ON THE TRANSIENT ATMOSPHERIC RESPONSE TO AN IMPULSIVE SEA-ICE FORCING

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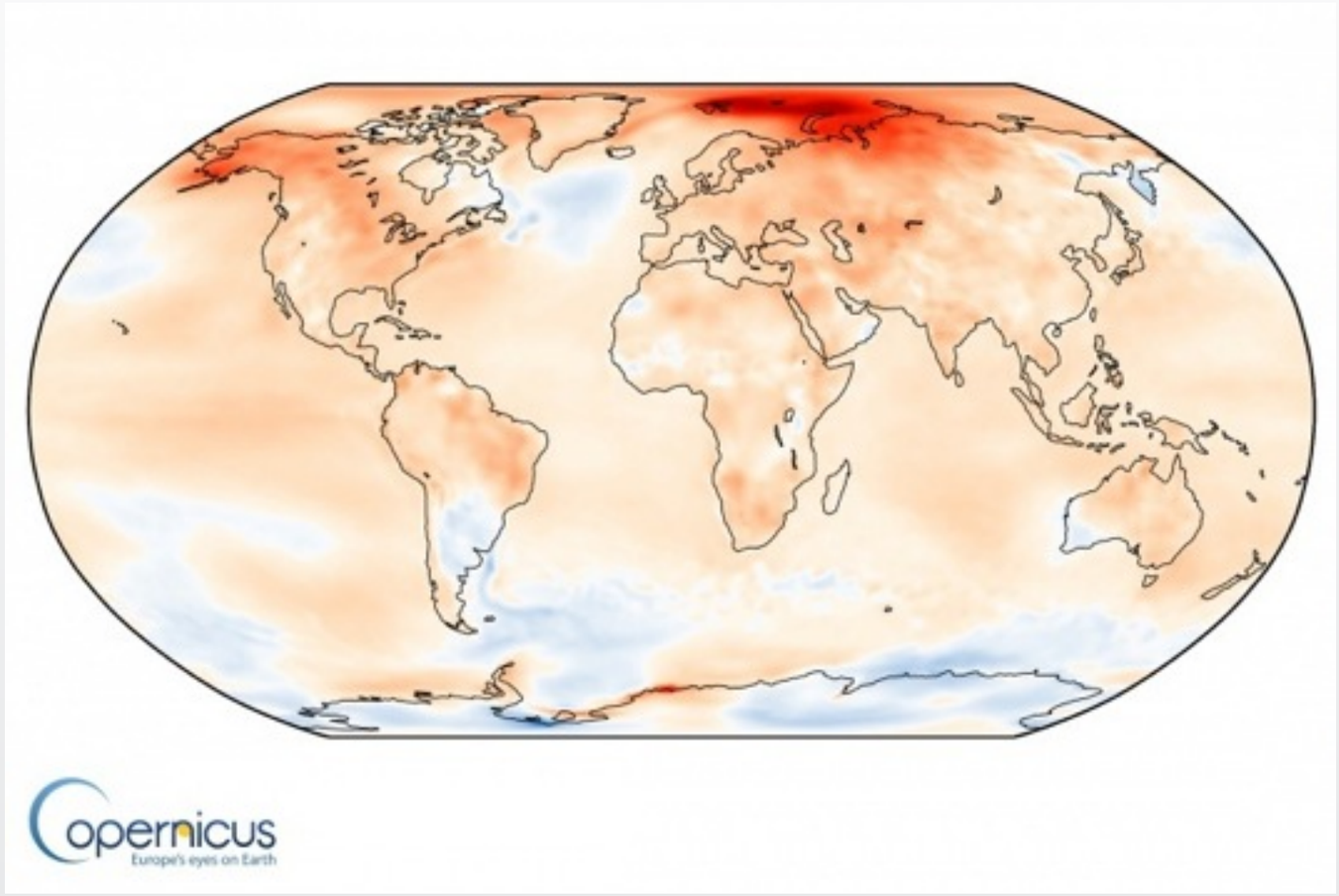
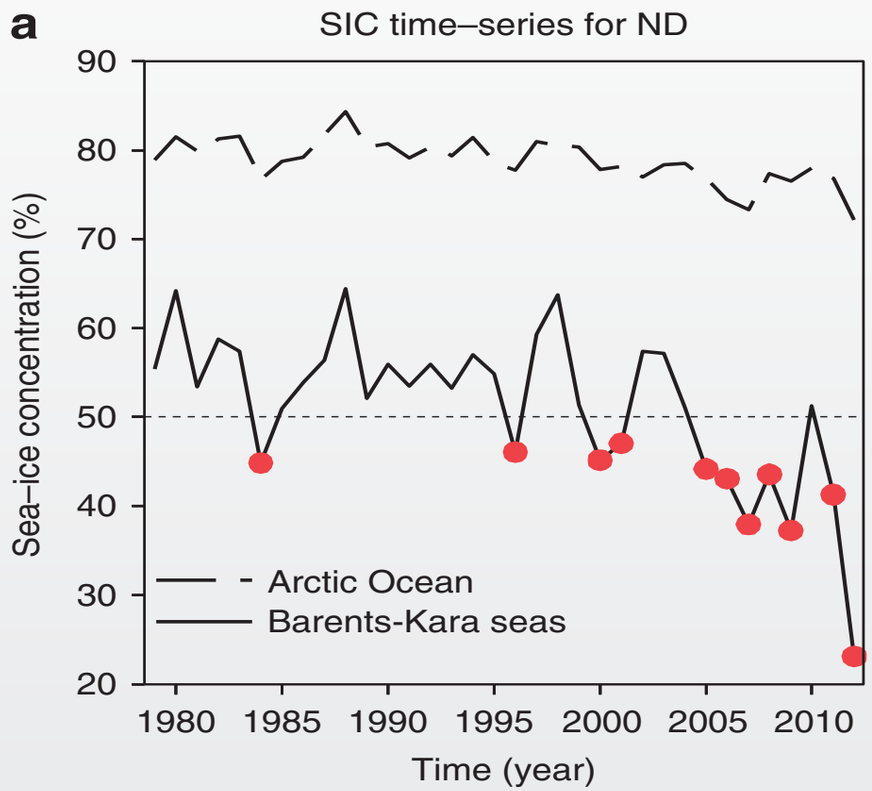
Copernicus Climate Change Service

T2m anomaly (1979-2010) for July 2015- July 2016



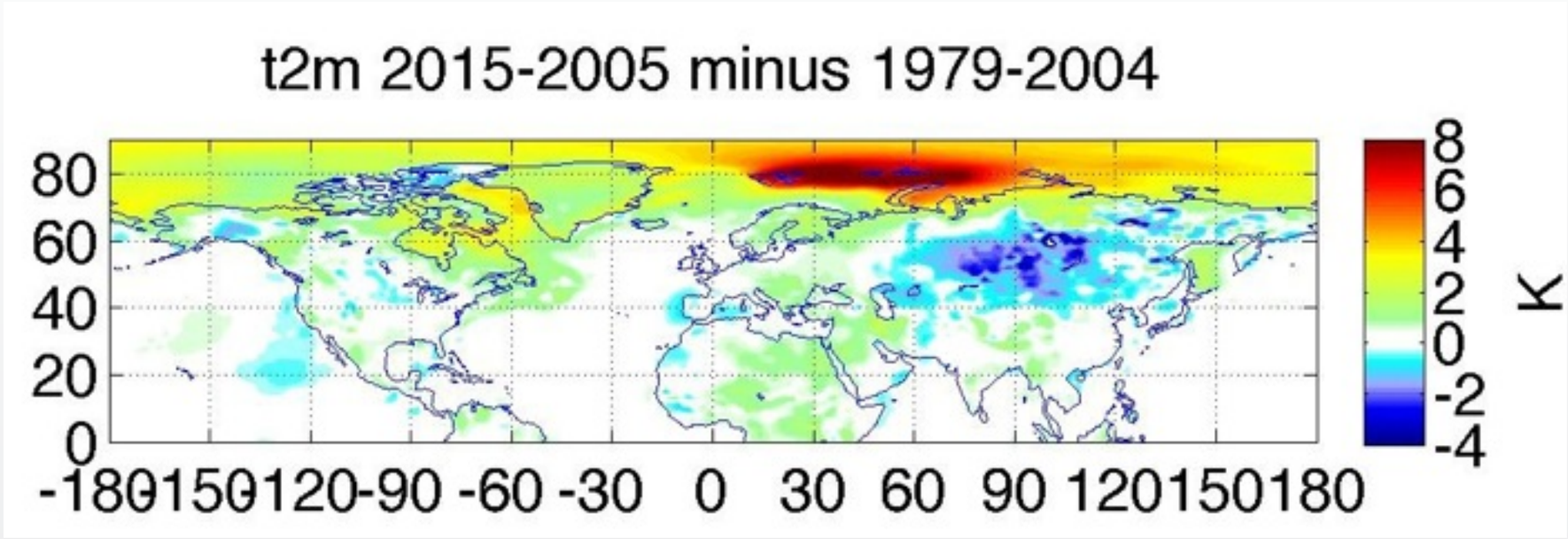
SOURCE: C3S website
https://climate.copernicus.eu/

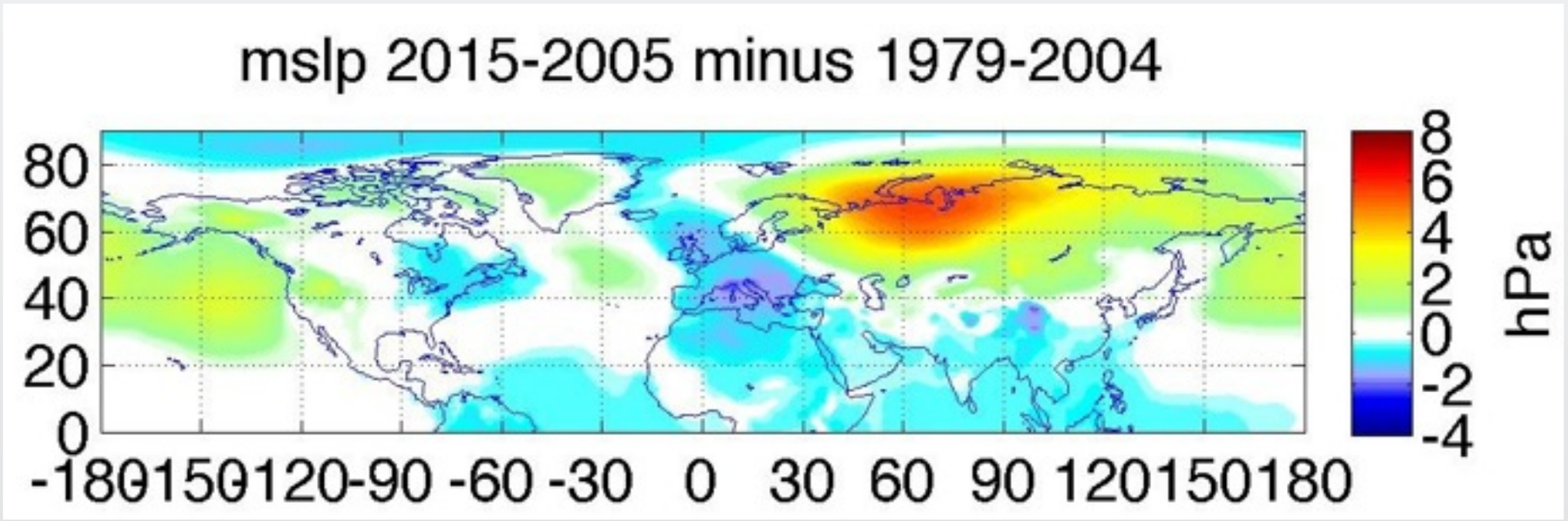


Kim et al. (2014)

LOCAL CIRCULATION

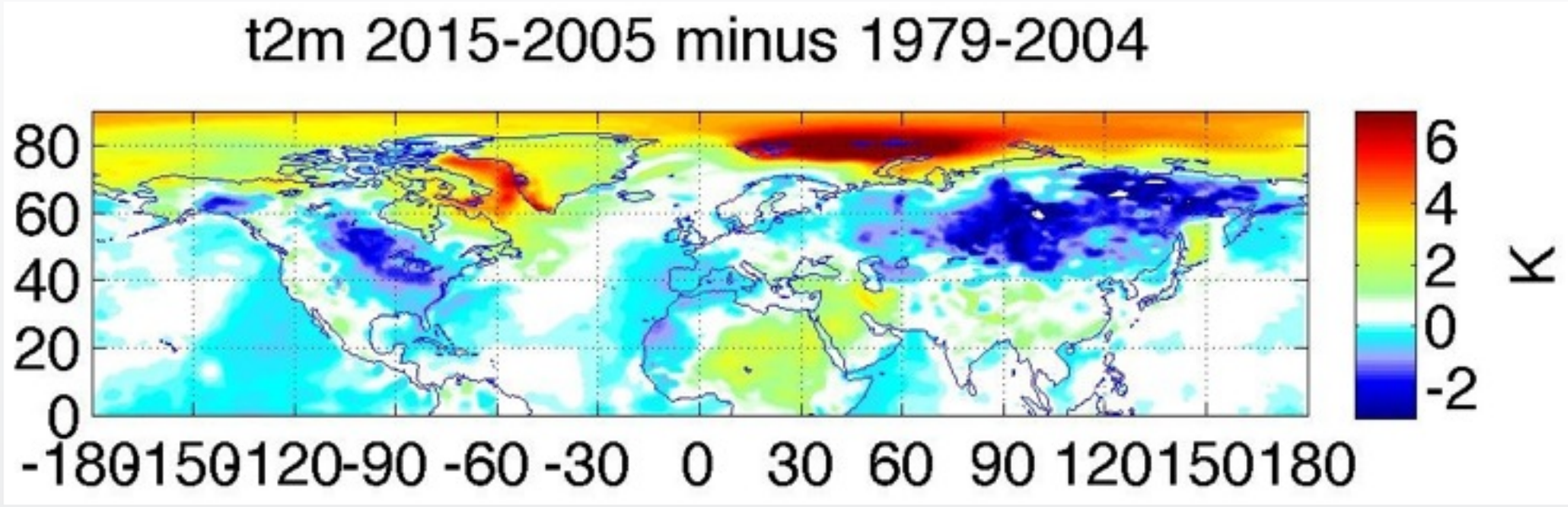
DJF

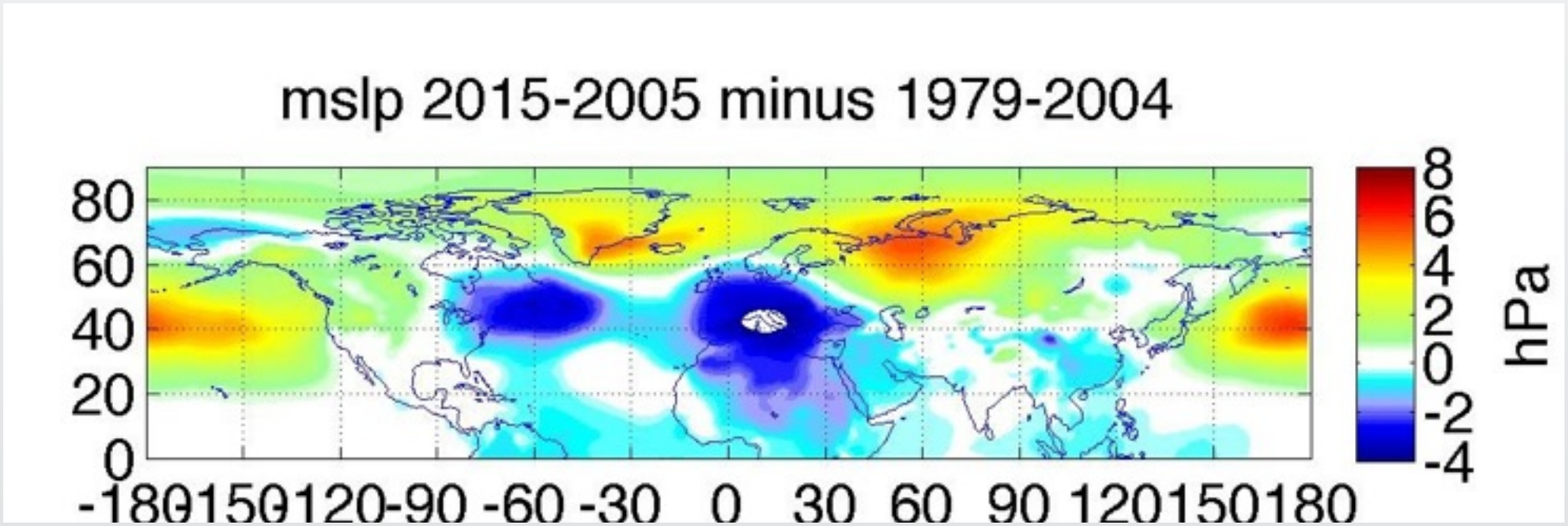




Warm Arctic Cold Continents

FEBRUARY





- Sea-ice reduction B-K —> Negative NAO (Honda et al. 2009, Grassi et al. 2013, Pedersen et al. 2015)

- NAO induced sea-ice anomalies have a negative feedback NAO+—>ICE- —> NAO- (Yamamoto et al. 2006,Deser et al. 2007, Strong and Magnusdottir 2009)

- Impact of sea-ice changes is non-linear with respect to amplitude (Petoukhov and Semenov 2010, Semenov and Latif 2015)

Observed Atmospheric Coupling between Barents Sea Ice and the Warm-Arctic Cold-Siberian Anomaly Pattern

