National Snow and Ice Data Center

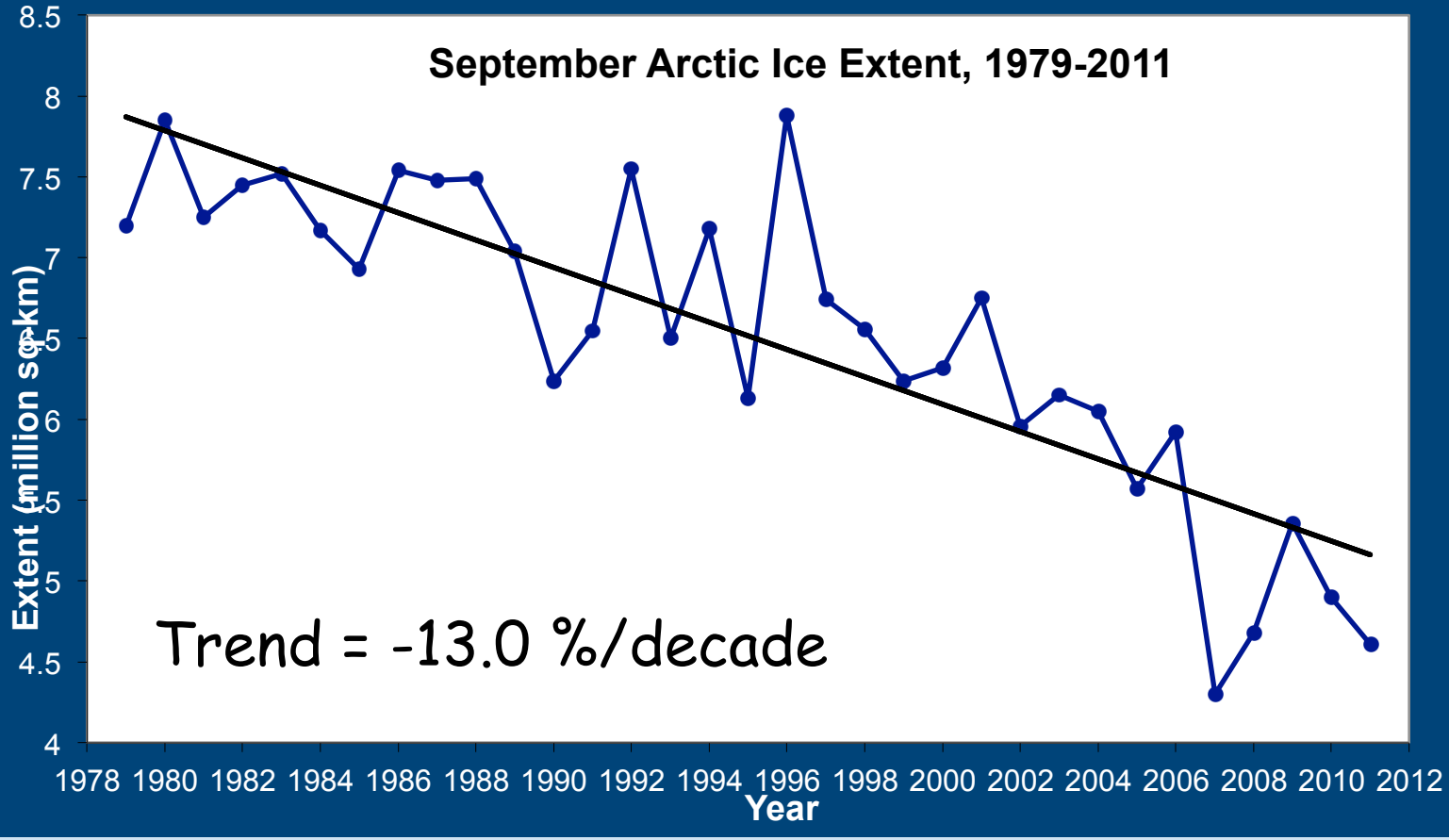
Supporting Cryospheric Research Since 1976

