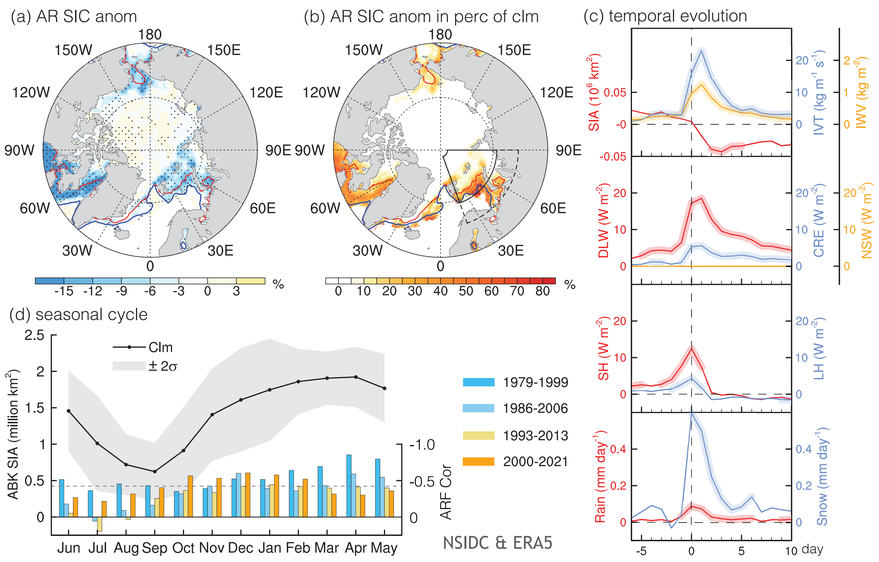
More frequent atmospheric rivers slow the seasonal recovery of Arctic sea ice

Pengfei Zhang (PSU), Gang Chen (UCLA), Mingfang Ting (Columbia U.), L. Ruby Leung (PNNL),
Bin Guan (JPL), Laifang Li (PSU)

Motivation

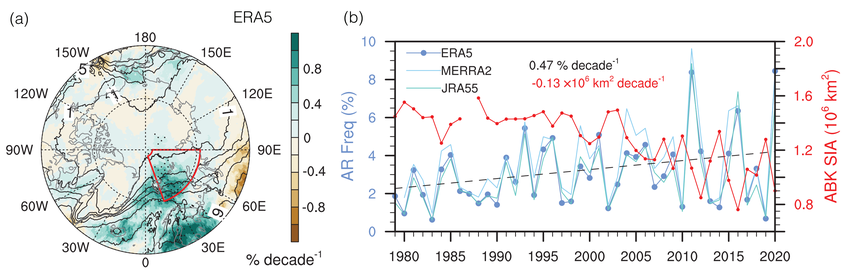
- ARs' melting effect on the cryosphere: ice sheet melt in Greenland and West Antarctica, polynyas in Weddell Sea, 2016-17 record low Arctic sea ice growth (e.g., Hegyi & Taylor 2018, Mattingly et al. 2018, Wille et al. 2019, Francis et al. 2020)
- The extent to which moisture transport influences winter Arctic sea ice loss has not been conclusively quantified.
- To what extent human activities have contributed to the high latitude AR changes?
- What is the mechanism for Arctic AR changes?

ARs' Melting effect on Arctic sea ice



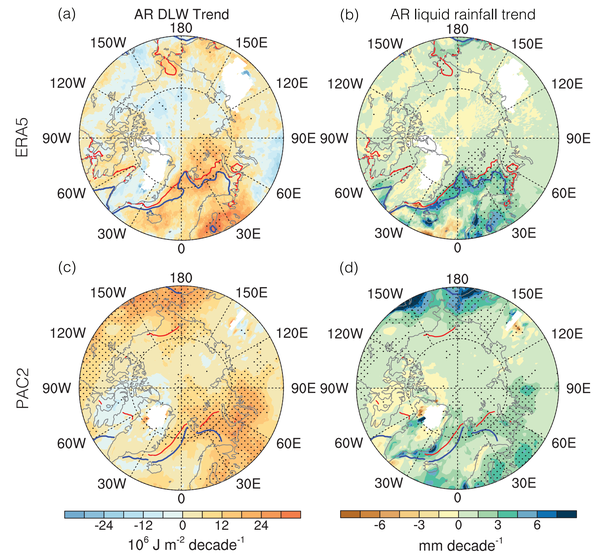
Increased AR penetration into the Arctic

