

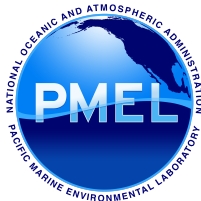


PMEL

Pacific Marine Environmental Laboratory

Arctic Climate Dynamics

James Overland





PMEL Arctic Project

- Climate Dynamics- Wang, Wood, Bond, Soreide
- Carbon Chemistry- Mathis, Evans, Cross
- Pacific Ecosystems- Stabeno, Moore, Mordy



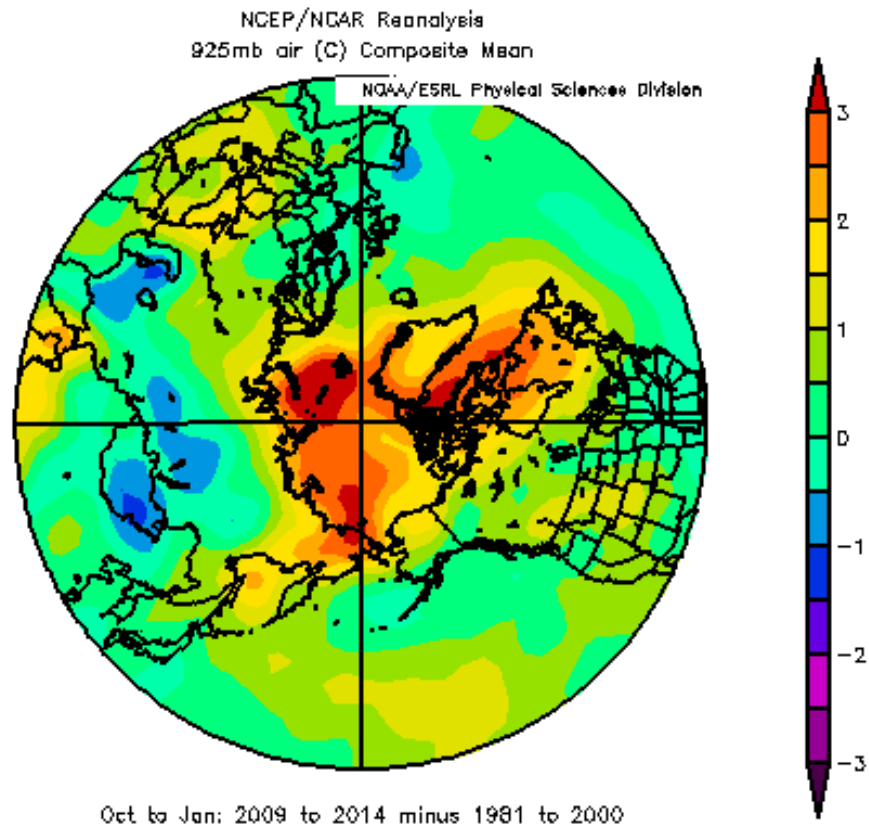
Background

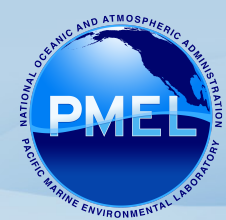
Arctic Change is happening faster than in other regions of the globe (Arctic Amplification)

**Arctic is a Science Grand Challenge for NOAA
(NOAA Arctic Vision and Strategy Document and others)**

Our Goal: Maintain an up-to-date Arctic climate change detection activity for NOAA that includes **improved understanding** and **communication** of Arctic climate variability and trends.

