Climatology of sea ice changes attributed to cyclones, fronts, and cold-air outbreaks

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https://svs.gsfc.nasa.gov/11238

Motivation

Changing Arctic

Increasing fractions of dynamically fragile first-year ice

→**Rising importance of atmosphere-sea ice coupling**

→Consider atmosphere-sea ice coupling in weather & sea ice forecasts and climate models

Rapid changes in sea ice cover on synoptic scale

- **Cyclones**
- **Fronts**
- **Cold-air outbreaks (CAO)**

Goal: estimate contribution of weather effects on sea-ice concentration (SIC)

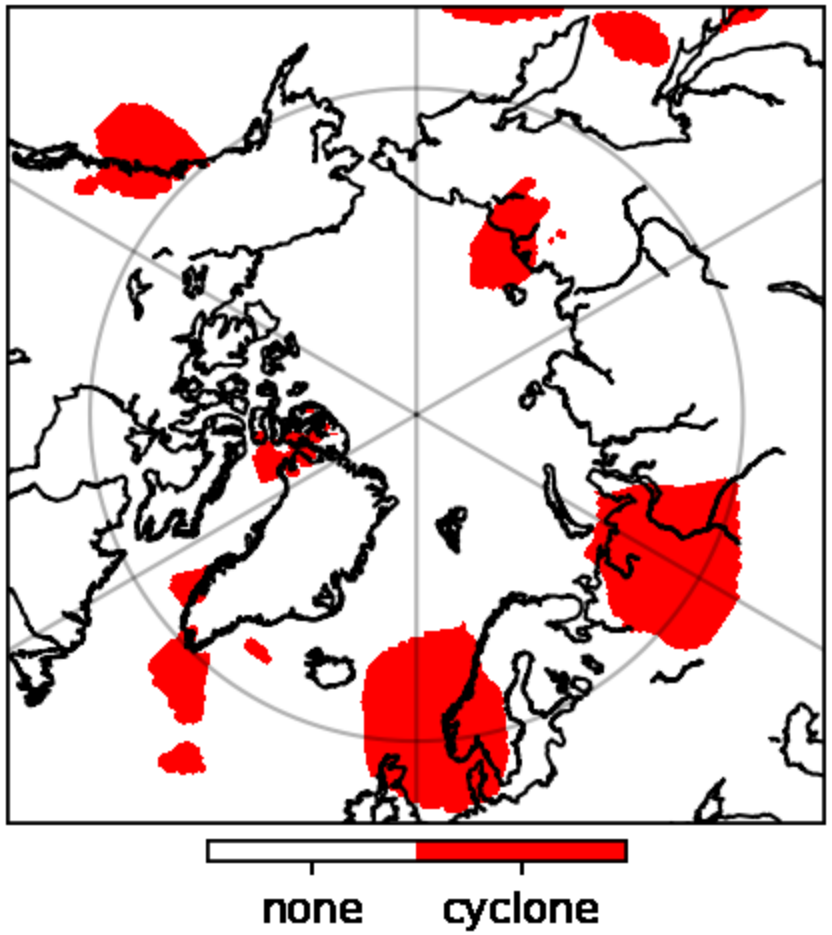
Method: feature-based analysis of sea ice climatologies

CERA-SAT 2008-2016 **fully coupled reanalysis**

feature based analysis of sea ice climatologies (CERA-SAT 2008-2016)

