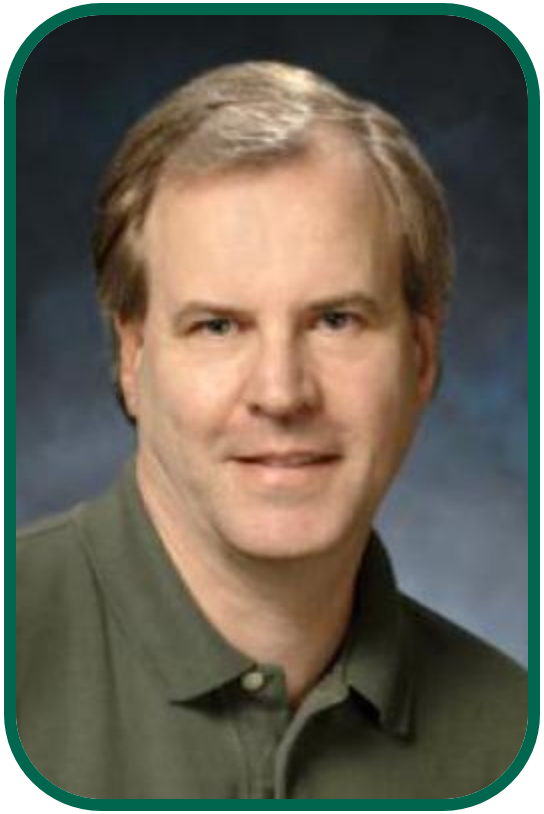
An Adventure in Climate Modeling and Science Policy

Warren M. Washington
National Center for Atmospheric Research

January 2010
American Meteorological Society Annual Meeting

NCAR

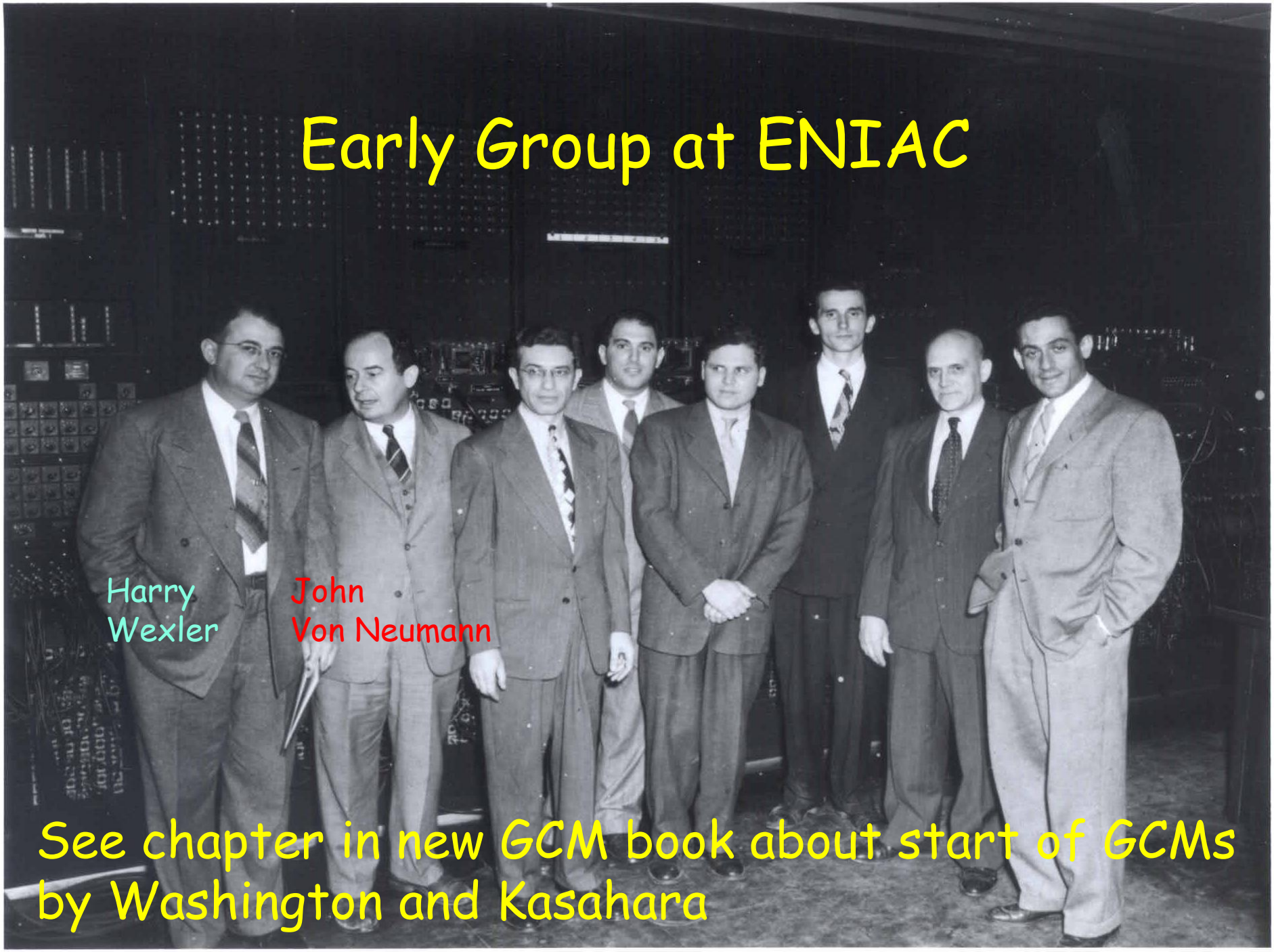
Thanks to Jerry Meehl and Dave Bader



Topics

- Photos of pioneers in climate modeling
- Low emission advice for policymakers
- Some personal reflections on mixing science with policy