Arctic (temperature) Amplification: 3X Mid-latitudes





Relevance

Contributed to writing of the **NOAA Arctic Vision and Strategy Plan**

Part of the NOAA Arctic Task Force

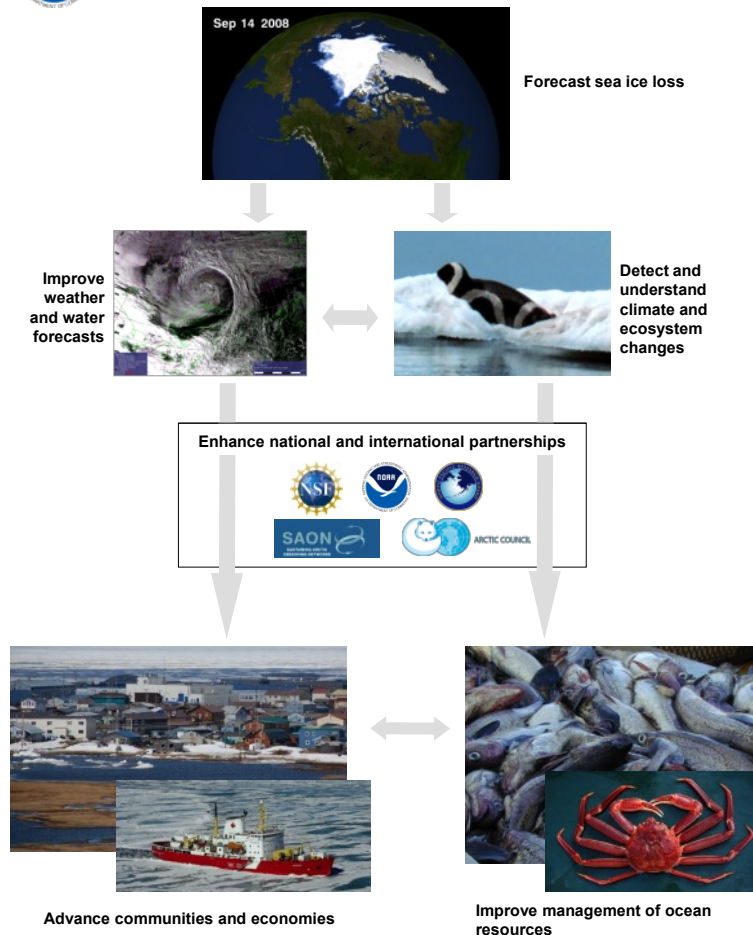
Pro-Active: Symposia and Workshops on Arctic Amplification and Linkages

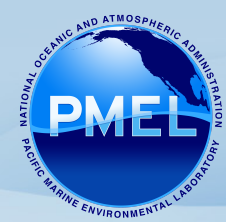
Collaborates Internationally:
U. Alaska, Rutgers, U. Sheffield,
KOPRI (Korea)

Diversified Funding Sources: CPO, ONR, BOEM



NOAA's Six Strategic Goals for the Arctic





Performance

Lead and contributing authors to the **5th IPCC Assessment Report**, Chapter 10 on Detection and Attribution of Climate Change, Cryosphere

Provided climate and sea ice projections to the Arctic Monitoring and Assessment Program (AMAP) of the Arctic Council (the SWIPA Report)

Contributed to the Integrated Arctic Management Report to the President
US Navy 2014 Arctic Roadmap
National Earth System Prediction Capability (ESPC)

US government responses to the **Endangered Species Act** and Marine Mammal Commission

Arctic Reportcard



Arctic Climate Dynamics

- 1. Arctic Reportcard**
- 2. Serve on the NOAA Arctic Task Force**
- 3. Arctic Rediscovery Project**
- 4. Seasonal & Decadal Sea Ice Projections**
- 5. Arctic and mid-latitude linkages**

Arctic Report Card: Update for 2013

Tracking recent environmental changes

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HOME
Executive Summary

ATMOSPHERE

Air Temperature
Clouds & Surface Radiation
Ozone
UV Radiation
Black Carbon

SEA ICE & OCEAN

Sea Ice
Ocean Temperature & Salinity

MARINE ECOSYSTEMS

Sea Ice Biota
Marine Fishes
Benthic Communities

TERRESTRIAL ECOSYSTEMS

Vegetation
Muskoxen
Caribou & Reindeer

TERRESTRIAL CRYOSPHERE

Snow
Glaciers & Ice Caps
Greenland Ice Sheet
Lake Ice
Permafrost

What's new in 2013?

There were fewer snow and ice extremes than in 2012. Many regions and components of the Arctic environment were closer to their long-term averages, but the effects of a persistent warming trend that began over 30 years ago remain clearly evident.

The impacts of the warming climate on the physical environment during those 30 years are influencing Arctic ecosystems on the land and in the sea.



Highlights

Summer surface air temperatures were particularly low across the central Arctic Ocean, northern Canada and Greenland relative to 2007-2012 (a period of pronounced summer sea ice retreat), and were somewhat lower than the long-term average of 1981-2010.

Snow extent in May 2013 reached a new record low in Eurasia, while Northern Hemisphere-wide snow extent was below average for spring (April, May, June).

Minimum sea ice extent in September 2013 exceeded the record low of 2012, but was the 6th lowest since observations began in 1979 despite the relatively cool summer of 2013. The seven lowest minimum ice extents have occurred in the last seven years, 2007-2013.

Arctic tundra vegetation greenness (a measure of productivity) and growing season length have continued to increase since observations began in 1982.

