Distributed Hydrology Soil Vegetation Model

Developed in early 1990s (Wigmosta et al., 1994)

Updated by Lettenmaier and others at Pacific Northwest National Laboratory

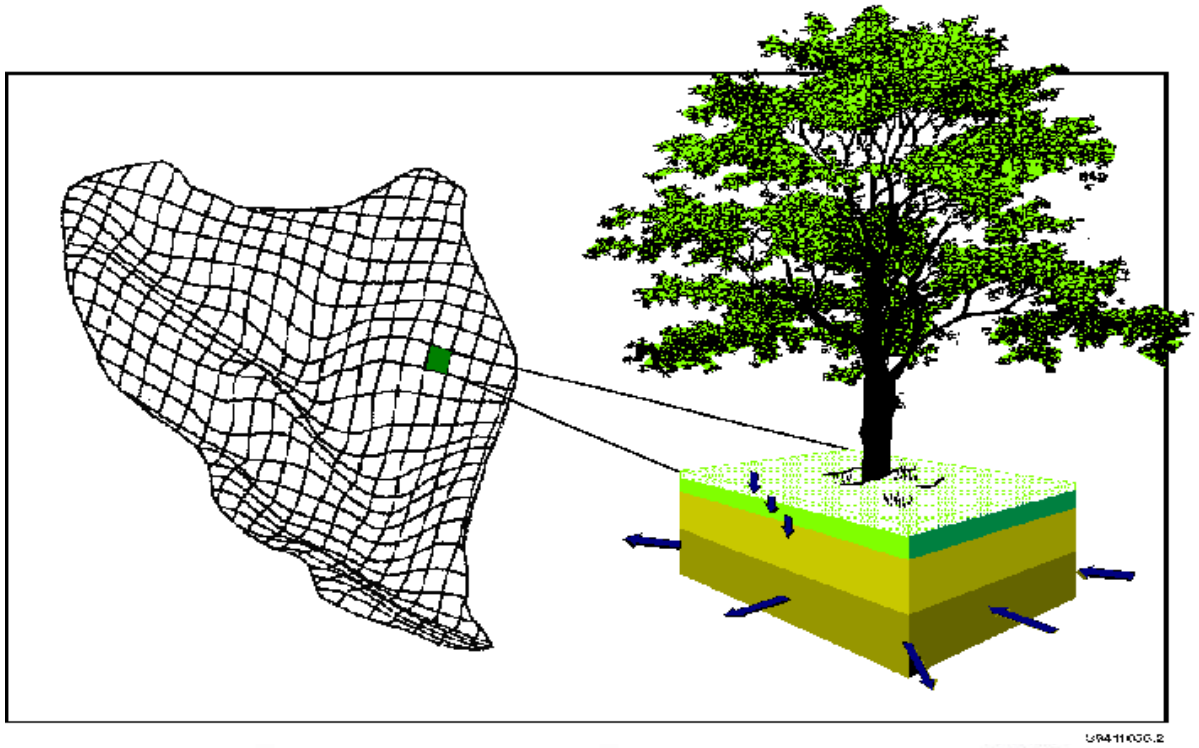
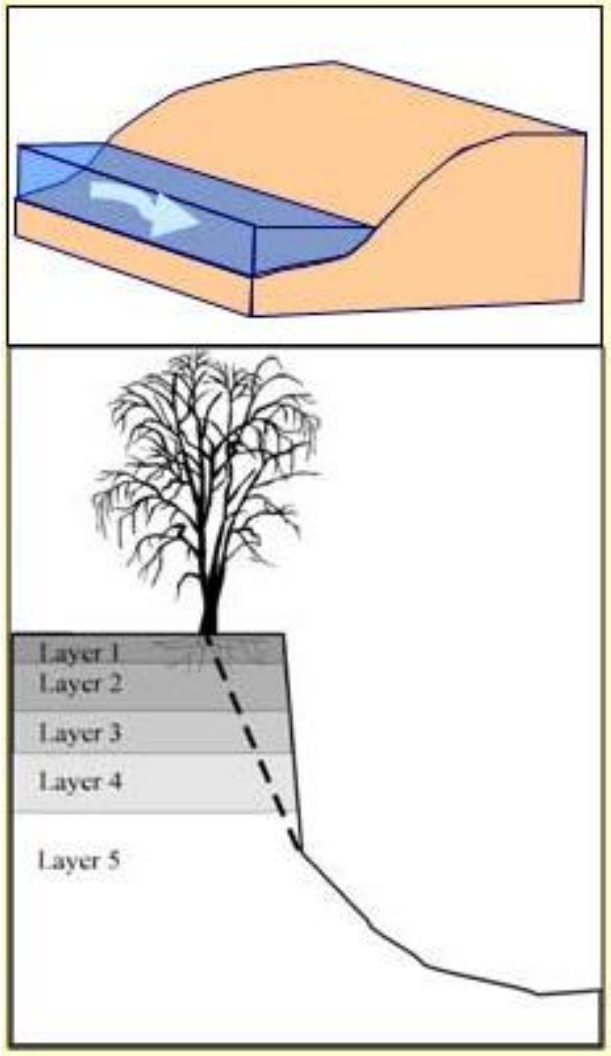


