Thank you for signing in early

The webinar will begin promptly at
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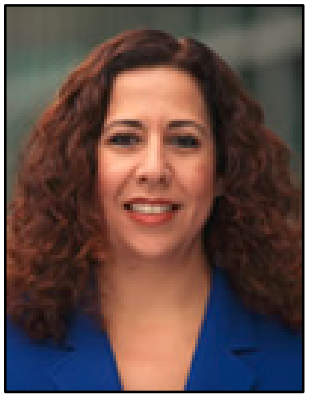
"Use of Climate Information for Decision-Making and Impacts Research: State of our Understanding"

April 7, 2016

SERDP DOD • EPA • DOE | ESTCP

Welcome and Introductions



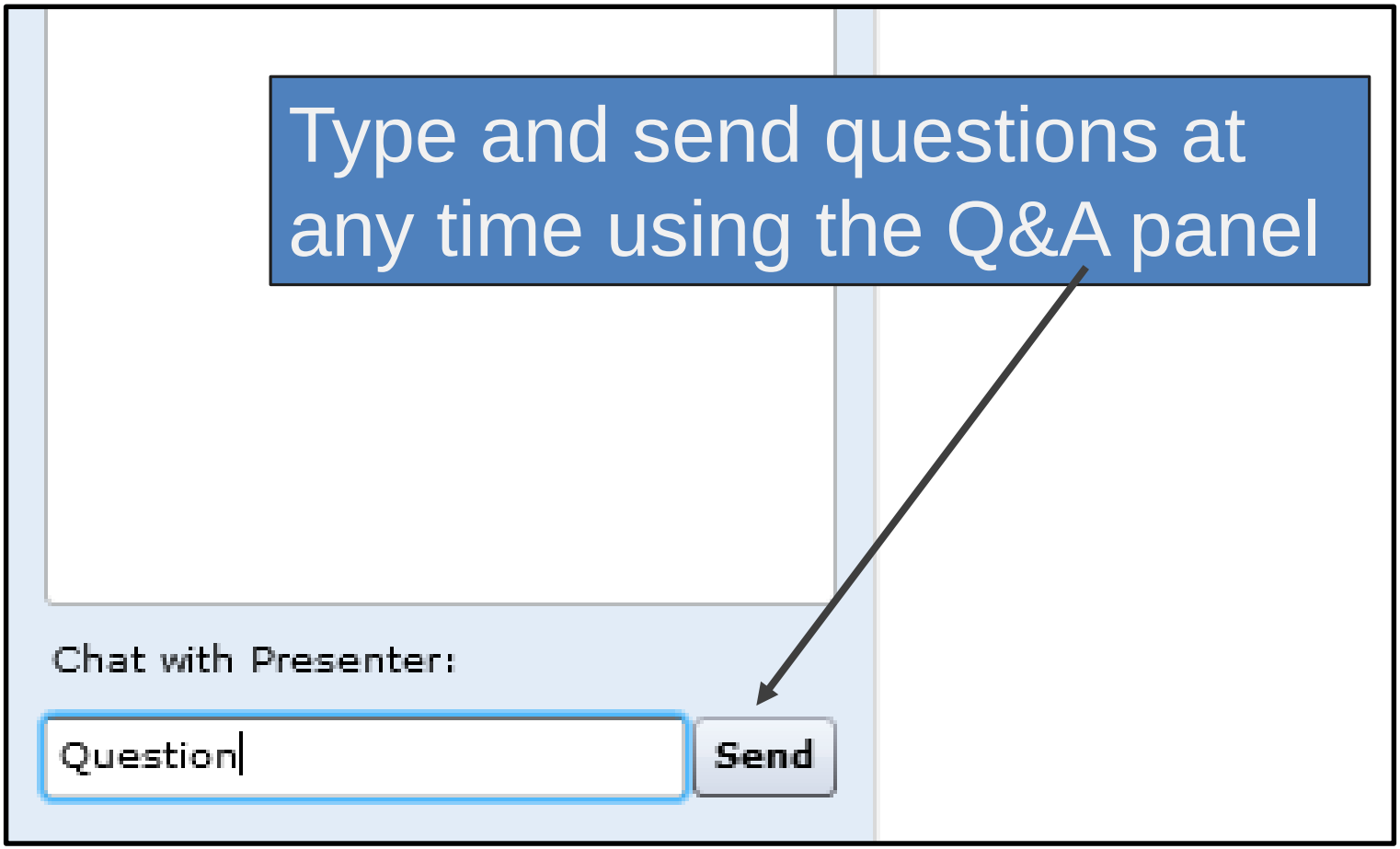
Rula A. Deeb, Ph.D.
Webinar Coordinator

SERDP DOD • EPA • DOE | ESTCP

Agenda

- **Webinar Logistics** (5 minutes)
  Dr. Rula Deeb, Geosyntec Consultants
- **Overview of SERDP and ESTCP** (5 minutes)
  Dr. John Hall, SERDP and ESTCP
- **Use of Climate Information for Decision-Making and Impacts Research: State of our Understanding** (55 minutes + Q&A)
  Dr. Rao Kotamarthi (Argonne National Laboratory)
  Dr. Linda Mearns (National Center for Atmospheric Research)
  Dr. Katharine Hayhoe (Texas Tech University)
  Dr. Christopher Castro (University of Arizona, Tucson)
  Dr. Donald Wuebbles (University of Illinois, Urbana)
- **Final Q&A session**

How to Ask Questions



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- Delays in the broadcast audio
  - Click the mute/connect button
  - Wait 3-5 seconds
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  - If delays continue, call into the conference line
    - U.S./Canada: 1-877-665-8320
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    - Required conference ID: 77924258
- Submit a question using the chat box

SERDP and ESTCP Overview

John Hall, Ph.D.

Resource Conservation and Climate Change Program Manager

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SERDP

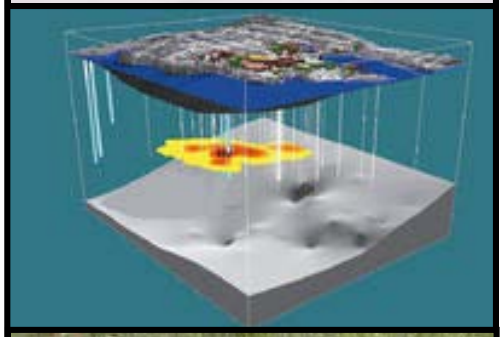
- Strategic Environmental Research and Development Program
- Established by Congress in FY 1991
  - DoD, DOE and EPA partnership
- SERDP is a requirements driven program which identifies high-priority environmental science and technology investment opportunities that address DoD requirements
  - Advanced technology development to address near term needs
  - Fundamental research to impact real world environmental management

ESTCP

- Environmental Security Technology Certification Program
- Demonstrate innovative cost-effective environmental and energy technologies
  - Capitalize on past investments
  - Transition technology out of the lab
- Promote implementation
  - Facilitate regulatory acceptance

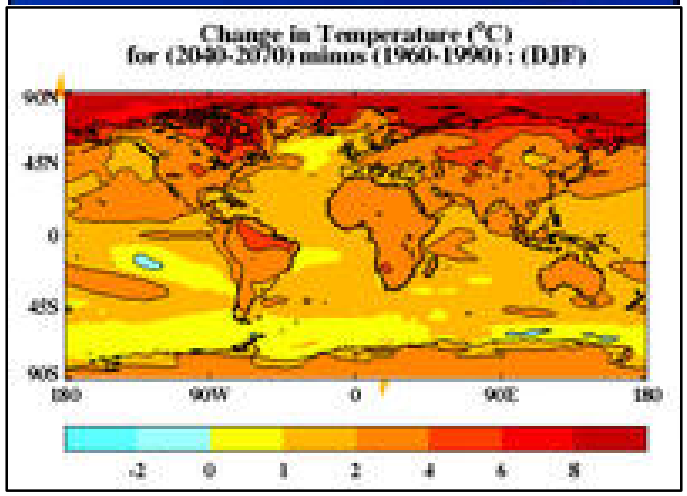
Program Areas

1. Energy and Water
2. Environmental Restoration
3. Munitions Response
4. Resource Conservation and Climate Change
5. Weapons Systems and Platforms



Resource Conservation and Climate Change

- Natural resources
  - Ecological forestry
  - Arid lands ecology and management
  - Cold regions ecology and management
  - Pacific island ecology and management
  - Coastal and estuarine ecology and management
  - Living marine resources ecology and management
  - Species ecology and management
  - Watershed processes and management
- Climate change
  - Vulnerability and impact assessment
  - Adaptation science
  - Land use and carbon management
- Air quality
  - Fugitive dust
  - Fire emissions



SERDP and ESTCP Webinar Series

DATE	Topics
April 21, 2016	Long Term Monitoring Issues at Chlorinated Solvent Sites
May 05, 2016	Battery Energy Storage
May 19, 2016	Quality Assurance Project Plan (QAPP) for Geophysical Classification Investigations – Part 1
June 02, 2016	Insensitive Munitions
June 16, 2016	Quality Assurance Project Plan (QAPP) for Geophysical Classification Investigations – Part 2
June 30, 2016	TBD
July 14, 2016	Remote Methods for Water Conservation
July 28, 2016	An Environmentally Acceptable Alternative for Fast Cook-off Testing, Demonstration, Validation and Implementation Efforts

http://serdp-estcp.org/Tools-and-Training/Webinar-Series

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Introduction

Use of Climate Information for Decision-Making and Impacts Research: State of our Understanding

Rao Kotamarthi, Ph.D.
Argonne National Laboratory

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Agenda

- Overview of the report
  - *Use of climate information for decision-making and impacts research: State of our understanding*
- High-resolution climate projections
  - Why get them?
  - What is downscaling?
- Examples, recommendations and guidelines
  - Illustrative examples
  - Regional considerations
  - Recommendations and guidelines

Report Overview and Project Team

- Follow-up to five research projects investigating decision-making in DoD and its relationship to available and needed climate information at appropriate spatial and temporal scales, with the objective of helping DoD users, and by extension those conducting the impacts research that informs potential decisions, to make useful decisions informed by the state of the science in a rapidly changing climate
- Report authors
  - Dr. Rao Kotamarthi (Argonne National Laboratory)
  - Dr. Linda Mearns (National Center for Atmospheric Research)
  - Dr. Katharine Hayhoe (Texas Tech University)
  - Dr. Christopher Castro (University of Arizona, Tucson)
  - Dr. Donald Wuebbles (University of Illinois, Urbana)

Report Goals

<u>Provide information</u> for selecting climate information and downscaled climate products, focusing on applications to **<u>vulnerability and impact assessments and adaptation planning</u>**, at a level useful for **<u>action officers</u>** within the Office of the Secretary of Defense, military service headquarters, installation oversight commands, and **<u>planners and key installation managers</u>** with a range of knowledge and experience on climate information and decision-making

SERDP REPORT

USE OF CLIMATE INFORMATION FOR DECISION-MAKING AND IMPACTS RESEARCH: STATE OF OUR UNDERSTANDING

MARCH 2016

Rao Kotamarthi
Environmental Science Division, Argonne National Laboratory, Argonne, IL

Linda Mearns
Regional Integrated Science Collective, National Center for Atmospheric Research, Boulder, CO

Katharine Hayhoe
Climate Science Center, Texas Tech University, Lubbock, TX

Christopher L. Castro
Department of Hydrology and Atmospheric Science, University of Arizona, Tucson, AZ

Donald Wuebbles
Department of Atmospheric Sciences, University of Illinois, Urbana, IL

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https://www.serdp-estcp.org/Program-Areas/Resource-Conservation-and-Climate-Change/Climate-Change/

Report Overview

- Convey a basic understanding of climate modeling and future projections
- Describe how to incorporate these into vulnerability and impact assessments, climate resilience and preparedness, and adaptation planning

Report Overview (Cont'd)

- ***Do not*** recommend "best" climate models, methods, or projections
- ***Do*** recommend appropriate use of high-resolution projections to help users make useful decisions informed by the state of the science in a rapidly changing climate
- ***Do*** encourage continuing dialogue between climate and user communities

Glossary and Definitions

GCM	Global Climate Model (or General Circulation Model, when referring to the older climate models that consisted of atmospheric and ocean components only)
RCM	Regional Climate Model
RCP	Representative Concentration Pathway
NCEP	National Centers for Environmental Prediction
NCEI	National Centers for Environmental Information (formerly NCDC, National Climate Data Center)
ENSO	El Niño-Southern Oscillation
T, P	Temperature and Precipitation

