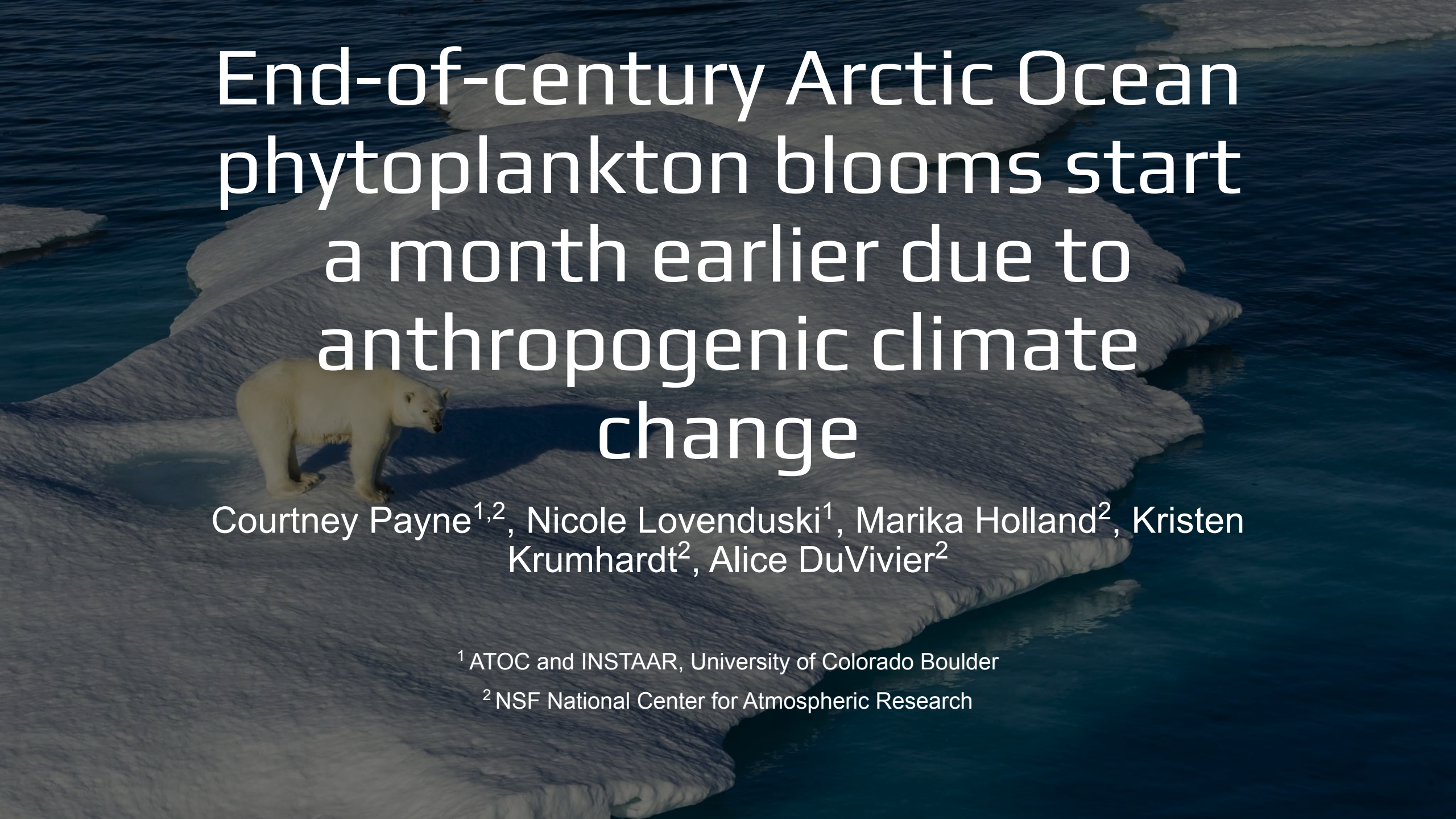
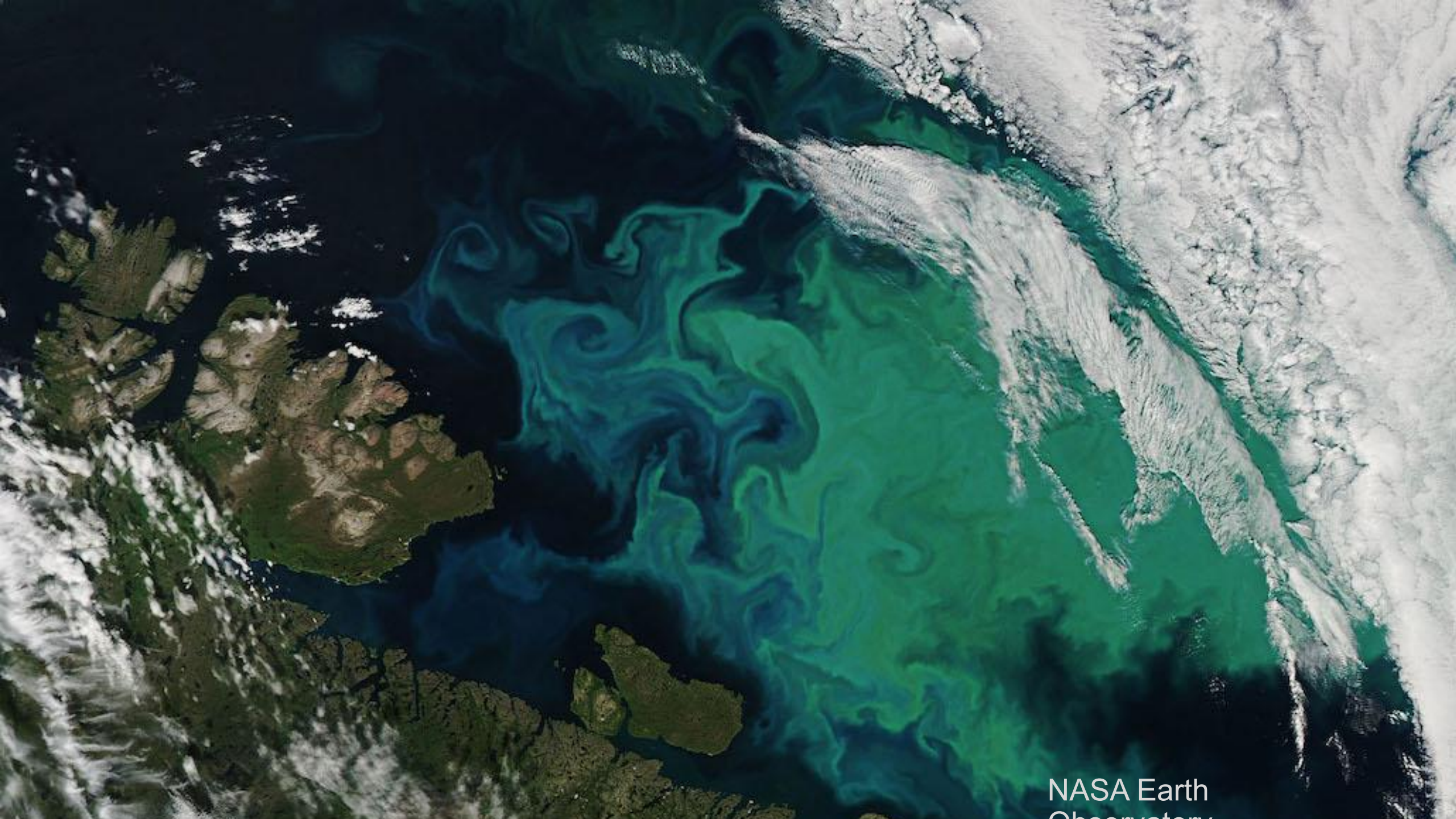


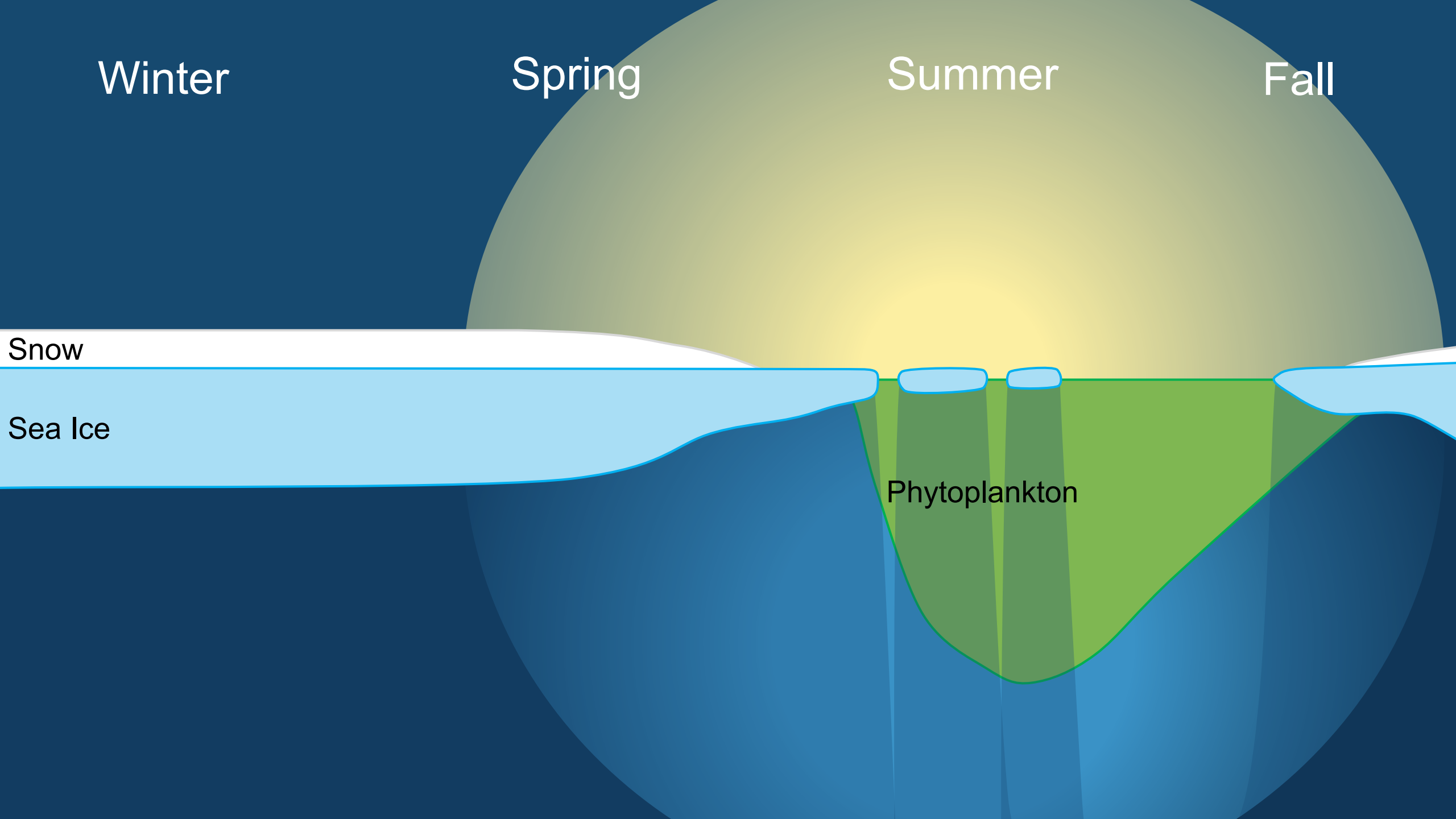
End-of-century Arctic Ocean phytoplankton blooms start a month earlier due to anthropogenic climate change

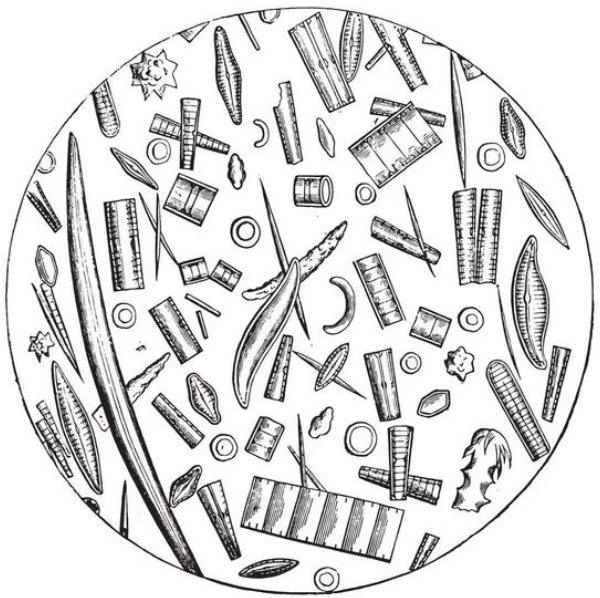
Courtney Payne[1,2], Nicole Lovenduski[1], Marika Holland[2], Kristen Krumhardt[2], Alice DuVivier[2]

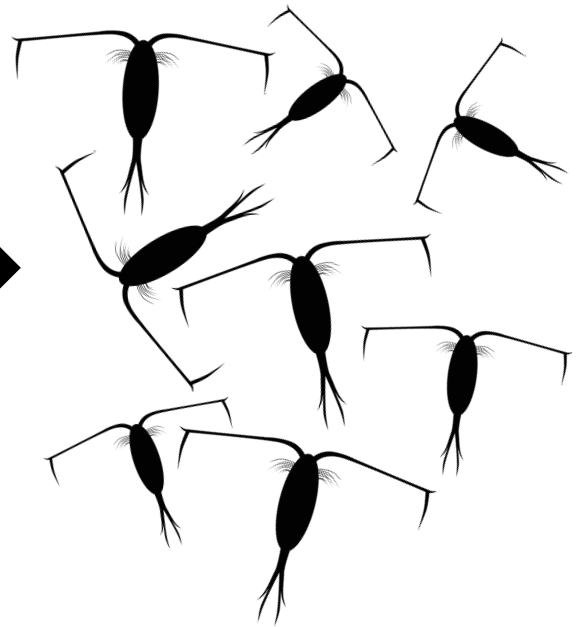
[1] ATOC and INSTAAR, University of Colorado Boulder

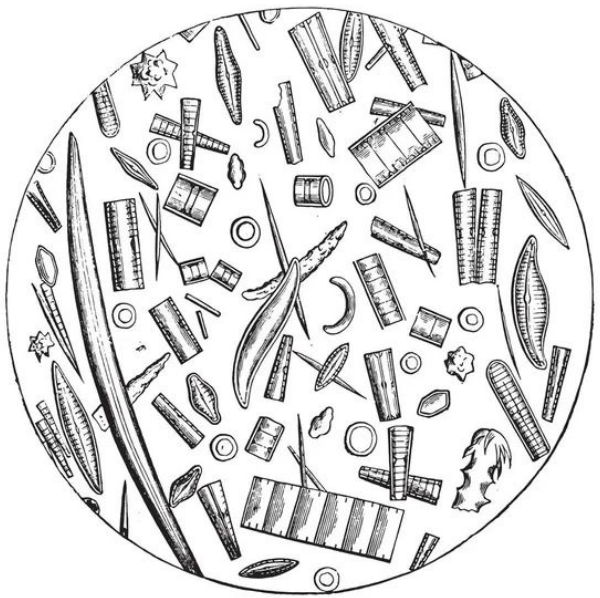
[2] NSF National Center for Atmospheric Research