Fig. 2.1. Model representation of a watershed. DEM data are used to model topographic controls on absorbed solar radiation, precipitation, air temperature, and downslope water movement. Grid cells are allowed to exchange water with their adjacent neighbors, resulting in a three-dimensional redistribution of surface and subsurface water across the landscape (adapted from Wigmosta et al., 1994).

Bank Stability and Toe Erosion Model



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

Based on Limit Equilibrium analysis

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

BSTEM: Hydraulic processes

Source: Simon et al., 2000

Critical shear stress:

- Based on hydraulic stress required to mobilize sediment particles
- Combines physical relationships and empirical methods

Excess shear stress is that available to cause erosion:

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

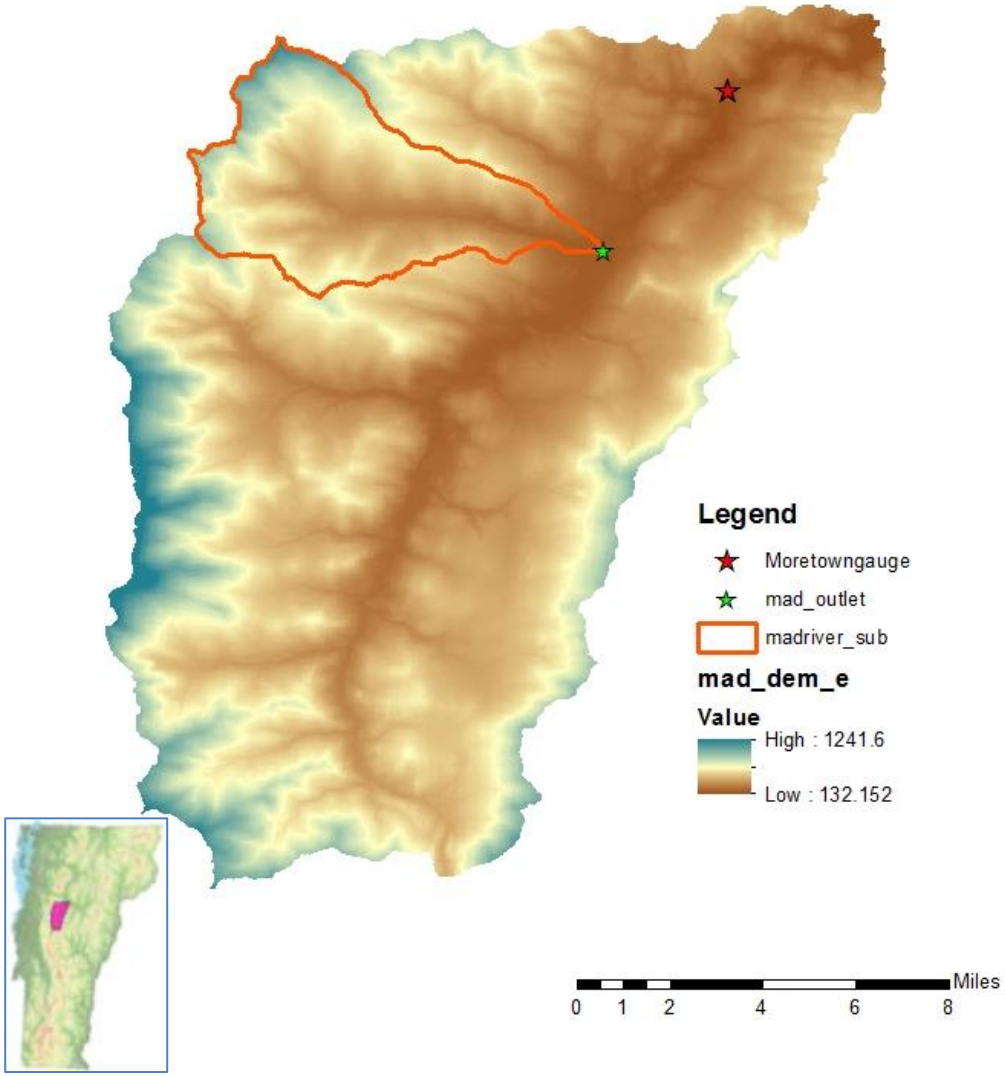
Model Application to Shepherd Brook

