

Interactions between Arctic cyclones, atmospheric rivers, and sea ice in a warming climate

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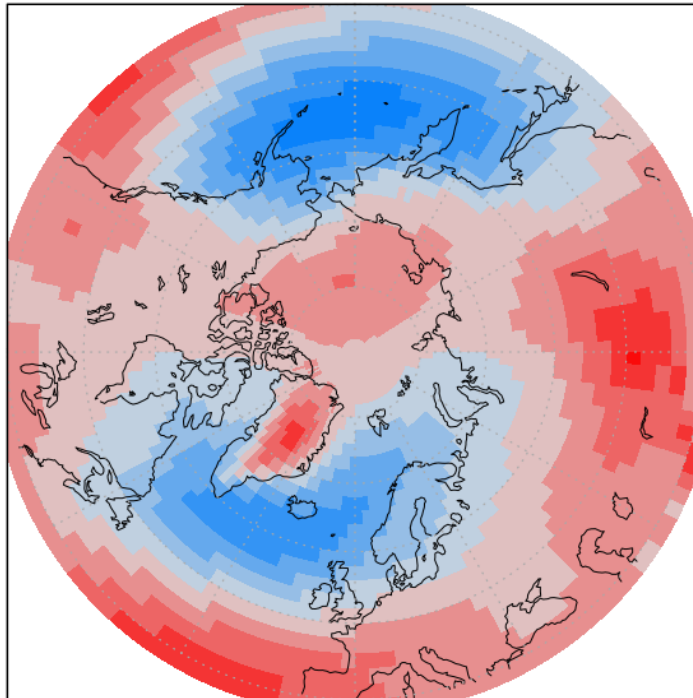
Cheers!



Relationship between Sea Ice and Atmospheric Circulation

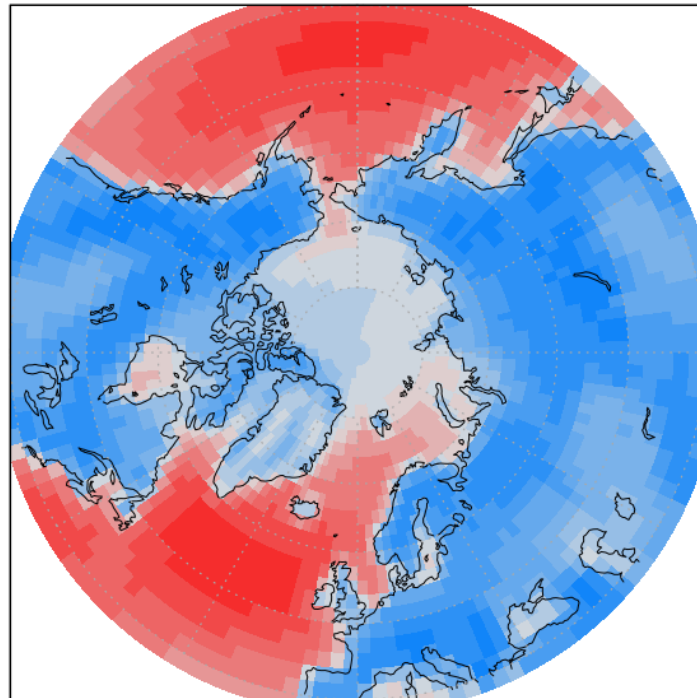
Present-day climatology (CMIP5)

CMIP5 MMM Annual Sea Level Pressure (mb)
2006–2015 Climatology



1006 1008 1010 1012 1014 1016 1018 1020 1022

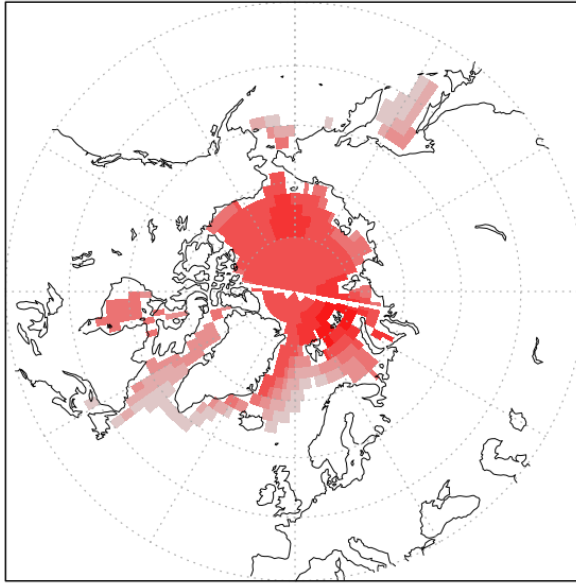
CMIP5 MMM Annual Surface Wind Speed (m/s)
2006–2015 Climatology



