Hydrologic issues

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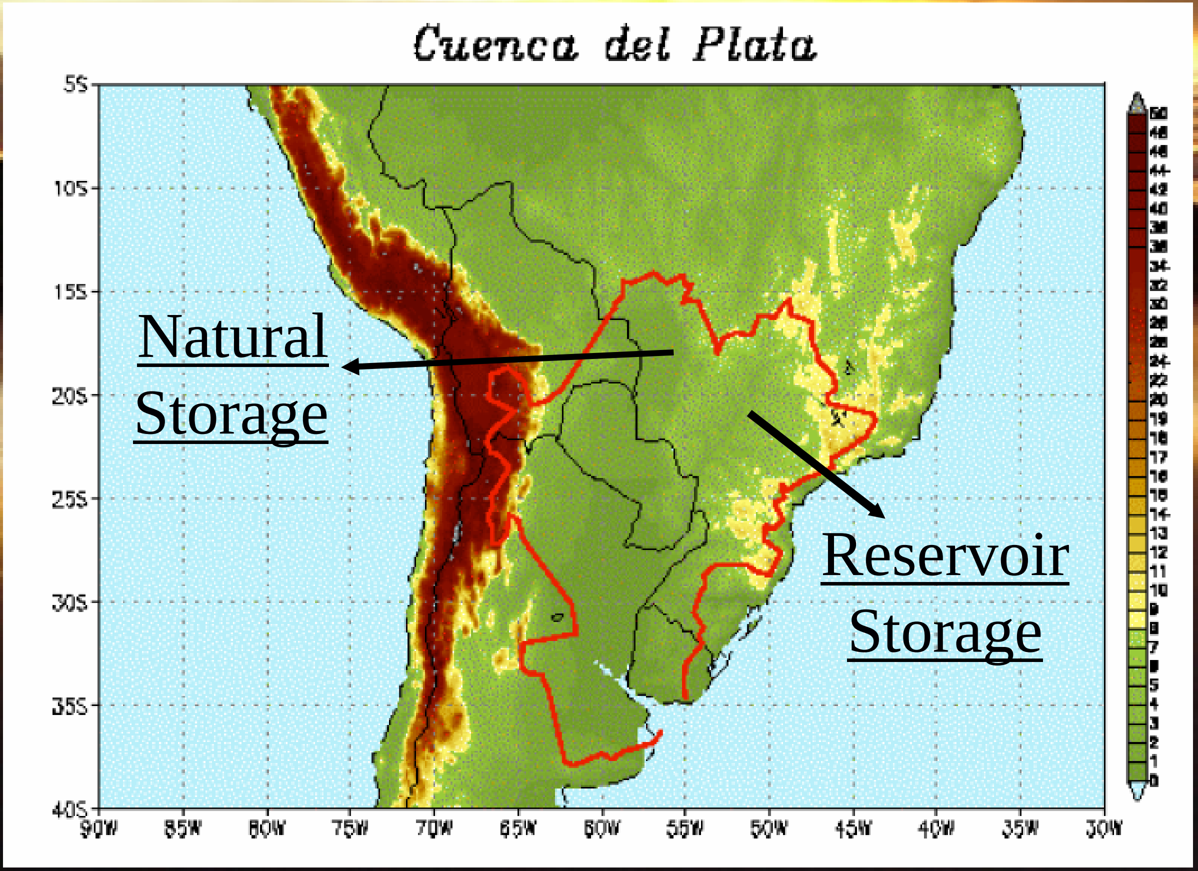
Scientific questions

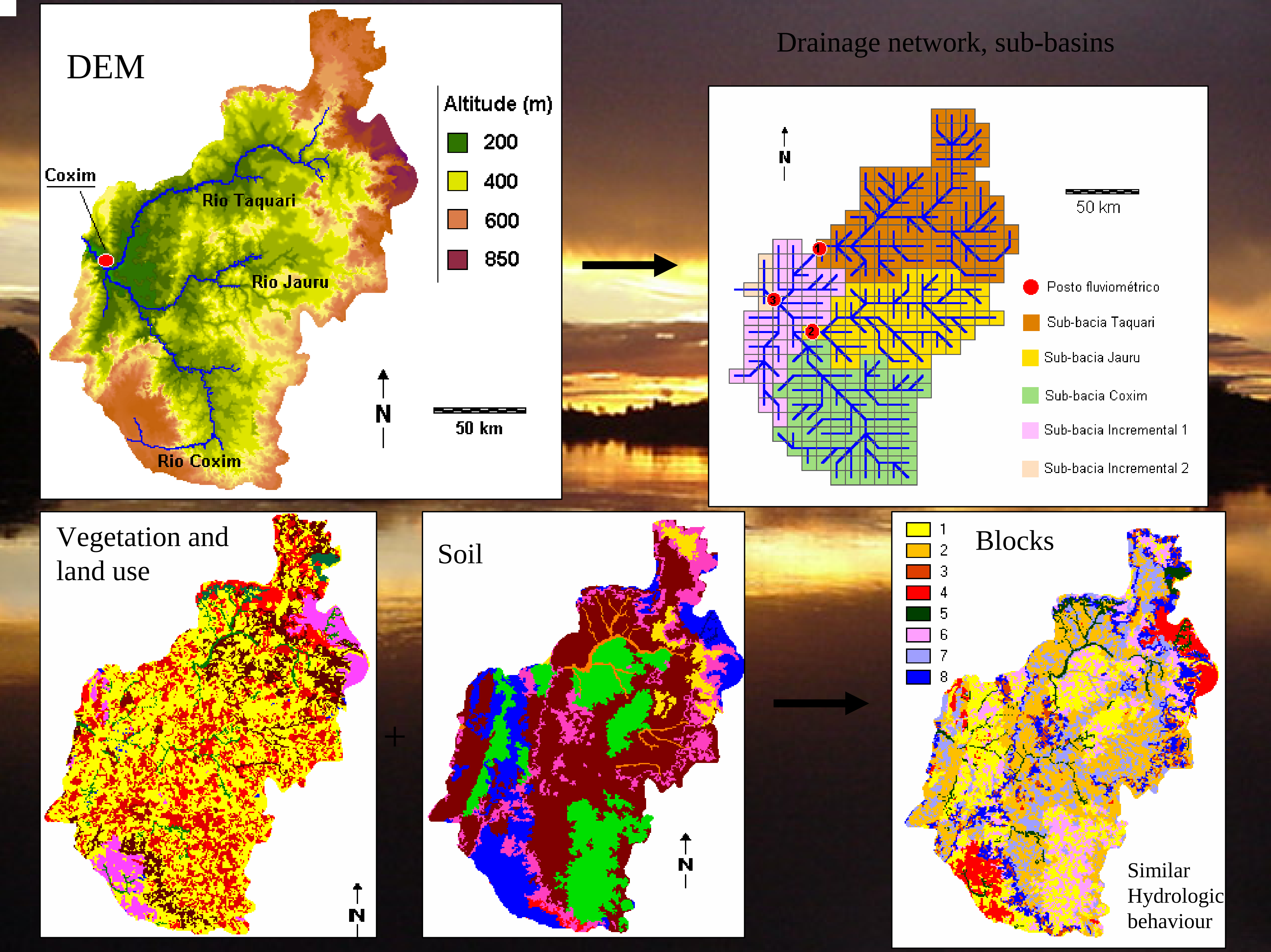
- *What role do **soil processes** play in the basin?*
- *Do the large variations in the **flooded area of the Pantanal** impact and are themselves influenced by the variations in the region's climatology?*
- *Does water evaporated from the Pantanal wetland fall as precipitation elsewhere within the Plata Basin? If so, how much is **recycled**, and where does it fall?*
- *What developments and improvements in **hydrological models** are required to better represent the relationships among model parameters and changes in soil use?*

