CLIMATE CHANGE AND UNCERTAINTY: IMPLICATIONS FOR CANADA LYNX CONSERVATION AND MANAGEMENT IN THE CONTIGUOUS US

CLIMATE MODELING 101

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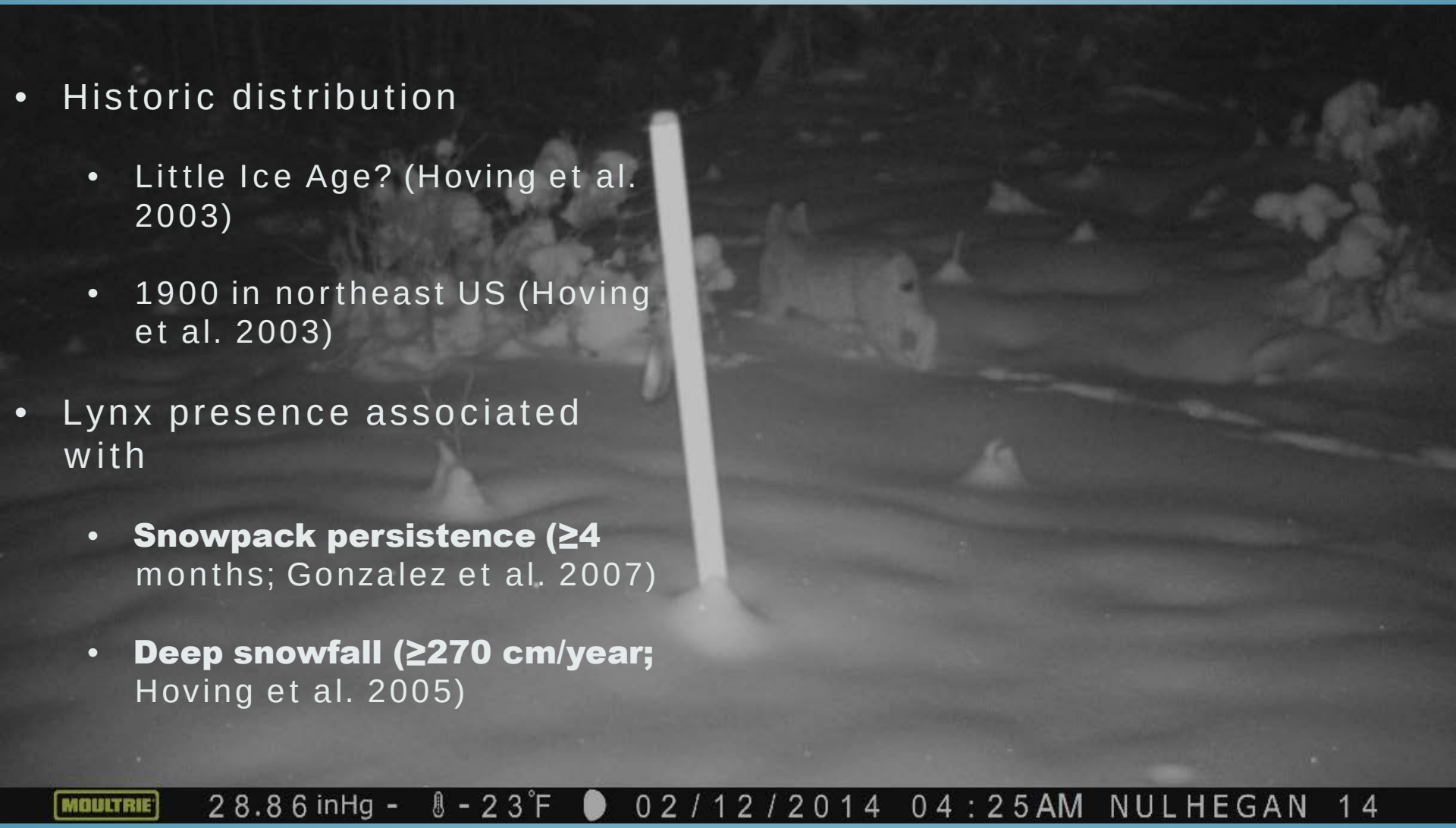
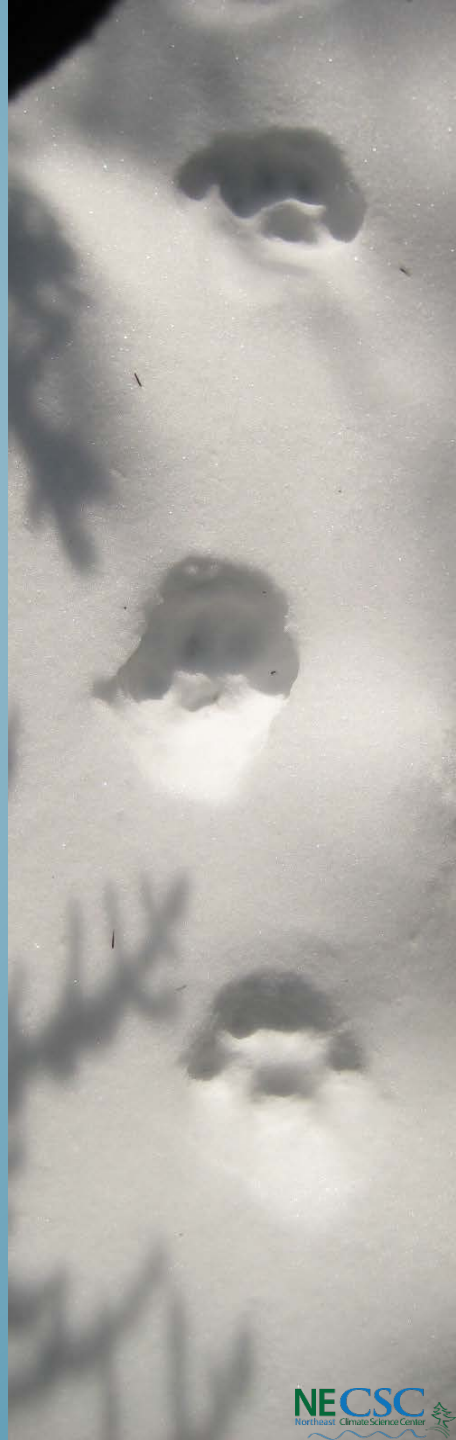
Lynx distribution and climate

- Historic distribution
  - Little Ice Age? (Hoving et al. 2003)
  - 1900 in northeast US (Hoving et al. 2003)
- Lynx presence associated with
  - **Snowpack persistence (≥4** months; Gonzalez et al. 2007)
  - **Deep snowfall (≥270 cm/year;** Hoving et al. 2005)



How else may climate influence lynx?