Consequences of an Ice-Diminished Arctic Ocean

Julienne Stroeve

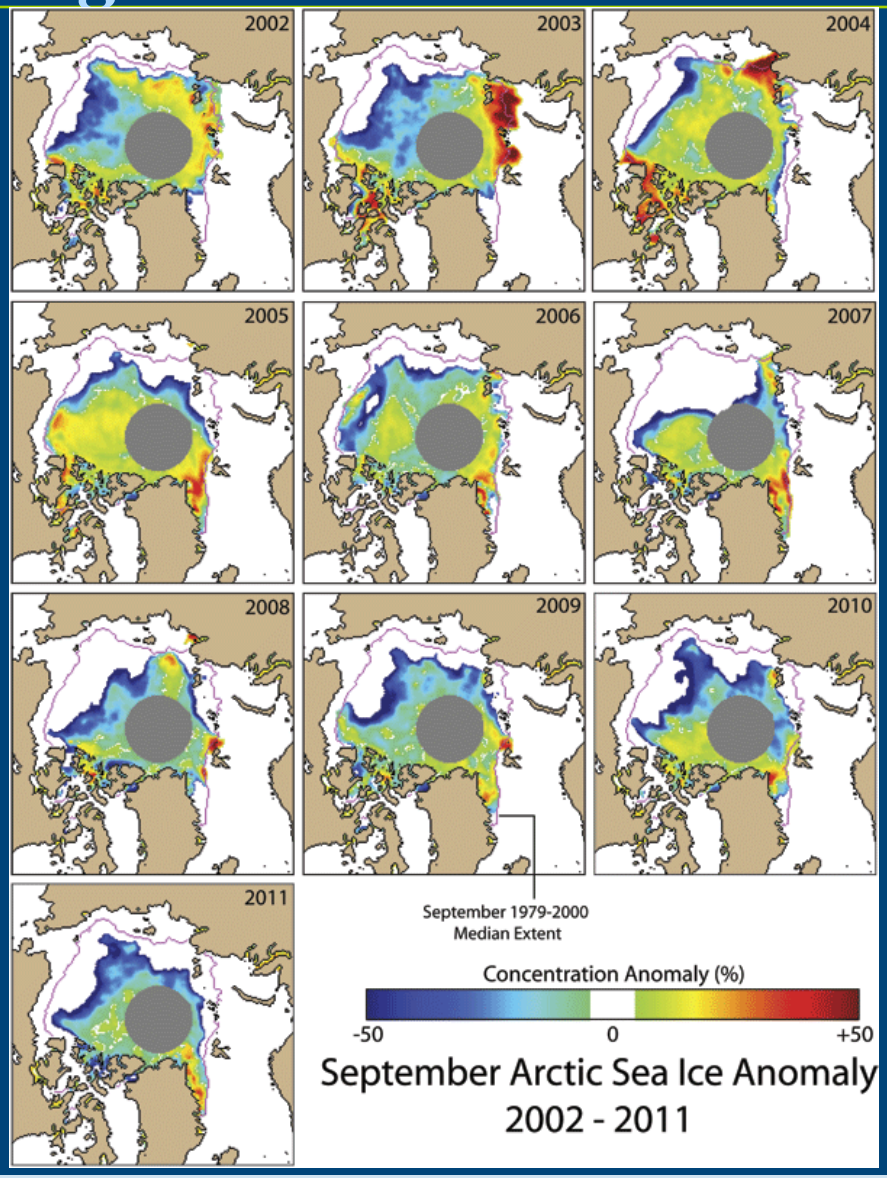
The Situation

- Passive microwave satellite observations have documented a 30-40% reduction in the end-of-summer ice cover since the late 1970s.



Data from NSIDC Sea Ice Index, Fetterer et al. 2002

Regional Ice Losses

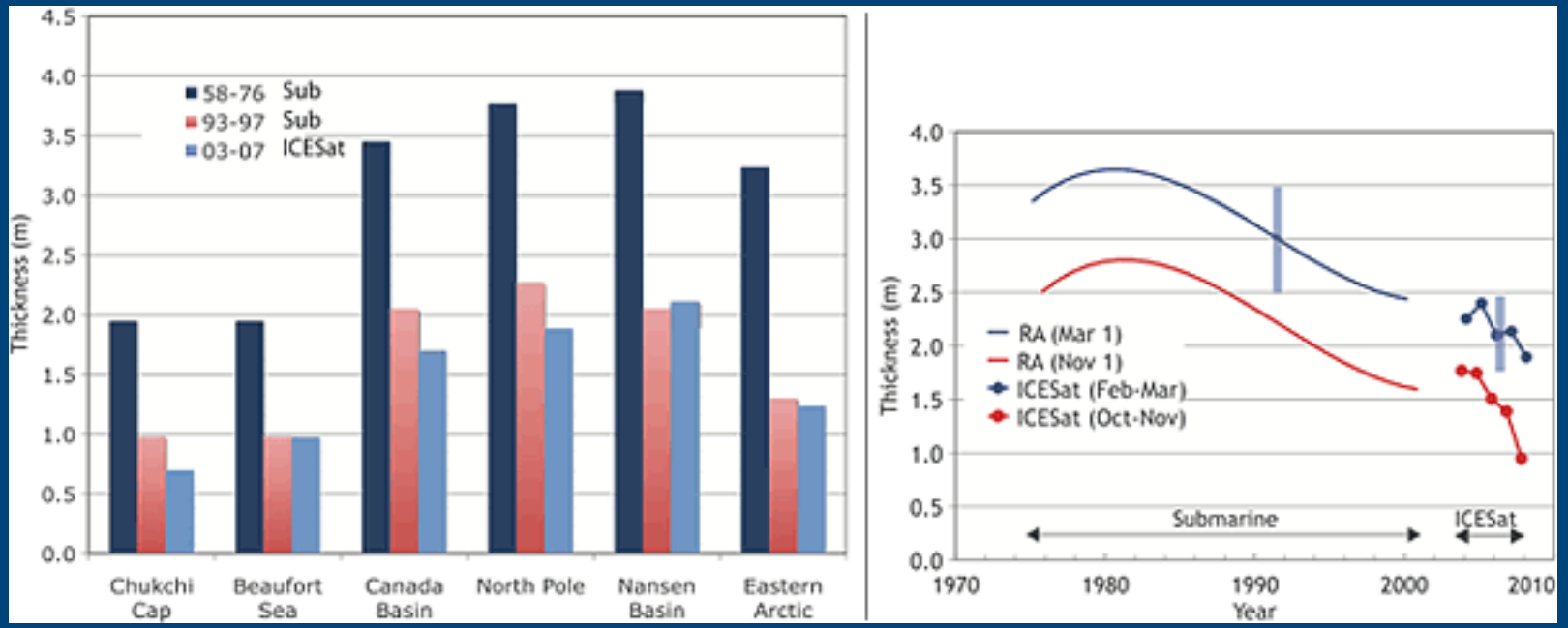


- The last decade has seen ice loss off both the Eurasian and North American coasts.
- Since 2007, either the NWP or the NSR has opened during summer, sometimes both.