Early Group at ENIAC



See chapter in new GCM book about start of GCMs by Washington and Kasahara


Jule Charney
Norman Phillips
Phil Thompson
??
George Platzman


Bert Bolin
Joe Smagorinsky

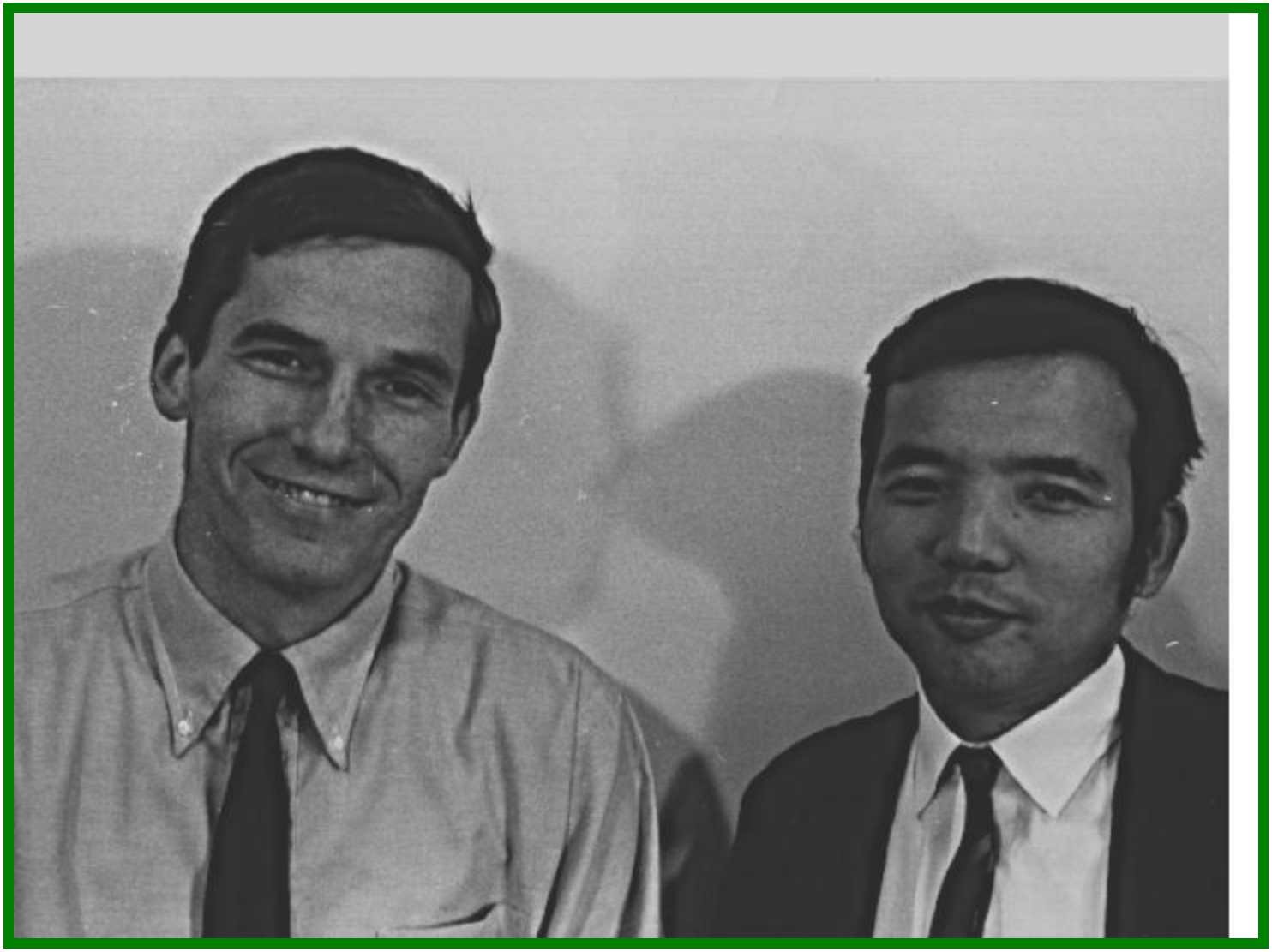
Members of the Numerical Weather Prediction Group (ca. 1955). Kanzaburo Gambo, leader of the group is sitting third from the left. Others are Akio Arakawa (sitting, far left) Akira Kasahara (sitting, second from right), Yoshio Kurihara (standing, fifth from right), Kiduro Miyakoda (standing, eighth from right), Syukuro Manabe (standing, far left), Takio Murakami (standing, second from right), and Katsuyuki Ooyama (standing, fourth from left).

John Lewis, AMS Bulletin

Professor Syono with students and Associate Professor Isono in a classroom at the Geophysical Institute, University of Tokyo (ca. 1955). From left to right: Kenji Isono, Masahiko Aihara, Michio Yanai (standing), Shigekata Syono, Kikuro Miyakoda, Syukuro Manabe, unknown partially obscured). Makoto Komabayashi, and unknown (partially obscured).

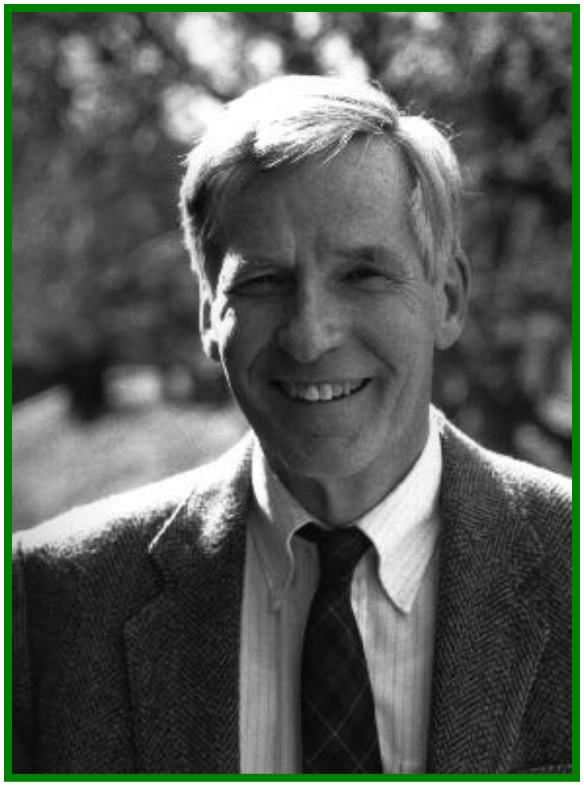
John Lewis, AMS Bulletin

Kirk Bryan and Suki Manabe in the early days



GFDL Pioneers in building and coupling Atmospheric and Ocean Models

Suki Manabe



Kirk Bryan

Chuck Leith, LLNL
" a one man effort"

