Monitoreo de la deformación de la superficie a partir de datos Sentinel (INSAR) en Quito, Ecuador

Pedro Alejandro ESPÍN BEDÓN

Laurence Audin
Marie-Pierre Doin
Erwan Pathier

2019

@ B. Bernard

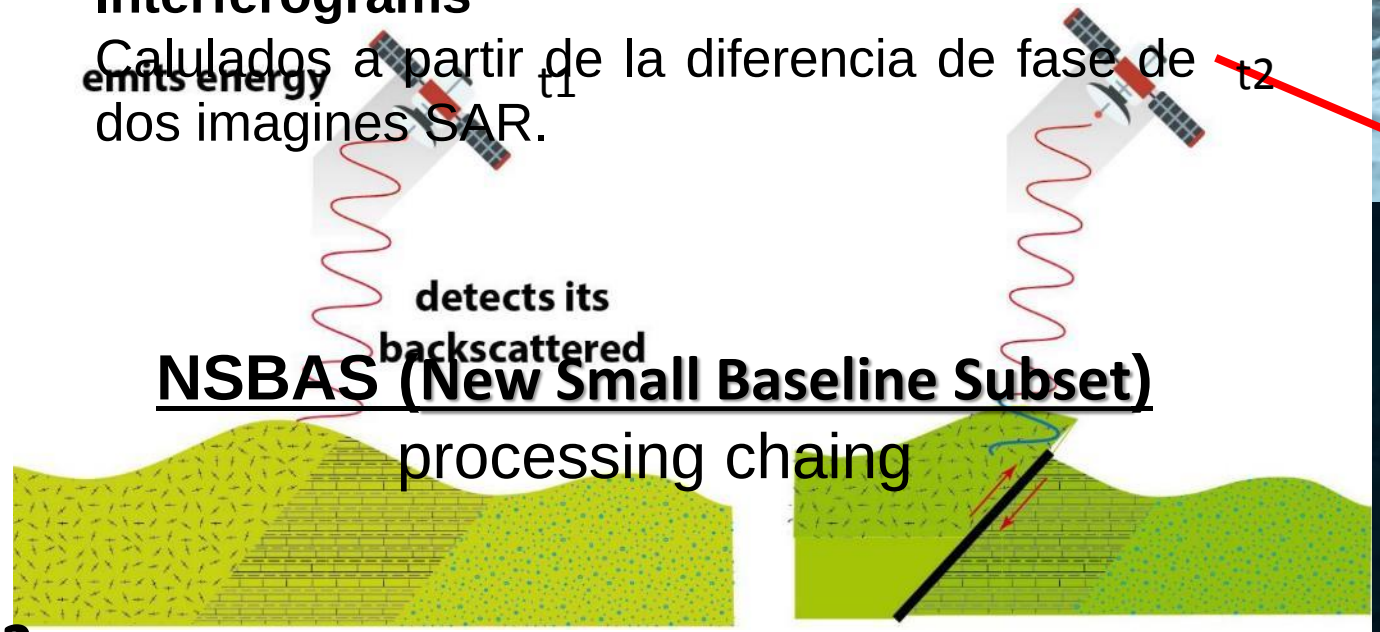
InSAR (Synthetic Aperture Radar Interferometry)

Remote Sensing

SAR (**S**ynthetic **A**perture **R**adar) imagenes tomadas en diferente tiempo de la misma área

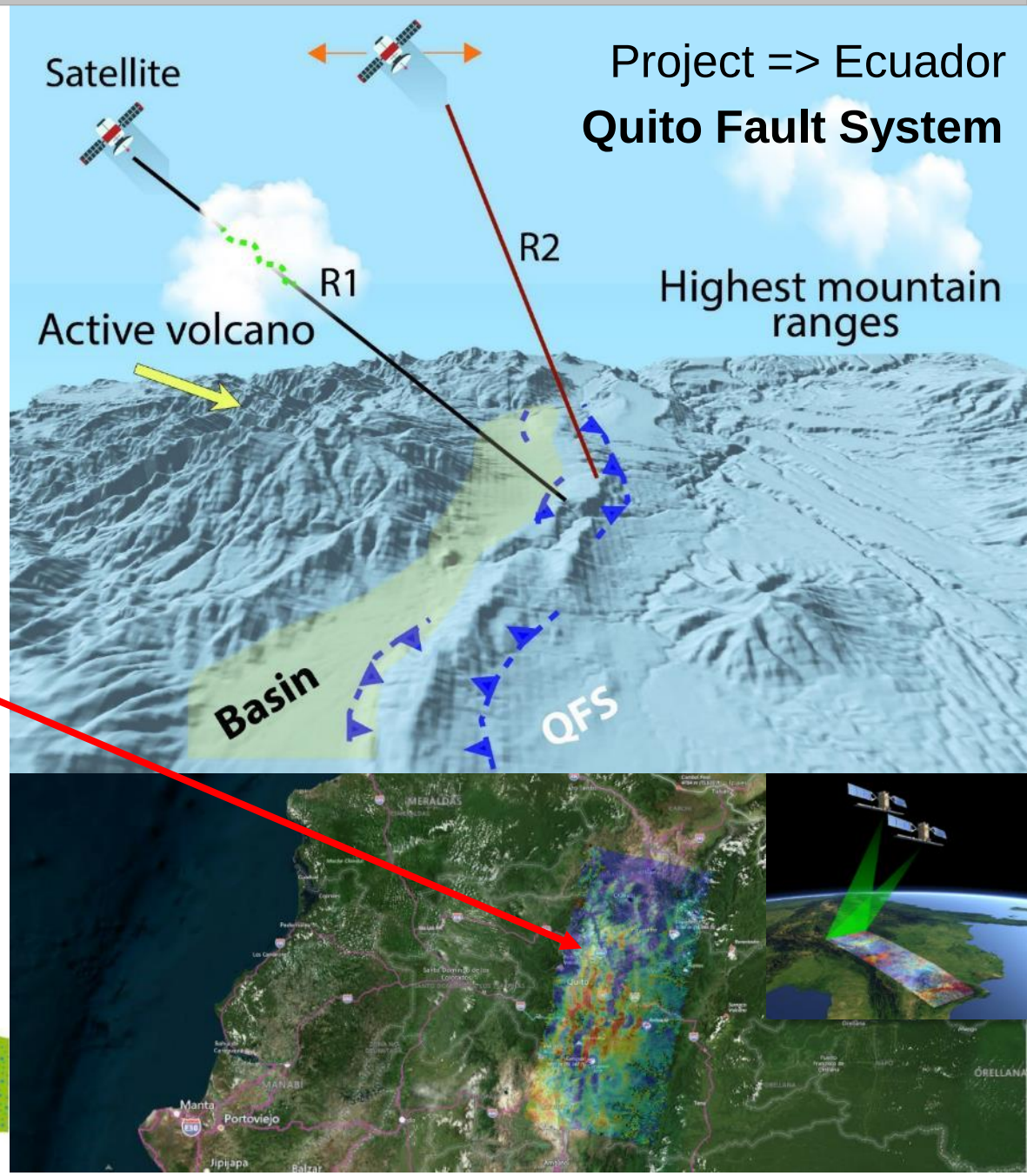
Interferograms

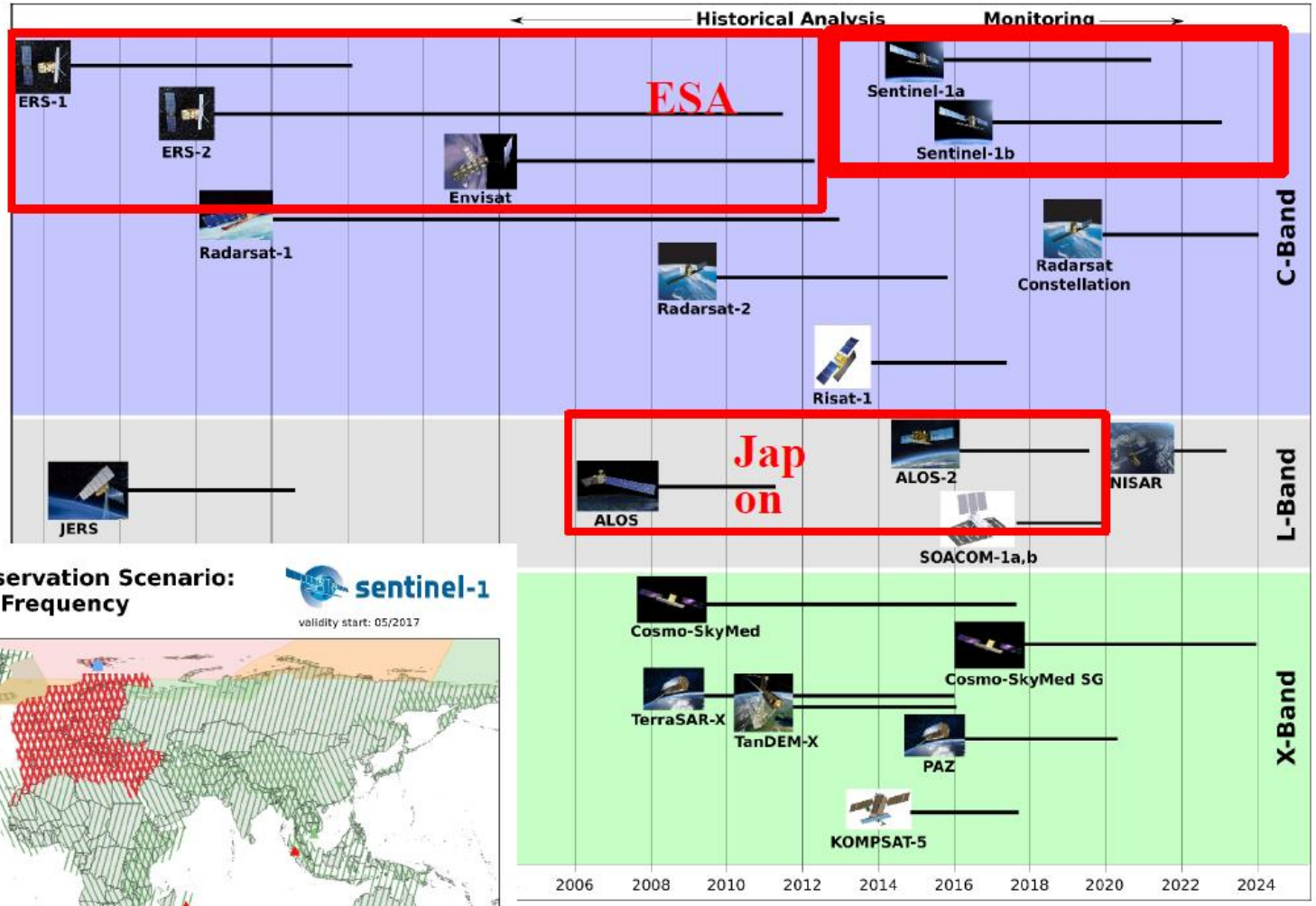
Calulados a partir de la diferencia de fase de dos imagines SAR.

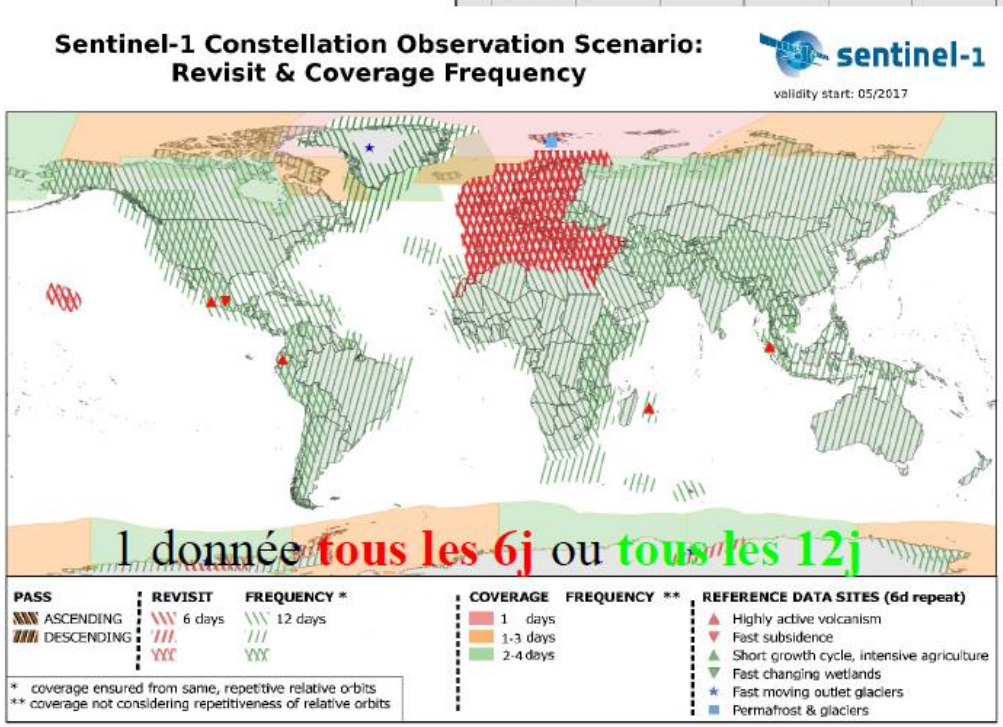


NSBAS (New Small Baseline Subset)

processing chaing

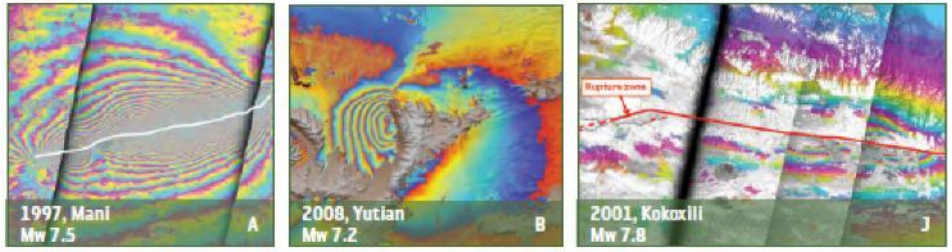



Historical Analysis
Monitoring
ESA
ERS-1
ERS-2
Envisat
Radarsat-1
Sentinel-1a
Sentinel-1b
Radarsat-2
Radarsat Constellation
Risat-1
C-Band
Jap on
JERS
ALOS
ALOS-2
NISAR
SOACOM-1a,b
L-Band
Cosmo-SkyMed
Cosmo-SkyMed SG
TerraSAR-X
TanDEM-X
PAZ
KOMPSAT-5
X-Band
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024

