Developing a large scale stream temperature model within the Community Earth System Model framework

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Background

- A model for river transport of heat is needed to close the energy budget between land and ocean in ESMs and to support modeling of the water-energy nexus
- The CESM-CLM soil thermodynamics module can be utilized to provide boundary conditions to the heat transport model
- **Mo**del for **S**cale **A**daptive **R**iver **T**ransport (MOSART) can be used to physically simulate heat transport along with water
- MOSART-heat is developed based on MOSART/CLM

Model Structure
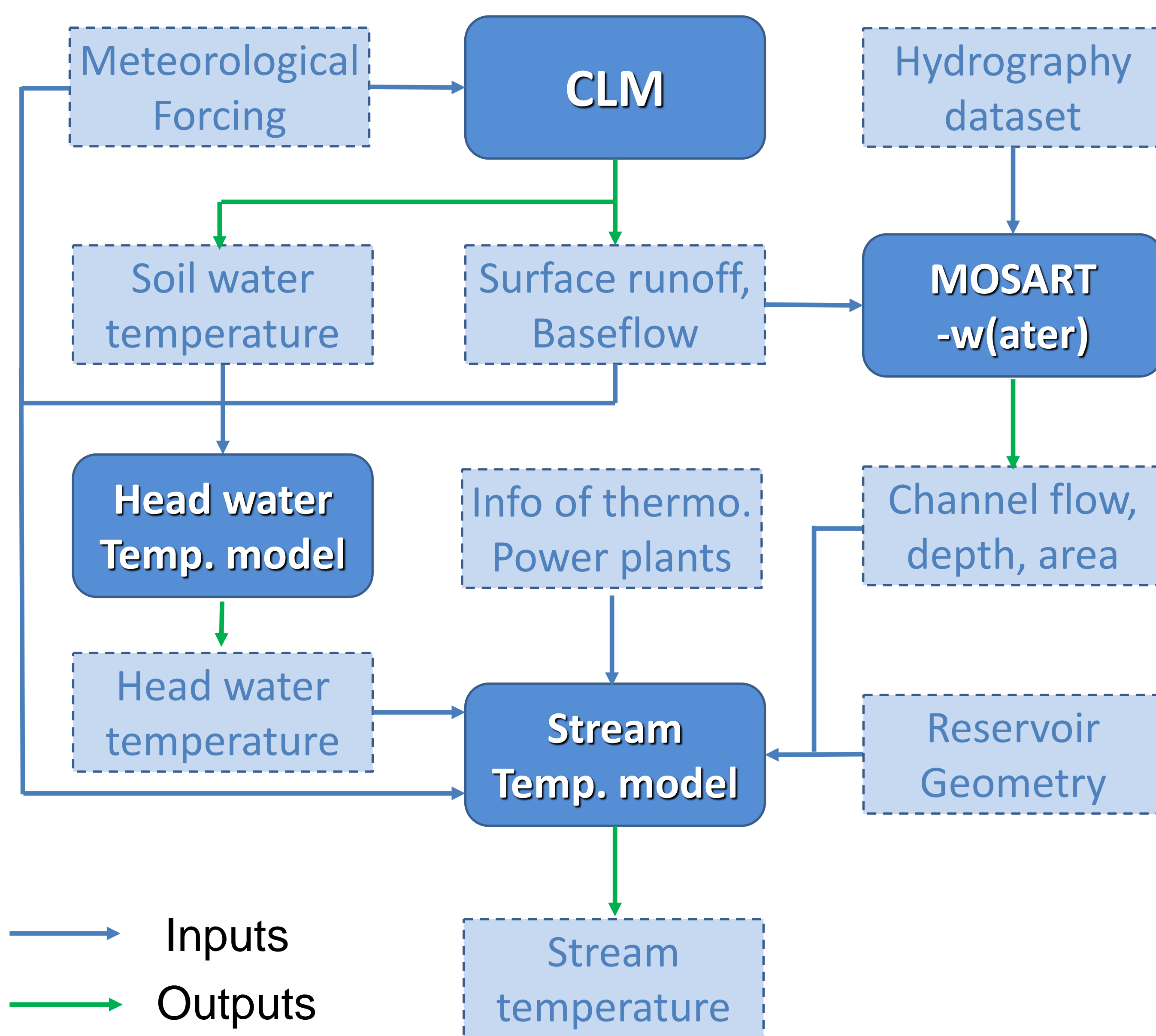

Inputs and Observation Data

- NLDAS2 hourly atmospheric forcing at 1/8th degree resolution
- Global hydrography dataset including channel geometry, flow direction, channel slope, Manning's roughness coefficient, etc., at 1/8th degree resolution
- Reservoir info from USGS (for future use)
- Power plant info from UCS-EW3 (for future use)
- Observed daily flow from USGS
- Observed daily stream temperature from USGS and Bureau of Reclamation
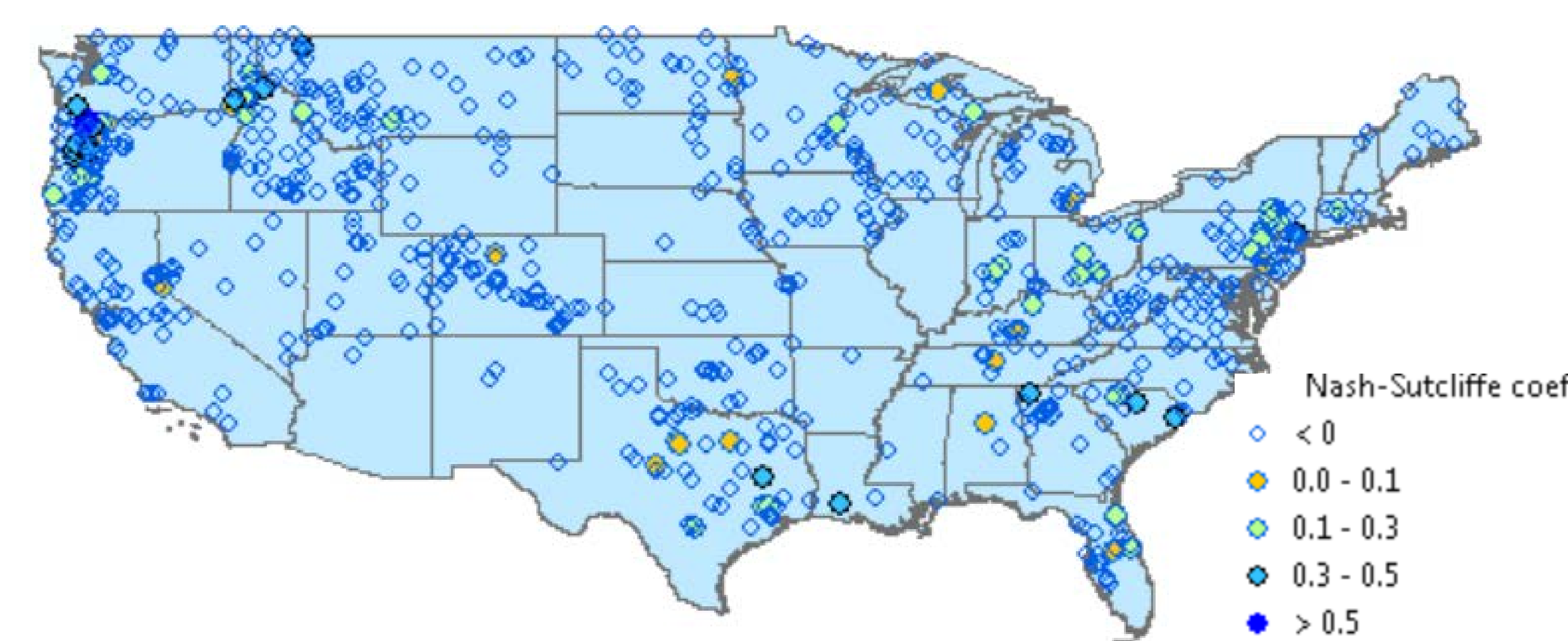
Preliminary Results over the US

