"DeepMIP"

Deep-time Model Intercomparison Project

14th-15th January 2015, Boulder, Colorado, USA

This document summarises the main decisions and discussions regarding the model experimental design and development of a proxy synthesis, as discussed on Day 2 of the DeepMIP meeting. It also includes a list of immediate tasks for the various working groups.

General

We will focus on 3 Eocene time periods:

(a) The EECO
(b) Pre-PETM
(c) PETM

(b) provides a reference point for both (c) and (a). In addition, all three time periods can be referenced to modern. This is in recognition that both modelling and proxies are strongest when considering relative changes. The precise definition of these 3 Eocene time periods is to be finalised (see below). We will aim to publish paper(s) on 3 proxy databases corresponding to these 3 time periods, with full assessment of uncertainties, highlighting our state-of-the art knowledge of these time periods, and ultimately make this online and open-access. In terms of the climate modelling, this will correspond to 2 experiments (plus preindustrial/modern), as the experimental design for the EECO (a) and PETM (c) will be identical (the difference in forcings is within uncertainty). Finally, we will carry out an assessment of the models through model-data comparison.

Organisation

Tasks:

- *Membership and coordinators of working groups to be confirmed.*

DeepMIP will have a very strong bottom-up component, with individual researchers using the DeepMIP framework to leverage funds, and to guide the direction of the group. However, there will also be some coordination of efforts.

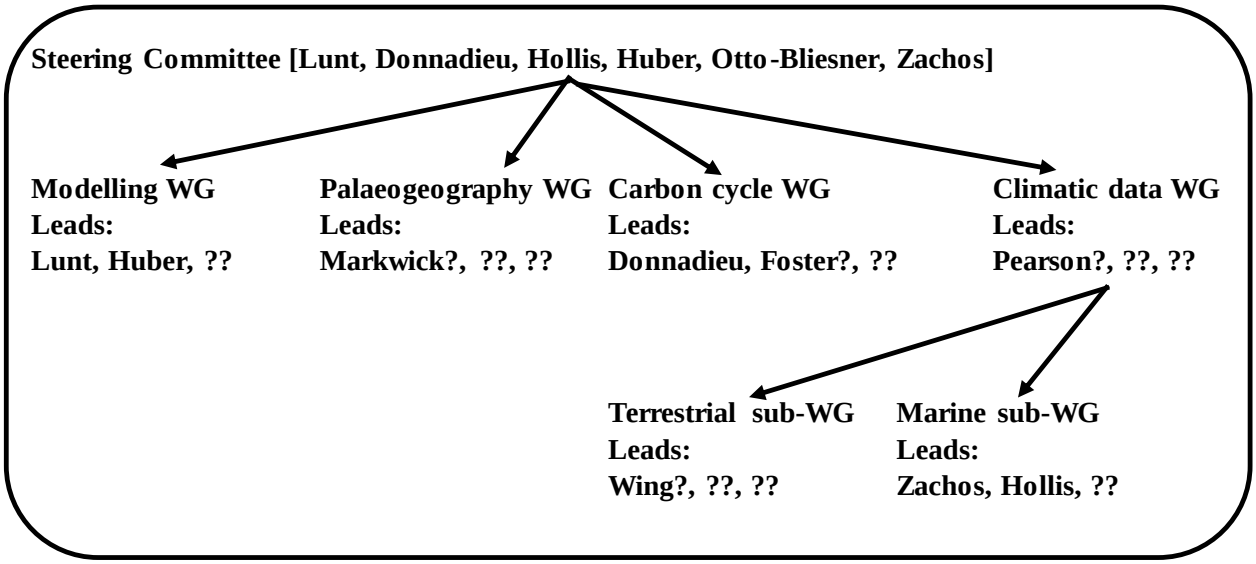
DeepMIP will be organised into working groups, which will vary from very informal to more formal.

The Steering Committee will oversee all working groups.

