Last Millennium Climate Reanalysis Project

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Abstract

Paleoclimate proxy data provide a critical reference history for Earth's climate. Analysis of such data has evolved from time series analysis to statistical reconstructions calibrated against the instrumental record. Although such data provide the only direct measure of climate history, interpretation is challenged by, among other factors, measurement and timescale noise, and a lack of complete physical constraints. Climate models provide a complementary perspective on Earth's climate history through simulations that attempt to replicate the information obtained from proxy data. Although such simulations contain the physical constraints from fluid dynamics, interpretation of such simulations is challenged by, among other things, model bias and a lack of constraints from the known proxy record. Over the past decade, the fusion of proxy data and climate simulations has progressed to the point where it is now possible to use data assimilation approaches similar to those used for reanalysis of observations during the instrumental record. Such approaches provide not only a reconstruction of the global mean surface temperature, but the spatial distribution and uncertainty in the temperature field, and potentially many others fields as well. Here we propose to use a data assimilation approach to extend the reanalysis time period to the last 1000 years. The product, the Last Millennium Climate Reanalysis, will revolutionize our ability to diagnose low-frequency climate variability and the statistics of extreme events. Moreover, such a dataset will provide "hindcast" information against which to measure the skill of models used in decadal climate predictions, which are critically important for evaluating projections of near-term climate change. Gridded reconstructions of multiple climate variables (temperature, pressure, precipitation), constrained by paleoclimate observations and consistent with the dynamical and thermodynamic constraints offered by general circulation models, will be a game-changer for climate science, extending the instrumental record by a factor of five to ten, yielding insight on trends and on changes in extremes across mean-state changes (e.g. between the "Medieval Warm Period" and "Little Ice Age" and the present). As part of the reconstruction effort, the team will involve the paleoclimate community through an advisory panel and annual workshops on topics related to the reanalysis effort. Relevant to the climate observation and modeling competition, the proposed reanalysis is a synthesis effort that aligns specialized paleoclimate data with the agency climate portfolio developed by the Climate Program Office in support of NOAA and U.S. Climate and Global change goals.