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Targeted Training Activity: ENSO-Monsoon in the Current and Future Climate

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Using Climate Forecasts for Adaptation

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USING CLIMATE INFORMATION FOR ADAPATION

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1. END-TO-END FORECASTING

- CLIMATE INFORMATION
- IMPACTS
- APPLICATIONS

2. OBSTACLES TO END-TO-END FORECASTING

3. INSTITUTIONS FOR END-TO-END FORECASTING

4. ADAPTATION AS AN ONGOING PROCESS INDEPENDENT OF CLIMATE CHANGE

GENERAL PRINCIPLES:

- ANY KNOWLEDGE ABOUT THE FUTURE SHOULD BE BETTER THAN NO KNOWLEDGE ABOUT THE FUTURE

- CLIMATE INFORMATION IS ANY INFORMATION (PAST, PRESENT, AND FUTURE) THAT GIVES US INFORMATION ABOUT THE FUTURE.

- THE FORECAST MUST COME WITH MEASURES OF UNCERTAINTY

- UNCERTAIN FORECASTS IMPLY INCREMENTAL RESPONSES

- THE FORECAST HAS TO BE RELEVANT, UNDERSTANDABLE, AND ACTIONABLE

- DEFINITION: AN APPLICATION OF A FORECAST IS AN INFLUENCE ON A DECISION.

▶THE APPLICATION OF THE FORECAST MUST BE DEMONSTRABLY BENEFICIAL.

▶THEREFORE WE HAVE TO UNDERSTAND HOW DECISIONS ARE MADE.

1. END-TO-END FORECASTING

- **CLIMATE INFORMATION**
  - **PAST CLIMATE INFORMATION**
    - **INSTRUMENTAL**
    - **PALEO**
  - **NOWCASTS**
  - **FORECASTS**
- **CLIMATE IMPACTS**
  - **THE NORMAL WORKINGS OF THE SYSTEM**
    - **VULNERABILITY**
      - **EXPOSURE**

SENSITIVITY

RESILIENCE

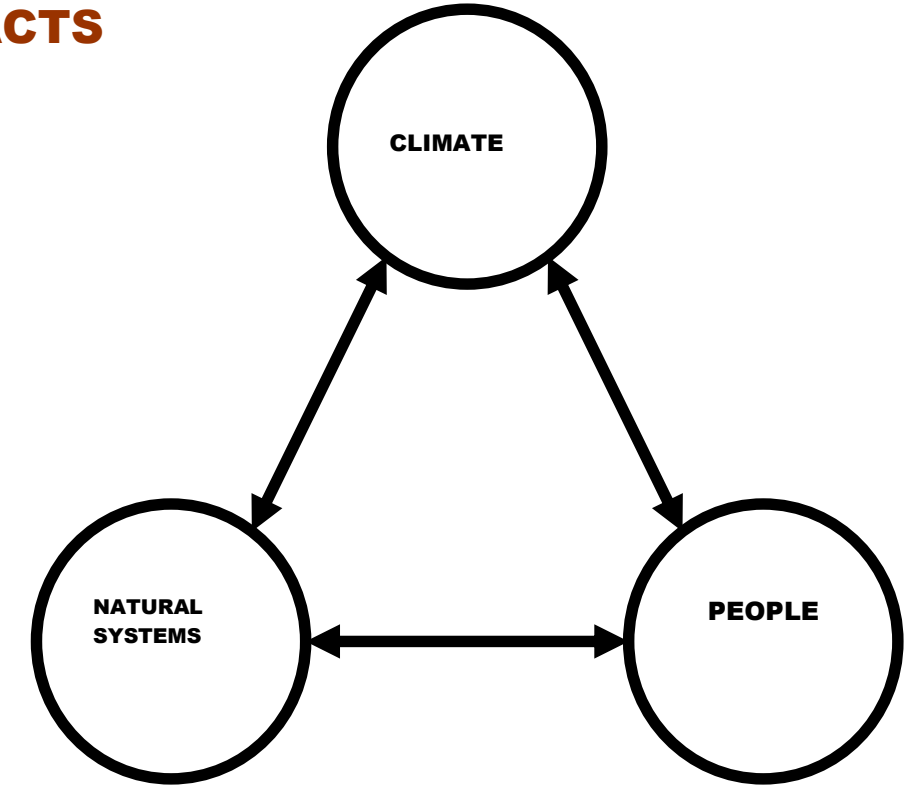
COPING: INFRASTRUCTURE

HEDGING-INSURANCE

RESPONSE

OPPORTUNITY

➔INTEGRATED IMPACTS



▶APPLICATIONS

- ➔IDENTIFY APPLICATION
- ➔UNDERSTAND NORMAL DECISION PROCESS
- ➔IDENTIFY USEFUL CLIMATE INFORMATION
- ➔CONVEY CLIMATE INFORMATION
- ➔RECEIVE THE SAME CLIMATE INFORMATION CONVEYED
- ➔MAKE APPROPRIATE DECISION
- ➔EVALUATE DECISION
- ➔ITERATE

