Climate indexes and intraseasonal influences on brazilian natural energy

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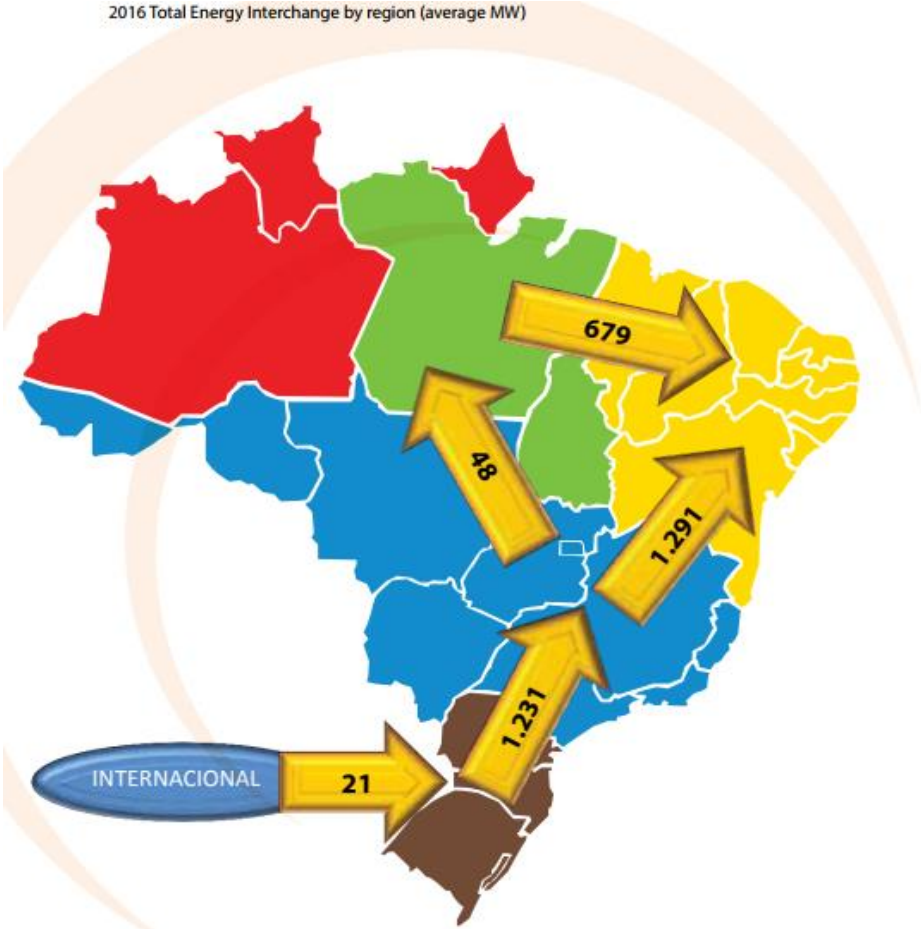
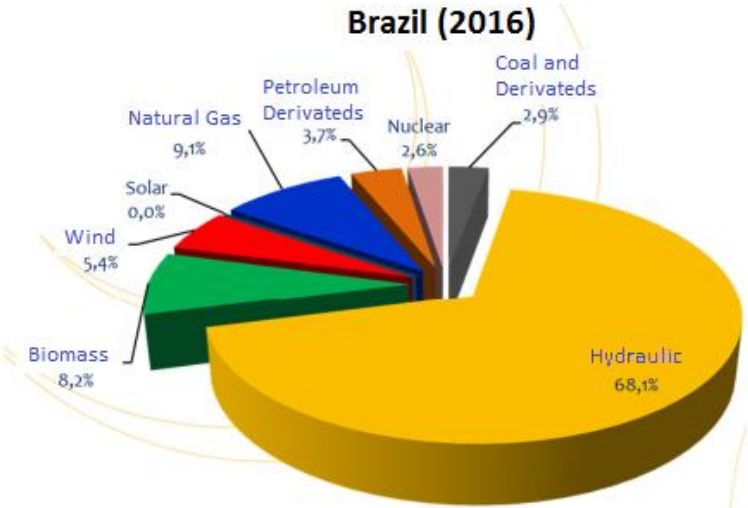
CLIMATEMPO
O céu fala. A gente entende.

