How NACP and the terrestrial community see themselves fitting into the new science plan

Ken Davis
Penn State
Co-Chair, NACP Science Steering Group
Member, Carbon Cycle Science Working Group

OCB summer workshop, 20 July, 2009 Woods Hole, MA

Does Ken hope the

will

How NACP and the terrestrial community see themselves fitting into the new science plan

and what are the potential links to the OCB community?

noisy, obnoxious

Ken Davis

Penn State

Co-Chair, NACP Science Steering Group

Member, Carbon Cycle Science Working Group

OCB summer workshop, 20 July, 2009

Woods Hole, MA

my background/biases

- physics, astrophysics
- boundary layer meteorology, flux measurement methods
- CO_2 flux and mixing ratio measurements and analyses
- carbon data assimilation, climate ethics

outline

- New carbon cycle science plan: early signs
- NACP - status and future
- Role of NACP in the new carbon cycle science plan
- Role of the terrestrial carbon cycle community in the new carbon cycle science plan

new carbon cycle science plan

Areas where the 1999 CCSP needs to be expanded or enhanced

1. Effects of human activities on carbon cycling (Humans are the largest cause of CO2/CH4 radiative forcing and probably the least predictable element of the global C cycle. Fossil emissions included. Broaden our 'team', don't dilute it.)
2. Vulnerability and resilience of ecosystems to changes in carbon cycling and associated changes in climate (Ocean acidification.)
3. Efficacy and environmental consequences of carbon management policies, strategies, and technologies (1999 CCSP had lots of details about how to implement observations, but very little about modeling, prediction and management, though this was the stated goal of the research. Expand detail in these areas.)

Ken's spin on things are in blue.

Current version of the major questions for the new Plan:

- How do natural processes and human actions affect the carbon cycle, on land, in the atmosphere, and in the oceans? (mechanistic understanding)
- How do policy and management decisions affect the levels of atmospheric carbon dioxide and methane? (evaluate and guide carbon/climate management)
- How are ecosystems, species, and resources impacted by increasing greenhouse gas concentrations, the associated changes in climate, and carbon management decisions? (impacts of atm C increase on ecosystems)

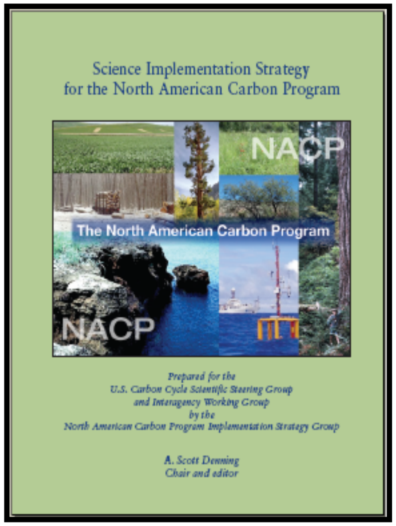
Likely elements called for in the next carbon cycle science plan

- Global analyses and international cooperation
- Sustained (and expanded) observational and experimental networks, network design research
- Predictive modeling and model hindcasting studies
- Focus on important (large C flux), dynamic, poorly understood portions of the carbon cycle (human emissions, high latitude ecosystems, tropics)
- Ocean acidification research
- Incorporation of disturbance (including human) into terrestrial ecosystem studies
- Increased importance of uncertainty assessment
- Increased involvement of the integrated assessment and policy analysis communities
- Emphasis on holistic climate system - ecological impact analyses (N2O, albedo, biodiversity)

