Abrupt Warming in the Arctic Ocean Trigger by An Increase in Extreme Events

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01

The abrupt shift at 2007

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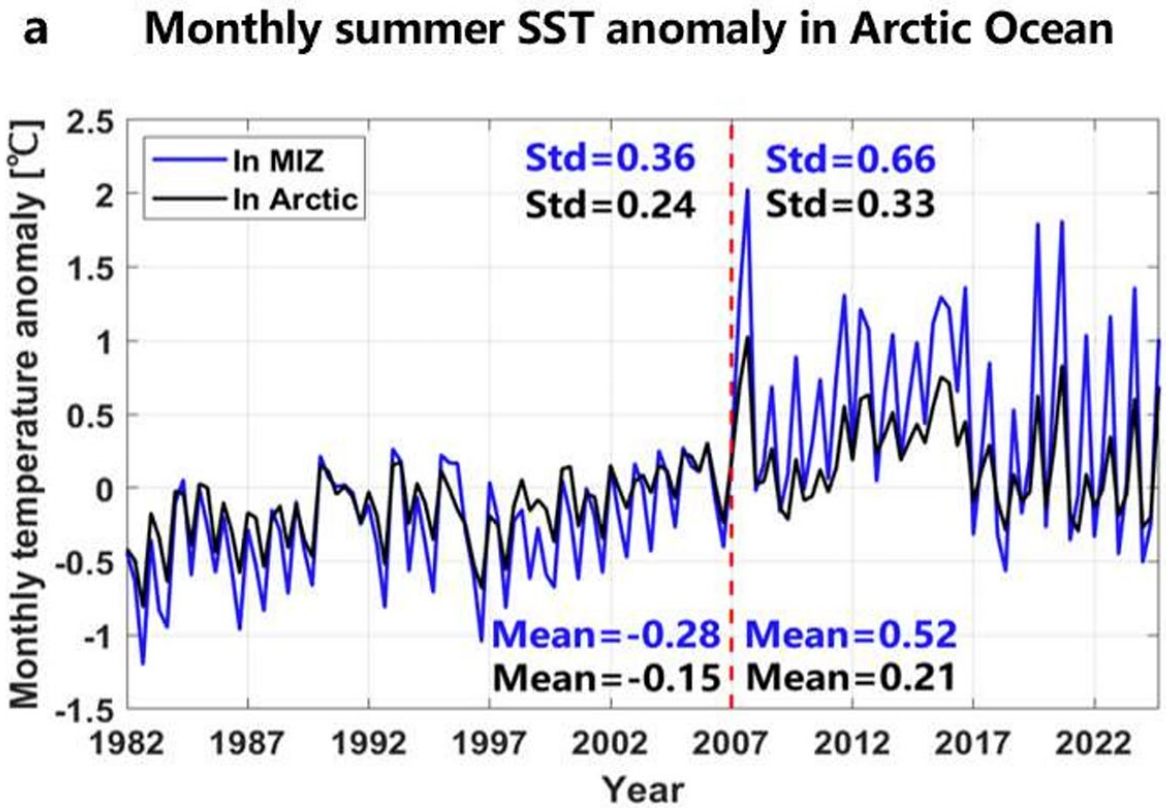
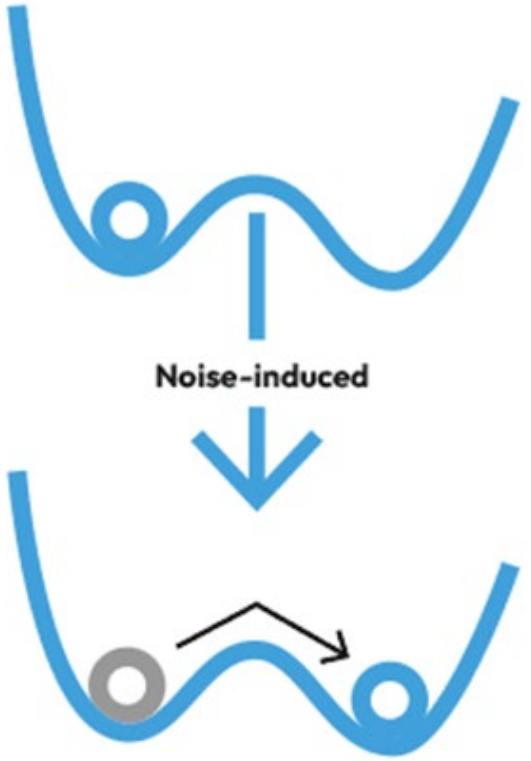
A sudden surge by 0.8°C and a doubled variability in sea surface temperature within the marginal ice zone