*Brazil's **large territorial extension** provides the country unique characteristics, as it is influenced by a **variety of dynamical systems** with different spatial and temporal scales resulting in several climatic regimes in its subregions. The largest energy source for all regions is hydropower and a sequence of years with low precipitation depleted the reservoirs of a few areas, one of them is the northeast region.*

*In this study we explore the annual and interannual characteristics of key areas with large average flow and how different **Atlantic and Pacific related indexes** influence those areas. The Madden-Julian influence was analyzed for intraseazonal signals. Monthly and daily flow rates from 1931 to 2015 were correlated with climate indexes such as Southern Oscillation Index (SOI), Niño 3.4, Niño 1+2, Multivariate ENSO Index (MEI), Atlantic Multidecadal Oscillation (AMO), Tropical South and North Atlantic Index (TSA and TNA) and North Atlantic Oscillation Index (NAO).*

Brazilian Energy System





Hydraulic Offer in 2016 **421,7 TWh**

Total Offer in 2016 **619,7TWh**

Brazilian Energy System

Instaled Capacity (MW)

Source	2015	2016	Δ 16/15
Hydropower	91.650	96.925	5,8%
Thermal	39.580	41.276	4,3%
Nuclear	1.990	1.990	0,0%
Windpower	7.633	10.124	32,6%
Solar	21	24	13,1%
Available Capacity	140.874	150.338	6,7%

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Brazilian Energy System

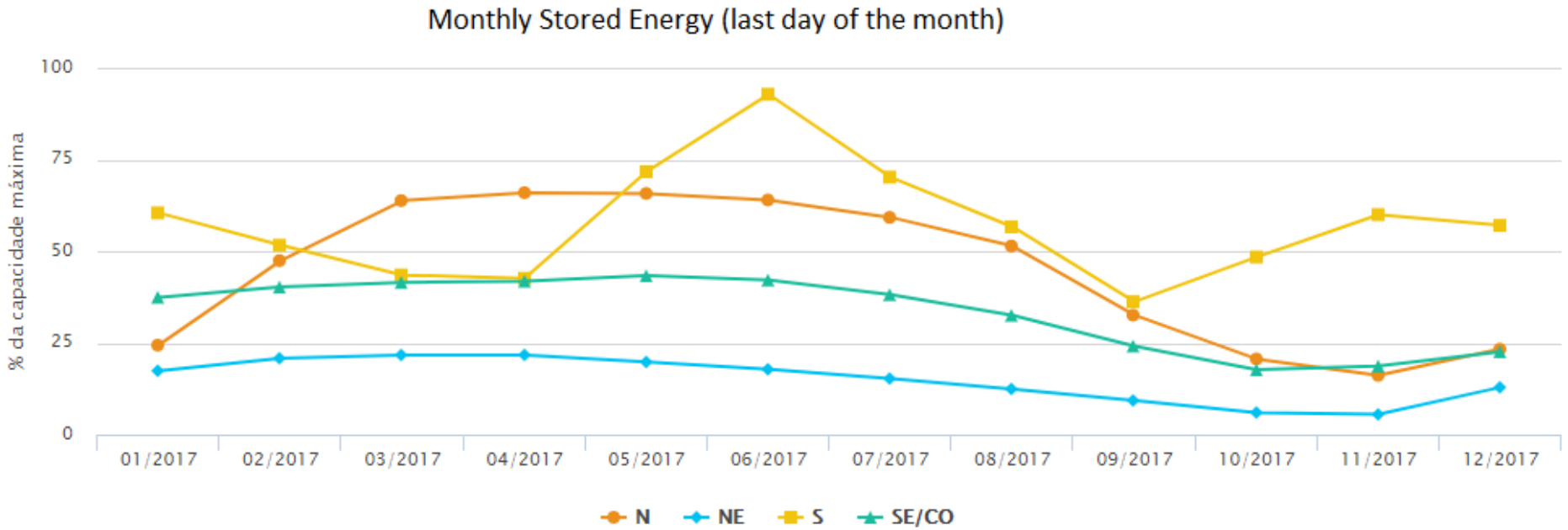
Consumption by electric subsystem (GWh)

