

Transport of Nutrients and Contaminants in Amazon Rivers

Renato S. Silva

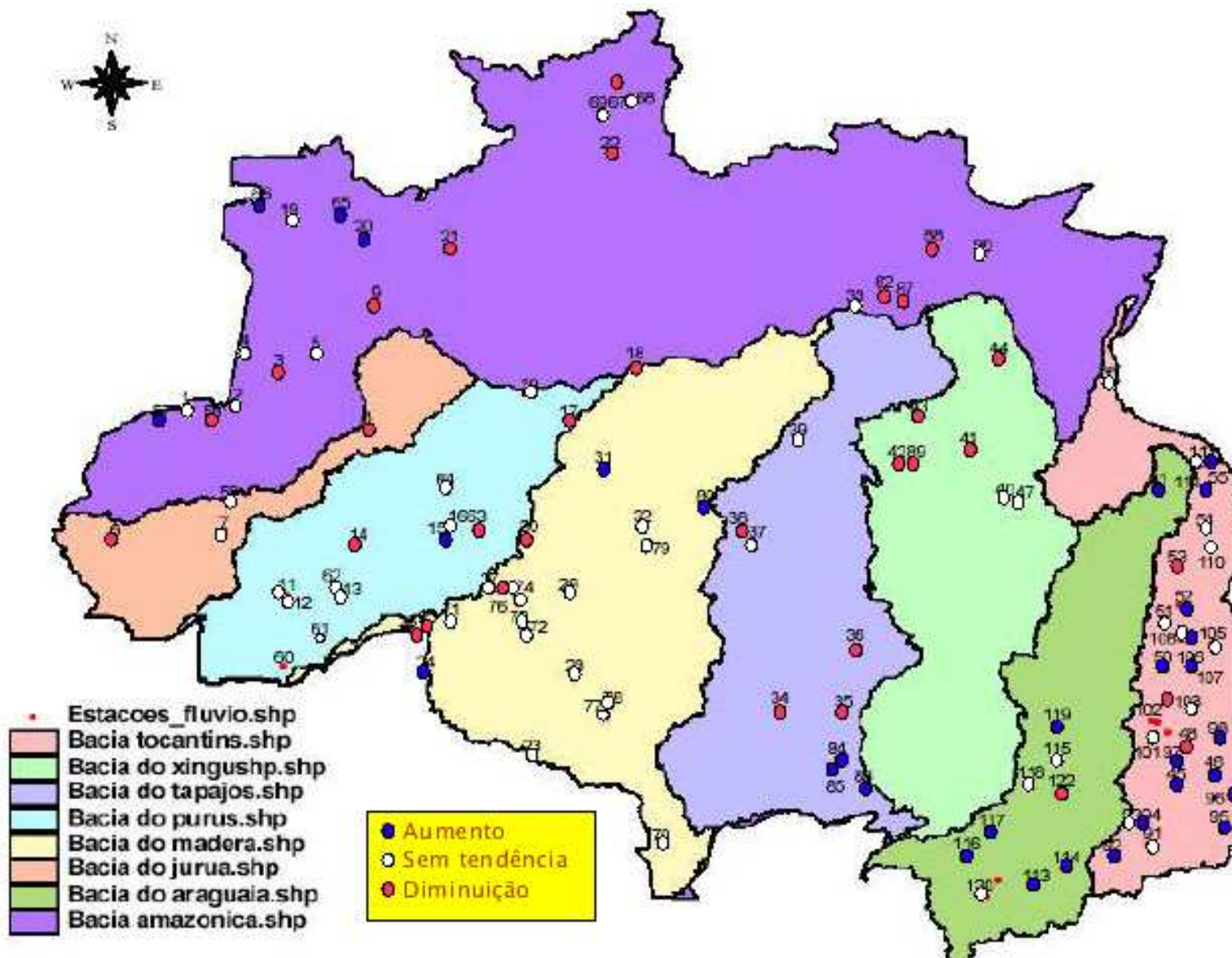
LNCC - MCT

Surface Waters

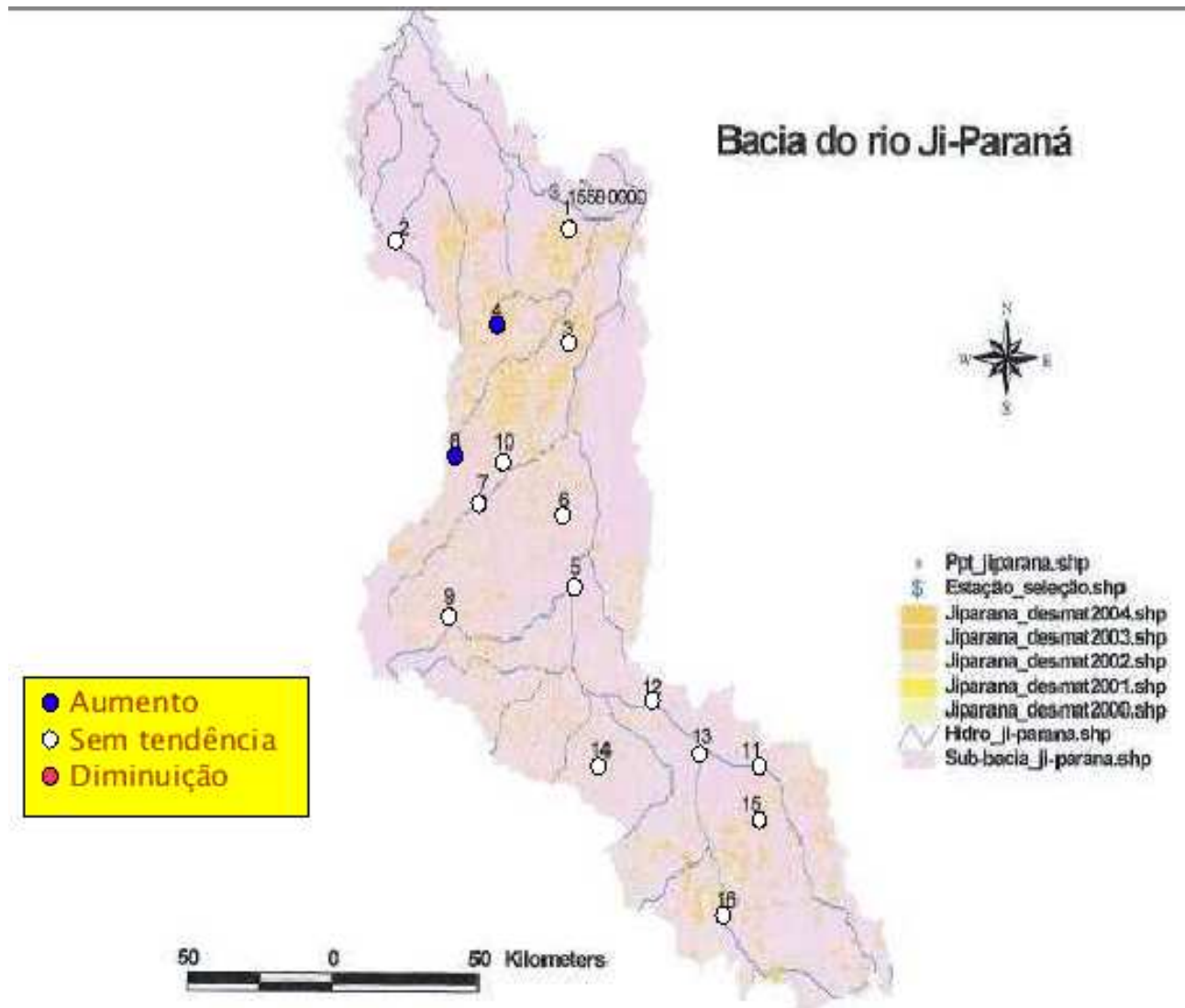
- Statistical Models
 - Analysis of the Data, Monitoring
 - Prediction
- Numerical Models
 - Temperature
 - Water Quality - Dissolved Oxygen
 - 2D-H hydrologic model

- LNCC - INPA
 - Human Impact on Rivers Discharge
- Tendency Tests
- Non-parametric test
 - *Spearman's Rho Test*
 - *Kendall's Tau Test*
 - *Sazonal Mann-Kendall Test*