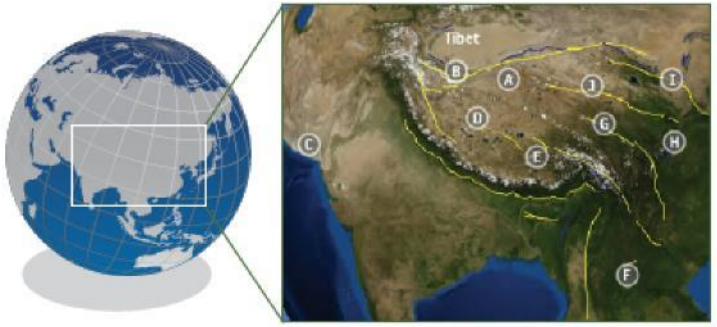

Sentinel-1 Constellation Observation Scenario:
Revisit & Coverage Frequency
sentinel-1
validity start: 05/2017
1 donnée tous les 6j ou tous les 12j
PASS
ASCENDING
DESCENDING
REVISIT
6 days
FREQUENCY *
12 days
COVERAGE FREQUENCY **
1 days
1-3 days
2-4 days
REFERENCE DATA SITES (6d repeat)
Highly active volcanism
Fast subsidence
Short growth cycle, intensive agriculture
Fast changing wetlands
Fast moving outlet glaciers
Permafrost & glaciers
* coverage ensured from same, repetitive relative orbits
** coverage not considering repetitiveness of relative orbits

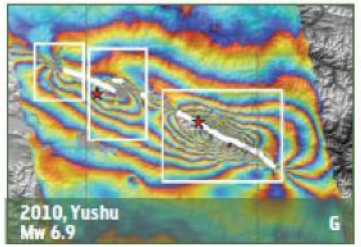
EQ seen by InSAR

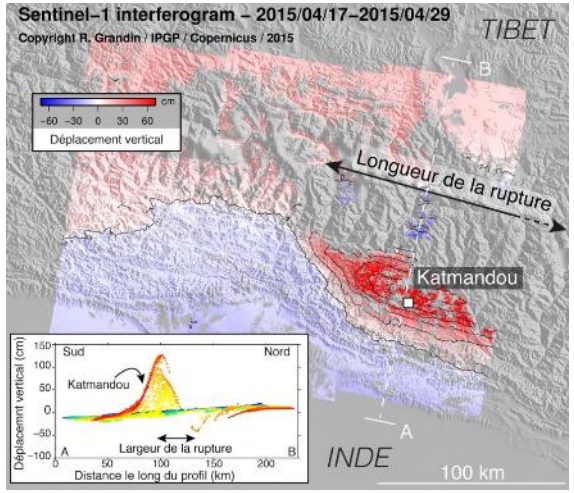
Systematic mapping and modelling

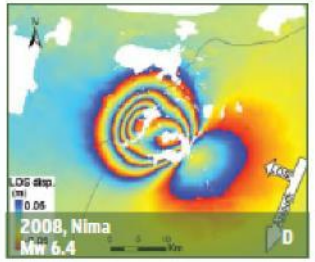


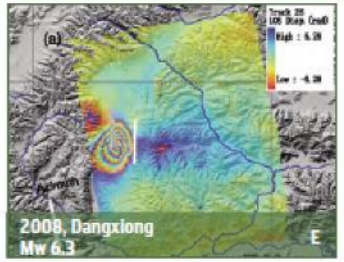
The Western region of China has been monitored using repeat pass InSAR. The figure shows earth quake related ground motion on active faults (note the coseismic motion associated with the magnitude 8.0 Wenchuan earthquake in 2008).

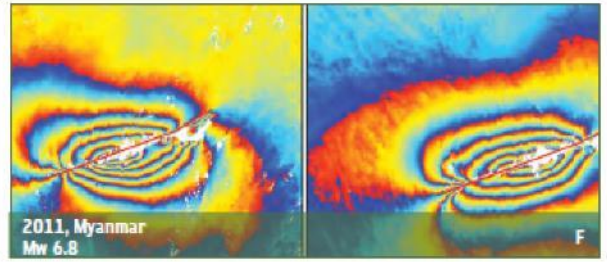








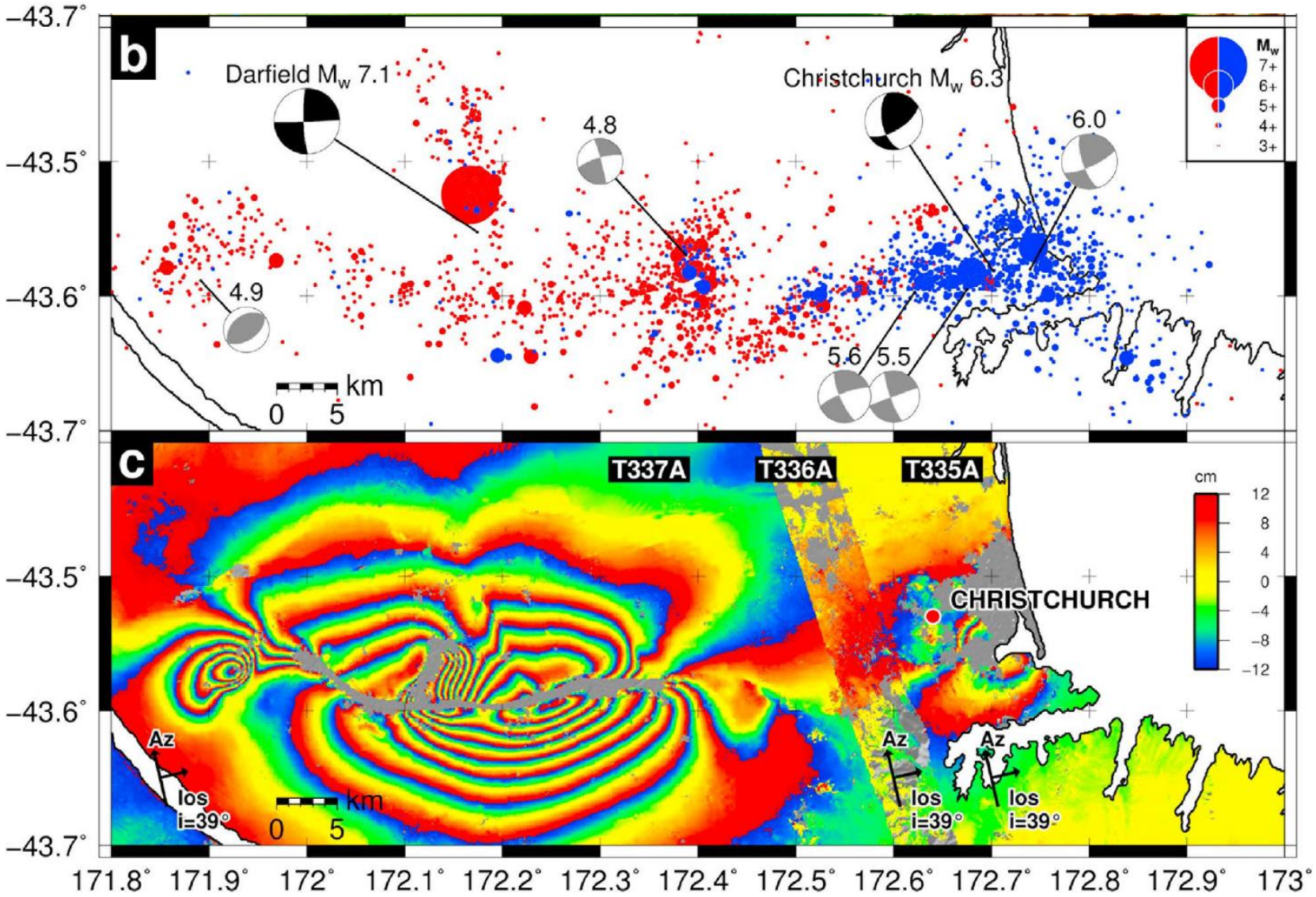




(10 years of the ESA/NRSCC Dragon Program)

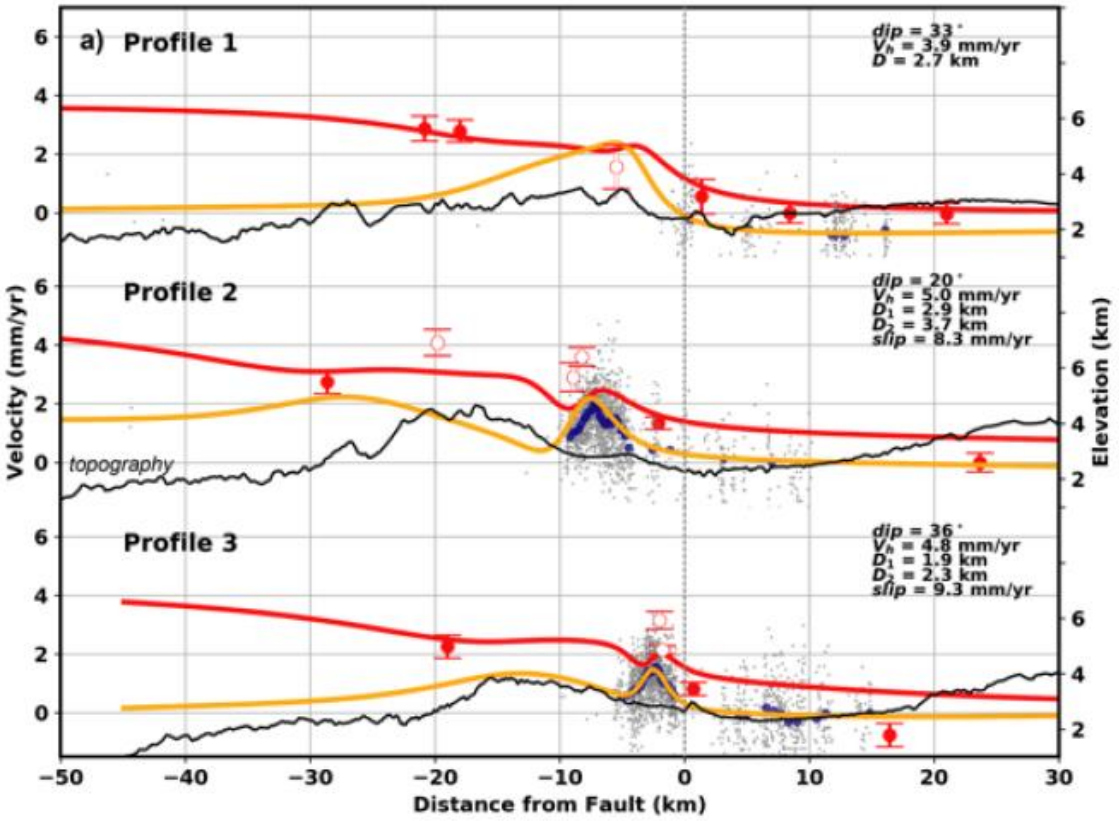
2010 Mw 7.1 Darfield earthquake, New Zealand

… seismology + InSAR

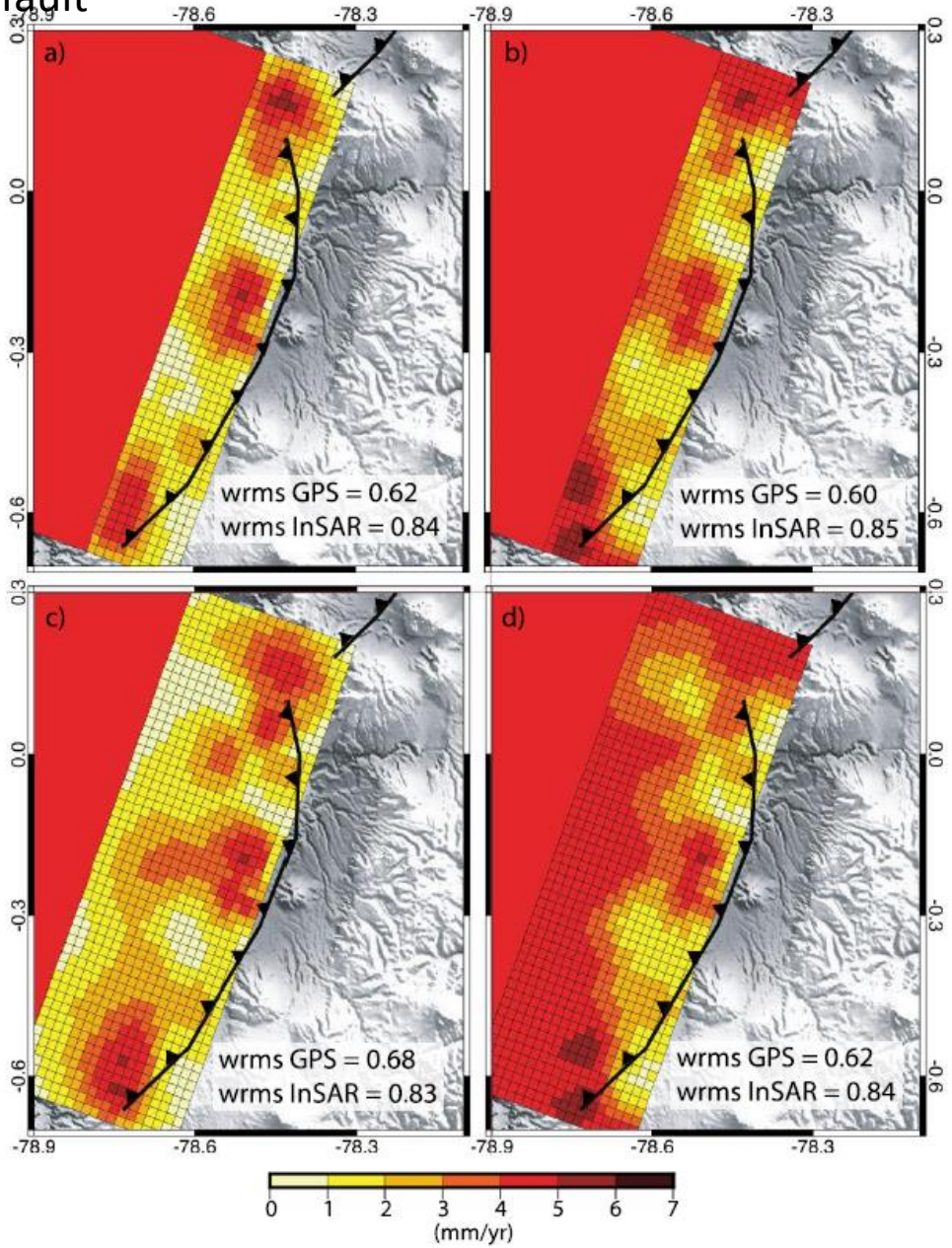


Elliott, et al., 2012

Marinieri et al 2019 - Geodetic evidence for shallow creep along the Quito fault



Results of the Bayesian inversion using GPS and InSAR data and the Flat Décollement Ramp (FDR) model with a décollement depth at 10 km.