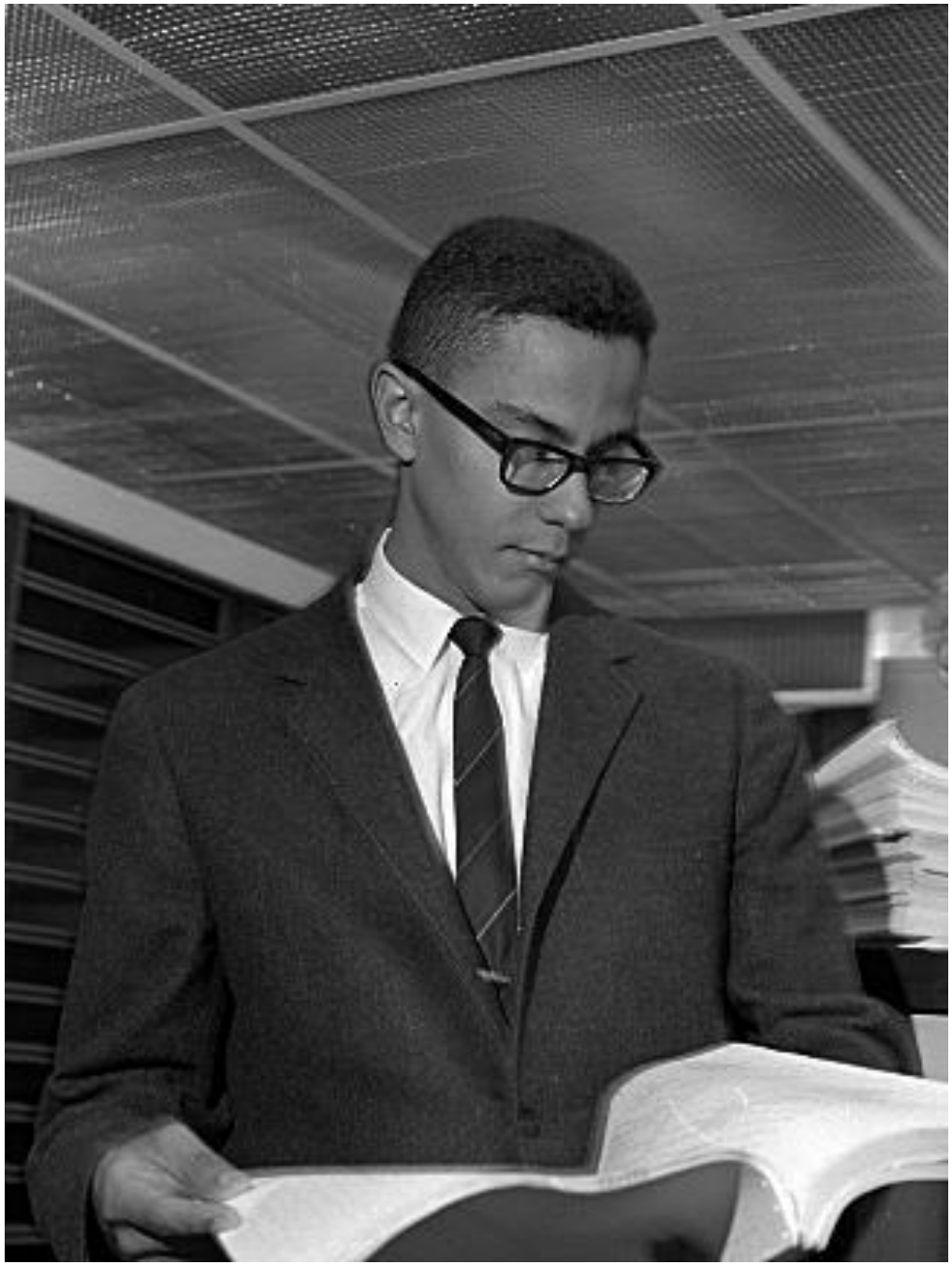
UCLA Group

Yale Mintz

Akio Arakawa

NCAR's
Akira Kasahara

NCAR's
Warren Washington



OSU and Rand Group
Larry Gates and Michael Schlesinger

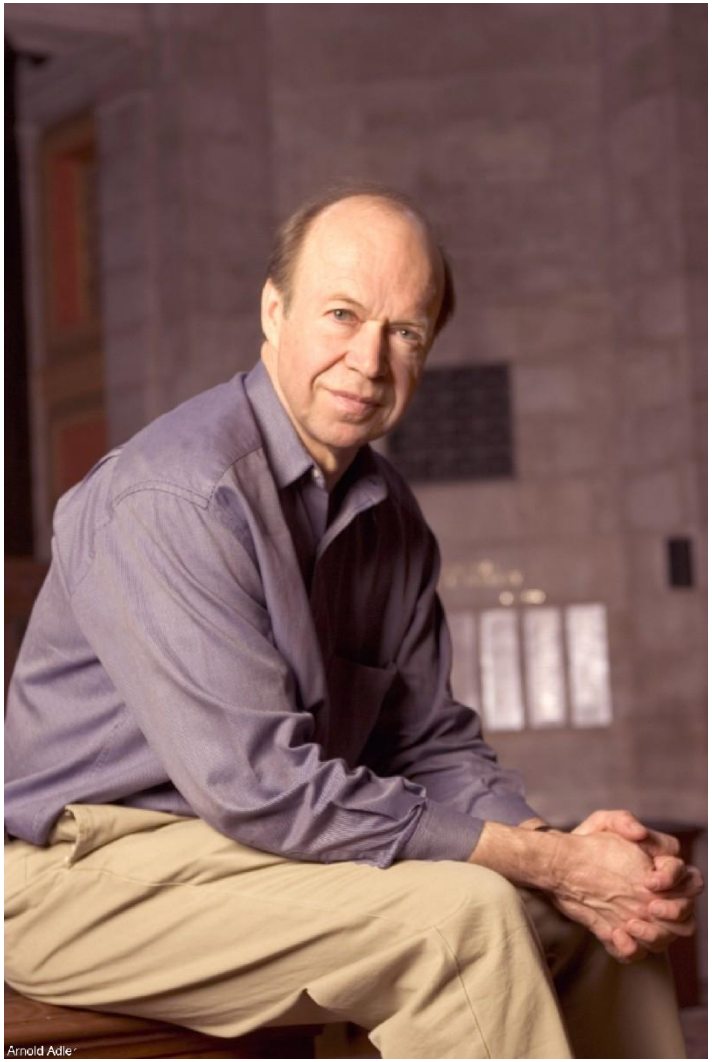
Keep it simple for three reasons:

- Computers were slow
- Our understanding of physical processes was so limited…do first order treatments
- Try only one thing at a time to understand what is causing what to change in the model…can't do this anymore

Steve Schneider

Recent book:
Science as a Contact Sport

Jim Hansen



Recent Book:
Storms of My Grandchildren:
The Truth About the Coming Climate Catastrophe and Our Last Chance to Save Humanity

