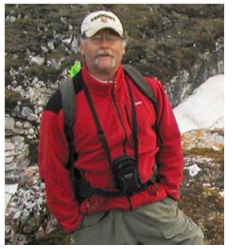

Experimental Program to Stimulate Competitive Research

# NSF Reverse Site Visit
# September 6, 2012

Presenting Today:

Judith Van Houten, VT EPSCoR PD and University Distinguished Professor at University of Vermont (UVM)



W. Breck Bowden, Science Leader, Internal Steering Committee Member, Director of the UVM Water Resources and Lake Studies Center, *Chair of the Lake Champlain Basin Program Technical Advisory Committee*

Arne Bomblies, Question 2 Leader, Assistant Professor of Civil Engineering at UVM

Christopher Koliba, Question 3 Leader, Associate Professor of Community and Applied Economics at UVM

Also attending:

Asim Zia, Assistant Professor of Community and Applied Economics at UVM

Declan McCabe, Professor of Biology at Saint Michael's College

# Research on Adaptation to Climate Change in the Lake Champlain Basin: New Insights through Complex Systems Modeling

**Context of the RII award** – **Van Houten**

***Progress*** made in Year 1

**Science and engineering research** that we call **RACC**

**Bowden, Bomblies, Koliba**

**Outreach and Broader Impact**

**Diversity and Workforce Development Plans - Van Houten**

**Sustainability Plan**

**Pilot** and **Private Sector Innovation Awards** - **Van Houten**

***Progress on:***

External Engagement Plan
Cyberinfrastructure Plan
Assessment Plan
Management Plan
Mentoring Plan (in CWDD above)
Data Management Plan - Koliba above


VERMONT EPSCoR

RACC
Research on Adaptation to Climate Change

# The State Context

Vermont is a **small, rural state** with a population of about 620,000.

***Higher Education:***

•One research university (University of Vermont)
•State College System: 3 state colleges, a technical college and 12 community college sites
•18 independent colleges (e.g. Green Mountain, Saint Michael's, Middlebury Colleges)

***The Economy:***

Our economy is driven by **tourism, health care, government jobs and manufacturing. Small businesses** are the large majority of Vermont businesses.

DRAKER

Monitoring and Controls for Solar Arrays

# VT EPSCoR Alignments and Partnerships:

## *State of Vermont:*

Governor Peter Shumlin

## *Partners and Stakeholders:*

Agency of Natural Resources
Governor's Climate Cabinet
Lake Champlain Basin Program
Nature Conservancy of New York and Vermont
Lamoille River Project
Lake Champlain International

*"The Vermont Climate Cabinet unanimously agreed to become a partner in the EPSCoR Research on Adaptation to Climate Change (RACC) project. The cabinet members look forward to seeing the results of this collaboration in this exciting and important project."*

Deb Markowitz, Secretary of Agency of Natural Resources

# VT EPSCoR Alignments and Partnerships:

## *University of Vermont (UVM):*

Closely aligned with "spires of excellence" in Complex Systems, Food Systems and investments in research on the environment.

"***This partnership with VT EPSCoR advances opportunities consistent with our strategic plan***." *E. Thomas Sullivan, President of UVM*


## *Baccalaureate Institutions:*

We include a diversity of institutions in our research and broader impacts: state colleges, community colleges and private colleges

"***The presence of CWDD on the Saint Michael's campus contributes to our increasingly strong research culture, and provides support for both students and faculty to do the important work of RACC.***" *Karen Talentino, VPAA of Saint Michael's College*

"***We applaud Vermont EPSCoR for its inclusion of the Vermont State College faculty and students in their research and outreach. Vermont EPSCoR is a truly state-wide program.***" *Timothy Donovan, Chancellor Vermont State College System*

# VT EPSCoR Alignments and Partnerships:

## *Congressional Delegation Support:*

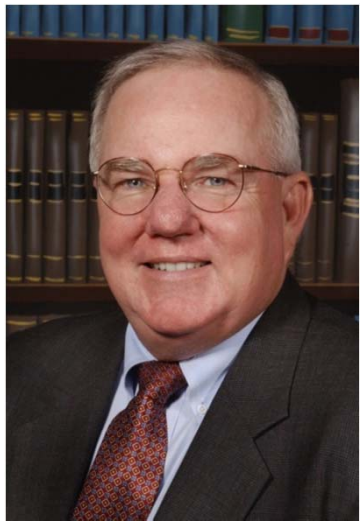
We have the strong support of our US Senators and Representative.

Senator Leahy

Senator Sanders

Rep. Welch

## *Our State EPSCoR governing board is the Vermont Technology Council*



*"Vermont EPSCoR is a cornerstone of our state's economic development strategy. VT EPSCoR's success in building research infrastructure in both higher education and the business sector has opened new avenues for growth, and has facilitated partnerships with diverse stakeholders across the state."*

*John Evans, PhD, President, Vermont Tech. Council*

**The State S&T Plan** has thoroughly incorporated VT EPSCoR's infrastructure building potential.

Vermont's Science & Technology Plan

The Vermont Technology Council believes that Vermont's focus must be on growing its own technology- and knowledge-based firms.

The Vermont Science & Technology Plan builds on our state's competitive advantages and suggests several strategies for turning science and engineering "know how" into new products and services.

These strategies, summarized here, will foster the development and commercialization of new products, better leverage the state's research and development resources, create jobs, and further diversify the region's industrial base in an increasingly competitive global economy.

This Plan is intended to provide state government, economic development organizations, and business and academic leaders with a framework for making informed decisions to maintain a vibrant, dynamic state economy.

### Strategy One

Solid Research Infrastructure: Support and Expand Vermont's Research and Development Infrastructure

1.1: Firmly establish a culture of research and development in Vermont's universities and colleges through continued support for research infrastructure programs such as Vermont EPSCoR and the Vermont Genetics Network.

1.2: Focus our research and development resources on several key science and technology areas: environmental science and sustain-

***Driving Our Research and Outreach for Broader Impacts:***

VERMONT EPSCoR

## The Economic Impacts of the Lake Champlain Basin

The health of Lake Champlain is extremely important to the economy of the region because the Lake, which borders on Vermont, New York and Quebec, brings over $1.5B in lake-related revenue into the region each year.

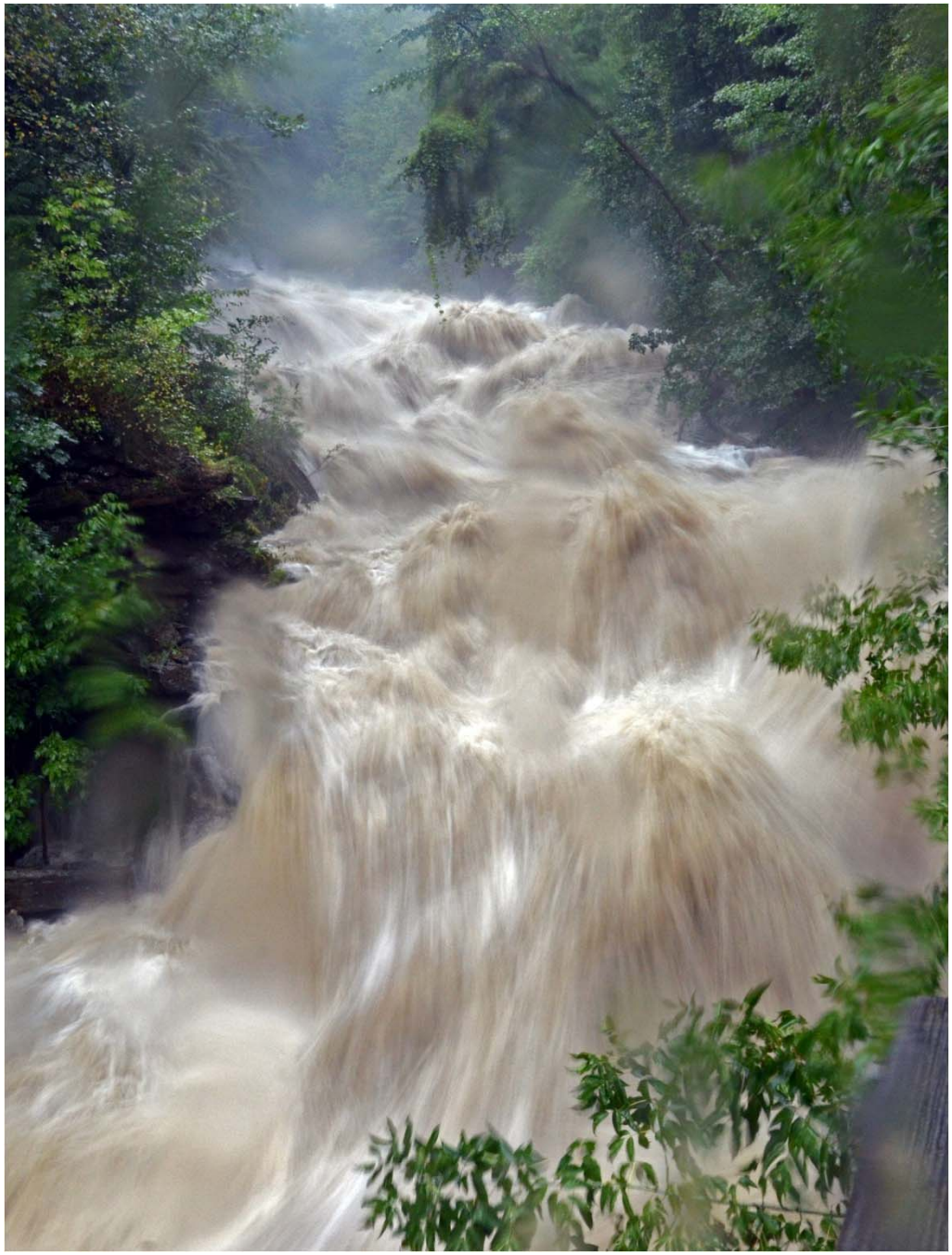
Provides drinking water to 30% of basin residents.

Increasingly perceived as a **human and natural coupled system that is affected by climate** - after 3 federal disaster declarations for three 100-year flood events in 12 months preceded by a blizzard that broke all historic records.

***Driving Our Research and Outreach:***

The stubborn problems of phosphorus pollution and algal blooms in Lake Champlain. From the beautiful watershed comes storm water run off, sediment and nutrients that fuel algal blooms. Managers must make decisions about development, land and lake use, agriculture practices in light of the predictions of more precipitation, less snow and more rain and more severe storm events.

VERMONT EPSCoR



Tropical Storm Irene,
Aug. 27, 2011
(Gordon Miller)

VERMONT
EPSCoR

Vermont EPSCoR

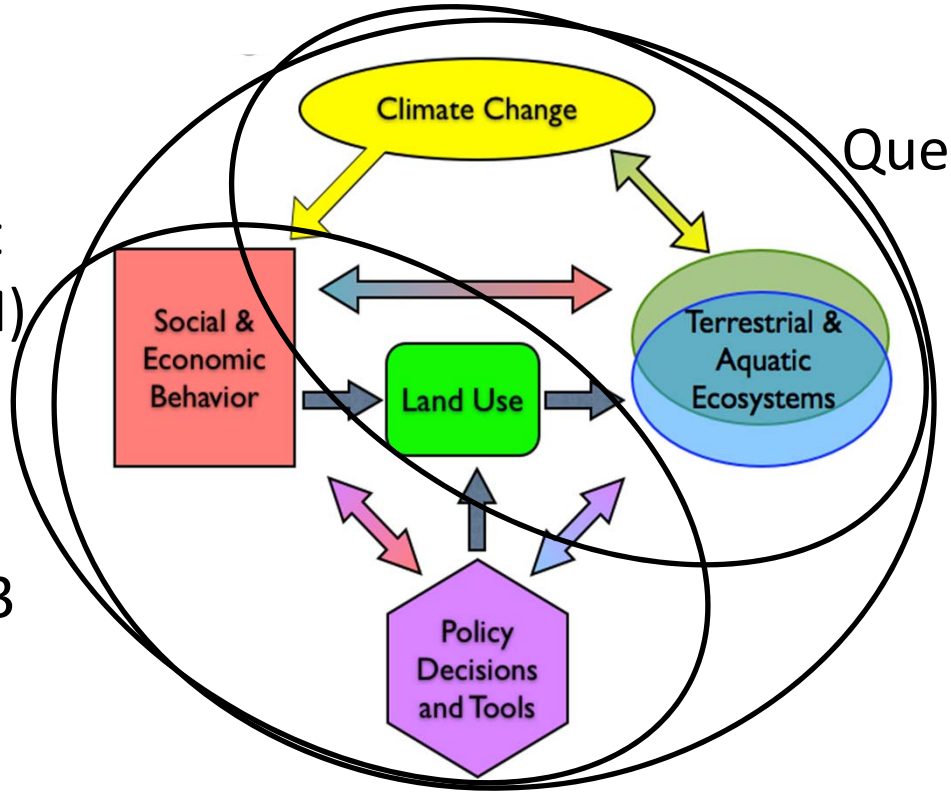
Experimental Program to Stimulate Competitive Research

# Research on Adaptation to Climate Change: Introduction and Question 1

# The Overarching RACC Question

How will the interactions of climate change and land use alter hydrological processes and nutrient transport from the landscape, internal processing and eutrophic state within the lake, and what are the implications for adaptive management strategies?

Integrated Assessment Model (IAM)




Questions 1 and 2

Question 3

# The Core RACC Research Questions

- Q1: What is the relative importance of endogenous (in-lake) processes versus exogenous (to-lake) processes to eutrophication and harmful algal blooms?
- Q2: Which alternative stable states can emerge in the watershed and lake resulting from non-linear dynamics of climate drivers, lake basin processes, social behavior, and policy decisions?
- Q3: In the face of uncertainties about climate change, land use and lake response scenarios, how can adaptive management interventions be designed, valued, and implemented in the multi-jurisdictional region?

# The Core RACC Research Questions

- Q1: What is the relative importance of endogenous (in-lake) processes versus exogenous (to-lake) processes to eutrophication and harmful algal blooms?
- Q2: Which alternative stable states can emerge in the watershed and lake resulting from non-linear dynamics of climate drivers, lake basin processes, social behavior, and policy decisions?
- Q3: In the face of uncertainties about climate change, land use and lake response scenarios, how can adaptive management interventions be designed, valued, and implemented in the multi-jurisdictional region?

# Immediate Relevance

## Cyanobacteria implicated in large fish kill in Missisquoi Bay on 17 August 2012

Photo credit: Courtney Giles

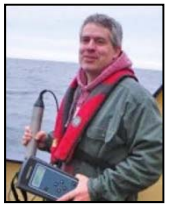
Photo credit:
Vermont Dept. of Health

Photo credit: Steve Garceau

# The RACC Q1 Research Team

William “Breck” Bowden
RACC Science Leader
University of Vermont

**Andrew Schroth**
**RACC Q1 Team Leader**
**University of Vermont**



Jason Stockwell
RACC Q1 Faculty
University of Vermont

Beverley Wemple
RACC Q1 Faculty
University of Vermont

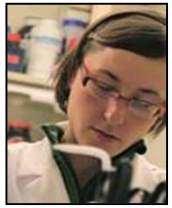
Don Ross
RACC Q1 Faculty
University of Vermont

Declan McCabe
RACC Q1 Faculty
Saint Michael’s College

Robert Genter
RACC Q1 Faculty
Johnson State College

Tom Manley
RACC Q1 Faculty
Middlebury College

Pat Manley
RACC Q1 Faculty
Middlebury College

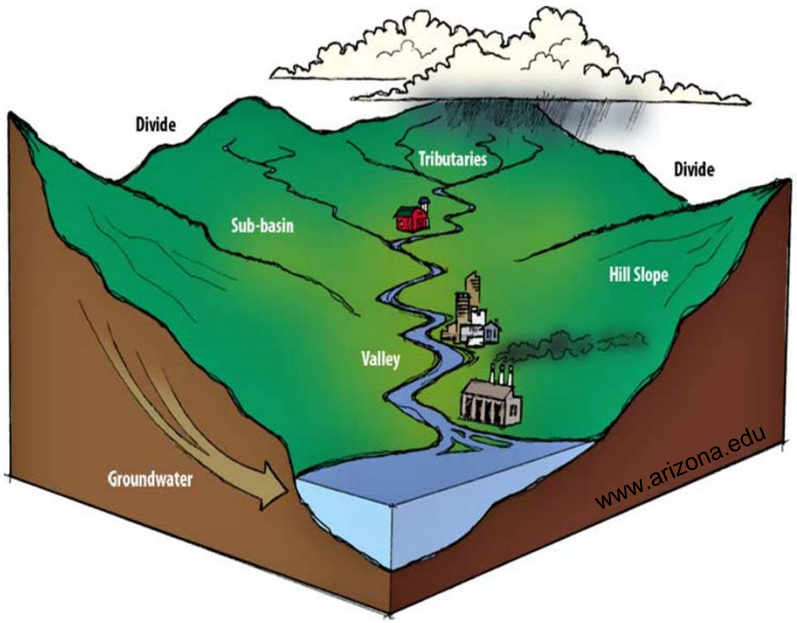


Courtney Giles
RACC Q1 Post Doctoral
University of Vermont

Peter Isles
RACC Q1 Ph.D. Student
University of Vermont

Trevor Gearhart
RACC Q1 Ph.D. Student
University of Vermont

# Approach to Question 1




- What are the important sources of nutrients & sediment to the lake?
- How do land use and climate affect the nature and strength of these sources?
- How are nutrients and sediments transformed in transport to the lake?
- How do the loadings of these materials affect lake processes?

