



**National Centre for  
Earth Observation**  
NATURAL ENVIRONMENT RESEARCH COUNCIL



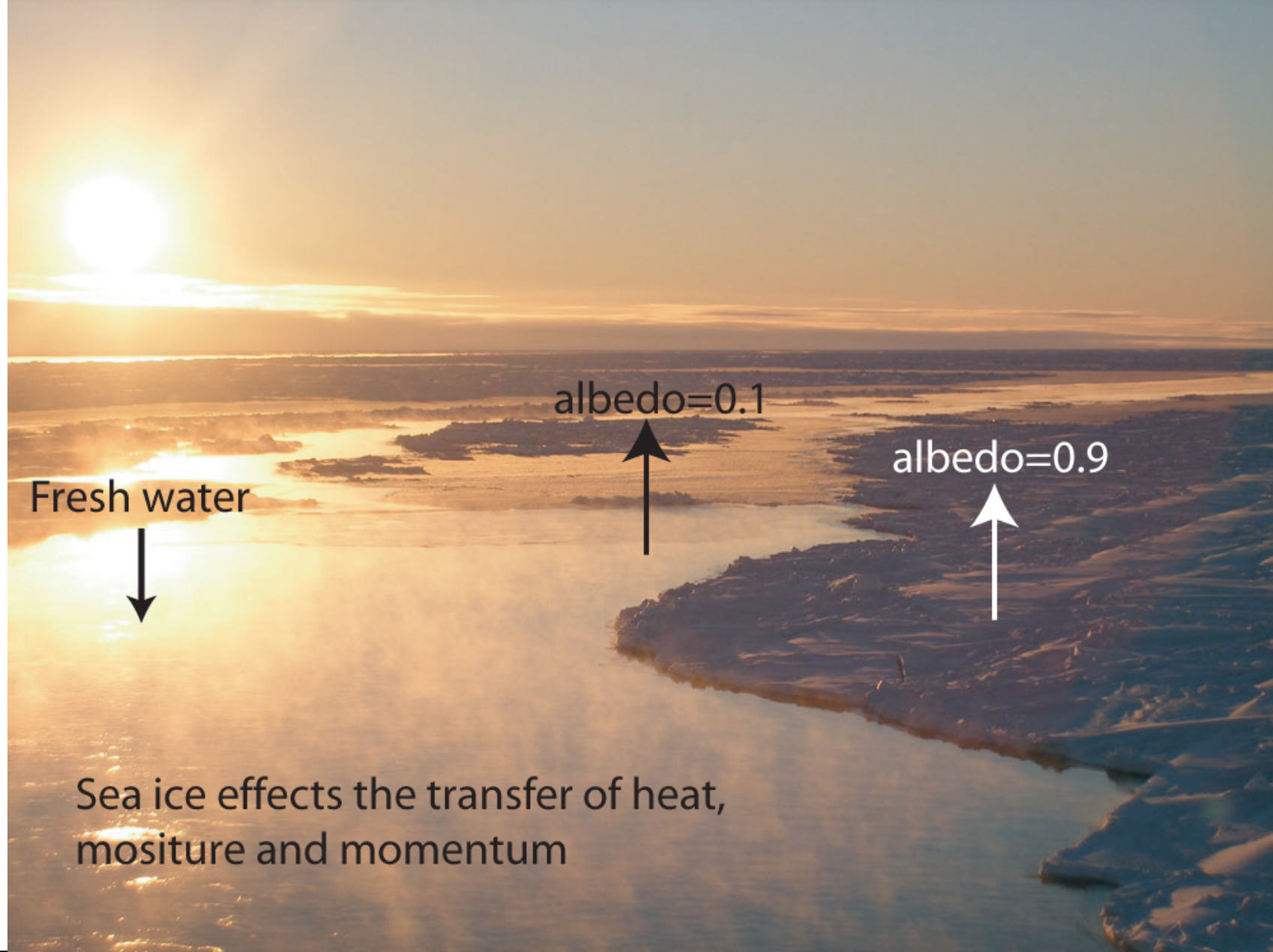
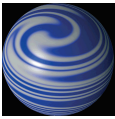
**UCL**

# Role of ice thickness in Arctic sea-ice predictability

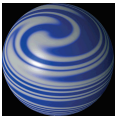
Katharine Giles, Seymour Laxon and Andy Ridout  
Centre for Polar Observation and Modelling, University  
College London.

[k.giles@cpom.ucl.ac.uk](mailto:k.giles@cpom.ucl.ac.uk)

Image: newforestobservatory.com

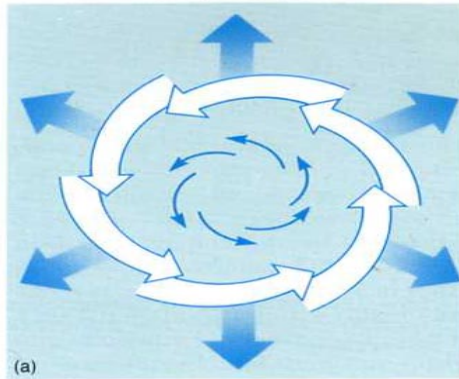






**NORTHERN HEMISPHERE**

CYCLONIC WIND



ANTICYCLONIC WIND

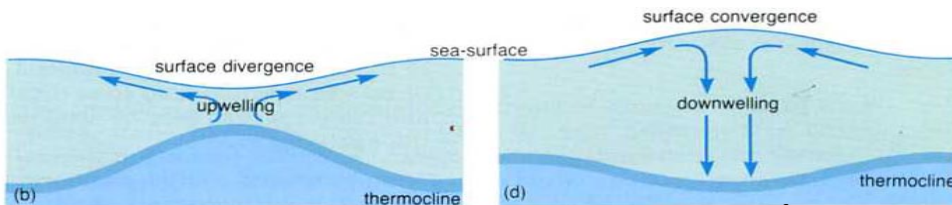
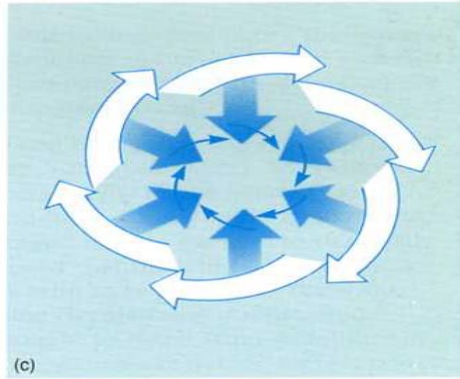
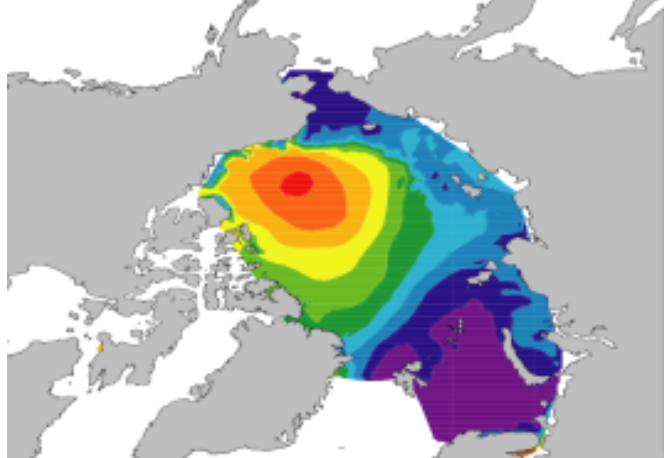
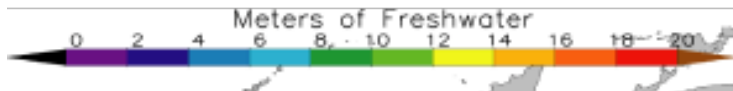