Some of my Collaborators with my wife Mary

Bert Semtner, Larry King and Bob Chervin

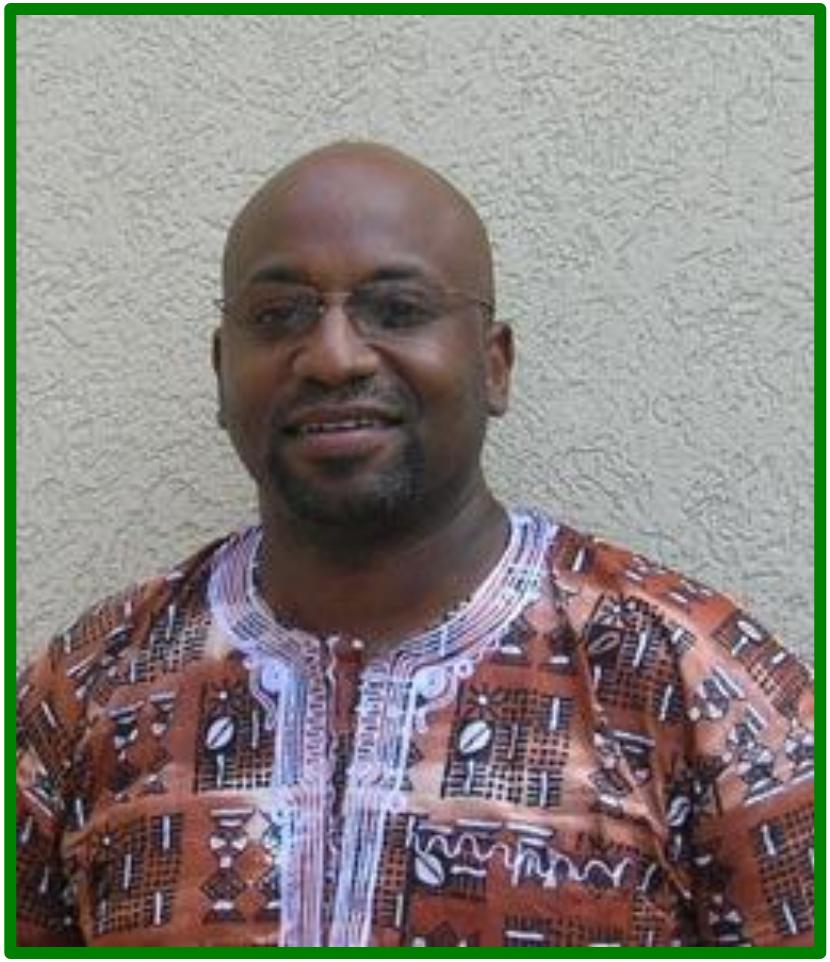
John Kutzbach
"modeling past climates"

V. Ramanathan

"trace gases, aerosols, monsoons, climate change feedbacks"

Greg Jenkins (Howard University)

"Helping understand the climate and climate change of West Africa"



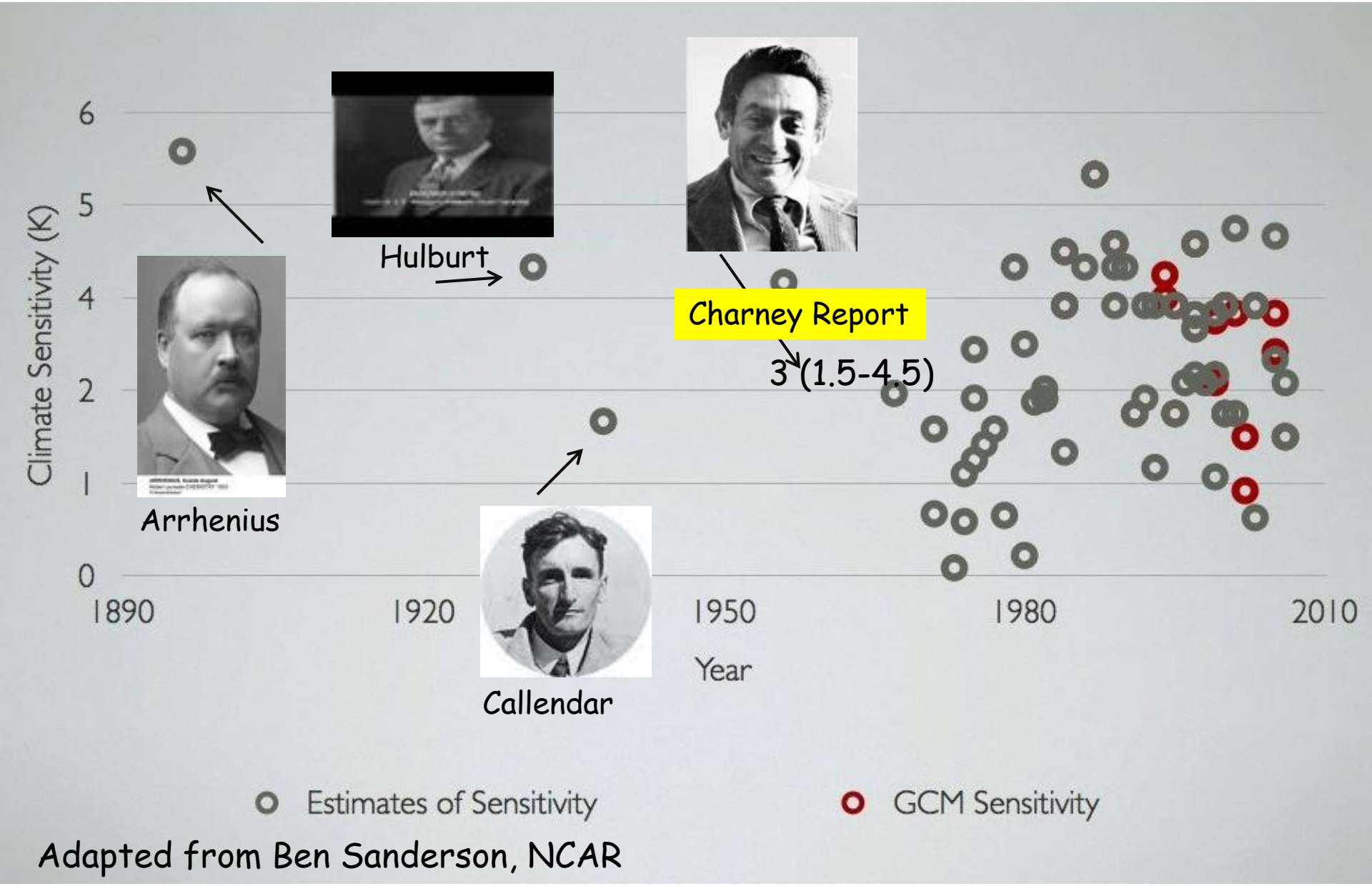

Julie Arblaster
Aixue Hu
Lawrence Buja
Jerry Meehl
Warren Washington
Gary Strand
Haiyan Teng
Adrianne Middleton
David Lawrence
Stephanie Shearer