# Focus Watersheds



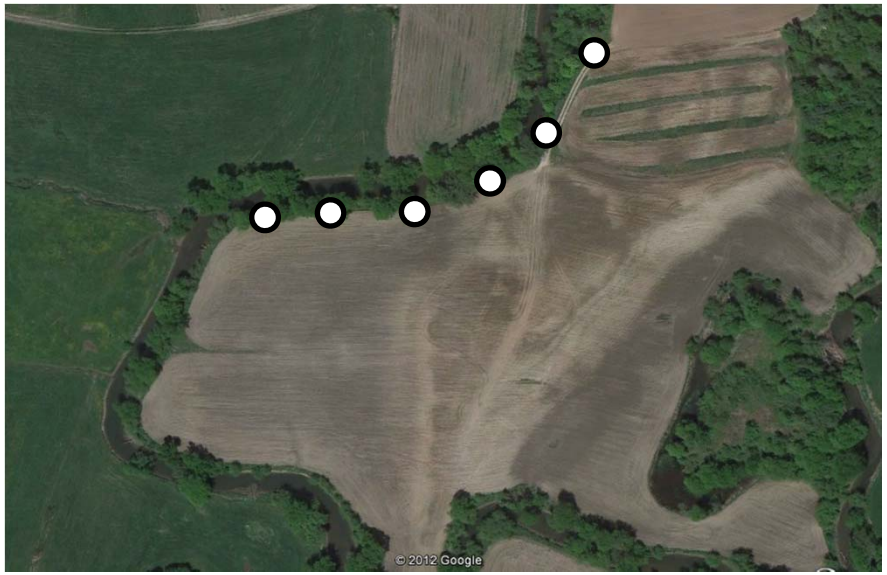
Agriculture: runoff, groundwater, soils, stream bank erosion

Forested: soils, groundwater, roads, channel migration, erosion

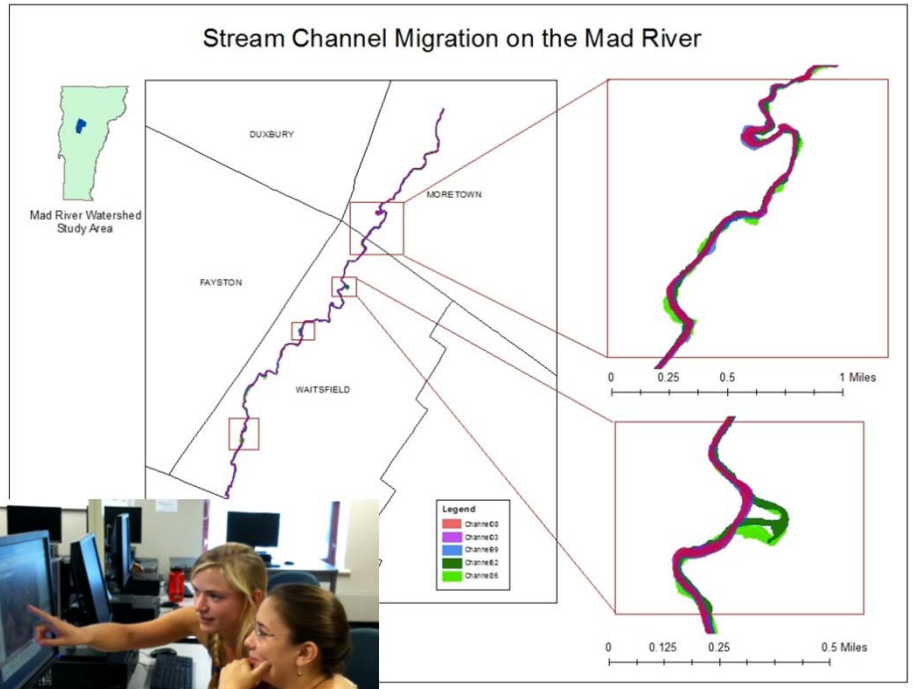
Urban: stormwater runoff, wastewater, stream erosion

# What we have accomplished?

## Source area characteristics




N/P Distribution across riparian zones



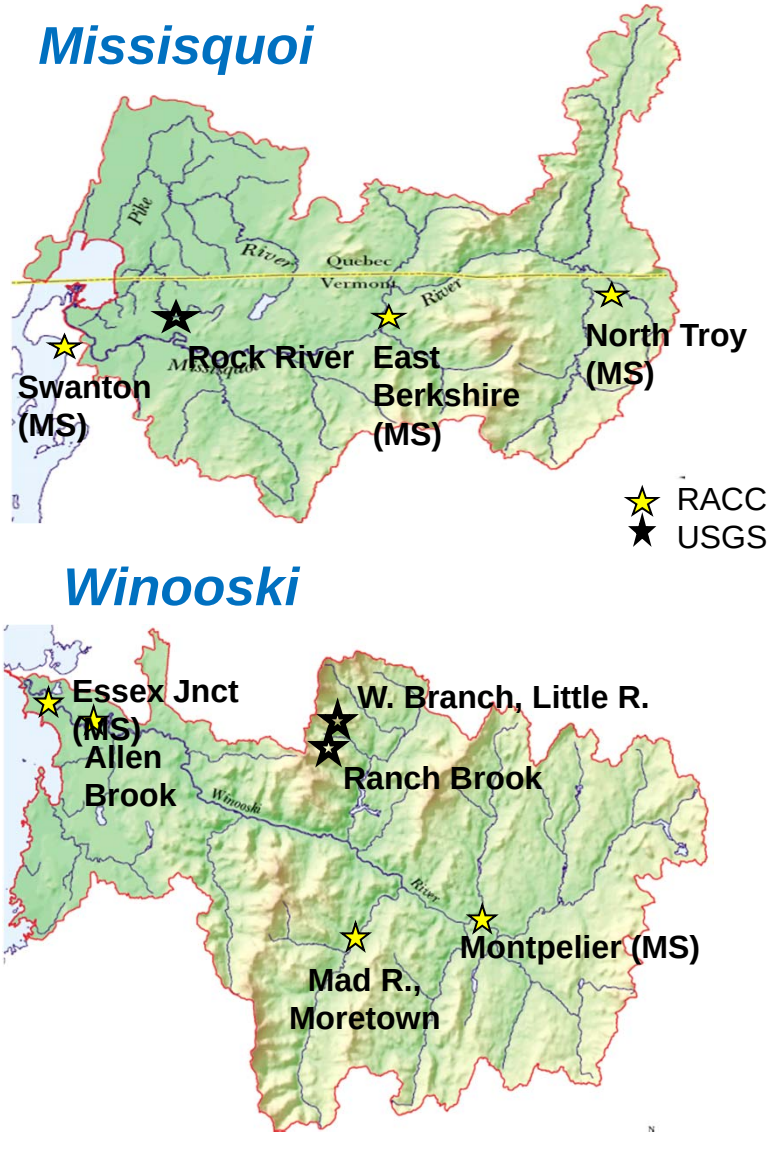

Interns Lindsay Jordan (background) and Elizabeth Olliver (foreground)

Don Ross (UVM)

Beverly Wemple (UVM)

# What we have accomplished?

## Instrumented key sub-watersheds

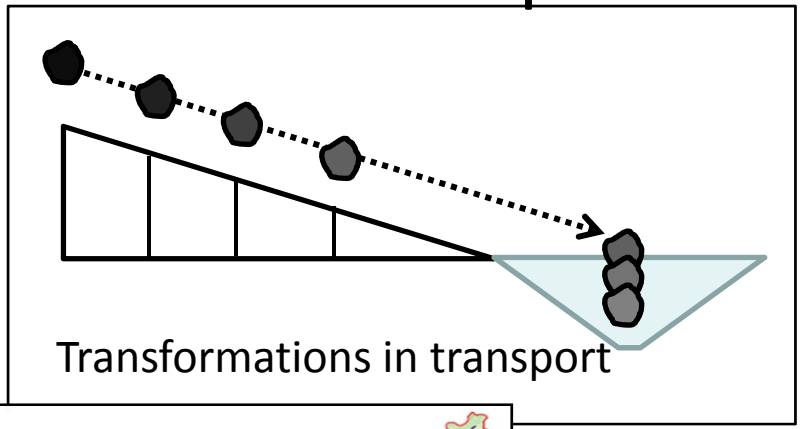


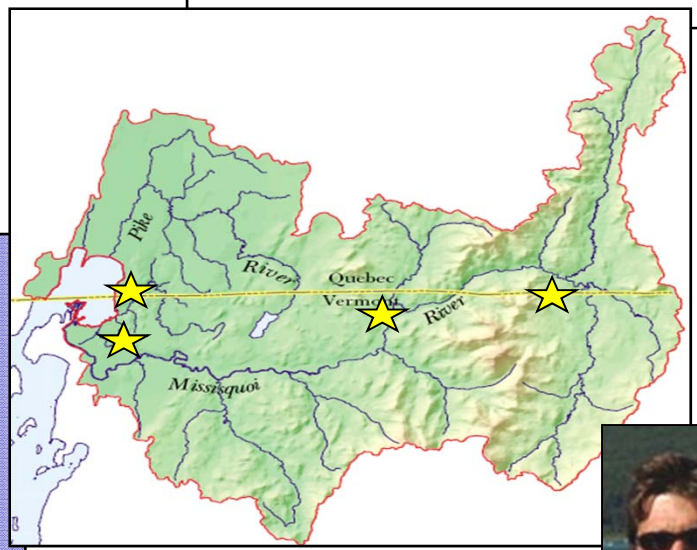

Beverly Wemple *et al.* (UVM)

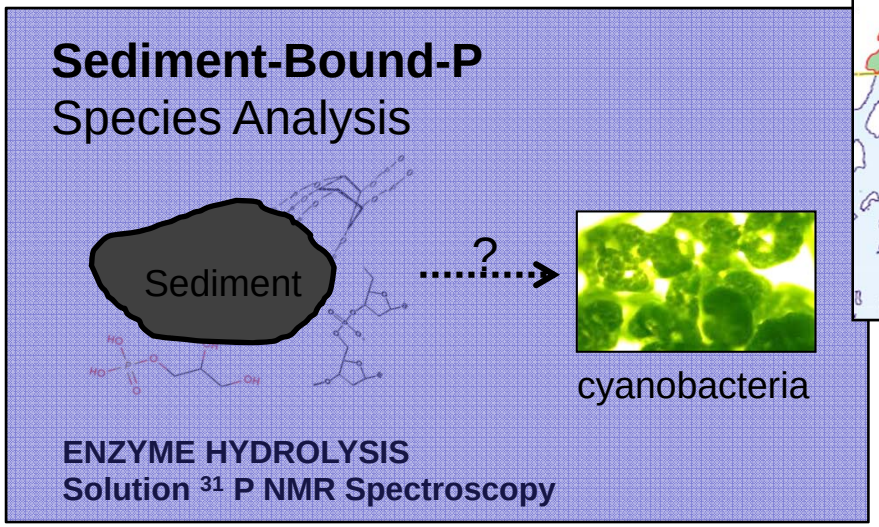
# What we have accomplished?

## Characterization of transformations in transport

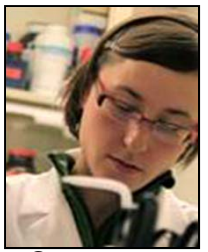
- What are the primary forms of P transported to Lake Champlain via *external sediment loading*?
- How algal-available are these sediment-bound-P forms?
- How do redox processes influence P cycling and *internal loading* from lake sediments?




Andrew Schroth



Courtney Giles

# What we have accomplished?

## Missisquoi Bay Advanced Monitoring Systems

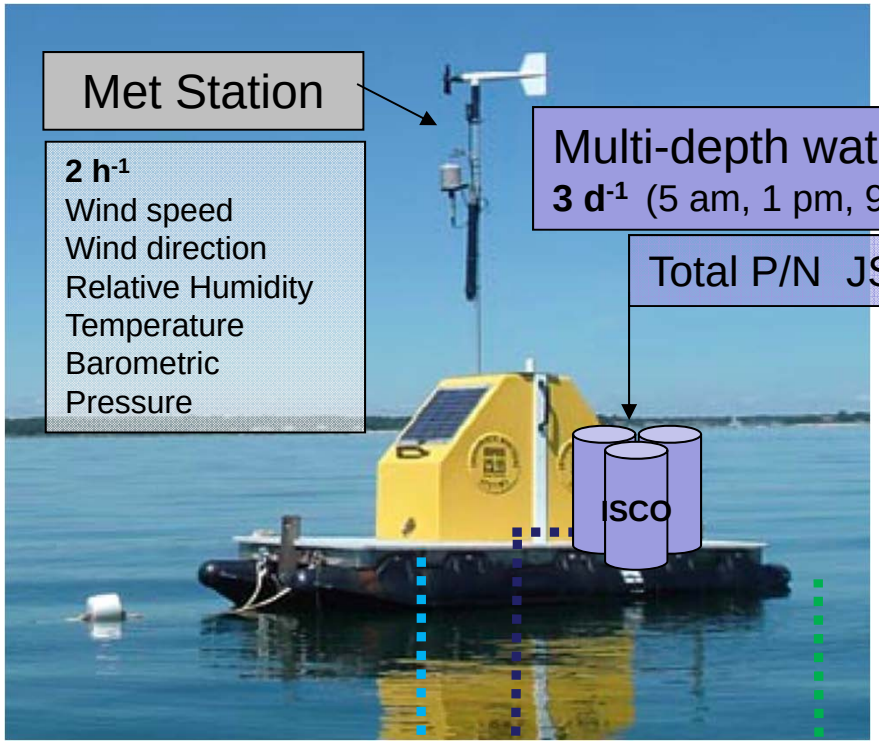
**High-Frequency HydroMet Station**

Data logger
CSI software tools
Cellular communication
Four WebCams (360° view)
RM Young wind speed and direction
Air temperature/relative humidity
Incoming solar radiation sensor (PAR)
RM Young barometric pressure
Titus IWS
Surface water temperature
RPR temperature string (5 m)
Downward looking ADCP (Nortek)


Pat and Tom Manley
Middlebury College

# What we have accomplished?

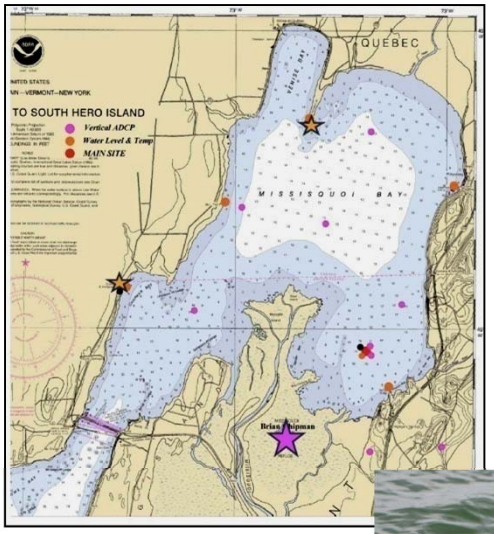
## Missisquoi Bay Advanced Monitoring Systems



# What we have accomplished?

## Spatial sampling efforts

**Hydrodynamics Monitoring Array** to describe local physical state, current, sediment transport, water levels, temperature profile, lateral and vertical waves




**Distributed sampling stations** for all analytes and phytoplankton

**Sediment profile sampling** for nutrient species analysis and redox potential

# What we have accomplished?

## Integrated water sampling & analysis network

Johnson State College

Robert Genter

Saul Blocher

St. Michael's College

Declan McCabe

Katie Chang

# What are we working on?

## Bioindicators to explore the effects of nutrient dynamics on aquatic food webs

How does food web structure influence grazing pressure on cyanobacteria, competition for nutrients, and the spatial and temporal dynamics of nutrient recycling?

**Sampling & identification**

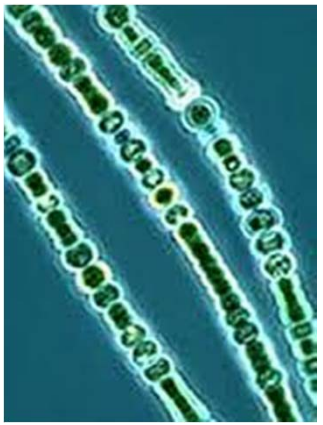
Phytoplankton

Zooplanton

Benthic invertebrates

Aquatic plants

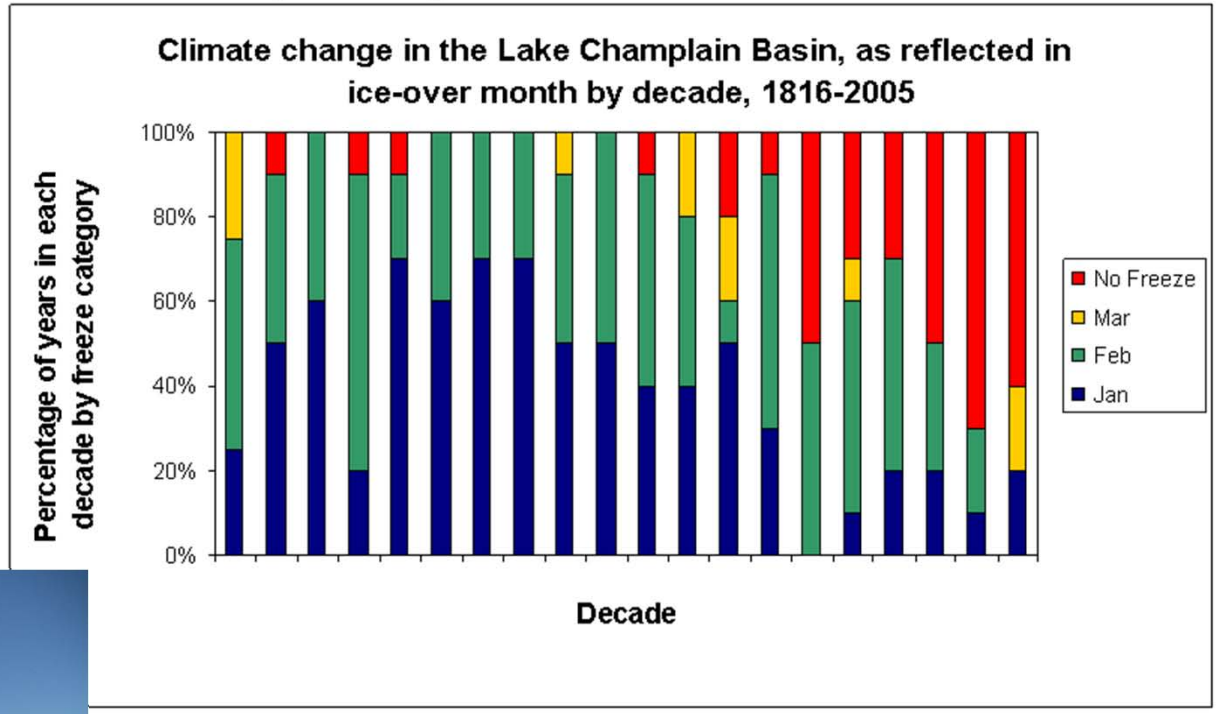
Fish

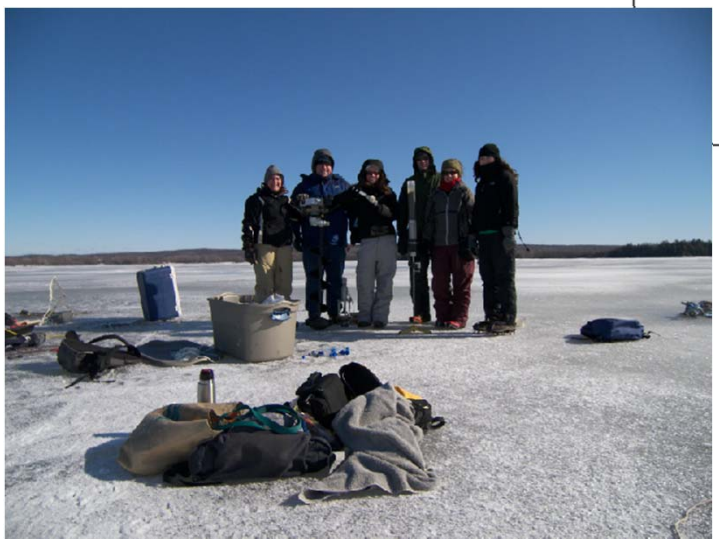


# What are we working on?

## Winter Sampling

Duration and extent of ice cover is decreasing!



