Southern New England's Changing Climate

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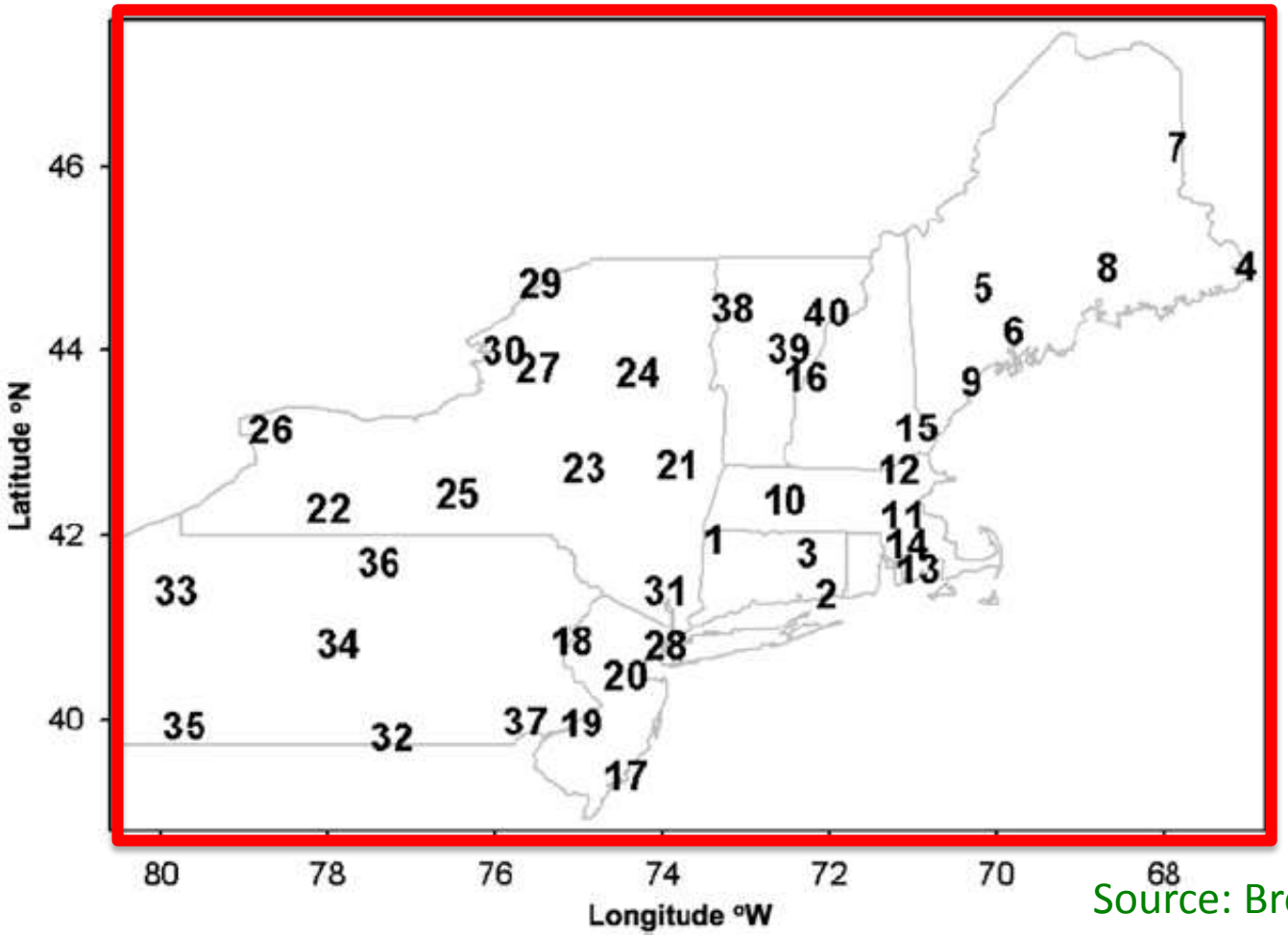
Historical perspective (instrumental data)

IPCC scenarios of future emissions
& global temperature response

Results from regional model simulations

Results from statistical downscaling

Distribution of long-term instrumental data sets in the NE U.S.



Source: Brown et al., 2010

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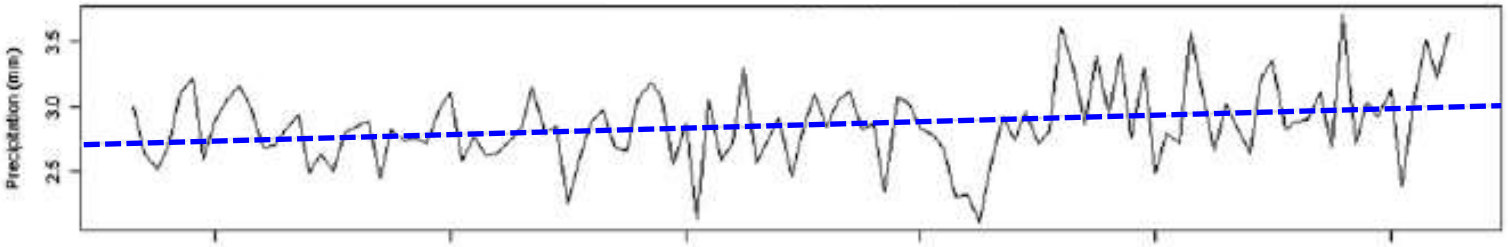
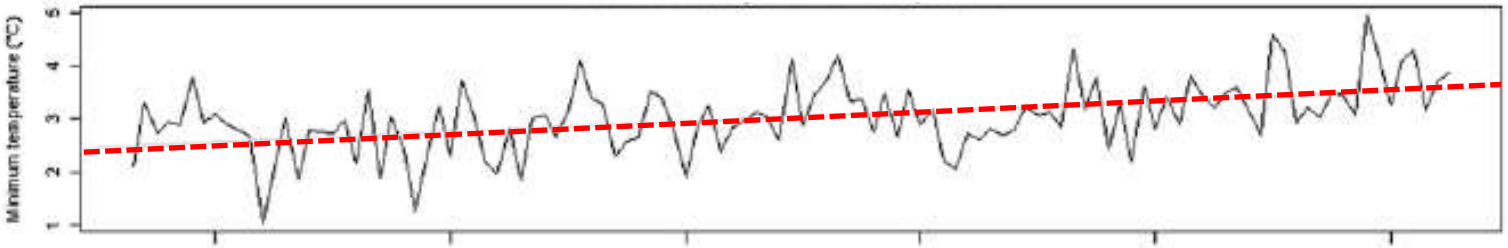
Annual precipitation: 1890-2005

5”

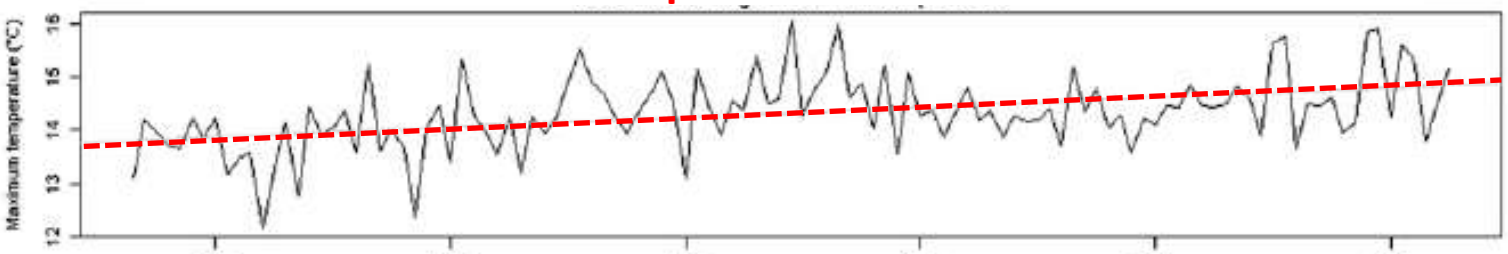


Mean annual minimum temperature: 1890-2005

1°C



Mean annual maximum temperature: 1890-2005



1900 1920 1940 1960 1980 2000

Source: Brown et al., 2010

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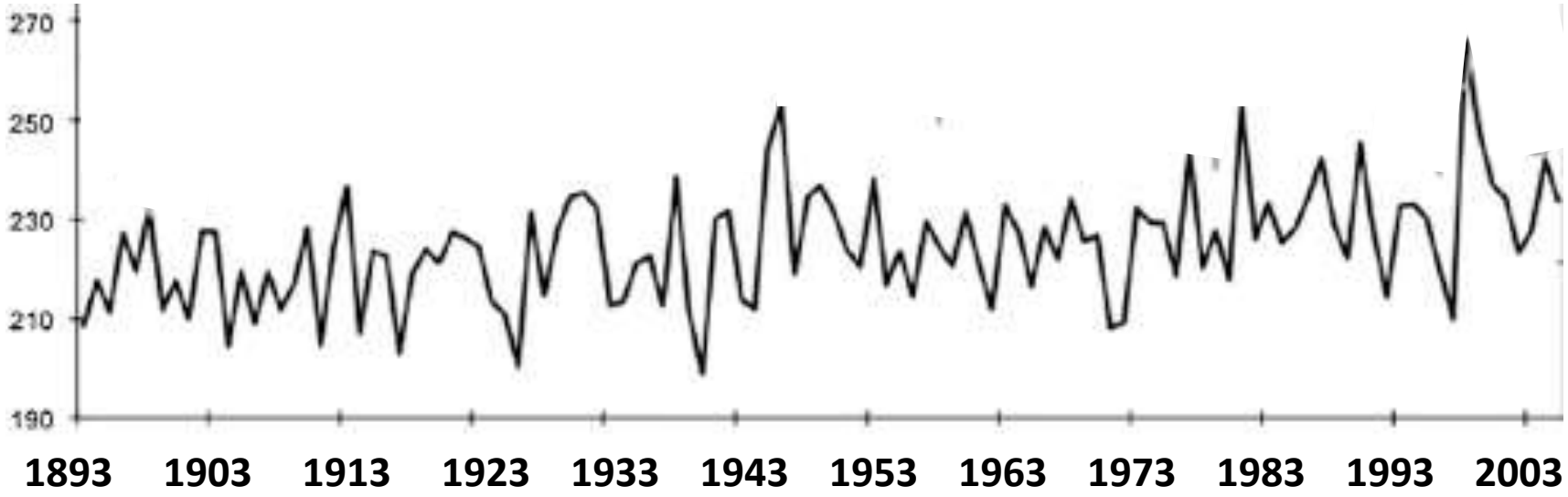
Length of growing season (days)

(Trend = 0.15 days/year or ~16.5 days over the period of record)



Number of days between first span of at least 6 days with daily mean temperature >5°C and first span after 1 July of 6 days with daily mean temperature <5°C

