Key information and data that is available, and transparent protocols required, to support mainstreaming of climate change into planning processes

air • planet • people

Caspar Ammann
National Center for Atmospheric Research



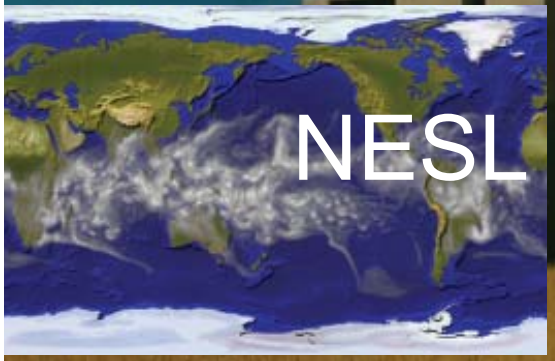



NCAR/NSF Scientific Facilities

- US National Science Foundation FFRDC
- 900 Staff, 500 Scientists/Engineers, 4 Boulder campuses
- Governed by > 104 universities

HAO : High Altitude Observatory

Earth Observing Laboratory : EOL



NESL :NCAR Earth System Laboratory

Computational & Information Systems : CISL

RAL : Research Applications Laboratory

ISP: Integrated Science Program (crosscutting)

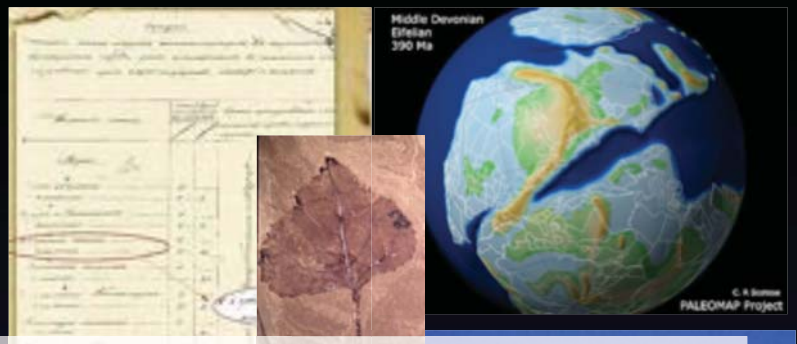
Outline

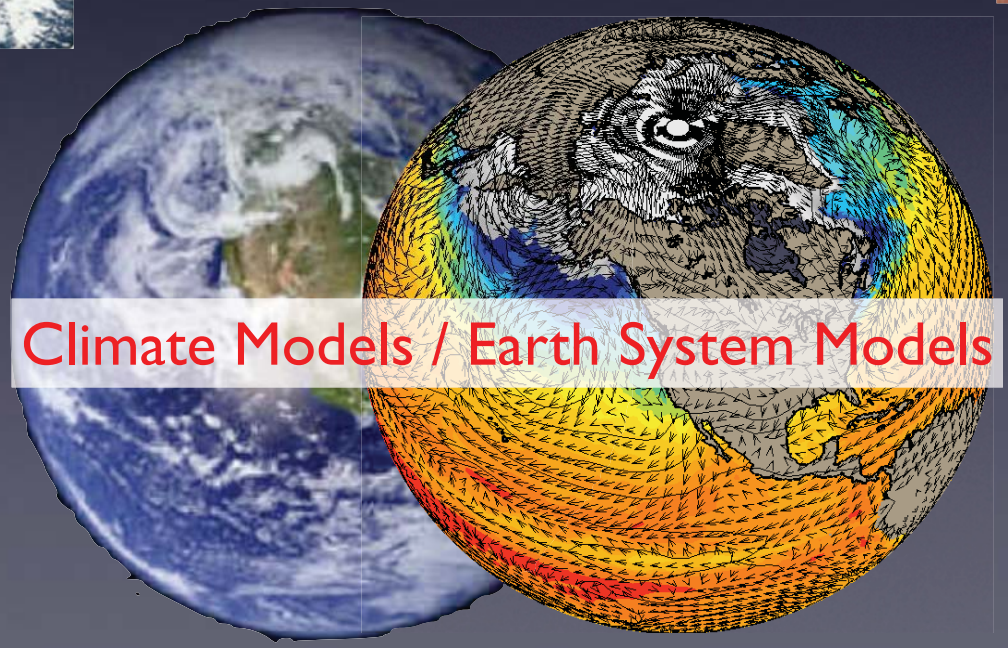
1. climate science tools and climate change research
2. the practitioners dilemma and other challenges
3. development of effective / best-practice protocols and the need for iterative steps
4. future developments and potential scenario tools

Best/effective Practice for Embedding Climate Science

- **iterative process** for identifying weather/climate vulnerability ("indices")
- need for good **observational baseline**
- **test** prediction/projection tools on "indices" and in contexts
- **recognize limitations** resulting from spatial resolution and bias issues
- understand, make transparent, further **explore uncertainties**
- form **community of practice** focused on applications while recognizing context of societal and physical realities

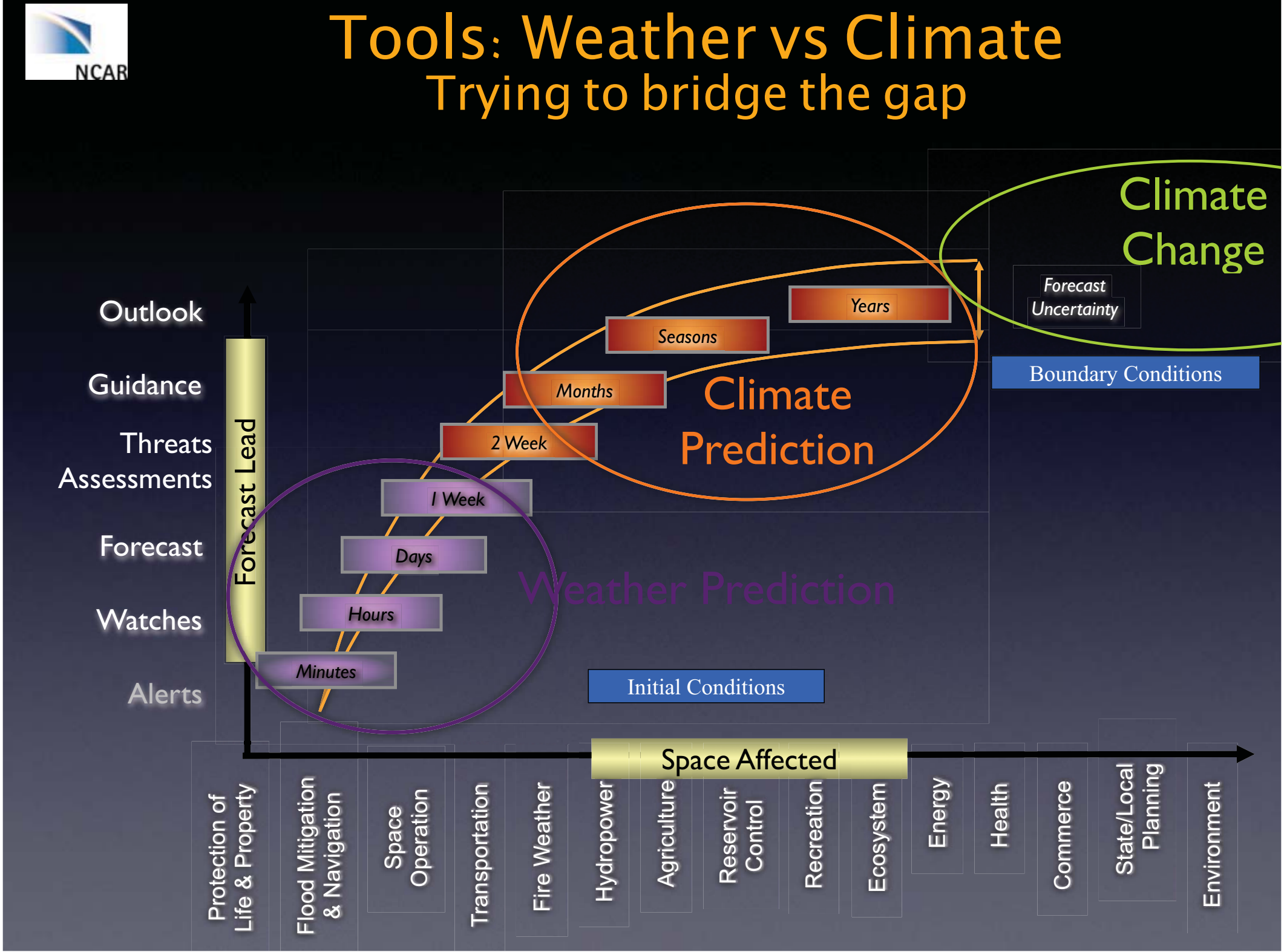
Studying Weather and Climate



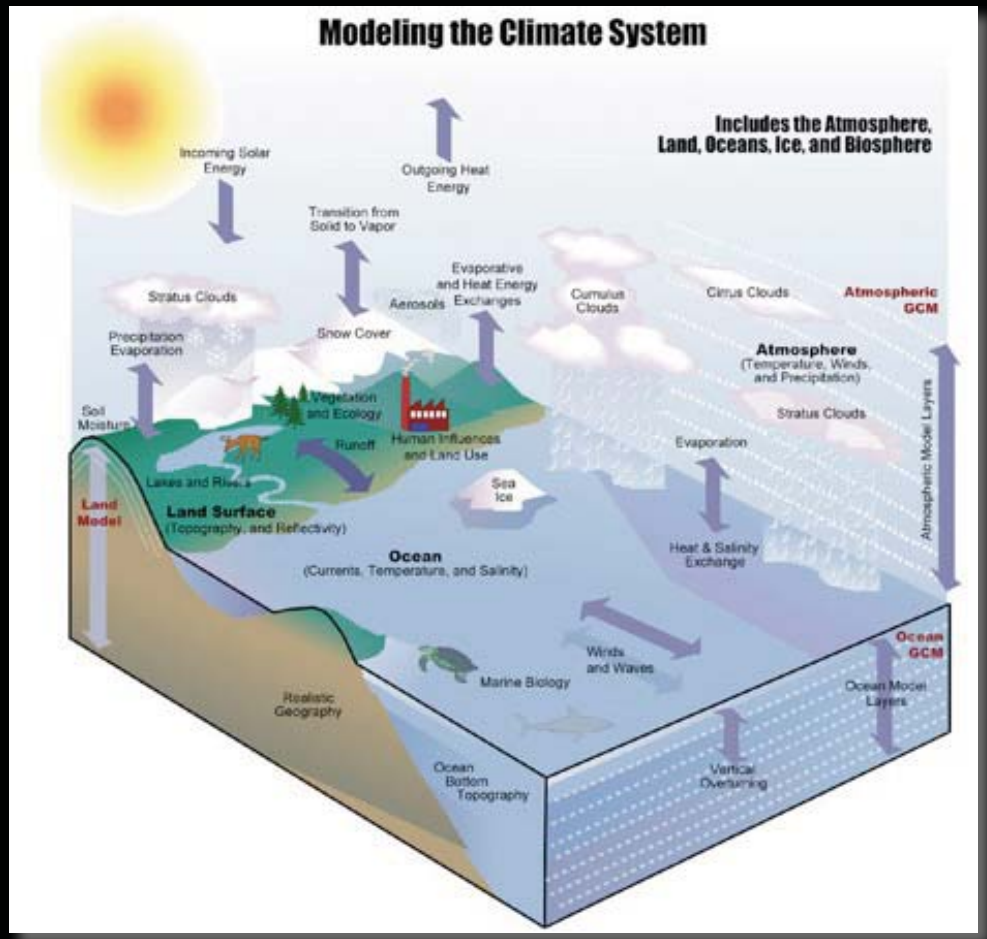


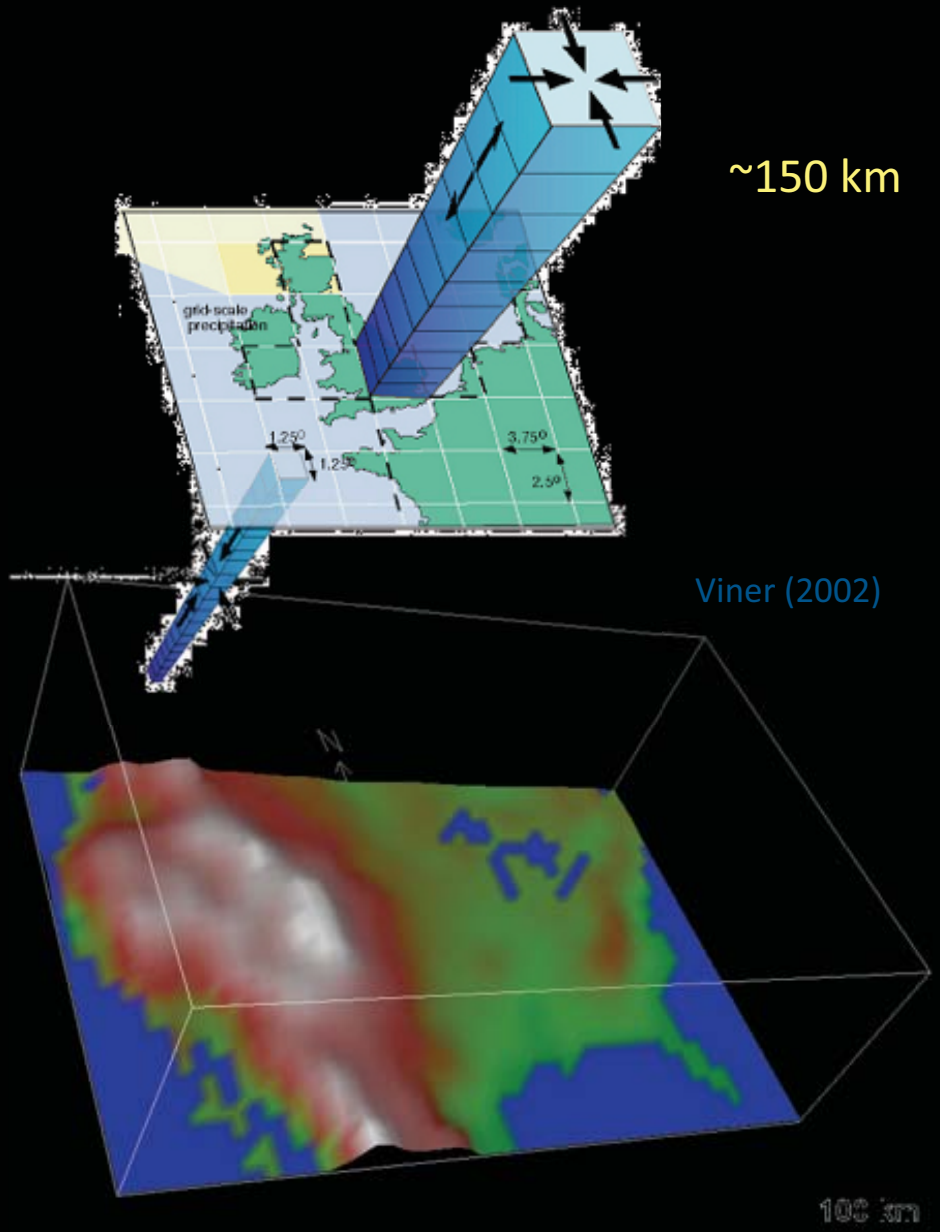
Tools: Weather vs Climate

Trying to bridge the gap



Climate and Earth System Models





~150 km

Viner (2002)

