Regional-scale attribution of the early 2000s Eurasian cooling

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PRIMAVERA GA4 – WP5
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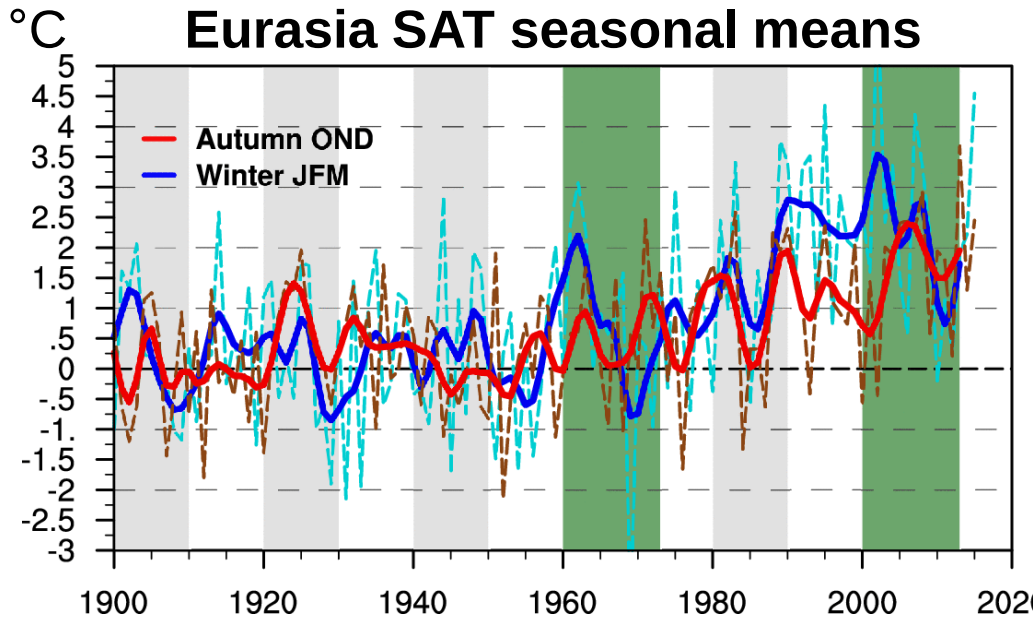


