Annual September Arctic Sea ice extent 1979-2012

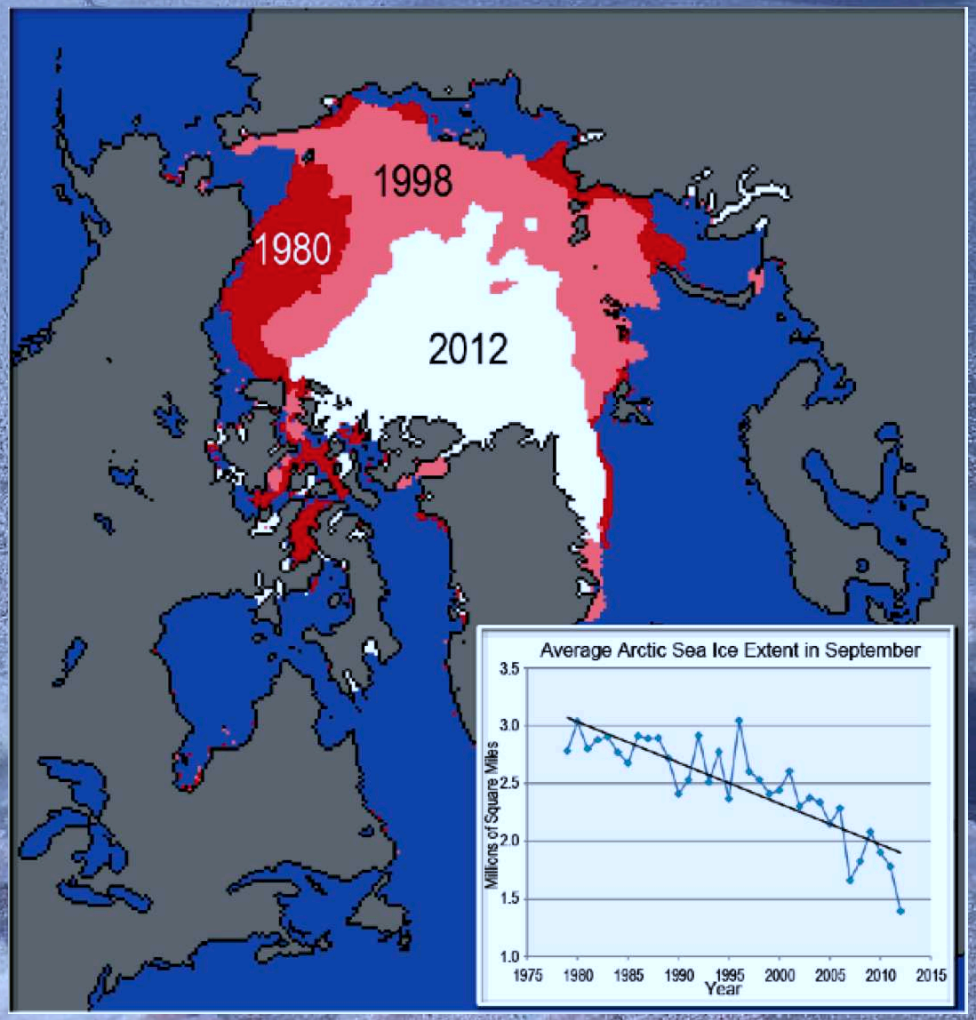

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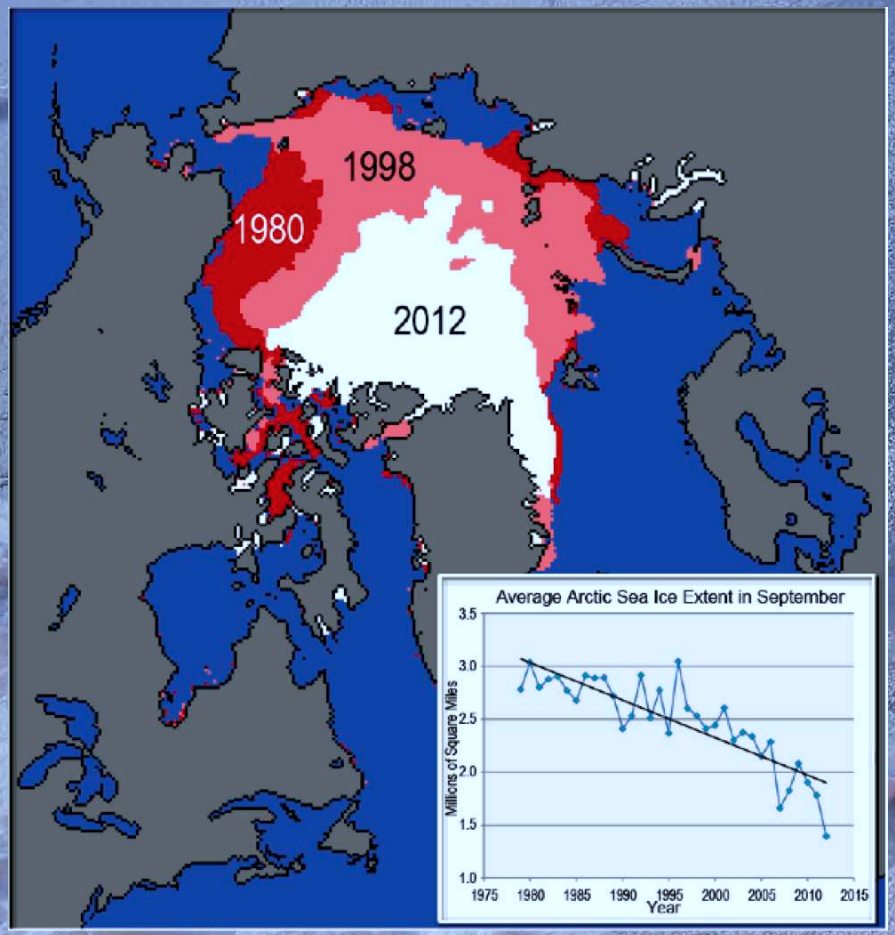
Figure from National Assessment Rep. *Draft 2013*

Annual September Arctic Sea ice extent 1979-2012



Notes: The month of September has the minimum sea ice cover each year. Passive microwave instruments on satellites have observed sea ice extent since 1979 with high fidelity. The sea ice cover has decreased by about 40% since the start of the record.