Hydrology of LPB



Hydrologic modelling

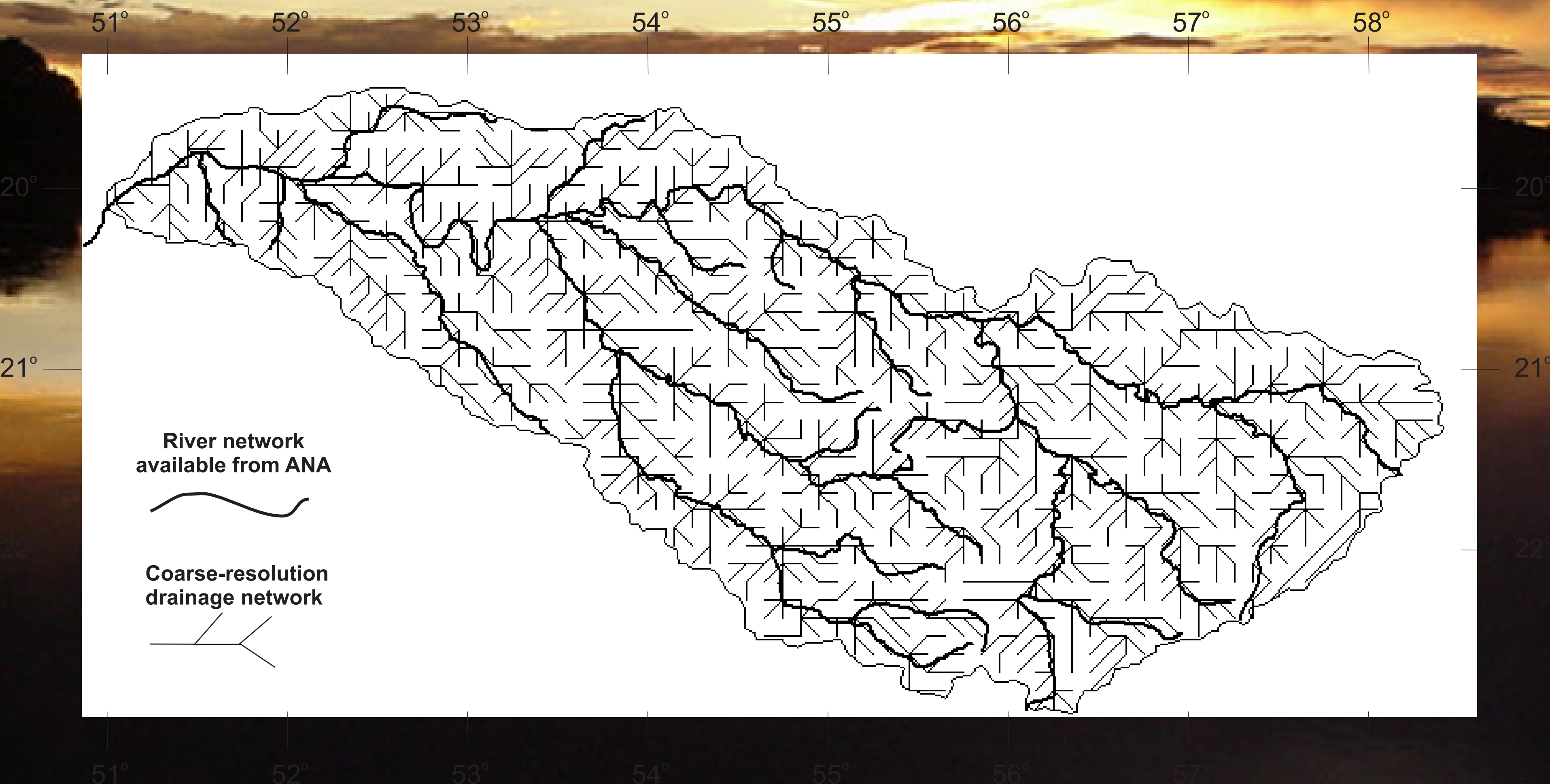
- Macro-scale hydrologic model
- Several parts of the LPB already modelled
- Attempts to evaluate land use change effects
- Climatic variability effects
- Streamflow forecasts based on Precipitation Forecasts
- Verification of satellite estimates of precipitation (TRMM and Hidroestimador)
- Use of reanalysis data


DEM
Altitude (m)
200
400
600
850
Coxim
Rio Taquari
Rio Jauru
Rio Coxim
N
50 km
Drainage network, sub-basins
N
50 km
Posto fluviométrico
Sub-bacia Taquari
Sub-bacia Jauru
Sub-bacia Coxim
Sub-bacia Incremental 1
Sub-bacia Incremental 2
Vegetation and land use
N
Soil
N
Blocks
1
2
3
4
5
6
7
8
Similar Hydrologic behaviour

Free regional/global available information

- Soil data:
  - FAO (1974)
  - Soil and Terrain Digital Database for Latin America and the Caribbean (SOTERLAC, 1993-1997)
  - RADAM Brasil project;
- Topography data:
  - Shuttle Radar Topographic Mission (SRTM)
  - Global 30 Arc-Second Elevation Dataset (GTOPO30);
- Land cover:
  - Global Land Cover Characteristics Data Base (USGS)
  - LANDSAT images from Earth Science Data Interface (ESDI) at the Global Land Cover Facility;
- Climate:
  - NOAA
  - NCEP
  - METeorological Aerodrome Report
  - National Water Resources Agency of Brazil (ANA);

