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Unravelling the thermal state of the southern Central Andes and its controlling factors

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The Andes represent the modern type area for orogeny at a non-collisional, ocean-continent convergent margin. Subduction geometry, tectonic deformation, and seismicity at this plate boundary are closely related to lithospheric temperature distribution in the upper plate. Despite recent advances in the assessment of the thermal state of the Andean lithosphere and adjacent regions derived from geophysical and geochemical studies, several unknowns remain concerning the 3D temperature configuration at lithospheric scale. In particular, it is not clear how both, the configuration of the continental overriding plate (i.e., its thickness and composition) and the variations of the subduction angle of the oceanic Nazca plate influence thermal processes and deformation in the upper plate. To address this issue, we focus on the southern segment of the Central Andes (SCA, 29°S-39°S), where the Nazca plate changes its subduction angle between 33°S and 35°S from the Chilean-Pampean flat-slab zone (< 5° dip, 27-33°S) in the north to a steeper sector south of 33°S (~30° dip). Additionally, the overriding plate exhibits variations in the crustal geometry and density distribution along- and across-strike of the subduction zone. We derived the 3D lithospheric temperature distribution and the surface heat flow of the SCA from the inversion of S-wave velocity to temperatures and calculations of the steady-state conductive thermal field. The configuration of the region – concerning both, the heterogeneity of the lithosphere and the slab dip – was accounted for by incorporating a 3D data-constrained structural and density model of the SCA into the workflow. We conclude that the generated thermal model allows us to evaluate how mantle thermal anomalies and first-order structural and lithological heterogeneities in the lithosphere, observed across and along-strike of Andean orogen, affect the thermal field of the SCA and thus the propensity of the South American lithosphere to specific styles in deformation. In addition, our results are useful to constrain thermo-mechanical simulations in geodynamic modelling and therefore, contribute to a better understanding of the present-day rheological state of the Andes and adjacent regions.