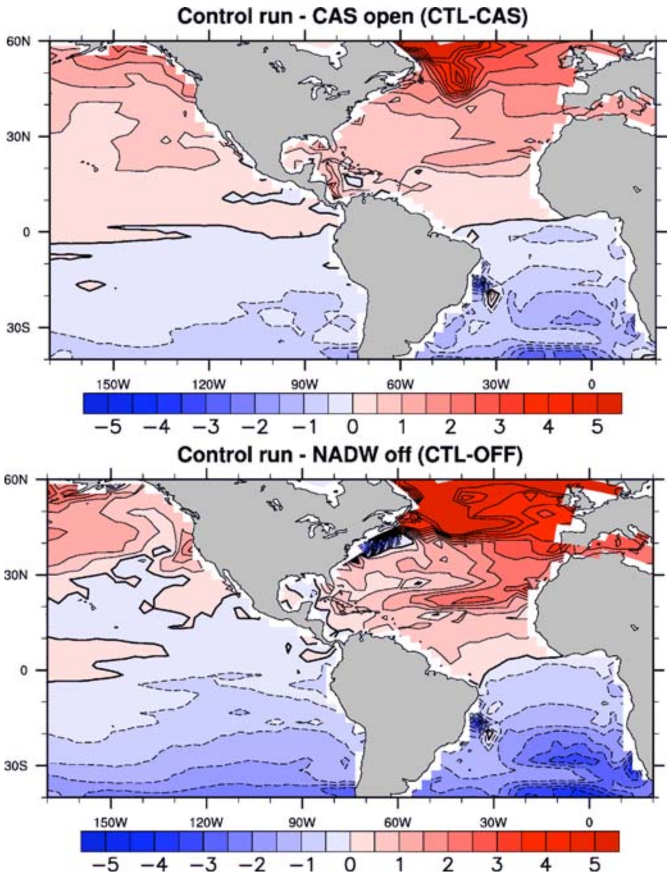
Supplementary information

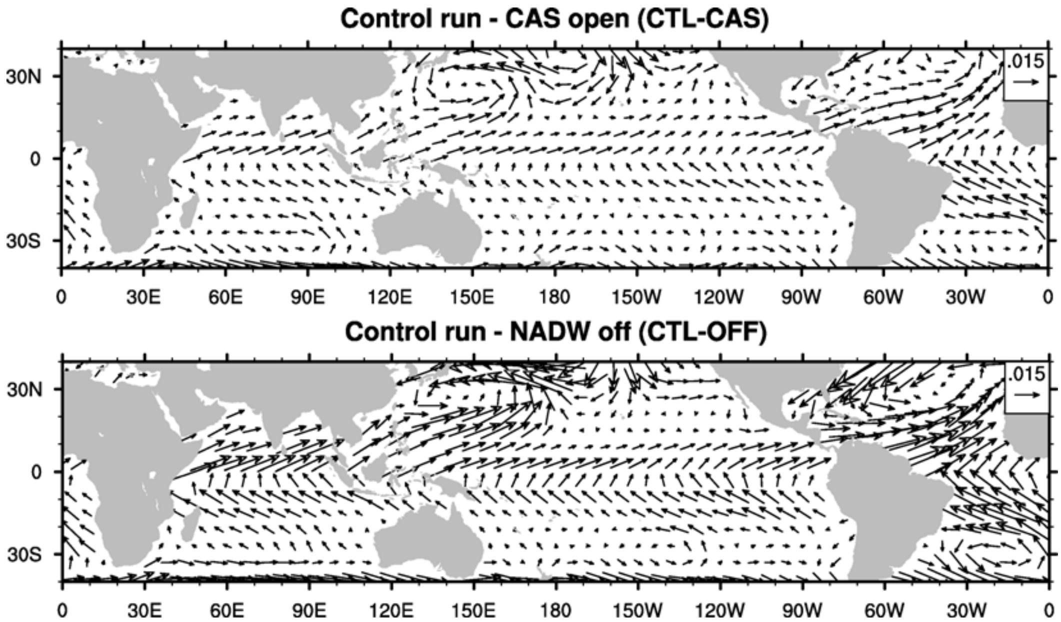
Assessing the influence of wind-stress changes on Pacific thermocline depth

Cooling of the North Atlantic induced by a weakening of the AMOC does not only affect the atmospheric circulation in the North Atlantic realm. *Zhang and Delworth* [2005] identified an "atmospheric bridge" that conveys a cooling signal from the tropical North Atlantic to the Pacific via the Central American region. As a result, trade winds intensify over the northeastern tropical Pacific and a southward surface wind anomaly is induced across the equator. In addition, strong cooling over the North Atlantic may excite a large-scale stationary wave pattern, resulting in an anomalous cyclonic surface wind over the extratropical North Pacific [*Zhang and Delworth*, 2005]. Hence, changes in surface wind-stress cannot be ruled out *a priori* as a factor in modifying the Pacific TCD. In the following, however, we demonstrate that wind-stress effects do *not* account for the changes in eastern equatorial Pacific TCD found in the ECBILT-CLIO model experiments, supporting our explanation of an internal oceanic adjustment process [*Timmermann et al*., 2005] that determines the depth of the eastern Pacific tropical thermocline.

