South East European Virtual Climate Change Center

Projected changes in the hydrological cycle

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Background

- **Main water users:**
  agriculture, industry, energy, householders
- **Water availability problem in Europe:**
  water and population are unevenly distributed
  subregions have different degree of water stress
- **South-eastern Europe, Mediterranean and Alps are most sensitive to climate changes**
- **Water-related climate change impacts:**

higher freshwater demand, especially for irrigation

more frequently and severe floods and droughts

larger soil erosion

reduce in water quality

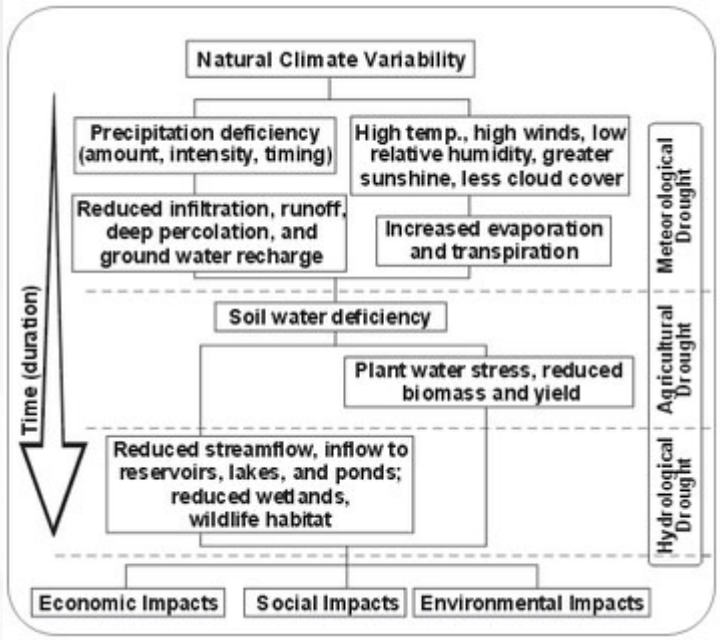
decrease in groundwater resources

salt water intrusion in coastal aquifers

impact on aquatic ecosystems

increase in risks of water-transmissive diseases

Hydrological cycle changes

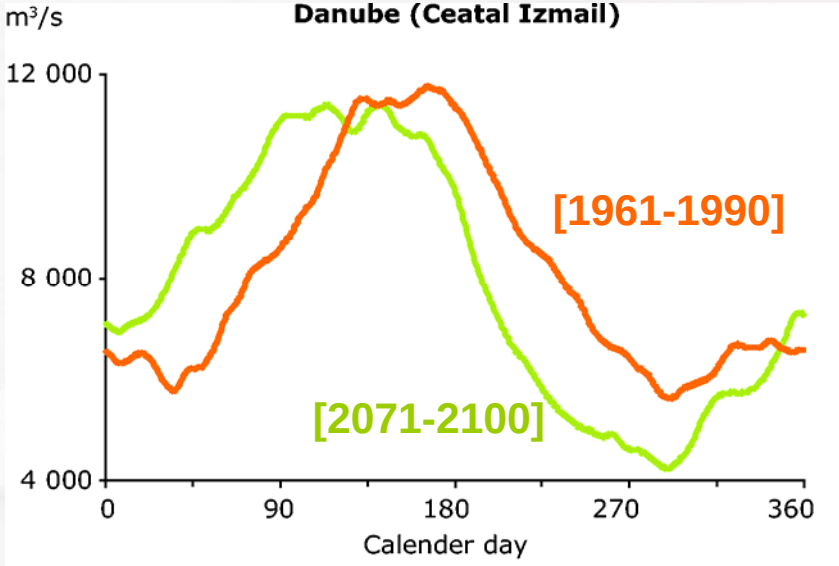


- **In general, annual water availability will increase in northern and north-western Europe and decrease in southern and south-eastern Europe.**