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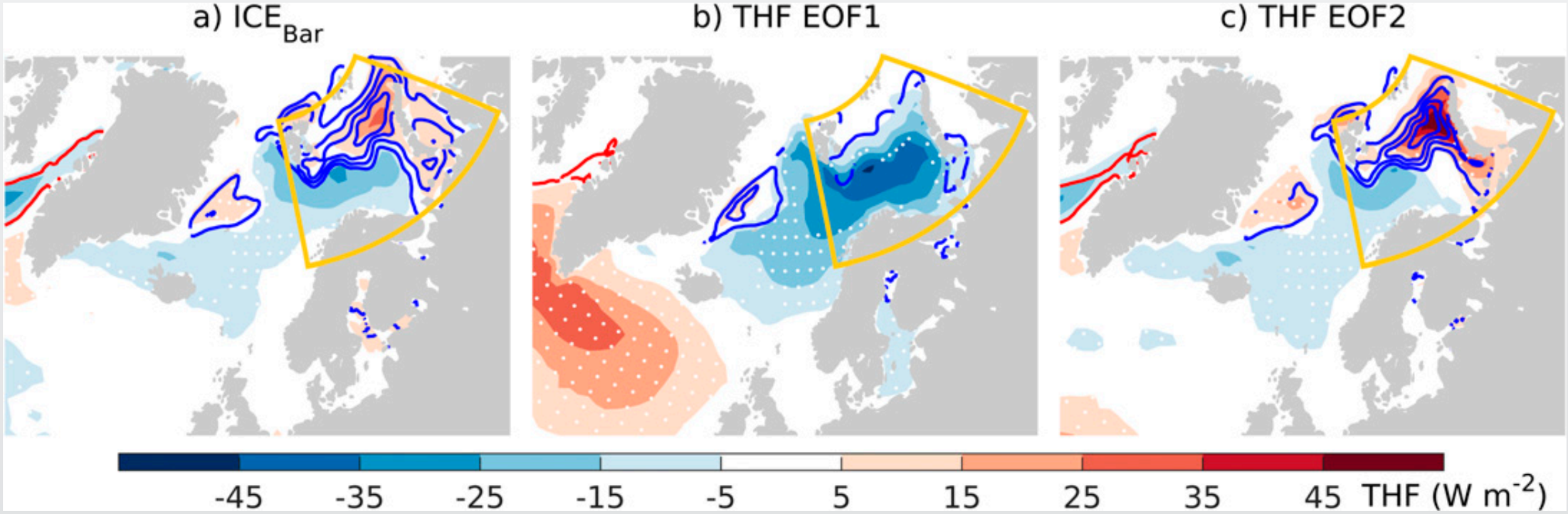
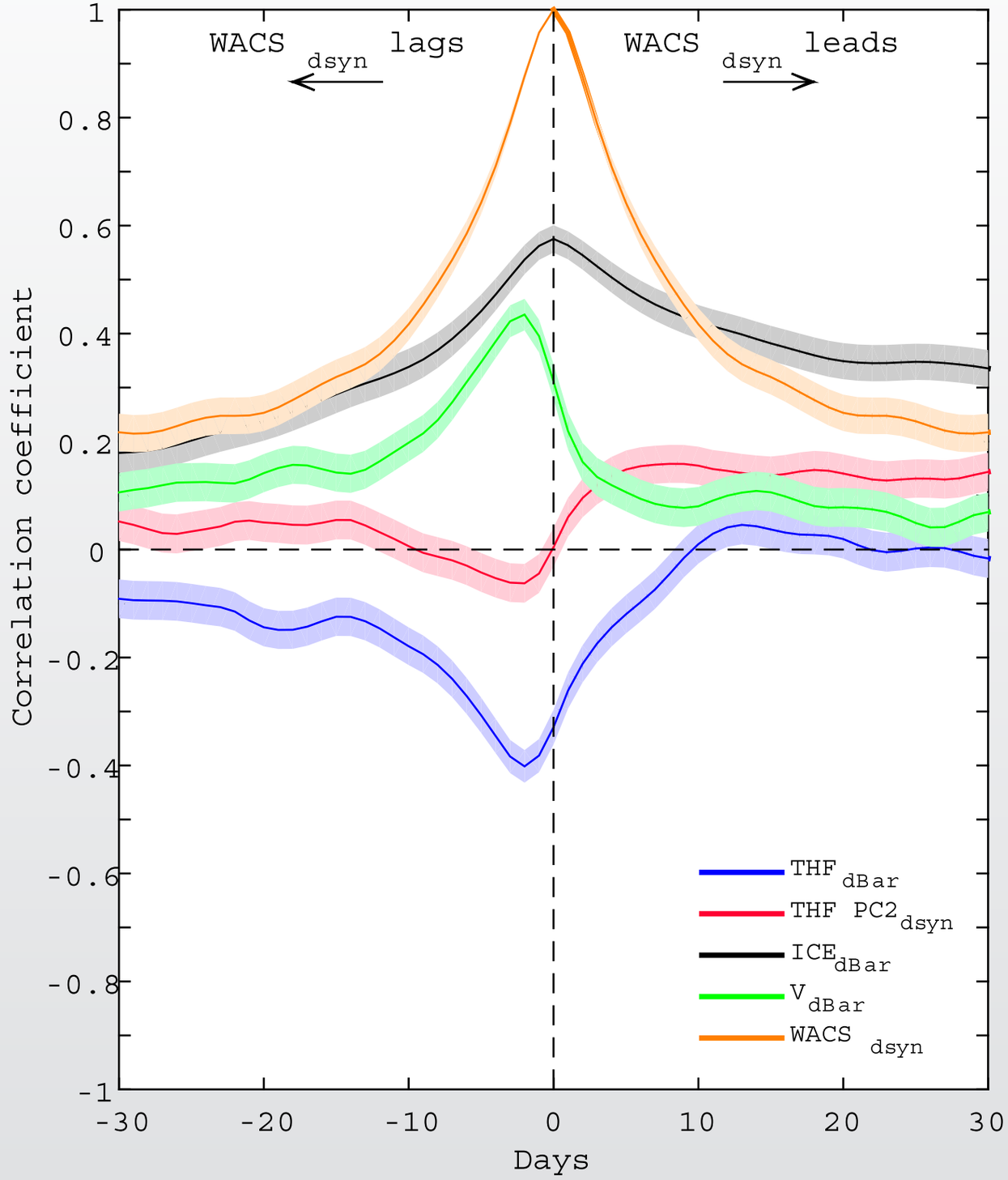
NILS GUNNAR KVAMSTØ

Geophysical Institute, University of Bergen, and Bjerknes Centre for Climate Research, Bergen, Norway

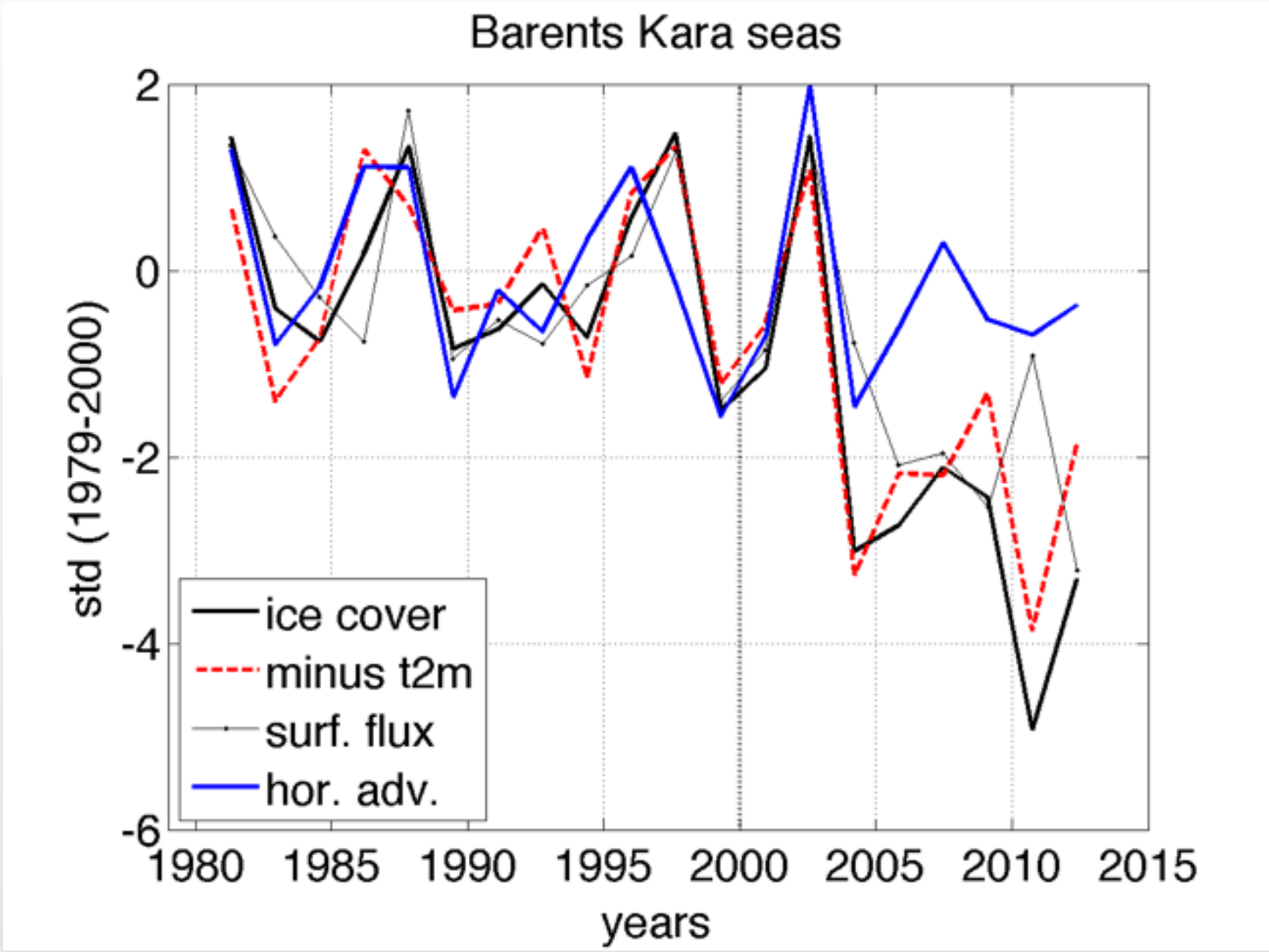
JCLI 2015



Intraseasonal sea-ice-atmosphere interaction



DJF TIME SERIES

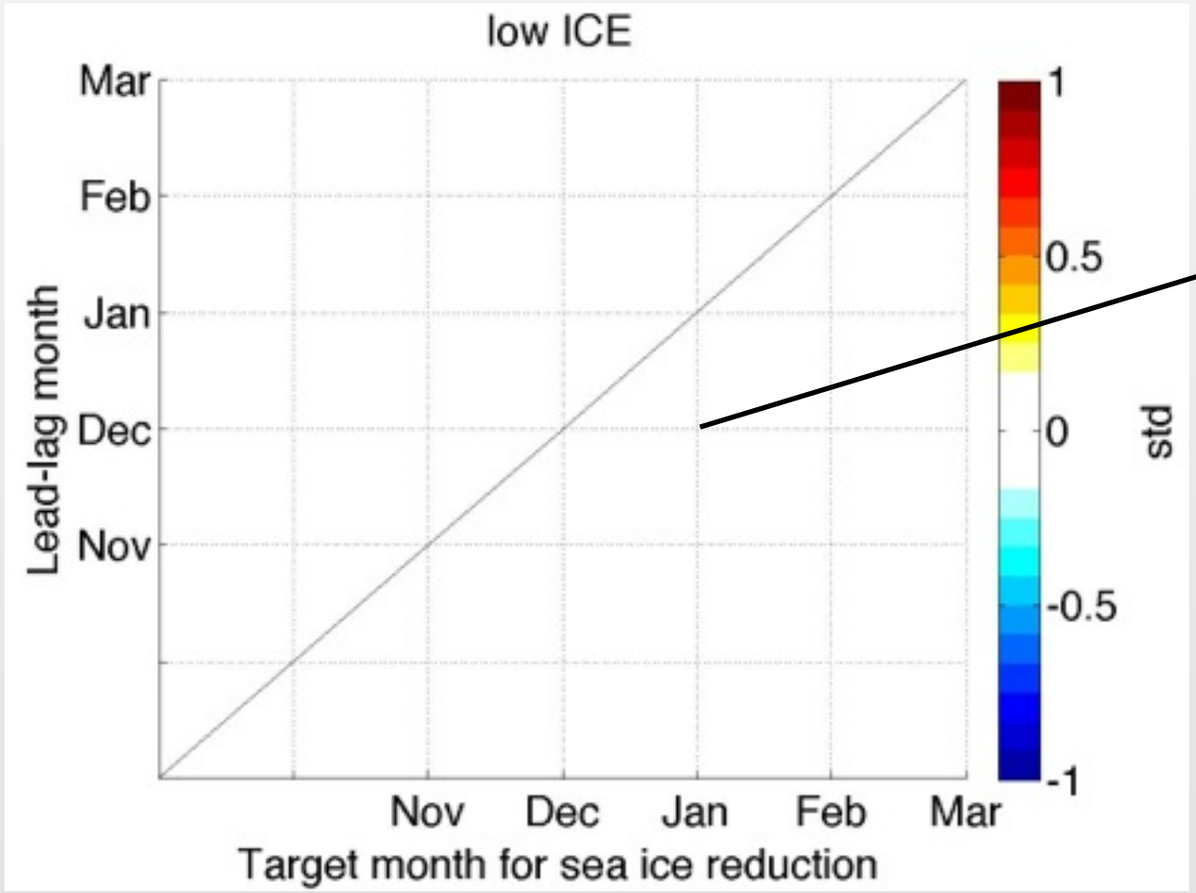


ICE 1979-2015

ICE 1979-1999

METHODOLOGY

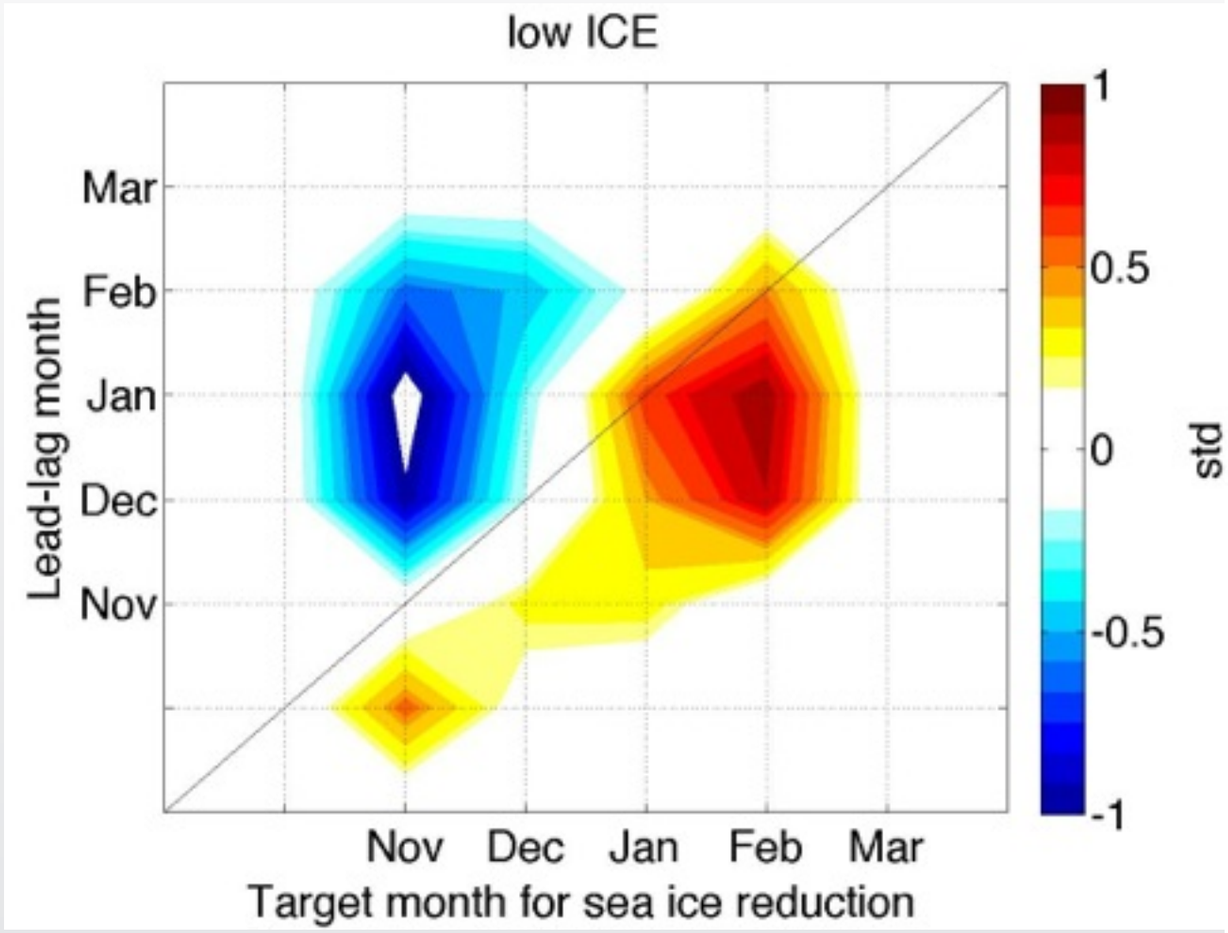
- ERA-INTERIM Reanalysis: Z500, surface fluxes, vT
- Idealised Experiment: ICTP AGCM prescribed sea-ice reduction



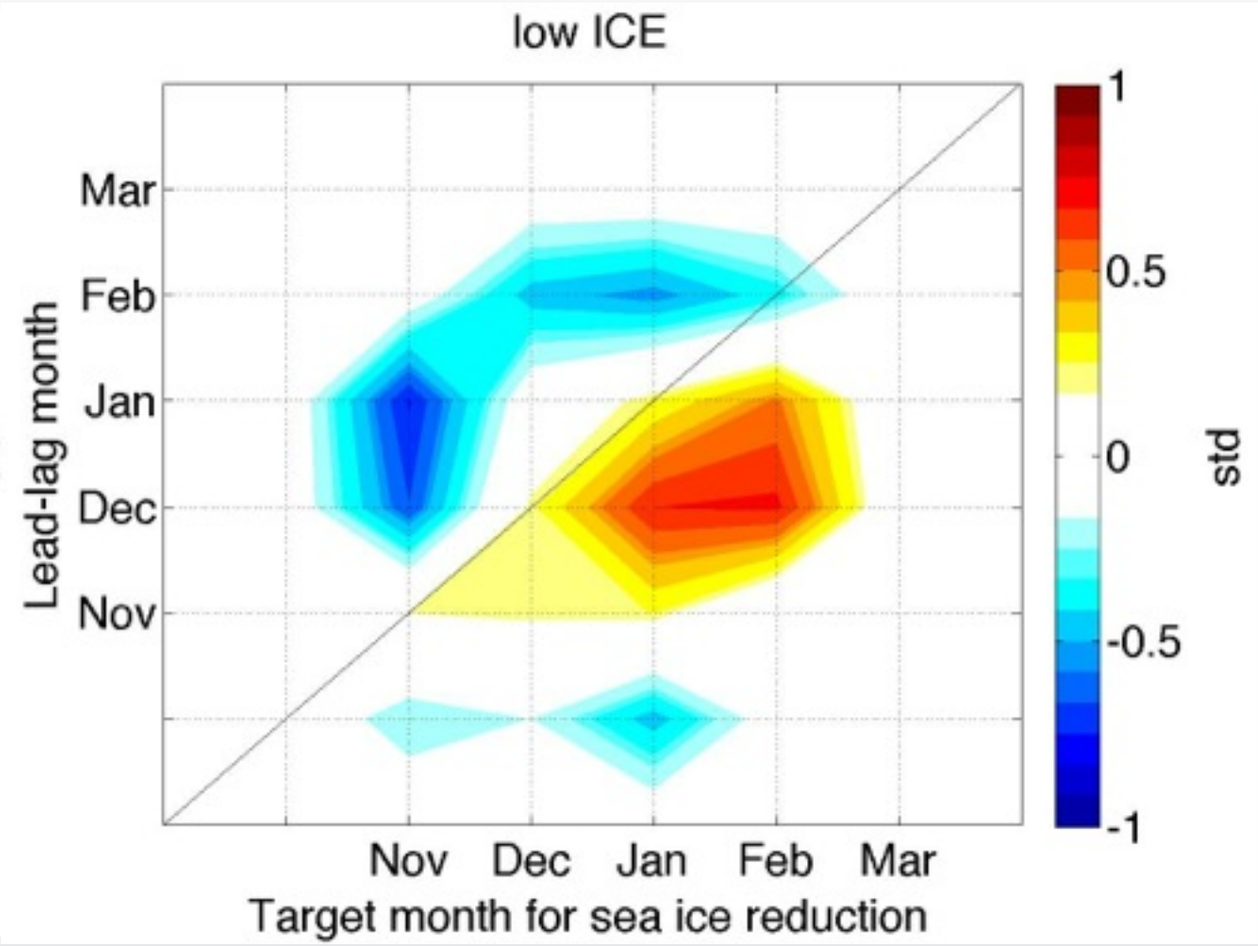
Signal in December associated to low sea-ice in January

