SCIENTIFIC GUIDANCE FOR MODELING CLIMATE CHANGE

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REPRESENTATIVE CONCENTRATION PATHWAYS

Labelled as RCP **2.6**, RCP **4.5**, RCP 6.0, RCP **8.5**

"RCPs were chosen to represent a broad range of climate outcomes… and are neither forecasts nor policy recommendations"

STAC emphasized a need to evaluate a range of future conditions

- We are beginning analyses with RCP 4.5 model runs

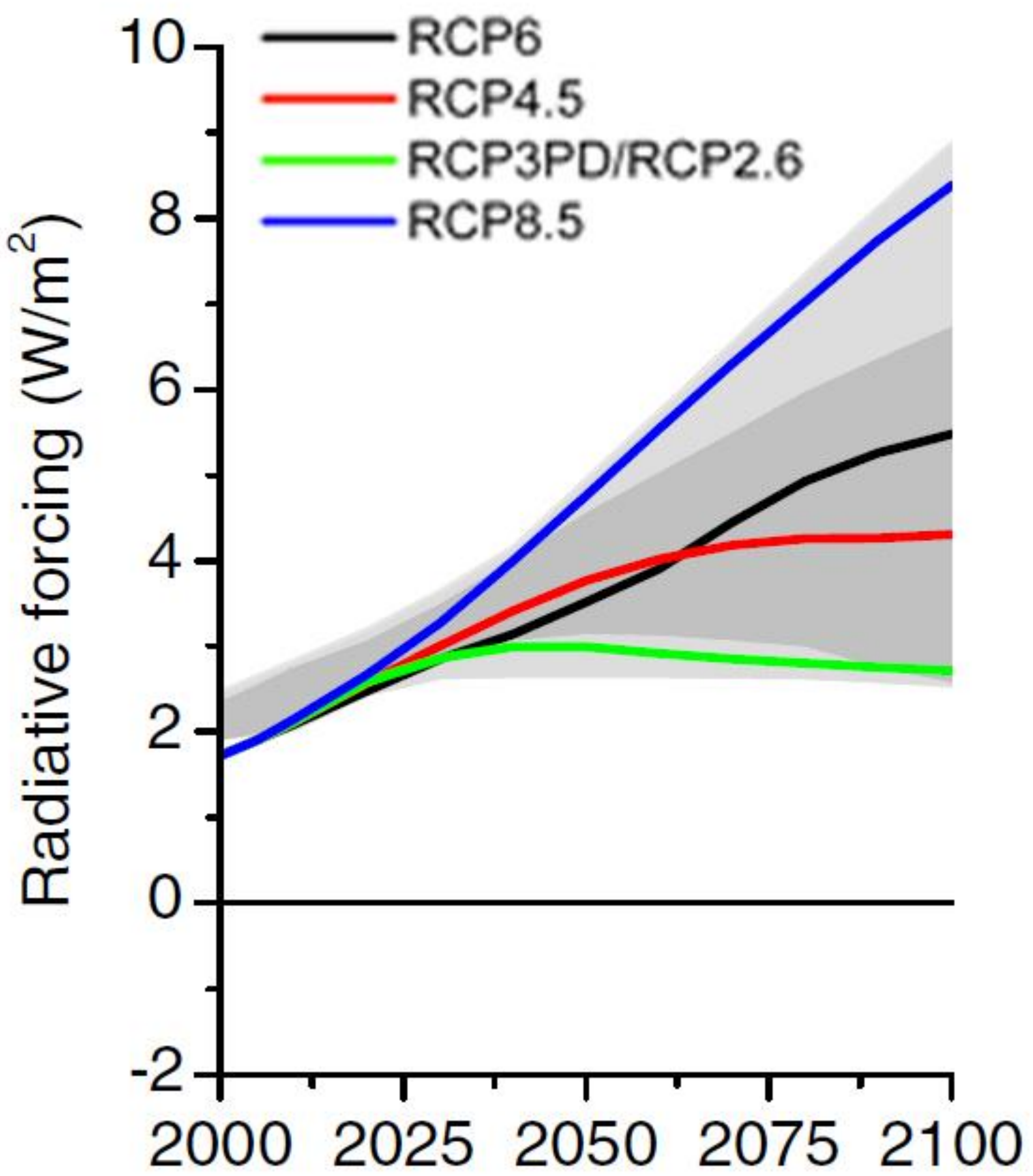
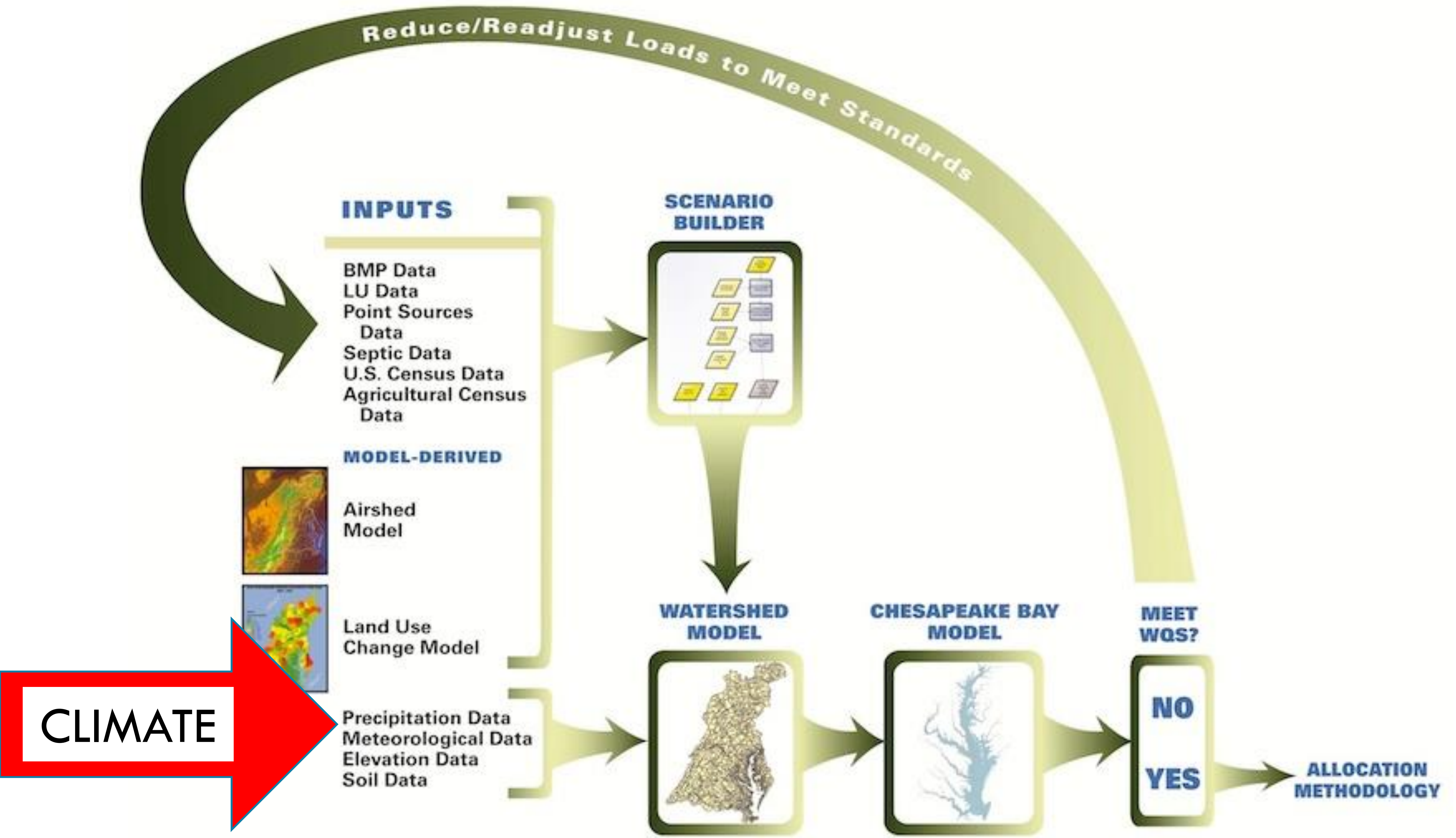