Projected changes in river flow

- **Projected changes in river flow strongly depend on changes in precipitation, but its connection is not linear**
- **Less snow on mountains during winter**
  => less snow melt in spring
  => shift in flow regime
- **Less precipitation during winter**
  => decrease in ground water
  => decrease in summer flow in rivers that strongly depend on ground water
- **Increase in temperature**
  => longer vegetation growth period
  => increase in evapotranspiration
  => lower groundwater recharge

The Danube river flow



- decrease in summer minimum flow
- shift in maximum flow toward winter and autumn
- prolonged maximum and minimum flows duration

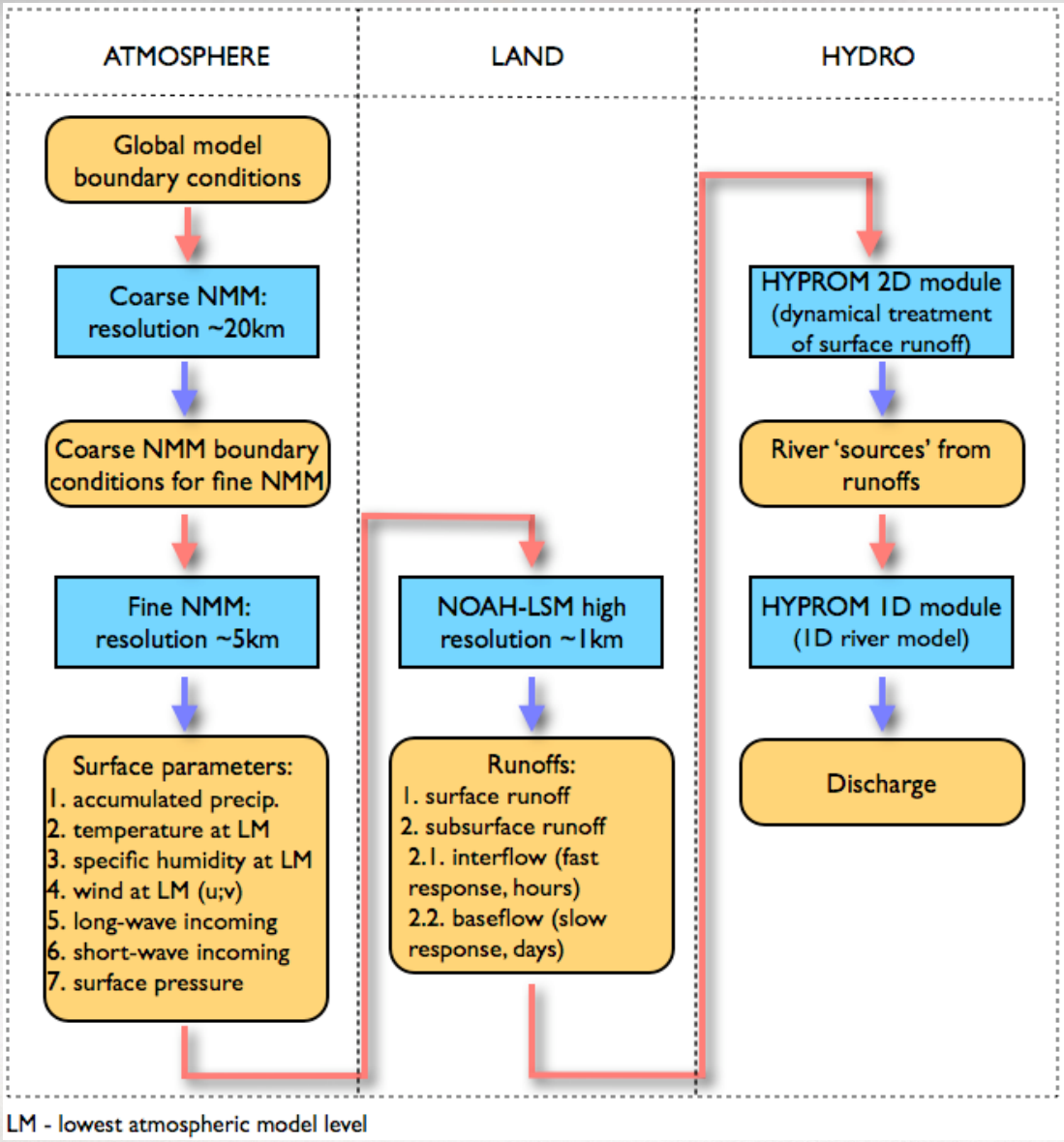
HYPROM as a tool for water resources assessment

