North American Surface Climate Simulation in CCSM4 (C20th and RCPs)

Synte Peacock NCAR

CCSM4 1degree track1simulations:

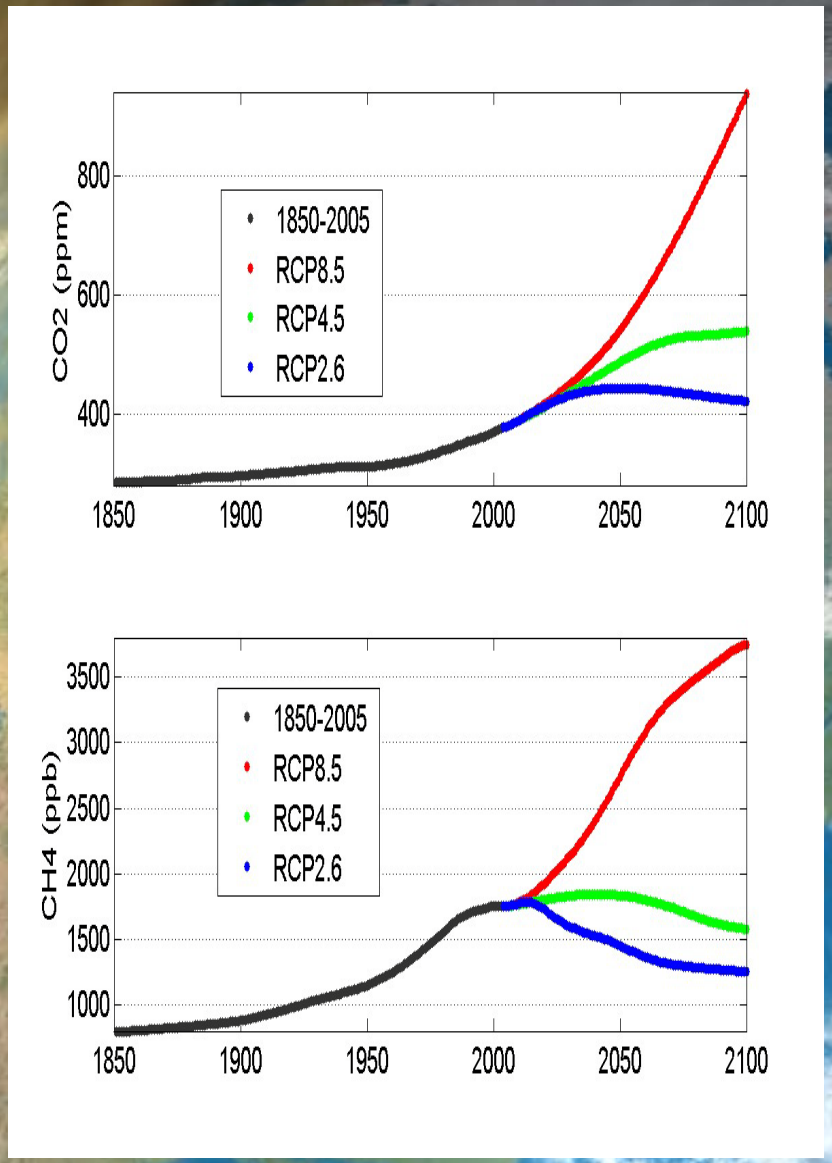
•1300 year "1850 control" run

• six 20th century ensembles (1850-2005)

• six ensemble members for each RCP (so far RCP2.6, 4.5 and 8.5 completed)

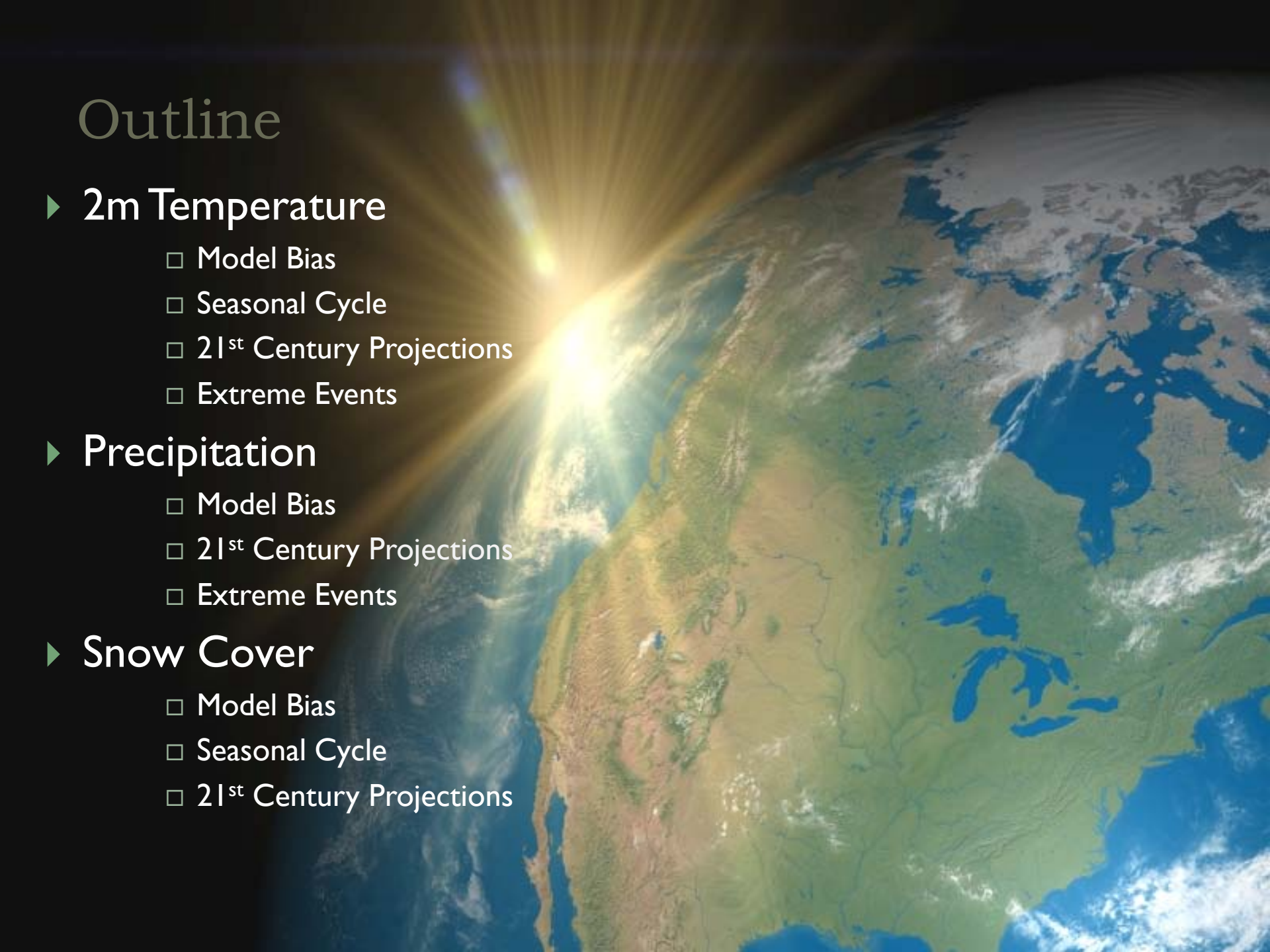
• In this talk results will be shown from C20th and RCP8.5 simulations; Results from other RCPs discussed in special issue paper

RCPs (Representative Concentration Pathways)