Statistical Models - Results

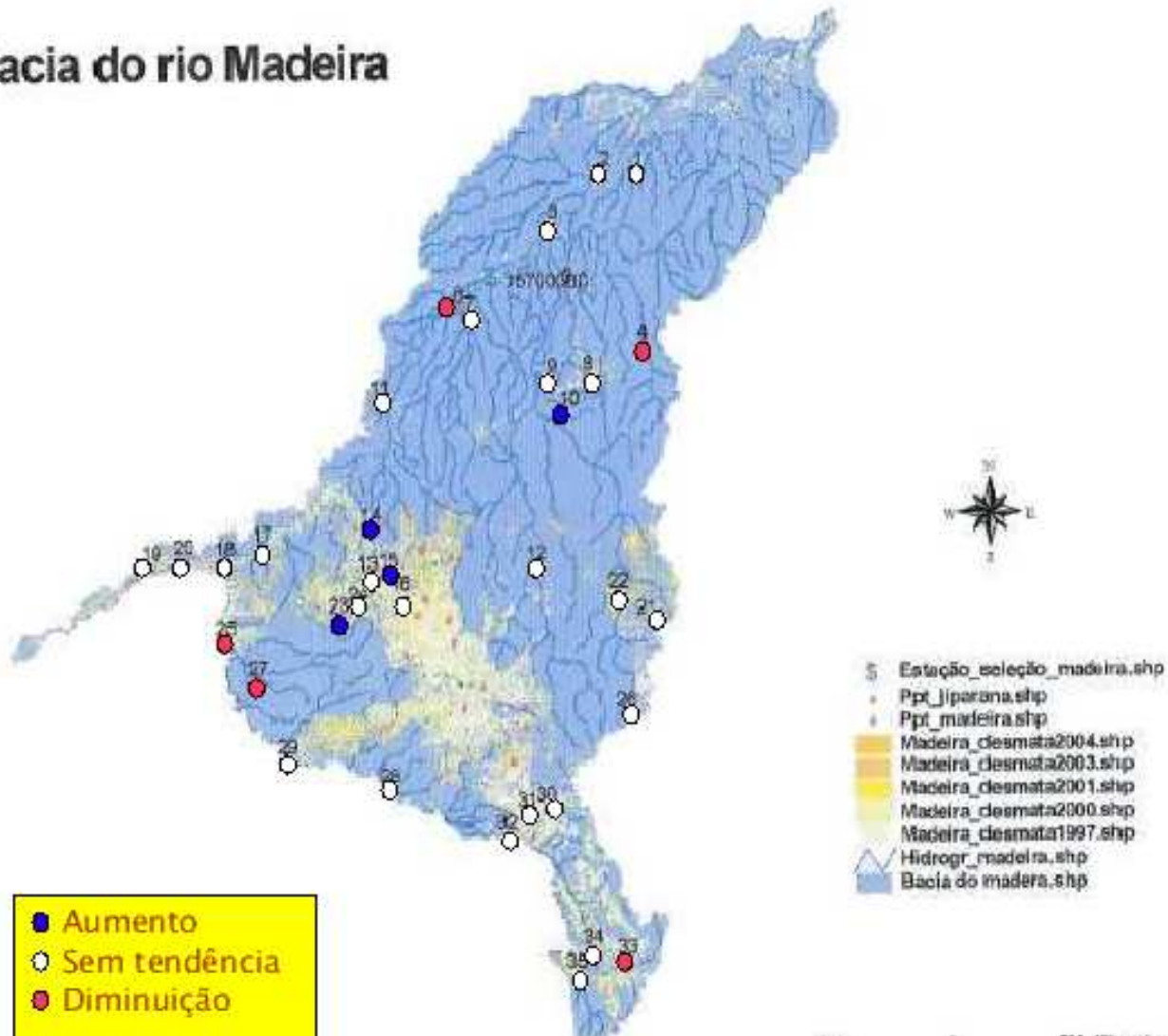


Statistical Models - Results

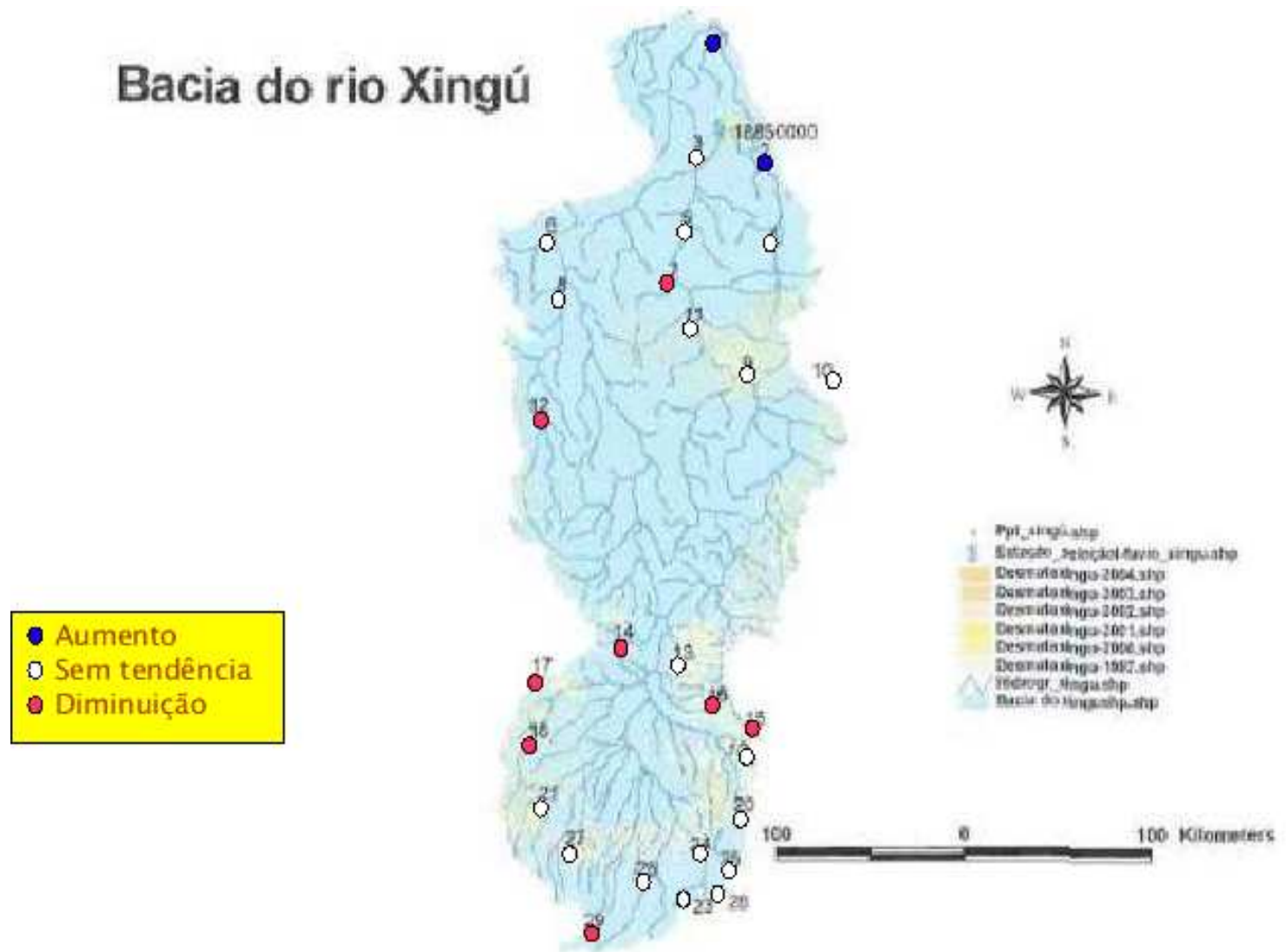


