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# Recent trends and variability in the Canadian Archipelago

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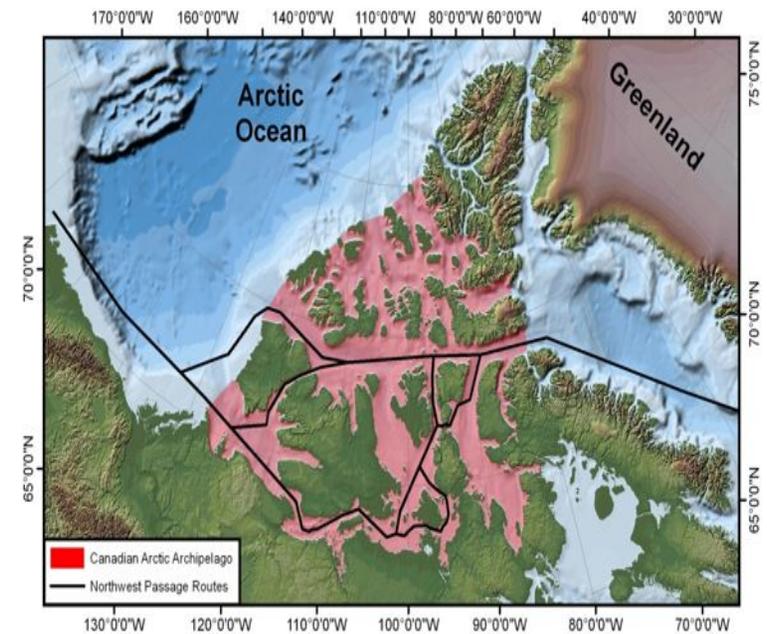
**and**

**Adrienne Tivy, International Arctic Research Center,  
Fairbanks**

Thanks to:

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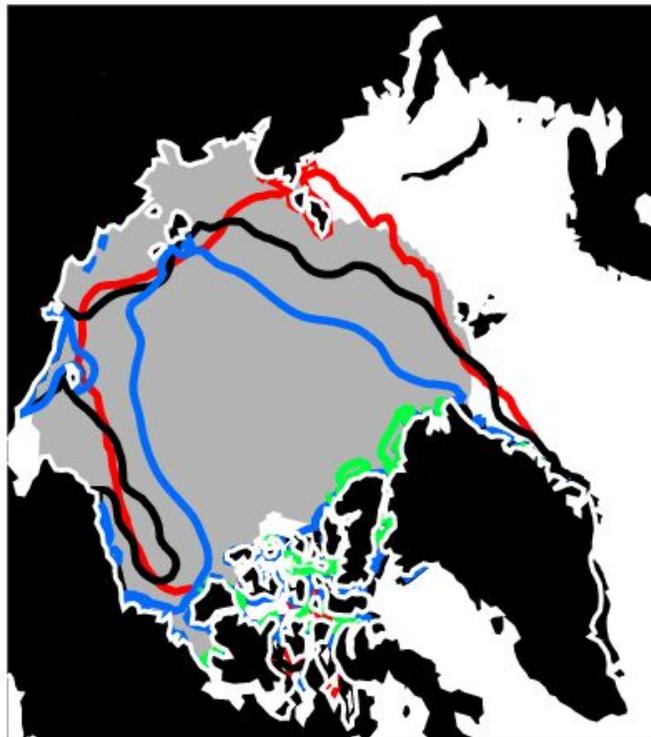
# Canadian Arctic Archipelago (CAA)