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Figure from National Assessment Rep. *Draft 2013*

Sea Ice Area Thickness From Submarines and Satellites

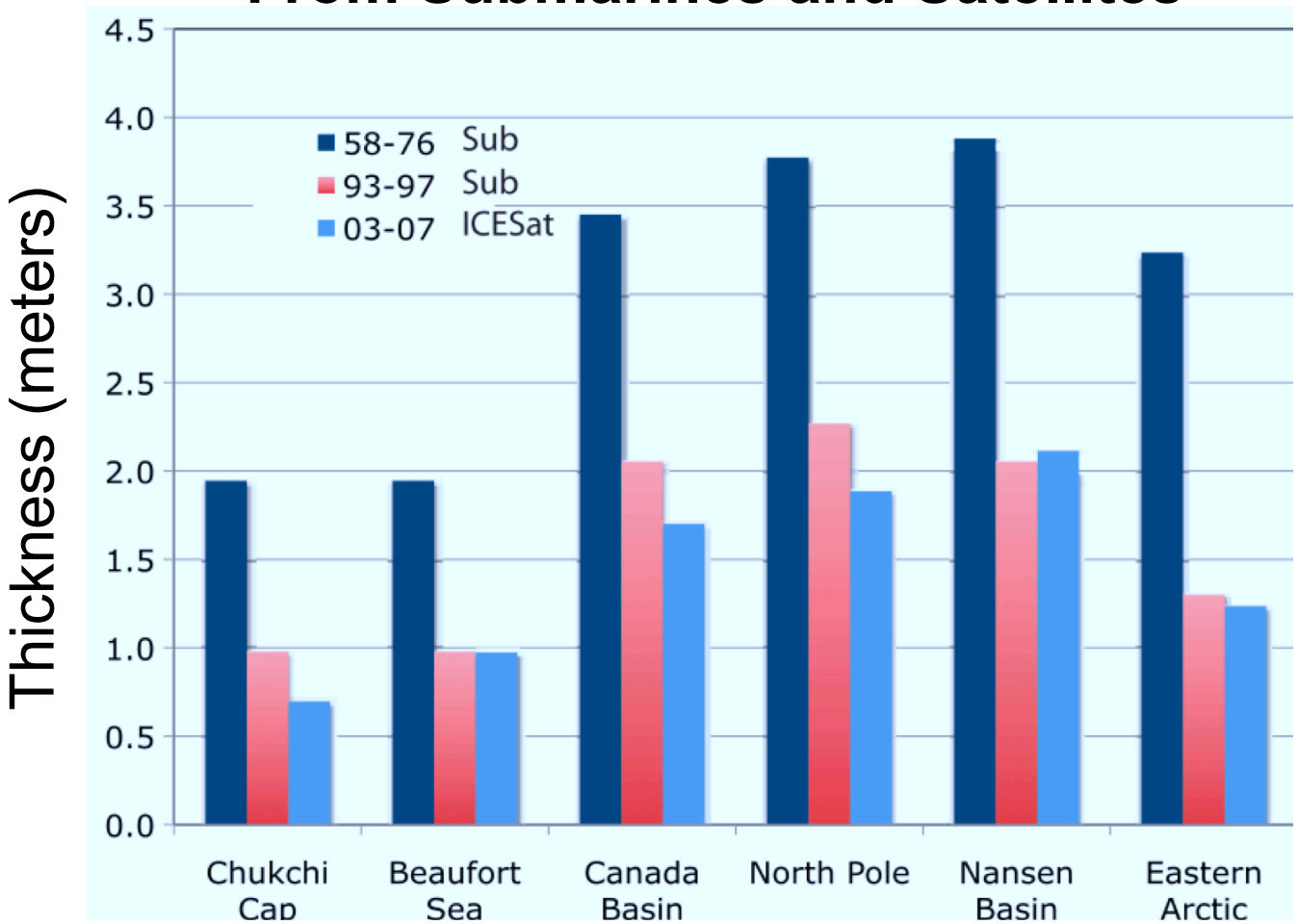

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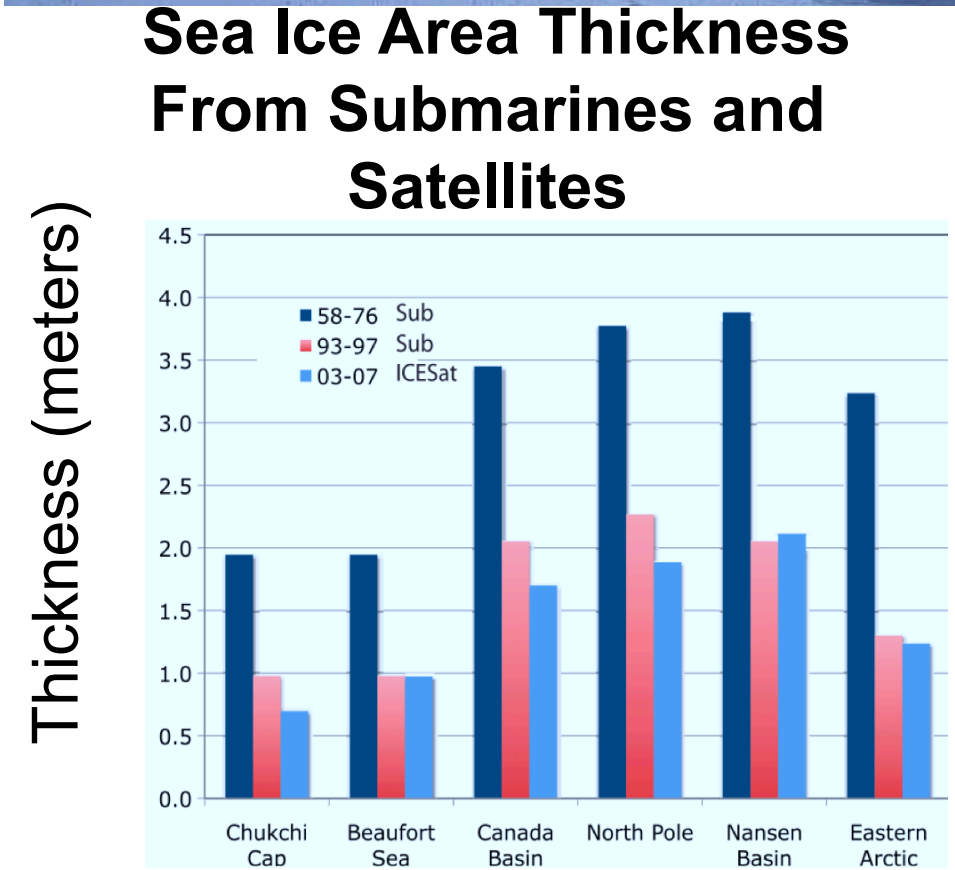
Figure from Kwok & Rothrock 2009