Grande river basin drainage network



Ended and ongoing applications of the hydrological model

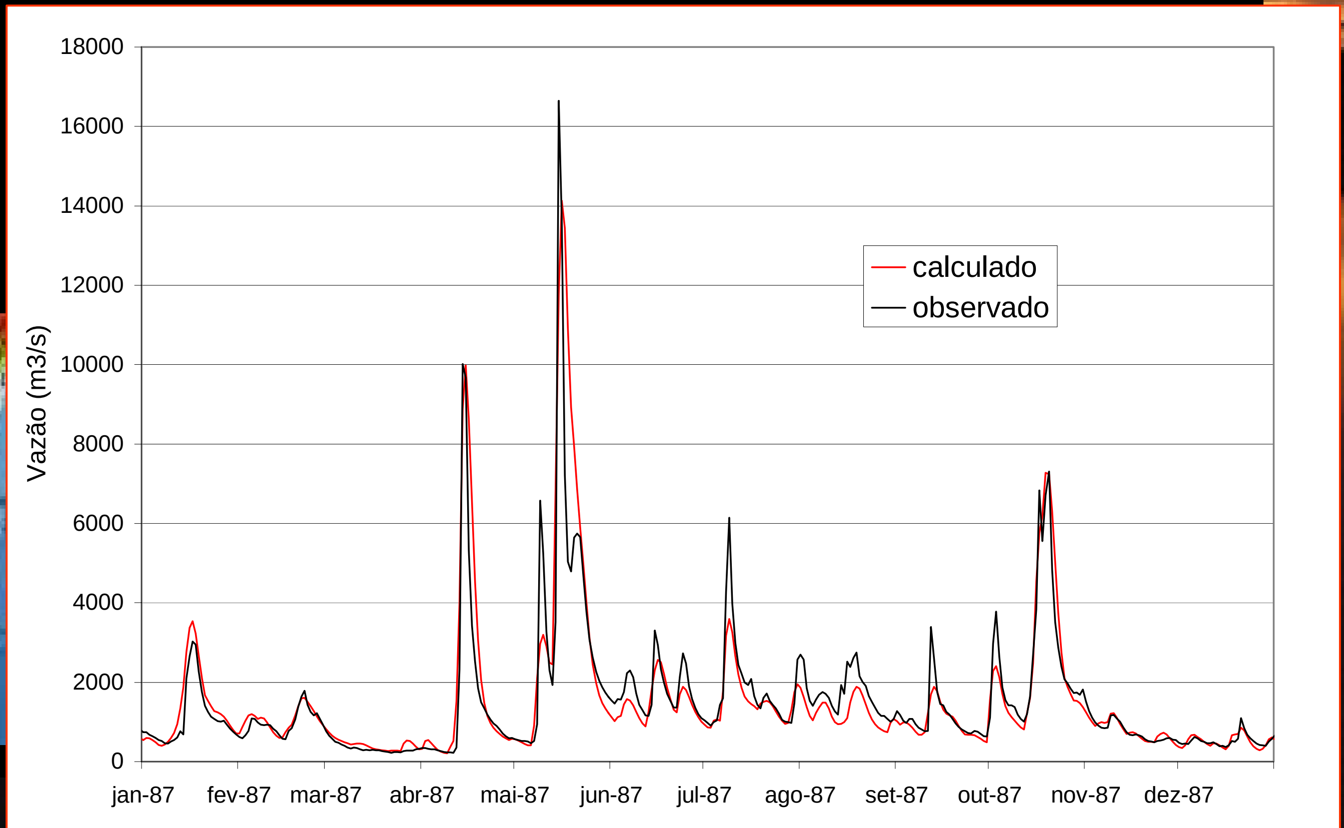
- 1) Taquari-Antas
- 2) Uruguay*
- 3) Paraguay*
- 4) São Francisco
- 5) Corumbá*
- 6) Paraná to Itaipu*
- 7) Paranaíba*
- 8) Tapajós
- 9) Madeira

- * (inside LPB)

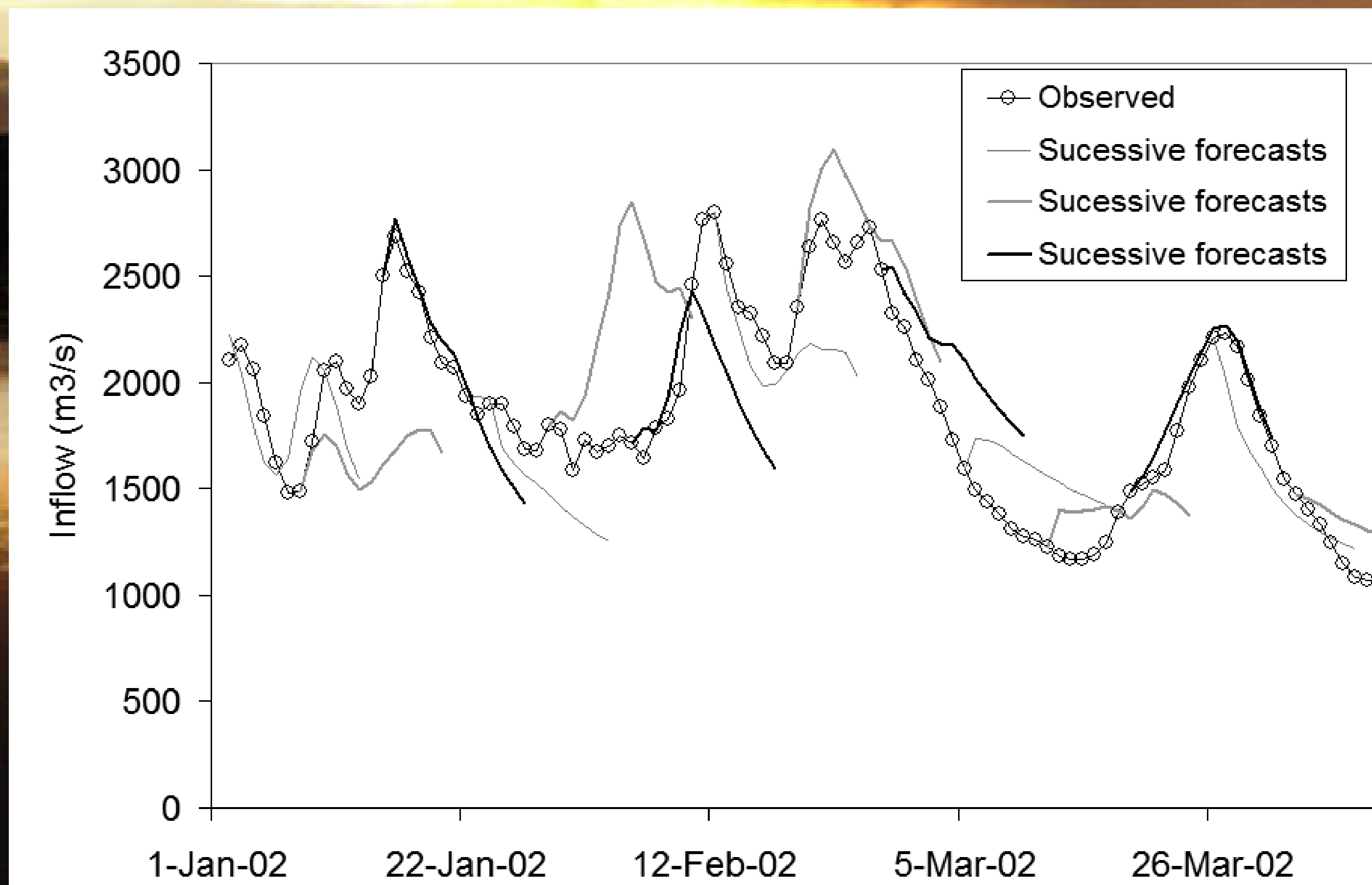
Parameters are calibrated but are related to the blocks, or patches, which means they have the same value for the same land use + soil types.

Application with parameters calibrated on neighbour basin give good results.

