

The background of the slide is a photograph of a mountainous landscape. In the foreground, there is a green, grassy field. In the middle ground, a large, modern research facility with multiple buildings and a central tower is visible. The facility is situated at the base of a steep, rocky mountain. The mountain has a rugged, craggy appearance with some sparse vegetation. The sky is blue with some white clouds. The overall scene is a scenic view of a research center in a mountainous region.

NCAR Overview

Peter Backlund

Director, Integrated Science Program, and
Director, Research Relations
National Center for Atmospheric Research

June 23, 2011



National Center for Atmospheric Research

- A federally funded research and development center (FFRDC) operated by UCAR and supported by NSF (and others)
- A national center for research and education in the atmospheric and related sciences
- A provider of computational, data, and observational facilities and services for the university community

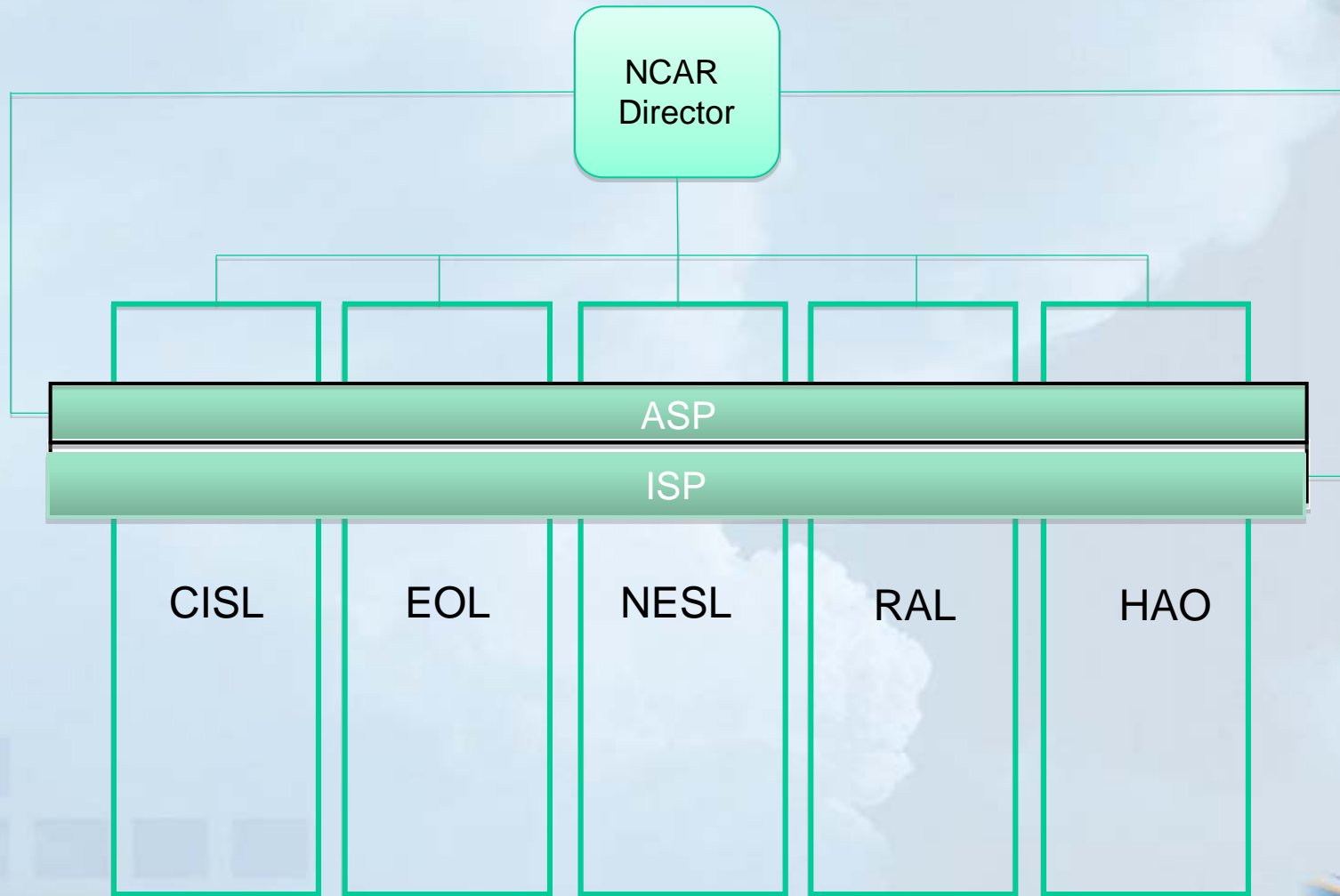


The NCAR Mission

- **To understand the behavior of the atmosphere and related physical, biological and social systems**
- **To support, enhance and extend the capabilities of the university community and the broader scientific community, nationally and internationally**
- **To foster the transfer of knowledge and technology for the betterment of life on Earth**



Organization of the National Center for Atmospheric Research





National Center for Atmospheric Research

Research Areas (a sampling):

- Climate Change
- Weather
- Atmospheric Chemistry and Air Quality
- Solar Processes
- Sun-Earth Connections
- Turbulence
- Human and environmental impacts of atmospheric changes
- Mathematics and computer science applied to Geosciences



Institution Rankings

Citations per paper

Jan 1 1999-June 30, 2009

Rank	Institution	N	C/N
1	NCAR (all UCAR)	3,060	21.99
2	Max Planck Society	2,798	21.12
3	U. Washington	2,973	20.16
4	NOAA	4,375	18.87
5	NASA	5,323	17.92
6	U. Colorado	3,359	17.10
7	U.S. Geol Survey	3,958	13.01
8	Chinese Acad Sci	9,025	6.36

A world class scientific institution

NCAR's Strategic Plan



NCAR

Imperatives (*all important*)

- **Innovation and creativity**
- **Prediction and attribution of Earth system changes and impacts**
- **Atmospheric and Earth system models**
- **Supercomputing and data services**
- **Observational facilities and services**
- **Scientific applications, technology, and information products**
- **Support for university students and early career scientists and engineers**



Frontiers (*in Priority Order*)

- **Modeling and Analysis Focused on Informing Climate Change Adaptation and Mitigation.**
- **Water resource availability, vulnerability and adaptation planning in western North America.**
- **New tools for integrating Earth system measurements with models.**
- **New grid-based means of interacting with universities and the broader science and education community.**
- **Assess regional climate and predict wind and cloud cover in support of renewable energy industries. Understand environmental impacts renewable energy technologies.**



A Few Research and Facility Highlights



NCAR-Wyoming Supercomputing Center



NCAR

NWSC

NCAR-Wyoming Supercomputing Center



For more information visit, www.nwsc.ucar.edu

NWSC Partners:



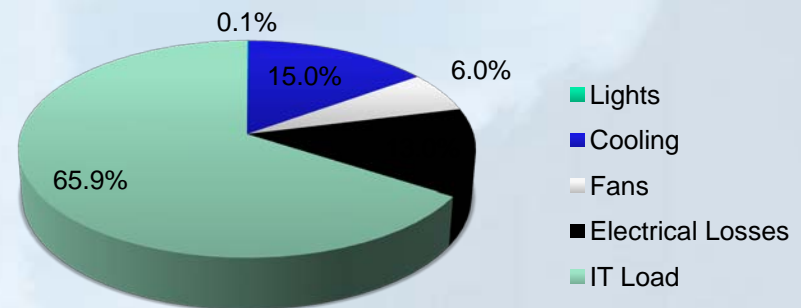
Architects, Contractors and Consultants:

H+L Architecture | Saunders Construction, Inc. | California Data Center Design Group | Rumsey Engineers | RMH Group
Martin & Martin Consulting Engineers | Rider Levett Bucknall | Reliable Resources | E Cube, Inc.

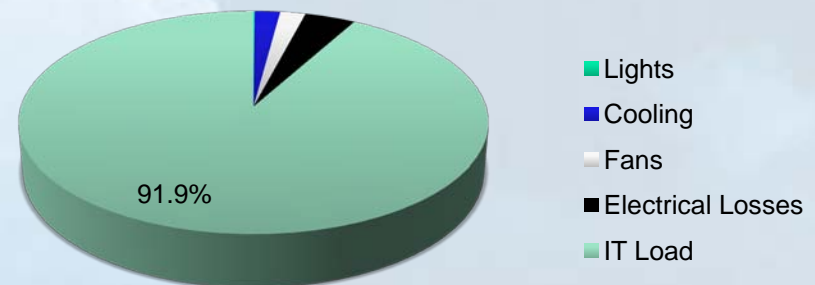
Big Picture Focus On Efficiency

- Utilize the regions cool, dry climate to minimize energy use
- Utilize the waste heat generated from computing to provide:
 - Building heating
 - Generator block heating
 - Reheating of coils
- Focus on the biggest losses
 - Compressor based cooling
 - UPS losses
 - Transformer losses
- Minimizing energy use makes good environmental and economic sense
 - *Reduced operating costs*
 - *NCAR has always strived to be a good steward of taxpayer dollars*