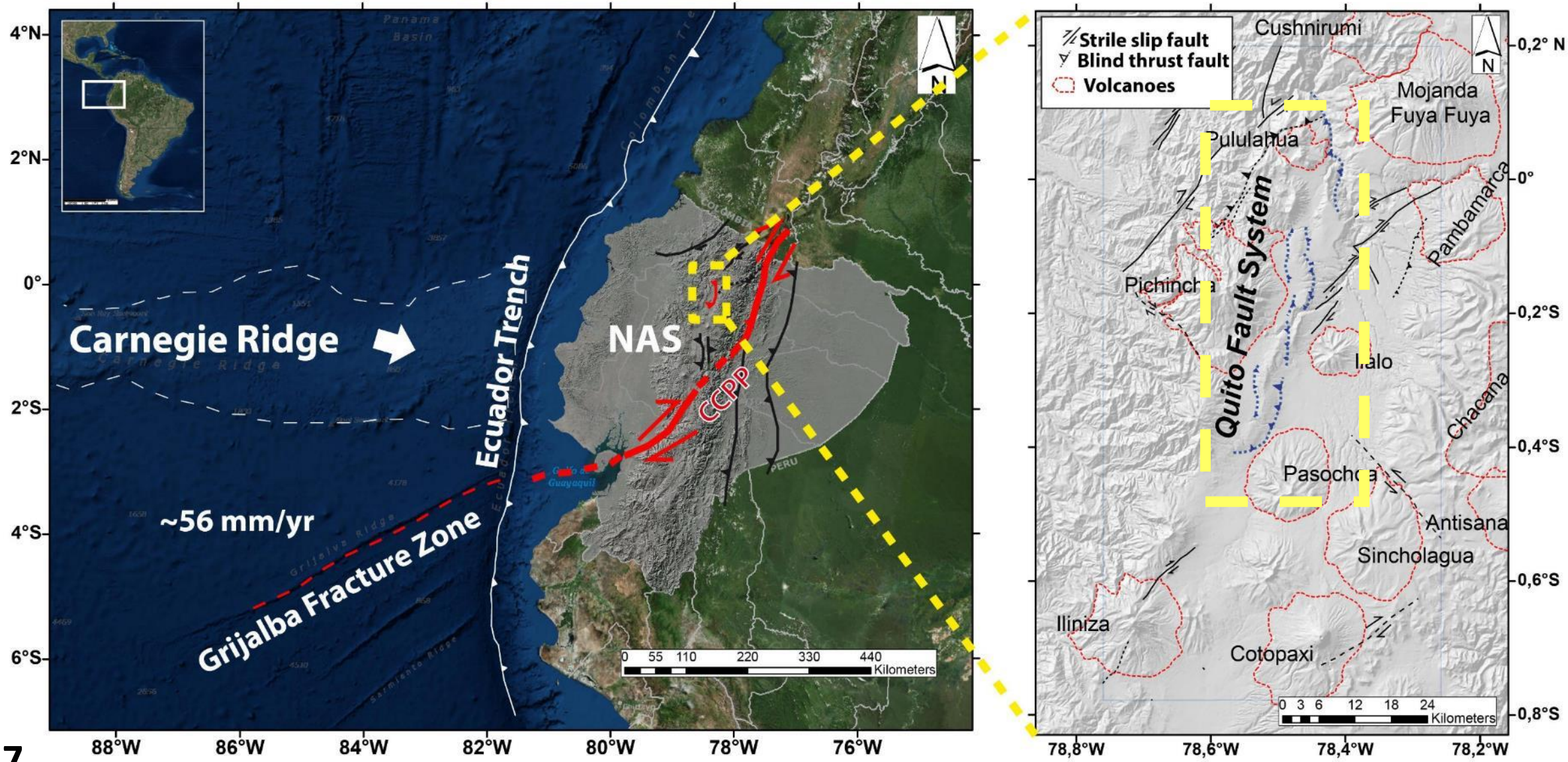


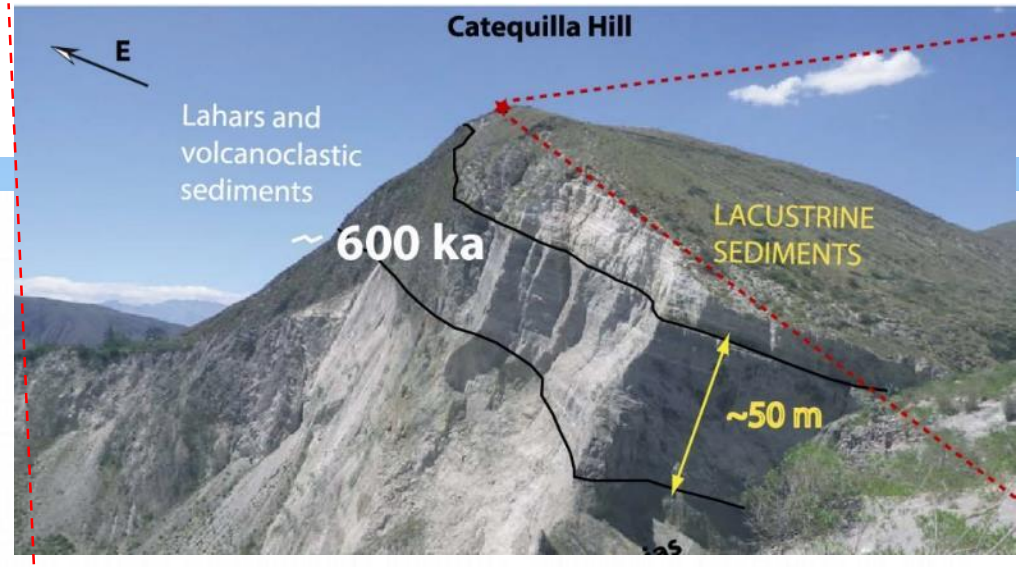
Selection of four different fault slip models along the Quito Fault System**.** Fault dipping at 20° with a shortening rate between 4.6 and 4.9 mm/yr and a flat décollement at either at 7 km depth (a and b) and 13 km depth (c and d).

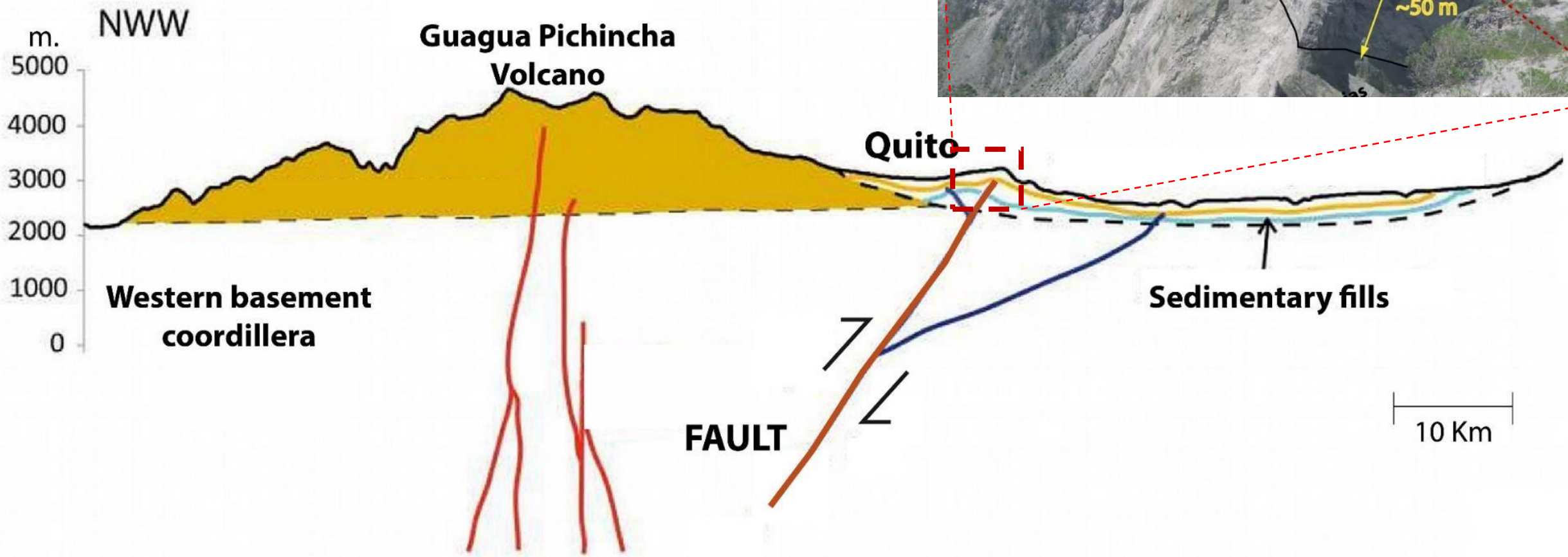
CONTEXTO GEODINAMICO

- Migración NE (NAS)

- 10 mm/yr



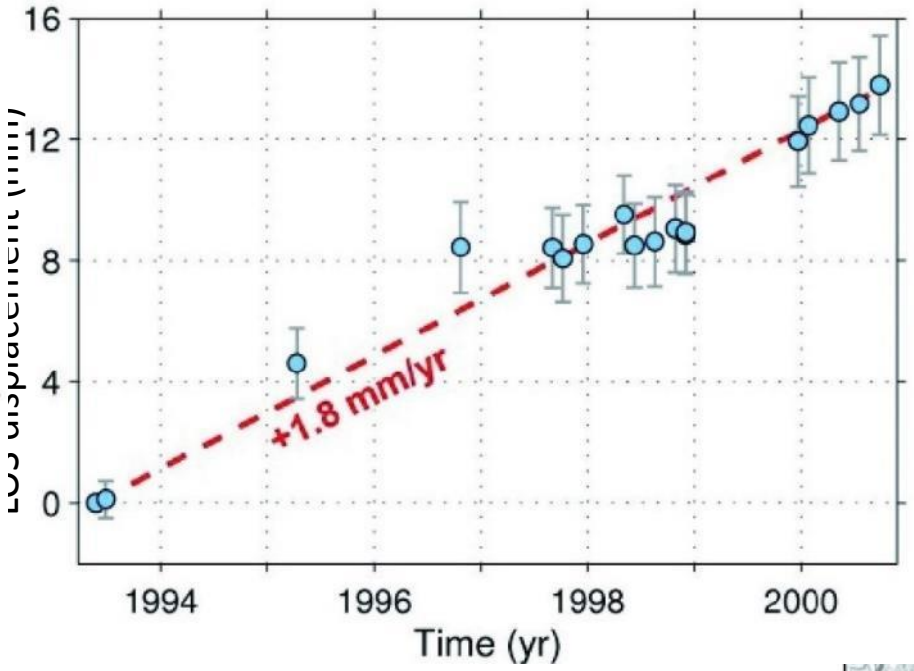




Alvarado et al, 201

YEAR	EVENTS
600.000	Neotectonic 1 mm/yr
1755	Quito earthquake Mb 6.3
1993-2000	InSAR LOS ERS 1.8 mm/yr
1996-2011	GPS 4 mm/yr
2016	Pedernales Mw 7.8 Subduction earthquake