2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5

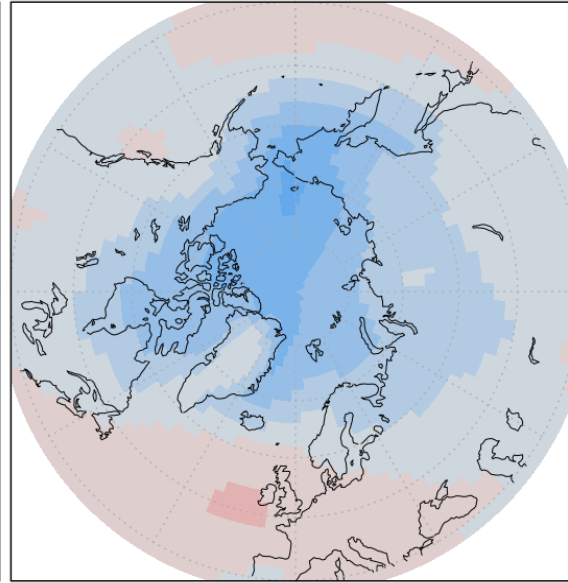
Sea ice cover = high pressure and light winds
Open ocean = low pressure and strong winds

CMIP5 MMM Annual Sea Ice Area Trend (%)
Years 2006–2100, RCP8.5



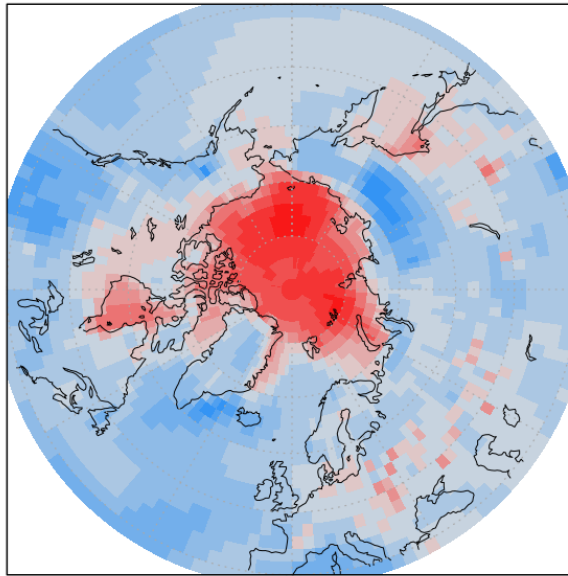
**Future
Sea Ice
Trend**

CMIP5 MMM Annual SLP Trend (hPa)
Years 2006–2100, RCP8.5



**Future
SLP
Trend**

CMIP5 MMM Annual Surface Wind Speed Trend (%)
Years 2006–2100, RCP8.5

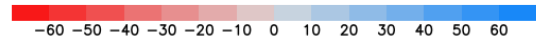
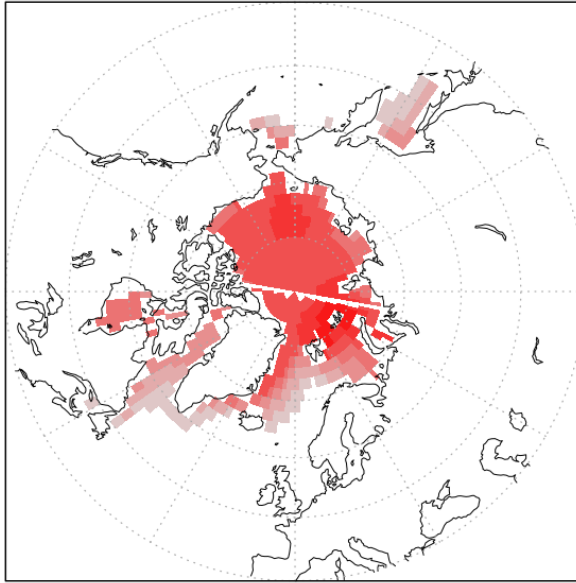


**Future
Wind
Trend**

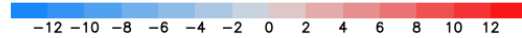
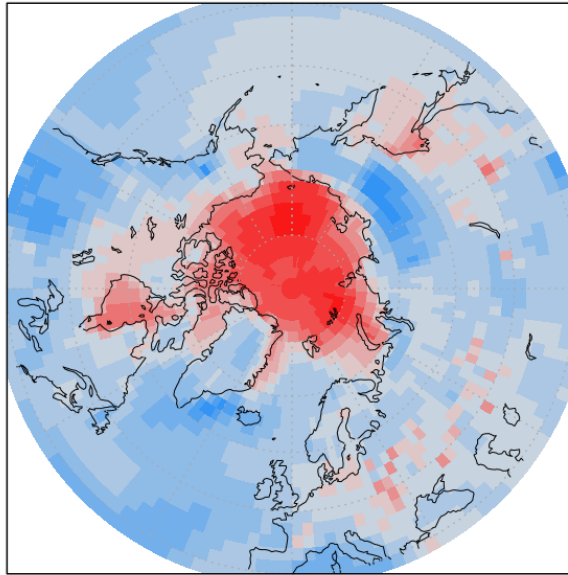
Sea ice loss = windier, lower SLP