NACP status and future

NACP Questions

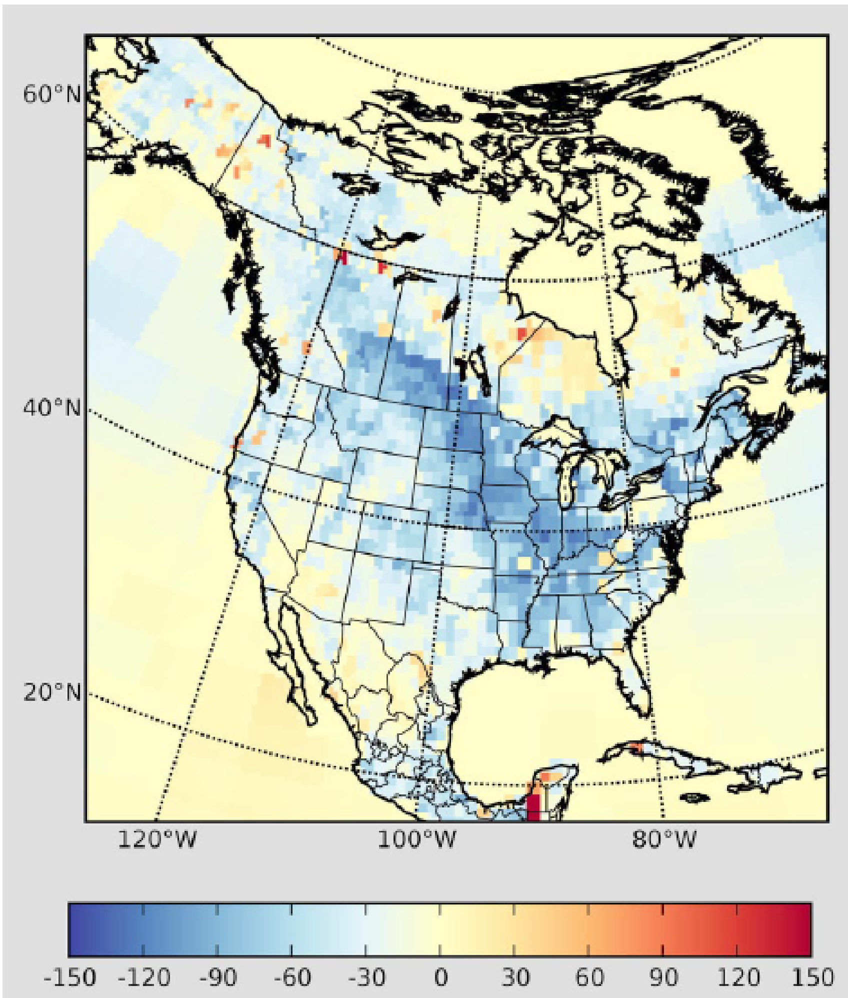
1. What is the carbon balance of North America and adjacent oceans? What are the geographic patterns of fluxes of CO_2, CH_4, and CO? How is the balance changing over time? ("***Diagnosis***")
2. What processes control the sources and sinks of CO_2, CH_4, and CO, and how do the controls change with time? ("***Attribution***")
3. Are there potential surprises (could sources increase or sinks disappear)? ("***Prediction***")
4. How can we enhance and manage long-lived carbon sinks ("sequestration"), and provide resources to support decision makers? ("***Decision support***")

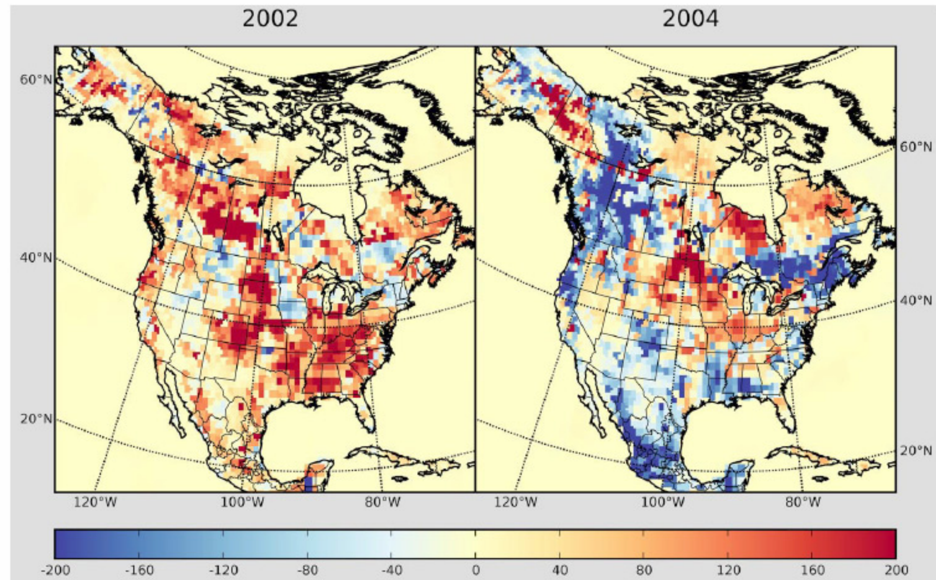


Implementation Strategy, 2005

diagnoses

Carbon tracker results





Annual NEE (gC m^{-2} yr^{-1}) for 2000-2005 (left).
Summer NEE for 2002, 2004 (above).
Peters et al, 2007, PNAS

