PERÚ | Ministry of Environment | Geophysical Institute of Peru

Hydrologic Modeling in the Western Amazon Basin using Satellite data

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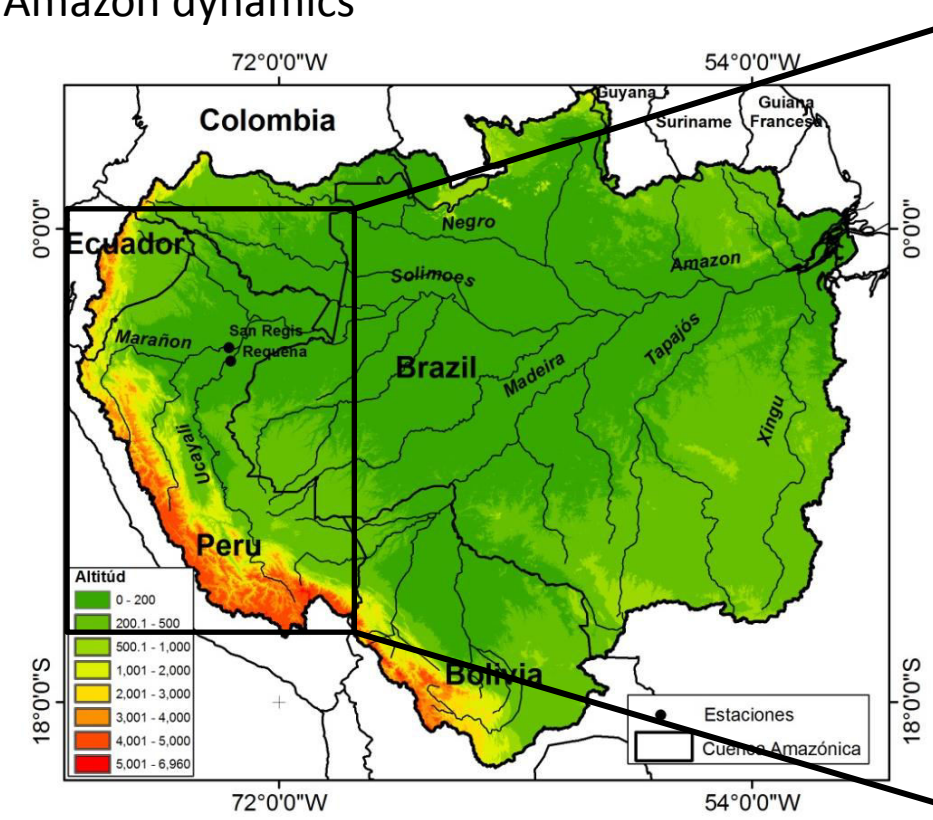
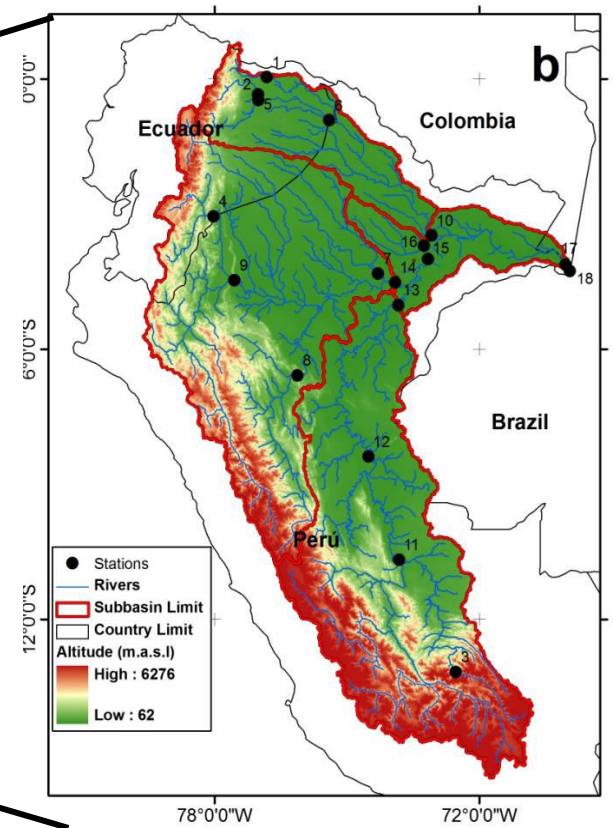
Peru, Amazon country

Over 70% of Peru is in the Amazon basin

98% of the water resources of Peru drain into the Amazon Basin

The Amazon River originates in the Peruvian Andes. The Andes are the "engine" of the Amazon dynamics

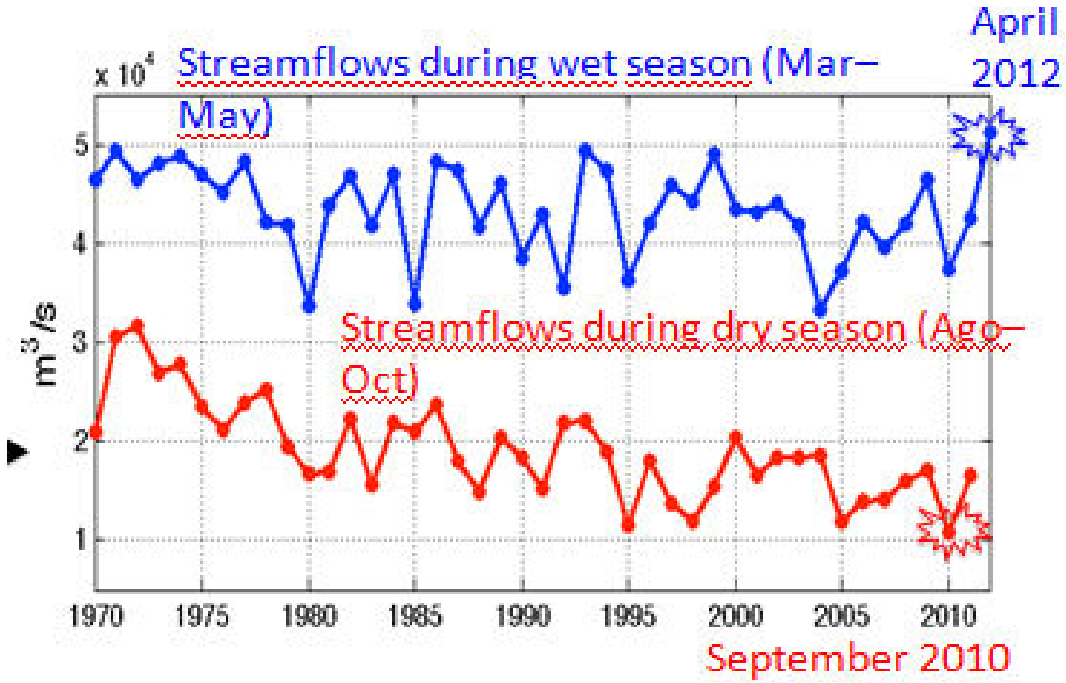




878,305 km2 (To the location station Tabatinga) , average flow 35,000 m3/s(station Tamshiyacu)

