



Intermittency of Arctic-midlatitude linkages: the stratospheric pathway

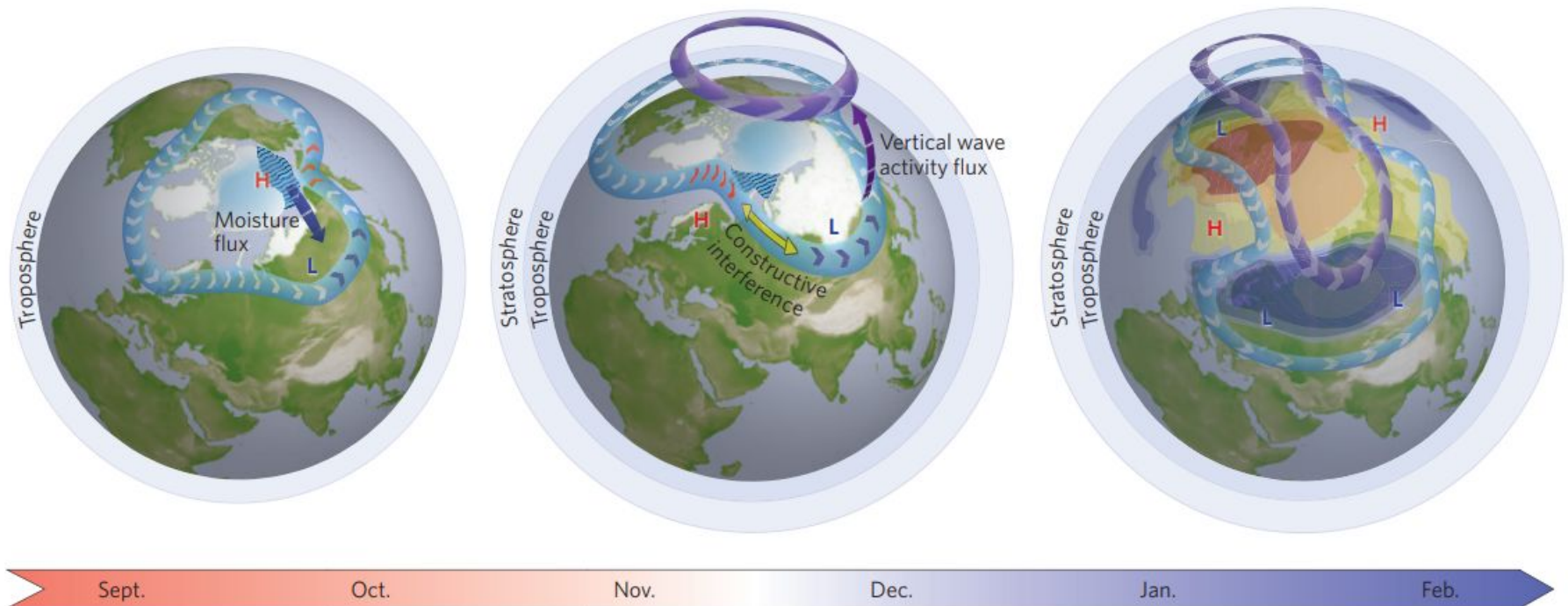
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