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Using the HAND Terrain Descriptor to define Hydrological Response Units for Hydrological Modelling in the Amazon

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The Amazon River basin is the largest in the world ($\sim$ 6*106 km2) with diverse regional climate and particular hydraulic features which include low gradients, back-water effects and extensive inundated areas. Saturated areas, such as floodplain forests, may play an important role in the water balance, since the transpiration rates from soil to atmosphere in these areas, even during dry periods, may be close to the potential evapotranspiration rate. This effect needs to be included in hydrological models, but difficulties arise in defining saturated regions in large areas such as the Amazon. Among several methodologies used to overcome them, the Height Above Nearest Drainage – HAND (Rennó et al. 2008) is a new quantitative topographic algorithm for classifying terrain and relating it to local soil water conditions, which was applied and validated with field data in several areas of Amazon Basin. HAND can be used to estimate the depth to the permanently saturated zone using a concept called draining potential, which is the vertical distance of a given grid point to its drainage outlet grid point at the stream river. Classifying all grid points according to their respective draining potentials allows them to be grouped into classes of equivalent draining gravitational potential, defining environments or zones with inferred similar hydrological properties that match with relevant soil water and land cover characteristics. This study reports on the use of the HAND algorithm and the Digital Elevation Model from the Shuttle Radar Topographic Mission (SRTM-DEM) to estimate areas in the Amazon basin where soil may be perennially saturated to the surface, as a means of improving results of the large-scale distributed and process-based hydrological model MGB-IPH. This model uses physically-based equations to simulate hydrological processes, such as the Penman Monteith model for evapotranspiration. The river basin is discretized into several catchments and each catchment is divided in Hydrological Response Units (HRUs). HRUs are usually defined using a combination of soil types and land cover maps. This methodology was changed in order to include information about probably saturated areas, which was obtained by applying the HAND algorithm on the SRTM digital elevation model of the whole Amazon basin. We used HAND to classify the terrain in two categories: probably saturated and probably not saturated. The probably saturated areas were included as a new Hydrological Response Unit within the model, guiding the choice of parameter values, to include processes such as transpiration supplied from water table trough capillary rise. We hope that the introduction of this new information in the definition of HRUs can result in a better representation of evapotranspiration during dry seasons. A better model calibration and more reliable results in some regions of the Amazon basin (e.g. Tapajos, Xingu and Tocantins basins) could only be adequately assessed considering the mapped saturated areas and its effects on water flux from water table to atmosphere by evapotranspiration, since in these areas, it was previously verified an unreal excess of runoff when comparing simulated and observed flow. In general, despite problems in representing vegetation in SRTM-DEM which interfere on algorithm application, model results were improved and applicability of HAND for hydrological model shows to be encouraging.