Colleagues, Friends and Family at the Warren Washington Symposium, NCAR 2007

Low Emission Future Climate Change Simulations

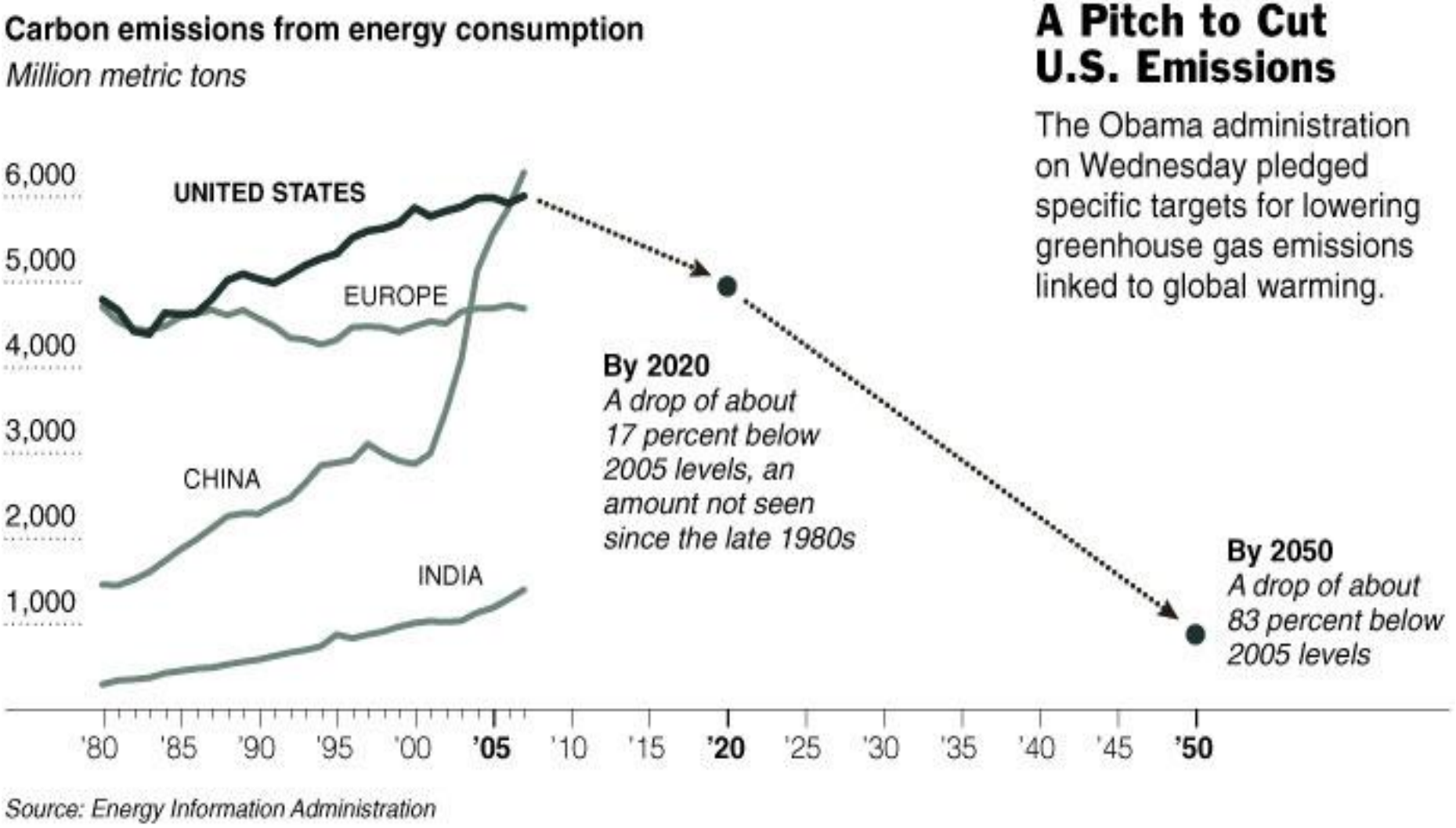
- Can we stabilize global warming using the Climate Change Science Program (CCSP) and CMIP5 RCP scenarios?
- Can we limit global warming to 2°C or less from years 1870 to 2100?
- What are the climate change impacts on surface temperature, precipitation, sea ice, permafrost, and heat waves?

Climate Sensitivity Estimates



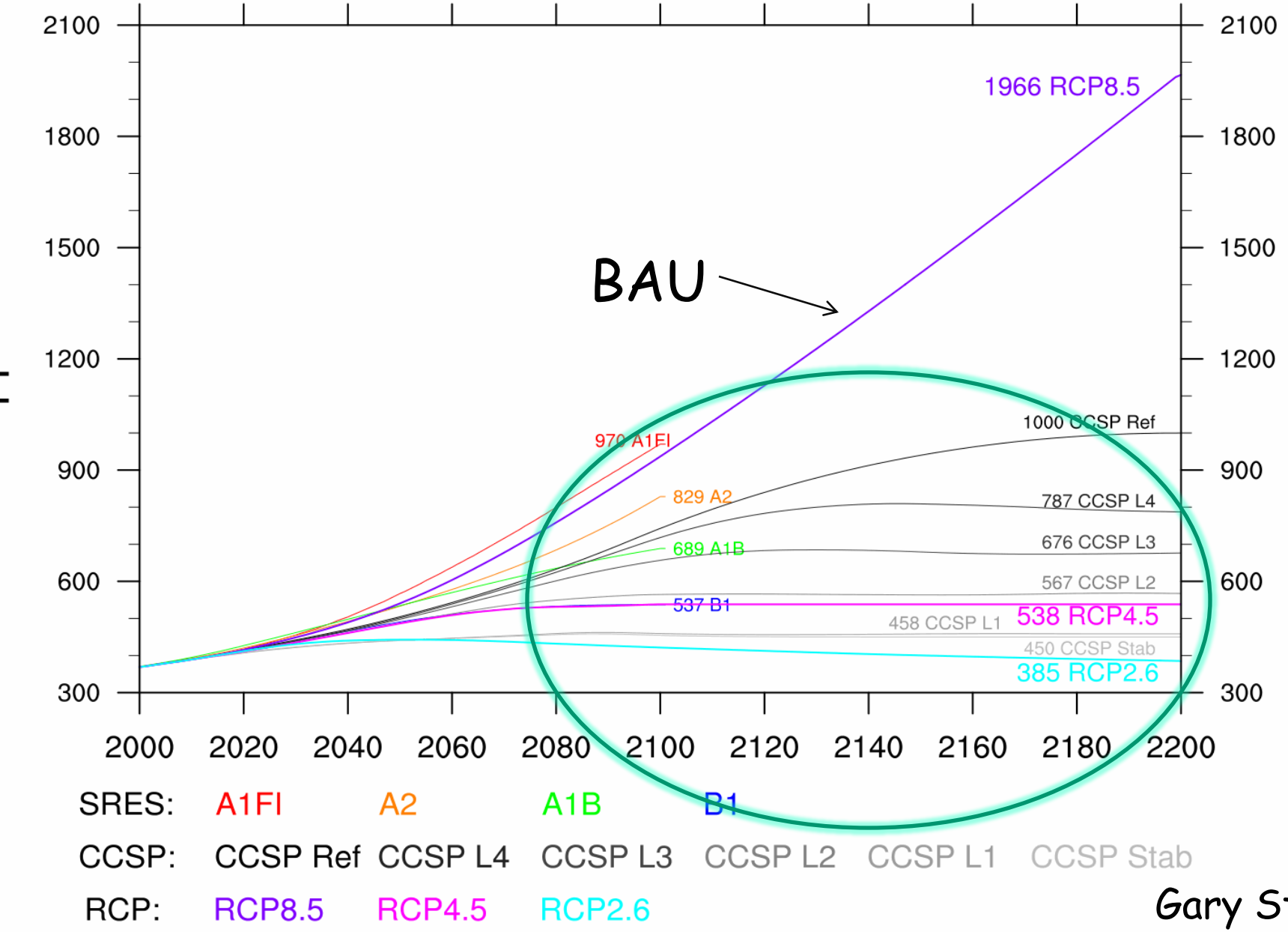
Adapted from Ben Sanderson, NCAR

Carbon Emissions (Four Biggest)

