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Relationships between circulation modes and surface climatic variables: a comparison of reanalyses

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The circulation modes from five atmospheric reanalyses (20CR, ERA-20C, ERA-40, JRA-55, and NCEP/NCAR) are identified over the Northern Hemisphere Extratropics between 1957 and 2002 separately for winter (December-February), spring (March-May), summer (June-August) and autumn (September-November). To obtain circulation modes, rotated principal component analysis (RPCA) based on correlation matrix is applied to monthly mean 500 hPa heights for each season. RPCA is an appropriate method for the identification of circulation modes; each mode calculated from RPCA is described by its score and loading, the former standing for circulation index and the latter for the spatial representation of that circulation mode. As expected, the number of circulation modes is different in each season and is highest in summer. The (dis)similarity of the modes between the reanalyses is evaluated and the statistical significance of differences is assessed using the Fisher transform of loadings. The spatial representation of some circulation modes, such as Eurasian pattern 1 and Eurasian pattern 2, in 20CR reanalysis differs from other reanalyses considerably more than how the other four reanalyses differ from each other. Relationships between circulation modes of all five reanalysis and monthly temperature and precipitation are described by Pearson correlation for nearly 650 stations in all continents of the Northern Hemisphere. Some differences, although with little significance, appear between ERA-20C, ERA-40, JRA-55, and NCEP/NCAR reanalyses. Relationships between some circulation modes and surface climate variables in the 20CR reanalysis are highly significantly different from the other four reanalyses.