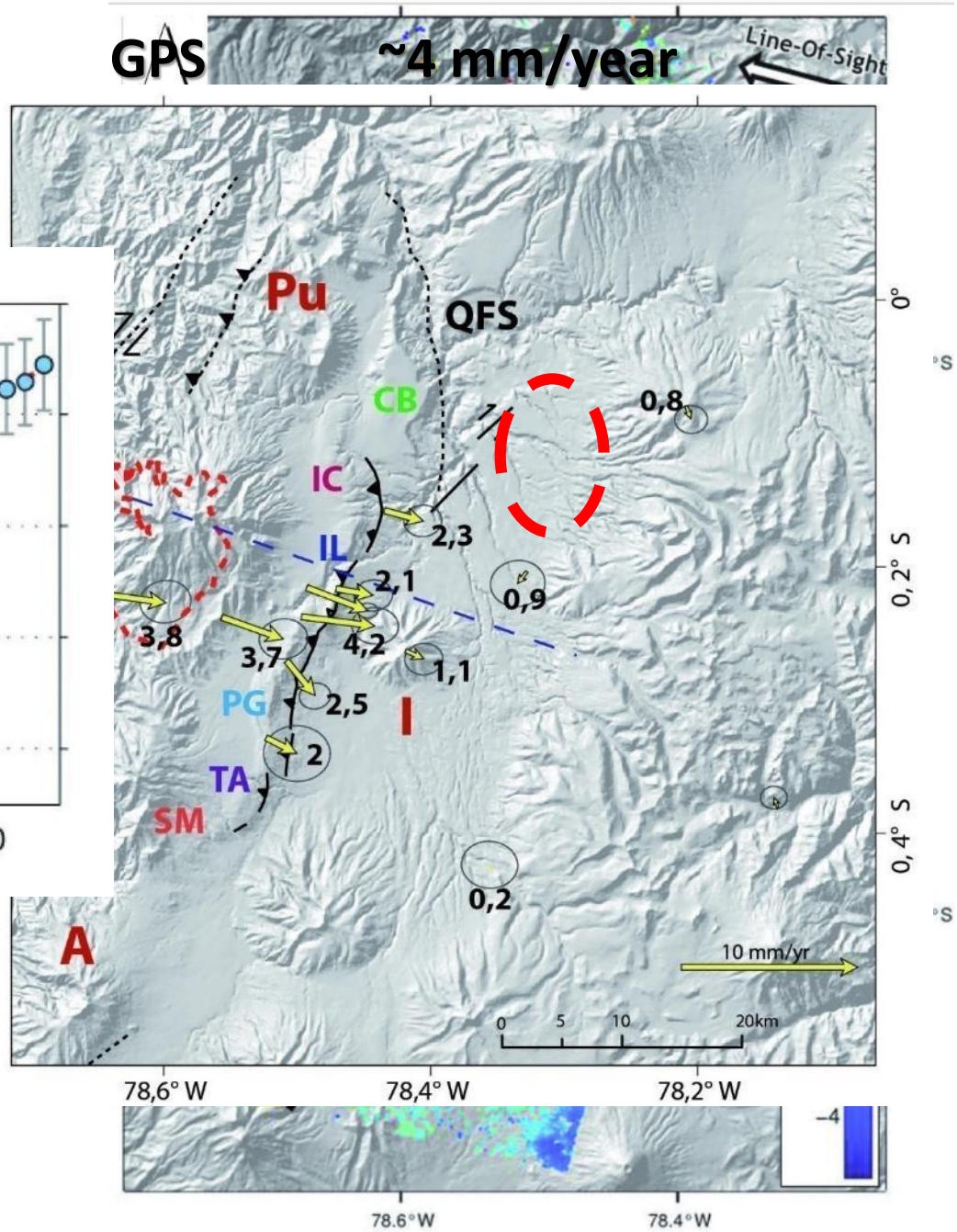
Geodetic studies



Time Series

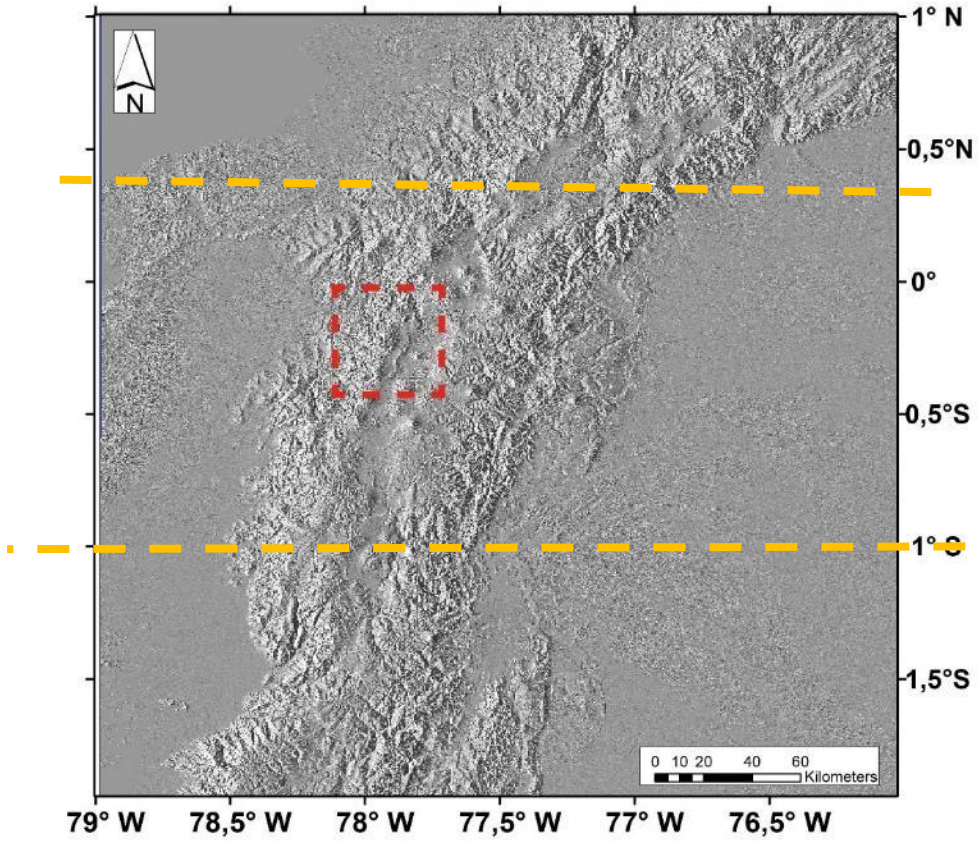
PS InSAR

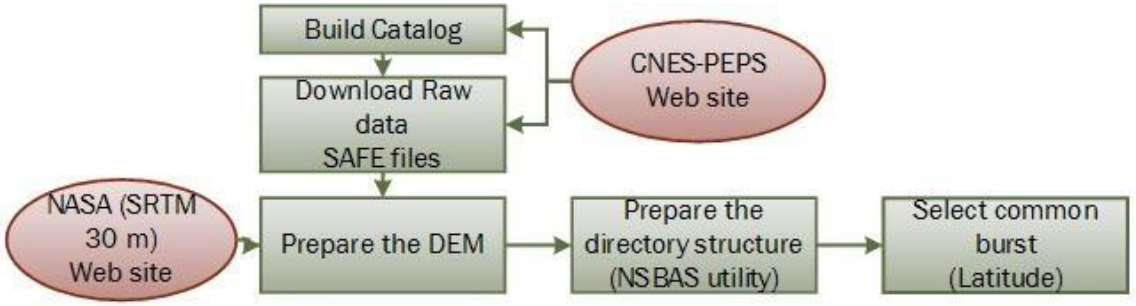
19 ERS SAR

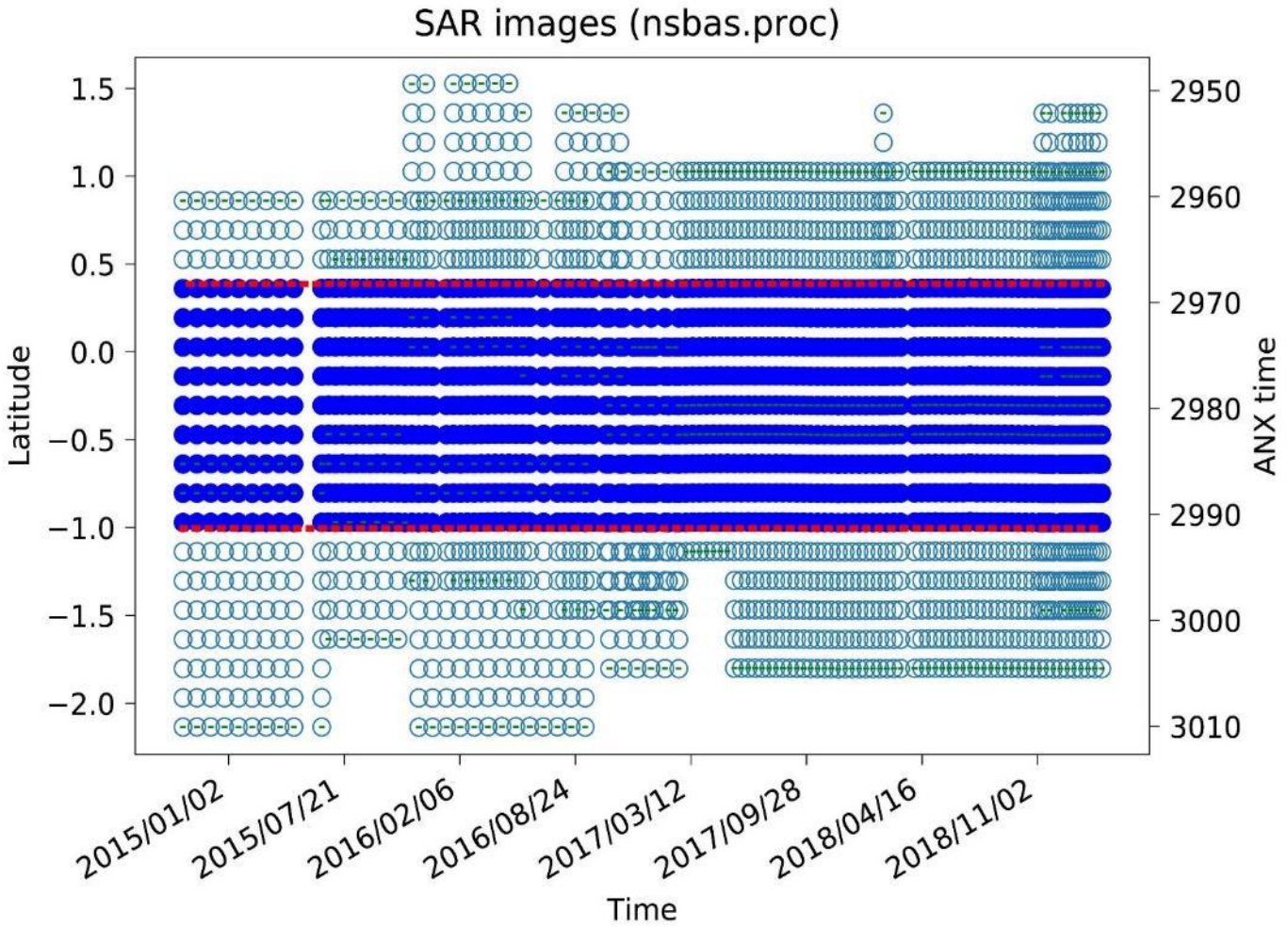


NSBAS chain automation

New Small Baseline Subset (NSBAS)



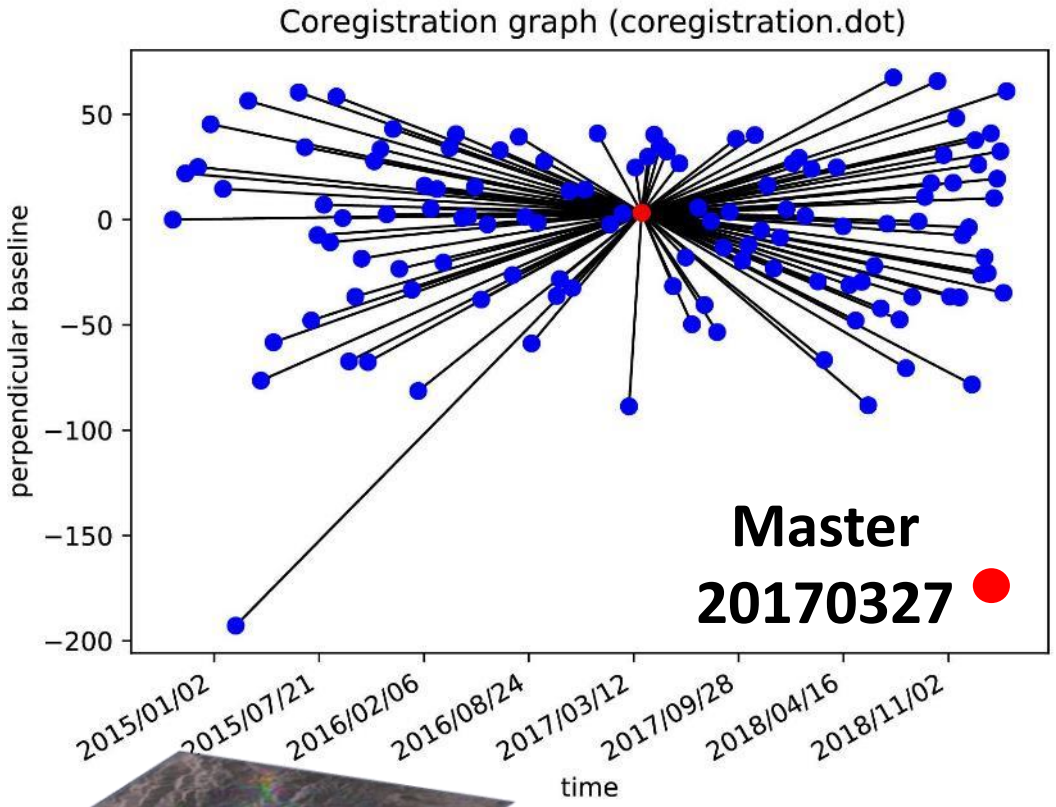


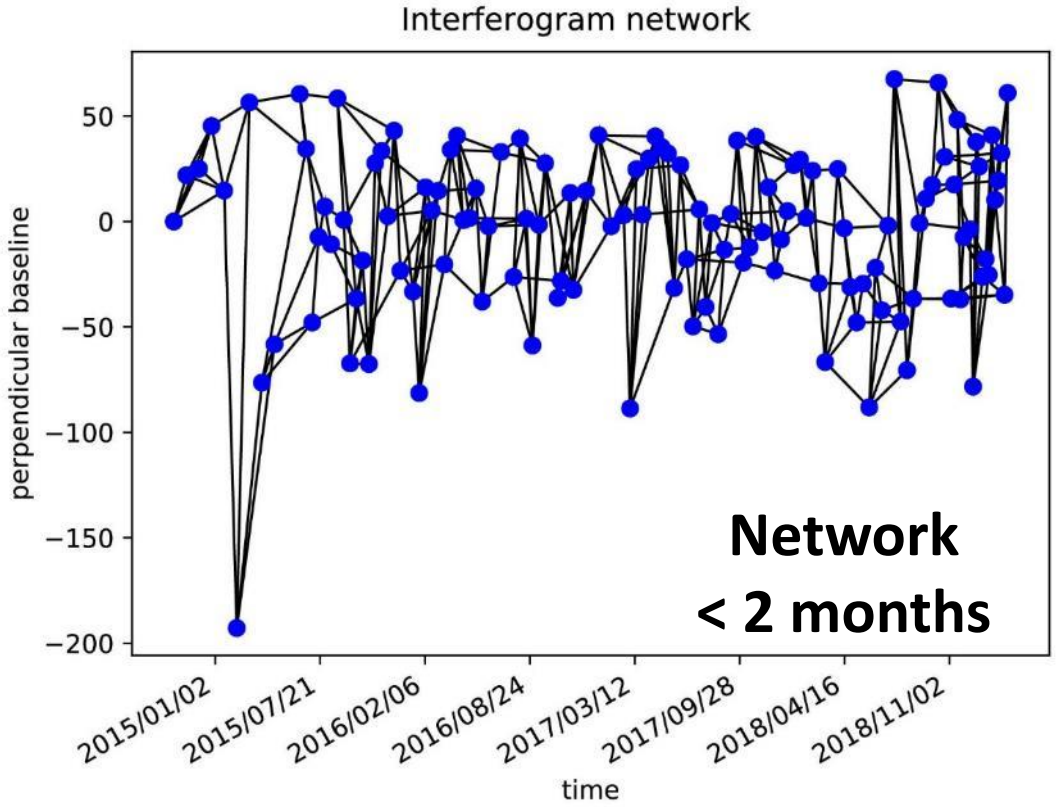


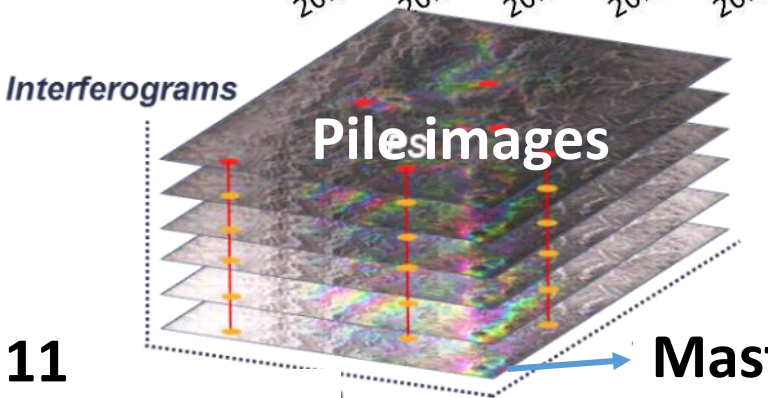
NSBAS chain automation

105 images (Imagenes Descedentes)

