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Meeting climate targets by direct CO_2 injections: what price would the ocean have to pay?

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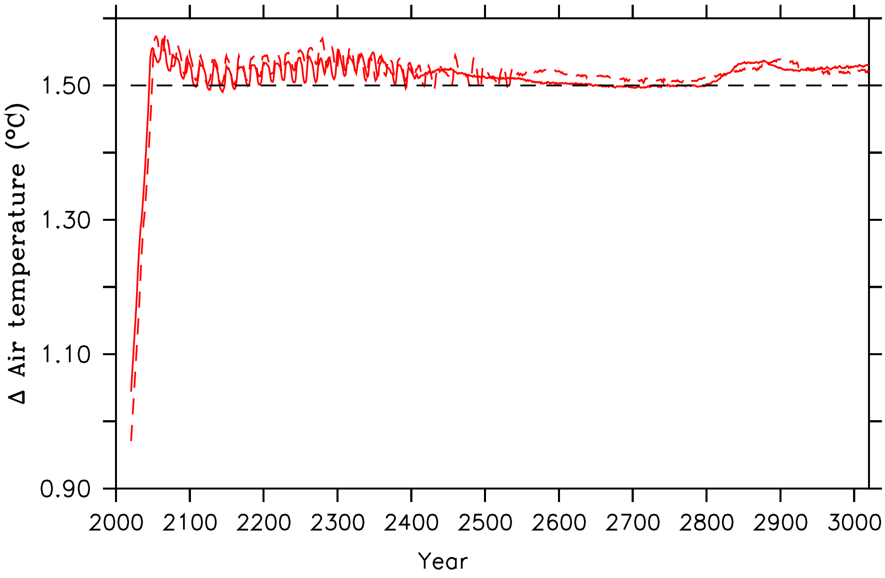

Figure S1: Global mean surface air temperature, relative to preindustrial, of the A1_Comitw simulation (solid) and the A1_Comitw_sed run (dashed). The horizontal dashed black line denotes the 1.5°C climate target.

