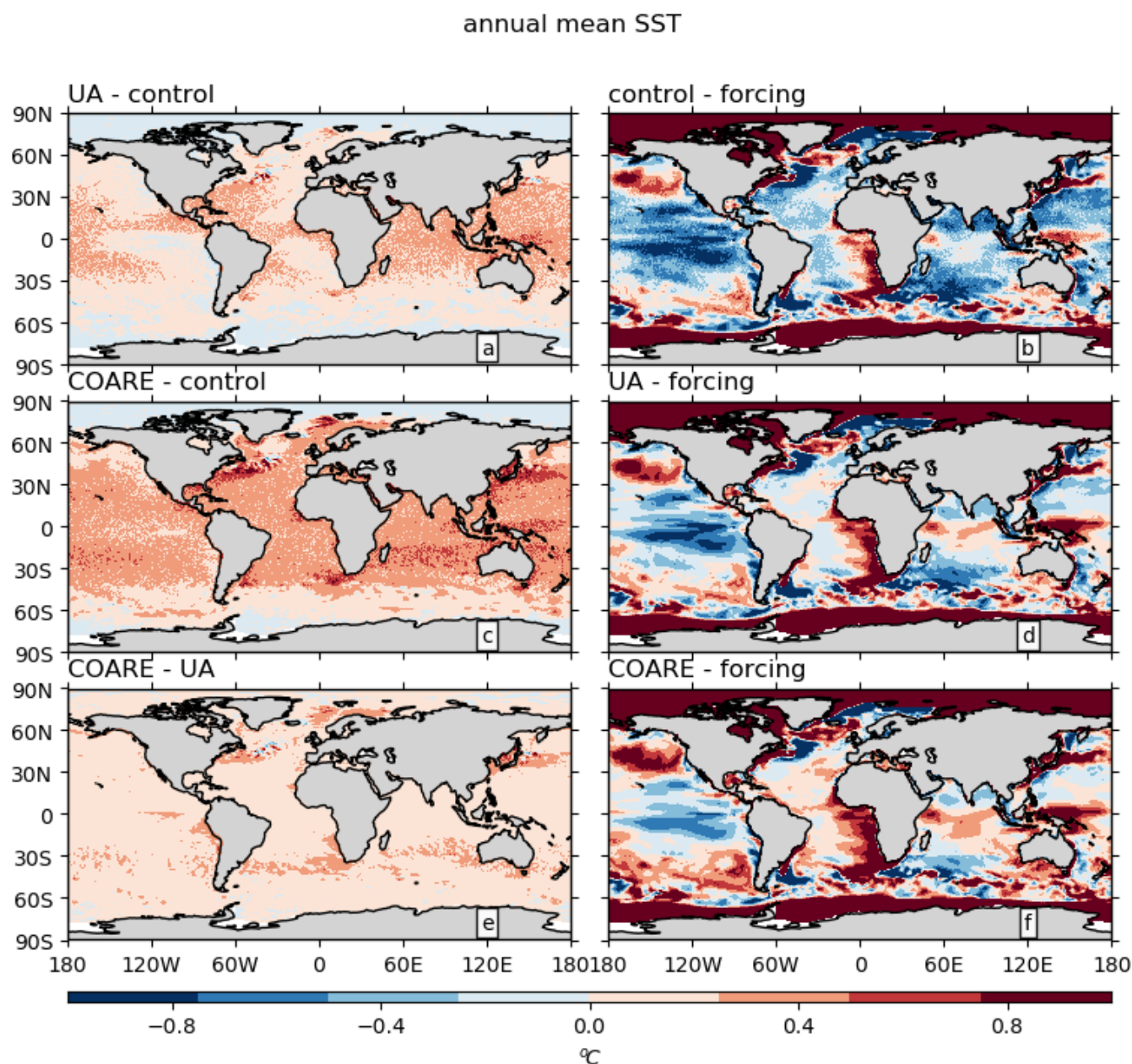
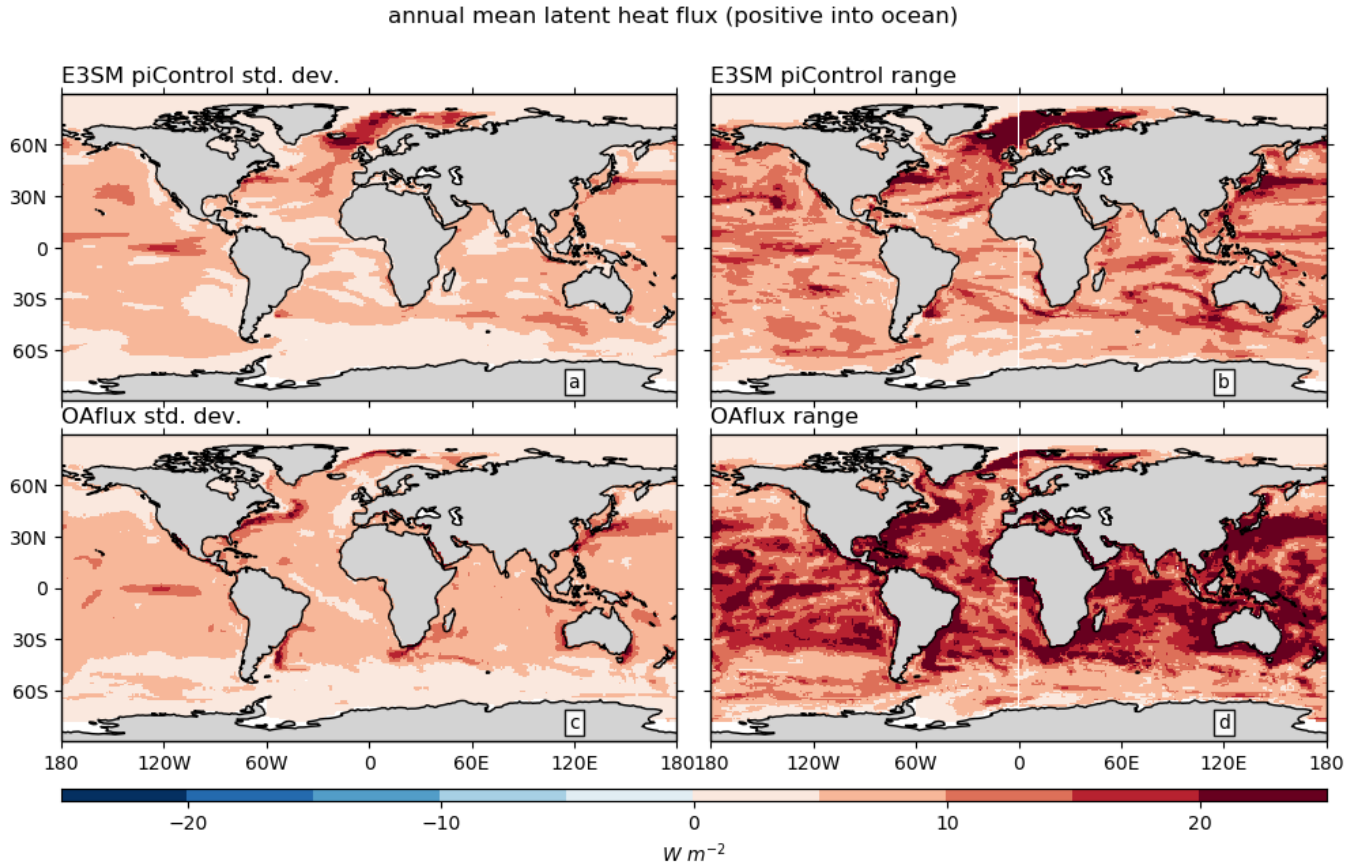


## Supplementary Material

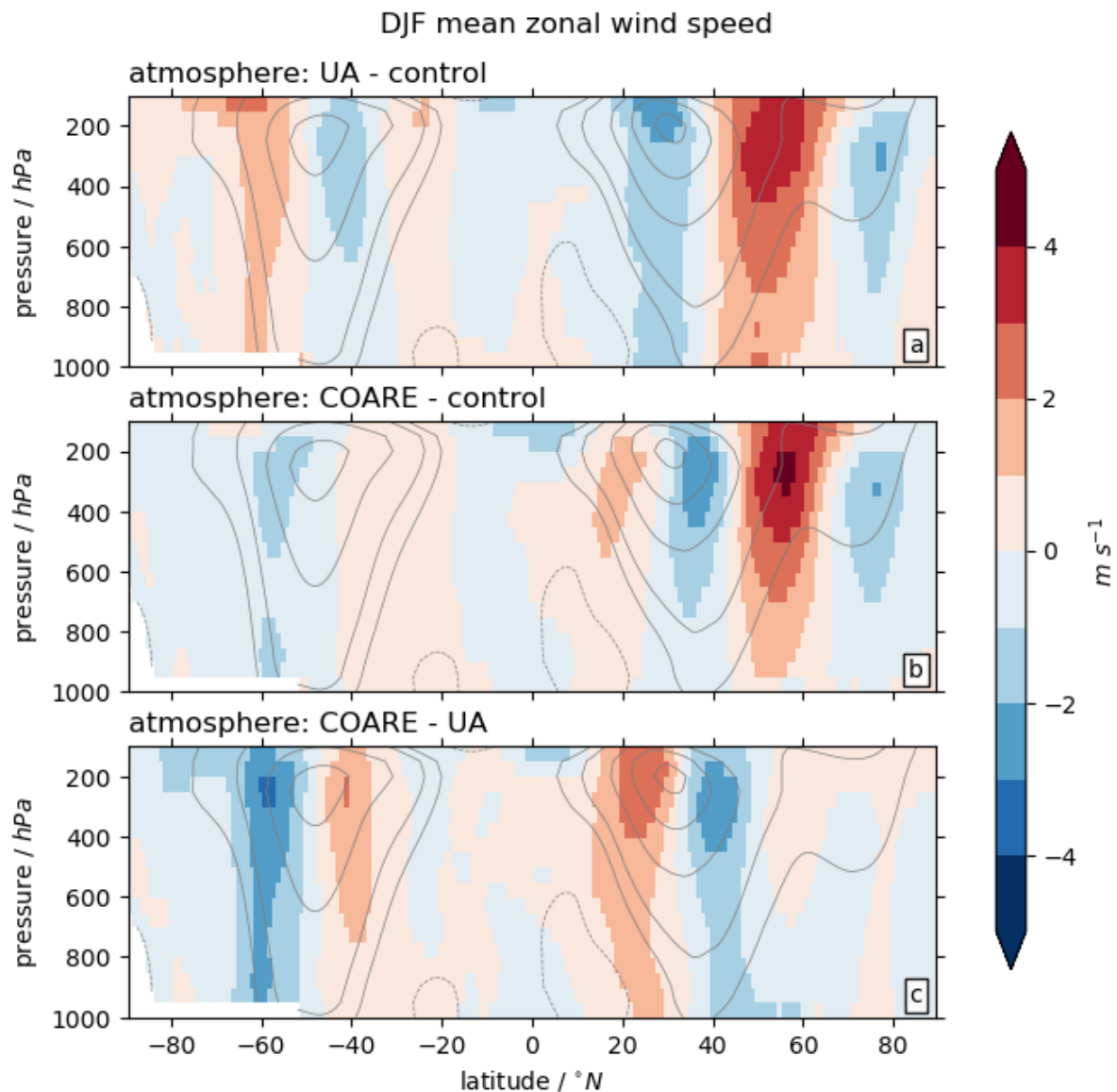
### 1 SUPPLEMENTARY FIGURES



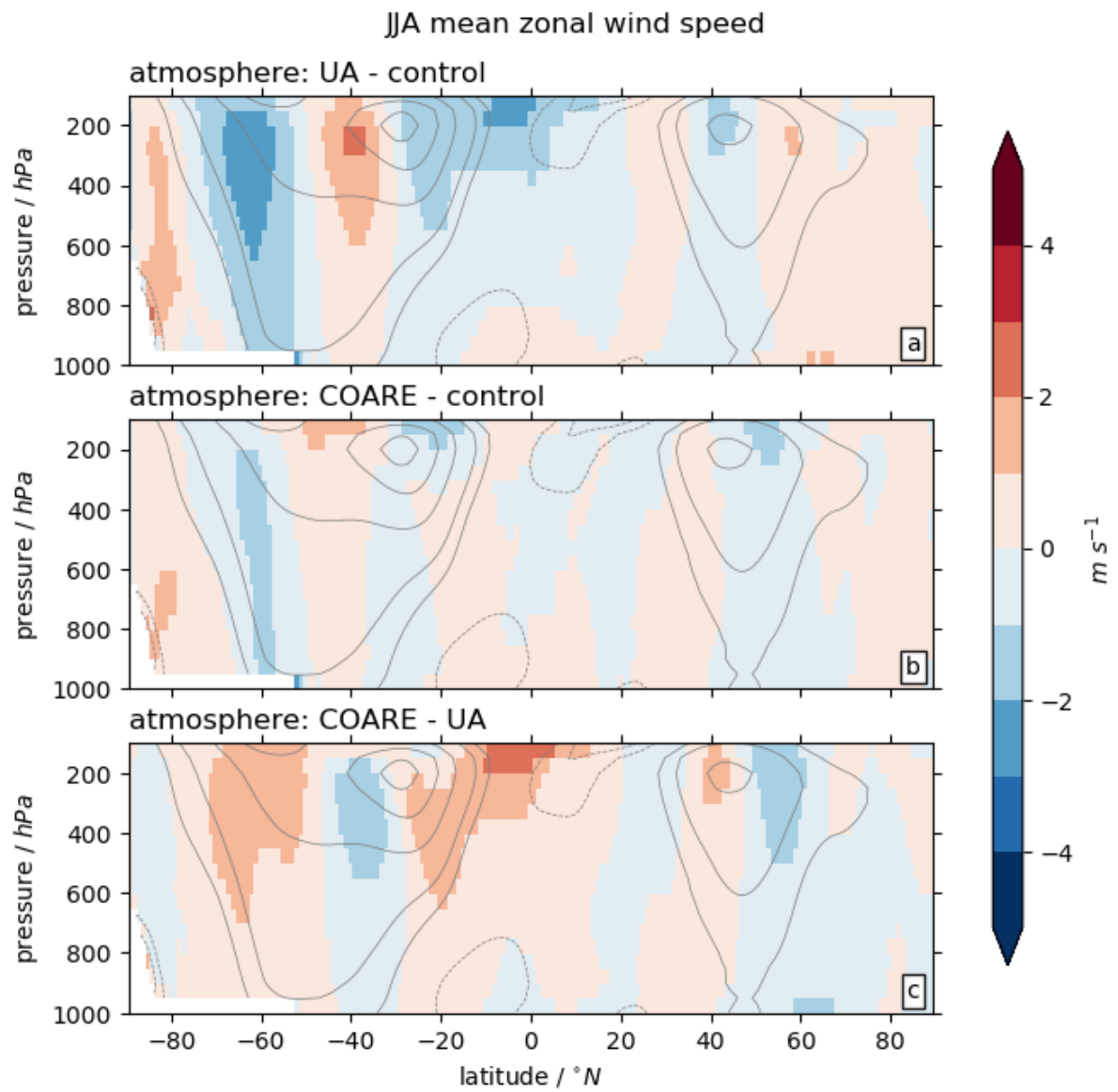
**Figure S1.** Annual mean surface temperature difference between (left column) pairs of ocean model runs and (right column) ocean model runs and forcing data used in the atmosphere model runs. The same observation-based surface temperature forcing is used for all three atmosphere model runs. The large differences in polar regions in the right column are due to the fact that the forcing data represents the temperature of the surface in contact with the atmosphere — ocean or sea ice — while the ocean model results are ocean water temperature everywhere.