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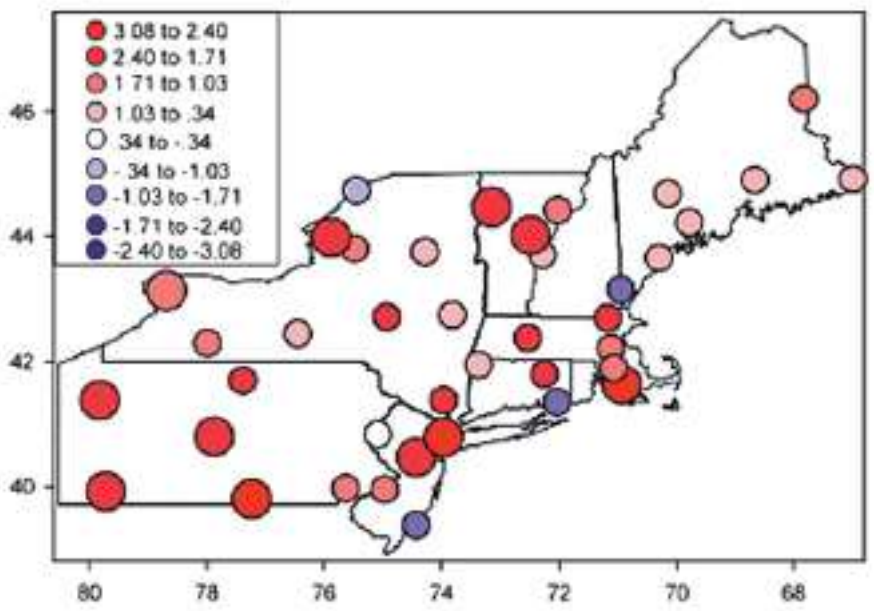
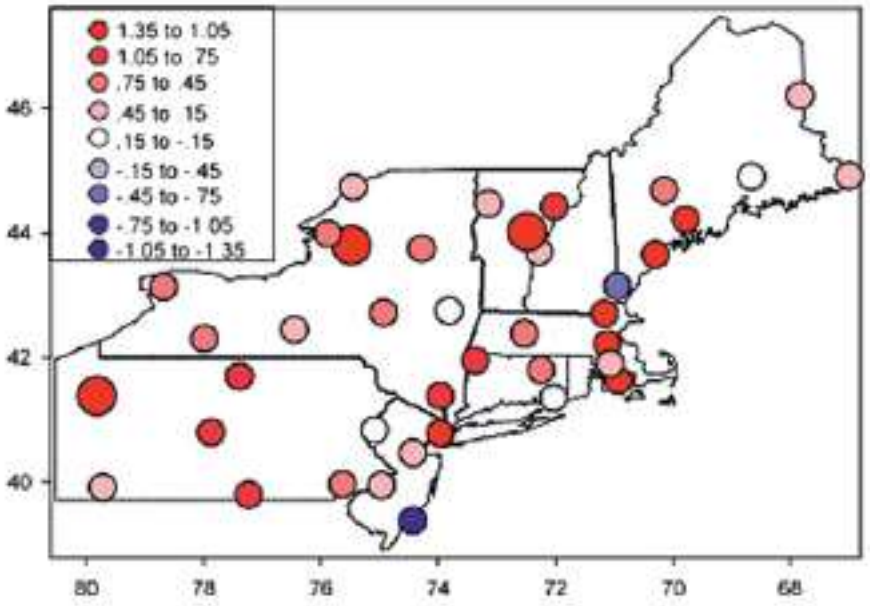
Trends (1951-2005) in:

Very wet days:
Annual total PRCP >95th percentile



Extremely wet days:
Annual total PRCP >99th percentile



Source: Brown et al., 2010

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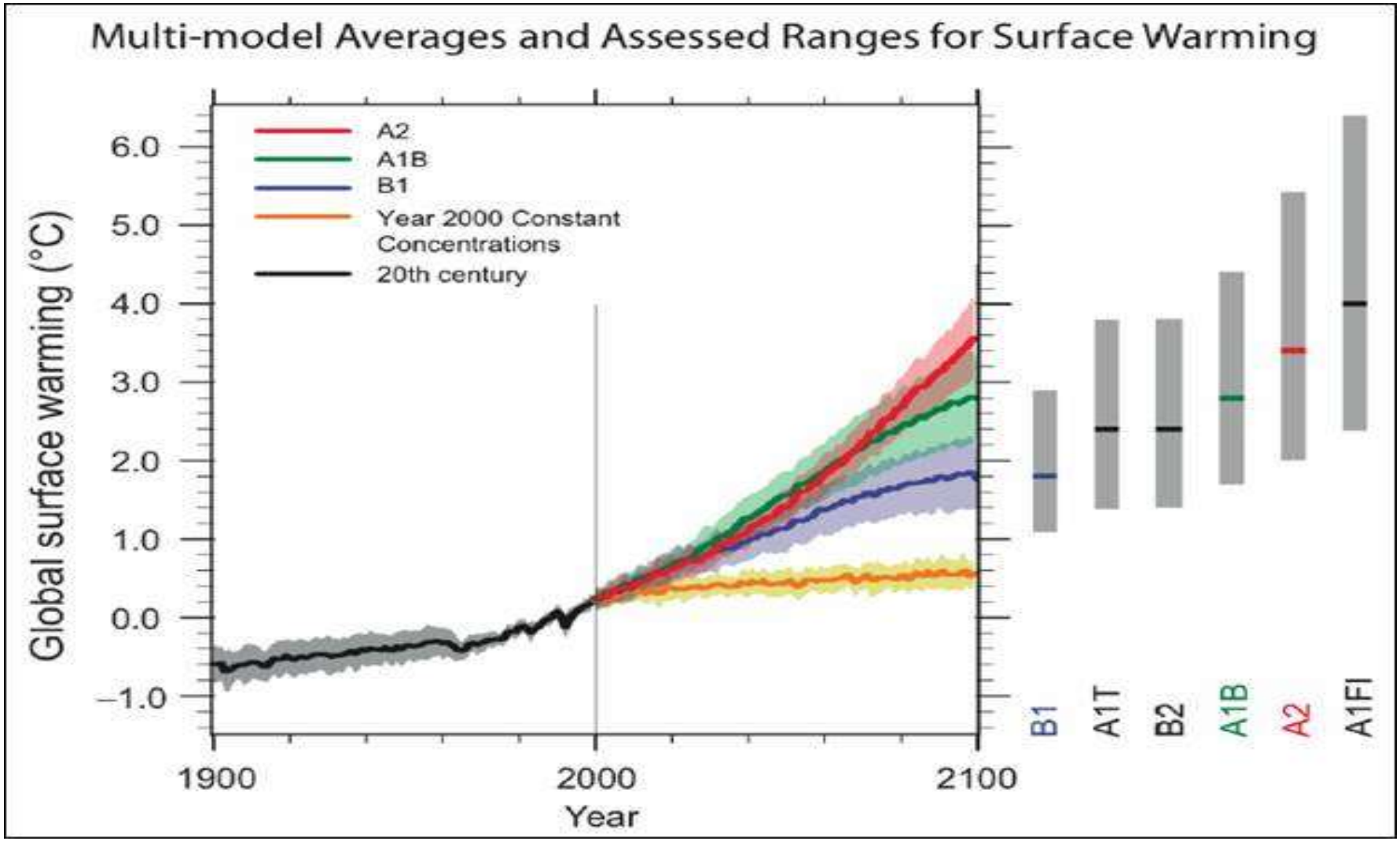
IPCC Emission scenarios (4th and 5th Assessment Reports) & consequent changes in global average temperature