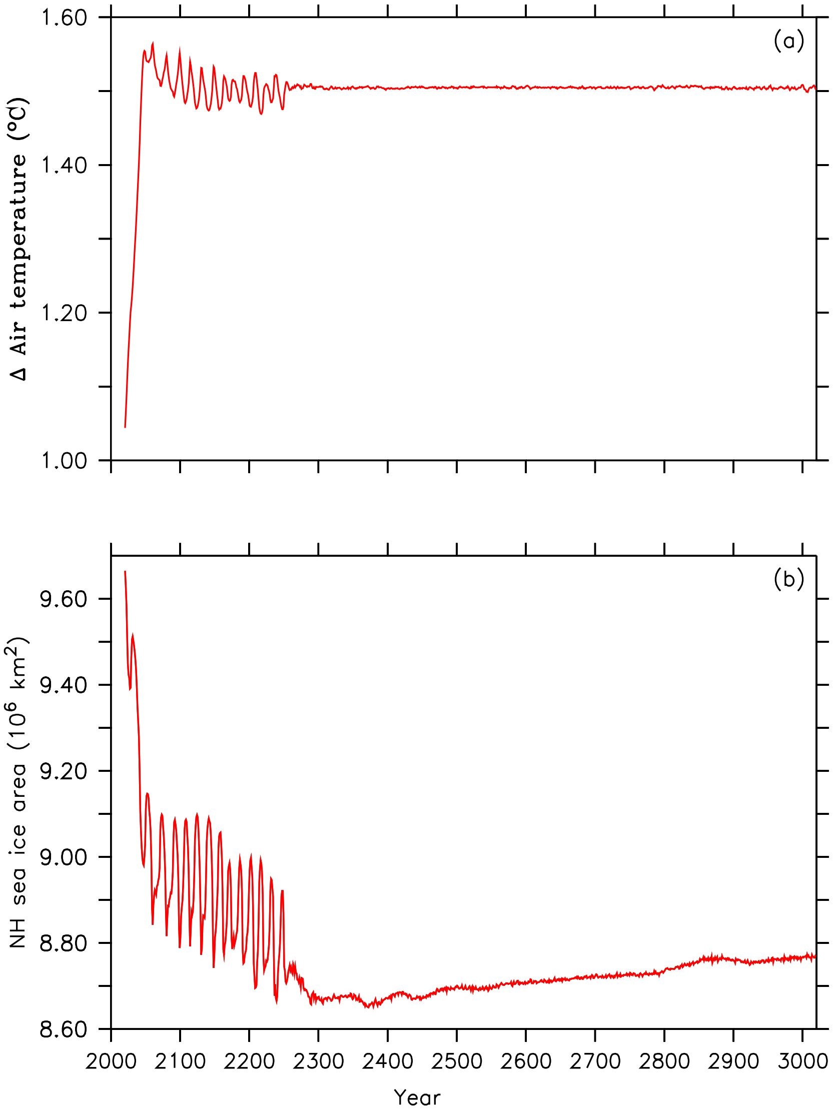

Figure S2: Time-series of the default A2 simulation for **(a)** global mean surface air temperature, relative to preindustrial, and **(b)** northern hemisphere (NH) sea ice area.

