Climate Change and the Cryosphere: Snow, Water, Ice and Permafrost in the Arctic

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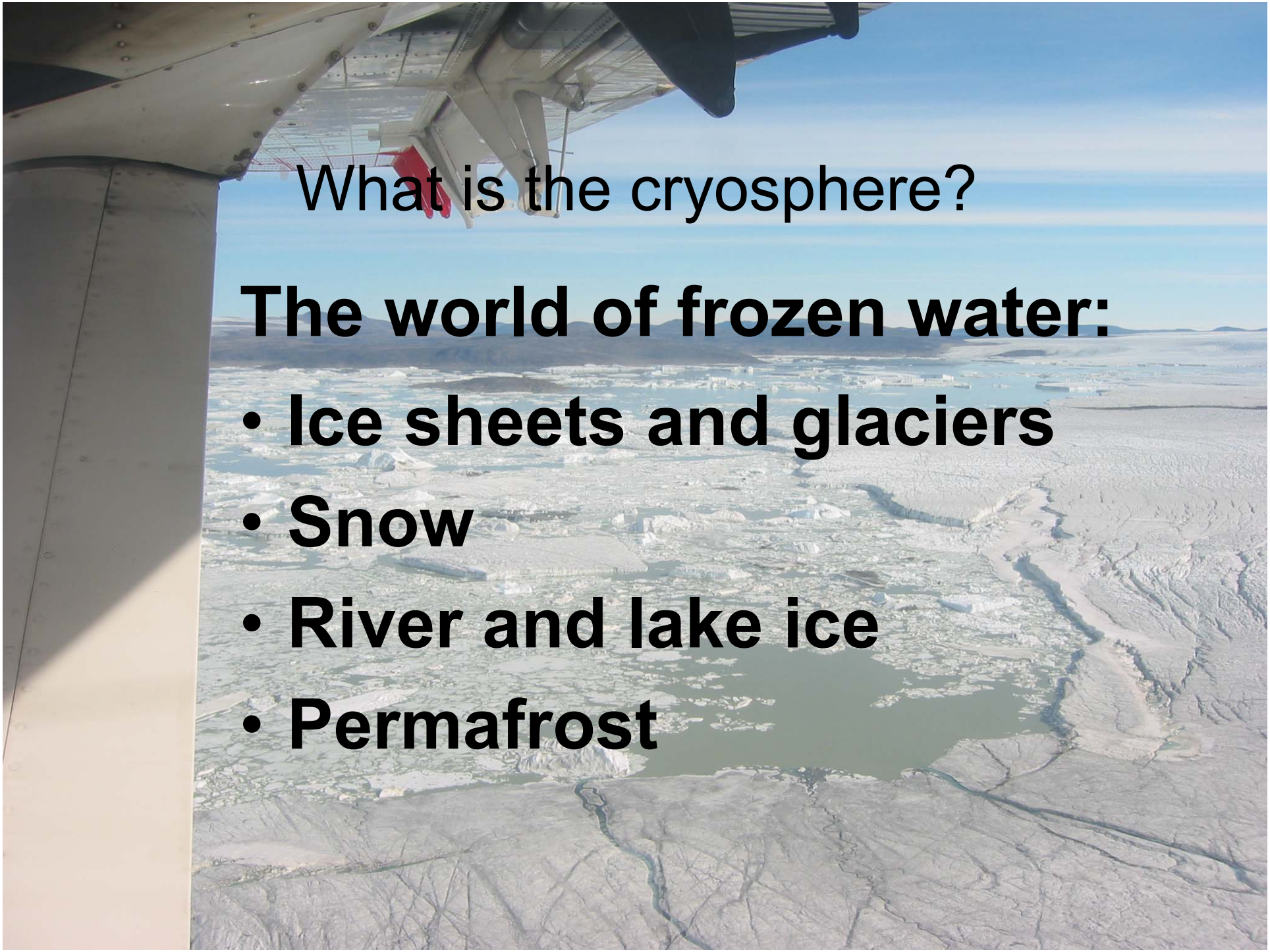
Large part of the presentation has been prepared by AMAP Secretariat