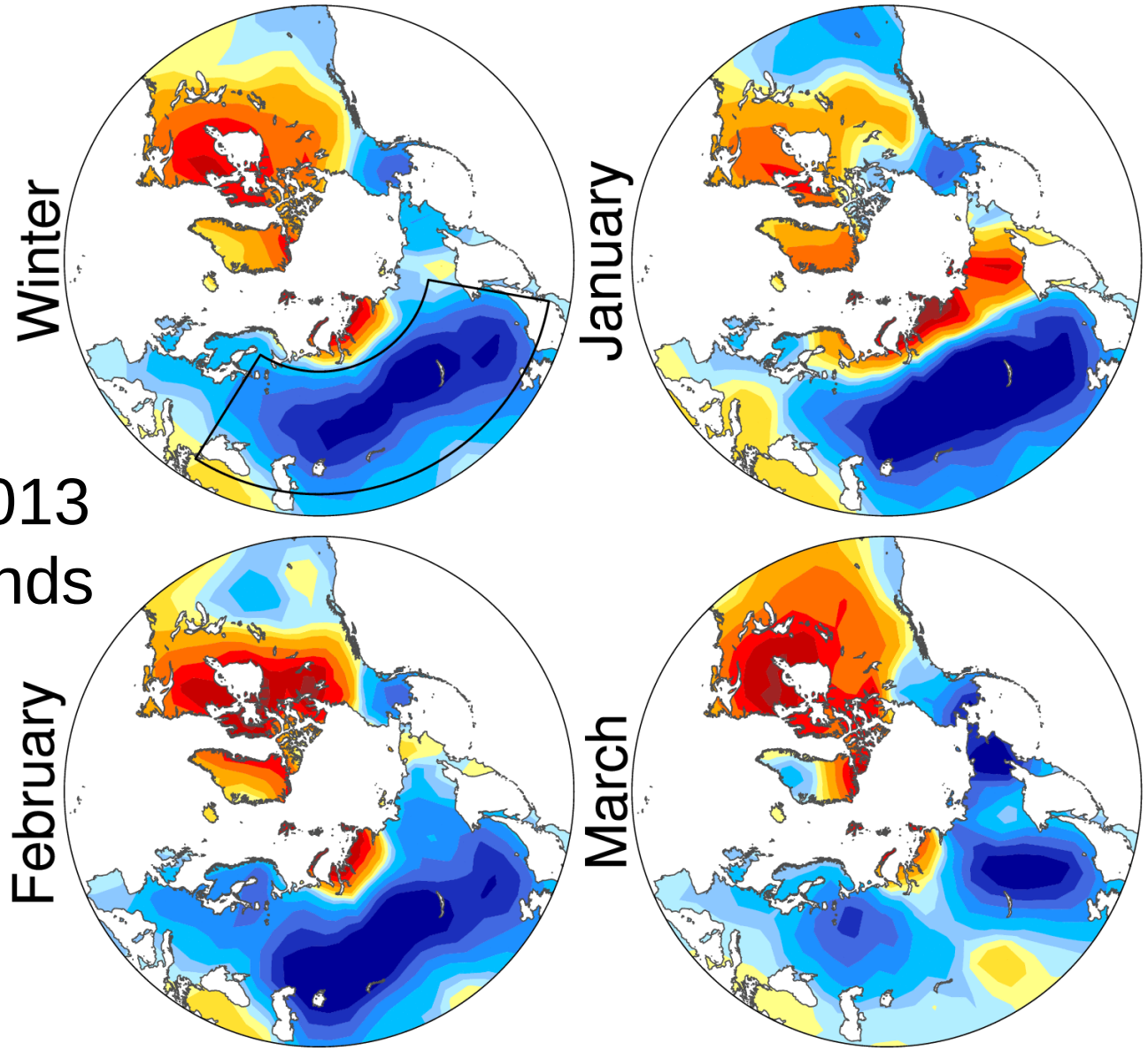
Cowtan & Way 2014

CERFACS

Co-funded by
the European Union

PRIMAVERA

Seasonality: winter as JFM



2002-2013
SAT trends

Attribution of the Eurasian cooling

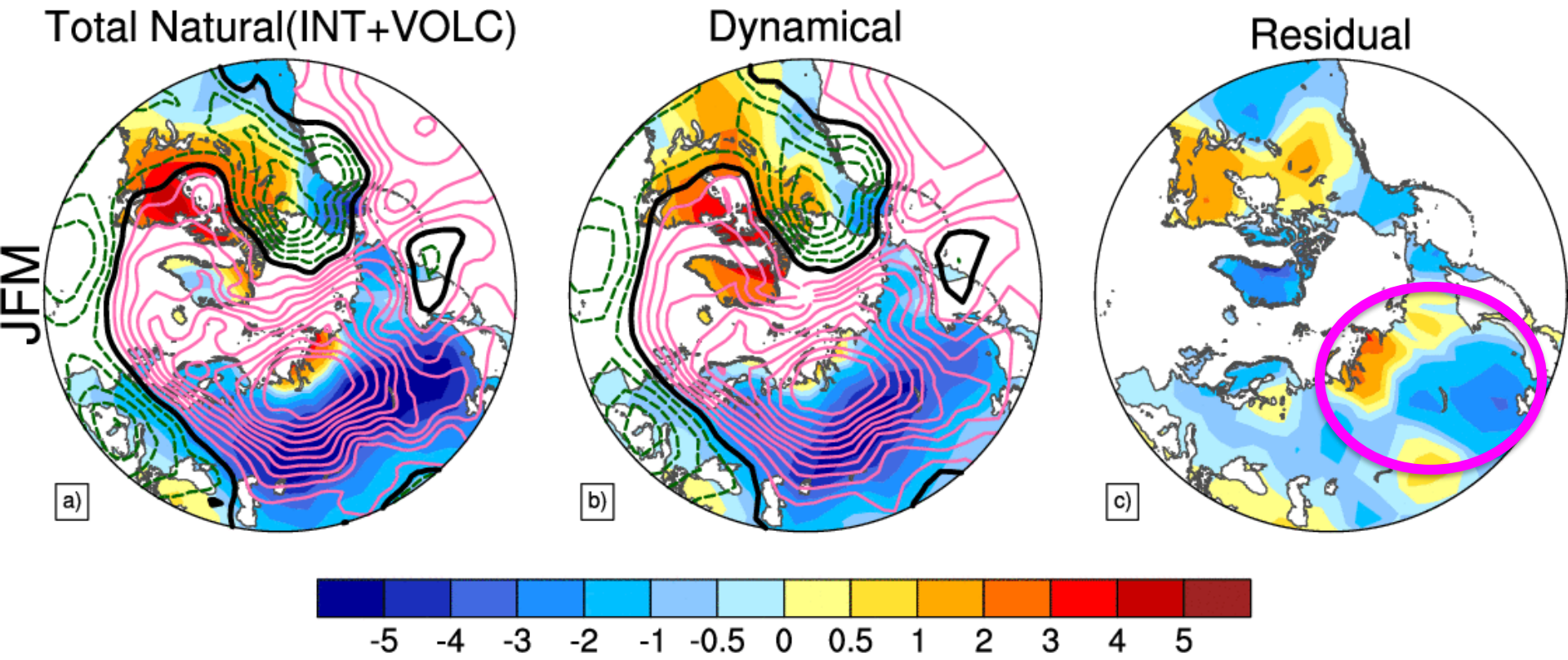
$\Rightarrow$ Use observations and data-driven methods to assess ANT versus NAT (*INT* + *Ext.NAT*)

$\Rightarrow$ Use dynamical adjustment to extract from NAT the purely circulation-related part

