



What are the local impacts of Arctic climate change?

Collaborative Project: Arctic Climate Stability and Change
European Climate Research Alliance General Assembly 2015:
“New knowledge for risk reduction”
26. March, 9:15-9:30

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ARCTIC SUMMIT

STILL ICY: HAS INVESTING IN
THE ARCTIC BEEN OVERSOLD?

MARCH 12TH 2015 • HOTEL BRISTOL, OSLO

Analyse risk and evaluate opportunity in the High North alongside over 150 leading stakeholders from government, civil society and business.

The ice might be melting but planned Arctic megaprojects are coming to a grinding halt with dropping oil prices....

The icy 'last frontier' is expensive and hazardous for all industries ...

Is commercial interest in the Arctic a bubble about to burst?

.... indigenous groups remain skeptical about the impact commercial activity will have on climate change, biodiversity and local communities.

TOPICS:

- Effects of sanctions against Russia by US/EU on the Arctic energy industry
- Will China benefit from the deterioration in US/EU-Russian relations in the Arctic?
- **Can the Arctic serve as a reliable alternative transport corridor?**

ARCTIC OPENING:

Opportunity and Risk in the High North

LLOYD'S

© Lloyd's 2012

**Future Investment
~ 100 billion Euro
in the next 10 years**

Conclusions :



Investment in science and research – both by governmental agencies and by private companies – is essential to close knowledge gaps, reduce uncertainties and manage risks. ...

Further research is required to ensure future development takes place sustainably and does not cause irreparable damage to the environment.

Why 'people' care about Arctic Climate change



Arctic transport may boost in coming years ...

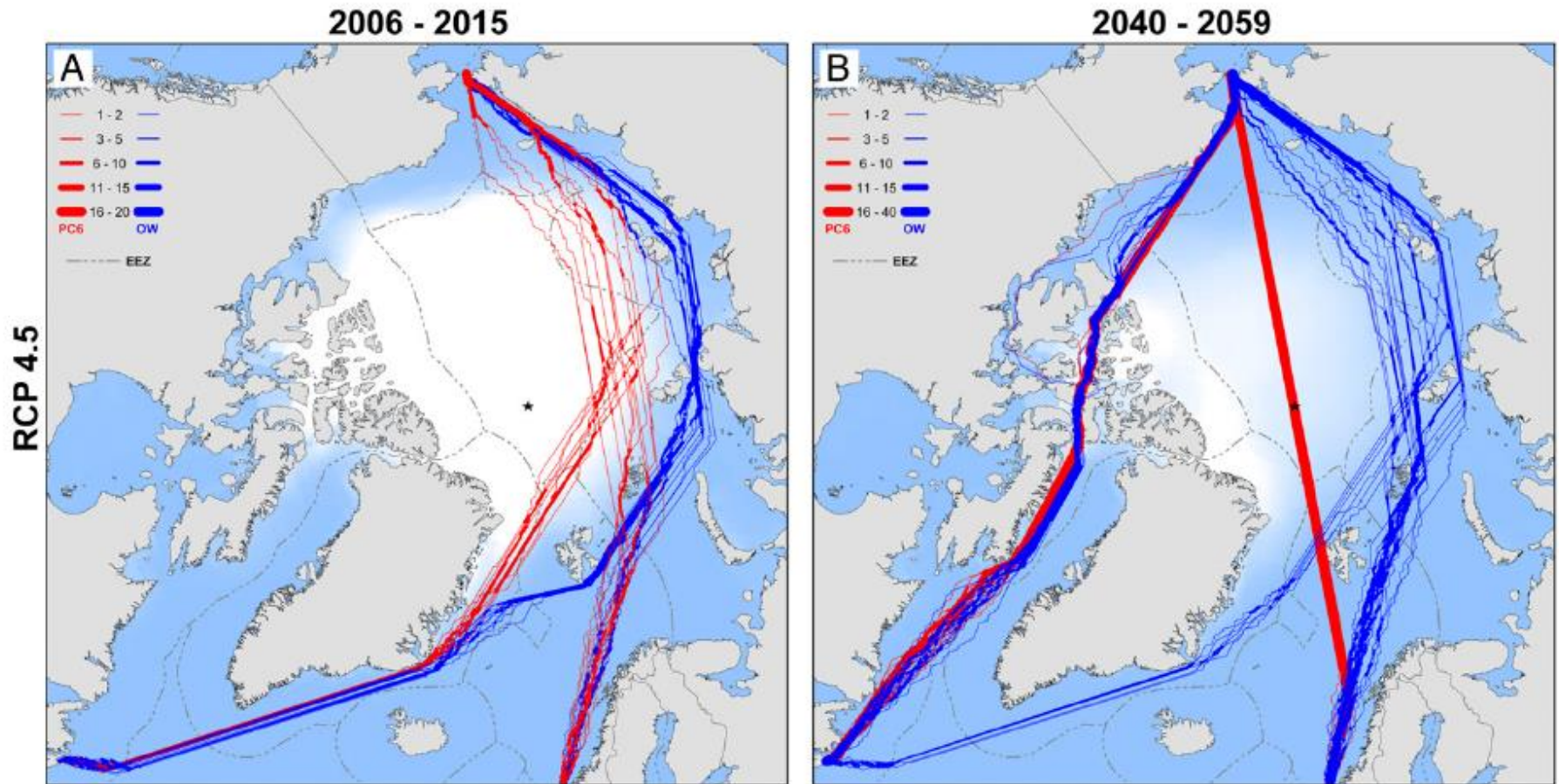
The icebreaker “Snow Dragon” was the first Chinese vessel to sail the Northern Sea Route via the Barents Sea in 2012.



By 2020 as much as 15 percent of the China's international trade can be shipped through the Arctic.

Vessel transits	2011	2012	2013	2014
NSR	41	46	71	31
Suez Canal	17.799	17.224	16.596	17.148

Arctic Shipping – the forecast

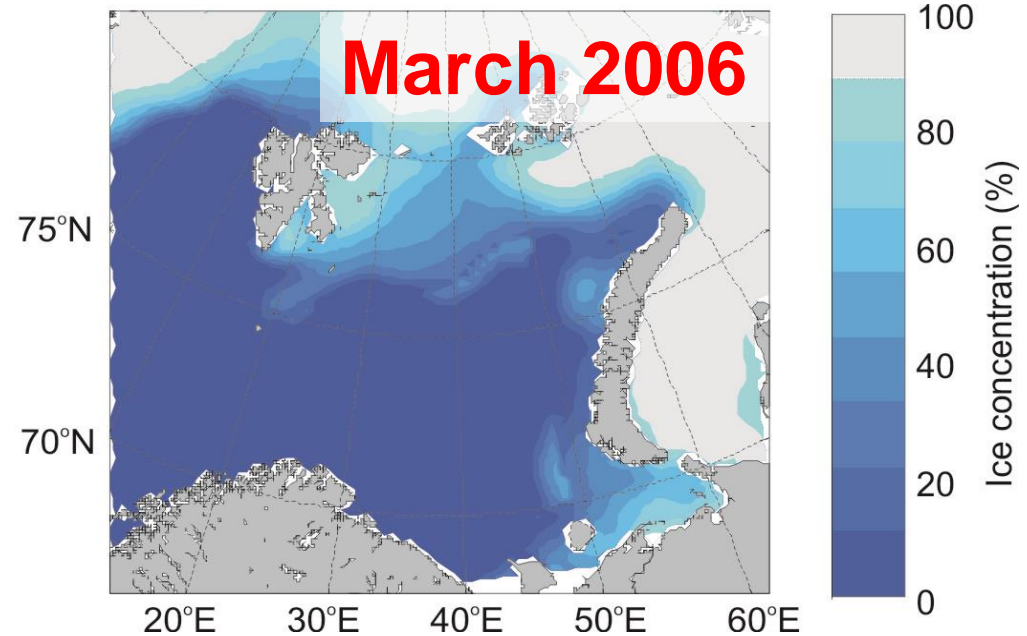
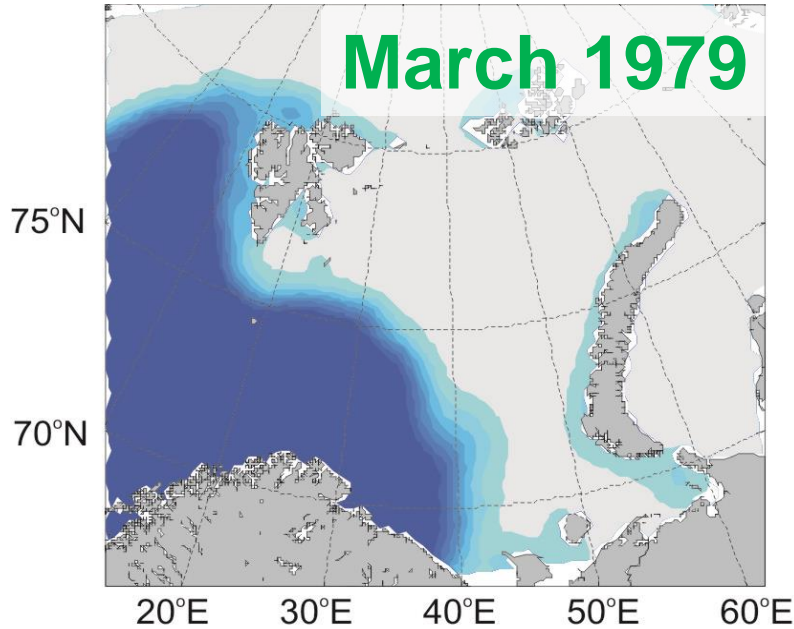


Blue lines are # of
Open Water vessels

Red lines are for
Polar Class 6 vessels

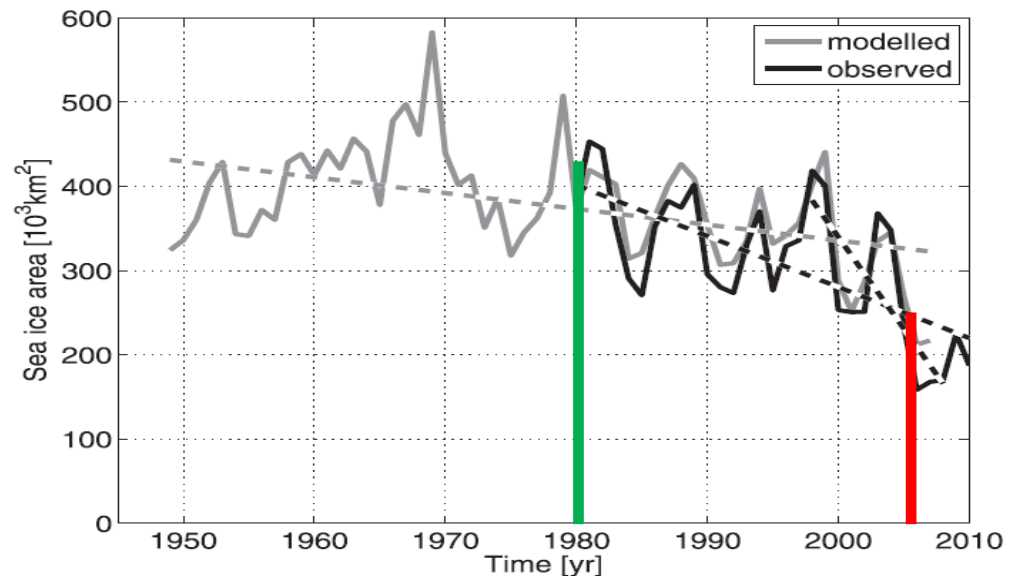
7 models (CMIP5). September – high peak season.
Possible crossings
– no economic or governance factors

