

# Arctic Sea Ice Projections & Uncertainties

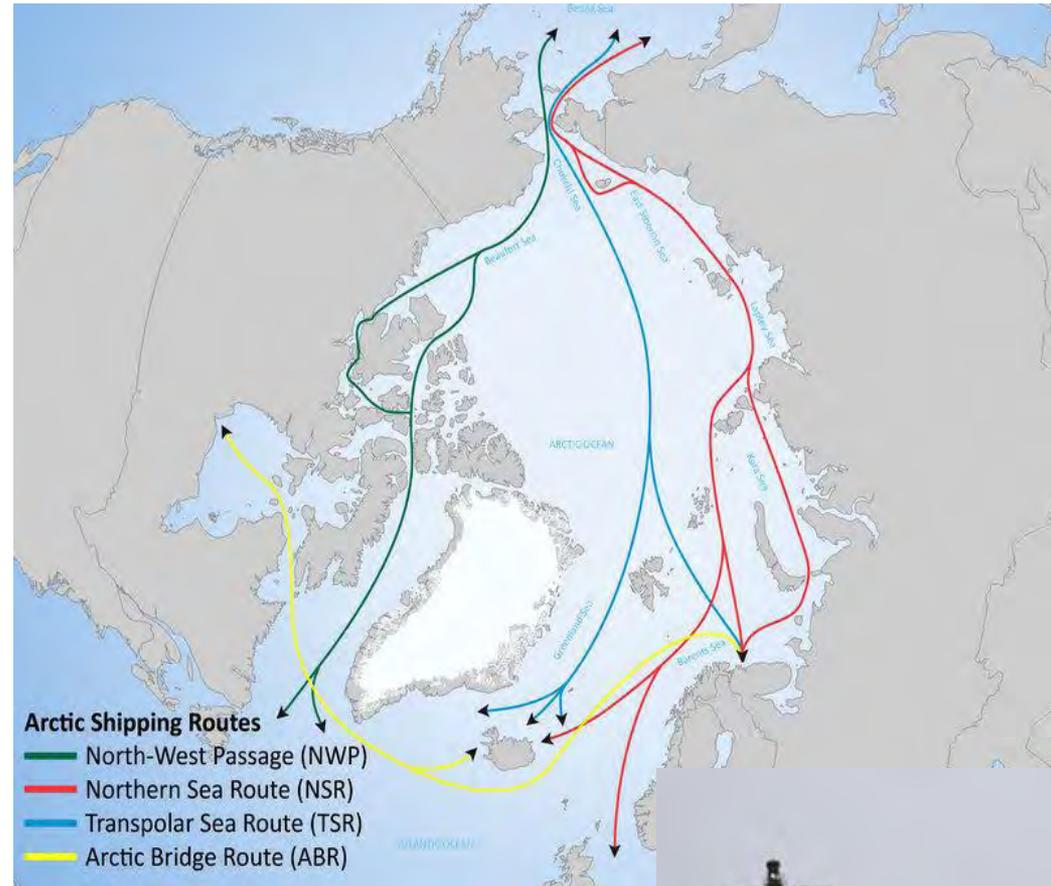
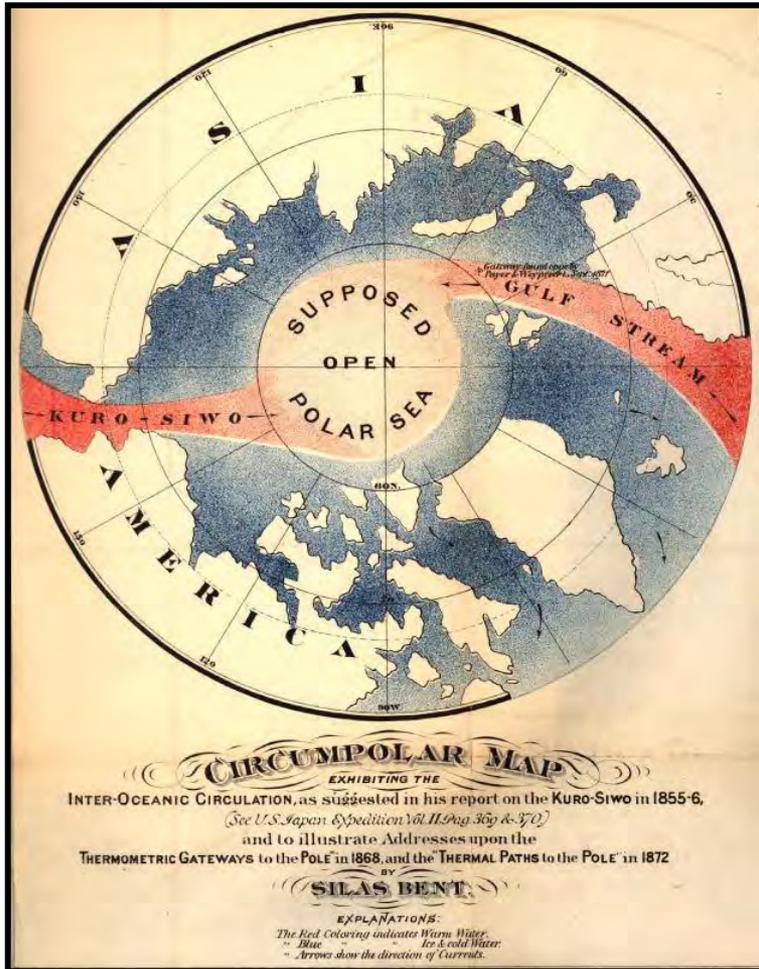
- An update from CMIP5 models

