The role of Arctic Amplification and atmospheric internal variability on Eurasian winter

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Warm Arctic Cold Eurasia (WACE)

**Part 1:** ERA interim reanalysis and AMIP-type experiments (Blue-Action)

a) Trend-related WACE and inter-annual variation related WACE are discrete

b) Why the AMIP runs of ECHAM6 does not simulate the observed trend-related WACE?

**Part 2:** PAMIP experiments 1.1, 1.2, 1.3, 1.6

How the 2m air temperature and SLP responds to present and further sea ice changes?

ECHAM6.3 HR (T127/L95, 100KM)
Part 1: Data and Experiments

- ERA Interim reanalysis (1979-2013)
- Blue-Action: coordinated experiments

**Exp1**: Daily varying sea surface temperature (SST) and sea ice (SIC) **DailySST/SIC**

**Exp2**: Daily varying SST but daily climatological SIC over Arctic **DailySST/ClimSIC**

- 10 ensemble members for each experiment
- Each run over the period 1979-2013 and CMIP6 forcing
Method

Barents Sea SAT anomaly

ERA Interim

DJF

DailySST/SIC

DailySST/ClimSIC
Method

Barents Sea SAT anomaly

\[ Y = a + bX ; \ b = \text{regression coefficient} \]

Full-field regression

\[ \text{b x } \sigma_x \]

De-trended field regression

\[ = \]

Residual or trend related part in the full field regression

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• WACE in the year-to-year variations
• WACE can arise without SIC variations: internal variability (IV)
Barents Sea SAT related changes in NH SAT: Detrended

De-trended

IV-WACE

Full-field

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Barents Sea SAT related changes in NH SAT: Detrended

- Trend removed, both experiments show the IV-WACE pattern
- SAT in the Labrador Sea is related to the inter-annual sea ice change
The method effectively separates the trend related pattern.
Barents Sea SAT trend related changes in NH SAT

Residual:

- Two discrete WACE pattern IV-WACE and AA-WACE

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Ghosh et al. (in preparation)
Barents Sea SAT trend related changes in NH SAT

Residual:

- ECHAM6 AMIP runs could not capture the observed trend related WACE

Ghosh et.al. (in preparation)
PC of Eurasian SAT: ERA and Exp1

Mori et al. 2014
PC of Eurasian SAT: ERA and Exp1

PC1 has a general positive trend in Exp1 than in ERA

Ghosh et al. (in preparation)
Warm Arctic Cold Eurasia (WACE)

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Part 2: PAMIP experiments 1.1, 1.2, 1.3, 1.6

How the 2m air temperature and SLP responds to present and further sea ice changes?

ECHAM6.3 HR (T127/L95, 100KM)
100 members
Barotropic SLP response
Cooling over Eurasia — but not significant
Large inter-annual variability — pattern resembles AO related temperature variations
Future — Present day sea ice (1.6 — 1.1)

Baroclinic SLP response
Conclusions

Part 1  Ghosh et.al. (in prep)

- In ERA-Interim, two discrete WACE
  1) IV-WACE and
  2) trend-related AA-WACE

- ECHAM6 AMIP experiments
  1) simulate the IV-WACE. The IV-WACE is independent on SIC

- AA-WACE is not simulated. The positive trend in the 1st mode of variability in Eurasian SAT is leading to “warm Eurasia” condition.

Part 2

- Pre-industrial to present day sea ice change response is different from present day to future sea ice change response: Barotropic and Baroclinic
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Spread of 2 m air temperature in 1.6 and 1.1
Response to present day sea surface temperature compared to the pre-industrial
PC2 related SLP variations

ERA

PC2 reg

PC2 detrend

Diff

ERA: with trend, strengthening of surface high over Eurasia and weakening of surface low over Arctic

Exp 1

PC2 reg

PC2 detrend

Diff

Exp 1: with trend, no strengthening of surface high and no presence of surface low over Arctic

Ghosh et al. (in prep)
Barents Sea SAT related SLP variations

Barents Sea SAT index show further similar circulation than PC2.

With trend, strengthening of surface high over Eurasia is still missing.

PC2 and Barents SAT has not the similar dynamical association as in ERA.
Contributions of the EOFs on the AA-WACE 1980 -2017

However, the phase of the first mode of variability is playing a crucial role to determine the strength and even presence of AA-WACE in the overall trend.

The trend in the 2nd mode, the AA-WACE, is the signature of the Arctic sea ice loss over Eurasia and it is indeed intensifying.

Ghosh et.al. (in prep)