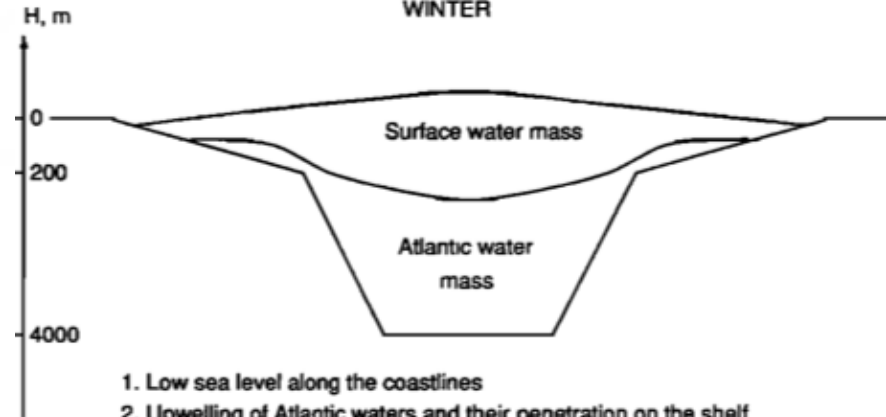
Figure from Ocean Circulation – The Open University



Mean annual fresh water content of the Arctic Ocean excluding sea ice (Serreze et al., 2006).

**ANTICYCLONIC ATMOSPHERIC CIRCULATION**

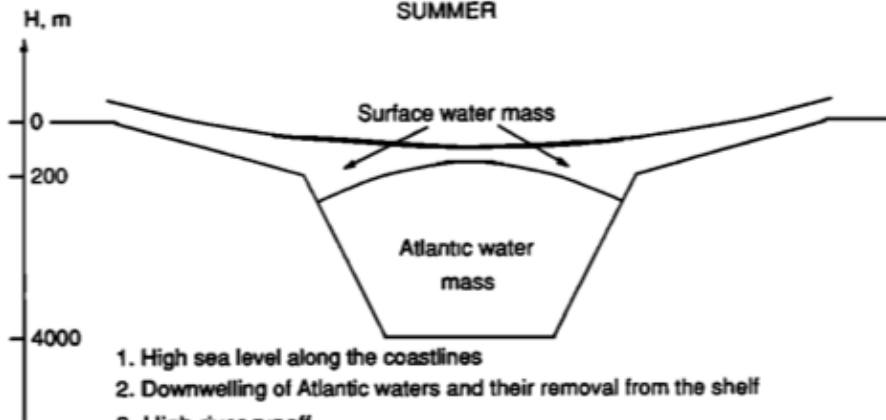
WINTER



1. Low sea level along the coastlines
2. Upwelling of Atlantic waters and their penetration on the shelf
3. Low river runoff
4. Weak vertical water stratification
5. Increase of heat exchange between atmosphere and ocean

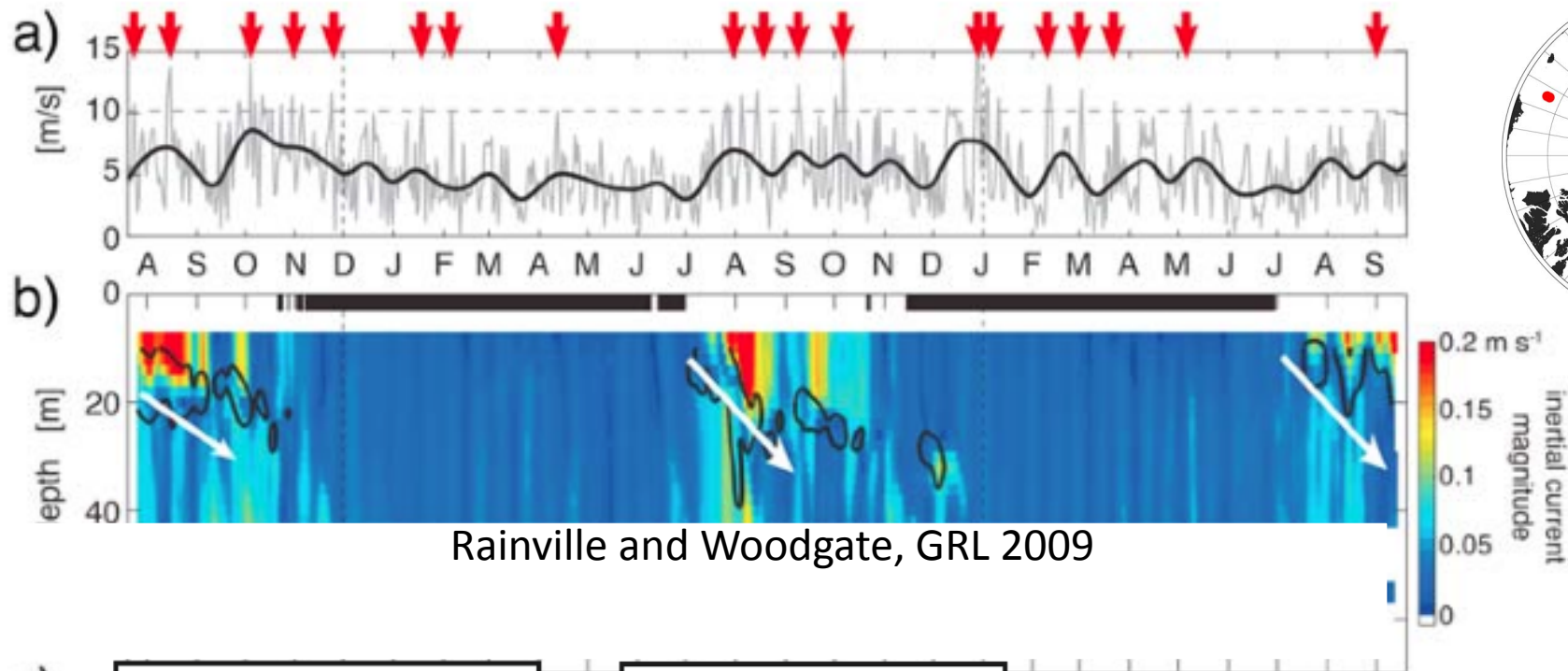
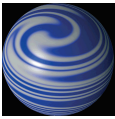
**CYCLONIC ATMOSPHERIC CIRCULATION**

