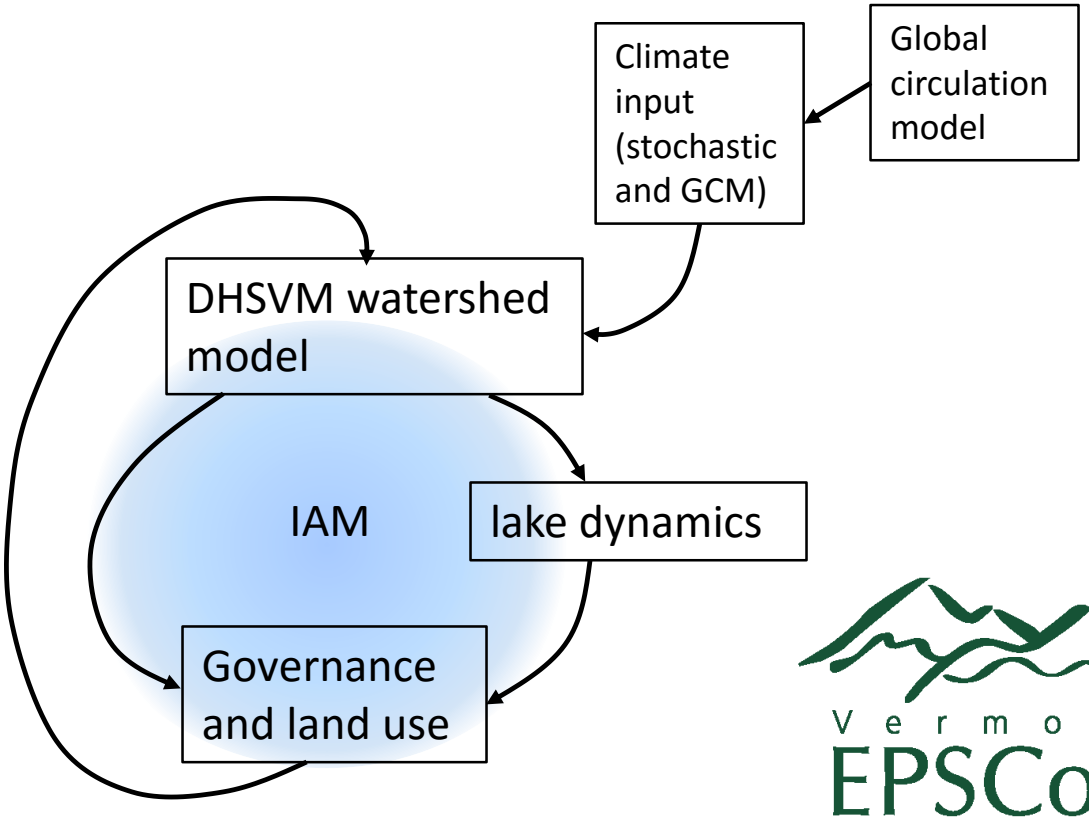
Question 2: Watershed component

"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?"

