Article

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

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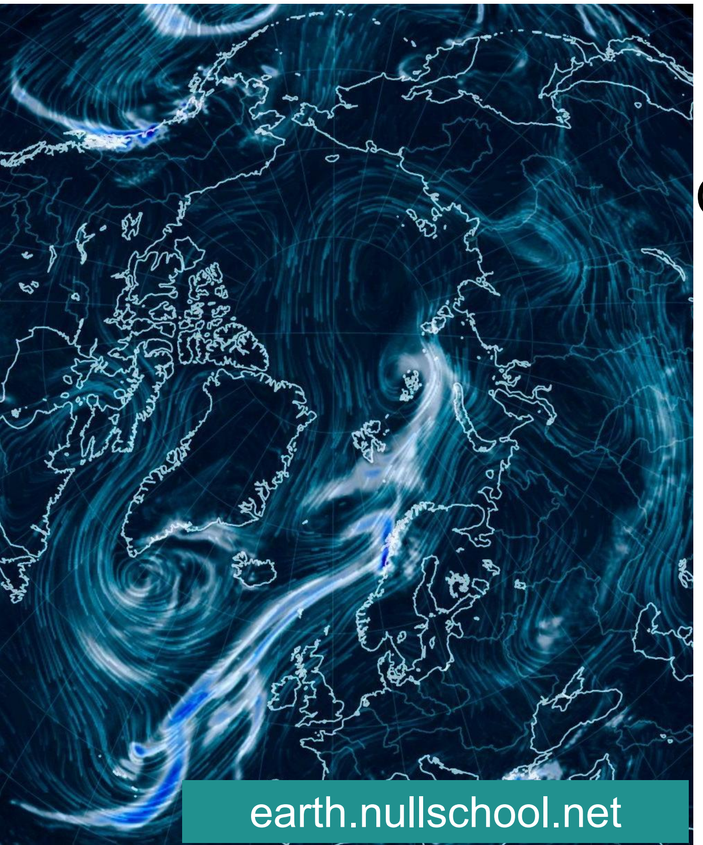
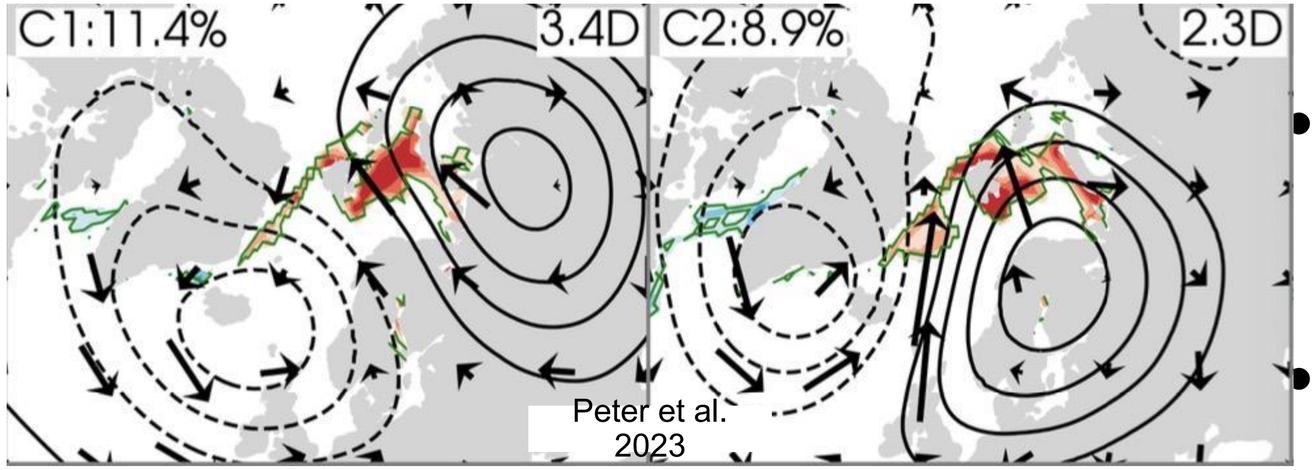
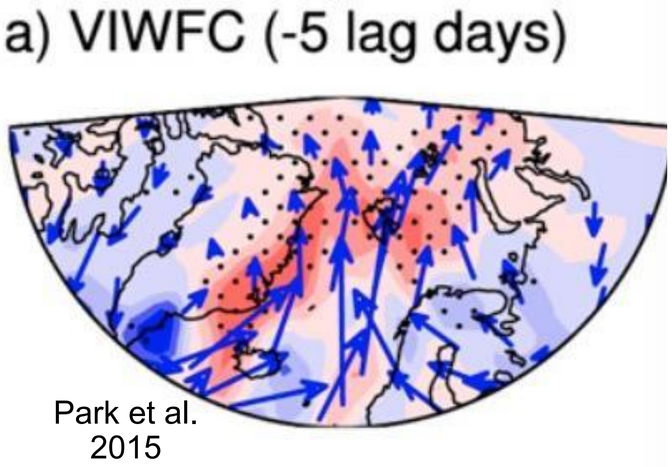


