



# “MONITOREAMIENTO DEL EFECTO POSTSISMICO DEL TERREMOTO DEL MAULE, A PARTIR DE OBSERVACIONES GNSS”



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Hector Parra, IGM-Chile  
Rodrigo Maturana, IGM-Chile



# Tectonic setting of Chile

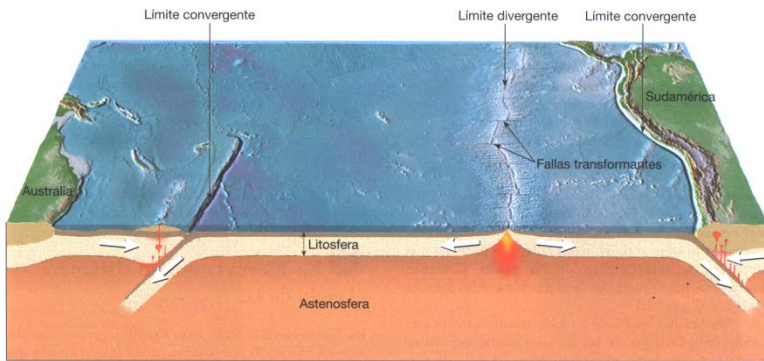
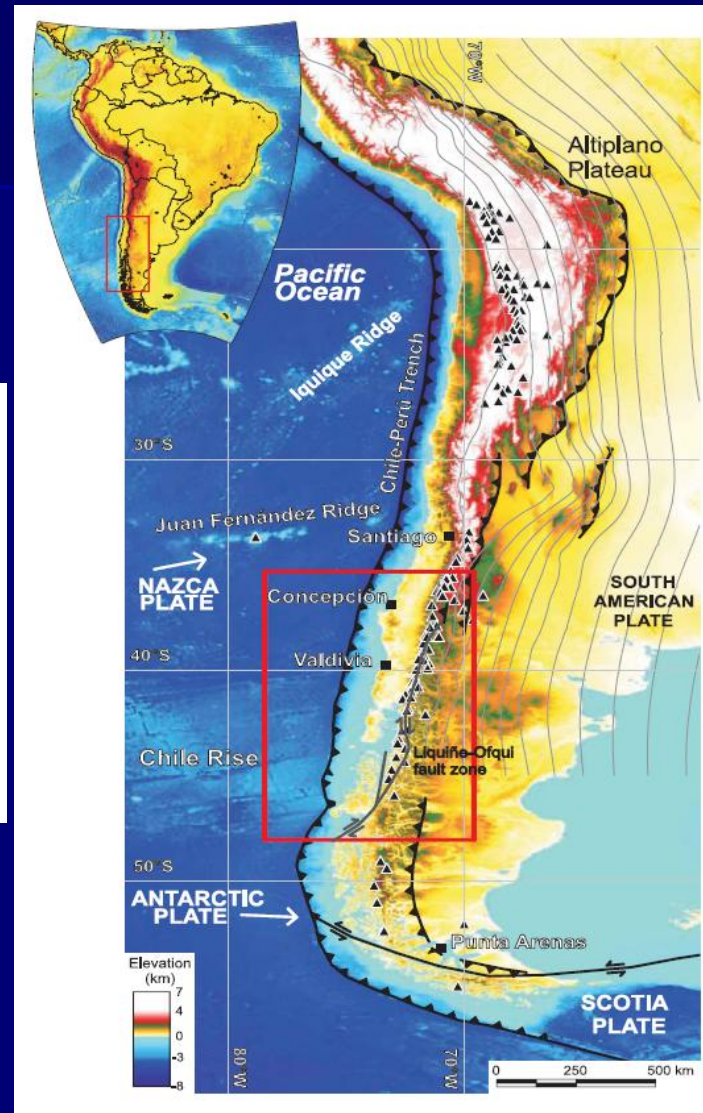
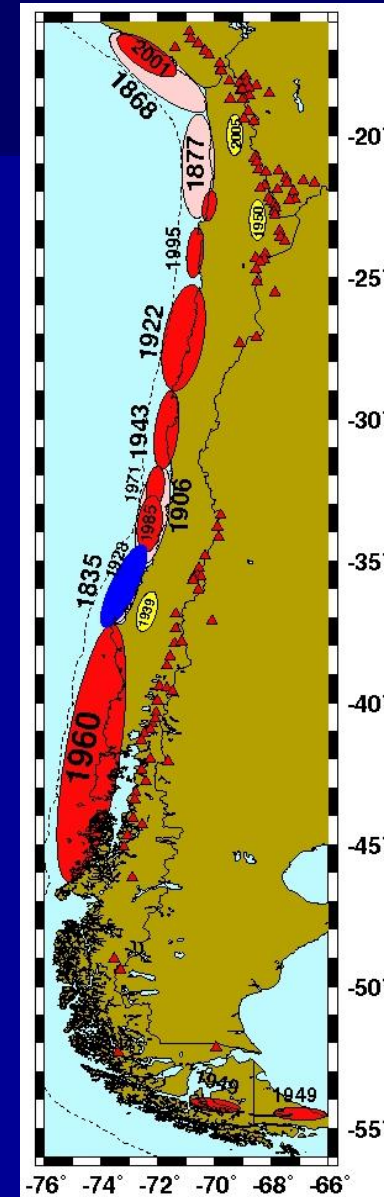


Figura 1.11 Vista de la Tierra en la que se muestra la relación entre los límites de placa divergentes y convergentes.