Increased variance after 2007 marks a **noise-induced transition** (Ditlevsen et al. 2010).

“noise” refers to short-term perturbations



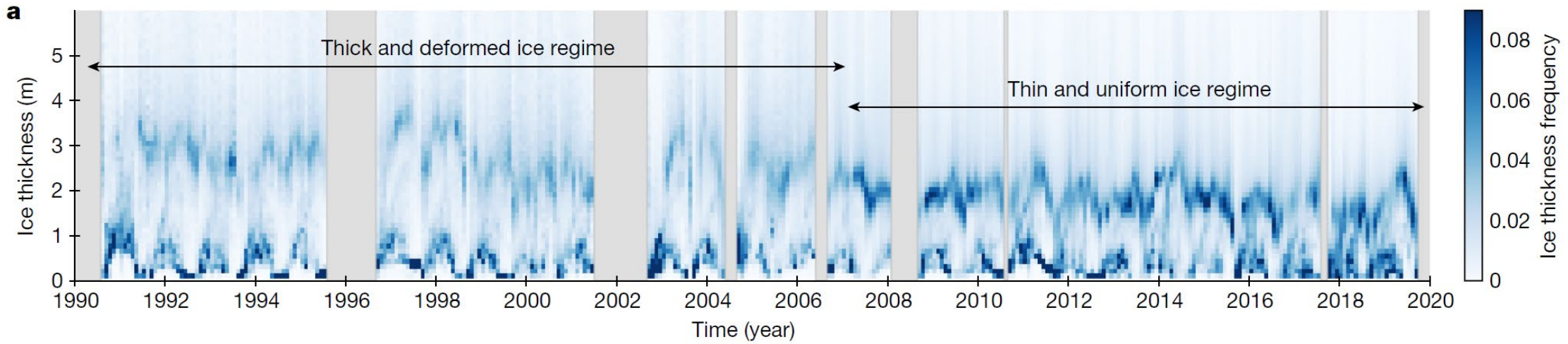


Apply to both OISST and OSTIA datasets

Sea ice change at 2007

Arctic sea ice regime shifted in 2007 **from thicker and deformed to thinner and more uniform ice cover** (Sumata et al. 2023).

Thinner Arctic sea ice is more likely to break up (e.g. Rheinlænder et al., 2022, 2024), and Arctic Ocean is more susceptible to air-sea interactions

