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Intercomparison of the northern hemisphere winter mid-latitude atmospheric variability of the IPCC models

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We compare, for the overlapping time frame 1962-2000, the estimate of the northern hemisphere mid-latitude winter atmospheric variability within the available XX century simulations of about 20 global climate models included in the Intergovernmental Panel on Climate Change - 4th Assessment Report with the NCEP-NCAR and ECMWF reanalyses. We compute the Hayashi spectra of the 500hPa geopotential height fields and introduce an ad hoc integral measure of the variability observed in the Northern Hemisphere on different spectral sub-domains. The total wave variability is taken as a global scalar metrics describing the overall performance of each model, while the total variability pertaining to the eastward propagating baroclinic waves and to the planetary waves are taken as scalar metrics describing the performance of each model in describing the corresponding specific physical process. Only two very high-resolution global climate models have a rather good agreement with reanalyses. Large biases, in most cases larger than 20%, are found in all the considered metrics between the wave climatologies of most IPCC models and the reanalyses. The span of the climatologies of the various models is, in all cases, over 50% of the climatology of the reanalyses. In particular, the travelling baroclinic waves are typically overestimated by the climate models, while the planetary waves are usually underestimated. This closely resembles the results of many diagnostic studies performed in the past on global weather forecasting models. The vertical resolution of the atmosphere and, somewhat unexpectedly, of the adopted ocean model seem to be critical in determining the agreement of the climate models with the reanalyses. The models ensemble obtained by arithmetic averaging of the results of all models is biased with respect

to the reanalyses but is comparable to the best 5 models. This study suggests serious caveats with respect to the ability of most of the presently available climate models in representing the statistical properties of the global scale atmospheric dynamics of the present climate and, a fortiori, in the perspective of modelling climate change.