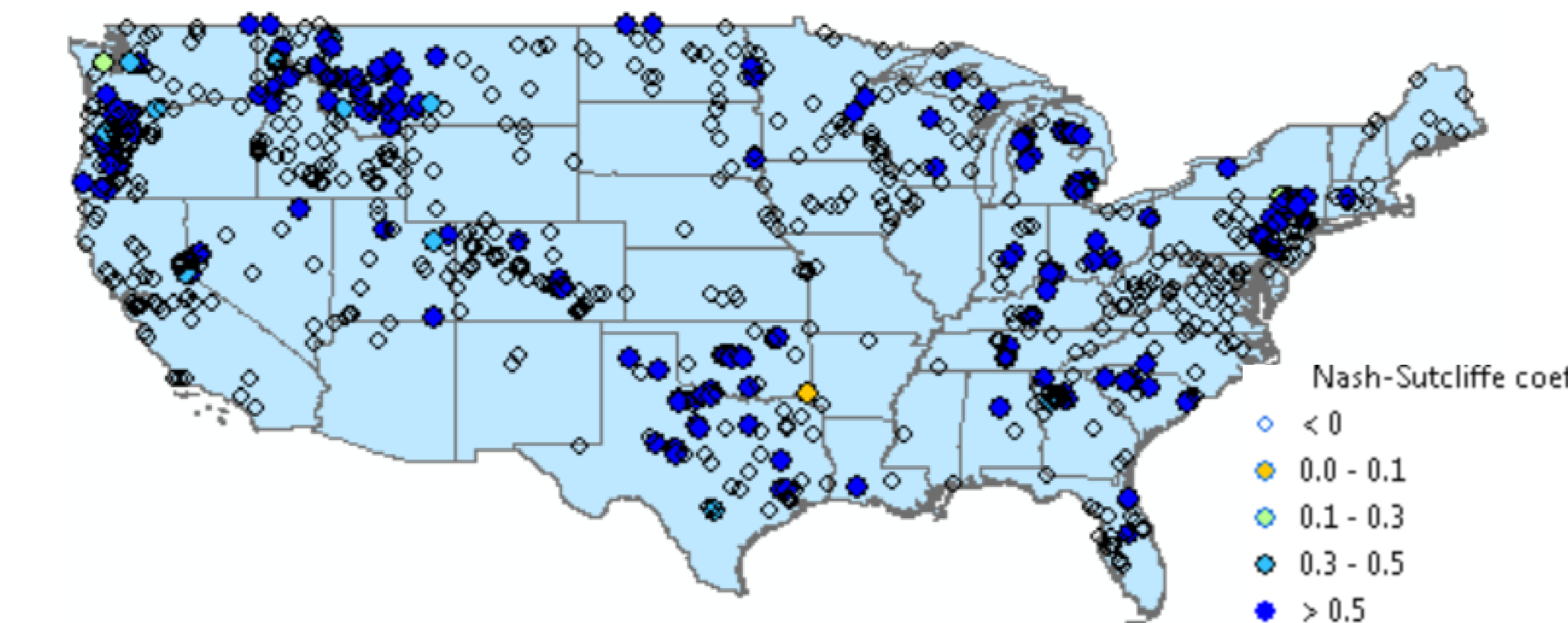- Simulated head water temperature in 2000-2004 (°C)