Typical Modern Data Center



NWSC Design





NCAR
Data Center

Shot on June 3, 2011
Colorado Sky-Shots
(303) 571-5704



NCAR

NCAR GV Research Aircraft



NCAR

START-08/Pre-HIPPO Field Campaign



123 flight hours over six weeks in April/May and June of 2008

START08 PIs: Laura Pan (NCAR), Elliot Atlas (Miami U), Kenneth Bowman (TAMU)

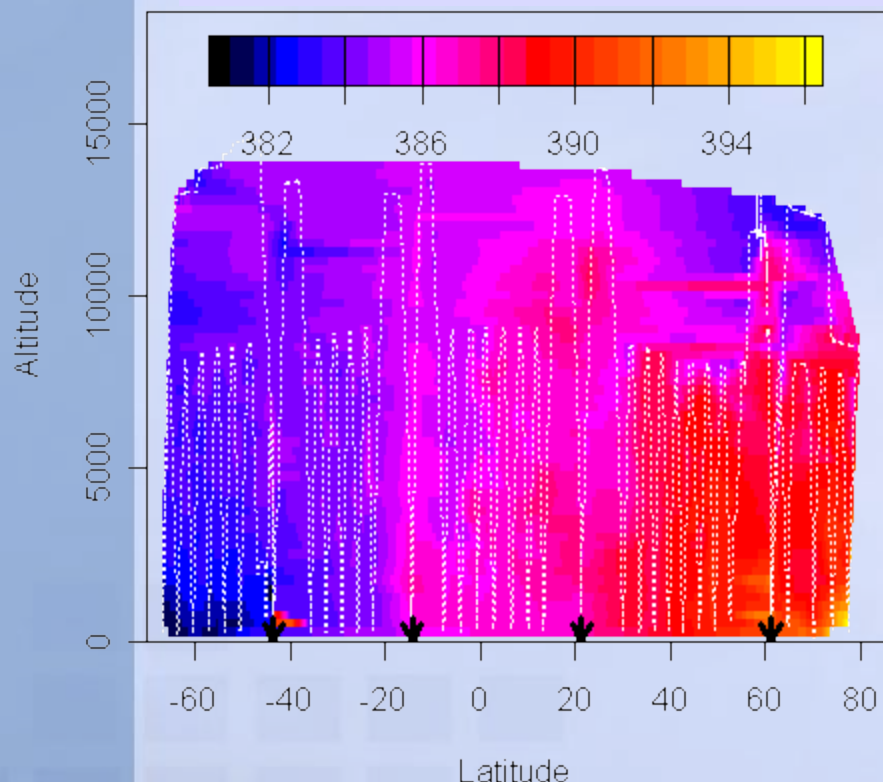
HIPPO PIs: Steve Wofsy (Harvard), Britt Stephens (NCAR), Jim Elkins (NOAA), Ralph Keeling (Scripps)



HIAPER Pole-to-Pole Observations (HIPPO) of Carbon Cycle and Greenhouse Gases Study



CO₂ abundance image courtesy of the
HIPPO Science Team, March 2009



PIs from Harvard, NCAR,
Scripps, and NOAA



The inaugural January 2009 mission flight path,
27,760 miles in 21 days.

Five missions over the course of three years

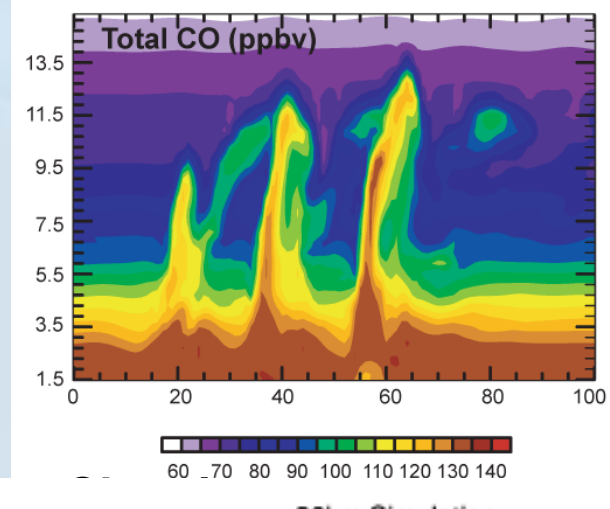
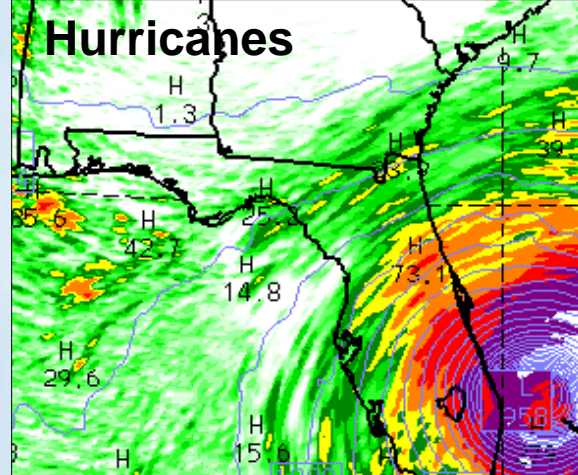


NCAR

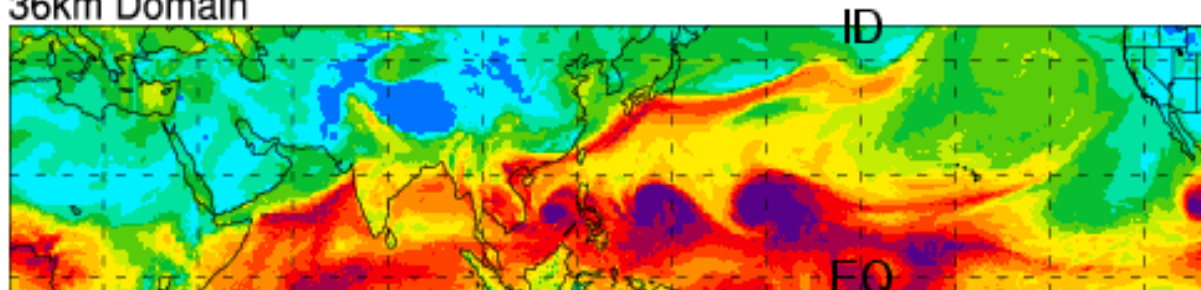
Advanced Community Models



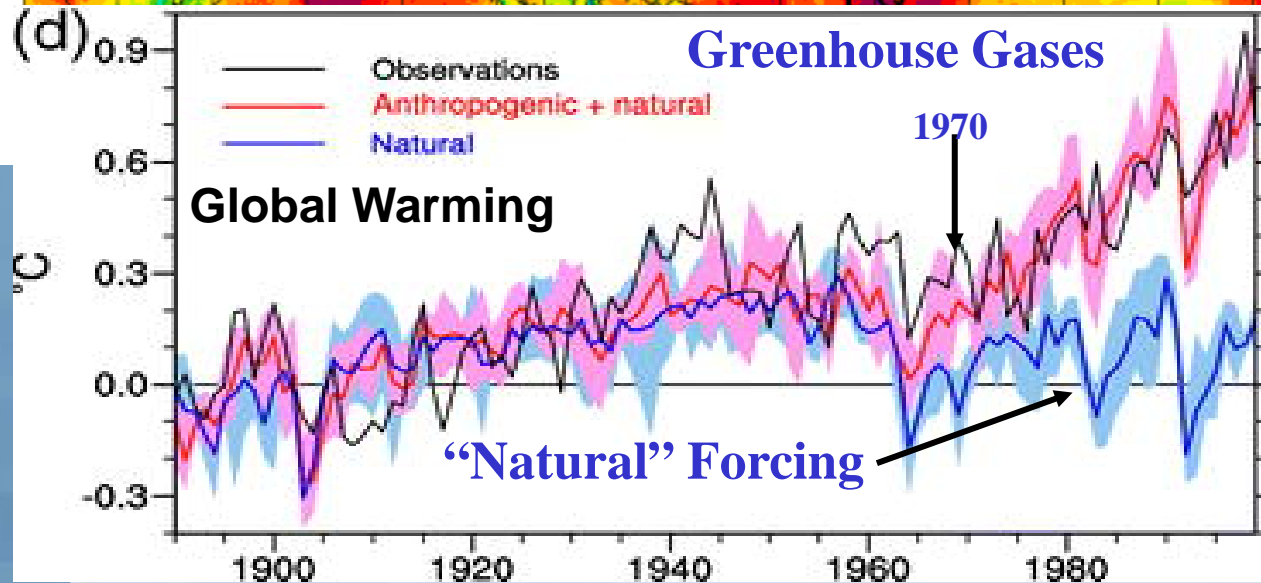
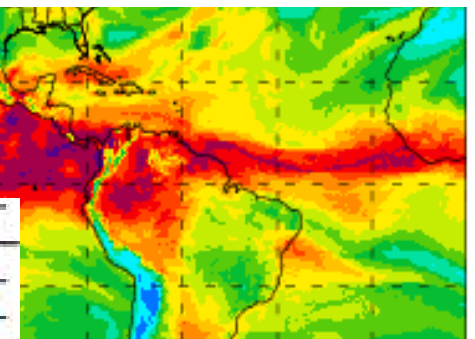
Advanced Community Models