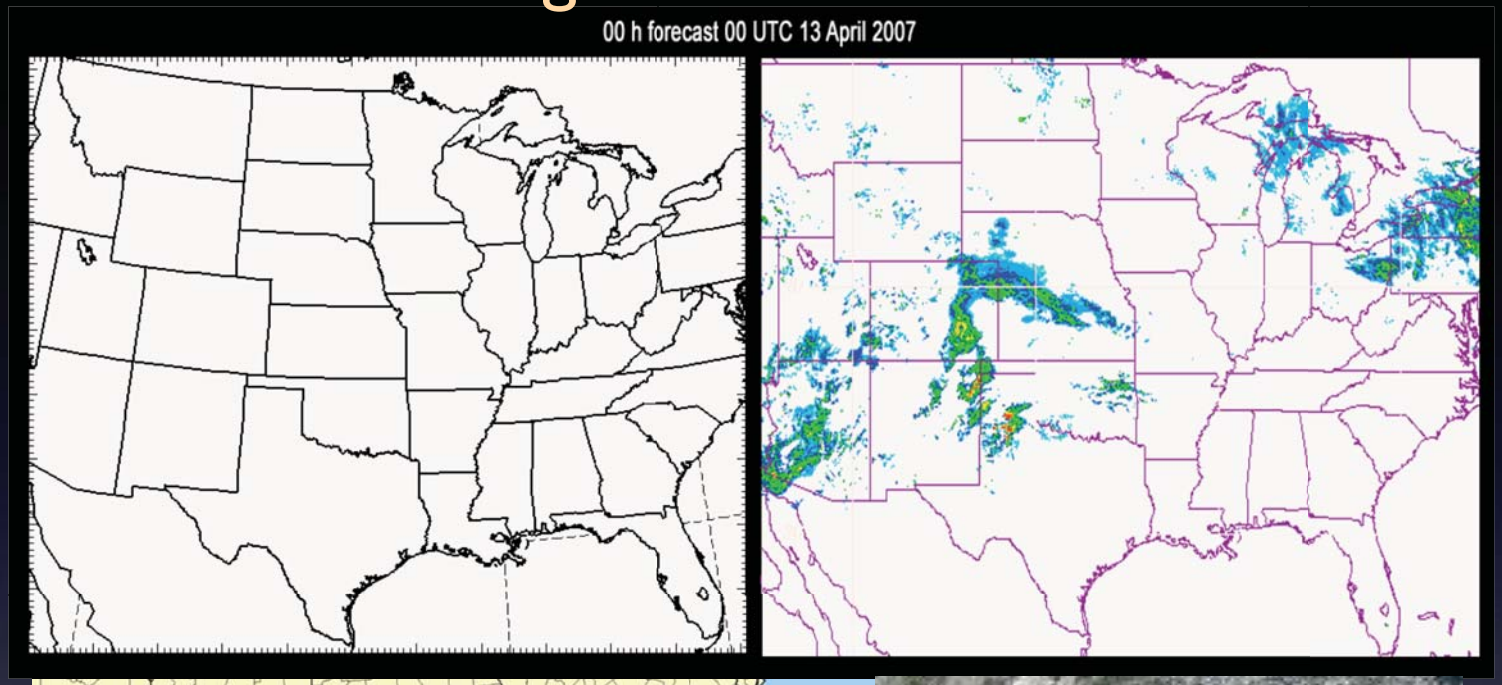
Global Model Computation:

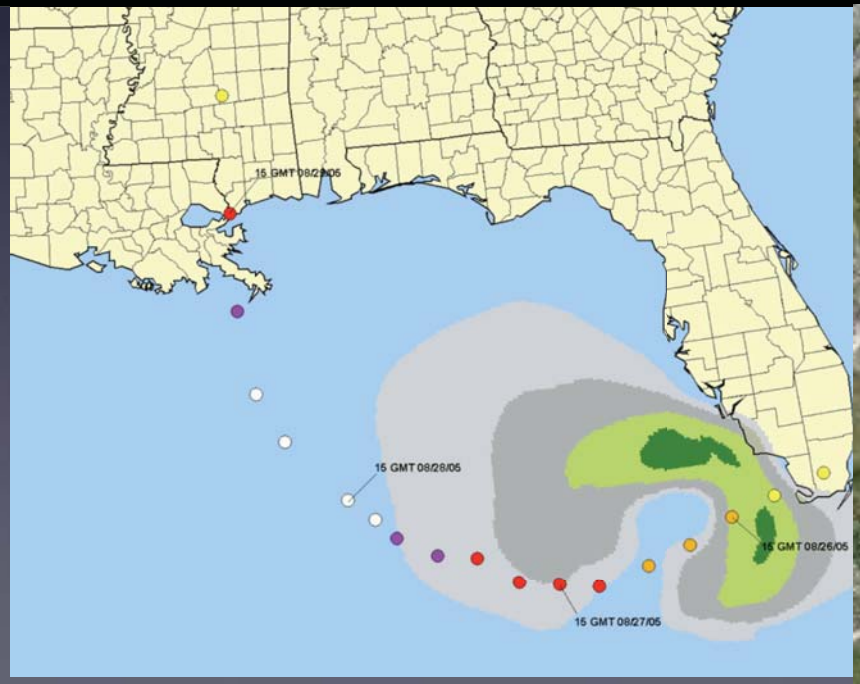
- 10-15 minute time steps
- 1-10 quadrillion calculations / Model yr