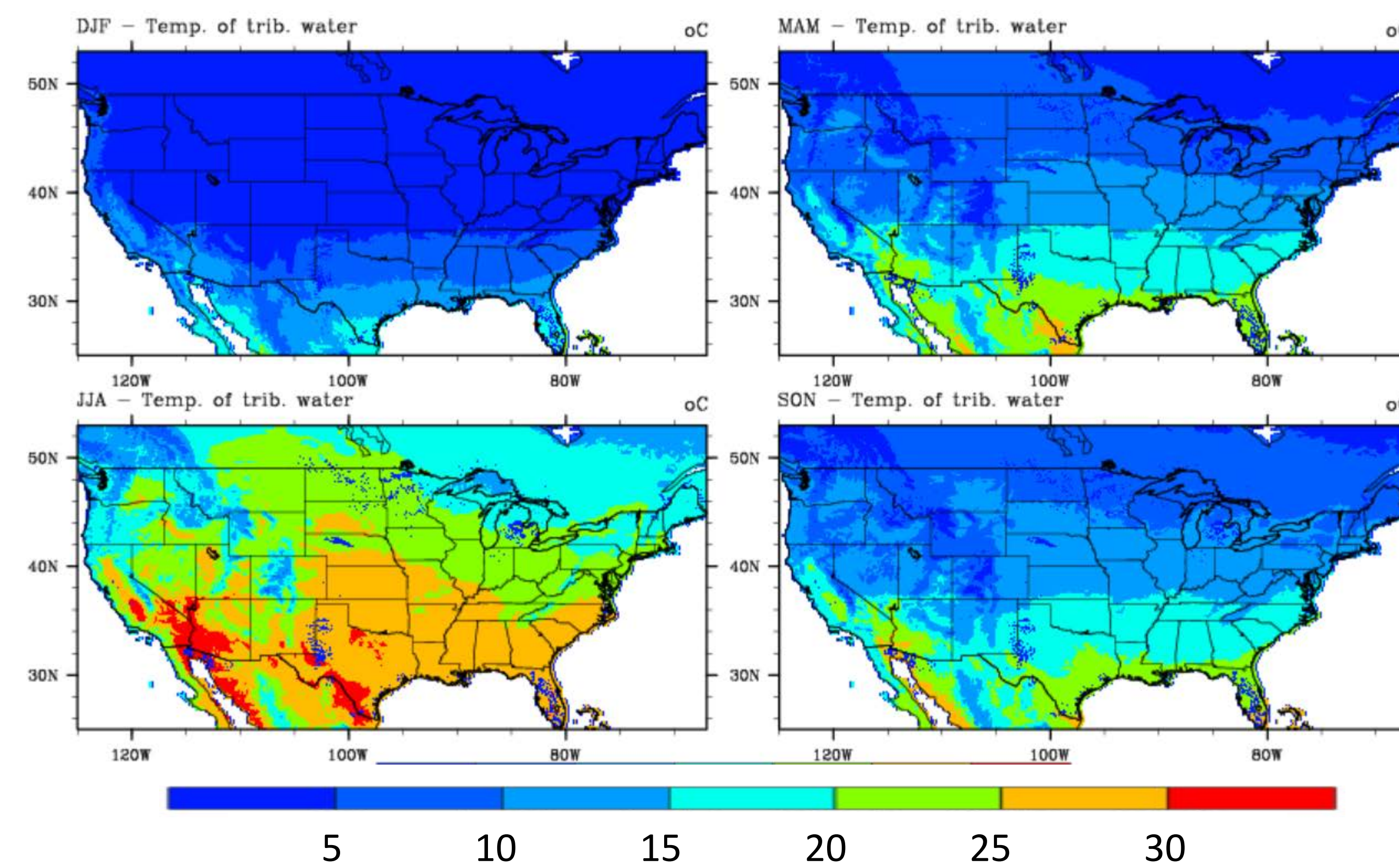
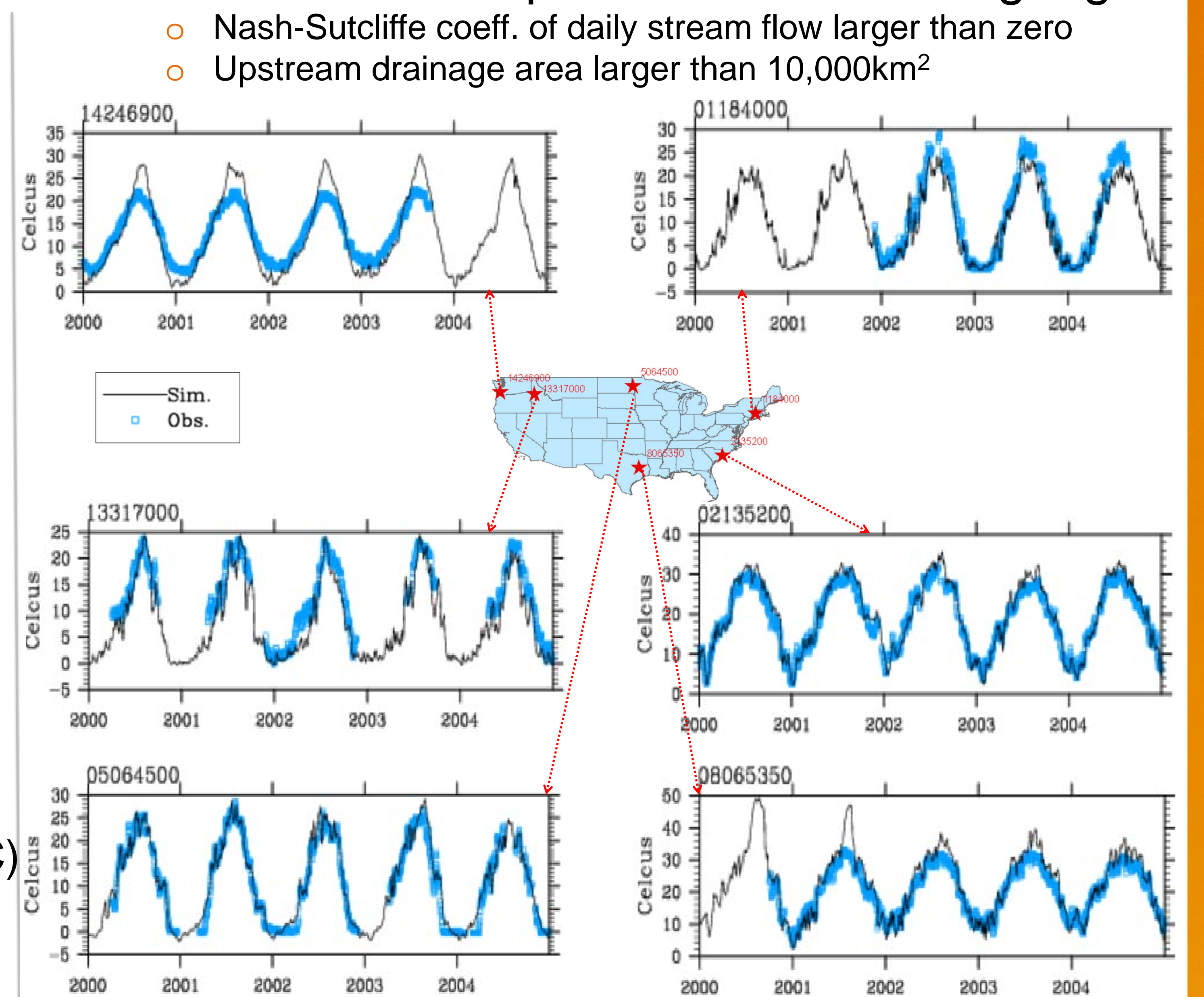- Simulated main channel water temperature in 2000-2004 (°C)
