Investigating the Effects of Hydropower Development, Deforestation and Climate Change on the Hydrology of Rivers in the Brazilian Amazon

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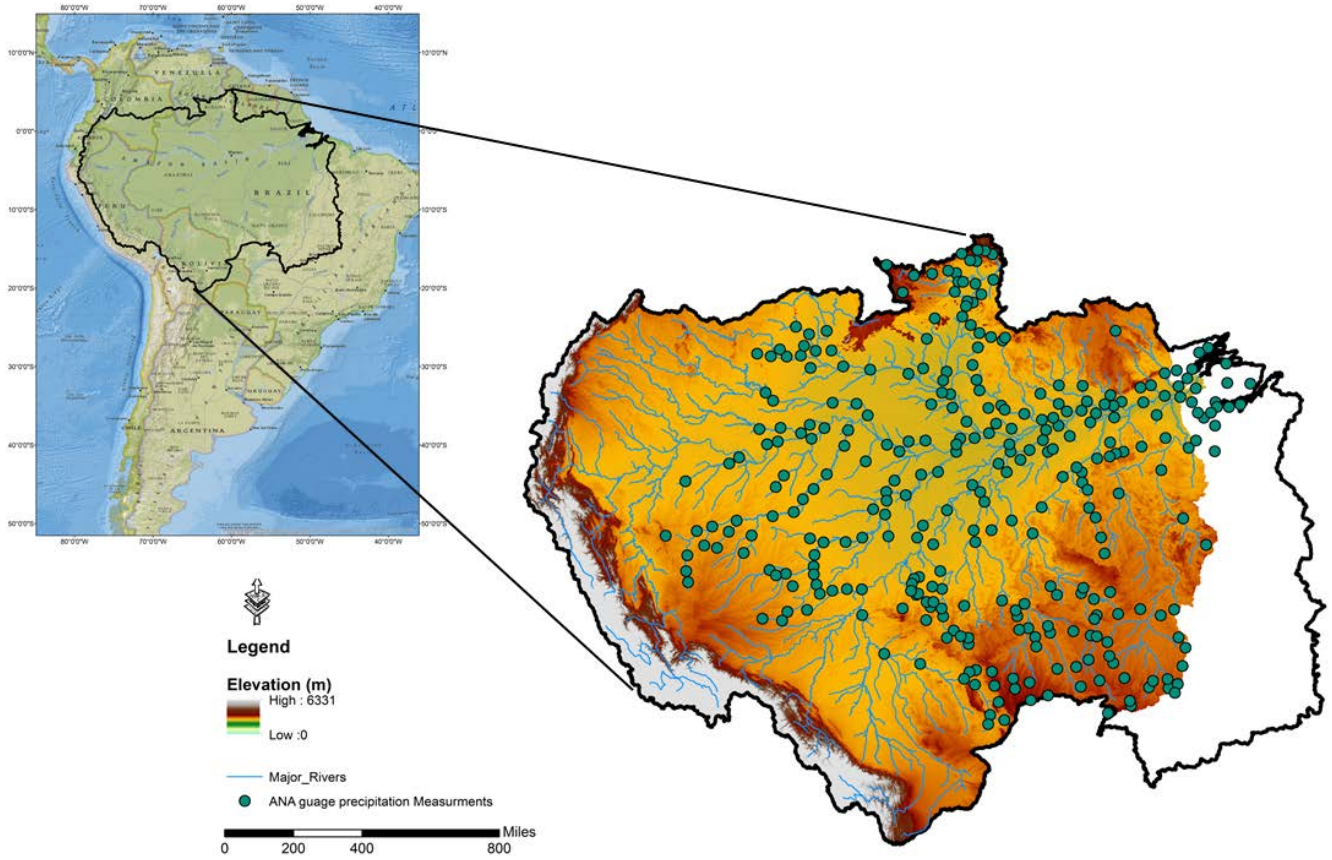
Project Overview

- Rethinking Dams: Innovative hydropower solutions to achieve sustainable food and energy production, and sustainable communities
- Project Goals:
  - Determine the impacts of Brazil's hydropower development on:
    - Communities
    - Fisheries and ecosystems
    - Land Use and Land Cover
    - Hydrology
  - Investigate alternative power generation solutions
    - In-stream turbines
    - Solar power