**MUYIN WANG & JAMES OVERLAND**

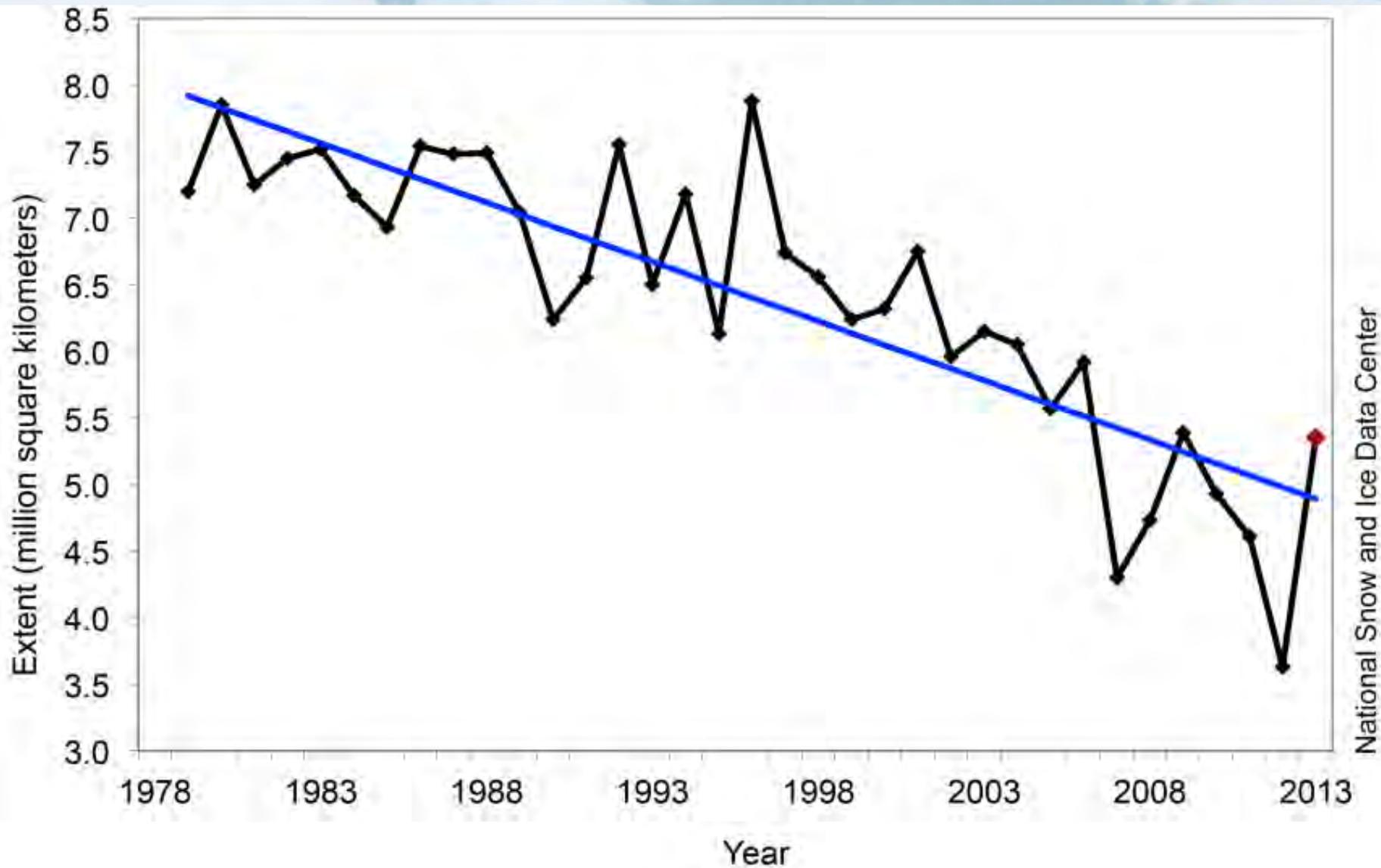
**JISAO/UW, PMEL/NOAA**



# Increased links between the Arctic and mid-latitudes



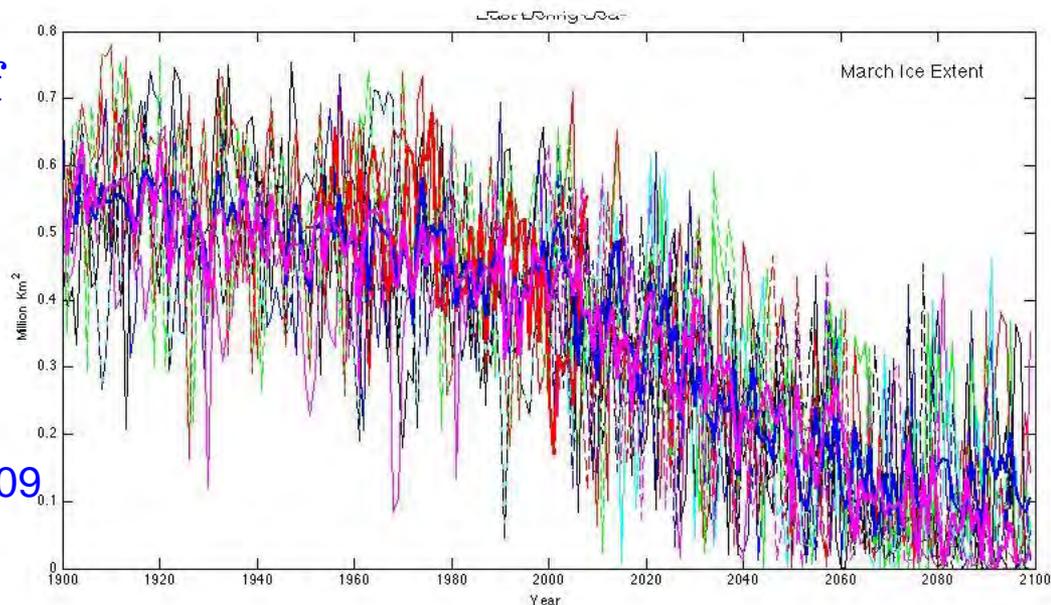
# Three Scientific Approaches of Arctic Sea Ice Prediction



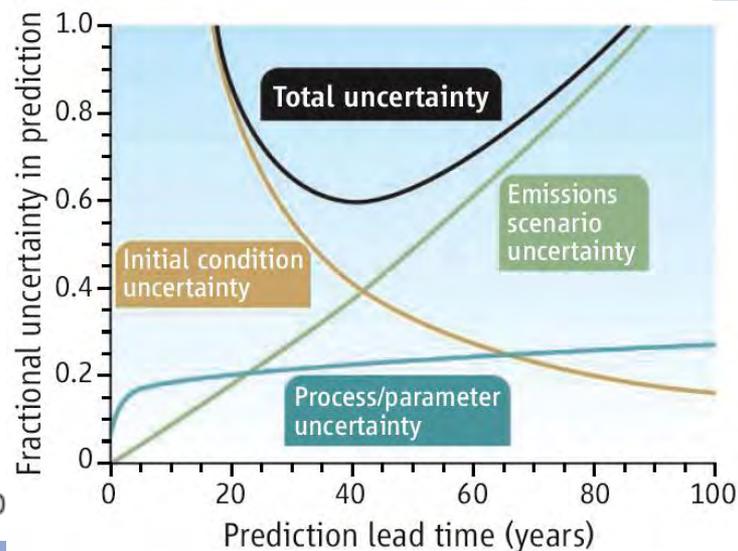
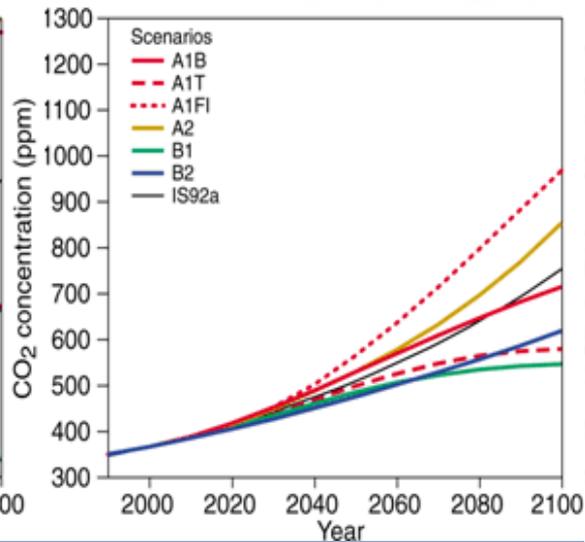
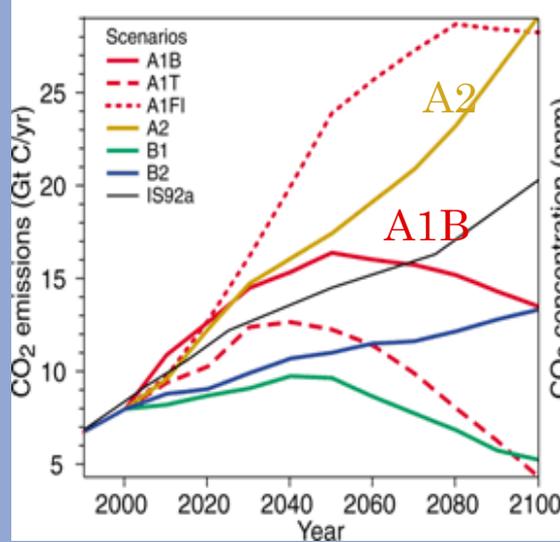
# Source of Projection Uncertainties

- Internal Variability of climate system
- Model Uncertainty
- Emission Scenarios

