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Drastic changes in the Nordic Seas oceanic circulation and deepwater formation in a Pliocene context

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The Nordic Seas are a major area of deepwater formation, thus playing a crucial role in the global oceanic circulation. In the recent years a cooling and freshening of the Norwegian Sea has been observed (Blindheim et al., 2000), highlighting potential changes in this area linked to climate change. Here, we use climate simulations of the mid-Pliocene warm period with the NorESM-L model. This period is considered to be the last interval when Earth experienced temperatures higher than today for a sustained period of time, in equilibrium with CO_2 concentrations similar to present-day and a reduced Greenland Ice Sheet. We find that oceanic circulation in the Nordic Seas is drastically modified. The strength of the East Greenland Current is reduced, which implies less Arctic water going to the North Atlantic from the west of the Fram strait, which creates a compensating outflow current from the east of the Fram Strait to the North Atlantic along the Voring plateau (coast of Norway). The Norwegian Atlantic current is shifted westward, meaning that there is increased Atlantic water influence in the Greenland Sea, which becomes much warmer, and increased Arctic influence along Norway, which becomes colder than present. Circulation becomes anticyclonic instead of cyclonic. Circulation in the subpolar gyre is strongly reduced, together with deepwater formation on average both in the Irminger Sea and the Nordic Seas. Convection sites in the Nordic Seas shift from the eastern part to the western part. Sensitivity experiments show that these changes are not reproduced in other Pliocene contexts, such as when CO_2 is low (280 ppm) or when Barents Sea is turned to land, suggesting that the ultimate driver of these changes is higher CO_2. When Barents Sea is land, which was the reality of the Pliocene, circulation and sea-surface temperature show a good agreement with reconstructions from marine proxies (De Schepper et al., 2015). This means that NorESM-L is able to properly simulate this area, meaning that our results could have implications in terms of long-term, equilibrium response of this sensitive area as well as global deepwater formation to CO_2 rise.

References :
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