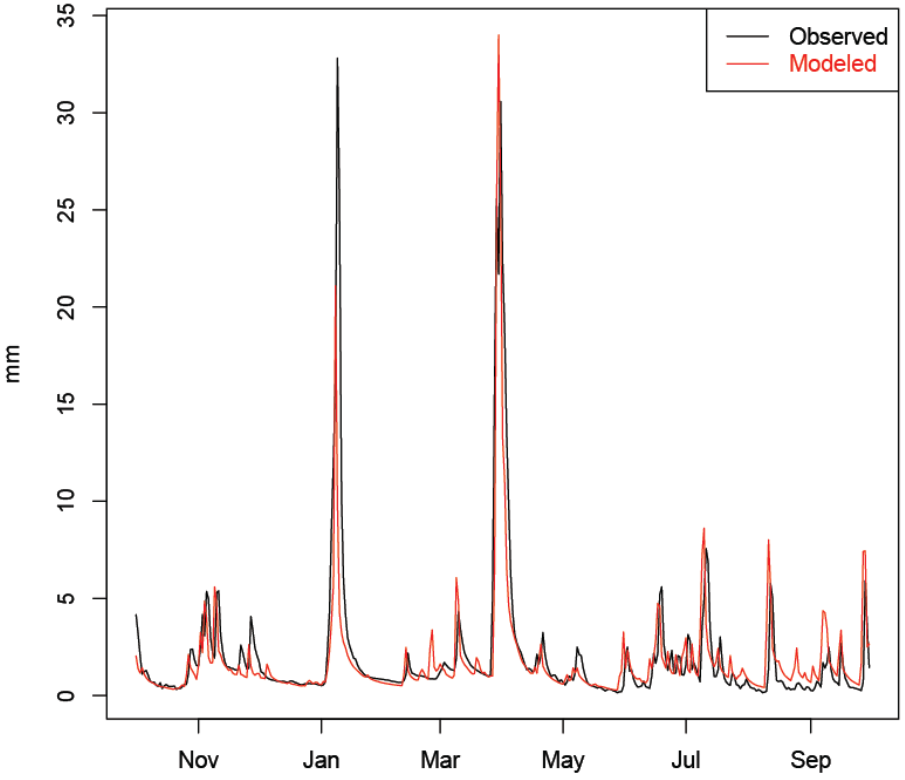


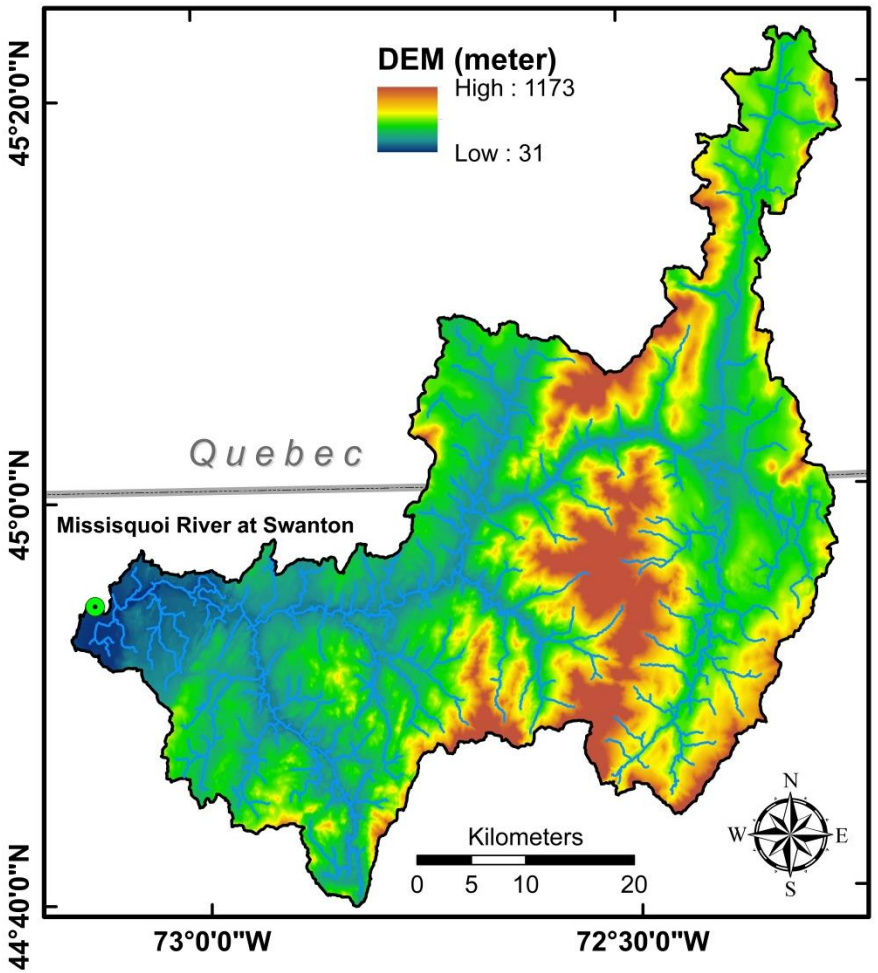
Vermont EPSCoR

Experimental Program to Stimulate Competitive Research

Missisquoi Model: a key component of integrated model

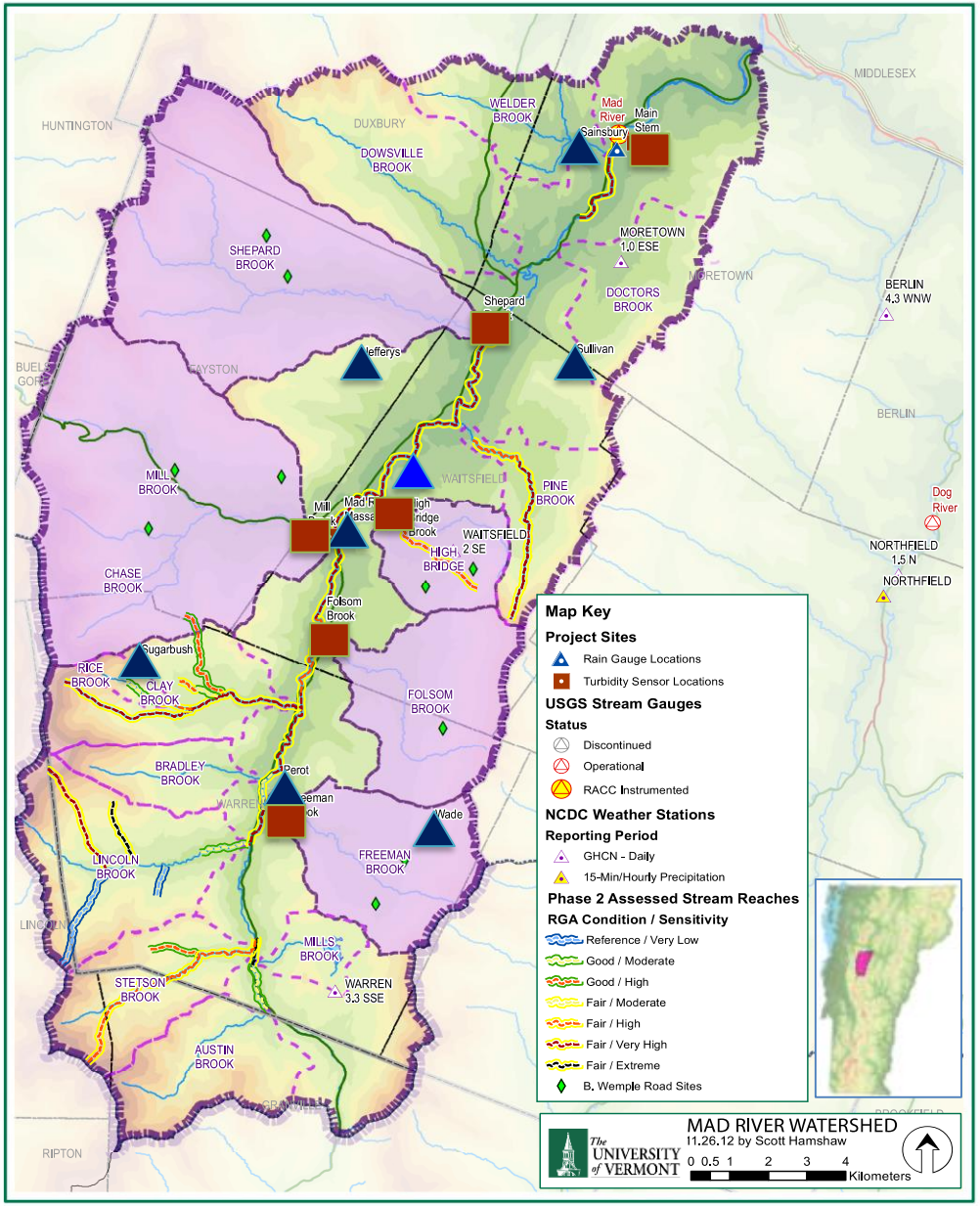
1997-1998 Water Year Observed and Simulated Runoff



