Expressive fluxes over Amazon floodplain units revealed by high resolution 2D modelling

Alice Cesar Fassoni-Andrade¹, Rodrigo Paiva², Sly Wongchuig³, Cláudio Barbosa⁴, and Fabien Durand³

¹Instituto de Desenvolvimento Sustentável Mamirauá (IDSM), Tefé, Amazonas, Brazil
²Institute of Hydraulic Research, Federal University of Rio Grande do Sul (UFRGS), Porto Alegre, Brazil
³Laboratoire d'Etudes en Géophysique et Océanographie Spatiales (LEGOS), Université Toulouse, IRD, CNRS, CNES, UPS, Toulouse, France
⁴Instrumentation Lab for Aquatic Systems (LabISA), Earth Observation Coordination of National Institute for Space Research (INPE), São José dos Campos, Brazil

Water fluxes in the Amazon River floodplain affect hydrodynamic and ecological processes from local to global scales. These fluxes remain poorly understood due to difficult access and limited data in the Amazon basin. In this study, we characterize the hydrodynamics of eight floodplain units of the central Amazon River (40'000 km²) using the 2D hydraulic model HEC-RAS. Remote sensing data, such as floodplain topography estimated by Landsat images, water surface elevation from altimetry, and surface water extent products, were used for model validation. High resolution modeling improved the representation of river and floodplain discharge, water surface elevation (77 cm accuracy) and flood extent (~80% - high water period, ~52% - low water period). The floodplain is organized in units of about 80 km with upstream inflow and downstream outflow. These gross flows are much larger than the net flows with values of up to 20% of the Amazon River discharge and a residence time around 6 days during floods (several months during low water period). Water extent does not have strong interannual variability during floods as the volume stored in the floodplain, possibly due to topographic constrains. Significant flood extent and volume hysteresis, as well as active flow and storage zones on the floodplain, highlight the complexity of floodplain hydrodynamics. Extreme floods strongly impact the onset and duration of the flood of up to 2 months and, consequently, on the period of high connectivity with the river. These findings are important for understanding carbon and sediment fluxes, and the effects of climate change on water fluxes and riparian communities.