

BIOEARTH PROJECT INTEGRATION PROGRESS

All-Hand Meeting
June 26, 2012
Pullman, WA

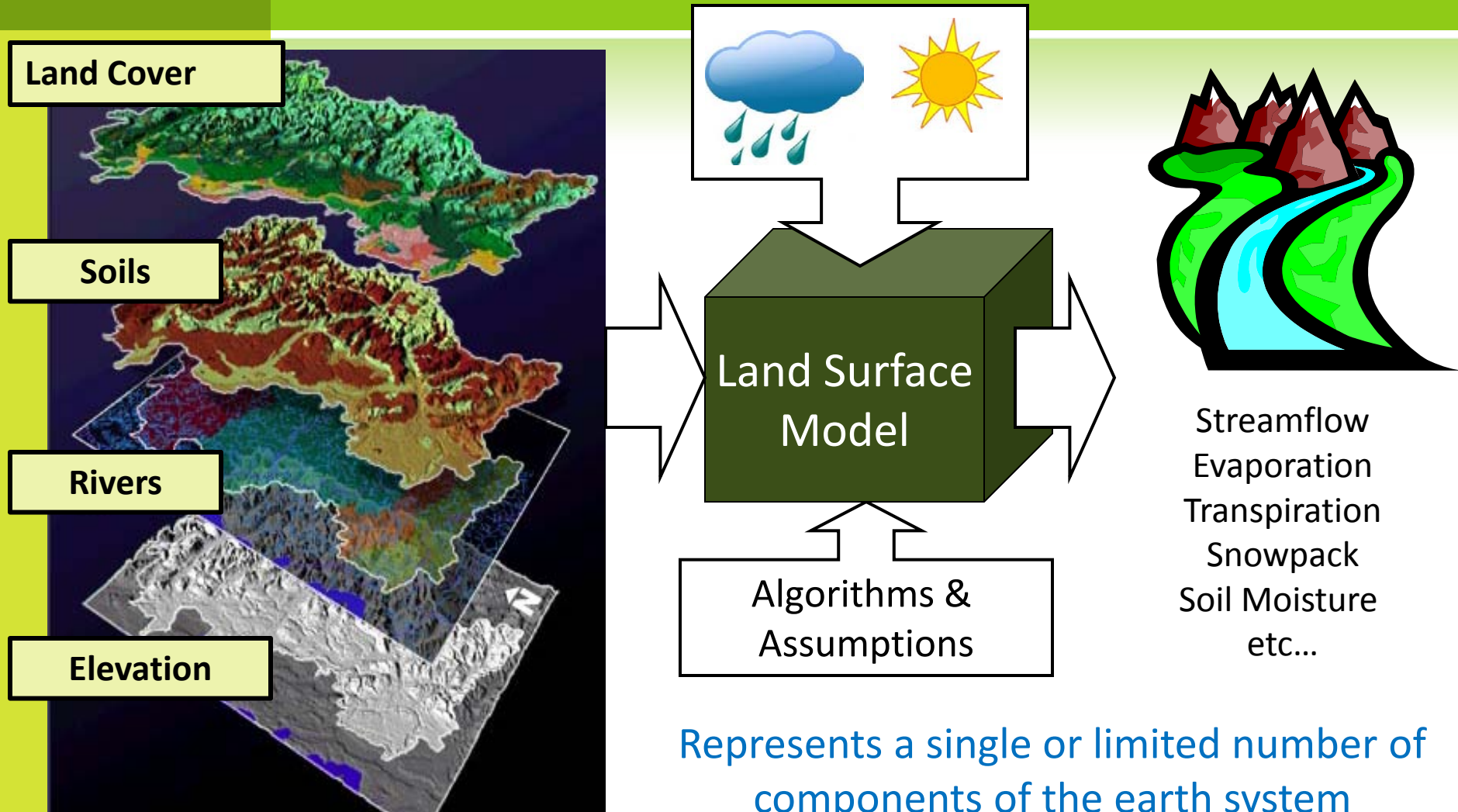
OUTLINE

- ◎ Brief Intro to Earth System Models
- ◎ Brief Overview of BioEarth
- ◎ Progress on project Integration
- ◎ List of individuals in each working group

INTRODUCTION TO EARTH SYSTEM MODELS

WHAT IS NOT AN EARTH SYSTEM MODEL?