Mad River Watershed
(144 $\mathbf{mi^2}$)

Shepherd Brook sub-basin
(17.2 $\mathbf{mi^2}$)

Sub-watershed dimensions

- **30 X 30 m resolution**
- **10 X 10 m for sediment routing**
- **Cols, rows = 364, 318**



Model Application to Shepherd Brook

Field-derived Inputs

- Meteorological data :

  temperature, RH, precipitation, shortwave/long-wave radiation, wind speed

- Stream data:

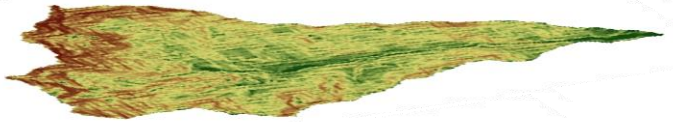
  channel gradient, friction angle, initial bank geometry, roughness of channel bed

- Soil/vegetation parameters:

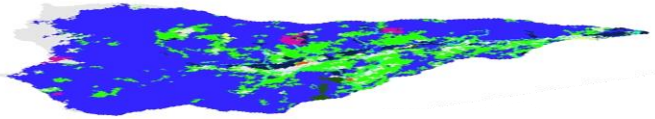
  cohesion, saturated unit weight/bulk density, hydraulic conductivity, porosity, grain size distribution, roughness coefficient, rooting depths/soil layers, LAI

GIS-derived Inputs (for sub-basin)

Road/stream networks



Soil depth



Vegetation/land use

Soil type/classification

Elevation

Mask

Model Application: Data for 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**

