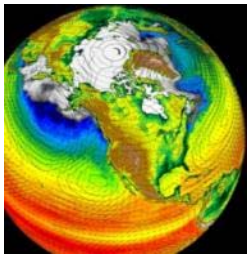
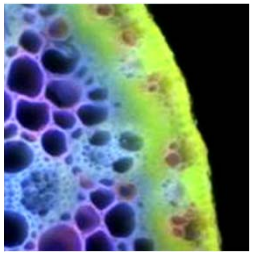
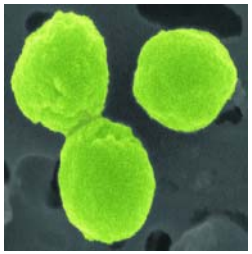
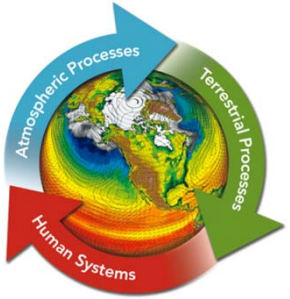








Human-Earth Systems Interactions and Impacts on the Water Cycle

Anthony Janetos, Ken Strzepek and Adam Schlosser, Co-Chairs

Washington DC

September 24-26, 2012

Suggestions for Scientific and Modeling Priorities

- Modeling human water use directly – particular focus on agriculture and energy uses
- Modeling interactions among human systems – water management, agriculture, energy system – at appropriate scales
- Modeling feedbacks to the atmosphere from land surface change and energy system change
- Assessing predictability of water cycle for both coupled human-Earth systems and uncoupled systems – evaluating model performance
- Coastal zone – not just sea-level rise, but also biogeochemical flows, coastal transport, etc.
- Direct human impacts
- Uncertainty as a scientific topic, but also as an element of communication with user communities

Suggestions for Scientific and Modeling Priorities

- Added somewhat to the original list
- Major focus on modeling at regional scales
- Recognized the importance of potential hierarchy of models
- Importance of making progress in both uncoupled models of climate and human processes
- And of making progress in coupled model systems
- Recognized this is being done with carbon, but has not really been attempted for water
- Progress is certainly feasible, but will be intermittent
- Surprises await

Suggestions for Scientific and Modeling Priorities

- Modeling human water use directly – particular focus on agriculture and energy uses
  - Scale aware: What's "good" for a user and how that relates to modeling framework.
    - How do we cross both spatial and temporal scales, and what are the appropriate questions that can be posed and addressed at a given scale?
  - Timescales: "policy" ~50 years… yet farmers are "weeks"!
    - Different implications for modeling needs.
  - Enable direct linkages between water and land/energy in IAMs.
  - Emergence of agent based methods (ABMs) along with econometric methods.
  - Do current methods of operational/management tools for water systems faithfully employ climate data (from GCMs, etc.).
  - Can we recommend an equivalent GTAP effort for **water?**

Suggestions for Scientific and Modeling Priorities

- Modeling interactions among human systems – water management, agriculture, energy – at appropriate scales
  - Introducing water endogenously within IAMs, especially at regional scale.
  - Interactions between growing demand for food and biomass crops.
  - Can we track how these might change if climate/environment changes?
    - Example: impact of water-stress on solar/dry-cooling deployment in southwest. Can we translate this to other regions?
  - But also need rapid development of new crop types within climate models so that we don't lose information in the coupling itself – especially important for regional issues
  - Need consistent and persistent dialogue with hydrologic and climate modeling communities for model development and evaluation
    - This group needs to be "dynamic" in the sense that capabilities and needs of both impact and climate models **will** change.

Suggestions for Scientific and Modeling Priorities

- Modeling feedbacks to the atmosphere from land surface change and energy system change
  - Incorporate irrigated agriculture in IAMs
    - These also must capture the relevant hydrologic and biogeochemical aspects.
    - Some decisions regarding irrigation may have nothing to do with water stress (i.e. buffering of diurnal temperature cycle).
  - Firming up the uncertainties in the *physical and dynamical response* of the climate system from land use.
    - Are there thresholds in the extent and/or expanse of land use change that are big enough to matter in climate models?
    - Need to take the current suite of one-way coupling "IAM" experiments of land-use impacts (e.g. RCP, biofuel penetration scenarios) to the next step (i.e. two-way) where results indicate a strong potential for feedbacks
  - Urbanization
    - Important phenomenon, but under-represented in both IAMs and climate models
    - Need studies to determine what is best way to represent this at regional scales

Suggestions for Scientific and Modeling Priorities

- Assessing model performance and predictability of water cycle for both coupled human-Earth systems and uncoupled systems
  - Can the human system cause the climate system become more or less predictable?
    - How do change in human systems affect decadal predictions?
    - Identify areas where good model performance is unattainable without the socio-economic drivers.
    - Effects of managed infrastructure (i.e. dams) on the past.
  - Hindcasts for IAMs
    - IAMs do simulate physical quantities as well as economic behavior that should be observable
    - This is an extremely difficult problem because preferences and structure of the economy change over time, and data are not readily available for long periods
    - Assess the persistence of societal decisions – is there “predictability” over short time periods (years to decades)?

