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Ensemble simulations of the Last Millennium using an Earth System Model including an interactive carbon cycle

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The climate evolution from 800 AD to present is simulated using a comprehensive Earth System Model consisting of the atmosphere model ECHAM5 and the ocean model MPIOM. Modules for land surface and ocean biogeochemistry allow for the interactive simulation of the carbon cycle. New reconstructions of the external forcing components (solar irradiance, volcanic eruptions, and land-cover changes) are applied. In addition to a long, unforced control integration an ensemble of five full-forcing experiments has been analyzed to assess the role of the respective external forcings in comparison with internal variability of the climate system. The simulations show a range of climate variability consistent with reconstructions. The model simulates a relatively warm period in the 12th century and a cold early 19th century followed by a pronounced global warming due to anthropogenic CO2 emissions. The cooling in the earlier stage of the Little Ice Age is less pronounced than reconstructions suggest, most likely to a relatively moderate solar forcing.
Particular emphasize is given to the variability in the carbon cycle and it's response to variation of the external forcing.