# Towards a typology of low waters in the Amazon basin

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With many thanks to discharge data collectors (!!!) :

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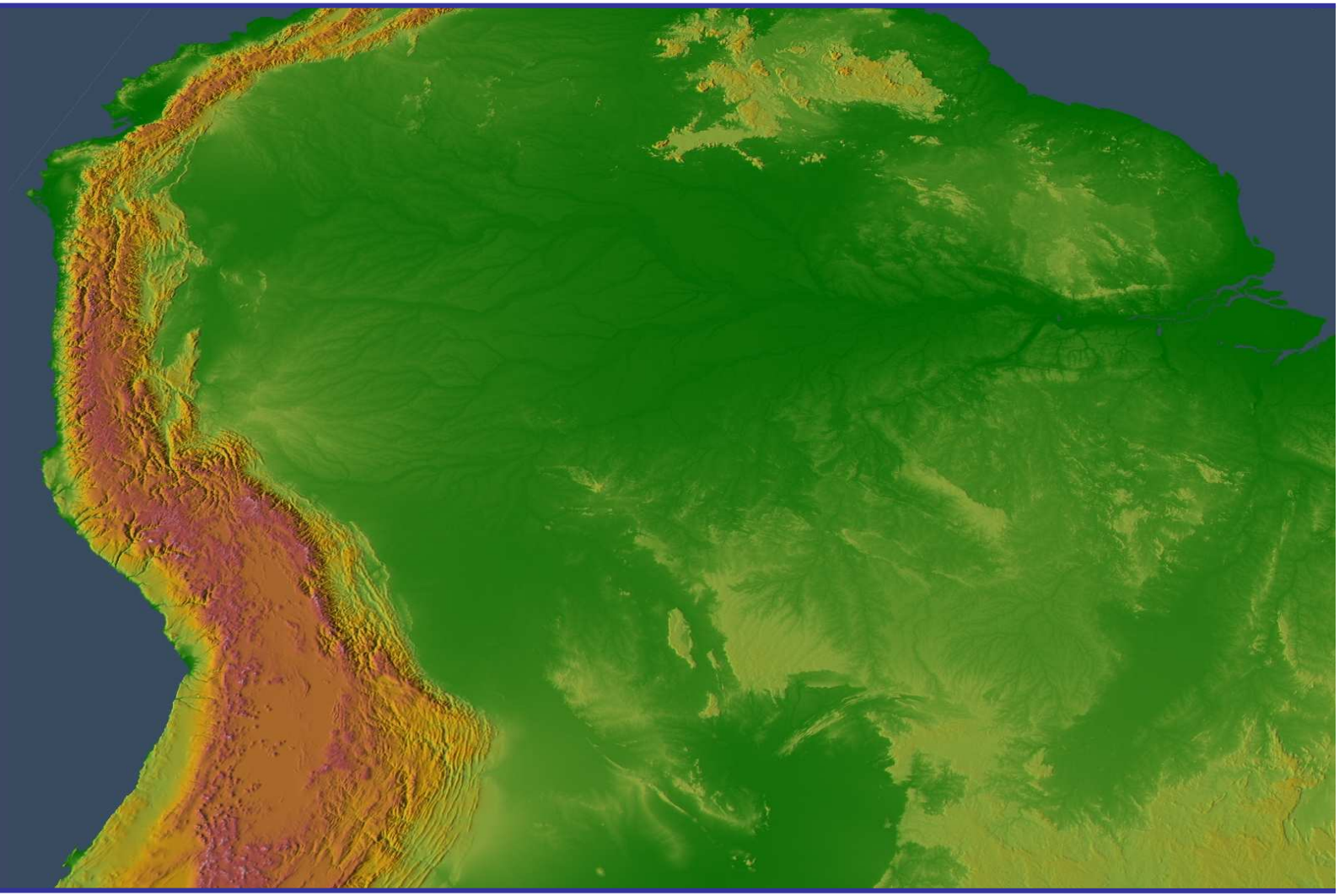
…and certainly more.