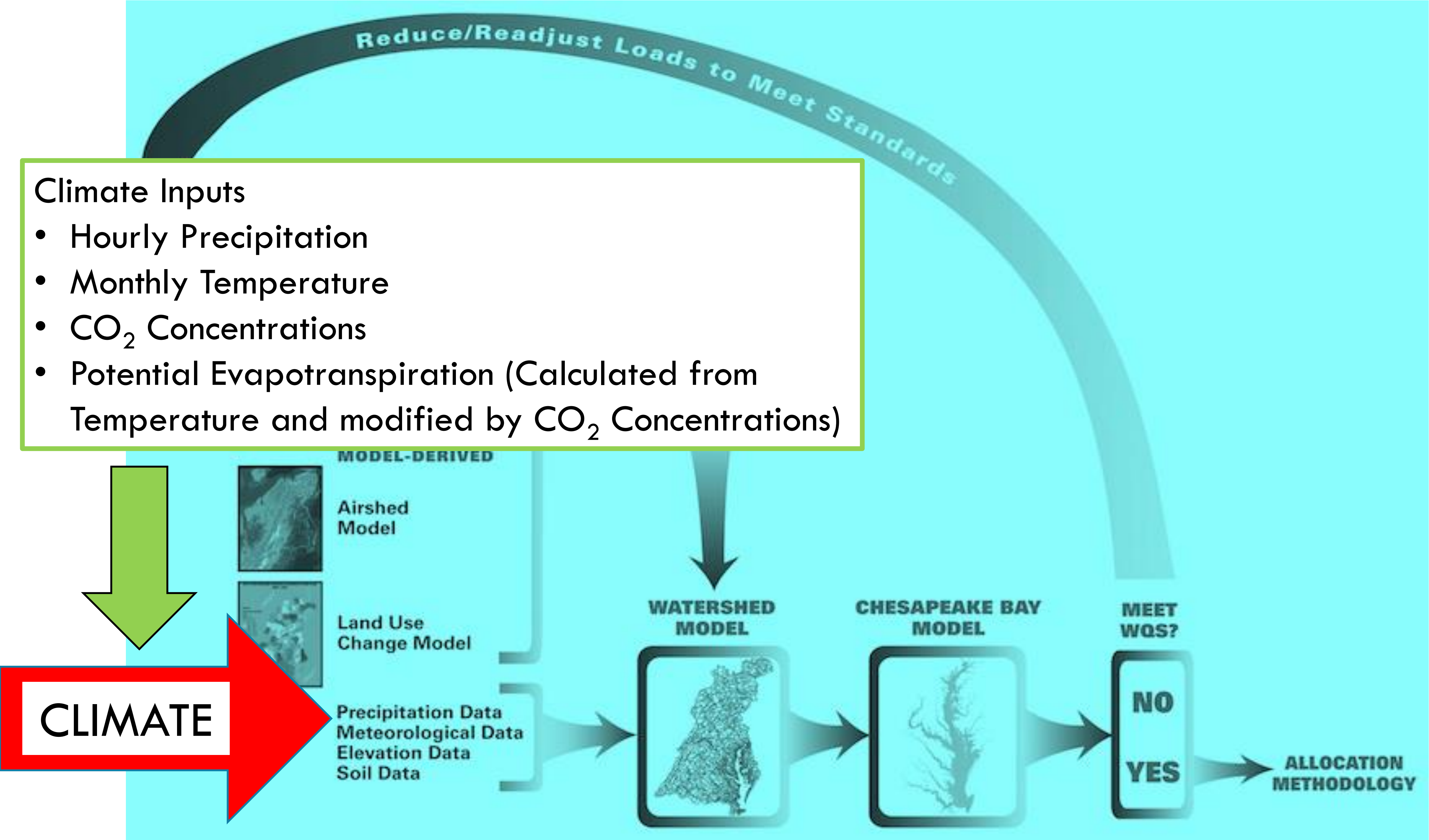
Figure Credit: Radiative Forcing of the Representative Concentration Pathways. From van Vuuren et al (2011) The Representative Concentration Pathways: An Overview. Climatic Change, 109 (1-2), 5-31.



Reduce/Readjust Loads to Meet Standards
INPUTS
BMP Data
LU Data
Point Sources Data
Septic Data
U.S. Census Data
Agricultural Census Data
MODEL-DERIVED
Airshed Model
Land Use Change Model
CLIMATE
Precipitation Data
Meteorological Data
Elevation Data
Soil Data
SCENARIO BUILDER
WATERSHED MODEL
CHESAPEAKE BAY MODEL
MEET WQS?
NO
YES
ALLOCATION METHODOLOGY

Climate Inputs

- Hourly Precipitation
- Monthly Temperature
- CO_2 Concentrations
- Potential Evapotranspiration (Calculated from Temperature and modified by CO_2 Concentrations)



CLIMATE INPUT OPTIONS

Δ Approach – Historical compared to Projected Run

- Good, Simple, Intuitive
- Harder to capture changes in variability

Use Median/Mean Downscaled Projection

- Better captures changes in means and extremes
- Changes in quartiles/quantiles are less arbitrary
- Need to choose a model that performs well regionally (possible to use a variation of Chris Morefield's LASSO approach)
- Significant time required – calibration of historical forcing run before future projection run