2. OBSTACLES TO END-TO-END FORECASTING

- INAPPROPRIATE INFORMATION
- INFORMATION MISCONVEYED
- INFORMATION MISUNDERSTOOD
- INFORMATION IGNORED
- DECISION INAPPROPRIATE
- BAD LUCK--FIRST APPLICATION BLOWN
- LOCALIZED (NOT DIFFUSED)
- DISTRIBUTIONAL INEQUITIES
- LEGAL ISSUES

3. INSTITUTIONS FOR END-TO-END FORECASTING

▶ A NATIONAL CLIMATE SERVICE

THE CLIMATE SERVICE IDENTIFIES, DESIGNS, AND PRODUCES AUTHORITATIVE AND TIMELY CLIMATE INFORMATION FOR USE IN SUPPORTING POLICY AND MANAGEMENT DECISIONS IN THE PUBLIC AND PRIVATE SECTORS, ON REGIONAL, NATIONAL, AND INTERNATIONAL SPACE SCALES.

➔DESIGNS, ESTABLISHES, AND MAINTAINS U.S. COMPONENT OF A GLOBAL CLIMATE OBSERVING SYSTEM

➔MAKES GLOBAL ANALYSES AND FORECASTS

➔ARCHIVES INSTRUMENTAL, PALEO, AND MODEL DATA

➔SHAPES, DOWNSCALES, AND DELIVERS TIMELY AND AUTHORITATIVE INFORMATION TO REGIONAL CLIMATE CENTERS

➔PERFORMS THE RESEARCH NEEDED TO SUSTAIN ABOVE

▶REGIONAL CLIMATE CENTERS

➔KNOWS THE CUSTOMER

➔MAINTAINS REGIONAL OBSERVATIONS

➔DISTRIBUTES CLIMATE INFORMATION

➔PRODS THE NATIONAL CLIMATE CENTER

➔INTERFACES WITH SECONDARY DISTRIBUTORS (PRIVATE SECTOR)

➔IDENTIFIES RESEARCH NEEDED IN THE REGION

▶THE IRI: A PILOT INSTITUTION TO DEMONSTRATE END-TO-END FORECASTING

4. ADAPTATION

►Adaptation to the impacts of future climate conditions is place-based

►One cannot adapt solely to the impacts of “climate change” on regional space scales

►When climate is changing, climate variability is changing

►Adaptation requires getting the variability correct

►Our entire current climate enterprise (and planned climate enterprise) is directed toward mitigation and is inadequate for providing the information for adaptation to future climate impacts.

WHAT IS ADAPTATION?

Adaptation is the process of taking actions to ameliorate the adverse impacts of future climate conditions on a system and/or taking actions to take advantage of beneficial impacts of future climate conditions.

►There are adverse impacts on the system of interest because the system is **vulnerable** (i.e. has latent negative potential)

►There are favorable impacts on the system of interest because the system is **opportune** (i.e. has latent positive potential)

►**Vulnerability or Opportunity can be viewed as the simultaneous action of three separate factors:**

Exposure of the system to climate conditions

Sensitivity of the system to these conditions

Adaptive capacity of the system involved

►**Because climate is only one of a number of stressors, and because these stressors vary regionally, adaptation is inherently place-based---on this everyone agrees.**