Large land mammals convey a mixed message, with muskox numbers stable/increasing since the 1970s, while many caribou and reindeer herds currently have unusually low populations for the period 1970-2013.

Changes in fish and bottom dwelling organisms include continued northward migration of species not previously seen in the Arctic.

[NOAA Press Release & Press Conference Statement \(PDF\)](#)

[Graphics and visuals are available here as PDF and PPT](#)
[Visual Highlights from Climate.gov](#)



NOAA designated as “Influential Scientific Information (ISI)”.

147 authors from 14 countries

NOAA Cross-Line Office Response to Shell 2012 Sea Ice Season Request



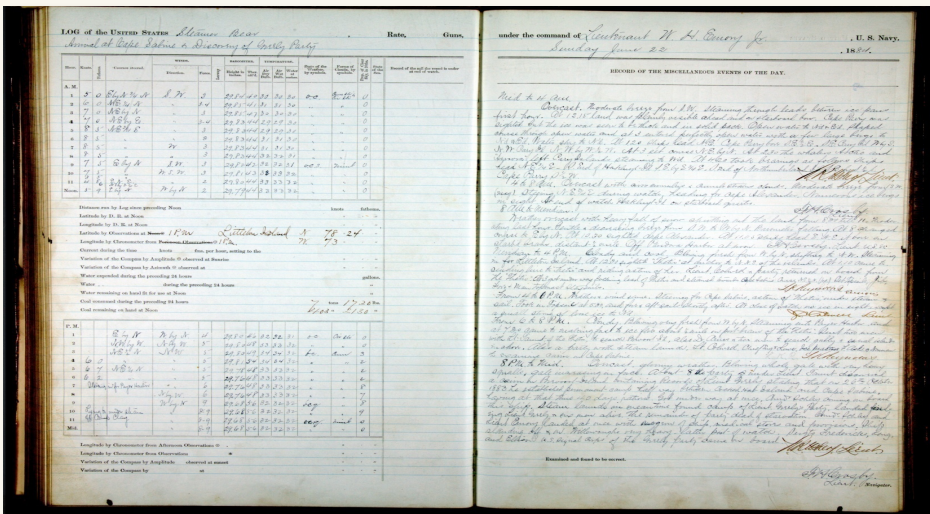
No Data	1-3 Tenths
Sea Ice Free	3-6 Tenths
Open Water	7-10 Tenths

Years	June	July	August	September	October	November	December
2011							17
2010						1	
2009							20
2008						7	
2007						9	
2006							20
2005							18
2004						8	
2003							17
2002							14
2001						8	
2000						23	
1999						24	
1998							21
1997							1
1996						15	
1995						27	
1994						7	
1993							19
1992							13
1991						18	
1990							15

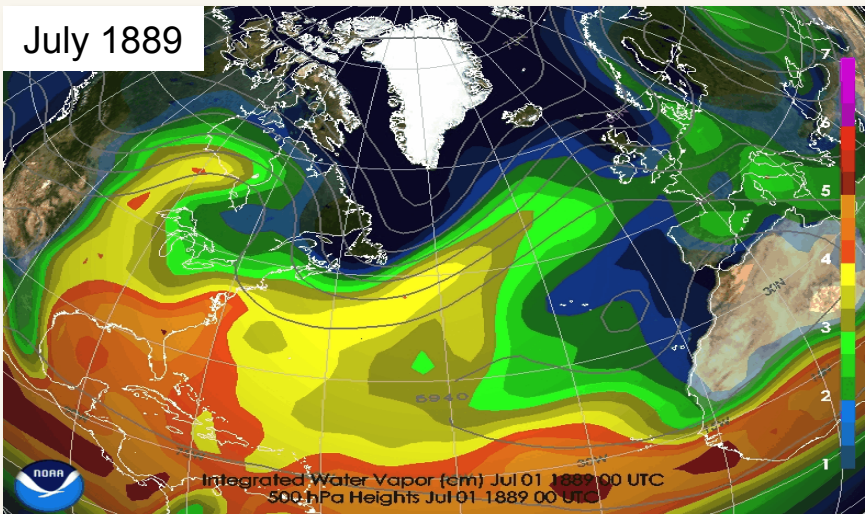
Old Weather

Arctic

Our Weather's Past, the Climate's Future



Original logbook of the USS *Bear*, 1884. NOAA-NARA Joint Imaging Project – Old Weather



