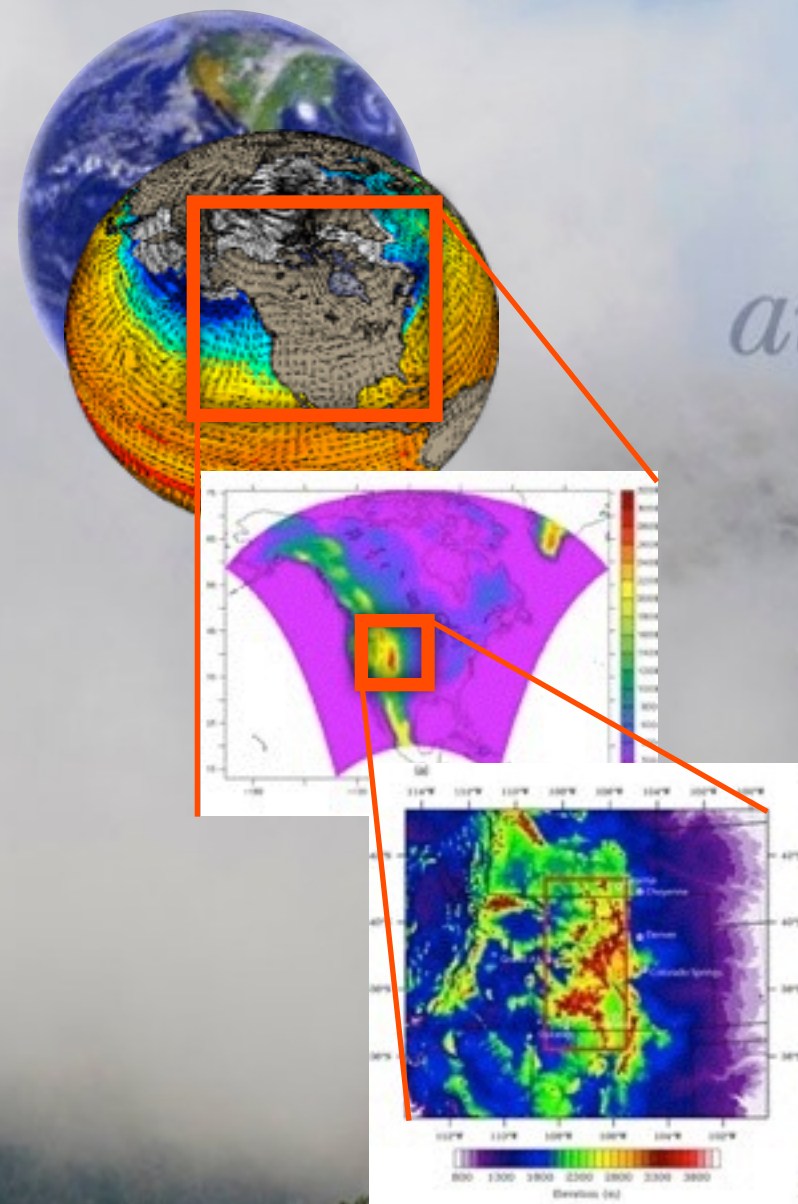


Climate Science for Agriculture

Challenges and Opportunities of Using Climate Model Projections

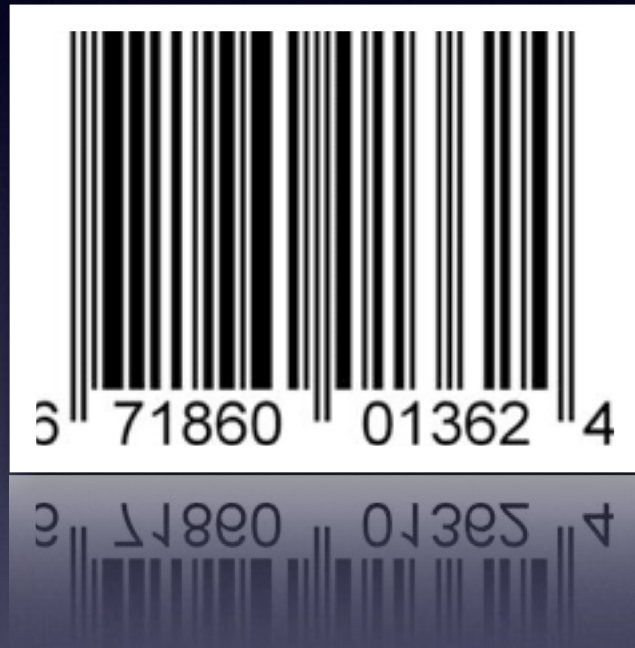
air • planet • people



Caspar Ammann (ammann@ucar.edu)
National Center for Atmospheric Research

Key Themes

Facing the “Practitioners Dilemma”



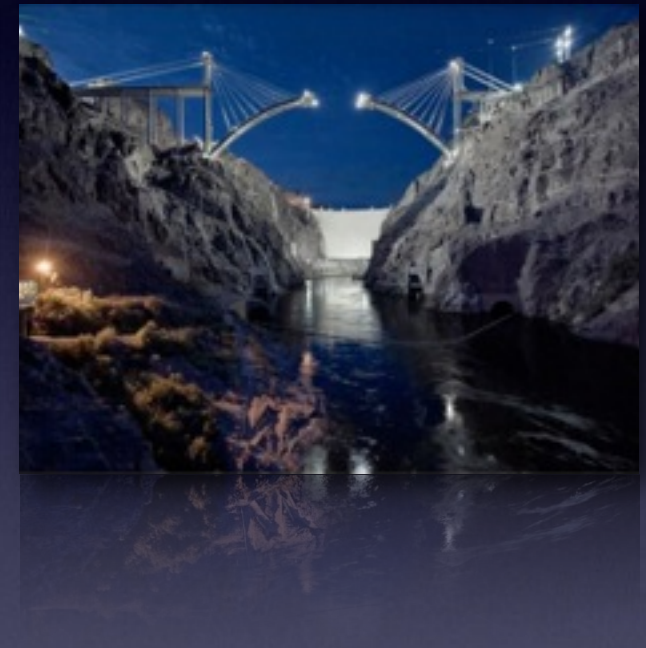
Data



Evaluation



Translation

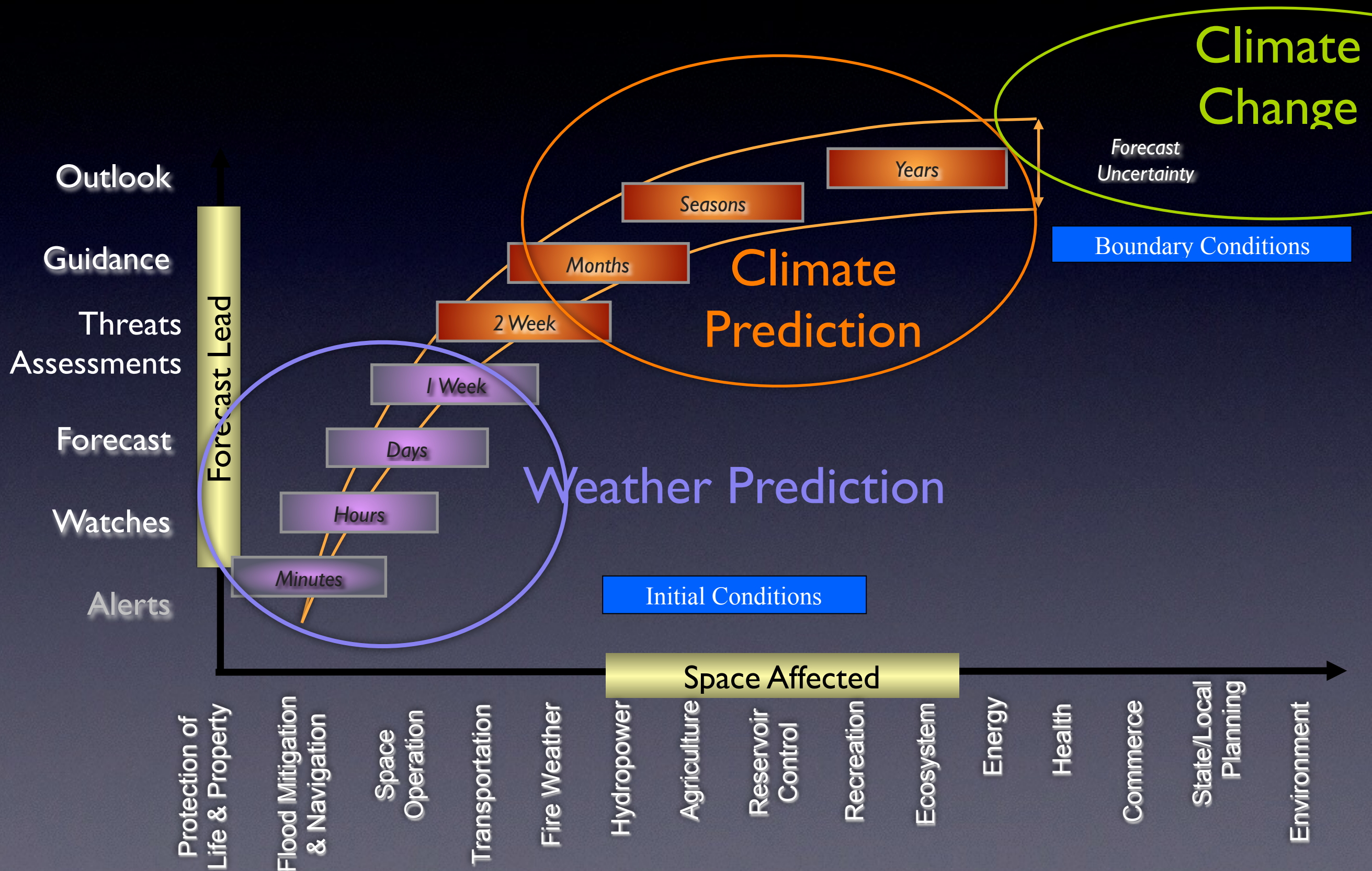


Best Practice



Tools: Weather vs Climate

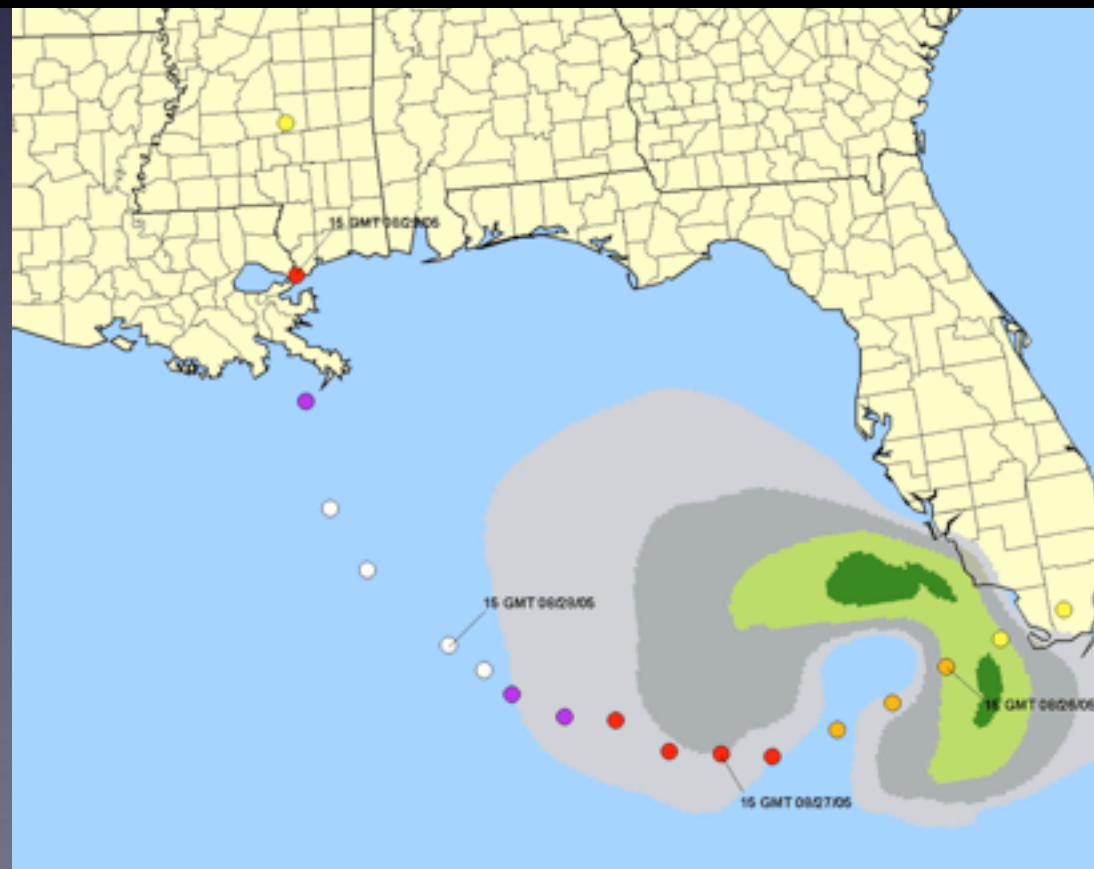
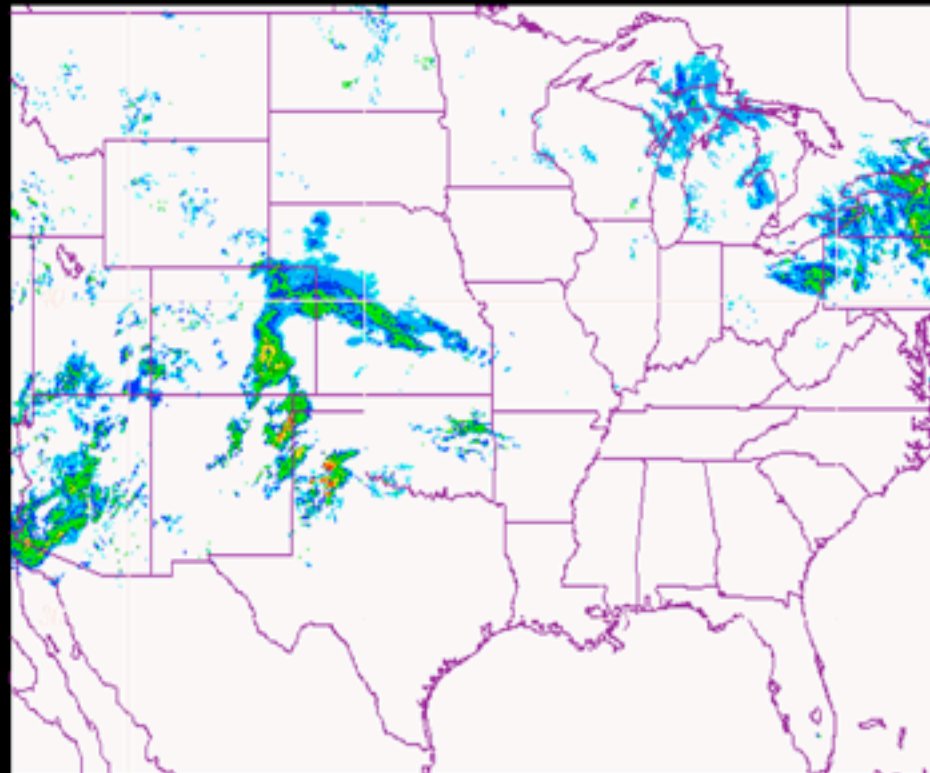
Trying to bridge the gap



