

Xanthos: An extensible global hydrologic model

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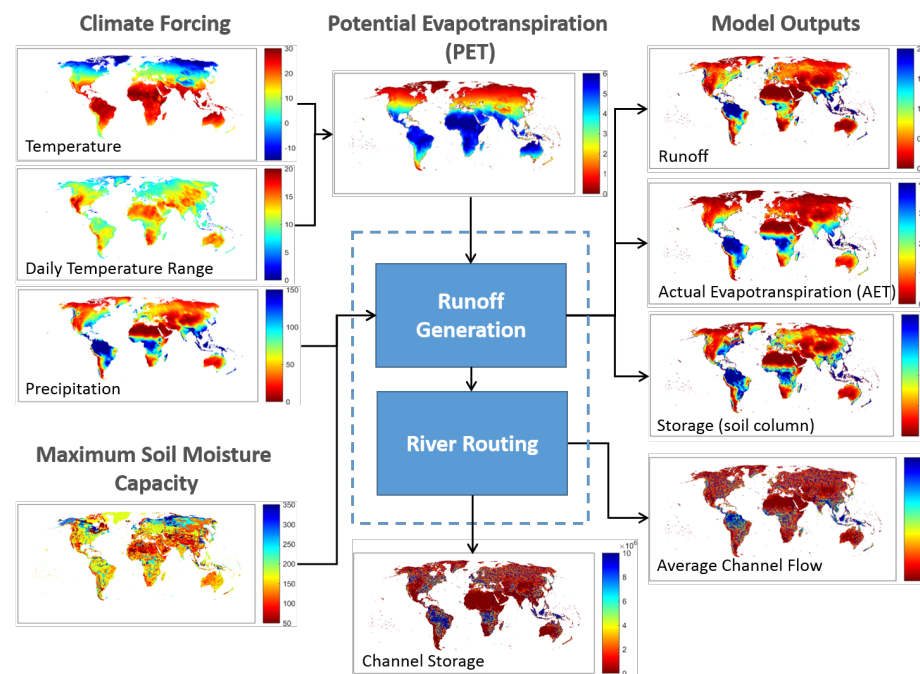
JGCRI - Pacific Northwest National Laboratory
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Outline

- ▶ Background
- ▶ Conceptual development
- ▶ Functionality
- ▶ Products
- ▶ Applications
- ▶ Ongoing development

Background

- ▶ Developed at the Joint Global Change Research Institute
- ▶ Global hydrologic model built to quantify and analyze global water availability
- ▶ Quantify future freshwater availability under various climate scenarios
- ▶ Monthly time-step
- ▶ 0.5 degree spatial resolution





Conceptual development

- ▶ Extensible and portable
- ▶ Configurable
- ▶ Can be utilized by other models
- ▶ Performance indicators
- ▶ Build upon previous investments
- ▶ Capture annual and seasonal signals of water fluxes and pools
- ▶ Incorporate the impact of land-use and land-cover on water fluxes
- ▶ Track groundwater recharge and storage