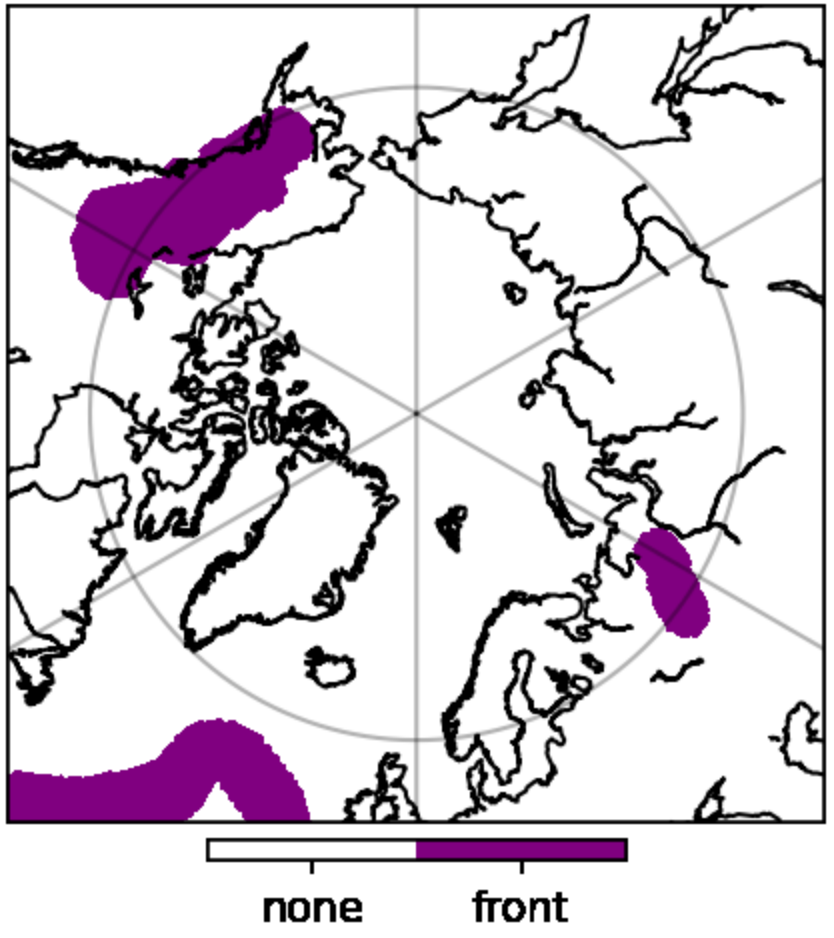
Cyclone masks

closed contours around SLP minimum



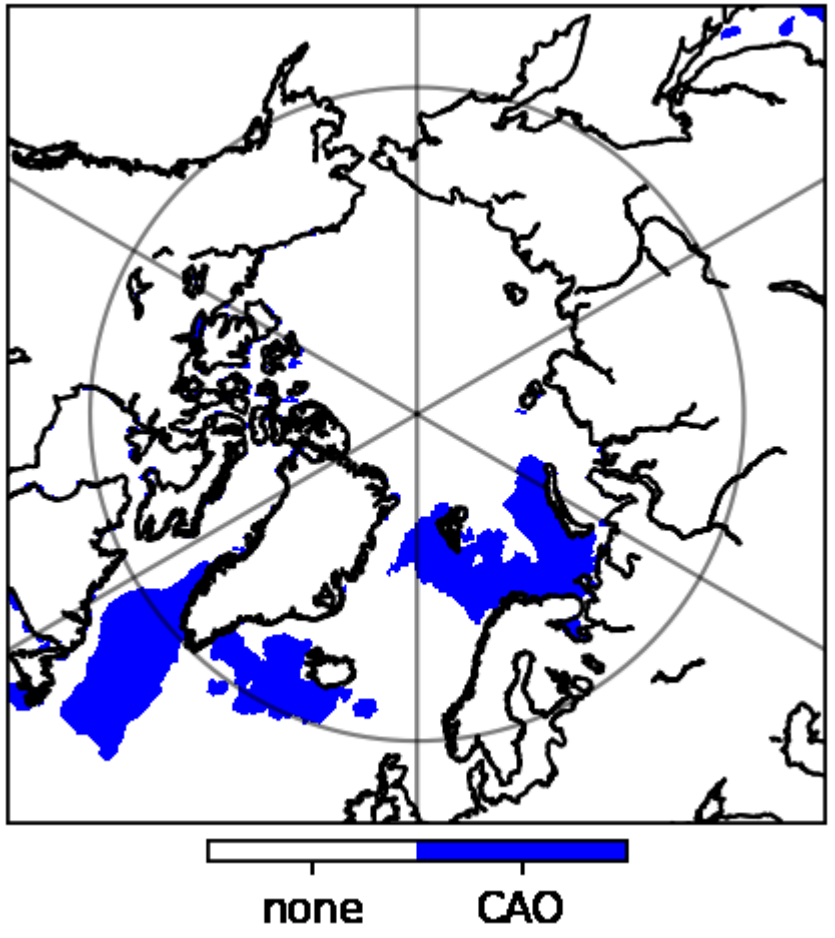
Front masks

volumes of equiv. pot. temp. gradients intersecting with 850 hPa, +/-200 km



CAO masks

surface pot. temp. Exceeds pot. temp. at 850 hPa by min 4K



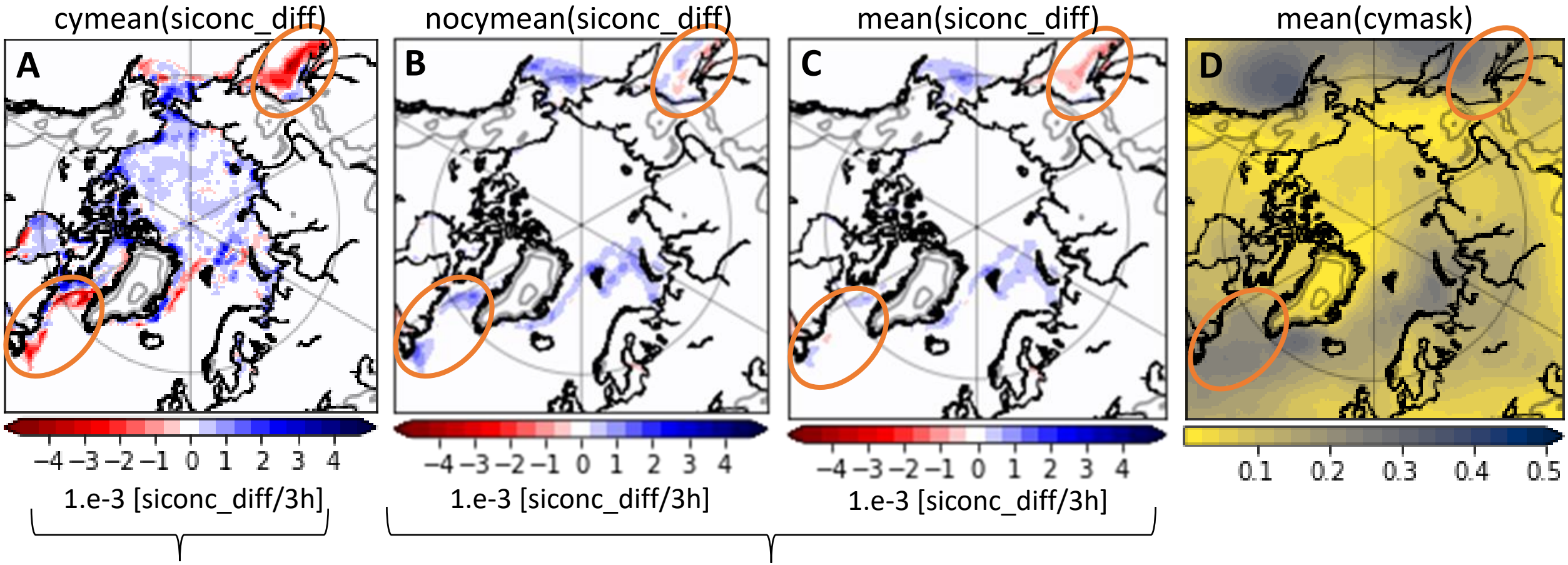