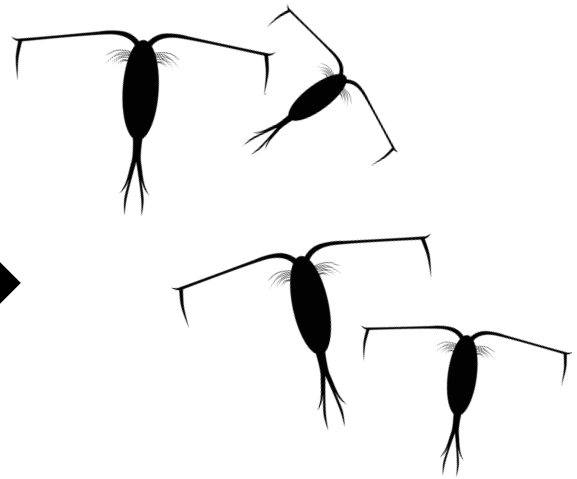

NASA Earth


Winter
Spring
Summer
Fall
Snow
Sea Ice
Phytoplankton

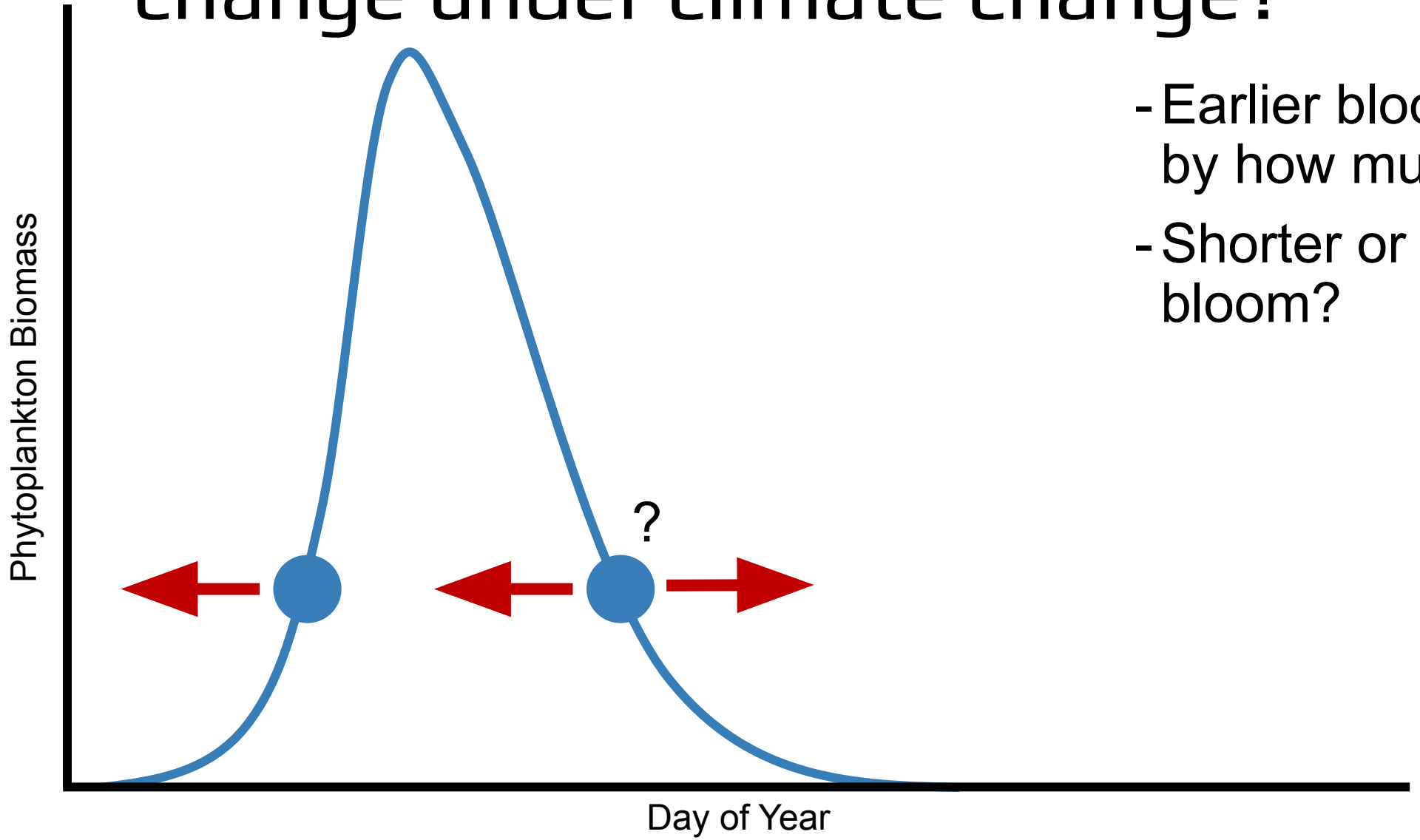






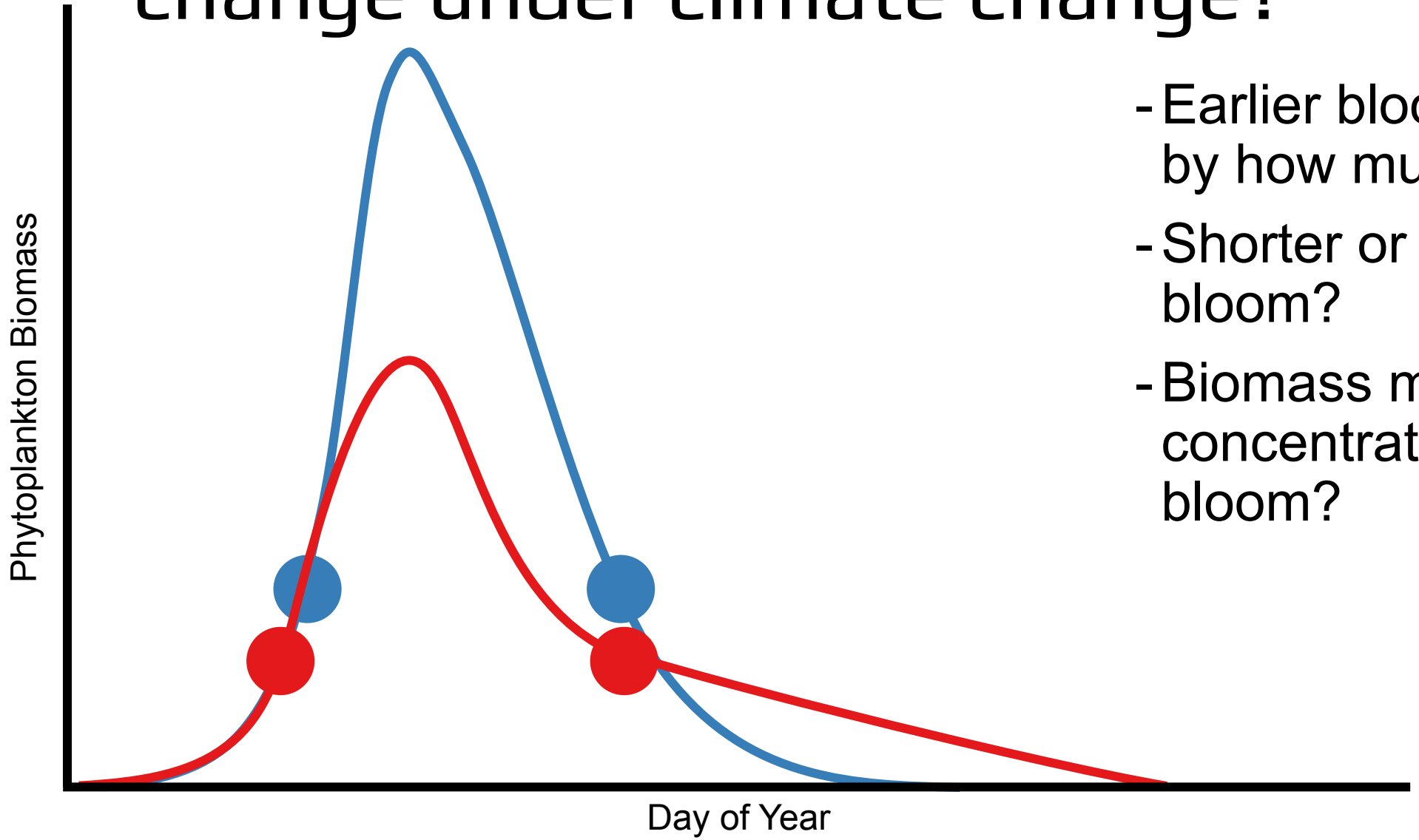


How will Arctic phytoplankton blooms change under climate change?



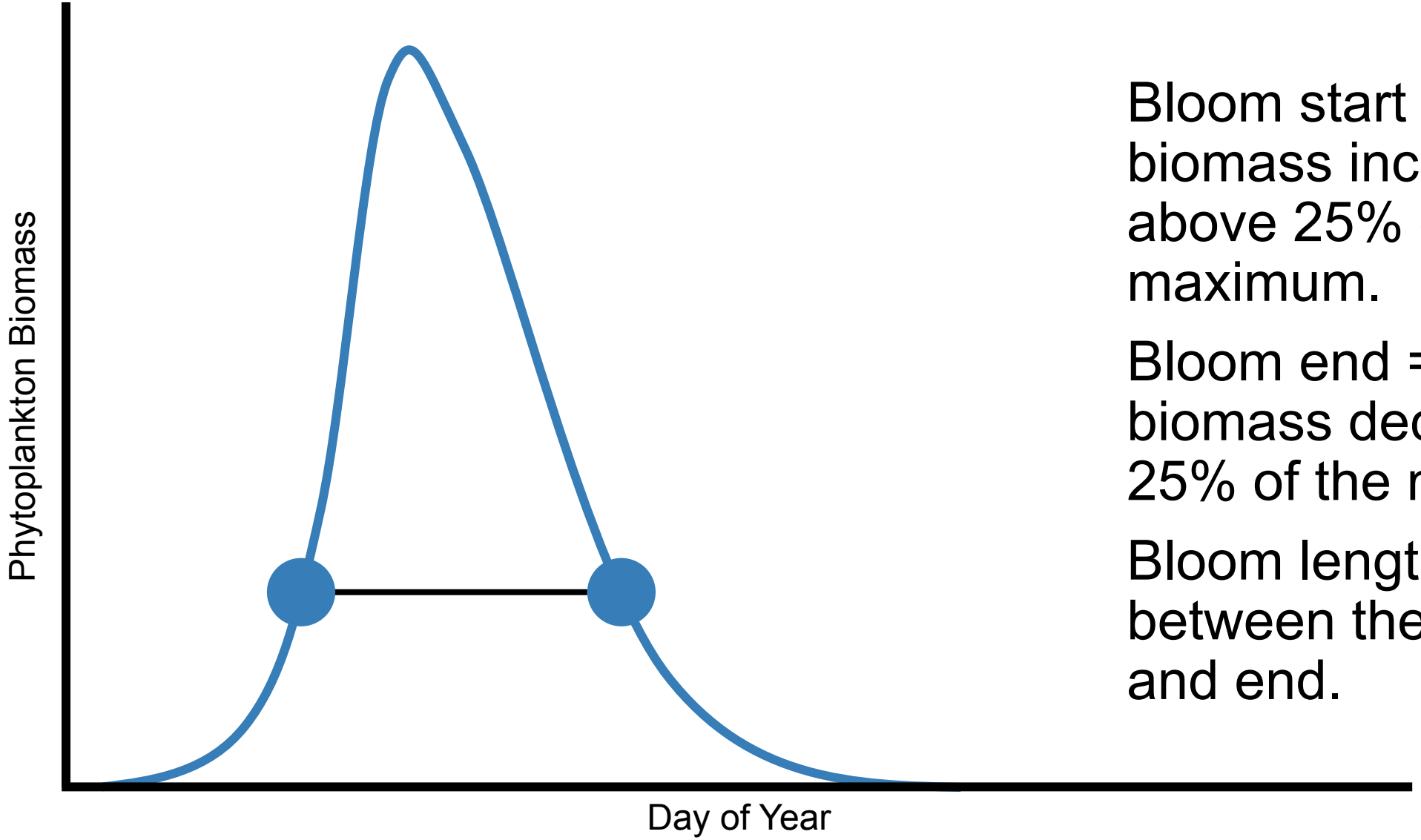
- Earlier bloom start (but by how much?)
- Shorter or longer bloom?

How will Arctic phytoplankton blooms change under climate change?



- Earlier bloom start (but by how much?)
- Shorter or longer bloom?
- Biomass more/less concentrated in the bloom?

Defining the Arctic phytoplankton bloom



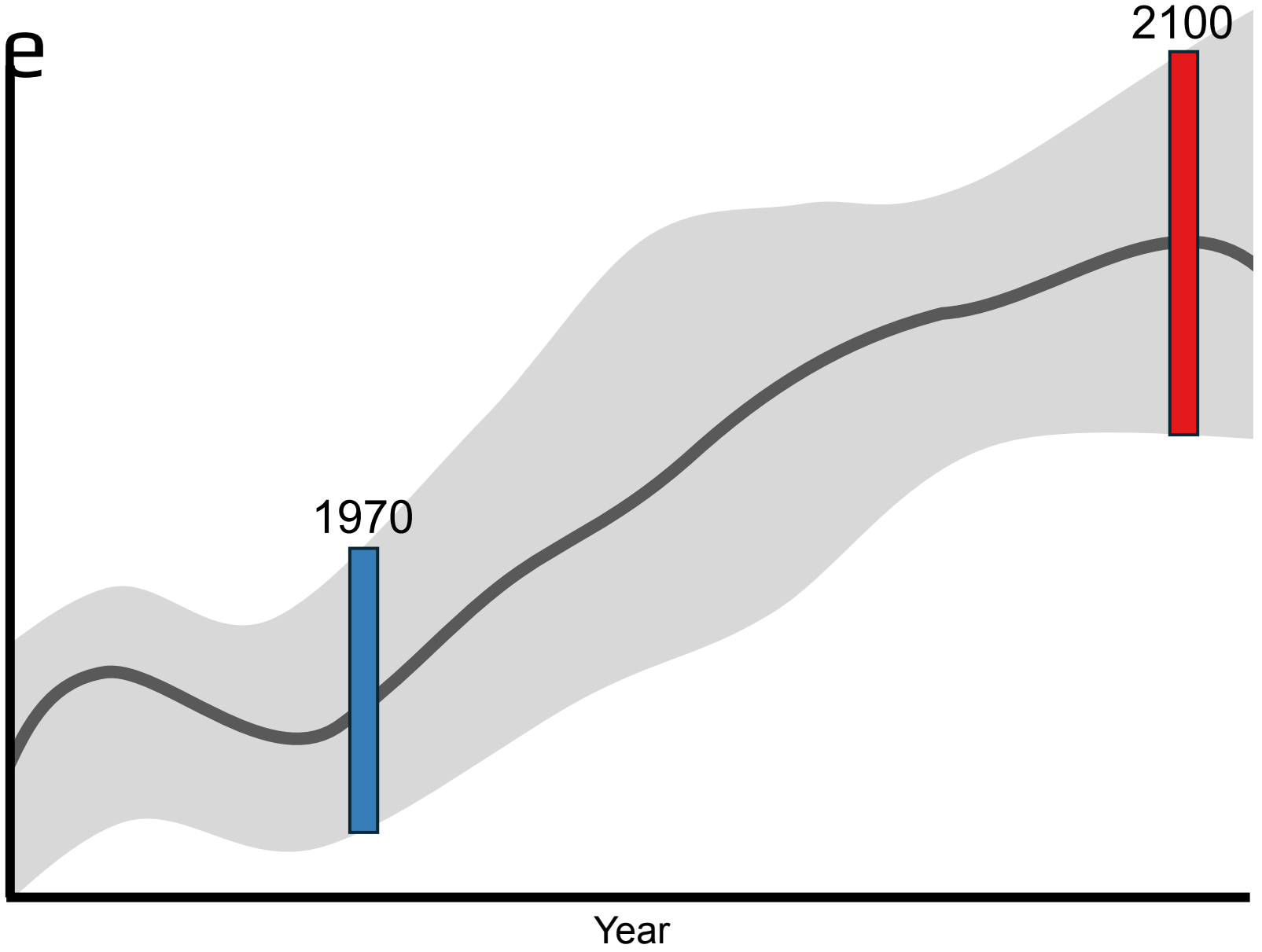
Bloom start = date when biomass increases above 25% of the maximum.

