Geophysical Research Abstracts
Vol. 14, EGU2012-4725, 2012
EGU General Assembly 2012

Testing the robustness of proxy-based North Atlantic Oscillation reconstructions

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The reconstruction of past atmospheric circulation is crucial for the understanding of natural climate change and its driving factors. A recent reconstruction suggests that, during Medieval times, the European region was dominated by a persistent positive phase of the North Atlantic Oscillation (NAO), followed by a shift to a more oscillatory behavior. We test this hypothesis and the concept underlying the reconstruction in a pseudo-proxy approach using instrumental records, reanalysis data sets and millennial simulations with four different climate models. While a shift from a more positive to a more negative phase of the NAO seems to be likely, the amplitude and persistence of the reconstructed positive phase cannot be reproduced by models. The analysis further reveals that proxy locations that were used in the reconstruction are not always sufficient to describe the NAO. This is reflected in a failure of the reconstruction to verify against instrumental records of the NAO in the 19th century. It is shown that, by adding complementary proxies, the robustness of a NAO reconstruction can be improved to the degree that it would withstand the tests presented here.