Weather Modeling

needs good initial conditions

00 h forecast 00 UTC 13 April 2007

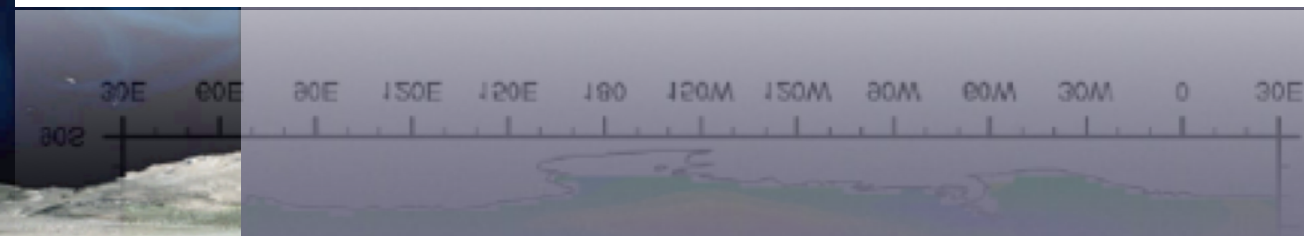
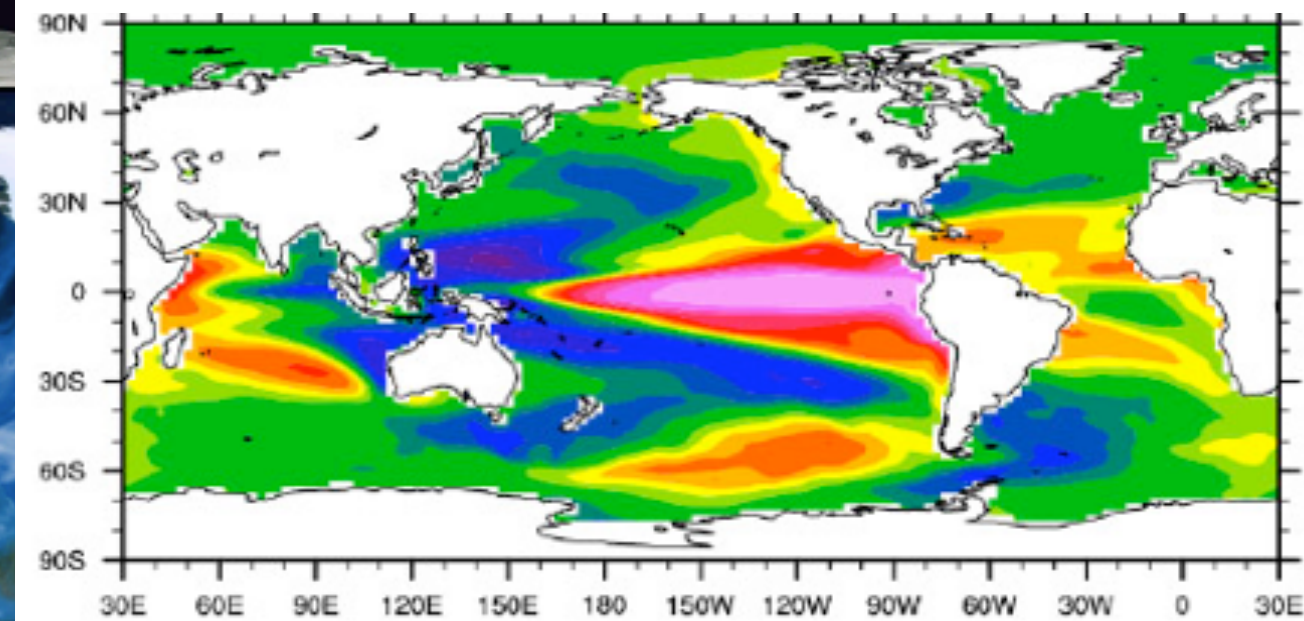
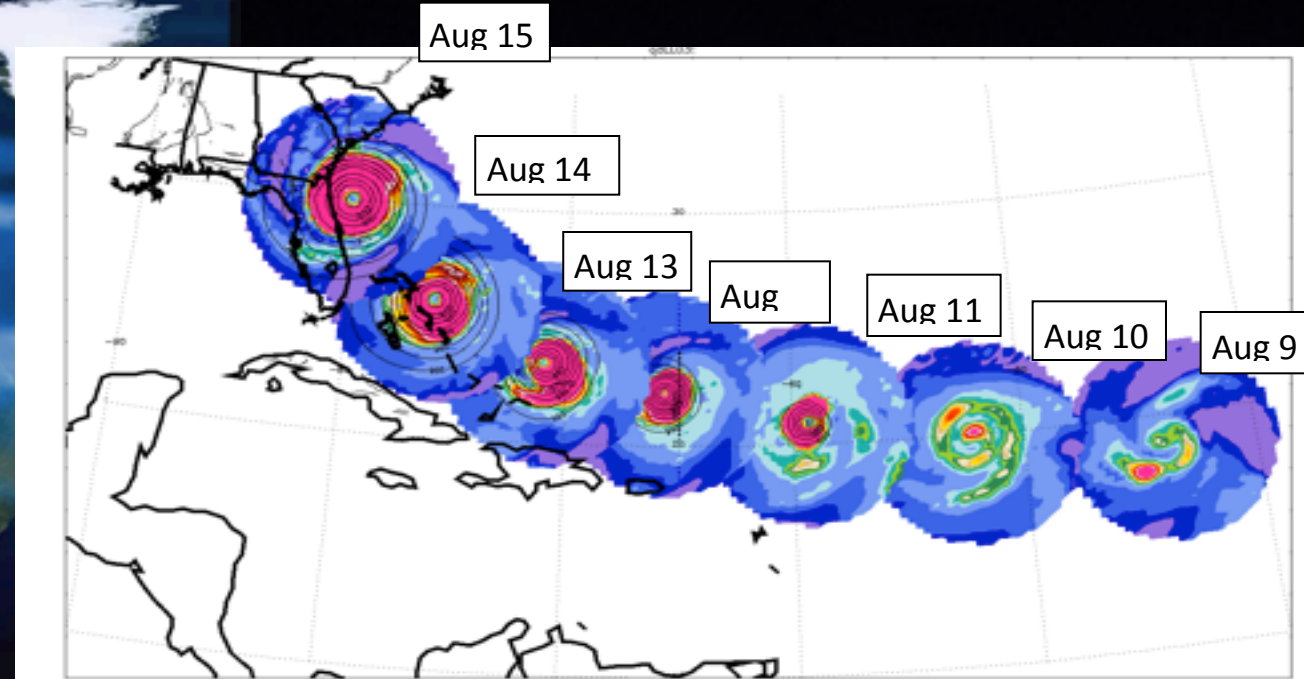
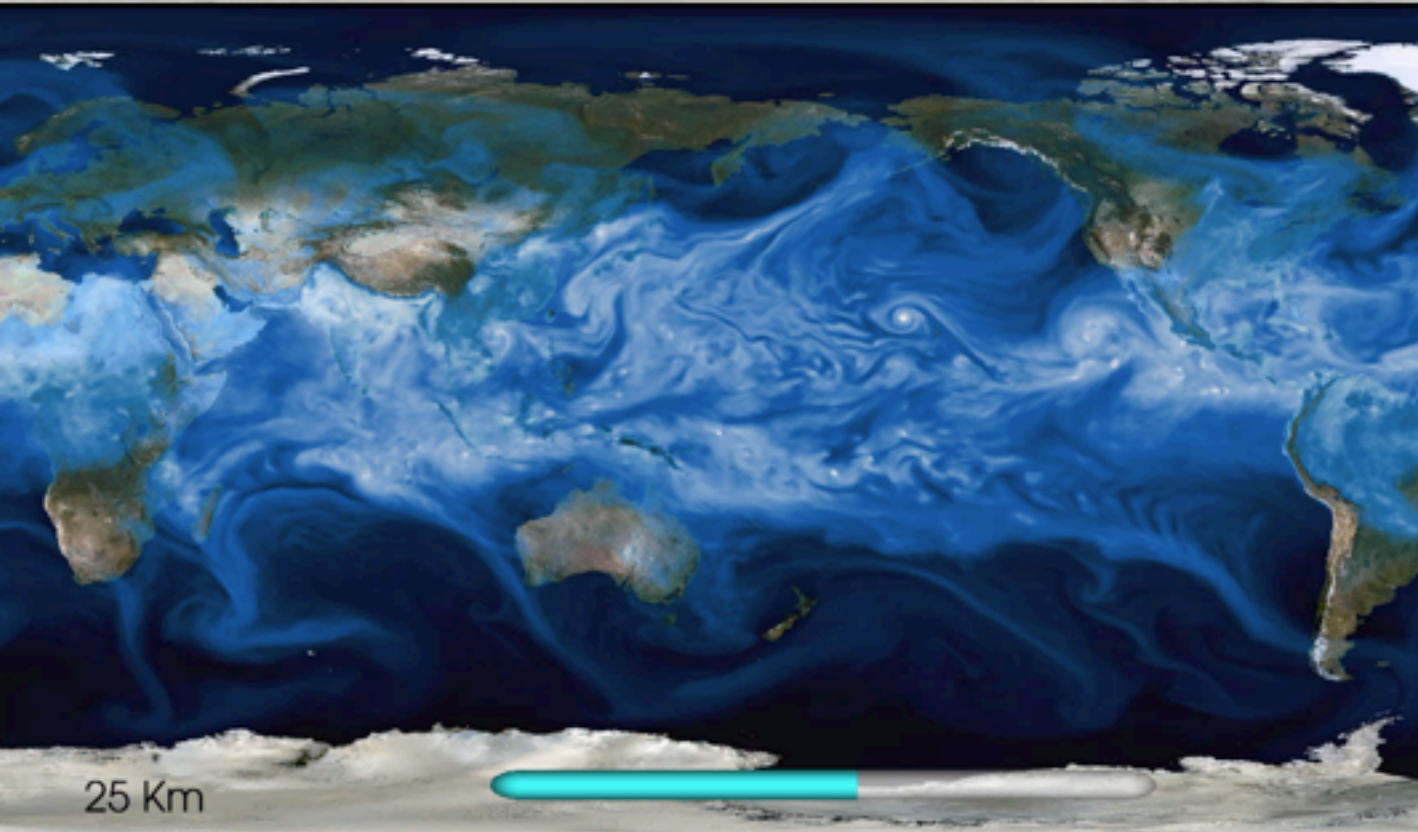
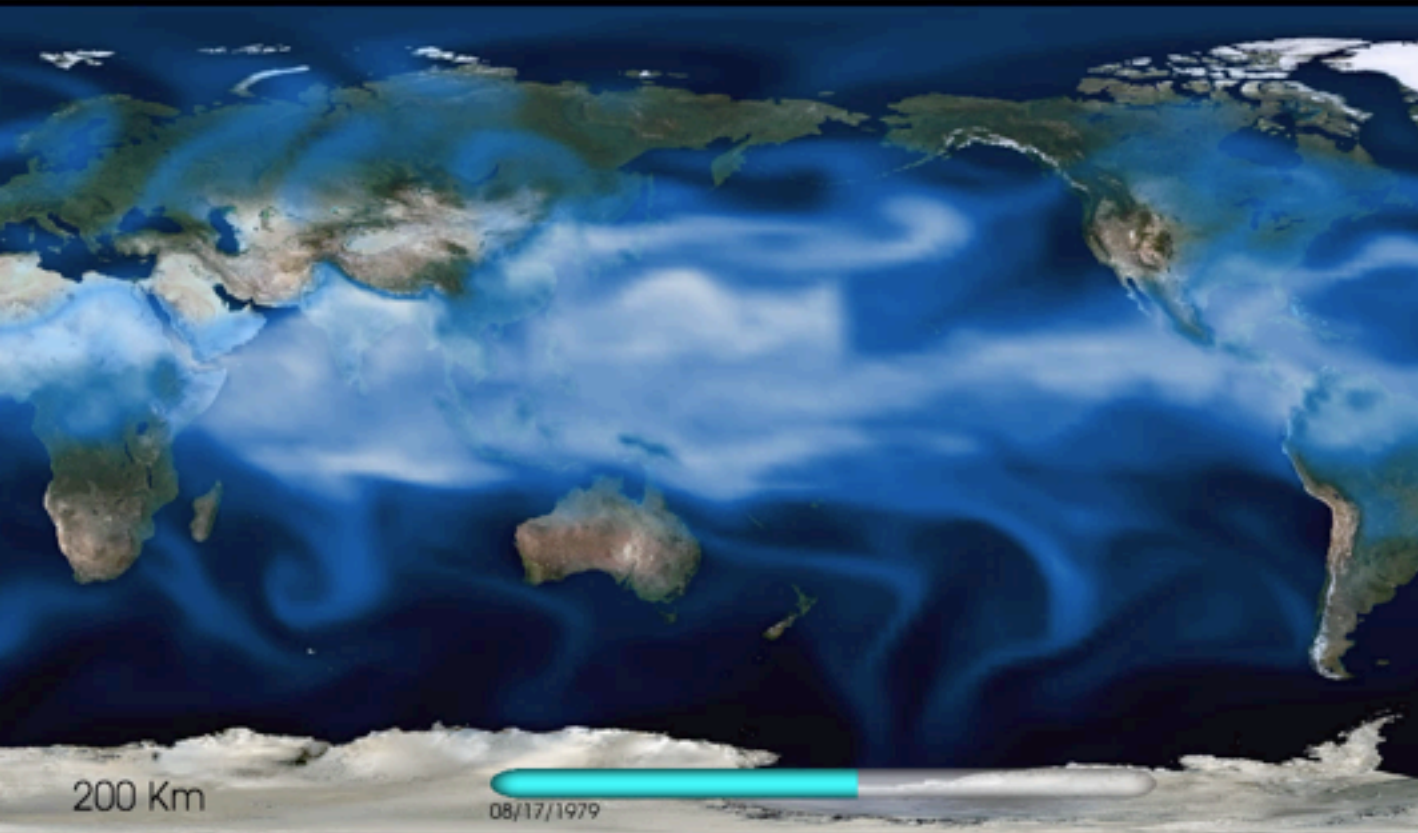


