# On the linkage between eastern Arctic sea-ice variability and the Euro-Atlantic atmospheric circulation in current climate

## (observations and model diversity)

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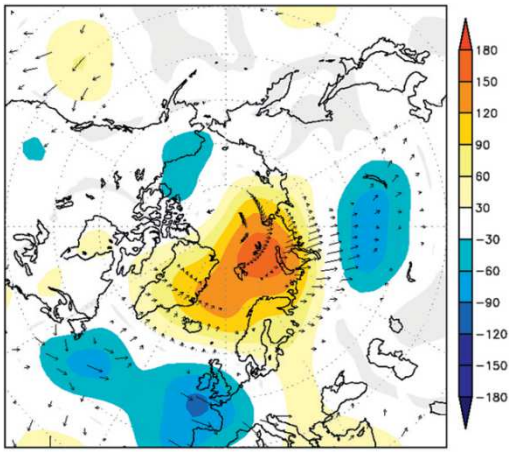
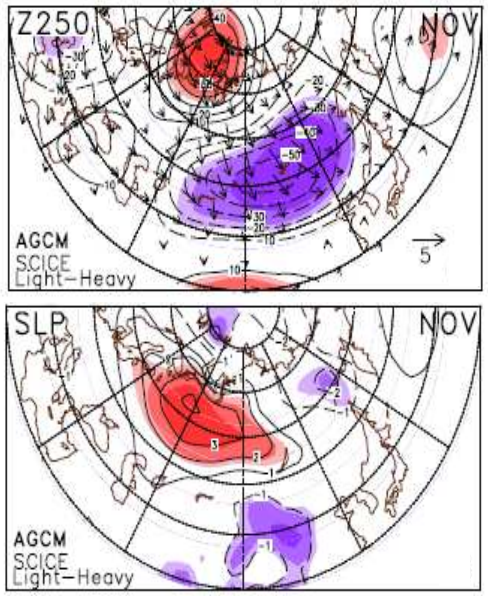
[MOD] A. Arribas (MetOffice), Y. Gao (NERSC/BCCR), V. Guemas (BSC, CNRM), M. P. King (URC/BCCR), D. Matei (MPI-M), R. Msadek (GFDL, CERFACS), W. Park (GEOMAR), E. Sanchez-Gomez (CERFACS)

# SPARC DynVar workshop 2016

Z250 / WAF (DJF)




Inoue et al. (2012, GRL)

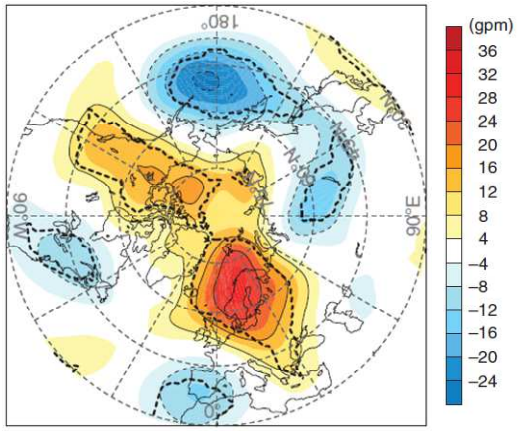



Honda et al. (2009, GRL)

might be non-linear to SIC reduction!

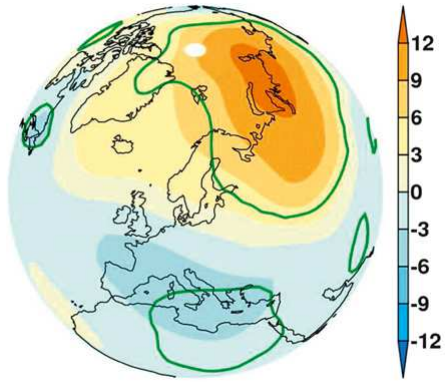
Petoukhov and Semenov (2010, JGR)

ΔZ500 for ND, CAM5




Kim et al. (2014, Nat.Comms)

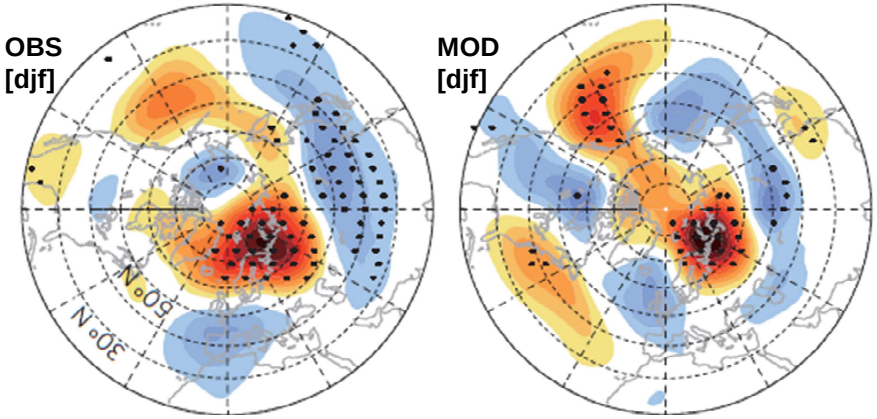
SLP JAN [CAM]



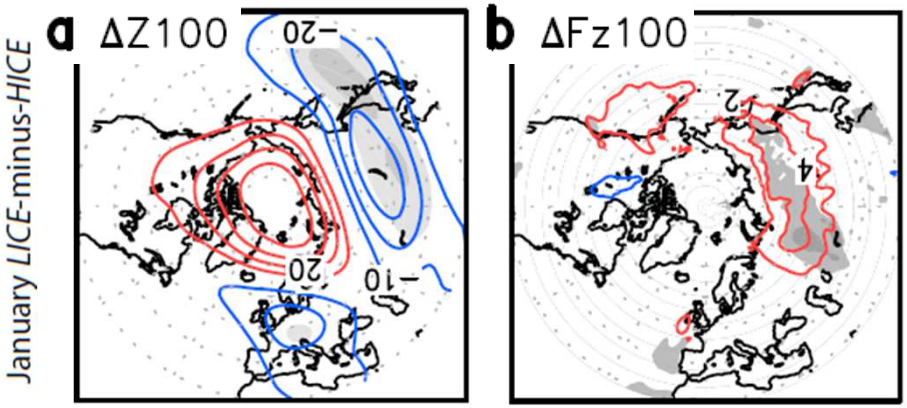

Grassi et al. (2013, JCLIM)

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

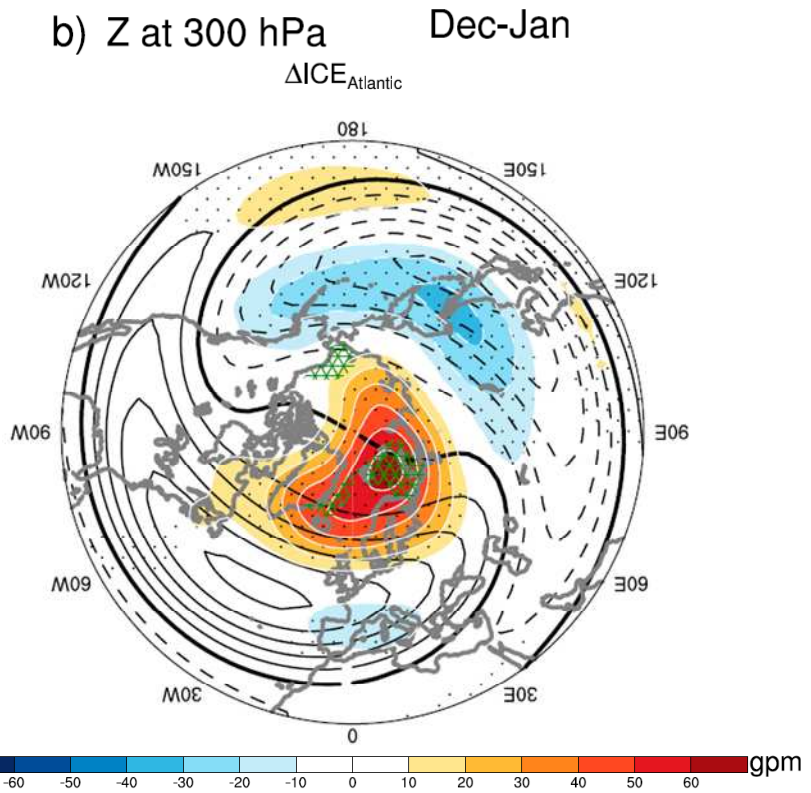
# SPARC DynVar workshop 2016




Mori et al. (2014, Nat.Geosci)




Nakamura et al. (2016, GRL)

