On polar-nonpolar linkages: observations and model diversity (eastern Arctic sea-ice variability)

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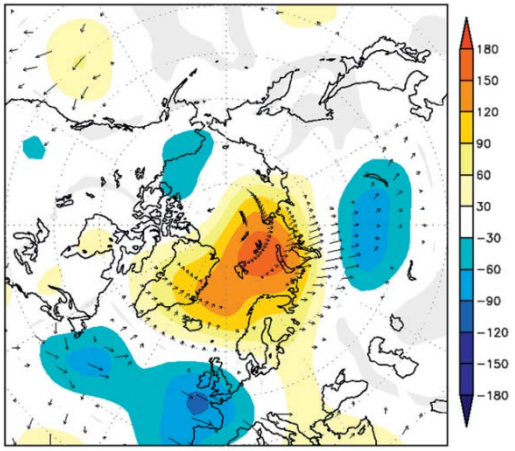
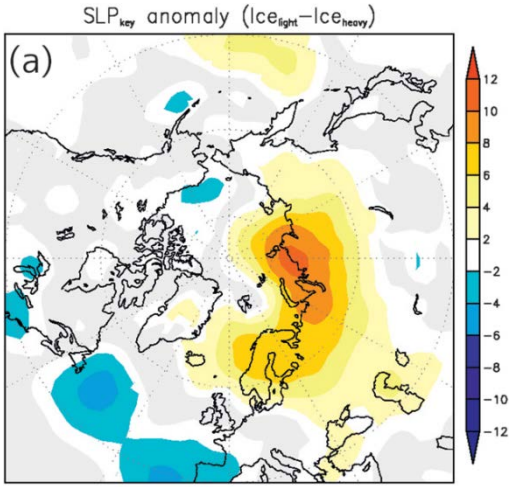
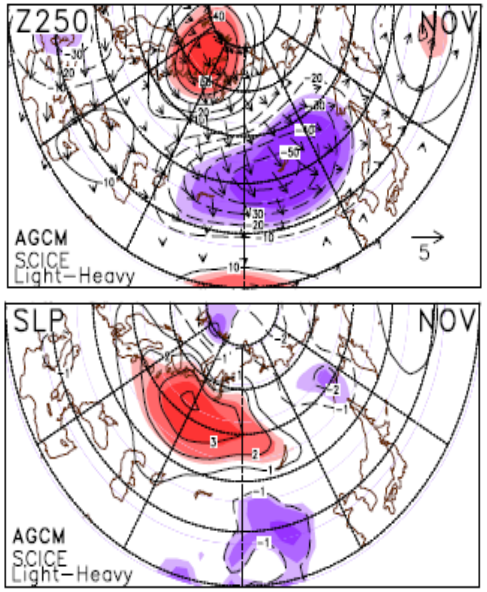
ECOMS Final Meeting (2016)

Z250 / WAF (DJF)





Inoue et al. (2012, GRL)

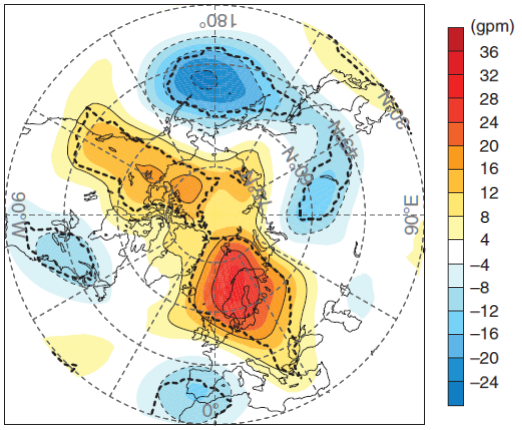


Honda et al. (2009, GRL)

might be non-linear to SIC reduction!

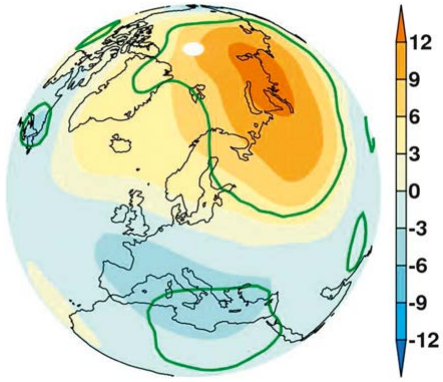
Petoukhov and Semenov (2010, JGR)

ΔZ500 for ND, CAM5



Kim et al. (2014, Nat.Comms)

SLP JAN [CAM]



Grassi et al. (2013, JCLIM)

RECENT REVIEWS: Bader et al. 2011; Cohen et al. 2014; Vihma 2014; Walsh 2014; Gao et al. 2015; Overland et al. 2015

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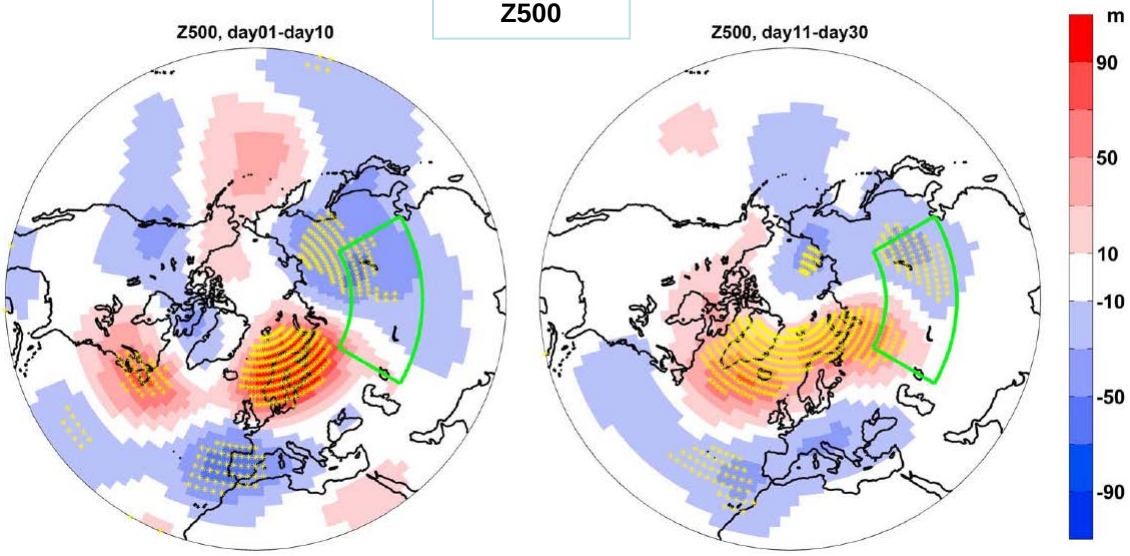
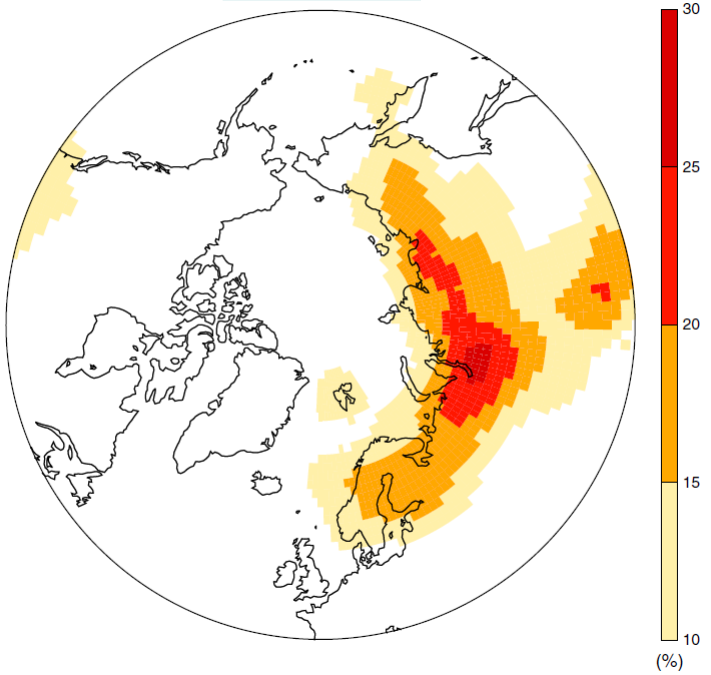
Z500



Jung et al. (2014, GRL)

initializing sea-ice reduces RMSE over Eurasia

SLP



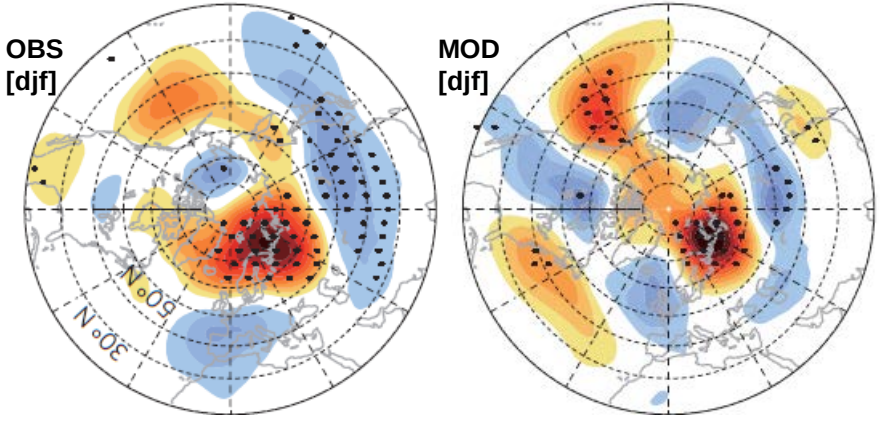
Day et al. (2014, GRL)

might be non-linear to SIC reduction!

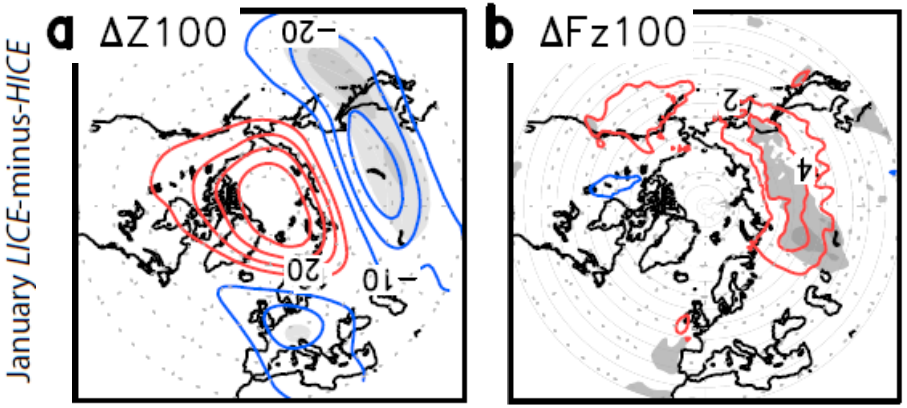
Petoukhov and Semenov (2010, JGR)

RECENT REVIEWS: Bader et al. 2011; Cohen et al. 2014; Vihma 2014; Walsh 2014; Gao et al. 2015; Overland et al. 2015

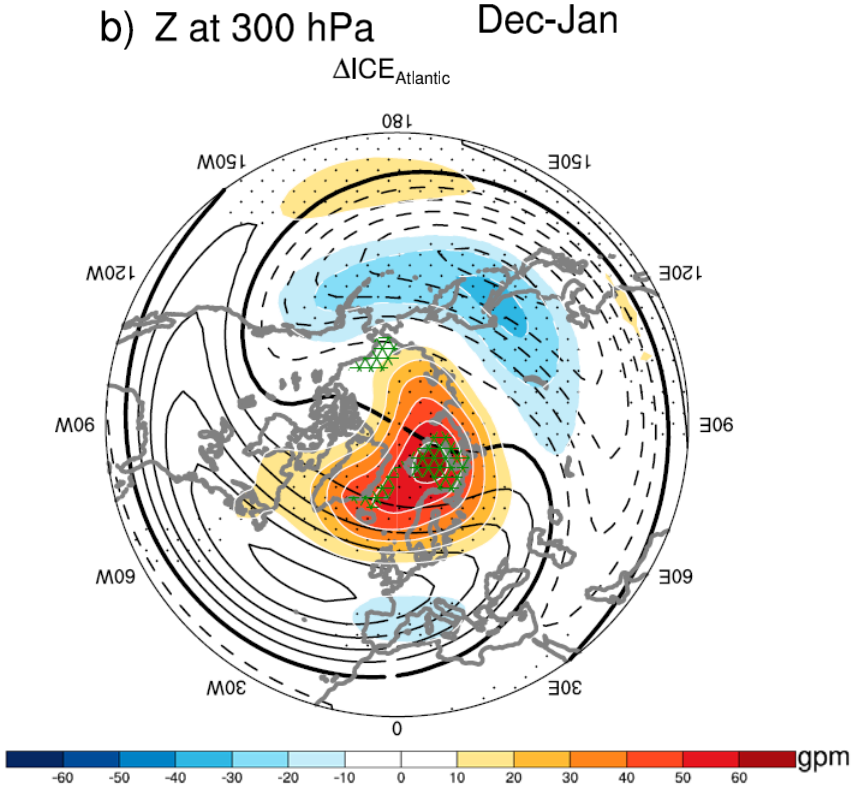
ECOMS Final Meeting (2016)