AMAP, IASC, IASSA, IPY, WCRP/CliC



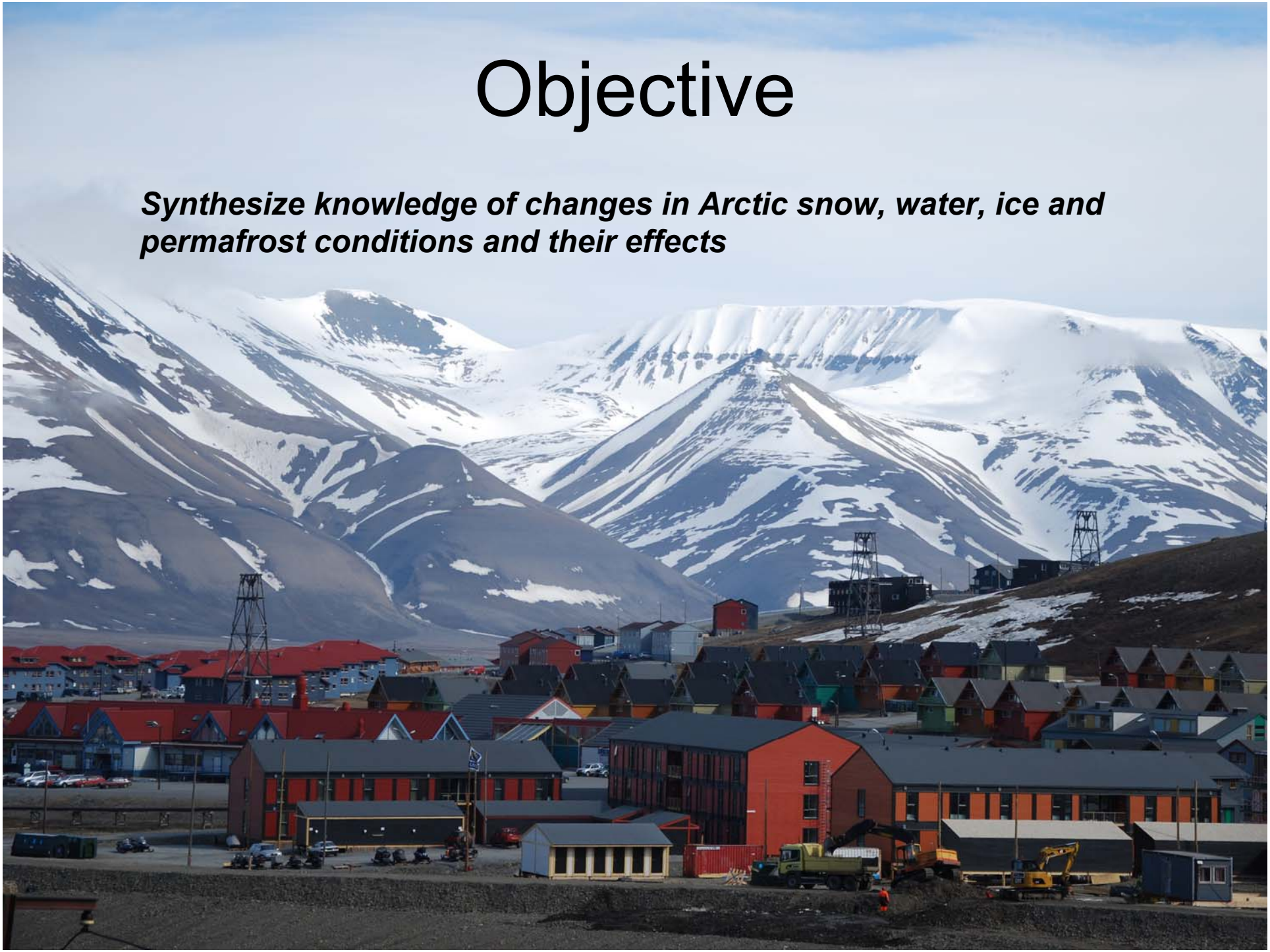
What is the cryosphere?

The world of frozen water:

- **Ice sheets and glaciers**
- **Snow**
- **River and lake ice**
- **Permafrost**

Objective

Synthesize knowledge of changes in Arctic snow, water, ice and permafrost conditions and their effects



SWIPA background

- Project focuses on changes in the Arctic cryosphere
- Benchmark is the 2005 ACIA report
- Assessment based on peer-reviewed science including IPY-results