“Bottom-up” flux estimate example: Potter et al., 2007

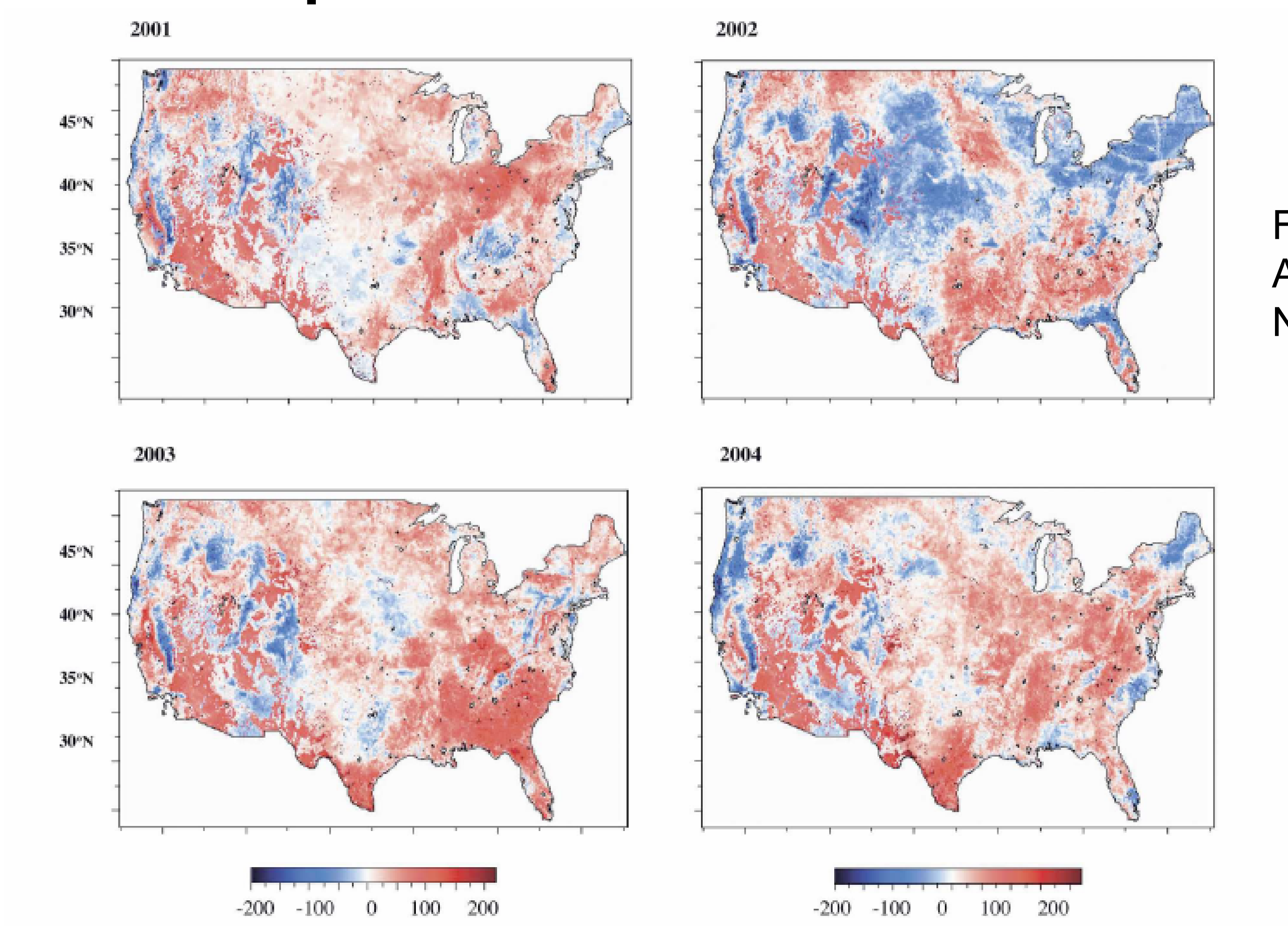
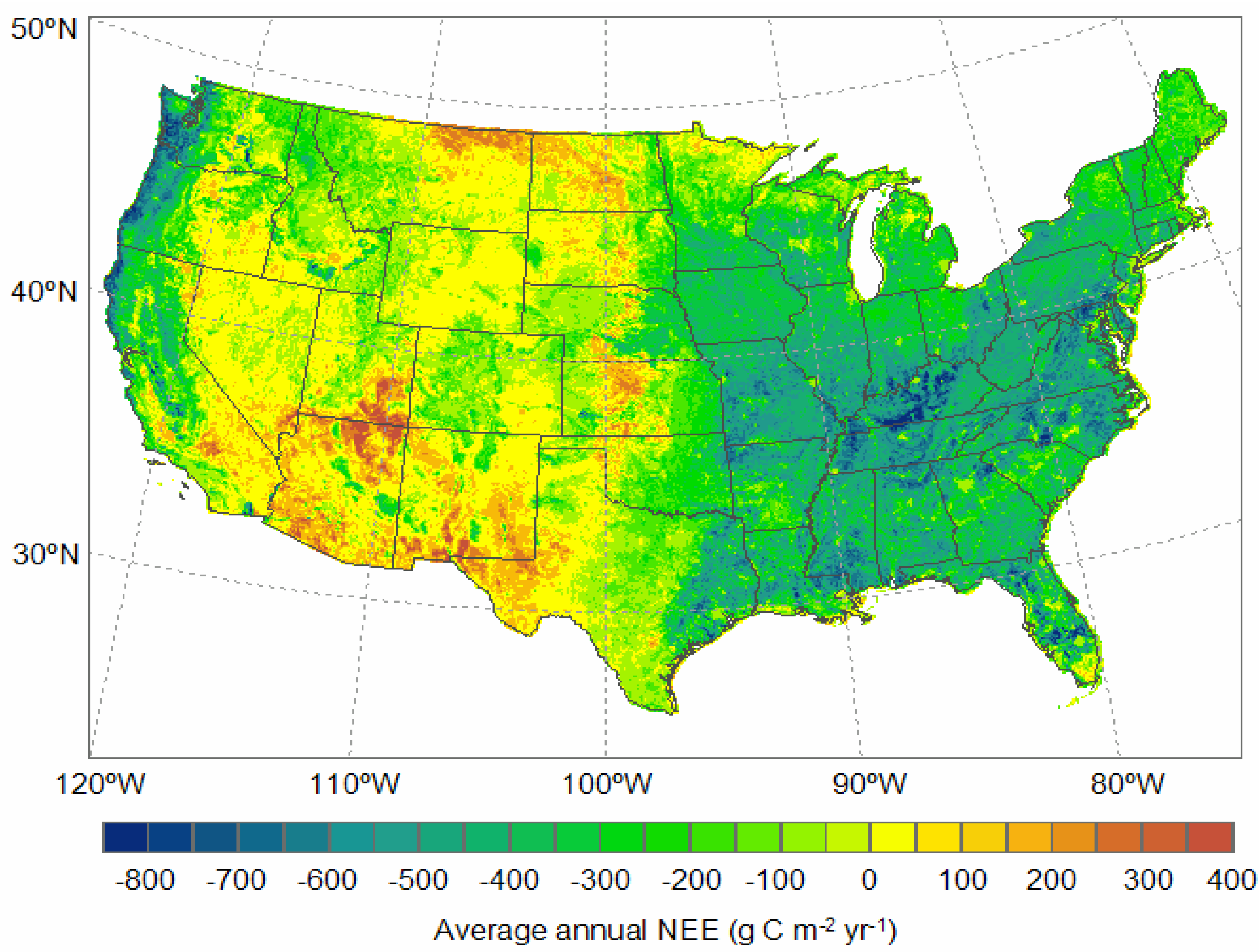


