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Continental-scale temperature covariance in proxy reconstructions and climate models

Claudia Hartl-Meier (1), Ulf Büntgen (2,3,4), Jason Smerdon (5), Eduardo Zorita (6), Paul Krusic (7,8), Fredrik Ljungqvist (9,10), Lea Schneider (1), and Jan Esper (1)

(1) Department of Geography, Johannes Gutenberg University, Mainz, Germany (c.hartl-meier@geo.uni-mainz.de), (2) Department of Geography, University of Cambridge, Cambridge, UK, (3) Swiss Federal Research Institute WSL, Birmensdorf, Switzerland, (4) CzechGlobe Research Institute CAS and Masaryk University, Brno, Czech Republik, (5) Lamont-Doherty Earth Observatory of Columbia University, Palisades, New York, USA, (6) Institute of Coastal Research, Helmholtz-Zentrum Geesthacht, Geesthacht, Germany, (7) Department of Physical Geography, Stockholm University, Sweden, (8) Navarino Environmental Observatory, Messinia, Greece, (9) Department of History, Stockholm University, Stockholm, Sweden, (10) Bolin Centre for Climate Research, Stockholm University, Stockholm, Sweden

Inter-continental temperature variability over the past millennium has been reported to be more coherent in climate model simulations than in multi-proxy-based reconstructions, a finding that undermines the representation of spatial variability in either of these approaches. We assess the covariance of summer temperatures among Northern Hemisphere continents by comparing tree-ring based temperature reconstructions with state-of-the-art climate model simulations over the past millennium. We find inter-continental temperature covariance to be larger in tree-ring-only reconstructions compared to those derived from multi-proxy networks, thus enhancing the agreement between proxy- and model-based spatial representations. A detailed comparison of simulated temperatures, however, reveals substantial spread among the models. Over the past millennium, inter-continental temperature correlations are driven by the cooling after major volcanic eruptions in 1257, 1452, 1601, and 1815. The coherence of these synchronizing events appears to be elevated in several climate simulations relative to their own covariance baselines and the proxy reconstructions, suggesting these models overestimate the amplitude of cooling in response to volcanic forcing at large spatial scales.