Spatio-temporal variability of synchronicity between ice retreat and phytoplankton blooms in the polar regions

Rubao Ji[1],

Yun Li[1], Stephanie Jenouvrier[1], Meibing Jin[2],

Julienne Stroeve[3], Garrett Campbell[3], Øystein Varpe[4]

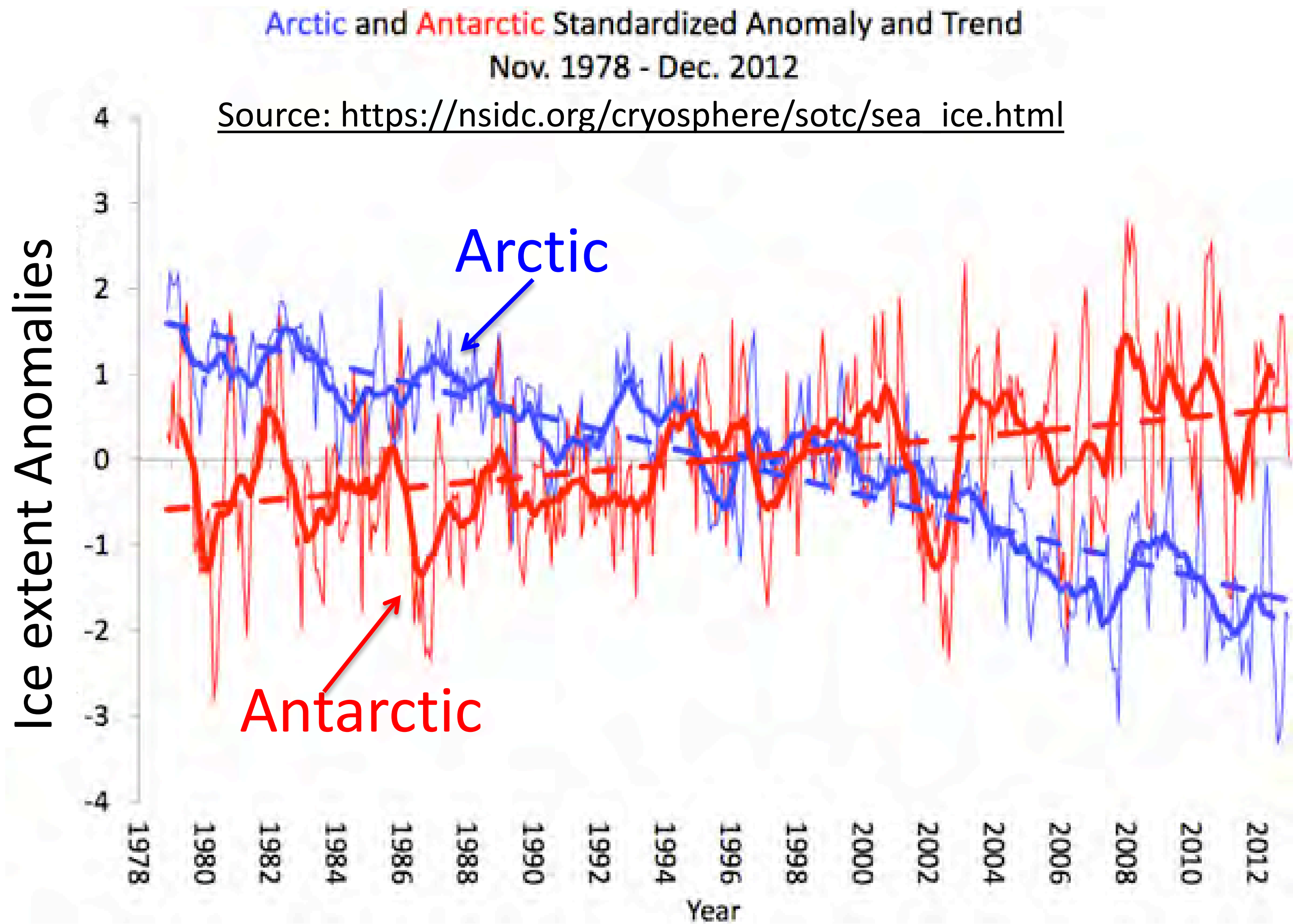
[1] Woods Hole Oceanographic Institution, USA.