$\Rightarrow$ Use different sets of model experiments to test impact of potential local or remote drivers

Extract dynamical response (analog method)

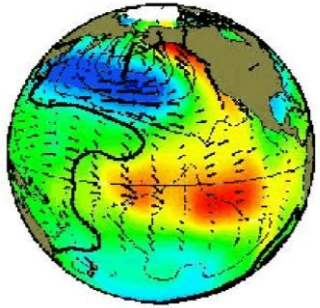
2002-2013 Winter SAT & SLP trends



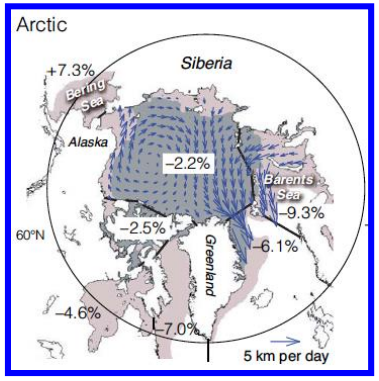
SAT: Deg. K / 12 years
SLP: 1 hPa / 12 years

Causal factors of circulation changes ?

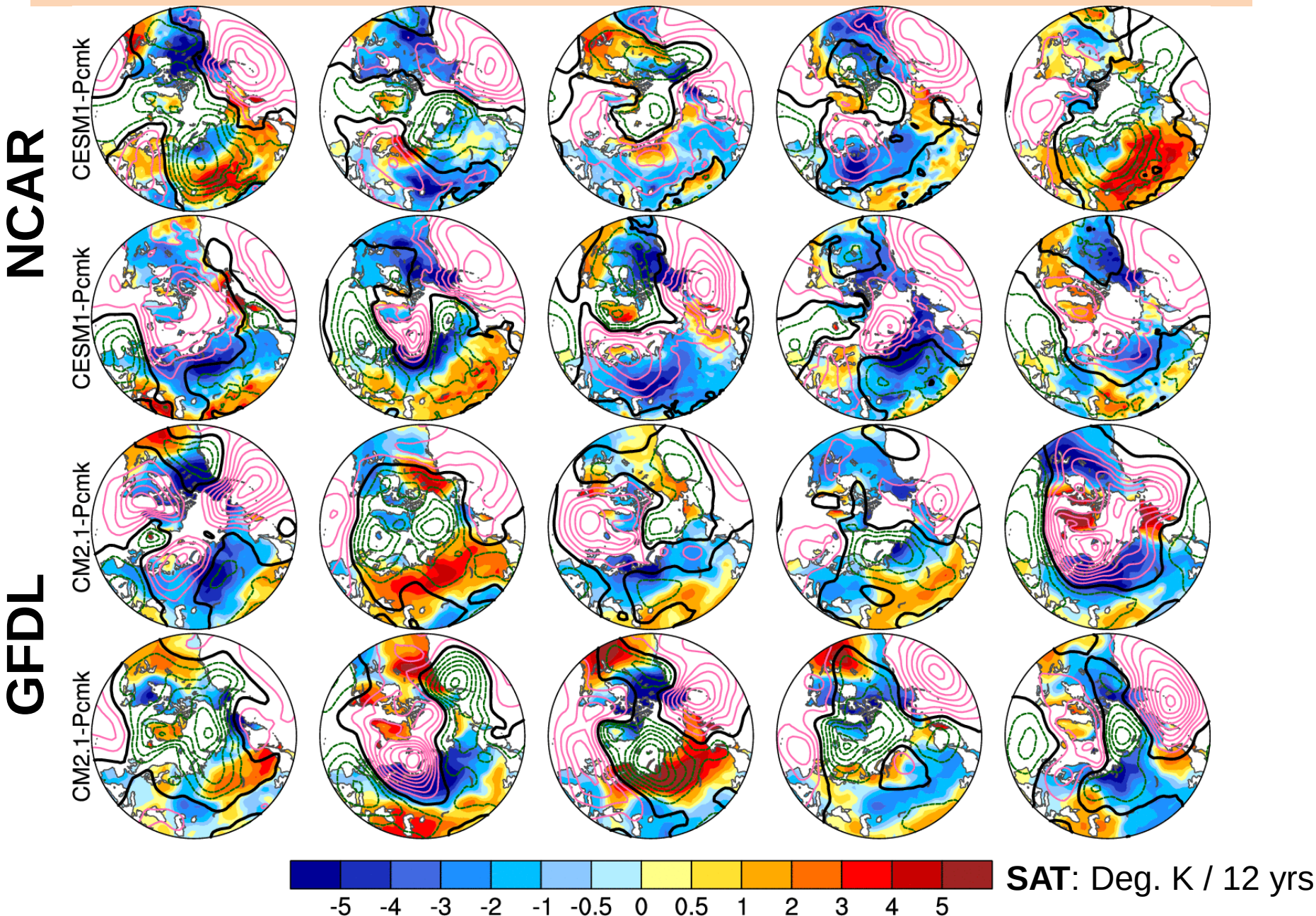
- Null hypothesis: internal atmospheric variability
- Tropical Pacific ?