ANSWER: "STAND-ALONE" MODELS





TYPES OF “STAND-ALONE” MODELS USED IN EARTH SYSTEM MODELS

- ◎ Process-based models (algorithms based on first principles)
- ◎ Distributed in space; continuous in time
- ◎ Linux-based programming and shell scripting; often run on a computing cluster; generally no user-friendly interface; continuous development
- ◎ Many of these are community models; they are maintained at a single institution but developed, tested, and applied by a much larger research community

The screenshot displays a VMware Workstation interface. The main window shows a Linux terminal with the following commands and output:

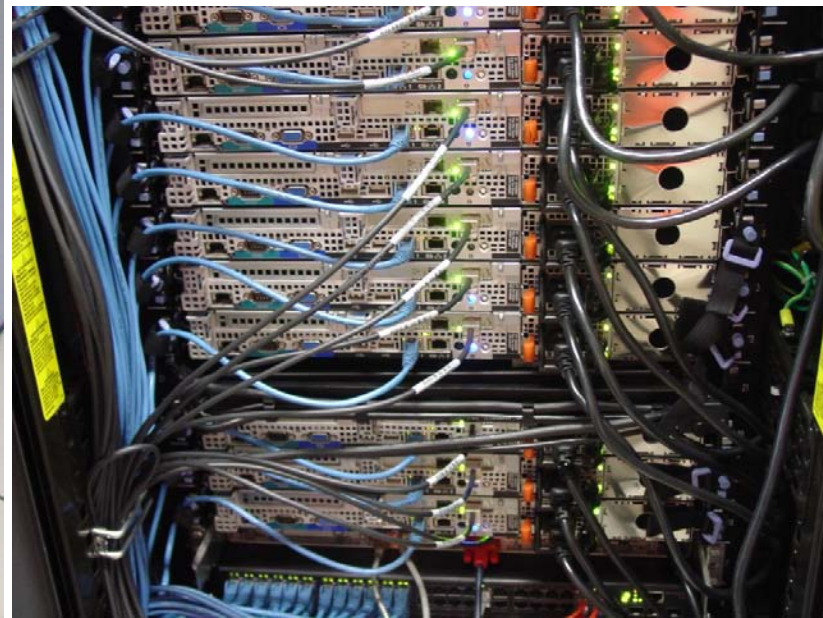
```
an.malek@debian:~$  
an.malek@debian:~/VIC_CropSyst_CodeFromKi$ ls  
al_param_set1      result  
al_param_set1~     rout_results  
ensitivityAnalysis  soil  
ns                 Vic4.0.7_crop  
an.malek@debian:~/VIC_CropSyst_CodeFromKi$  
Sep19_2011$
```

The code editor window shows the file `runoff.c [VIC4_0_7_crocppp] - Code::Blocks`. The code is in C and includes comments and logic for handling negative baseflow and computing thermal energy. The visible code snippet is:

```
547  
548  
549 /** If negative baseflow  
550 if ( *baseflow < 0  
551 layer[index].eval  
552 *baseflow = 0;  
553 }  
554 #if LINK_DEBUG  
555 if(debug.PRT_BALANC  
556 debug.outflow[dist][k  
557 debug.outflow[dist][k  
558 }  
#endif  
} /** Loop over wet and  
/** Recompute Thermal F  
if(options.FULL_ENERGY  
  
for(lindex=0;lindex<  
tmp_layer = find_av  
&(l  
soil  
moist[lindex] = tmp  
}  
  
distribute_node_moist
```

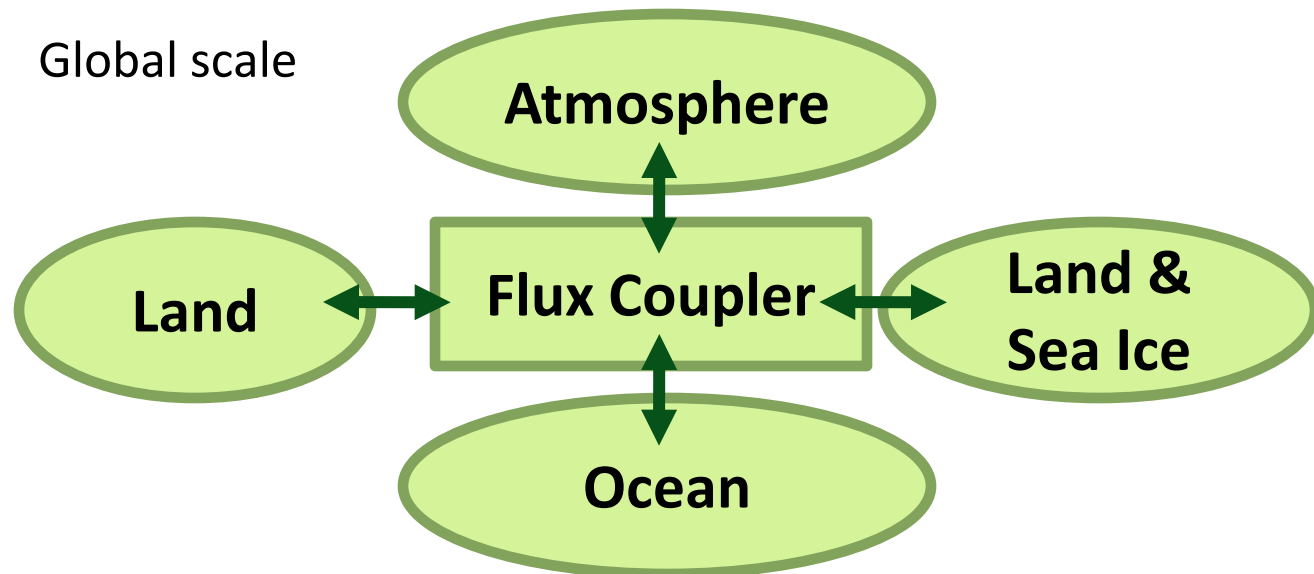

PARALLEL COMPUTING

- ◎ High performance Clusters available to project
 - ◎ Aeolus
 - ◎ WSU central
 - ◎ New NSF facility in WY