Bloom end = date when biomass declines below 25% of the maximum.

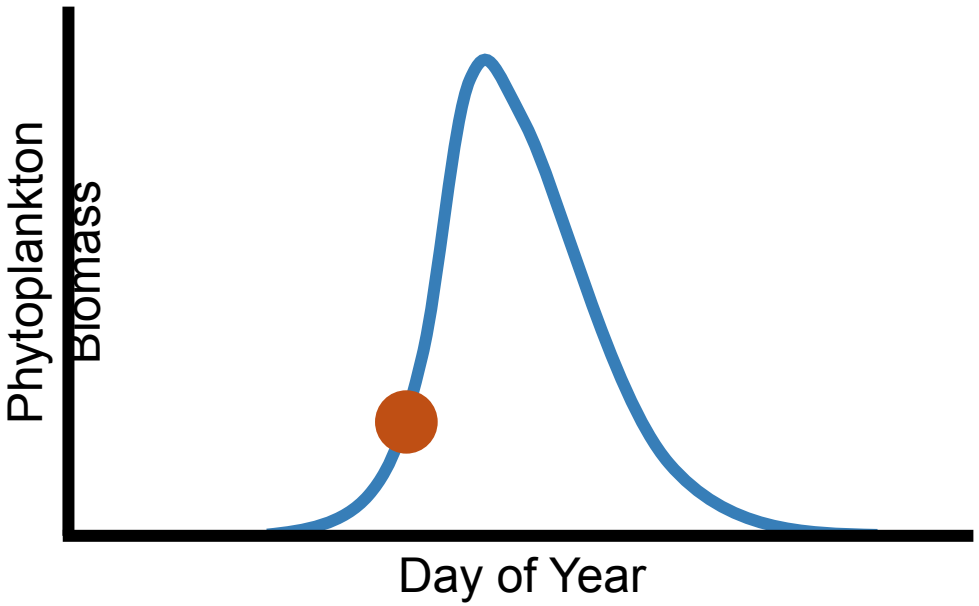
Bloom length = days between the bloom start and end.

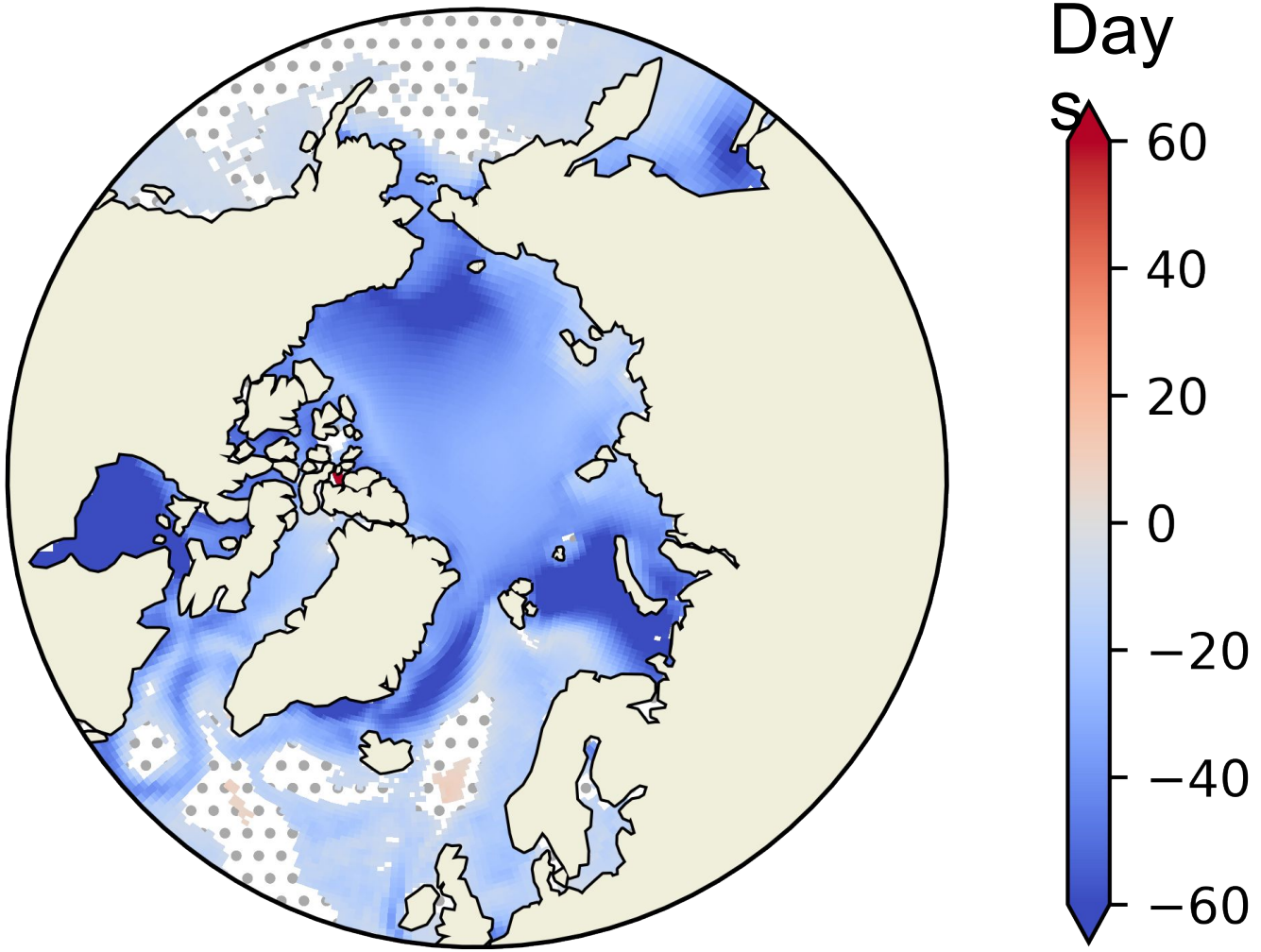
The Community Earth System Model Large Ensemble

- 50 ensemble members with the same climate forcing.
- To assess the impact of climate change on bloom dynamics, we compare 1970 to 2100.

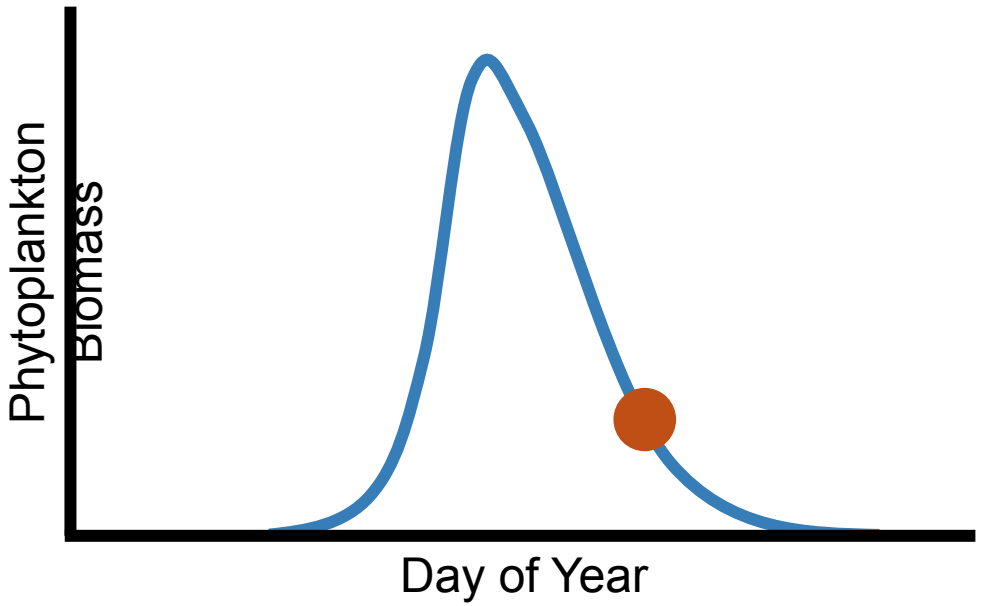


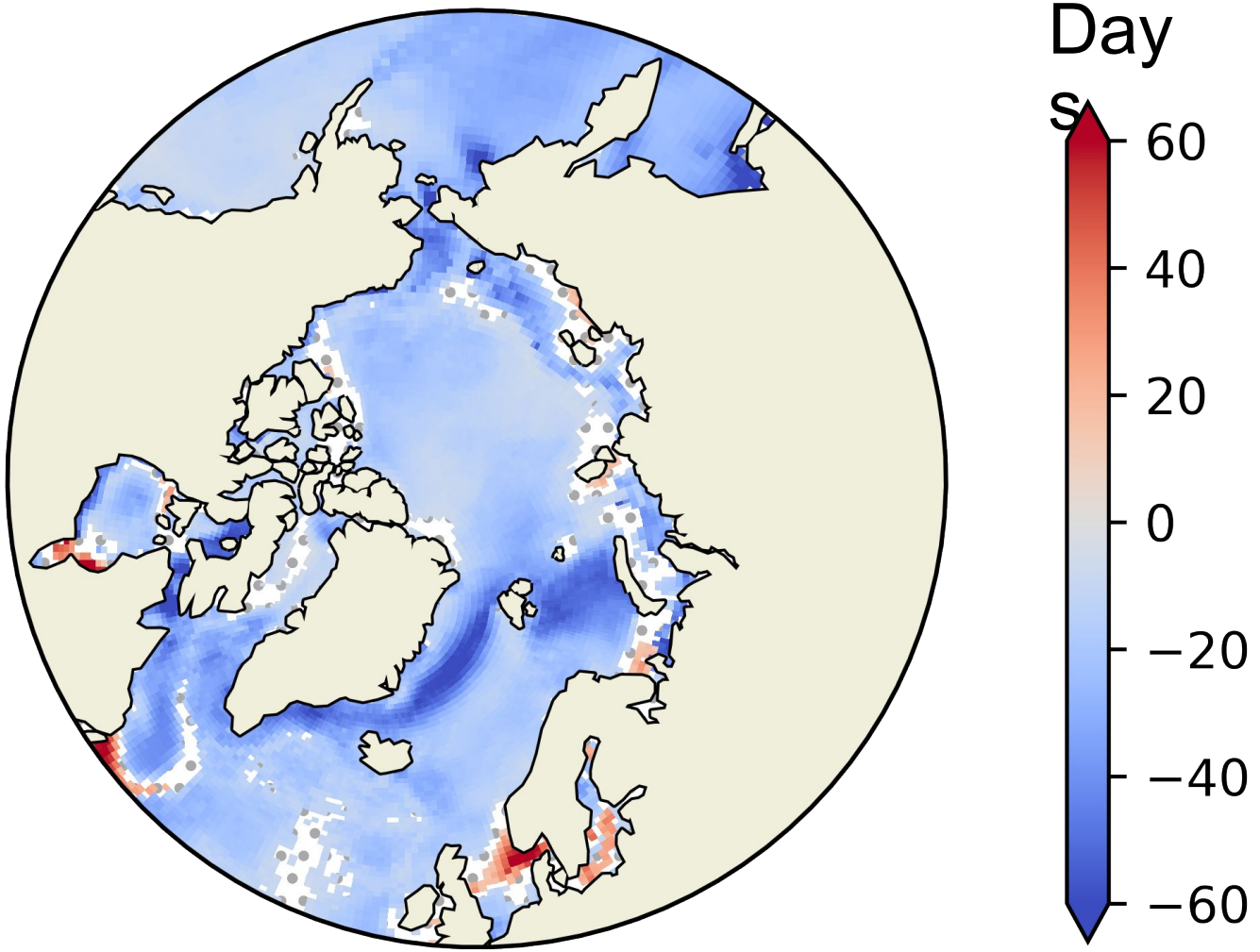
By 2100, the phytoplankton bloom starts 34 days earlier across the Arctic Ocean than it did in 1970.



