

CLIMATE FORECASTS AND ITS USE FOR RESERVOIR INFLOW FORECASTS IN ANNUAL WATER ALLOCATION: CHALLENGES & OPPORTUNITIES.

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CONTEXT

CLIMATE FORCING

CLIMATE FORECAST SYSTEM

THE CHALLENGE FOR APPLICATION

WATER MANAGEMENT

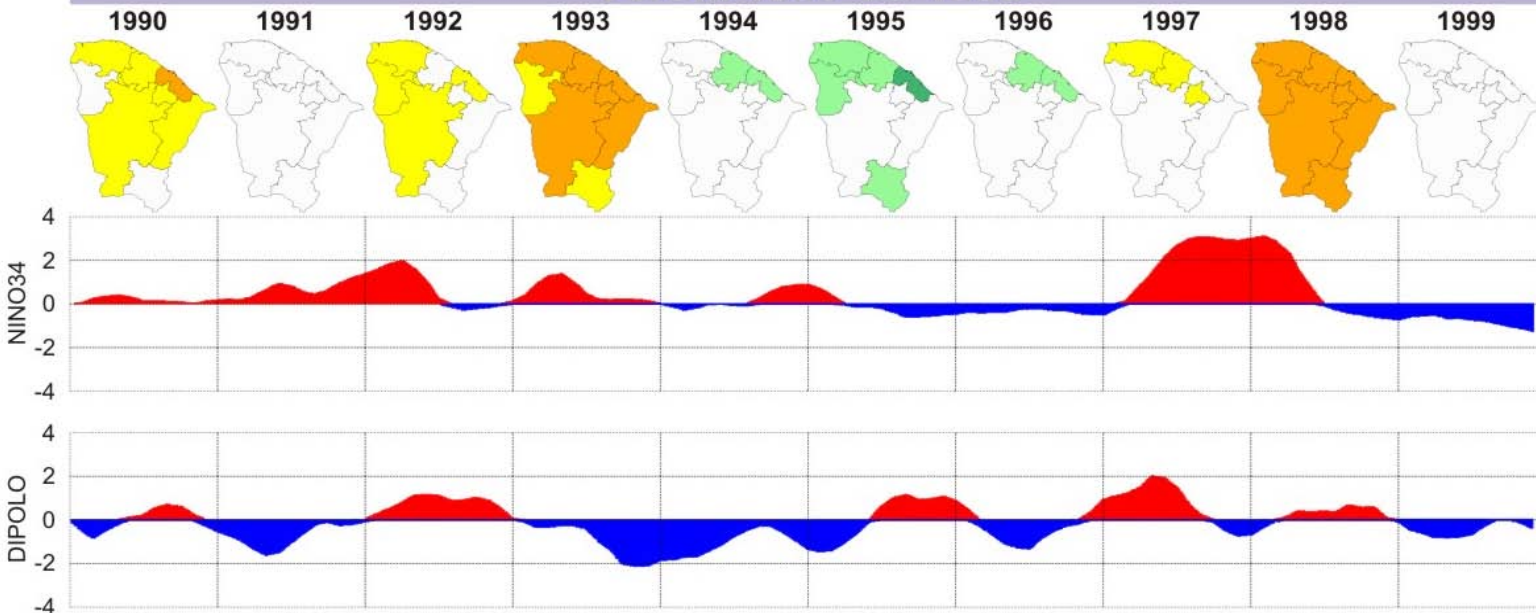
Forecast Horizon,
Statistical & Dynamical Streamflow Forecasts
Reservoir Operations
User/Stakeholder Engagement

FINAL MESSAGES

FORCINGS

CLIMATE MONITORING/FORECAST

FROM 1990 TO 1999

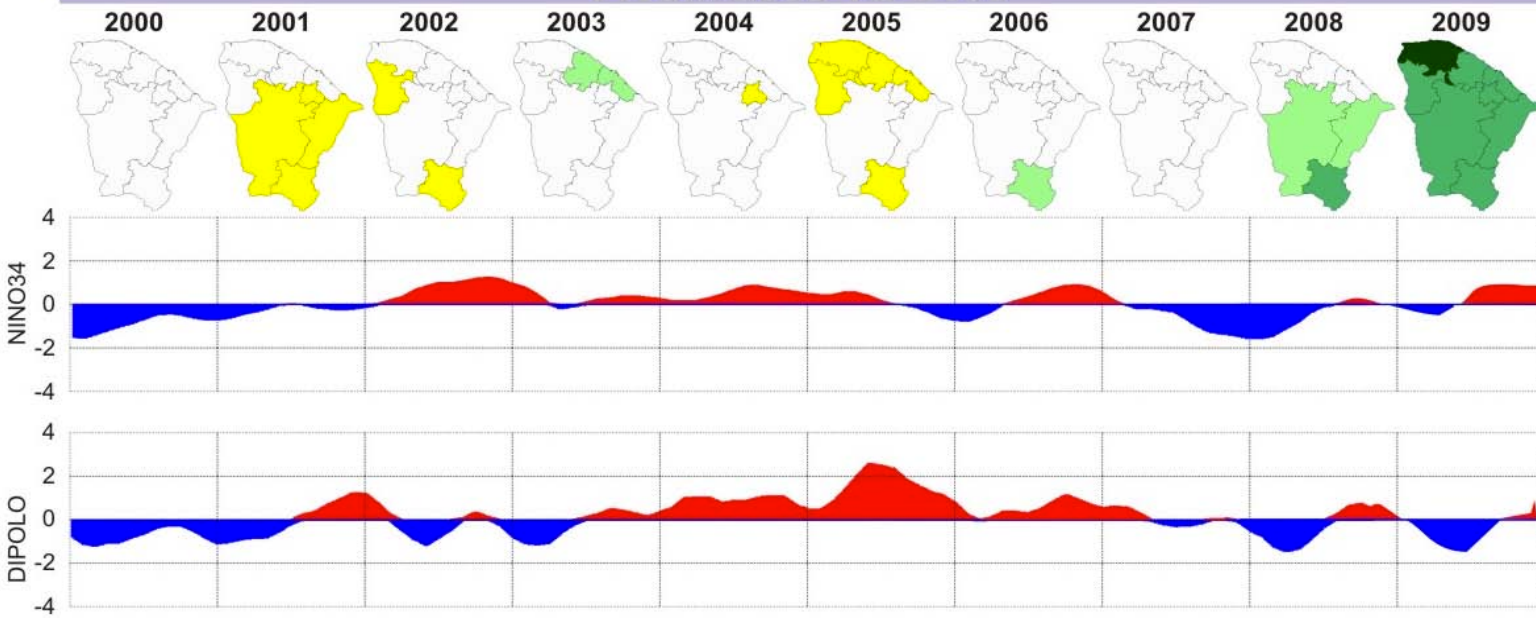


Regions

REGIONS OF THE STATE OF CEARÁ

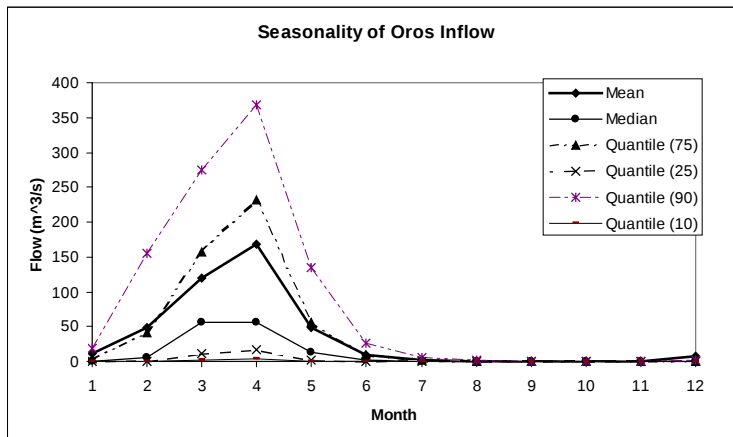
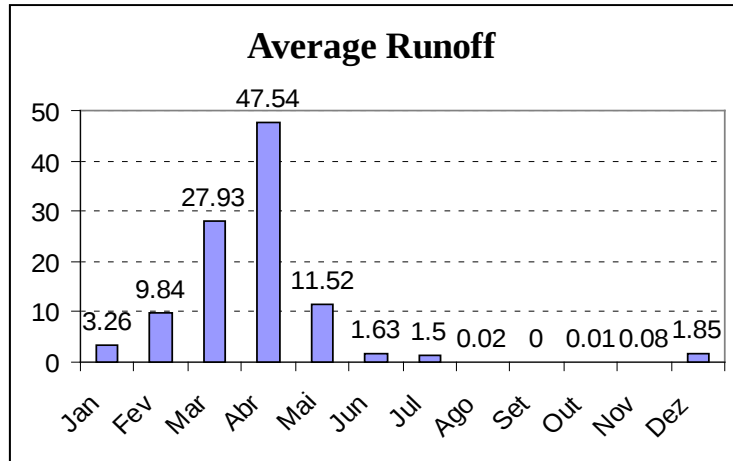


FROM 2000 TO 2009

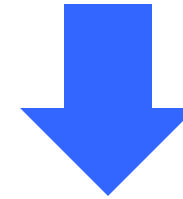


STANDARDIZED PRECIPITATION INDEX





Low depth soils, cristaline embasement (@ the surface sometimes), high evaporation and highly concentrated precipitation regime.

