Arctic sea ice loss: present and future

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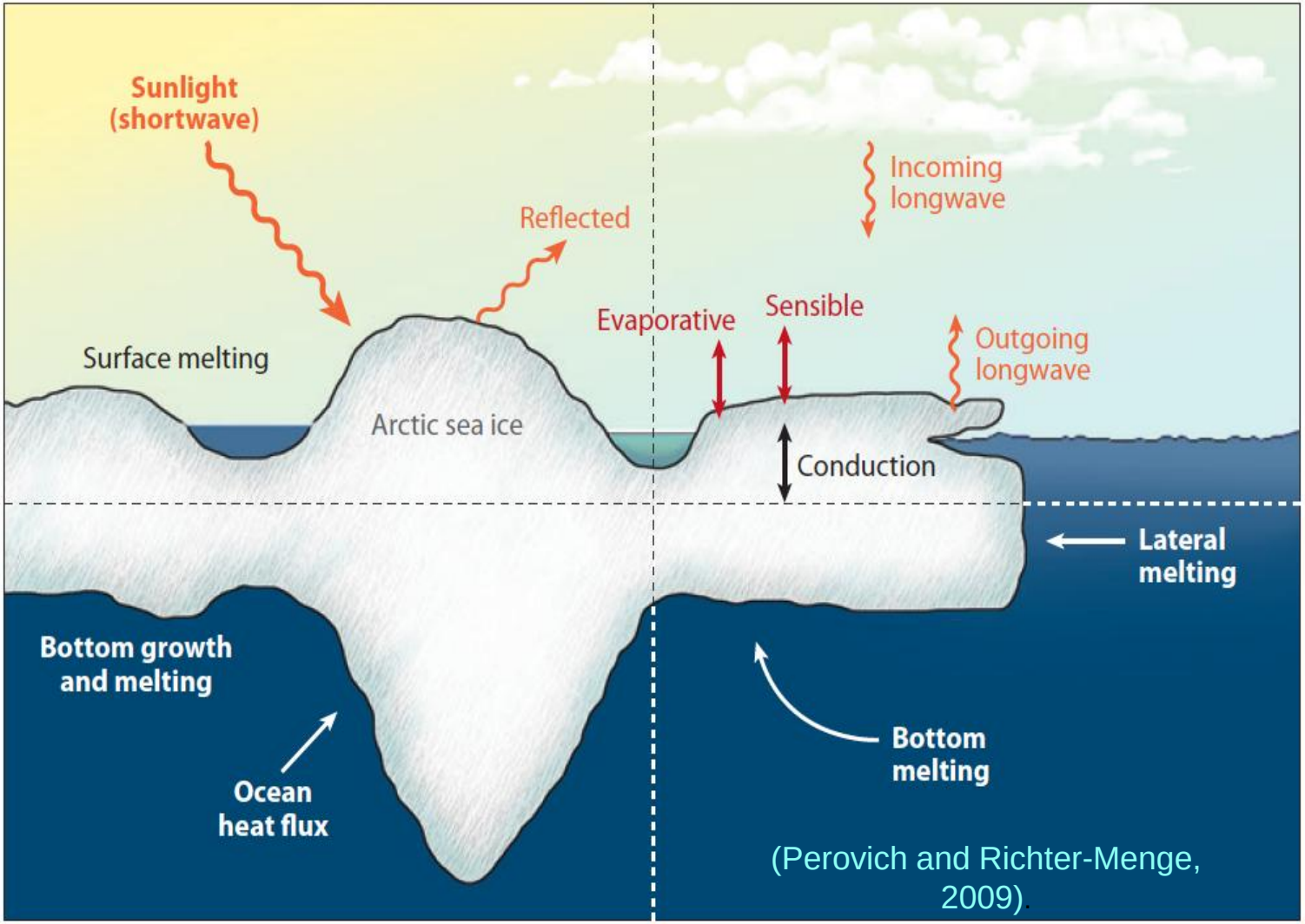
Sea ice processes



(Perovich and Richter-Menge, 2009).

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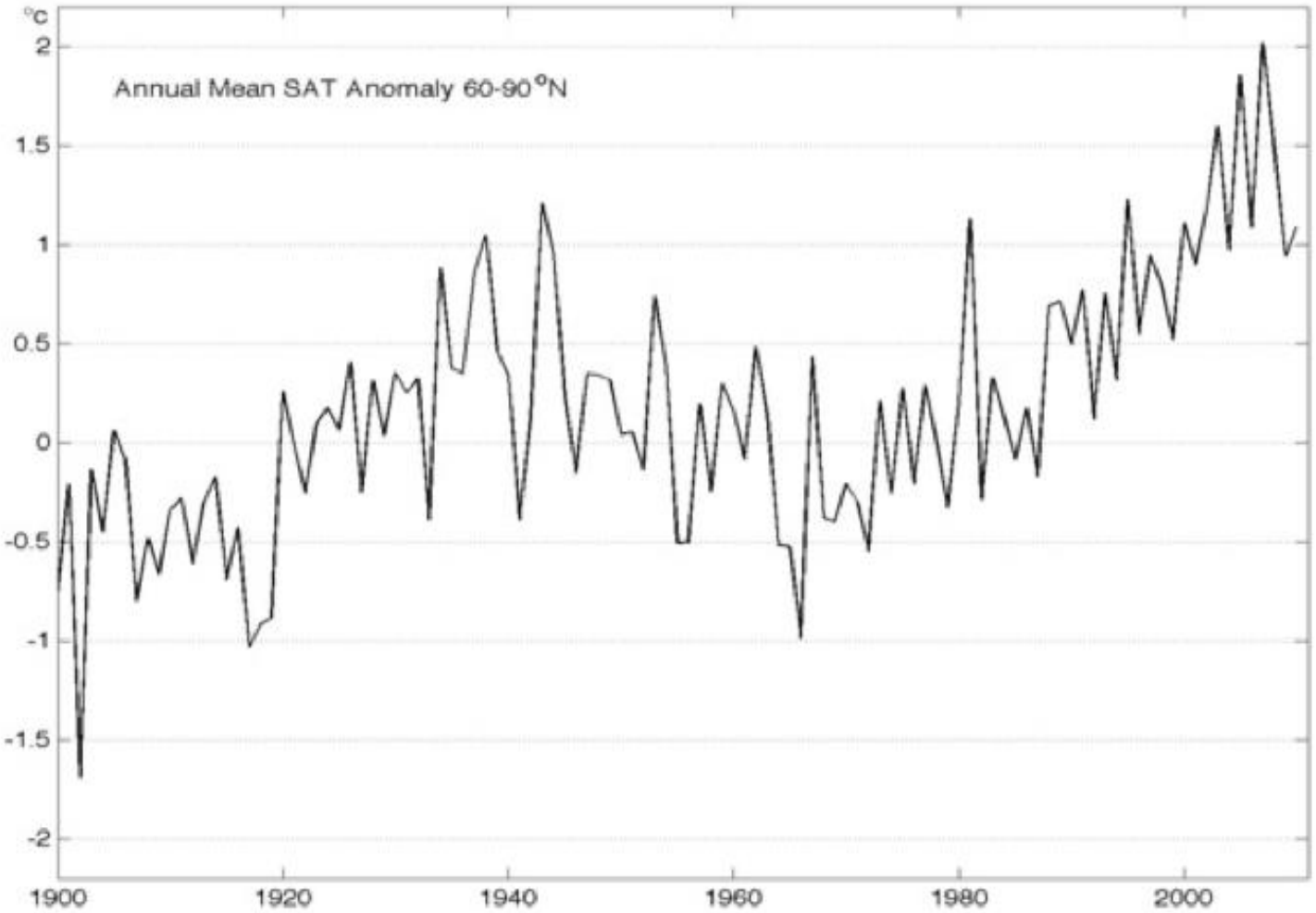
Arctic air temperature 1900 - 2010