Barents Sea Ice loss driven by Atlantic Heat



Årthun et al (2012)
Smedsrud et al (2013)

**Explains much of the
Arctic Sea Ice Loss
during winter**





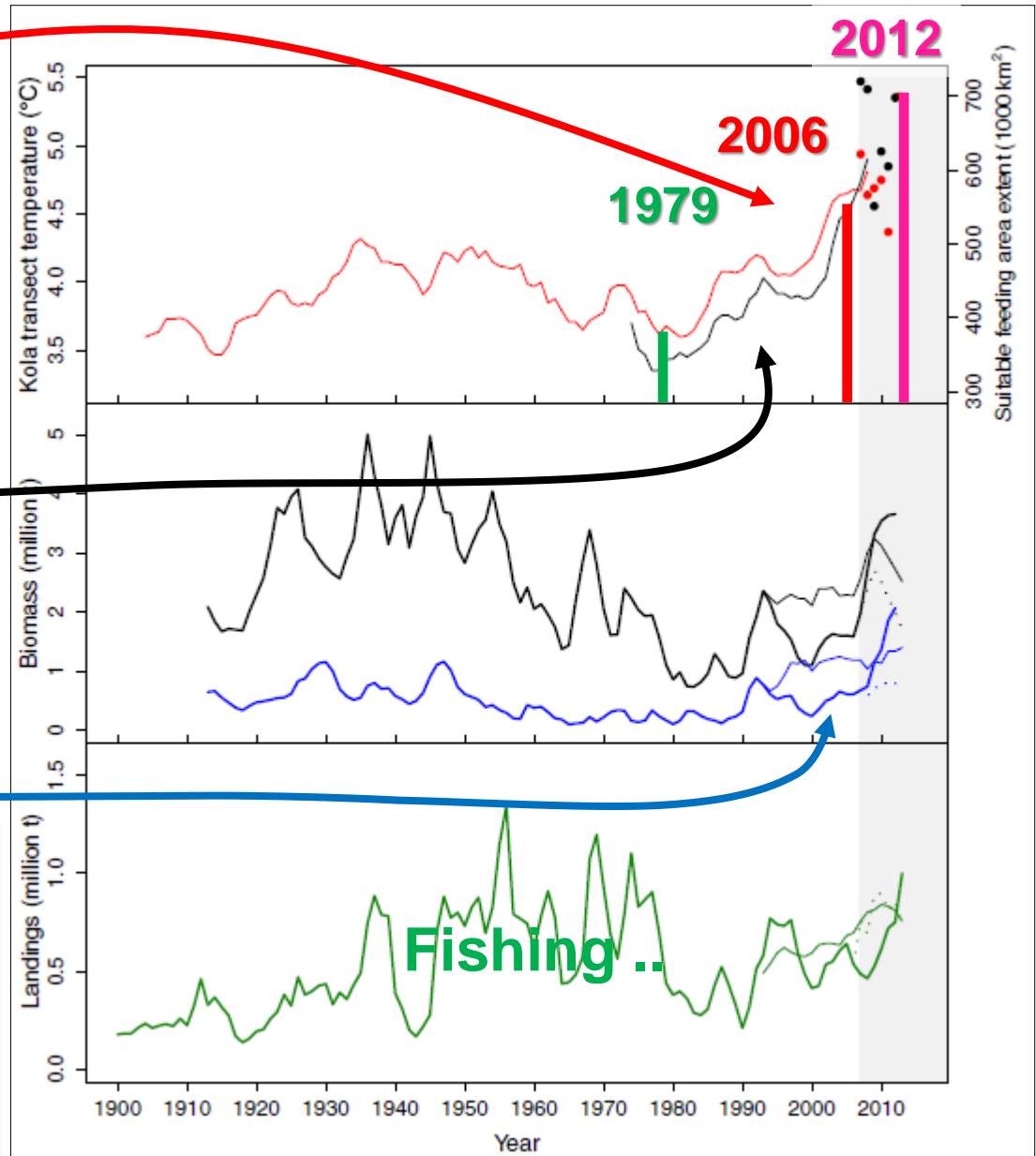
Barents Sea **Warming**
and good Harvest Control
(onwards from 2007)
increased Cod stock to
Historical high level

Suitable Feeding Area

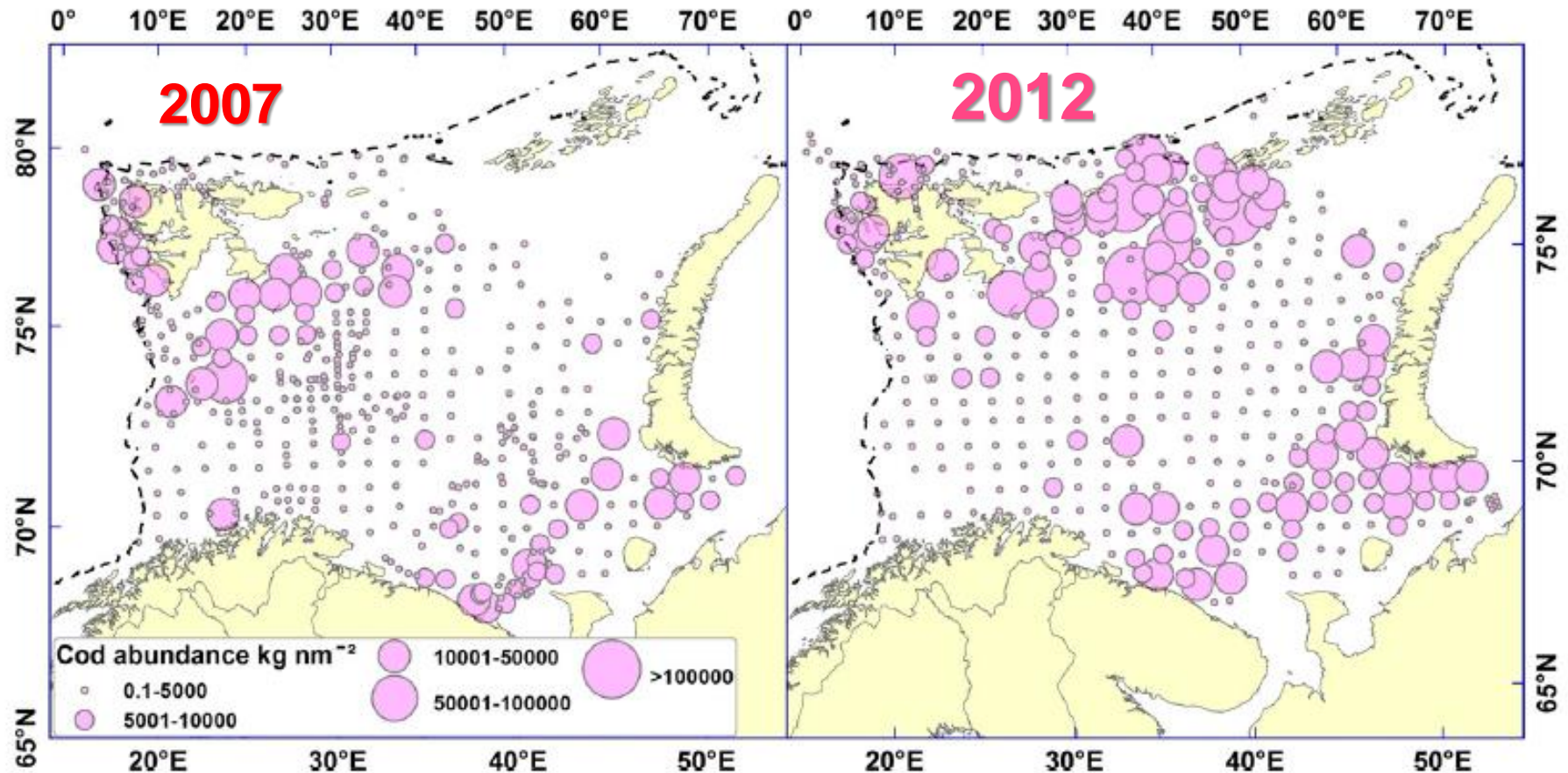
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Ice free area

Spawning stock biomass



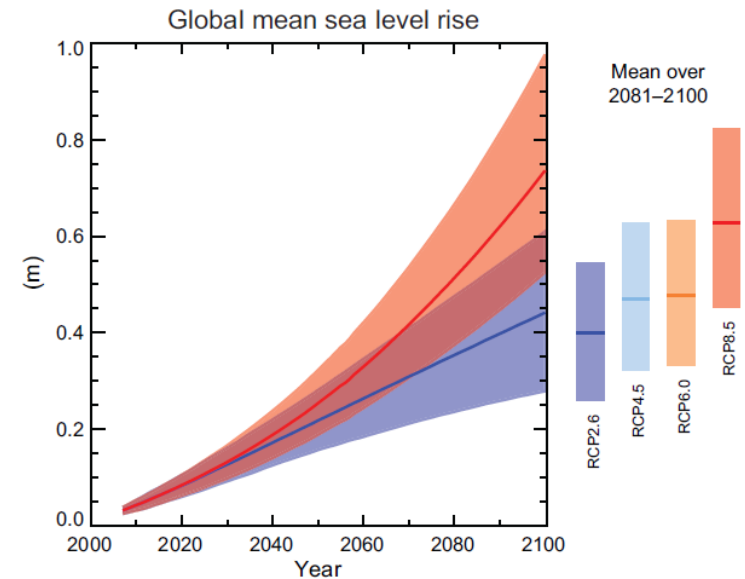
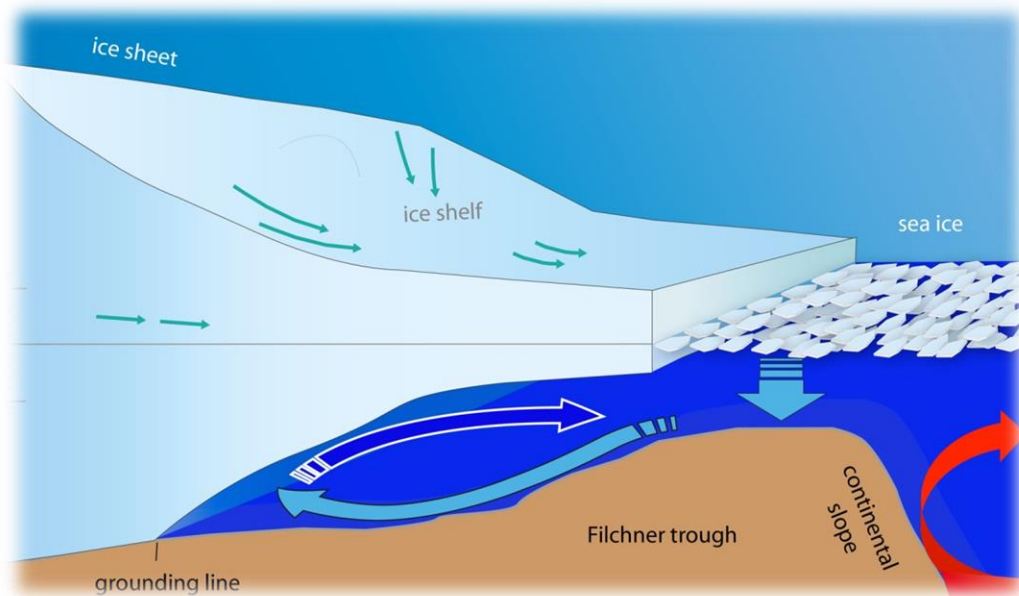
Barents Sea Cod Stock