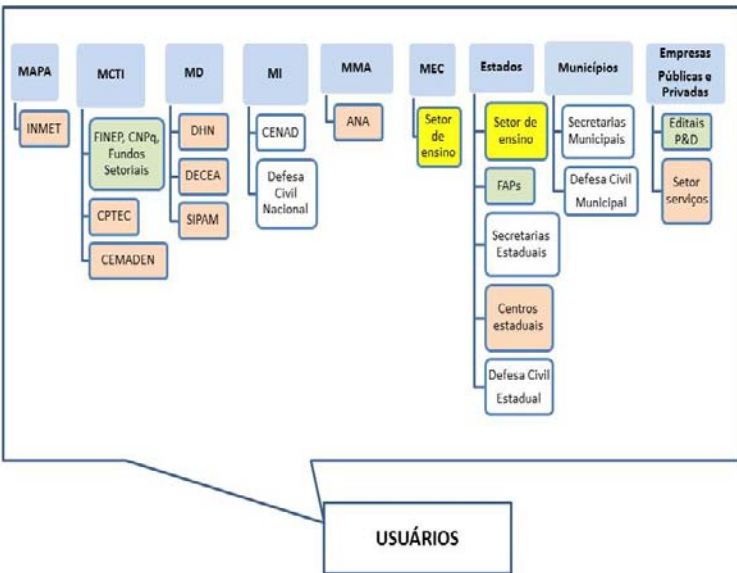


Ephemeral rivers running only a few months in the first semester.

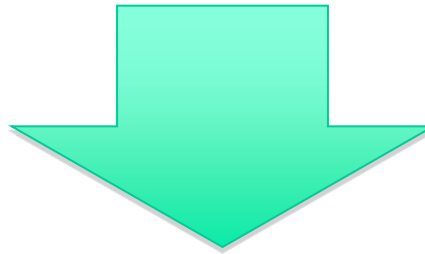
The seasonality of rainfall regime is determined by the Inter-Tropical Convergence Zone (ITCZ) Feb-May

CONTEXT

THE “MESSY” INSTITUTIONAL FRAMEWORK



**ARE THE ROLES OF ALL
INSTITUTIONS WELL DEFINED?
VERY FUZZY!
AND MORE AND MORE
INSTITUTIONS BEING CREATED...**



**A CHALLENGE FOR
APPLICATION AS WELL**



**MONITORING
FORECAST
RESPONSE**

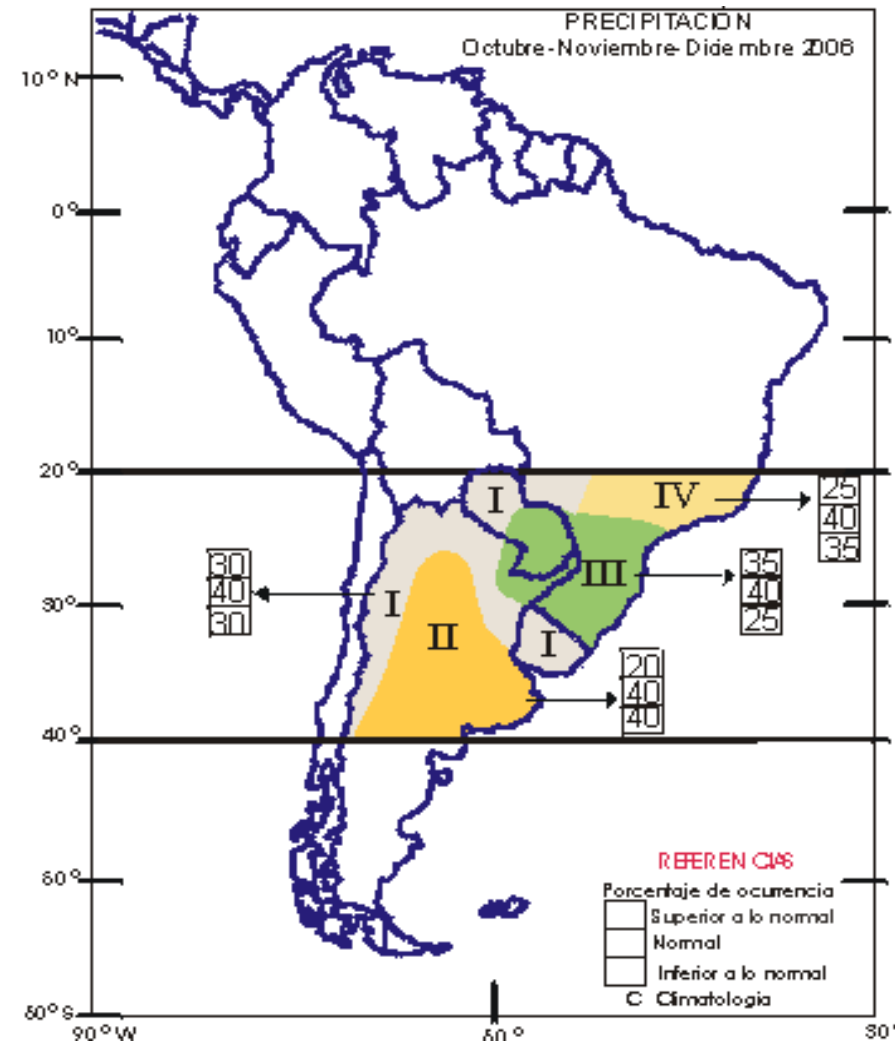
All regions have highest probability on the normal category.

Did we genuinely think that normal was the most likely category everywhere, or did we think it was the safest forecast everywhere?

70 – 80% of all the African RCOF forecasts have highest probability on normal.

Are we really forecasting what we think, or are we playing safe?

Courtesy: Simon Mason (IRI)



Based on: Guidance on Verification of Operational Seasonal Climate Forecasts
By Simon J. Mason (IRI), prepared under the auspices of the World Meteorological Organization (WMO), Commission for Climatology XIV, Expert Team on CLIPS
Operations, Verification and Application Service

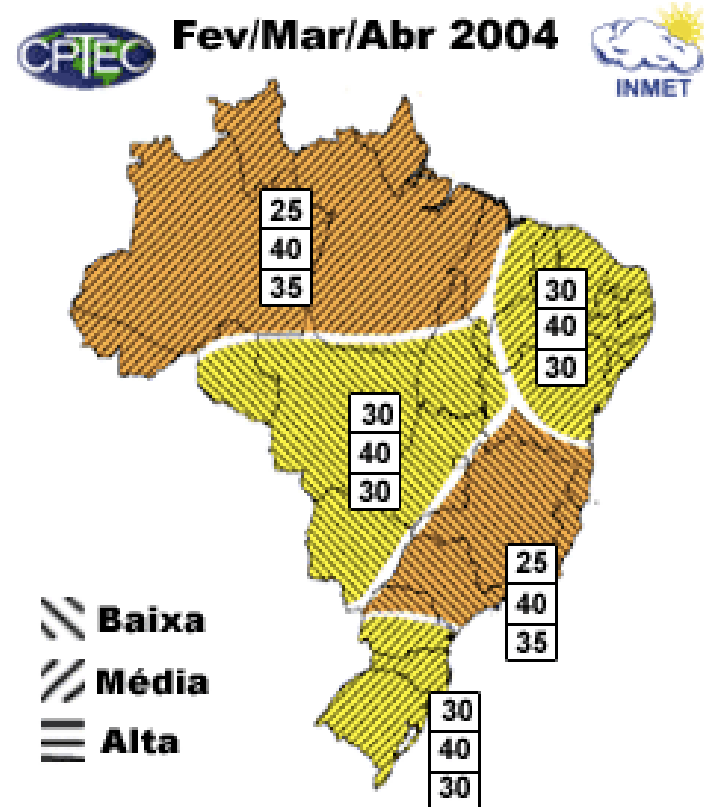
REASONS:

➤ CLIMATE FORECAST SYSTEM HAS NO FOCUS ON APPLICATION

✧ FORECAST FORMAT (TERCILES) AND THE FORECASTING AREA IS NOT APPROPRIATE FOR THE WATER SECTOR ... (IN GENERAL)

✧ SUBJECTIVITY OF THE CONSENSUS FORECAST ("EXPERTS' OPINIONS ...") (70% OF THE FORECASTS HAVE AS MOST LIKELY CATEGORY THE NORMAL CATEGORY – THIS IS NOT CONSISTENT WITH OBSERVATIONS!)