Extreme events in Peruvian Amazon Basin (Floods and Droughts)

Fuente: AFP/SENAMHI



http://mexico.cnn.com

(Espinoza et al., 2011, 2012).

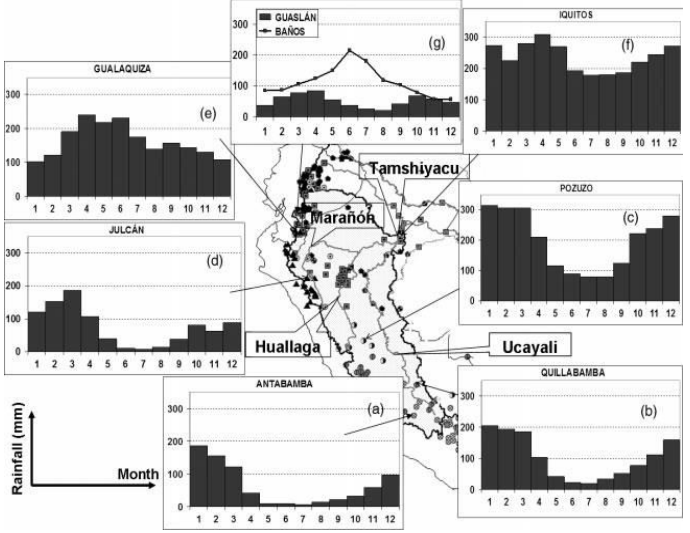
INTRODUCTION

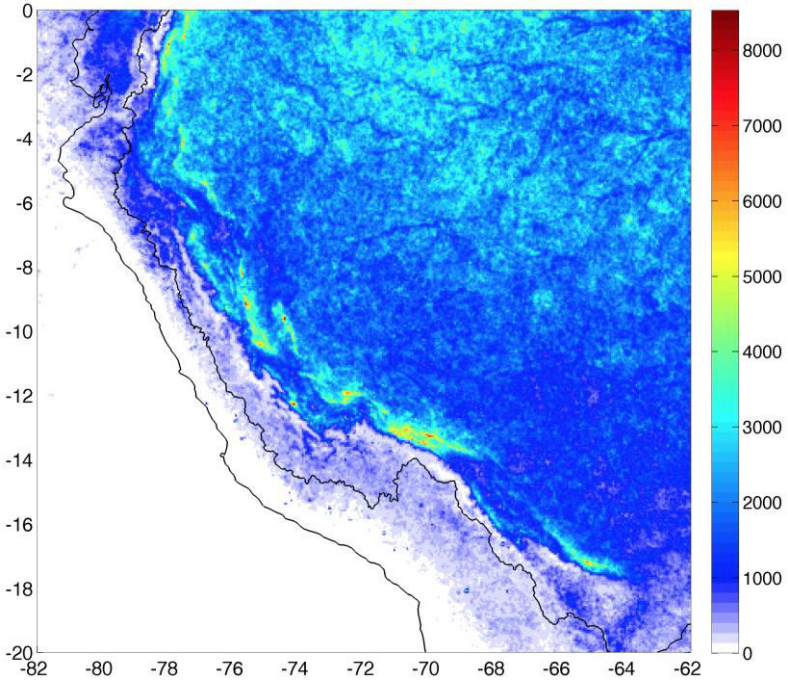
Predictions from rainfall–runoff models are often unsatisfactory because spatial variability in rainfall is poorly represented in regions where data are scarce

furthermore the catch of conventional raingauges is representative of only a small radius around the instrument..

satellite estimates can be an alternative source of data for rainfall-runoff simulation, by improving the spatial distribution of rainfall.

One of the more promising applications of satellite-based rainfall estimates is the coupling of rainfall measured in real time, meteorological forecasts and rainfall–runoff models for flow forecast, since there are very few real-time raingauges in most of the Perú

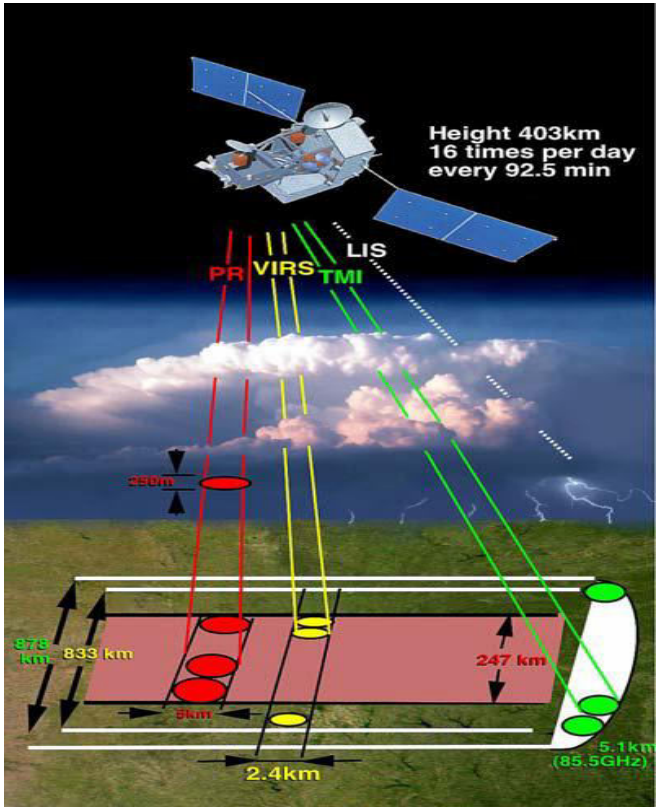




1. **Rainfall regimes in eight stations in the Peruvian and Ecuadorian Amazon basin., (Espinoza et al., 2009).**
2. **Spatial distribution of precipitation from Radar precipitation TRMM (Source : Steven Chavez , paper in preparation)**

Main Objective

Evaluation of the usefulness of the estimates of rainfall, TRMM, CMORPH, PERSIANN as an input variable from the modeling rainfall - runoff in the Peruvian Amazon basin using a distributed hydrological model.



