HYDROLOGICAL PROCESSES ANALYSIS IN AMAZONIA

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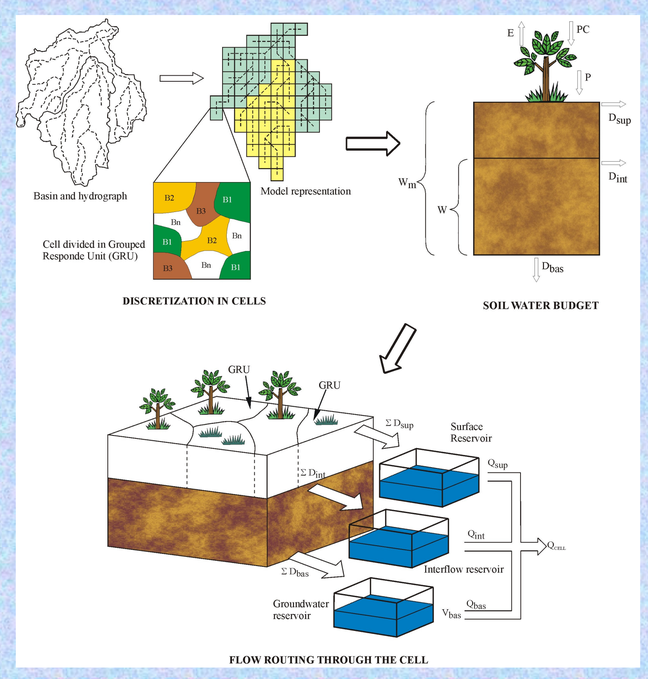
INTRODUCTION

The hydrological processes are related to several issues in Amazonia: environmental equilibrium, energy generation, water resources management, deforestation and climate change impact. These matters justify the need to understand the hydrological processes observed in the basin. The higher our knowledge about the hydrological cycle in Amazon the better our capacity to manage its water resources.

The objective of this work is to analyze the major hydrological processes of the Amazon basin using hydrological model. The following processes were analyzed: canopy interception, evapotranspiration, soil moisture and flow generation. The Madeira River basin is the study area and alternative databases were tested with the objective of being used in the simulations.

METHODS

The large scale hydrological model used is called MGB-IPH (Large Basins Hydrological Model). It is distributed in cells and runs in daily or hourly time steps. Each cell is divided into blocks, which are defined by a combination of land use, vegetation, and soil type.



MGB-IPH model

Model Equations

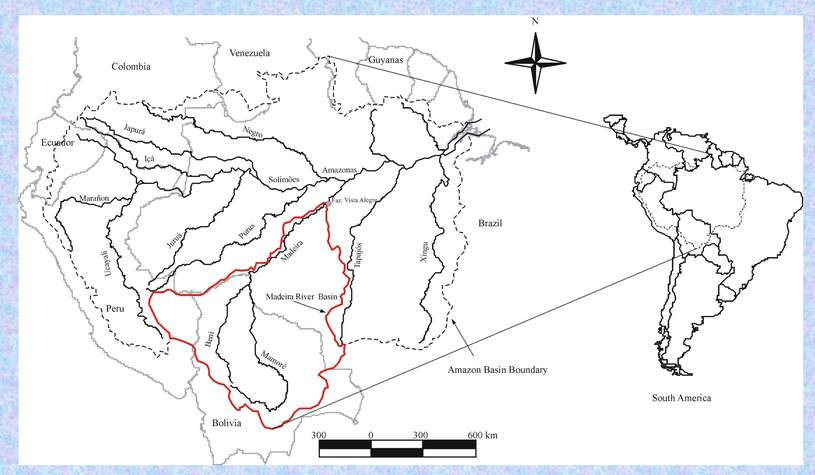
The evapotranspiration is estimated through the Penman-Monteith equation. The flow generated over or in the soil is propagated through the cell using three linear reservoirs. Flow propagation in the river network is based on the Muskingum-Cunge method.

Data Set

- Precipitation data from rain gauges (Brazilian part);
- Precipitation from NCEP/NCAR reanalysis (Bolivian and Peruvian parts);
- Climatological data from the ISLSCP project (net radiation, vapor pressure, air temperature, wind speed and atmospheric pressure);
- Soil map: RADAM-Brasil project;
- Land use map: AVHRR satellite images

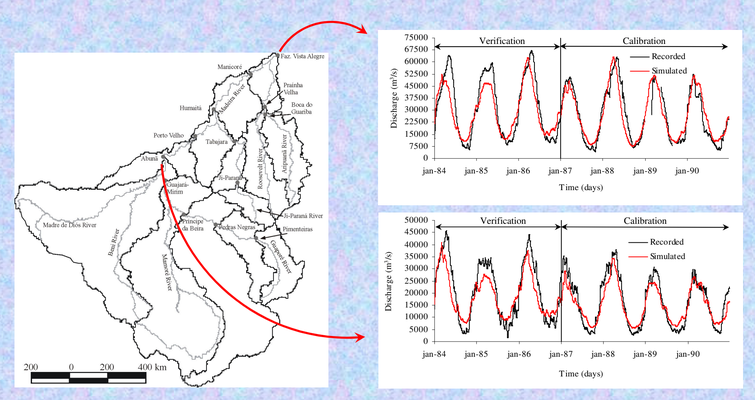
STUDY AREA

The Madeira River basin occupies an area of 1.42 millions km^2. The mean annual rainfall is 1,940 mm and its mean flow is 31,200 m^3.s^{-1}. Although the drainage of the basin is 23% of the Amazon basin, its contribution to total discharge is 15%.