Hawkins and Sutton, 2009

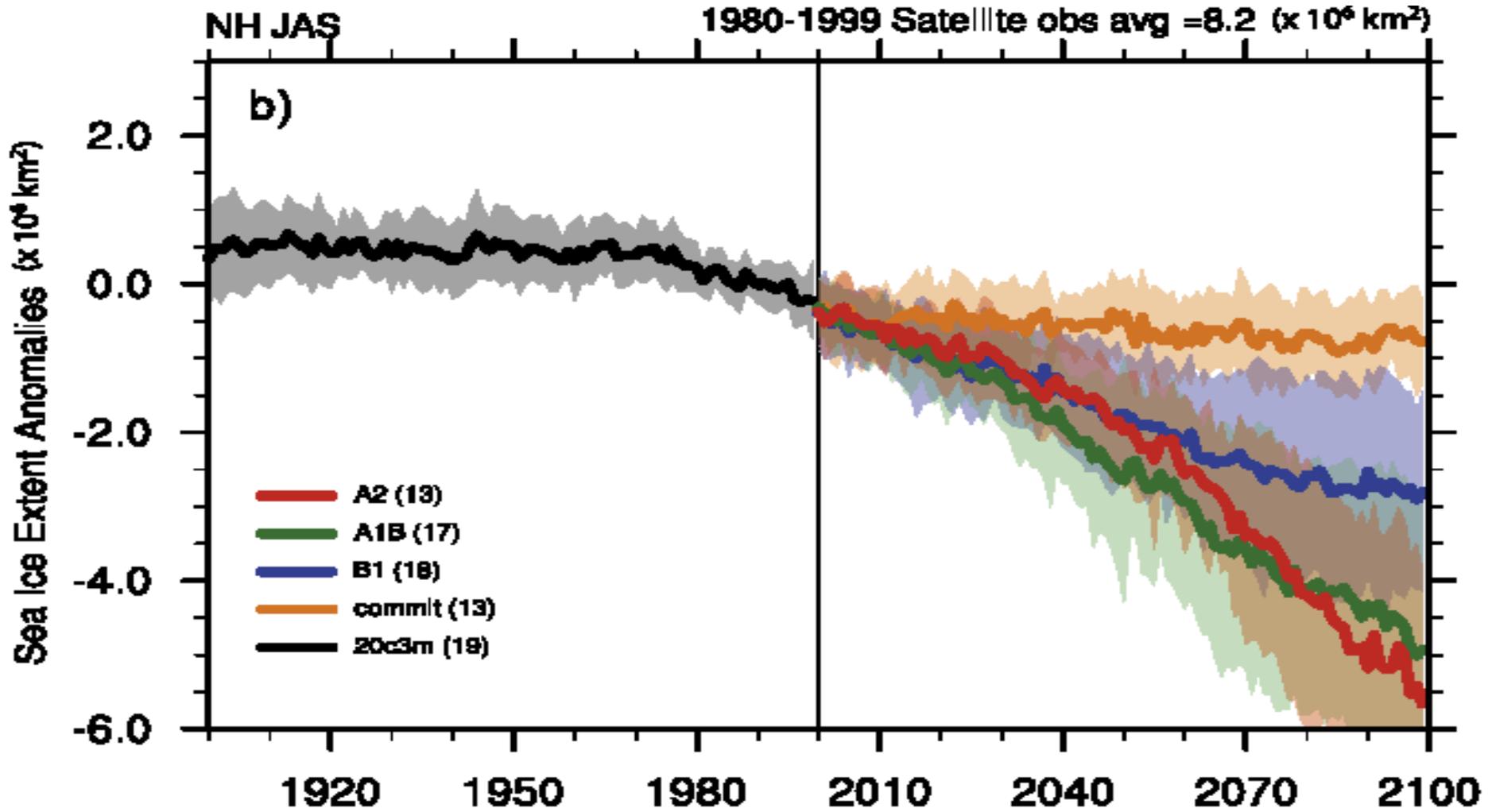


(a) CO<sub>2</sub> emissions

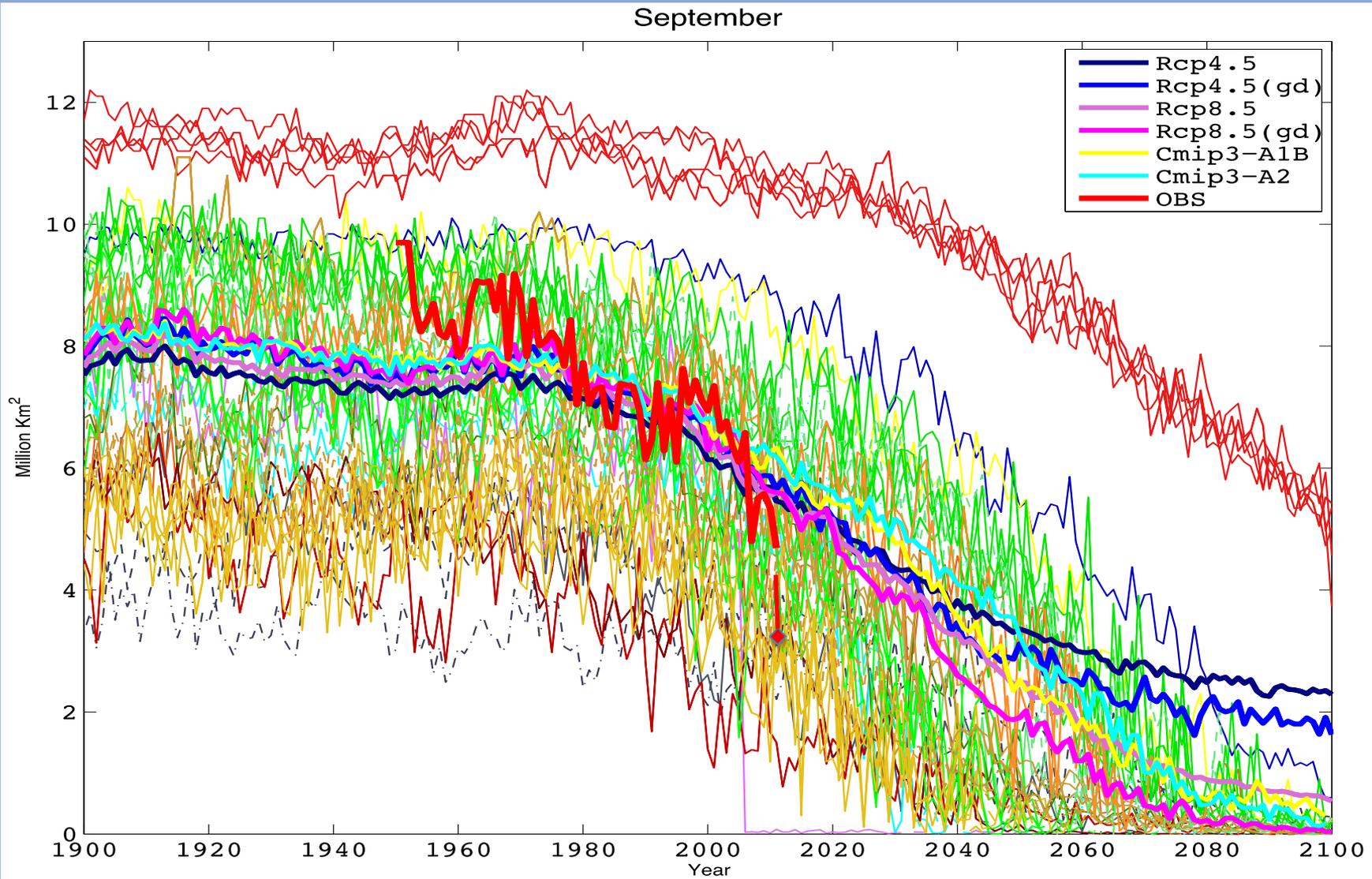


Cox and Stephenson, 2007

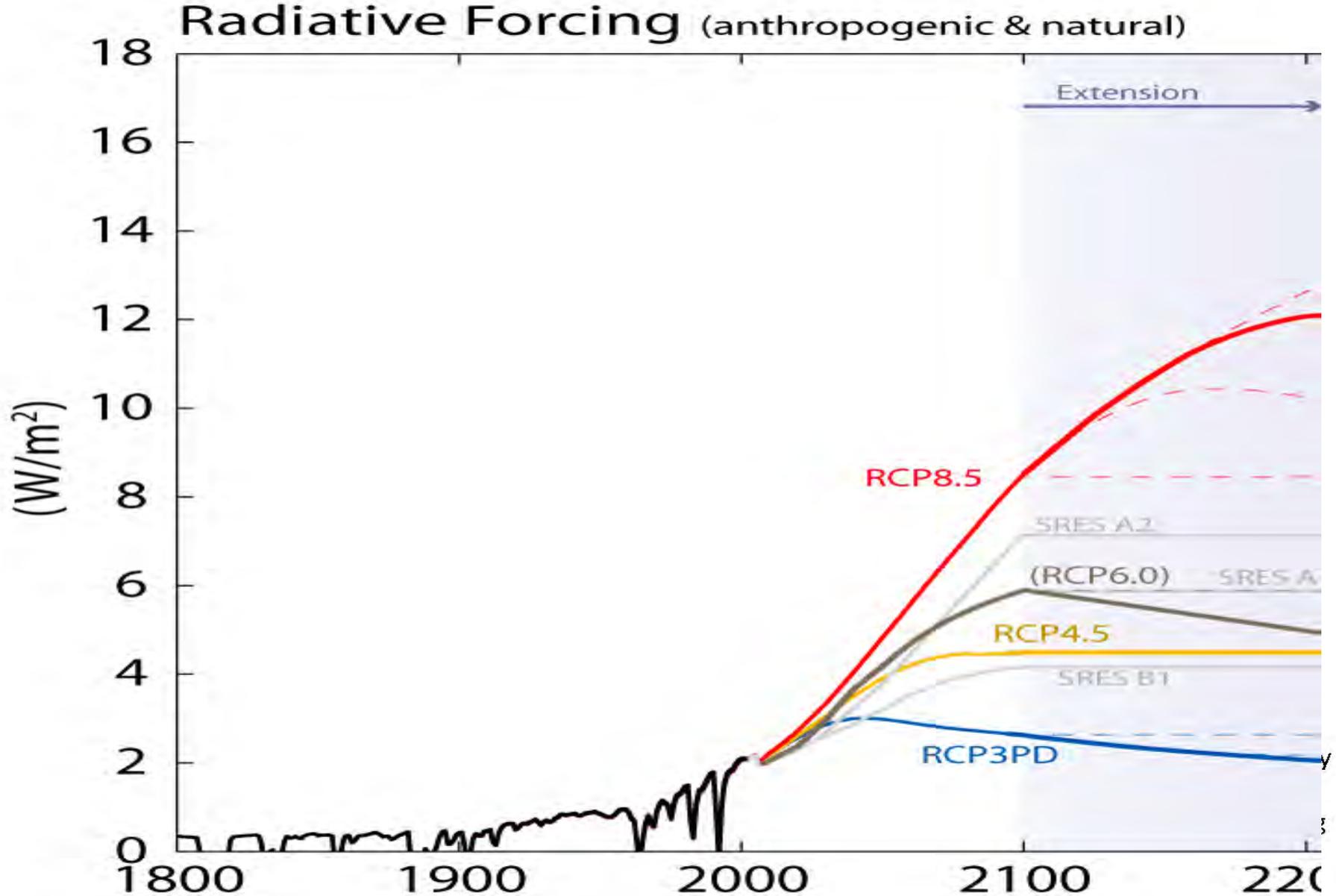
# Assumption: Ensemble Mean



# September Sea Ice Extent from CMIP Models

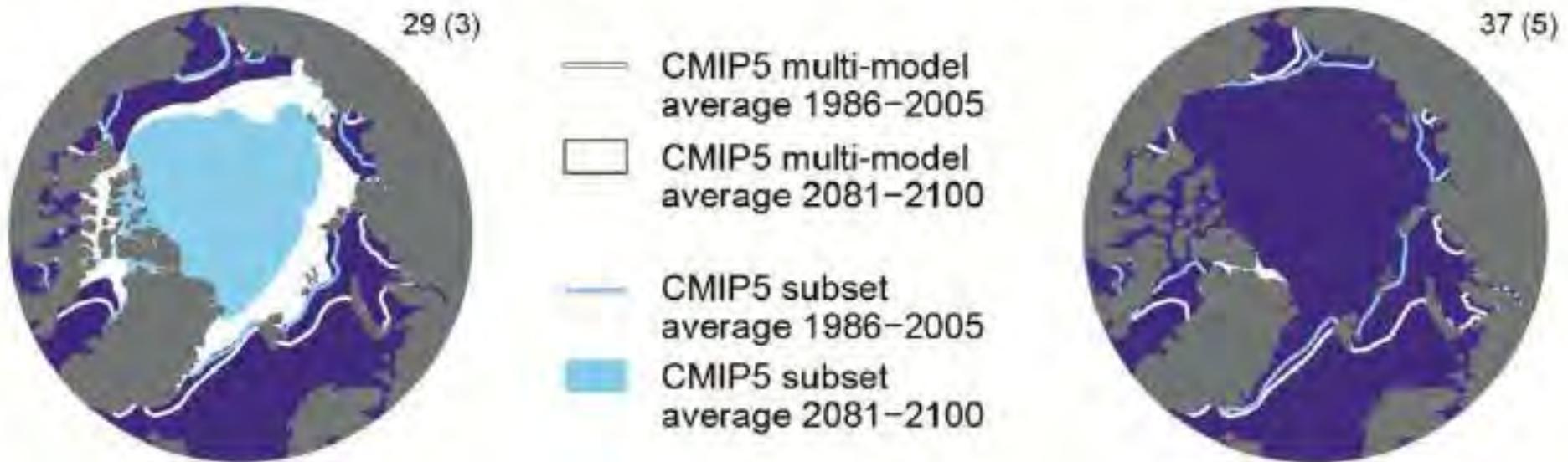


# Representative Concentration Pathways (RCPs)



# IPCC AR5 E.5 Cryosphere

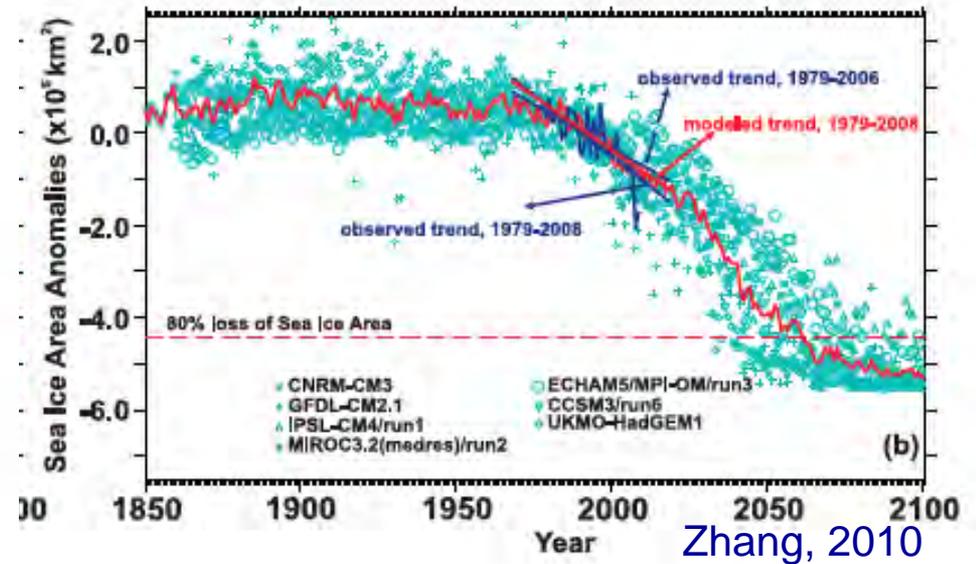
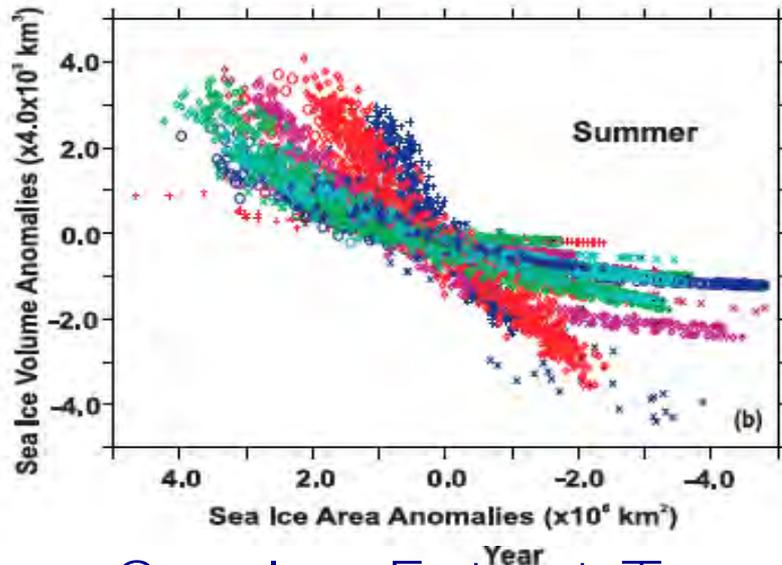
Northern Hemisphere September sea ice extent (average 2081–2100)