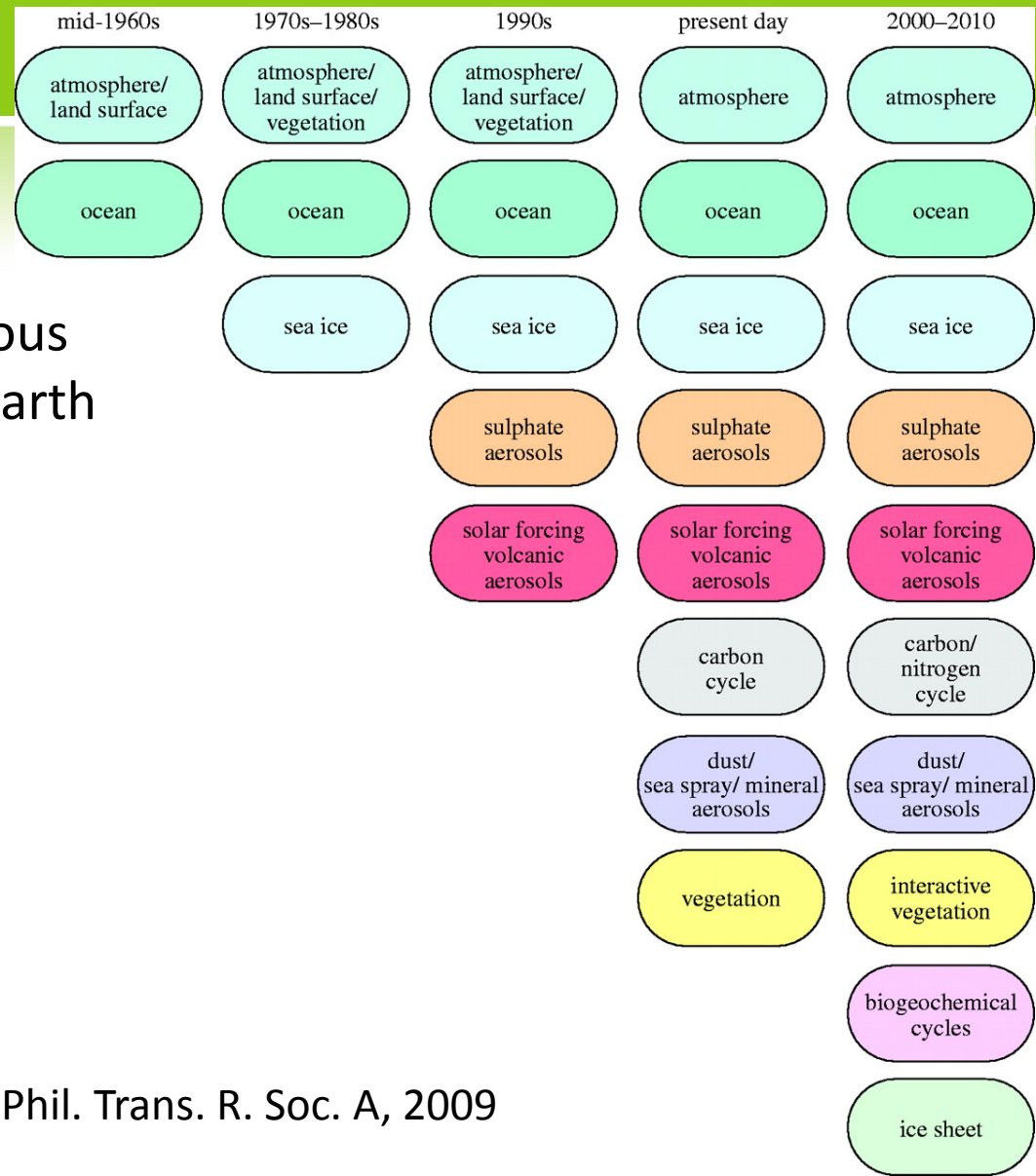


WHAT IS AN EARTH SYSTEM MODEL?

- ⊙ Incorporates interactions between multiple components of the earth system
- ⊙ Example: Community Earth System Model (CESM)
 - ⊙ Maintained at National Center for Atmospheric Research (NCAR); developed by greater community
 - ⊙ Global scale



EVOLUTION OF GLOBAL CLIMATE MODELS TO EARTH SYSTEM MODELS



⊙ A “flux coupler” ties the various components together in an Earth System Model

- ⊙ Energy
- ⊙ Heat
- ⊙ Momentum
- ⊙ Moisture
- ⊙ Etc...