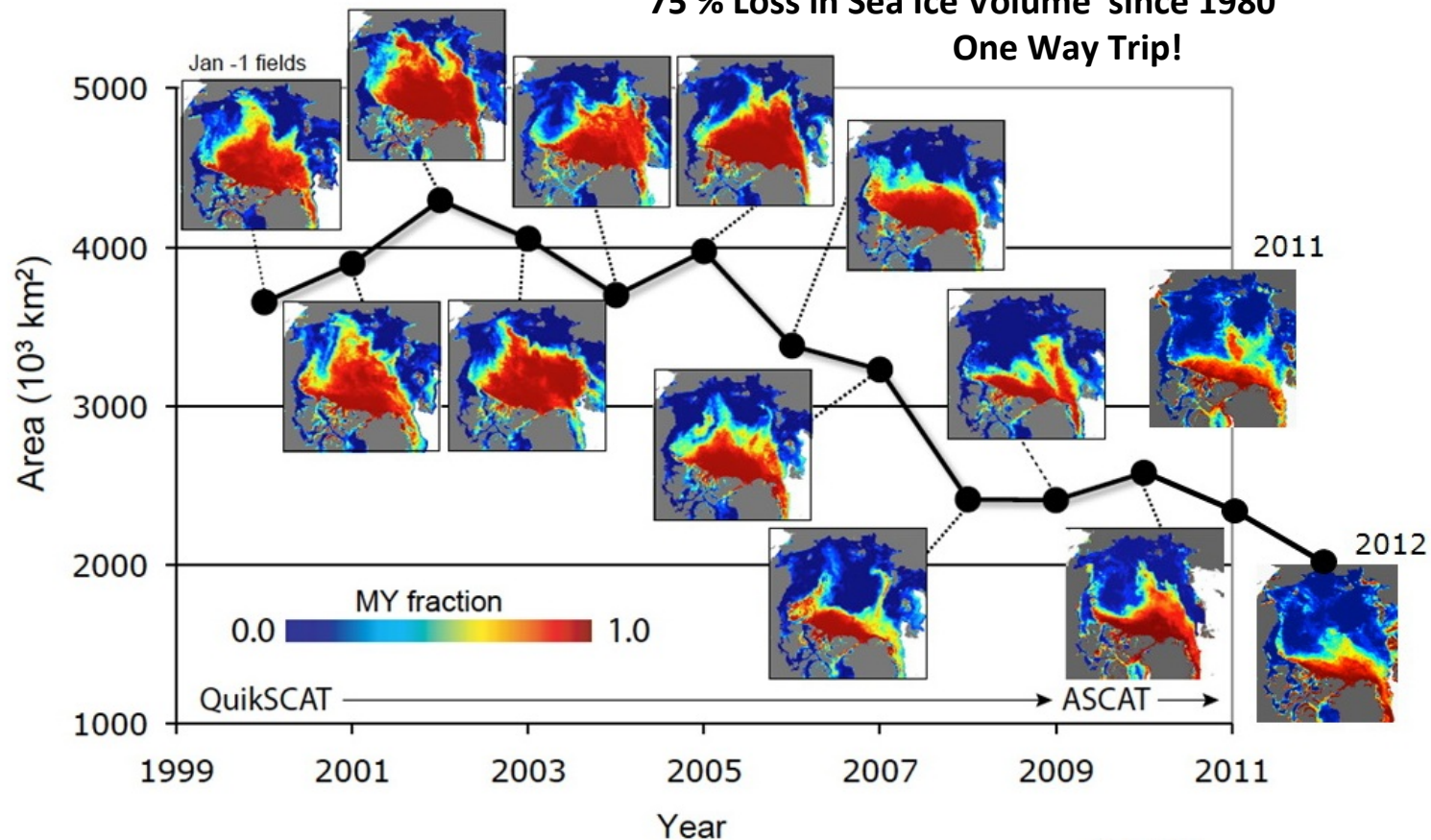
Neff, W., G. P. Compo, F. Martin Ralph, and M. D. Shupe (2014), Continental heat anomalies and the extreme melting of the Greenland ice surface in 2012 and 1889, *Journal of Geophysical Research: Atmospheres*, 119(11), 2014JD021470.