- Population cycles (Hone et al. 2011) and declines (Yan et al. 2013)
- Population viability (Carroll 2007)
- Increased competition with sympatric carnivores (Parker et al. 1983, Peers et al. 2013)
- Reduced genetic diversity (Koen et al. 2014)
- Access to hares (Watt 1973, Stenseth et al. 2004)
- Coat color mismatch (Mills et al. 2013, 2014)



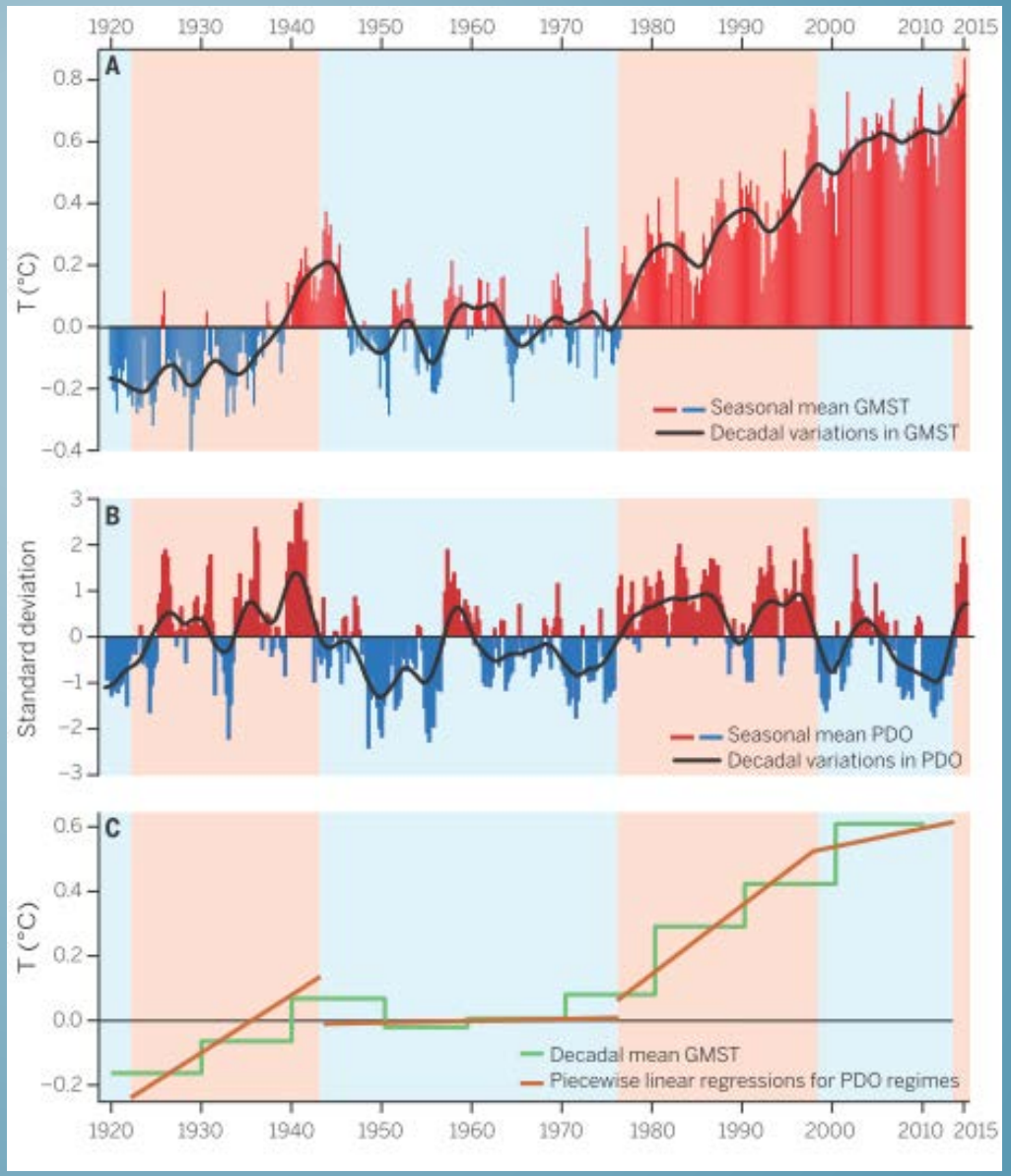
Increase in global mean surface temperature (GMST)

-Natural variation can mask change, especially short-term

-Attributed to the recent "climate hiatus" (15 yrs)