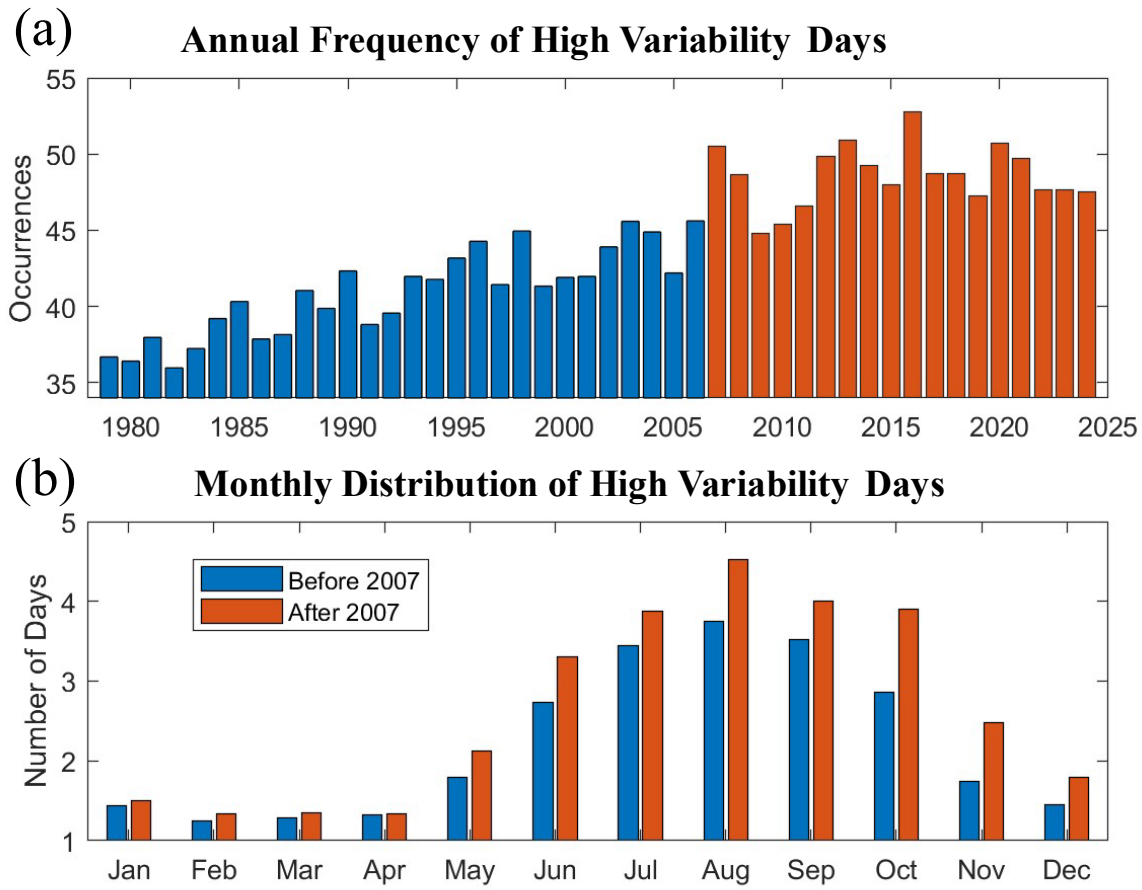


Sumuta et al., 2023

Sea ice variability after 2007