How does ice cover affect lake biology and chemistry?

Winter grab sampling of water profile chemistry/biology and sediment cores

# Milestones for Overarching Question

| MILESTONES | | Status |
|---|---|---|
| **Overarching Question: How will the interaction of climate change and land use alter hydrological processes and nutrient transport from the landscape, internal processing and eutrophic state within the Lake and what are the implications for adaptive management strategies?** | | Underway |
| Draw from data collected and models developed in Questions 1-3 a description of the processes that affect the states and health of the Lake. | | Underway |
| Put into action the IAmodel for policy makers and managers to address potential responses to climate change | | Underway |

# Milestones for Questions 1 and 2 (partial)

| MILESTONES | Y1 | Status |
|---|---|---|
| **Lake process model development (Question 1)** | | |
| Install instrumented stations and long term under ice sensor array water column sampling | X | Completed. Ready for winter |
| Establish work flow with Labs in UVM, SMC, JSC | X | Completed |
| Determine nutrient transport parameters for and integrate with IAModel (ARIES platform) | X | Underway |
| Organize and carry out biological & nutrient sampling | X | Underway |
| **Data collection and hydrology model development (Question 2)** | | |
| Install and use automated water samplers at gauging stations and well networks | X | Completed and underway |
| CWDD teams collect/analyze samples during high precip events | X | Completed and underway |

Vermont EPSCoR

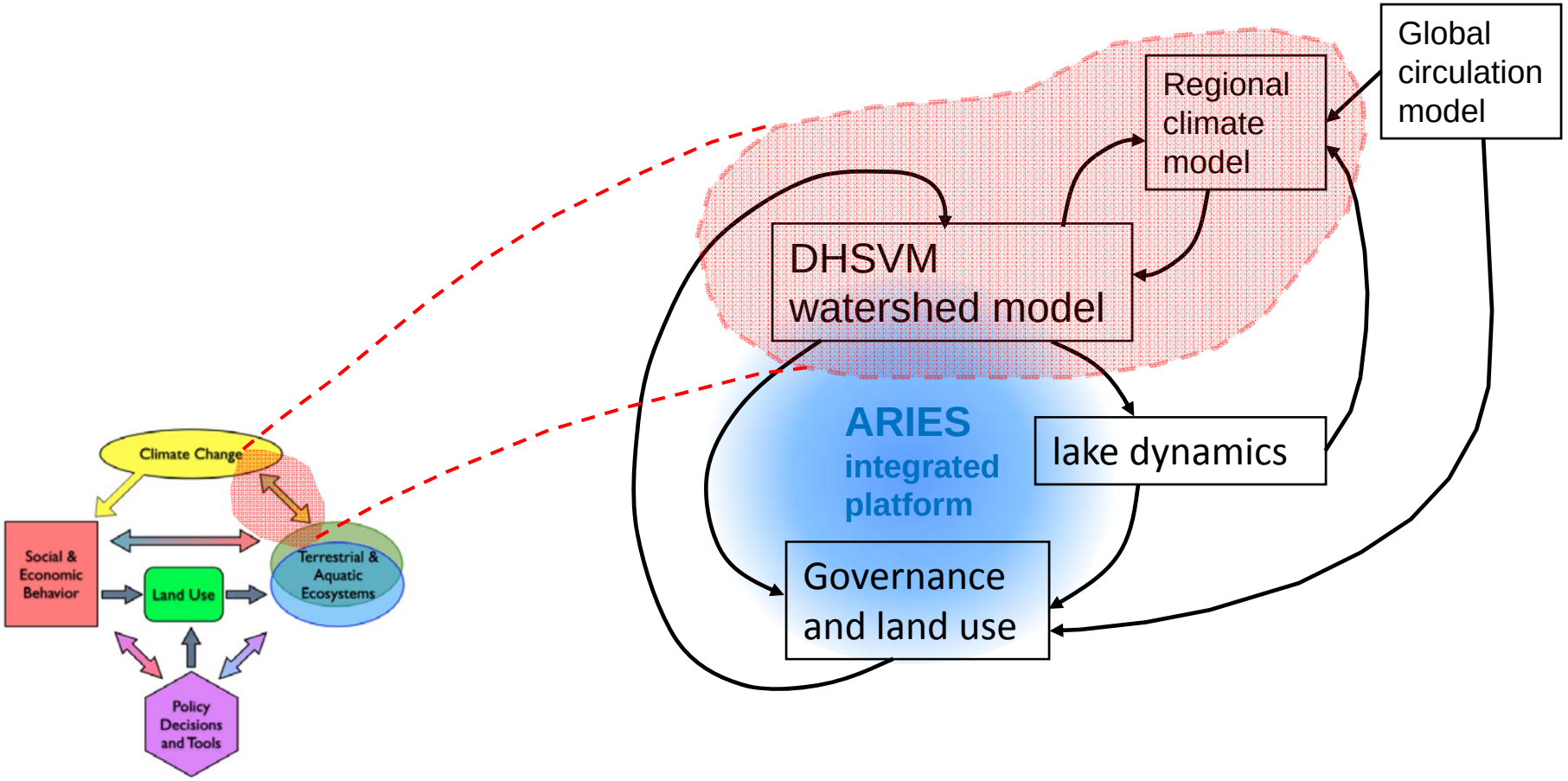
Experimental Program to Stimulate Competitive Research

# Question 2

# The Core RACC Research Questions

- Q1: What is the relative importance of endogenous (in-lake) processes versus exogenous (to-lake) processes to eutrophication and harmful algal blooms?
- Q2: Which alternative stable states can emerge in the watershed and lake resulting from non-linear dynamics of climate drivers, lake basin processes, social behavior, and policy decisions?
- Q3: In the face of uncertainties about climate change, land use and lake response scenarios, how can adaptive management interventions be designed, valued, and implemented in the multi-jurisdictional region?

# Question 2: Watershed component



**We are taking a SYSTEMS APPROACH to impacts and adaptation studies.**

**We seek to understand:**

1. The expected impact of precipitation change on:
    1. Sediment and non-point phosphorus mobilization
    2. Flooding/scouring of channels and floodplains
    3. Natural vegetation and farming practices
    4. Built environment

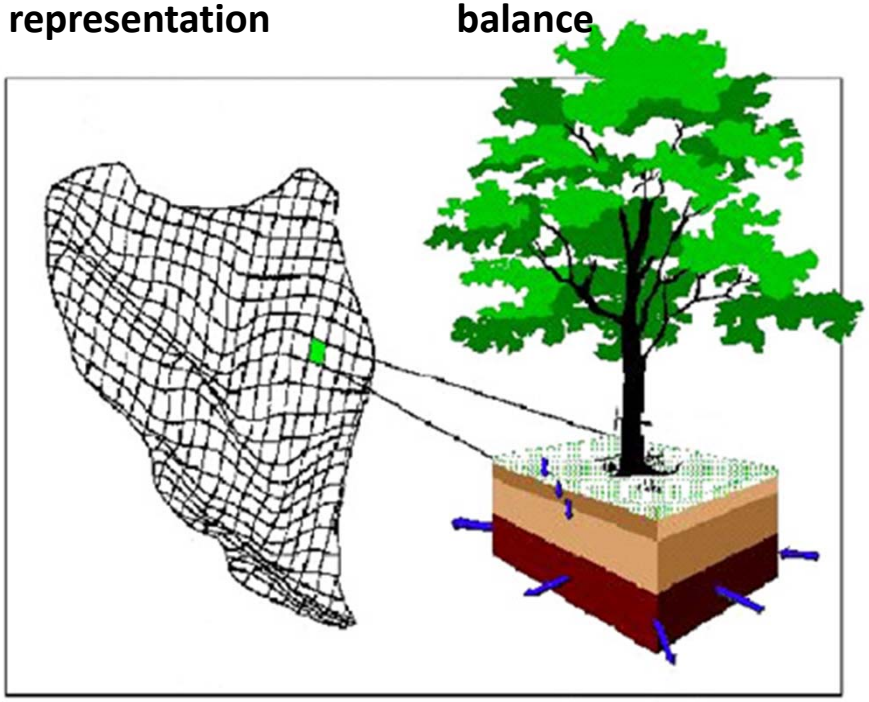
    } Watershed model
2. The expected impact of temperature change on:
    1. Natural vegetation
    2. Frozen ground
    3. Snow/rain ratio

    } Regional Climate Model
3. System resilience to future changes under a variety of scenarios
    1. What variables dominate? (e.g. land use, governance, etc)
    2. What alternative stable states may the watershed take on? (agricultural/ urban, forest succession, healthy channels/impacted, etc)

# Model choice: Distributed hydrology-soil-vegetation model (DHSVM)

DHSVM model representation

1-D vertical water balance



Surface/subsurface flow
Redistribution to/from neighboring pixels

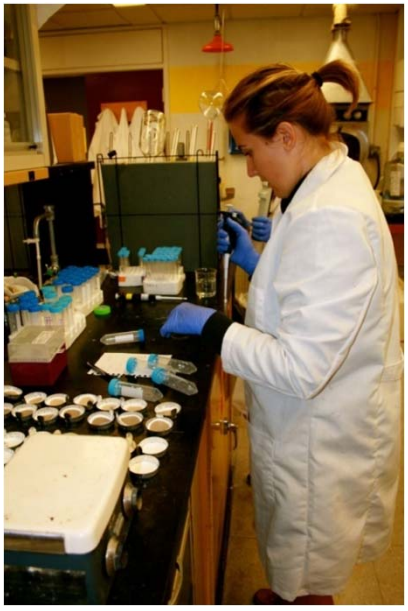
- Physically-based hydrology model that represents the effects of
  1) Topography
  2) Soil
  3) Vegetation
- Solves the energy and water balance at each grid cell at each time step

**Team Members:**

Ibrahim Mohammed, PhD
RACC Postdoc

Jody Stryker
RACC GRA

Justin Guilbert
RACC GRA



Haleigh Marshall
CWDD Intern

Andrea Brendalen
CWDD Intern

VERMONT EPSCoR

## Team members from academia and private sector:

•Leslie Kanat
**Johnson State College Geology**

•Arne Bomblies
**UVM Civil and Environmental Engineering**

•Brian Beckage
**UVM Plant and Soil Science**

•Declan McCabe
**St. Michael's College Biology**

•Lesley Ann Dupigny-Giroux
**UVM Geography**

•Robert Genter
**Johnson State College Biology**

•Donna Rizzo
**UVM Civil and Environmental Engineering**

•Beverley Wemple
**UVM Geography**

•Mandar Dewoolkar
**UVM Civil and Environmental Engineering**

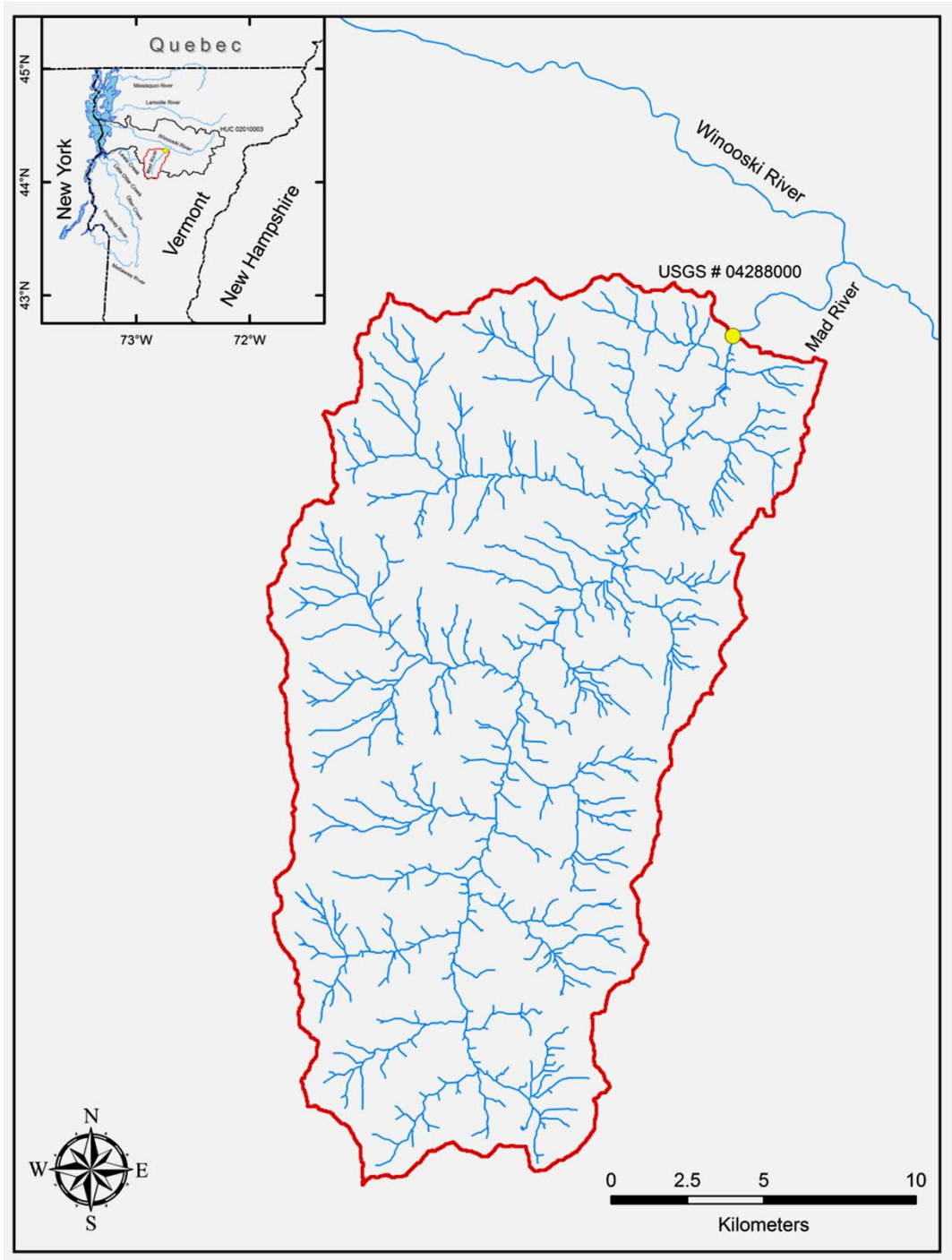
•Alan Betts
**Atmospheric Research, Pittsfield, VT**