-12 -10 -8 -6 -4 -2 0 2 4 6 8 10 12

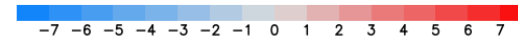
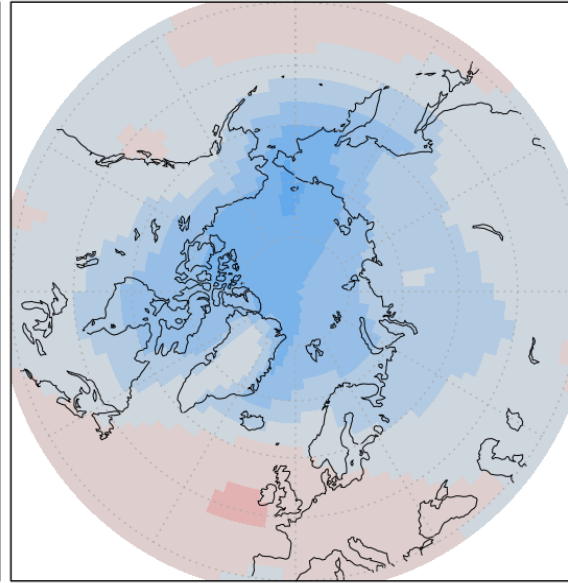
CMIP5 MMM Annual Sea Ice Area Trend (%)
Years 2006–2100, RCP8.5



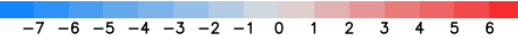
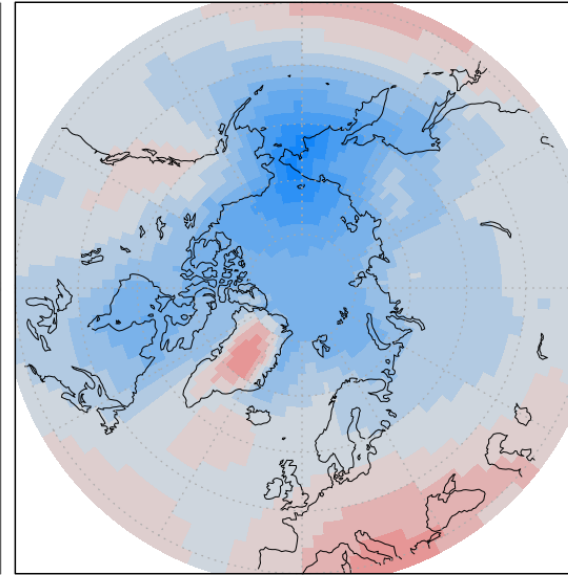
CMIP5 MMM Annual Surface Wind Speed Trend (%)
Years 2006–2100, RCP8.5