36km Domain



Regional Climate

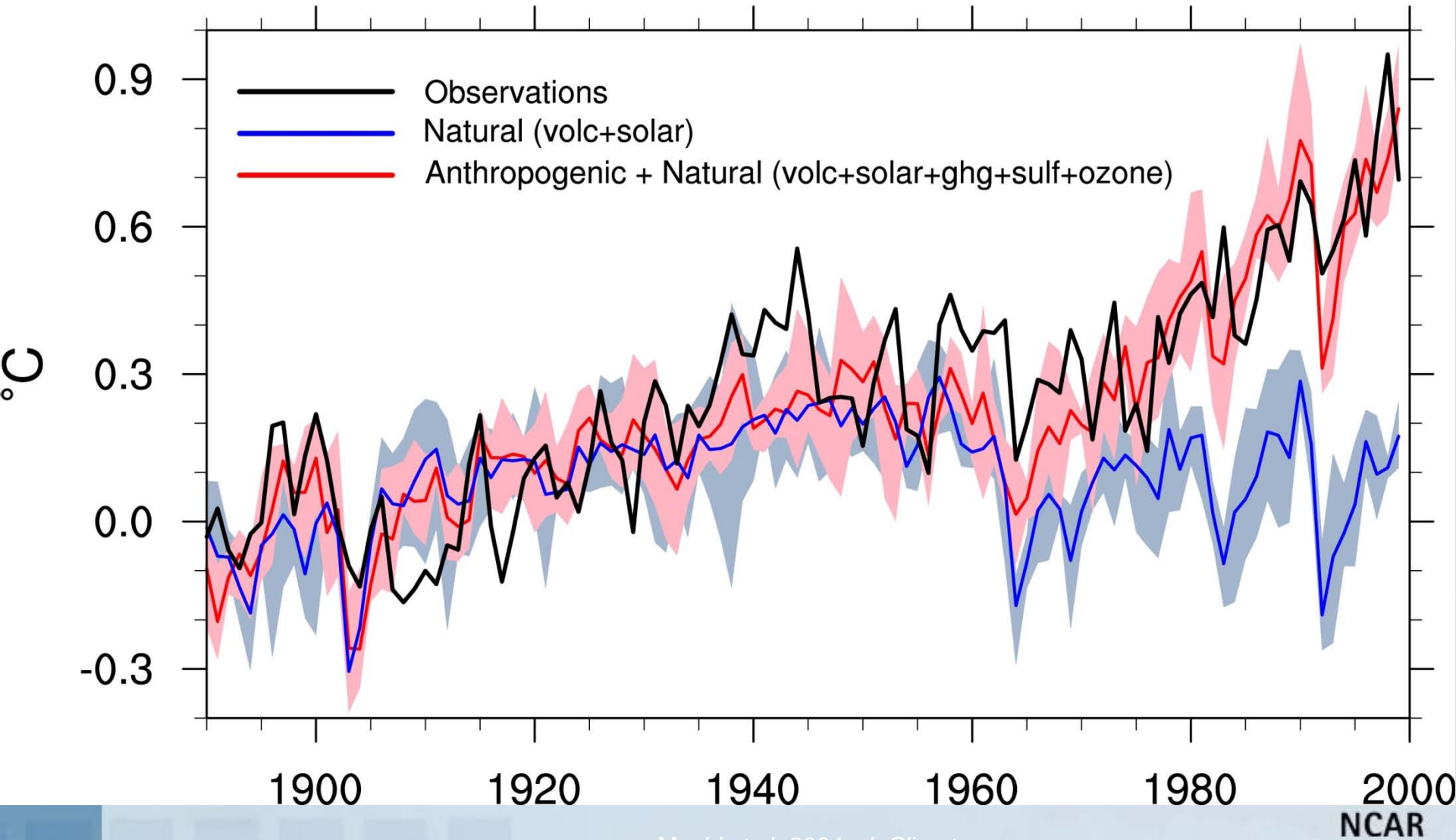


NCAR

Simulation of 20th Century Warming

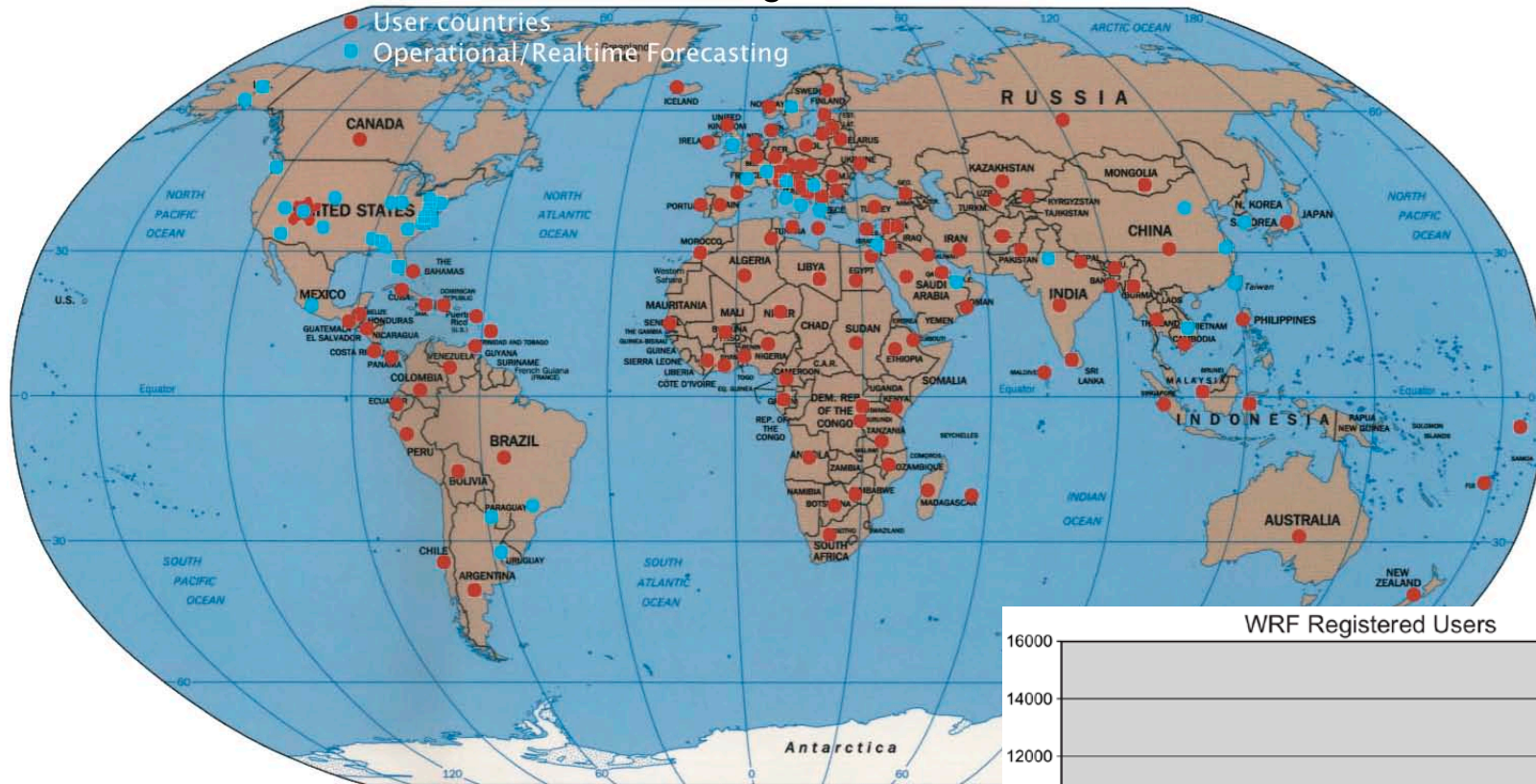
Global Temperature Anomalies

from 1890-1919 average



Worldwide WRF User Participation

134 Foreign Countries



Registered Users 6/20/11

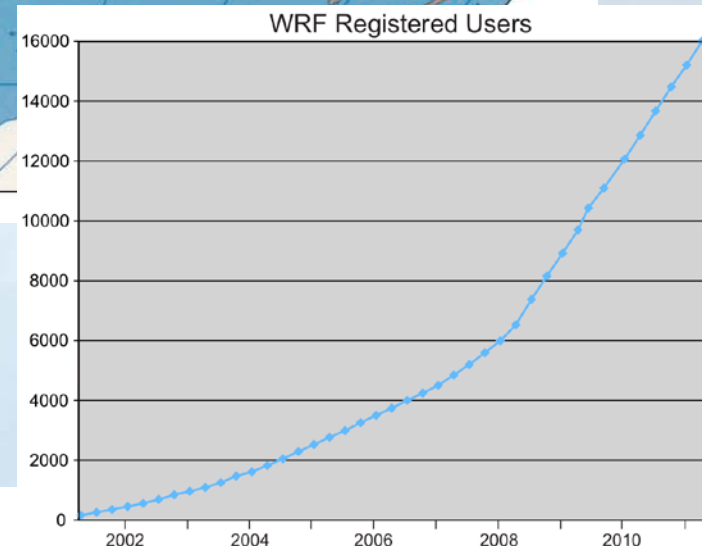
U.S. Universities, govt. labs,
and private sector