- Approximately 200 scientists have contibuted Guided by an integration team (The SWIPA IT)
- The summary for policy makers was delivered at the Arctic Council Ministerial in Nuuk, May 12, 2011

Science Report

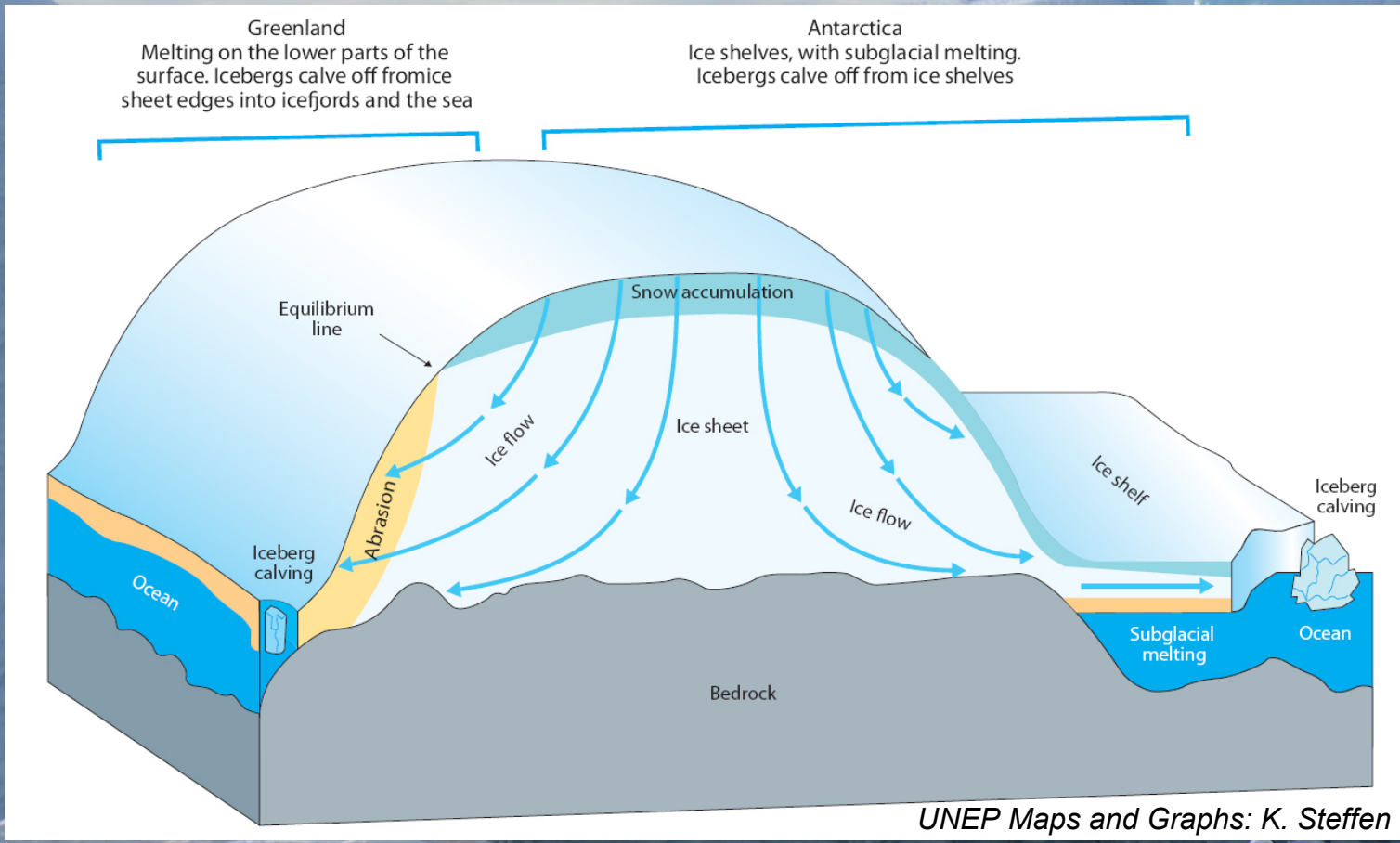
Past, present and future climate					
SEA ICE	GREENLAND ICE SHEET	MOUNTAIN GLACIERS	SNOW	PERMAFROST	RIVERS LAKES
The human dimension					
Feedbacks, sea level change, contaminants, ecology, knowledge gaps and needs.					