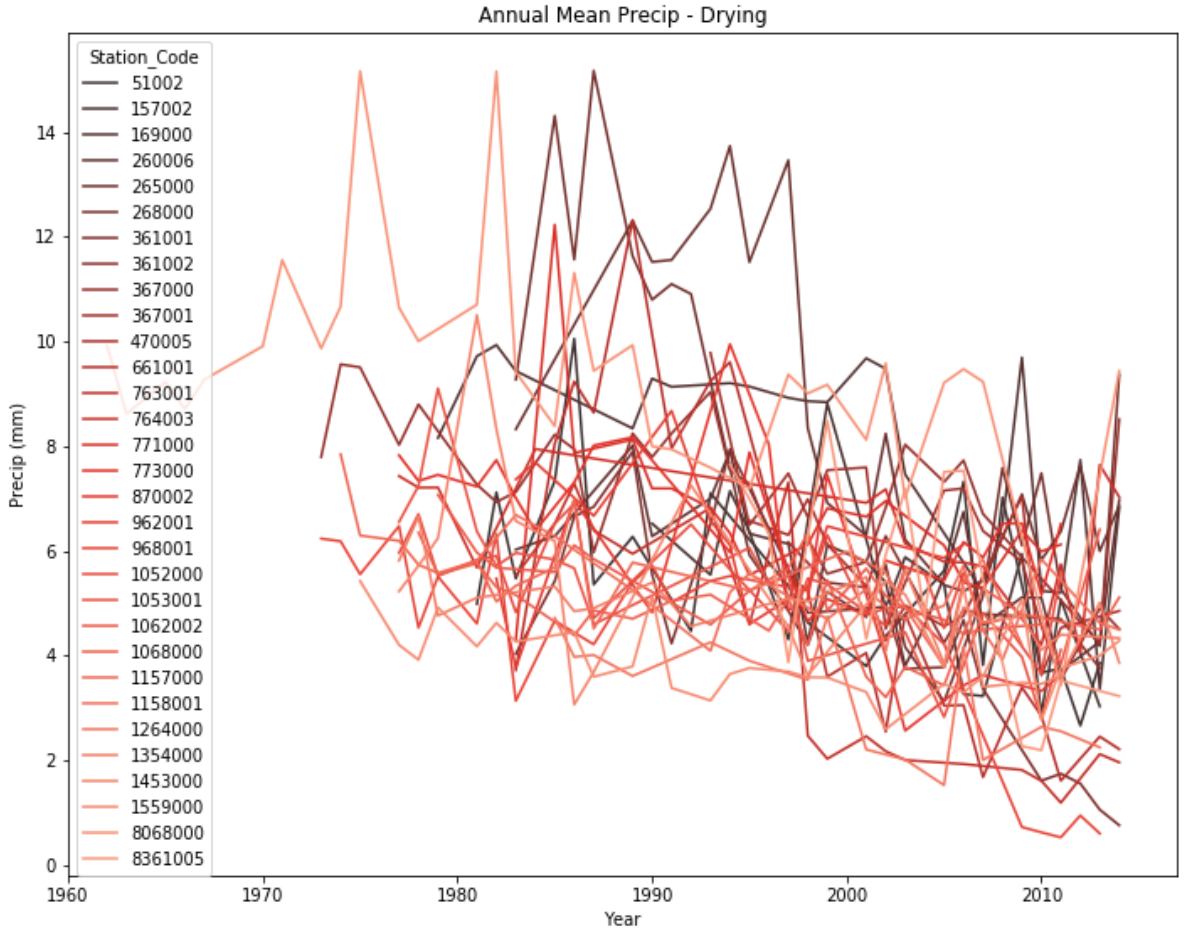
Precipitation Trends

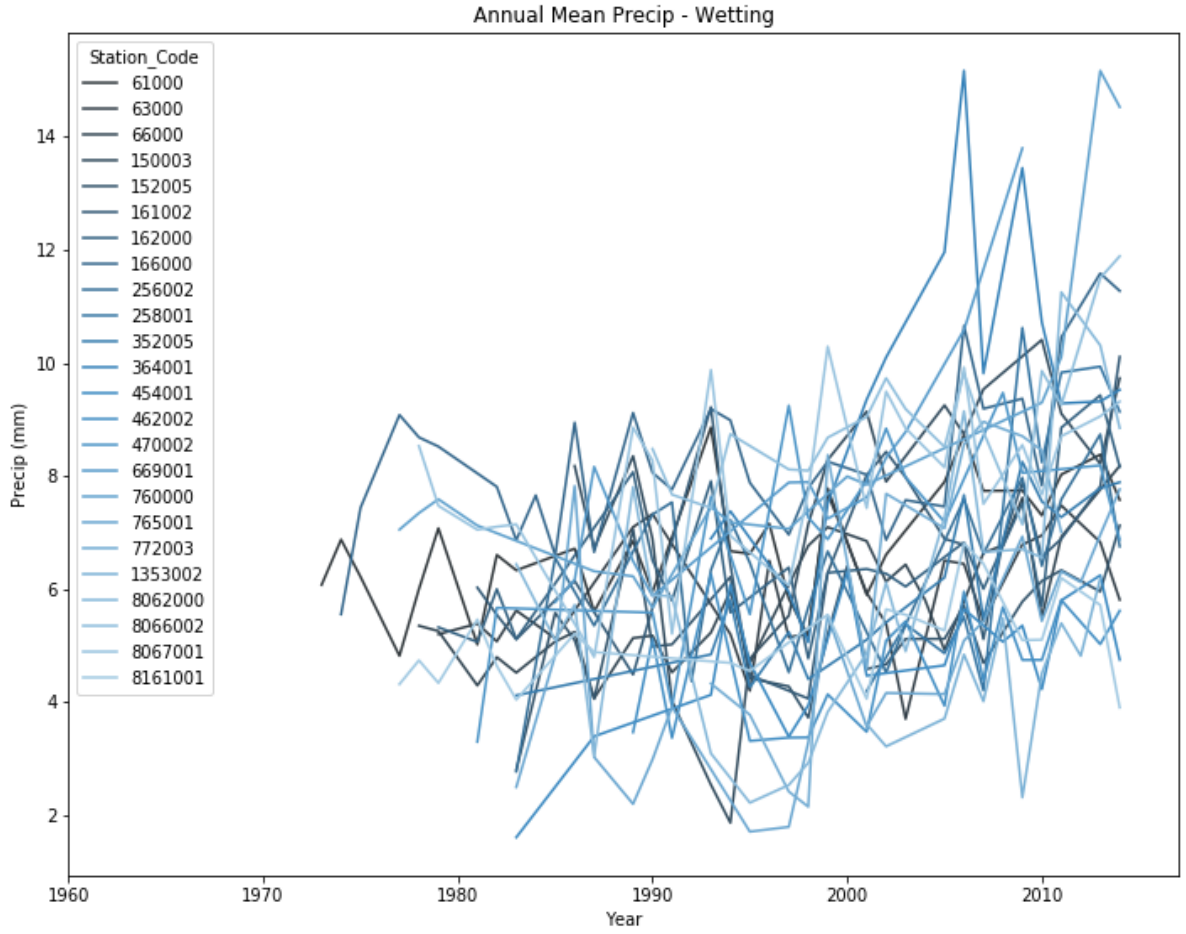
Study Area

- Elevation map
- ANA gauge precipitation stations
- Major rivers

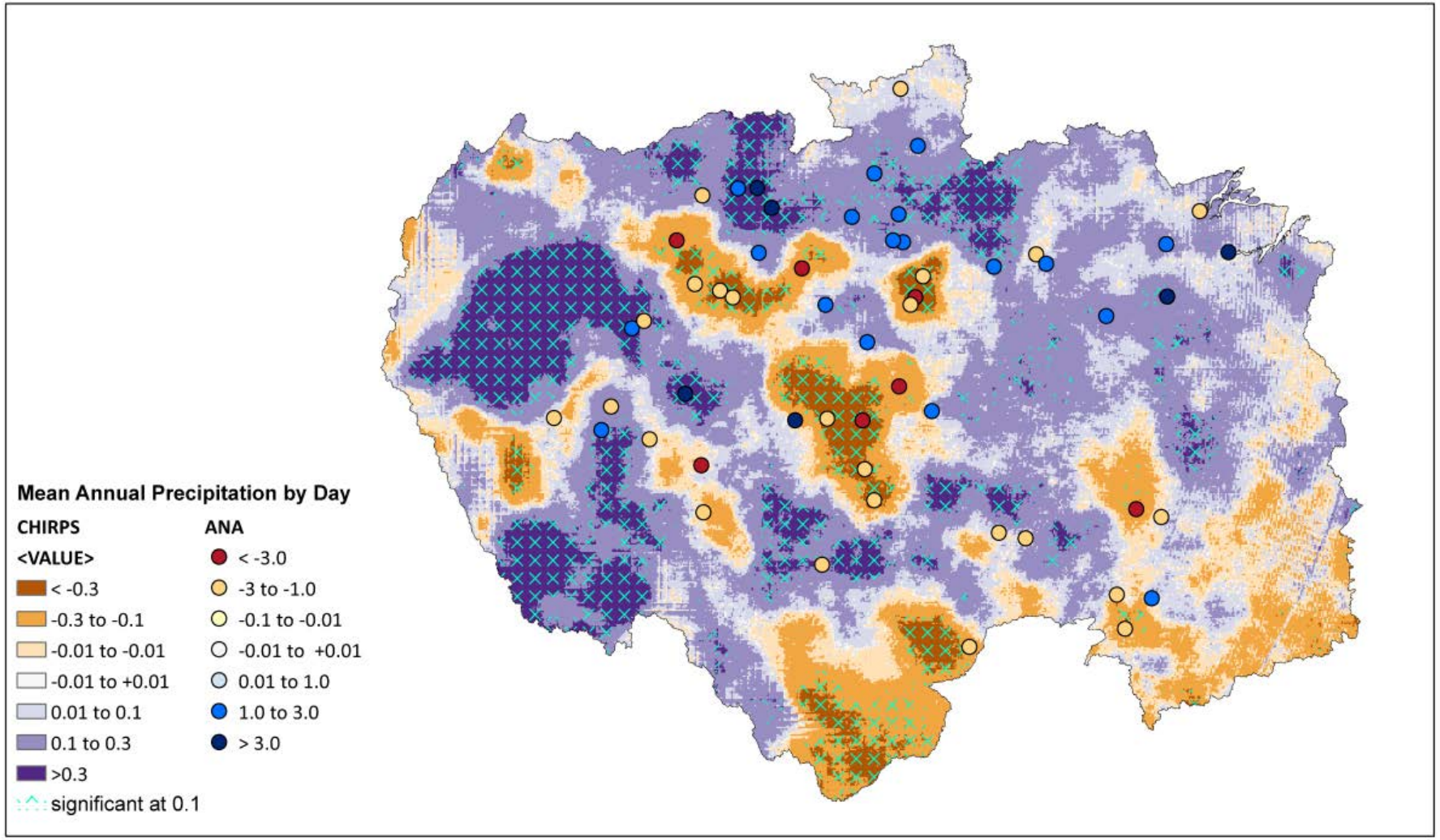


Trends in Annual Average Rainfall





Mean Annual daily Precipitation Trend 1982-2017



Jirau and Santo Antonio Dams

Dramatic land use change in the Southern Amazon Basin

- Deforestation
- Soy agriculture
- Increases temperature
- Alters precipitation patterns