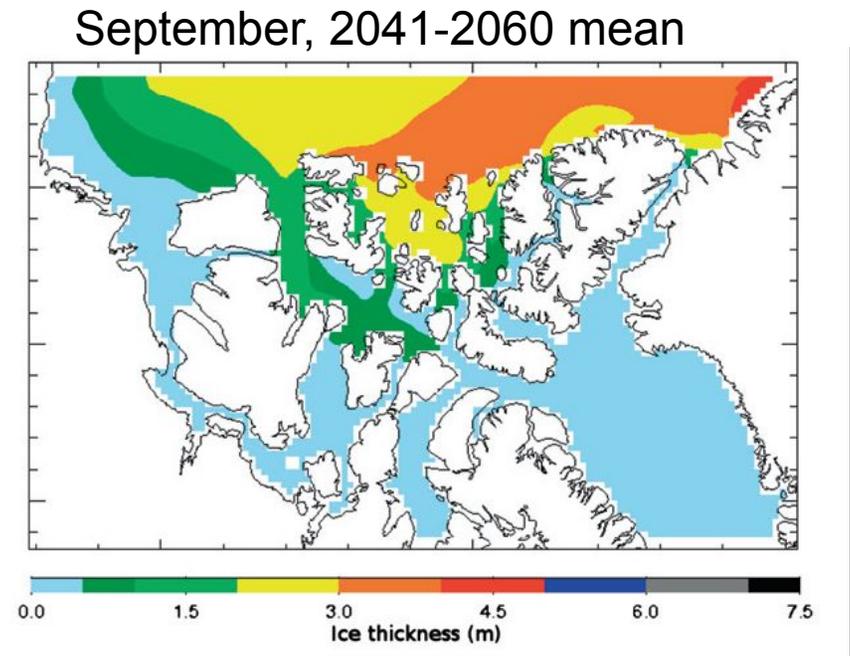
- Landfast in winter
- Less influenced by wind



# Summer sea ice-free conditions in the CAA will lag the Arctic Ocean



September ice extent (Holland et al., 2006)

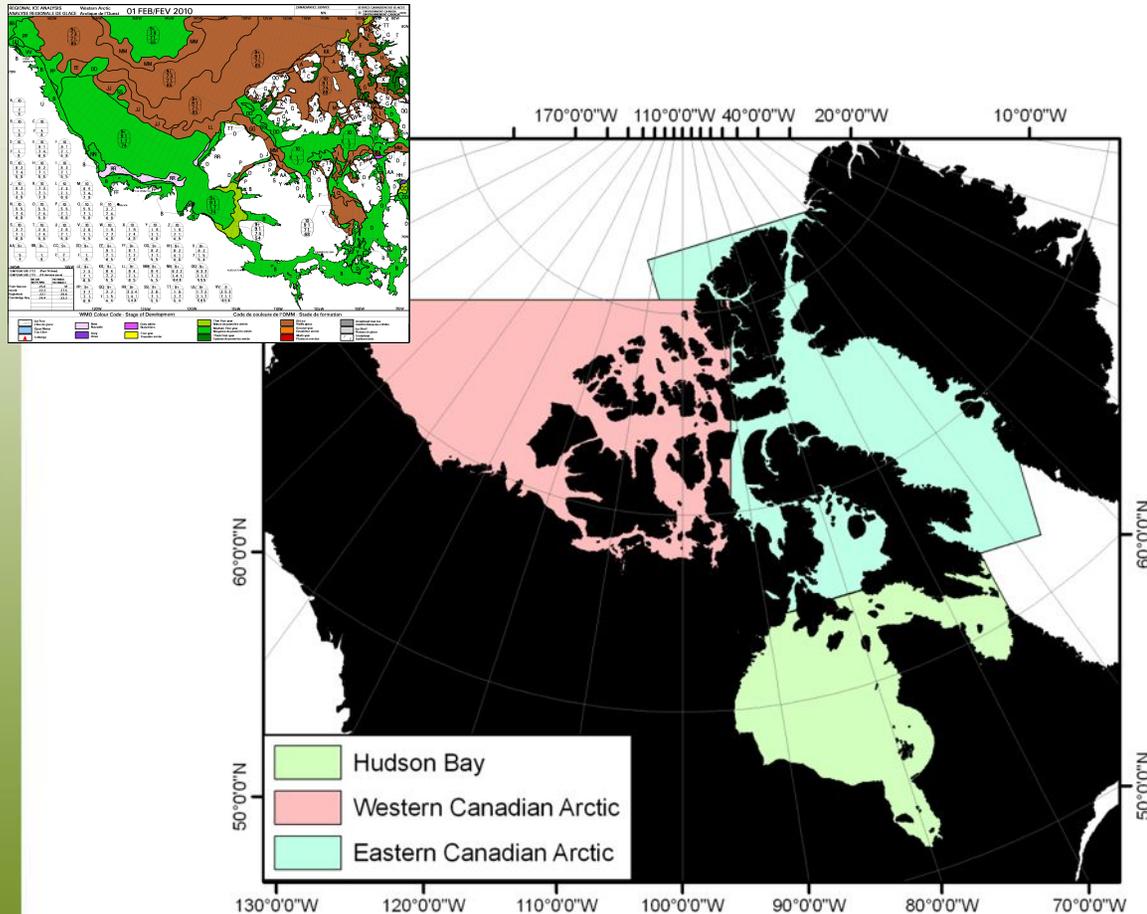


From Sou and Flato 2009

- Sea ice free Archipelago will undoubtedly lag the Arctic Ocean.
- How has the Canadian Arctic Archipelago responded to change?