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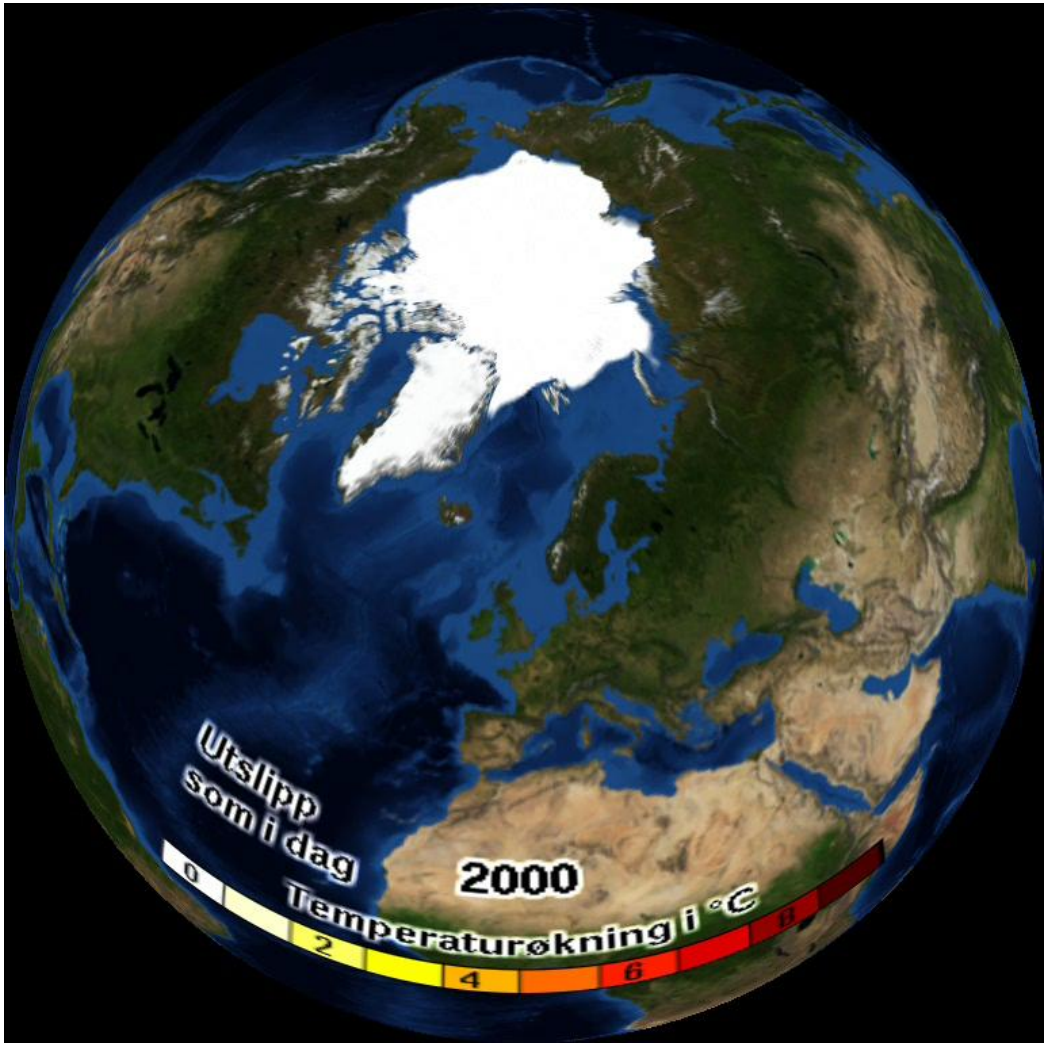
Arctic-wide annual average surface air temperature anomalies relative to the 1961-90 mean, based on land stations north of 60° N. Data are from the CRUTEM 3v dataset, available online at www.cru.uea.ac.uk/cru/ data/temperature/. Note this curve does not include marine observations.

Bergen Climate Model (BCM)

Simulation of sea surface temperture 2000-2100



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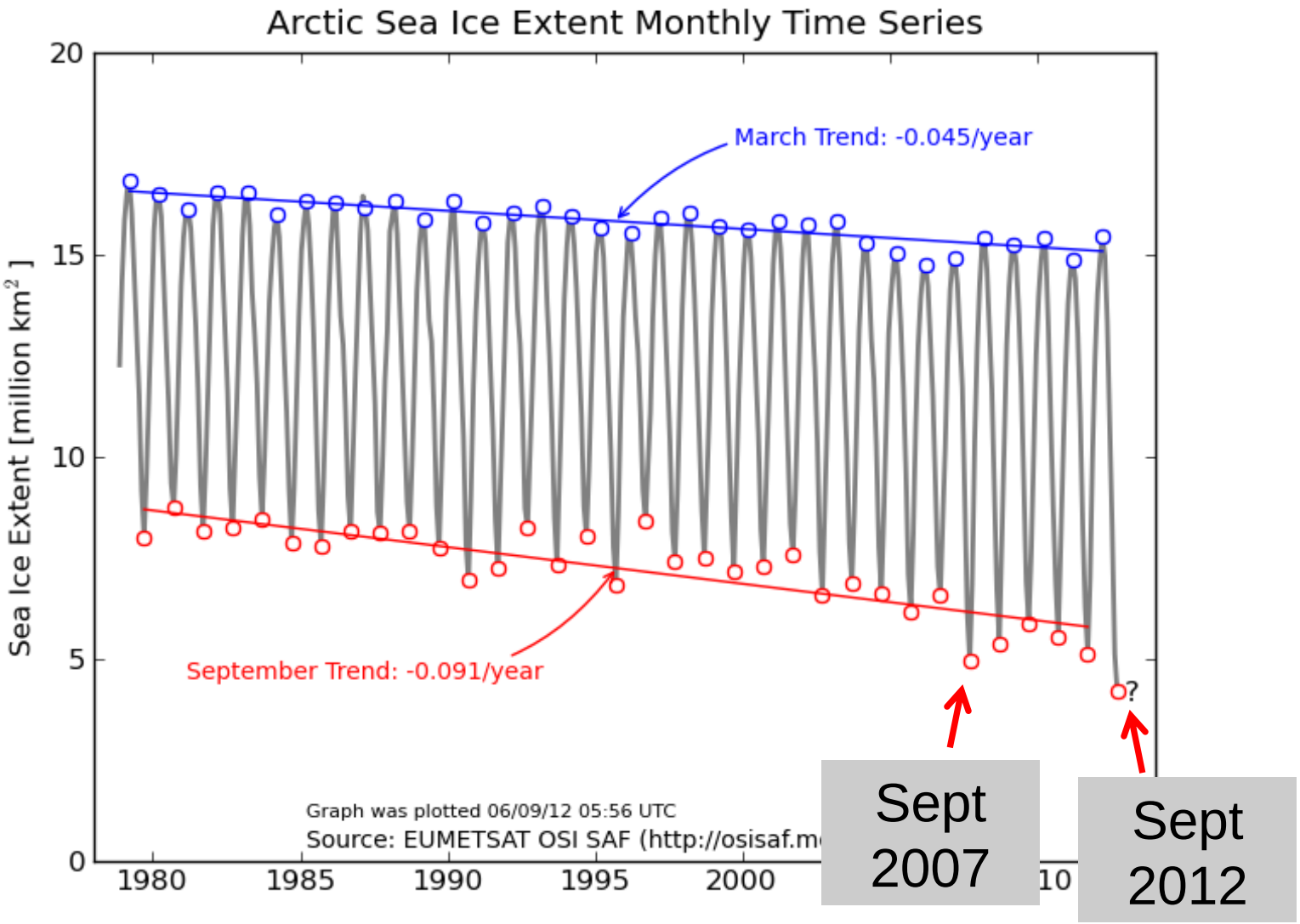
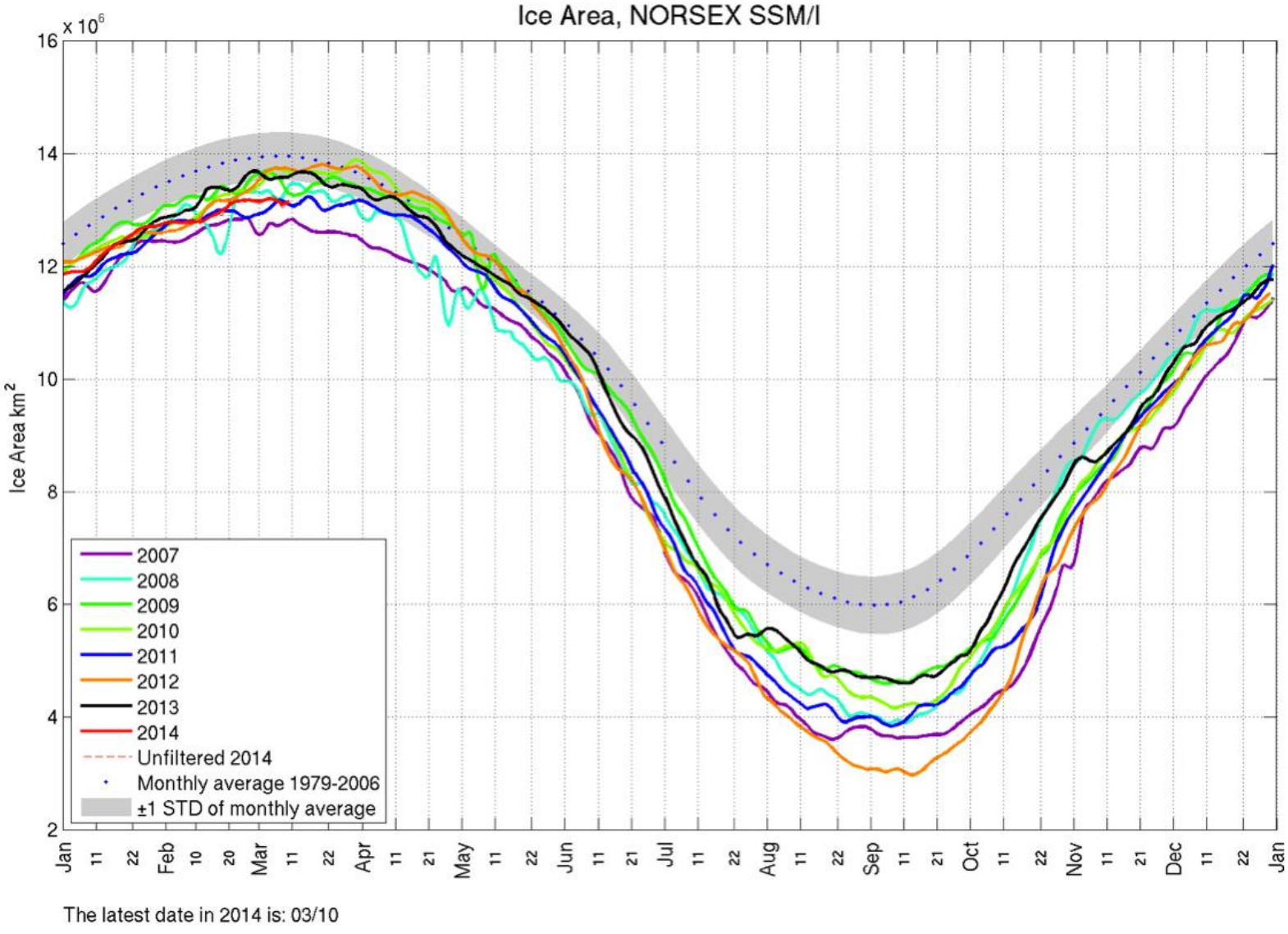
Arctic sea ice extent summer minimum