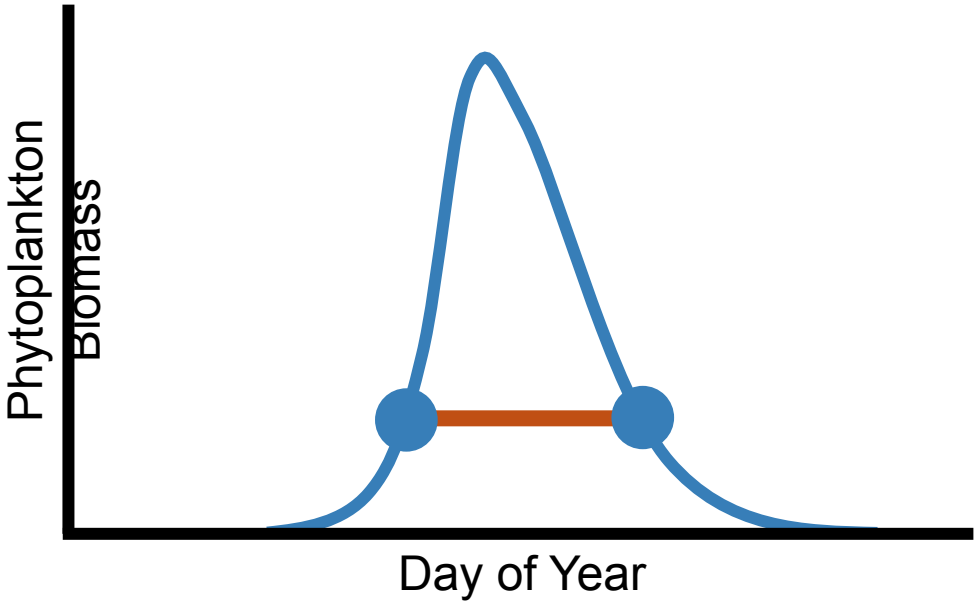


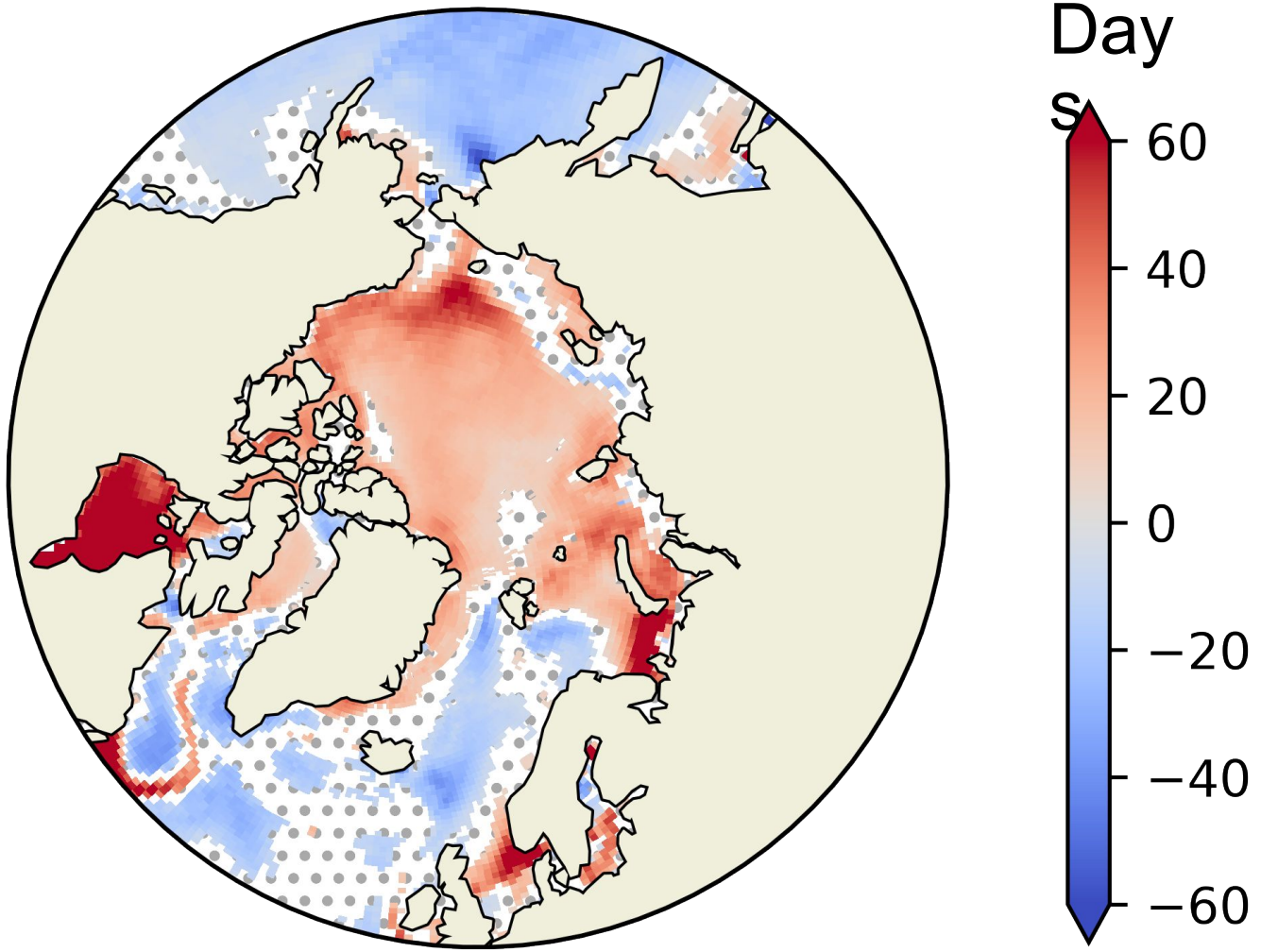
The phytoplankton bloom also ends earlier in 2100, but only by 19 days.

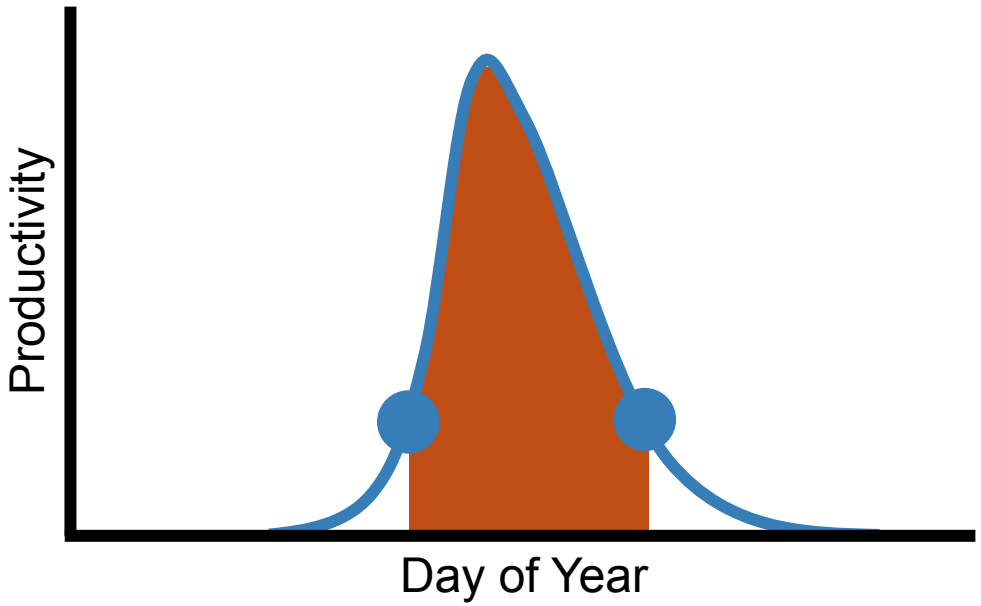


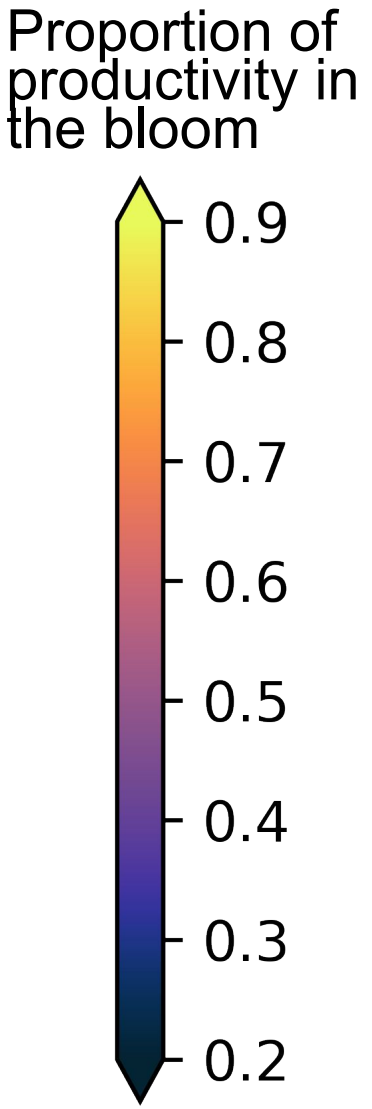


The bloom is 14 days longer across the Arctic in 2100 than in 1970.

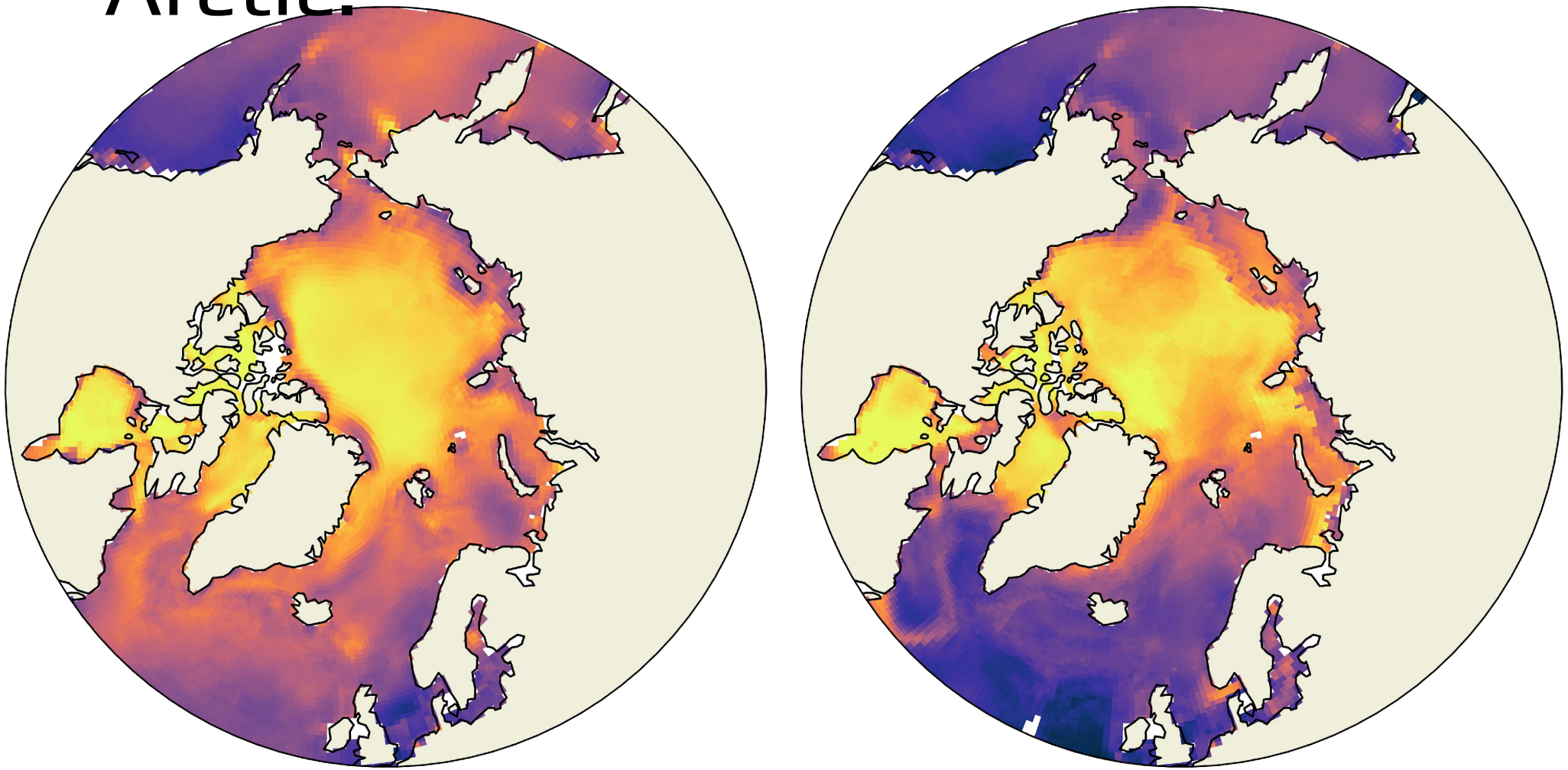




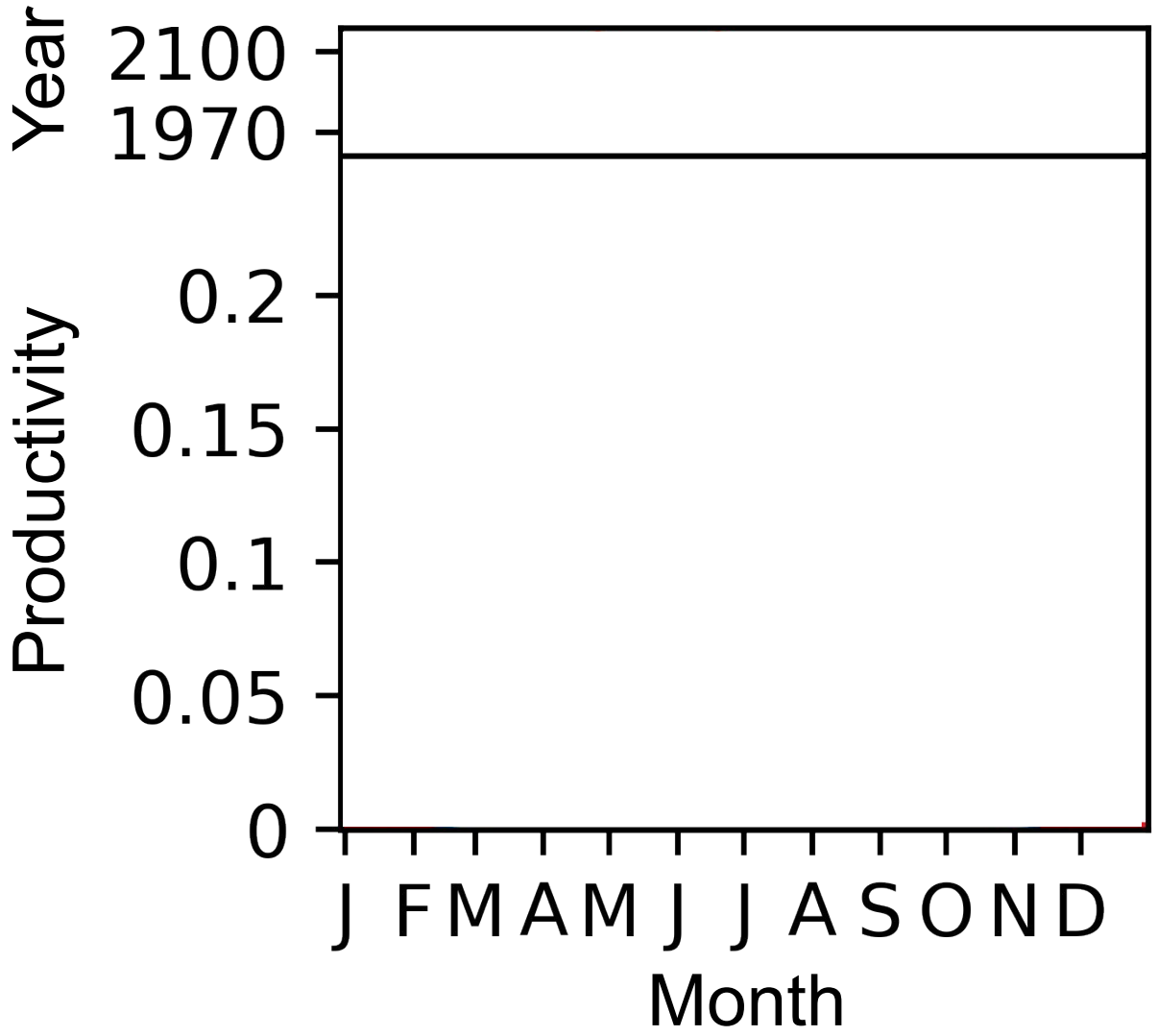

Productivity
Day of Year

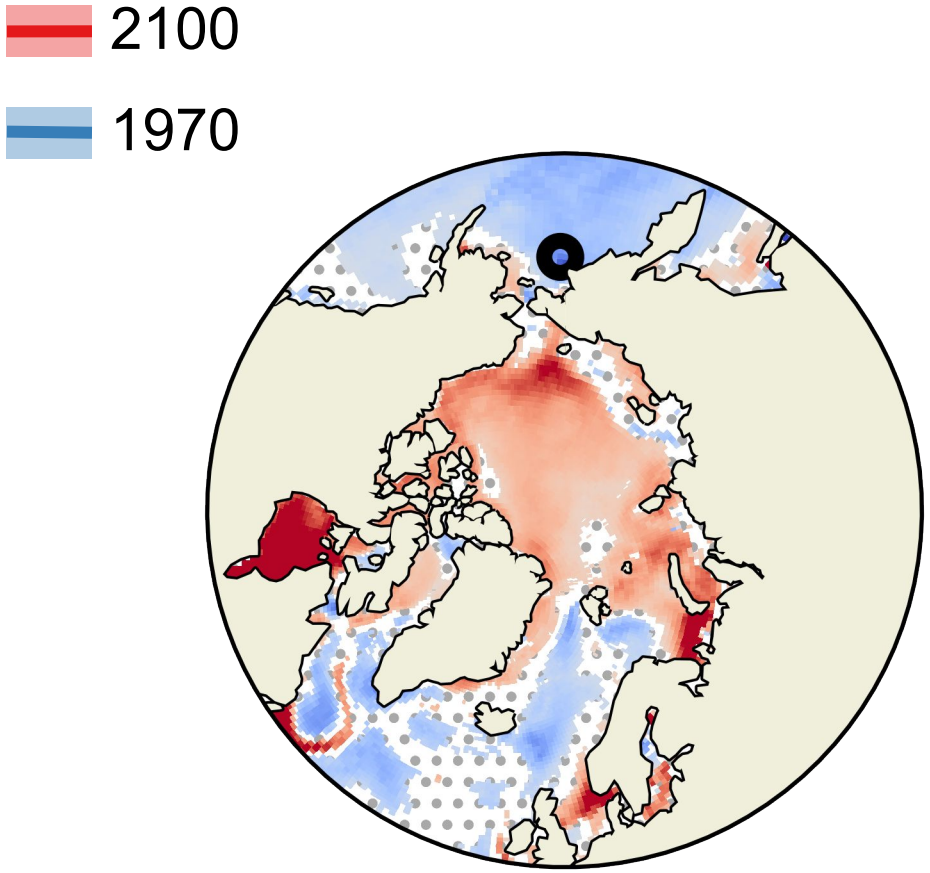

Proportion of productivity in the bloom
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2

The bloom loses its importance in the sub-Arctic and inflow shelves to the Arctic.

