



Contrasting Deep and Shallow Arctic Warming Events on the Intraseasonal Time Scale in Boreal Winter

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1 Motivation

Most previous studies regarding causes or impacts of Arctic warming only focused on the surface warming, while the vertical structure of Arctic warming has recently attracted increasing attention. The findings, that Eurasian cooling tends to occur in the presence of **deep rather than shallow** Arctic warming (seasonal mean or trend)^[1-2], could help clearly comprehend the divergent arguments on the warm Arctic-cold Eurasia (WACE) phenomenon^[3-4].

2 Warming Event Identification

Where (warming)

Barents-Kara Seas (BKS)
[70°–80°N, 30°–70°E]



Fig. 1. Location of BKS

Definition (two criteria)

① BKS T_{2m} exceeds one SD* & lasts more than three days

② BKS T_{500hPa} exceeds one SD*
(SD*: standard deviation)

	DEEP	SHALLOW
①	True	True
②	True	False

P.S.: Multiple peaks within 10 days are considered as the same event with the maximum peak marked as day 0.

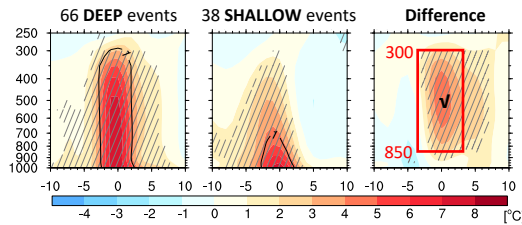


Fig. 2. Time-evolving vertical profile of BKS temperature anomalies

✓ Significant differences of BKS-averaged temperature anomalies lie between 850 hPa and 300 hPa.

3 Results

How BKS 850–300-hPa warming forms

$$\frac{\partial T}{\partial t} = -u \frac{\partial T}{\partial x} - v \frac{\partial T}{\partial y} + \sigma^* \omega + Q_{\text{diabatic (negligible)}}$$

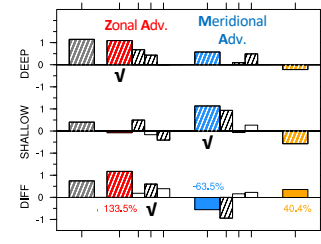
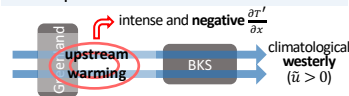


Fig. 3. Thermodynamic diagnostic results

✓ Deep events are mainly contributed by ZA, while shallow events by MA.
✓ Most warming difference comes from ZA2 ($-\tilde{u} \frac{\partial T}{\partial x}$), which is crucial in driving deep but absent in shallow events.



Important role of upstream activities

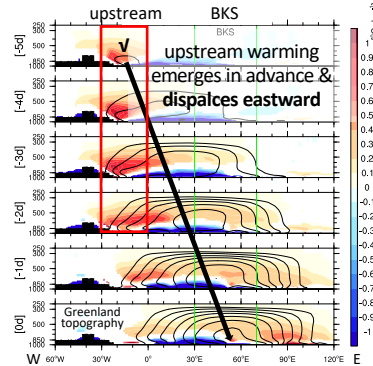


Fig. 5. Cross section of 70°–80°N-mean temperature (contour) and latent heating (color) anomalies

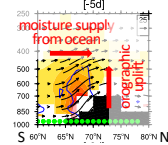


Fig. 6. Processes causing upstream latent heating

✓ Deep BKS warming originates from upstream warming, which could be prompted by upstream precip. & released latent heating therefrom.

4 Take-home Messages

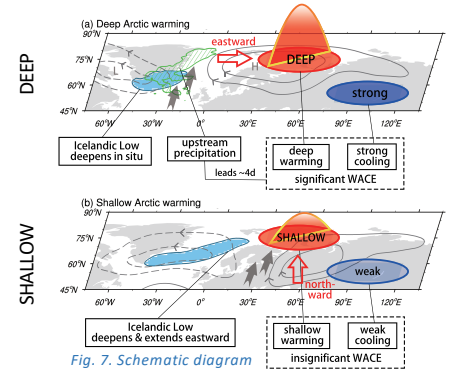


Fig. 7. Schematic diagram

southerly near Greenland (**in-situ deepened IL***)
→ upstream convection → upstream warming
→ deep BKS warming & **strong** Eurasian cooling

southerly over Eurasian lands (**eastward-extended deepened IL***) → **shallow** BKS warming & **weak** Eurasian cooling (IL*: Icelandic Low)

5 References

- [1] He, S. et al., 2020: Eurasian Cooling Linked to the Vertical Distribution of Arctic Warming. *Geophys. Res. Lett.*, 47.
- [2] Ogawa, F. et al., 2018: Evaluating Impacts of Recent Arctic Sea Ice Loss on the Northern Hemisphere Winter Climate Change. *Geophys. Res. Lett.*, 45, 3255–3263.
- [3] Cohen, J. et al., 2019: Divergent consensus on Arctic amplification influence on midlatitude severe winter weather. *Nat. Clim. Change*, 10, 20–29.
- [4] Outten, S. et al., 2022: Reconciling conflicting evidence for the cause of the observed early 21st century Eurasian cooling. *Weather Clim. Dynam.*, 4, 95–114.