[2] University of Alaska Fairbanks, USA

[3] National Snow and Ice Data Center, USA

[4] University Centre in Svalbard (UNIS), Norway

Changing Sea Ice



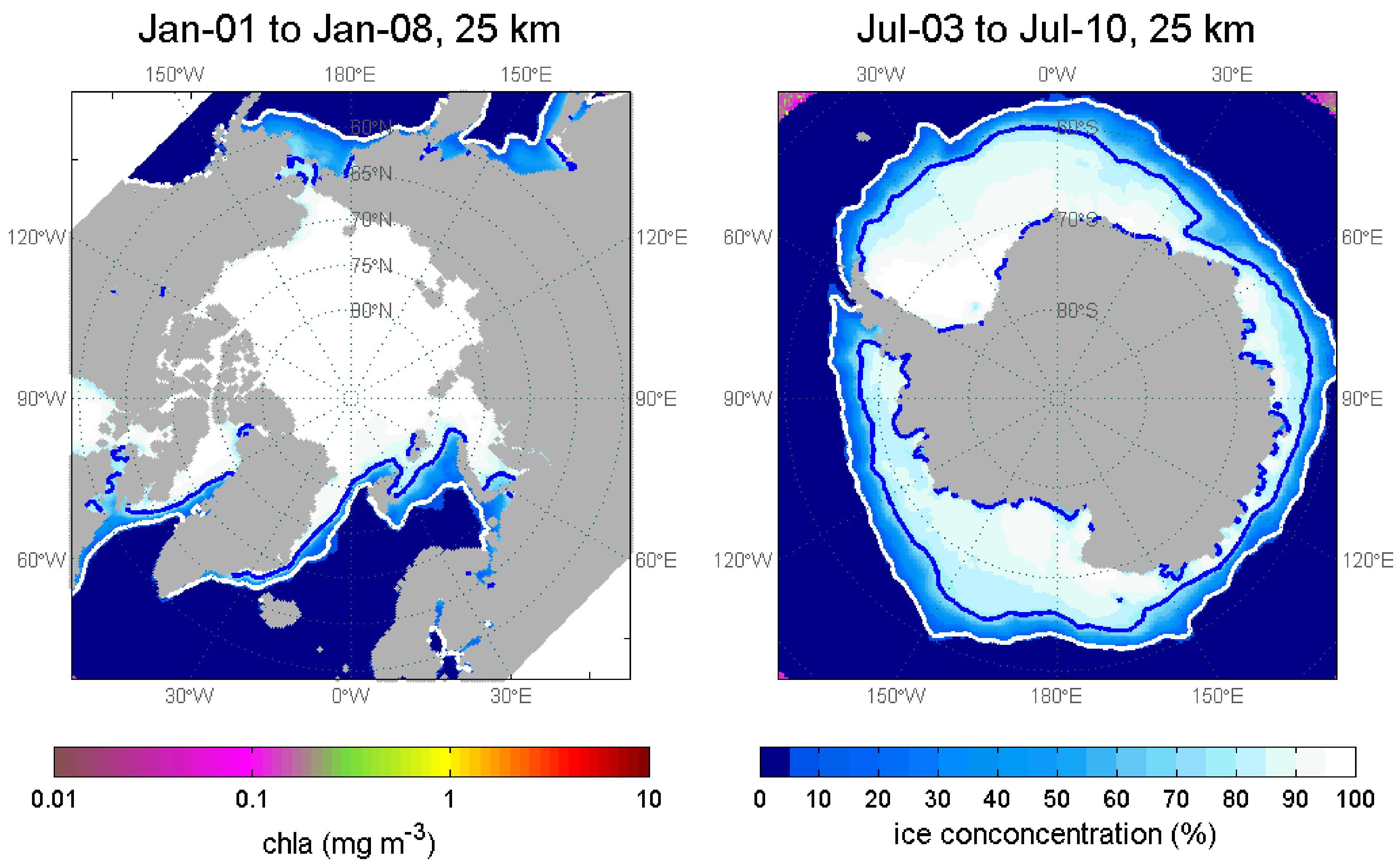
Key questions

1) Variability of ice retreat and phytoplankton bloom timing

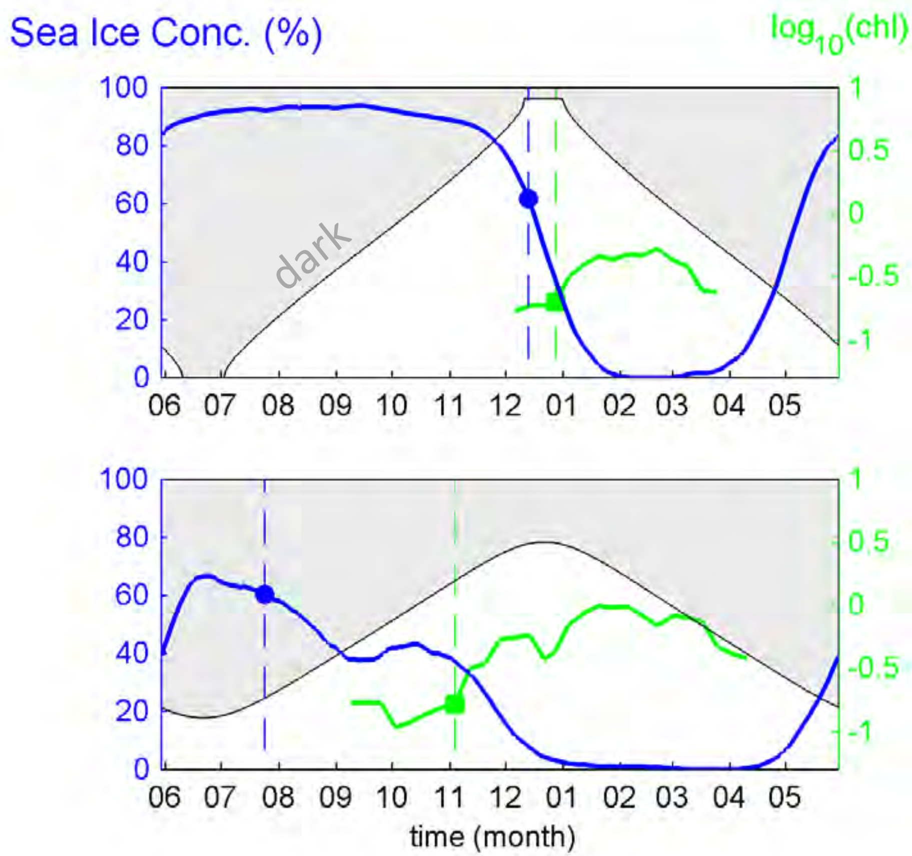
2) Links between ice retreat and phytoplankton bloom timing (lags & synchronicity)

3) Differences between polar systems

Ice, light and phytoplankton



Timing detection



<u>Data</u>

- NSIDC **Sea Ice Concentration** (SIC) dataset, 25 km, quasi-daily, 1978-2013
- GLOBCOLOUR **chlorophyll**, 4 km, 8-day, 1997-2013

<u>Processing</u>

- Interpolate chla onto sea ice mesh (grid-average)
- 24-day (3-point) running mean for sea ice (chla)