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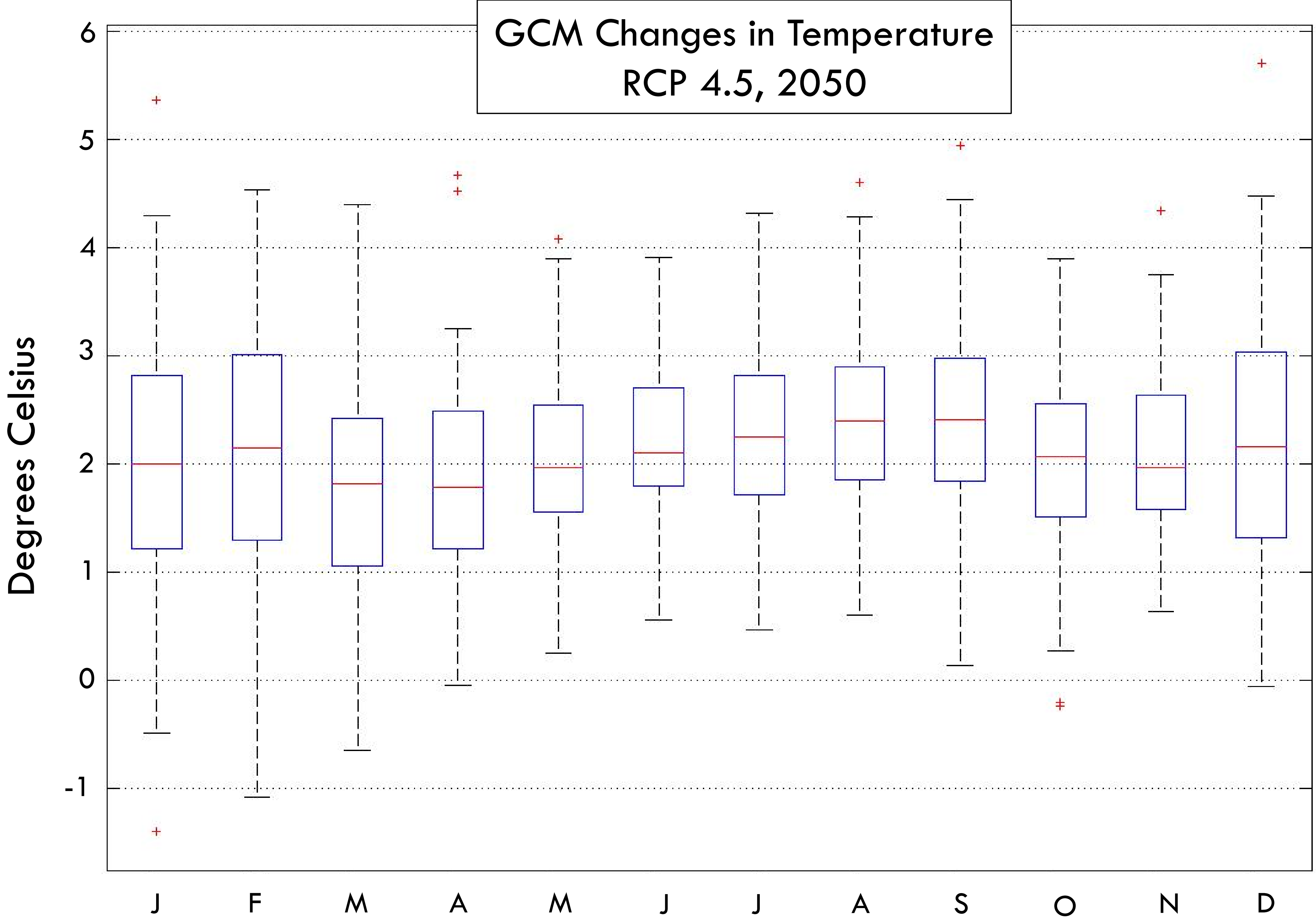
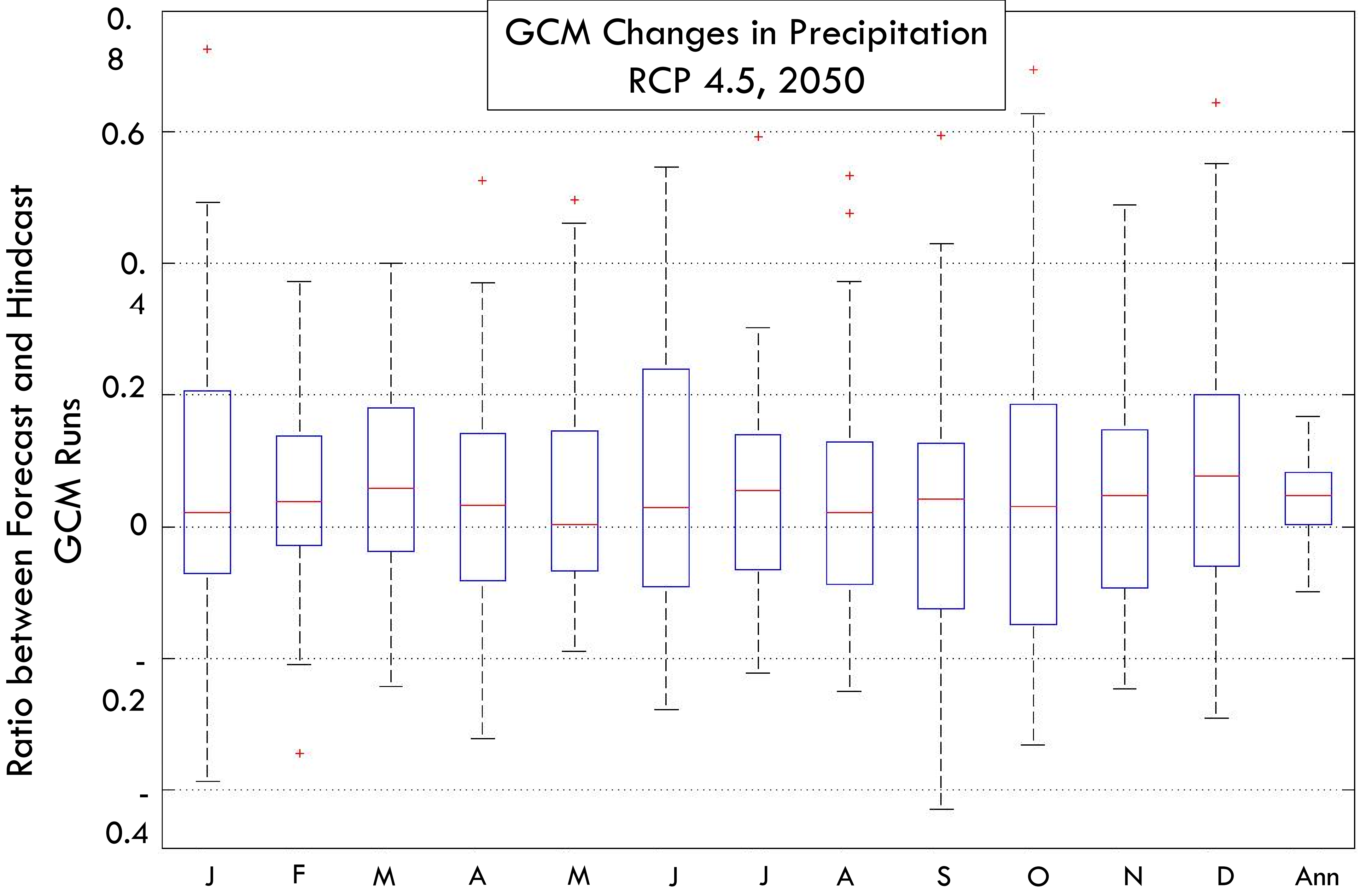
WINNER!