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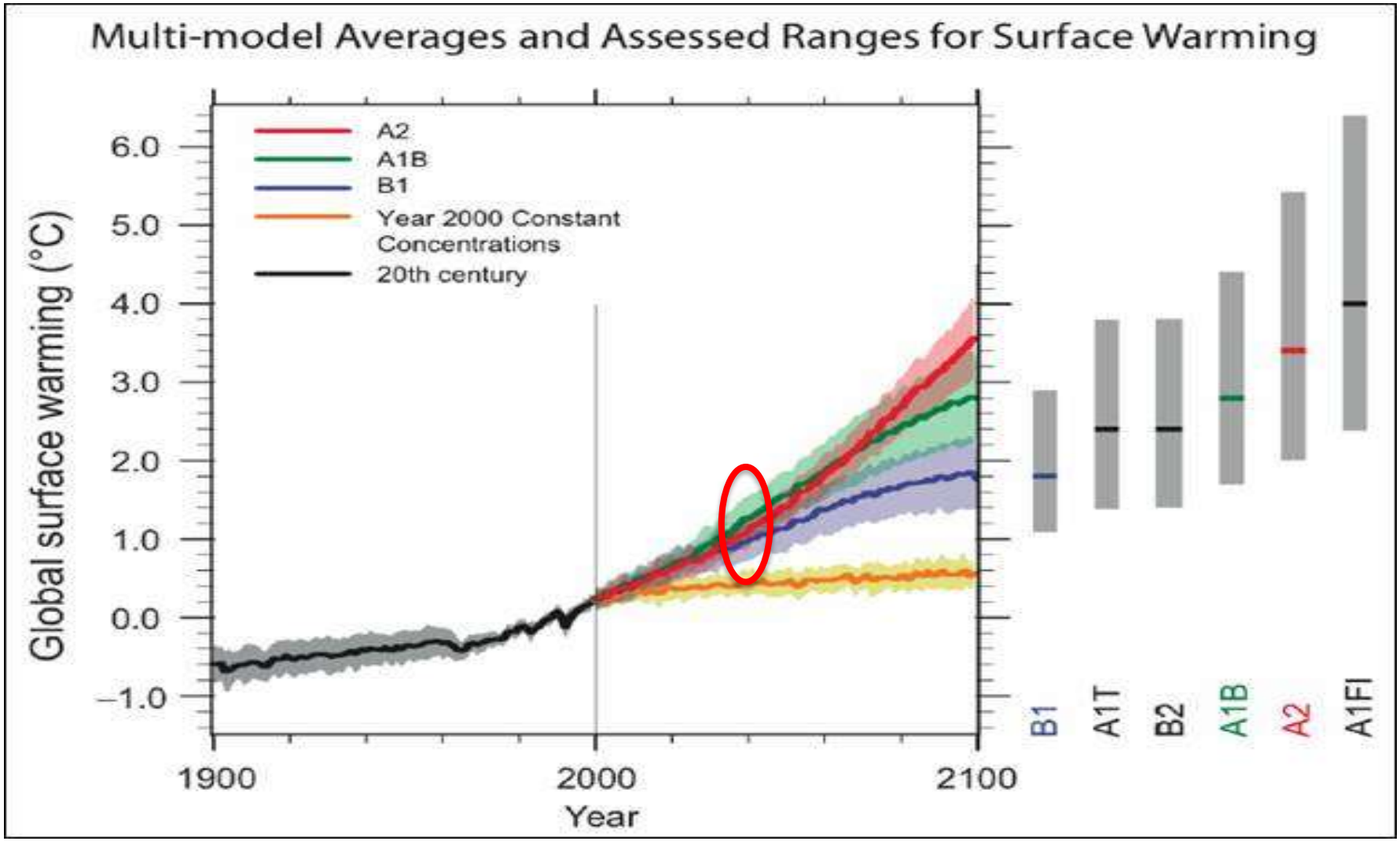
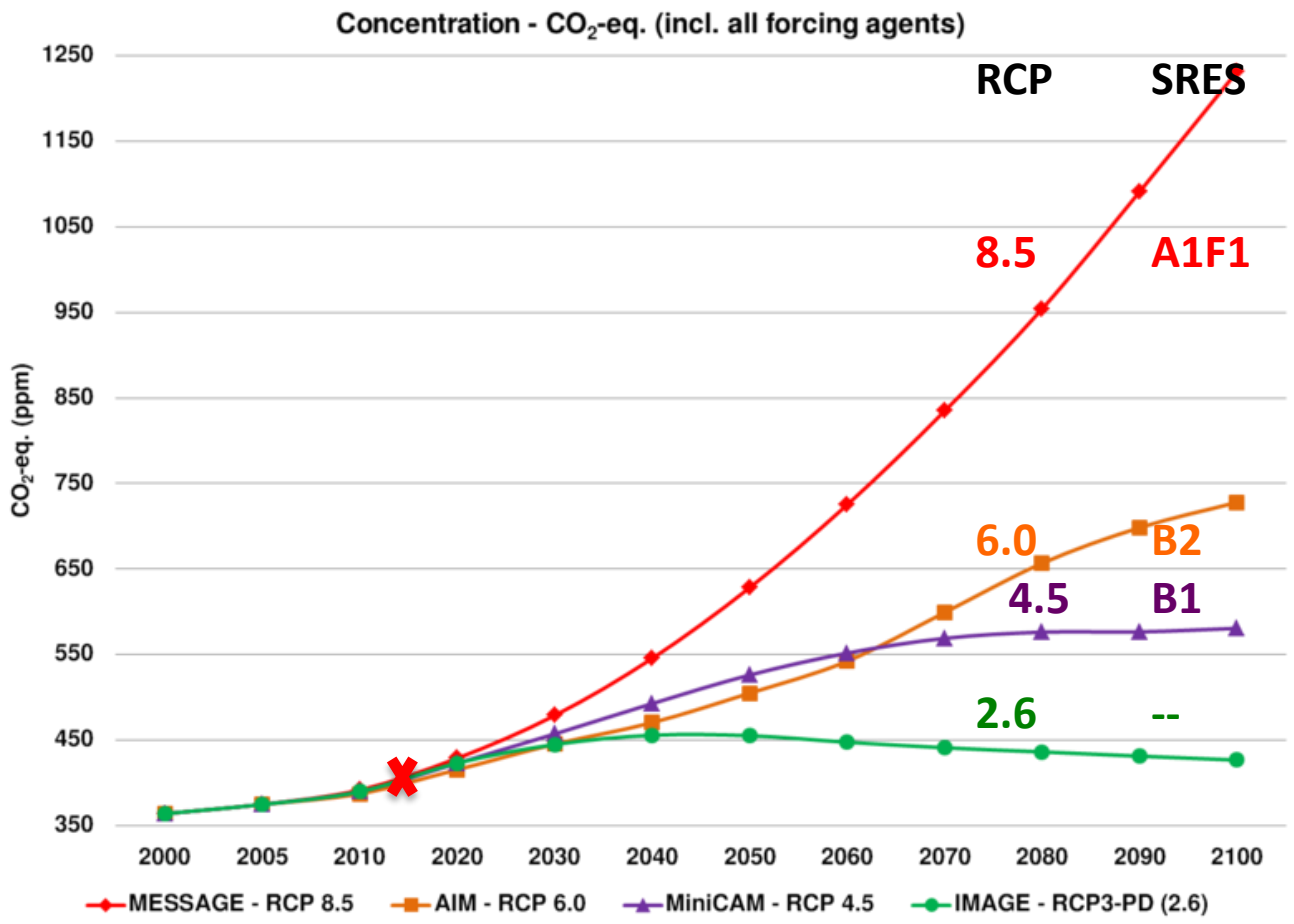

Multi-model Averages and Assessed Ranges for Surface Warming
Global surface warming (°C)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
−1.0
A2
A1B
B1
Year 2000 Constant Concentrations
20th century
1900
2000
2100
Year
B1
A1T
B2
A1B
A2
A1FI



Global mean annual Temperature (relative to Pre-industrial)

3.6°C

2.2°C

2.0°C

1.5°C

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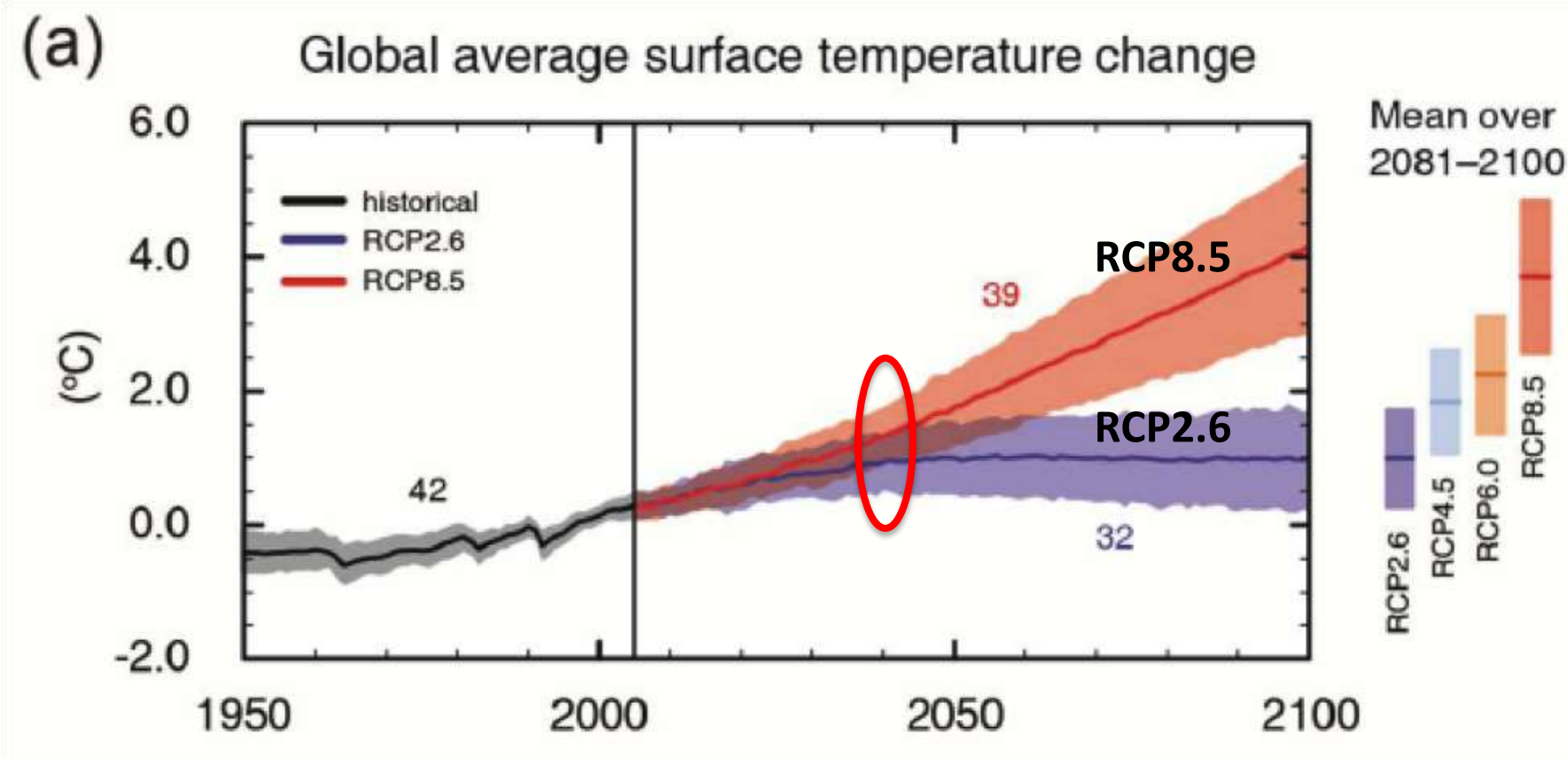

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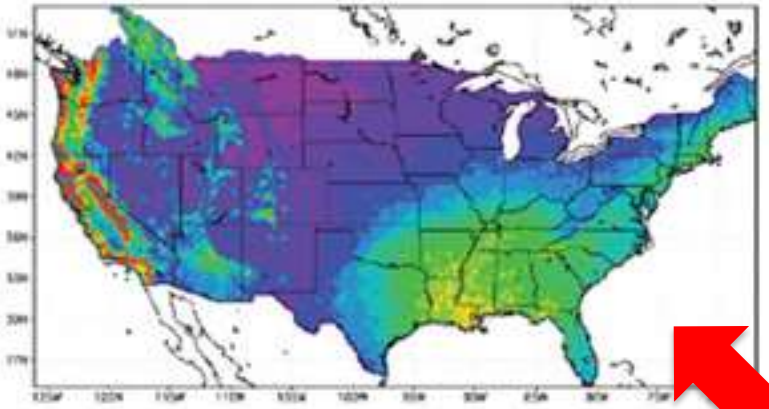
Dynamical downscaling: High-resolution Regional Climate models (RCMs) driven by Global Climate Models (GCMs)

Statistical downscaling: Statistical methods processing and interpolating GCM outputs

Winter (DJF) Precipitation at Different Spatial Scales

Observation (4 km)



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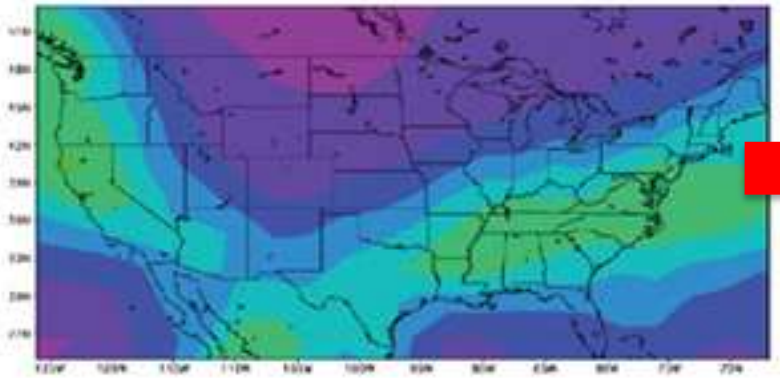
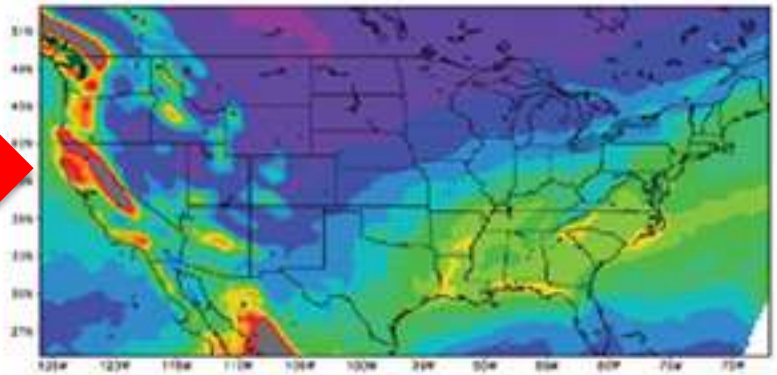
Global climate model (>300 km)



Regional climate model (36 km)



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NARCCAP

The North American Regional Climate Change Assessment Program (NARCCAP) is an international program to produce high resolution climate change simulations…using a set of regional climate models (RCMs) driven by a set of atmosphere-ocean general circulation models (AOGCMs)

The RCMs (with a spatial resolution of 50 km) are nested within the AOGCMs for the current period 1971-2000 and for the future period 2041-2070, forced with the SRES A2 emissions scenario.

