Contribution of Ural and Kamchatka blockings to the amplified warm Arctic-cold Eurasia pattern under Arctic sea ice loss and Eurasian cooling

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Quick Summary

Motivation & Objectives

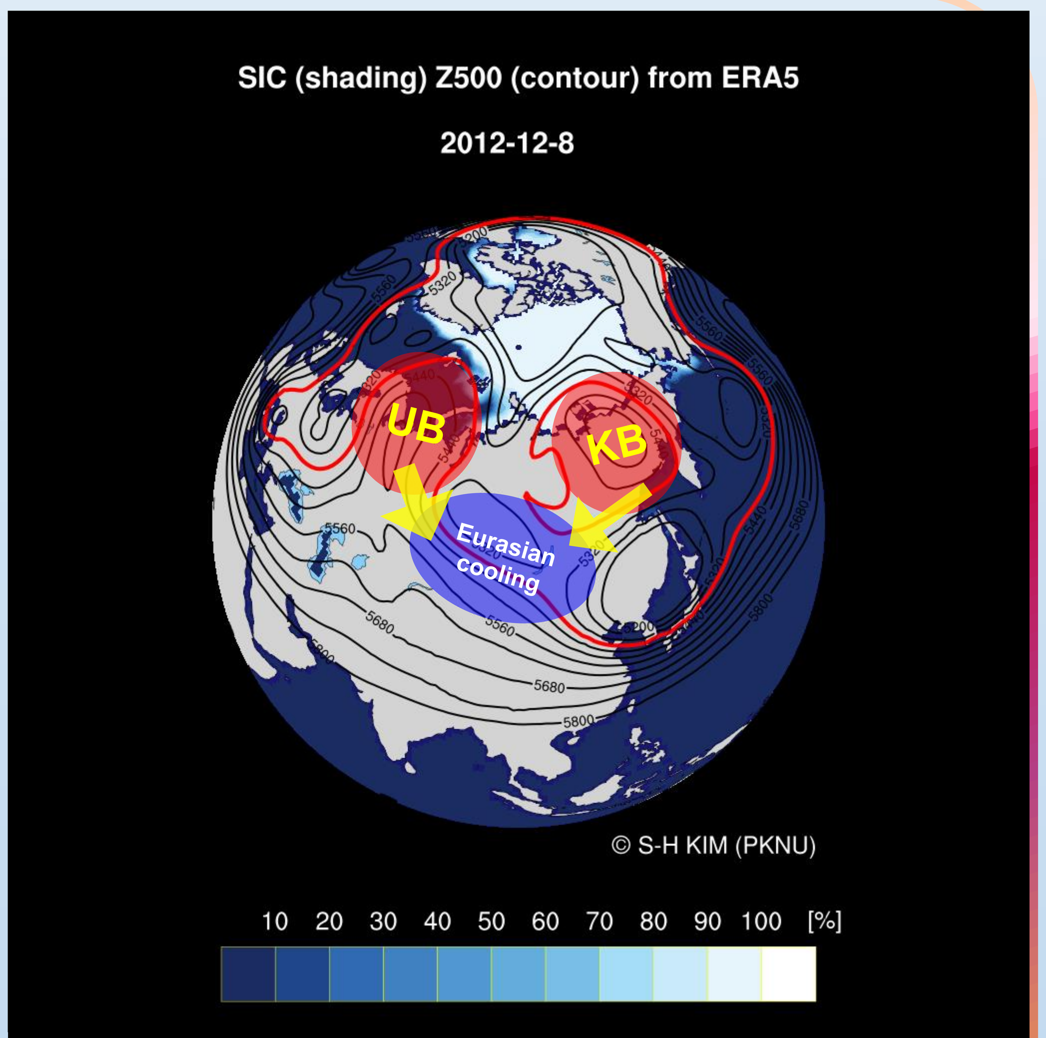
In early winter, sea ice loss over the Barents-Kara Seas can bring more frequent Ural blocking (UB). However, previous studies used the one-type of blocking detection method (local reversal type by Tibaldi & Molteni 1990).

Q1. If we use more different types of blocking detection methods, how will the blocking frequencies related to sea ice loss change?
Q2. Can climate models reproduce the observed linkage between blocking frequency and sea ice loss?

Take-away points

- Increased frequencies of Ural and Kamchatka blocking are concurrent with both the sea ice loss and Eurasian cooling, emphasizing the synergic conditions of sea ice and internal variability in facilitating the frequent blocking events.
- Surface impact of the two regional blockings contributes to the amplified warm Arctic and cold Eurasia (WACE) pattern, which is an internal variability of winter surface air temperature over Eurasia.
- CAM5 model experiments can reproduce the observed linkage among the sea ice, blocking, and WACE pattern.