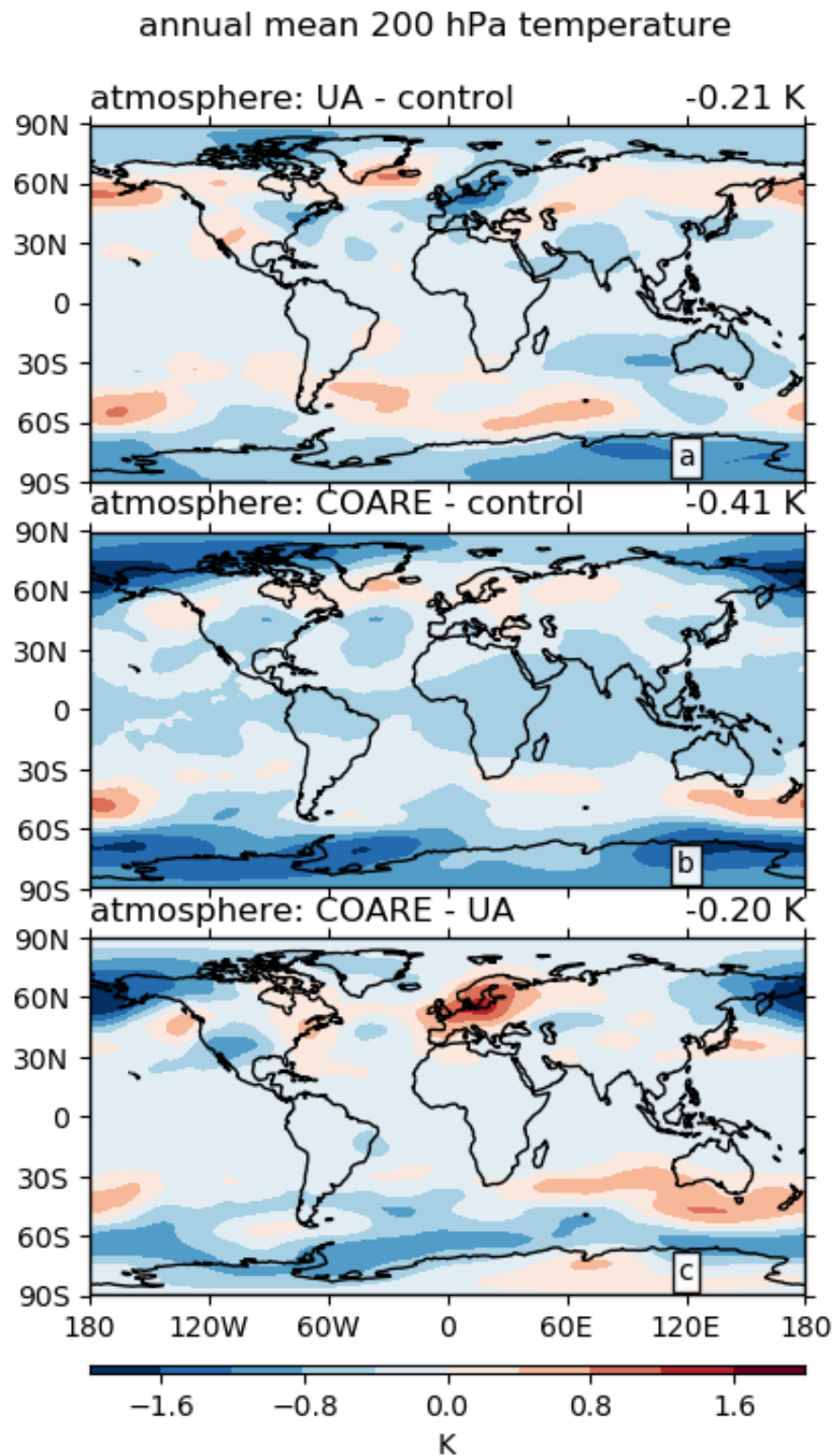
**Figure S2.** Measures of annual mean latent heat flux variability: (top left) interannual standard deviation from E3SMv1 pre-industrial control run, years 401-500; (top right) range (maximum minus minimum) of non-overlapping 5-year means (401-405; 406-410; ... 496-500) from E3SMv1 pre-industrial control run; (bottom left) interannual standard deviation from OAflux, years 1958-2018; (bottom right) range of non-overlapping 5-year means (1958-1962; 1963-1967; ...2013-2017) from OAflux.