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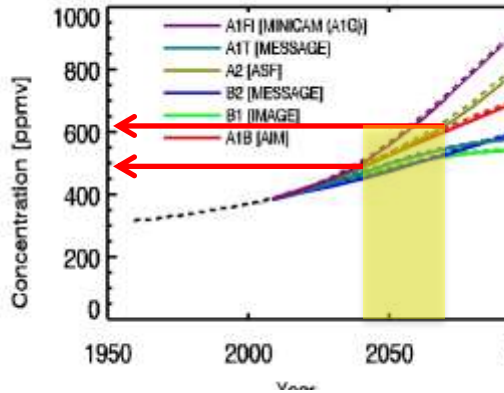
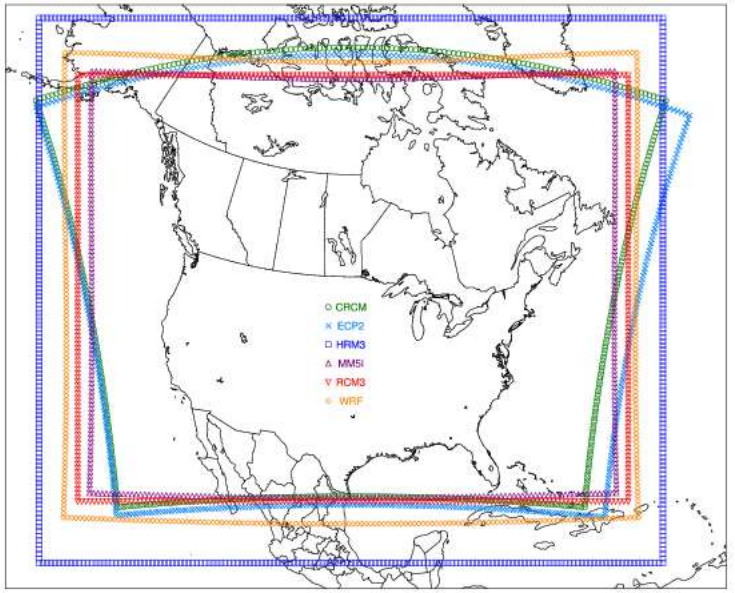
AO-GCM	Regional model
CCSM [NCAR]	CRCM
CCSM [NCAR]	MM5I
CCSM [NCAR]	WRFG
CCSM3 [NCAR]	WRFG
GFDL [NOAA]	ECP2
GFDL [NOAA]	HRM3
GFDL [NOAA]	RCM
HADCM3 [UK]	HRM3
HADCM3 [UK]	MM5I
CGCM3 [Canadian]	RCM3
CGCM3 [Canadian]	CRCM

1971-2000 = baseline
2041-2070 = SRES A2
A2: 500-600ppmv



NARCCAP RCM Domains



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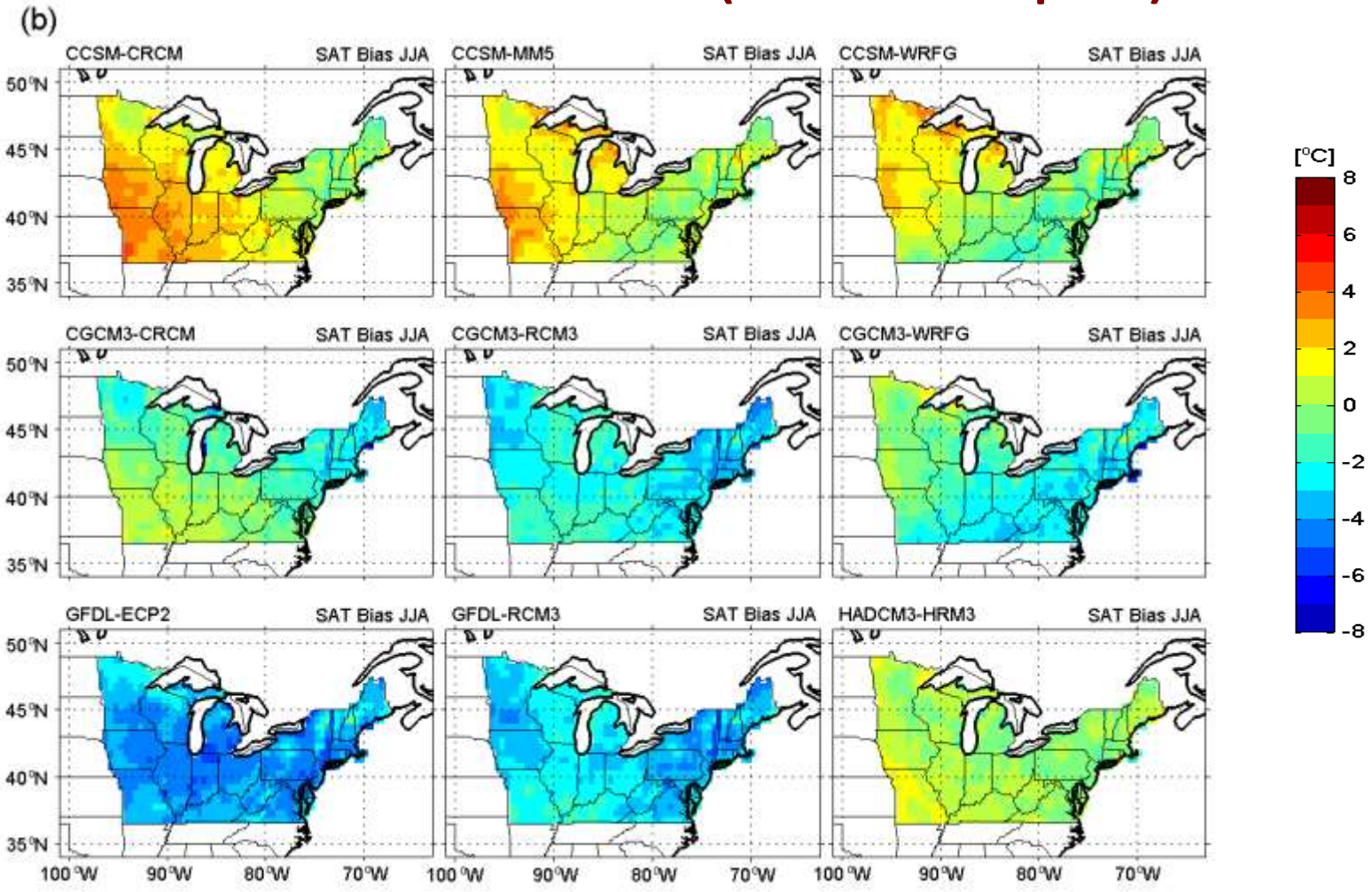
Dynamical Downscaling

Summer temperature biases [1971-2000]: Individual model results (9 GCM-RCM pairs)



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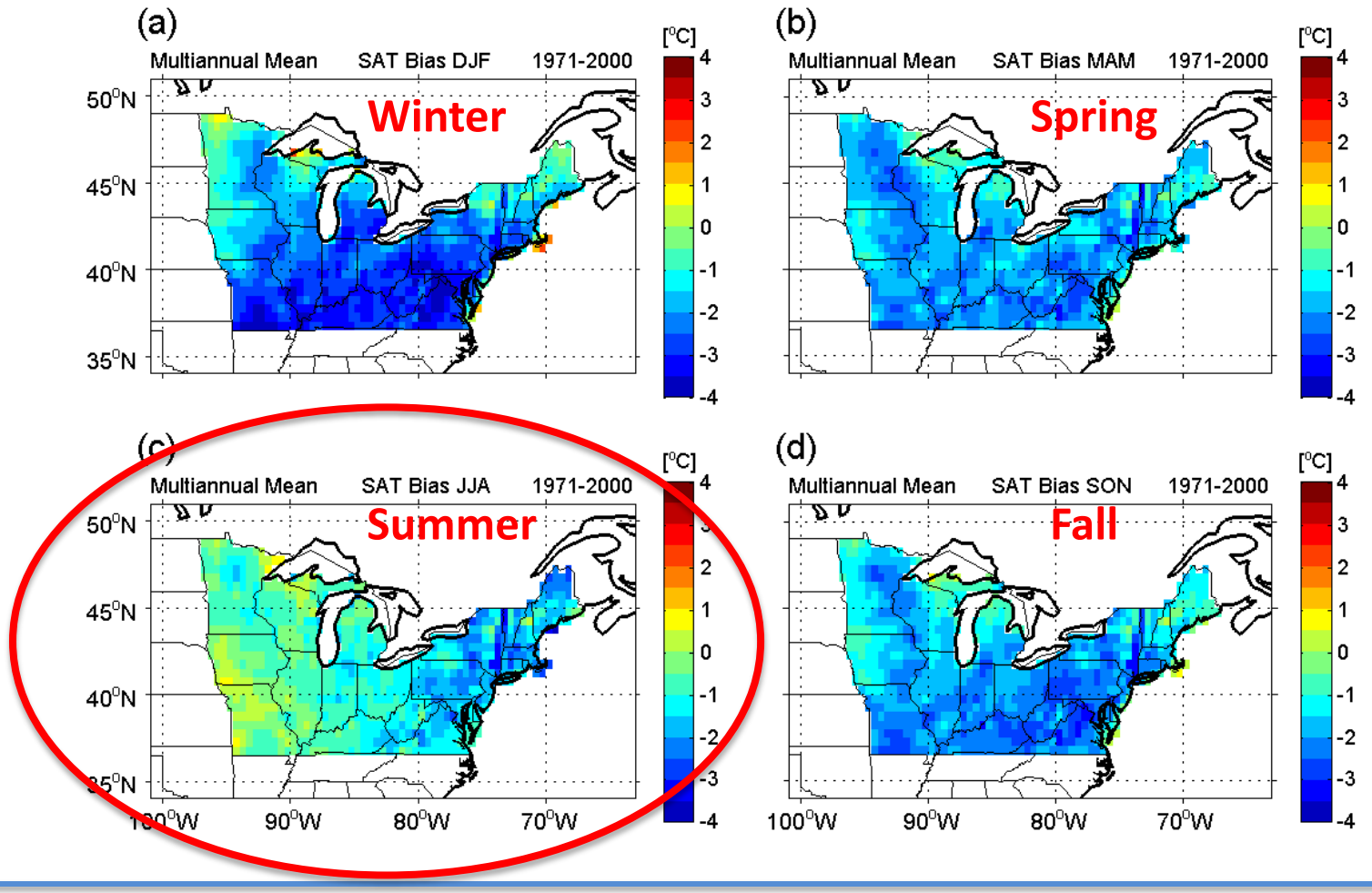
Multi-model means (9 GCM-RCM combinations):(Model minus observed