- Arctic sea-ice ?

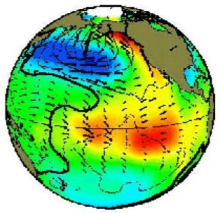


Tropical Pacific influence: Pacemaker runs

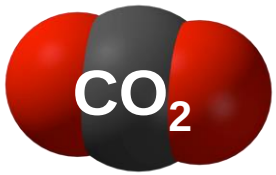


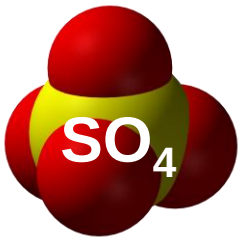
Tropical Pacific influence: Pacemaker runs

TPAC

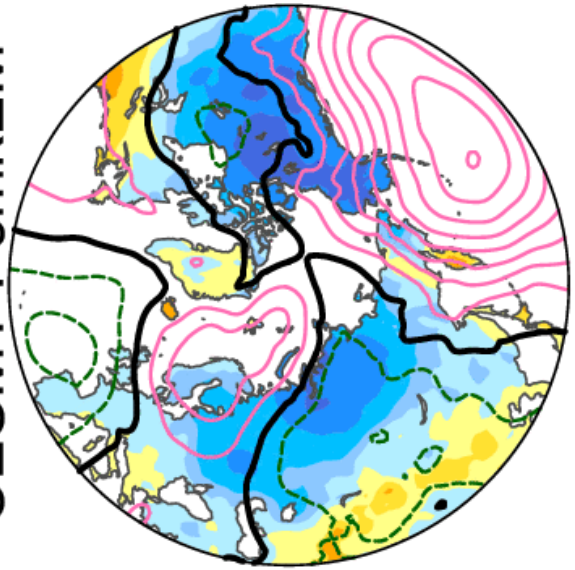


ANT

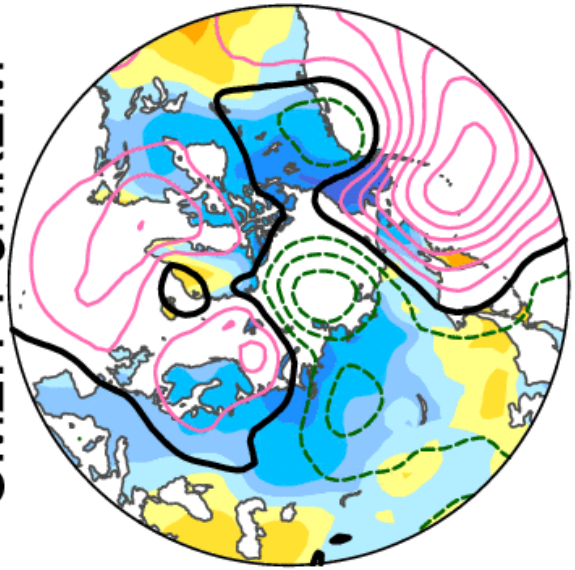




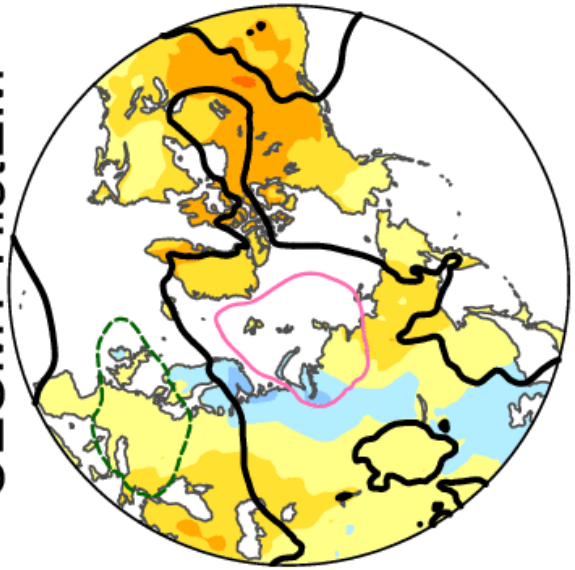
CESM1-PcmkEM



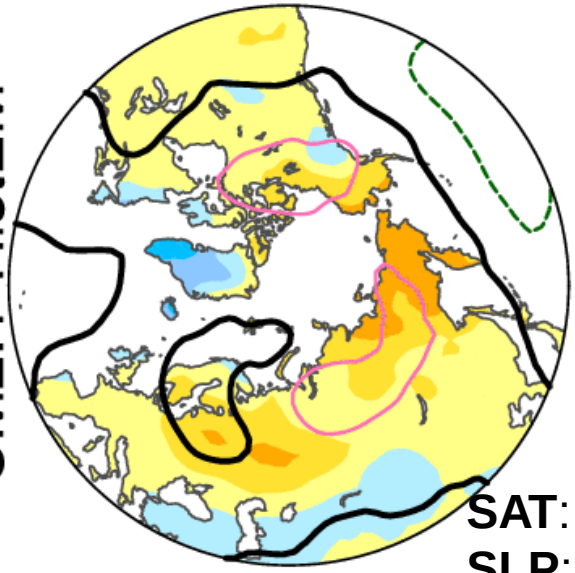
CM2.1-PcmkEM



CESM1-HistEM



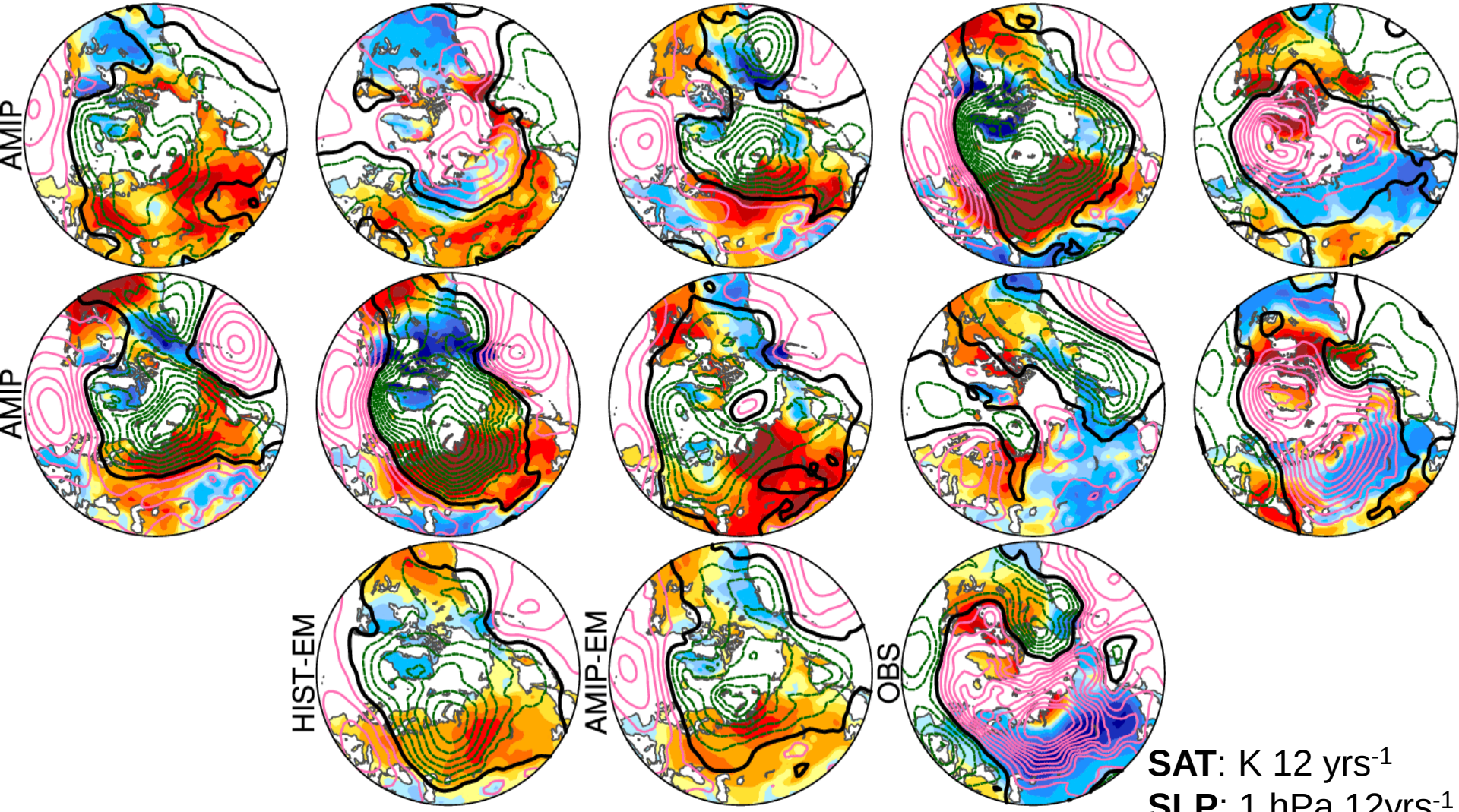
CM2.1-HistEM



SAT: Deg. K / 12 yrs
SLP: 1 hPa 12yrs^{-1}

Arctic sea ice influence: AMIP & HIST

Winter (JFM) SAT and SLP trends in CNRM-CM6-1-LR runs

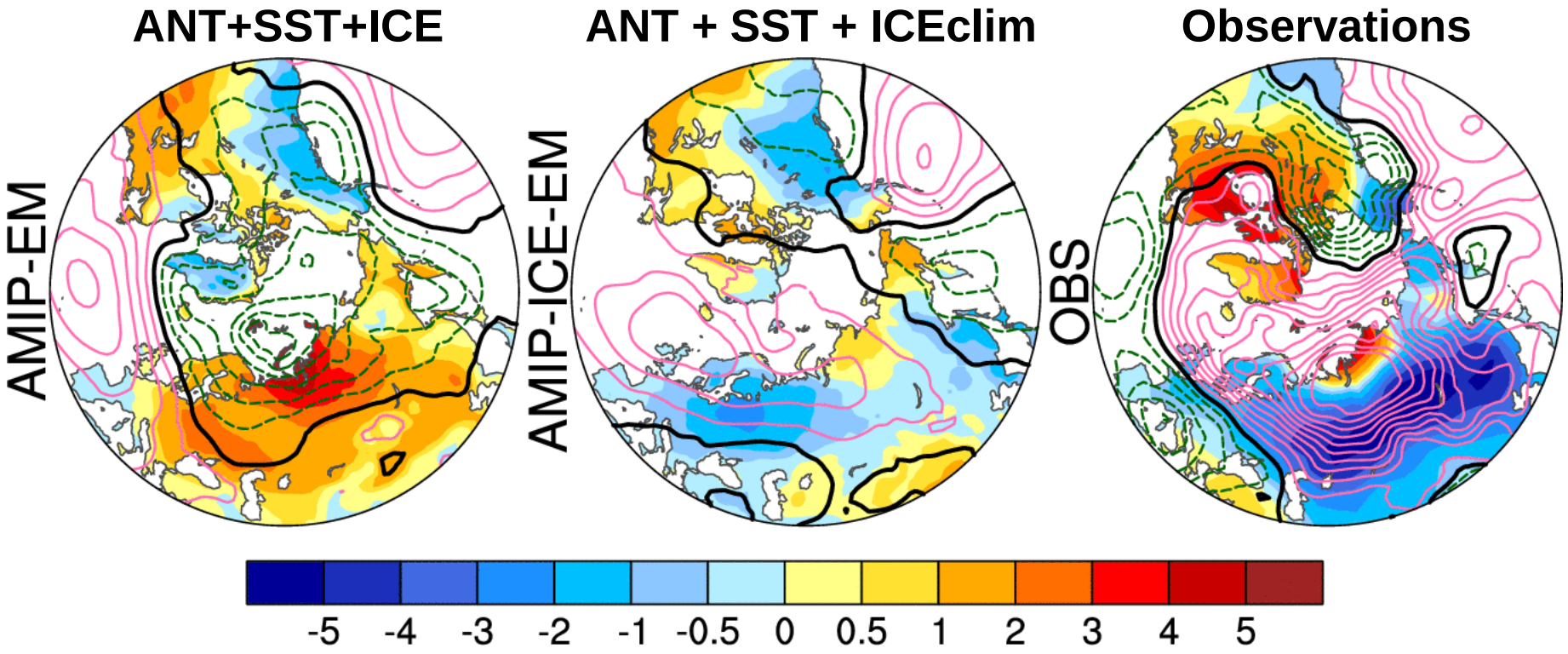


SAT: K 12 yrs^{-1}