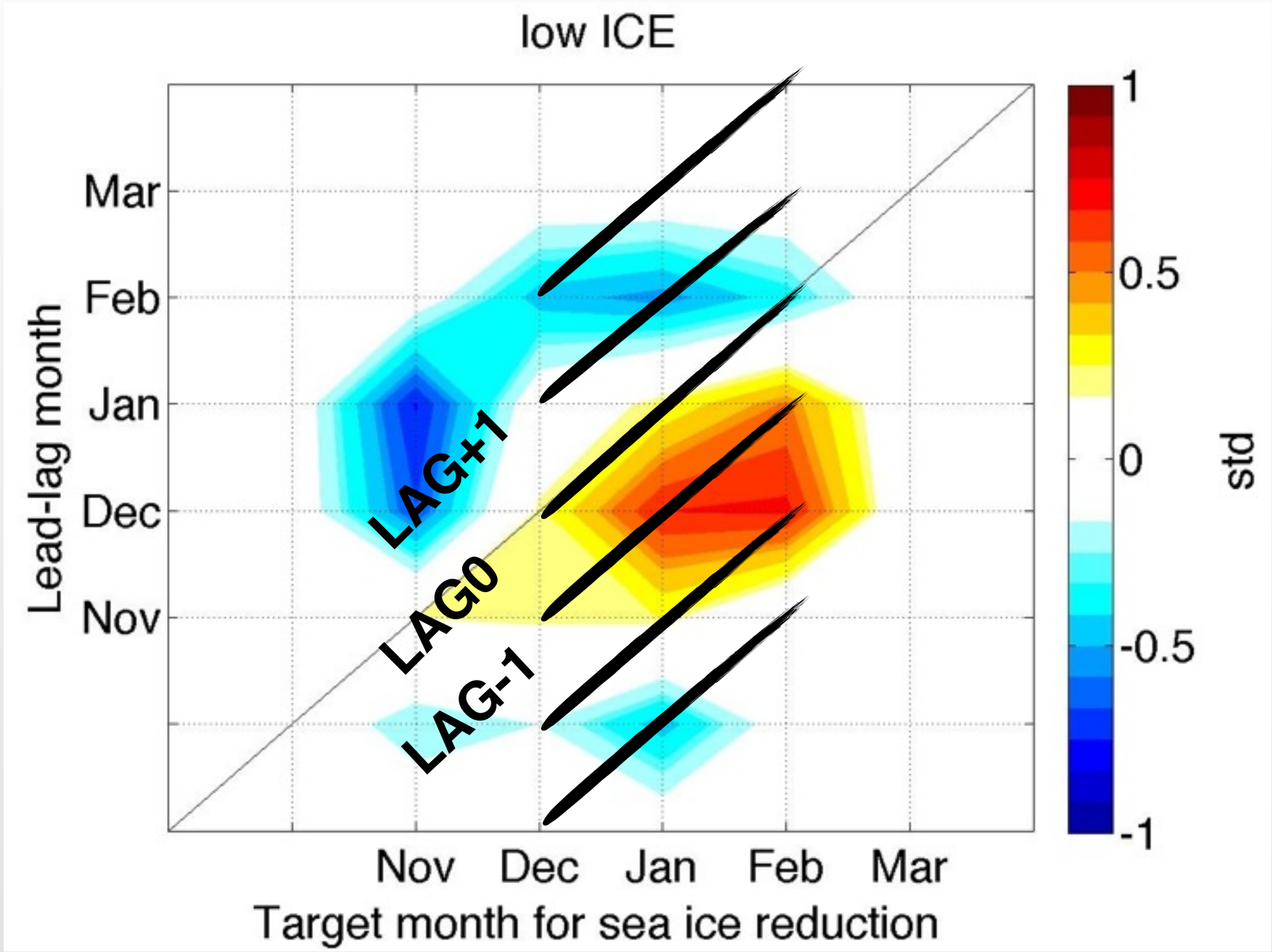
PROJECTION ONTO NAO

1979-1999



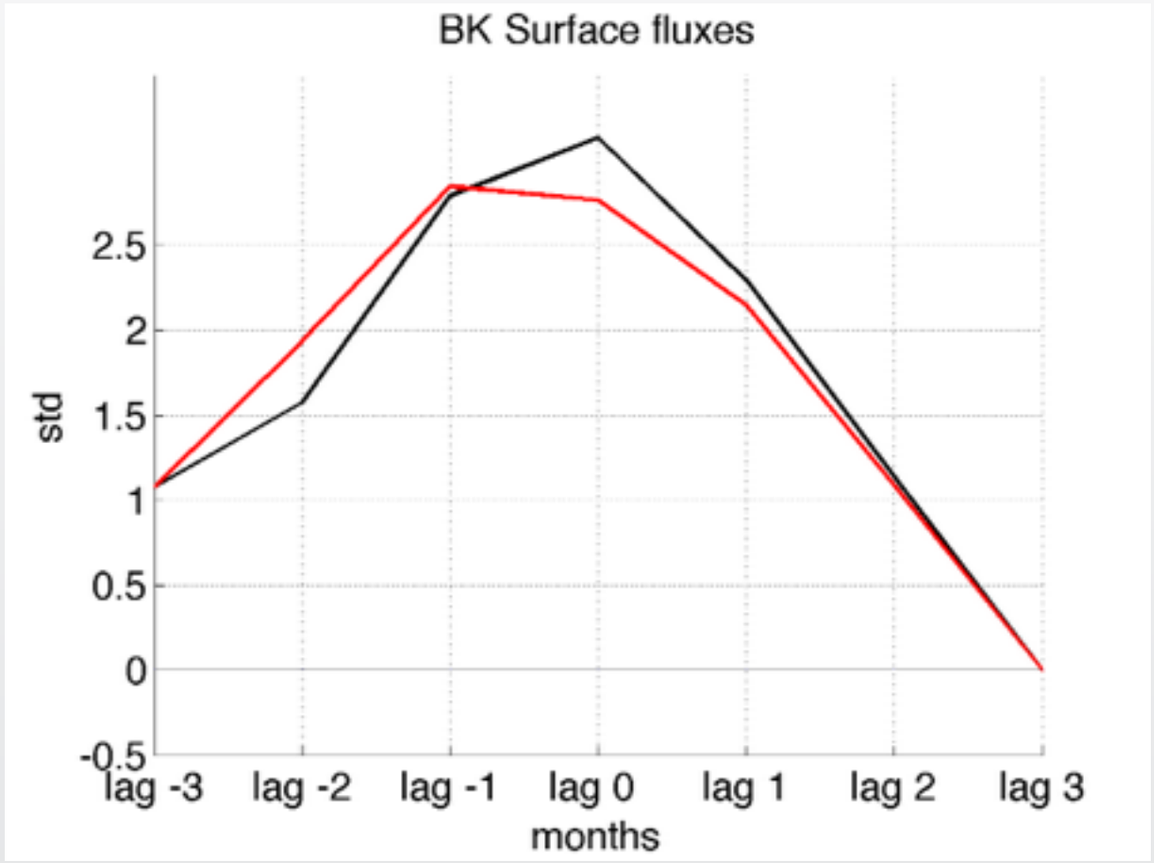
1979-2015

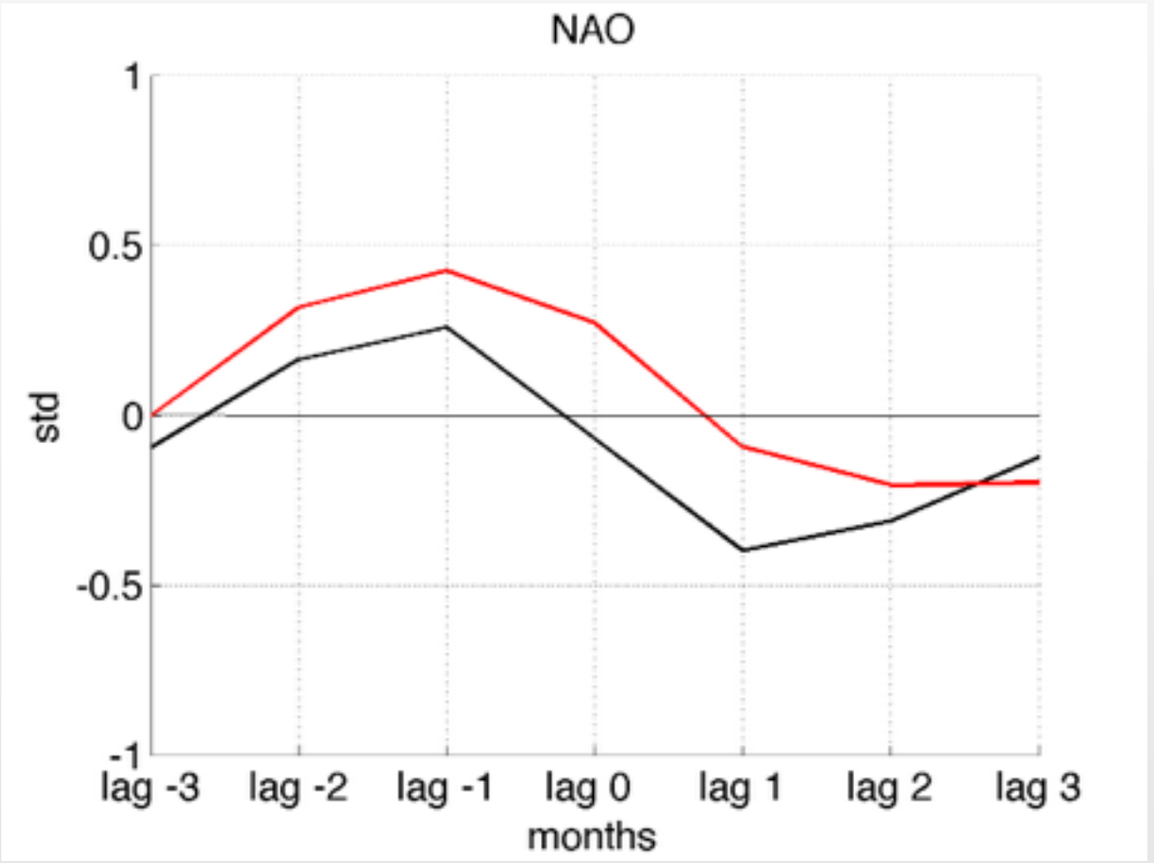



low ICE
Mar
Feb
Jan
Dec
Nov
Lead-lag month
LAG+1
LAG0
LAG-1
Nov
Dec
Jan
Feb
Mar
Target month for sea ice reduction
1
0.5
0
-0.5
-1
std

