

## Atmospheric teleconnection patterns and eddy kinetic energy content: wavelet analysis

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**Abstract.** In this paper, we employ a non-decimated wavelet decomposition to analyse long-term variations of the teleconnection pattern monthly indices (the North Atlantic Oscillation and the Southern Oscillation) and the relationship of these variations with eddy kinetic energy contents ( $K_E$ ) in the atmosphere of mid-latitudes and tropics. Major advantage of using this tool is to isolate short- and long-term components of fluctuations. Such analysis allows revealing basic periodic behaviours for the North Atlantic Oscillations (NAO) indices such as the 4–8-year and the natural change of dominant phase. The main results can be posed as follows. First, if the phases of North Atlantic and Southern Oscillations vary synchronously with the 4–8-year period then the relationship between the variations of the NAO indices and the  $K_E$  contents is the most appreciable. Second, if the NAO phase tends to abrupt changes then the impact of these variations on the eddy kinetic energy contents in both mid-latitudes and tropics is more significant than for the durational dominance of certain phase.

### 1 Introduction

Since last decades of past century, many scientists use the new powerful tool based on the wavelet decomposition for analyzing various signals. One can say without exaggeration, the wavelets has made revolution in both theory and practice of nonstationary signal processing. At present, the family of analysing function dubbed wavelets is being increasingly used in problems of pattern recognition; in processing and synthesising various signals, speech for instance; in analysis of images of any kind (these may be iris images, X-ray picture of a kidney, satellite images of clouds or a planet surface, an image of mineral, etc.); for study of turbulent fields, for contraction (compression) of large volumes of information, and in many other cases.

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Some ideas of the wavelet theory were partially developed a long time ago. For instance, A. Haar published as far back as a 1910 the complete orthonormal system of basis function with the local domain of definition, which are now named as Haar's wavelets. However one can note that probably first mention about wavelets has appeared in the literature on digital processing and analysing of geophysical signals (e.g. Goupillaud et al., 1982; Morlet et al., 1984). During the last years many scientists applied the wavelet transform for an analysis of meteorological time series. In particular, Astaf'eva (1996) concluded that the wavelet analysis of monthly mean values of the Southern Oscillation index reveals the self-similar structure of the data and the presence of a process resembling a cascade one on scales from a month to several decades (up to 70–80 years). Torrence and Webster (1999) analysed the system of the El Niño–Southern Oscillation and Indian monsoon. They showed that the wavelet power spectra and variance time series show interdecadal changes in 2–7 year variance, and indicate intervals of high variance (1875–1920 and 1960–1990) and an interval of low variance (1920–1960). Oh et al. (2003), by using wavelet decomposition based on non-decimated wavelet transform, detected the original periodicities, such as the Schwabe and Hale cycle of solar variability, in irradiance reconstructions. Also, they evaluated common temporal characteristics in both solar forcing and temperature series, focusing on the well known Gleissberg (around 85 years) and the sunspot cycle (around 11 years).

It is clear, although there are numerous investigations on the above mentioned methods, they can not embrace all meteorological applications. Therefore in current essay, using wavelet transform we attempt to explain the reasons of temporal fluctuations for eddy kinetic energy content ( $K_E$ ), which can be considered as one of many parameters responsible for the intensity of atmospheric eddy evolution. The  $K_E$  content is determined by the perturbations of wind components from zonal mean state and the budget equation of this energy can be considered to examine the evolution of eddy activity. Here, we use wavelet decomposition to identify

# Atmospheric Teleconnection Patterns And Eddy Kinetic

**Lauren Gardner**



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