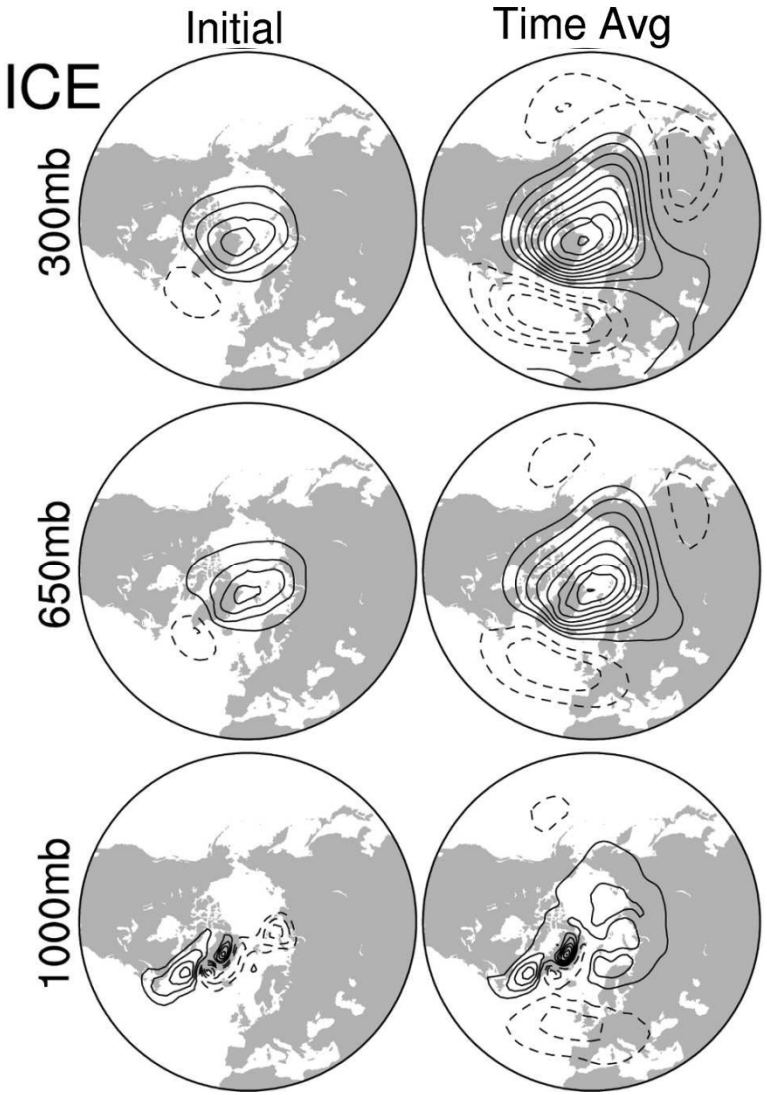


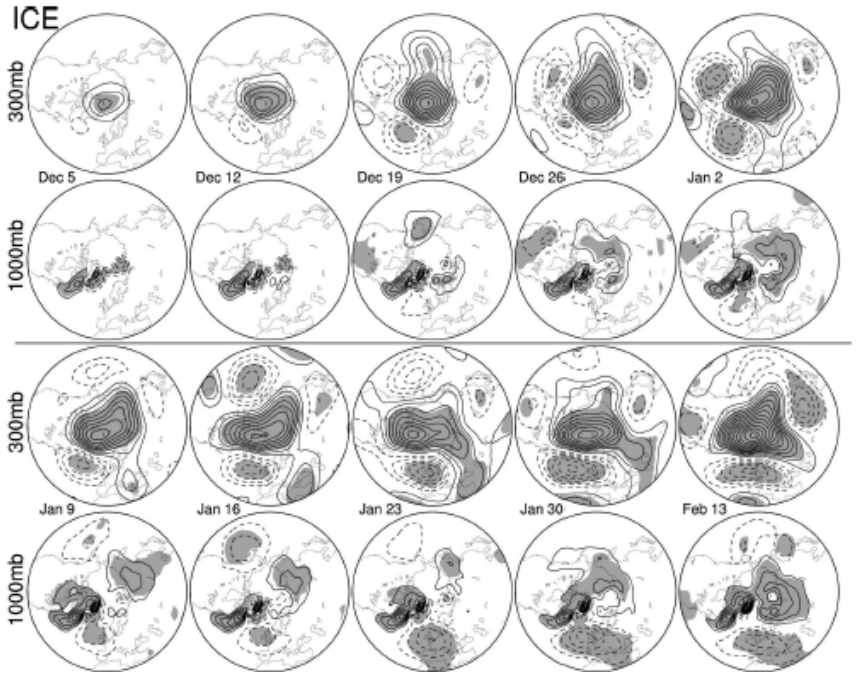

Sun et al. (2015, JCLIM)

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

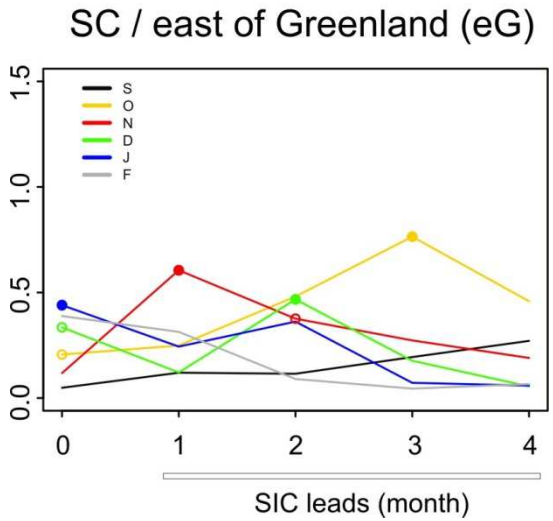



the equilibrium response to SIC reduction over G-B Seas, which projects on the negative NAO, is reached in about two months

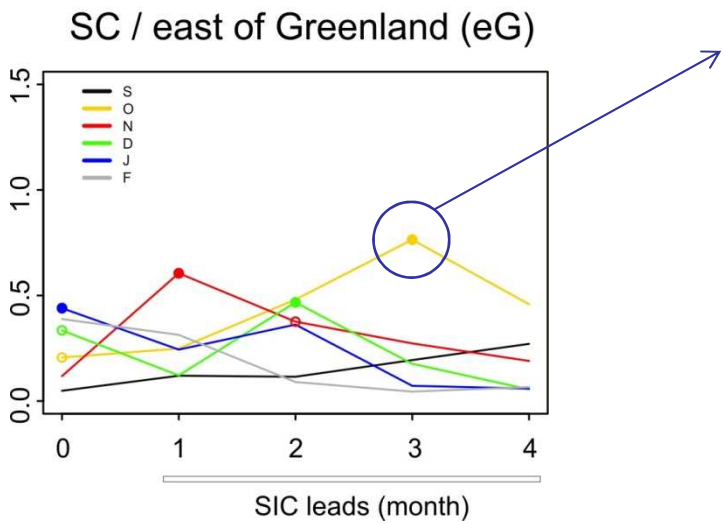
Deser et al. (2007, JCLIM)

HadISST




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

HadISST




might be linked to winter blocking over Eurasia

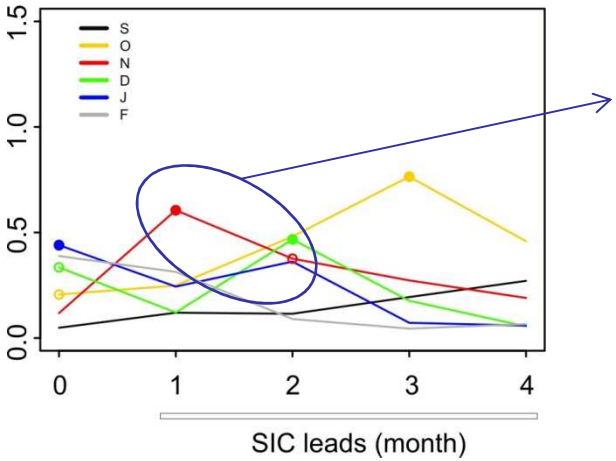
Mori et al. 2014 (Nat.Geosci); García-Serrano et al. (2015, JCLIM)

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

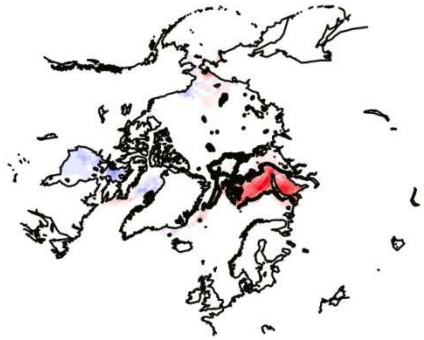
- detrended, monthly anomalies;
period 1979-2013;
target – cold season (Sep-to-Feb)

HadISST

SC / east of Greenland (eG)