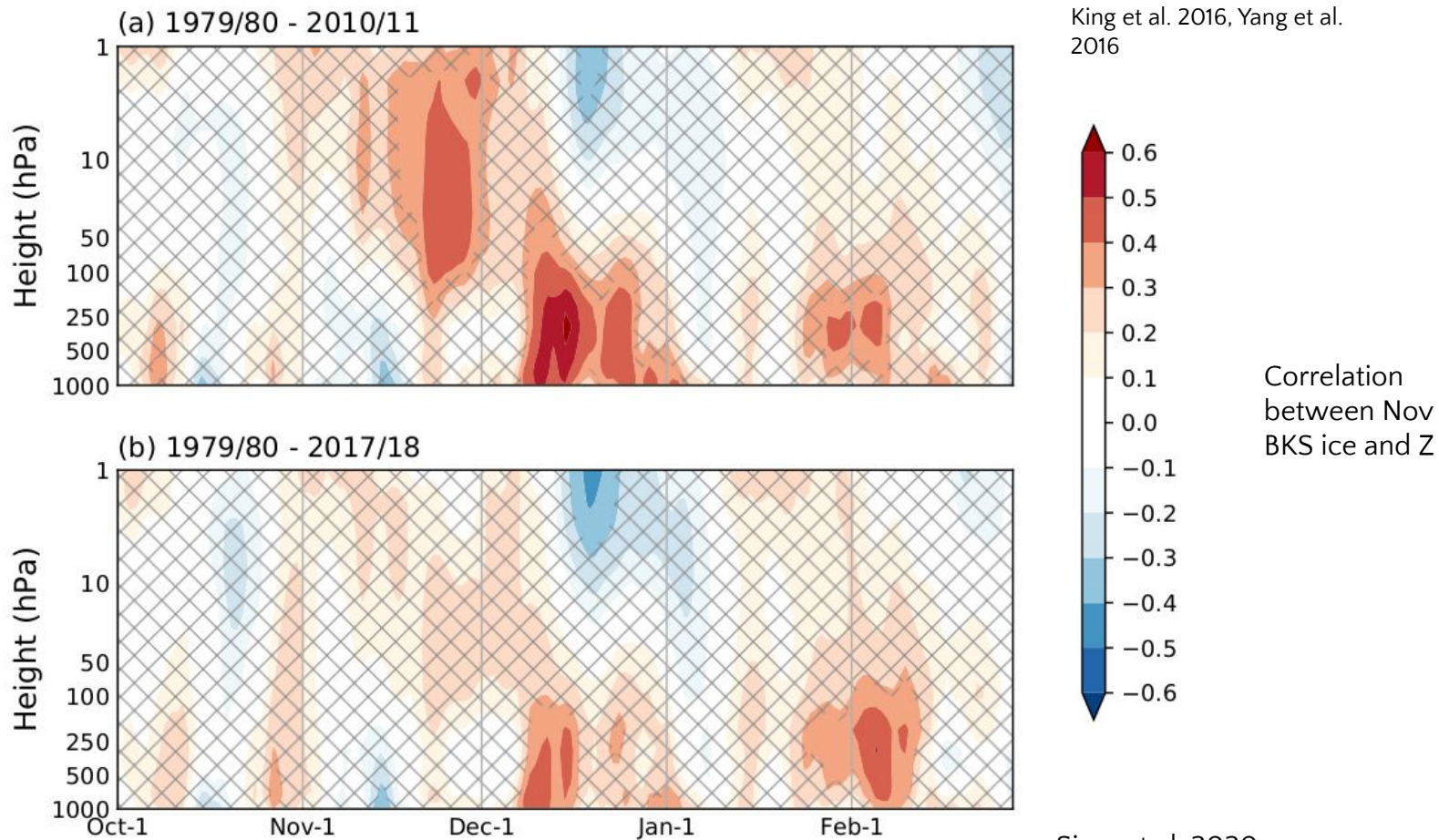
Siew et al. 2020, accepted
Discussion paper: <https://www.weather-clim-dynam-discuss.net/wcd-2019-11/>