Working groups will initially be set up for palaeogeographies, climatic data, carbon cycle, and modelling. Other working groups may emerge over time. The working groups ensure, for example, that methodologies are consistent across proxies, and across models. Within the 'climatic data' working group, there will be sub-groups working on marine and terrestrial archives.

Each working group will have two or more overall coordinators, who will liaise with the Steering Committee, plus perhaps individuals leading specific efforts (e.g. for each proxy within the marine data sub-working group). All working groups will have at least one modeller and one data person involved. Suggestions for some coordinators are listed below, but all members of DeepMIP are encouraged to put themselves forward for coordinating working groups.

All members of DeepMIP are encouraged to join the various working groups. The initial membership of each working group is in the appendix (currently made up mostly of those at the meeting).



Modelling experimental design

Tasks:

- *Modelling working group: Model experimental design paper to be edited and submitted to Geoscientific Model Development. The paper will also include a very brief summary of the way forward for the proxy synthesis.*
- *Palaeogeography working group: Make a decision on the primary palaeogeography used in DeepMIP.*

The previously circulated DeepMIP model design paper will be edited based on discussions at the meeting.

The main points which differ from the draft experimental design (in addition to the change in time period) are:

- The suggested CO_2 levels for the primary simulations are 800, 1600, and 3200 ppmv (800 and 1600 if limited resource). This is based on recent work that Gavin Foster presented at the meeting, based on a combination of Boron isotopes and cGENIE modelling. Key aspect is that with 2 (or ideally 3) CO2 levels, model output for other CO_2 values can be interpolated (or extrapolated). Some discussion of favouring integer multiples of 280, e.g. 3x, 6x (840, 1680).
- Some discussion around raising CH_4 to e.g. 3500 ppbv (following Beerling et al, PNAS, 2011). Final decision needed on this. Alternative is to develop a scaling as a function of CO2. Or, ignore CH4 and use modern solar constant, assuming these approximately cancel (which would make comparison with modern much cleaner).
- Simulations will be carried out with modern orbits (some discussion around using zero eccentricity).
- Length of simulations will be "at least 1000 years" rather than 2000 years. Criterion for stabilisation to include a factor related to SST trends "not strongly trending".
- Sufficient output retained such that averages can be calculated from arbitrary years of the simulation.
- Non-CO2 greenhouse gases added to 'best in show' category.
- Palaeogeographies – the palaeogeography working group will make a decision about which paleogeography to use – options include Herold et al, Lunt et al, and a new bespoke geography. Some discussion around hotspot vs. paleomag reference frame. Whatever paleogeog we choose should have associated rotational data so that proxies can be back-rotated from their modern location in a consistent way with the models.
- Solar constant will be adjusted from modern following e.g. Gough. Or, leave as modern and assume this roughly cancels additional non-CO2 greenhouse gases.
- For aerosols, leave this as an option to each group. Model boundary conditions related to dust will be made available as in Herold et al.
- Vegetation – groups may use dynamic, or dastaset provided in Herold et al, or some other choice.
- Lakes – none, or predicted, or Getech if using Lunt et al palaeogeography.
- Soils – global mean or modern
- Initial conditions – change to initial salinity to reflect lack of ice sheets: 35 psu or +0.3 psu to be distributed homogeneously globally and over all depths.
- Subgroup to make recommendation about format and variables of model output (important to include data community in this discussion). There was a call for some high-frequency data, especially precipitation. This can be produced in a short run at the end of a long spinup if necessary.
- Some models to include e.g. oxygen or hydrogen isotopes where available.
- Sensitivity studies to include orbits, higher CO_2, changes to stratospheric ozone, and uncertainties in palaeogeography (e.g. gateways).
- We may give guidance to modelling groups to choose a CO2 level which gives reasonable bottom-water temperatures (i.e ~10^{o}C)

Also some discussion about 'complementary' modelling that could form an important part of DeepMIP. This includes regional modelling, high-res modelling (including atmosphere-only and ocean-only), box modelling, transient simulations with EMICs, e.g. cGENIE, and forward proxy models.

