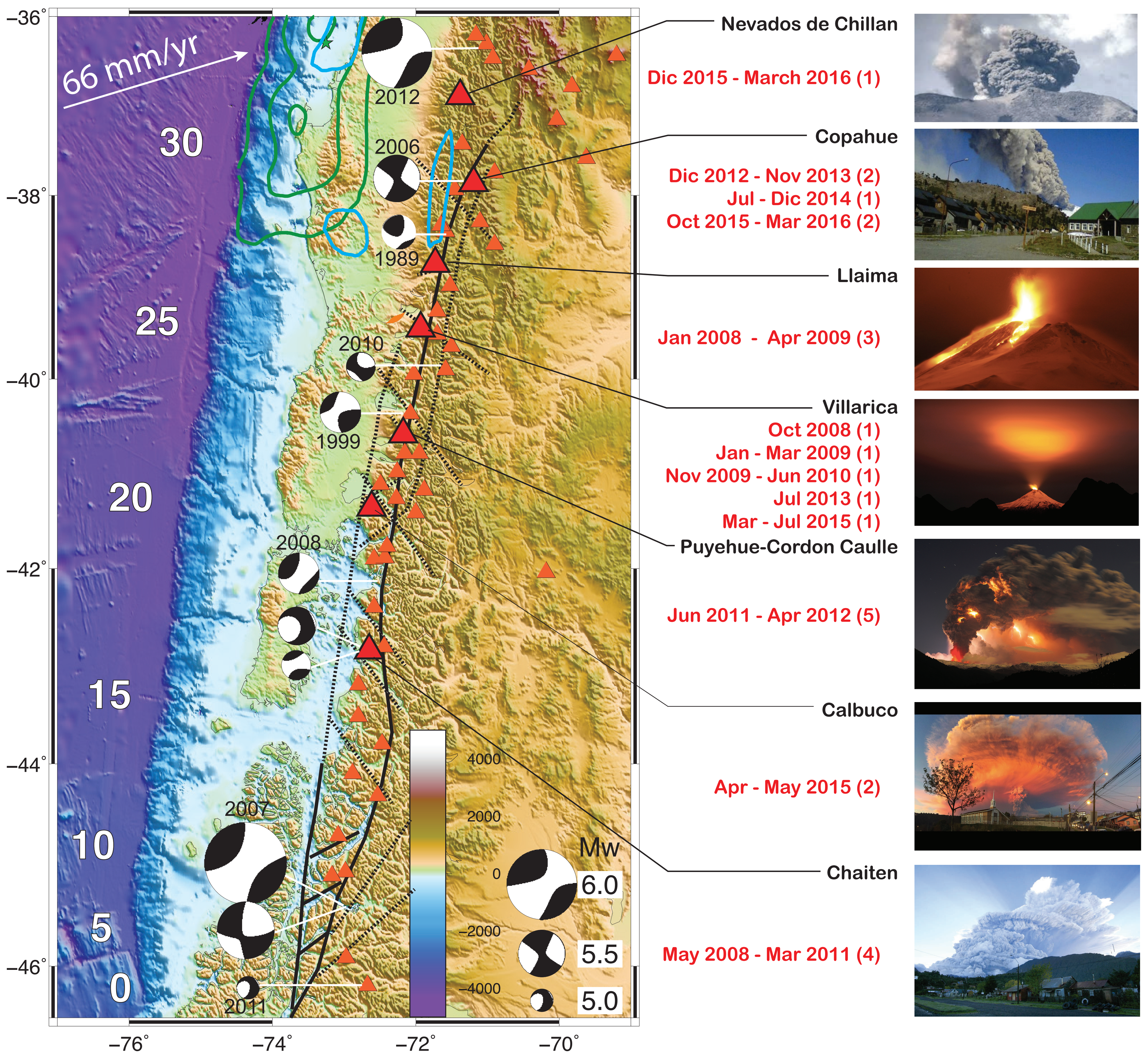
(1) Universidad de Concepción
DOCTORADO en Ciencias GEOLÓGICAS DCG