Sea Ice Area Thickness From Submarines and Satellites



Notes: Independent evidence of sea ice loss from submarines and a laser altimeter satellite indicate at least as much decline in sea ice thickness since 1958-1976. Thinner ice is more susceptible to melt away and leave open water in summer.

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Figure from Kwok & Rothrock 2009

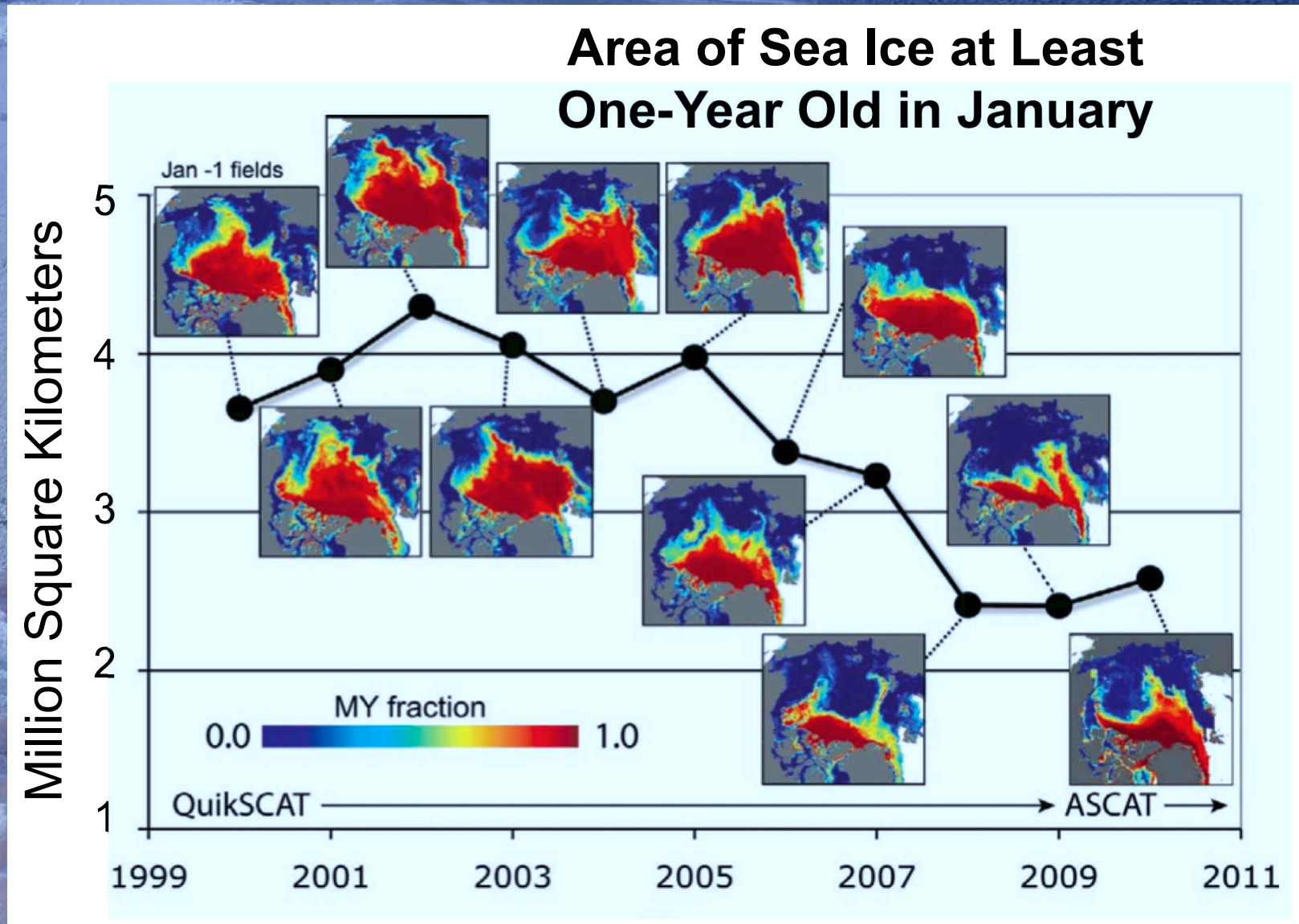

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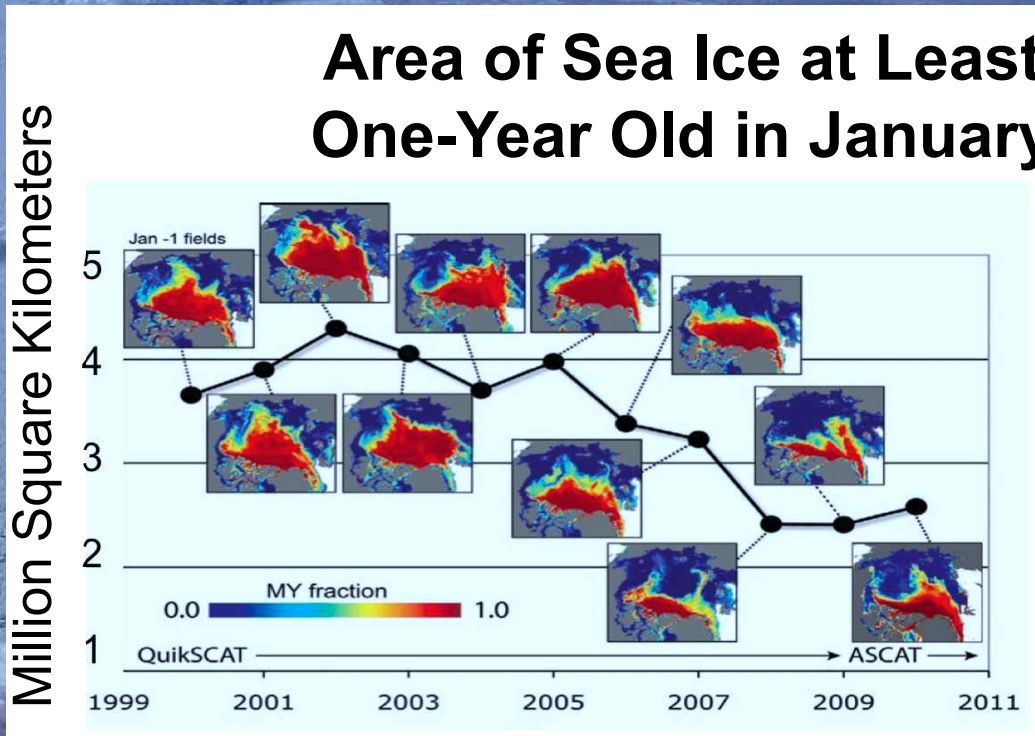
Figure from Polyakov et al 2011

Area of Sea Ice at Least One-Year Old in January



Notes: Yet another independent line evidence of sea ice loss a satellite that measures scatter differently from multi-year (MY) and firstyear ice indicates that the amount of multi-year ice is greatly diminished in January.

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Figure from Polyakov et al 2011

