

# Updated interseismic velocity solution in Central-North Chile ( $25^{\circ}\text{S}$ - $29^{\circ}\text{S}$ ) : Focus on the area of Taltal

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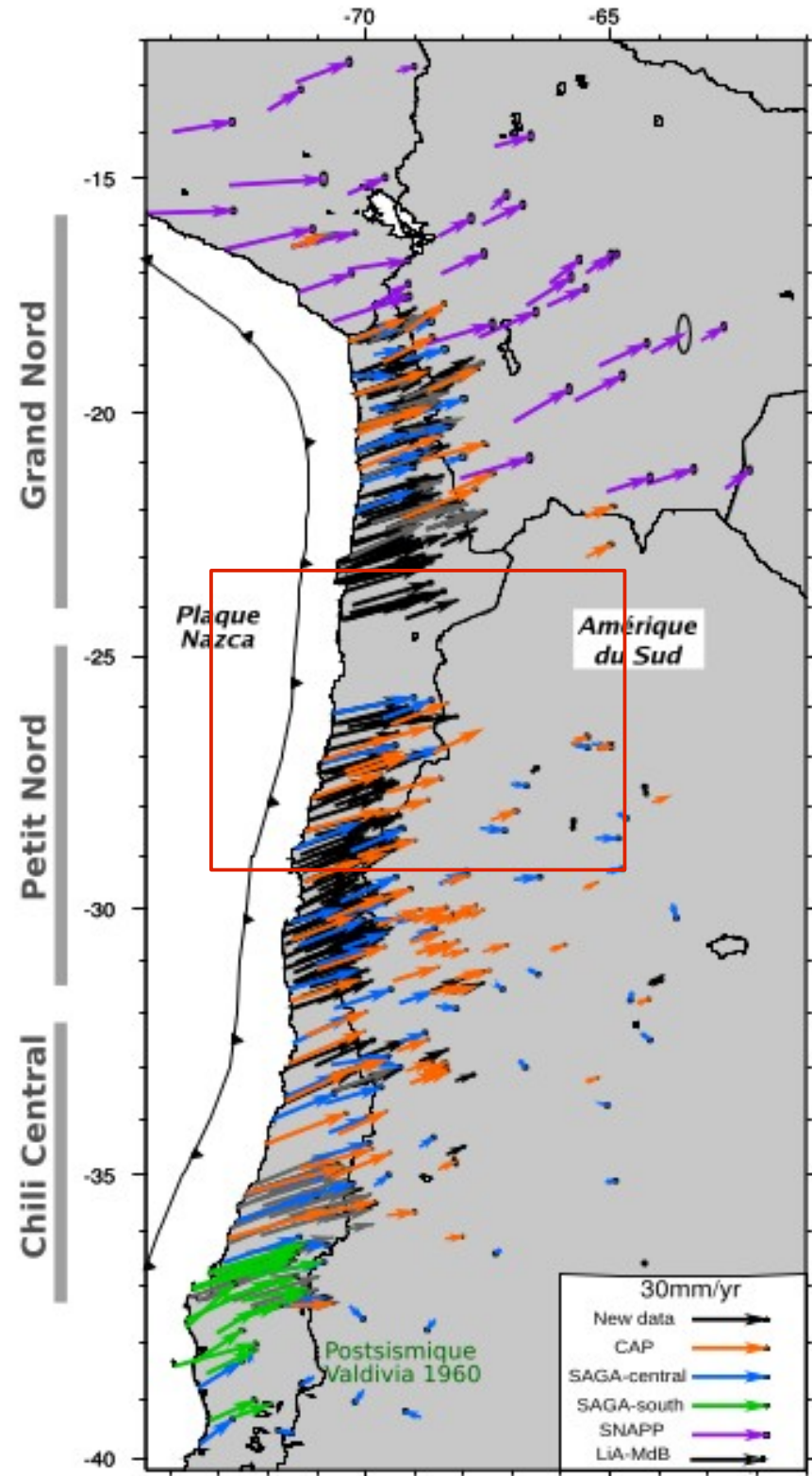


Conference G2 – Strasbourg – 17/19 November 2014

# Interseismic velocity field back in 2012

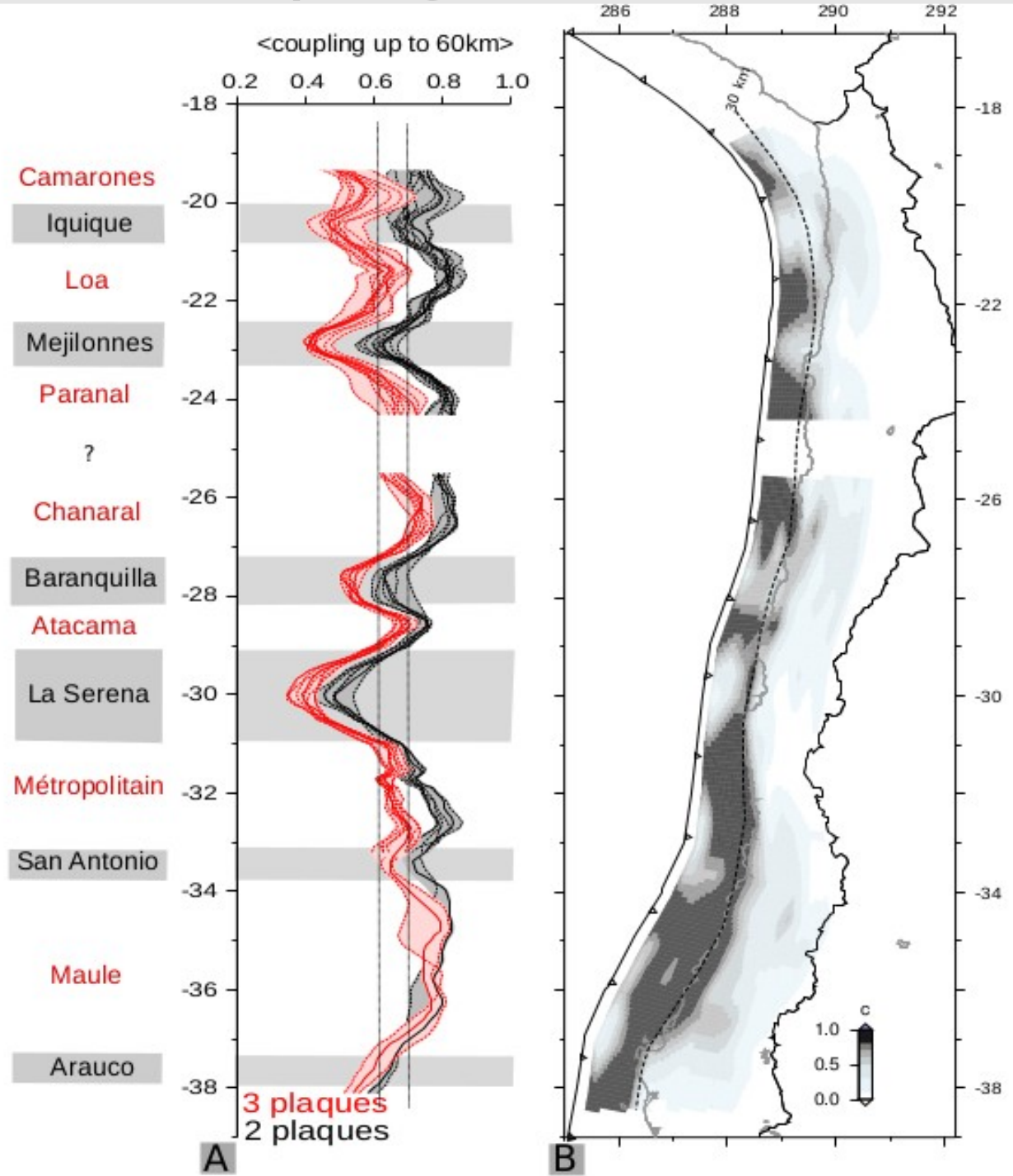
Compilation of all existant interseismic horizontal velocities (mm/yr), in Chile in 2012, plotted in a Stable South America reference frame defined by NNR-Nuvel1A

Metois et al.