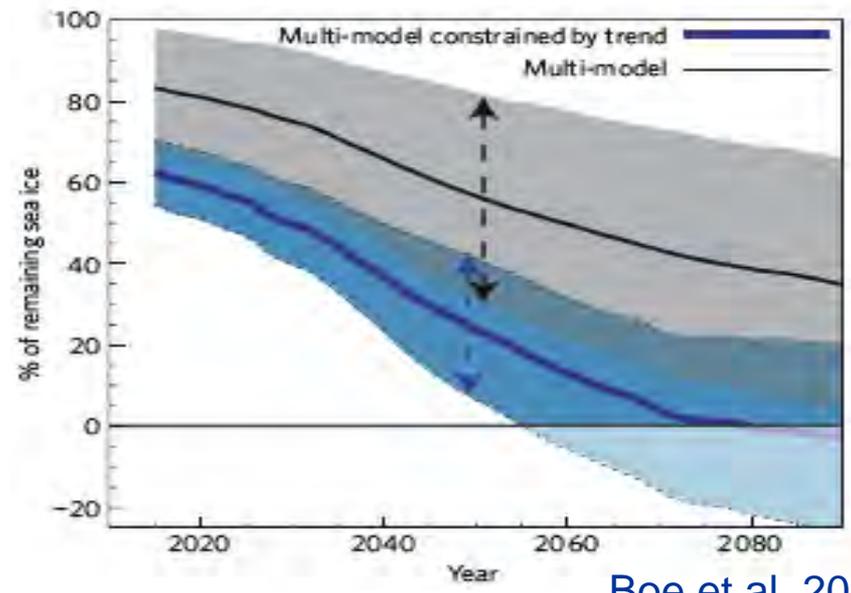
It is very likely that the Arctic sea ice cover will continue to shrink and thin and that Northern Hemisphere spring snow cover will decrease during the 21st century as global mean surface temperature rises.

Based on an assessment of the subset of models that most closely reproduce the climatological mean state and 1979–2012 trend of the Arctic sea ice extent, a nearly ice-free Arctic Ocean in September before mid-century is likely for RCP8.5

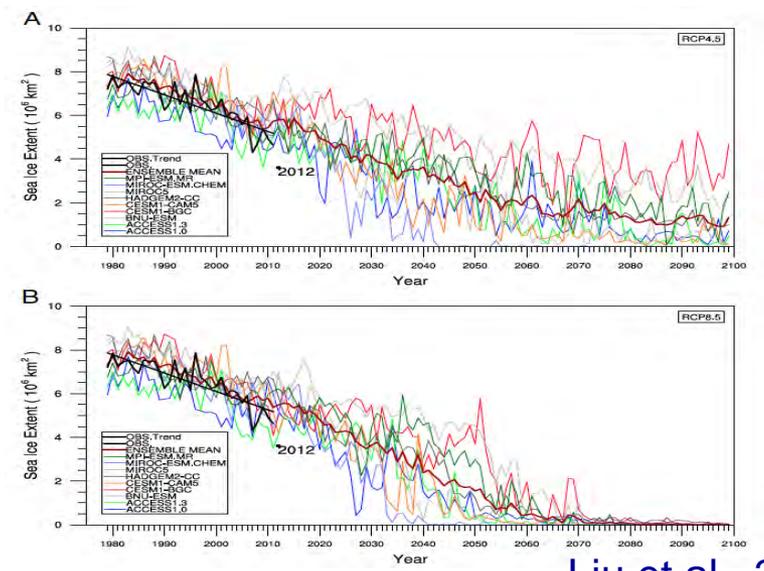
# Sensitivity of Ice Coverage to GLB Warming Forcing



