



Modelización climática global EC-EARTH

J. García-Serrano

Climate Prediction Group
Earth Sciences Dept. (BSC-ES)





Modelización climática global EC-EARTH

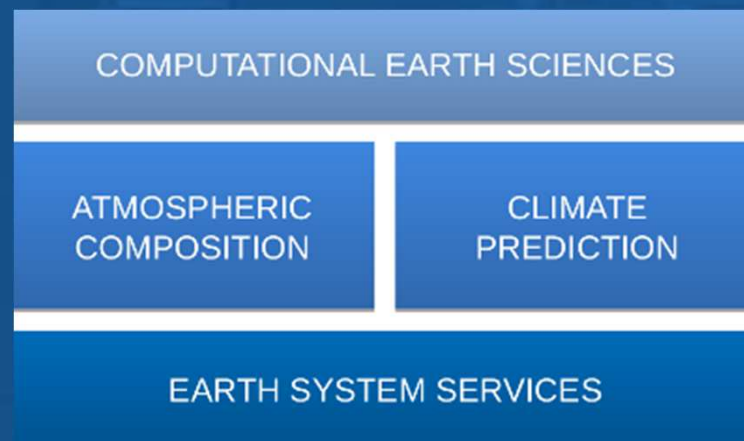


**Climate
Forecasting
Unit**

2010-2015



2015-2017



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DE CIÈNCIES DEL
CLIMA



**Barcelona
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Centro Nacional de Supercomputación

Multi-model decadal forecast exchange

The Met Office coordinates an informal exchange of near-real time decadal predictions. Many institutions around the world are developing decadal prediction capability and this informal exchange is intended to facilitate research and collaboration on the topic.

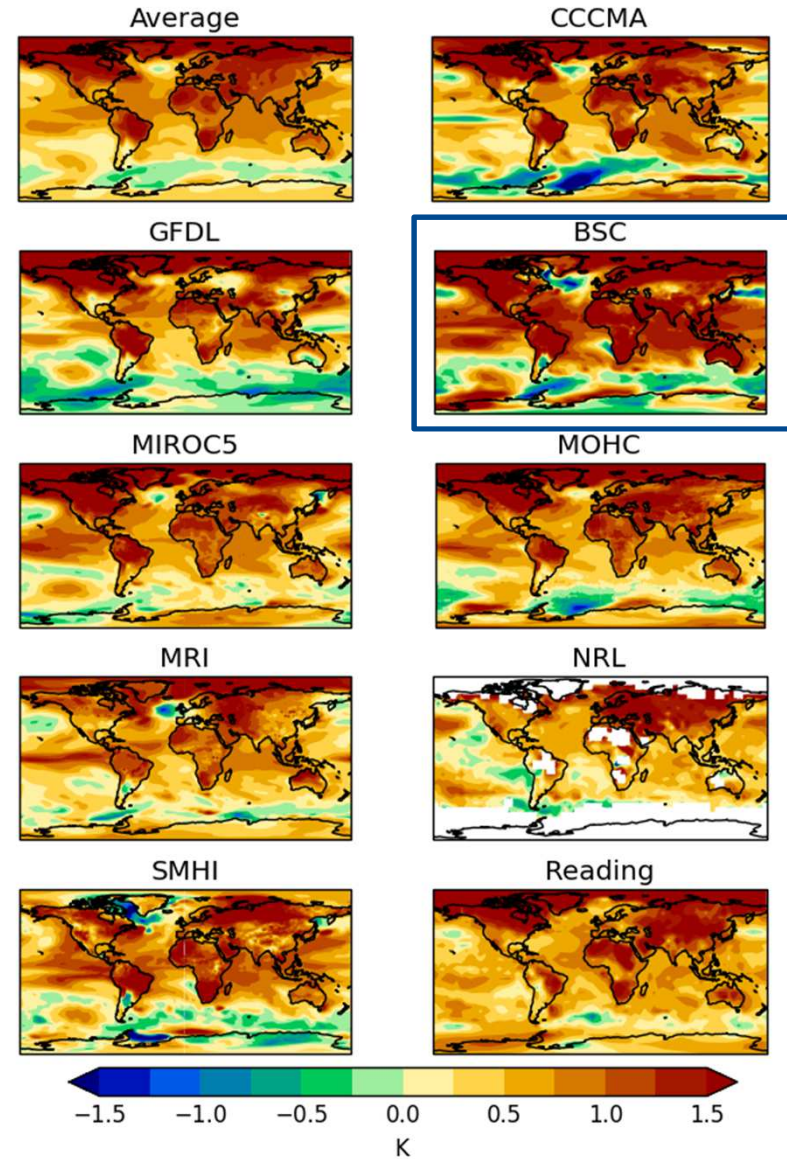
The contributing prediction systems are a mixture of dynamical and statistical methods. The prediction from each institute is shown below, alongside an average of all the models. When possible, observations for the period of the forecast are also shown. Currently three variables are included: surface air temperature, sea-level pressure and precipitation. These are shown as differences from the 1971-2000 baseline. More diagnostics, including ocean variables are planned for the future. Please use the drop-down menus below to explore the data collected to date.

This work is supported by the European Commission SPECS project.

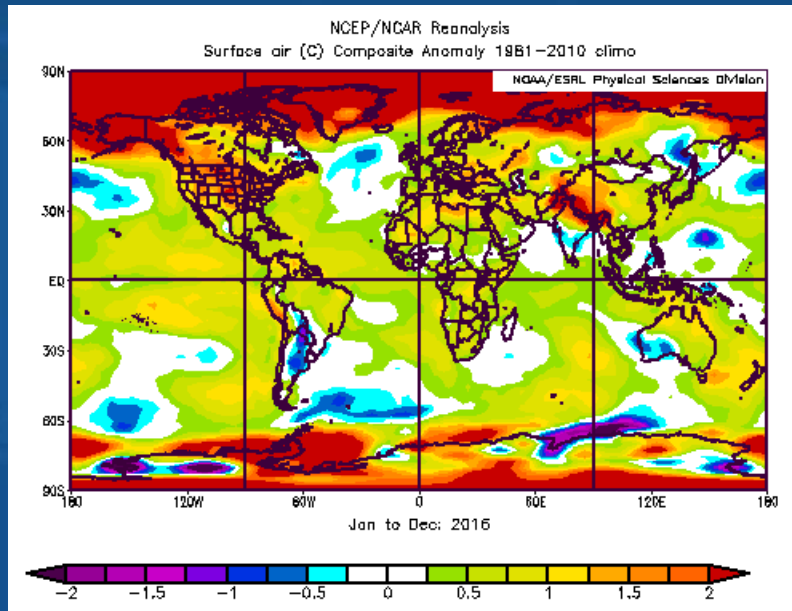


Smith et al. (2013, ClimDyn) - UPDATED

2015 predictions for 2016 surface temperature

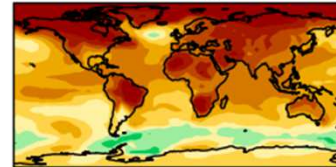


Jan-Dec 2016

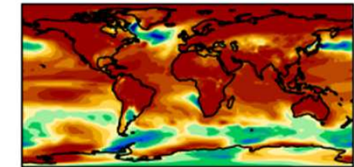


2015 predictions for 2016 surface temperature

Average



BSC

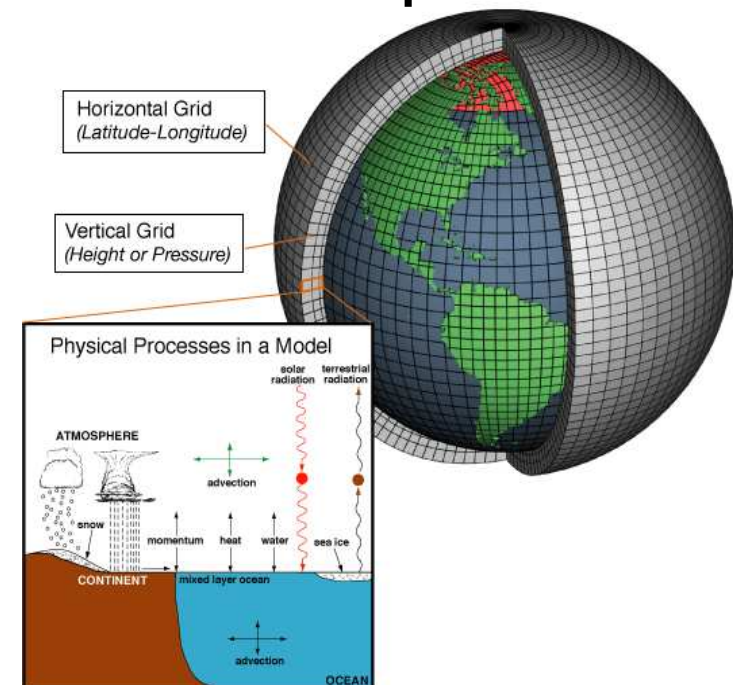


What's new in EC-EARTH? (CMIP5 → CMIP6)

- IFS (representing the atmosphere):
cy31r1 → cy36r4
T159 (1.125°) → T255 (0.75°)
L62 (top 5hPa) → L91 (top 0.01hPa)
e.g. interactive aerosols, better snow treatment
- NEMO (representing the ocean):
v2 → v3.6
L46 → L75
e.g. improved runoff distribution
- LIM (representing the sea-ice):
v2 → v3
single → multiple (5) ice category
e.g. multi-layer halo-thermodynamics,
EVP rheology



EC-EARTH coupled model



- NEMO3.6: ORCA1 L75
- IFS [cy36r4]: T255 L91 (top 0.01hPa)
- LIM3: multiple (5) ice categories
- H-TESSSEL – land-surface processes
- OASIS3-MCT – coupler



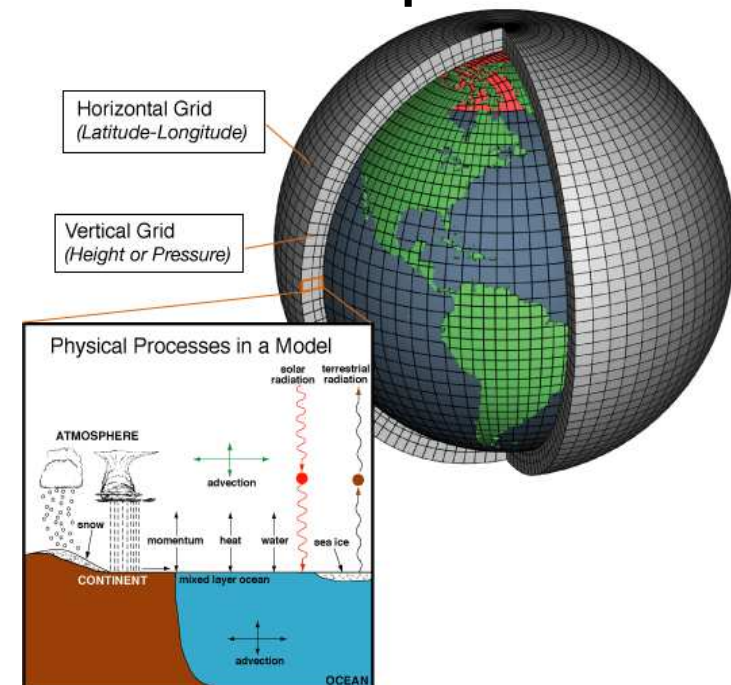
atmosphere
reanalysis
(ERA-Interim)

ice
reanalysis
(IC3/BSC)

land reanalysis
(ERA-Land)