5543

Foreign users

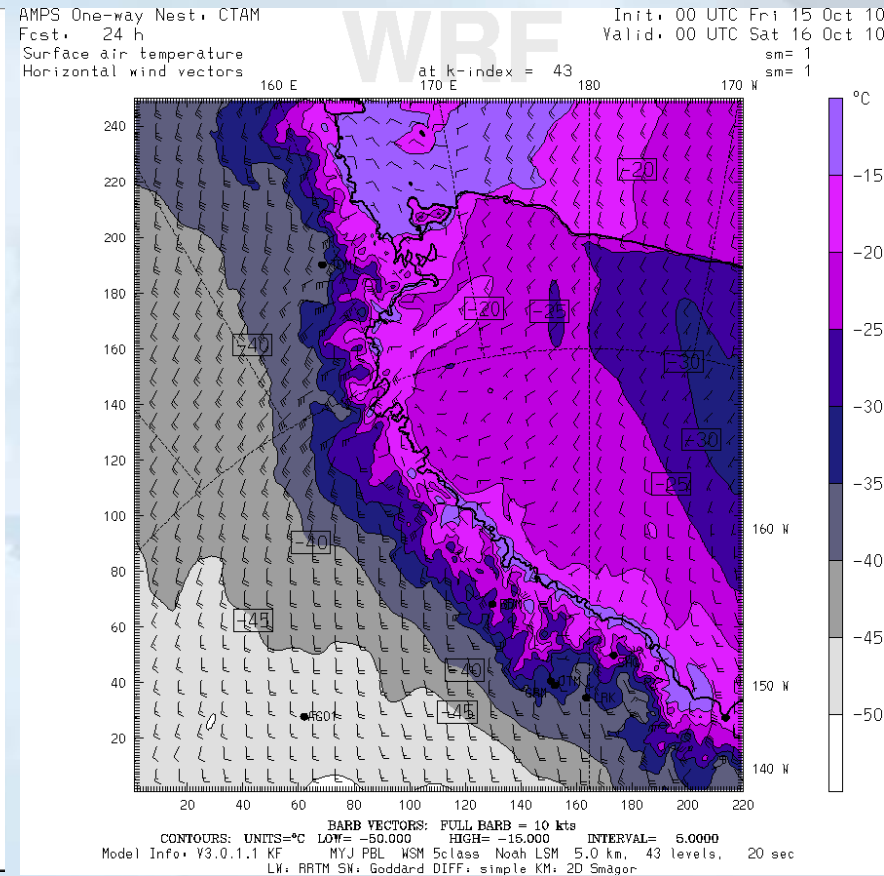
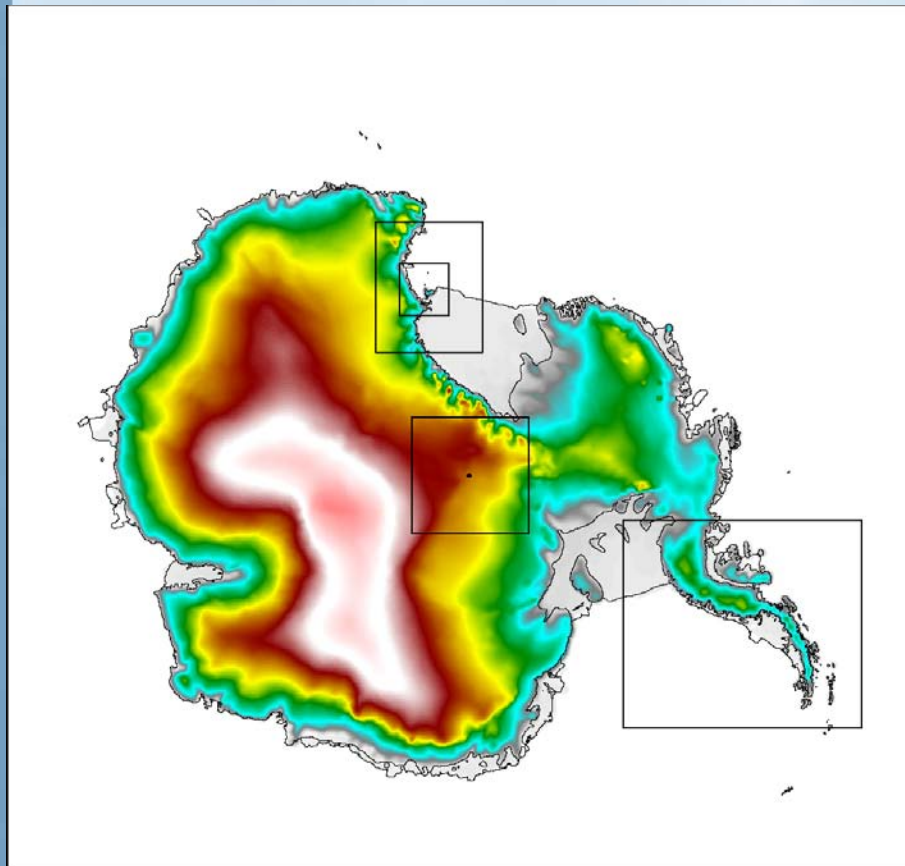
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16770



