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).

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.

Improve channel roughness
Larger river size → smaller roughness coefficient

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.

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.