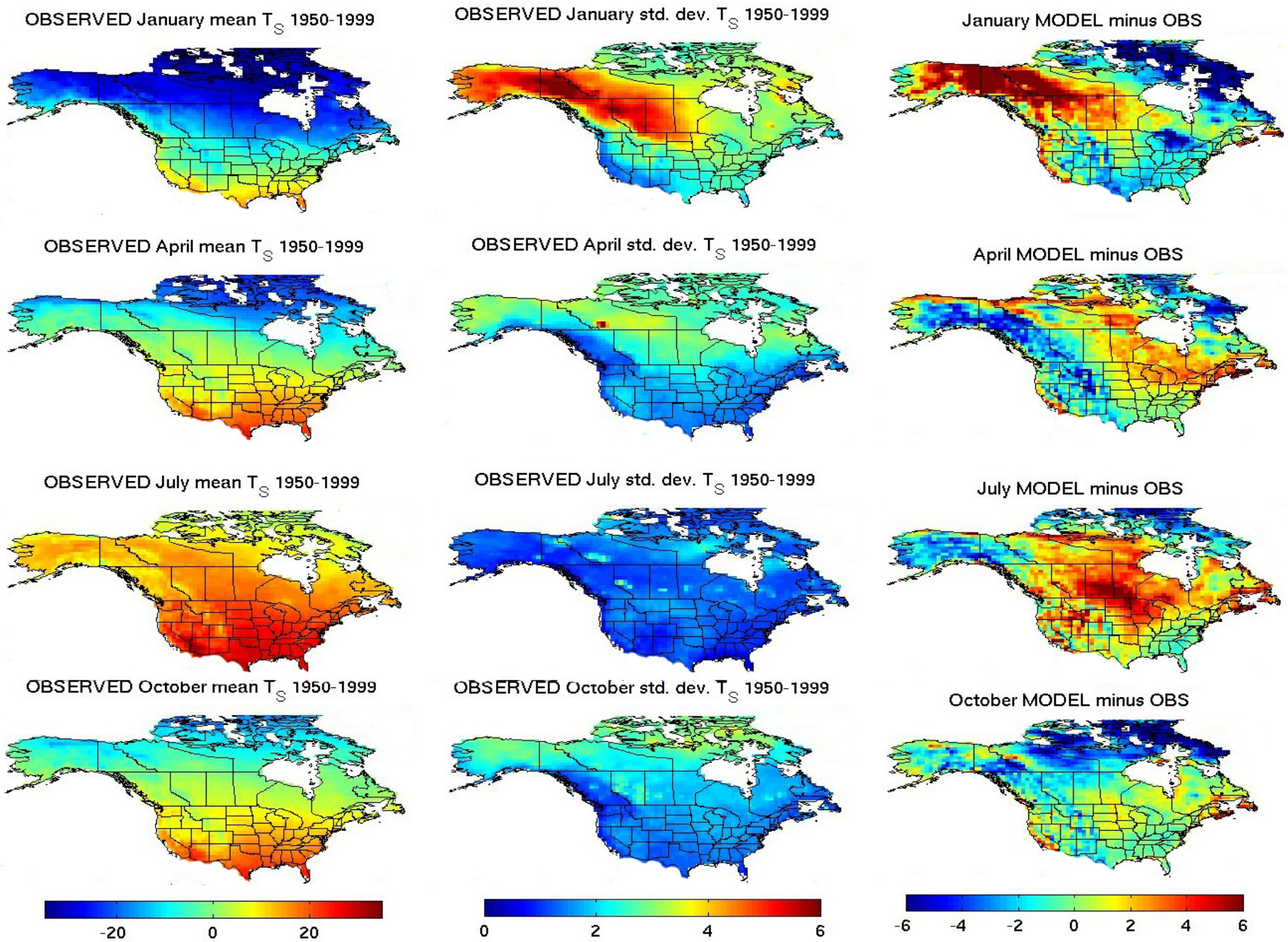


Outline

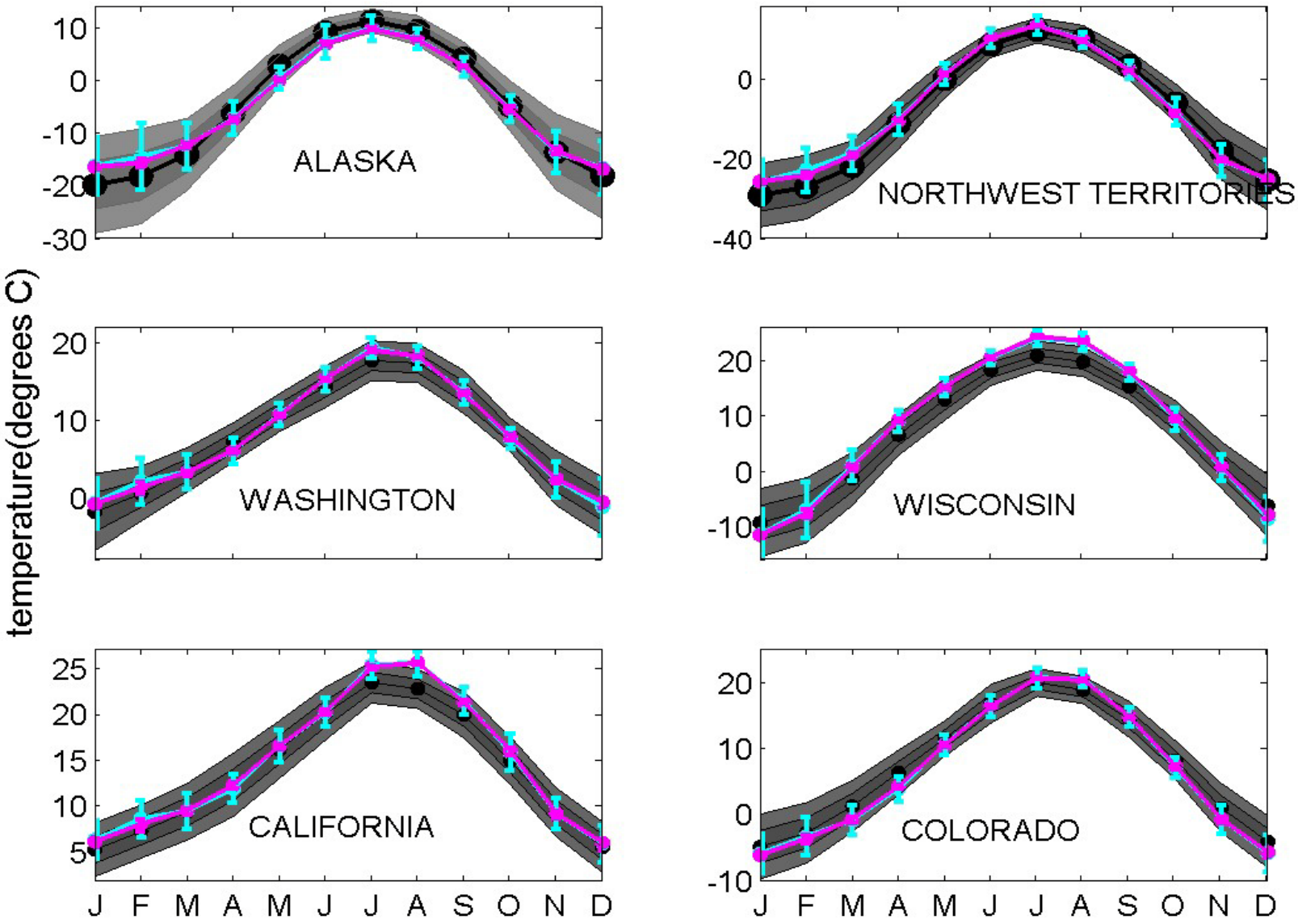
- 2m Temperature
  - Model Bias
  - Seasonal Cycle
  - 21st Century Projections
  - Extreme Events
- Precipitation
  - Model Bias
  - 21st Century Projections
  - Extreme Events
- Snow Cover
  - Model Bias
  - Seasonal Cycle
  - 21st Century Projections