Annual September Sea Ice

Model Projections – High Emissions Scenario

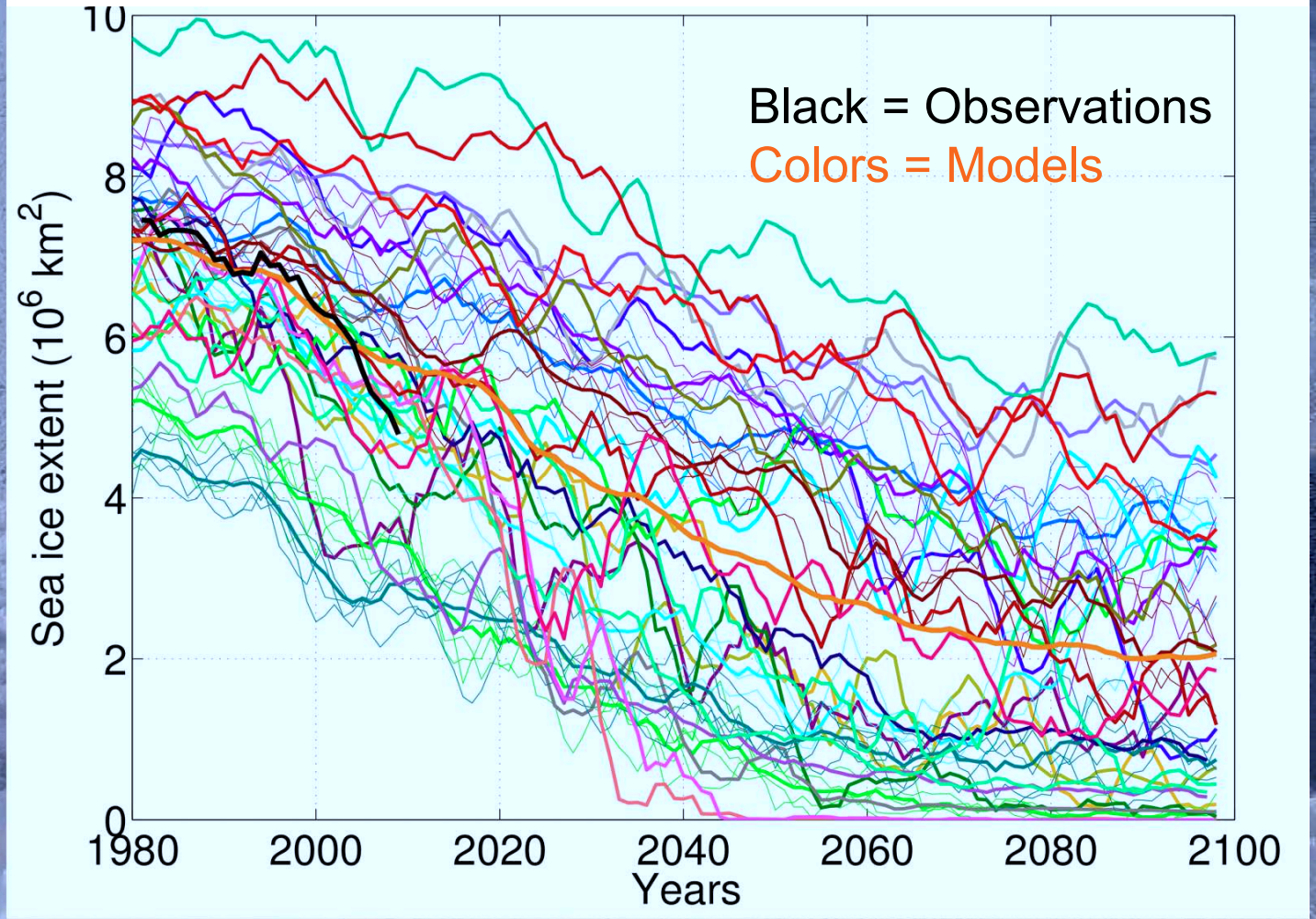

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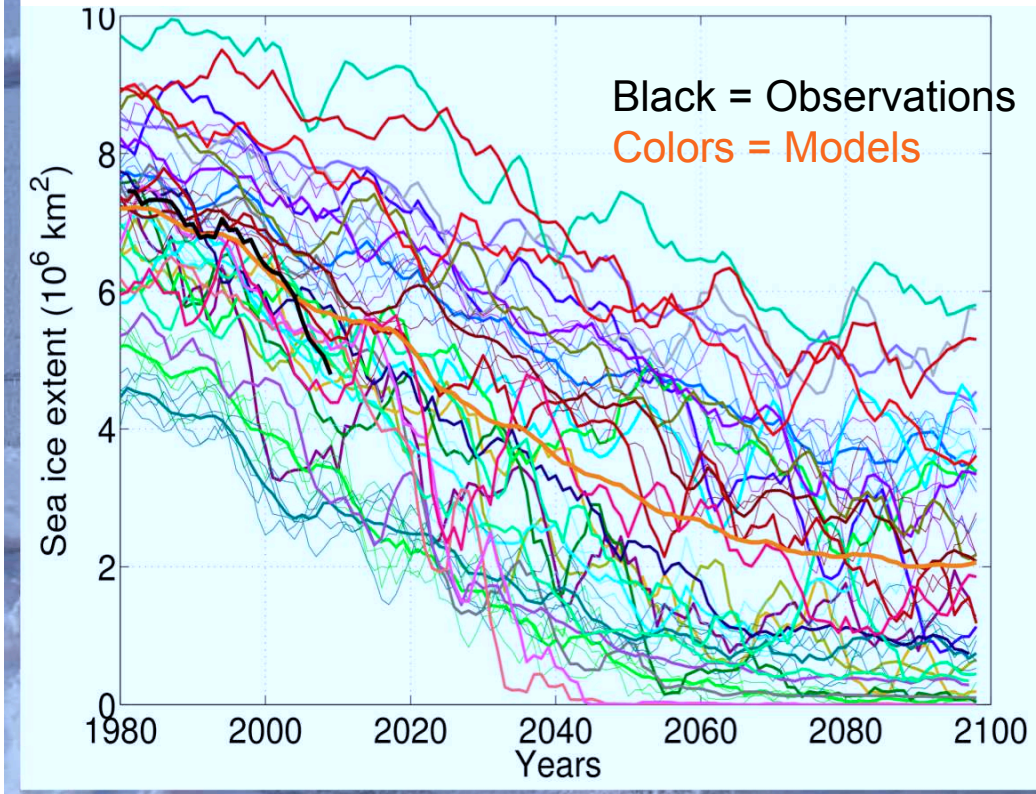
Figure from Massonett et al 2013

Annual September Sea Ice
Model Projections – High Emissions Scenario



Notes: Climate model projections from CMIP5 have a wide spread, but the ensemble mean agrees well with the observed sea ice cover loss for Septembers prior to 2000. The models are capable of exhibiting 5-10 year periods of even more rapid ice loss than has been observed since 2000. However, the rapid ice loss periods are not in sync with the observed ice loss due to random internal (sometimes called natural) variability.

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Figure from Massonett et al 2013