	2012	2013	2014	2015	2016	Δ% (2016/2015)	Part. % (2016)	
Brasil	**448.176**	**463.134**	**474.823**	**464.976**	**460.829**	**-0,9**	**100**	**Brazil**
Sistemas Isolados	7.822	5.796	3.769	3.321	2.942	-11,4	0,6	Isolated Systems
Norte	29.822	32.085	33.787	33.582	34.433	2,5	7,5	North
Nordeste	63.896	68.680	72.031	72.926	73.307	0,5	15,9	Northeast
Sudeste/C.Oeste	269.146	276.181	280.417	273.135	268.084	-1,8	58,2	Southeast/Midwest
Sul	77.491	80.393	84.819	82.012	82.063	0,1	17,8	South

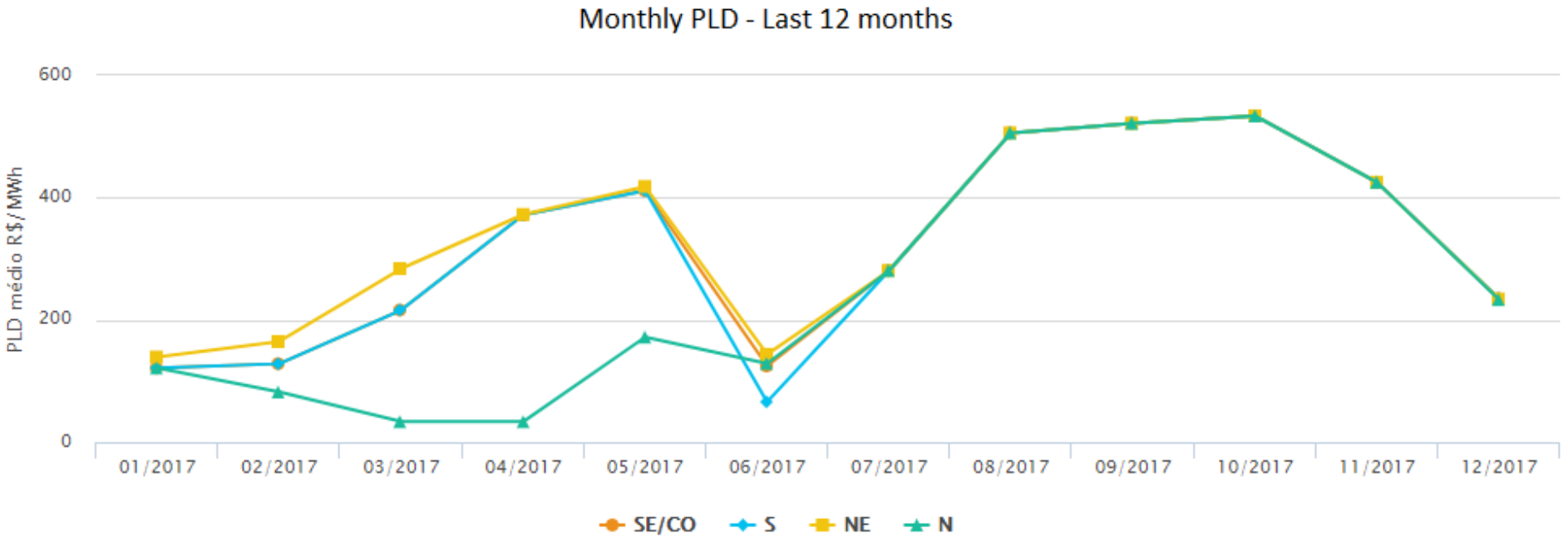
Consumption by end-use sector (GWh)

	2012	2013	2014	2015	2016	Δ% (2016/2015)	Part. % (2016)	
Brasil	**448.176**	**463.134**	**474.823**	**464.976**	**460.829**	**-0,9**	**100**	**Brazil**
Residencial	117.646	124.908	132.302	131.190	132.872	1,3	28,8	Residential
Industrial	183.475	184.685	179.106	168.856	164.557	-2,5	35,7	Industrial
Comercial	79.226	83.704	89.840	90.768	87.873	-3,2	19,1	Commercial
Rural	22.952	23.455	25.671	25.899	27.266	5,3	5,9	Rural
Poder público	14.077	14.653	15.354	15.189	15.092	-0,6	3,3	Public Sector
Iluminação pública	12.916	13.512	14.043	15.333	15.035	-1,9	3,3	Public lighting
Serviço público	14.525	14.847	15.242	14.730	14.969	1,6	3,2	Public service
Próprio	3.359	3.371	3.265	3.011	3.164	5,1	0,7	Own use