# Sea Ice Information Sources



CIS Ice Charts from 1968  
to present

AMSR from 1978

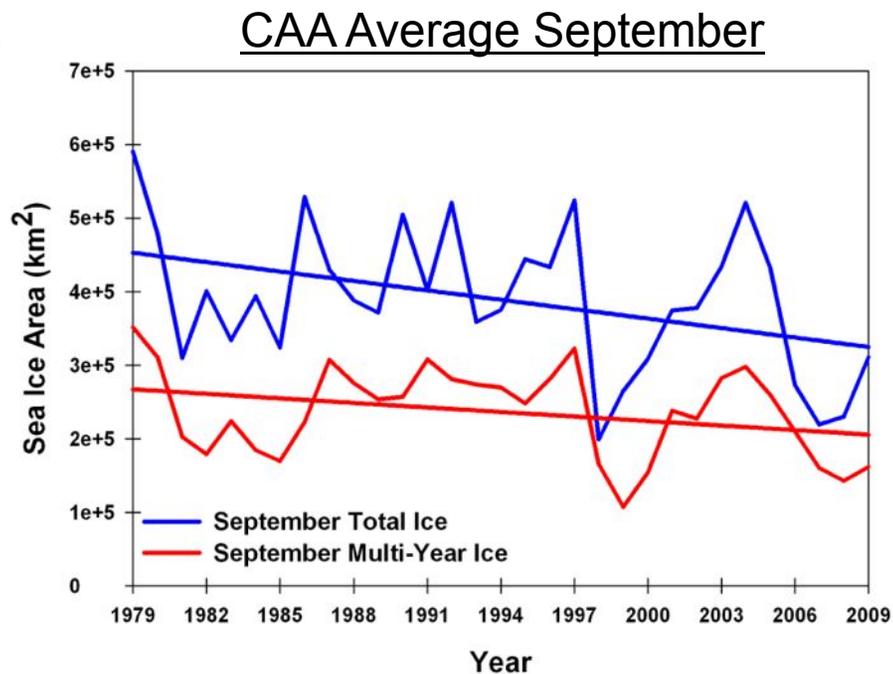
Qscat from 1999



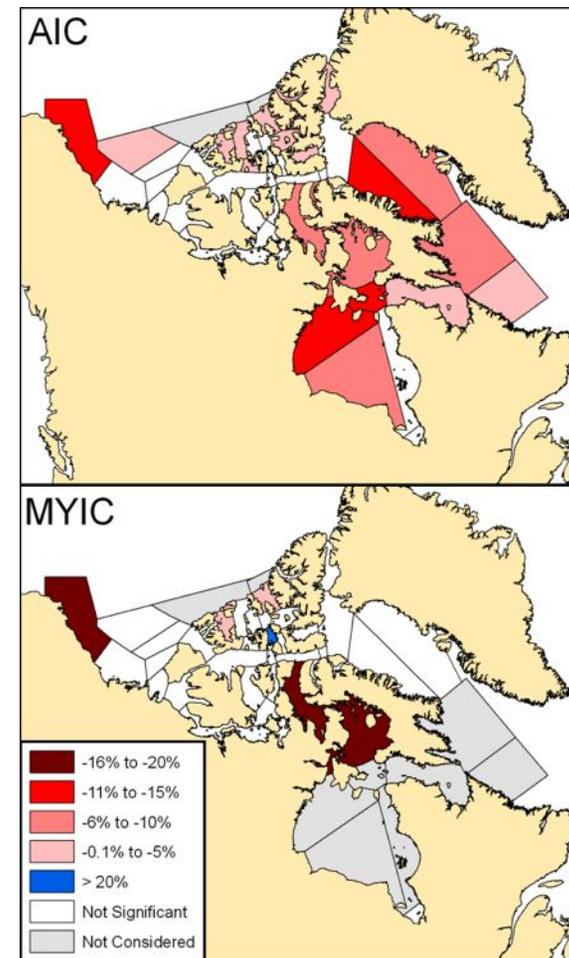
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# Recent trends and variability in total and multi-year sea ice