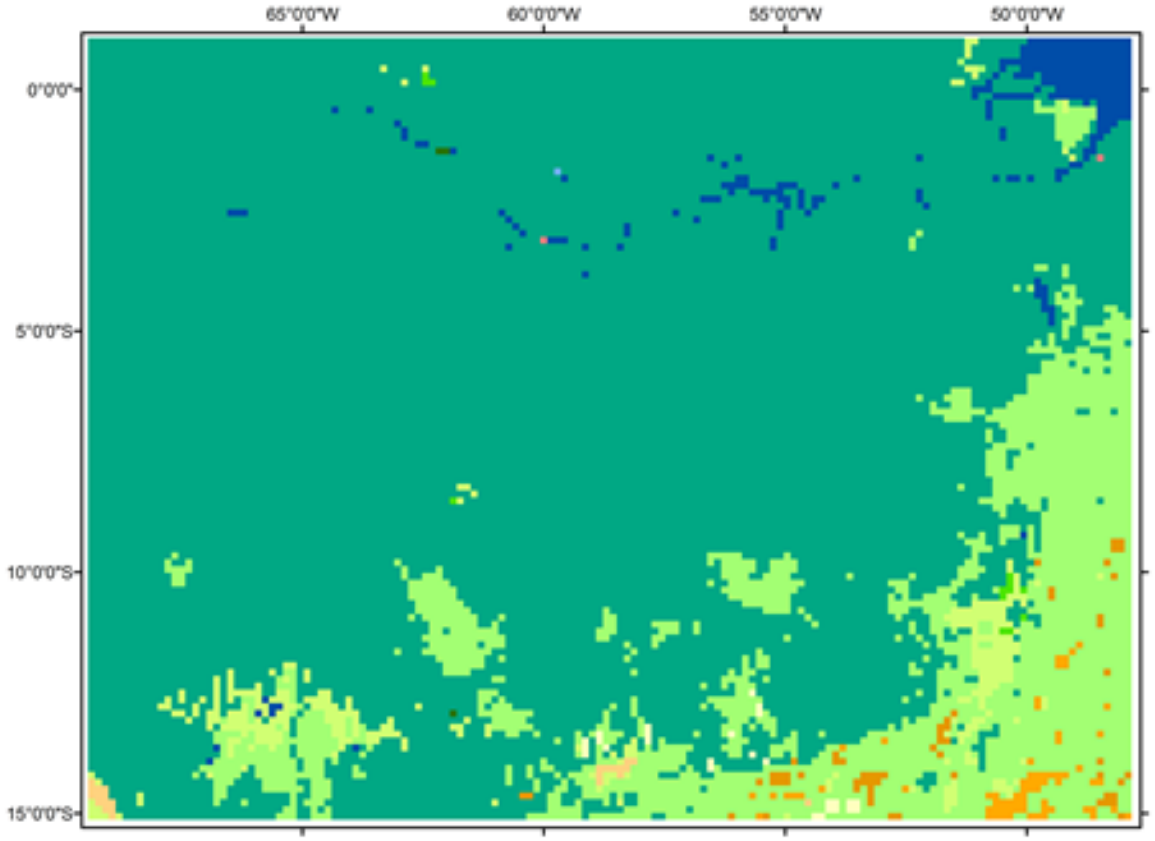
Hydrology –Modeling

- Landscape Hydrology Model
  - Process-based
  - Fully-discretized
  - Integrated GW/SW
  - Fully-coupled
  - Modular