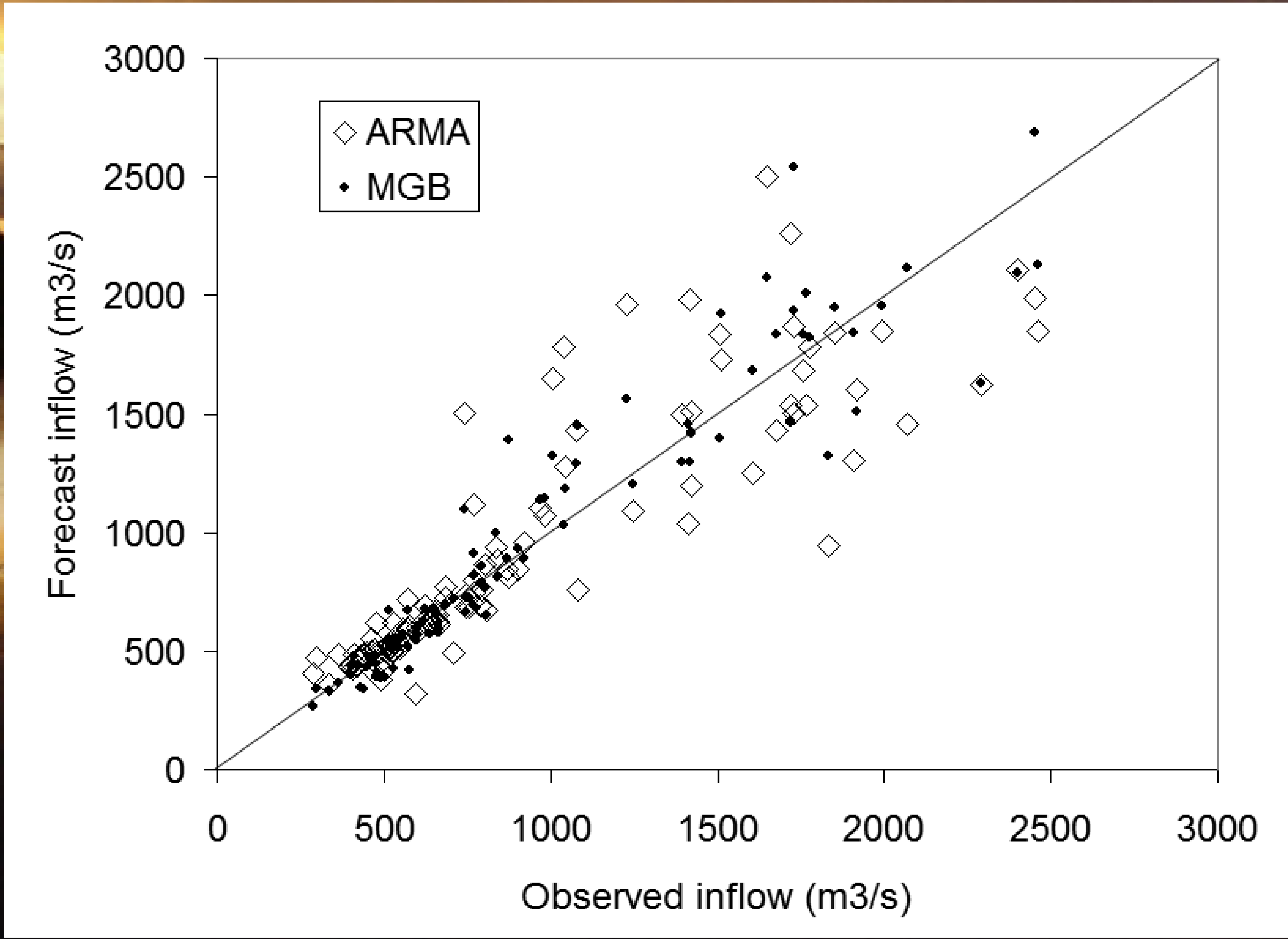
Example: Calculated versus observed hydrograph in river Uruguay with model parameters calibrated for the Taquari Antas basin (the basins have similar geological characteristics and climate)



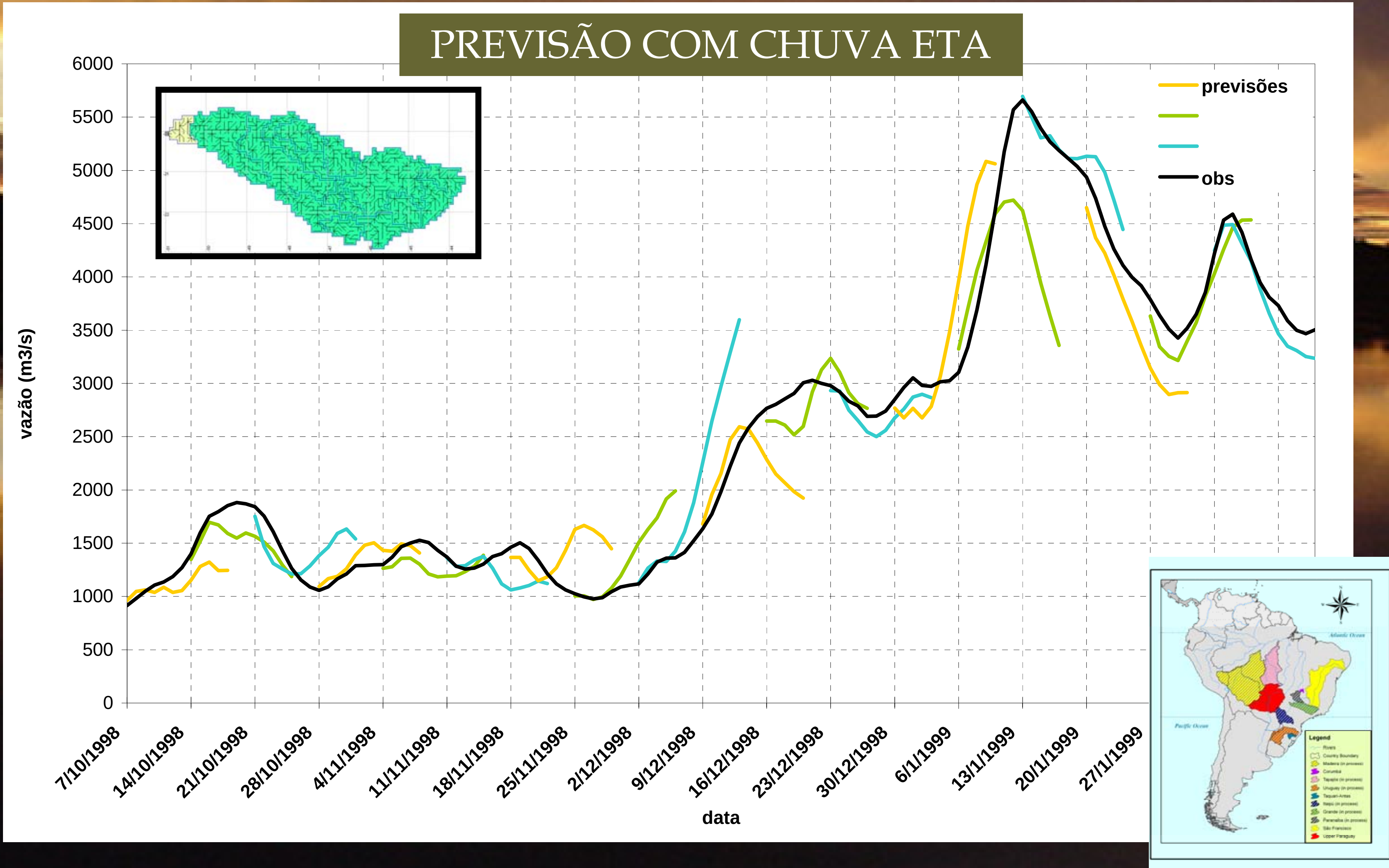
Streamflow forecasting using medium range ETA/CPTEC forecasts



