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The evolution of near-surface temperatures of last 2,000 years in a fully coupled Earth System Model - Comparison with PAGES2k reconstructions

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The climate of the last 2,000 years is investigated with a fully coupled earth system model MPI-ESM-P. For the first time also changes in volcanic activity are implemented in addition to changes in orbital, solar and greenhouse gas concentrations and land use changes after 800 AD.

On global scales, temperatures show a clear reflection of the large tropical volcanic eruptions in the 6th, 13th and 19th century. On regional scales, for instance over the NH continents the gradual decline of orbitally induced boreal summer short wave insolation is evident with a long-term reduction in near-surface temperatures. A comparison between recent reconstructions carried out in the context of the PAGES2k consortium reveal a high degree of similarity over those areas on decadal time scales, especially over Europe.

Over the southern hemisphere the situation is however more heterogeneous and the model simulation shows no such clear cut changes compared to the northern hemispheric continents. For instance, the change in the GHG concentrations does not lead to a pronounced increase in the temperatures over Antarctica. Here the reconstruction shows quite stable levels also in the 20th century, whereas the simulation shows a similar increase as for the northern hemisphere.

The simulation shows that the decadal-scale climate variability is driven i) by volcanic activity and ii) during the absence of sustained and long term changes of external forcing by internal processes. An important and still unresolved issue however relates to the large discrepancies in the evolution of southern hemispheric temperatures, especially in the 20th century over the high southern latitudes between the model simulation and the PAGES2k reconstruction.