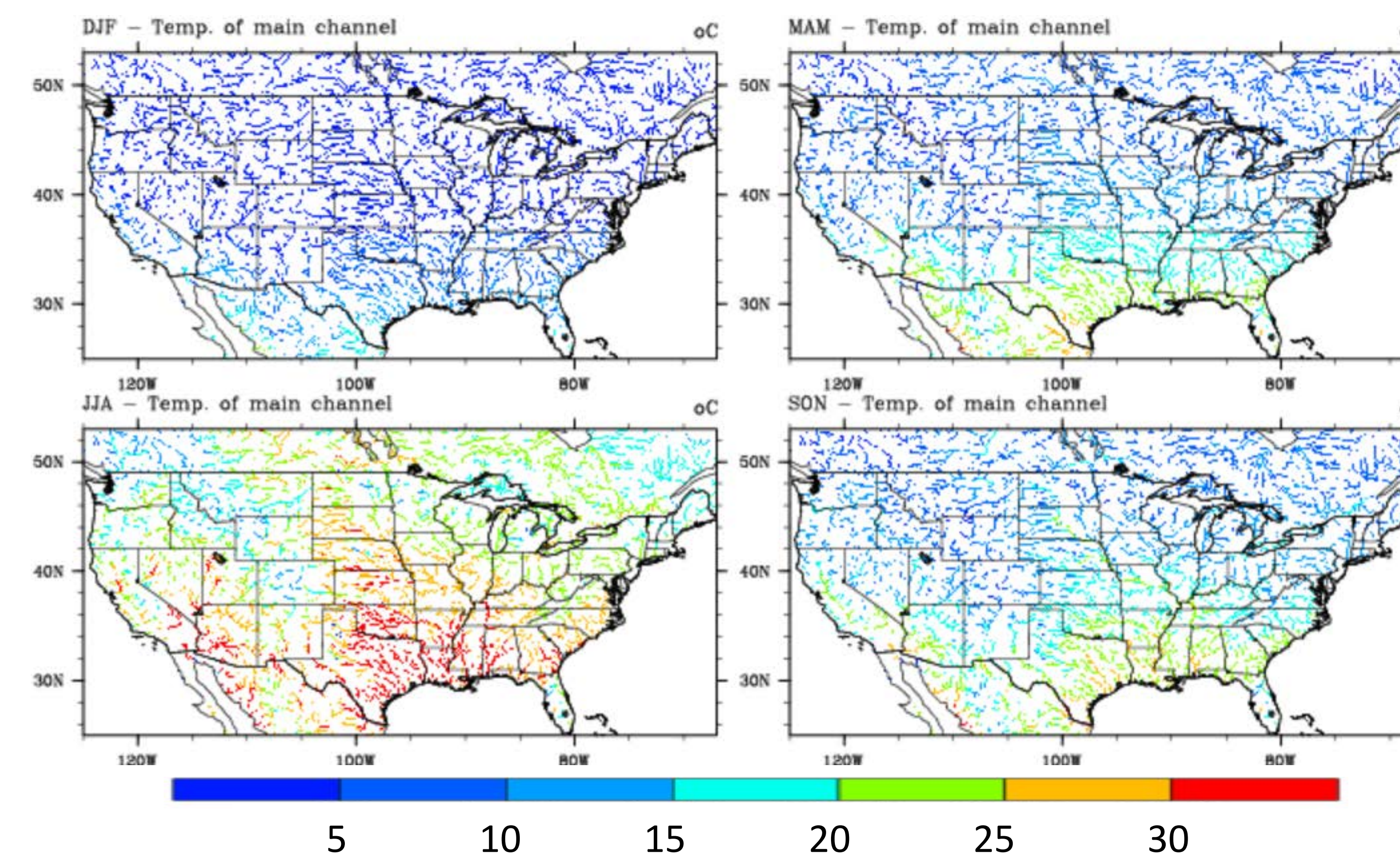
- Nash-Sutcliffe coeff. for daily stream flow validation