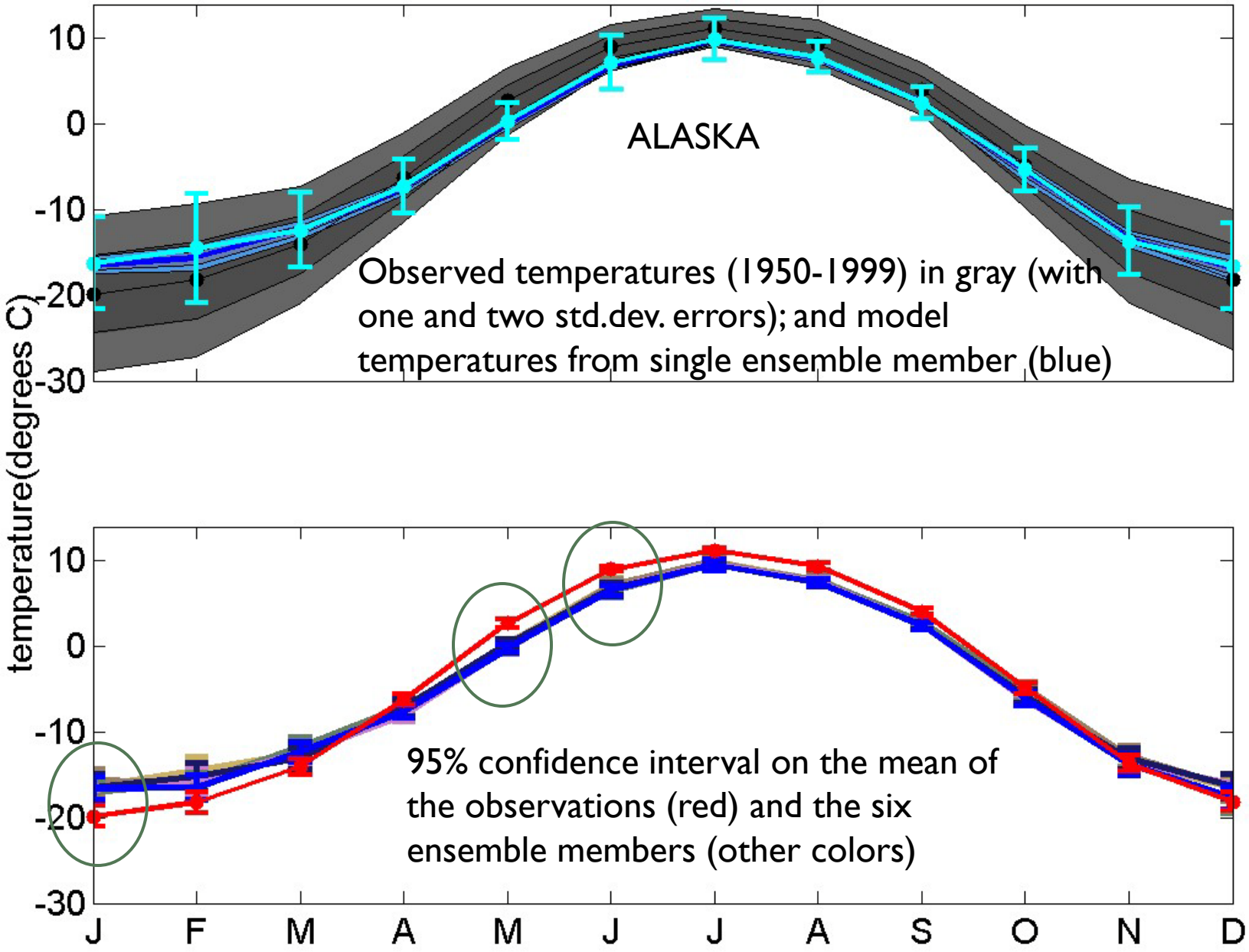


2m Temperature: Observations (mean and std. dev) and model bias

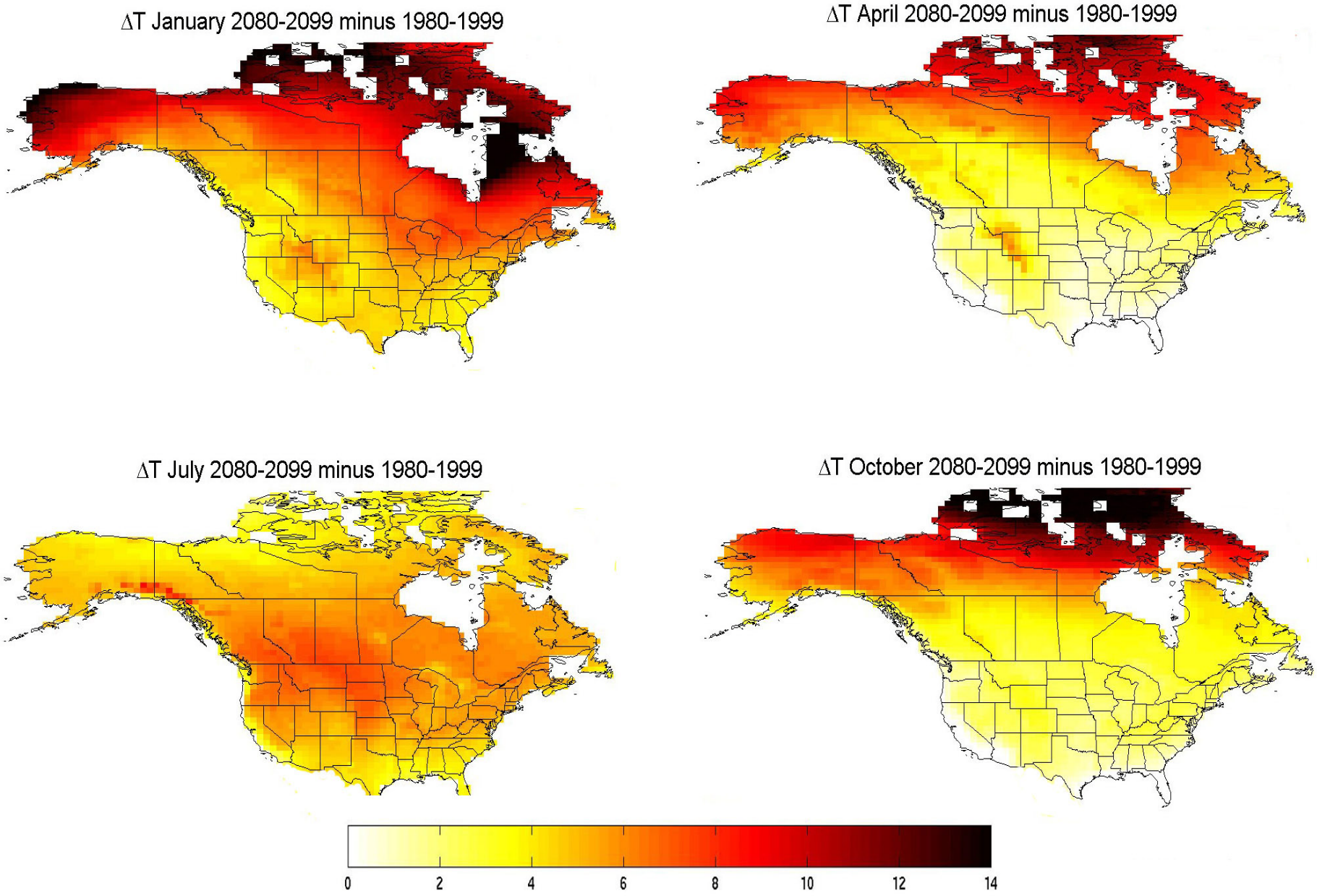


2m Temperature: Seasonal Cycle

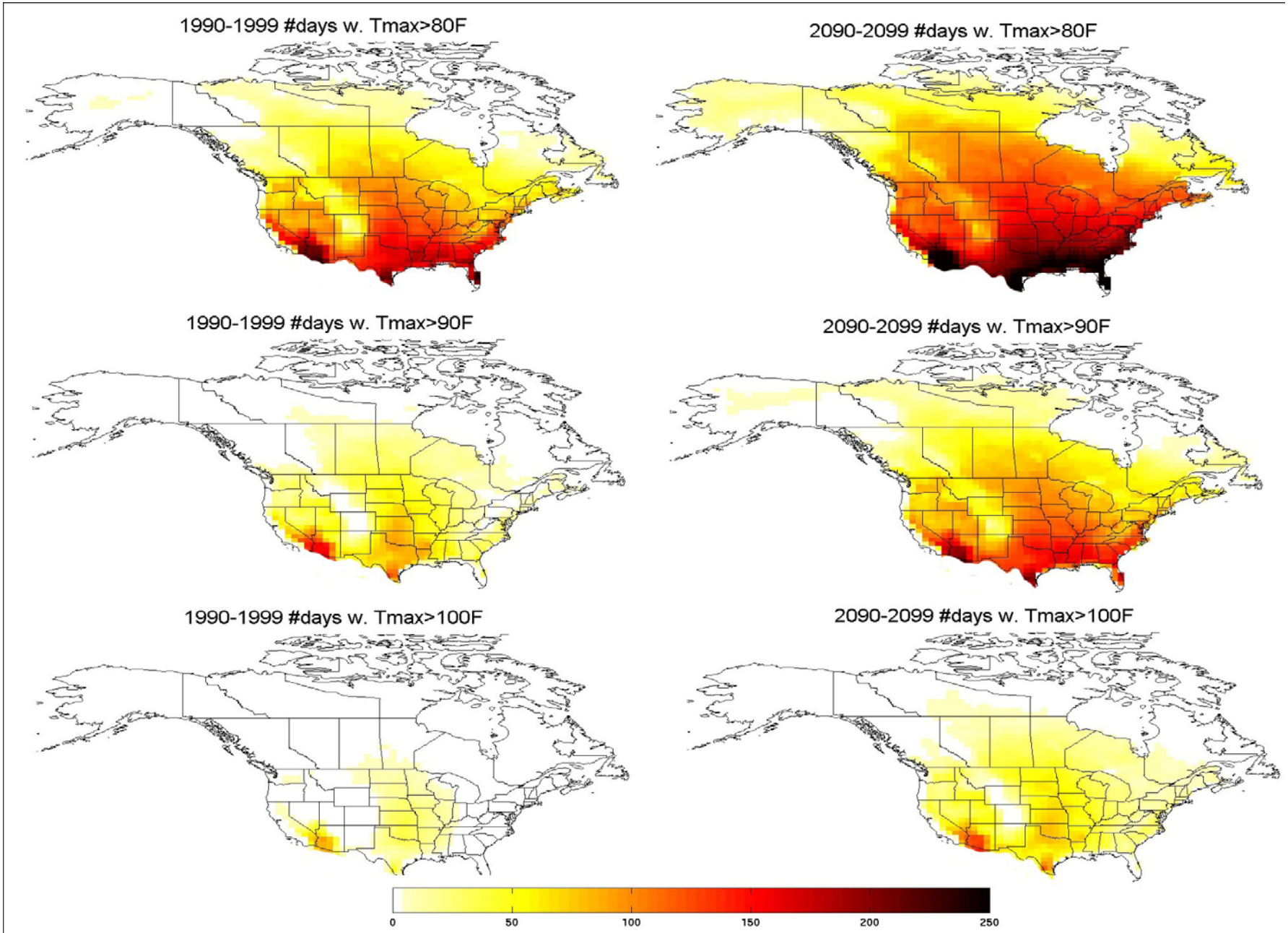



ALASKA
Observed temperatures (1950-1999) in gray (with one and two std.dev. errors); and model temperatures from single ensemble member (blue)
95% confidence interval on the mean of the observations (red) and the six ensemble members (other colors)
temperature(degrees C)
10
0
-10
-20
-30
J
F
M
A
M
J
J
A
S
O
N
D

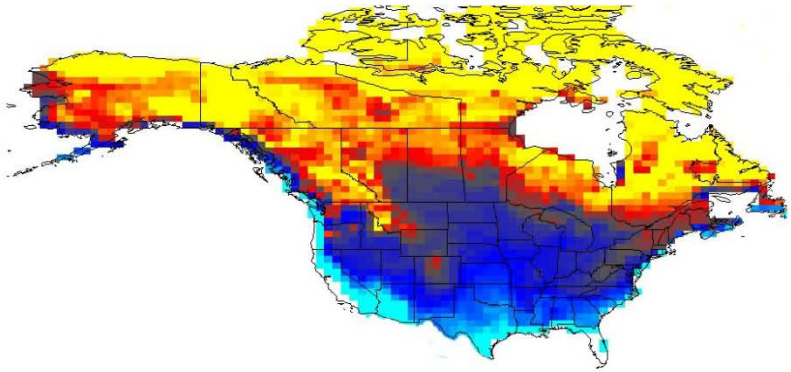
2m Temperature: 21st Century Projections