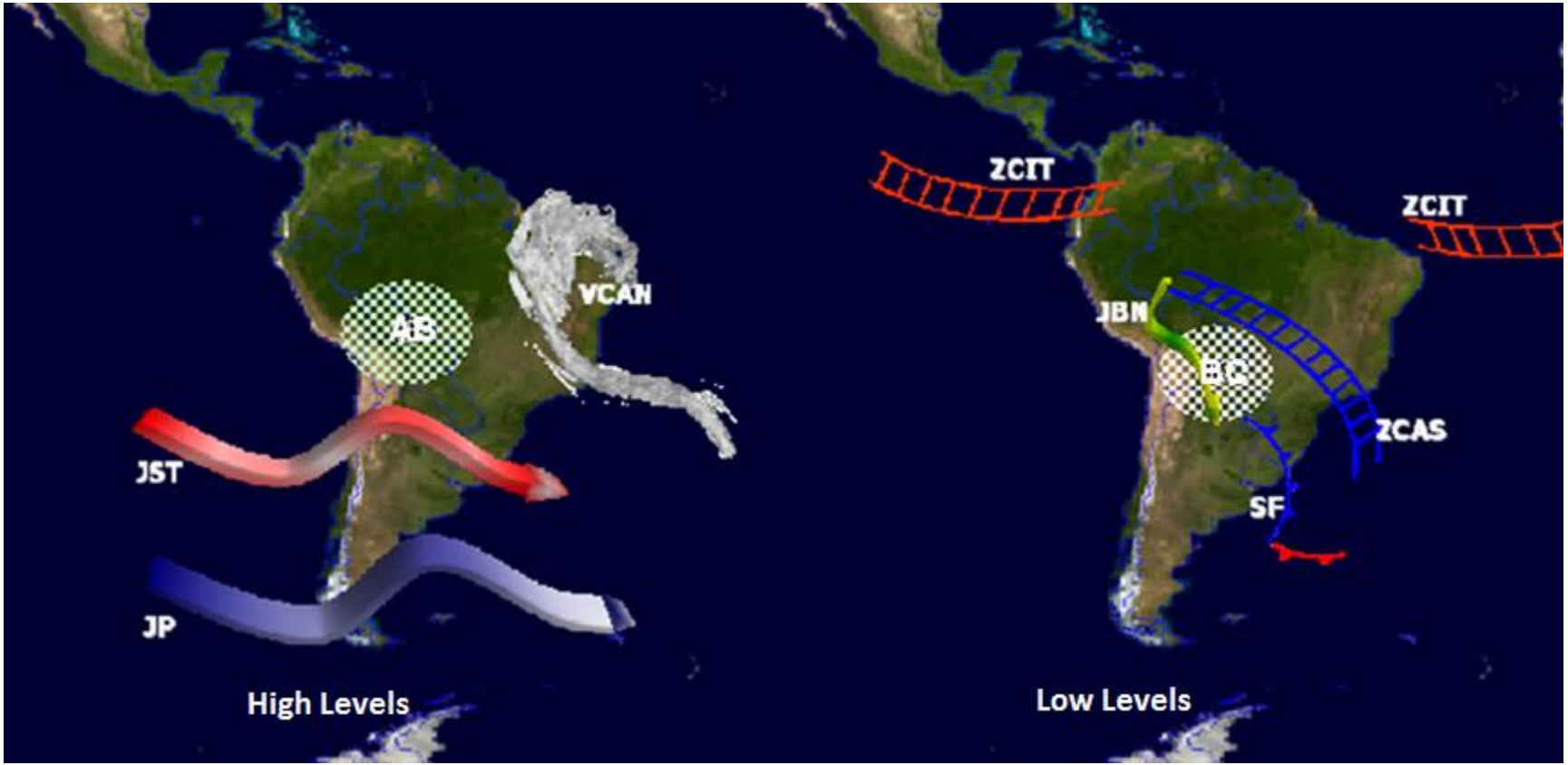
Brazilian Energy System



Brazilian Energy System

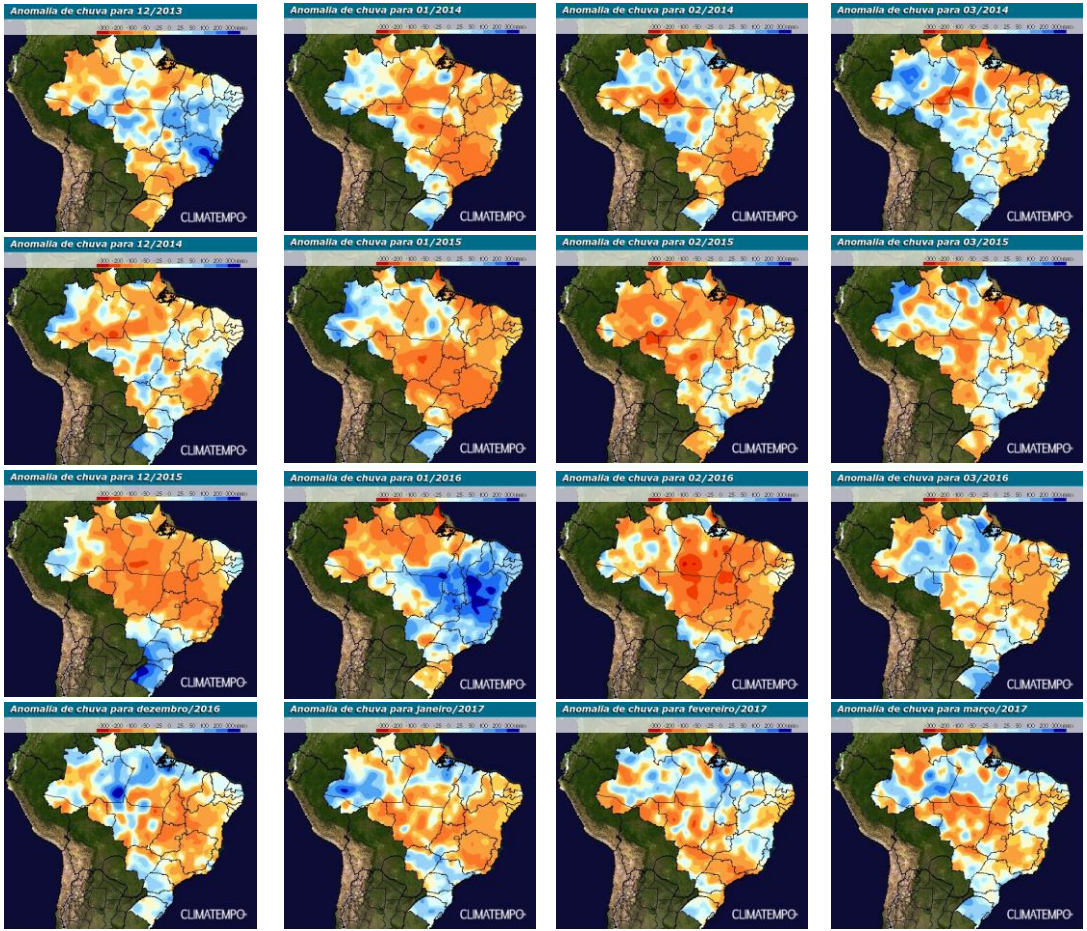


Brazilian Main Meteorological Influences

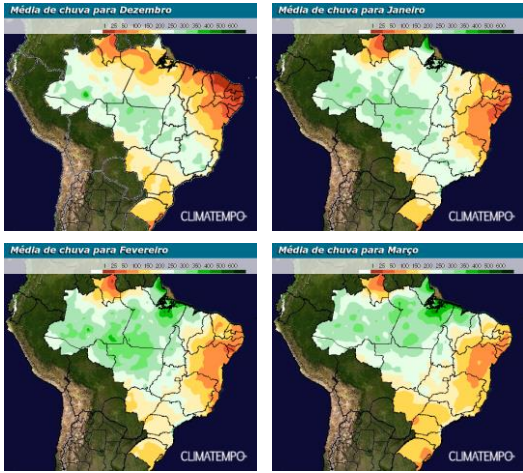