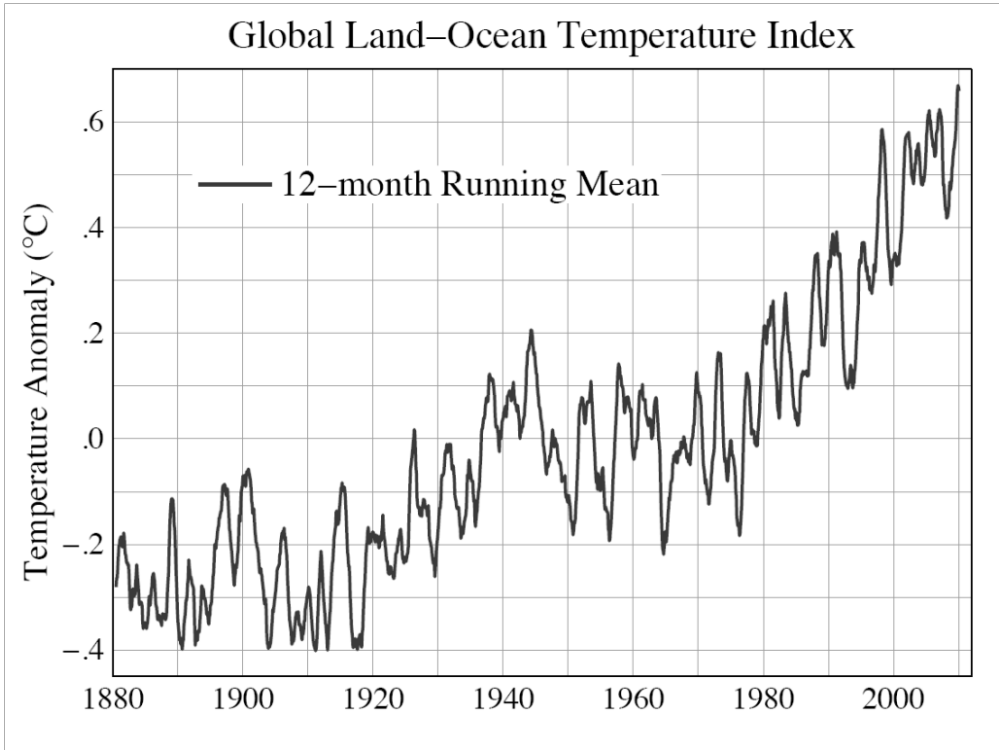
ADAPTATION TO WHAT?

►The space scale of adaptation is place-based and ranges down to the watershed scale (can be a small as 10km).

►Adaptation requires decisions to be made by some agency on some time scale.

►There is an intrinsic time scale to the way societies make decisions and this is one year—the time scale on which budgets are formulated and laws are passed.

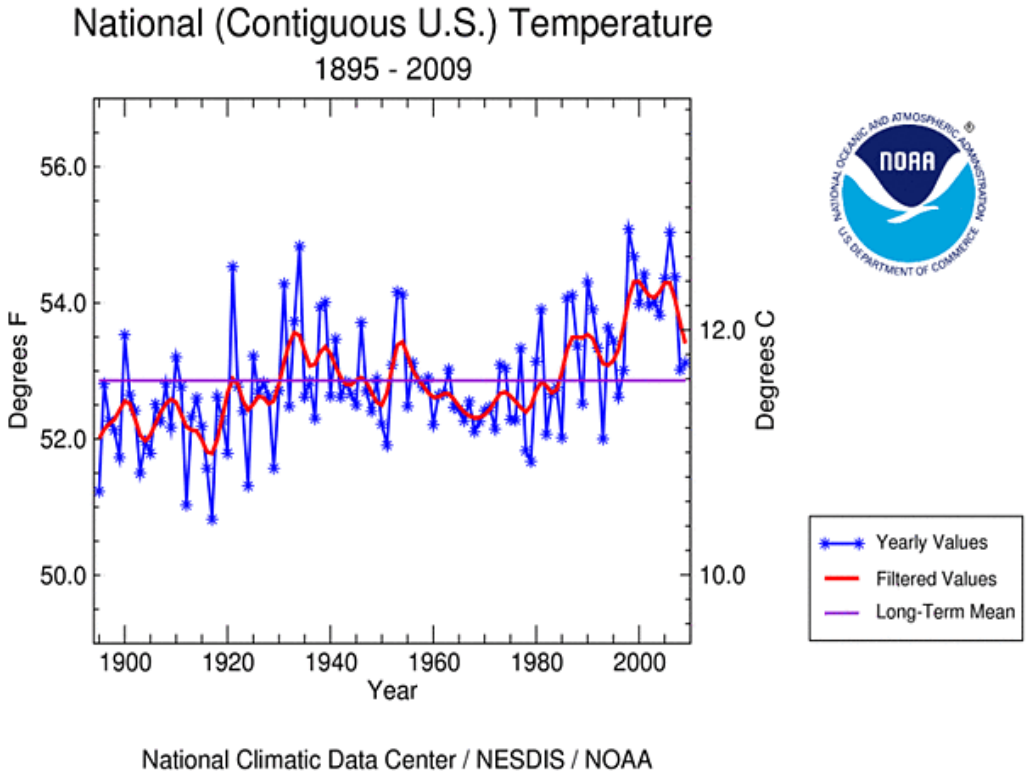
►The globally averaged surface temperature is useful for mitigation but has little relevance for adaptation.



