

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 $\Leftrightarrow$ <i>Penultimate DeGlaciation</i> - PGM $\Leftrightarrow$ <i>Penultimate Glacial Maximum</i>)

	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	CO₂ = 191 ppm CH₄ = 385 ppb N₂O = 201 ppb CFC = 0 O₃ = 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 !]
Solar constant	1361.0 ± 0.51365 W m ⁻²
Trace gases	CO₂ = Transient, as per the spline of Koehler et al. (2017) : [Access to data] CH₄ = Transient, as per the spline of Koehler et al. (2017) : [Access to data] N₂O = 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 O₃ = 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

	PMIP4 specifications
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
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 <i>fSL</i> and a constant 0.0135 Sv flux around the Antarctic coast between 140-130 ka [Access to data] - <i>fSL</i> : meltwater flux based on changes in sea-level - <i>fIRD</i> : meltwater flux based on Norwegian Sea and North Atlantic IRD - <i>fIC</i> : meltwater flux based on ice-sheet changes - <i>fSL2</i> : meltwater flux based on changes in sea-level and triangular input max. 0.15 Sv between 131-128 ka on the Antarctic coast - <i>fUN</i> : 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)	ψ^1 (ka)	ψ^2 (ka)	ψ^3 (ka)	ψ^4 (ka)	ψ^5 (ka)	References	Tracer interpretation	Core, coordinates and depth/elevation	Chronology	ψ^1 (ka)	ψ^2 (ka)	ψ^3 (ka)	ψ^4 (ka)	ψ^5 (ka)	References		
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	Atm. CO ₂ concentration	EDC	75.0°S, 123.19°E, 3233 m asl	Ice core: AICC2012 chrono.	135.8±2.7	increases			128.0±1.8	Benitez et al. (2015)	
Benthic $\delta^{13}\text{C}$									SST										
North Atlantic intermediate-depth ventilation	ODP983	60.40°N, 23.64°W 1984 m	136.1±1.2	weaker vent.			128.1±0.9	Raymo et al. (2004) Barker et al. (2015)	North Atlantic Summer SST (FFA)	ODP980	55.80°N, 14.11°W, 2180 m depth	Alignment onto Corchia U-Th based chrono.	136.9±1.6				128.7±1.3	Oppert et al. (2006)	
North Atlantic deep-water ventilation	ODP980	55.80°N, 14.11°W 2180 m	137.1±1.9			128.6±1.8	127.6±1.3	Oppert et al. (2006)	W. Medit.: Sea SST (Ua-37)	ODP 976	36.20°N, 4.31°E 1198 m depth	Alignment onto Corchia U-Th based chrono.	135.9±1.1	134	133.3**	131.4±0.9	warmer [F]	Martini et al. (2014)	
North Atlantic deep-water ventilation	MD95-2042	37.80°N, 10.17°E 3146 m				131.0±1.4	stronger vent. (T)	Shackleton et al. (2003)	Southern Ocean Summer SST (FFA)	MD02-2488	46.48°S, 88.02°E, 3420 m depth	Alignment onto AICC2012					130.2±1**	max. warm [G]	Govin et al. (2009) Govin et al. (2012)
Southern Ocean deep-water ventilation	Stack of U1308 + CH09-K09 and ODP 1863	49.88°N, 24.24°W, 3083 m 41.78°N, 47.25°W, 4100 m 33.69°N, 57.62°W, 4584 m	135.9±2.0			130.3±1.6	129.2±1.4	Hodeti et al. (2008) Lafont et al. (1999) Doney et al. (2017)	Southern Ocean SAT (Mg/Ca)	MD07-2120	45.54°S, 174.92°E, 1210 m depth	Alignment onto AICC2012					128.1±2.5**	max. warm [S]	Pahani et al. (2003)
Planktic $\delta^{18}\text{O}$ and $\delta^{13}\text{O}_{\text{sw}}$									Air temperature (SAT)										
North Atlantic surface $\delta^{18}\text{O}$	ODP980	55.80°N, 14.11°W 2180 m				130.0±1.3		Oppert et al. (2006)	Antarctic Annual SAT (ice 40)	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**		Jouzel et al. (2007)
Antarctic	SE98-02	40.51°N, 32.05°W 1984 m				131.0±1.1		CS98	SAT	Corchia Cave, Italy	43.97°N, 13.07°E, 640 m a.s.l.	Alignment onto Corchia U-Th based chrono.				131.0±0.7	128.6±0.6	warmer [K]	(Dreydale et al., 2018)
Speleothem $\delta^{18}\text{O}_c$									Precipitation										
North Atlantic surface $\delta^{18}\text{O}$	ODP980	55.80°N, 14.11°W 2180 m				130.0±1.3		Oppert et al. (2006)	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/cool [L]	Brauer et al. (2007)
Antarctic	SE98-02	40.51°N, 32.05°W 1984 m				131.0±1.1		CS98	(Temperate tree pollen)	Jouanneau des seigneurs, Greece	39.45°N, 20.91°E, 470 m a.s.l.	Orbital tuning					132.7±2.3	warmer [H]	Tzedakis et al. (2003)
Mean ages for the beginning of ψ^1 - ψ^5 from Tables 3 and 4									Intensity of Asian monsoon ($\delta^{18}\text{O}_c$)										
Mean ages			136.4±1.7	133.9±0.8	133.3±1.1	130.4±1.3	128.5±1.3		Intensity of Asian monsoon ($\delta^{18}\text{O}_c$)	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**	128.9±0.1	warmer [P]	Cheng et al. (2016)
Mean ages for the beginning of ψ^1 - ψ^5 from Tables 3 and 4									Intensity of East Asian monsoon (grain size)										
Mean ages			136.4±1.7	133.9±0.8	133.3±1.1	130.4±1.3	128.5±1.3		Intensity of East Asian monsoon (grain size)	Chinese loess	35.62-37.14°N 103.20-109.85°E	Alignment onto Hula-Sanbao U-Th based chrono.					130.2±0.4 o	warmer [Q]	Yang and Ding (2014)
Table 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).

CH69-K09 (txt)
MD95-2042 (txt)
ODP976 (txt)
ODP980 (txt)
ODP983 (txt)
ODP1063 (txt)
SU90-03 (txt)
SL_LIG_Dutton2017 (txt)
d13Cstack (txt) Stack of U1308, CH69-K09 and ODP1063
IRD-stack (txt)
Figure 9 data (xlsx)

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Last update: **2019/02/15 10:03**