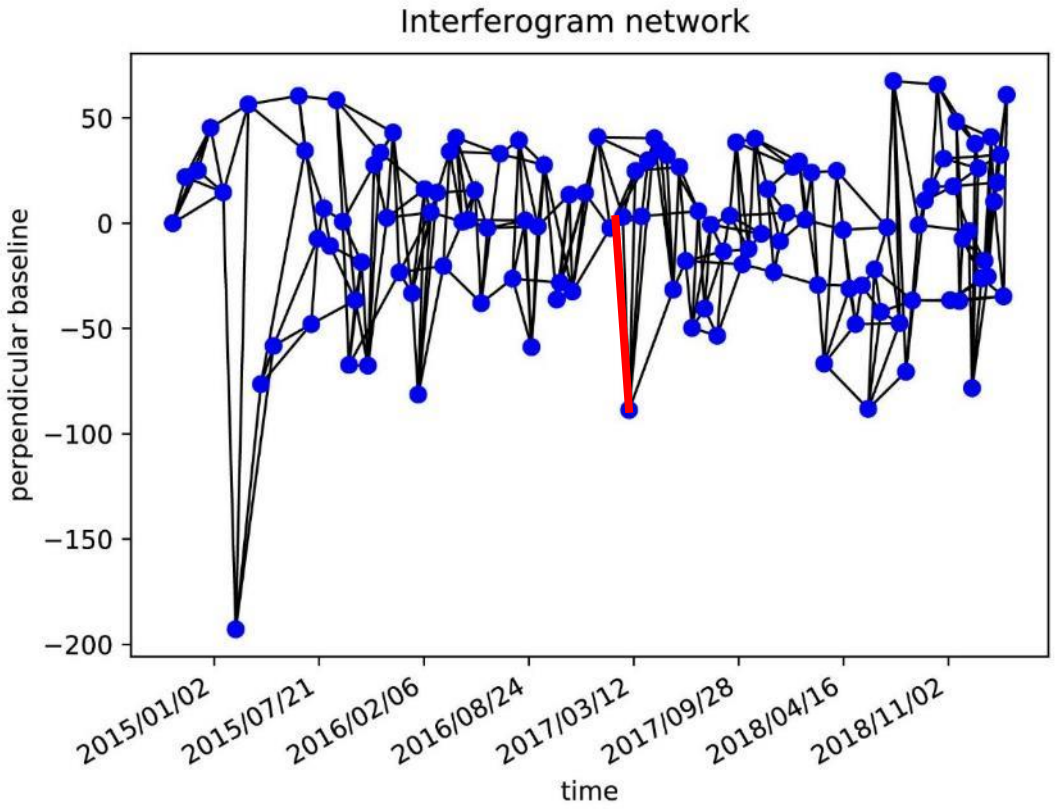
264 a 300 Interferograms

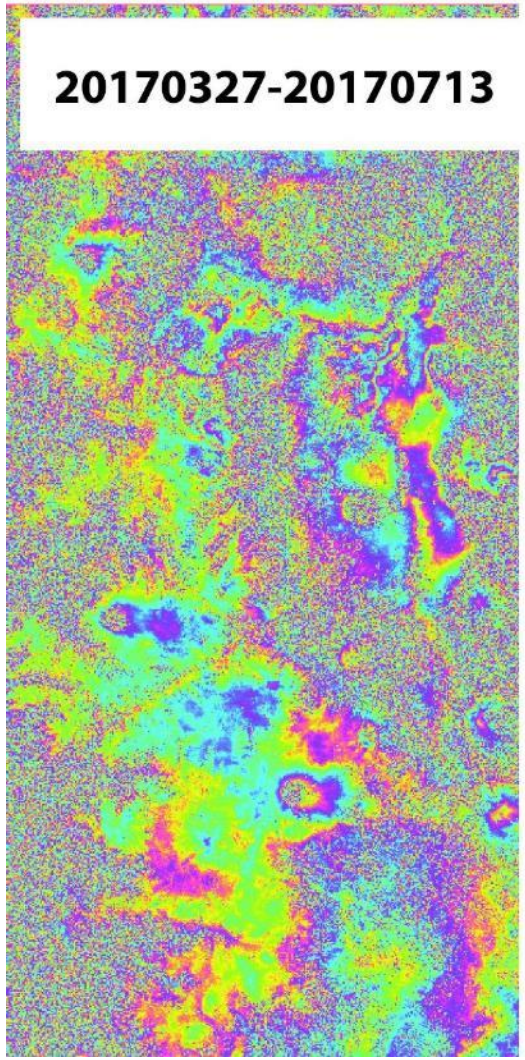




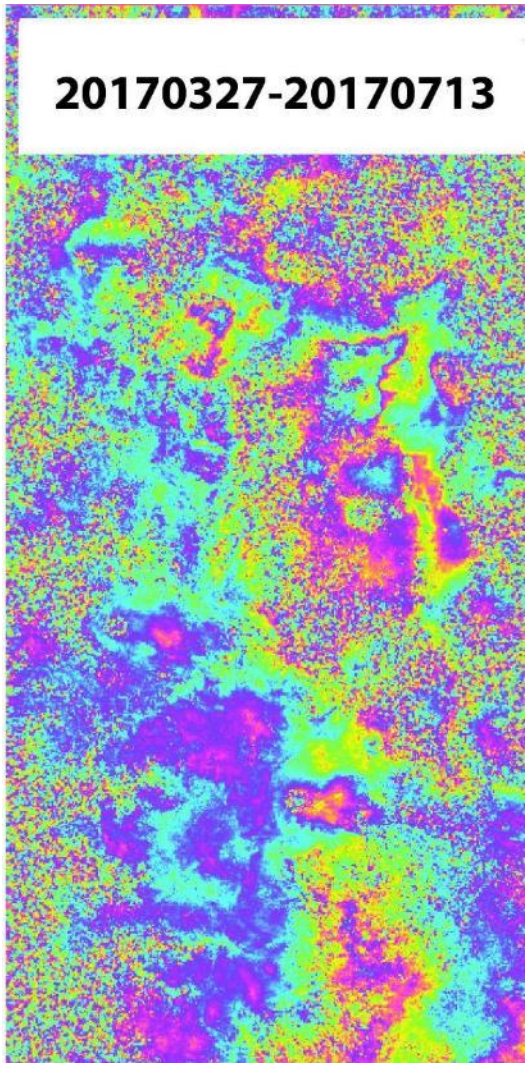


NSBAS chain automation

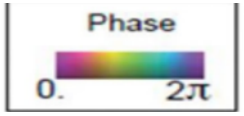




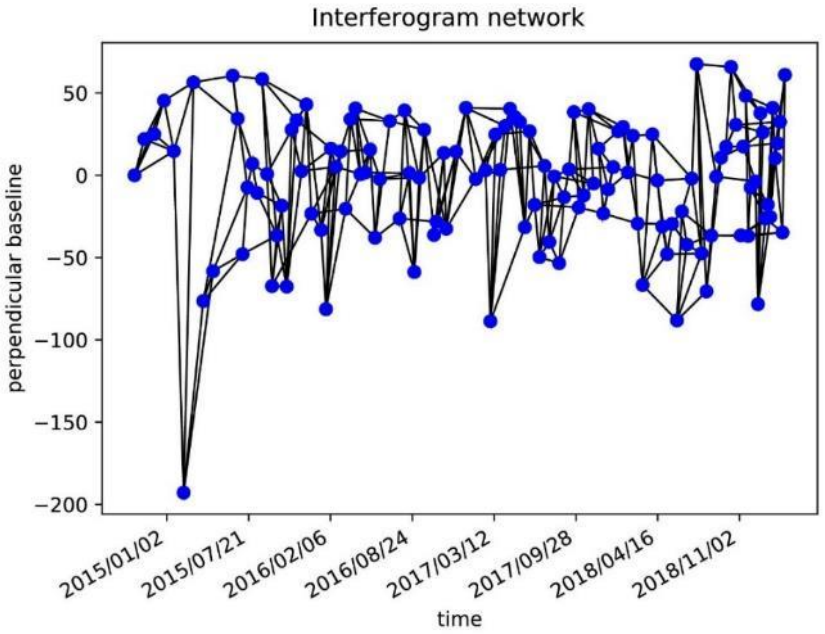
Wrapped Interferogram



ERA-5 Wrapped Interferogram

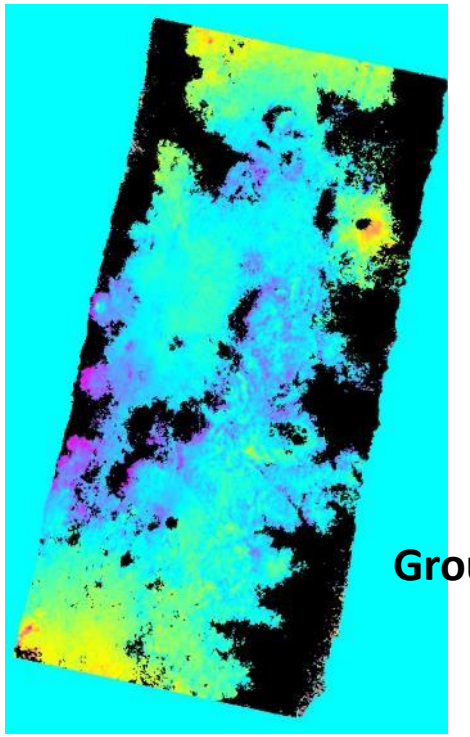


NSBAS chain automation



Compute Network inversion

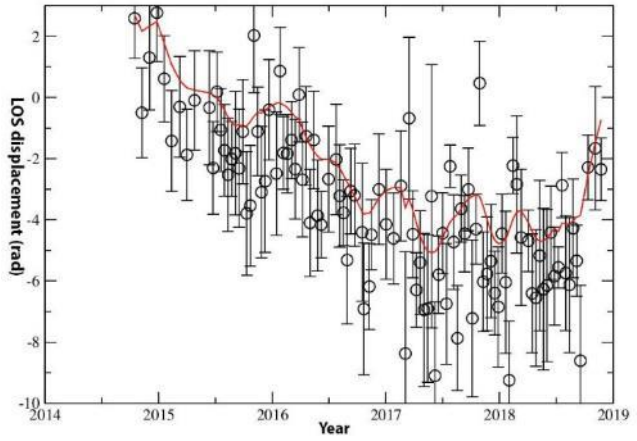
Time Series



Root mean square map (RMS)

Ground velocity map

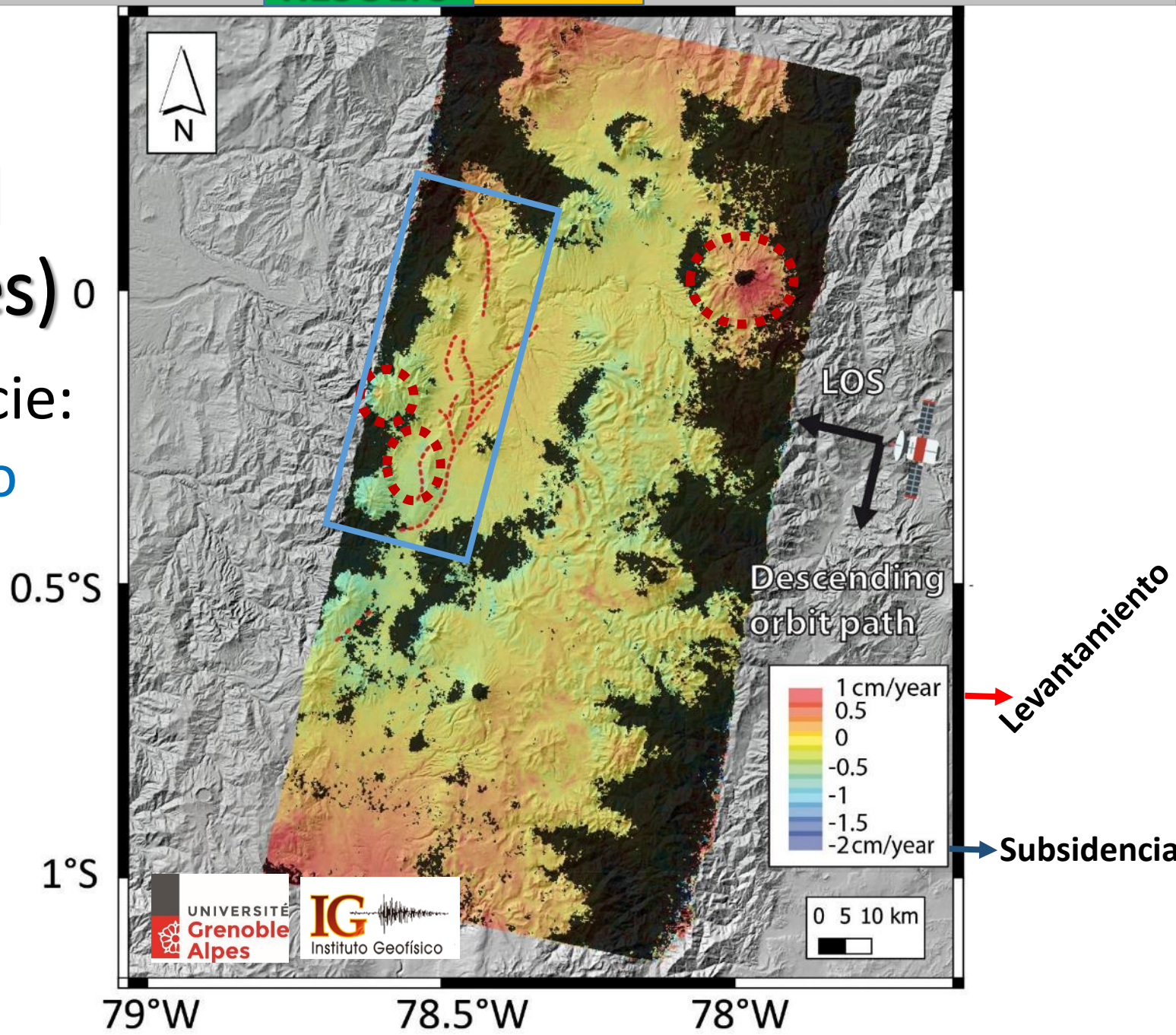
Extract the Time Series



Mapa de velocidad (Imagenes Descedentes)