Sea Ice Anomalies from the NASA Team Algorithm, Cavalier et al., 2003

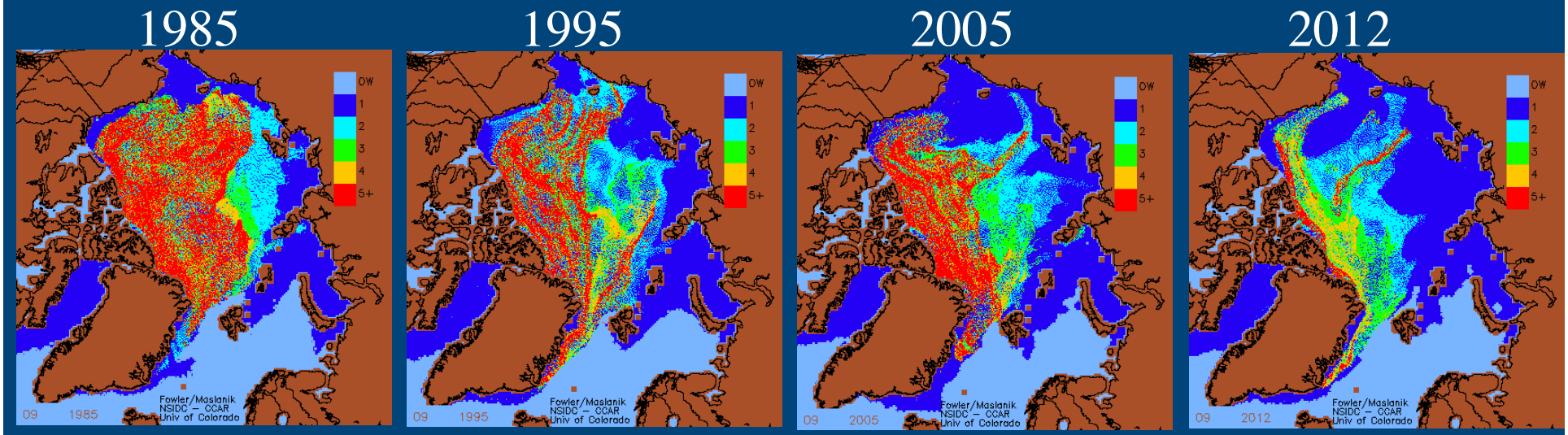
Ice Thickness has also Declined

- Thickness observations from submarine records and satellite altimetry show thinning ice cover.

