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Quantifying continental-scale river run-off in the past: a tool for validating climate models

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Models that are used to predict future climate behaviour require rigorous testing to reduce the uncertainties associated with their predictions. This validation process is typically carried out by running climate model simulations for the present day where they can be compared with instrumental records of climate and periods in the past where there is sufficient climate proxy information to permit robust model-data comparison. Proxies that record climatic information over the continents are mainly vegetation based. To be an effective test of model output which consists of average values for each model grid square tens of kilometres in across, large plant datasets are required. This, and the need to calibrate climate characteristics of fossil plant material through the habitats of modern plants, restricts useful datasets to the Quaternary. Since Quaternary climatic conditions are relatively cold, proxy datasets from this period are a rather poor test that climate models accurately replicate warmer environments. Scenarios like these lie deeper in the past (e.g. Miocene, Eocene and Cretaceous).

An alternative approach to validating the behaviour of climate models over the continents is to use a proxy from which river run-off can be quantified. Direct analysis of fluvial sediments is problematic because of the non-depositional nature of much of the system. Equally, once river water reaches the open ocean, many of its geochemical characteristics become undetectable because they are mixed and overprinted by the voluminous ocean water signal. Analysing for the chemical characteristics of river water that are preserved in fossils and sediments and deposited in marginal marine settings is however a viable alternative. These systems which include large estuaries and semi-enclosed seas like the Mediterranean and Baltic, capture, average and temporally store run-off from substantial river catchments that extend across large continental areas.

There are several techniques that can be used for quantifying the fresh-water inflow to marginal marine systems. These include faunal assemblages, δ18O, deuterium concentrations of biomarkers and Sr isotope ratios. Some of these methods quantify run-off indirectly through salinity of the water and make the assumption that salinity is the product of simple mixing between ocean and fresh water.. In other areas, this assumption is invalid because evaporation is the dominant control on salinity. This presentation examines the pros and cons of available techniques for quantifying river run-off on a continental scale in the past and its potential for validating climate models.