**Hydrology and present geodynamic of South American basins, 4th ORE-HyBAm scientific meeting**

*6-9th of September 2011, Lima, Peru*

## A growing concern

Record after record…: 1997/98, 2005, 2010

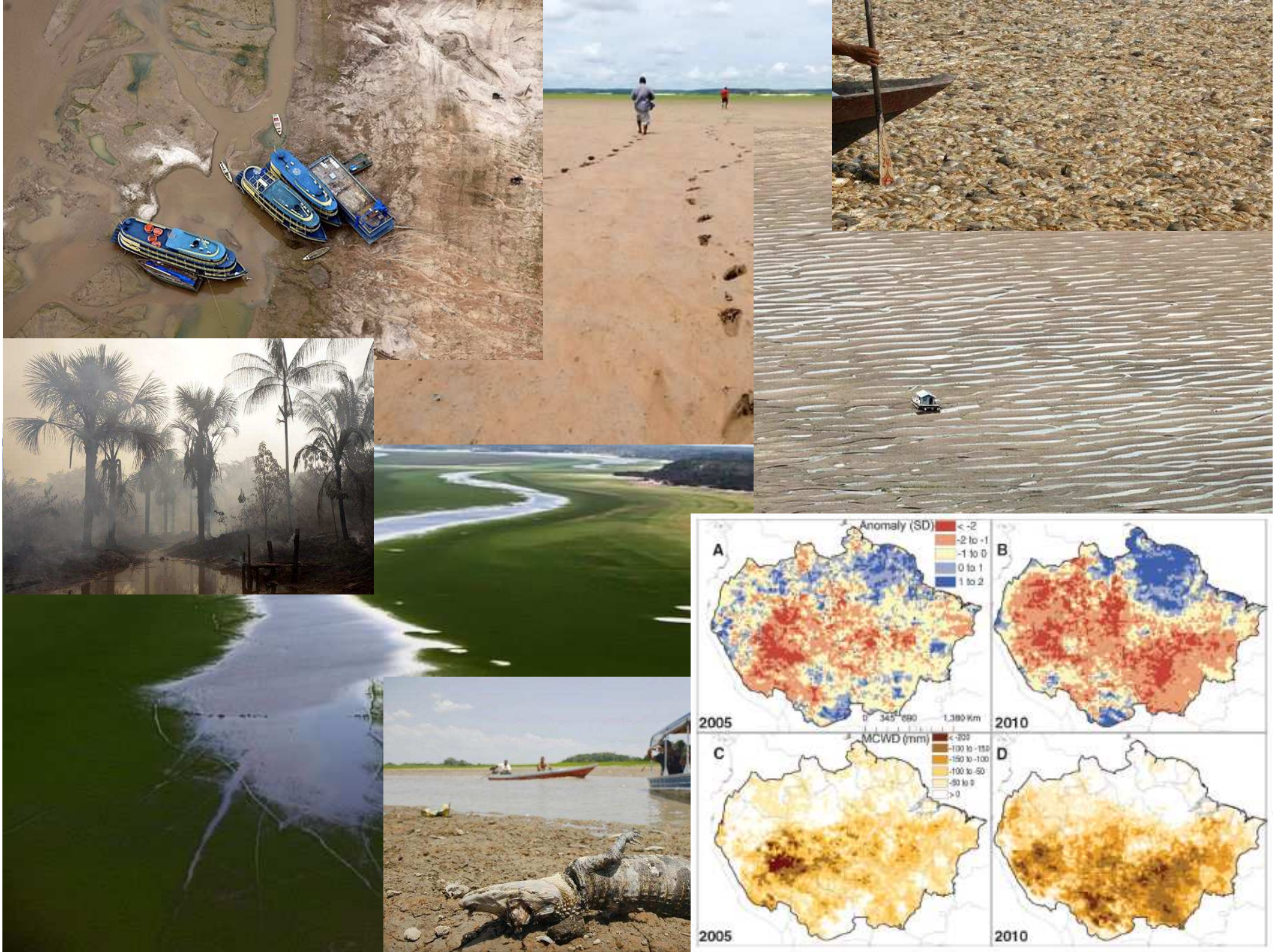
Dramatic impacts:

-on biosphere (tree and fauna…) *(e.g. Phillips et al.2009)*

-on the carbon cycle *(Lewis et al.2011)*

-on Amazonian populations (health, food, mobility) *(Drapeau et al.2011)*

Amazonian droughts may benefit from climate change and deforestation and become more frequent and/or more intense in the future. This could have a catastrophic impact upon the Amazonian environment (Dieback hypothesis, *e.g. Malhi et al.2009, Betts et al.2004, Cox et al.2004…*).