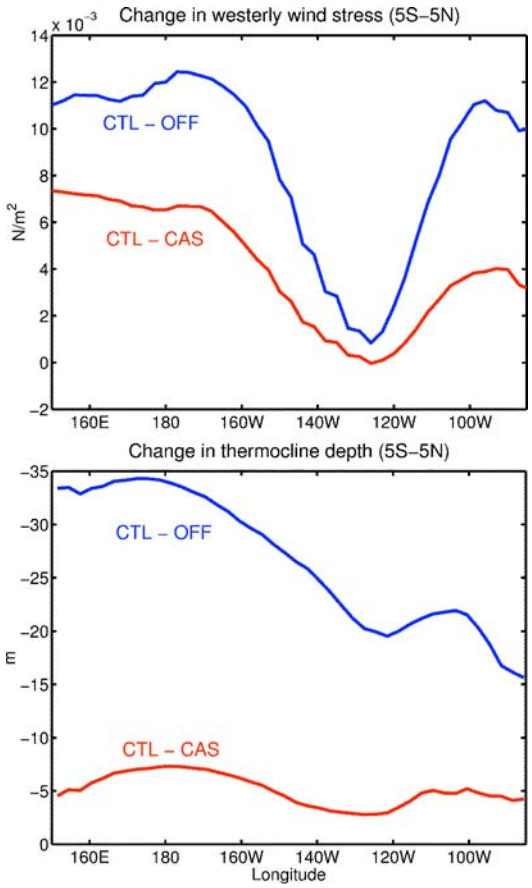
Suppl.-Fig. 1 shows differences in sea-surface temperature for CTL minus CAS (top) and CTL minus OFF (bottom). The warming of the North Atlantic realm in response to AMOC intensification is clearly visible in both cases. As a consequence, ECBILT-CLIO simulates both the tropical atmospheric bridge and the extratropical teleconnection between the Atlantic and Pacific oceans in both experiments CAS and OFF (note that the sign of changes is opposite as compared to *Zhang and Delworth* [2005], since we consider here the effect of AMOC *strengthening* rather than weakening). The warming of the North Atlantic in experiment CTL relative to CAS and OFF results in a weakening of the trade winds over the northeastern tropical Pacific with corresponding changes in surface wind-stress (**Suppl.-Fig. 2**). **Suppl.-Fig. 3** displays the changes in wind stress over the equatorial Pacific. Compared to experiments CAS and OFF an eastward surface stress-anomaly is found in the control run over the entire equatorial Pacific. This eastward anomaly tends to *deepen* the tropical thermocline in the eastern Pacific. Hence, wind-stress anomalies tend to work against the internal thermocline adjustment mechanism and cannot account for the eastern equatorial Pacific thermocline shoaling in response to AMOC intensification. We further note that the simulated TCD increase in the Pacific north of ~20°N (**Fig. 2**) is attributable to extratropical changes in surface wind-stress and the associated Ekman pumping.



Suppl.-Fig. 1. Differences in annual-mean sea-surface temperature (°C) between the ECBILT-CLIO present-day control run CTL and (top) experiment CAS and (bottom) experiment OFF.



Suppl.-Fig. 2. Differences in annual-mean surface wind-stress (N m^{-2}) between the ECBILT-CLIO present-day control run CTL and (top) experiment CAS and (bottom) experiment OFF.



Suppl.-Fig. 3. Eastward component of surface wind-stress anomalies over the equatorial Pacific (top) and tropical Pacific TCD (as given by the depth of the 20°C isotherm) anomalies (bottom; negative TCD anomalies represent a shoaling of the thermocline). Annual means averaged over 5°S-5°N are shown.

Timmermann, A., S.-I. An, U. Krebs, and H. Goosse (2005), ENSO suppression due to weakening of the North Atlantic thermohaline circulation, *J. Climate*, *18*, 3122–3139.

Zhang, R., and T. L. Delworth (2005), Simulated tropical response to a substantial weakening of the Atlantic thermohaline circulation. *J. Clim.*, *18(12)*, 1853-1860.