The Greenland Ice Sheet in a Warming Climate

Warming temperatures during past few decades has caused

- **Increased melting of surface of the ice sheet**
- **Increased flow of ice from the margins and discharge of icebergs from glaciers**
- **This dramatic loss has surprised scientists**

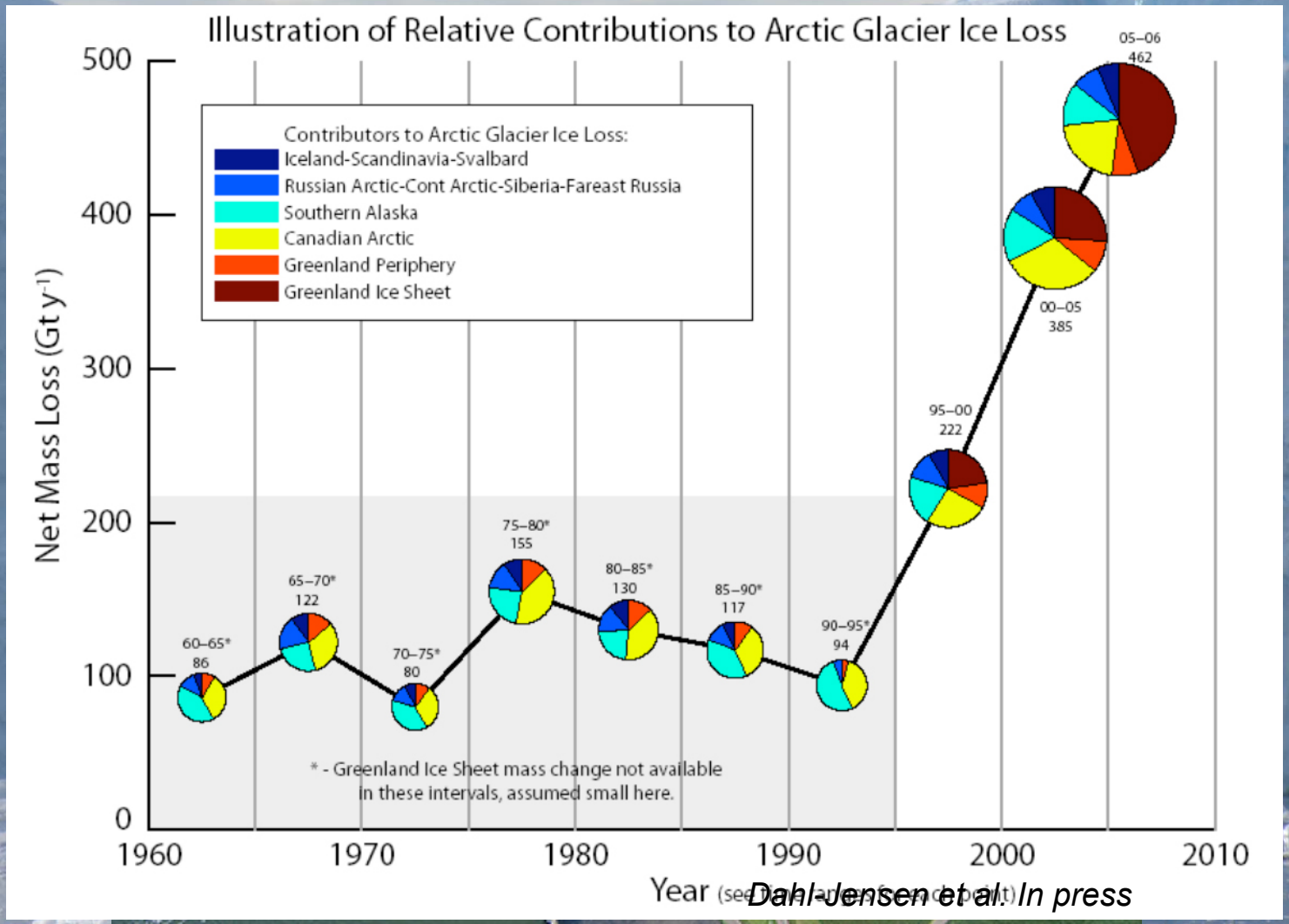
Greenland Ice Sheet



UNEP Maps and Graphs: K. Steffen

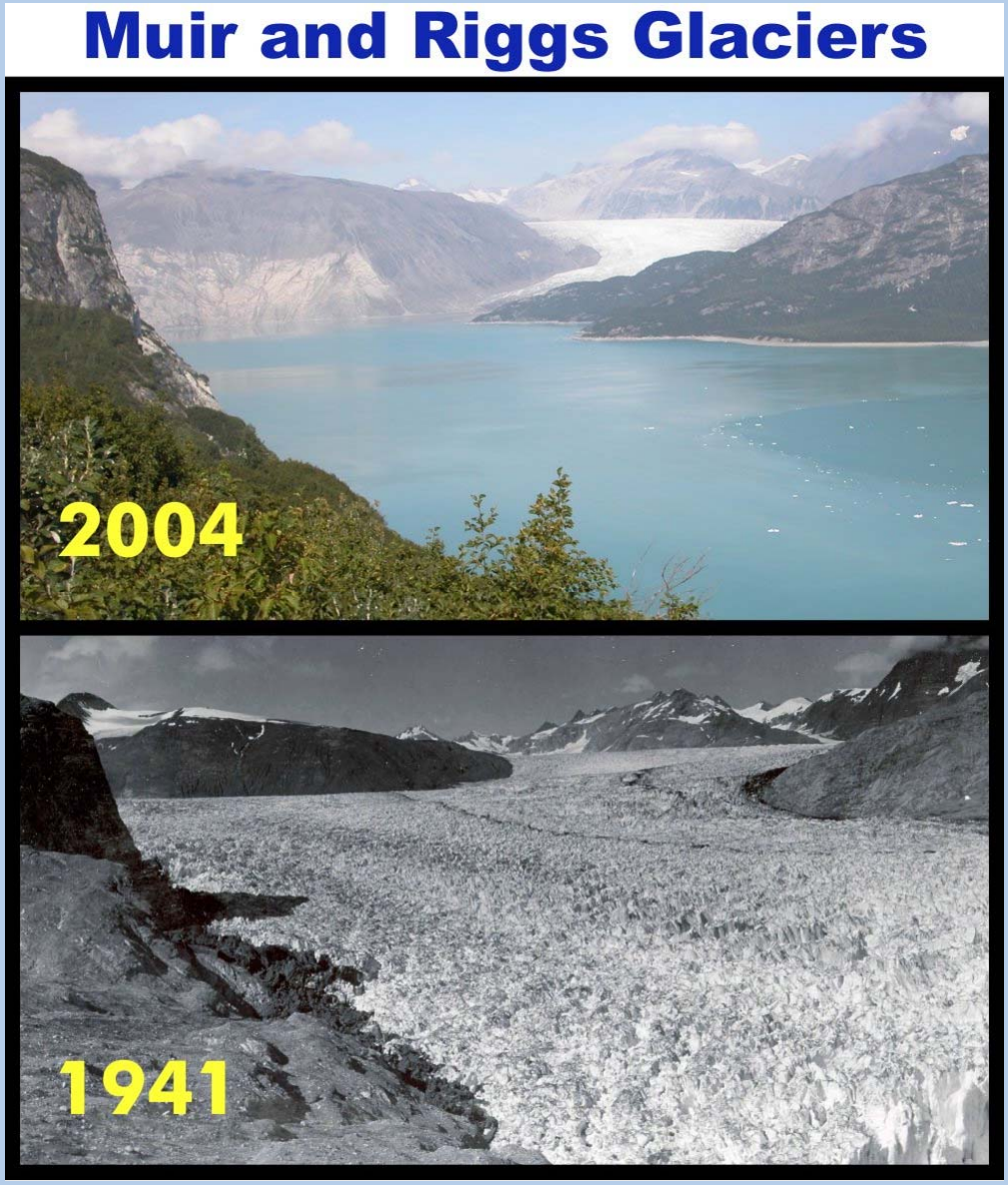
Mass loss has increased from 50 GT/yr (1995-2000) to 205 GT/yr (2005-2006)

