BioEarth

Biosphere-relevant earth system model

Terrestrial Group Progress

All-Hand Meeting
June, 2012

Working Group IB: Terrestrial

Terrestrial Team
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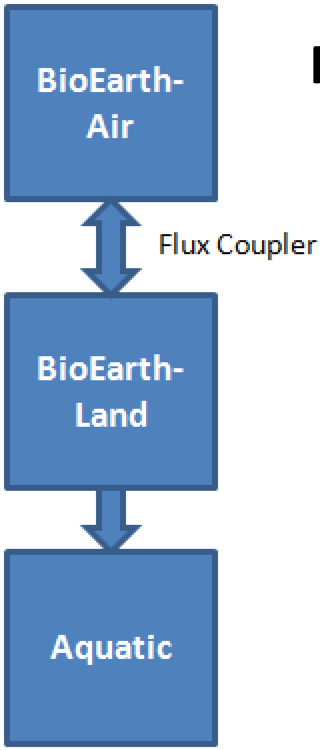
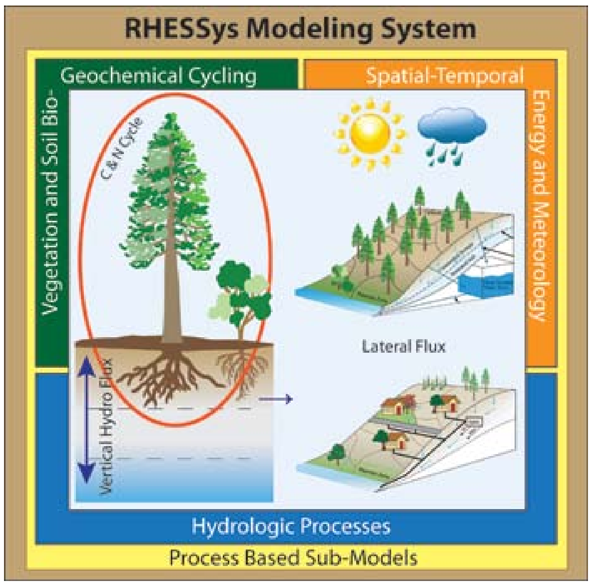
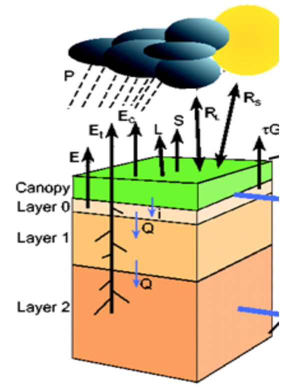
Christina Tague, UCSB
Jun Zhu, UCSB

Models in BioEarth-Land



RHESSys: ecohydrology and dynamic vegetation





VIC large-scale physical hydrology: we will utilize surface energy balance components

CropSyst: will use to incorporate crops into RHESSys

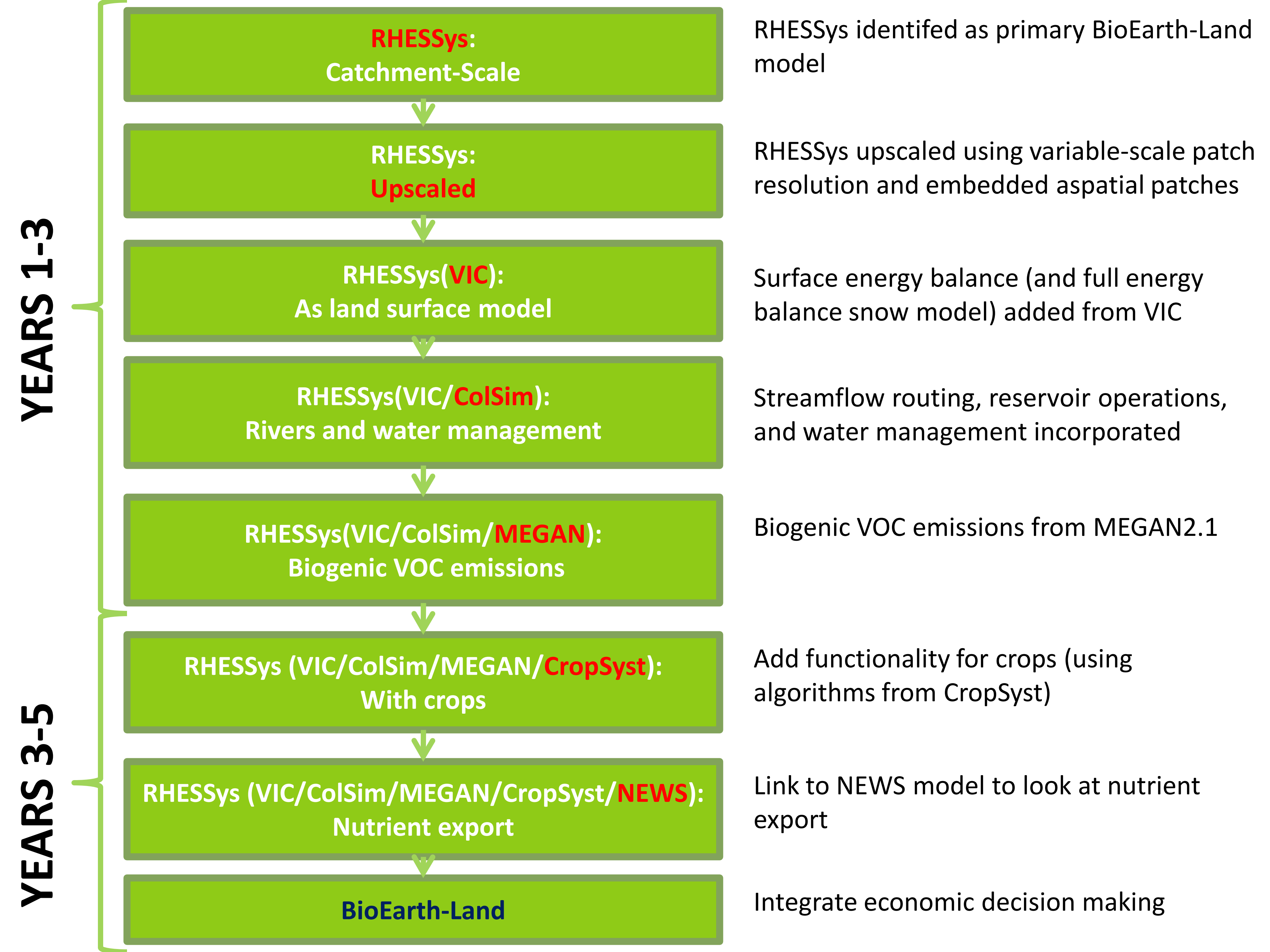
Streamflow routing, reservoirs, water management