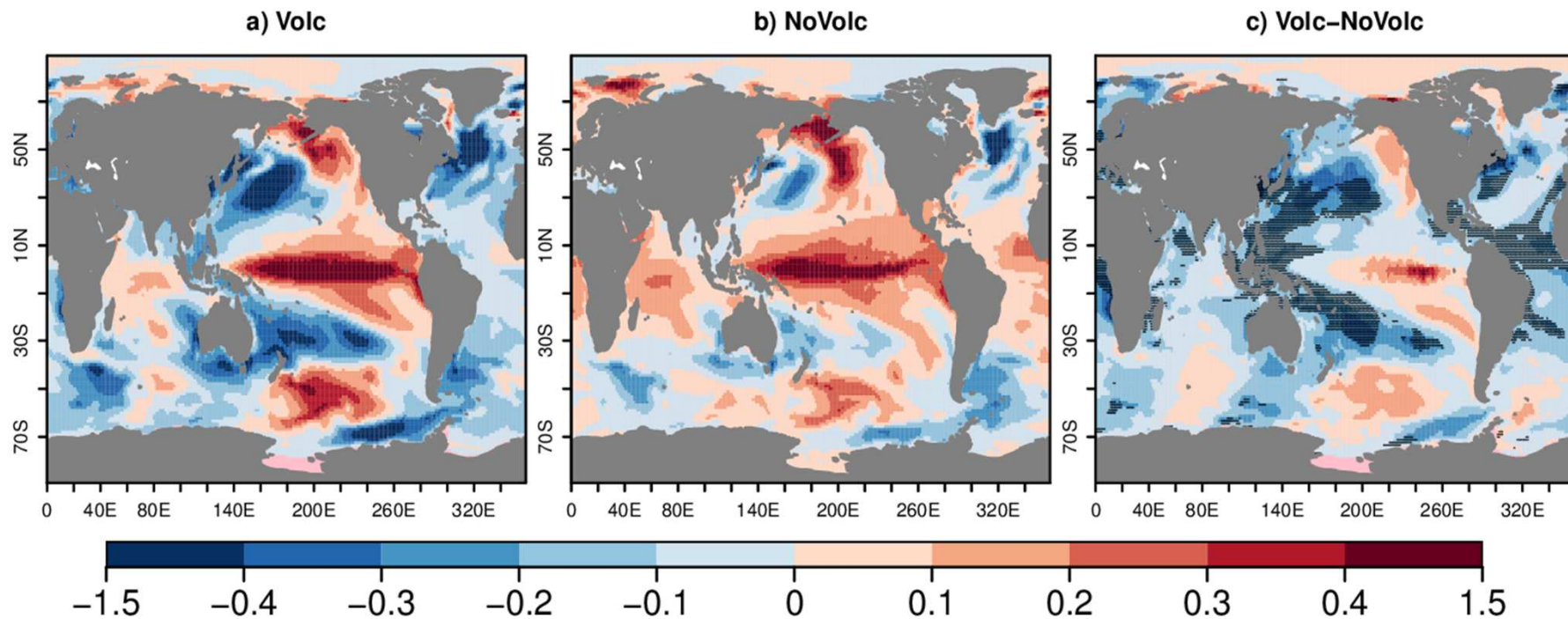
ocean reanalysis
(ORAS4)

EC-EARTH coupled model

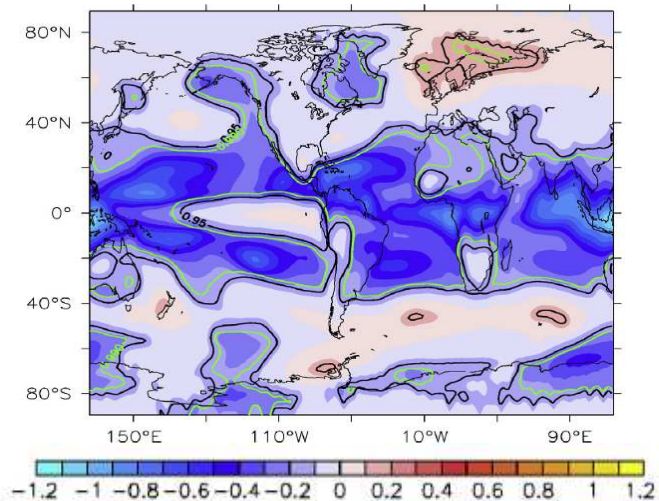


- Generation of in-home **sea ice reconstruction** / reanalysis – **data assimilation techniques** to exploit existing atmospheric and oceanic reanalyses – development of initialization methods (anomaly vs. full-field)
- **Analyses of mechanisms** leading to model bias and development of bias correction techniques accounting for sensitivity of bias to prediction start date
- **Improvement of forecast systems** through better process representation: inclusion of new parameterizations, new model components, high resolution, parameter calibration
- **Identifying sources of skill** such as soil moisture, sea ice thickness, aerosols, biogeochemistry, through multi-faceted forecast quality assessment and sensitivity experiments
- Development of reliable techniques for attribution of extreme events, analysis of case studies: e.g. 2014 Antarctic sea ice maximum, 2010 heat wave
- Dissemination: Tropical cyclone damages/ **hosting of an operational website for the next hurricane season** gathering predictions from all existing centers

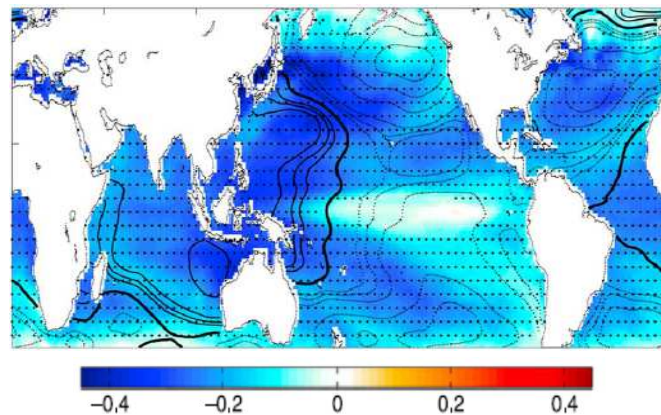
Mean SST anomaly - first forecast year following the Agung (1963), El Chichon (1982) and Pinatubo (1991) eruptions in EC-Earth2.3 decadal hindcasts. Stippling for differences statistically significant at 95% level.



Mean SST anomaly - first forecast year following the Agung (1963), El Chichon (1982) and Pinatubo (1991) eruptions in EC-Earth2.3 decadal hindcasts. Stippling for differences statistically significant at 95% level.

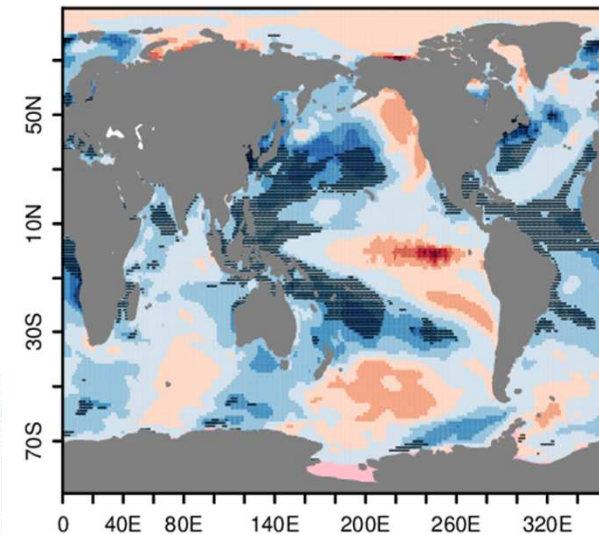


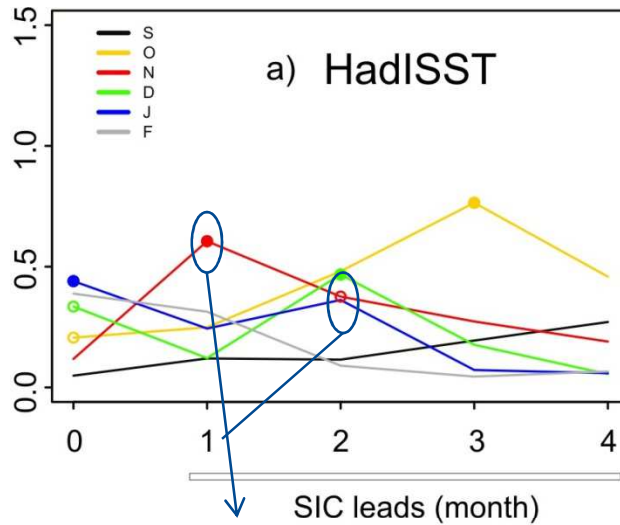
Swingedouw et al.
(2017, Glob.Plain.Change)



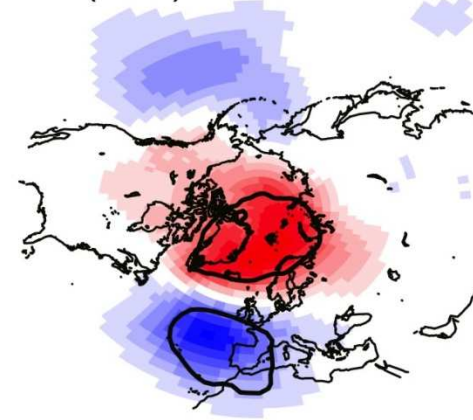
Maher et al. (2015, GRL)

c) Volc-NoVolc

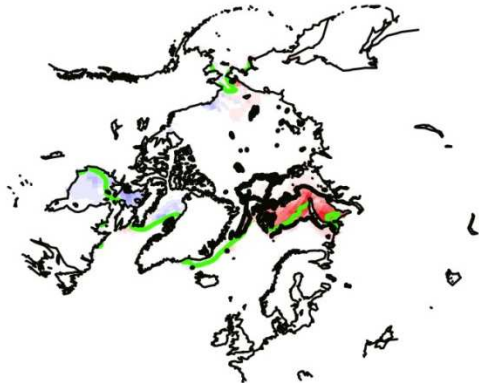




b) SLP (dec) x MCA-SIC/eA_{NOV}

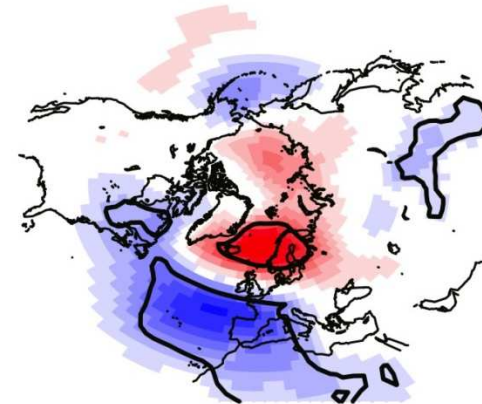


c) MCA-SIC/eA_{NOV} x SIC (nov)



sig.lev.(SC)=6%

d) MCA-SIC/eA_{NOV} x SLP (jan)