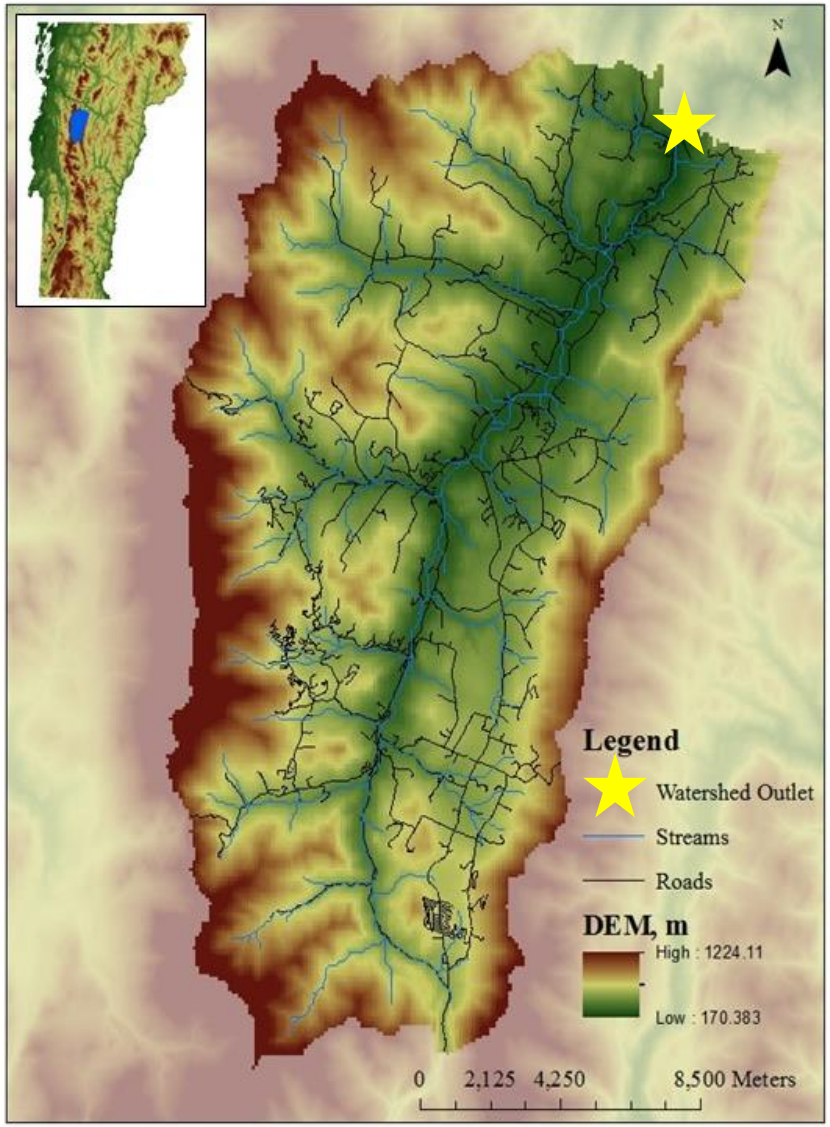


Model Application: Data for calibration/validation

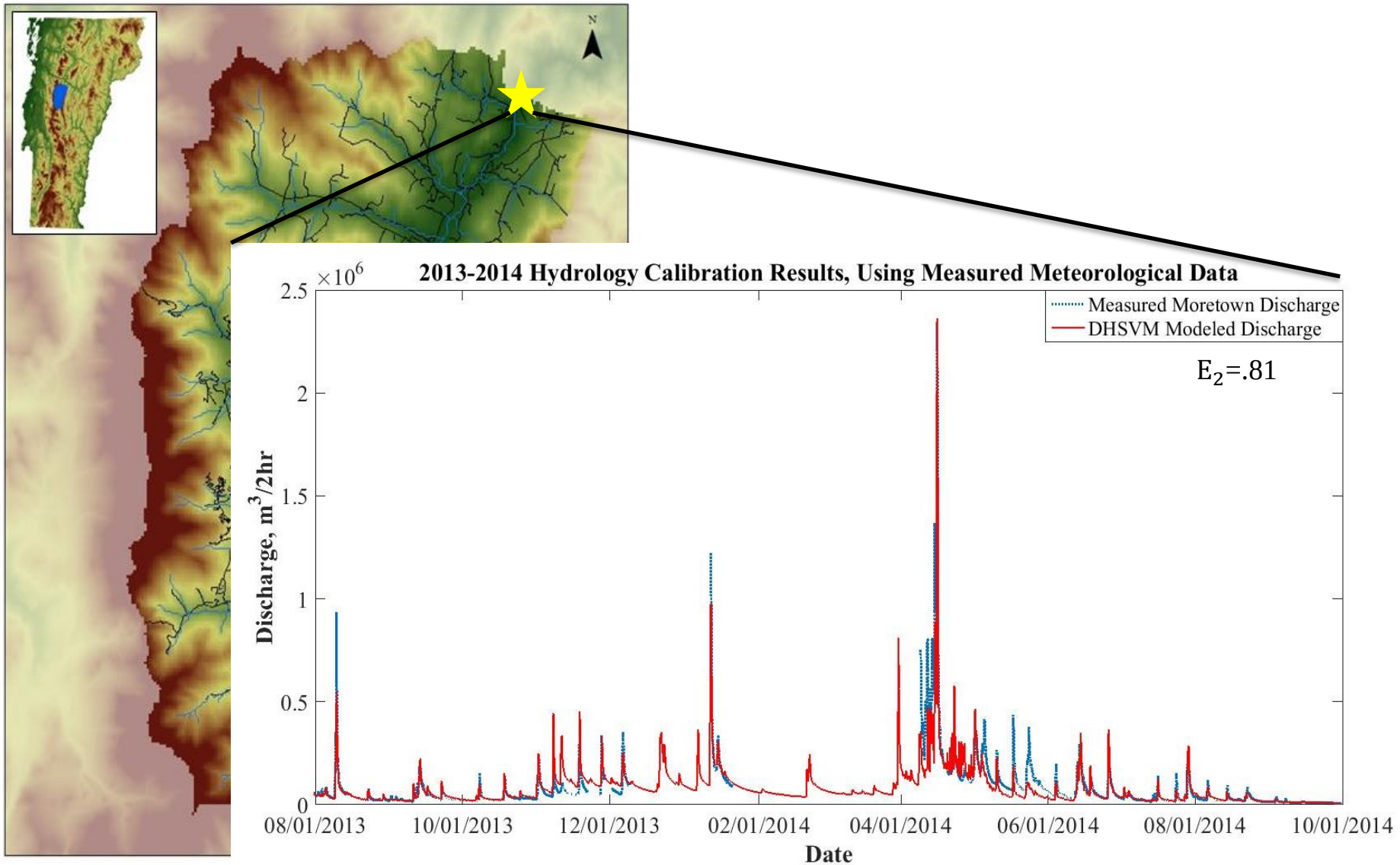
- Discharge from Moretown USGS gauge
- Turbidity measurements
- Snow pack depths
- LIDAR bank scans
- Isotope data
- Other modeling efforts