- Trend in AR frequency in early winter (NDJ) in 1979-2020

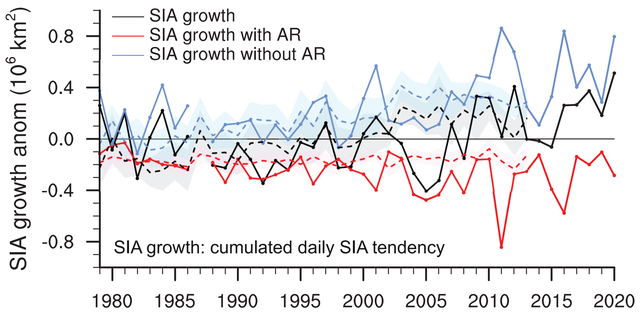


Red sector: Barents-Kara Seas and the neighboring central Arctic (ABK)

Impacts of AR trends on sea ice



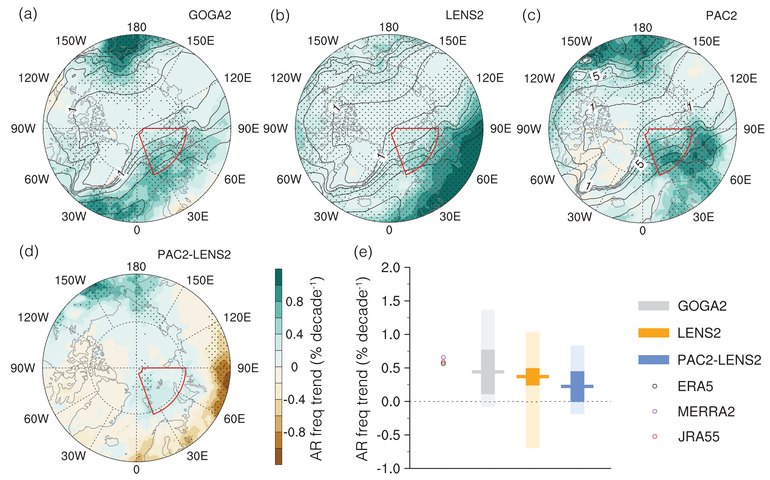
- It is expected that the ARs' melting effect is enhanced.



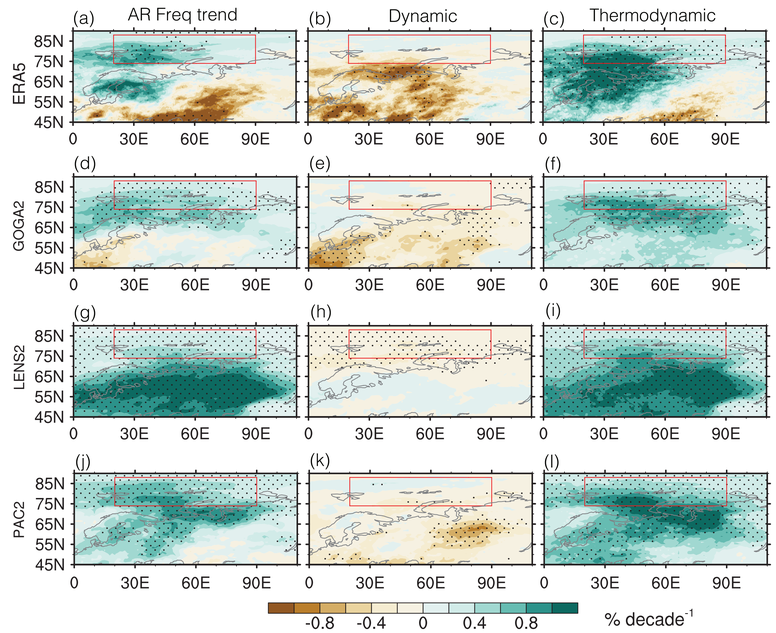
- Winter SAT is freezing, which could induce a faster sea ice growth given a warming summer. As we can see in the SIA growth without the ARs' impact.
- AR's melting effect slows the fast sea ice growth and account for 33% of the total sea ice coverage decline in ABK.

Drivers of Arctic AR changes

- CESM2 model ensembles (1979-2014):
  - GOGA2: atmosphere only forced by observed SST/SIC and historical external forcing (10)
  - LENS2: coupled ensemble forced by historical external forcing (50)
  - PAC2: same as LENS2 but the SSTa in tropical Pacific is nudged to the observed (10)
  - PAC2-LENS2: isolating the tropical Pacific influence



Mechanism of Arctic AR changes



Conclusion Remarks

- AR frequency increases in ABK and its melting effect is enhanced.
- AR frequency change explains 33% early winter sea ice coverage decline in 4-decades.
- In addition to anthropogenic forcing, tropical pacific influence is indispensable.
- Thermodynamic effect is dominant in ARF increase

Email: pfz5053@psu.edu

Publication: Zhang et al. (2023) More frequent atmospheric rivers slow the seasonal recovery of Arctic sea ice. Nature Climate Change, 13, 266-273. doi: 10.1038/s41558-023-01599-3