CMIP5 MMM Annual SLP Trend (hPa)
Years 2006–2100, RCP8.5



CMIP5 MMM Winter SLP Trend (hPa)
Years 2006–2100, RCP8.5



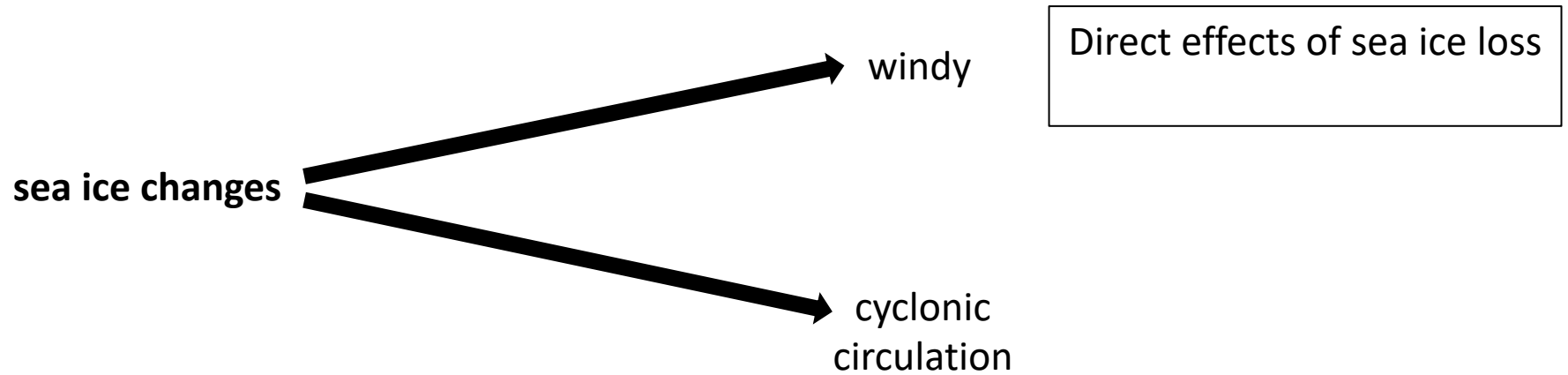
**Future
Sea Ice
Trend**

**Future
SLP
Trend**

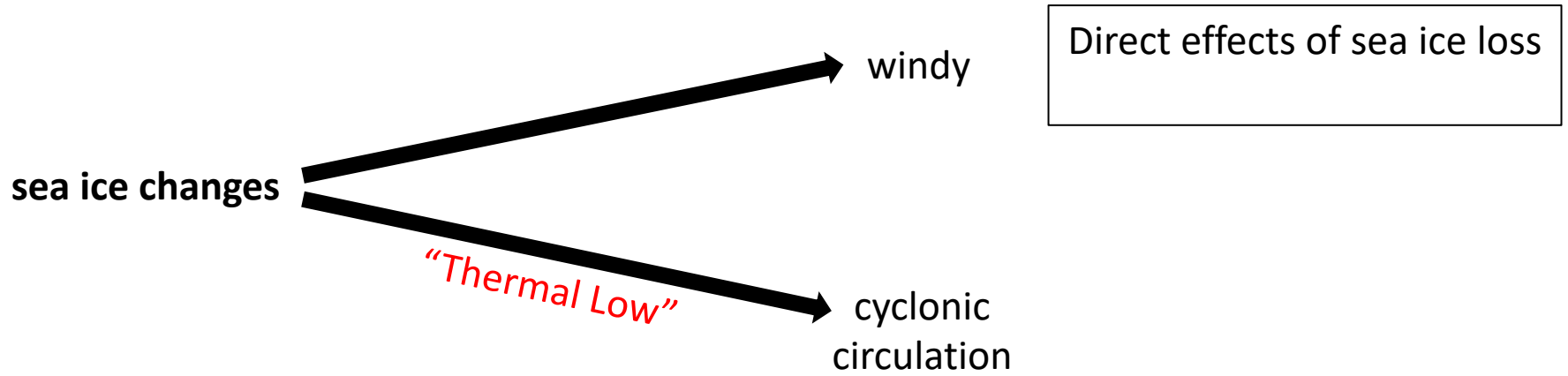
**Future
Wind
Trend**

**Future
SLP
Trend
(winter)**

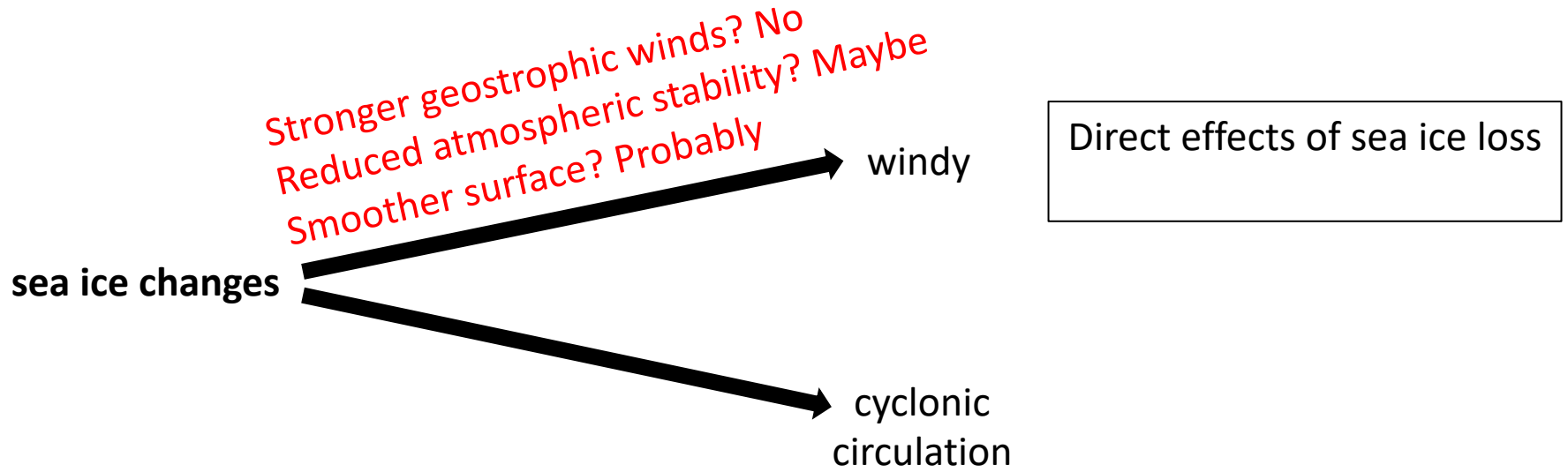