(Zhang et al NCC 2023)

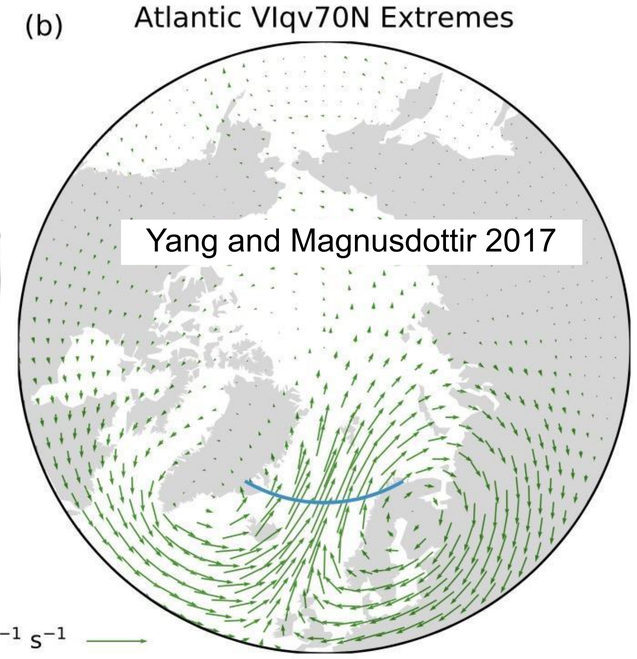
Ural/Scandinavia blocking and Barents-Kara Sea sea ice