Model simulations are generally too cold compared to observations



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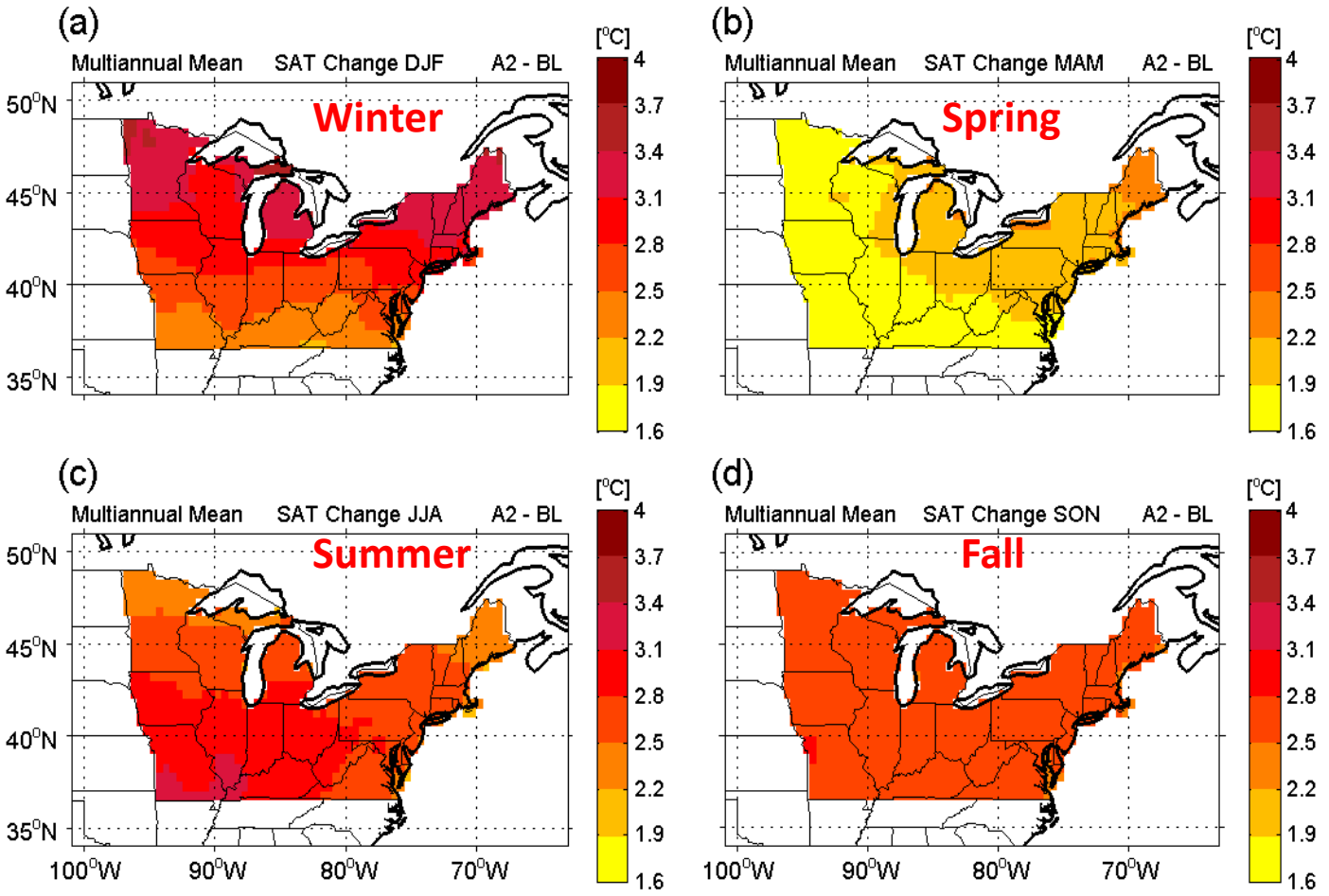
Seasonal temperature changes (SRES A2-baseline): multi-model means



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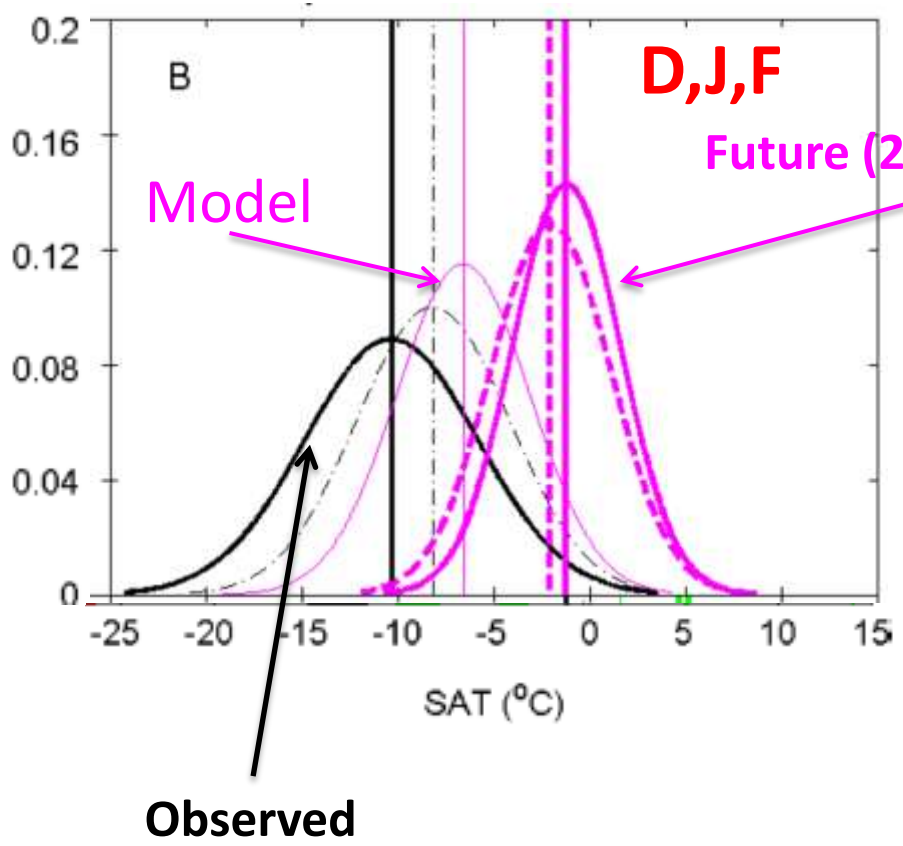

