# Atmospheric circulation responses over Asia to sea-ice loss in the Barents and Kara seas in winter: a perspective revealed from reanalysis and CMIP5 data

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## Introduction

Previous observational studies have suggested that the autumn sea ice that is closely connected with the winter Siberian high (or positive geopotential height anomalies around Ural) is in the Barents and Kara (B-K) seas.

However, some model studies indicate that there is no positive Siberian high response to sea-ice loss in the B-K seas in winter.

To investigate whether the uncertainty may be from observational analysis, using sea ice and the atmosphere in winter to reinvestigate the Siberian high response to sea-ice loss in the B-K seas.

The reinvestigation is based upon a hypothesis that If an external forcing is stronger, the atmospheric response may be stronger and thus the results may be more reliable. Because the sea-ice forcing in the B-K seas that persists from the previous autumn, especially September, is weaker than that which persists from November–December.

To enhance reliability of results, nine models from CMIP5 are used to investigate this issue.

## Possibility of hypothesis

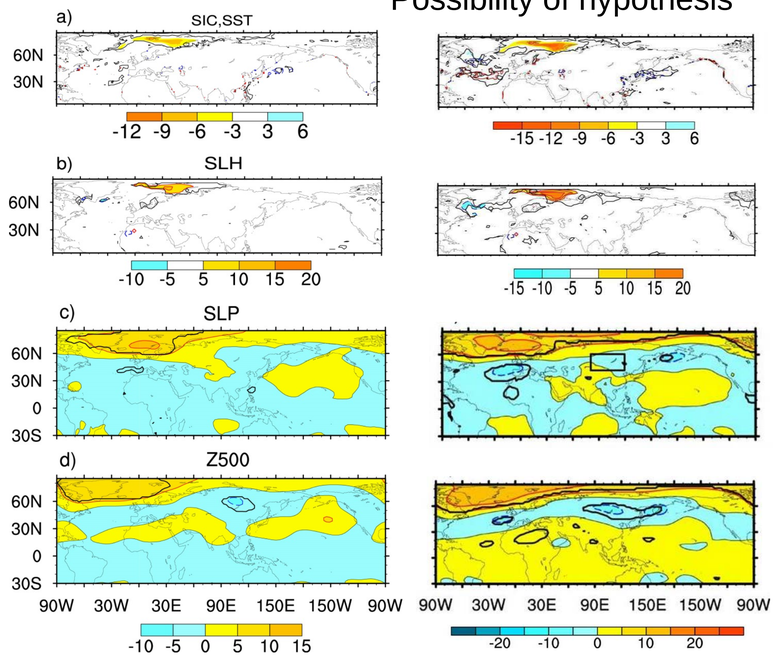


**Fig. 1** JFM mean SIC/SST, SLH (surface latent and sensible heat fluxes), SLP, and Z500 regressed against the sign-reversed SO (left panel) and ND (right panel) B-K sea ice area (SIA), data is from CMIP5.

The longer the sea-ice anomalies drive the atmosphere,

the weaker the sea-ice anomalies are (cf. left and right panels).

Then they weaken the surface heat flux anomalies release.

Thus the atmospheric responses become weaker along with the driving time of external forcing.

Therefore,

JFM mean SLP/Z500 regressed against ND B-K SIA may be a more reliable indication of the atmospheric response to B-K sea ice loss than that regressed against SO B-K SIA

## Results

Sea ice anomalies in JFM, which is persisted from ND, is dominant oceanic forcings.

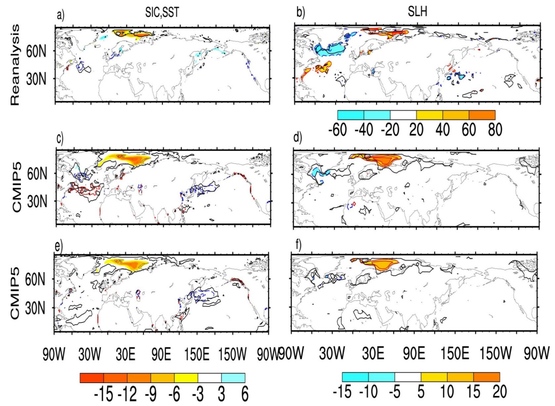


**Fig. 2** JFM mean (a, c) sea ice (shaded, %) and SST (contour, ° C), (b, d) SLH (W m$^{-2}$) regressed against the sign-reversed ND B–K SIA index. (e, f) are same as (c, d), except that they are regressed against the SST-independent ND B–K SIA index..

Key atmospheric system affecting Asia, not enhanced Siberian high, but Arctic-Asia dipole (both Reanalysis and CMIP5)

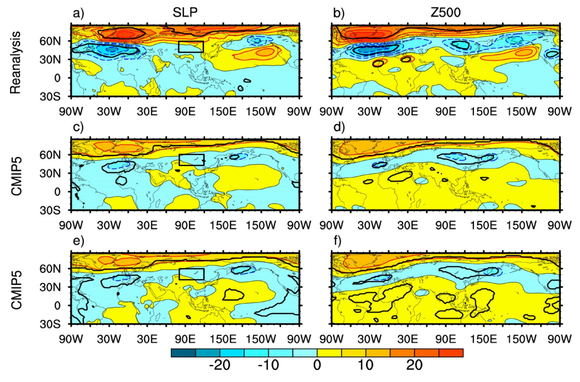


**Fig. 3** Same as Fig.2, but for SLP (a, c, e; hPa) and 500 hPa geopotential height anomalies (b, d, f; gpm).

Climate effects

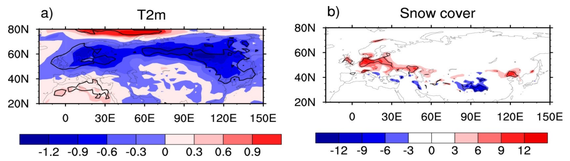


**Fig. 4** JFM mean (a) surface air temperature (° C) and (b) snow cover (%) regressed against the sign-reversed ND B–K SIA index.

ND VS. SO BK-SIA

JFM Arctic-Asia index VS. ND BK-SIA

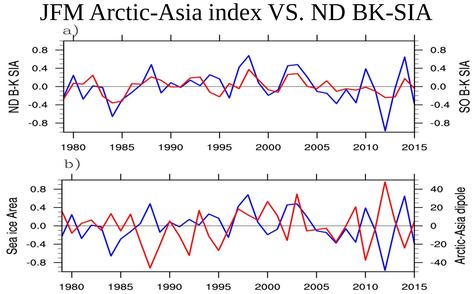


**Fig. 5** Time series of detrended B–K sea-ice area in ND (blue) and SO (red), (b) time series of detrended B–K sea-ice area in ND (blue) and Arctic-Asia index in JFM (red)..

## Conclusions

1, The results show that the Siberian high is not a key system by which the B-K sea ice influences the Asian winter climate. However, an Arctic-Asia dipole structure, with opposite anomalies over the mid-latitudes of Asia and over the adjoining Arctic, seems to be a key atmospheric circulation anomaly influencing the Asian winter climate.

2, Similar atmospheric circulation responses are obtained from reanalysis data and multi-models with multi-ensembles in CMIP5, and the sea-ice anomaly is the dominant factor driving the overlying atmosphere.

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