example: 01.03.2008 00:00 UTC

Results

example for March 2008-2016

March 2008-2016

Cyclone masks

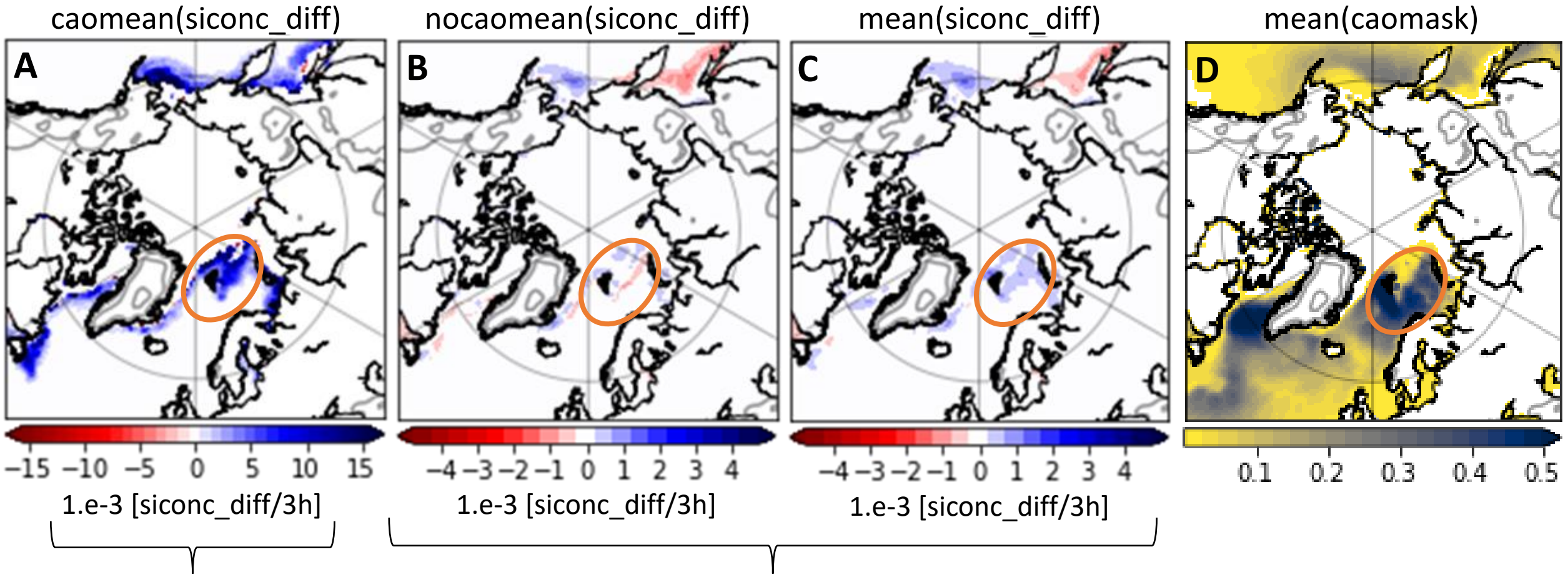


- **SIC increase & decrease under cyclone masks**

- **negative effect of cyclones on SIC dominates**
- **effect on SIC climatology rather small compared to individual signals**

