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Differential uplift of three Pliocene sea level indicator sites in southern Argentina driven by upwelling asthenosphere through the Patagonian slab window

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Bivalve and gastropod shell beds deposited during the Early Pliocene (4.69-5.23 Ma) occur in uplifted outcrops (36 – 180 m above sea level) along the east coast of Patagonian Argentina. These rock units provide a record of sea level during a geologic period when atmospheric CO2 and temperatures were higher than today. As such, reconstructing the elevation of global mean sea level (GMSL) during this time allows us to better understand how sensitive ice sheets are to increased past and future warming. However, reconstructing GMSL from local sea level indicators is hindered by effects such as mantle dynamic topography and glacial isostatic adjustment (GIA) that cause local sea level to deviate from the global mean. Here we use geodynamic modeling to better understand this complex dynamic setting and quantify the amount of uplift along this coastline.

Despite being located on a relatively stable passive margin, significant variations in the elevation of the paleo shoreline indicators imply that the underlying convecting mantle is deforming the coastline. In particular, the subduction of the Chile Rise beginning ~18 Ma beneath Patagonia has generated a slab window underneath this region through which hot asthenosphere ascends. However, the former slab is still present deeper in the mantle, which causes a complex interplay between the downwelling slab and the upwelling asthenosphere. To quantify the effects of dynamic topography change since the Pliocene, we run 3D mantle convection simulations using the code ASPECT. We initialize our global model with a composite temperature structure derived from recent tomographic studies and a calibrated parameterization of upper mantle anelasticity. Independent estimates of pressure and temperature from thermobarometric calculations of proximal Pali-Aike xenoliths agree with the thermal structure of the tomography-based Earth model. We back-advect temperature perturbations and extract the resulting change in dynamic topography. Pairing GIA models and a suite of convection simulations in which we vary the

viscosity and buoyancy structure with the observed differential paleo shoreline elevations allows us to forward model the most likely scenario for uplift along this coast.