- All sea ice area  $-8.7\%$  decade<sup>-1</sup> (sig)
- MYI area  $-6.4\%$  decade<sup>-1</sup> (not sig)

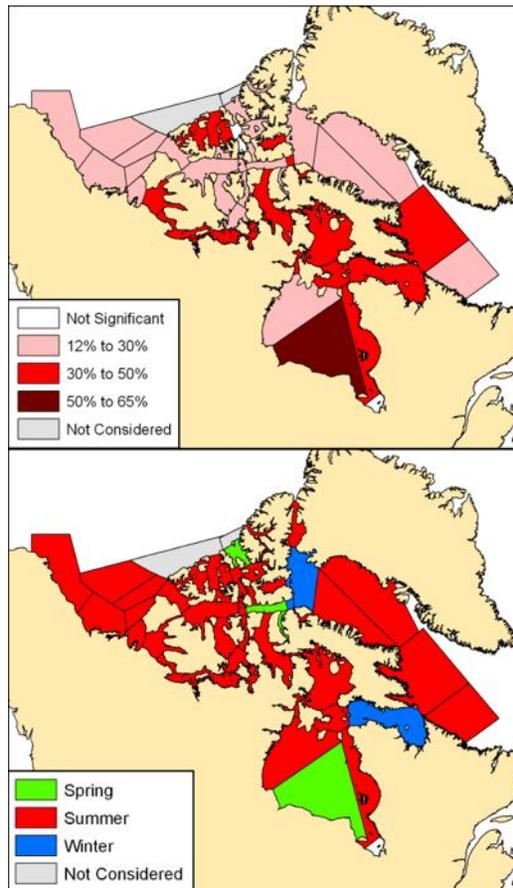


Howell et al. 2009-GRL; Tivy et al. submitted-JGR

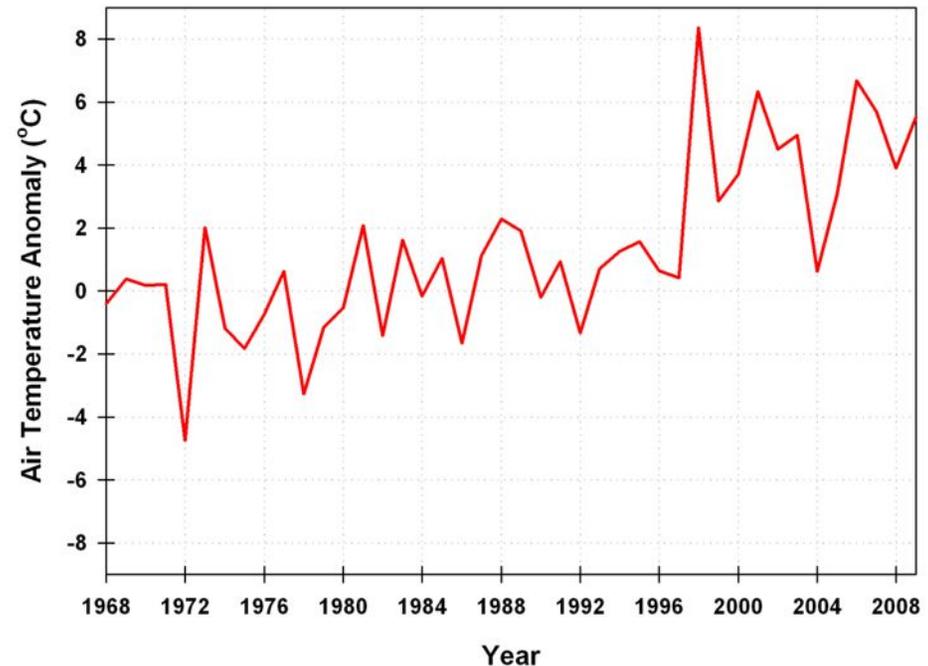


# CAA sea ice variability: links to air temperature

## Air temperature & total sea ice correlation



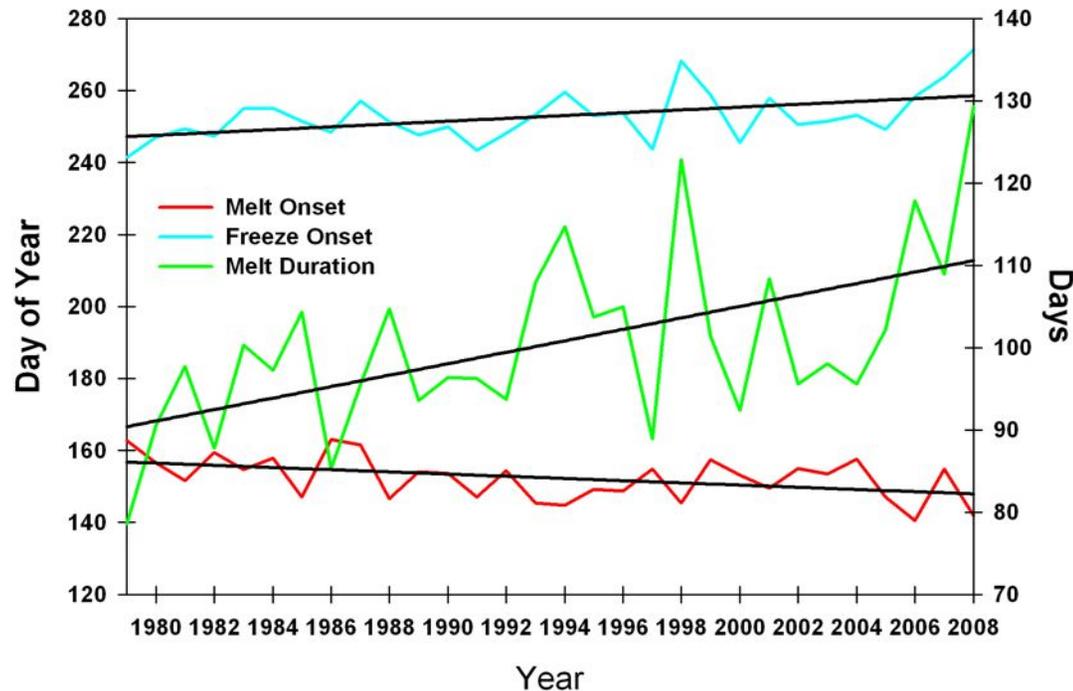
## Summer SAT over the CAA



- Correlation with total sea ice are significant in summer.
- But correlation with MYI is not significant!