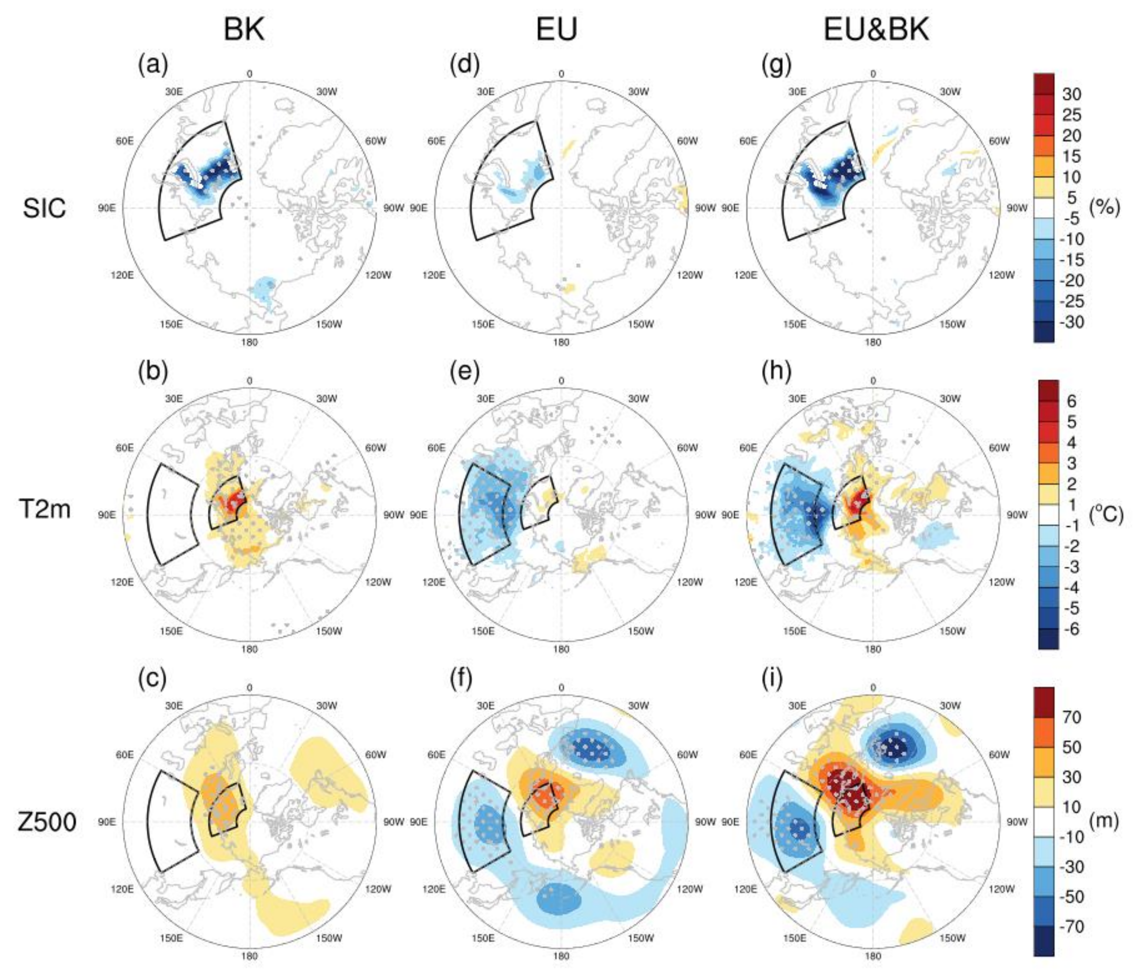
For more information, please contact author (seonhwa@pukyong.ac.kr) or check the article :
Kim, S. H., et al. (2022) Contribution of Ural and Kamchatka Blockings to the Amplified Warm Arctic–Cold Eurasia Pattern under Arctic Sea Ice Loss and Eurasian cooling. *Journal of Climate*, 35(13), 4071-4083.