Moreno et al, 2010





# Ciclo Sísmico

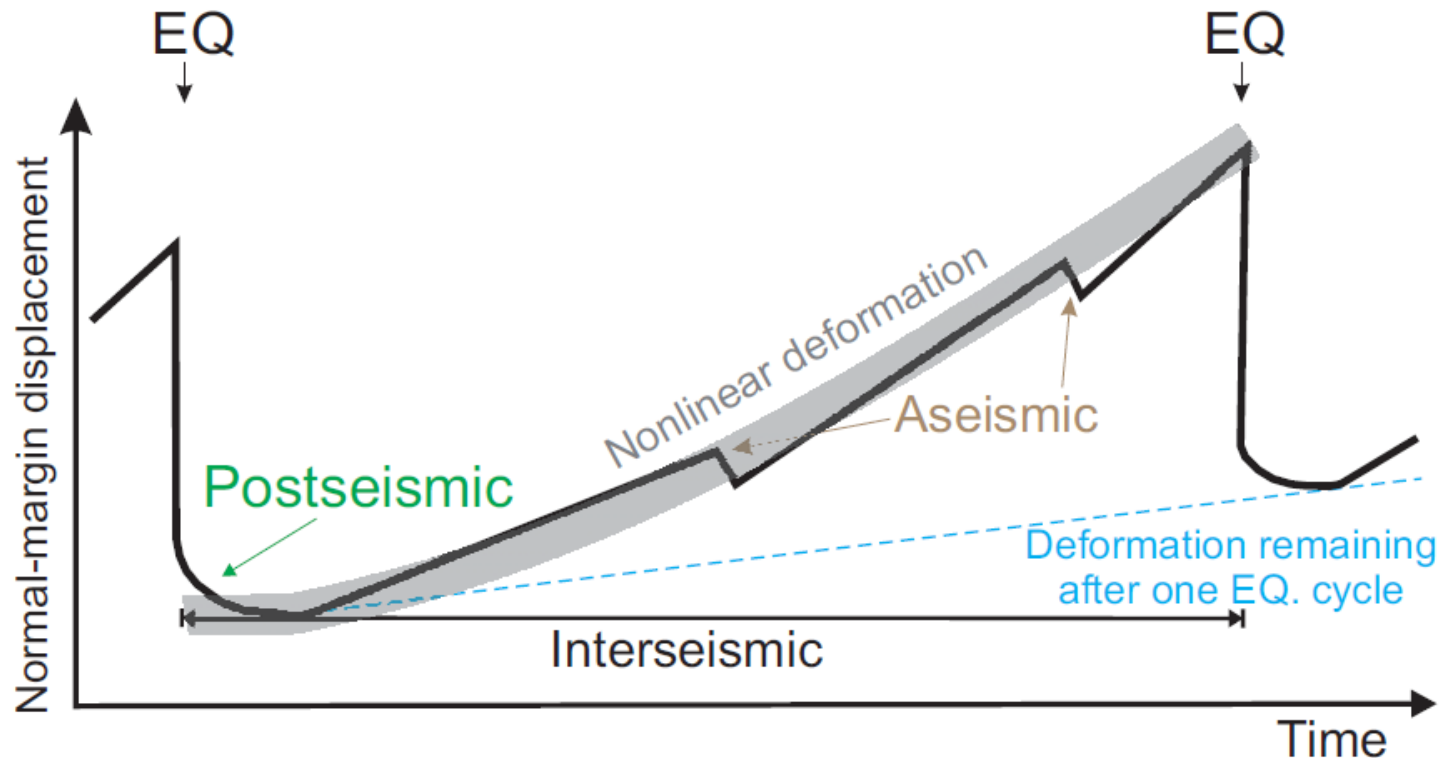
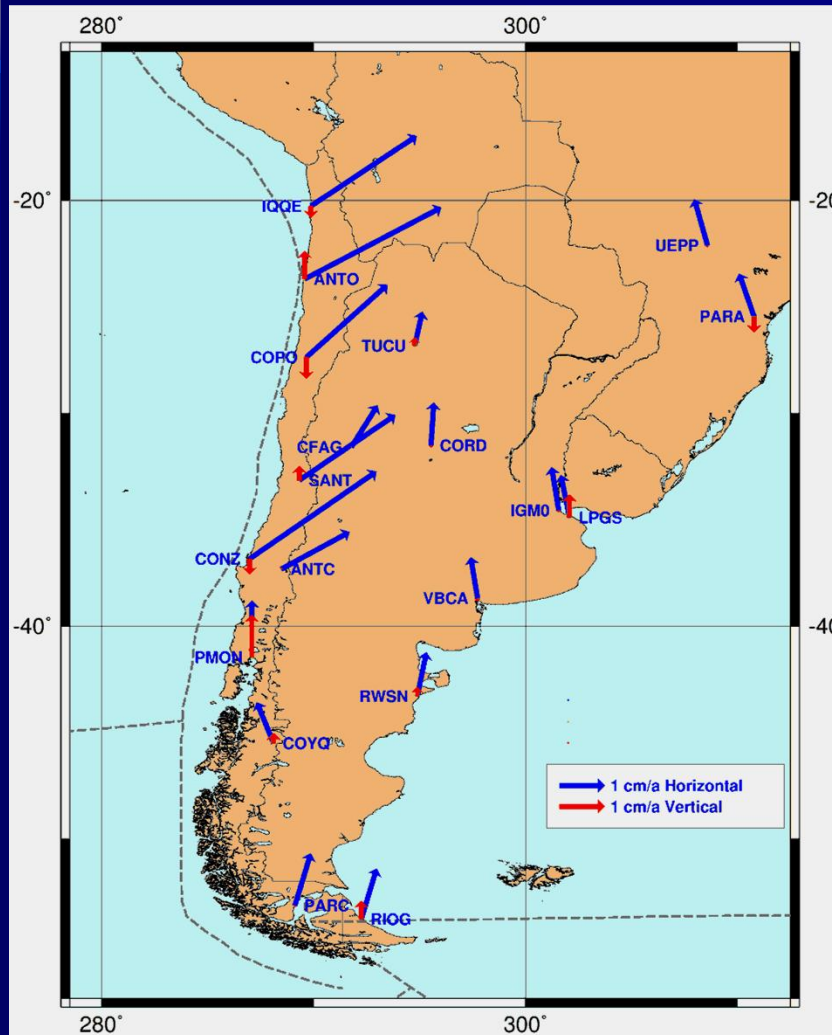


Figure 1.1: Scheme of the earthquake cycle deformation for a surface site above the seismogenic zone in a subduction zone. Periods of transient deformation may be superimposed on interseismic strain accumulation influencing the interface coupling.