GCM Changes in Temperature
RCP 4.5, 2050
Degrees Celsius
6
5
4
3
2
1
0
-1
J
F
M
A
M
J
J
A
S
O
N
D


GCM Changes in Precipitation
RCP 4.5, 2050
Ratio between Forecast and Hindcast GCM Runs
0.8
0.6
0.4
0.2
0
-0.2
-0.4
J
F
M
A
M
J
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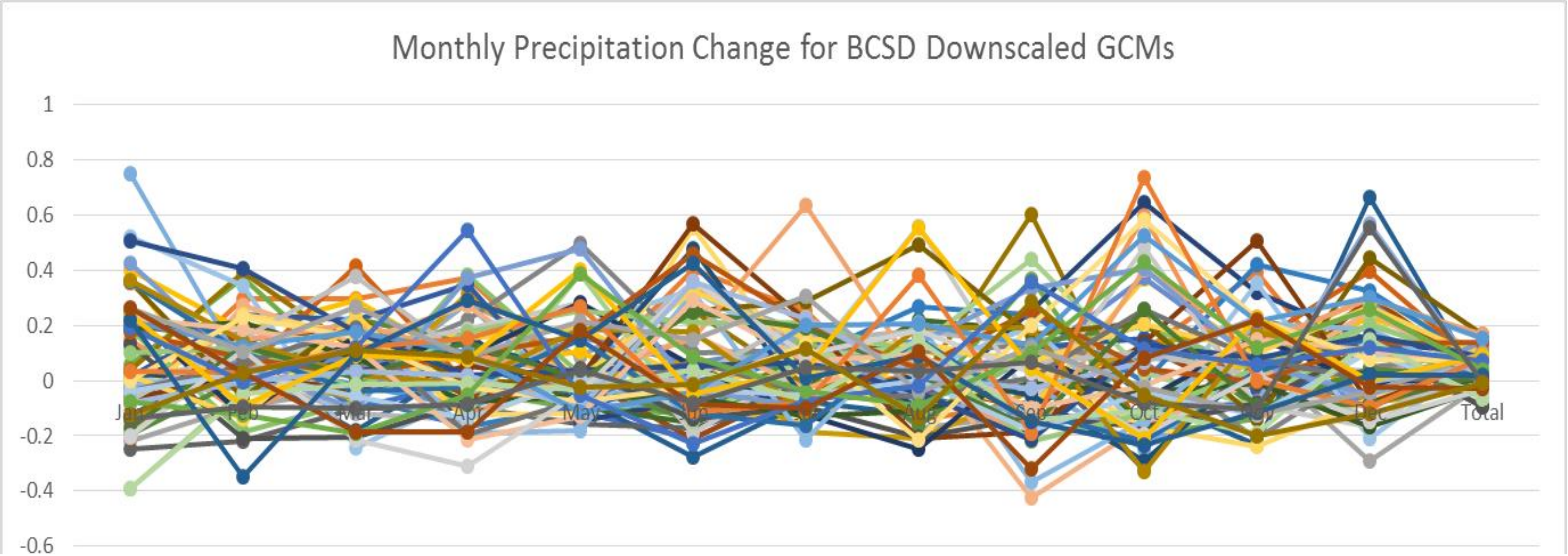
VARIABILITY AMONG GCMS

Across the board, GCMs agree on overall increases in temperature

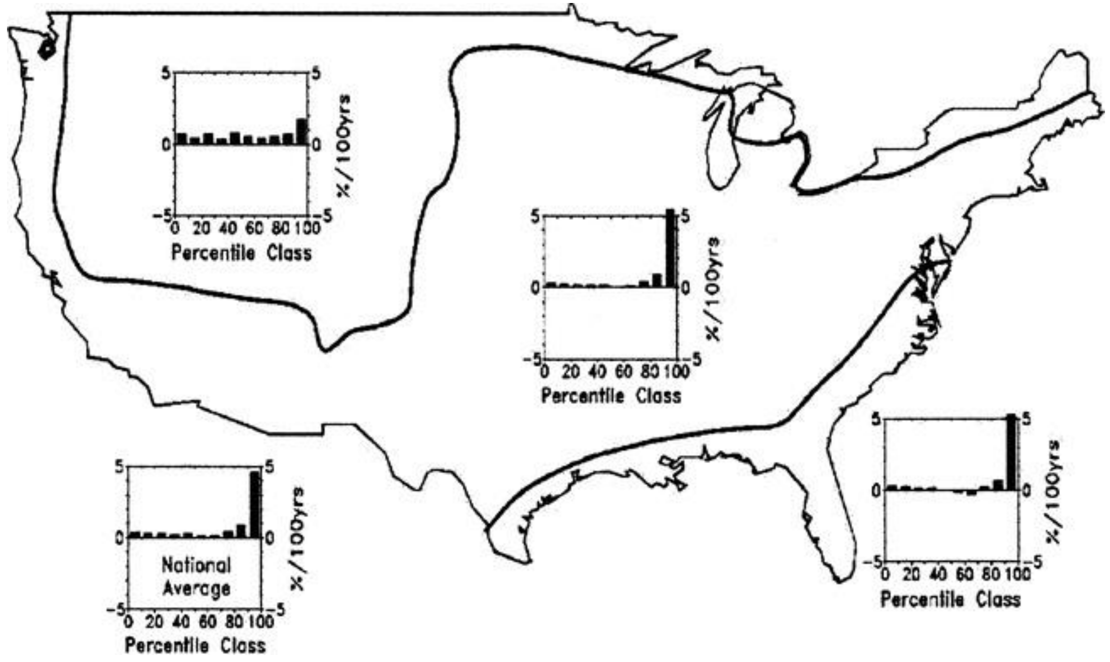
Overall agreement in terms of the magnitude of precipitation change is less straightforward, although the direction of change is generally positive