Daily sea ice extent from passive microwave data



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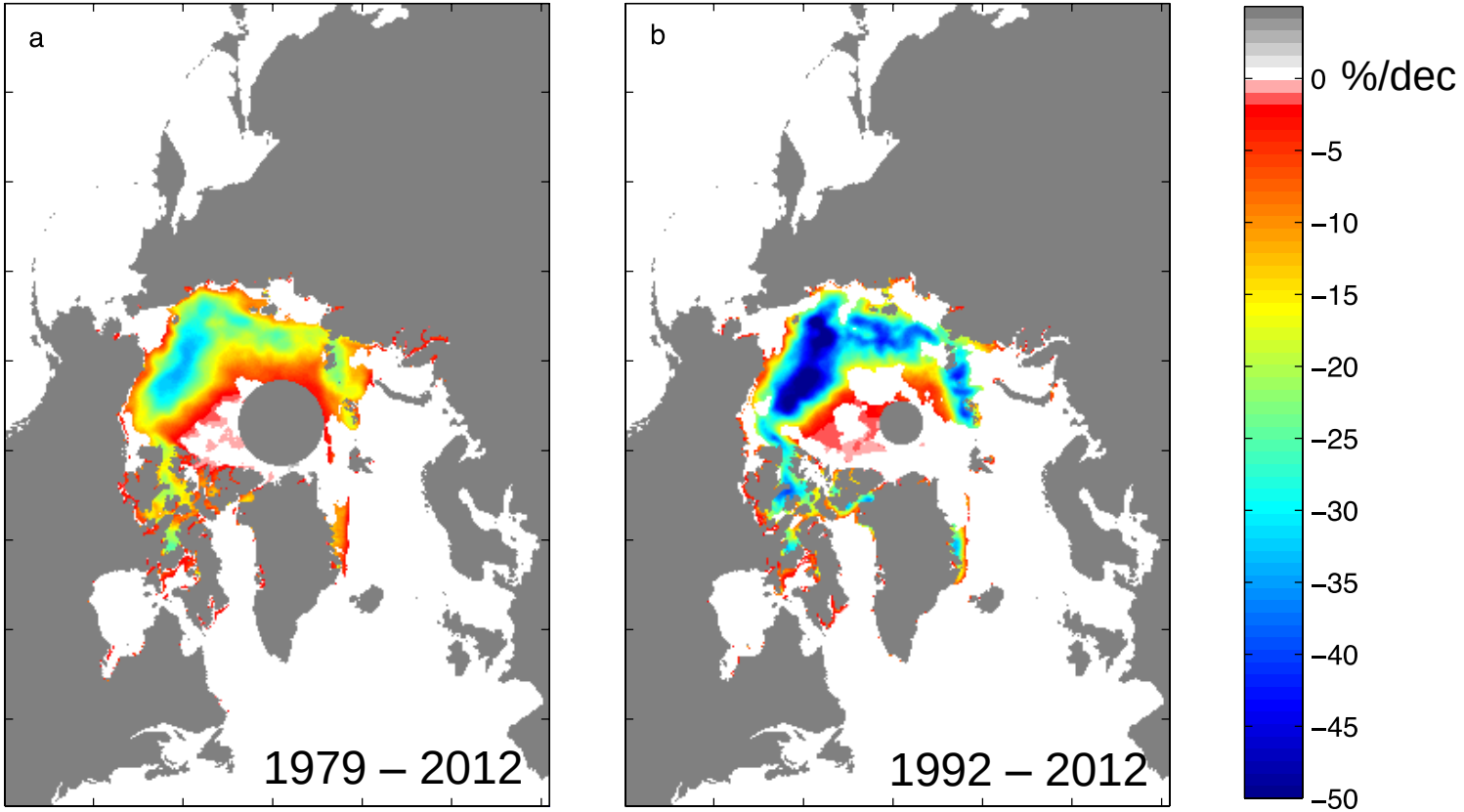
http://arctic-roos.org

Trends in sea ice concentration

Average September trend



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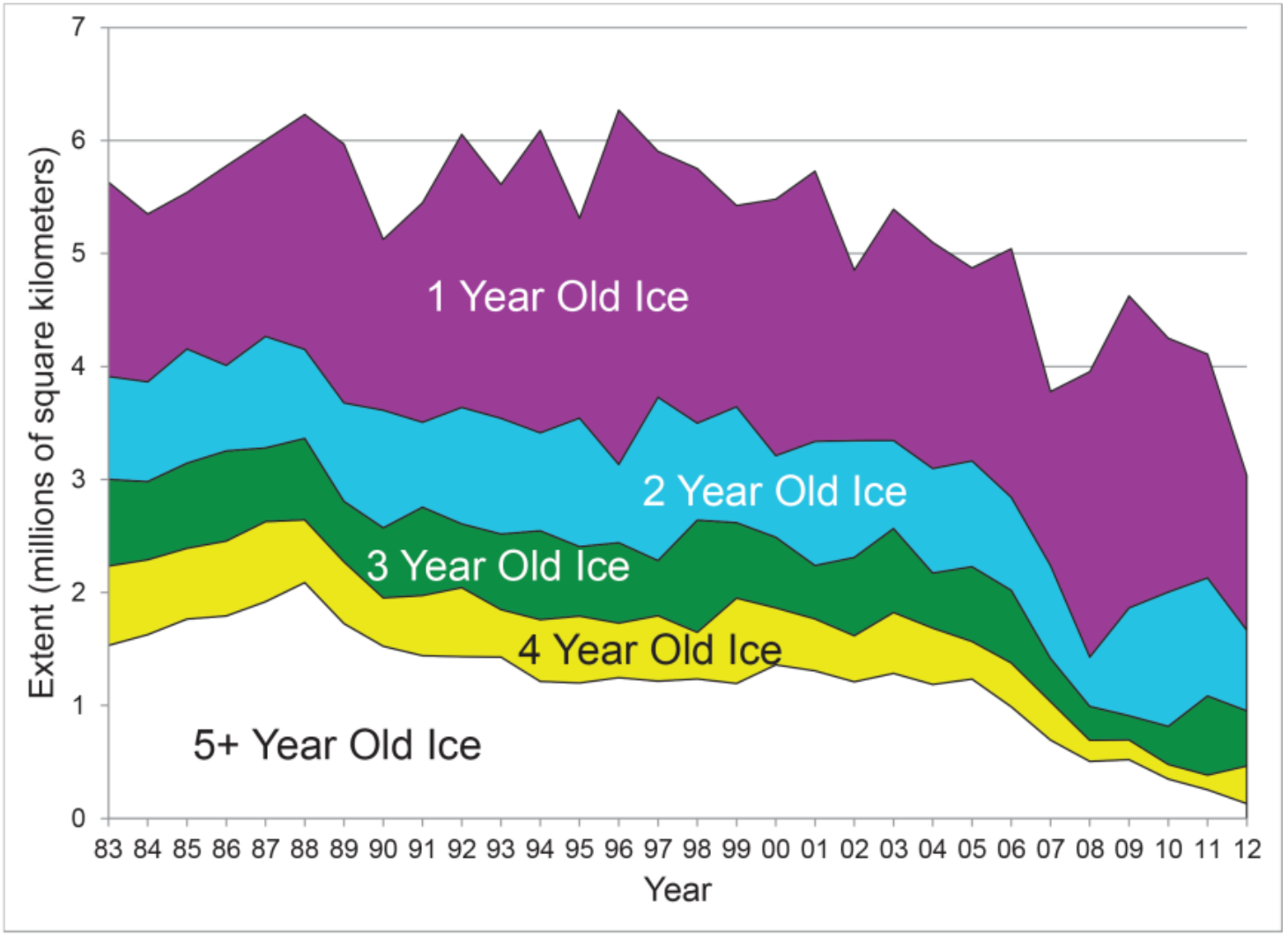
Less old ice