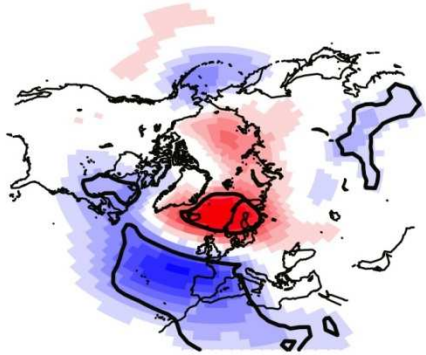



a) **MCA-SIC/eG$_{NOV}$ x SIC (nov)**



sig.lev.(SC)=6%

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

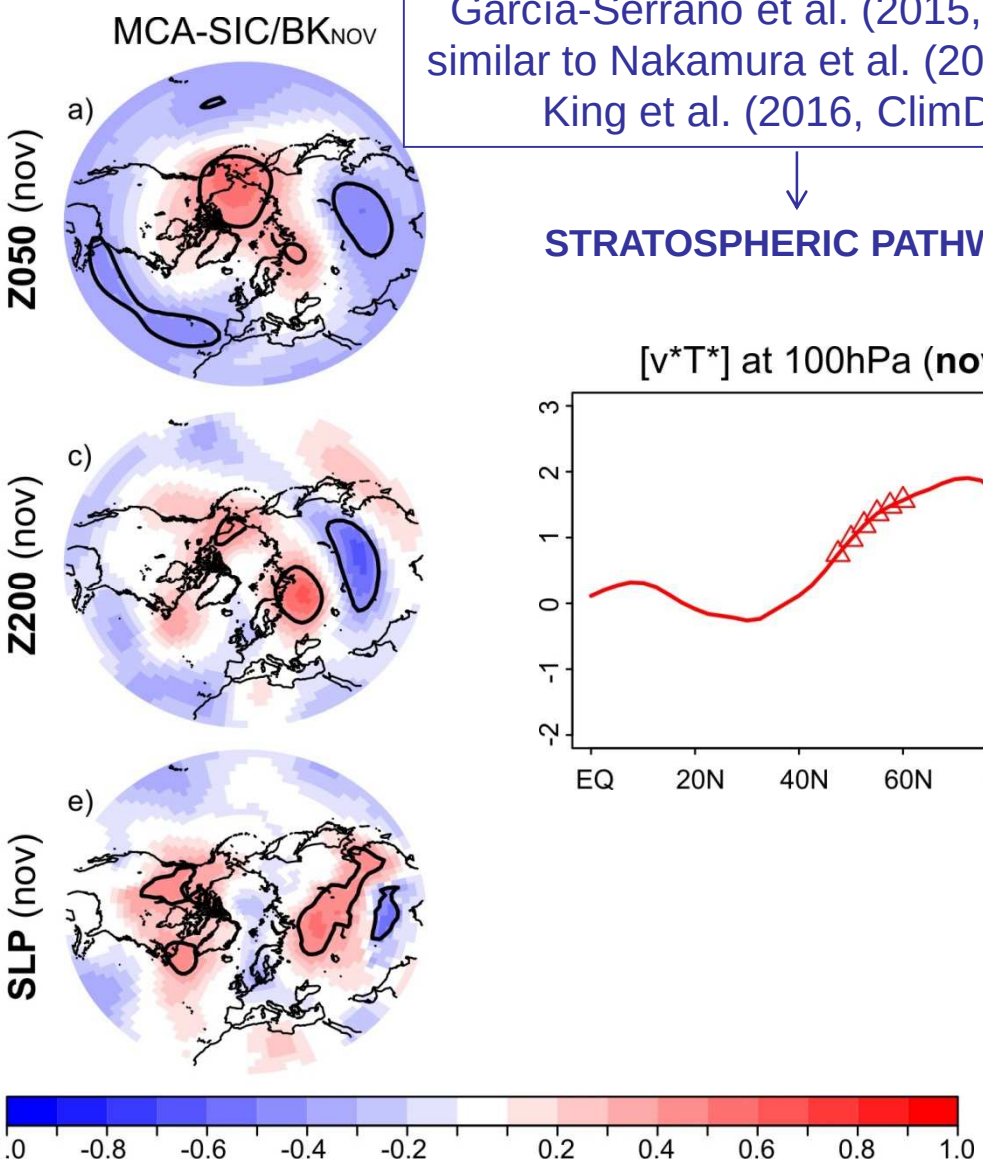


- detrended, monthly anomalies;
period 1979-2013;
target – cold season (Sep-to-Feb)

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

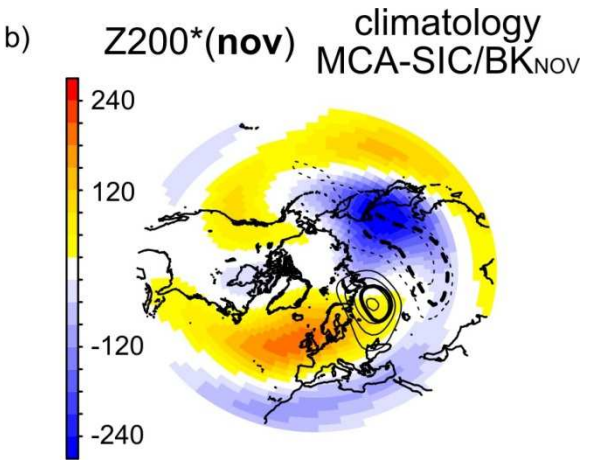
↓

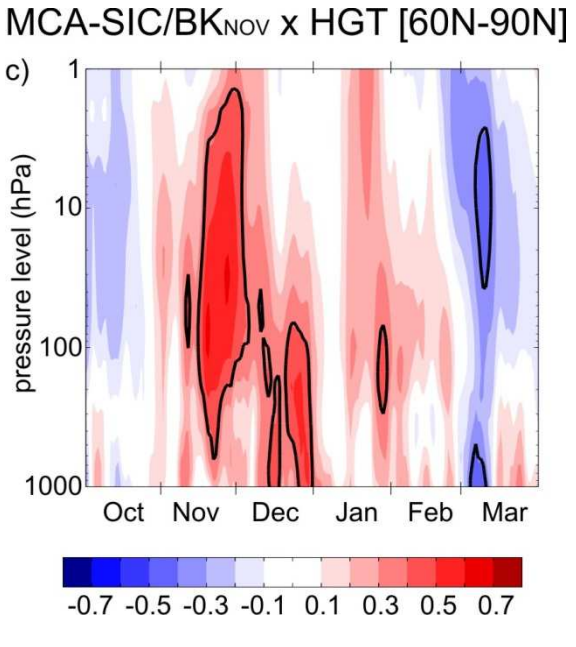
**STRATOSPHERIC PATHWAY**





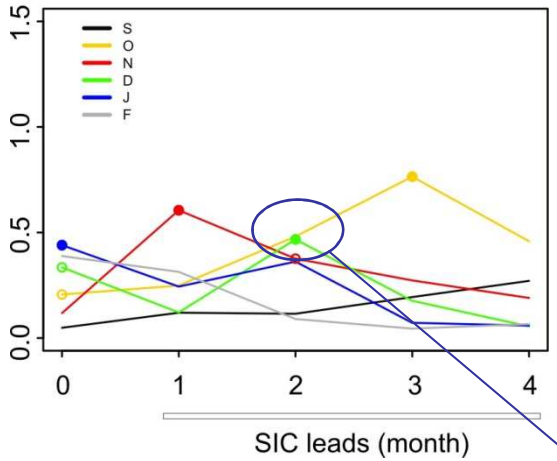




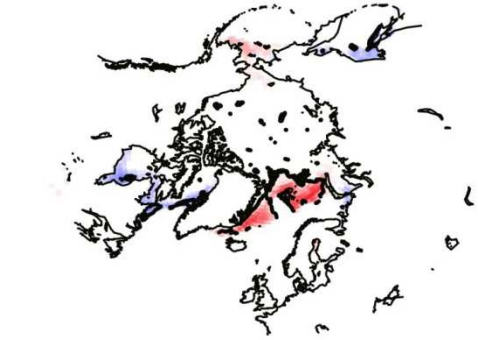
HadISST

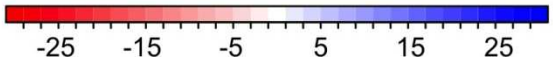
SC / east of Greenland (eG)



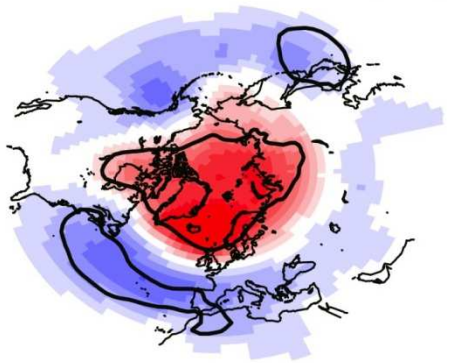

- detrended, monthly anomalies;
period 1979-2013;
target – cold season (Sep-to-Feb)