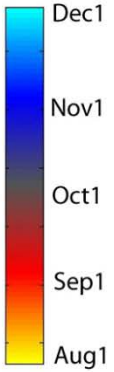


2m Temperature: Extreme Events

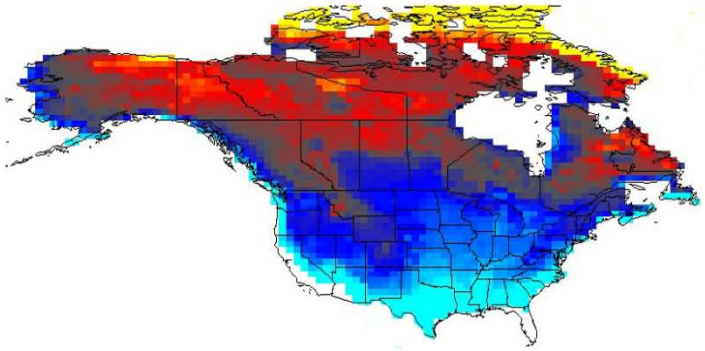


First Frost day 1990-1999

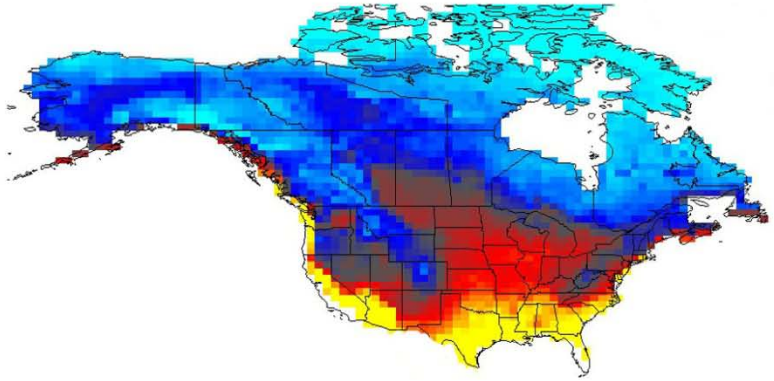


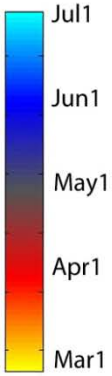


First Frost day 2090-2099

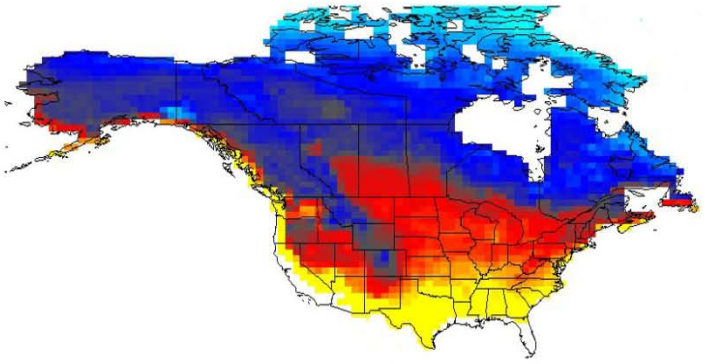


Last Frost day 1990-1999

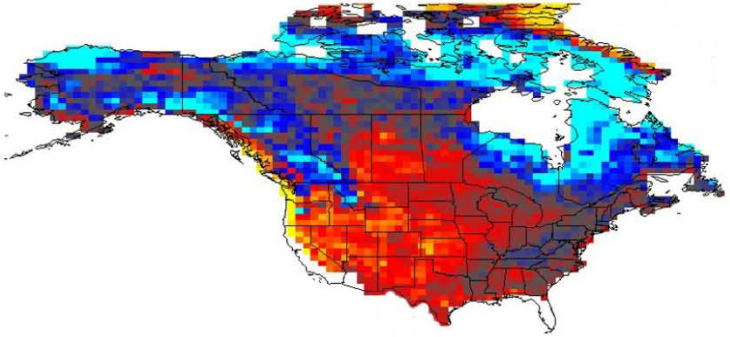


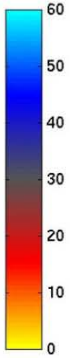


Last Frost day 2090-2099

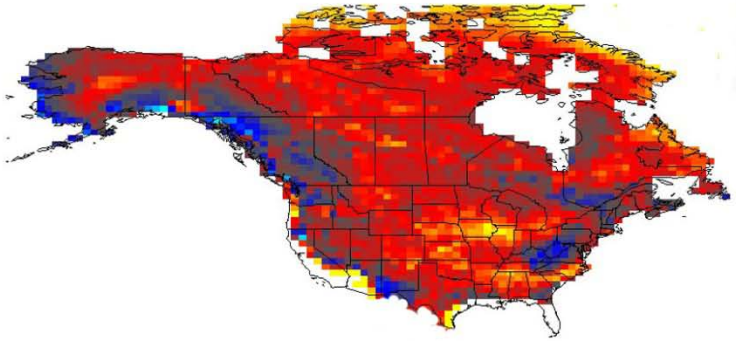