# Elastic coupling model

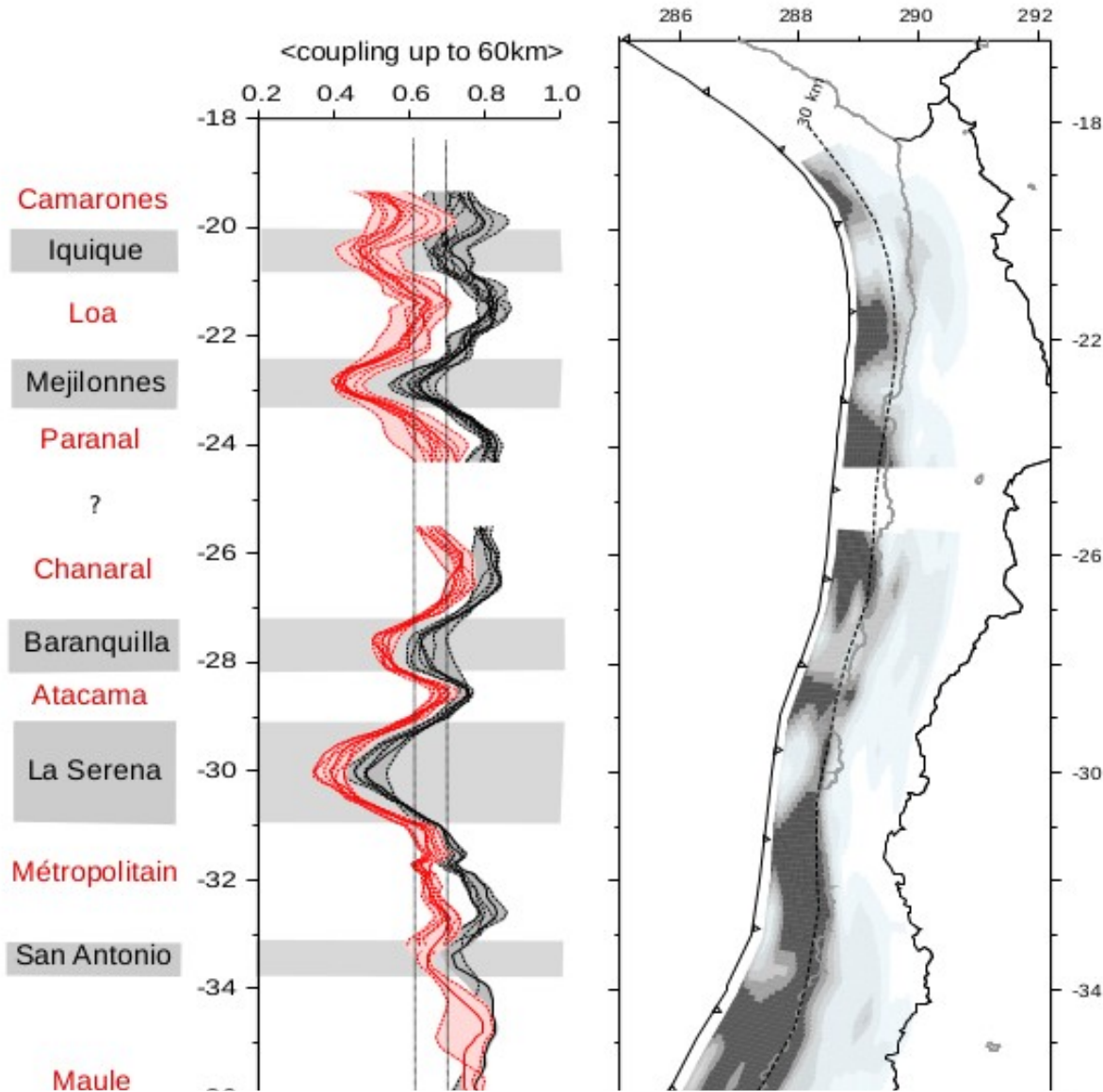
Metois et al, 2013



Model based on the elastic backslip DEFNODE code (McCaffrey et al., 2002)

# Elastic coupling model

Metois et al, 2013



Preferred three-plate model featuring an Andean sliver best described by the Eulerian pole

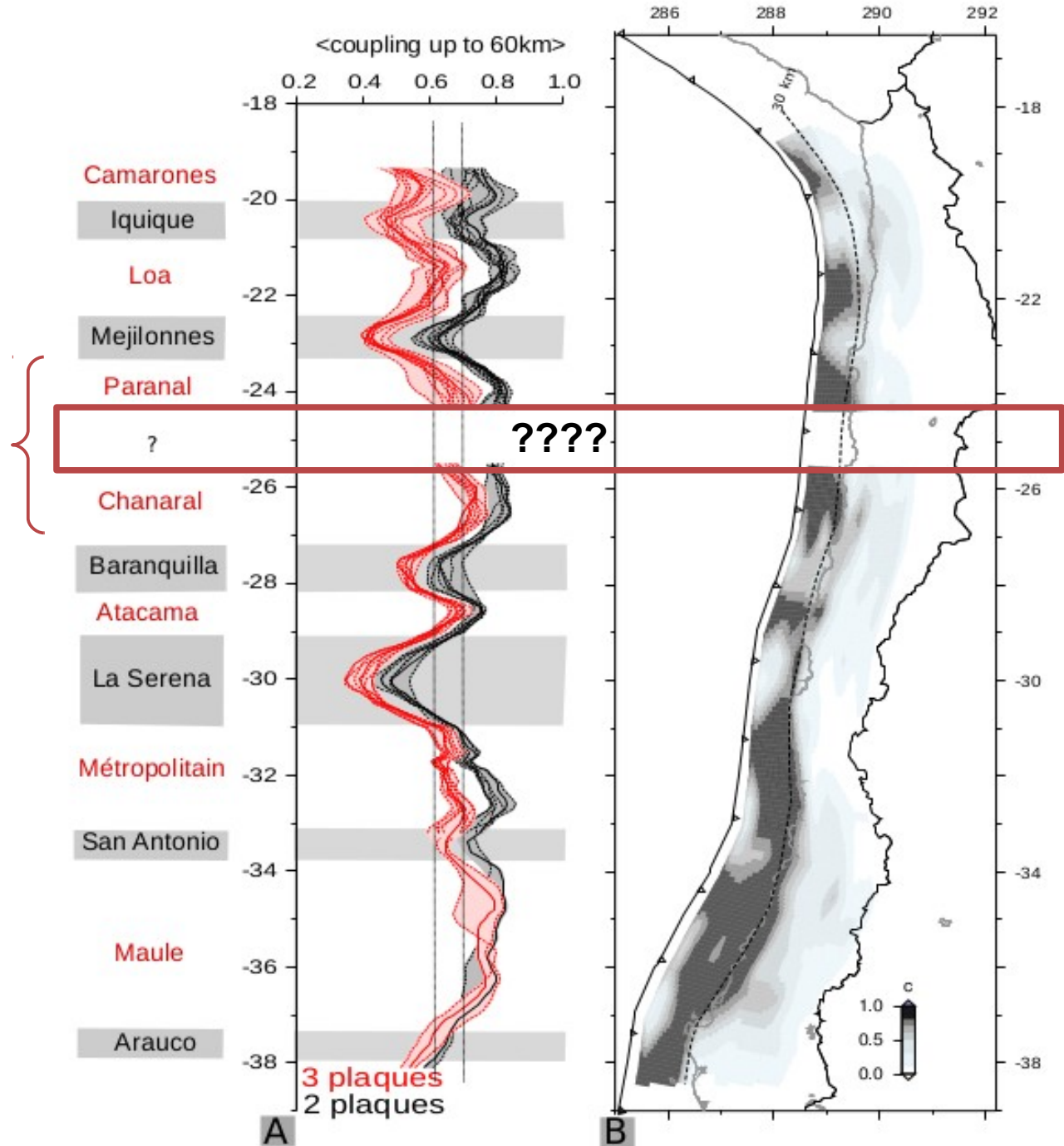
- $48.6^{\circ}\text{S}$ ,  $47.8^{\circ}\text{W}$ ,  $-0.19^{\circ}/\text{Myr}$  for the area between  $24^{\circ}\text{S}$  et  $18^{\circ}\text{S}$
- $39.2^{\circ}\text{S}$ ,  $61.5^{\circ}\text{W}$ ,  $-0.25^{\circ}/\text{My}$  for the area between  $26^{\circ}\text{S}$  et  $34^{\circ}\text{S}$

# Why keeping on ?

Two segments highly coupled separated by a low coupled intersegment ?

Only one highly coupled segment ?

→ Crucial question in terms of seismic alea



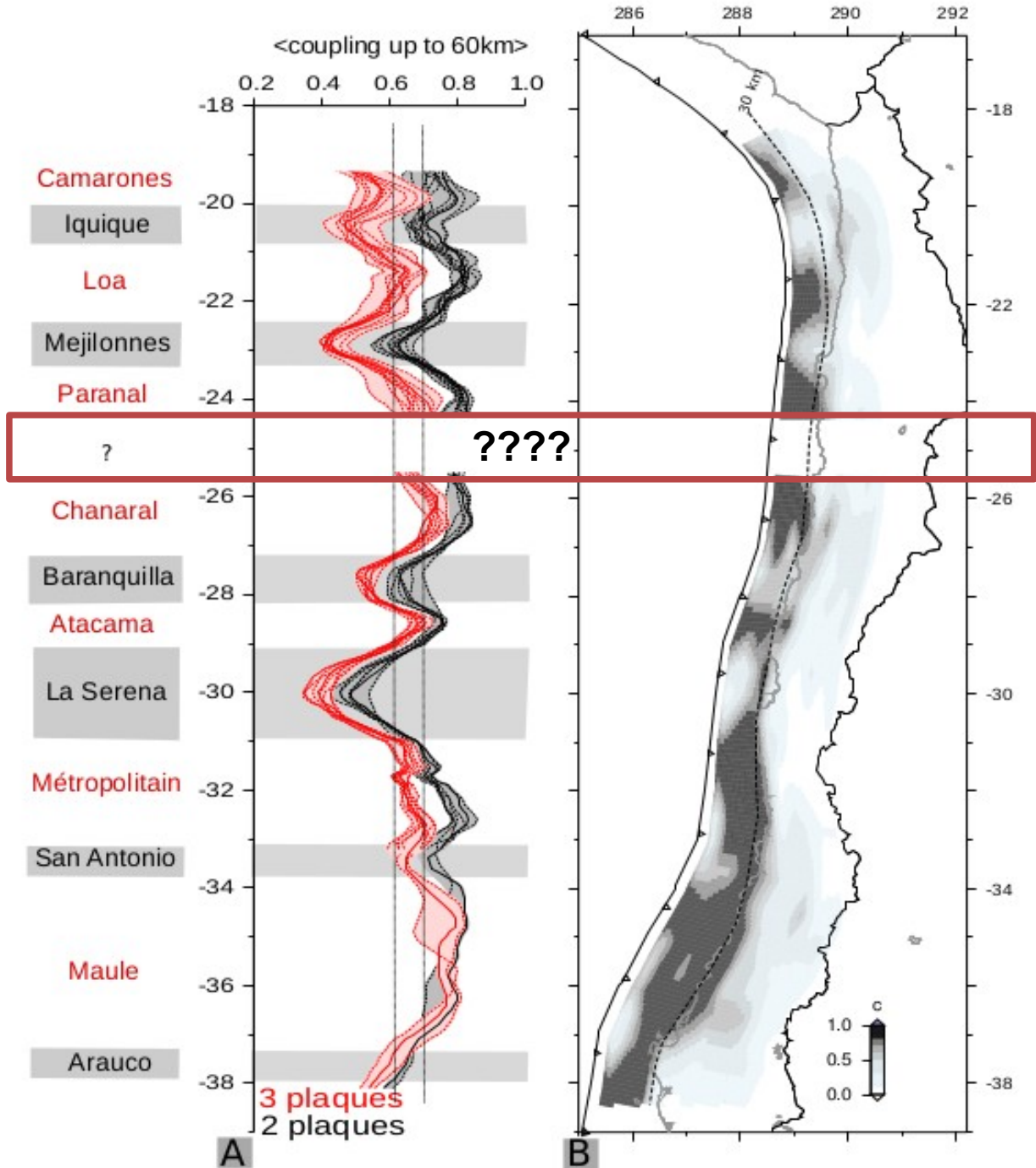
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Better definition of the coupling pattern constrained by velocities determined after 5 measurements (vs 3 up to now)



