

CS486C – Senior Capstone Design in Computer Science

Project Description

Project Title: Interactive web visualization of past climates	
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Project Overview:

Climate change is a defining challenge of the 21st century, and climate has always been fundamentally tied to societies and environments. To forecast and prepare for climate change in our future, it is fundamental that we understand how and why climate has changed in the past. The study of past climates, or paleoclimatology, deals with these questions, and scientists travel the world to understand how and why climate has changed in both the recent and distant past. Clues about past climate can be discovered in a wide variety of ways; just a few examples include study of tree rings in the Southwest, ice cores in Greenland, corals in Bermuda, and lake mud in the Arctic. Each of these studies provide small snapshots into what climate looked like in these places hundreds or thousands of years ago.

Over the past 30 years or so, paleoclimatologists have now developed thousands of these paleoclimate datasets from around the world, and major international efforts now focus on integrating all of these separate datasets into unified “climate reconstructions”, which

are effectively dynamic maps that show how temperature or precipitation across specific regions have varied across time throughout Earth’s history. Traditionally, these efforts only happen sporadically, and become quickly outdated as new data are added that help refine the overall record. To address this, the Paleoclimate Dynamics Laboratory at NAU, along with collaborators at the University of Southern California, are launching a new project called PReSto (Paleoclimate Reconstruction Storehouse), that will streamline this process, and keep climate reconstructions up to date with the latest datasets and most state-of-the-art methods.

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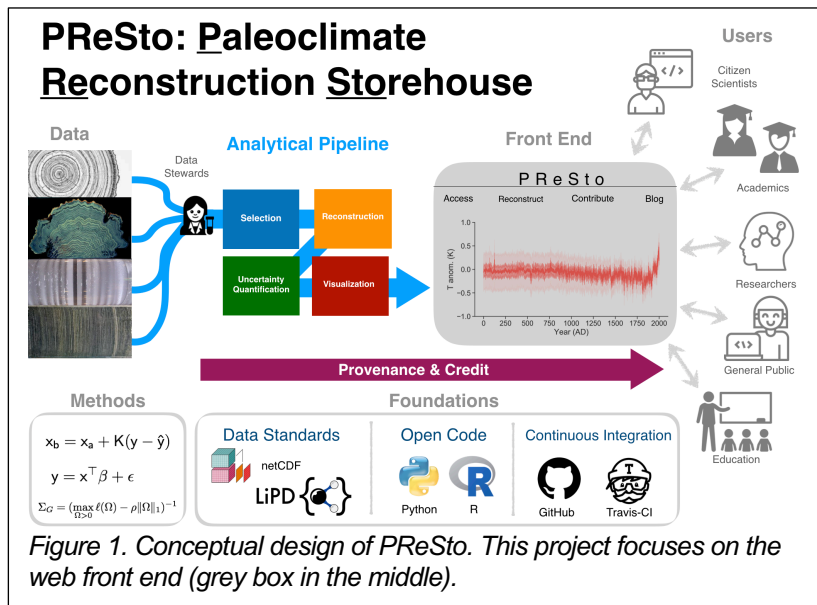


Figure 1. Conceptual design of PReSto. This project focuses on the web front end (grey box in the middle).

One problem that has always plagued climate reconstructions is a lack of easy access to the results. We have made tremendous progress on the back end algorithms and computational processes, but ultimately these packages require substantial technical/programming expertise to config and apply them to actual data; and the results tend to be large numeric datasets that must then be retrieved and visualized by the scientist in order to draw conclusions. This makes the results of our efforts largely inaccessible, even to many paleoclimatologists and related scientists; beyond paleoclimatologists, there one can also envision a broad range of students, policy makers, and members of the general public who might be interested in what past climate looked like. Was the December of

1776, when George Washington crossed the Delaware, particularly cold? Did the Mayan civilization fall because of drought? Why are there Hippopotamus fossils in the Sahara? Historians, archeologists and ecologists, and many others are interested in past climate, but the results of climate reconstructions have always been difficult to navigate without specialized software and technical skills.

Our vision to address this shortcoming is a modern web application that regularly ingest new reconstructions being produced by PReSto, and presents them effectively and elegantly to a wide range of informed end-users in the form of visualize interactive maps and graphs that allow users to navigate through past climate in space and time. Some key features will include:

- Automated ingestion and processing of standardized NetCDF files that contain the reconstruction data
- Interactive maps that show temperature or precipitation changes as color-gridded overlays
- Allowing users to drag and select regions of interest, and calculating and visualizing averaged changes through time.
- Intuitive and creative visualizations of uncertainty
- Flexible data export
- Dynamic animations of climate changes through space and time

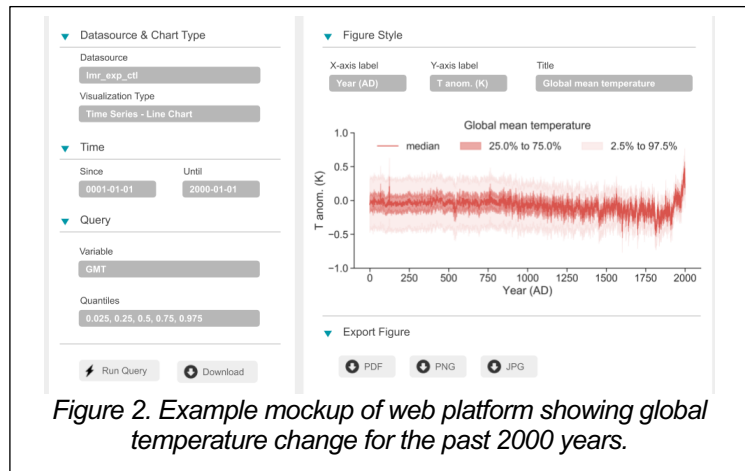


Figure 2. Example mockup of web platform showing global temperature change for the past 2000 years.

If successful, it's difficult to overstate the impact of this platform on both science and public education. Climates of the past are of large public interest, and thousands of scientists, educators and interested citizens want to be able to easily access and navigate a state-of-the-art dataset of past climates. Such a web platform does not yet exist, and the time is right for that to change.

Knowledge, skills, and expertise required for this project:

- Knowledge of modern Web2.0 programming techniques, frameworks, and languages required to develop the web app
- Knowledge of back-end server and database technologies, in order to integrate with the existing Presto backend infrastructure.
- Knowledge of big data management/access
- Knowledge of interactive data visualization: techniques, tools, Javascript packages

Equipment Requirements:

- There should be no equipment or software required other than a development platform and software/tools freely available online.
- Development/deployment webserver will be provided, i.e., arranged through NAU ITS.

Software and other Deliverables:

- A working web application, as outlined above, available at paleopresto.org (we've reserved this url) and hosted on NAU's webserver.
- A strong as-built report detailing the design and implementation of the product in a complete, clear and professional manner. This document should provide a strong basis for future development of the product.
- Complete professionally-documented codebase, delivered both as a repository in GitHub, and as a physical archive on a USB drive.