Sea Ice Concentrations in 2030 Projections

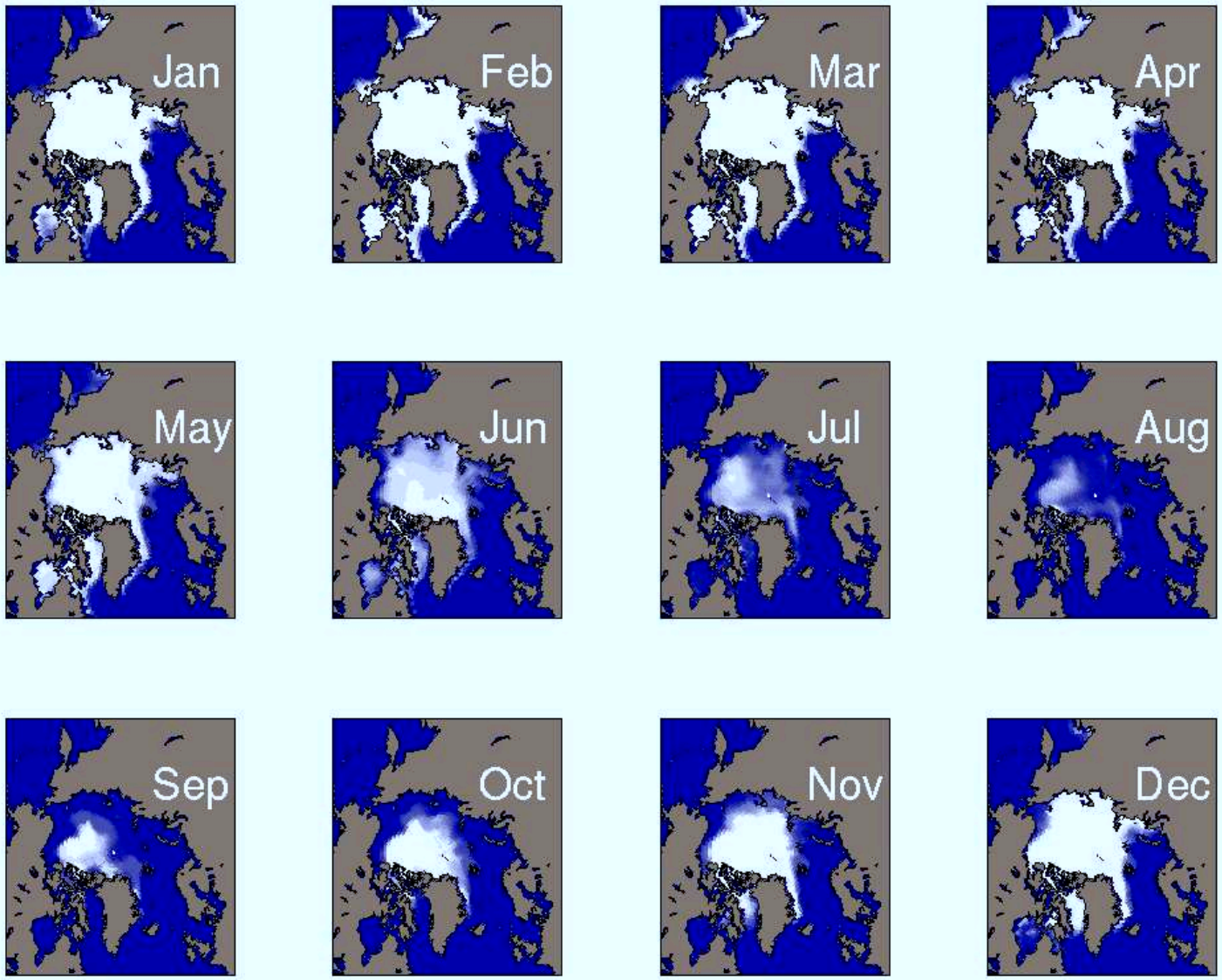
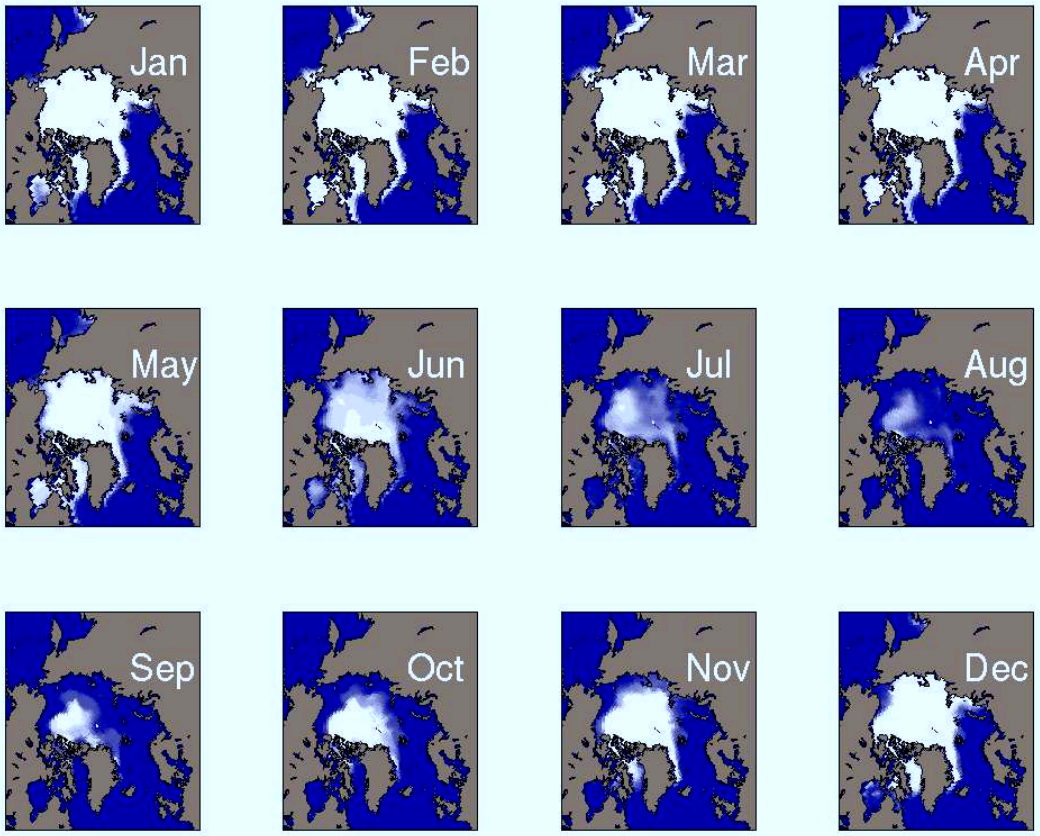