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

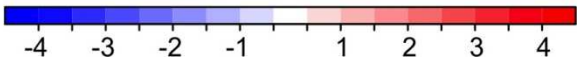


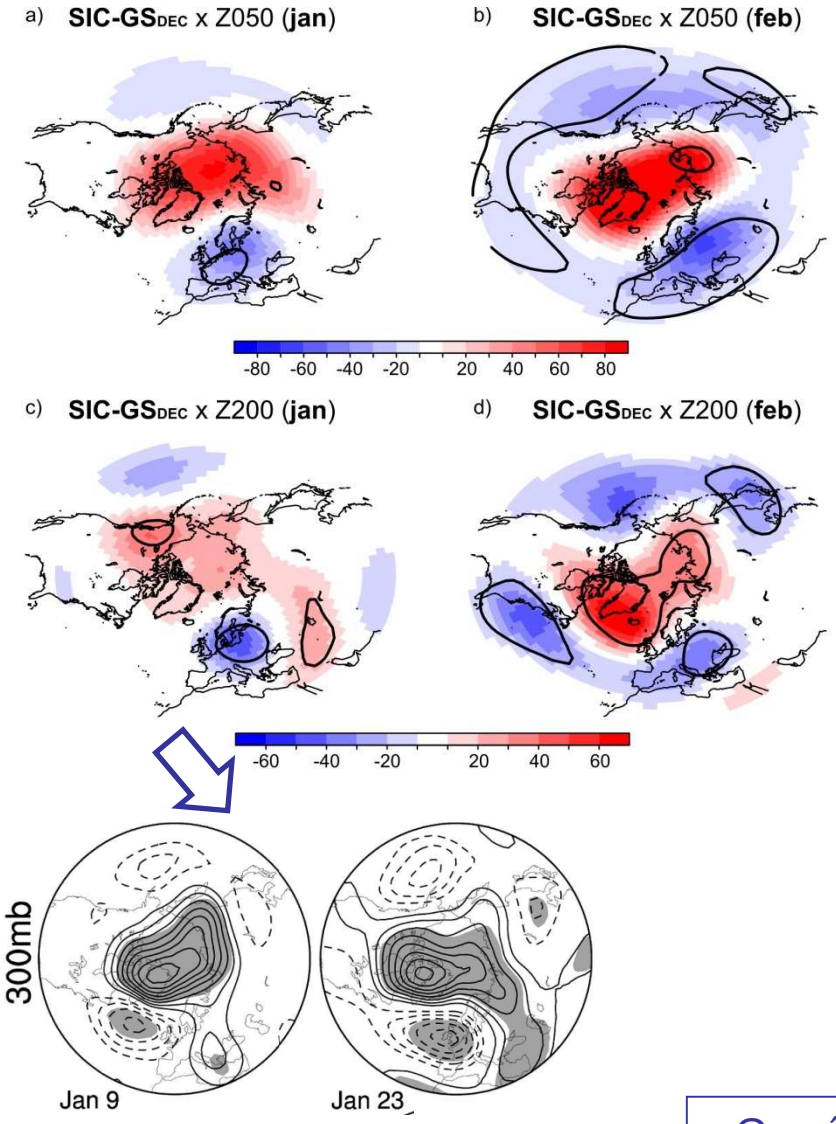



d) **MCA-SIC/eG$_{DEC}$** x SLP (**feb**)



sig.lev.(SC)=0%

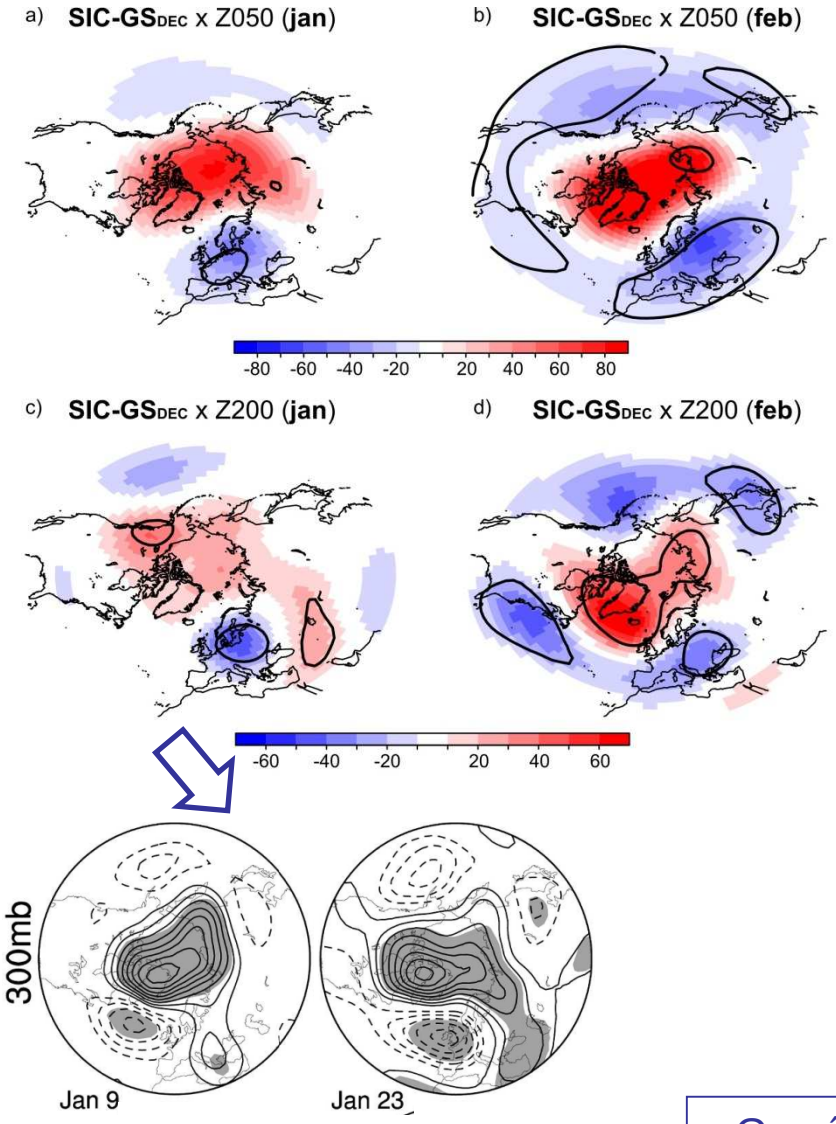





Deser et al. (2007, JCLIM)

García-Serrano and Frankignoul (2015, ClimDyn)

# SPARC DynVar workshop 2016

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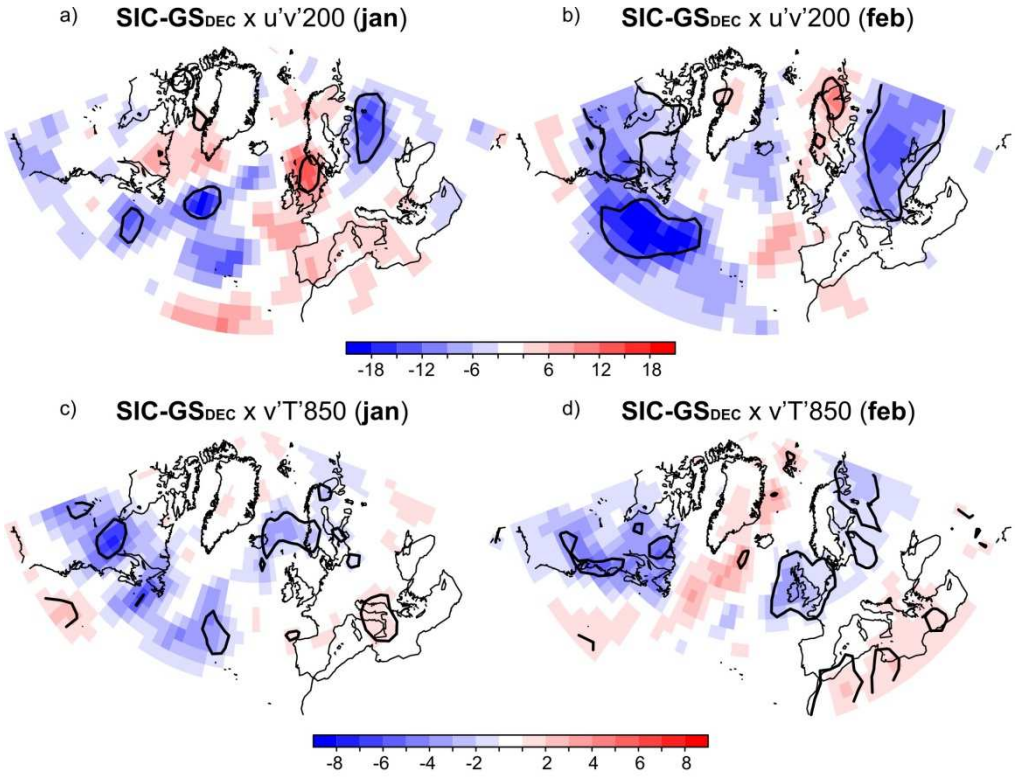
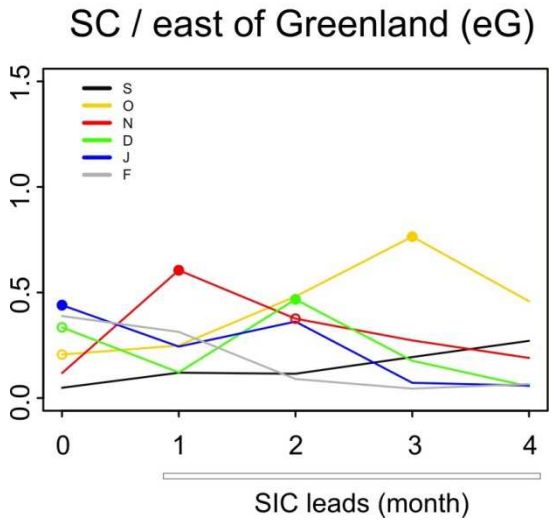