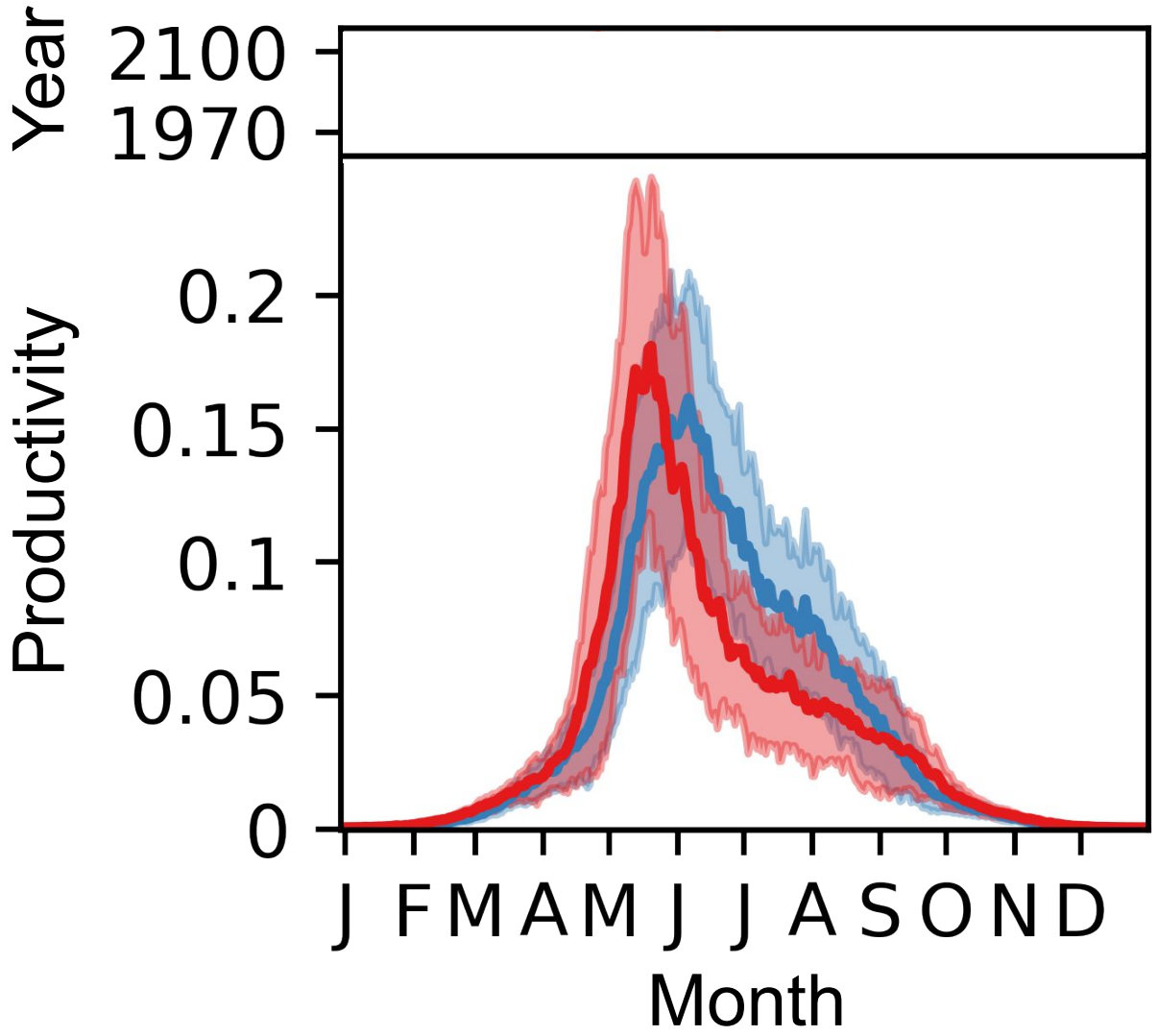


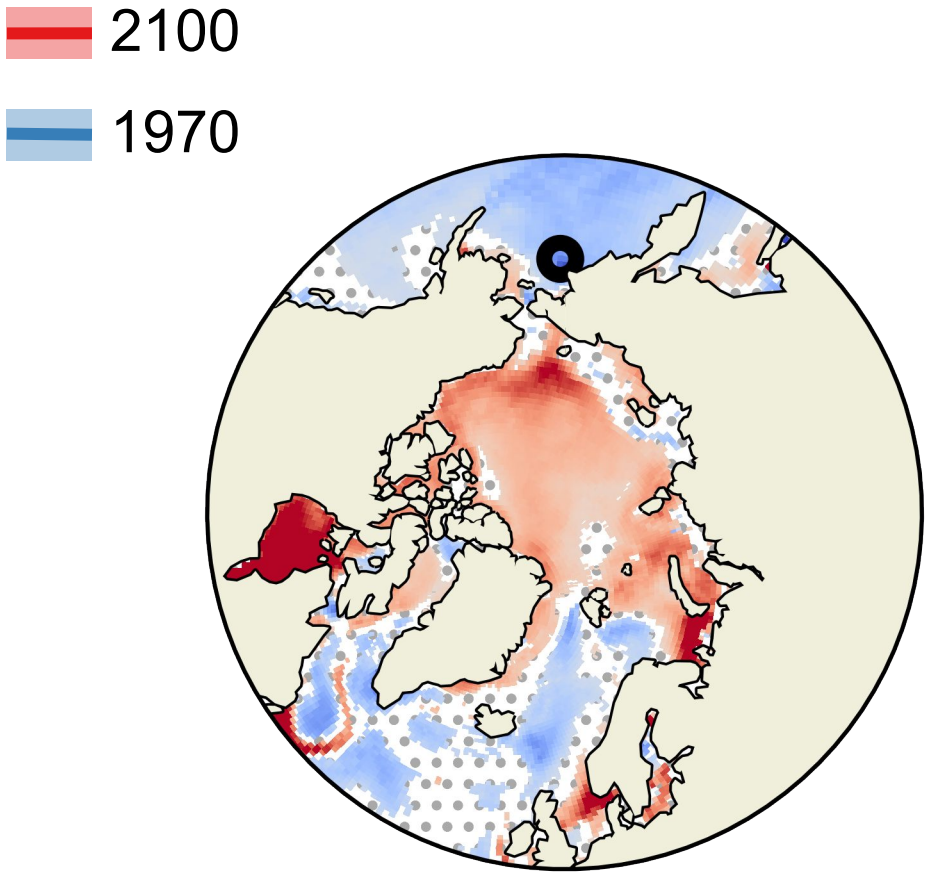
The Bering Sea



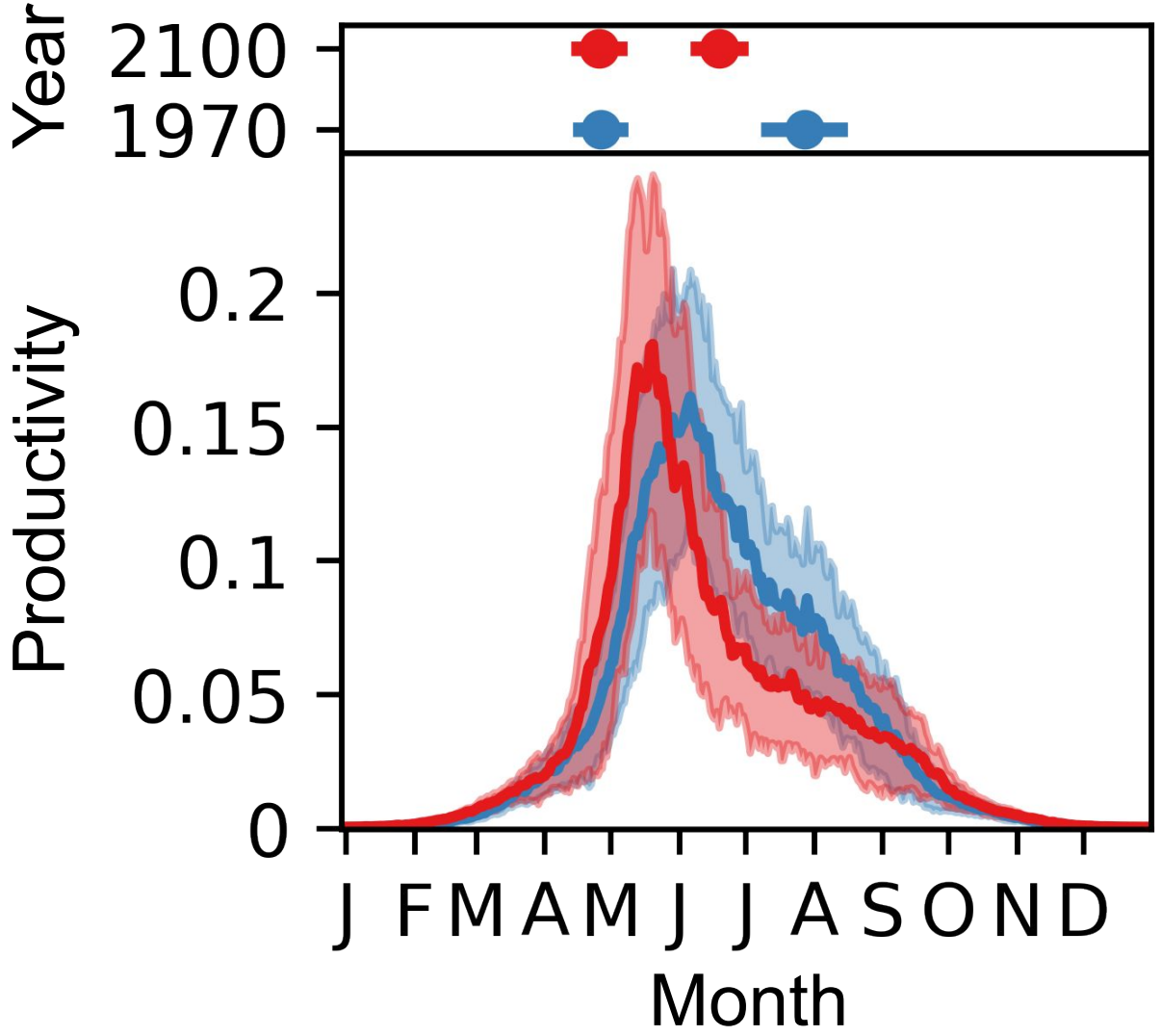


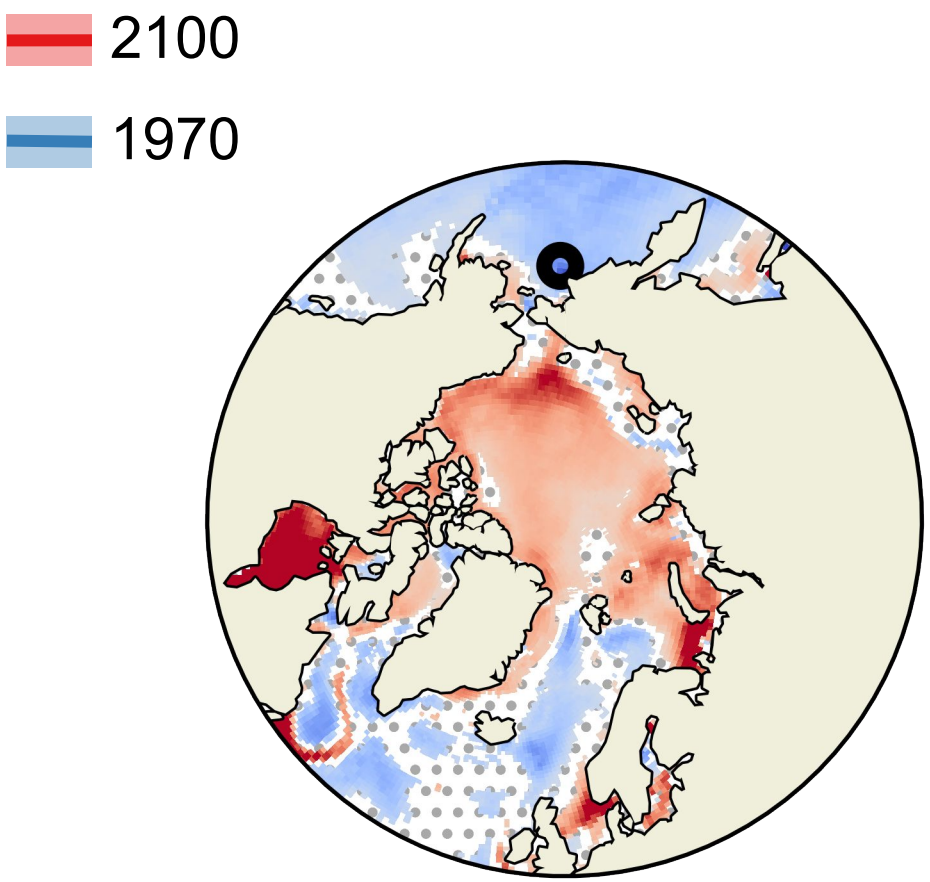
The Bering Sea



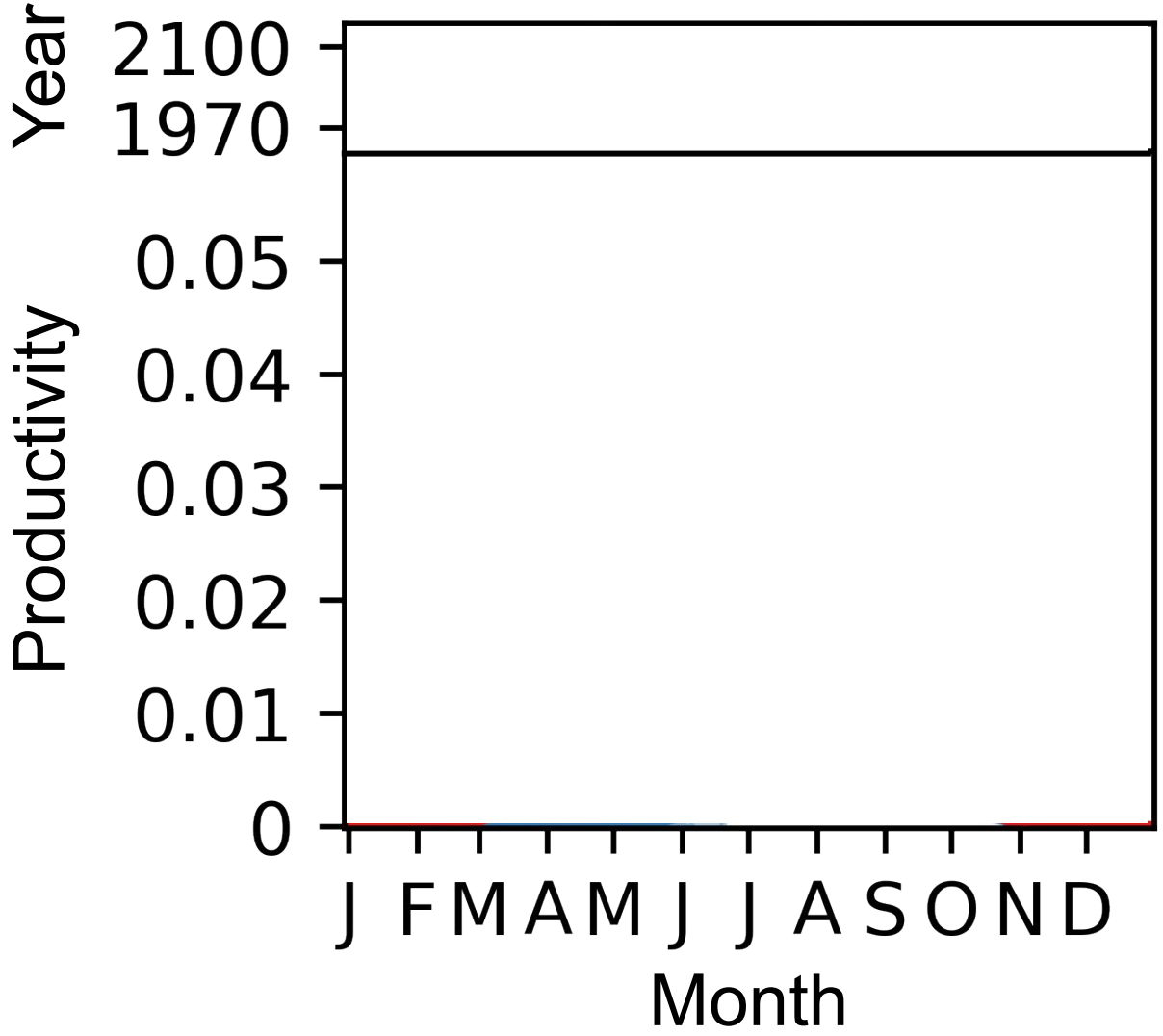


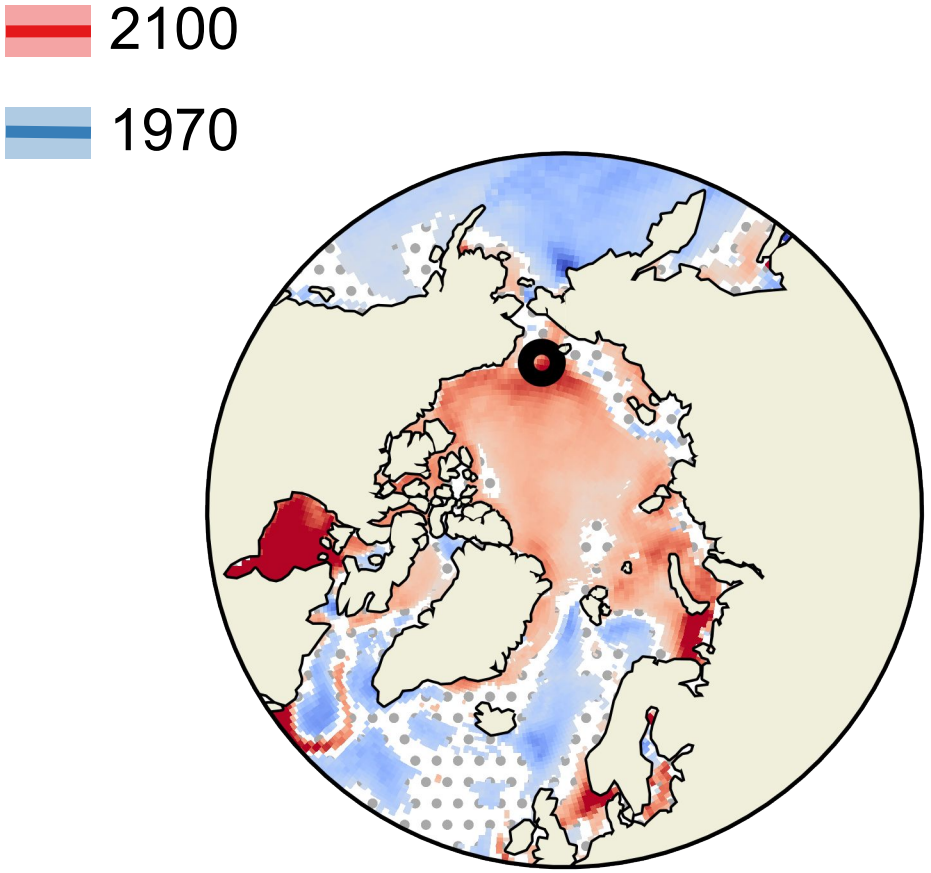
The Bering Sea: shorter bloom, less production concentrated in the bloom.