Weather Modeling

need good initial conditions

Models

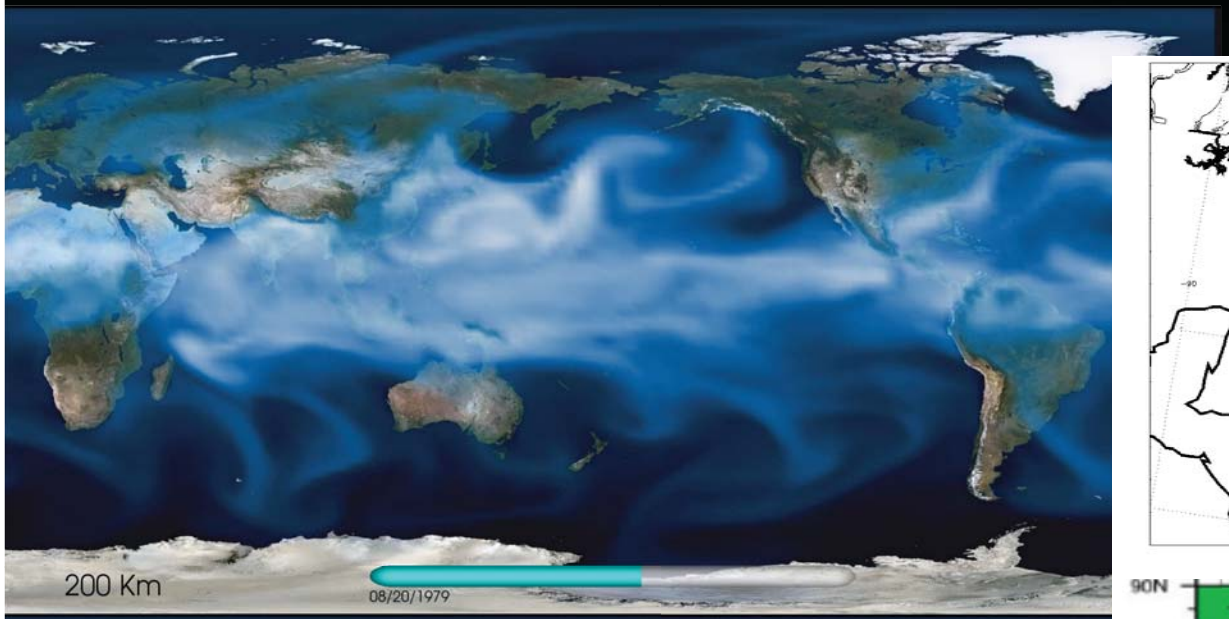


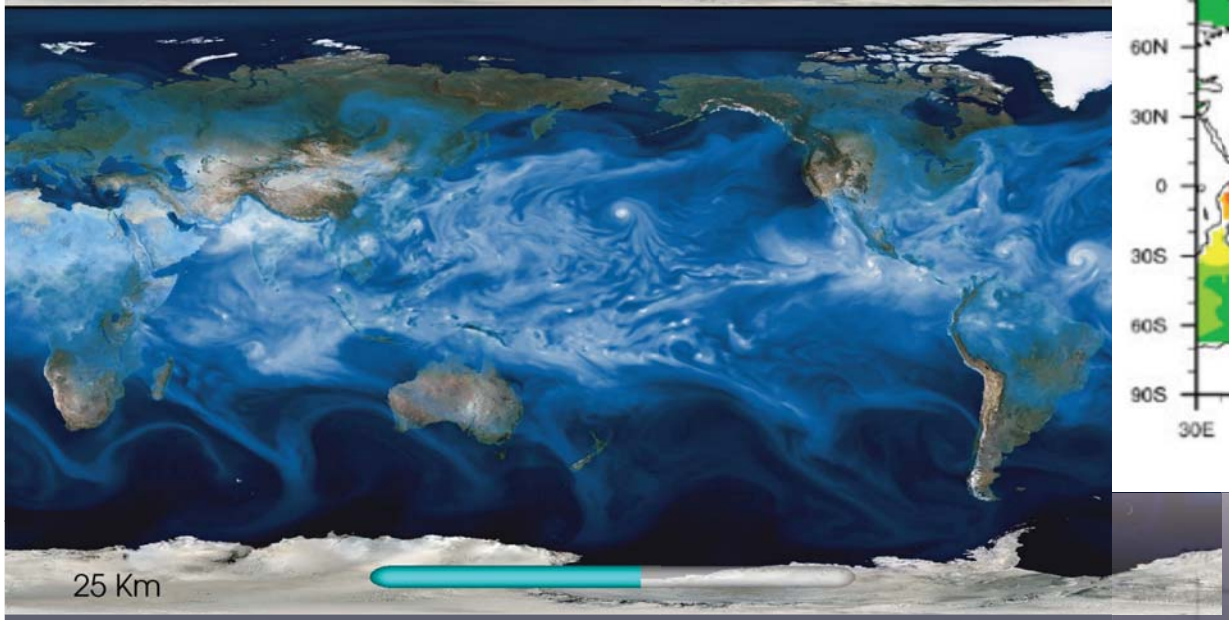


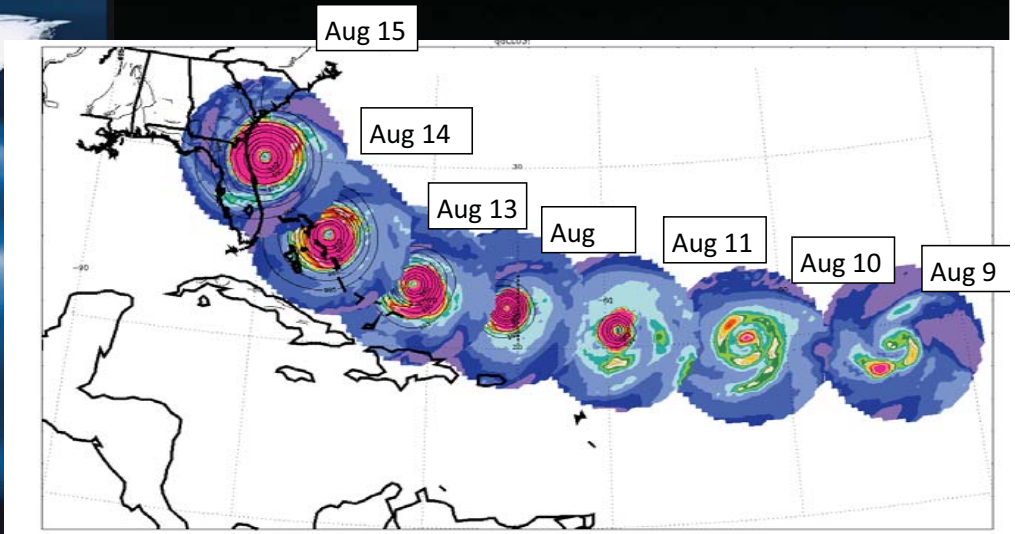
Observations

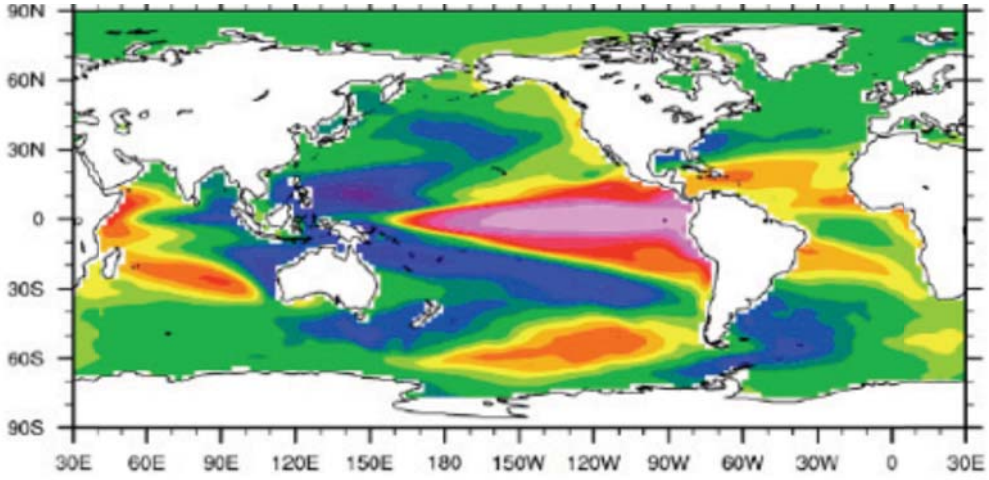
Tools to Study Climate

From global radiation to regional processes and impacts

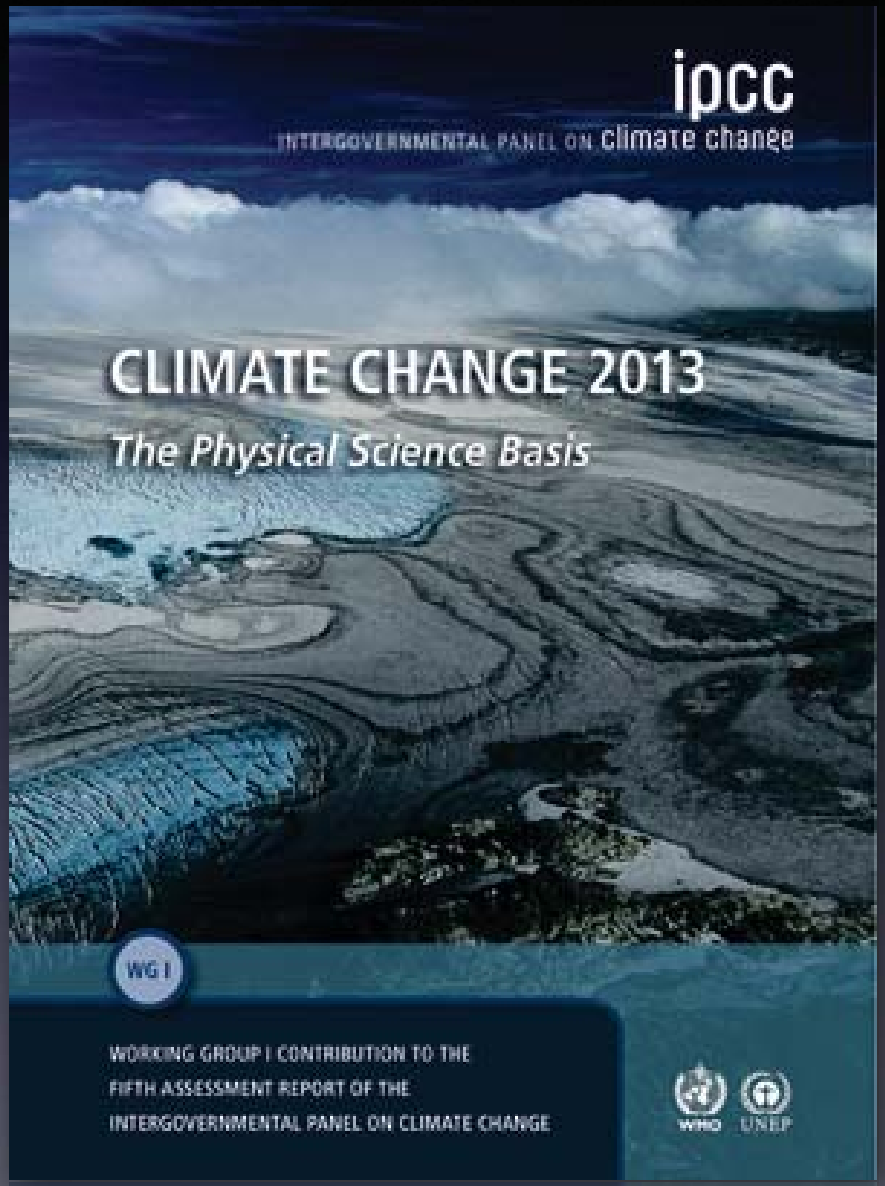


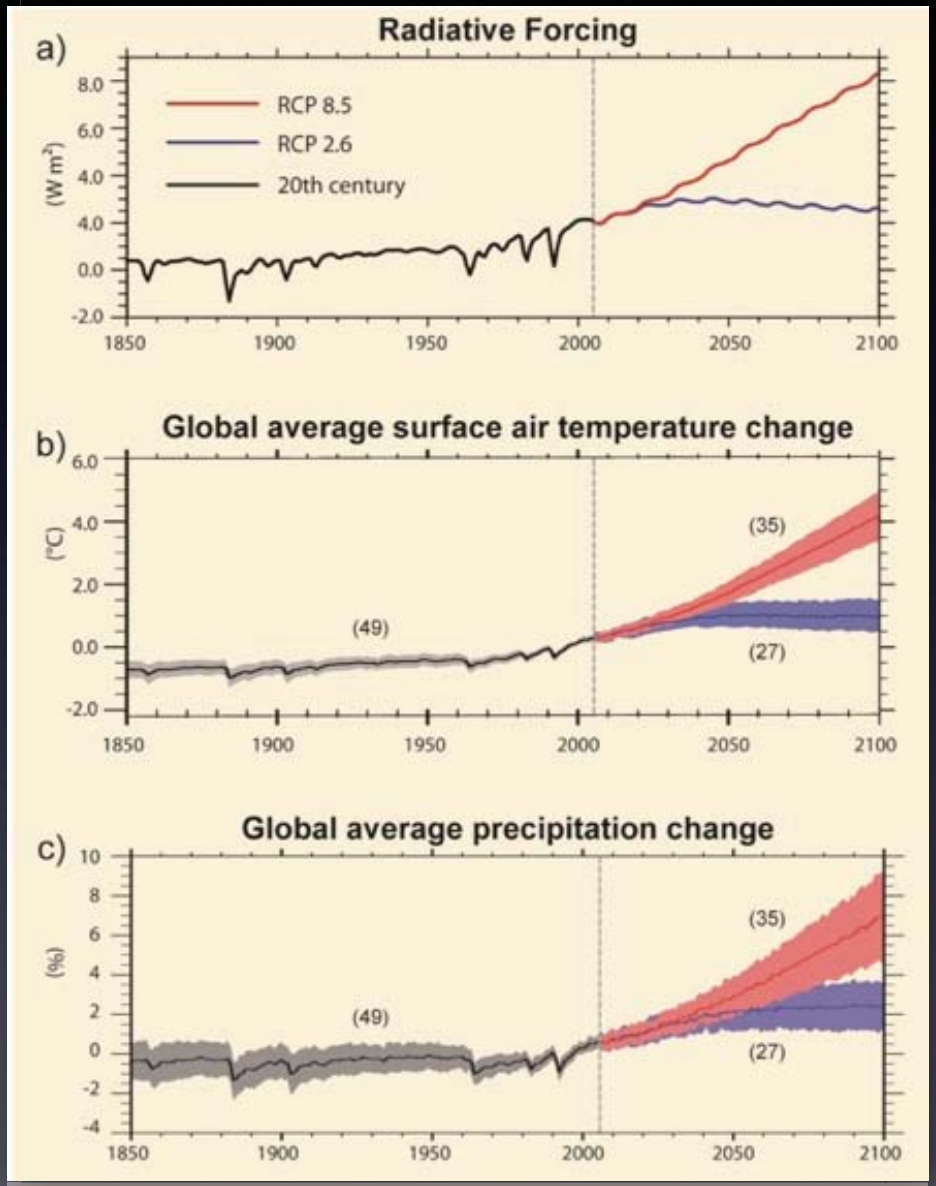


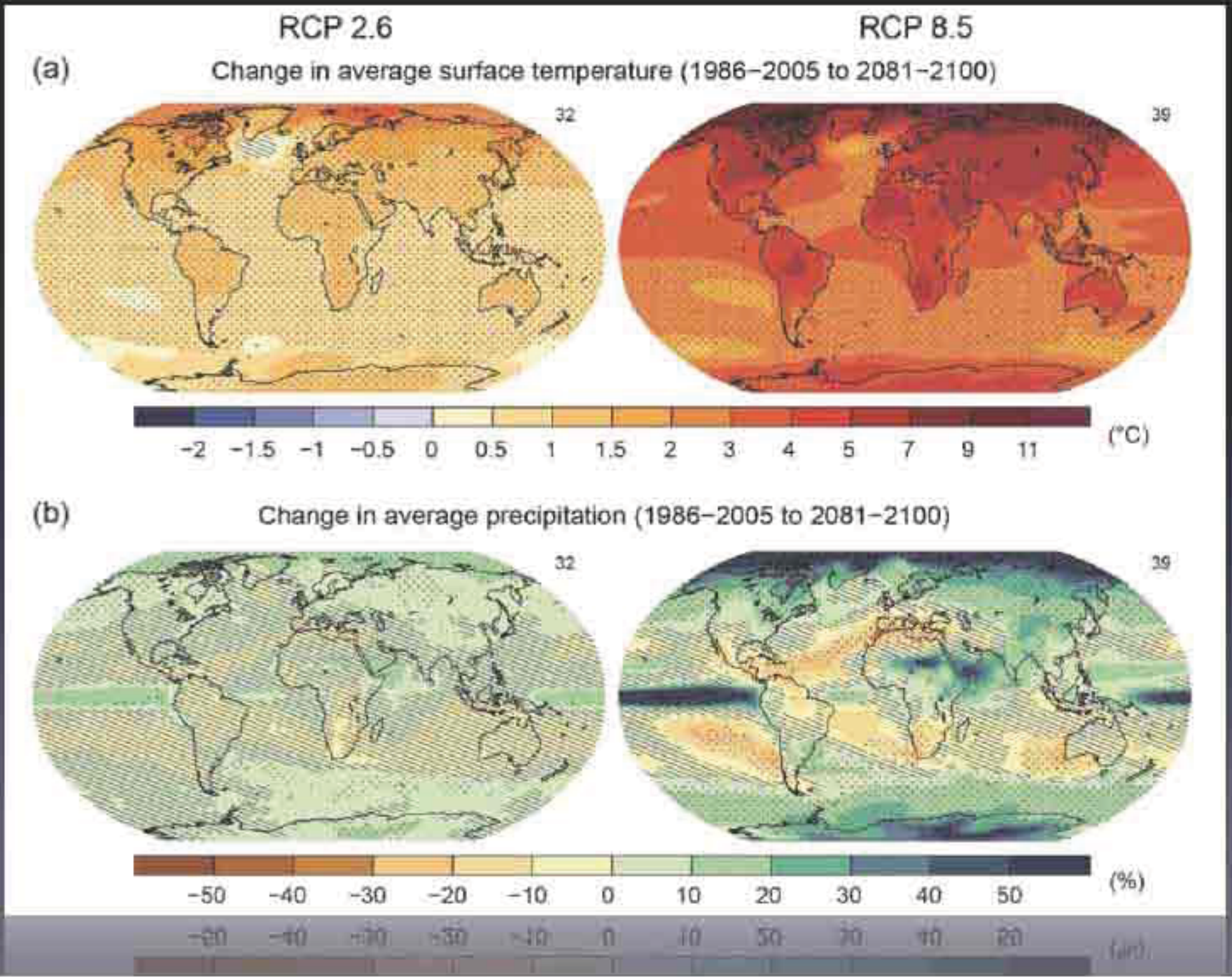




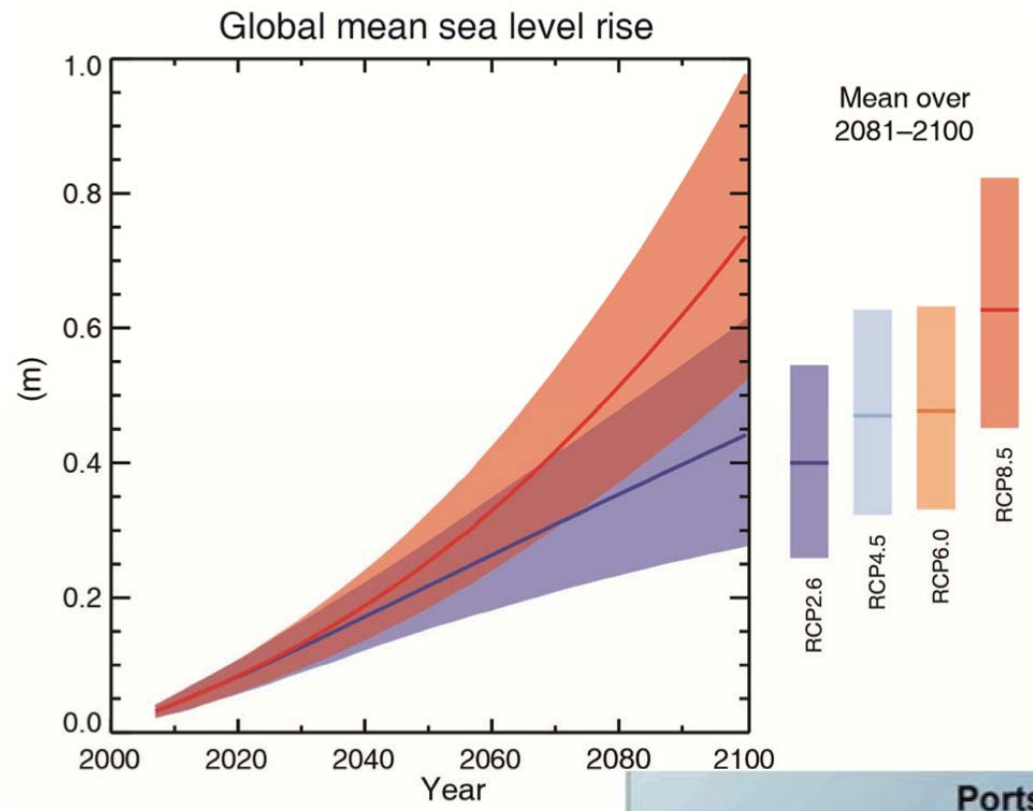
IPCC AR5 : Release Sept. 27, 2013

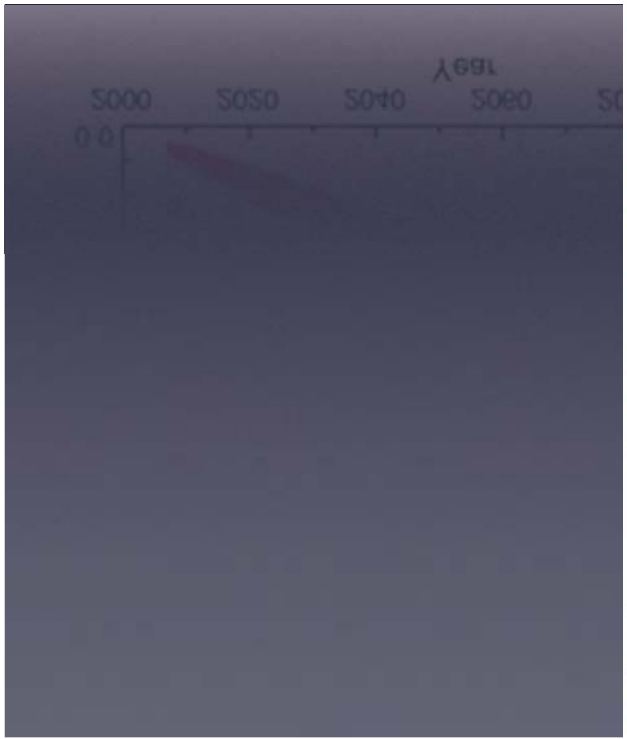





RCP 2.6
RCP 8.5
(a)
Change in average surface temperature (1986–2005 to 2081–2100)
32
39
−2 −1.5 −1 −0.5 0 0.5 1 1.5 2 3 4 5 7 9 11
(°C)
(b)
Change in average precipitation (1986–2005 to 2081–2100)
32
39
−50 −40 −30 −20 −10 0 10 20 30 40 50
(%)

Sea Level





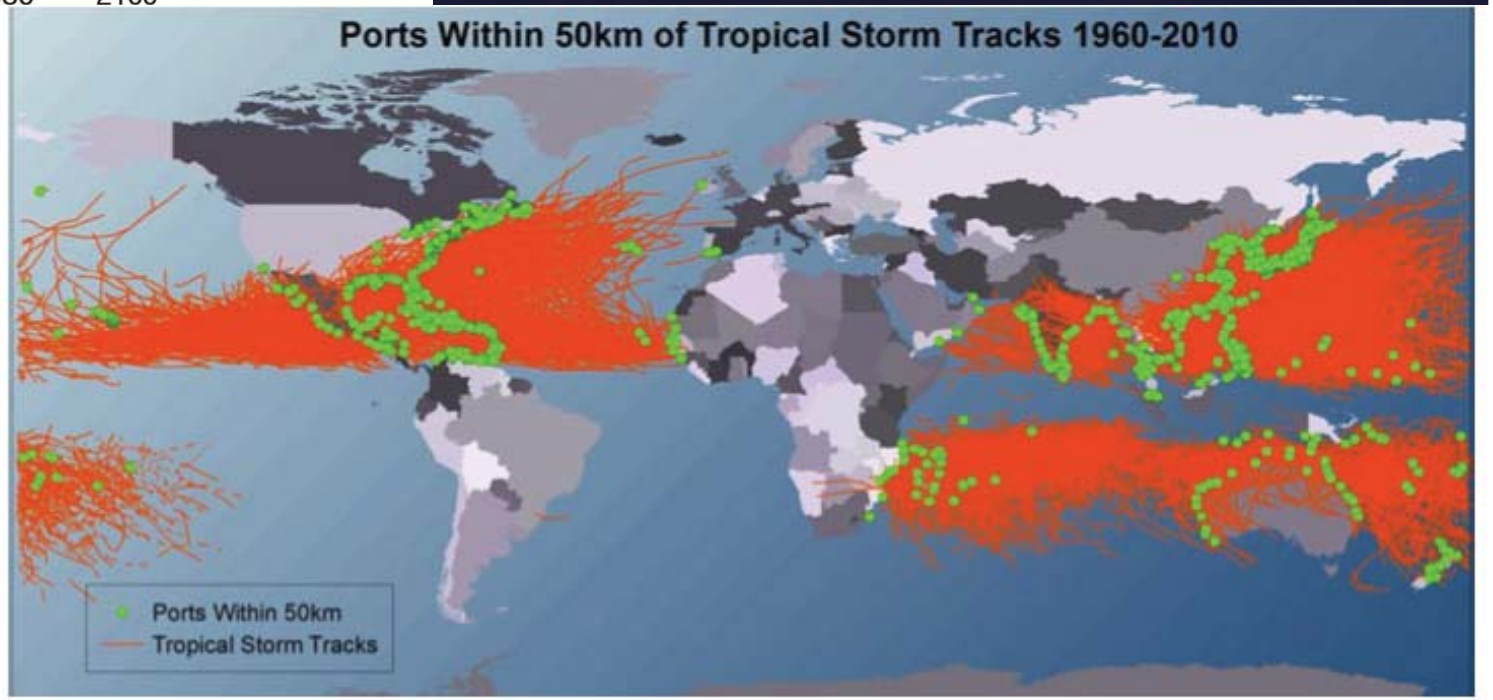
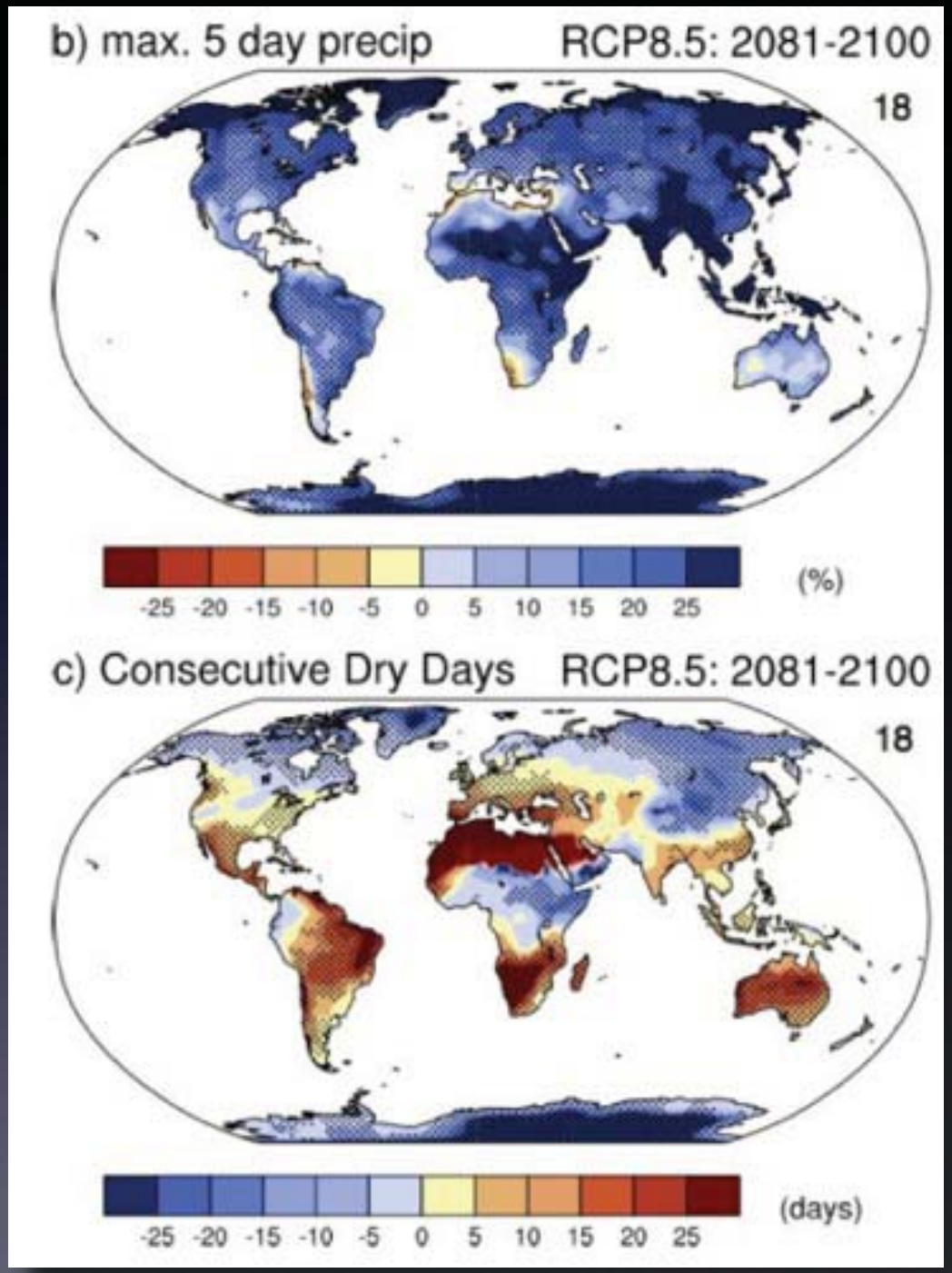


