R: Modeling inundation in the Amazon Basin: Uncertainties in topography, channel geometry and flow representation

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Objective

River inundation has significant impacts on water, energy and carbon cycles of the Amazon Basin. Modeling river flow and inundation of this basin with the continental-scale model faces a number of challenges including uncertainties in the following aspects:

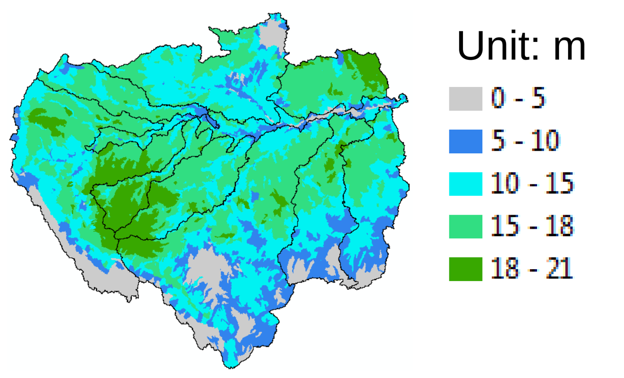
- ❑ Floodplain topography
- ❑ Channel cross-sectional geometry
- ❑ Channel roughness
- ❑ Representation of river flow

Efforts were made to handle these uncertainties when applying the MOSART–Inundation model in the Amazonia. Effects of these uncertainties on surface water dynamics were investigated.

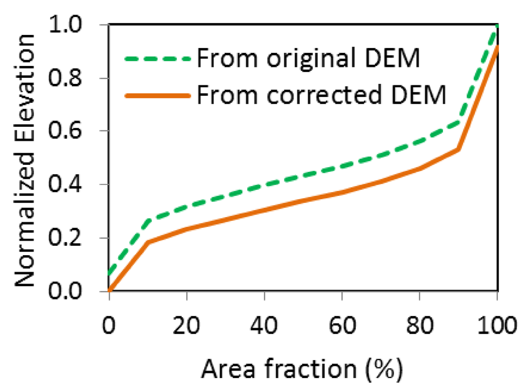
Approach

Refine floodplain topography

Vegetation-caused biases in the HydroSHEDS DEM data were alleviated by using a 1-km vegetation height map (*Simard et al.*, 2011) and a 90-m land cover dataset for floodplains (*Hess et al*., 2003, 2015).



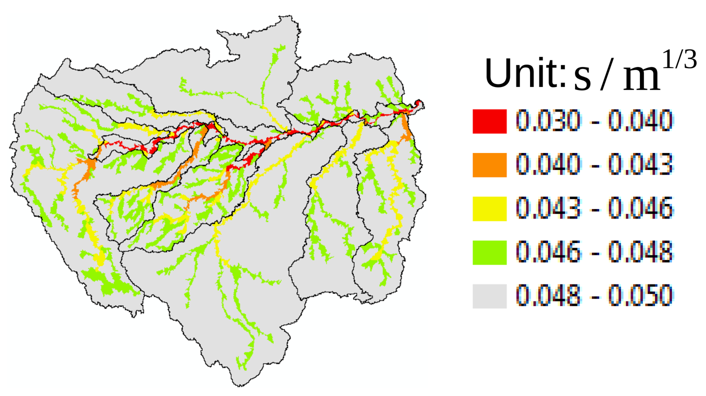
DEM deductions of subbasins



Averaged elevation profiles

Improve channel roughness

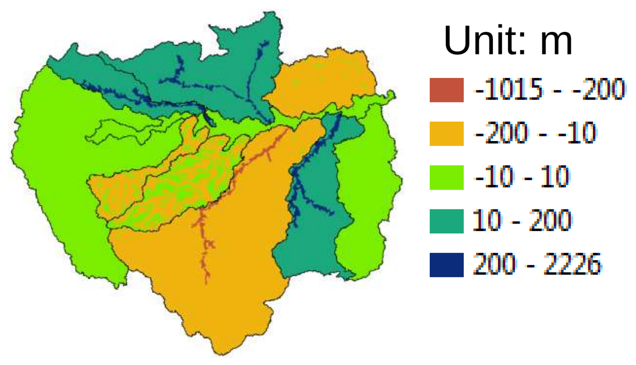
Larger river size → smaller roughness coefficient



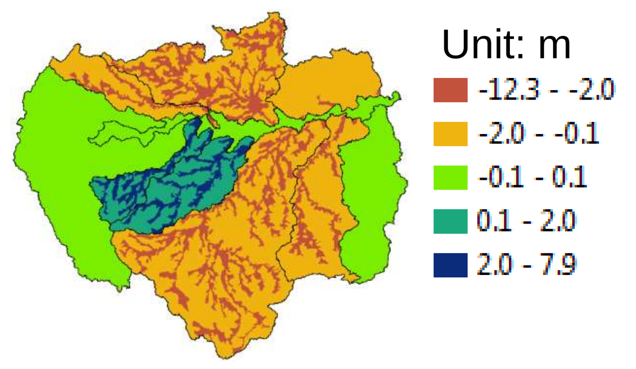
Channel roughness coefficients

Improve channel geometry

Basin-wide empirical formulae for channel cross-sectional geometry (*Beighley and Gummadi*, 2011) were adjusted for most subregions based on local information.