➤ THERE ARE ALTERNATIVES, BUT NOT VERY WELL EXPLORED AT THE OPERATIONAL LEVEL – STILL PERCEIVED AS RESEARCH AREA



Distribuição de probabilidade (%) de ocorrência de chuvas em relação a média histórica

	Acima da média histórica
	Próximas à média histórica
	Abaixo da média histórica

As regiões hachuradas indicam a confiabilidade da previsão (vide legenda na figura)

Period 2002-2012

Forecast issued in Jan
For the trimester
FEB-MAR-APR

Verification for all
forecasting areas.

The forecasting areas
were defined by the
consensus working
group

40
35
25

CATEGORY	OBSERVED		
BELOW	6		
NORMAL	6		
ABOVE	10		

REMARKS ON THE SUBJECTIVE AND THE MODEL-BASED SYSTEM:

- ❖ From 2004 up to now it seems that an upper limit for probabilities ($P \leq 45\%$). Why?
- ❖ Inconsistent forecasts: No comparison can be made between this year forecast and previous years' forecasts. The identified probabilities depend on who leads the COF meeting at that moment and the composition of the group.
- ❖ The most likely category identified by using RSM was observed in 13 out of 22 forecasts (in other two areas, RSM indicated two categories as most likely and observation was classified as one of those)
- ❖ CONSENSUS: The most likely category was observed in 5 out of 22.
- ❖ 68% of the forecasts in our COFs have the category NORMAL as the most likely. Any similarities with the findings of Mason for the RCOFS in Africa?

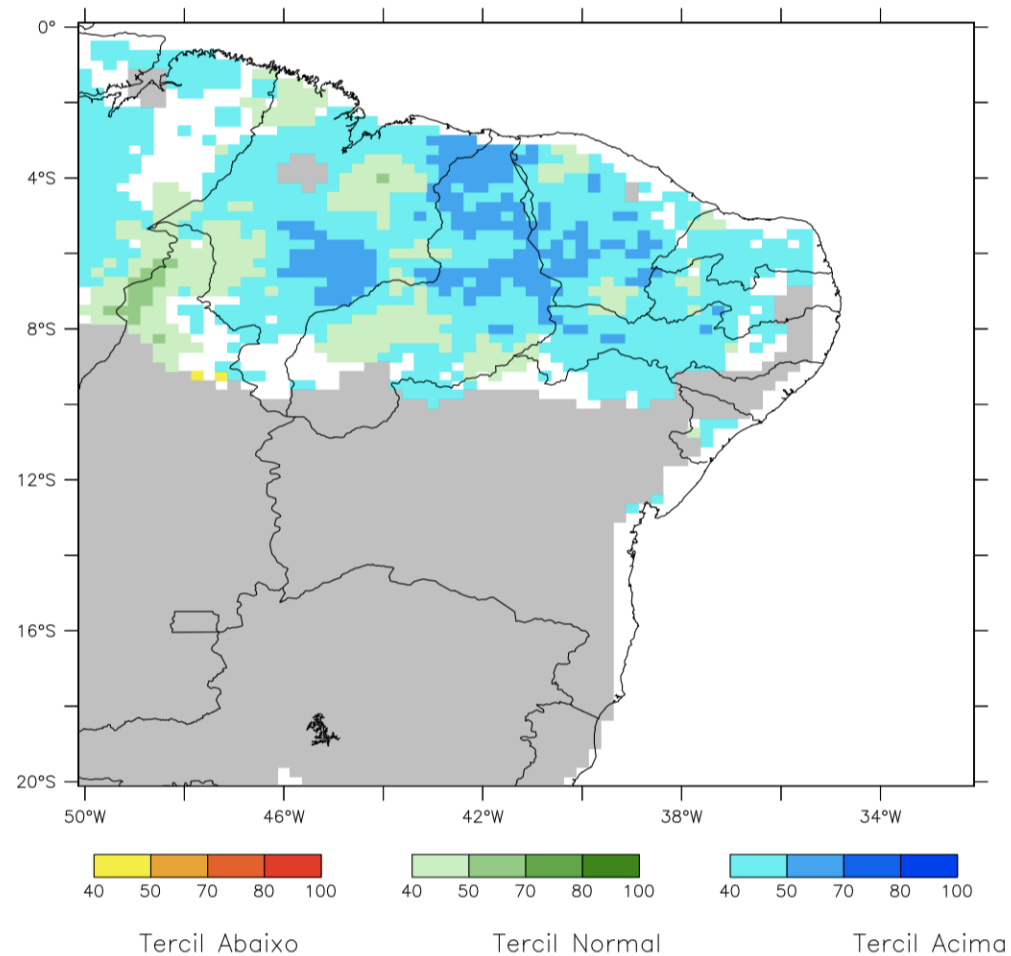
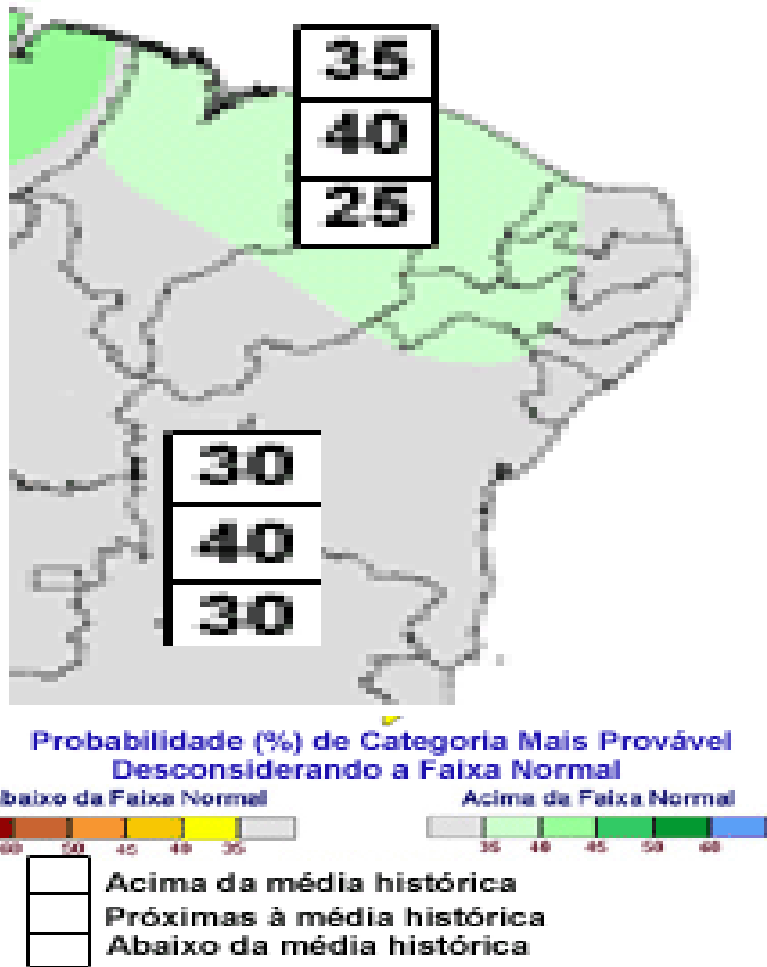
Inter-institutional Confort Zone
(ITCZ)

2009: JAN → FMA

Observed: Floods

CONSENSUS

OBJETIVE

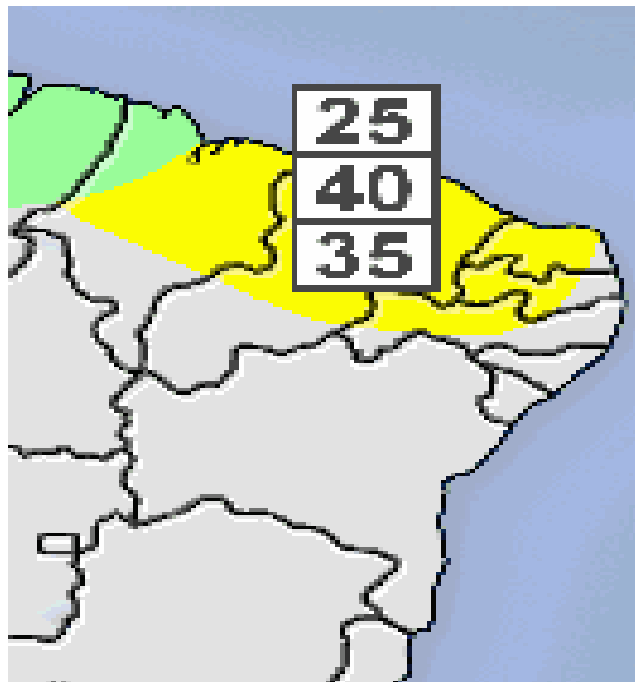


2012: JAN → FMA

Observed: Strongest Drought (50 yrs)