1979-2015

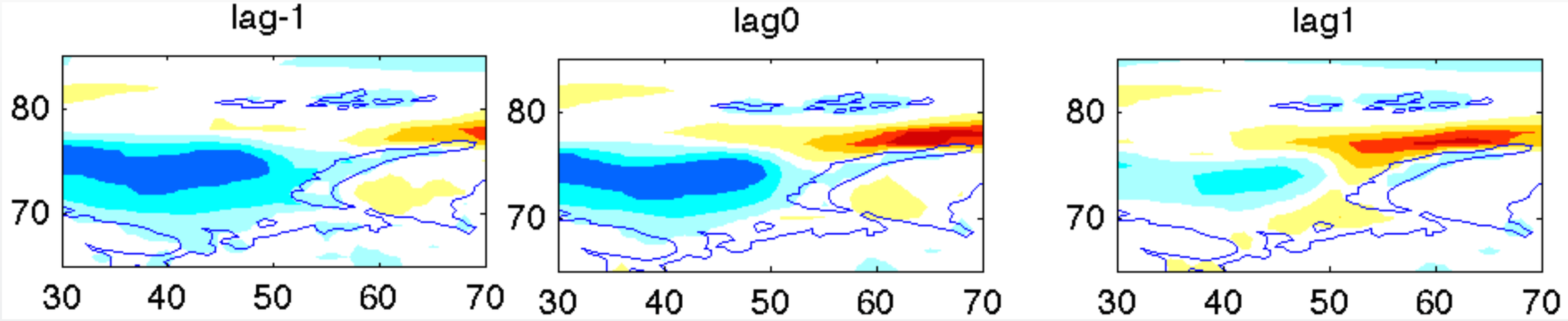
1979-1999

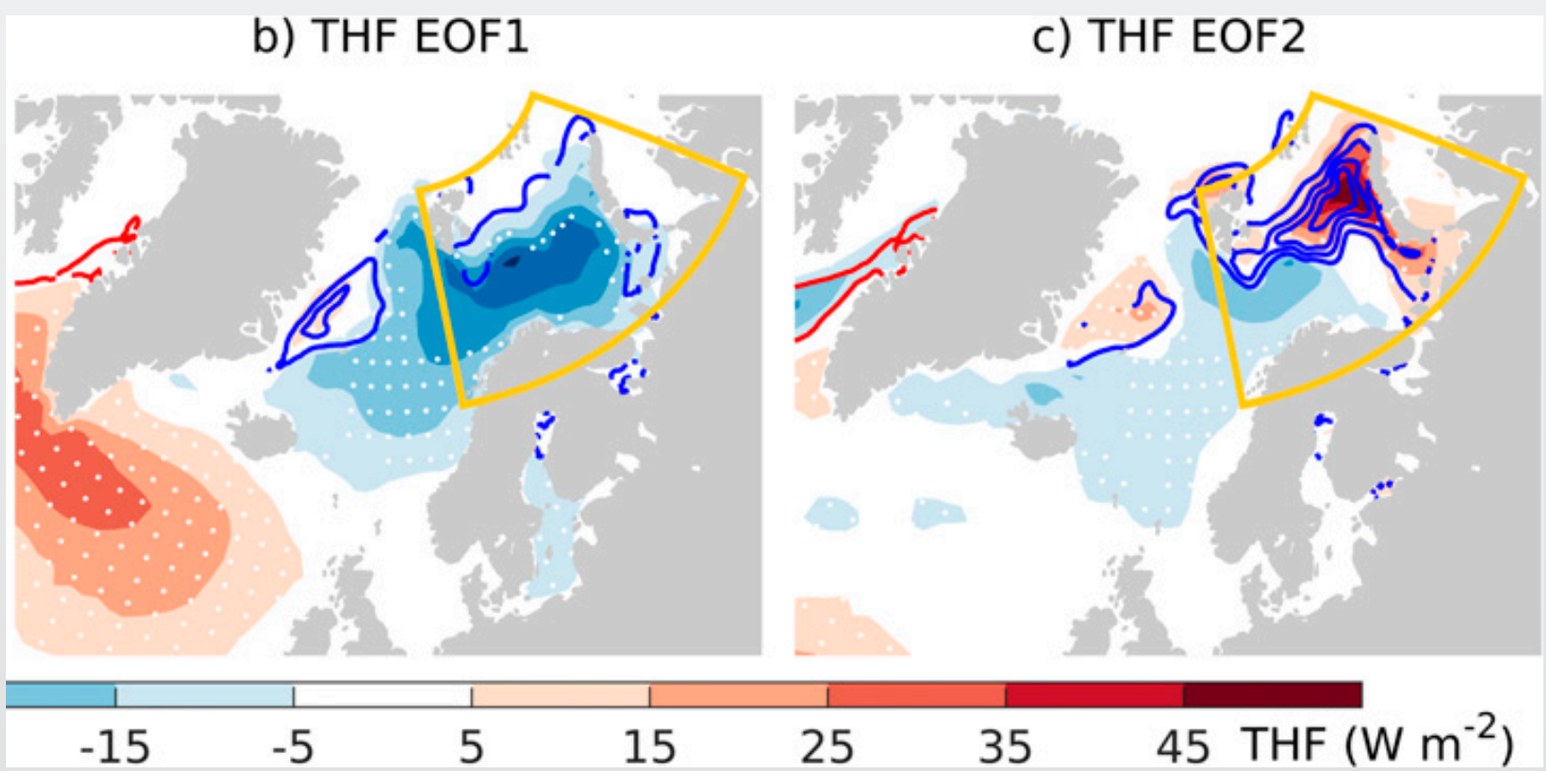




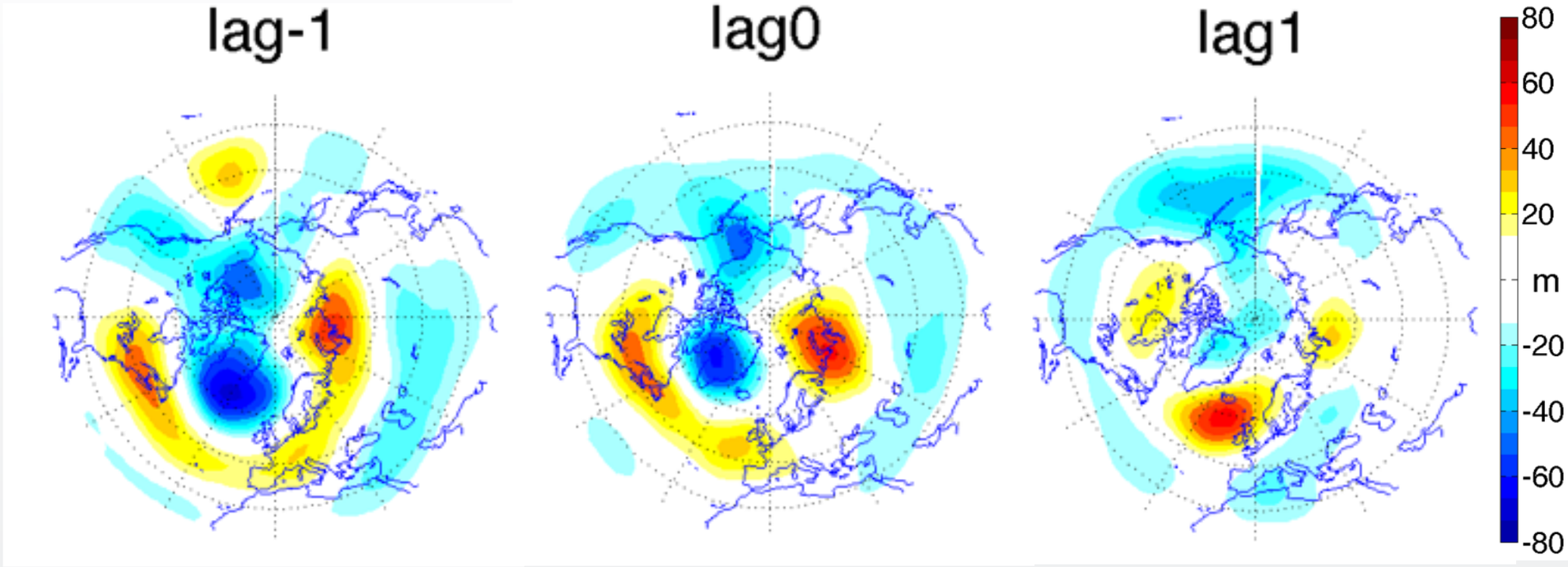
Surface heat flux

ERA-INTERIM

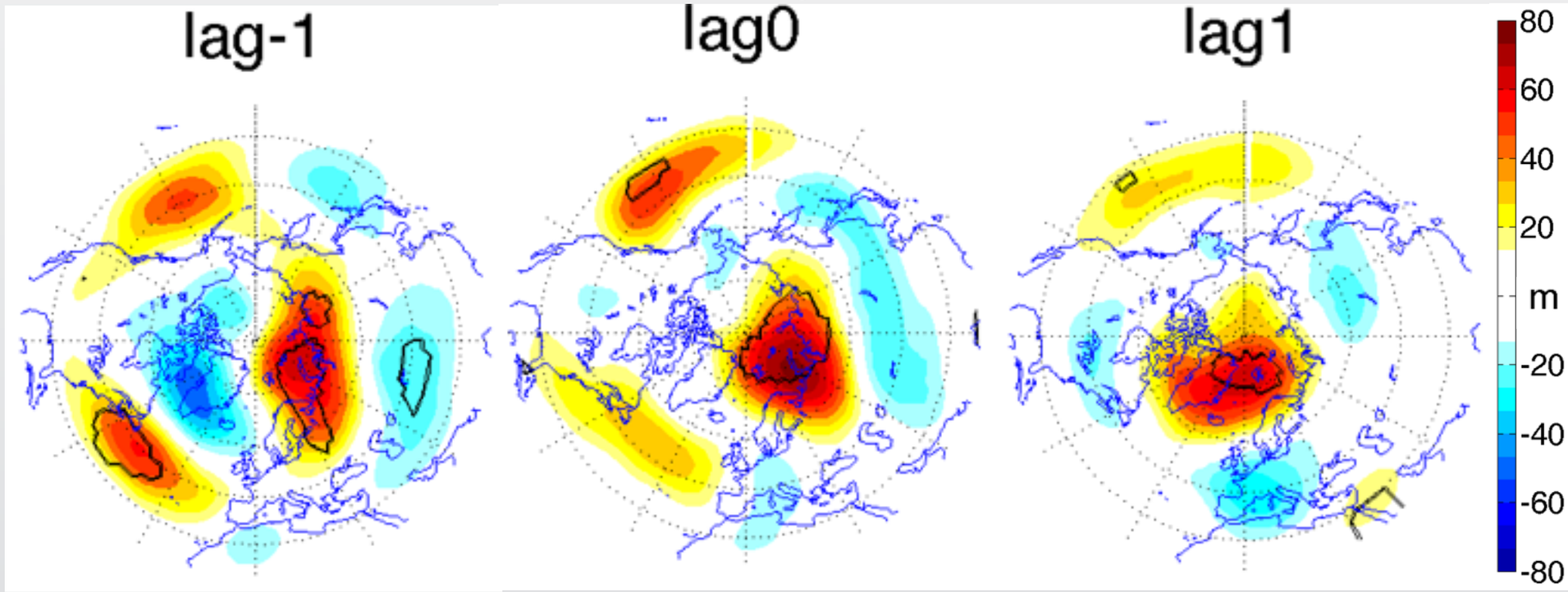


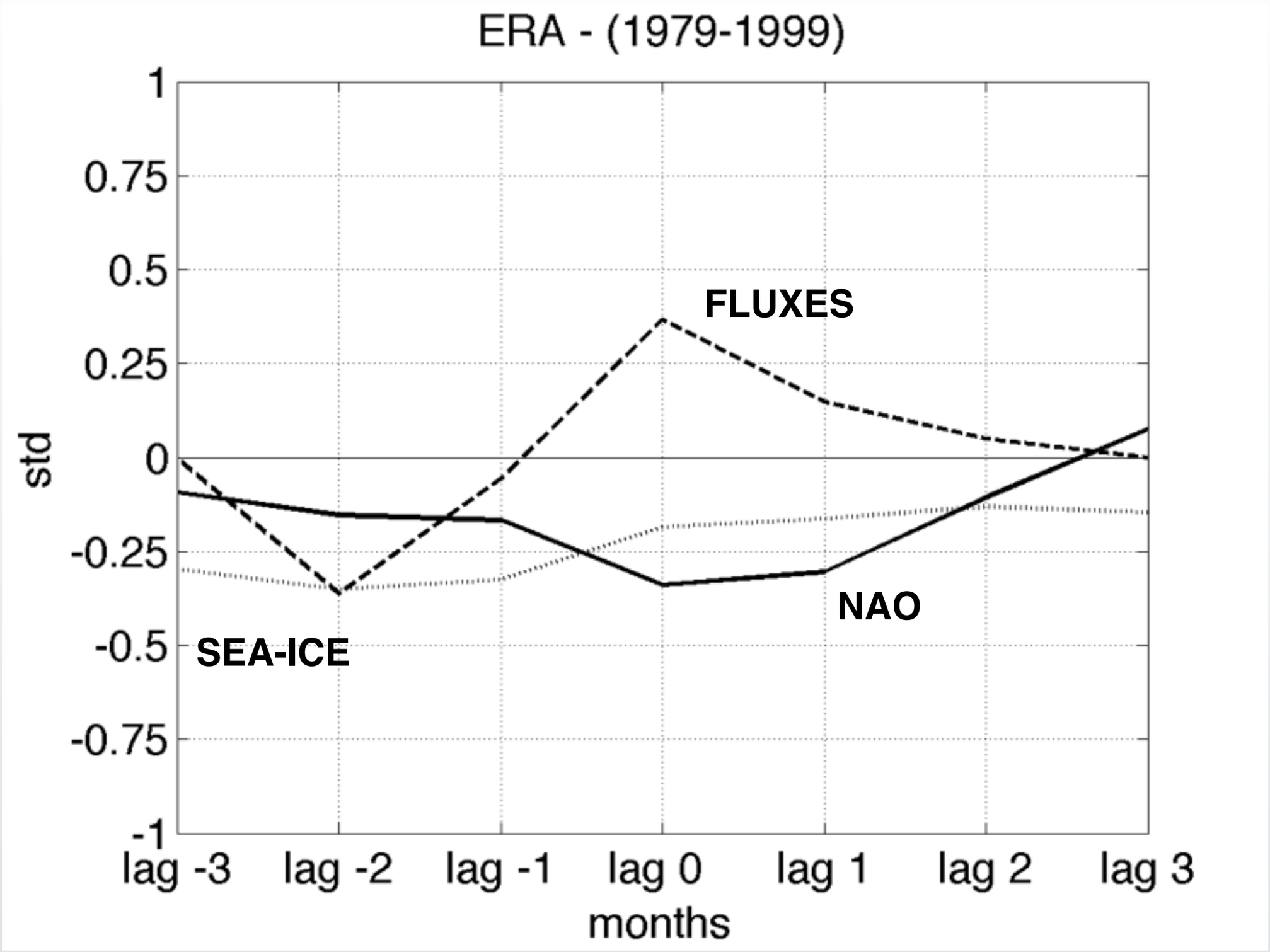


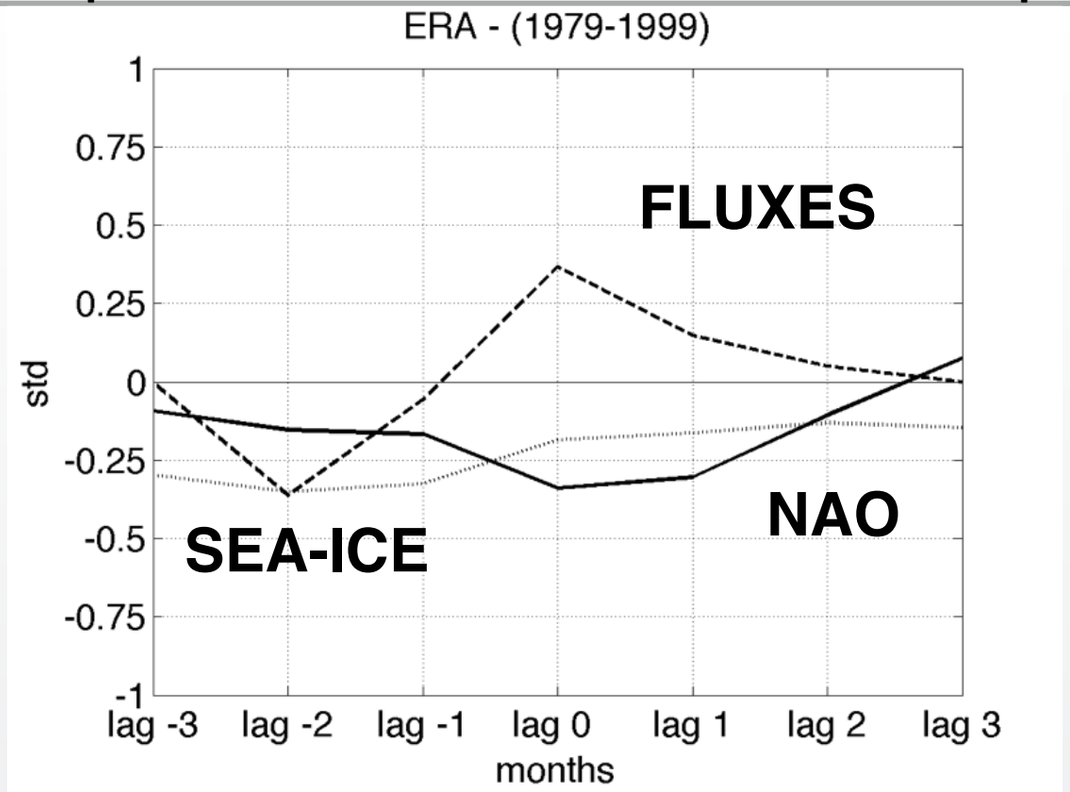
z500 anomaly 1979-1999



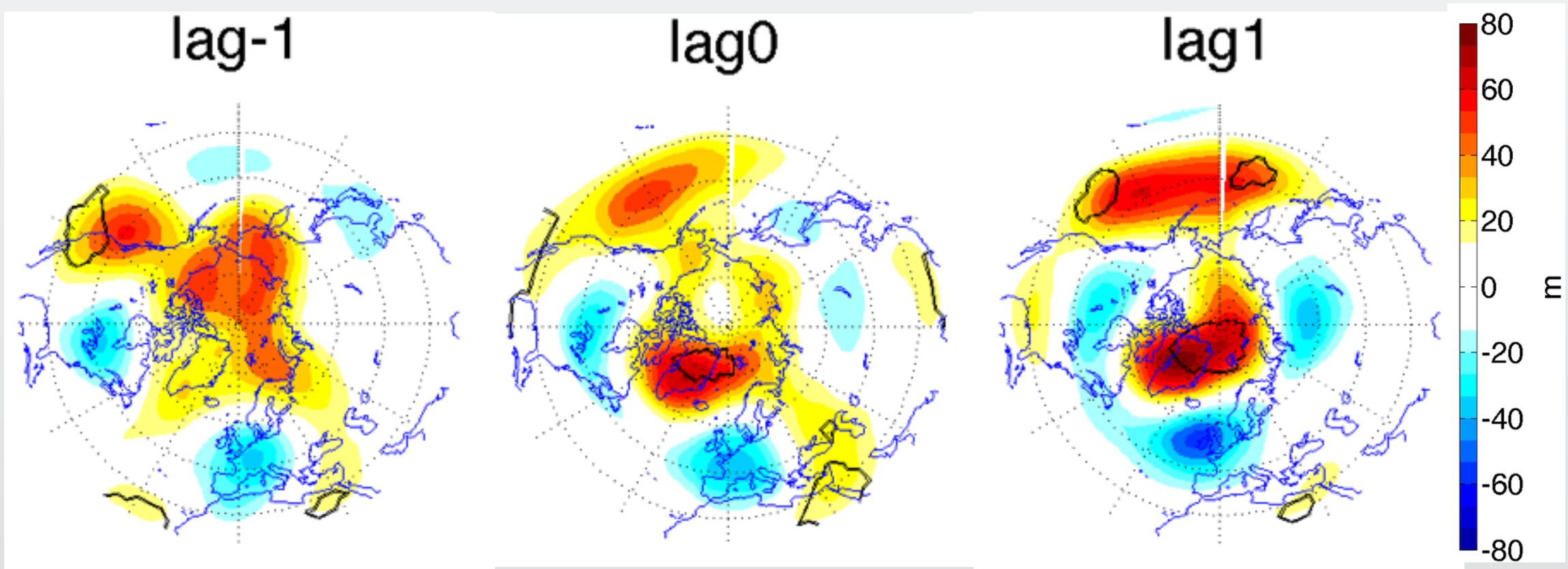
z500 anomaly 1979-2015



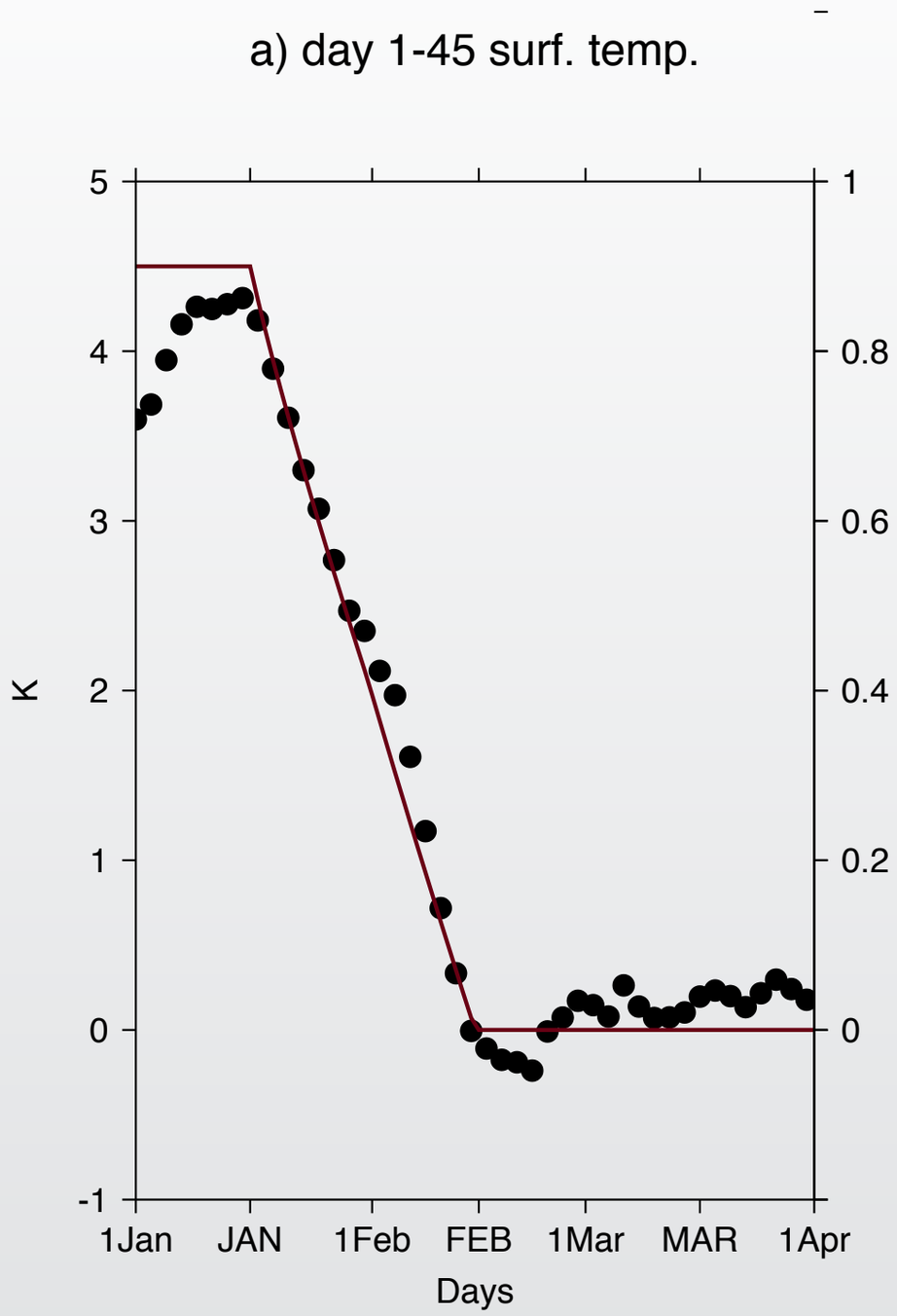

ERA - (1979-1999)
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
std
FLUXES
NAO
SEA-ICE
lag -3
lag -2
lag -1
lag 0
lag 1
lag 2
lag 3
months



Z500 (1979-2015 minus 1979-1999)