Hydrological Deficiency – Rainny Season 2014 to 2017

Precipitation Anomaly maps

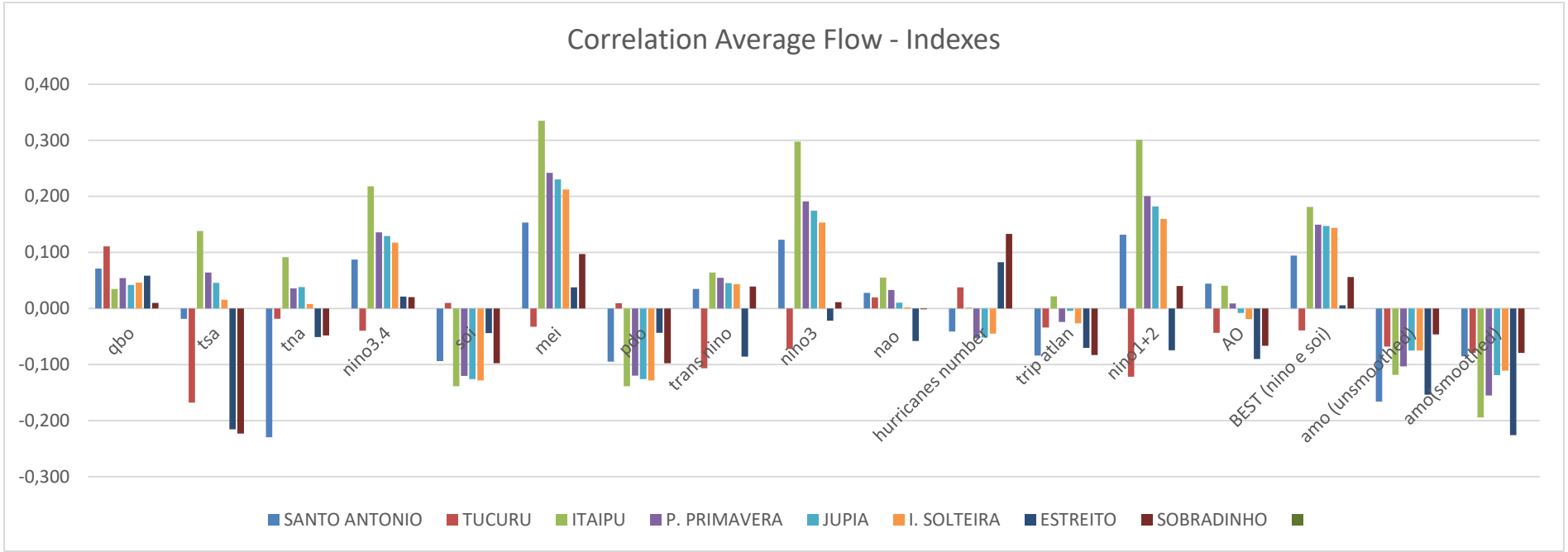


Precipitation Climatology

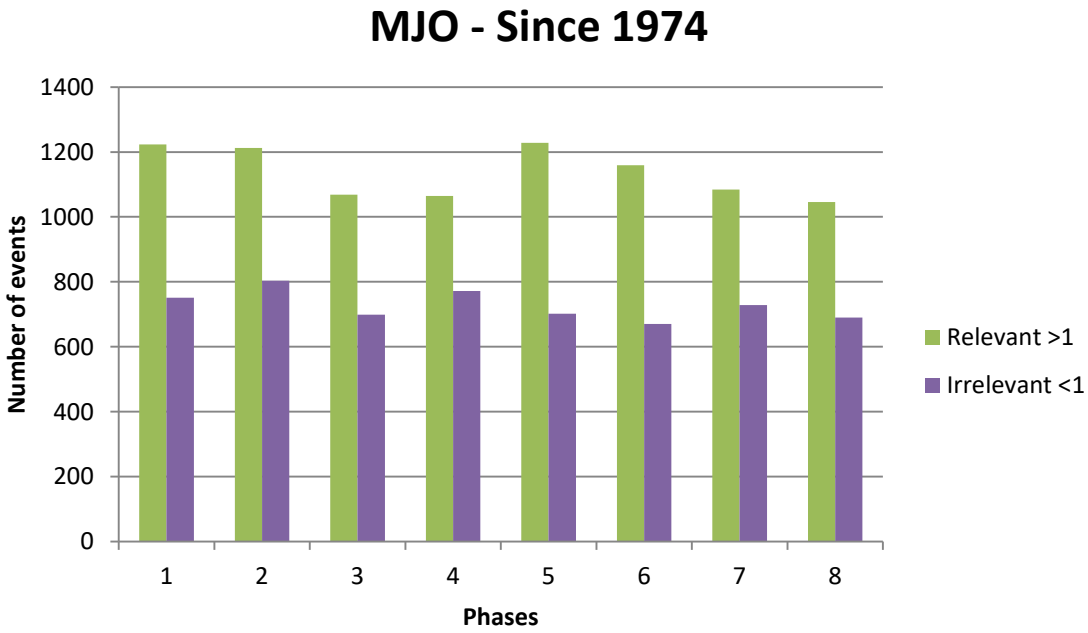


Studied Hydroeletric Plants