Polar/non-polar linkages

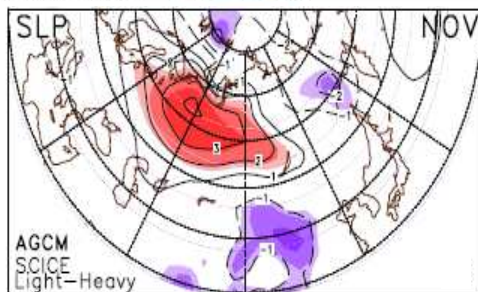
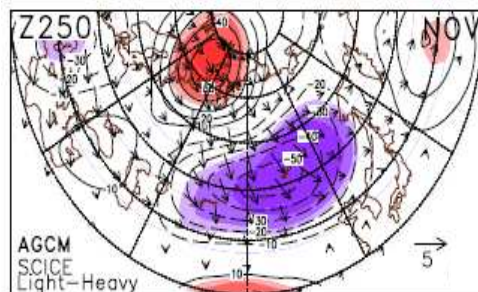
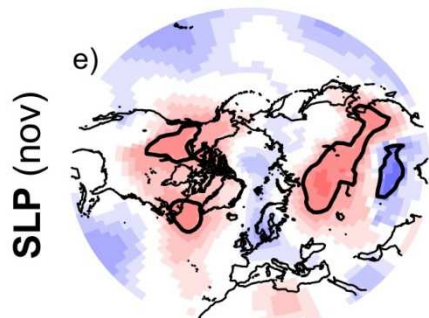
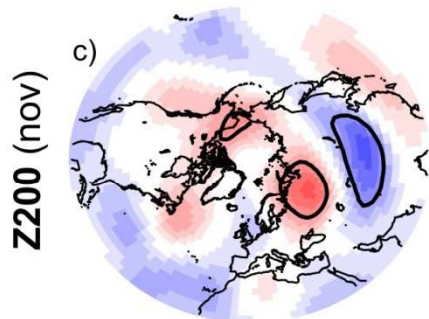
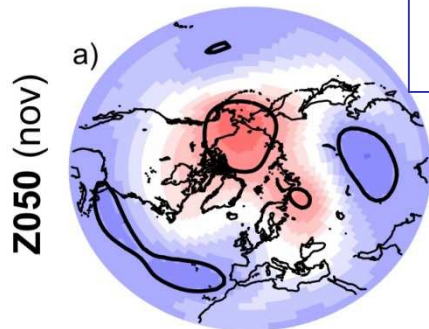


García-Serrano et al. (2015, JCLIM);
similar to Nakamura et al. (2015, JGR);
King et al. (2016, ClimDyn)

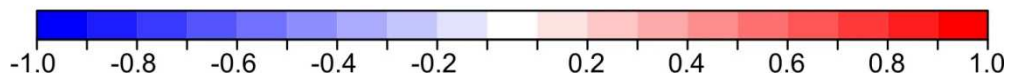


STRATOSPHERIC PATHWAY

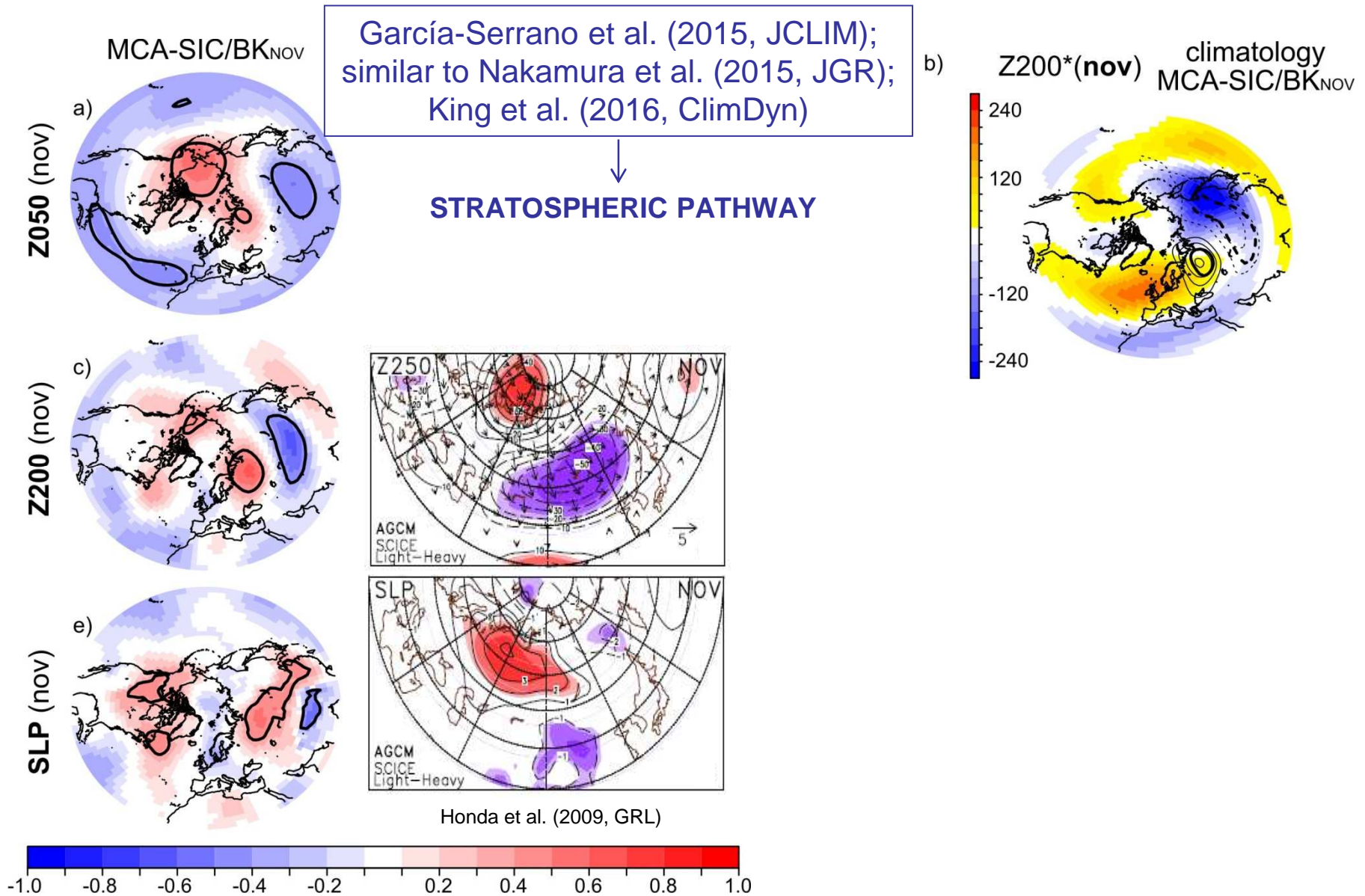
MCA-SIC/BK_{NOV}



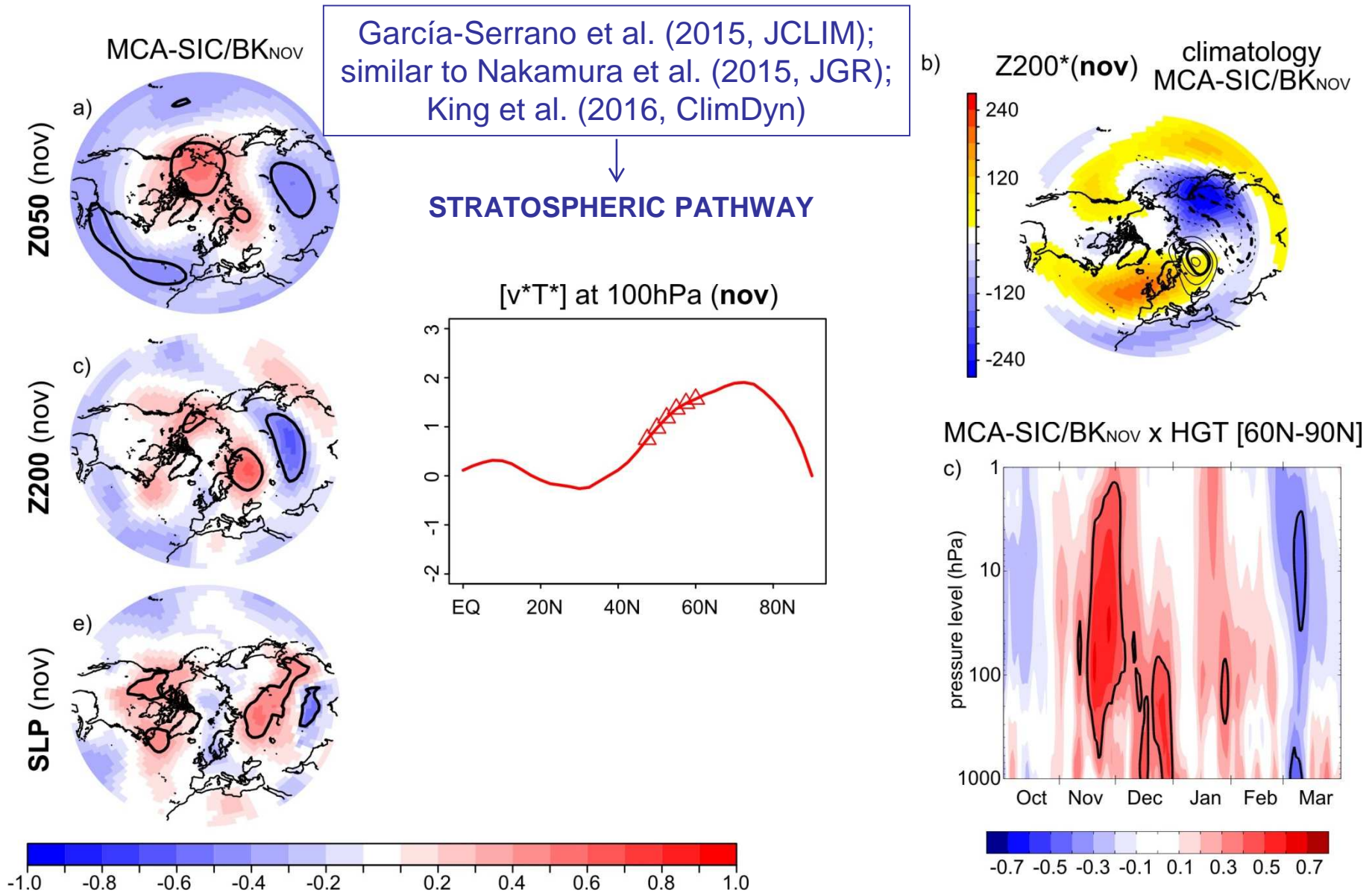
Honda et al. (2009, GRL)