Peter et al. 2023

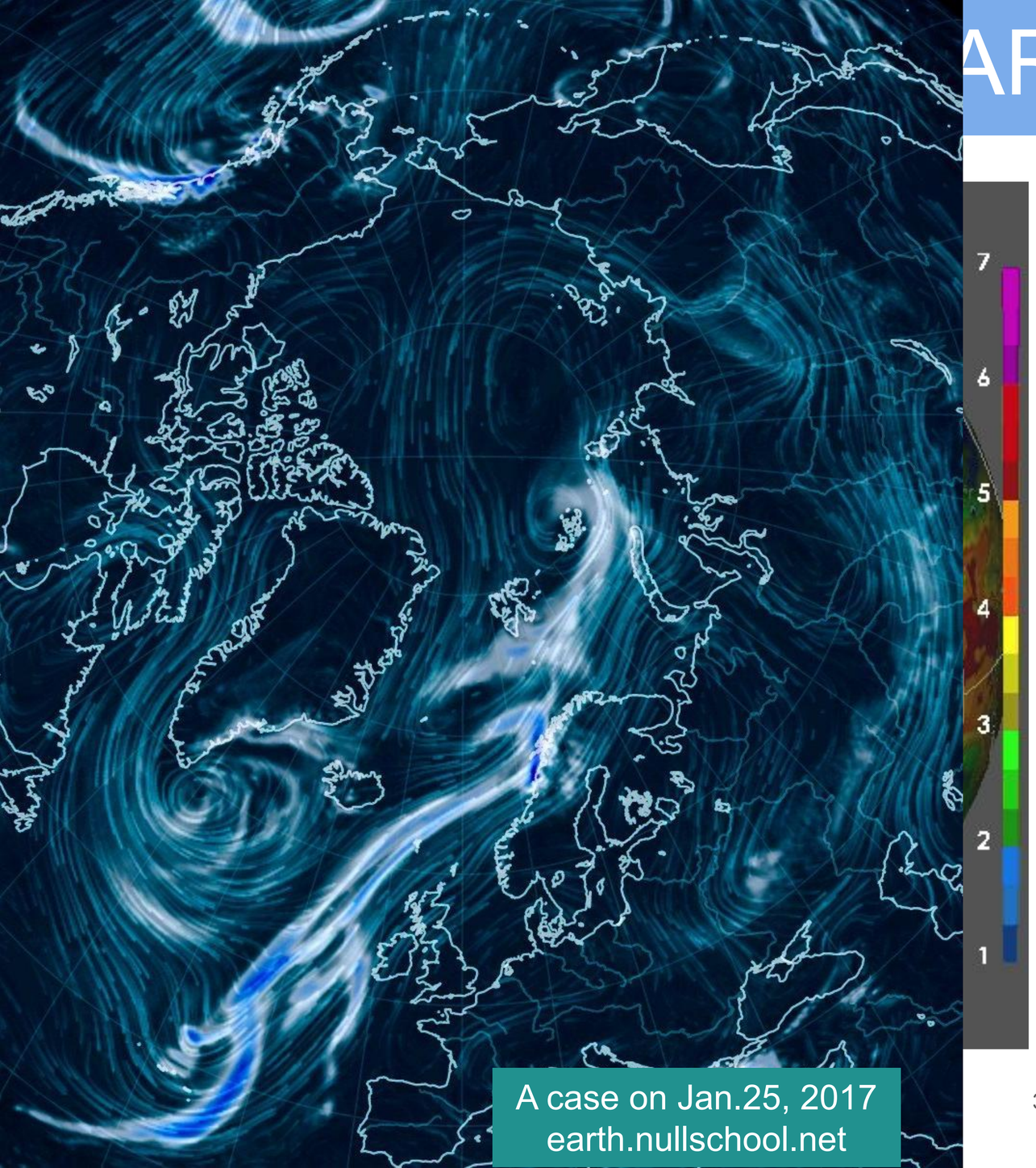


Park et al. 2015



- Ural blocking/anticyclone are linked to BKS sea ice retreat(e.g., Gong and Luo 2017; Peter et al. 2023)
- Can be explained by the significant poleward moisture transports to the west of the anticyclone (Park et a. 2015, Yang and Magnusdottir 2017,….)
- To what extent does the melting effect of moisture transport contribute the rapid decline of Arctic sea ice ?

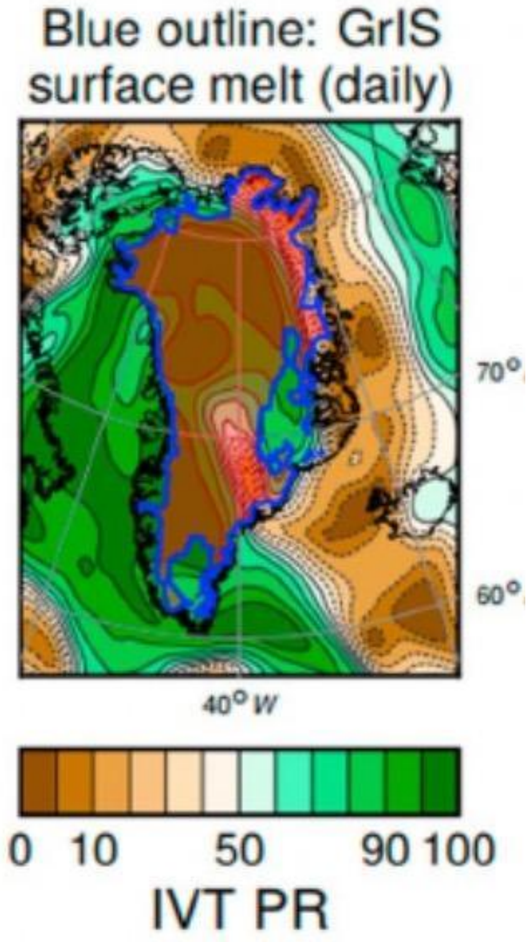
ARs)