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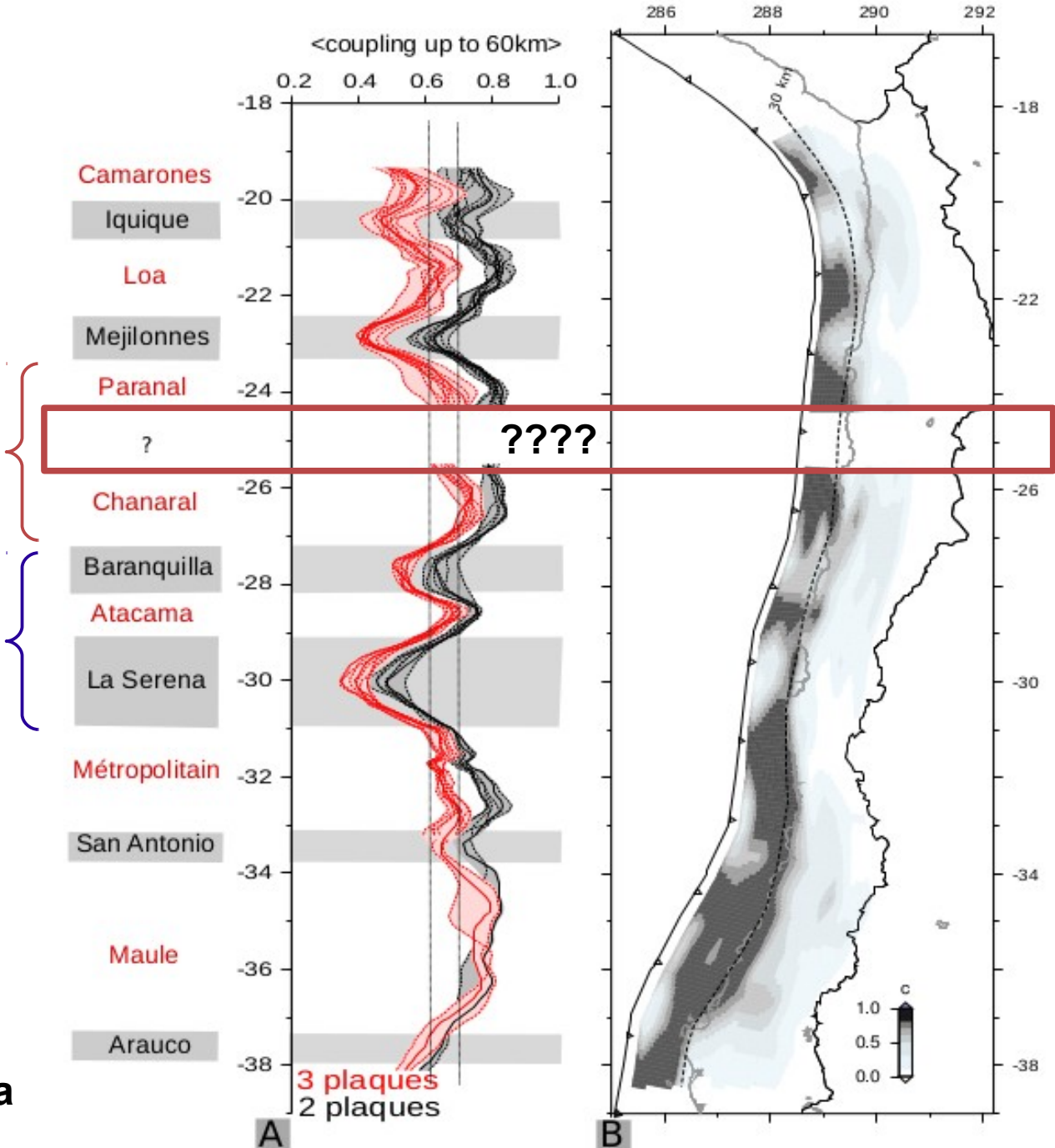
Only one highly coupled segment ?

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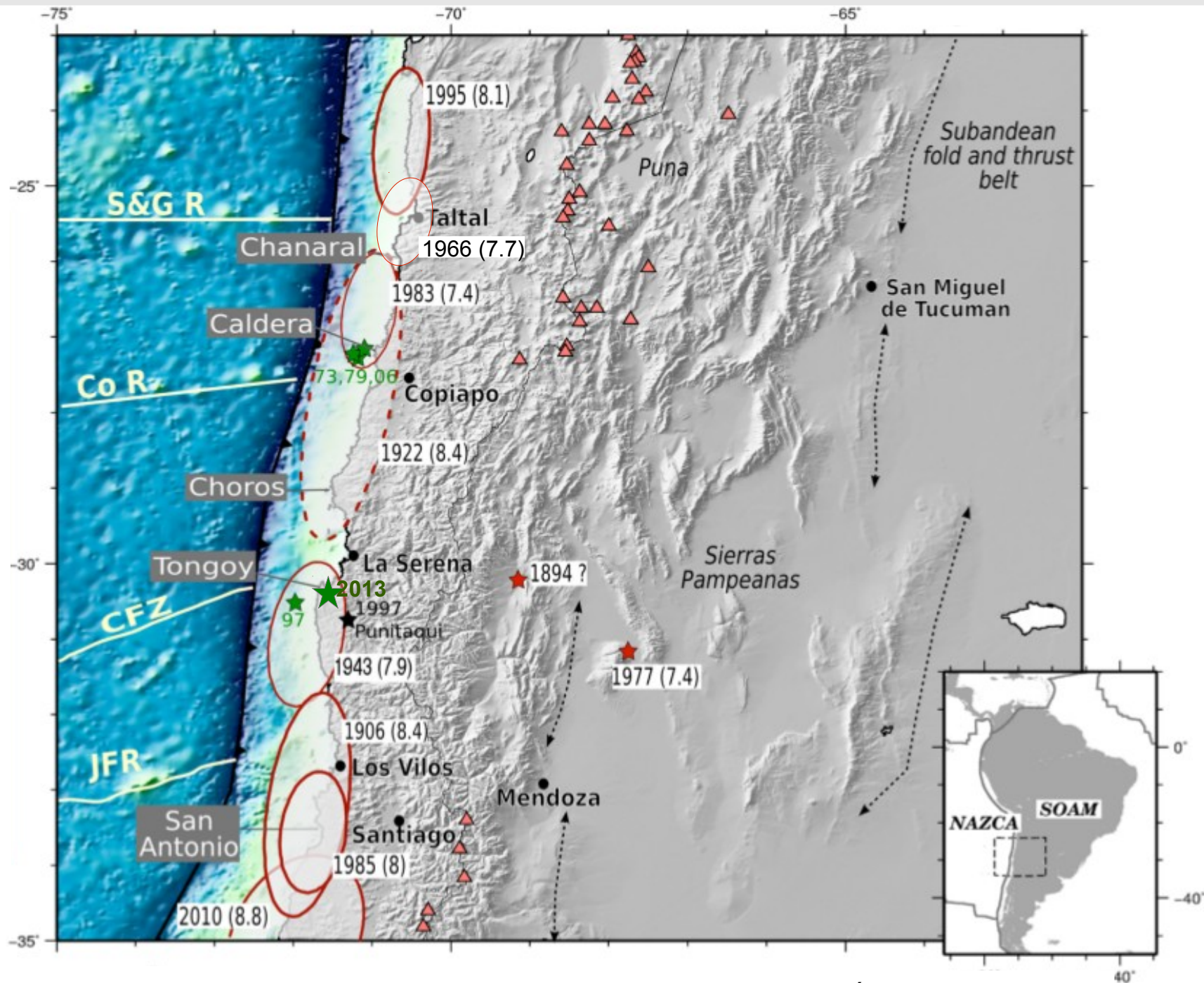
Better definition of the coupling pattern constrained by velocities determined after 5 measurements (vs 3 up to now)