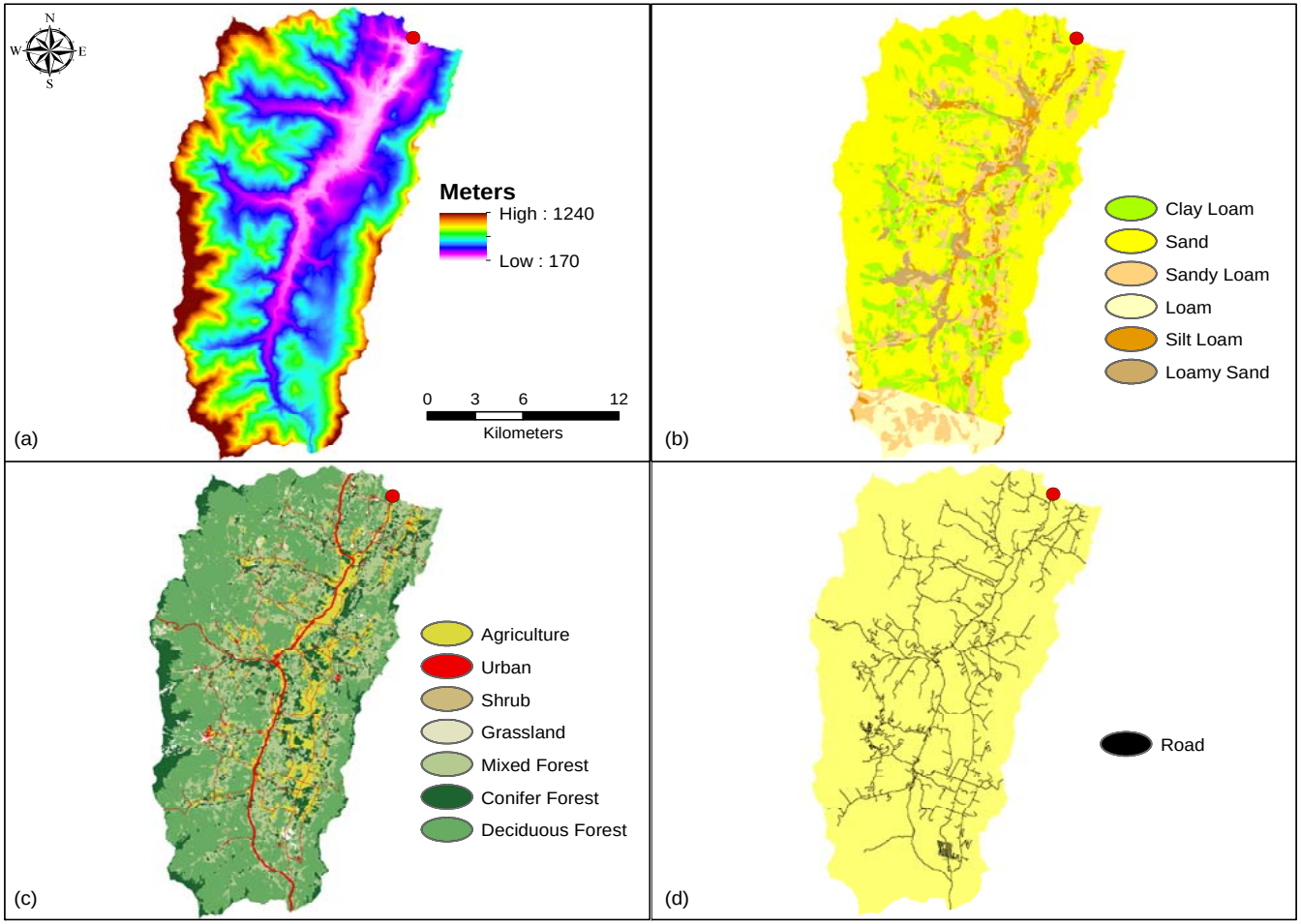
•Aleksandra Drizo
**Phospho-Reduc, LLC**

VERMONT EPSCoR

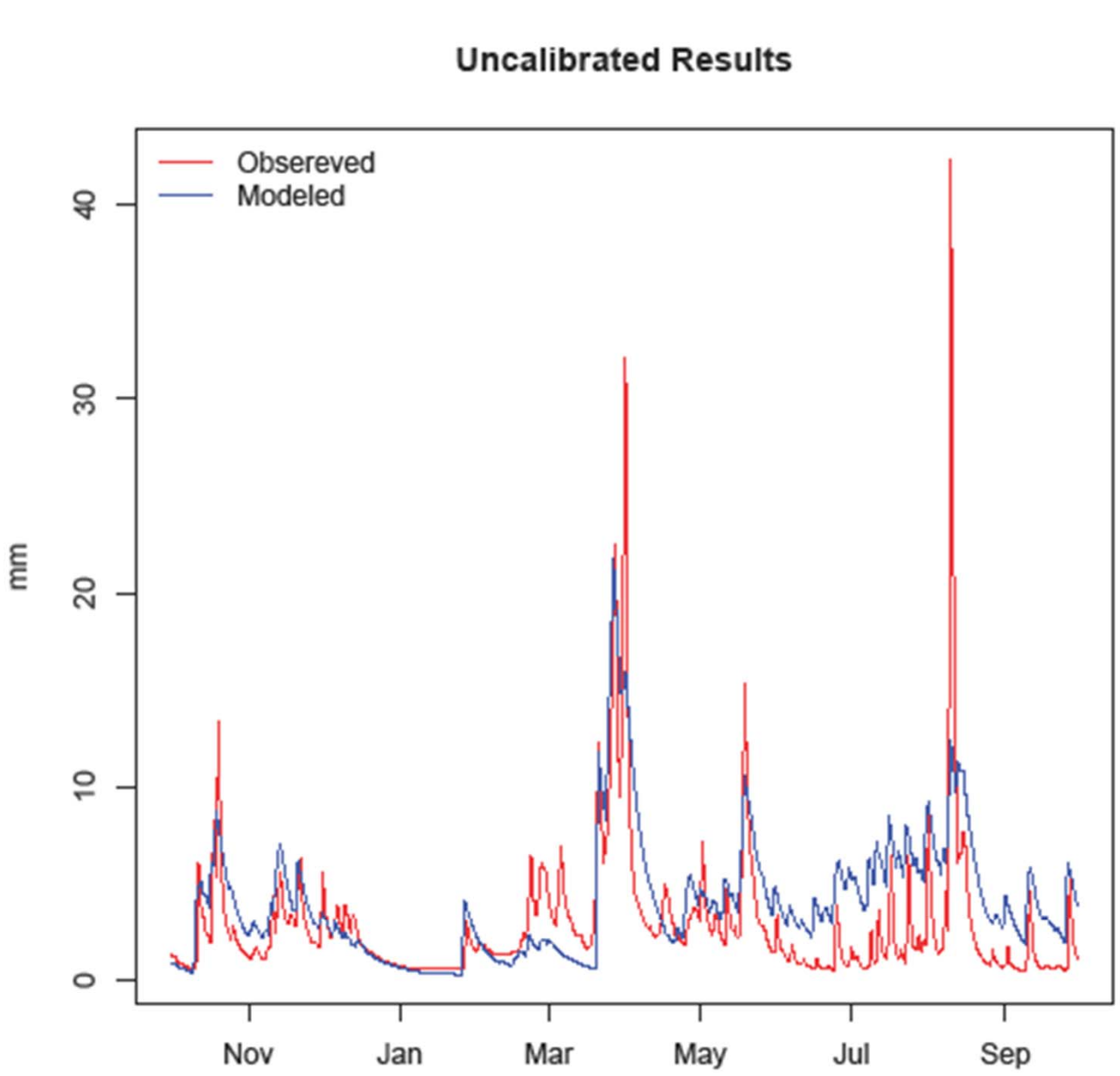
**Hydrological modeling:**

## Begin with Mad River watershed






Spatial input data. a) Digital Elevation Model (DEM) (30 meter grid size), b) Soil Texture, c) Land Cover, and d) Roads. Soil Texture data are from SSURGO 2.2 dataset, Land Cover data are from the NLCD 2006 dataset, and Roads data are from the Vermont E9-1-1 GIS dataset.


Uncalibrated Results
Obsereved
Modeled
mm
0
10
20
30
40
Nov
Jan
Mar
May
Jul
Sep

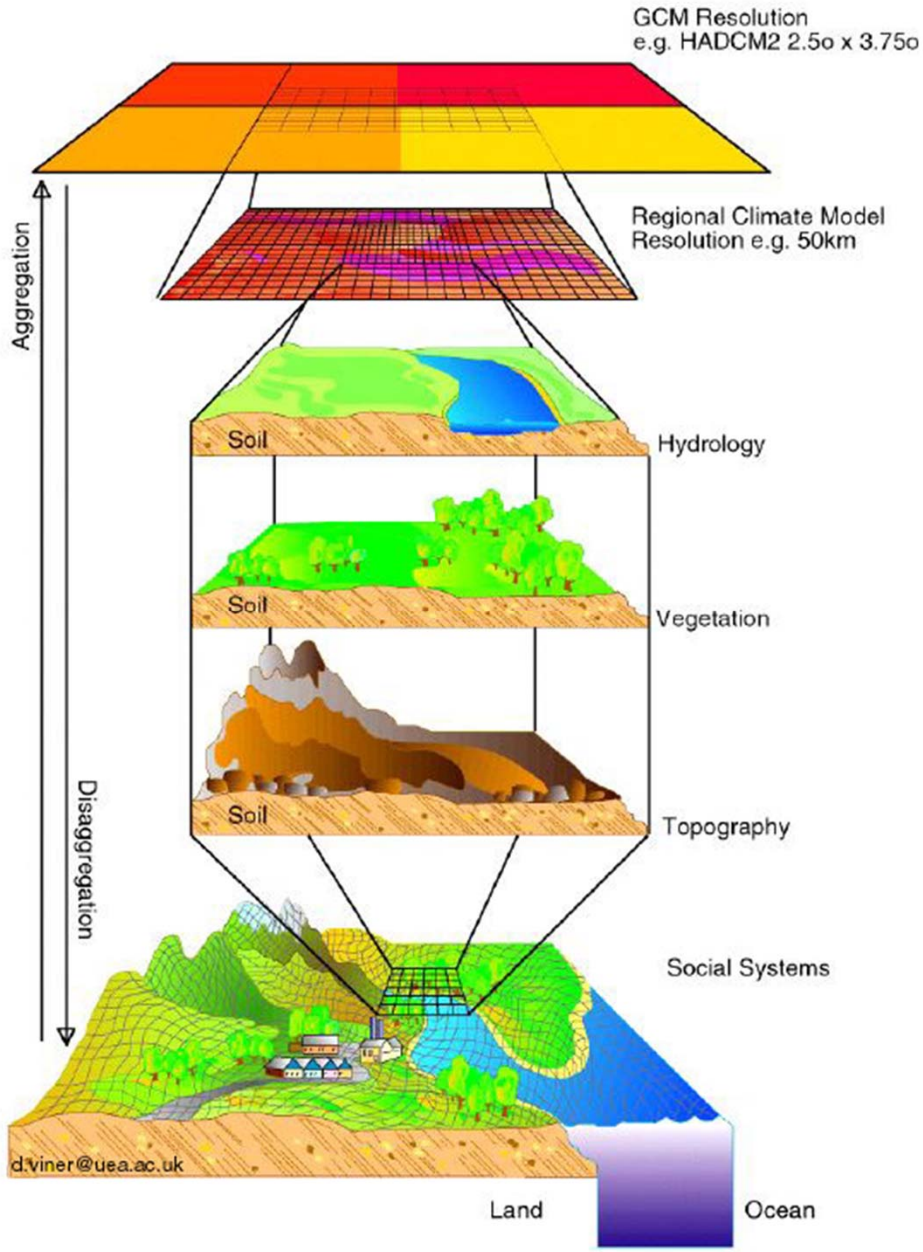
# Climate downscaling

Dynamic (regional climate models)

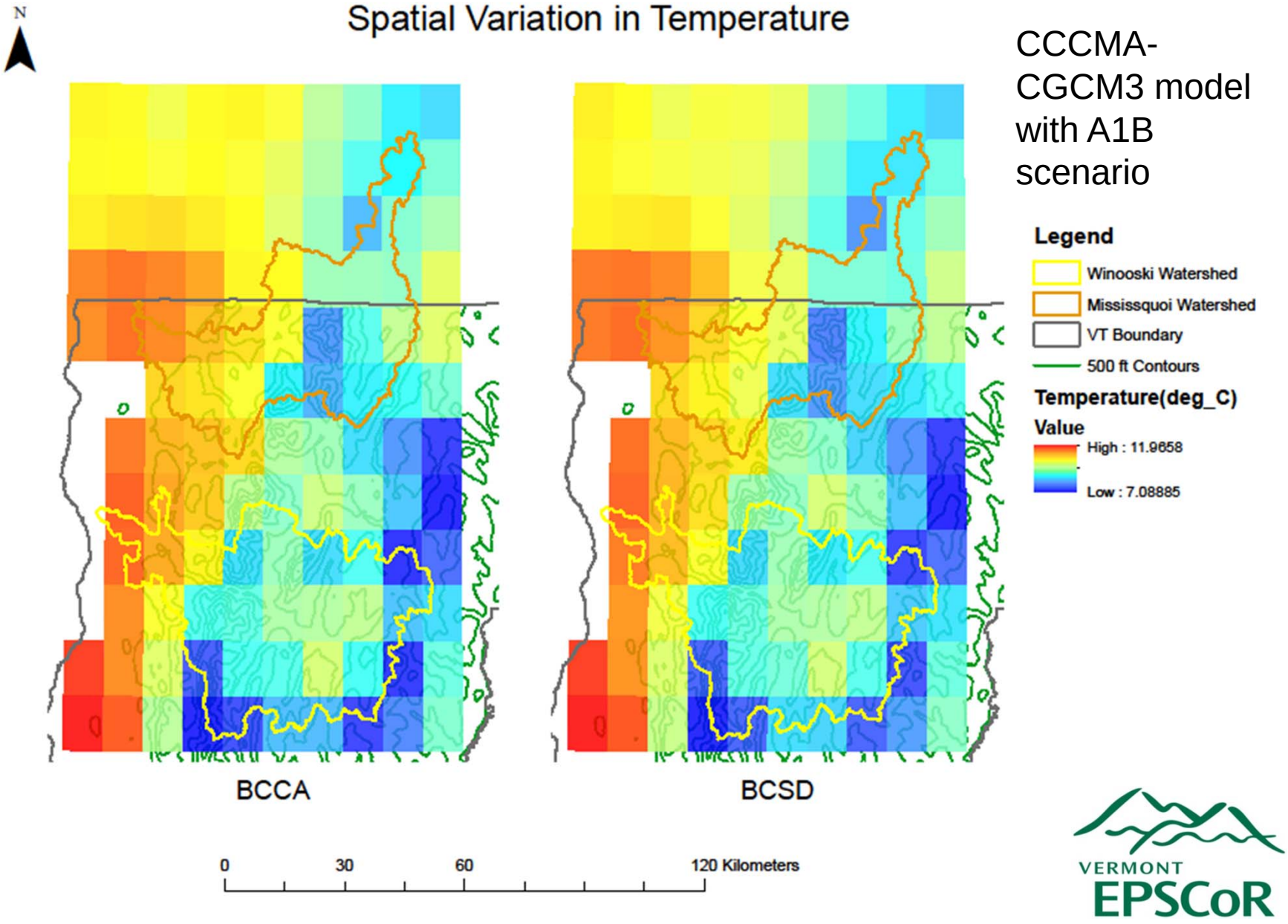
- •Computationally expensive
- •Captures local processes and feedbacks