The worlds largest cod stock increased and recently moved north

Greenland melting & Sea Level Rise

- **Global mean sea level 1900 – 2010 rose by 0.19m**
- **Likely to rise between 0.3 and 0.9m until 2100**
(IPCC report, 2013)
- **Still low confidence in ice sheet models and coupling to ocean (ice-shelf modelling)**



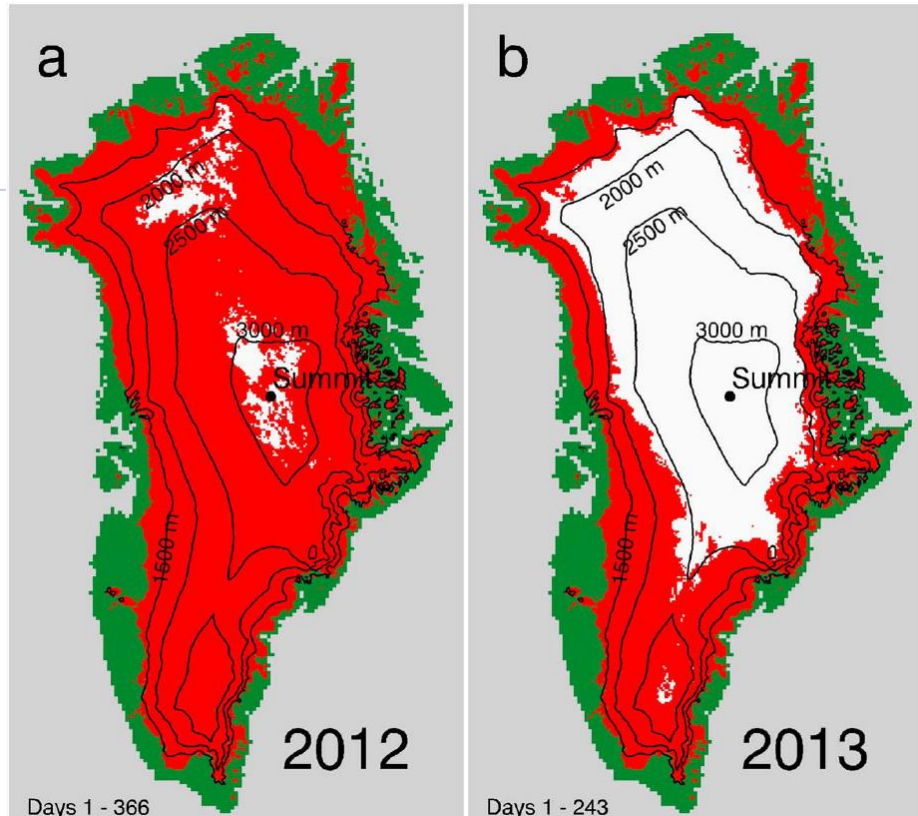
Greenland melting – atmospheric circulation

Large annual variations in melt

- **2012: 95% of surface area**
- **2013: 49% of surface area**

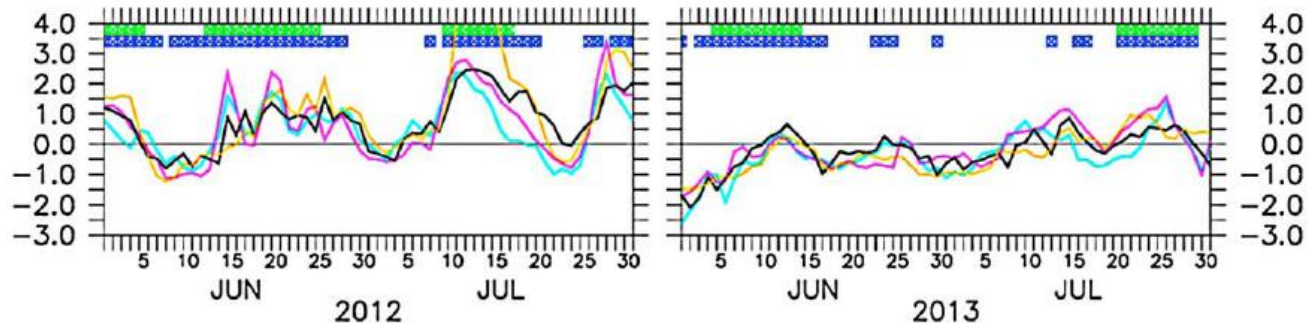
Blocking events bring more subtropical air masses and cause temperature anomalies of 6-8°C.

Häkkinen (2014)



Melting and surface temperature anomalies:

Green = Blocking days
Blue = Blocking
+ Wave breaking

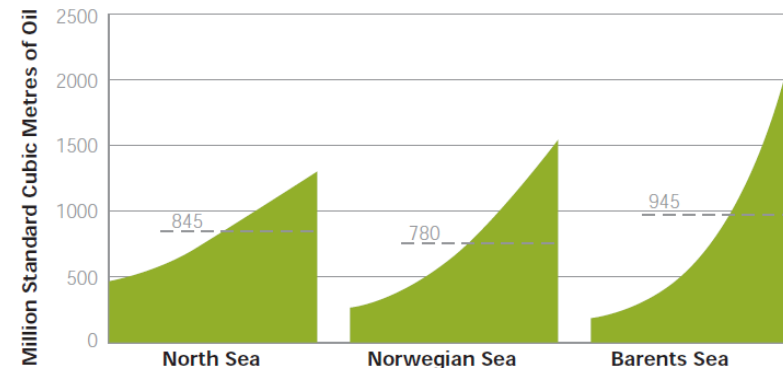
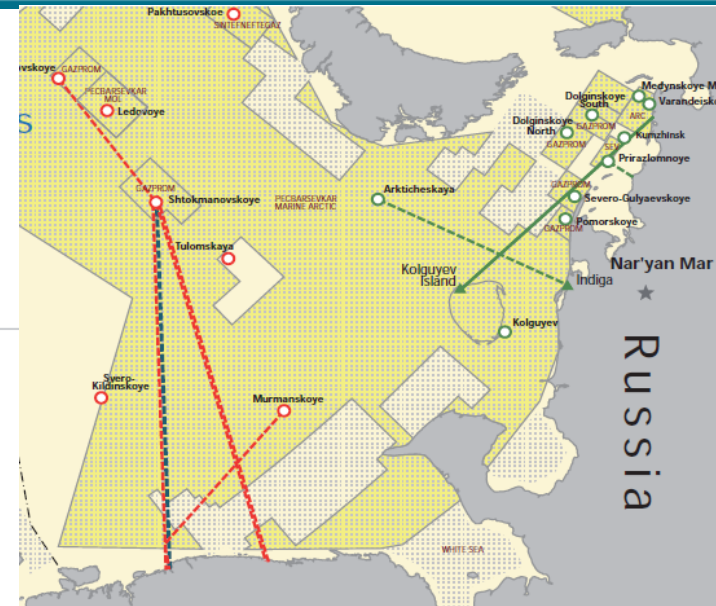




Arctic mineral resources

- › Was commercially attractive:
 - prices were high
 - access is good
 - technically feasible
- › 30%* of global gas reserve
- › 13%* of global oil reserve
- › Unexplored minerals: Gold, Platinum, Olivine, Uranium

(* Uncertain estimates - US Geological survey, 2008)



Source: The Resource Report 2011, Norwegian Petroleum Directorate October 2011

People in the Arctic

- › About 155,000 Inuit still pursue a traditional way of life
 - Canada, Alaska, Greenland and Russia
- › They have explored legal ways of linking human rights and climate change to put pressure on nations to cut greenhouse gas emissions.
- › Spokeswoman Sheila Watt-Cloutier:
 - "Global warming is a matter of life and death".
 - "We hunt on the sea ice for food on the table. You go to the supermarket".
- › Tourism is increasing
 - hotel nights in Greenland up 30%
 - hotel nights on Svalbard up 150%



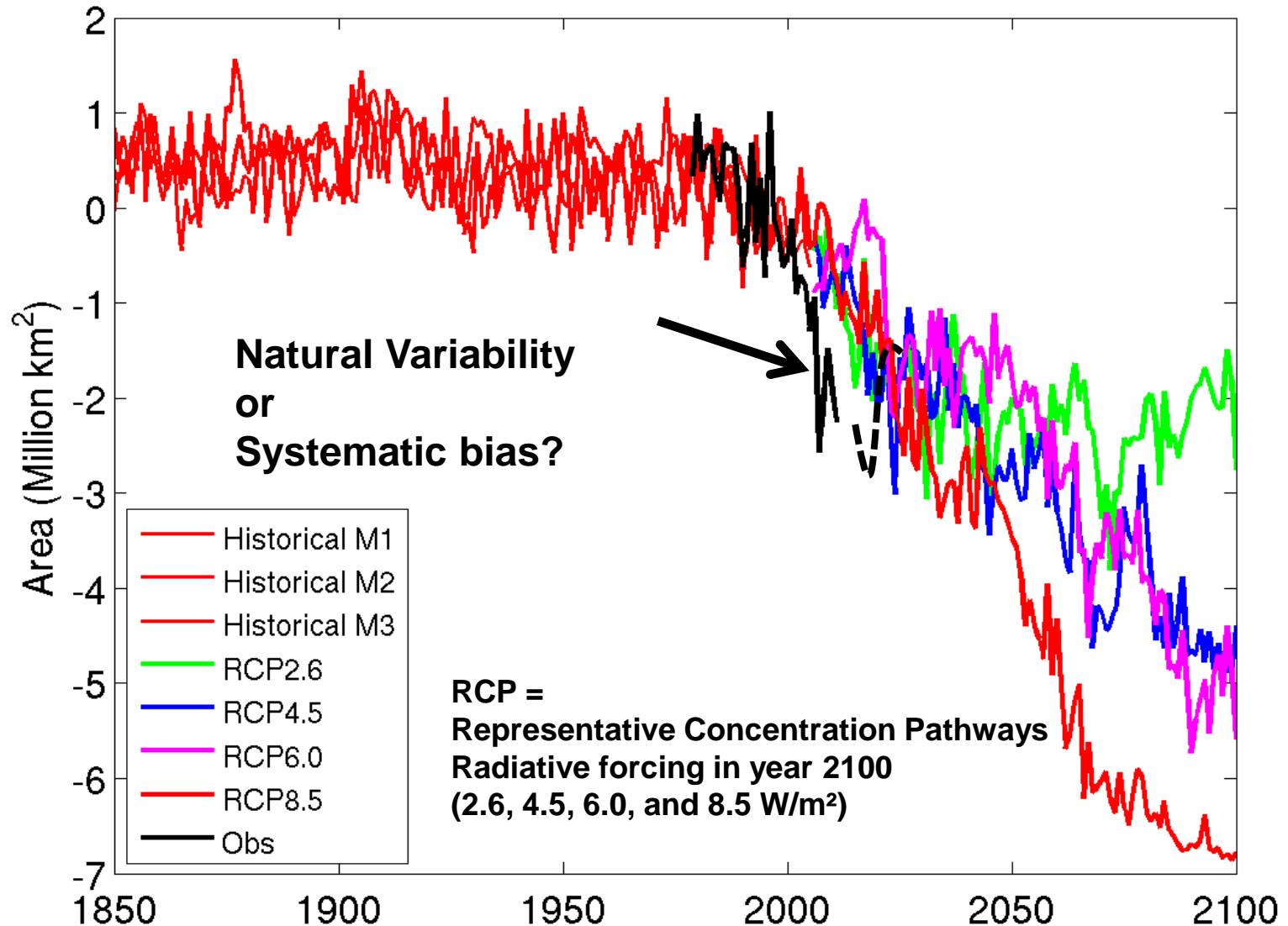


Local Arctic impacts:

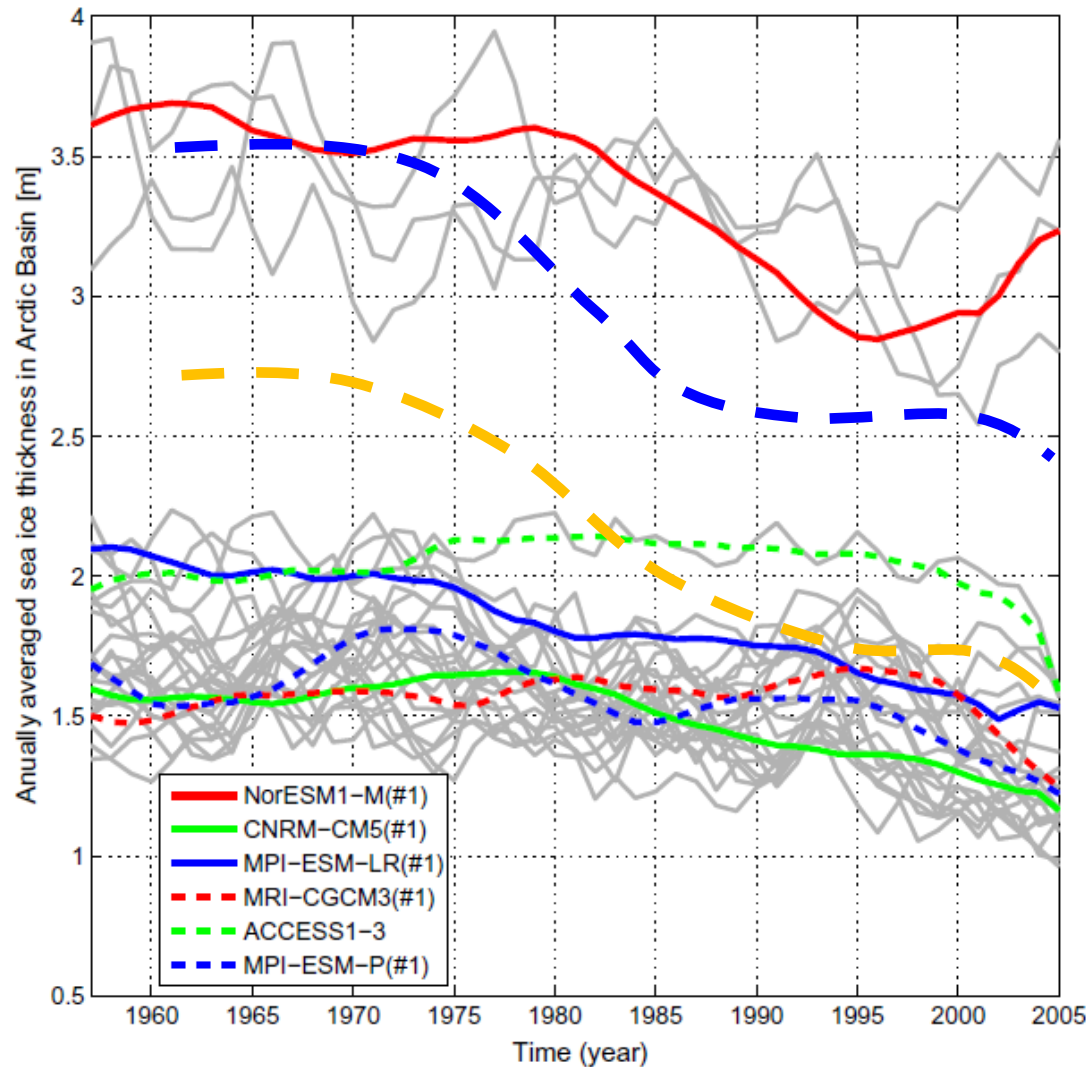
- **Transportation may boost: Northern Sea Route first**
- **Fishing is moving north with warming and ice loss**
- **Greenland melting affects Global Sea Level rise**
- **Arctic mineral resources are under exploitation**
- **Governance (Harvest control and regulations) needed**
- **Tourism is growing – Inuits are struggling**



Sea Ice Anomalies - NorESM September



Still room for improvements in the Arctic for CMIP5 Models



Winter mean thickness

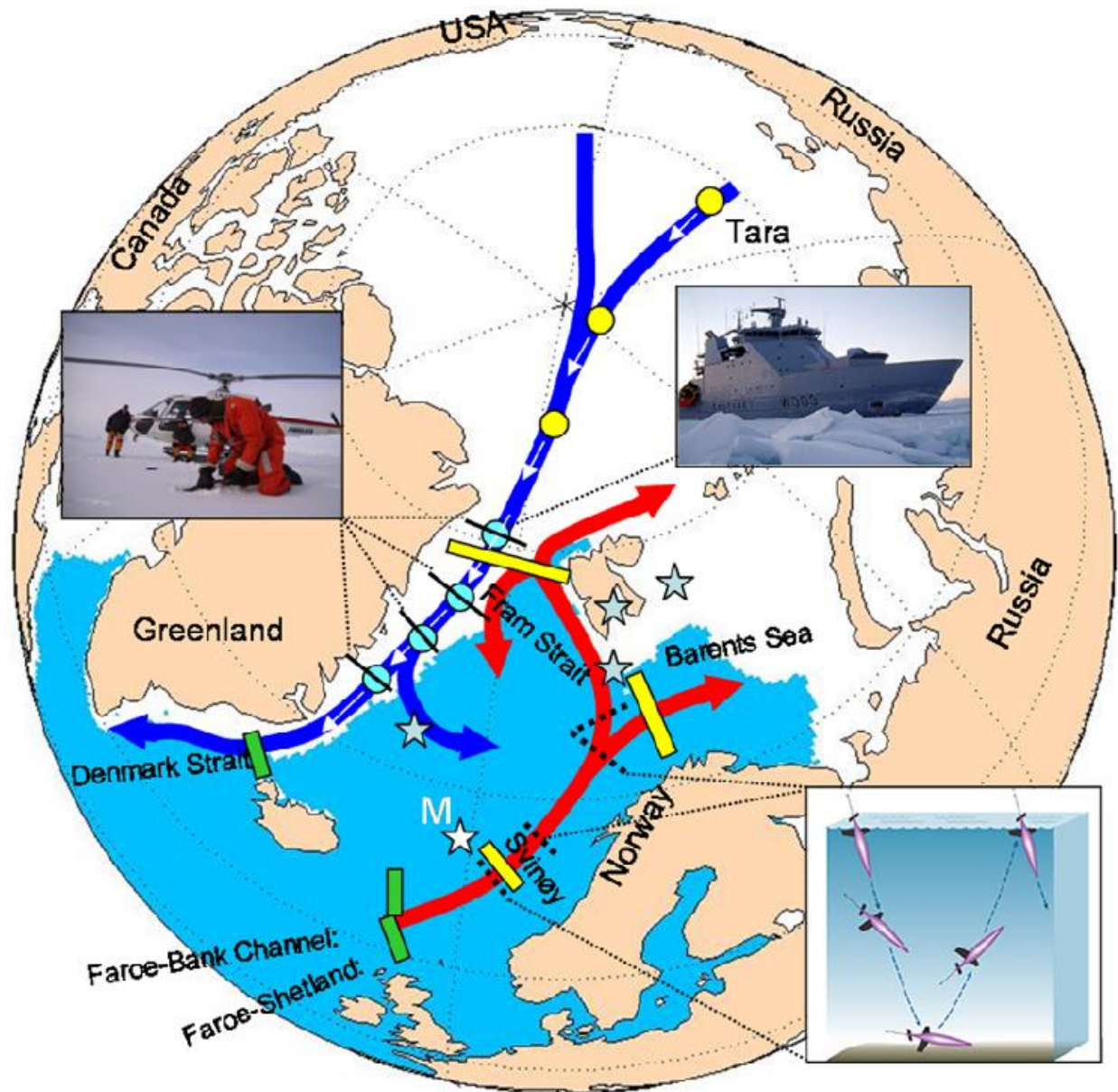
Kwok & Untersteiner (2011)

Autumn mean thickness



Outline:

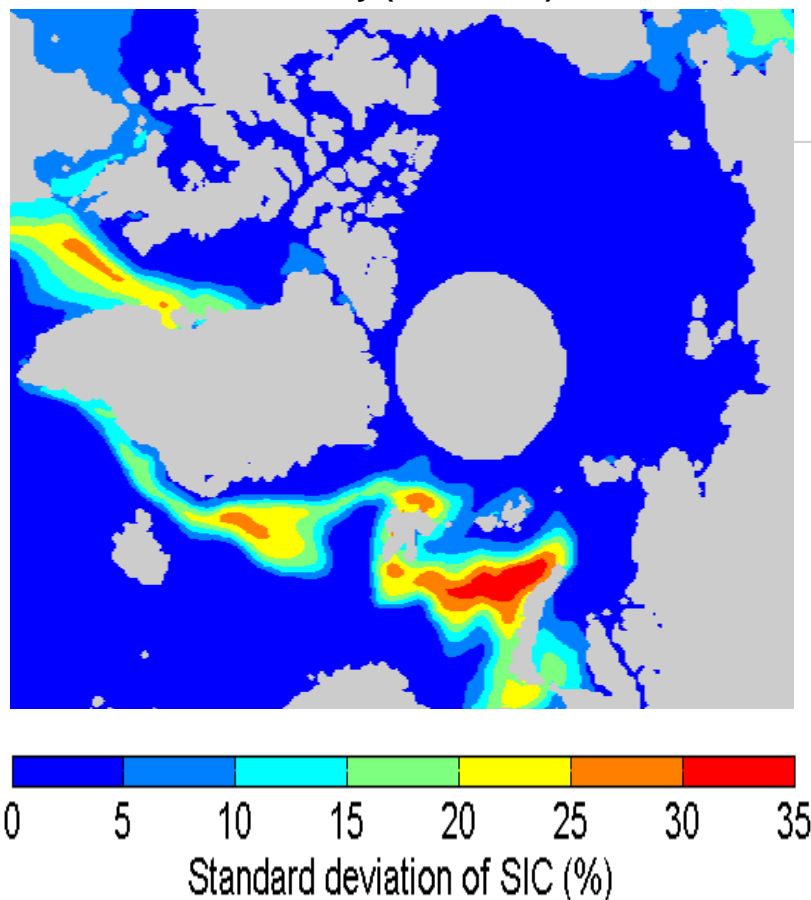
- Barents Sea
- Arctic Basin
bottom melt
- Fram Strait Ice
export