MEGAN Biogenic VOC Emission Estimates

Global NEWS
Global Nutrient Export from Water(S)heds

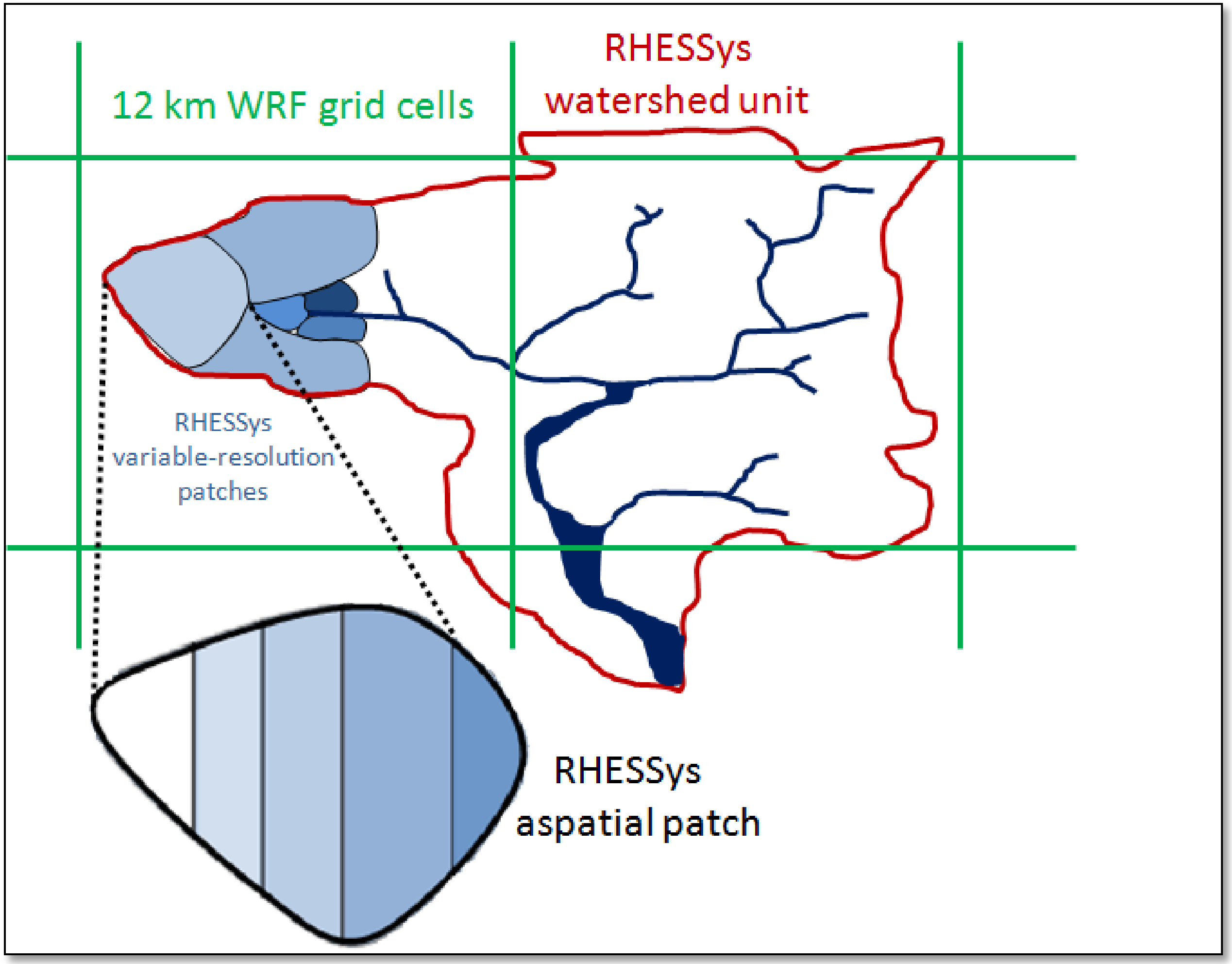
Nutrient Export

Economic Decision Making


YEARS 1-3
YEARS 3-5
RHESSys:
Catchment-Scale
RHESSys identifed as primary BioEarth-Land model
RHESSys:
Upscaled
RHESSys upscaled using variable-scale patch resolution and embedded aspatial patches
RHESSys(VIC):
As land surface model
Surface energy balance (and full energy balance snow model) added from VIC
RHESSys(VIC/ColSim):
Rivers and water management
Streamflow routing, reservoir operations, and water management incorporated
RHESSys(VIC/ColSim/MEGAN):
Biogenic VOC emissions
Biogenic VOC emissions from MEGAN2.1
RHESSys (VIC/ColSim/MEGAN/CropSyst):
With crops
Add functionality for crops (using algorithms from CropSyst)
RHESSys (VIC/ColSim/MEGAN/CropSyst/NEWS):
Nutrient export
Link to NEWS model to look at nutrient export
BioEarth-Land
Integrate economic decision making

Progress Towards RHESSys Upscaling

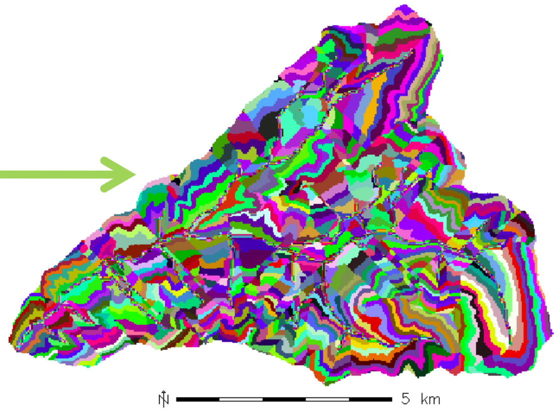
- 12 km grids converted from latitude/longitude boxes to watershed boundaries (see right)
- RHESSys will run at a finer resolution (for each "patch") within each watershed, handling all hydrology
- RHESSys patches resolution will be finer within riparian areas and coarser in upland areas; these scales are one of our research questions
- Patches will be sub-divided statistically to increase computational efficiency (i.e., the patches can be bigger)



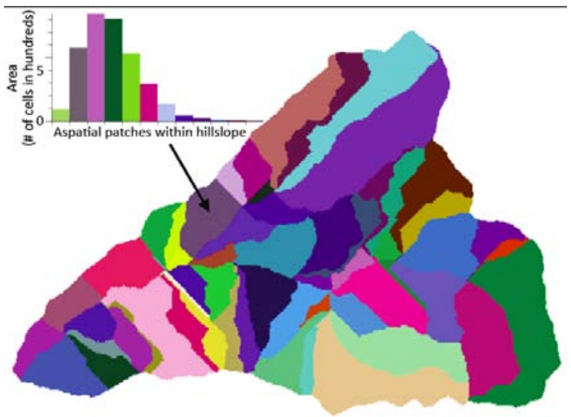
- RHESSys will route flow within the VIC grid; a separate routing algorithm will be used to route flow contributed from the VIC grids

