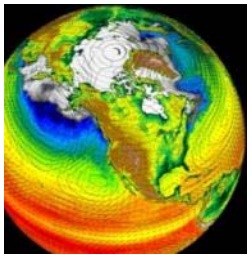

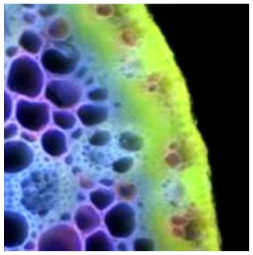
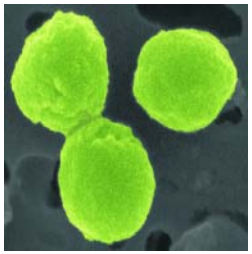

Community Modeling and Long-term Predictions of the Integrated Water Cycle

Crosscutting Breakout Group A, Day 1

Washington DC

September 24-26, 2012

Charge to the crosscutting groups:

Integrative Modeling Challenges (IMCs)

Discuss and recommend synergistic research activities to address Integrative Modeling Challenges (IMCs) that cut across all six topics of the workshop. Our goal is to robustly test and advance modeling capabilities that will lead to an improved scientific understanding of the critical systems and their interactions, long-term prediction of the integrated water cycle and the more effective use of models for decision support.

Charge to the crosscutting groups:

Discussions should include aspects such as:

- Hypothesis driven modeling experiments and predictability studies
- Multi-scale, multi-system needs for science and decision support
- Model development needs
- Data/observation needs
- Model intercomparison, testing and evaluation
- Computational requirements (e.g., computing resources, common software infrastructure for model/data development)
- Software infrastructure (e.g., tools for model/data integration and interoperability)
- Data management and visualization
- Strategies for interactions with the users

Crosscutting Group A

- Mike Bosilovich
- Kate Calvin
- Mauro DiLuzio
- Randy Dole
- Chris Duffy
- Paul Faeth
- Jay Famiglietti
- Bill Gutowski
- Forrest Hoffman
- **Tony Janetos (day 1)**
- Randy Koster
- **Dave Lawrence (day 2)**
- **Reed Maxwell (day 2)**
- Soroosh Sorooshian
- **Ken Strzepek (day 1)**
- Sean Swenson
- Claudia Tebaldi
- John Weyant
- Cathy Wilson
- Minghua Zhang

Criterion for Discussion

- Focused on potential case studies
  - Implications for BOTH evolution of the physical climate system
  - AND for understanding how the future of human demand for and use of water might change
- Explore
  - Implications for observations and data
  - Model development and evaluation
  - Importance of doing “range-finding” experiments
- Looking for topics that community could get started on now
- And that could stimulate the kind of collaboration and interaction among modelers coming from different backgrounds and with different initial interests

Implications of water management and land cover and land use changes for energy and water resources and climate

- Goal
  - More tightly integrate and analyze feedbacks of irrigation and land use on climate and weather AND water and energy systems in integrated Earth System Modeling framework
- Motivations:
  - Links to energy system (biofuels, water diversion for irrigation means water not available for cooling at power stations)
  - Impact of irrigation / LCLUC tightly tied to physical model representation of water cycle so will spur model development

Implications of water management and land cover and land use changes for energy and water resources and climate

- Questions:
  - How does irrigation and agriculture and land cover and land use change impact local, regional and global climate and climate variability including phenomena such as MCS, diurnal cycle of precipitation, extremes ?
  - How could climate change and socioeconomic responses to climate change alter irrigation practices and LCLUC under various policy scenarios?
  - Will increased frequency / amplitude of droughts lead to increased irrigation investments and how could this feedback onto climate and water resource availability?
  - For different policy scenarios, are we creating a vulnerability on the water side that didn't show up in energy side?
  - If farmer sutilized a seasonal forecast to change irrigation practice, what impact would that have?

Implications of water management, land cover and land use changes for energy and water resources and climate

- Terrestrial System Model development needs
  - Targeted attention to hydrologic response to LCLUC; dynamic roots, canopy turbulent processes, partitioning of ET, soil degradation
  - Greater variety of modeled crops, including those used for biofuels
  - Irrigation: More realistic treatment of water diversions, groundwater pumping, aquifers, range of irrigation practices
  - Irrigation and water use datasets (historic and future irrigation equipped area time series

Implications of water management, land cover and land use changes for energy and water resources and climate

- IAM development needs
  - Expansion of IAMs to include more explicit treatment of water
  - Ability to model agriculture practices in response to water scarcity
  - Model crop yields (who models the crop yield?)