- **atmosphere:**
  NMMe non hydrostatic model
- **land:**
  NOAH land surface scheme
- **hydrology**:
  HYPROM2D surface runoff
  HYPROM1D river routing

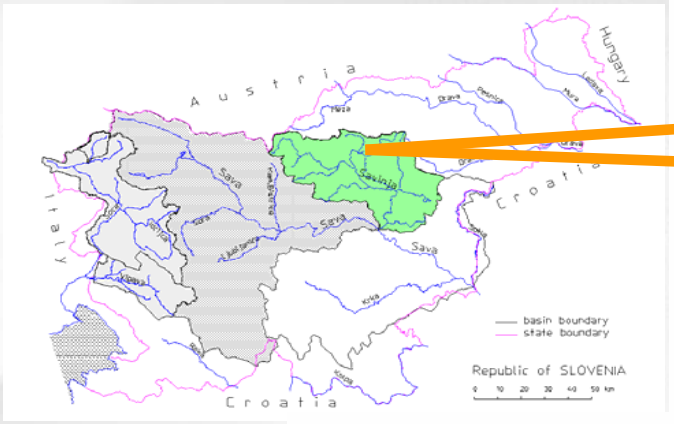
- dynamical treatment of an overland flow
- suitable for long term and flash flood simulations
- computationally efficient

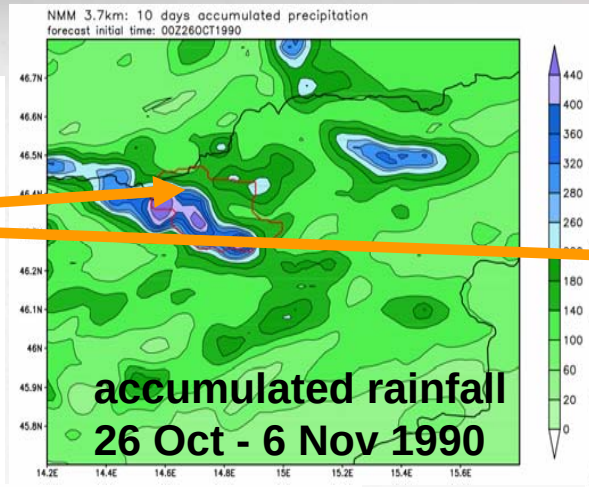
Datasets:

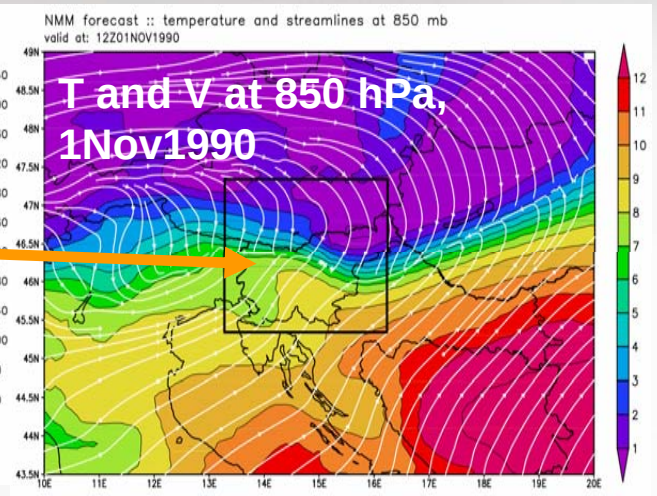
HYDRO1k USGS topography
FAO soil texture data
USGS land use data