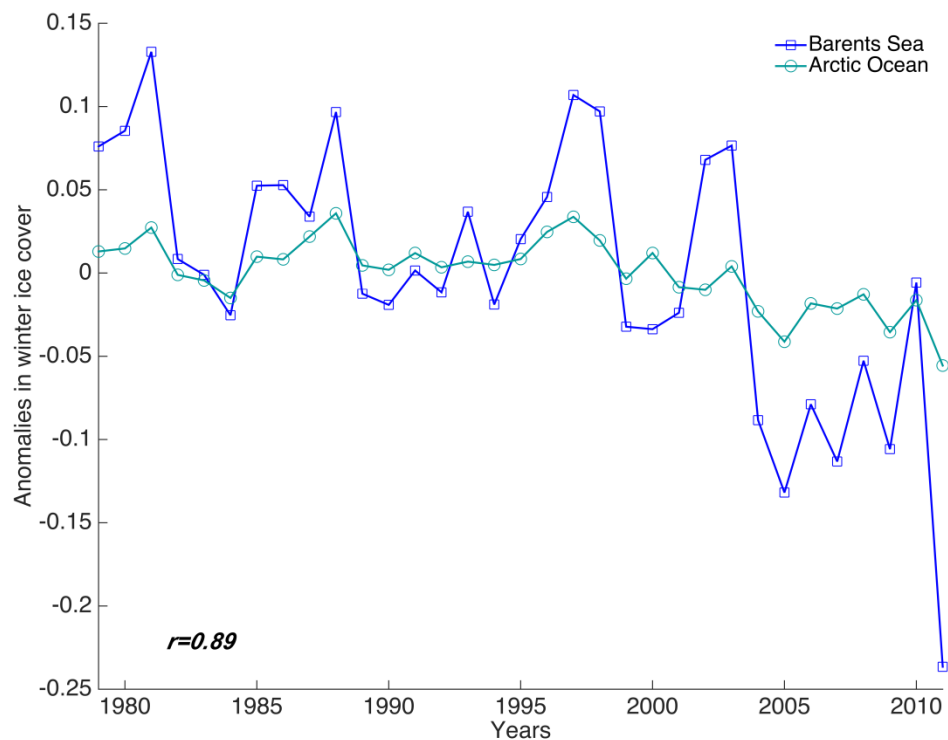


Barents Sea ice \approx Arctic Winter sea ice

Interannual variability (1979-2011) in sea ice cover



Yearly mean area fraction anomalies



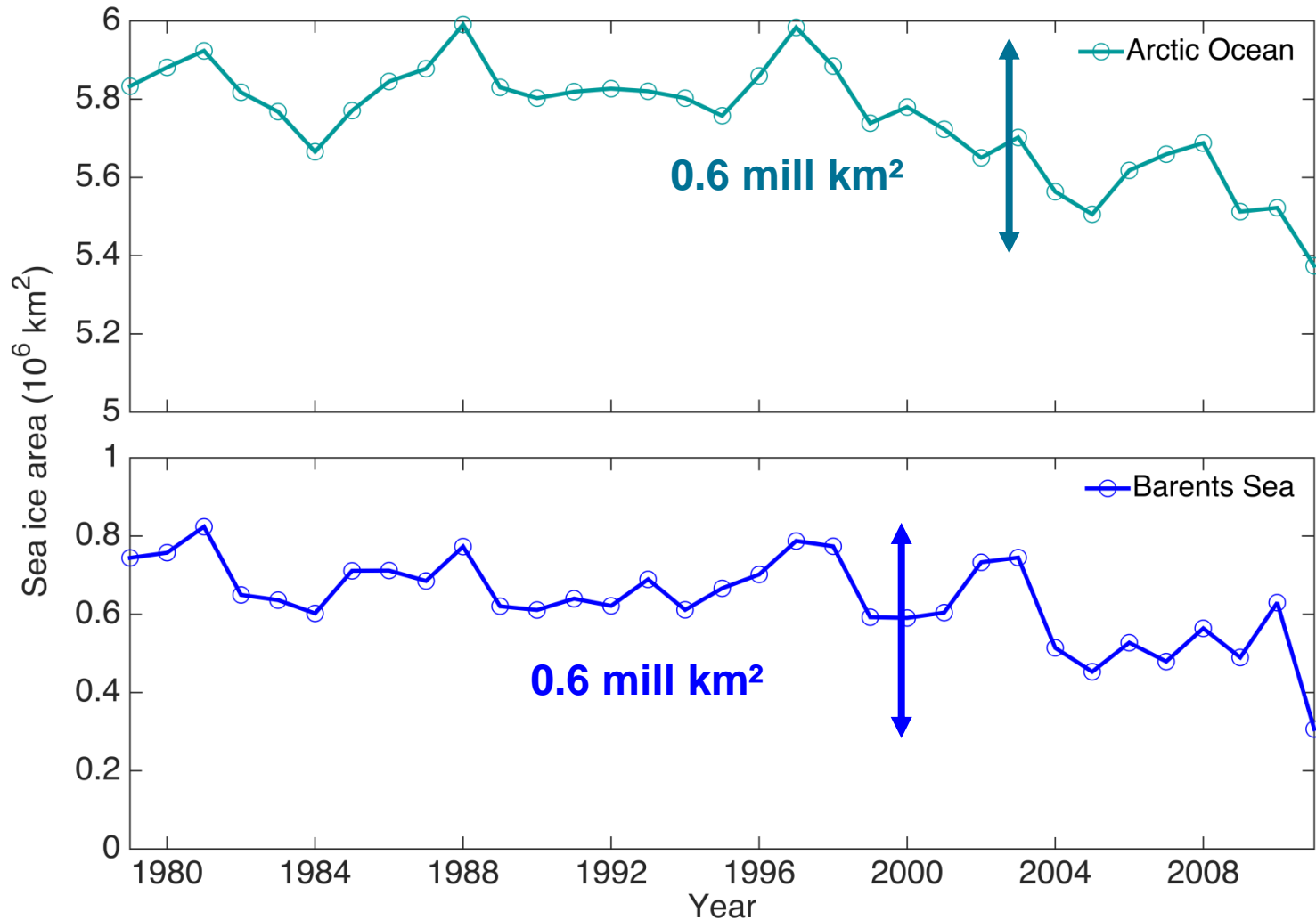
Both variability and recent winter loss is dominated by the Atlantic sector.

December – January - February data only

Sorokina (In preparation, 2015)



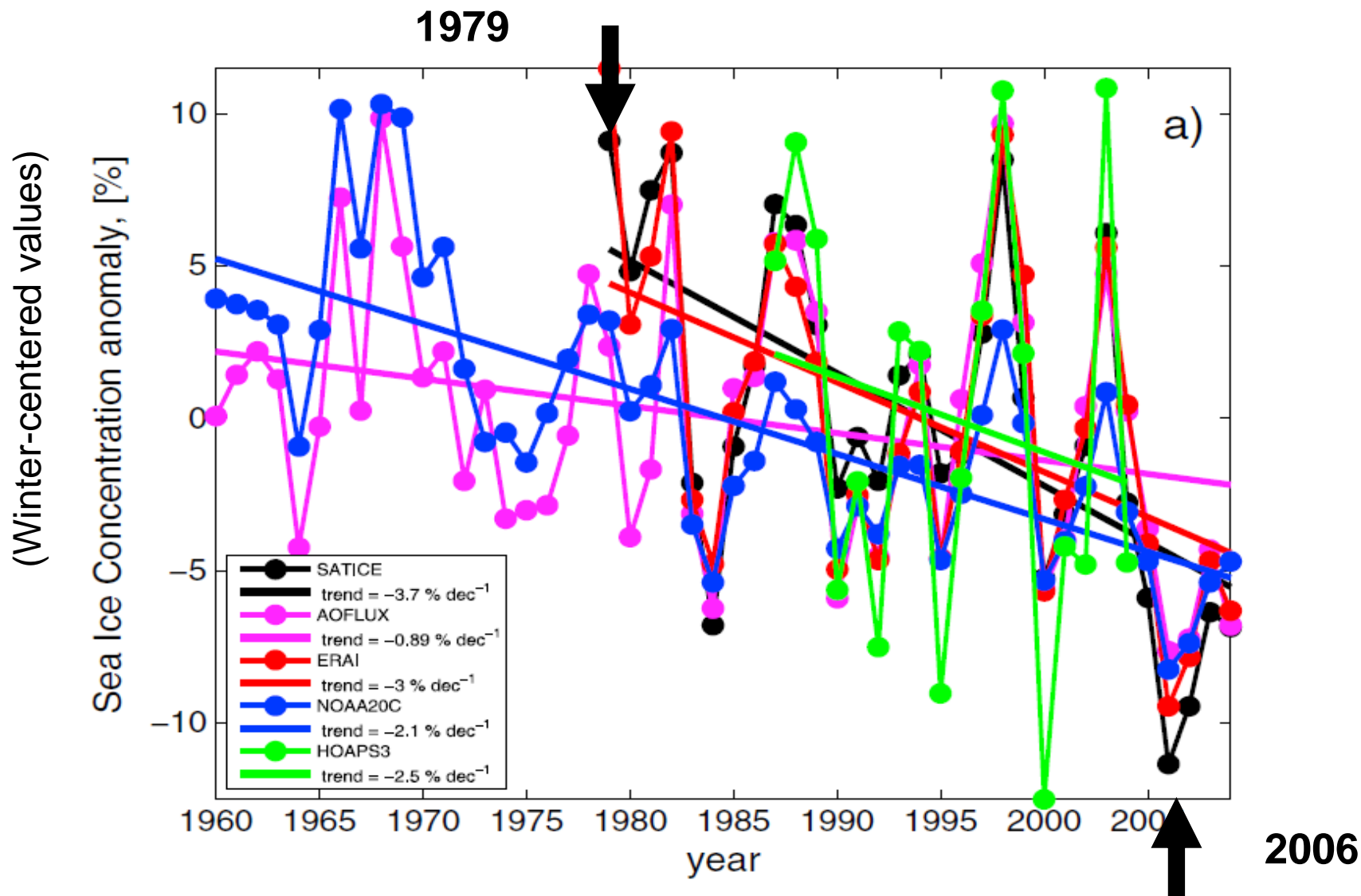
Barents Sea Winter Ice v.s. Arctic Basin Winter ice



Sorokina (In preparation, 2015)