Statistical Models - Results

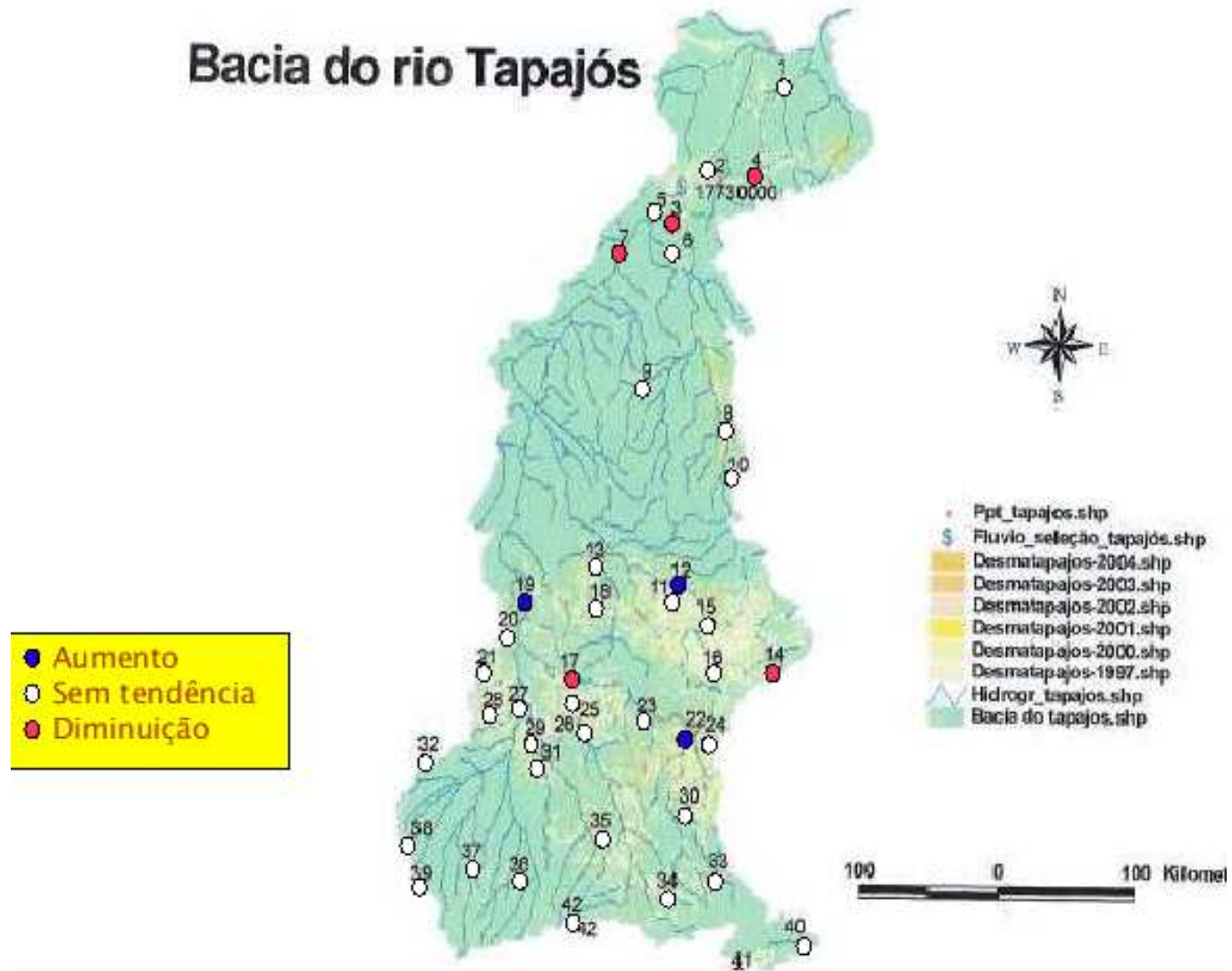
Bacia do rio Madeira



Statistical Models - Results