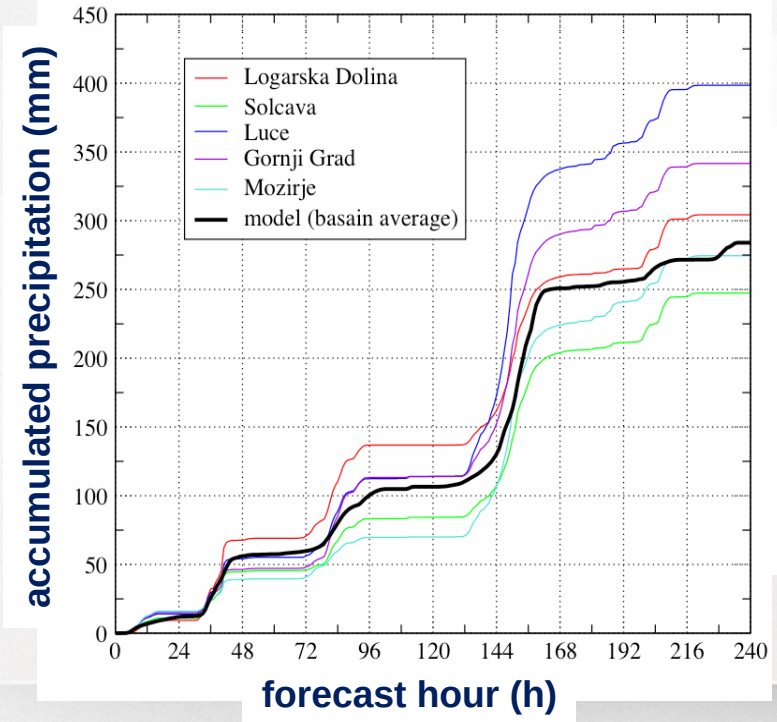
The Savinja river (Slovenia) – flash flood case study