-Overall trend is towards increased global temps especially after mid-1970s

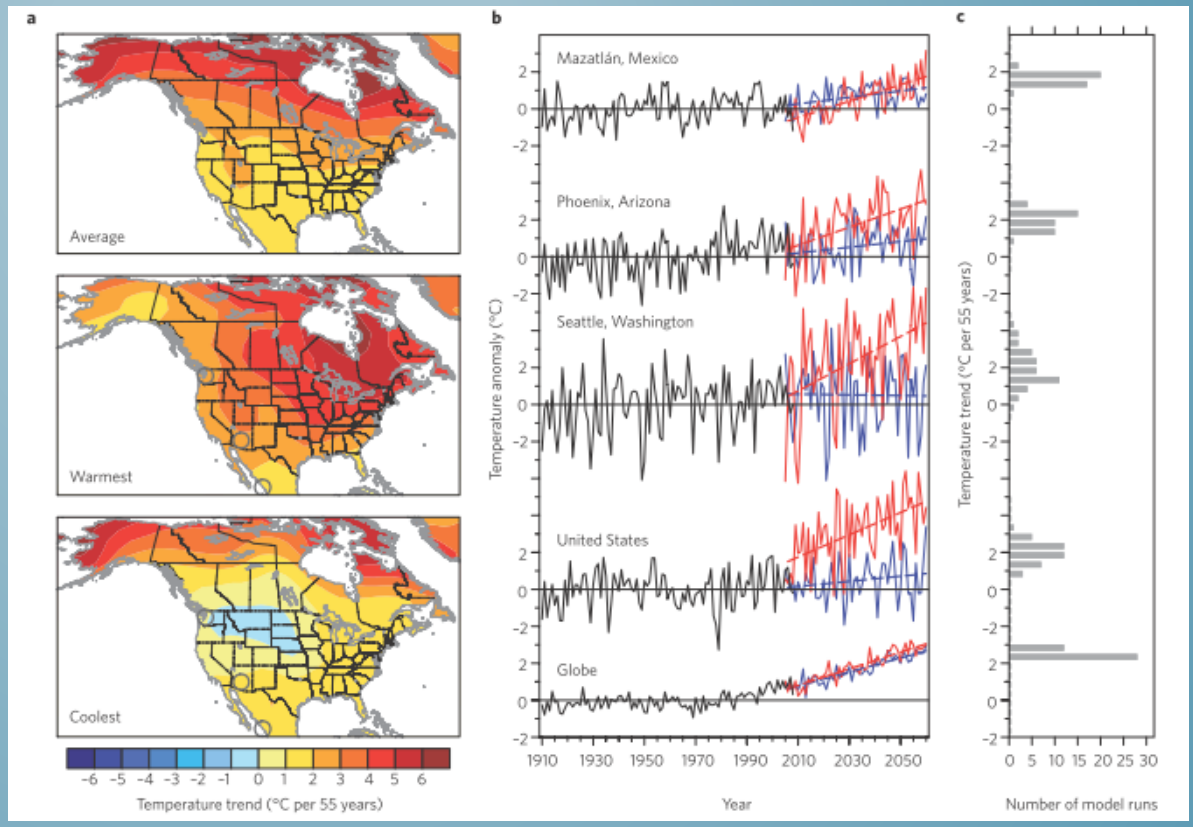
-GMST may be increasing due to latest El Nino event



Seasonal GMST temperature trends compared to century mean (Trenberth 2015)

Climate change and uncertainty in North America

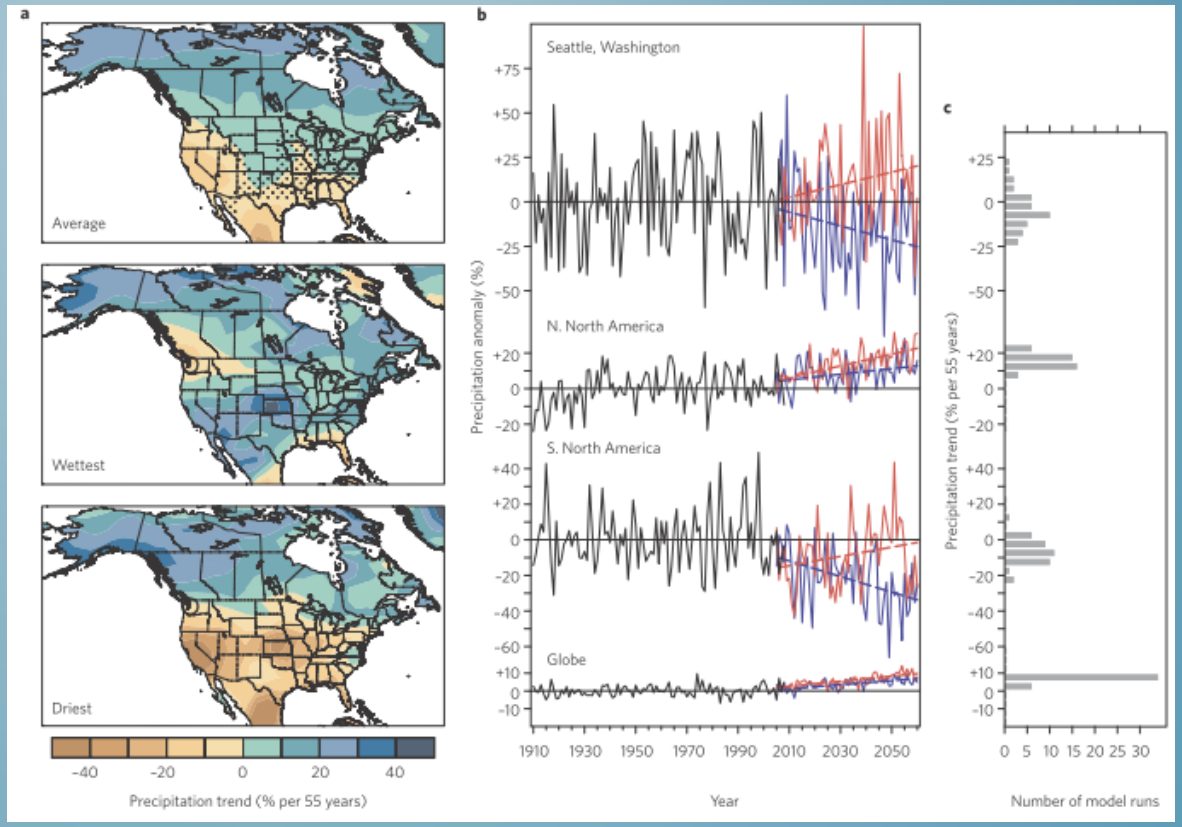
- Winter temperature projections
  - Average of 40 model runs and warmest and coolest scenarios
  - Overall increase in winter temperature with greatest increase in northeast US
  - Uncertainty given emission scenarios



Observed winter temperature and predictions based on common record (Deser et al. 2013)

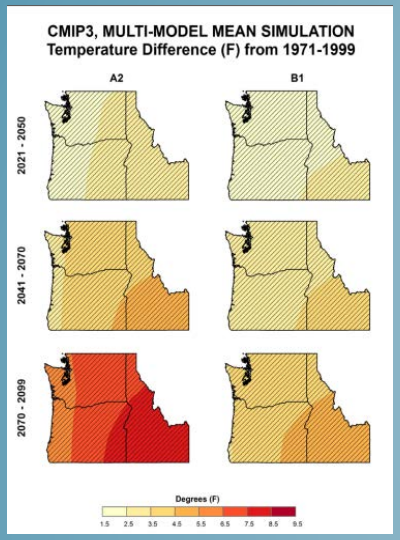
Climate change and uncertainty in North America