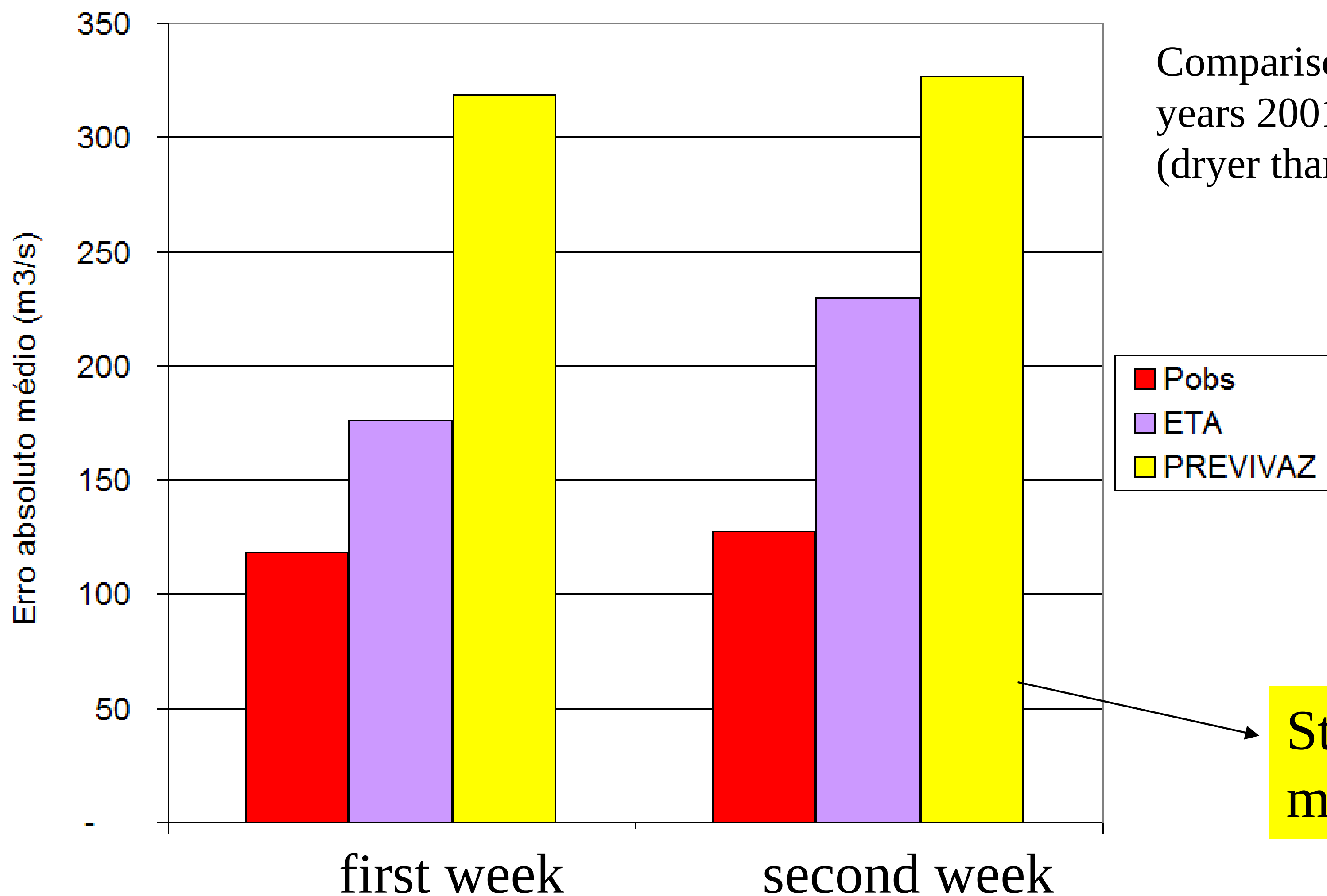
Comparison with forecasts currently in use



Previsão de vazões de curto prazo – ÁGUA VERMELHA



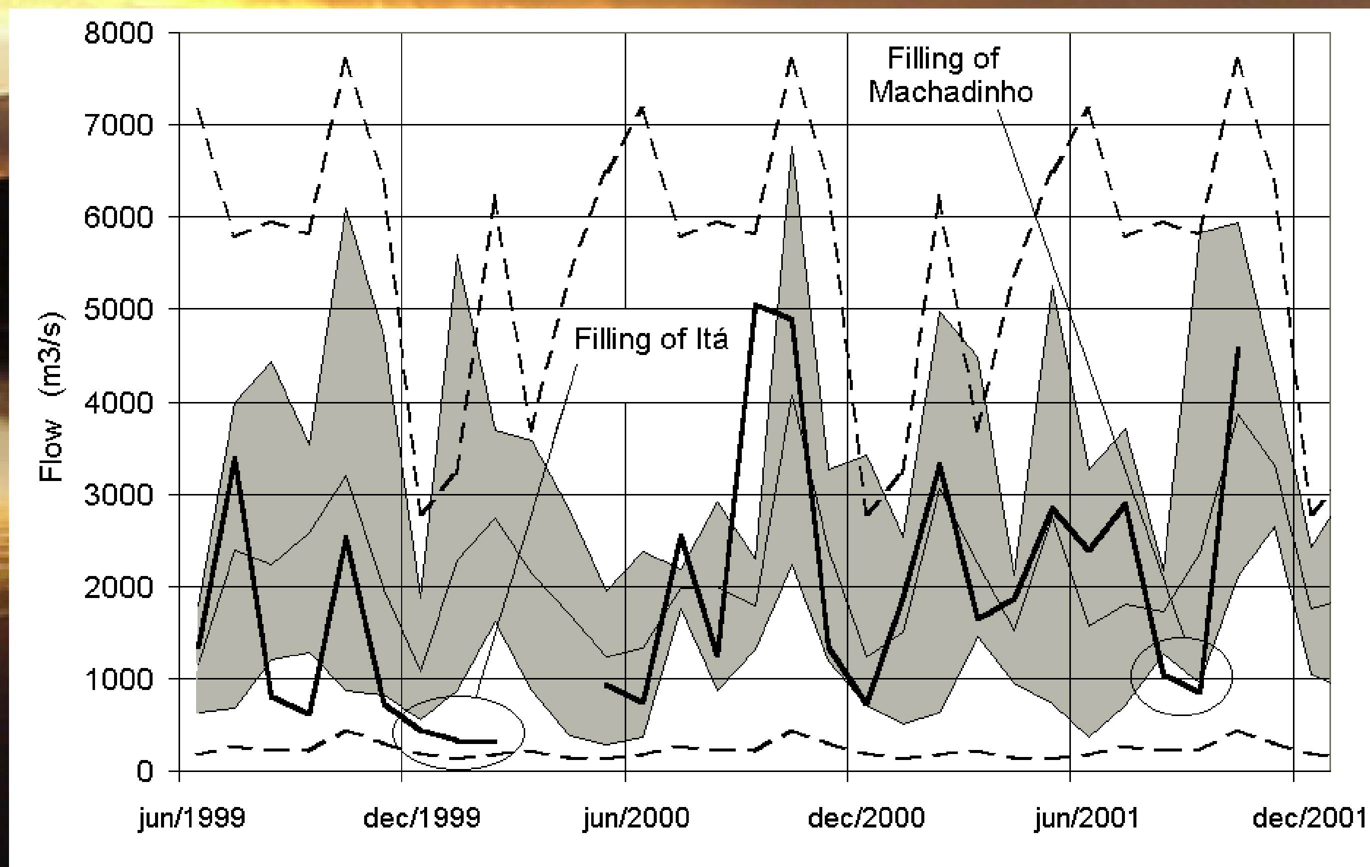
Mean error compared to stochastic model that is in operational use today