# Recent trends and variability: sea ice phenology parameters

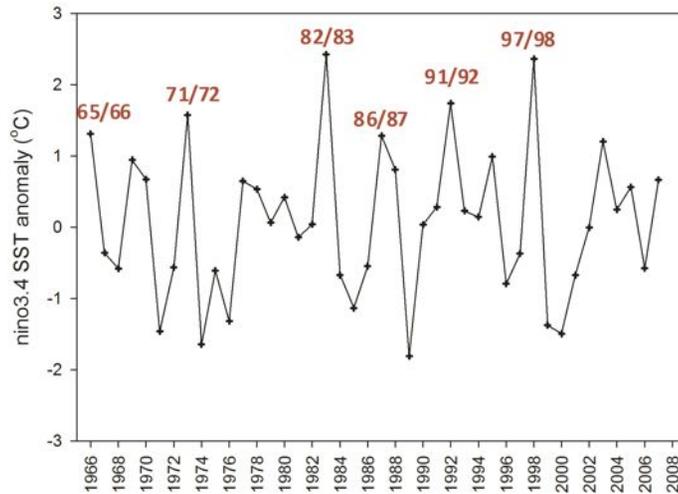


- Melt onset  $-3.1$  days decade<sup>-1</sup> earlier (sig)
- Freeze onset  $3.9$  days decade<sup>-1</sup> later (sig)
- Melt season length increasing at  $7.0$  days decade<sup>-1</sup> (sig)

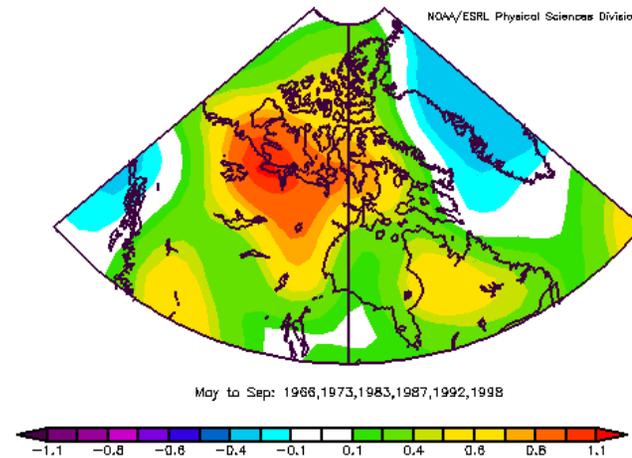
- Melt duration is correlated with AIC (total sea ice) and FYI.
- Why is the increase in thermal forcing not significantly effecting MYI ?