PRECIPITATION CHANGES

Factors of Intensity, Duration, and Frequency are expected to change, resultant from climate impacts

- To begin this analysis, we have only altered the anticipated changes in Intensity



Groisman, Pavel Ya, et al 2004

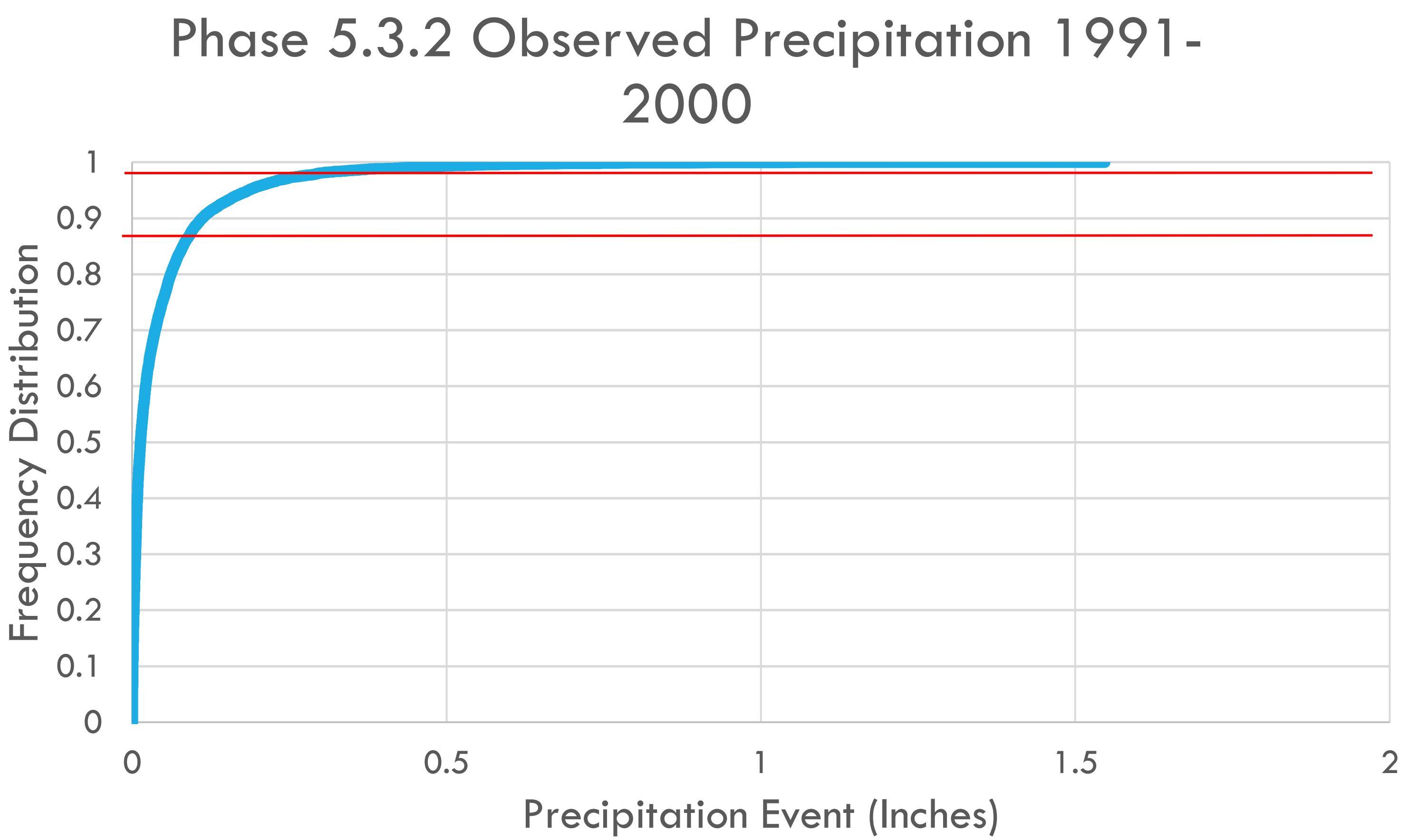
- Precipitation events will be modified based on anticipated future monthly variability