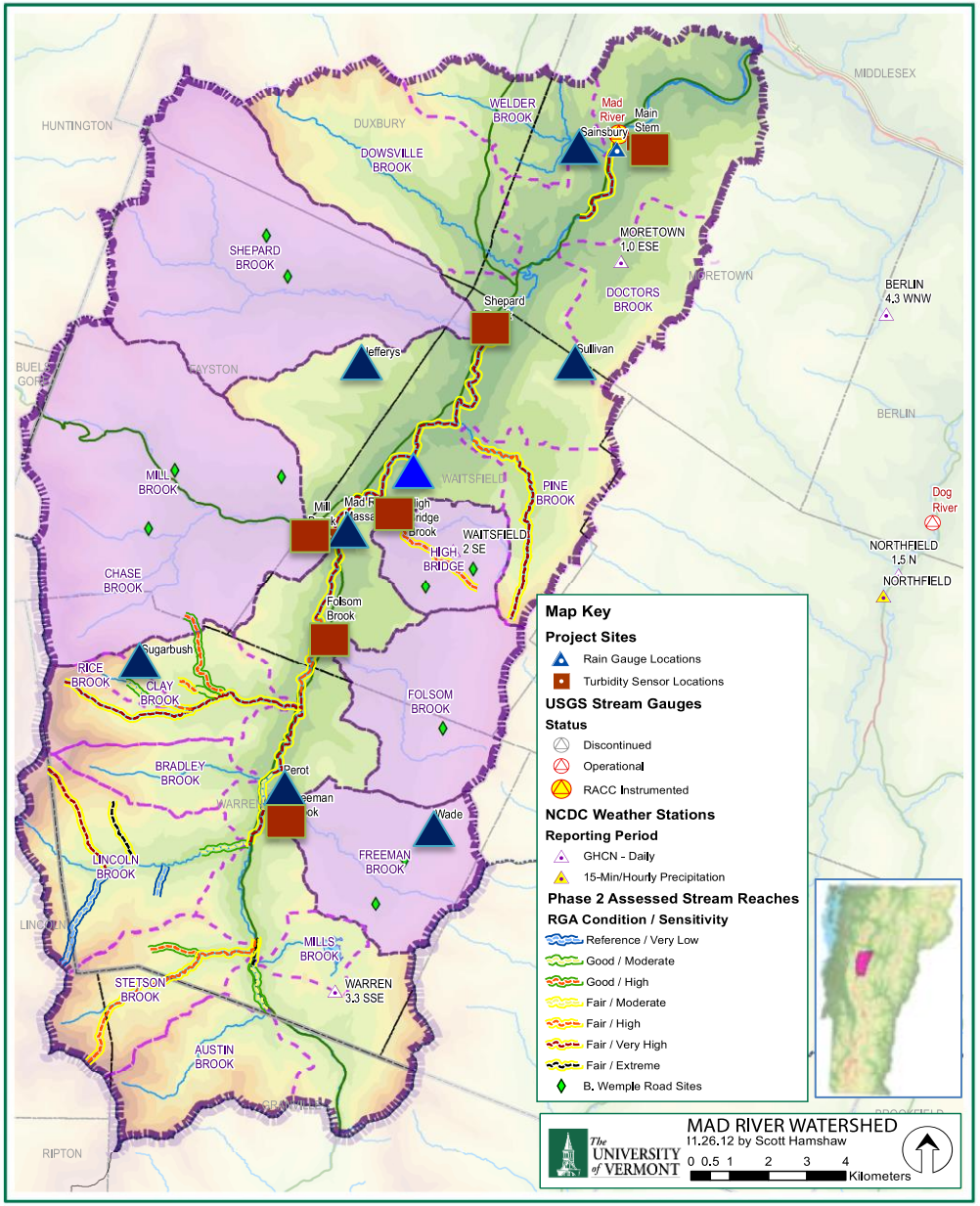
- **Piezometers and stage sensors:**
  - **water table elevation with respect to stream flow height**

Lareau Farms soil test pit, summer 2013.