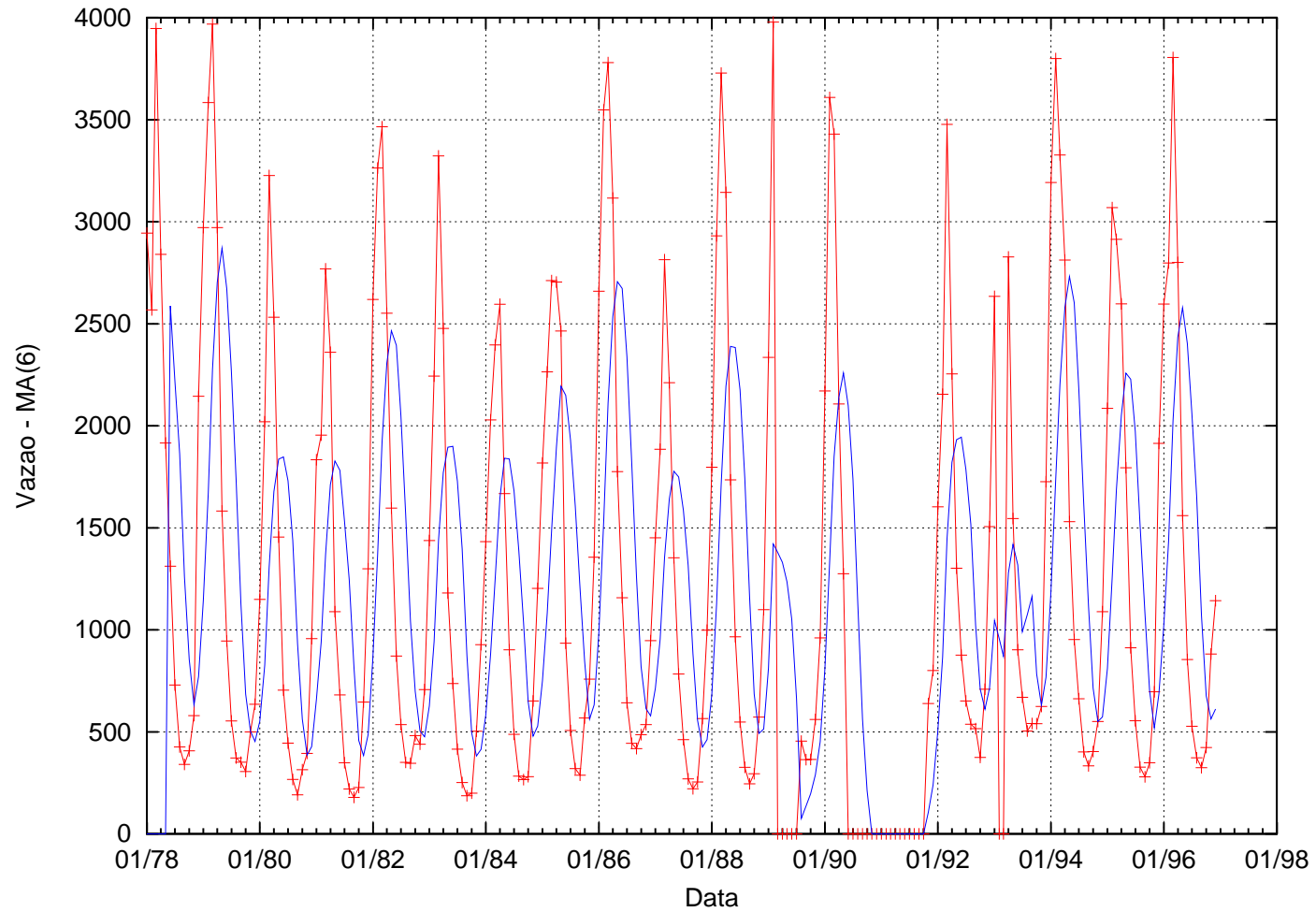


Statistical Models - Results

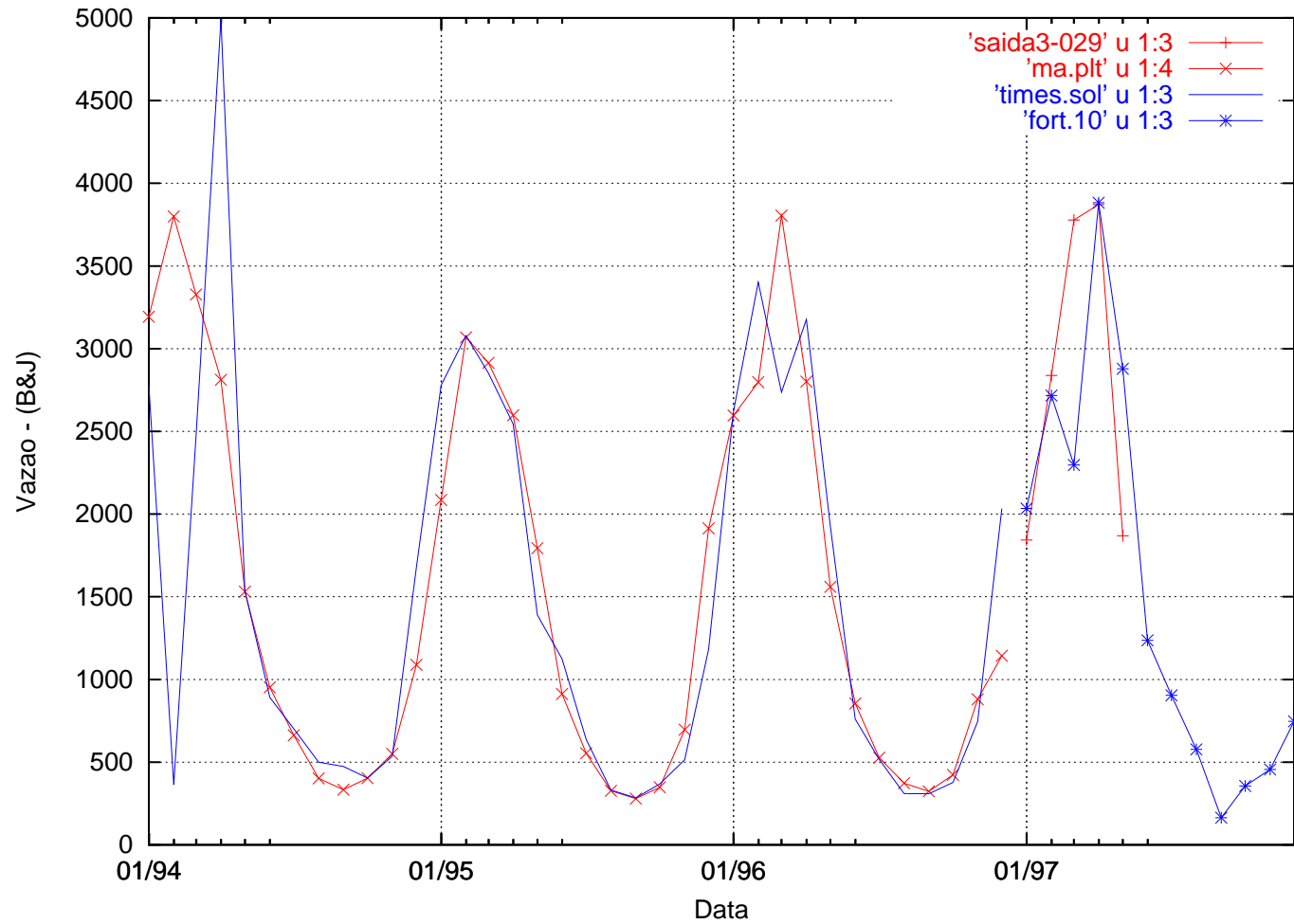


- Quality Control / Prediction
 - Reference Distribution
 - Control Graphics
 - Moving Average (MA)
 - Exponentially Weighted Moving Average (EWMA)
 - ARIMA Models