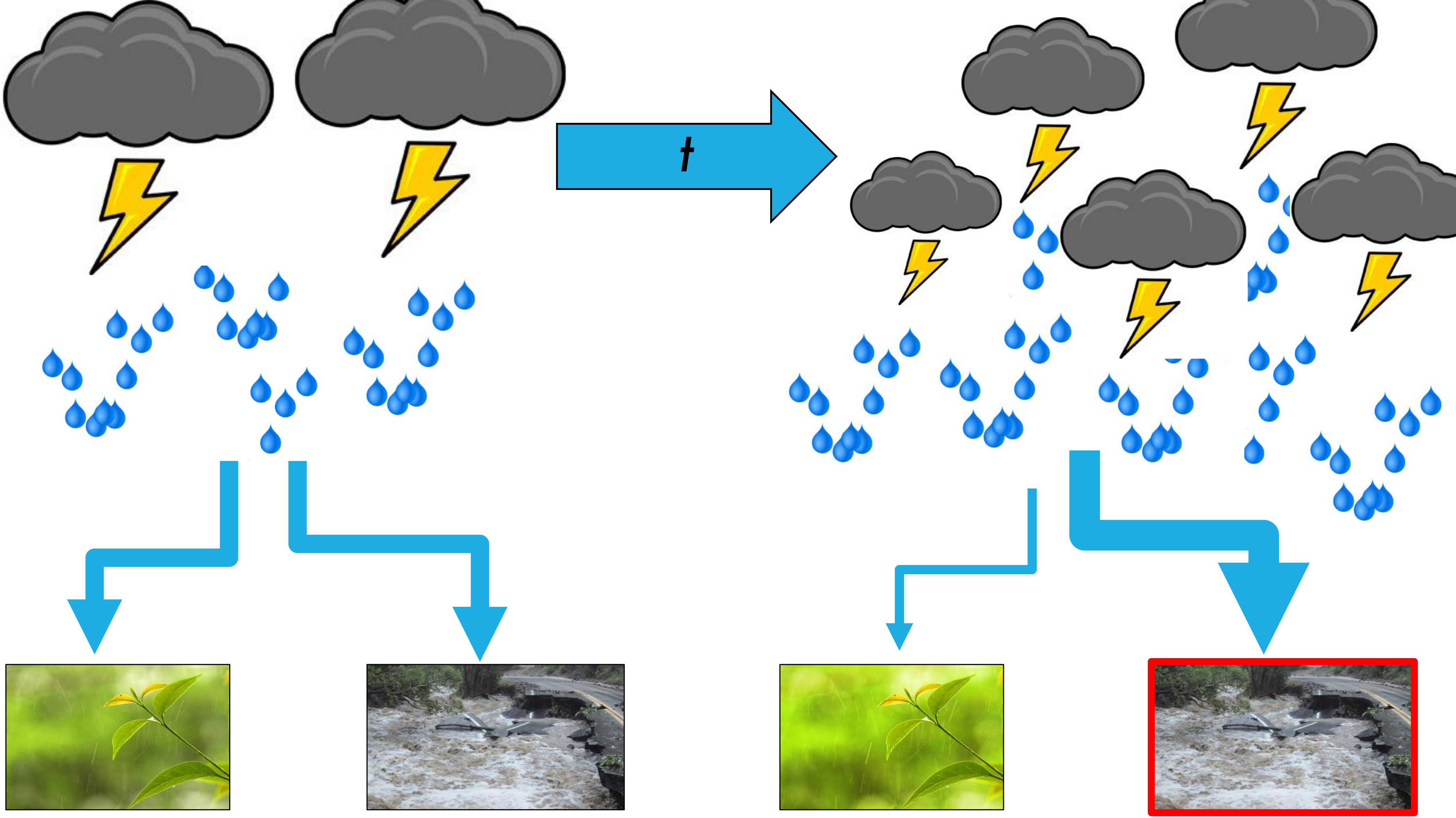
PRECIPITATION CHANGES

Changes in total volume per month were applied to each event based on weighted decile values provided by Groisman, Pavel Ya, et al (2004)

- This information could be extracted from daily GCMs

Decile weighting was held constant throughout the watershed, but the capability exists to modify the proportions of assigned volume based on location

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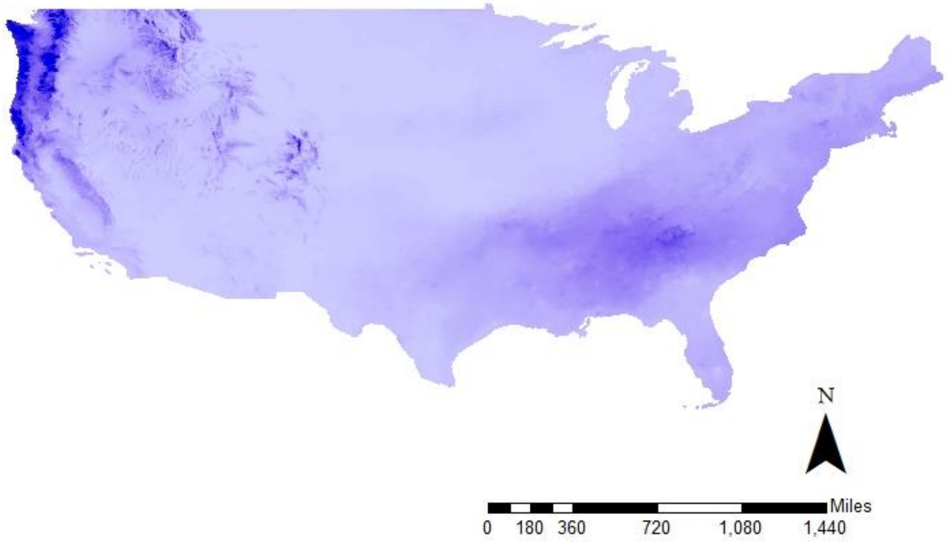
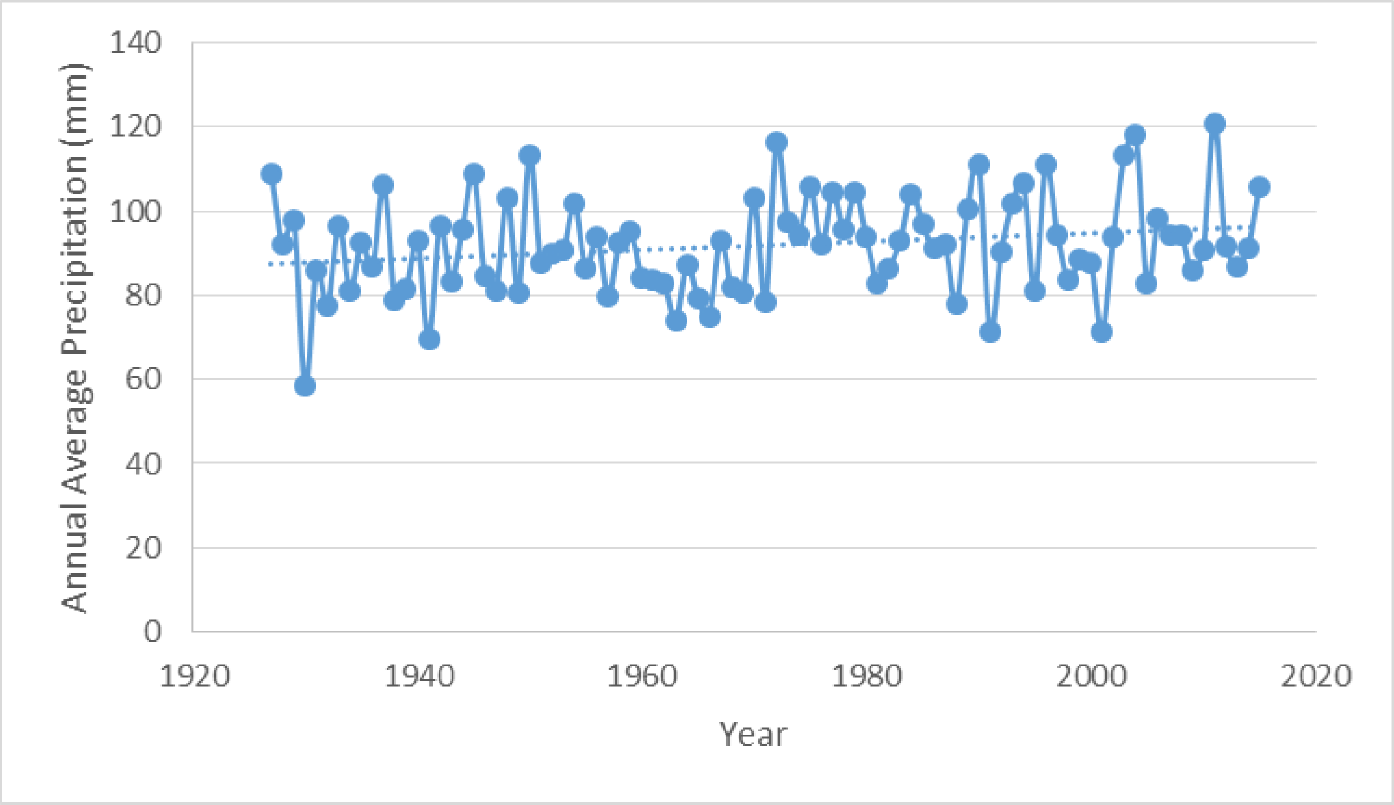
2025 APPROACH