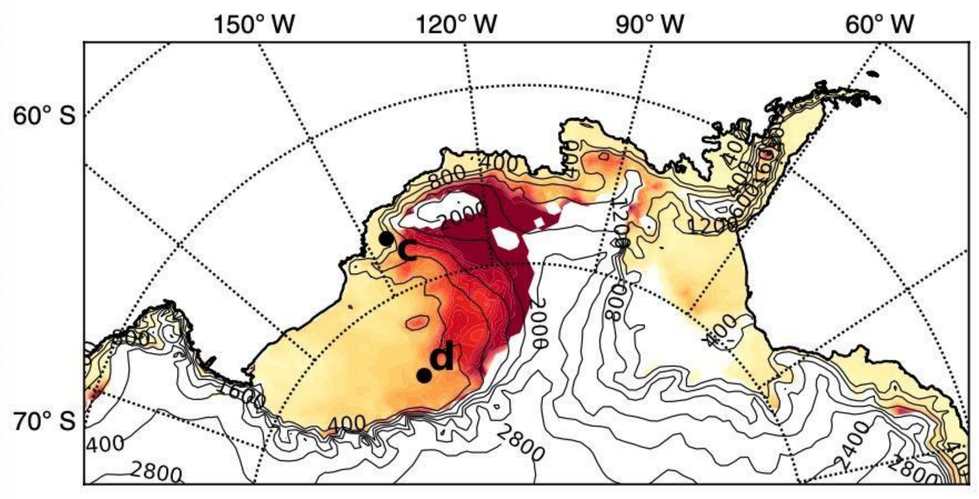


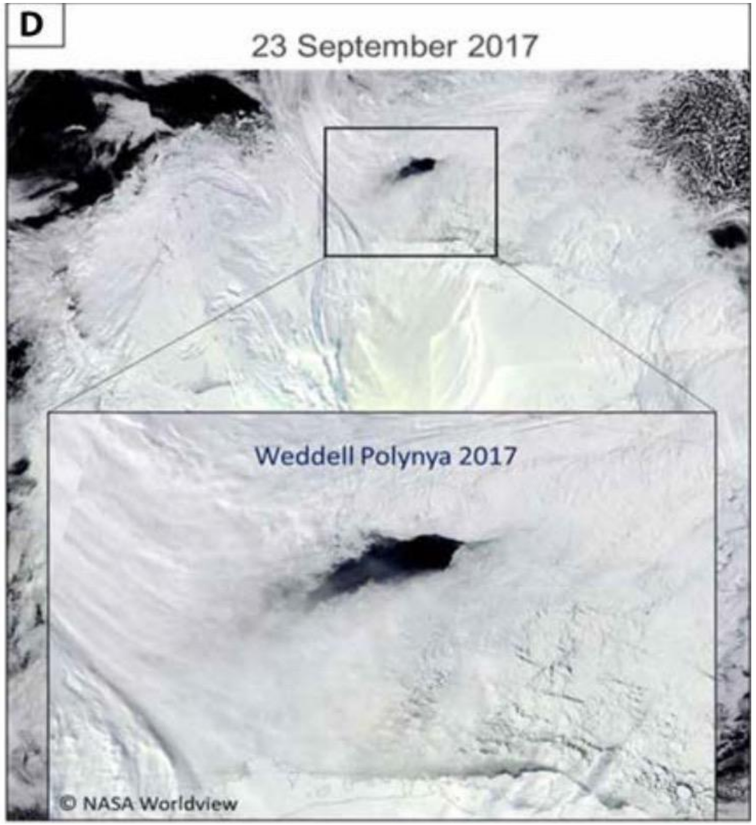
- Narrow, elongated synoptic jets of water vapor
- length>2000km; intensity > 85th percentile of IVT.
- Up to 90% poleward water vapor transport in midlatitude (Zhu and Newell 1998; Newman et al. 2012)

Polar ARs—Melting effect

- Ice sheet melt in Greenland and West Antarctic, polynya events in the Weddell Sea, and 2016-17 record low winter Arctic sea ice (Hegyi and Taylor 2018; Mattingly et al. 2018, Wille et al. 2019, Francis et al. 2020)







Contents

- What’s the melting effect of ARs on Arctic sea ice in winter?
- Is there a change in Arctic ARs? To what extent the AR changes contribute to the sea ice decline trend?
- To what extent human activities have contributed to Arctic AR changes ?