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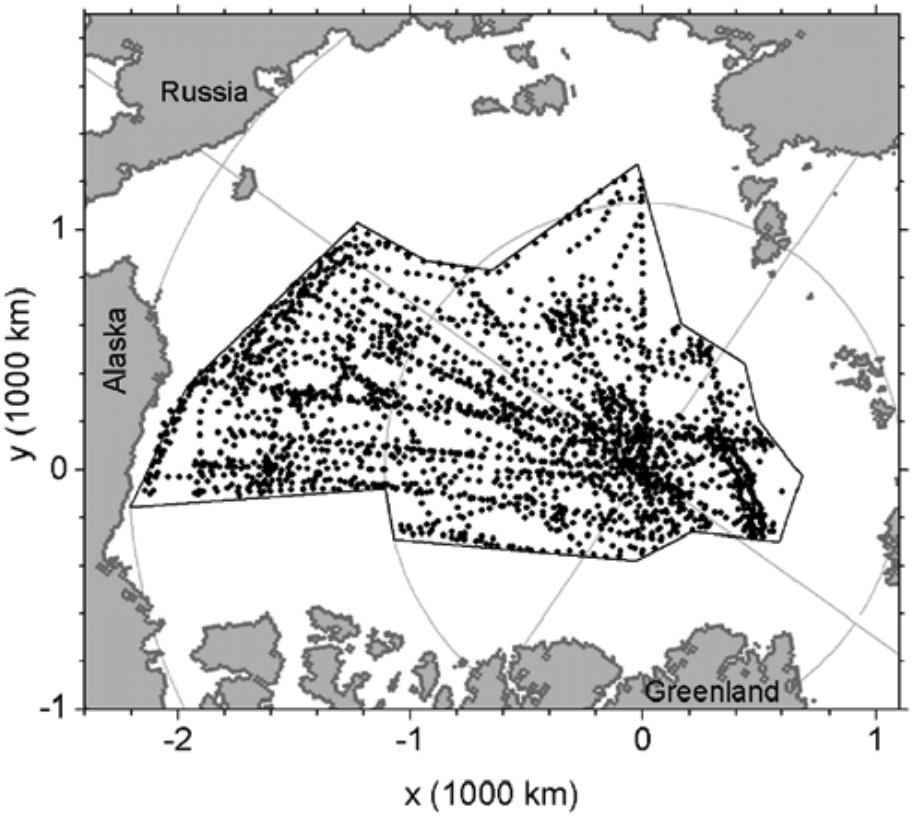
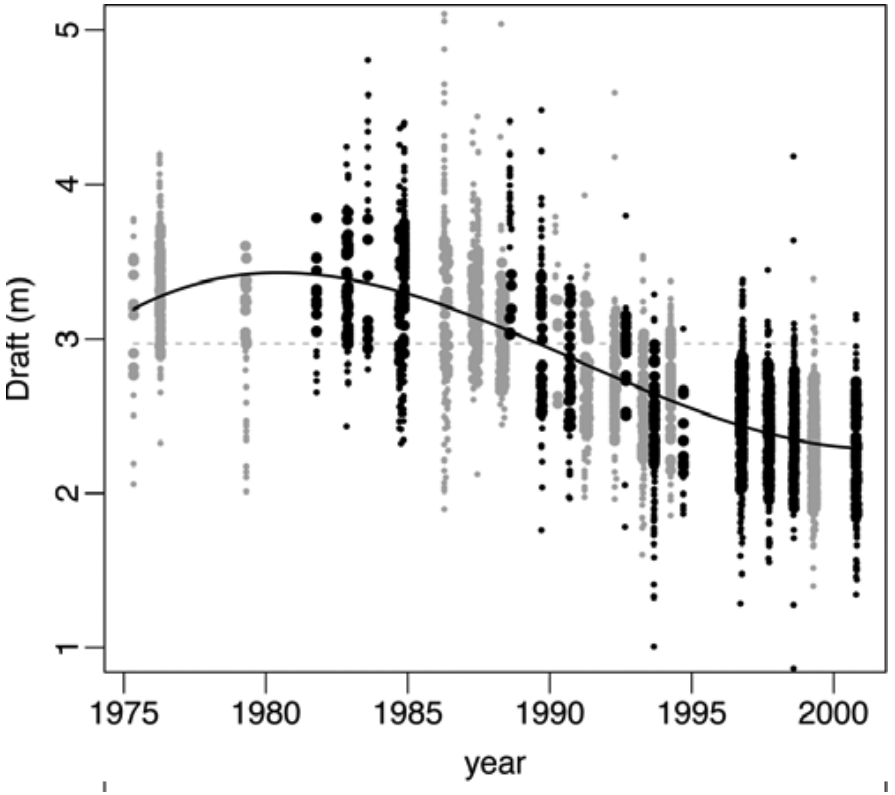
Based on satellite observations; from J. Maslanik, M. Tschudi, Univ. Colorado

Observed thickness reduction from submarine data 1975 -2000





1980: 3.42 m, 2000: 2.29 m (mean value) Rothrock et al., 2008

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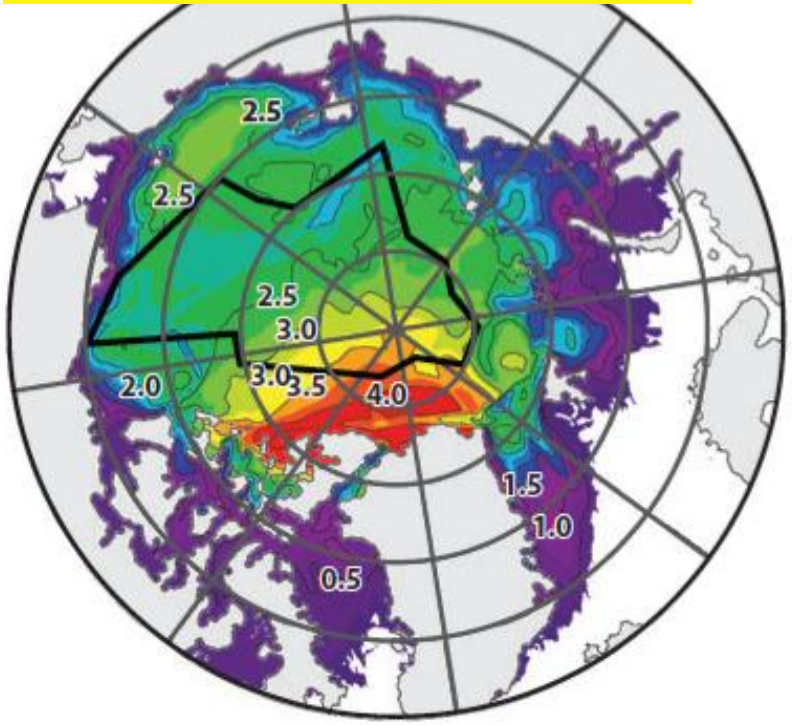
Ice thickness changes from 1988 to 2004

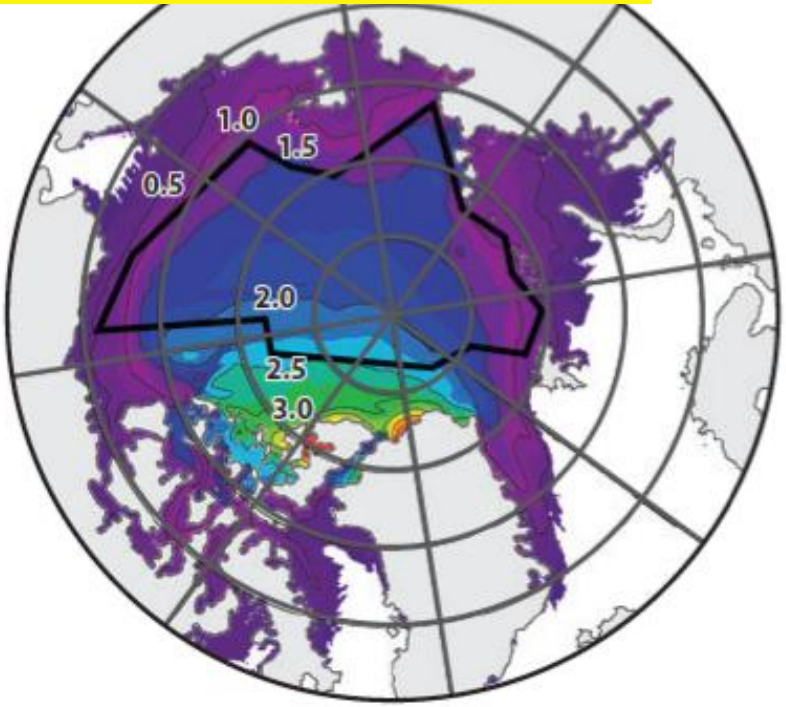
NAME model + submarine obs

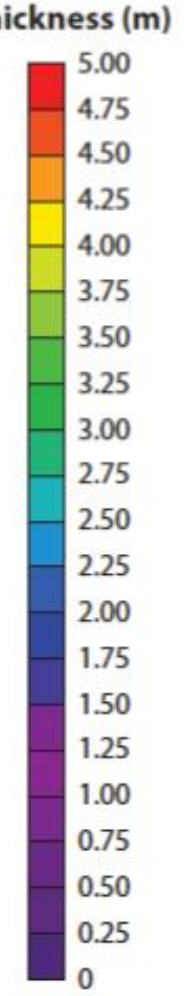
Oct-Dec 1988



NAME model + IceSat obs

Oct-Dec 2004





Maslowski et al.,2012

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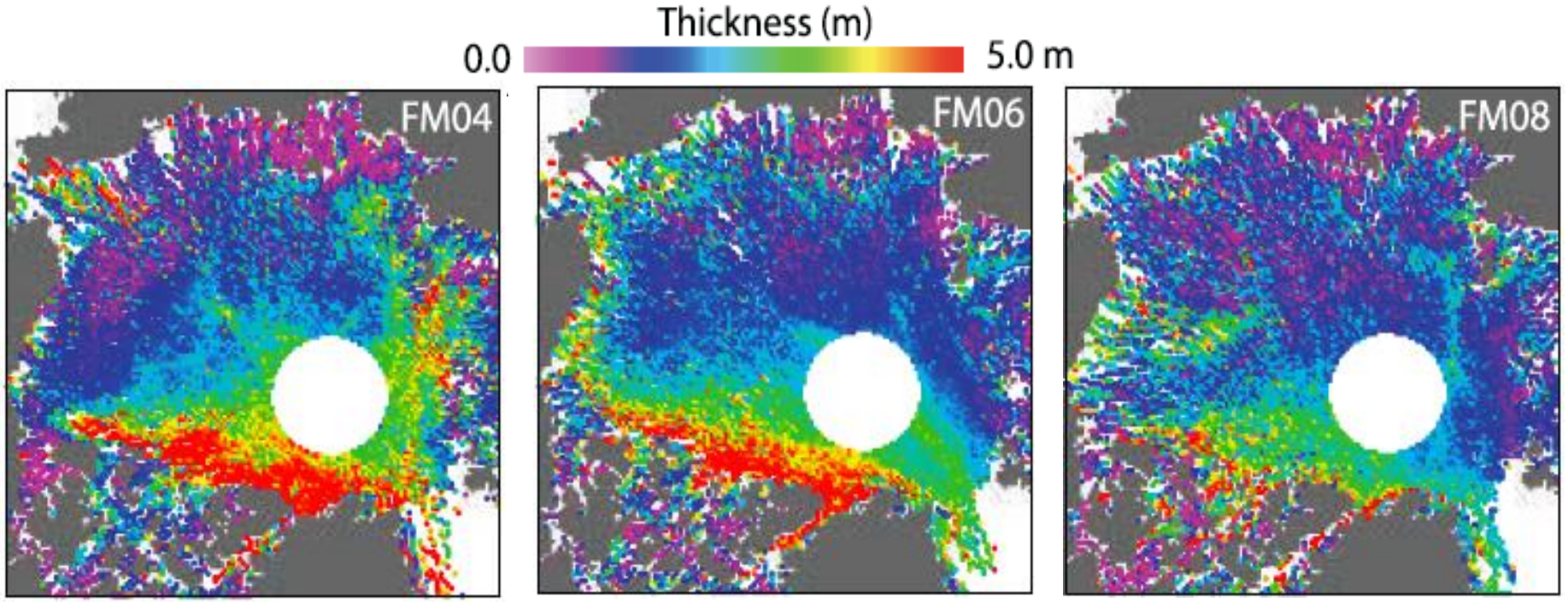
Ice thickness retrieval from IceSat data: 2004, 2006, 2008