Anomaly (SD)
< -2
-2 to -1
-1 to 0
0 to 1
1 to 2
A
B
2005
2010
0 345 690 1,380 Km
MCWD (mm)
< -200
-100 to -150
-150 to -100
-100 to -50
-50 to 0
> 0
C
D
2005
2010

## A growing concern

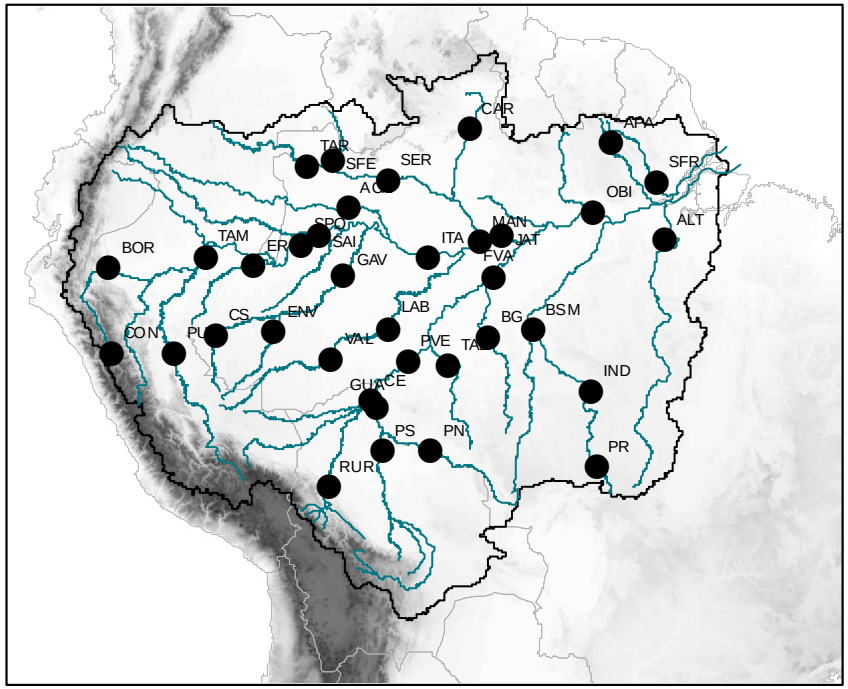
Case studies represent most of the literature on Amazonian droughts. (Williams *et al*, 2005, Marengo *et al*, 2008; Aceituno *et al*, 2009; Tomasella *et al*, 2011; Espinoza *et al*, 2011…)

However, more integrative, systematic studies of Amazonian meteorological and hydrological droughts are still lacking.

Through the results of a statistical analysis, we try here to present few elements of classification that could allow us to build-up a typology of droughts and low waters in the Amazon basin.

# Data

We use a dataset of daily discharge values from 36 stations, collected by the Environmental Research Observatory HyBAm between 1980 and 2009.



# Indicators

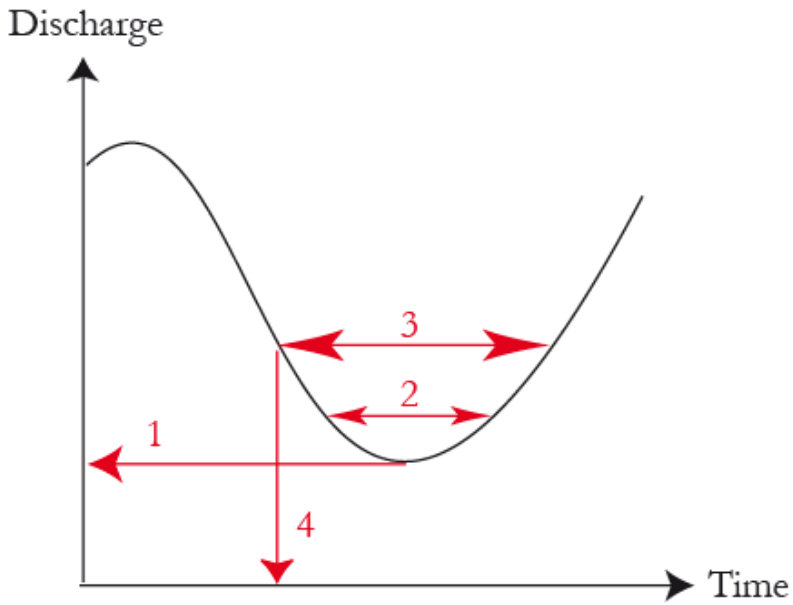
4 indicators are used in ordered to characterized each low-waters stages:

- **Index 1**: minimum discharge value

- **Index 2**: number of days the discharge is below Q5

- **Index 3**: number of days the discharge is below Q25

- **Index 4**: starting time of the seasonal low flow



## Statitical analysis

A Principal Component Analysis (PCA) is performed on each one of these indicators in order to identify the spatial and temporal modes of variability characterizing the low-waters stages, on which a typology could be built.

| | PC1 | PC2 | PC3 | PC4 | PC5 | PC6 | PC7 | PC8 | PC9 |
|---|---|---|---|---|---|---|---|---|---|
| Debmin | 31,5 | 12,5 | 9,9 | 8,0 | 6,8 | 4,3 | 3,6 | 3,5 | 2,8 |
| DebinfQ25 | 27,9 | 15,6 | 11,2 | 8,3 | 5,7 | 5,2 | 4,7 | 3,1 | |
| DebinfQ5 | 29,2 | 11,9 | 10,4 | 9,6 | 6,6 | 5,4 | 5,1 | 3,6 | 3,0 |
| Debut | 23,8 | 15,2 | 12,9 | 7,9 | 6,2 | 4,7 | 4,2 | 3,8 | 3,0 |

% of explained variance

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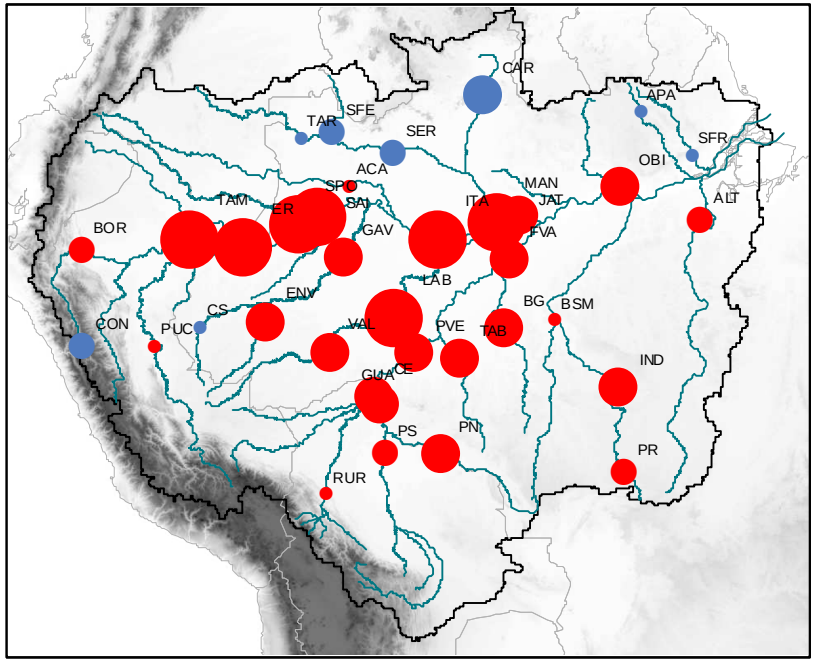
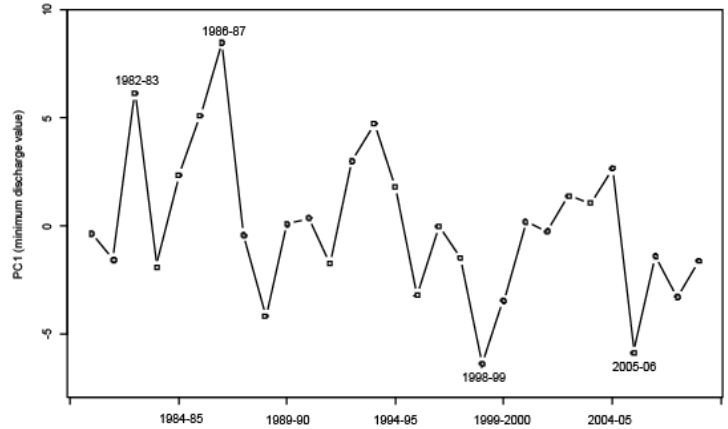
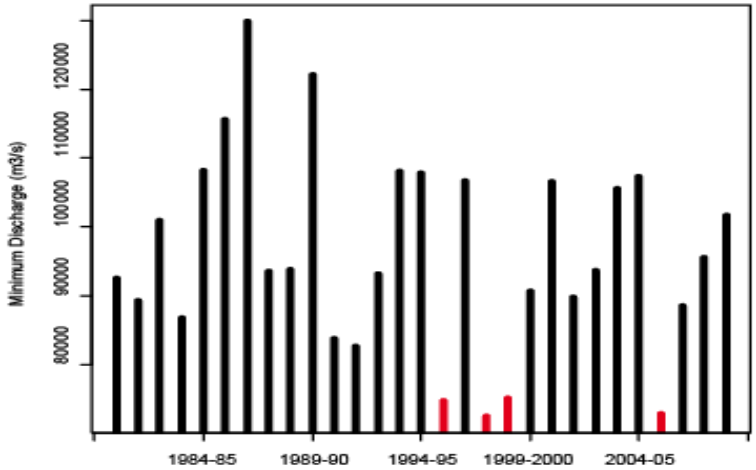
% of explained variance