High-Resolution Climate Projections:
Why we need them and how we get them

Katharine Hayhoe, Ph.D.
Climate Science Center
Texas Tech University

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Agenda

- Overview of the report
  - *Use of climate information for decision-making and impacts research: State of our understanding*
- High-resolution climate projections
  - Why get them?
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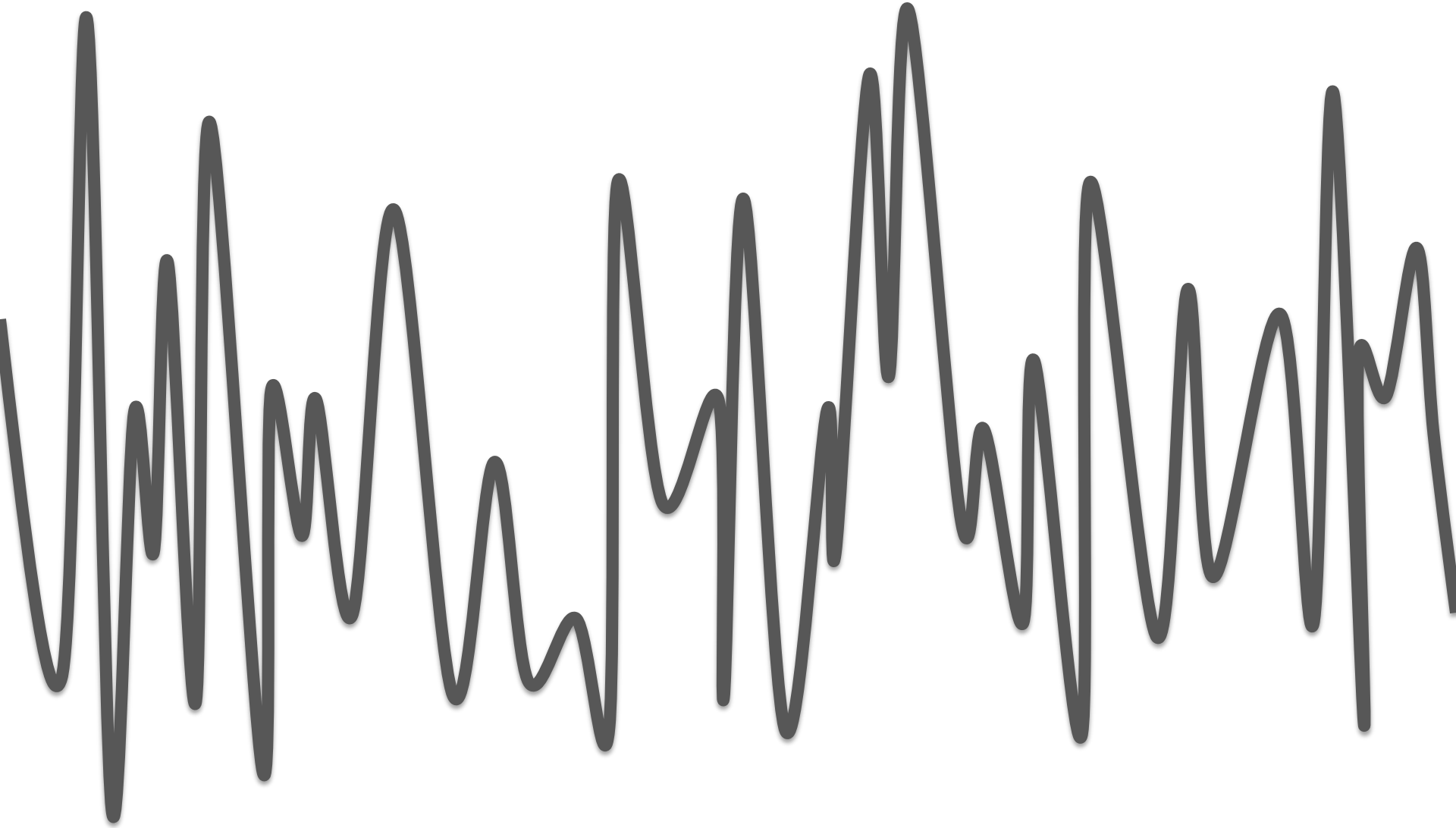
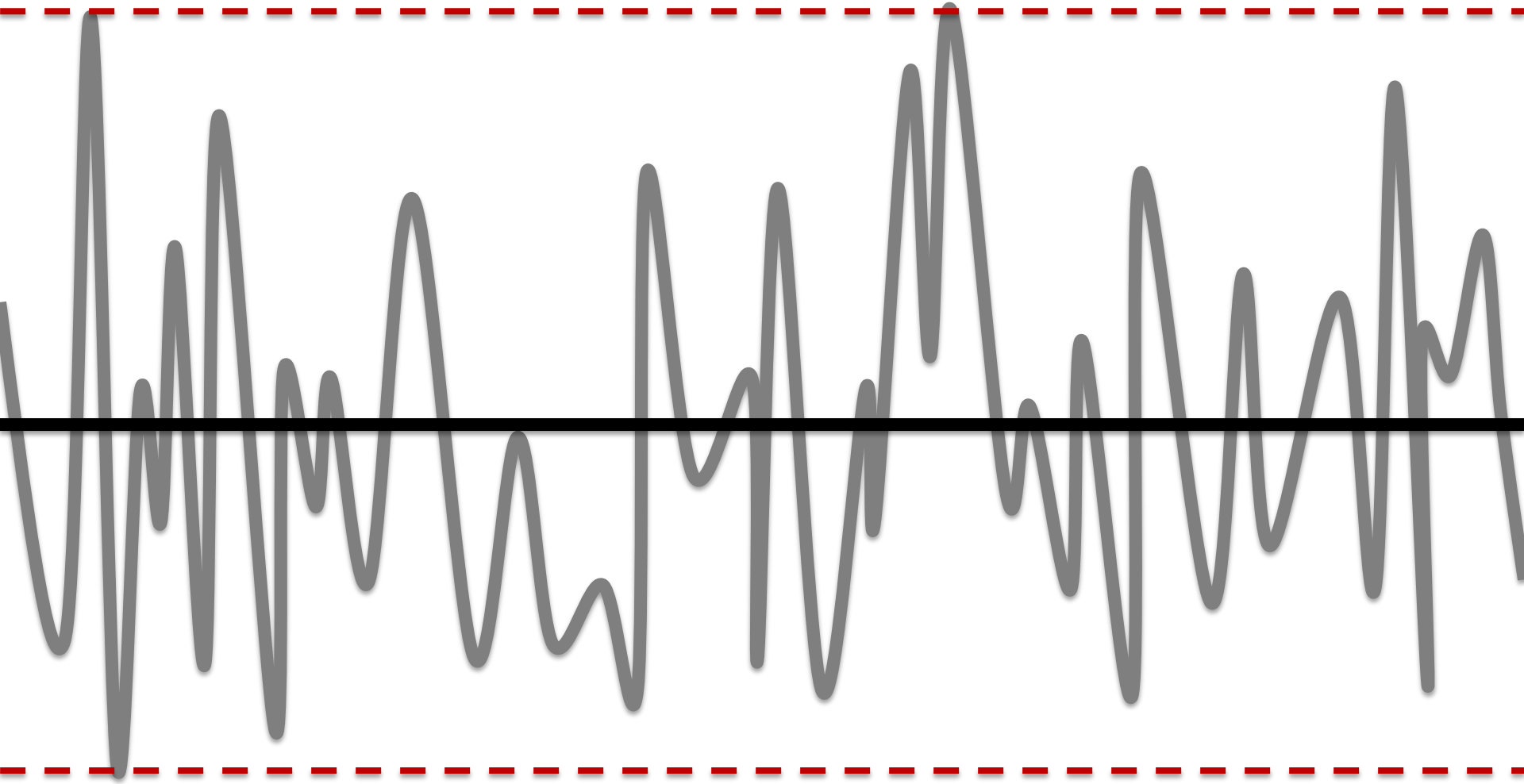
- Examples, recommendations and guidelines
  - Illustrative examples
  - Regional considerations
  - Recommendations and guidelines

Normal Climate

Normal Climate



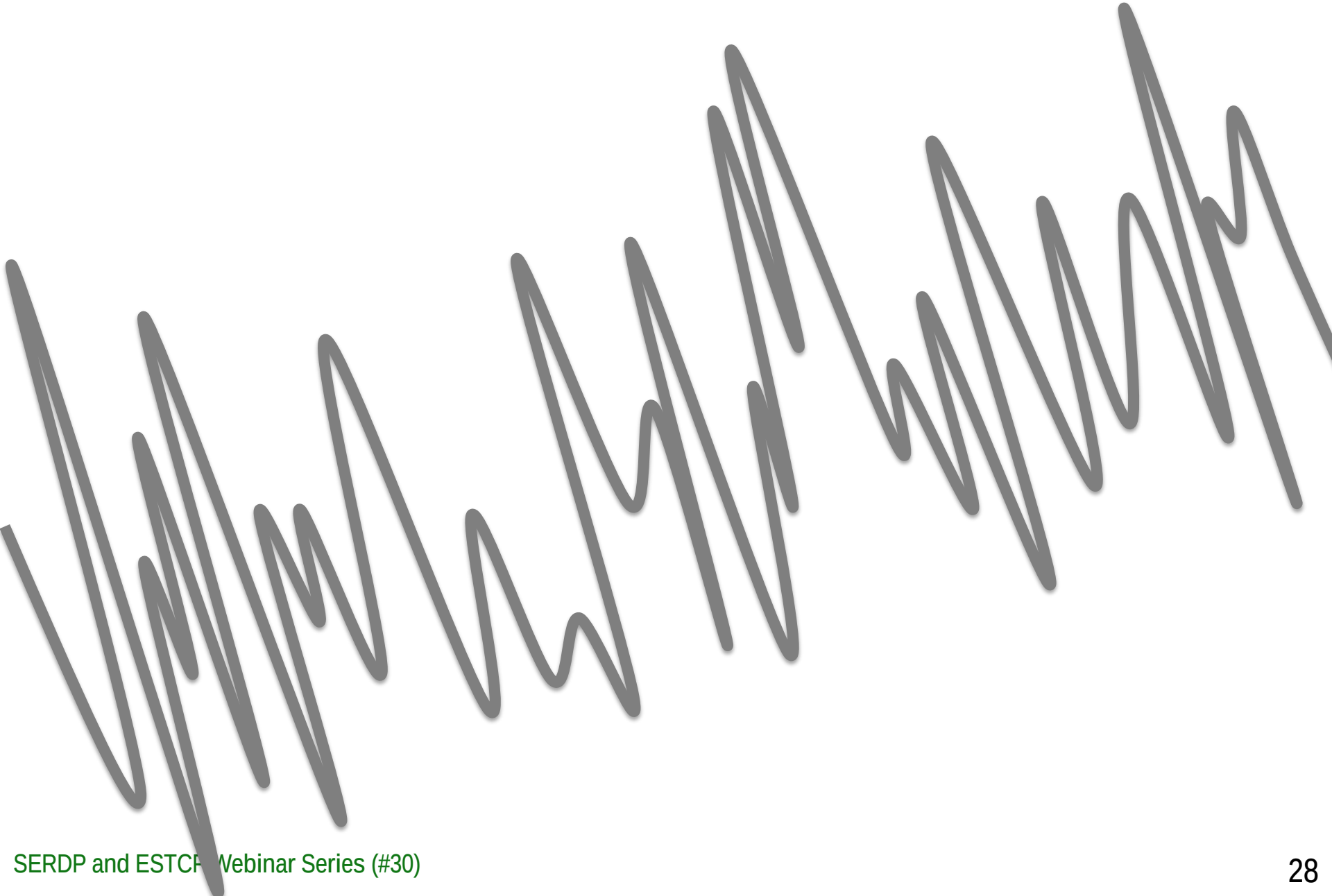


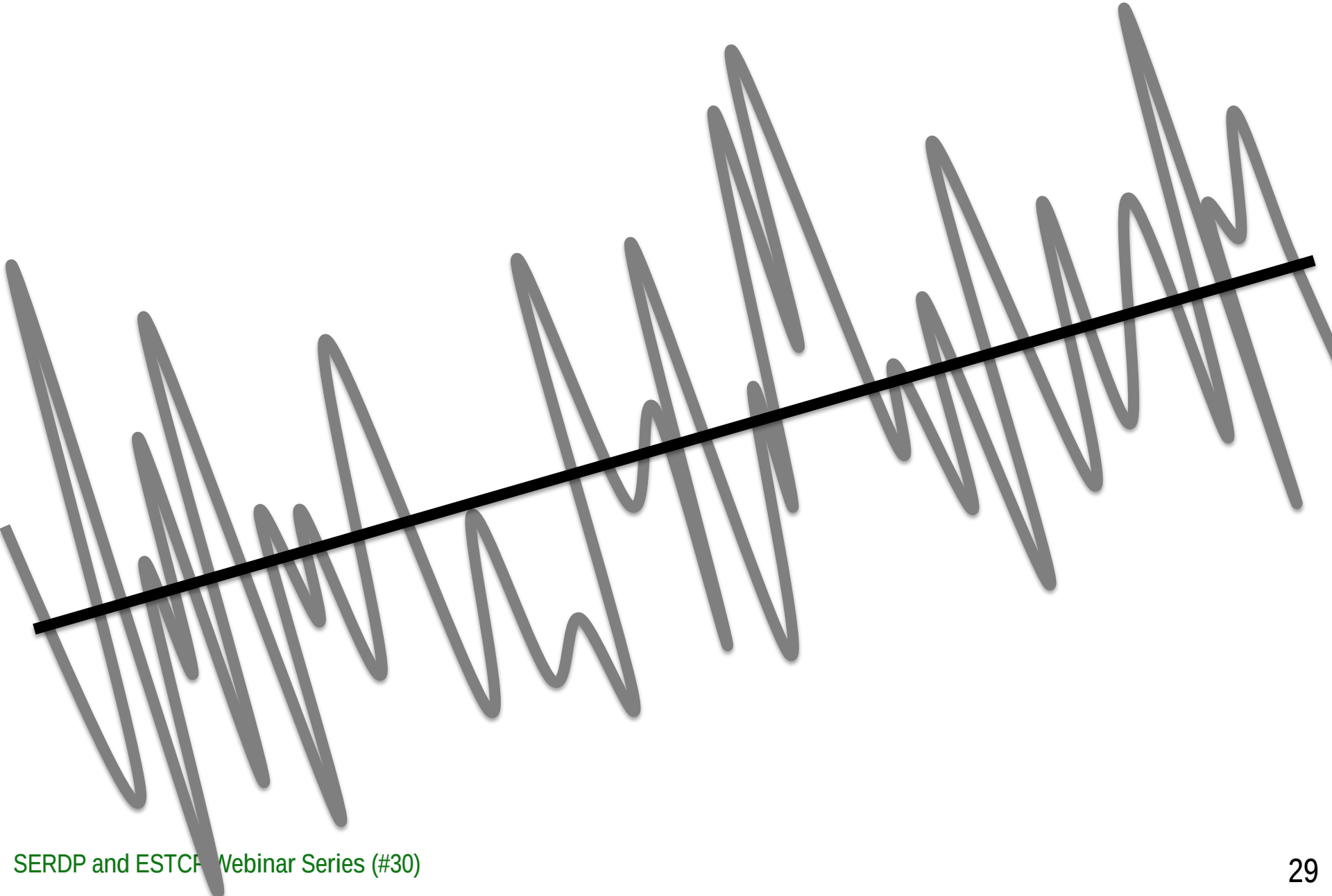
Why does *climate* matter?