Mori et al. (2014, Nat.Geosci)



Nakamura et al. (2016, GRL)

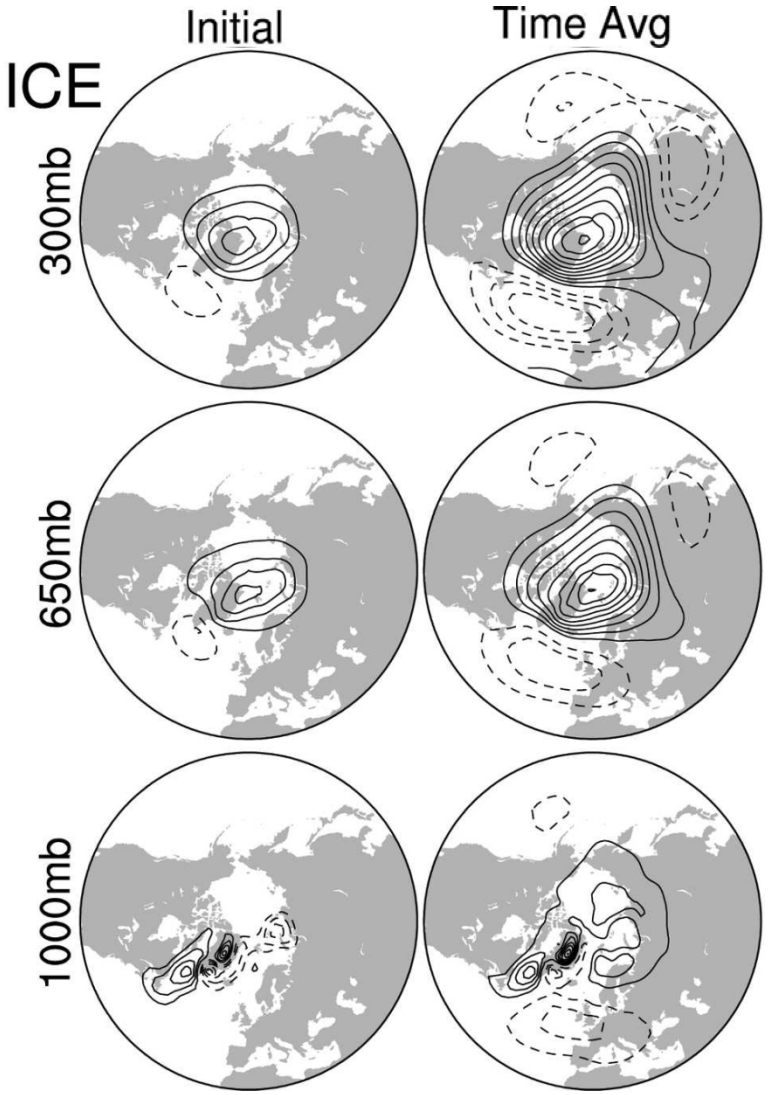


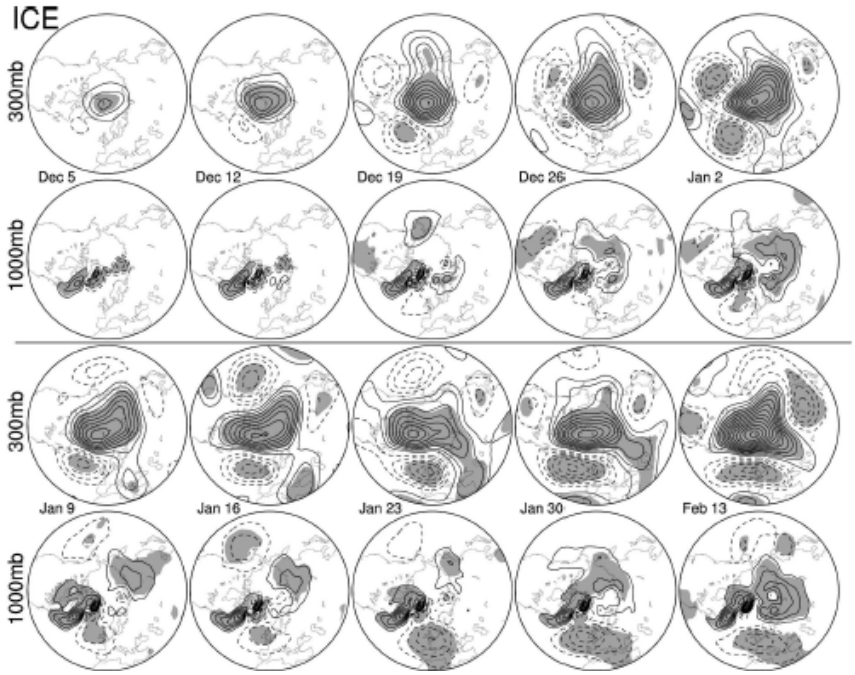
Sun et al. (2015, JCLIM)

might be non-linear to SIC reduction!

Petoukhov and Semenov (2010, JGR)

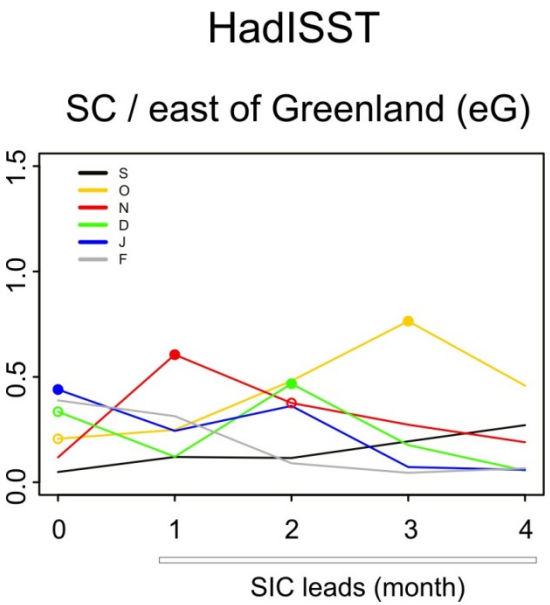
RECENT REVIEWS: Bader et al. 2011; Cohen et al. 2014; Vihma 2014; Walsh 2014; Gao et al. 2015; Overland et al. 2015





the equilibrium response to SIC reduction over G-B Seas, which projects on the negative NAO, is reached in about two months

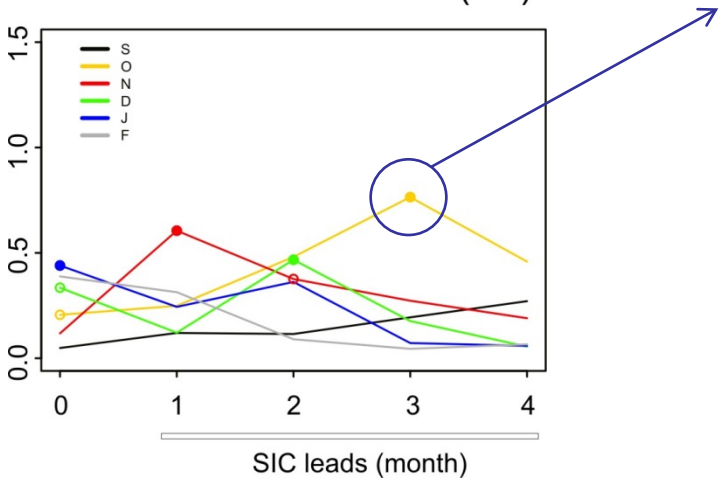
Deser et al. (2007, JCLIM)



- detrended, monthly anomalies;
period 1979-2013;
target – cold season (Sep-to-Feb)

HadISST

SC / east of Greenland (eG)



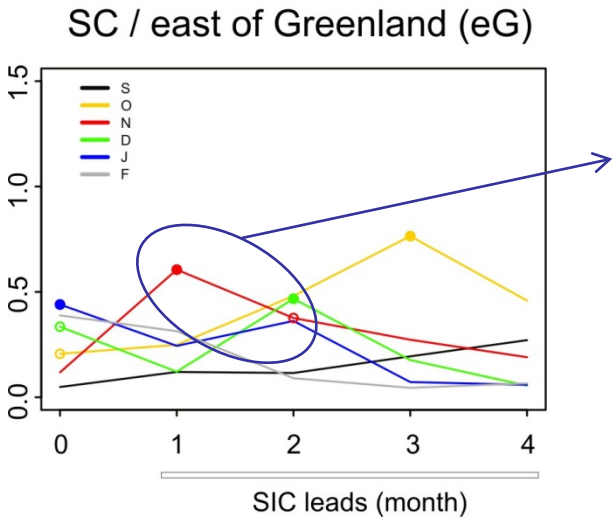
might be linked to winter blocking over Eurasia

Mori et al. 2014 (Nat.Geosci); García-Serrano et al. (2015, JCLIM)

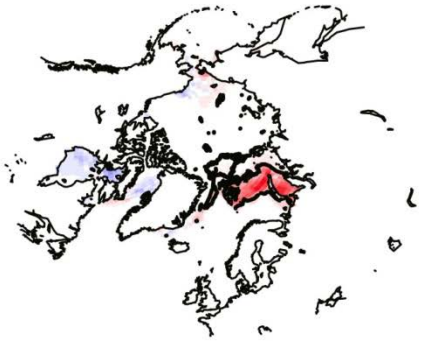
but the lead-time is longer than the expected atmospheric response time to SIC forcing

- detrended, monthly anomalies;
period 1979-2013;
target – cold season (Sep-to-Feb)

HadISST

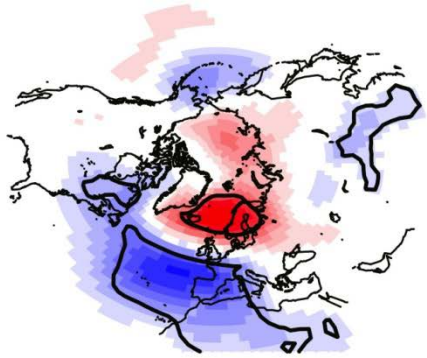


a) **MCA-SIC/eG$_{NOV}$** x SIC (**nov**)



sig.lev.(SC)=6%

b) **MCA-SIC/eG$_{NOV}$** x SLP (**jan**)



- detrended, monthly anomalies;
period 1979-2013;
target – cold season (Sep-to-Feb)

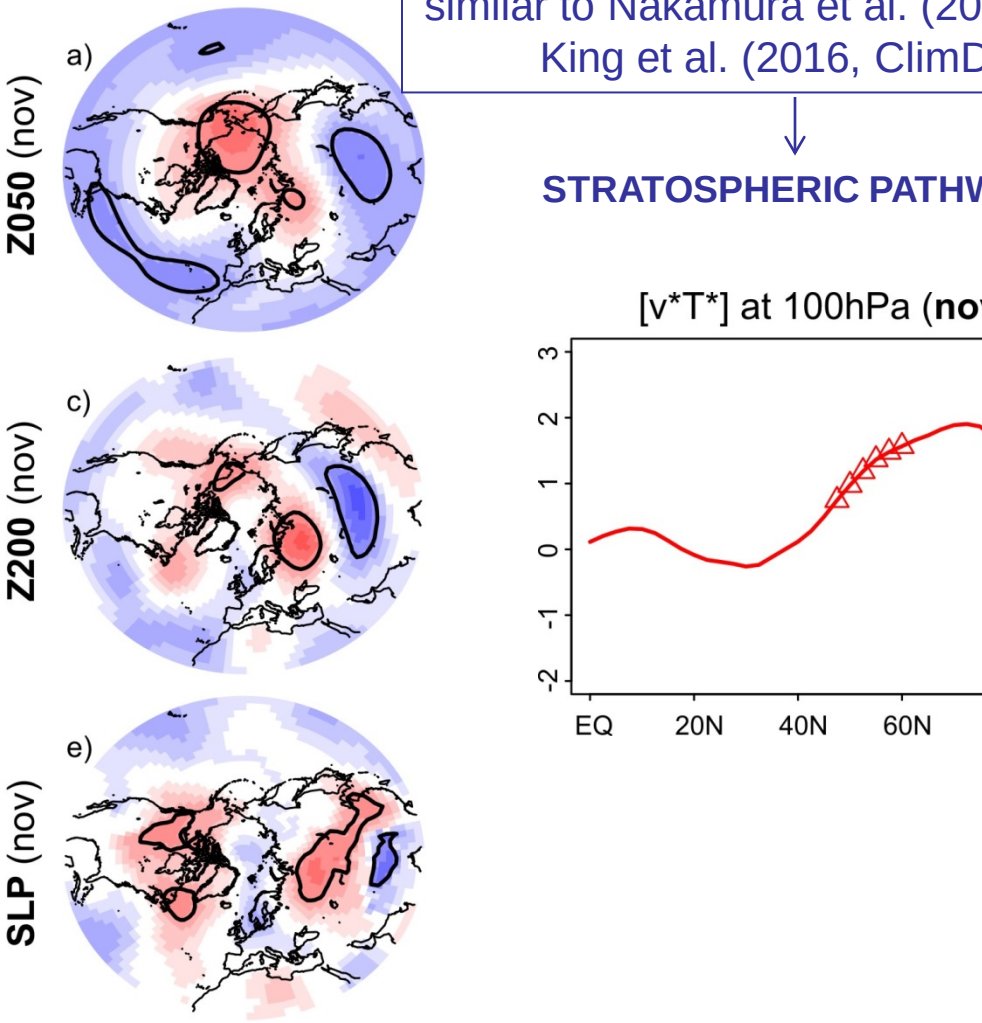
ECOMS Final Meeting (2016)