# Atmospheric circulation links: Arctic Oscillation & ENSO



- NAO/ENSO is not correlated with summer AIC
- Preceding NDJFM ENSO is correlated with MYIC and negatively with FYIC



Composite MJJAS SAT for  
El Niño Events

Tivy et al. submitted-JGR

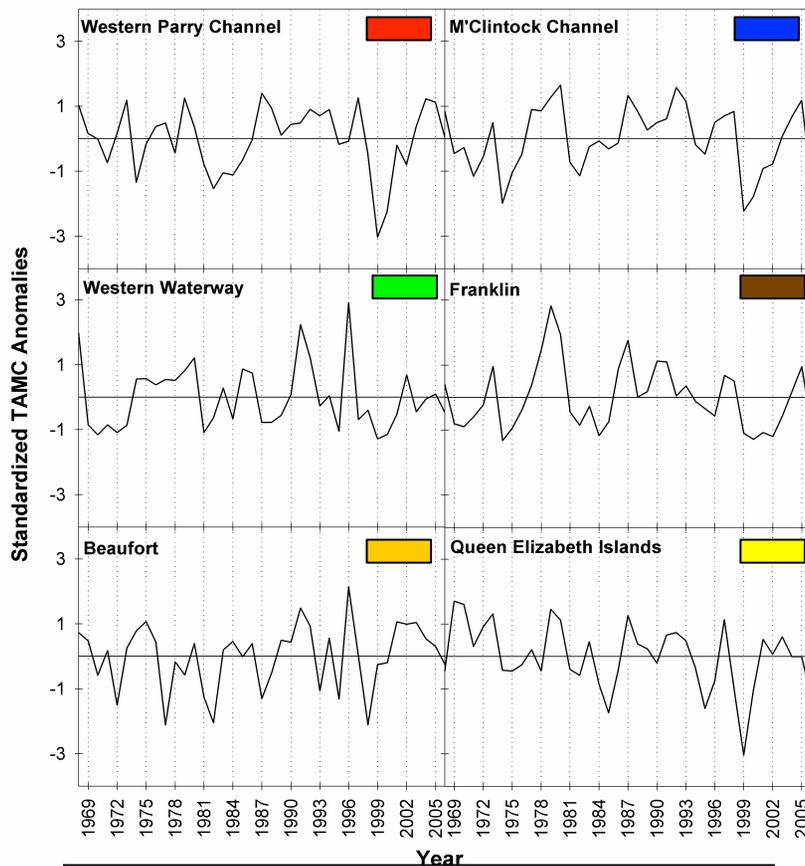


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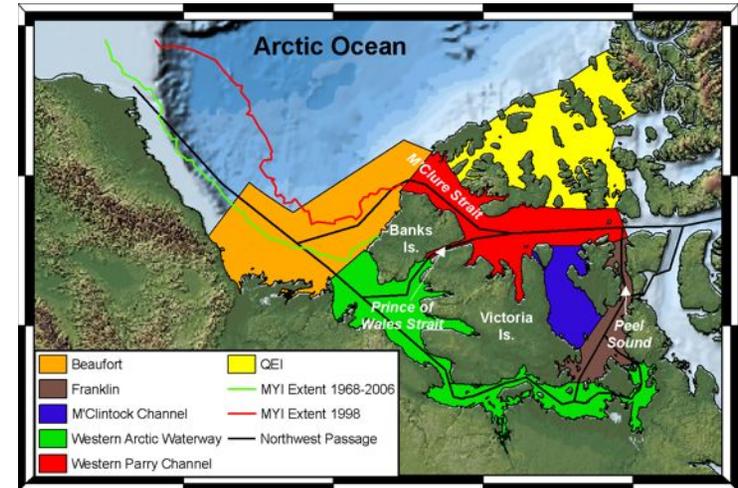
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# MYI variability within different region of the CAA: sea ice dynamics vs thermodynamics

## Multi-year Ice



Mechanism maintains heavy sea ice conditions within the CAA



No significant MYI decreases with time.