→ Complete elastic coupling model

→ Interseismic visco-elastic model across the whole area



# Sismotectonic context of the area



Major ruptures and swarms in the area, updated from Métois et al., 2013



# GPS network in 2012...



# GPS network in 2014

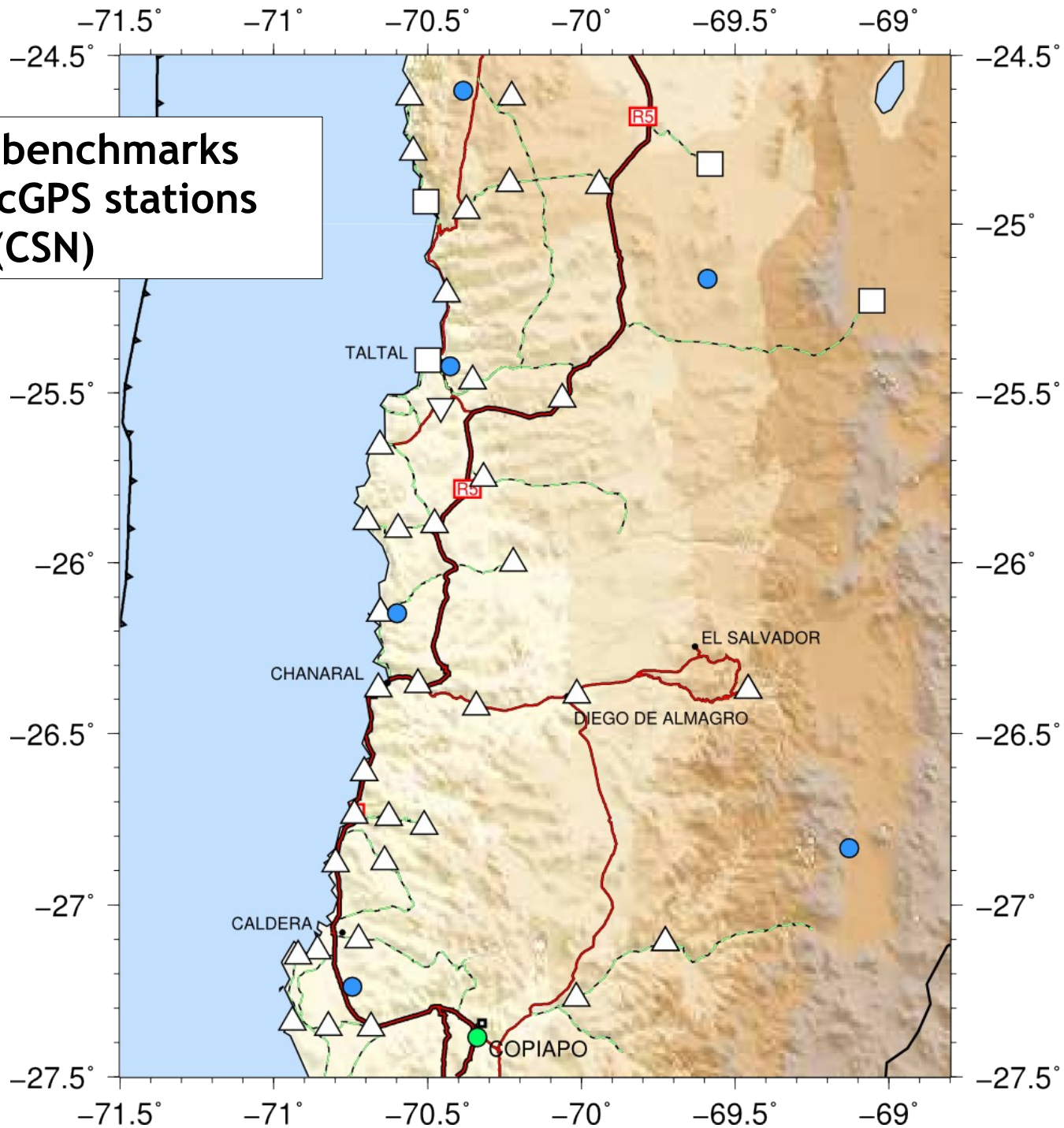
16 new benchmarks  
in 3 campaigns



- △ Fr benchmark
- Ge benchmark
- ▽ Am benchmark
- Am cGPS

# GPS network in 2014

16 new benchmarks  
+ 6 new cGPS stations  
(CSN)

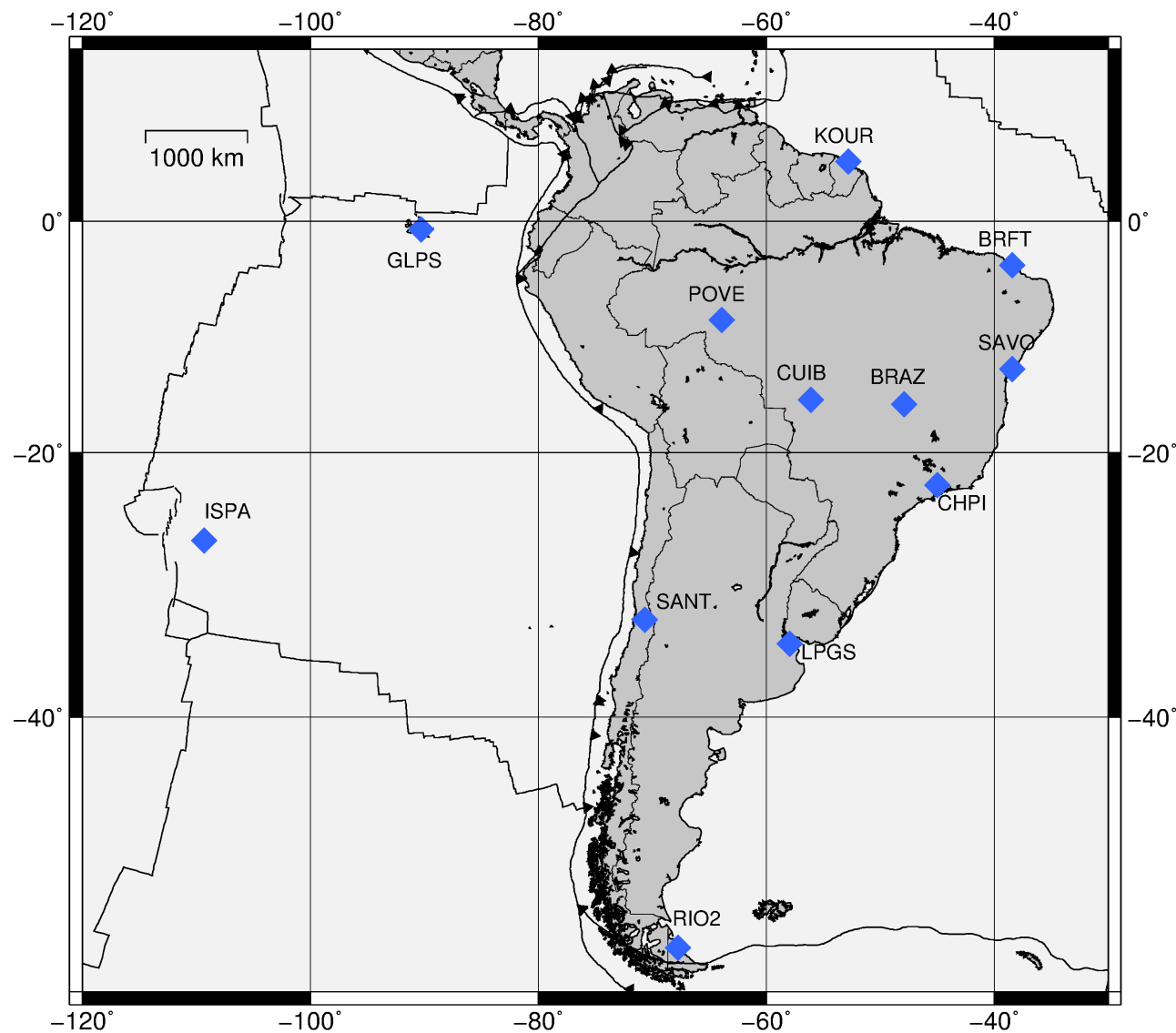


- △ Fr benchmark
- Ge benchmark
- ▽ Am benchmark
- CSN cGPS
- Am cGPS

# Data Processing - Reference frame mapping

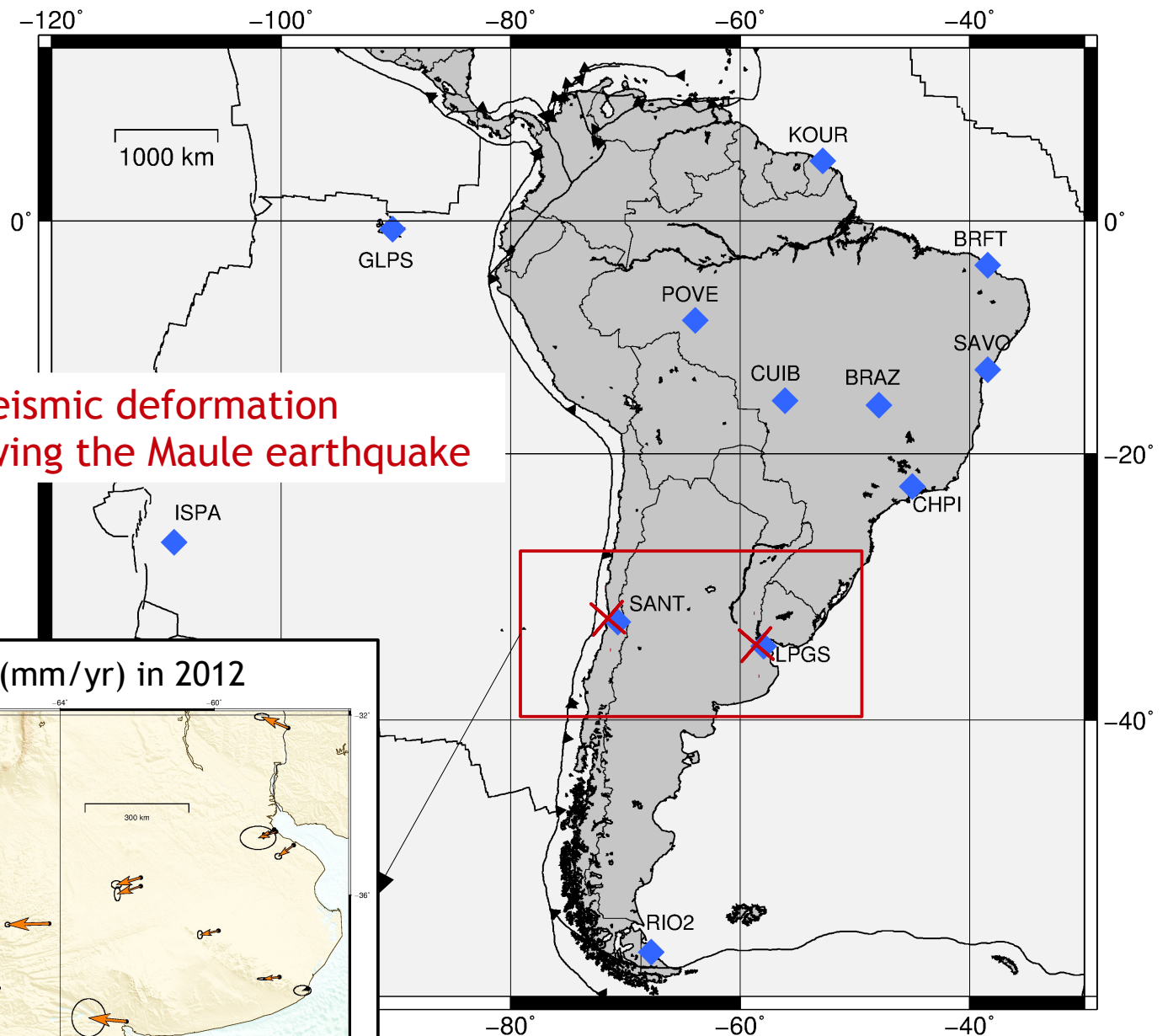
Data processing using GAMIT/GLOBK [King and Bock , 2002 ; Herring, 2002].