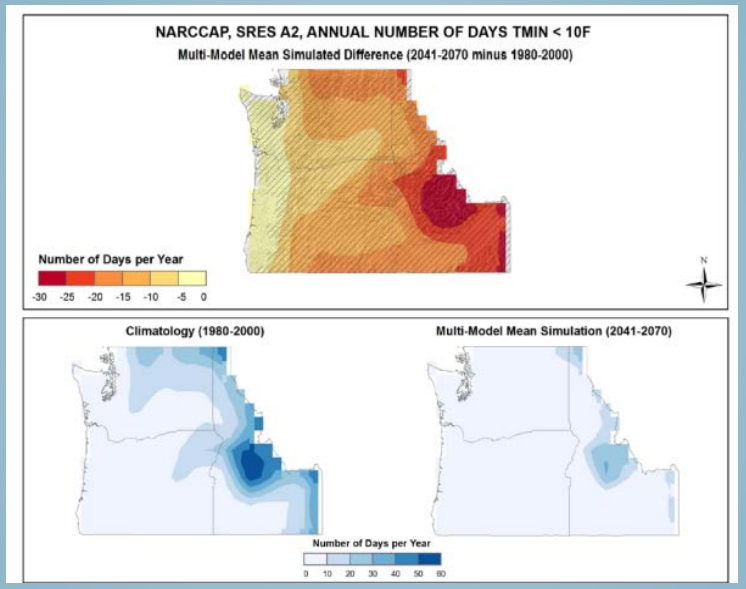
- Winter precipitation projections
  - Average of 40 model runs and wettest and driest scenarios
  - Increase in precipitation in eastern US and
  - Drier in the Northwest US
  - Uncertainty given emission scenarios and spatial formation of clouds

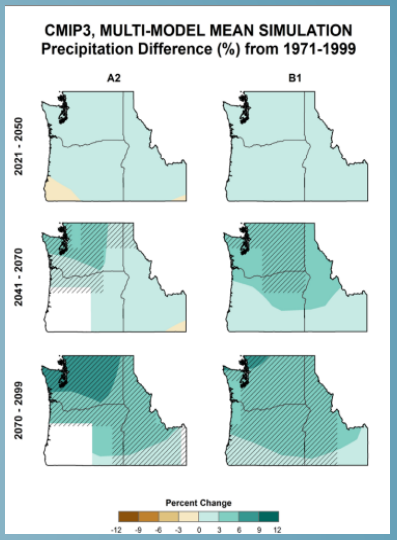


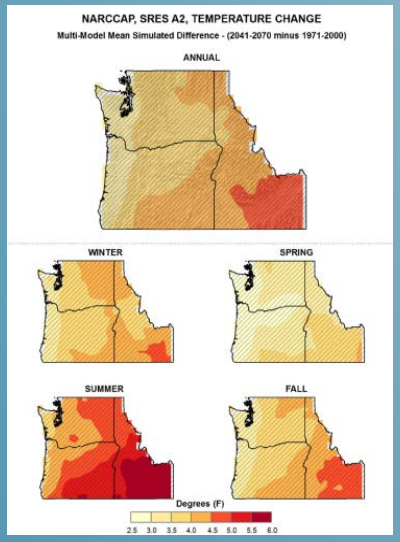
Observed winter precipitation and predictions based on common record (Deser et al. 2013)

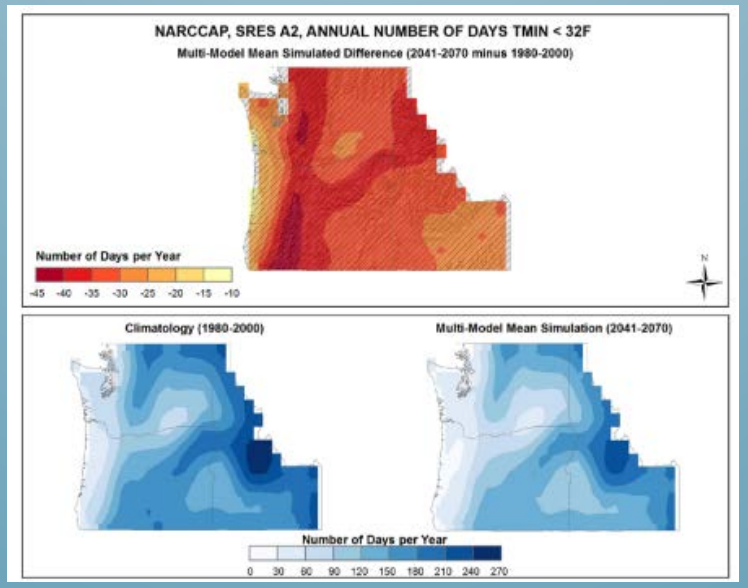
Northwestern US: Predicted climate change

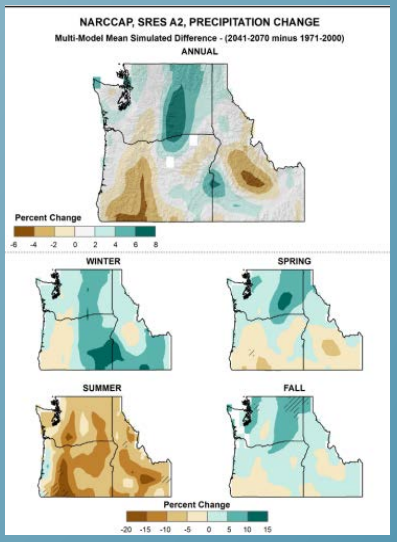












Figures from Kunkel et al. (2013)

Northwestern US: Snowpack trends and projections

- Recent trends
  - Decrease in spring snowpack at lower elevations but unequivocal at high elevation (Mote et al. 2008)
  - Overall decline in snowpack the latter half of the 20th century (Mote et al. 2005; Pierce et al. 2008)
  - Decrease in overall snowpack (Pierce and Cayan 2013; Knowles 2015)
  - Lower proportion of winter precipitation occurring as snow (Knowles et al. 2006)
- Projections
  - Lower proportion of winter precipitation occurring as snow and reduced number of snowfall days (Pierce and Cayan 2013; Lute et al. 2015)
  - Decrease in snowfall season and snowfall (Pierce and Cayan 2013).