6080 active subscribers to wrf-news@ucar.edu

WRF Forecasting in Antarctica



The Nested Regional Climate Model

Jim Hurrell and Greg Holland

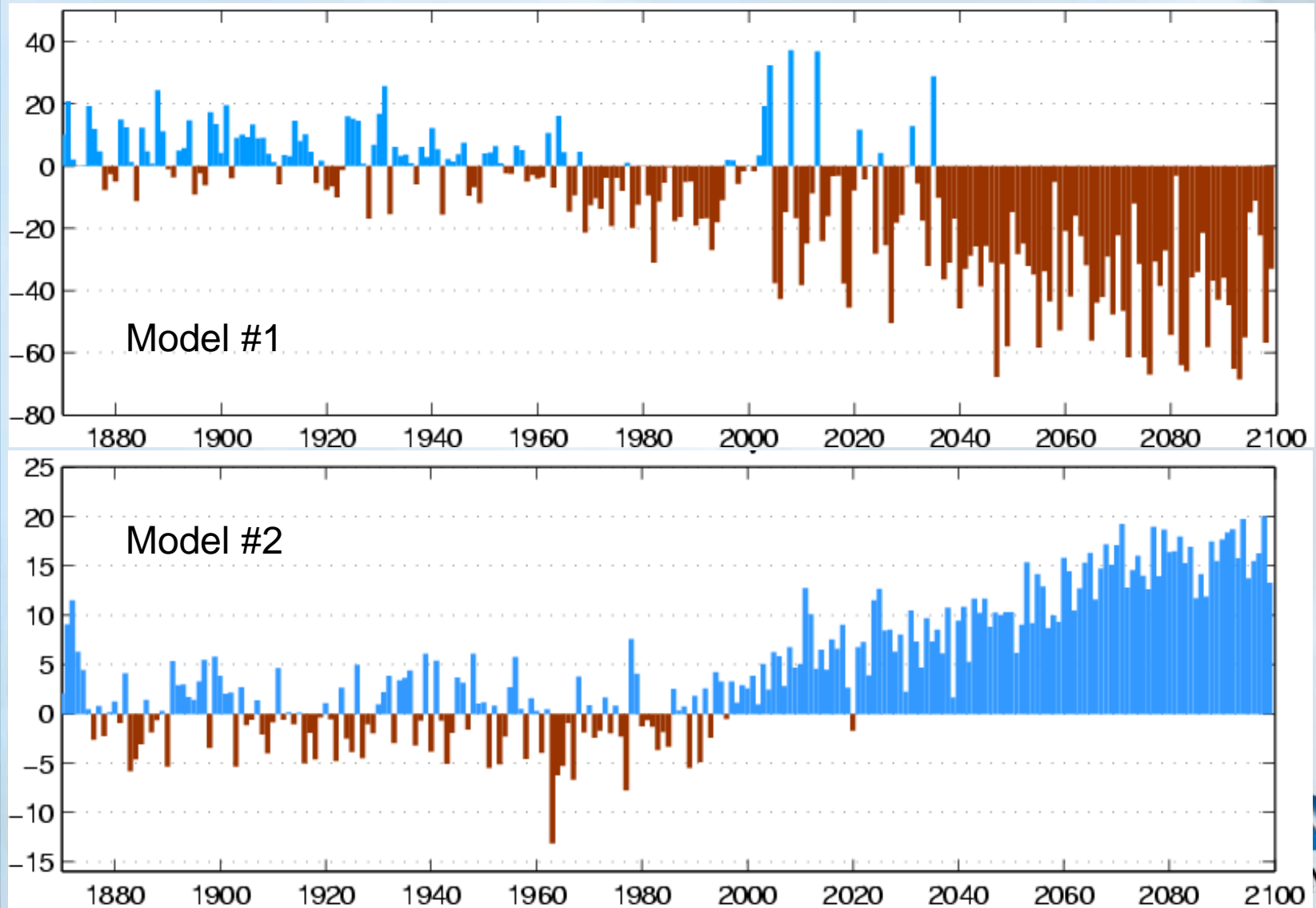
CGD and MMM, NCAR



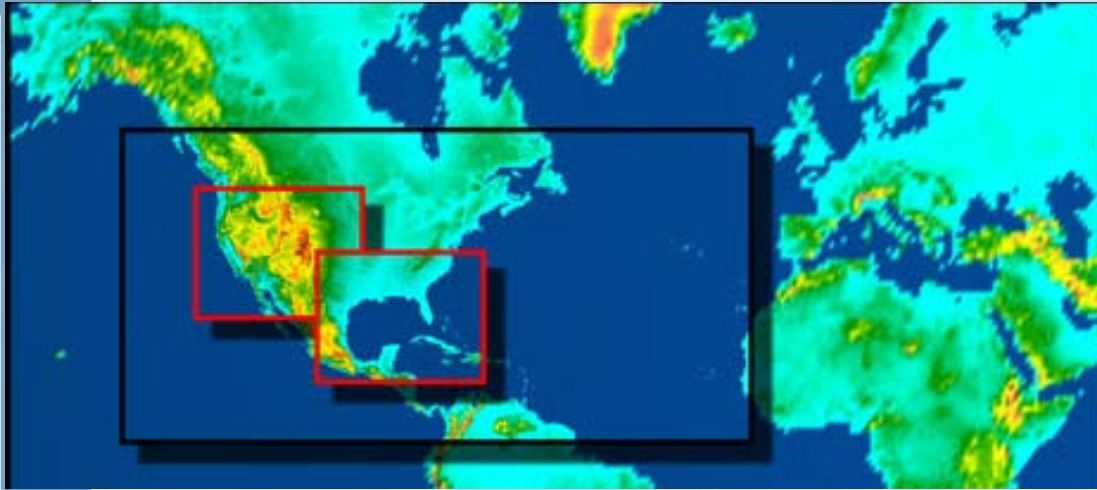
NCAR

Uncertainties in Regional Change

Sub-Saharan Rainfall



North Atlantic and North American Regional Climate Changes



The goal is to simulate the effects of climate change on precipitation across the intermountain West States and tropical cyclones, with a focus on the Gulf of Mexico.

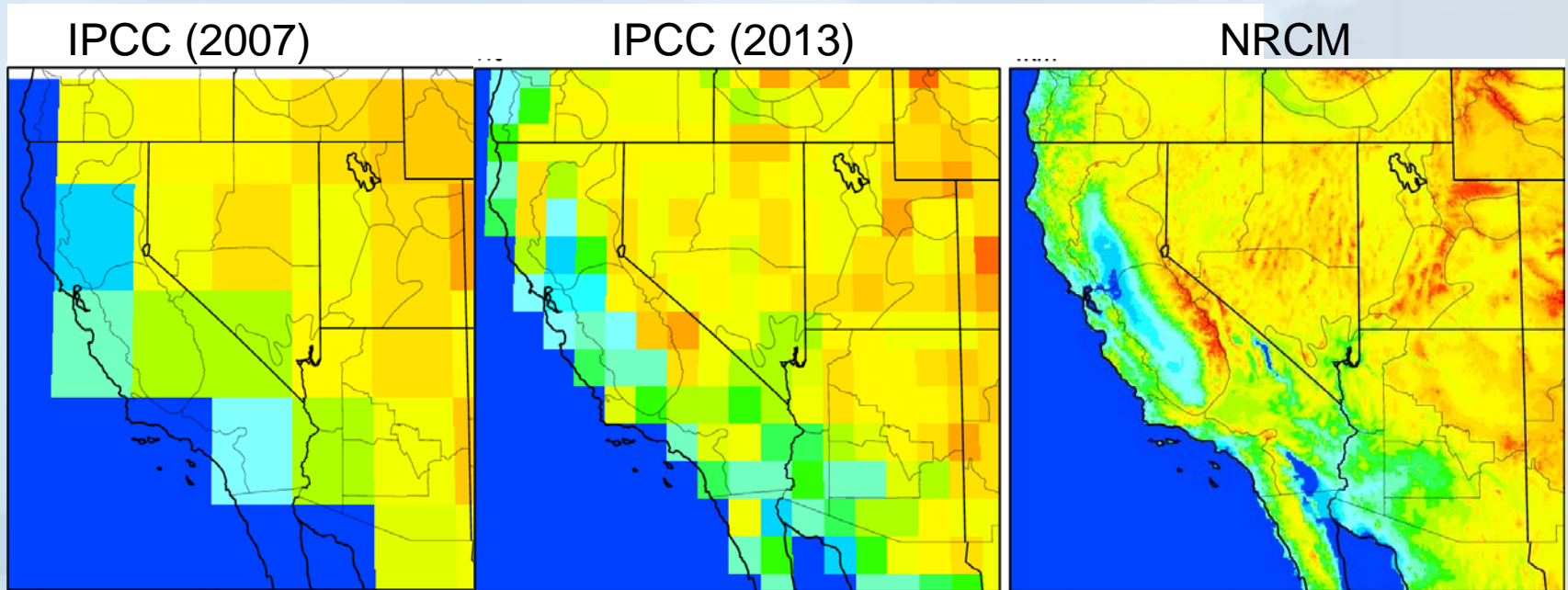
- 36, 12 and 4 km domains nested into CCSM
- 1996-2005, then time slices out to 2050
- Multi-member ensembles for each period
- Dedicated time on NCAR IBM Power 6 (Bluefire) since July:
 - 24 nodes (~20% of total number of processors)
 - 36 (12) km simulations use 128 (256) processors per job
 - Will use 3.9M processor hours through 11/08
 - ~300 Tb of data (to date); 450 Tb total (including earlier runs)



Improving Predictions of Regional Changes in Weather and Climate

The Nested Regional Climate Model

High Resolution Climate Modeling



NCAR



Climate 2.0 - Usable Science for Society

The fundamental question that society is asking of climate science has dramatically changed.

Climate 1.0 Is anthropogenic climate change occurring?

- Classic, low-resolution, global climate modeling (past 40 years)
- After broad acceptance of IPCC AR4 findings, the question is now....

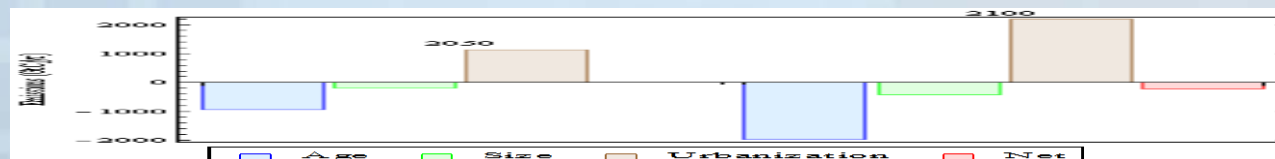
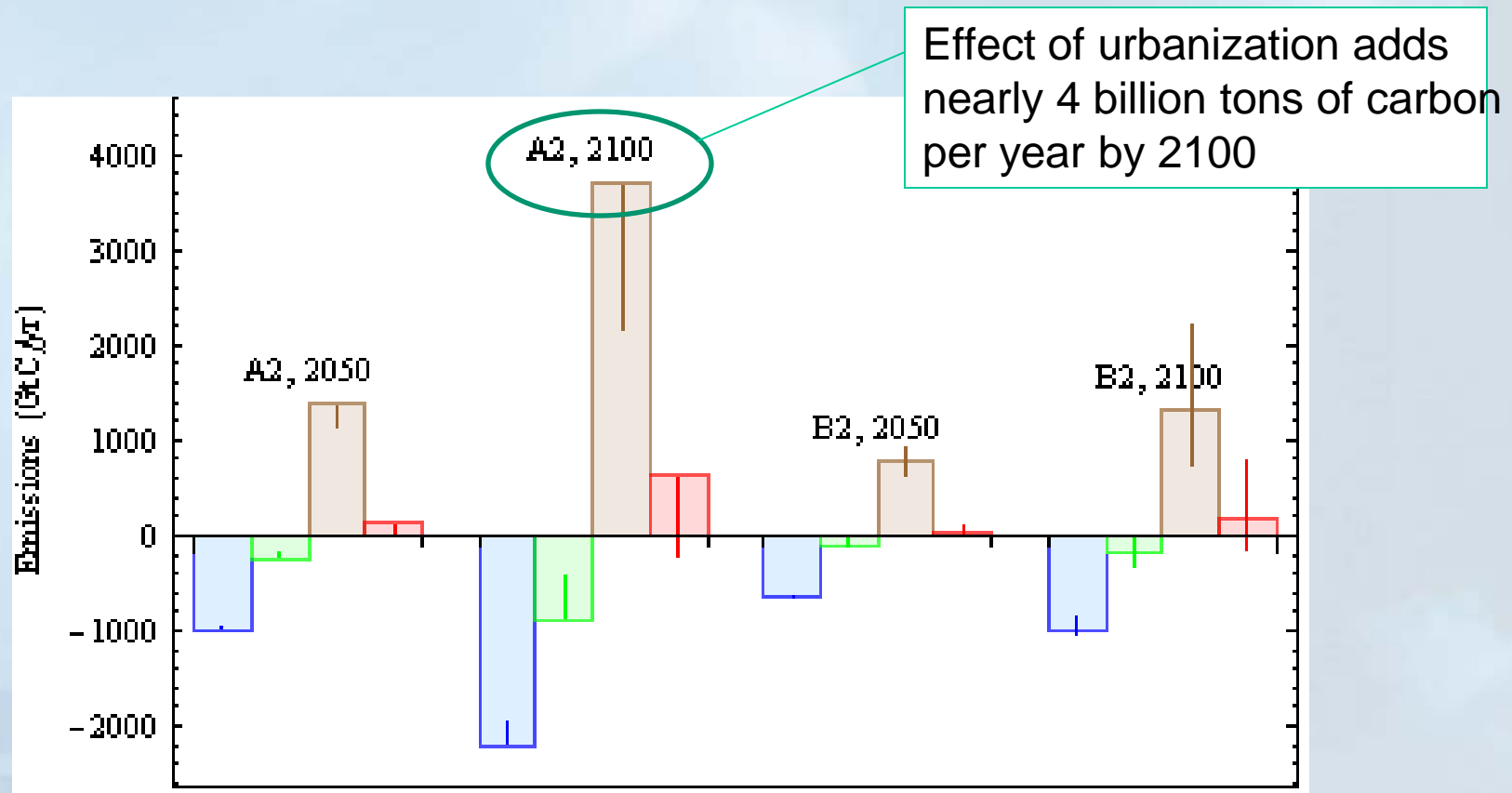
Climate 2.0 What is the impact of this climate change on our coupled human & natural systems?

