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A comparison of the North Atlantic atmospheric dynamics in CMIP5 models and the 20CRv2c Ensemble over the past 150 years

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It is of fundamental importance to evaluate the ability of climate models to capture the large-scale atmospheric circulation patterns and, in the context of a rapidly changing climate, the robustness of the long-term changes in the large-scale atmospheric dynamics they produce. Here we approach this problem from an innovative point of view based on dynamical systems theory. We characterize the atmospheric circulation over the North Atlantic in the CMIP5 historical simulations (1851 to 2000) in terms of two instantaneous metrics: local dimension of the attractor and stability of phase-space trajectories. We then use these metrics to compare the models to the 20CRv2c reanalysis over the same historical period. The comparison suggests that: i) most models capture to some degree the median attractor properties and models with finer grids perform better; ii) extremes of the dynamical systems metrics match large scale patterns similar to those found in the reanalysis in most of the CMIP5 models; iii) changes in the attractor properties observed for the ensemble mean 20CRv2c reanalysis are artefacts due inhomogeneities in the standard deviation of ensemble over time; iv) the long-term trends in local dimension observed among the 56 members of the 20-CR ensemble are coherent with those observed in the CMIP5 multimodel mean.