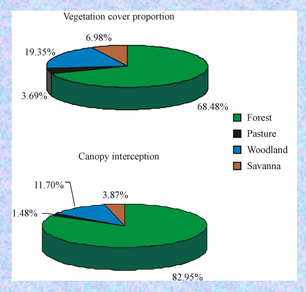
SIMULATIONS USING MGB-IPH

- 13 sub-basins discretized into 0.25° x 0.25°
- Daily time steps
- Calibration period: 1987 - 1990
- Verification period: 1984 - 1986



RESULTS

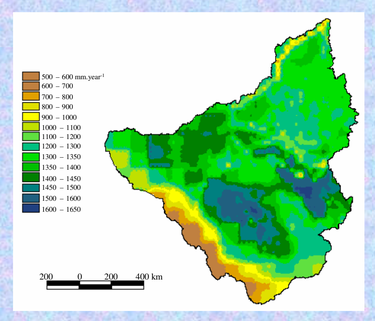
Interception



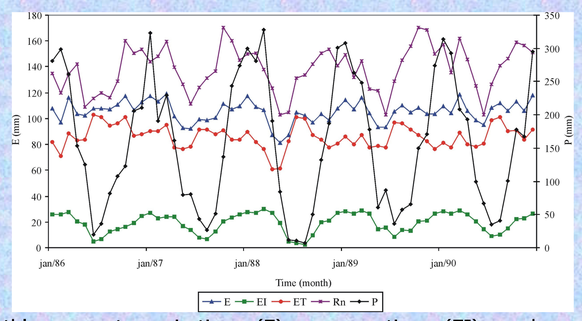
Canopy interception is related to vegetation cover density and precipitation characteristics. In a basin with large forest cover, interception plays an important role. Canopy interception is equivalent to the variation of the interception reservoir in the MGB-IPH. The interception calculated with the model was 13.6% of the mean precipitation in the basin.

Evapotranspiration

In the model simulations, there was enough energy to evaporate all the water intercepted by the vegetation at any time step. The remaining energy was used in the vegetation transpiration process, which depends on the soil moisture state. The mean annual evapotranspiration calculated was 1265 mm for the whole basin.



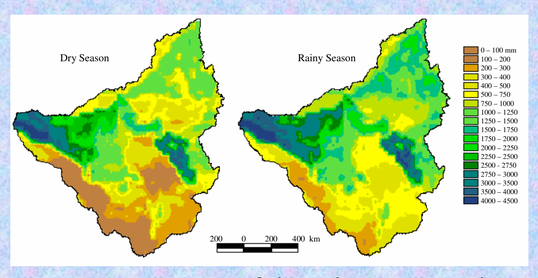
Mean annual space variation of the evapotranspiration calculated with MGB-IPH



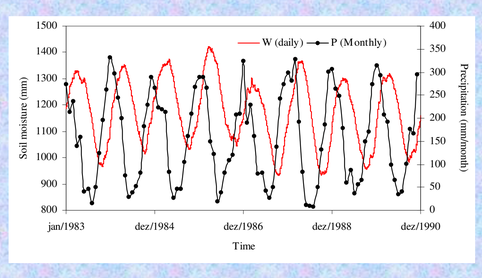
Monthly evapotranspiration (E), evaporation (EI) and vegetation transpiração (ET) using MGB-IPH, net radiation (R_n) and precipitation (P)

Soil Moisture

The water present in the soil is an important variable of the hydrological cycle and of the climate of Amazonia. Under climate change conditions, soil moisture may be affected by a long period of low precipitation rates.

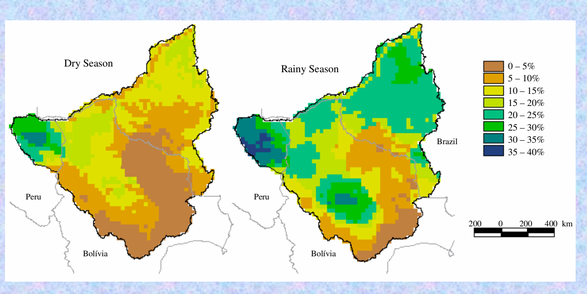


Mean space variation of the soil moisture on the period 1983-1990 calculated with MGB-IPH (dry and rainy season).



Daily soil moisture (calculated with MGB-IPH) and monthly precipitation at the basin.

Flow Generation



Space distribution of saturated soil in the Madeira River basin, calculated with MGB-IPH (dry and rainy season).

In forested basins, a large proportion of the water flows on the surface. In MGB-IPH, the flow generation depends on the proportion of saturated soil in the basin. Mean value of the proportion of saturated soil in the Madeira River basin calculated with MGB-IPH ranged from 12% to 25%.

CONCLUSIONS

The MGB-IPH parameterization was able to represent the hydrological processes of the Amazon basin satisfactorily. The results of the simulations showed an agreement between recorded and simulated discharges. In addition, the hydrological processes estimated with the model were similar to the values measured by research in Amazonia.

The model simulations helped to improve the knowledge about hydrological processes in Amazonia. Moreover, the simulations permitted a large scale evaluation of the processes in opposition to experiments generally carried out in this region. These results make it possible to determine the space distribution of the processes and to identify the most important regions for each variable.

ACKNOWLEDGEMENT