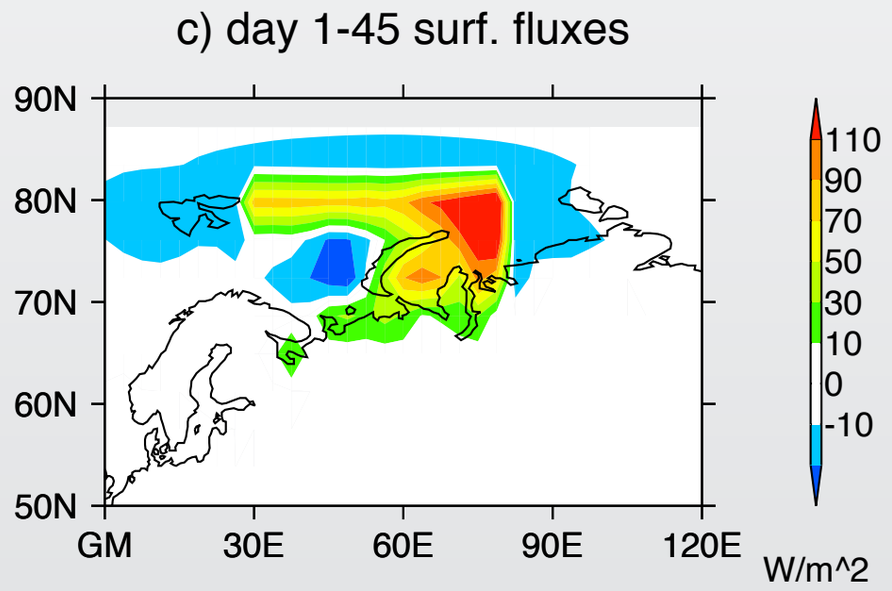
AGCM SIMULATION



Speedy AGCM

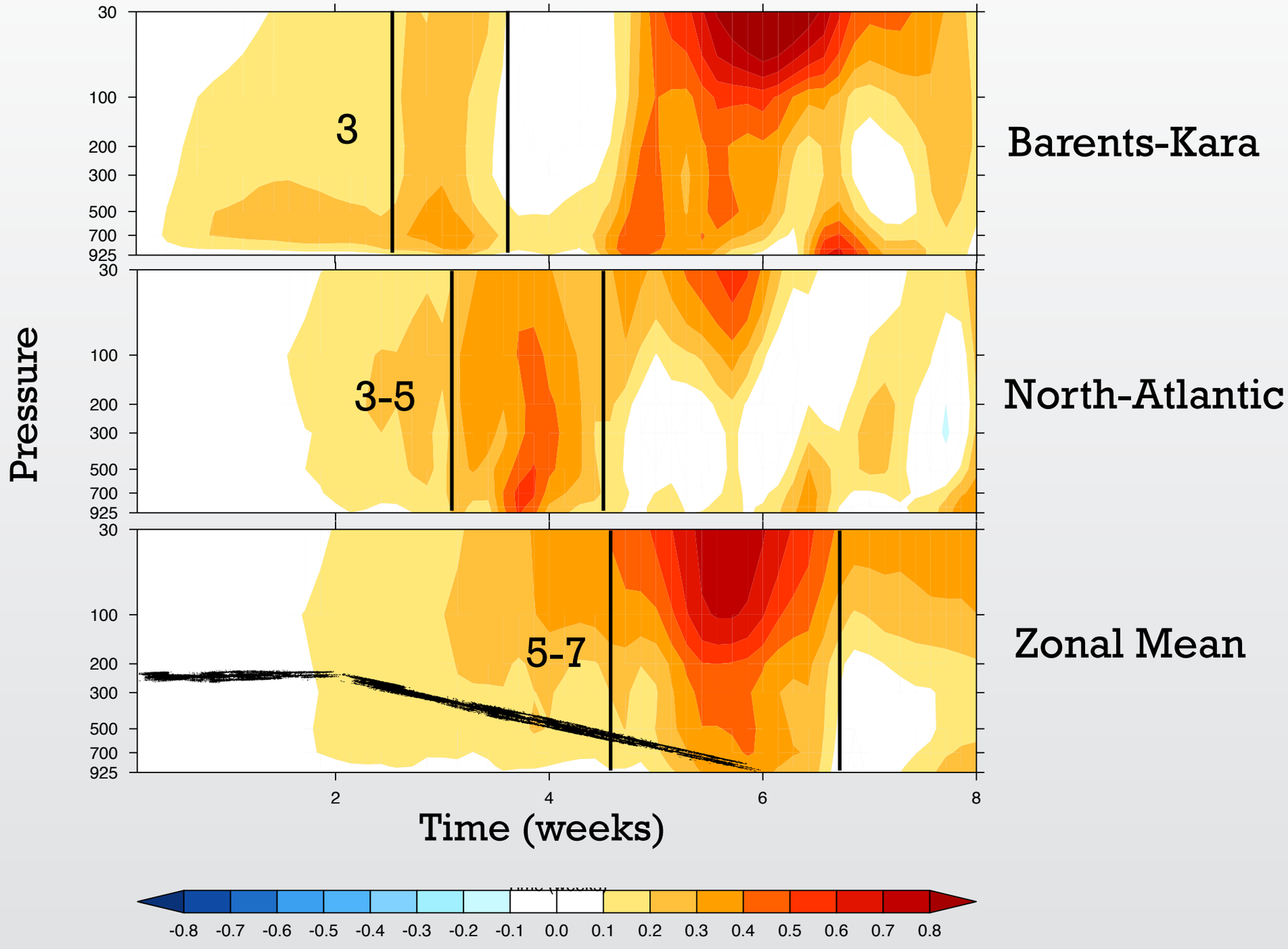
Ensemble of 100 initial Conditions with clim. sea-ice (CTL) and reduced sea ice in B-K (PRT)

Sea ice forcing persists for two weeks then linearly regressed to clim.

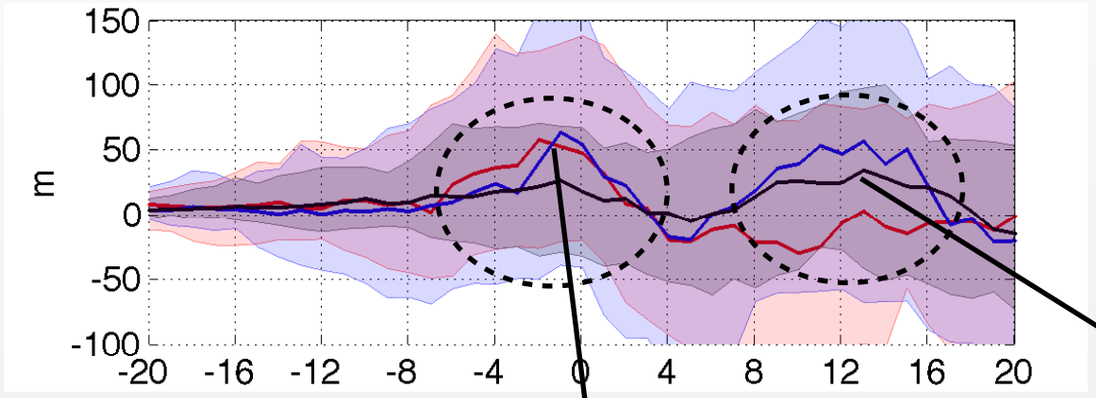


TRANSIENT RESPONSE

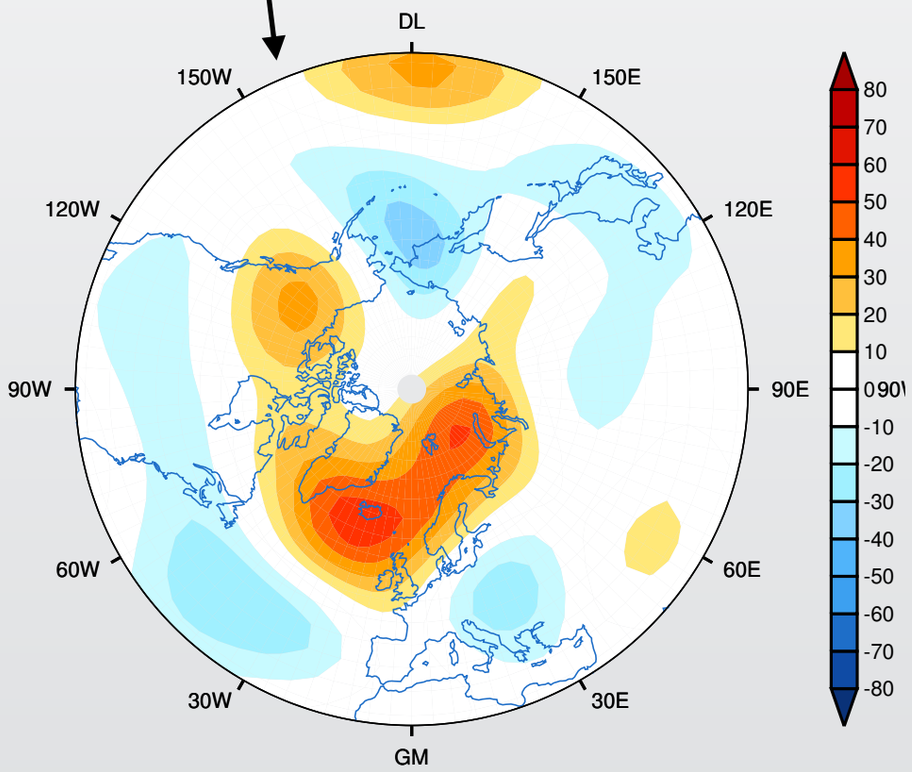
Normalised Z (60N-90N)



