Large Arctic Climate Changes

James Overland and Muyin Wang
NOAA/PMEL
Arctic (temperature) Amplification: 2-3 times changes in Mid-latitudes
Decline in Arctic Multiyear Sea Ice Coverage 40% Since 1980 (Red)
Arctic is Now Mostly First Year Sea Ice (Blue)

70% Loss in Sea Ice Volume since 1980
One Way Trip!

R. Kwok
October 2014

First year at sea ice at 78N from 300 feet;
New Environment
On land, there is additional evidence of the impact of the persistent warming trend.

- Between 1982 and 2013, the tundra biomass increased by 20 percent.
- The number of days of melting in June and July 2014 exceeded the 1981–2010 average over most of the ice sheet.
“Arctic Amplification”: Global Warming + Multiple Feedbacks

- Global Warming
- Reduction of Arctic sea Ice
- Atmosphere warming
- Ocean absorbs more heat
- Sept Sea Ice Extent

- OND Temp Anomaly

- 2008
- Summer SST anomaly (°C)
- 2008
- Alaska
- Russia
- Greenland
What is Special about the Arctic?
Future Sea Ice loss Occurring Faster than Projected
Wide Range of September Sea Ice Extent Hindcasts and Predictions
from IPCC

89 ensemble members from 36 CMIP5 models under strongest (RCP8.5) emissions scenario Overland and Wang (2013)
Adaptation mode before 2040
Three Patterns of Arctic/Subarctic Climate Variability

Arctic Warming Pattern

Arctic Oscillation/ North Atlantic Oscillation (AO/NAO)

Pacific Decadal Oscillation/ Pacific North American Pattern (PDO/PNA)

Prediction of sea ice loss and open water duration is difficult for Barents Sea because Atlantic current is too weak in climate models, but Barents is part of Arctic Warming Pattern, so expect major changes by 2030.
Southeastern Bering Sea Variability much larger than Global Warming contribution

Monthly St Paul Island Temp Anomaly

2000  2015

St Paul air temperatures

1970  2000

M2 Ocean temps

Stabeno

NCEP/NCAR Reanalysis 925mb air (C) Composite Mean

September Sea Ice Minimums

Wang and Overland, 2015
Future Sea Ice Duration in Alaska Arctic
Still have a winter wall of freezing temperatures

Observations (72 N)
3 months Open Water Now

Ensemble mean of 12 CMIP5 models
5 months Open Water by 2040

Wang and Overland, 2015
Zonal Mean Distribution of Ice Free Months

Wang and Overland, 2015
Modest Global Warming + Large Arctic Amplification = Adaptation in next 20 Years
Predictions

• Arctic already has new normal.
• The Arctic climate has shifted from thick multi-year-old sea ice to mostly first-year sea ice. Difficult to return to old system. One-Way Trip over next three decades!
• Winter still wins! Future extended periods of newly open water will be seasonally limited to summer and early fall.