Barents Sea Ice anomalies

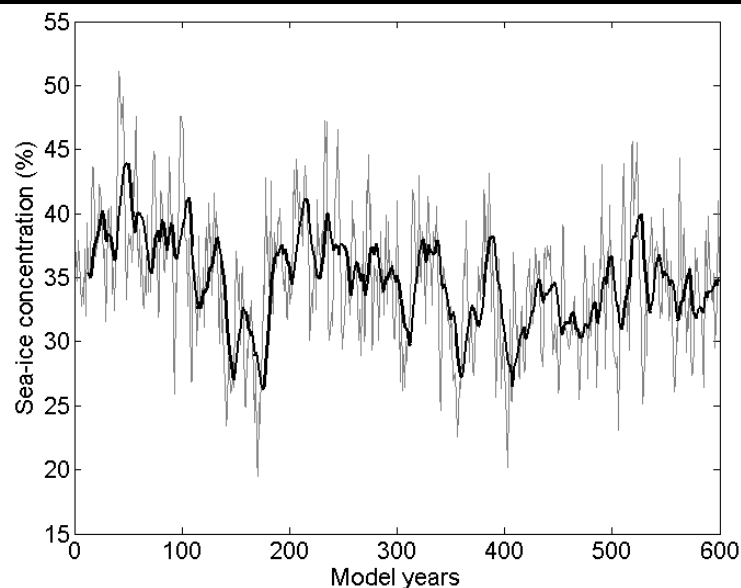
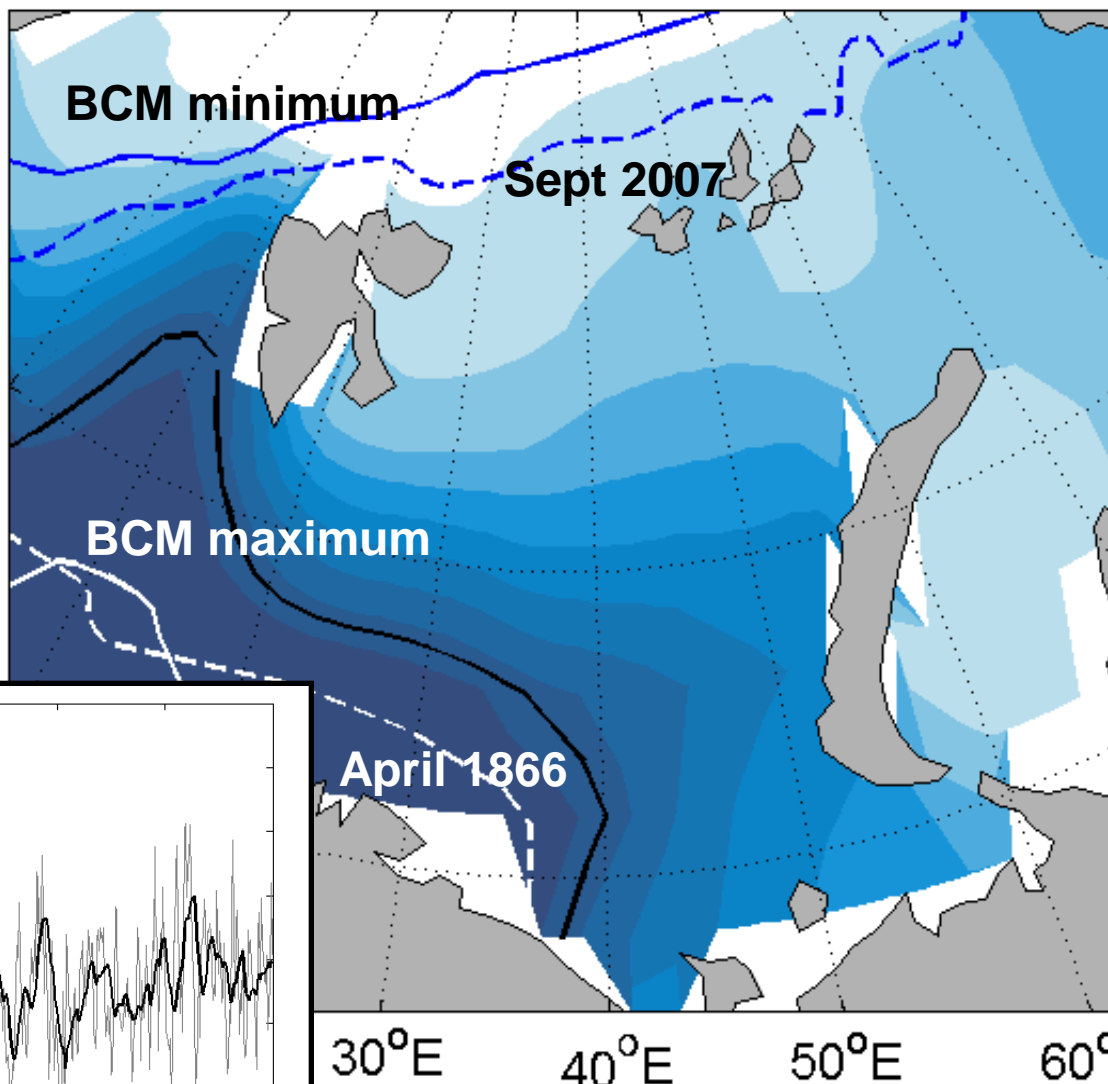




Sea Ice Bergen Climate Model

600 years
Control simulations

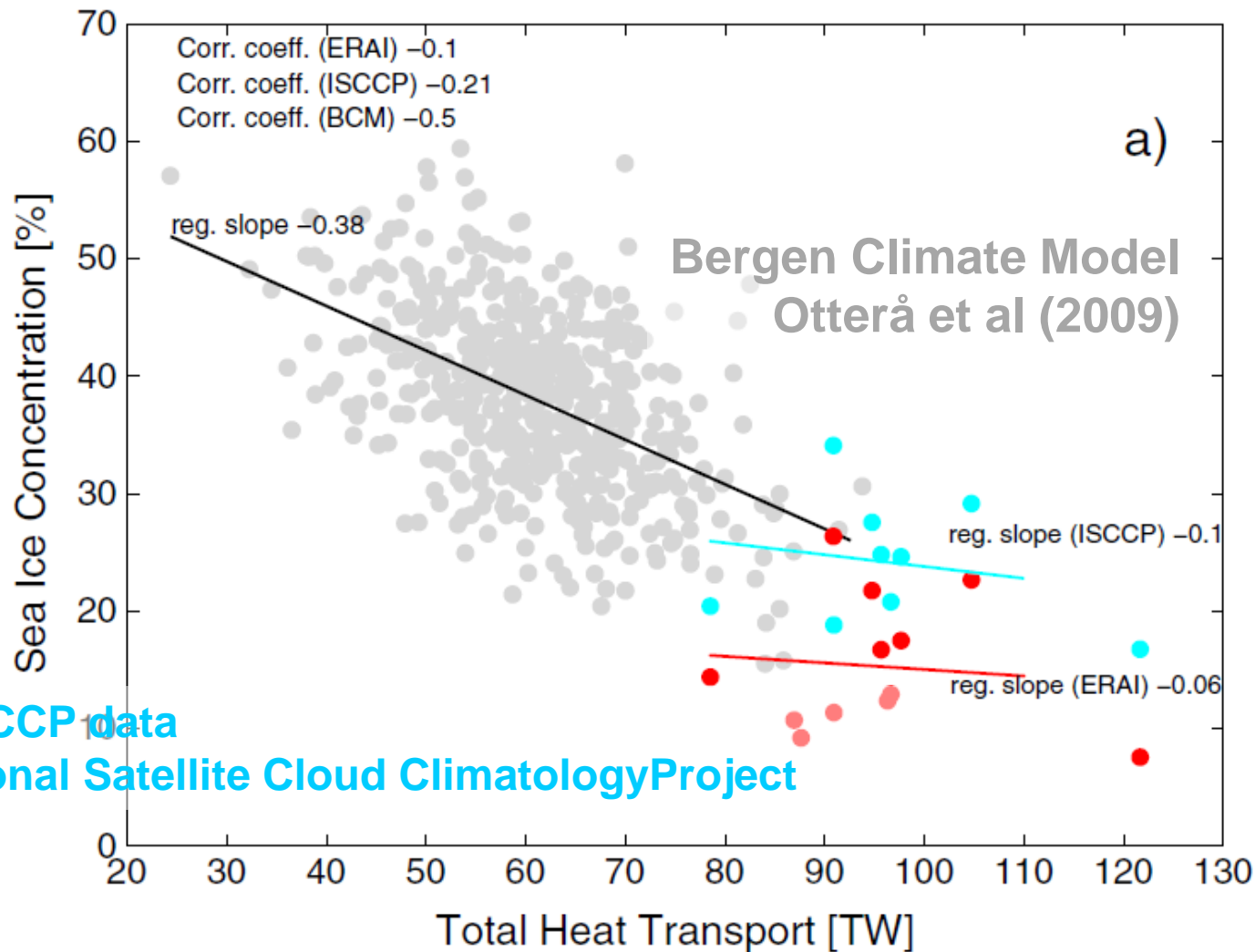
75°N



Smedsrud et al (2013)



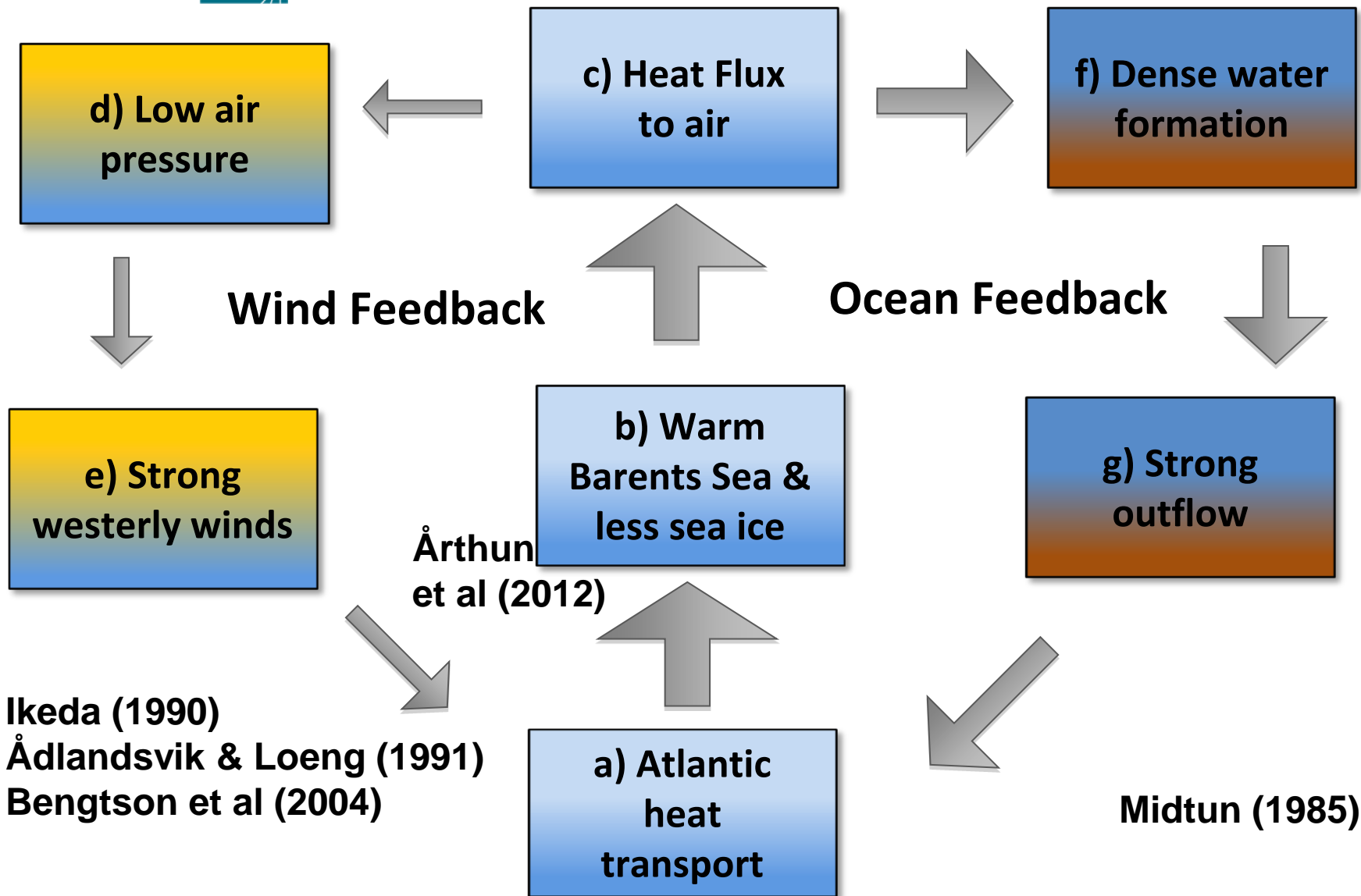
More Ocean heat transport => less sea ice