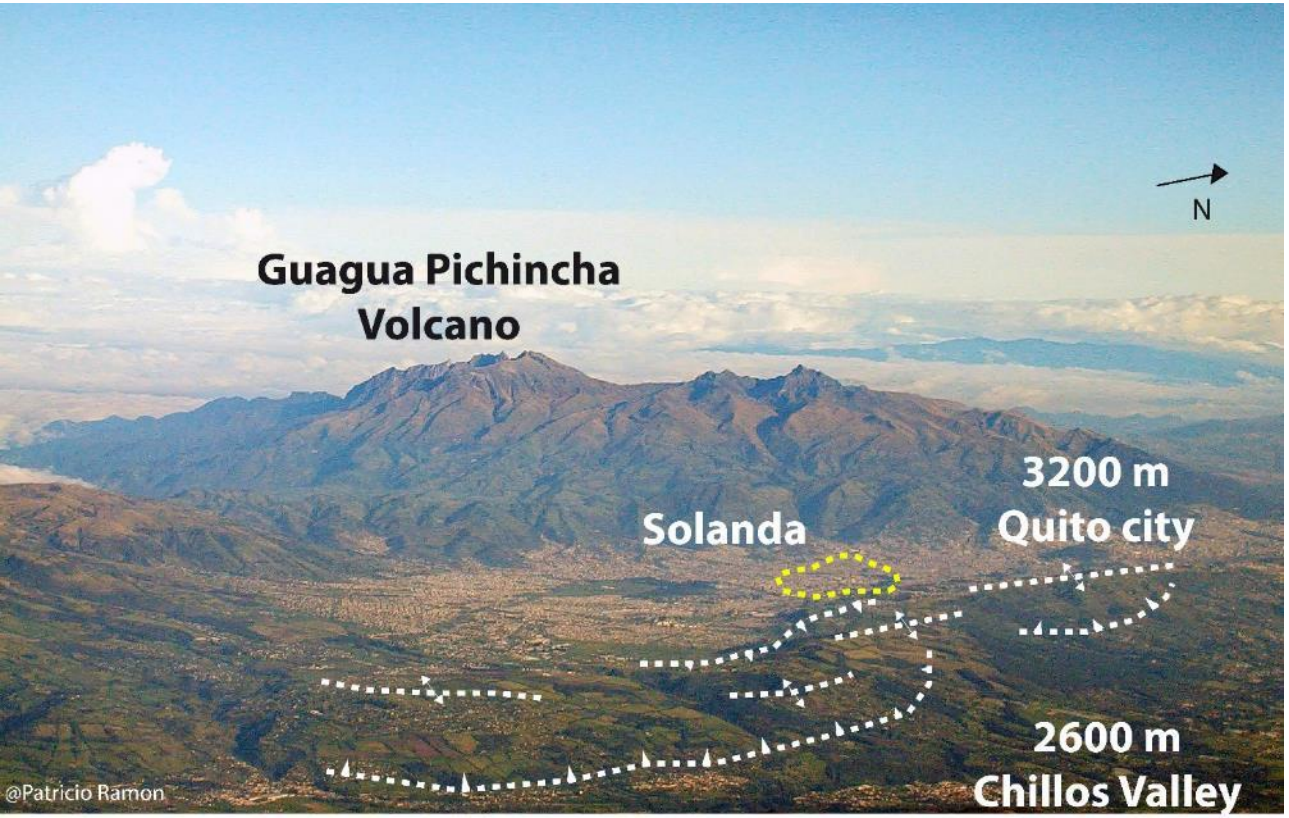
Deformación de la superficie:

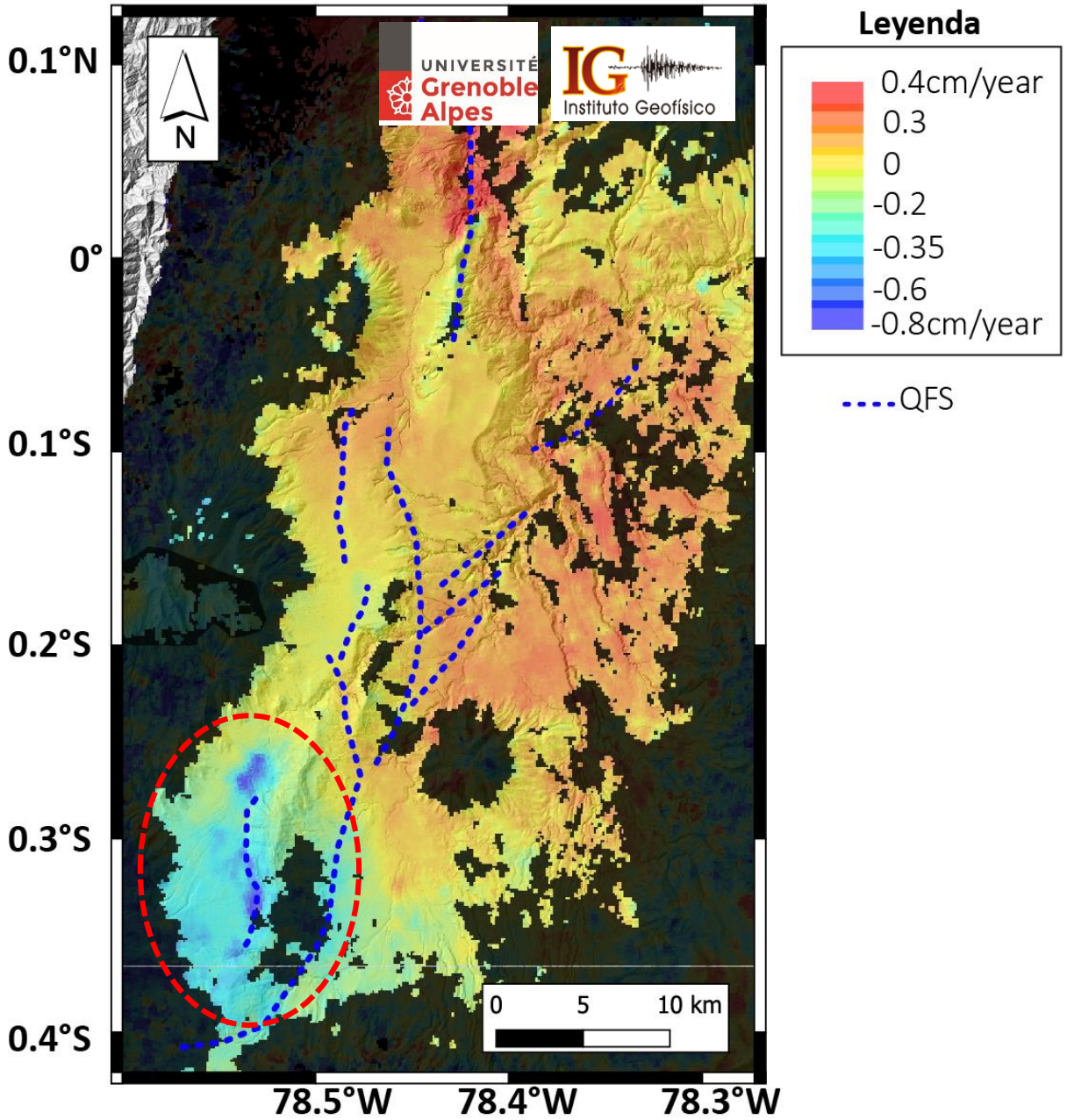
1. Area de la falla de Quito
2. Toda el área de estudio
    - 2.1. Volcanes
    - 2.2. Antrópicos



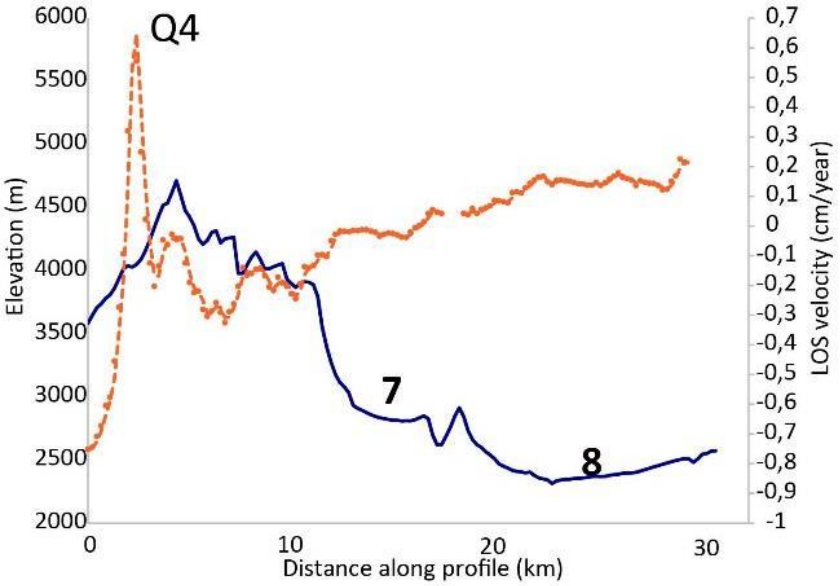
Espín Bedón et al., 2019 **Deformation monitoring from Synthetic Aperture Radar Interferometry (INSAR) Sentinel data in Quito, Ecuador**

Sistema de Falla de Quito (QFS)