SLP: 1 hPa 12yrs^{-1}

Arctic sea ice influence: WP5-6 AMIP

Winter (JFM) SAT and SLP trends in AMIP, AMIP-ICE and OBS



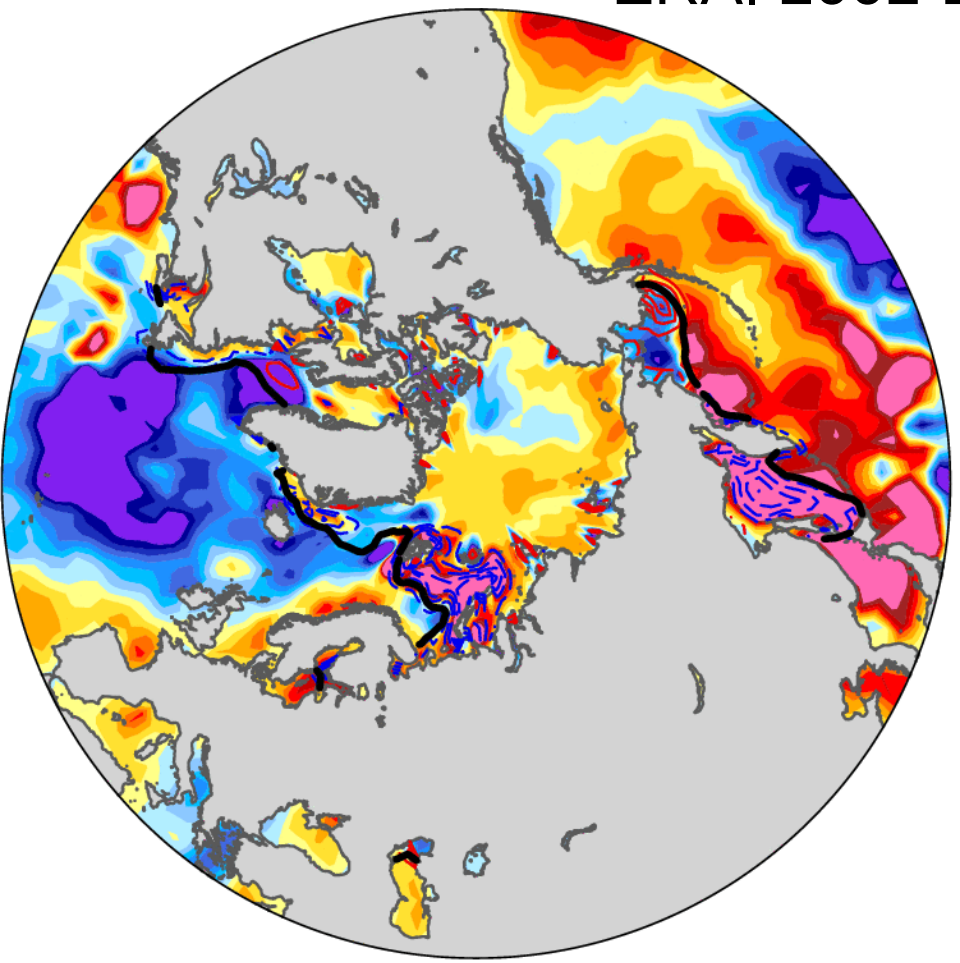
SAT: Deg. K / 12 years
SLP: 1 hPa / 12 years

Summary

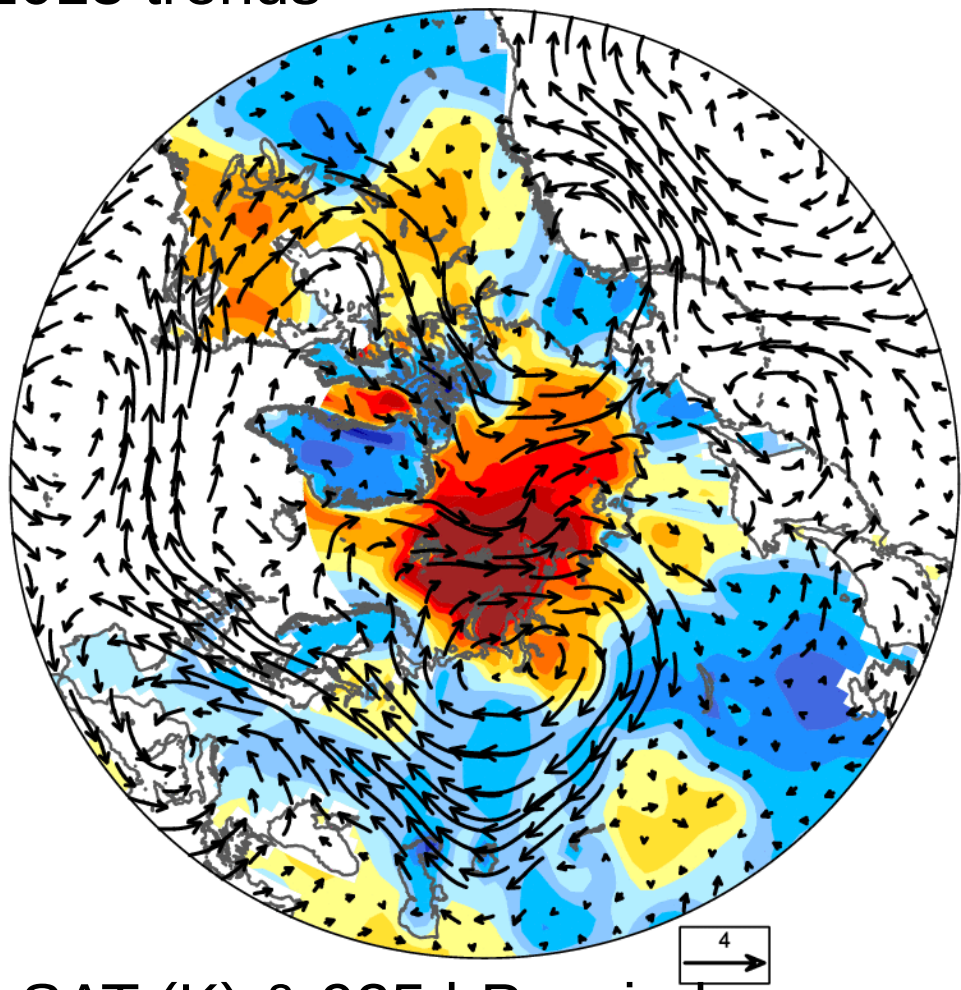
- Early 2000s Eurasian cooling mostly due to internal atmospheric variability
- Strengthening and westward shift of the Siberian High blocked mild westerly flow and induced inflow of cold Arctic air
- Small contribution from tropical Pacific forcing related to a negative IPV trend during 2002-2013
- Barents-Kara sea-ice decline responsible for the coastal Arctic warming residual pattern
- Possible small impact of post-2005 volcanic eruptions

