

# DAPS - Paleoclimate Reanalyses, Data Assimilation and Proxy System modeling

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The analysis of observations and numerical simulations are two key pillars of many scientific disciplines. Traditionally, a study is initially focused on one of these two aspects and the other one appears in a second stage, to test a hypothesis or validate a conclusion (Fig. 1). Data assimilation uses observations and simulations to produce estimates based on both sources of information, given uncertainties in each. If key assumptions within the approach are met, this approach allows estimation for regions and times which lack observations, leads to mechanistic analyses and re-evaluation of uncertainty estimates, and provides the rationale for new observational and modeling experiments.

Perhaps, particularly in paleoscience, combining the information deduced from simulations with that from observations may not be straightforward and a wide range of issues must be addressed before that is possible. For instance, the variable measured in environmental archives collected in the field (such as tree-ring width or pollen assemblage) may not be directly simulated by the model, it may map as a response to more than one environmental variation, and there is chronological uncertainty. Model results and observations thus have to be processed and interpreted appropriately before a quantitative evaluation of the agreements and inconsistencies between the two may be made. The spatial scales represented by the records and model results are generally also different and difficult to determine accurately. Additionally, both observational error and model biases need to be quantified to make a meaningful comparison, and new approaches to validation of the results and interpretations must be developed.

The goal of the new PAGES working group on Paleoclimate Reanalyses, Data Assimilation and Proxy System modeling (DAPS; <http://pastglobalchanges.org/ini/wg/daps/intro>) is to

address these challenges. Specifically, DAPS is designed to stimulate the development of methods for the joint and quantitative use of observations and models in paleoscience, by promoting integrative research and mechanistic understanding of process and history by combining, as objectively as possible, all available sources of paleoenvironmental information.

Reanalyses are probably the most complete illustration of the approach. Using data assimilation techniques, they combine observations with a description of the dynamics of a system, as represented in a model, to reconstruct the state of this system, explicitly taking into account all the uncertainties in each. Observations and model are thus merged from the beginning of the process (Fig. 1). The quality of the product is linked to the quality of both sources of information but, even more crucially, their integration. This implies a deep understanding of not only data assimilation techniques and dynamics, but also the characteristics of the paleoclimate records and their uncertainties. This requires strong interaction between the different communities involved.

A critical step in the reanalysis is an objective model-data comparison. This implies the development and inclusion of "proxy system" models (e.g. Evans et al. 2013) for the paleoclimatic observations, so the measured variable can be directly assimilated into numerical simulations. Ideally, those proxy system models are based on a mechanistic understanding of the way the recorded signal arises from the external environmental conditions as simulated by the numerical model, then imprinted into an archive, and observed. Proxy system models may also be applied in standard simulations when model outputs are compared to observations.

Successful applications of proxy system models and data assimilation have been previously

demonstrated (e.g. Dee et al. 2016). DAPS will review these and identify areas in which improvements can be achieved through synergies and coordination. Another important goal is to establish a code repository facilitating joint activities, and to encourage new users to develop applications and collaborations, particularly between groups that have traditionally not yet extensively interacted. The plan is to further these goals through workshops and training activities organized via DAPS, targeting both early-career and experienced scientists and those who may not be familiar with data assimilation techniques.

Join this initiative! Subscribe to the DAPS mailing list (<http://listserv.unibe.ch/mailman/listinfo/daps.pages>) to be informed about plans for workshops and training activities. Do not hesitate to contact the members of the steering committee with questions and suggestions.

## AFFILIATIONS

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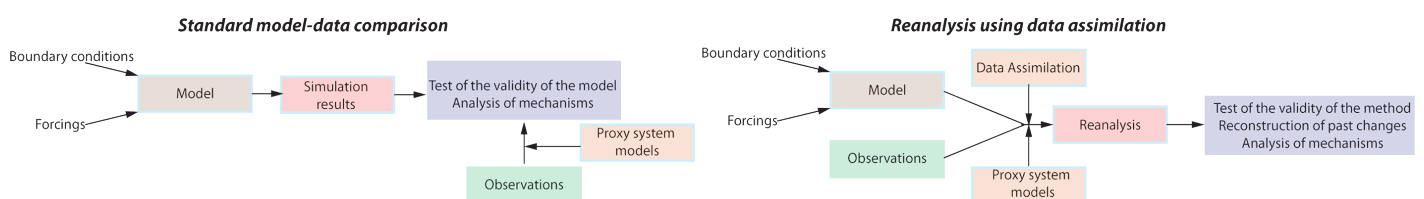
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## REFERENCES

Dee et al. (2016) *J Adv Model Earth Sy* 8: 1164-1179

Evans MN et al. (2013) *Quat Sci Rev* 76: 16-28



**Figure 1:** Schematic representation of a classical model-data comparison and of a reanalysis, illustrating in particular the role of proxy system models.