Statistical Models - Results



Statistical Models- Results

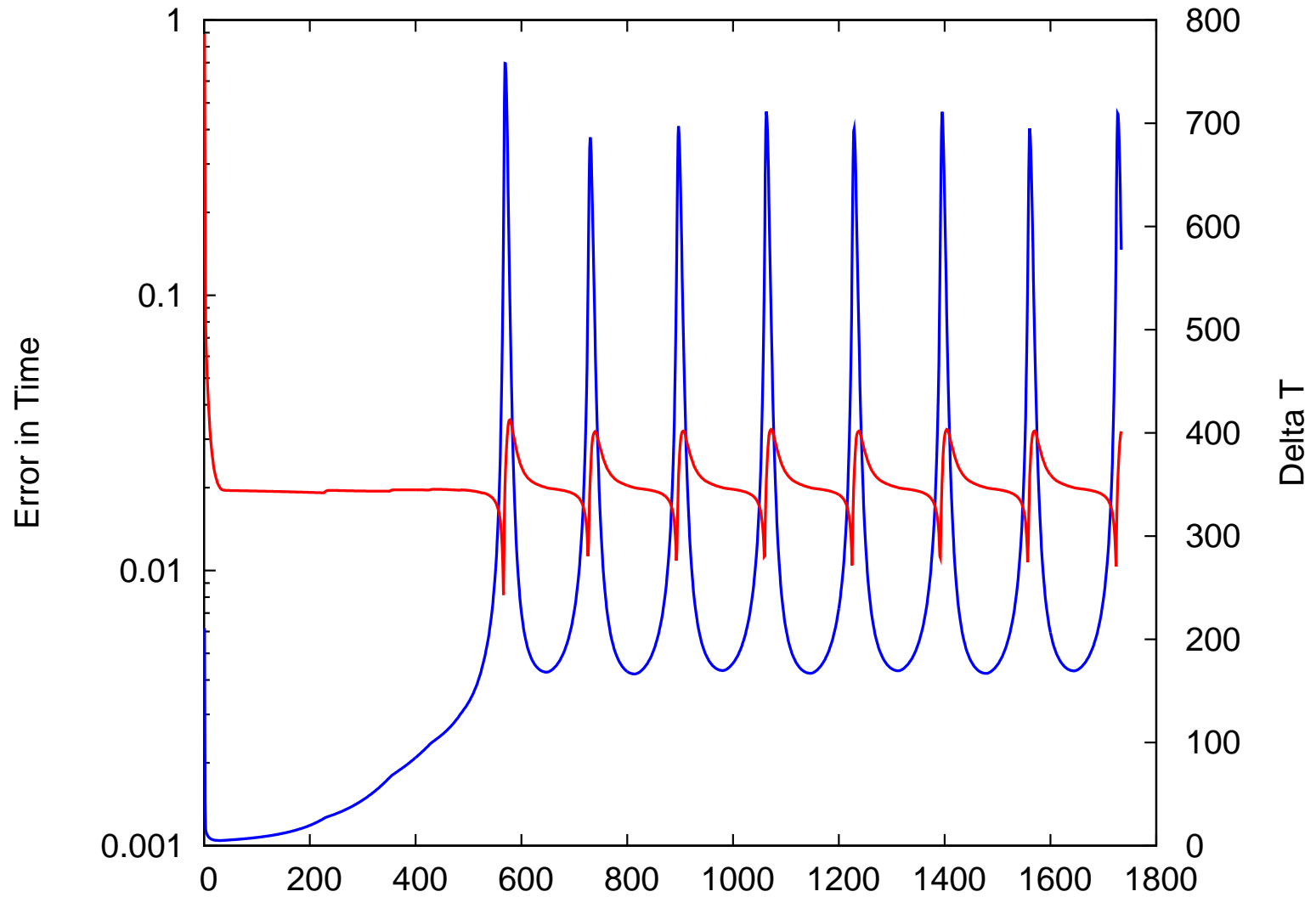


- FEM - Petrov-Galerkin Space-Time Formulation
- Temperature

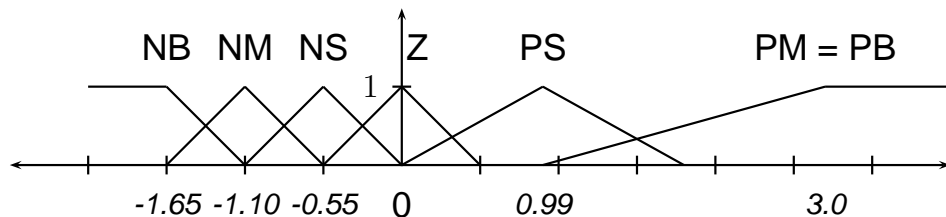
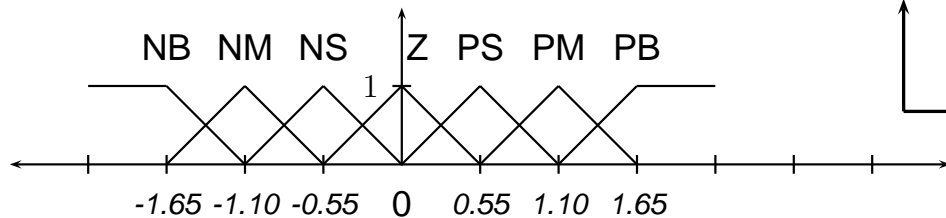
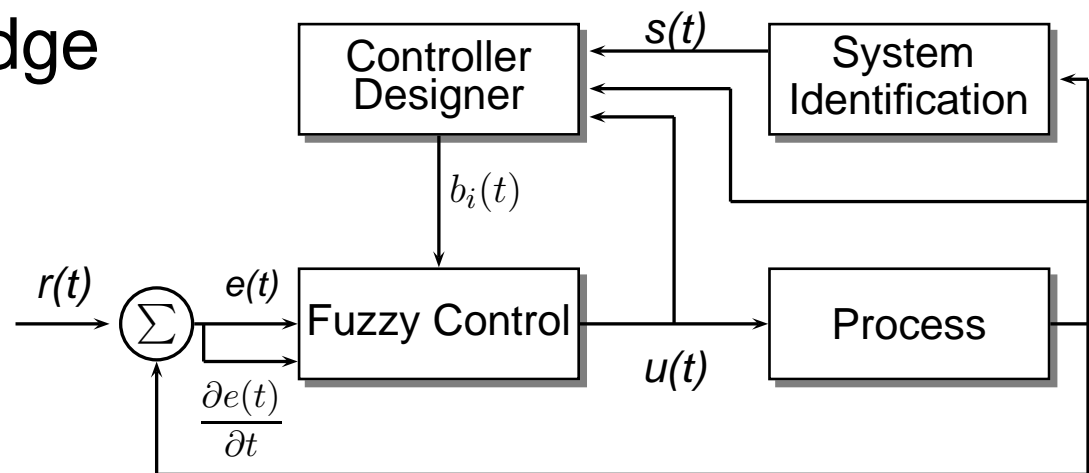
$$\rho c H \frac{\partial T}{\partial t} - \nabla \cdot (\mathbf{K} H \nabla T) + \mathbf{u} \cdot H \nabla T = f$$

- solar radiation (direct);
- atmosphere radiation;
