Design for the Penultimate Deglaciation experiment

You will find on this page information about the experiment design for the PMIP4 Penultimate Deglaciation experiments.

This protocol is a product of the *PAGES-PMIP working group on Quaternary Interglacials* (QUIGS)

Please make sure to read the Associated publications before setting up your experiments or using the output data, and read any *how-to* sections associated with specific boundary conditions.

Get in touch with the following people if you have questions:

Laurie Menviel	Experimental design questions
Emilie Capron	Experimental design questions
Ruza Ivanovic	working group leader
Jean-Yves Peterschmitt	Technical questions or missing data

Associated publications

- **Penultimate Deglaciation experiment design, version 1:**

  The penultimate deglaciation: protocol for PMIP4 transient numerical simulations between 140 and 127 ka, version 1.0, Menviel et al, GMD, 2019, https://dx.doi.org/available_soon

Version 1 Specifications

For general advice on boundary condition implementation in palaeoclimate models, see Kageyama et al. (2016).

Penultimate Glacial Maximum spinup (140 ka)

If possible, this spinup simulation should start from the PMIP4-CMIP6 LGM (21 ka) experiment, as equilibrium would be reached more quickly.

	PMIP4 specifications
PMIP4 name	**PDGv1-LGMspin**

	PMIP4 specifications
Astronomical parameters	**eccentricity** = 0.033 **obliquity** = 23.42° **perihelion-180°** = 251° **Date of vernal equinox** : Noon, 21st March
Solar constant	1361.0 ± 0.51365 W m^{-2}
Trace gases	**CO_2** = 195 ppm **CH_4** = 387 ppb **N_2O** = 201 ppb **CFC** = 0 **O_3** = Preindustrial (e.g. 10 DU)
Ice sheets, orography and coastlines	140 ka data from Combined ice-sheet reconstruction (IcIES-NH, GSM-G and GSM-A): [Access to data]
Bathymetry	Keep consistent with the coastlines, using either: - Data associated with the ice sheet - Preindustrial bathymetry
Global ocean salinity	+ 0.85 psu, relative to preindustrial
All others	See manuscript section 6.1

Transient Penultimate Deglaciation (140-127 ka)

These are the specifications for the full transient run 140-127 ka.

	PMIP4 specifications
PMIP4 name	**PDGv1**
Initial conditions (140 ka)	Recommended: PDGv1-LGMspin See above for details. The method must be documented, including information on the state of spinup
Astronomical parameters	Transient, as per Berger (1978) [Access to data **&** README !]
Solar constant	1361.0 ± 0.51365 W m^{-2}
Trace gases	**CO_2** = Transient, as per the spline of Koehler et al. (2017): [Access to data] **CH_4** = Transient, as per the spline of Koehler et al. (2017): [Access to data] **N_2O** = Linear increase from 201 ppb at 140 ka to 218.74 ppb at 134.5 ka then transient, as per the spline of Koehler et al. (2017): [Access to data] **CFC** = 0 **O_3** = Preindustrial (e.g. 10 DU)
Ice sheet	Transient: Combined ice-sheet reconstruction (IcIES-NH, GSM-G and GSM-A) [Access to data] How often to update the ice sheet is optional
Orography and coastlines	Transient. To be consistent with the choice of ice sheet. Orography is updated on the same timestep as the ice sheet. It is optional how often the land-sea mask is updated, but ensure consistency with the ice sheet reconstruction is maintained
Bathymetry	Keep consistent with the coastlines, and otherwise use either: - Data associated with the ice sheet; it is optional how often the bathymetry is updated - Preindustrial bathymetry