Volcanism and Tectonics in Action along the Southern Andes

space-time analysis of current deformation recorded by GNSS and seismicity

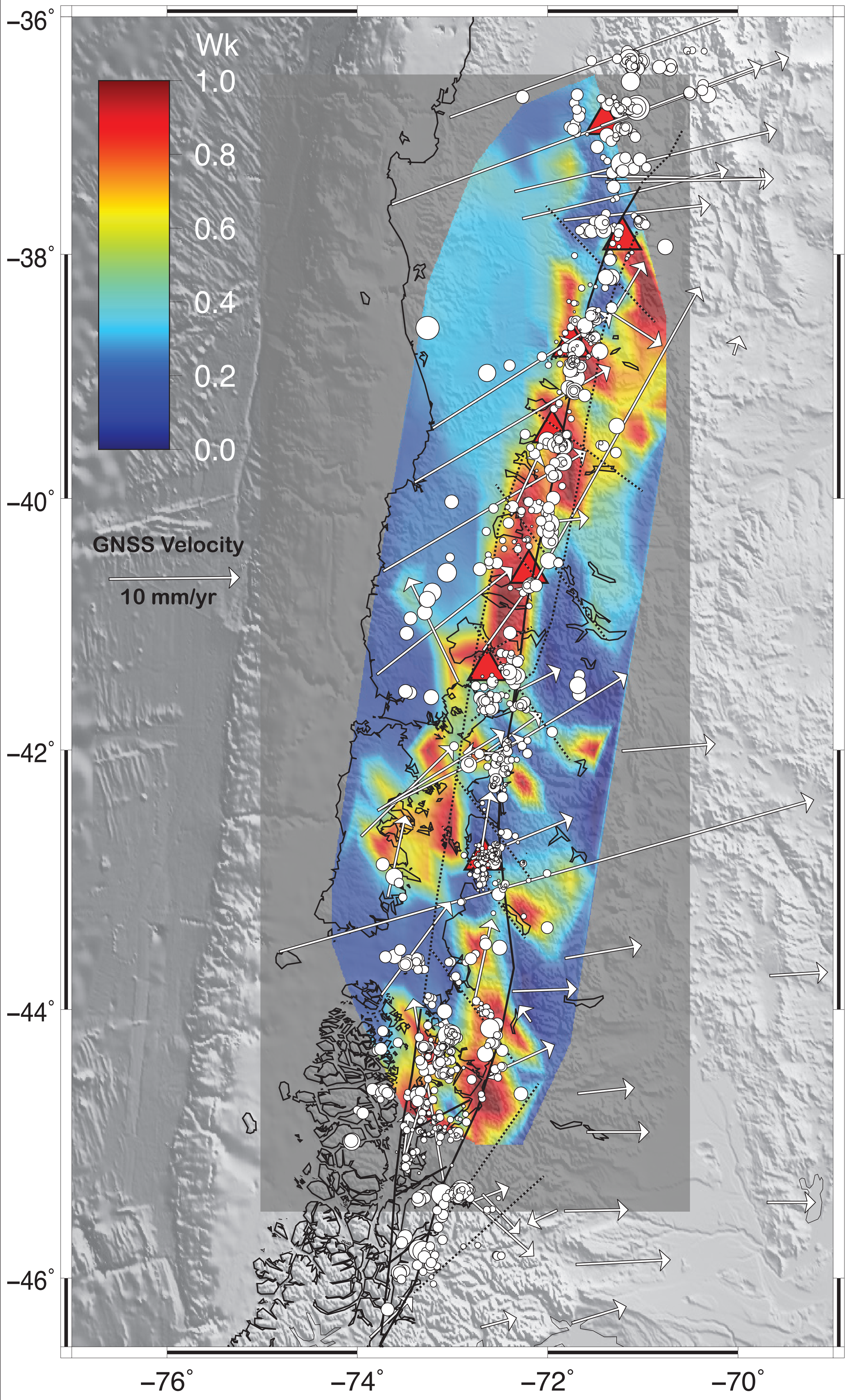
Andrés Tassara (1), Scott Giorgis (2), Vicente Yáñez (1), Francisco Garcia (1), Rodrigo Mora (1), Juan Carlos Baez (3) and Luis Lara (4)
(2) State University of New York College at Geneseo
(4) SERNAGEOMIN Gobierno de Chile
(3) CSN Centro Sismológico Nacional Universidad de Chile