March 2008-2016

Cold-air outbreak (CAO) masks

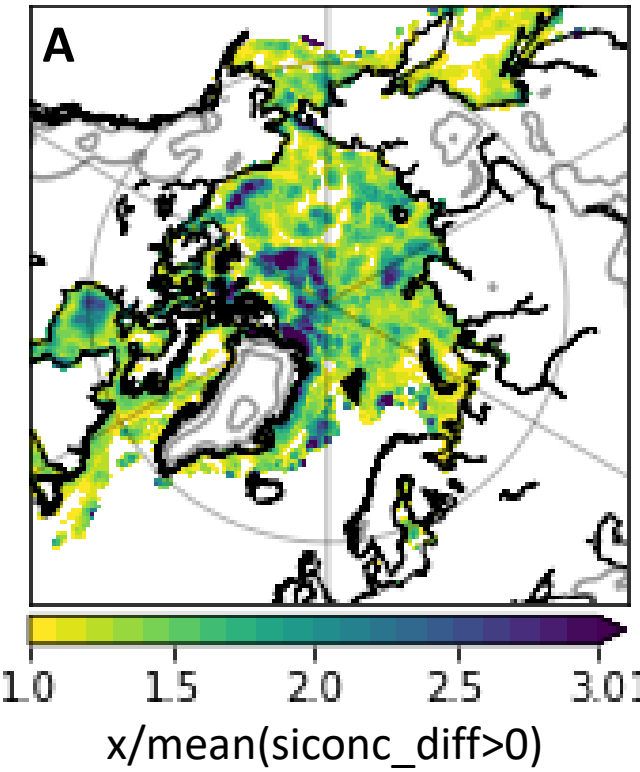


- **mostly SIC increase under CAO masks**
- **stronger signals than for cyclone & front masks**
- **positive effect of CAOs on SIC dominates**
- **effect on SIC climatology rather small compared to individual signals**