Conceptual Framework



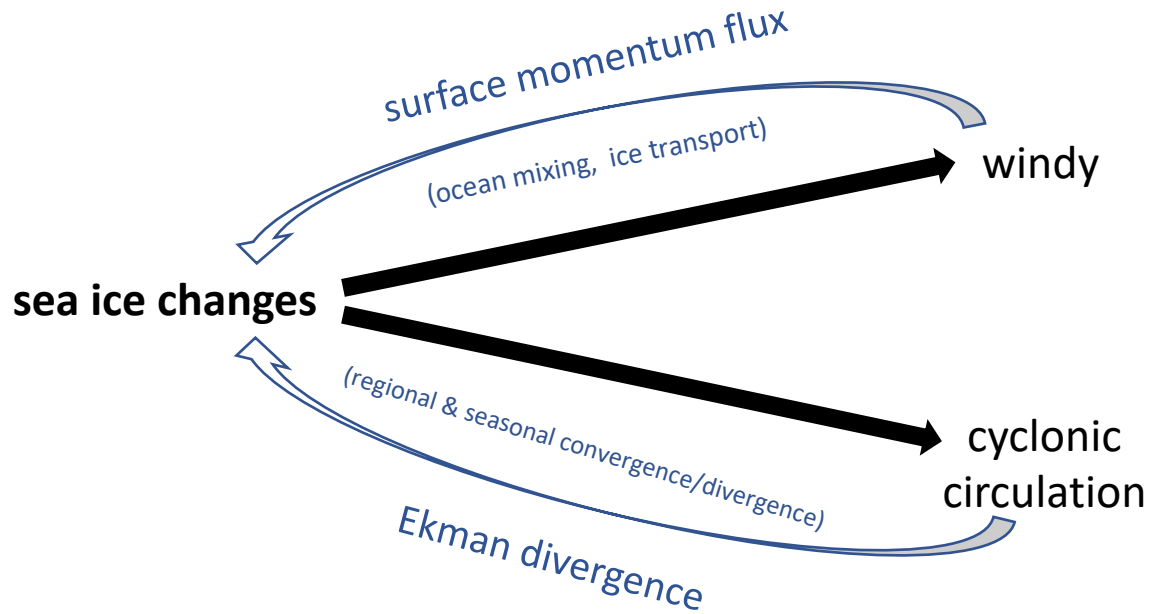
Conceptual Framework



Conceptual Framework



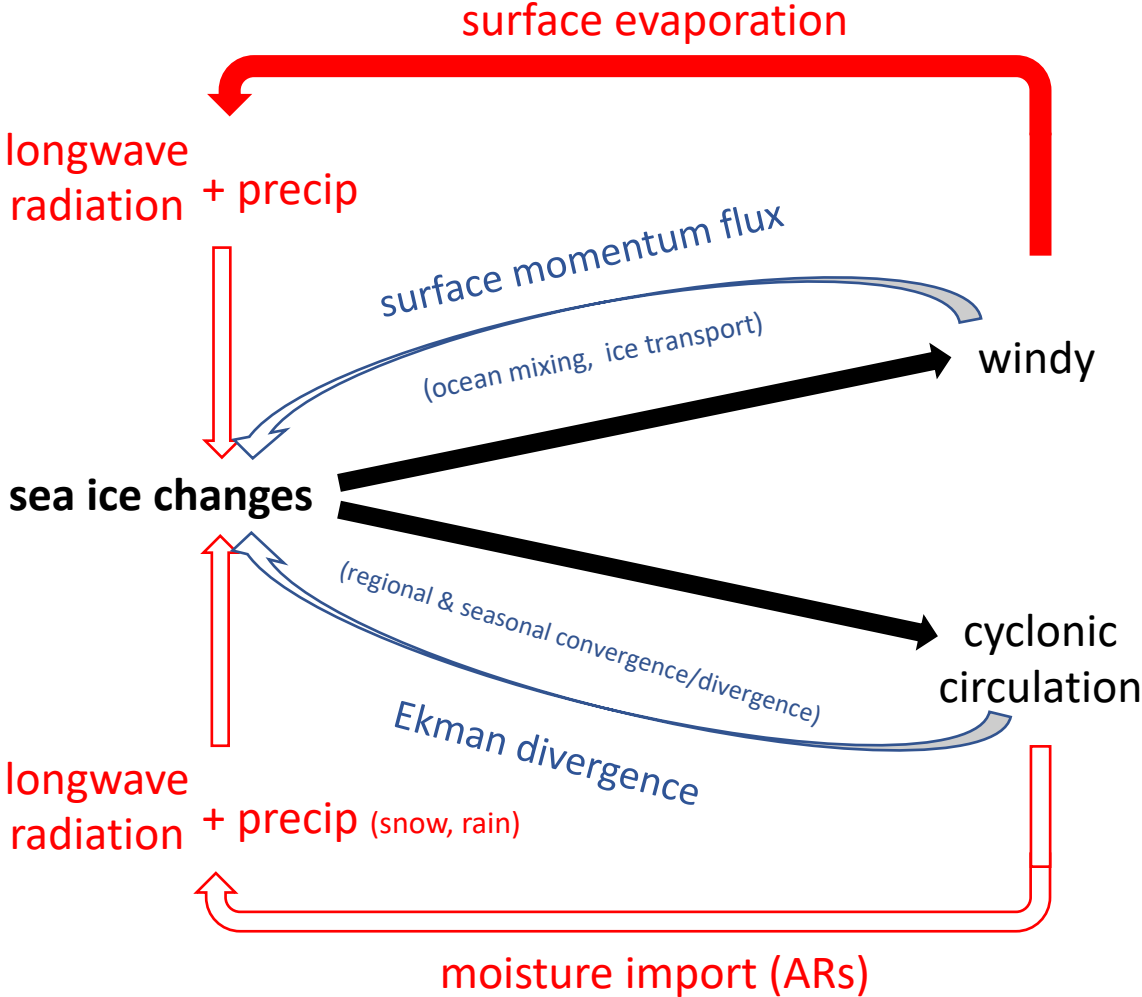
Conceptual Framework



Direct effects of sea ice loss

Oceanic feedbacks

Conceptual Framework

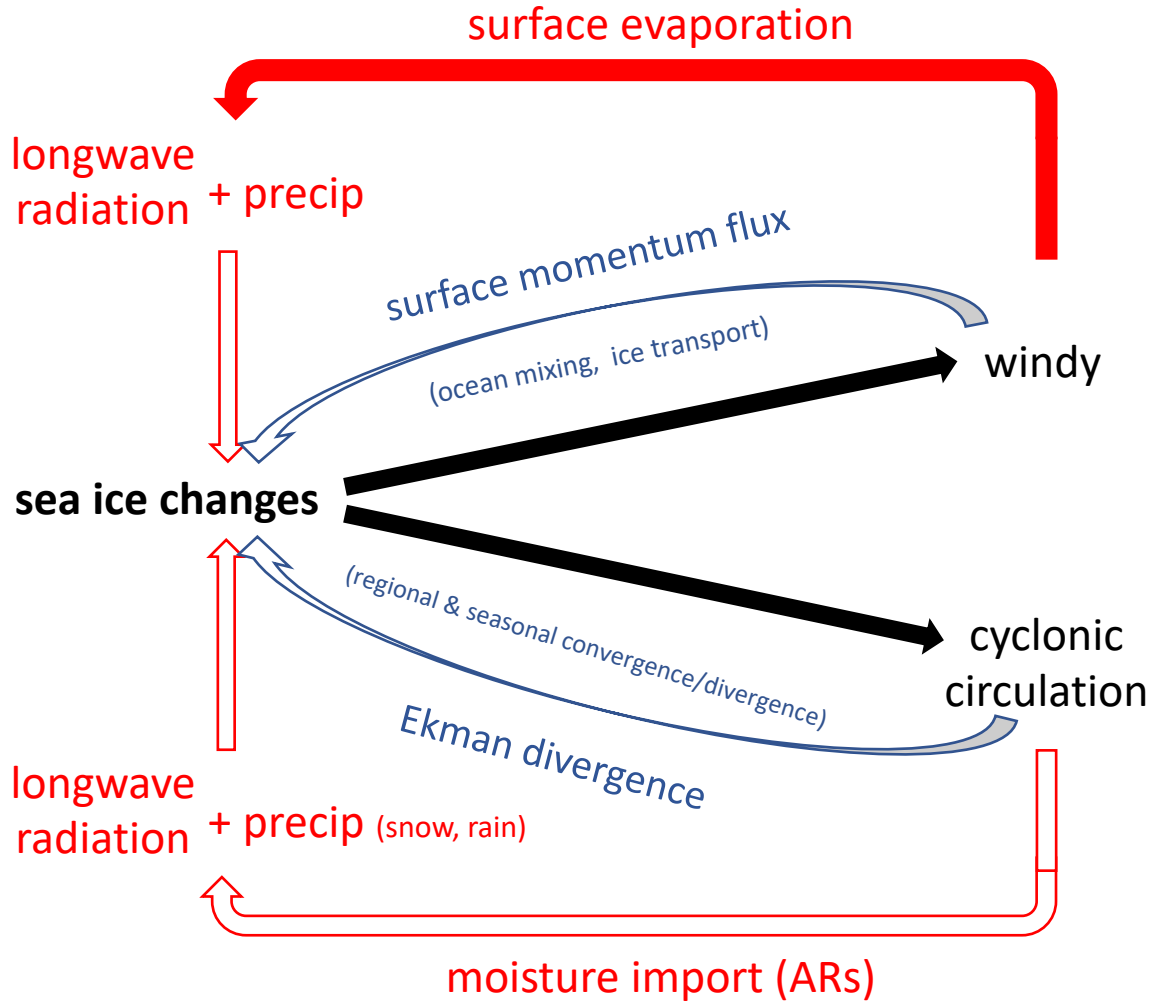


Direct effects of sea ice loss