Development of proxy synthesis

Tasks:

- *Climatic data working group: Define start and end point of each period.*

- *Climatic data working group: Identify lead researchers for each proxy*
- *Climatic data working group: Collation of main pre-existing records into an initial version 0.1 database*
- *Carbon cycle working group: Produce a short written justification for the CO_2 levels in the model experimental design.*

Aim is to produce 3 Eocene datasets, made up of existing (and some new) data:

(a) EECO (~53 – 50 Ma)
(b) Pre-PETM (~0.5 Ma prior to onset of carbon isotope excursion, e.g. 56.4-55.9 Ma)
(c) Core CIE PETM (~0.05 Ma duration, e.g. 55.9-55.85 Ma)

The start and end-date of each time period needs to be confirmed. Likely this will be defined relative to CIE excursion for (b) and (c).

Focus in DeepMIP will be on both temperature and precipitation data. Other data such as e.g. oxygen isotopic composition of seawater, carbon isotopes, circulation proxies such as Nd etc, will not be included at this stage as not all (or no) models are able to simulate them.

Data do not need to represent surface temperatures – models simulate temperature through the depth of the water column.

Temperature proxies likely to include e.g. TEX, Mg/Ca, $\delta^{18}O$, LMA/Clamp, clumped isotopes.

All data will be assessed based on expert opinion, e.g. high, medium, low confidence. A key question is exactly how to define the uncertainties / confidence in the proxies in a way which is useful for model-data comparison. In addition, the confidence in estimates of absolute T, might be different than confidence in estimates of ΔT, across the P-E boundary, for example.

Ideally have multiple proxies for all sites – this will contribute to the 'confidence' assessment. The exceptions might be the high latitude sites (absence of carbonate).

Excitement around resurrecting the Paleogene isotopic record through novel techniques as presented by Reinhard Kozdon, and/or modelling of diagenesis. Modeling might place limits on the impacts of diagenesis which will be critical for establishing SST in the open ocean.

Ideally have an online open-access database for 3 time periods as the final outcome. EECO and PETM/pre-PETM marine compilations of Tom Dunkley Jones (Dunkley Jones et al, Lunt et al,), and EECO terrestrial compilations of Huber and Caballero are a good starting point for such a database.

Work Plan:

1. Table of sites and lead researchers
2. Prioritise proxy gaps in existing records
3. Construct database (PMIP-style)
4. Write paper
5. Collect new records (e.g. Indonesia, Tanzania, Nigeria)

Other

Dan will write EOS meeting report article (500 words, deadline is 2 months after the meeting).

Discussion of the name. Suggestions include "EoMIP2", "HotMIP", as well as current "DeepMIP". Many were in favour of HotMIP, but will it be taken seriously by future climate community?

Funding? Possibilities include NERC large/standard grant, NSF, ESF, Philanthropic….

IPCC paper deadline likely ~July 2019 (paper submission deadline for AR5 was July 2012). Recognition that the 'Paleoclimate' chapter may not exist in next IPCC report, but our work can in any case contribute to the 'Model Evaluation' chapter.

Next DeepMIP meeting in Bristol in 2017? Small proxy meeting at ICP in late Aug 2016, Utrecht.

Working groups

Marine
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Chris Hollis
Paul Pearson
Bridget Wade
Carrie Lear
Reinhard Kozdon
David Evans
James Super
Kate Littler
Aradhna Tripati
Sandy Kirtland Turner
Jess Tierney
Tom Dunkley Jones
Appy Sluijs
Richard Zeebe
Gavin Foster
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Terrestrial
Scott Wing
Katie Snell
Ulrich Salzmann
Gary Upchurch
Srinath Krishnan
James Super
Liz Kennedy

Modelling
All modellers

Paleogeography
Paul Markwick
Nicky Wright
Michiel Baatsen
Matt Huber
Chris Hollis