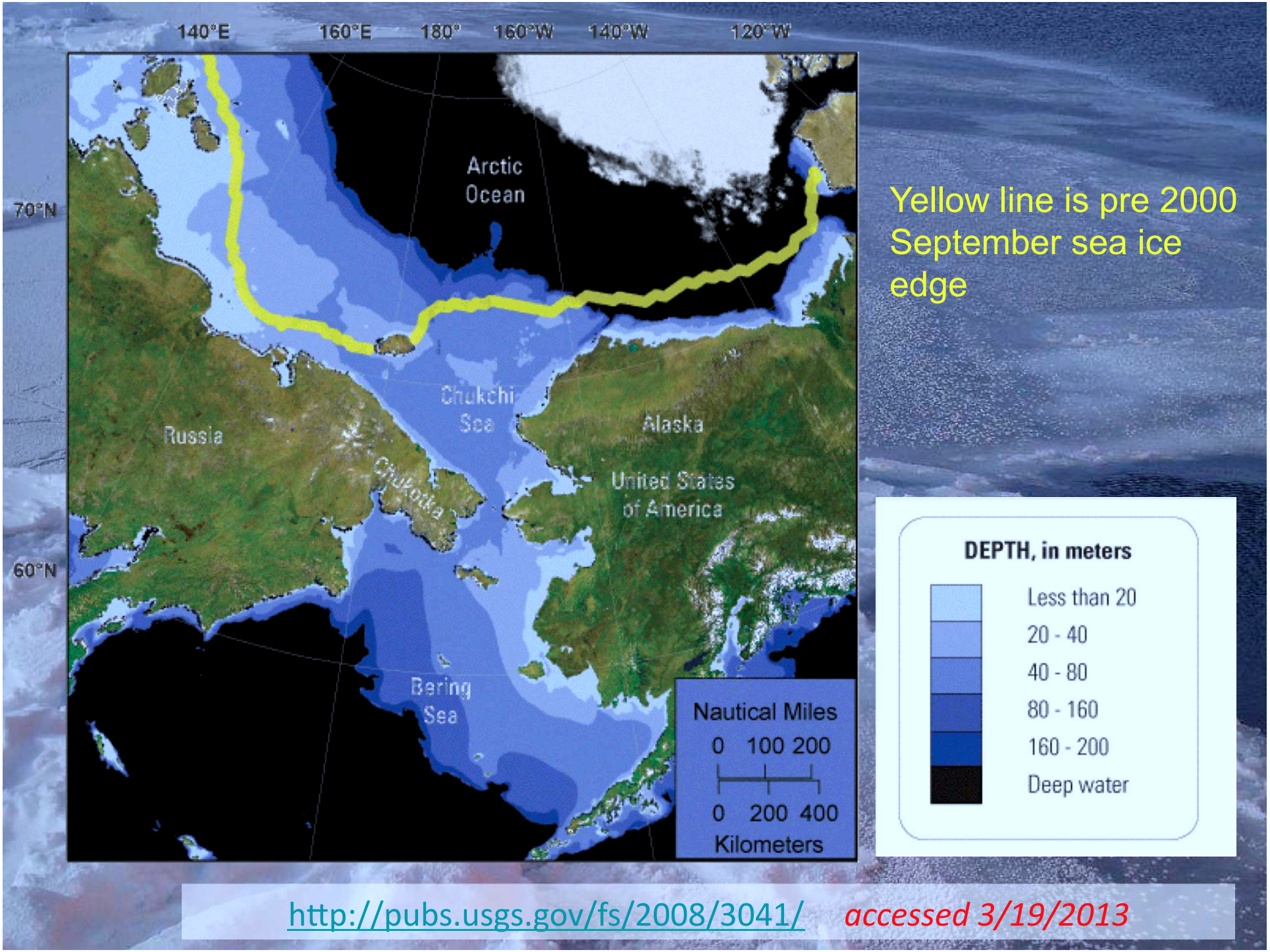
Figure made for this presentation with CMIP5 data but with a subset that are most successful at matching observations. Moderate emissions scenario

Sea Ice Concentrations in 2030 Projections



Notes: Climate model projection for each month in 2030 from a subset of seven models. The sea ice cover is very low for September and August, while in winter months, the ice is still considerable. High winter ice cover will likely last for at least another century. A concentration of 50% at a given location can indicate either half of models have complete ice-covered and half have open water or all models have a mixture of half ice and half open water.

Figure made for this presentation with CMIP5 data but with a subset that are most successful at matching observations. Moderate emissions scenario



http://pubs.usgs.gov/fs/2008/3041/ *accessed 3/19/2013*

Notes: In the last decade the sea ice in late summer no longer covers the continental shelves (the light blue regions in the figure). The continental shelves are biologically rich due to nutrients in runoff from land and cycling from sediments. When the sea ice shrinks, animals on the sea ice cannot access marine biology on the shelves. The increase in light availability shifts species' success below the surface as well.