Suggestions for Scientific and Modeling Priorities – Extras from the breakout group.

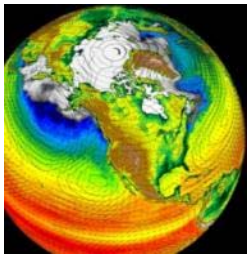
- Coastal zone – not just SLR but also biogeochemical flows, transport, etc.
  - No in-stream processing included in earth-system models.
    - Passive tracers within rivers may evolve in the near term due to entrepreneurial efforts.
    - Large model development effort to incorporate the more dynamic and biogeochemical “full river” processes.
  - Mid-term focus on the fertilizer management and the impacts on sediment transports.
    - Both development and evaluation (in IAMs and earth-system models).

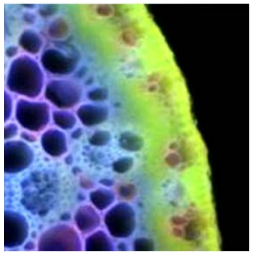
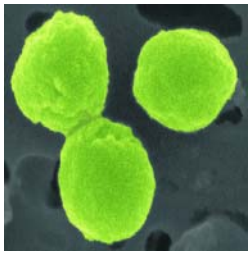
Suggestions for Scientific and Modeling Priorities – Extras from the breakout group.

- Direct human impacts
  - Drought and nutrition
  - Floods and access to potable water
  - Sea-level rise and infrastructure.
  - Mortality and disease from extreme events.
  - Improving spatial projections of both the human populations and aspects of their vulnerability
  - Challenge of projecting the extreme physical events themselves – and their locations

Suggestions for Scientific and Modeling Priorities – Extras from the breakout group.

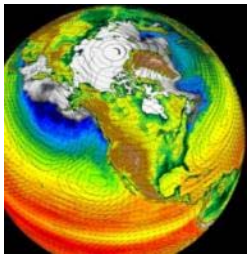
- Uncertainty and risk
  - Importance of evaluating uncertainty beyond metrics of model performance – as an element of communicating about risk in decision-making
  - Importance of understanding uncertainty as a function of model structure
  - Effective communication to end-users
  - Importance of ability to do lots of simulations, ensembles, and scenarios to characterize uncertainties of different kinds
  - Importance of novel techniques to explore and incorporate the range methods to capture all elements of uncertainty.
    - What dimensions of uncertainty are important and translate to risk metrics – fat tails in pdf's? Low probability, high impact?
    - "All elements of uncertainty are not created equal" – so identify the important aspects of uncertainty germane to the area of interest or impact sector.

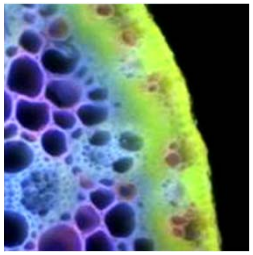
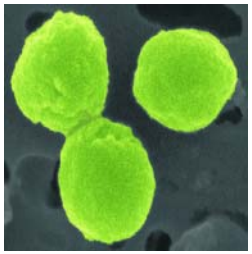


Prediction is very difficult, especially about the future.

Niels Bohr



BACK UP SLIDES ON NOTES

What did we miss?

- More emphasis on the socio-economics
  - Not just Influence of climate/water on “pricing” side of water movement and management.
  - Also and issue of incentives – need data to test this.
- Aspects of risks
  - What we know and don’t know.
  - Danger of making a quantification from misuse of data.
- Allow for a hierarchy of models that is flexible between linkages and coupling.
  - Only allow for what is needed to answer/address issue(s) of focus.
  - Framework that adapts to scenario development.
- Challenges of predicting human behavior. What are the limits?

What did we miss?

- Ability to do large ensembles to span the range of plausible outcomes and trajectories in the human-earth linkages.
- How and what information allows people to plan? Do they care more about first/2nd order statistics or are the extremes more influential?
  - How well do earth-system models portray these features in the current climate and how robust are their projections?
  - What is an “extreme” to the end user? Let climate/earth-system modelers understand that so they can assess model capabilities.
- Requirement and availability for more information
  - Challenges in consistently and effectively incorporating observed linkages into model constructions that then have high fidelity.
  - Obtaining records and recording information that is needed to service these linked models.

What did we miss?

- What are the practical limits to models?
  - May never be able to model processes and linkages required.
- Start thinking about what really drives the human system
  - Economics, culture, governance, and education.
  - More of a long-term strategic solution/thinking.
- Thinking more about the ecosystem facet.
  - How we manage/handle ecosystems and the water impacts
  - How long can you preserve areas that you are trying to protect/serve/manage? When does abandonment become the only practical strategy?
- More comprehensive sets of water-use data.
  - Water-use data at the basin level.
  - Change the way in which data is recorded and delivered w/ more frequent and temporally-resolved records
    - Not just annual use reports every 5 years (for example for USGS).

What did we miss?

- Going beyond ag/energy circumstances.
  - Housing, access to potable water,
- Water quality – importance of urbanization
- Sea level rise
  - Coastal issues regarding storms and floods as well
  - How do these impact natural and manage systems and infrastructure.