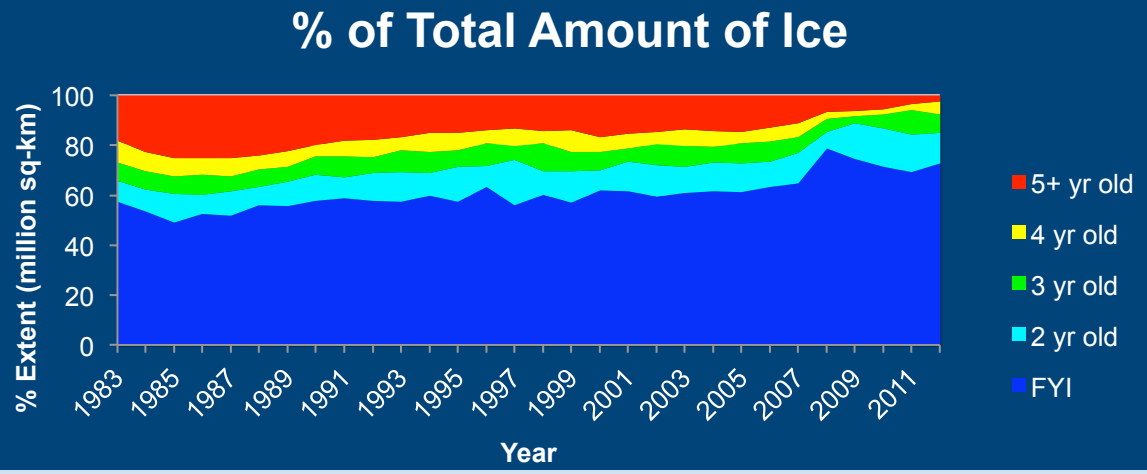


Graphs from Kwok and Rothrock, 2009

Thinner Ice is Reflected in a Younger Ice Cover



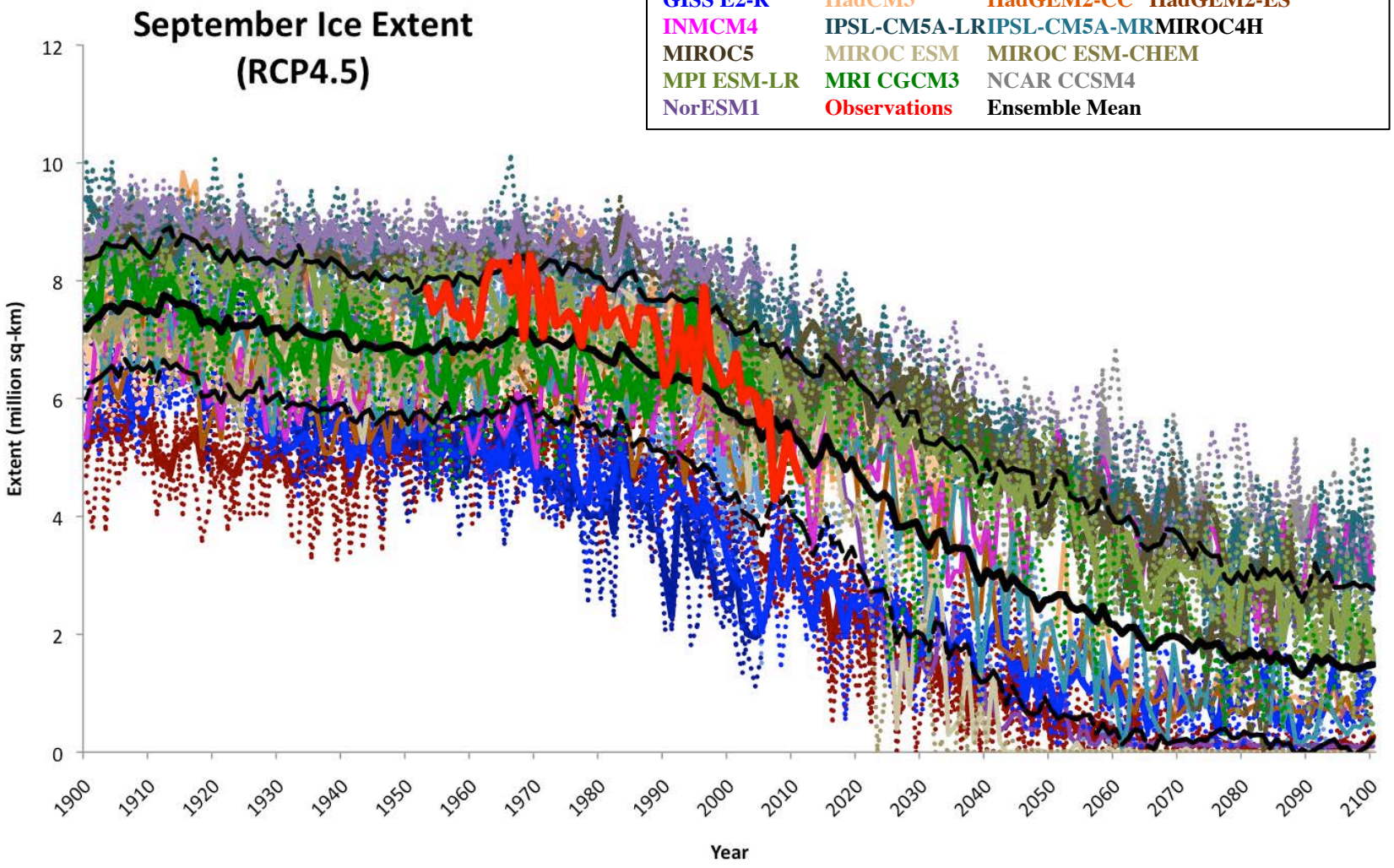
Ice Age for week 9 (Feb 27 to Mar 4)



