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Late Miocene model-data comparisons and challenges

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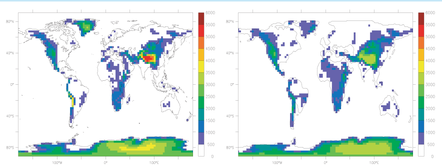
(1) INTRODUCTION

The Late Miocene climate (5.3 Ma to 12 Ma) is a potential analogue for future climate change, as it is believed to have been considerably warmer than the modern, especially at high latitudes. However, it currently has limited use as a test-bed of climate models as there is only a limited amount of reliable climate data with which to test model predictions. **This work provides a guide of where paleo proxy data acquisition could be most effectively targeted in the future, to best evaluate climate model simulations.**

We carry out a suite of Late Miocene atmosphere-only GCM simulations. We initially evaluate these simulations relative to the limited data of continental temperature and precipitation which is available. We locate those regions which exhibit the largest change in temperature and/or precipitation relative to modern, as these will have the largest signal-to-noise ratio for evaluating climate models. We then locate those regions which display the largest sensitivity to the prescribed SST distribution, as it is these regions which are most likely to vary between different climate model simulations, and therefore provide a strict test of the reliability of the models. **Future work should aim to collect data in these regions and to carry out fully-coupled simulations of the Late Miocene.**

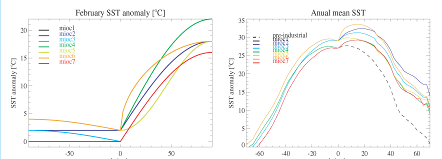
(2) BOUNDARY CONDITIONS

For the model simulations, we use the Late Miocene paleogeographical reconstruction of Markwick: (Gladstone et al, PPP, in press), shown below.



Paleogeographies used in the GCM simulations, for the modern (left) and Late Miocene (right).

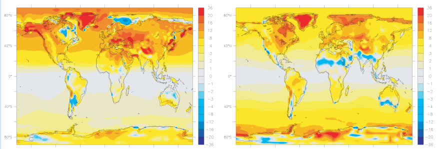
The simulations we carry out are atmosphere-only GCM simulations. Therefore we need to prescribe the Sea Surface Temperatures (SSTs). Because of the uncertainty associated with this, we carry out a suite of 7 simulations with different prescribed SST distributions. All SST distributions are assumed to be generally warmer than pre-industrial, and with a reduced equator-to-pole temperature gradient.



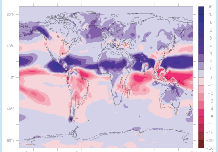
Prescribed SSTs in the Late Miocene GCM simulations. Anomalies relative to pre-industrial(left), and absolute (right)

(3) GCM RESULTS

Here we concentrate on one of the seven Late Miocene simulations: mioc4. Shown below are the modelled changes in temperature and precipitation relative to a pre-industrial simulation.



Surface air temperature change, Late Miocene minus pre-industrial. DJF (left), JJA (right)

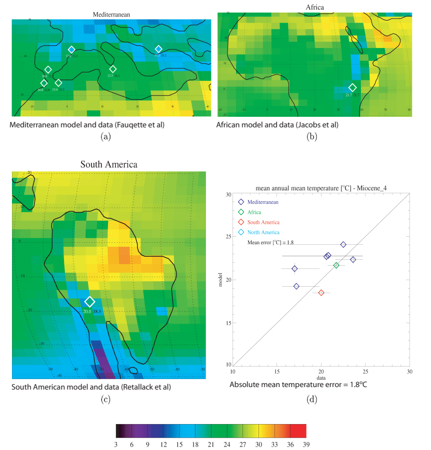


Annual mean precip change, Late Miocene minus pre-industrial

The prescibed SST change is in general amplified over land. In JJA, there is an intensification of the African and Asian monsoons, leading to a decrease in temperature. There is a northwards shift of the ITCZ, leading to a large increase in precipitation in North Africa.