- water radiation;
- convection;
- evaporation.

Adaptive Δt



- Adaptive Fuzzy Control
- Learning Capability
- Heuristic Knowledge



Water Quality Model

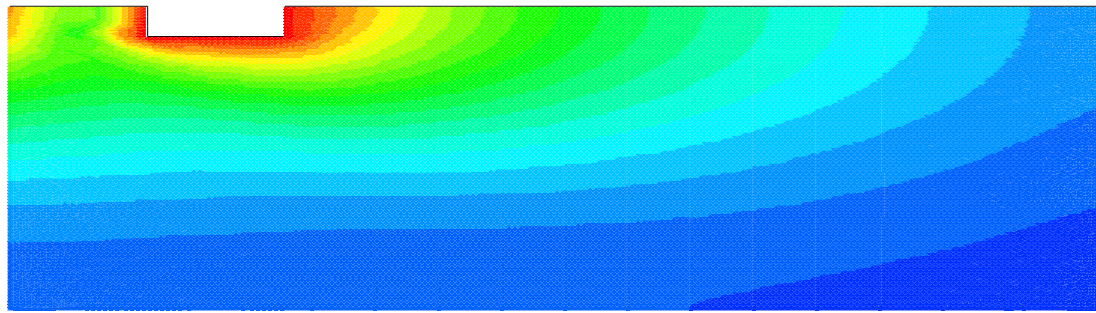
- Dissolved Oxygen

$$\frac{\partial C1}{\partial t} - \nabla \cdot (\mathbf{D1} \nabla C1) + \mathbf{u} \cdot \nabla C1 = -k1C1$$

$$\frac{\partial C2}{\partial t} - \nabla \cdot (\mathbf{D2} \nabla C2) + \mathbf{u} \cdot \nabla C2 = k1C1 - k2C2$$

