Statistical Properties of Mid-latitude Atmospheric Variability

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Data and Methods

An ensemble of 6 model integrations for the period 1869-2002 are available from the C20C web site (http://www.hadc20c.org/). The integrations were made with the HadAM3 model with the full set of forcings including observed SSTs and sea-ice extents from the HadISST data set (Rayner et al., 2003) and all well-established climate forcings. Natural forcing simulations take into account sea-surface temperatures, volcanic aerosols, solar variability, orbital changes, while greenhouse gas changes, atmospheric ozone change, sulphate aerosols and land-surface changes are considered as anthropogenic forcings for anthropogenic simulations. Brief descriptions of the models and simulations can be found on the C20C web-page: (http://www.iges.org/c20c). The 103-yr record (1901–2002) of daily 500-hPa height geopotential fields has been used. The JJA season has been analyzed.

The blocking detection method is based on the Tibaldi and Molteni index (1990), which identifies amospheric blocking highs when easterlies are present in the region where storm-tracks and mean flow interact the most (Carillo et al., 2000). The index is based mainly on the midlatitude geopotential height meridional gradient computed at 500 hPa level, such that a given longitute is defined blocked at a specific time if the meridional gradient is positive (for details see Tibaldi and Molteni, 1990). Blocking diagnostic has been widely used both in forecast models (Anderson, 1993; Tibaldi et al., 1995; Ferranti et al., 1994; Jung, 2005) and in climate simulations (D'Andrea et

al., 1998; Doblas-Reyes et al, 2002; Matsueda et al., 2009; Vial and Osborn, 2011). Blocking diagnostic, together with spectral decomposition (Dell'Aquila et al., 2005) and probability density function representation of planetary-wave activity indicators (Hansen and Sutera, 1986; Corti et al., 1999; Ruti et al, 2006 among others), are a powerful analysis tool which can be easly applied to daily data of the 500 hPa geopotential height.

Results

Blocking frequency has first been analysed for all natural forcings and all focings simulations, and results are presented in Fig. 1. There are two main regions of blocking development: the Euro-Asian (0° - 60°E), which is bounded by a sharper topography, the Ural Mountains, and the Pacific (90°E to 90°W). The Pacific sector is characterized by two peaks at the entrance and exit of the Pacific jet. The higher frequency over the Euro-Asian sector respect to the Pacific one is probably related to the seasonal cycle of the high-frequency component of the atmospheric variability which shows a minimum in summer over the Pacific (Tyrlis and Hoskins, 2008).

There is clear indication of a significant increase in blocking frequency over the Euro-Asian sector for all forcings simulations. There is also no clear indication of a difference over the other regions.

FIGURES.

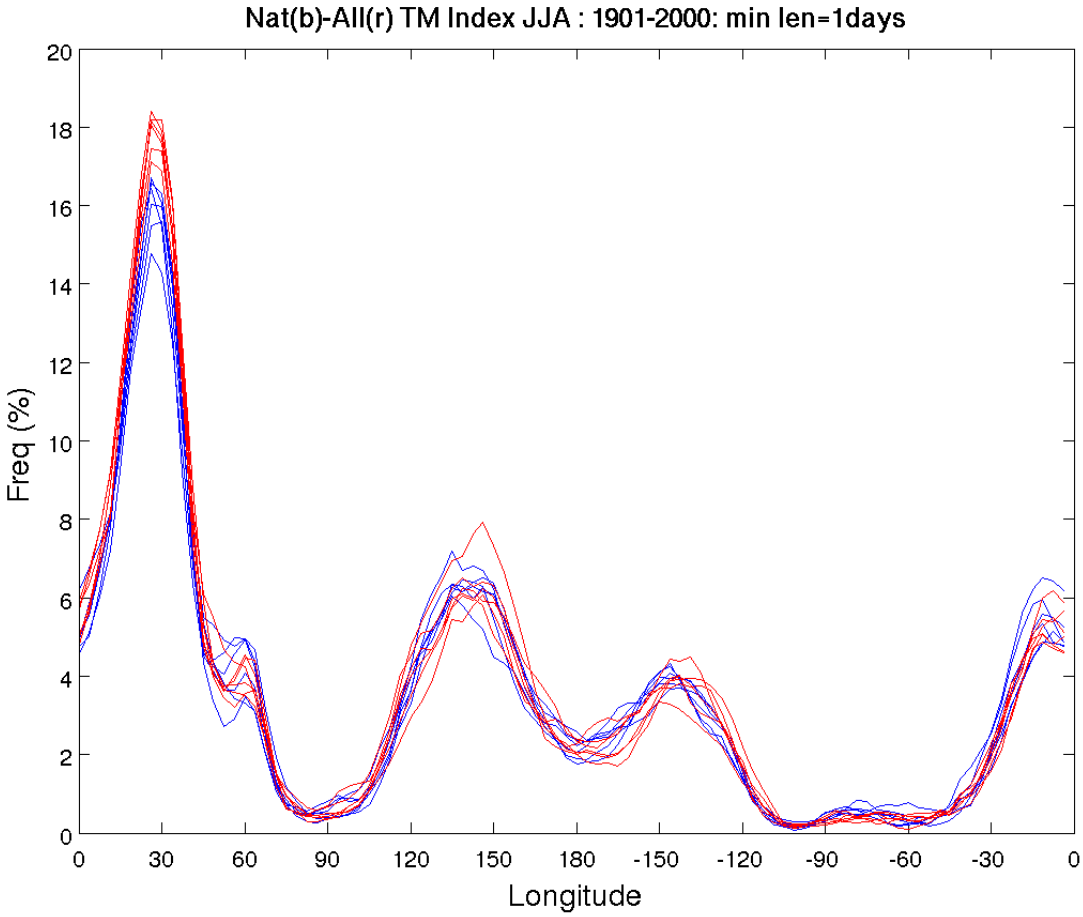

Figure 1. Frequency of all summer days that are part of large-scale blocking episodes as a function of longitude for the all natural forcings (blue curve) and all forcings (red curve). Results for all 6 members are shown .