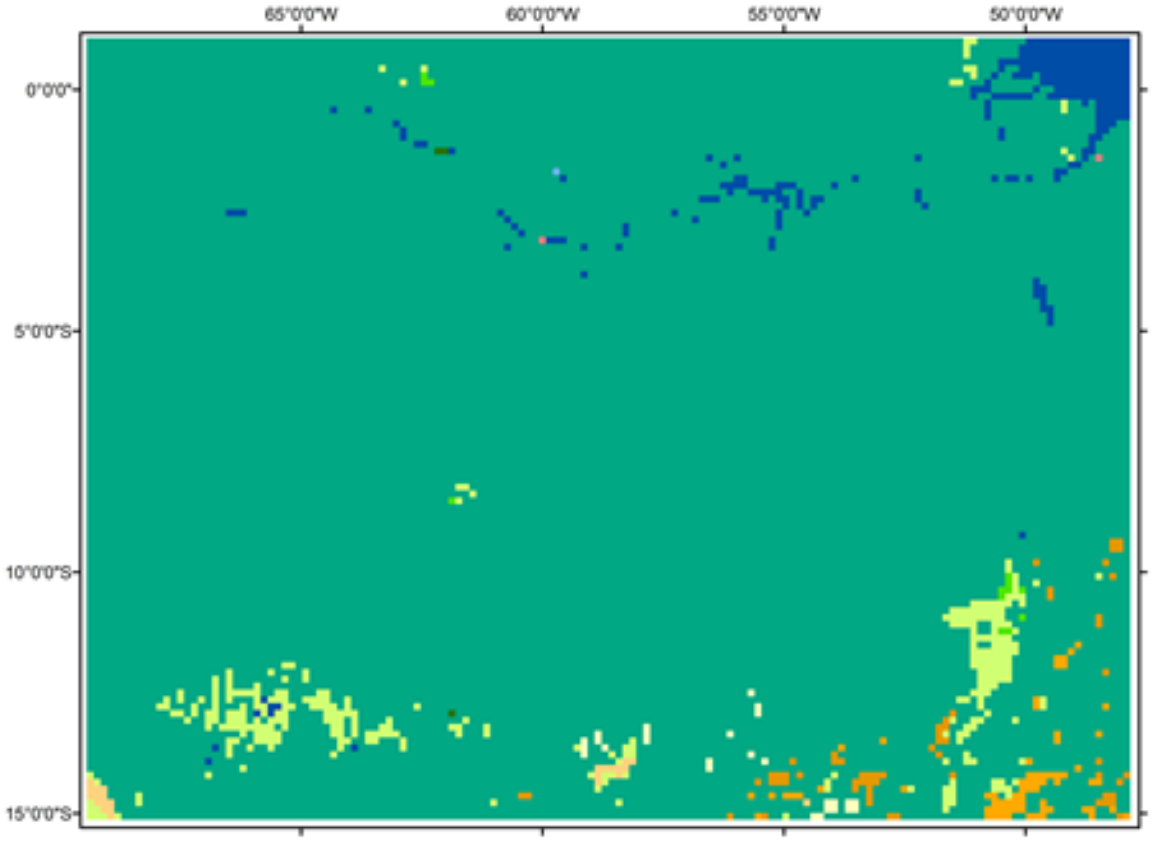
Regional Climate Simulations

Landcover Change Scenarios

Current Land cover

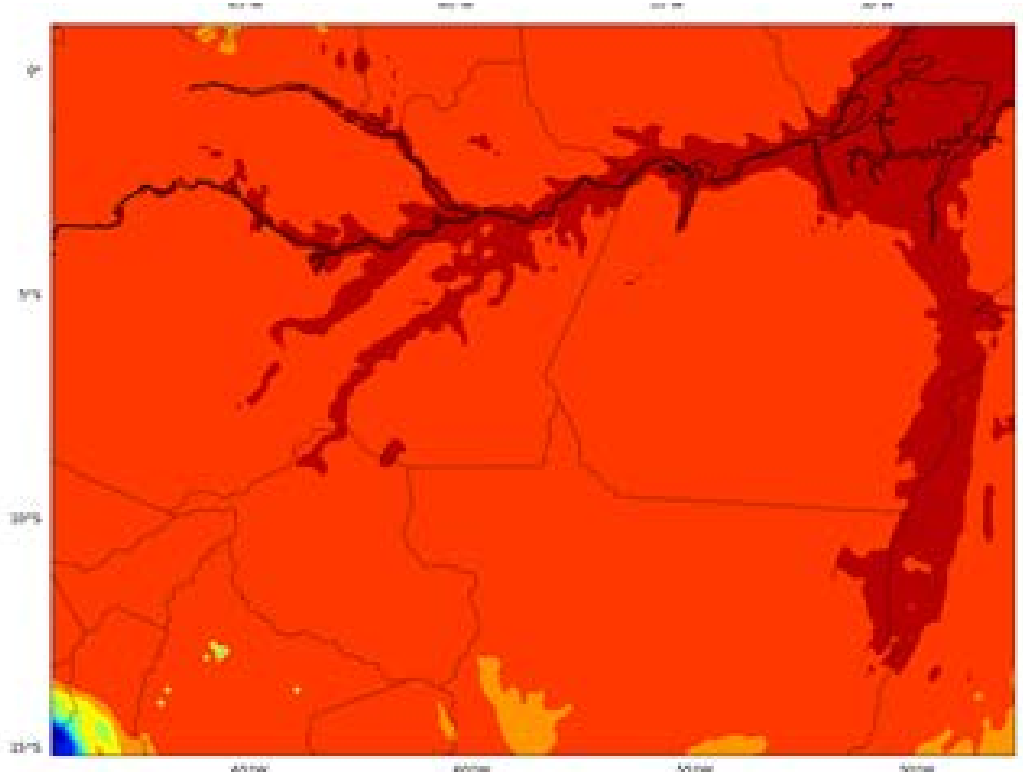


Presettlement land cover

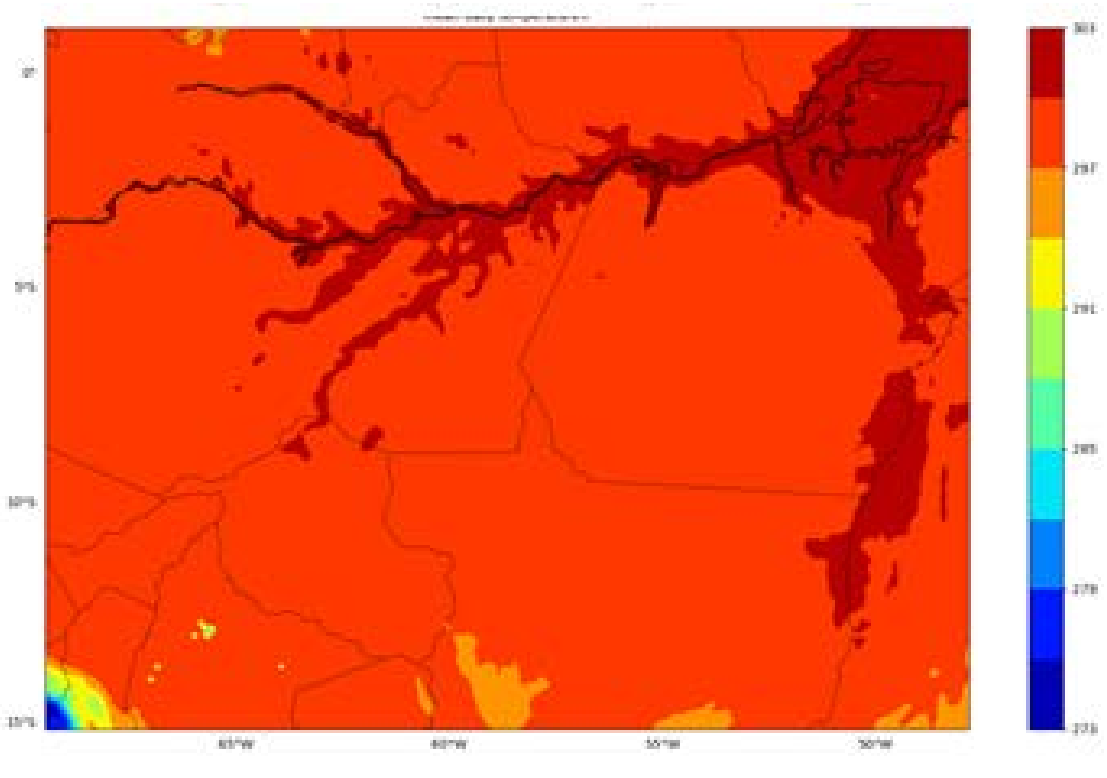


Initial Outputs

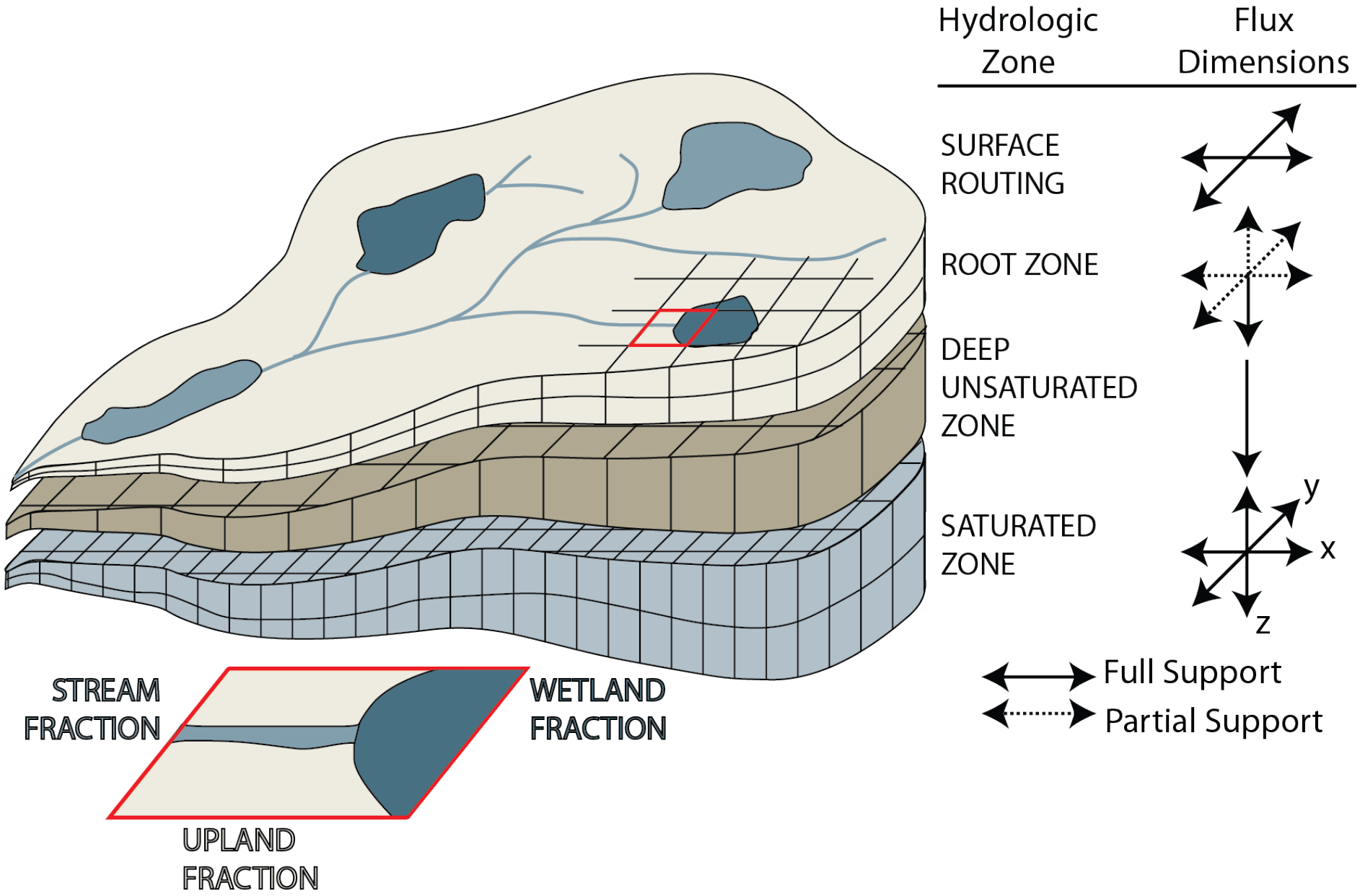
Current Land cover

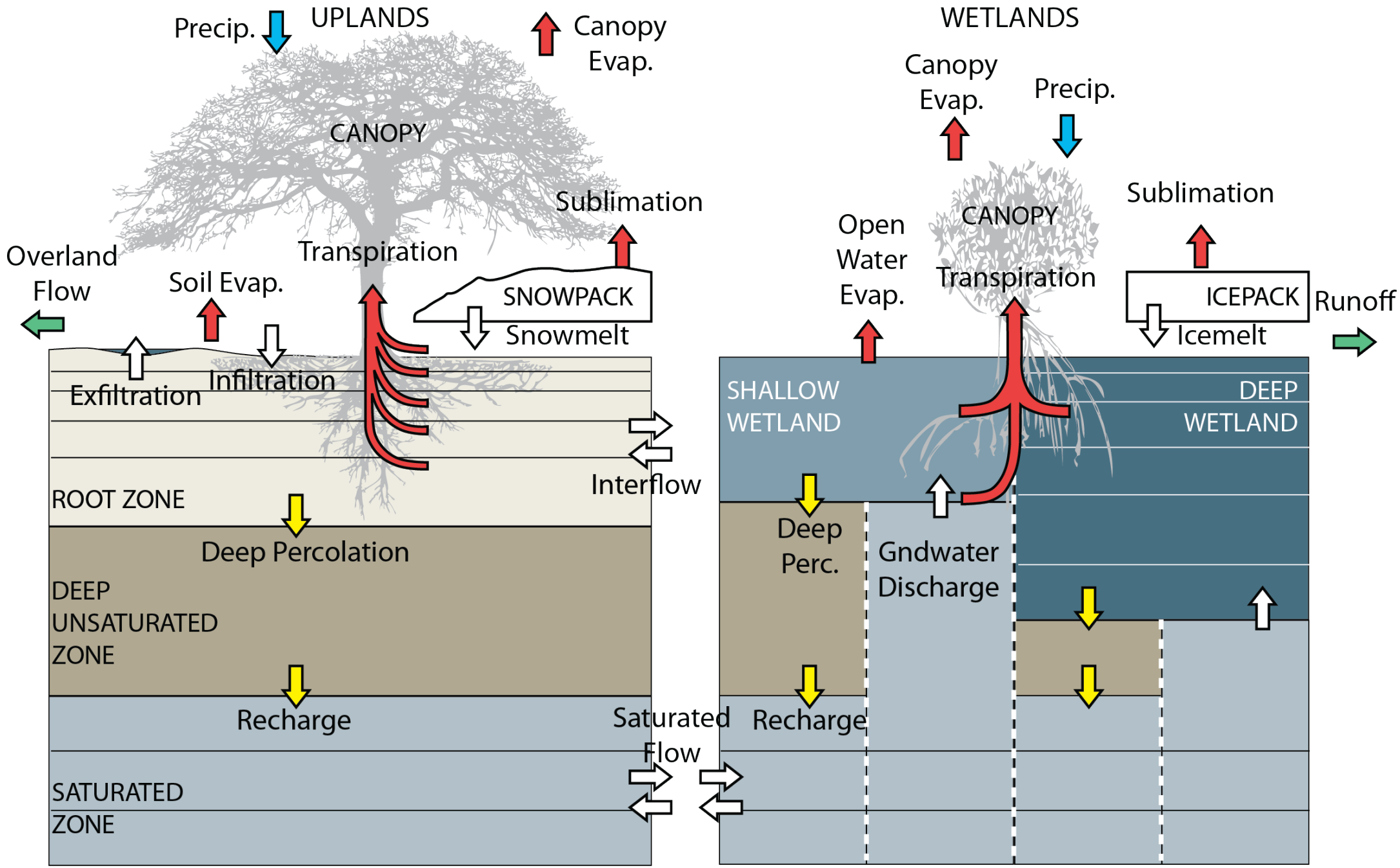