# First results - Variability




**Exemple of PC1 (minimum discharge): « South/North » pattern**

- Spatial pattern (top-left)
- Temporal pattern (top-right)
- Minimum discharge value at Obidos (bottom-right)

# First results - Variability

Some spatial pattern are similar for different indexes:

| | PC1 | PC2 | PC3 | PC4 | PC5 | PC6 | PC7 | PC8 | PC9 |
|---|---|---|---|---|---|---|---|---|---|
| Debmin | 31,5 | 12,5 | 9,9 | 8,0 | 6,8 | 4,3 | 3,6 | 3,5 | 2,8 |
| DebinfQ25 | 27,9 | 15,6 | 11,2 | 8,3 | 5,7 | 5,2 | 4,7 | 3,1 | |
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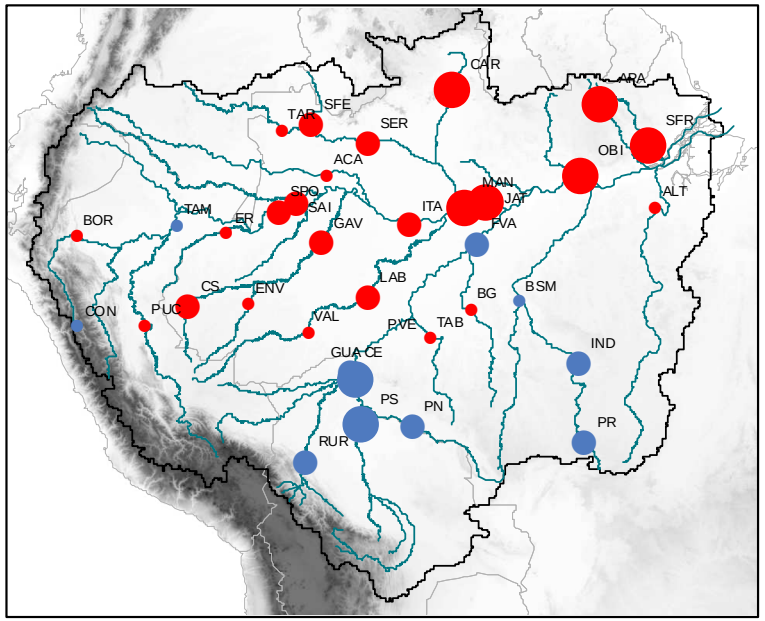
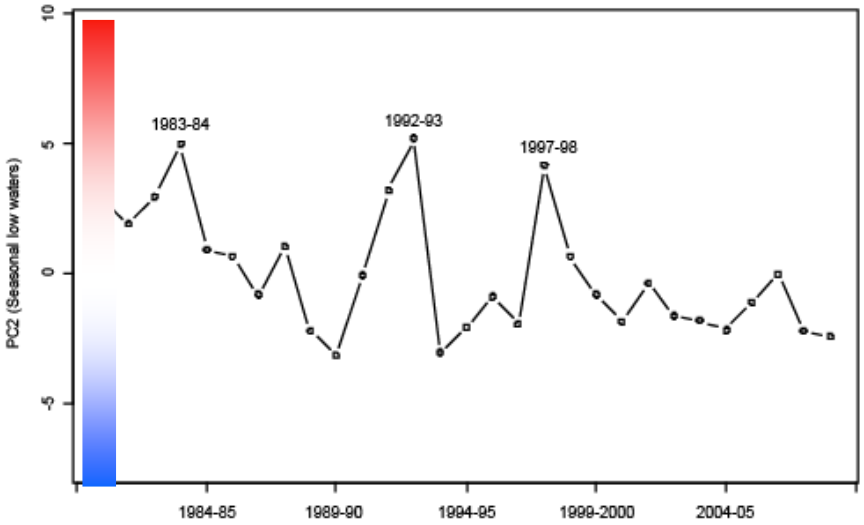
- North/South
- ENSO
- Negro or North-West
- East/West
- South-West
- Mouth