Impacts of changes in the Greenland Ice Sheet



Dahl-Jensen et al. In press

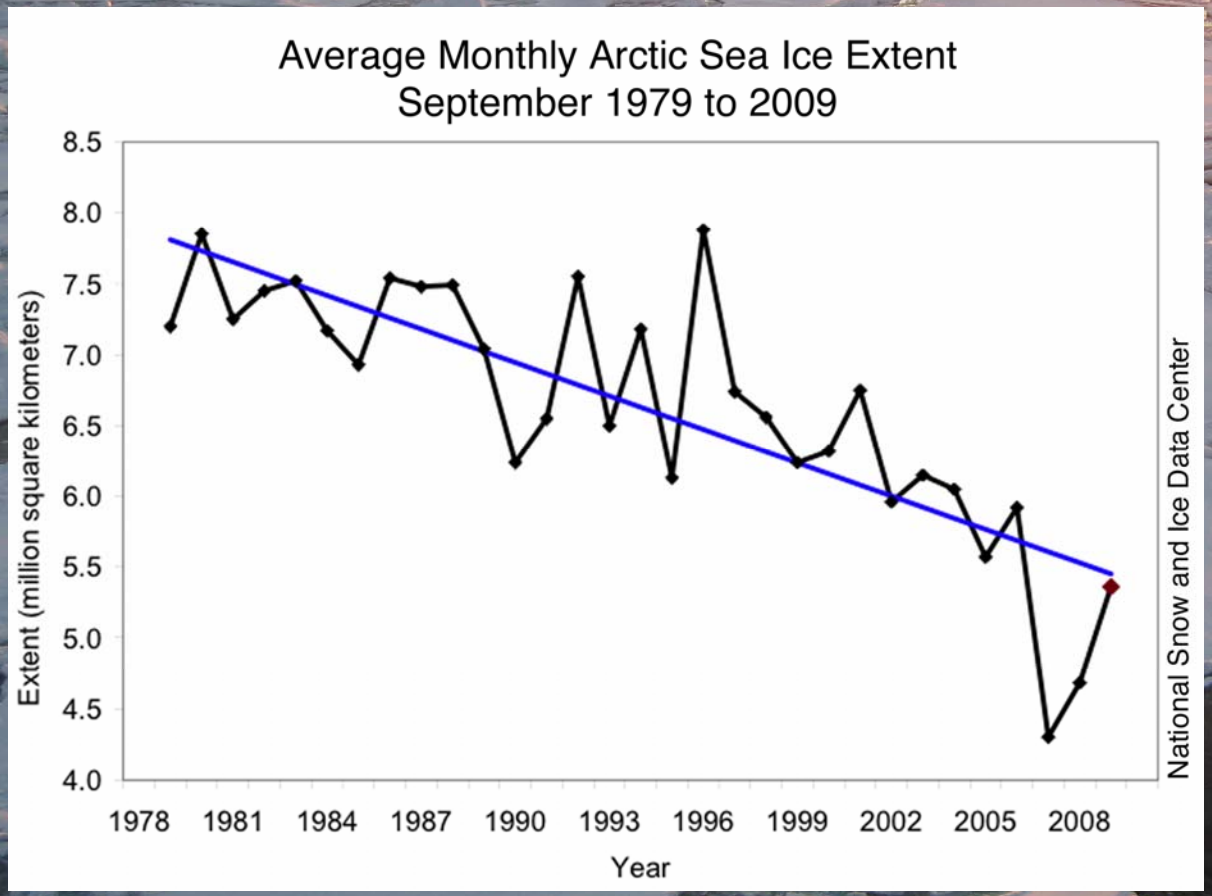
Ice caps and mountain glaciers

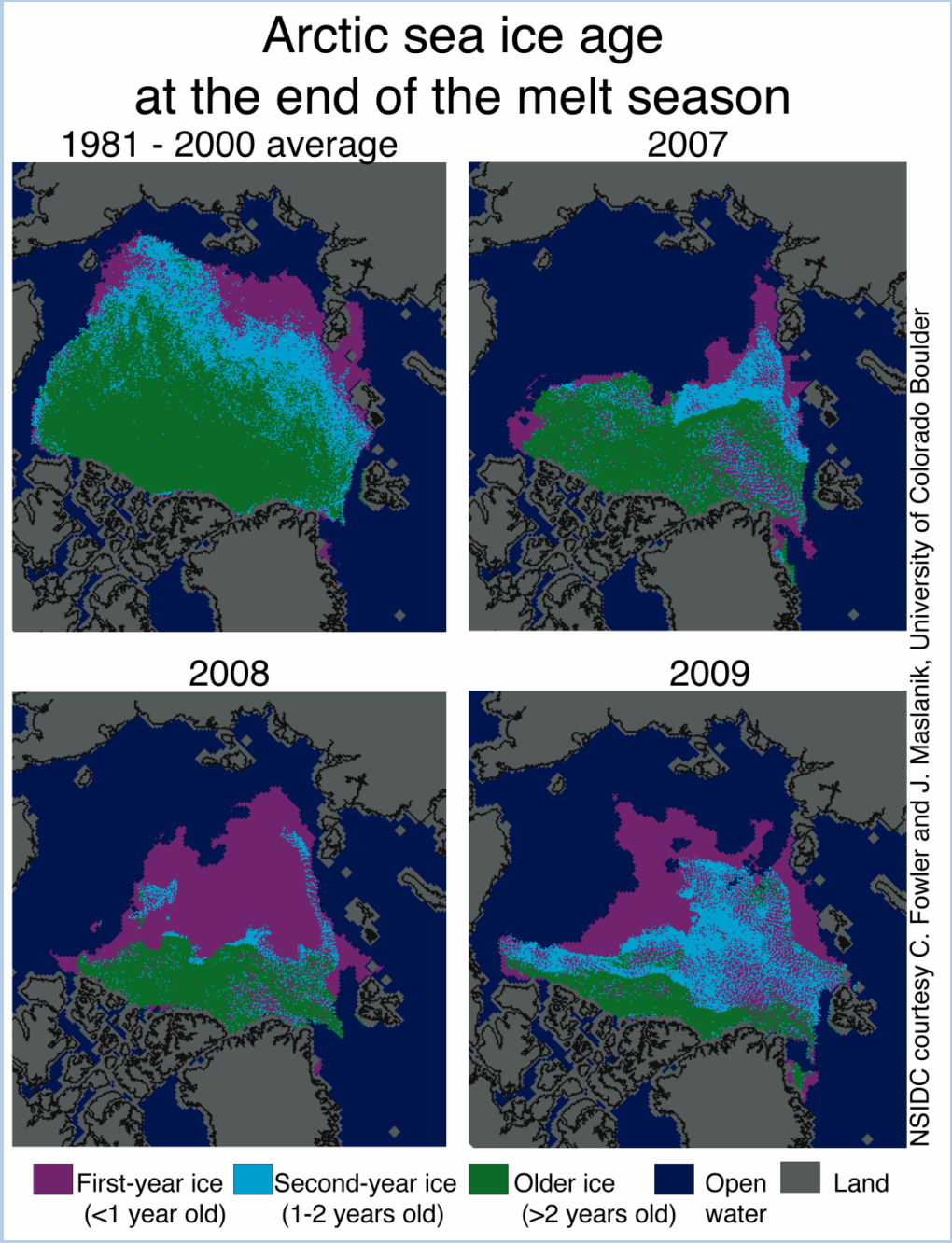


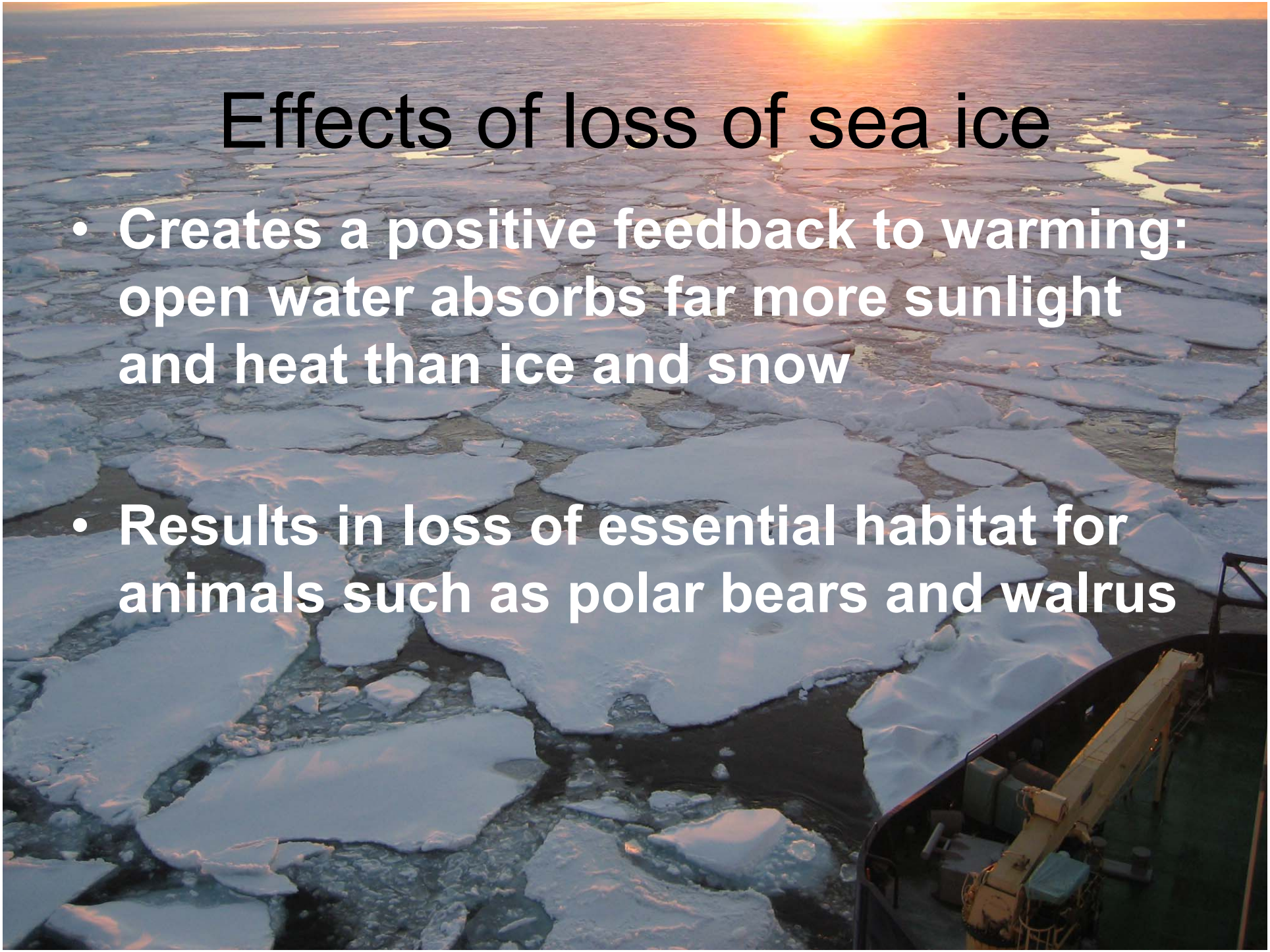
Changes in glaciers and ice caps

- Widespread reductions in glacier-covered areas in Arctic
- Rates of retreat have increased over past 15 to 20 years
- Russian mountain glaciers have lost from 17% to 50% of surface area in past 50 to 60 years
- Icebergs calved from Arctic glaciers can be serious hazard to navigation

