PMIP-carbon: towards a multi-models comparison of climate-carbon interactions at the Last Glacial Maximum

N. Bouttes[1] (nathaelle.bouttes@lsce.ipsl.fr), R. Ivanovic[2] , A. Abe-Ouchi[3], H. Kobayashi[3], L. Menviel[4], A. Oka[3], A. Yamamoto[3] and members of PMIP-carbon

[1]LSCE/IPSL, CEA/CNRS/UVSQ/Paris-Saclay, Gif-sur-Yvette, France
[2]University of Leeds, United Kingdom
[3]FUniversity of Tokyo, Japan
[4]University of New South Wales, Australia

Introduction

More and more climate models now include the carbon cycle, as climate-carbon interactions are crucial to anticipate future atmospheric CO_2 concentrations and associated climate change. Yet, climate-carbon coupled simulations compared whithin CMIP have been restricted to present and future periods so far, as simulations of past periods did not include the carbon cycle.

Climate-carbon interactions can vary depending on the background climate state, hence it is necessary to compare model results among themselves and against data for past periods, such as the Last Glacial Maximum. The Last Glacial Maximum (~21,000 years ago) is largely different from the present (~4°C colder with large ice sheets in the Northern Hemisphere) and well documented in paleorecords. Although this period has been studied for years, the reasons for the low atmospheric CO_2 at that time (~100 ppm lower) have not yet been completely elucidated and models have not yet reached a consensus.

Here we present a new project of model intercomparison aiming at comparing climate-carbon interactions in LGM simulations to better understand the carbon cycle processes and past changes recorded in ice and sediment cores.

Protocol

PMIP-carbon

The protocol mainly follows the PMIP4 recommandations for the Last Glacial Maximum (LGM). **Two main simulations are required:**

- **a pre-industrial (PI)**
- **an LGM simulation** with LGM boundary conditions from PMIP4 if possible (Kageyama et al., 2017), or as closed as PMIP4 ones otherwise (changes of orbital parameters, greenhouse gases and ice sheets).

The models should include a carbon cycle module and no change of code should take place between LGM and PI.

Several optional runs are also proposed:

1. Simulation with fixed PI climate, i.e. CO_2 for the radiative part kept to PI values, while the CO_2 for the carbon cycle is changed to LGM value, to see the CO_2 influence on chemistry without any circulation change vs climate allowed to evolve

2. Additional simulations with modifications for the LGM such as changes in concentration of salinity, alkalinity, nutrients…

3. Additional simulations with different parameterizations to modify circulation or biogeochemistry (hosing, brine, productivity efficiency…).

Model groups involved

15 model groups have expressed interest:

- 7 Intermediate complexity models:

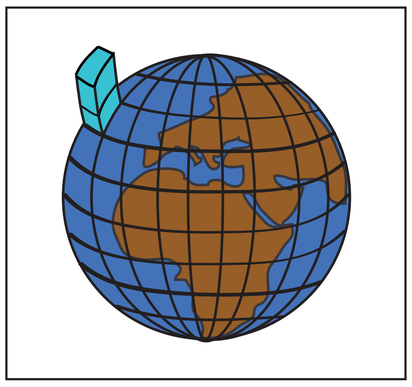
- Bern3D-LPX, University of Bern, Switzerland
- CLIMBER-X, PIK, Germany
- Genie, University of California, Riverside; University of Bristol, UK; University of St Andrews, UK, University of Cardiff, UK; Stockholm University, Sweden
- iLOVECLIM, LSCE/IPSL, France; Vrije Universiteit Amsterdam, The Netherlands
- LOVECLIM, UNSW, Australia
- UVic/MOBI, Oregon State University, US; CCT-Conicet Cenpat, Argentina
- UVic, UNSW, Australia

- 7 Atmosphere-ocean GCMs:

- FAMOUS, University of Leeds, UK
- HadCM3, University of Leeds, UK
- IPSL-CM5 / IPSL-CM6, LSCE/IPSL, France
- MIROC-ES2L, JAMSTEC, Japan; The University of Tokyo, Japan
- MIROC4m-COCO, JAMSTEC, Japan; The University of Tokyo, Japan
- MPI (HAMOCC), MPI, Germany
- NorESM1/NorESM2, Uni Research Climate, Norway; University of Bergen, Norway

- 1 Ocean GCM:

- REcoM, AWI, Germany



How to participate

- Run the simulations
- Contact me (nathaelle.bouttes@lsce.ipsl.fr) and other members of PMIP-carbon to participate, be added to the email list and upload your results

Conclusions and perspectives

- **New project initiated, aiming at first model intercomparison of carbon results for the Last Glacial Maximum**
- **So far, simulations from 4 models are available for analysis (LOVECLIM, MIROC-ES2L, MIROC4m-COCO, iLOVECLIM)**
- **More simulations from other models should become available soon**

References
Kageyama, M. et al. (2017), Geosci. Model Dev., 10, 4035-4055.