Moreno et al, 2010



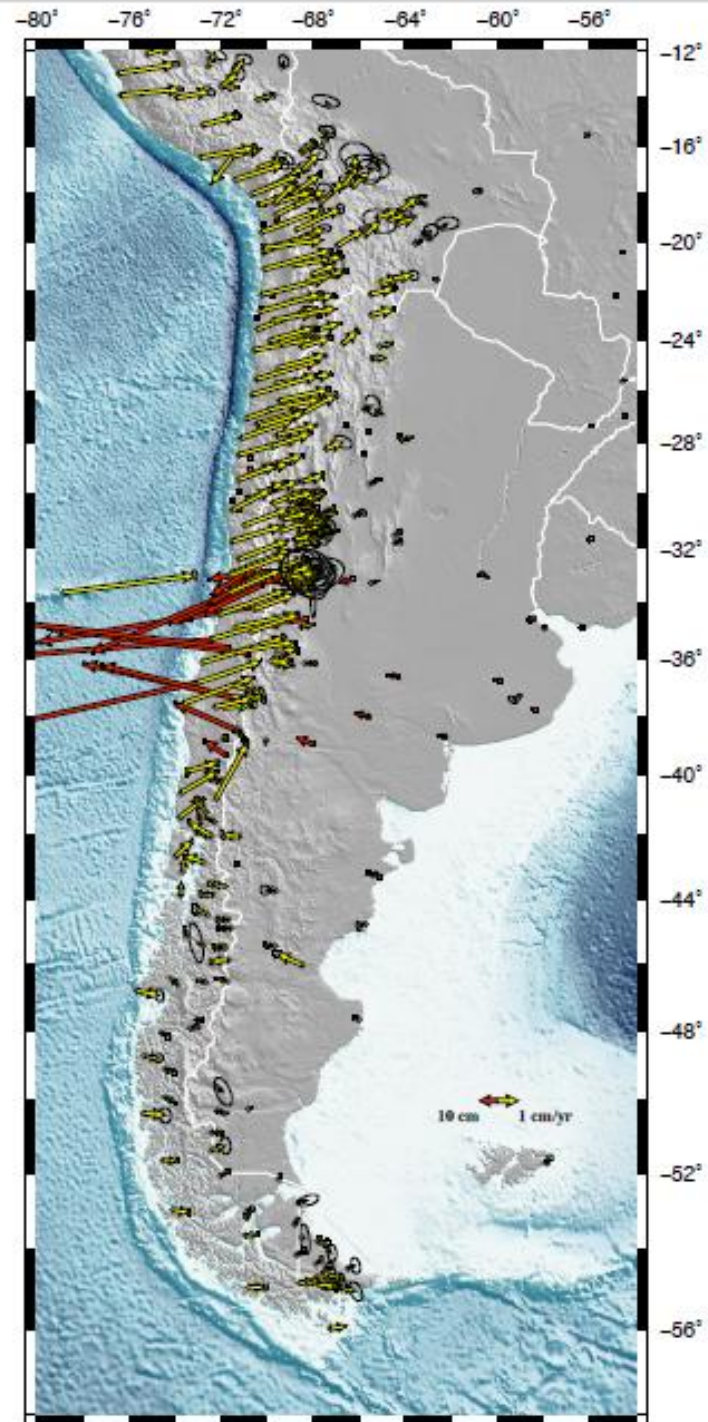
# Tendencias Previas

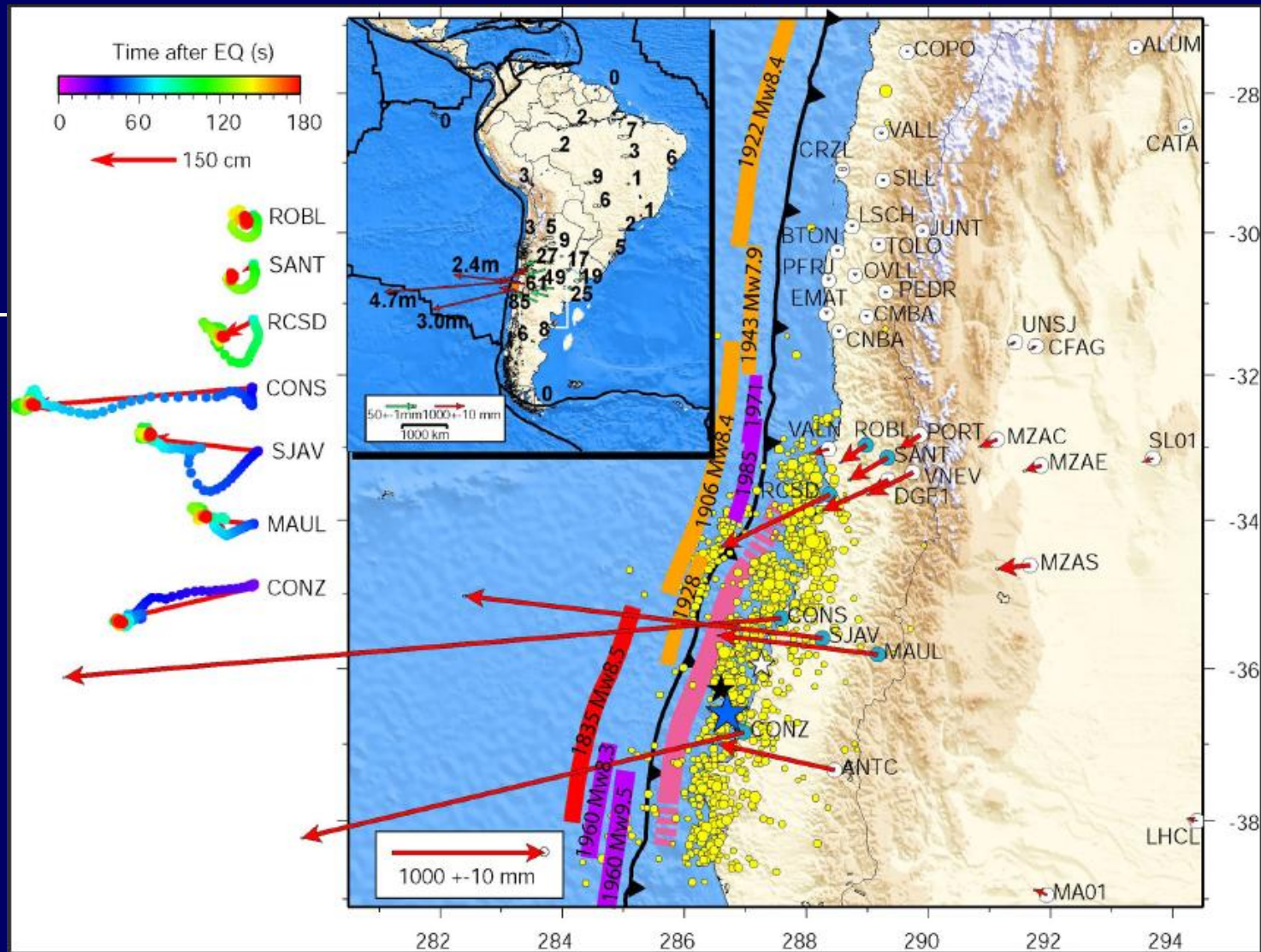


EST.	N (mm/a) $\sigma$	E (mm/a) $\sigma$	UP (mm/a) $\sigma$
ANTC	8,2 $\pm$ 0,5	15,1 $\pm$ 0,5	0,3 $\pm$ 2,1
ANTO	15,8 $\pm$ 0,9	30,2 $\pm$ 1,1	6,2 $\pm$ 3,0
CFAG	9,2 $\pm$ 1,3	5,8 $\pm$ 1,6	0,0 $\pm$ 3,3
CONZ	19,3 $\pm$ 1,0	28,1 $\pm$ 1,0	-3,5 $\pm$ 3,8
COPO	16,0 $\pm$ 1,1	17,9 $\pm$ 0,9	-4,7 $\pm$ 3,3
CORD	9,5 $\pm$ 0,7	0,6 $\pm$ 0,9	-0,4 $\pm$ 3,1
COYQ	9,0 $\pm$ 0,5	-2,2 $\pm$ 0,6	2,2 $\pm$ 1,6
IGMO	9,5 $\pm$ 1,7	-1,6 $\pm$ 0,7	-0,4 $\pm$ 3,2
IQQE	15,5 $\pm$ 1,3	23,4 $\pm$ 1,6	-2,5 $\pm$ 4,6
LPGS	9,4 $\pm$ 0,6	-1,9 $\pm$ 0,5	5,1 $\pm$ 3,1
PARA	9,4 $\pm$ 0,6	-3,3 $\pm$ 0,7	-3,5 $\pm$ 2,1
PARC	11,5 $\pm$ 0,5	3,5 $\pm$ 0,7	-0,3 $\pm$ 2,1
PMON	-12,5 $\pm$ 0,8	0,0 $\pm$ 0,6	9,4 $\pm$ 1,8
RIOG	11,2 $\pm$ 0,3	3,4 $\pm$ 0,3	4,1 $\pm$ 0,7
RWSN	9,7 $\pm$ 0,9	-2,7 $\pm$ 0,5	2,0 $\pm$ 1,5
SANT	14,4 $\pm$ 0,5	21,2 $\pm$ 0,8	3,1 $\pm$ 0,7
TUCU	7,5 $\pm$ 0,5	1,7 $\pm$ 0,8	1,9 $\pm$ 2,0
UEPP	10,2 $\pm$ 0,5	-2,9 $\pm$ 0,4	-0,4 $\pm$ 0,8
VBCA	9,0 $\pm$ 0,5	-1,5 $\pm$ 0,8	-0,7 $\pm$ 2,3



A map showing interseismic velocities (yellow) and Maule co-seismic displacement (red) for the M8.8 Chile earthquake. Ben Brooks, James Foster, Mike Bevis, Bob Smalley, Hector Parra, Juan Carlos Báez Soto, Mauro Blanco, Eric Kendrick, Jeff Genrich, and Dana Caccamise





## The 2010 Mw 8.8 Maule Mega-Thrust Earthquake of Central Chile, Monitored by GPS

C. Vigny, A. Socquet, S. Peyrat, J.-C. Rugg, M. Métois, R. Madariaga, S. Morvan, M. Lancieri, R. Lacassin, J. Campos, D. Carrizo, M. Bejar-Pizarro, S. Barrientos, R. Armijo, C. Aranda, M.-C. Valderas-Bermejo, I. Ortega, F. Bondoux, S. Baize, H. Lyon-Caen, A. Pavez, J. P. Vilotte, M. Bevis, B. Brooks, R. Smalley, H. Parra, J.-C. Baez, M. Blanco, S. Cimbaro, E. Kendrick  
(Science.1204132, 2011)