ARs' melting effect on the Arctic sea ice

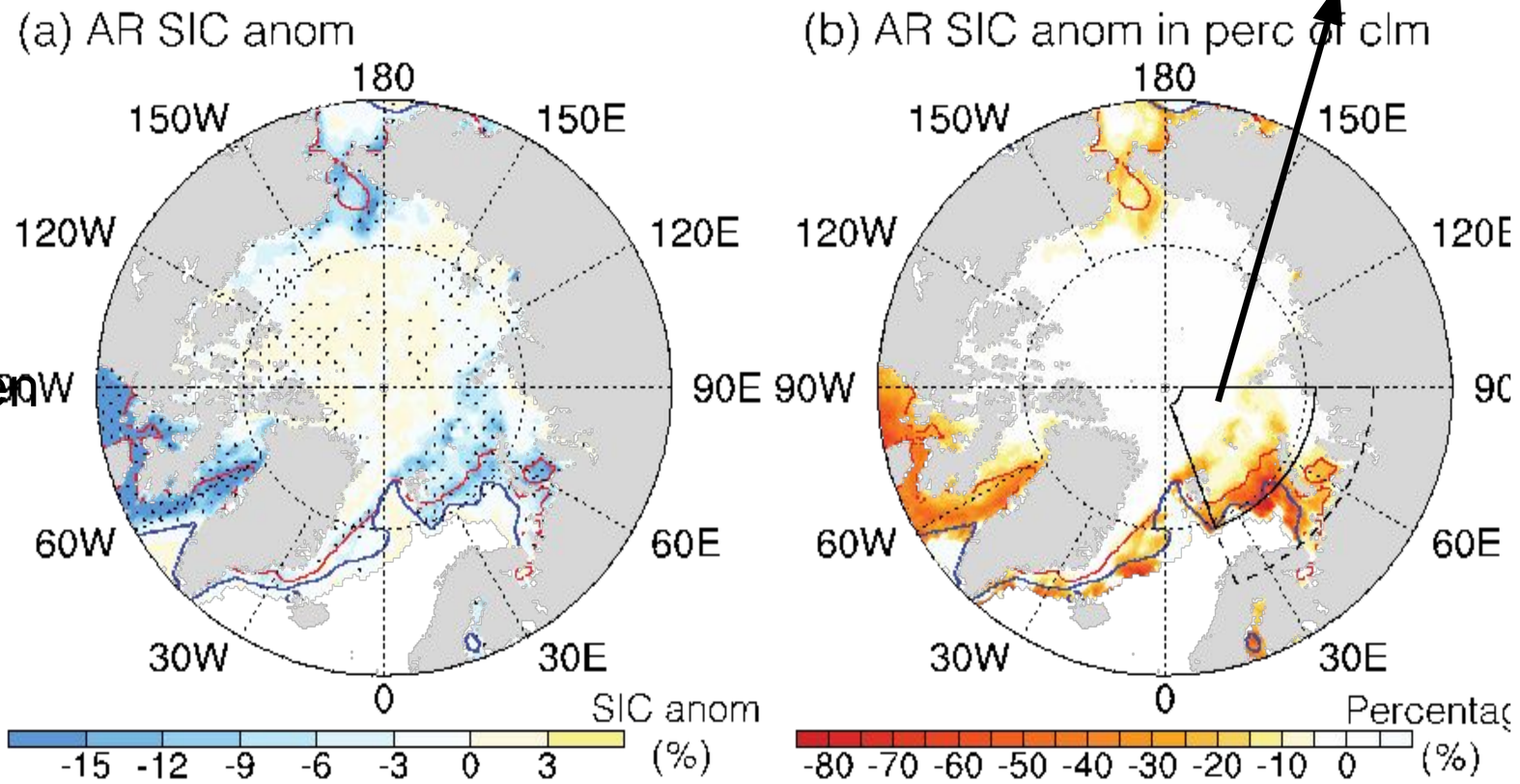
Composites in NDJ during 1979-2021

Red contour: clm ice edge on Oct.31
Blue contour: on Jan.31

- Significant ice reduction when ARs are deteched;
- especially on the newly formed ice cover, which is thinner, fragile.