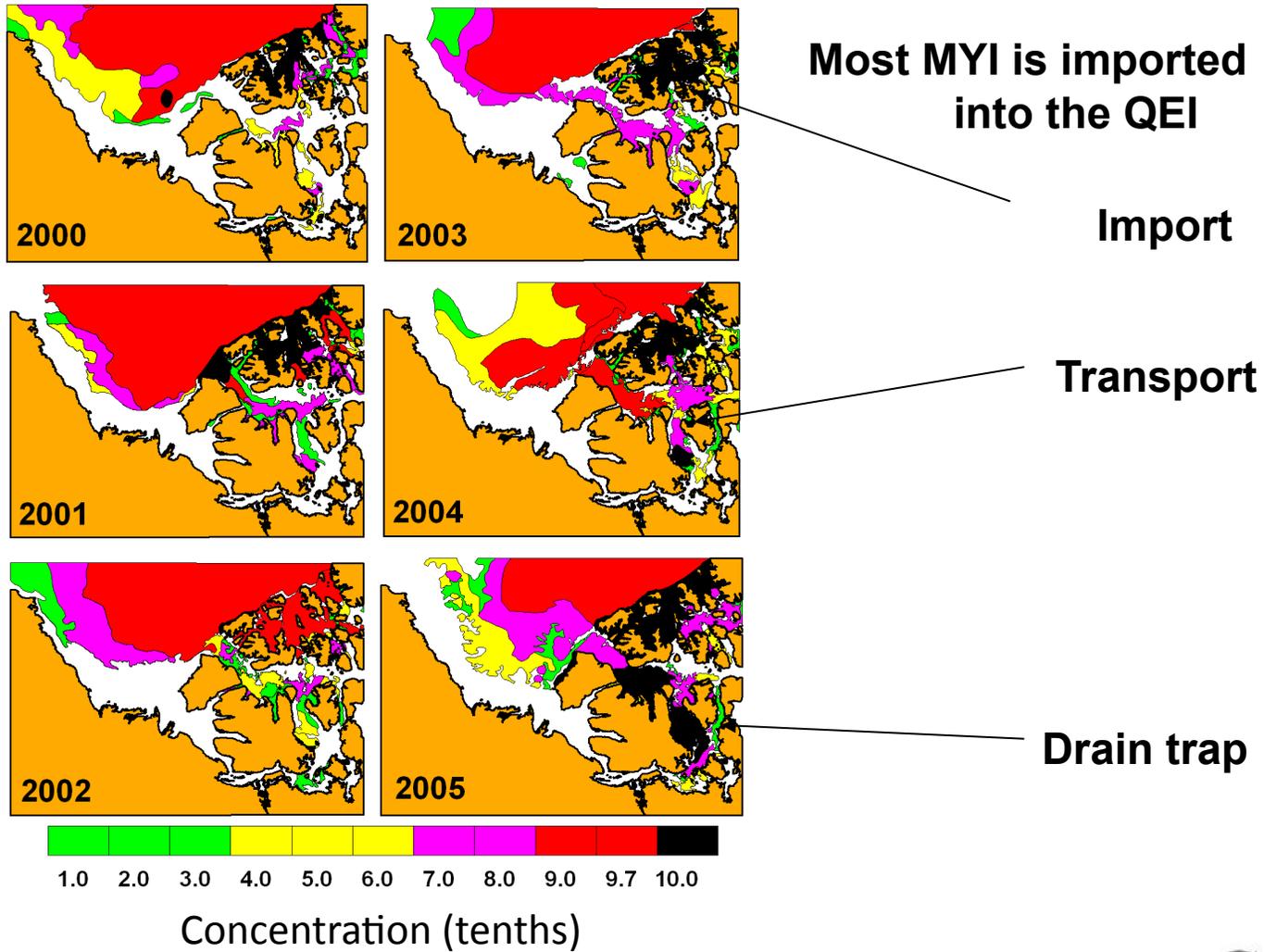
Air temperatures are increasing significantly at  $\sim 0.5^{\circ}\text{C decade}^{-1}$