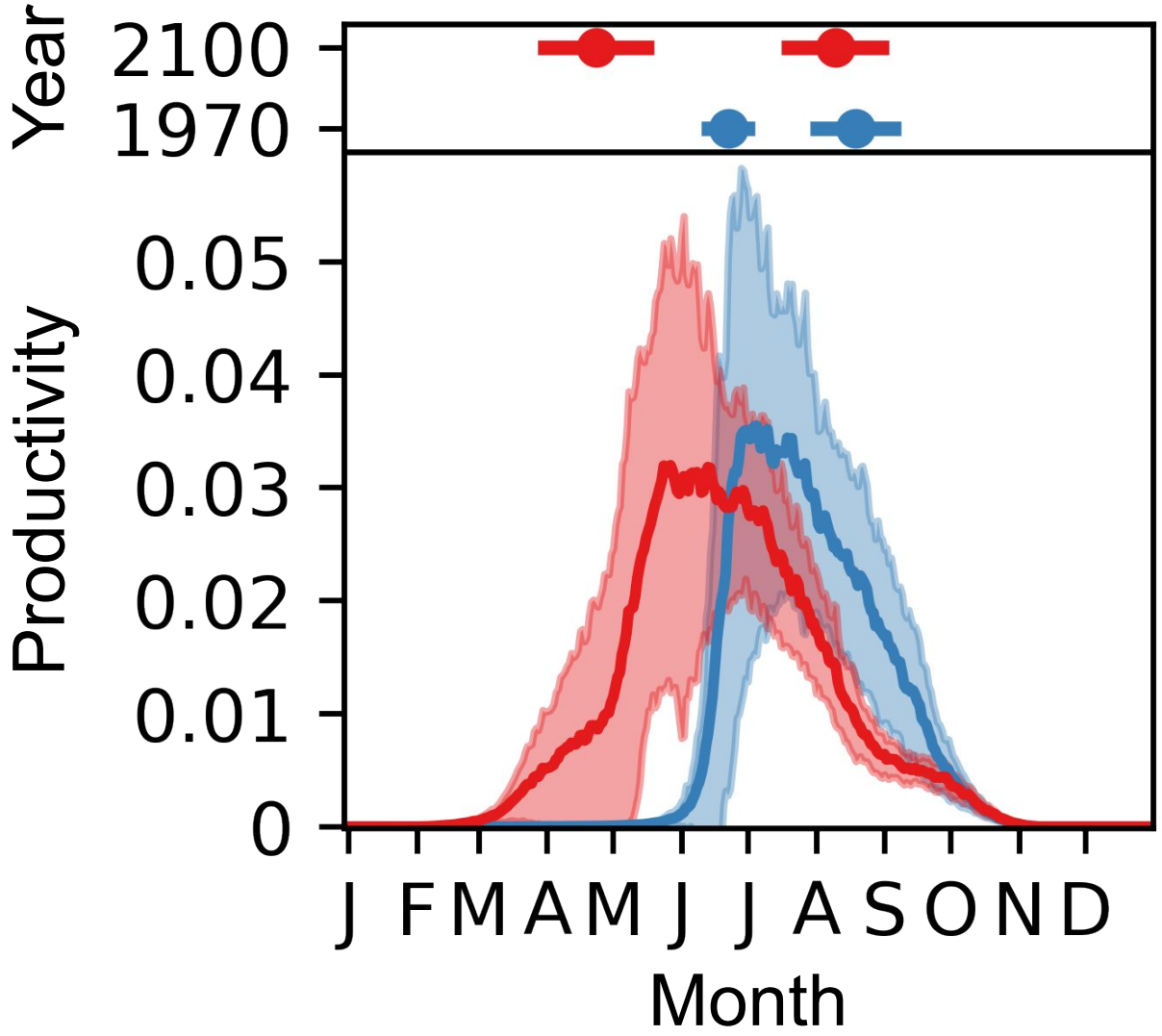


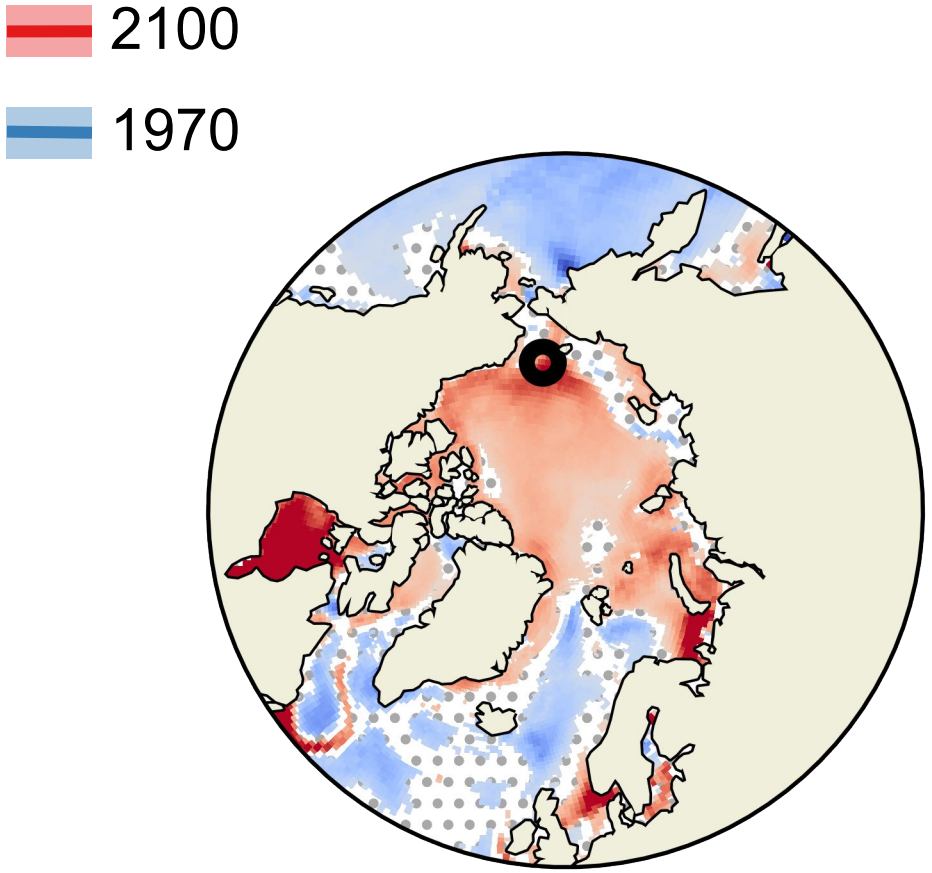
The Chukchi Sea



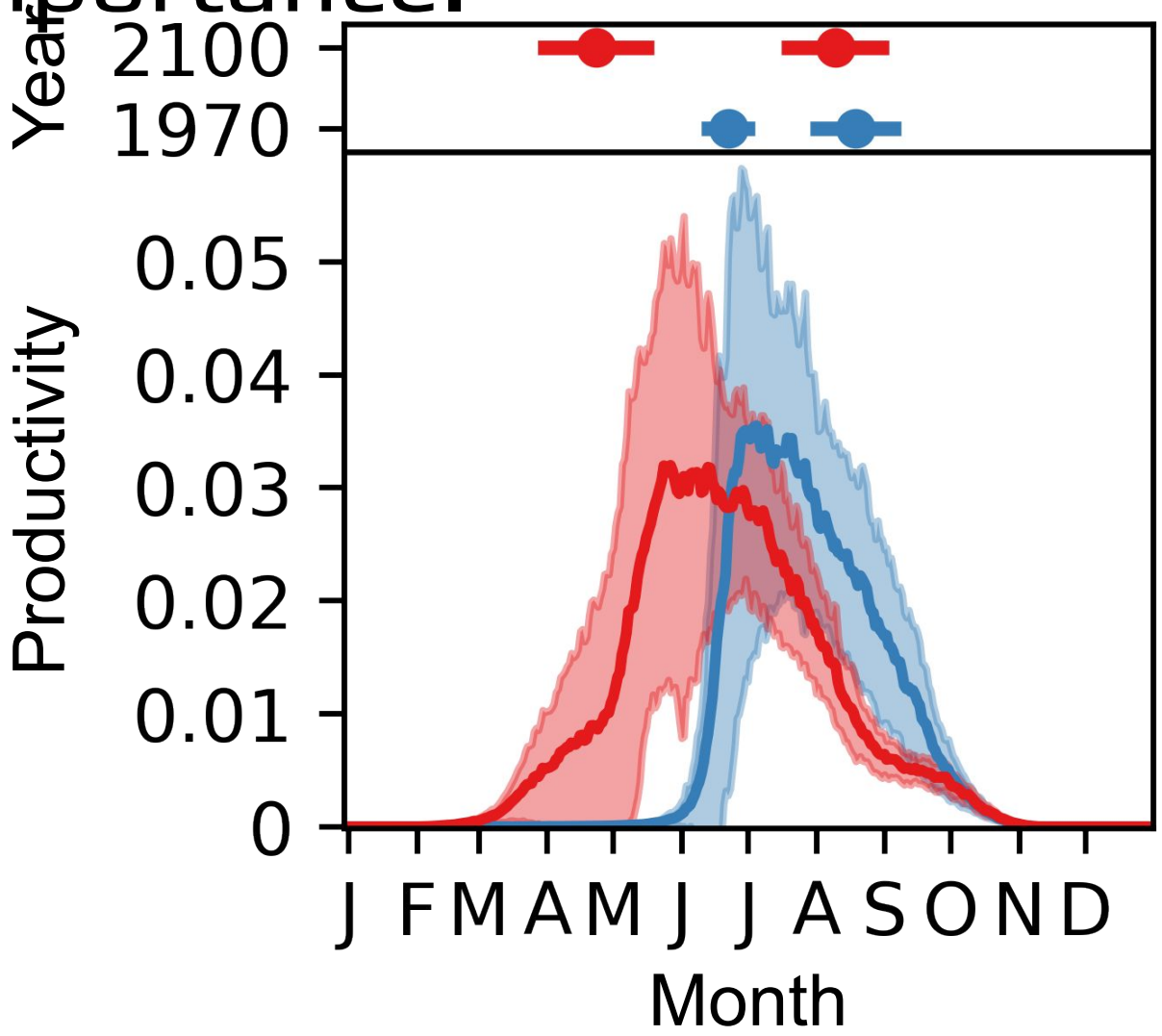


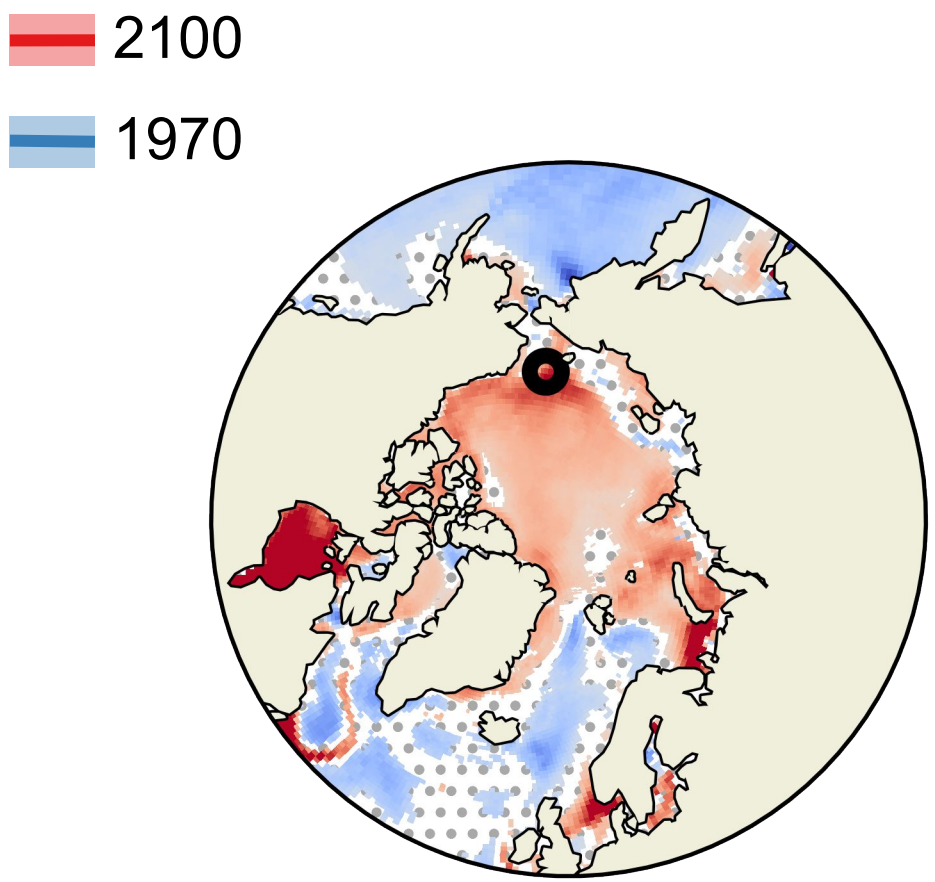
The Chukchi Sea



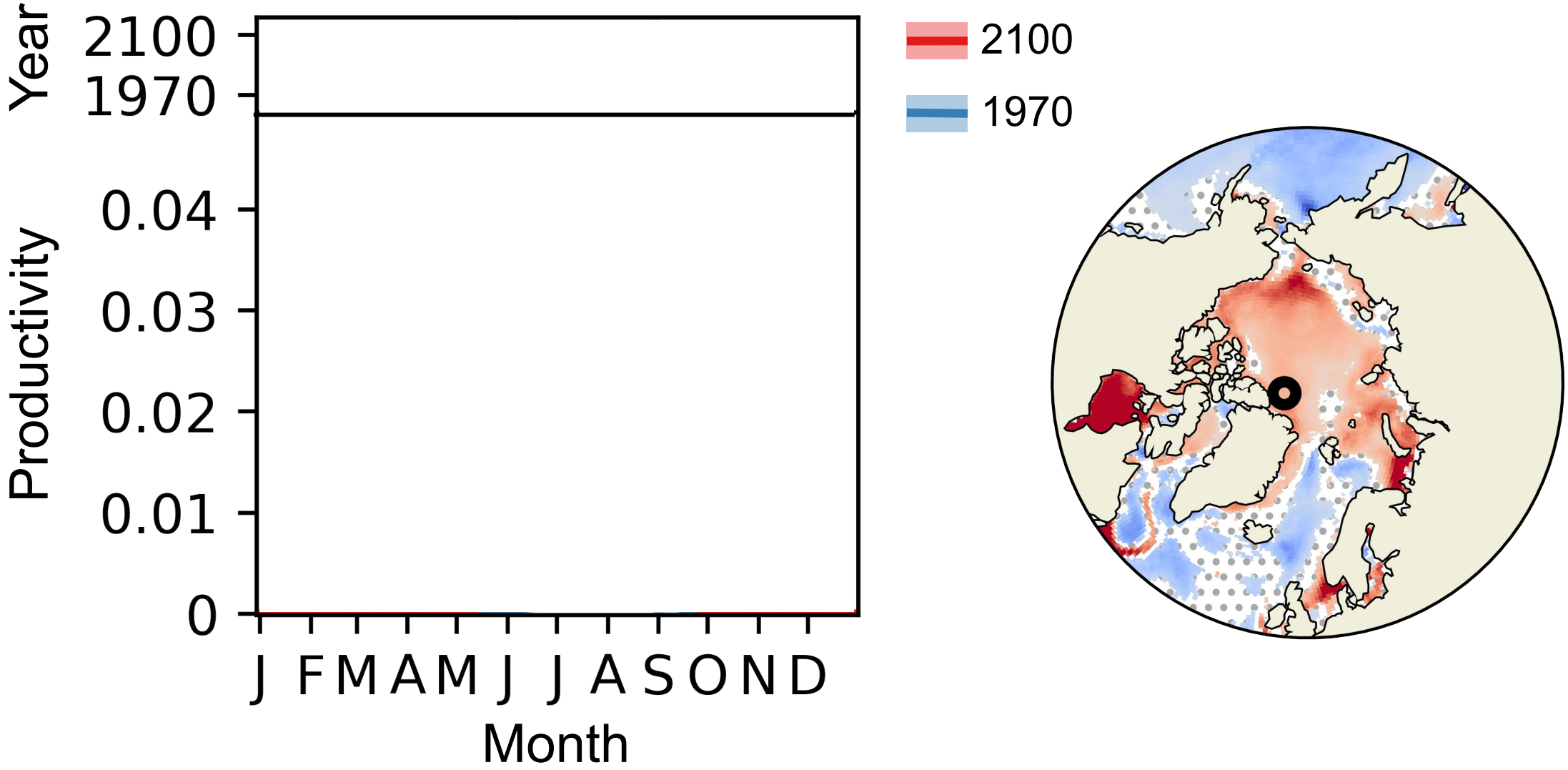


The Chukchi Sea: earlier, longer (but more variable) bloom, with no change in bloom importance.

