Sensitivity of the North Atlantic storm track to regional drivers of change

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In the **zonal mean**, the **extra-tropical storm tracks** are expected to shift **poleward** and **upward** in response to anthropogenic greenhouse-gas forcing[1], consistent with **enhanced tropical convection** widening the **Hadley cell**.

Model simulations suggest, however, that the **North Atlantic storm track** will respond **differently**. Instead of a poleward shift, a **strengthening** and an **eastward extension** towards Europe is predicted (Figure 1a), albeit with a **large inter-model spread** (Figure 1b).

As part of the **TEMPEST** project we are investigating the **mechanisms** behind this North Atlantic storm track response pattern, and also the **sources** of the large inter-model spread.

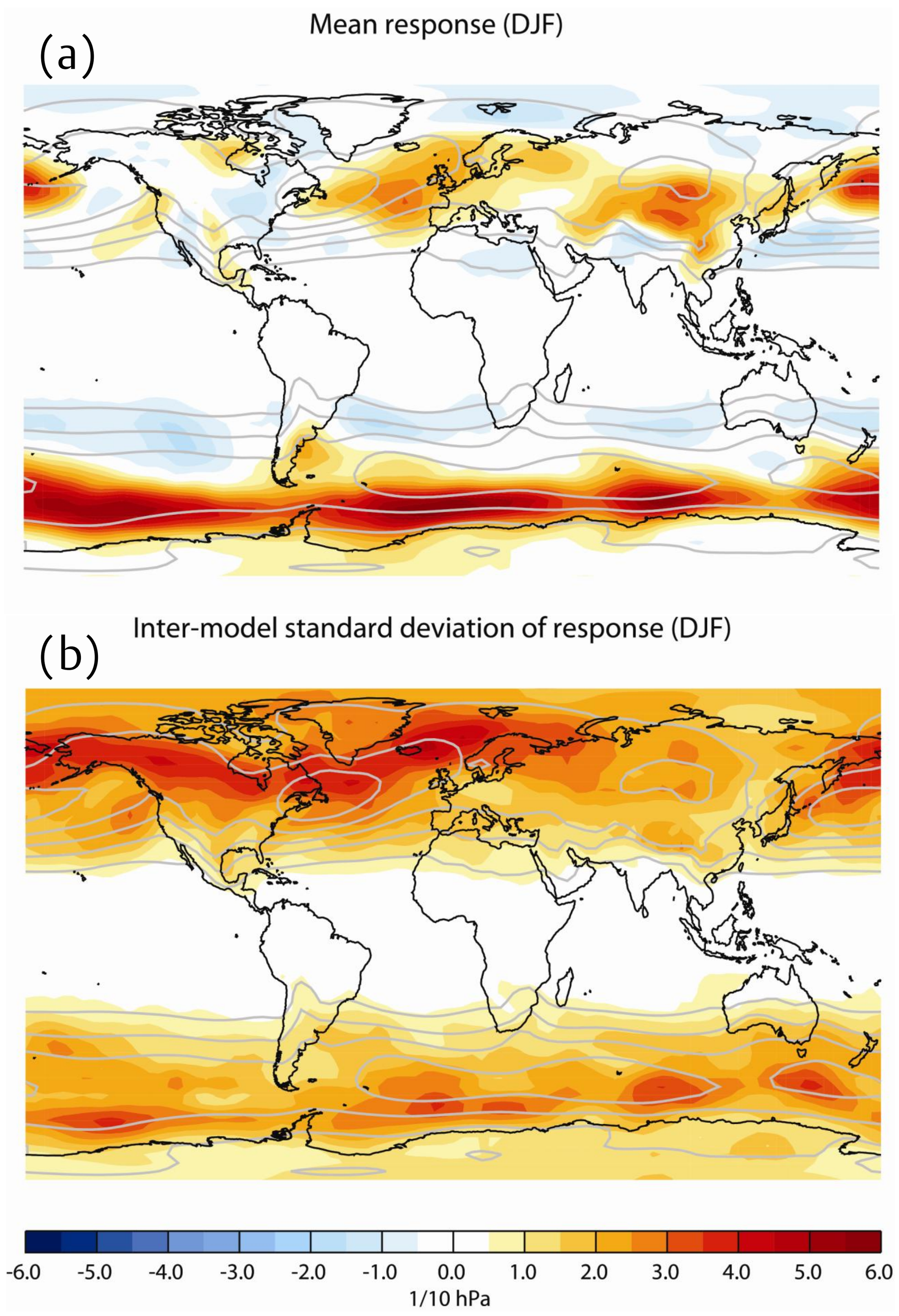


Figure 1: MSLP DJF storm tracks from the CMIP3 multi-model dataset.

