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Evolution of the Hadley Circulation in the ERA-20CM Simulations

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Recent changes of the Hadley Circulation (HC) have been widely investigated in reanalysis products and climate model simulations. Studies tend to agree that the HC has intensified and widened over the three past decades. However, understanding its long term (centennial) evolution is still a challenge. Progresses are needed to improve our knowledge about the response of the HC to global warming and to diagnose the ability of models to simulate past changes. Our study focuses on the evolution of the HC during the 20^{th} Century in the ERA-20CM Experiment (1900-2009), an ensemble of AMIP-like model simulations in which climate evolution is forced by an ensemble of 10 different realizations of prescribed SSTs (HadISST2) and by radiative forcings following CMIP5 recommendations. Our results suggest that Northern Hemisphere (NH) HC has weakened at rate of -0.236 x 10^9 Kg/s per decade during the 20^{th} century, in agreement with the slowdown of HC with increasing of global surface temperatures and GHG concentration shown in climate projections. NH HC weakening trend is due to persistent decreasing tendency until 70's, which actually has reversed its sign in the last decades of the 20^{th} century. From a monthly point of view, weakening of NH HC primarily occurs in January and February. Further, the Southern Hemisphere (SH) HC has significantly widened and its southern edge has shifted toward the pole at rate of about 0.05 $^{\circ}$lat. /decade during the 20^{th} Century. This trend is the result of a strong negative rate, which took place in the mid 30's. Moreover, SH HC poleward shift is persistent over seasons, but much more evident in austral spring and summer. Comparing ERA-20CM to observations and previous simulations we find a trend that is much weaker than in reanalyses, but comparable in magnitude with CMIP5 existing historical simulations.