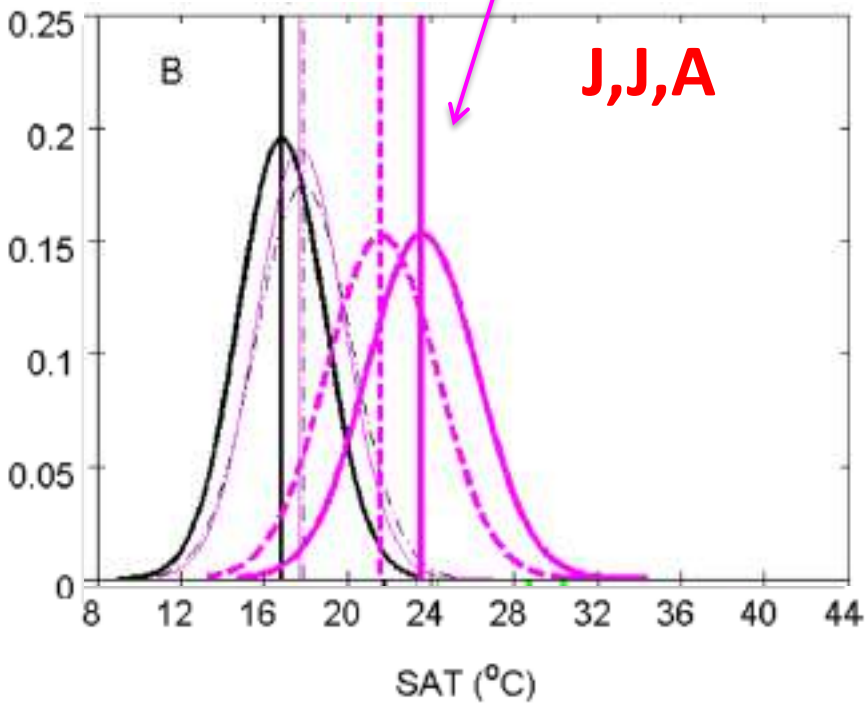

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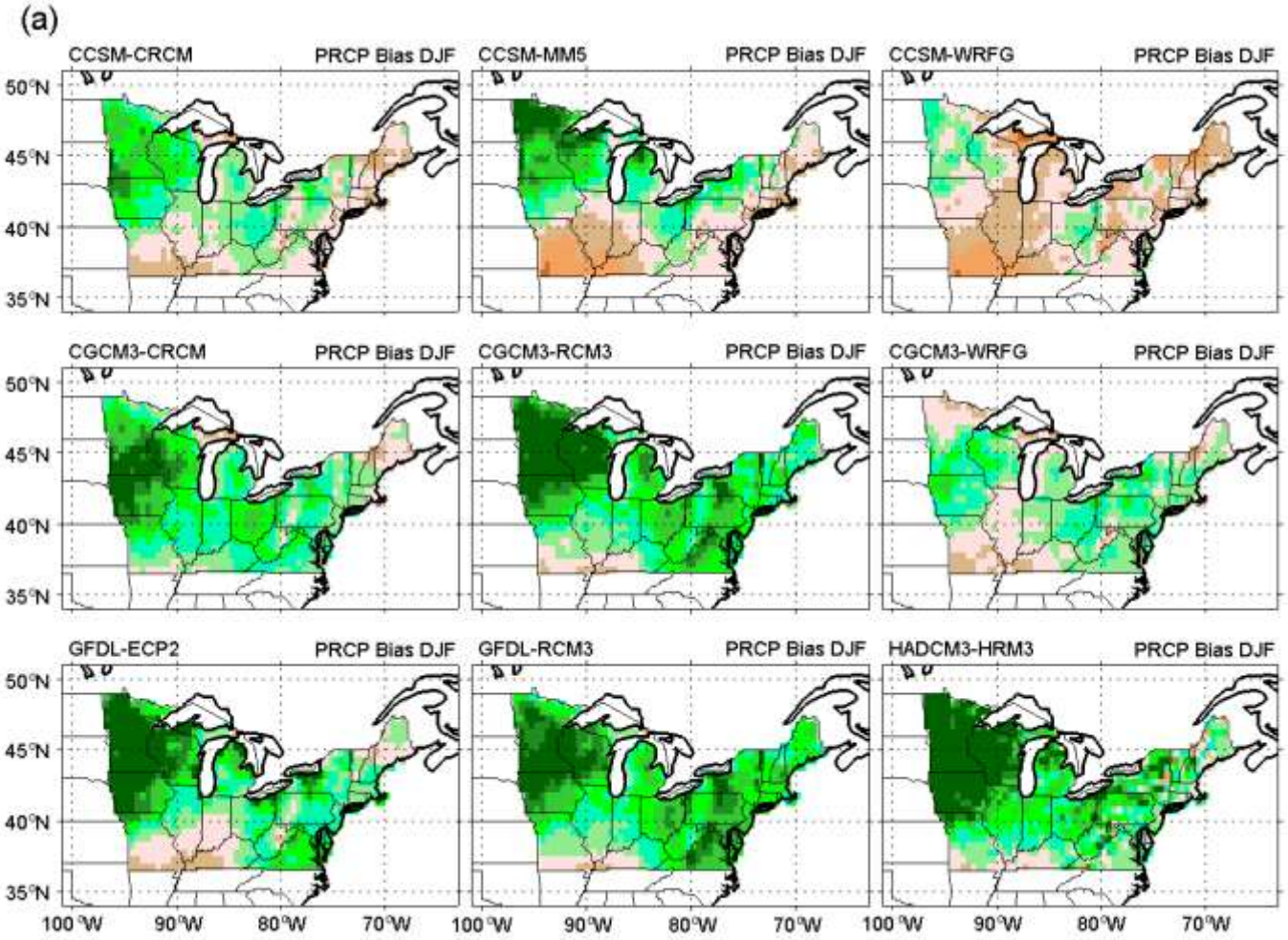
Winter precipitation biases [1971-2000]: Individual model results (9 GCM-RCM pairs)



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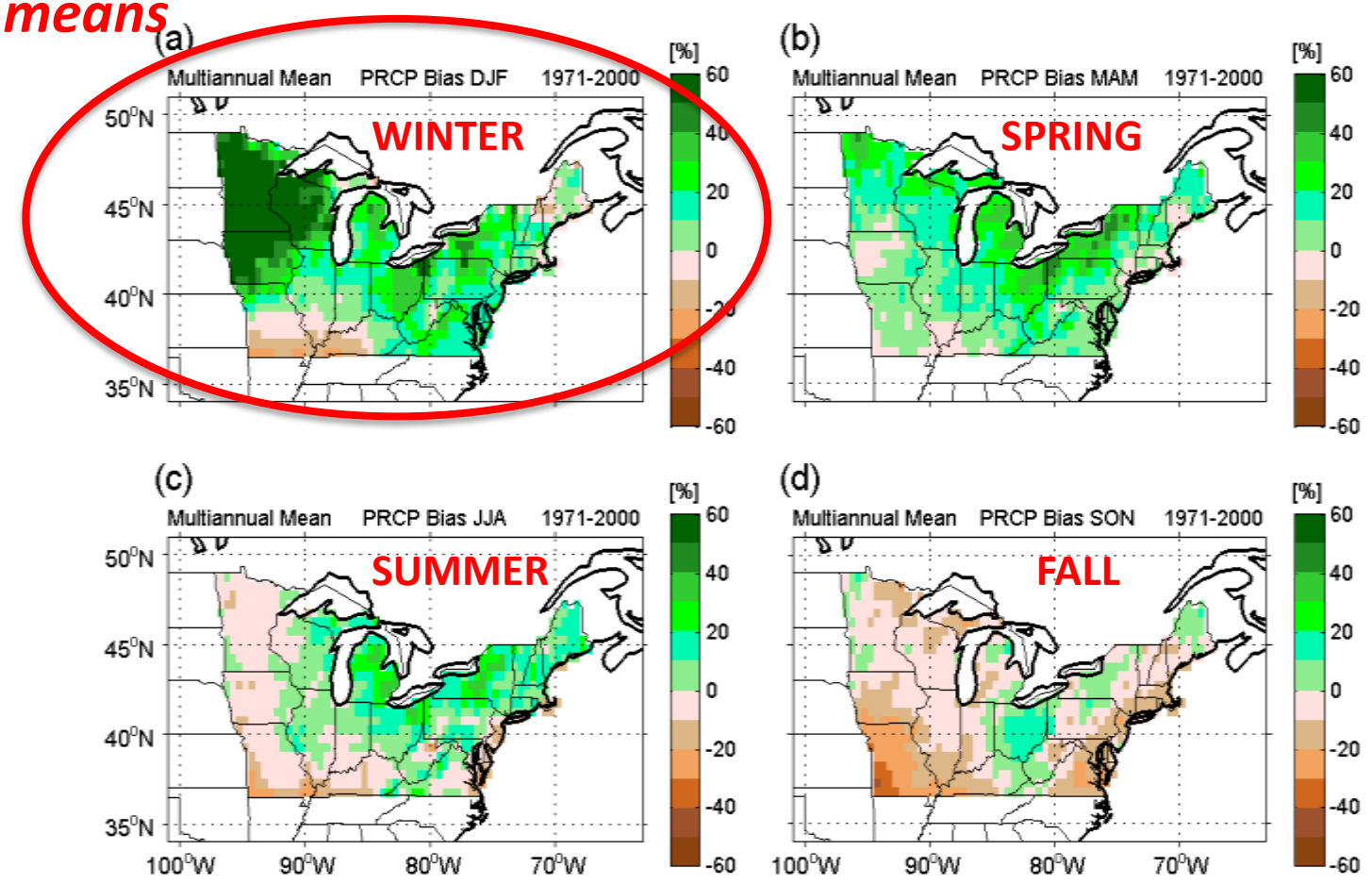
Model simulations are generally too wet in Winter and Spring, too dry in Fall, compared to observations [1971-2000]: *multi-model means*



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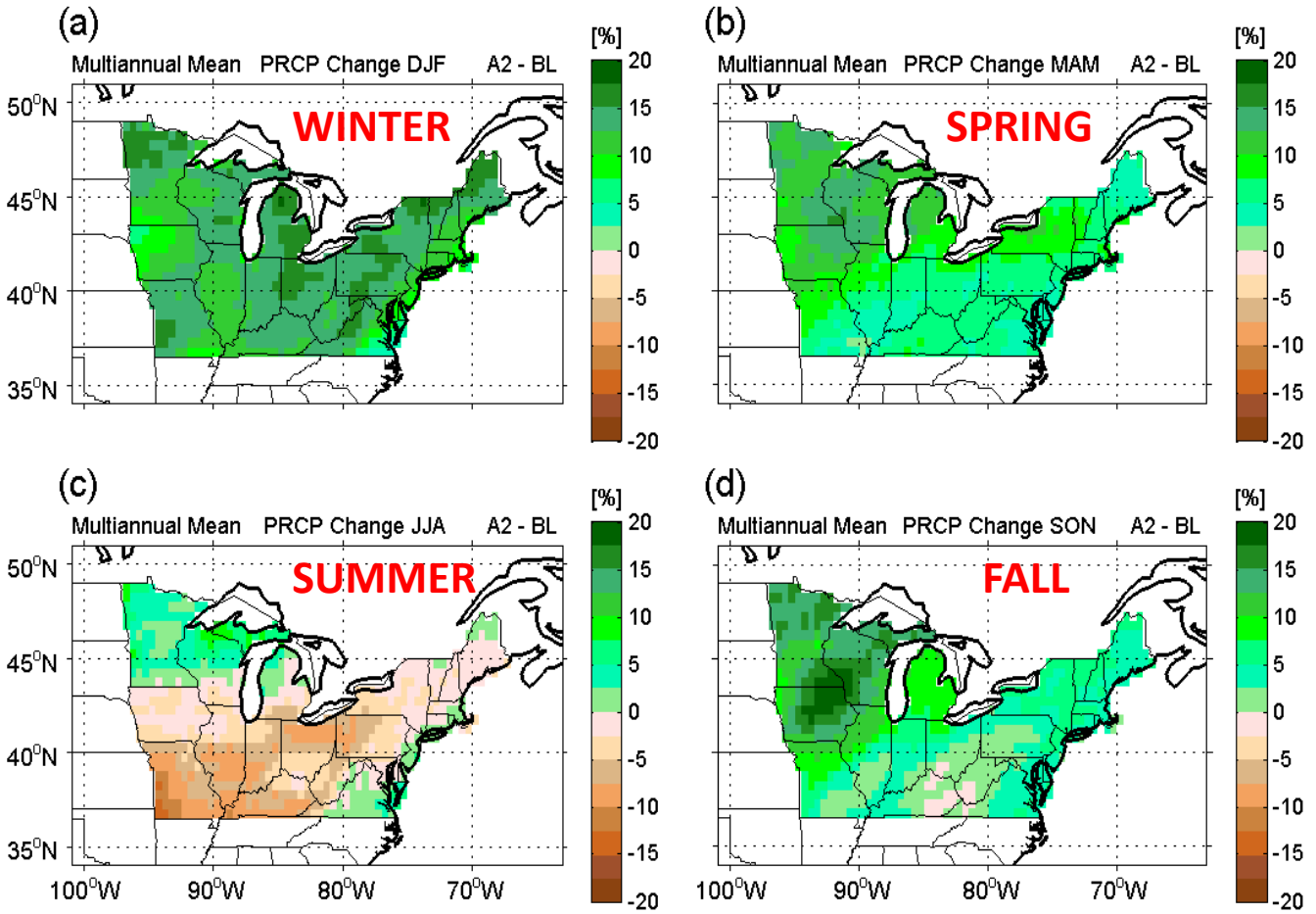
Seasonal precipitation changes (SRES A2-baseline): *multi-model means*