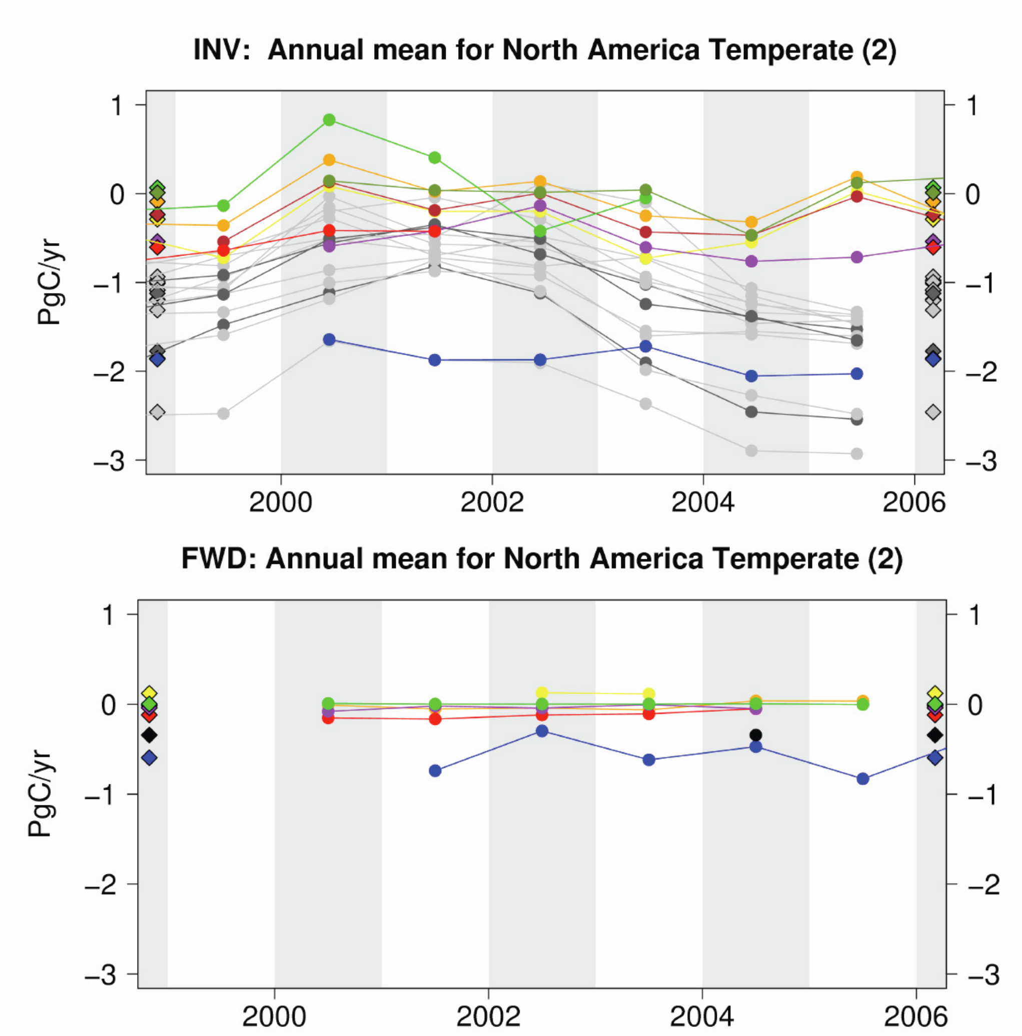
Figure 8. Annual NEP.