García-Serrano et al. (2015, JCLIM); similar to Nakamura et al. (2015, JGR); King et al. (2016, ClimDyn)

↓

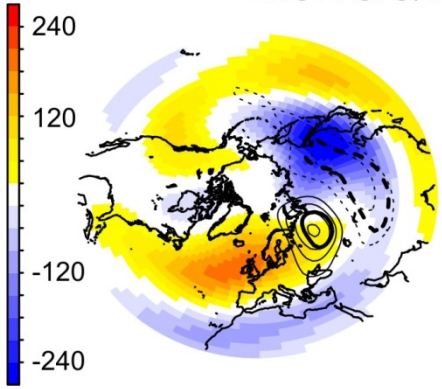
STRATOSPHERIC PATHWAY

MCA-SIC/BK$_{NOV}$

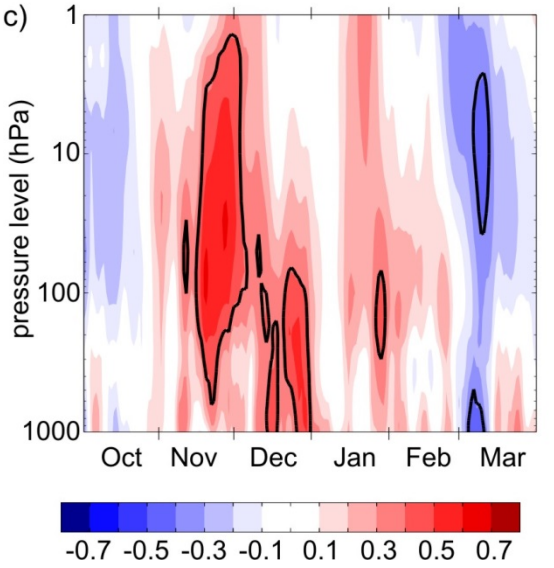


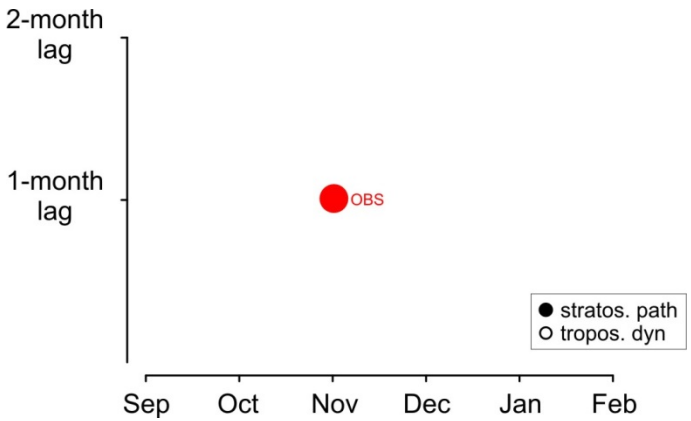
[v*T*] at 100hPa (**nov**)

b) Z200*(**nov**) climatology MCA-SIC/BK$_{NOV}$



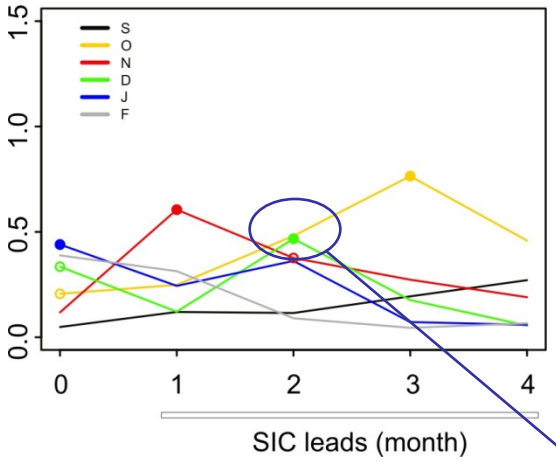
MCA-SIC/BK$_{NOV}$ x HGT [60N-90N]




2-month
lag
1-month
lag
OBS
stratos. path
tropos. dyn
Sep
Oct
Nov
Dec
Jan
Feb

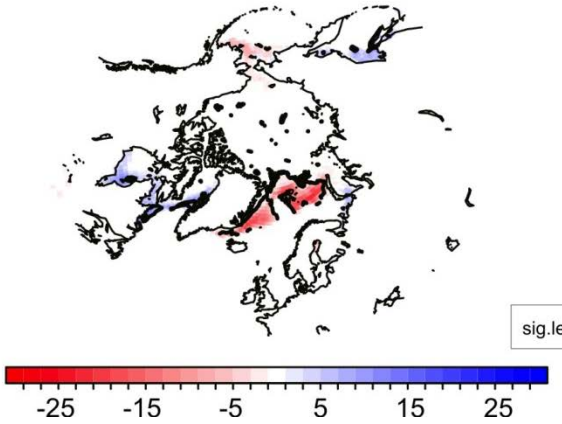
HadISST

SC / east of Greenland (eG)

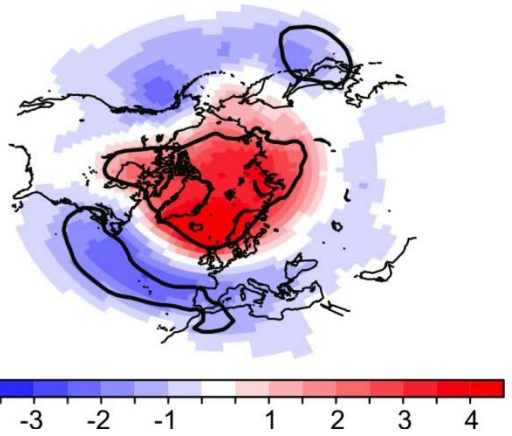


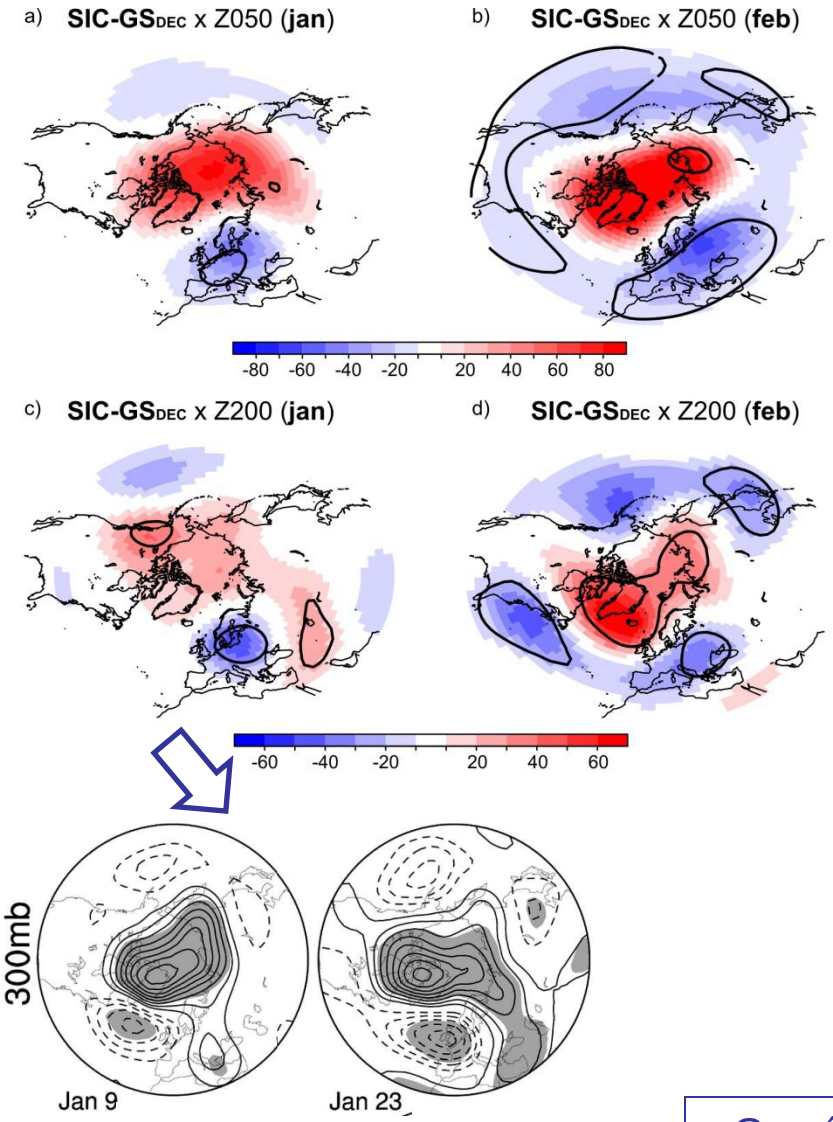
- detrended, monthly anomalies;
period 1979-2013;
target – cold season (Sep-to-Feb)

c) **MCA-SIC/eG$_{DEC}$** x SIC (**dec**)



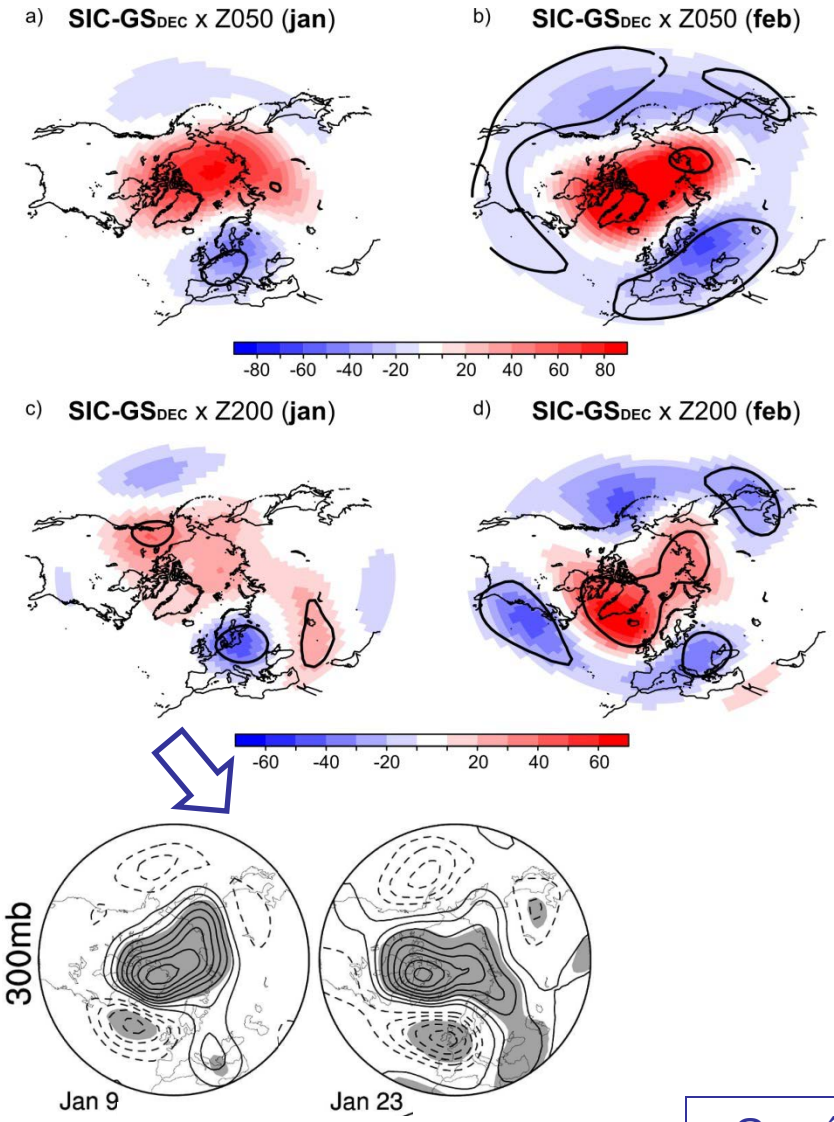
d) **MCA-SIC/eG$_{DEC}$** x SLP (**feb**)



