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Model-simulated regimes over the Northern Hemisphere

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The large-scale circulation of the extratropical atmosphere can be described by the alternation of circulation regimes (or weather regimes), in which anomalies in the amplitude and phase of planetary waves are dynamically equilibrated by variations in diabatic energy sources and non-linear interactions with synoptic-scale eddies. The variation of circulation regime properties is an important issue for climate predictions, from seasonal forecasts to future climate scenarios. However, either when validating model results against observations, or when comparing regime properties in different periods, one is faced with the problem of estimating the significance of the products of complex statistical tools. Specifically, one needs to quantify the uncertainty in regime properties arising from the internal, chaotic dynamics of the atmosphere, and use such information to assess the predictability of such properties as a response to external variations in forcing terms.

Given the limitations of the observed record of upper-air fields, it is very difficult to address these issues from re-analysis data. However, ensembles of GCM simulations can provide reliable estimates of the effects of internal vs. external variability in regime properties. Here, we make use of ERA40 re-analysis data and of a large set of ensemble simulations with atmospheric GCMs to investigate the following specific topics:

a) To what extent are the properties of model-simulated regimes over the Northern Hemisphere and the Euro-Atlantic region consistent with those of regimes obtained from re-analysis data?

b) Are the differences between observed regime properties in different periods of the late 20th century within the range of internal atmospheric variability for the same external forcing?

c) Are interannual variations in regime frequencies (at least partially) reproducible as a function of SST anomalies?