RECOGNIZED NEED TO IMPROVE PREDICTABILITY OF EARTH SYSTEM MODELS

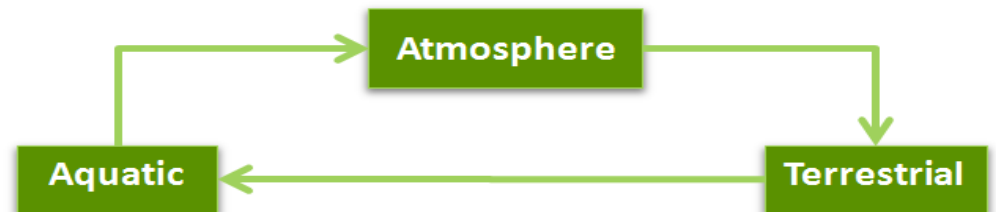
- ◎ Multiple agencies are recognizing the need to ensure that scientific knowledge gained by modeling efforts is useful for planning and decision making
- ◎ Example: NSF/DOE/USDA EaSM program
 - ◎ Finer in time: decadal climate variability and change
 - ◎ Finer in space: dynamics at regional scale resolved
 - ◎ Impacts on ecological, agricultural, and other human systems (e.g., feedbacks between ecosphere and anthrosphere)
 - ◎ Effectively translate model results and uncertainties for decision making under climate change