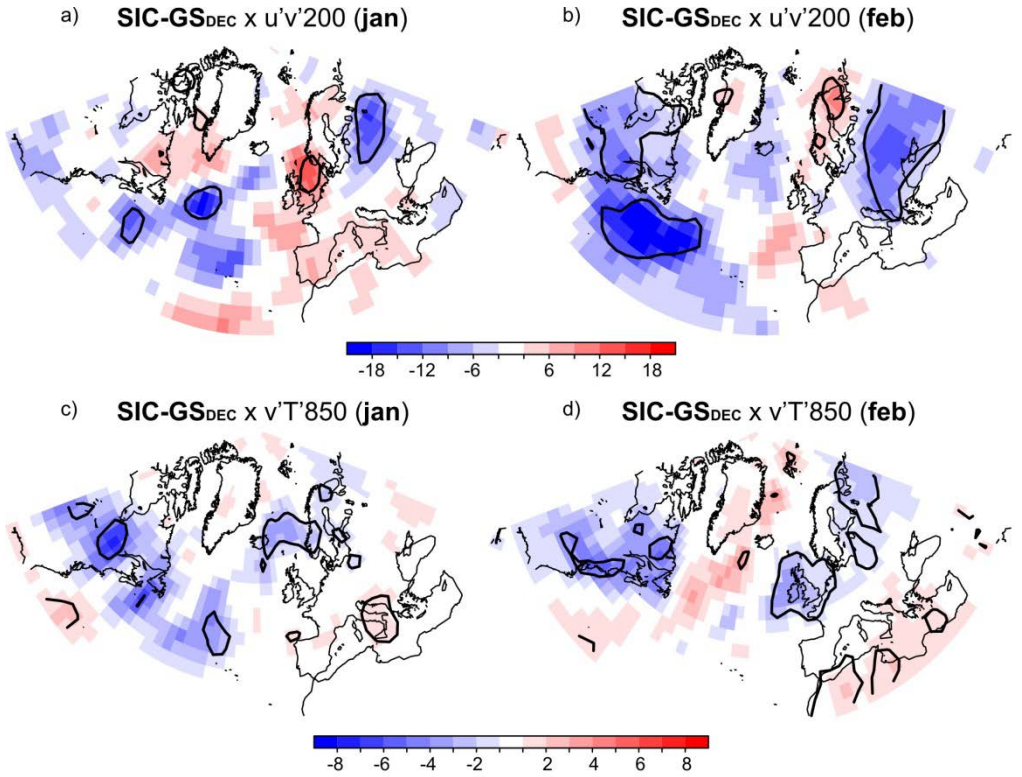


Deser et al. (2007, JCLIM)

García-Serrano and Frankignoul (2015, ClimDyn)

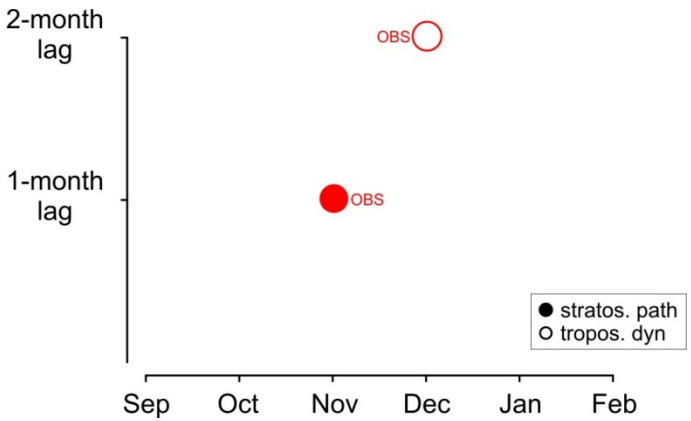


Deser et al. (2007, JCLIM)

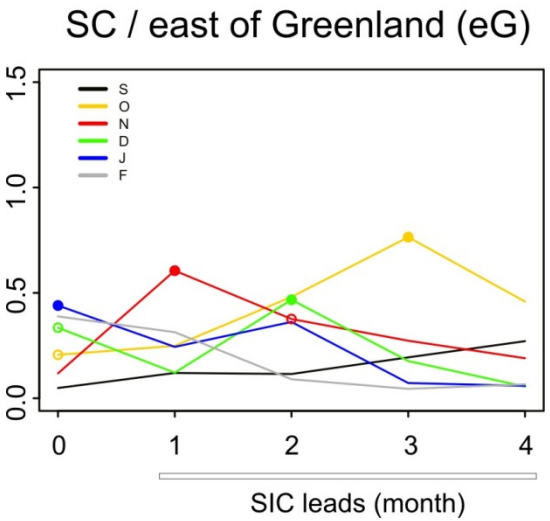


TROPOSPHERIC DYNAMICS

García-Serrano and Frankignoul (2015, ClimDyn)


2-month lag
1-month lag
OBS
OBS
stratos. path
tropos. dyn
Sep
Oct
Nov
Dec
Jan
Feb

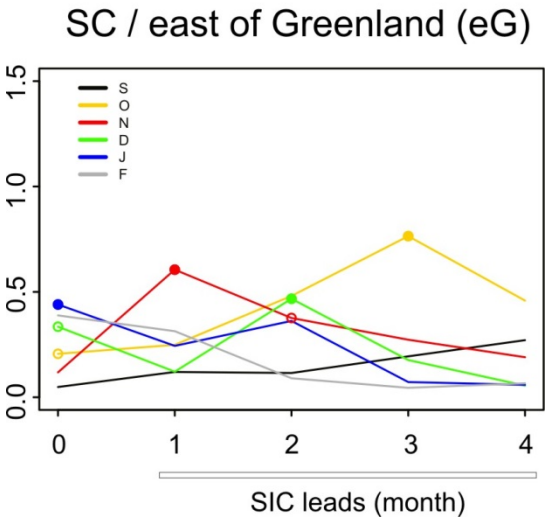
HadISST

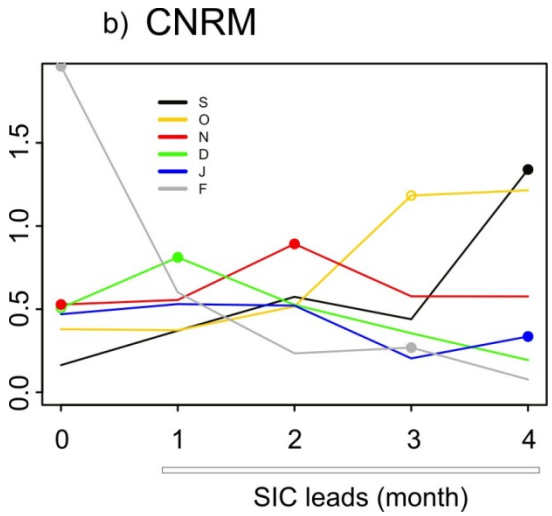


- detrended, monthly anomalies;
period 1979-2013;
target – cold season (Sep-to-Feb)

- **CMIP5**: no multi-model, each model individually;
CCSM4 (5mb), CNRM-CM5 (10mb), EC-EARTH2.3 (3mb), GFDL-CM2.1 (10mb), HadGEM2-ES (4mb), IPSL-CM5A-LR (3mb), MPI-ESM-MR (3mb), NorESM1-M (3mb) - HISTORICAL+RCP4.5 RUNS

HadISST





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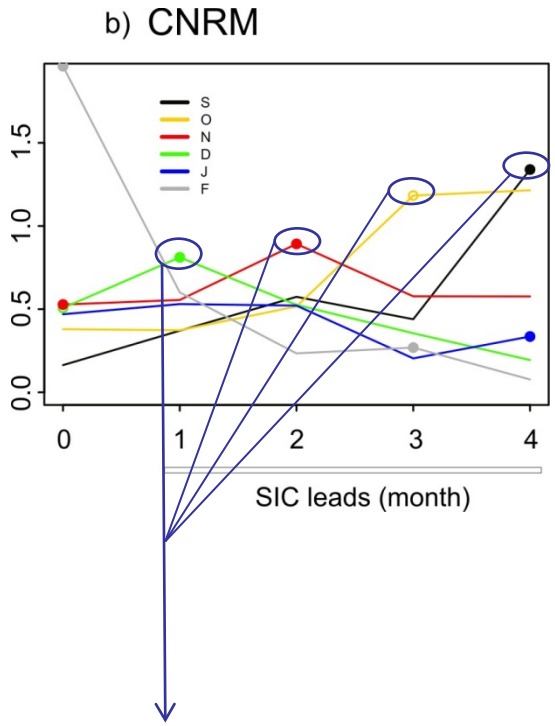
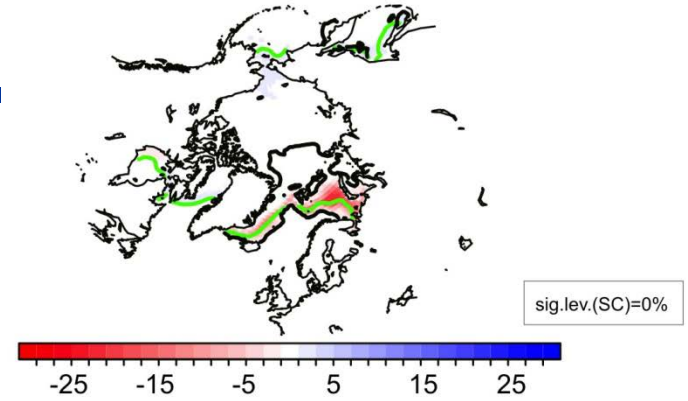
CCSM4 (5mb), CNRM-CM5 (10mb), EC-EARTH2.3 (3mb), GFDL-CM2.1 (10mb), HadGEM2-ES (4mb), IPSL-CM5A-LR (3mb), MPI-ESM-MR (3mb), NorESM1-M (3mb) - HISTORICAL+RCP4.5 RUNS



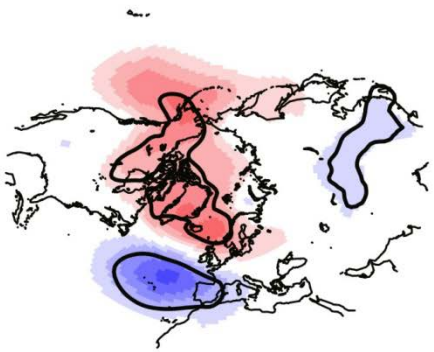
SIC persistence from Sep to Dec; sig. influence on the atm. – Jan

CNRM

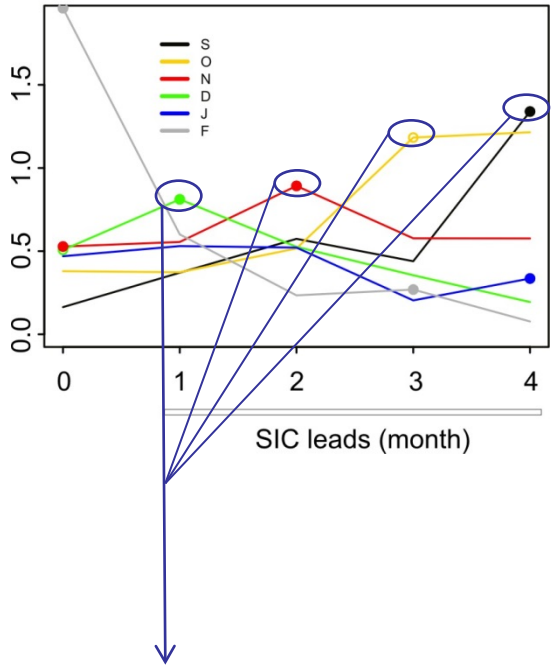
a) **MCA-SIC/eA$_{DEC}$ x SIC (dec)**



b) **MCA-SIC/eA$_{DEC}$ x SLP (jan)**



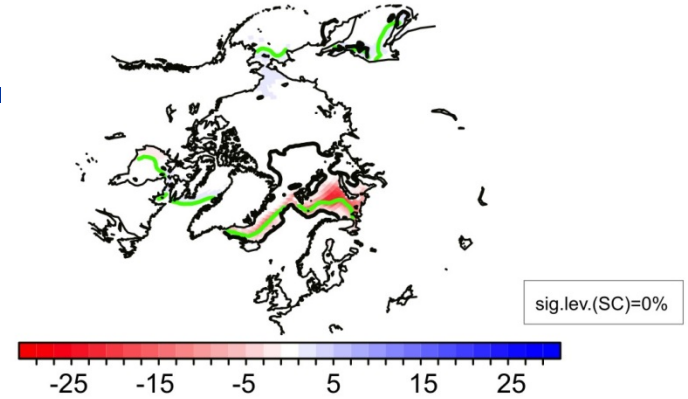
b) CNRM



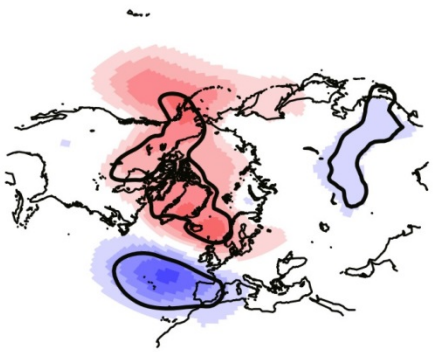
SIC persistence from Sep to Dec; sig. influence on the atm. – Jan