	PMIP4 specifications
River routing	Ensure that rivers reach the coastline It is recommended (optional) to use one of the following: - Self-consistent paleo-routing described in section 6.2.3 - Preindustrial configuration for the model - Manual/model calculation of river network to match topography
Freshwater fluxes	Recommended North Atlantic option is *fSL* and a constant 0.0135 Sv flux around the Antarctic coast between 140-130 ka [Access to data] - *fSL* : meltwater flux based on changes in sea-level - *fIRD* : meltwater flux based on Norwegian Sea and North Atlantic IRD - *fIC* : meltwater flux based on ice-sheet changes - *fSL2* : meltwater flux based on changes in sea-level and triangular input max. 0.15 Sv between 131-128 ka on the Antarctic coast - *fUN* : Globally uniform meltwater input based on sea-level changes
Vegetation & land cover Aerosols (dust)	Prescribed preindustrial cover or dynamic vegetation model Prescribed preindustrial distribution or prognostic aerosols

Focused simulations

- Empty
- Empty

Paleorecords to use for model-data comparisons

Overview

See Table 3 and Table 4 of the Penultimate Deglaciation GMD paper

Click on a table to get a bigger version,
or download the GMD paper

Table 3

Tracer interpretation	Core	Coordinates and depth (m)	$\varphi 1$ (ka)	$\varphi 2$ (ka)	$\varphi 3$ (ka)	$\varphi 4$ (ka)	$\varphi 5$ (ka)	References
Sea-level								
Sea-level	**Red Sea cores**	-	137.0±0.7 *increases*		133.4±0.7 *main increase*		130.2±1	Grant et al. (2012) This study
Benthic $\delta^{13}C$								
North Atlantic intermediate-depth ventilation	**ODP983**	60.40°N, 23.64°W 1984 m	136.1±1.2 *weaker ventil.*				128.1±0.9	Raymo et al. (2004) Barker et al. (2015)
	ODP980	55.80°N, 14.11°W 2180 m	137±1.9			128.6±1.8	127.6±1.3	Oppo et al. (2006)
North Atlantic deep-water ventilation	**MD95-2042**	37.80°N, 10.17°E 3146 m				131.0±1.4 *stronger ventil.* (T)		Shackleton et al. (2003)
	Stack of U1308 CH69-K09 and ODP 1063	49.88°N, 24.24°W, 3883 m 41.76°N, 47.35°W, 4100 m 33.69°N, 57.62°W, 4584 m	135.9±2.0			130.3±1.6	129.2±1.4	Hodell et al. (2008) Labeyrie et al. (1999) Deaney et al. (2017)
Southern Ocean deep-water ventilation	**MD02-2488**	46.48°S, 88.02°E 3420 m			131.9±2.1 *stronger ventil.* (U)	130.2±2.2 *weaker ventil.* (V)		Govin et al. (2009) Govin et al. (2012)
Planktic $\delta^{18}O$ and $\delta^{18}Osw$								
North Atlantic surface $\delta^{18}O$ *salinity*	**ODP980**	55.80°N, 14.11°W 2180 m				130.0±1.3		Oppo et al. (2006)
	SU90-03	40.51°N, 32.05°W				131.0±1.1		CS98
	MD95-2042 **ODP 976**	37.80°N, 10.17°E 36.20°N, 4.31°E			133.9±0.9	131.6±1.5 131.9±0.9		Shackleton et al. (2003) Martrat et al. (2014)
Speleothem $\delta^{18}Oc$								
North Atlantic surface $\delta^{18}O$	**Corchia Cave, Italy**	43.97°N, 13.0°E, 840 m a.s.l			133.9±1.2 *NA meltwater input* (I)	131.0±0.7 *NA meltwater paused* (J)		Drysdale et al. (2009) Tzedakis et al. (2018) Marino et al. (2015)
Mean ages for the beginning of φ1-φ5 from Tables 3 and 4								
Mean ages			136.4±1.7	133.9±0.8	133.3±1.1	130.4±1.3	128.5±1.3	

Table 3.

