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Impact of resolution and stochastic physics on the representation of Euro-Atlantic weather regimes

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A set of atmosphere-only ensemble simulations forced by observed Sea Surface Temperatures (SSTs), provided within the PRIMAVERA project framework, is studied to assess the following scientific questions:
• Is the model able to represent the observed weather regimes over the Euro-Atlantic region?
• Does the representation improve if resolution is increased or stochastic physics is used? How and why?
A model's resolution describes the smallest scale at which physical processes are resolved, with any smaller scale processes being approximated in some way. The stochastic parametrisation scheme introduces random perturbations to the unresolved physical processes, in order to represent the sub-grid scale variability that models fail to capture. Weather regimes could be understood as envelopes of daily atmospheric variability with typical persistence, spatially well defined and limited in number. Weather regimes over the Euro-Atlantic region are computed via k-means clustering of DJF Z500 daily data for observations and simulations in the same way. The k-means algorithm is applied to the first 4 Principal Components (PCs), which always explain more than 50% of the variance. The representation of weather regimes is assessed comparing it with the observed one, by means of the following metrics: significance of cluster partition (how well the clusters are defined and separated), frequency of weather regime occurrence and pattern correlation relative to observations. Uncertainty in the metrics refers to the difference in the metrics between ERA-Interim and NCEP/NCAR reanalysis.
Clustering analysis on the model data identifies the standard 4 regimes for the Euro-Atlantic region: NAO+, Blocking, Atlantic Ridge and NAO-. In general, models underestimate NAO+ and Blocking frequency and overestimates Atlantic Ridge and NAO- frequency. However, there is a big variability among the ensemble members: certain single members can have frequency closer to the observations with respect to the unique partition case, where all the ensemble members are considered together.
Overall the improvement due to increased resolution and stochastic physics activation is evident in most of the models.