TECTONIC SETTING AND RECENT ACTIVITY



Topography/bathymetry map of the Southern Andean margin showing main tectonic features. White arrow is convergence velocity. White numbers are ages of the Nazca plate. Green contours are co-seismic slip (1, 5, 10 m) of the Mw8.8 Maule 27/2/2010 earthquake (Moreno et al., 2012). Blue contours are afterslip (1.2 m) cumulated during the first year after the Maule earthquake (Bedford et al., 2013). Beach-balls represent full focal mechanisms of shallow earthquakes (<15 km) as reported by the GCMT; note variable percentages of a left-lateral strike-slip double couple component and a significant compensated linear vector dipole (magma injection?). Bold lines are mapped faults and/or strong geomorphic features, segmented lines are less obvious lineaments. Margin-parallel structures belong to the Liquiñe-Ofqui Fault Zone (LOFZ), which is intersected by inherited oblique structures. Red triangles are active volcanoes (Smithsonian Institute Global Volcanic Program SI-GVP) with enlarged ones corresponding to those that have erupted since 2008. The eruptive activity of these 7 volcanoes is described in the right panel in terms of the approximate time period and Volcanic Explosivity Index (VEI) of most notable events (SI-GVP).

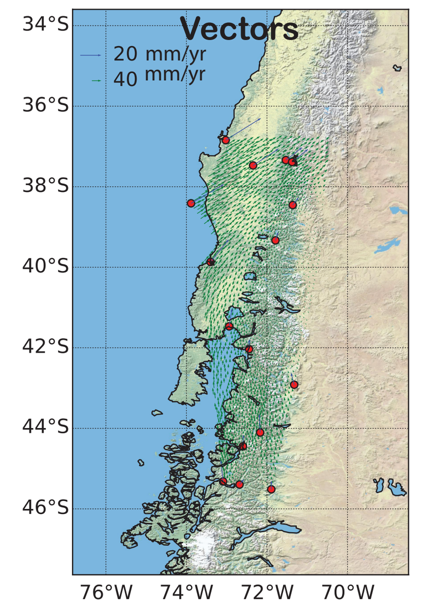
GNSS SURFACE DEFORMATION AND SEISMICITY



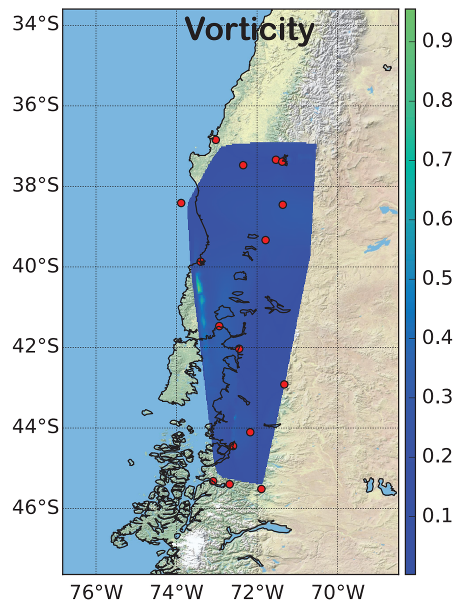
We use surface velocity vectors computed from campaign (Wang et al., 2007) and continuous GNSS stations (most of them administrated by the Chilean national seismic center CSN) before the 2010 Maule earthquake. With theses vectors we interpolate an interseismic velocity field from which we calculated velocity gradients parallel and normal to the strike of the LOFZ. From the velocity gradient field we finally computed this map of kinematic vorticity Wk assuming monoclinic transpression. Into this conceptual framework, Wk is the ratio between LOFZ-parallel simple shear and LOFZ-normal pure shear. Wk values near unity (warm colors) indicate dominance of strike-slip deformation parallel to the LOFZ, whereas low Wk (cold colors) shows predominant compression normal to the LOFZ. Note (1) the strong concentration of high Wk along the traces of the LOFZ between 38° and 41.5°S, (2) the location of recently erupted volcanoes in regions of maximum Wk into this segment, (3) a more spotty distribution of high Wk in partial coincidence with the LOFZ south of 41.5°S, and (4) the apparent segmentation of the LOFZ generated by NW-oriented inherited faults.