CNRM

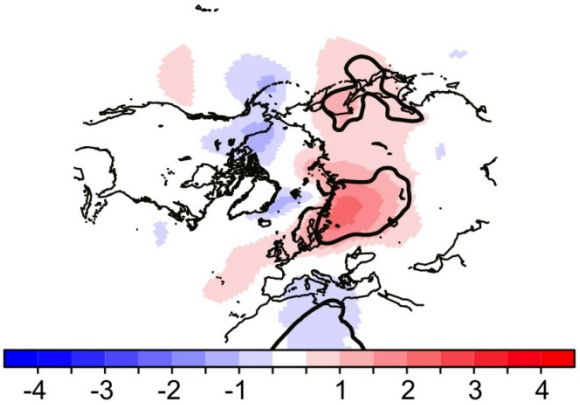
a) **MCA-SIC/eA$_{DEC}$** x SIC (**dec**)



b) **MCA-SIC/eA$_{DEC}$** x SLP (**jan**)

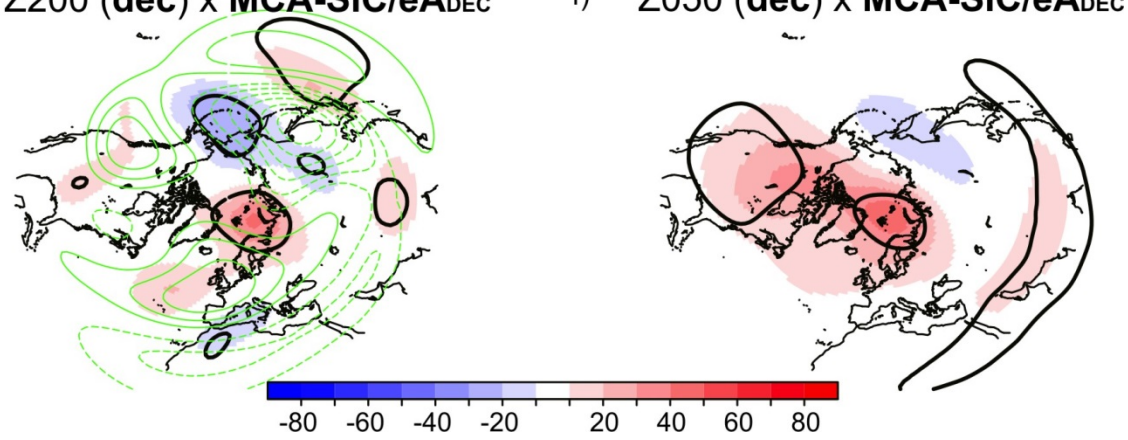


c) SLP (**dec**) x **MCA-SIC/eA$_{DEC}$**

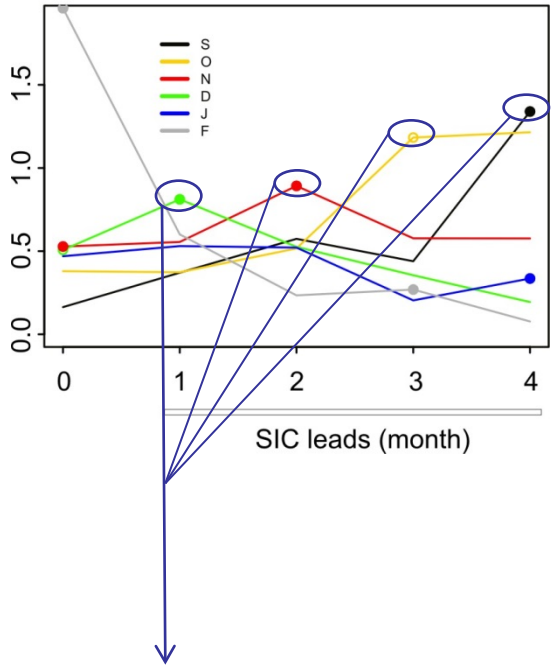


e) Z200 (**dec**) x **MCA-SIC/eA$_{DEC}$**

f) Z050 (**dec**) x **MCA-SIC/eA$_{DEC}$**



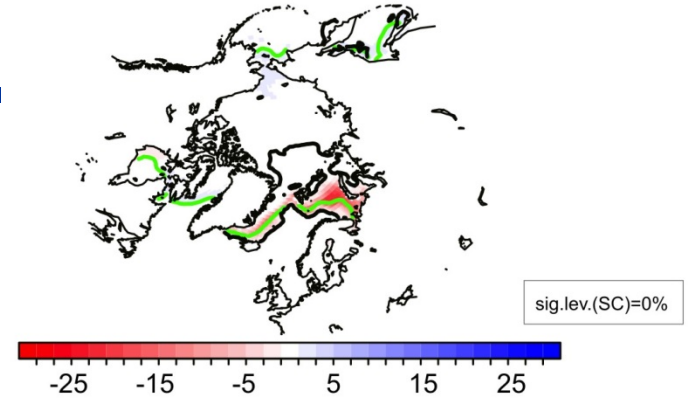
b) CNRM



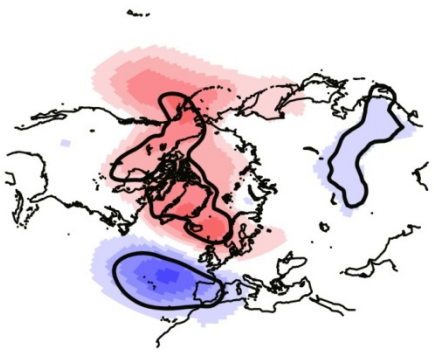
SIC persistence from Sep to Dec; sig. influence on the atm. – Jan

CNRM

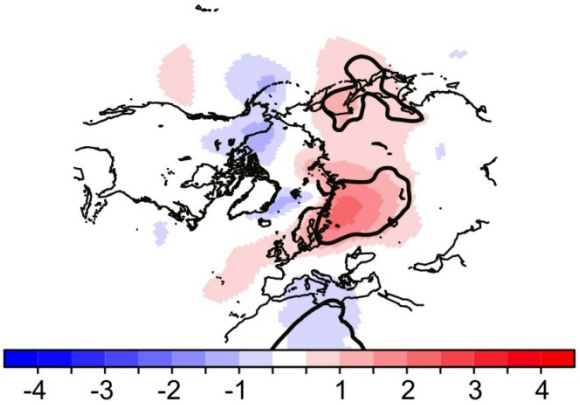
a) **MCA-SIC/eA$_{DEC}$** x SIC (**dec**)



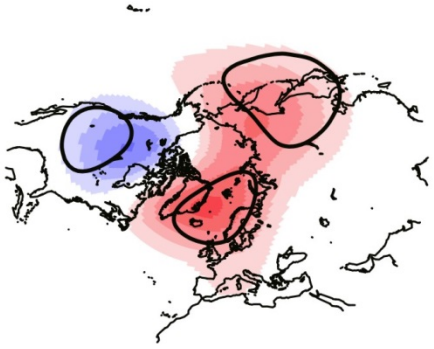
b) **MCA-SIC/eA$_{DEC}$** x SLP (**jan**)



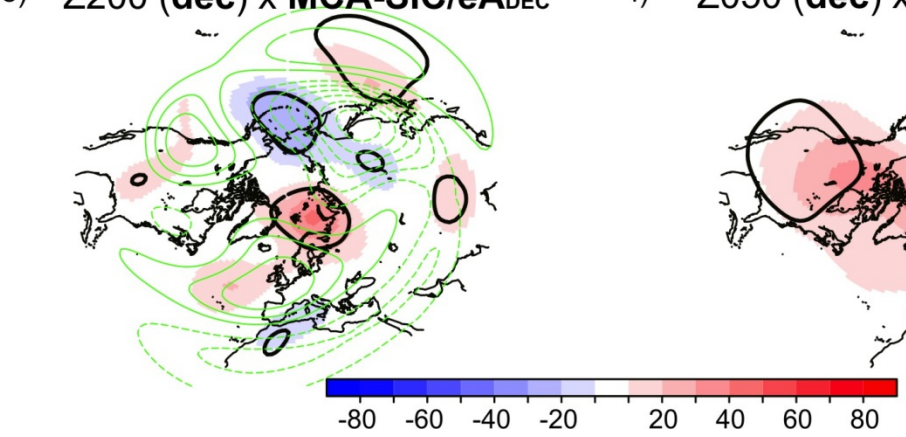
c) SLP (**dec**) x **MCA-SIC/eA$_{DEC}$**



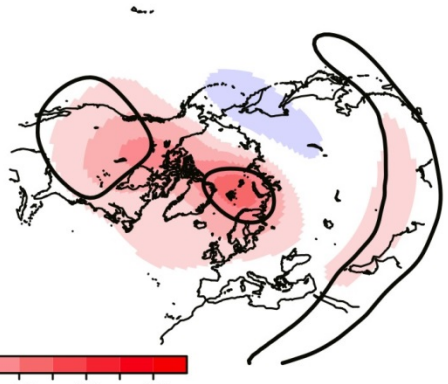
d) Z050 (**jan**) x **MCA-SIC/eA$_{DEC}$**



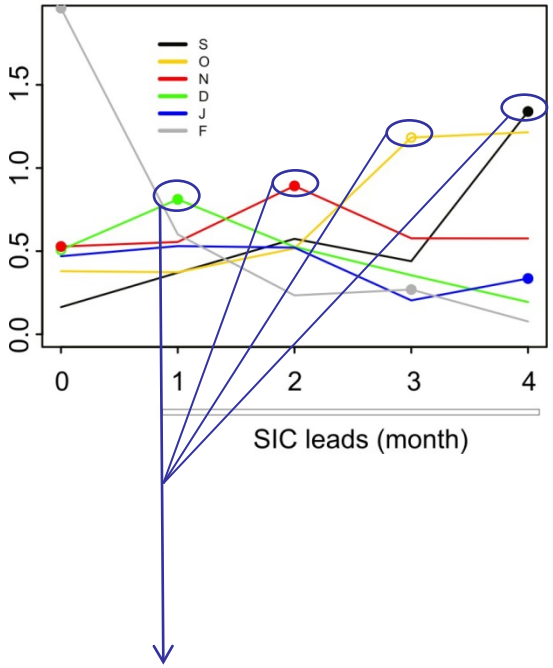
e) Z200 (**dec**) x **MCA-SIC/eA$_{DEC}$**



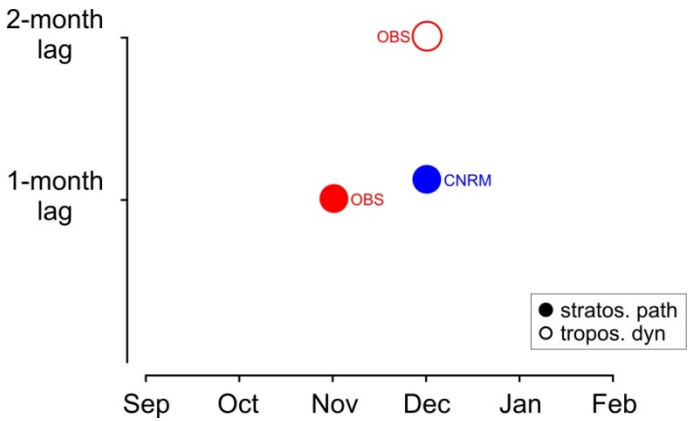
f) Z050 (**dec**) x **MCA-SIC/eA$_{DEC}$**



b) CNRM



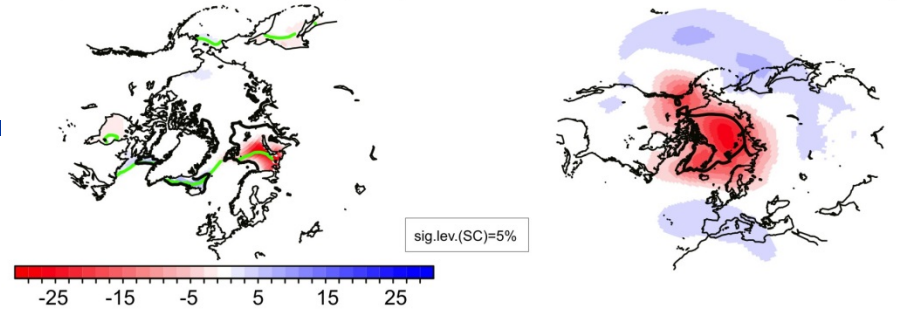
SIC persistence from Sep to Dec; sig. influence on the atm. – Jan


2-month lag
1-month lag
OBS
CNRM
OBS
stratos. path
tropos. dyn
Sep
Oct
Nov
Dec
Jan
Feb