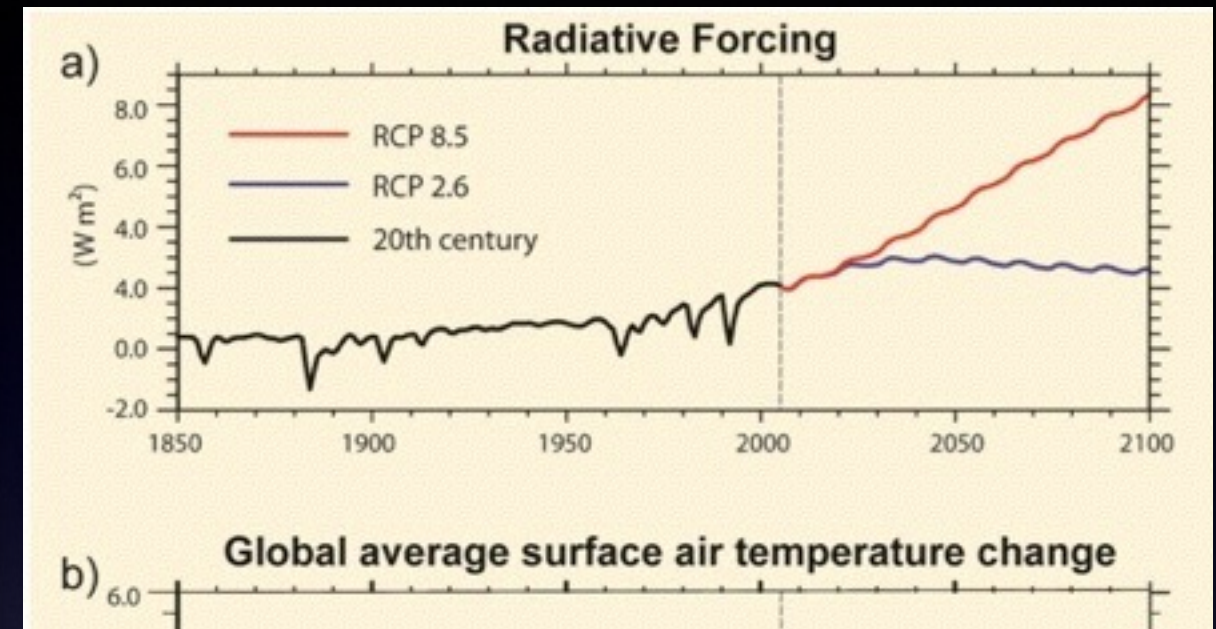
Models

Observations

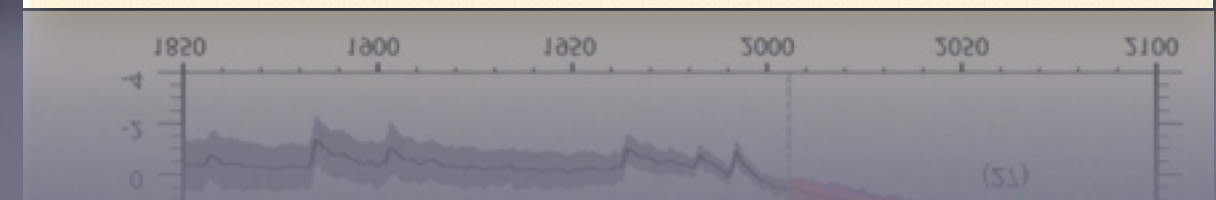
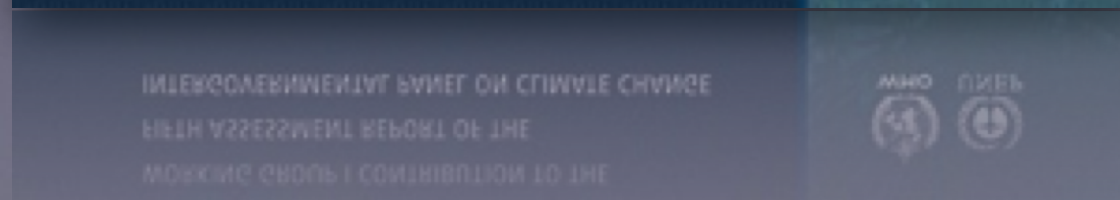
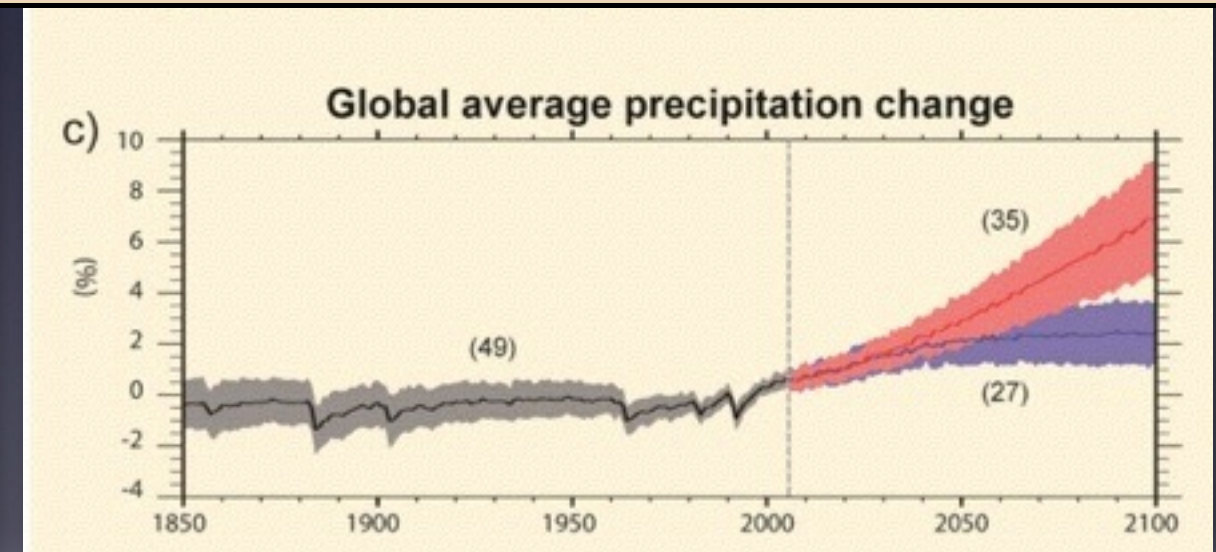
Tools to Study Climate

From global radiation to regional processes and impacts



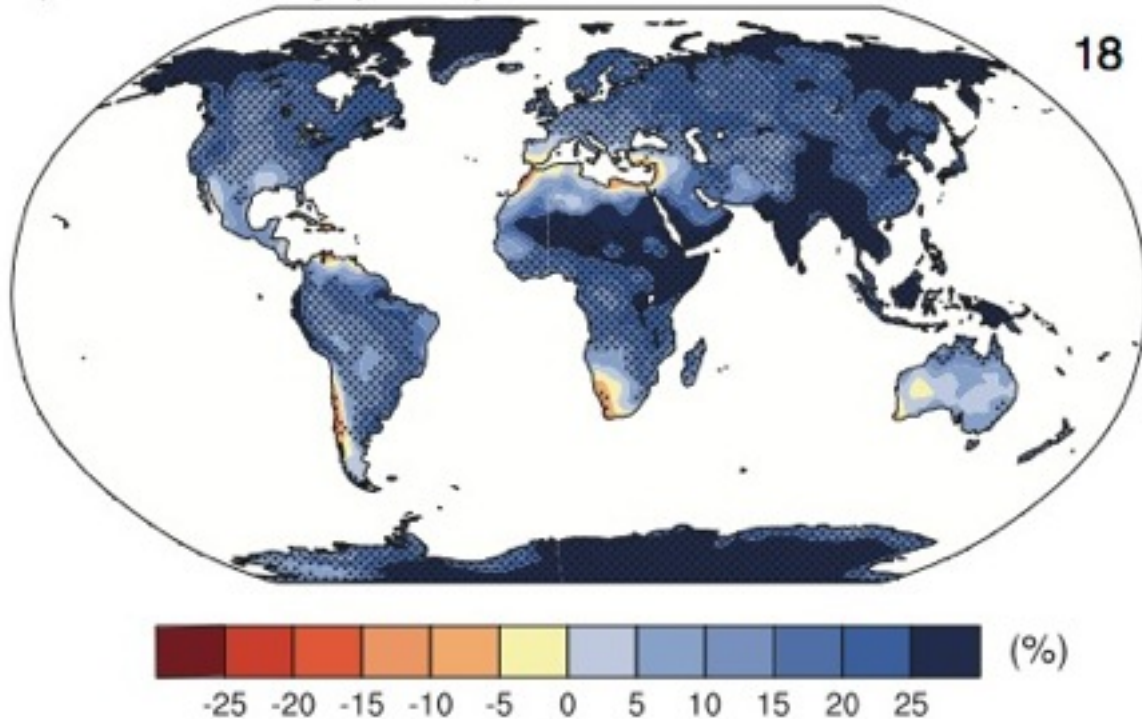


Human influence has been detected in warming of the atmosphere and the ocean, in changes in the global water cycle, in reductions in snow and ice, in global mean sea level rise, and in changes in some climate extremes (Figure SPM.6 and Table SPM.1). This evidence for human influence has grown since AR4. It is *extremely likely* that human influence has been the dominant cause of the observed warming since the mid-20th century. {10.3–10.6, 10.9}

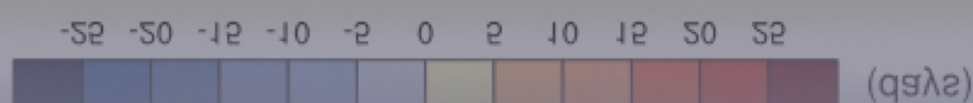
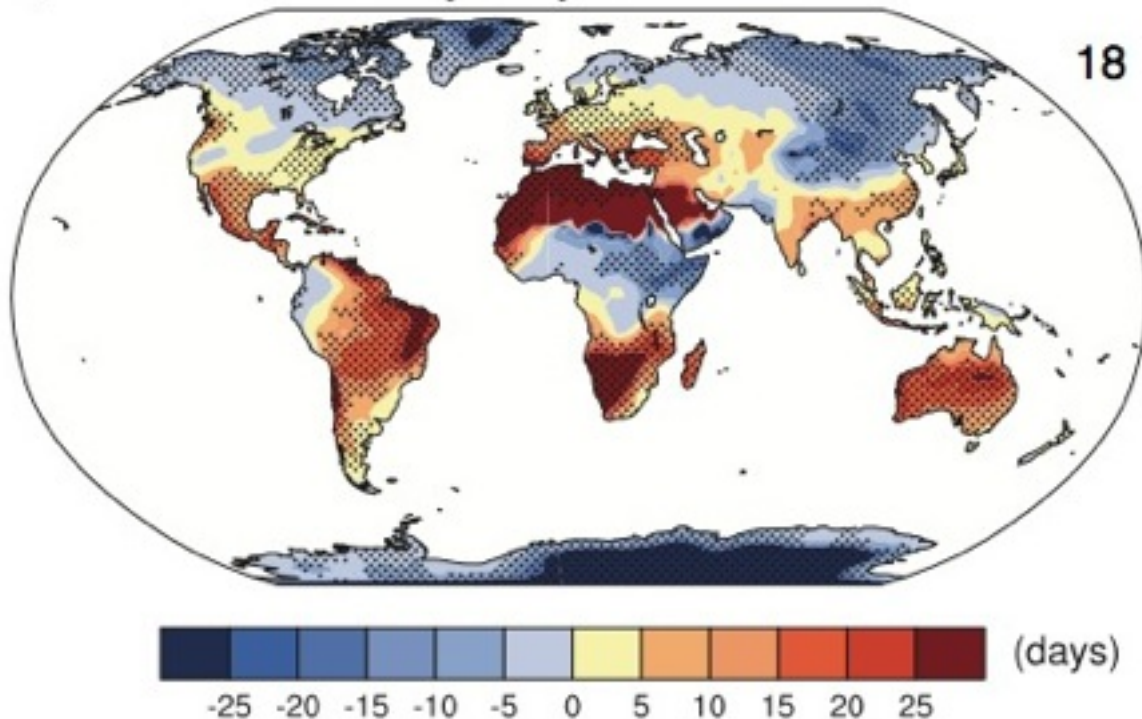


Projected Changes in selected Episodes

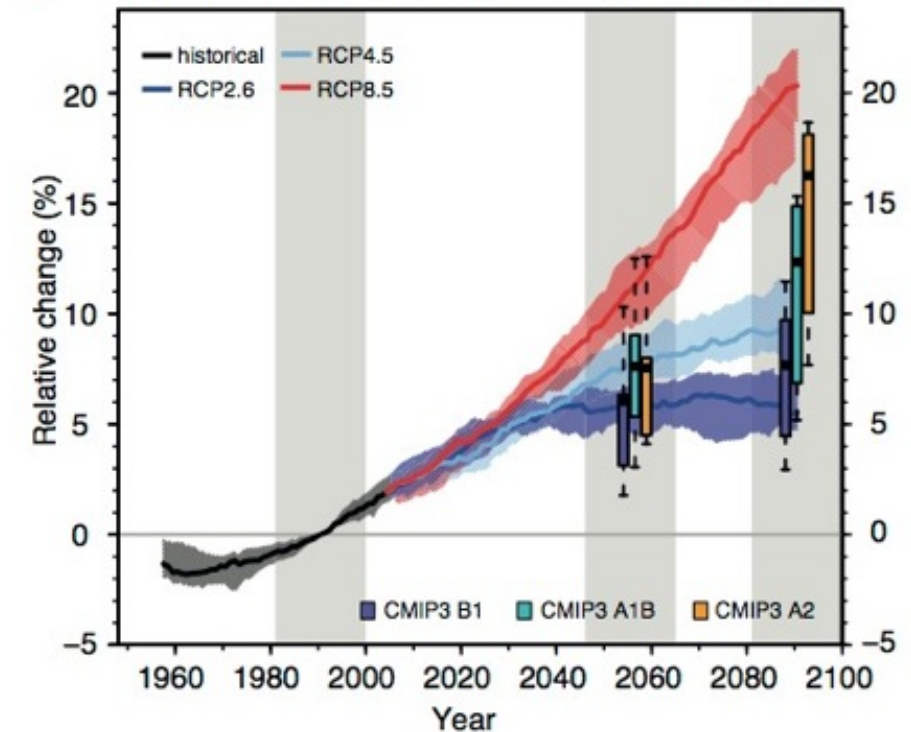
b) max. 5 day precip RCP8.5: 2081-2100



c) Consecutive Dry Days RCP8.5: 2081-2100



a) Wettest consecutive five days (RX5day)



Intra-Seasonal Variability

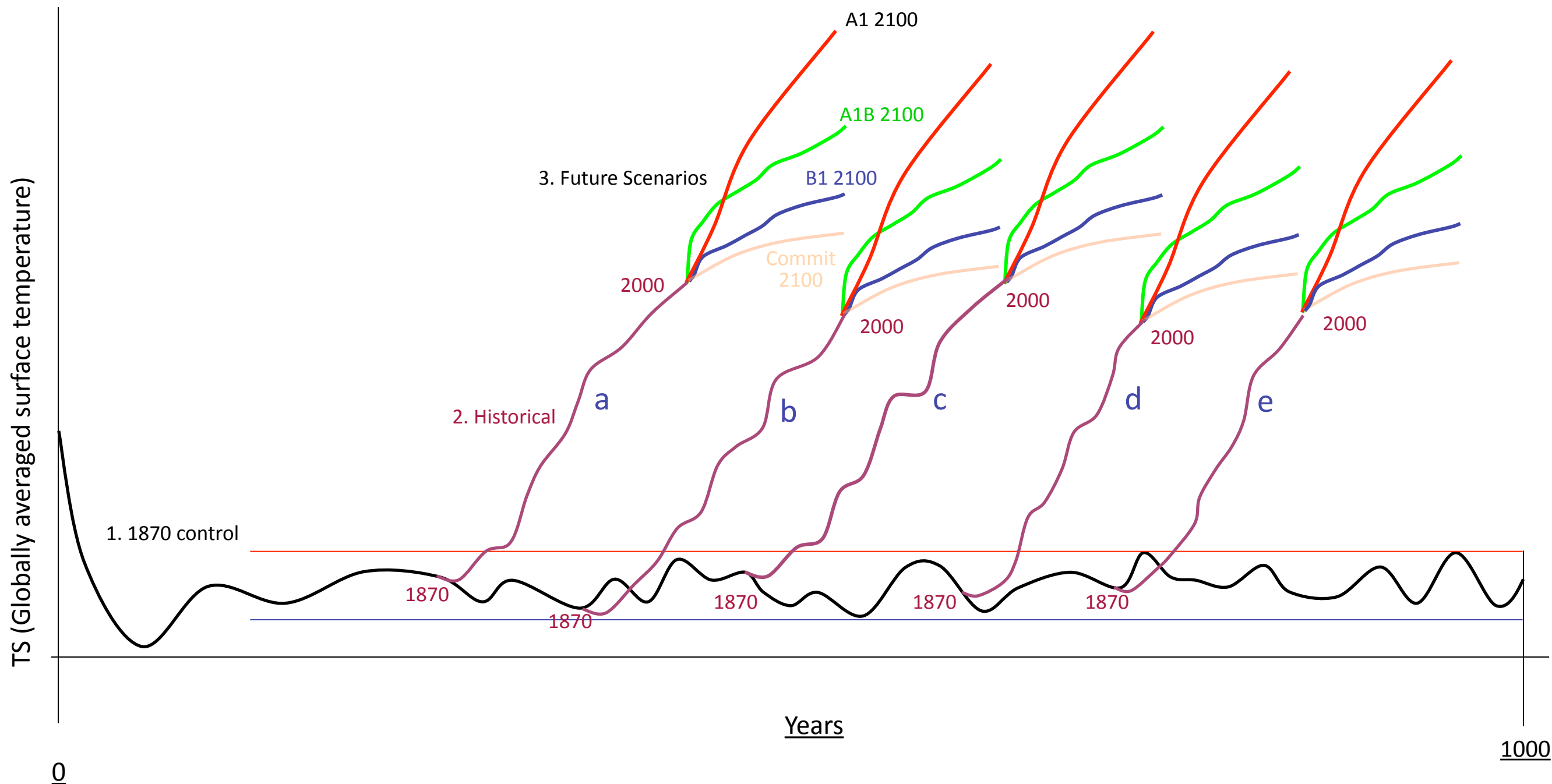
when wet : wetter..
when dry : drier...