Sea Ice Concentration anomalies associated with ARs

Barents-Kara and the central Arctic to the north
ABK



Data: ERA5, NSIDC (SIC)
AR algorithm: Guan and Wailser (2015) and Mattingly (2018)

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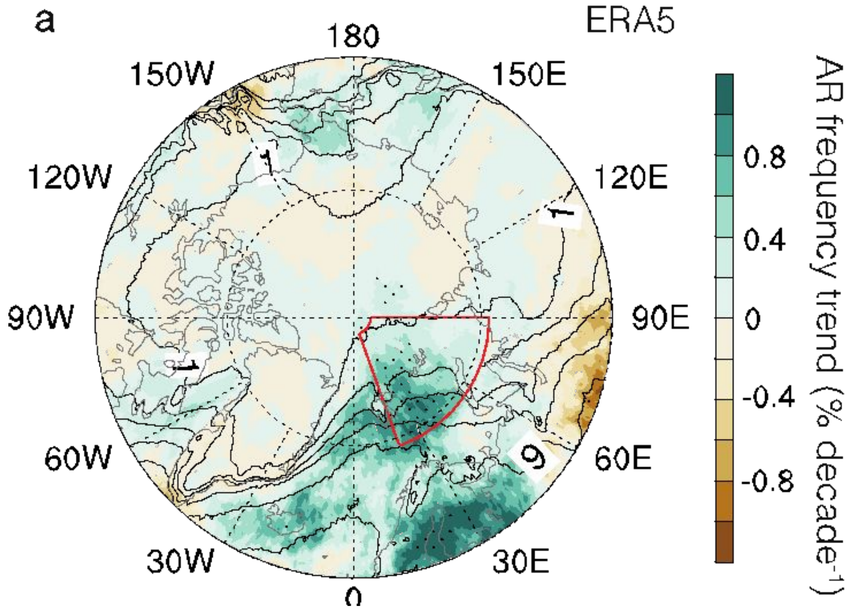
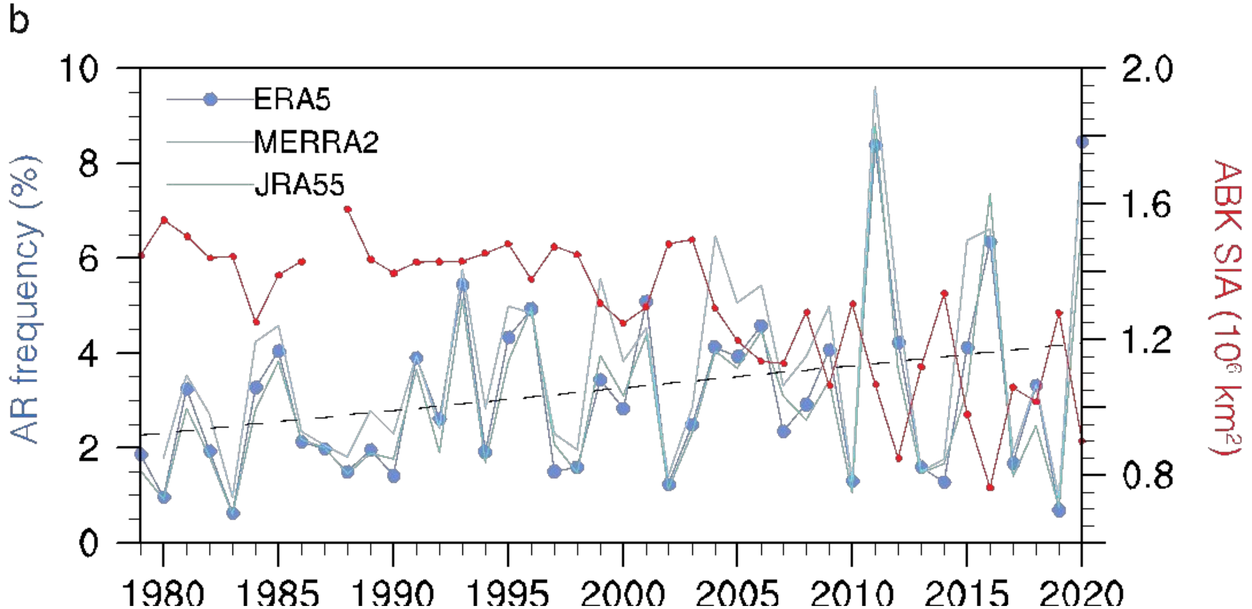
Increased AR penetration