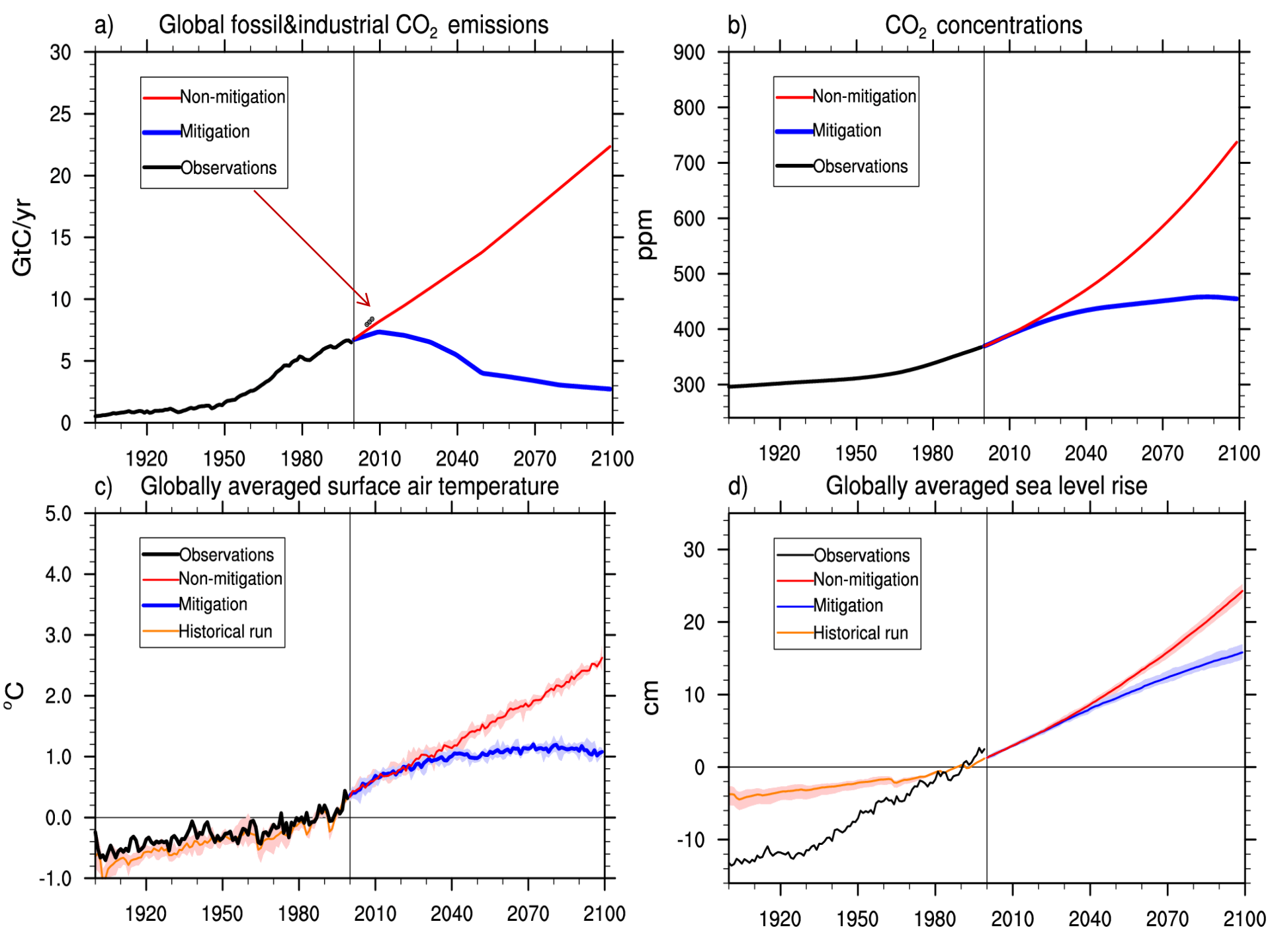


NY Times , 26 November 2009

CO_2 concentrations



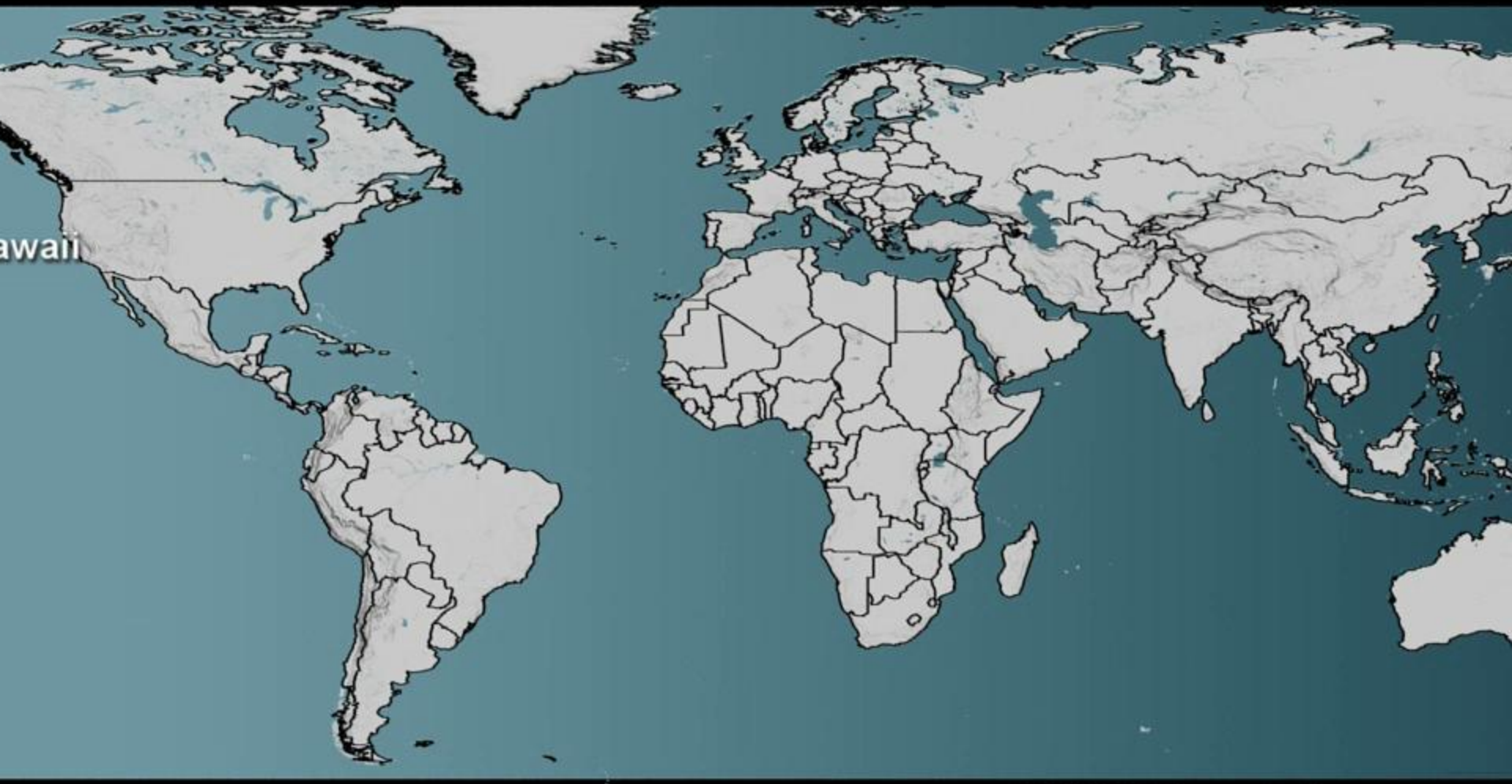
Gary Strand


a) Global fossil&industrial CO_2 emissions
GtC/yr
Non-mitigation
Mitigation
Observations
b) CO_2 concentrations
ppm
c) Globally averaged surface air temperature
°C
Historical run
d) Globally averaged sea level rise
cm
1920
1950
1980
2010
2040
2070
2100

Conclusions

- Sizeable cuts in emissions are required…in the range of 70-80%
- "Real" climate sensitivity is not known
- Next IPCC assessment will have more realistic models but sizeable uncertainties and model biases will still exist. There will still be a range of climate sensitivity similar to what was in the Charney Report.

AIRS Mid-Tropospheric Carbon Dioxide



Sep 2002

AIRS CO2 Concentration

364 368 371 375 379 382 386

ppmv

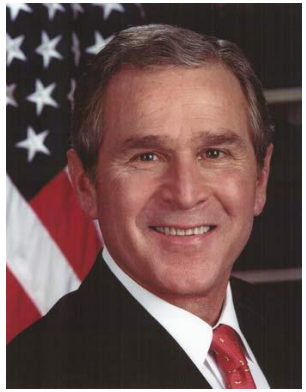