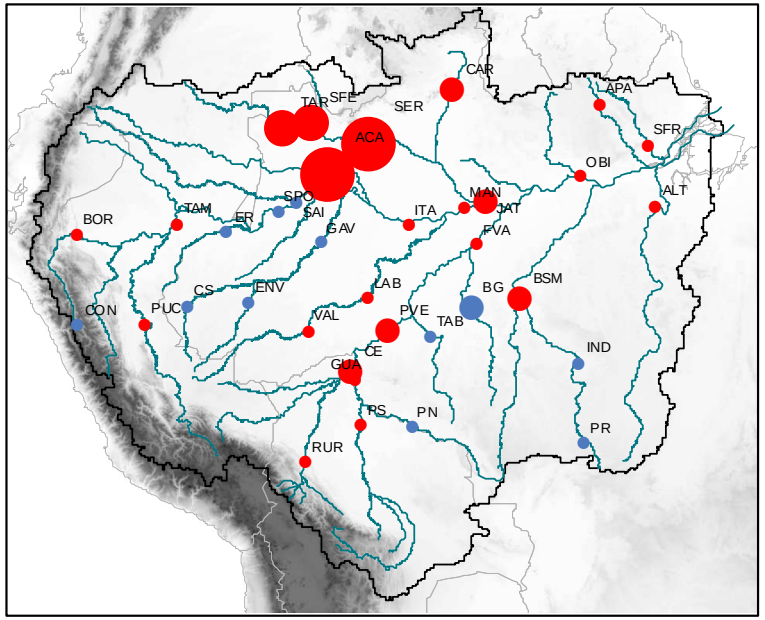
# First results - Variability

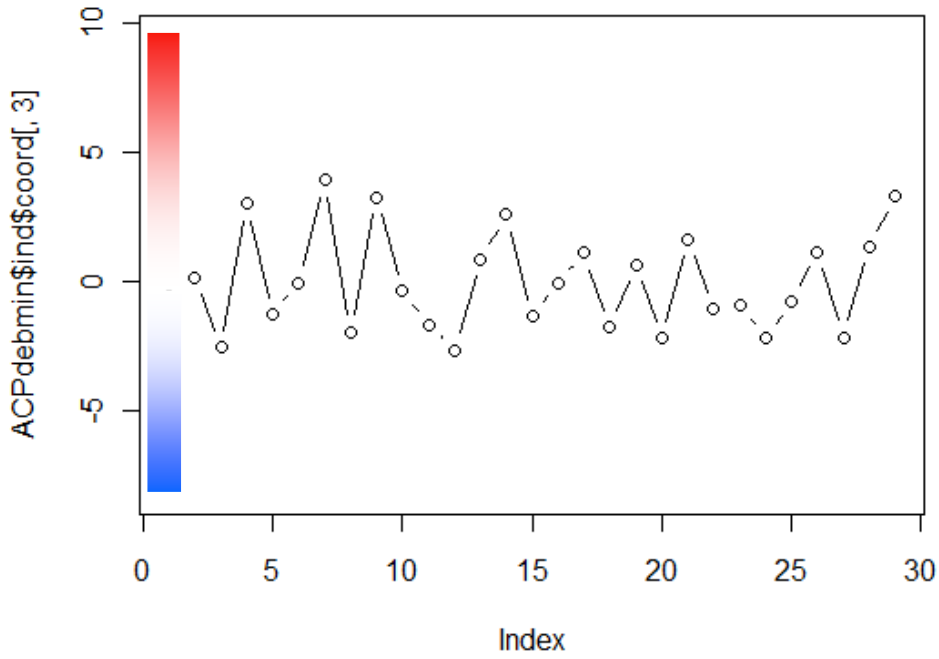



**Exemple of PC2 (Nb of Days < Q25) :**
**« ENSO » pattern**

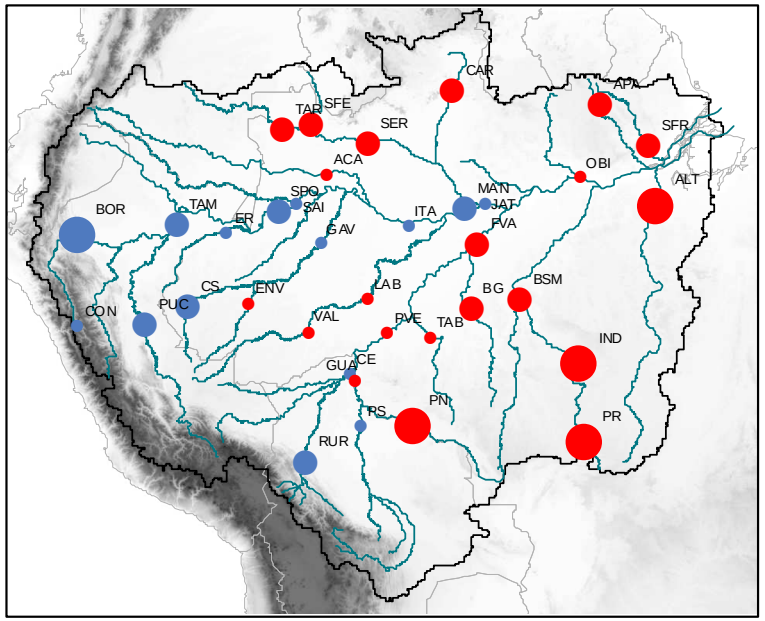
# First results - Variability

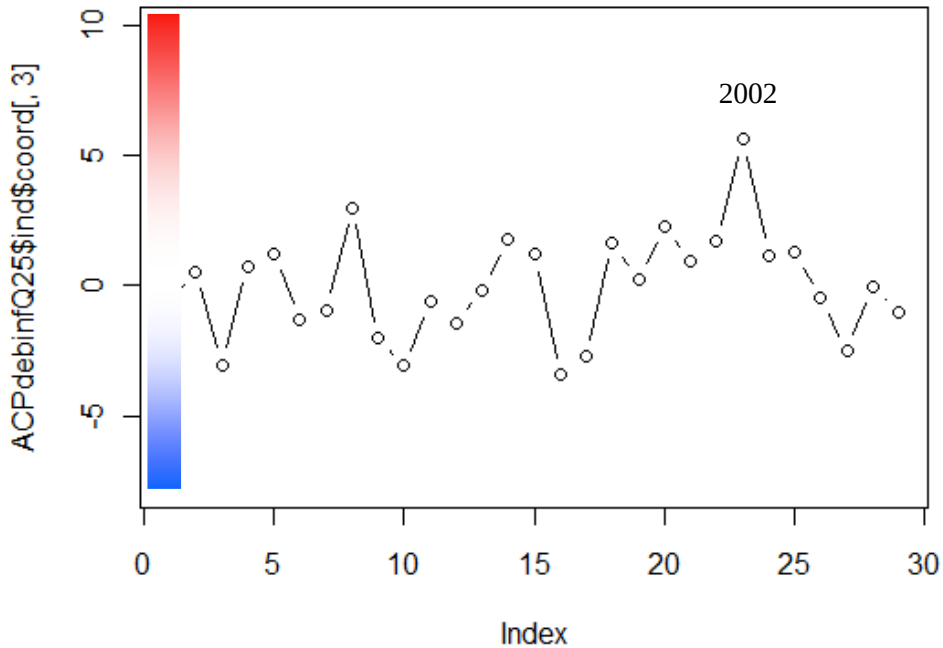



**Exemple of PC3 (minimal discharge) :**
**« Negro, or NW »**

# First results - Variability




**Exemple of PC3 (Nb of Days < Q25) :**
**« East/West » pattern**

# First results - Trends

Some components also indicate a trend over the last decades. It seems to indicate a tendency to dryer and longer low waters conditions in the South of the basin.