Turns this... ...into this

Decline in Arctic Ocean Multiyear Sea Ice Coverage 50 %

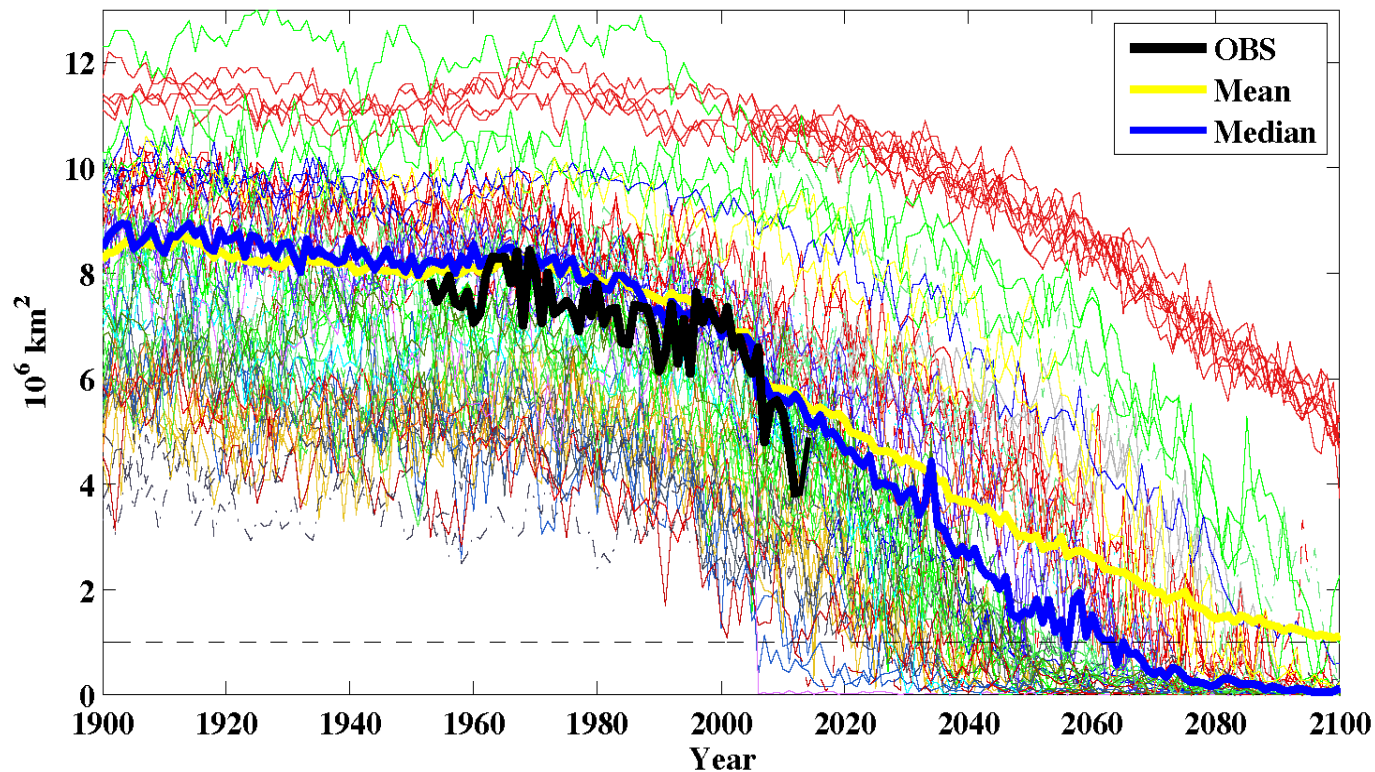
75 % Loss in Sea Ice Volume since 1980

One Way Trip!



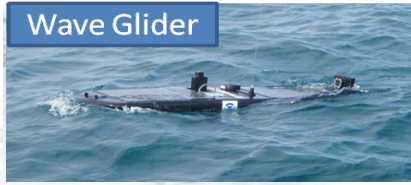
(Kwok, 2010)