Accounting for Sub-Patch Heterogeneity: Embedded Aspatial Patches

- Explicit patch representation: where spatial organization matters (spatially explicit patches)



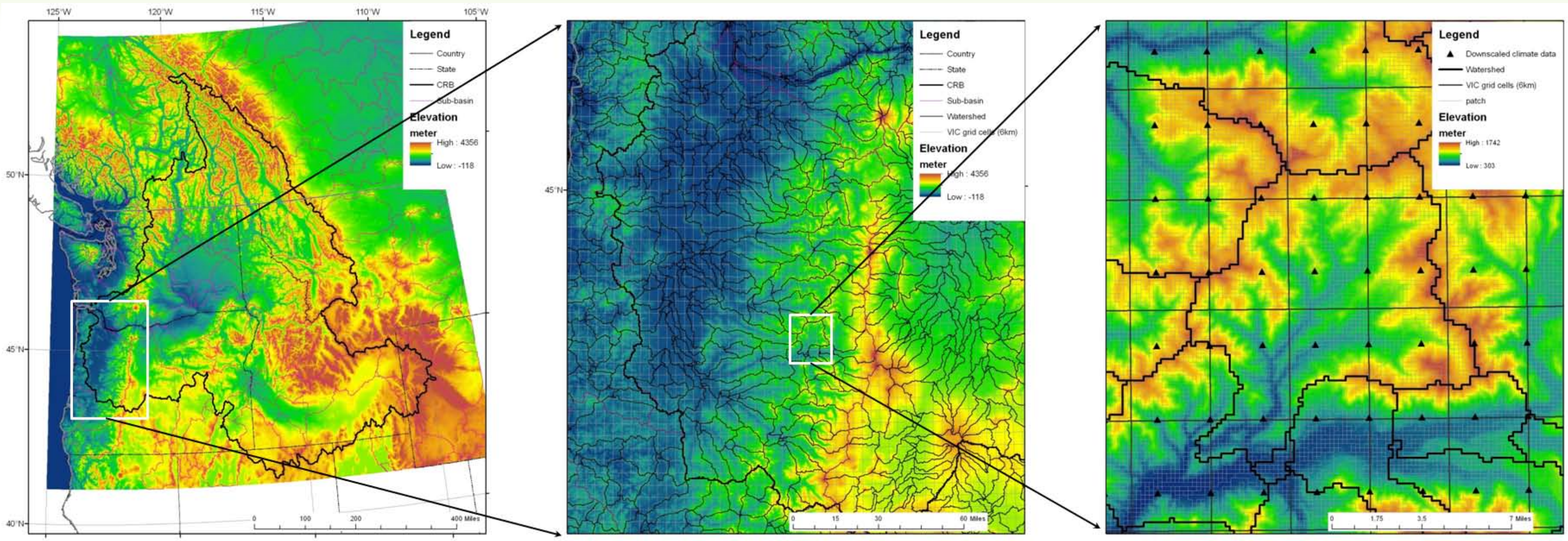
- Implicit patch representation: when the aggregate effect of spatial heterogeneity matters but not its spatial pattern (embedded aspatial patches)



Strategy	# patches	NSE	Log NSE	% error
Spatially explicit	4313	0.73 – 0.78	0.74 – 0.92	3.2 – 4.8
Aspatial Embedded	633	0.70 – 0.72	0.75 – 0.86	1.8 – 8.9

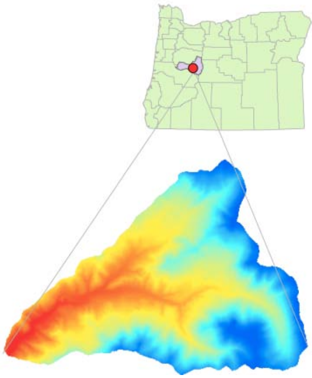
Tague et al. poster

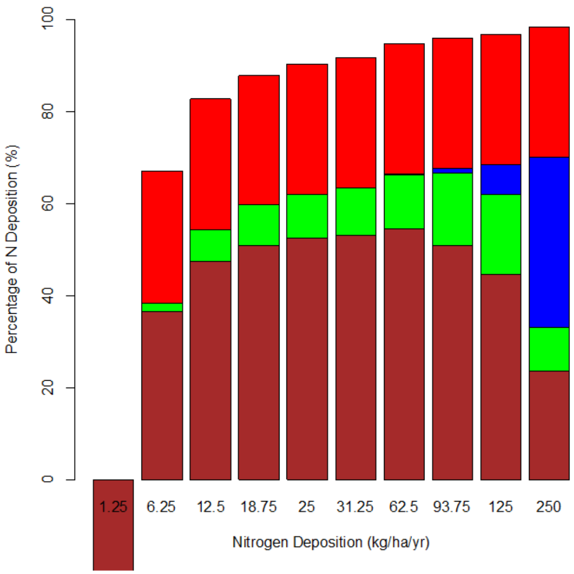
Watershed comparison to 6 km grid cells

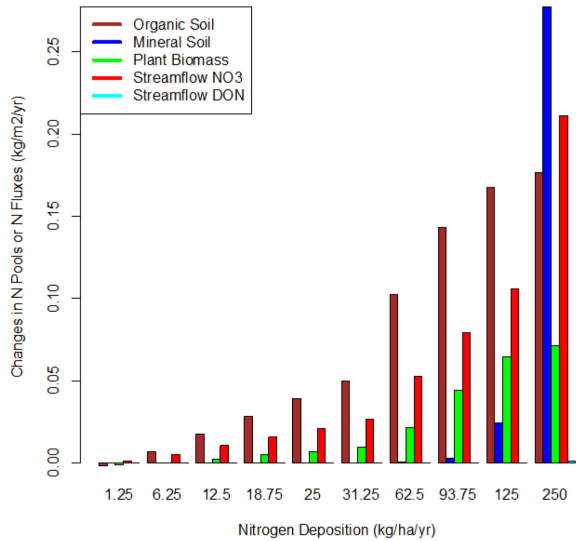


Liu et al. poster

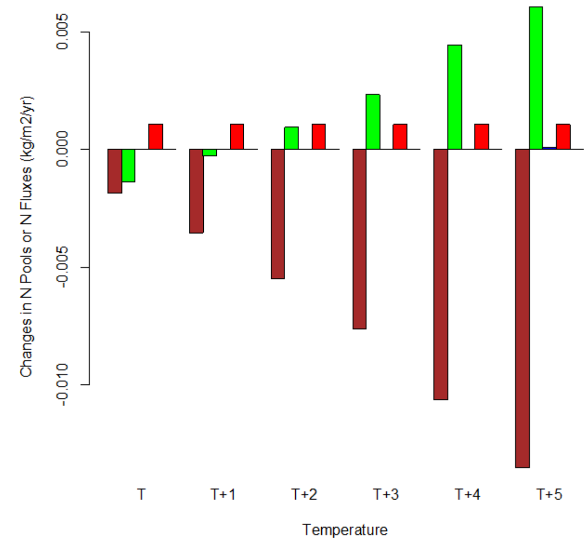
Sensitivity of N-retention and export to temperature and nitrogen Deposition at the HJ Andrews Experimental Site