**TROPOSPHERIC DYNAMICS**

García-Serrano and Frankignoul (2015, ClimDyn)

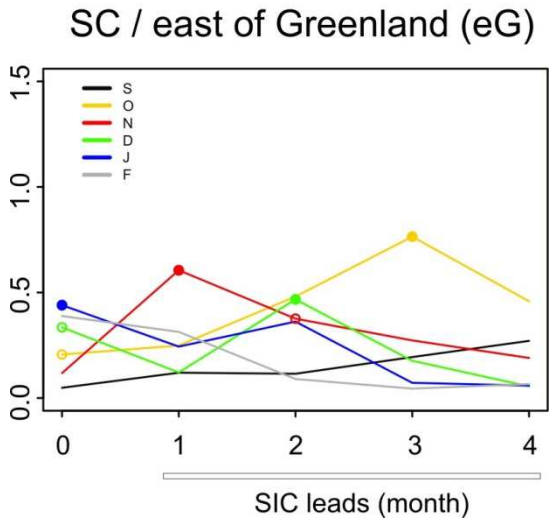
HadISST

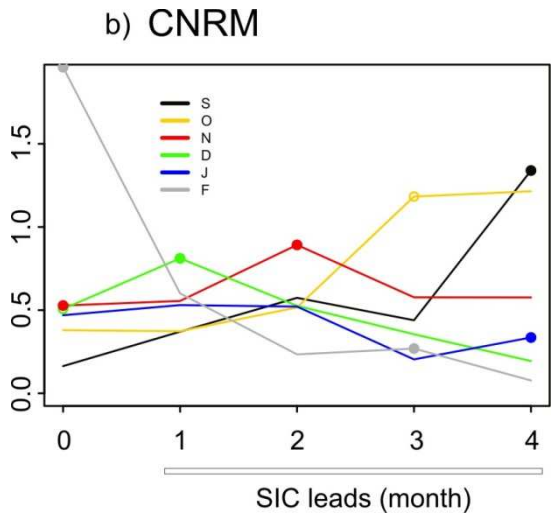



- detrended, monthly anomalies;
period 1979-2013;
target – cold season (Sep-to-Feb)

- **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




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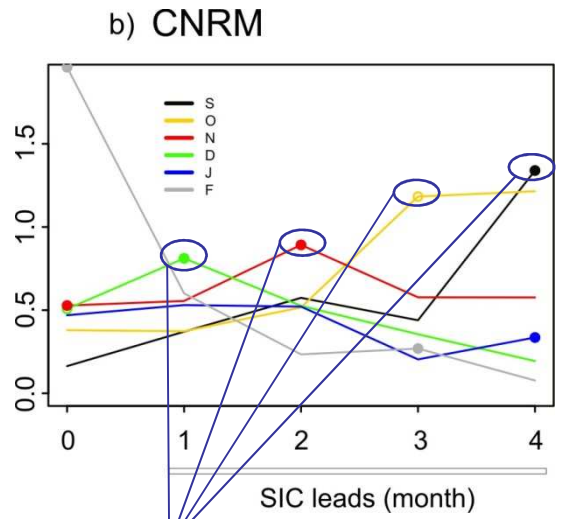
target – cold season (Sep-to-Feb)

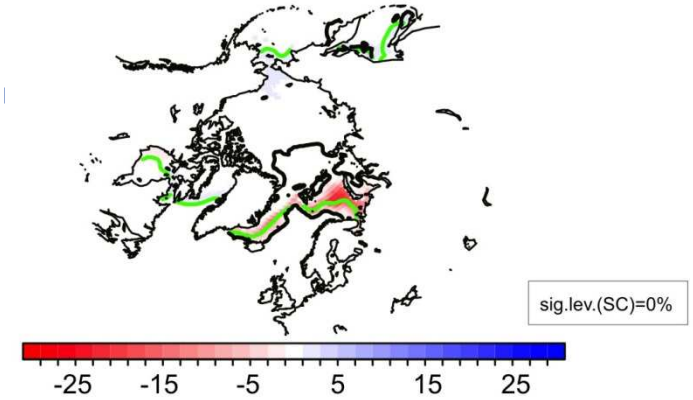
- **CMIP5**: no multi-model, each model individually;
CCSM4 (5mb), CNRM-CM5 (10mb), EC-EARTH2.3 (3mb), GFDL-CM2.1 (10mb), HadGEM2-ES (4mb), IPSL-CM5A-LR (3mb), MPI-ESM-MR (3mb), NorESM1-M (3mb) - HISTORICAL+RCP4.5 RUNS