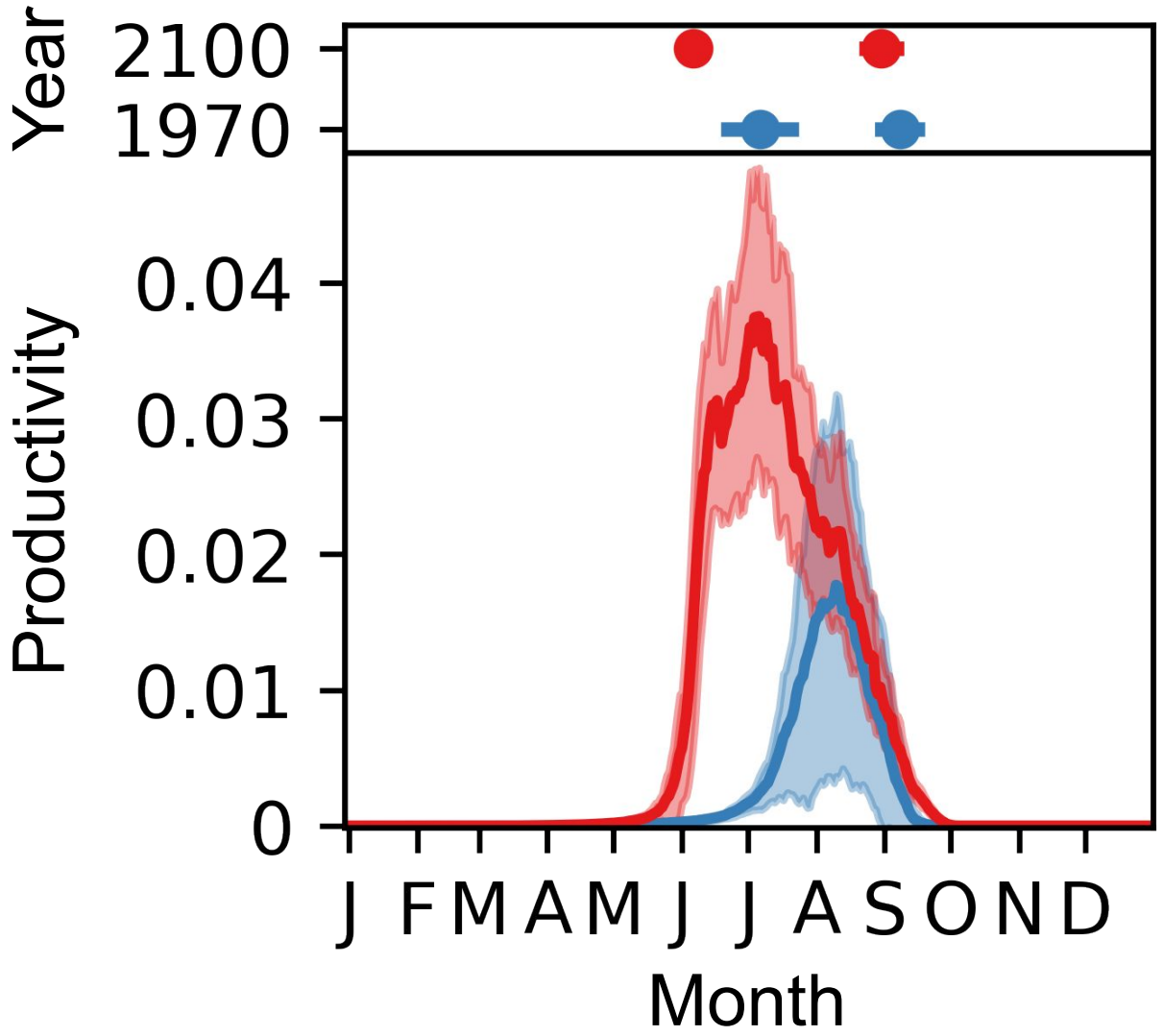


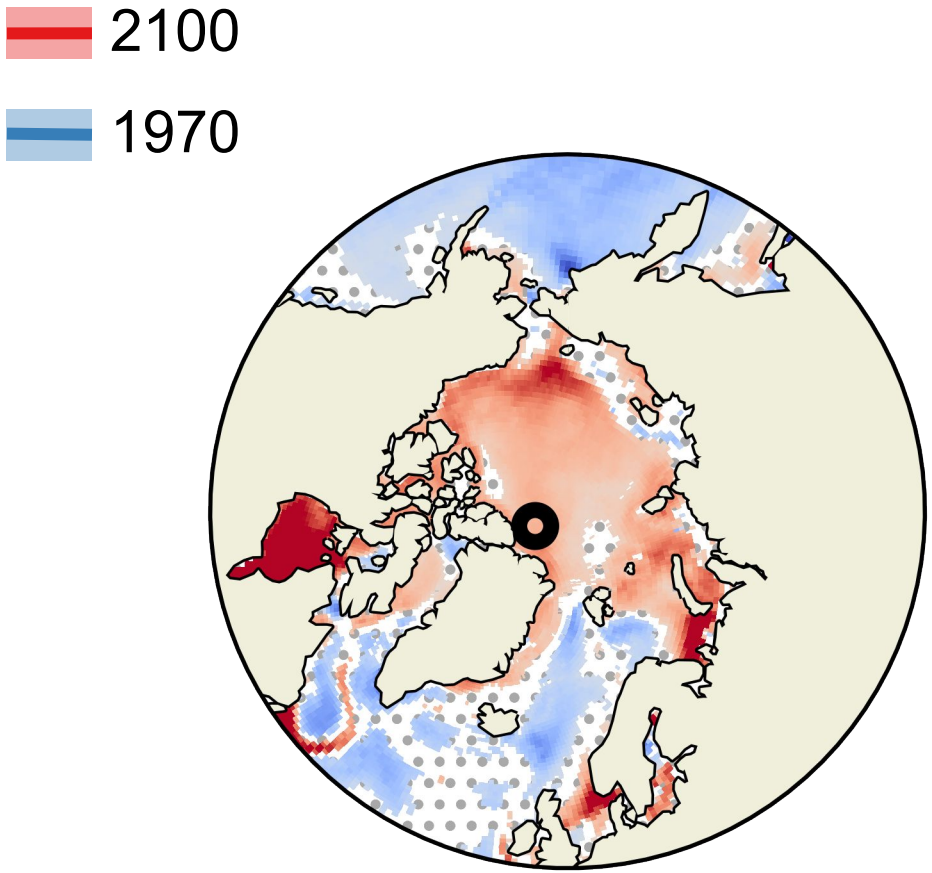


The Central Arctic

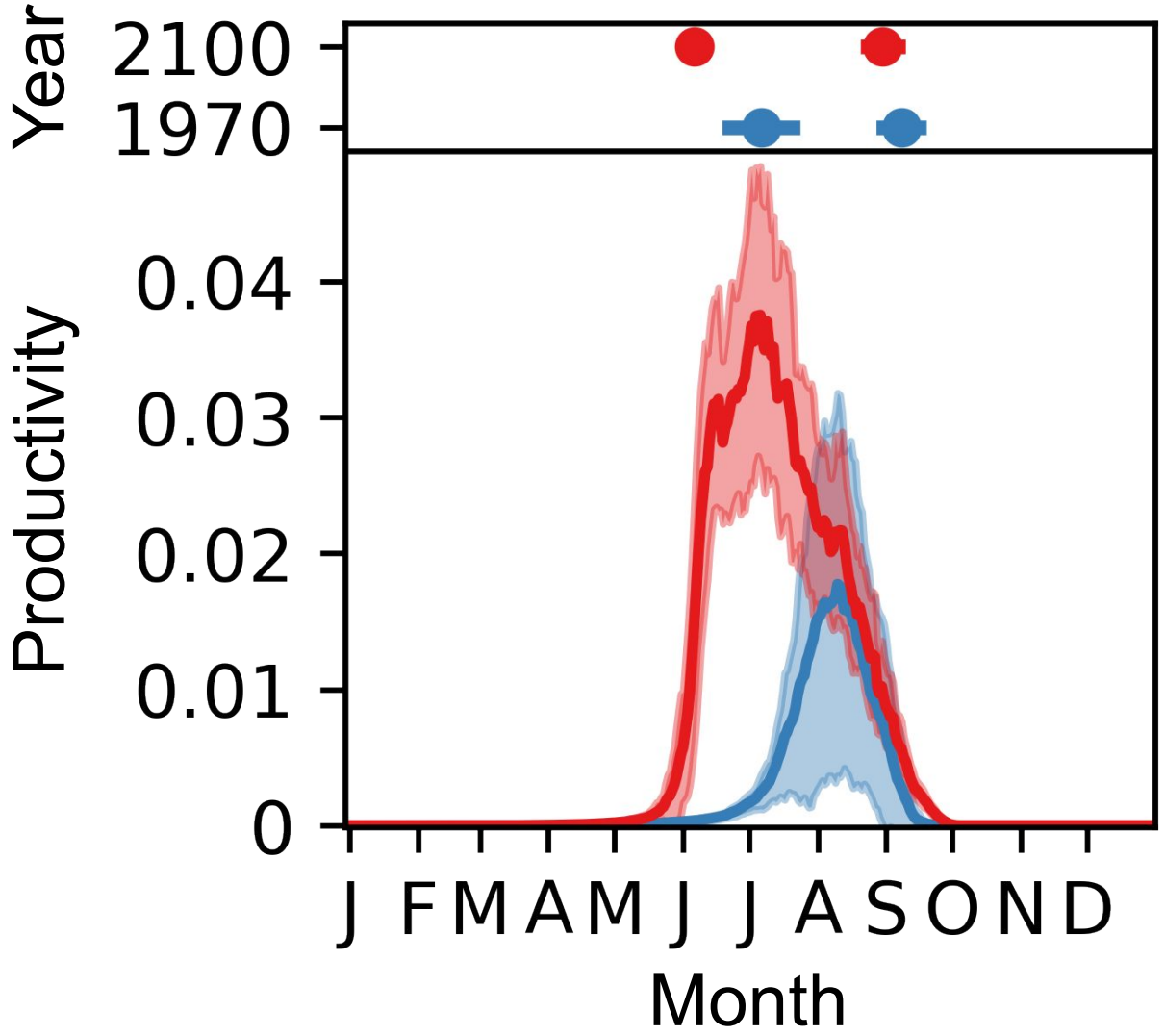


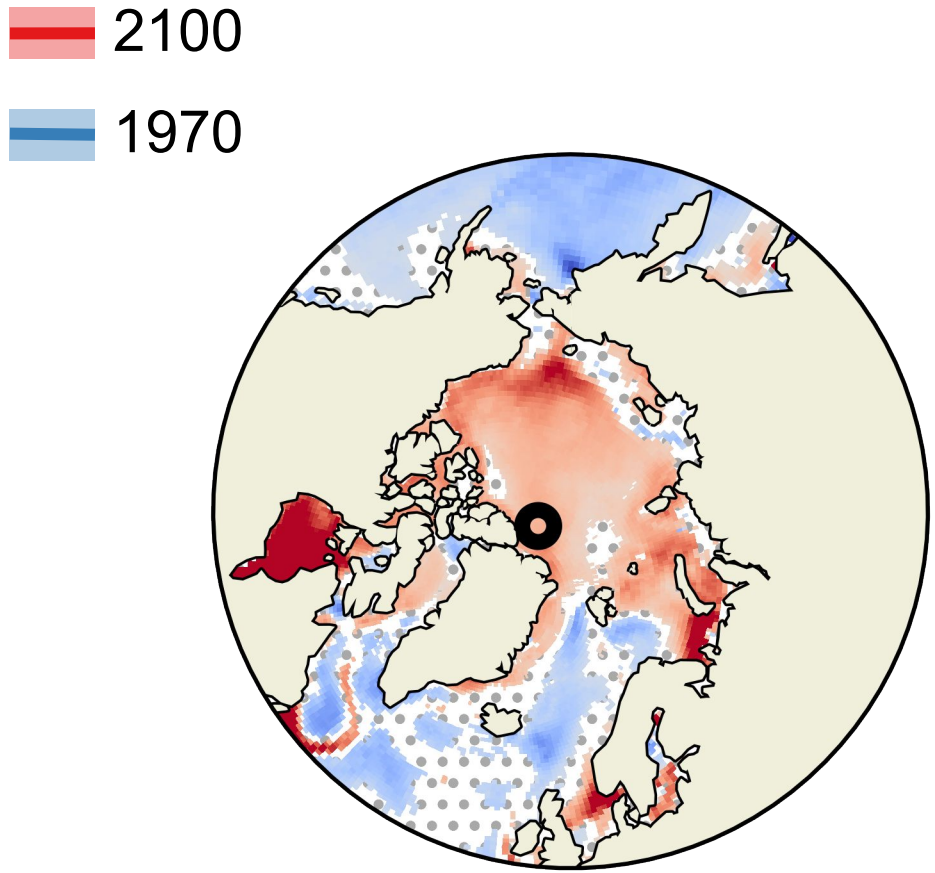
The Central Arctic





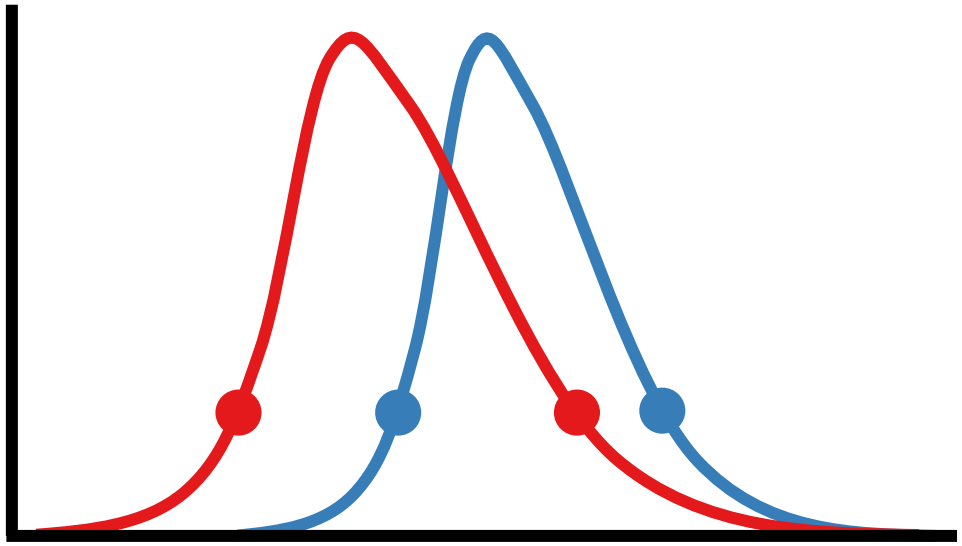
The Central Arctic: a slightly longer, earlier bloom and more annual production.

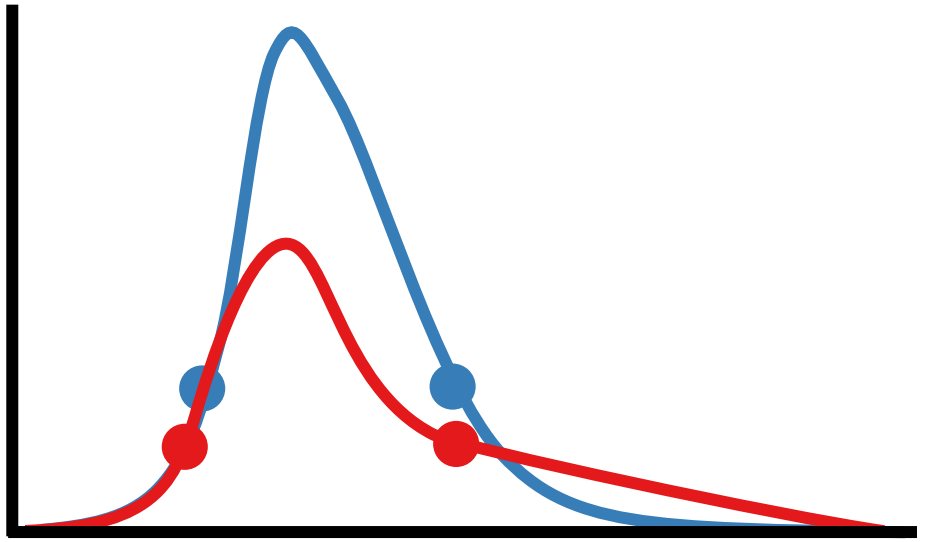




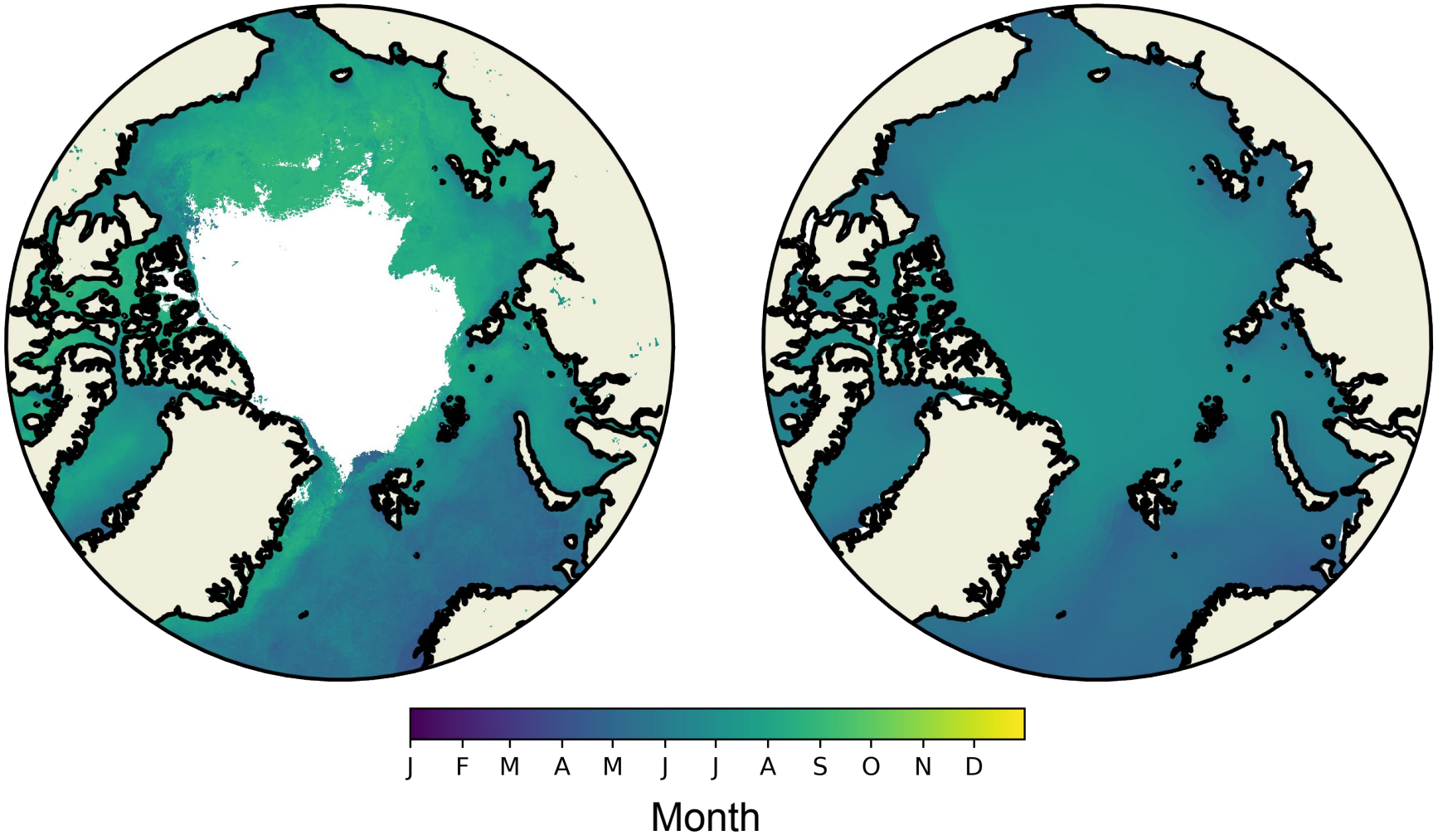
Summary

- Arctic phytoplankton blooms will be generated earlier in the year in the future. In much of the Arctic, blooms will also last longer.