Reference frame in South America prior to 2010 :



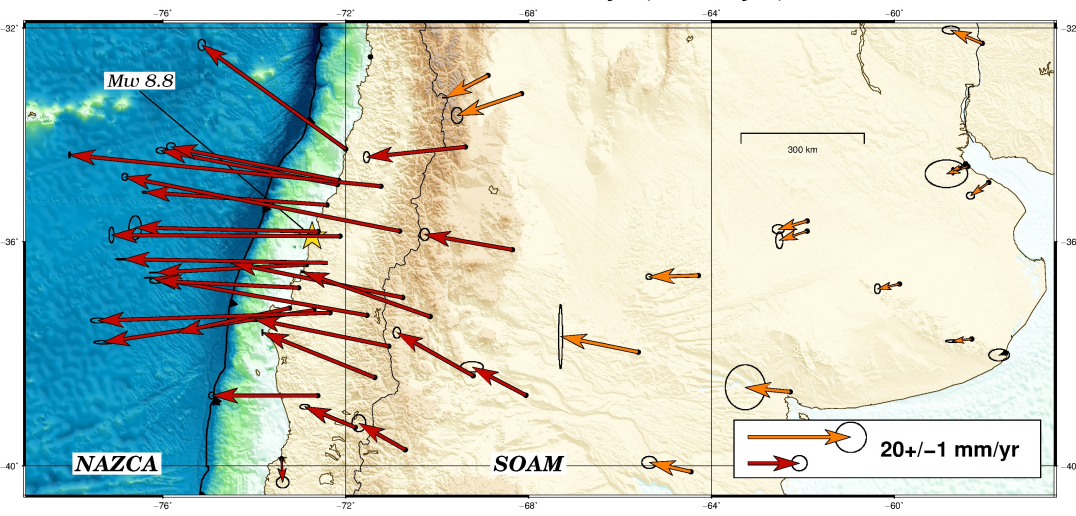
# Reference frame mapping

SOAM Reference frame prior to 2010 :



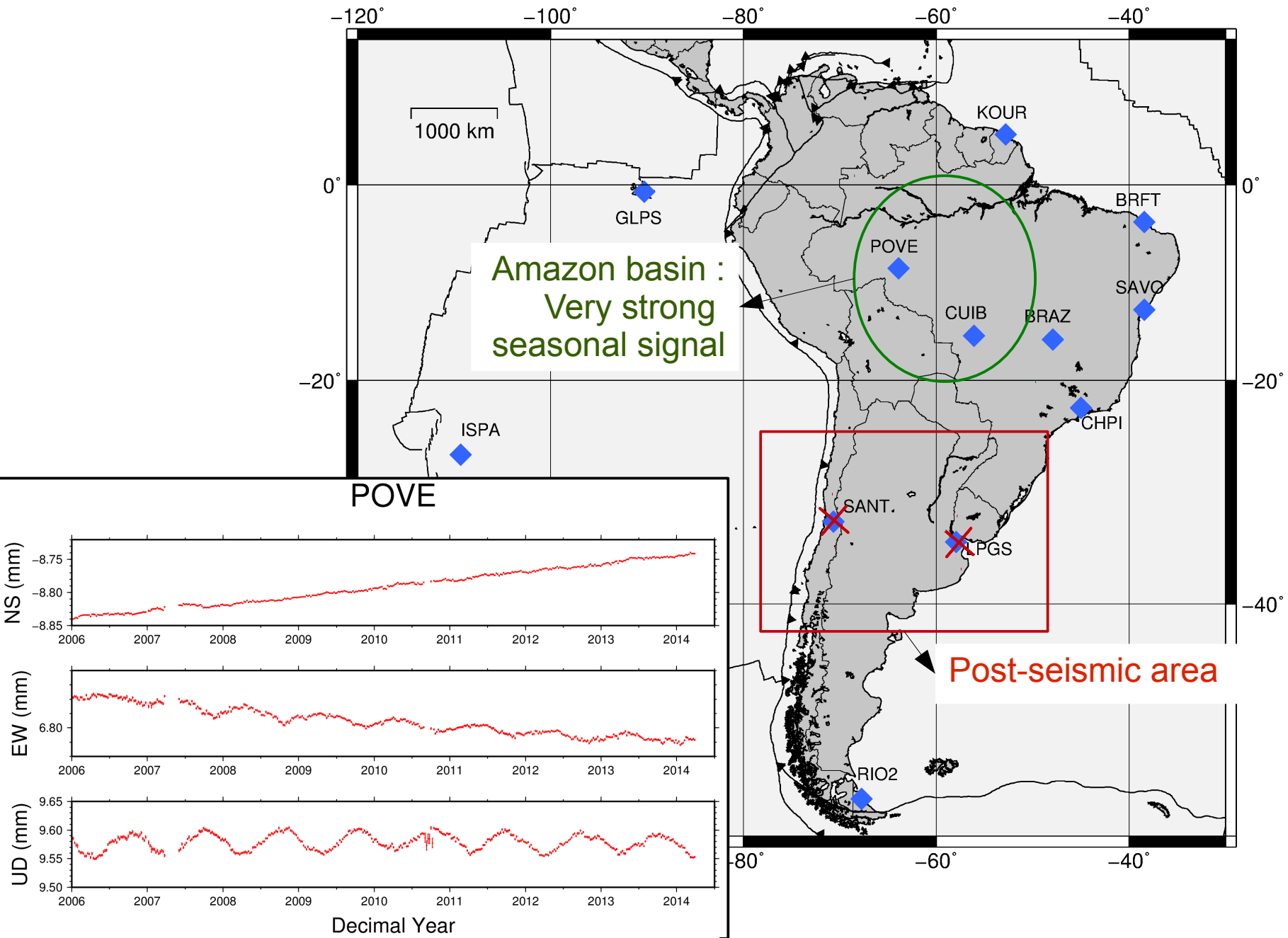
Postseismic deformation following the Maule earthquake

Mean horizontal velocity (mm/yr) in 2012



# Reference frame mapping

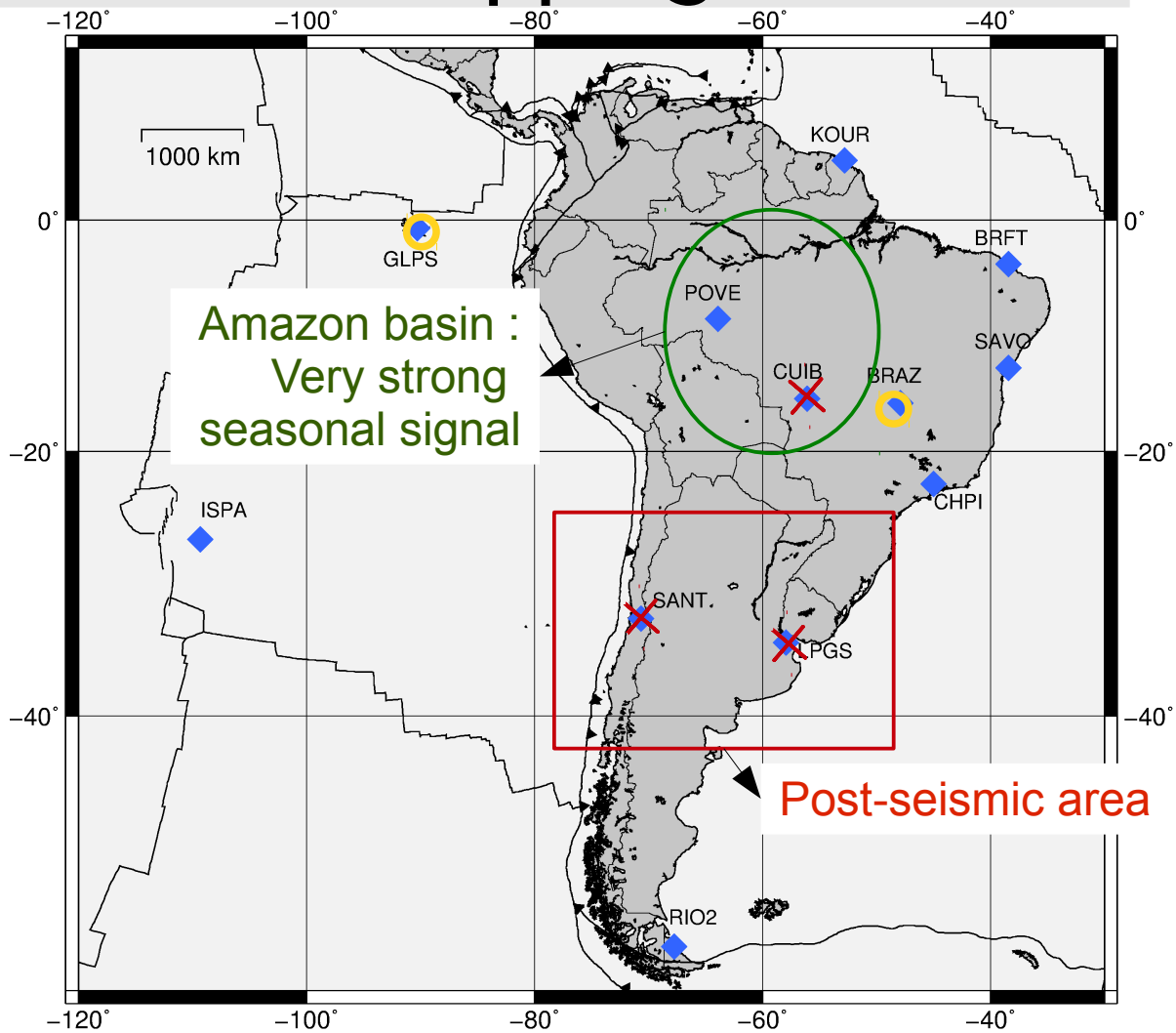
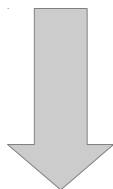
Reference frame prior to 2010 :



# Reference frame mapping

Reference frame prior to 2010 :

**Necessity to build a new and robust reference frame**



Global combination between 2004 and 2014, of sGPS data + appropriate selection of cGPS across the SOAM continent, (including IGS, RAMSAC, RBMC, and Chilean stations, (*h-files* provided by C.Vigny), - global *h-files* provided by the SOPAC.

Exclusion of stations severely affected by mega-earthquakes (Tocopilla 2007, Maule 2010, Pisagua 2014...etc.)