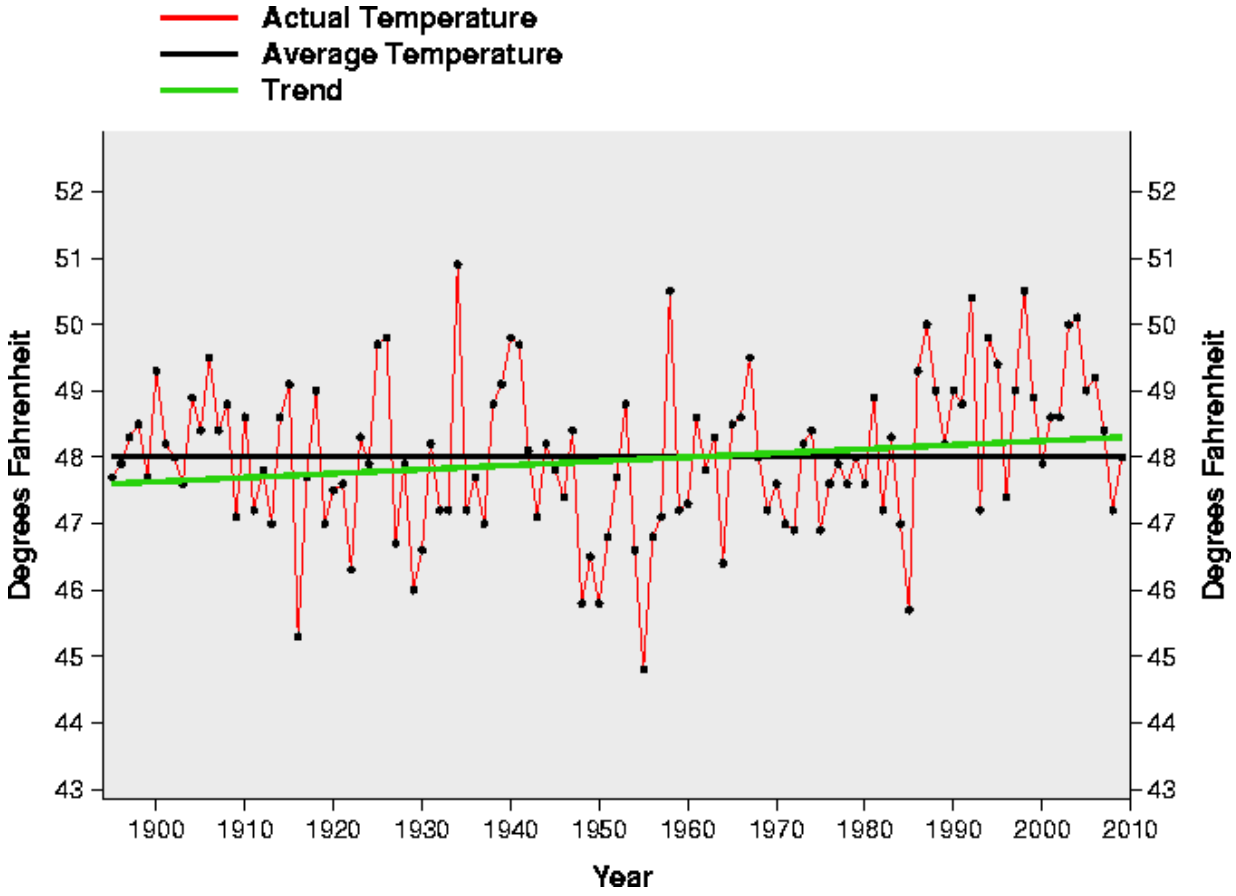
The observations of annually averaged global surface temperature up to July 2010 (NASA GISS: downloaded from http://data.giss.nasa.gov/gistemp/2010july/)