First Frost day difference 2090-2099 minus 1990-1999

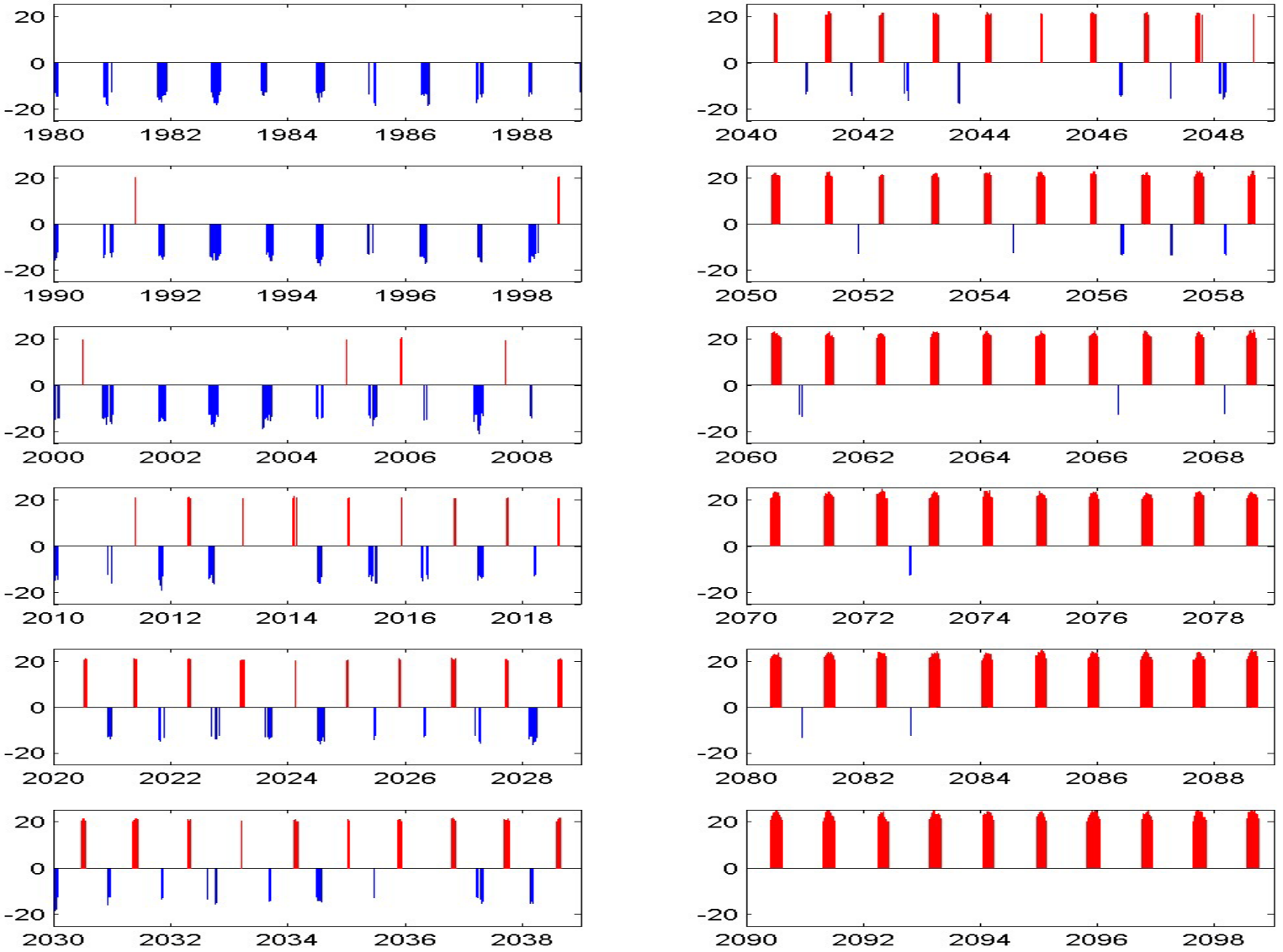




Last Frost Day difference 1990-1999 - 2090-2099

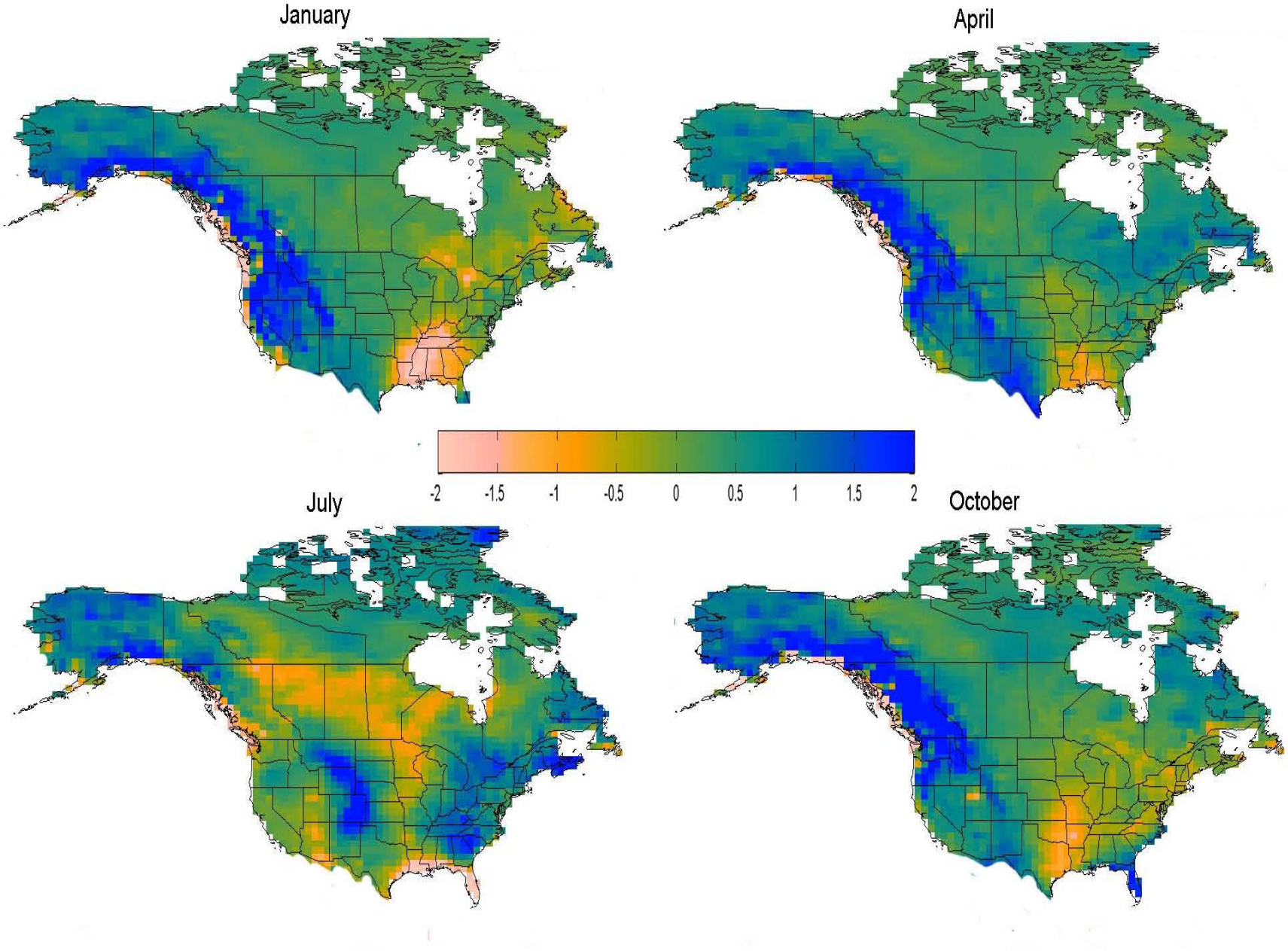


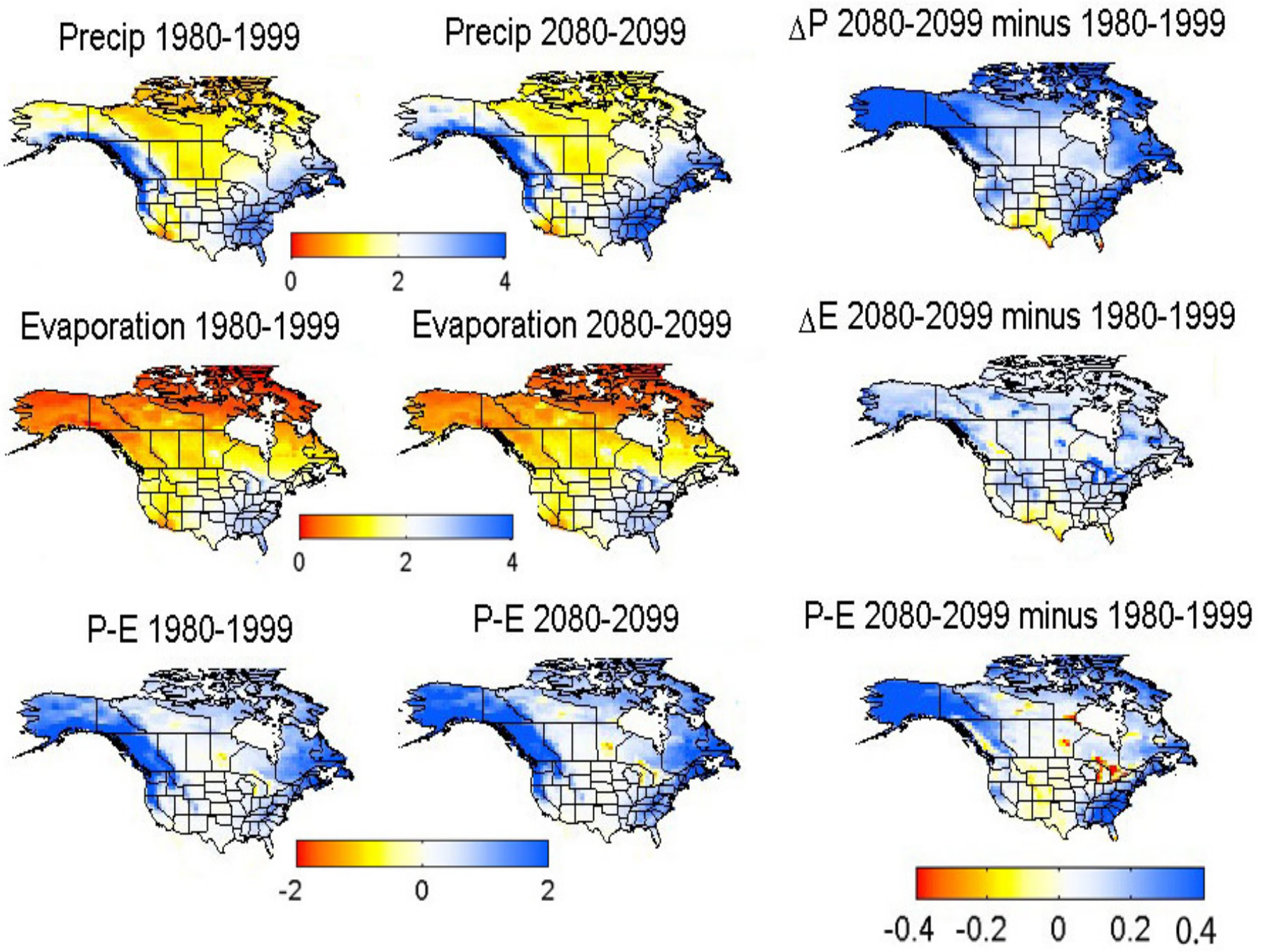
Cold Snaps and Heat Waves (RCP 8.5)

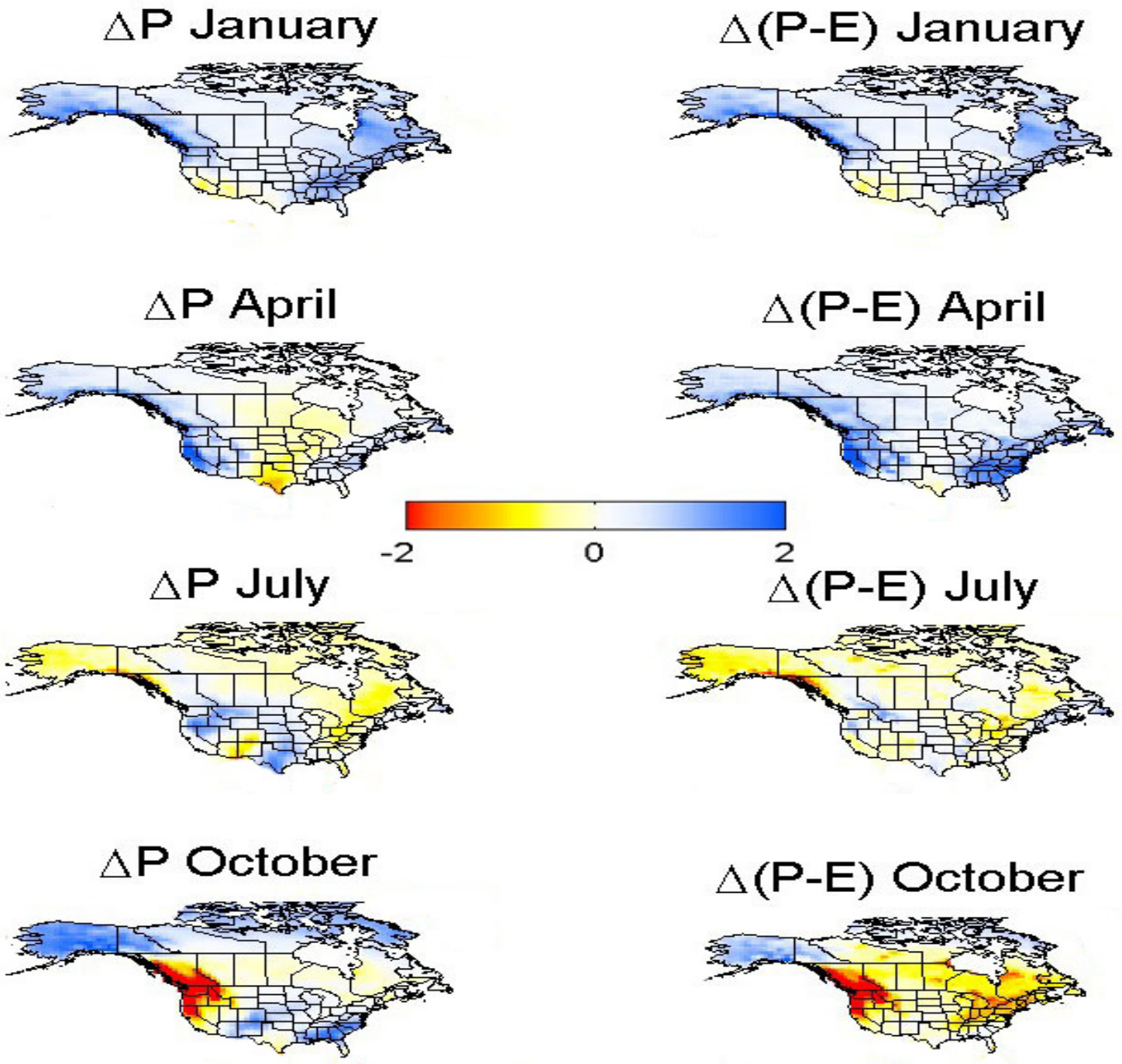


Bars show days warmer than the mean of the warmest 10 days (99.95th percentile) or colder than the mean of the coldest 450 days(bottom 25th percentile) in the period 1950-1999