- Magnitude and speed? Direct and indirect impacts?
- Adaptation and mitigation - options & limits?
- Regional/Local focus on “usable” science
- Sustainable Systems: Energy, Food, Water, Health, Cities, Ecosystems
- Societal Impacts: GIS, extremes, climate services

Addressing these much more complex, questions requires:

- Vast improvements to existing climate tools (CESM & WRF/NRCM)
- Integrating new approaches, priorities, capabilities,
- New collaborators & partners

Demographic composition effects on global emissions

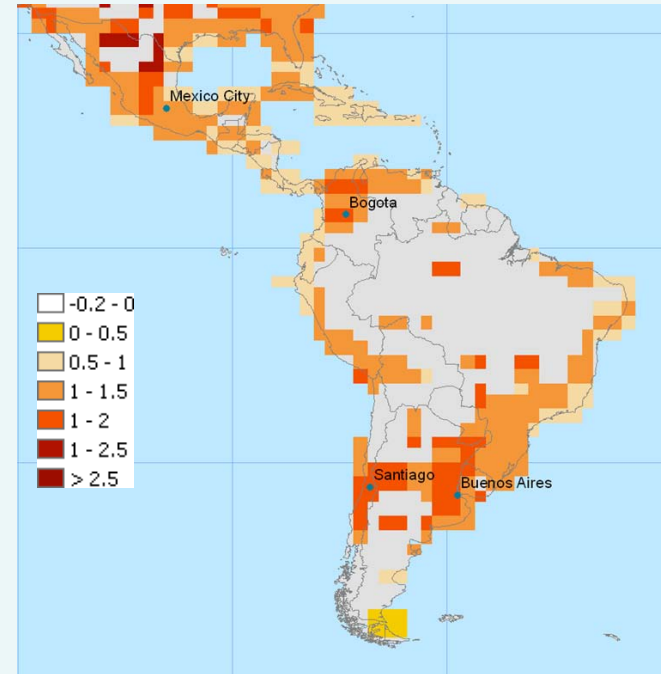


Urban development and vulnerability

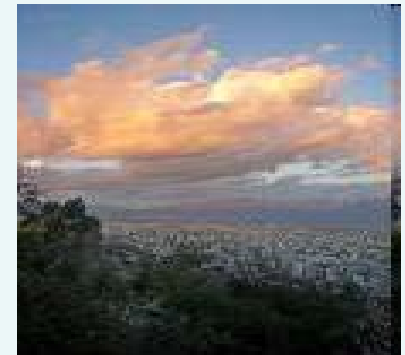
Paty Romero-Lankao

ADAPTE

- Cities and climate are co-evolving in a manner that could place more populations at risk from exposure to extreme temperature and air pollution
- ADAPTE brings together experts from different countries and disciplines
- Independent and combined effects of climate, air pollution and social vulnerability on health outcomes
- How populations are actually adapting



Projected increased severity of the worst annual heat events by 2030. CCSM-3 simulations A2 scenario
Source: Wilhelmi (2009).

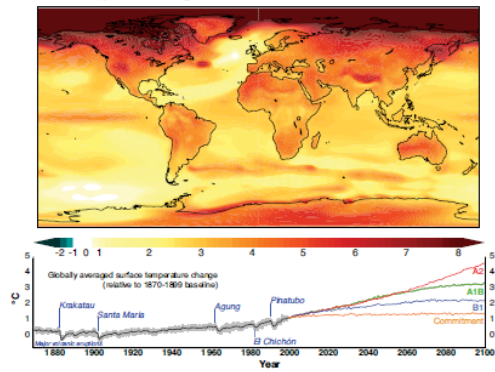


NCAR GIS Program

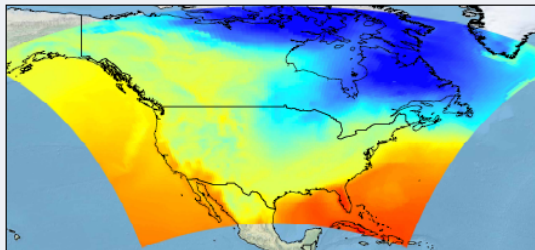
Climate Modeling

NCAR scientists carry out detailed, state-of-the-art climate simulations on some of the world's fastest supercomputers to develop insights on impacts of global and regional climate change affecting human and natural systems. Our GIS systems turn these petabytes of climate data into usable science for society.

Surface temperature change relative to 1870-1899 baseline CCSM3 IPCCAR4

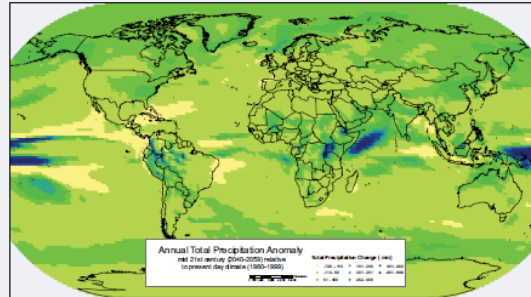


THE COMMUNITY CLIMATE SYSTEM MODEL (CCSM) IS A FULLY COUPLED GLOBAL MODEL OF THE EARTH'S PAST, PRESENT, AND FUTURE CLIMATE STATES [HTTP://WWW.CESM.UCAR.EDU](http://www.cesm.ucar.edu)

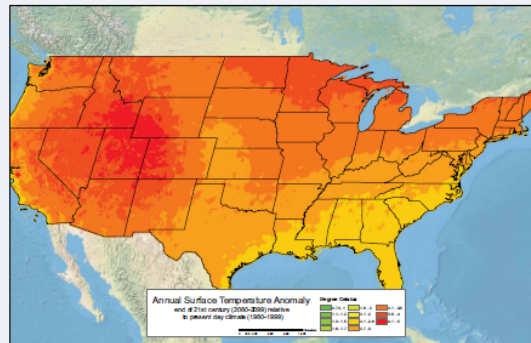


THE NORTH AMERICAN REGIONAL CLIMATE CHANGE ASSESSMENT PROGRAM IS AN INTERNATIONAL PROGRAM THAT PRODUCES HIGH RESOLUTION SIMULATIONS OF FUTURE CLIMATE ON A REGIONAL SCALE [HTTP://WWW.NARCCAP.UCAR.EDU](http://www.narccap.ucar.edu)

GIS Climate Change Portal

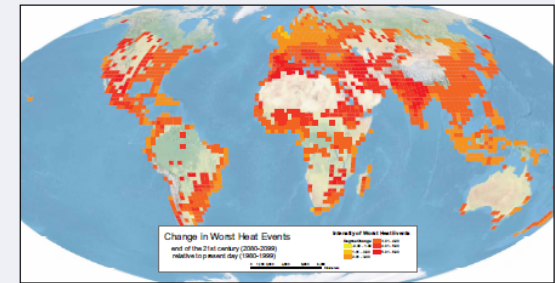


The GIS Program at NCAR provides access to climate change projections generated by the Community Climate System Model through the GIS Climate Change portal. The portal serves a community of GIS users interested in climate change research and applications.

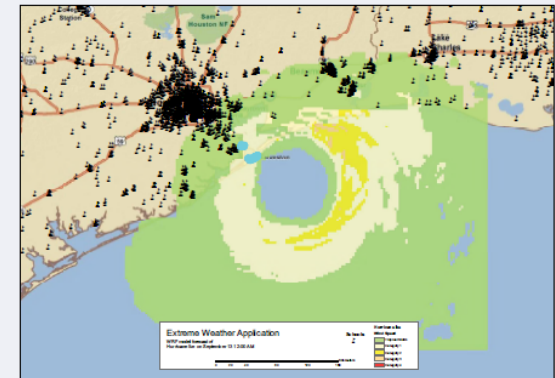


Research Enabled by GIS

NCAR scientists conduct research that integrates the Earth system and social sciences in a GIS. Research examples illustrate how simulations from global climate and weather forecast models are being analyzed in a GIS with respect to societal vulnerability to, for example, urban heat waves and tropical cyclones.



