoku-Oki earthquake (Mw 9.0), Japan.

GNSS data recorded and processed at 1 Hz.

(Animation generated during Ph.D. thesis work at Caltech).



Future Plans

- Currently publishing Time series from CSN RINEX.
- We are processing all RINEX data available from EarthScope (ex UNAVCO) in South America.
- We will soon start asking other institutions to process their data with attribution (DOI assigned to datasets of each institution)
- We aim to expand to all South America.




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Thank you for the invitation
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