REMINDER: BIOEARTH COUPLING TERMINOLOGY

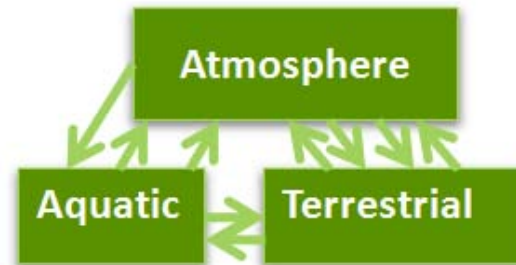
- ◎ SEQUENTIAL



- ◎ ITERATIVE



- ◎ FULLY COUPLED





BIOEARTH OVERVIEW

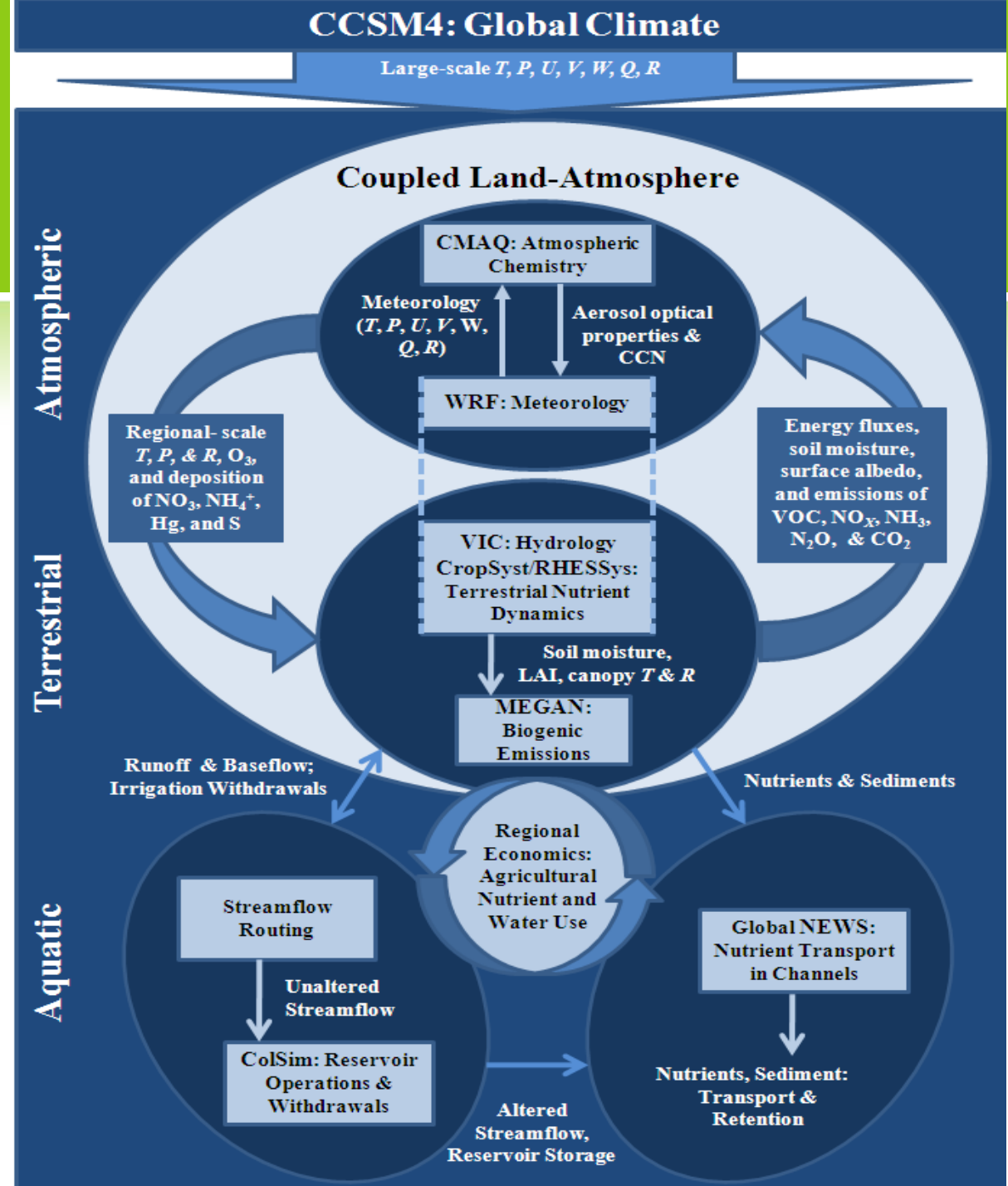
GOAL AND OBJECTIVES

Overarching Goal: To improve the understanding of regional and decadal-scale C:N:H₂O interactions in context of global change to better inform decision makers involved in natural and agricultural resource management.

Specific Objectives:

1. ***Air to Land Linkage:*** To investigate the role that atmospheric processes play in land surface C:N:H₂O cycles.
2. ***Coupled Air/Land:*** To explore how ecosystem changes in the PNW affect land/atmosphere interactions.
3. ***Coupled Air/Land/Human:*** To examine how potential policy changes might affect the interactions between C:N:H₂O cycles and regional-scale climate.
4. ***Communication:*** To explore how to best communicate the model results to resource managers and policy makers.

BIOEARTH



APPROACH AND RATIONALE

- ⊙ Integrate or link existing sophisticated “stand-alone” models; as the “stand-alone” components continue to improve by their developers, BioEarth will also improve:



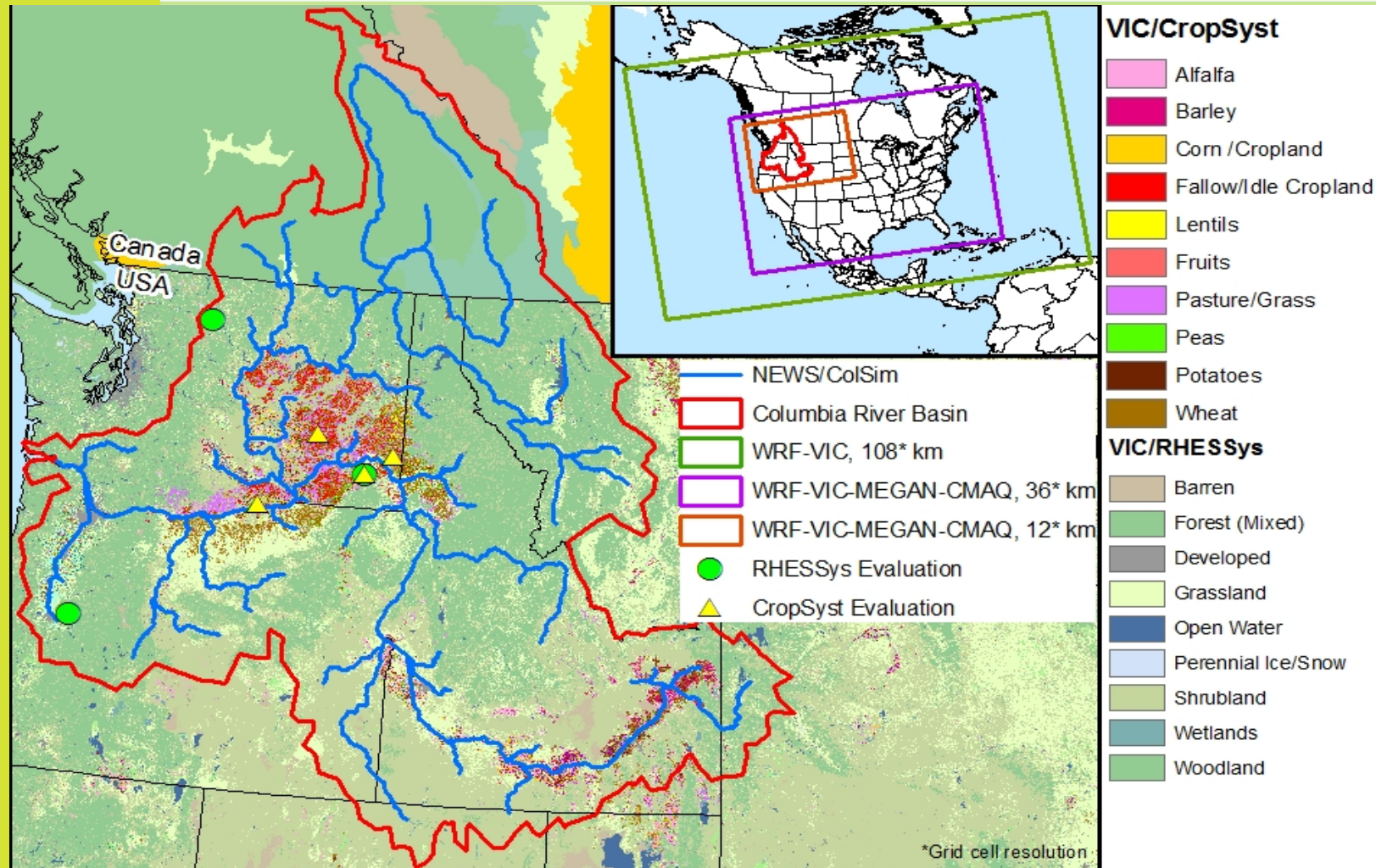
- ⊙ Meteorology: Weather Research and Forecasting (WRF); maintained at NCAR
- ⊙ Air Quality: Community Multiscale Air Quality (CMAQ); maintained at EPA
- ⊙ Ecohydrology: Regional Hydro-Ecological Simulation System (RHESSys) (adapted for larger scales using elements from other community models, e.g., the VIC model); maintained at UCSB
- ⊙ Cropping Systems: CropSyst; maintained at WSU
- ⊙ Biogenic Emissions: Model for Emissions of Gasses and Aerosols from Nature (MEGAN); maintained at NCAR
- ⊙ Existing “flux couplers”: e.g. WRF-VIC, WRF-CMAQ