Flux Tower Upscaling



Xiao et al, 2008, Agr. and F. Met.

Continental Aggregate Flux: Multi-Model Comparison



Preliminary findings: “Inversions” show much more interannual variability and a larger N. American sink vs. “forwards” models.

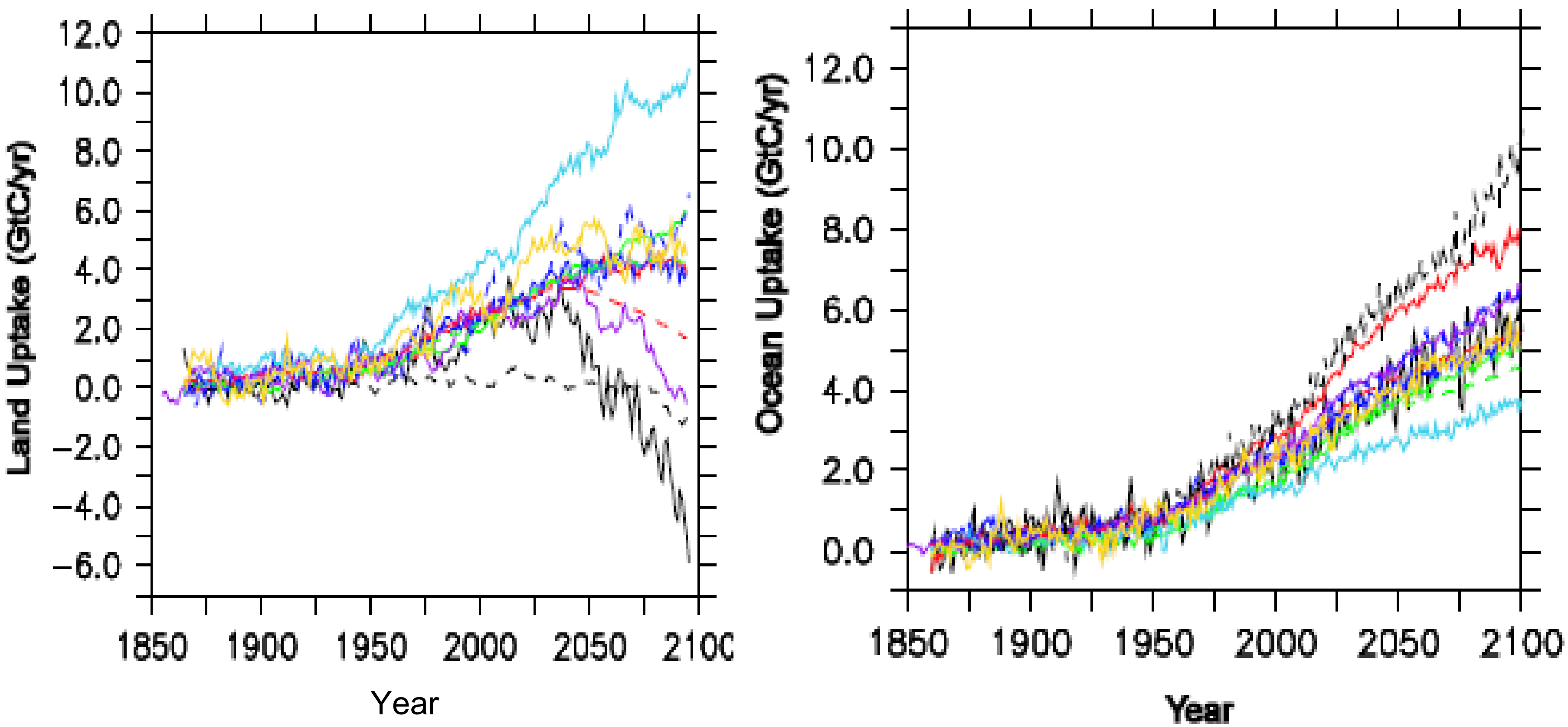
Courtesy A. Jacobson and D. Huntzinger. Being updated as we speak.

prediction

Uncertain prediction of future carbon fluxes

C^{4}MIP: comparison of coupled climate/carbon models

Large range of uncertainty (16 GtC yr^{-1} range in land flux, 6 GtC yr^{-1} range in ocean flux by 2100)



Friedlingstein et al., 2006

NACP status

- We are nearing “success” at regional and continental diagnoses of the CO_2 budget.
- Essential elements of our continental observation and analysis system are endangered.
- We need to engage whole-heartedly in research that is integrated with decision support. This will require:
  - Increased emphasis on prediction, model-data syntheses and model comparisons.
  - Increased emphasis on uncertainty assessment, network design, and data/metadata management.
  - Increased focus on human emissions of carbon and study of the mechanisms governing these emissions.
- We need to articulate which decisions we are supporting.

Draft updates of the 2005 NACP SIS

1. We need to transition essential elements of the observational, data management and analytic system to stable, long-term support.
2. We need a more explicit and precise discussion of the decision support goals to be integrated into the NACP. (C regulation. C/climate management)
3. We need new intensives to accelerate:
   - Integration of decision support into the NACP
   - Network design, uncertainty assessment and reduction
     - Potentially including new field or experimental work
   - Model-data syntheses and comparisons, including prediction
   - Predictive skill for large C flux, dynamic and poorly understood portions of the carbon cycle (e.g. human emissions, high latitude ecosystems)

role of the NACP in the new carbon cycle science plan

Envisioned role of the NACP in the new CCSP

- Demonstrate maintained continental to regional diagnoses and attribution of the C balance, including human emissions.
- Support carbon regulation via independent evaluation of the carbon balance of the continent.
- Aid carbon/climate management by greatly improving our ability to predict future C fluxes.
- Lead initiatives for global analyses and partnerships.

role of the terrestrial carbon cycle community
In the next carbon cycle science plan