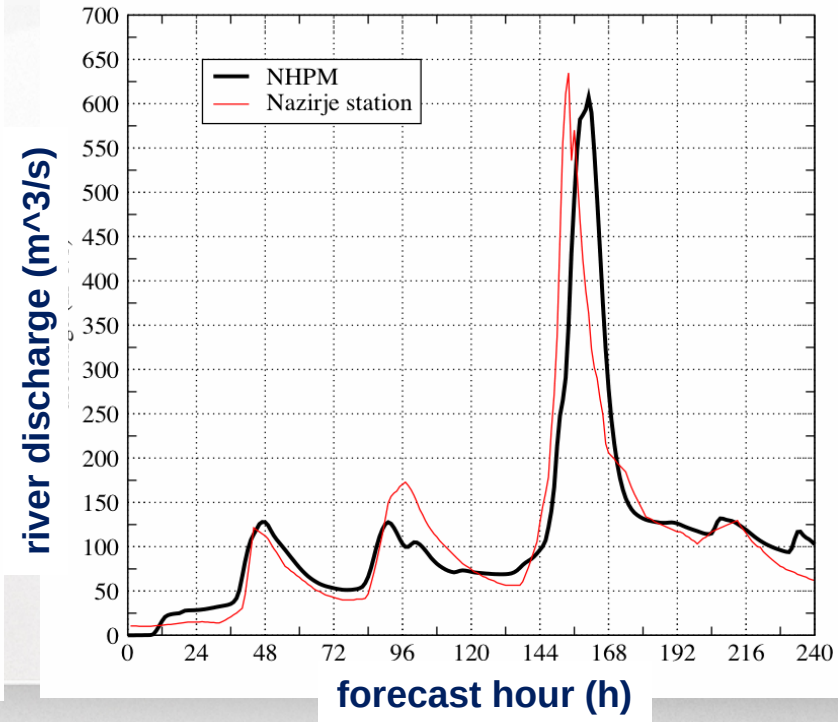




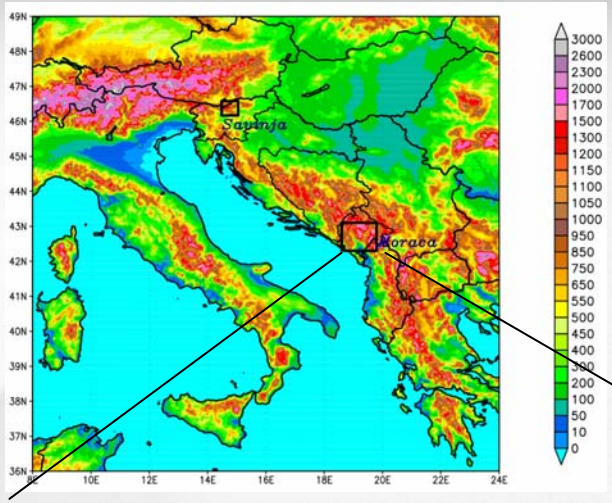


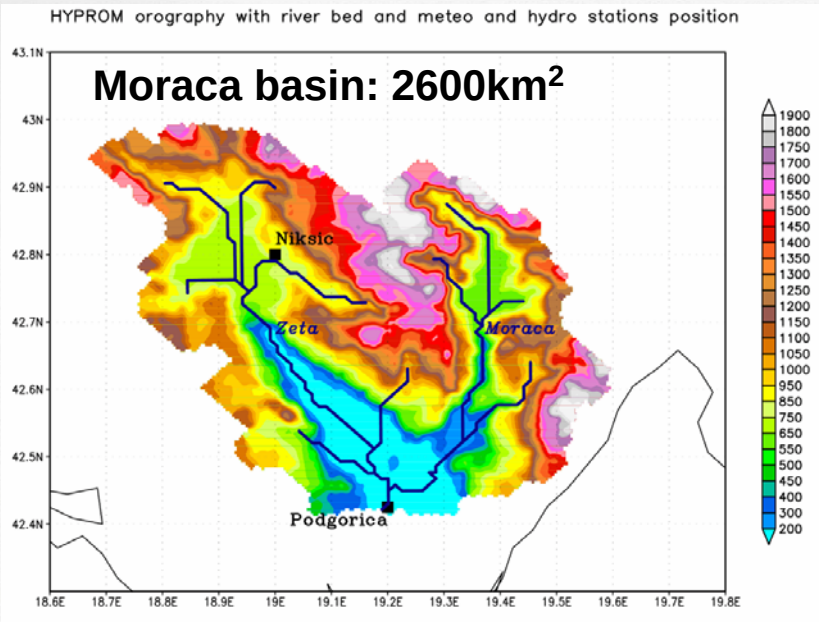