# NO linealidad



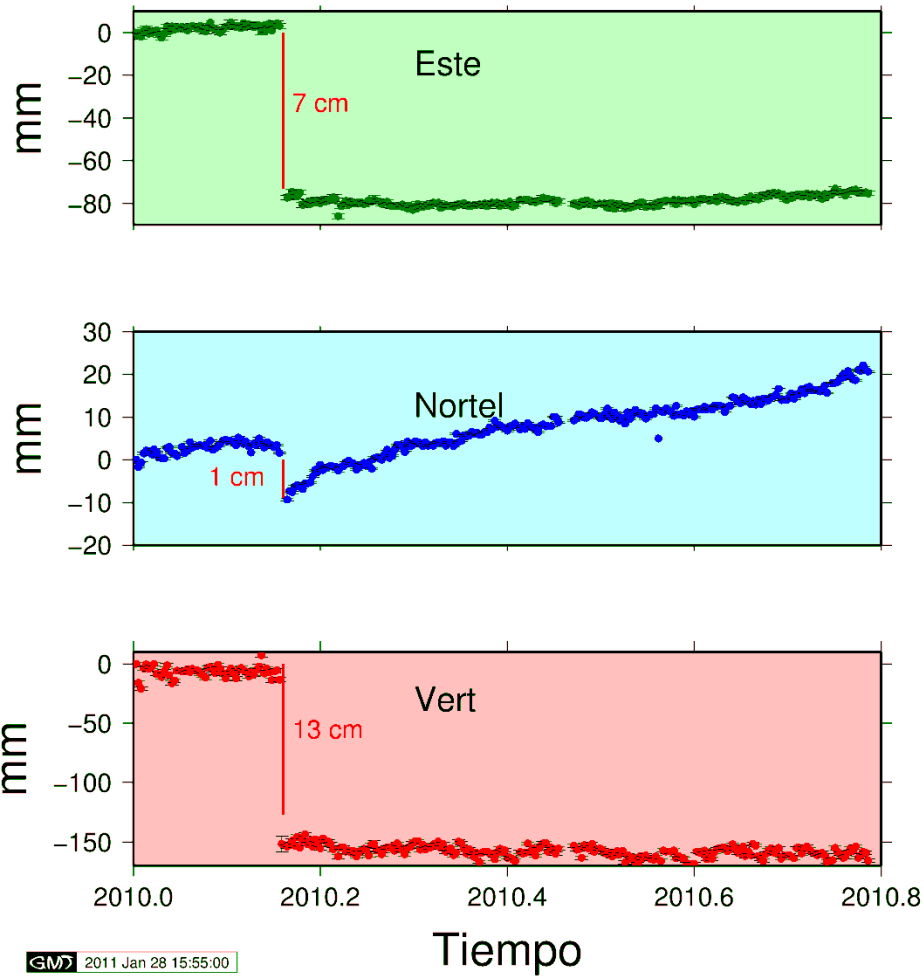


# Time series Valparaiso

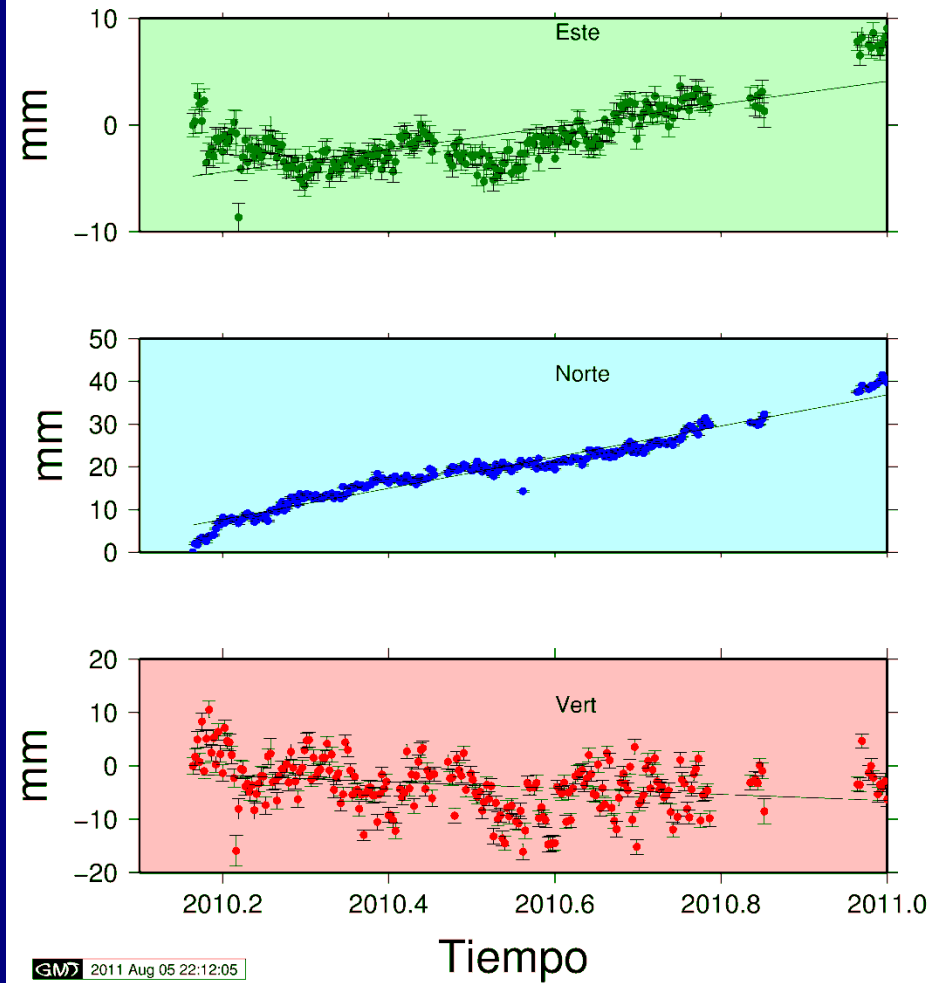
CO-SISMICO

POST-SISMICO

## VALP



## VALP





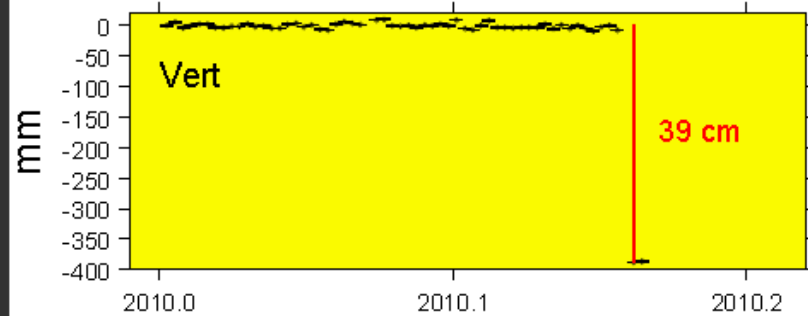
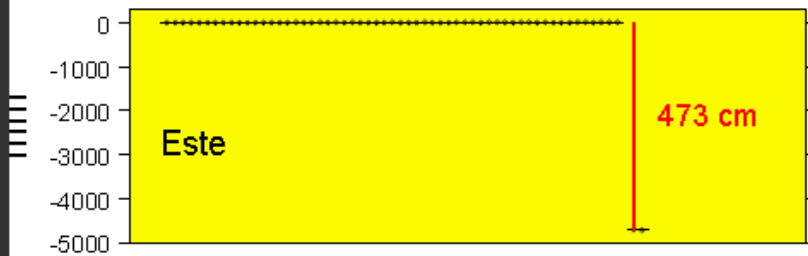
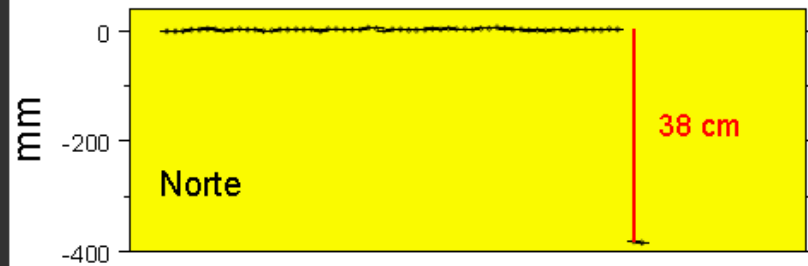