Fig. 1 Ports within 50 km of tropical storm tracks, 1960–2010. Port and storm data from National Geospatial-Intelligence Agency (2011) and Knapp et al. (2010)

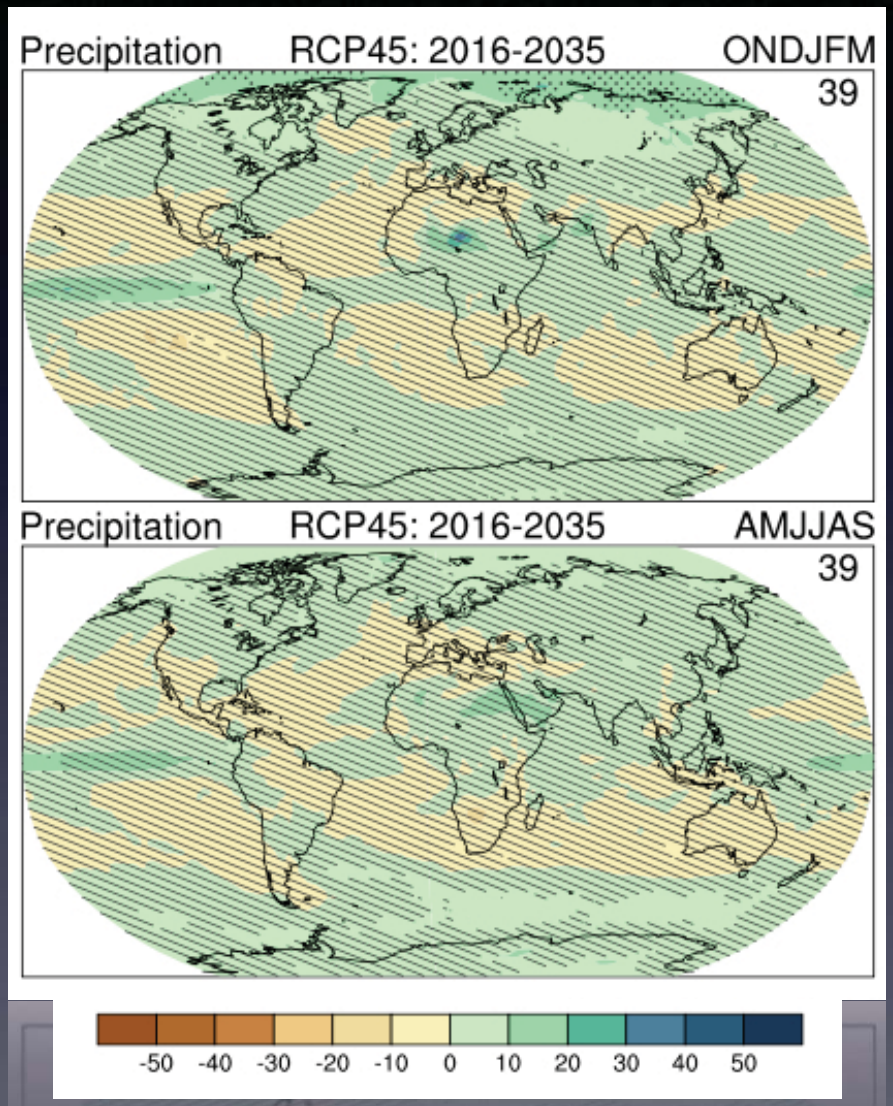


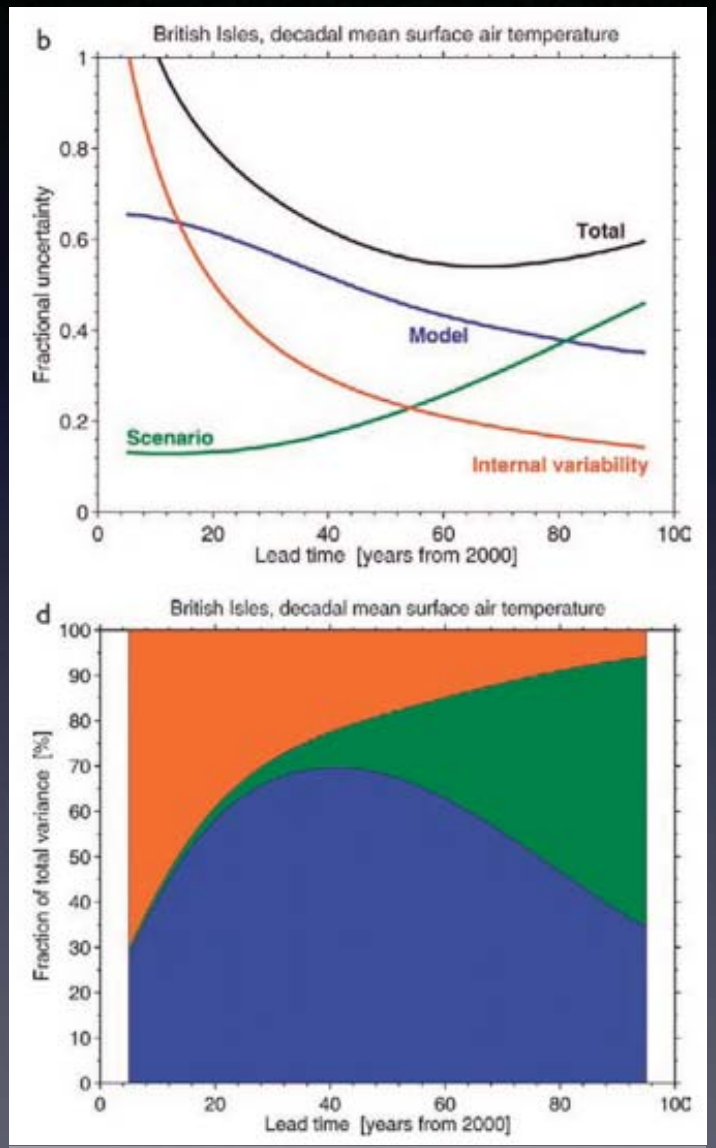
Intra-Seasonal Variability

when wet : wetter..

when dry : drier...

Next 20-40yrs: Internal Variability dominates Regional Climate Change (in models)

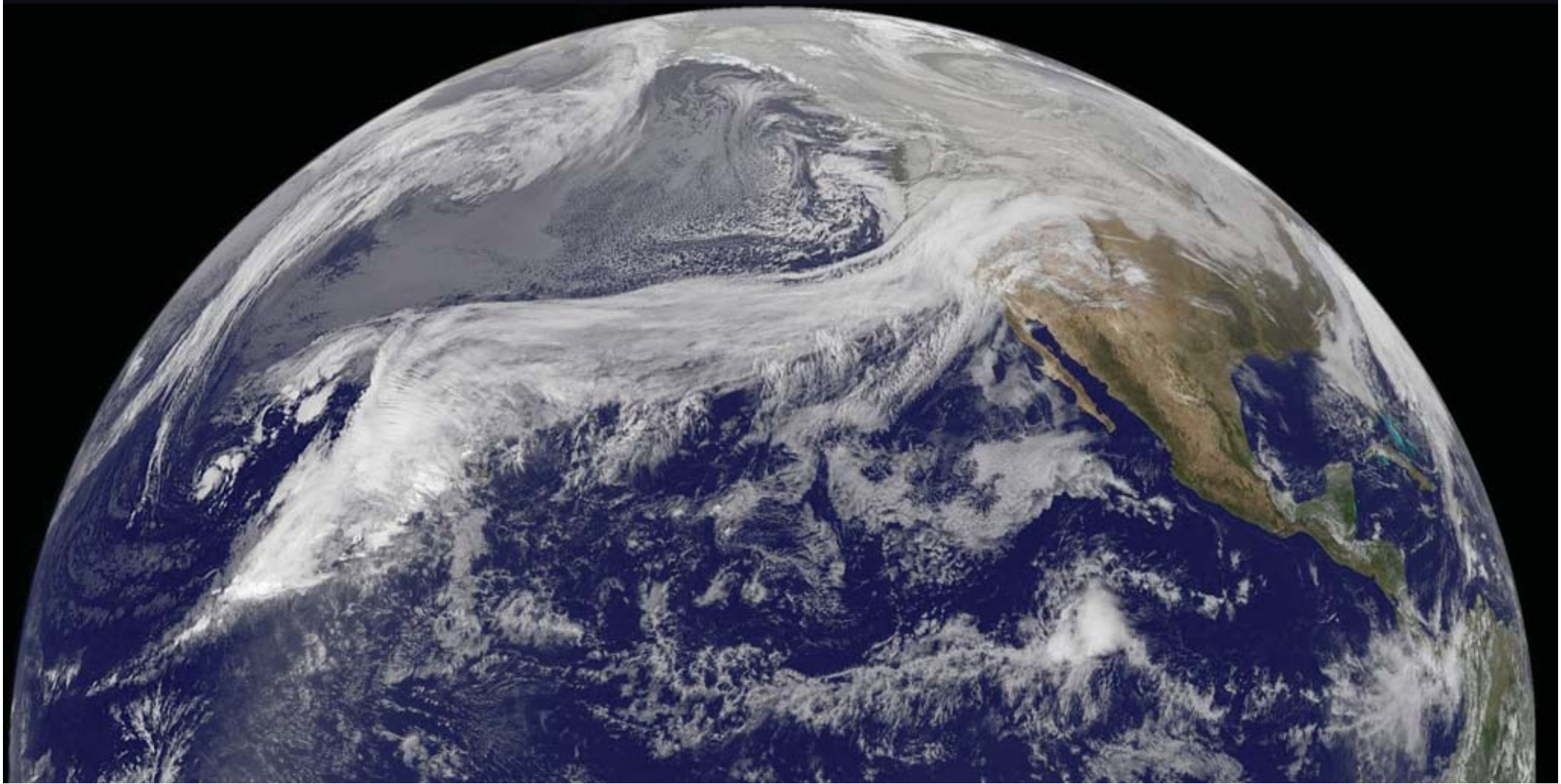




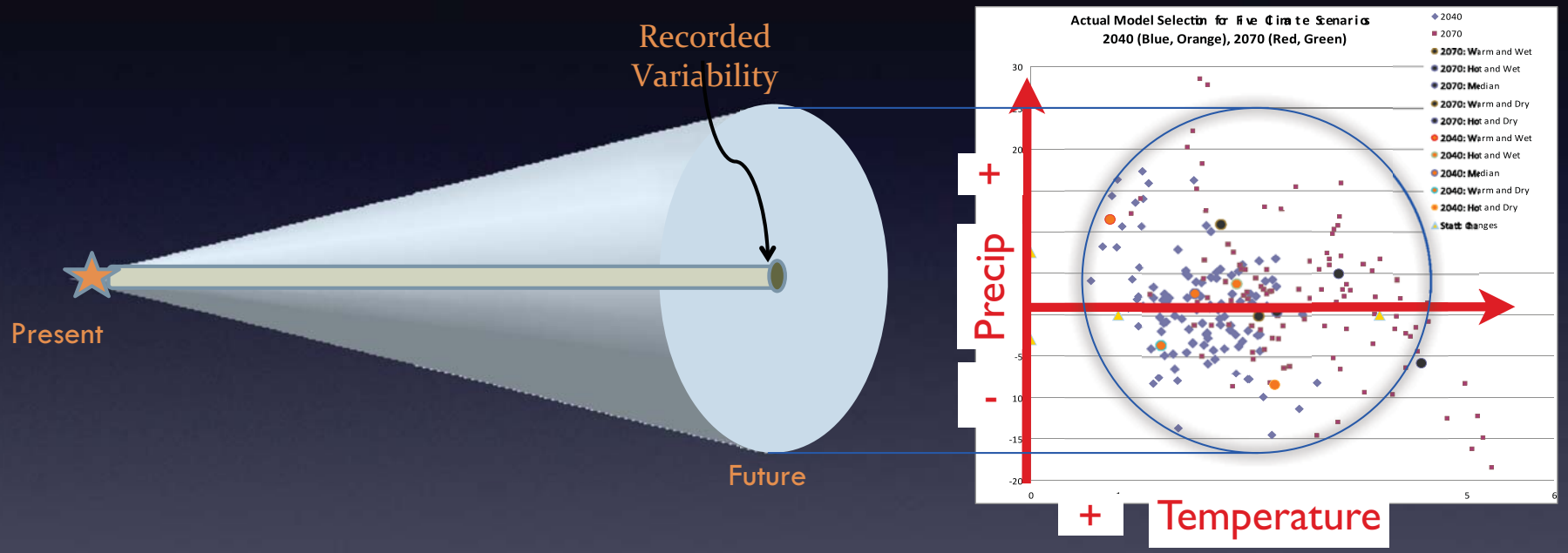
Hawkins and Sutten (2009)

Global processes well understood.

What does it mean for different regions?



The "Practitioners Dilemma"