SUMMER

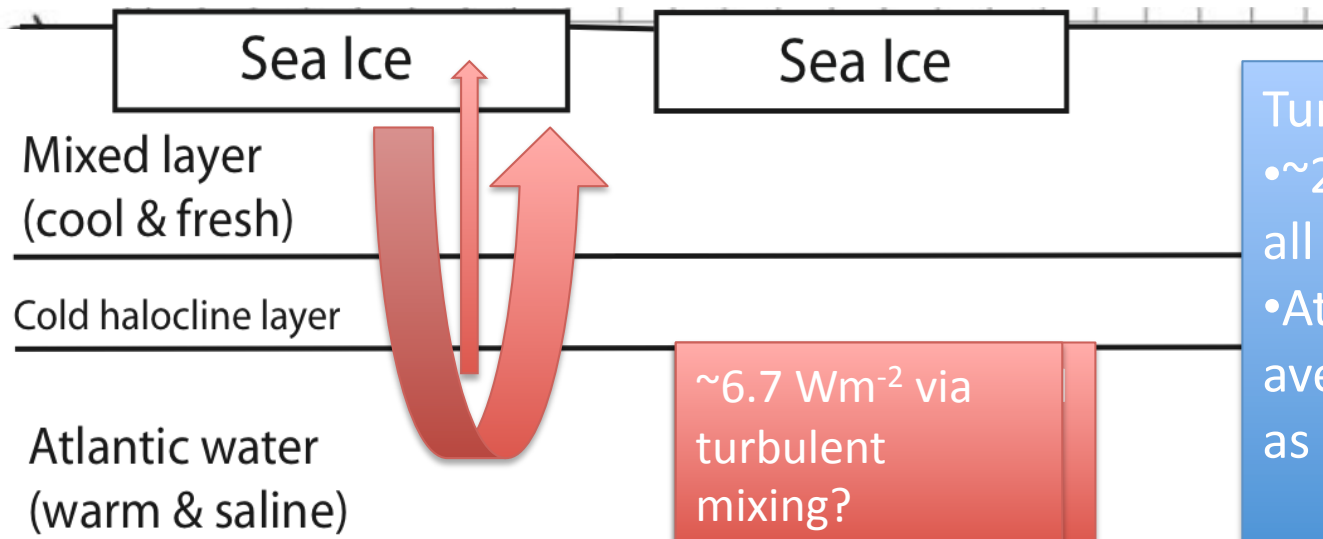


1. High sea level along the coastlines
2. Downwelling of Atlantic waters and their removal from the shelf
3. High river runoff
4. Strong vertical water stratification
5. Low heat exchange between atmosphere and ocean

Two circulation regimes of the wind-driven Arctic Ocean, Proshutinsky & Johnson 1997.