## Sea Ice Extent Trend

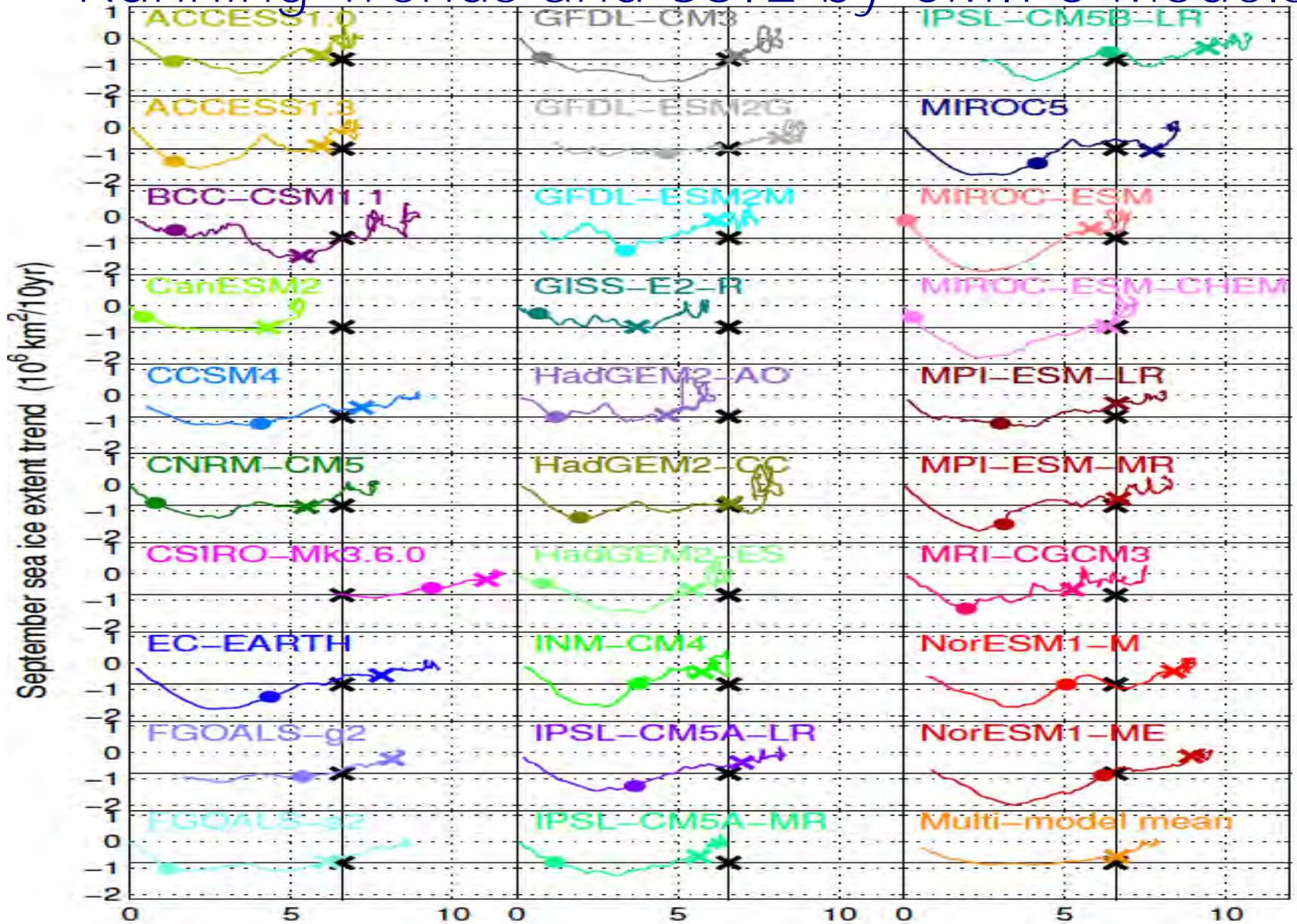


Boe et al. 2009

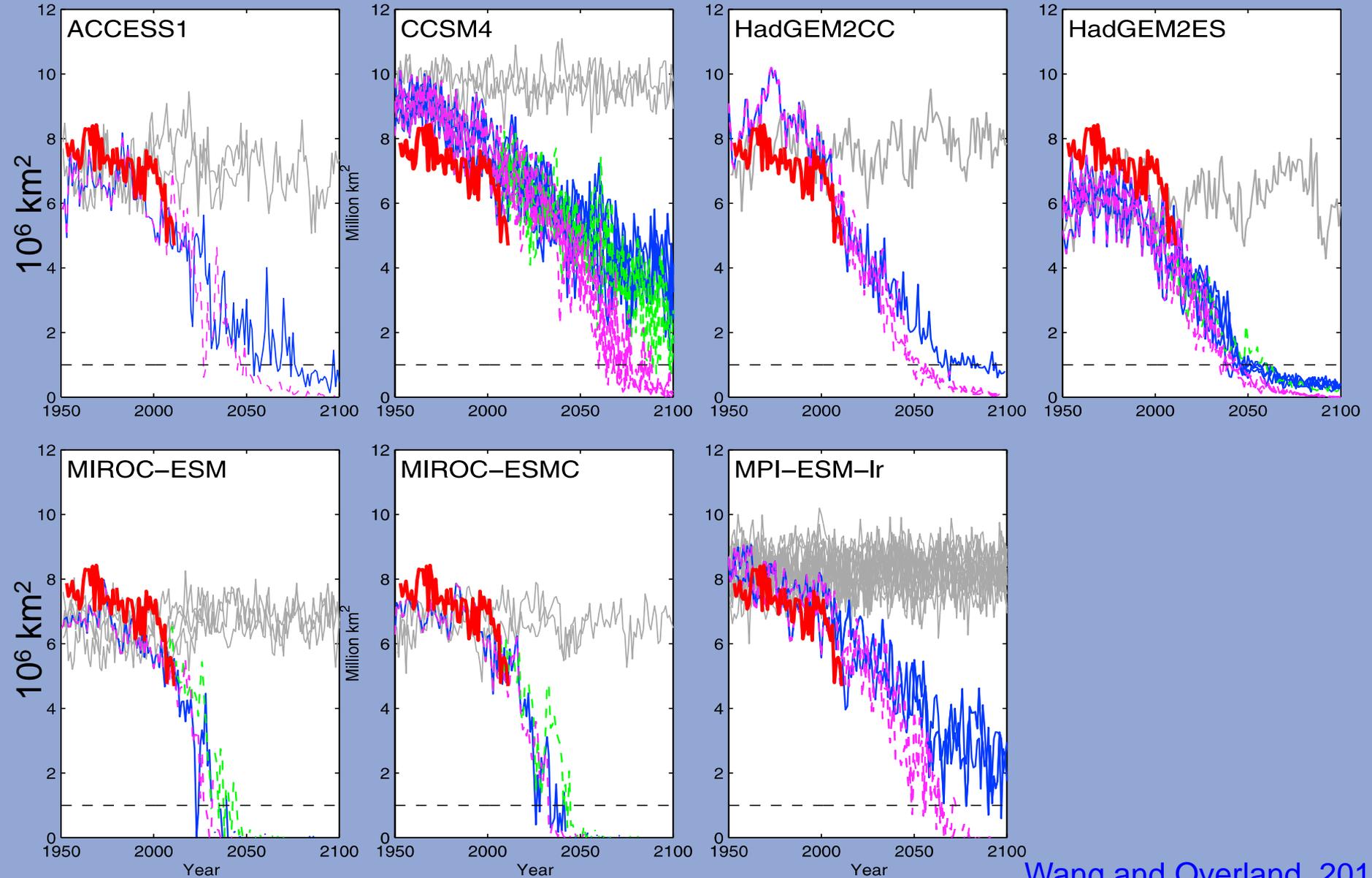


Liu et al., 2013

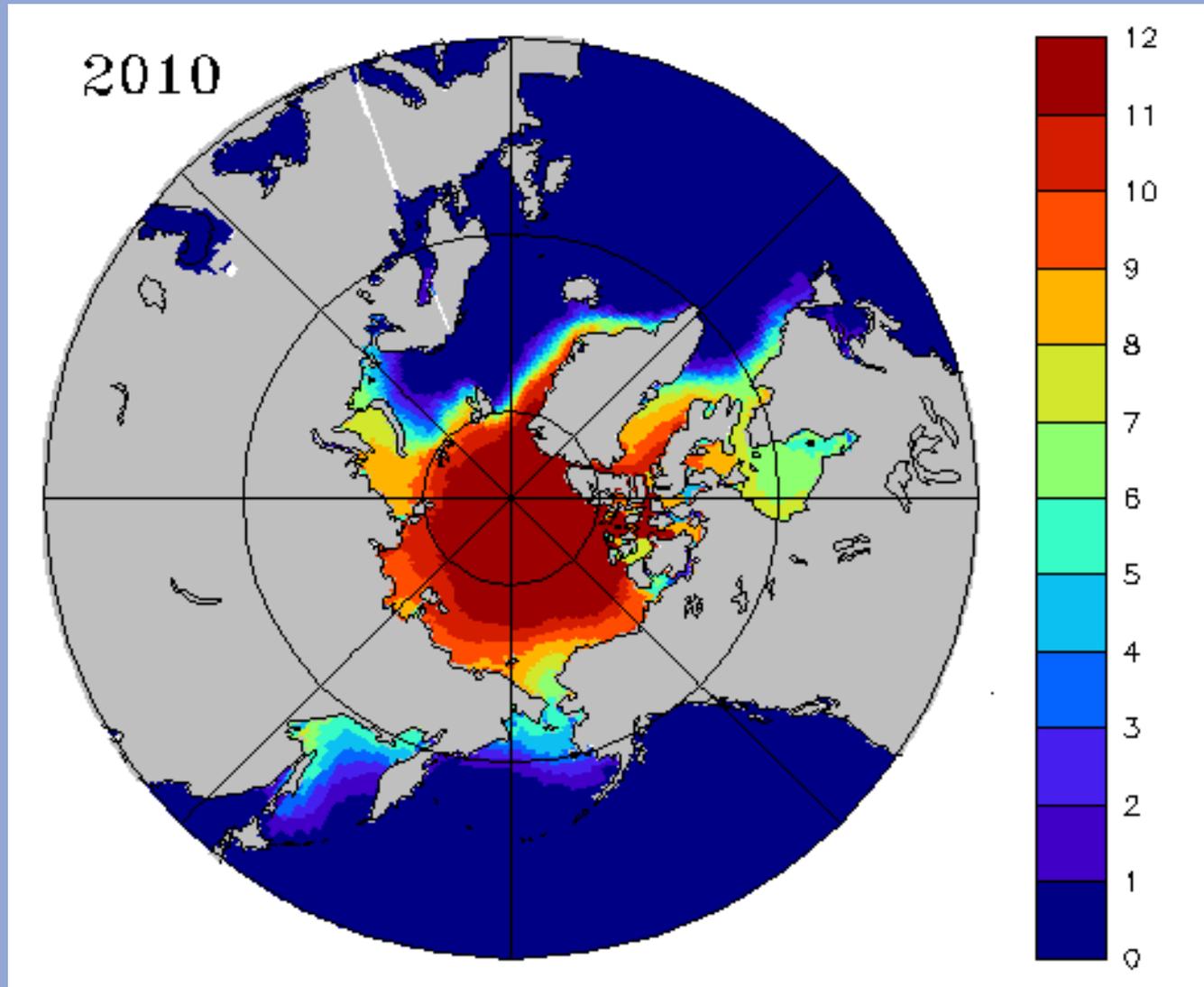
# Running Trends and SSIE by CMIP5 Models