<u>Timing detection</u>

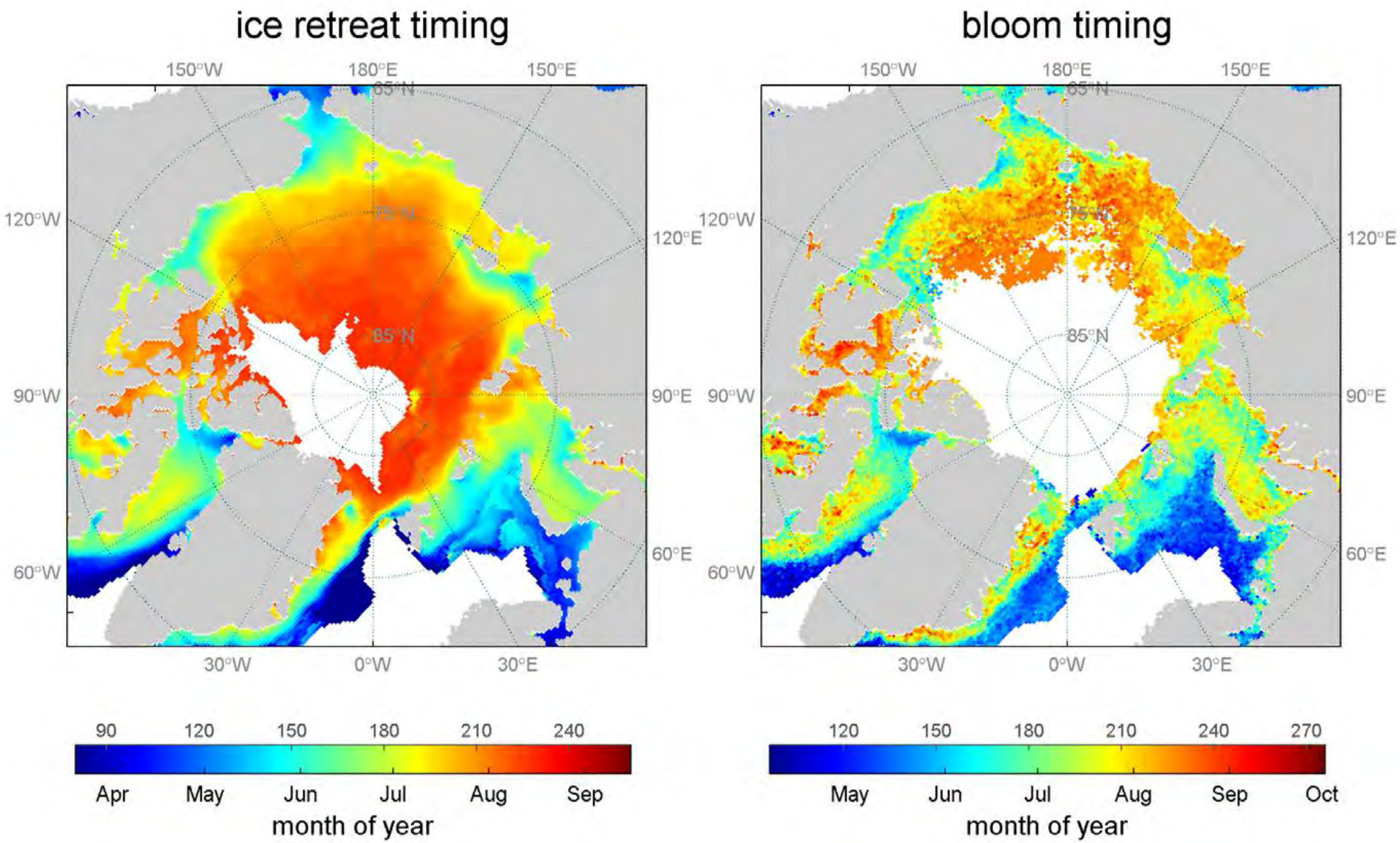
$$t_{\text{ice\_retreat}} = \min(t_{\max}, t|_{SIC=60\%})$$