Wide Range of September Sea Ice Extent Hindcasts and Predictions

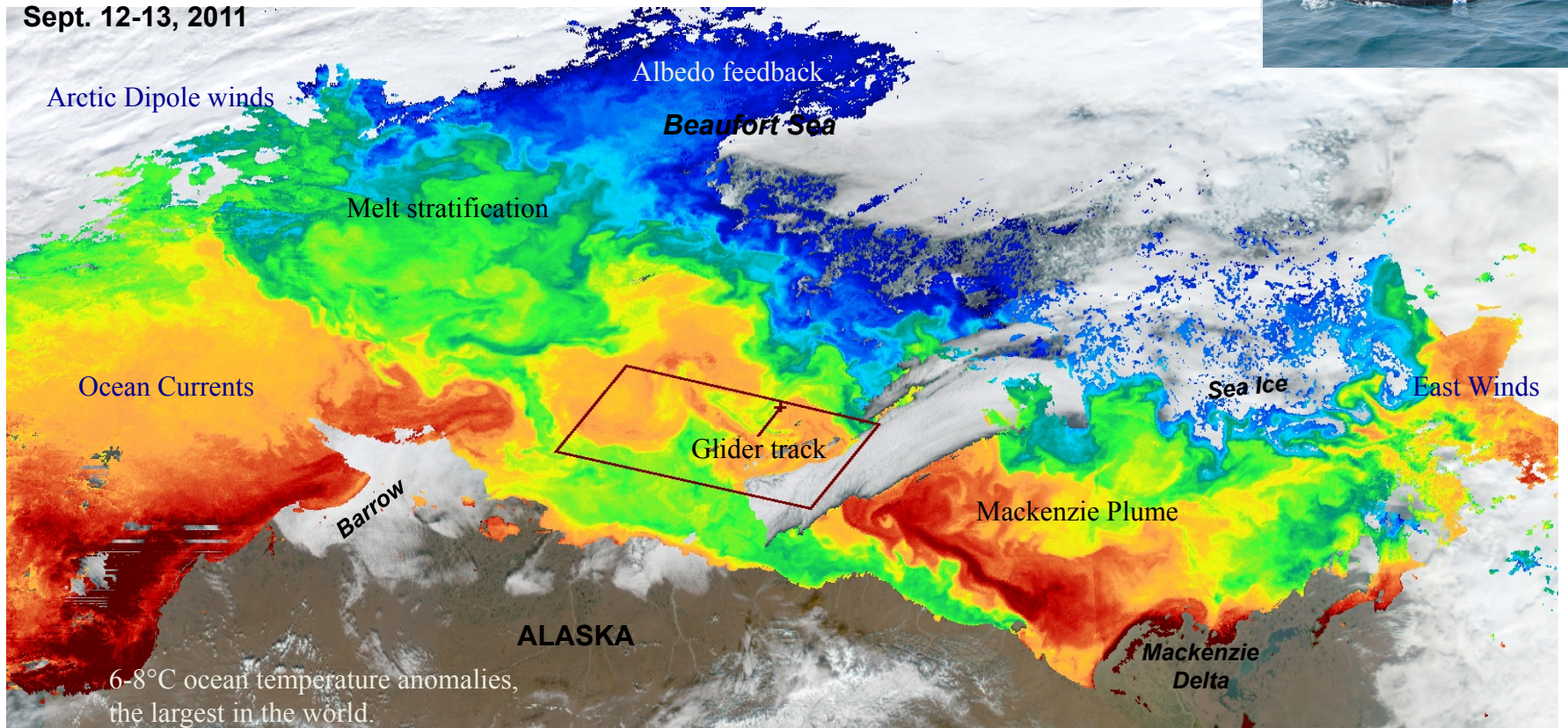


89 ensemble members from 36 CMIP5 models under strongest (RCP8.5) emissions scenario

Pacific Arctic Ocean Heat Storage



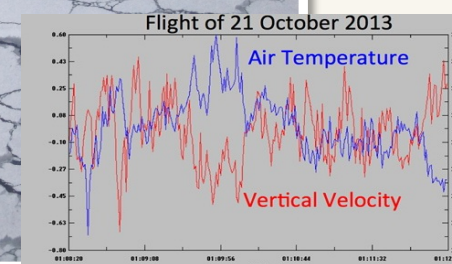
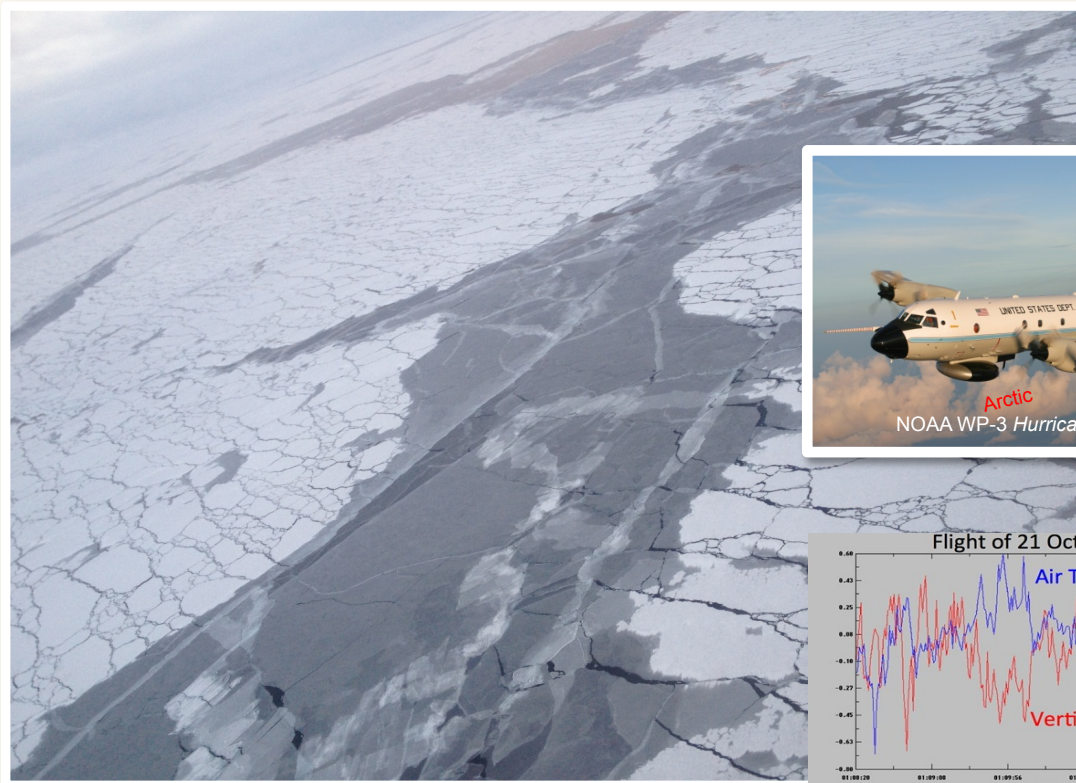
Sept. 12-13, 2011



