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Intercomparison of circulation modes among five reanalyses

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Five atmospheric reanalyses (20CRv2, ERA-20c, ERA-40, JRA-55 and NCEP-1) are used for the identification of circulation modes over the Northern Hemisphere Extratropics between 1957 and 2002 separately for winter (December- February), spring (March-May), summer (June-August) and autumn (September-November). Rotated principal component analysis of monthly mean 500 hPa heights is utilized for identification of circulation modes for each season. The spatial (dis)similarity of the circulation modes between the reanalyses is evaluated and the statistical significance of differences is assessed using the Fisher transform of loadings. The total identified number of circulation modes is 9 in winter, 12 in spring, 14 in summer and 10 in autumn. Generally, the highest agreement of circulation modes is found in winter, the lowest in summer. However, reanalyses may be divided into two subgroups, among which are the differences higher than within subgroups. The first subgroup contains reanalyses covering more than century long time period (20CRv2 and ERA-20c), while the second group includes reanalyses covering shorter than century period (ERA-40, JRA-55 and NCEP-1). The highest differences between these subgroups are found in summer and spring, while the differences between them almost completely diminish in autumn. The spatial representation of some circulation modes, such as Eurasian pattern 1 (EU1) and Eurasian pattern 2 (EU2) in winter, or the North Atlantic oscillation in spring differ in some reanalyses from remaining reanalyses considerably more than how the other four reanalyses differ from each other. Generally, these differences have two main causes: (1) bias in geopotential heights over some areas influences shape and location of centre(s) of circulation mode (e.g. EU1 in 20CRv2) or(2) centre(s) of circulation mode changes shape and/or location with different number of rotated loadings (e.g. EU2 in NCEP-1 and ERA20c). Biases in geopotential heights are predominantly found over large parts of Eurasia in 20CRv2 in winter, thus influencing EU1. Regarding the second cause, majority of the circulation modes seem to be resistant to number of rotated loadings.