Supplementary Material : Declining Winter Heat Loss Threatens Continuing Ocean Convection at a Mediterranean Dense Water Formation Site, S. A. Josey and K. Schroeder

Robustness of Long-Term North-West Mediterranean Changes to Potential Land Influence
Our methodology has been to include all ocean grid cells, including those adjacent to land, in the regionally averaged values noted in the main text. However, we have also considered whether the NWMed heat flux weakening discussed in the paper is potentially influenced by grid cells adjacent to land at the northern boundary of the NWMed region. To do this we select a sub-region chosen to avoid the land boundary (Supp. Fig.1 lower panel).

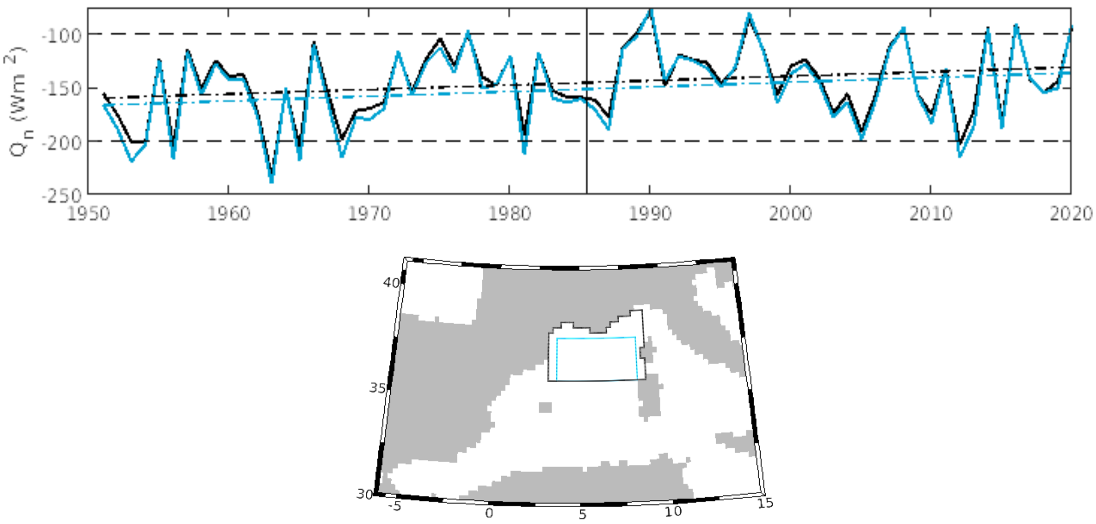
Time series of the winter mean net heat flux show a very similar variation in the sub-region to the full region (Supp. Fig.1 upper panel) with a slight offset as the heat loss in the sub-region is typically slightly stronger. The means for the two periods are:

Full Region: -154±6 Wm^{-2} in 1951-1985, -137±6 Wm^{-2} in 1986-2020.

Sub-Region: -160±6 Wm^{-2} in 1951-1985, -143±6 Wm^{-2} in 1986-2020.

These values show that the weakening of the NWMed heat loss is observed in both the full and sub-regions. So, it is clear that the presence of cells adjacent to land in the full region does not strongly influence our results.

For completeness, we have also obtained linear fits to the time series for both the full region and sub-region. The trend for the full NWM region is 0.42+/-0.20 Wm^{-2} yr^{-1} and for the sub-box is 0.44+/-0.21 Wm^{-2} yr^{-1} ; both of which are significant at 95% level. The trend for the sub-region is very close to that for the full NWM region. Note that for both regions the weakening should not necessarily be considered to follow a smooth linear trend but these results do provide a measure of the substantial changes that have taken place in the NWMed.



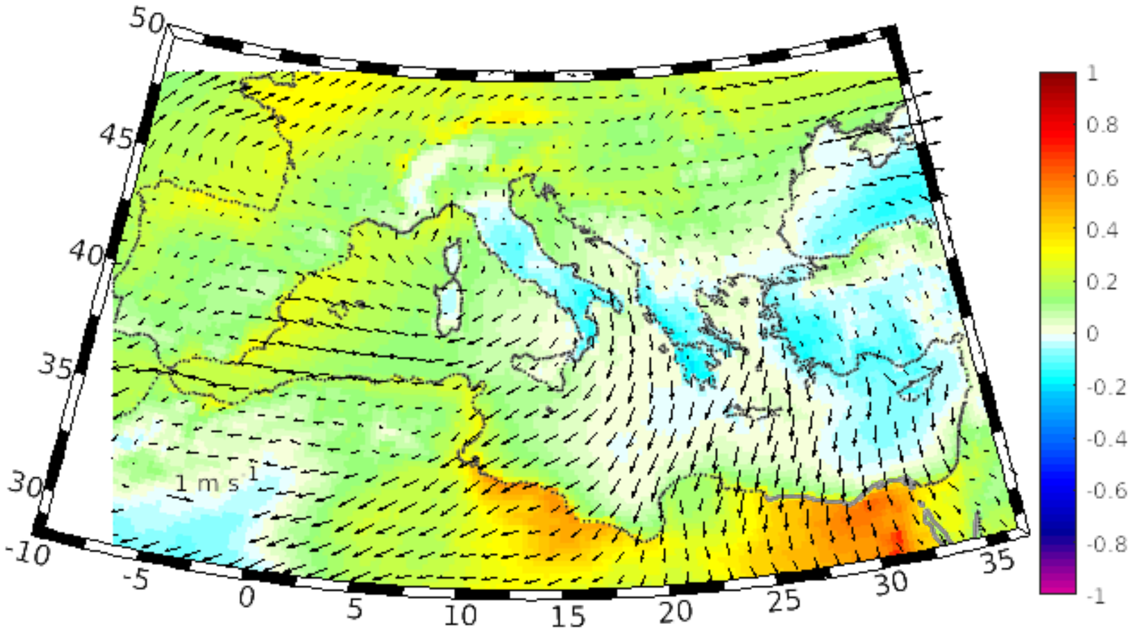
Supplementary Figure 1. Upper panel: Time series of ERA5 NWMed full region (black) and sub-region (light blue) winter Q_n. Dash-dot lines show linear fits in each case. Lower panel : The full (black outline) and sub-regions (blue outline) used for the analysis.

Finally, note we have also checked whether the two period means are robust to changes in the start and end dates and find that they are not strongly influenced by the choice of date. Specifically, taking the full NWM box to carry out this test, we find that varying the initial date of the first period mean results in the following values -154 W/m² (1951-1985), -154 W/m²

(1952-1985), -153 W/m² (1953-1985), -152 W/m² (1954-1985). Likewise, varying the end date for the second period gives -137 W/m² (1986-2020), -138 W/m² (1986-2019), -138 W/m² (1986-2018), -138 W/m² (1986-2017).

Atmospheric Humidity Change over the Mediterranean Region

To complement the changing near surface air temperature field shown in Fig.4a, the corresponding field for near surface humidity is shown in Supp. Fig.2. This shows that the humidity field over the Mediterranean Sea follows a similar pattern to that for air temperature, with increasing humidity in the NWMed and little change in the Aegean Sea region.



Supplementary Figure 2. Difference (1986-2020 minus 1951-1985) of ERA5 winter 2 m specific humidity (coloured field, g kg^{-1}) and 10 m wind speed (vectors).