Contours show the 1960-2000 multi-model mean storm track (hPa) and the shading shows (a) the multi-model mean 2060-2100 response, and (b) the inter-model spread in the responses. Data for this analysis was available for 15 of the 23 CMIP3 models.

Possible drivers of change

Table 1 lists some **physical processes** which are likely to be important factors in setting the **intensity** and **location** of the North Atlantic storm track. They are split into **"global drivers"** , meaning those that act on all storm tracks, and **"regional drivers"**, meaning those that are particular to the North Atlantic region.

Here we focus on the **regional drivers of change**, in particular the impacts of the **Atlantic sea surface temperatures** and the **Arctic sea ice extent**. We have designed a series of **atmospheric GCM** experiments to investigate quantitatively the effects of these drivers on the storm track.

Global drivers	Regional drivers	
Upper level pole-eq. T contrast	Atlantic SSTs	AMOC?
Low level pole-eq. T contrast	Arctic sea ice extent	
Local moisture content	Land-sea contrast	
	Tropically-forced stationary waves	

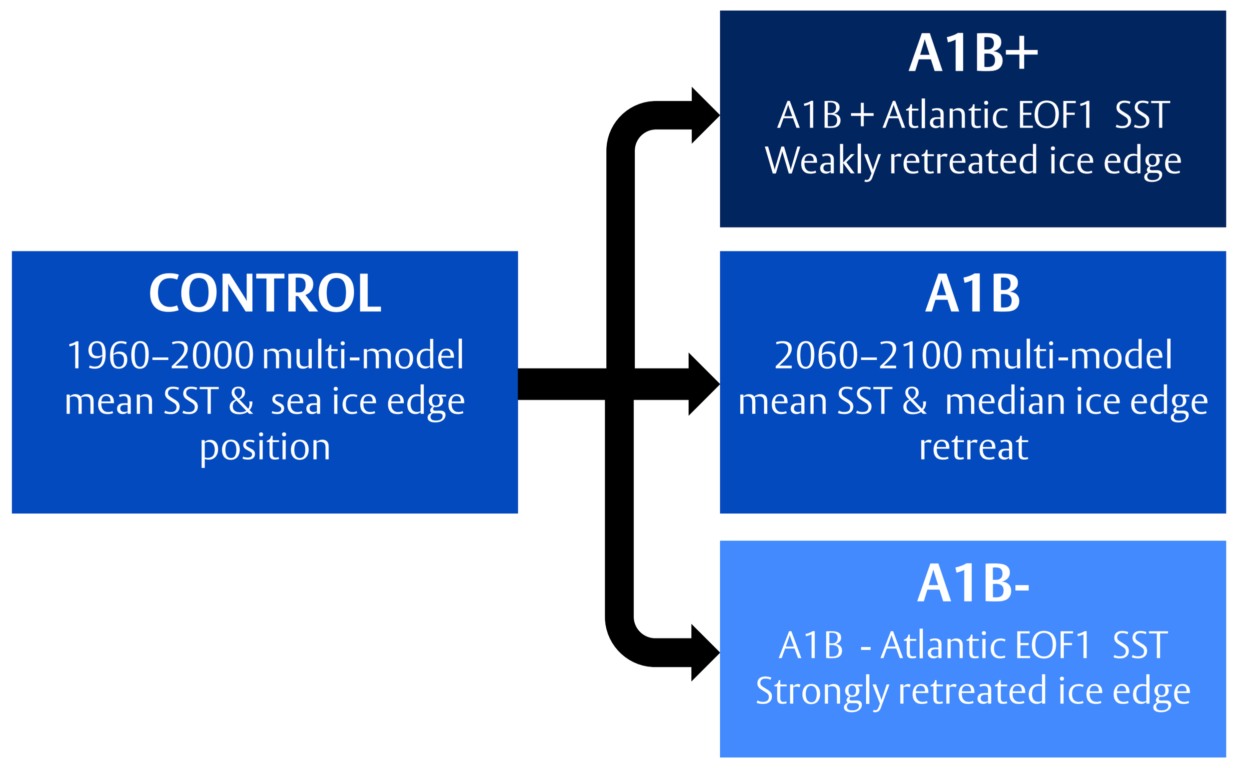
Table 1. Possible drivers of change for the North Atlantic storm track

There are **two** main questions we would like to answer

1. Is the **mean response** of Figure 1(a) reproduced using the CMIP3 multi-model mean SST and sea ice fields to force the model
2. Is the **spread** of Figure 1(b) reproduced using forcing fields that represent the spread in the CMIP3 SST and sea ice response fields?

Experimental design

We will run four simulations using the **Met Office Unified Model** (HadGAM1) as illustrated below.



