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Variations in periodicity of atmospheric teleconnection patterns as revealed by wavelet analysis

R. Huth, **P. Sauli**

Institute of Atmospheric Physics, Prague, Czech Republic (huth@ufa.cas.cz, pkn@ufa.cas.cz)

The wavelet analysis is a powerful tool for detecting an oscillatory behaviour of various phenomena and localizing their periodicity in time. The necessary assumption of its application is an equal temporal distribution of datapoints. In an attempt to apply the wavelet transform to the modes of low-frequency atmospheric circulation variability (teleconnection patterns), we must first define these modes in a monthly resolution throughout the year. The solution to this task is not self-evident as the majority of the modes is active in a part of year only. We tested several possible methodological configurations and found out that rotated principal component analysis (PCA) of a covariance matrix fed by monthly mean anomalies is the most convenient tool. The decision on whether to compensate for an unequal variance of the circulation variables during the year by normalizing the data prior to PCA by a month-specific standard deviation appears to be of secondary importance since the resultant modes do not differ except for the variance they explain (i.e., their order of importance). 12 modes are detected, most of which are active in winter. Morlet wavelet is selected as a base for the analysis. The wavelet transform uncovers different periods as dominant for different modes; for example, the North Atlantic Oscillation (NAO) possesses strongest variations for the 8 and 14 year periods. For the majority of modes, considerable temporal variations of their periodicities are detected. The analysis is conducted on two datasets: (i) 500 hPa heights, covering whole Northern Hemisphere north of 20°N and extending from 1950 to 2003, and (ii) sea level pressure, which extends from 1899 to 2000, but with gaps mainly over former U.S.S.R., some other parts of Asia, and the Pacific Ocean in early years. In addition to monthly means, 10-day means are also analyzed. This study is supported by the Grant Agency of the Czech Academy of Sciences, project A300420506.