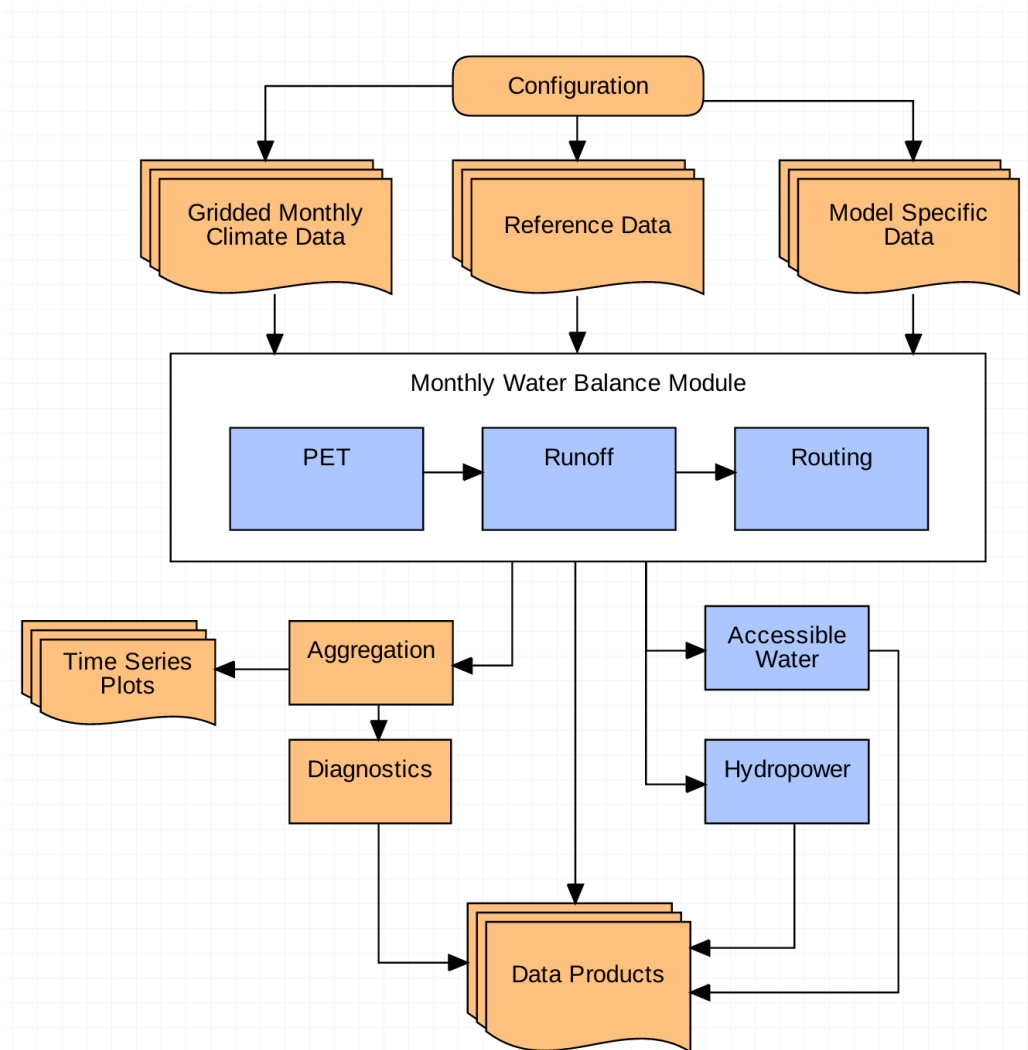
Python chosen due to...

- ▶ Integration potential with other hydrologic data models (ArcHydro, etc.)
- ▶ Widely used by the scientific community
- ▶ Many online resources