Changes in N stores and pools with increasing N deposition

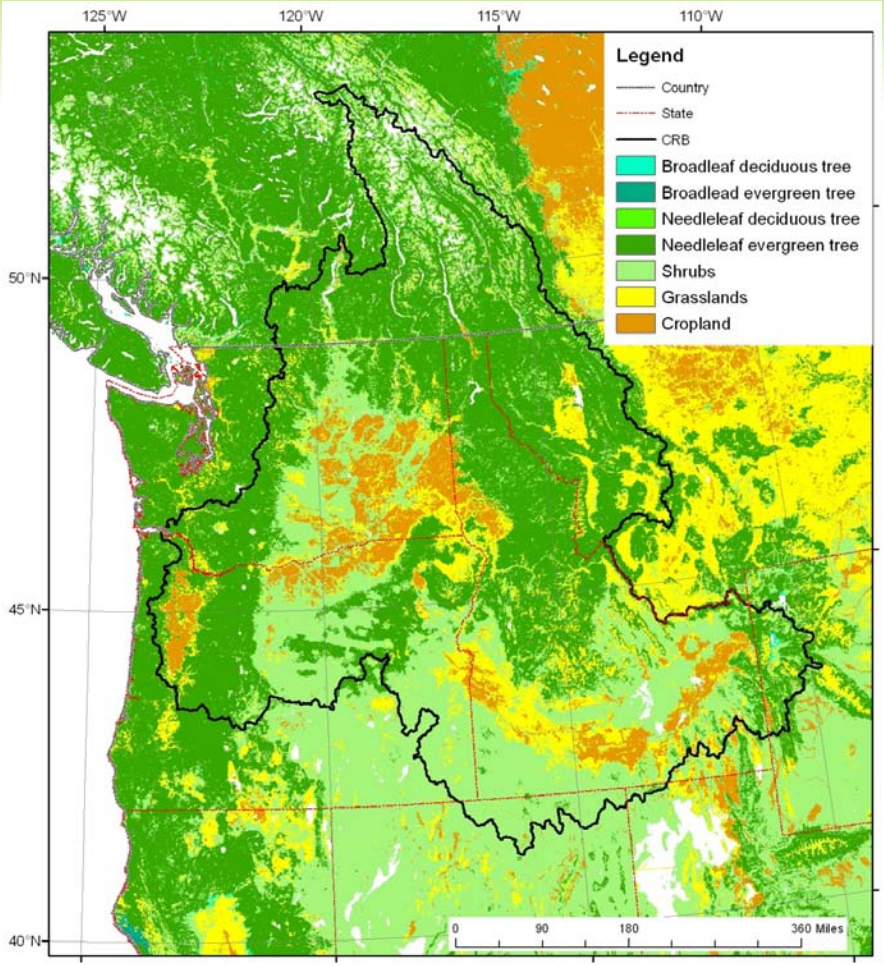


Changes in N stores and pools with increasing temperature

For both temperature and N-deposition increase scenarios, responses are relatively linear and the thresholds, where ecosystem behavior shows dramatic changes in the pattern of response, are not likely to be reached within the next decades. NEXT step: the dry basin (Deschutes)

Zhu et al. poster

Progress on Consistent Land Cover



Vegetation Cover from Alex Guenther: The newest land cover dataset is 30-m in resolution, uses CLM plant functional types, and includes species composition for crops, trees, shrubs, grass. The database integrates CDL, NLCD, FIA, and NRCS data with adjusted NLCD in urban areas. Also included is MODIS 8-day LAI for individual years

Student Activities (…all of these students also have posters…)

Sarah Anderson
Atmospheric Sources and Deposition of Nitrogen

Overarching Goal: To better understand atmospheric deposition of nitrogen, its source-receptor relationships, and its ecological impacts.

Specific Objectives/Aims/Questions:

- What are patterns (either spatial or temporally) are observable in nitrate isotopic composition in precipitation samples?
- Certain isotopic measurements reflect atmospheric chemistry. Do isotopic measurements and results from atmospheric chemistry models agree?
- How do biological indicators of atmospheric nitrogen deposition, such as lichens and mosses, reflect actual deposition and how are they affected by deposition?

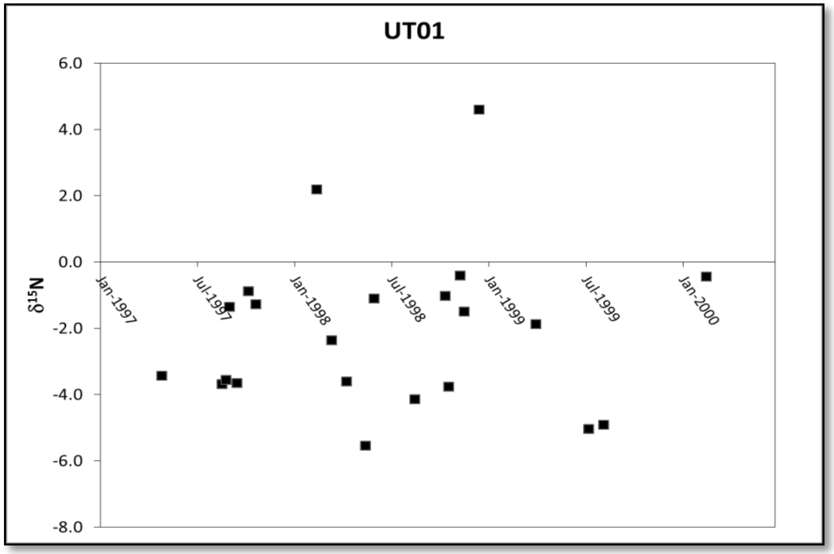
Rationale: Nitrogen deposition is a major nutrient flux into terrestrial ecosystems with excess causing acidification, eutrophication, and biodiversity loss. It is a major concern for sensitive ecosystems across the Pacific Northwest.