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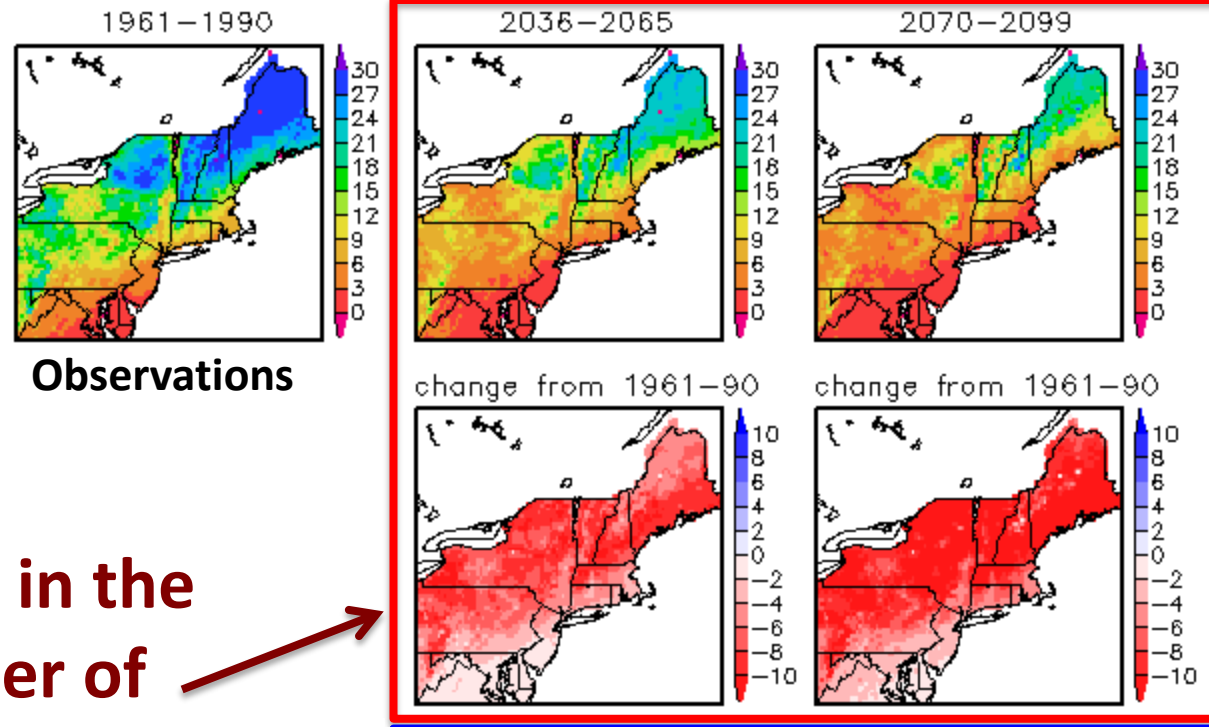
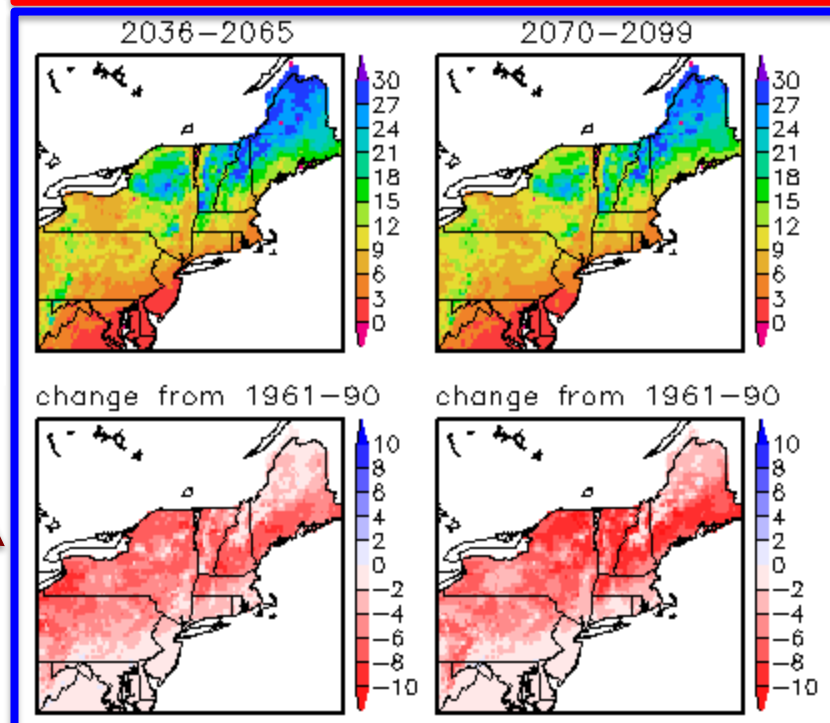
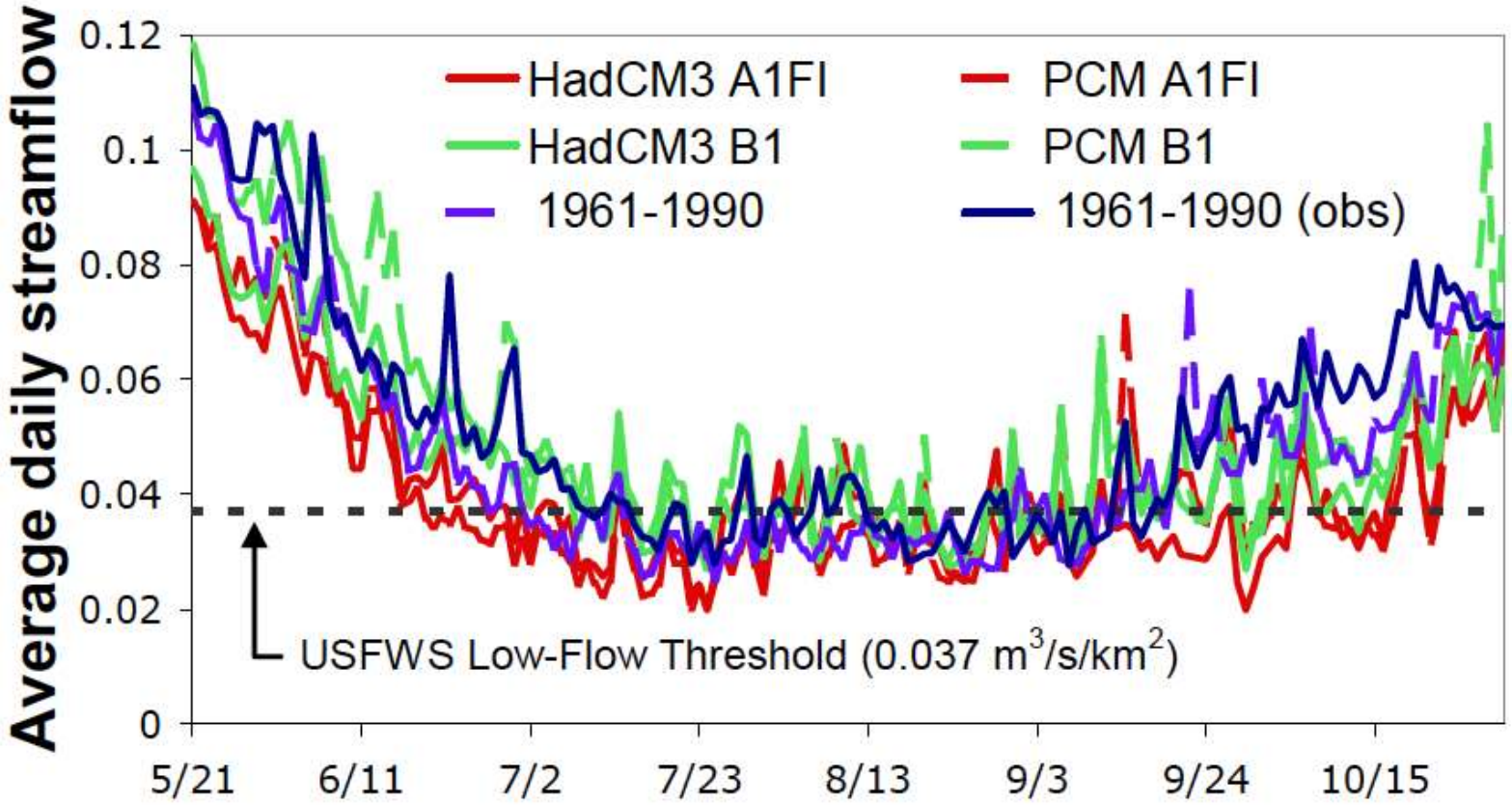


Change in the number of snow-covered days per month in winter (D,J,F)



Values are the average of the HadCM3 and PCM-forced VIC simulations

Source: Hayhoe et al. 2006



Projected changes in average daily flows during the period 21 May through 31 October (cubic meters per second per square kilometer of drainage area); the overall average reflects the mean of the 51 stream values irrespective of the area of their drainage basins

Source: Hayhoe et al. 2006

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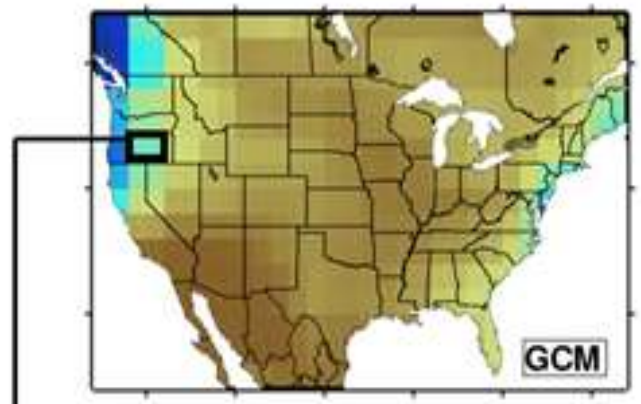
Statistical downscaling:

Goal is to obtain high-resolution climate (<10km) from relatively coarse-resolution (~150-300km) global climate models (GCMs).

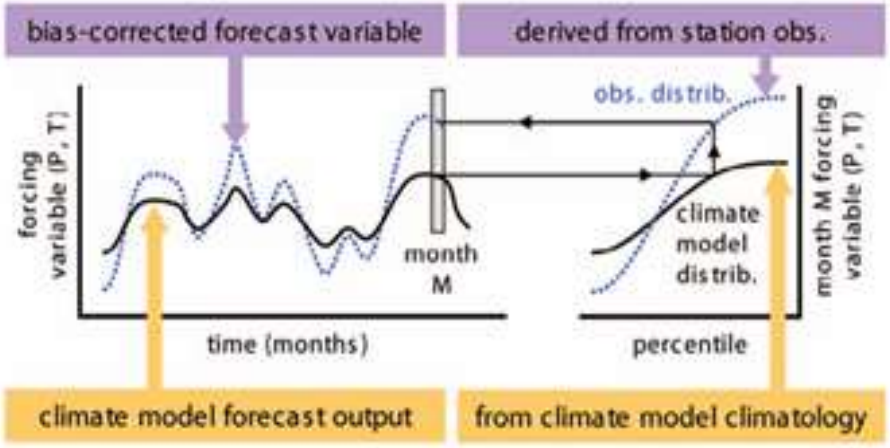
Derives statistical relationships between observed variables and larger (GCM) scale variables
Various methods proposed but BCSD (Bias-correction and spatial disaggregation) is widely adopted.