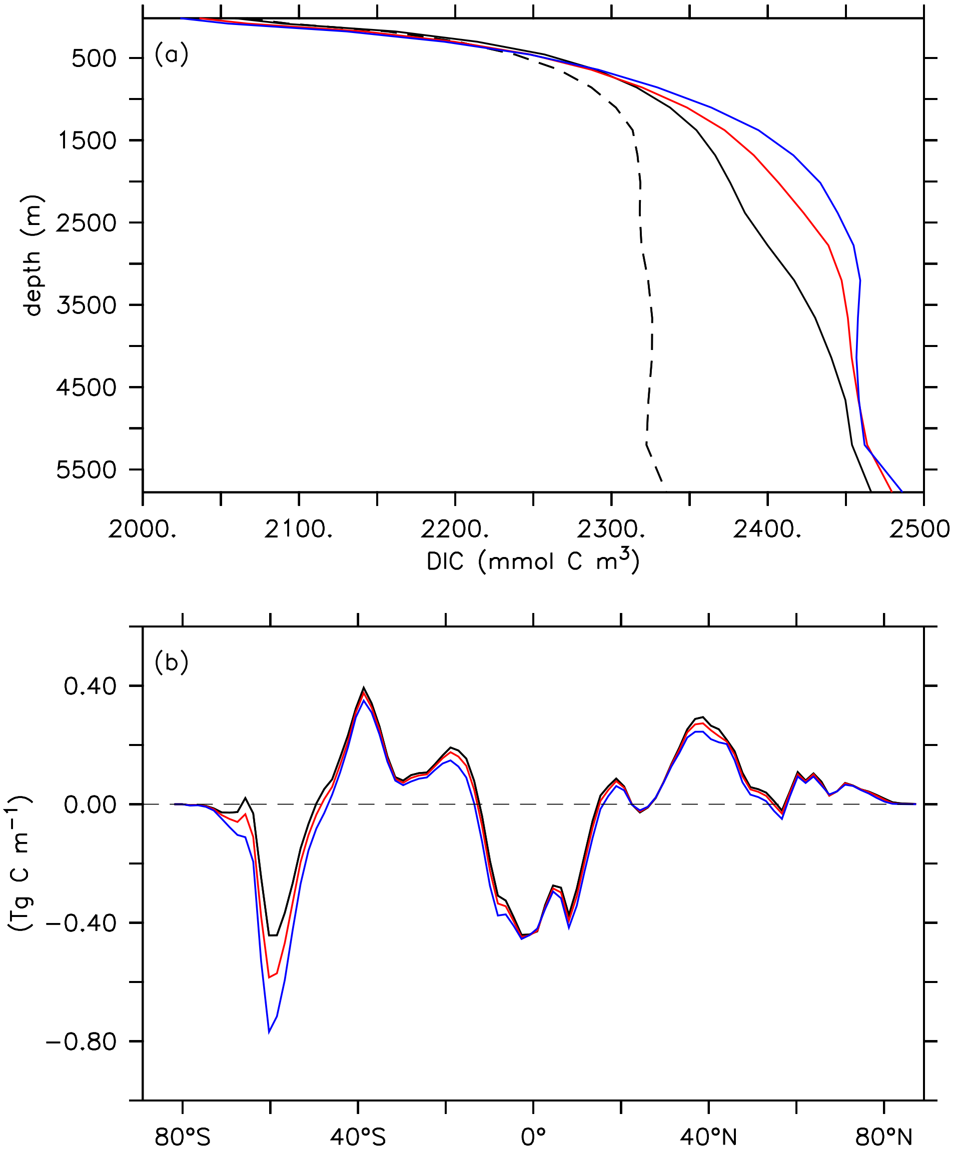

Figure S3: Comparison between the different default injection experiments, i.e., A1 simulation (black lines), A2 simulation (red lines) and the A3 simulation (blue lines) for **(a)** global mean profile of DIC in year 2020 (dashed black line) and global mean profiles in year 3020 (solid lines), and **(b)** cumulative atmosphere-to-ocean carbon flux in year 3020.