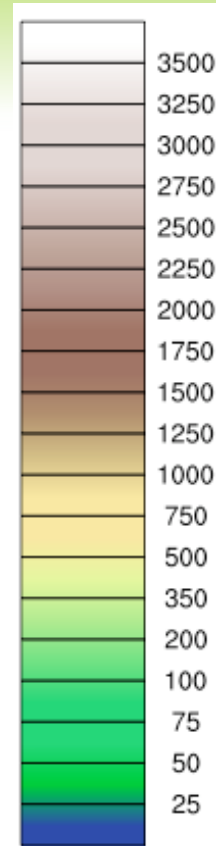
BIOEARTH FEATURES FOR NATURAL AND AGRICULTURAL RESOURCE MANAGEMENT

- ◎ BioEarth is unique in that it is a BOTTOM-UP approach (from catchment to regional scale) rather than a TOP-DOWN approach (global to regional scale)
- ◎ Emphasis on details needed to inform agricultural and natural resource use and management
 - ◎ Economics (macroeconomic drivers, regional dynamics, individual response)
 - ◎ Crop producer decisions, including modeling of crop growth and phenology
 - ◎ Forest management decisions, including modeling of biomass and succession
 - ◎ Water management, including modeling of reservoirs and curtailment
 - ◎ Nitrogen management, including modeling of coupled biogeochemical cycles
- ◎ Relevant outputs for decision making: air & water quality, water availability, crop & forest productivity, greenhouse gas emissions, carbon sequestration, hydropower potential, economic impacts
- ◎ Communications research; stakeholder engagement throughout and after development

MODELING DOMAIN: THE PACIFIC NORTHWEST



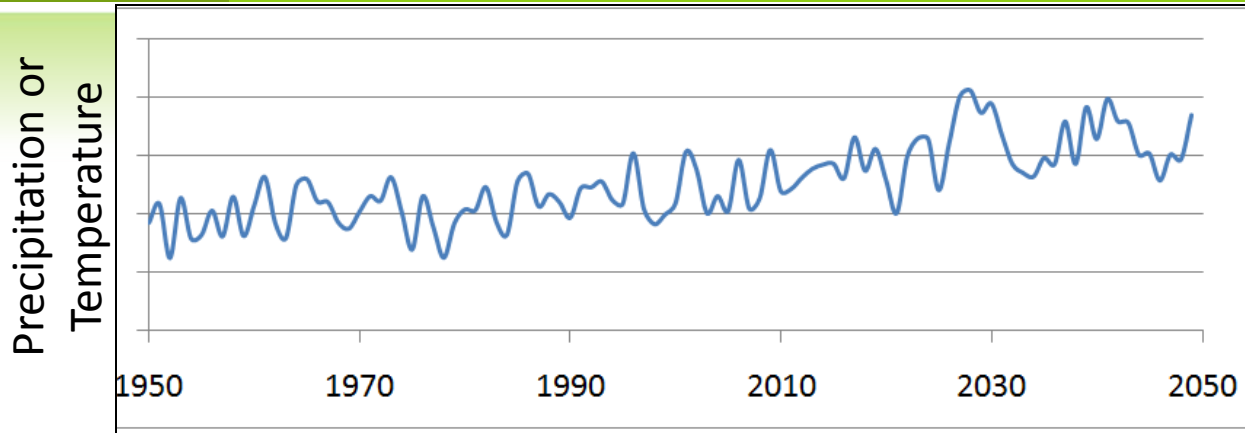
NEW SIMULATION DOMAIN (12 KM PIXELS)



Terrain Height (m)

This slide's
for you
Mike!