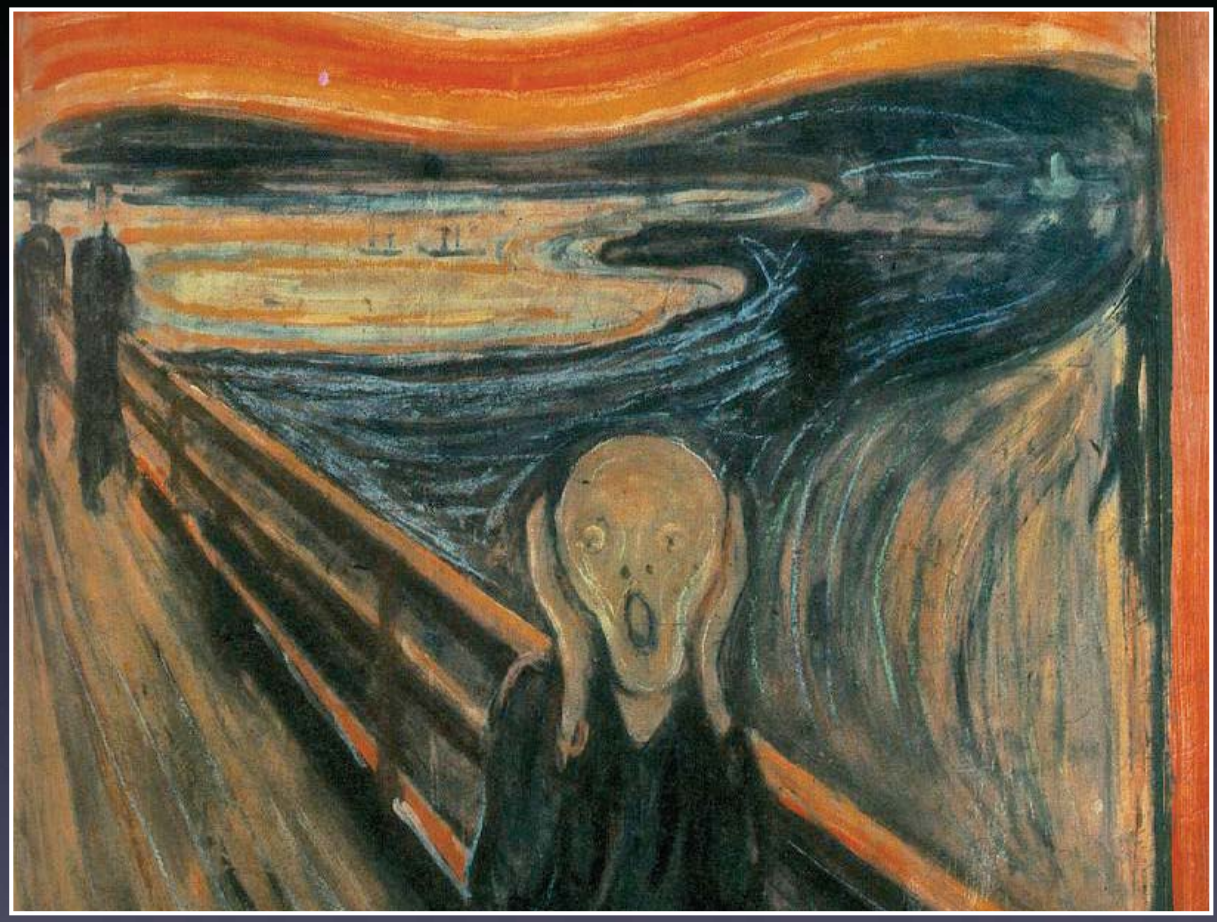


after Laurna Kaatz, Denver Water

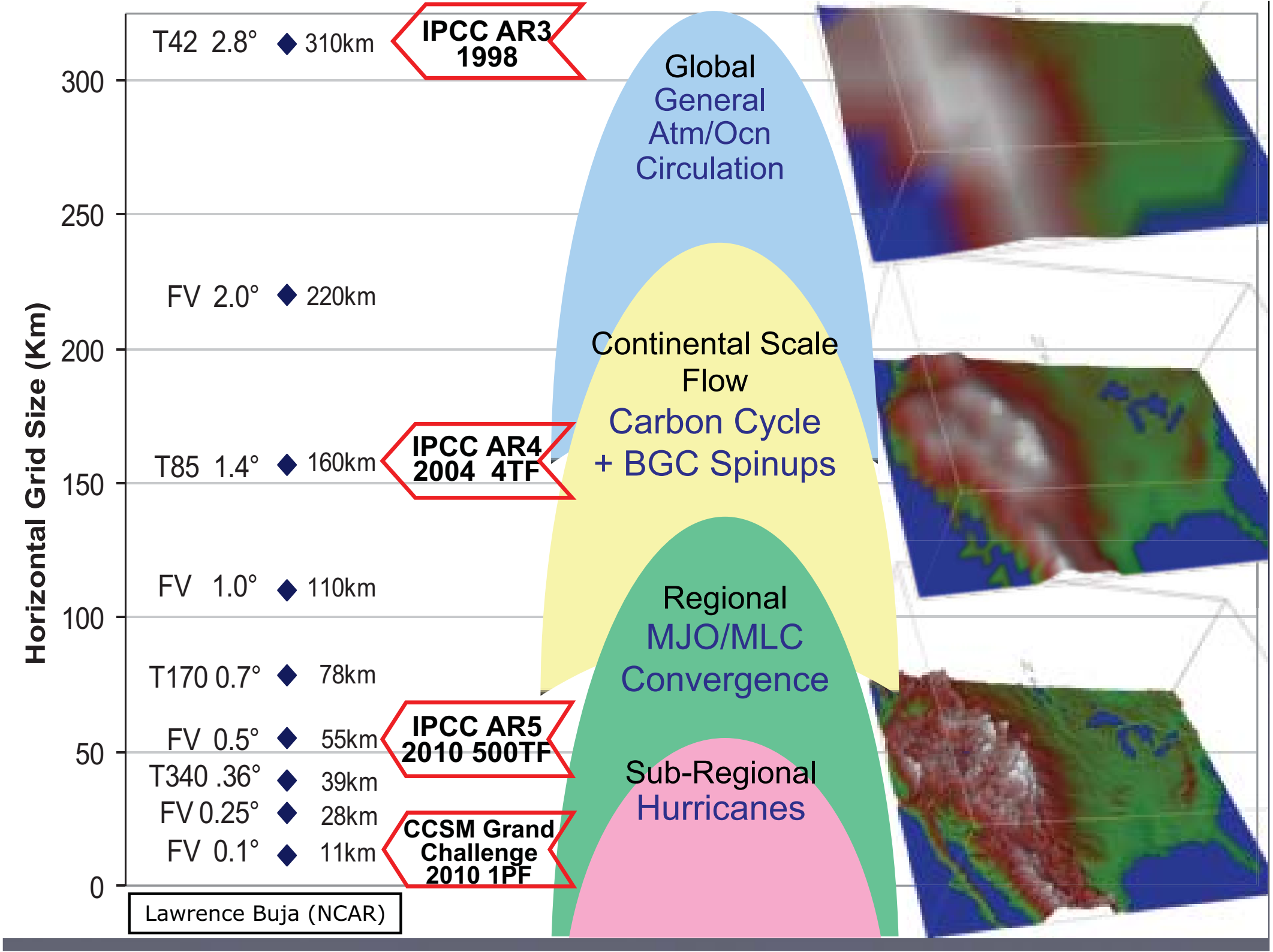
Stocktaking :"Climate Science Needs"

- what weather events or climate characteristics are seen as the primary threat for your country? which is next?
- how do you recognize change against natural variability?
- if adapting for ongoing/future changes, what are implications for connected socio-economic areas?
- what assistance would benefit your adaptation planning process most effectively?

... challenges to be aware of ...

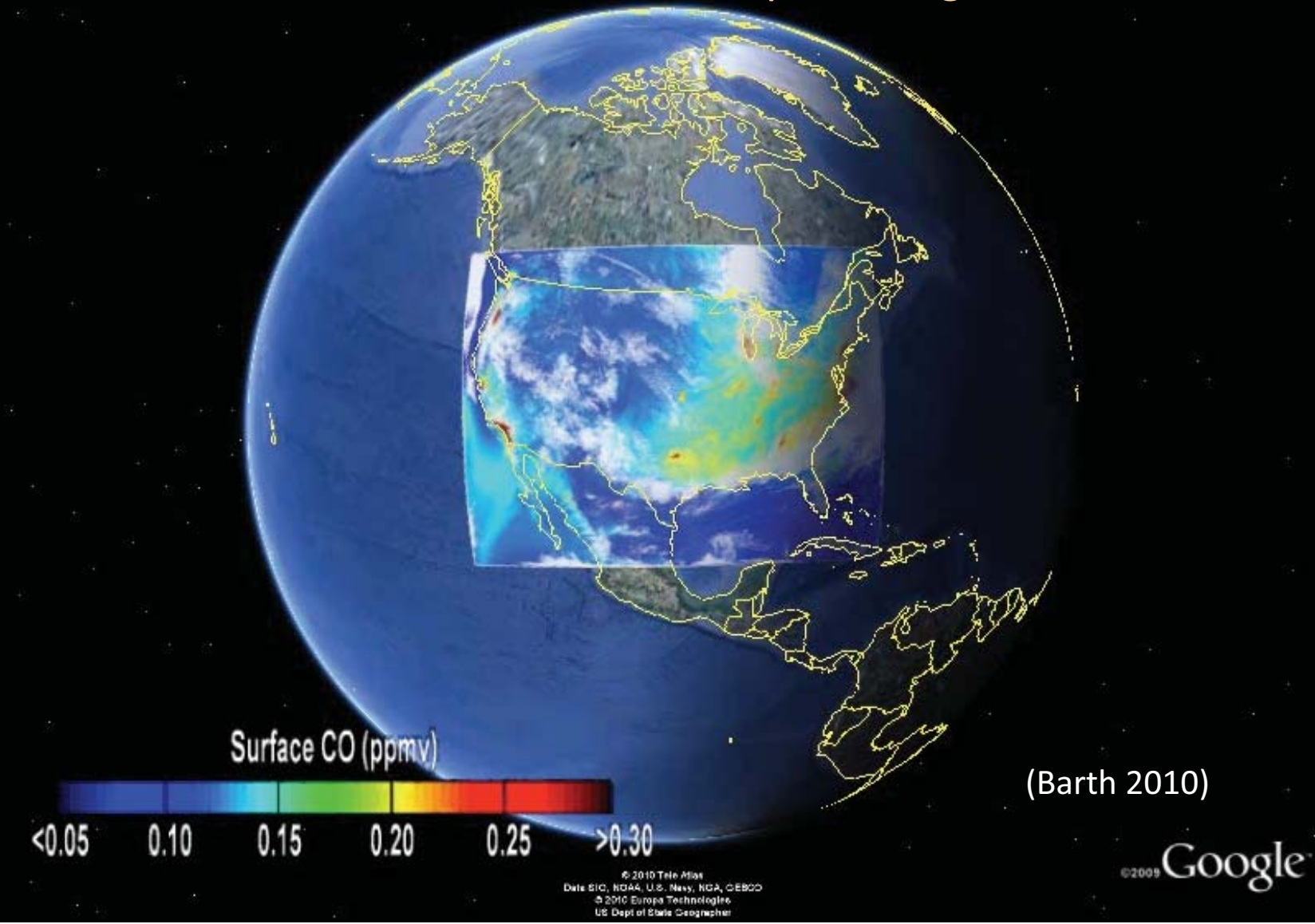


- Resolution issues
- Internal variability ("weather": do ensembles)
- Model biases and uncertainties
- *Limited understanding ("change in variability")*


Horizontal Grid Size (Km)
300
250
200
150
100
50
0
T42 2.8° ◆ 310km
FV 2.0° ◆ 220km
T85 1.4° ◆ 160km
FV 1.0° ◆ 110km
T170 0.7° ◆ 78km
FV 0.5° ◆ 55km
T340 .36° ◆ 39km
FV 0.25° ◆ 28km
FV 0.1° ◆ 11km
IPCC AR3 1998
IPCC AR4 2004 4TF
IPCC AR5 2010 500TF
CCSM Grand Challenge 2010 1PF
Global
General
Atm/Ocn
Circulation
Continental Scale
Flow
Carbon Cycle
+ BGC Spinups
Regional
MJO/MLC
Convergence
Sub-Regional
Hurricanes
Lawrence Buja (NCAR)

Precision WRF: WRF-Hurricane, WRF-Chem, WRF-Health, WRF-Crop

WRF Chem predicting CO concentrations across US
based on known emissions and prevailing weather



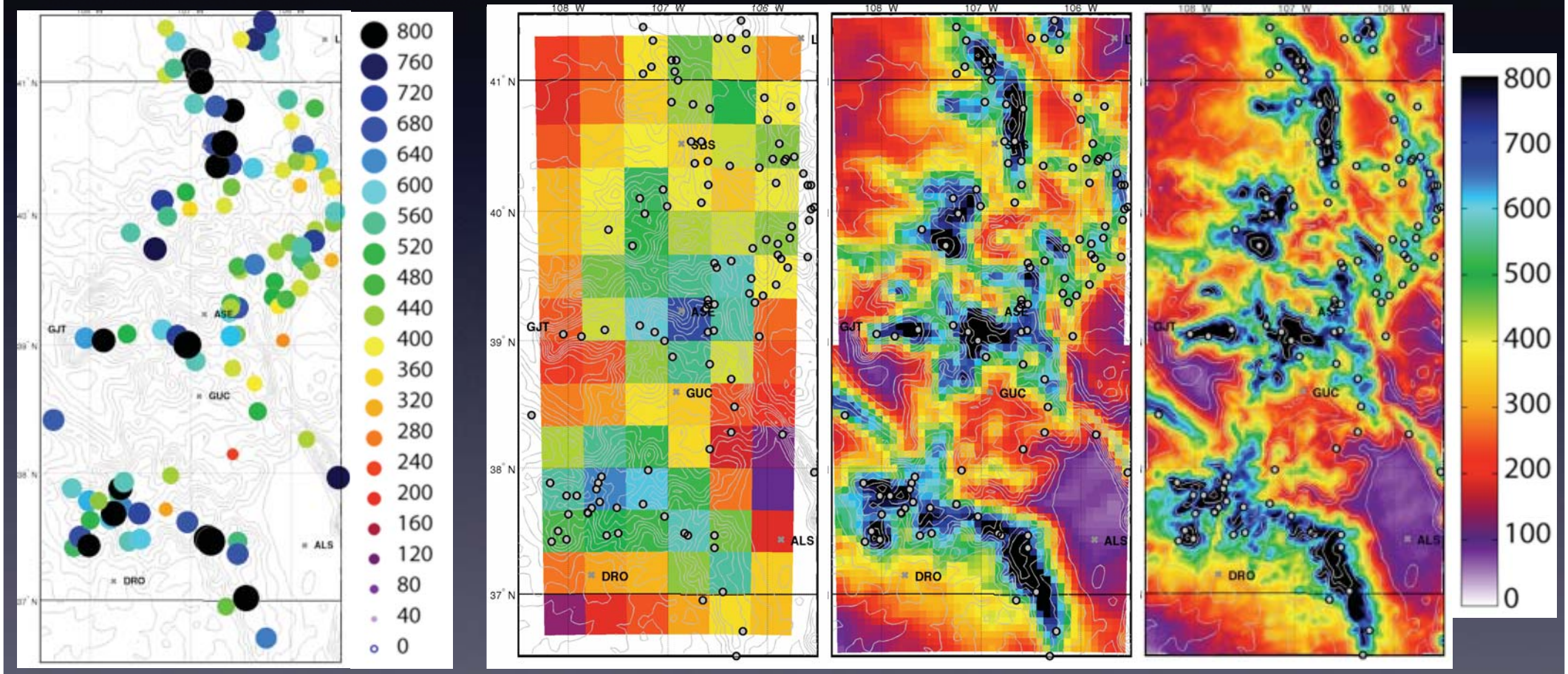
Barth
NCAR

(Barth 2010)

Resolution Requirements: Snow in Terrain

1 Nov. 2007-1 May 2008

SNOTEL Obs. 36 km 6 km 2 km



WRF - Roy Rasmussen (NCAR-RAL)

Interpreting an Ensemble of a Scenario

Ensemble : pixels are independent point-wise expected values
Requirement: sampling from same "process"

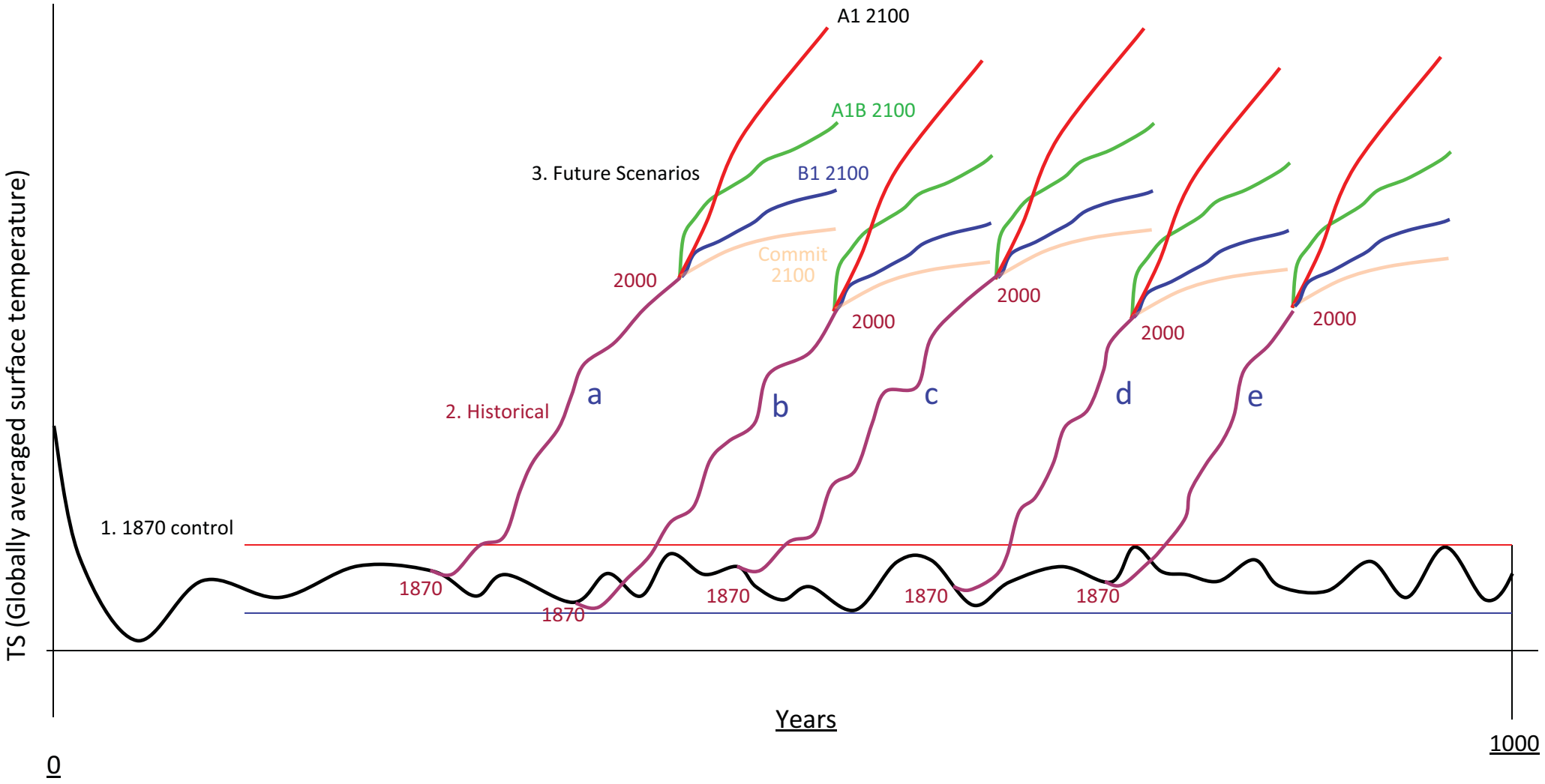
Images curtesy J. Salavon

Ensemble Climate Simulations

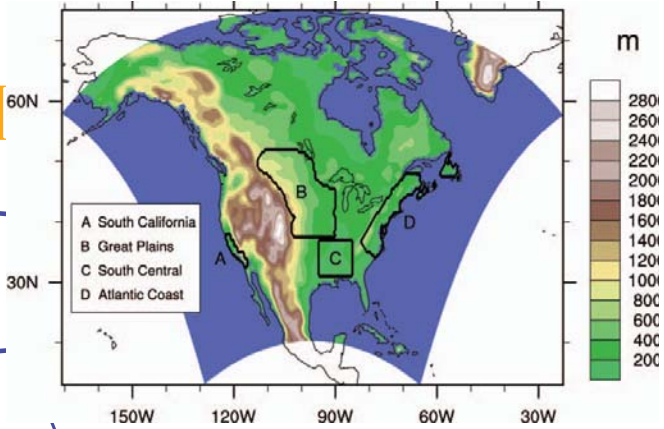
Stage 1. 1870 control run: 1000 years with constant 1870 forcing: Solar, GHG, Volcanic Sulfate, O3