Advising Six Presidents:

Carter

Reagan

Bush, Sr.

Clinton



Bush, Jr.

Obama

Discuss different policies!

Credits

Stephanie Shearer, NCAR/CGD assisted in preparing this presentation.

The End

Again I want to thank you all for contributing to this symposium.

Retrospective View of Early Climate Modeling

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National Center for Atmospheric Research

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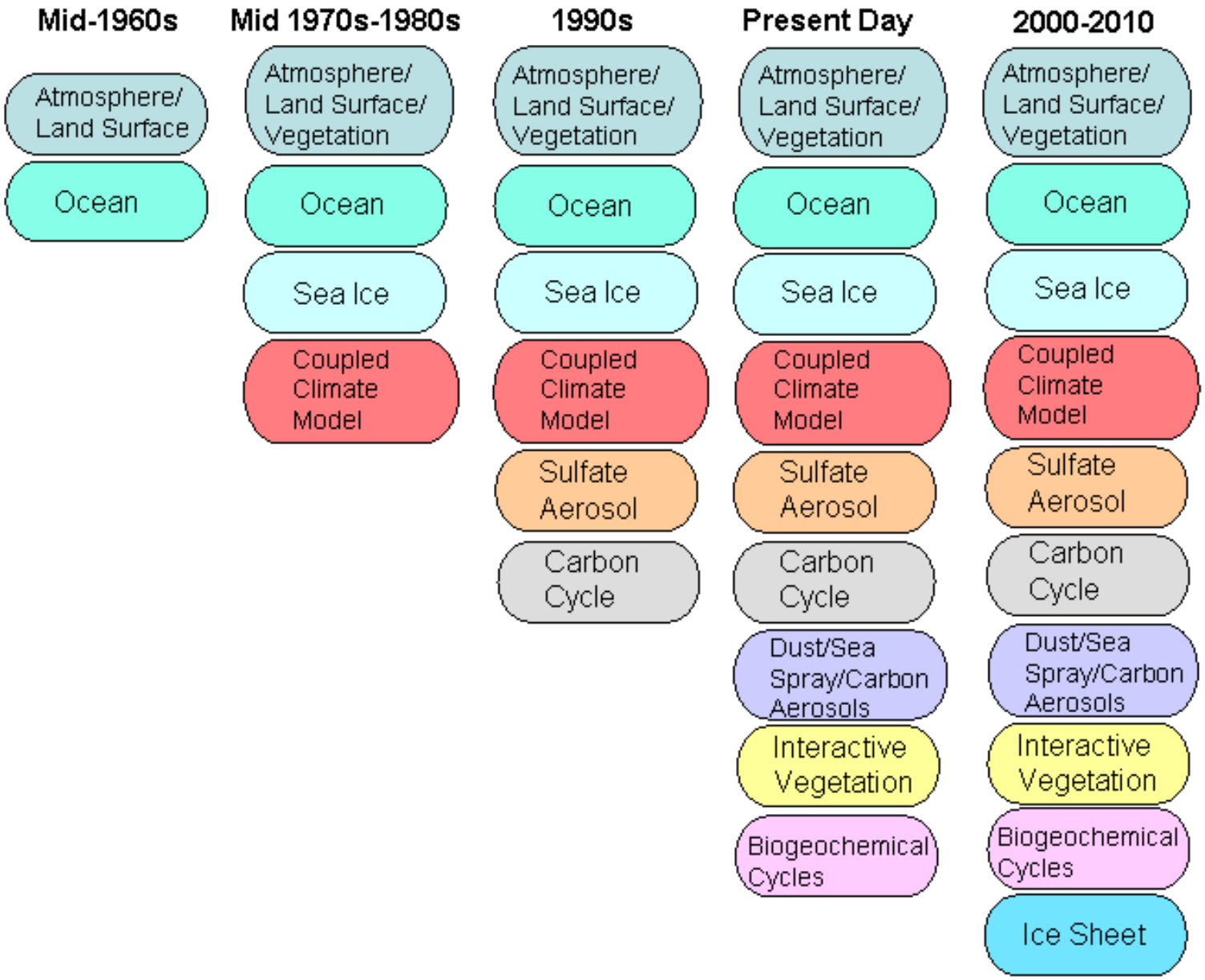
American Meteorology Society Annual Meeting
January 2007

Development of Numerical Methods

- Norman Phillips insightful general circulation model
- Norman Phillips analysis of non-linear instability
- Finite difference schemes
- Akiro Arakawa novel conservation methods
- Spectral methods with transform of non-linear terms
- Semi-Lagrangian Method
- Spectral Finite Element Methods