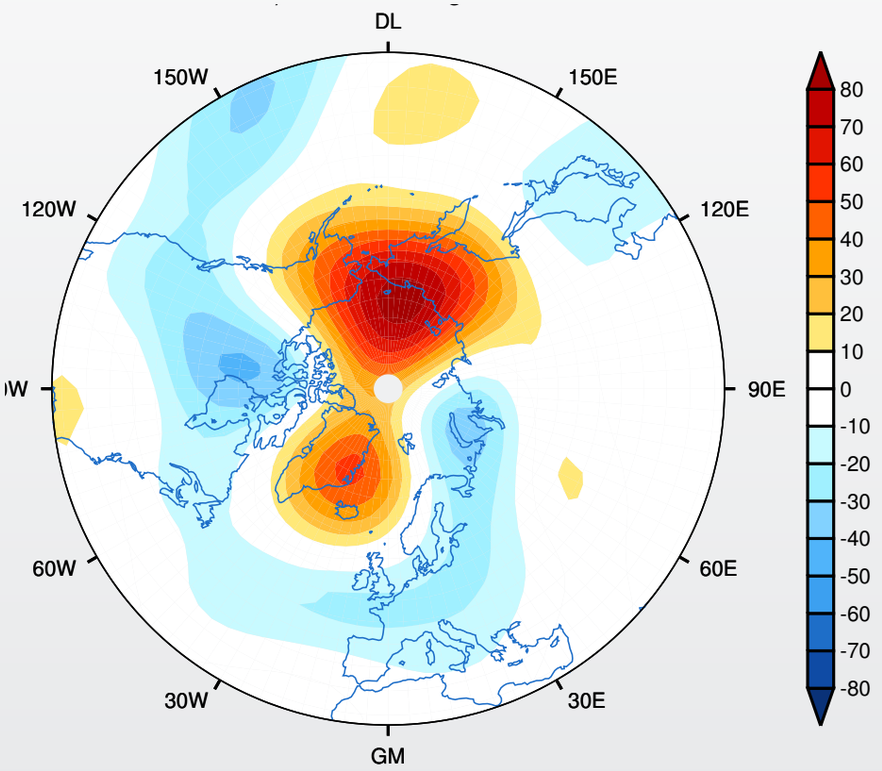
FAST AND DELAYED RESPONSE: 2



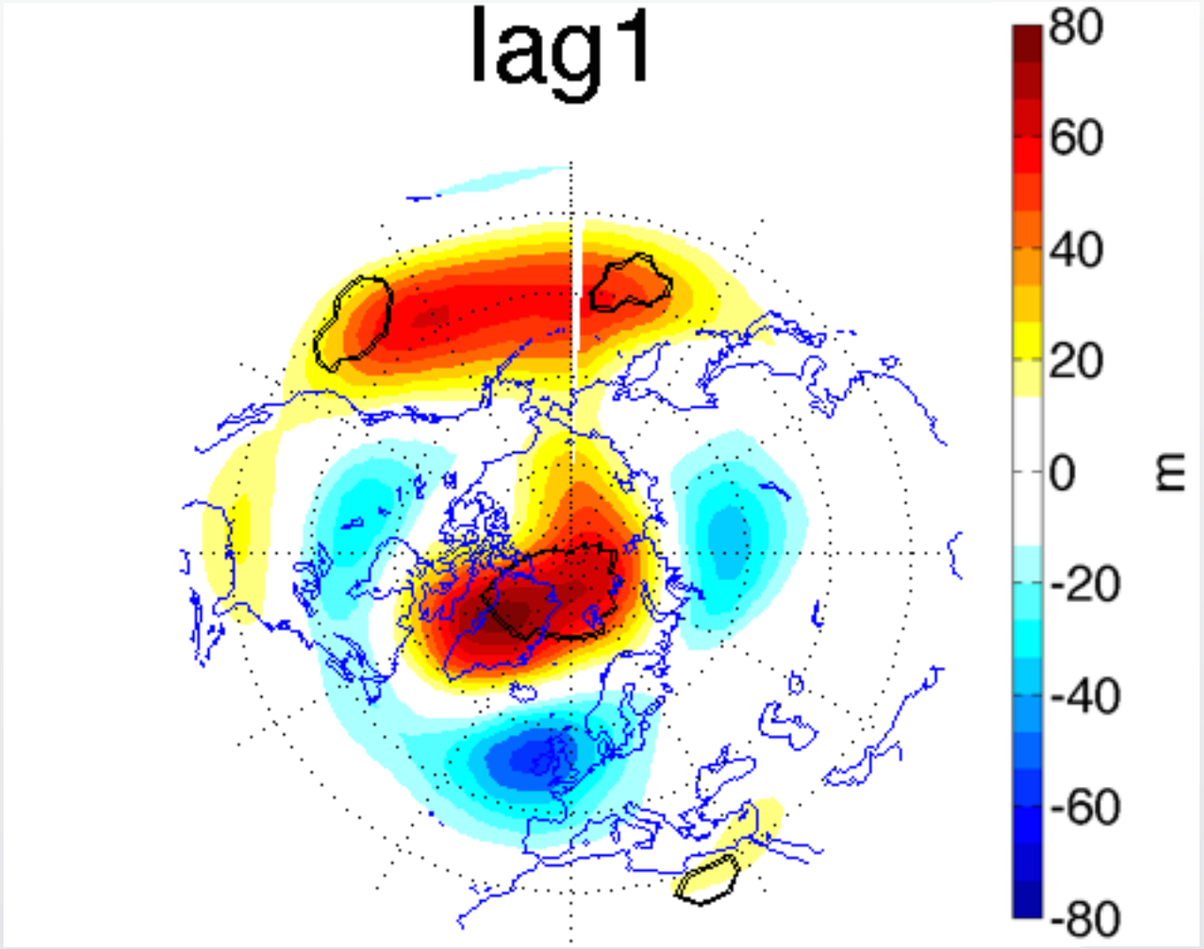
A



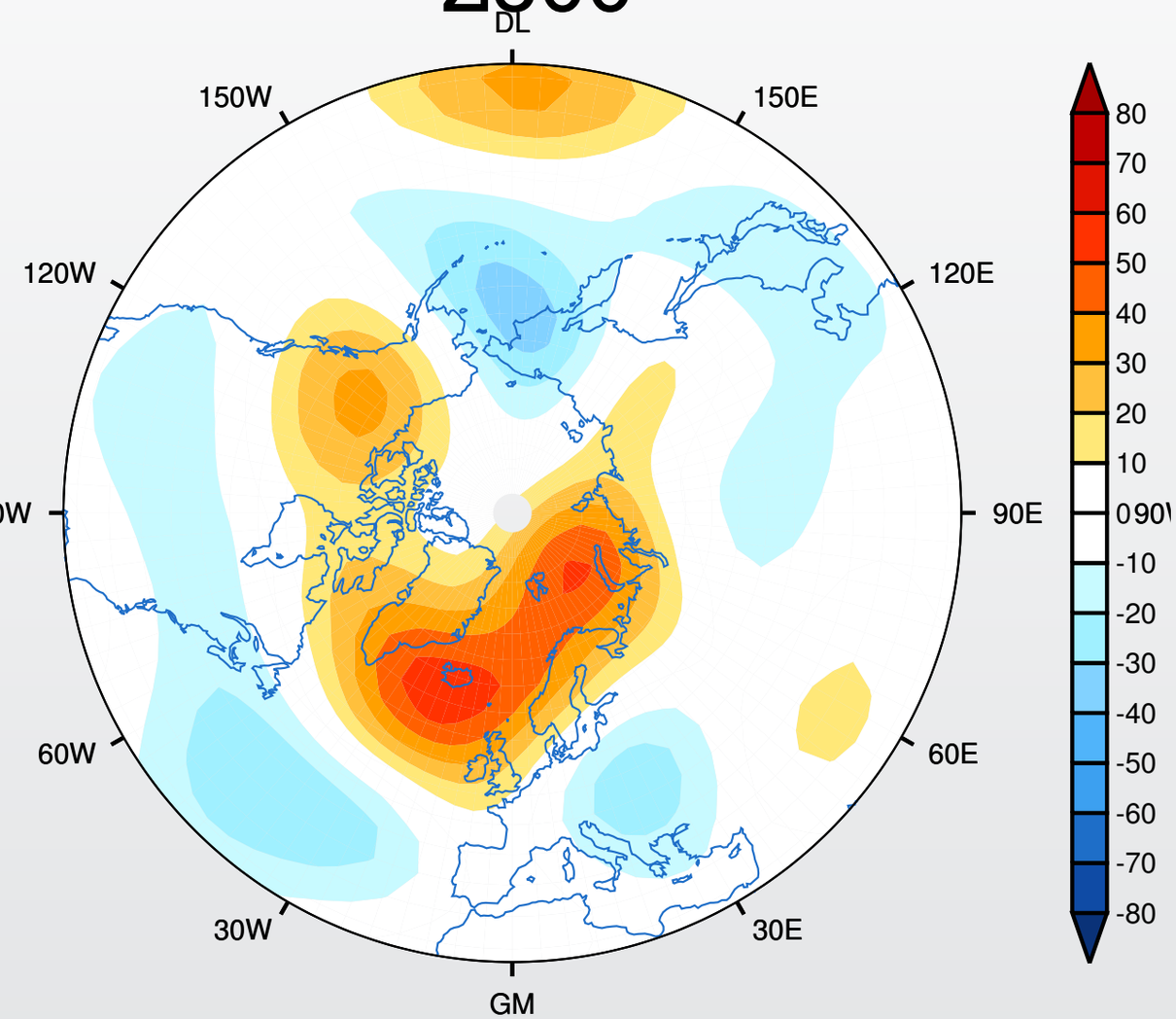
B



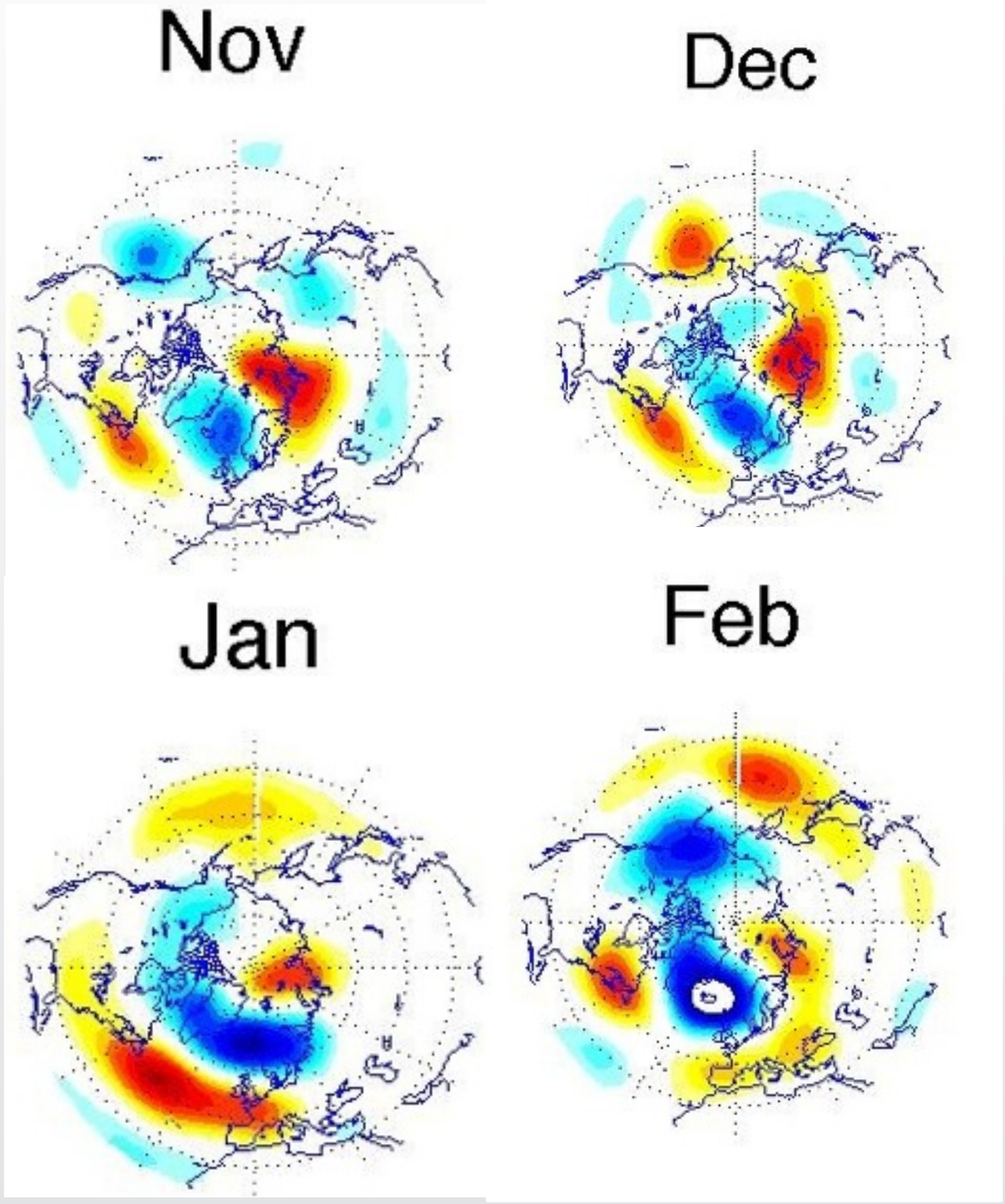
ERA INTERIM Z500



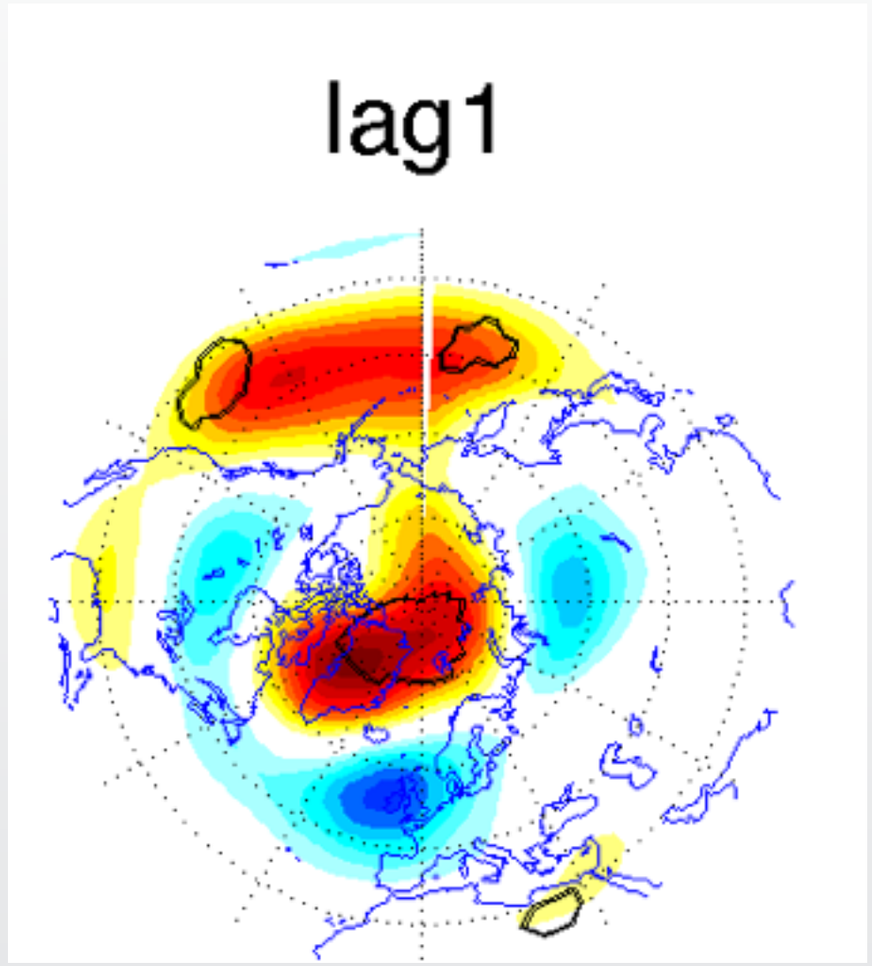
SPEEDY FAST RESPONSE Z500



Z500(HOR.ADV.)



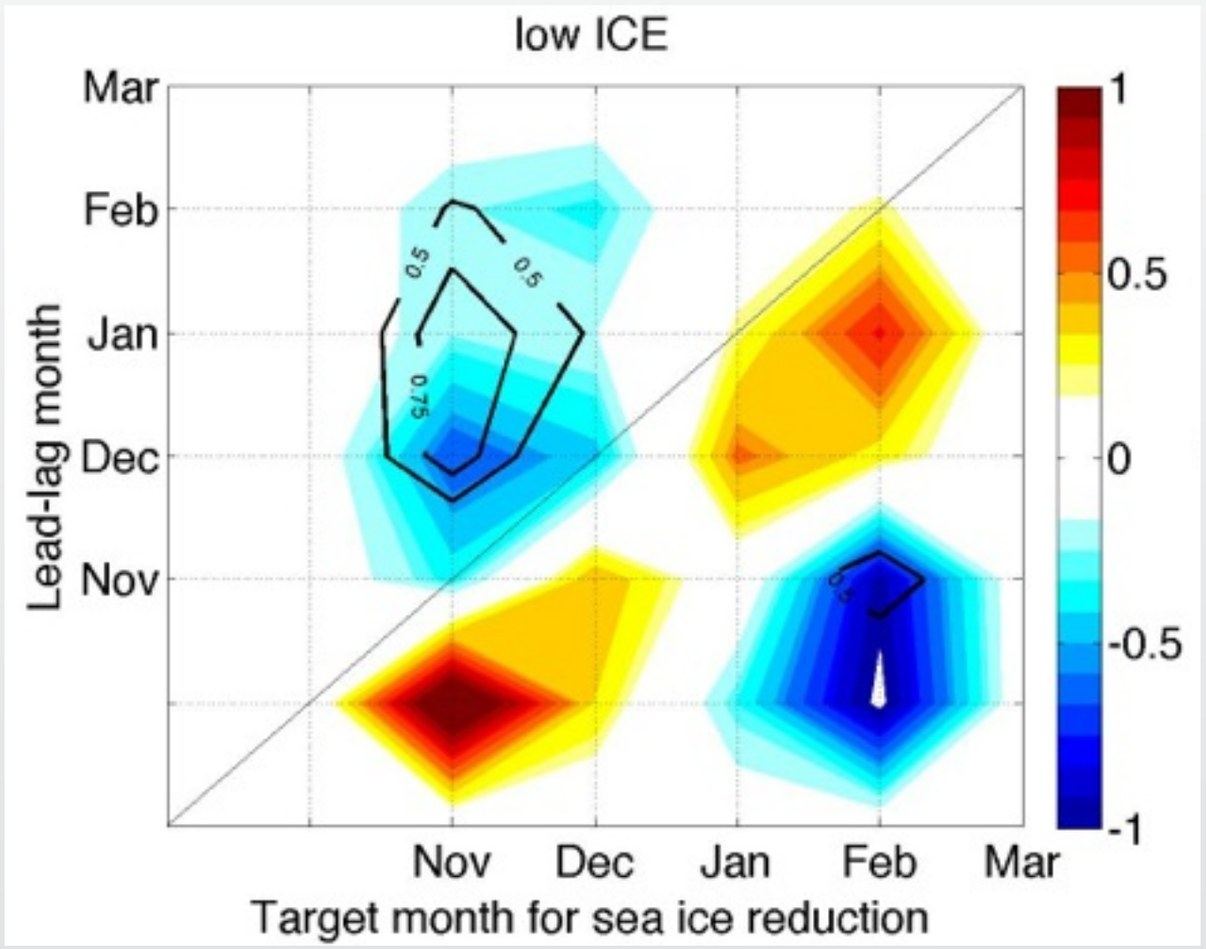
Z500(Response)



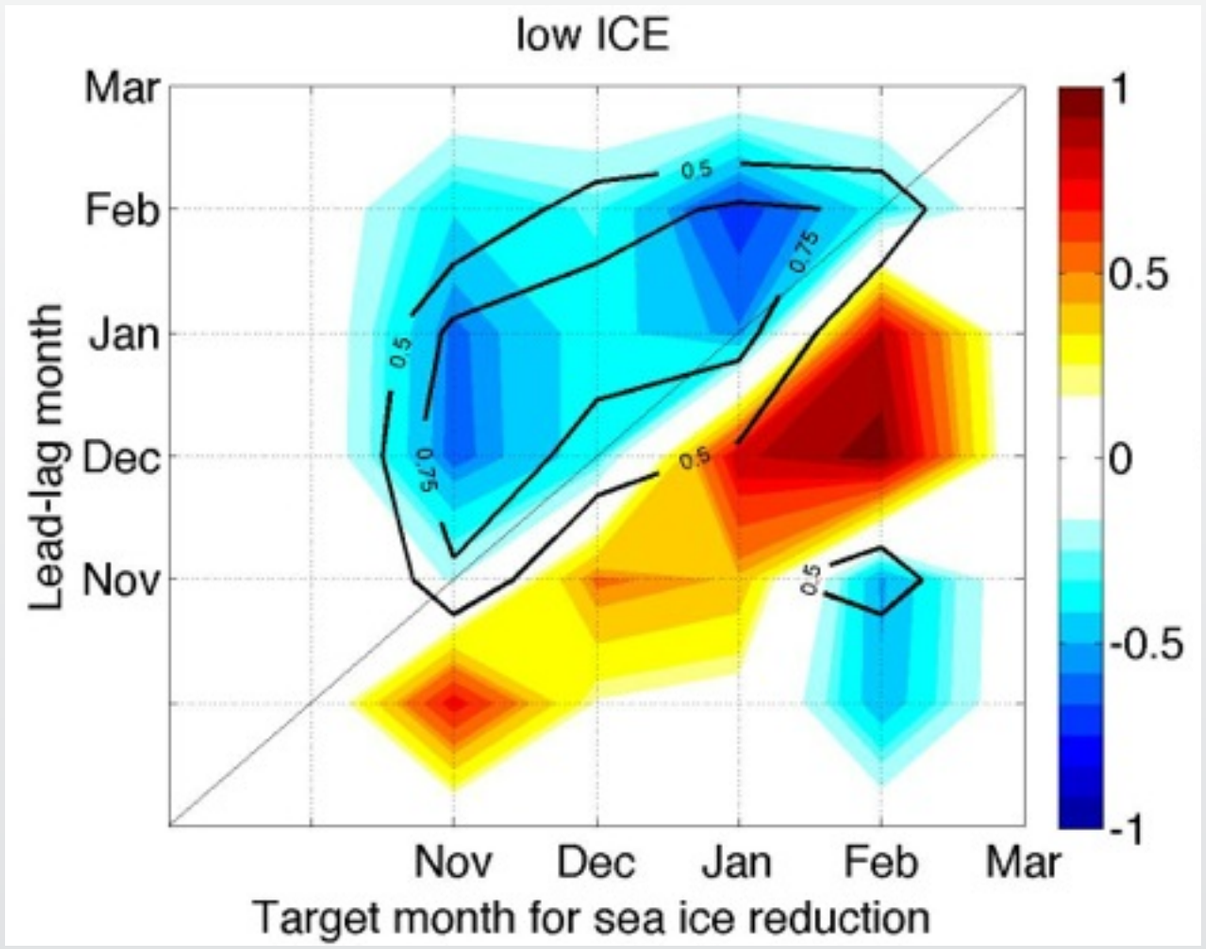
A PERSPECTIVE

RIGHT SIDE Index = corr(Z500,Zha)
LEFT SIDE Index = corr(Z500,Zforced)

1979-2000



1979-2015



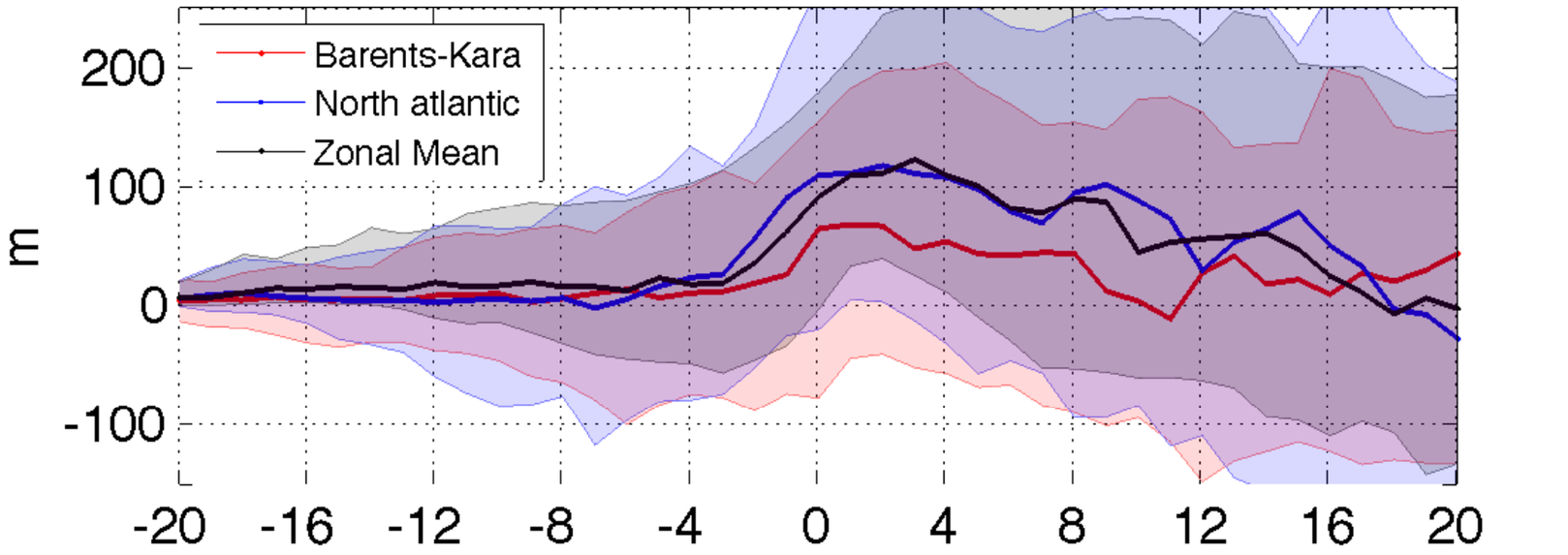
Comments

- A coupled perspective

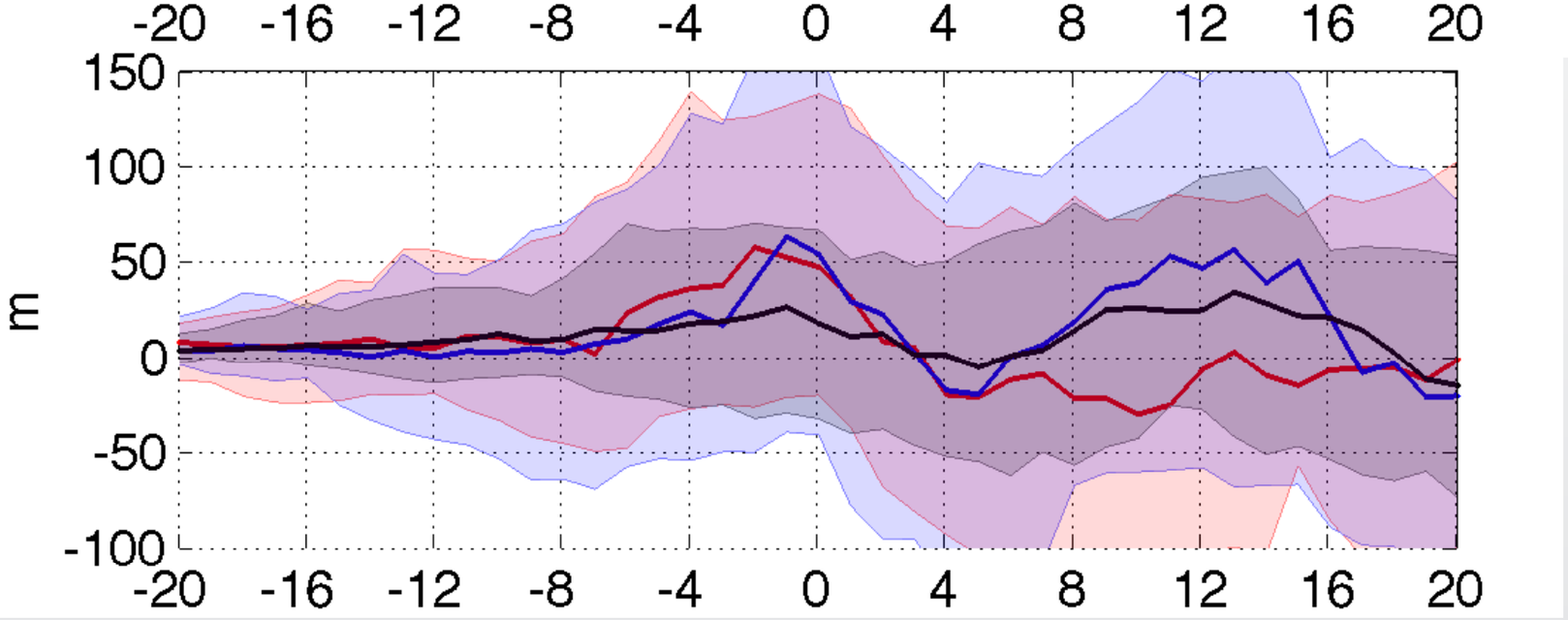
- The impact of the recent sea ice reduction on the sea-ice-NAO connection can be interpreted as the intraseasonal atmospheric response to surface fluxes on a time scale of 1 or 2 months

- Other indices can provide useful information to represent the atmospheric patterns involved in the lead-lag relationship