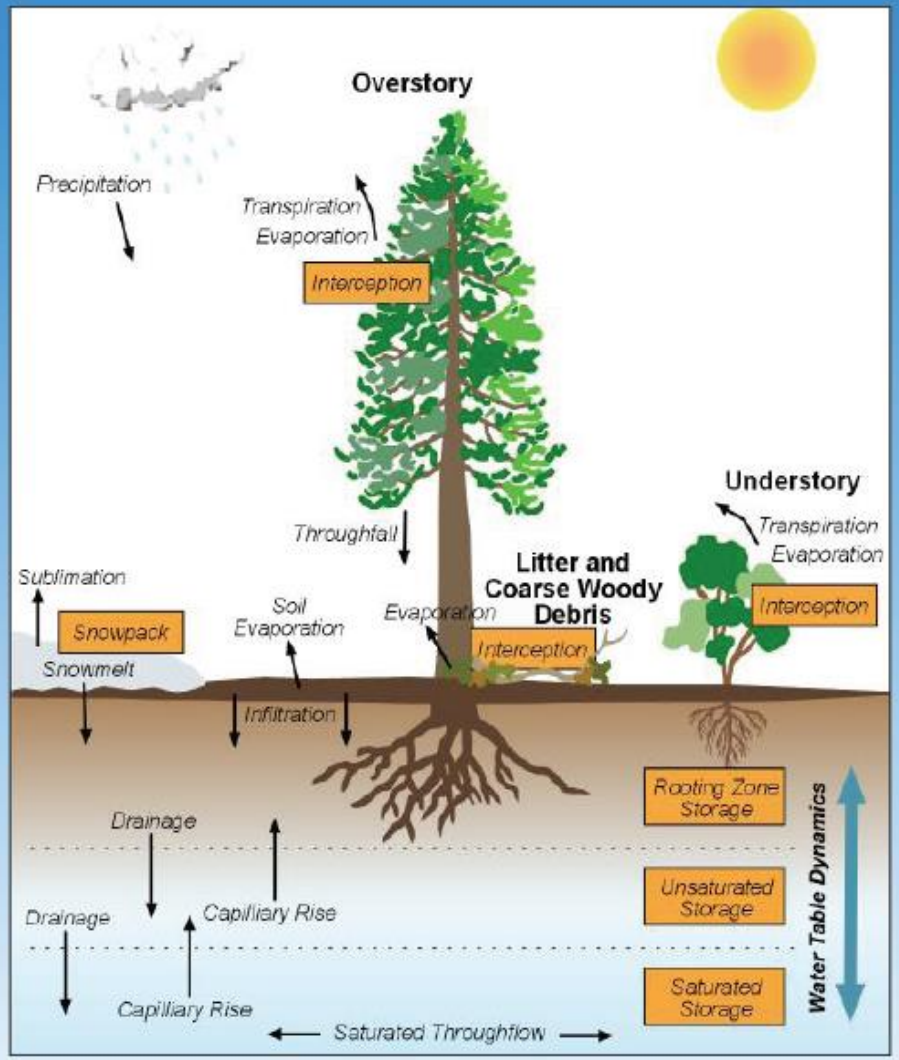
Source: http://www.ars.usda.gov. Jet testing and bore hole shear testing for bank parameters.

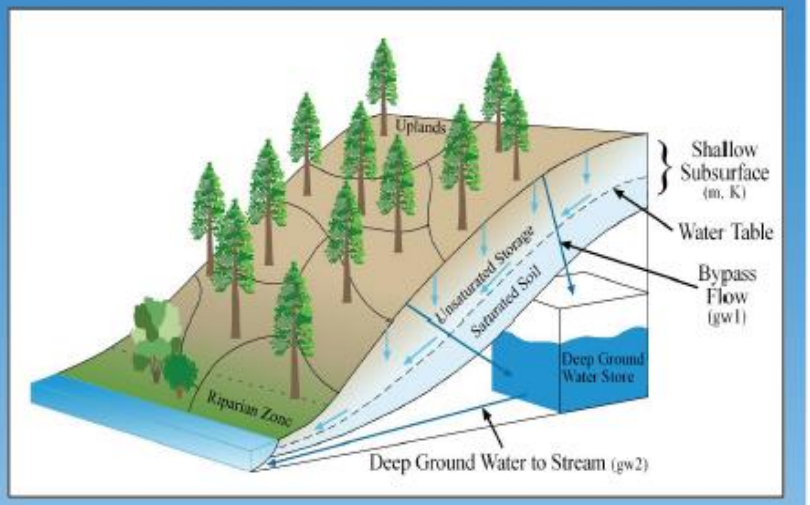
Model Application: Data for calibration/validation