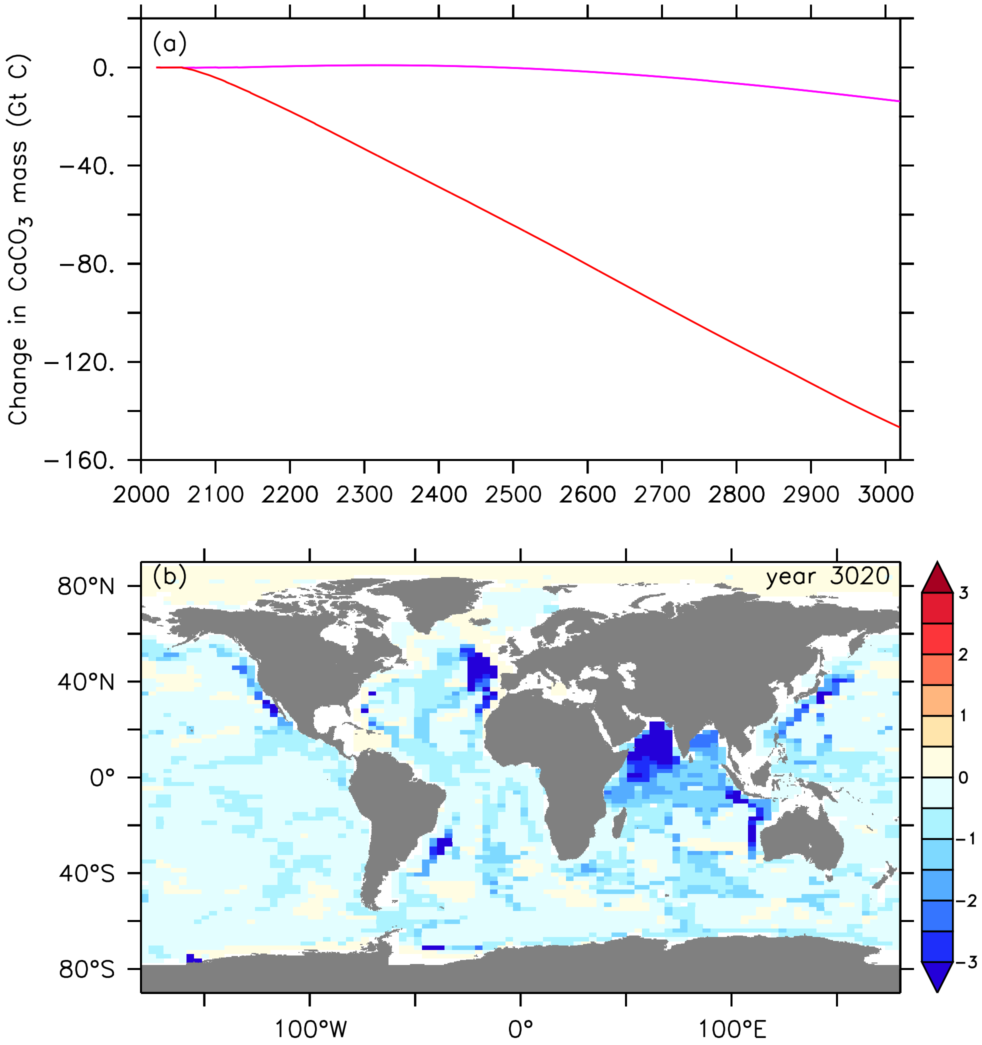

Figure S4: (a) Time-series of change in CaCO$_3$ mass for the RCP 4.5 control_sed simulation (purple line) and the A2_sed run, relative to the year 2020, and **(b)** global distribution of change in CaCO$_3$ mass (Kg C/m^2) in the 1.5°C_target_sed run (year 3020 minus year 2020).

1. Evolution of aragonite saturation horizon

With respect to the evolution of the aragonite saturation horizon ($\Omega_{AR}=1$, ASH) after the beginning of the RCP 4.5 control run (Fig. S5), we observe that the ASH is mainly affected in down- and upwelling regions by the year 2100 (Fig. S6). This is caused by the deeper penetration and higher concentrations of the respective CO_2 emissions (e.g., Orr et al., 2005). With respect to the *A2* experiment, we find an accelerated shoaling of the ASH in the Atlantic and smaller changes in the Pacific and Indian Ocean by the year 2100, when compared to the respective changes in the RCP 4.5 control run (Fig. S7). This can be explained by the fact that injections in the Pacific and Indian Ocean were carried out in waters already beneath the simulated ASH, which occurred at a depth of about 600 - 1200 m during the injection period (Fig. S5). This is in contrast to the Atlantic injection sites where the simulated ASH was at a depth of about 3000 m at the beginning of the simulated injections (Fig. S5), thus causing the simulated increase in the volume of undersaturated water. Consequently, the injections could have, for example, additional implications for the distribution of aragonite forming deep-sea scleractinian corals (Guinotte et al., 2006) in the Atlantic. Furthermore, it is likely that the accelerated shoaling of the saturation horizons for aragonite (and calcite) in the Atlantic due to the injections would drive a change in habitat quality for a variety of deep-sea calcifiers (Orr et al., 2005). By the end of the simulations (year 3020), we observe similar changes in the ASH in the RCP4.5 control run when compared to the *A2* experiment, although with a slightly higher shallowing of the ASH in the Pacific and Indian Ocean (Figs. S8-9). We find nearly the same evolution pattern of the ASH in the *A3* experiment (not shown).