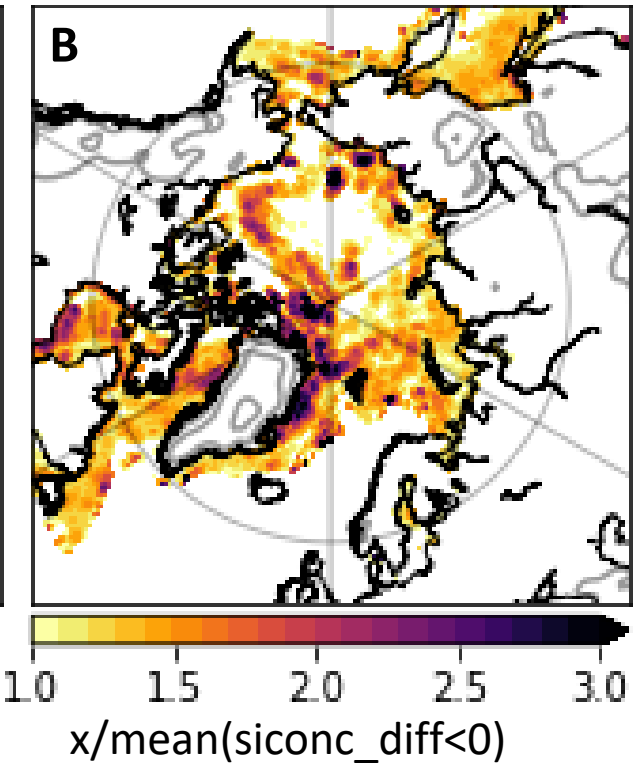
March 2008-2016

Cyclone mask = True

cymean(siconc_diff > 0)

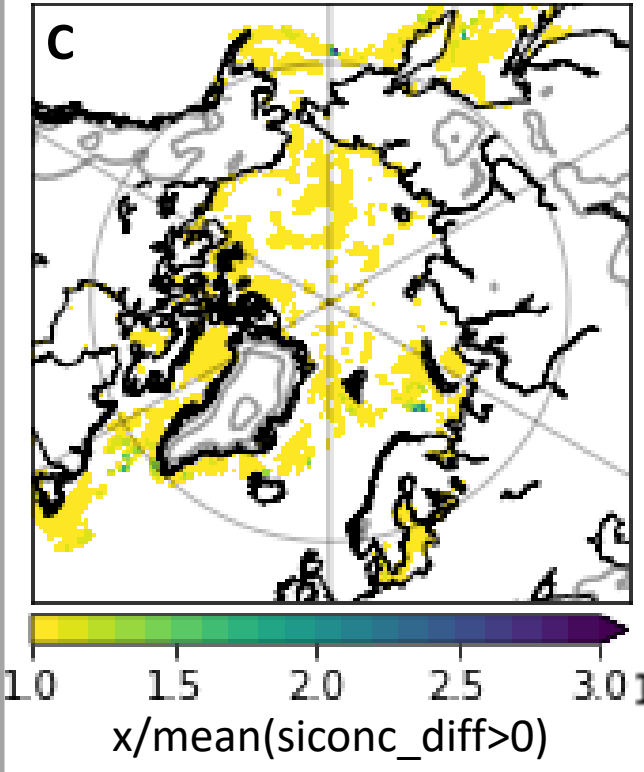


cymean(siconc_diff < 0)

