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December 20, 2019

## Reply to reviewer 1

We would like to thank the reviewer for their comments on the paper. Below, the reviewers comments are in black and the responses in blue italics. Changes to the paper are shown in red in the revised paper.

### General comment

The paper documents the sea surface cooling by extratropical cyclones and its impact on the 2013/2014 winter SST in the mid North Atlantic. The conclusions and interpretations are adequately supported for the most part. The paper is well written and conclusions are concise and clear.

*Thank you.*

### Specific comments

1. Does the warming tendency in the warm sector has any effect on SST? In Section 4.1, the cyclone mask is created so as to encompass the cold front and the cyclone center. Does this method include the warm sector properly?

*The cyclone masking methodology was designed to capture the anomalous flux occurring behind the cold front and therefore the reviewer is correct, the effect of the warm sector (outside the 14° radius) is not assessed. This can be seen in the examples in figures 10(e) and (f) which capture the anomalously high flux behind the cold front but not the anomalously low flux ahead of the cold front (in the warm sector). However, it is also clear that the negative anomalies behind the cold front are 2-3 times larger in magnitude than the positive anomalies in the warm sector. We have tested the sensitivity of the results to increasing the mask radius to 16° and the contribution of cyclones to the total heat flux anomaly in the mid-north Atlantic increases from 68% to 71%. Therefore, making the mask larger, and thus including more of the warm sector, actually increases the contribution from cyclones. The results of the sensitivity test are already reported in the paper so we have not altered the text.*

2. The authors focus on the 2013/2014 winter, but I expect that cyclones could play an important role even in other years. The authors might want to estimate cyclones contribution to the winter climatology of the net heat flux using your cyclone masking technique. It would develop a much deeper understanding of the cyclones role.

*This is an excellent suggestion. We have started to apply our cyclone masking technique to other years and seasons. However, including this analysis would increase the length of the paper significantly. Therefore, we will publish this work as a separate publication to avoid a very long paper.*

3. In addition to the strength and number of cyclones, the propagation speed is probably also important for the cooling. The high fraction of time of cyclone mask in 2013/2014 around the UK seems to be partly due to the stagnation of cyclones (Fig. 8).

*The reviewer is right in their interpretation of the high mask fraction over the UK in the 2013/14 season. Towards the end of the storm track the cyclones slow down becoming quasi-stationary. The effect of propagation speed is taken into account in the masking methodology since multiple timesteps for a single cyclone will contribute to the seasonal climatological cyclone-related  $Q_N$ . This explanation has been added to section 4 of the revised paper.*

4. Is the anomalously zonal storm track in 2013/2014 associated with the westerly jet?

*Yes. As shown in Kendon et al. (2015), the 2013/14 season was associated with an anomalously strong and zonally elongated upper-level westerly jet. This extra information has been added to the text in section 4.*

5. The distribution of the  $Q_n$  anomaly in Figure 8f is different and shifted from that of the cyclones in Figure 8d. Why are they different?

*As shown in figure 7, the maximum net surface heat flux occurs to the rear of the cyclone centre, typically to the north-west. Therefore, we expect the anomalous net surface heat flux to be to the north-west of the anomalous storm track activity.*

6. The anomalous  $Q_n$  not associated with cyclones in Figure 11b still has a tripole pattern. So do you think that the tripole pattern has basically nothing to do with cyclones?

*This is an interesting point. Since the  $Q_N$  anomaly pattern when cyclones are not present is similar to that when cyclones are present we conclude that the environmental flow anomaly in 2013/2014 is responsible for generating the tripole of anomalous  $Q_N$  values. This pattern is consistent with the anomalous 500hPa geopotential height anomalies over the North Atlantic shown in Bao and Wallace (2015). The role of cyclones embedded within the seasonal flow anomaly is to enhance the negative  $Q_N$  anomalies in the mid-Atlantic and reduce the positive  $Q_N$  anomalies in the Norwegian Sea. We have re-written the description of this figure in section 4 to make the explanation clearer.*

7. L153-164.rs It is difficult to identify the position of the cold front and warm section in Figure 4. How about plotting the cold and warm fronts? These fronts could be delineated based on Figure 5 or the map of relative vorticity of wind.

*Cold and warm front position have been added to this figure.*

## Technical comments

1. L38. of the wind driven currents

*Changed.*

2. L128. over 6 K over the winter

*Changed.*

3. L135. The density of sea water  $1000 \text{ kg/m}^3$  might be acceptable, but the more practical value (like  $1024 \text{ kg/m}^3$ ) should be used.

*In the revised paper  $1024 \text{ kg/m}^3$  has been used for the density of sea water. The conclusions remain unchanged.*

4. L143. figure 3(a)?

*Changed.*

5. Figure 4. What do contour lines show?

*The contour lines show mslp. This has been added to figure 4 caption.*

6. L246. the conclusion does not

*Changed.*

7. L250. the anomalous Qn

*Changed.*

8. L250. figure 8(f)

*Changed.*

Kendon, M. and McCarthy, M., 2015. The UK's wet and stormy winter of 2013/2014. *Weather*, 70(2), pp.40-47.

Bao, M. and Wallace, J.M., 2015. Cluster analysis of Northern Hemisphere wintertime 500-hPa flow regimes during 1920–2014. *Journal of the Atmospheric Sciences*, 72(9), pp.3597-3608.