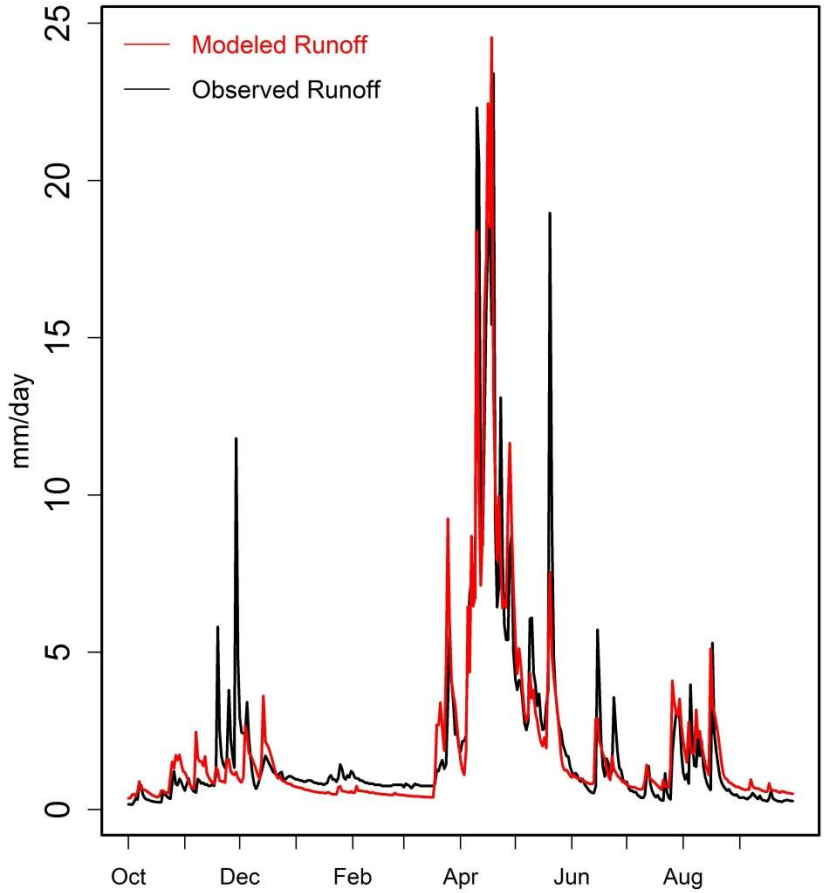
Flow Results Using Measured Meteorological Data

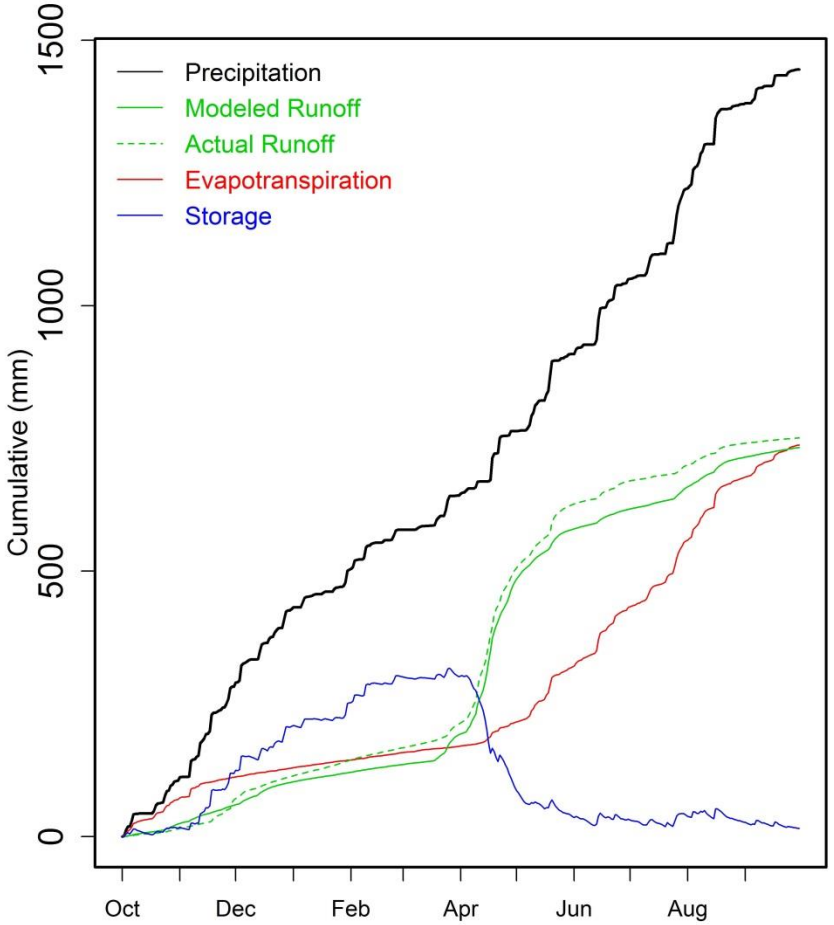


Flow Results Using Measured Meteorological Data

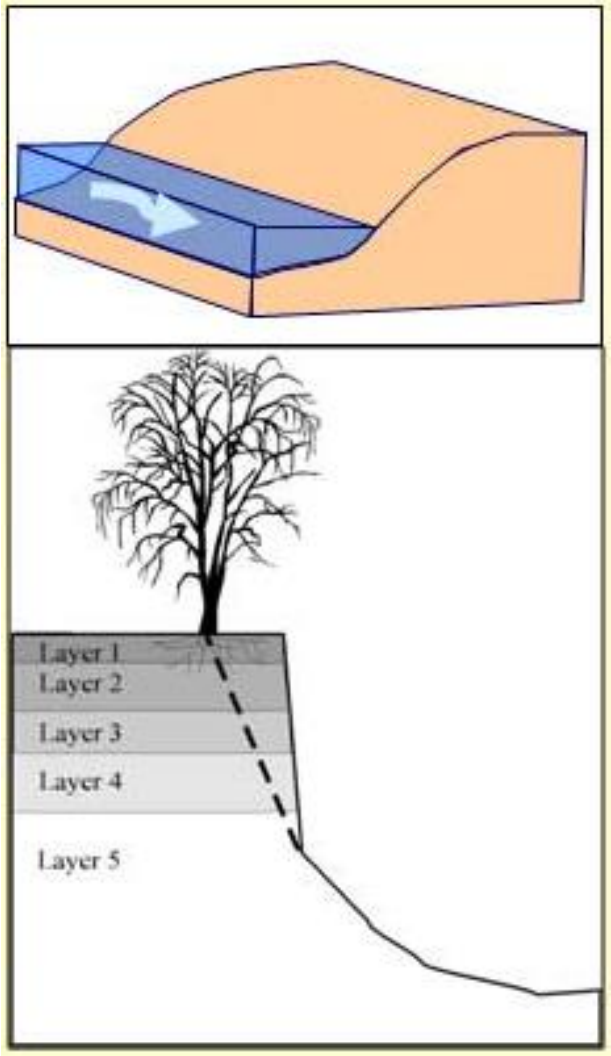


Hydrology model calibration:





Bank Stability and Toe Erosion Model fully coupled with distributed hydrology model



BSTEM was Developed in the 1990s at USDA-ARS National Sedimentation Laboratory
(Simon et al., 1999)

Source: http://ars.usda.gov/Research/docs.htm?docid=5045

BSTEM: Hydraulic processes

Excess shear stress is that available to cause erosion:

$$\tau_e = \tau_o - \tau_c$$

Data collection for model parameterization

Data collection for model parameterization

- **Soil test pits:**
  - **information about soil layering**
  - **composition of soils**
  - **grain size distribution**

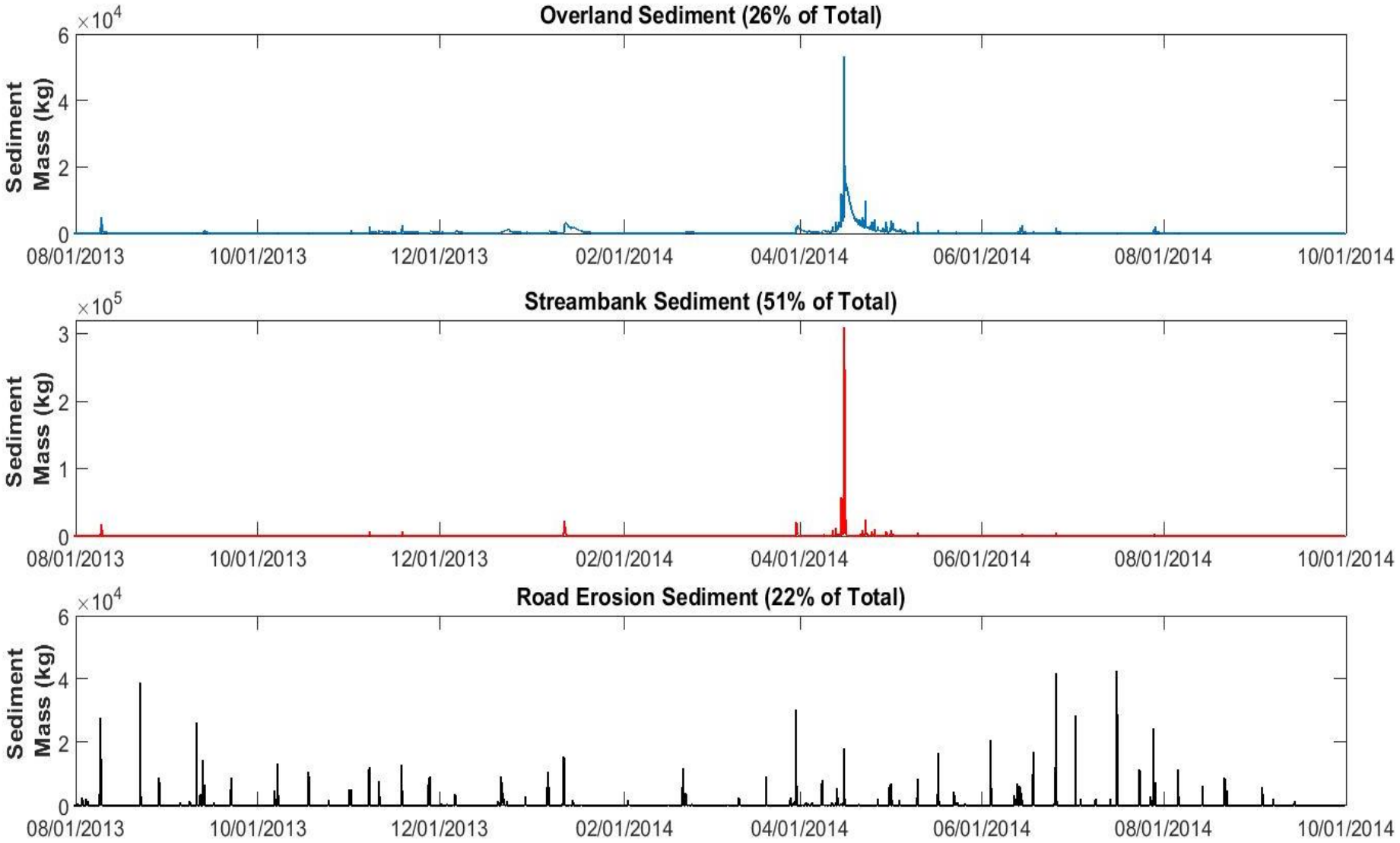
- **Infiltration measurements:**
  - **range for saturated hydraulic conductivity**

- **Jet testing/bore hole shear testing:**
  - **cohesion of bank materials**
  - **erodibility**

- **Piezometers and stage sensors:**
  - **water table elevation with respect to stream flow height**