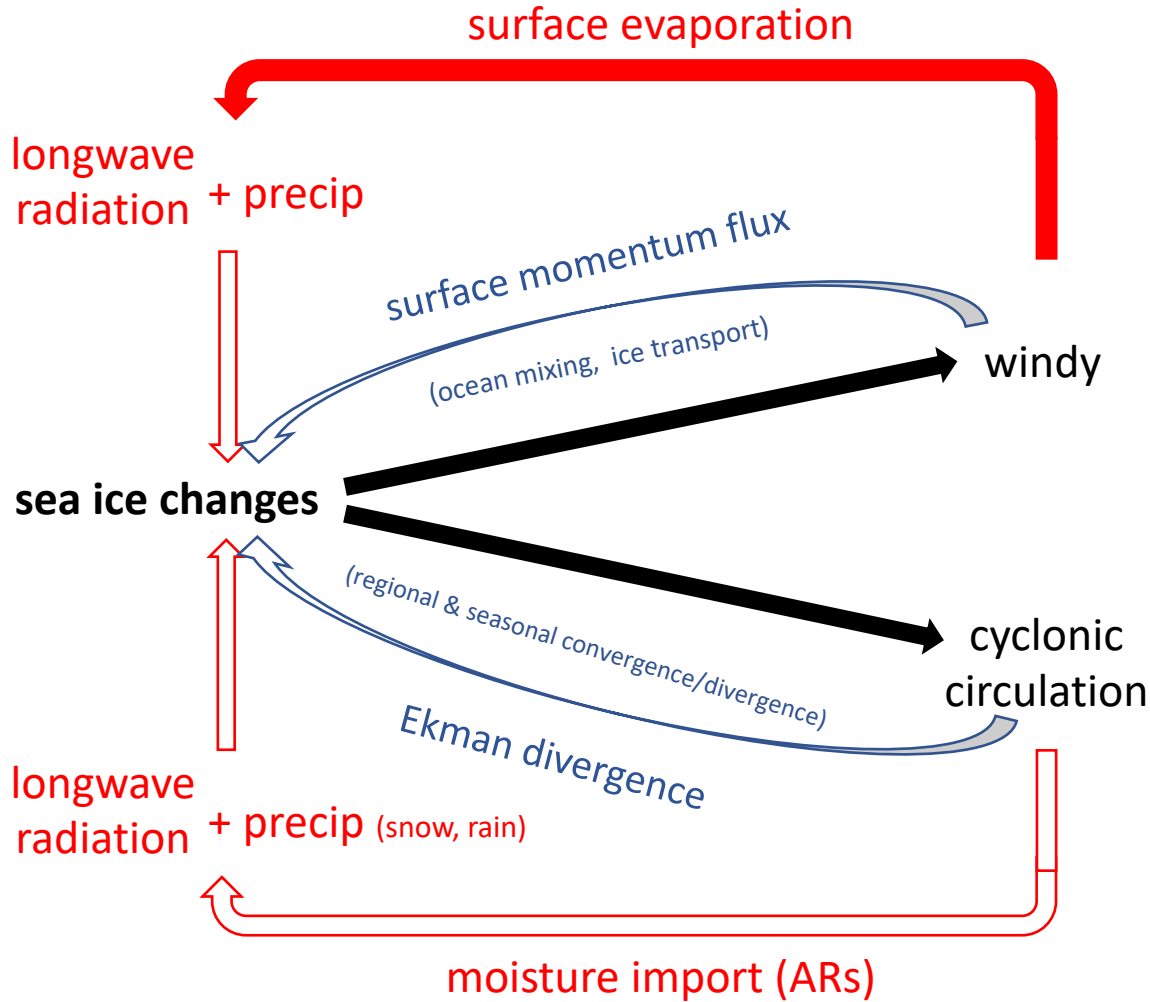
Atmospheric feedbacks

Oceanic feedbacks

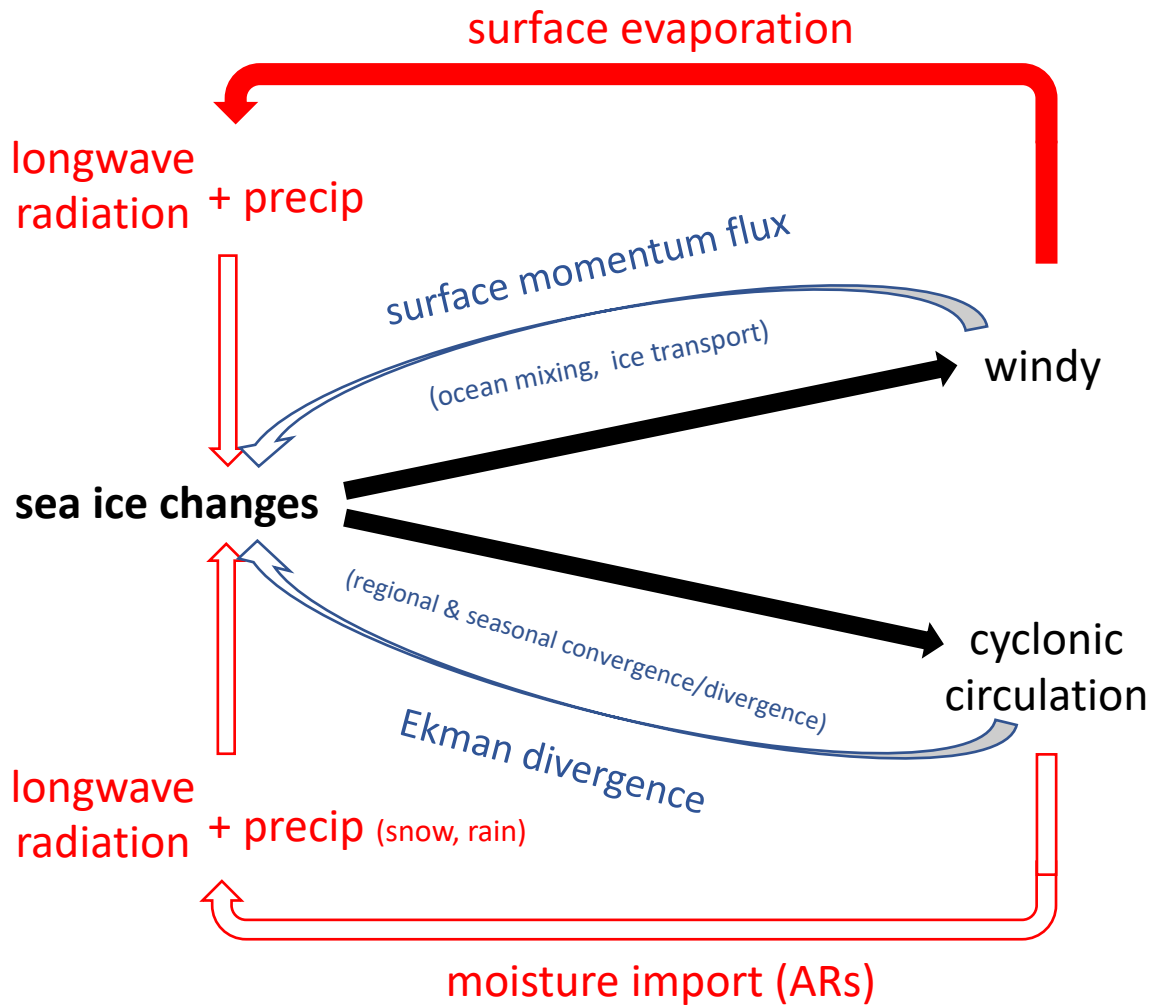
1. How do extratropical cyclones, associated ARs, and Arctic winds affect sea ice through heat, moisture, and momentum fluxes?



2. How does sea ice in turn affect cyclones, atmospheric rivers, and Arctic winds?