Table 4

Tracer interpretation	Core, coordinates and depth/elevation	Chronology	$\varphi 1$ (ka)	$\varphi 2$ (ka)	$\varphi 3$ (ka)	$\varphi 4$ (ka)	$\varphi 5$ (ka)	References
Atm. CO_2 concentration								
Atm. CO_2 concentration	**EDC** 75.05°S, 123.19°E, 3233 m asl	Ice core AICC2012 chrono.	137.8±2.7 *increases*				128.0±1.8	Bereiter et al. (2015)
SST								
North Atlantic *Summer* SST (FFA)	**ODP980** 55.80°N, 14.11°W, 2180 m depth	Alignment onto Corchia U-Th-based chrono.				129.7±1.3	128.7±1.3	Oppo et al. (2006)
North Altantic *Summer* SST (FFA)	**SU90-03** 40.51°N, 32.05°W, 2475 m depth	Alignment onto Corchia U-Th-based chrono.	136.9±1.6 *colder* [E]			131±1 *warmer* [F]		CS98 Cortijo et al. (1999)
W. Mediterr. Sea SST (Uk'37)	**ODP 976** 36.20°N, 4.31°E 1108 m depth	Alignment onto Corchia U-Th-based chrono.	135.9±1.1 *colder* [A]	134 ±1.1 [B]	133.3** ±0.9 [C]	131.4±0.9 *warmer* [D]		Martrat et al. (2014)
Southern Ocean *Summer* SST (FFA)	**MD02-2488** 46.48°S, 88.02°E, 3420 m depth	Alignment onto AICC2012				130±2.1** *max. warm* [R]		Govin et al. (2009) Govin et al. (2012)
Southern Ocean SST (Mg/Ca)	**MD97-2120** 45.54°S, 174.92°E, 1210 m depth	Alignment onto AICC2012				128.1±2.5** *max. warm* [S]		Pahnke et al. (2003)
Air temperature (SAT)								
Antarctic *Annual* SAT (Ice δD)	**EDC ice core** 75.1°S, 123.35°E, 3233 m a.s.l.	Ice core AICC2012 chrono.	135.6±2.5 *(warmer)* [W]			129.4±1.8** *max. warm* [X]		Jouzel et al. (2007)
SAT Southern Europe ([Mg])	**Corchia Cave, Italy** 43.97°N, 13.0°E, 840 m a.s.l	Alignment onto Corchia U-Th-based chrono.				131.0±0.7 *warmer* [K]	128.6±0.6 *warm plateau* [L]	(Drysdale et al., 2018)
Precipitation								
Vegetation/precipitation in Southern Europe	**Lago di Monticchio, Italy** 40.93°N, 15.58°E, 656 m a.s.l.	Independent absolute varve chronology					127.2±1.6 *max. warm/wet* [G]	Brauer et al. (2007)
(Temperate tree pollen)	**Ioannina terr. sequence, Greece** 39.65°N, 20.91°E, 470 m a.s.l.	Orbital tuning				132.7±2.3 *wetter* [H]		Tzedakis et al. (2003)
Intensity of Asian monsoon ($\delta^{18}Oc$)	**Chinese Caves** 25.28°N to 32.5°N 108.08-119.16°E 680 - 1900 m a.s.l.	Absolute U-Th-based chronology	135.6±0.5 *drier* [M]	133.7 ±0.5 [N]	133.3** ±0.5 [O]	128.9±0.1 *wetter* [P]		Cheng et al. (2016)
Intensity of East Asian monsoon (grain size)	**Chinese loess** 35.62-37.14°N 103.20 - 109.85°E	Alignment onto Hulu-Sanbao U-Th-based chrono.				130.2±0.4 o *wetter* [Q]		Yang and Ding (2014)
Mean ages for the beginning of φ1-φ5 from Tables 3 and 4								
Mean ages			136.4±1.7	133.9±0.8	133.3±1.1	130.4±1.3	128.5±1.3	

Table 4.

Data

CH69-K09
MD95-2042

ODP976
ODP980
ODP983
ODP1063
SU90-03

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