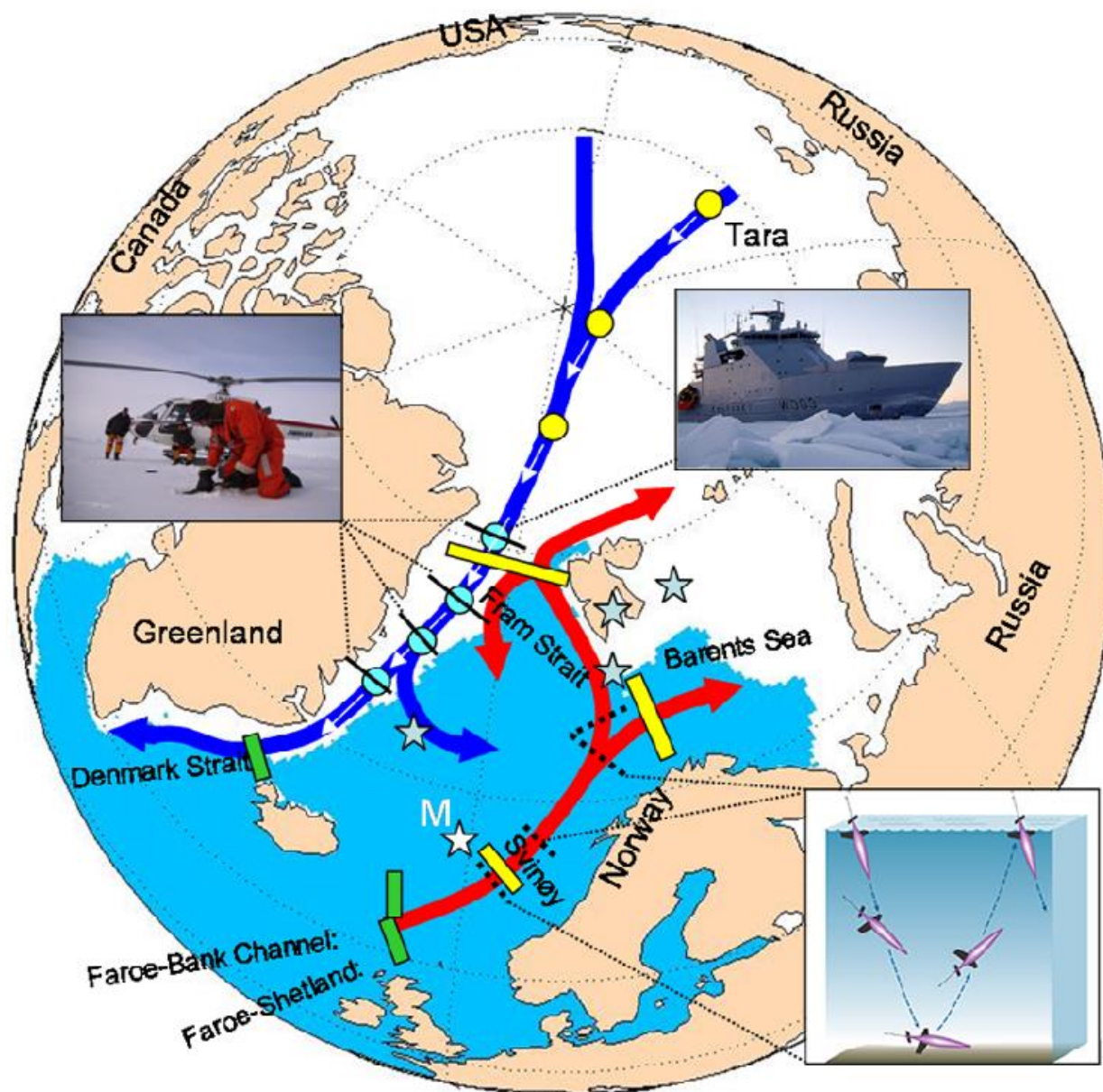
Obs + ISCCP data
International Satellite Cloud Climatology Project

Obs + ERA Interim reanalysis
(European Centre for Medium range Weather Forecast)

Smedsrud et al (2013)



Fram Strait Ice export



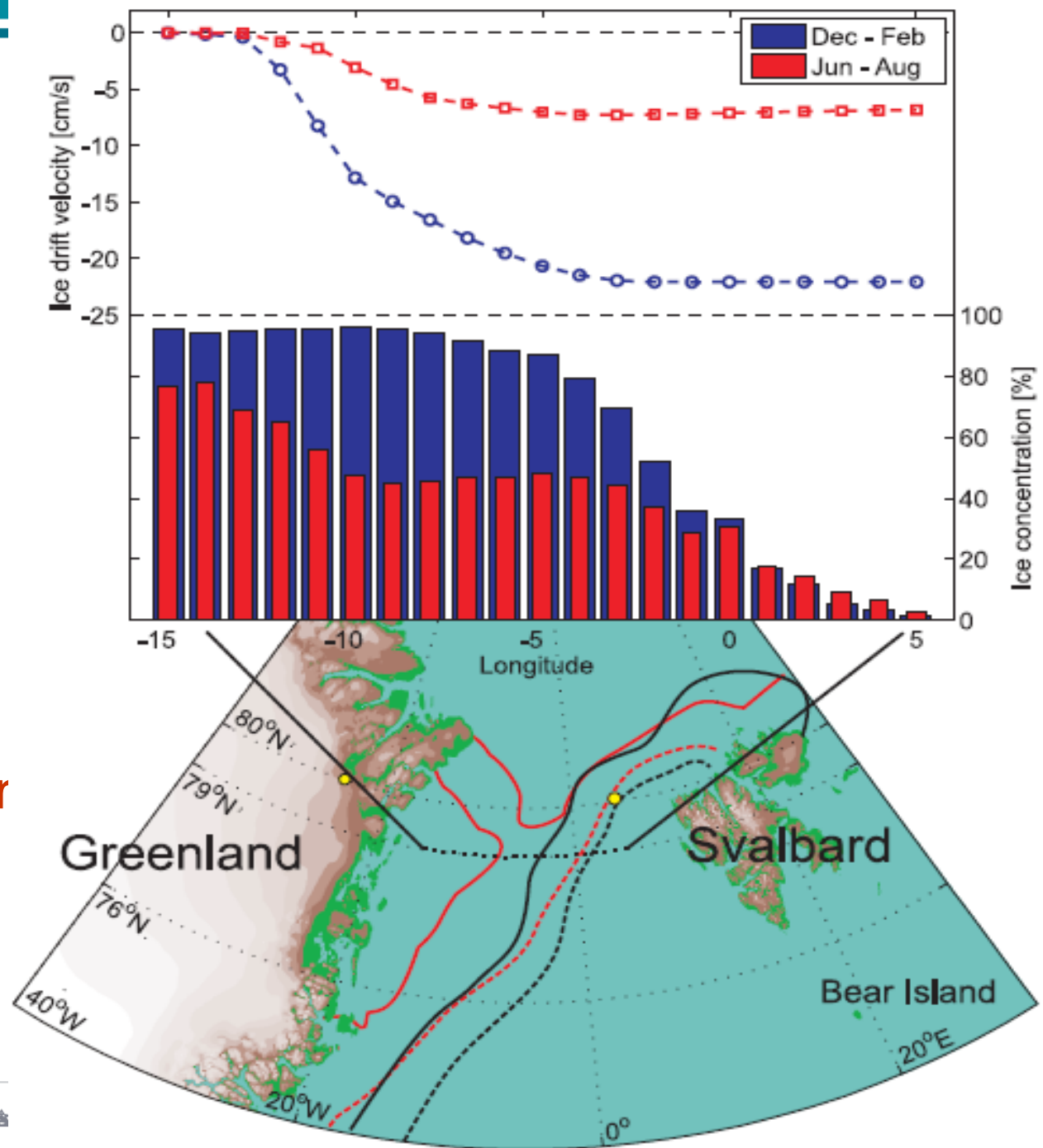


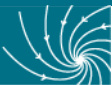
A “river” of sea ice:

West:
zero speed

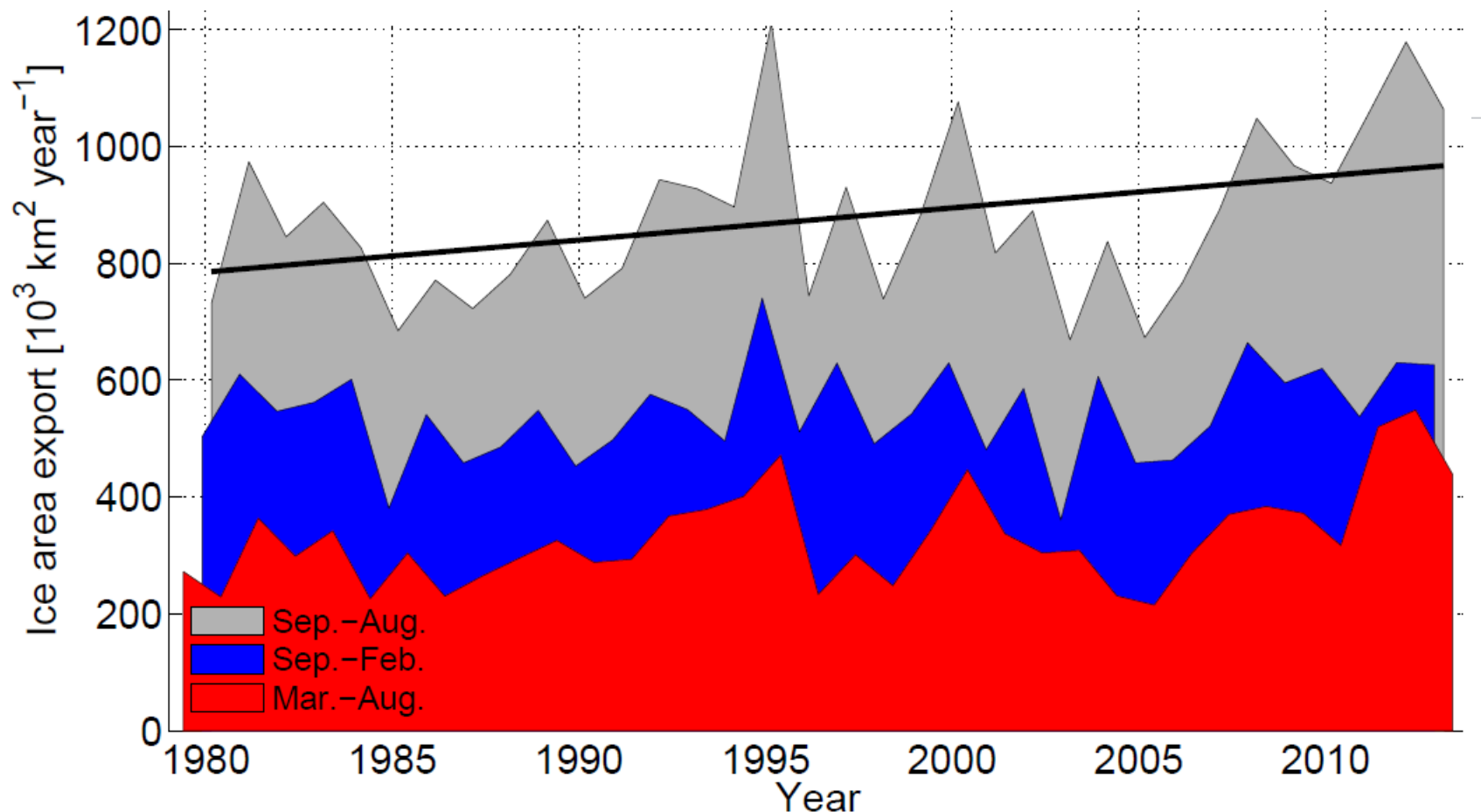
East:
zero ice
(area/concentration

[Smedsrud et al 2011]