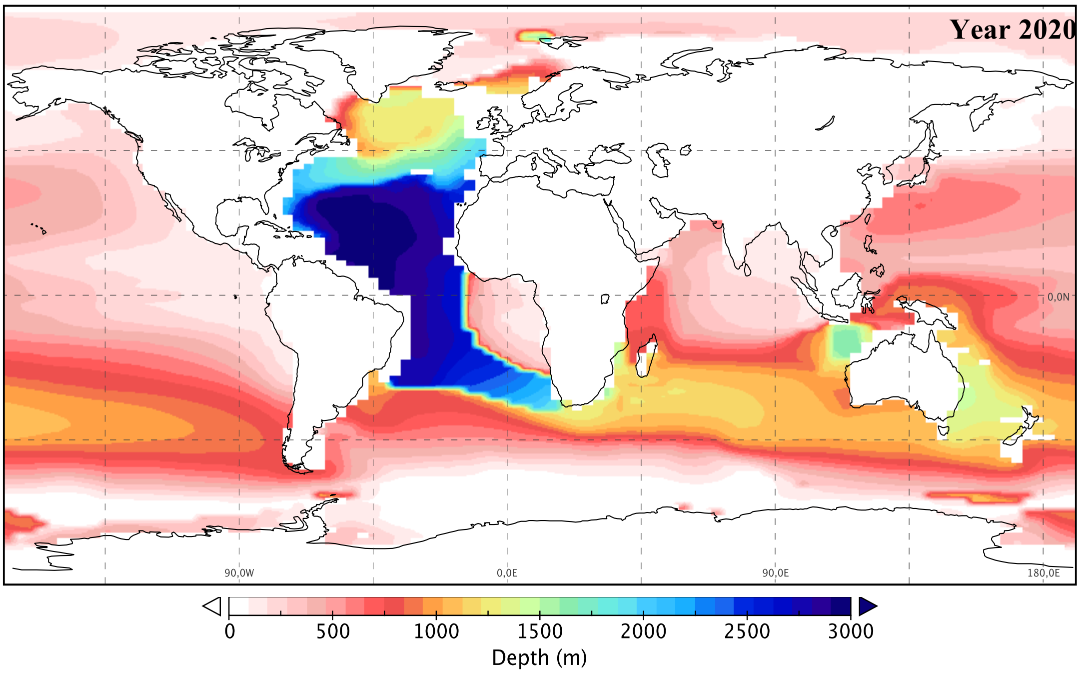

Figure S5: Depth of aragonite saturation horizon (ASH) at the beginning of the RCP 4.5 control run (year 2020).

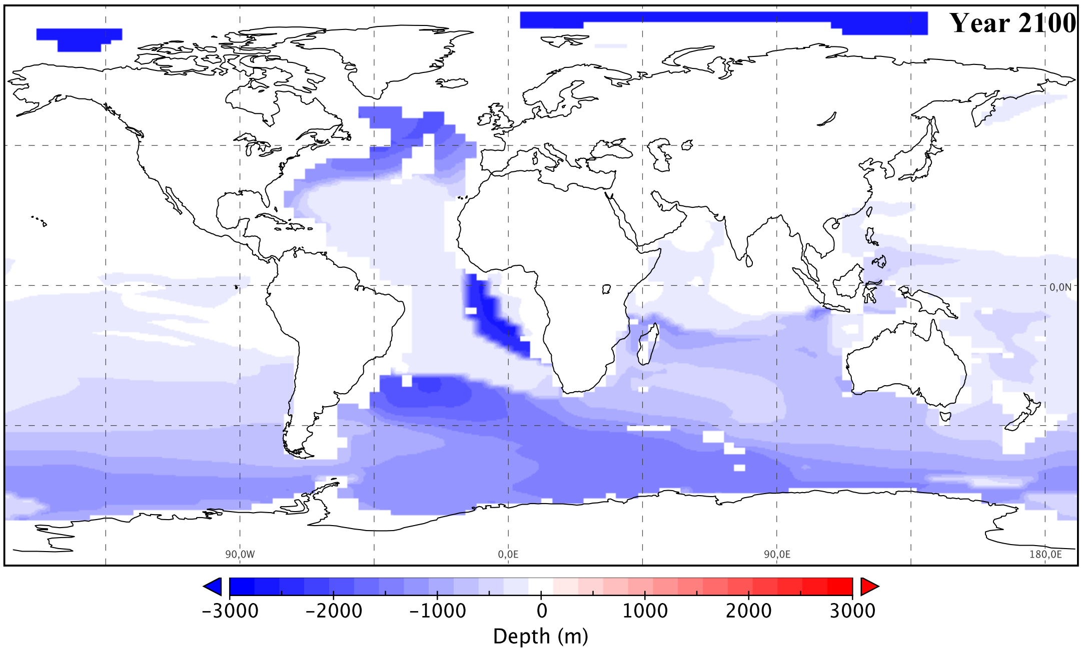

Figure S6: Relative changes in depth of aragonite saturation horizon (ASH) in the RCP 4.5 control run in 2100, i.e., year 2100 minus year 2020.