(Kwok et al., 2009)

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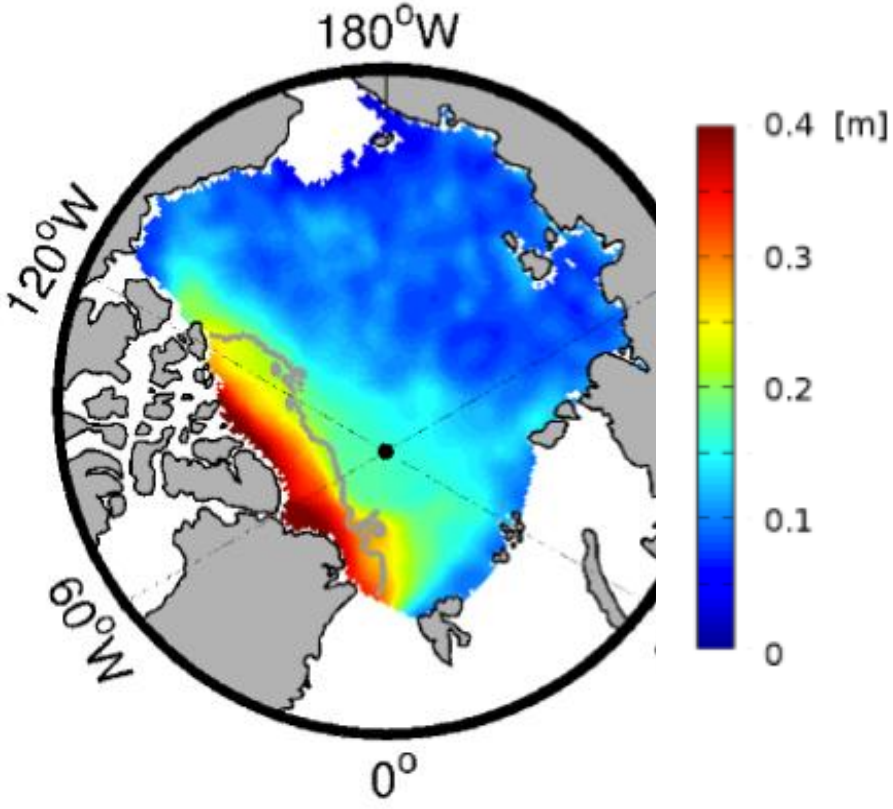
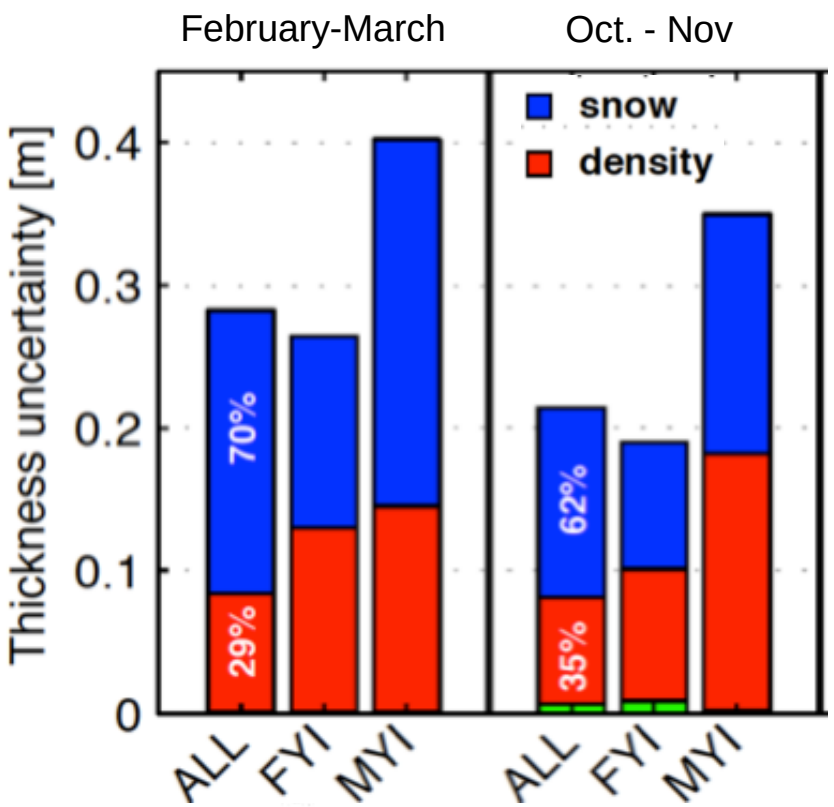
Uncertainty in ice thickness estimation





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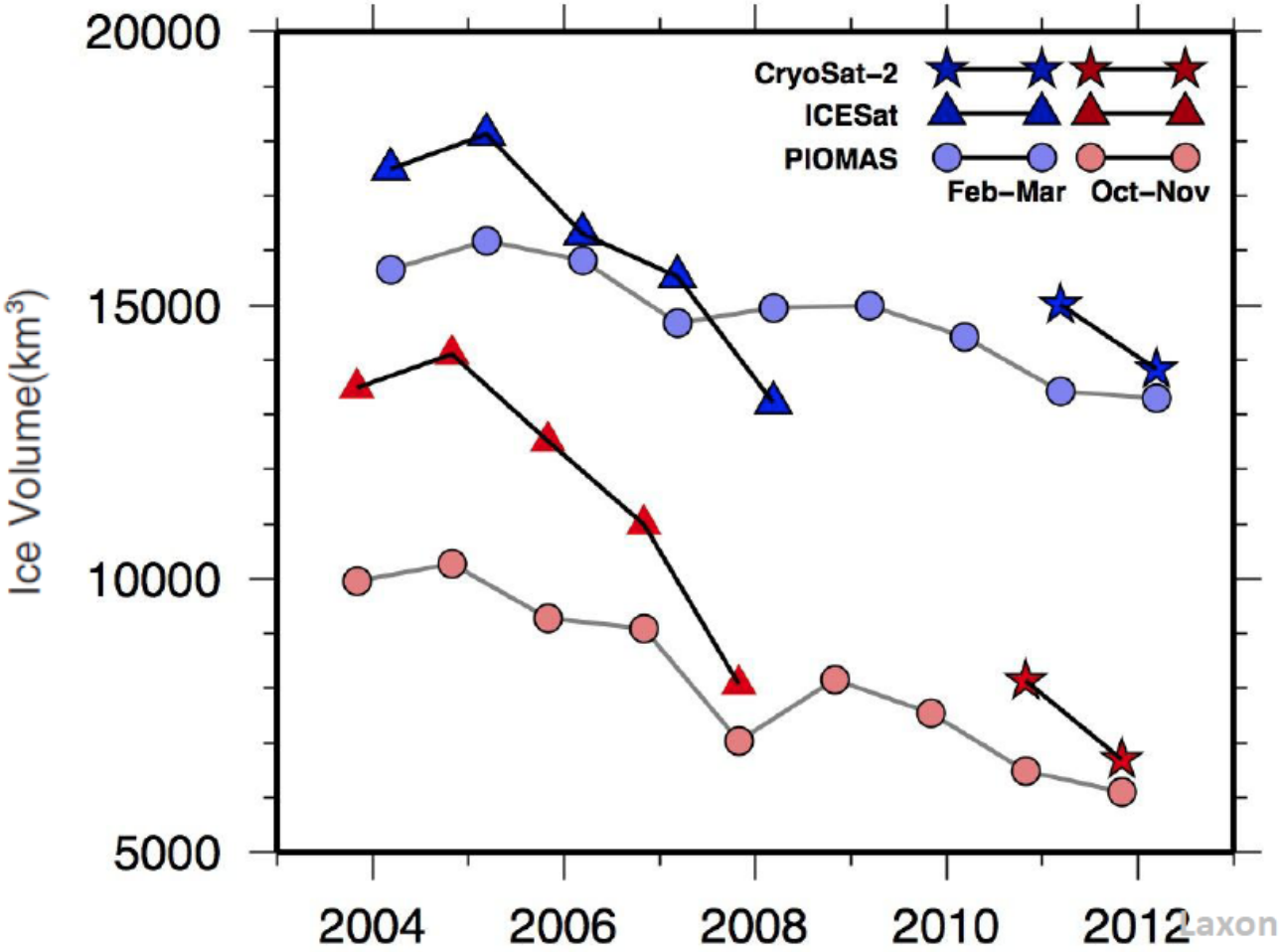
Analysis of IceSat thickness retrieval uncertainty due to ice density and snow cover uncertainty (Zygmuntowska et al. 2014)