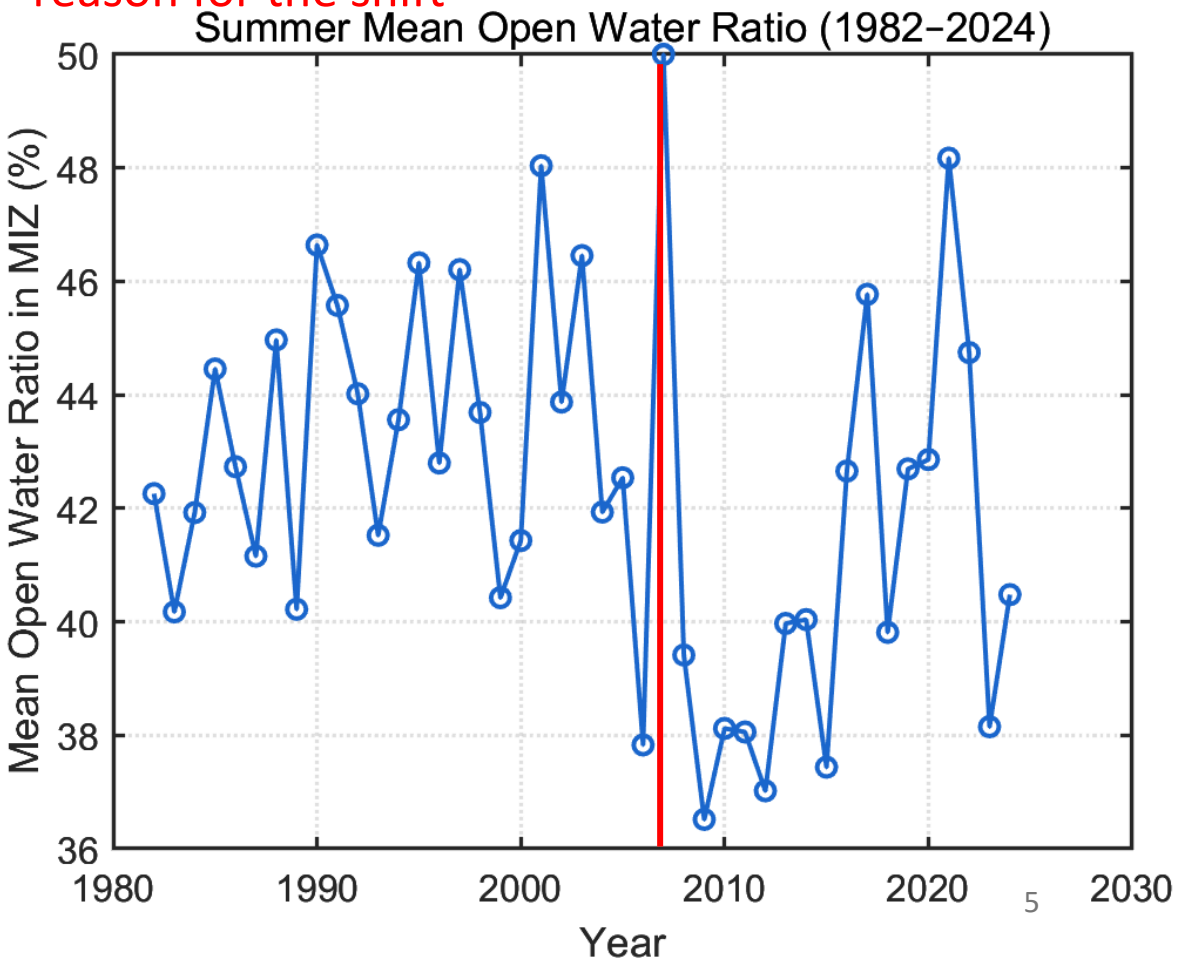
Sea ice concentration has **more daily variability**