# Definition of a new Stable South America reference frame

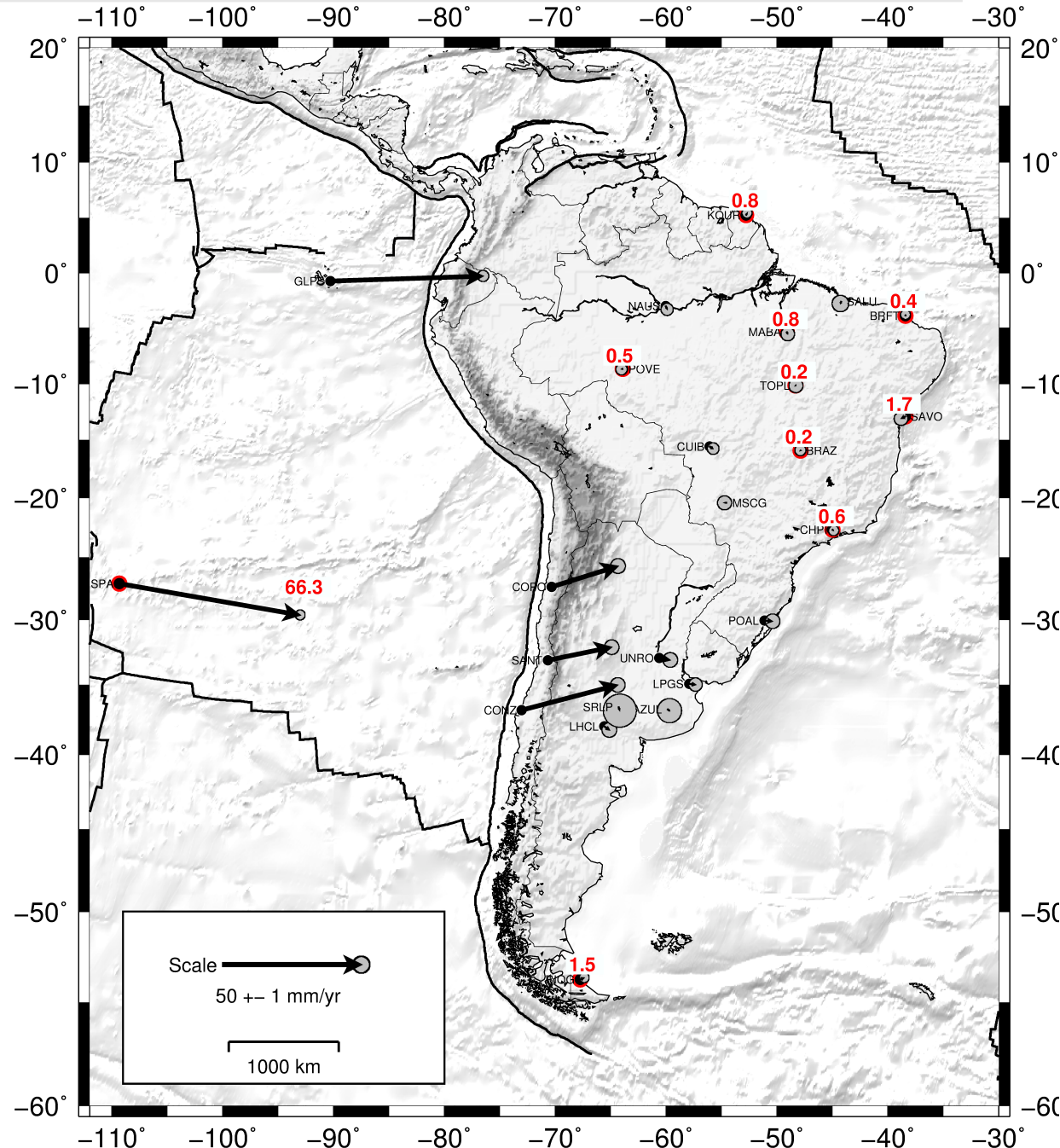
Estimated Stable South America rotation vector :  
 $21.9^\circ\text{S}, 133.7^\circ\text{W}, 0.121^\circ/\text{Myr}$

Statistics :  
 $W_{rms} = 0,6 \text{ mm/yr}$  ,  $rms = 0,9 \text{ mm/yr}$

Estimated Relative Nazca/SOAM rotation vector :  
 $54.3^\circ\text{N}, 01.9^\circ\text{W}, 0.6^\circ/\text{Myr}$

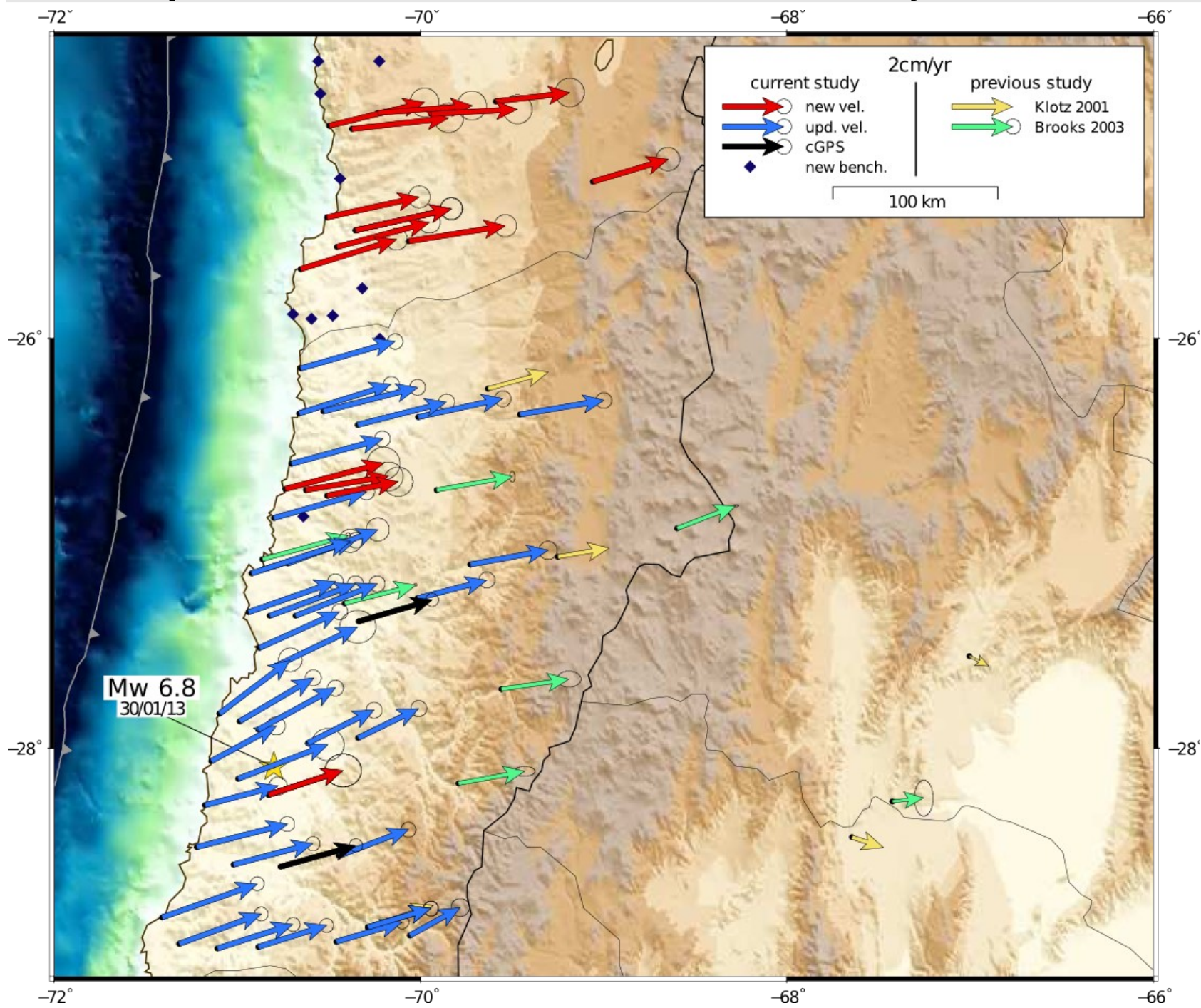
→ At  $31^\circ\text{S}$  on the trench :  
 $67 \text{ mm/yr}, 79^\circ\text{N}$

Large scale network and far field horizontal velocities, plotted in our South-American reference frame. Red numbers indicate the velocity in mm/yr, ellipses depict the region of 99 % confidence. Stations used to estimate the pole : KOUR, BRFT/FORT, SAVO, MABA, TOPL, BRAZ, CHPI





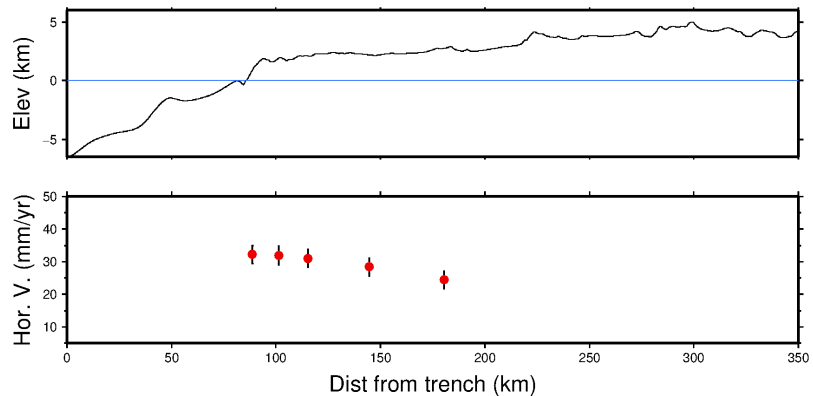
# Updated interseismic velocity field



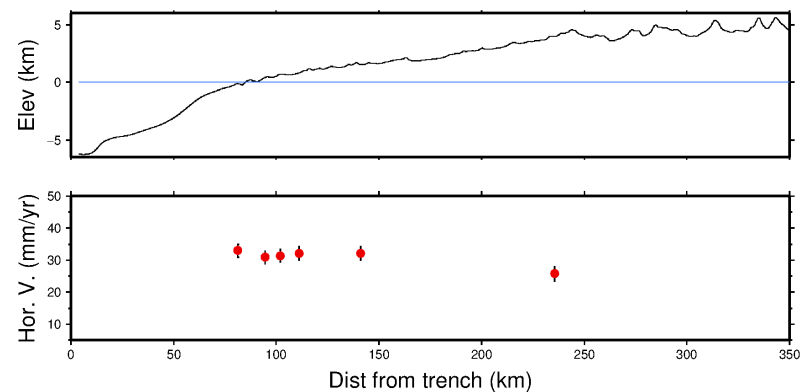
Interseismic horizontal velocities (mm/yr) plotted in our Stable South America reference frame