Stage 2. Historical: 1870-2000 run using time-evolving, observed, Solar, GHG, Volcanoes, O3

Stage 3. Future Scenarios: 4 2000-2100 IPCC Scenarios from end of historical run



NARCCAP PLAN – PHASE II



A2 Emissions Scenario

Global Models

GFDL
Time slice
50 km

GFDL | **CGCM3** | **HADCM3** | **CCSM**

CAM3
Time slice
50km

1971-2000 current — **Provide boundary conditions** — 2041-2070 future

MM5	RegCM3	CRCM	HADRM3	RSM	WRF
Iowa State/ PNNL	UC Santa Cruz ICTP	Quebec, Ouranos	Hadley Centre	Scripps	NCAR/ PNNL

Regional Models

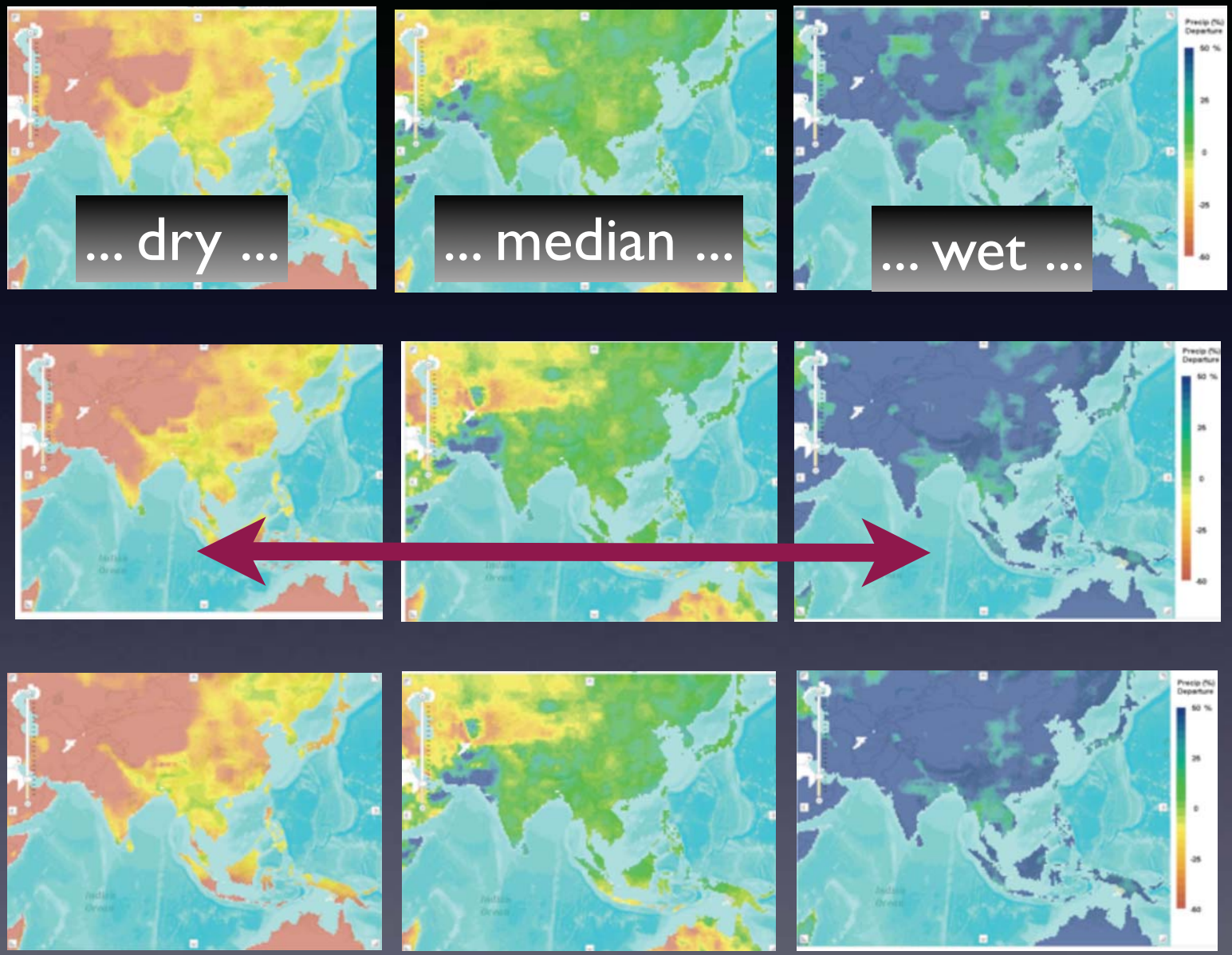
Significant large scale differences / ranges

Precipitation Projection CMIP-3 statistically downscaled 50km

B1 "small"

A1B "medium"

A2 "large"

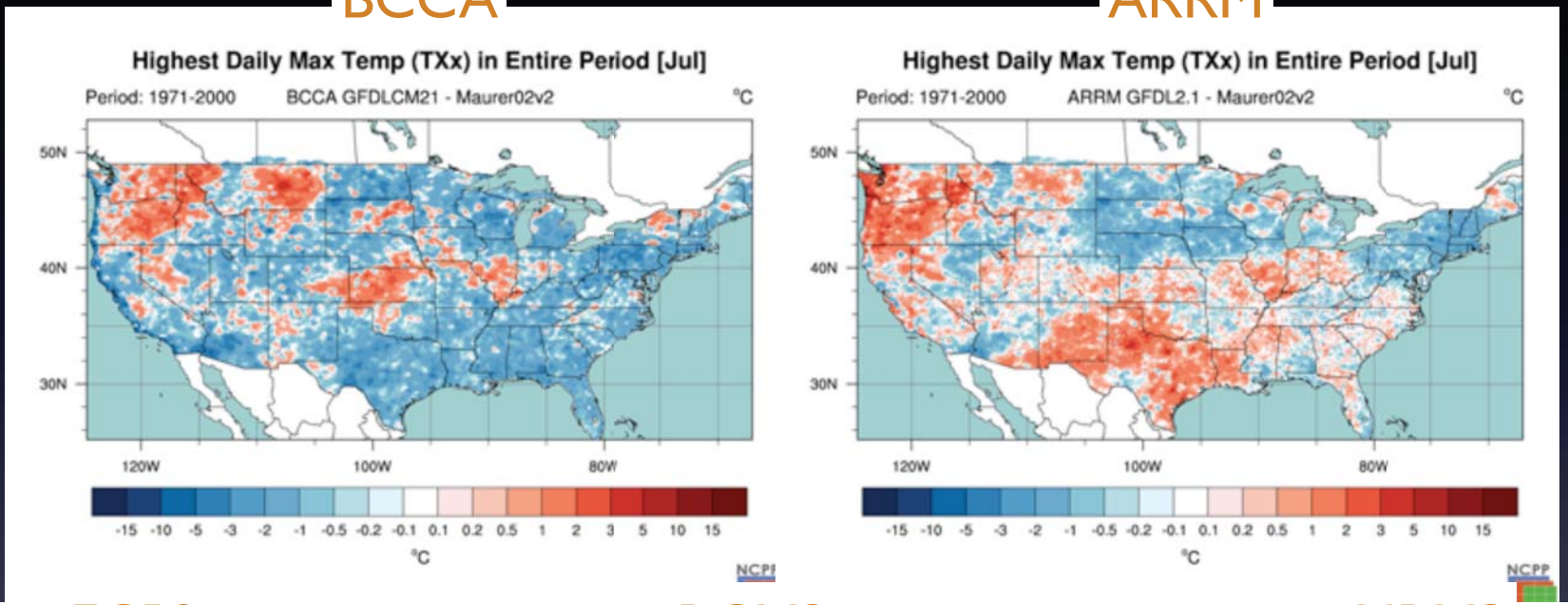


Data: Maurer et al. 2009 based on statistical downscaling with bias-correction (Wood et al. 2004) Visualization: Climate Wizard (www.climatewizzard.org)