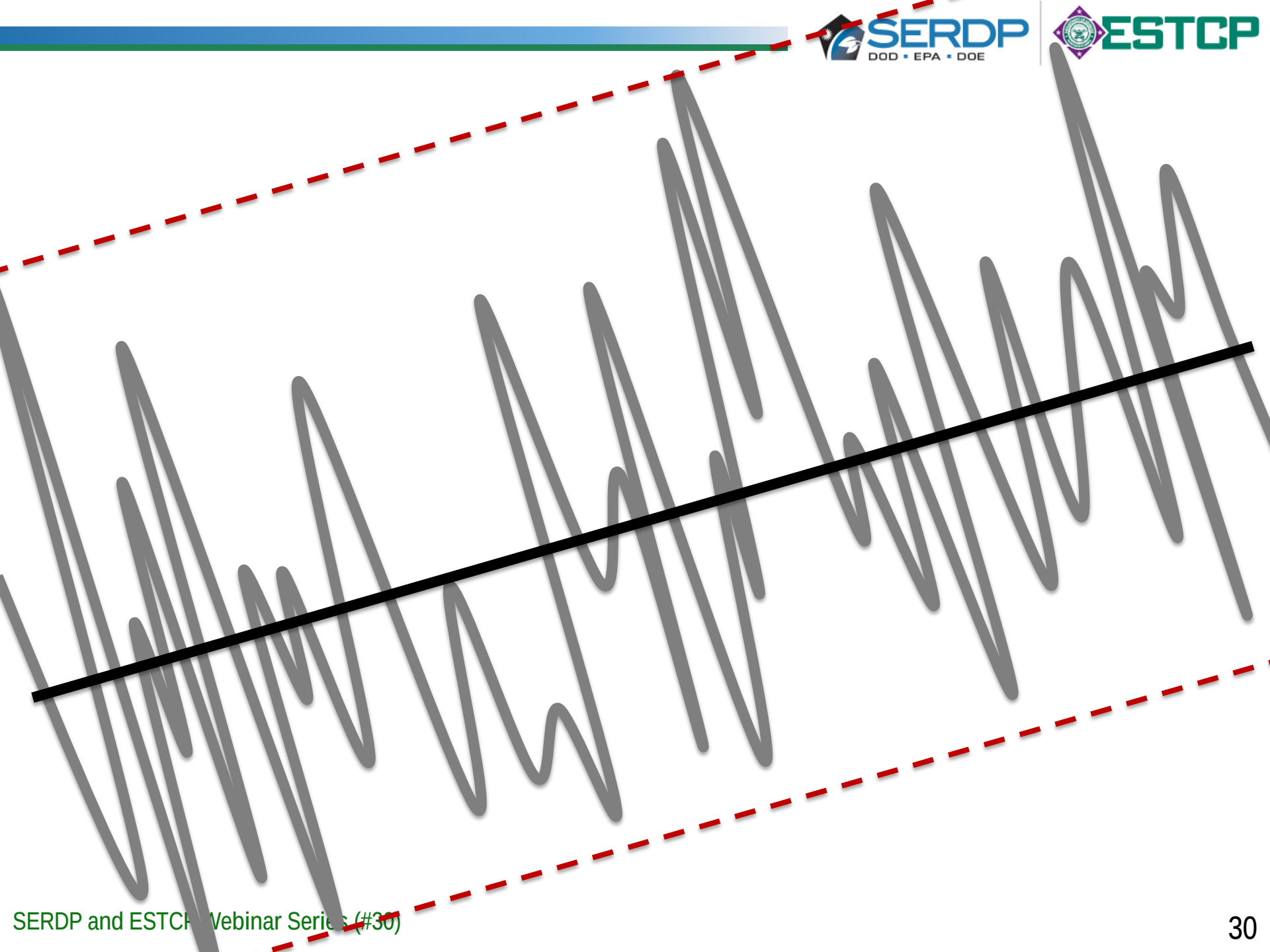
- Temperature
- Precipitation
- Sea level
- Frequency and intensity of extreme events

- Infrastructure design and maintenance
- Emergency response management
- Long-term investment and planning

DOD's built and natural infrastructure at permanent installations and other sites







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Idalou
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114
Lubbock
82

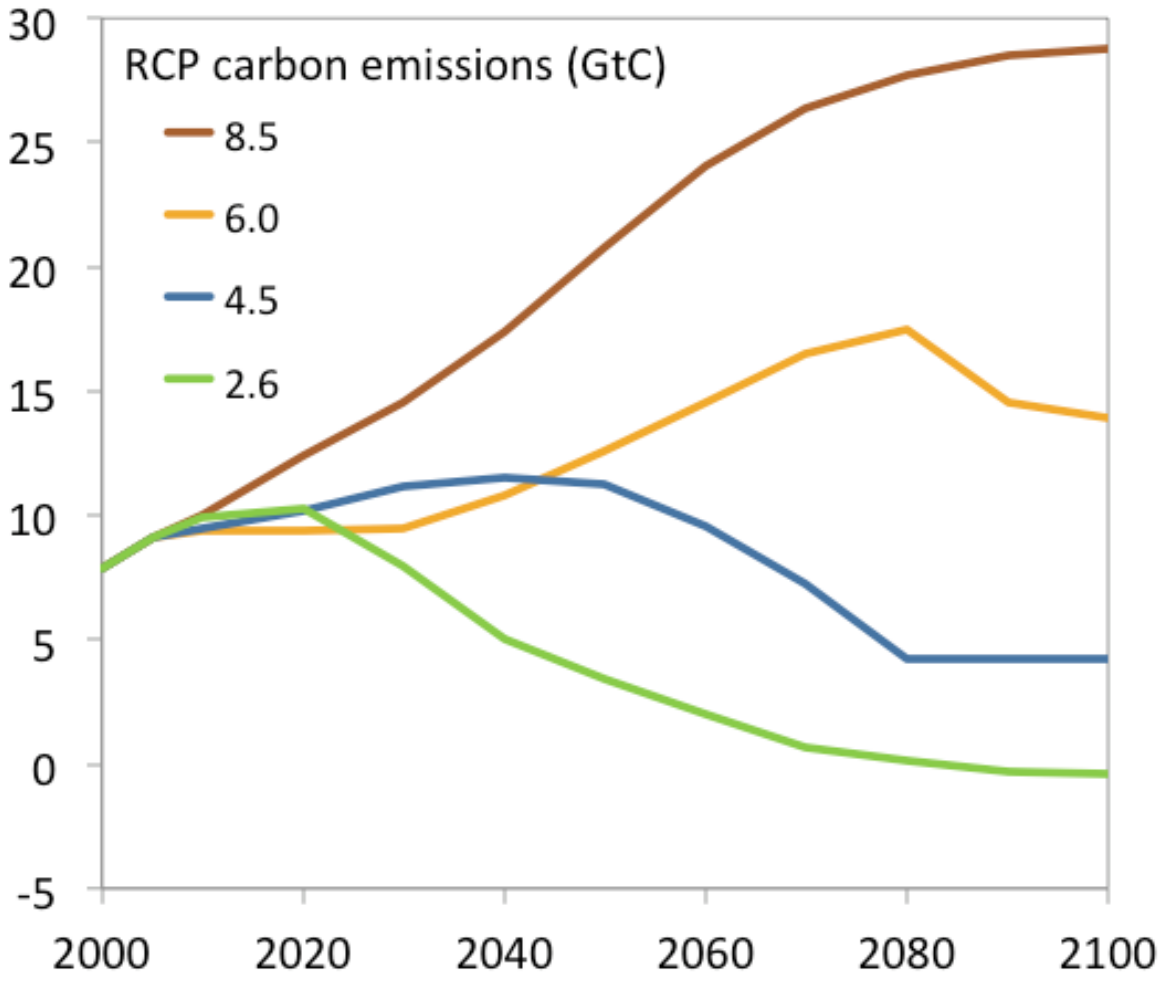
Planning for the future
based on the past
is like driving down the road
looking in the rear-view mirror

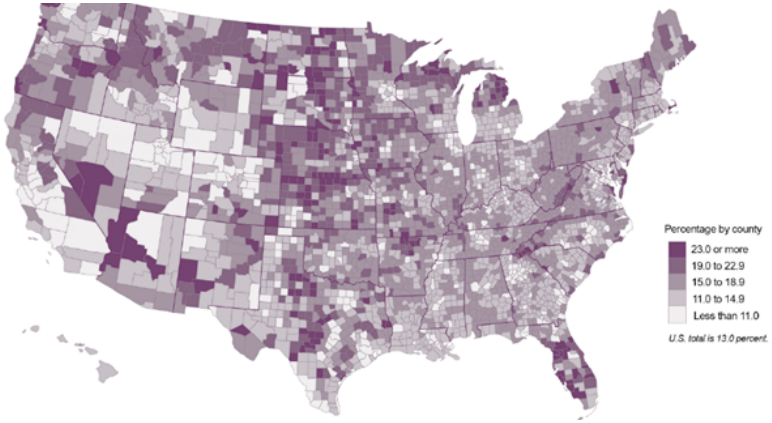
We need climate projections because **our climate is changing rapidly**

as a result of human emissions of carbon dioxide and other heat-trapping gases

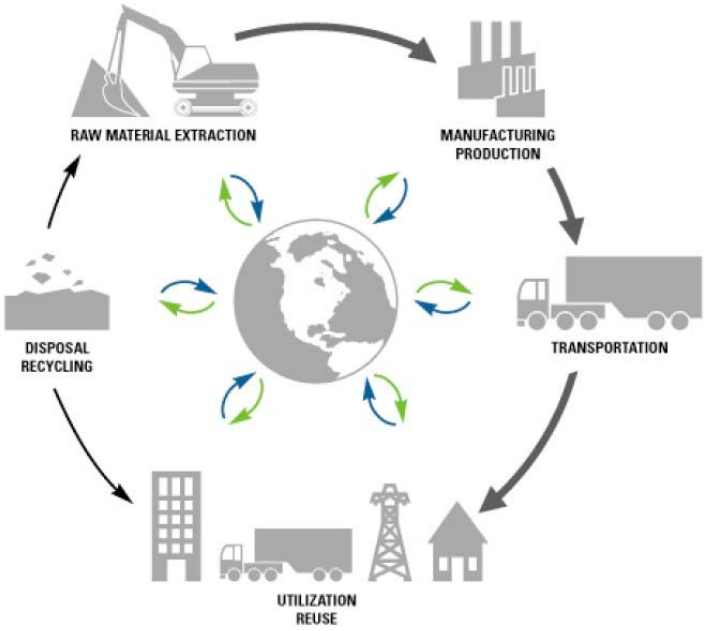
at a pace that far exceeds any experienced during the history of human civilization