**Figure S3.** Pressure-latitude section of December to February zonal mean wind differences from atmosphere simulations: (top) UA minus control, (middle) COARE minus control and (bottom) COARE minus UA. Contours of zonal mean wind speed from the control atmosphere simulation are overlaid on each panel: contours are at speeds of 5, 10, 20, 30 and 40  $m s^{-1}$  with solid lines for positive values and dashed lines for negative. The sign convention is that positive values mean eastward winds.

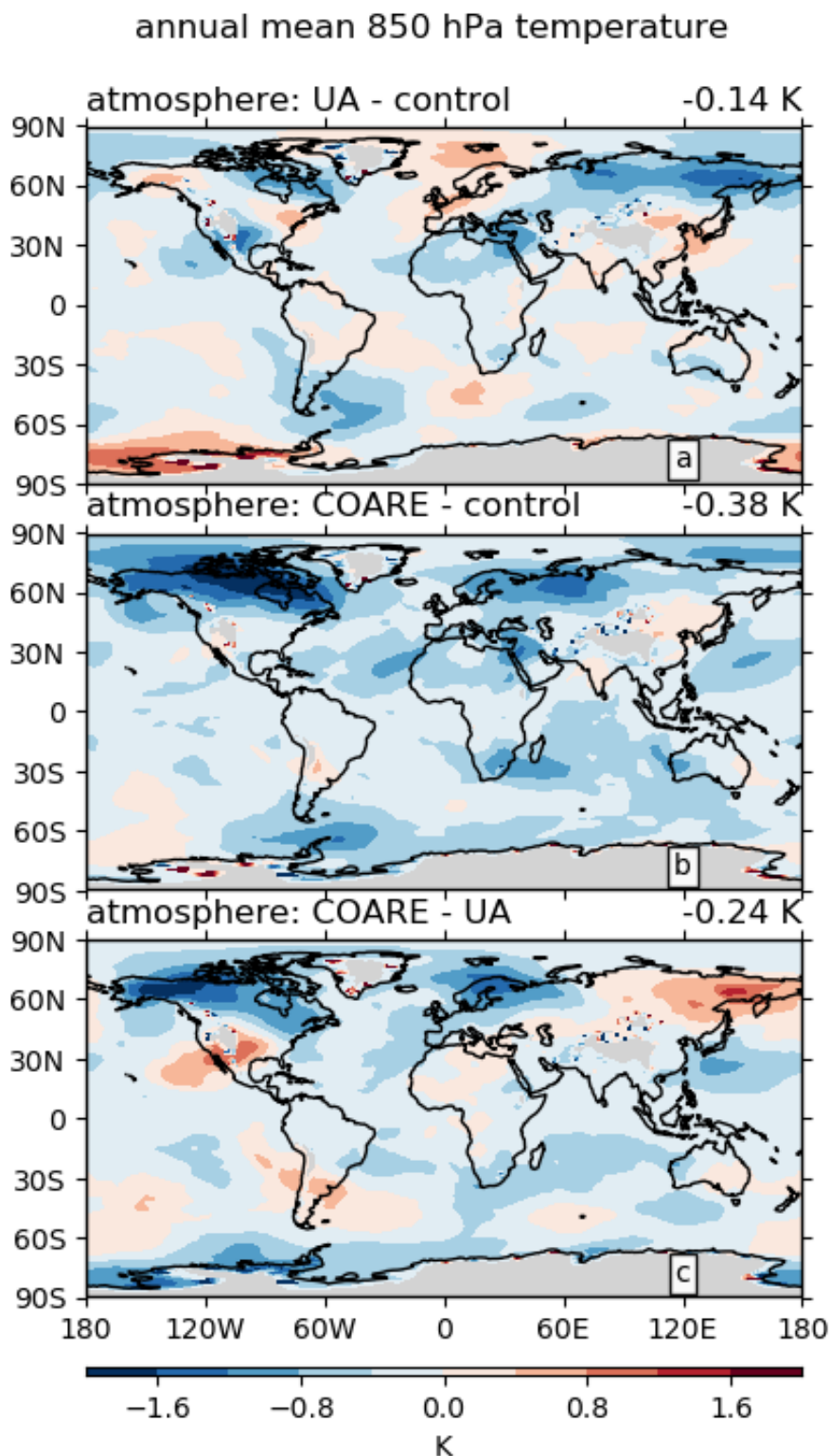


**Figure S4.** The same as Figure S4 except for June to August zonal mean wind differences.

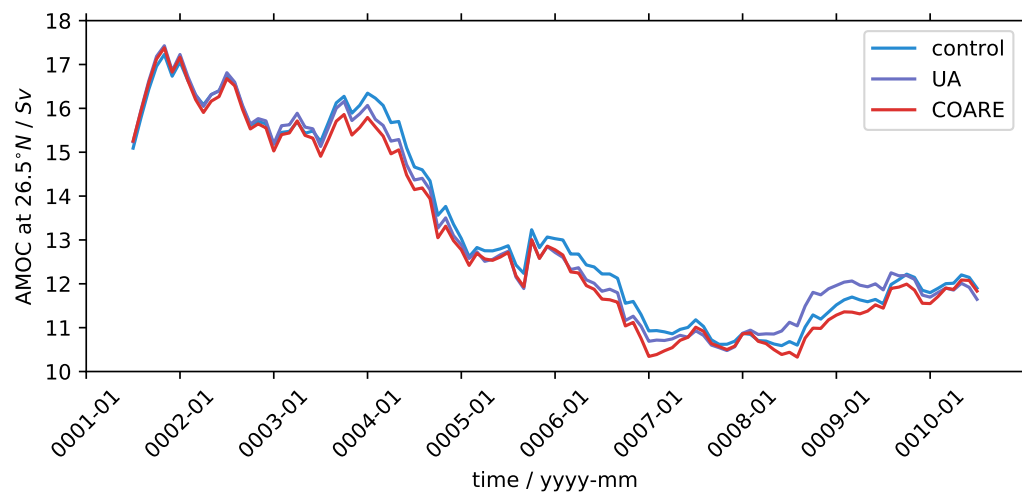


**Figure S5.** Annual mean temperature differences at 200 hPa from atmosphere simulations: (top) UA minus control, (middle) COARE minus control and (bottom) COARE minus UA. The global mean of each field is given at the top right of each panel.





**Figure S6.** Annual mean temperature differences at 850 hPa from atmosphere simulations: (top) UA minus control, (middle) COARE minus control and (bottom) COARE minus UA. The global mean of each field is given at the top right of each panel.



OcnAMOC\_timeseries.py up to date with last commit: 965d5b6c44a45e59efe4e07ca8c0fe9479f785d1

**Figure S7.** Maximum Atlantic meridional overturning circulation at 26.5 °N over the course of ocean simulations. A 12-month running mean filter has been applied. Units are Sverdrups: 1 Sverdrup =  $10^6 \text{ m}^3 \text{ s}^{-1}$ .