Table S1. Look-up table for Cullen et al. (1992) used to compute E^*_{inh} for diatoms.

Spectral Number	λ_1	λ_2	$\varepsilon(\lambda)$
1	279.902	280.732	9.83E-03
2	280.732	281.562	9.16E-03
3	281.562	282.392	8.50E-03
4	282.392	283.222	7.85E-03
5	283.222	284.052	7.21E-03
6	284.052	284.882	6.57E-03
7	284.882	285.712	5.95E-03
8	285.712	286.542	5.33E-03
9	286.542	287.37	4.65E-03
10	287.37	288.199	4.18E-03
11	288.199	289.027	3.61E-03
12	289.027	289.855	2.84E-03
13	289.855	290.708	2.27E-03
14	290.708	291.56	1.81E-03
15	291.56	292.413	1.59E-03
16	292.413	293.265	1.36E-03
17	293.265	294.118	1.19E-03
18	294.118	294.996	1.05E-03
19	294.996	295.874	9.70E-04
20	295.874	296.751	8.72E-04
21	296.751	297.629	8.09E-04
22	297.629	298.507	7.28E-04
23	298.507	299.412	6.66E-04
24	299.412	300.316	6.06E-04
25	300.316	301.221	5.53E-04
26	301.221	302.125	4.94E-04
27	302.125	303.03	4.48E-04
28	303.03	303.962	4.08E-04
29	303.962	304.895	3.61E-04
30	304.895	305.827	3.16E-04
31	305.827	306.76	2.83E-04

32	306.76	307.692	2.55E-04
33	307.692	308.654	2.27E-04
34	308.654	309.615	1.97E-04
35	309.615	310.577	1.77E-04
36	310.577	311.538	1.54E-04
37	311.538	312.5	1.36E-04
38	312.5	313.5	1.22E-04
39	313.5	314.5	1.09E-04
40	314.5	315.5	9.93E-05
41	315.5	316.5	9.04E-05
42	316.5	317.5	8.43E-05
43	317.5	318.5	7.67E-05
44	318.5	319.5	7.11E-05
45	319.5	320.5	6.70E-05
46	320.5	321.5	6.30E-05
47	321.5	322.5	5.87E-05
48	322.5	323.5	5.63E-05
49	323.5	324.5	5.33E-05
50	324.5	325.5	5.11E-05
51	325.5	326.5	4.89E-05
52	326.5	327.5	4.78E-05
53	327.5	328.5	4.61E-05

Table S2. List of experiments.

Casename	UV radiation forcing	CO_2 concentration	Notes
cw4_nw_cntrl_tuvcpl_waccm6_4p2z_CullenNealeLorenzo_EinhPI	E*inh(PI)	284 ppm	Fully coupled simulation used to force physics of several DATM simulations.
CESM214_tuvcpl_datm_marbl4p2z_CNL_PICPOC_Einh0	E*inh(0)	284 ppm	Offline simulation forced by cw4_nw_cntrl_tuvcpl_waccm6_4p2z_CullenNealeLorenzo_EinhPI.
CESM214_tuvcpl_datm_marbl4p	E*inh(PI)	284 ppm	