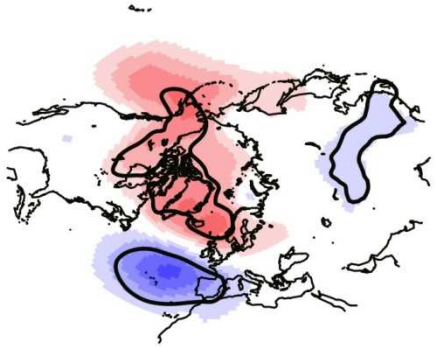

SIC persistence from Sep to Dec; sig. influence on the atm. – Jan

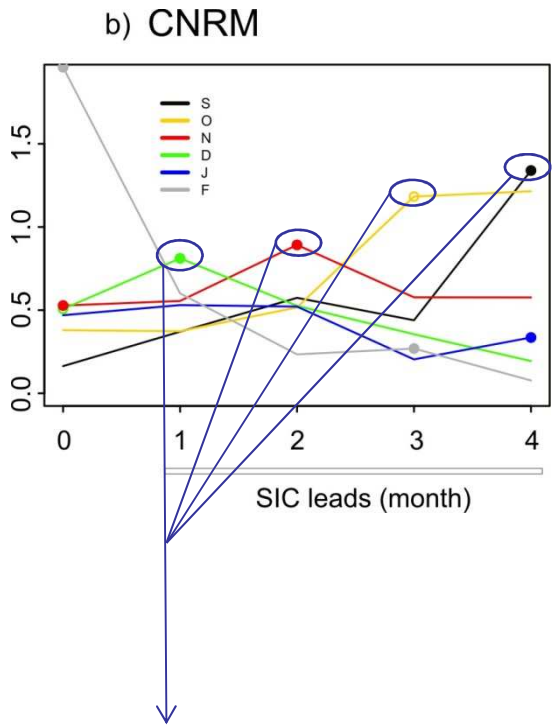
CNRM

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




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



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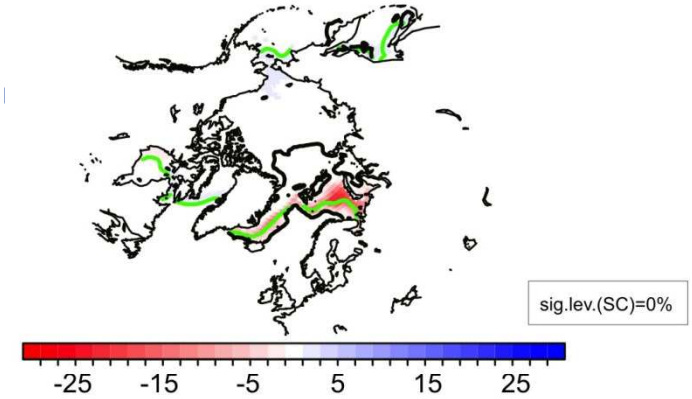
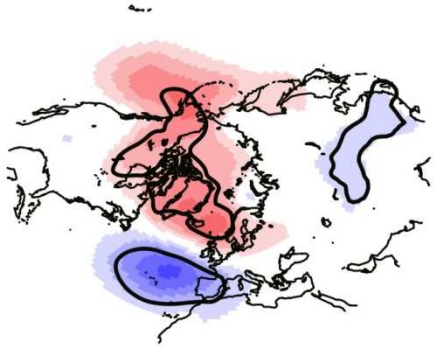
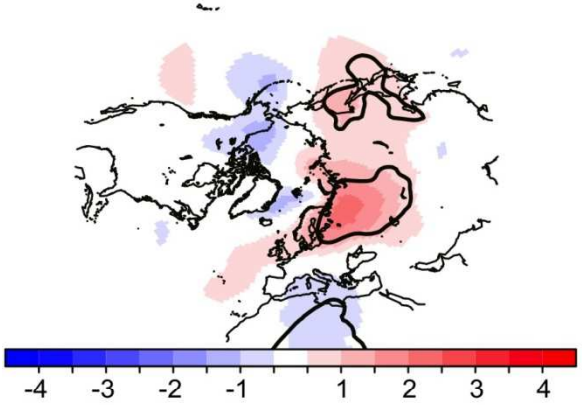



b) **MCA-SIC/eA$_{DEC}$** x SLP (**jan**)

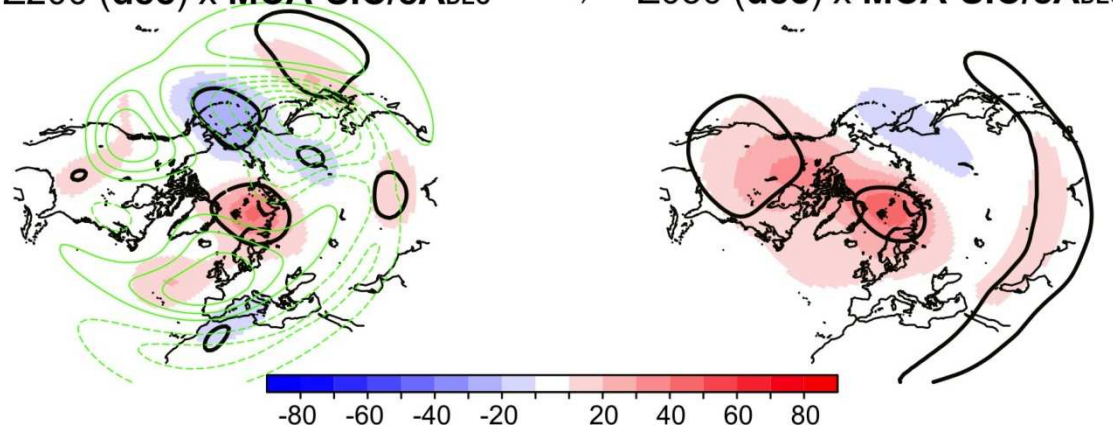


c) SLP (**dec**) x **MCA-SIC/eA$_{DEC}$**

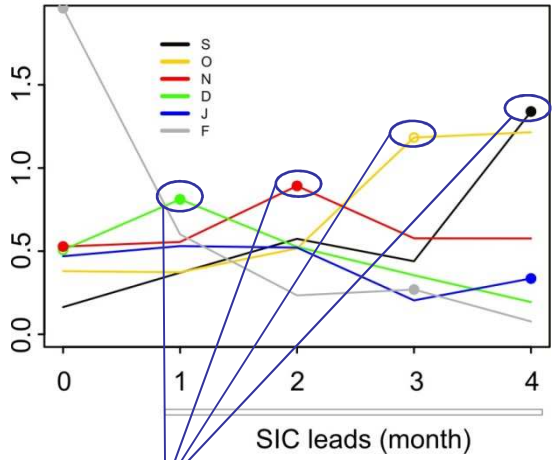



e) Z200 (**dec**) x **MCA-SIC/eA$_{DEC}$**

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




b) CNRM

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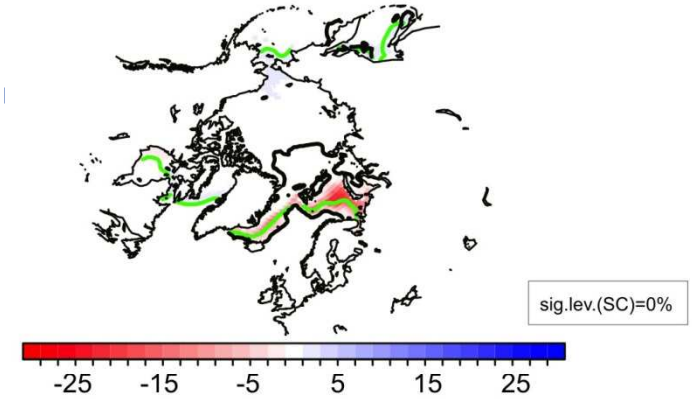
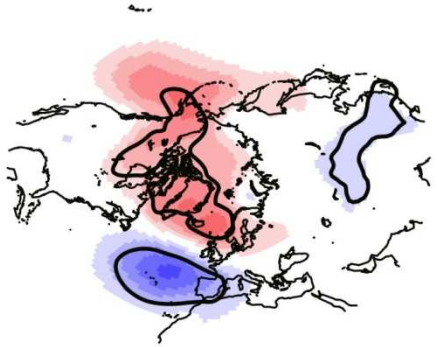
sig. influence on the atm. – Jan

CNRM

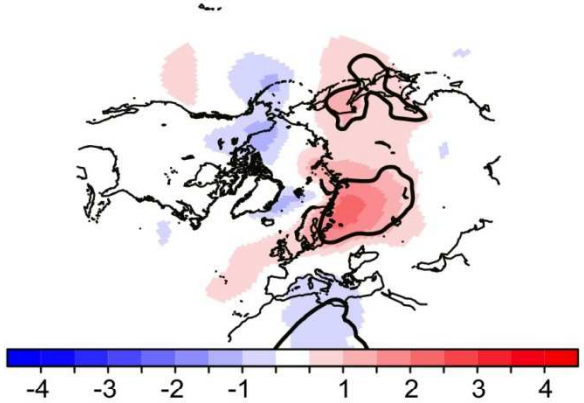
a) **MCA-SIC/eA$_{DEC}$** x SIC (**dec**)



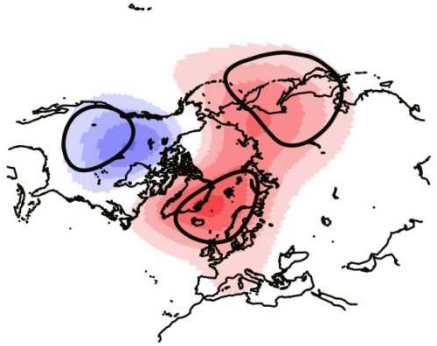

b) **MCA-SIC/eA$_{DEC}$** x SLP (**jan**)