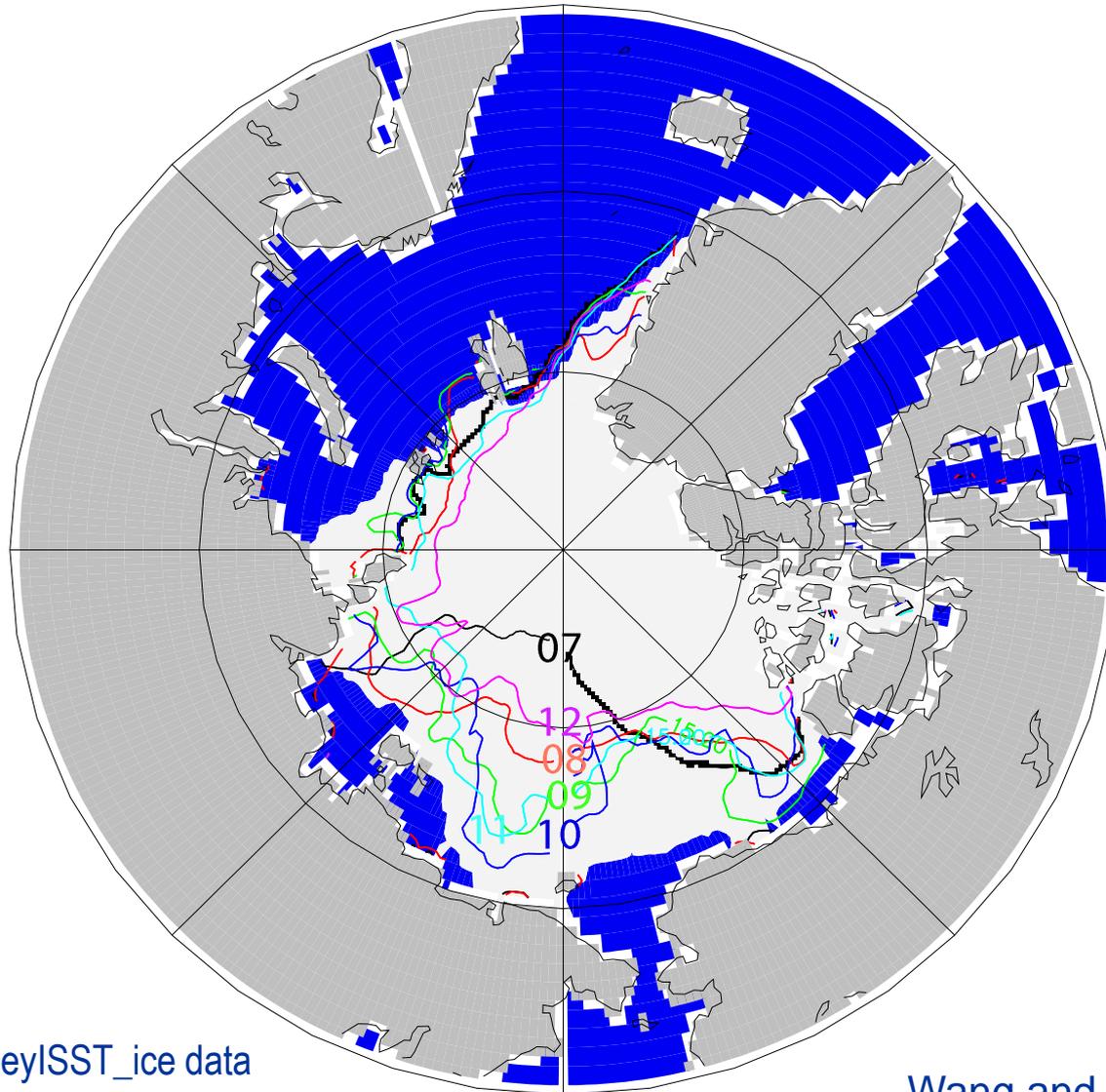
# September Sea Ice Extent



# No. of Month Sea Ice Cover by 12 models



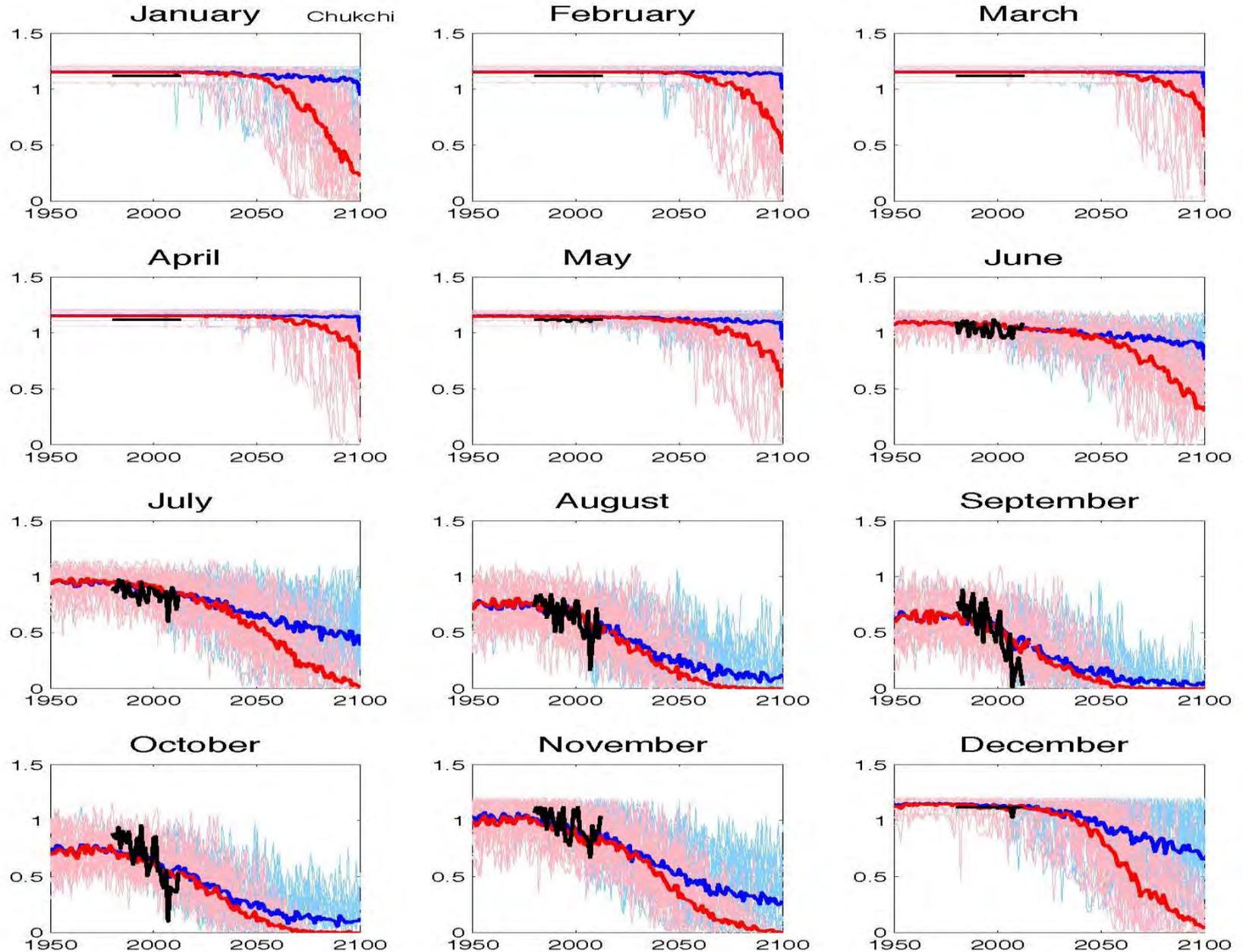
# Recent Arctic Sea Ice Cover/Ice Edges



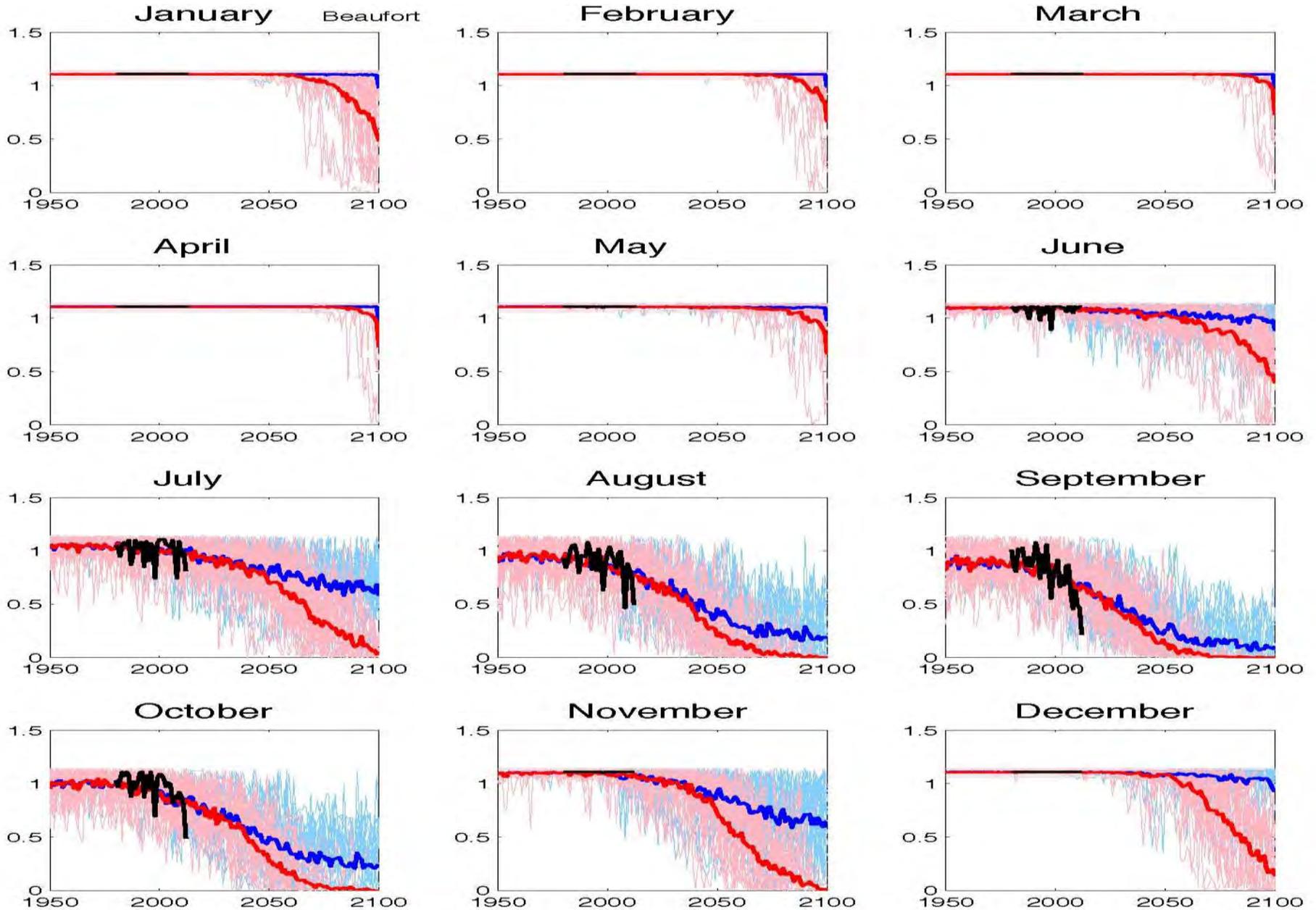
Based on HadleyISST\_ice data

Wang and Overland, submitted

# Time Series of Sea Ice Extent over the Chukchi Sea

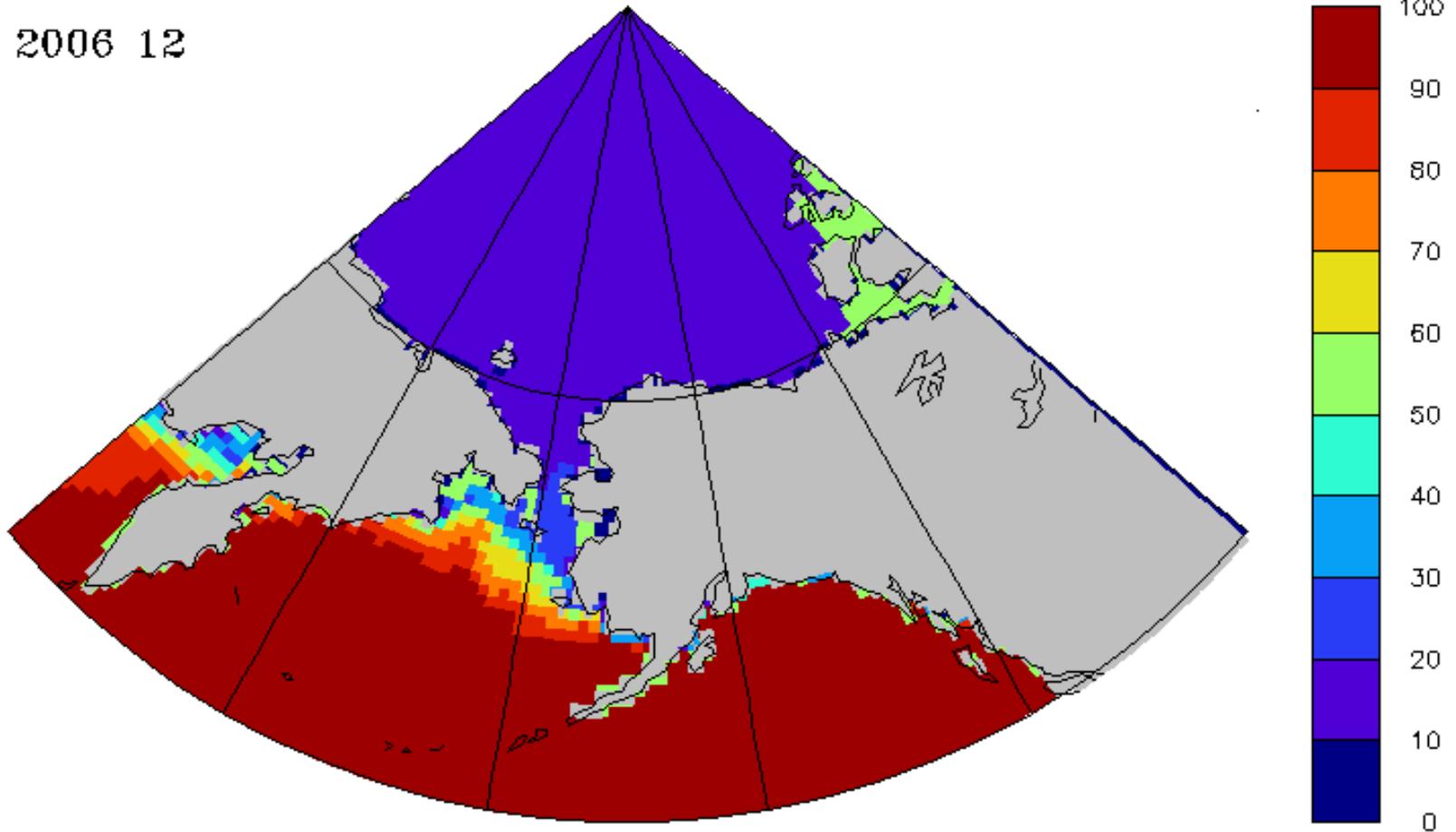


# Time Series of Sea Ice Extent over the Beaufort Sea



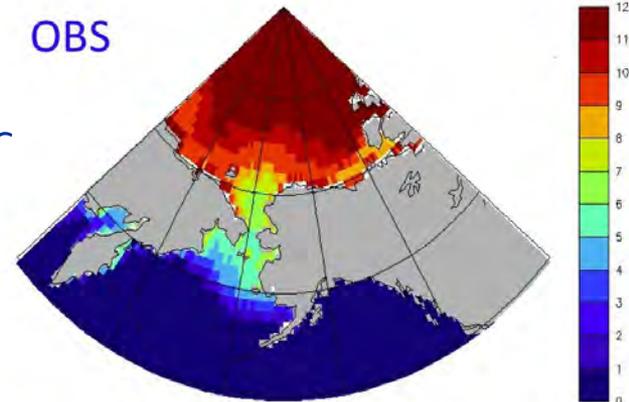