EGU 2020-7905
CL4.11

A stratospheric pathway is one of the proposed mechanisms that links reduced Arctic sea ice to negative phase of NAO/AO



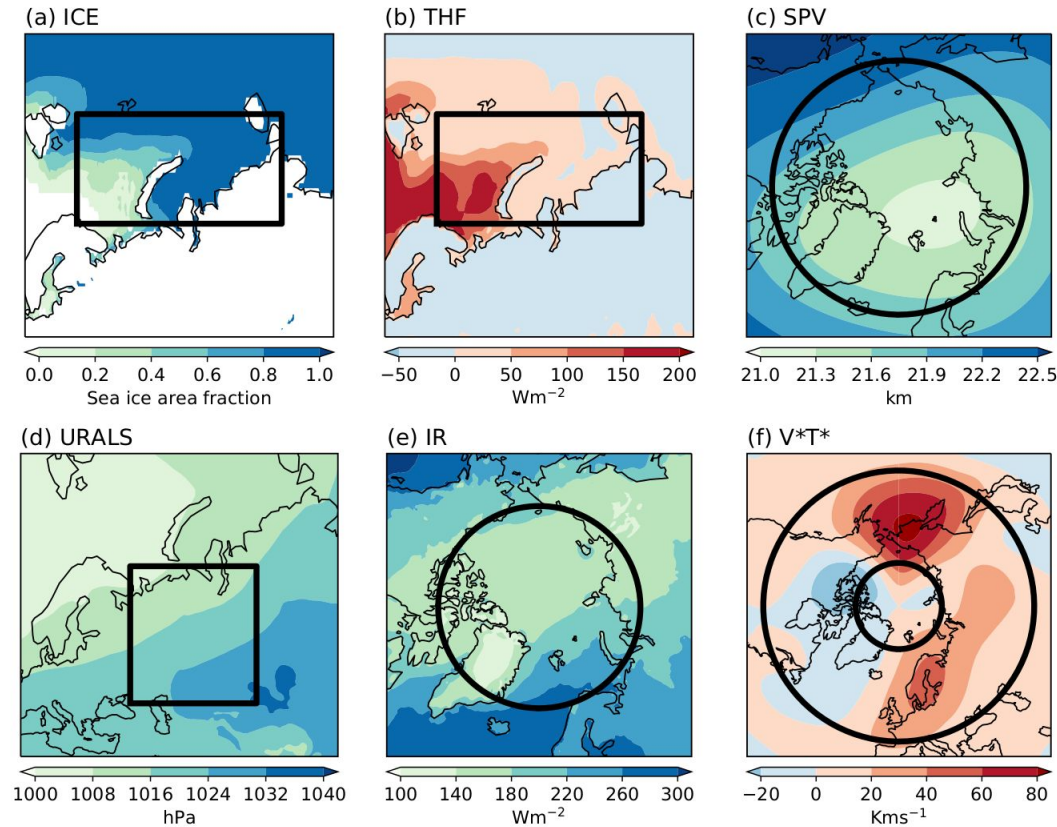
Stratospheric pathway changes depending on observational period used



E.g., Kim et al. 2014,
Nakamura et al. 2014,
García-Serrano et al. 2015,
King et al. 2016, Yang et al.
2016

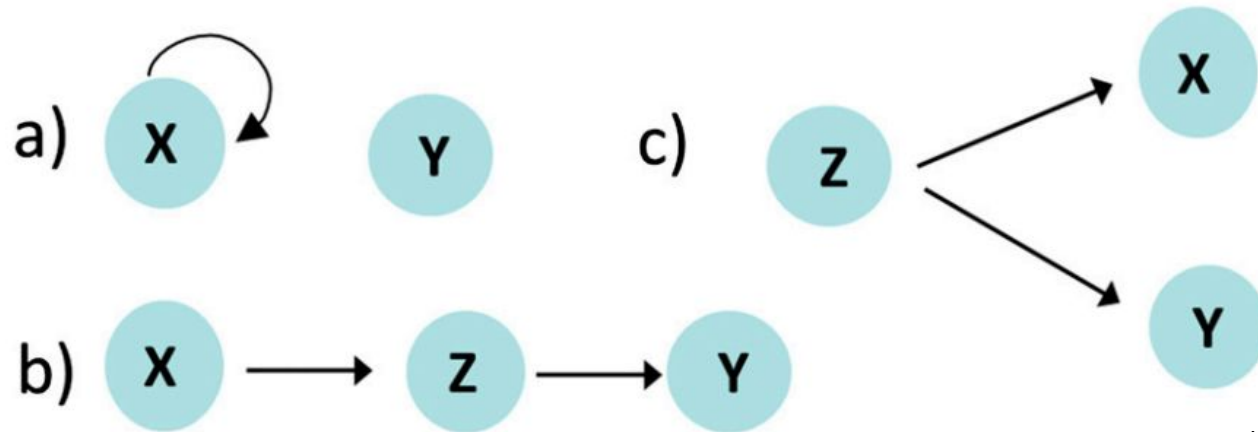
Siew et al. 2020
(accepted)