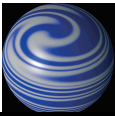
Rainville and Woodgate, GRL 2009



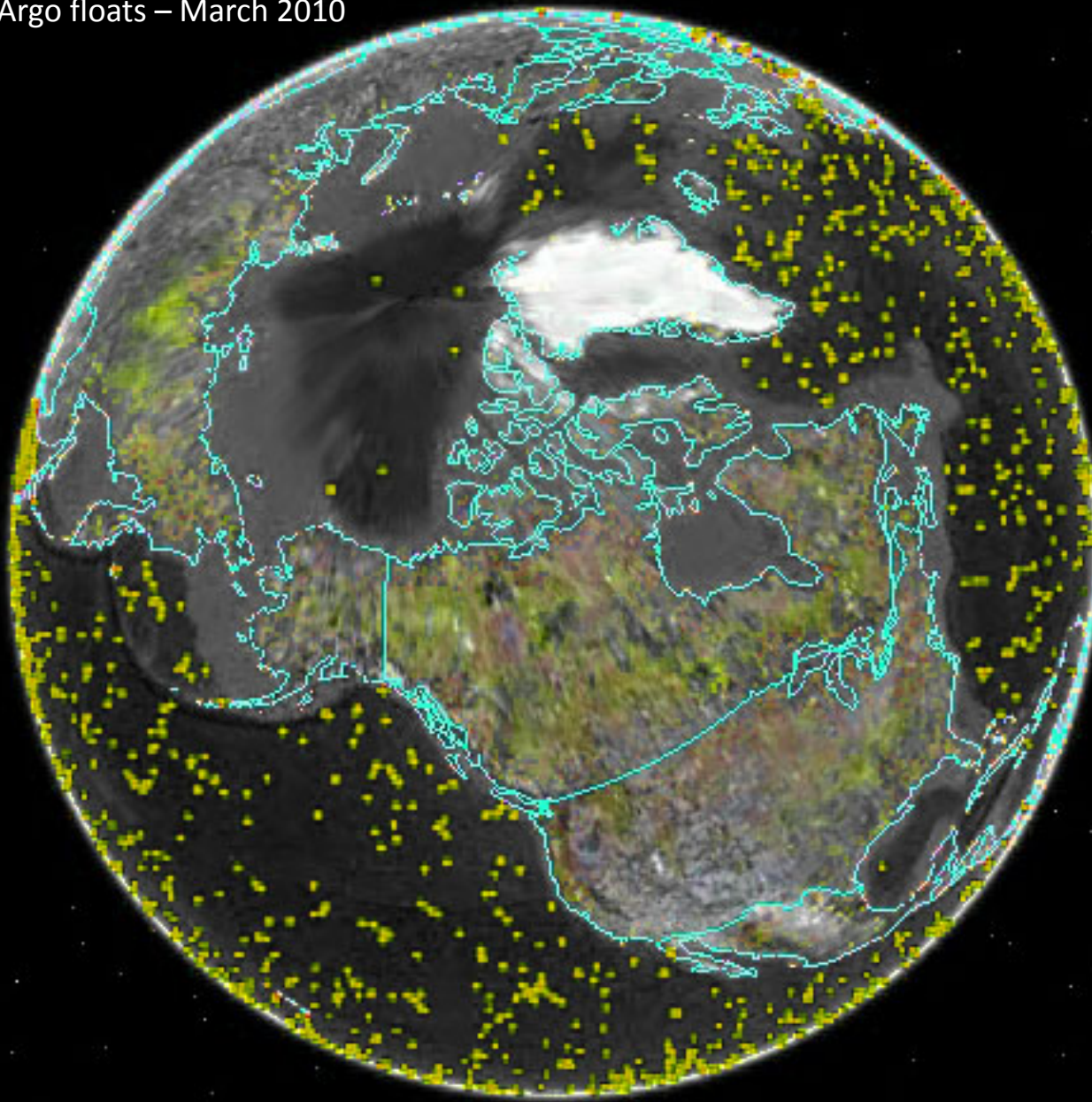
Turner, JPO 2010

- $\sim 25 \text{ Wm}^{-2}$  required to melt all the sea ice in one year
- Atlantic layer basin average heat loss could be as large as  $\sim 6.7 \text{ Wm}^{-2}$