Presettlement land cover



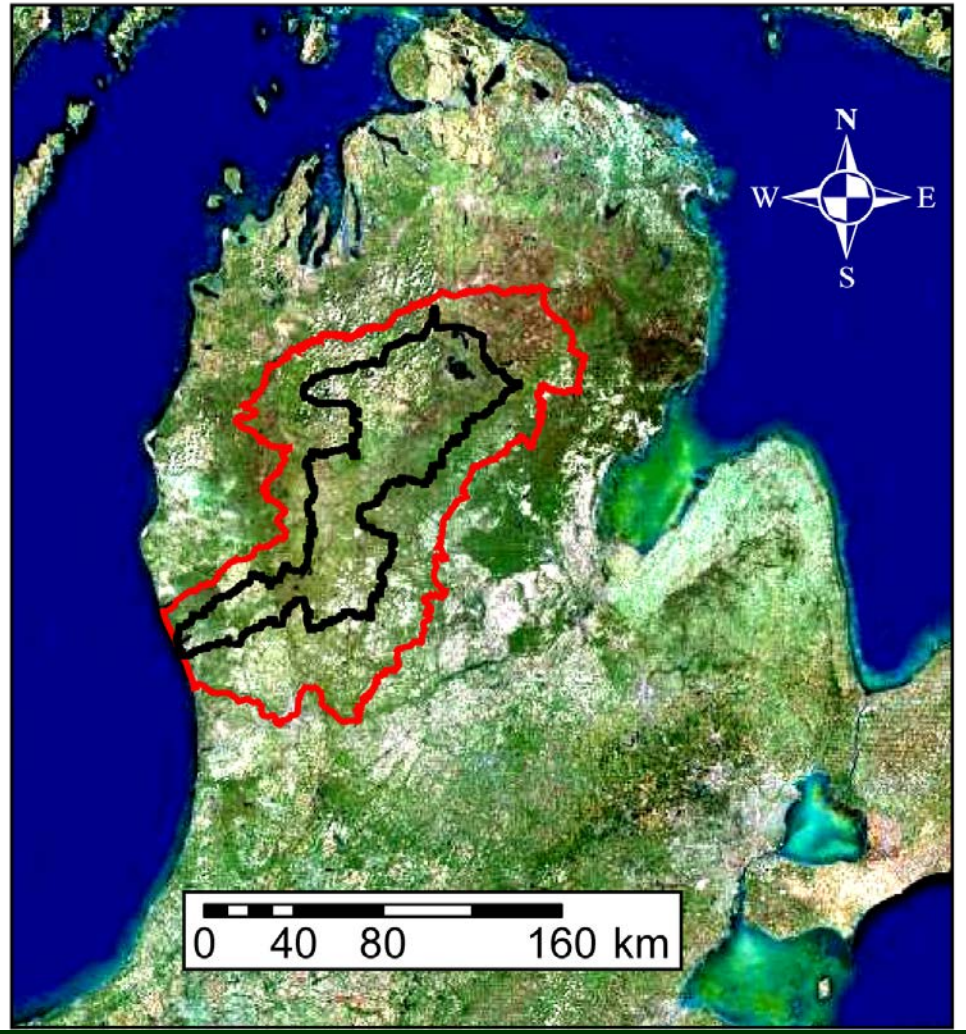
LHM Discretization



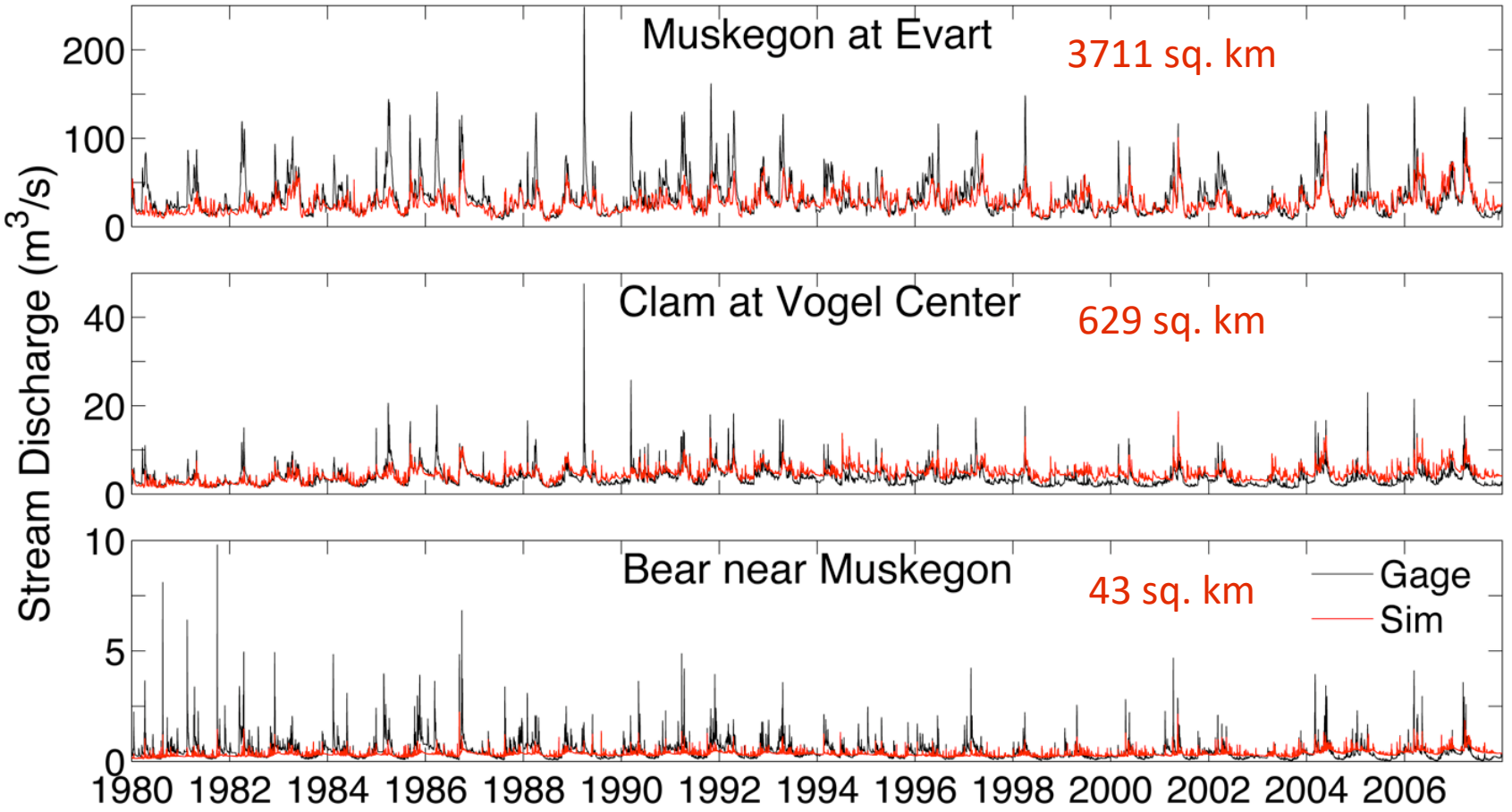

Precip.
UPLANDS
Canopy Evap.
CANOPY
Sublimation
Transpiration
Overland Flow
Soil Evap.
SNOWPACK
Snowmelt
Exfiltration
Infiltration
Interflow
ROOT ZONE
Deep Percolation
DEEP UNSATURATED ZONE
Recharge
Saturated Flow
SATURATED ZONE