Source: SRTM

Data used

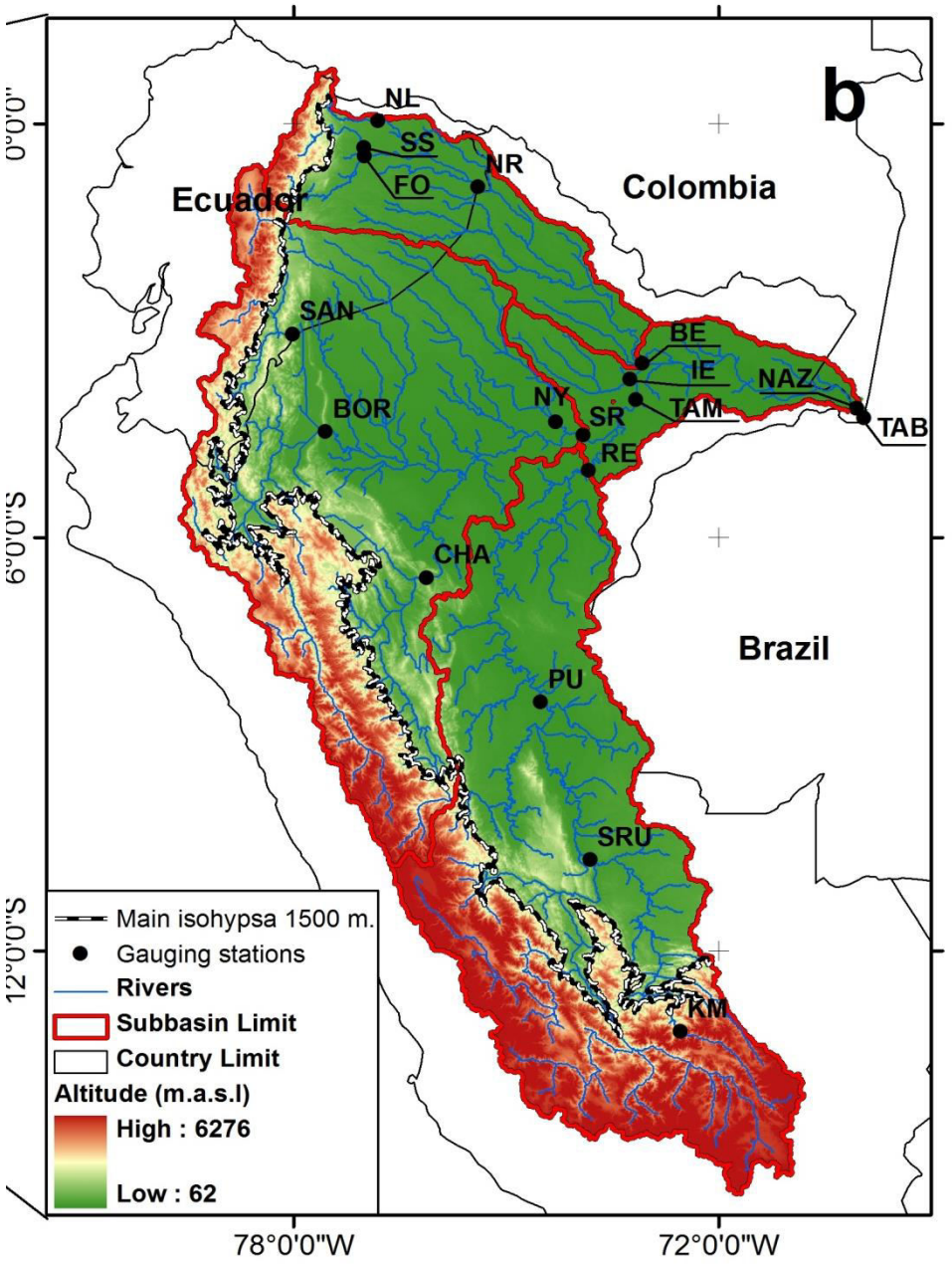
•Observed flows from the network ORE-HYBAM

•Reanalysis NCEP-NCAR (Relative Humidity, Vel. Wind, Solar radiation, air temperature)

•**SRTM** (The Shuttle Radar Topography Mission).