MODIS sea surface temperature (colors) and true-color composite image (land, sea ice, and clouds)



PMEL NOAA Research Aircraft flights to the American Arctic October-November 2013 and October 2014



Newly formed sea ice recently broken by swell
No multiyear sea ice was seen on the Arctic Flux flights in 2013



Will Arctic changes lead to mid-latitude weather extremes in the coming decades?

Attribution is Controversial

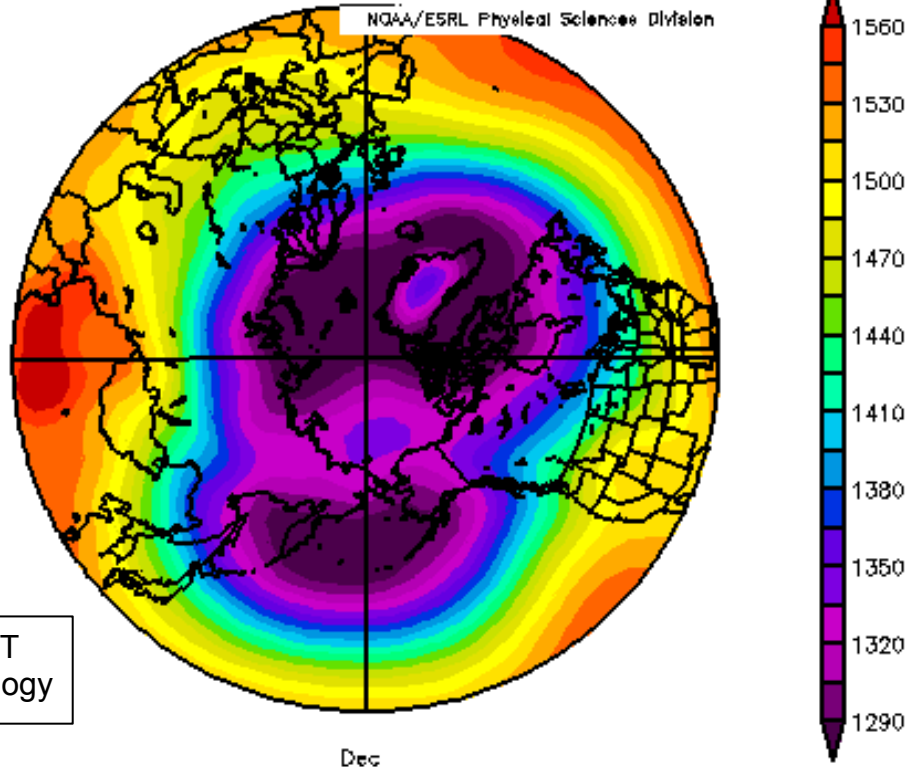
Length of time series (<10 Years) is too short to robustly differentiate Arctic forcing from random events

Complex interaction of Arctic forcing with chaotic mid-latitude flow; will not happen the same way in every year

Worth further investigation for potential of improving seasonal forecasts, especially with continued Arctic external forcing