CONSENSUS

OBJETIVE



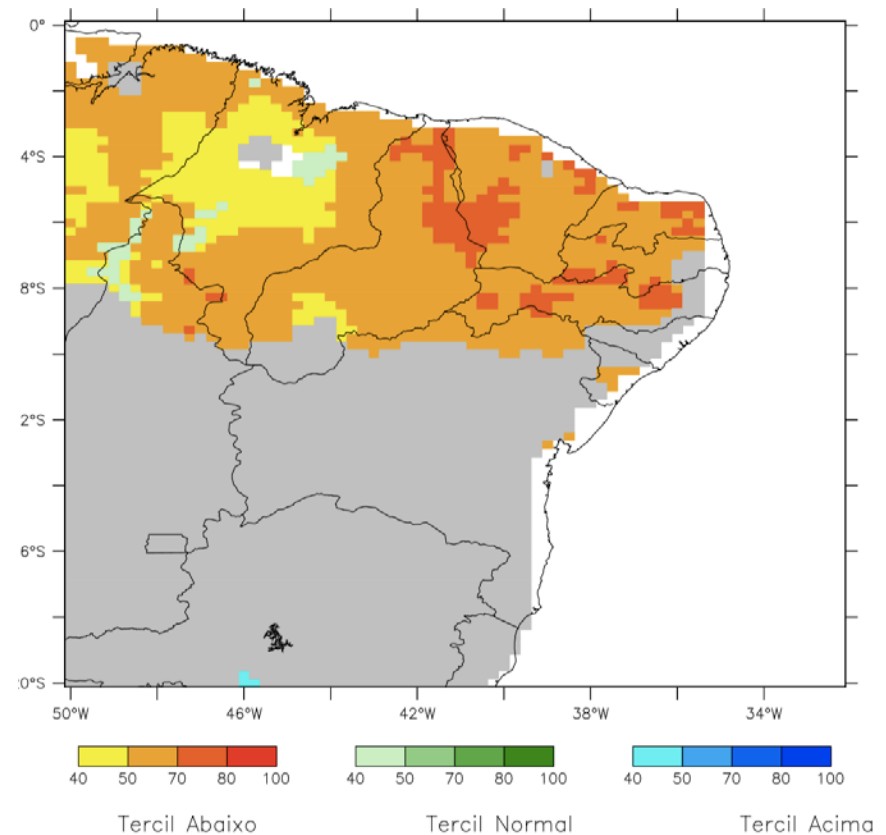
Probabilidade (%) de Categoria Mais Provável
Desconsiderando a Faixa Normal

Abaixo da Faixa Normal

Acima da Faixa Normal



Acima da média histórica
Próximas à média histórica
Abaixo da média histórica



40 50 70 80 100

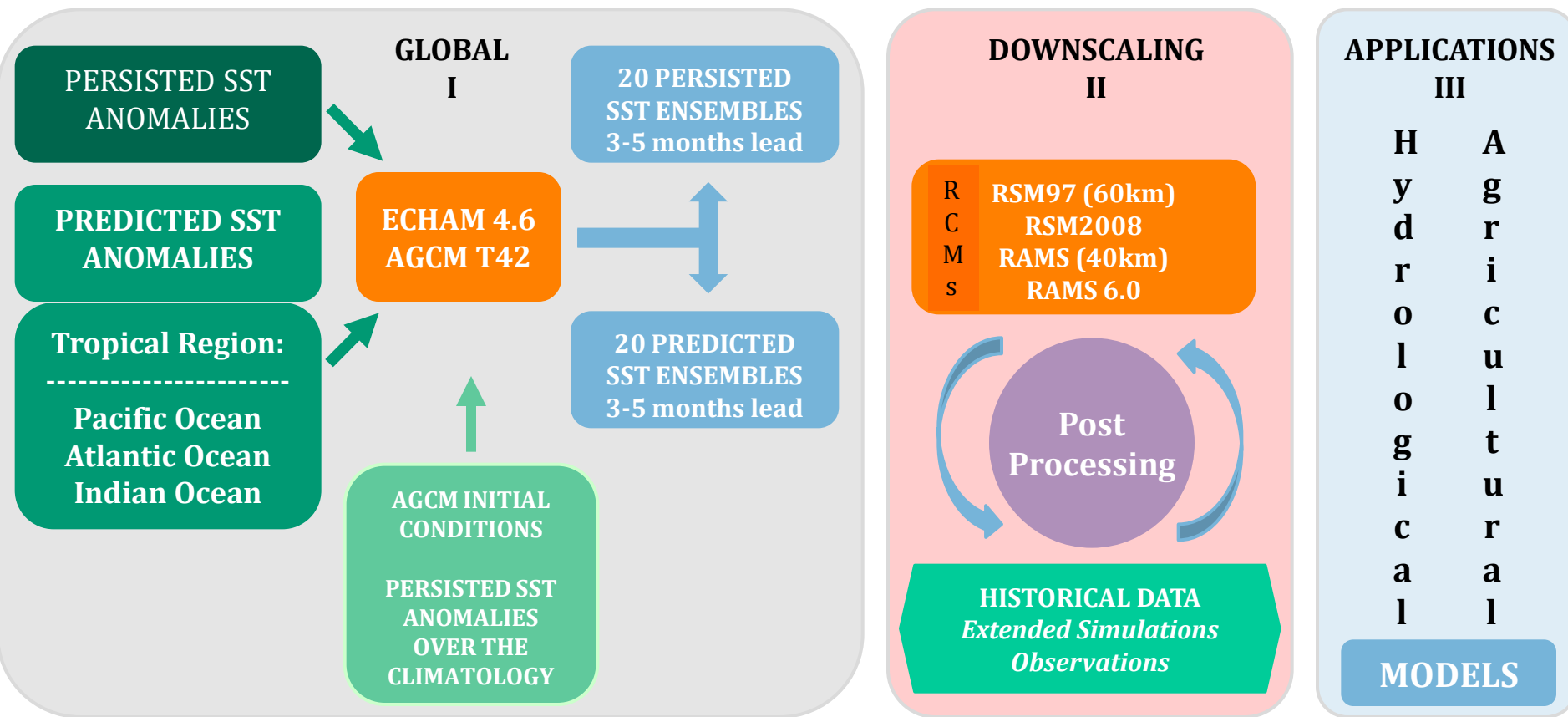
40 50 70 80 100

40 50 70 80 100

Tercil Abaixo

Tercil Normal

Tercil Acima

CLIMATE FORECAST SYSTEM

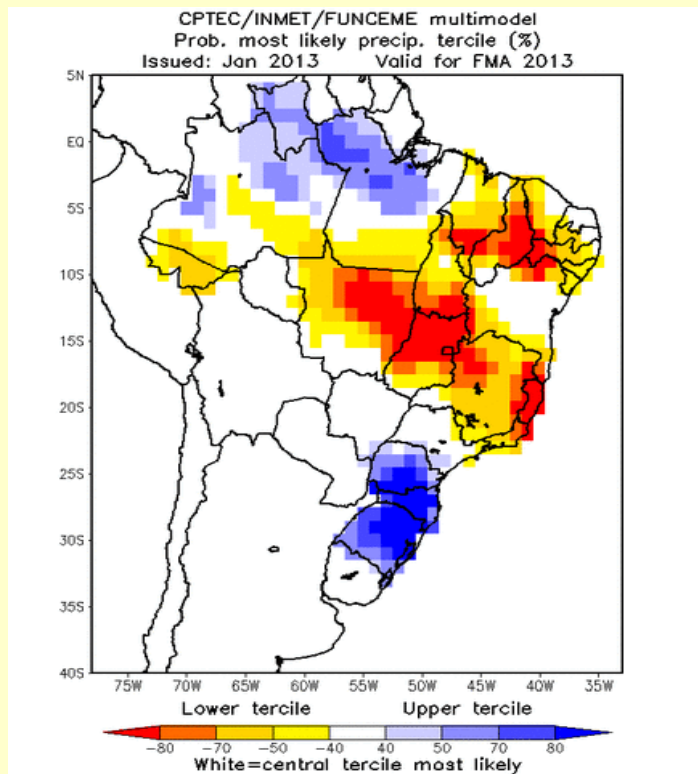
CPT
Multi-ensemble

Data requirements: Precipitation, Inflow & Crop Yield data

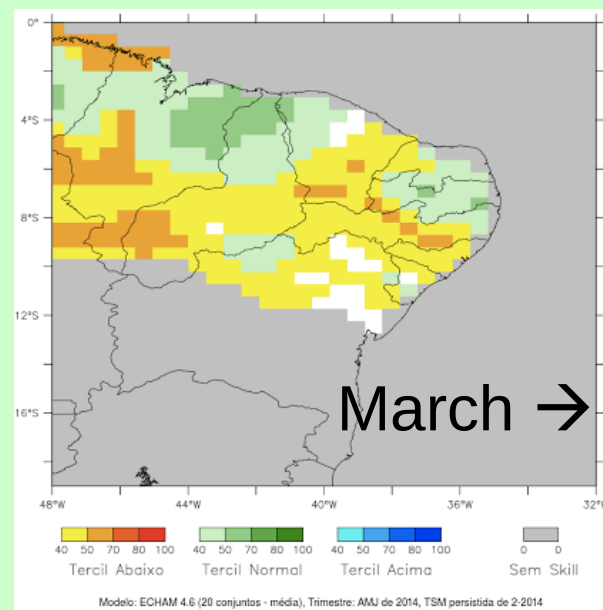
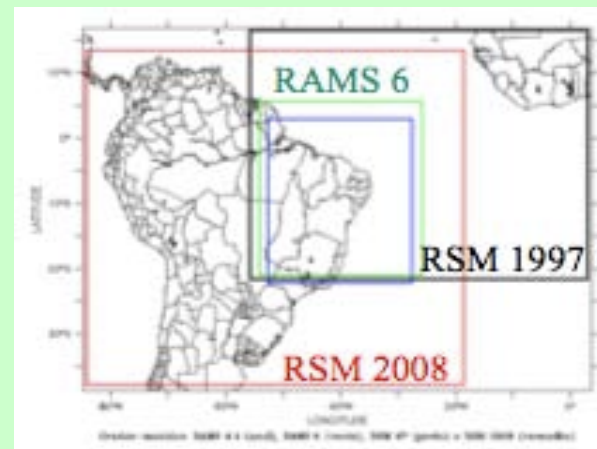
The state climate forecast includes:

1. Global Climate Models ECHAM 4.6, CFSv2 + 1 (CAM3)

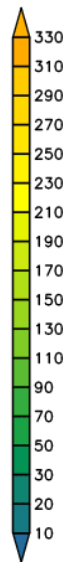
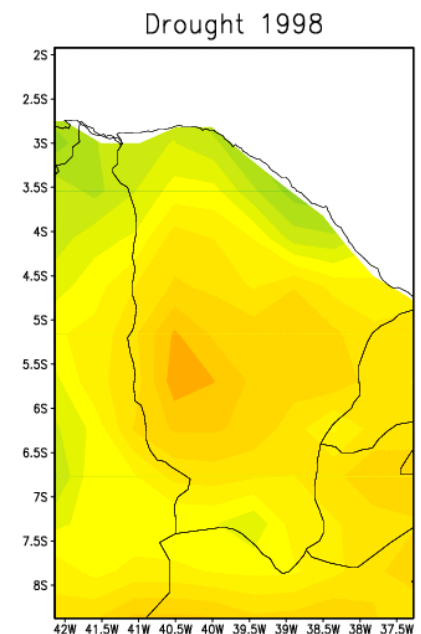
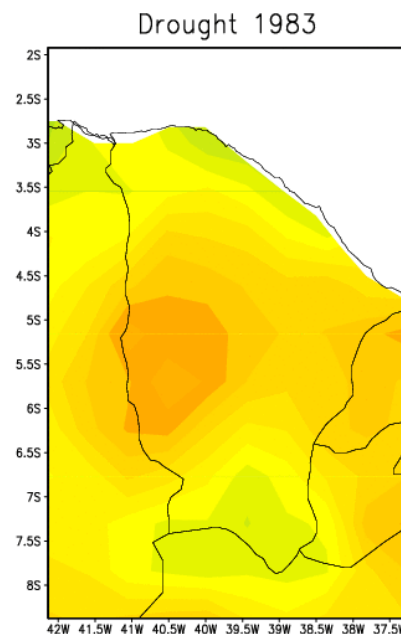
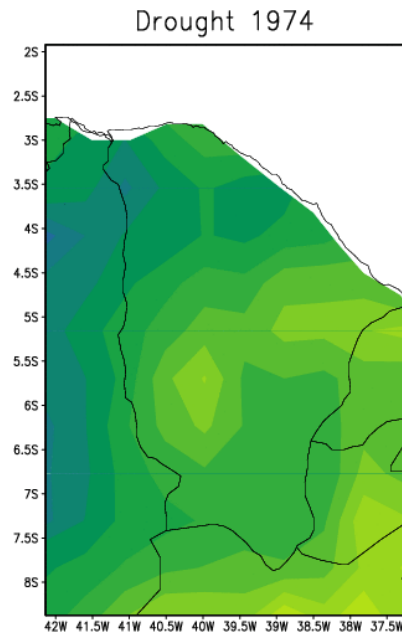
Multi-ensemble: CPTEC/INPE (3GCMS), INMET & FUNCEME (ECHAM4.6)



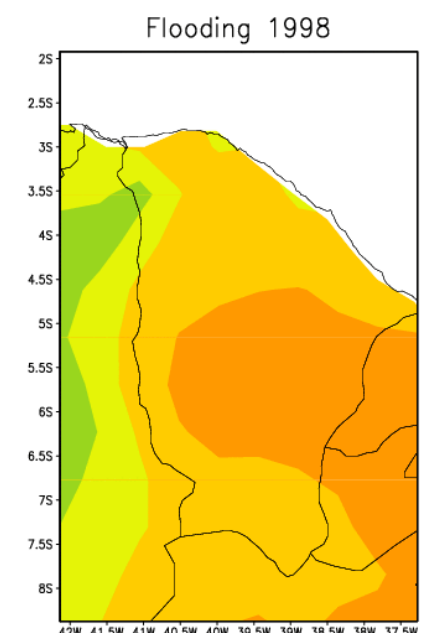
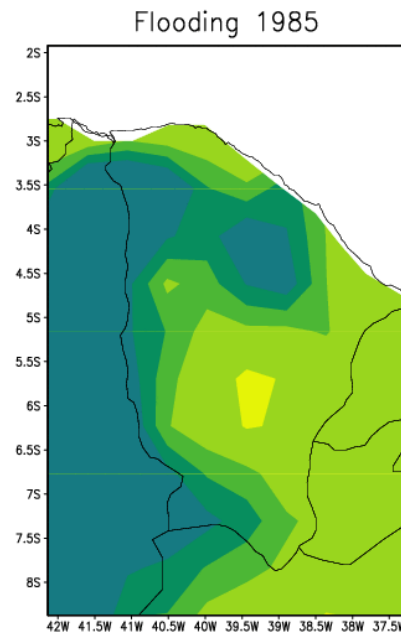
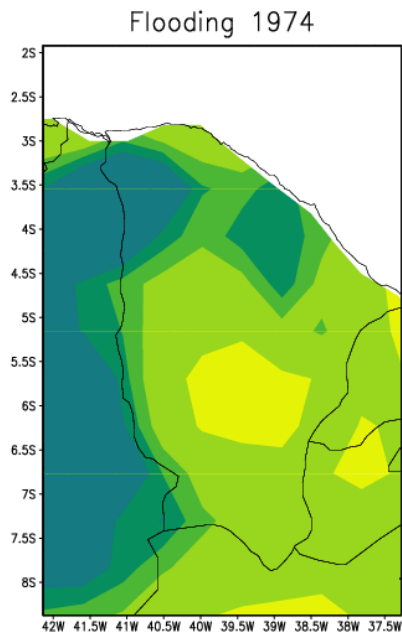
4 Regional Climate Models (dynamical/statistical) + 1 (WRF 3.5) → MRM



DROUGHT INDEX



FLOOD INDEX



Forecasting rainfall is no the same that forecasting...