Ice volume decrease



Laxon et al., 2013

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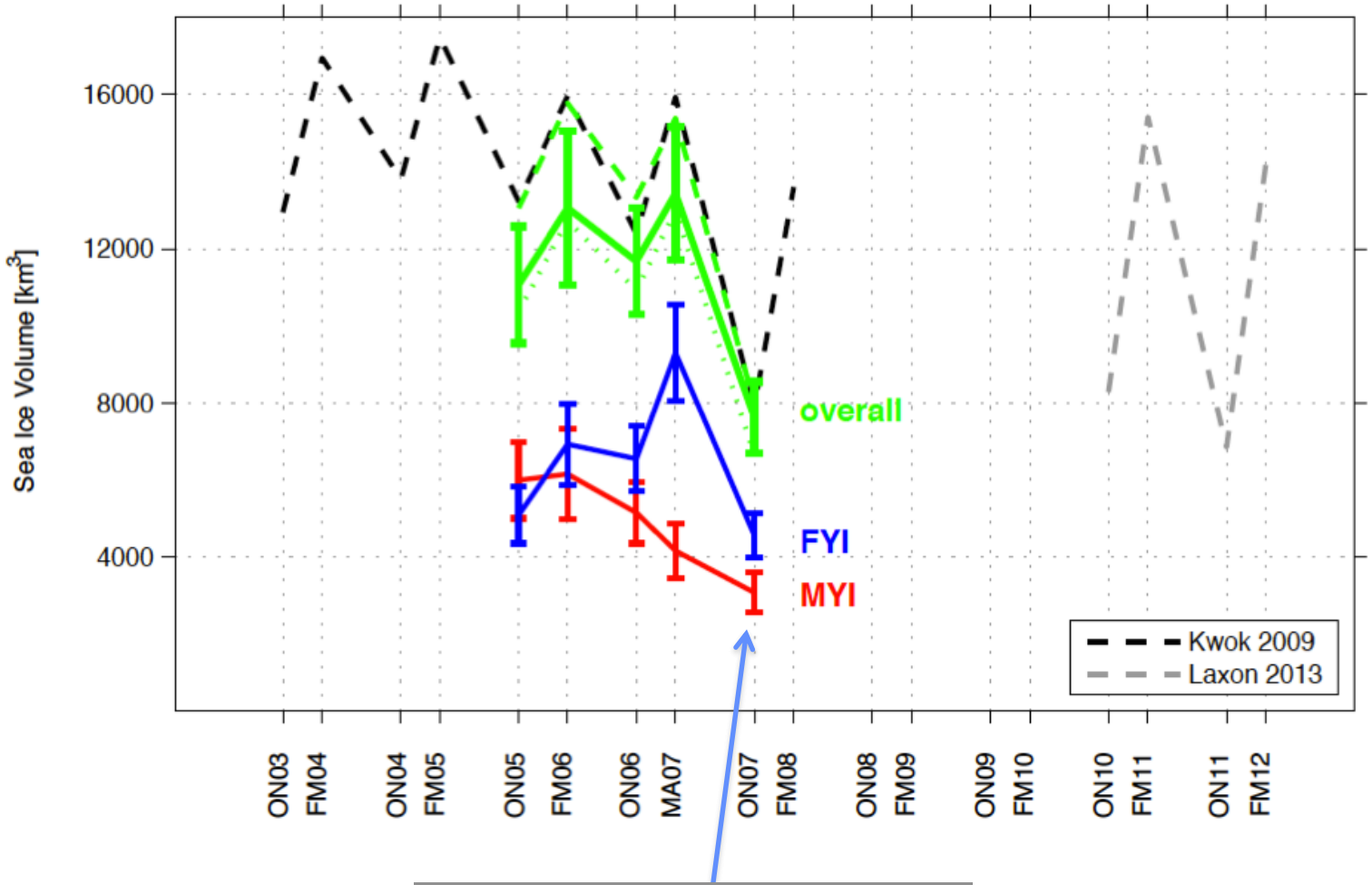
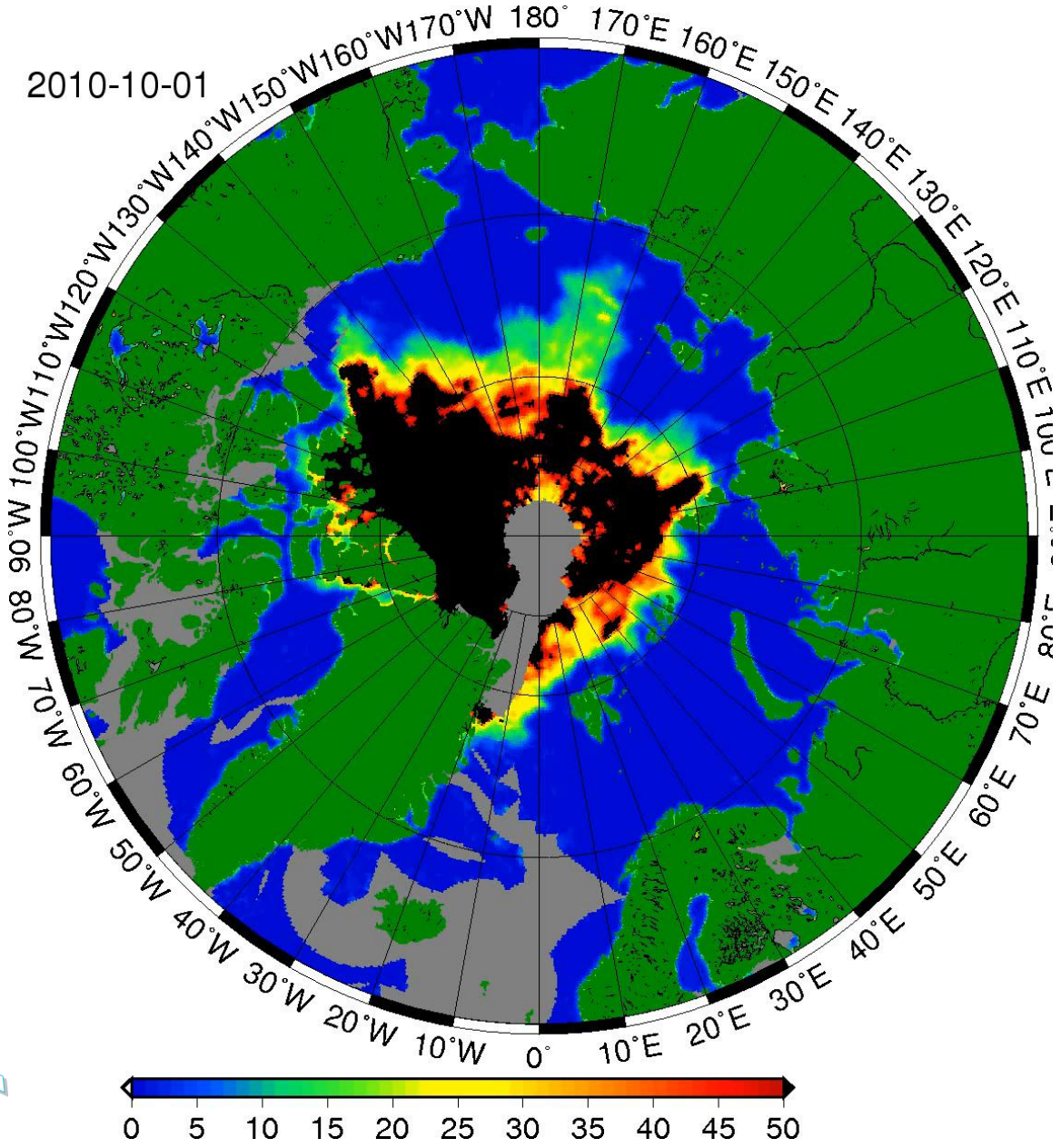
Sea ice volume with uncertainties