Future Scenarios

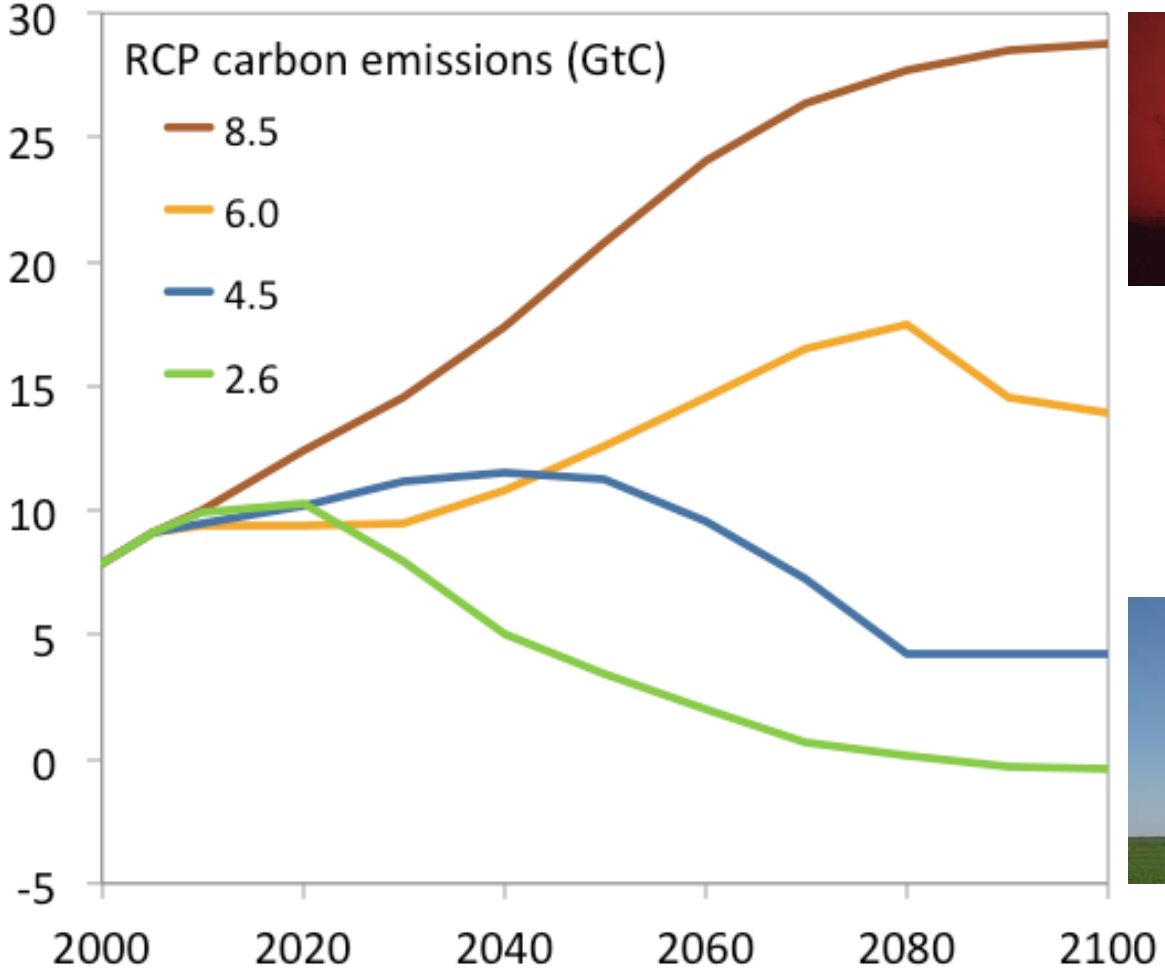




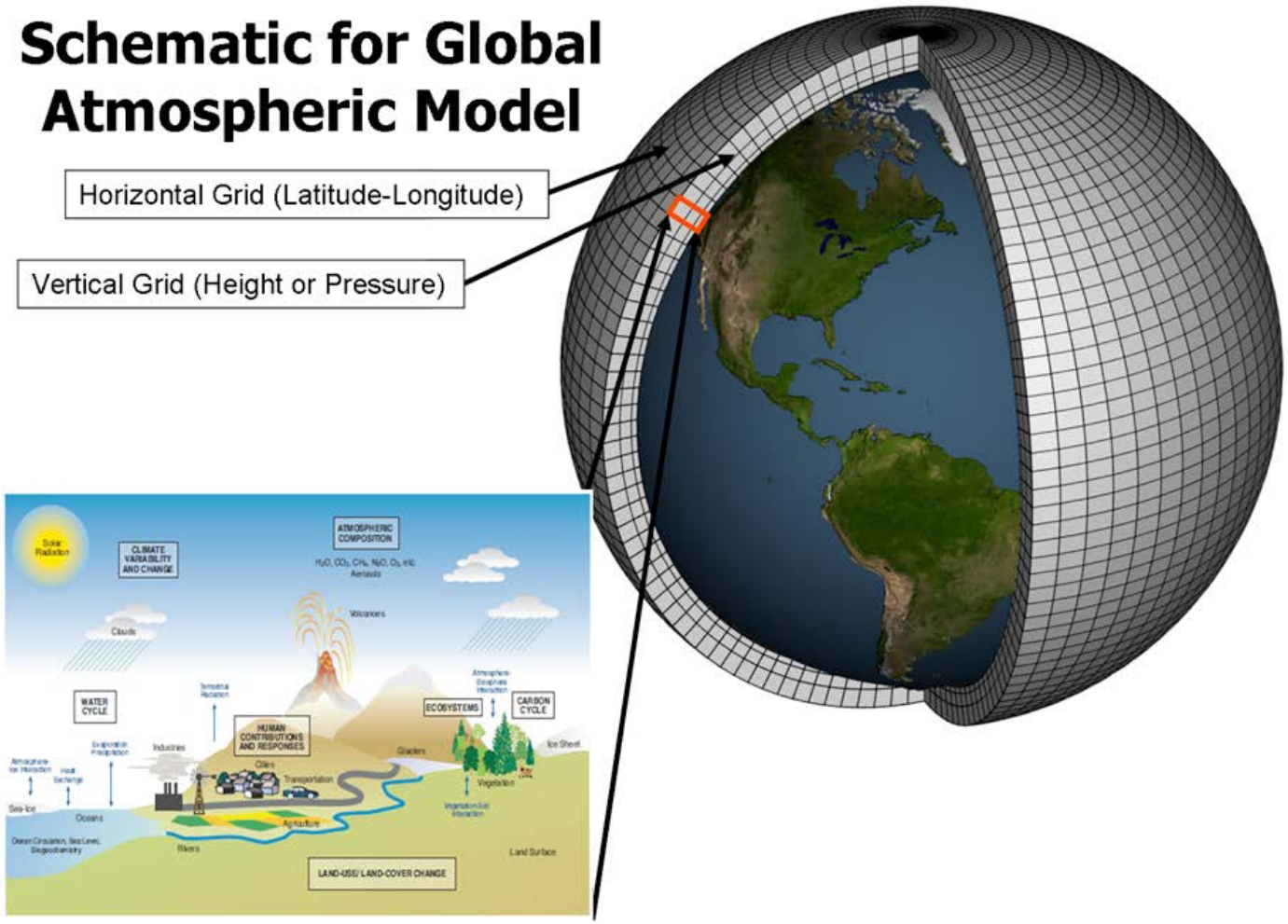
… incorporating demographics, economics, and technology