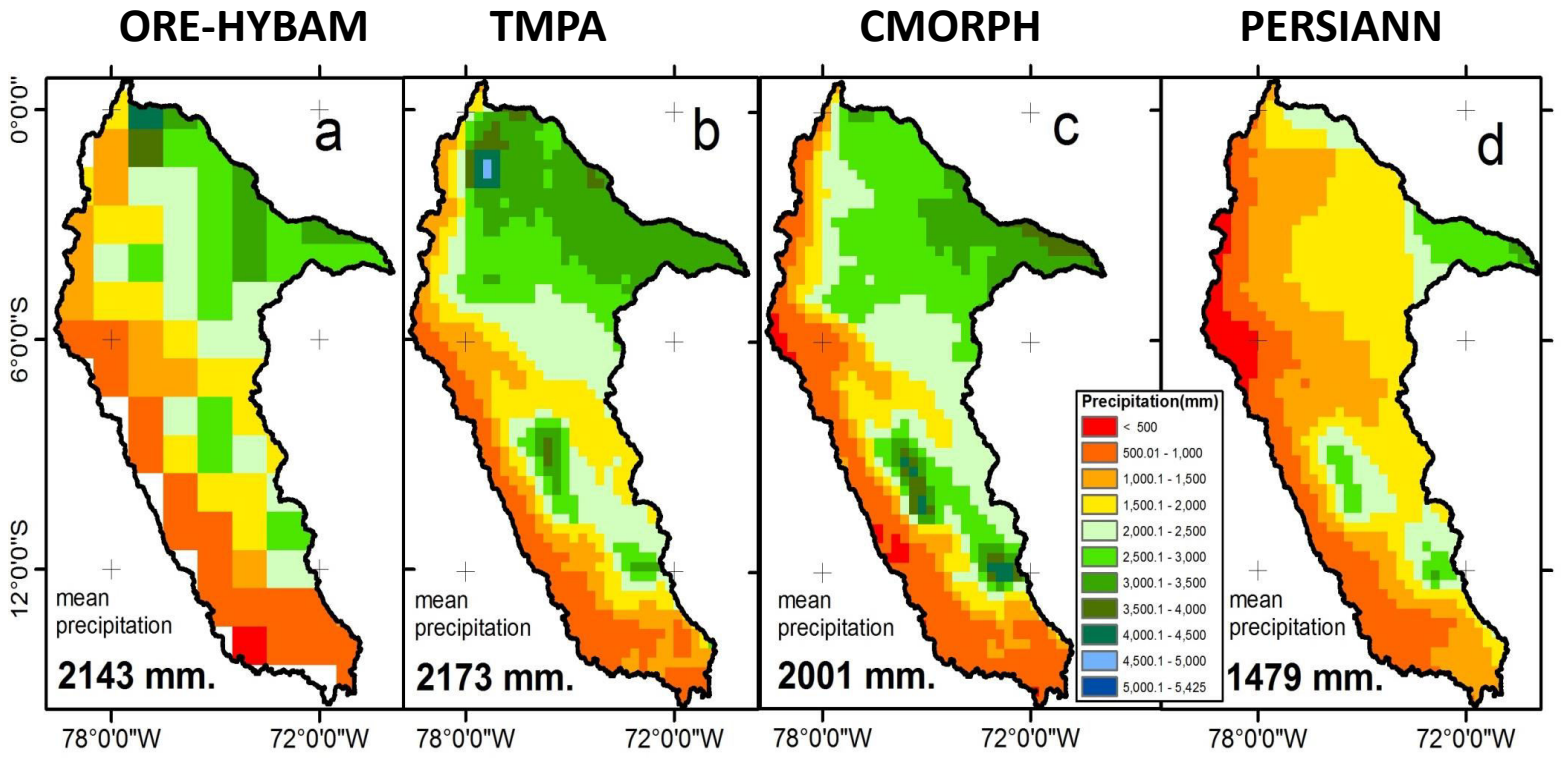
Government Institutions

•Mapa de cobertura vegetal del Perú (INRENA-PERU
•Mapa de suelos del Perú (INRENA)
•Mapa de tipos de vegetación del Ecuador continental (INEFAN 1999)
•Mapa general de suelos del Ecuador (Sociedad Ecuatoriana de la Ciencia del Suelo 1986)
•Mapa de uso de suelo de Colombia (IGAC, 2002)
•Mapa de suelos de Colombia (IGAC, 2005) .



Annual average precipitation 2003-2009

Dataset	Spatial Resolution	Spatial Coverage	Temporal Resolution	Time step	Reference
TMPA	Grid (0.25° x 0.25°)	Quasi global (180°W-180°E, 50°N-50°S)	3 h	01/1998- present	Huffman et al., 2007
CMORPH	Grid (0.25° x 0.25°)	Quasi global (180°W-180°E, 60°N-60°S)	3 h	12/2002- present	Joyce et al., 2004
PERSIANN	Grid (0.25° x 0.25°)	Quasi global (180°W-180°E, 50°N-50°S)	6h	03/2000- present	Sorooshian et al., 2000
ORE-HYBAM	Grid (1° x 1°)	Amazon basin	24h	01/1980-12/2009	Espinoza et al., 2009a; Guimberteau et al., 2012

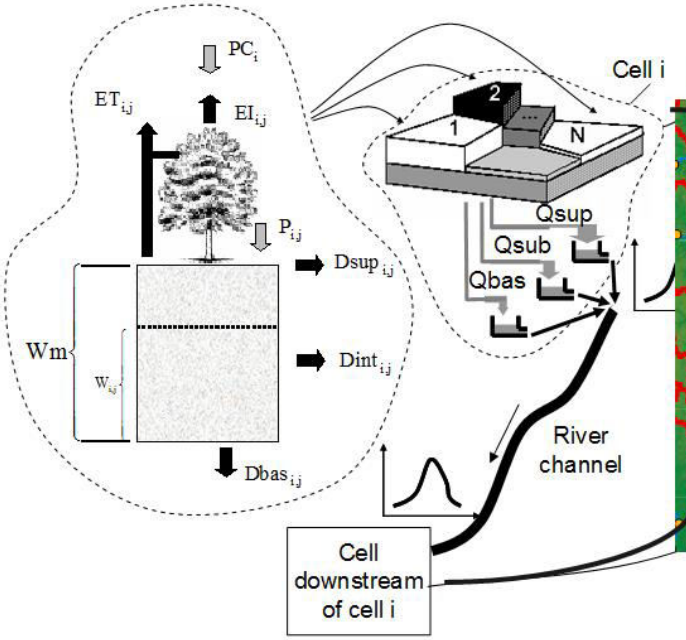


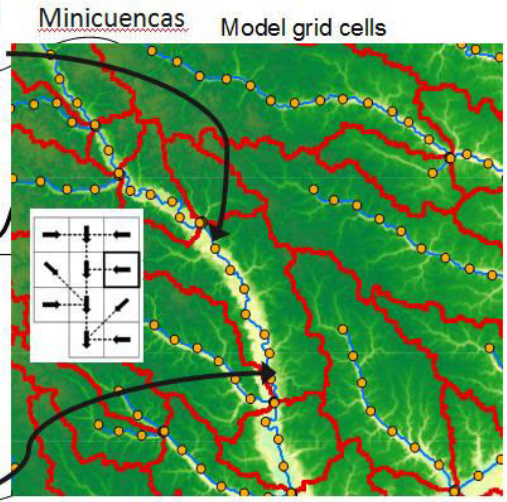
Mean precipitation: (a) TMPA V7, (b) CMORPH , (c) PERSIANN. d) ORE-HYBAM over the PEAAB for each satellite datasets, period from 2003-2009.