Fram Strait ice area export – Based on observed Sea Level Pressure and high resolution remote sensing

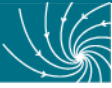


Annual values based on observed SLP (1979 - 2003), and observed ice drift (SAR, 2004 - 2013).

Annual values (grey – trend 7.0% pr decade) averaged for September 1. - August 31.

Winter export (blue – trend +3.4% pr decade) is September – February.

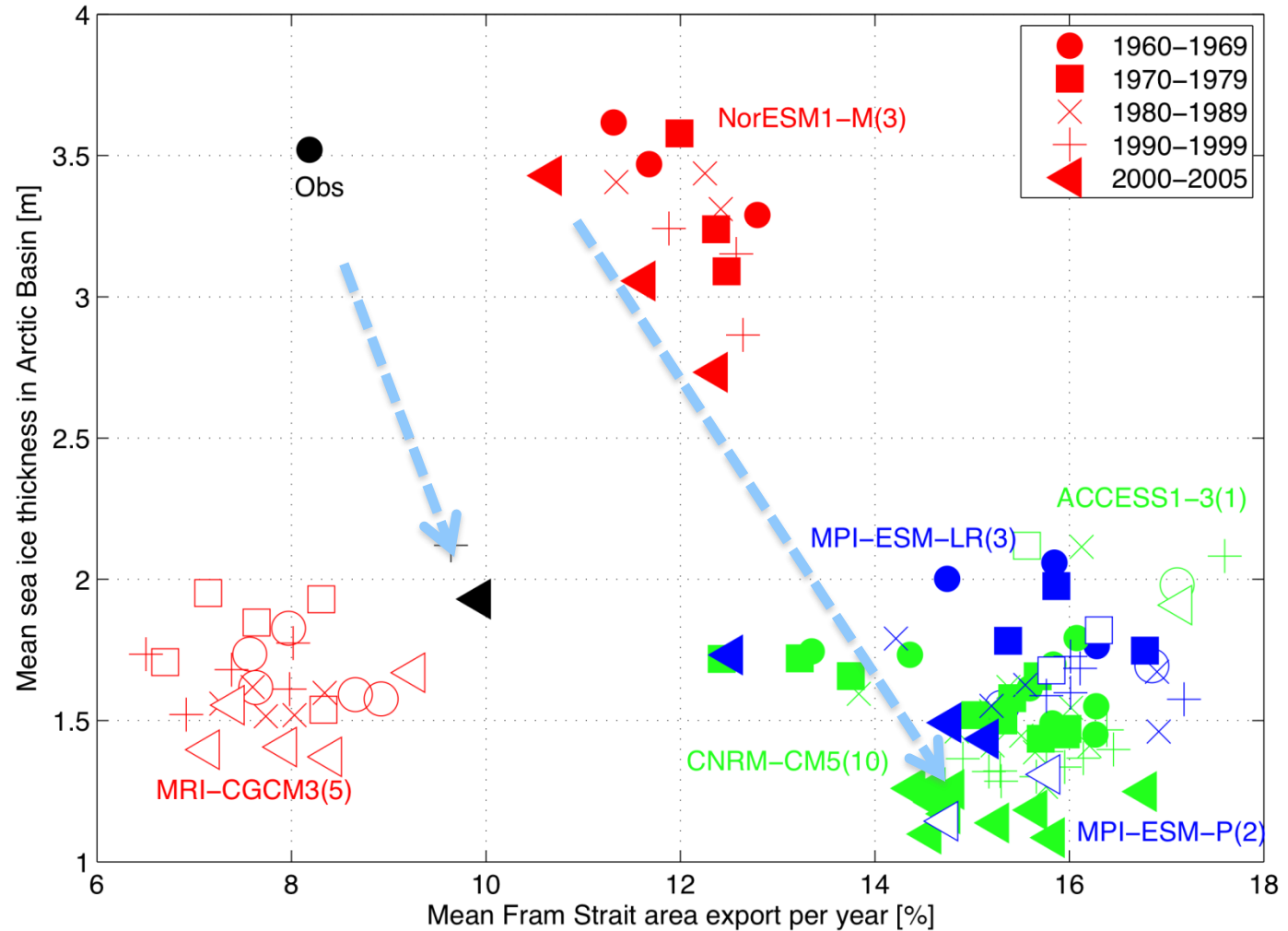
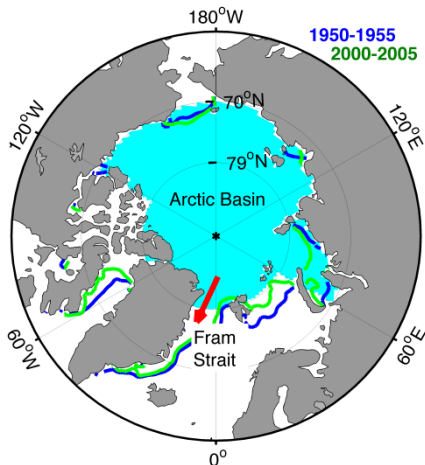
Spring export (red – trend +13.9% pr decade) is March - August.



A Link between Arctic sea ice thickness & ice area export in CMIP5 models

More
Export
=
Thinner
ice

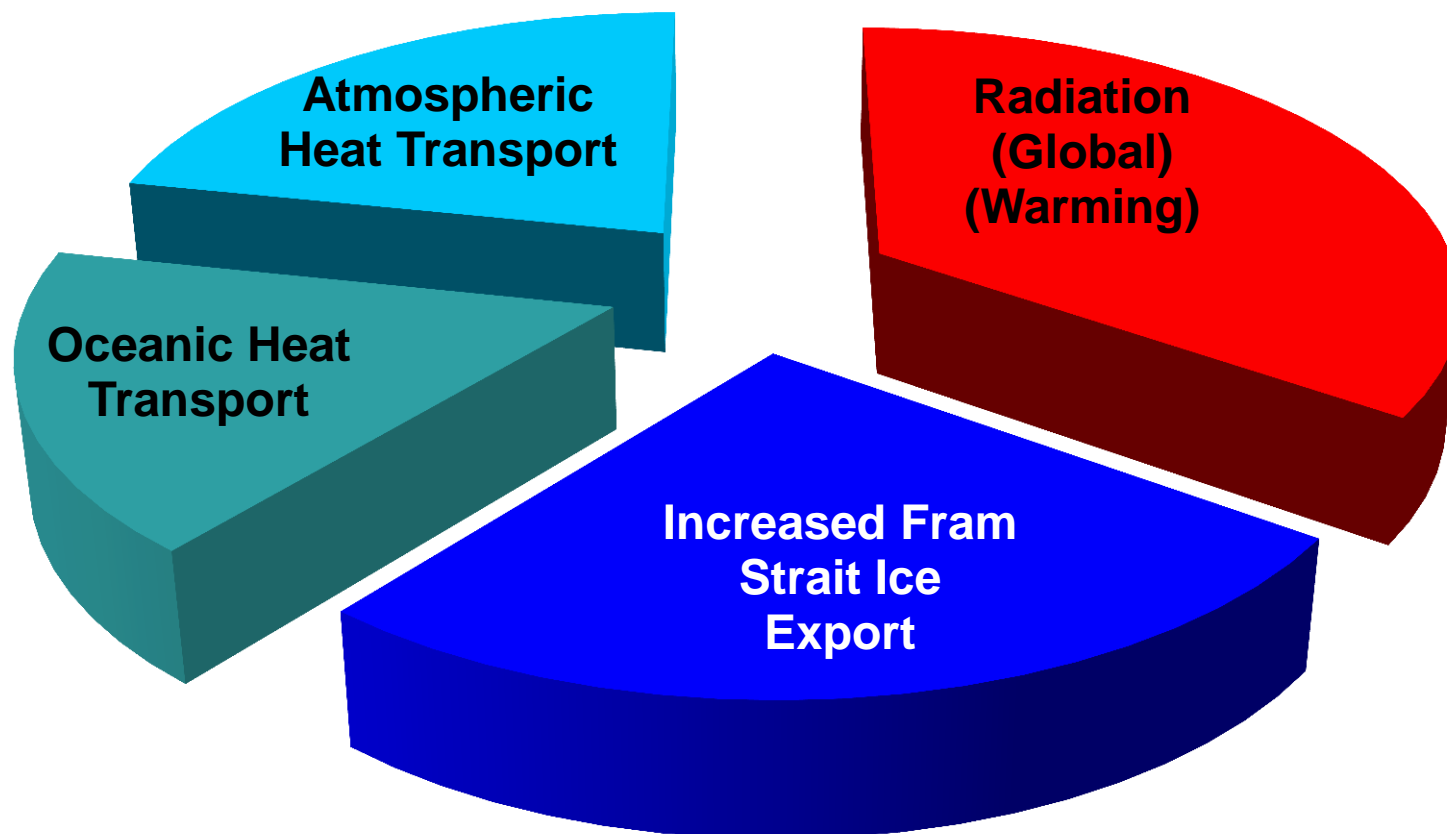
Annually 10-18%
of the sea ice
covered Arctic
Basin is exported



(Langehaug et al 2013)



Arctic Sea Ice Loss





Summary:

- ❖ Earth system models are “good enough”
- ❖ An optimistic scenario “saves” the Arctic Sea Ice
- ❖ Loss of area (summer ~50%) and thickness (3.5m => 1.8m)
Largest contributor is increased longwave radiation
- ❖ Increased Fram Strait Export
Caused by stronger winds – NOT related to global warming
- ❖ Winter ice loss in Atlantic sector
Largely caused by increase Atlantic heat transport
- ❖ Four main reasons for ice loss:
 - Radiation (Global warming)
 - Ice Export
 - Oceanic heat
 - Atmospheric heat