ANALYSIS OF CCSM SIMULATIONS OF PRESENT-DAY AND FUTURE CLIMATE WITH RESPECT TO THE URBAN HEAT ISLAND EFFECT AND FUTURE HEAT WAVES.



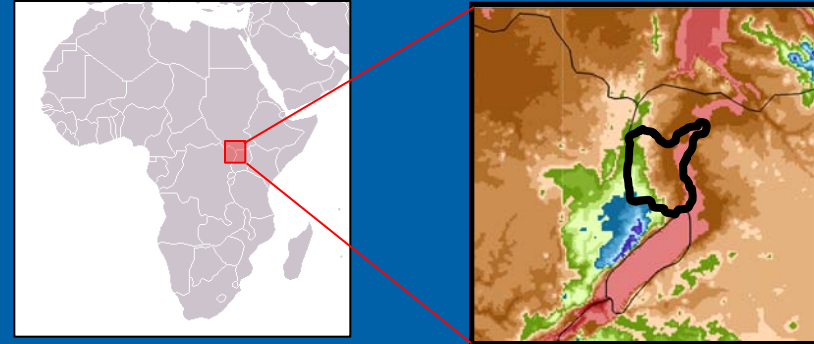
INTERACTIVE, ARCGIS SERVER-BASED WEB APPLICATION INTEGRATES WEATHER RESEARCH AND FORECASTING (WRF) HURRICANE FORECAST MODEL OUTPUT WITH SOCIOECONOMIC AND INFRASTRUCTURE DATA. [HTTP://WRF-MODEL.ORG](http://wrf-model.org)

Weather, Climate and Health

Mary Hayden, Andy Monaghan

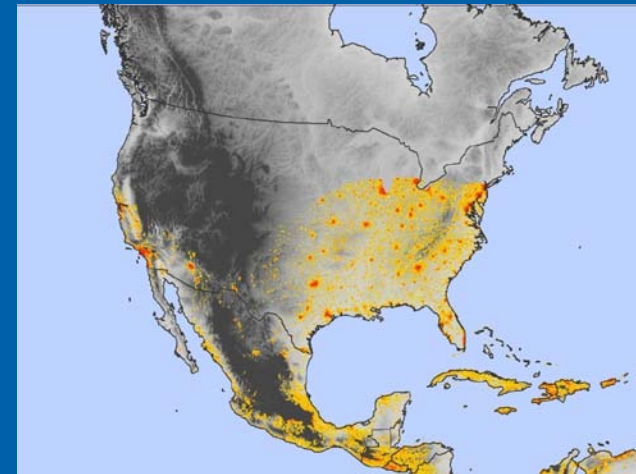
**Uganda: CDC Modeling Human
Plague Incidence**

Ghana: The WX-Meningitis Project



**Phoenix: An Framework of local Vulnerability
& Adaptive capacity to Extreme Heat**

**North America: *Aedes aegypti* range
expansion in the Americas
Mexico: Dengue transects**



Water Systems

Roy Rasmussen



Water System Program

Global Water Cycle Studies

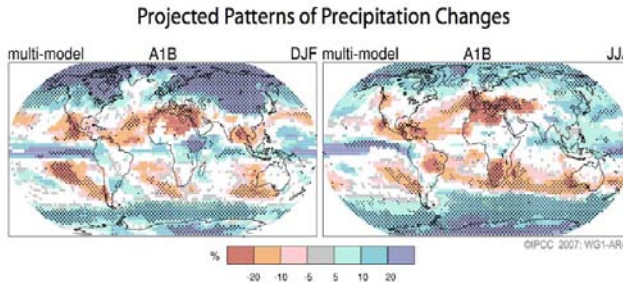
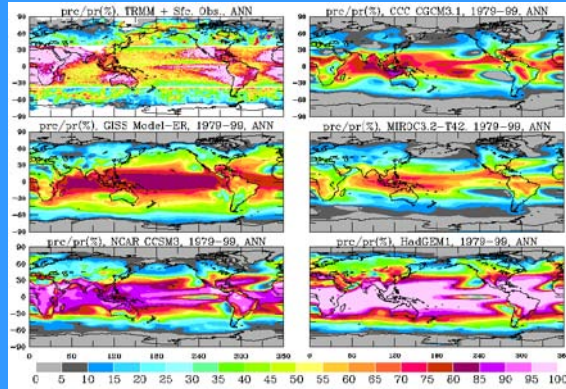
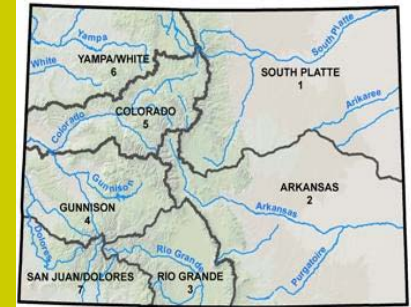


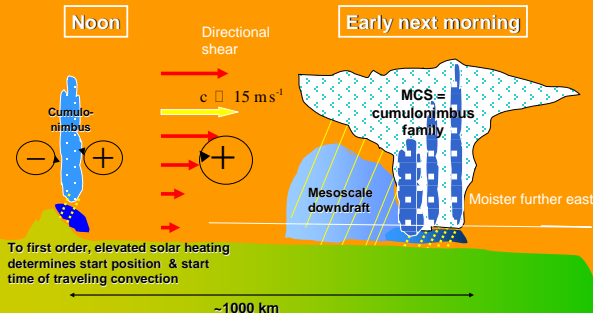
FIGURE SPM-7. Relative changes in precipitation (in percent) for the period 2000-2099, relative to 1980-1999. Values are multi-model averages based on the SRES A1B scenario for December to February (left) and June to August (right). White areas are where less than 66% of the models agree in the sign of the change and stippled areas are where more than 90% of the models agree in the sign of the change. (Figure 10.9)

Colorado Headwaters

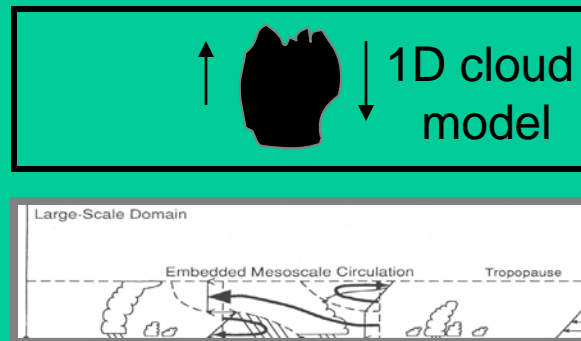


How Does the Water Cycle Change as Climate Changes?

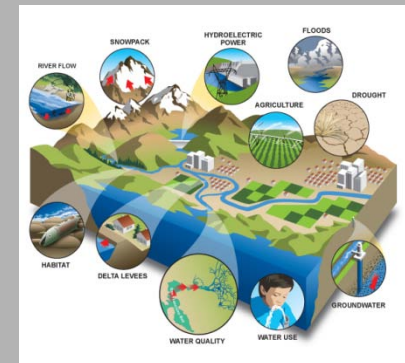
Diurnal Cycle of Precipitation In the Lee of Topography



Convective Parameterization



Societal Impacts



Challenge of Predicting Water Cycle Changes under Climate Change

IPCC IV Projected precipitation changes in global climate models over regions where people live (+/- 50 latitude) mostly show low confidence (less than 66% of the models agree on the sign of the precipitation change, white region). This is especially true in northern hemisphere summer and southern hemisphere winter (red outlines).