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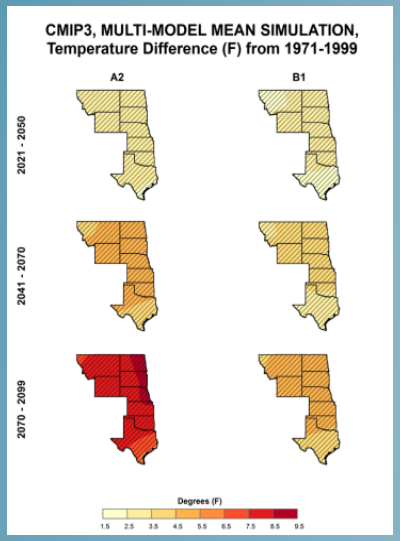
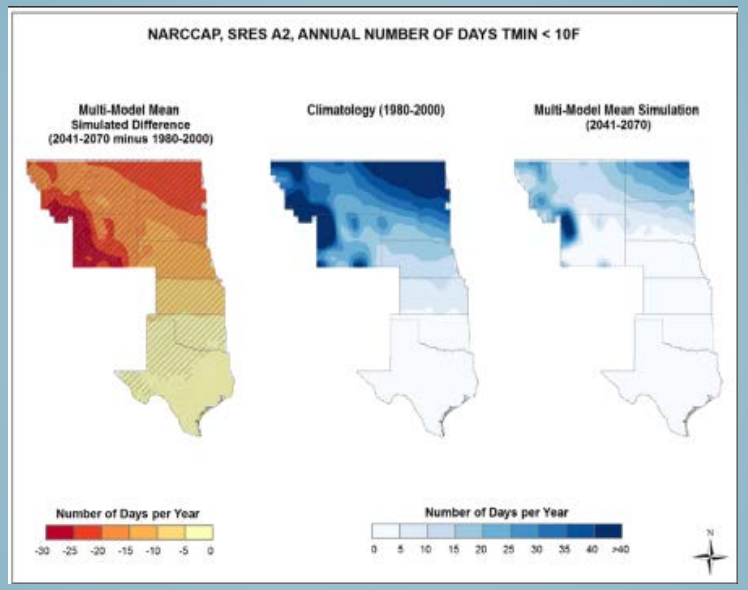
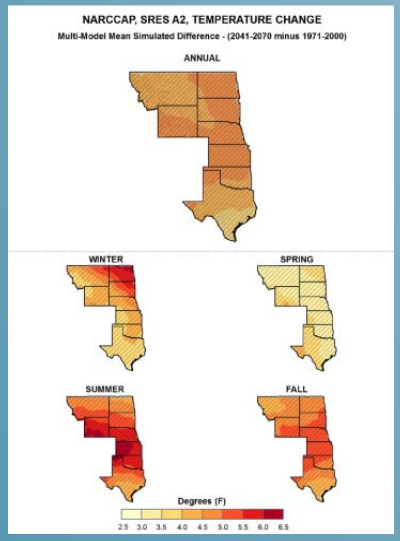
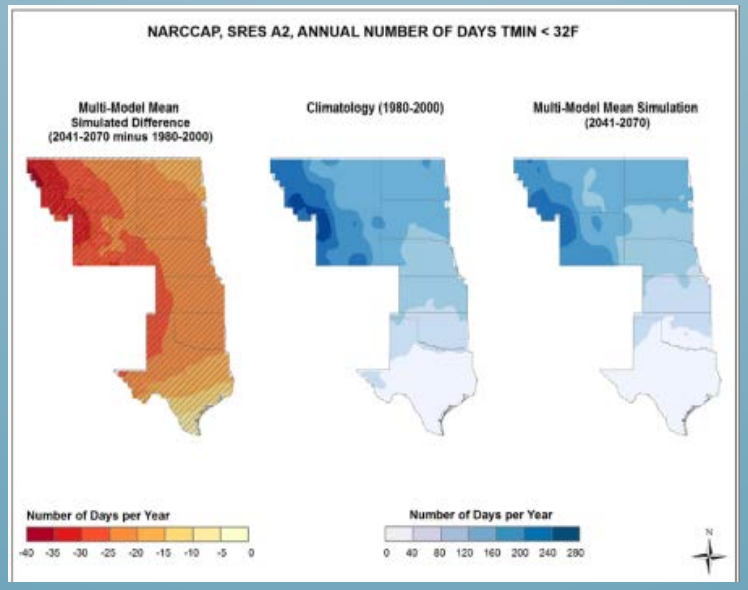
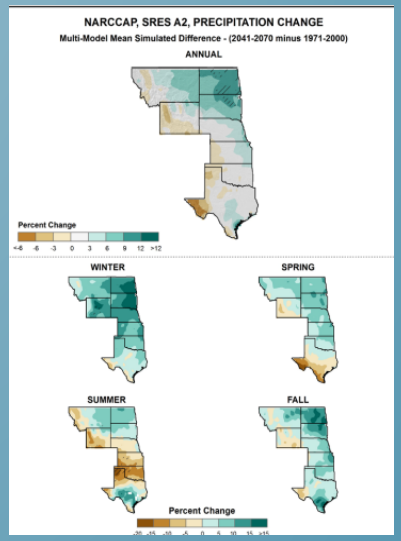
Northern Rockies: Predicted Climate Change