Sept 2007: very low extent

Ref. Zugmuntowska et al., 2014

Estimating ice thickness below 0.5 m from SMOS satellite



L-band passive microwave data from SMOS since 2010

Animation of daily maps for October – December 2010

Ref- G. Heygster

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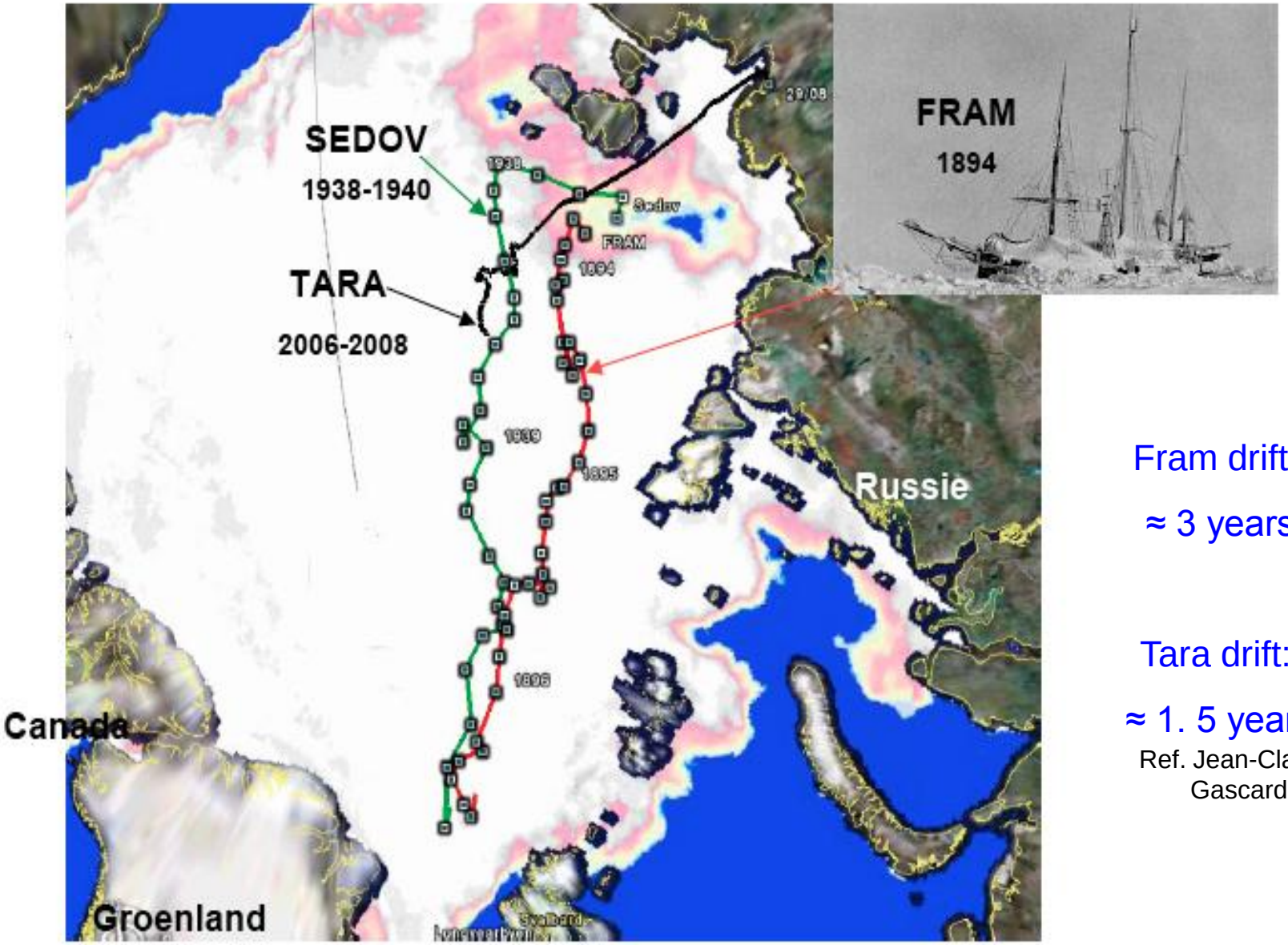
Transpolar ice drift: 1894 – 1938 – 2006



Fram drift:

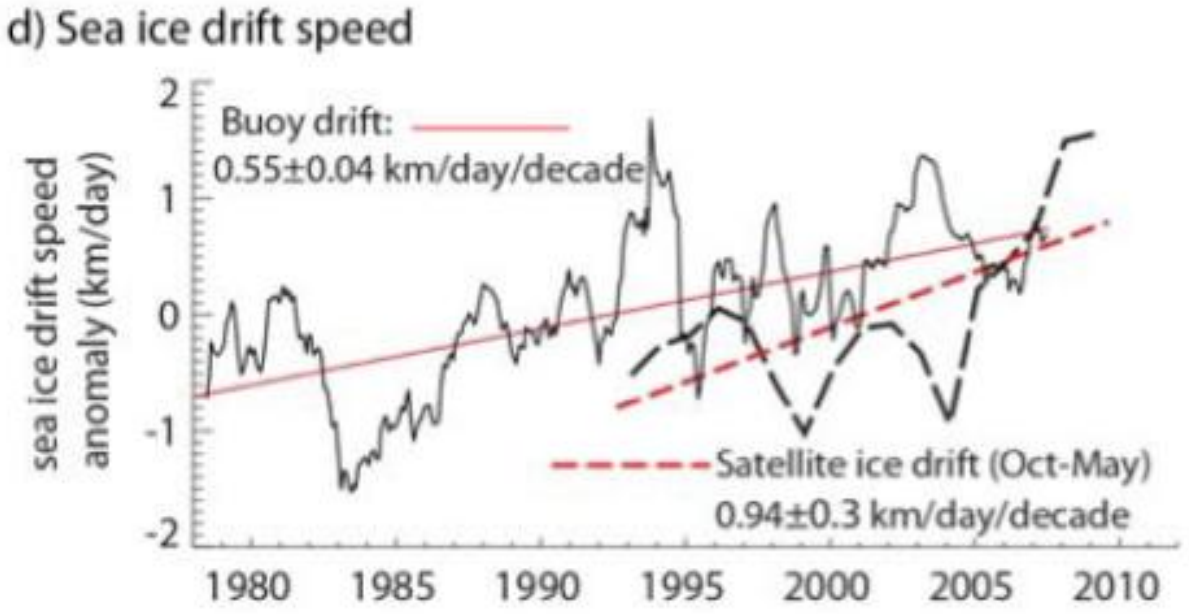
≈ 3 years

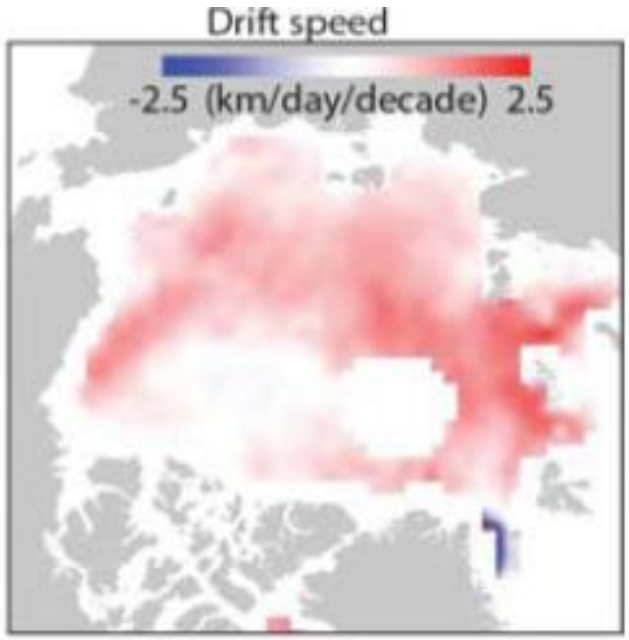
Tara drift:

≈ 1. 5 years

Ref. Jean-Claude Gascard

Increasing ice speed





IPCC 2013

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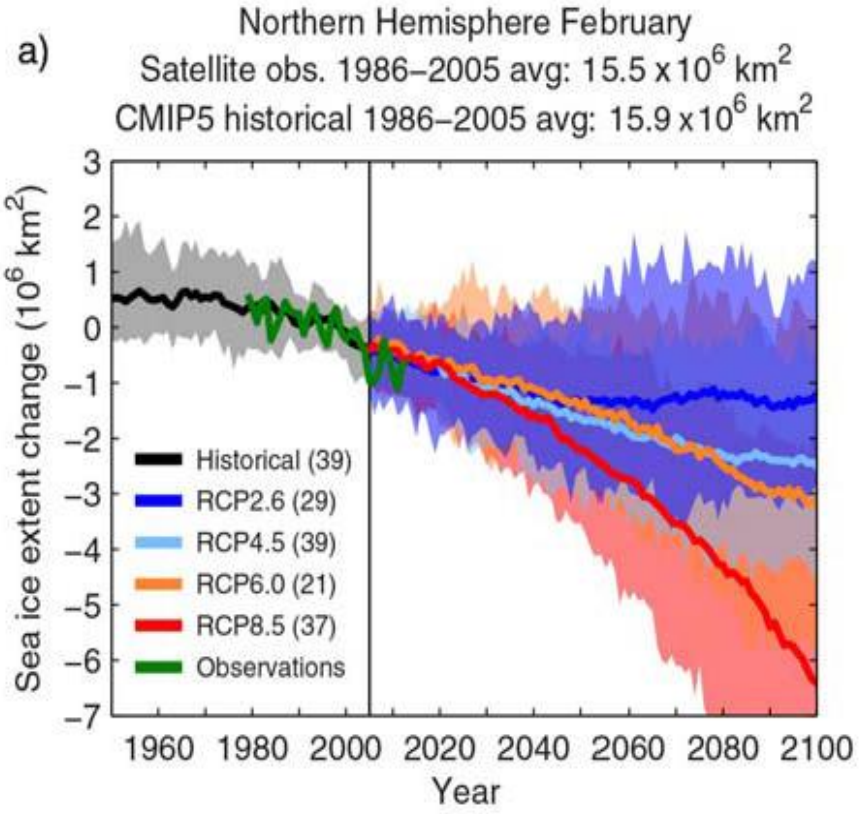
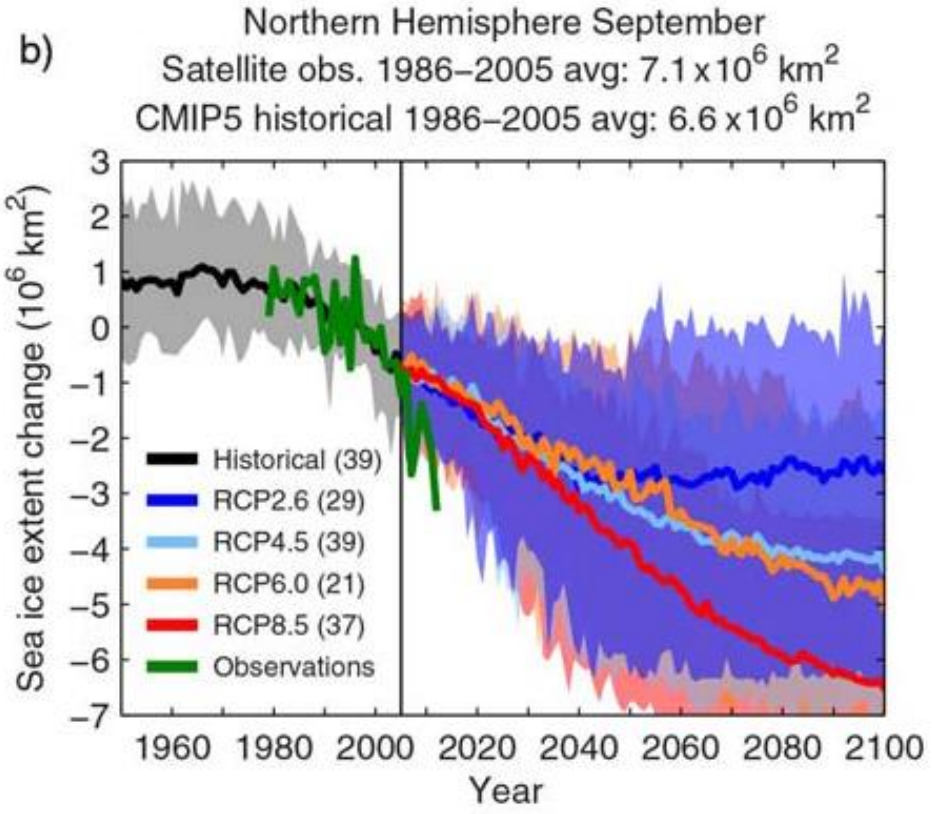
How do models project sea ice extent in the 21st century ?