Xanthos – Model overview

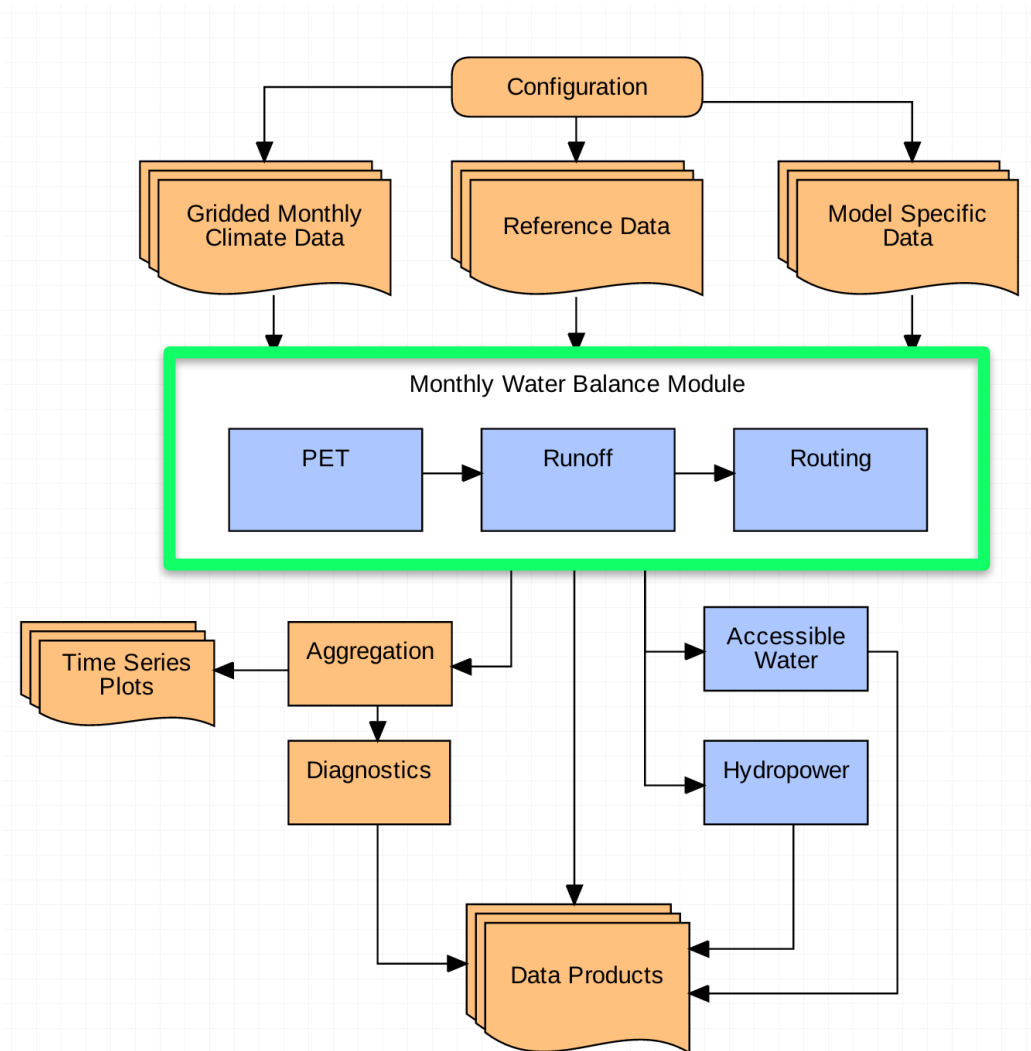
- ▶ Configuration
- ▶ On-demand data
- ▶ Water balance configuration
- ▶ Post water balance modules
- ▶ Reporting
- ▶ Diagnostics

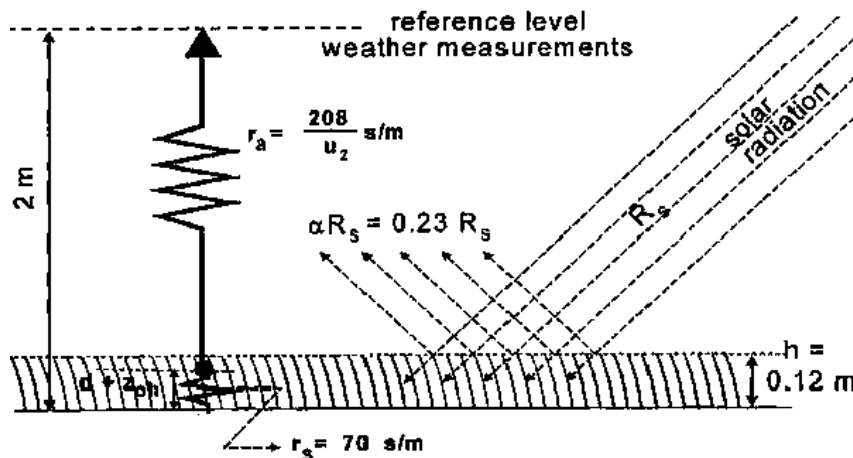
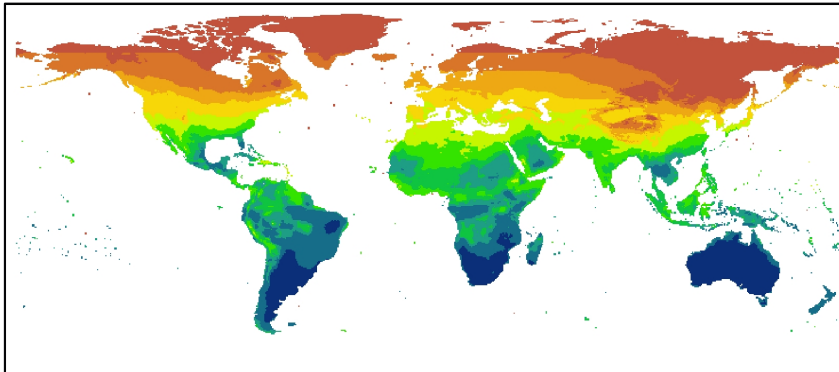