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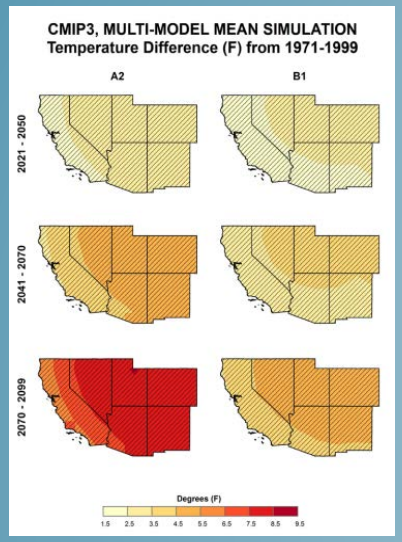
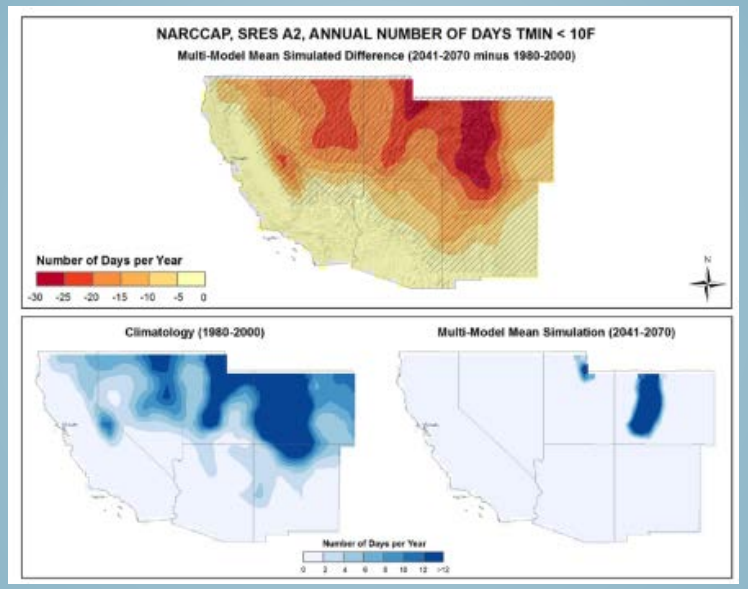
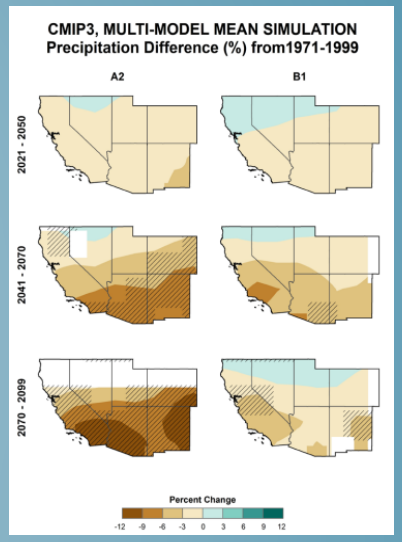
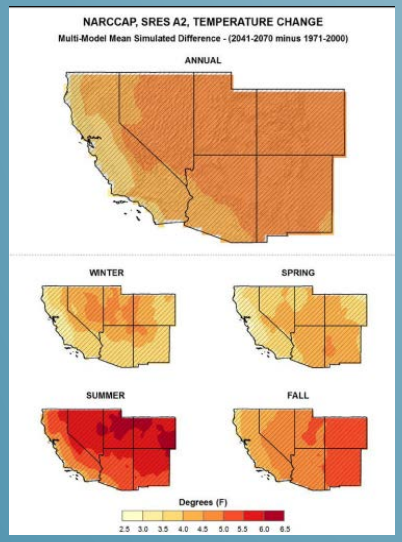
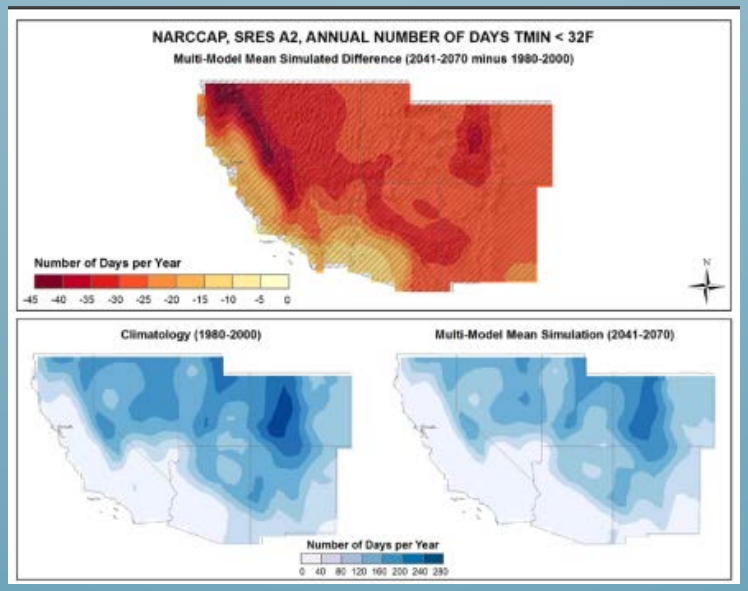
Southern Rockies: Predicted climate change

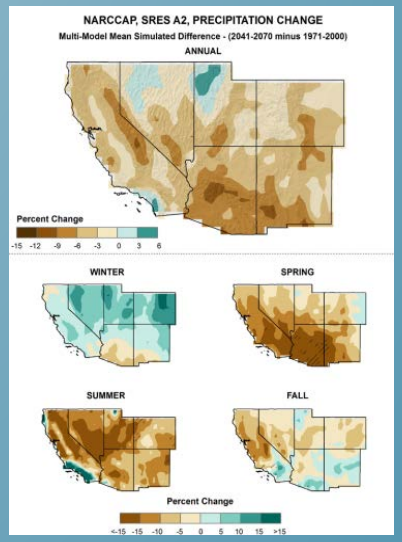










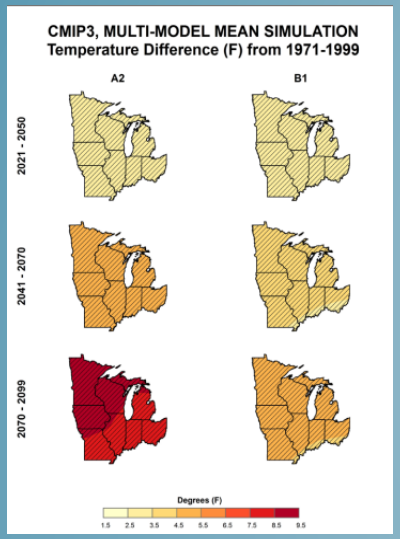


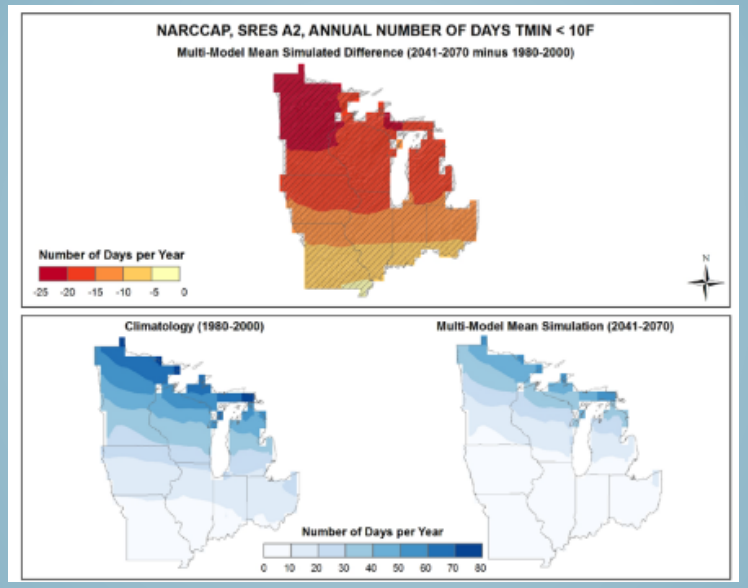
Figures from Kunkel et al. (2013)

