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Assessment of winter mid-latitude atmospheric variability in CMIP5 models using a process-oriented metric

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We compare different global climate models included in the fifth phase of the Climate Model Intercomparison Project (CMIP5), in terms of their capability in reproducing the northern hemisphere mid-latitude winter atmospheric variability.
We use the space-time Hayashi spectra of the 500hPa geopotential height fields to characterize the variability of atmospheric circulation regimes and we introduce an ad hoc integral measure of the variability observed in the Northern Hemisphere on different spectral sub-domains.

The overall performance of each model is evaluated by considering the total wave variability as a global scalar measure of the statistical properties of different types of atmospheric disturbances.
The variability associated to eastward propagating baroclinic waves and to planetary waves is instead used to describe the performance of each model in terms of specific physical processes.
The atmospheric variability estimated for planetary and baroclinic waves by the CMIP5 historical simulations agrees with the NCEP reanalysis only for two global climate models; large biases, even larger than 20%, are found in several cases.

Both for the historical and the rcp45 runs (referred to years in which we predict an increase of 2°C in the global temperature with respect to the preindustrial period), the baroclinic waves are typically underestimated by the climate models and the planetary waves are usually overestimated, in contrast with previous studies on CMIP3 models.
Comparing the rcp45 runs with the historical ones, we notice a shift of the models ensemble, obtained by arithmetic averaging of the results of all models, toward higher values of the baroclinic waves for the future with respect to the past