# Updated interseismic velocity field

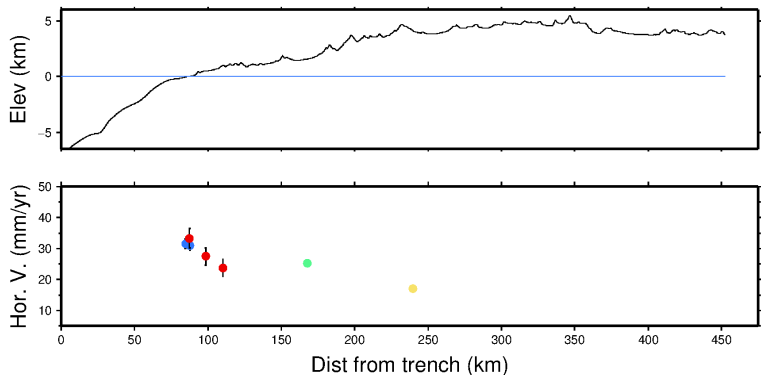
Profile g – Julia



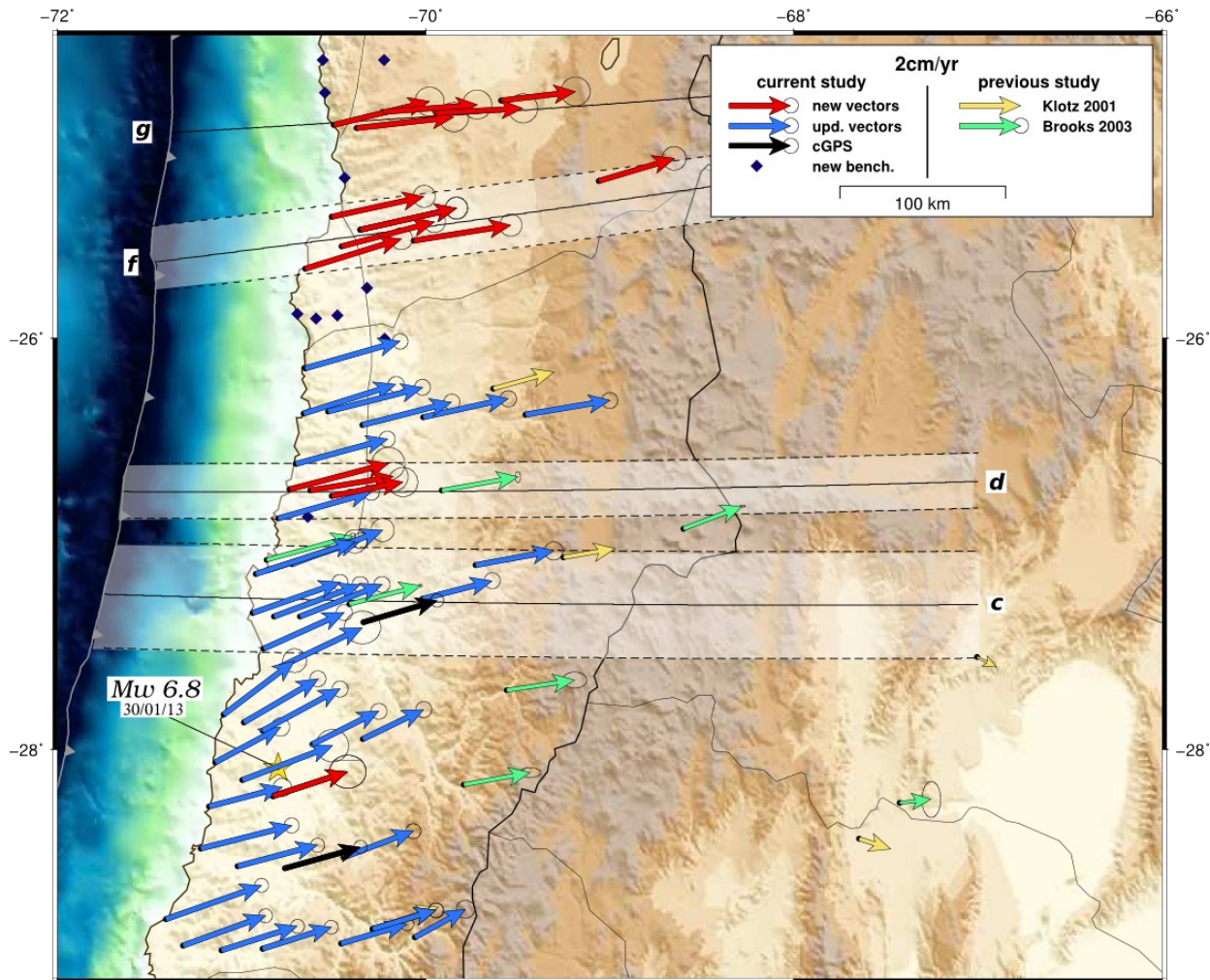
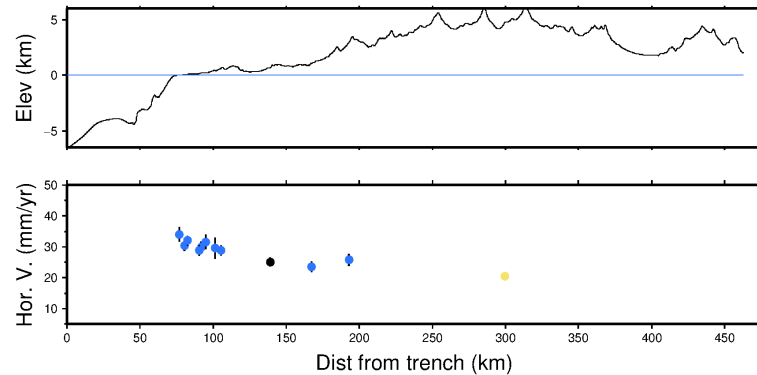
Profile f – Taltal