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



Vertical and Lateral drainage in RHESSys

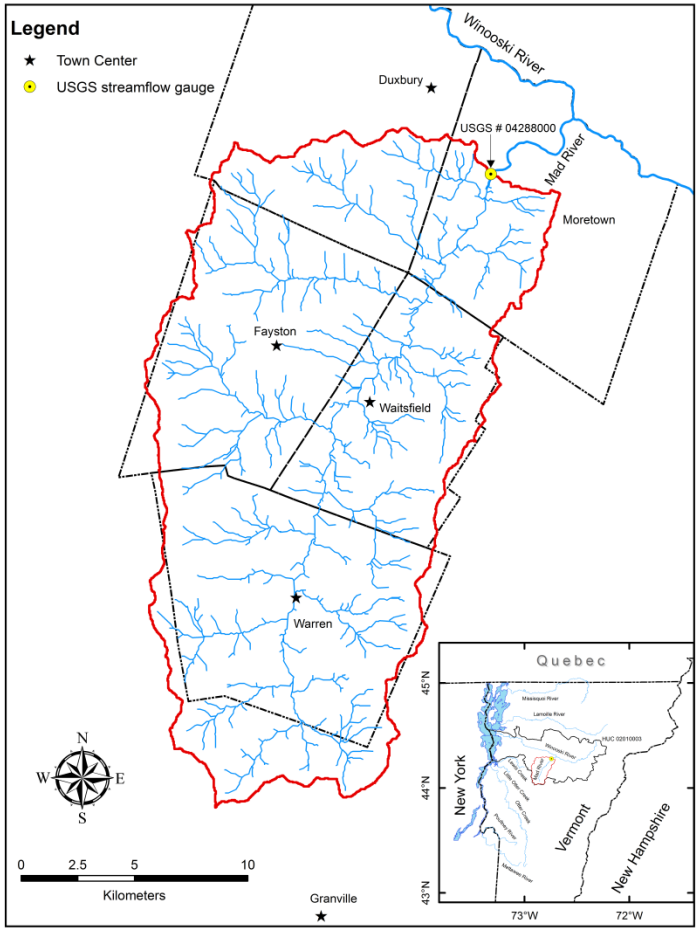


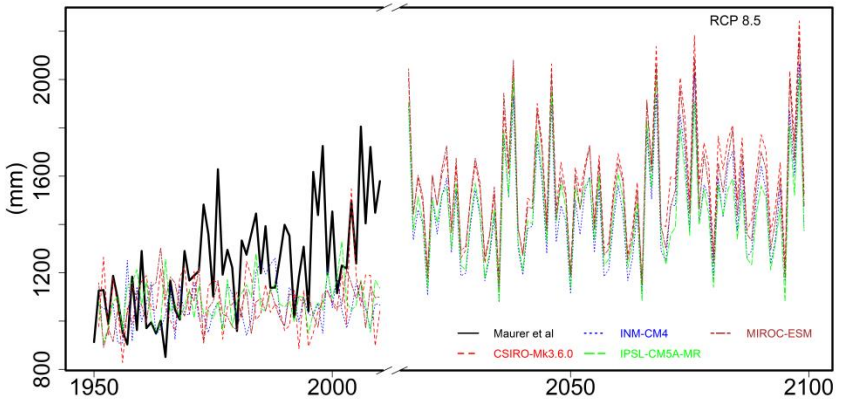


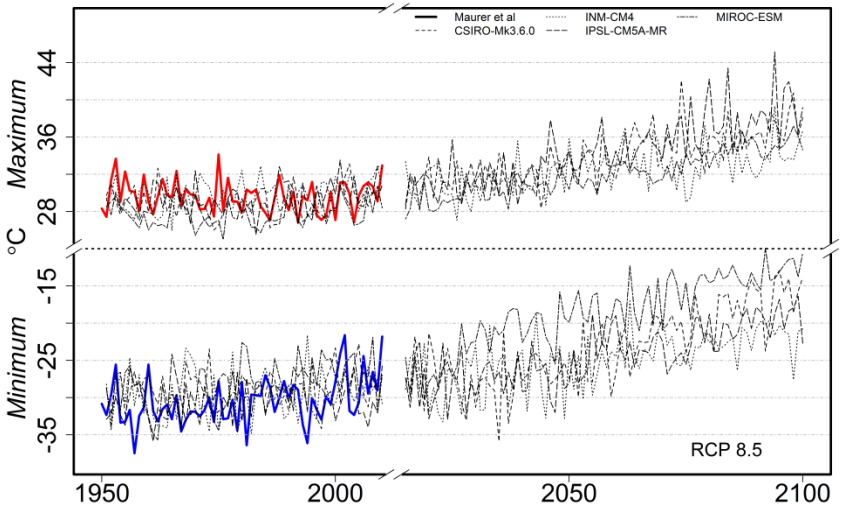
http://fiesta.bren.ucsb.edu/~rhessys/index.html