- While the bloom in the central Arctic will remain a concentrated source of production, the bloom is reduced in importance on inflow shelves into the Arctic Ocean and in the [illegible]c.

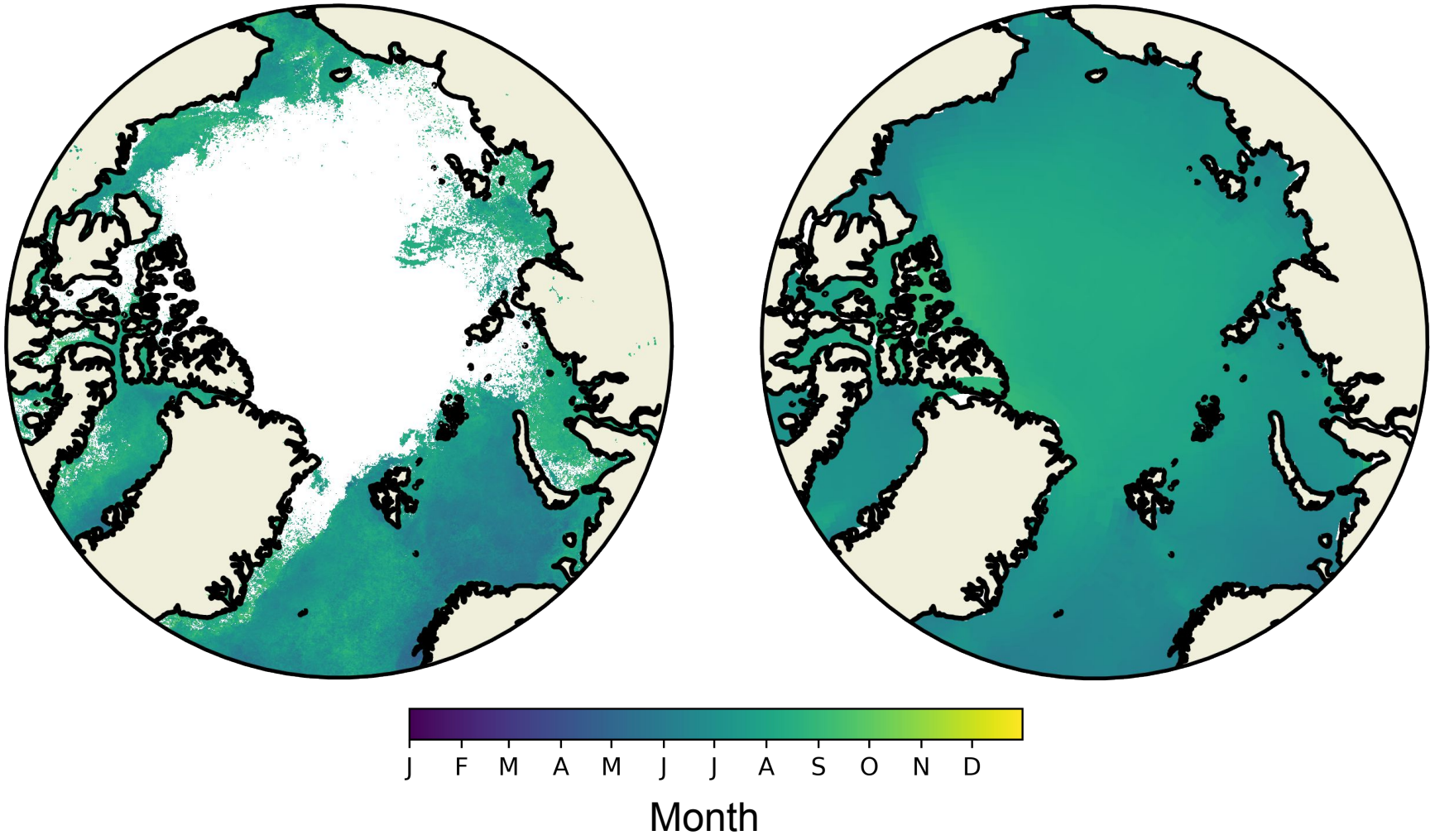




Chl-derived mean bloom start (2005-2014) from the satellite record (left) and an ensemble member of the CESM2-LE (right)



Chl-derived mean bloom end (2005-2014) from the satellite record (left) and an ensemble member of the CESM2-LE (right)



Annual average NPP (2005-2014) from the satellite record (left) and an ensemble member of the CESM2-LE (right)