Precipitation: 20th century model bias (mm/day)




Precip 1980-1999
Precip 2080-2099
ΔP 2080-2099 minus 1980-1999
0
2
4
Evaporation 1980-1999
Evaporation 2080-2099
ΔE 2080-2099 minus 1980-1999
0
2
4
P-E 1980-1999
P-E 2080-2099
P-E 2080-2099 minus 1980-1999
-2
0
2
-0.4
-0.2
0
0.2
0.4



(2080-2099)
minus
(1980-1999)

Precipitation: 21st Century Changes (2080-2099) minus (1980-1999)

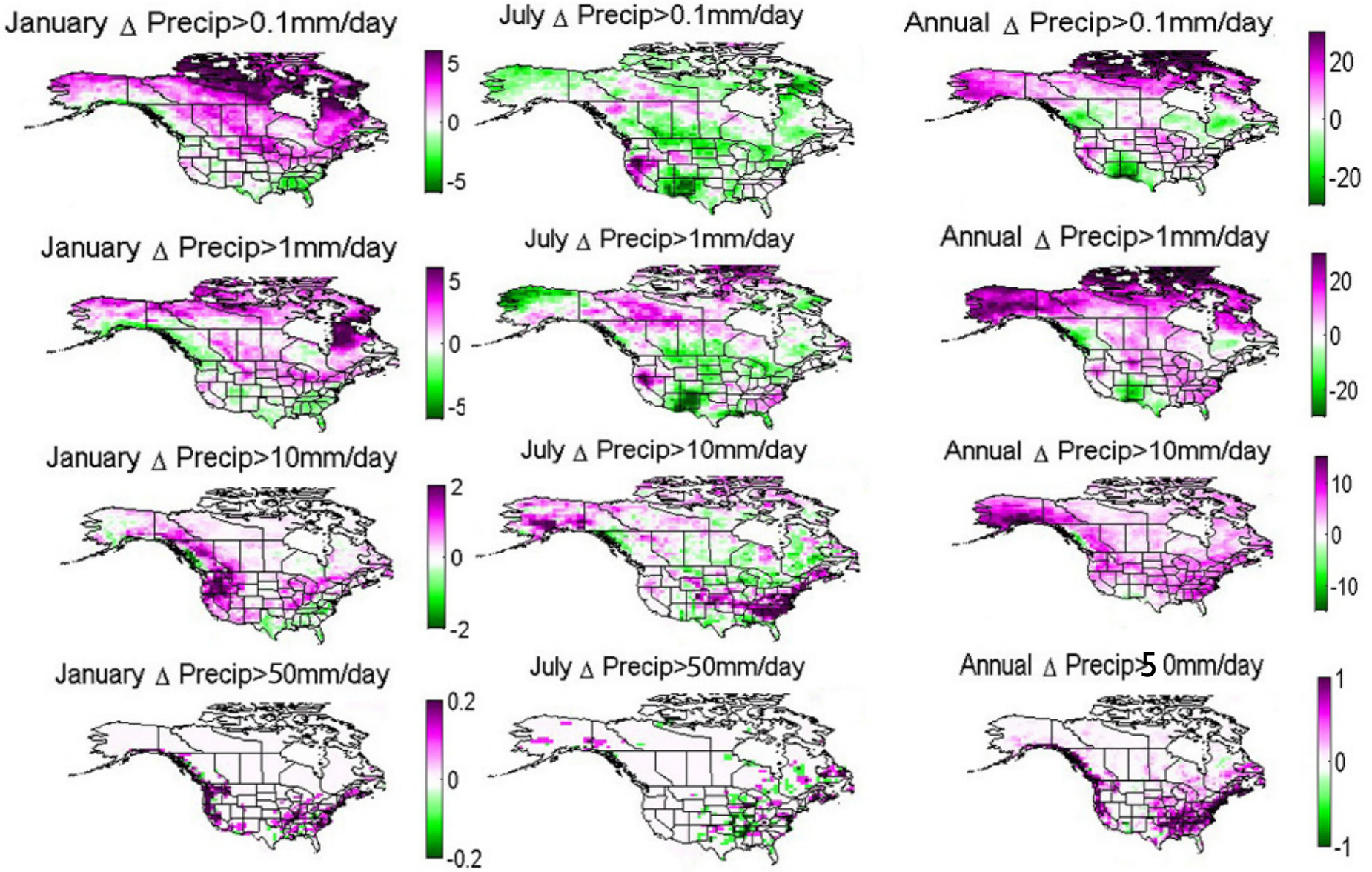
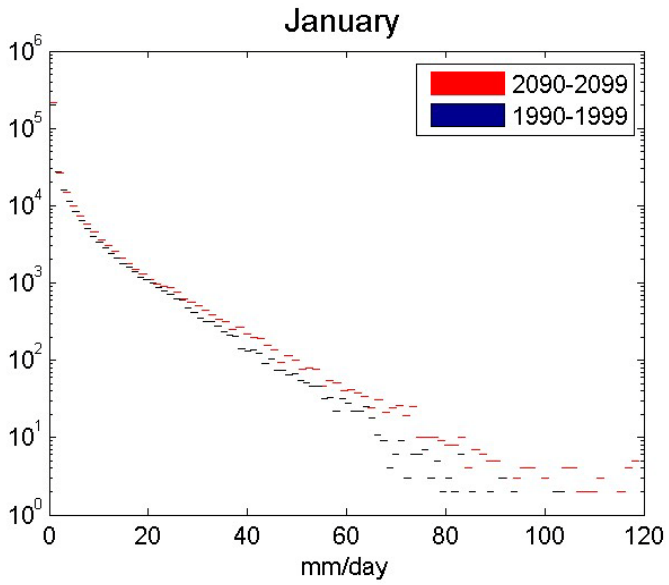
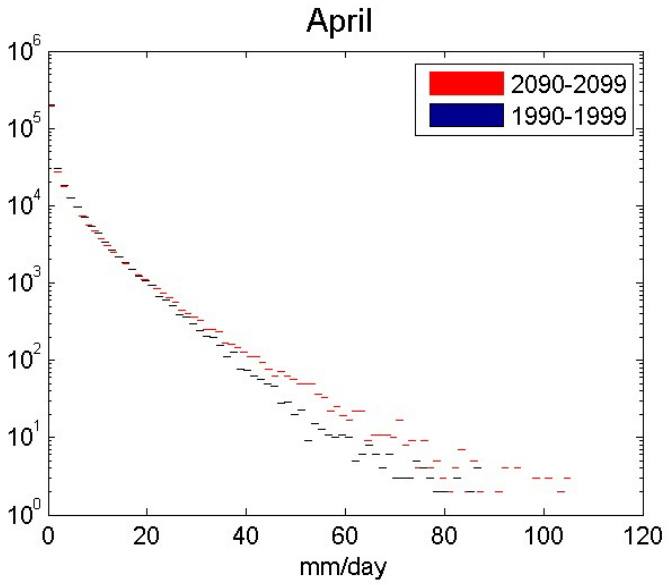
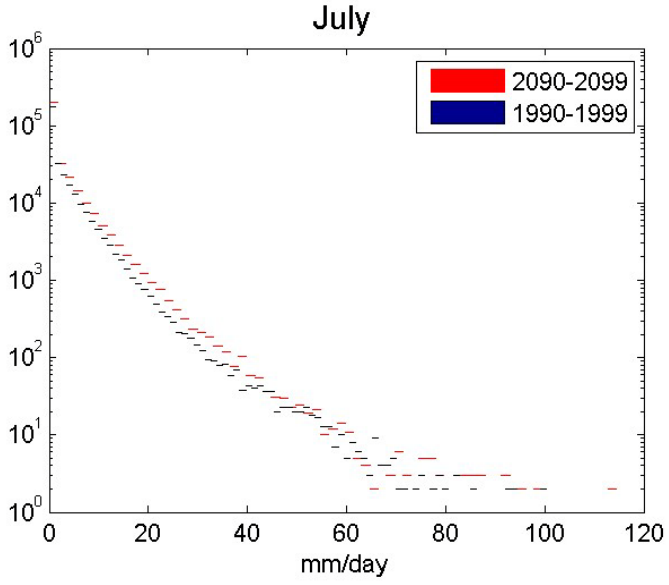
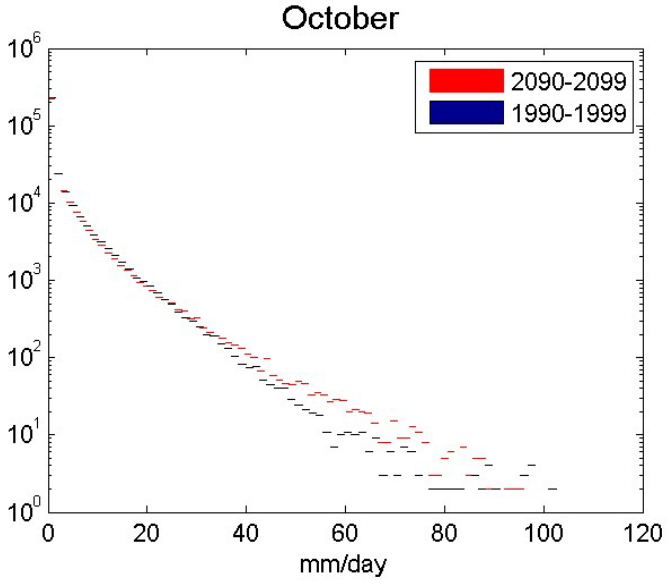