Profile d – Obispo

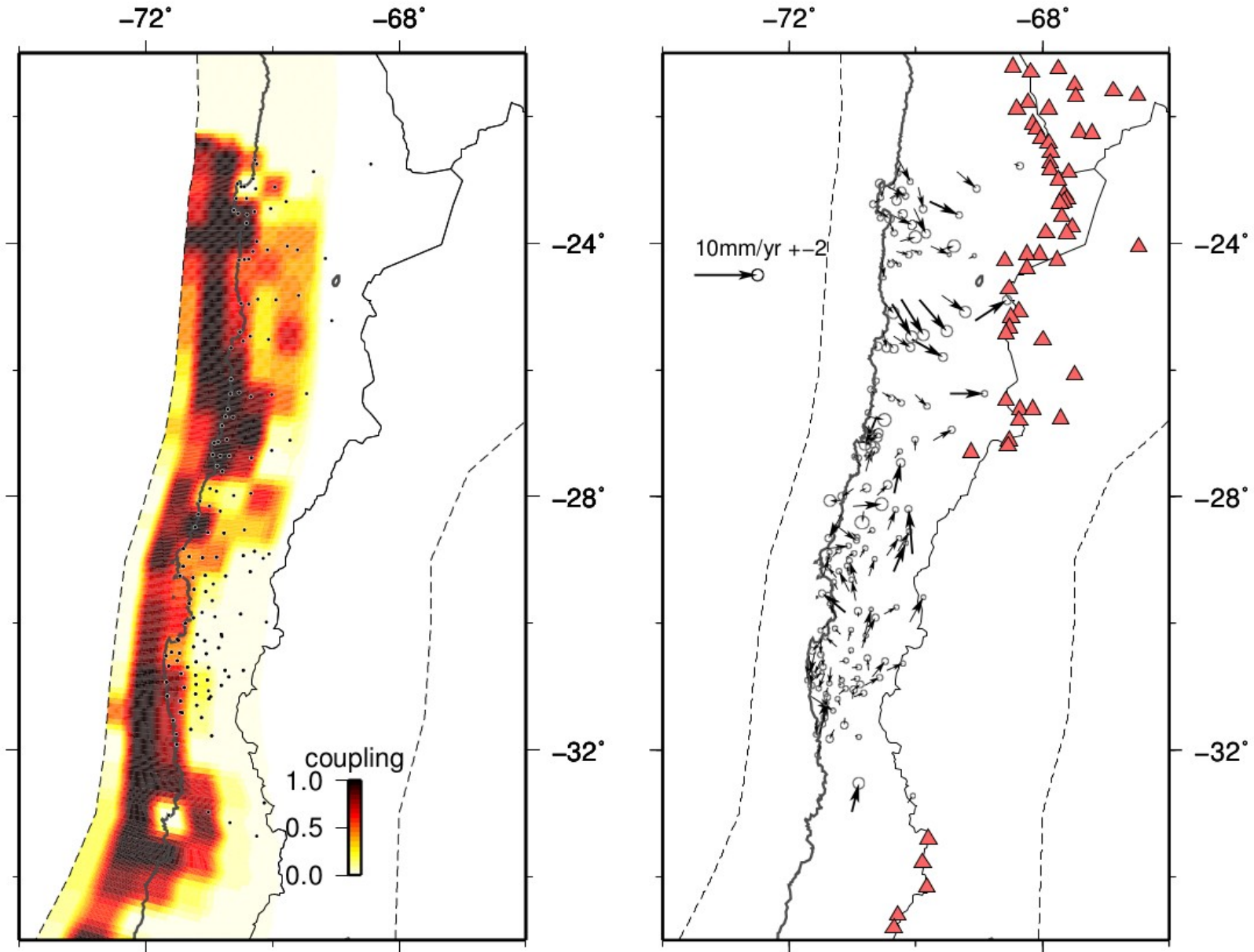


Profile c – Copiapo



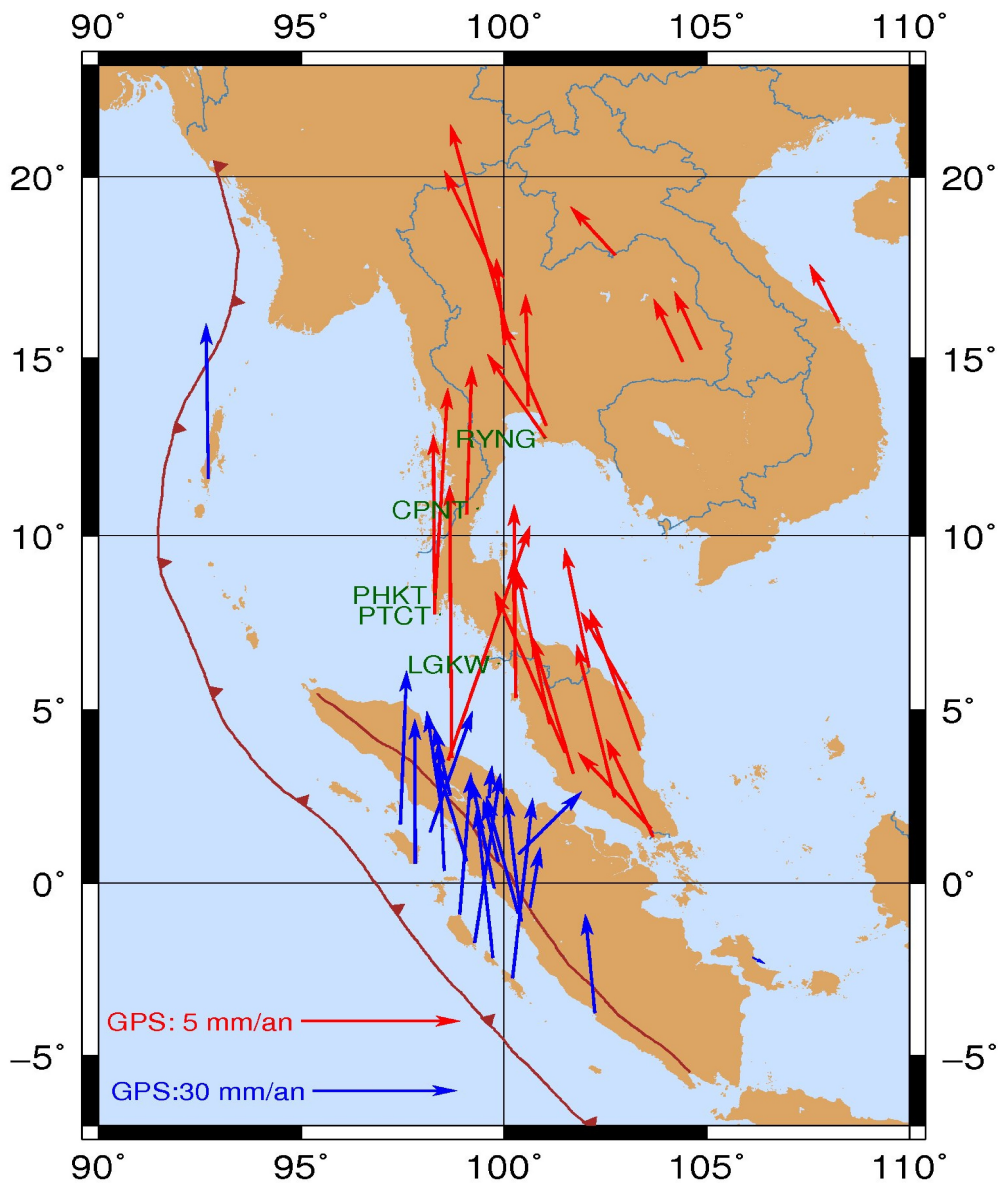
Interseismic horizontal velocities (mm/yr) plotted in our Stable South America reference frame

# Preliminary updated elastic coupling model

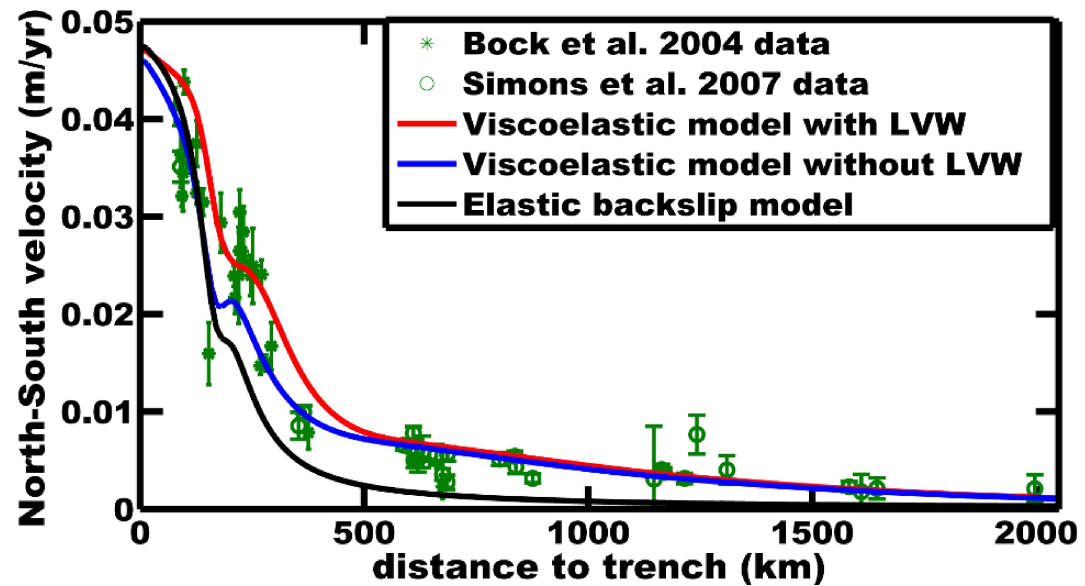


Coupling distribution and associated residuals of the preliminary three-plate models

# Visco-elastic modeling of the seismic cycle



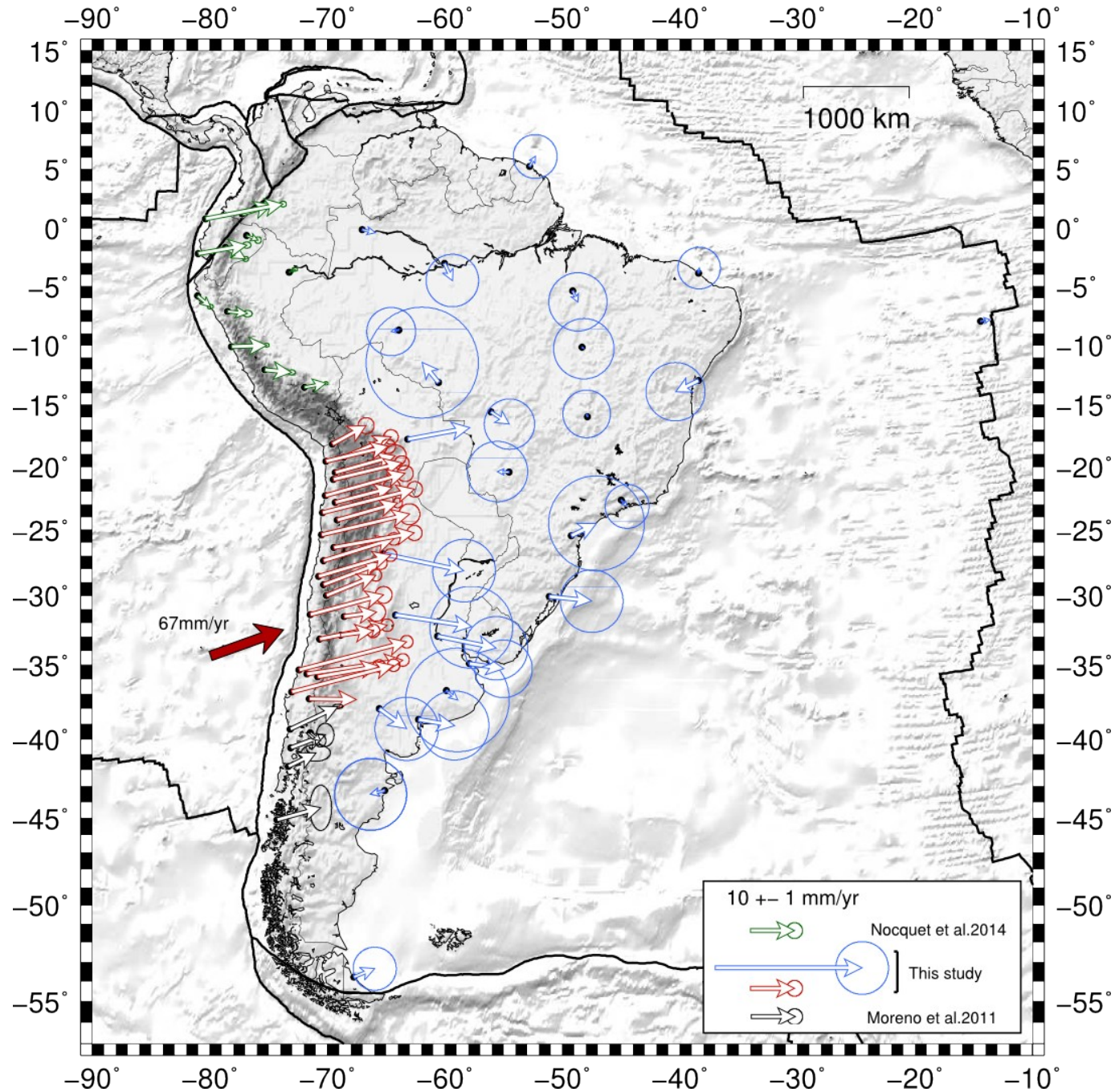
Interseismic deformation prior to the 2004 Sumatra-Andaman earthquake



Trubienko et al., 2014

Viscoelastic models explain the far-field interseismic velocities

# Long term velocities across South-America between 2004-2014 expressed in our stable SOAM reference frame



# Conclusion

## Still work to do in Chile...

- Small scale with newly densified areas - Taltal :
  - complete the interseismic velocity field in a critical area because in between two highly coupled segment.
  - Two campaigns still necessary to determined robusts velocities
  - update of the elastic coupling model
- Large scale on South America :
  - Visco-elastic modelling of the seismic cycle in order to better understand the large scale deformations

Thank you for your attention...

