Supporting Information for "Benchmark calculations of radiative forcing by greenhouse gases"

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Table S1. Perturbations around present-day (PD) conditions used to identify representative columns; these are similar to, but not the same as, the perturbations used in RFMIP experiment *rad-irf* for reasons described in the main text. Perturbations are applied to each profile drawn from ERA-Interim profile set. Carbon dioxide concentrations are relative to a pre-industrial (PI) volume mixing ratio of 278 $\times 10^{-6}$. GHG refers to well-mixed greenhouse gases.Temperature T and relative humidity RH perturbations (12, 13) use the average of two models from the CMIP5 archive (GFDL-CM3 and GFDL-ESM2G) with relatively low and high climate sensitivities, respectively.

	Perturbation
1	PI 0.5×CO_2
2	PI 2×CO_2
3	PI 3×CO_2
4	PI 8×CO_2
5	PI CO_2
6	PI CH_4 (0.722 ppmv)
7	PI N_2O (0.273 ppmv)
8	PI HFC (all HFC at zero)
9	PI O_3 (from CMIP6 PI ozone file)
10	PD +4K temperature, no H_2O change
11	PD +20% humidity
12	PI T, RH, O_3, GHG
13	2095 RCP8.5 T, RH, O_3, GHG
14	PI O_3, GHG
15	PI O_3, GHG, but PI 4×CO_2
16	2095 Avg Sens RCP4.5 O_3, GHG
17	2095 Avg Sens RCP8.5 O_3, GHG

Table S2. Ratio of all-sky to clear-sky instantaneous radiative forcing, and the top-of-atmosphere and the surface, across a range of models and experiments in CMIP6. Clear-sky and all-sky (including clouds) fluxes are computed using a second radiative transfer calculation in which the forcing agents are modified for diagnostics purposes. Results from HadGEM3 and IPSL-CM6A use diagnostic calculations requested for CFMIP in which CO_2 concentrations are quadrupled from pre-industrial values. Values from GFDL-CM4, performed for this work, are computed by setting forcing agents to pre-industrial values in three RFMIP fixed-SST integrations. Results from HadGEM3 are preliminary and may be revised before they are made publicly available. Shortwave forcing at the top of atmosphere is so small that inferences of cloud masking are quite uneven across models.

	HadGEM3-GC31-LL	IPSL-CM6A-LR	GFDL-CM4		
experiment	amip	historical	4xCO2	GHG	anthro
LW TOA	0.764	0.735	0.763	0.757	0.767
LW SFC	0.622	0.608	0.696	0.689	0.680
SW SFC	0.718	0.732	0.711	0.853	0.714

Table S3. Global-mean clear-sky stratospheric adjustment, in $\mathrm{W\,m^{-1}}$, to stratospheric cooling computed assuming that the dynamical heating of the stratosphere. The GFDL GRTCODE line-by-line model is used to compute heating rates under the various

Experiment	LW TOA	LW SFC	SW TOA	SW SFC
Present-day	0.933	-0.062	-0.000	0.000
Future	3.324	-0.148	-0.000	0.001
Last Glacial Maximum	-0.841	0.069	0.000	-0.000
Present-day CO_2	0.779	-0.045	-0.000	0.000
Present-day CH_4	-0.031	0.002	-0.000	0.000
Present-day N_2O	0.007	-0.001	-0.000	0.000
Present-day O_3	0.244	-0.020	0.000	0.000
Present-day halocarbons	-0.062	0.004	-0.000	0.000
$\frac{1}{2}\times CO_2$	-1.430	0.116	0.000	-0.000
$2\times CO_2$	1.679	-0.085	-0.000	0.001
$3\times CO_2$	2.786	-0.122	-0.000	0.001
$4\times CO_2$	3.629	-0.144	-0.000	0.001
$8\times CO_2$	5.854	-0.181	-0.000	0.002