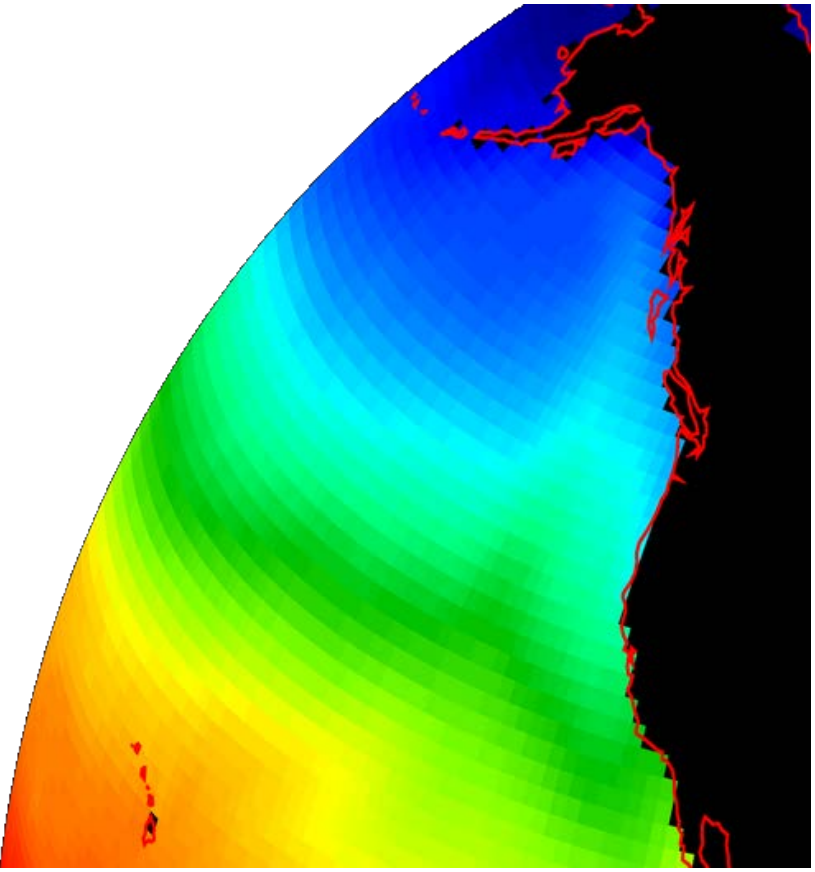
Future Scenarios

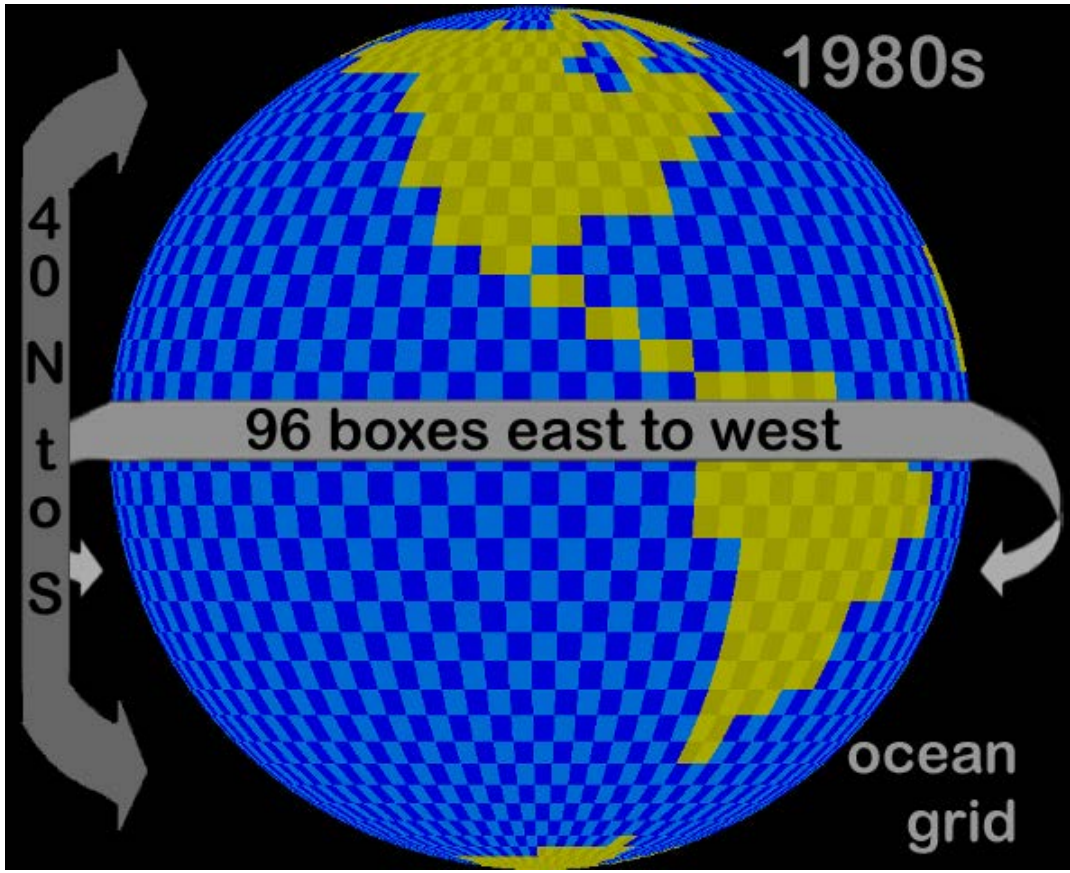


Global Climate Models

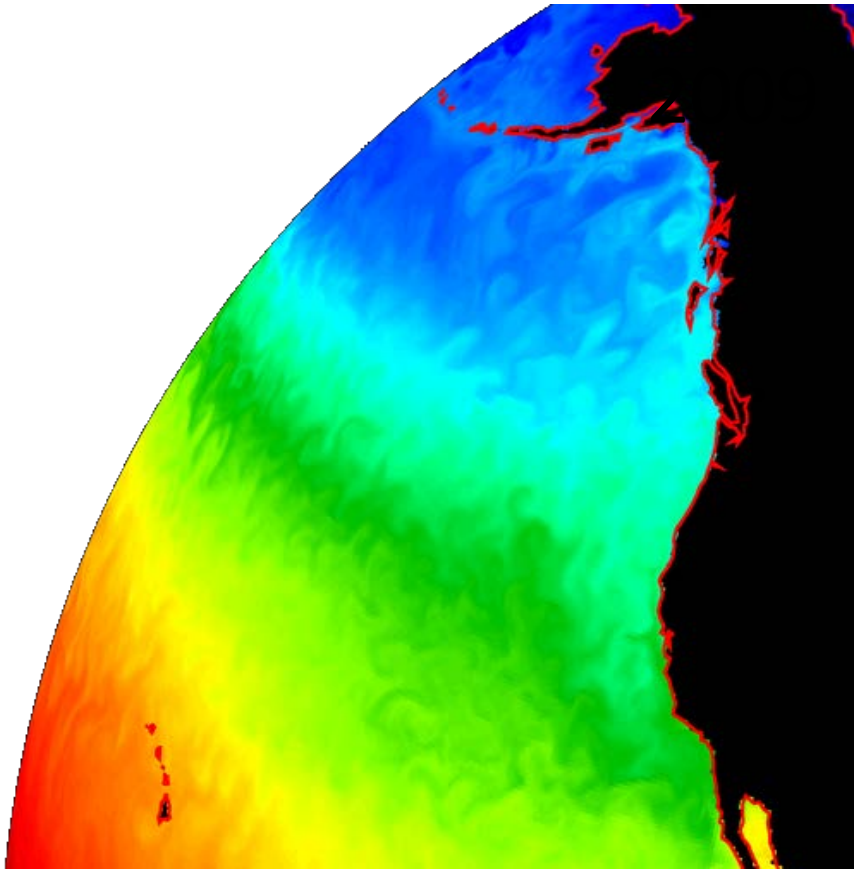


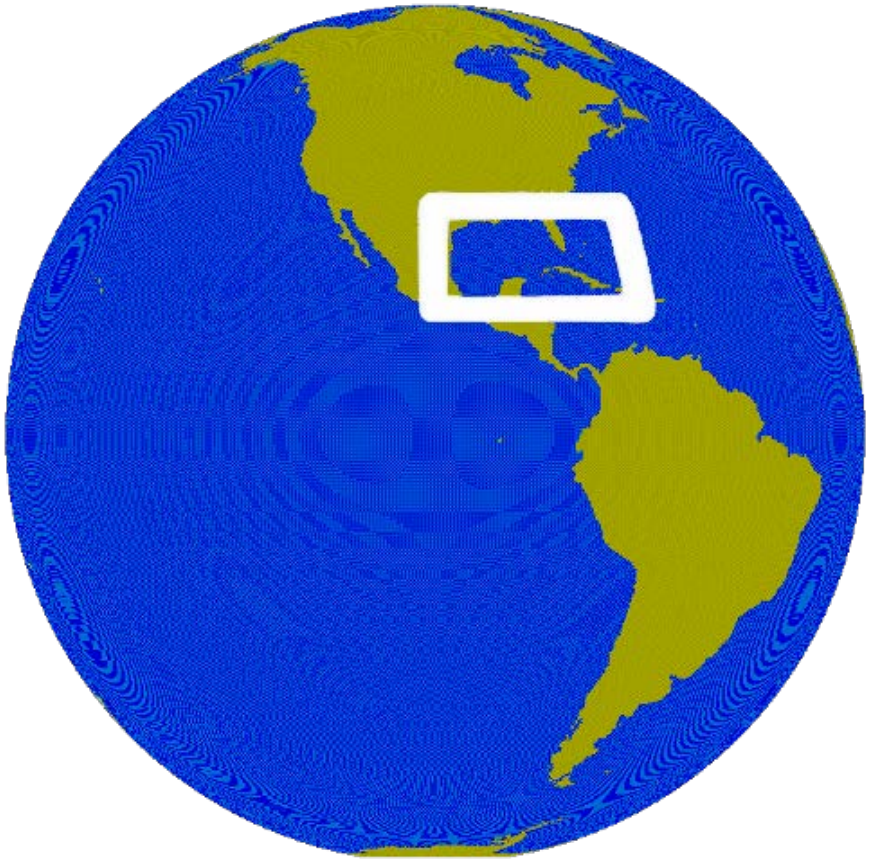
Climate Models of the 1980s



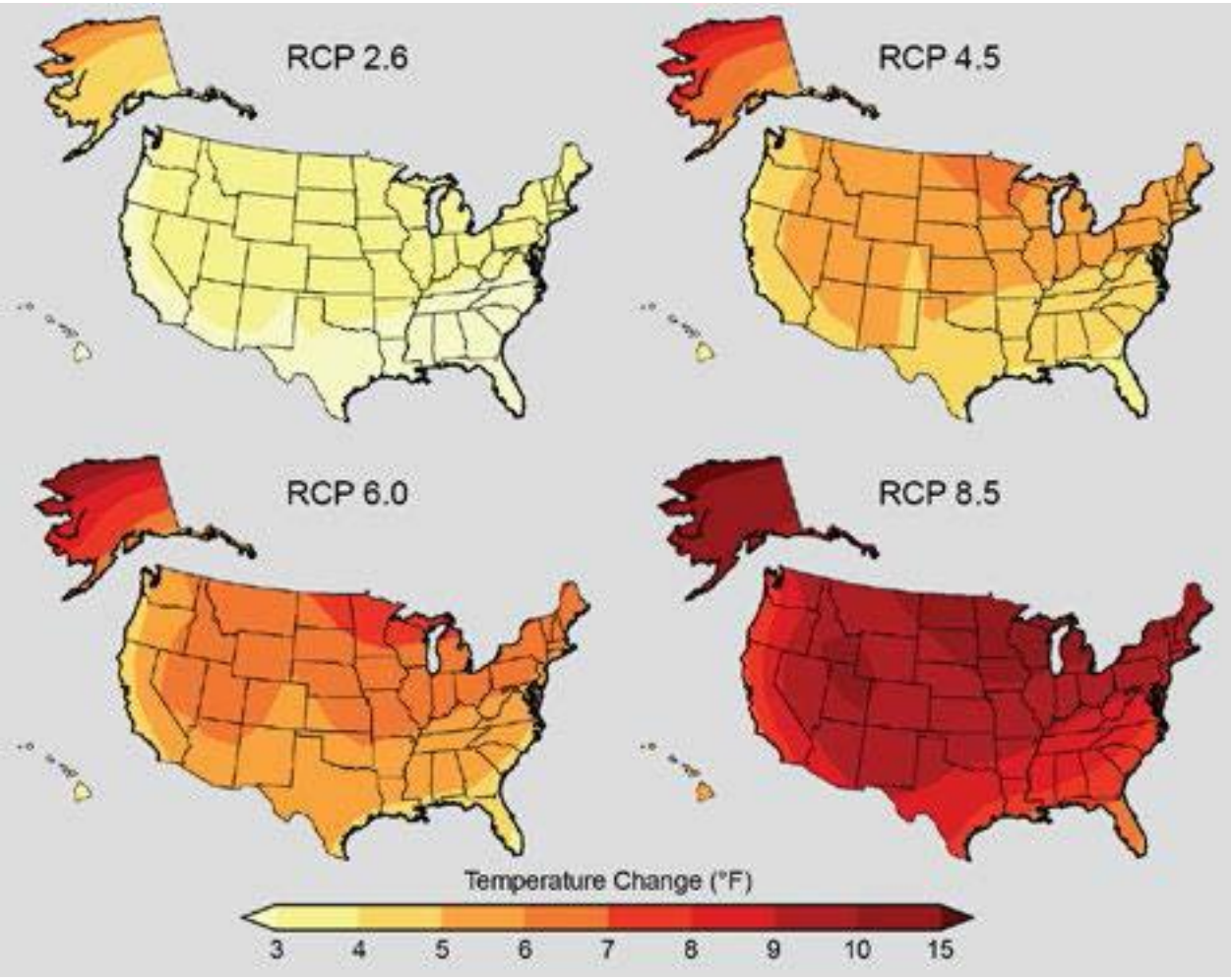


Climate Models of the 2010s





Annual Temperature Change 2070-2099 Compared to 1970-1999



Why are projections uncertain?

HUMAN

We don’t know what future emissions from human activities will be

SCIENTIFIC

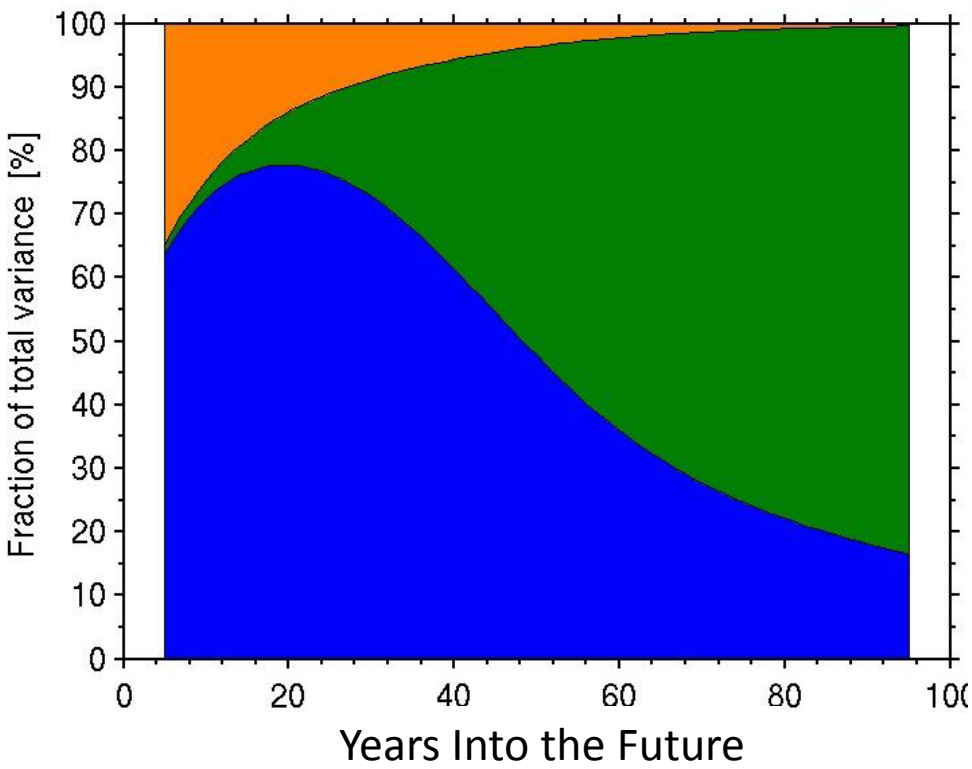
We don’t know how sensitive the planet is, and our ability to simulate the climate system is limited and incomplete, particularly at the local to regional scale

NATURAL

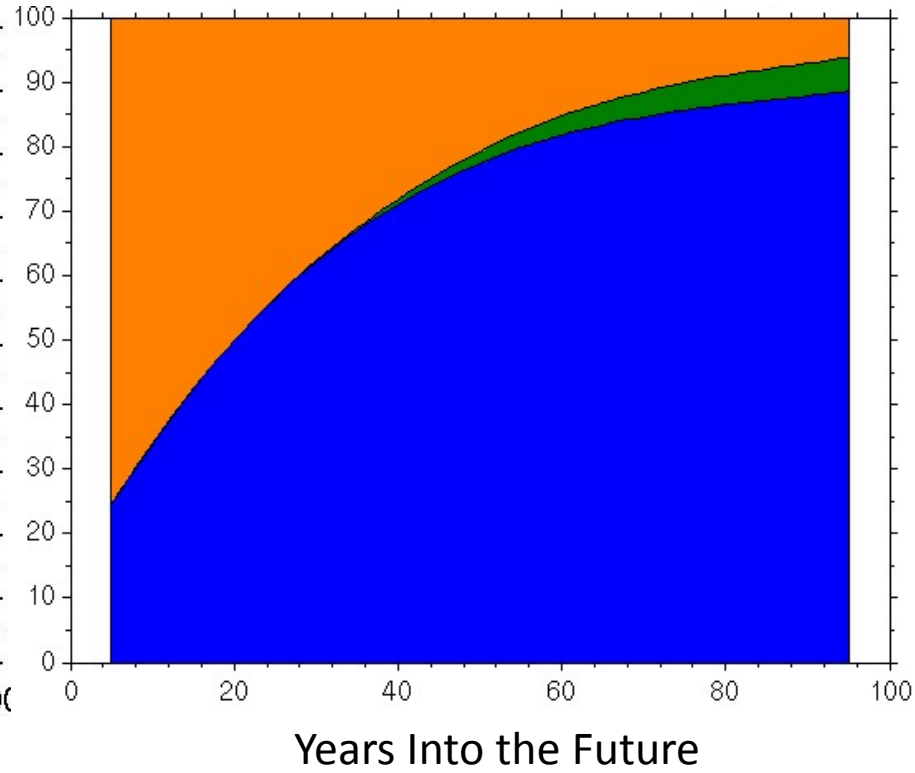
Continuous natural variations in climate make it difficult to predict conditions over shorter time scales

Uncertainty varies over time

TEMPERATURE



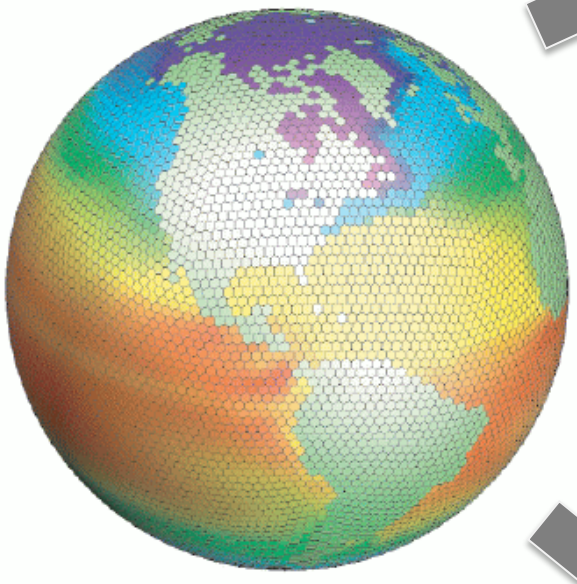
PRECIPITATION



NATURAL **HUMAN** **SCIENTIFIC**

- Climate projections are generated when future scenarios are used as input to global climate models
- There is no “most likely” scenario or “best” climate model
- Recommendations regarding which scenario(s) and models to use depends on the application; however, more is generally better than less