after 2007: sea ice is prone to break up



Sea ice becomes more fragmented at 2007, but not for the following years

The change in open water ratio after 2007 is not the reason for the shift



02

Feedback Between short-term extremes and mean-state change

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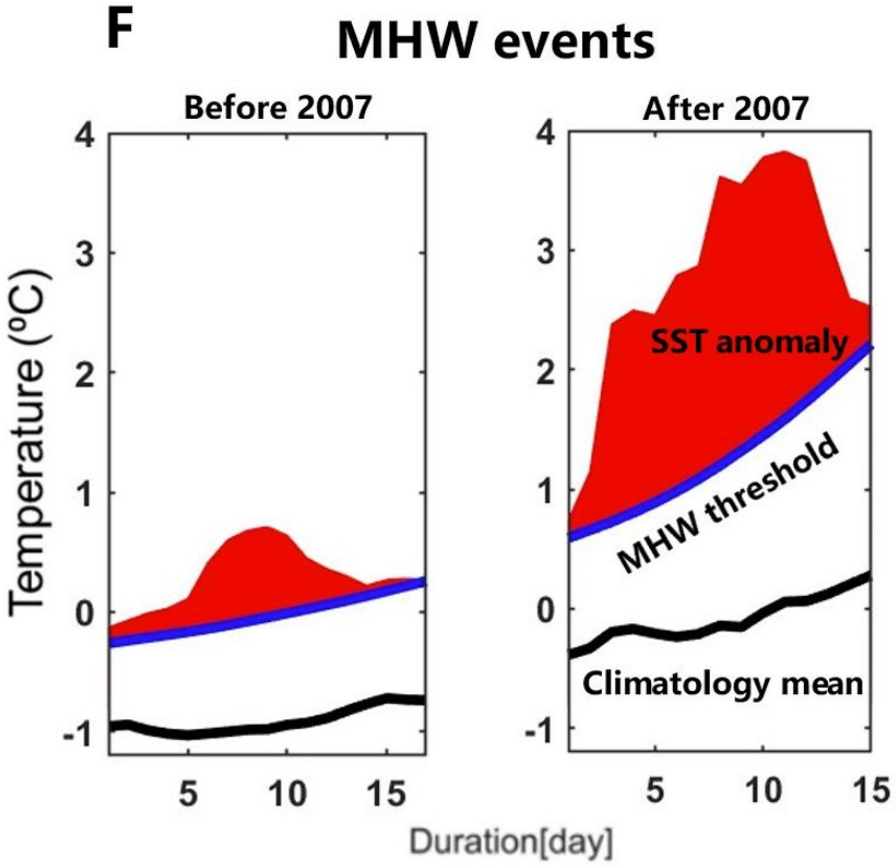
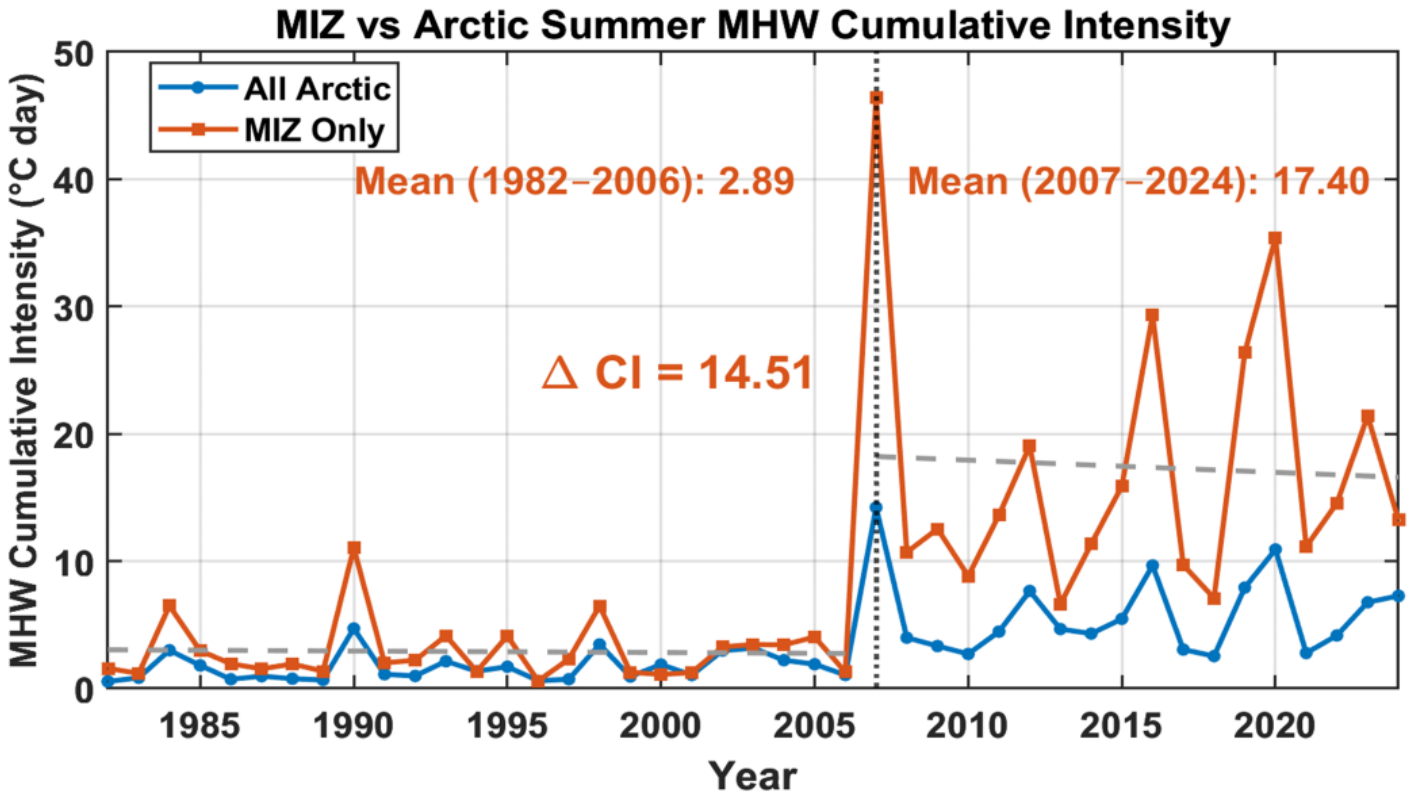
Abrupt increase in Arctic marine heatwaves (MHWs)