GLOBAL Y TO Y VARIATION ≤.3ºC

When we move to smaller space scales, the variability increases:



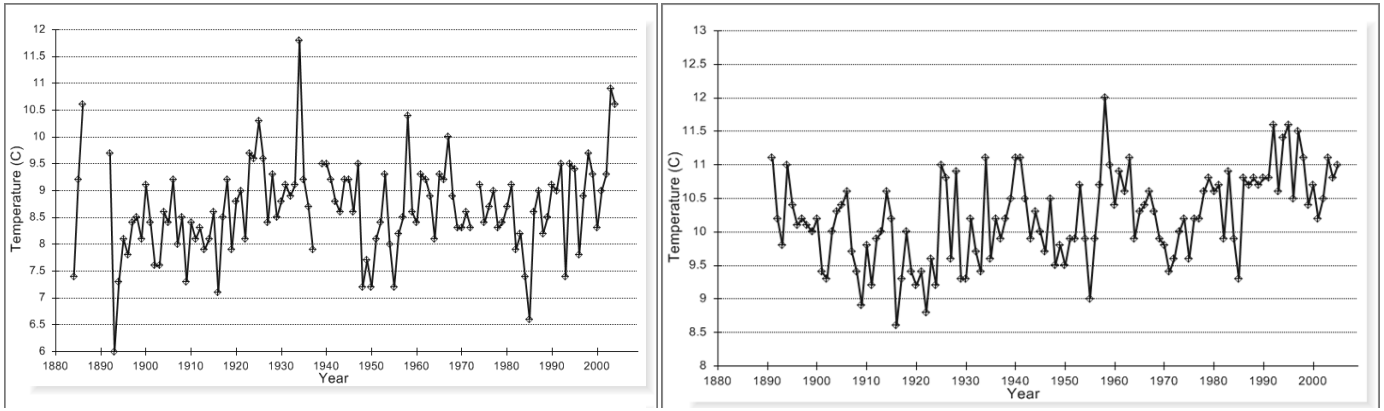
CONTINENTAL Y to Y Variation ~1ºC



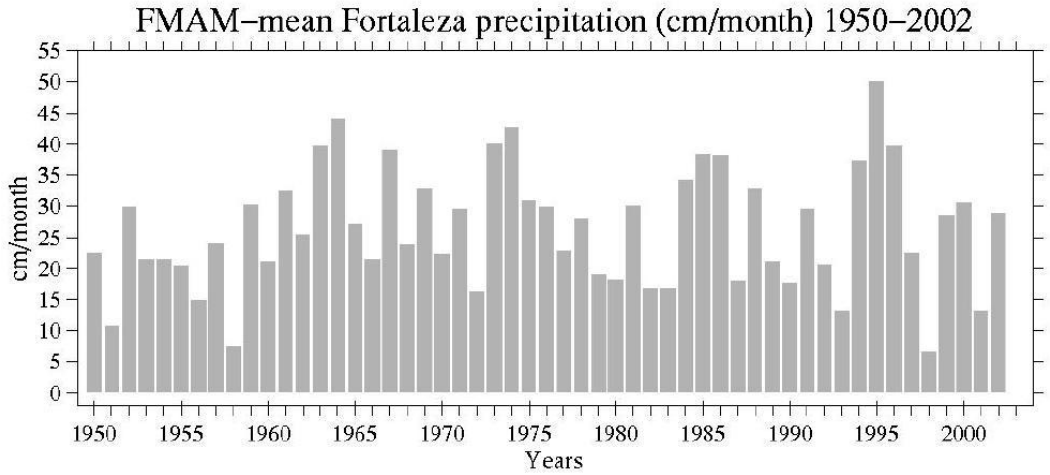
Annual 1901 - 2000 Average = 47.97 degF
Annual 1895 - 2009 Trend = 0.06 degF / Decade

STATE OF WASHINGTON

Y-to-Y variation ~2ºC



Annually averaged surface temperature variations at a single station. Left Panel: Ellensburg, Washington located east of the coastal ranges of mountains in the center of the State of Washington. Right Panel, Aberdeen, on the Pacific Coast of Washington State. Plotted using NOAA NCDC data at site: http://www.appinsys.com/GlobalWarming/climate.aspx