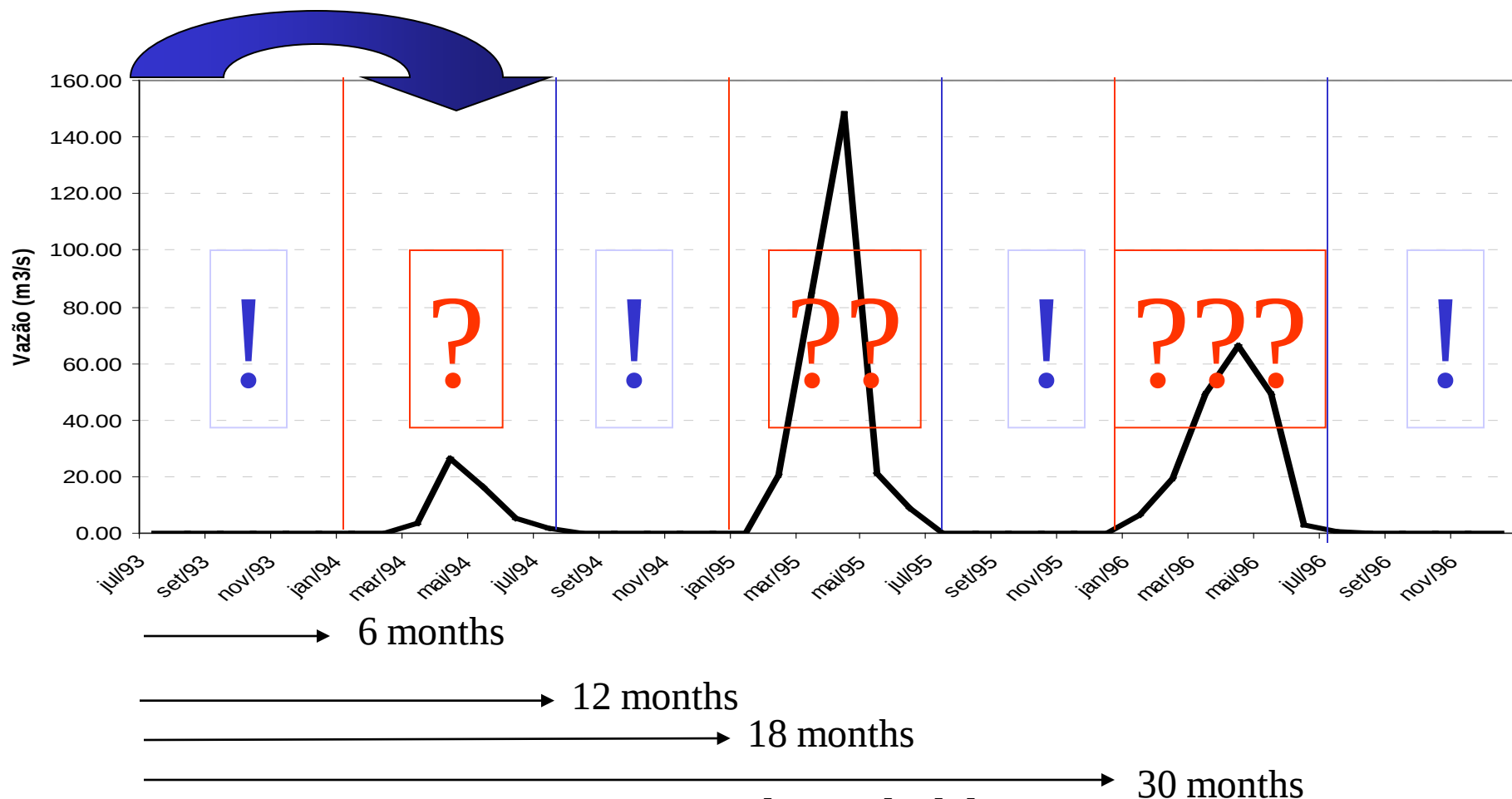
There are intermediate factors ...

Rainfall is not the only factor ...

Science/technology is needed to transform rainfall in

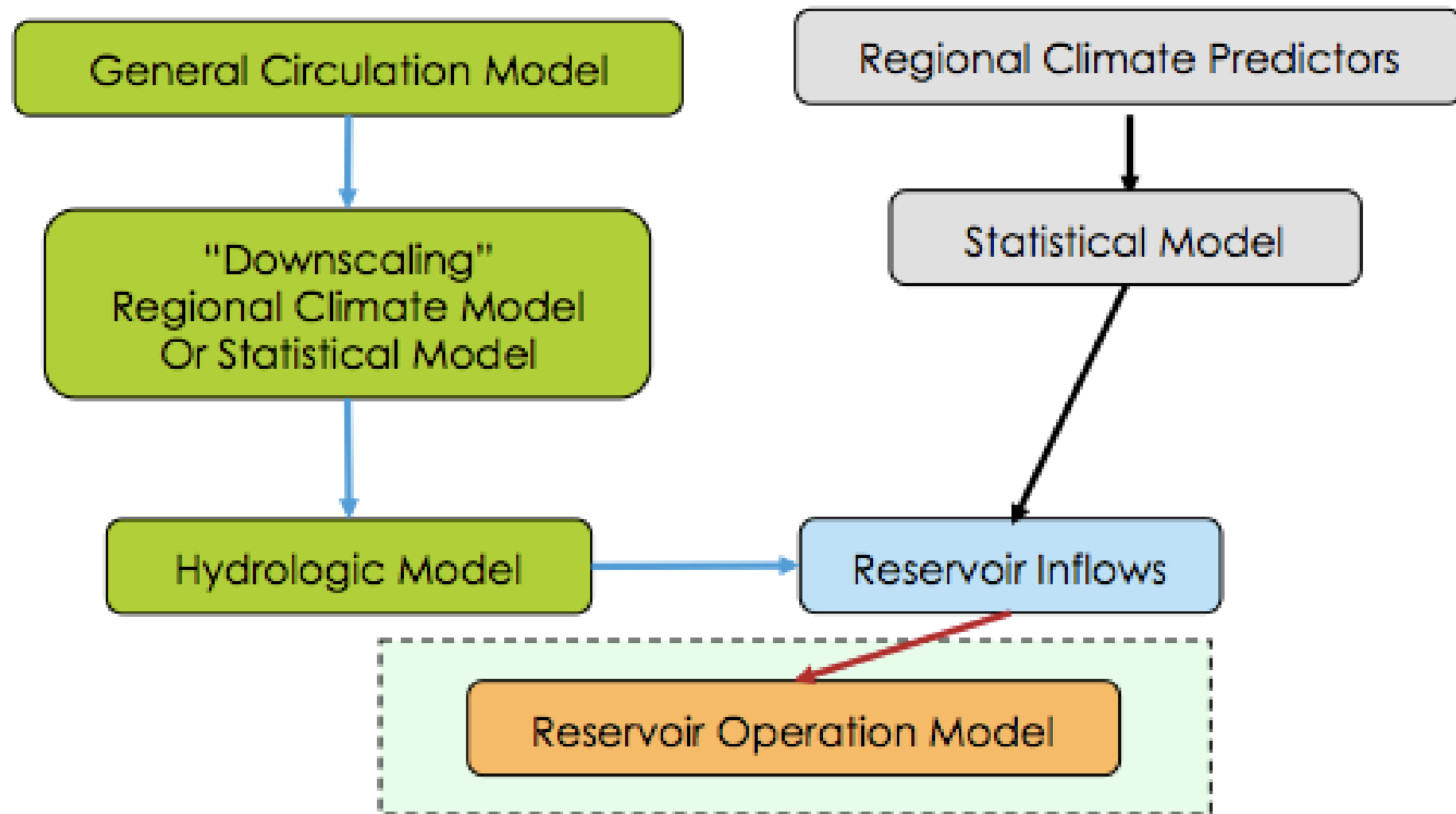


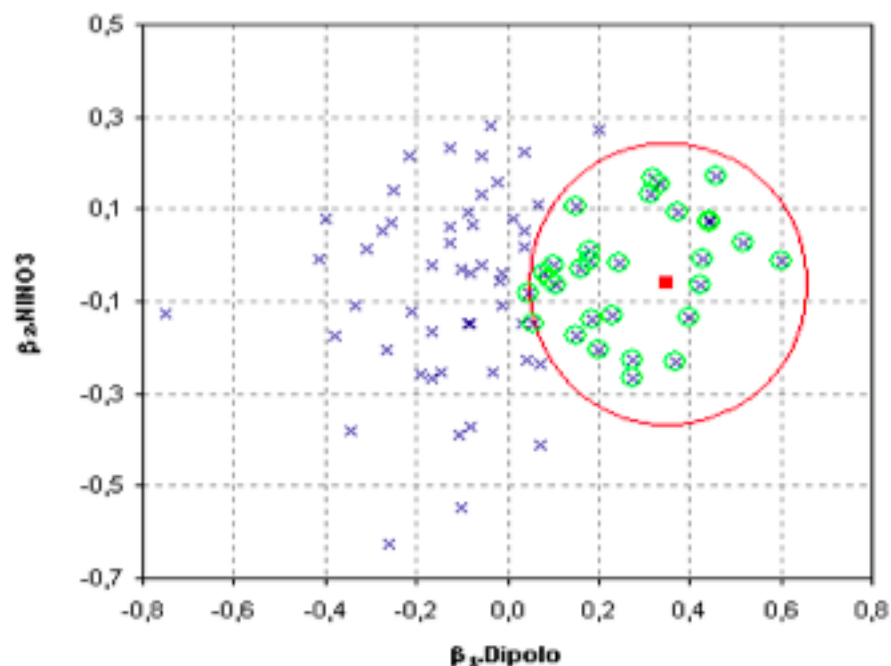
WATER ALLOCATION



A forecast is made at each time point for the balance of the period, and the decision for reservoir operation is updated using this forecast

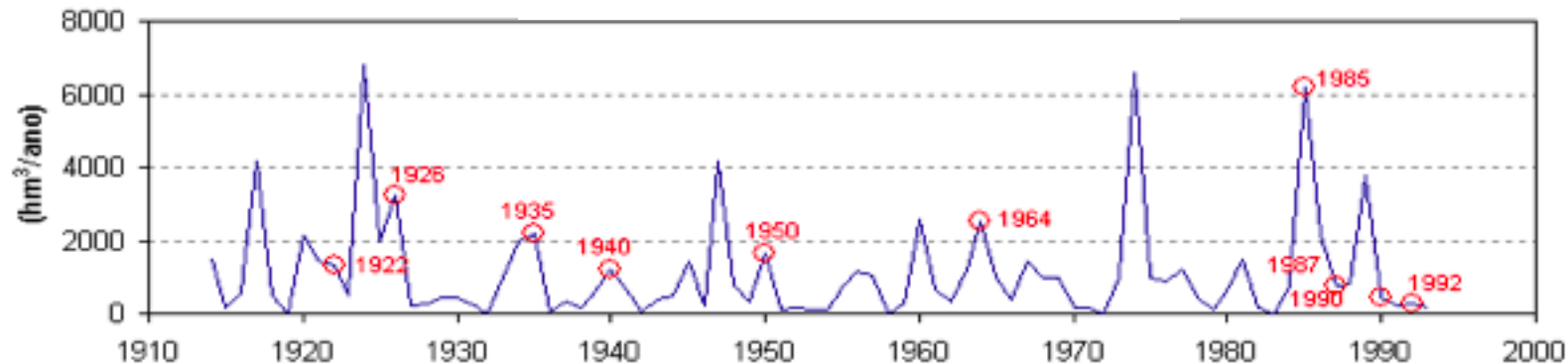
Need forecasts of monthly and annual flow at each reservoir that are spatially consistent