Excerpt from a speech by *Christina Tague*

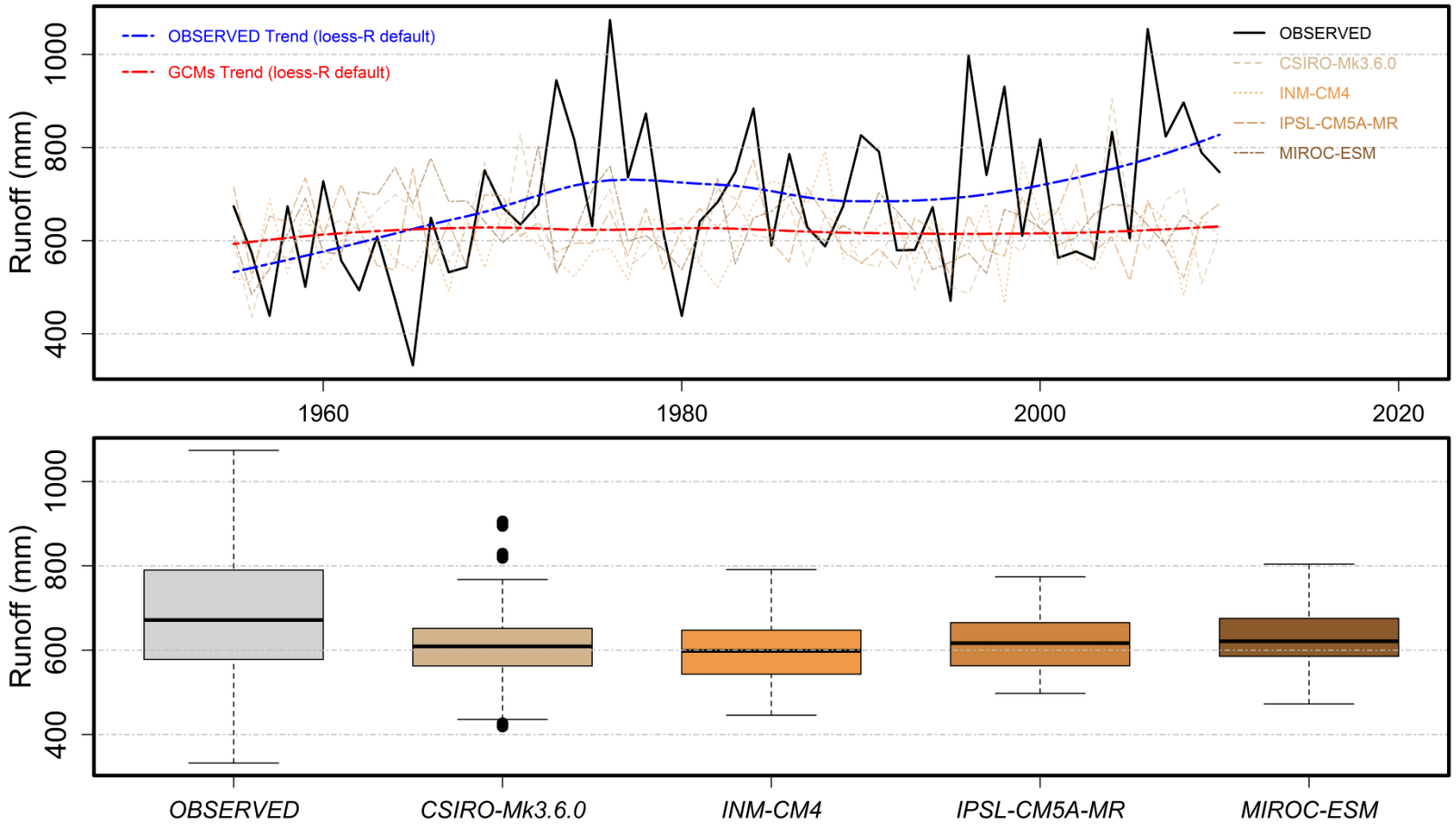
MRV & Climate Input







Downscaled GCM Climate



Missisquoi Model

1997-1998 Water Year Observed and Simulated Runoff