ENSEMBLE CLIMATE SIMULATIONS

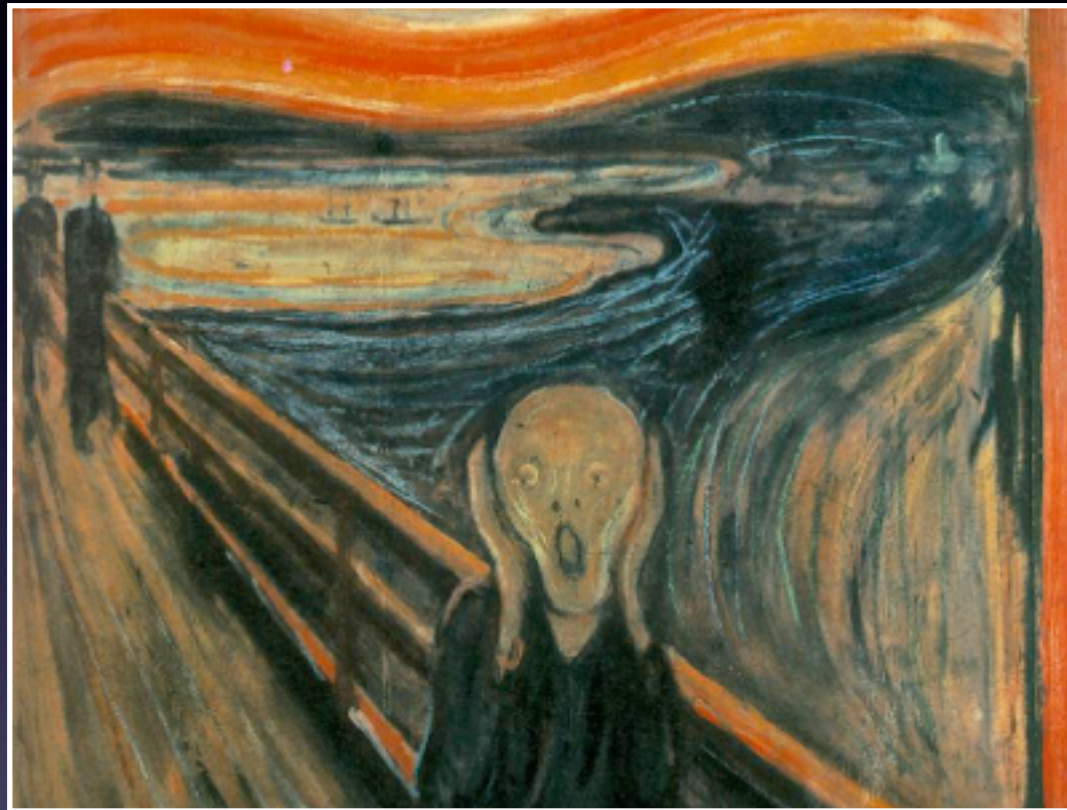
Stage 1. 1870 control run: 1000 years with constant 1870 forcing: Solar, GHG, Volcanic Sulfate, O3

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



But data availability is not enough
... challenges to be aware of ...



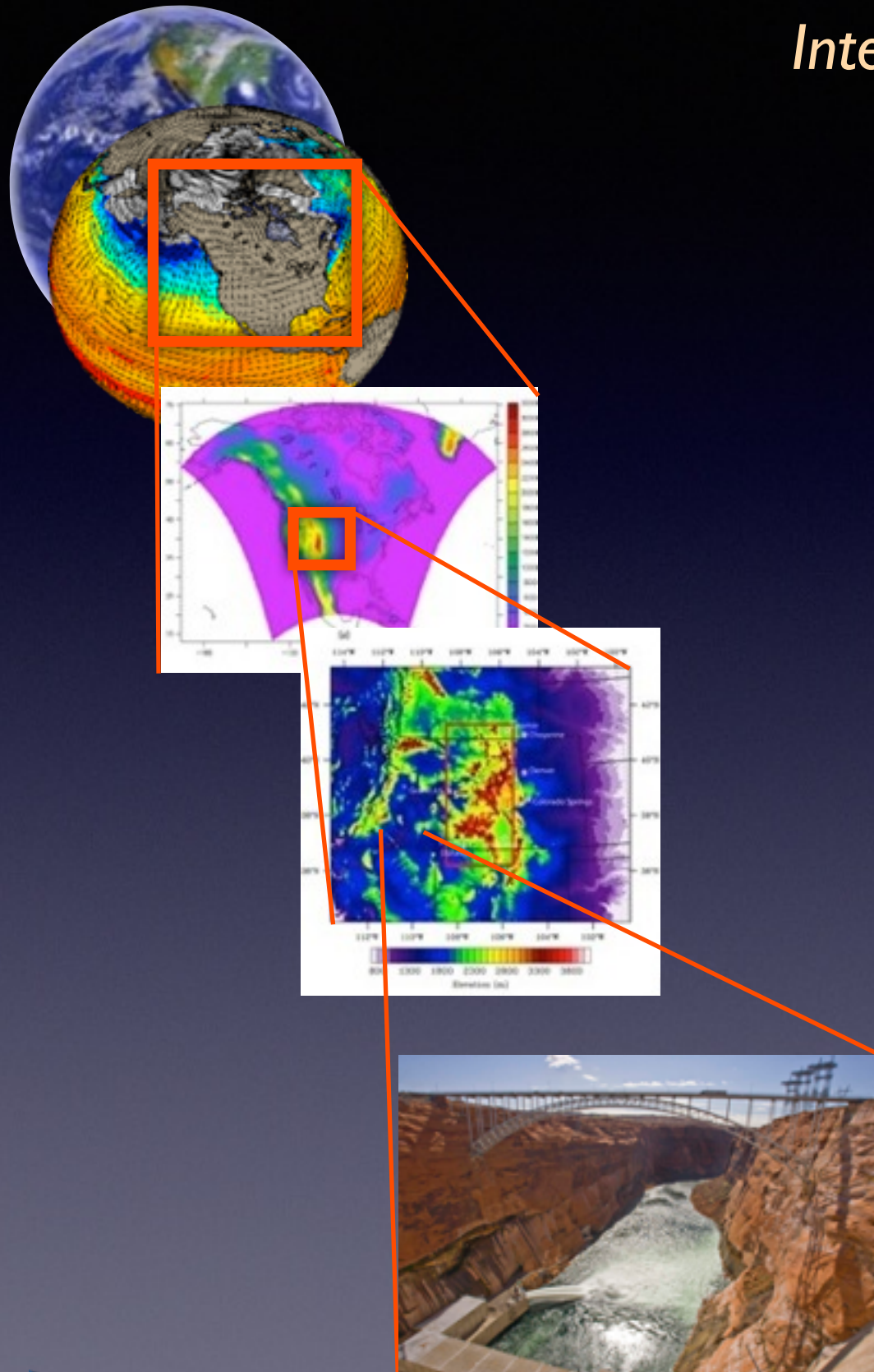
Understanding climate data and information production “chain”:

- Resolution issues - processes representation
- Key climate indices that best encapsulate impacts and vulnerabilities
- Model biases and a cascade of uncertainties, exposing assumptions
- Internal variability: “weather” vs “climate” (do ensembles)
- Limited understanding (“change in variability”) - flexible Scenarios

New Focus on Regional Climate and Impacts

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

e.g.: Agriculture



Is there an App for that?



*What data should I use? Which is the best?
What does it mean? Just give me the number!*



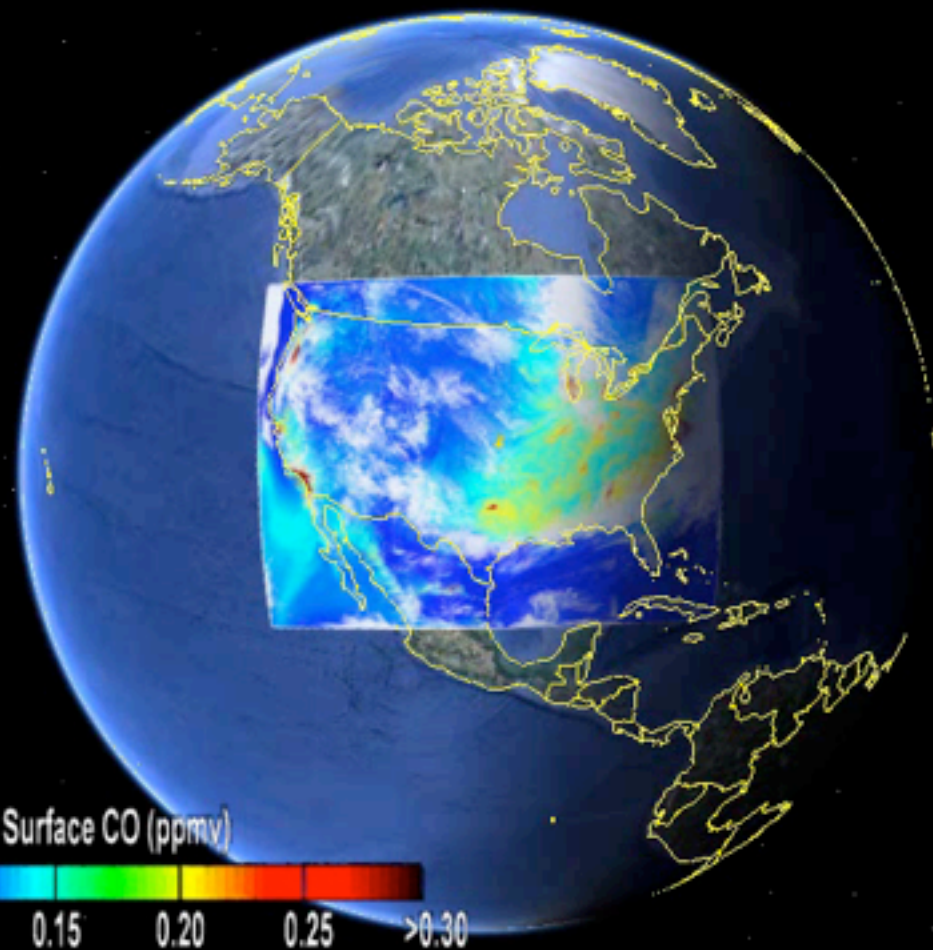
A bit like the Wild West out there...



HIGH RESOLUTION MODELING

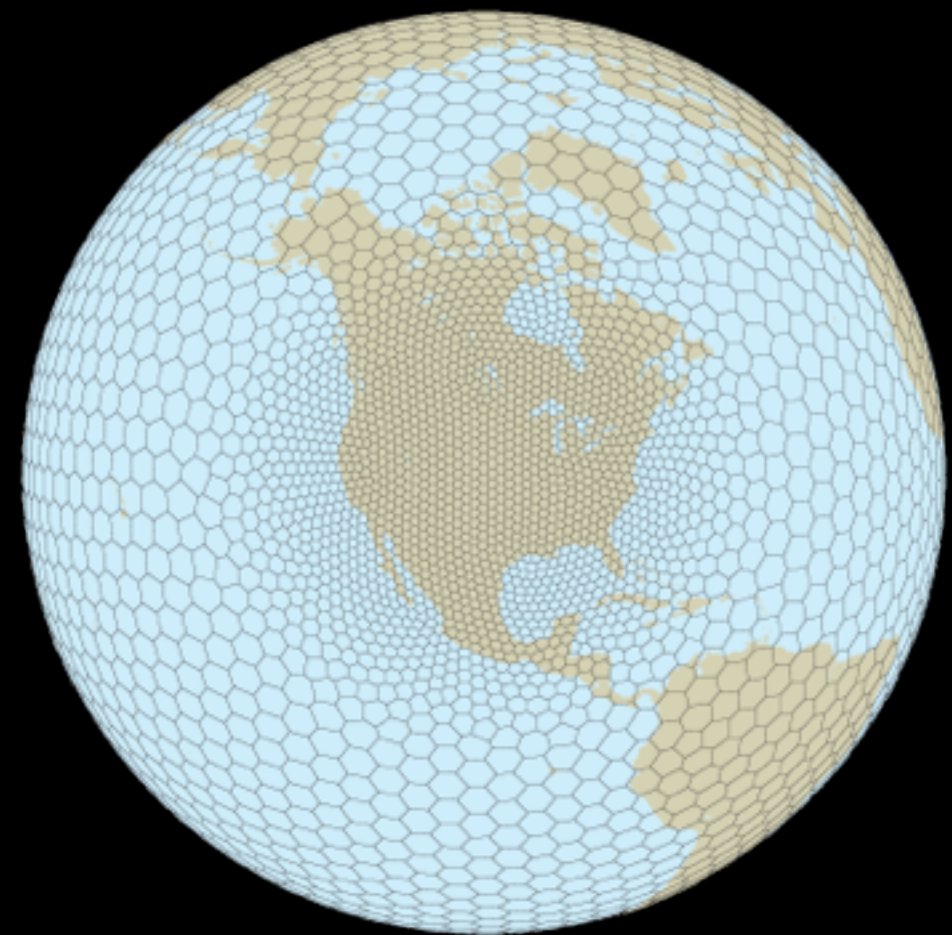
Current Nesting: WRF

Chem, hurricane, crop, hydro...