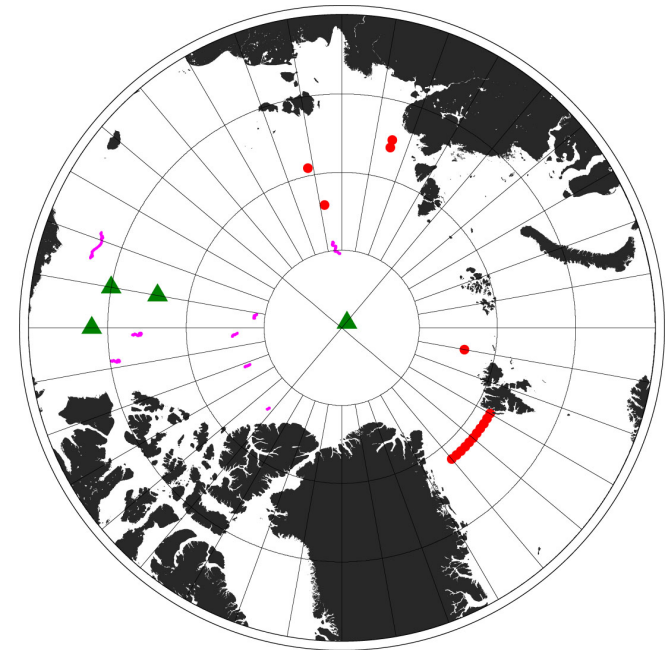


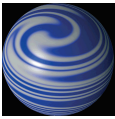


Argo floats – March 2010

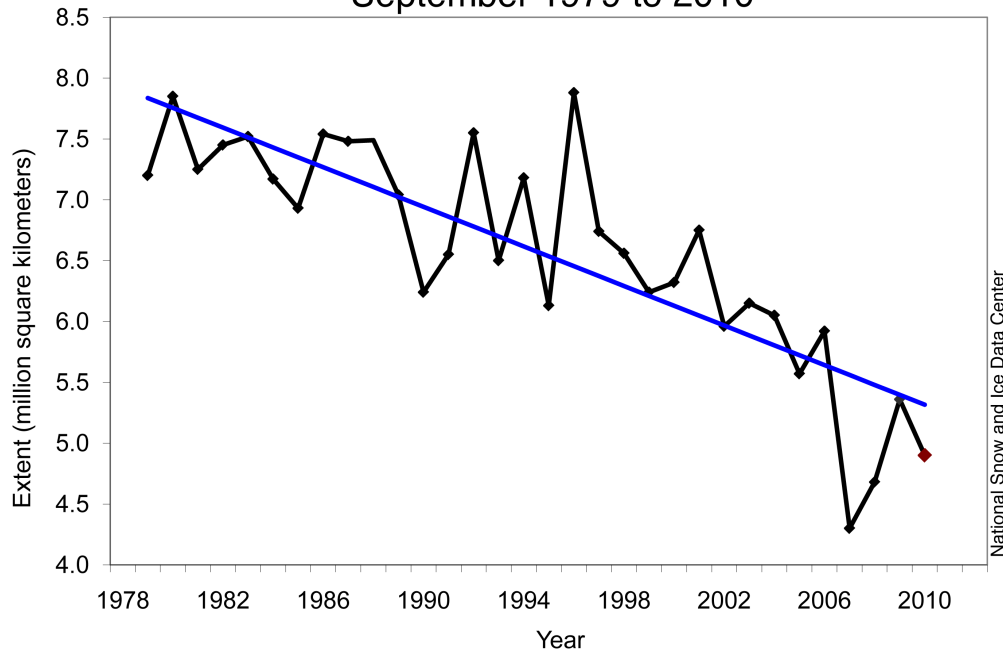


- Moorings
- ▲ BPR+Moorings
- ITP





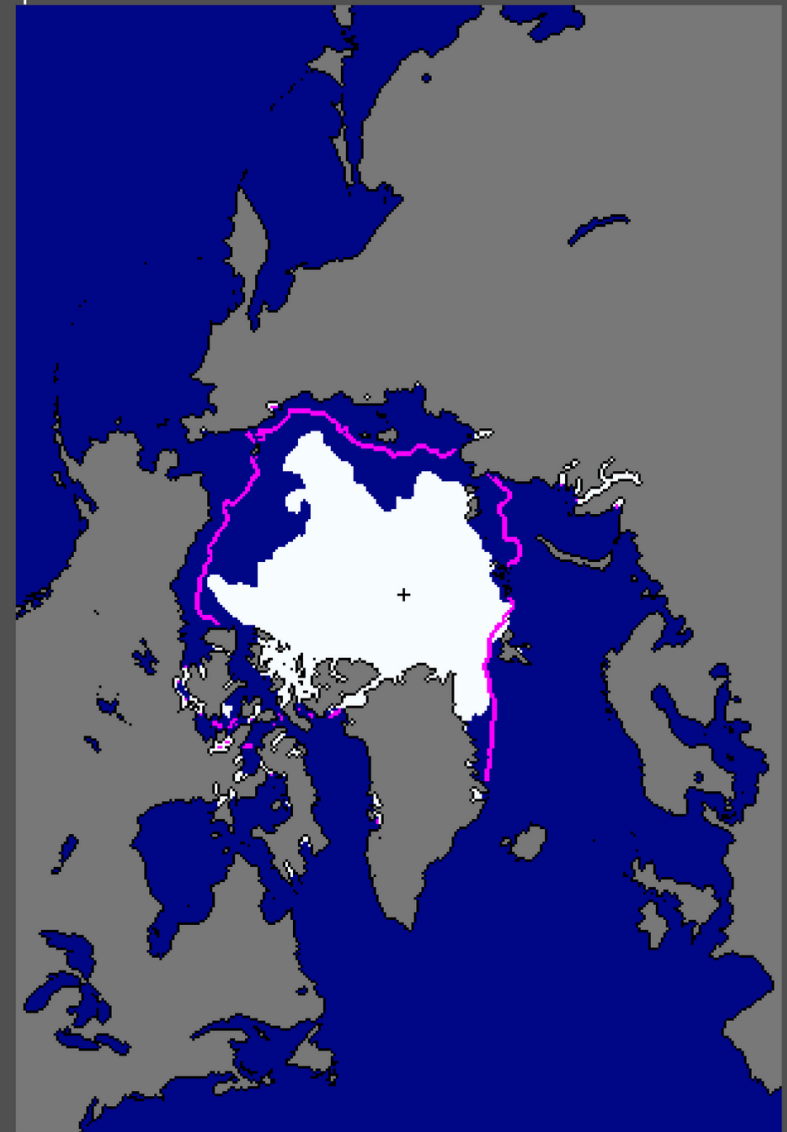
Average Monthly Arctic Sea Ice Extent  
September 1979 to 2010