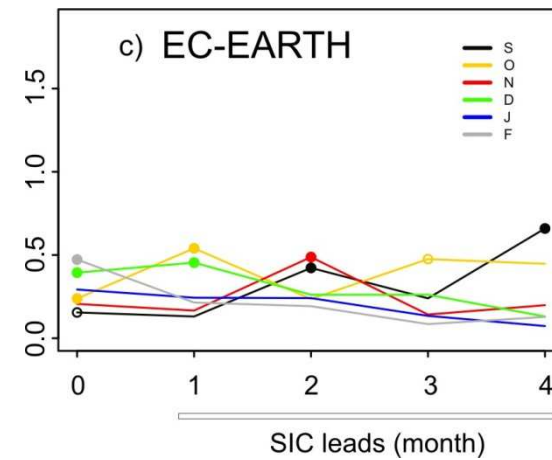


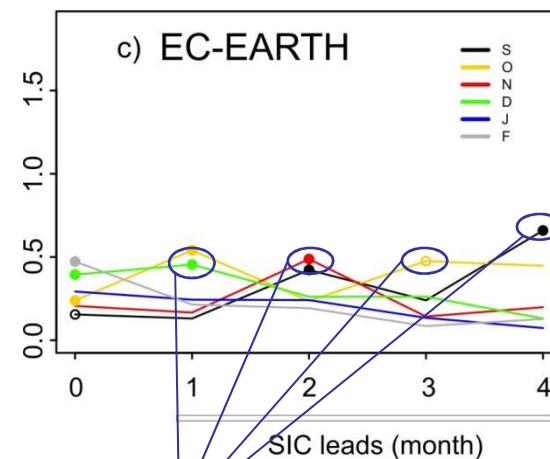
Polar/non-polar linkages



Polar/non-polar linkages



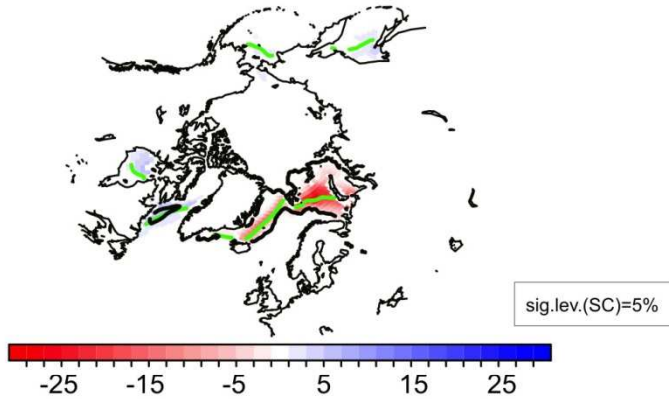




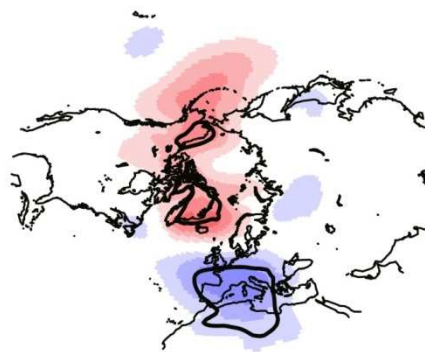
SIC persistence from Sep to Dec;
sig. influence on the atm. – Jan

EC-EARTH

a) $MCA-SIC/eA_{DEC} \times SIC$ (dec)



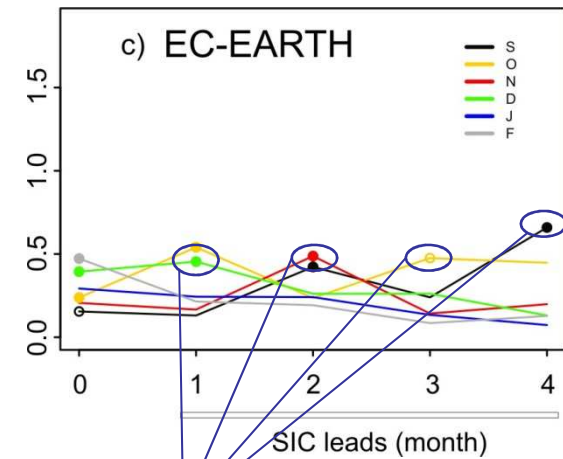
b) $MCA-SIC/eA_{DEC} \times SLP$ (jan)



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c) EC-EARTH



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

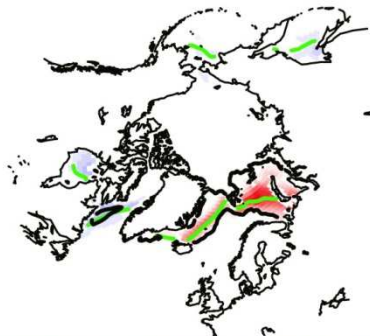
EC-EARTH



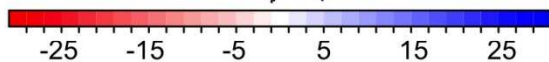
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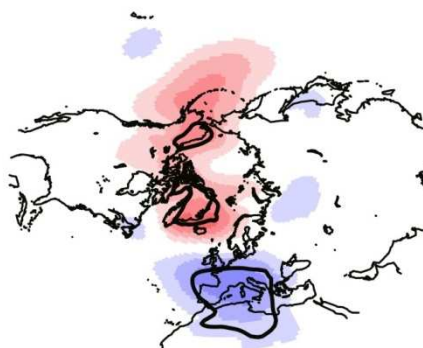
a) $MCA-SIC/eA_{DEC} \times SIC$ (dec)



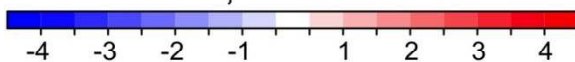
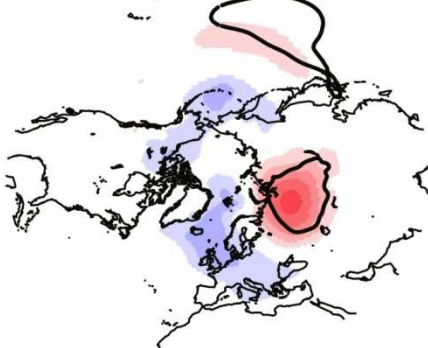
sig.lev.(SC)=5%



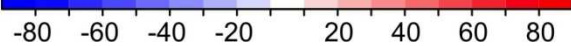
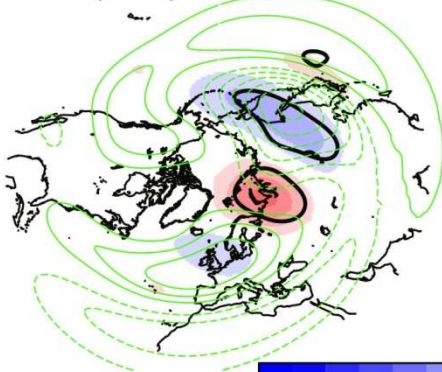
b) $MCA-SIC/eA_{DEC} \times SLP$ (jan)



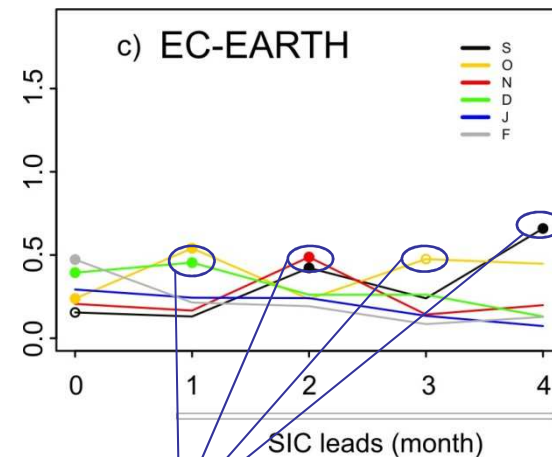
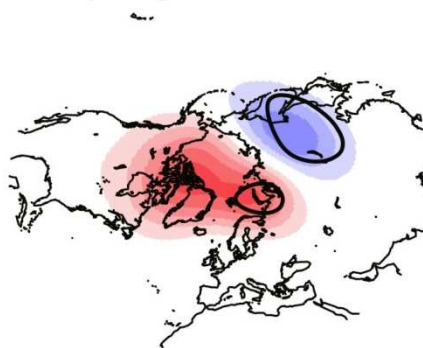
c) SLP (dec) $\times MCA-SIC/eA_{DEC}$



e) $Z200$ (dec) $\times MCA-SIC/eA_{DEC}$



f) $Z050$ (dec) $\times MCA-SIC/eA_{DEC}$



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

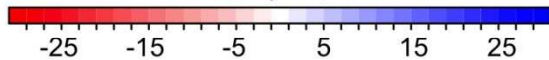
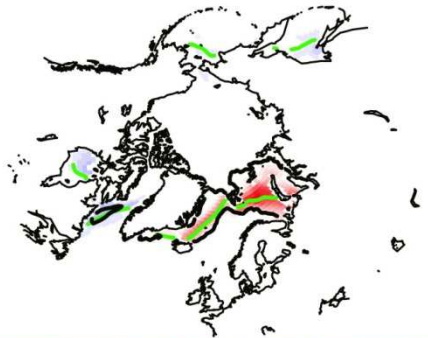
EC-EARTH



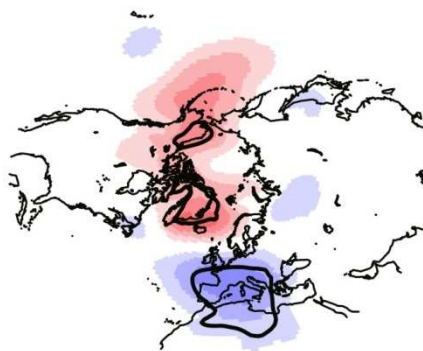
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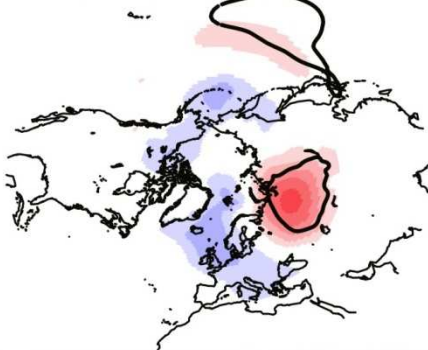
a) $MCA-SIC/eA_{DEC} \times SIC$ (dec)