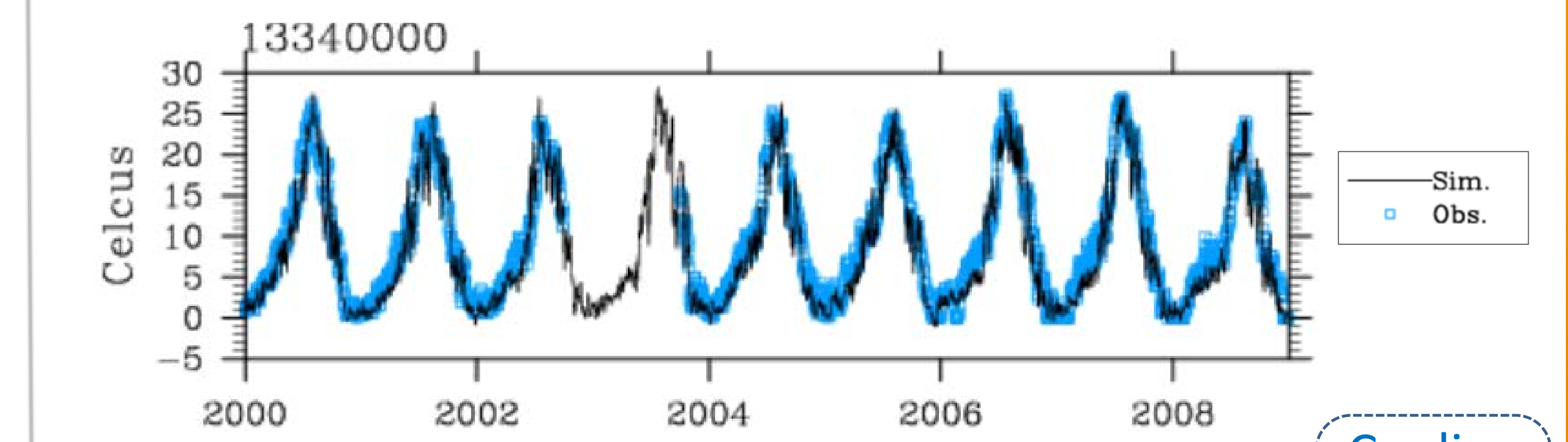- Nash-Sutcliffe coeff. for daily stream temperature validation