FAST AND DELAYED RESPONSE



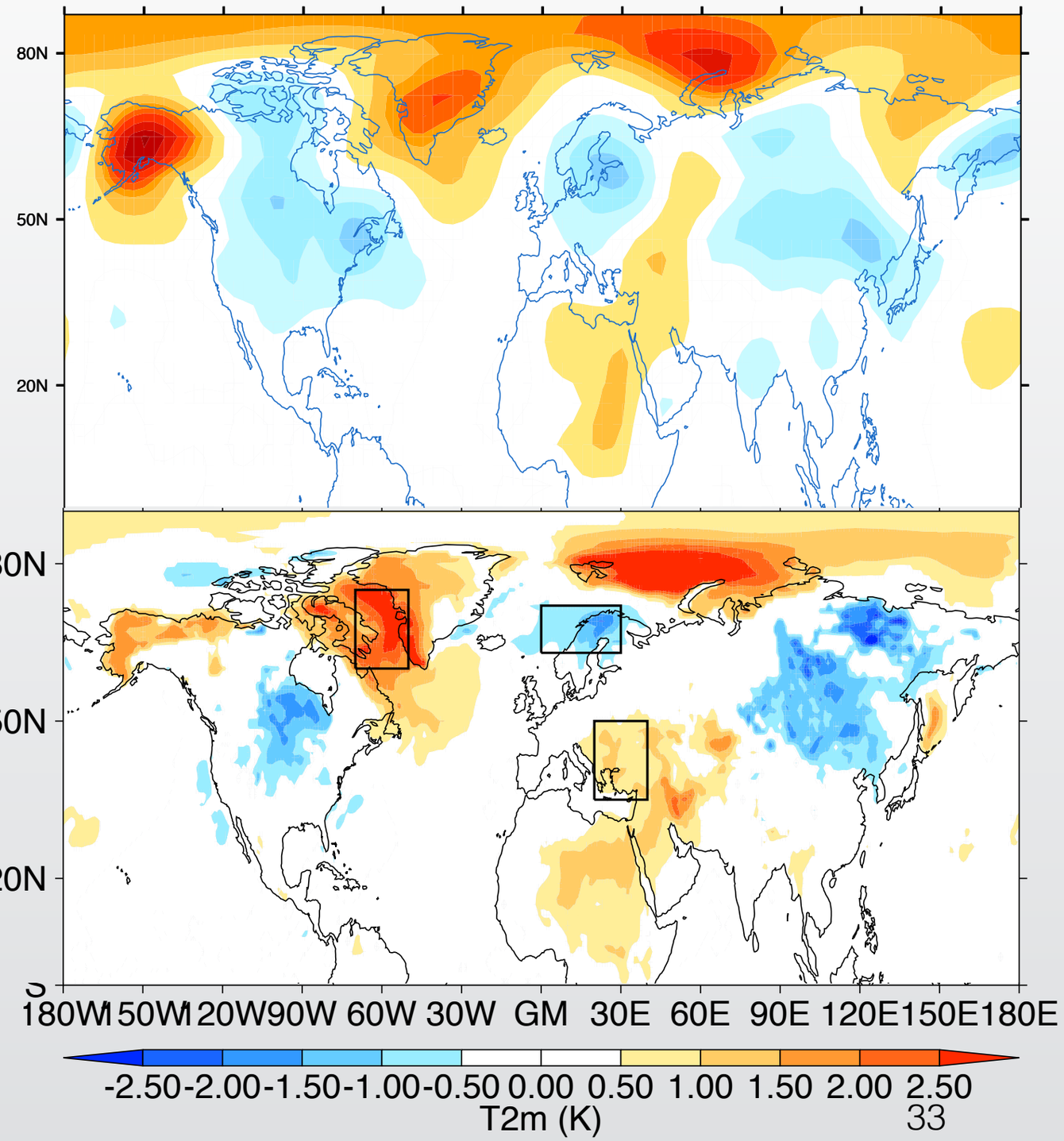
30 hPa,
Geopotential Height
PRT-CTL



300 hPa,
Geopotential Height
PRT-CTL

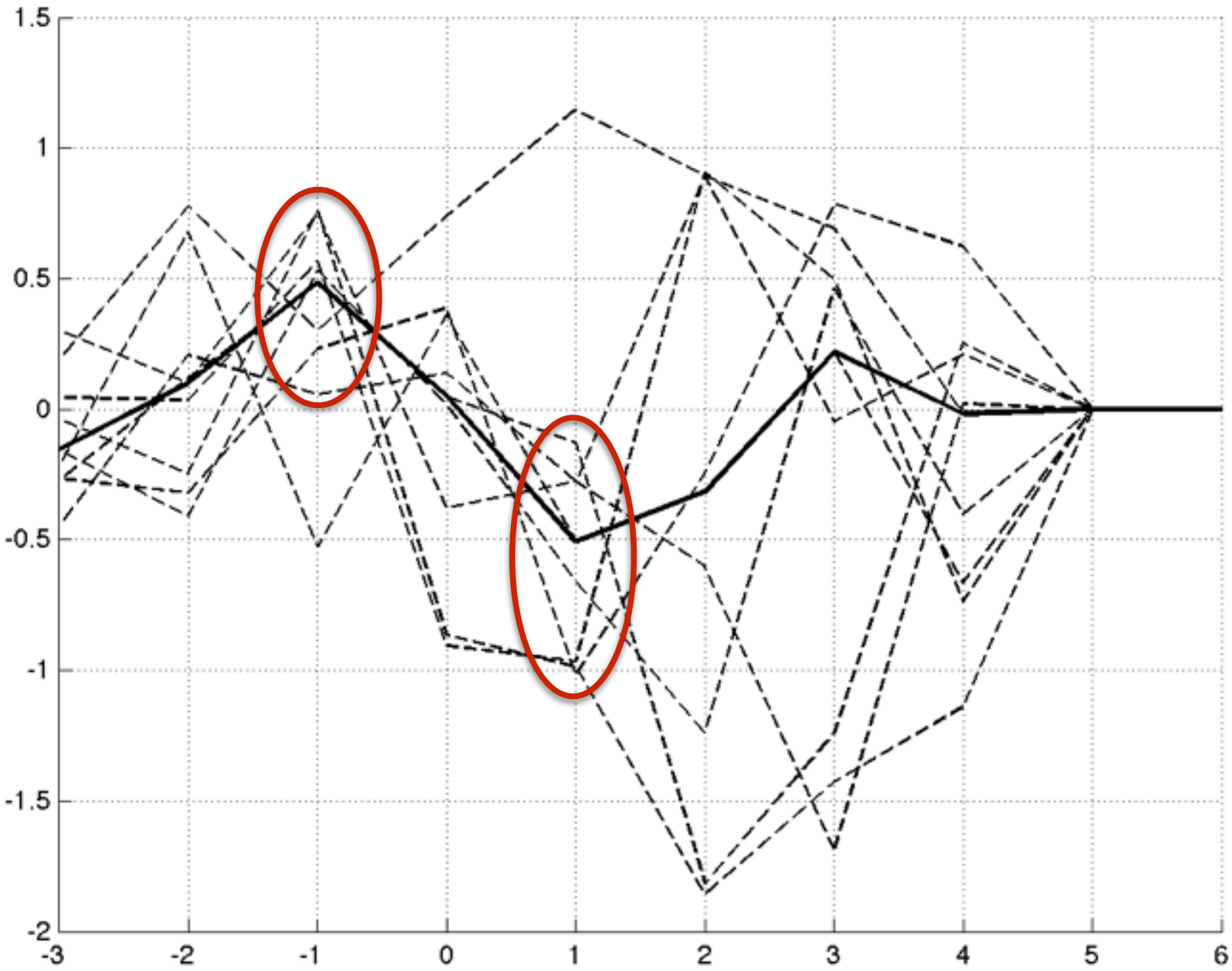
SURFACE TEMPERATURES

T2m Anomaly February **A+B**

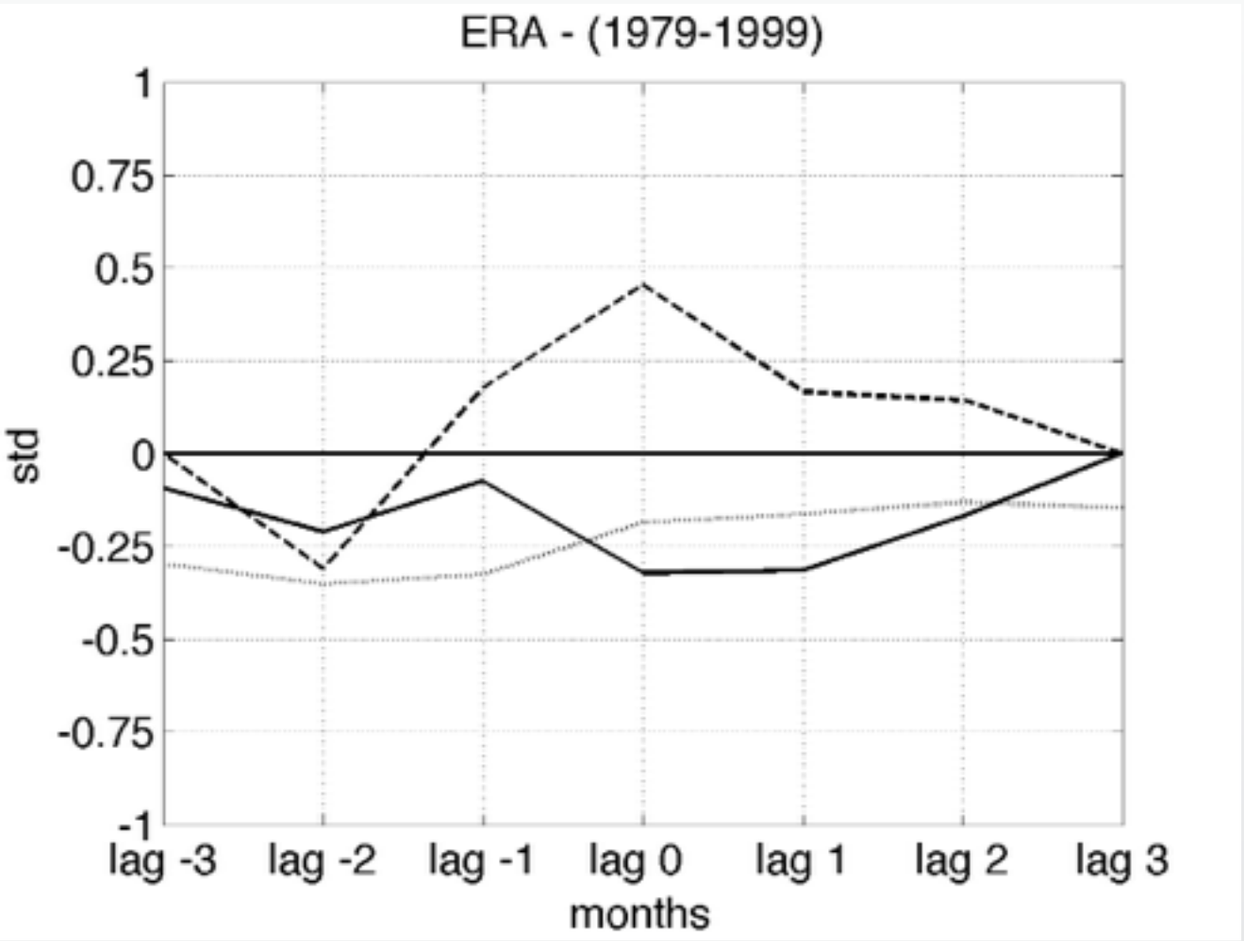


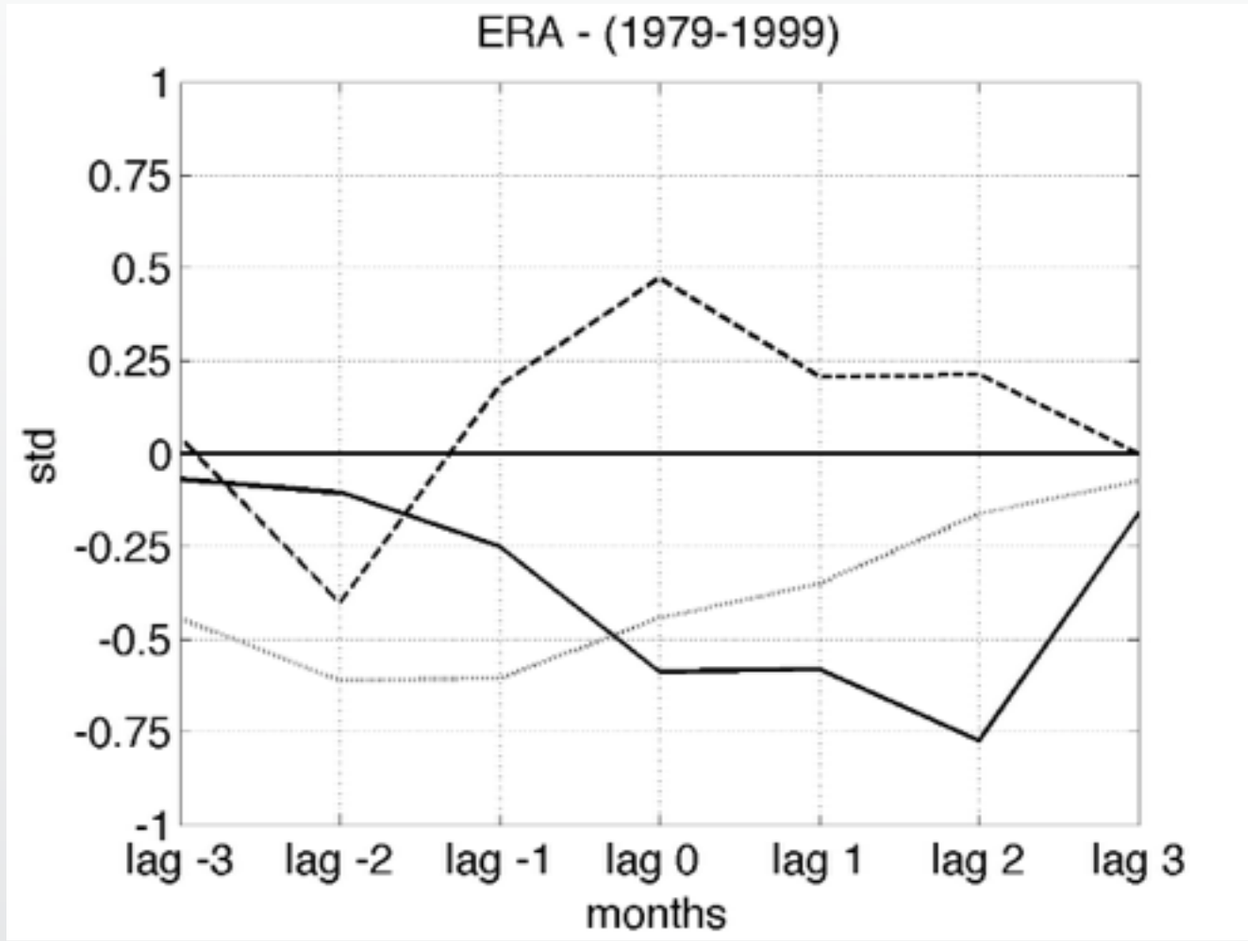
Speedy
Sea-ice Reduction
1-15 Jan

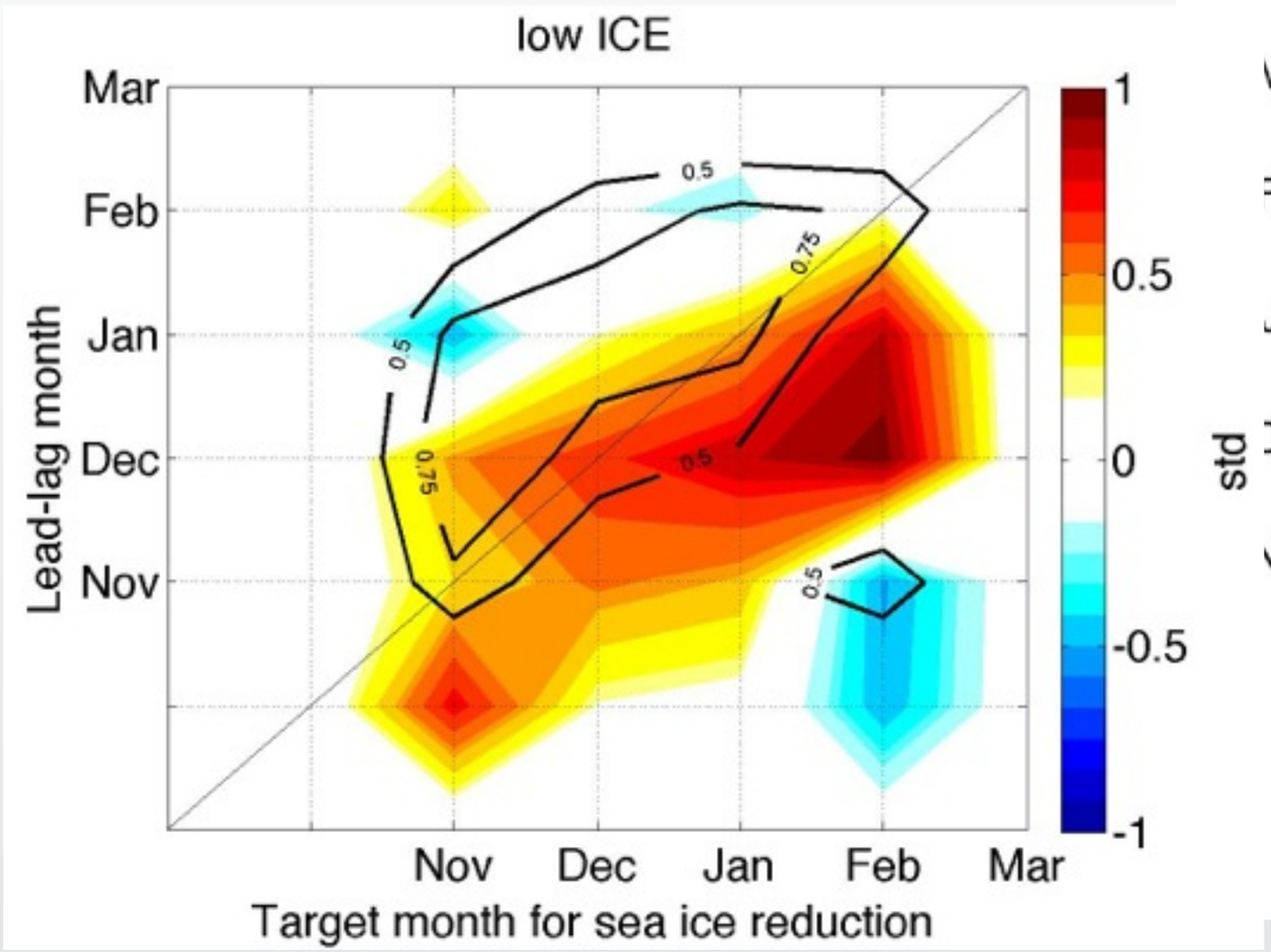
ERA-Interim
Low Sea-Ice
Dec-Jan

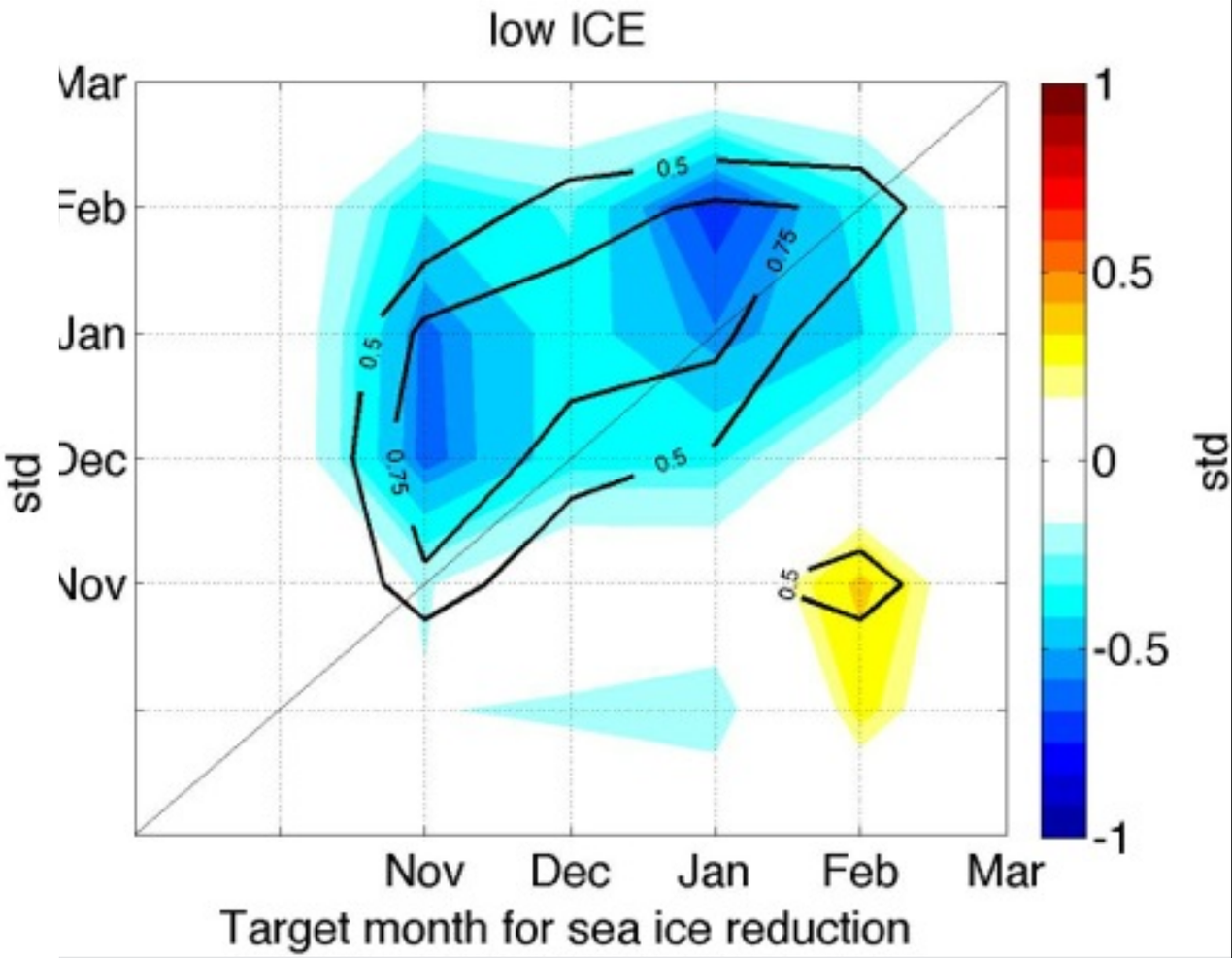

1.5
1
0.5
0
-0.5
-1
-1.5
-2
-3
-2
-1
0
1
2
3
4
5
6

Detrend


ERA - (1979-1999)
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
std
lag -3
lag -2
lag -1
lag 0
lag 1
lag 2
lag 3
months


ERA - (1979-1999)
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
std
lag -3
lag -2
lag -1
lag 0
lag 1
lag 2
lag 3
months

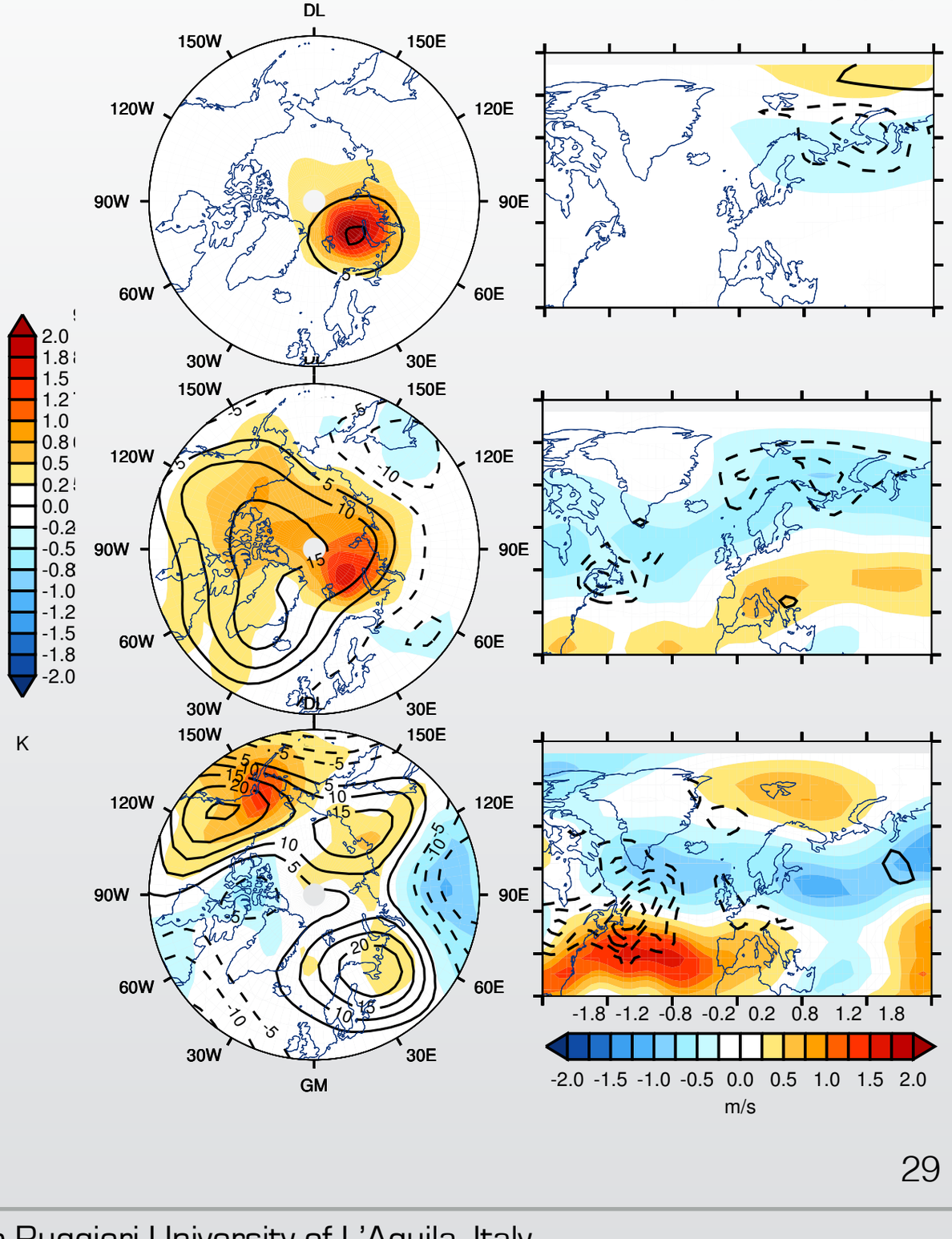

