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A quantitative relationship between interseismic strain and long term uplift in northern Chile

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Large earthquakes in subduction zones result from tectonic strain that has accumulated over decades to centuries along coupled regions of the plate interface. Additional elastic energy can also be released through aseismic slip during the post-seismic and inter-seismic phase. Assuming a fully elastic crust (i.e. that cannot accumulate permanent deformation), measuring and comparing strain increase and release often leads to a balanced budget. However, we know that part of the tectonic contraction we evidence with geodesy translates into permanent deformation resulting in mountain building or vertical motion of the coastal domain in subduction zones over millions of years. Although increments of permanent strain should be small compared to interseismic loading strain, we do not know yet how much of this contraction is stored permanently and how this deformation is partitioned between the different phases of the earthquake cycle. In northern Chile, we combine InSAR and GPS data using a Bayesian formalism to derive a probabilistic model of coupling along the megathrust. Vertical motion predicted by this coupling model correlates with long-term, holocene uplift suggesting part of the interseismic strain cannot be recovered elastically. In contrast with previous studies, our results take advantage of InSAR-derived deformation rates that are sensitive to vertical motion. We show that such inelastic deformation may be explained by a simple low-temperature, visco-plastic behavior of rocks.