# Time series Constitución

CO-SISMICO

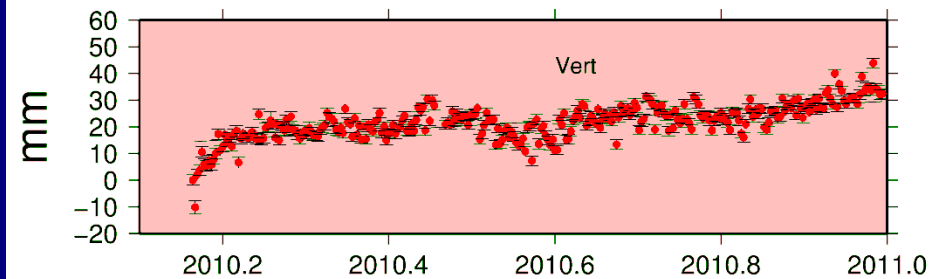
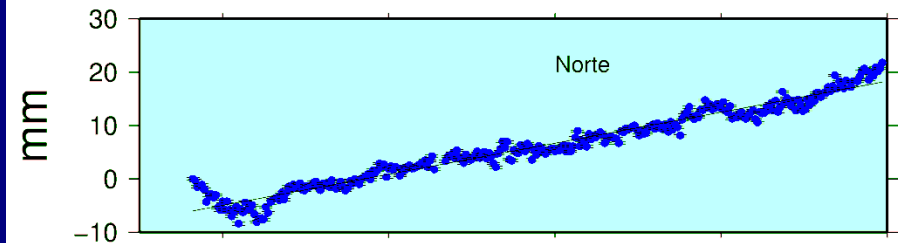
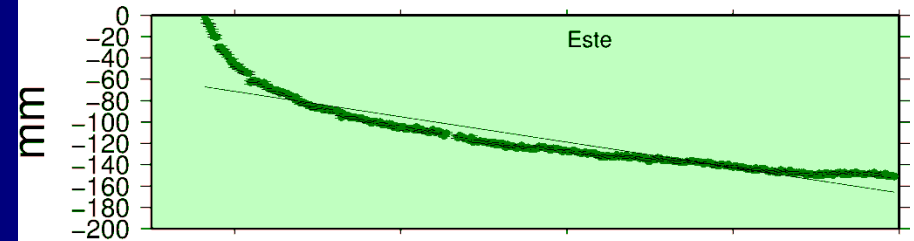
POST-SISMICO

## CONS



Tiempo

## CONS



Tiempo

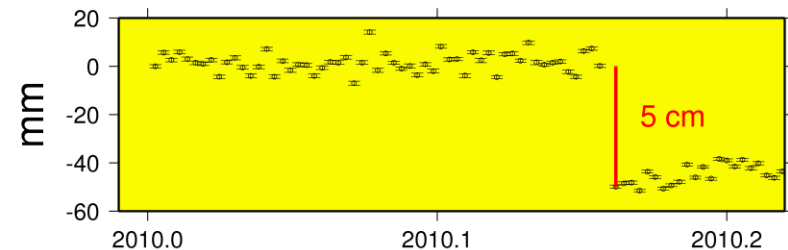
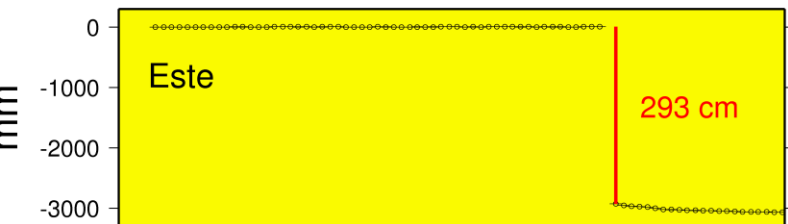


# Time series Concepción

CO-SISMICO

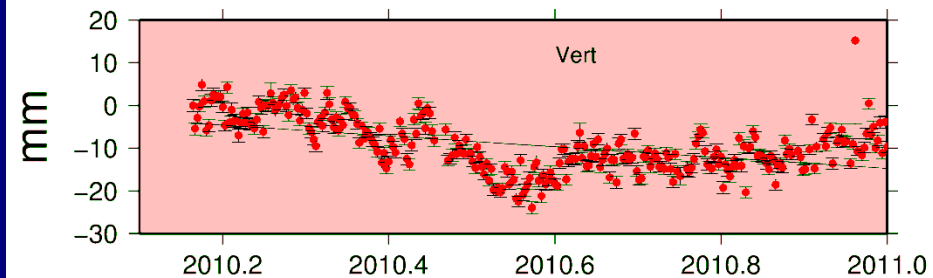
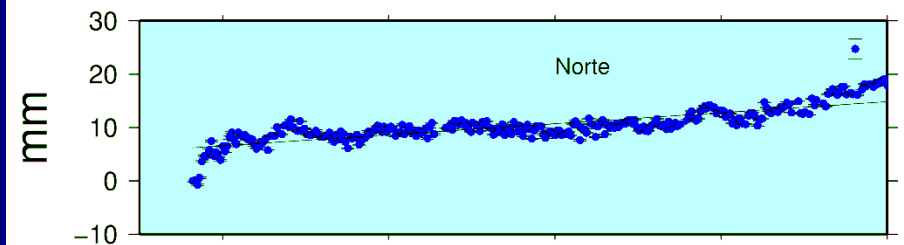
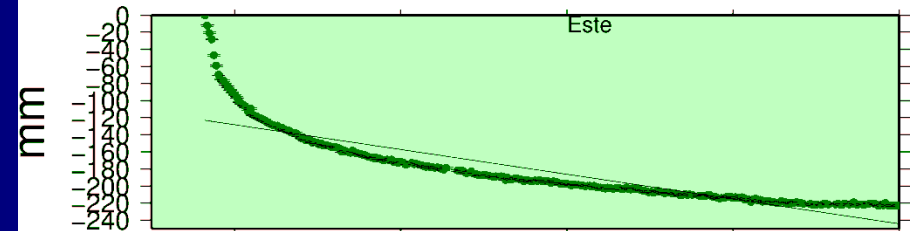
POST-SISMICO

