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Plio-QUMP (Quantifying Uncertainty in Model Predictions for the Pliocene)

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The mid-Pliocene is an interval of Earth history when temperatures were sustained at 2 to 3°C above pre-industrial values, caused at least in part by higher levels of CO2 in the atmosphere (∼380 to 425 ppmv). With a palaeo-geography almost identical to today, this interval provides an opportunity to examine the potential long-term effects of global warming through the use of modelling studies and data comparison. However, the uncertainty in model predictions of mid-Pliocene climate has not been fully explored.

The aim of Plio-QUMP (Quantifying Uncertainty in Model Predictions for the Pliocene) is to produce uncertainty estimates for model predictions through two stages. The first stage will create a series of ensembles based on Perturbed Physics in a climate model (UK Met Office Climate Model). The second stage of the project will explore the uncertainty in geological boundary conditions (e.g. initial trace gas concentrations, sea-surface temperatures, vegetation cover, orography, run-off, soils) some of which have been provided by the USGS Pliocene Research Interpretations and Synoptic Mapping (PRISM) Group.

Here we show initial results from a limited perturbed physics ensemble using the Hadley Centre Coupled Climate Model Version 3 (HadCM3) in which the sensitivity of the model-predicted climate to the alteration of a selection of atmospheric components with an interactive sulphur cycle is examined. The altered components are a series of parameters that exist in the model to enable complex flows and processes which can not be resolved on the grid scale to be effectively modelled; however these parameterisations have a range of possible values. By looking at the effects of changing parameters within an accepted range we can produce a climate sensitivity range for the HadCM3 model compared to the single value presently used. This Climate Sensitivity range has been shown previously to have a dramatic effect on the predictions of HadCM3. The initial parameterisations to be used are a development from work in Collins et al., 2006 & 2009 (in press). This new envelope of simulations is then compared to mid-Pliocene marine and terrestrial proxy data to examine the effect of the listed physics changes on the performance of the model compared to geological data.

In previous work, the parameterisations used have compared favourably to present day simulations using probabilistic prediction. This is achieved through the application of Bayes Theorem, which makes it possible to infer that a parameterisation set that performed well in a present day model run can be applied to either future climate change predictions or palaeo-climate modelling.