Channel-width adjustments



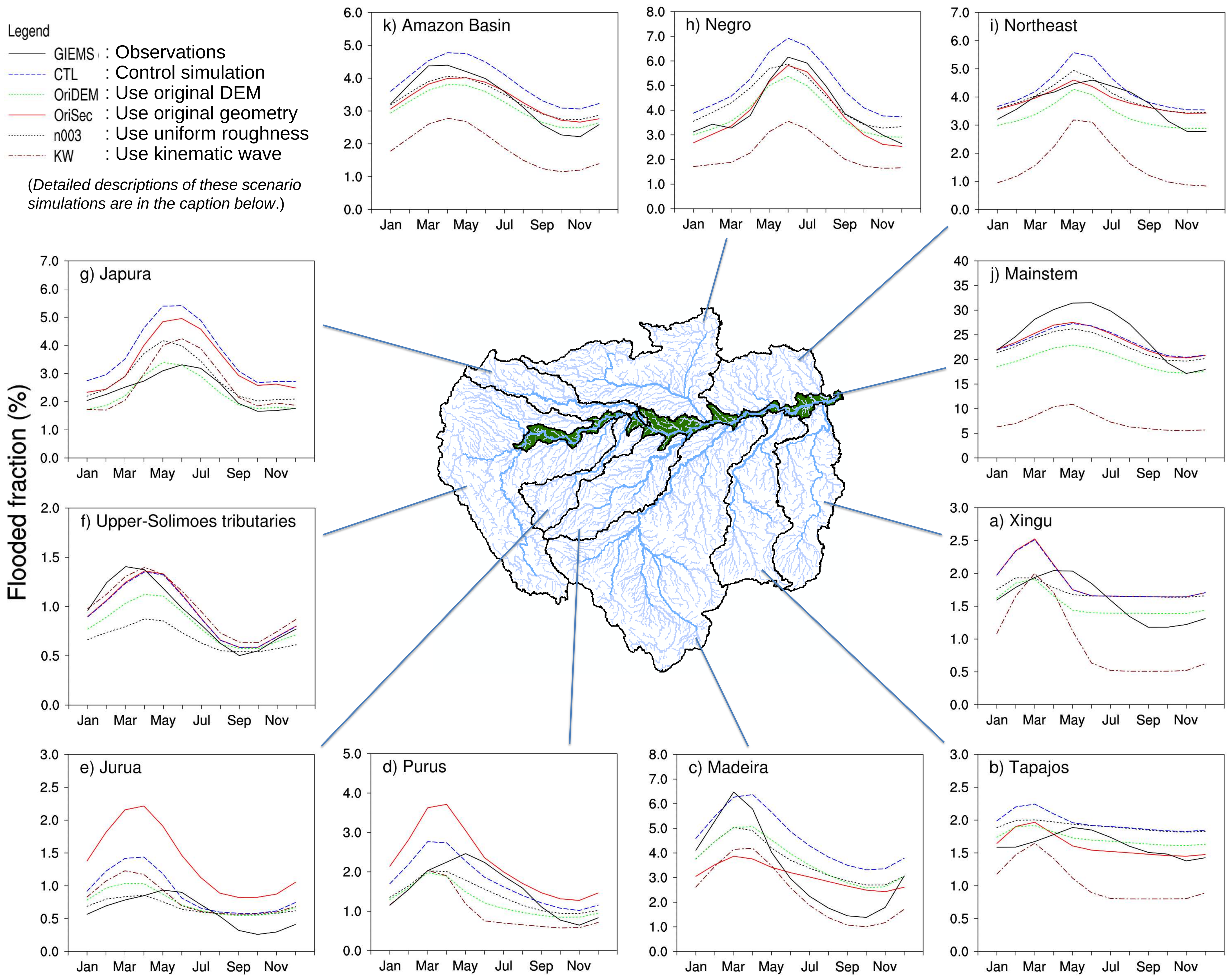
Channel-depth adjustments

Representation of river flow

Two river routing methods were used:

1. Diffusion wave method: represent backwater effects;
2. Kinematic wave method: not represent backwater effects.

Flood extent results of scenario simulations



Modeled and observed monthly flooded fractions of the entire Amazon Basin and its 10 subregions (averages of 13 years (1995 – 2007)).

The 5 scenario simulations: **CTL** – Control simulation; **OriDEM** – Using the original DEM (with vegetation-caused biases); **OriSec** – Using uniform basin-wide channel geometry formulae (without adjustments); **n003** – Using a uniform roughness coefficient (i.e., 0.03) for all the channels; **KW** – Using kinematic wave method to represent river flow (without considering backwater effects).

In the basin map: Black lines are boundaries between subregions; Dark green color indicates the mainstem subregion.

Impact

- ❑ Spatially diverse biases embedded in the model inputs of floodplain topography, channel cross-sectional geometry and channel roughness were alleviated.
- ❑ Refining floodplain topography, channel cross-sectional geometry, and channel roughness, as well as accounting for backwater effects evidently improve the simulated surface water dynamics (including streamflow, river stages and flood extent) in the Amazon Basin.
- ❑ The understanding obtained in this study could be helpful to improving the modeling of surface hydrology in river basins with extensive inundation, especially at regional or larger scales.

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