## CONZ

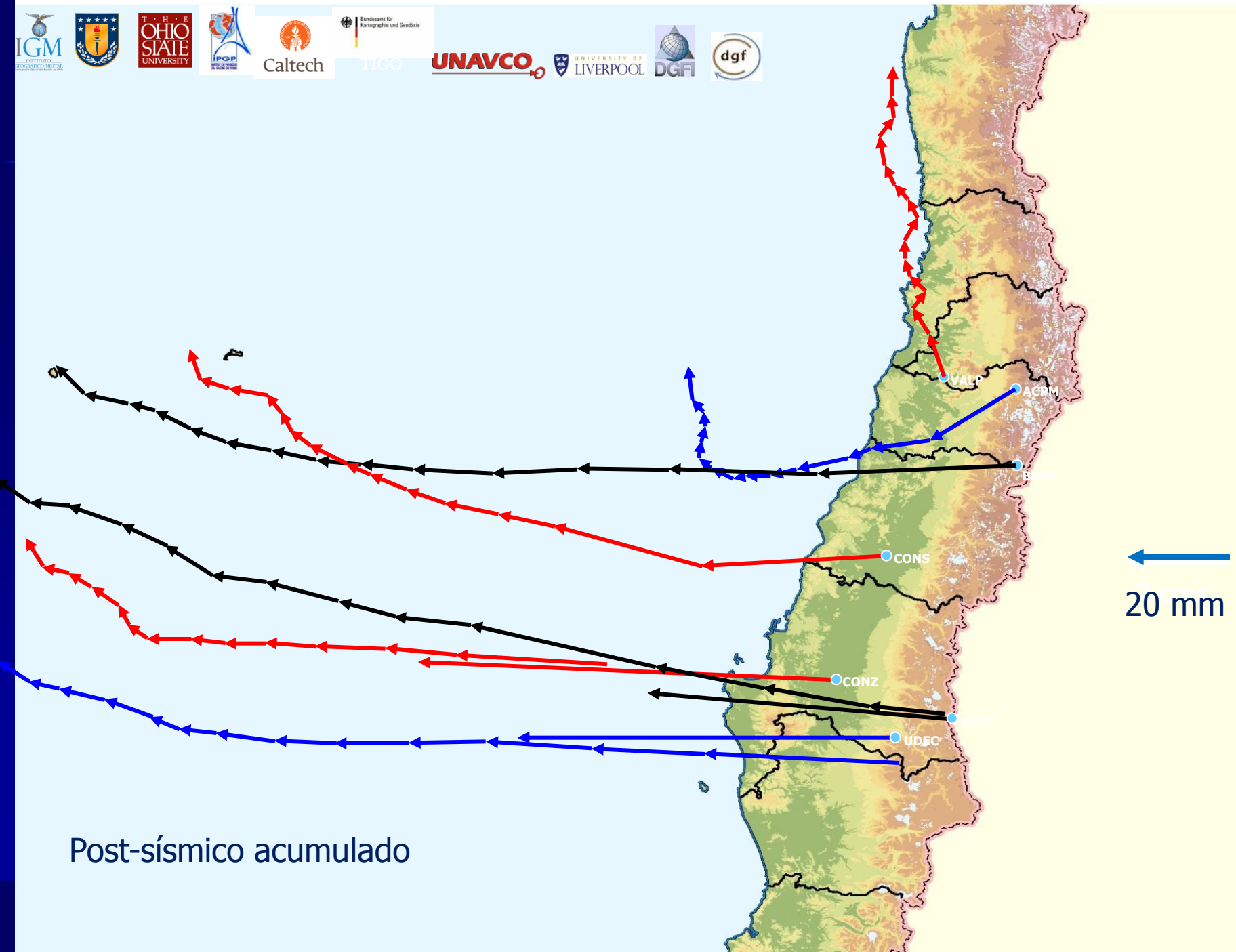


Tiempo

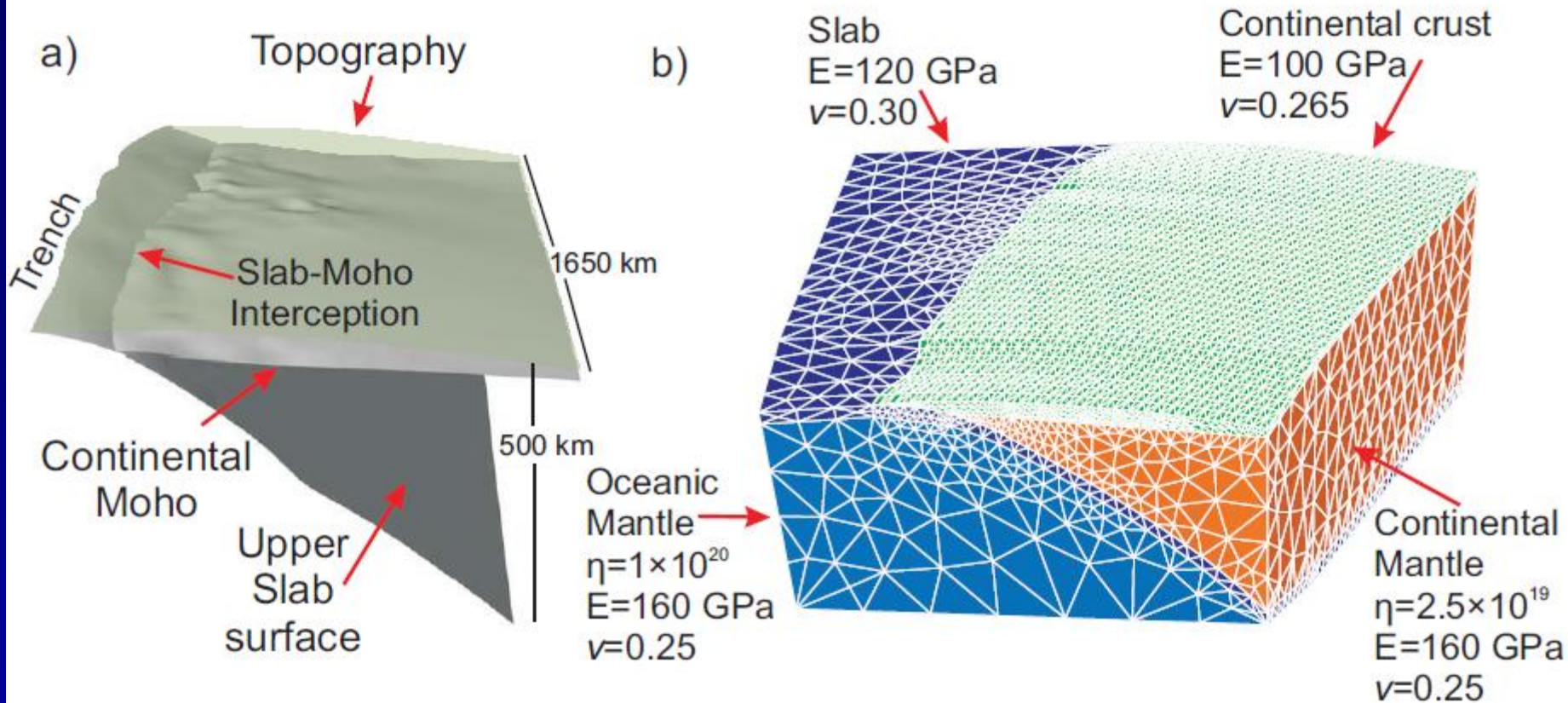
## CONZ



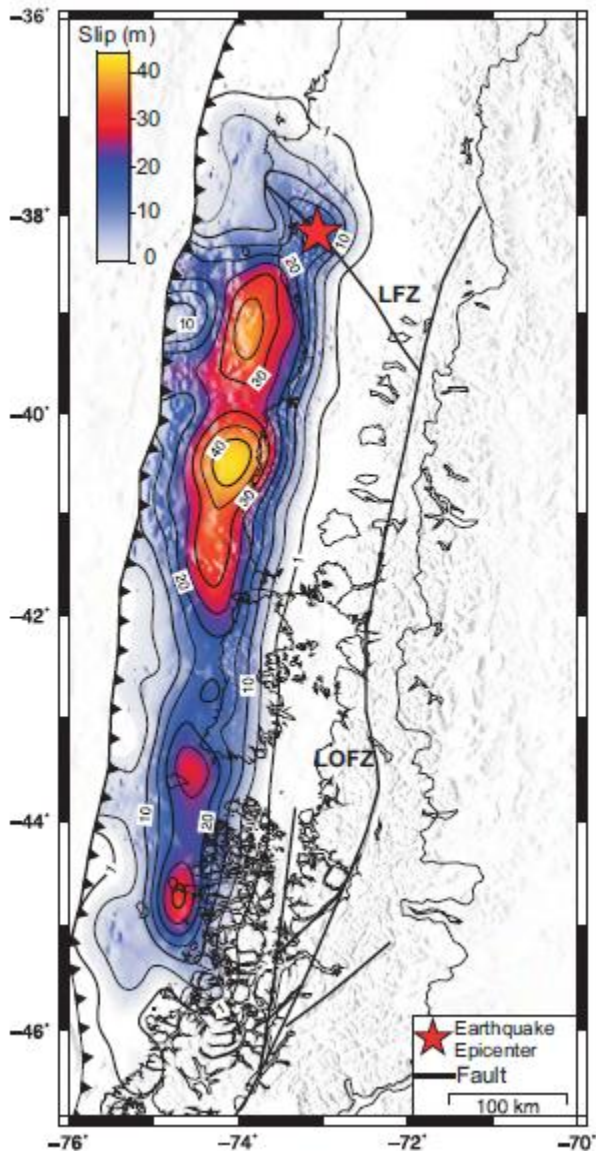
Tiempo



Post-sísmico acumulado



Moreno et al, 2010



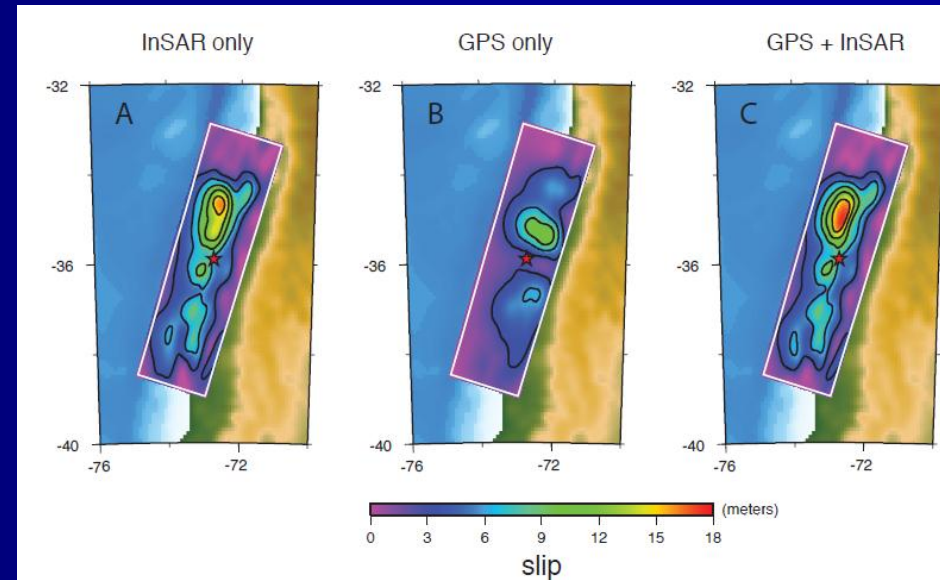
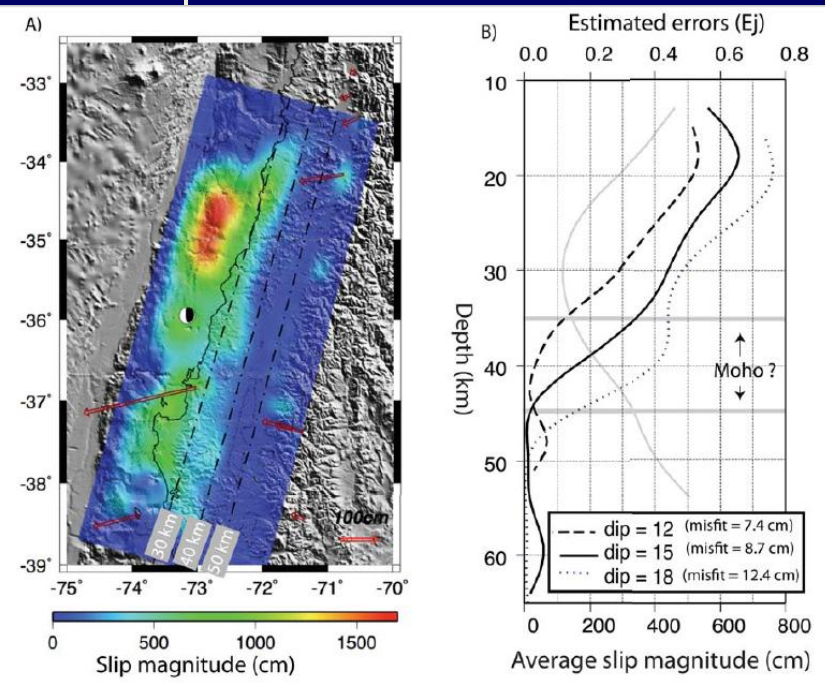
Earthquake cycle deformation and strain partitioning in the southern Andes from GPS and numerical models

Marcos Moreno, Daniel Melnick, Jan Bolte, Juergen Klotz, H. Echtler, Juan Báez, Junping Chen, Michael Bevis, Klaus Bataille, JGR2009JB007101



# INSAR/GPS

Resolution of slip. a) and c) are the input structures, which are used to construct synthetic datasets using the same configuration of InSAR and GPS data as in the inversions with real data. b) and d) are the corresponding inverted slip distributions