3. How will a changing climate affect these feedback processes and their relative importance over different spatial and temporal scales?

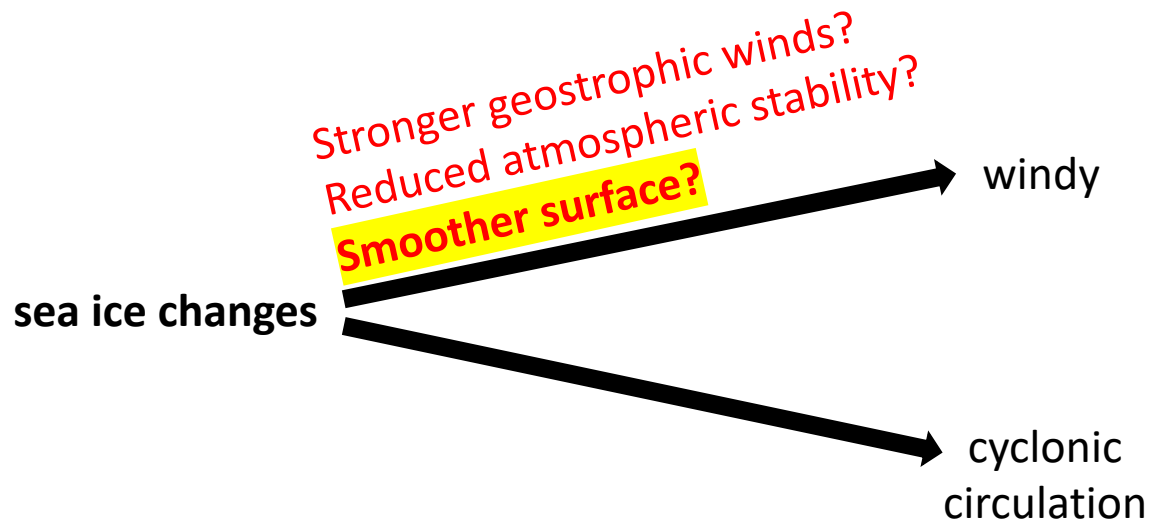


Research Tools

- CESM1 and **CESM2** Large Ensembles
- CMIP5 and **CMIP6** output
- PAMIP (especially prescribed sea ice experiments)

New Modeling Experiments (with CESM2)

1. Smoothed sea ice: reduce surface roughness of sea ice to open water value



New Modeling Experiments (with CESM2)

1. Smoothed sea ice: reduce surface roughness of sea ice to open water value
2. Suppressed atmospheric circulation change: use nudging to prevent circulation changes