MGB-IPH MODEL *METHODOLOGY*

$$W_{i,j}^{k} = W_{i,j}^{k-1} + \left(P_i - ET_{i,j} - Dsup_{i,j} - Dint_{i,j} - Dbas_{i,j}\right)\Delta t \qquad (1)$$

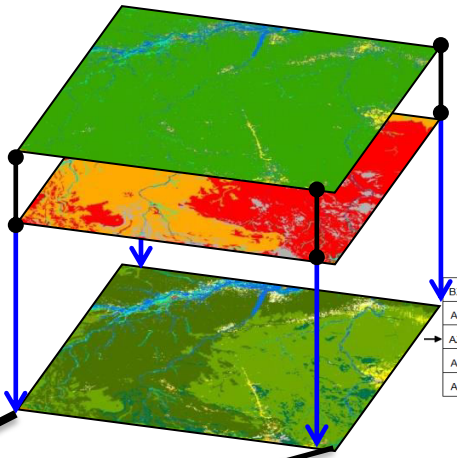
where k, i and j are indexes related to time step, cell and GRU, respectively; Δt is the

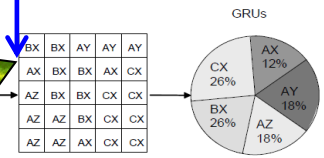




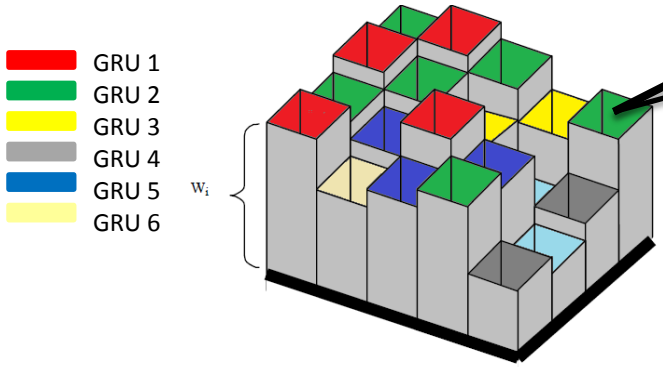
Hydrologic Response Units

Using GIS (Kouwen&Mousavi,2002; Beven, 2001)