GFDL CM 2.1 Downscaled

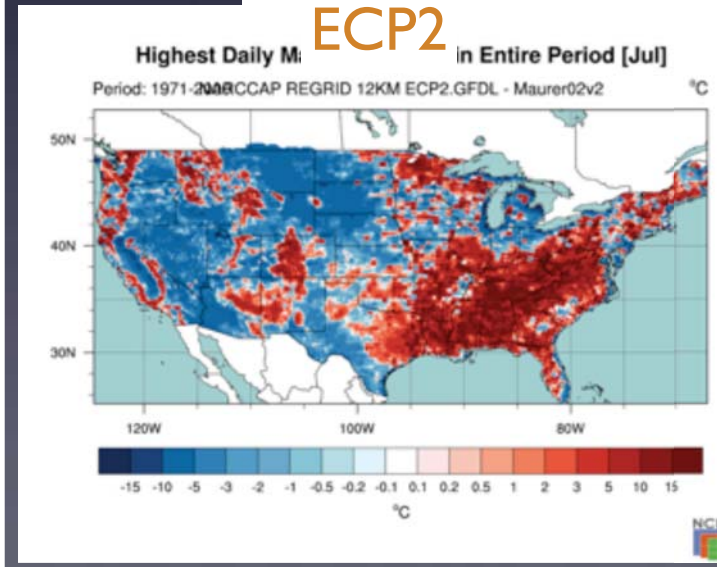
txx, max, July

BCCA

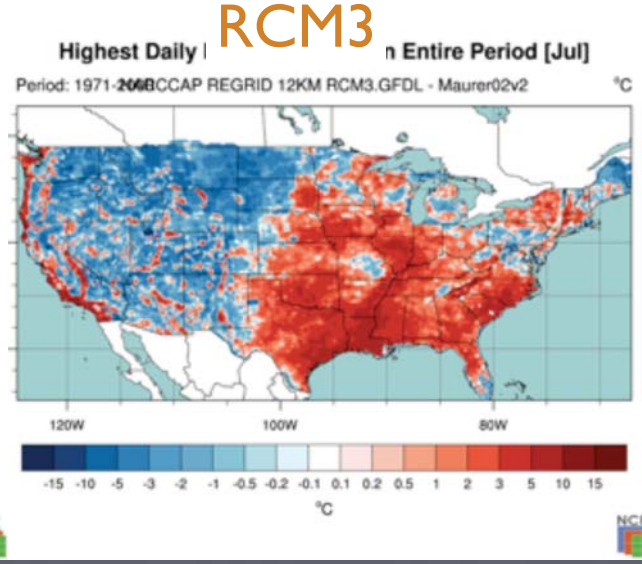


ARRM

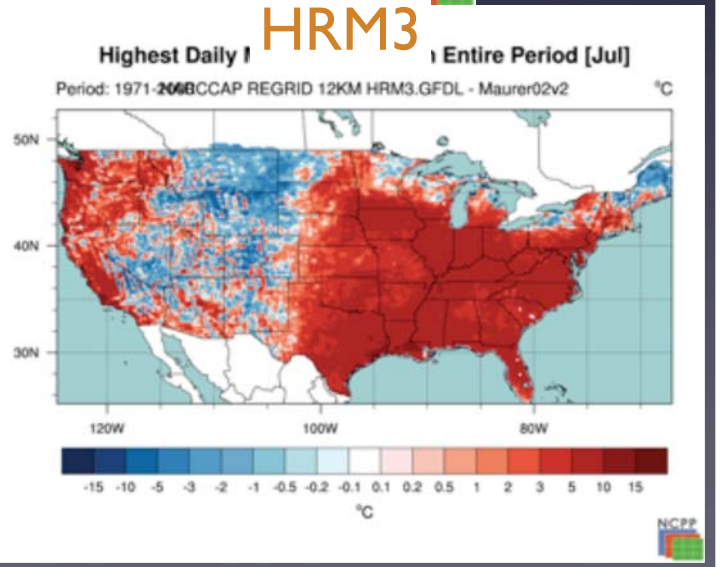
ECP2



RCM3



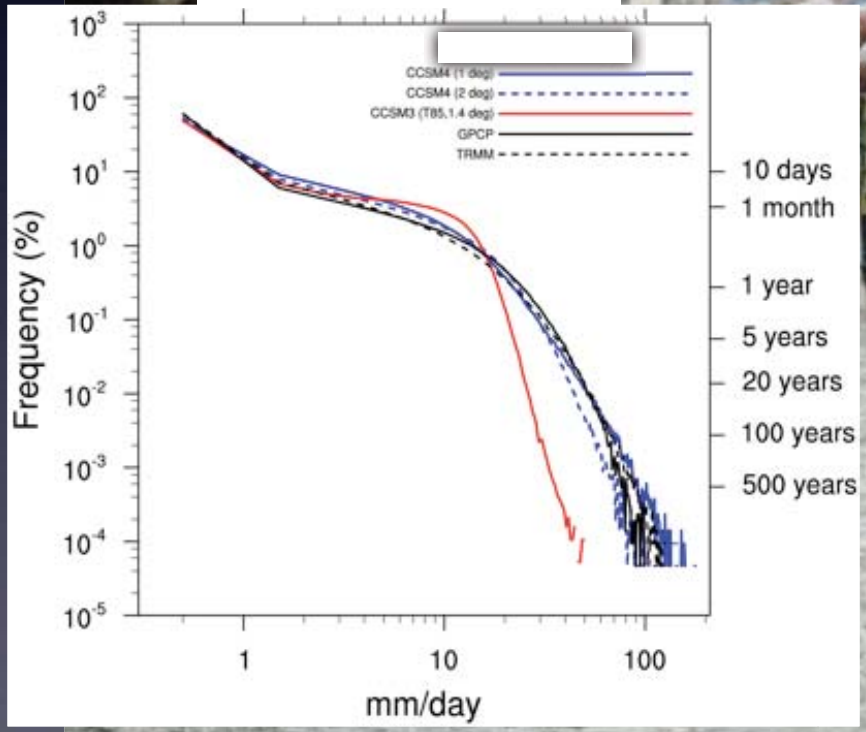
HRM3



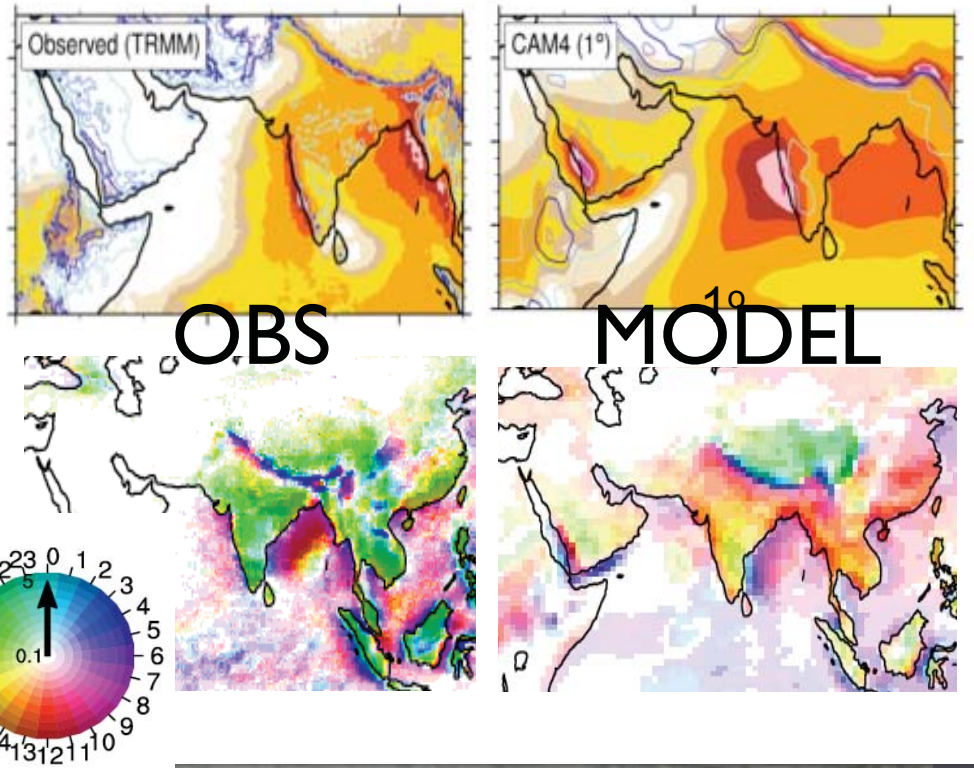
Application Context: Precip Biases

Critical Need for Translation and Guidance

Extremes

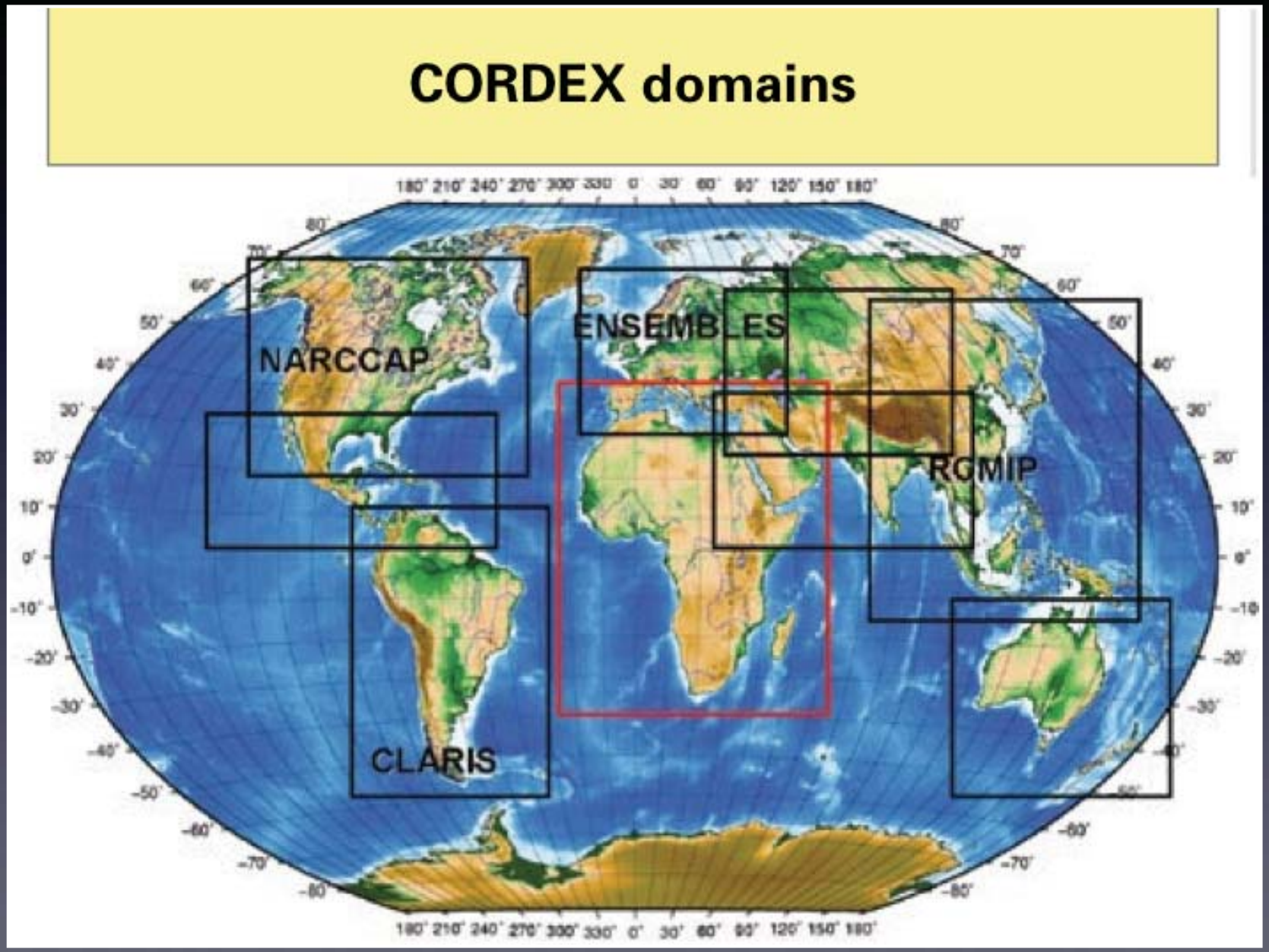


Space / Time



Odisha, India

Coordinated Regional Downscaling Experiment
CORDEX

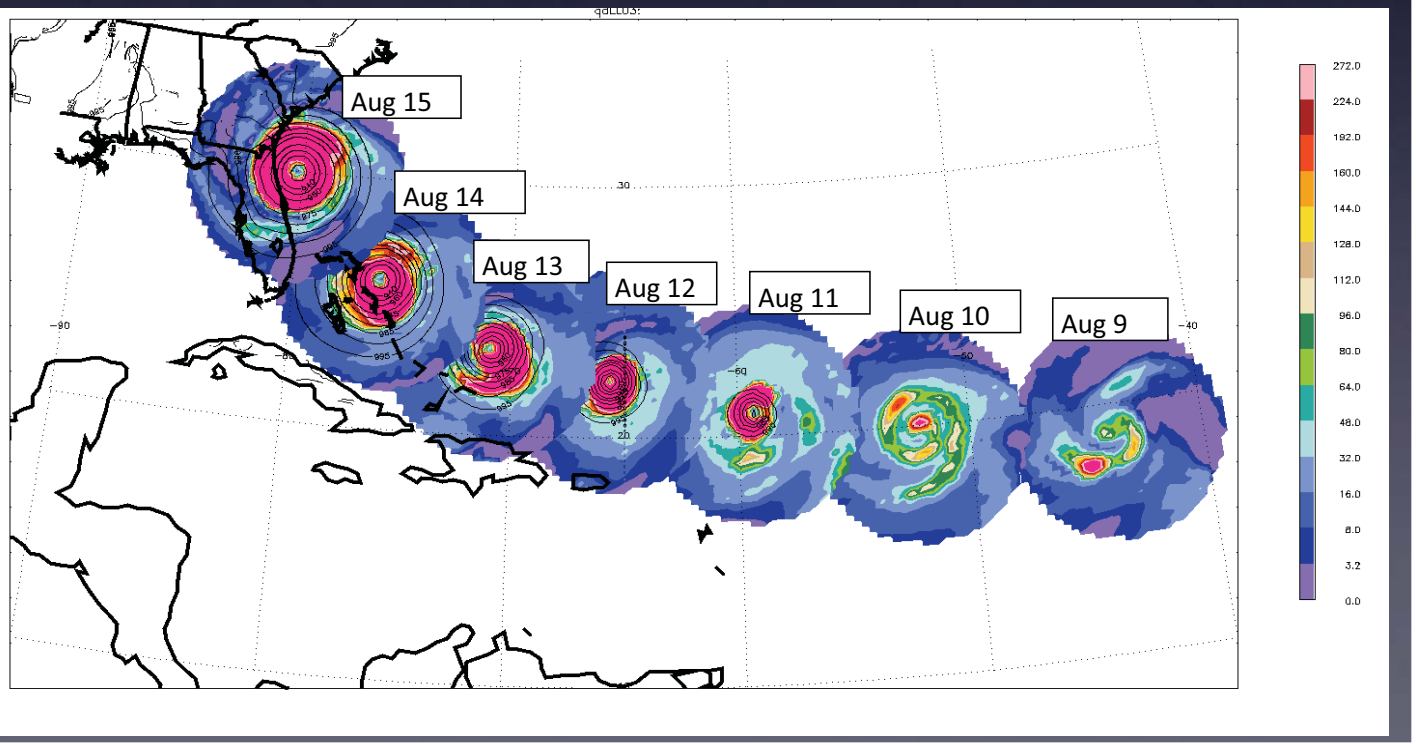


Application Context

Need for Translation and Guidance

DaNang : Typhoon

Experimental Design

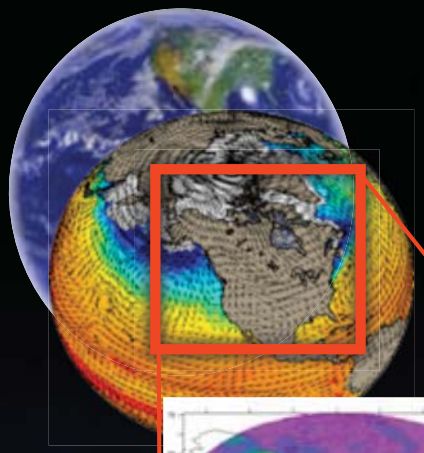


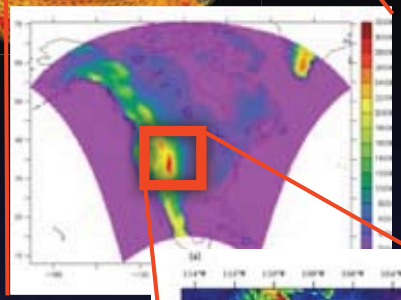
Water
Power
Sewer

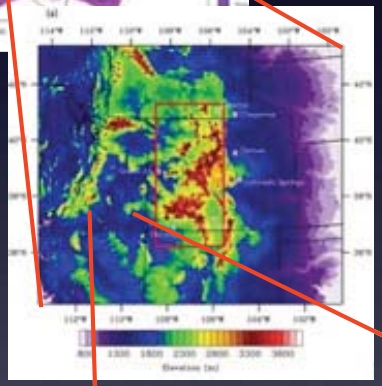
A bit like the Wild West out there...

Focus on Regional Climate and Impacts

Integration of data and knowledge across scales.
Global - to - Local



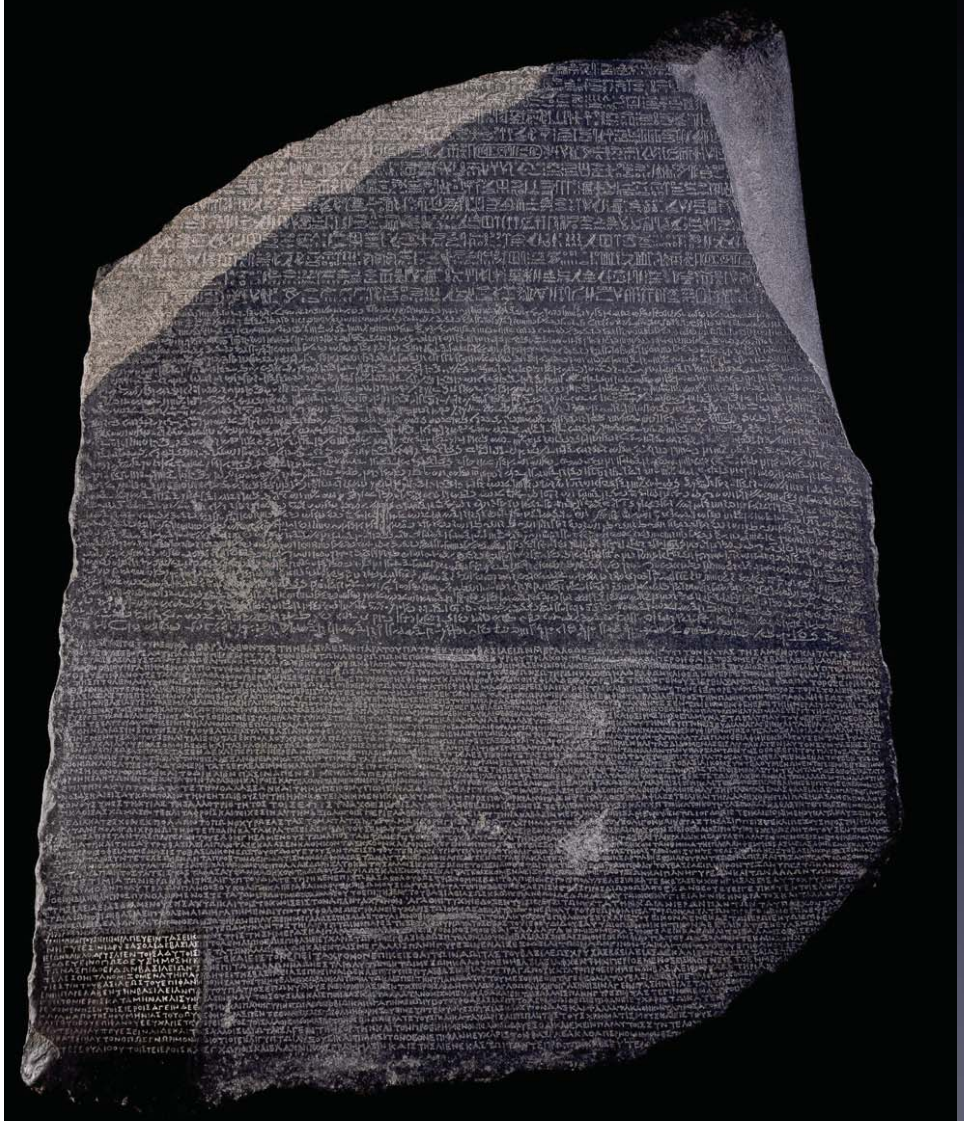




e.g.: Utility Planning

NCAR

Need for a ClimateTranslator



- **Data:** access, use (format, index, resolution)
  Which data to use? How to read it? Where does it come from?
- **Evaluation:** Quality Control Inter-comparison, data content info
  How good is data? Production assumptions? What are the uncertainties?
- **Translation of Scientific Knowledge** for exploration of impacts of change, guidance of use
  What does it mean? What is likely, what possible? Change in context?
- **Community of Practice**
  Collaboratively develops data requirements, handling of scenarios