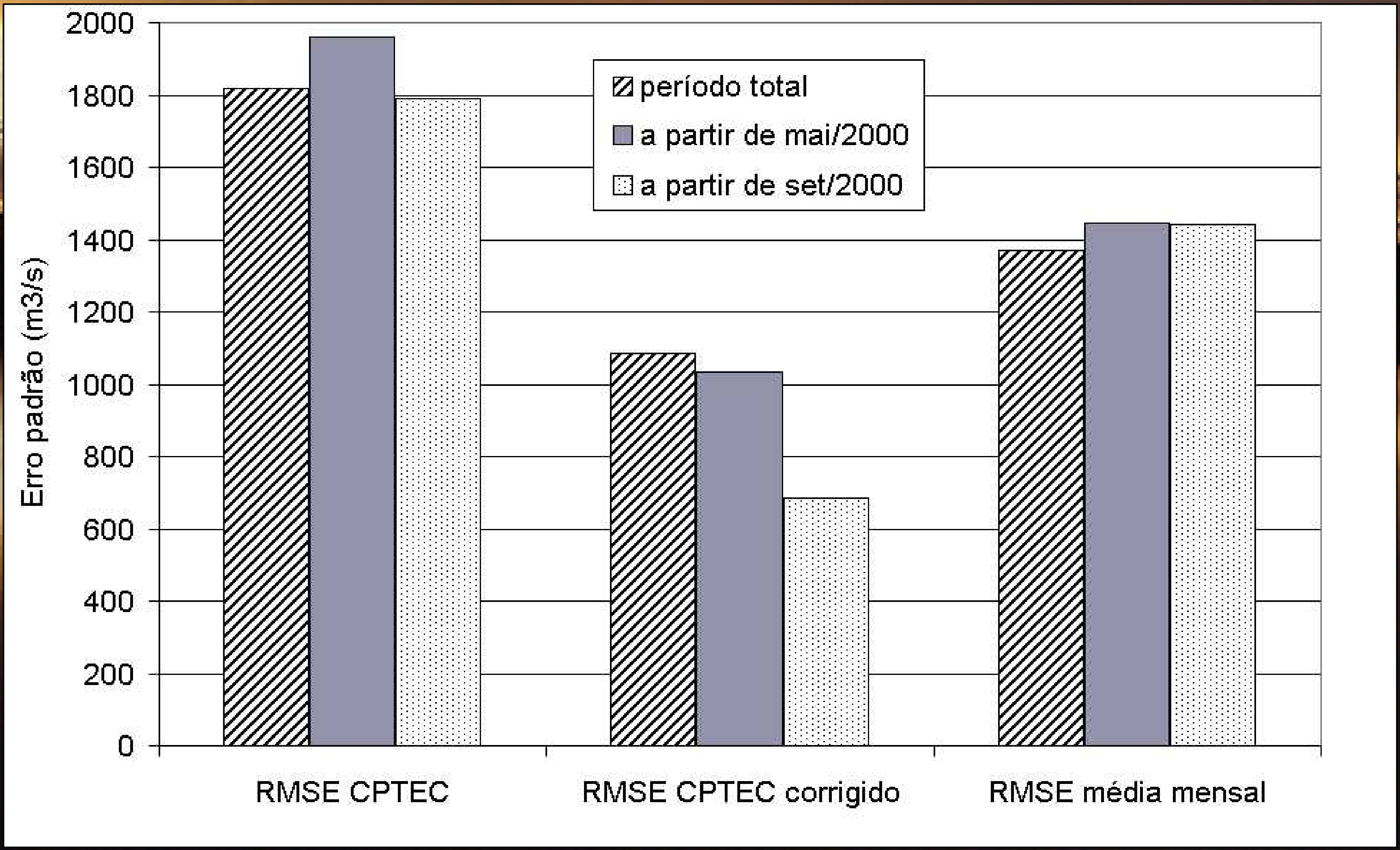
Comparison for years 2001 and 2002 (dryer than normal)

