

1. Polar-Amplification MIP of CMIP6 (PAMIP) Experiment Design

AIM: . To improve understanding of the range of model responses to reduced Arctic sea ice and possible mechanisms, using multi-model global climate model simulations.

- Atmospheric-only simulations forced with present day sea ice concentrations (SIC) versus future regional SIC.
- Sea surface temperature forcing consistent for all experiments (present day).
- Members initialized from single start date April 1st 2000 (historical run).
- Large ensemble (100 members) needed to distinguish a robust response from background variability.
- We use 150, plus 150 with opposite phase of QBO (HadGEM3 Met Office Model).

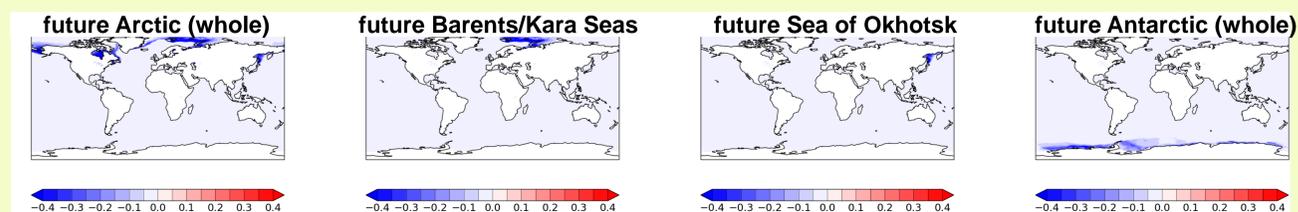


Figure 1: The sea ice forcing. Winter SIC for future (different regions) minus present day experiments.

2. Mid-Latitude Winter Response in Met Office Model

- Weakening of tropospheric winds towards North pole, strengthening towards jet core
- Pan-Arctic: Weakening of stratospheric winds
- Sea of Okhotsk: Tropospheric wind response but not stratosphere

Opposite hemisphere response – or just noise?

- Symmetric weakening of winds on equatorward side of jet in both hemispheres ?
- Significant Antarctic response for u-wind and pressure for BKSeas experiment ?

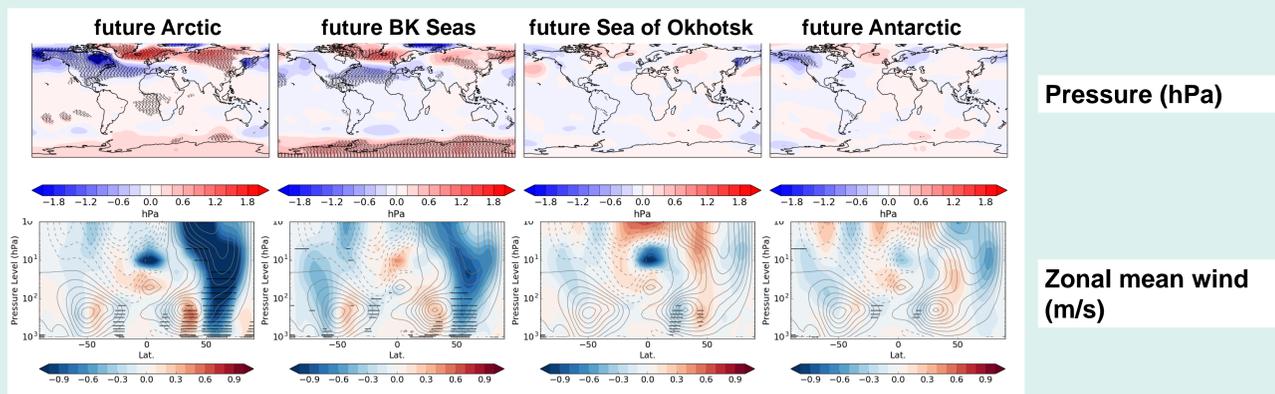


Figure 2a: Response to reduced sea ice, future minus present day experiments (stippling significant differences at 95% level relative to variability of 300 members, present day wind shown as contours at 5m/s intervals, negative dashed).

