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Title: Upper plate deformation is dominated by varying interface coupling in the Chilean subduction context

Abstract

It has been almost two decades now that GPS has been used to measure plate tectonics and quantify plate deformation. In South America, the debate rapidly focused on the motion of the Nazca plate relative to the South America plate. Space geodesy allows to compare plate motions averaged over a few years to plate motion averaged over several million of years. Since the initial work of (*Larson et al., 1997*) which found similar rates, it is well known now (eg*: Norabuena et al, 1998; Norabuena et al, 1999; Angermann et al., 1999; Altamimi et al., 2002; Kendrick et al, 2003; Vigny et al, 2008*) that in fact the present day motion of the Nazca plate is around 15% slower than its Nuvel-1A estimate. This finding has the important consequence that along the South American margin, instead of nearing 8 cm/yr, today's subduction rate ranges from 5.5 cm/yr in Equator to 7 cm/yr in central Chile, before it decreases again to 6.5 cm/yr in southern Chile. Part of this convergence rate is taken up by permanent strain contributing to the building of the Andes, but most of it generates elastic deformation recovered during the seismic cycle with an average of one M=8 event every ten years and at least one M>8.7 per century in what corresponds to the Chilean portion of the Nazca subduction.

Surface deformation is representative of these processes and GPS measurements made in the area aim at quantifying the different contributions and defining the style of deformation.Up to now, two different families of models have been presented: 2-plates model, involving homogeneous medium where the slab geometry varies with latitude and depth, (*Klotz et al., 2001; Khazaradze et al., 2003*); 3-plates model involving a rigid sliver between the 2 main plates (*Kendrick et al., 2003; Brooks et al, 2003)*. Steady state velocities predicted by these models differ at the cm/yr level in places and GPS measurements should allow to discriminate easily between them. However, recent measurements we carried out on small scale dense networks in Chile in the vicinity of the trench (Concepion - 36°S, Coquimbo - 30°S, Antofagasta – 22°S) show that the deformation exhibits very different patterns in distinct areas and abrupt changes with latitude. We demonstrate that to model these patterns with a full coupling on the trench is not possible everywhere, and following others, we conclude that coupling must be varying on the subduction interface, both with depth and along strike, and can reach value as low as 40% regionally and even less locally. Moreover, these low-coupling areas could correspond to transient deformation associated to the seismic cycle. This signal completely dominates the deformation patterns we measured at the surface over the last decade, and renders extremely difficult to detect the permanent deformation not taken up by the recoverable elastic deformation or even to simply quantify the style of deformation.