Statistical

- •Simpler
- •Assumes stationary transfer function

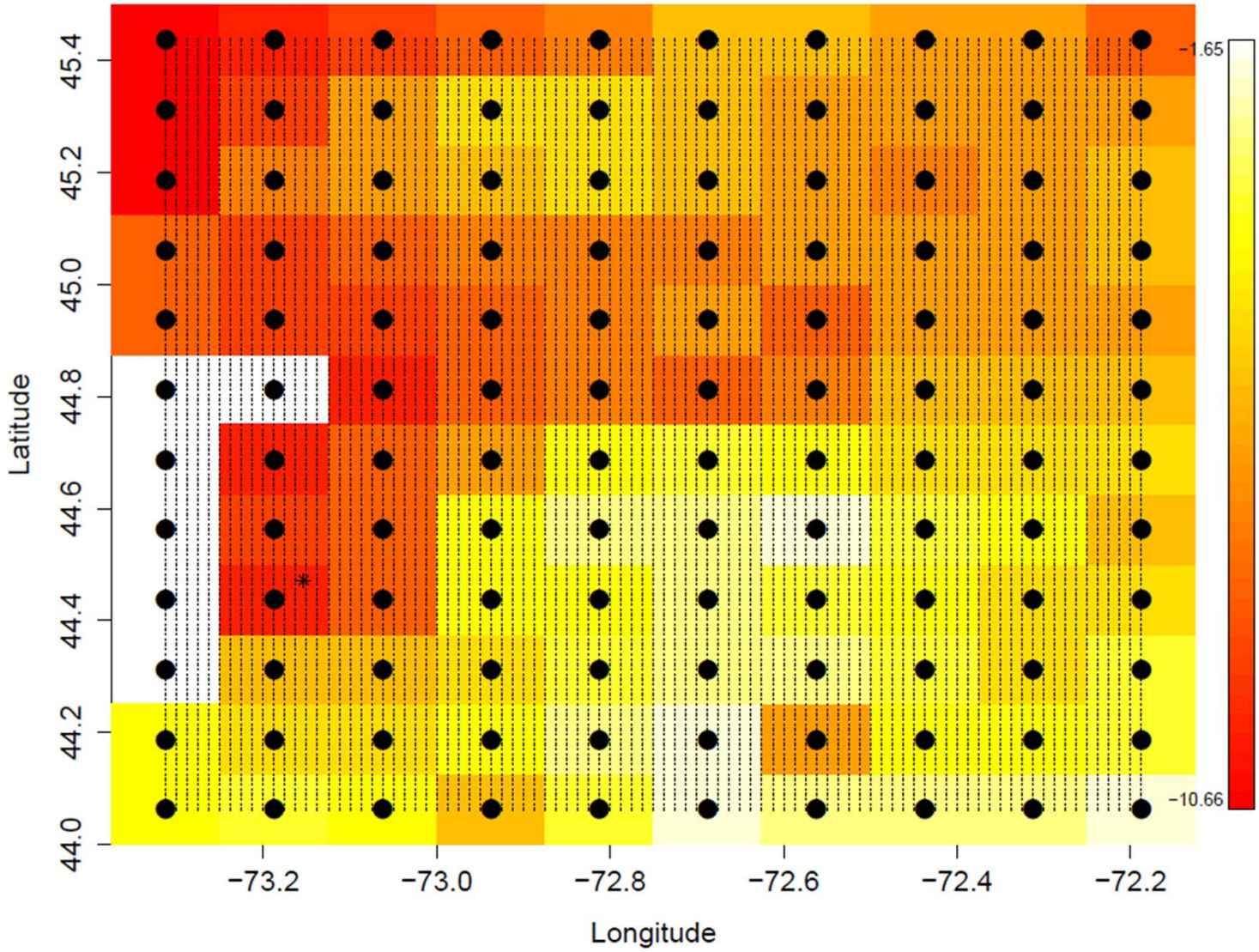


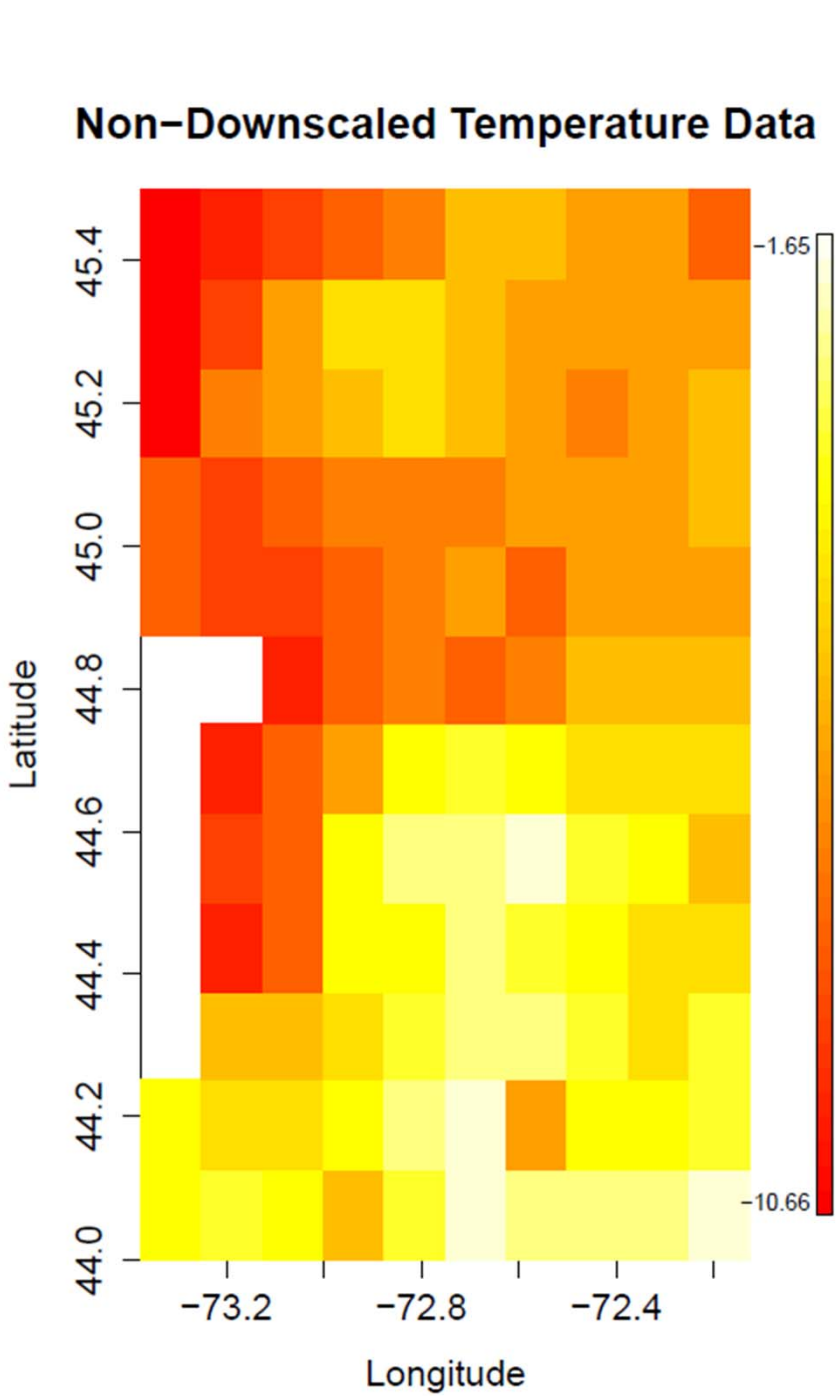

VERMONT EPSCoR

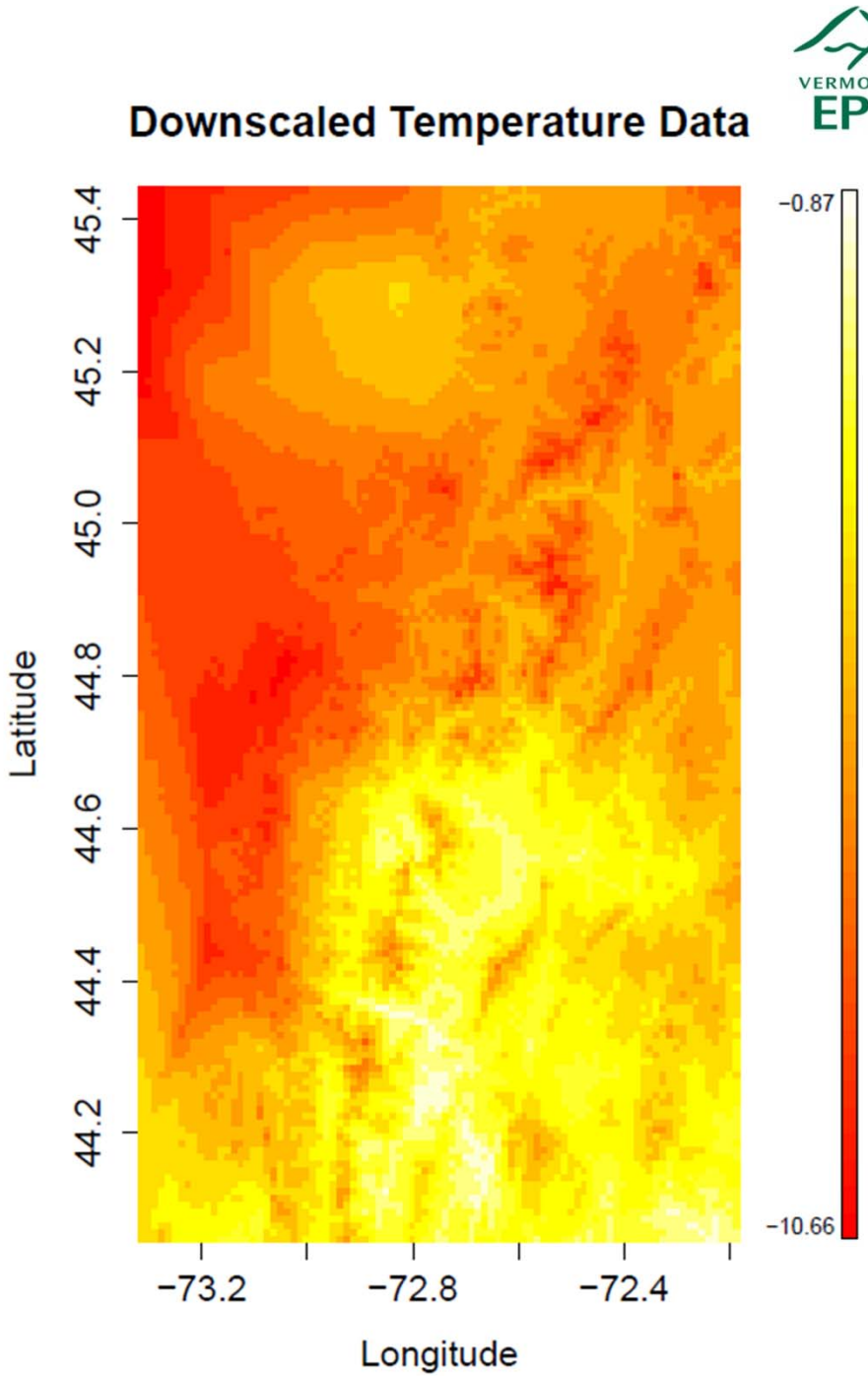

N
Spatial Variation in Temperature
CCCMA-CGCM3 model with A1B scenario
Legend
Winooski Watershed
Mississquoi Watershed
VT Boundary
500 ft Contours
Temperature(deg_C)
Value
High : 11.9658
Low : 7.08885
BCCA
BCSD
0
30
60
120 Kilometers
VERMONT
EPSCoR

VERMONT EPSCoR

# Non−Downscaled Temperature Data




Non−Downscaled Temperature Data
Latitude
45.4
45.2
45.0
44.8
44.6
44.4
44.2
44.0
−73.2
−72.8
−72.4
Longitude
−1.65
−10.66


Downscaled Temperature Data
Latitude
45.4
45.2
45.0
44.8
44.6
44.4
44.2
−73.2
−72.8
−72.4
Longitude
−0.87
−10.66

# Milestones for Question 2

| **Data collection and hydrology model development (Question 2)** | | |
|---|---|---|
| Install and use automated water samplers at gauging stations and well networks | X | Completed |
| CWDD teams collect/analyze samples during high precip events | X | Completed |
| Parameterize and validate coupled watershed/vegetation model | X | In progress |
| Select and downscale Climate Scenarios | X | In Progress with Cynthia Rosenzweig/NASA -GISS |

Vermont EPSCoR

Experimental Program to Stimulate Competitive Research

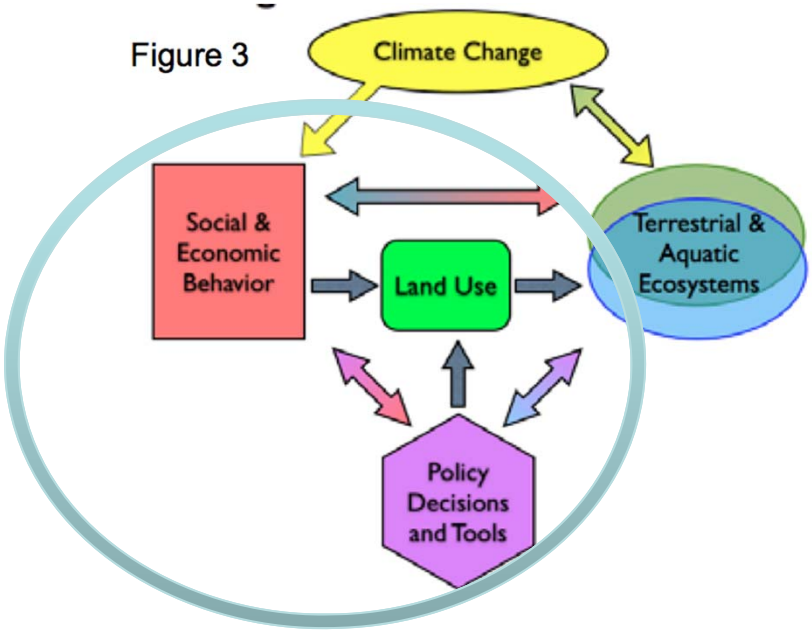
# Question 3

# The Core RACC Research Questions

- Q1: What is the relative importance of endogenous (in-lake) processes versus exogenous (to-lake) processes to eutrophication and harmful algal blooms?
- Q2: Which alternative stable states can emerge in the watershed and lake resulting from non-linear dynamics of climate drivers, lake basin processes, social behavior, and policy decisions?
- Q3: In the face of uncertainties about climate change, land use and lake response scenarios, how can adaptive management interventions be designed, valued, and implemented in the multi-jurisdictional region?

# RACC Question 3

Adaptive management of critical transitions in the Lake Champlain Basin




**In the face of uncertainties about climate change, land use and lake response scenarios, how can <u>adaptive management</u> interventions (e.g. regulation, incentives, treaties) be *designed*, valued and implemented in the multi-jurisdictional Lake Champlain Basin?**

VERMONT EPSCoR

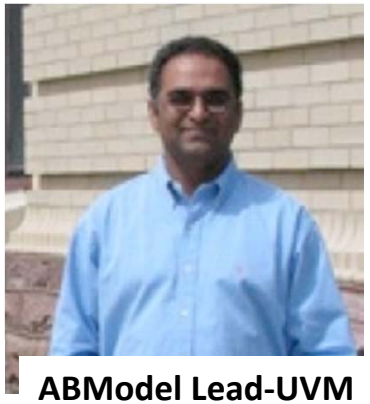
# The “Q3” Team:

Env. Policy-SMC

AIM Lead-UVM

Q3 Lead-UVM

Postdoc



ABModel Lead-UVM

Partner-VT ANR

Climate & Landuse

Postdoc

Climatology-JSC

Climate & Ecosystems-UVM

Climate Private Sector Consultant

Phosphorus Private Sector Consultant

Plant & Soil Sci. UVM

Climatology-UVM

Spatial Analysis-UVM

Problem Concept-ualization

*Accomplished*: Stakeholder meetings; archival analysis; historical timeline completed

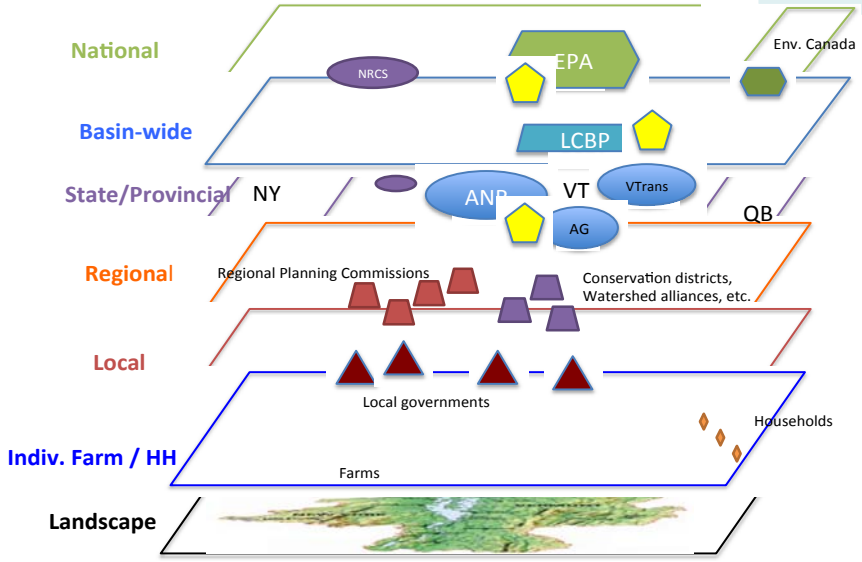
Qualitative Problem Mapping

Acc*omplished:* Interviews; source documents analyzed; survey protocols designed; participant observations undertaken; additional resources secured


Model Form-ulation

*Accomplished:* AnyLogic training; literature reviews; social network analysis; in progress

Model Calibration




Model Testing

Policy Evaluation

Knowledge Transfer

Preliminary Scoping Model of Lake Champlain Watershed Governance

# Accomplished: Stakeholder Engagement

## Stakeholder Engagement Meeting convened:

January 13, 2012

## Meetings involving the following agencies and organizations:

VT Agencies of Natural Resources and Agriculture; Lake Champlain Basin Program (LCBP); Natural Resources Conservation Service; Environmental Consulting Firms; Regional Conservation Districts; Interest Groups

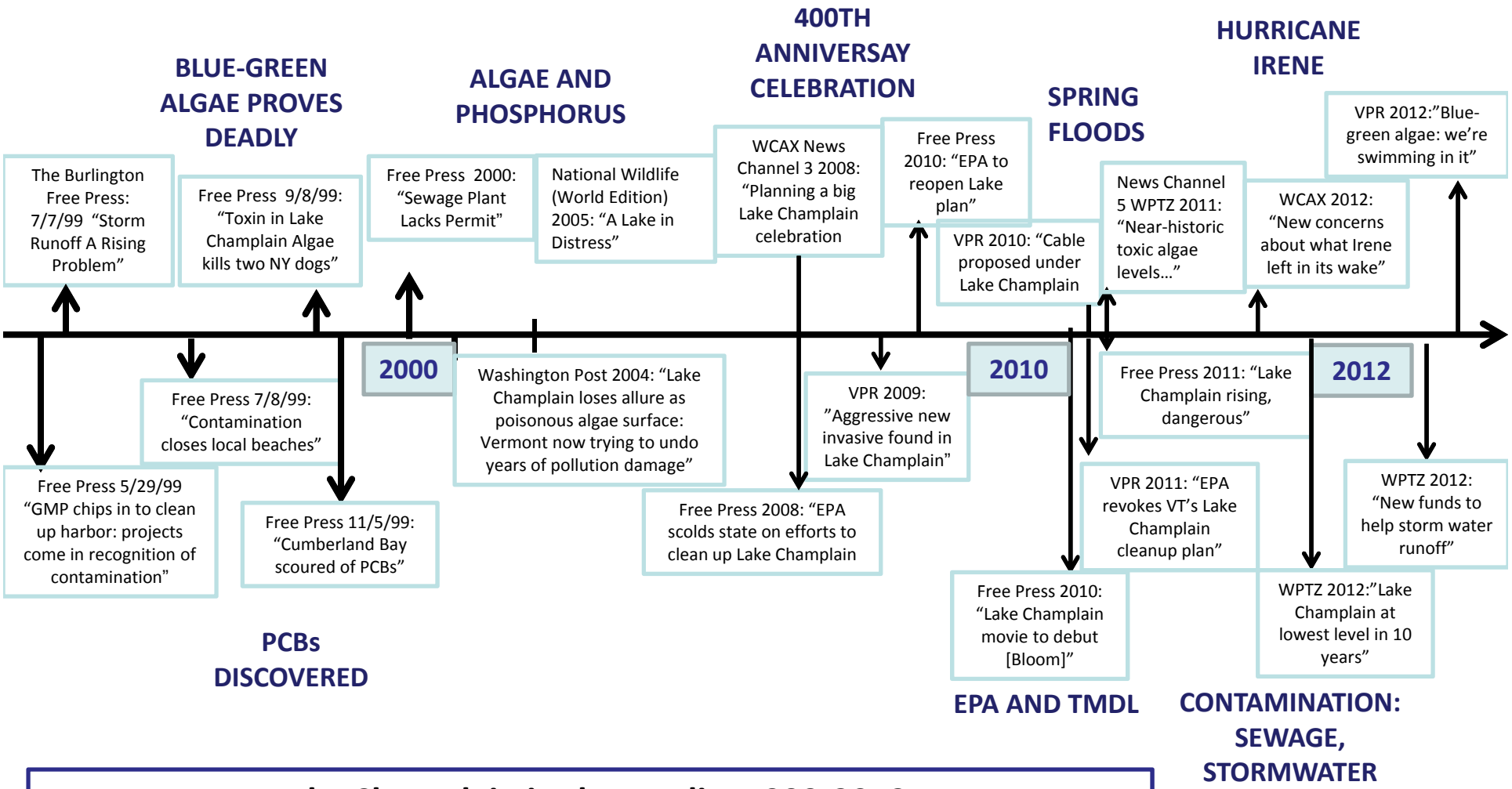
## Presentations about the project given to:

VT Climate Cabinet; Vermont Environmental Consortium; LCBP Technical Advisory Committee

## Topics of discussion:

- Joint research questions
- Data sharing
- Capacity building
- Co-construction of engagement strategy and mediated modeling activities

# Accomplished: Timeline of Media Events, Water Quality Policy, Economic & Landuse Trends




**Lake Champlain in the Media: 1999-2012**

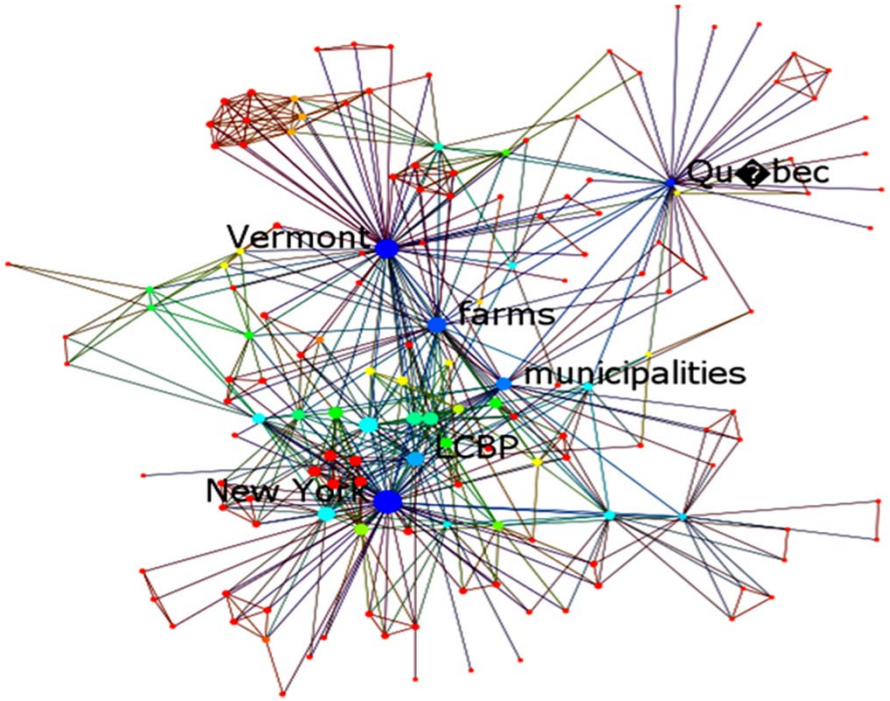
(Archives, Library Holdings, LEXISNEXUS)

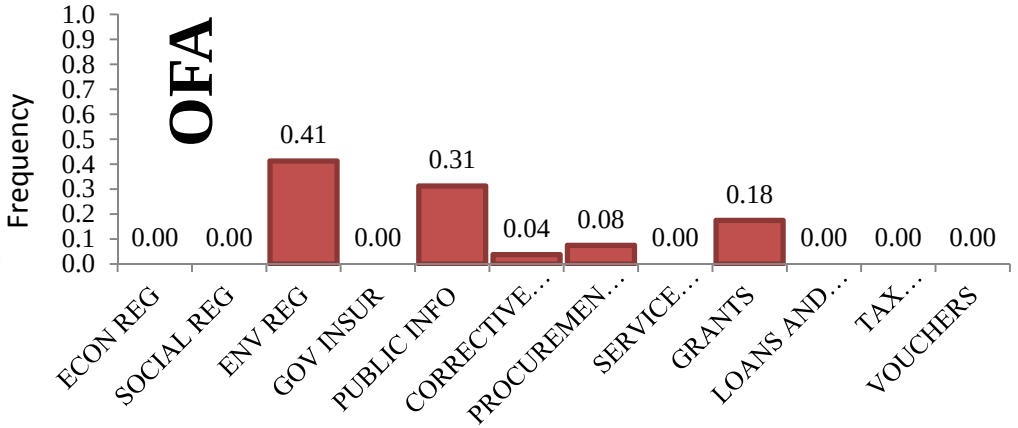
Adapted from research done by **Shapiro, M. 2012 (RACC EPSCoR Summer Intern)**

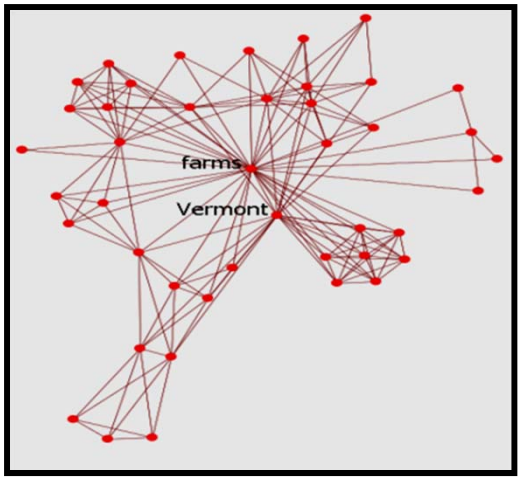
VERMONT EPSCoR

# Accomplished: Data mining for Governance Network Agent-Based Model

**Lake Champlain Basin Program – Agricultural**
**focus:** "Opportunities for Action" (OFA) Plan (2010)



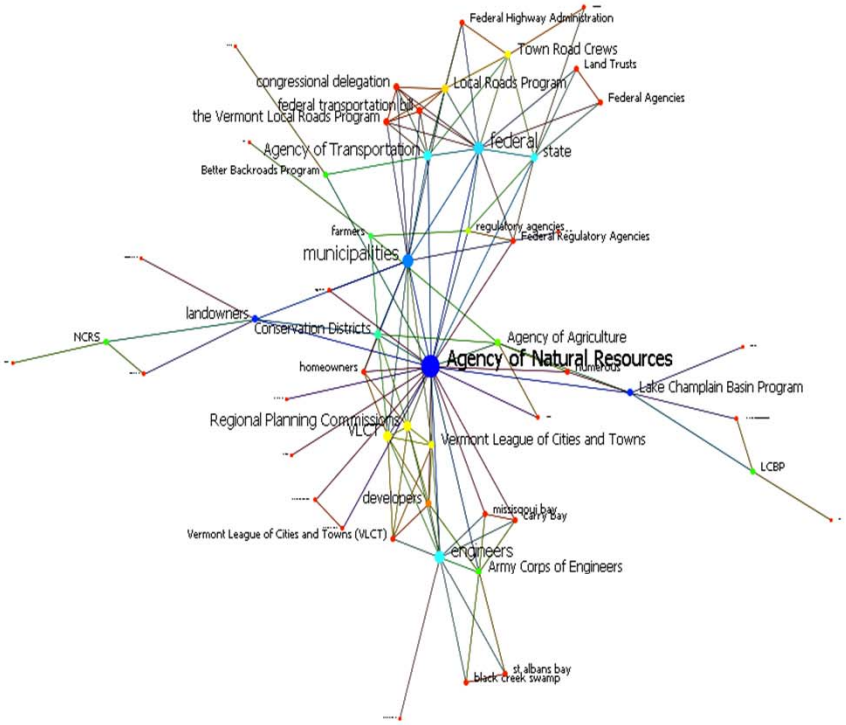



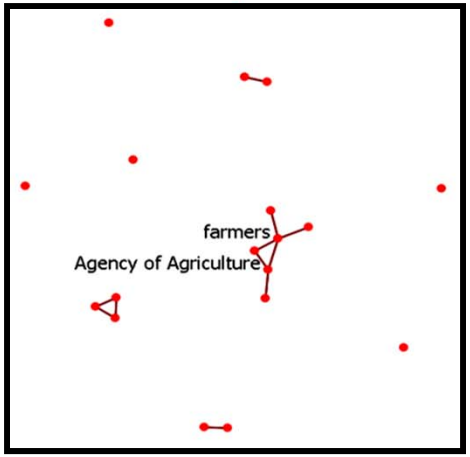



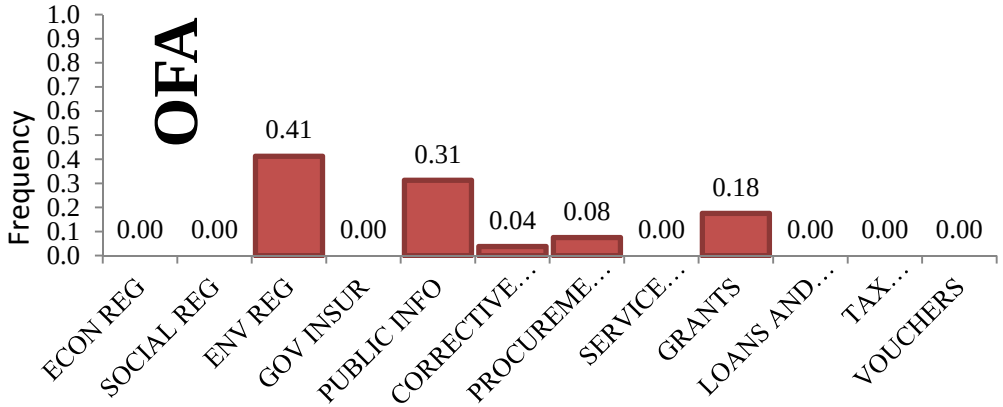

VERMONT EPSCoR

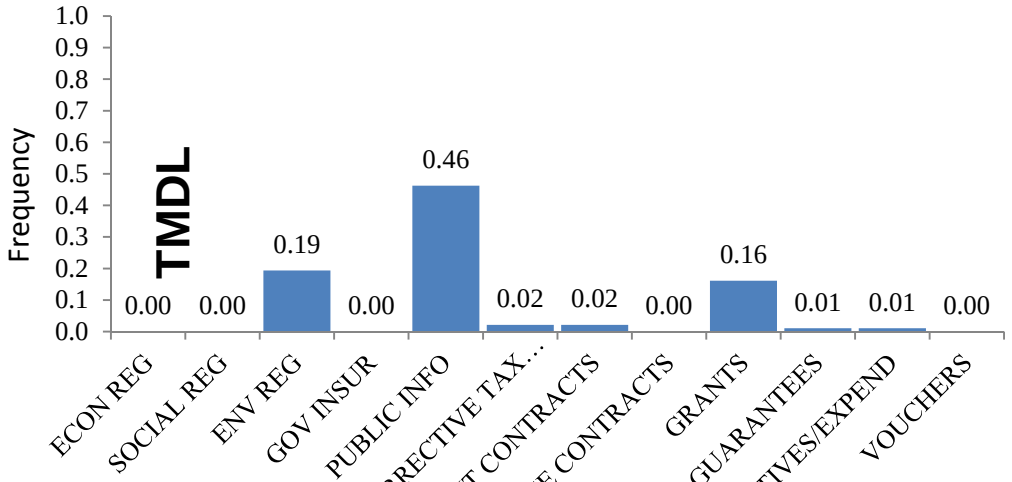
# Data mining for Governance Network Agent-Based Model

## **EPA-Driven TMDL** Plan- Agricultural focus (2010)



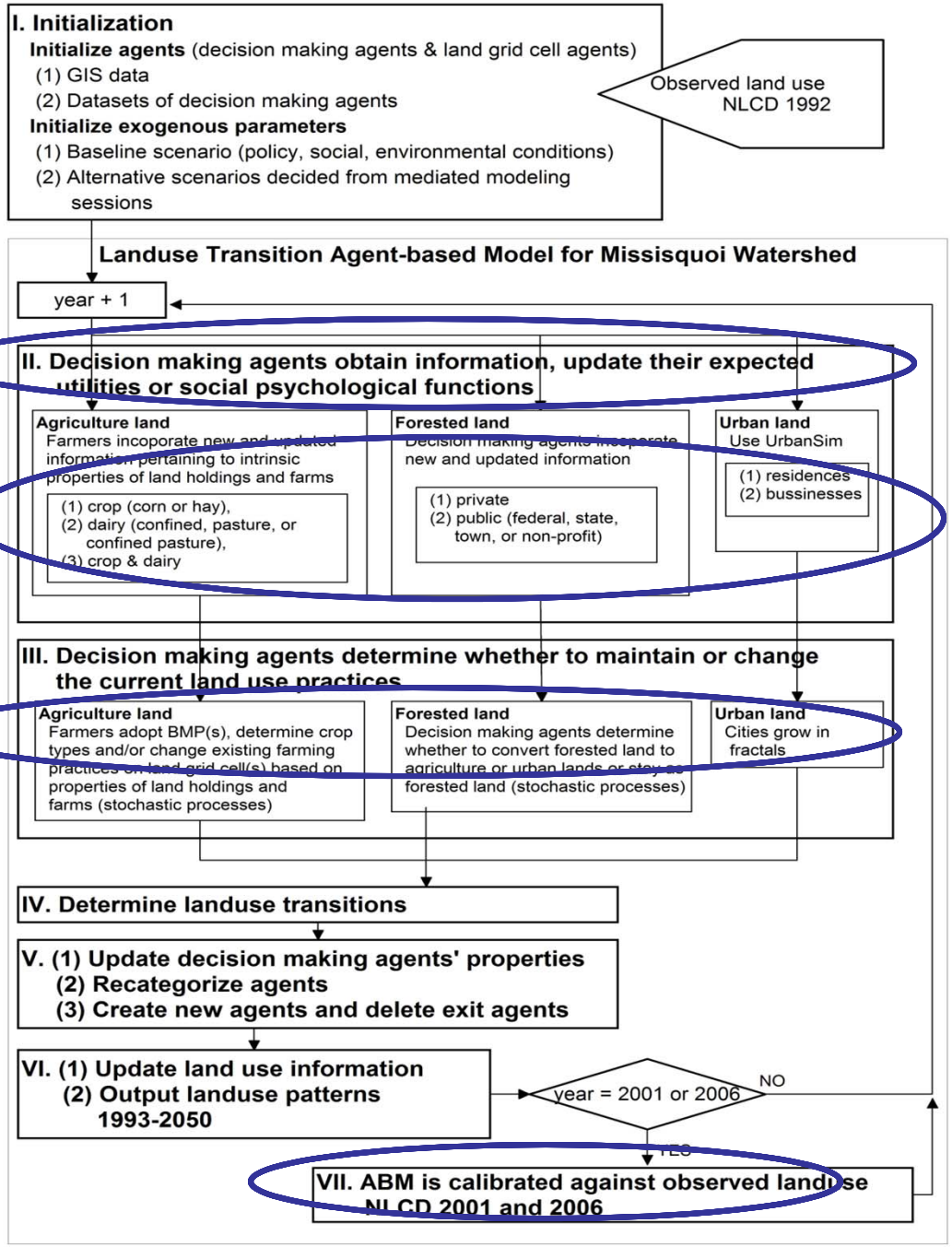




VERMONT EPSCoR

# Accomplished: Preliminary Architecture of Landuse Transition Agent Based Model (ABM)

- Three state landuse patterns
- Expected utility and theory of planned behavior
- Empirically-determined decision heuristics
- Calibrated to observed landuse patterns




VERMONT EPSCoR

# Accomplished: Planning for Interactive Scenario-Mediated Modeling Workshops

- **GOALS:**
  - Conceptualization of the problem and its boundary conditions
  - Implications of climate change based on agreed upon storylines
  - Used to inform the parameterization of our models
  - Generation of alternative scenario development using ABMs and IAM
  - Basis for coordinated strategic  action