model .vs. observations



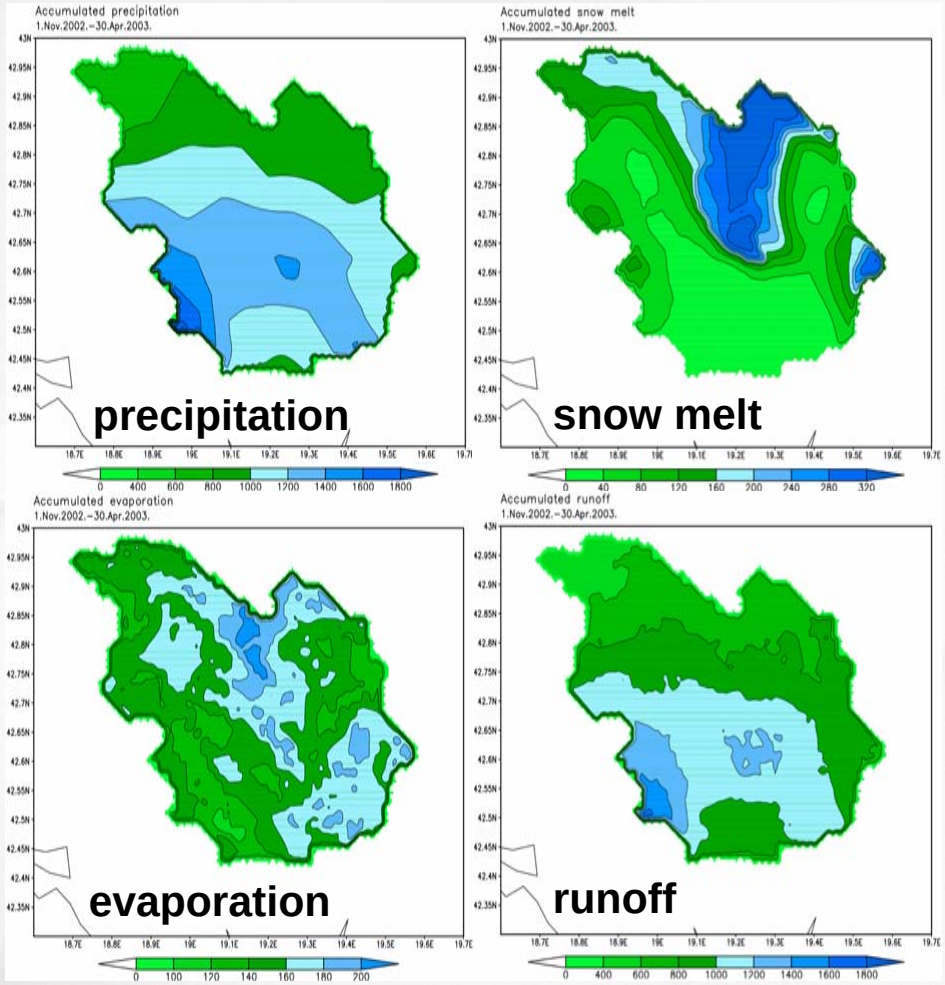


The Moraca river (Montenegro) – case study



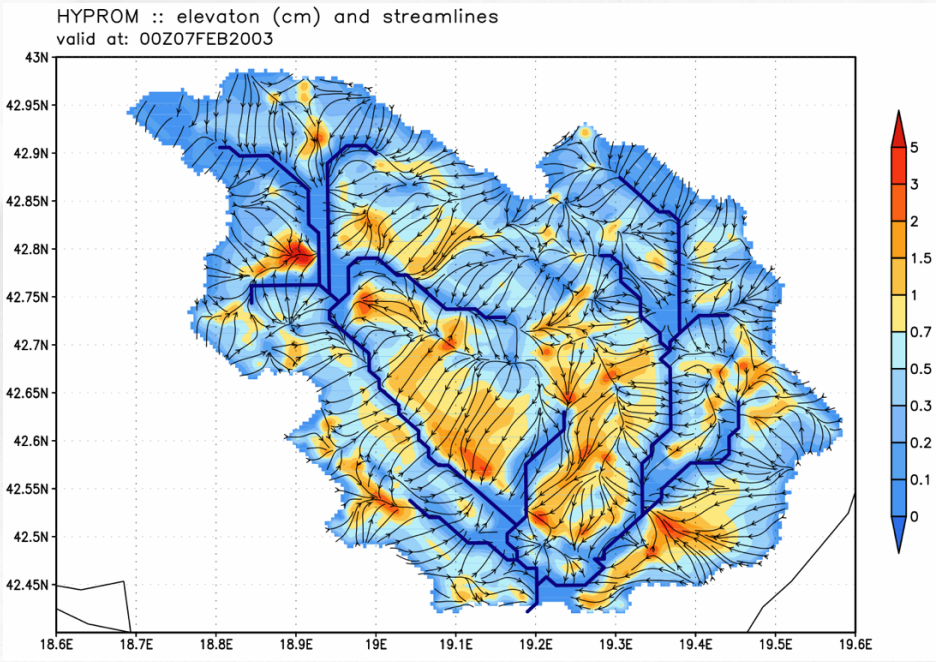