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

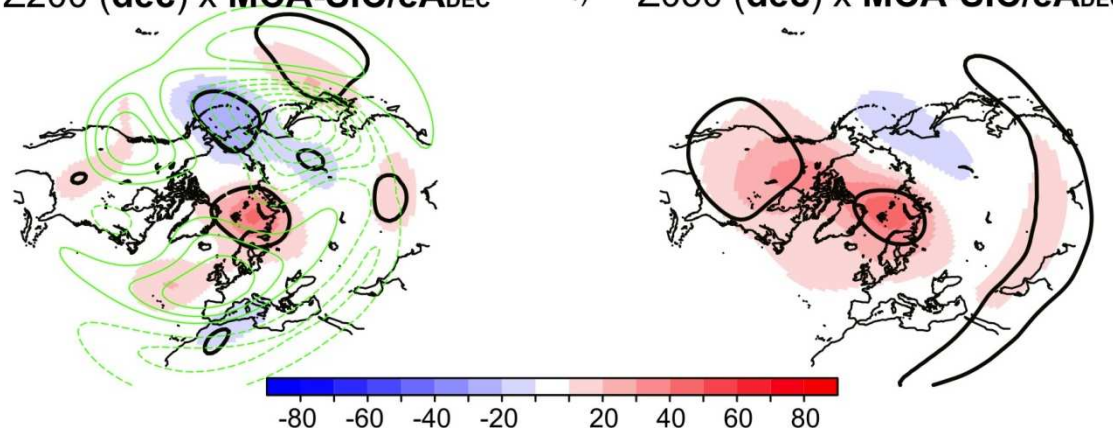



d) Z050 (**jan**) x **MCA-SIC/eA$_{DEC}$**

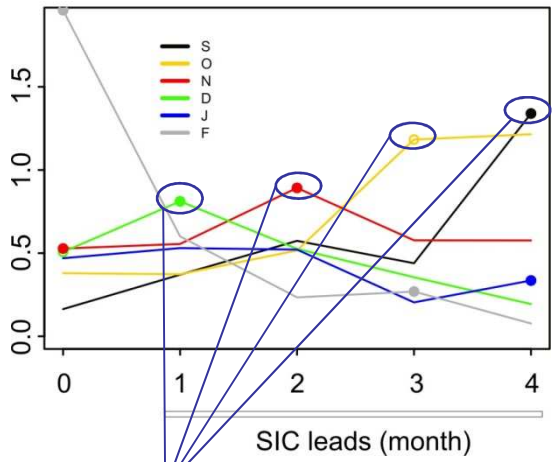


e) Z200 (**dec**) x **MCA-SIC/eA$_{DEC}$**

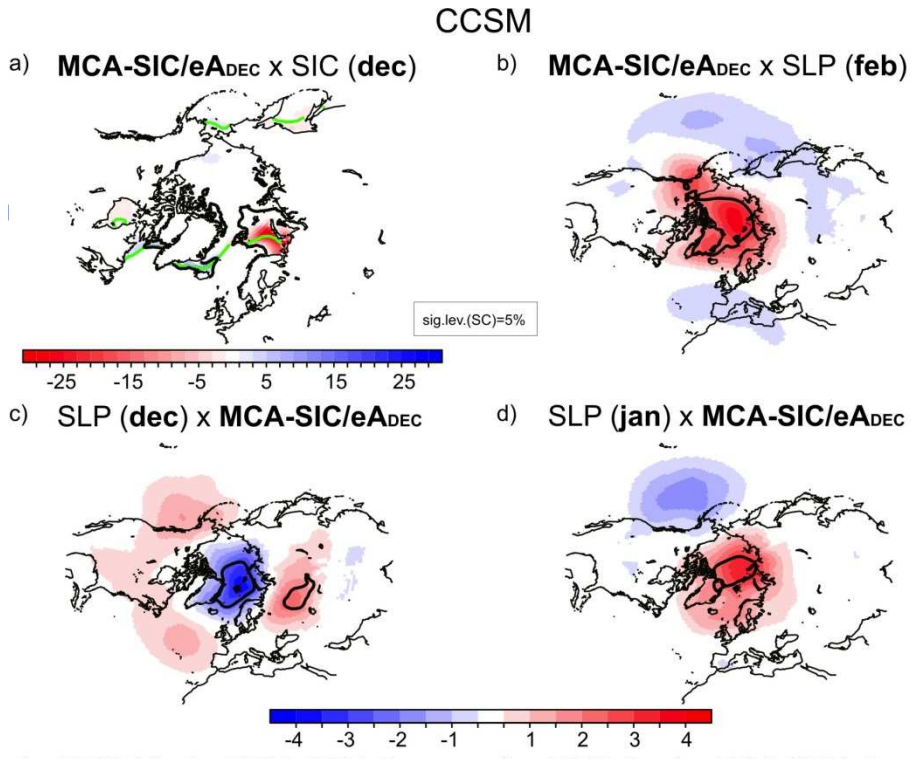
f) Z050 (**dec**) x **MCA-SIC/eA$_{DEC}$**

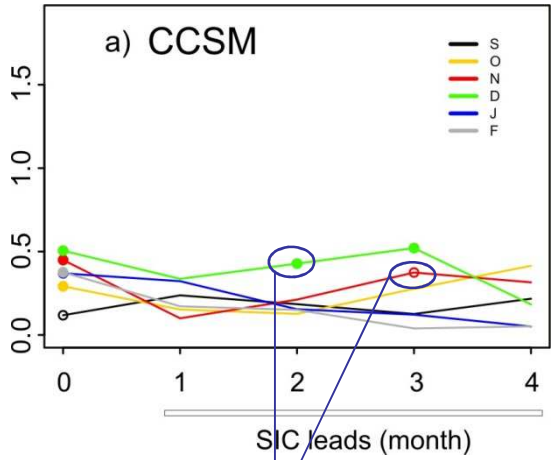



b) CNRM




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

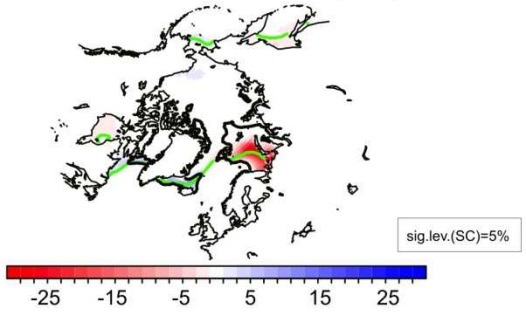


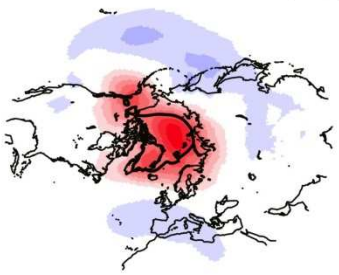

SIC persistence from Nov to Dec;
sig. influence on the atm. – Feb

CCSM

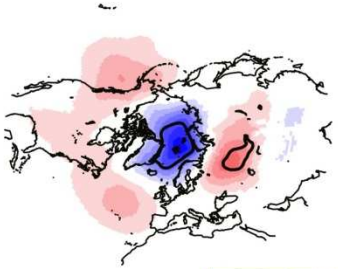
a) **MCA-SIC/eA$_{DEC}$** x SIC (**dec**)



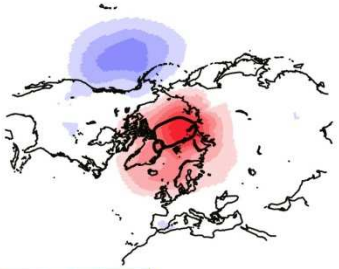

b) **MCA-SIC/eA$_{DEC}$** x SLP (**feb**)



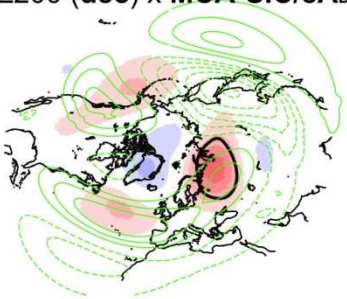
c) SLP (**dec**) x **MCA-SIC/eA$_{DEC}$**



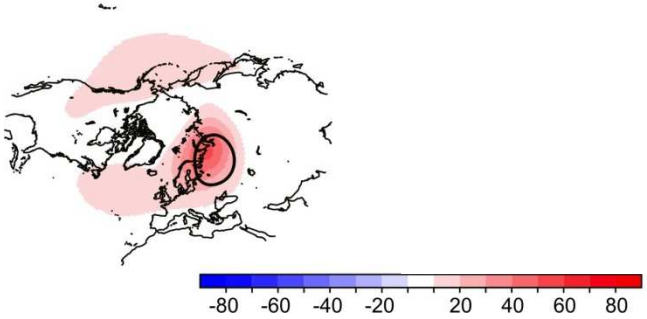
d) SLP (**jan**) x **MCA-SIC/eA$_{DEC}$**