Origin of residual SAT

ERAI 2002-2013 trends

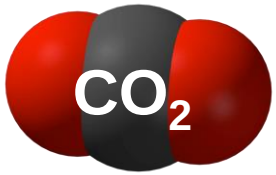


Turb. Heat Flux W.m^{-2} & SIC

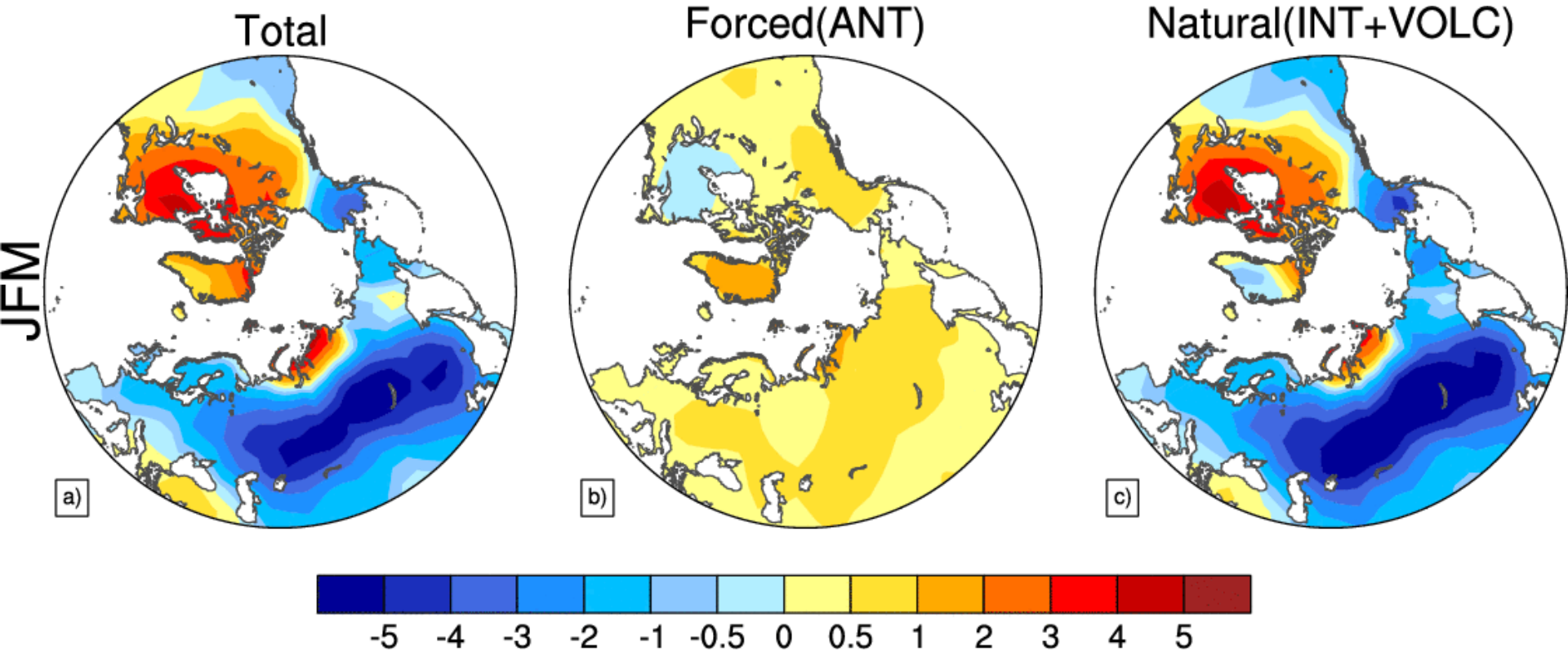


SAT (K) & 925 hPa winds

SAT Anthropogenic forced response



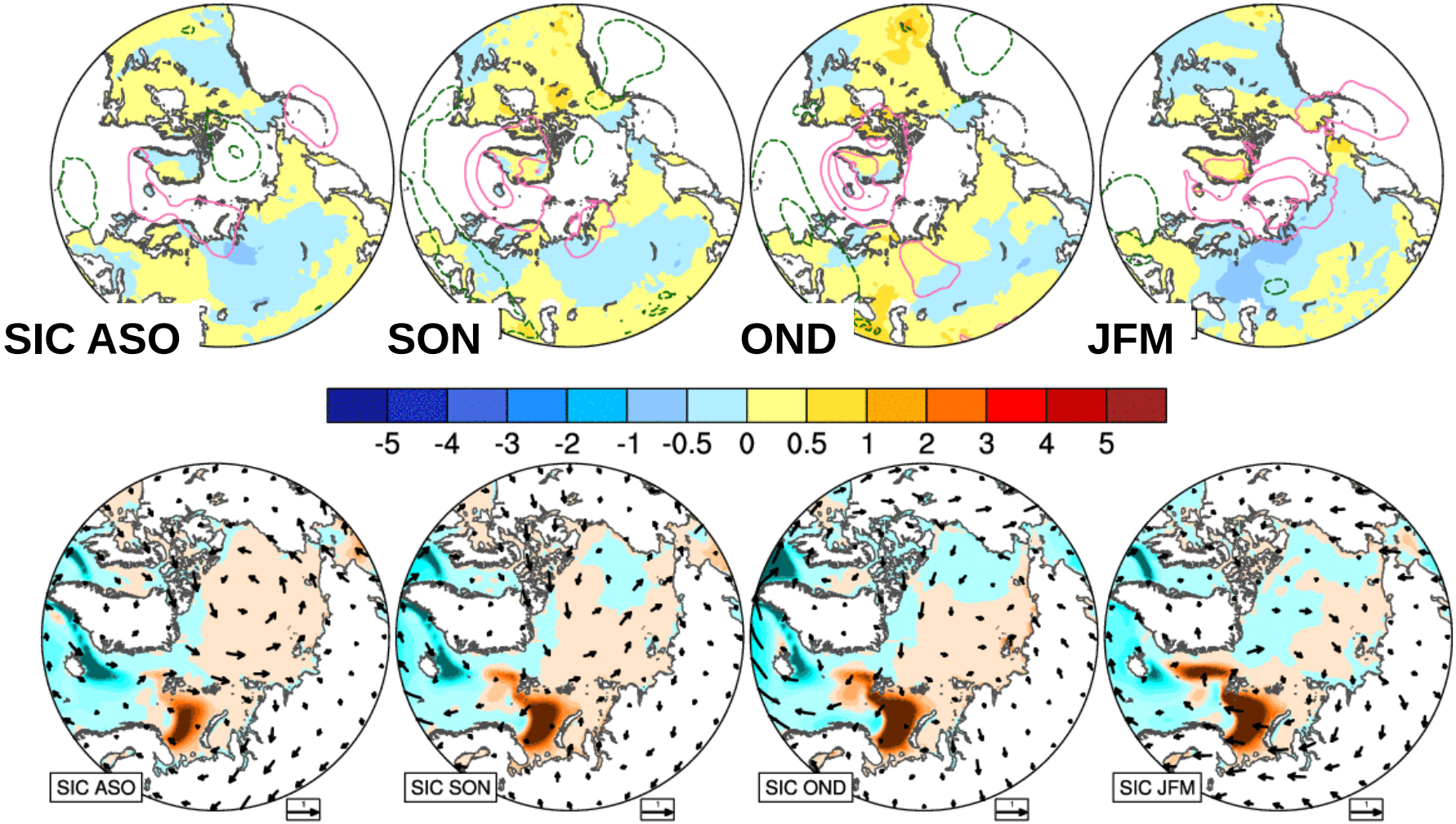
2002-2013 SAT trend



SAT: Deg. K / 12 years

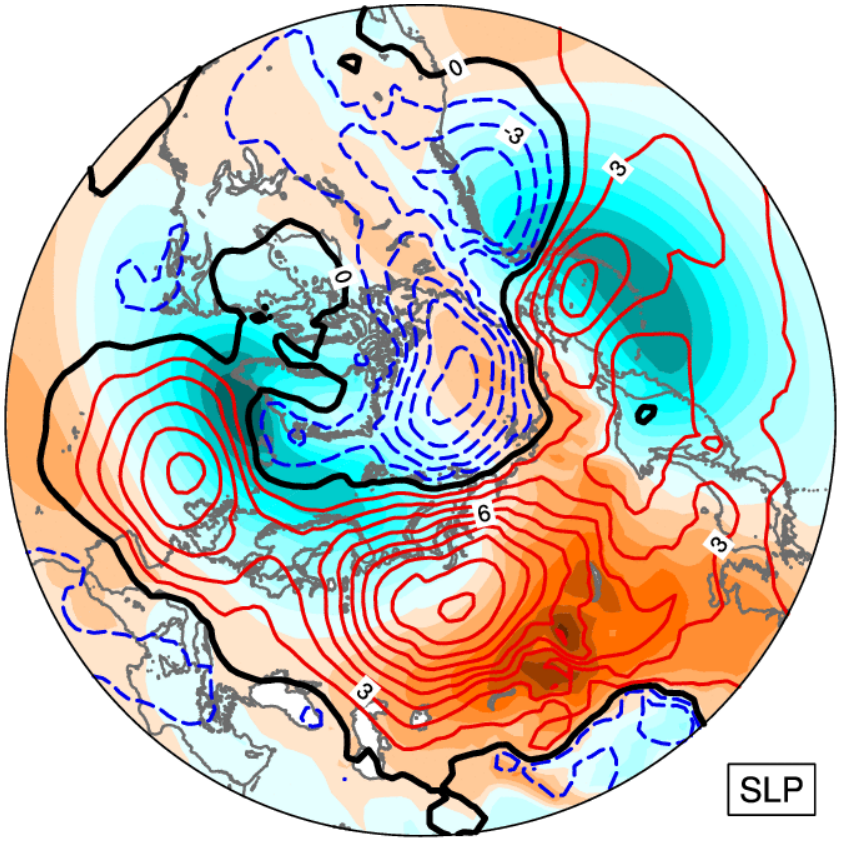
Arctic sea ice influence: CESM LENS