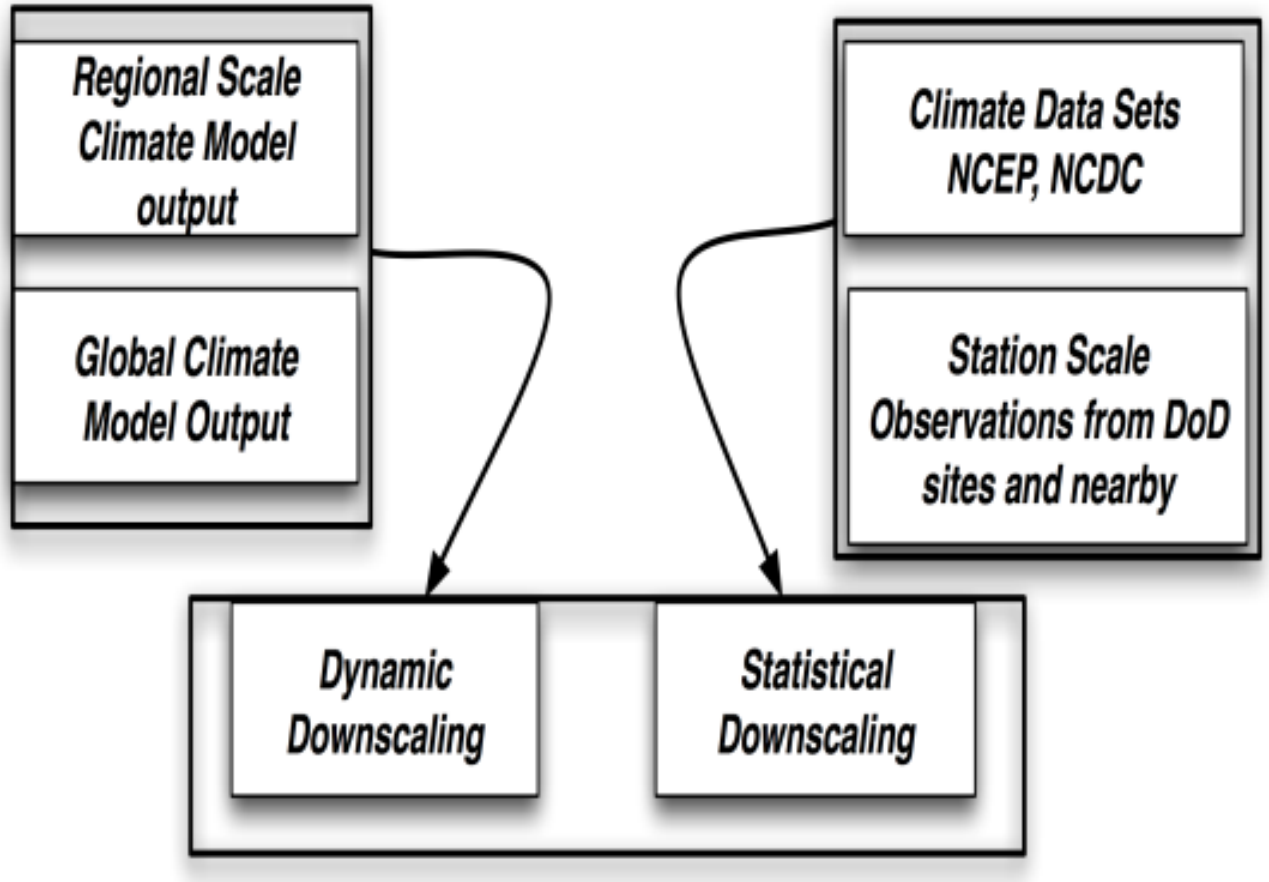
How do we get site-specific future projections?



What is Downscaling?

- Downscaling introduces new information into global climate model output to generate high-resolution climate projections
- It is not simply re-scaling or re-gridding the global model output
- New information comes from (**1**) higher-resolution modeling of physical processes or (**2**) historical observations

Two Approaches to Downscaling

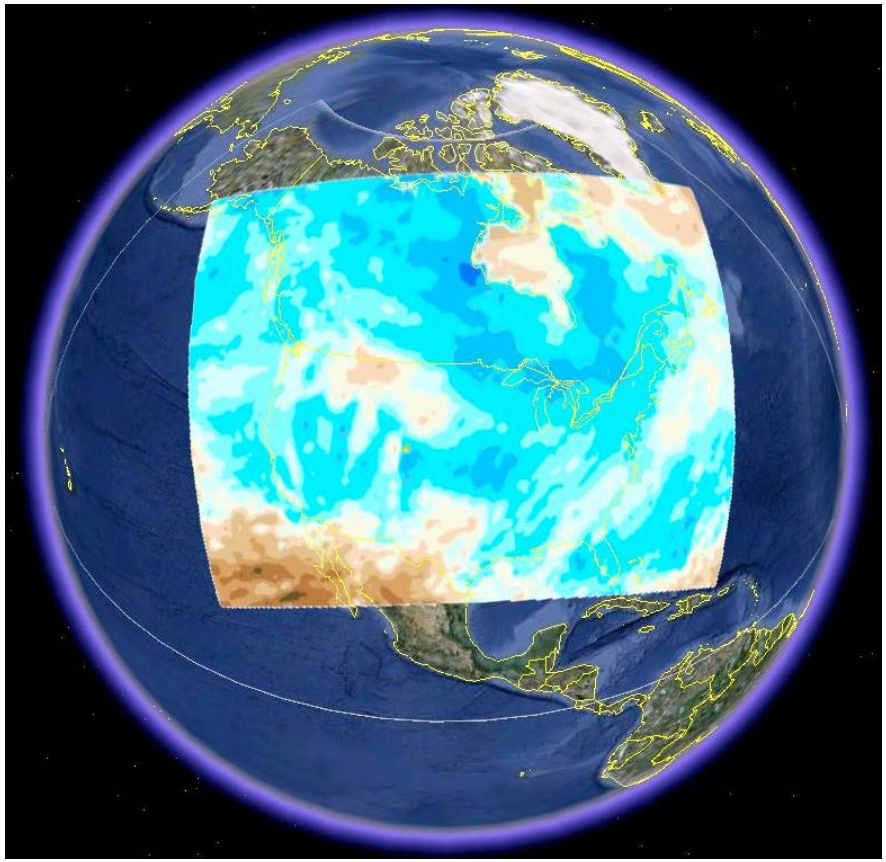


More info from higher-resolution modeling

More info from historical observations

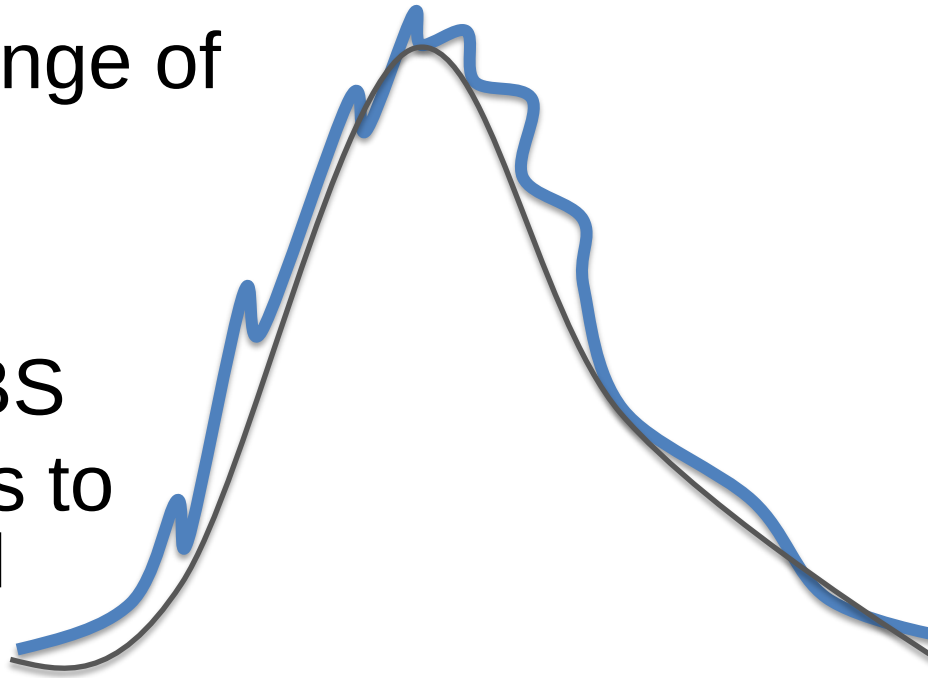
Regional Climate Models

- Resolve processes at finer spatial scales than a GCM
- Able to model complex terrain
- Can simulate hydrology and land surface processes
- Operate at spatial scales from 1 to 50 km



Empirical-Statistical Downscaling Models

- Encompass a broad range of techniques
- Develop statistical relationships between historical GCM and OBS
- Use these relationships to downscale future GCM projections
- Generate projections at spatial scale of observations, including both grids and individual weather stations



DYNAMIC	STATISTICAL
▪ Many variables	▪ Often limited to T,P
▪ Computationally expensive	▪ More computationally affordable
▪ Require additional bias correction	▪ Incorporate bias correction into model
▪ Can be used even if observations lacking	▪ Limited by available observations
▪ Don’t need to assume stationarity at scale of resolved processes	▪ Assume GCM-OBS relationship holds in the future

Downscaling Conclusions

- Downscaling is a way to translate GCM output into climate projections at impact-relevant scales
- There are two approaches to downscaling, dynamical and statistical
- There is no one “best” downscaling approach; the recommended option depends on the application
- As a general rule, it is recommended that statistical downscaling methods be used with caution for applications over complex terrain and coastal regions

Q&A Session 1

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Examples, Recommendations and Guidelines

Linda Mearns, Ph.D.
National Center for Atmospheric Research

Agenda

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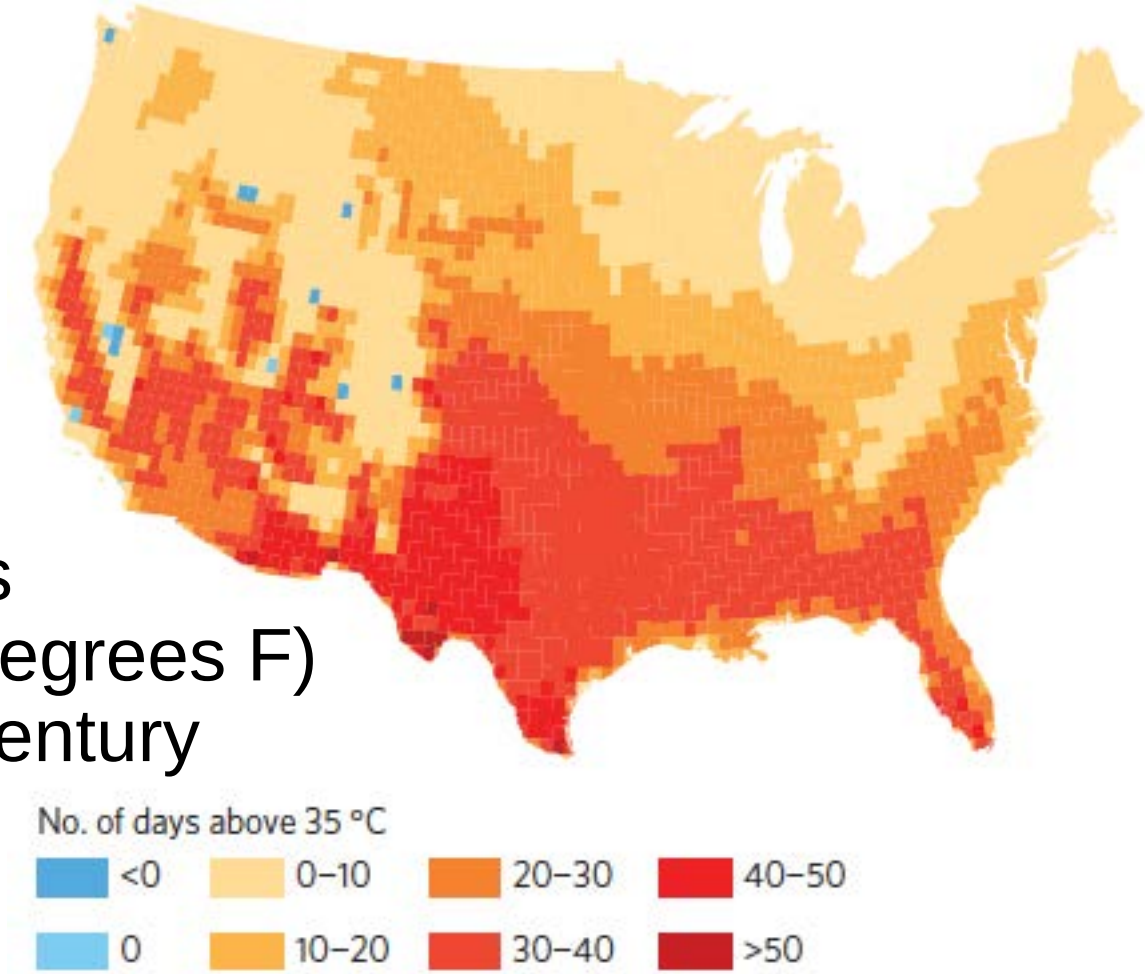
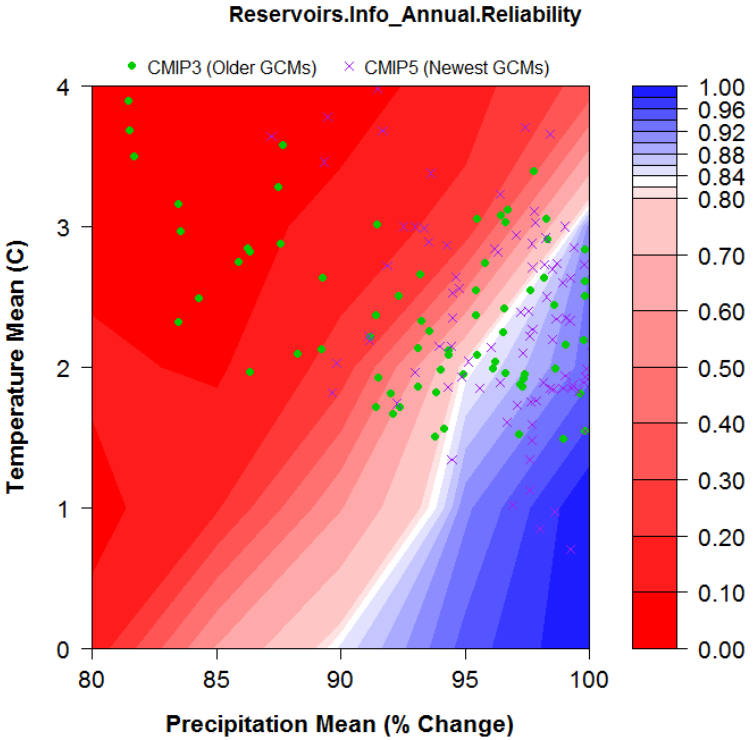
- Heat stress affects the health of those who work and exercise outdoors in summer. Substantial increases in heat stress are expected in the future
- Projected changes under the A2 scenario of number of days above 35°C (95 degrees F) for the mid-21st century compared to the current period