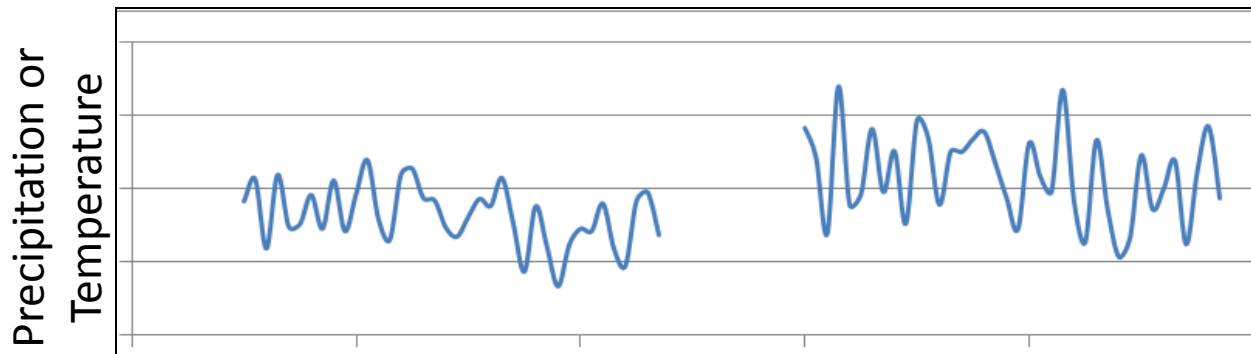
"TRANSIENT" VERSUS "DELTA CHANGE" CLIMATE DATA DOWNSCALING APPROACH



Transient

Historical
Observed


Future Predicted



**"Time Slice" for
the 2050s**

Historical 30 years

30 years of possibilities
for 2050s climate



PROJECT MANAGEMENT/INTEGRATION PROGRESS

WEBPAGE: [HTTP://WWW.CEREO.WSU.EDU/BIOEARTH/](http://www.cereo.wsu.edu/bioearth/)



WASHINGTON STATE UNIVERSITY
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BioEarth

Biosphere-relevant earth system model

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Regional Earth System Modeling



One of the greatest challenges of the 21st Century is understanding how changes in the balance of nutrients—carbon, oxygen, hydrogen, nitrogen, sulfur, and phosphorus—in soil, water, and air affect the functioning of ecosystems, atmospheric chemistry, and human health.

Poster Session on Climate, Land Use, and Agricultural and Natural Resources:
Activities in Interdisciplinary Research, Education and Outreach

Goal | Approach | Mission | Rationale | Framework | Product

Project Goal

- Improve understanding of the interactions among carbon, nitrogen, and water at the regional scale, in the context of global change, to inform



BioEarth Calendar

Partner Institutions:



CLARK UNIVERSITY



NCAR
NATIONAL CENTER FOR ENVIRONMENTAL RESEARCH



Oregon State UNIVERSITY OSU



Pacific Northwest
NATIONAL LABORATORY



DONALD BREN SCHOOL OF
ENVIRONMENTAL SCIENCE & MANAGEMENT
UNIVERSITY OF CALIFORNIA, SANTA BARBARA



WASHINGTON STATE
UNIVERSITY

**Calendar Kept
Current and Linked
From the Webpage**

WEBPAGE: REMAINING ITEMS

- ⊙ Materials for each team/working group, what will go into these?
- ⊙ Model descriptions, so far these exist for VIC, RHESys, and NEWS
- ⊙ Student profiles
- ⊙ 1-slide biosketches from new members
- ⊙ Papers, presentations, etc...
- ⊙ Will be updated continuously with material presented at key meetings

FORUM

The screenshot shows the BioEarth website header with the logo and navigation tabs for Forum and What's New. Below the header is a dark navigation bar with links for New Posts, Private Messages, FAQ, Calendar, Community, Forum Actions, and Quick Links. The main content area is titled 'Forum' and 'BioEarth Integrated Regional Modeling Initiative Forums'. It includes a welcome message and two main sections: 'Logistics and Scheduling' and 'Research Topics'. The 'Logistics and Scheduling' section has a sub-header and a description. The 'Research Topics' section lists four categories: Model Integration, Atmospheric Modeling, Terrestrial Modeling, and Aquatic modeling, each with a brief description of the models involved.

BioEarth

Forum What's New?

New Posts Private Messages FAQ Calendar Community Forum Actions Quick Links

Forum

BioEarth Integrated Regional Modeling Initiative Forums
Welcome to the BioEarth Integrated Regional Modeling Initiative Forums.