$$k = 0.38 * 1.047^{(T-20)}$$

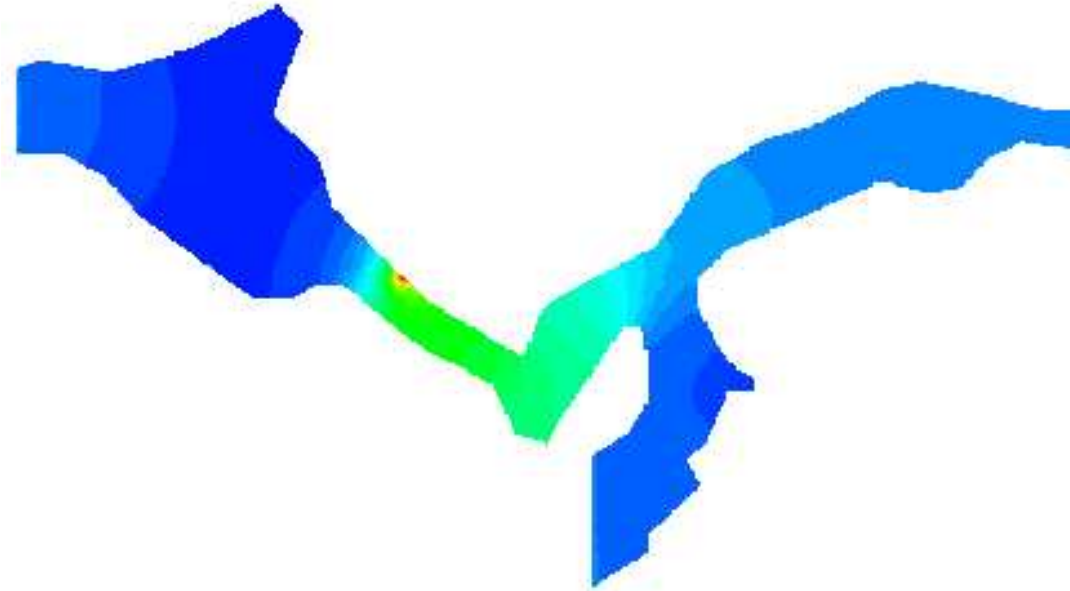
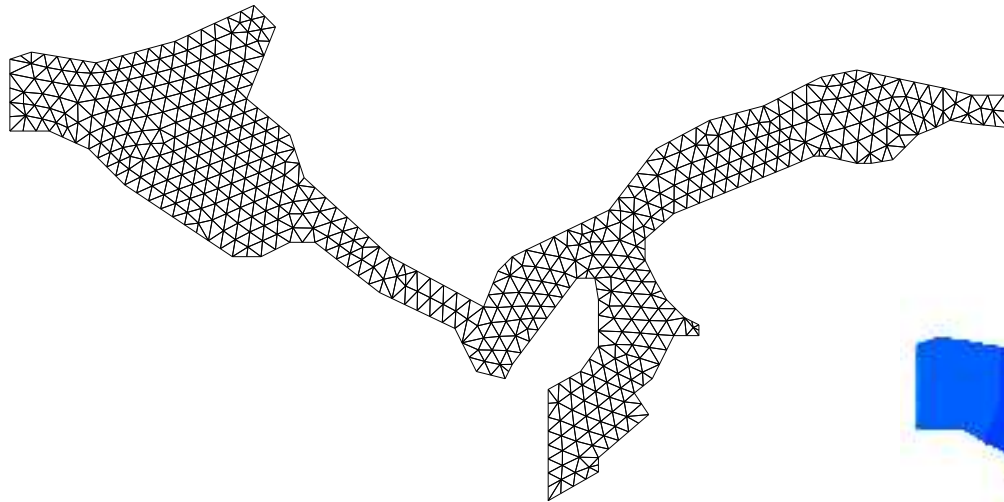
Water Quality Model



Niveis :

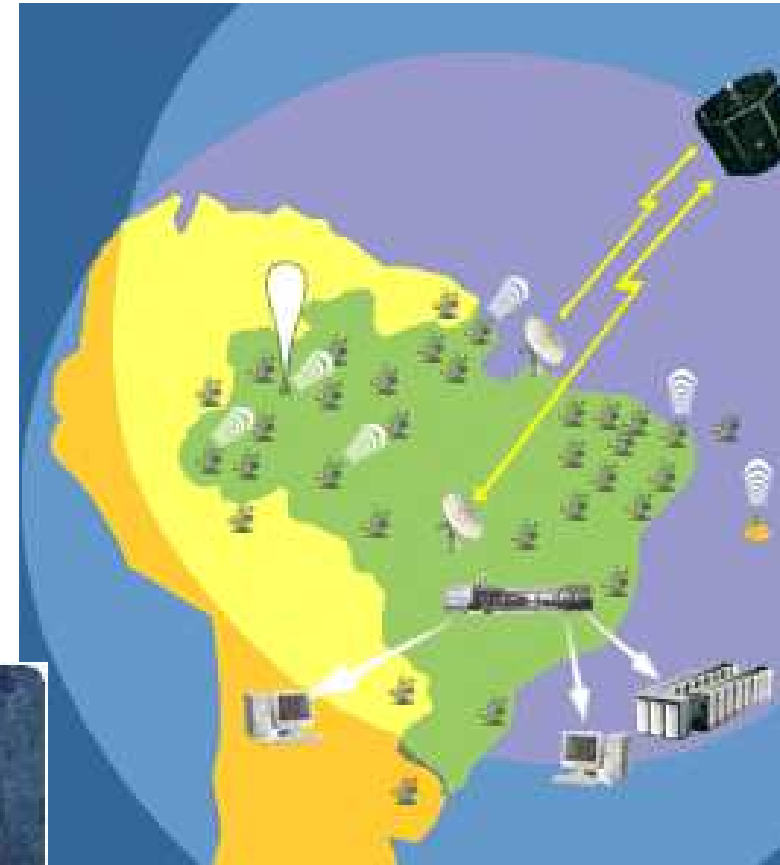
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0.662E+00
0.684E+00
0.707E+00
0.730E+00
0.752E+00
0.775E+00
0.797E+00
0.820E+00
0.842E+00

Negro River



Monitoring Network

- Statistical Models
- Numerical Models
- Fuzzy Logic
- Geoma Website



Newest Project

- Autonomous robot connected to PCD network
 - Collect data (submarine)
 - 3D problems in some regions
- Build the simulator to test the *intelligent* part as well as the control
 - Dynamics