Stochastic model

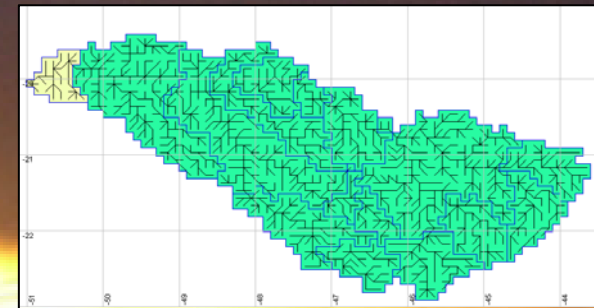
Long range forecasts



Forecasting errors

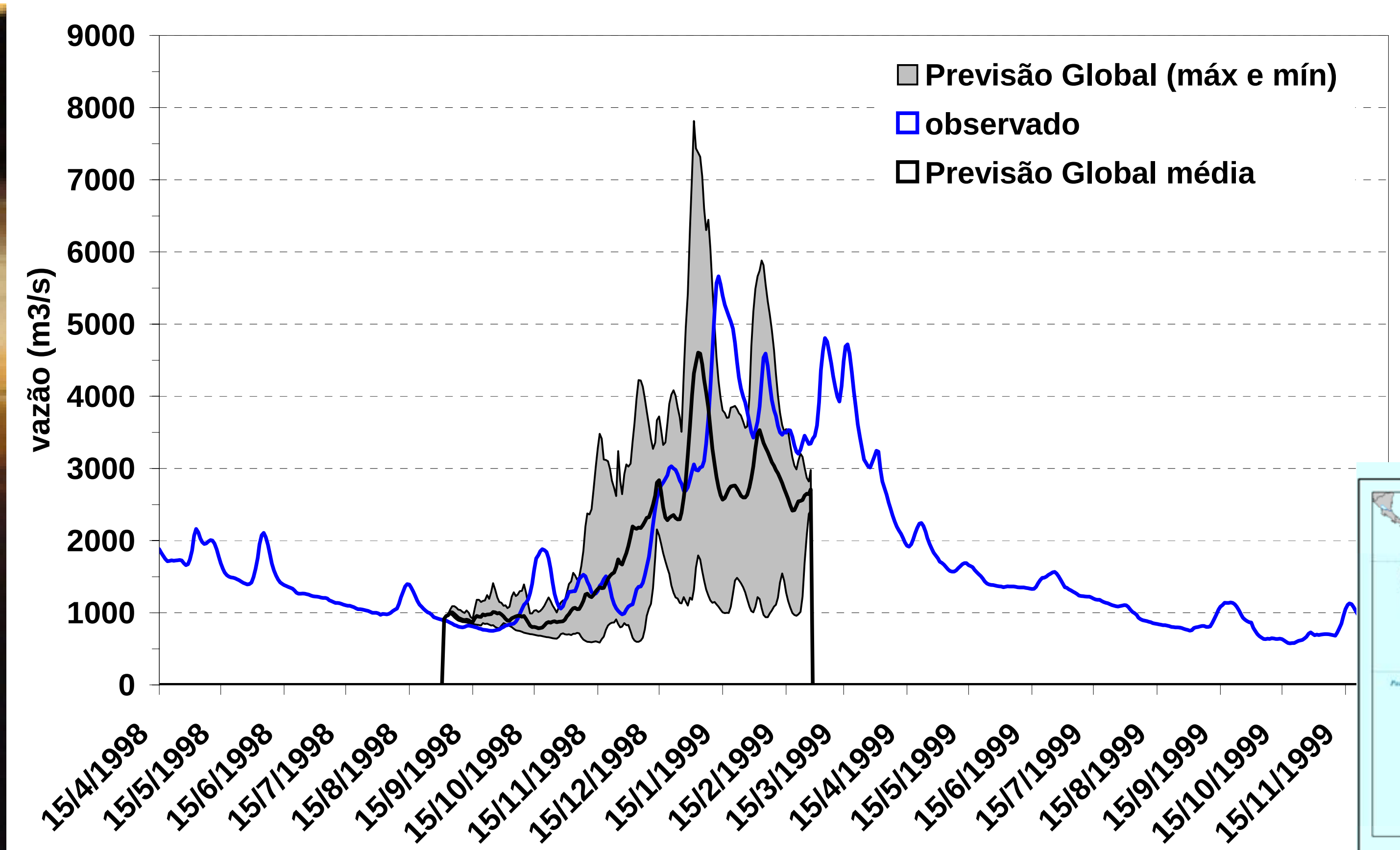


Previsão de vazão de longo prazo – ÁGUA VERMELHA

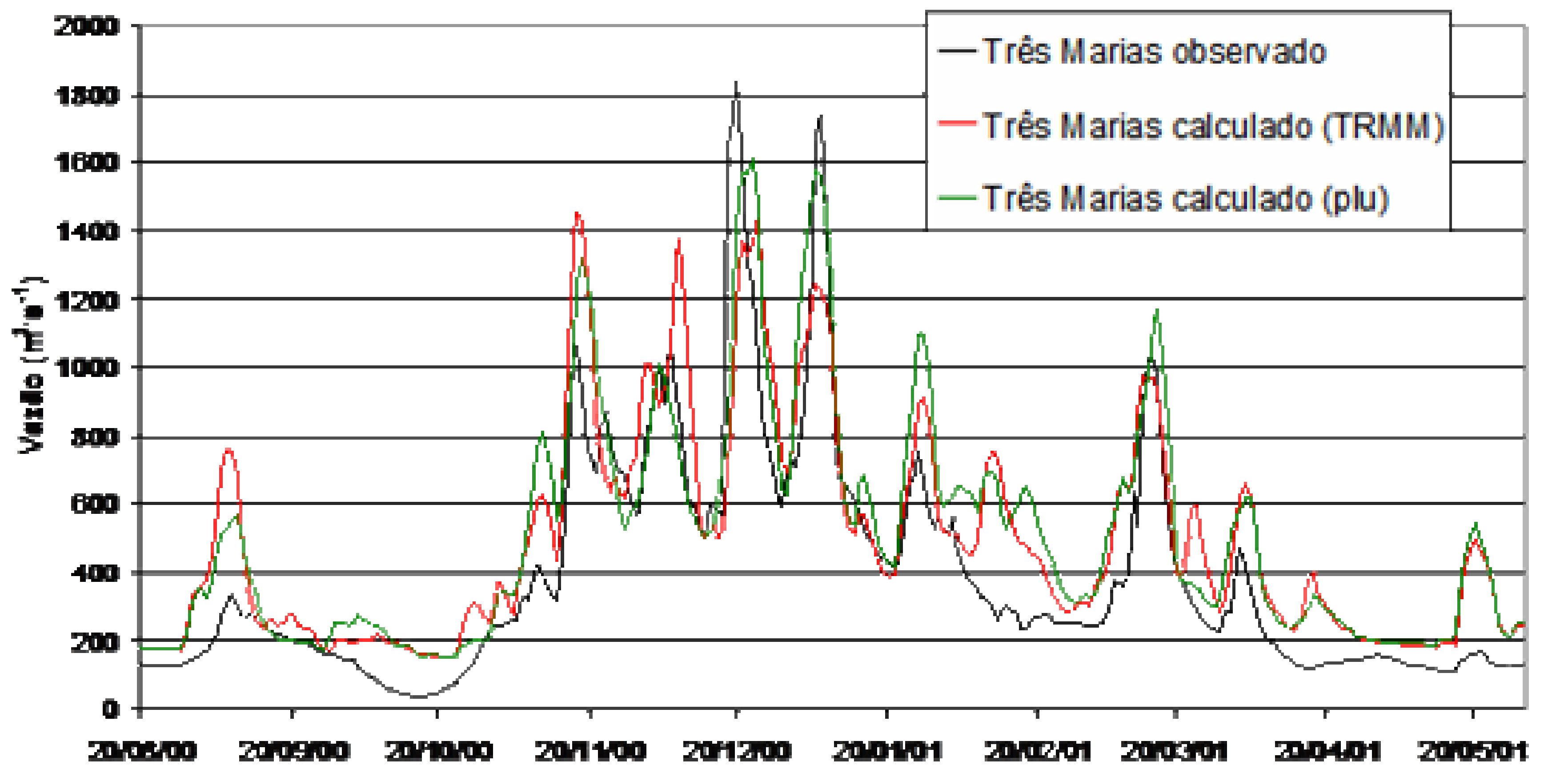


- rodada do modelo global de jun/98, com previsão de precipitação de set/98 a fev/99 (até seis meses de antecedência).