Sea ice in the Arctic



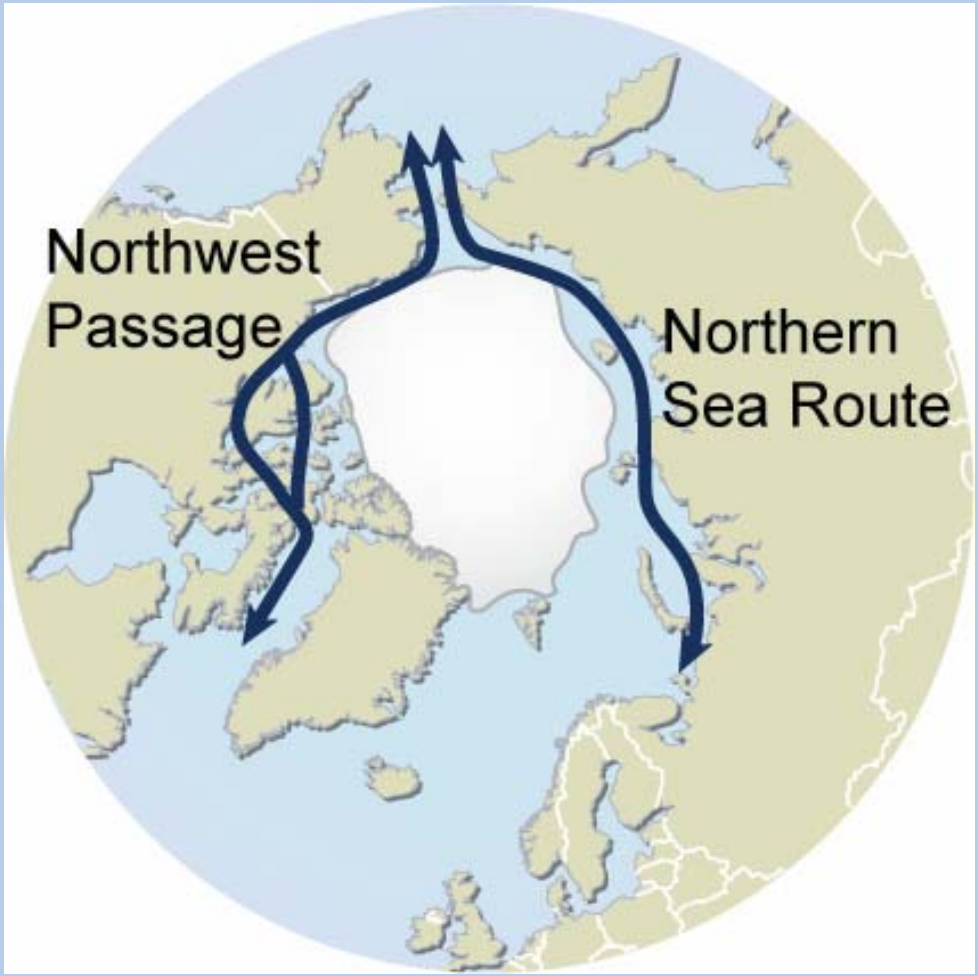

Arctic sea ice age
at the end of the melt season
1981 - 2000 average
2007
2008
2009
First-year ice
(<1 year old)
Second-year ice
(1-2 years old)
Older ice
(>2 years old)
Open
water
Land
NSIDC courtesy C. Fowler and J. Maslanik, University of Colorado Boulder



Effects of loss of sea ice

- **Creates a positive feedback to warming: open water absorbs far more sunlight and heat than ice and snow**
- **Results in loss of essential habitat for animals such as polar bears and walrus**

New sea routes



Lake and river ice

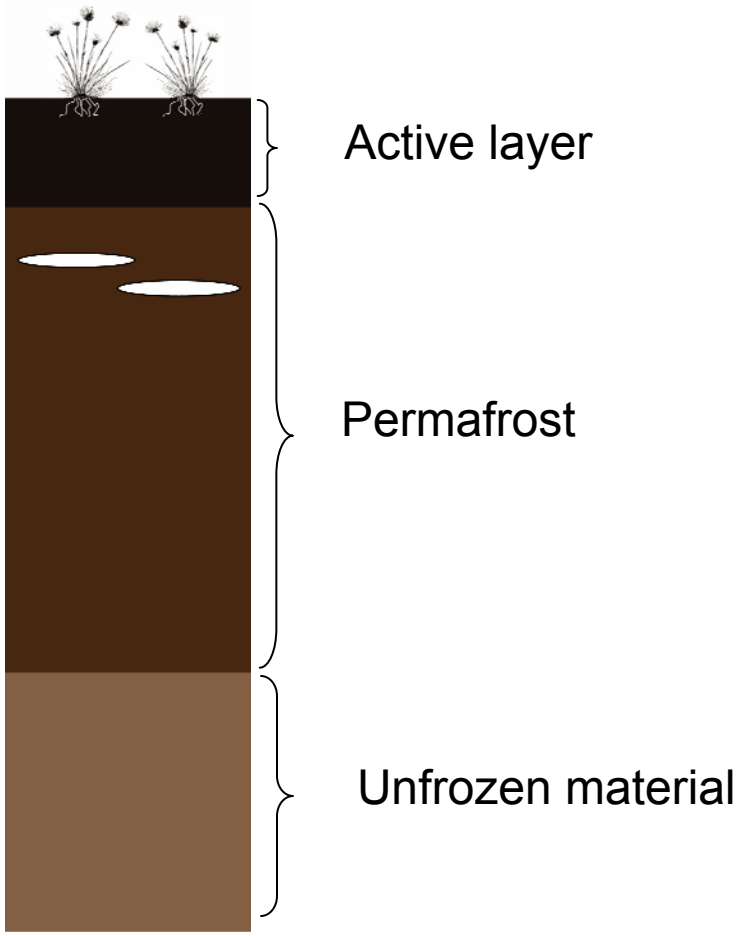
- Freshwater ice on lakes and rivers is dominant feature of Arctic
- Lakes covered by ice for 6 to 12 months a year
- Climate change resulting in earlier dates of ice break-up
- Some lakes in northern High Arctic are becoming ice-free in summer for first time