AR freq trend in ERA5



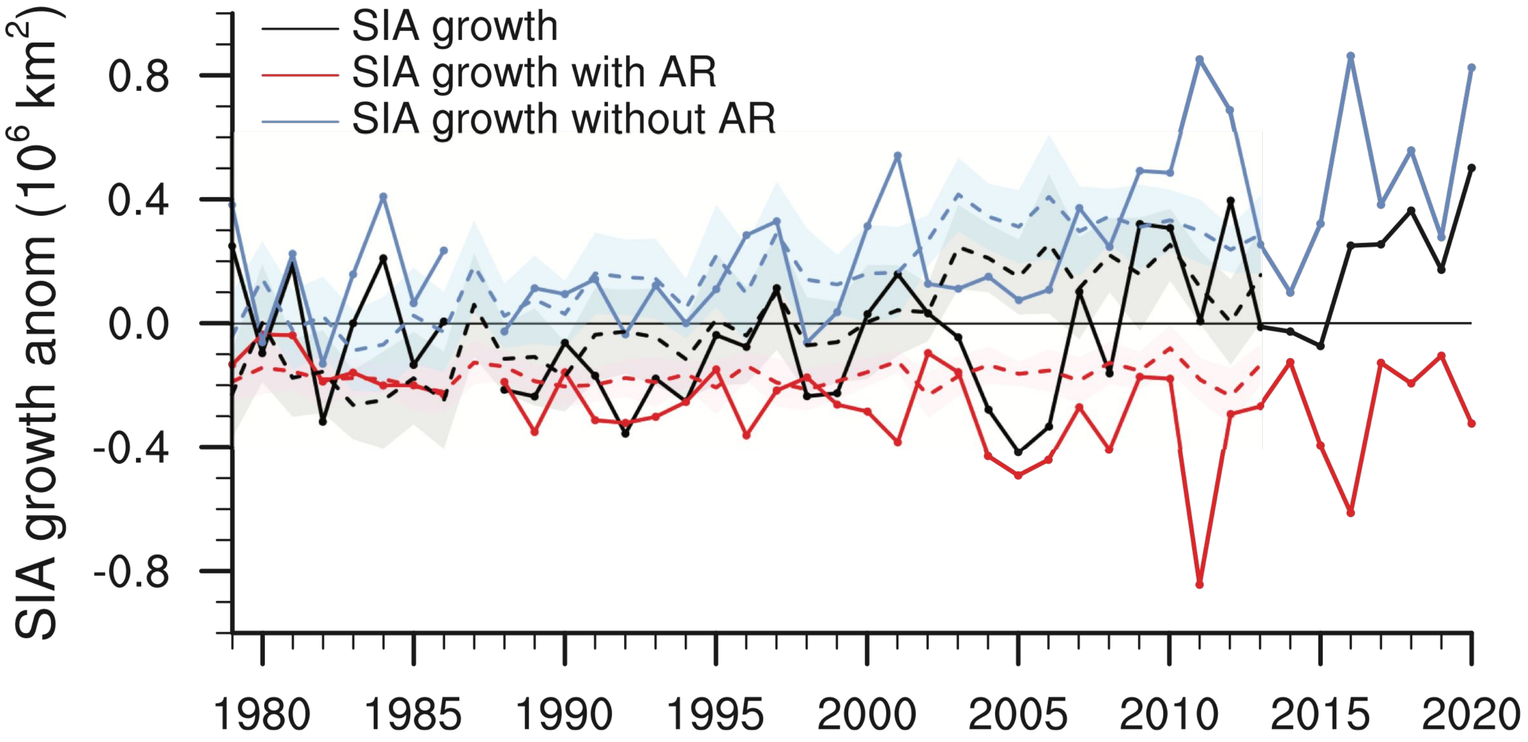
Three reanalysis datasets



- More frequent ARs in ABK in NDJ in 1979-2020
- AR increase trend coincides with local sea ice area decline

Increasing role of ARs in sea ice changes

Sea ice area tendency in NDJ



$$\sum_{Jan1}^{Jan31} \left(\frac{A_{i+1} - A_{i-1}}{2} \right)$$

Solid: Obs (NSIDC)
Dashed: PAC

- Frequent ARs can prevent the sea ice from growing to the extent allowed by the freezing surface temperature.
- Enhancement of melting effect of ARs accounts for ~34% of the total SIA decline in NDJ.