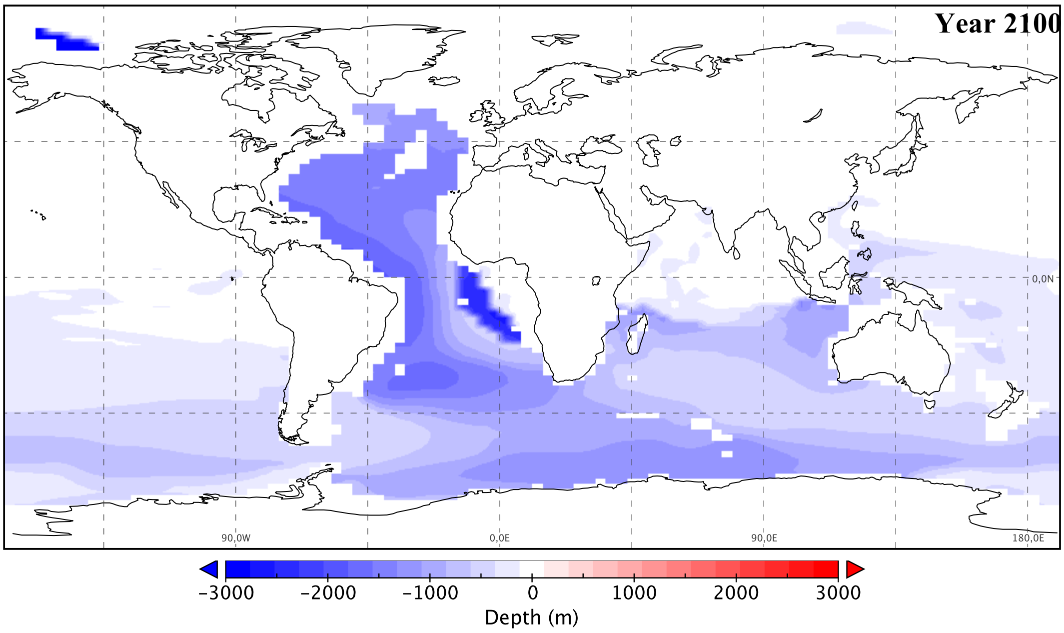

Figure S7: Relative changes in depth of aragonite saturation horizon (ASH) between the A2 simulation (year 2100) and the RCP 4.5 control run (year 2020).