- Atmosphere Model development needs
  - Diurnal cycle of precipitation
  - Atmospheric branch of land-atmosphere interactions (boundary layer and convection response to surface turbulent fluxes and turbulent flux variability)

Implications of water management, land cover and land use changes for energy and water resources and climate

- Observational regional testbed
  - Tower site network including observations of ET, soil moisture, P, net radiation, etc)
  - Sustained multi-year effort rather than field campaign
  - Should span range of surface types: irrigated/not, grassland, crops, forested
  - Midwest US, could leverage ARM site

Implications of water management, land cover and land use changes for energy and water resources and climate

- Model experiments
  - Sensitivity experiments to investigate terrestrial and atmospheric response to prescribed LCLUC and irrigation
    - Focus on scale dependence, variable resolution atm and lnd
    - What is spatial scale for downstream impacts on climate and weather?
  - IAM hindcasts of LCLUC, especially agriculture
  - Coupled iESM experiments to investigate questions posed at start
    - how much would increased irrigation in response to increased drought affect energy system through climate and water availability impacts

Implications of water management, land cover and land use changes for energy and water resources and climate

- Irrigation data (extraction data, irrigation equipped areas)
  - Timeseries of irrigation
- Spatio-temporal heterogeneity; land-atmosphere coupling scale, sensitivity of coupling to spatio-temporal heterogeneity
- Can we engage farmers to engage in irrigation expt? Or experimental farm? Take advantage of variations in farmers' response to drought

Implications of water management, land cover and land use changes for energy and water resources and climate

- Online and offline simulations to investigate how irrigation/LCC alter climate variability
- Does more interactive treatment of LCC/irrigation alter projections of water?
- Seasonal forecast: if people took advantage of a seasonal forecast, what would happen?

Implications of water management, land cover and land use changes for energy and water resources and climate

- Potential for conflict analysis
- Model-driven hypothesis generation
- Leverage ARM site
- Need for Modeling of Demand for and future development of Irrigation for Food and BioFuel production
- Need to provide linkage to Land Surface Models
  - areas irrigated and seasonal amounts of water application.
  - Seasonal Reservoir Surface areas to allow

Next Steps

- Need to discuss potential benefits and readiness of different communities to pursue any one of these
- Looking for interest, readiness of models, availability of observations and data to make case studies worthwhile
- Ability to diagnose and evaluate model performance
- Ability to say something that would be useful and interesting for "user" communities
- Overall – a focus on energy and land use related topics – and the latter primarily as they are connected to the energy system
- How does an improved understanding of these issues lead to progress in understanding the hydrologic and climate system – and vice versa

Crosscutting Group A (Day 1)

Integrative Modeling Challenge A.1

Key Features/Topic Relevance

A. ....
B. ....
C. ....

Approaches/Leveraging

A. ....
B. ....
C. ....

Scientific Impacts

A. ....
B. ....
C. ....

User Impacts

A. ....
B. ....
C. ....

Crosscutting Group A (Day 1)

Integrative Modeling Challenge A.2

Key Features/Topic Relevance

A. ....
B. ....
C. ....

Approaches/Leveraging

A. ....
B. ....
C. ....

Scientific Impacts

A. ....
B. ....
C. ....

User Impacts

A. ....
B. ....
C. ....

Crosscutting Group A (Day 1)

Integrative Modeling Challenge A.3

Key Features/Topic Relevance

A. ....
B. ....
C. ....

Approaches/Leveraging

A. ....
B. ....
C. ....

Scientific Impacts

A. ....
B. ....
C. ....

User Impacts

A. ....
B. ....
C. ....

Crosscutting Group A (Day 2)

Integrative Modeling Challenge A

Key Features/Topic Relevance

A. ....
B. ....
C. ....

Approaches/Leveraging

A. ....
B. ....
C. ....

Scientific Impacts

A. ....
B. ....
C. ....

User Impacts

A. ....
B. ....
C. ....

Research Elements

- Hypothesis driven modeling experiments and predictability studies
  - …
  - …
  - …
- Multi-scale, multi-system needs for science and decision support
  - …
  - …
  - …

Research Elements

- Model development needs
  - …
  - …
- Data/observation needs
  - …
  - …
- Model Intercomparison, testing and evaluation
  - …
  - …

Research Elements

- Computational requirements (e.g., computing resources, common software infrastructure for model/data development)
  - …
  - …
- Software infrastructure (e.g., tools for model/data integration and interoperability)
  - …
  - …
- Data management and visualization
  - …
  - …

Research Elements

- Strategies for interactions with the users

  (e.g., who are the users and what are their needs?; what frameworks or joint activities for researchers and users may lead to the improved use of models for decision support?)

