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Developing the Surface Input Reanalysis for Climate Applications (SIRCA) 1850-2011

Abstract

Climate change studies are increasingly focused on moving beyond understanding and predicting global scale changes to regional scale changes, especially changes in the statistics of severe weather and droughts. Assessing the evidence for such variations over the last 150 years, and evaluating the quality of models making predictions for the next hundred, requires a sub-daily (as opposed to monthly or longer-term average) tropospheric circulation dataset. The only large-scale dataset available for the early 20th century consists of error-ridden hand-drawn analyses of the mean sea level pressure field over the Northern Hemisphere. Modern data assimilation systems have the potential to improve upon these maps, but prior to 1948, few digitized upper-air sounding observations are available for such a "reanalysis." National and international plans to study climate change specifically require global gridded reanalysis datasets to achieve their goals. Under the 20th Century Reanalysis Project, we have demonstrated that the quantity of newly recovered surface pressure observations is sufficient to generate useful reanalyses of the entire tropospheric circulation back to 1871. We have found that using an Ensemble Kalman Filter that blends an ensemble of 6-hour numerical weather prediction model forecasts with the available surface observations, one can produce high-quality reanalyses of even the upper troposphere using only surface pressure observations. For the end of the 19th century, the accuracy of such upper-air circulation fields for the Northern Hemisphere in winter would be comparable to that of modern two to three day weather forecasts. Under SIRCA, we are using the Ensemble Filter, as developed at the University of Colorado and NOAA's Earth System Research Laboratory, and surface pressure observations gathered in international collaboration with the Atmospheric Circulation Reconstructions over the Earth initiative to produce the first-ever reanalysis dataset for the period 1850-2011. This will more than double the record of 6-hourly tropospheric gridded global fields from 60 years to 162, spanning a period for which no gridded upper-air analyses are currently available. These tropospheric circulation fields will also be the first to have objective uncertainty estimates for every analyzed variable. In addition to validating and improving climate models, our dataset will be used to study climatic variations that could not previously be addressed observationally, such as the 1877 El Nino and Indian famine, the 1930's U.S. Dust Bowl and the 1920's to 1940's Arctic warming. The dataset will also be used to reduce current uncertainties in several societally critical aspects of climate change such as trends in the frequencies of hurricanes and severe winter storms.