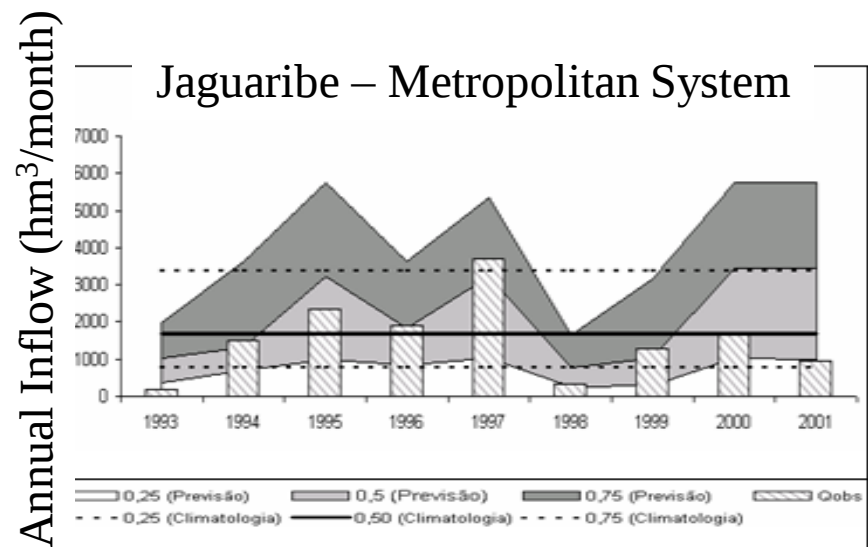


Year	Dist.	Year	Dist.
1935	0,073	1976	0,198
1926	0,087	1966	0,208
1987	0,095	1986	0,218
1950	0,116	1921	0,218
1964	0,140	1924	0,227
1922	0,155	1972	0,232
1990	0,160	1960	0,242
1985	0,165	1946	0,252
1992	0,170	1975	0,254
1940	0,176	1974	0,256
1991	0,182	1945	0,260
1973	0,182	1925	0,262
1938	0,183	1978	0,272
1914	0,189	1977	0,304
1923	0,193	1931	0,305

Annual Inflow – Orós Reservoir



Data requirements: Precipitation and Inflow monthly data & NINO34/DIPOLO indexes

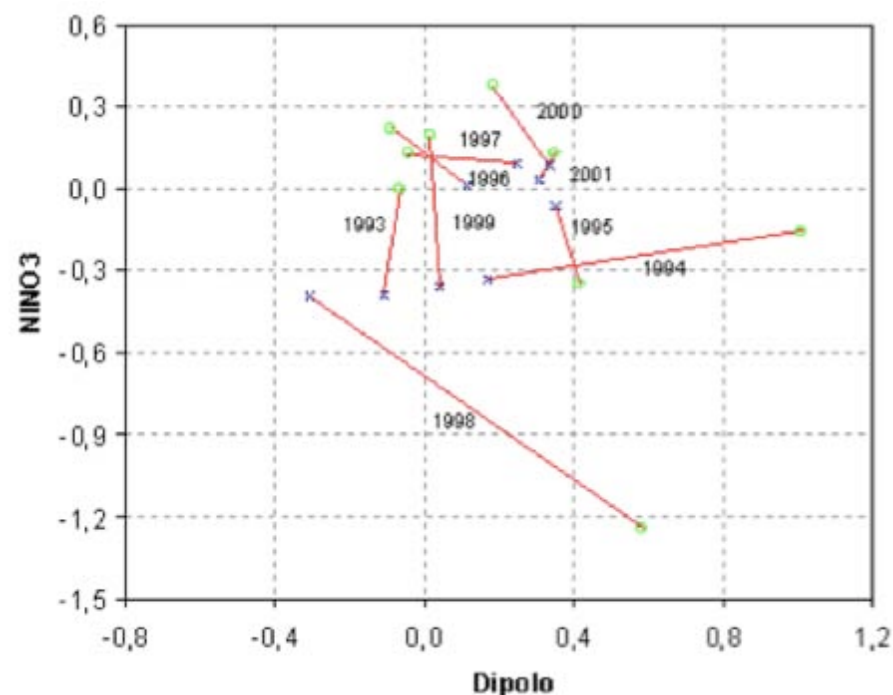


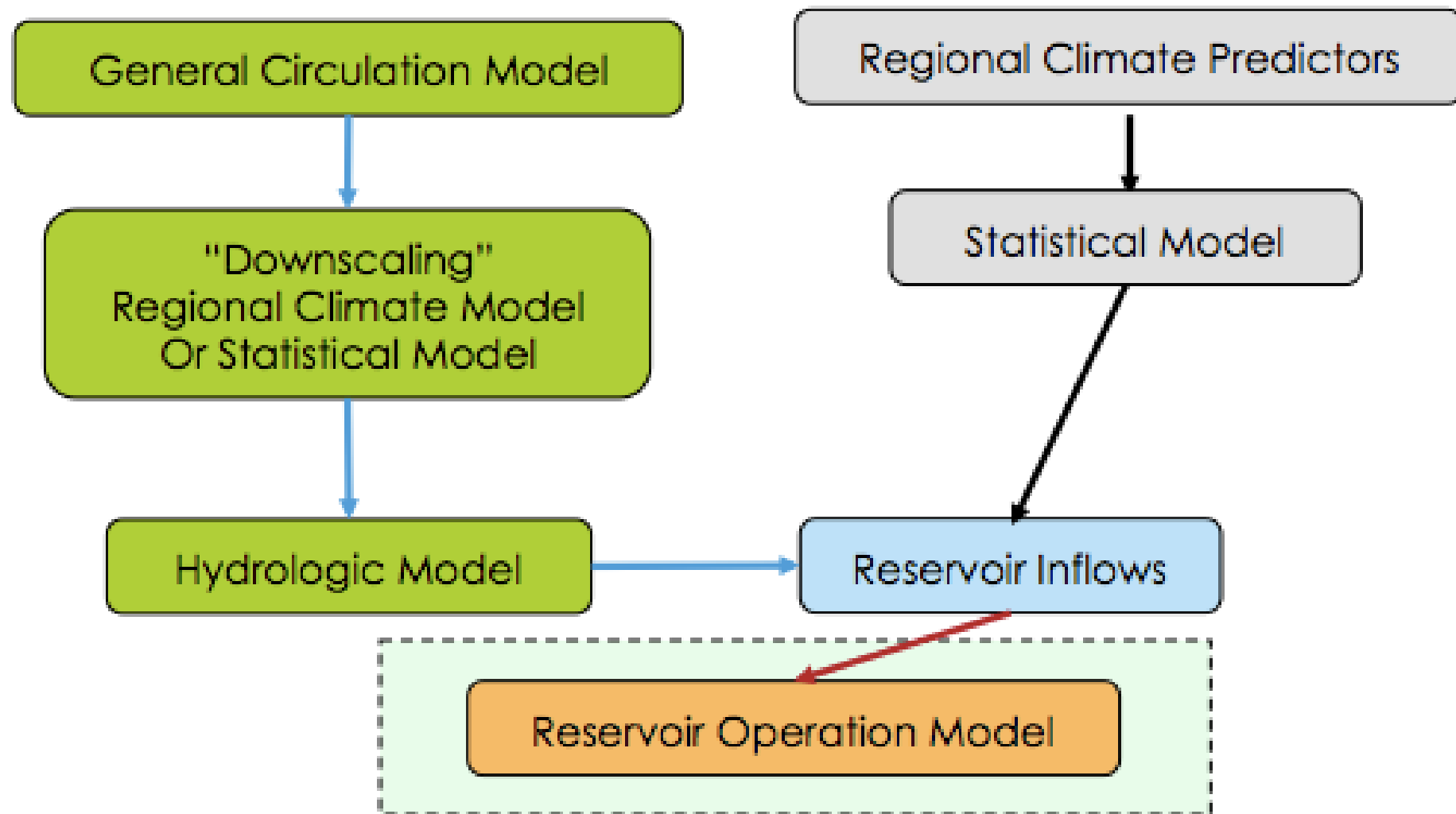
Statistical Analysis – Climatology & Forecast

Reports on correlation for the 90's: **91%**
(Souza Fo and Lall, 2003)

Cross-validation for a longer period is on the way...