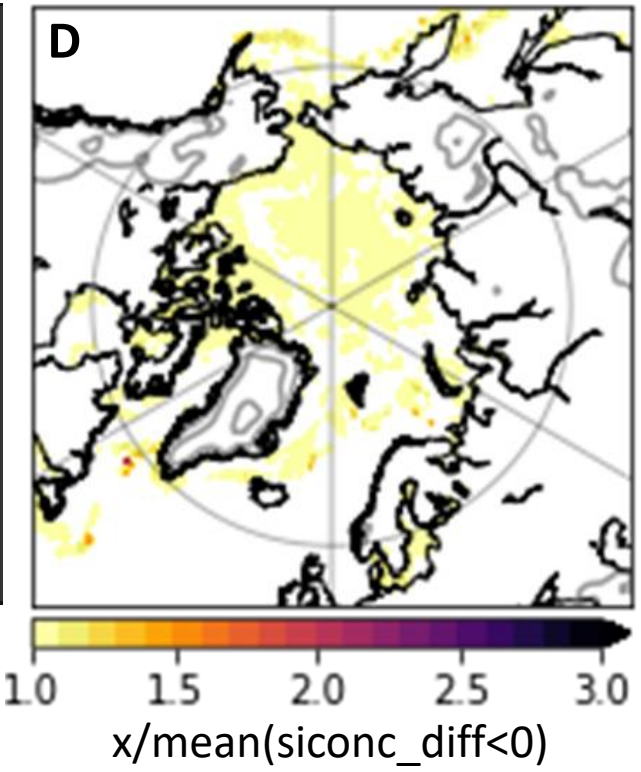


Cyclone mask = False

nocymean(siconc_diff > 0)



nocymean(siconc_diff < 0)



- **enhanced SIC increase & decrease under cyclone masks**

(analogous results for front masks and CAO masks)

Conclusion

- **Cyclones, fronts** and **cold-air outbreaks reinforce SIC increase & decrease** independent of the seasonal SIC tendency **+/-**

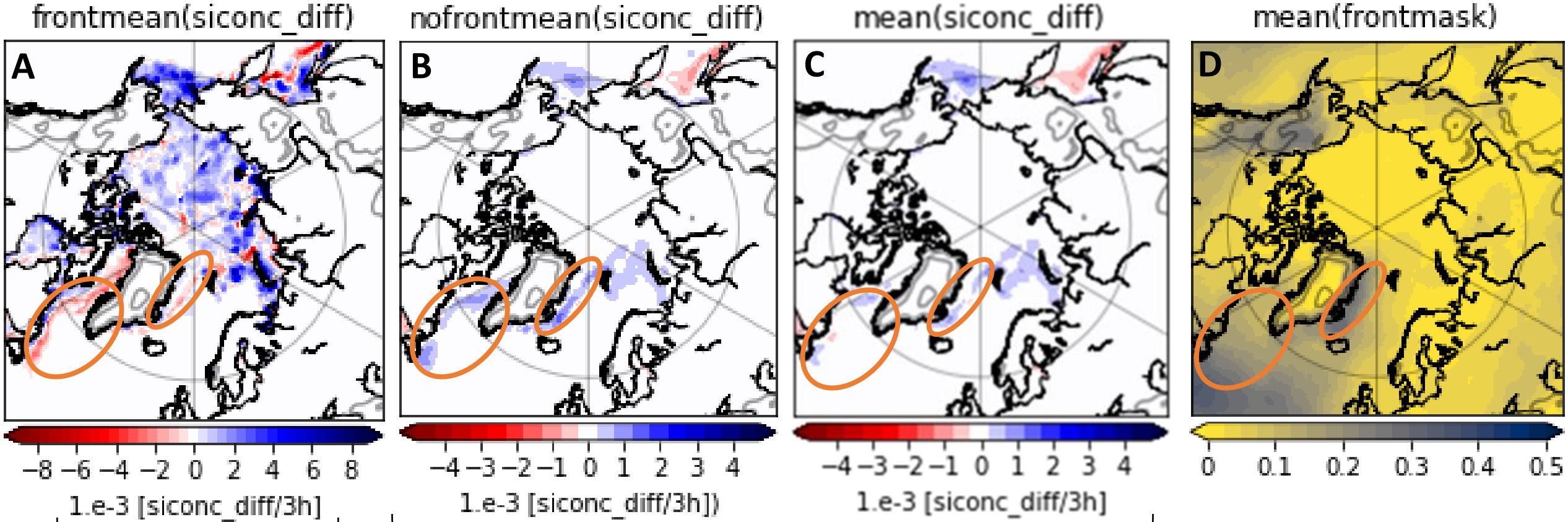
- Despite strong individual signals, the weather features have a rather small effect on SIC climatologies

- Observed overall effect on SIC:
  - **Cyclones:** **-** **slightly decreasing SIC**
  - **Fronts:** **-** **slightly decreasing SIC**
  - **Cold-air outbreaks:** **+** **increasing SIC**