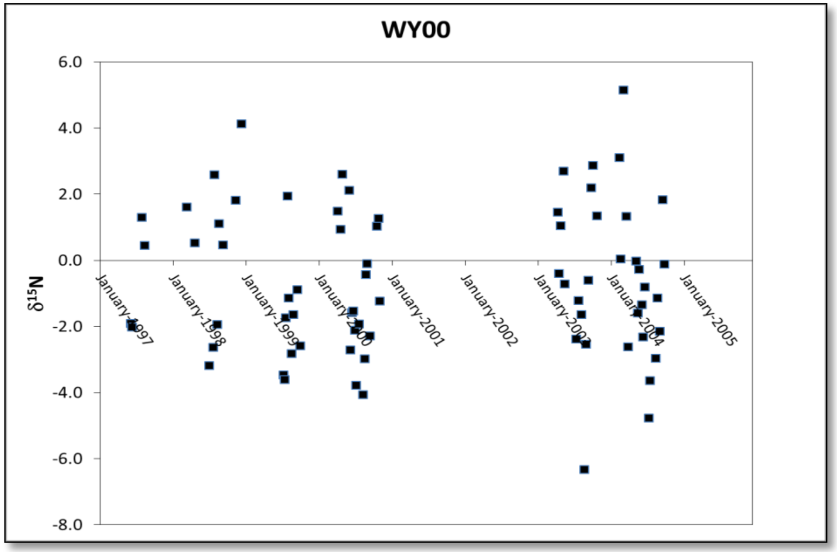
Relationships to BioEarth: Advised by R.D. Evans. Work with J. Adam, B. Lamb, S. Chung

Progress Report

Show any results, outcomes, progress, as relevant (includes figs/graphic if you like)

- Improved laboratory methods and began isotopic analyses of NADP samples focusing on 2 of 9 selected NADP sites
- Developing project with biological indicators to extend temporal and spatial scale N deposition measurements





Plans for Next Year

What you hope to accomplish in the next year and longer-term, if you like…

- **Finish running isotopic analyses on nitrate in NADP precipitation samples**
- **Continue working with HYSPLIT and begin working with CMAQ**
- **Begin isotopic analyses on biological indicators (ex. lichens) from the USFS and develop a project**
- **Pass my preliminary examination**

and longer-term…

- **Graduate ☺**

Gregory Gould

Progress Towards Assessing the Large-scale Impacts of Forest Fires on Runoff Erosion Across the Pacific Northwest

Overarching Goal: Achieve an improved understanding of how to upscale modeling of post-fire runoff erosion allowing us to better understand the controls on post-fire runoff erosion, including soil characteristics, topography, and climate.

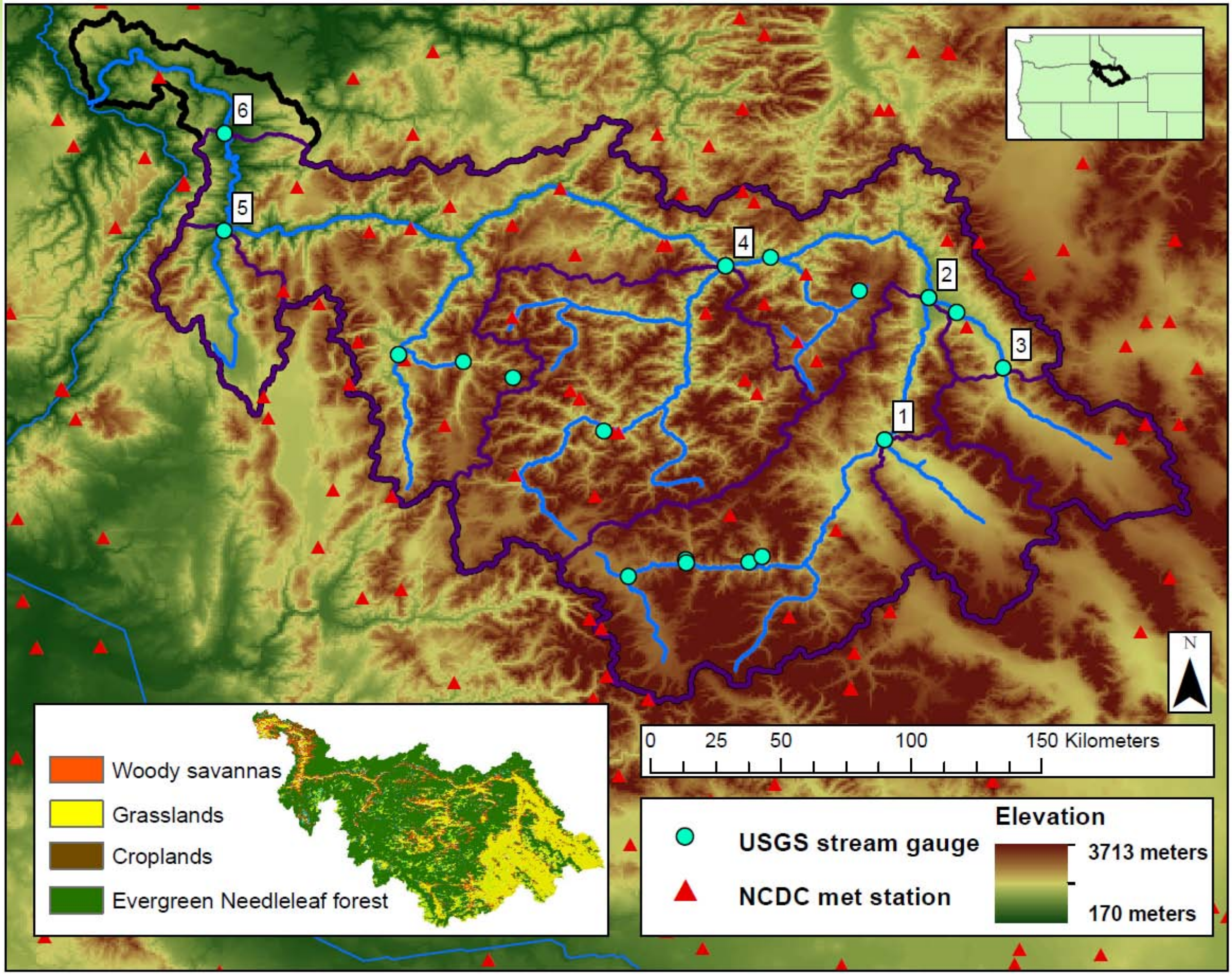
Specific Objectives/Aims/Questions: Implement a newly-developed physically-based modeling framework that combines large-scale hydrology with hillslope-scale runoff erosion (VIC-WEPP; Mao et al. 2010) over the Salmon River basin (SRB) of central Idaho to examine the relative sensitivity of SRB erosion rates to climate versus land cover and soil parameterization.