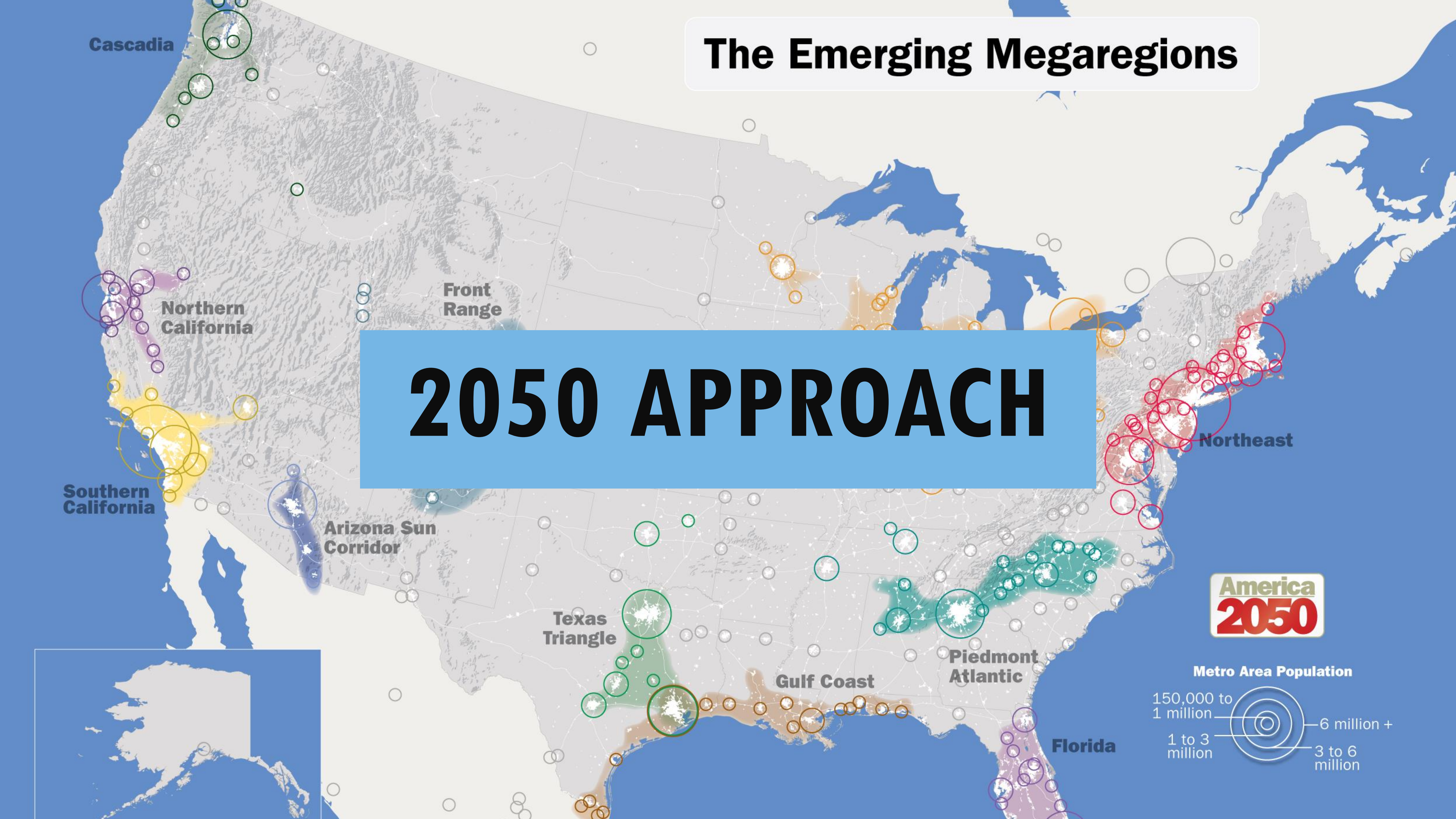
LONG TERM TRENDS

Based on Karen Rice's statistical analysis of long term trends in precipitation, gathered from PRISM data





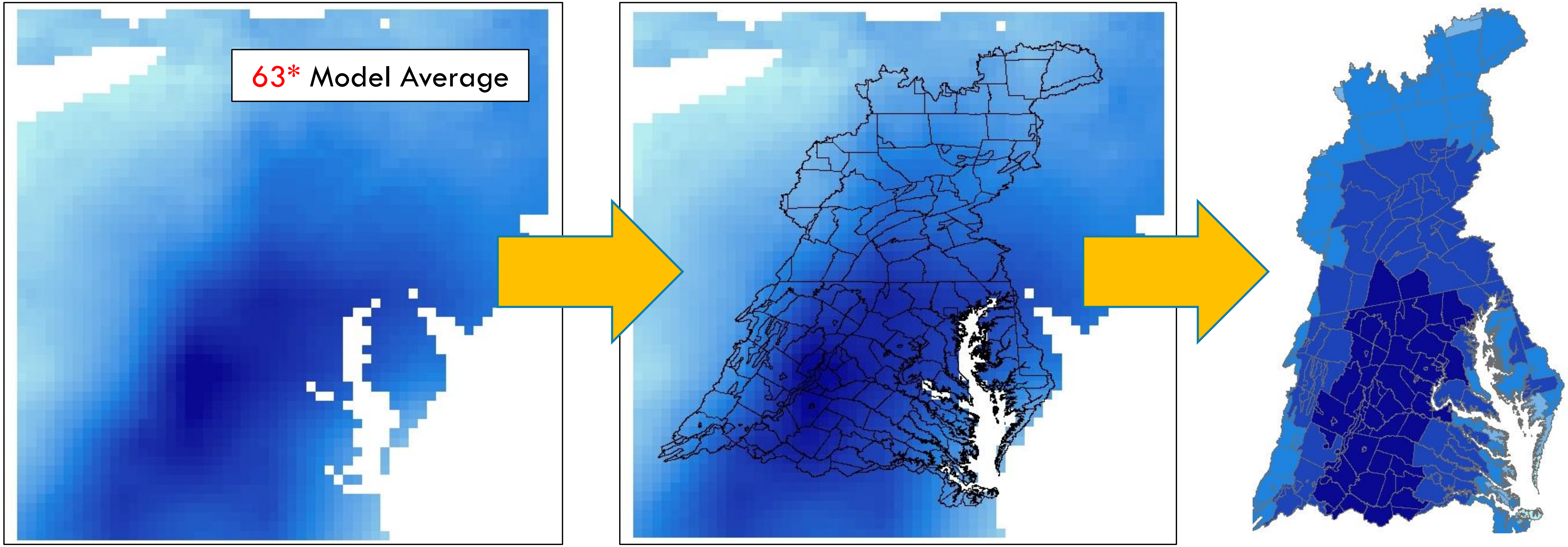
2050 APPROACH



CLIMATE MODELS

Initially, an ensemble comprised of 63 General Circulation Models (GCMs) was created in this analysis