In 2012, less than 3% of the ice cover is 5 years or older

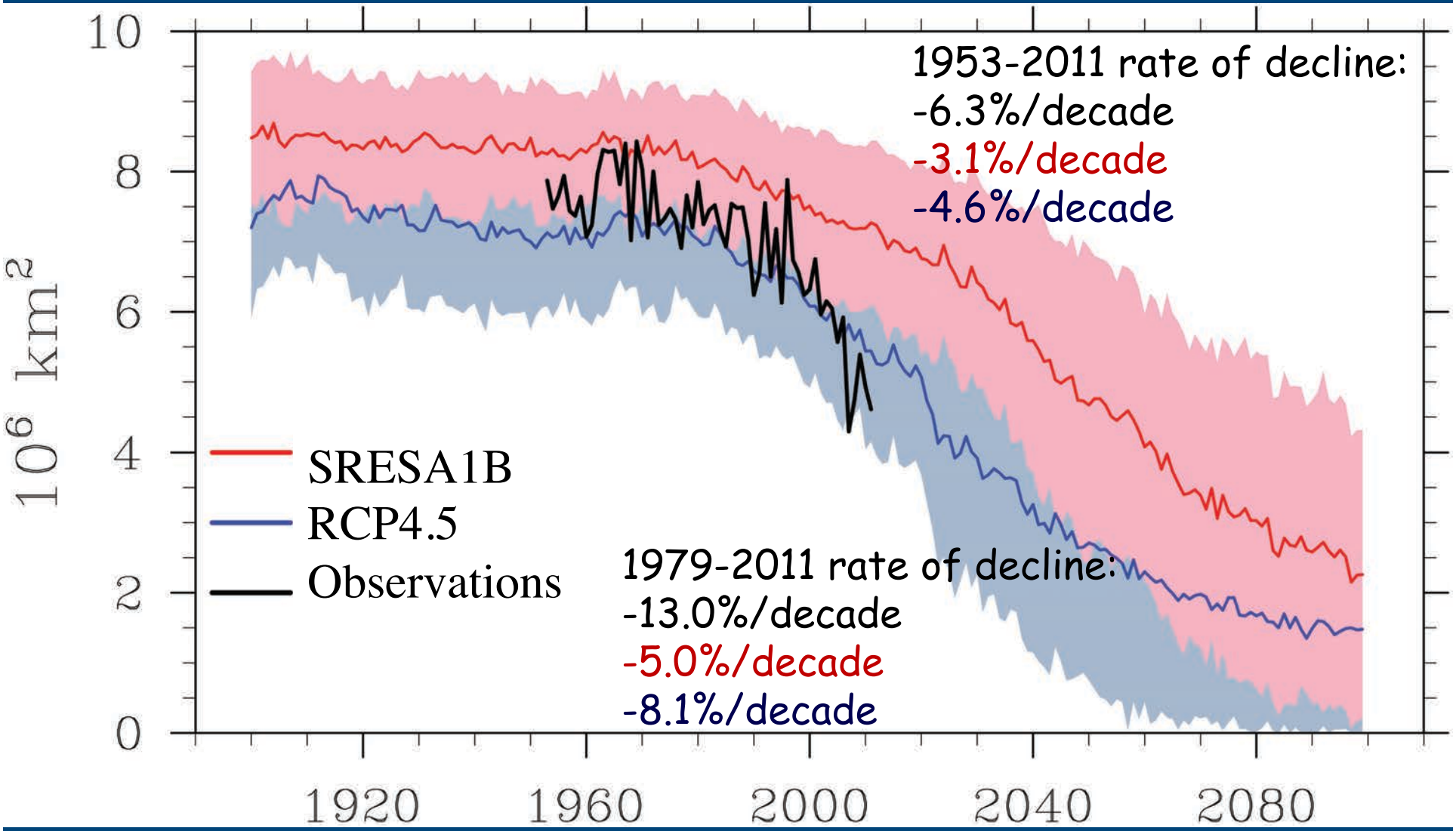
Data from Maslanik, Fowler and Tschudi

Future Projections from CMIP5



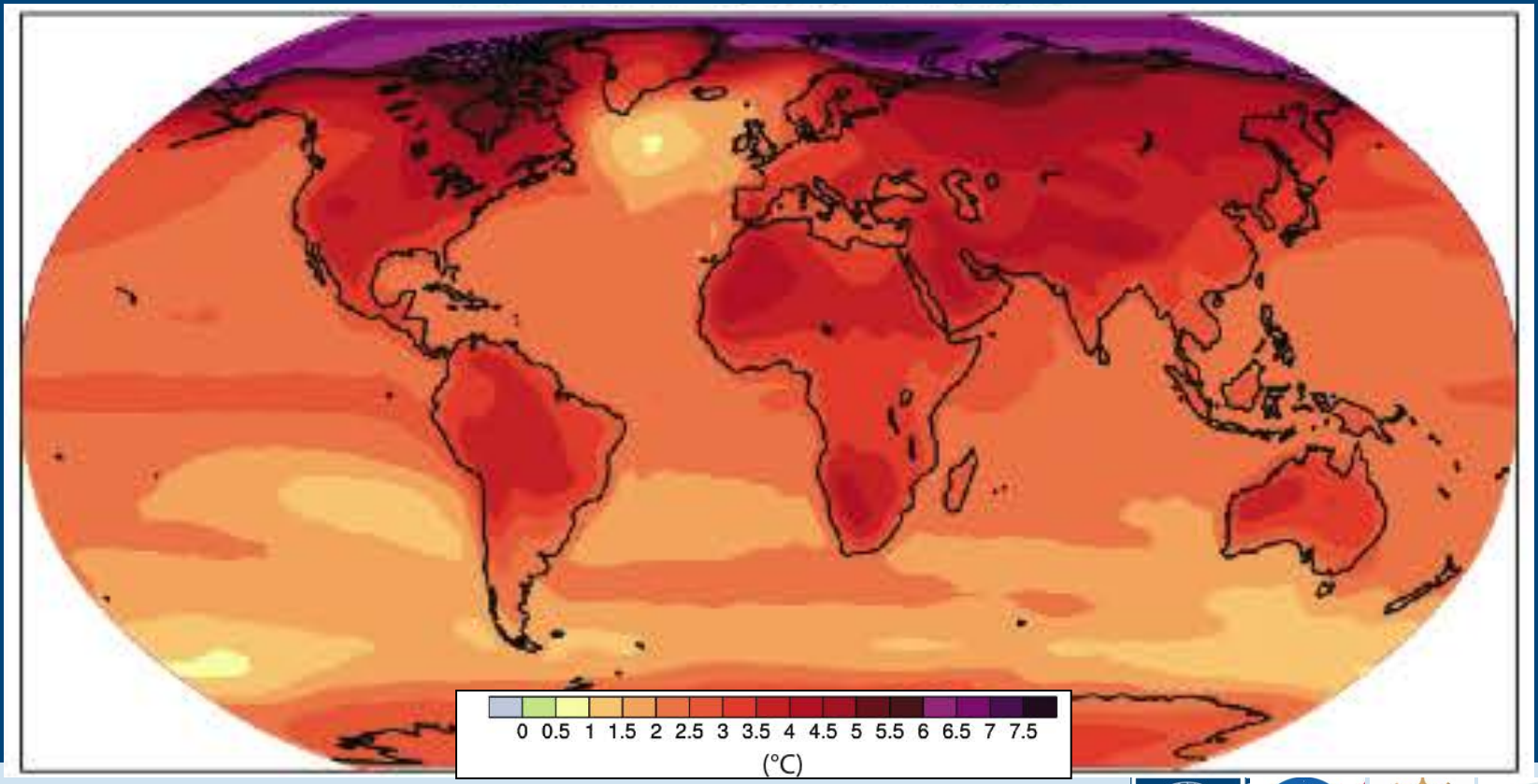
CMIP5 models versus observations

September Ice Extent: CMIP5 vs CMIP3



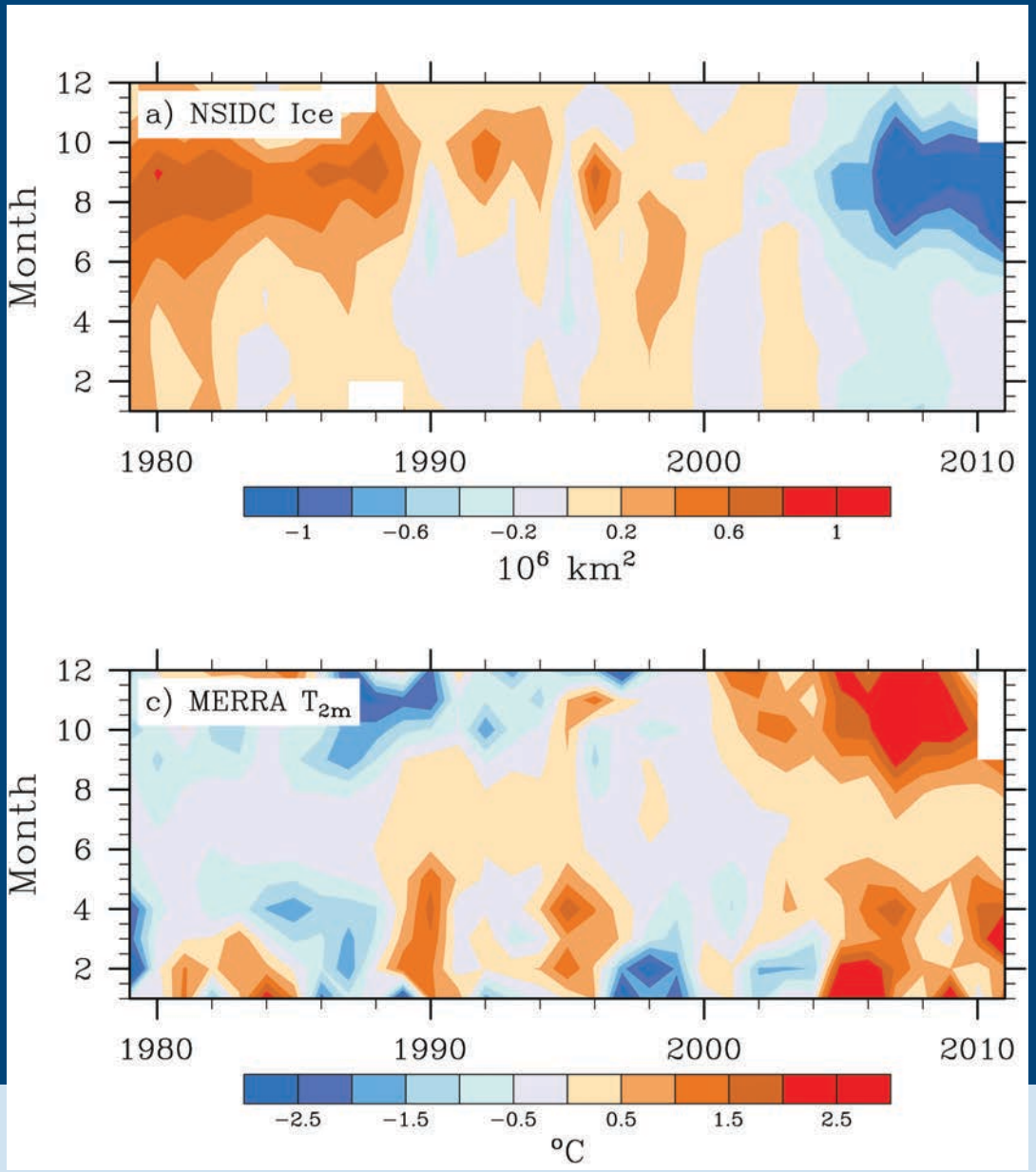
Climate Impacts of Reduced Sea Ice Cover

- Arctic Amplification has been a common feature of climate model predictions.
- Large fluxes of heat and moisture during fall/winter from loss of sea ice contribute to amplified warming in the Arctic.



IPCC-AR4 Ensemble Mean, A1B Scenario, courtesy M. Holland

Recent Sea Ice Loss has Warmed the Atmosphere



- Arctic Basin sea ice and T_m air temperature anomalies
- Warming most pronounced during autumn.