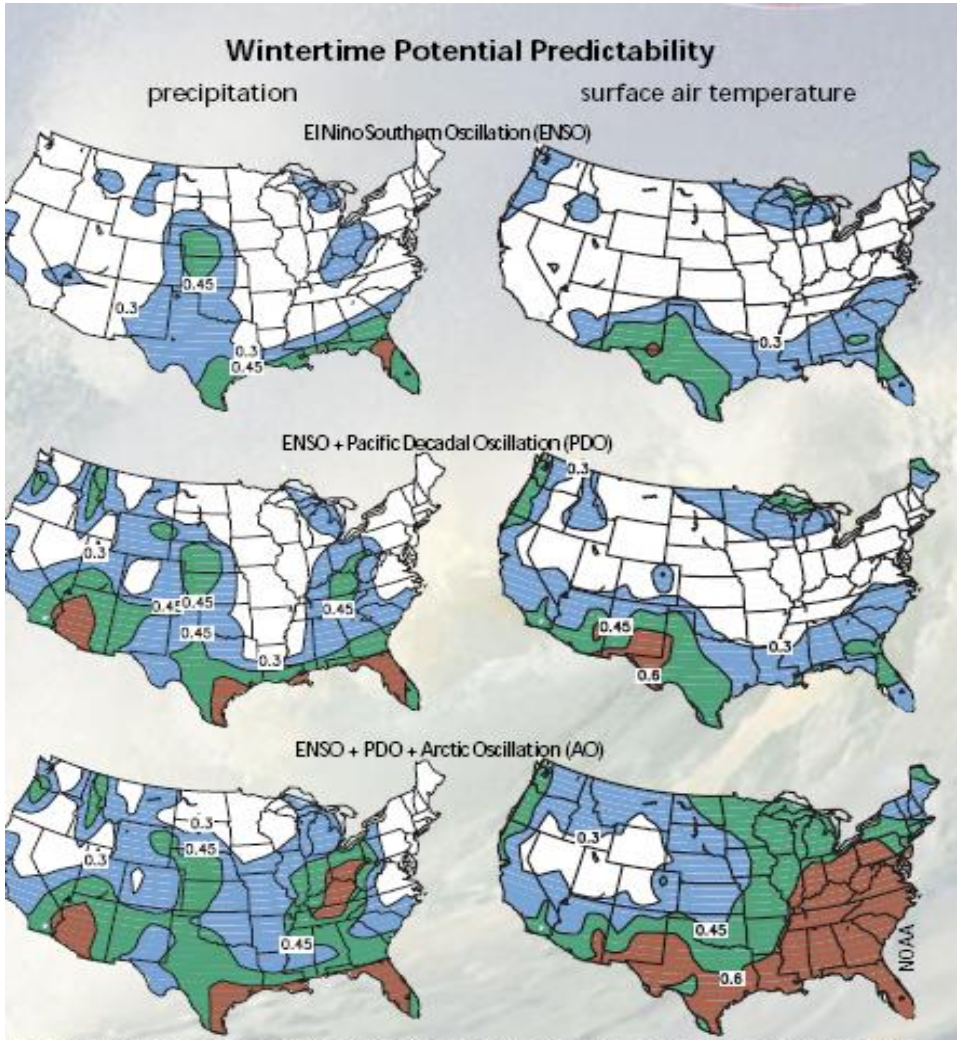
The year to year variation in rainy season precipitation in Fortaleza, Ceará, Brazil (downloaded from http://jisao.washington.edu/data/brazil/).

WHAT CLIMATE INFORMATION IS NEEDED?

In developing the yearly laws and budgets, and if next year's climate change is likely to be as large as the fifty year trend, two obvious questions arise:

1. **What will the climate be next year (or next few years) in the place?**
2. **How will climate variability in the place change as the world warms?**
3. **Requires information about the modes of variability and the stochastic component of climate. Trend plus stationary variability is not the most likely option.**

[That nature has graced us with only a handful of climate modes is a gift in this direction: MJO, Annual Cycle including monsoons, ENSO, NAO, PDO, PNA, AMO. The decadal variation of these modes is especially important.]


Wintertime Potential Predictability
precipitation
surface air temperature
El Nino Southern Oscillation (ENSO)
0.3
0.45
0.3
0.45
0.3
ENSO + Pacific Decadal Oscillation (PDO)
0.3
0.3
0.45
0.45
0.45
0.3
0.3
0.45
0.3
0.6
ENSO + PDO + Arctic Oscillation (AO)
0.3
0.3
0.45
0.45
0.3
0.45
0.6
NOAA