- **FIRST WORKSHOP**

  PLANNED FOR November, 2012

- **SECOND WORKSHOP**

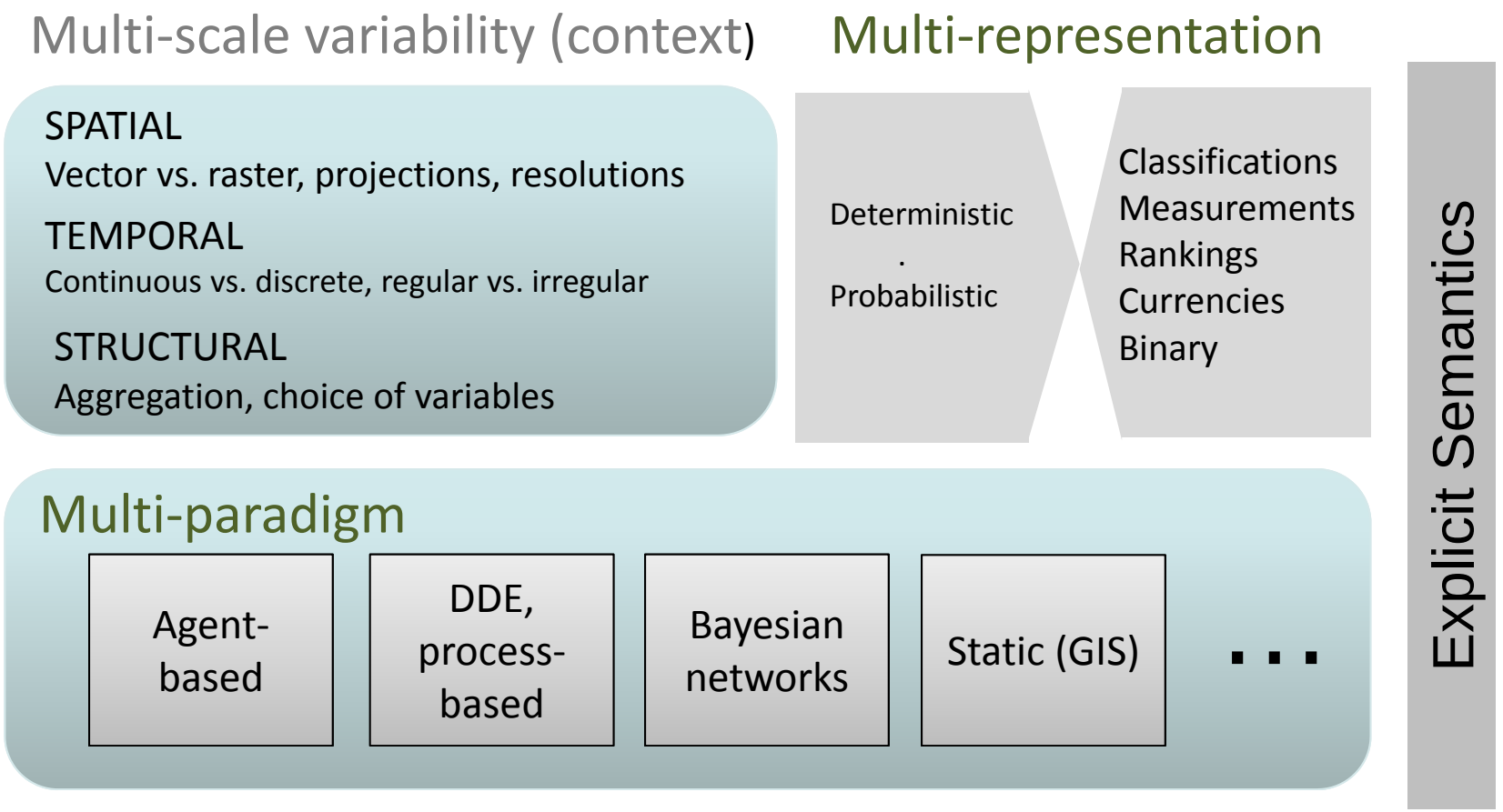
  PLANNED FOR April, 2013

IPCC
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE
WMO UNEP

CLIMATE CHANGE TEAM
VERMONT
AGENCY OF NATURAL RESOURCES

VERMONT EPSCoR

# Integrated Modeling Platform



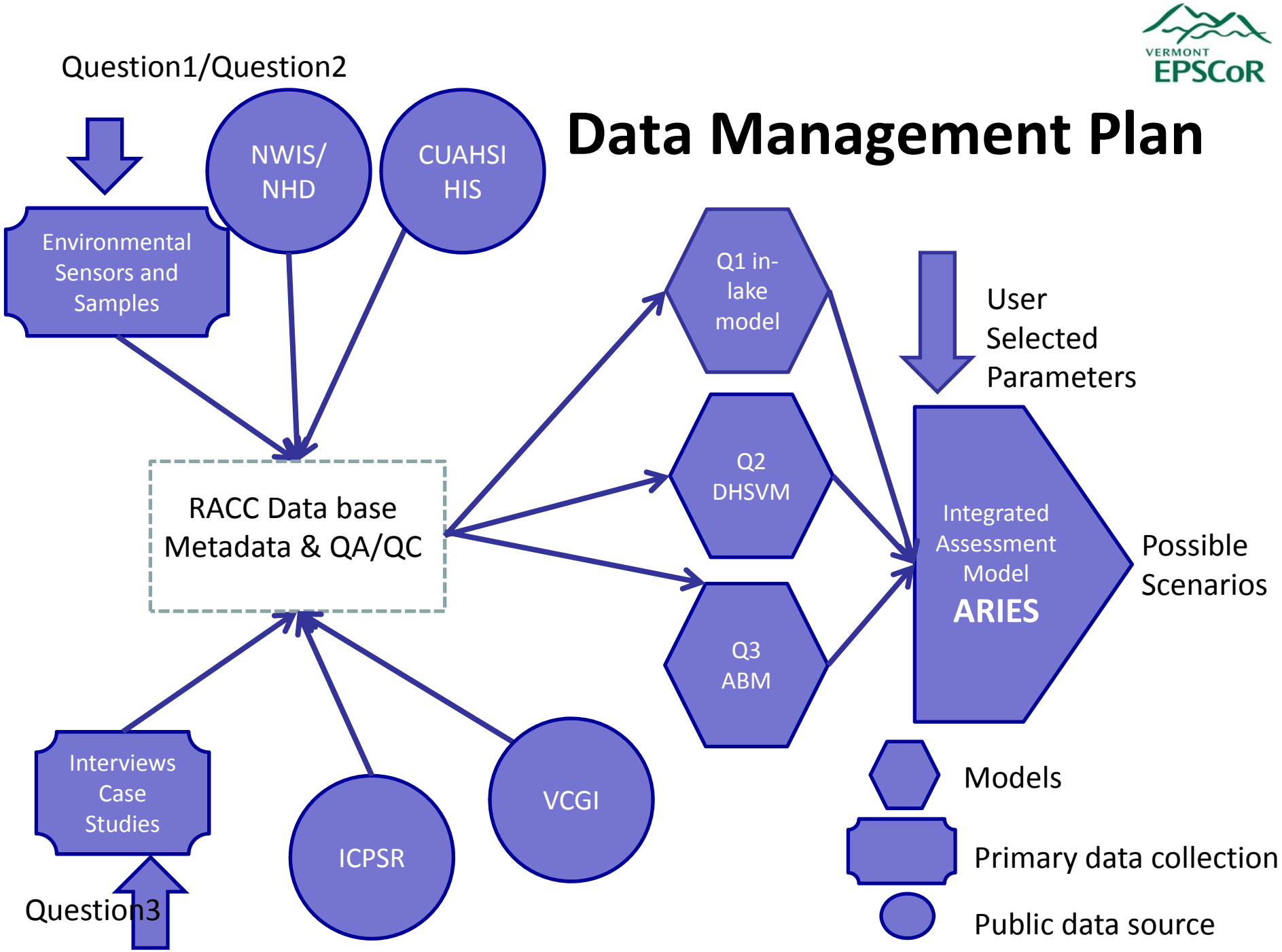

Semantically annotated data & models -> True Modularity, Substitutability
Content mediation and propagation -> Automatic Scaling & Matching

# Integrated Modeling Platform Selected

## **ARIES: AR**tificial **I**ntelligence for **E**cosystem **S**ervices

- **Assessment** toolkit for ecosystem services (ES) and their values.
- Not a single model, but an **intelligent system** that customizes models to user goals.
- A mapping process for ecosystem service **provision**, **use**, and **flow**.
- Includes both **deterministic** and **probabilistic** models to inform decision-makers of likelihood of possible outcomes.
- **Web-based**, customizable for specific user groups, geographic areas and policy goals.
- Target **audience** includes researchers, governmental decision makers and policy makers, business environment and various public-private sustainability initiatives.

# Data Management Plan



# Milestones for Question 3:

| | | |
|---|---|---|
| **Governance and ABM model development (Question 3)** | | |
| Convene mediated modeling sessions regarding climate change, land use storylines, coupled human system drivers, policy and governance drivers | X | In Progress |
| Develop conceptual models of watershed governance, parameterize watershed governance ABM, calibrate and validate governance ABMs | X | In Progress |
| Collaborate with ID, NH scientists; Hold joint meetings (VT 2012, ID 2014) | X | Joint meeting with WY EPSCoR and NWSC faculty May 2012; delaying meeting with ID, NH scientists |
| **Integration: IAModel Spatial Database Management Development** | | |
| Adapt the ARIES platform for RACC research through scoping models | X | In progress |
| Integrate multiple models | X | In progress |


Experimental Program to Stimulate Competitive Research

# Workforce Development and Diversity Plans

# Center for Workforce Development and Diversity
# Saint Michael's College

Education Outreach

Workforce Development

Broadening Participation

Service to the State

**Water Analysis Labs** for RACC research at Saint Michael's College and Johnson State College

**Integrate participants into RACC research**:

Internships for undergraduates - Veterans, Disabled

High school teachers and their students

Middle school teachers

New partner, Community College of Vermont

**Scholarships** for first generation and Native American students

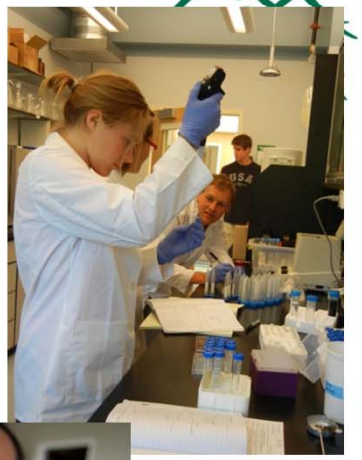
**Governor's Institutes of Vermont** – funds for girls and economically disadvantaged to attend

# How did the Undergraduates Integrate into RACC?

## Undergraduates:

38 from 11 institutions (including U. Metropolitana and U. PR)
68% are female; 18% under-represented

Added 14 undergraduates over 2011
(2011 67% female; 41% under-represented)
New in 2012: intern from **CCV**



UVM water analysis with grad student

SMC macroinvertebrate team

## What did they do?

In Lake Processes: 4 interns (UVM and Middlebury)
To Lake Processes: 24 interns (UVM, SMC, JSC, Middlebury)
Climatology: 4 interns (UVM, JSC)
Policy and Management: 6 interns (UVM, SMC)

## Water analysis for RACC research:

At SMC:
196 macroinvertebrate samples
53 stream grab samples
Total suspended solids (TSS)
158 watershed ISCO samples TSS
169 lake ISCO samples TSS

At UVM:
448 samples TSS
711 for total P
401 for *E. coli*

33 soil samples

At JSC:
1570 water samples analyzed for N, P; 796 for one analyte or more;
160 Ribotype identifications; 253 E. coli analyses

JSC ribotyping and water analysis team

# How did the High School Teams Integrate into RACC?

## 2012 Season

18 high school teams of a teacher and two students. Teachers: 50% female; 11% under-represented; students: 61% female; 11% under-represented

2 teams from PR; 2 from Poughkeepsie; 14 from Vermont

## Compared to 2011:

16 teams. Teachers: 43.8% female, 18.7% under-represented; students: 62.5% female, 18.7% under-represented

2 teams from PR; 1 from NY State; 1 from the Bronx; 1 from Poughkeepsie; 11 from Vermont

Above right University Gardens HS & Jose E. Aponte de la Torre HS, PR; Above Rice HS VT

## What did they do in RACC Research in 2012?

A. Install stage sensors; download data; take grab samples and soil samples; e-mail stage sensor logs; in fall, remove sensors from stream
B. Install temperature sensors; download data; collect macroinvertebrate samples and grab samples; upload data, send samples for analysis; identify macroinvertebrates; in fall, remove temperature sensors
C. Collect farm journals; interview community members; transcribe journals and interviews; send transcriptions, photographs and voice recordings for data management
D. All develop research question for academic year work and return in April to report out at CWDD

# Scholarships for First Generation and Native American Vermont STEM Undergraduates

Alexander Ferno, Katie Bedard, Judith Van Houten, Tazey Ryea, Miranda Lescaze

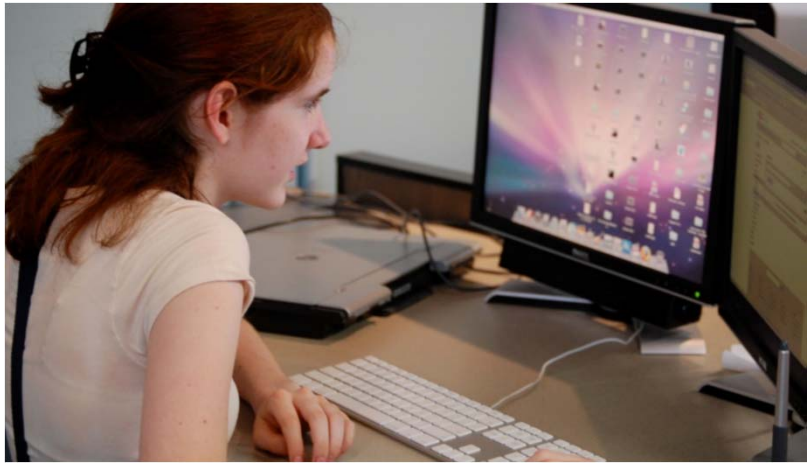
# Support for Girls and Rural Poor Students to attend the **Governor's Institutes** in Engineering, Math, IT, Environmental Science

## 2012

46 out of 56 (82%) girls received VT EPSCoR incentive funding
41 out of 176 (23%) total participants received VT EPSCoR need-based scholarships

## 2011

54 of 75 girls (72%) received our incentive funding
39 of 168 (23%) total participants received our need-based scholarships



# Mentoring Plans – Postdocs, Grad Students, Early Career Faculty

- **RACC Advisors assigned** to postdocs and grad students; PI and Science Leaders advise the early career faculty
- **Plans are made for**
  - **Regular meetings** with advisors
  - **Integration** into the interdisciplinary group
  - **Publications and funding proposals**
  - Achieving **career goals**
  - **Presentations at conferences**
- **All RACC participants mentor** undergraduates, high school teams, middle school teachers, or graduate students

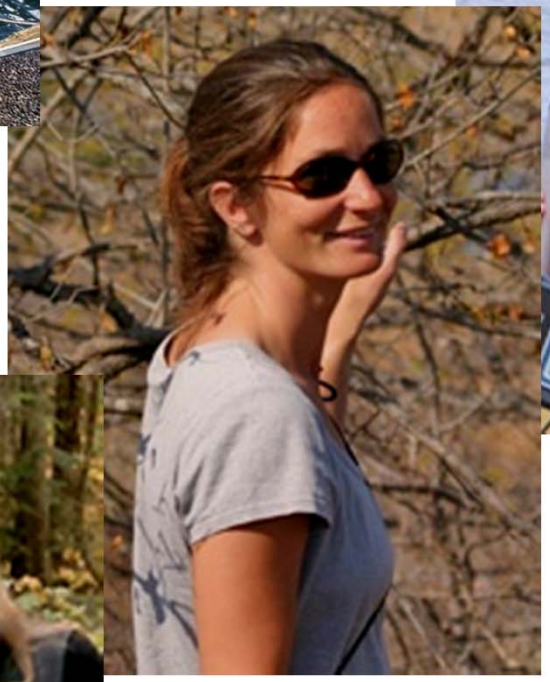
**Mentoring Program is Overseen by CWDD**

**Organized by CWDD:**

- Workshops on grant writing, scientific integrity, how to run a lab, how to train undergrads, technology transfer
- Visit to NSF program officers
- Training mentors to mentor in collaboration with NIH sister program Vermont INBRE

VERMONT EPSCoR

Dr. Courtney Giles and grad student Peter Isles



New faculty Stephanie Hurley, Carol Adair, Jason Stockwell

# Grant Writing Workshop – Something for Everyone
# August 17, 2012

Jennifer Rough, Grad Student, UVM

Dr. Ted Conway, NSF ENG/CBET

Dr. Mark Lubkowitz, Saint Michael's College, on RUIs

VERMONT EPSCoR

# Milestones Workforce Development and Diversity

| Integration of Participants and STEM Workforce Development Year 1 | Y 1 | Status |
|---|---|---|
| Use cyber-enabled communication for training and education outreach | X | Ongoing |
| Provide water analysis to support RACC research | X | Ongoing |
| Integrate high school students and teachers into research (16-25 teams per year) | X | 18 Teams formed |
| Integrate undergraduates into research (30-37 students per year) | X | 38 Placements (1 CCV) |
| Integrate middle school teachers into research (4 by year 2) | X | Recruited 1 teacher – did not join program |
| Increase diversity of participants at all levels, including disabled and veteran students | X | See demographics slide |
| Partner with GIV to increase participation of girls and economically-disadvantaged students | X | Completed for Year 1 |
| Establish a scholarship program to support first generation and Abenaki students enrolled in STEM majors | X | 2 Native American; 1 First Gen scholarship awarded |
| Partner with VT Technology Council to coordinate private sector technology internship program | X | 20 companies, 77 interns hired |
| Partner with INBRE to coordinate mentoring program for graduate students, postdocs and faculty | X | First mentoring workshop held August 15, 2012 |

# Diversity - Broadening Participation

Baseline for Participants:

135 women

24 from underrepresented groups

2012 Track-1 Year 1:

200 women

34 from underrepresented groups

Recruited to RACC research:

- 4 postdoctoral associates (2 female, 2 international)
- 6 graduate students (3 female)
- 4 new faculty (2 female)


Experimental Program to Stimulate Competitive Research

# Sustainability Plan: Pilot and Private Sector Innovation Awards

# Pilot Awards Complement RACC Research

## Year 1

| Last Name | First Name | Dept | Proposal Title |
|---|---|---|---|
| Beckage | Brian | Plant Biology | Improving regional predictions of forest change through inverse estimation of parameters in dynamic vegetation models |
| Stevens | Lori | Biology | Data Classification and Uncertainty Assessment using a Bayesian Artificial Neural Network: Forecasting Geomorphic and Habitat Assessment Scores for Vermont Streams |
| Stockwell | Jason | Rubenstein Ecosystem Science Lab | Comparative dynamics of a mid-trophic level omnivore in Lake Champlain: 1975 versus 2012 |
| Wemple | Beverley | Geography | Modeling the effect of changing precipitation and temperature on streamflow in upland forested watersheds |

# Private Sector Innovation

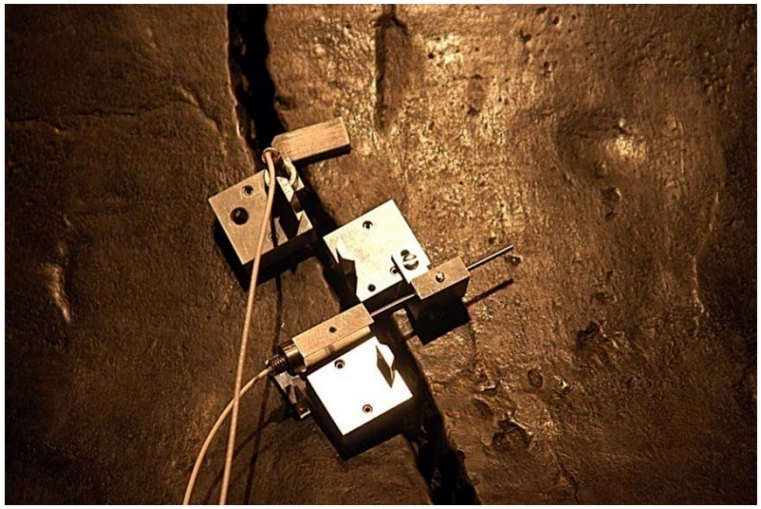
- Support high-tech companies to compete for Federal SBIR/STTR funding
- SBIR Phase (0) Awards