Next Generation: MPAS

Model for Prediction across Scales

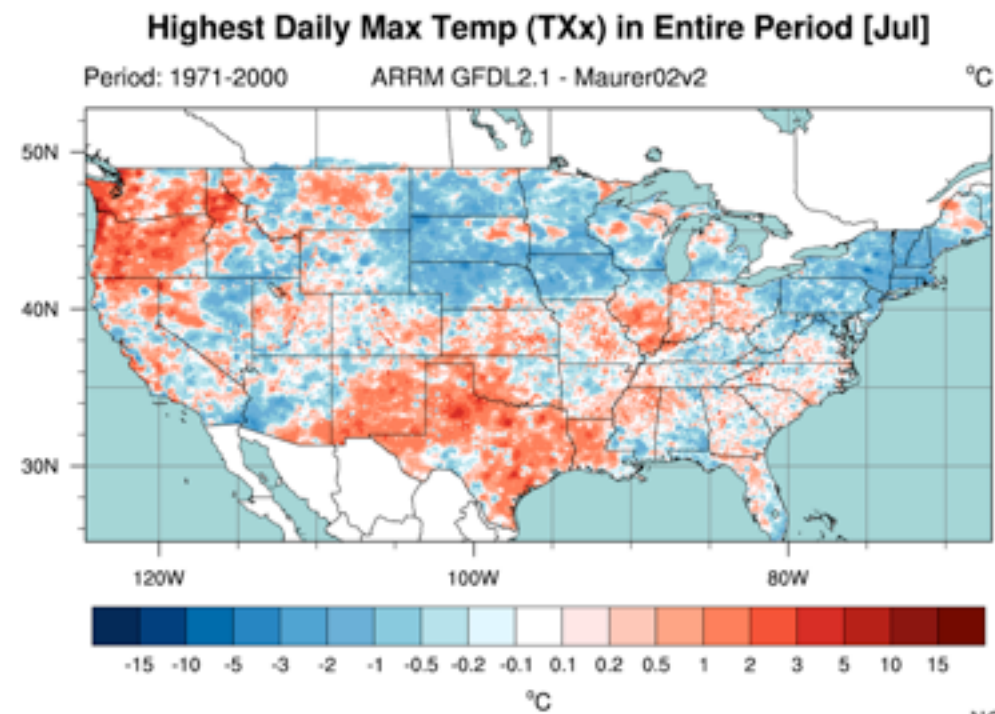
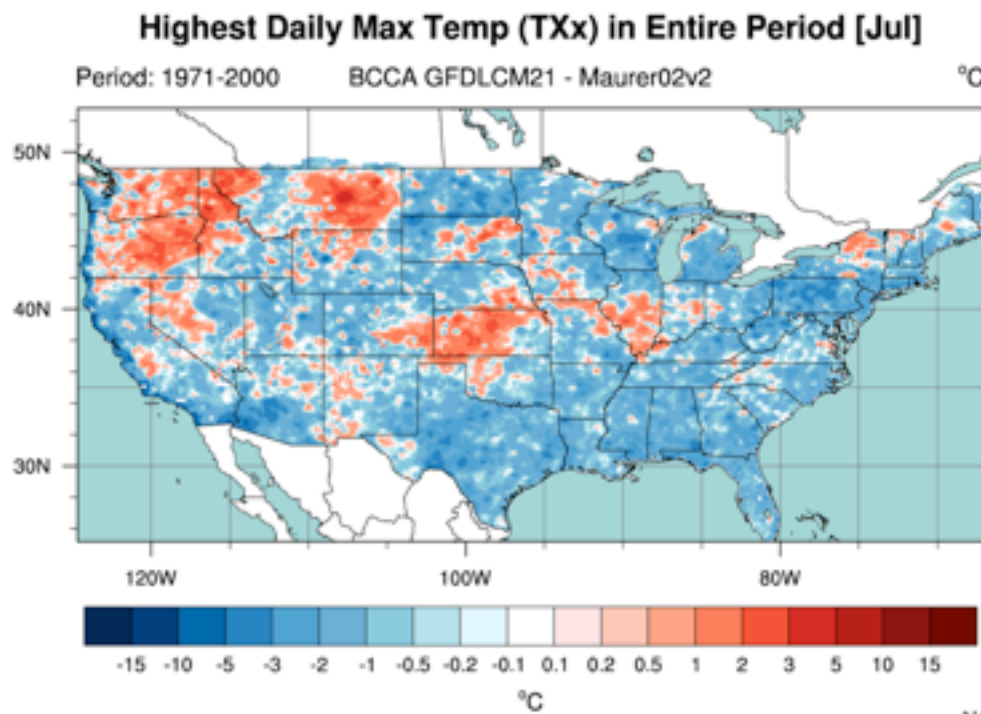


©2009 Google

GFDL CM 2.1 Downscaled document differences: txx, max, July

BCCA

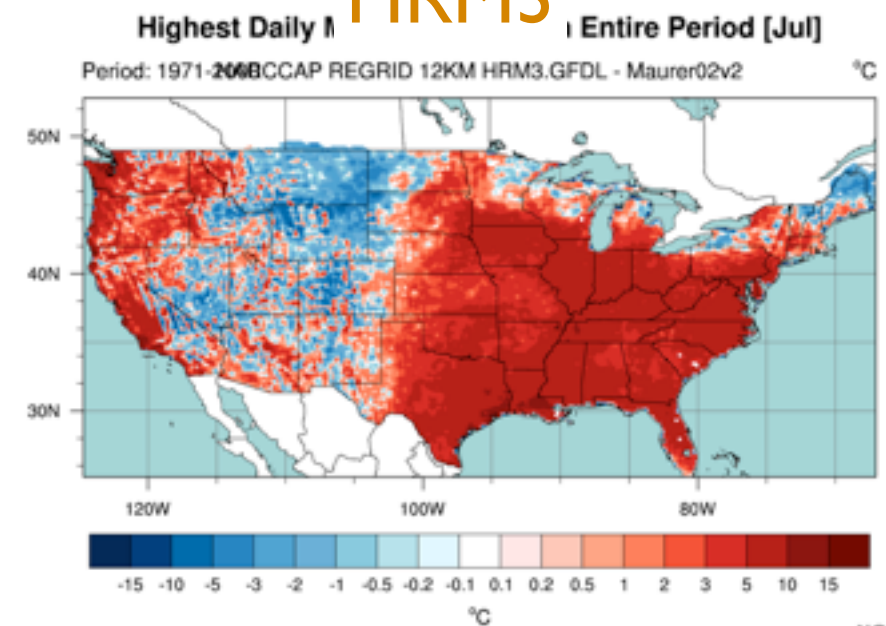
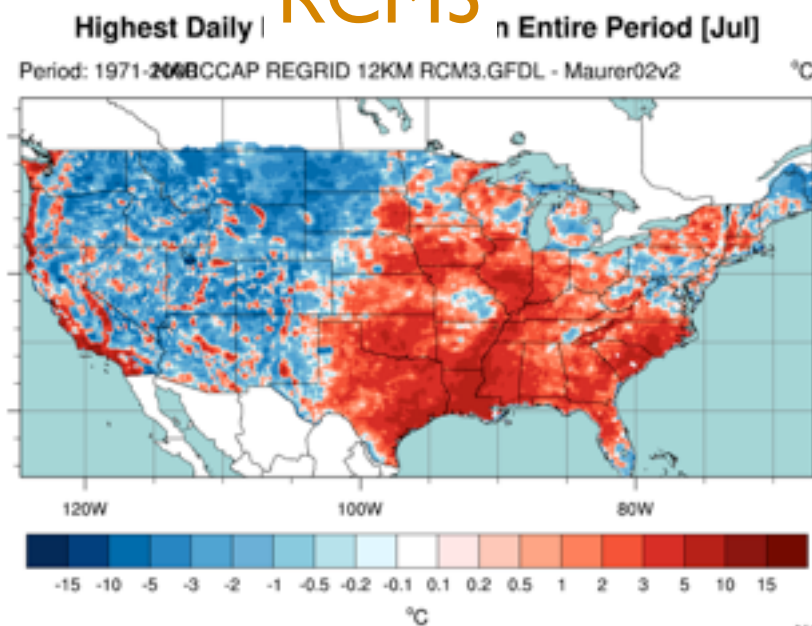
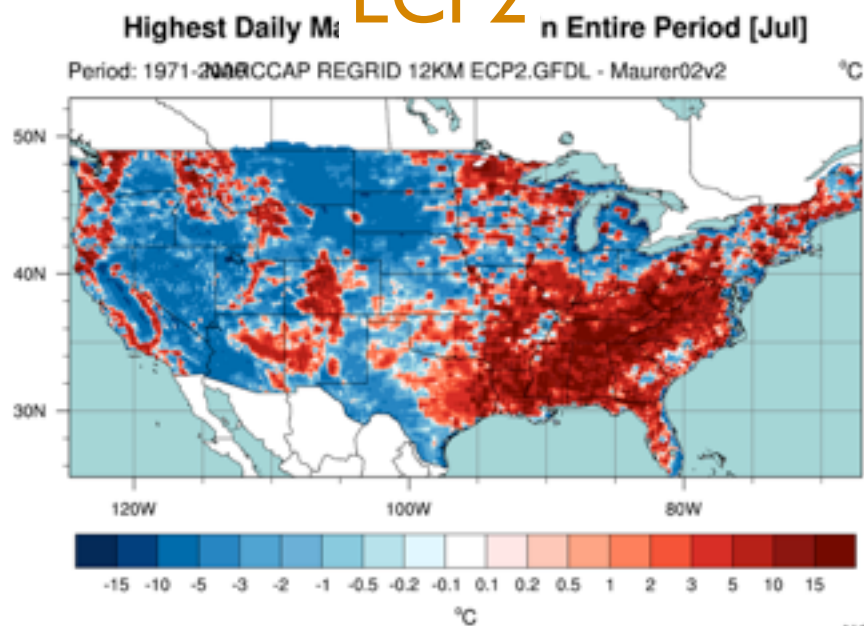
ARRM



ECP2

RCM3

HRM3



Data: Precipitation \neq Precipitation

Application-specific evaluation needed



Gorakhpur : Monsoon



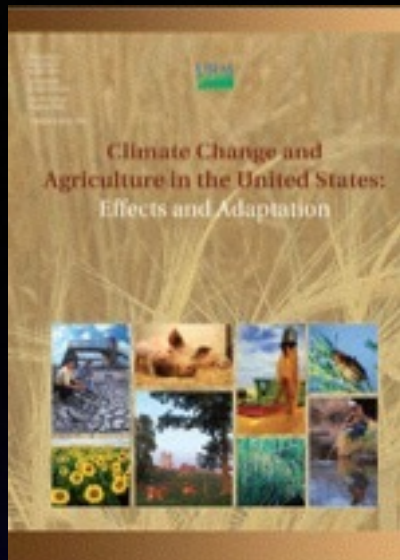
Nebraska : Drought



Hex River : Flash Flood



DaNang : Typhoon

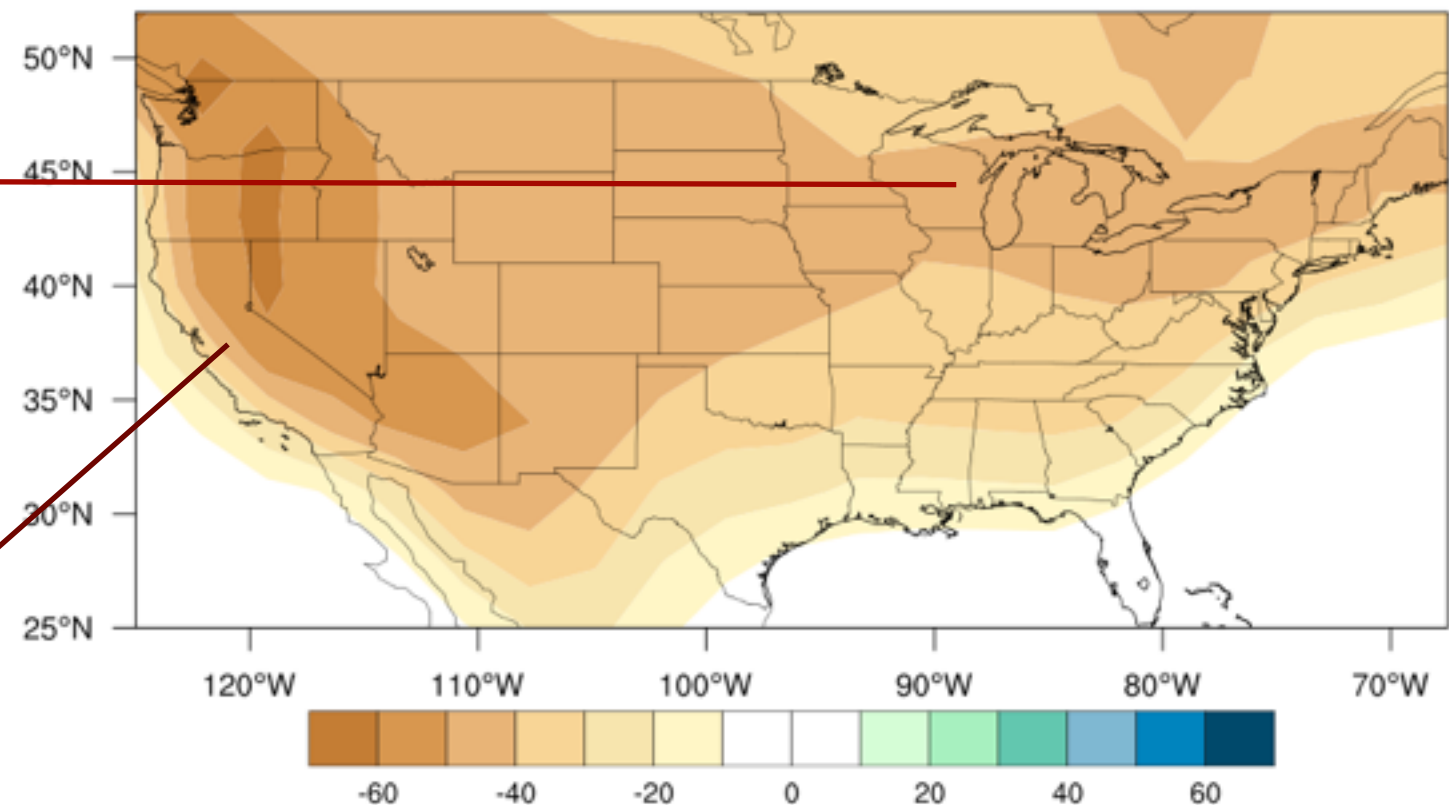
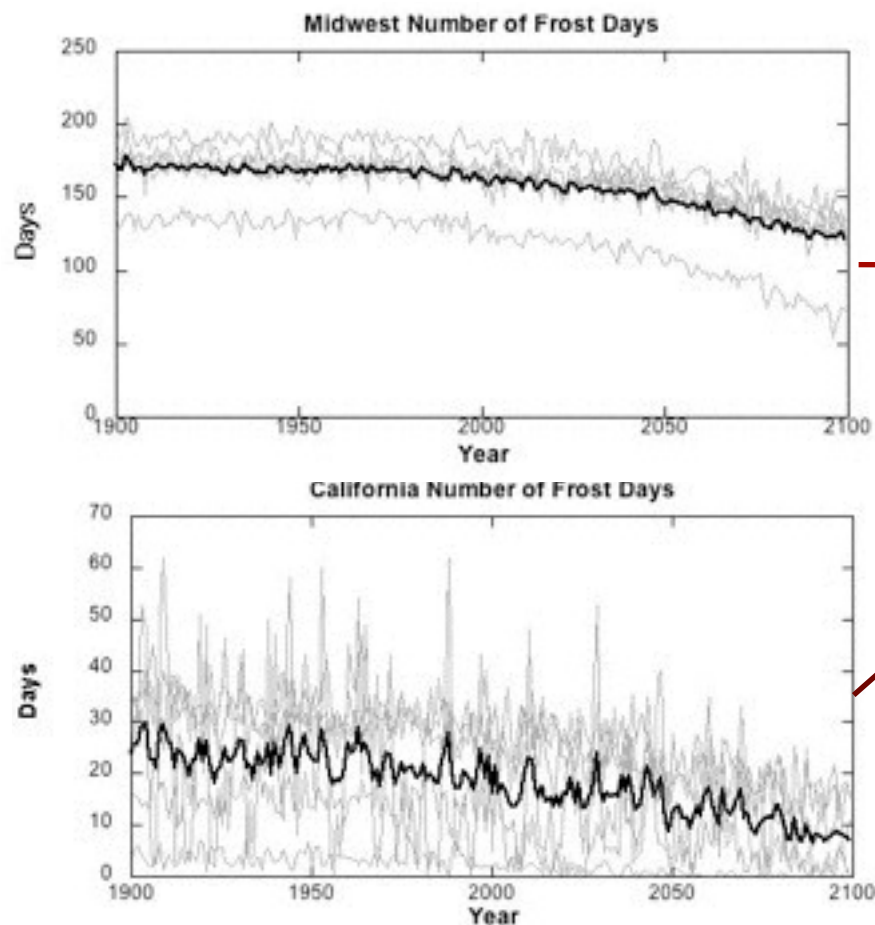


