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Centennial and decadal scale changes of synoptic activity in 20C Reanalysis (1871-2008): reliability and evaluation

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The recently available 20C Reanalysis (20CR) provides a good prospect for spurring the advances of numerical weather prediction for studies of long-term (more than a century) changes in characteristics of synoptic scale variability of atmospheric processes. Nevertheless, 20CR may be also a subject of systematic and time dependent biases and requires validation against the other reanalysis. In the first instance, we perform the comprehensive validation and intercomparison of the characteristics of synoptic activity in the 20CR against NCEP-NCAR reanalysis (NNR). Next we perform the critical analysis of the long-term variability in the intensity of synoptic scale processes over the last 138 years as revealed by 20CR. We use two major methodological tools for quantifying synoptic scale activity. Firstly, we analyze standard deviations of the band-passed heights of different levels in the troposphere. Secondly, we apply numerical storm tracking to obtain cyclone trajectories and to derive cyclone counts and characteristics of the cyclone life cycle. NNR shows higher magnitudes of synoptic scale variability quantified through the band-pass statistics as well as slightly higher cyclone counts for the period of overlap (1948-2008). High frequency synoptic scale activity may exhibit stronger differences between NNR and 20CR in low latitudes, while Arctic is characterized by the large spread in the magnitudes of low-frequency variability. Time variability for this period in 20CR and NNR is highly correlated over the Atlantic with correlations over the Pacific being somewhat smaller. Analysis of centennial scale changes in the characteristics of synoptic activity clearly demonstrates a secular upward tendency in the magnitudes of synoptic variations and the number of cyclones during the period from 1871 to 1947. This tendency is likely modulated by the inhomogeneous inherent in 20CR for this period. for minimizing the effect of changing data assimilation input we performed the processing of individual ensemble members instead of using ensemble averages for the analysis of climate variability. Both cyclone counts and magnitudes of the band-pass statistics demonstrate strong differences between the two estimates in the period 1871-1947, being, however, close to each other in the latest decades.