Decreases are always followed by period of recovery

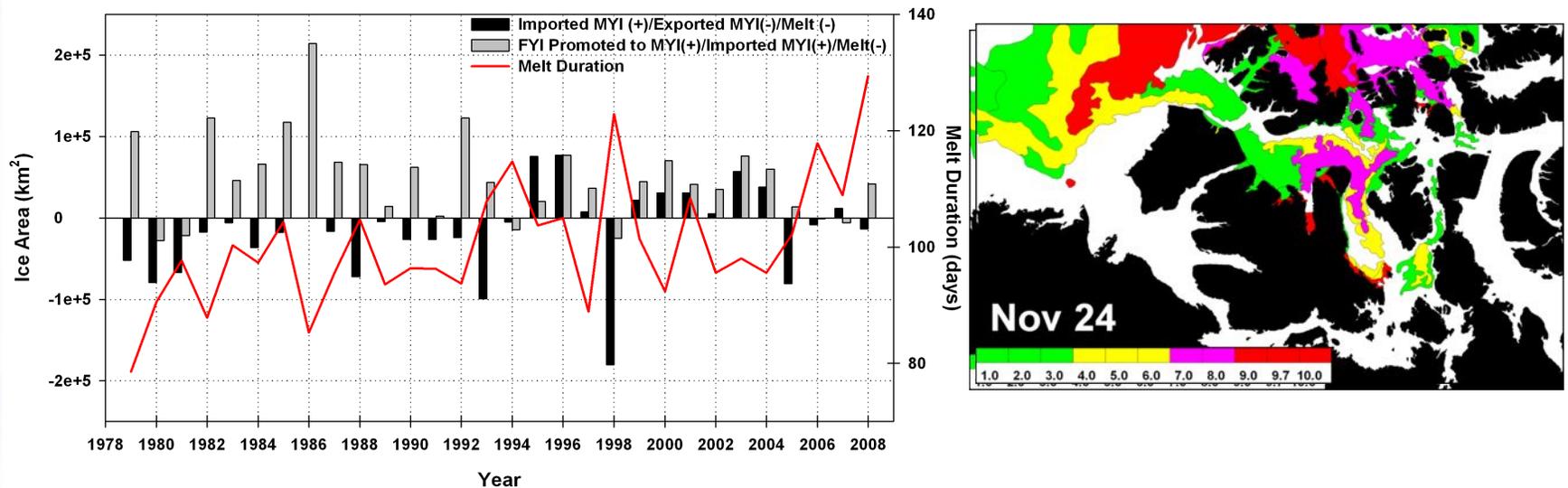
Source of MYI ?



# MYI Import and transport south



# Changes in the source input of multiyear ice



- Pre-1994; cooler temperatures (shorter melt season)  less dynamic movement but situation is reversed post-1994
- When one source is shut-down the other takes over
  - Will result in slower decreases within the CAA
- CAA MYI for 2007 & 2008 is mostly dynamic import

Howell et al. 2009-GRL



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# Conclusions

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- The CAA is experiencing decreasing sea ice conditions but they are not as dramatic compared to the Arctic Ocean
  - Air temperature are 'likely' responsible for some of the observed decreases
  - No trends in MYI
- The southern channels of the CAA act as a drain-trap for MYI
  - The drain-trap mechanism has and will continue to facilitate the presence of MYI within the CAA
- The source of CAA's MYI has changed because of longer melt seasons
  - Less first-year ice survival but more dynamic MYI import
- As the transition to a summer-time sea ice free Arctic continues the supply of MYI from the Arctic Ocean to the CAA is unlikely to stop
  - Atmospheric circulation continues to force sea ice up against the CAA hence creating very thick ice (15+ m ) that will likely be able to survive 2°C temperature warming



# Conclusions

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- Dynamic MYI import caveats:
  - i) Longer melt seasons may reduce MYI resonance time in the southern channels
  - ii) Longer melt seasons may allow MYI to transit more rapidly through the CAA (e.g. 2008/2009) especially late in the season
  - MYI could potentially be thicker than in the past
- The most direct route through the Northwest Passage will also continue to be susceptible to MYI during the transition to summertime sea ice free Arctic
  - Byam-Martin Channel remains the bottleneck
    - May only result in a minor lengthening of the shipping season
  - It will be difficult for the Northwest Passage to clear frequently
    - Longer melt seasons are not enough (i.e. 2008)
    - Several factors need to be in play
- Northern Sea Route and Transpolar Route will open first and be a more reliable and attractive ocean transit route



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# Thank You



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