CCSM

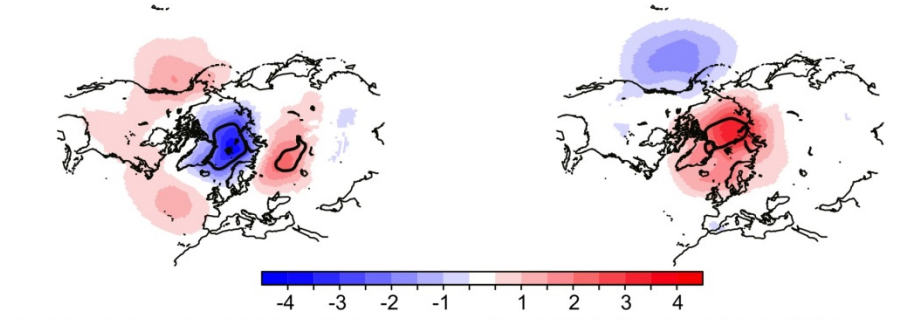
a) **MCA-SIC/eA$_{DEC}$** x SIC (**dec**)

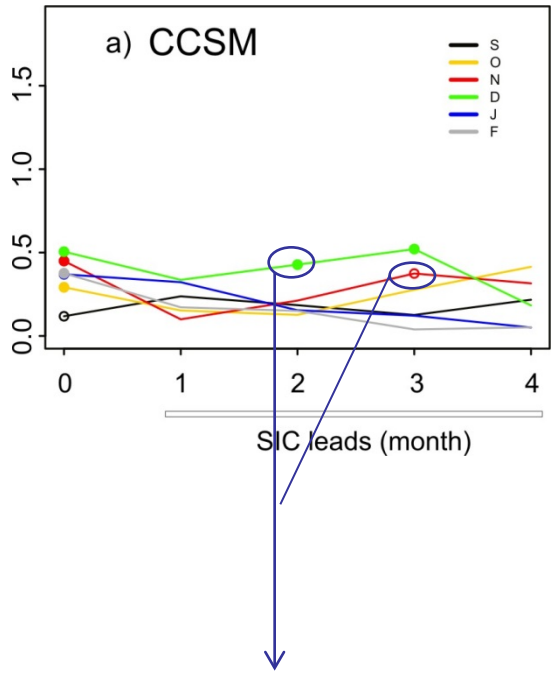
b) **MCA-SIC/eA$_{DEC}$** x SLP (**feb**)



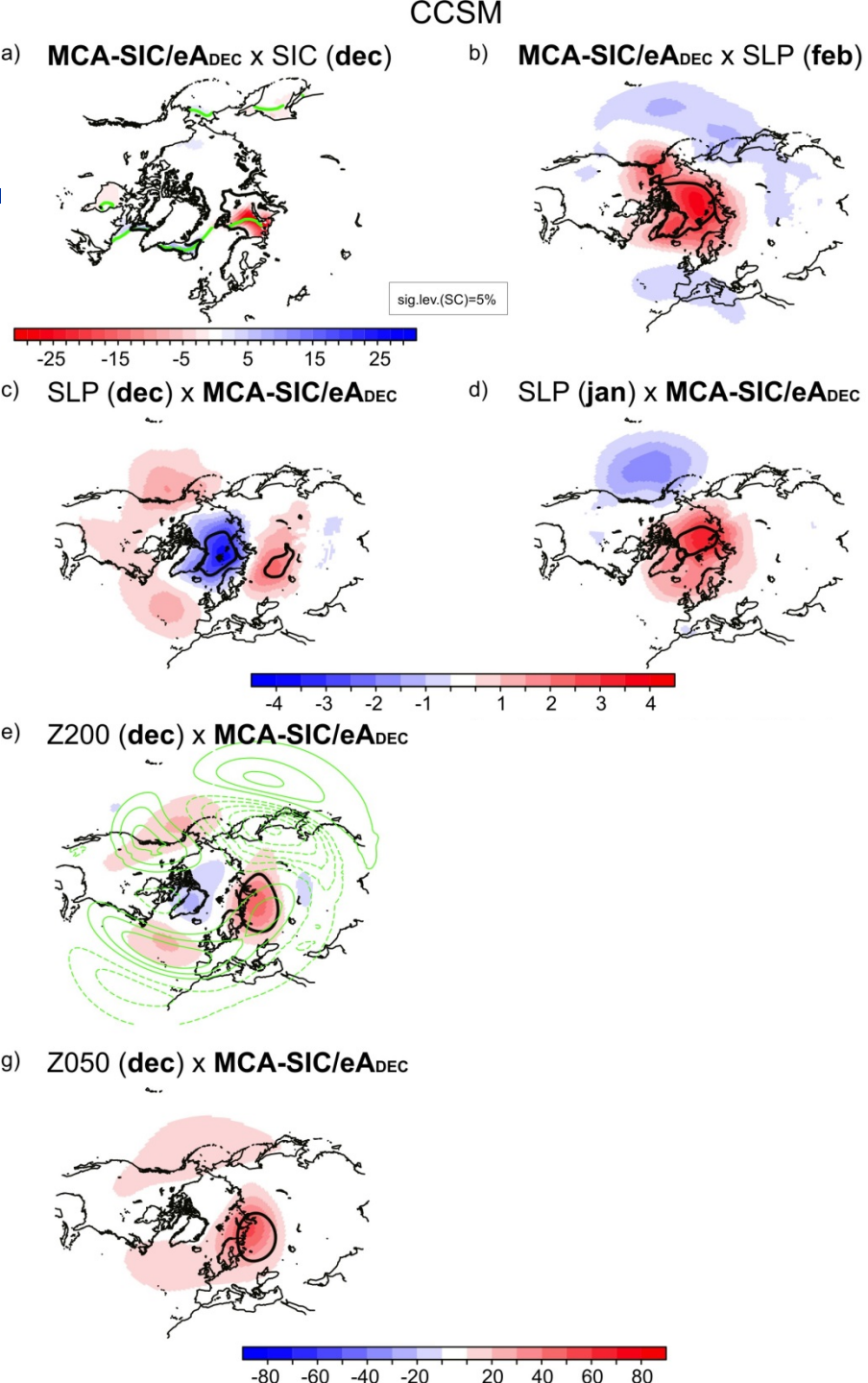
c) SLP (**dec**) x **MCA-SIC/eA$_{DEC}$**

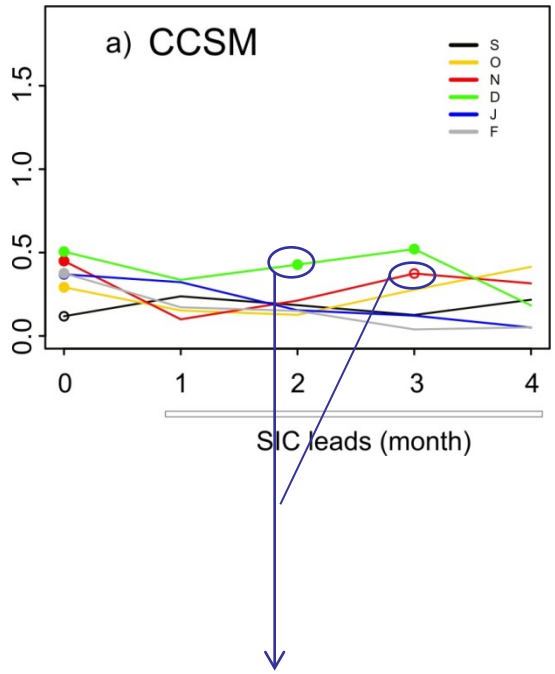
d) SLP (**jan**) x **MCA-SIC/eA$_{DEC}$**





SIC persistence from Nov to Dec; sig. influence on the atm. – Feb



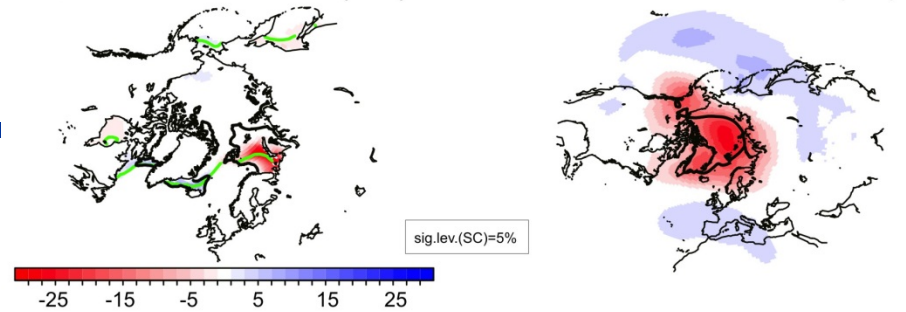


SIC persistence from Nov to Dec; sig. influence on the atm. – Feb

CCSM

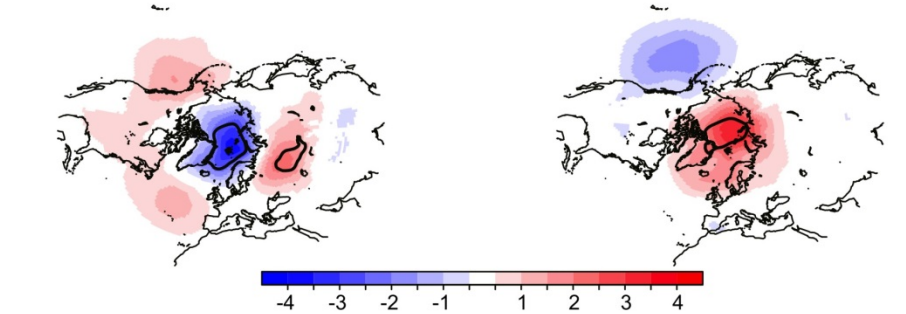
a) **MCA-SIC/eA$_{DEC}$** x SIC (**dec**)

b) **MCA-SIC/eA$_{DEC}$** x SLP (**feb**)



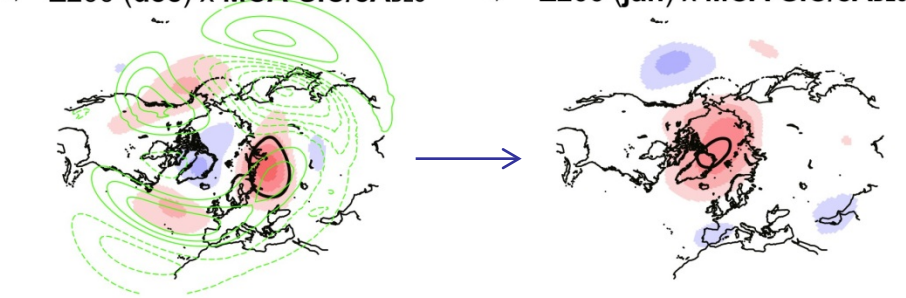
c) SLP (**dec**) x **MCA-SIC/eA$_{DEC}$**

d) SLP (**jan**) x **MCA-SIC/eA$_{DEC}$**



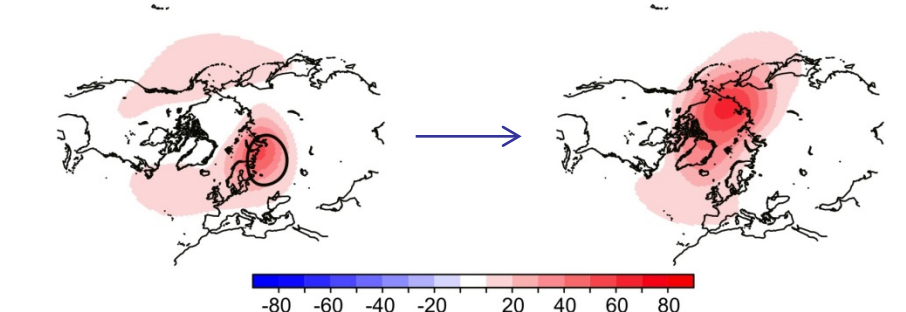
e) Z200 (**dec**) x **MCA-SIC/eA$_{DEC}$**

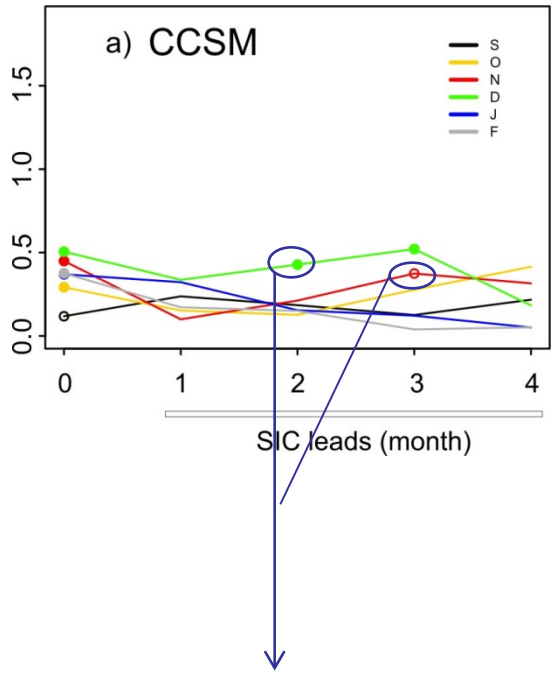
f) Z200 (**jan**) x **MCA-SIC/eA$_{DEC}$**