$$t_{\text{bloom}} = t|_{\max(\frac{dLn(chla)}{dt})}$$

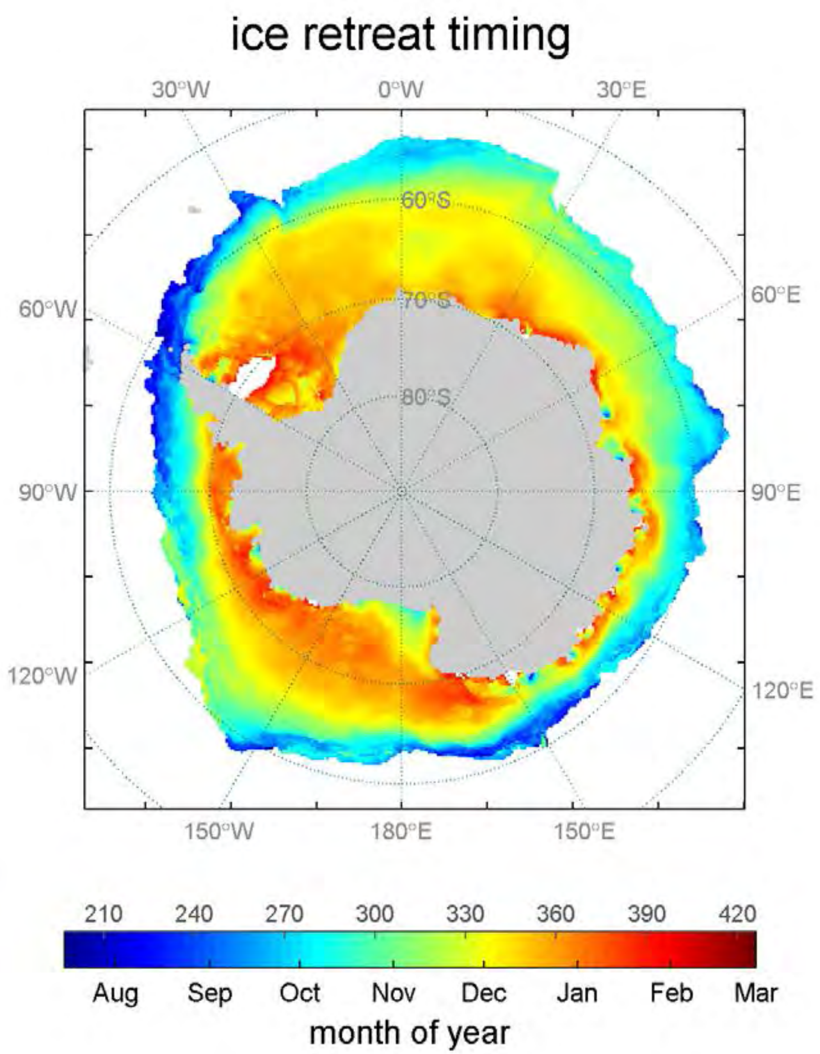
where,

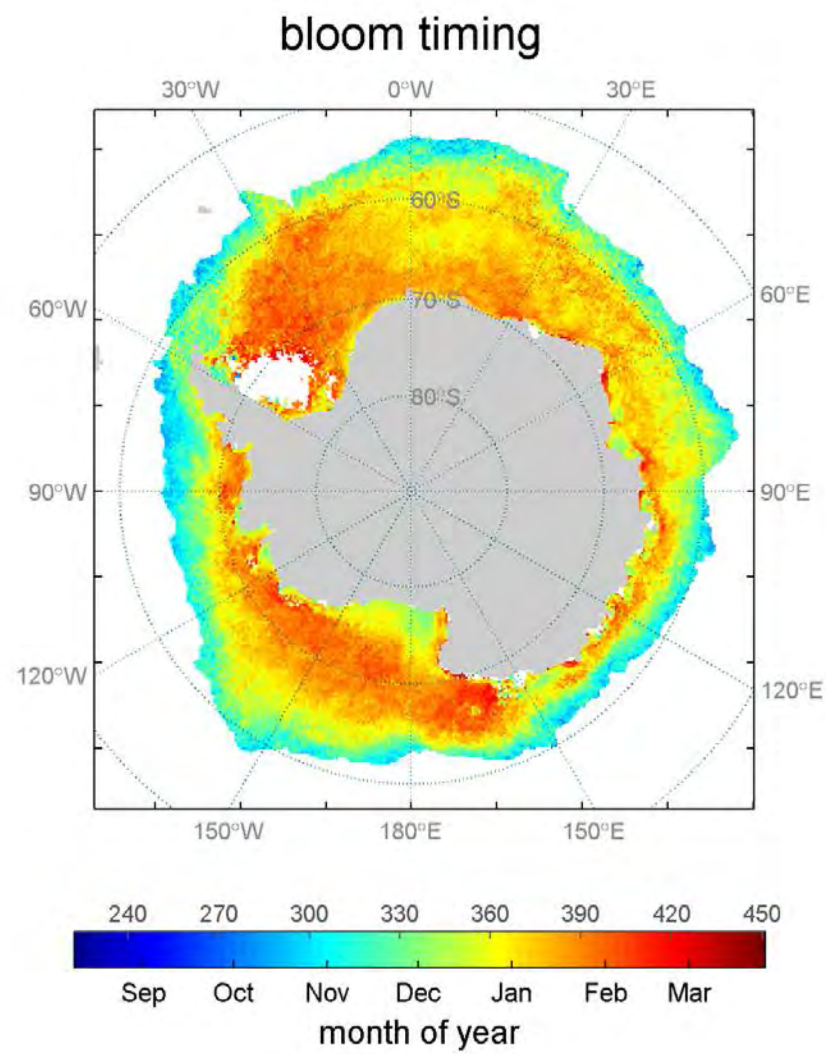
t_{max}= Sept-15 for the Arctic .
Feb-15 for the Antarctic.