North Atlantic Oscillation (NAO)

- Significant Negative NAO response for pan-Arctic and Barents/Kara Seas experiments

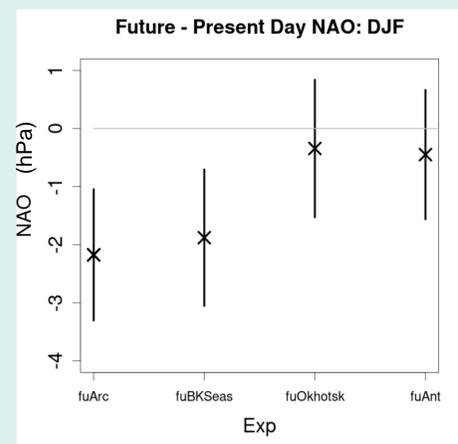


Figure 2b: Response to reduced sea ice for NAO index with 95% range from t-test (pressure difference Azores – Iceland in hPa).

3. Role of QBO in Met Office Model

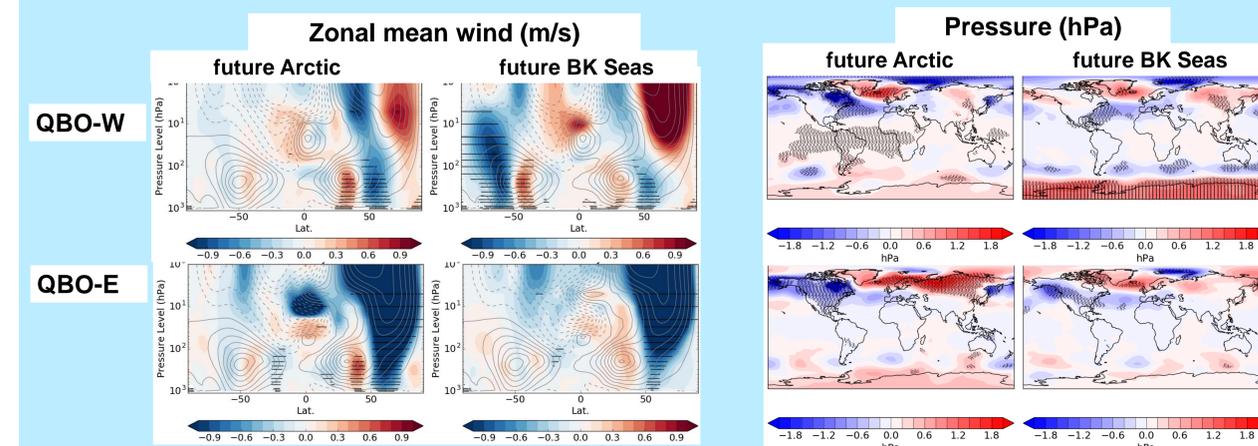


Figure 3: Response to reduced sea ice for alternative QBO phase, winter QBO-Westerly (+) or QBO-Easterly (-): future minus present day (as Fig 1 but 150 members).

Stratosphere: Weakening of winds throughout Arctic for QBO-E, no significant response for QBO-W

- Relates to increased upward wave activity as in Labe et al, (2019)

Troposphere: fuArc → Neg. NAO response for QBO-W; more extensive for QBO-E, less like NAO

Opposite hemisphere response? BK Seas → Significant Antarctic response in u-wind & pressure for QBO-W but not QBO-E ?

- May relate to QBO-W shifting zero-wind line into southern hemisphere (O'Sullivan and Salby, 1990) ?

4. Conclusions

- Response to reduced Arctic Sea Ice in Met Office model adds further evidence of
 - an equatorward shift of the tropospheric jet
 - a shift towards negative phase of North Atlantic Oscillation
- Response to reduced Arctic Sea Ice is somewhat dominated by Barents/Kara Seas
- Stratospheric response is much stronger for QBO-E experiments
- Multi-model analysis planned to further understand mechanisms of response