Causal Effect Network (CEN) is used to test the stratospheric pathway: Barents-Kara sea ice \rightarrow NAO



- (a) Barents-Kara sea ice
- (b) Turbulent heat fluxes
- (c) Strength of stratospheric polar vortex
- (d) Sea level pressure over Urals
- (e) Downward longwave radiation
- (f) Poleward eddy heat flux

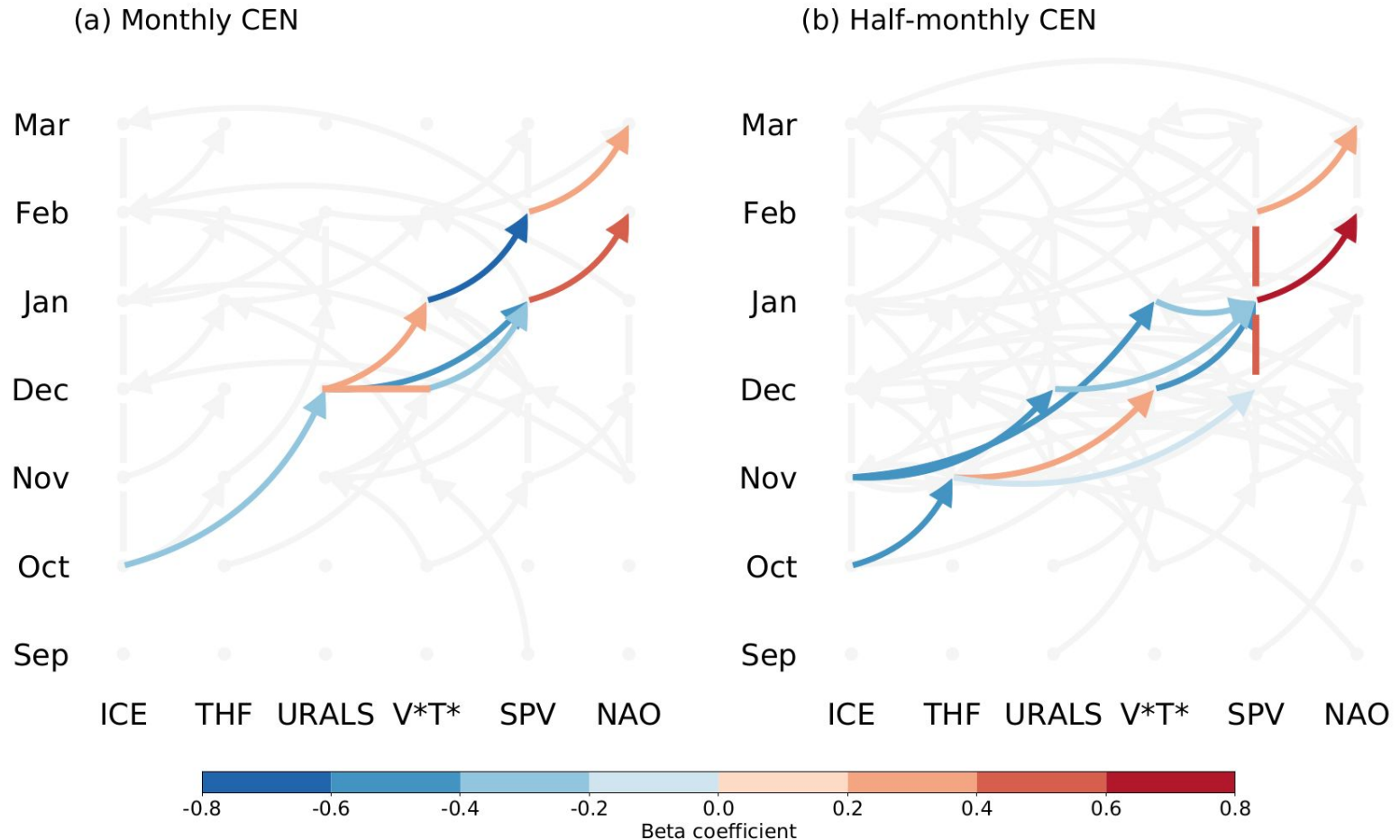
CEN is a framework that helps determine causality