Example: Hydrology

- Climate change affects water resource availability, surface runoff, groundwater, lake levels, and the maintenance of wetlands
- Statistical models can provide temperature and precipitation
- Hydrology models often need additional variables such as solar radiation, wind, and humidity
- These might require regional model simulations

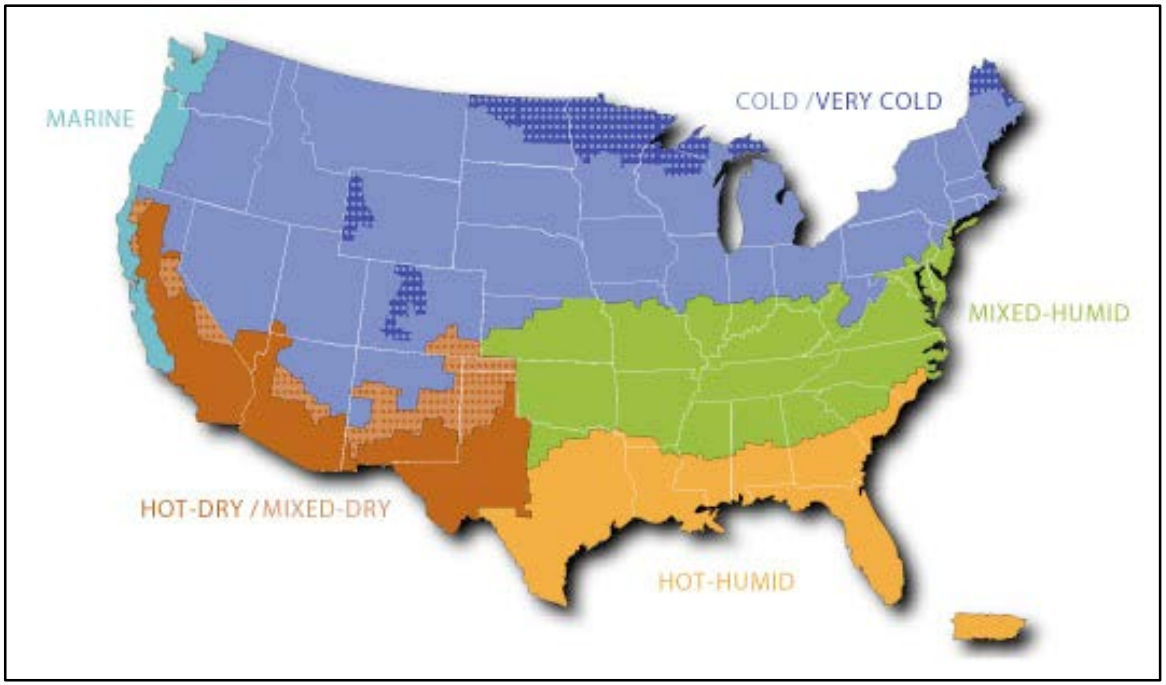


Example: Infrastructure

- Extreme heat causes roads to buckle and rail lines to warp, and affects aircraft takeoff. Extreme precipitation causes flooding
- Statistical models can calculate projected changes in extreme heat and precipitation
- Regional models are needed for certain extremes, such as severe storms or hurricanes

Regional Considerations

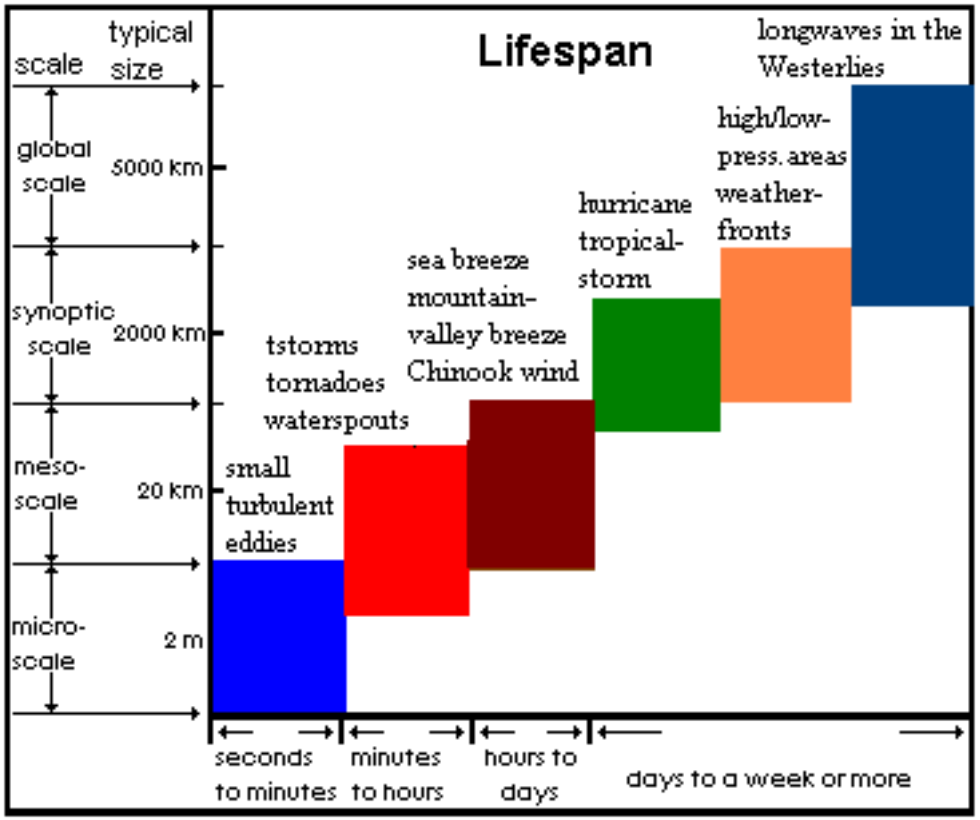
- Each geographic region of the U.S. has its own unique climate characteristics



- These are determined by factors such as latitude, proximity to bodies of water, complex terrain, and global atmospheric circulation patterns

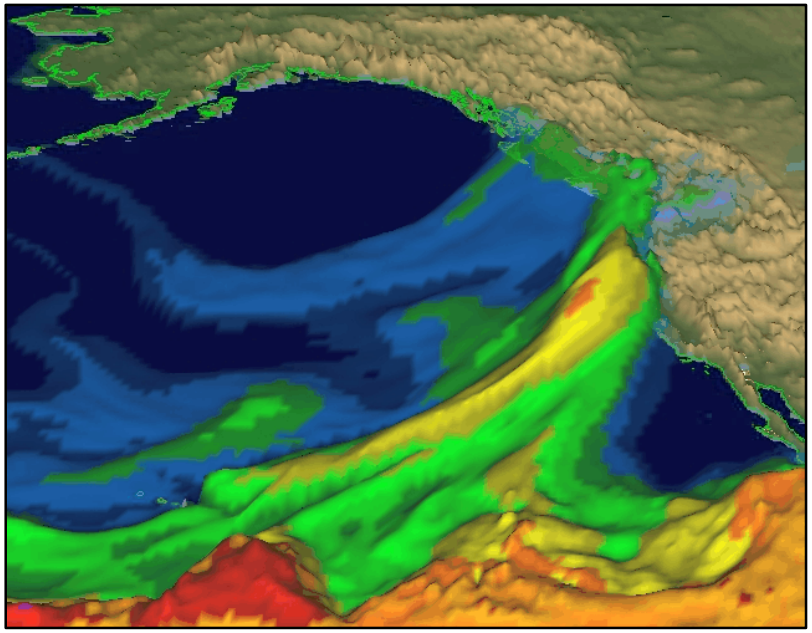
Regional Considerations

- Regional climate is highly dependent on time of year
- Weather phenomena vary during different seasons
- To inform what type of downscaling tool is most appropriate for a particular place, need to identify the specific meteorological phenomena most relevant to weather- and climate-related impacts

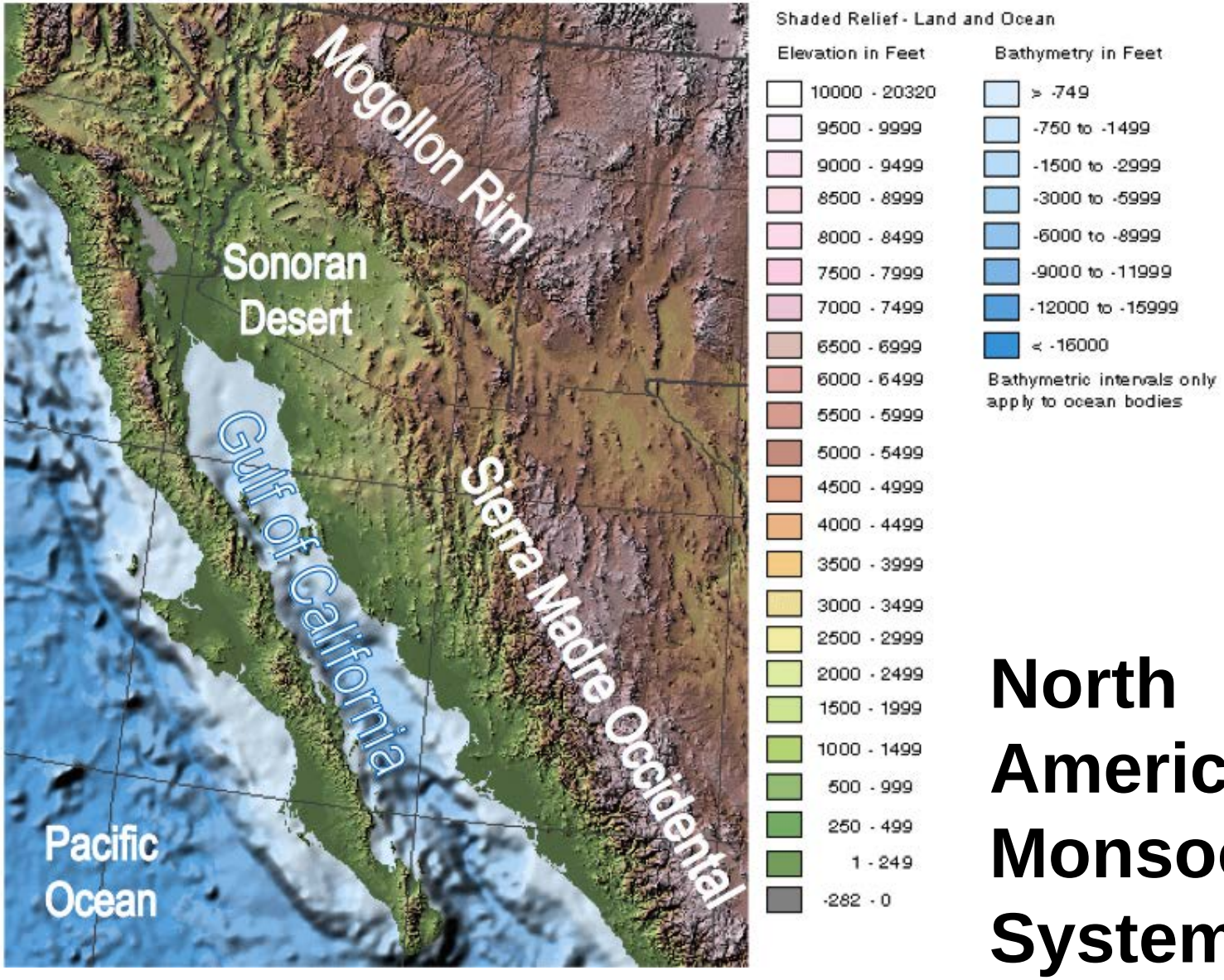


Example: Southwest U.S.