Winter (JFM) SAT and SLP composite versus SIC in preceding seasons

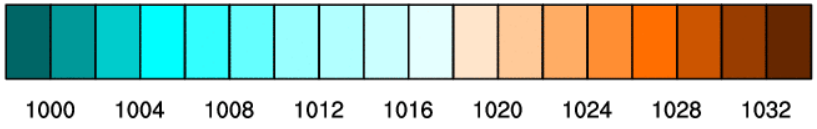


Siberian High: westward shift and intensification

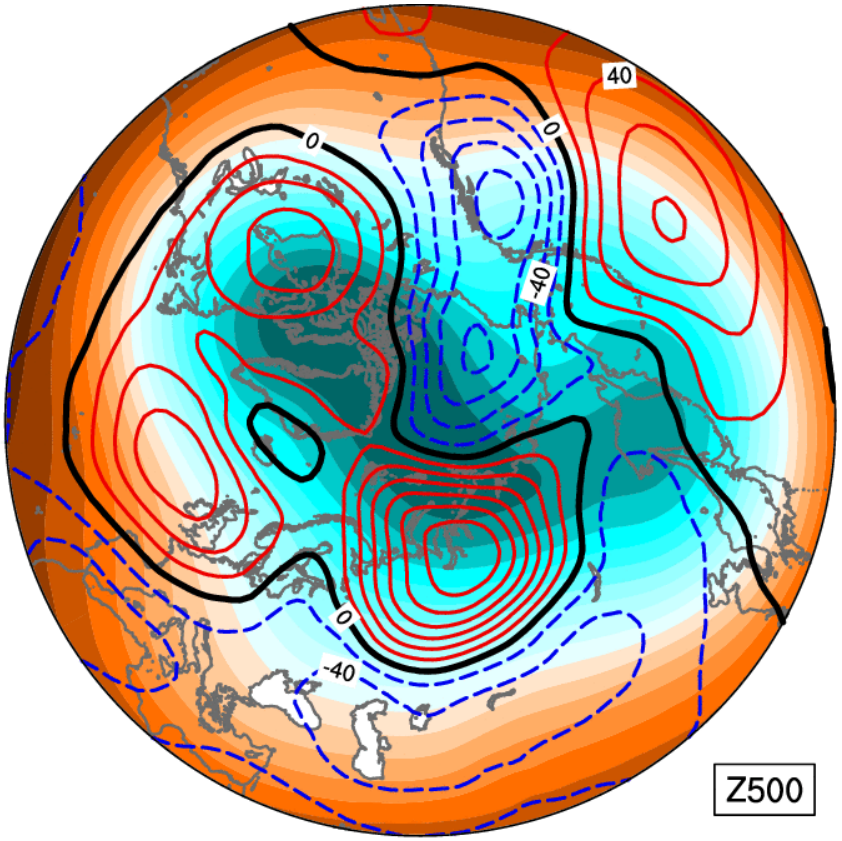
Sea level pressure



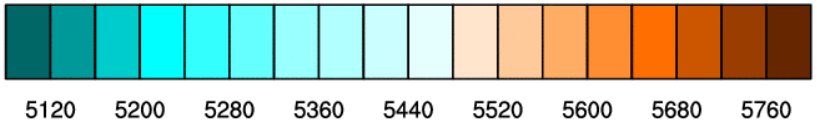
CI: 1.5 hPa



500 hPa Geopotential Height



CI: 20m

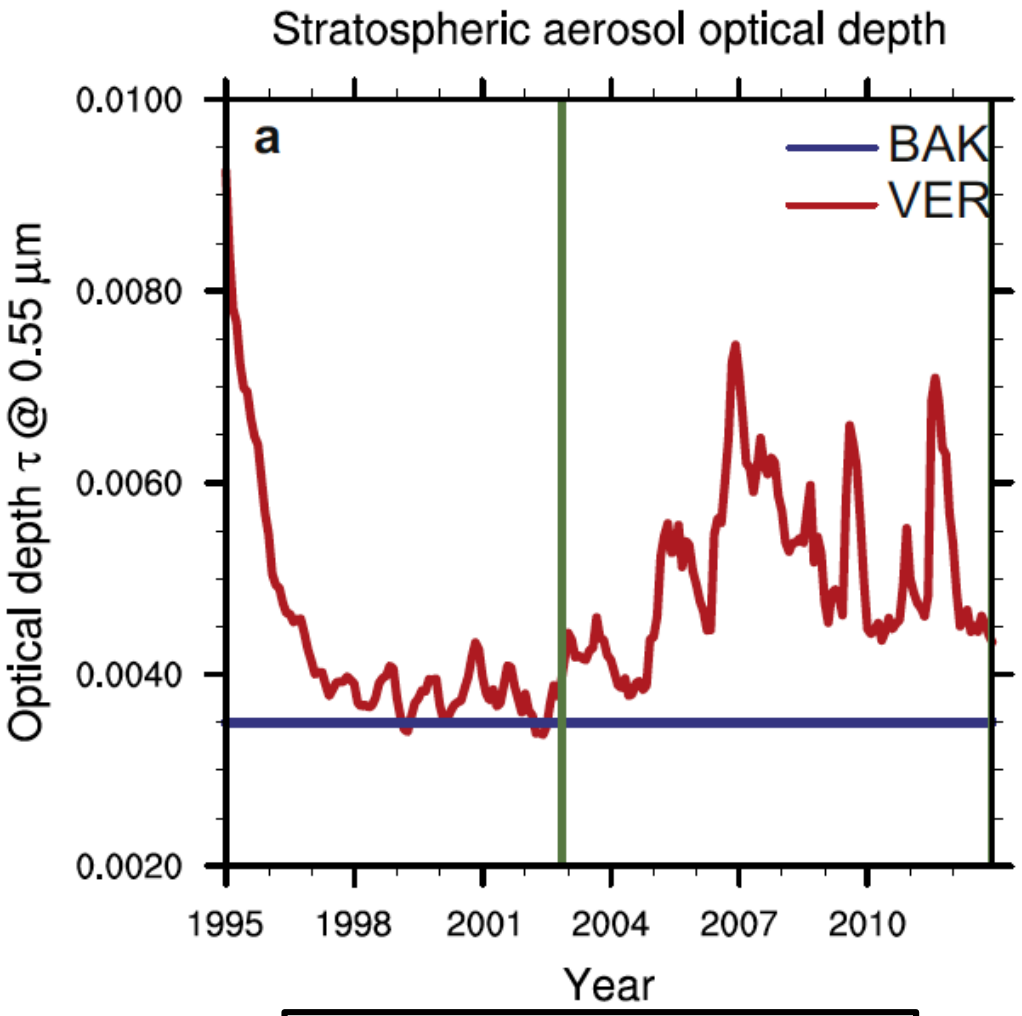


Volcanic forcing experiments

Two sets (6 members) of CNRM-CM HR decadal forecasts (2003-2012)