WETLANDS
Canopy Evap.
Precip.
Open Water Evap.
CANOPY
Transpiration
Sublimation
ICEPACK
Runoff
Icemelt
SHALLOW WETLAND
DEEP WETLAND
Deep Perc.
Gndwater Discharge
Recharge

Example in Michigan: Projected Changes in Recharge

- 43,000 km^2
  - 100 to 400m grid cells
- 28-year simulation
  - 1980 – 2007
  - Hourly timesteps
- Developing model of Michigan's entire Lower Peninsula

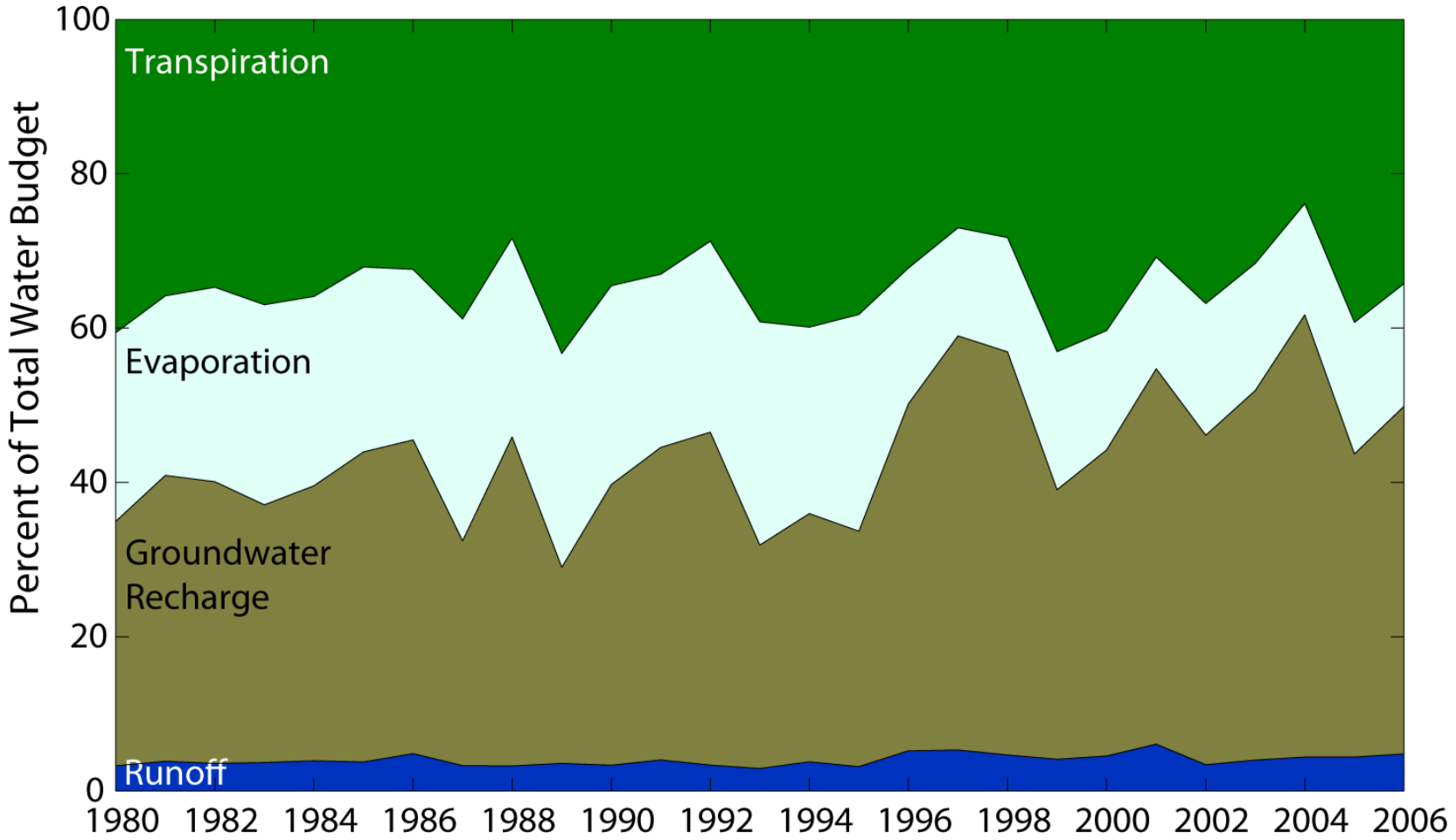


Uncalibrated Streamflow Predictions



- Good predictions of baseflow, across a wide range of scales
- Total discharge error less than 6% of annual precipitation

Simulated Water Budget



- ET is ~60% of the water budget
- Of the remainder: Recharge is ~85%, Overland Flow is ~15%