- In winter, mid-latitude cyclones and atmospheric rivers, exacerbated by ENSO-related variability



- In summer, the North American monsoon and associated thunderstorms, squall lines, microbursts, and dust storms



North American Monsoon System

Example: Gulf Coast

- In fall and spring, mid-latitude cyclones and extreme weather risks including thunderstorms, tornadoes, hail
- In fall and spring, severe weather brings squall lines and supercell thunderstorms
- In summer, mesoscale convective systems can bring straight-line winds and heavy rain

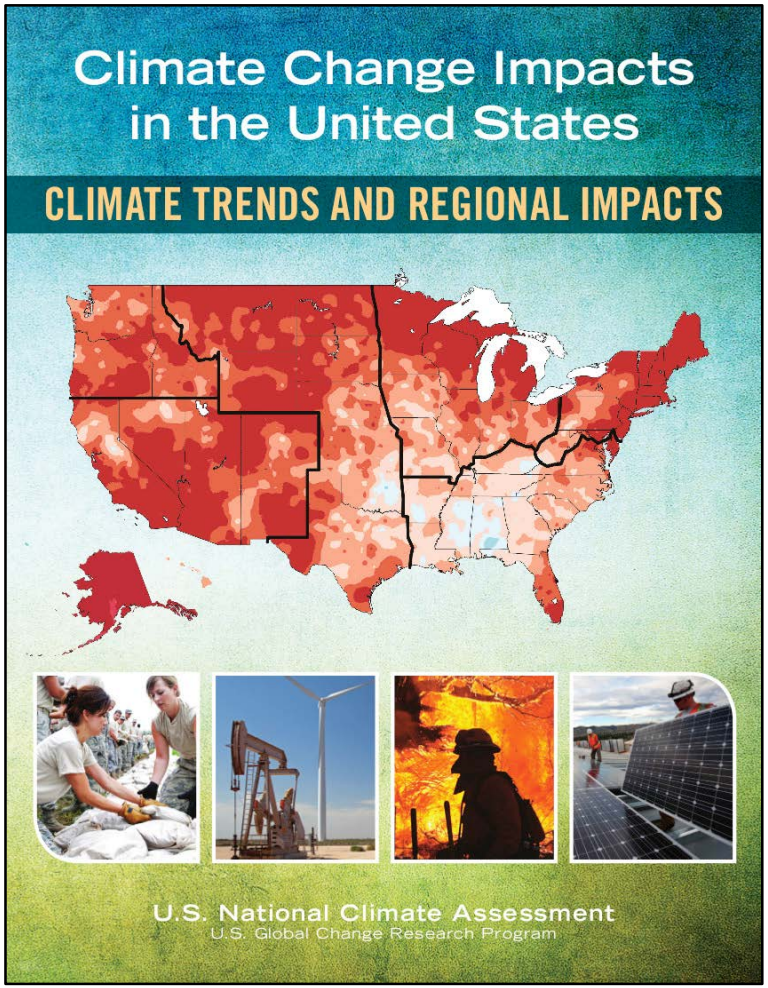
Example: Great Plains

- In winter, mid-latitude cyclones and occasional Arctic outbreaks bring rain, snow, ice storms, and blizzards

- In fall and spring, severe weather brings squall lines and supercell thunderstorms
- In summer, mesoscale convective systems can bring straight-line winds and heavy rain

Recommendations

- In some cases, to understand the sensitivity of a given system or region to a range of plausible future changes in mean climate, published climate projections or historical trends in regional temperature, precipitation, or sea level are often sufficient

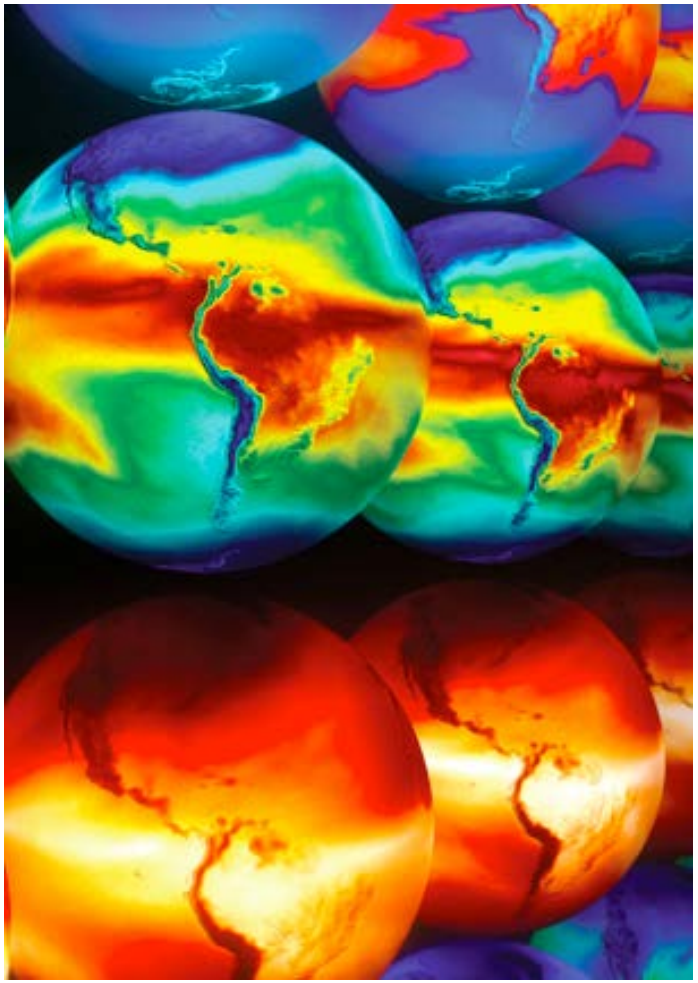


Recommendations

- In other cases, quantitative climate projections may be needed to understand projected impacts of climate change for a given timeframe or range of future scenarios
- ***Our strongest recommendation is to seek out an expert in the use of future climate information for advice and/or collaboration specific to your project***

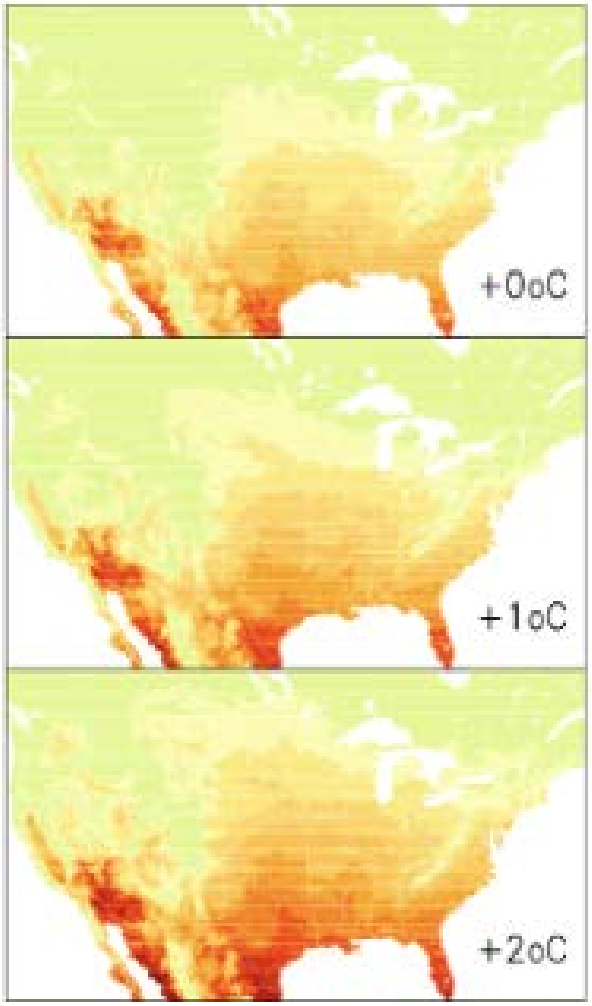
Guidelines: Climate Models

- Use multiple GCMs and/or ensembles from a single GCM
- Favor GCMs well-documented in the literature
- Attempting to identify a sub-set of “better” models will not necessarily improve future accuracy for the contiguous U.S.
- In other areas, such as the Arctic, the scientific literature may identify models unable to reproduce key local processes



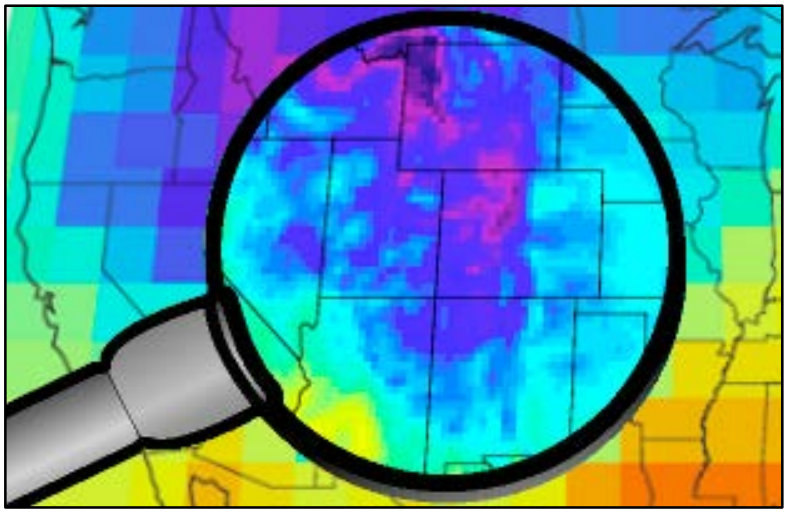
Guidelines: Future Scenarios

- There is no intrinsic reason a mid-range scenario is more likely than a higher or lower one
- A higher scenario provides insight into the impacts avoided by reducing emissions and provides potential upper limits to adaptation needs
- A lower scenario establishes a minimum requirement for adaptation, even if reductions were to occur



Guidelines: Downscaling

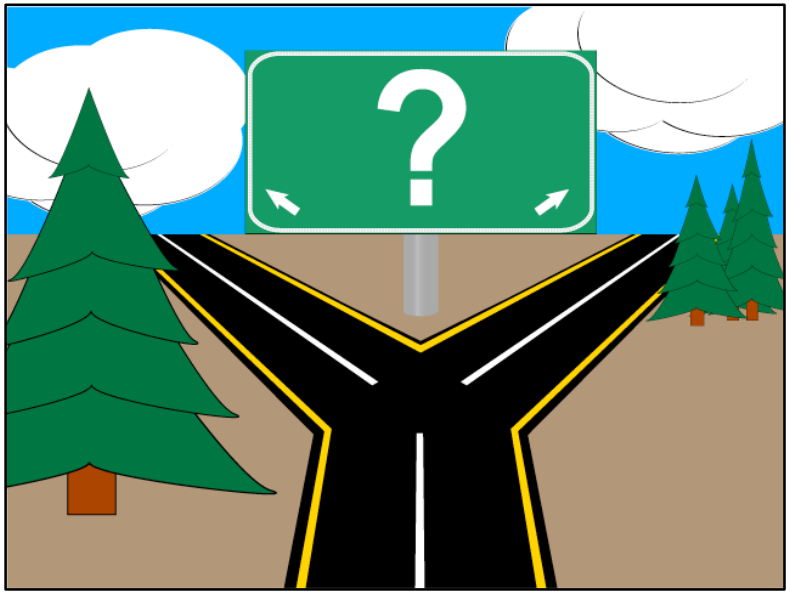
- Select a method able to credibly resolve spatial and temporal scales relevant to your specific application
- If it's important to have projections based on a range of climate models and scenarios, a statistical model may be best
- If a broad range of variables is needed, or projections for an area without long-term observations, a dynamical model may be best



Dynamical and statistical methods have different benefits and limitations that should be considered in making the choice

Guidelines: Uncertainty

- The most common approach is to use an ensemble of model simulations from a range of climate models driven by different future scenarios over different timescales
- Over shorter time scales, natural variability is most important
- Future scenarios become increasingly important after several decades
- Scientific or model uncertainty remains important throughout the century



Conclusions

- Incorporating climate projections into decision-making allows us to plan for a resilient future in a changing climate
- There are many good resources, datasets, and methods that provide climate information for decision-making
- While there is no “best” source for climate projections, understanding the questions being asked is key to informed selection of appropriate information
- If possible, seek advice and/or collaboration with someone who has expertise in climate projections for impact assessments

For additional information, please visit

https://www.serdp-estcp.org/Program-Areas/Resource-Conservation-and-Climate-Change/Climate-Change

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