Impacts on Autumn Precipitable Water

Anomalies in SON precipitable water during low/high ice years

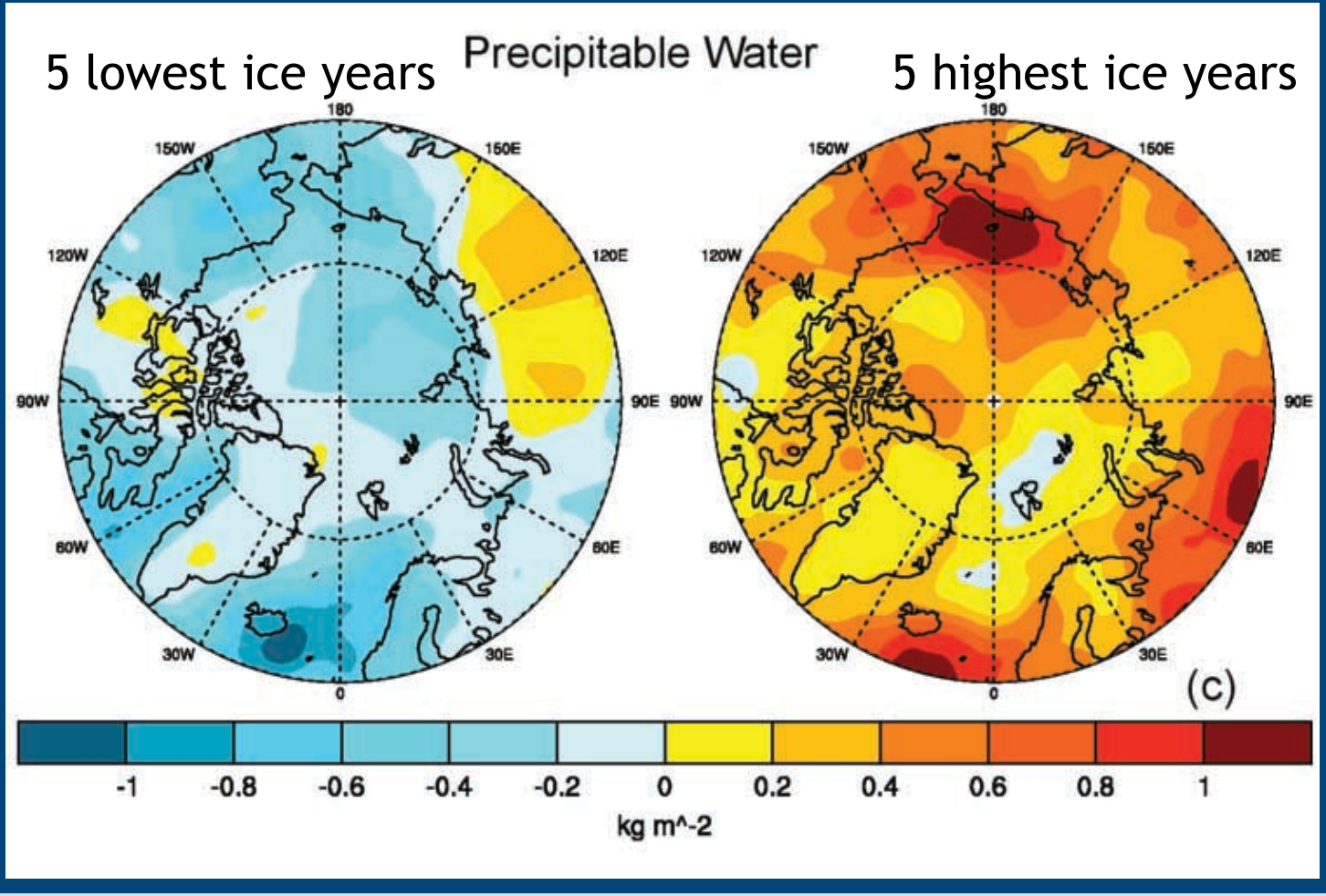
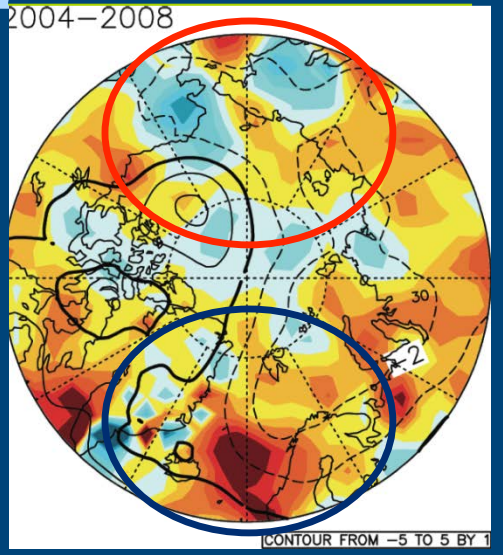


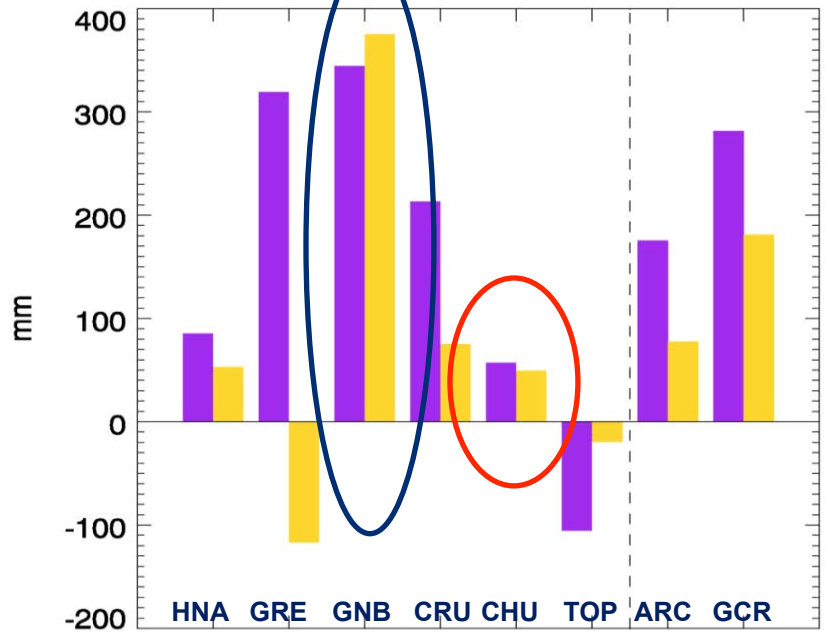
Figure from Stroeve et al., 2011

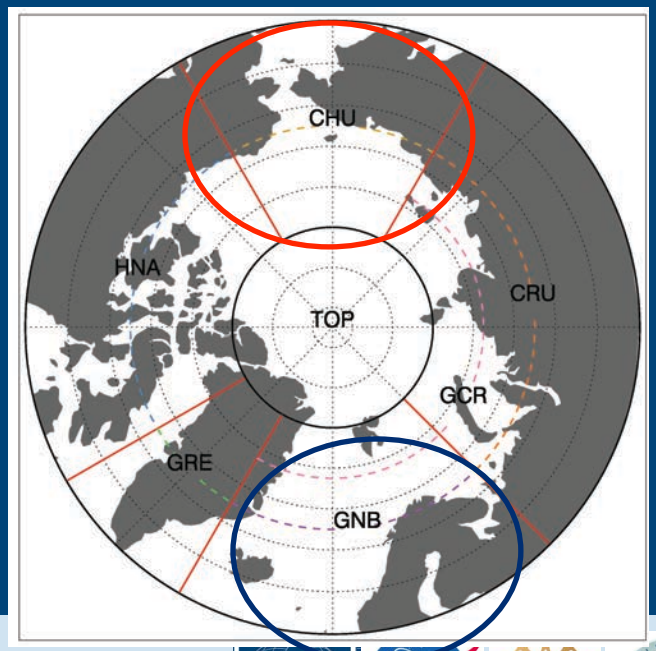
Impacts on Cyclone Associated Precipitation

- While positive precipitable water anomalies occur where ice has retreated, CAP anomalies dominate GNB region.