National Snow and Ice Data Center

-11.2% sea ice extent per decade

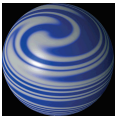
Sea Ice Extent  
Sep 2010



National Snow and Ice Data Center, Boulder, CO

Total extent = 4.9 million sq km





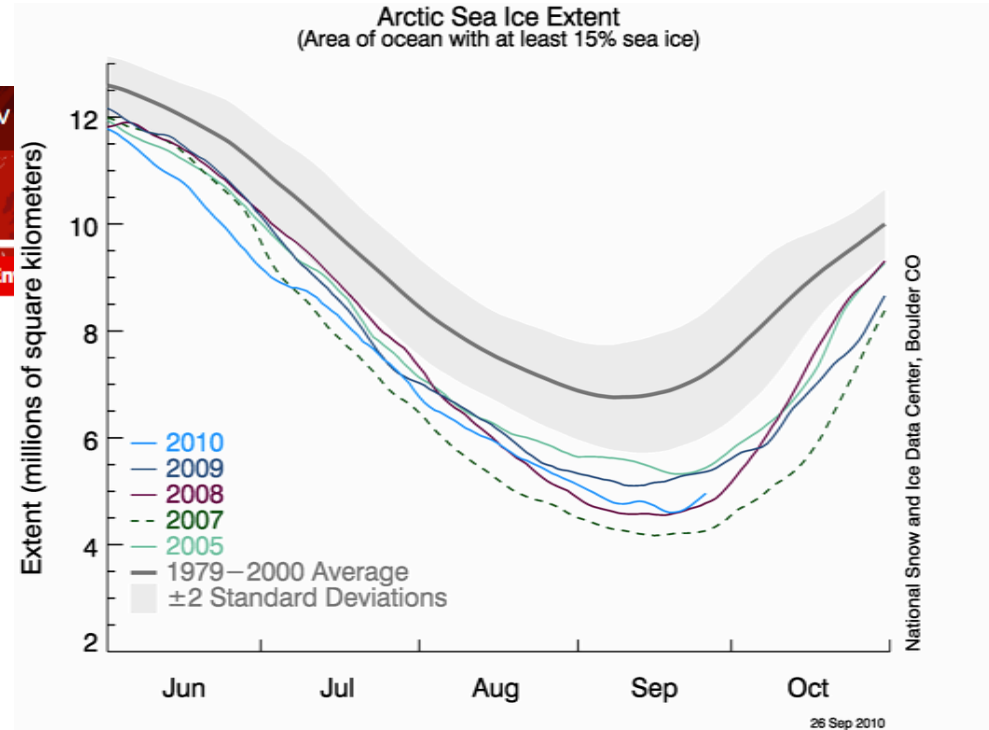
16 September 2010 Last updated at 00:12

## 'Rapid' 2010 melt for Arctic ice - but no record

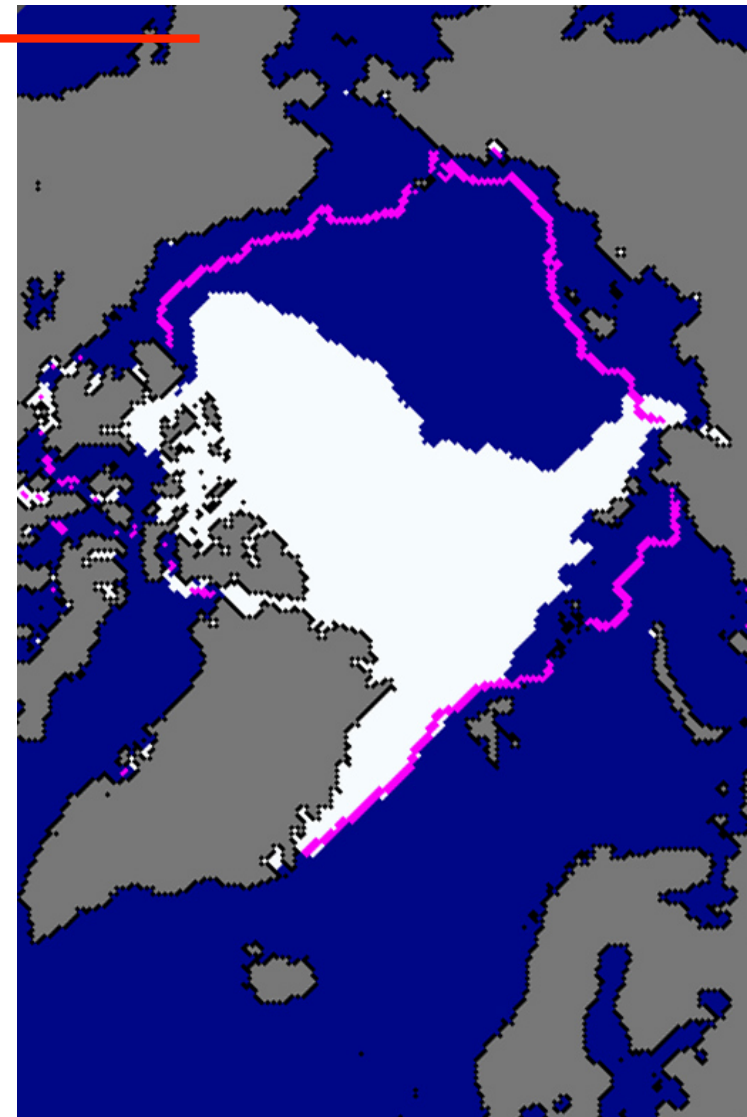
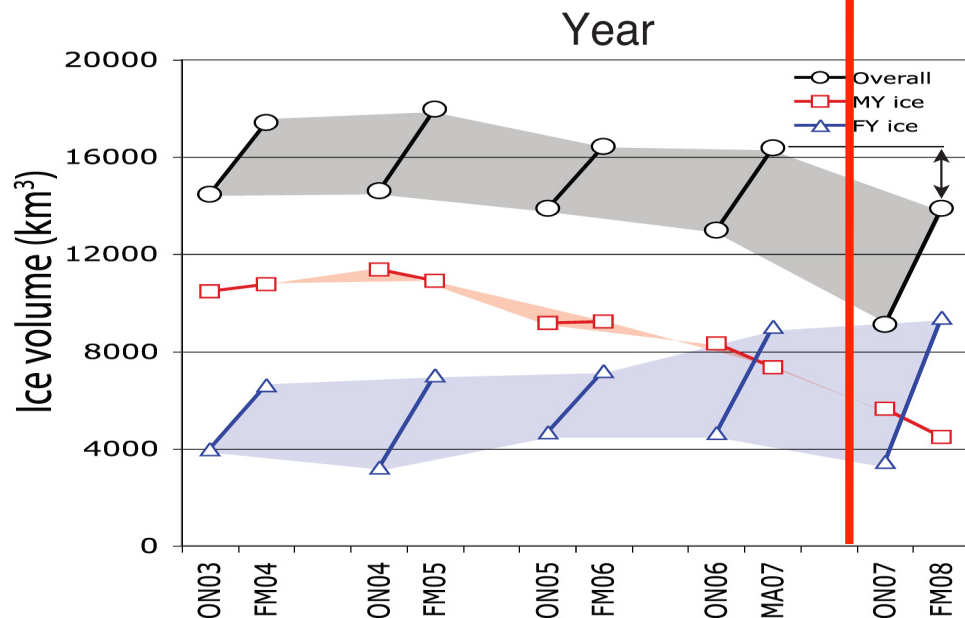
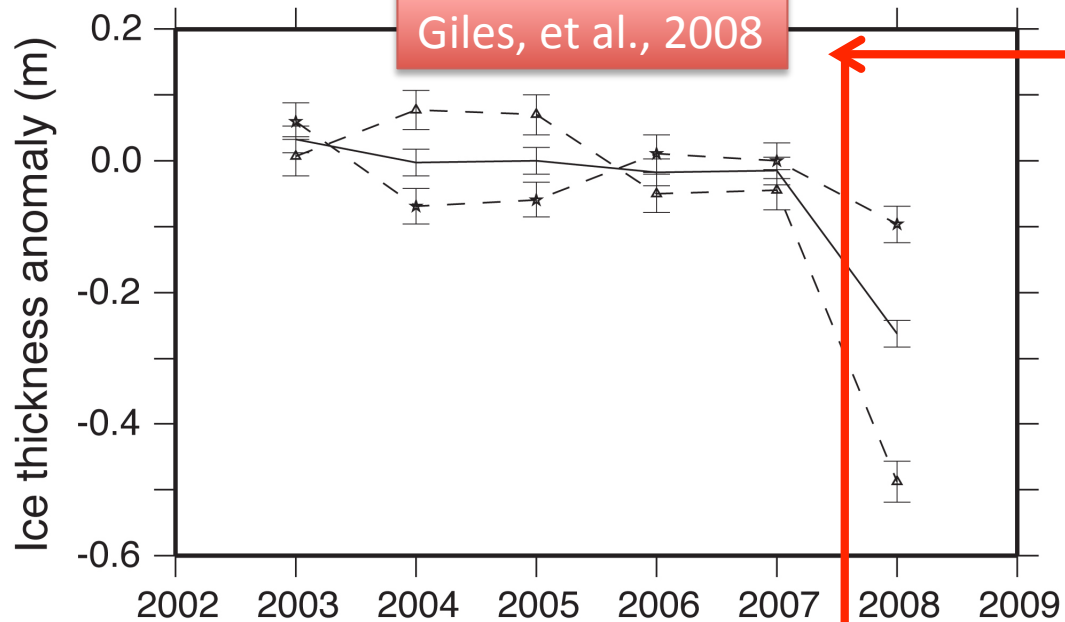
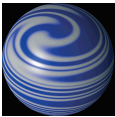
By Richard Black  
Environment correspondent, BBC News