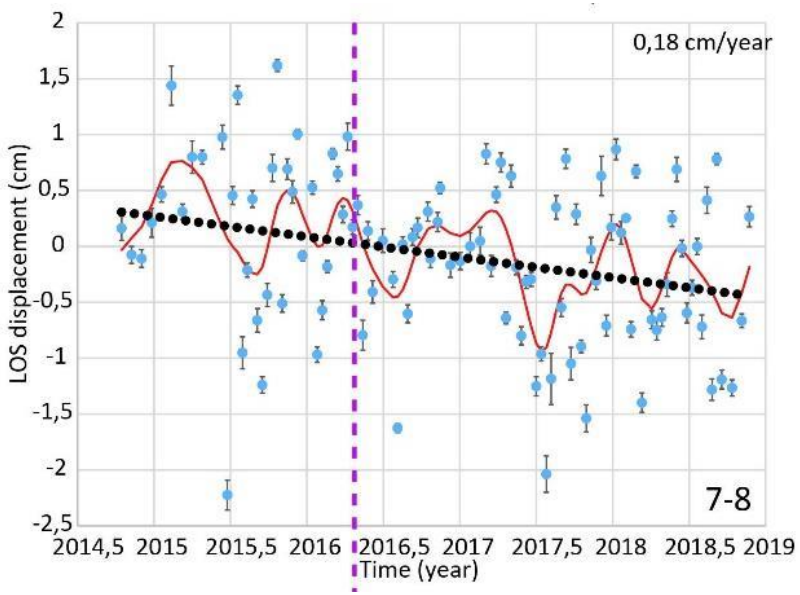


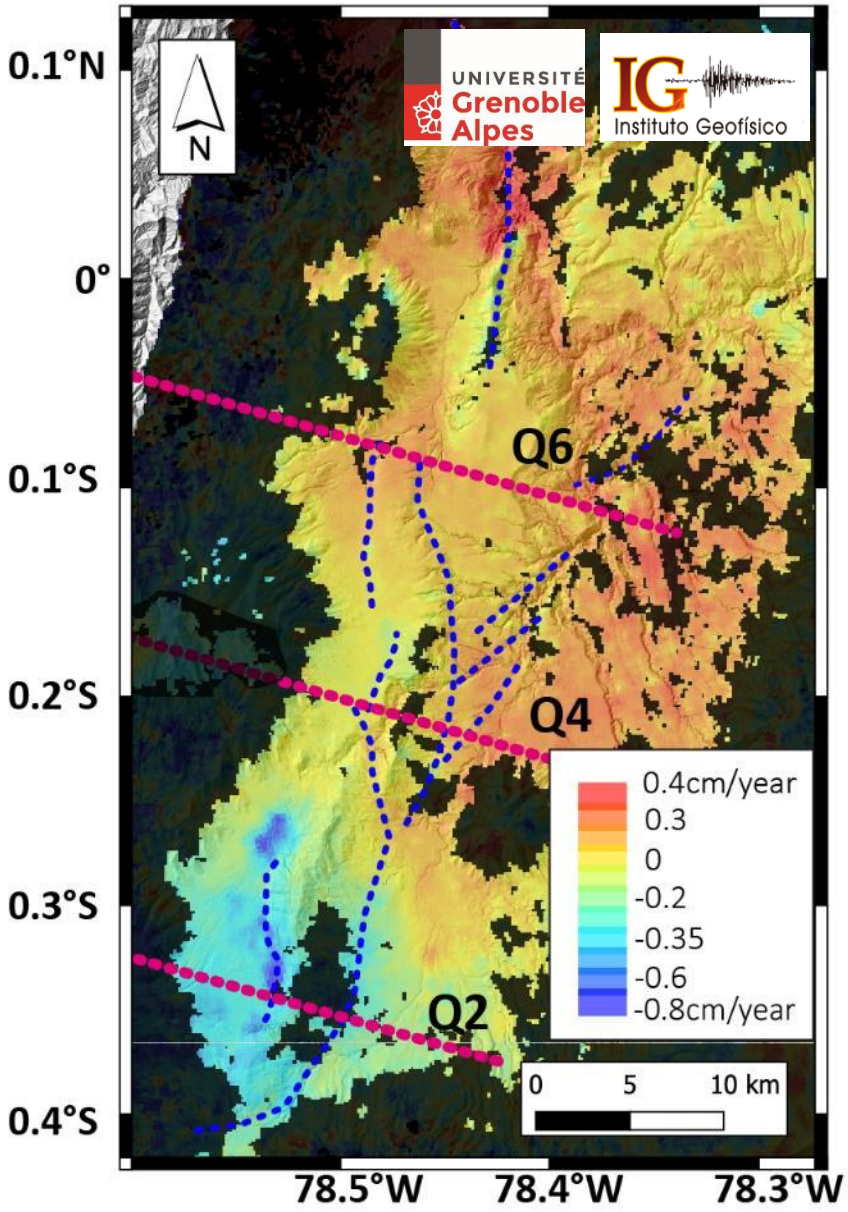


Profiles

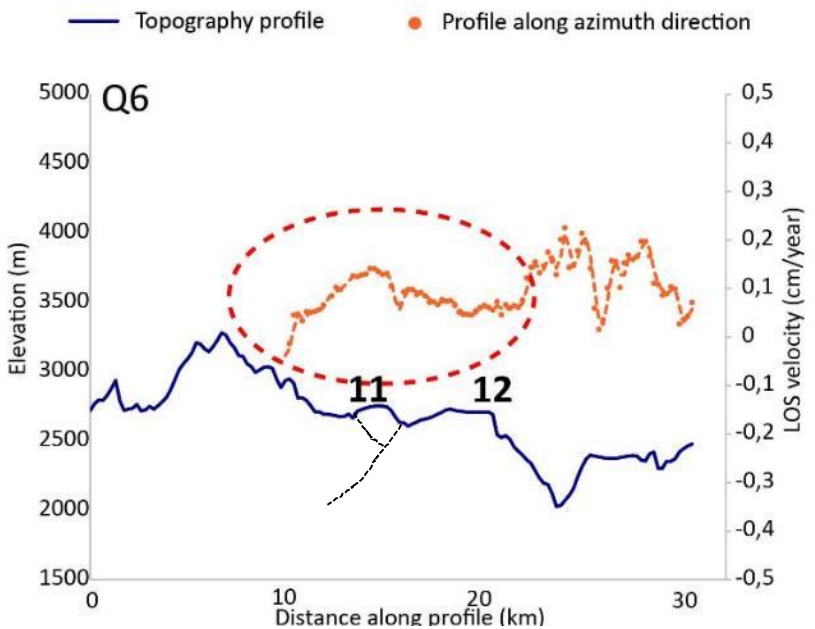


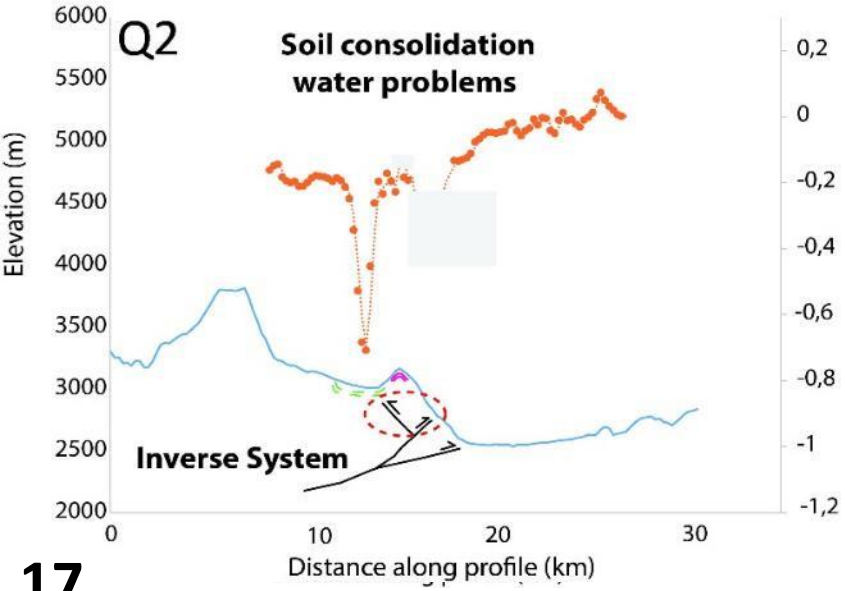
Time Series



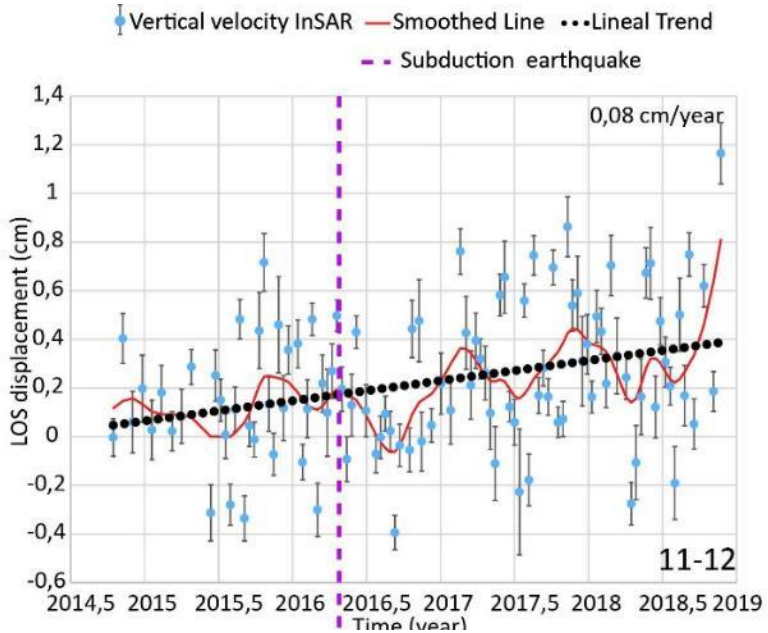


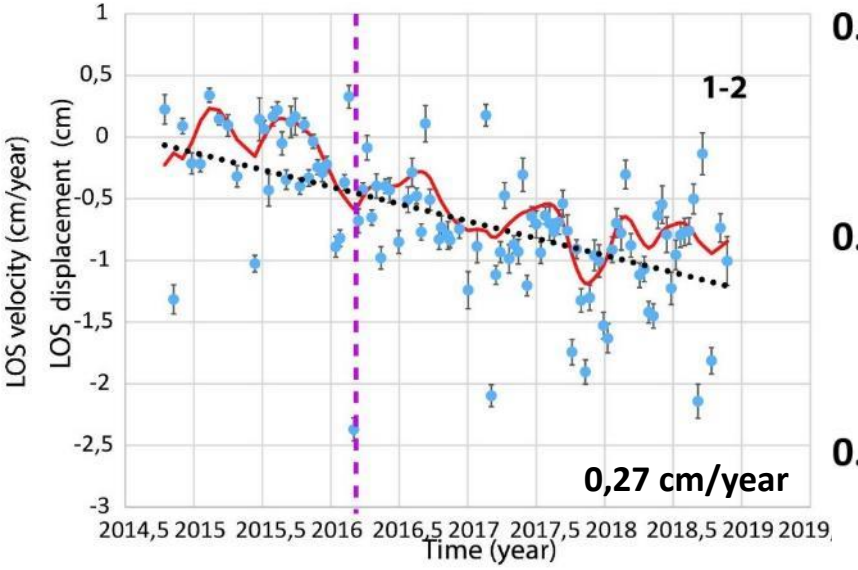
Profiles

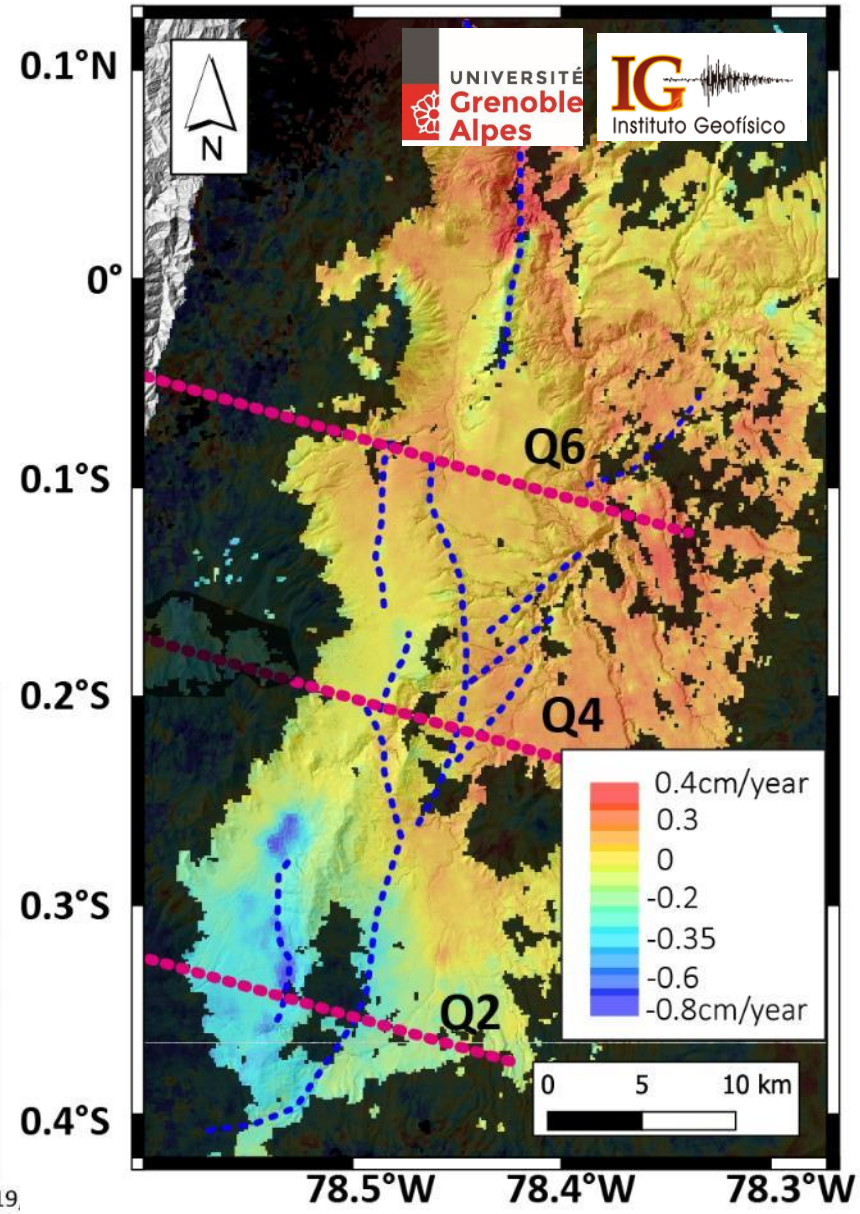


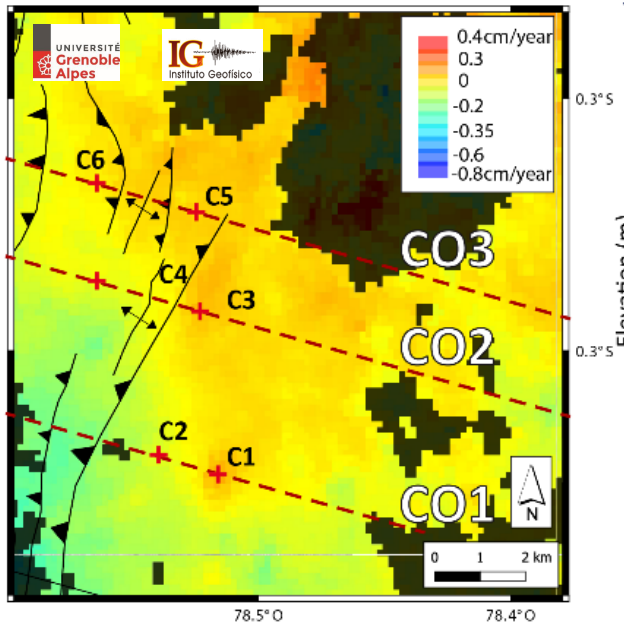


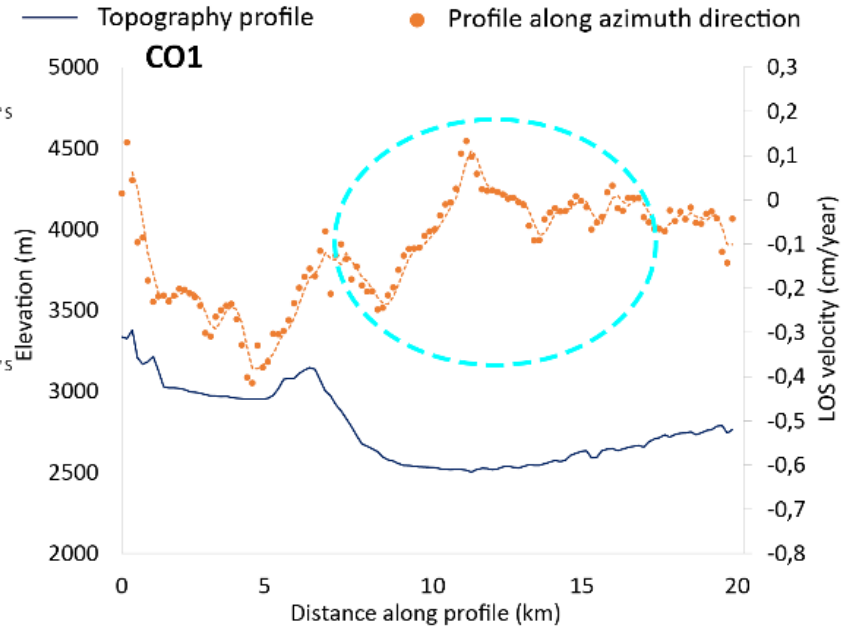
Time Series

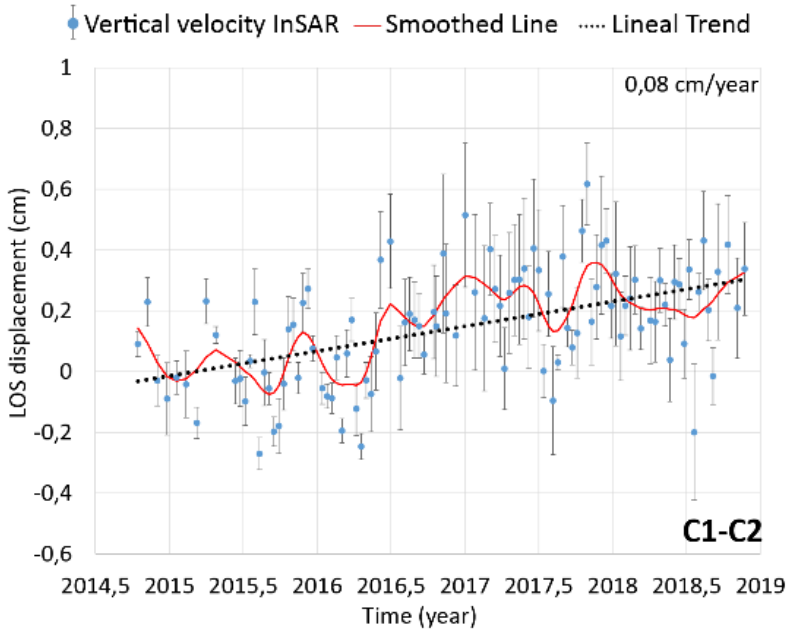


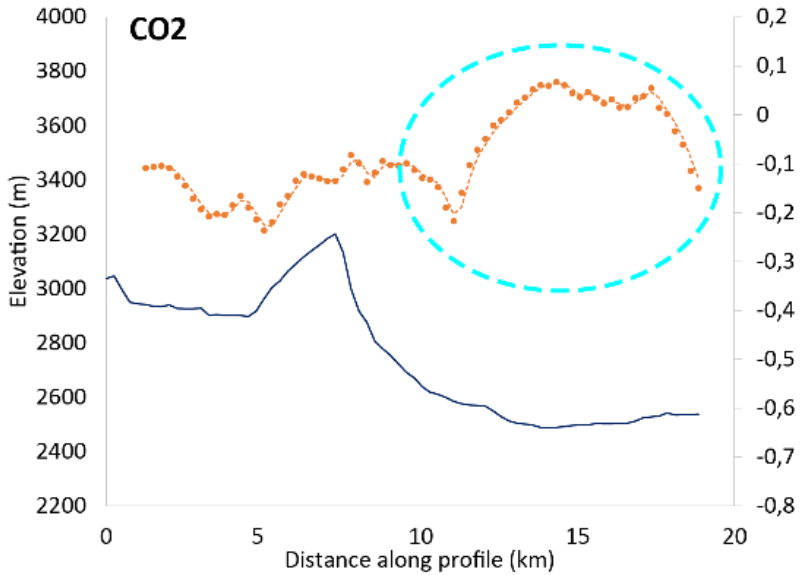


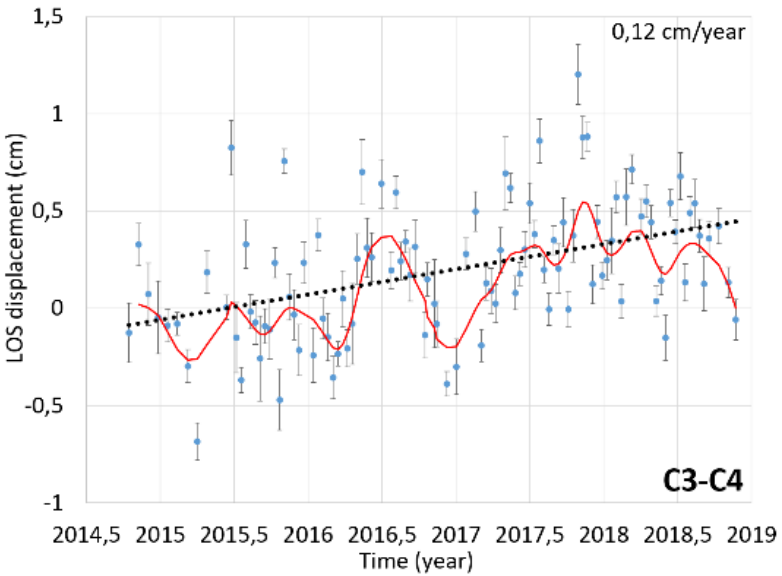


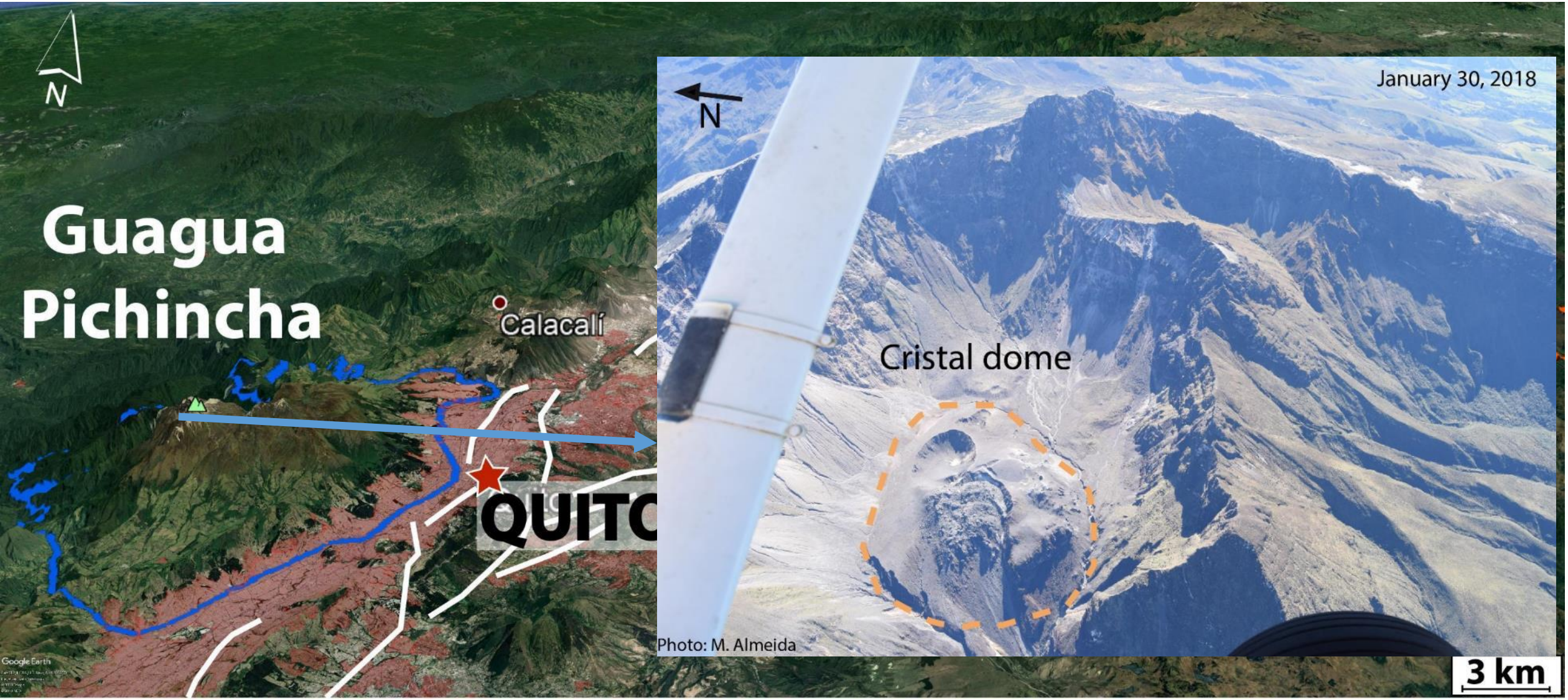

UNIVERSITÉ Grenoble Alpes
IG Instituto Geofísico
0.4cm/year
0.3
0
-0.2
-0.35
-0.6
-0.8cm/year
C6
C5
C4
C3
C2
C1
CO3
CO2
CO1
N
0 1 2 km
0.3°S
0.3°S
78.5°O
78.4°O


Topography profile
Profile along azimuth direction
CO1
Elevation (m)
LOS velocity (cm/year)
Distance along profile (km)

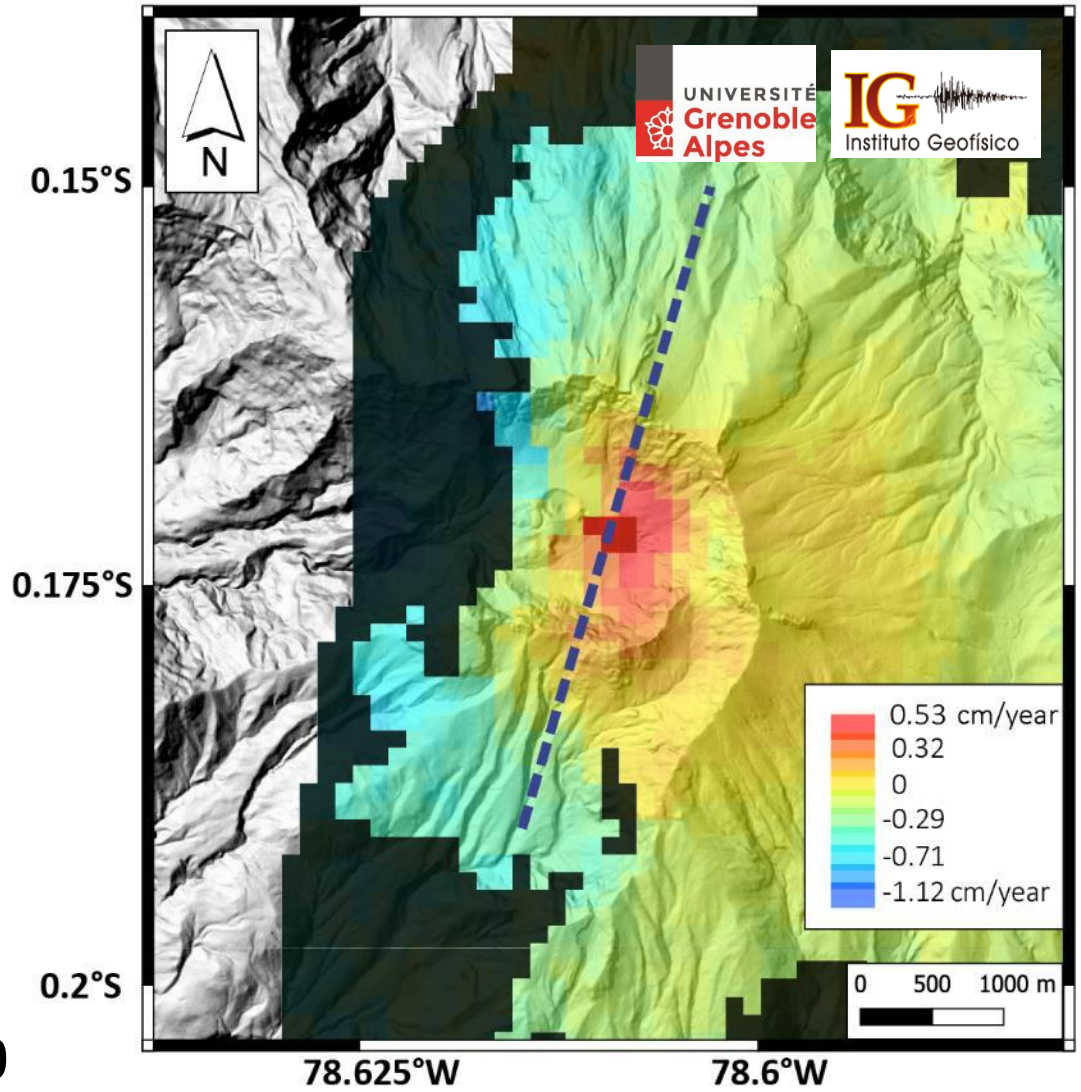

Vertical velocity InSAR
Smoothed Line
Lineal Trend
0,08 cm/year
C1-C2
LOS displacement (cm)
Time (year)


CO2
Elevation (m)
LOS velocity (cm/year)
Distance along profile (km)