2z_CNL_PICPOC_EinhPI			
CESM214_tuvcpl_datm_marbl4p2z_CNL_PICPOC_Einh20xPI	E*inh(20x PI)	284 ppm	
cw4_nw_cntrl_tuvcpl_datm_4p2z_CullenNealeLorenzo_Einh0_400ppm	E*inh(0)	400 ppm	
cw4_nw_cntrl_tuvcpl_datm_4p2z_CullenNealeLorenzo_Einh0_400ppm	E*inh (PI)	400 ppm	
cw4_nw_cntrl_tuvcpl_datm_4p2z_CullenNealeLorenzo_Einh0_400ppm	E*inh(20x PI)	400 ppm	
cw4_nw_cntrl_tuvcpl_datm_4p2z_CullenNealeLorenzo_Einh0_600ppm	E*inh(0)	600 ppm	
cw4_nw_cntrl_tuvcpl_datm_4p2z_CullenNealeLorenzo_Einh0_600ppm	E*inh (PI)	600 ppm	
cw4_nw_cntrl_tuvcpl_datm_4p2z_CullenNealeLorenzo_Einh0_600ppm	E*inh(20x PI)	600 ppm	
cw4_nw_cntrl_tuvcpl_datm_4p2z_CullenNealeLorenzo_Einh0_700ppm	E*inh(0)	700 ppm	
cw4_nw_cntrl_tuvcpl_datm_4p2z_CullenNealeLorenzo_Einh0_700ppm	E*inh (PI)	700 ppm	
cw4_nw_cntrl_tuvcpl_datm_4p2z_CullenNealeLorenzo_Einh0_700ppm	E*inh(20x PI)	700 ppm	

cw4_nw_cntrl_tuvcpl_datm_4p2z_CullenNealeLorenzo_Einh0_900ppm	E*inh(0)	900 ppm	
cw4_nw_cntrl_tuvcpl_datm_4p2z_CullenNealeLorenzo_Einh0_900ppm	E*inh (PI)	900 ppm	
cw4_nw_cntrl_tuvcpl_datm_4p2z_CullenNealeLorenzo_Einh0_900ppm	E*inh(20x PI)	900 ppm	

Supplemental Text

Supplemental Information: Phytoplankton Validation

The 4p2z simulations used here are also within 15% of present day NPP for CESM2-MARBL in a "3p1z" (3 phytoplankton, 1 zooplankton) simulation, reported as 48.9 Pg C yr^{-1} by Long et al. (2021), and are nearly identical to NPP reported in CESM1-BEC (55.9 Pg C yr^{-1}).

Sensitivity tests using 3p1z and 4p1z MARBL configurations without UV inhibition showed that moving from an implicit to an explicit coccolithophore functional type increased annual mean globally integrated NPP from 48.9 Pg C yr^{-1} to 56 Pg C yr^{-1}, still well within the range of model and satellite estimates. Adding an additional zooplankton functional type in 4p2z reduced the amplitude of seasonal phytoplankton blooms, correcting the tendency for seasonal blooms to be exaggerated due to the inability of one zooplankton functional type to control exponential phytoplankton growth. Globally integrated NPP was changed by less than 1% between 4p2z and 4p1z.

Supplemental Information: Phytoplankton Under Ozone Hole Stress

Low annual mean global sensitivity to 'ambient' UV radiation is consistent with the expectation that pre-industrial UV radiation should not significantly impact NPP. Observational studies of regional phytoplankton productivity changes in response to ambient UV radiation range from a 0.15\% annual mean reduction in NPP south of the Polar Front in the Southern Ocean (Helbling: et al., 1992) to a 4% to 7% reduction in NPP during austral spring across the Southern Ocean (Prezelin et al., 1994b). Smith et al. (1992) found a 3% reduction in a population of *Phaeocystis* when exposed to typical UV radiation levels, equivalent to an ozone layer with a thickness of 350 dobson units (DU), which is within the range of E*inh(PI). In the E*inh(PI) simulation, some parts of the Southern Ocean experience up to an 8% decline in NPP, adjacent to areas with an equally large increase in productivity. However, on average the Southern Ocean experiences a

1% to 2% decline in annual mean productivity, which is on the lower end of observational studies within the Southern Ocean. Precise validation is made difficult by the large uncertainty range, primarily due to a lack of information regarding how phytoplankton across most of the world, which does not experience an ozone hole, would be impacted by a sudden pulse of UV radiation.

Supplemental Figures

Figure S1. Coccolithophore net primary productivity for simulations with E*inh(0), E*inh(PI), E*inh(20x PI) with and without PIC/POC scaling. Dashed lines represent simulations with PIC/POC scaling. CO_2 is 284 ppm for all simulations. Text in legend indicates annual mean coccolithophore integrated NPP.