DeepMIP Meeting Utrecht 28th August 2016

Key Objectives: Confirm a plan for the next 12-18 months:

1. Agree process for making early Paleogene warm climate data compilations with improved age constraints, accuracy, uncertainty quantification and coverage;

2. collection of new data to improve geographic coverage and data quality.

Chronologies & Target Intervals:
Focus on PETM and EECO as states of peak-warmth, with the latest Paleocene used as a background climate state.

Orbital chronologies: some discussion of the length of the target interval relative to orbital variability: noted that in new benthic $\delta^{18}O$ records from ODP Site 1262 through the EECO, these could be as much as ~4ºC, and, with $\delta^{13}C$ records, possibly associated with a series of small hyperthermals. At this point most records lack such constraints, but it was accepted that orbital-resolved temperature records should be the long-term goal. Accepted that EECO intercomparisons without this resolution could have offsets of ~2-4ºC purely due to temporal mismatch.

Agreed to use the orbital chronology at ODP 1262 (Laurentano et al., 2016) as the standard to define EECO time interval, which shows good correlation to Shatsky Rise sites on the 400 and possibly 100ka periods. ***Not clear which sites should be chosen as PETM / late Paleocene reference.*** The target intervals from 1262 will then be translated into bio- magneto- and isotope-strratigraphies to correlate to other locations.

EECO time interval:
1. Main focus on conditions of true peak warmth – between carbon isotope excursions M (~52.0 Ma) and U (~50.3 Ma) (Kirtland Turner et al., 2014). This interval includes the marked ~0.75‰ rise in $\delta^{13}C$ at ~51.5 Ma, which could be used as a stratigraphic tie point to other locations.

2. Secondary inclusion of a wider interval to increase the potential number of data points to characterise near-EECO warmth. Propose to extend this secondary interval to between carbon isotope excursions J (~53.25 Ma) and W (~50.0 Ma).

Late Paleocene background: about 0.5Ma immediately before the onset of the PETM.

PETM: interval needs to be defined; based on $\delta^{13}C$ similar to (Dunkley Jones et al., 2013)Dunkley Jones et al. (2013)?

Paleogeography:
It was recognised that work by the Utrecht group (van Hinsbergen et al. 2015) makes a strong case for the use of a paleomagnetic reference frame for paleoclimate studies because it is referenced to the spin axis of the Earth rather than structural features of the mantle. However, several models have already adopted a mantle-based reference frame (Herold et al. 2014). Therefore, suggested that the best approach for proxy studies is to record paleolocations in both reference frames to allow comparison with specific models.

Noted that a number of groups are working on paleogeographic reference frames and reconstructions and this work should feed into the final data interpretations. E.g. in the SW Pacific, the difference between palaeomag and hot spot reference frames can be 7-9º latitude. Noted the importance of reporting which reference frame is being used.

TEX*: (LEAD GORDON INGLIS, plus Rich Pancost, Jessica Tierney, Peter Bijl)*

Agreed that the continued use of TEX_{86}^{L} was not to be advised, although there was a question if anyone has clearly stated / summarized the problems with this proxy. Discussion about whether this should be done in a data compilation outline paper. Agreed that a summary of the state-of-the-art would be useful from the TEX community. Gordon Inglis agreed to lead this, with input from (at least) Jessica Tierney, Richard Pancost and Peter Bijl. This should include a review of

the current proxies / calibrations as well as the required quality control checks (BIT, Methane Index) and the required reporting of primary data for inclusion in the DeepMIP compilation (primary GDGT ratios). There was a recognition that there is a great deal of work focusing on why TEX_{86} calibrations appear to overestimate temperature in high latitudes and/or shallower sites (e.g. studies by Inglis et al. 2015, Zhang et al. 2016, Ho and Laepple 2016). Noted that in the tropics does get close to mesocosm calibrations. Question of high-latitude summer bias; and appropriate water column depth for modern calibrations. Zhang - looking at the ring index to spot non-thermal factors influencing TEX; and whether the ring index can be used to calibrate temperature?