Xanthos – Water balance module

- ▶ Core of model
- ▶ PET, Runoff, and Routing
- ▶ Pick your own configuration
- ▶ Enforced format and types for transferred data

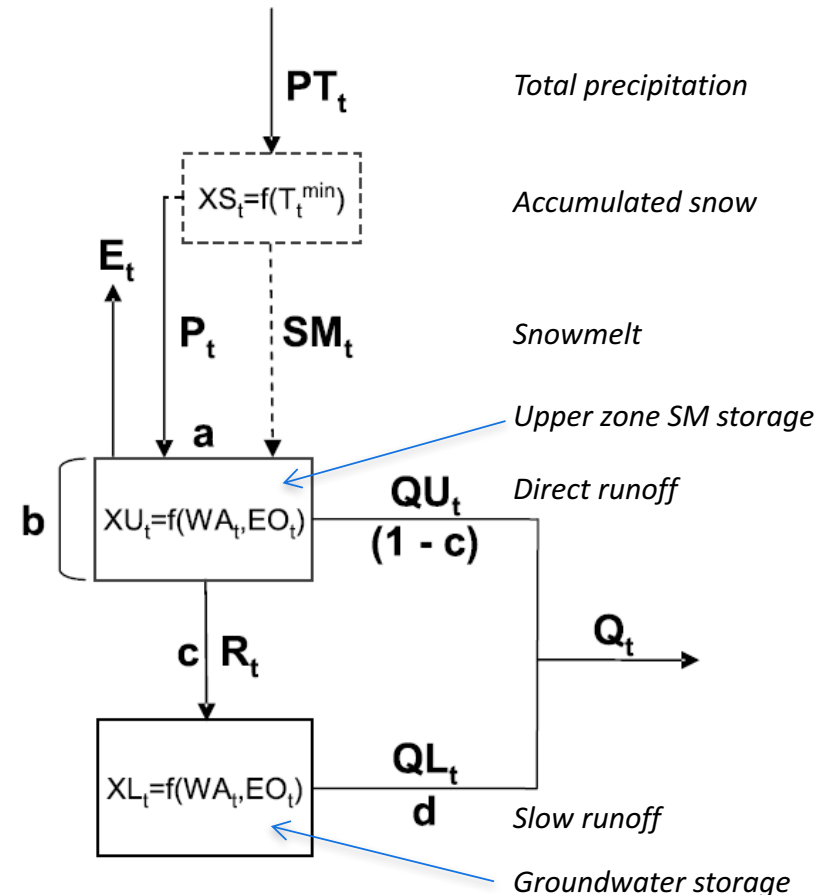




- ▶ Hargreaves
 - Comparable to Penman-Monteith but requires less parameterization
- ▶ Penman-Monteith
 - Used by the UN Food and Agriculture Organization (FAO)
 - Helps evaluate land-use and land-cover impact on water fluxes