# Pacific Arctic Dec. Sea Ice Cover

2006 12

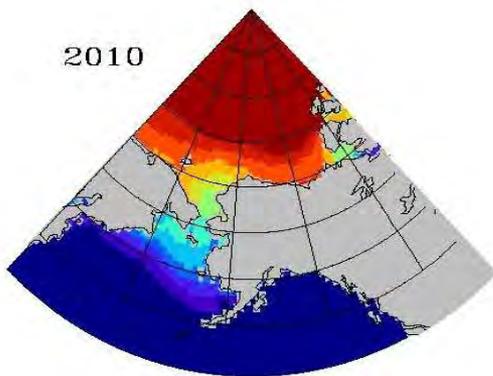


# Number of Month with Ice Cover

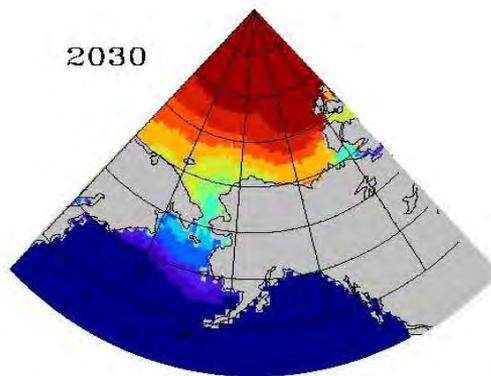
OBS



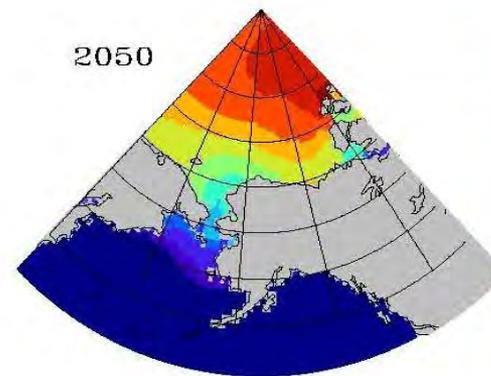
2010



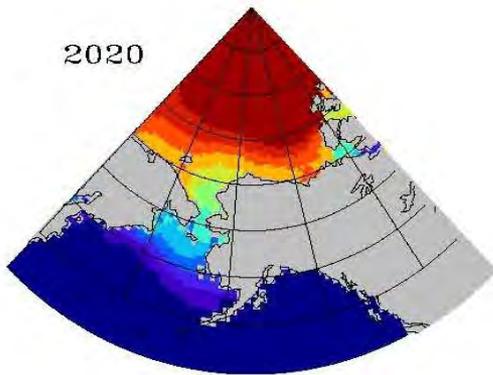
2030



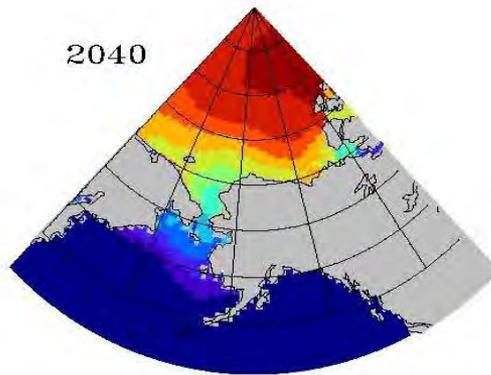
2050



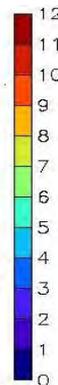
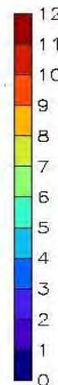
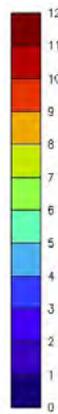
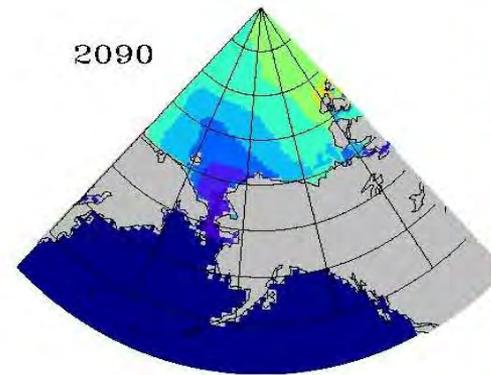