Appendix

March 2008-2016

Front masks



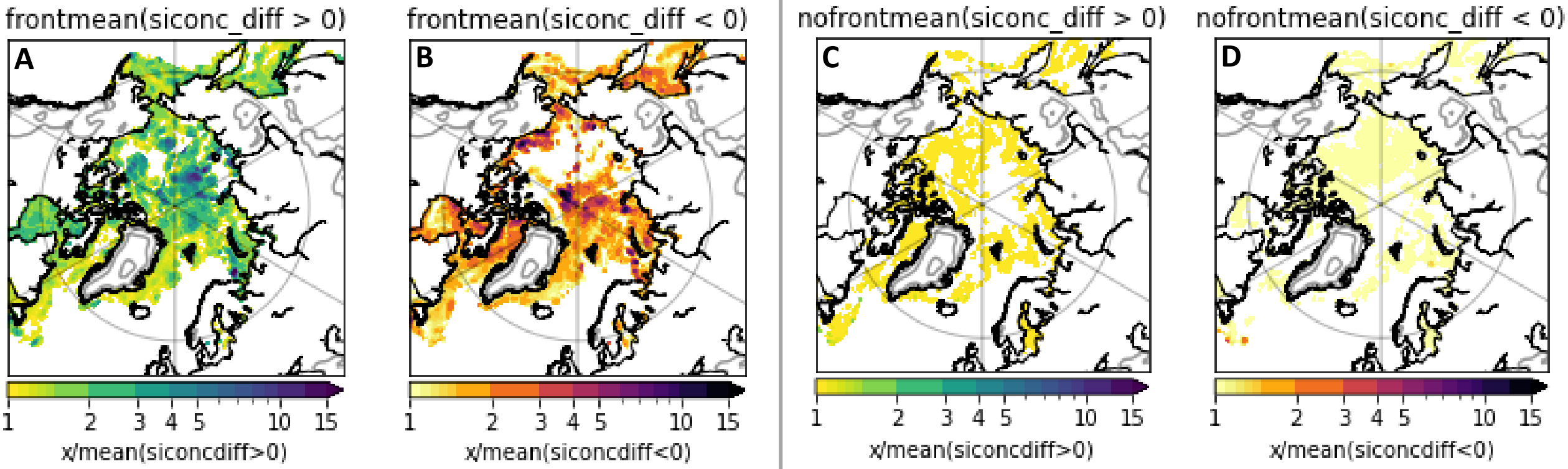
- **SIC increase & decrease under front masks**
- **Stronger signals than for cyclone mask**

- **negative effect of fronts on SIC dominates**
- **effect on SIC climatology is rather small compared to individual signals**

March 2008-2016

Front mask = True

Front mask = False



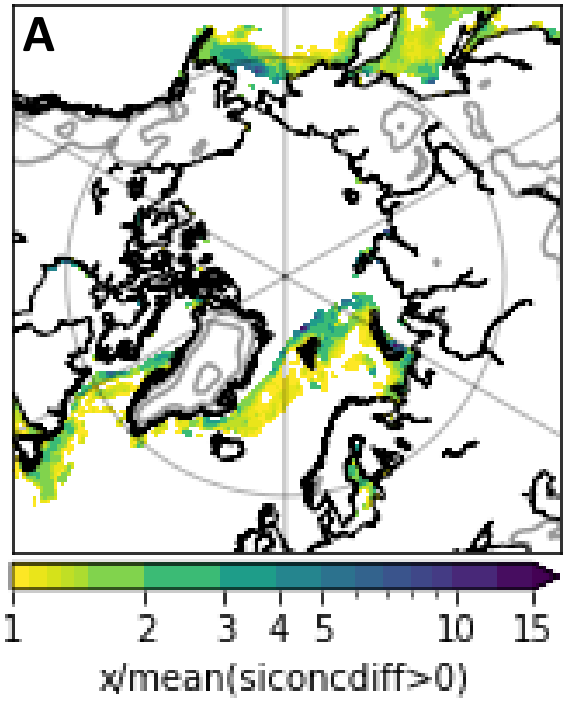
- **enhanced SIC increase & decrease under front masks**