  – …
  – …
  – …

Crosscutting Group B

- Kristen Averyt
- Jared Bales
- Bill Collin
- Wade Crow
- Noah Diffenbaugh
- Leo Donner
- **Chris Forest (day 2)**
- Inez Fung
- Auroop Ganguly
- Pierre Gentine
- Kathy Hibbard
- **Patrick Reed (day 2)**
- Bill Riley
- Adam Schlosser
- Siegfried Schubert
- Peter Thornton
- Eric Wood
- **Rob Wood (day 1)**
- Shaocheng Xie
- Craig Zamuda
- **Xubin Zeng (day 1)**

Crosscutting Group B (Day 1)

Integrative Modeling Challenge B.1

Key Features/Topic Relevance

A. ....
B. ....
C. ....

Approaches/Leveraging

A. ....
B. ....
C. ....

Scientific Impacts

A. ....
B. ....
C. ....

User Impacts

A. ....
B. ....
C. ....

Crosscutting Group B (Day 1)

Integrative Modeling Challenge B.2

Key Features/Topic Relevance

A. ....
B. ....
C. ....

Approaches/Leveraging

A. ....
B. ....
C. ....

Scientific Impacts

A. ....
B. ....
C. ....

User Impacts

A. ....
B. ....
C. ....

Crosscutting Group B (Day 1)

Integrative Modeling Challenge B.3

Key Features/Topic Relevance

A. ....
B. ....
C. ....

Approaches/Leveraging

A. ....
B. ....
C. ....

Scientific Impacts

A. ....
B. ....
C. ....

User Impacts

A. ....
B. ....
C. ....

Crosscutting Group B (Day 2)

Integrative Modeling Challenge B

Key Features/Topic Relevance

A. ....
B. ....
C. ....

Approaches/Leveraging

A. ....
B. ....
C. ....

Scientific Impacts

A. ....
B. ....
C. ....

User Impacts

A. ....
B. ....
C. ....

Research Elements

- Hypothesis driven modeling experiments and predictability studies
  - …
  - …
  - …
- Multi-scale, multi-system needs for science and decision support
  - …
  - …
  - …

Research Elements

- Model development needs
  - …
  - …
- Data/observation needs
  - …
  - …
- Model Intercomparison, testing and evaluation
  - …
  - …

Research Elements

- Computational requirements (e.g., computing resources, common software infrastructure for model/data development)
  - …
  - …
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  - …
  - …
- Data management and visualization
  - …
  - …

Research Elements

- Strategies for interactions with the users

  (e.g., who are the users and what are their needs?; what frameworks or joint activities for researchers and users may lead to the improved use of models for decision support?)

  – …
  – …
  – …

Crosscutting Group C

- Julio Bacmeister
- Ana Barros
- **Dan Cayan (day 2)**
- **Martyn Clark (day 1)**
- Dave Easterling
- Dave Gochis
- Mohamad Hejazi
- Paul Houser
- Kathy Jacobs
- Jim Kinter
- **Steve Klein (day 1)**
- Ruby Leung
- Brian O'Neill
- Taikan Oki
- Christa Peters-Lidard
- Steve Regan
- Guido Salvucci
- Graeme Stephens
- **Vince Tidwell (day 2)**
- Kevin Trenberth
- Mike Wehner

Crosscutting Group C (Day 1)

Integrative Modeling Challenge C.1

Key Features/Topic Relevance

A. ....
B. ....
C. ....

Approaches/Leveraging

A. ....
B. ....
C. ....

Scientific Impacts

A. ....
B. ....
C. ....

User Impacts

A. ....
B. ....
C. ....

Crosscutting Group C (Day 1)

Integrative Modeling Challenge C.2

Key Features/Topic Relevance

A. ....
B. ....
C. ....

Approaches/Leveraging

A. ....
B. ....
C. ....

Scientific Impacts

A. ....
B. ....
C. ....

User Impacts

A. ....
B. ....
C. ....

Crosscutting Group C (Day 1)

Integrative Modeling Challenge C.3

Key Features/Topic Relevance

A. ....
B. ....
C. ....

Approaches/Leveraging

A. ....
B. ....
C. ....

Scientific Impacts

A. ....
B. ....
C. ....

User Impacts

A. ....
B. ....
C. ....

Crosscutting Group C (Day 2)

Integrative Modeling Challenge C

Key Features/Topic Relevance

A. ....
B. ....
C. ....

Approaches/Leveraging

A. ....
B. ....
C. ....

Scientific Impacts

A. ....
B. ....
C. ....

User Impacts

A. ....
B. ....
C. ....

Research Elements

- Hypothesis driven modeling experiments and predictability studies
  - …
  - …
  - …
- Multi-scale, multi-system needs for science and decision support
  - …
  - …
  - …

Research Elements

- Model development needs
  - …
  - …
- Data/observation needs
  - …
  - …
- Model Intercomparison, testing and evaluation
  - …
  - …

Research Elements

- Computational requirements (e.g., computing resources, common software infrastructure for model/data development)
  - …
  - …
- Software infrastructure (e.g., tools for model/data integration and interoperability)
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- Data management and visualization
  - …
  - …

Research Elements

- Strategies for interactions with the users

  (e.g., who are the users and what are their needs?; what frameworks or joint activities for researchers and users may lead to the improved use of models for decision support?)

  – …
  – …
  – …