Figure shows change in av. number of days per year with precipitation above a given threshold

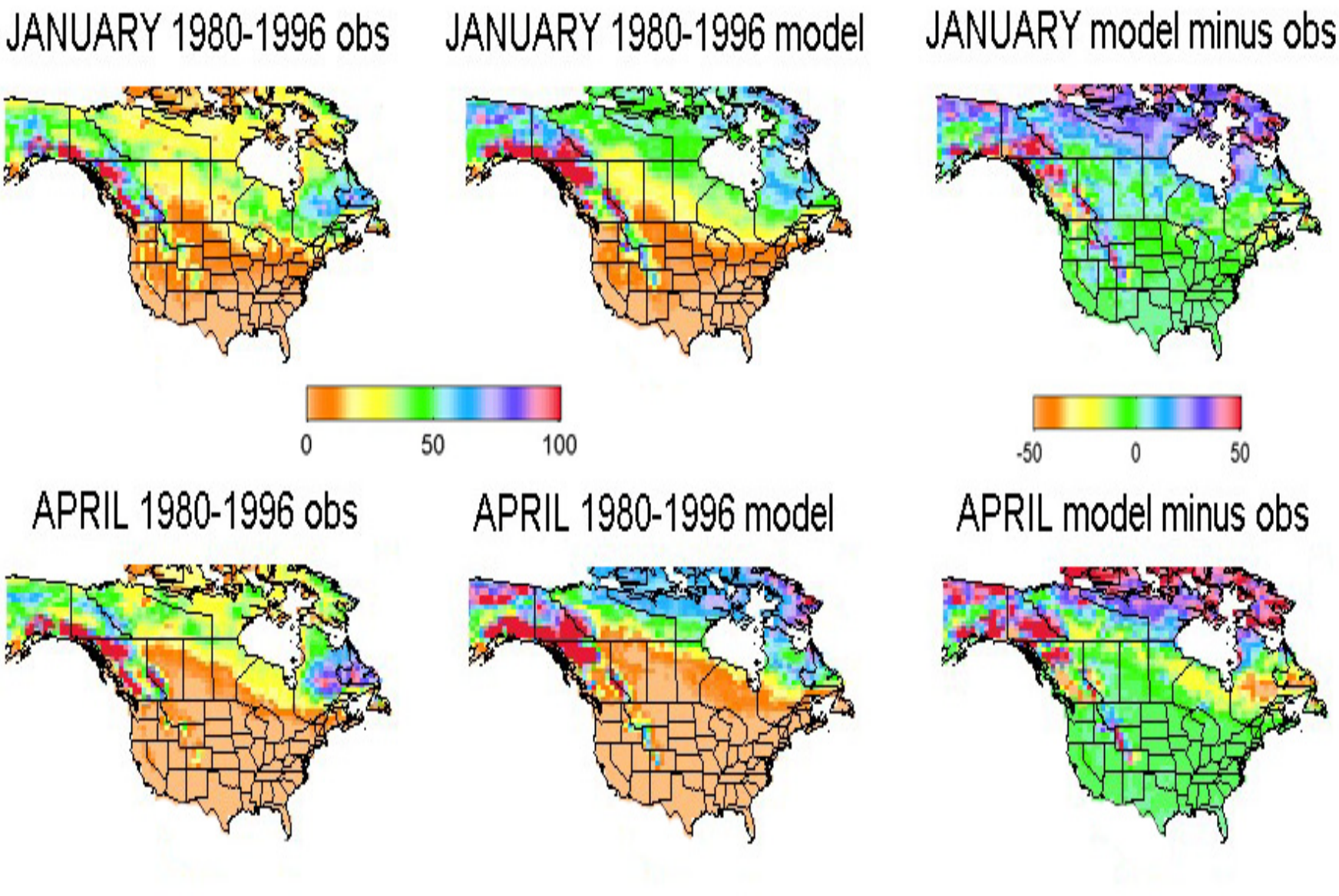

January
2090-2099
1990-1999
mm/day

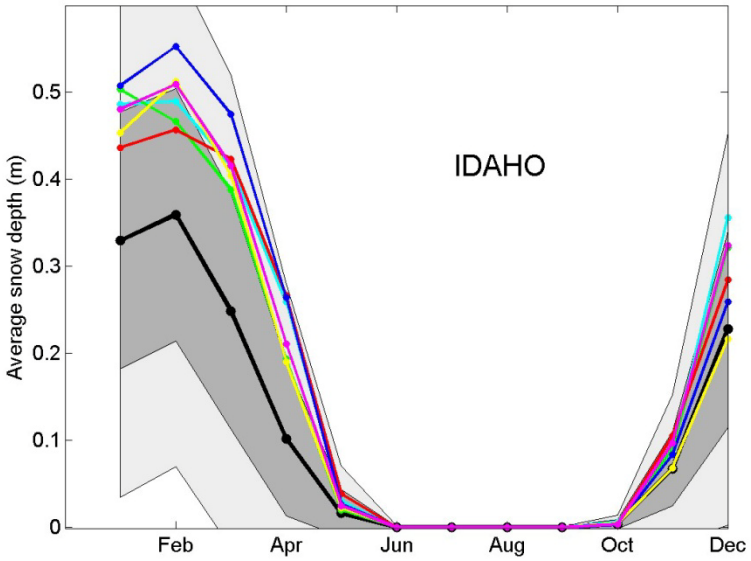

April
2090-2099
1990-1999
mm/day

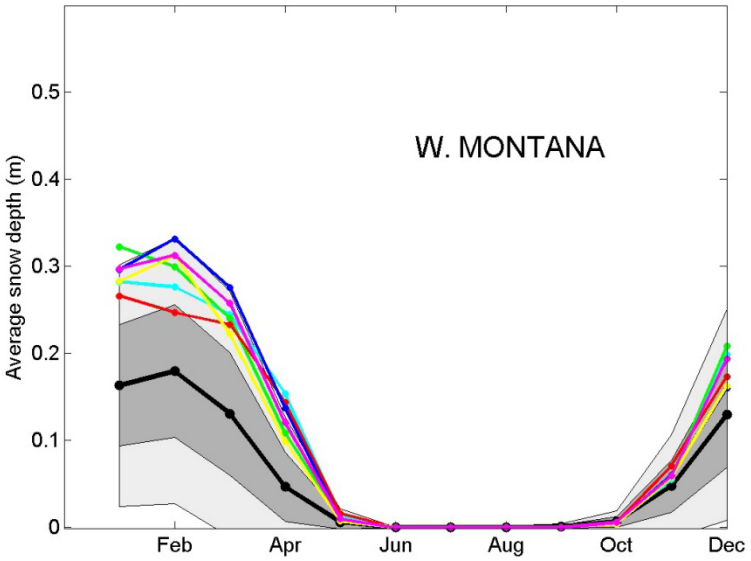

July
2090-2099
1990-1999
mm/day

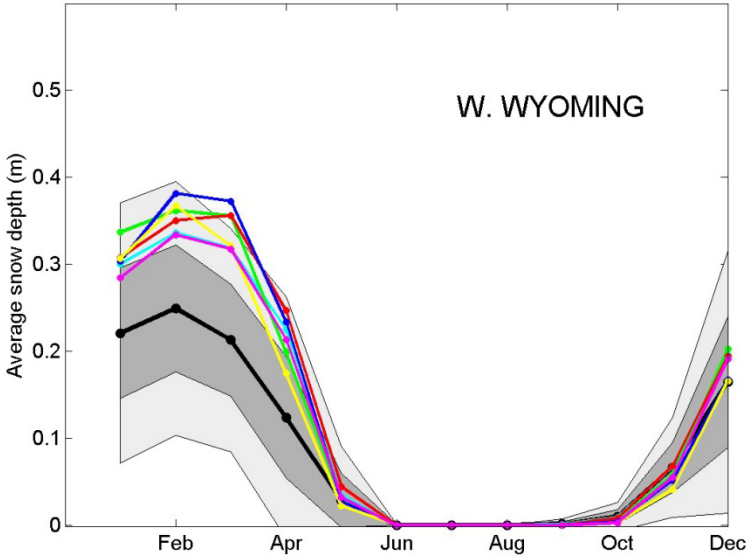

October
2090-2099
1990-1999
mm/day

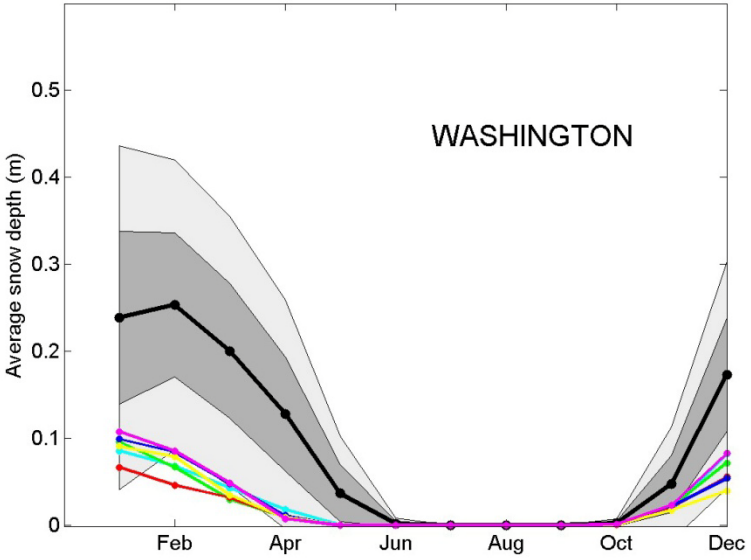
Snow Depth (cm): Observations, Model (ensemble mean), and difference