The Arctic on 3rd September, as visualised using data from Nasa's Aqua satellite

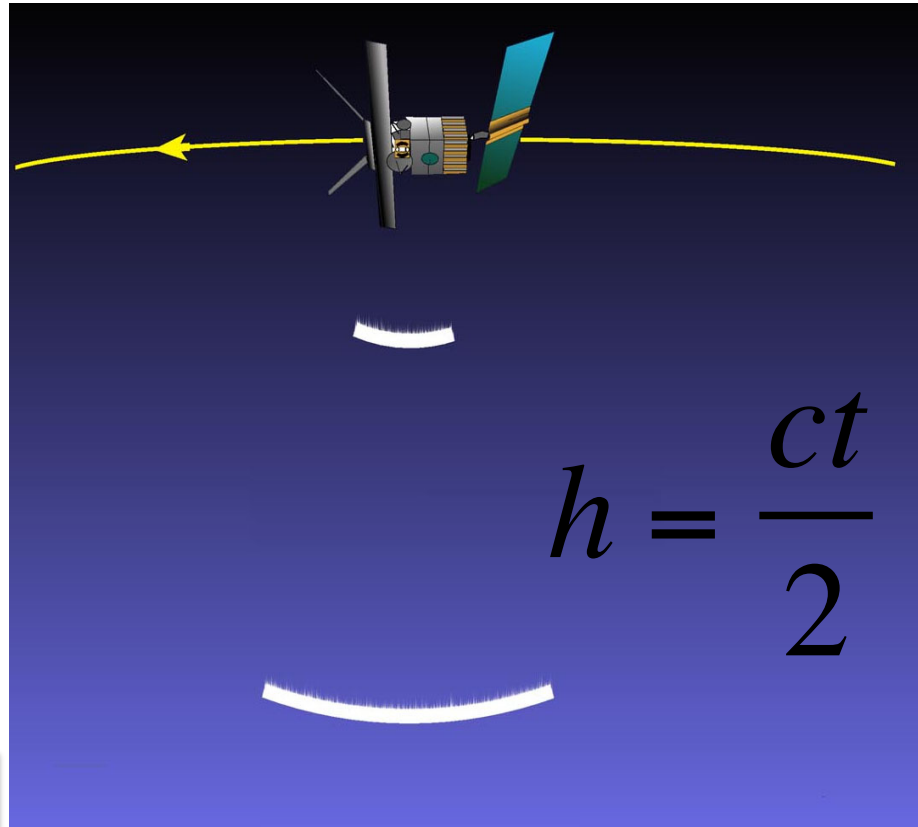
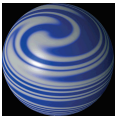


Third lowest ice-extent on record despite strongly negative winter 2009/2010 AO, which favors ice retention during the summer