Results of CMIP5 models (IPCC 2013)





Changes are relative to reference period 1986-2005

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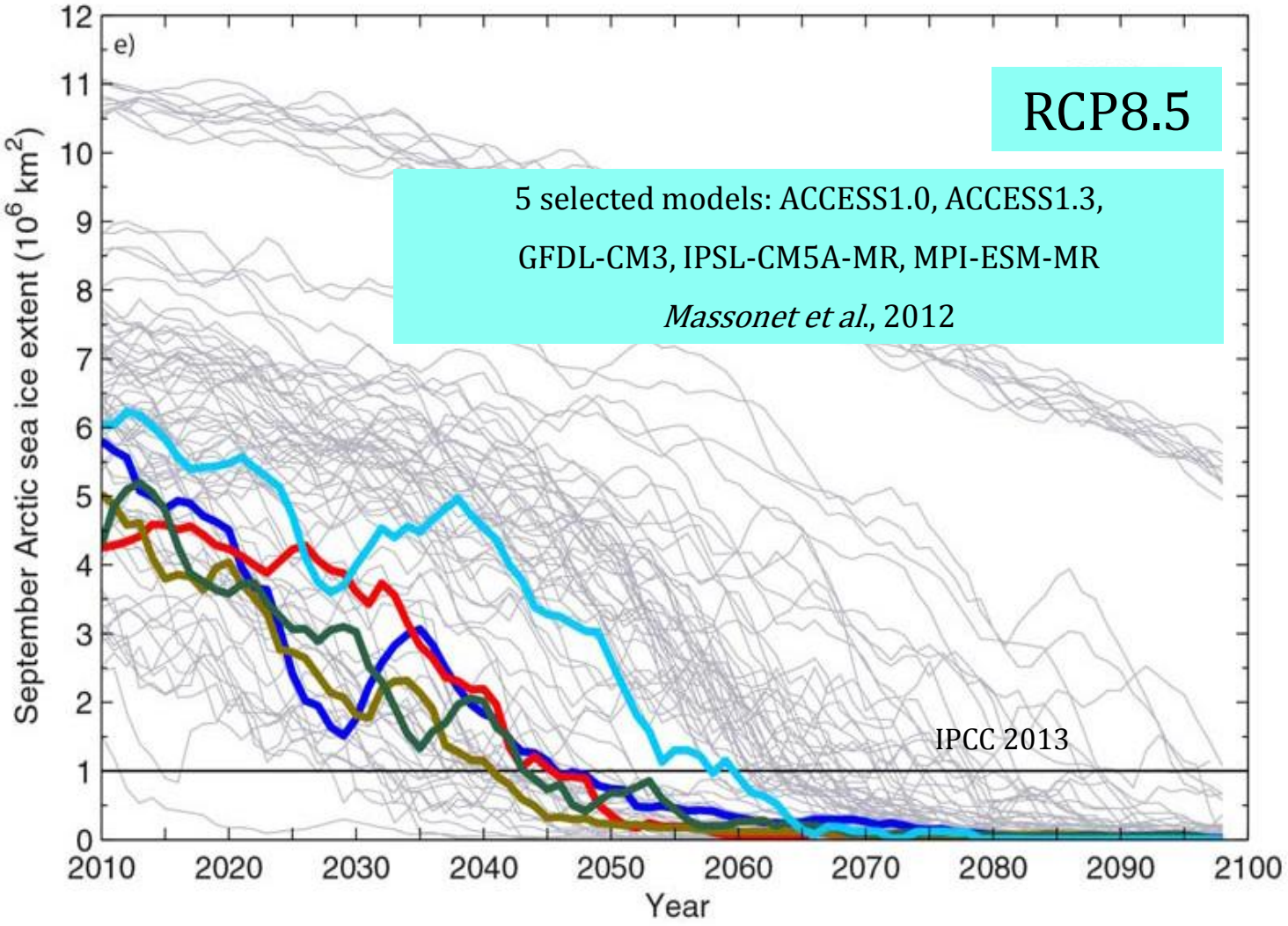
When can a nearly sea ice-free summer be expected in the Arctic ?



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What are the most pronounced changed observed in Arctic sea ice in the last decades ?

Sea ice variable	Change	Observed trend
Ice extent	Decrease	- 3.8 % per decade
Multiyear extent	Decrease	-13.5 % per decade
Ice thickness	Decrease	- 15 % per decade
Ice drift	Increase	+ 0.55 cm/s per decade
Melt season	Increase	+ 5.7 days per decade

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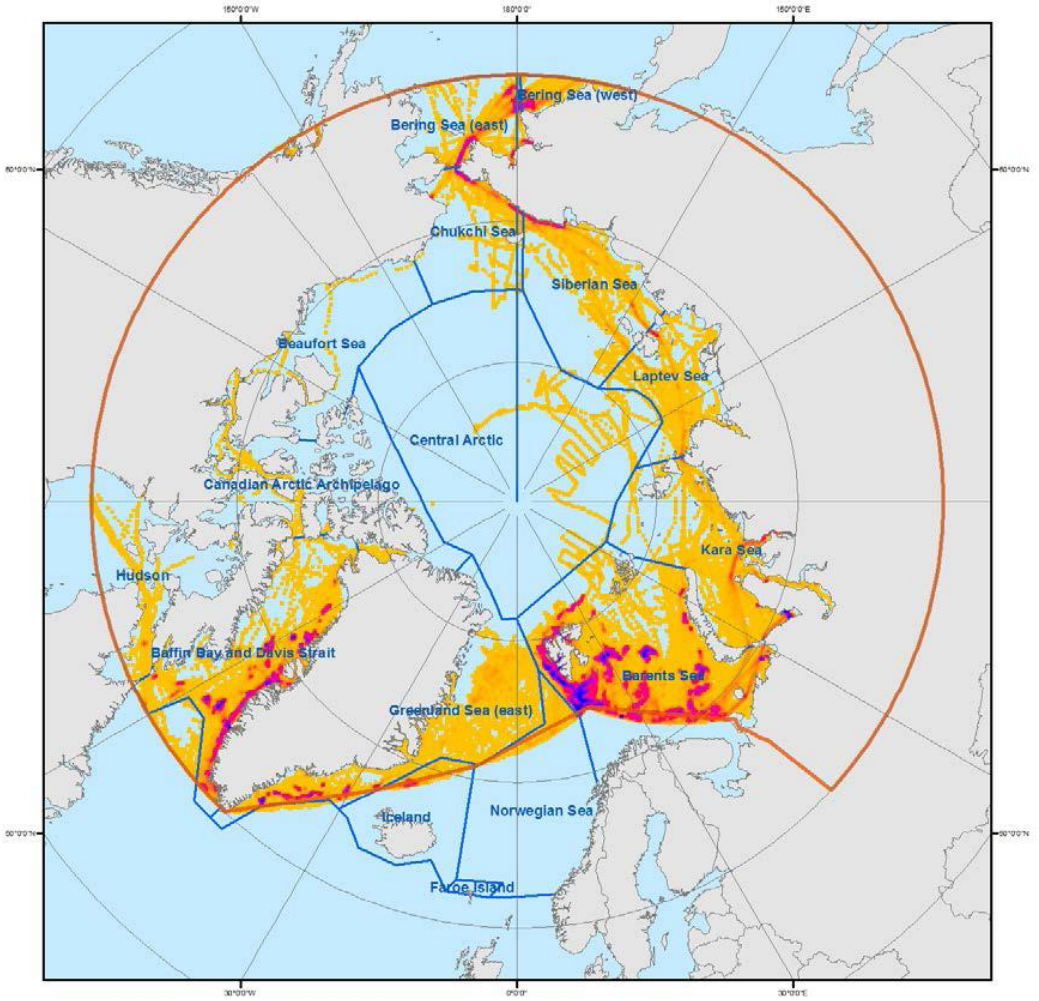
Ref. IPCC AR5

Arctic Transport Patterns

- Transit traffic along the Northern Sea
  - 2009: 4
  - 2010: 5
  - 2011: 34
  - 2012: 46
  - 2013: 71
  - Estimates for 2030: 480

http://www.arctic-lio.com/



Sources: AMSA report, 2009, DNV report, 2010

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