Rationale: Excess sediment in streams continues to be a concern for resource managers across the United States. The SRB is a large watershed that has been relatively undisturbed by human activities, providing an ideal study area.

Relationships to BioEarth: Excess sediment adversely impacts aquatic life, navigation, reservoir sedimentation and flood storage, drinking water supply, and aesthetics which directly affect resource managers and stakeholders.

PROGRESS REPORT

- Set up VIC over Salmon River basin and calibrating
- Evaluating timing of peak discharge in snowmelt (high elevation) dominate areas
- Collaboration with the Forest Service on soil erodibilty characteristics
- Collaboration with Purdue University for model coupling scheme (VIC-WEPP)



Salmon River basin study map for calibration of six sub-basins

Plans for Next Year

Large-scale implementation of VIC-WEPP over the Salmon River basin (SRB)

Run scenarios for both historical and an ensemble of future climate simulations to examine the sensitivity of SRB runoff erosion rates to climate

Field visits at Forest Service erosion measuring sites

A set of maps showing erosion over the SRB

Dissemination of information through conference presentations at appropriate scientific meetings and through journal papers

KEYVAN MALEK

EFFECT OF CLIMATE AND AGRICULTURAL PRACTICES MANAGEMENT ON ENVIRONMENT AND AGRICULTURAL PRODUCTIVITY OF YAKIMA RIVER BASIN

Overarching Goal:

Developing an integrated model (VIC-CropSyst) to simulate water and nitrogen cycle in agricultural region and using the integerated model effects of climate and agricultural strategies on environment and agricultural productivity will be investigated.

Specific Objectives/Aims/Questions:

1-how climate change affect soil moisture and evapotranspiration in agricultural regions?

2- how change in irrigation efficiency can change water availability for irrigation?

3- how in farm management of nitrogen use can affect emission of N to environment?

Rationale:

Yakima River Basin (YRB) is an important agricultural area in PNW and is sensitive to climate change, due to that management of agricultural practices like irrigation water management and nitrogen use management can significantly influence environment and economy of the region.

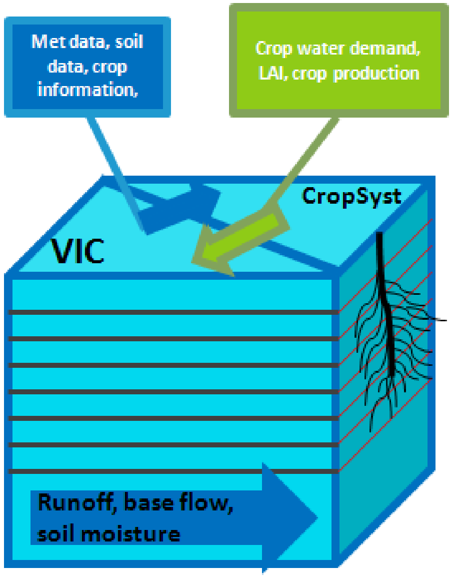
Relationships to BioEarth:

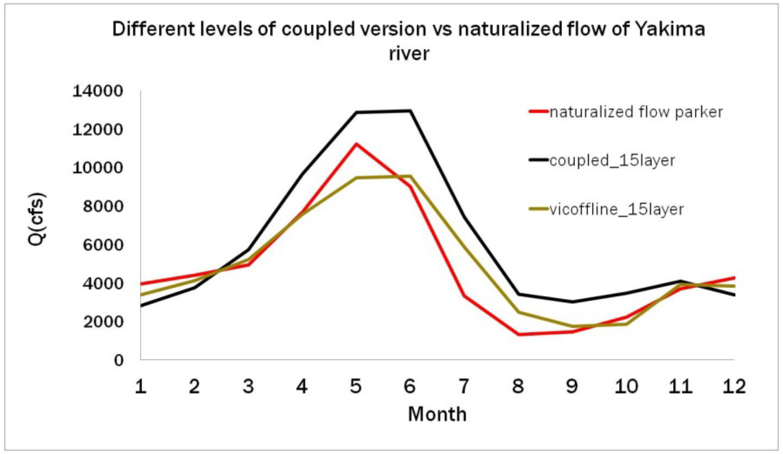
Coupled model, some modified data and methods will be used for developing the modeling framework of BioEarth

PROGRESS REPORT

Show any results, outcomes, progress, as relevant (includes figs/graphic if you like)

1- VIC and CropSyst coupling and testing for YRB





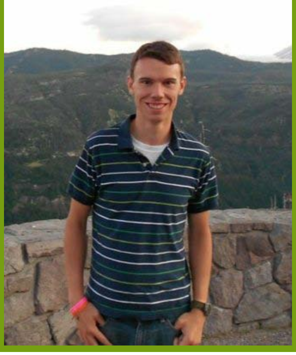
2- writing VIC codes in VBA

3- Creating soil file for CRB

Plans for Next Year

What you hope to accomplish in the next year and longer-term, if you like…

- ***calibration and evaluation of the model***
- ***Publish my first paper on the effect of climate change on soil moisture***
- ***Submit my 2nd paper on the effect of change in irrigation efficiency on water availability for agriculture***
- ***Preparing final soil file for BioEarth project***
- ***adding nitrogen model to VIC-CropSyst coupled model***



Justin Poinsatte

Biogeochemical response to nitrogen deposition in subalpine ecosystems of the Central Cascades

Overarching Goal:

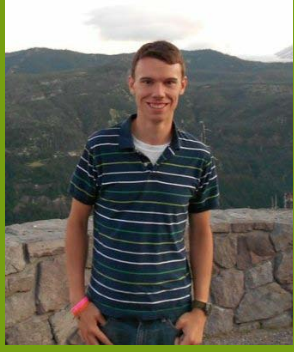
- Use synergistic modeling and experimental approach to evaluate subalpine ecosystem biogeochemical responses to elevated nitrogen (N) deposition

Specific Objectives/Aims/Questions:

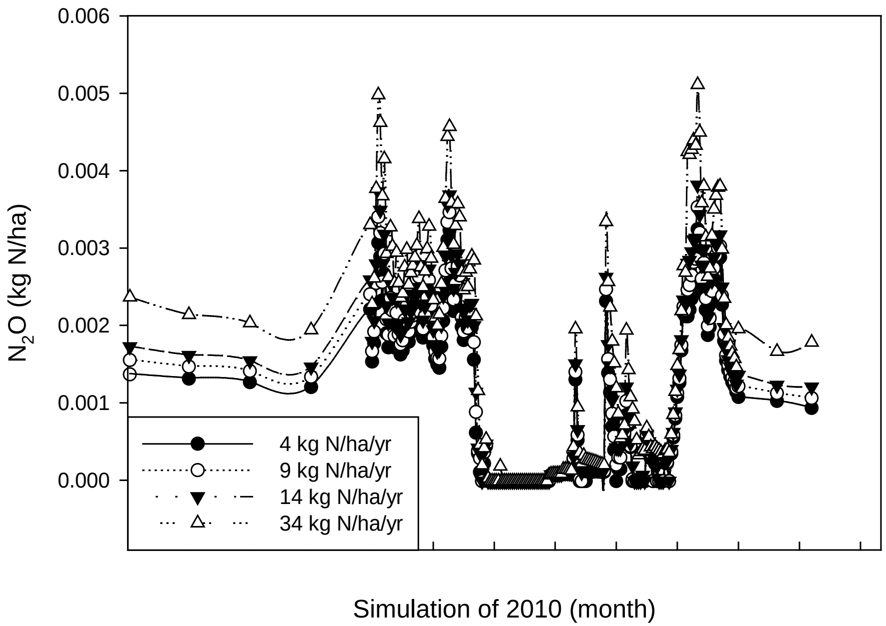
- Determine the sources and forms of N deposition stored in snowpack
- Identify the fate of snowpack N and the influence of snowmelt
- Determine if biogeochemical responses to N deposition vary by vegetation community

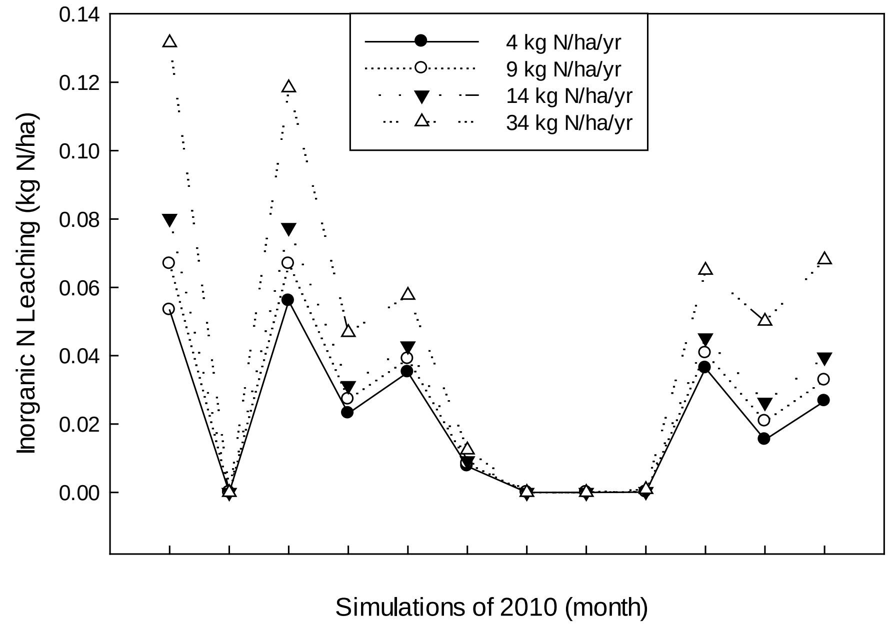
Relationships to BioEarth:

- Use of RHESSys for biogeochemical modeling



Progress Report

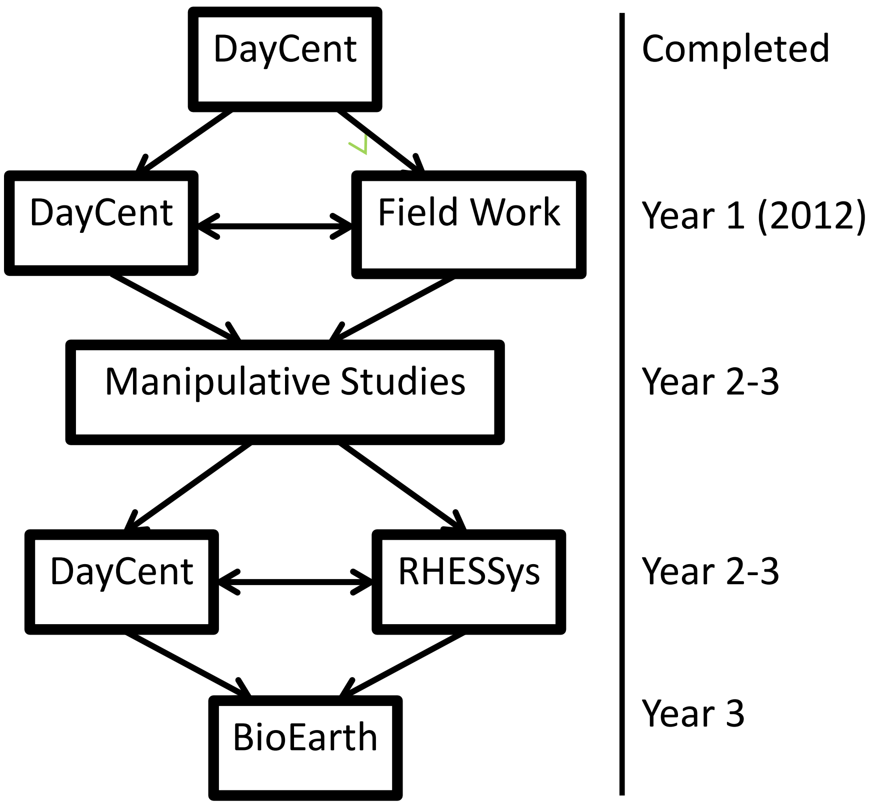




Results:

- N_2O emissions and NO_3^- leaching increase with elevated deposition rates
- Intense biogeochemical cycling occurring during snowmelt

Plans for Next Year



Objectives:

- Collect field data addressing biogeochemical cycling in subalpine vegetation communities
- Design and conduct field experiments to determine biogeochemical response to N deposition
- Reparameterize DayCent and RHESSys with field measurements and simulate response to elevated N deposition

KIRTI RAJAGOPALAN

INTEGRATED MODELING FOR INFORMING IRRIGATED AGRICULTURE DECISION MAKING AND APPLICATIONS IN THE COLUMBIA RIVER BASIN

Overarching Goal: *Facilitate the creation and application of an integrated modeling tool to study the combined effects of climate, economics and human influence on irrigated agriculture, with specific focus on the* ***human influence component and its interaction with economics.***

Specific Objectives/Aims/Questions:

What is the irrigation demand in the Columbia River basin (CRB) and how is it expected to change? What is the sensitivity of crop yields and revenue impacts to reduced water availability in the CRB?

How does producer response to a changing climate, water availability and other economic factors affect irrigation demand in the (CRB)?