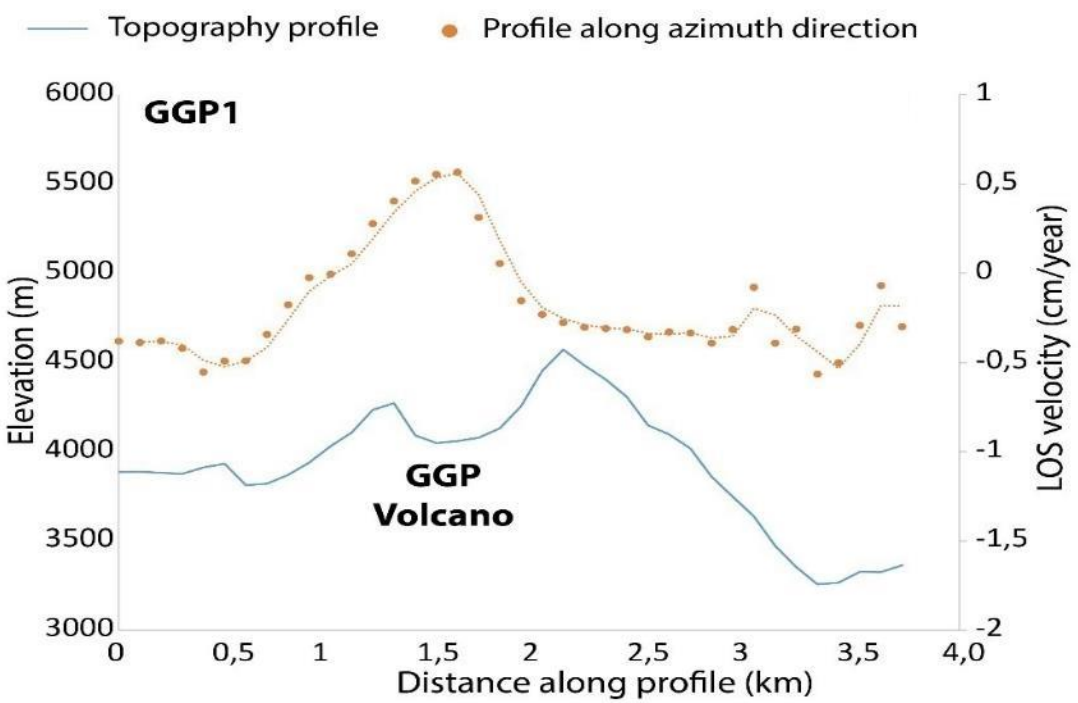

0,12 cm/year
C3-C4
LOS displacement (cm)
Time (year)


N
Guagua
Pichincha
Calacalí
QUITO
Google Earth
N
January 30, 2018
Cristal dome
Photo: M. Almeida
3 km

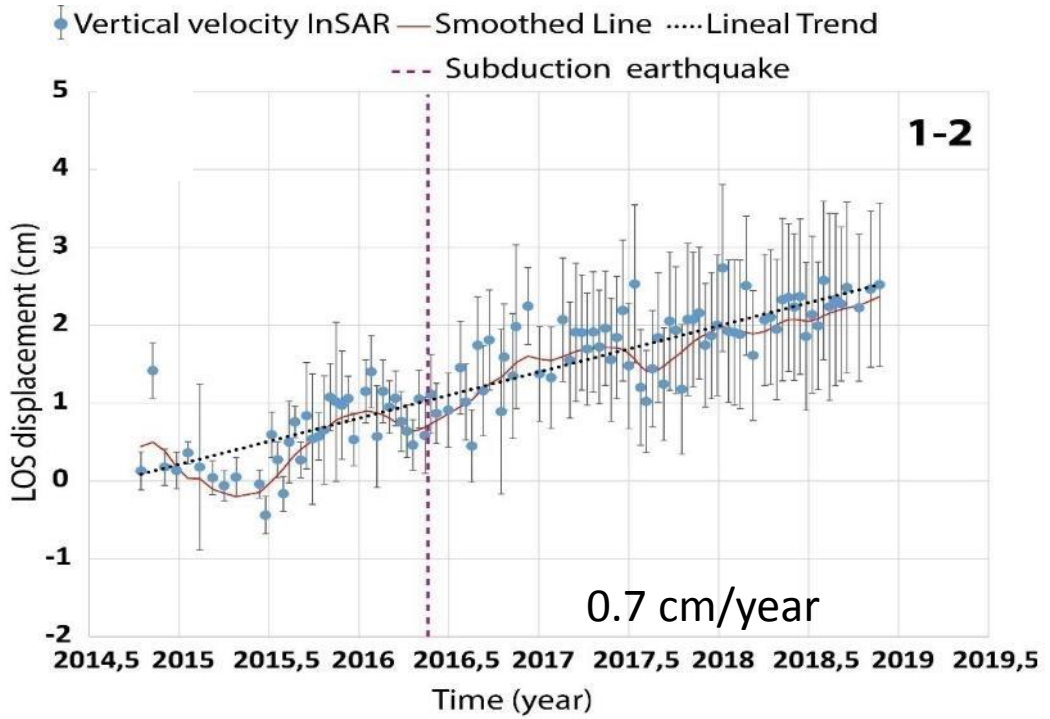
Guagua Pichincha Volcano



Profiles



Time Series



CONCLUSIONES

- El segmento norte de la Falla de Quito

  Pequeña taza de desplazamiento entre 2014 y 2018 comparada con ~1.8 mm/year de desplazamiento asismico observado entre 1993 y 2001.

- Los segmentos central y sur muestran un relativa patron de subsidencia de ~0,27 cm/year
- La dinámica del area urbana con impactos antrópicos de la superficie.
- Fue un excelente test de NSBAS, a lo largo de un area de una falla inversa, vegetada, region con alta topografia para el monitoreo con los nuevos datos Sentinel-1.

REFERENCIA:

Espín Bedón et al., 2019 **Deformation monitoring from Synthetic Aperture Radar Interferometry (INSAR) Sentinel data in Quito, Ecuador**

(https://www.researchgate.net/publication/336104153_Deformation_monitoring_from_Synthetic_Aperture_Radar_Interferometry_INSAR_Sentinel_data_in_Quito_Ecuador)

Thanks