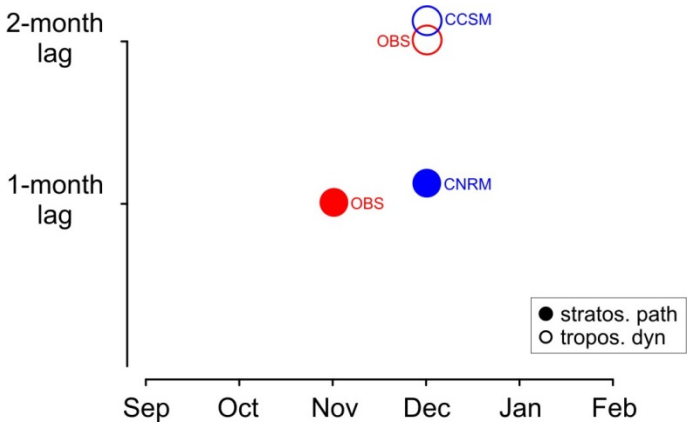
g) Z050 (**dec**) x **MCA-SIC/eA$_{DEC}$**

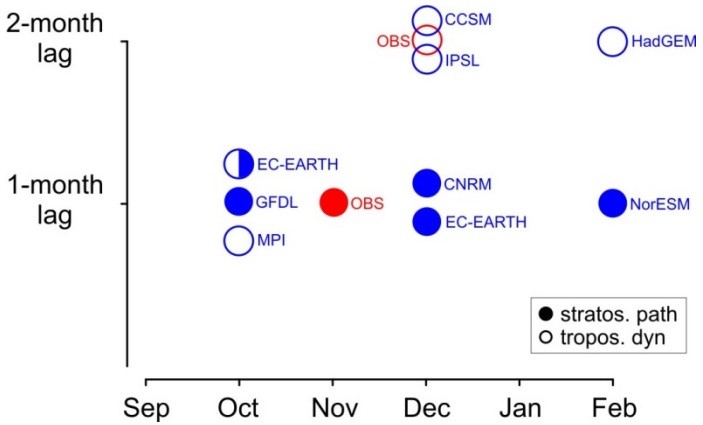
h) Z050 (**jan**) x **MCA-SIC/eA$_{DEC}$**





SIC persistence from Nov to Dec; sig. influence on the atm. – Feb


2-month lag
1-month lag
CCSM
OBS
CNRM
OBS
stratos. path
tropos. dyn
Sep
Oct
Nov
Dec
Jan
Feb


2-month lag
1-month lag
CCSM
OBS
IPSL
HadGEM
EC-EARTH
GFDL
MPI
OBS
CNRM
EC-EARTH
NorESM
stratos. path
tropos. dyn
Sep
Oct
Nov
Dec
Jan
Feb

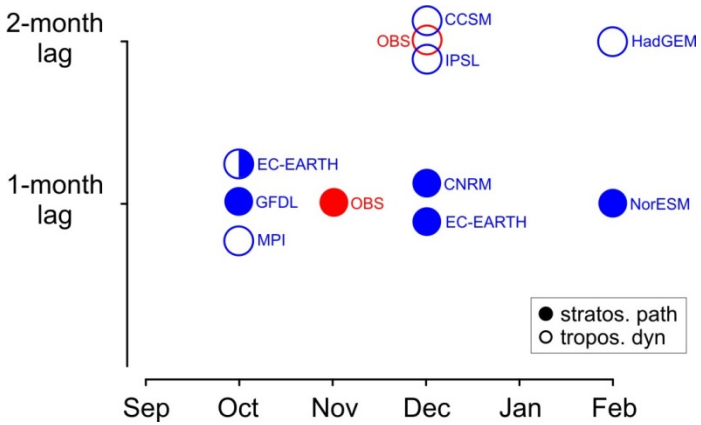
SUMMARY

- CMIP5 models analysed here show a significant link with sea-ice reduction over the eastern Arctic (Greenland-Barents-Kara Seas) followed by a negative NAO-like pattern

- If the simulated relationship takes *one month* – the results suggest (in general) that a stratospheric pathway could be at play [in observations, this is shown for SIC in Nov]

- If the simulated relationship takes *two months* – the results suggest (in general) that tropospheric dynamics are dominant [in observations, this is shown for SIC in Dec]

- Target experiments are needed to gain insight into the role played by the background-flow

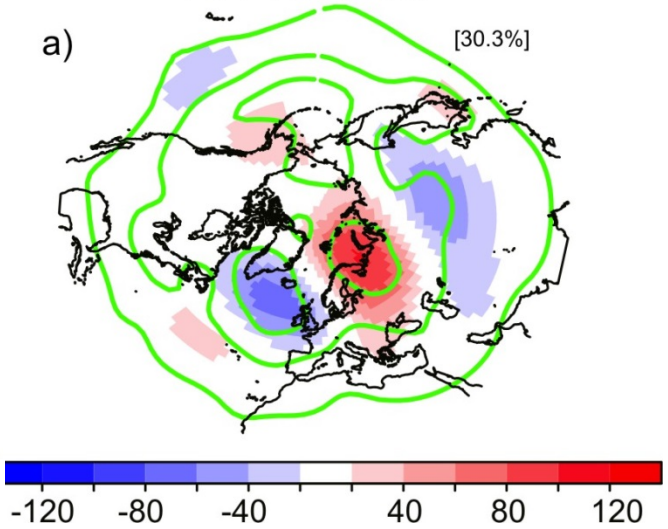


EXTRA SLIDES

The research leading to these results has received funding from the European Union 7th Framework Programme (FP7 2007-2013), under grant agreement n.308299 (NACLIM – www.naclim.eu)

EOF1 Z200-Eurasia (**nov**)

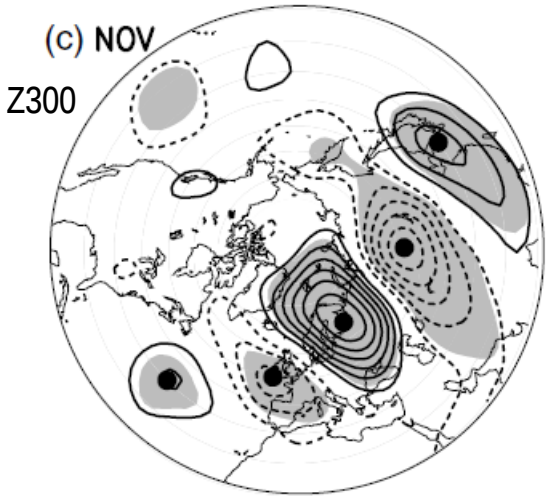
ERA-interim



the **Ural-Siberian** anticyclone

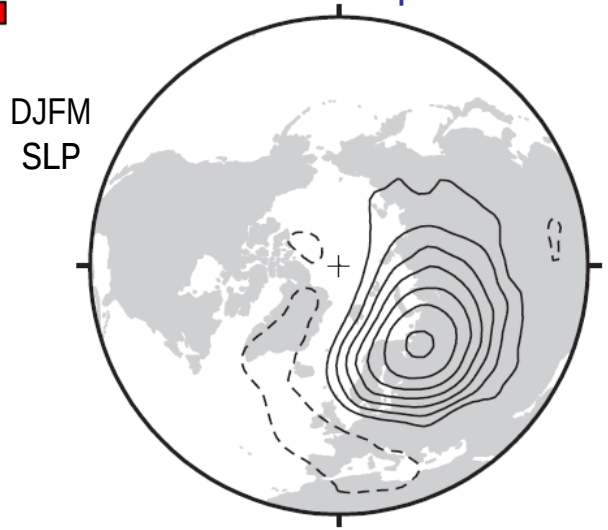
Santolaria et al.
(in preparation)

the **SCA** pattern



Bueh and Nakamura (2007, QJRMS)

the **Russian** pattern



Smoliak and Wallace (2015, JAS)

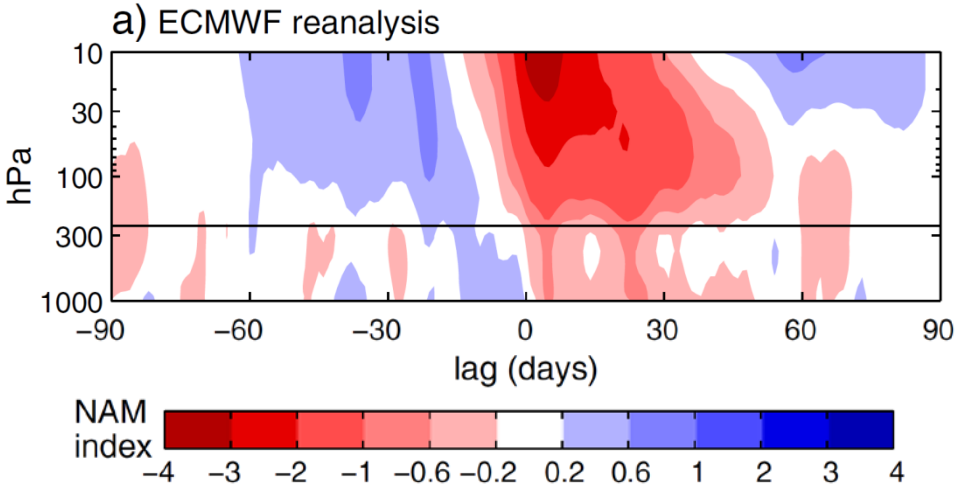
García-Serrano et al. (2015, JCLIM); similar to Nakamura et al. (2015, JGR); King et al. (2016, ClimDyn)

↓

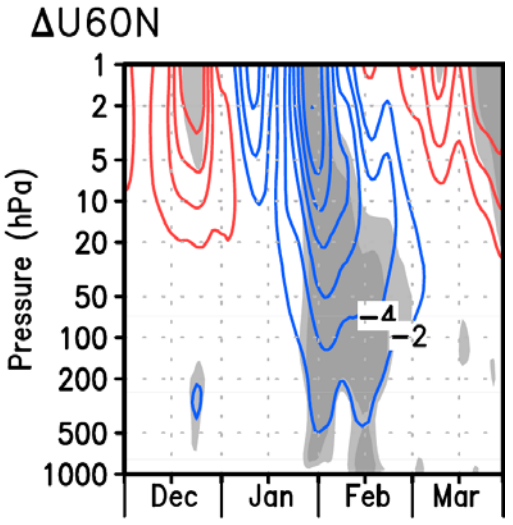
STRATOSPHERIC PATHWAY

troposphere-stratosphere coupling between (heat-flux) eddy waves and climatological wave pattern is instantaneous

Shaw et al. (2014, JGR)



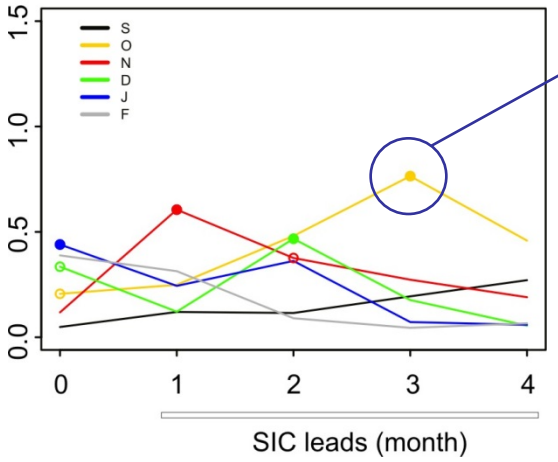
Charlton-Perez et al. (2013, JGR)



Nakamura et al. (2016, GRL)

HadISST

SC / east of Greenland (eG)

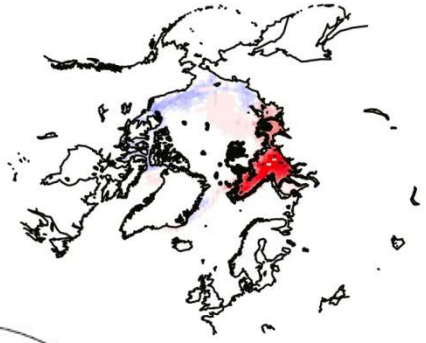


might be linked to winter blocking over Eurasia

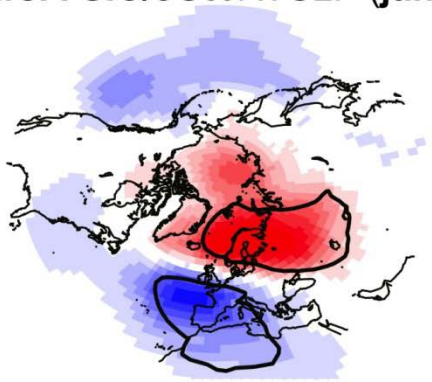
Mori et al. 2014 (Nat.Geosci); García-Serrano et al. (2015, JCLIM)

but the lead-time is longer than the expected atmospheric response time to SIC forcing