These GCMs were statistically downscaled using a Bias-Corrected Spatial Disaggregation (BCSD) method at a resolution of 1/8° latitude-longitude (approx. 12 km)



DE and DC Models Used

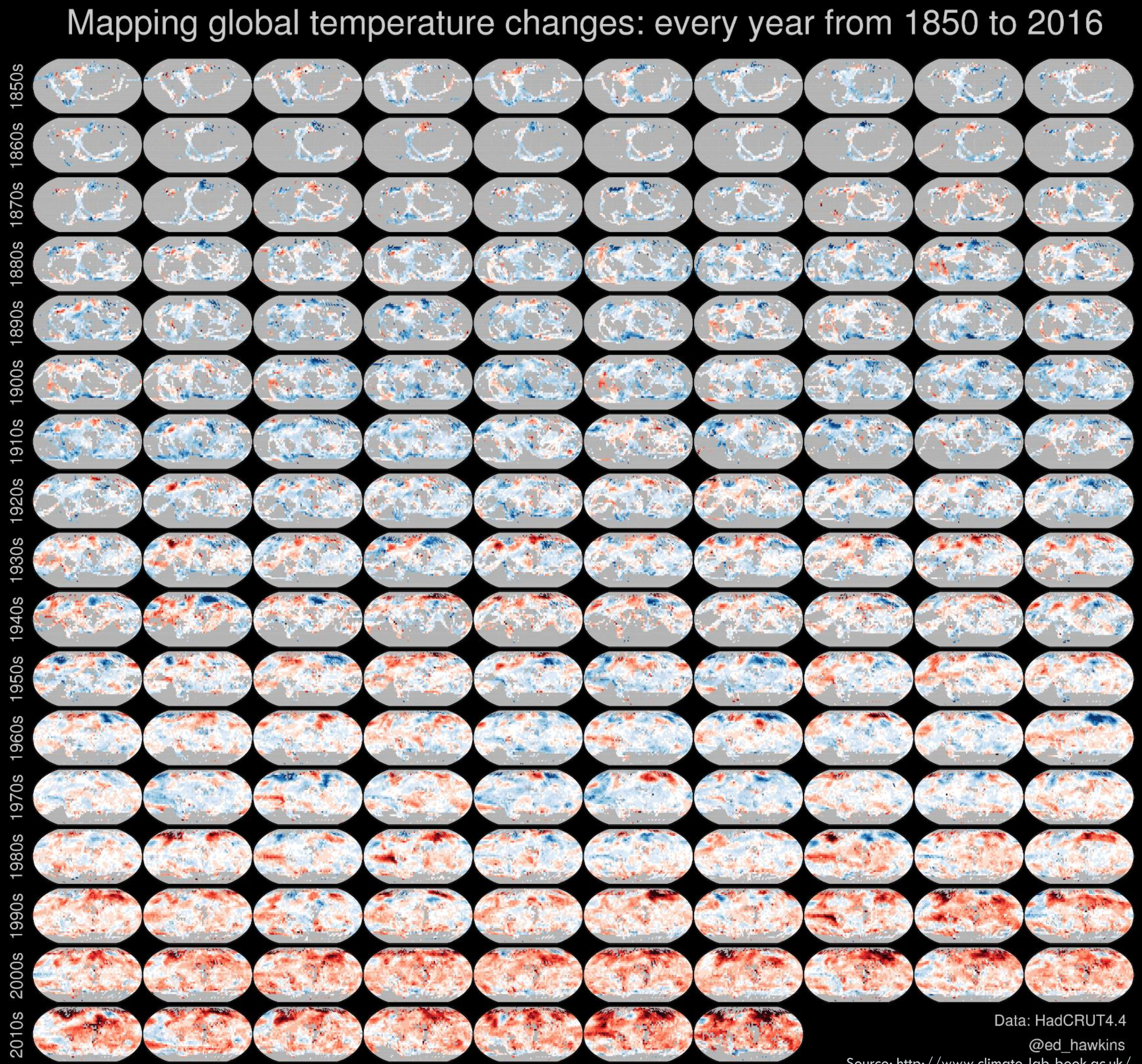
ORIGIN	CMIP5 model(s)	CMIP5 scenario(s)
National Center for Atmospheric Research, USA	CCSM4	4.5, 8.5
Centre National de Recherches Météorologiques, France	CNRM-CM5	4.5, 8.5
Commonwealth Scientific and Industrial Research Organisation, Australia	CSIRO-MK3.6.0	4.5, 8.5
Geophysical Fluid Dynamics Laboratory, USA	(used for CMIP3 scenarios, not CMIP5)	(used for CMIP3 scenarios, not CMIP5)
Max Planck Institute for Meteorology, Germany	MPI-ESM-LR	4.5, 8.5
UK Meteorological Office Hadley Centre	HadGEM2-CC	4.5, 8.5
Institute for Numerical Mathematics, Russian	INMCM4	4.5, 8.5
Institut Pierre Simon Laplace, France	IPSL-CM5A-LR	4.5, 8.5
Agency for Marine-Earth Science and Technology, Atmosphere and Ocean Research Institute, and National Institute for Environmental Studies, Japan	MIROC5	4.5, 8.5
Meteorological Research Institute, Japan	MRI-CGCM3	4.5, 8.5

COMPARISON OF STATISTICAL DOWNSCALING METHODS

Gutmann, Ethan, Et Al. "An Intercomparison of Statistical Downscaling Methods Used for Water Resource Assessments in the United States." *Water Resources Research* 50.9 (2014): 7167-7186.

- We assess four commonly used statistical downscaling methods... **The AR method reproduces extreme events and wet day fraction well at the grid-cell scale, but over (under) estimates extreme events (wet day fraction) at aggregated scales. BCSDm reproduces extreme events and wet day fractions well at all space and time scales, but is limited to rescaling current weather patterns**

Questions?



Source: http://www.climate-lab-book.ac.uk/

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