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*Supplement of*

## **Coupled climate–carbon cycle simulation of the Last Glacial Maximum atmospheric CO<sub>2</sub> decrease using a large ensemble of modern plausible parameter sets**

**Krista M. S. Kemppinen et al.**

*Correspondence to:* Krista M. S. Kemppinen ([krista.kemppinen@asu.edu](mailto:krista.kemppinen@asu.edu))

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S1

The ensemble was integrated for another 10 kyr after stage 3 (yielding 20 kyr of LGM climate in total) to simply verify, by analysing a subset of the ensemble, that the sediments (being the slowest component in the model) were in equilibrium by 10 kyr.

S2

ENS<sub>315</sub> has a mean atmospheric CO<sub>2</sub> concentration of  $278.1 \pm 1.3$  ppmv (standard deviation). The ensemble mean and range for the eight modern climate plausibility metrics of Holden et al., 2013a are shown in Table S2.1. The ensemble response is additionally reported in Table S2.2 for the annual average global ocean carbon inventory, sea surface temperature and sea ice area, and compared with observations. The ensemble mean ocean carbon inventory is close to the 36,000 PgC equilibrium preindustrial ocean carbon inventory predicted by GENIE-1 in Lenton et al. (2006), below reconstructed estimates of ca. 38,000 PgC (Houghton et al., 1990), largely attributable to an underestimated ocean volume at our low resolution (Lenton et al 2006). The ensemble mean sea surface temperature (SST) exceeds observations but the error is still comparable to that associated with previous model predictions (e.g. Kim et al., 2003). The ensemble mean sea ice area (SIA) lies within the range of observed estimates.

**Table S2.1. The eight modern climate plausibility metrics.** The first two columns show the mean (plus minus one standard deviation) and range of ENS<sub>315</sub>, the second and third, the same metrics but for the Holden et al. (2013a), H13, ensemble (Table 2). All values are annual averages, except for the Antarctic sea ice area.

	ENS <sub>315</sub> mean	ENS <sub>315</sub> range	H13 Mean	H13 range
Global surface air temperature (°C)	$13.7 \pm 1.1$	11.8 to 16.2	$13.6 \pm 1.1$	11.7 to 16.2
Atlantic overturning stream function maximum (Sv)	$17.5 \pm 3.2$	8.4 to 25.8	$17.5 \pm 3.2$	10.0 to 25.8
Atlantic overturning stream function minimum (Sv)	$-4.1 \pm 1.0$	-6.9 to -0.9	$-4.1 \pm 1.0$	-6.8 to -1.0
31 <sup>st</sup> December Antarctic sea ice area (million km <sup>2</sup> )	$6.7 \pm 2.7$	1.2 to 13	$6.8 \pm 2.8$	1.2 to 12.9
Global VegC (PgC)	$499.9 \pm 94.5$	328.6 to 765.5	$492 \pm 94$	326 to 762
Global SoilC (PgC)	$1329.7 \pm 279.2$	896.1 to 2353.2	$1351 \pm 308$	896 to 2430
Surface sediment wt% CaCO <sub>3</sub>	$34.4 \pm 7.9$	19.1 to 51.5	$34.1 \pm 7.8$	20.0 to 50.0
Global ocean O <sub>2</sub> (µm kg <sup>-1</sup> )	$164.1 \pm 19.3$	121.8 to 217.5	$165 \pm 20$	117 to 216

**Table S2.2. Preindustrial ocean carbon inventory, sea surface temperature and sea ice area.** All values are annual averages.

	ENS <sub>315</sub> mean	ENS <sub>315</sub> range	Observations
Global ocean carbon inventory (PgC)	36056.2 ± 252.4	35280.5 to 36655.7	38000 Houghton et al. (1990)
Global sea surface temperature (°C)	18.9 ± 1.2	16.4 to 21.9	15.9 NCDC, 2015
Global sea ice area (million km <sup>2</sup> )	23 ± 4.2	16.3 to 38.6	19 to 27 Lemke et al. (2007)

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