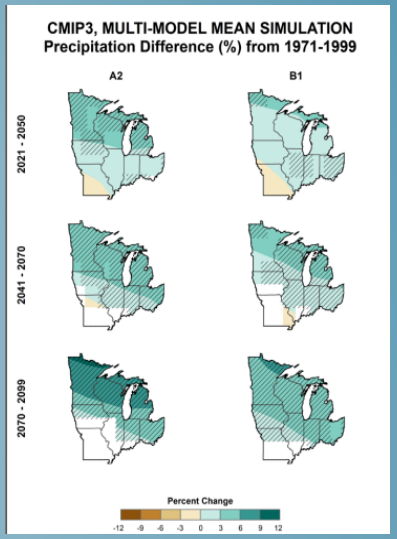
Northern & Southern Rockies: Snowpack trends and projections

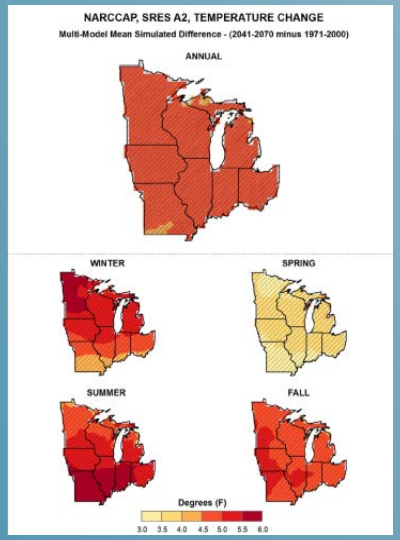
- Recent trends
  - Overall decline in snowpack the latter half of the 20th century (Pierce et al. 2008).
  - Decrease in overall snowpack (Knowles 2015).
  - Lower proportion of winter precipitation occurring as snow (Knowles et al. 2006; Pierce and Cayan 2015).
- Projections
  - Lower proportion of winter precipitation occurring as snow and reduced number of number of snowfall days (Pierce and Cayan 2013; Lute et al. 2015)
  - Decrease in snowfall season and snowfall (Pierce and Cayan 2013).