(4) COMPARISON WITH EXISTING DATA

Here we compare the modelled land temperature changes with some existing observations, the majority of which are concentrated around the Mediterranean.



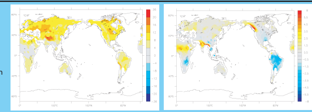
Mediterranean model and data (Fauqette et al) (a)
African model and data (Jacobs et al) (b)
South American model and data (Retallack et al) (c)
Absolute mean temperature error = 1.8°C (d)

The model-data comparison is reasonable, indiating that our prescribed SSTs are not completely wrong. This is also supported by a comparison with precipitation data (not shown).

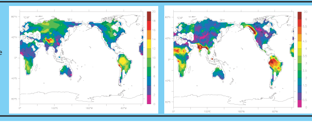
(5) GUIDE FOR PALEODATA ACQUISITION

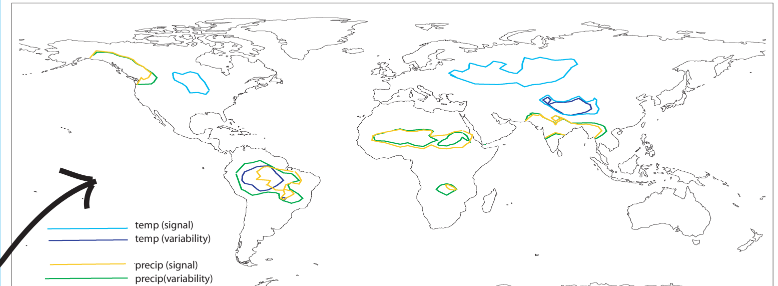
Here we assume that data from two particular types of regions will be useful for model-data comparison. Firstly, regions where there is a large change in climate compared to the modern. Secondly, regions where there is disagreement between different model simulations (i.e. regions where the model is most sensitive). We diagnose both of these types of regions from our ensemble of seven Late Miocene simulations (see right).

Change in climate compared to pre-industrial, mean of the seven Late Miocene simulations. Temperature (left), and precipitation (right). For temperature, the zonal mean has been removed to account for errors in our prescribed SSTs.



The range of simulated climate change from the seven Late Miocene simulations. Temperature (left), and precipitation (right).





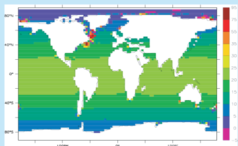
Regions where new paleodata proxies could be targetted, in order to best evaluate model simulations of the Late Miocene. Regions in light blue (orange) show a large temperature (precipitation) change. Regions in dark blue (green) show a large model spread in temperature (precipitation)

(5) CONCLUSIONS AND FUTURE WORK

In this poster we have described seven atmosphere-only Late Miocene GCM simulations. We have characterised their main differences to the pre-industrial climate. We have made a comparison of the modelled continental temperature and precipitation to paleo proxy data. We find that the model simulations in general agree well with the paleodata.

We have used the results to make some inferences about the most useful places to collect new paleo proxy data for the Late Miocene. These regions correspond to places where the change in temperature or precipitation relative to the modern is largest (so that there is a large signal-to-noise ratio), or where the model exhibits a high degree of variability across different SST distributions (a large spread of model results means that the most reliable simulations can more easily be ascertained).

Future work should aim to obtain paleo proxy data in these regions. Work should also be done to obtain more reliable and widespread SST estimates which are not affected by diagenesis or other problems. Additionally, a global bathymetric dataset should be derived to enable fully coupled GCM simulations to be carried out. Ideally, these fully-coupled simulations should include a specific representation of Oxygen isotope fractionation, to enable a direct comparison to be made with proxy estimates of SSTs and deep-ocean temperatures. The figure on teh right shows our latest attempt at a fully coupled simulation of teh Late Miocene.....



Our latest effort at a fully-coupled Late Miocene simulation....check out the North Atlantic!