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Global spatial patterns of natural and forced variability in the past millennium

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Several climate simulations over the past millennium with the model ECHO-G, driven by past solar variations, greenhouse gas concentrations and a parametrization of volcanic forcing, have been analysed to estimate the magnitude of externally forced variability relative to total variability at different time scales. The effect of individual volcanic eruptions has not been targeted in this study, which is rather focused on the signal of the slowly varying external forcings through time. Several variables have been placed in the focus of this study: near surface temperature, precipitation, sea-level pressure and the atmospheric zonally averaged meridional circulation. Due the to the length of the simulated period the simulation ensemble size is small. The externally forced signal is therefore identified by applying correlation techniques between the fields simulated in the various simulations.
As expected the externally forced signal becomes stronger going from inter-annual to multi-decadal scales, but the spatial patterns differ for the different variables. For near-surface temperature the effect of external forcing is stronger in the tropics, where forced variability at multi-decadal time scales explains about 50% of the total variance. The external signal for precipitation is much weaker even at multi-decadal time scales, but at high-latitudes it amount to about 25% of the total variance. The corresponding spatial patters for sea-level pressure also displays larger externally forced variance at high latitudes (about 30%) than in the Tropics, but certain sea-level-pressure structures like the subtropical anticyclones display larger externally forced variability than the surrounding regions. Regarding the zonally averaged atmospheric meridional circulation, the externally forced signal is not very strong at multi-decadal time scales. It is mostly restricted to the Ferrell cell in the Southern Hemisphere with no clear signal of a response of the Hadley cell to external forcing