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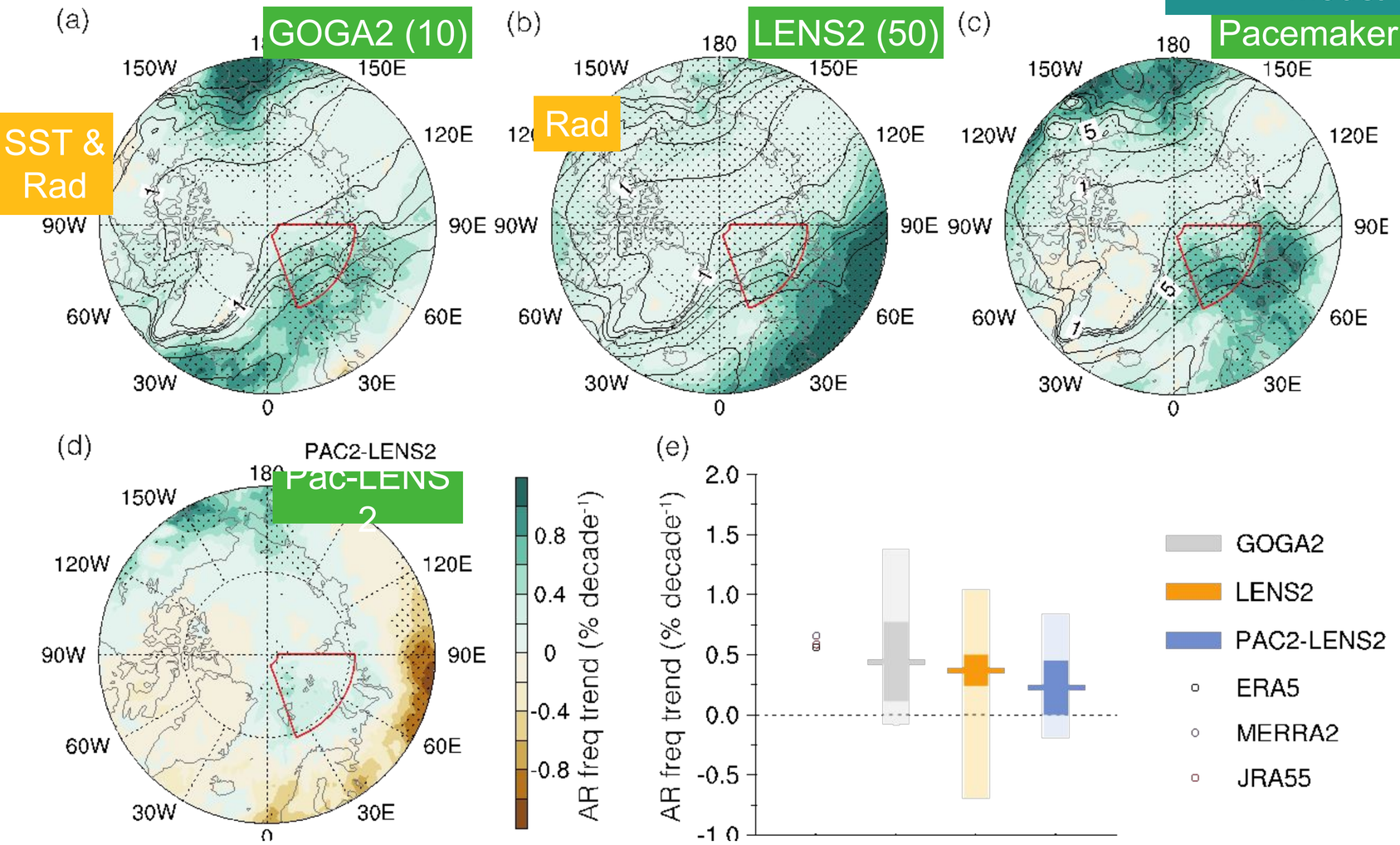
Drivers of increased AR frequency

Model experiments: CESM2 (CVCWG/NCAR)



- Tropical Pacific variability (Ding et al. 2014; Meehl et al .2018; et al.)
- By comparing AR changes across 3 ensembles, it becomes apparent that tropical Pacific variability cannot be ignored.

Darker color bar: 2.5-97.5% confidence interval

Conclusion remarks

- ARs exert a pronounced melting effect on Arctic sea ice.
- More frequent ARs has been observed in Arctic in recent decades.
- The increase in AR frequency accounts for 34% of the sea ice area decline trend.
- Tropical Pacific variability is essential for the formation of the observed spatial pattern of AR changes

Thanks for your attention!

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