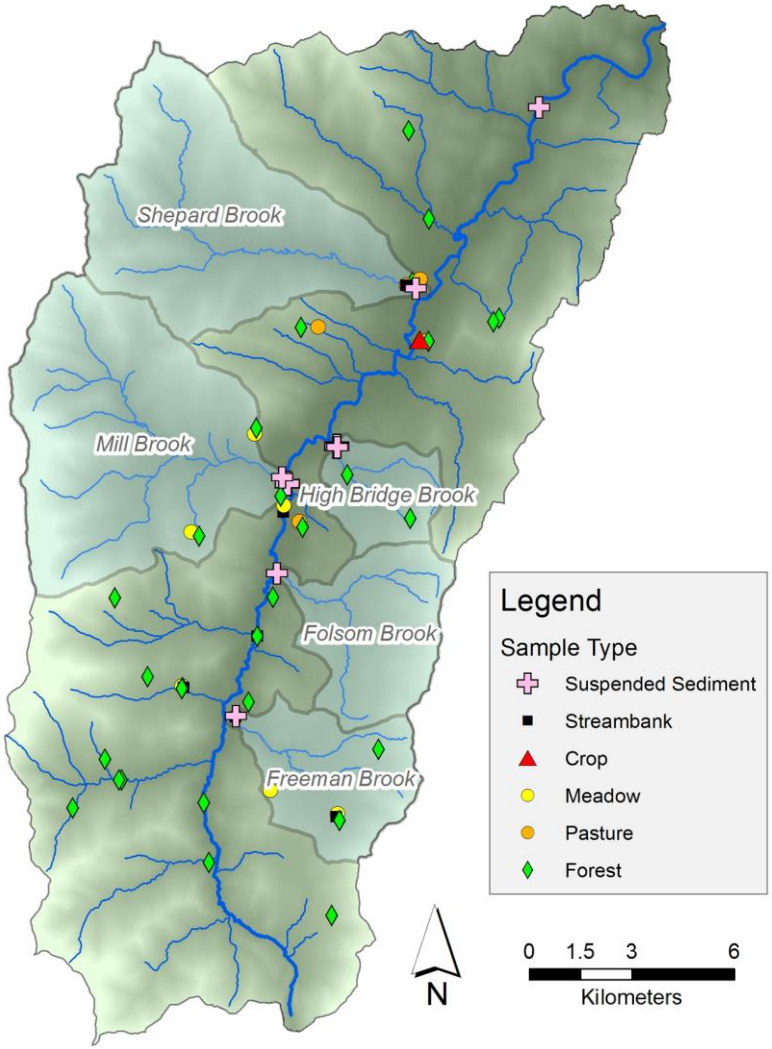
Lareau Farms soil test pit, summer 2013.

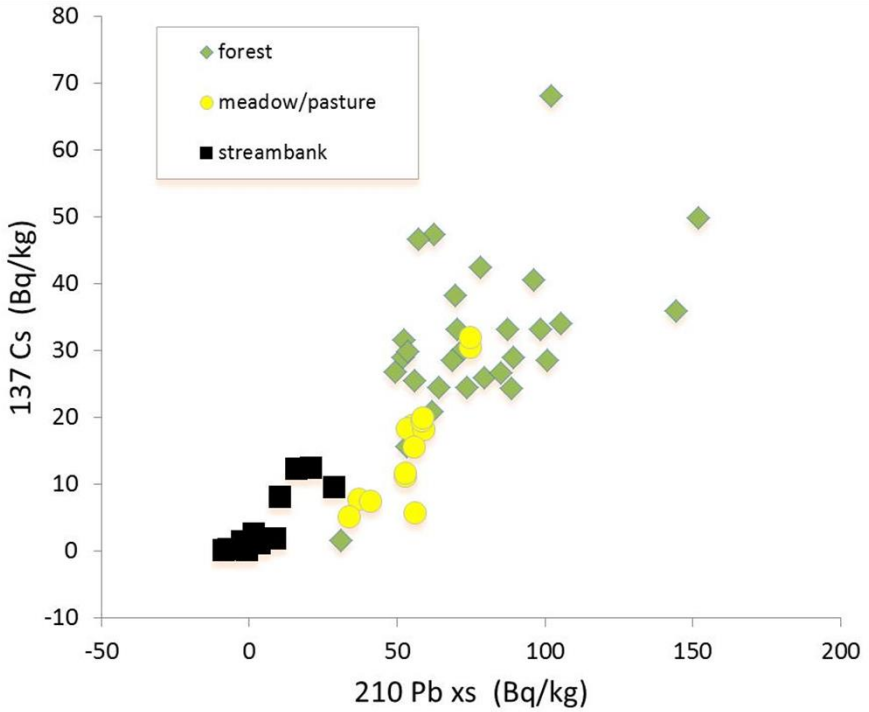
Relative Sediment Contributions from 3 Watershed Sources



Sediment Tracer Study – Mad River Watershed

- Radionucleides help track the source of suspended sediment.