2020



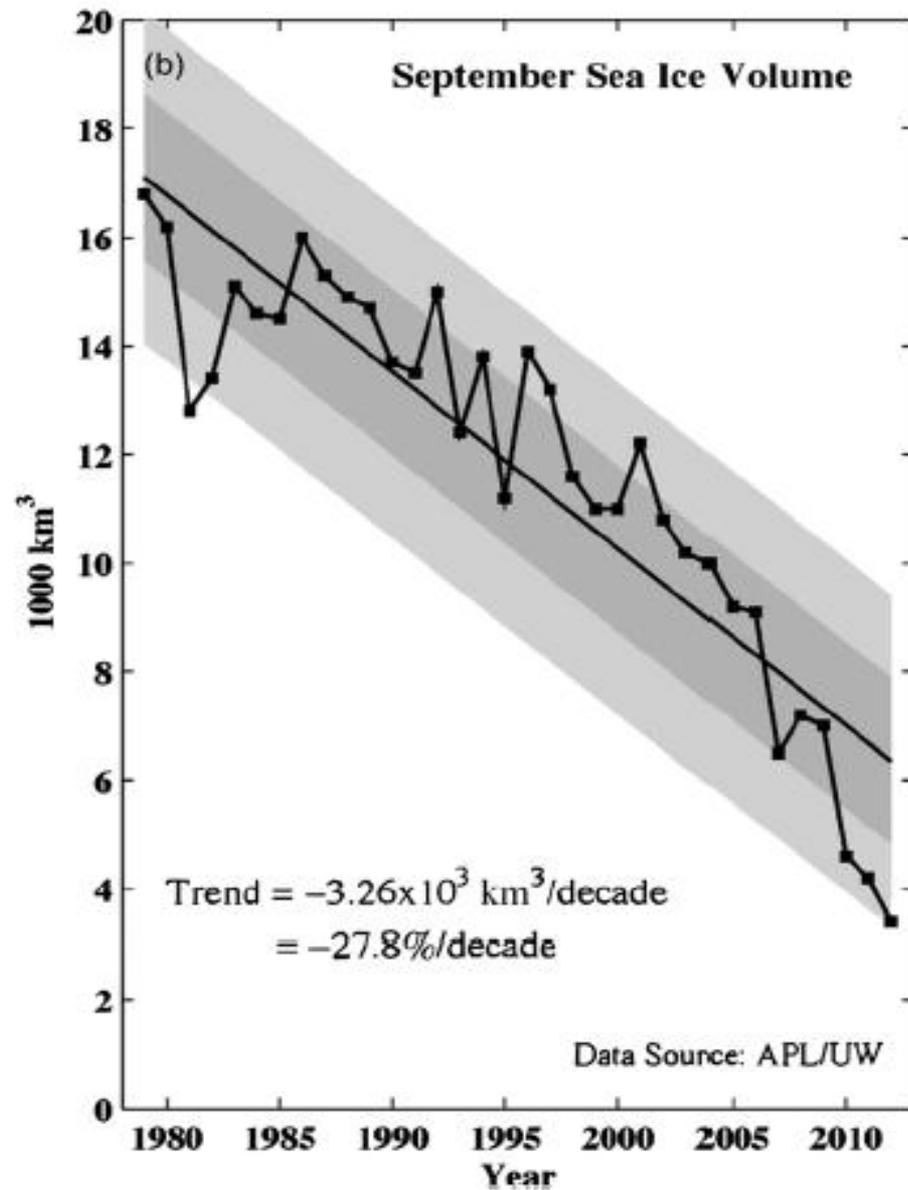
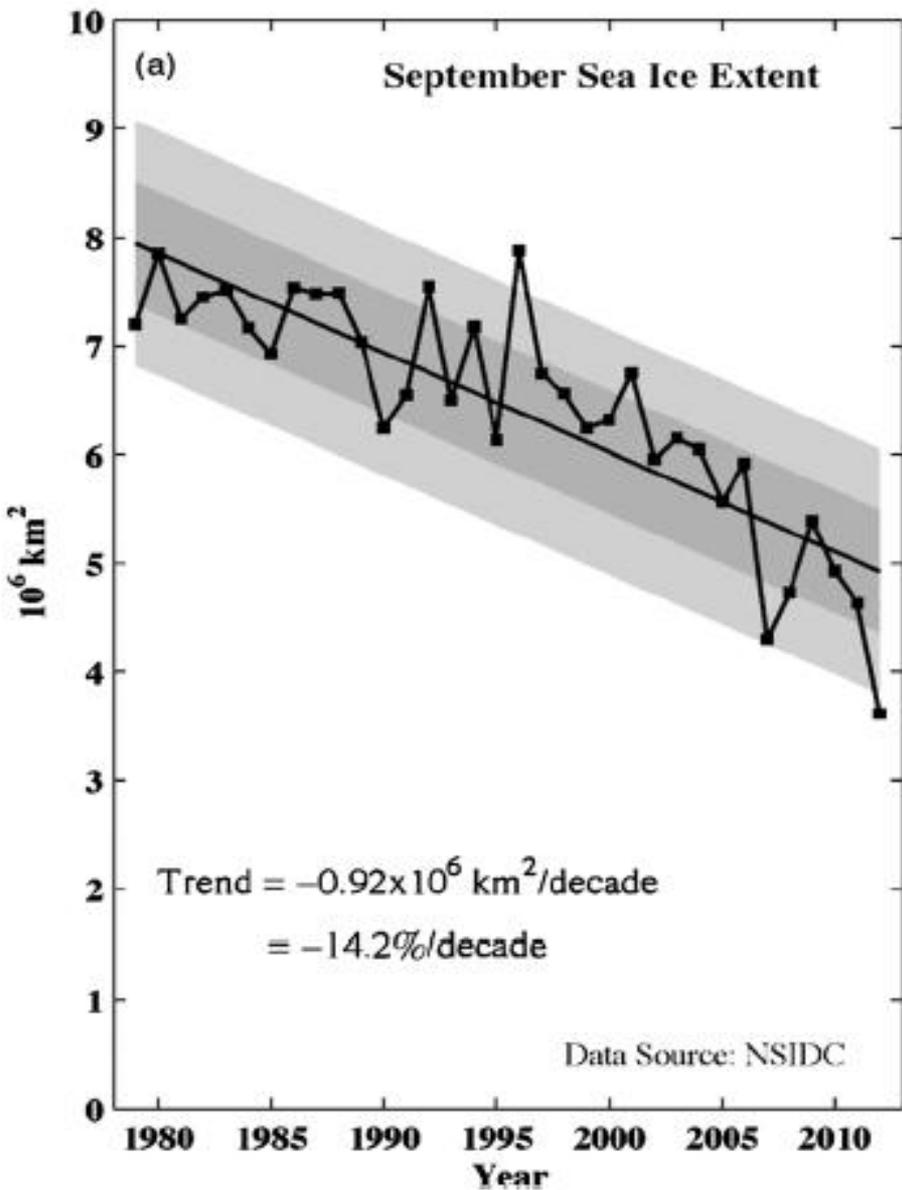
2040



2090



# Measure of Quality of Sea Ice



# SUMMARY

❖ The rapid decline of arctic sea ice can have impacts on all aspects of the Arctic system: from physical to components of ecosystem, to the word **economics...**



- ❖ Climate models are the only tools we have to make objective predictions after careful assessment and evaluation.
- ❖ Model selection is necessary but not sufficient.