Climatology: Arctic

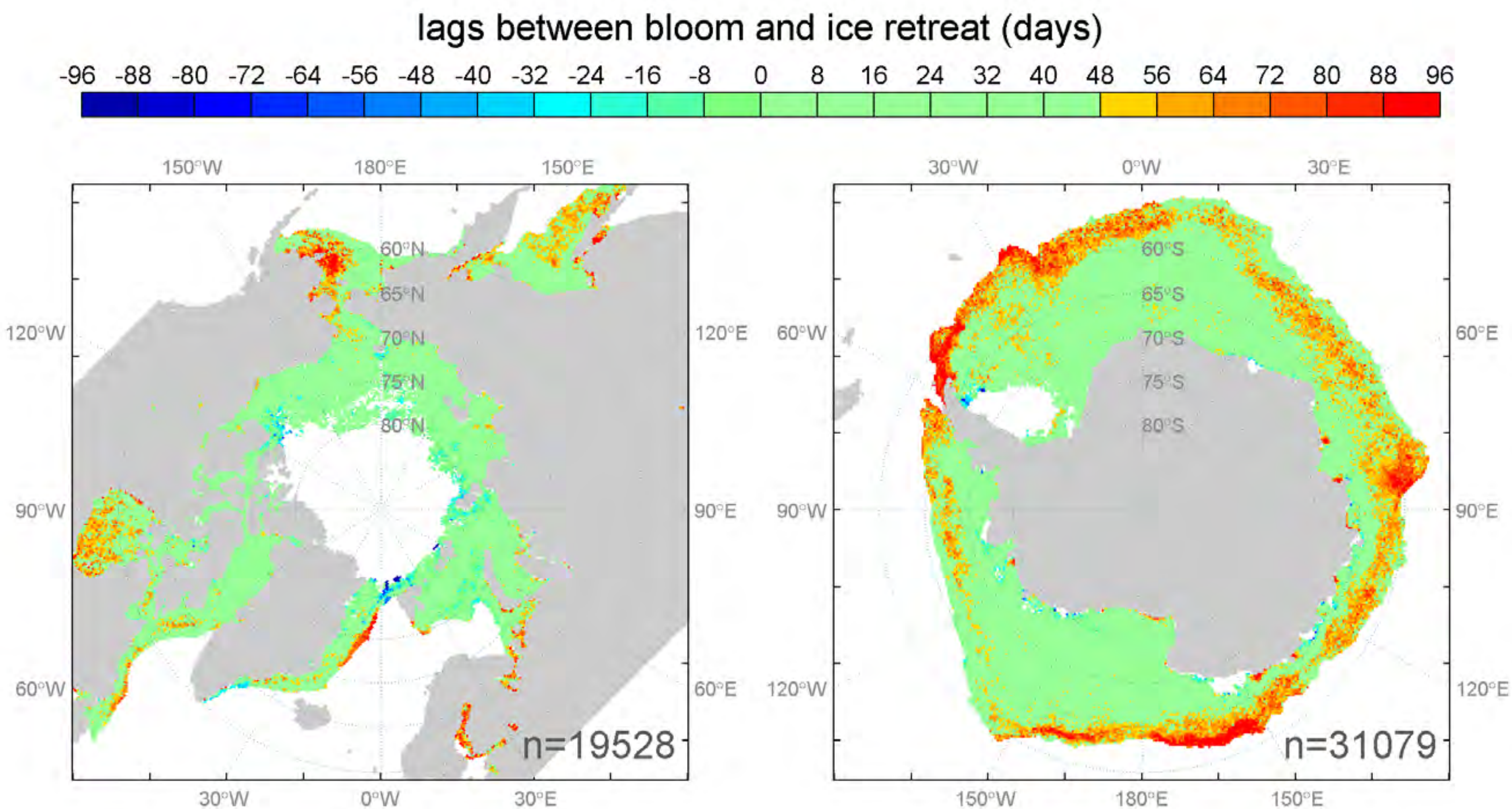


Climatology: Antarctic

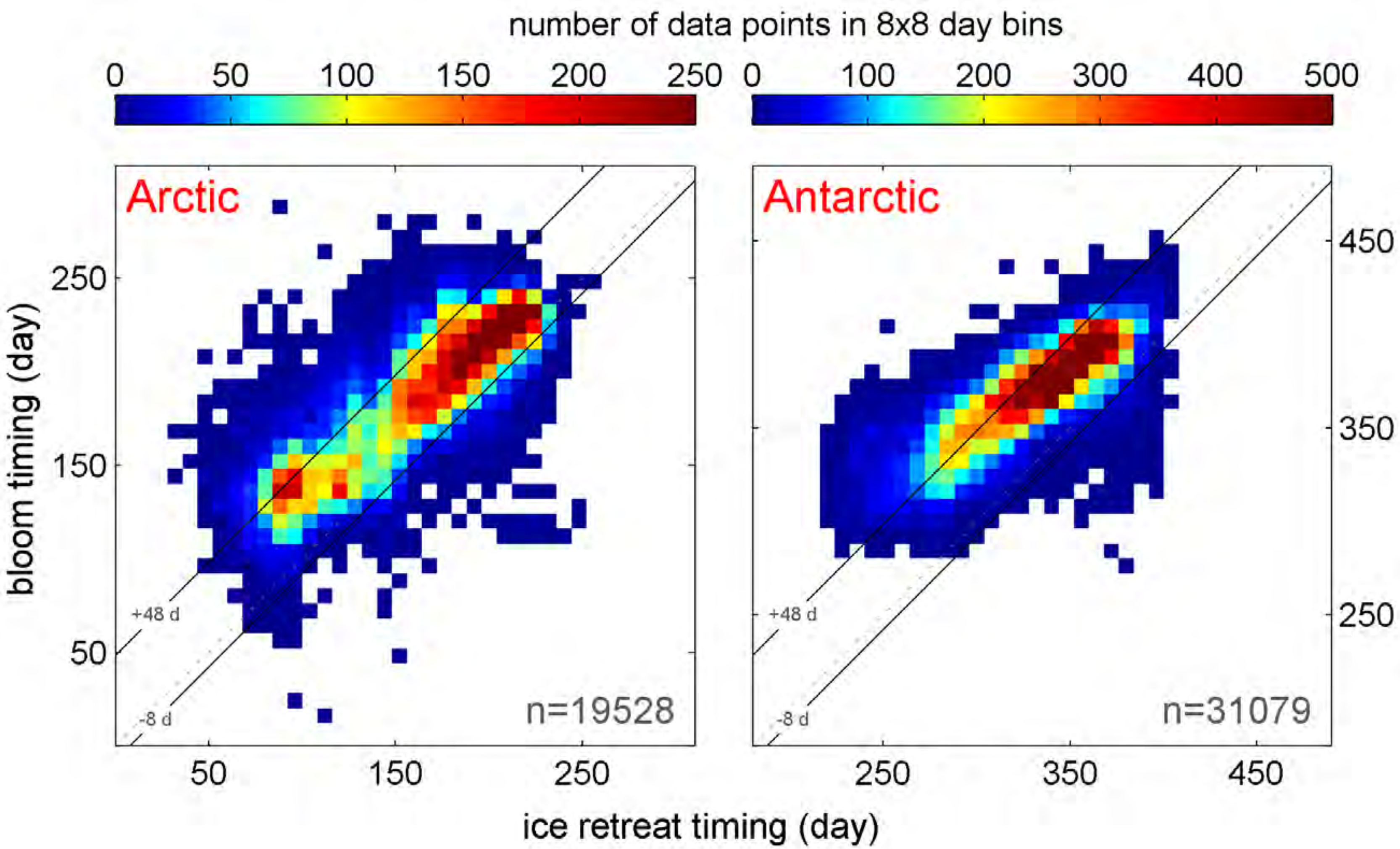




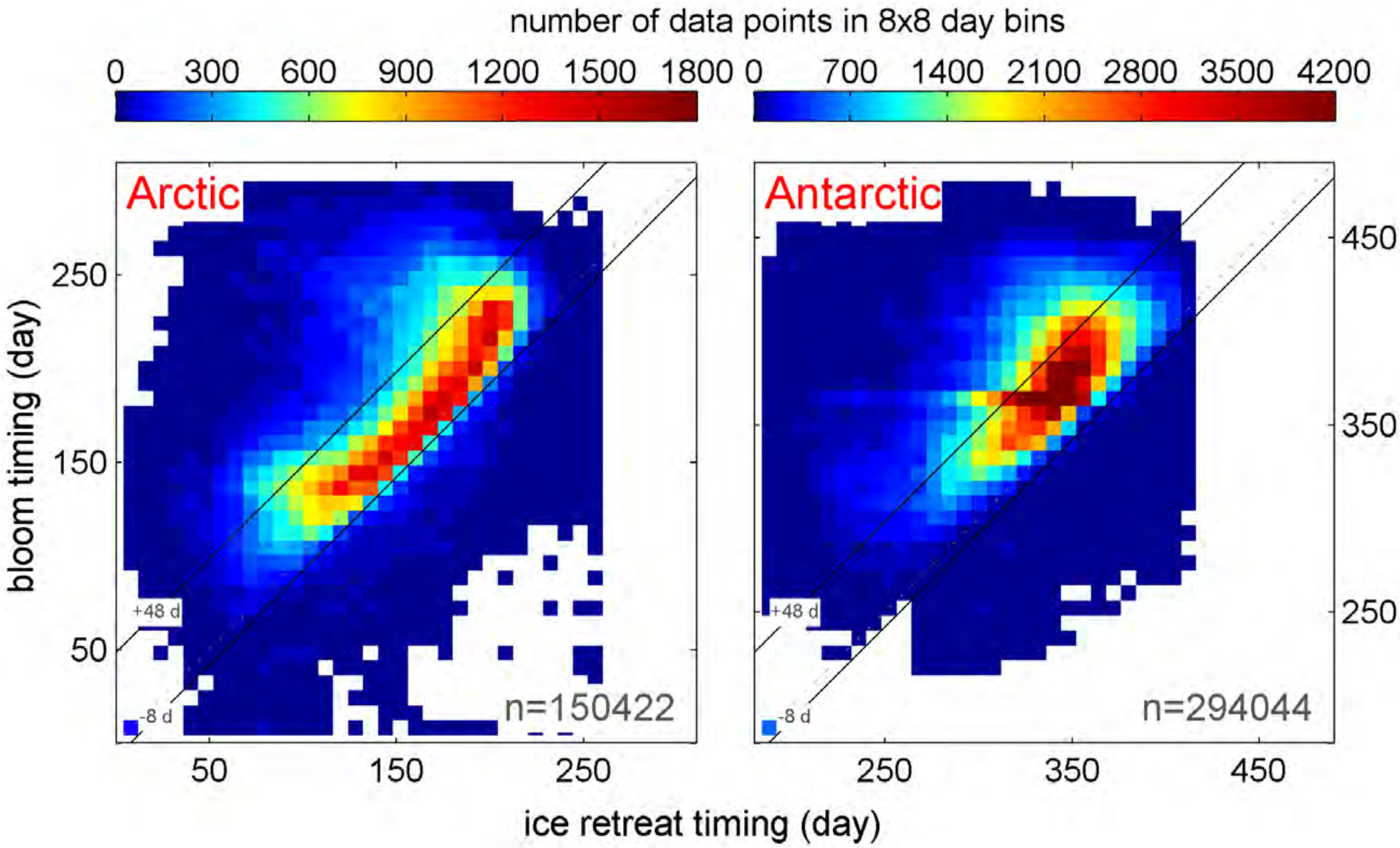
Climatology: time lags



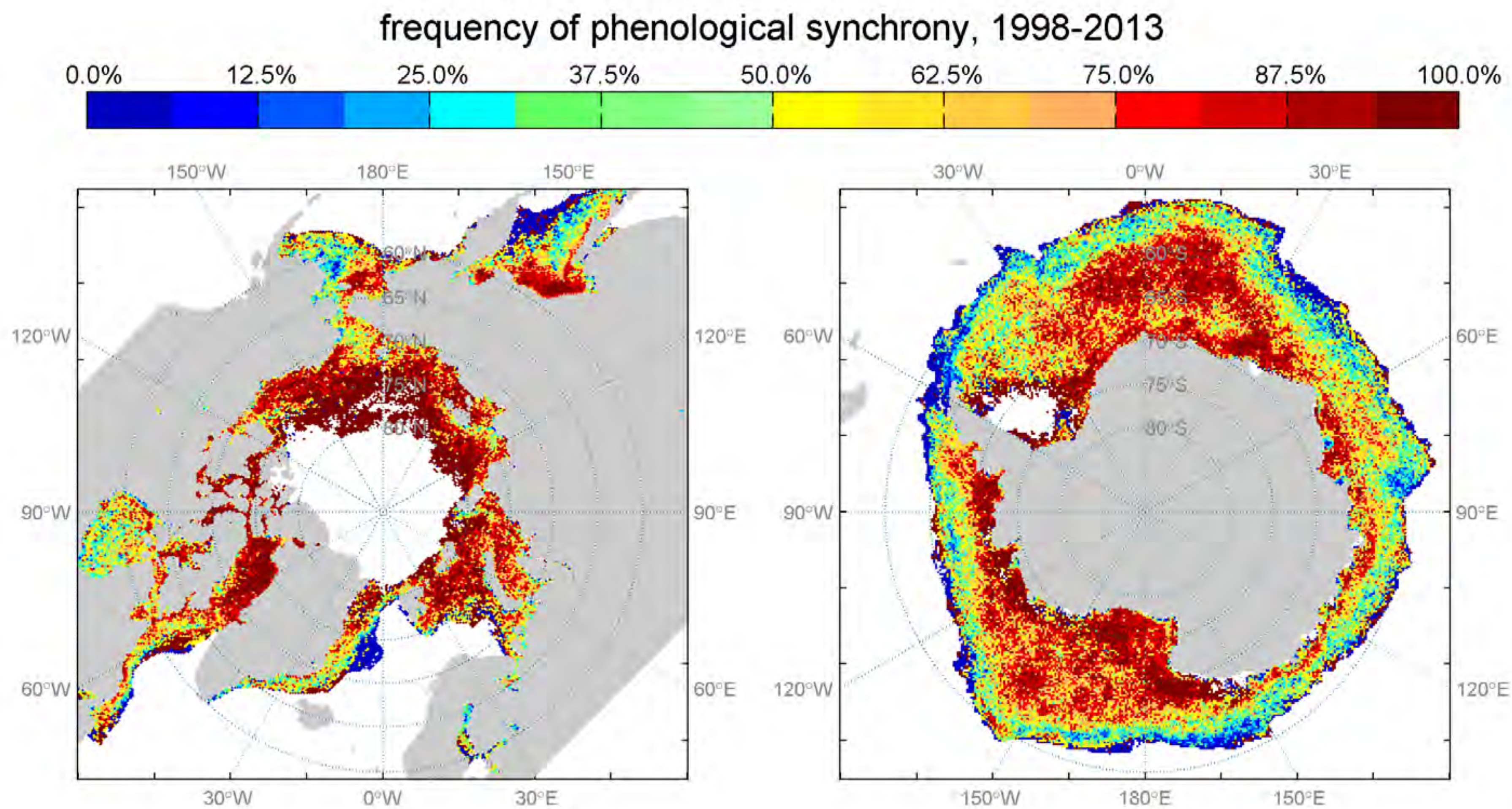
Synchronicity plot: climatology



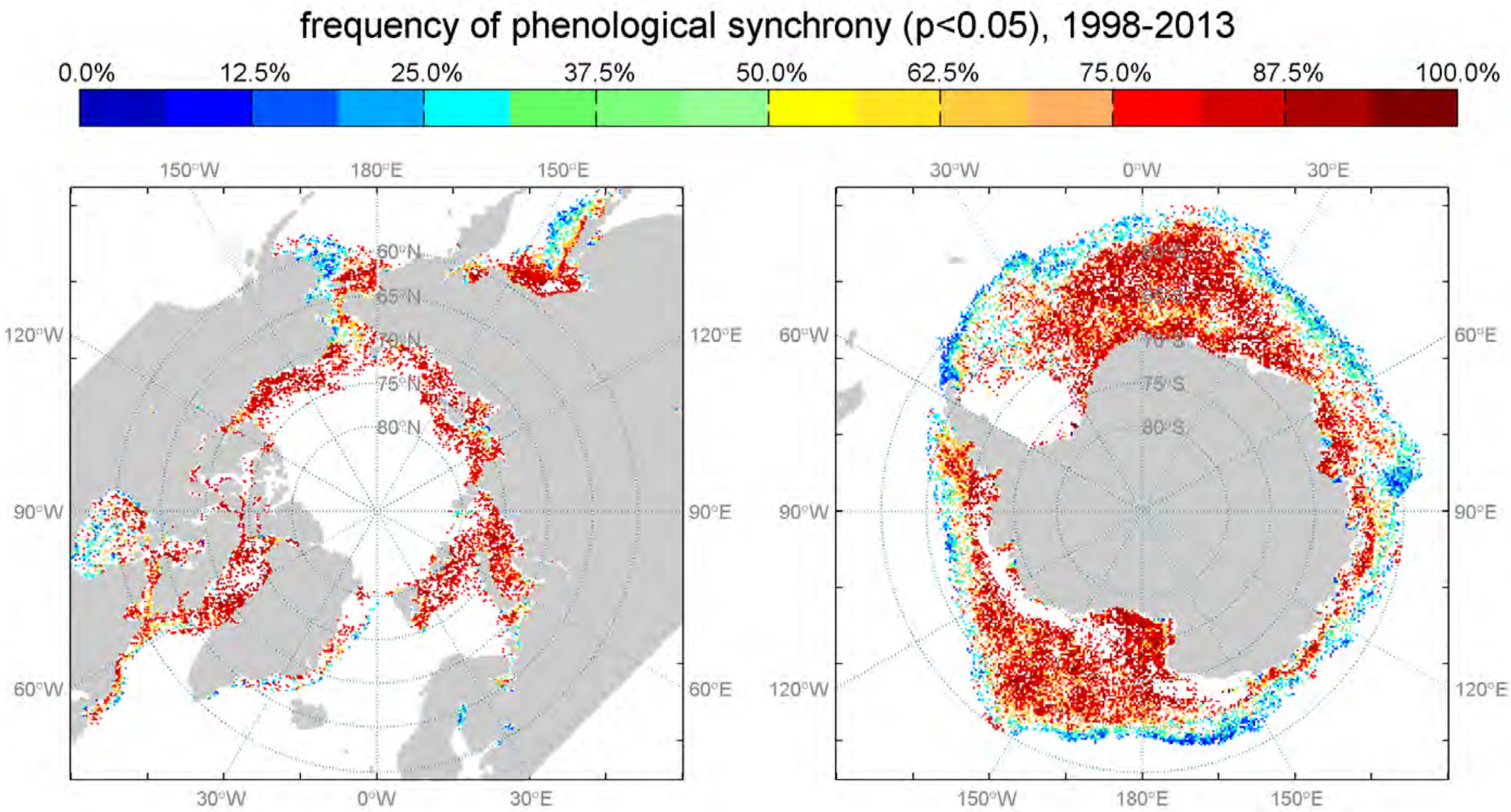
Synchronicity plot: 1998-2013