Both are full-field initialized with the ocean GLORYS reanalysis

a. Use observed Vernier AOD dataset (**VER**)
b. Use low-activity period AOD value (**BAK**)

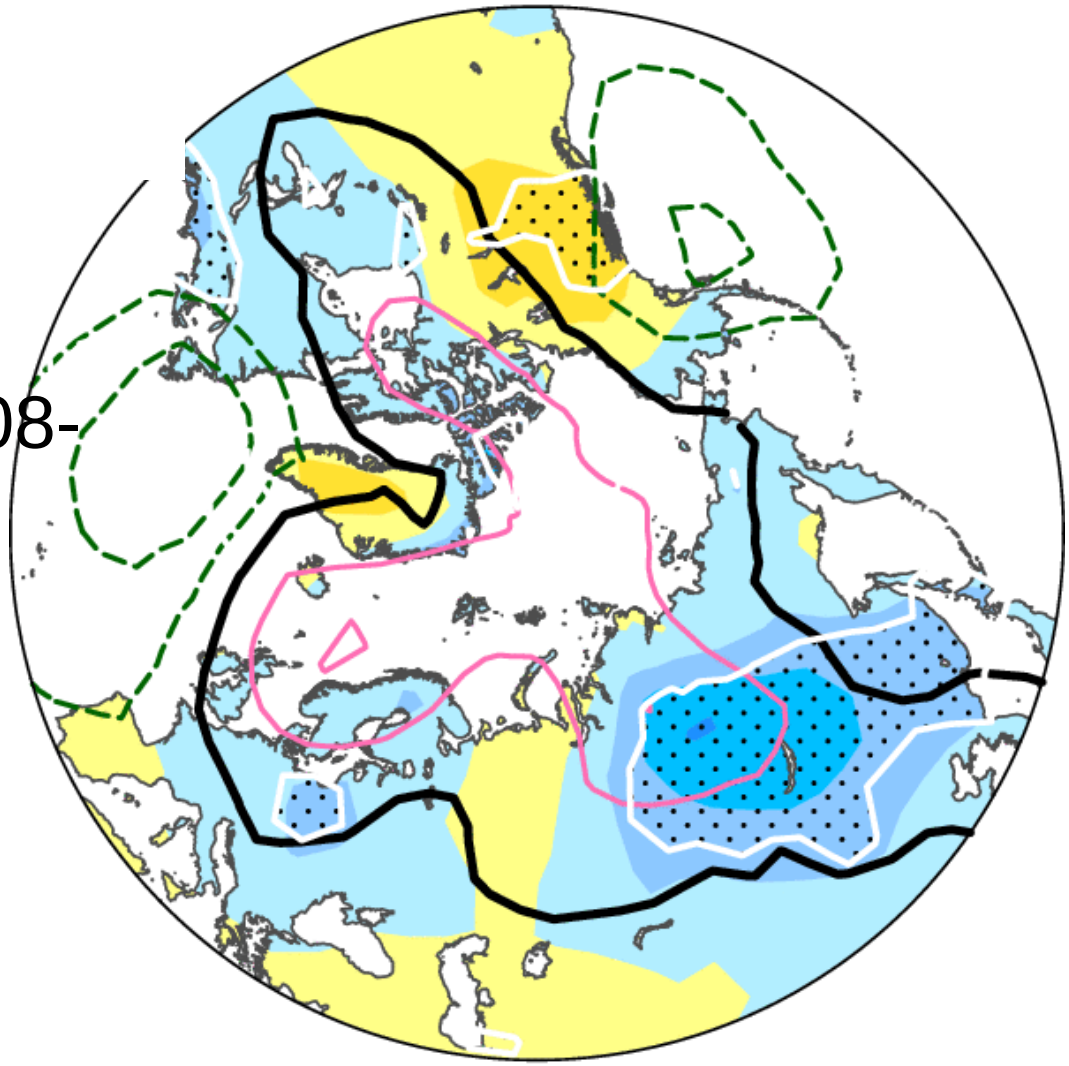
Bias correction does not change results



Monerie et al. ERL 2017

Volcanic forcing SAT response

VER – BAK:
SAT & SLP 2008-2012
difference with
2003-2007



SAT: Deg. K

-3 -2.5 -2 -1.5 -1 -0.5 0 0.5 1 1.5 2 2.5 3