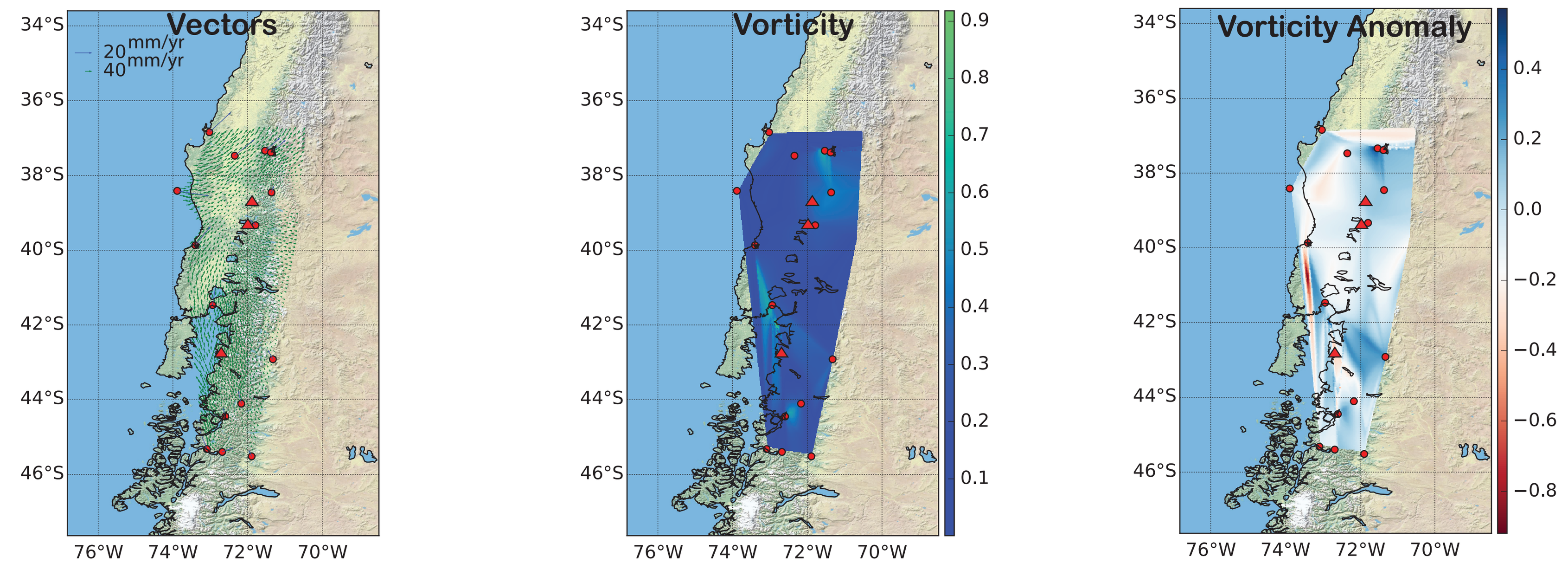
With points are preliminary epicenter locations of earthquakes recorded by the seismic network of the Observatorio Volcanologico de los Andes del Sur (depending on the Chilean geological survey SERNAGEOMIN) between 01/01/2010 and 16/3/2016. These events are shallower than 10 km and have local magnitudes between -0.7 and 5.3 (size scaled by magnitude). Note that regions of high seismicity density are commonly aligned with the LOFZ or oblique structures and seems to be surrounding patches of high Wk.

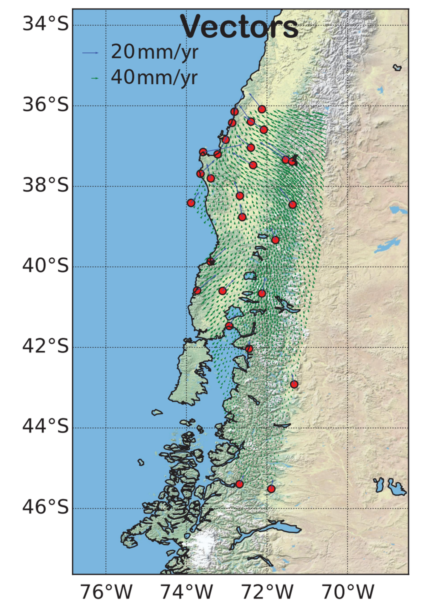
TIME-VARIABLE ANALYSIS OF VORTICITY



We interpolate velocity fields from time-series of continuous GNSS stations and derive maps of Wk (without imposing monoclinic transpression). Upper panels are for the time period 01/07/2007 - 26/2/2010. Lower panels are for 01/01/2009 - 30/5/2009 encompassing eruptions of Llaima, Villarica and Chaiten. Vorticity anomaly is the difference between maps of both periods, highlighting regions of enhanced surface deformation that seems to (loosely) correlate with erupted volcanoes.







Time period of the upper panels is between 01/07/2012 - 01/07/2015, after most of the postseismic deformation of the Maule earthquake vanished. Lower panels are for 01/12/2012 - 31/1/2013 one month before and after the start of Copahue eruptive process. Both vorticity maps show a region of high vorticity immediately to the west of the volcano, which is more clear in the vorticty anomaly map. This suggests that the eruption was likely activated by deformation of the volcano´s basement.