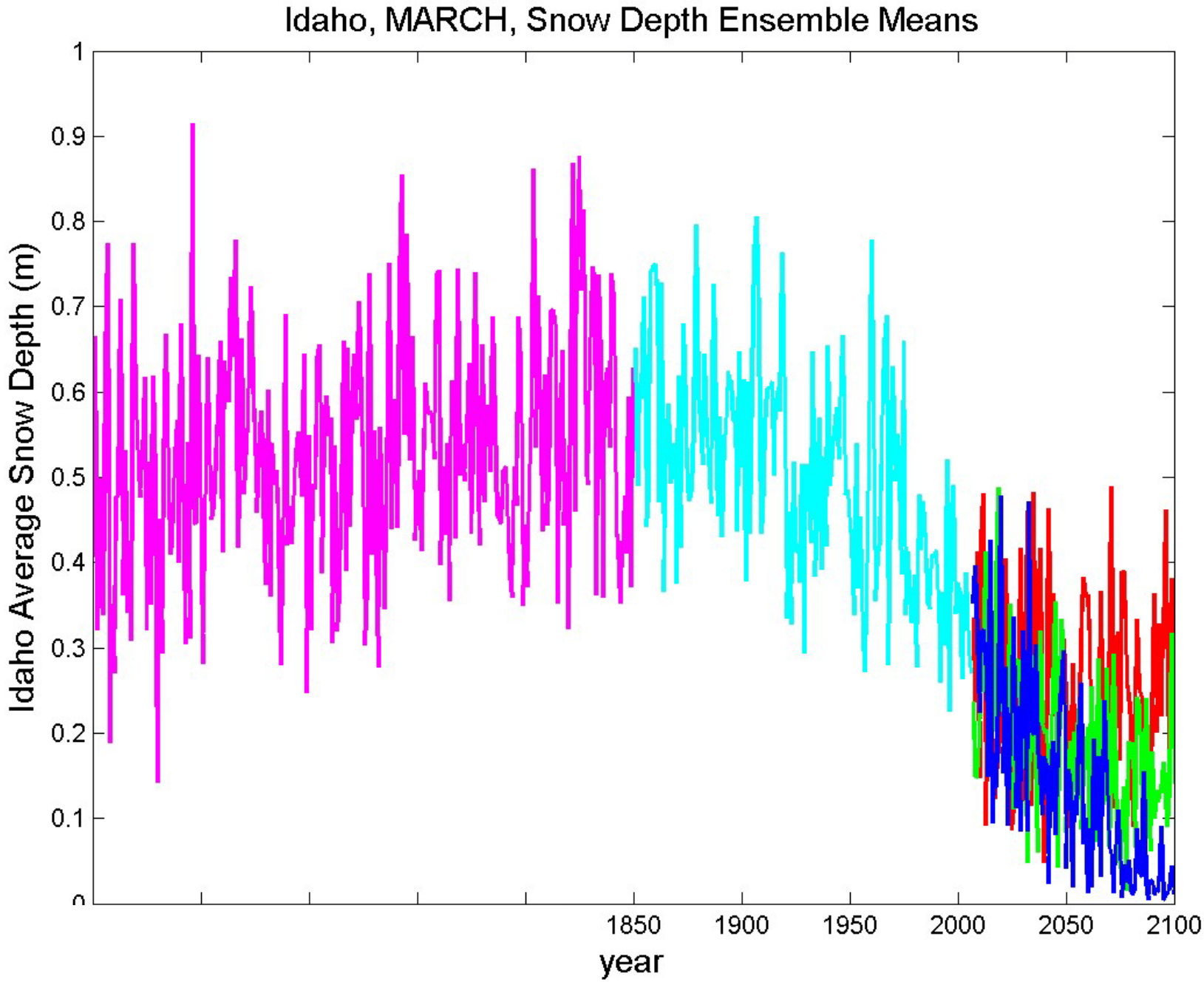



IDAHO
Average snow depth (m)
0
0.1
0.2
0.3
0.4
0.5
Feb
Apr
Jun
Aug
Oct
Dec


W. MONTANA
Average snow depth (m)
0
0.1
0.2
0.3
0.4
0.5
Feb
Apr
Jun
Aug
Oct
Dec

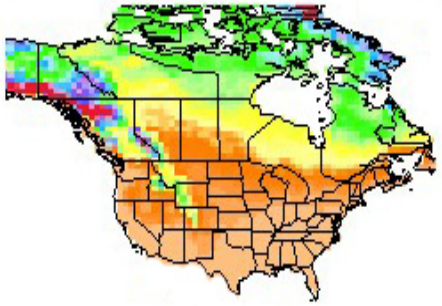

W. WYOMING
Average snow depth (m)
0
0.1
0.2
0.3
0.4
0.5
Feb
Apr
Jun
Aug
Oct
Dec


WASHINGTON
Average snow depth (m)
0
0.1
0.2
0.3
0.4
0.5
Feb
Apr
Jun
Aug
Oct
Dec

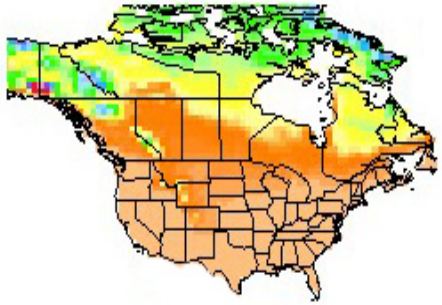

Idaho, MARCH, Snow Depth Ensemble Means
Idaho Average Snow Depth (m)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1850
1900
1950
2000
2050
2100
year

Snow Depth Projected Changes under RCP8.5

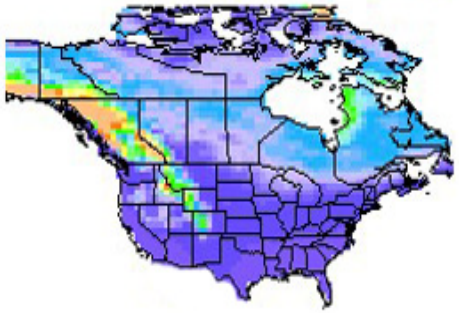
Snow Depth December 1980-1999



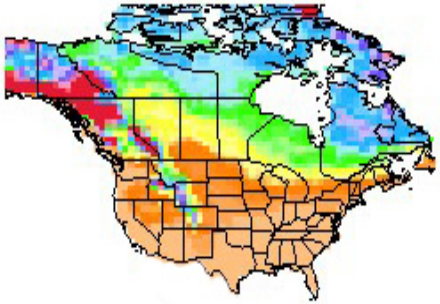
Snow Depth December 2080-2099



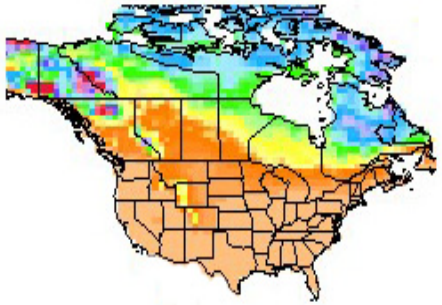
Δ(Snow Depth) December



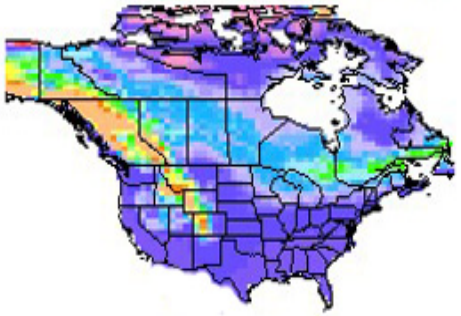
Snow Depth February 1980-1999



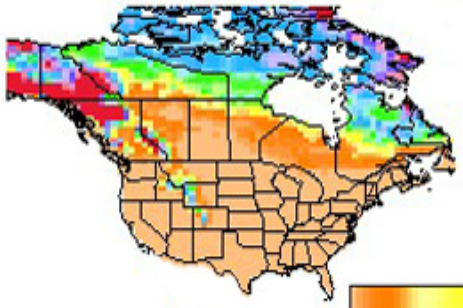
Snow Depth February 2080-2099



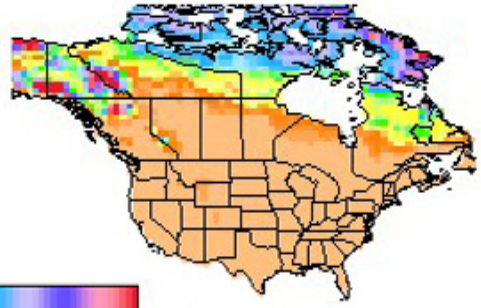
Δ(Snow Depth) February



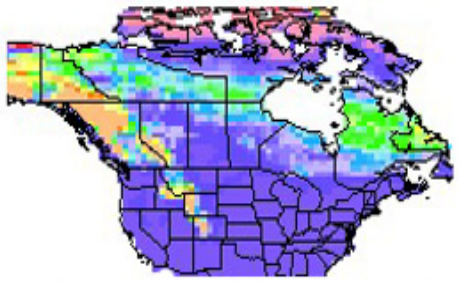
Snow Depth April 1980-1999

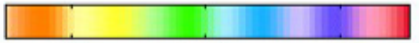


Snow Depth April 2080-2099



Δ(Snow Depth) April





Summary

- Is there a more quantitative way to present information on model bias then just maps of mean(obs) minus model ensemble mean?
- Very strong seasonal variability in projected temperatures (spatial patterns remarkable similar for all RCPs)
- Projected changes in length of growing season show interesting asymmetry
- No evidence of massive drought over most of North America in CCSM4
- Snow cover over continental US projected to almost disappear in spring end of 21st century under RCP8.5