Previsão de vazões em Água Vermelha – COM correção do Global



Use of sattellite estimates of precipitation



Challenges and opportunities in hydrologic model development

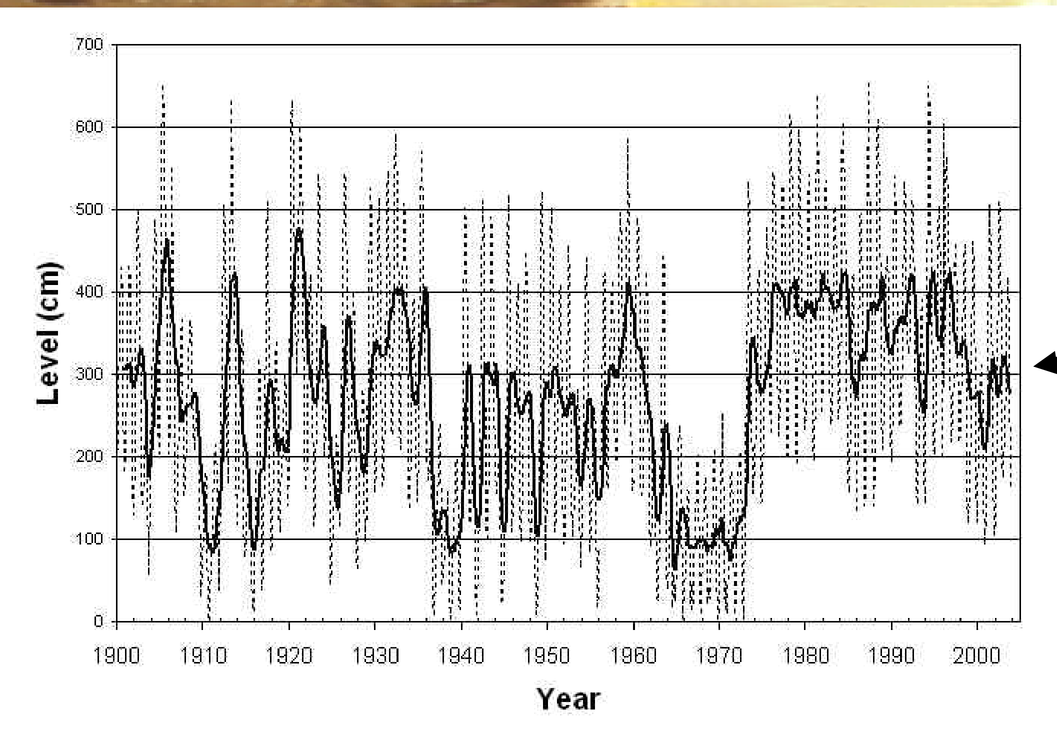
- Parameter values for hydrological models can be **hardly known a priori**, as shown one more time recently by Lohmann et al. (2004).
- The usual approach in the case of distributed models of large basins is to **relate parameter values to readily obtainable information**, such as land use and vegetation classes, or soil types.
- However, unlike regional atmospheric models, hydrological models are **seldom used without parameter calibration**. Calibration of such models can use a criterion of fit in the form of a multi-objective function, minimized by manual iterations or using automatic optimization methods based on evolution algorithms (Sorooshian et al., 1993; Collischonn and Tucci 2003; Gupta et al., 1998; Boyle et al., 2000; Vrugt et al., 2003).
- **Multi-objective methods** will be even more important as data from **flux measurement towers** become available, leading to a problem of which data should be given more confidence: latent heat fluxes for different land use and vegetation, measured by flux towers at spatially restricted spots, or streamflow, as an integrator of the hydrological processes occurring over the whole basin.

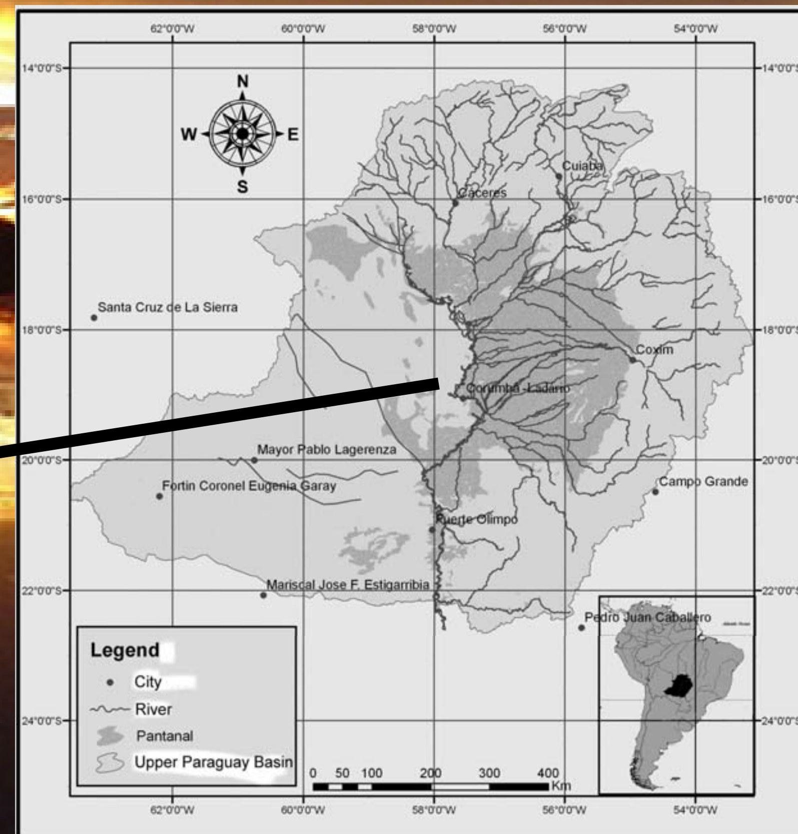
SVATs in hydrology and meteorology

- One could say that hydrological models have good results when integrated over large areas for the wrong reasons, i.e. a sum of locally doubtful results is able to generate regionally reasonable results, while atmospheric models SVATs are a collection of good reasons that result in a rather poor performance when integrated over larger areas. Therefore the coupling of hydrologic and atmospheric modeling needs a move to more similarity in both kinds of models.

- *Development of coupled atmospheric-hydrologic models could be accomplished in well identifiable steps. The first step could be to implement the SVATs used in atmospheric models in the structure of an hydrological model and force it with observed rainfall and surface temperature, incoming short wave radiation, wind speed, humidity and pressure data. Calculated runoff could then be compared to observed streamflow at gauging stations, in order to analyze SVAT results integrated over large areas. The second step would be the identification of shortcomings of the SVAT performance, and identify the reasons for poor performance. At the same time evaporation calculated by distributed hydrological models well fitted to reproduce only streamflow should be compared to latent heat fluxes at the locations where measurement towers were installed. So the fourth step would be analyze these results and identify shortcomings of the hydrological models SVATs. A fifth step would be to propose common SVATs that could be used both in hydrological and atmospheric models, maybe with a flexible, user settable, complexity, and taking into account the spatial variability that cannot be entirely represented by the models spatial resolution (subgrid variability). After this steps the new common hydrologic-atmospheric SVATs could be tested as the land module of atmospheric models.*

Variability in hydrologic time series





River Paraguay level at Ladario (Pantanal)
Return to "normal" range?

Unpublished work by Allasia