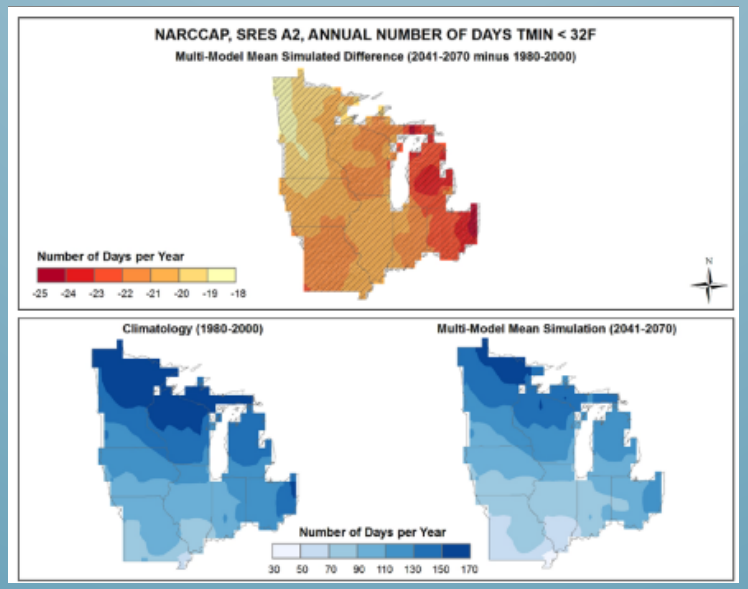
Great Lakes: Predicted Climate Change

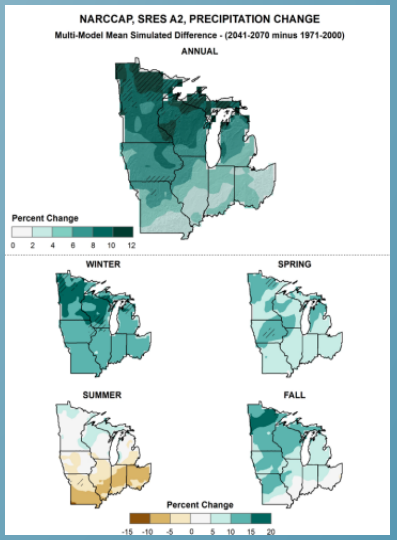










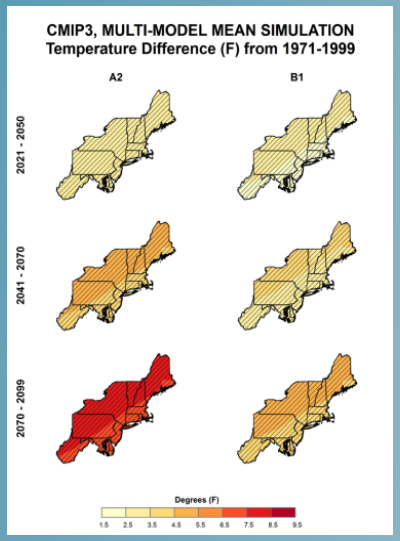


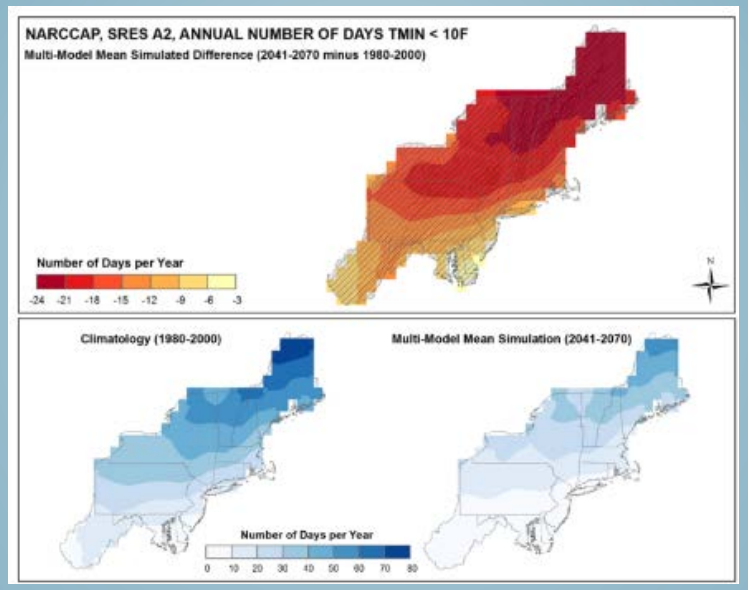
Figures from Kunkel et al. (2013)

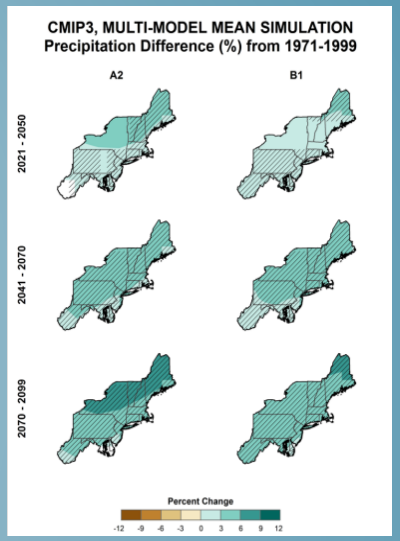
Great Lakes: Snowpack trends and projections

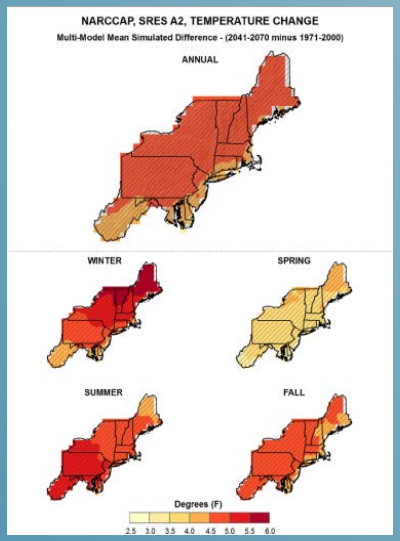
- Recent trends
  - Increase in lake effect snow (Andresen et al. 2012) and longer snow seasons (Kunkel et al. 2007; Knowles 2015) to the north.
- Projections
  - Increased winter precipitation throughout Midwest, but lower proportion occurring as snow (Notaro et al. 2014; Suriano and Leathers 2015).
  - Increased lake effect snow around Lake Superior with eventual decline towards end of century (Notaro et al. 2015).
  - Increased lake effect snow north of eastern Great Lakes then gradual decline (Suriano and Leathers 2015)
  - Decline in snowfall and length of snowpack coverage (Notaro et al. 2014; Notaro et al. 2015)

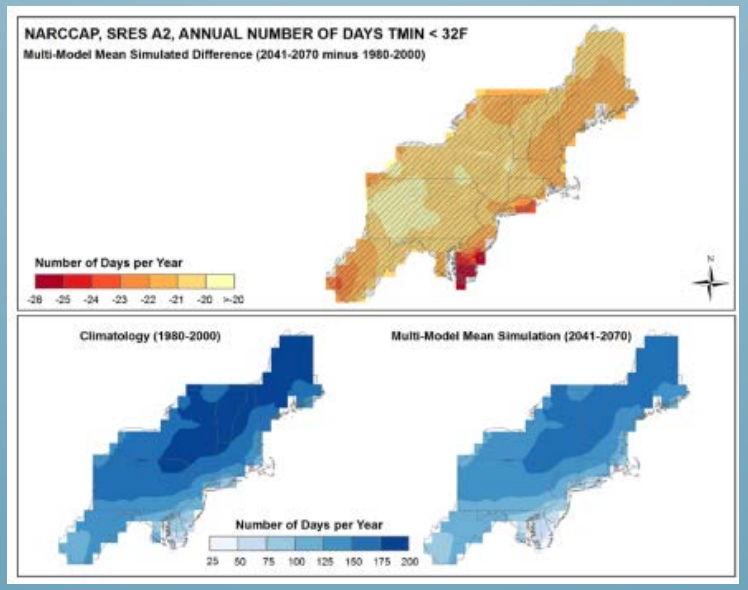
Northeast: Predicted Climate Change

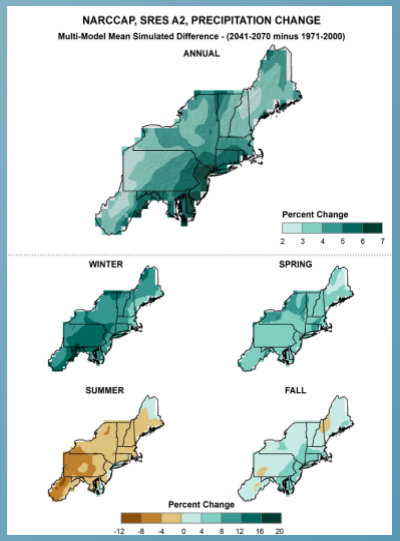












Figures from Kunkel et al. (2013)

Northeast: Snowpack trends and projections

- Recent trends
  - Reduction in number of snow covered days (Burakowski et al. 2008; Campbell et al. 2010; Bryan et al. 2015) and snowfall
  - Lower proportion of winter precipitation occurring as snow (Huntington et al. 2003; Brian et al. 2015)
- Projections
  - Increased winter precipitation (Rawlings et al. 2012; Notaro et al. 2014), but lower proportion occurring as snow
  - Decline in snowfall and length of snowpack coverage (Notaro et al. 2014)

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