※ A Schematic showing the key dynamical mechanism that links regional blockings with Barents-Kara sea ice loss and Eurasian cooling

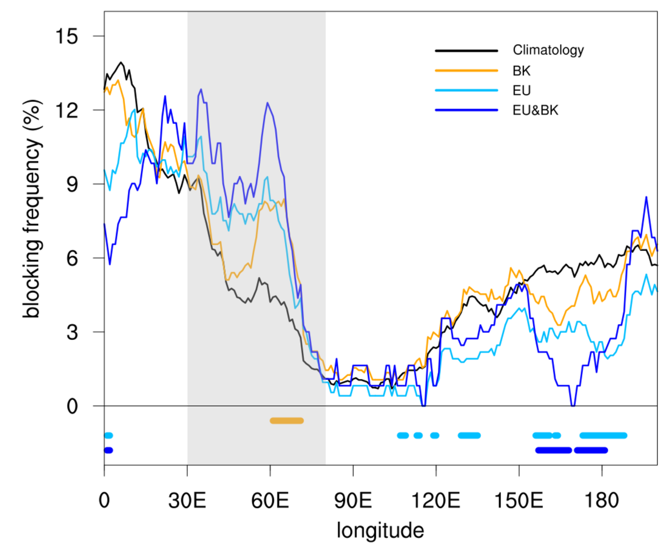
Key Results

Observed composite fields for each cases

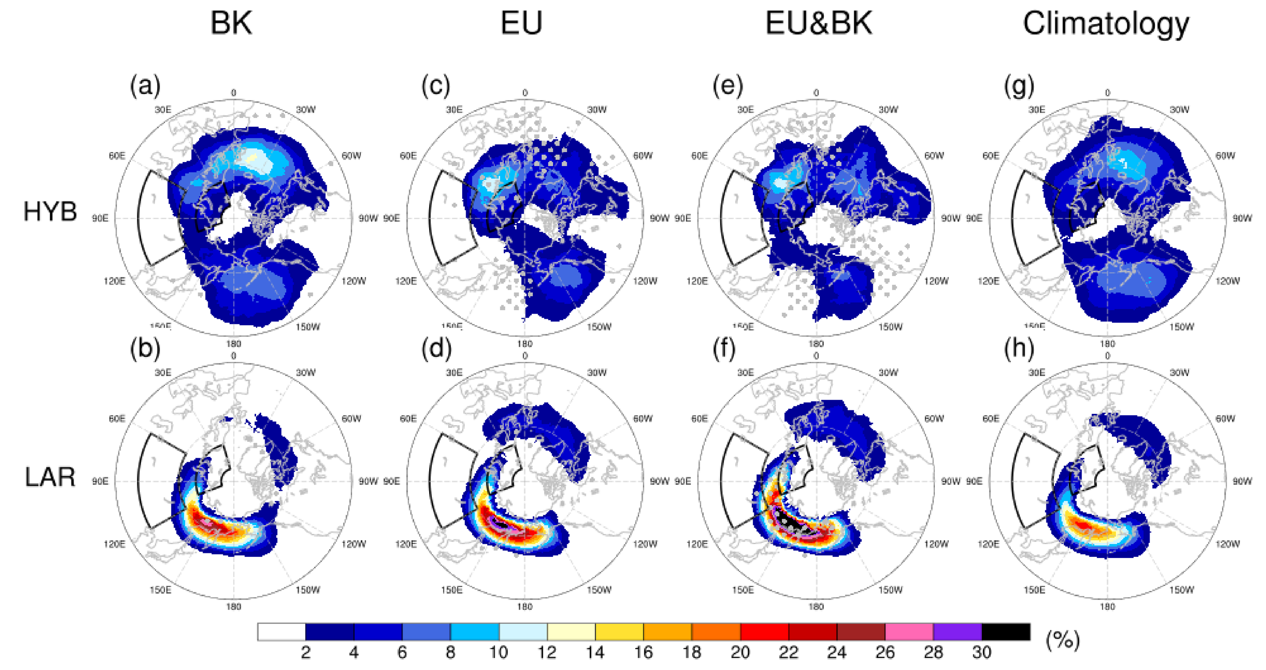


Sea ice loss cannot bring Eurasian cooling by itself. When the Eurasian cooling concurs with the sea ice loss, the positive WACE pattern appears with the more robust Eurasian cooling.

