

Interactive comment on “Climate and carbon-cycle variability over the last millennium” by J. H. Jungclaus et al.

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General comments: For the first time the Hamburg MPI for Meteorology Earth system model (ESM) ECHAM5 is used to study the role of external climate forcing and internal climate variability by also including a fully interactive carbon-cycle. The study was performed for the last 1200 years. By using state-of-the-art data for the different forcings the authors were able to successfully simulate the Northern Hemisphere temperature as it was reconstructed based on different proxy time series. Similar to other authors they demonstrate that groups of volcanic events in combination with solar irradiance minima (e.g. Wolf, Spörer, Maunder, Dalton) are substantial for the formation of multidecadal-scale Little Ice Age cold relapses. The authors discuss some aspects of the MWP-LIA transition but do not touch the question of changing circulation modes

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or regimes. In more detail they discuss the role of the carbon cycle and point to the problem that the simulated multi-centennial CO₂ concentrations are smaller than in the observed records.

The MS gives an important new insight into the climate dynamics of the last millennium. I therefore recommend to accept it after minor revisions.

Specific comments: Page 1012, line 1: The expression Medieval Warm Period MWP is widely used. Because of the large heterogeneity of the spatiotemporal structure several authors prefer to use the expression Medieval Climate Anomaly MCA (e.g. Mann et al. 2009, *Science*, 326, 1256-1260).

Page 1014 and 1015, solar and volcanic forcing: My impression is that the uncertainties related to the reconstruction of both forcings are still huge because we do neither have good reconstruction data nor do we satisfactorily understand the specific dynamics. A joint effort is needed to get to better reconstructions of solar and volcanic forcing.

Page 1018, line 17: I looked through about 50 significant time series around the globe. Their warmest peaks occur at a different time. This fact was already demonstrated by Bradley et al. (*Science* 302/2003, 404 – 405).

Page 1019, line 2-4: I am convinced both aspects are important: a) the superposition of a group of volcanic events with solar activity minima; b) internal variability. I am not convinced that only one mode (e.g. NAO) was responsible for the MCA-NAO transition. It was likely a combination of different processes, e.g. represented by the complex interaction between NAO and ENSO.

Typographic errors:

Page 1024, line 12: Intersomparison

Page 1040, legend Fig. 5: Also

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