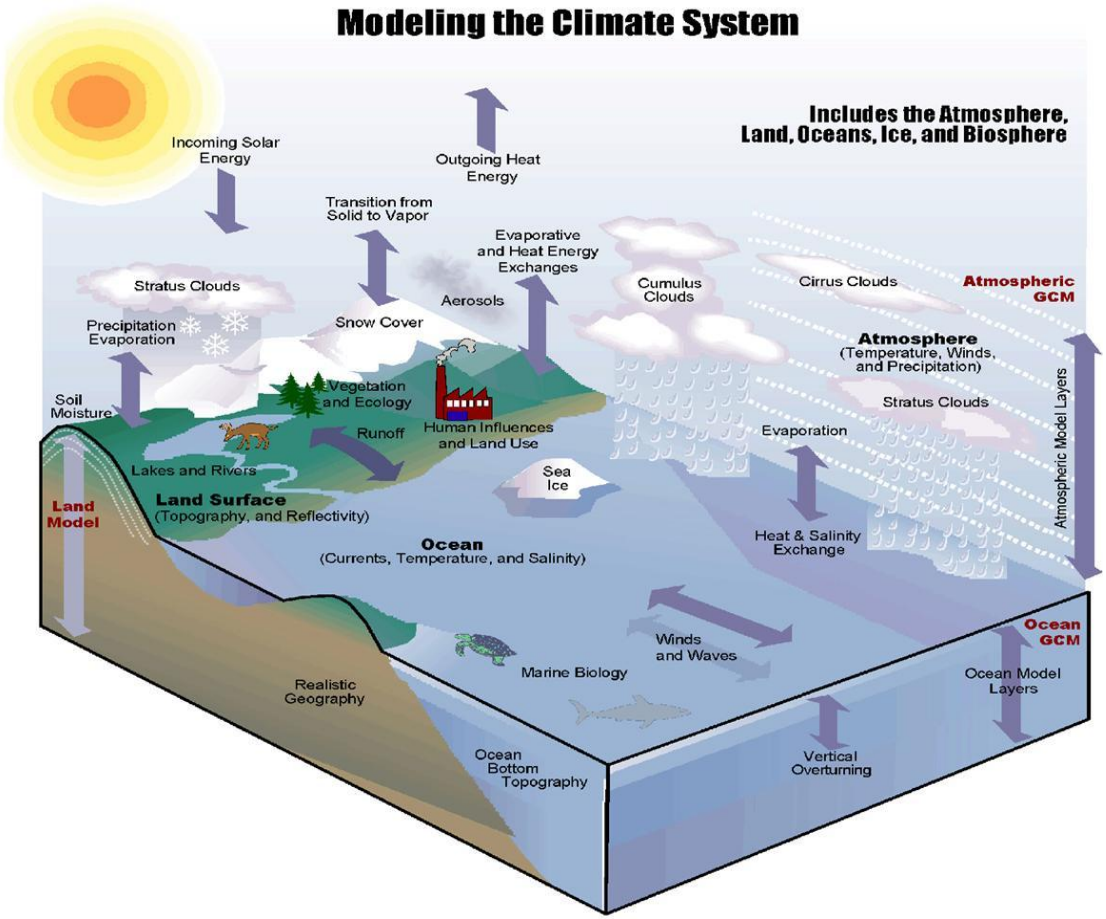
Timeline of Climate Model Development



The Earth Climate System

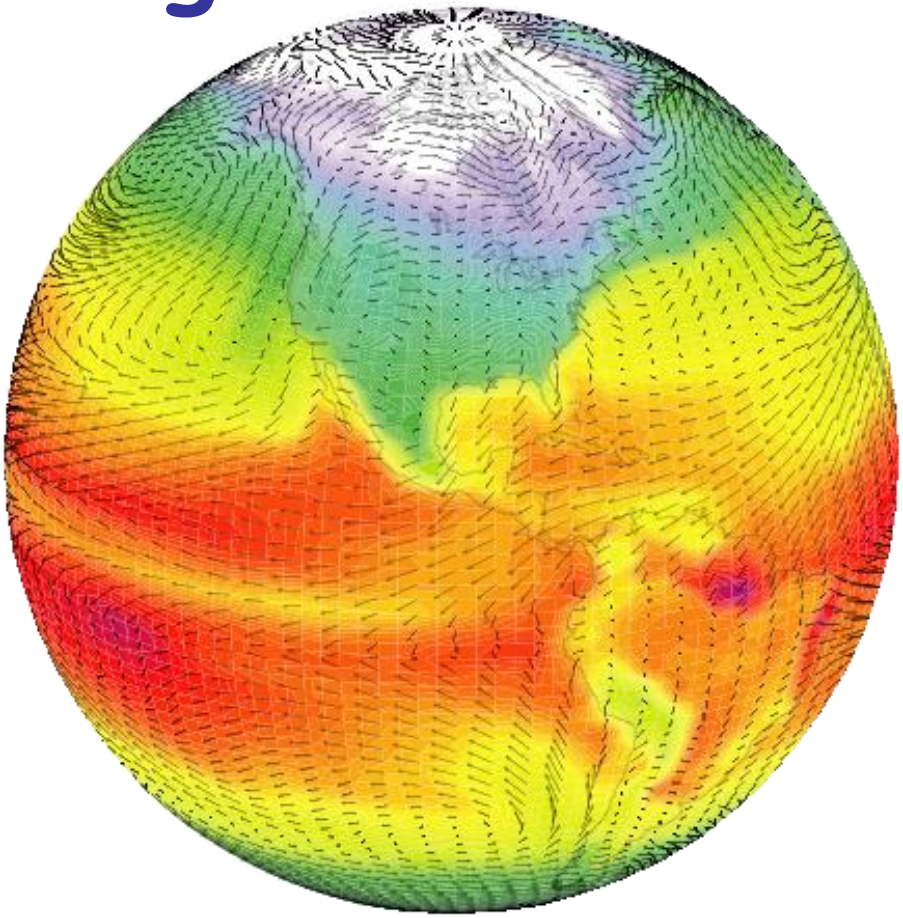
What scientific/engineering question(s) require p

The Grand Challenge problem is to predict future climates based on scenarios of anthropogenic emissions and changes resulting from options in energy policy.



Future Coupled Climate Modeling

- Danger: Confidence in modeling the physical climate system does not extend to modeling the biogeochemical coupling
- Using observational data to validate and constrain the process models for terrestrial carbon cycle and atmospheric aerosols
- Extending cryosphere to include ice sheets.



What Needs To Be Done?

- For the science/engineering community
  - » Discoveries of feedbacks between ecosystems and climate
  - » Fundamental science of aerosols effect in the atmosphere
  - » Advances in science for climate prediction
- For the public
  - » US and International Climate Energy policies
  - » Contribution to international assessments of climate change and its causes such as the Intergovernmental Panel on Climate Change (IPCC) Assessment

Problem Areas

- Mountains
- More realistic ocean, land/vegetation, hydrological, and sea ice processes
- Numerical methods and coupling methods
- Increased resolution, scaling to massive parallel computer systems
- Clouds, convection, boundary, and radiation interactions

Part of Modeling Group at Princeton

Jule Charney

Norm Phillips

John von Neumann