Nudging observed winds in the Arctic to quantify associated sea ice loss in the past decades and 2020

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Most models show a lower sensitivity to anthropogenic forcing (2016).

**Observed Arctic sea-ice loss directly follows anthropogenic CO$_2$ emission**

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**Abstract**

Most models show a lower sensitivity, which is possibly linked to an underestimation of the modeled increase in incoming longwave radiation and of the modeled Transient Climate Response.
Two ideas to explain the discrepancy (lower sensitivity) between the simulations and observations

1. The trends are due to anthropogenic forcing but models are less sensitive (Solution: recalibration)
2. Internal variability plays an important role (Solution: understand the internal source)

Anthropogenic thermal warming

Arctic amplification

- Sea ice loss
- Albedo feedback
- Cloud cover and water vapor
- Black carbon aerosol
- Local thermal inversion/Lapse rate feedback
- Vegetation feedback
- Poleward heat and moisture transport by atmosphere and ocean

Internal atmospheric dynamical warming
Goal: Quantify the contribution of internal and anthropogenic forcing in the recent sea ice decline (2000-2012)

Approach: Use a nudging method available to the CESM to quantify the role of observed winds in driving sea ice changes and compare it with that due to CO2 forcing in the same model
Linear trends of JJA atmospheric variables from 1979 to 2018

Obs
- a) Obs (79–18)

Forced
- b) CESM–LEN (79–18)
- c) Nudging (79–18)

Wind-driven
- d) Obs (79–18)
- e) CESM–LEN (79–18)
- f) Nudging (79–18)

Shading: temp
black contour: height
Red contour : omega
Linear trends of Sep sea ice from 1979-2018

da September total sea ice area in Obs, LEN and Nudging runs
Sea ice trends in each month (79–18)
Anomalous circulation and SST in JJA of 2020
Pacific-Arctic teleconnection (PARC)

The summer PARC mechanism

1. ECP SST Cooling
2. Reduced convection
3. Barotropic Rossby wave propagation
4. Barotropic Anticyclone
5. Surface friction driven adiabatic descent & warming
6. Subsidence, warming & moistening
7. Increased longwave emission
8. Sea Ice Melt

Baxter et al. 2019
Take-home message

- Wind related internal variability contributes to 30-40% of September sea ice loss from 1979 to 2018 (60% for 2000-2012) though its adiabatic warming in summer and associated dynamical drifting effects only play a minor role.
- A similar internal process may also play a role to cause strong sea ice melt in the summer of 2020.
- The model constrained by observed winds in the Arctic can simulate a similar local energy budget as observations at the TOA and surface.
- Large scale wind changes is important in shaping Arctic climate in the past decades and its future changes is a critical factor to determine Arctic climate projections.