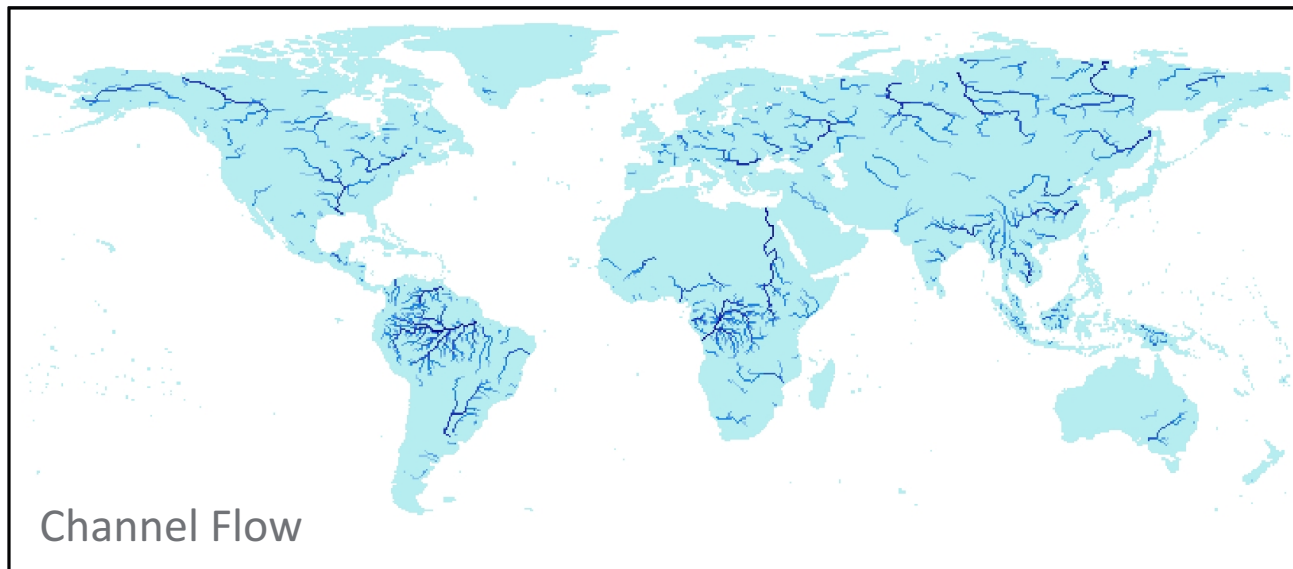
Xanthos – Runoff

- ▶ **GWAM method**
 - Reproduces historical streamflow observations and simulates the future availability of freshwater
- ▶ **ABCD method**
 - Simulates streamflow in response to precipitation and PET
 - Tracks groundwater recharge and storage
 - Captures annual and seasonal signals of water fluxes and pools



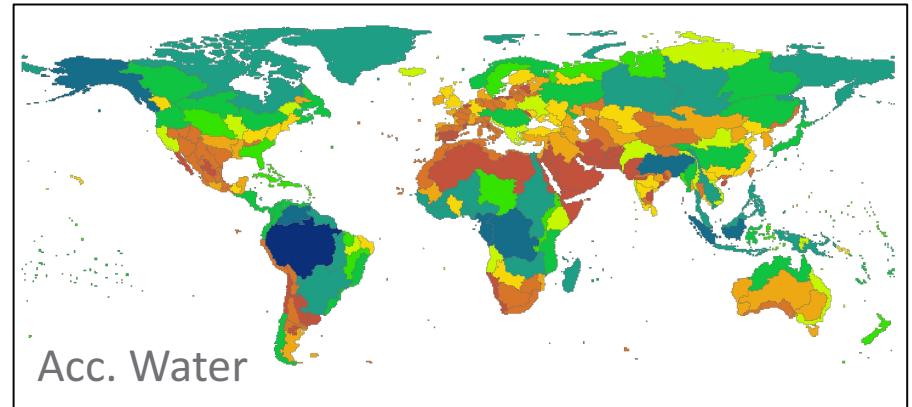
ABCD Method

- ▶ Cell-to-cell modified version of the River Transport Model (RTM)
 - Produces gridded average channel flow and channel storage
 - New improvements in estimated streamflow velocity (Li et al.)



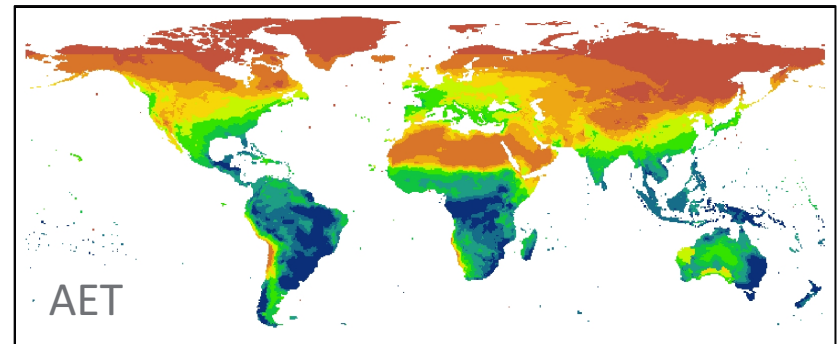
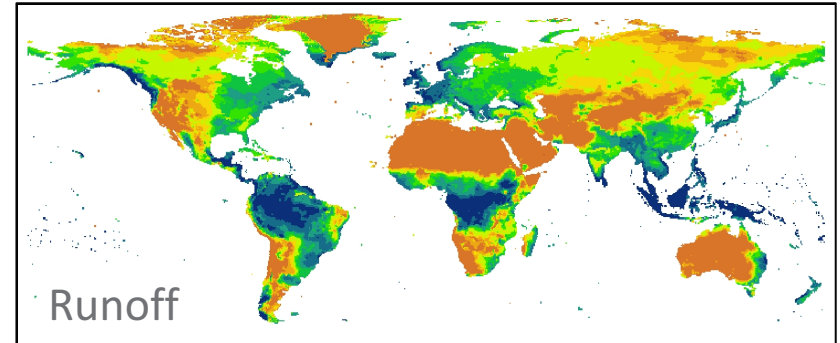
Xanthos – Additional modules

