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Low-frequency variability of synoptic-scale atmospheric circulation patterns in the Northern Hemisphere extratropics and associated hindcast skill of decadal forecasting systems

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The inter-annual to multi-decadal variability of recurrent, synoptic-scale atmospheric circulation patterns in the Northern Hemisphere extratropics, as represented by the Jenkinson-Collison classification scheme, is explored in reanalysis data spanning the entire 20th century, and in global climate model (GCM) data from the historical, AMIP and DCPP experiments conducted within the framework of CMIP6. The aim of these efforts is to assess the effect of coupled vs. uncoupled and initialised vs. non-initialized GCM simulations in reproducing the observed low-frequency variability of the aforementioned circulation patterns.

Results reveal that the observed annual counts of typical recurrent weather patterns, such as cyclonic or anticyclonic conditions and also situations of pronounced advection, exhibit significant oscillations on multiple time-scales ranging between several years and several decades. The period of these oscillations, however, is subject to large regional variations. This is in line with earlier studies suggesting that the extratropical atmospheric circulation's low frequency variability is essentially unforced, except in the Pacific-North American sector where the forced variability is enhanced due to ENSO teleconnections. Neither the periods obtained from historical nor those obtained from AMIP experiments align with observations. Likewise, not even the periods obtained from different runs of the same GCM and experiment correspond to each other. Thus, in an non-initialized model setup, ocean-atmosphere coupling or the lack thereof essentially leads to the same results. Whether initialization and/or augmenting the ensemble size can improve these findings, will also be discussed.

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