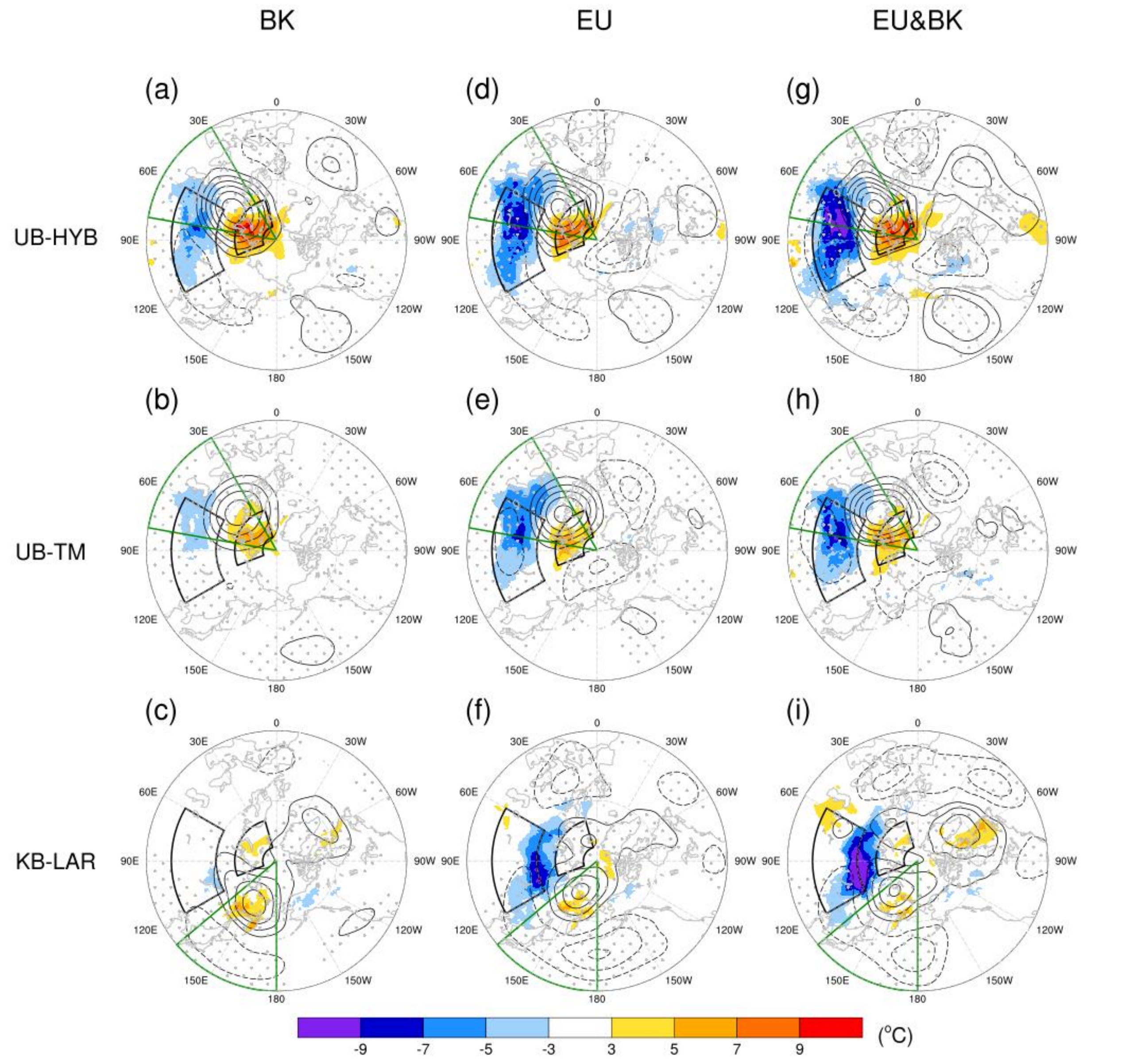
Observed blocking frequency for each cases