Change in Total SON CAP due to a change in event mean output or event frequency (2004-2008) – (1999-2003)





Figures from Stroeve et al., 2011

Coastal Communities are Threatened

- Lack of sea ice exposes shoreline communities to waves and storms that are creating severe erosion problems.

Upper right photo credit: Craig George

Impacts on Marine Activity

Hard Minerals

Maritime Tourism

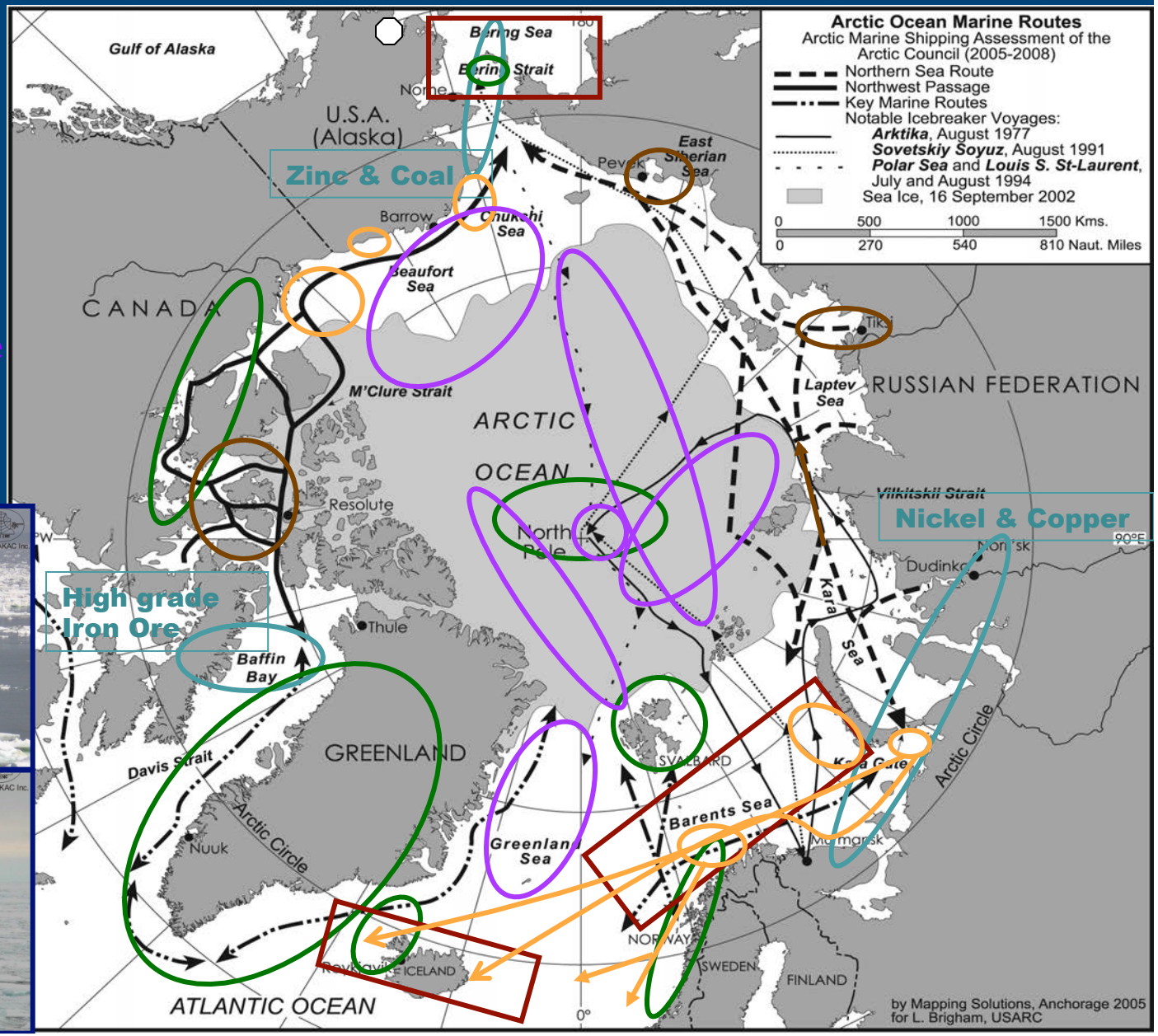
Major Fisheries

Oil and Gas

Summer Sea Lift

Exploration/Science

In 2004, ~6,000 ships



Summary Statements

- Sea ice thickness and extent has declined during the 2nd half of the 20th century/early 21st century.
- Models simulate continuing retreat of the ice cover and summer ice-free conditions as early as 2050.
- Climate impacts are already being felt.
- Increased development of Arctic natural resources (hydrocarbons, hard minerals, fisheries) will increase marine activity and risk of oil spills.

Observational Needs

- Accessibility and interoperability of products, through consistent formatting and metadata and/or easy to use freeware tools.
- Need for climate data records.
- For satellites, continuity is critical. This includes not only the PM record, but also VIS/IR, SAR, Scatterometer, and altimetry.
- For *in situ*, ice mass buoys (including FYI), cameras, sensors that conduct staring-mode observations of change.