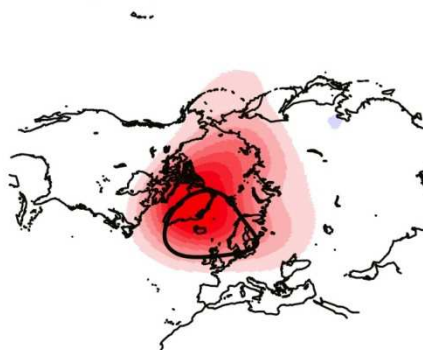
b) $MCA-SIC/eA_{DEC} \times SLP$ (jan)



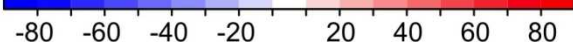
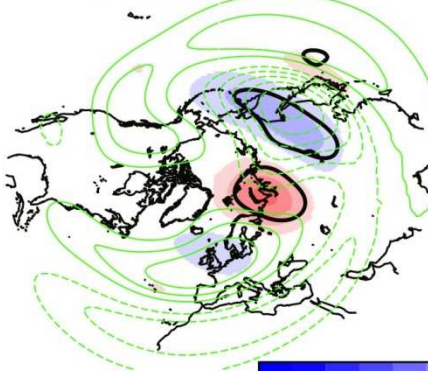
c) SLP (dec) $\times MCA-SIC/eA_{DEC}$



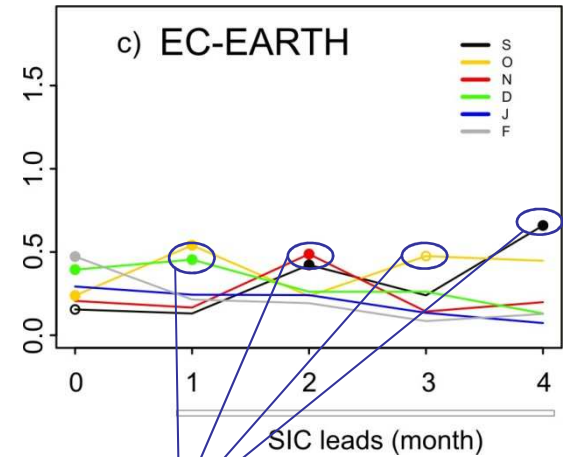
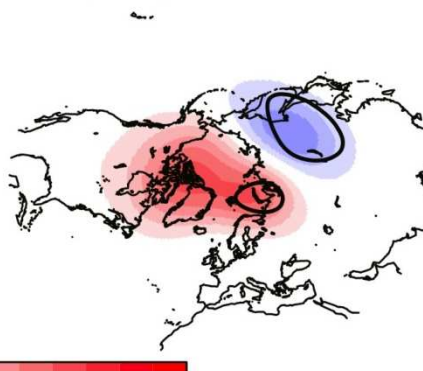
d) $Z050$ (jan) $\times MCA-SIC/eA_{DEC}$



e) $Z200$ (dec) $\times MCA-SIC/eA_{DEC}$



f) $Z050$ (dec) $\times MCA-SIC/eA_{DEC}$



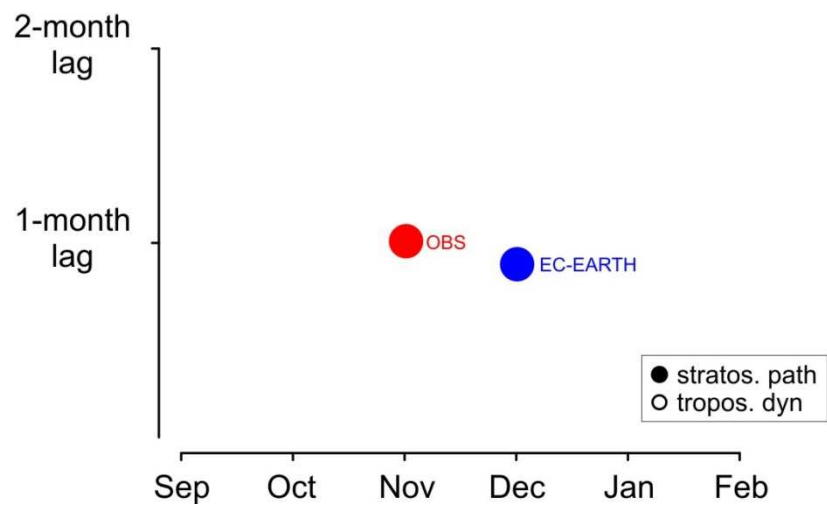
SIC persistence from Sep to Dec;
sig. influence on the atm. – Jan

Polar/non-polar linkages

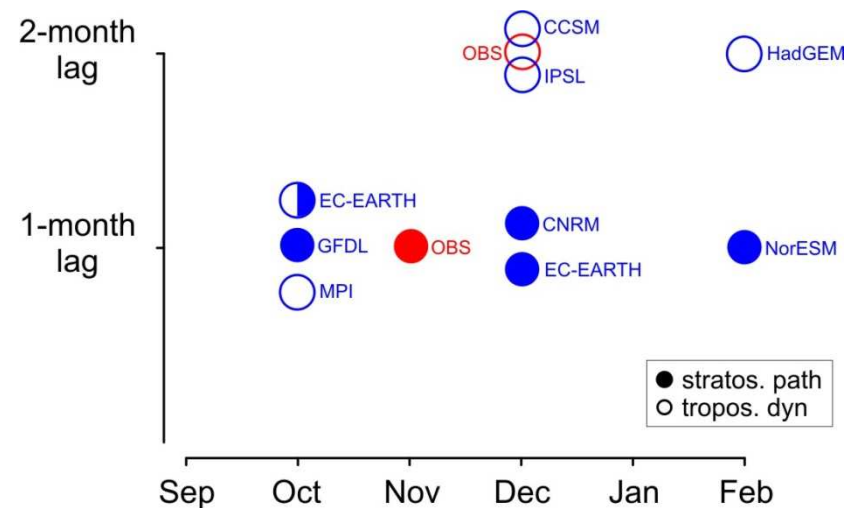


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- CMIP5 models analysed show a significant link with sea-ice reduction over the eastern Arctic (Greenland-Barents-Kara Seas) followed by a negative NAO-like pattern
- If the simulated relationship takes *one month* – the results suggest (in general) 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



Impact of high resolution (DJF)



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Hres T511/ORCA0.25

Ires T255/ORCA0.25

Sres T255/ORCA1.0

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Hres T511/ORCA0.25

Ires T255/ORCA0.25

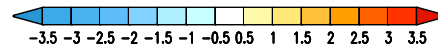
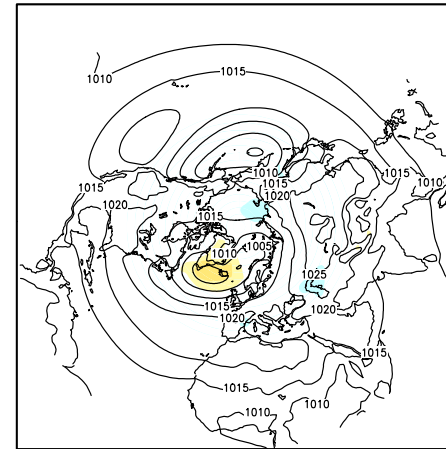
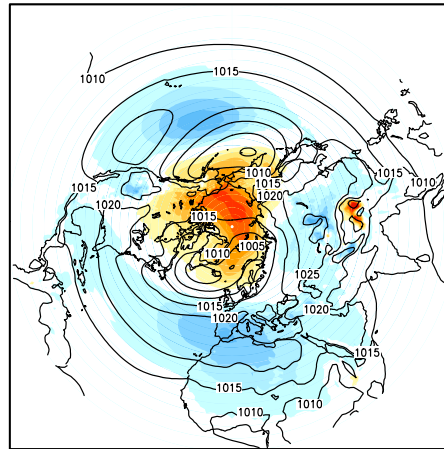
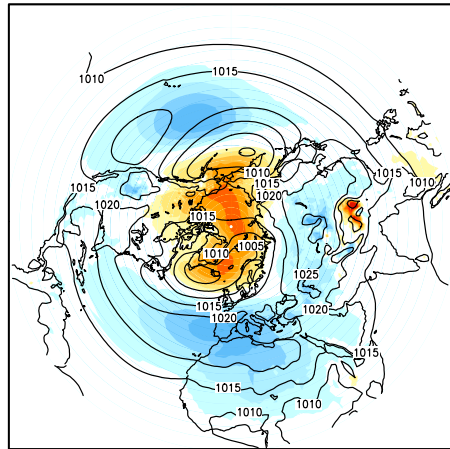
Sres T255/ORCA1.0

Hres - Sres

Hres - Ires (atm)

Ires - Sres (ocn)

clim
SLP



Impact of high resolution (DJF)



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Hres T511/ORCA0.25

Ires T255/ORCA0.25

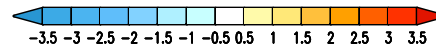
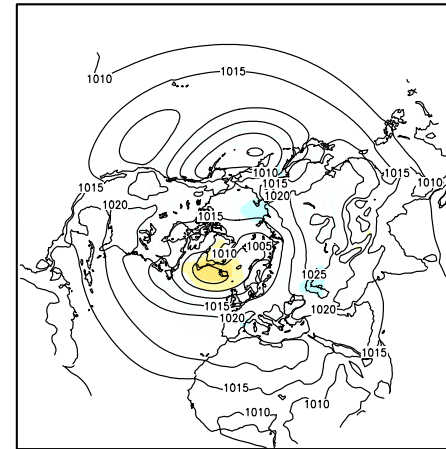
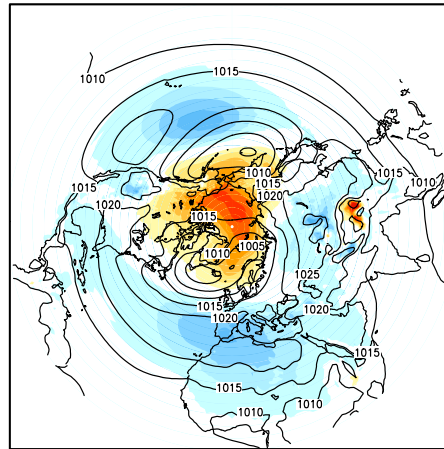
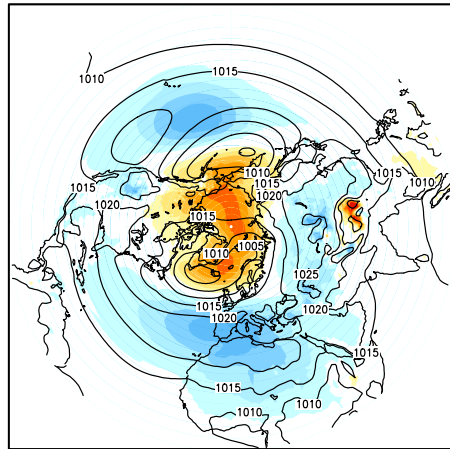
Sres T255/ORCA1.0

Hres - Sres

Hres - Ires (atm)