MHWs: short-term extreme warming events

Red area denotes cumulative intensity

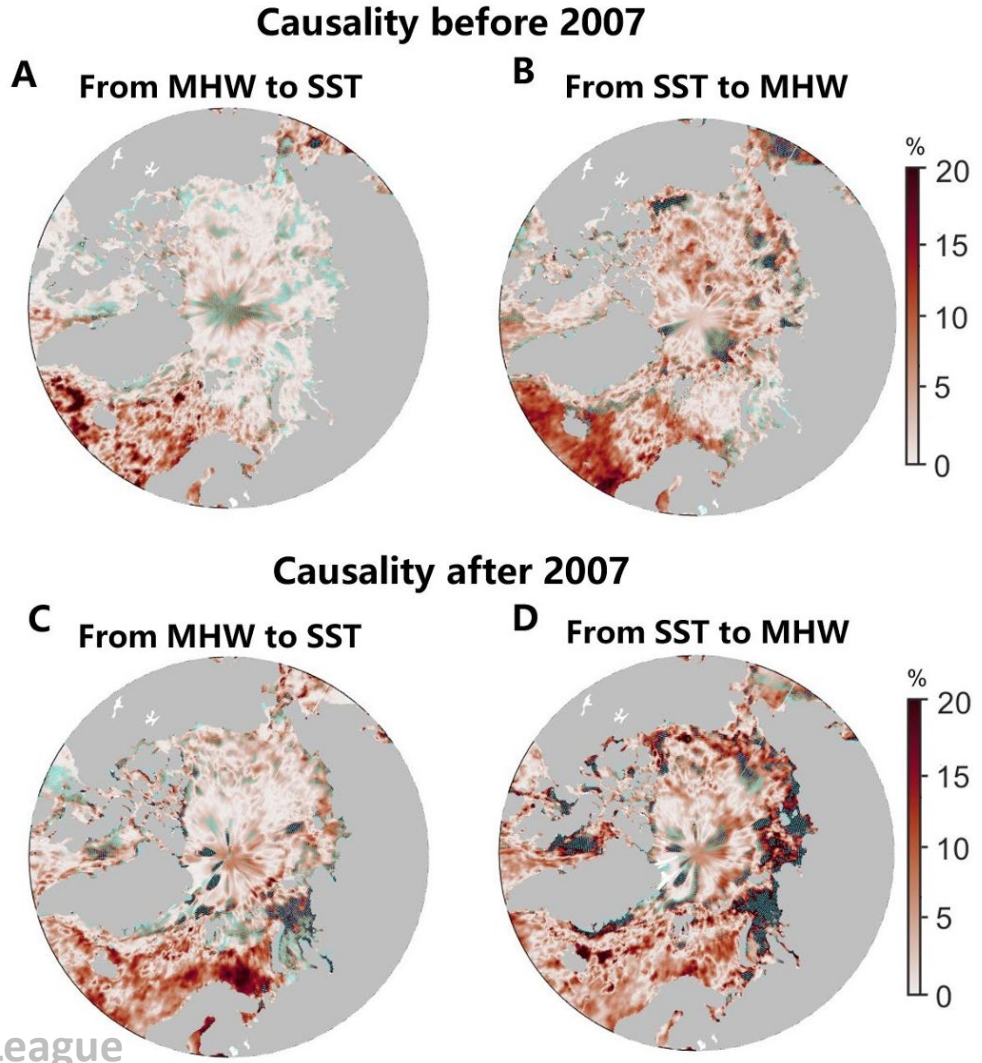


Much stronger after 2007

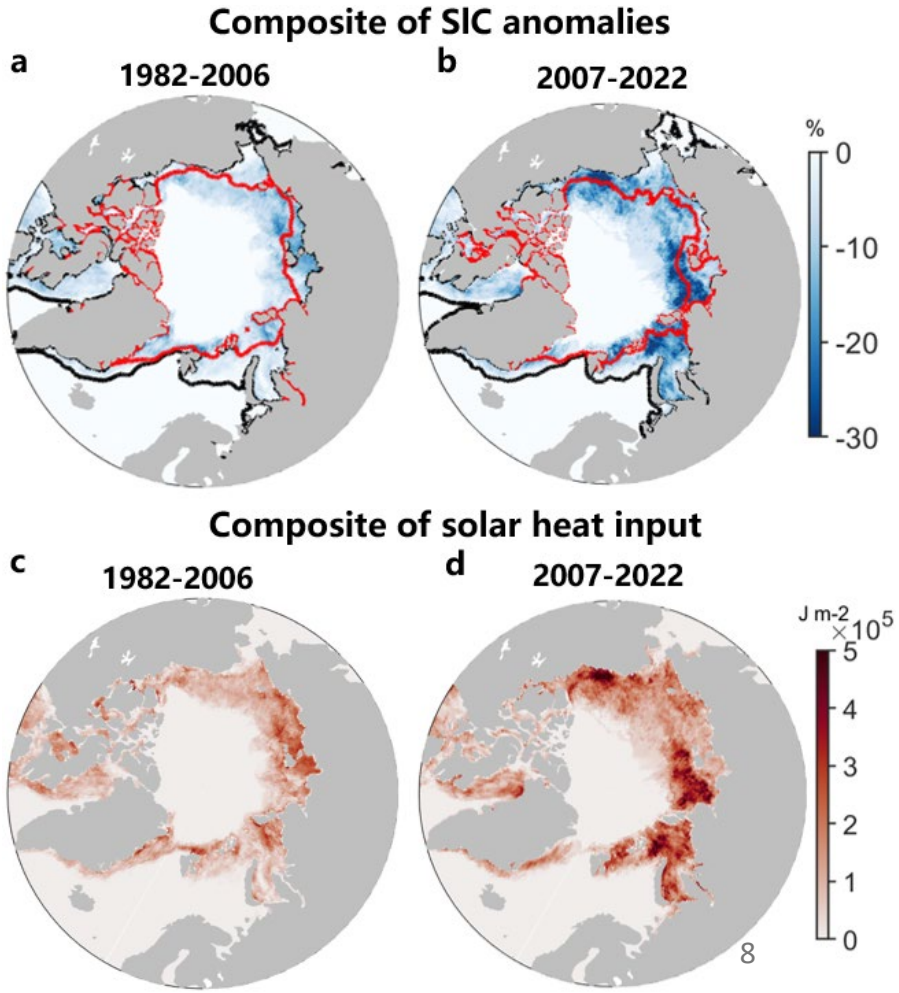


Strengthened feedback between short-term extremes (noise) and mean state after 2007

Causality calculation: Liang-Kleeman information flow (Liang, 2021)



The increased MHWs after 2007 have stronger impacts on sea-ice melting and solar heat input



Main messages

2007: A noise-induced transition in the marginal ice zone

– SST abruptly increases, variability doubles

– Background: Sea ice becomes thin and fragile → ocean more susceptible to air-sea interactions

Trigger: Remarkable increase in short-term heating extremes (MHWs)

New state after 2007:

– Elevated MHWs

– Enhanced sea ice melting and solar heat absorption

Welcome collaboration!

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(Subarctic-Arctic Interest League)

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