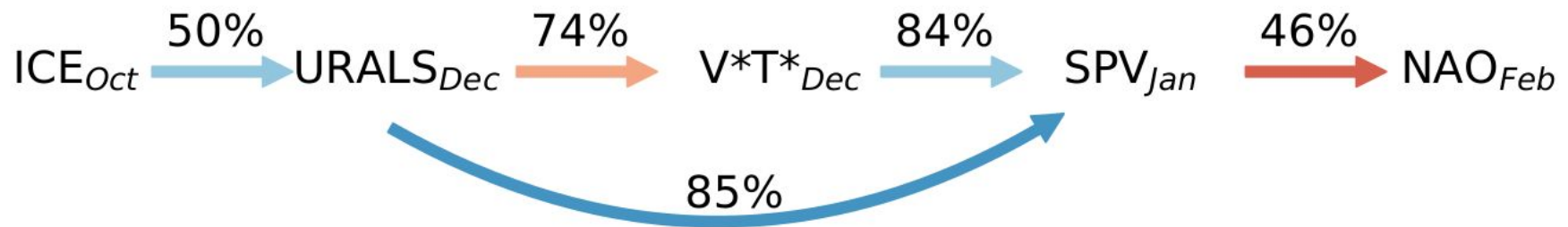
Kretschmer et al. 2016

Examples where X and Y are correlated but there is no direct causal linkage between them

CEN detects the stratospheric pathway:
 \downarrow Oct BKS ICE \rightarrow \uparrow Dec Urals SLP \rightarrow \uparrow Dec V*T* \rightarrow \downarrow Jan SPV \rightarrow \downarrow Feb NAO



But the pathway is intermittent; the whole stratospheric pathway is detected in only 16% of bootstrapped samples

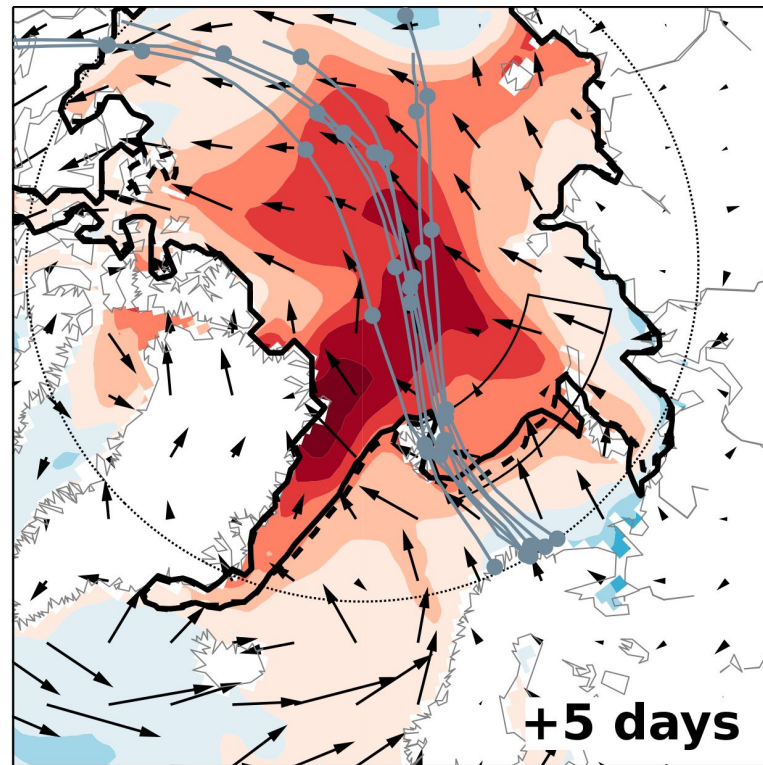


Siew et al. 2020 (accepted)