Ires - Sres (ocn)

clim
SLP

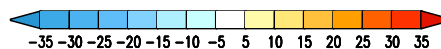
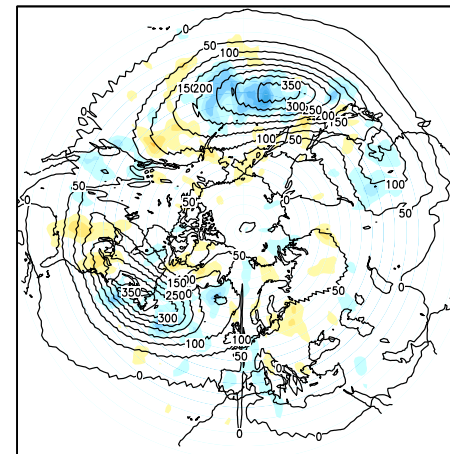
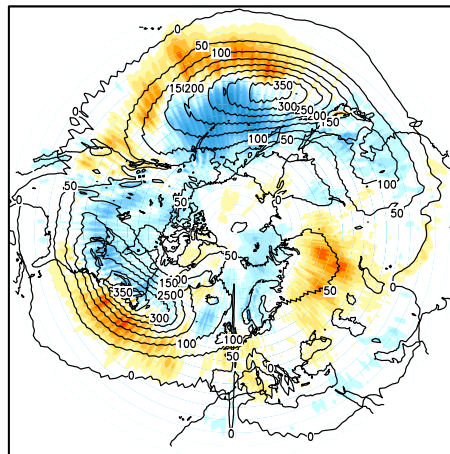
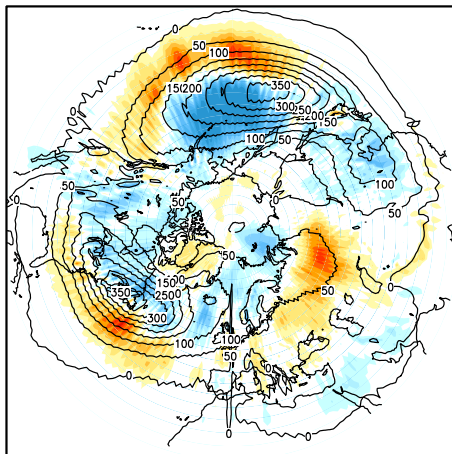


Hres - Sres

Hres - Ires (atm)

Ires - Sres (ocn)

clim
v'T'500



Impact of high resolution (DJF)



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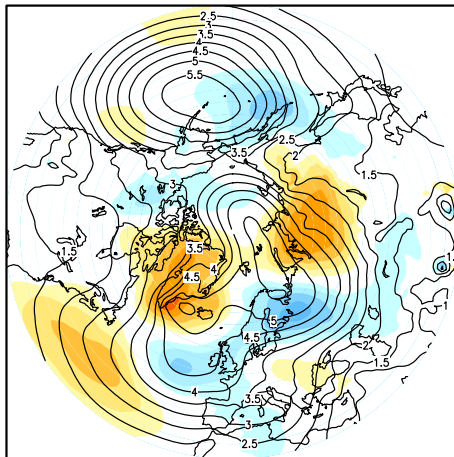
Hres T511/ORCA0.25

Ires T255/ORCA0.25

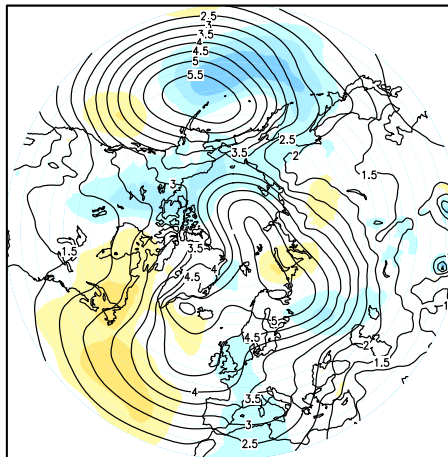
Sres T255/ORCA1.0

st.dev.
SLP

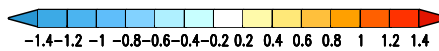
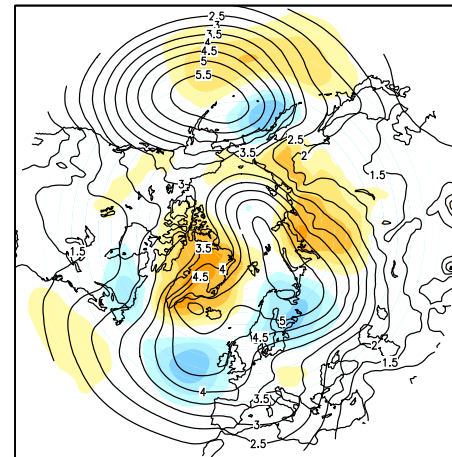
Hres - Sres



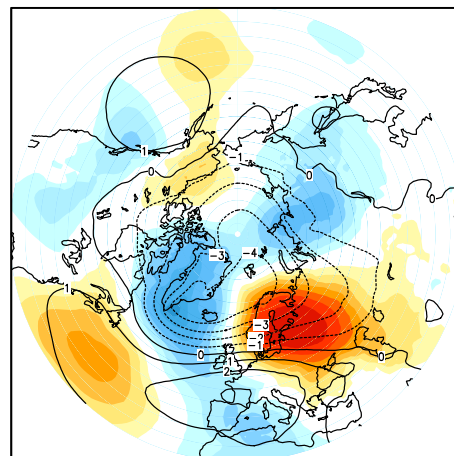
Hres - Ires (atm)



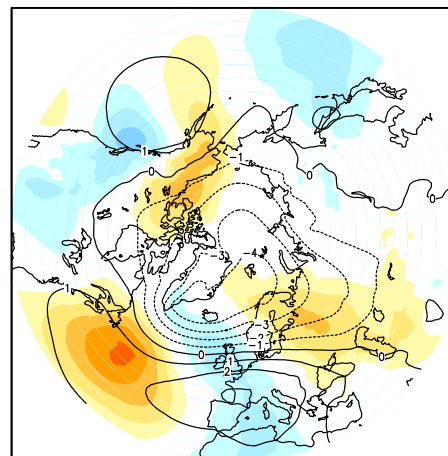
Ires - Sres (ocn)



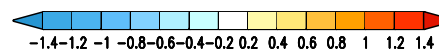
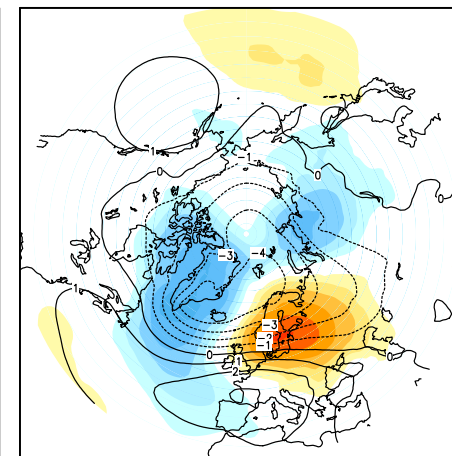
Hres - Sres



Hres - Ires (atm)



Ires - Sres (ocn)



Impact of high resolution (DJF)



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Hres T511/ORCA0.25

Ires T255/ORCA0.25

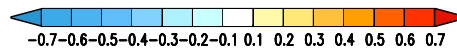
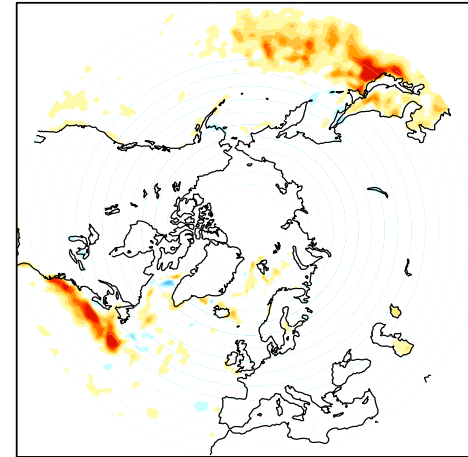
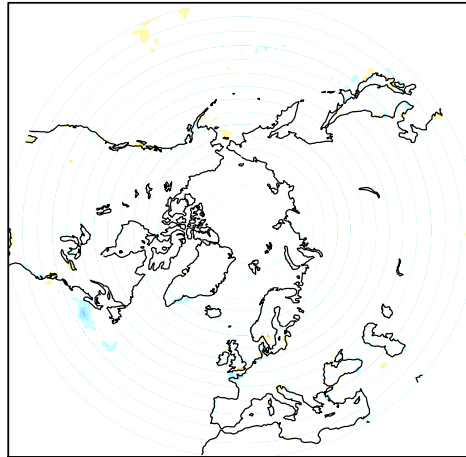
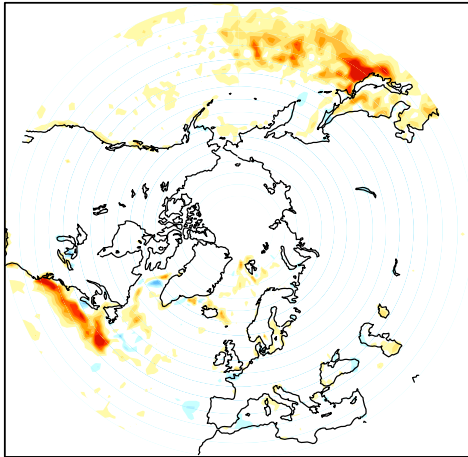
Sres T255/ORCA1.0

Hres - Sres

Hres - Ires (atm)

Ires - Sres (ocn)

st.dev.
SST

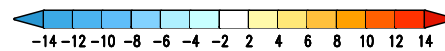
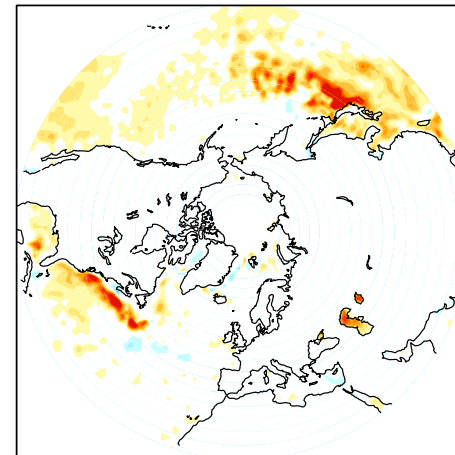
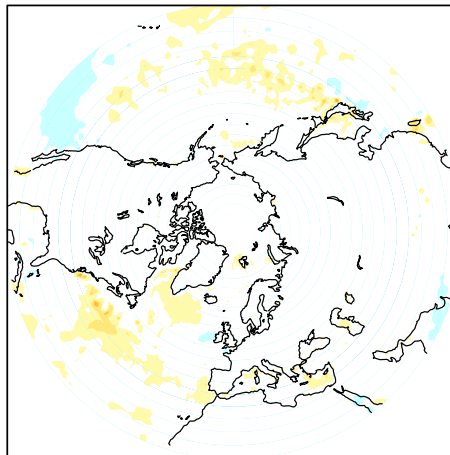
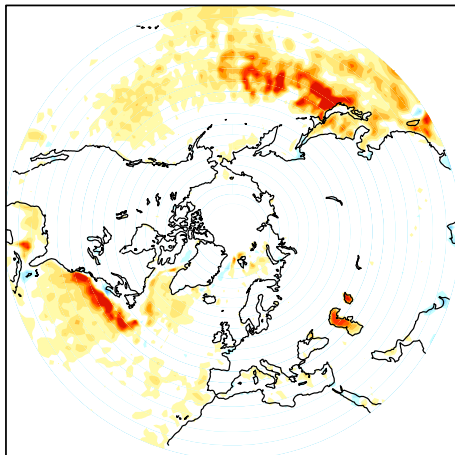