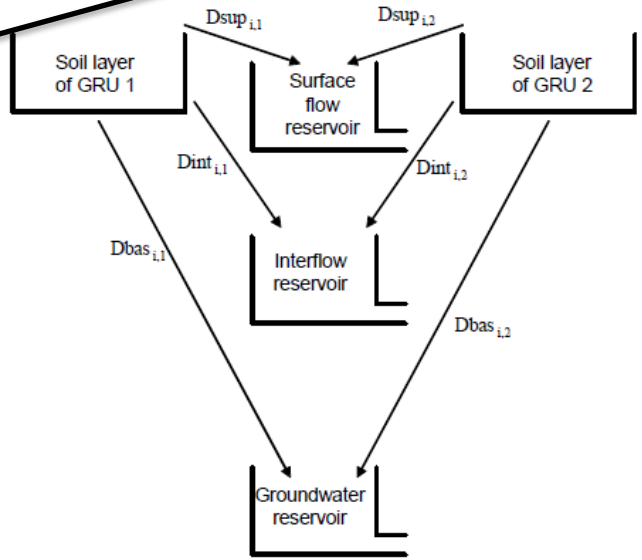




Collischonn 2007

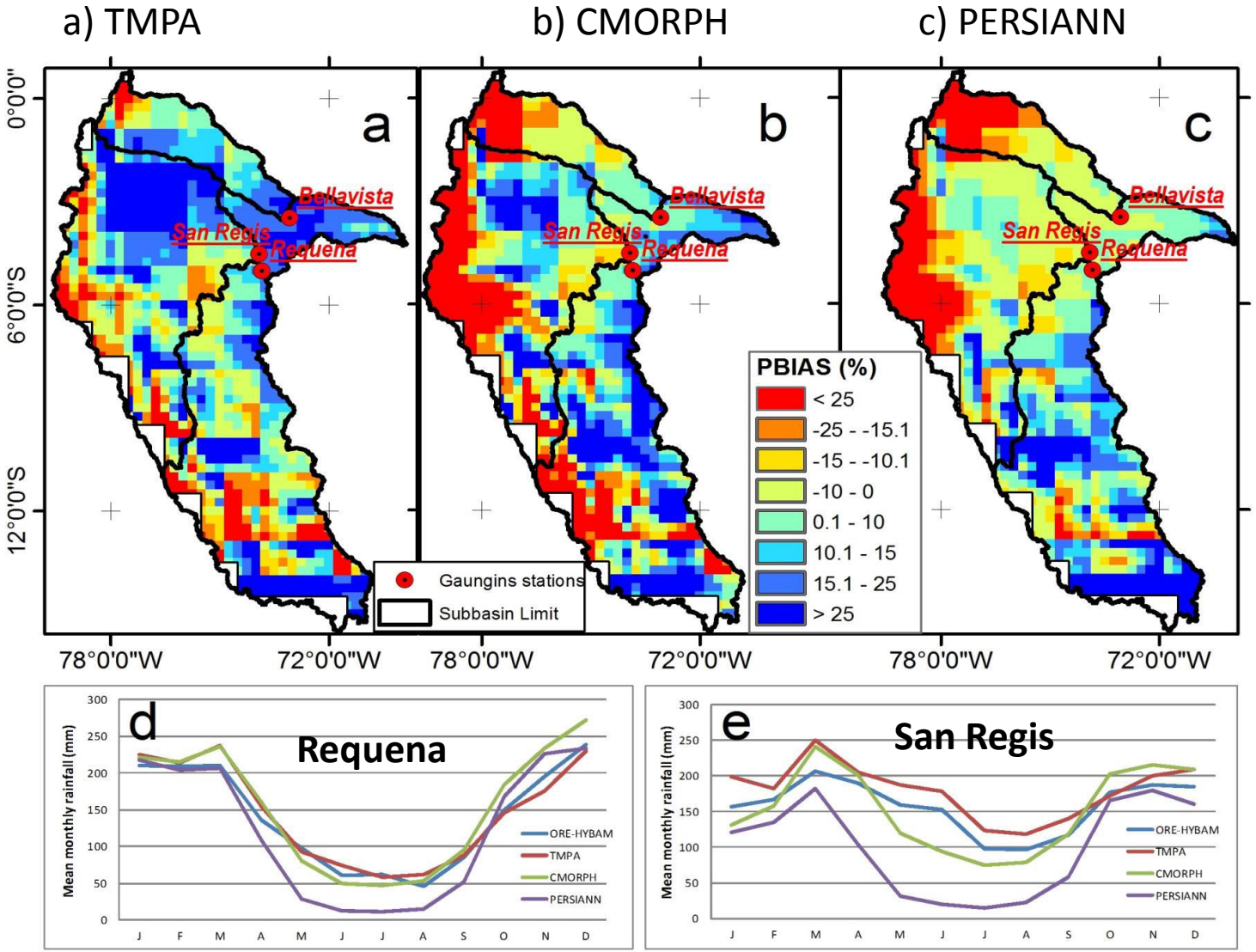


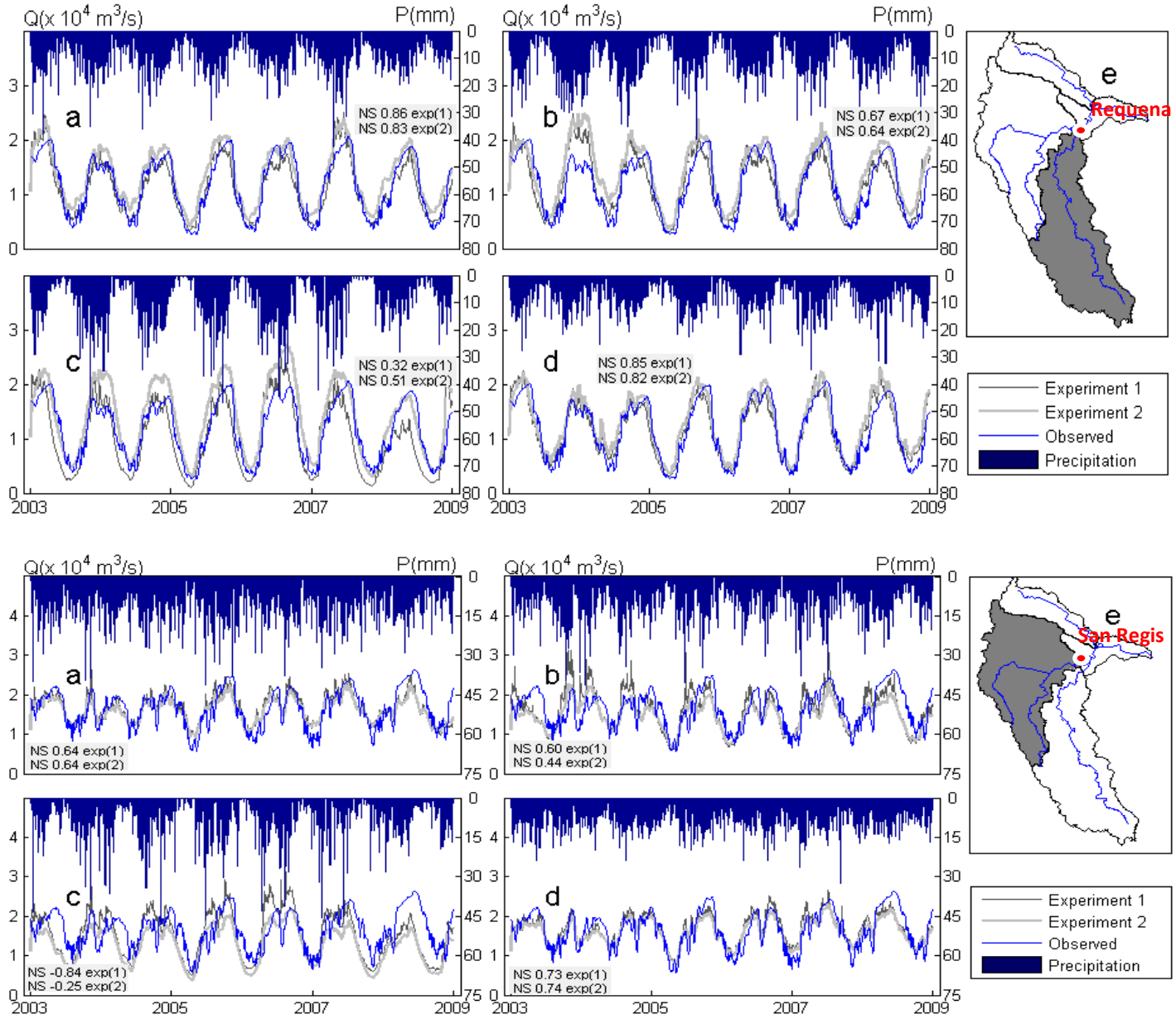
w $_i$ = capacidade de armazenamento de cada um dos reservatórios



Results

Average Bias relative spatial variability with respect to observed data ORE-HYBAM 2003-2009 (a - c) / Average monthly rainfall (d-e).