Channel water temperature at selected gauges
- Nash-Sutcliffe coeff. of daily stream flow larger than zero
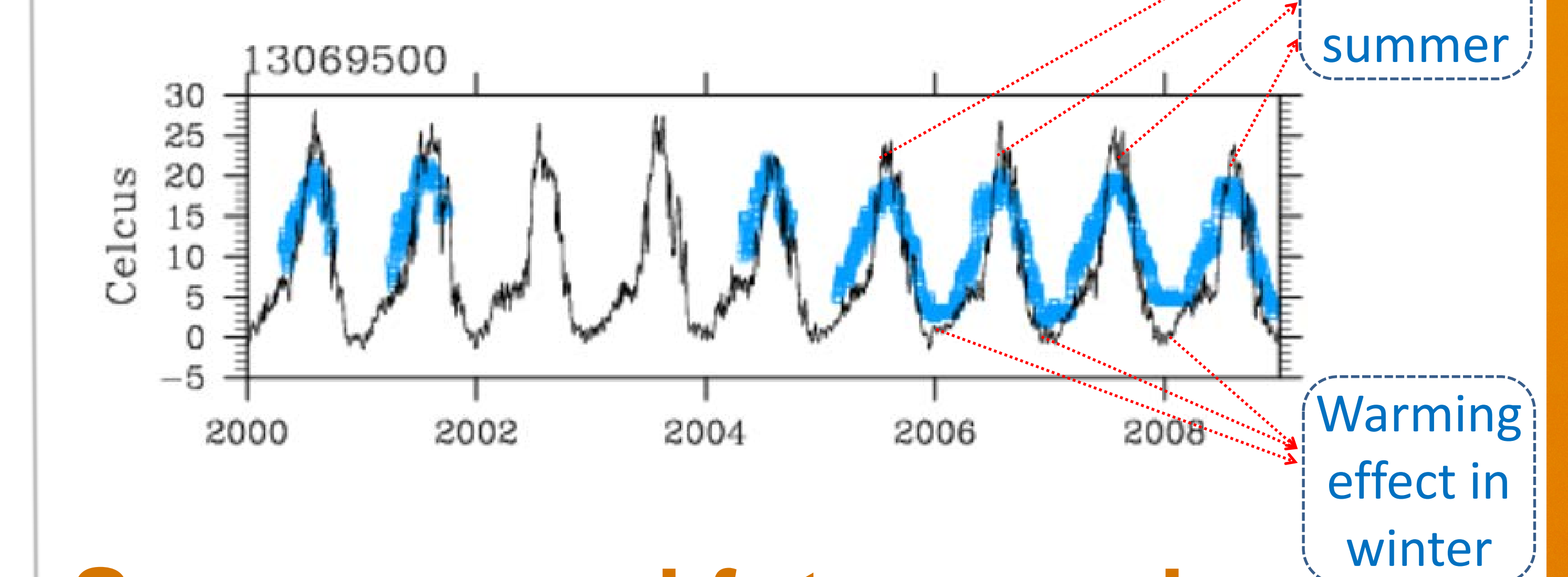- Upstream drainage area larger than 10,000km²

Impacts of reservoir operation

- A USGS gauge with drainage area subject to minimal human influences and good streamflow simulation

- A USGS gauge downstream of a reservoir

Cooling effect in summer

Warming effect in winter

Summary and future work

- MOSART-h is able to simulate stream temperature reasonably well over large scales given climatic and anthropogenic uncertainties
- Stream temperature is controlled by both heat transport in the river and heat exchange between the river and atmosphere
- Impacts of reservoir and power plant operation will be incorporated next

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