Impacts of changes in lake and river ice

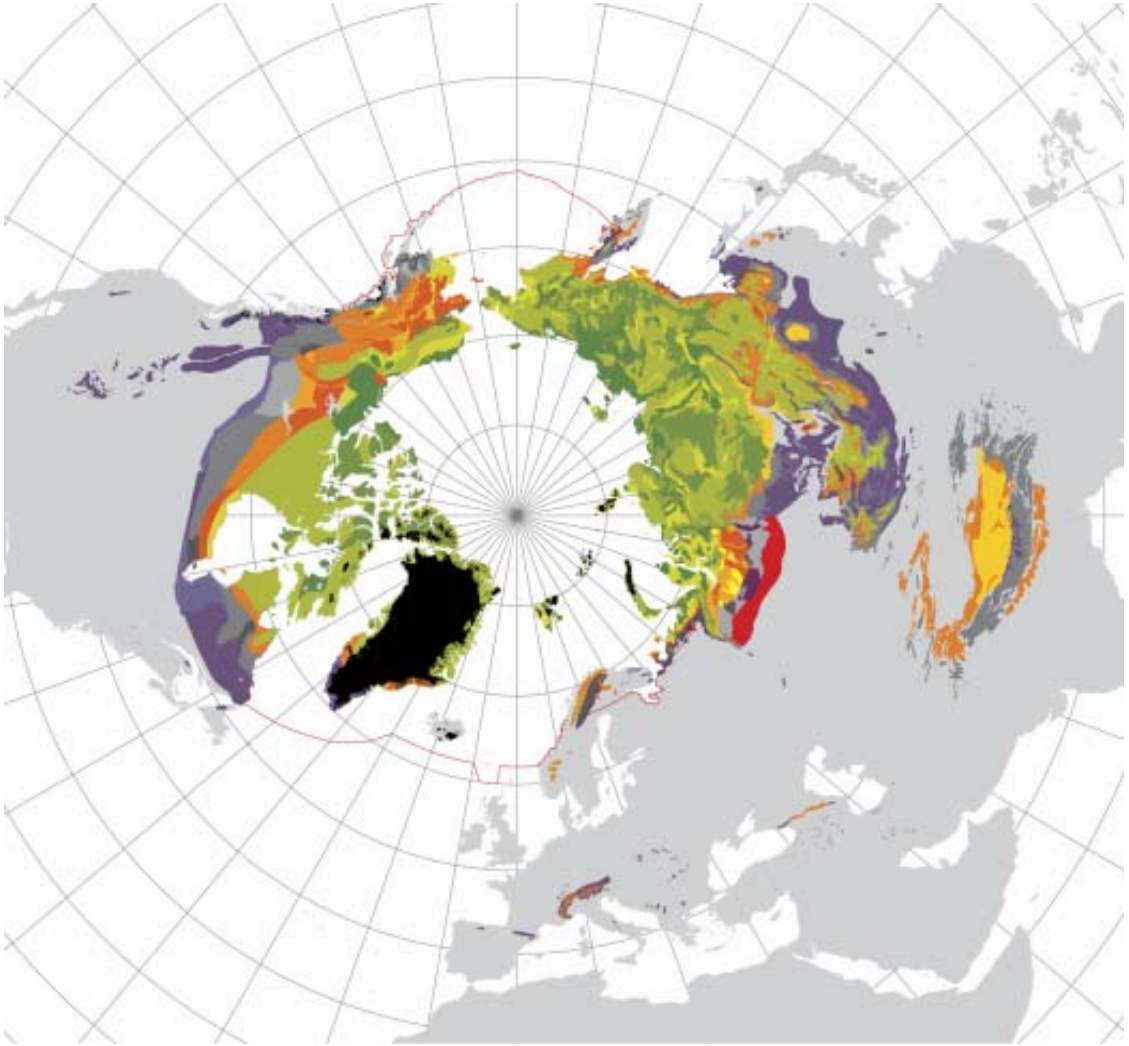
http://icetruckers.blogspot.com

Permafrost?!

= any material that stays at or below 0 °C for two or more consecutive years



Permafrost distribution in the Arctic



Map prepared by AMAP based on Brown et al., 1998

Permafrost distribution in the Arctic

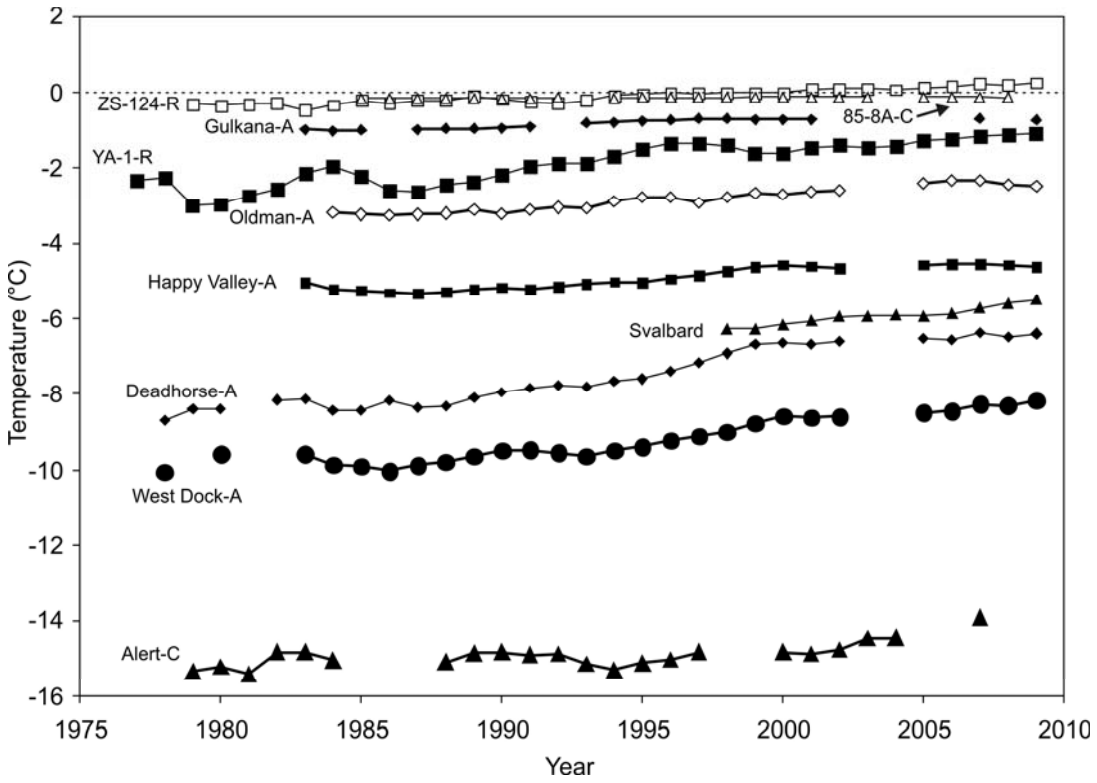
Map prepared by AMAP based on map drafted by Hugues Lantuit

Ground temperatures

Current trends

Future predictions

Why do we care?



Romanovsky et al., 2010

Warming typically between 0.5 to 2 °C