Oxygen isotopes: *(LEAD JIM ZACHOS, plus Reinhard Kozdon & others Celli Hull, Paul Pearson, Bridget Wade, Kirsty Edgar?)*
Noted that new nanoSIMS data from a number of relevant sites e.g. Maud Rise (Kozdon) may be overcoming the problems of diagenetic resetting of planktic foraminifera isotopes. This is ~4ºC warmer than original data, and is in better agreement with both ion probe and whole shell calcite Mg/Ca temperature estimates. Complementary proposals for further development and application of these methods will be submitted to UK and US funding agencies within the next few months (Kozdon, Lunt). [*A follow up meeting of Kozdon, Lunt, Hollis, Lear, Coxall was held during ICP to start co-ordinating proposals; in particular to do an inter-lab comparison at selected sites*]

Mg/Ca: *(LEAD CARRIE LEAR, plus Kirsty Edgar, David Evans)*
Carrie Lear and Kirsty Edgar working on data compilation for the Cenozoic. David Evans working on paired clumped isotope – Mg/Ca constraints on Mg/Ca_{sw}. Suggest that these three lead on the Mg/Ca proxy summary and data compilation.

Clumped Isotopes: *(LEAD ARADHNA TRIPATI, plus David Evans)….*

Databases:

Yale Group: Simon D'Haenens, Celli Hull, Ellen Thomas – focusing on open access database of data from 5 sites (ODP Sites 1263, 1209, 1215, 690 and DSDP Site 401) between the PETM and ETM3.

Bremen, Pälike database: working on a useable DSDP/ODP/IODP database. Likely starting to be operative within 6 months. ***In follow up meeting, this was chosen as the best host for DeepMIP data. Plan to submit raw geochemical data with metadata to this repository starting 2017. Data can then be extracted from this database for the target time intervals and be subject to a consistent set of temperature calibrations to generate the DeepMIP compilation.***

ACTION POINTS: *(marine proxy leads to co-ordinate: Hollis, Dunkley Jones, Zachos, Lear)*

1. Data Compilation Summary text: in the first instance for the website, this would define the target time intervals, means of stratigraphic correlation, proxy methodologies and metadata requirements for the DeepMIP data compilation. Use EoMIP and PETM compilation text as a basis and then send to proxy leads to edit and refine to the current state-of-the-art.

- End October 2016: Initial outline text to be circulated to DeepMIP marine proxy team;

- **End 2016:** Revised submissions from proxy leads back to DeepMIP co-ordinators.

- **End January 2017:** Text made available online through DeepMIP website.

2. GMD data compilation methods paper: based on the results of 1., plan to develop this into a GMD paper within early 2017. **Aim to include terrestrial working group** (Salzmann, Wing).

3. Data compilation: data compilation based on the above framework needs to be completed within 18-24 months in order to meet likely deadlines for IPCC AR6.

Funding: some discussion of funding through C4P (US) or Past Earth Network (UK).

4. Heiko Pälike to distribute templates (data and age model) for uploading proxy data to database.

5. Dan Lunt to distribute timetable for overall project, leading up to the next IPCC.

6. Proposed to have a DeepMIP themed session at next CBEP in September 2017 (Jim Zachos)**; with the next DeepMIP meeting in the UK spring 2018.**

7. Circulate a summary of what people are doing / plan to do: sites mentioned at the meeting:

1. EECO sites U1409 planktic & benthic (Kirtland Turner plus others);

2. benthic data from ODP 1258 Demerara Rise (Kirtland Turner)

3. TEX_{86} from Blake Nose and SE Australia – (Bijl, Frieling, Sluijs);

4. Topical Atlantic (ODP 959) & Nigeria (Sluijs, Bijl)

5. Belgium fish otoliths & TEX_{86} (Daan Vanhove, Peter Stassen)

6. Rockall NE Atlantic (Dunkley Jones, Edgar, Bendle) – isotopes, Mg/Ca and TEX_{86}.

7. Clumped isotopes form the Southern Ocean – Maud Rise, Kerguelen 784, 865, 1209 (Tripati?)

8. NanoSIMS - ODP 690 and other sites (see above – Kozdon and Lear groups).

9. NanoSIMS, Mg/Ca, d18O, TEX86 - Hollis/Kozdon/Zachos/Wade/Littler/Pancost: SW Pacific DSDP 277, 207, 206, Hampden for EECO, DSDP 277 for PETM-late Paleocene.