Hres - Sres

Hres - Ires (atm)

Ires - Sres (ocn)

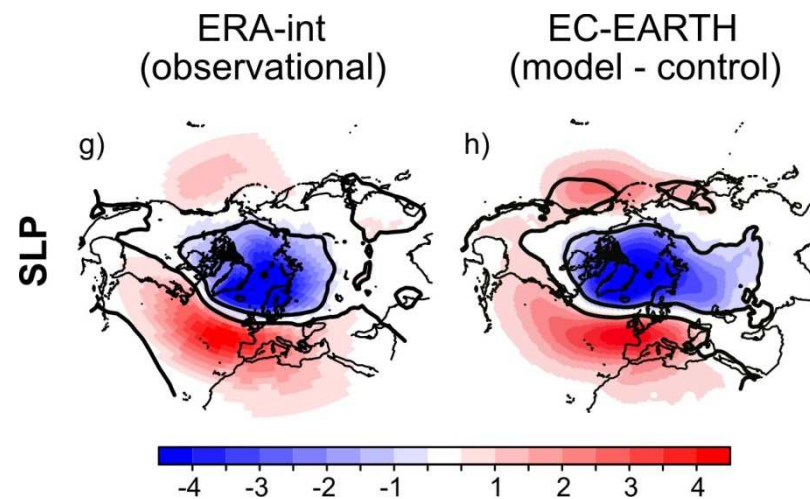
st.dev.
THF



NAO dynamics + nudging



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NAO dynamics + nudging

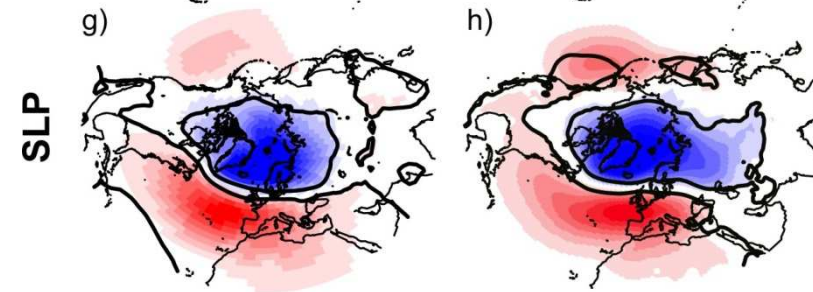


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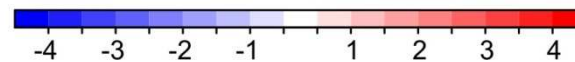
ERA-int
(observational)

EC-EARTH
(model - control)



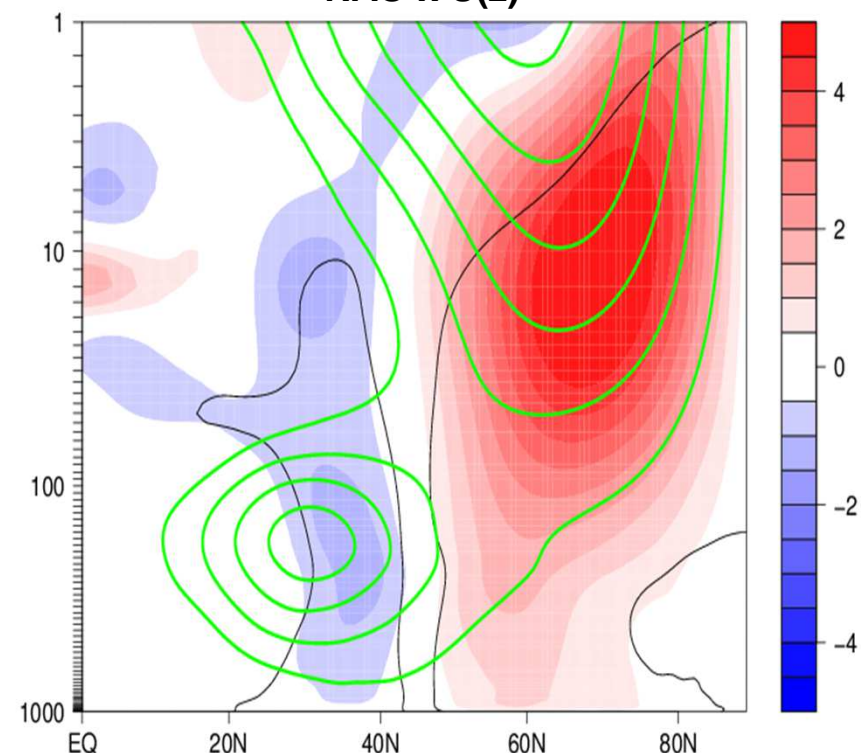
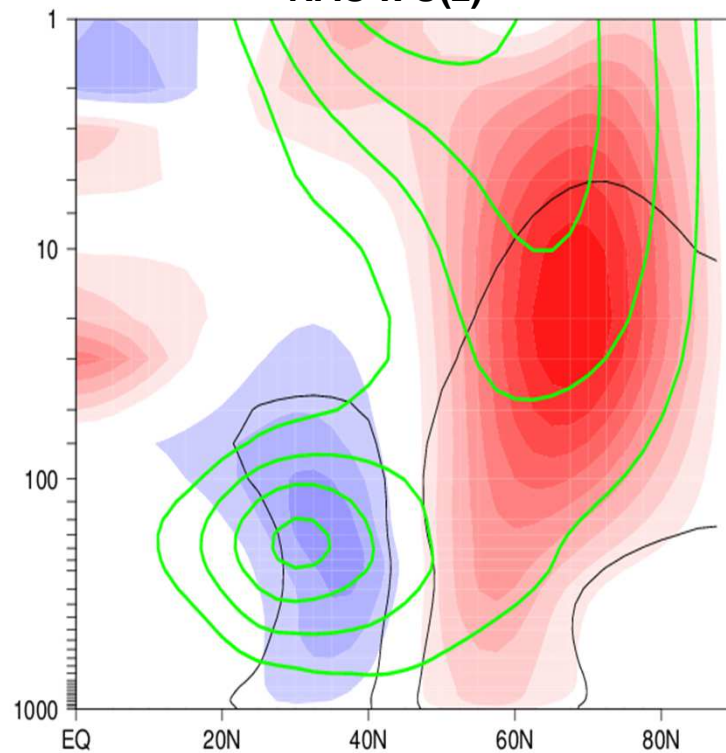
ERA-int

EC-EARTH



NAO x U(z)

NAO x U(z)



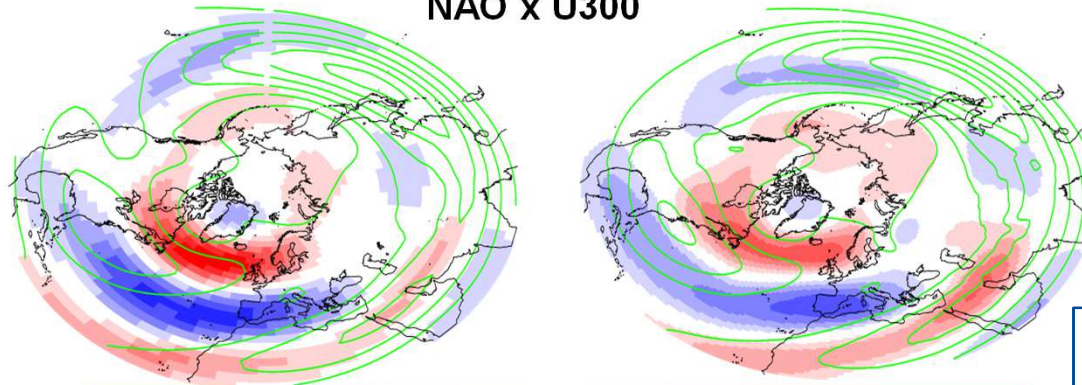
NAO dynamics + nudging



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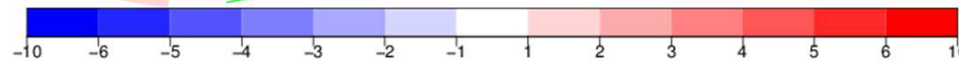