Rationale:

Irrigated agriculture is a vital part of the economy in the CRB region and there is interest in understanding the dynamics of what affects it and how it might change.

Relationships to BioEarth:

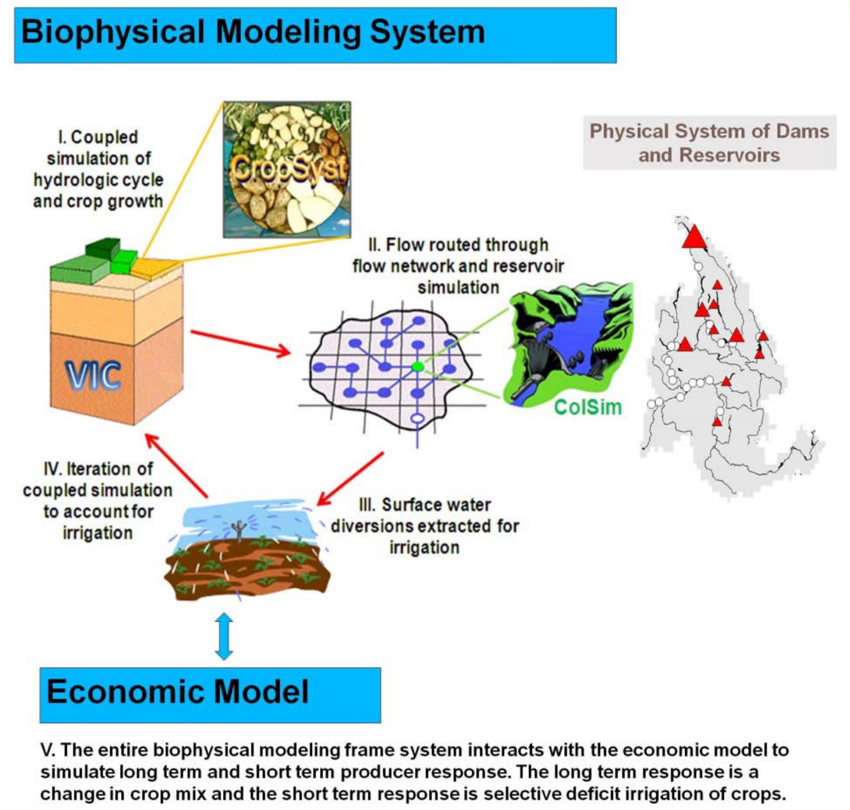
This work fits within the ***aquatic*** *framework of BioEarth and in the* ***interface between the terrestrial and aquatic*** *frameworks.*

Progress Report

An integrated biophysical (hydrology, crop growth, reservoir model and water rights curtailment) and economic model developed .

The integrated model applied over the Columbia River basin to study the impacts of climate and economics on irrigation demand in the 2030s.

This framework and its components will be used / expanded upon for BioEarth.



Plans for Next Year

1) *Work with the economics team to expand current functionality related to how producers react to a changing climate, water scarcity and other economic factors.*

2) *Incorporate reservoir modeling functionality in the "space before time" version of the hydrology model.*

Julian Reyes

Modeling of Nitrogen in Grassland Systems

Overarching Goal: Investigate how nitrogen cycles in grassland systems, how grassland N can be improved in modeling, and how N interacts with hydrology and biogeochemical cycling in grasslands.

Specific Objectives/Aims/Questions: Improve N cycling within RHESSys with respect to grassland systems and grassland management

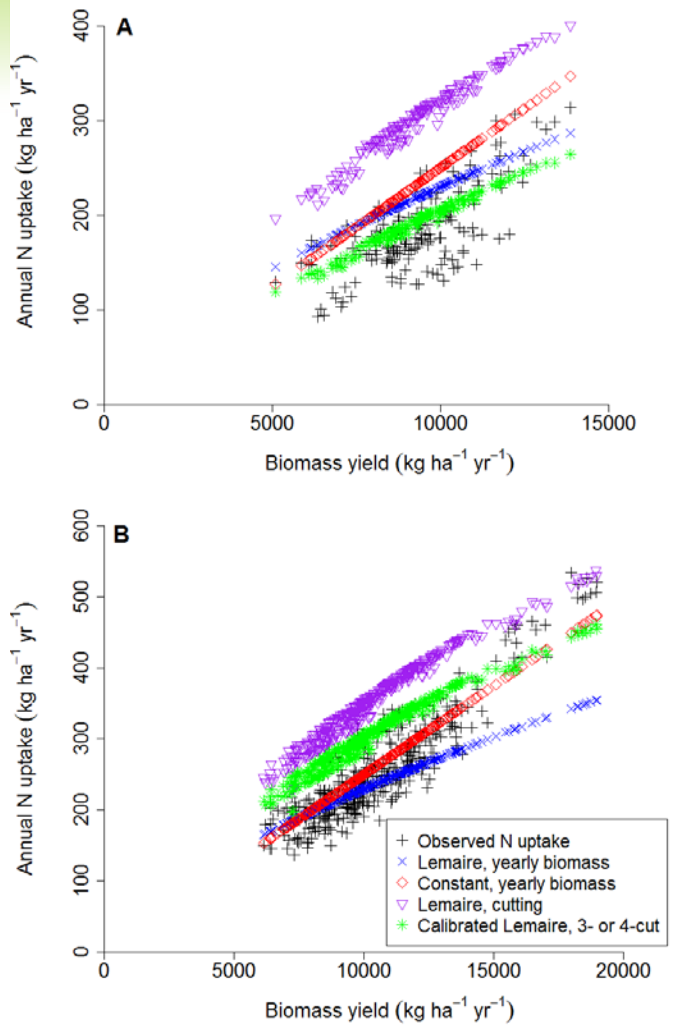
Rationale: Advances in Earth systems modeling have begun to incorporate more processes related to agroecosystem functions, such as management, along with biogeochemical cycling, carbon cycling, and the climate system (Donner and Kucharik, 2003; Bondeau et al., 2007).

Relationships to BioEarth: terrestrial modeling w/ RHESSys linking hydrology and biogeochemistry

Progress Report

❖ Critical N-uptake was computed with observed values to give an indication of the spread of actual values and the related uncertainty.

❖The comparison of observed N uptake and N uptake by a variety of methods suggests yield gaps or limitations. Most N uptake observations in both cutting systems) lie below the Lemaire reference curve, indicating N-limitation in our datasets, or an overestimation of N uptake by Lemaire.



Plans for Next Year

- ❖ Submit paper for publication related to work during Fulbright year (2011-2012) while at the University of Bonn
- ❖ Complete and focus dissertation proposal
- ❖ Complete NSPIRE Internship with an institution in Germany