- 10,000 samples of 39 winters with replacement
- Numbers on arrows show the occurrence rates

Synoptic processes at shorter time scales are a possible source of intermittency

Synoptic moist intrusion event (grey lines) on 27 Dec 1999 causes warming (shading) and sea ice reduction (black contour)



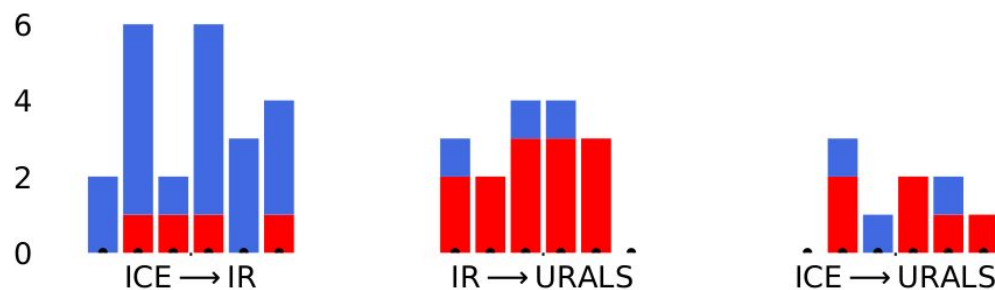
Synoptic processes at shorter time scales are a possible source of intermittency

Results from pentad CEN to show synoptic linkages. Bars show the numbers of detected linkages in Oct, Nov, Dec, Jan, Feb and Mar (left to right).

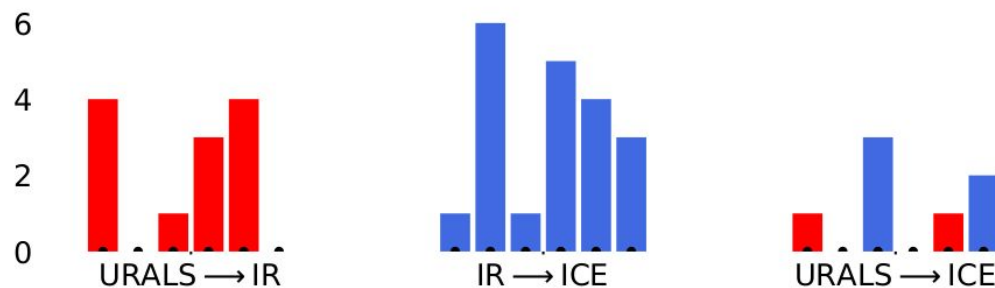
Red: Positive relationship
Blue: Negative relationship

E.g., In (b), high Urals sea level pressure (URALS) leads to enhanced downward longwave radiation (IR), which reduces the Barents-Kara sea ice (ICE), consistent with moist intrusion pathway.

(a): From the Arctic



(b): To the Arctic



Summary

- The CEN detects a stratospheric pathway leading from late fall BKS ice reduction to the negative NAO in late winter in the satellite period
- However, this pathway is highly intermittent (the whole stratospheric pathway is detected in only 16% of bootstrapped samples)
- Synoptic variability (e.g., moist intrusions) may contribute to the intermittency. Other factors discussed in the paper include ENSO, the tropospheric pathway and background states

Siew, P. Y. F., Li, C., Sobolowski, S. P., and King, M. P.: Intermittency of Arctic-midlatitude teleconnections: stratospheric pathway between autumn sea ice and the winter NAO, *Weather Clim. Dynam.*, accepted, 2020

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