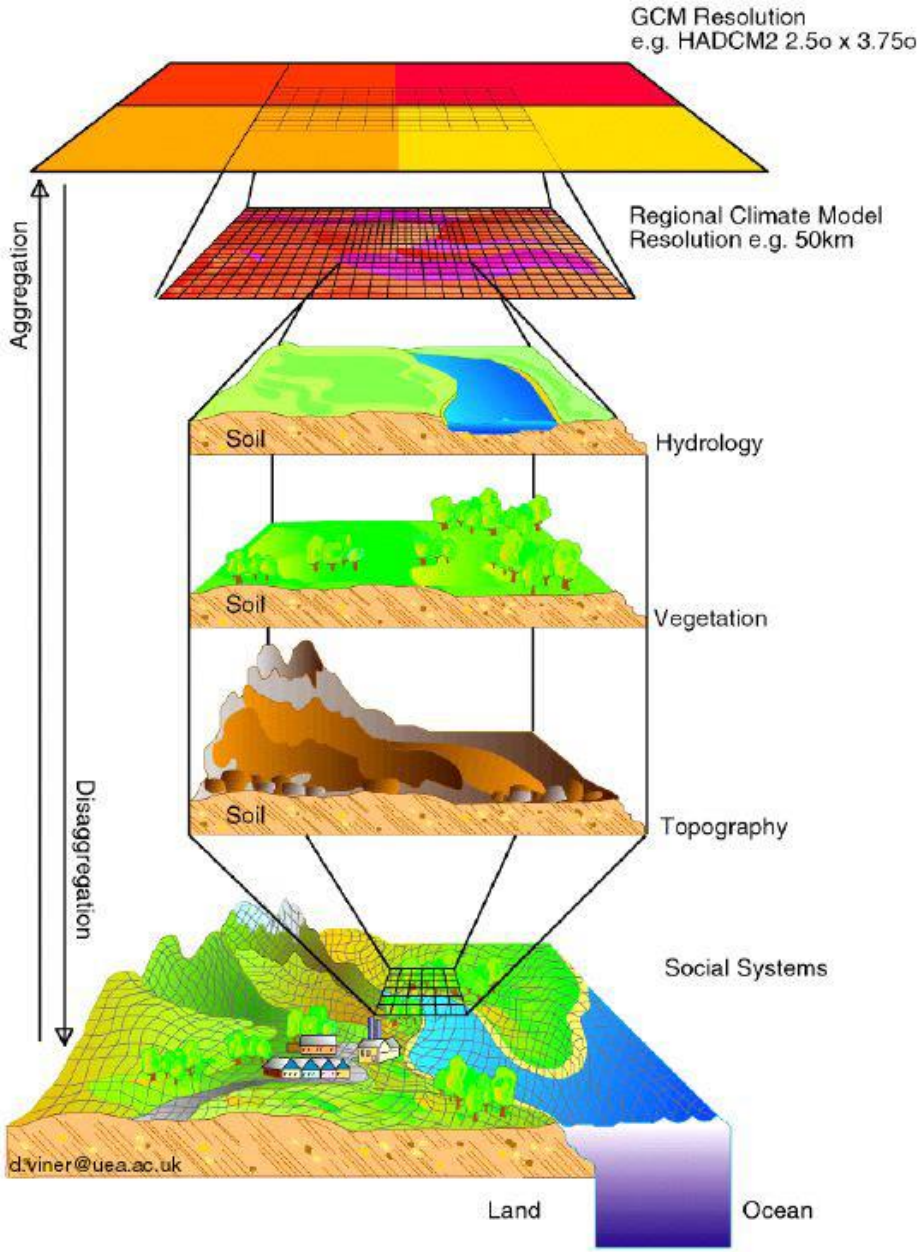




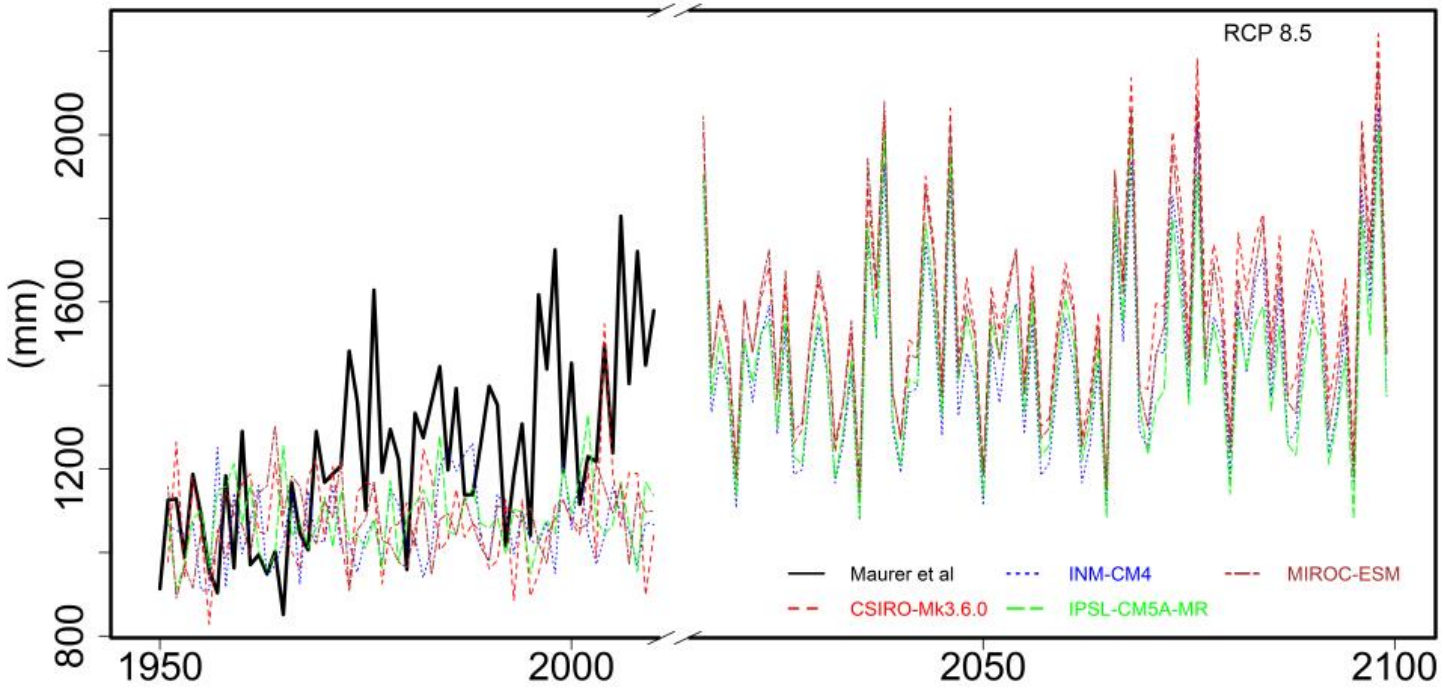
One becquerel (Bq) is defined as the activity of a quantity of radioactive material In which one nucleus decays per second.

Example preliminary results, 2013 sampling campaign

Climate downscaling



Limited use for extremes analysis: results from delta method for statistical downscaling



Use of extreme value statistics to generate time series.