Data: Precipitation ≠ Precipitation

Application-specific evaluation needed

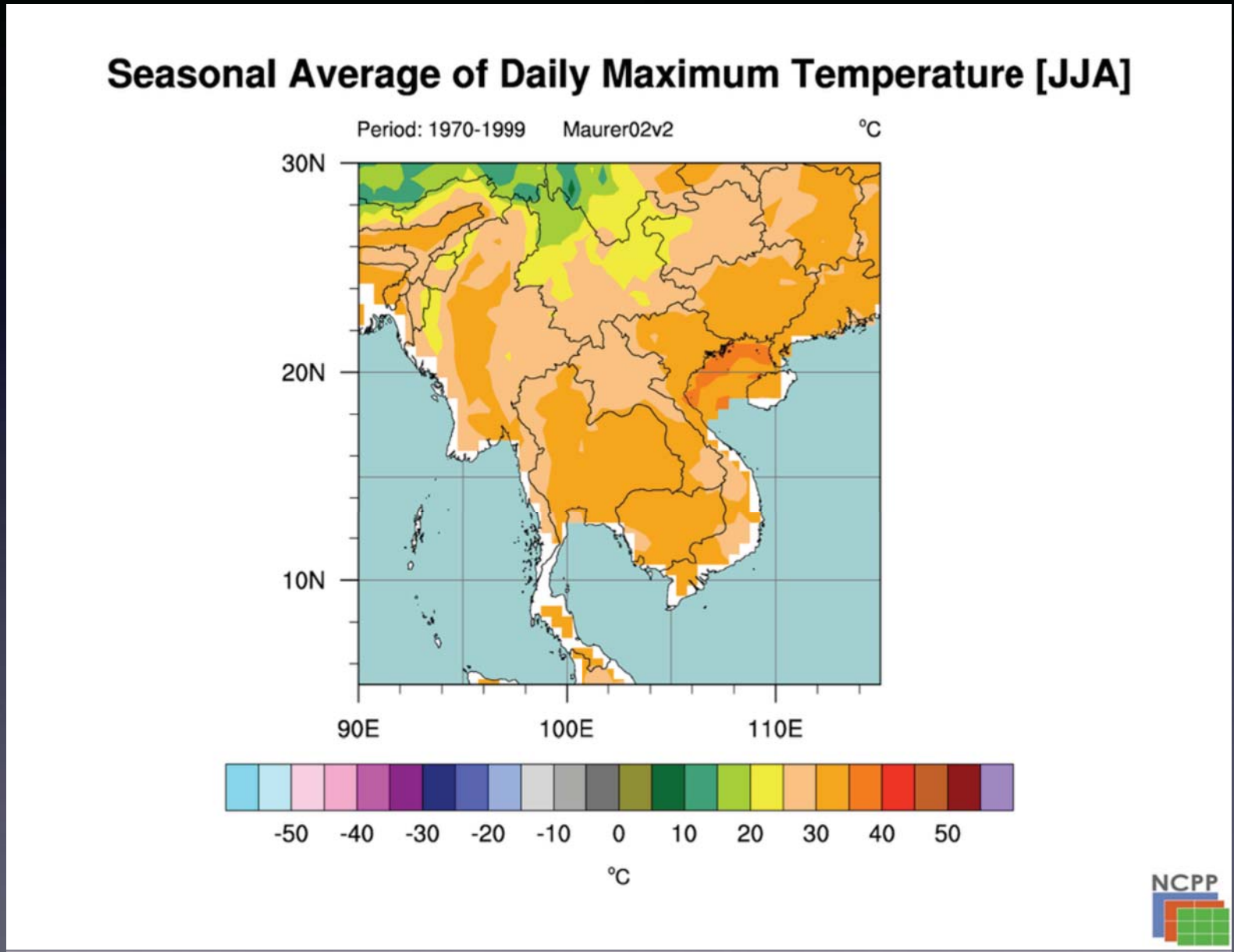
Gorakhpur : Monsoon

Nebraska : Drought

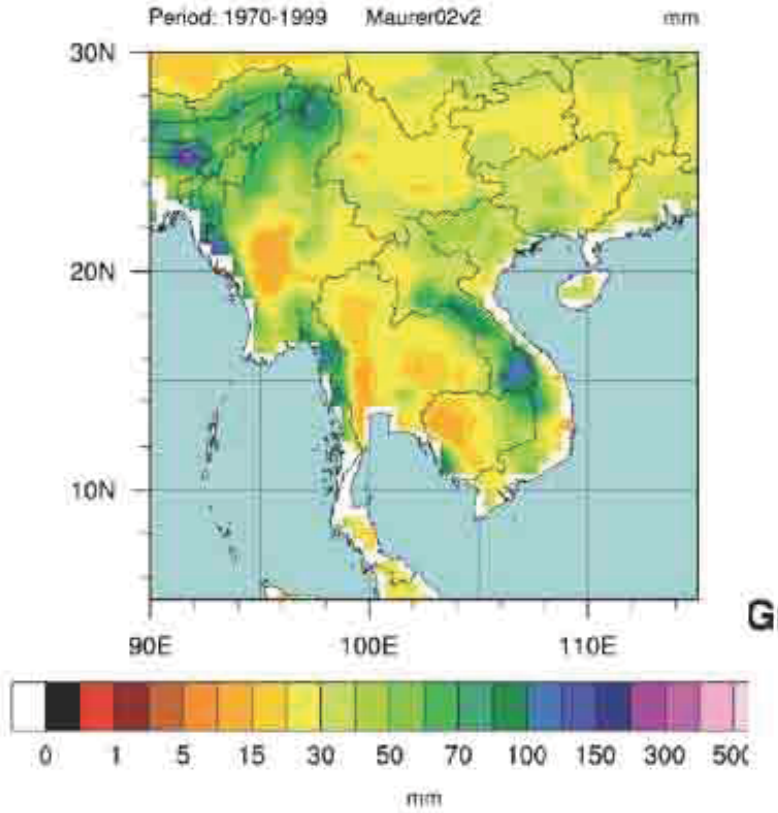
Hex River : Flash Flood

DaNang : Typhoon

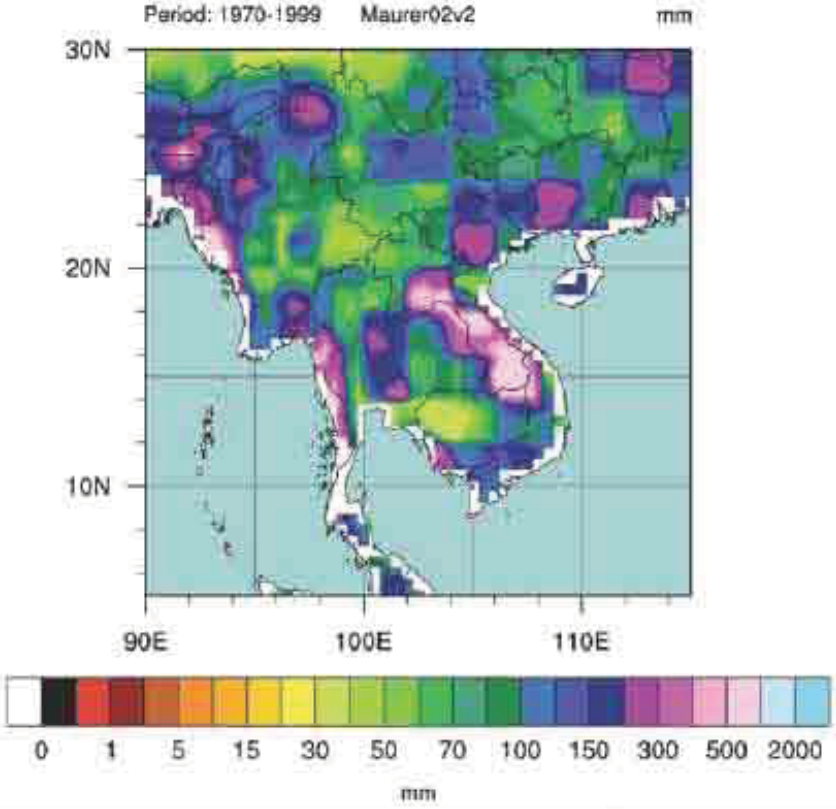
Standardized Data Evaluation for SE Asia?



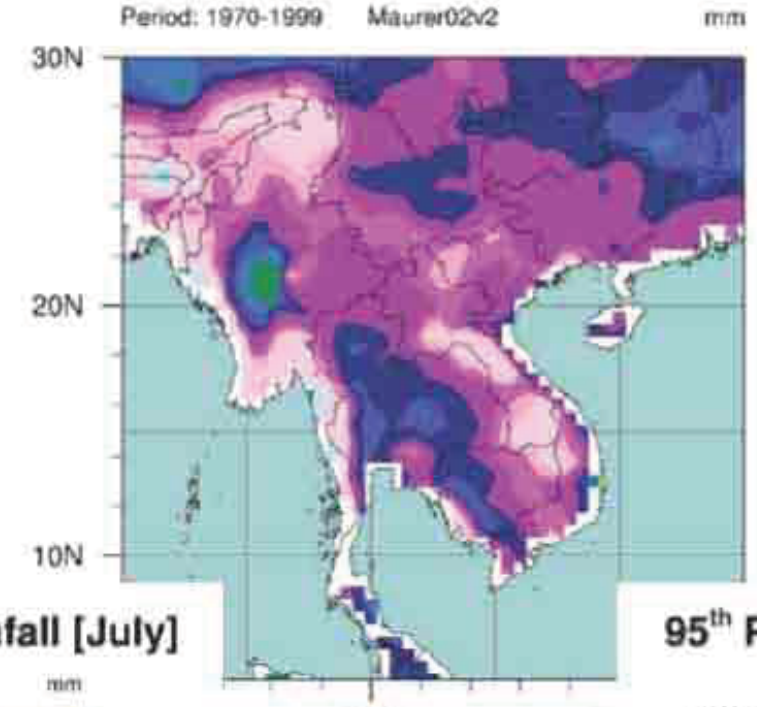
Average Maximum 1-Day Precipitation (RX1day) [Jul]



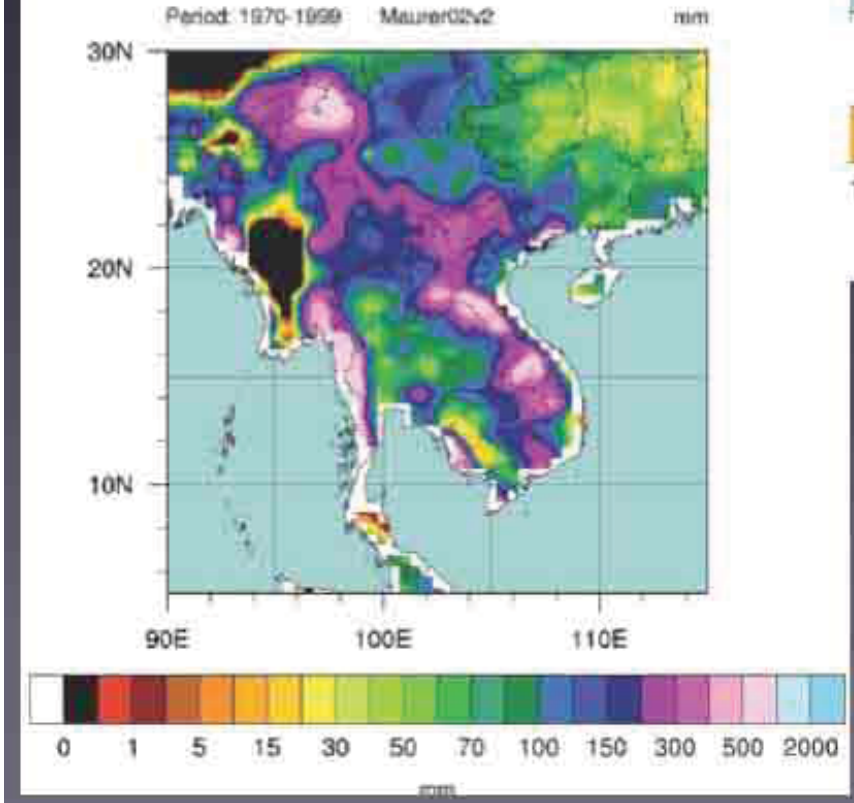
Greatest Maximum 1-Day Precipitation (RX1day) in Entire Period



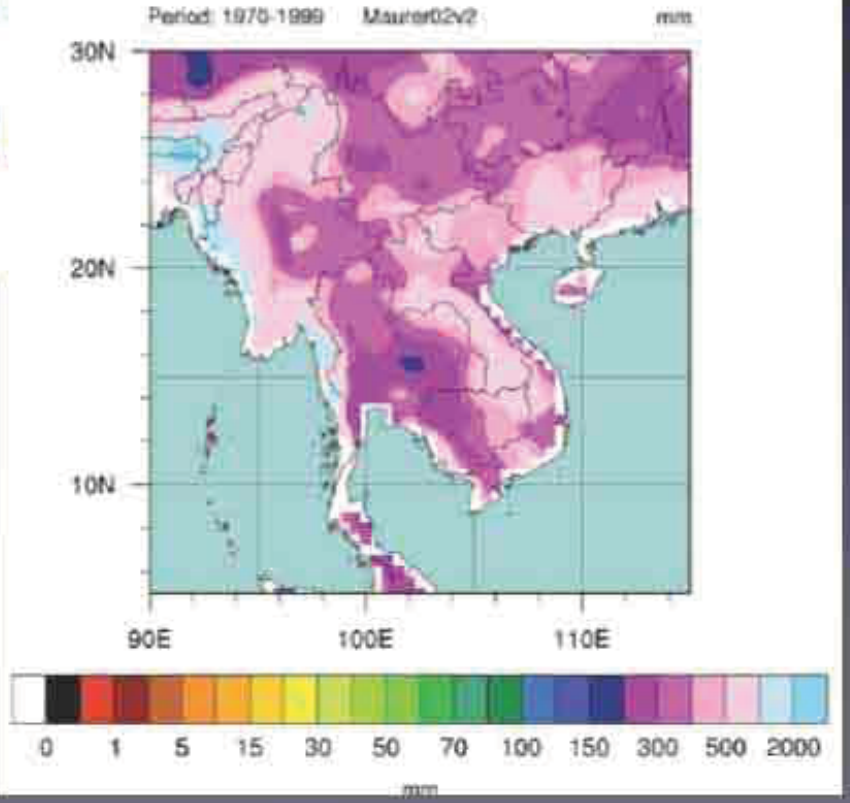
Monthly Average of Total Precipitation [July]



5th Percentile of Monthly Rainfall [July]



95th Percentile of Monthly Rainfall [July]




If I'd known they wanted me to use all this info- I would never have asked for it!
Julie

Provide information with balance

To be relevant, need to establish the right balance !

~~80%~~ 10% Efficient data access, handling

~~15%~~ 70% Flexible analysis, evaluation, exploration

~~5%~~ 20% Communication, visualization

NCAR

Is there an App for that?

NCAR UCAR | ClimateDataGuide

inform • compare • discover

Unparalleled Expert Guidance > >

Search and access 145 data sets covering the Atmosphere, Ocean, Land and more. Explore climate indices, reanalyses and satellite data and understand their application to climate model metrics. This is the only data portal that combines data discovery, metadata, figures and world-class expertise on the strengths, limitations and applications of climate data. Discover it now.

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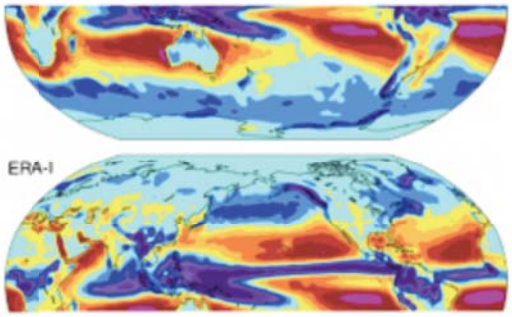
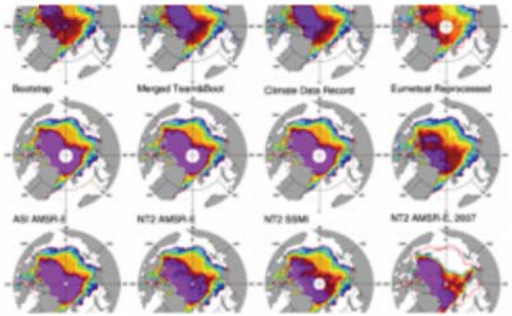


Atmospheric Reanalysis: Overview & Comparison Tables

Reanalysis a systematic approach to produce data sets for climate monitoring and research. Reanalyses are created via an unchanging ("frozen") data assimilation scheme and model(s) which ingest all available observations every 6-12 hours over the period being analyzed. This unchanging framework provides a... more



Sea Ice Concentration data: Overview, Comparison table and graphs

Sea ice concentration is both an indicator and driver of high-latitude climate change with strong societal and ecological importance. It is a key boundary condition for atmospheric models (including those used in atmospheric reanalyses) and a benchmark for coupled climate models. As such, numerous methods have been... more

NASA MERRA

The Modern Era Retrospective-Analysis for Research and Applications (MERRA) was

FEATURED DATA EXPERT

Dr. James Hurrell at NCAR.

Hurrell North Atlantic Oscillation (NAO) Index (PC-based)

see who else has contributed

SHARE CLIMATE DATA GUIDE

CLIMATE DATA TRENDS

News about climate data and its applications

NCAR's Climate Data Guide launches refreshed website - important info for users

Nature: "Researchers who share [data] get plenty of personal benefits, including more connections with colleagues, improved visibility and increased citations. The most successful sharers...get noticed, and their work gets used."

Research Data Alliance to hold second plenary meeting in Washington, DC

Billion-dollar decisions held up by poor use of climate data

Developing Communities of Practice

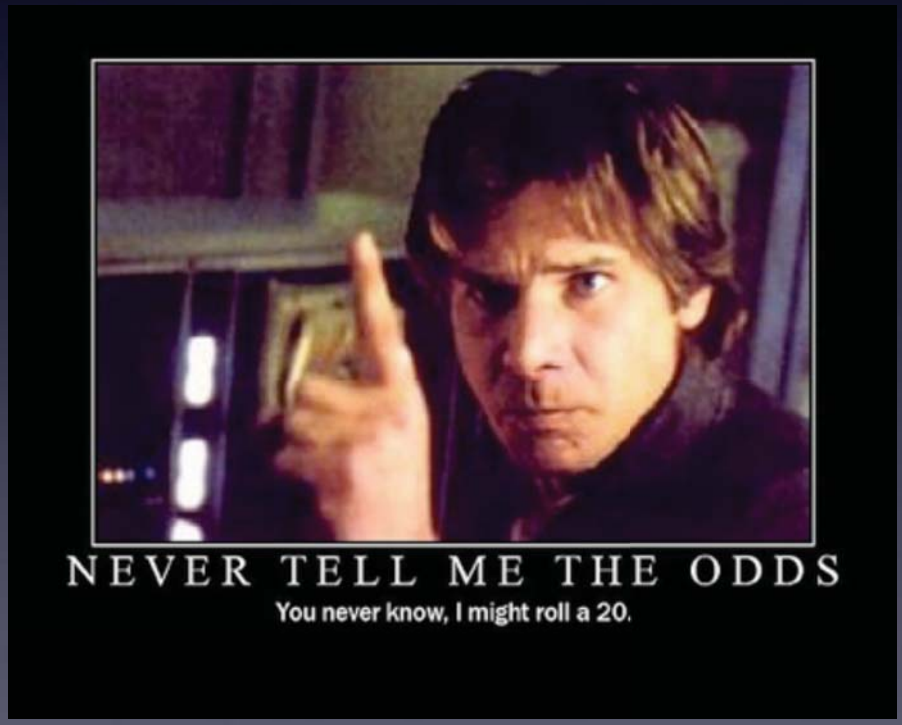
Helping Gorakhpur: "Climbing Everest"

- Map: Define climate/other vulnerabilities
- Base-camp: Get all obs. / other data
- Khumbu: Iteratively identify relationships
- South-Col: Test models, scenarios
- Summit: Integrated impact analysis
- Get back safely: Translate, guide

But how are we going to explore all possible options, from the science and management perspective?

What is Likely?

What is Possible?



Efficiently explore different scenarios

(emissions, mean response, individual events, pathways, contexts)

Best/effective Practice for Embedding Climate Science

- **realizing that an iterative process is needed** for identifying weather/climate vulnerability ("indices")
- the need for good and available **observational baseline**
- **required tests** of tools on "indices" and for contexts
- **recognize inherent limitations** resulting from spatial resolution and biases in climate products
- understand the different sources, make transparent for impacts and further **explore uncertainties / scenarios**
- form a **community of practice** focused on applications while recognizing context of societal and physical realities

Thanks! Any Questions?

Caspar Ammann, National Center for Atmospheric Research
email: ammann@ucar.edu