Projected Patterns of Precipitation Changes

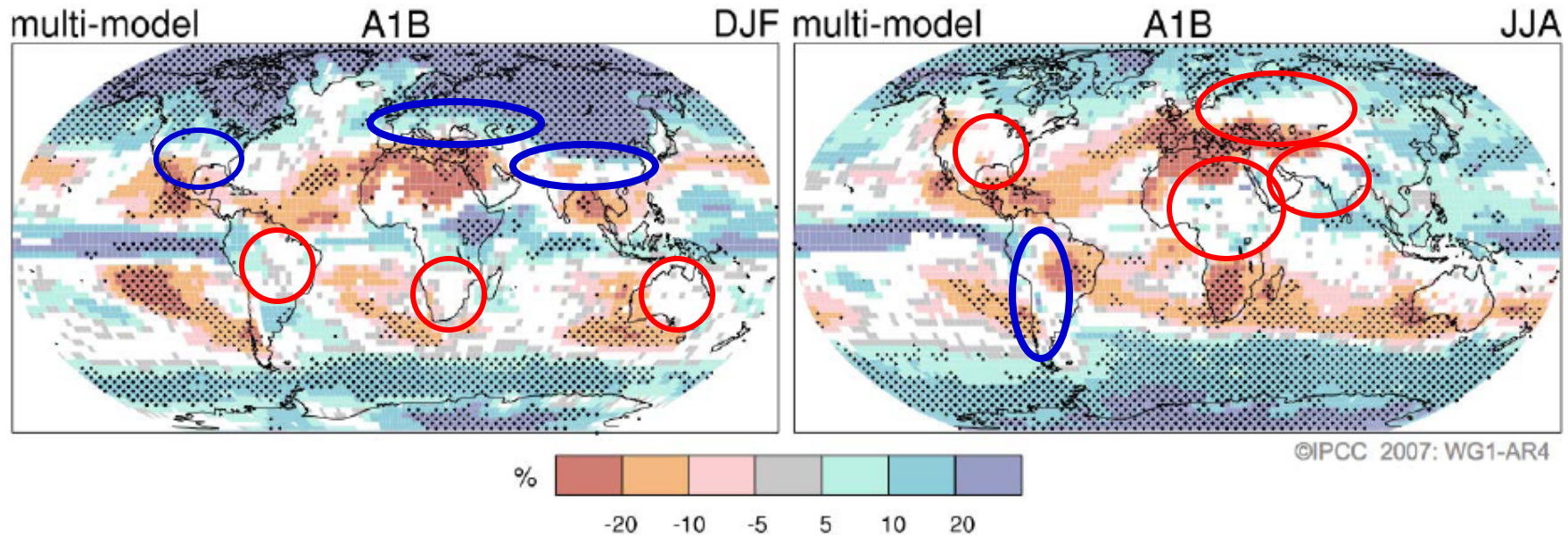


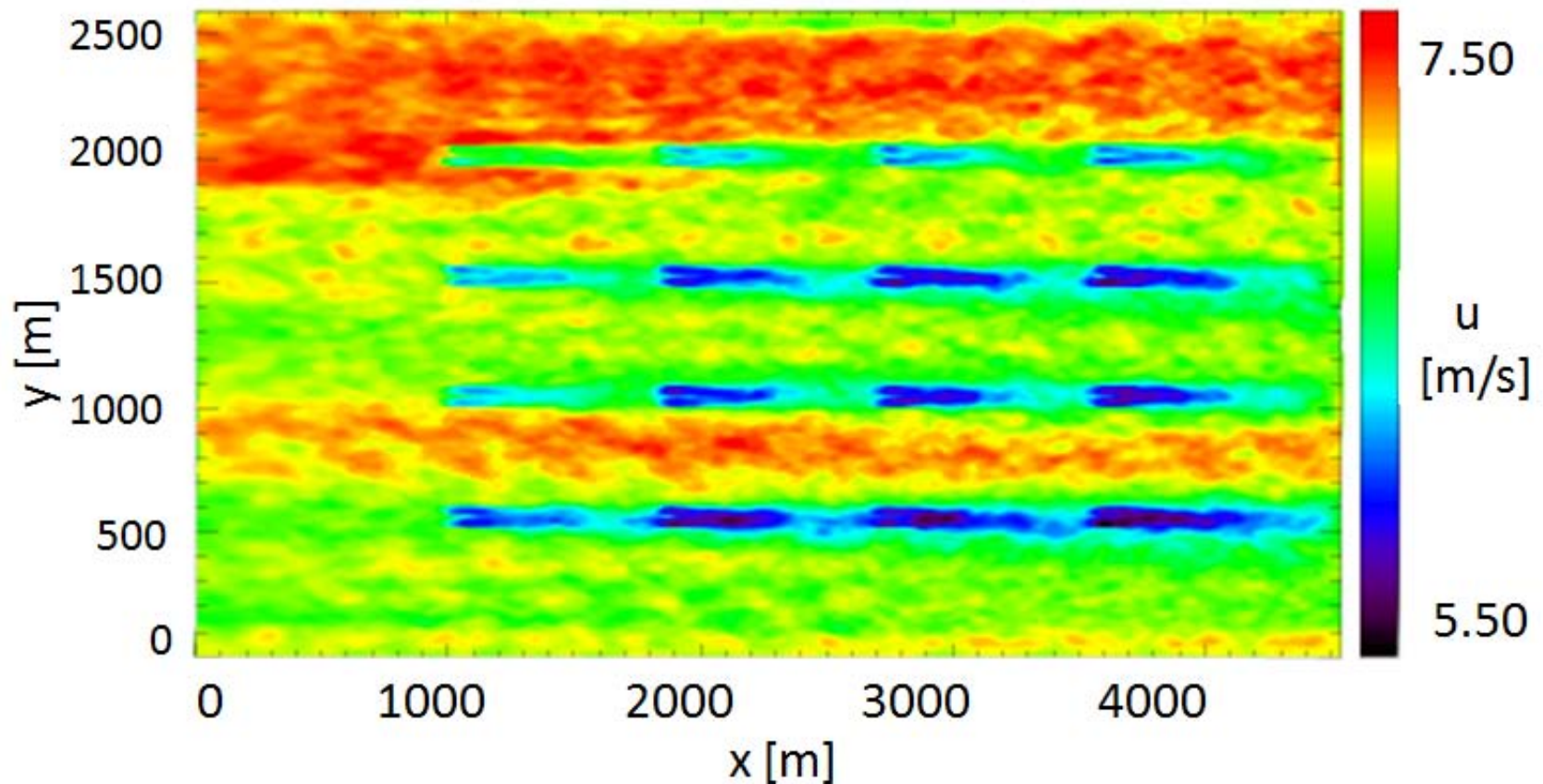
FIGURE SPM-7. Relative changes in precipitation (in percent) for the period 2090–2099, relative to 1980–1999. Values are multi-model averages based on the SRES A1B scenario for December to February (left) and June to August (right). White areas are where less than 66% of the models agree in the sign of the change and stippled areas are where more than 90% of the models agree in the sign of the change. {Figure 10.9}

Renewable Energy

Sue Ellen Haupt



Wake Effects of an Array of Wind Turbines

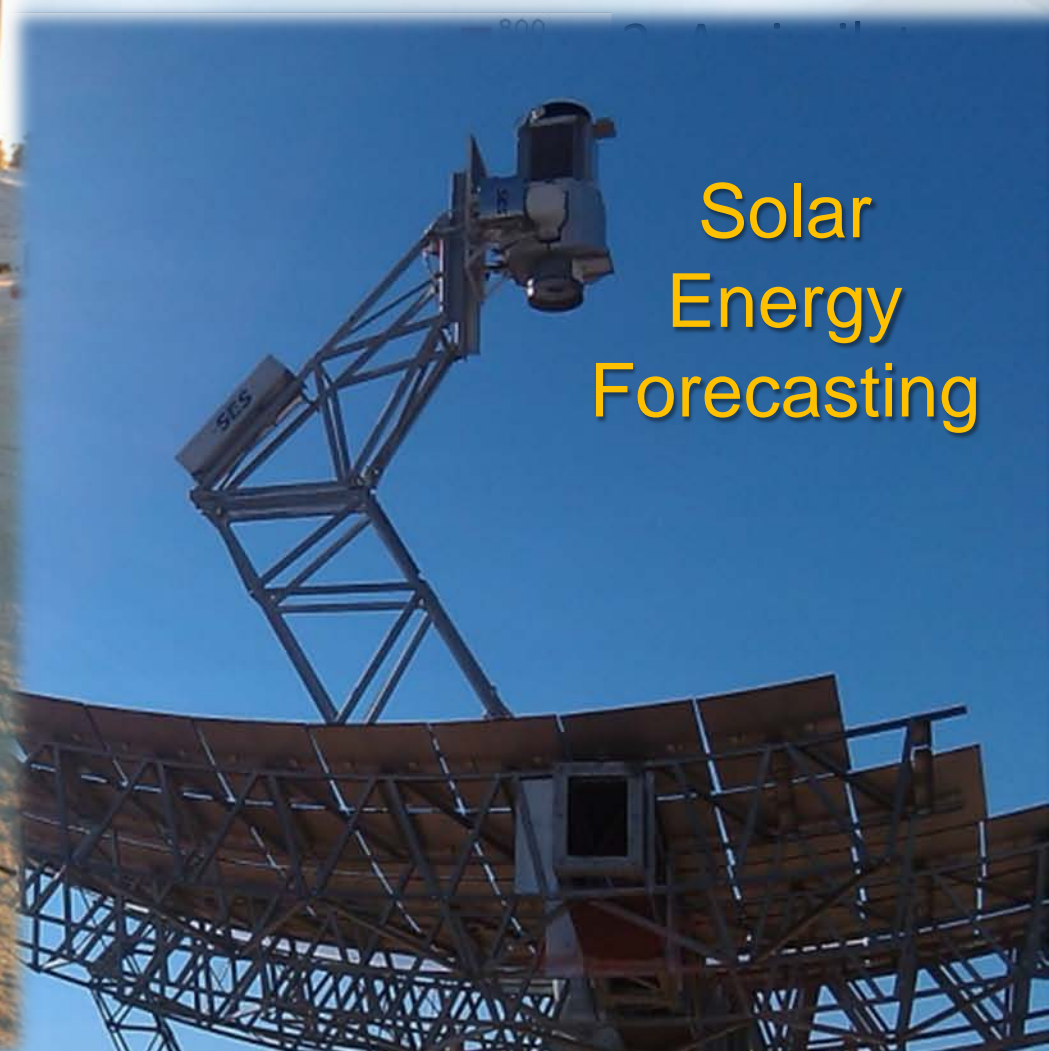


Future R&D Efforts

Blending Mesoscale and
Microscale Models

Forecasting
Blade Icing

Solar
Energy
Forecasting



Thank You