Coseismic slip distribution of the February 27, 2010 Mw 8.9 Maule, Chile earthquake, Fred Pollitz, Benjamin A. Brooks , Xiaopeng Tong , Michael Bevis, James Foster , Roland Burgmann , Robert Smalley , Juan Baez, Christophe Vigny , Anne Socquet , Jean-Claude Ruegg , Jaime Campos , Sergio Barrientos , Héctor Parra, Sergio Cimbarro , Mauro blanco , 2011GL047065.

The Mw8.8 2010 Maule, Chile Earthquake: Significant slip occurred only above the continental Moho  
Xiaopeng Tong, David Sandwell , Karen Luttrell , Benjamin A. Brooks , Michael Bevis , Masanobu Shimada , James Foster , Robert Smalley Jr. , Héctor Parra , Juan Baez , Mauro blanco , Eric Kendrick , Jeff Genrich , Dana Caccamise II  
GRL 2010GL045091 (in review)



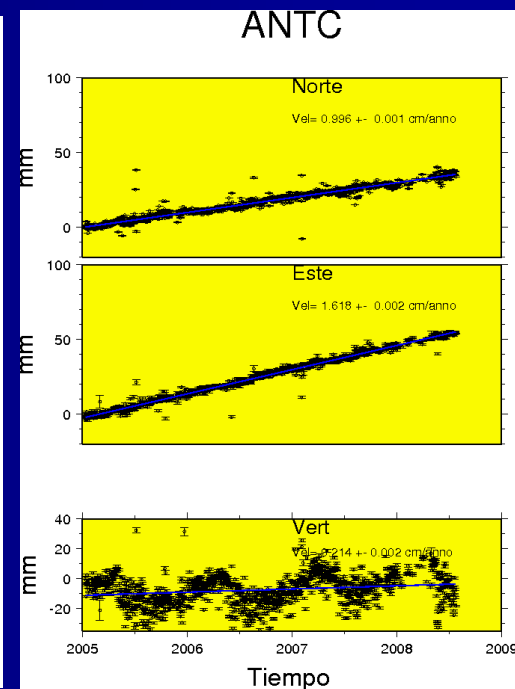
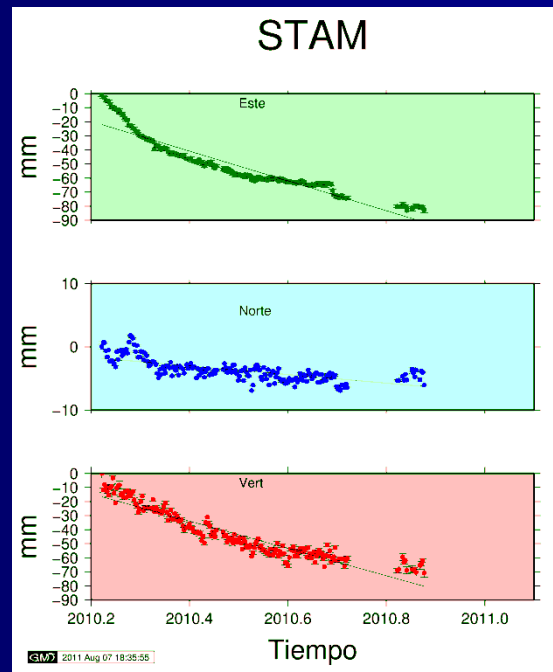
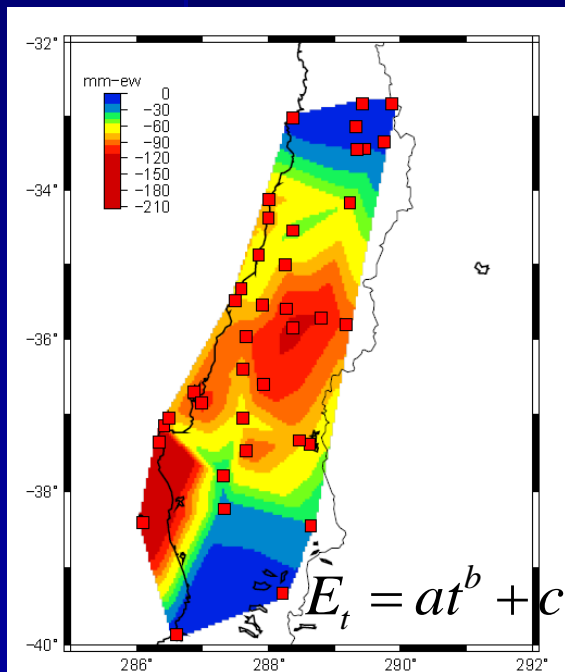
# Estimación de la velocidad