- Encourage transformative research by supporting high risk-high impact work
- IF Awards

- Expedite collection of data for SBIR Phase (I) and (II) proposals; Leverage existing facilities and technologies
- Use of Facilities Awards

# SBIR Phase (0)

- Invented in Vermont in 1991
- Awards:
  - $15,000
  - For feasibility or preliminary studies to improve competitiveness for Federal SBIR/STTR funding
  - To date, 148 awarded to 89 companies
  - Success: 27% have received Federal SBIR/STTR awards; national average is ~10%
  - Half of Vermont SBIR/STTR awardees had received prior Phase (0) funding



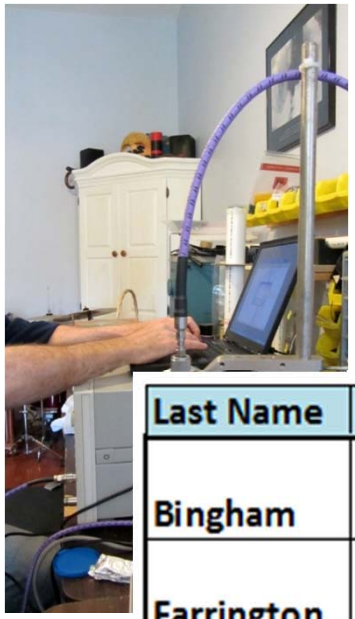
*Liberty Bell crack monitored by VT company.*
*MicroStrain, Inc. leveraged $60,000 in EPSCoR Phase (0) awards into 11 Phase I, 5 Phase II and 3 Phase III awards totaling about $8.2M.*

# SBIR Phase (0)
# Year 1

| Last Name | First Name | Company/Institution | Proposal Title |
|---|---|---|---|
| Dahiya** | Anju | General Systems Research LLC | Algae biomass production for Biofuel - an integrated approach for Cost-effectiveness |
| Farrington | Stephen | Transcendev | PRISMS - Profile Resolving in Situ Moisture Probe |
| Boerger | Brent | Advanced Photon Sciences LLC | Variable Frequency Pulsing Laser for Noncontact NDT |
| Redmond | Steve | Delta Tri-Gen LLC | Fuel Crop Cultivation for Remediating Methane Digester Effluent from Dairy Whey |
| Sprenger | Jeffrey | MicroBrightField, Inc. | Human Brain Scanner, a system to generate complete microscopic digital representations of human histologic brain specimens |

**This award was reviewed and administered for Vermont NASA EPSCoR.

# Innovation Fund (IF) Awards Year 1



***"IF this works, it would change the field, but the risk is too high."***

- Preliminary data not required
- Evaluation done by entrepreneurs

| Last Name | First Name | Company/Institution | Proposal Title |
|---|---|---|---|
| Bingham | Peter | Microprocessor Designs Inc | Tongue Pressure Biofeedback for Sleep Apnea |
| Farrington | Stephen | Transcendev | RFID Sensing of Corrosion in Reinforced Concrete Bridges |
| Gouli | Vladimir | University of Vermont | Identification and Isolation of Heterokaryons from Hyphal Fusion of Entomopathogenic Fungi |
| Stromgren | Peter | Bolway, Longley & Traver, Inc. | Ink Jet Printable Electrically & Thermally Conductive Coating |

# Use of Facilities Award
# Year 1

Vermont EPSCoR

## Dr. Anju Dahiya, General Systems Research LLC

Low cost algal biomass production, integrated with treatment of wastewater from dairies, breweries and/or capture flue/$CO_2$ gases.

Facilities used:

- Flow cytometry
- Microscopy
- NMR

# Milestones for Sustaining RACC Research and Innovation

| Sustaining RACC Research and Innovation through Seed Funding Year 1 | Y 1 | Status |
|---|---|---|
| Review proposals and make 4-6 Pilot Awards for complementary research annually | X | 4 Pilots Awarded |
| Review proposals and make up to 8-10 SBIR Phase (0) awards annually | X | 4 SBIRs Awarded |
| Review proposals and make up to 4 IF awards annually | X | 4 IFs Awarded |
| Review proposals and make up to 2 Use of Facility Awards | X | 1 Award |


Experimental Program to Stimulate Competitive Research

# External Engagement Plan

# External Engagement Plan

- Designed to improve the understanding of Vermont NSF EPSCoR's goals and mission
- Intended to broaden support of policy makers, the business community and the general public
- Continues a partnership with Vermont Public Television (VPT)
- Brings RACC graduate students, faculty and postdocs into contact with students and teachers to make an effective impact on public awareness


VERMONT PUBLIC TELEVISION

Be more PBS

Partnership with **Vermont Public Television.**

3-4 television episodes each year; fifth year of episodes airs October 2012.

**Short videos from episodes are disseminated electronically** on the VT INBRE statewide listserv of 4,000 people in academic and private sector and on a VPT listserv of 29,000 subscribers

Posted on iTunes and YouTube.

**Last Season:**

- "Email Blasts" for each episode reach 13,000 viewers specifically interested in science programming
- Multiple Facebook ads for upcoming episodes. 38,413 impressions and 542 click-throughs
- Emerging Science was among **VPT's Top 25 programs for the month of November 2011**
- **The top rated program for Women 18-35**
- **Seen by 8,598 viewers**

VERMONT EPSCoR

# Emerging Science in the Classroom

- Materials available to **all schools** via the VPT Website – meet Vermont Teaching Standards
- VT Department of Education Learning Network of Vermont **mini-workshops** for teachers using 2011 episodes - February 7th (Cyber Shadows), February 15th (Out of this World), and March 13th (Regeneration)
- **VT EPSCoR faculty participate in these workshops** to interact with the audiences
- **Vermont Science Initiative** incorporates the *Emerging Science* materials into high and middle school classes

# Science: Becoming the Messenger - March 29, 2012


- NSF OPLA
- Graduate Students, early career faculty, Public Relations Officers
- New RACC Faculty, Carol Adair, used skills from the workshop when interviewed by Vermont Public Radio about her new publication in Nature on climate change – **"It was incredibly helpful."**

# Face-to-Face Interactions with Students and Teachers

**Some examples:**

**November 2011: Community College of Vermont (CCV)**
**Winooski Campus** - RACC Member, Dr. Alan Betts: Climate Change in Vermont

**March 2012: Waitsfield Elementary School**
RACC Member, Dr. Alan Betts: Understanding Weather and Climate, 5th and 6th grade

Dr. Alan Betts

**June-July 2012: Governor's Institutes of Vermont (GIV)**
VT EPSCoR Faculty participate: Donna Rizzo, Josh Bongard, Chris Danforth, Peter Dodds

**July 2012: Satellites, Weather and Climate (SWAC)**
RACC Member, Dr. Lesley Ann Dupigny-Giroux (UVM), training K–12 science and mathematics Vermont teachers in the atmospheric, climate, and geospatial sciences

Dr. Lesley-Ann Dupigny-Giroux

# Milestones for External Engagement

| External Engagement Year 1 | Y1 | Status |
|---|---|---|
| Utilize Web based communication (RACC Website, Social Media Sites, YouTube) supplemented with print materials | X | Ongoing |
| Use cyber resources for video conferencing with Partners & Stakeholders and meetings hosted by VT EPSCoR | X | 47 video-conferences; 30 videos of meetings available on web |
| Produce Emerging Science Television Series, Webcasts, Outreach Visits and Curriculum Guides with VPT | X | Ongoing |
| Increase face to face interactions of RACC group; Café Scientifque, Emerging Science HS, VT State House | X | Ongoing |
| Host NSF OLPA Communicating Science Workshop | X | March 29-30, 2012 |
| Host annual State meeting[1], CWDD Research Symposium, Grant Writing Workshop[1], Tech Transfer (to be scheduled) | X | [1] August 16 &17,2012; [2]April 16, 2012 |


Experimental Program to Stimulate Competitive Research

# Cyberinfrastructure Plan

# Milestones for Cyberinfrastructure Plan

| Cyberinfrastructure Progress Year 1 | Y 1 | Status |
|---|---|---|
| Deploy cyberinfrastructure for sensors in lake and under ice | X | Sensors deployed; under ice grab samples |
| Connect data flows from models | | Planning complete |
| Curate data in appropriate CUAHSI and ICPSR sites | X | Ready for Data |
| Drupal-drive web site established for RACC participants to upload data and communicate | X | Established and in process |
| Support videoconferencing | X | 47 video-conferences; 30 videos of meetings – available on web |

VERMONT EPSCoR

Vermont, Delaware, Maine – weekly videoconference

Vermont EPSCoR

Experimental Program to Stimulate Competitive Research

# Evaluation and Assessment

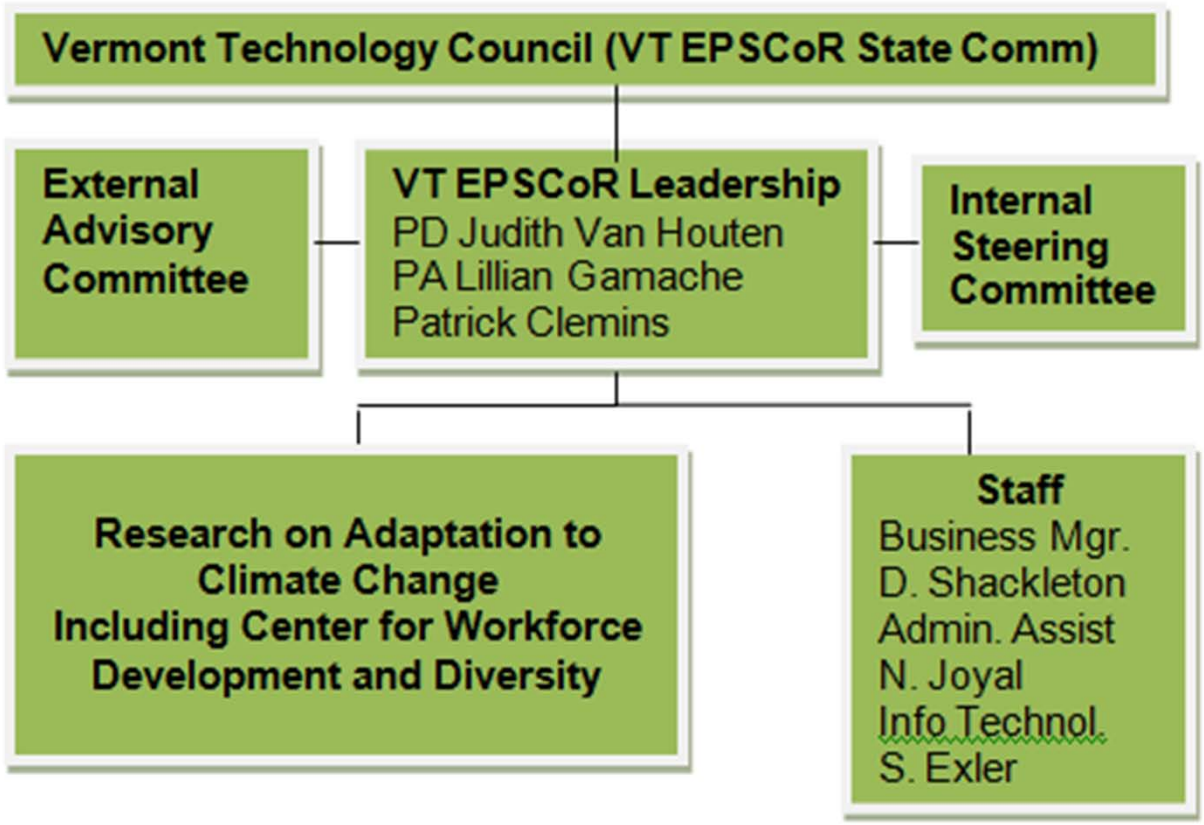
# Formative Assessment

- ✓ **Monthly reviews** in Staff and Science Leader meetings of Milestones from Strategic Planning
- ✓ **Internal Steering Committee** (Jan 13, 2012)
- ✓ **Annual Progress Report** (June 1, 2012)
- ✓ **External Advisory Committee** (August 16, 2012)
- ✓ **AAAS consultants** (July 19-21, 2012)
- ✓ Report from External Evaluator on **Surveys** of all participants (Dr. Joy Livingston, Flint Springs Associates) (July 2012)
- ✓ **Reverse Site Visit** review of Progress in Year 1 (Sept 6, 2012)
- ✓ Reiterate

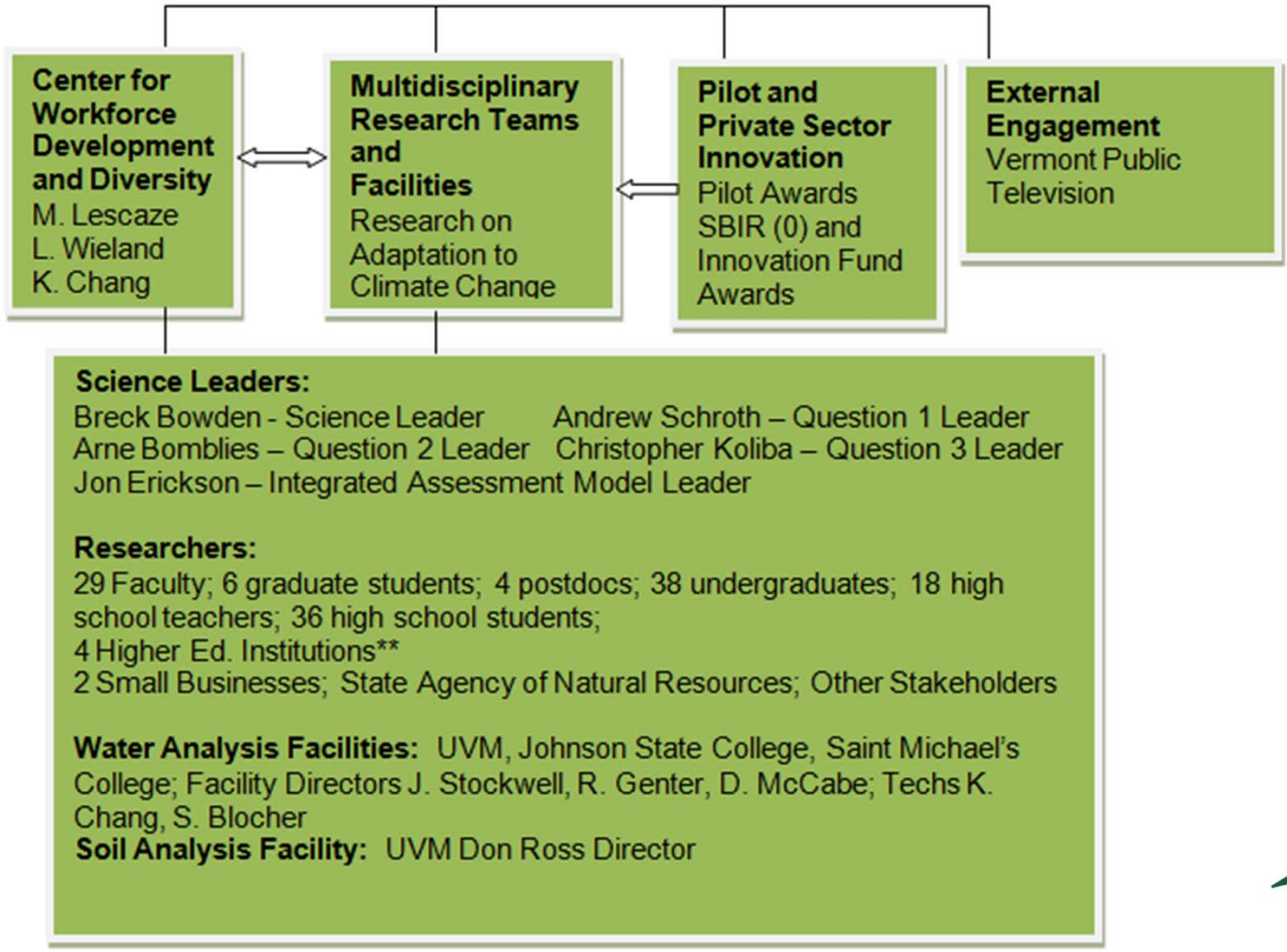

Experimental Program to Stimulate Competitive Research

# Management Plan

# Management Plan:
# Management Organization of VT EPSCoR



# Organization and Leadership of RACC Research and Programs




Vermont EPSCoR

Vermont EPSCoR

Experimental Program to Stimulate Competitive Research

# Challenges Addressed and to Address

**From Strategic Planning:**

**Regional Climate Data Downscaling**: Well Underway

**Add Another Social Scientist:** Dr. Taylor Ricketts, Director Gund Institute of Ecological Economics at UVM

**Face to Face Interactions:** Calendar of many events

**Data Management Plan:** Implementing work flow

**Cyber-enabled Outreach:** Videoconferencing frequent and effective for communicating among the institutions, water analysis labs, remote student sites; mobile app planned for Year 2

**Personnel recruited:** Very successful in recruitment of four faculty, including **Dr. Andrew Schroth**, who leads Question 1.

All graduate student and postdoc recruitments completed. (We have 2 postdocs instead of 2 graduate students and one postdoc for Question 3. We will renew efforts to recruit the graduate students in Year 2.)

**Equipment:** In place

**From Formative Assessment of Year 1:**

**More intense efforts for Year 2:**

Governor's Institutes enrollment of girls and rural poor

Middle School Teachers in RACC

Veterans and Disabled in RACC

More CCV interns

More undergraduates and high school teams from underrepresented groups

Thank you for your attention!


**Experimental Program to Stimulate Competitive Research**