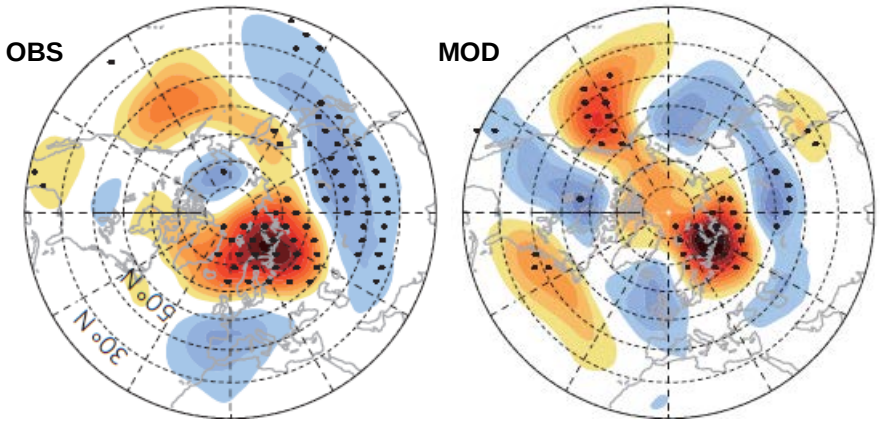
a) **MCA-SIC/eG$_{OCT}$ x SIC (oct)**



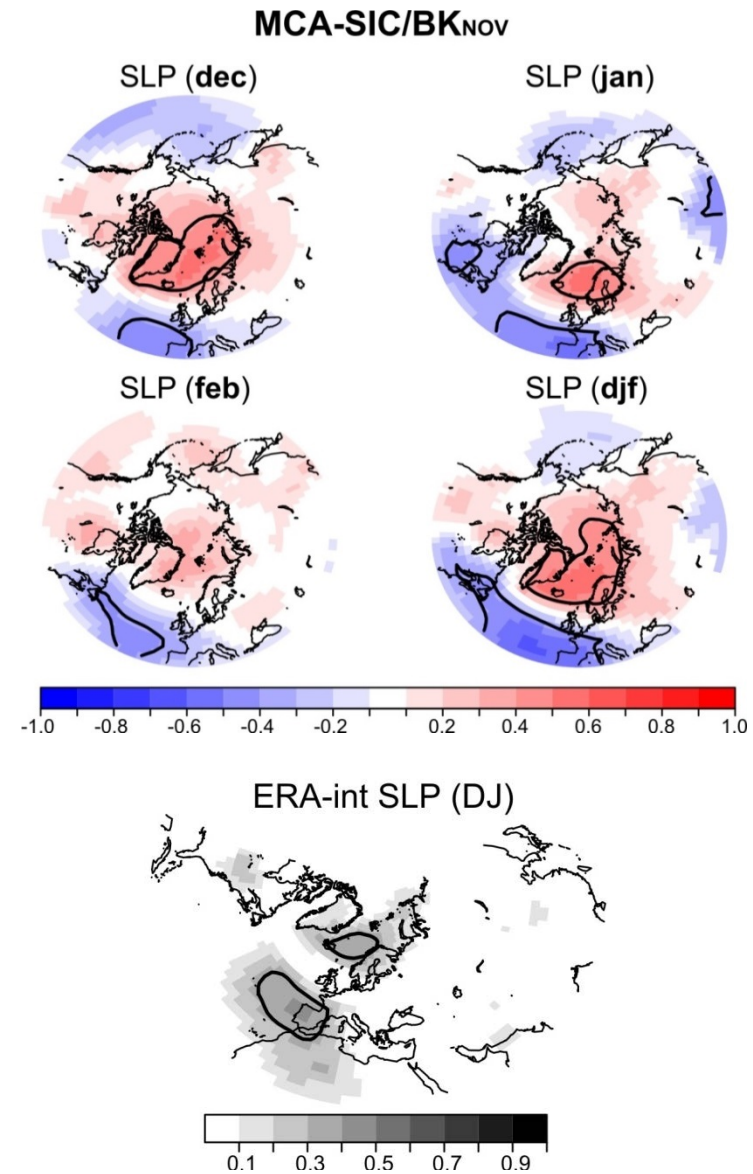
b) **MCA-SIC/eG$_{OCT}$ x SLP (jan)**

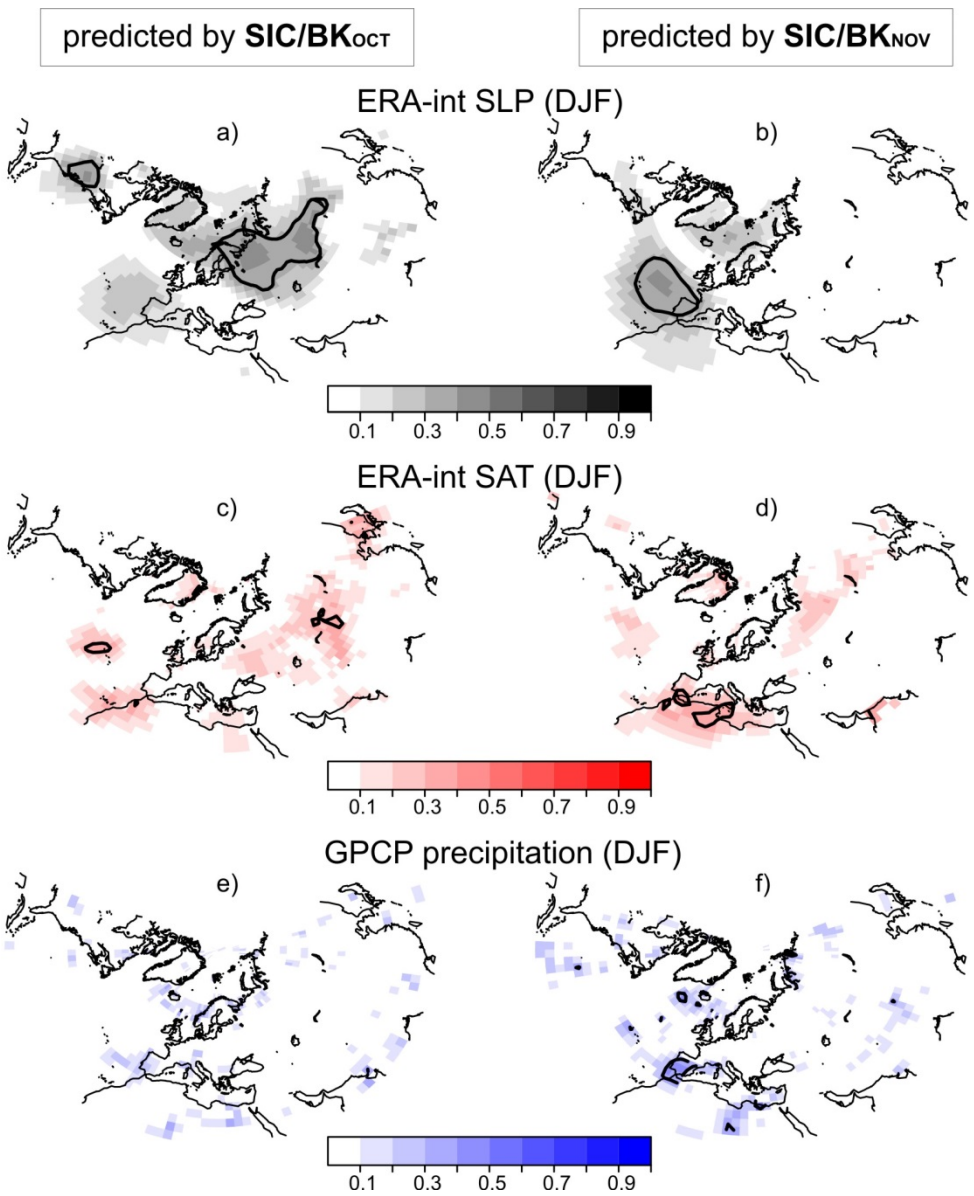


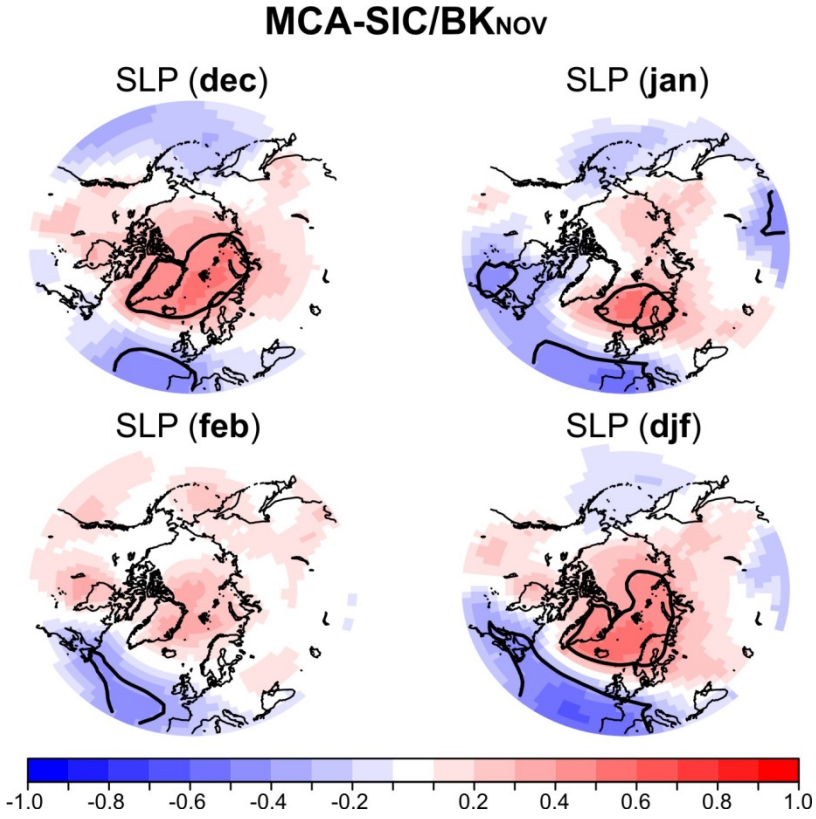
sig.lev.(SC)=2%

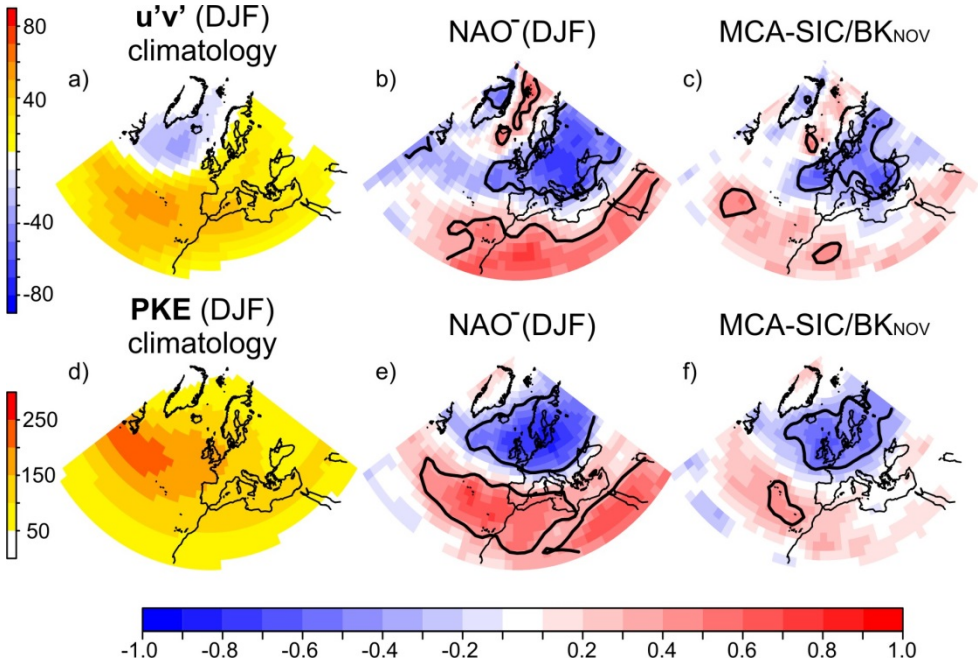


Mori et al. (2014, Nat.Geosci)


MCA-SIC/BKNOV
SLP (dec)
SLP (jan)
SLP (feb)
SLP (djf)
-1.0 -0.8 -0.6 -0.4 -0.2 0.2 0.4 0.6 0.8 1.0
ERA-int SLP (DJ)
0.1 0.3 0.5 0.7 0.9


predicted by SIC/BKOCT
predicted by SIC/BKNOV
ERA-int SLP (DJF)
a)
b)
0.1 0.3 0.5 0.7 0.9
ERA-int SAT (DJF)
c)
d)
0.1 0.3 0.5 0.7 0.9
GPCP precipitation (DJF)
e)
f)
0.1 0.3 0.5 0.7 0.9


MCA-SIC/BKNOV
SLP (dec)
SLP (jan)
SLP (feb)
SLP (djf)
-1.0
-0.8
-0.6
-0.4
-0.2
0.2
0.4
0.6
0.8
1.0


80
40
-40
-80
u'v' (DJF)
climatology
a)
NAO⁻(DJF)
b)
MCA-SIC/BKNOV
c)
PKE (DJF)
climatology
d)
NAO⁻(DJF)
e)
MCA-SIC/BKNOV
f)
250
150
50
-1.0
-0.8
-0.6
-0.4
-0.2
0.2
0.4
0.6
0.8
1.0