NAO x U300

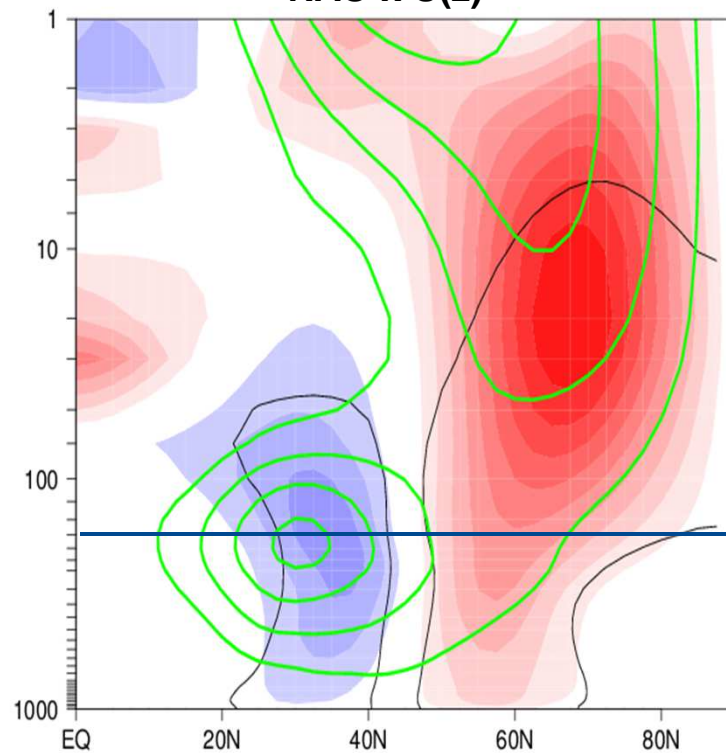


ERA-int

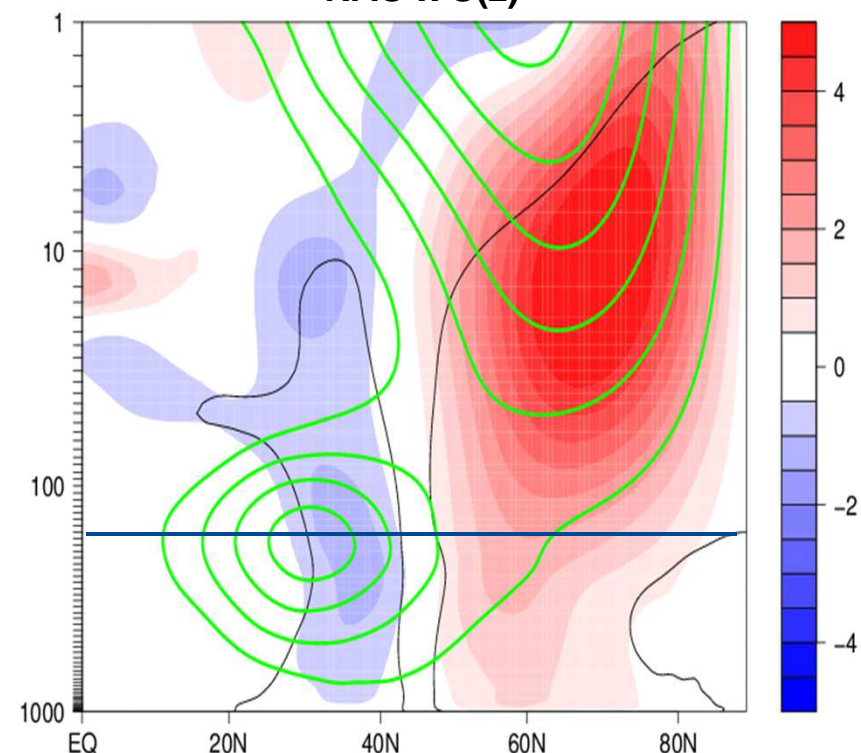
EC-EARTH



NAO x U(z)



NAO x U(z)



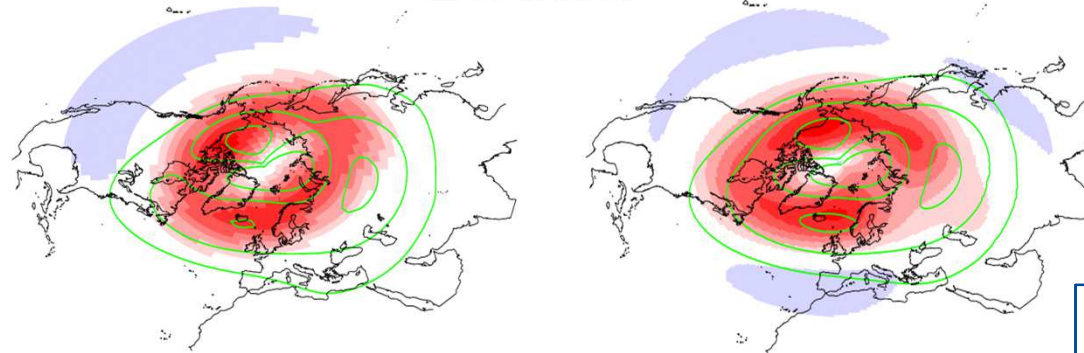
NAO dynamics + nudging



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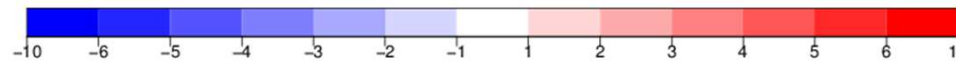


NAO x U30

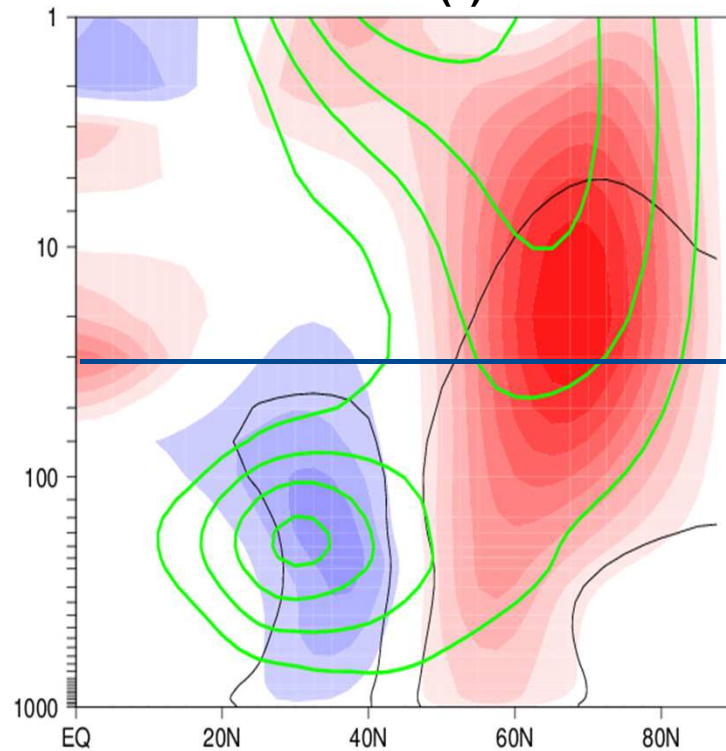


ERA-int

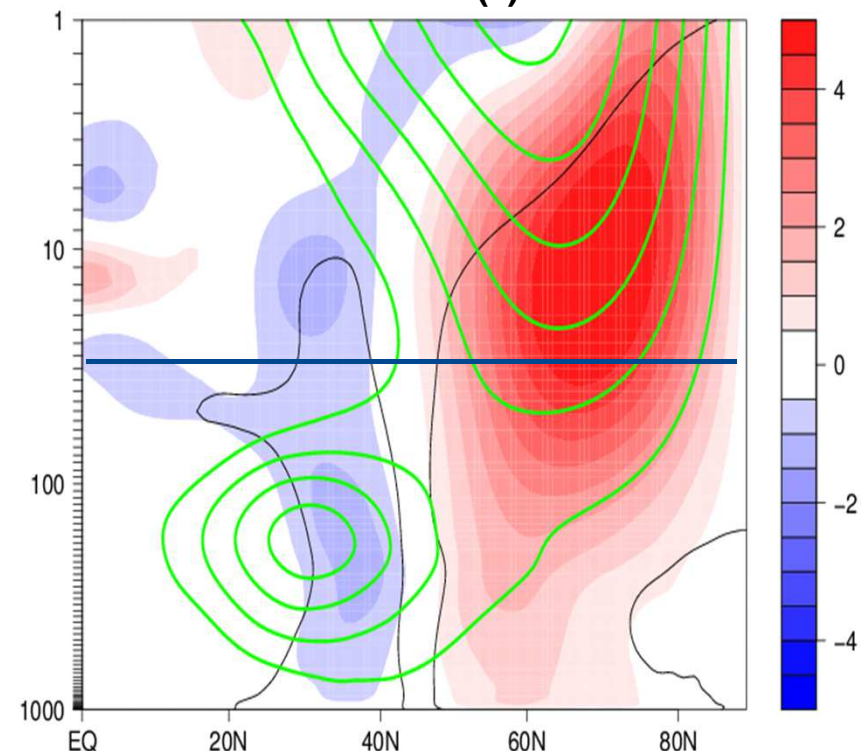
EC-EARTH



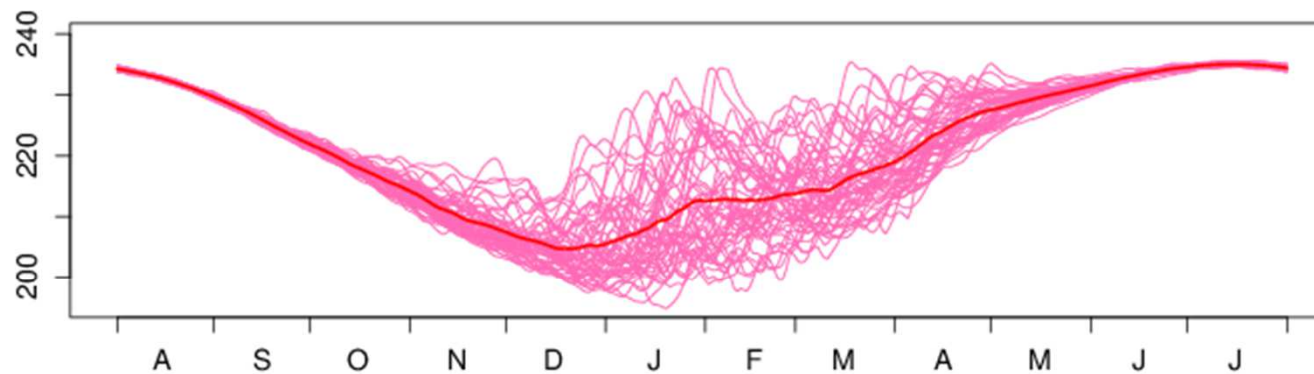
NAO x U(z)



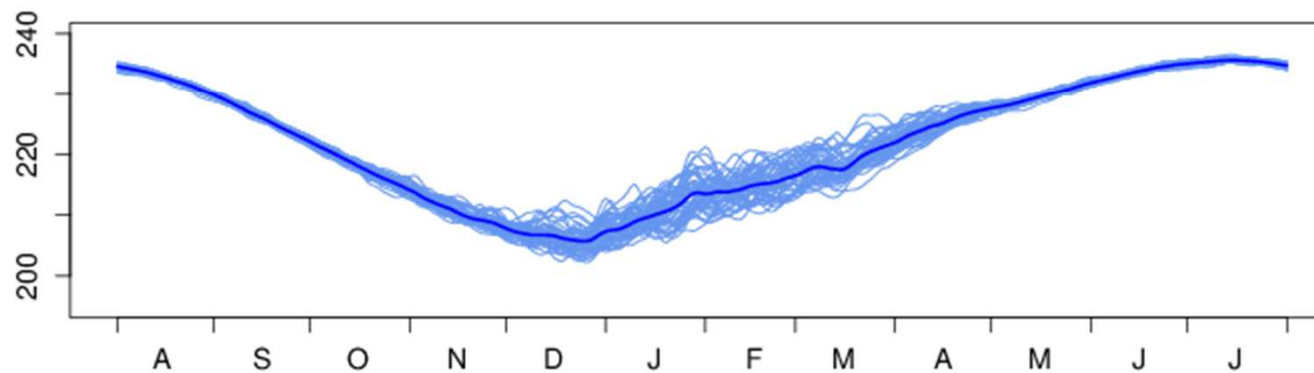
NAO x U(z)



{T@60N-90N}30hPa FREE RUN



{T@60N-90N}30hPa NUDGED RUN





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EXTRA SLIDES

- NEMO2: ORCA1 L46
- IFS [cy31r1]: T159 L62 (top 5hPa)
- LIM2: single ice category
- H-TESEL – land-surface processes
- OASIS3 – coupler



initial conditions

atmosphere
reanalysis
(ERA-Interim)

ice
reanalysis
(IC3/BSC)

land reanalysis
(ERA-Land)

ocean reanalysis
(e.g. ORAS4)

EC-EARTH coupled model