- ▶ Accessible water
 - Calculates renewable water resources that are accessible for use by basin
- ▶ Hydropower
 - Estimates of actual and potential hydropower resources (Turner et al.)



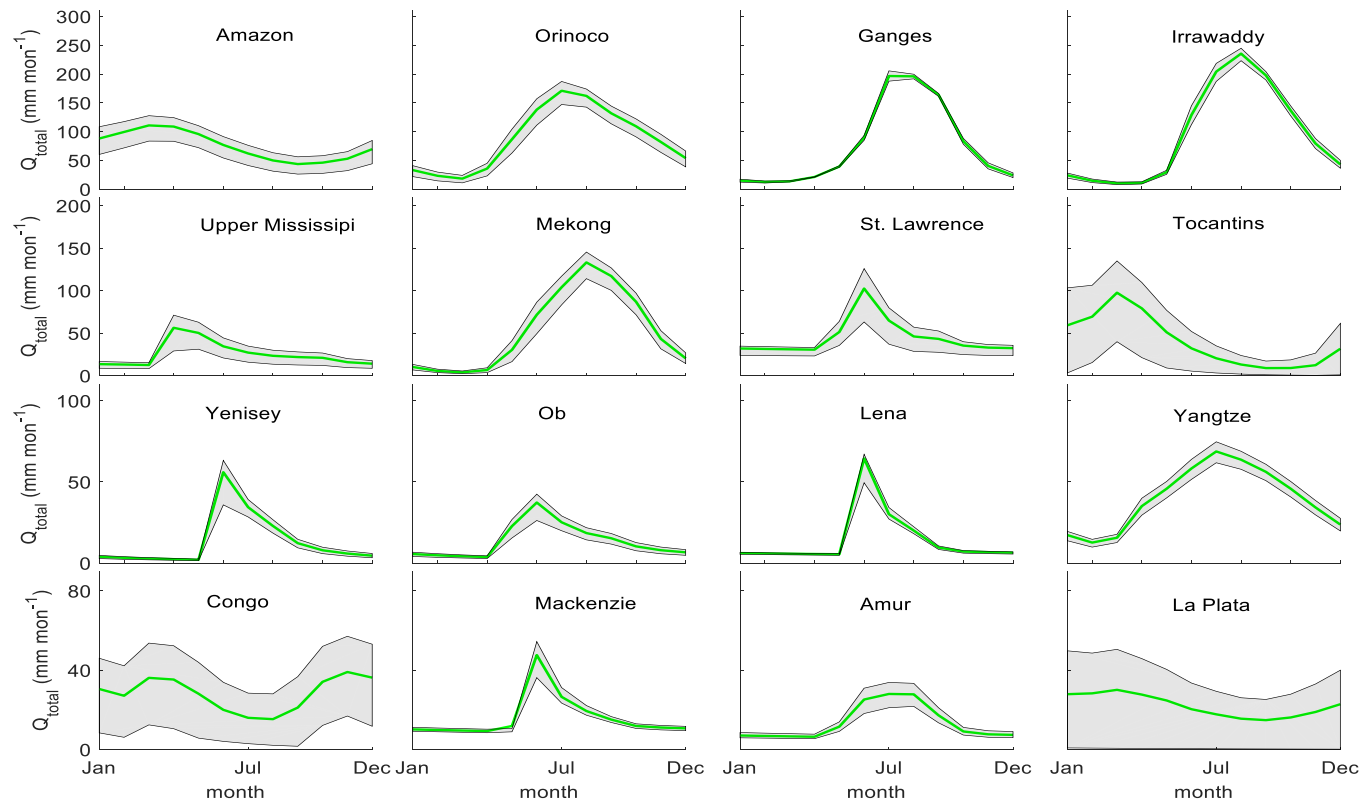
Xanthos – Products

- ▶ Runoff
- ▶ Actual evapotranspiration (AET)
- ▶ Storage (soil column)
- ▶ Average channel flow
- ▶ Channel storage
- ▶ Accessible water by basin
- ▶ Hydropower estimates and potential
- ▶ Diagnostics
- ▶ Time-series plots



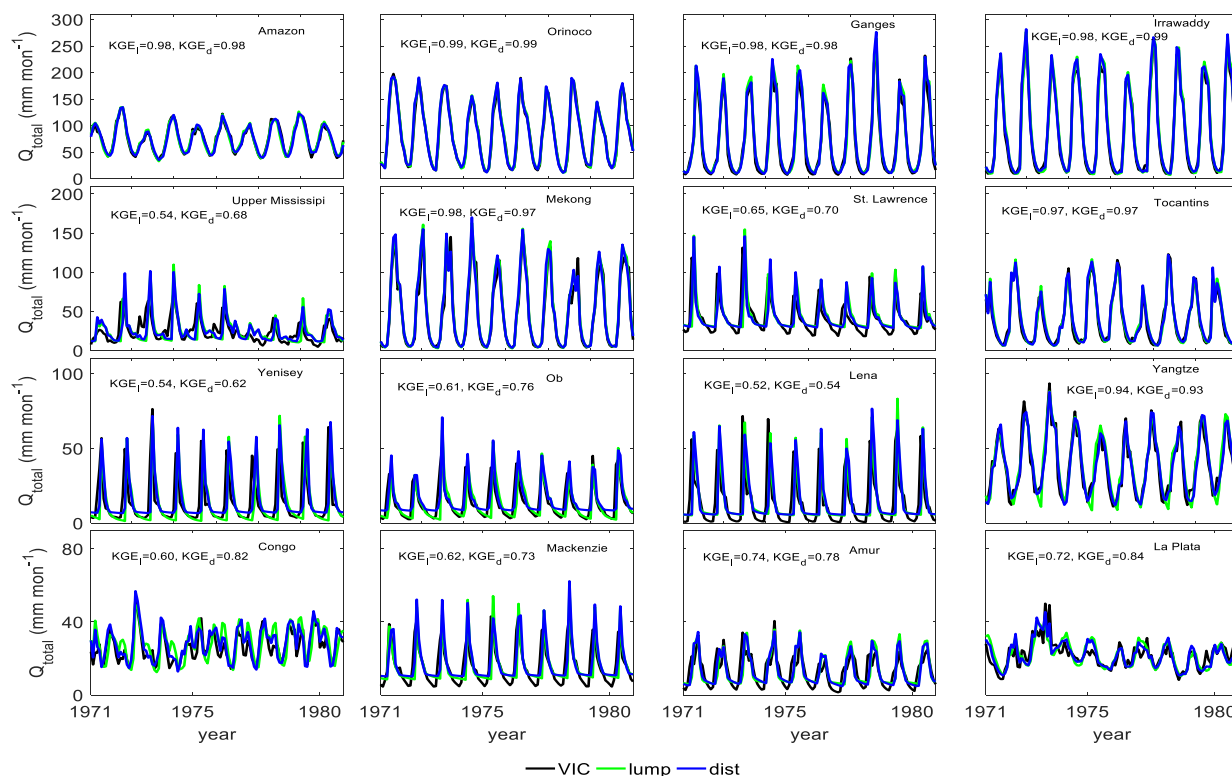
Xanthos – Uncertainty

100,000 Xanthos simulations for sixteen of the world's river basins with 100,000 combinations of parameters to examine uncertainty in total runoff.





Xanthos – Computational Efficiency



	1000 years' simulation (s)
lumped	0.03
distributed	3.20
VIC	~1 week



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Thank you

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Xanthos – Questions?



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