【Grant-in-Aid for Scientific Research (S)】

Generation of Millennium Atmospheric Reanalysis Product

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Project Information	Project Number : 22H04938 Project Period (FY) : 2022-2026 Keywords : old weather, isotope proxies, data assimilation, climate impact on social changes, humanities and sciences

Purpose and Background of the Research

● Outline of the Research

Using the data assimilation methods developed by the applicants to date to constrain climate models with alternative climate information and archival weather records, we will create the world's first large-scale data set that reconstructs the climate and weather over the past 1,000 years. After fully examining the data set from geophysical and historical perspectives, we will answer the question, "How have climate and weather changes affected or not affected human society over the past 1,000 years of history?" We will then quantitatively analyze the causal relationship between history and climate by examining the complex factors that lead to social changes from a climate trigger and the extent and continuity of these changes.

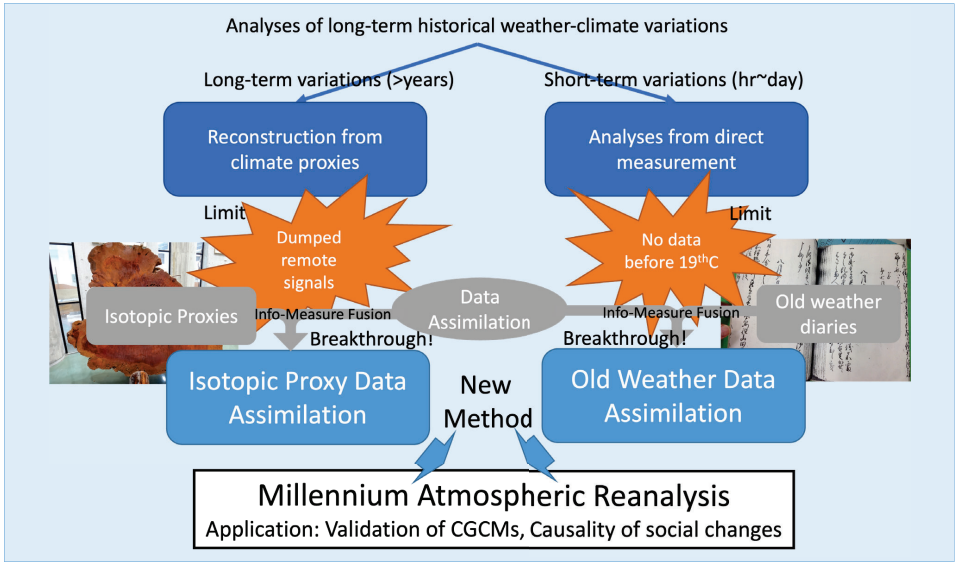

Figure 1. : Schematic of the two main methods for this project

● Academic Question

It is extremely important to "scientifically" unravel how humans have overcome or failed to overcome crises in the past. The two technologies that make it possible to estimate detailed spatiotemporal distributions of past climate and weather conditions for which there is no direct observational information have been developed through the Principal Investigator's Kiban A (FY 2018-2020). In this Kiban S, the techniques will be used to generate a dataset of global climate and weather over a period of 1,000 years to answer the question, "How have climate and weather variations affected or not affected human society over the past 1,000 years of history?"

● Academic Originality and Creativity

The relationship between climate, environment, and society, a long-standing "question" of humankind that has sometimes been criticized as "environmental determinism," is expected to be elucidated by bringing together the most advanced methodologies of both natural scientists and historians.

The fact that the geophysical model is driven by information based on the historical record of weather in the distant past as a constraint is unique in that it already satisfies the collaboration between the humanities and sciences. In addition, the elucidation of long-term pre-modern climate change and its detailed mechanisms is expected to make direct contributions to hydrology, climatology, meteorology, oceanography, and isotope geochemistry. Furthermore, the ability to more objectively and quantitatively examine the mechanisms of historical events, such as famines and conflicts, through a more in-depth study of the relationship between weather, climate, and hydrological events will be of great significance in predicting the future of the global environment.

Expected Research Achievements

● Generation of Millennium Atmospheric Reanalysis Product

Atmospheric reanalysis data are the best estimates of the 4-dimensional (3D + time) distribution of physical quantities on the Earth's surface, such as temperature, wind speed, rainfall, etc., at high frequency (typically every 6 hours) over long periods of time (typically several decades). This research will produce a product that significantly exceeds the longest existing atmospheric reanalysis product (approximately 180 years), the 20th Century Reanalysis 3rd Edition (see Figures 1 and 2).

● Visualization of the spatial distribution of climatic, meteorological, and hydrological risks and the distribution of social changes across the globe

Visualization of the estimated changes in climatic, meteorological, and hydrological conditions and social changes in various regions on a spherical display and WebGIS will increase the efficiency of collaboration between earth scientists and historians to analyze their causal relationships. In addition, we will extract multiple direct and indirect factors and attempt to express them in a mathematical model. By achieving these objectives, we will be able to go beyond the one-dimensional, case-by-case analysis of correlations that have been used in previous climate-history research. The project will enable quantitative analysis of the causal relationship between history and climate by taking into account the complex factors between climate and social events and their spatiotemporal effects.

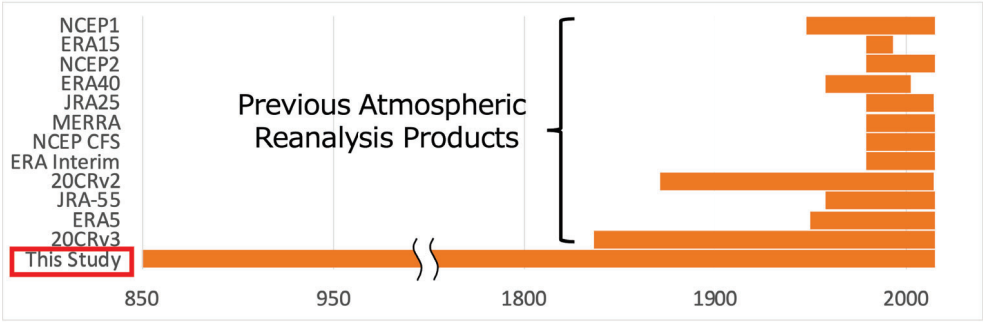

Figure 2. Comparison of the temporal range of previous atmospheric reanalysis products and this study

Homepage Address, etc.	https://isotope.iis.u-tokyo.ac.jp/ (Yoshimura lab's HP)