low ICE
Mar
Feb
Jan
Dec
Nov
Lead-lag month
0.5
0.75
1
0.5
0
-0.5
-1
Nov
Dec
Jan
Feb
Mar
Target month for sea ice reduction


low ICE
Mar
Feb
Jan
Dec
Nov
std
0.5
0.75
1
0.5
0
-0.5
-1
Nov
Dec
Jan
Feb
Mar
Target month for sea ice reduction

REGIMES OF ATMOSPHERIC RESPONSE

Z500 - T850

V'T' 850 - U300

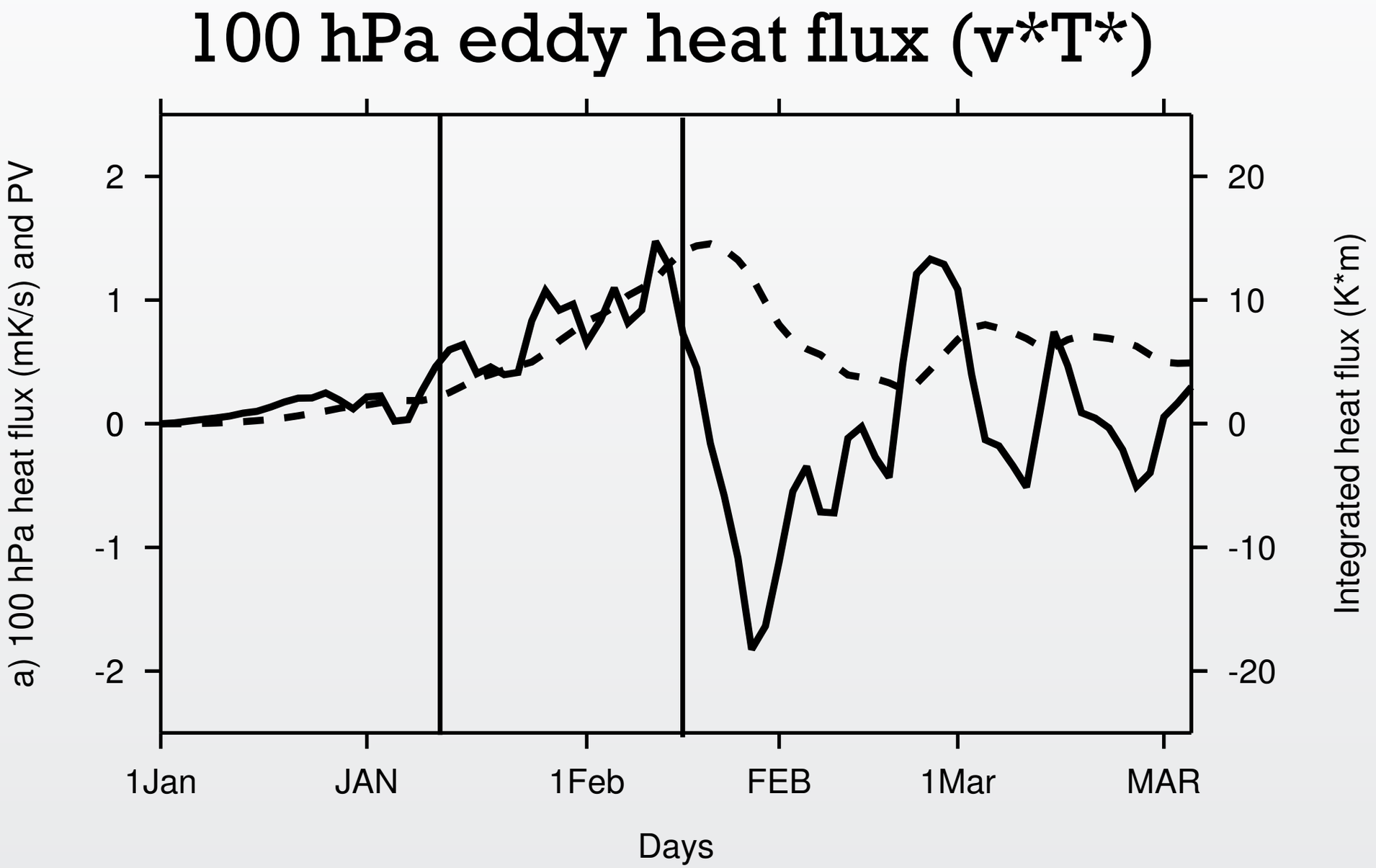


Up to Week 3 — Shallow, local, fast

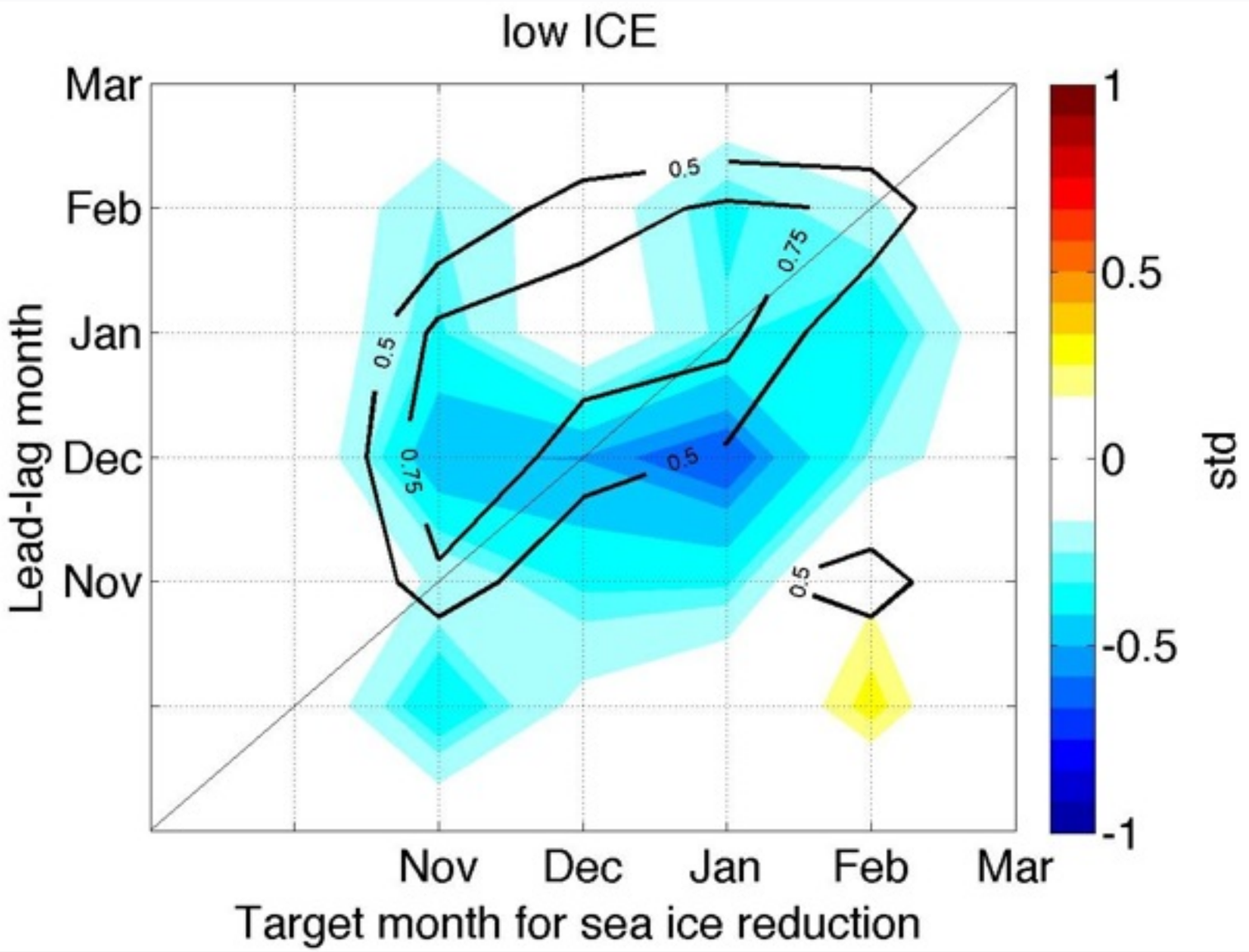
Week 3-5 — Deep, non-local, fast

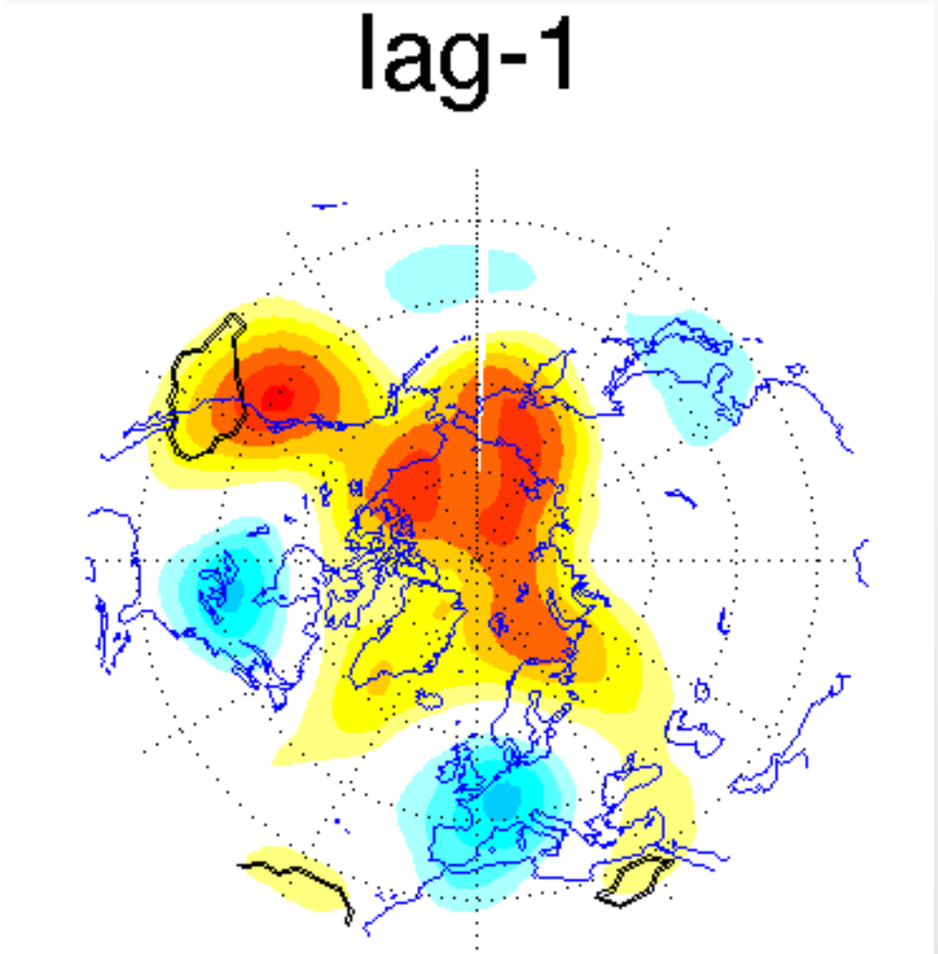
Week 5-7 — Deep, non-local, delayed

THE UPPER-TROPOSPHERE



- November sea-ice can be used to predict NAO 1-2 months ahead NOT LINKED TO RECENT SEA ICE LOSS (Garcia Serrano et al.2015)


low ICE
Mar
Feb
Jan
Dec
Nov
Lead-lag month
0.5
0.75
0.5
0.75
0.5
0.5
1
0.5
0
-0.5
-1
std
Nov
Dec
Jan
Feb
Mar
Target month for sea ice reduction


lag-1