March 2008-2016

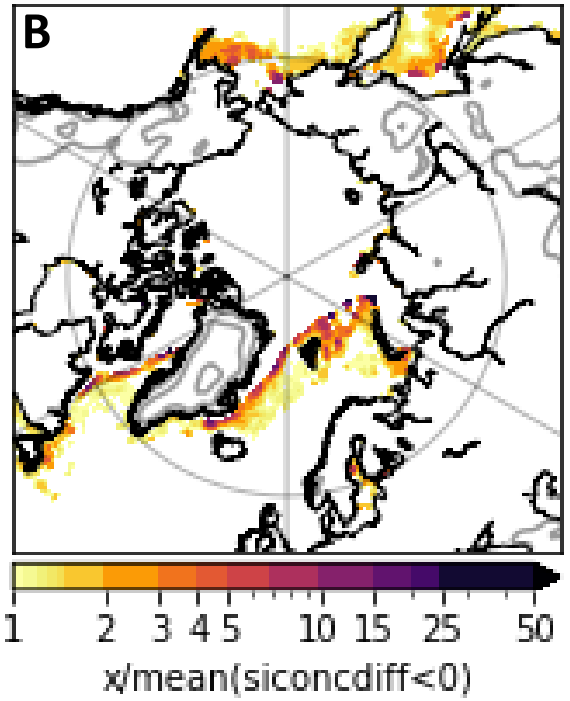
CAO mask = True

CAO mask = False

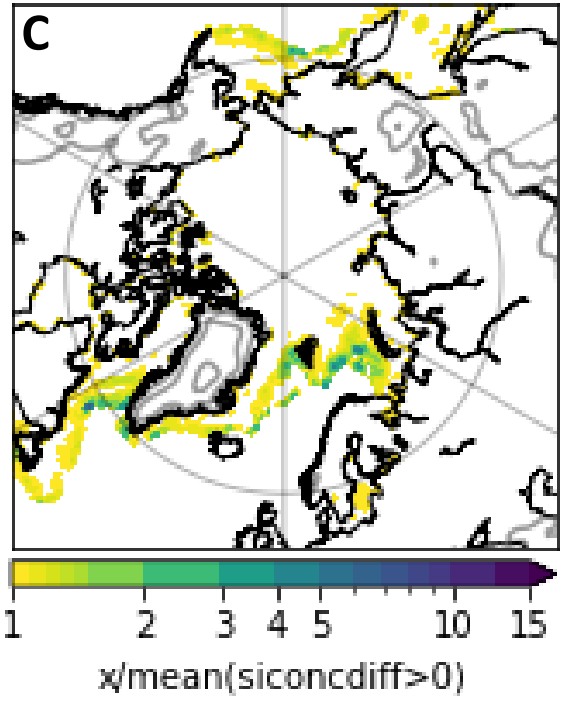
caomean(siconc_diff > 0)



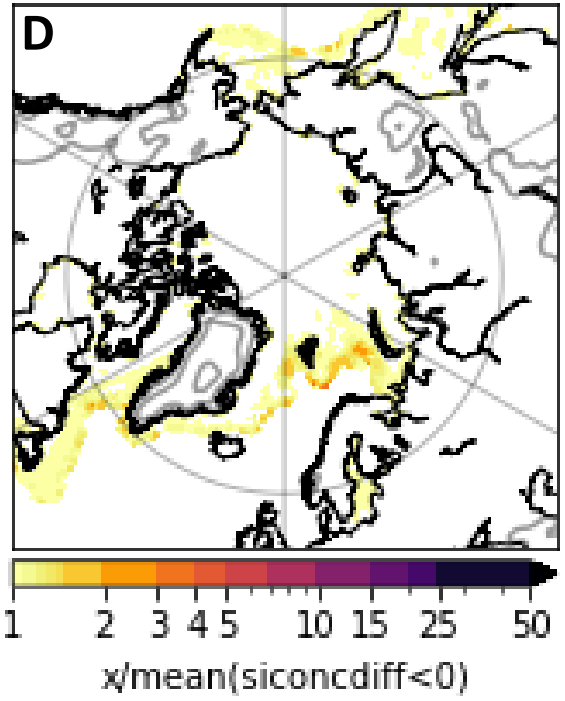
caomean(siconc_diff < 0)



nocaomean(siconc_diff > 0)



nocaomean(siconc_diff < 0)



- **enhanced SIC increase & decrease under CAO masks**