CHANGES IN OCEAN CONDITIONS JUN → DEC





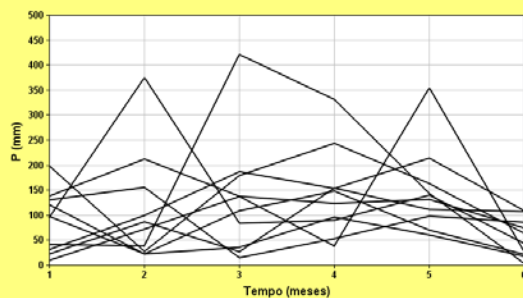
GCMs → RCMs → Hydrological Models ∴ Inflow forecast

RSMs

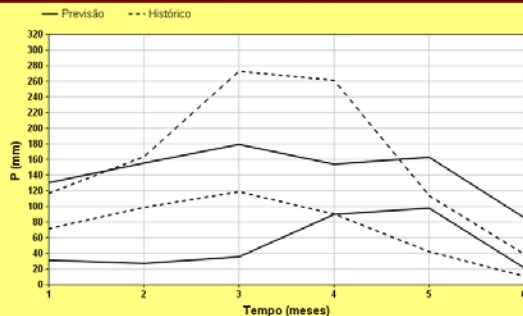
RAMSs



Previsão de Precipitações

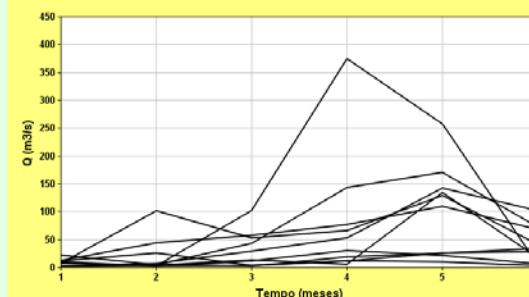


Previsão vs. Histórico (Precipitação) - Percentis de 25 e 75%

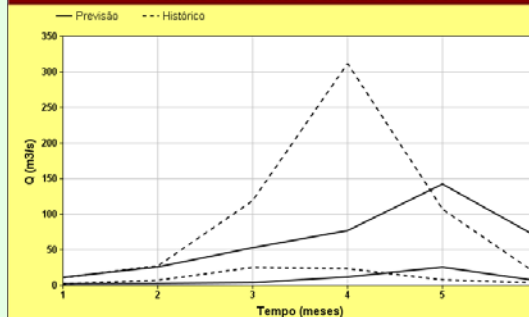


Hydrological
Models

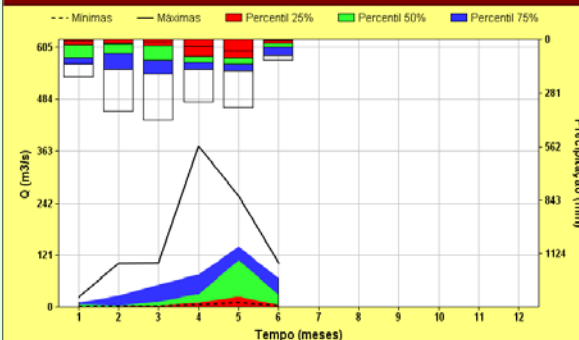
Previsão de Vazões



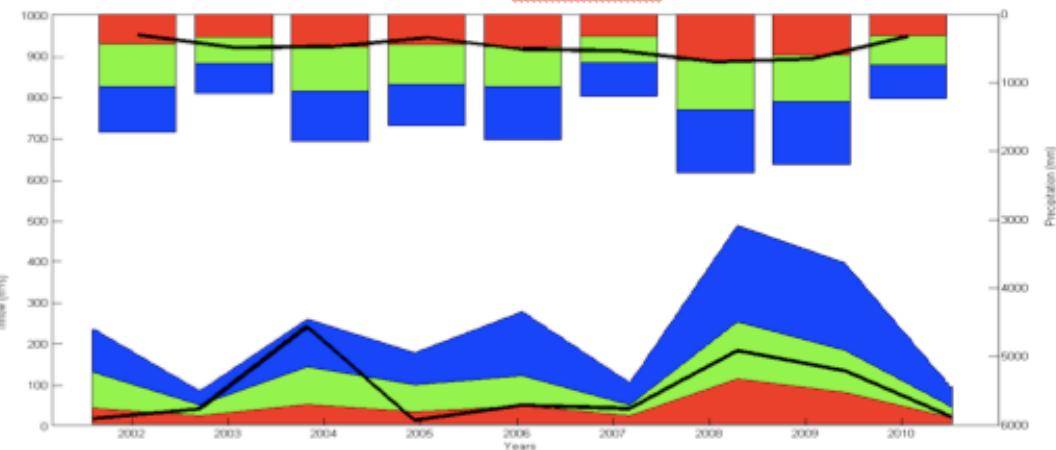
Previsão vs. Histórico - Percentis de 25 e 75%



Previsão de Vazões - Estatísticas

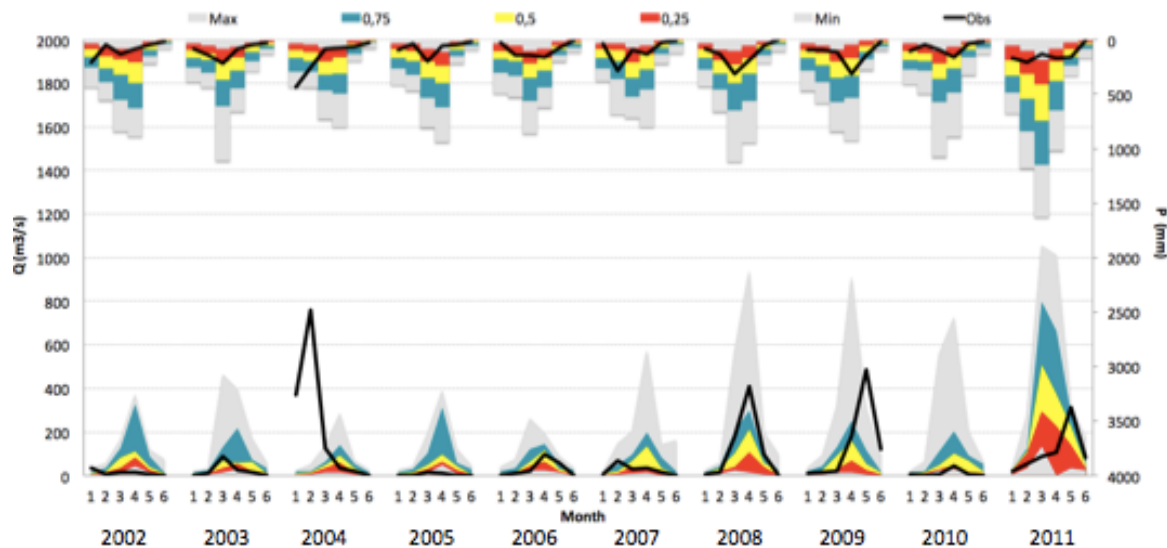


ORÓS Reservoir



OROS Reservoir

RSM – issued from Dec to Apr each Year
Precipitation, Inflow (forecast statistics and observed values)



NEGOTIATION PROCESS INVOLVES LOCAL COMMITTEES

**11 WATER BASIN COMMITTEES: STATE, UNION, MUNICIPALITIES,
FARMERS, OTHER USERS**

RESERVOIR OPERATIONS GROUP: DNOCS, COGERH, FUNCEME



PRODUCTS WITH THE INVOLVEMENT OF THE WATER MANAGEMENT AGENCY:

Climatic and inflow forecasts (by use of Dynamical Models)
issued in a monthly basis

Web products & DSS → Several ongoing developments

Hydro web site ...

DSS → easy generation of inflow forecasts based on the methods
above

Old products → interfaces are being modified as requested by the water
manager

Constant feedback and updates are being made in several products.

- INSTITUTIONAL VULNERABILITIES IN MOST OF THE STATES OF NORTHEAST (e.g. STAFF).
- BASIC TOOLS, EVEN WHEN AVAILABLE, ARE NOT INCORPORATED IN THE OPERATIONAL ACTIVITIES OF WATER AGENCIES (E.G., DSS, Hydrological Models, ...)
- INCAPACITY OF THE STATE WATER RESOURCES SYSTEMS IN INCORPORATING THE MONITORING/FORECASTING INFORMATION IN RESERVOIR SYSTEM OPERATIONS.

Weak links → Institutions involved in the process
Cooperation may be intended but has to be effective!

Met Service & Water Manager

Water Managers & Ownership of water-related products

Communication of the results

- What is the best way to present information in water basin committees?
- Met. Services → Communication strategy is needed!

The needed information → exists – useful – used

In the right time, horizon and necessary formats as needed by the user.

Thank you !!!