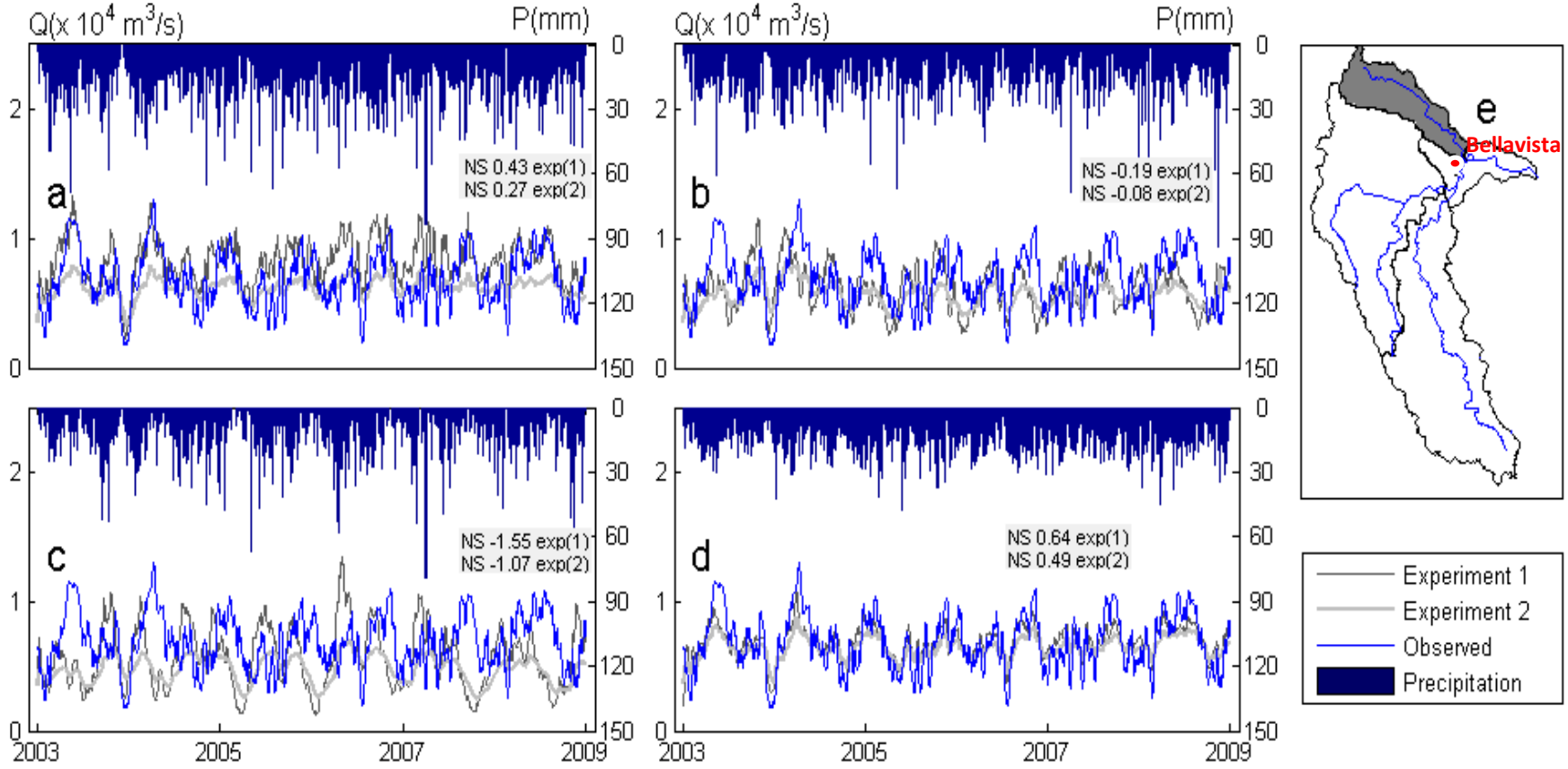




Model Results

Streamflow hydrographs at Requena (over) and San Regis (under)stations, from January 2003 to December 2009: (a) TMPA V7, (b) CMORPH, (c) PERSIANN, (d) ORE HYBAM, and (e) Locations

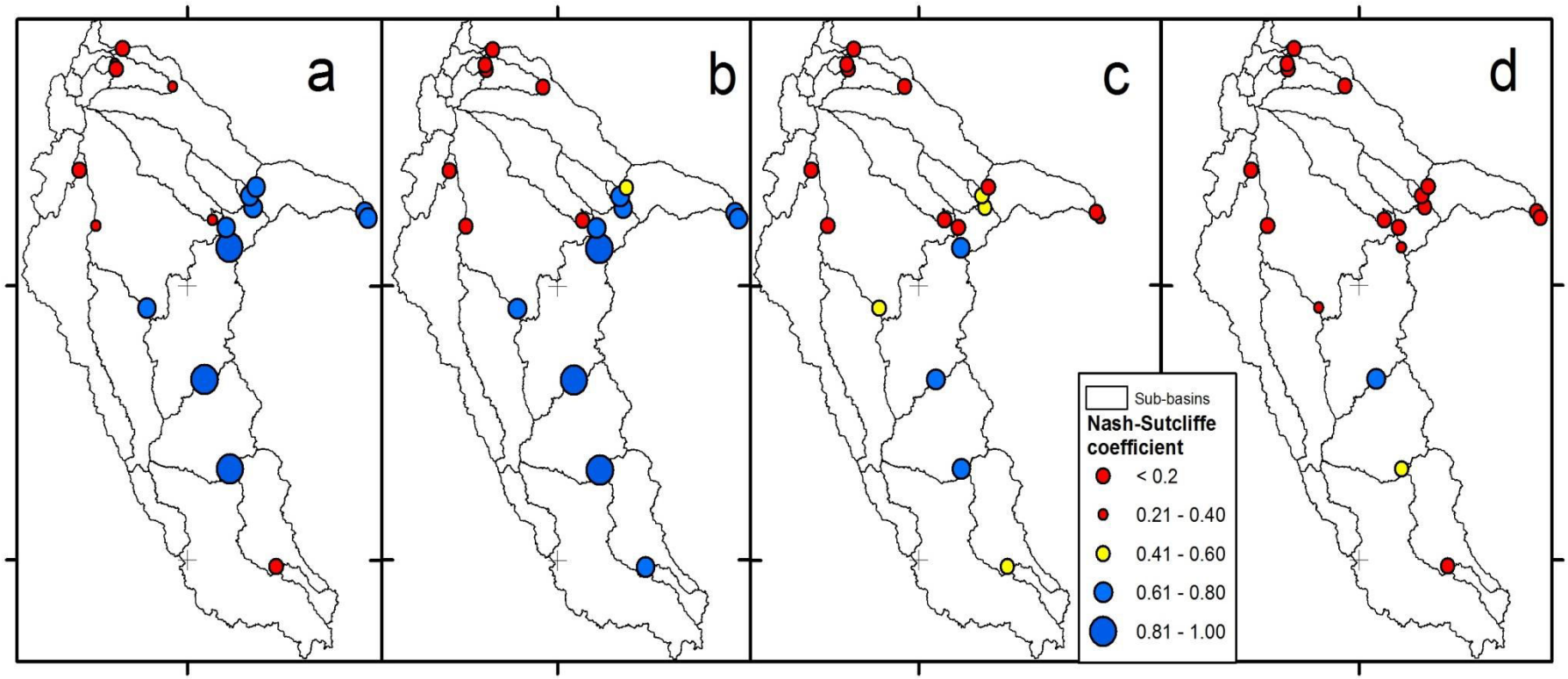
Model results



Streamflow hydrographs at Bellavista station, from January 2003 to December 2009: (a) TMPA V7, (b) CMORPH, (c) PERSIANN, (d) ORE HYBAM, and (e) Location of the Napo river basin.