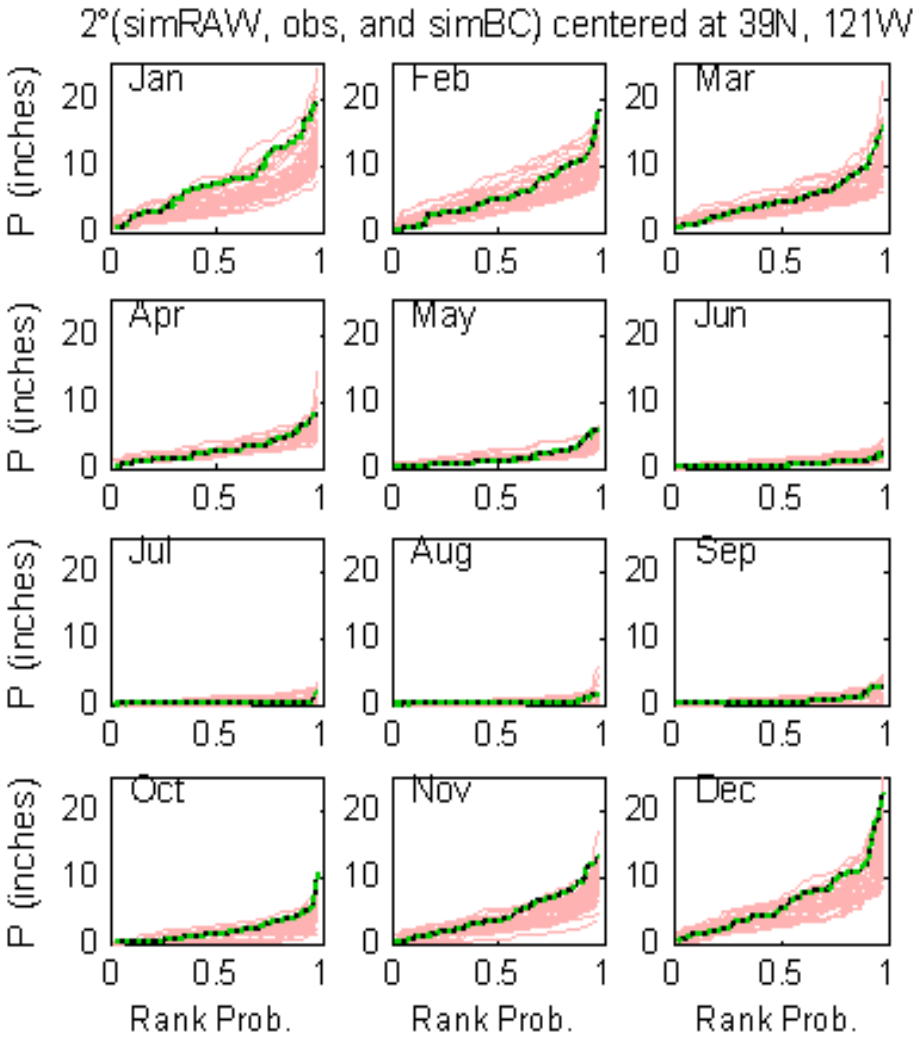
GCM projections of future climate are then used to drive the statistical relationships to estimate the smaller-scale details of future climate; *assumes bias corrections don't change*

BCSD (bias-correction and spatial disaggregation)



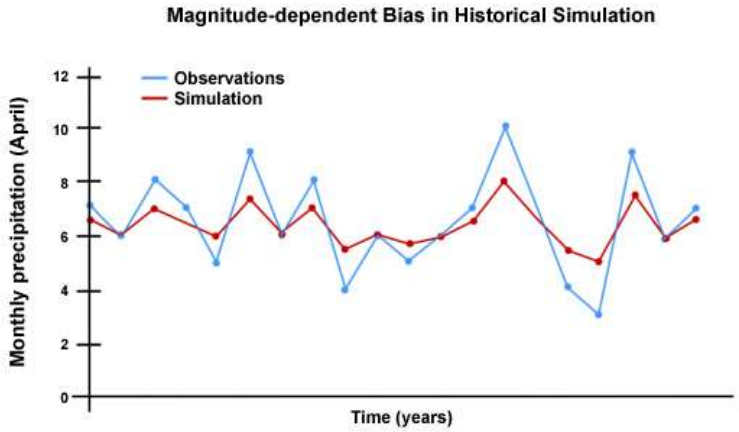
Wood et al., BAMS 2006

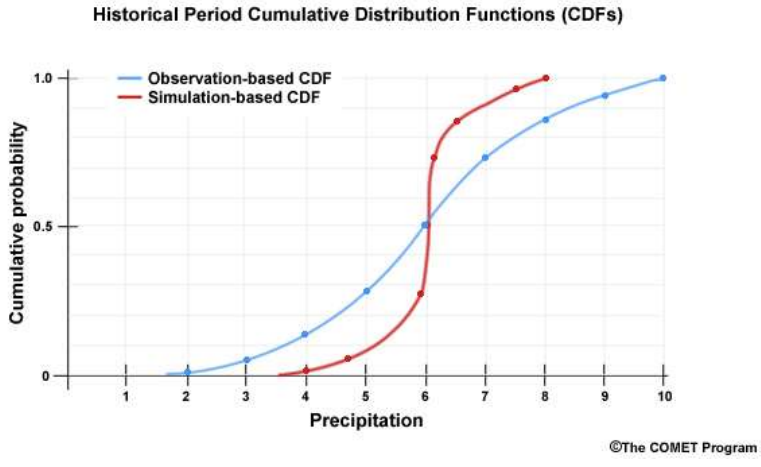




http://gdo-dcp.ucllnl.org/downscaled_cmip_projections/dcpInterface.html#About

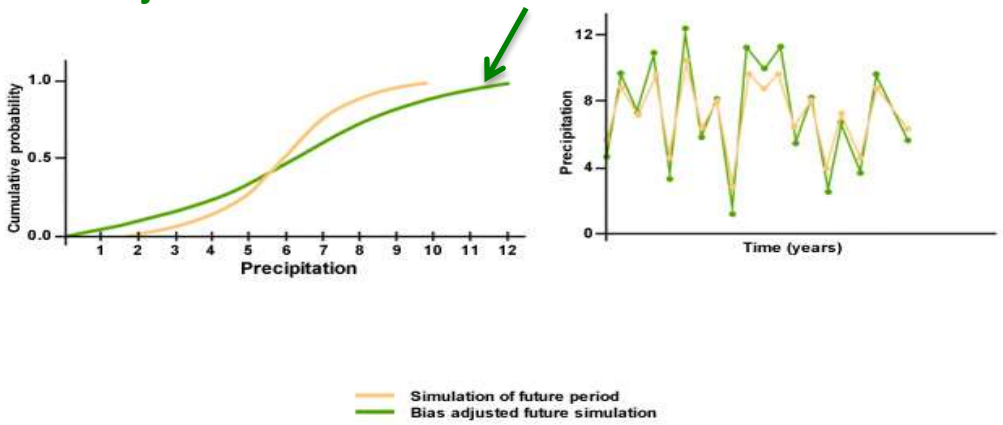
Bias-Correction Statistical Downscaling (BCSD):





CDF and Time Series Views of Future Period Bias Correction

Apply bias-adjustments to obtain "corrected" future simulations:



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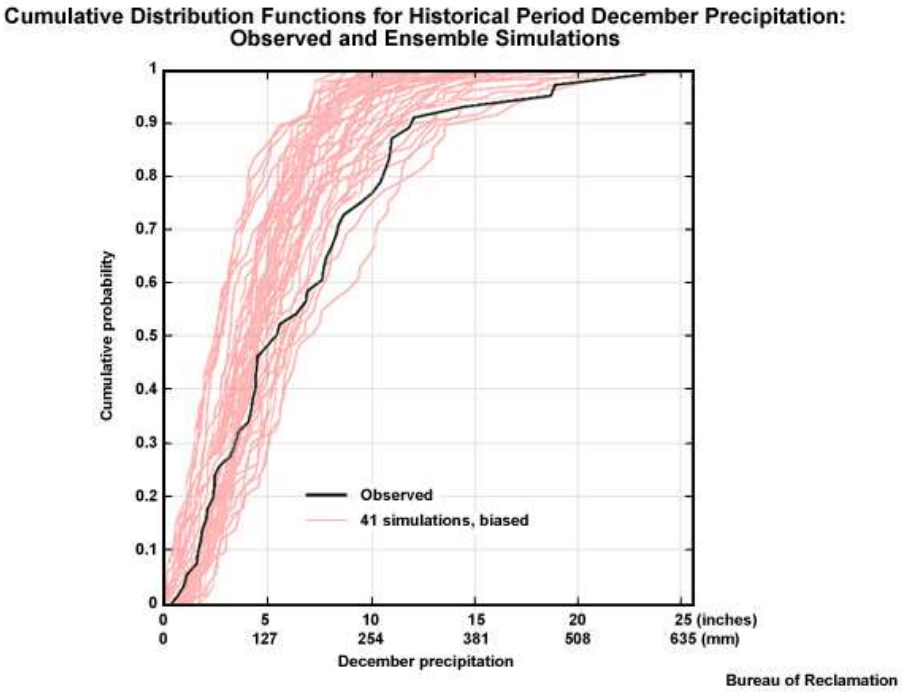

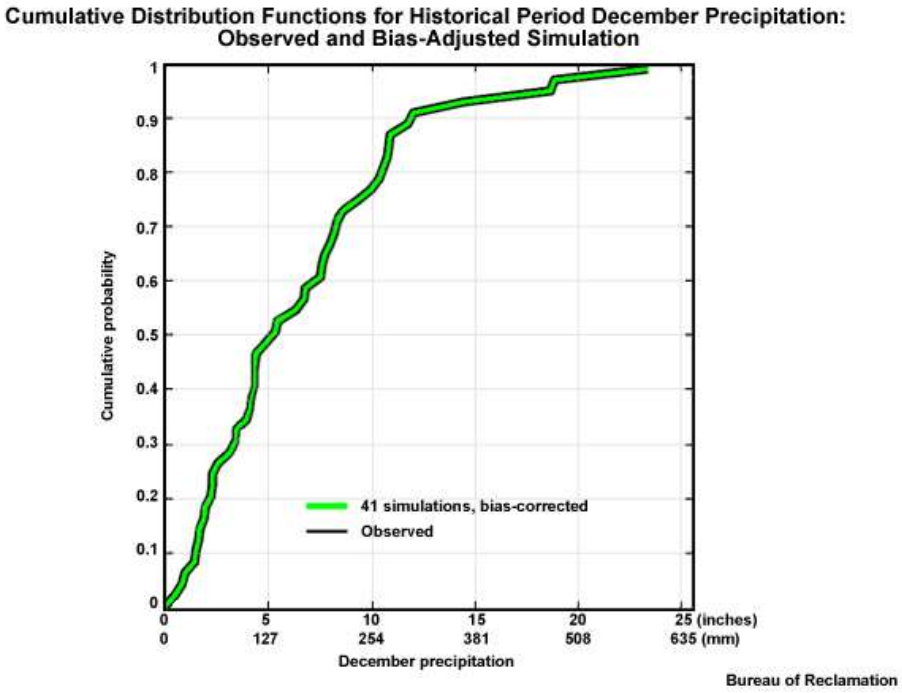

For future scenarios, each simulation uses the same set of distribution-based bias corrections that were obtained for the baseline period.

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