USDA: From Evaluation to Translation

e.g.: *Change in Number of Frost Days*



Tech Report
for NCA



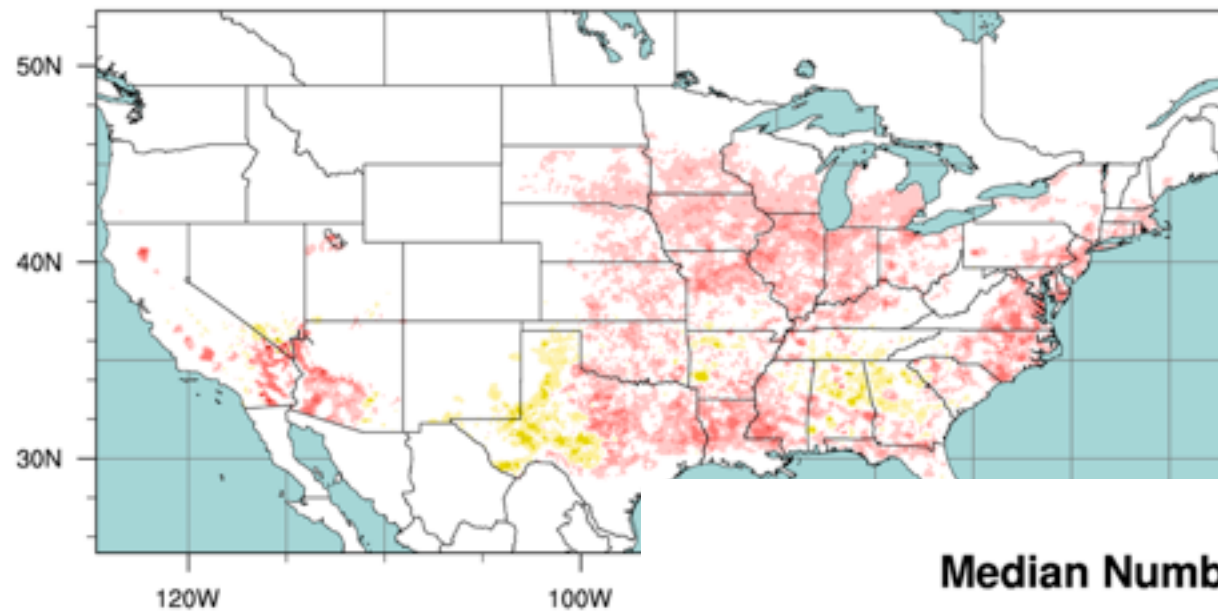
#Tropical Nights (August)

ARRM

BCCA

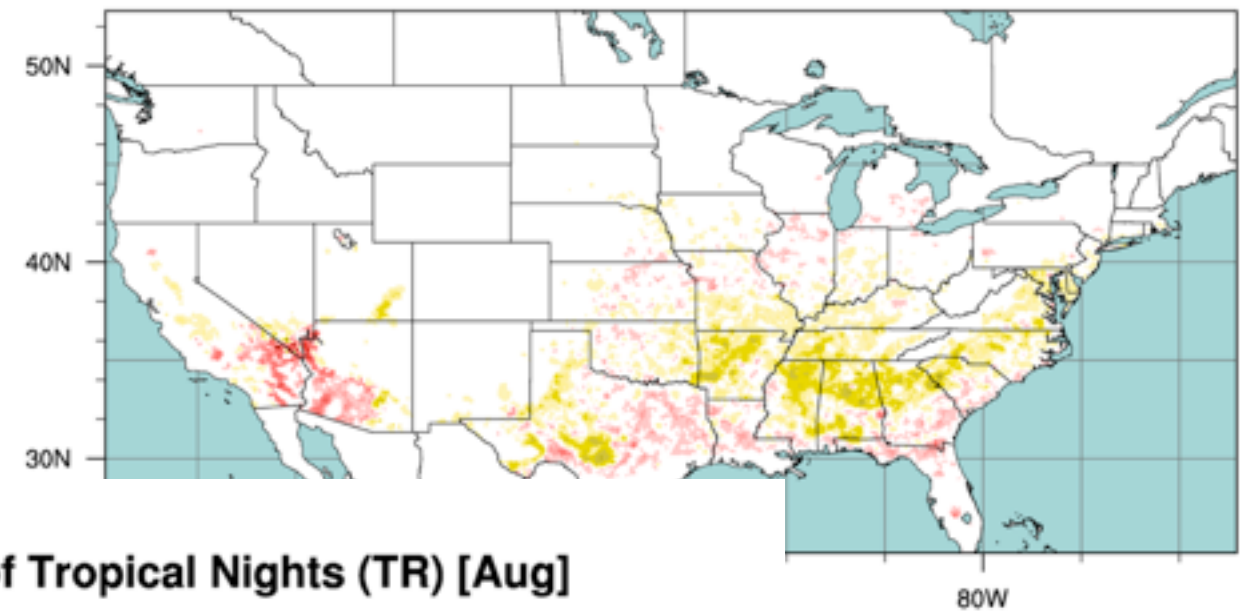
Median Number of Tropical Nights (TR) [Aug]

Period: 1971-2000 ARRM ECHAM5 - Maurer02v2 days



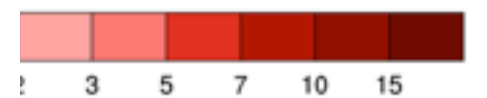
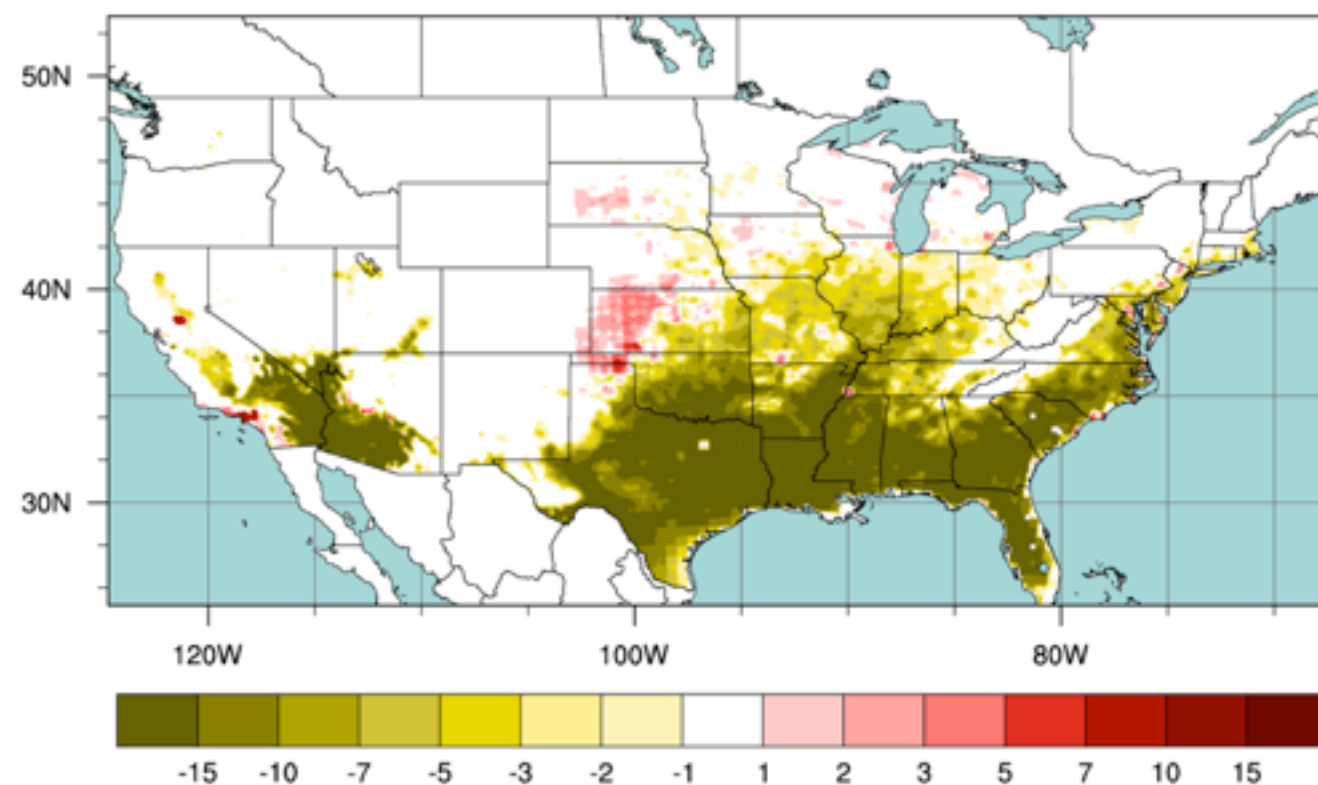
Median Number of Tropical Nights (TR) [Aug]

Period: 1971-2000 BCCA MPIECHAM5 - Maurer02v2 days



Median Number of Tropical Nights (TR) [Aug]

Period: 1971-2000 WRF-G REGRID 12KM WRF-G.CGCM3 - Maurer02v2 days



WRF-G

Appropriate Ensembles”

How does a passenger jet look like?

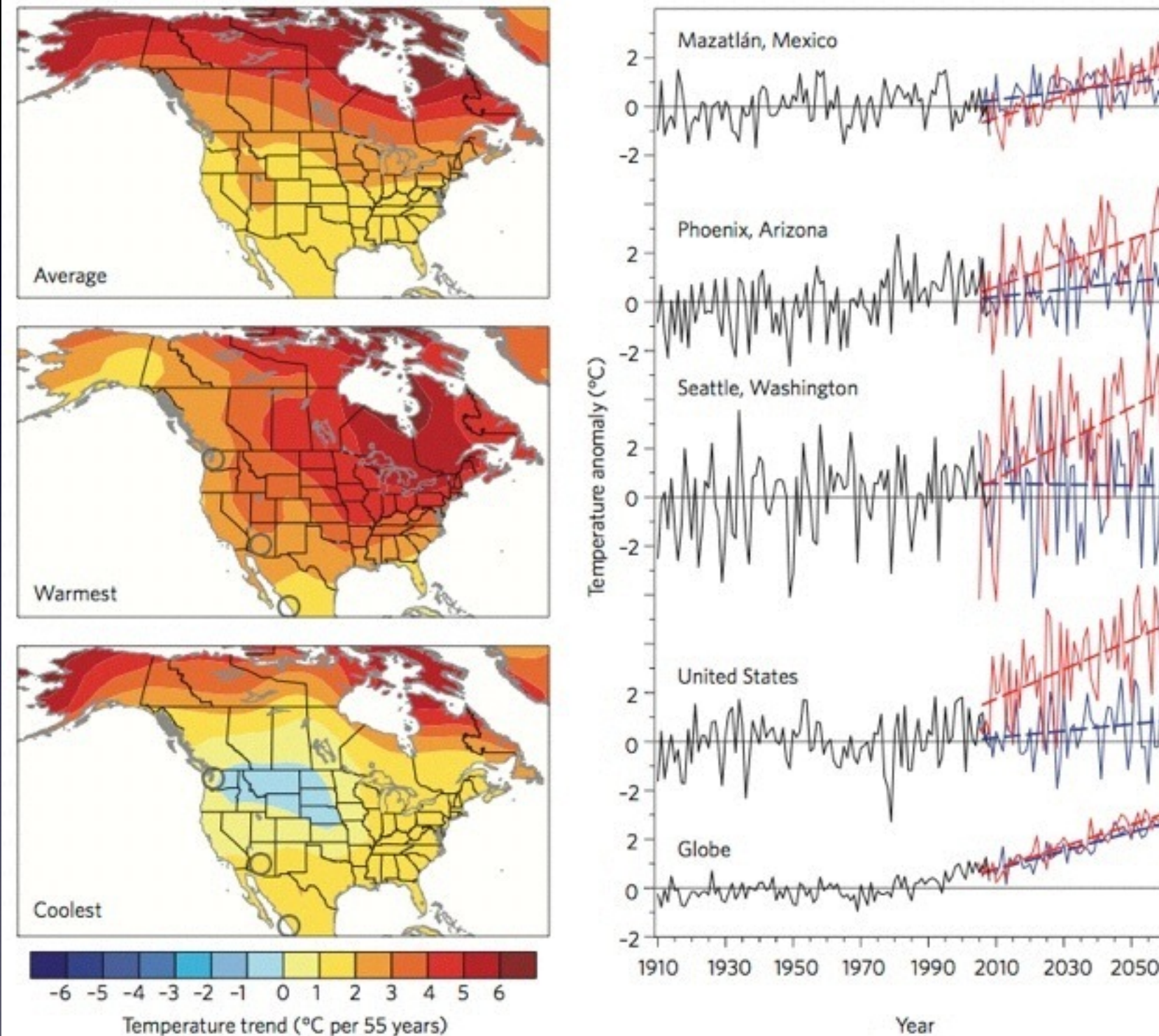


- Is the average meaningful?
- Not independent information
- Better and worse information
- Does it reflect the what we think the uncertainty is?