Nash–Sutcliffe efficiency coefficients maps

ORE-HYBAM **TMPA** **CMORPH** **PERSIANN**



Conclusions

The modeling using precipitation satellite is able to reproduce hydrographs for large river in the Peruvian Amazon, these results suggest that the product 3B42 v7 can be used as input to a hydrological model of rainfall - runoff in the Marañon and Ucayali basins.

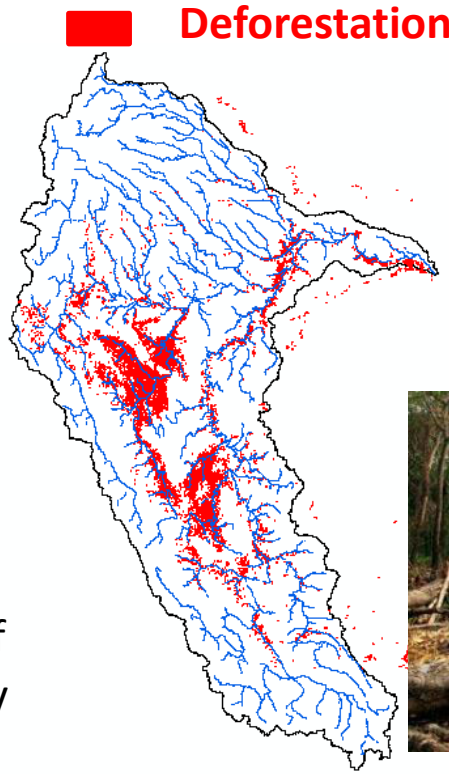
The results show a clear opposition in the performance of the model in the basins located between the north and south of the tropical regions of the Peruvian Amazon, and similar conditions for satellite precipitation products used, this model shows the difficulty of hydrographs represent observed in regions closer to the equator, characterized by weak seasonal variability, achieving performance levels NS <0.4.

Results using HYBAM ground-based dataset in this study, shows better results in model performance, this is mainly when drainage area is greater than 100,000 km^2 (NS>0.64). This indicates that rainfall observed data are even more reliable source than estimates satellite (TMPA, CMORPH, PERSIANN). It is likely that remote sensing of rainfall can improve in the near future. Nonetheless, is very important increase ground based measurements, in order to improve validation mechanisms estimated rainfall.

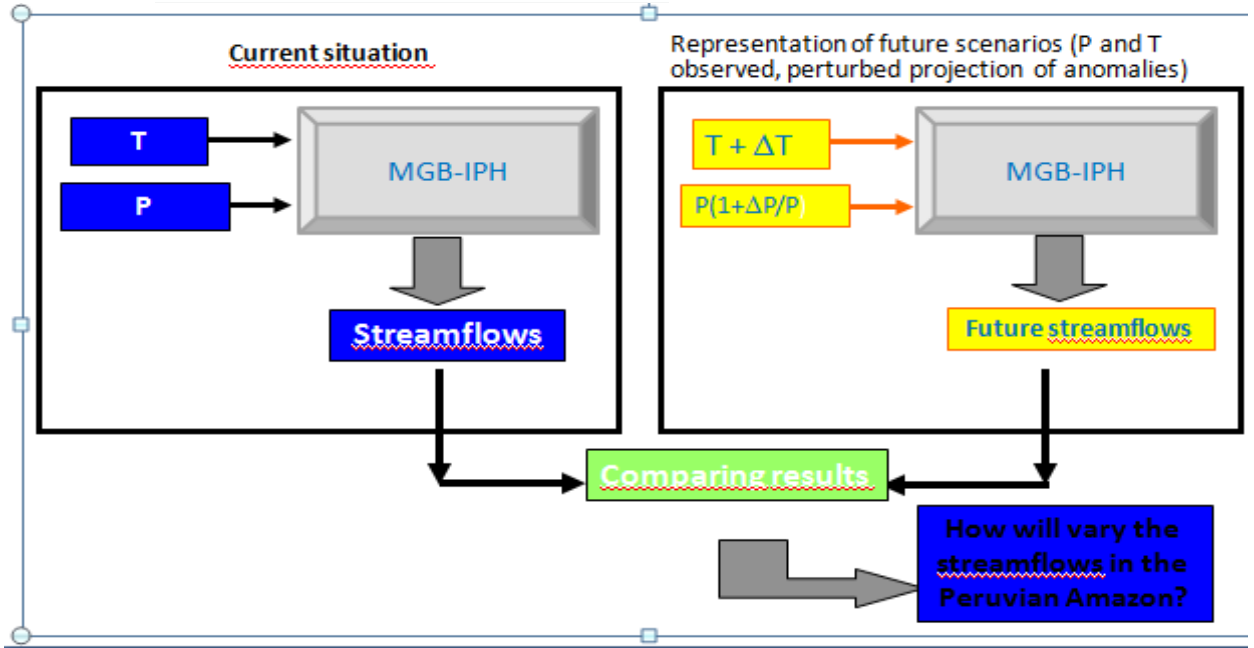
Perspectives

1. what are the impacts of land use change / deforestation on river flows in the Peruvian Amazon?

7, 172 553.97 ha has been deforested, representing 9.25% of the area of the Amazon rainforests of the country and 5.58% of the country (Ministry of Environment, 2009)



2. what are the impacts of Climate Change in the Peruvian Amazon?



THANK YOU
GRACIAS
MERCI
OBRIGADO

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Senamhi

IRD Institut de recherche pour le développement

HOMINEM CUPIO ET AGRUM COLERE

HiBAm

CONCYTEC CONSEJO NACIONAL DE CIENCIA, TECNOLOGÍA E INNOVACIÓN TECNOLÓGICA