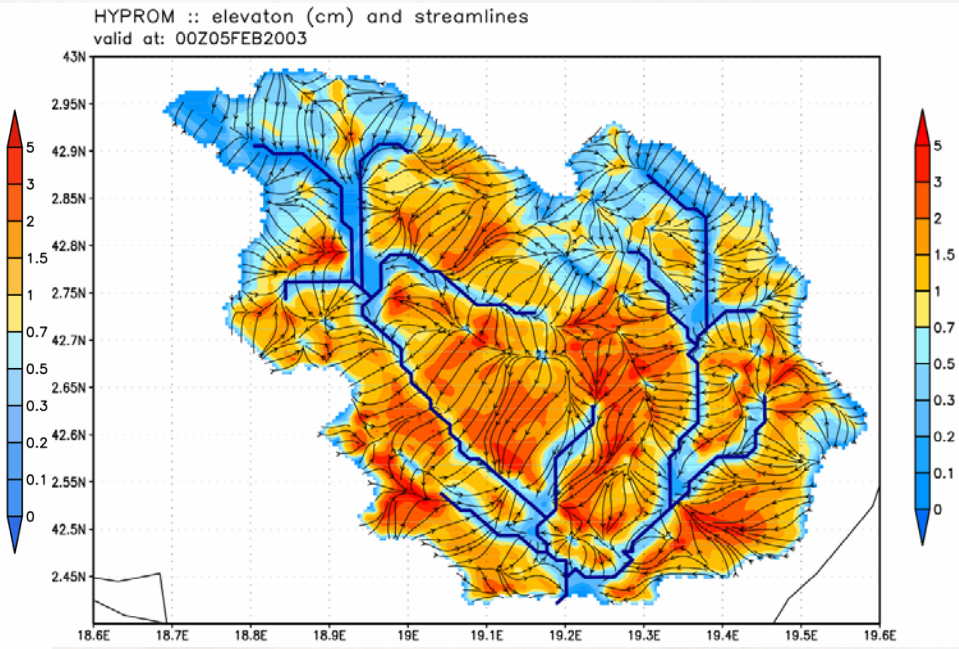
Water budget components
six months accumulations [Nov 2002 – Apr 2003]



