Geophysical Research Abstracts, Vol. 9, 03756, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-03756

On the stability of large-scale atmospheric teleconnection patterns in reconstructions and ensemble GCM simulations of the last 500 yr

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Teleconnection patterns, like the North Atlantic Oscillation (NAO), are major players in atmospheric variability. Trends in these patterns contribute to warming trends in the Northern Hemisphere. Studies show that not only the low-frequency variability connected to teleconnections change with time, but also the centres of action shift. Thus, there is still a major need to understand the low-frequency variability and the stability of these teleconnections. A detailed analysis is undertaken for teleconnection patterns of the Northern Hemisphere in an ensemble of GCM simulations for the past 500 yr and a 1990 control simulation. Four transient simulations are performed with the Community Climate System Model (version 3.0, CCSM3), using time-varying greenhouse gas, solar, and volcanic forcing functions. A first focus is set to the Atlantic-European region, where the model results are compared with 500-yr proxy-based reconstructions. In these reconstructions, pronounced interdecadal variations appear to "lock" the atmospheric circulation in quasi-steady long-term patterns over multi-decadal periods, controlling at least part of the temperature and precipitation variability. Different circulation patterns are persistent over several decades for the period 1500 to 1990 AD. The 1990 control simulation exhibits some substantial differences, with unsteady teleconnections. Comparing the behaviour of teleconnection patterns in the 1990 control simulation with the quasi-steady (over several decades) teleconnections in the reconstructions suggest that the external forcing could play a major role in "locking" the atmospheric circulation. This hypothesis is the basis of the analysis of the transient ensemble simulations of the past 500 yr, where we investigate the influence of the different forcing functions on the teleconnections. Preliminary modelling results show that the quasi-steady (over several decades) teleconnections are found in the rather

small North-Atlantic European area, which is used in climate reconstructions. However, teleconnection patterns show an unsteady behaviour when increasing the area to hemispheric scale, suggesting that either the reconstruction area is too small, or the reconstruction method does not provide enough degrees of freedom to cover the variability of teleconnections correctly, or the simulations underestimate the connection between forcing and the stabilisation of teleconnections.