| | PC1 | PC2 | PC3 | PC 4 | PC5 | PC6 | PC7 | PC8 | PC9 |
|---|---|---|---|---|---|---|---|---|---|
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| DebinfQ5 | 29,2 | ***11,9*** | 10,4 | 9,6 | 6,6 | 5,4 | ***5,1*** | 3,6 | 3,0 |
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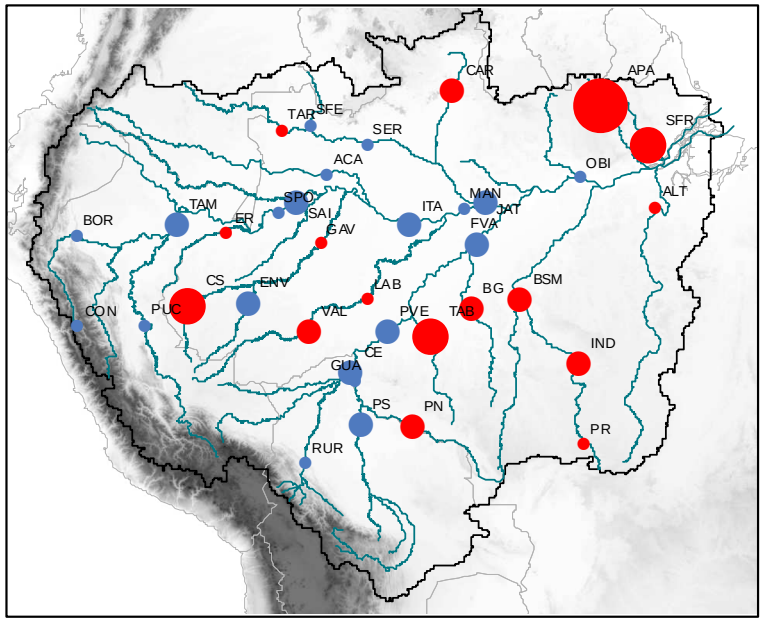


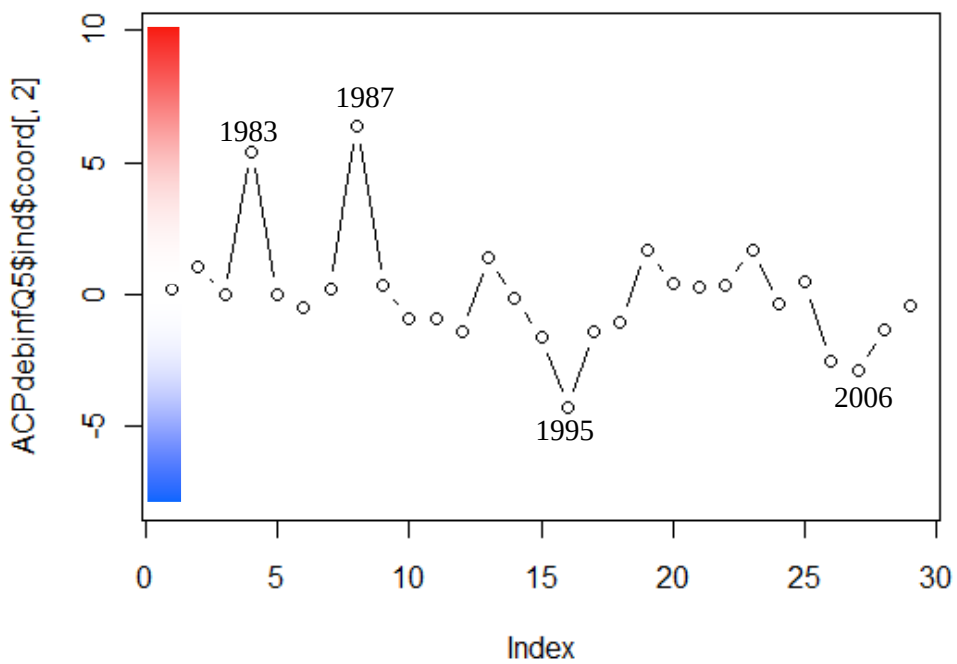


**Exemple of PC2 (Nb of Days < Q5) :**
**« Mouth, or Atlantic » pattern**

## Conclusion

This exploratory statistical analysis shows that Principal Component Analysis allows us to discriminate various modes of variability of Amazonian low waters, related to climatic modes of variability (ITCZ, SST).

The possibility for discriminating the influence of the different types of ENSO events is noticeable.

These modes also tend to confirm the current drying of the southern part of the basin.

Future work will aim at building comprehensive classification of Amazonian drougths and low waters.

Thank you for your attention !