The Moraca river - surface runoff

An example of heavy rain event



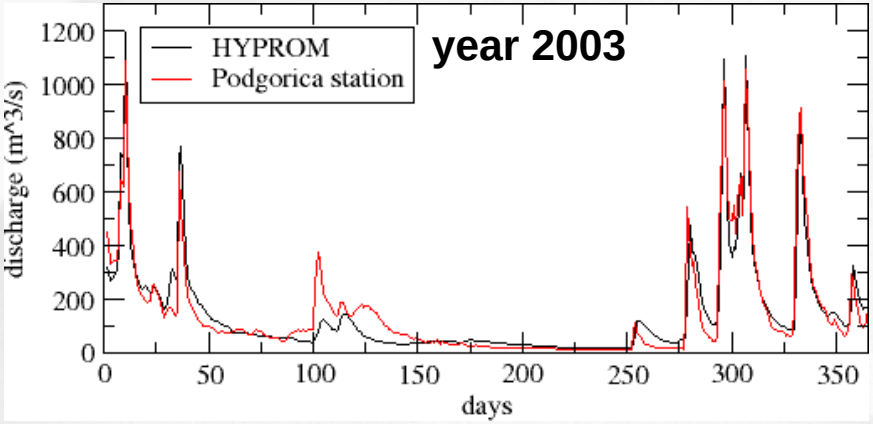


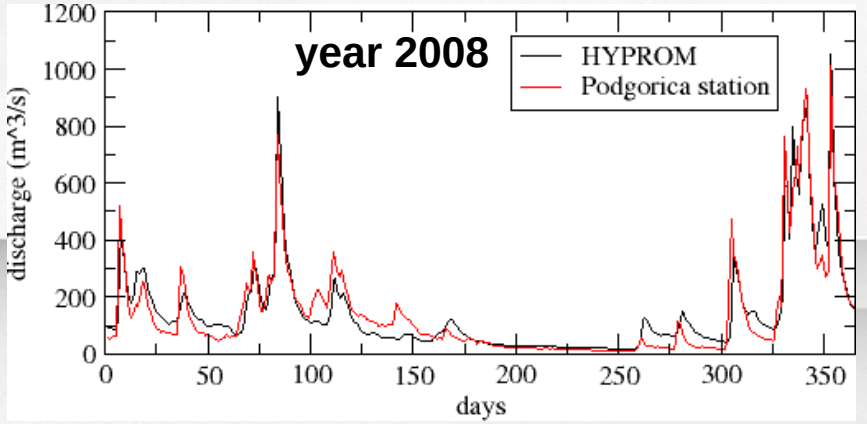
5 Feb 2003

7 Feb 2003

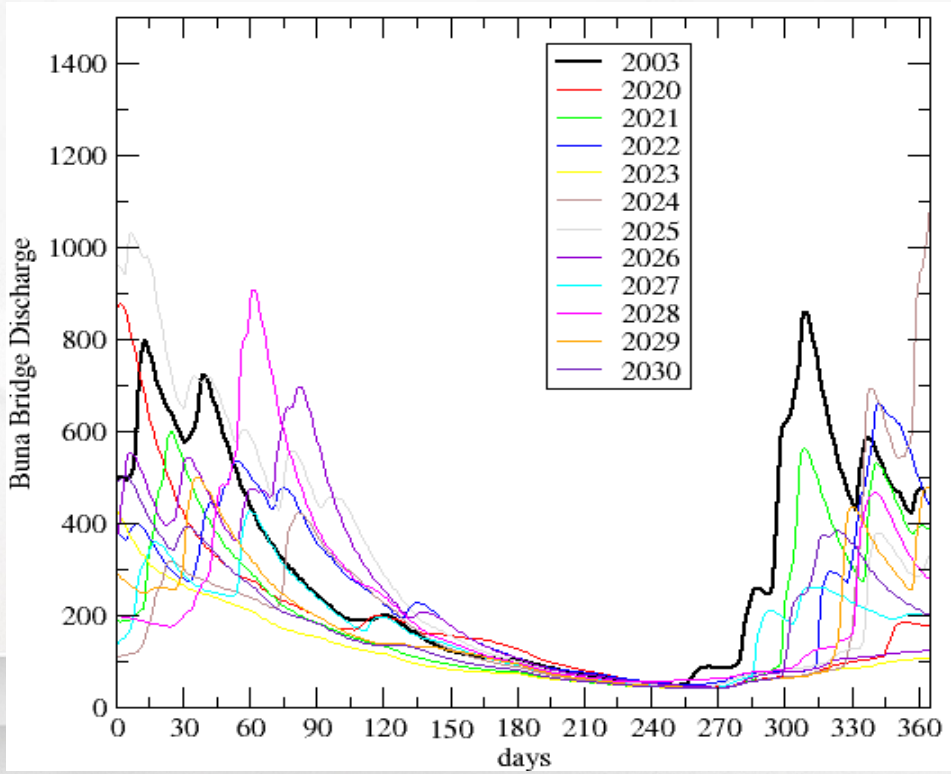
The Moraca river discharge

model .vs. observations





climate change projections 2020-2030



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