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-PGMspin** (PDG ⇔ ***P****enultimate* ***D****e****G****laciation* - PGM ⇔ ***P****enultimate* ***G****lacial* ***M****aximum*)

	PMIP4 specifications
Astronomical parameters	**eccentricity** = 0.033 **obliquity** = 23.414° **perihelion-180°** = 73° **Date of vernal equinox** : Noon, 21st March
Solar constant	1361.0 ± 0.51365 W m^{-2}
Trace gases	**CO_2** = 191 ppm **CH_4** = 385 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] (Abe-Ouchi et al 2013; Briggs et al 2014; Tarasov et al 2012)
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-PGMspin 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 !] (`md5sum bein1.dat ⇒ 726dfae36b33ae248bdb94f59387a19f`)
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] (Abe-Ouchi et al 2013; Briggs et al 2014; Tarasov et al 2012) 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] `(md5sum t2-fwfflux_v190201.txt ⇒ 5d073eb89df1c884fc654de930840d1b)` - *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

Table 3 / **Table 4**

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

Tracer interpretation	Core	Coordinates and depth (m)	φ1 (ka)	φ2 (ka)	φ3 (ka)	φ4 (ka)	φ5 (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 δ^{13}C								
North Atlantic intermediate-depth	**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)
ventilation	**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	**MD95-2042**	37.80°N, 10.17°E 3146 m				131.0±1.4 *stronger ventil.* (T)		Shackleton et al. (2003)
ventilation	**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 δ^{18}O and δ^{18}Osw								
North Atlantic surface δ^{18}O	**ODP980**	55.80°N, 14.11°W 2180 m				130.0±1.3		Oppo et al. (2006)
salinity	**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 δ^{18}Oc								
North Atlantic surface δ^{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.

Tracer interpretation	Core, coordinates and depth/elevation	Chronology	φ1 (ka)	φ2 (ka)	φ3 (ka)	φ4 (ka)	φ5 (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 Atlantic *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 (δ^{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

You will find below the data mentioned in Table 3, Table 4, Figure 8 and Figure 9 of the GMD paper

The data files have a version string (`_vYYmmDD`) in their file name, indicating when they have been uploaded to this site (in case we have to update them later and use a more recent version/date).

You can also check that you have the correct version of the files by computing their checksums (`md5sum data_file`) and comparing them to the checksums in the table below. Getting a different checksum means that you either have a wrong version of the file, or that the file content was corrupted during the transfer

Data	version string	md5sum
CH69-K09 (txt)	_v190201	4f4edfba575324b504beb20ade0b9d28
MD95-2042 (txt)	_v190201	cc24515a1a59417486e80155c4ebbbaa
ODP976 (txt)	_v190201	6958069100a8df8fde00dd06e0f9bd52
ODP980 (txt)	_v190201	c8310b4db60415e055c131d57b6cfd56
ODP983 (txt)	_v190201	e7cb293ceb7b7f7a8771206ec794c938
ODP1063 (txt)	_v190201	bb075a7f8fe8ffb9bd3778d6584c3924
SU90-03 (txt)	_v190201	445ea11f144843ceb7f8128df5fafaf6
SL_LIG_Dutton2017 (txt)	_v190201	c1151b63ae7c720e7b5b6b3ff2f2451a
d13Cstack (txt) Stack of U1308, CH69-K09 and ODP1063	_v190201	d44b91b35fbf6e2e142dd749200b68e4
IRD-stack (txt)	_v190201	51bf8dd9d019bf76e3a983eddf35782e
Figure 9 data (xlsx)	_v190213	9ec7aae777fdce6e1447a93054622f2c

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