Kwok et al., 2009





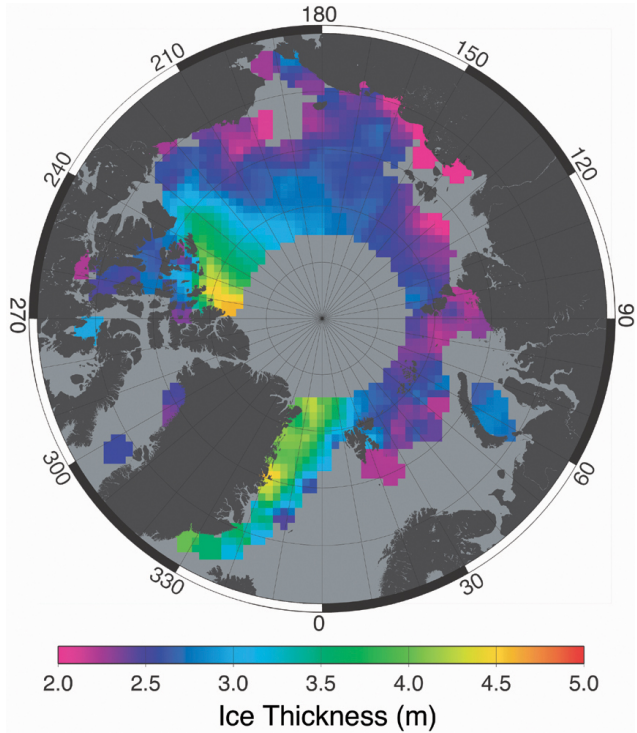
1993-1996 1995-2003



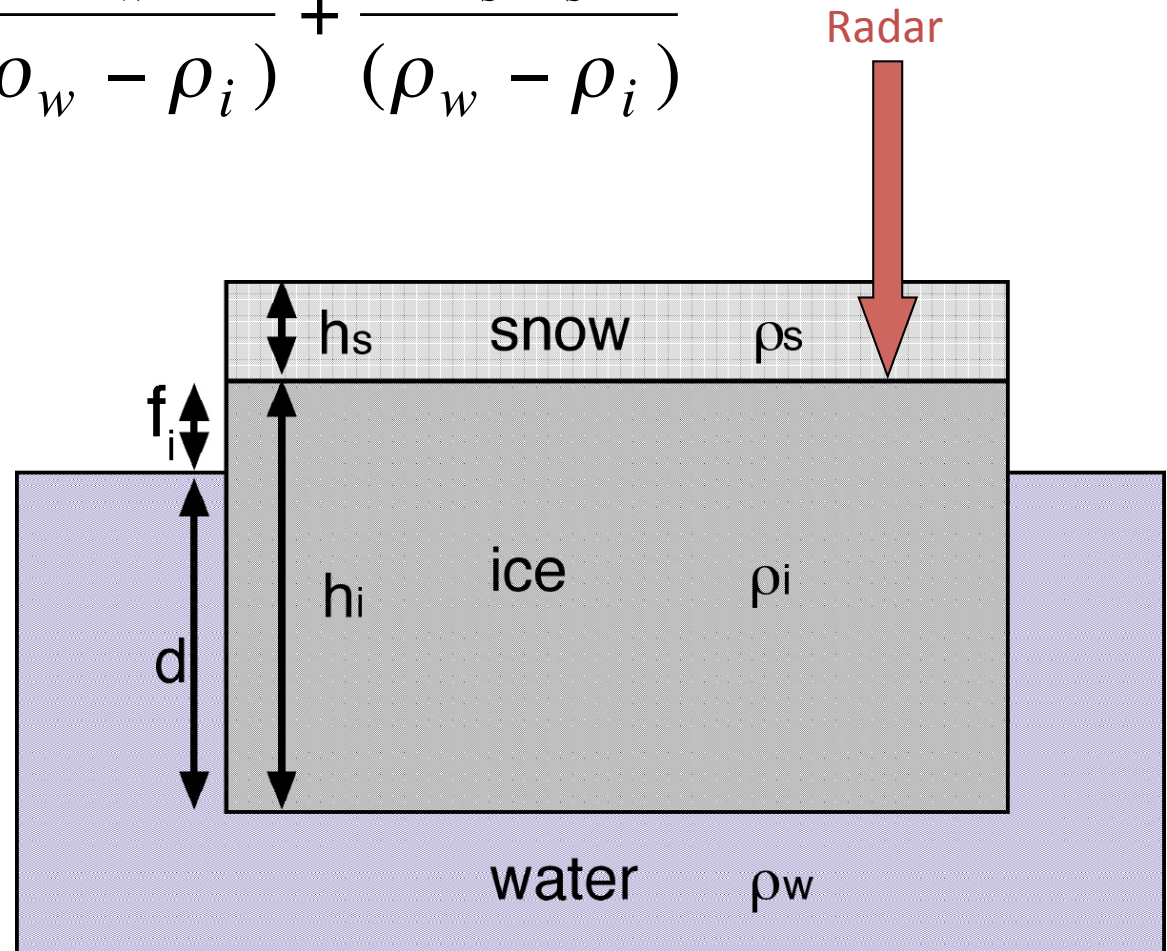
2003-2009



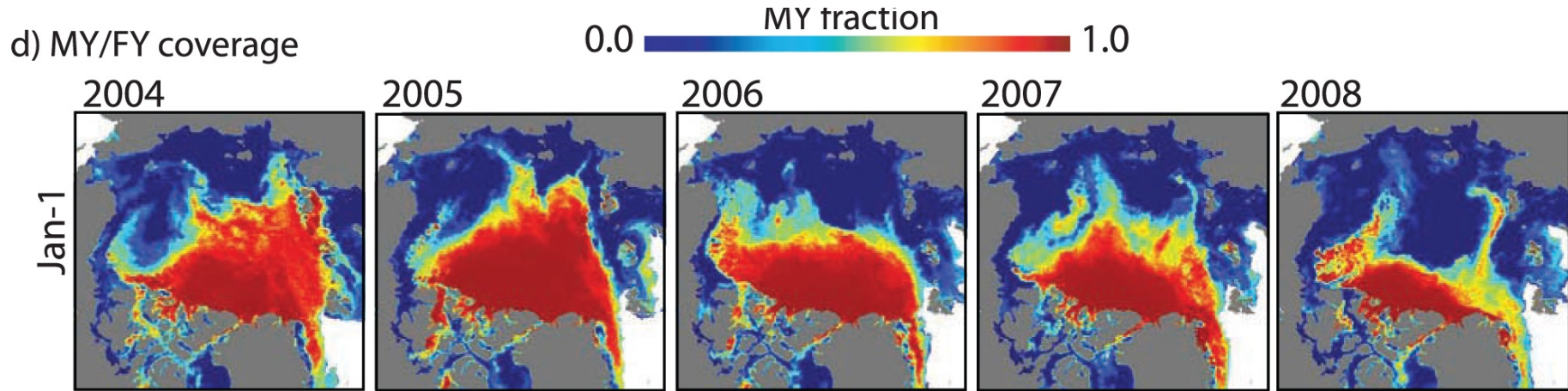
$$h_i = f_i \frac{\rho_w}{(\rho_w - \rho_i)} + \frac{h_s \rho_s}{(\rho_w - \rho_i)}$$



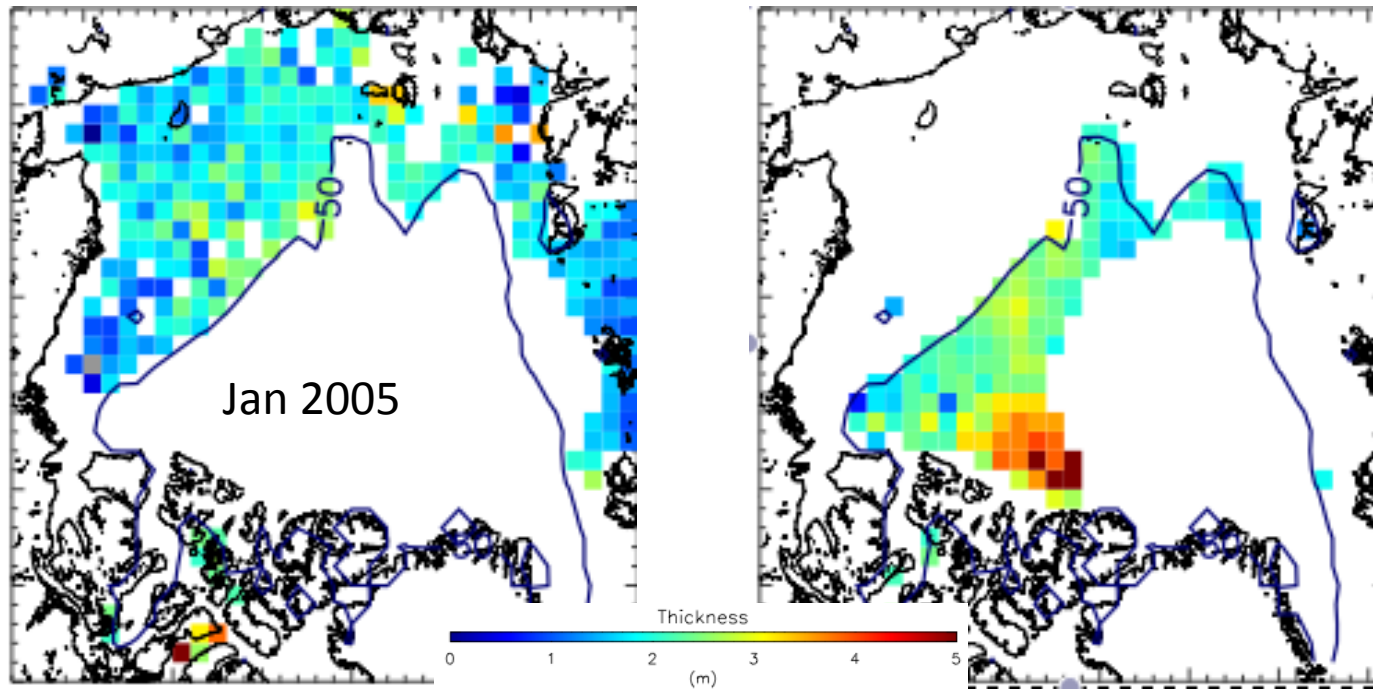
Mean winter Arctic sea ice thickness  
from October 1993 to March 2001

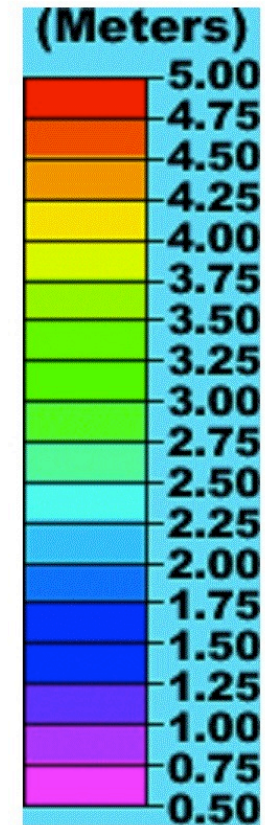
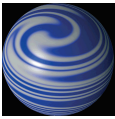






Kwok et al., 2009, QuikSCAT MY ice fields



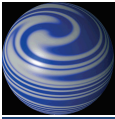


esa

cryosat-2

Arctic sea ice thickness for 09/10/2010





# Thank you!