These represent multi-model mean conditions for late the 20th and 21st centuries (**CONTROL** and **A1B**), and also the inter-model spread in the 21st century predictions (**A1B+** and **A1B-**).

The spread in the SST responses is characterised using the **leading inter-model EOF pattern**. That is, the pattern which explains the most of the spread between the 22 individual models. An example is shown in Figure 2.

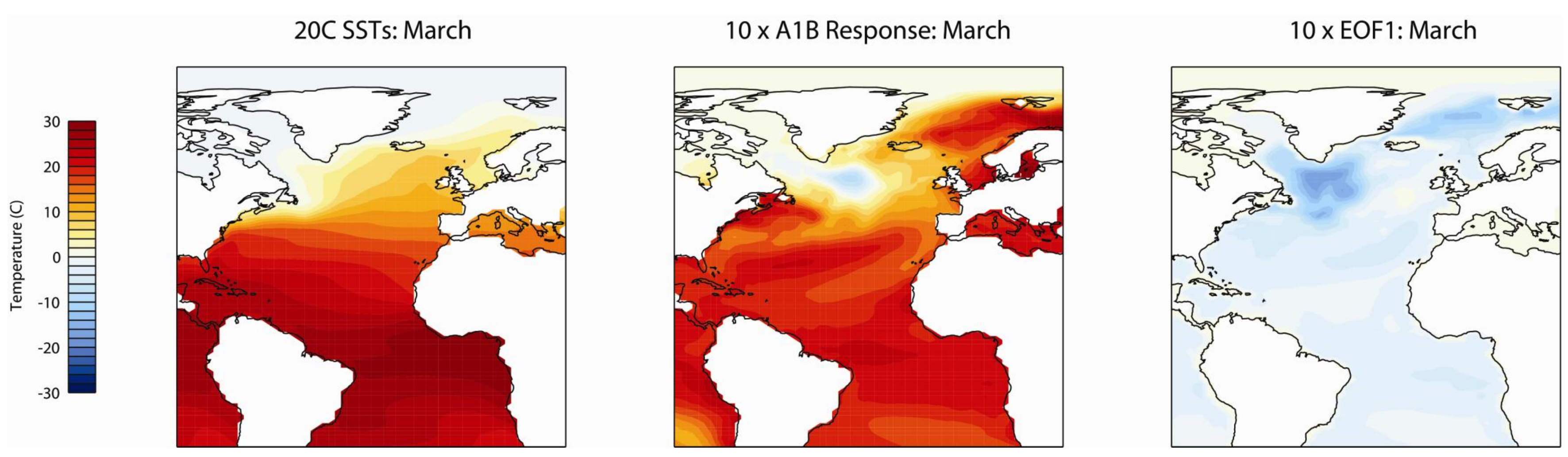
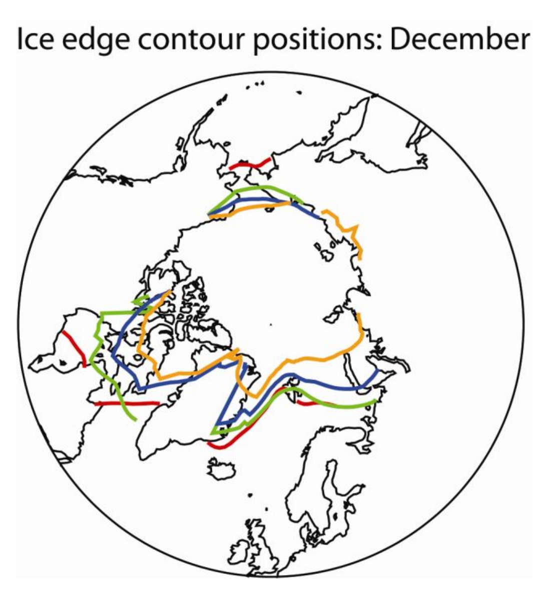


Figure 2. Atlantic SST distributions for March: (a) the multi-model mean, (b) the A1B multi-model response, and (c) the inter-model EOF pattern.

The spread in the ice extent responses is characterised by measuring the **distance of ice edge retreat** at each longitude in each model. The **median** and **quartile** values are then used to generate artificial ice distributions that exhibit low, medium and high retreats values.



Next steps

- The results of this experiment will be compared to recent work suggesting that much of the inter-model spread in the storm track responses is associated with the **spread in the AMOC** responses via the SSTs[2].
- Further experiments will be performed to analyse the impacts of the **other drivers of change** on the storm track responses.

References

1. Yin, J. H. (2005), *Geophysical Research Letters*, **32, L18701**
2. Woollings, T. J., Gregory J. M., Reyers, M. and Pinto, J. G. (in prep)

Acknowledgements

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