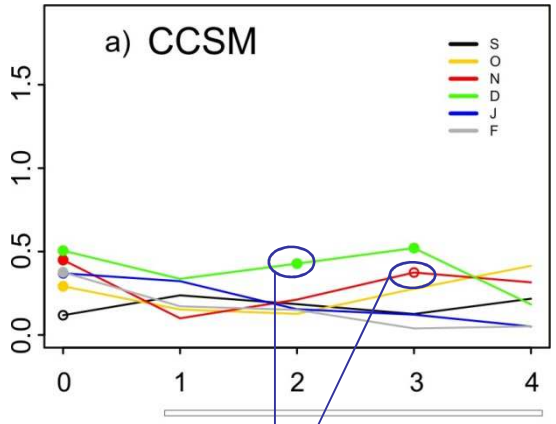



e) Z200 (**dec**) x **MCA-SIC/eA$_{DEC}$**

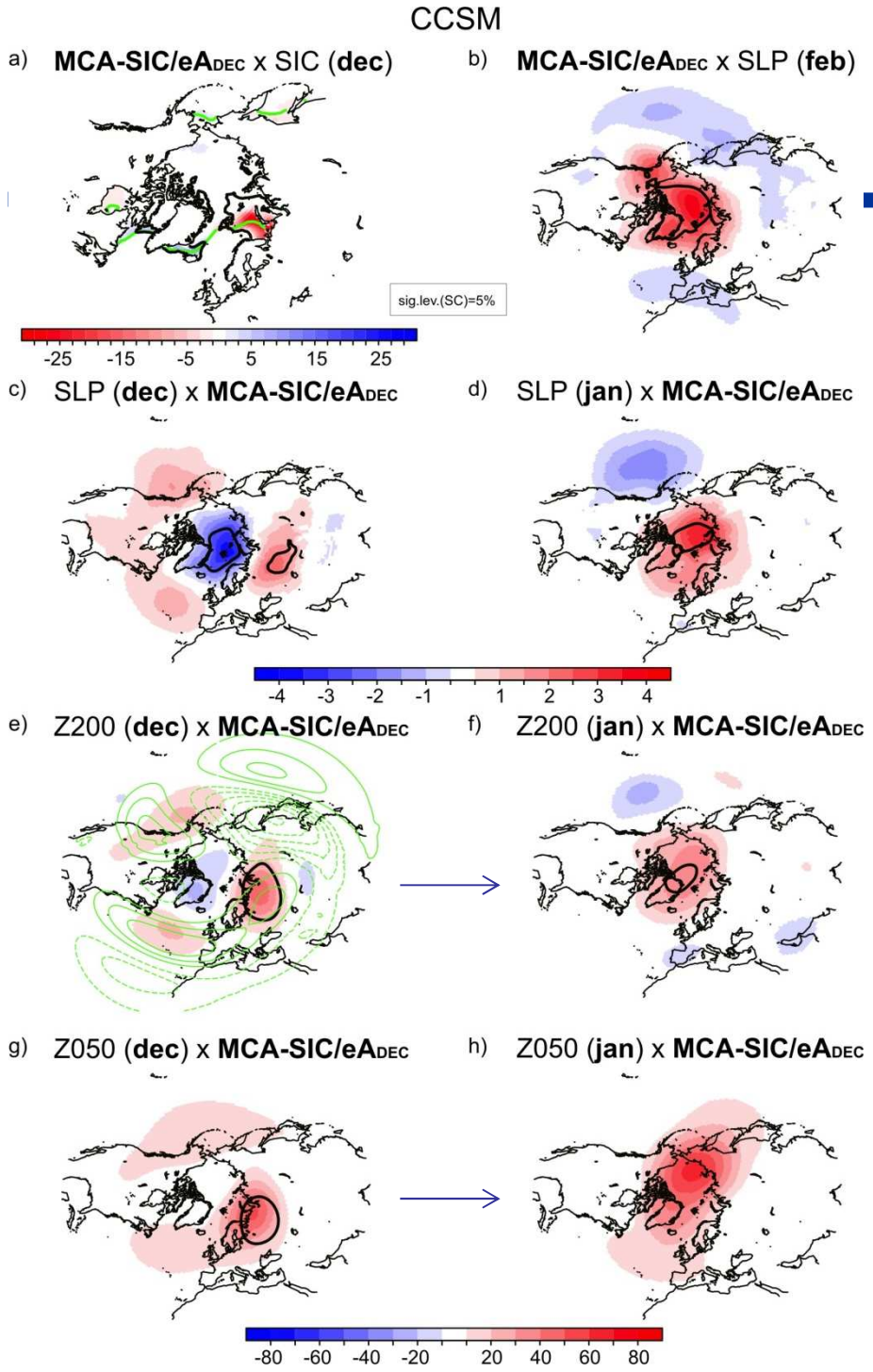


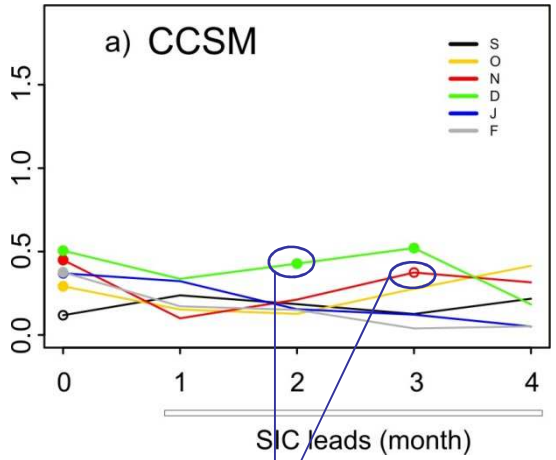
g) Z050 (**dec**) x **MCA-SIC/eA$_{DEC}$**




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




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

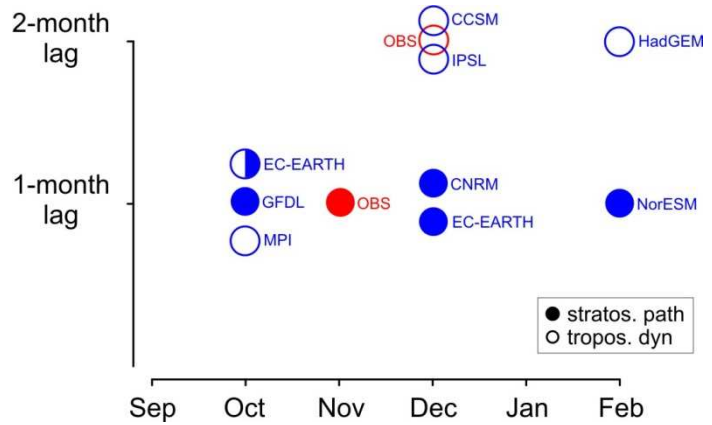
## SUMMARY

- 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

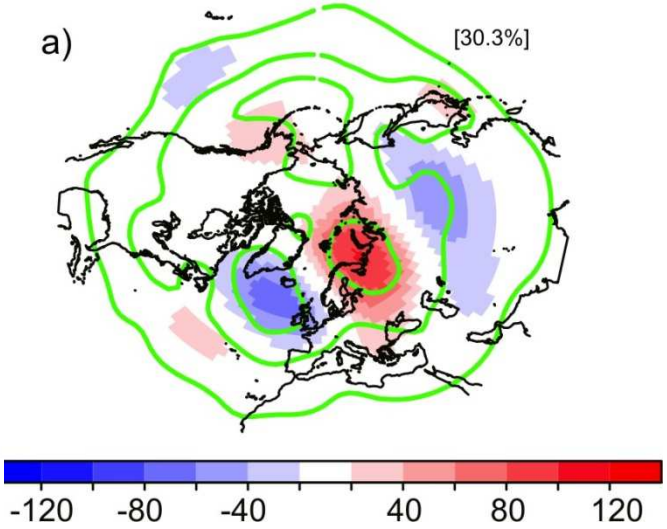


# EXTRA SLIDES

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**)

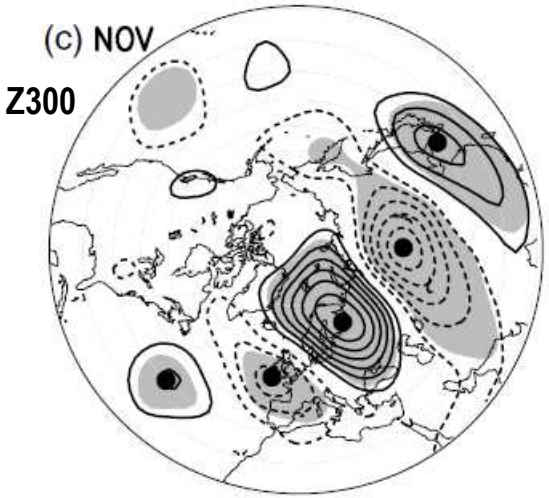
ERA-interim




the **Ural-Siberian** anticyclone

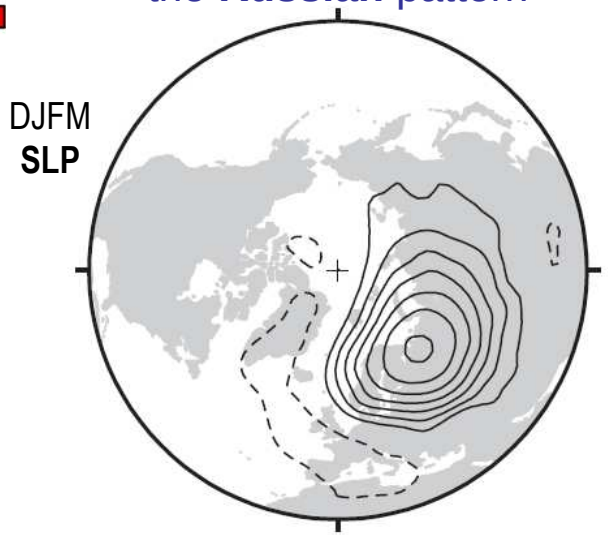
Santolaria et al.
(in preparation)

the **SCA** pattern




Bueh and Nakamura (2007, QJRMS)

the **Russian** pattern




Smoliak and Wallace (2015, JAS)