http://pubs.usgs.gov/fs/2008/3041/ *accessed 3/19/2013*

Snow on Sea Ice
Model Projections – High Scenario

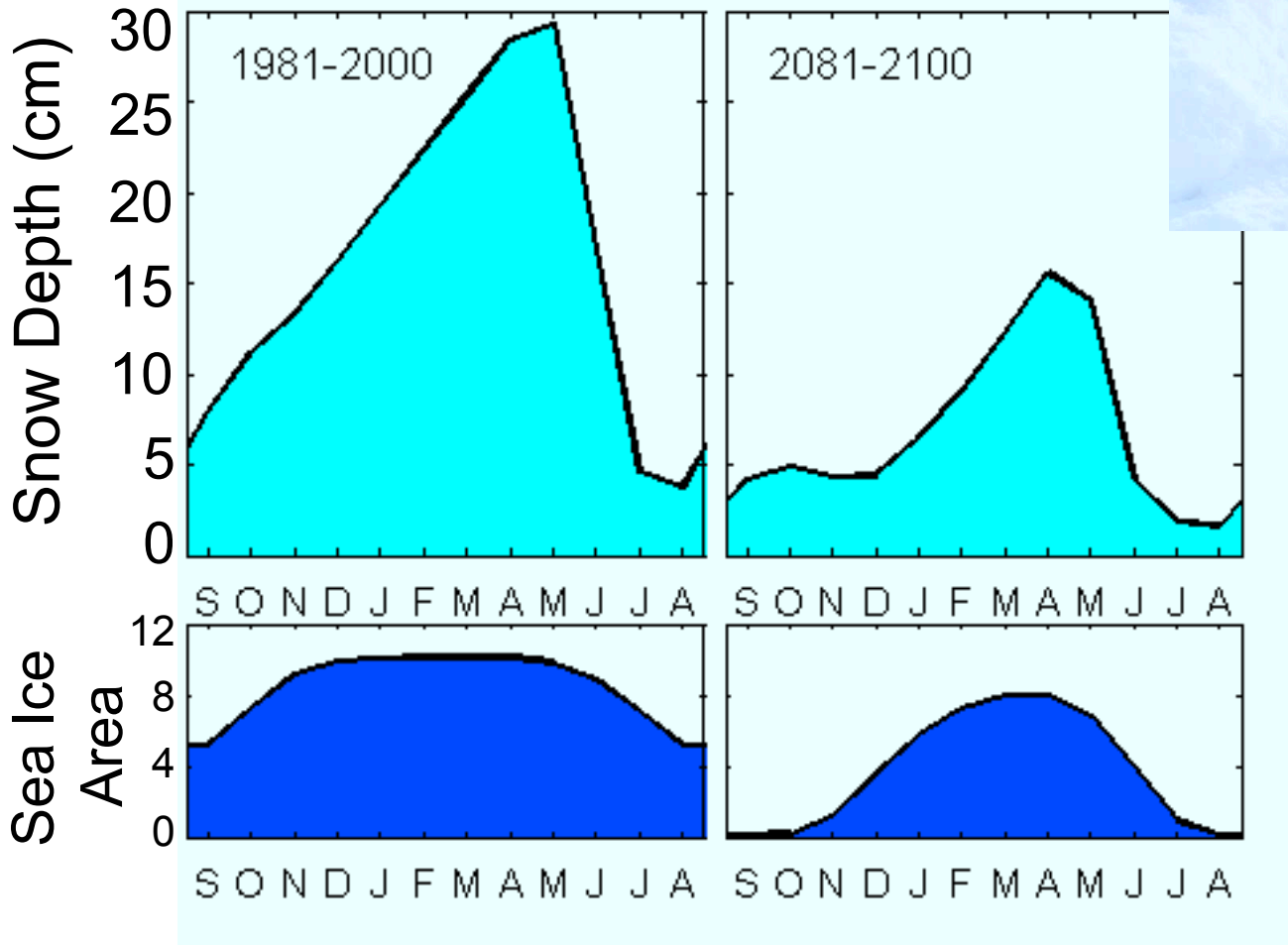
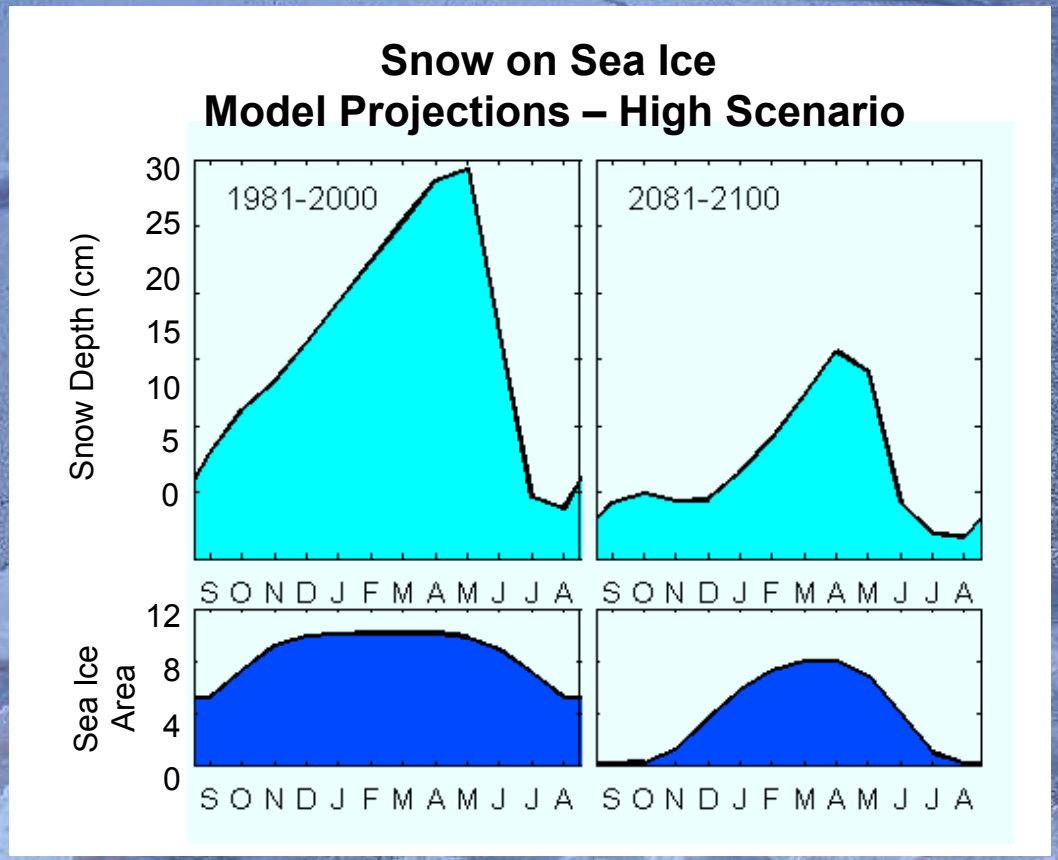


Figure from Hezel et al 2012



Notes: Even though sea ice area loss is greatest in summer, the impacts are year round. With low sea ice cover in late summer and fall, early snow falls into open water and doesn't begin to accumulate on vast areas of the Arctic until ice returns in winter. Ringed seals build caves in snow to make birth lairs. They require a minimum snow depth so their caves do not collapse. Late this century, the area of sea ice with sufficient snow depth is greatly diminished.

Figure from Hezel et al 2012

Newtok Village
Alaska

http://www.nytimes.com/2007/05/27/us/27newtok.html?_r=1
accessed 3/19/2013

Notes: Climate models have shown that sea ice loss causes surface air temperatures to increase over sea ice and 100s of miles inland on the perimeter of the Arctic Ocean. Warmer land surfaces causes permafrost degradation that weakens the structural integrity of the land and can damage infrastructure and alter ecosystems. The landscape in this village is uneven due to permafrost melting.

Newtok Village
Alaska

http://www.nytimes.com/2007/05/27/us/27newtok.html?_r=1

accessed 3/19/2013