Two issues: sampling and weighting

Internal Variability: Temperature Trend 2006-2060 (40 member ensemble, different initial conditions)

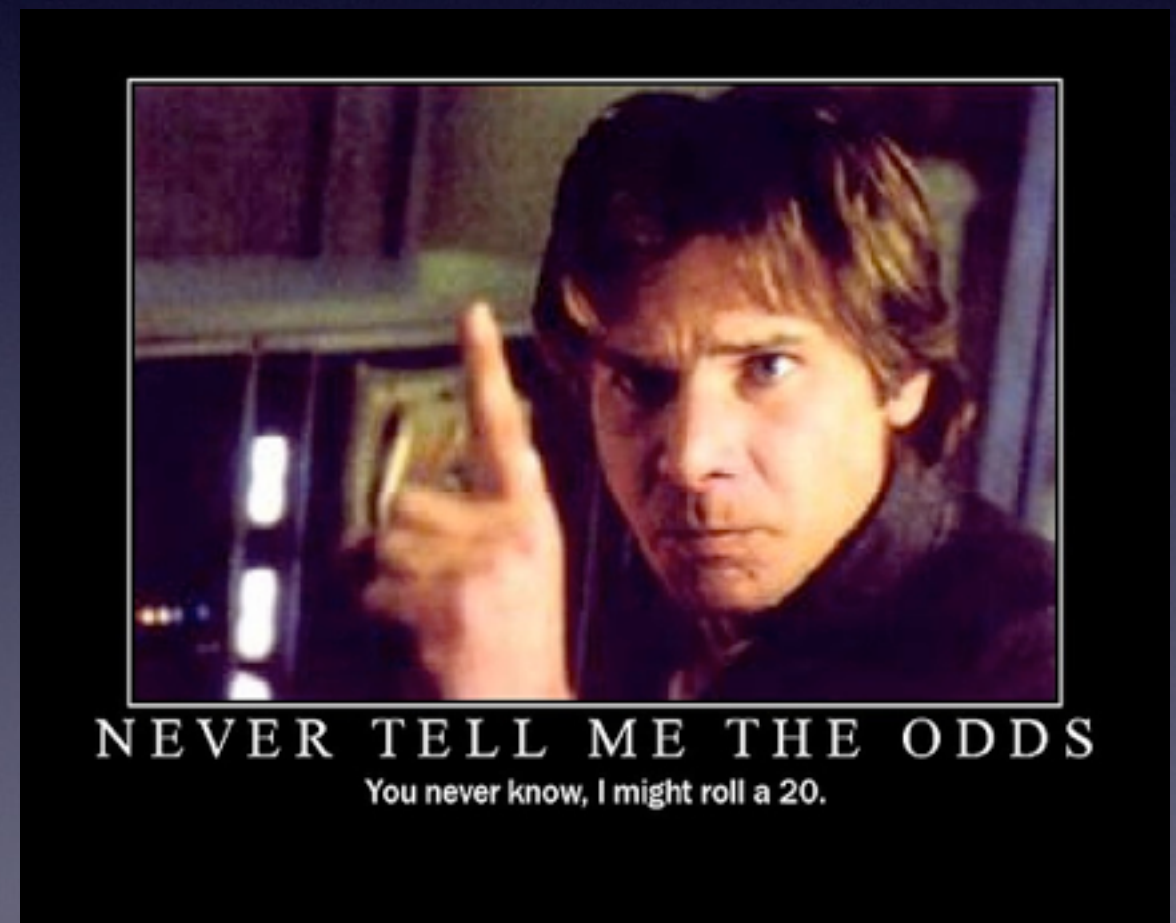


But how are we going to explore all possible options,
from both science and management perspectives?

What is Likely?

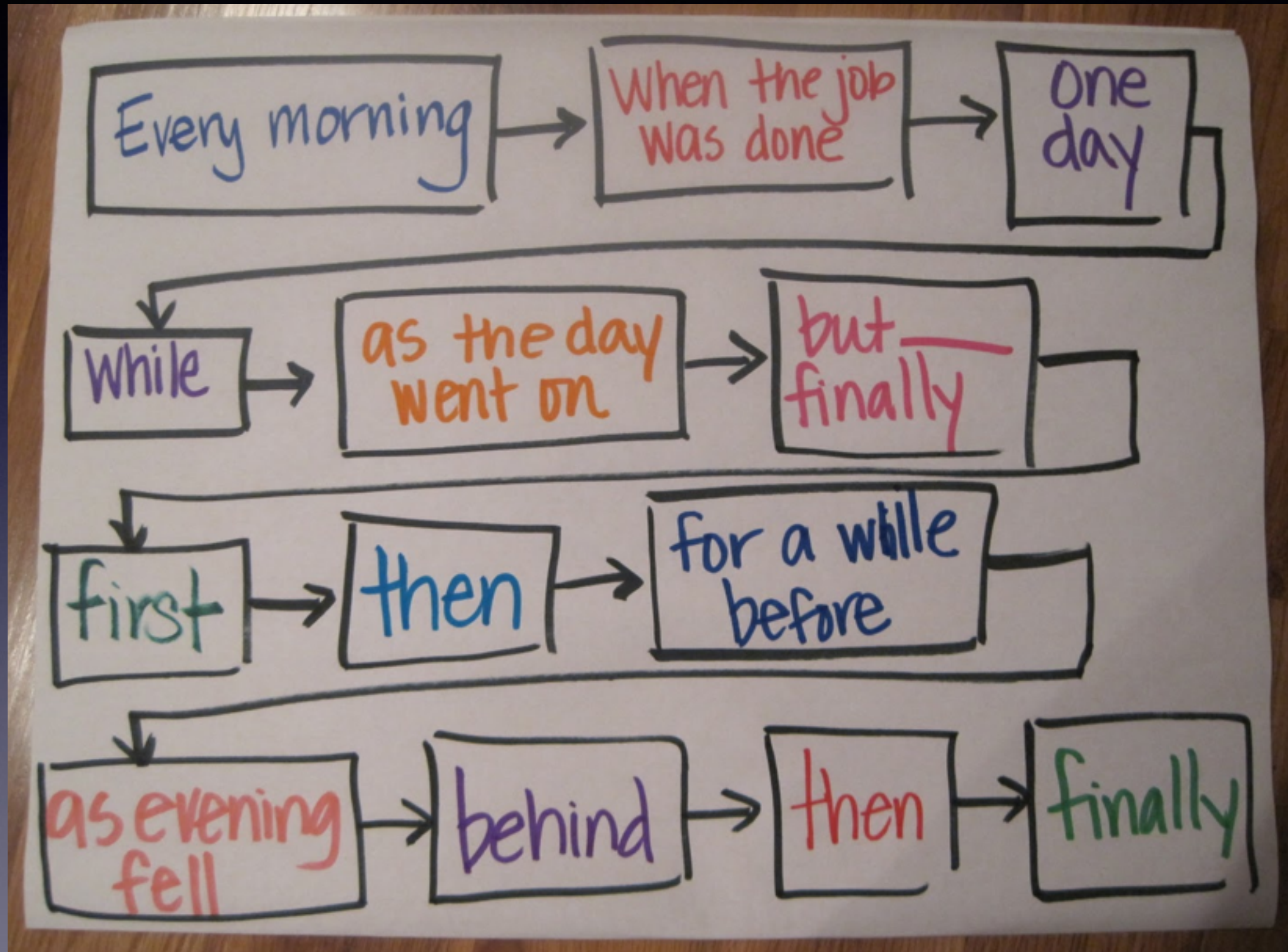


What is Possible?



Sequence of Events

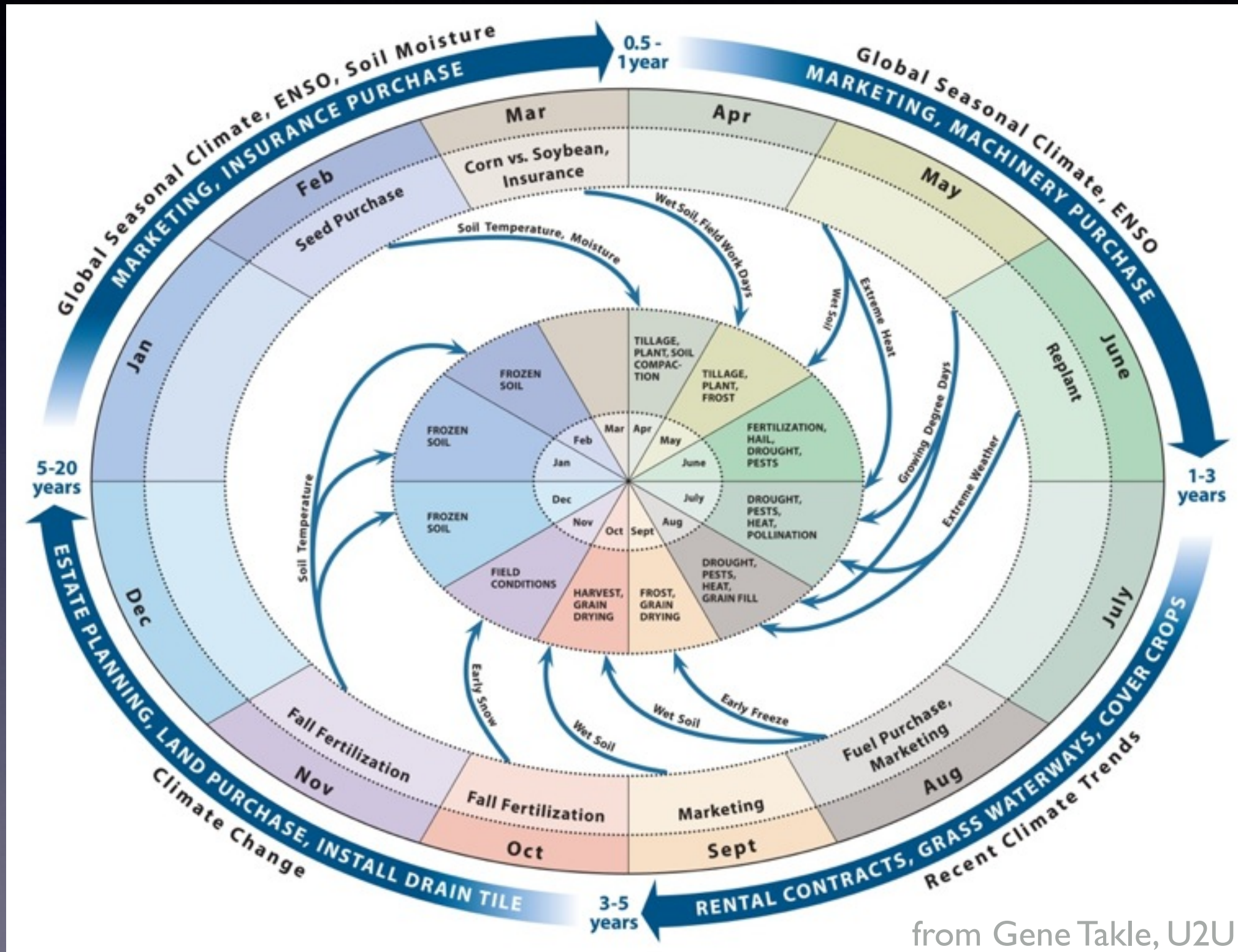
(daily, season, inter annual)



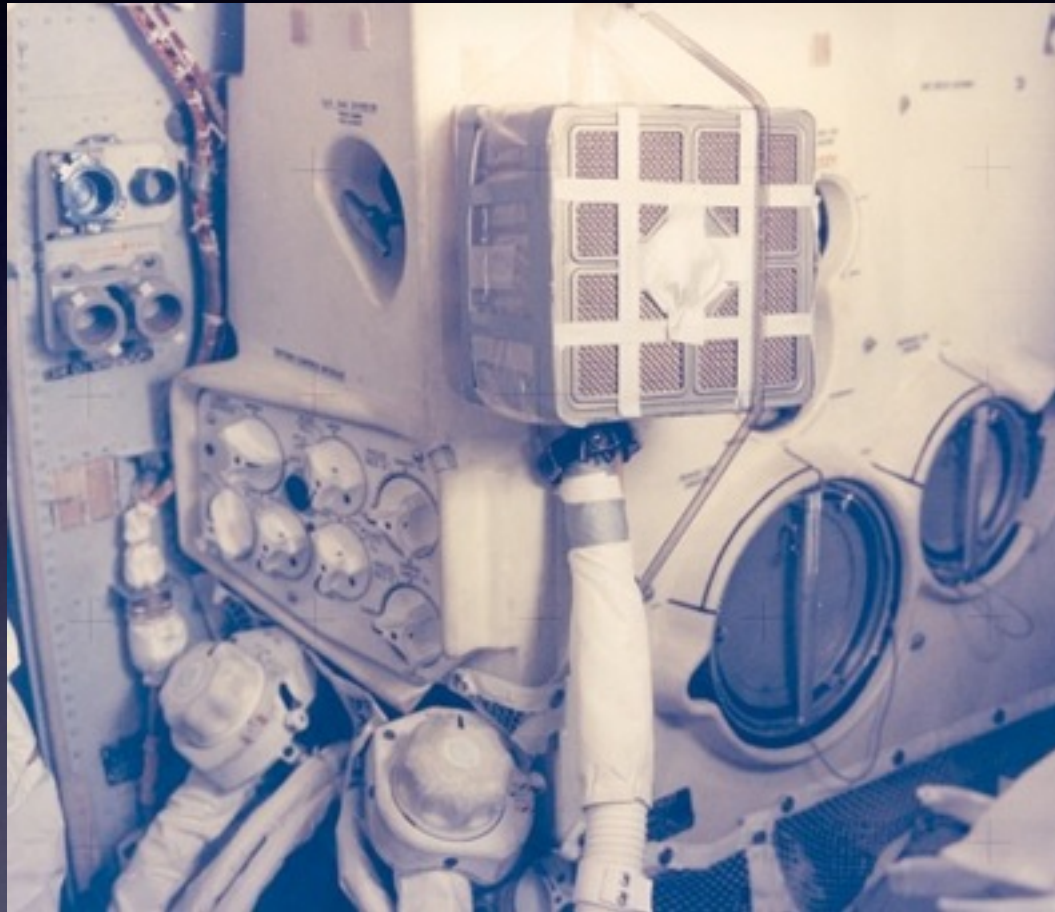
Facing the “Practitioners Dilemma” through Communities of Practice



Acknowledging and Responding to Agricultural Annual Decision Cycle



Challenges to making science more useful



but need for :
sustainable solutions, not “fixes”

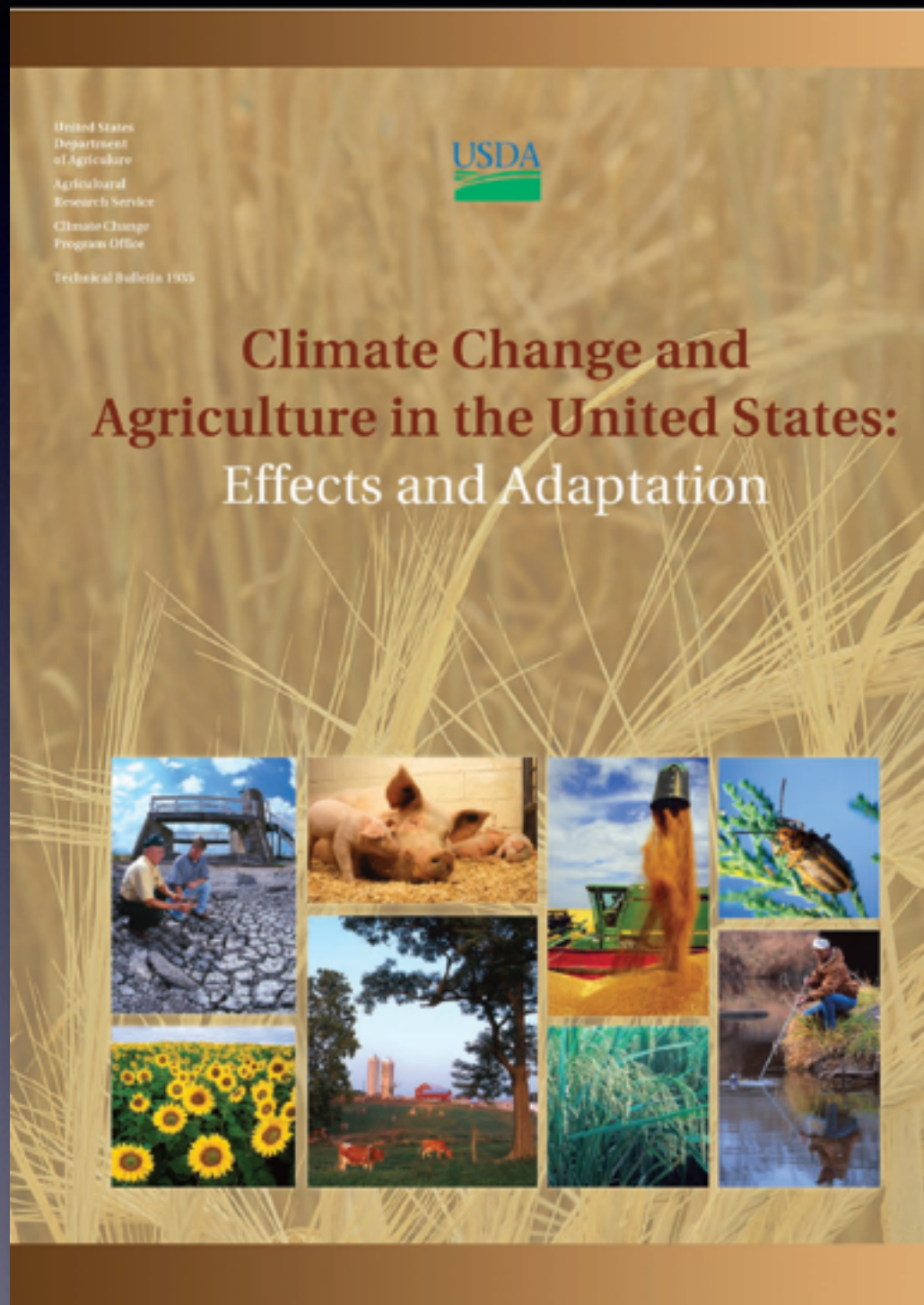
- **Data** accessibility, in application-oriented, useful form (format, index, resolution)
- **Evaluation:** Information about the data across the production “chain” vs observations, ensembles
- **Translation** of Scientific Knowledge for exploration of impacts of change, guidance of use, transparency of uncertainties
- **Community of Practice** that collaboratively develops data requirements and scenarios