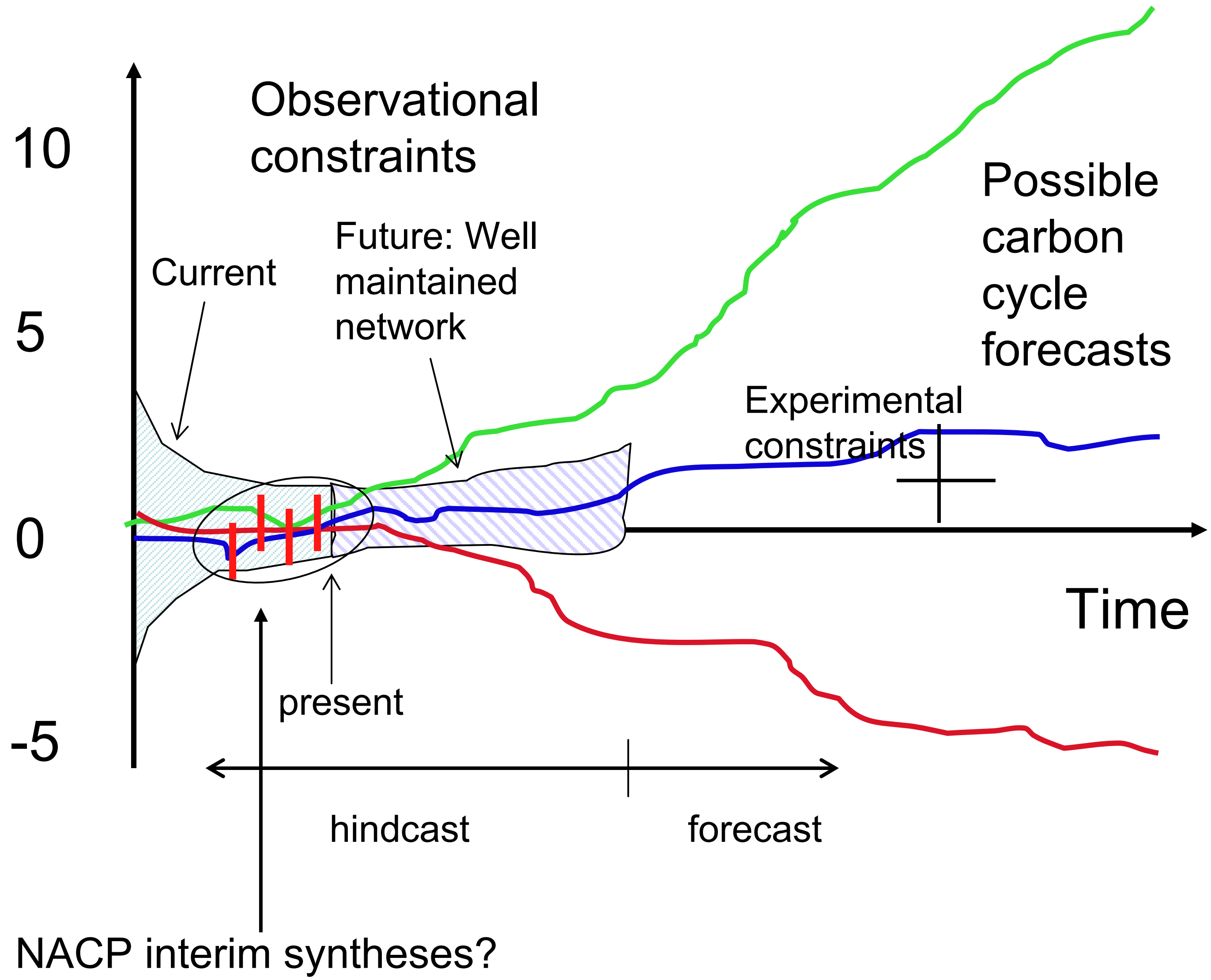
Role of terrestrial carbon cycle community in the next CCSP

- Reach convergence of biogeochemical models and atmospheric inversions globally.
- Improve predictive skill, including expanding processes included in predictions (disturbance, nutrient cycling, …) and understanding of particularly important ecosystems (high latitudes, tropics).
- Increase understanding of the impact of carbon and climate management (or lack thereof) on ecosystems.
- Critically evaluate terrestrial carbon cycle knowledge used in integrated assessment models and other tools used to guide policy.