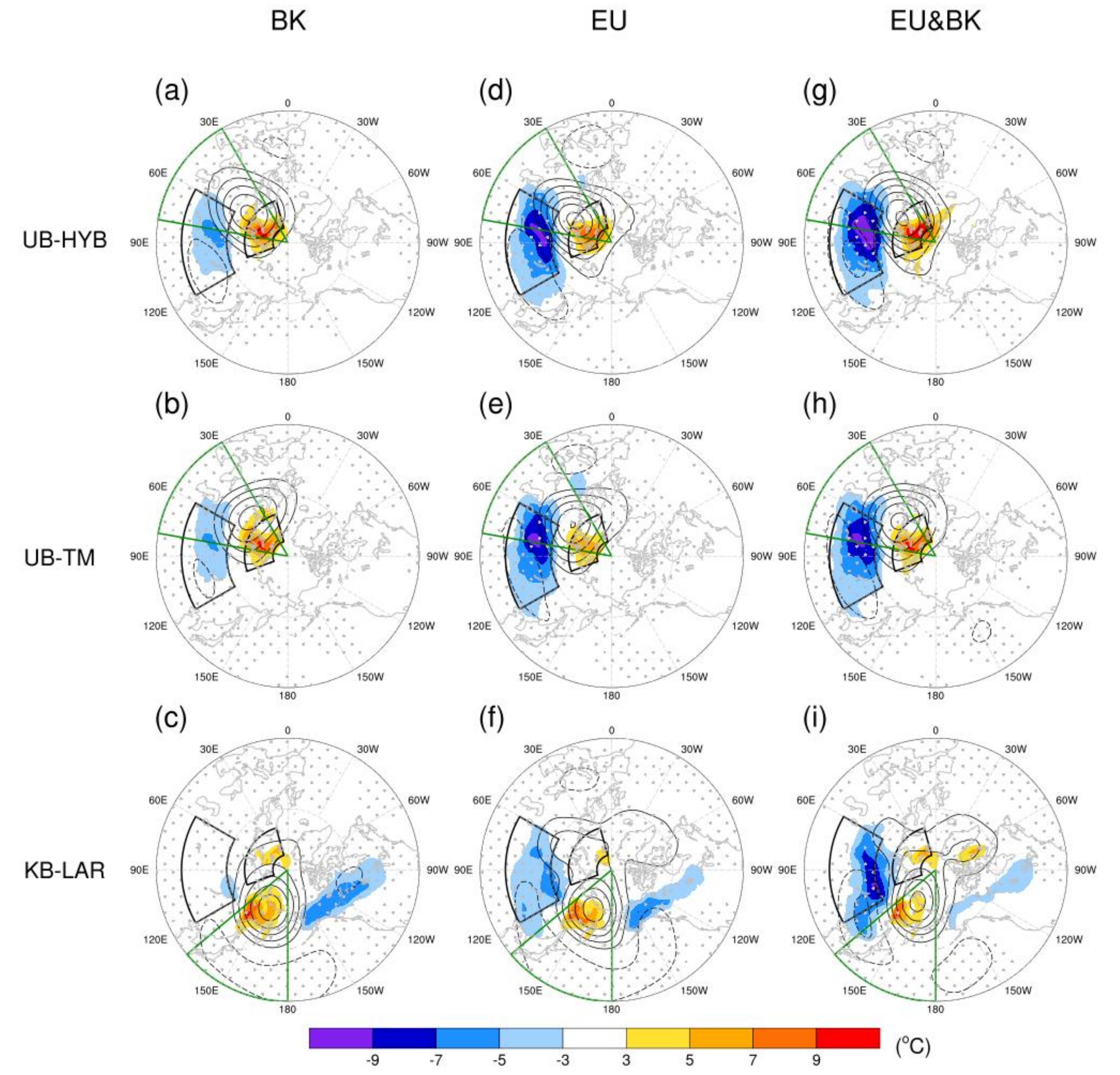
- TM, HYB methods → increased UB frequency
- LAR method → increased KB frequency



Observed regional blocking impacts for each cases



Modelled regional blocking impacts for each cases



Contour (Z500 anomaly) Shading (SAT anomaly) Black box (Barents-Kara, Eurasia domain) Green box (target blocking region)

If strong Eurasian cooling concurs with sea ice loss, the increased UB and KB are accompanied by a much stronger surface cold anomaly over Eurasia, contributing to the positive WACE pattern.

The CAM5 simulation in EU&BK case demonstrates the multiple blocking attributions to the positive WACE pattern, albeit rather weaker UB impacts in magnitude.

Data

Period: 1979-2020

Early winter (November-December)

ERA5 (daily Z500, SAT)

Hadley center (SIC)

Case definitions

BK	sea ice loss over Barents-Kara seas
	(17 years) When SIC over Barents-Kara is less than 50%
EU	Strong Eurasian cooling
	(12 years) When SAT over Eurasia is more than 0.5 std below the mean
EU & BK	Concurrent occurrence of sea ice loss & Eurasian cooling
	(6 years) When BK and EU case coincide

Blocking detection methods

1) TM method (Tibaldi and Molteni 1990)
2) Hybrid method (HYB, Dunn-siguon et al. 2013)
3) Large-scale reversal method (LAR, Masato et al. 2013)

◆ same tracking algorithm:
Spatial criteria= 2.5x10^{6}km^2
Overlap= 50%
Duration= 5 day

Model configurations

Model	CAM5	
Dynamic core	Finite Volume (horizontal 2.5° x 1.9°)	
Compset	F2000 (present climate simulation)	
Purpose	To evaluate the atmospheric response to sea ice loss, we conduct two equilibrium experiments	
Experiment Name	CTRL	LSIC
Boundary Condition	Climatological seasonal cycle of SIC, SST during 1979-2014	Composite seasonal cycle of SIC, SST in the Arctic Ocean during low years of BK SIC.
Run time	300 years	