But often black-box hand down:

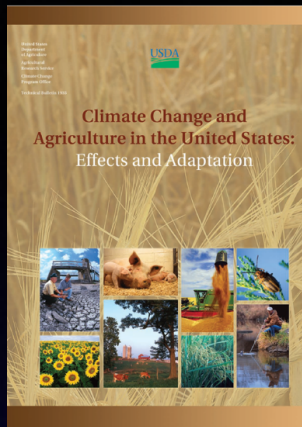
- no standardization (indices, usefulness)
- no regional ensemble analysis concept
- no coupling to context

U.S. Agriculture: \$300B/year commodities

- Climate change poses unprecedented challenges to the U.S. agriculture industry.
- Without significant adaptation measures, costs and losses will rise dramatically.
- Food security will be threatened worldwide.



Climate Change and Agriculture in US Research Needs



Data

*Indices / Target
for Evaluation*

*Translation
Guidance*

- **Improve projections of future climate conditions for time scales of seasons to multiple decades;** change and duration of average and extreme temperatures, precipitation , and related variables (e.g., evapotranspiration, soil moisture).
- **Evaluate and develop process level understanding** of the sensitivity of plant and animal production systems, including insect, weed, pathogen, soil and water components, to key direct, indirect and interacting effects of climate change effects
- **Develop and extend the knowledge, management strategies and tools needed by US agricultural stakeholders** to enhance the adaptive capacity of plant and animal production to climate variability and extremes. While existing management and agronomic options have demonstrated significant capacity for expanding adaptation opportunities, new adaptive management strategies, robust risk management approaches, and breeding and genetic advances offer much potential, but have yet to be evaluated.

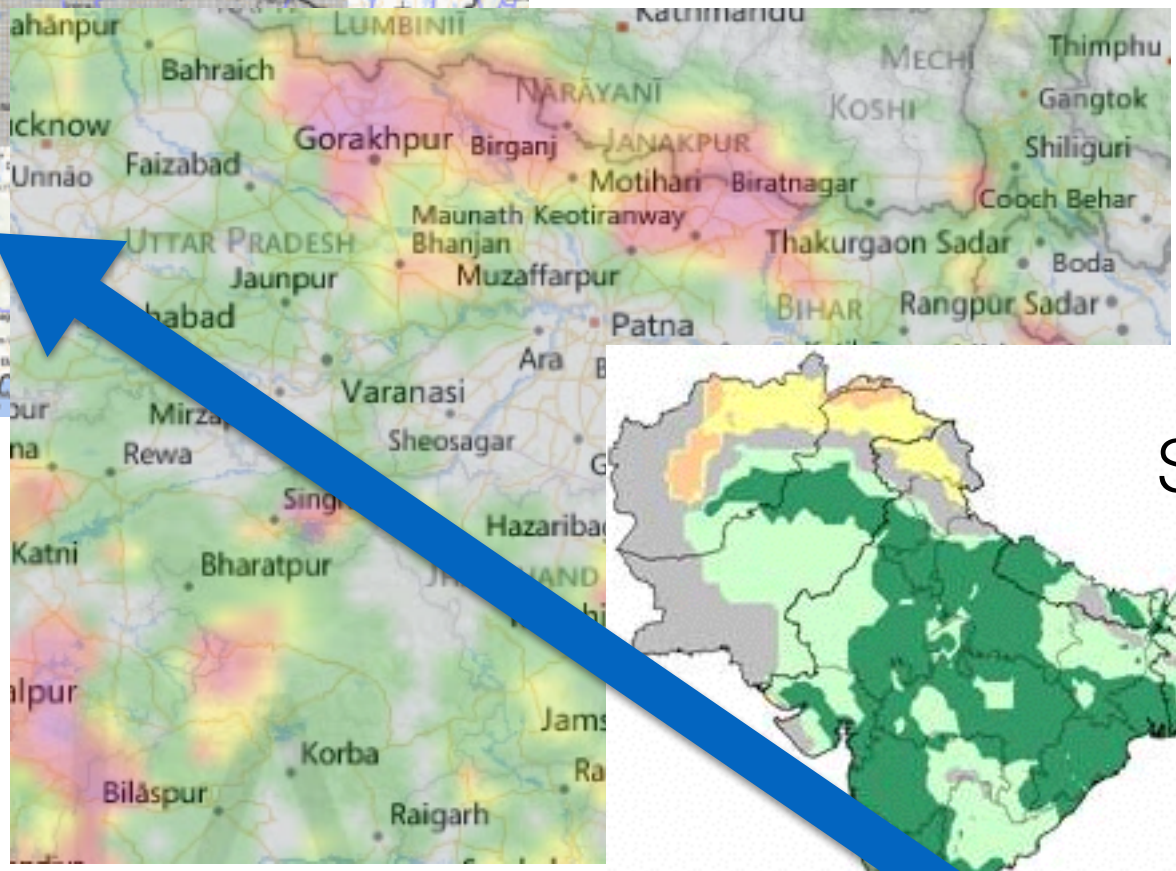
Seamless Integration

Weather - Season - Climate

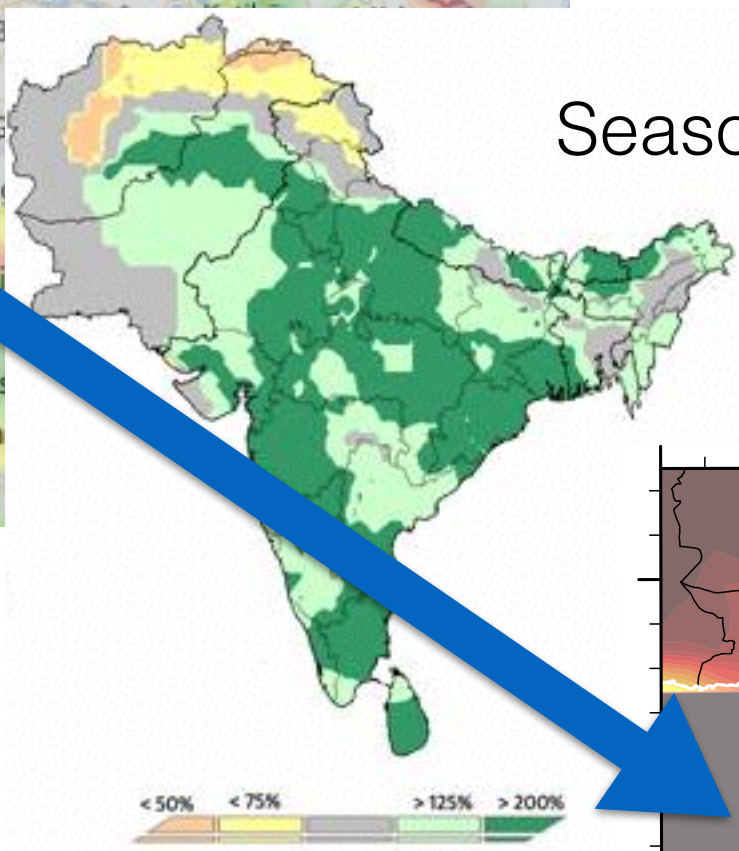


Observations

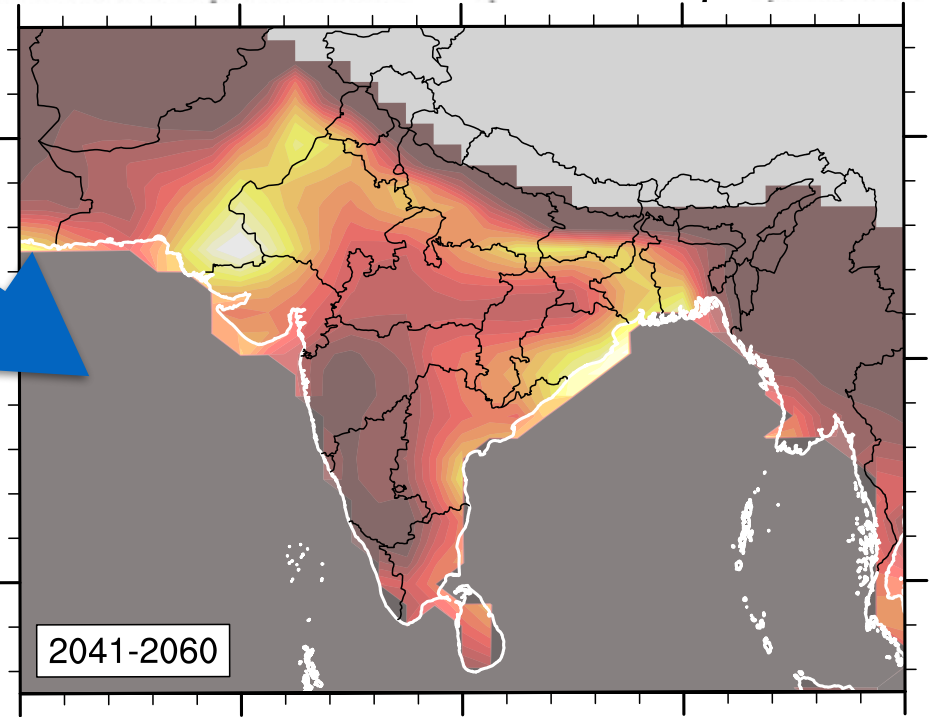
Weather Forecast



Seasonal Outlook



Climate Projection



June 2010
Y/Y Precipitation Outlook

2041-2060

NCAR - CESM Structure



CESM Management

CESM Scientific Steering Committee (Marika Holland, Chief Scientist)

CESM Advisory Board

Atm
Model

Ocean
Model

Land
Model

Polar
Climate

BioGeo
Chem

Chemistry
Climate

WACCM

Working Groups
Development →
Application ↓

Climate Change

PaleoClimate

Climate Variability

Societal Dimensions

Software Engineering

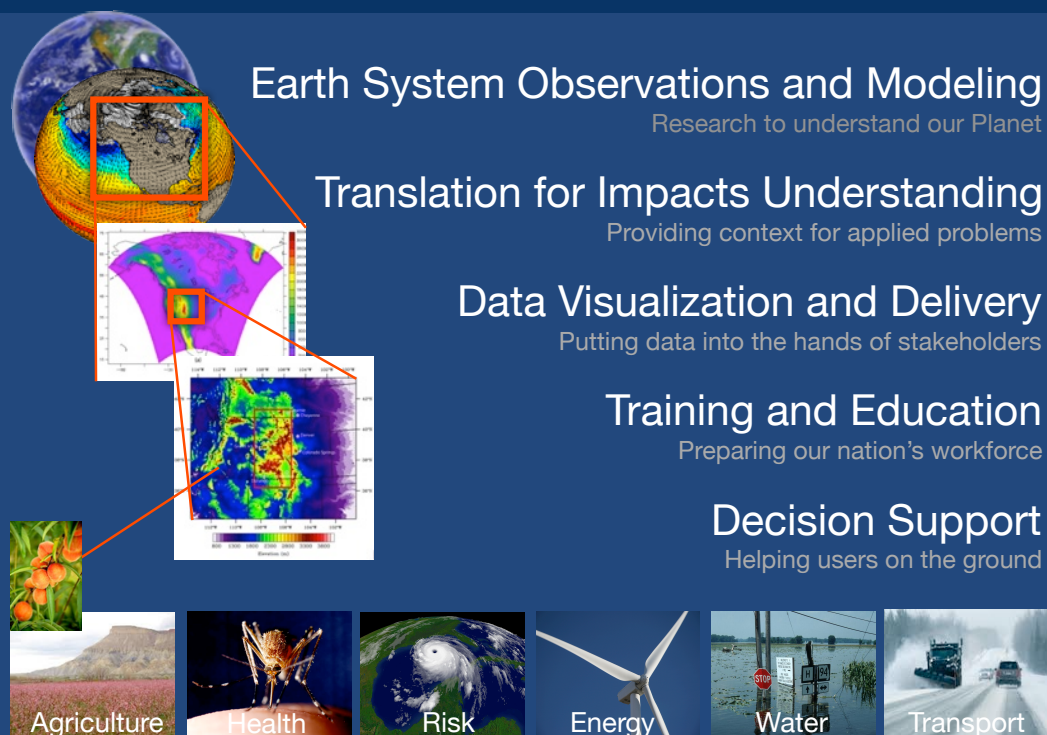


CCSM is primarily sponsored by
the National Science Foundation
and the Department of Energy

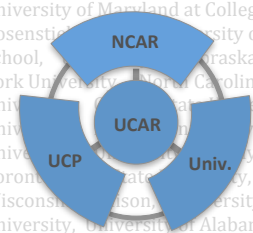
Thanks!

Building Climate Services with and for you

UCAR/NCAR CLIMATE SERVICES



UCAR / NCAR Climate Services Capabilities



Who We Are

- **NCAR**: Hundreds of scientists; state-of-the-art ground-based and airborne research capabilities and supercomputing facilities
- **UCP**: Science support programs for data delivery, visualization and archiving; training and education; logistical and program support
- 104 national and international partner **Universities**

What We Do

- **Scientific Leadership**: **Develop, coordinate** and **facilitate** climate science
- **Translation**: Climate science **interpretation** and **context** for stakeholders
- **Support for Climate Services**: **End-user focused** approaches for data, evaluation, training and education; logistical support for national and international programs
- **Standards**: Establish community **protocols** and **best practices** for data, community modeling, and analysis
- **Community Building**: Create impactful **connections** between scientists and stakeholders
- **Next generation**: **Capacity** building through Universities for the global marketplace
- **Decision Support**: End-to-end **tailored** solutions and applications

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EMAIL: AMMANN@UCAR.EDU