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Merging tree ring chronologies and climate system model simulated temperature by optimal interpolation algorithm in North America

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A new dataset of annual mean surface temperature has been constructed over North America in recent 500 years by performing optimal interpolation (OI) algorithm. Totally, 149 series totally were screened out including 69 tree ring width (MXD) and 80 tree ring width (TRW) chronologies are screened from International Tree Ring Data Bank (ITRDB). The simulated annual mean surface temperature derives from the past1000 experiment results of Community Climate System Model version 4 (CCSM4). Different from existing research that applying data assimilation approach to (General Circulation Models) GCMs simulation, the errors of both the climate model simulation and tree ring reconstruction were considered, with a view to combining the two parts in an optimal way. Variance matching (VM) was employed to calibrate tree ring chronologies on CRUTEM4v, and corresponding errors were estimated through leave-one-out process. Background error covariance matrix was estimated from samples of simulation results in a running 30-year window in a statistical way. Actually, the background error covariance matrix was calculated locally within the scanning range (2000km in this research). Thus, the merging process continued with a time-varying local gain matrix. The merging method (MM) was tested by two kinds of experiments, and the results indicated standard deviation of errors can be reduced by about 0.3 degree centigrade lower than tree ring reconstructions and 0.5 degree centigrade lower than model simulation. During the recent Obvious decadal variability can be identified in MM results including the evident cooling (0.10 degree per decade) in 1940-60s, wherein the model simulation exhibit a weak increasing trend (0.05 degree per decade) instead. MM results revealed a compromised spatial pattern of the linear trend of surface temperature during a typical period (1601-1800 AD) in Little Ice Age, which basically accorded with the phase transitions of the Pacific decadal oscillation (PDO) and Atlantic multi-decadal oscillation (AMO). Through the empirical orthogonal functions and power spectrum analysis, it was demonstrated that, compared with the pure simulations of CCSM4, MM made significant improvement of decadal variability for the gridded temperature in North America by merging the temperature-sensitive tree ring records.