Normal "POLAR VORTEX" of west to east flowing winds traps cold air in the Arctic

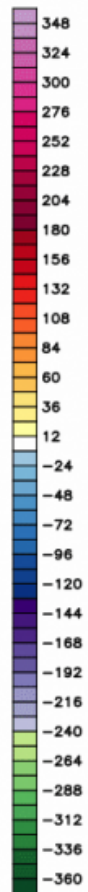
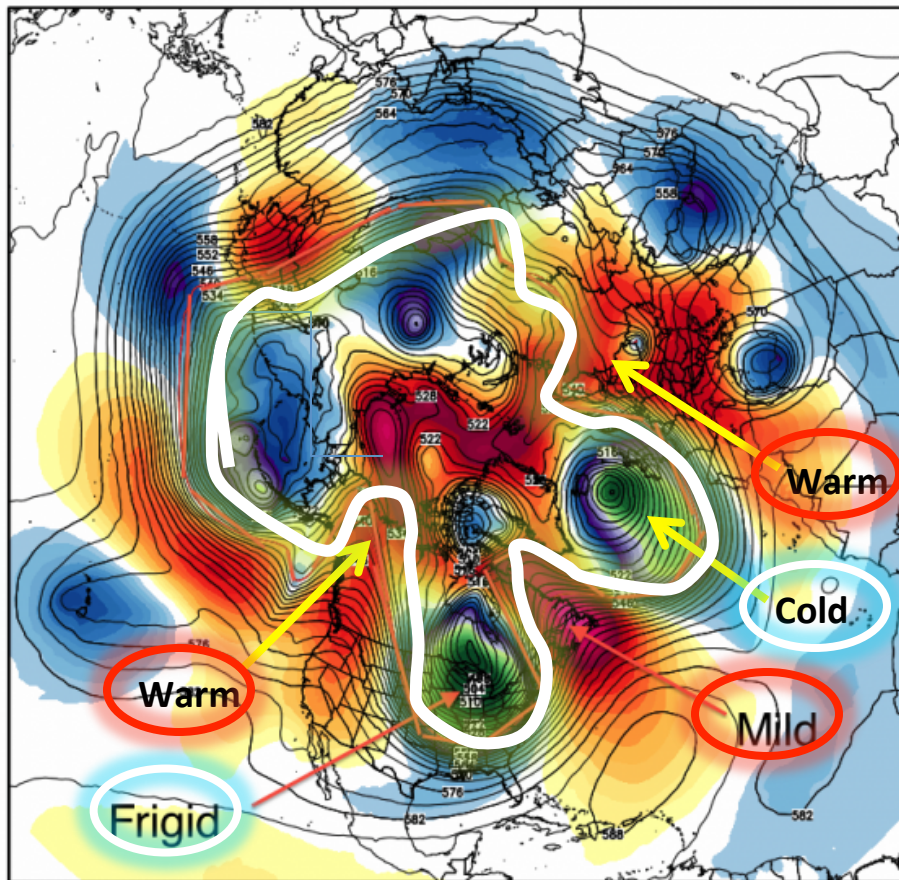
NCEP/NCAR Reanalysis
850mb Geopotential Height (m) Climatology 1968-1998
NOAA/ESRL Physical Sciences Division



Attack of the Polar Vortex - Early January 2014

ECMWF 500 hPa Geopotential Height [x10 gpm] & Anomaly [gpm]
INIT: 12Z02JAN2014 fx: [102] hr --> Mon 18Z06JAN2014

-413 ∴ 293 gpm





Quality

Science Impacts

Advocate for earlier future summer sea ice loss (2030-2040) than in model projections (2060-2090)

Endangered Species: Polar Bears and Ice Seals

Neutral on Arctic forcing of mid-latitude extreme weather

Publications

41 Peer reviewed from 2009-2014. Citation rate of over 190 per year.

Honors

2014 AGU Ambassador Award and AGU Fellow

2012 Department of Commerce Bronze Medal: *for scientific excellence in support of national and international policy on climate change in the Arctic*

2011 NOAA Administrator's Group Award: *for the development of a clear, concise and compelling Arctic Vision and Strategy document that aligns and articulates NOAA priorities*

Service

Chair of the Atmospheric Working Group (AWG) of the International Arctic Science Committee (IASC)

Affiliate Professor, University of Washington, Atmospheric Sciences

Future Directions

- Continue and Improve Communication Services: Report Card; Sea Ice Outlook; NOAA, International, and Public Forums
- Promote and Evaluate Seasonal Sea Ice Predictions, especially Alaska
- Potential Linkages of Arctic Change and Mid-Latitude Weather