## Caso 1:

$$X_i = X_0 + V_0(t_i - t_0) + \sum r$$

$$\sum r = \Delta X_{CO} + \Delta X_{POST} + \Delta X_{SILENT} + \Delta X_{SEASONAL} + \varepsilon$$





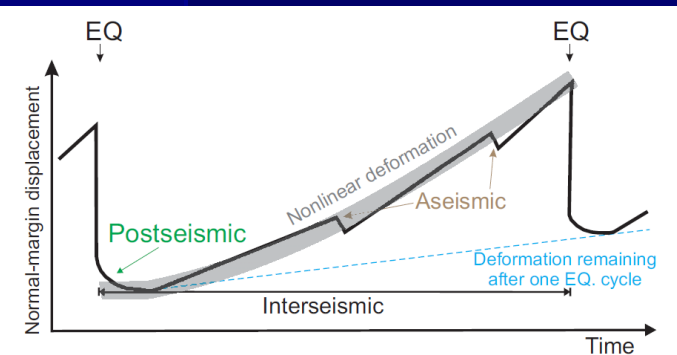
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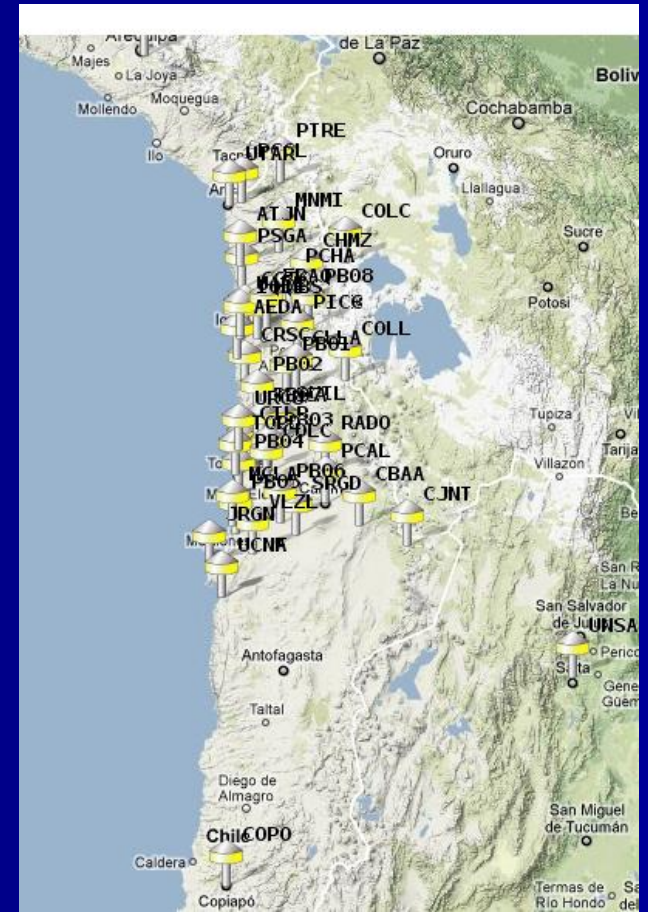
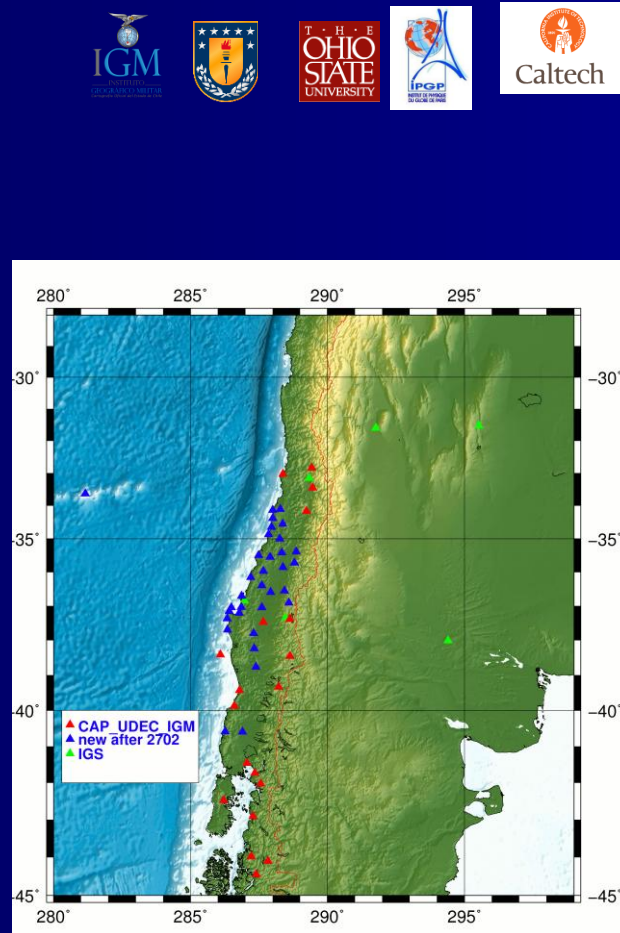
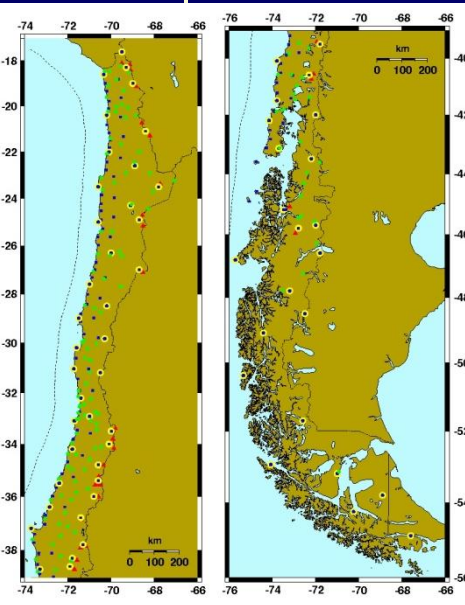
IGSyyPwww.ssc

Figure 1.1: Scheme of the earthquake cycle deformation for a surface site above the seismogenic zone in a subduction zone. Periods of transient deformation may be superimposed on interseismic strain accumulation influencing the interface coupling.





# Caso 1: Densificación en curso (SSN) y otros





# PROYECTO

## "Observaciones Geodésicas y Análisis de Sistemas en Regiones Sísmicas Activas en Chile"

Caso 2:



- Implementación de Centros de Análisis y Combinación Multi-técnica.



GNSS → IGM



VLBI → UDEC



LASER → UDEC

¿SOLUCIONES MENSURALES?





¡muchas Gracias!  
Danke für alles!  
Many thanks!  
Muito obrigado!



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