$$P_t \sim GEV(\mu(t,a,b), \sigma(t,a,b), \xi)$$

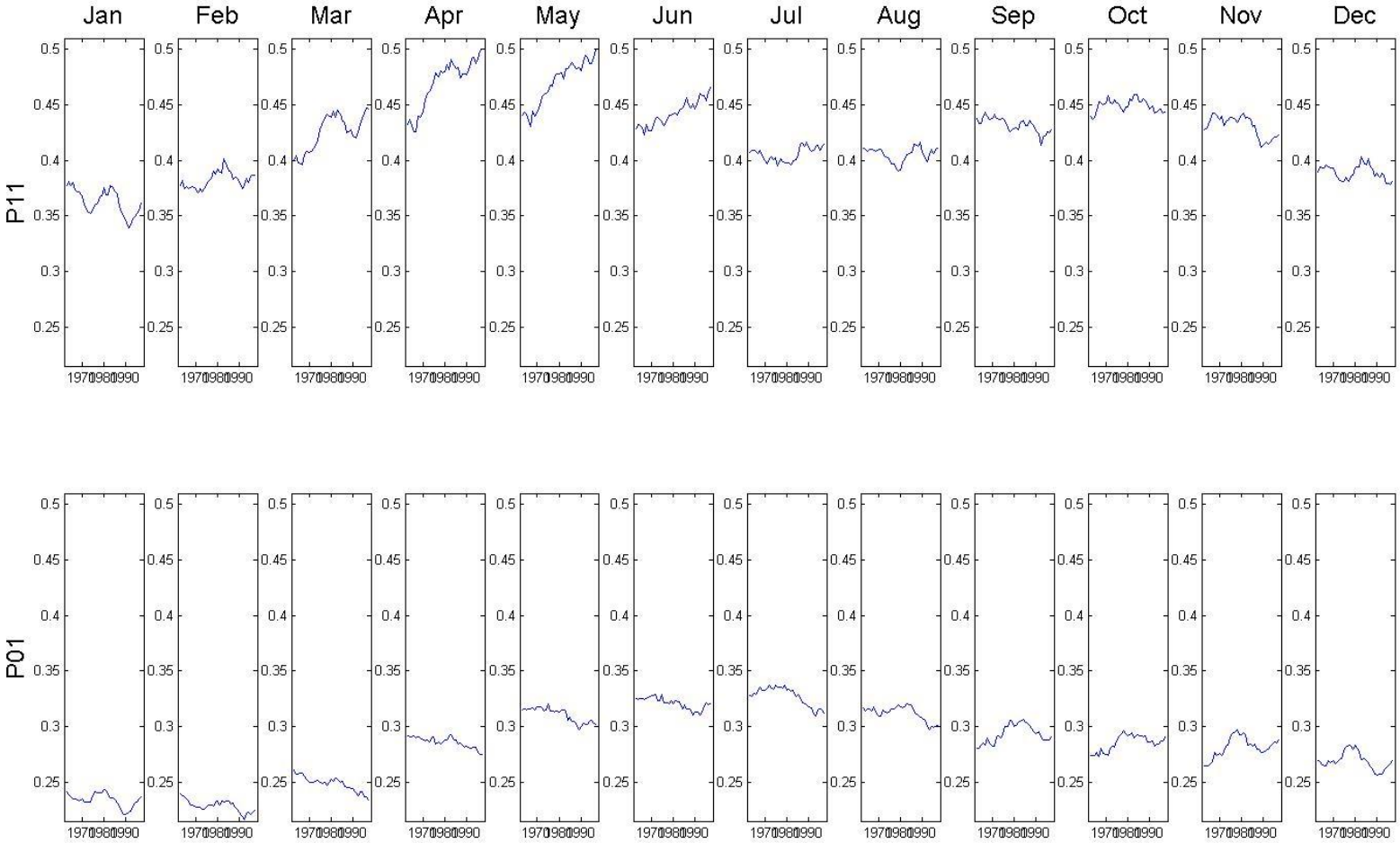
Annual maximum precipitation

Location parameter
Covariates:
t: time (for trend)
a, b: climate indices
e.g. NAO, AO

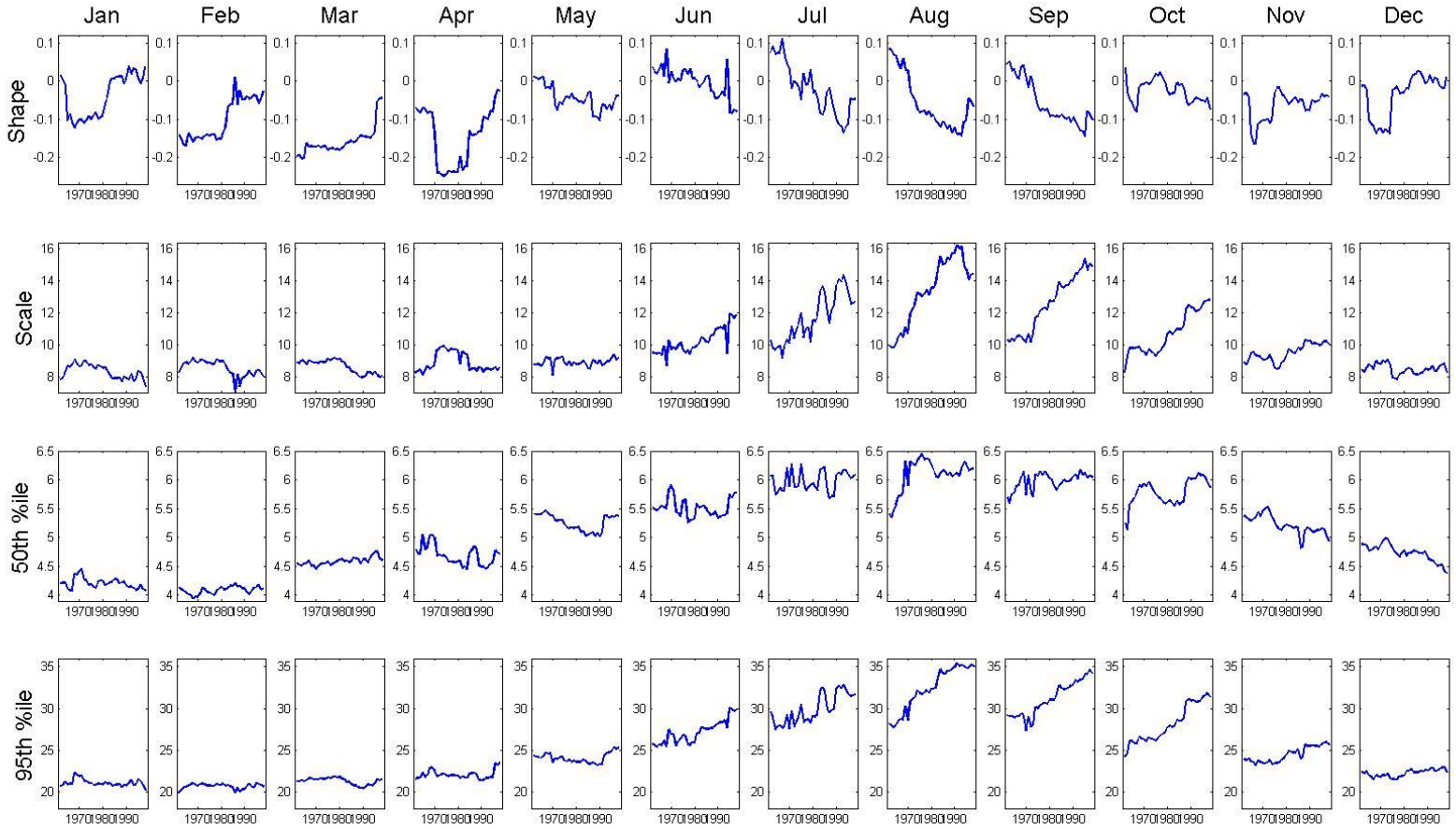
Scale parameter
Covariates:
t: time (for variability)
a, b: climate indices
e.g. NAO, AO

Shape parameter

Seasonality of Markov chain parameters: increased persistence in spring?



Seasonality of Generalized Pareto Distribution parameters, and percentiles: higher extreme daily precipitation in summer



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	Completed
Integrate lake, watershed and ABM models into IAM platform		In progress
Scenarios and theoretical studies		In progress
Select and downscale Climate Scenarios	X	Completed