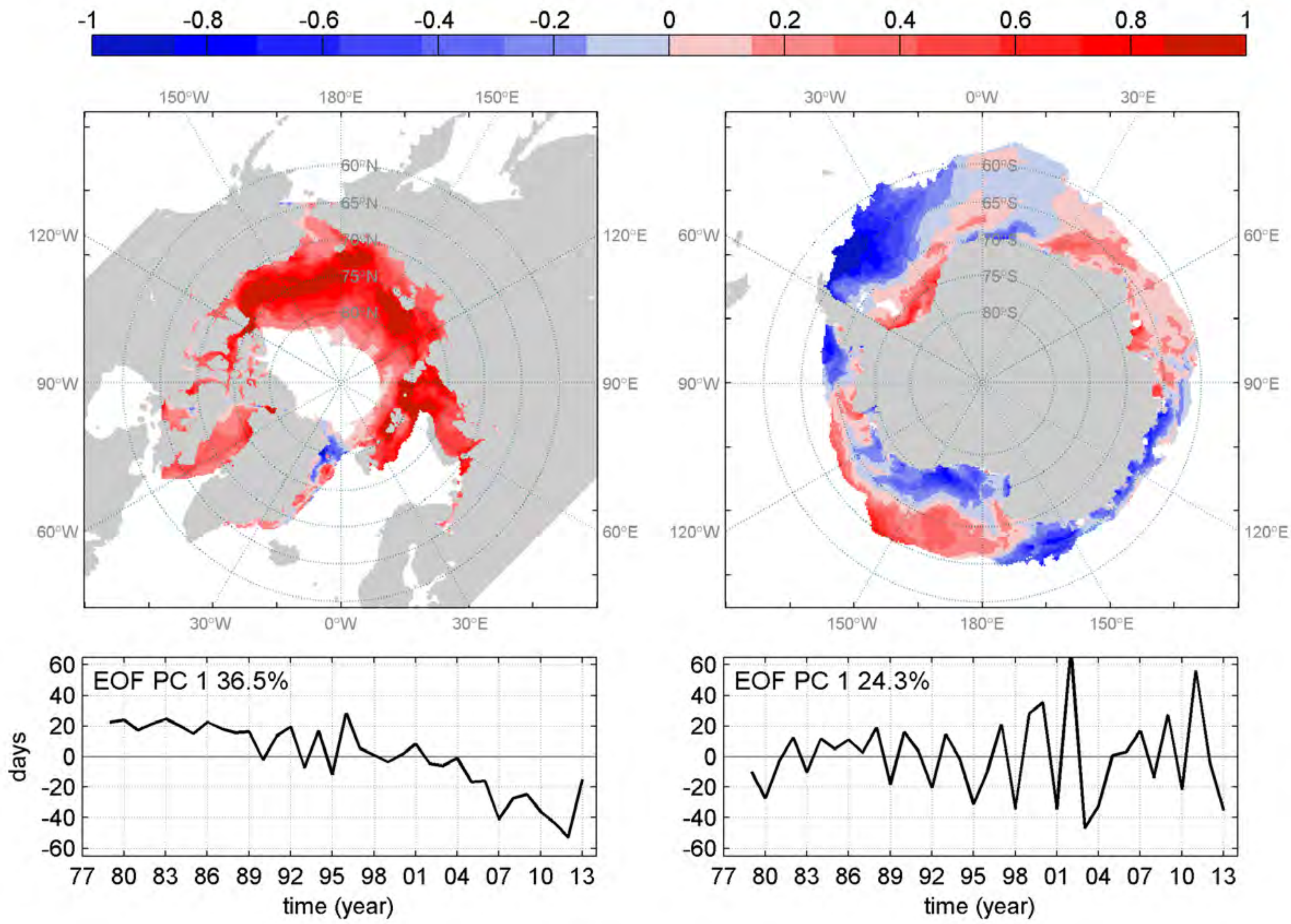
Frequency of Synchrony (Arctic vs Antarctic)



Frequency of Synchrony (Arctic vs Antarctic)



EOF analysis (Arctic vs Antarctic)



Summary

1) Climatology:

- Synchronicity varies over latitudes: higher synchronicity at high-latitudes than low-latitudes.
- Synchronicity pattern is similar in both polar regions.

2) Inter-annual:

- Higher probability of synchrony occurrence at high-latitudes than low-latitudes (in both polar regions)
- Ice retreat shows declining trend over the entire Arctic; but in Antarctic, no clear trend detected; with regional varibility.

3) Implications:

- Changing Ice retreat timing causes phytoplankton phenology shift, possibly leading to changes in growth season in polar systems, and affect higher trophic levels including zooplankton and even sea birds.

Acknowledgement

NSF: PLR – Arctic System Science Program

NSF: ANT – Antarctic Organisms & Ecosystem Program

NASA: Interdisciplinary Research in Earth Science