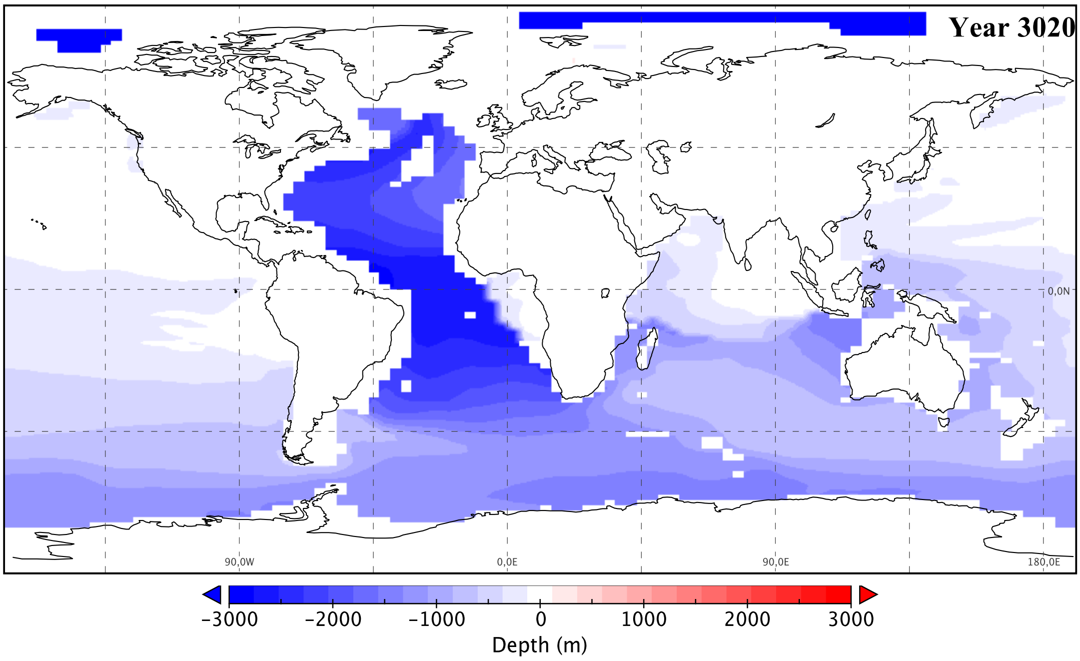

Figure S8: Relative changes in depth of aragonite saturation horizon (ASH) in the RCP 4.5 control run in 3020, i.e., year 3020 minus year 2020.

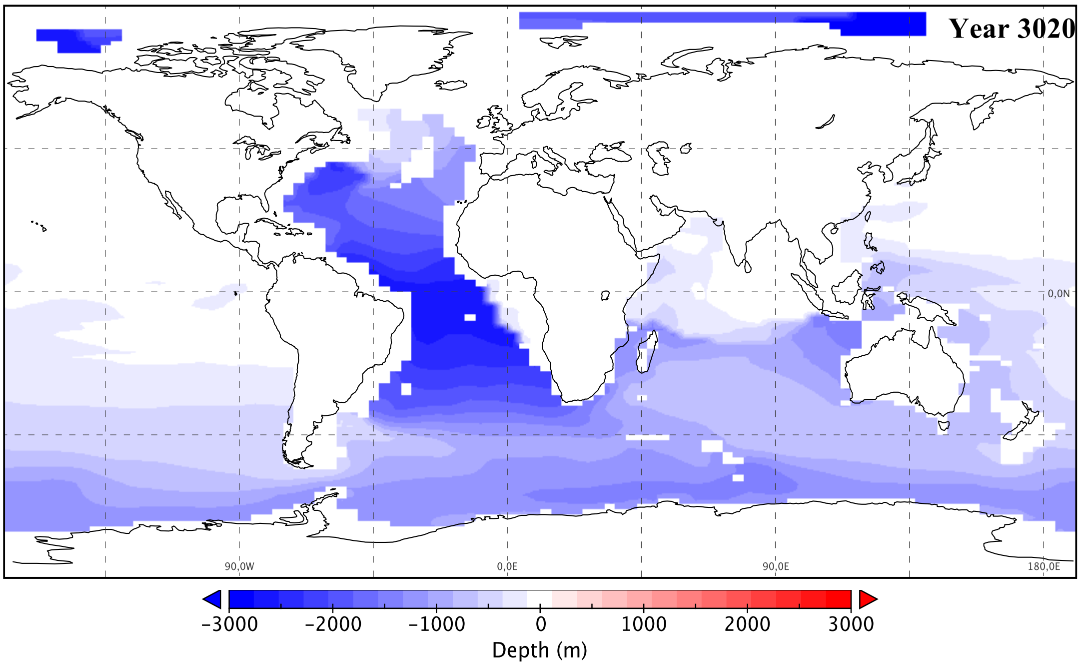

Figure S9: Relative changes in depth of aragonite saturation horizon (ASH) between the A2 simulation (year 3020) and the RCP 4.5 control run (year 2020).

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Guinotte, J. M., Orr, J., Cairns, S., Freiwald, A., Morgan, L. and George, R.: Will human-induced changes in seawater chemistry alter the distribution of deep-sea scleractinian corals?, Front. Ecol. Environ., 4(3), 141–146, doi:10.1890/1540-9295(2006)004[0141:WHCISC]2.0.CO;2, 2006.

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