Logistics and Scheduling

Logistics and Scheduling
Scheduling of all meetings, coordination within and between teams, etc...

Research Topics

Model Integration

Atmospheric Modeling
WRF: Meteorology, CMAQ: Atmospheric Chemistry

Terrestrial Modeling
CropSyst, RHESSys: Terrestrial nutrient dynamics, VIC: hydrology, MEGAN: Biogenic Emissions

Aquatic modeling
ColSim: Reservoir Operations and Withdrawals. Global NEWS: Nutrient Transport in Channels

What do we
plan on
doing with
this?

OK to start conversations by email, but then post to Forum as they develop and email the new thread to conversation participants.



PEER REVIEW GROUP

- ⊙ Water Resources: Alan Hamlet (Spring 2012)
- ⊙ Atmospheric Modeling: Jon Pleim (Spring 2012)
- ⊙ Land/Atmosphere Modeling: Robin Dennis accepted (Fall 2012)
- ⊙ Cyberinfrastructure: Ilkay Altintas accepted (Jan/Feb 2013)
- ⊙ Economics: Ronald Sands: to be invited
- ⊙ Ecology: Scott Ollinger to be invited
- ⊙ Agriculture: Possibly Clyde Frossi
- ⊙ Other: Please let me know if others are needed as we go forward
- ⊙ A “Peer Reviewer Expectation” document will be drafted early Spring 2012; minimal obligations – **DRAFT COMPLETE**

MEETING FREQUENCY

- ◎ Steering committee meetings: monthly (notes posted online)
- ◎ Working group meetings
 - ◎ WG I seminar: monthly (may be called “project integration” meetings starting Fall 2012)
 - ◎ Others have been more frequently
- ◎ All-hand meetings: bi-annually (is this too often?)
- ◎ Informal student meetings: monthly
- ◎ Peer review meetings: twice per semester
- ◎ Outreach Meetings: bi-annually starting year 2

WG I (MODELING TEAM)

SEMINARS

- ◎ We've heard about WRF, VIC-CropSyst, economic modeling, CMAQ, and RHESSys
- ◎ Upcoming presentations:
 - ◎ July 23: NEWS
 - ◎ Aug 6: Water Management
 - ◎ Kepler presentation tentative for Fall
- ◎ All presentations will be posted to website
- ◎ **WHAT DO WE WANT TO DO WITH THESE SEMINARS STARTING FALL 2012? Project Integration Meetings targeted at model interfaces?**



UPCOMING DEADLINES/EVENTS

- ⊙ Annual report to USDA – due Friday!
- ⊙ NSF EaSM-1 PI meeting in DC: July 9-11
- ⊙ USDA NIFA PD meeting: at Tri-Society Meeting in Ohio, October 21-24
- ⊙ Organization of a grad student visit to Prosser in September or earlier??



TEAMS AND TEAM MEMBERS

STEERING COMMITTEE

Steering Committee

Jennifer Adam, WSU

Michael Brady, WSU

Serena Chung, WSU

Dave Evans, WSU

Chad Kruger, WSU

Brian Lamb, WSU

Claudio Stockle, WSU

Joe Vaughan, WSU

WORKING GROUP IA: ATMOSPHERIC

Atmospheric Team

Jennifer Adam, WSU

Serena Chung, WSU

Alex Guenther, NCAR

Xiaoyan Jiang, NCAR (new)

Brian Lamb, WSU

Ruby Leung, PNNL

Mingliang Liu, WSU

Tsengel Nergui, WSU

Joe Vaughan, WSU

Jinho Yoon, PNNL (new)

WORKING GROUP IB: TERRESTRIAL

Terrestrial Team

*Jennifer Adam, WSU

Sarah Anderson, WSU

Janet Choate, UCSB

Dave Evans, WSU

Greg Gould, WSU (new)

John Harrison, WSU

Mingliang Liu, WSU

Terrestrial Team

Keyvan Malek, WSU

Cody Miller, WSU (new)

Justin Poinsett, WSU

Kirti Rajagopalan, WSU

Julian Reyes, WSU

Claudio Stöckle, WSU

Christina Tague, UCSB

Jun Zhu, UCSB

WORKING GROUP IC: CYBERINFRASTRUCTURE

Cyberinfrastructure Team

Jennifer Adam, WSU

Serena Chung, WSU

Ananth Kalyanaraman, WSU

Mingliang Liu, WSU

George Gruber, WSU (new)

*Joe Vaughan, WSU

WORKING GROUP II: ECONOMICS

Economics Team

*Michael Brady, WSU

Yong Chen, OSU

Jon Yoder, WSU



WORKING GROUP III: COMMUNICATIONS/EXTENSION

Communications Team

Liz Allen, Clark U.

*Chad Kruger, WSU

Fok Leung, WSU

Todd Norton, WSU (new)

Andy Perleberg, WSU

Jennie Stephens, Clark U.

Georgine Yorgey, WSU