Geophysical Research Abstracts
Vol. 21, EGU2019-14548, 2019
EGU General Assembly 2019

Study on proxy data assimilation aimed at climate reconstruction for the last millennium

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Climate reconstruction enables us to analyze long-term climate change. Understanding climate change is the key to improving climate prediction. In this study, we confirmed that annual variation of surface air temperature for the past millennium can be reconstructed by data assimilation using oxygen isotopic data of ice cores, corals, and tree-ring cellulose, based on the previous study (Okazaki and Yoshimura, 2017). This is an offline data assimilation approach. We used two isotope-incorporated AGCMs (IsoMIROC and IsoGSM) and associated proxy system models for corals, ice cores, and tree-ring celluloses to make prior fields, i.e., monthly averaged global distributions of δ18O of proxies, surface air temperature, precipitation, etc., for 130 years. Then we applied the offline data assimilation method to constrain the atmospheric fields by the observed isotopic data over the world. In total, we used 129 isotopic proxy data during 850 to 2000. Note that these inputted observation data are only from isotopic proxies that can be obtained for the long-time ago and modern observation data such as SST are not used. In this experiment, we tested if the surface air temperature and precipitation fields are constrained to be more consistent to the observed isotopic values. To validate the result in this study, spatial distribution of reconstructed surface air temperature is compared with that of Japanese 55-year Reanalysis from 1971 to 2000. We found that El Nino-like positive temperature anomalies in the tropical pacific were nicely reproduced. Some of the coral proxies in the Pacific played an important role to constrain the past climate through this data assimilation approach.