EGU23-9977, updated on 14 Aug 2023
https://doi.org/10.5194/egusphere-egu23-9977
EGU General Assembly 2023

A NASA GISTEMP Observational Uncertainty Ensemble: Regional and Monthly Uncertainty

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The historical global temperature record is an essential data product for quantifying the variability and change of the Earth system. In recent years, better characterization of observational uncertainty in global and hemispheric trends has become available, but the methodologies are not necessarily applicable to analyses at smaller regional areas, or monthly means, where station sparsity and other systematic issues contribute to greater uncertainty.

This work details a gridded uncertainty ensemble of historical temperature anomalies from the Goddard Institute for Space Studies (GISS) Surface Temperature product (GISTEMP) product. This ensemble characterizes the complex spatial and temporal correlation structure of uncertainty in gridded historical temperature, enabling proper uncertainty propagation for climate and social science at regional and monthly scales. This work details the methodology for generating the uncertainty ensemble, key statistics of the uncertainty evolution over space and time, and provides best practices for using the uncertainty ensemble in future studies. Summary statistics from the uncertainty ensemble are in good agreement with production GISTEMP.

Two applications of the uncertainty ensemble are also presented. First, the warmest year on record is shown to most likely be 2016 with a 53.2% chance and 2020 as the second most likely with a 44.4% chance. Second, it is shown that the arctic is warming 2.5 - 5 times faster than the globe, significantly faster than the regularly quoted twice as fast.