Vision

Terrestrial uptake of carbon (__C yr^{-1})

(details of flux magnitude and observations left ambiguous - could be applied to many regions or observations)



A well-known example of establishing predictive skill with hindcasting

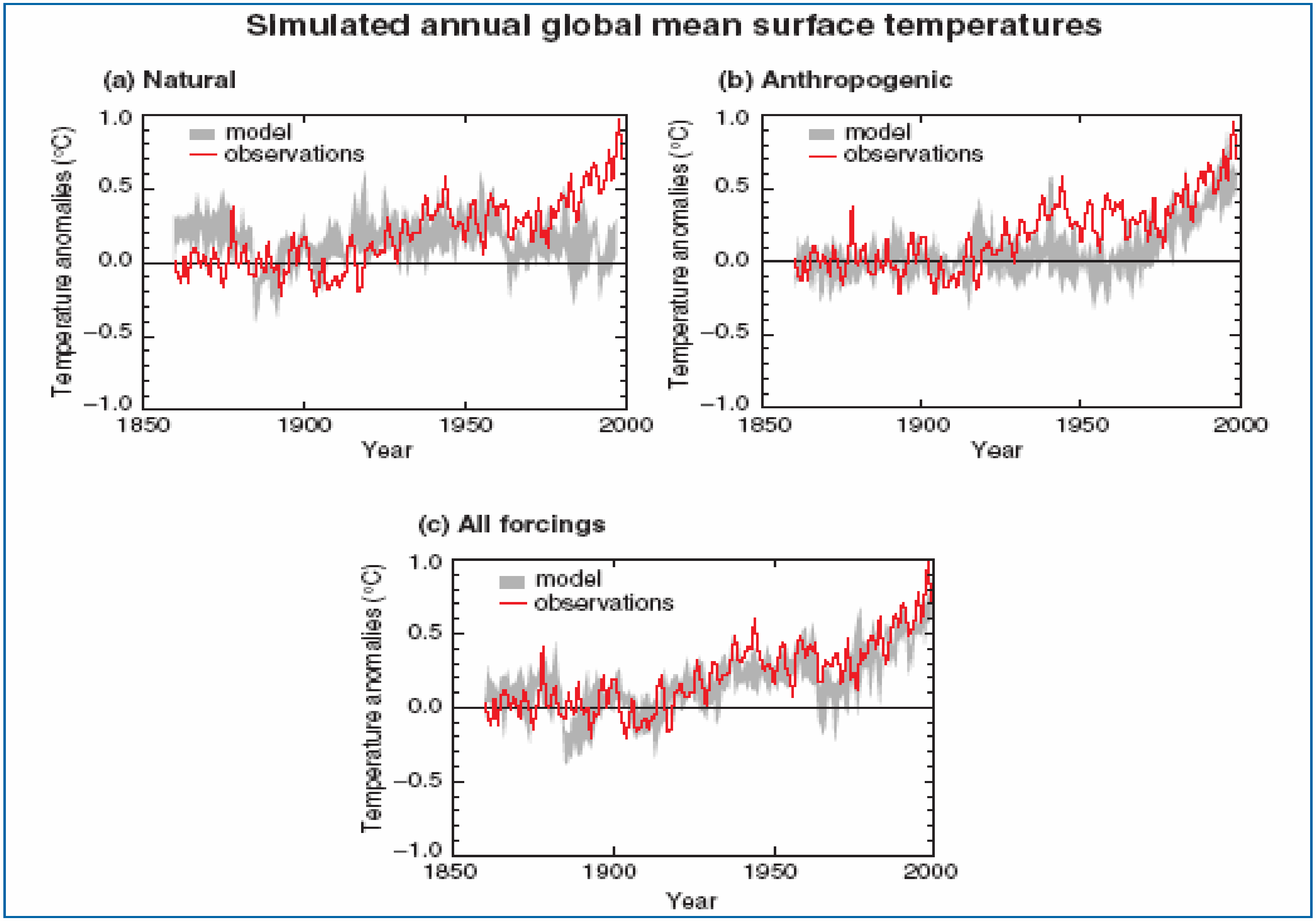


Figure 4: Simulating the Earth's temperature variations, and comparing the results to measured changes, can provide insight into the underlying causes of the major changes.

3rd IPCC report

What is “good enough?”