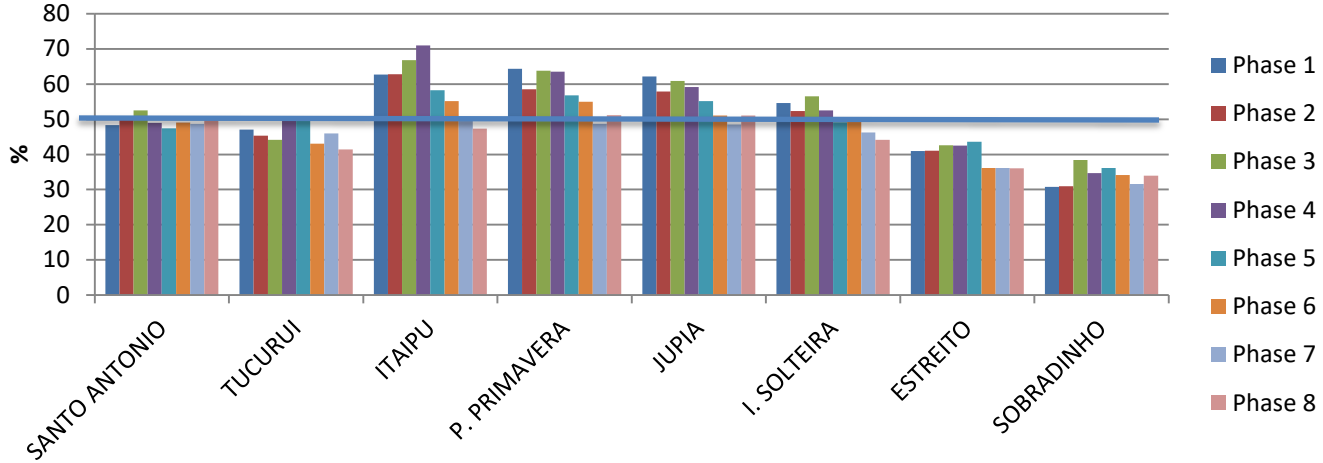
Oceanic Indexes



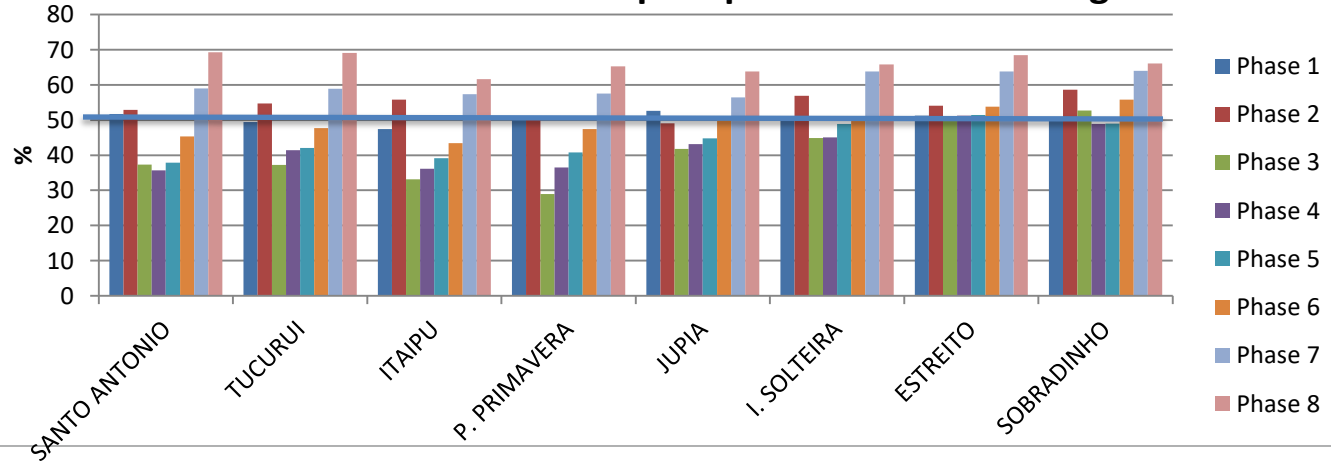
MJO - Influences



Revelant MJO - Events of precipitation above average



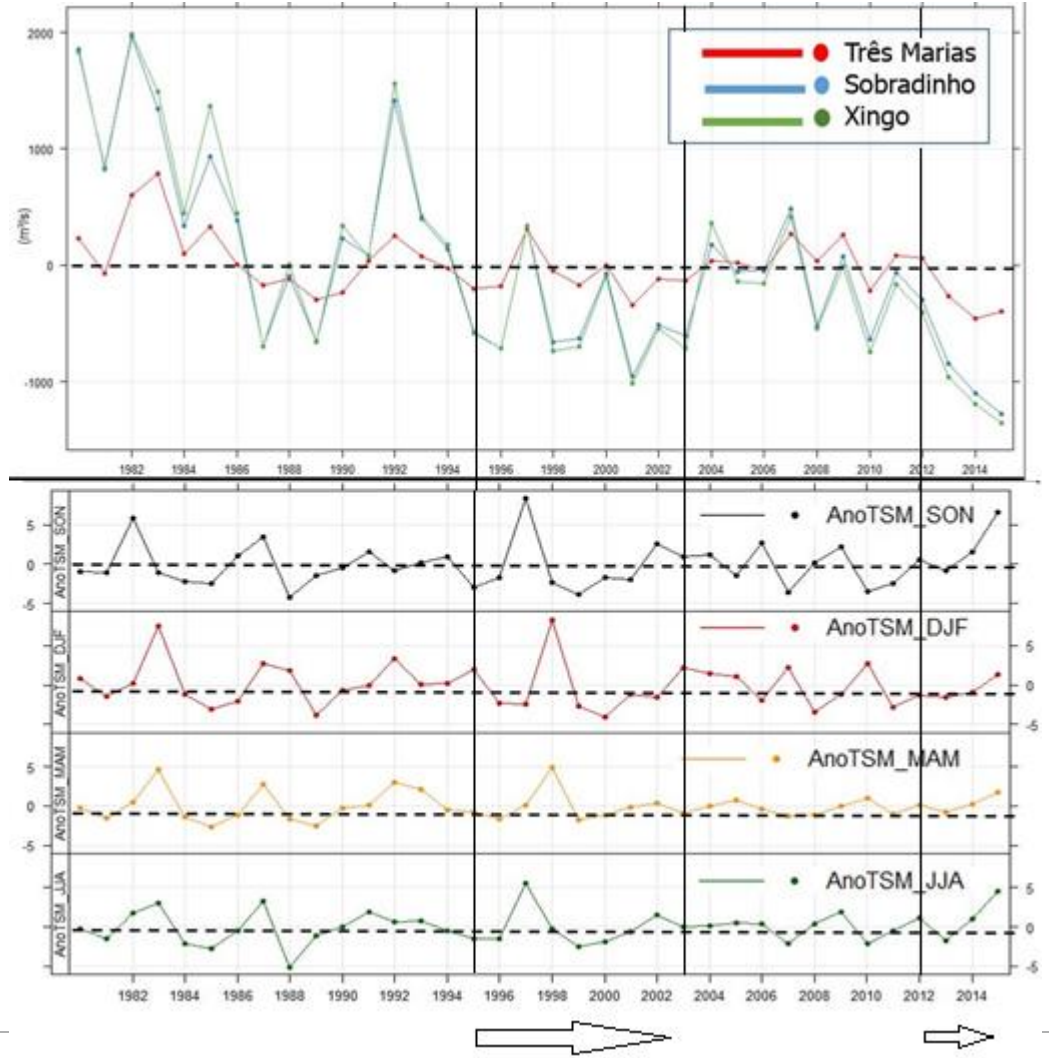
Revelant MJO - Events of precipitation below average



Focus on Northeast BR
Flow and ENSO Anomalies

Average annual flow during the hydrologic year (Oct to Sep) of the natural affluent flow to the Três Marias (SE), Sobradinho (NE) and Xingo (NE)reservoirs;

SST accumulated in quarters Sep-Oct-Nov (SON), Dec-Jan-Feb (DJF), Mar-Apr-Mai (MAM) and Jun-Jul-Aug (JJA) in Niño3 region.



In Northeast Brazil – Combined Indexes

Period	AMO	PDO	NAE NE (%)
dec51-feb52	0,18	-1,74	68
dec52-feb53	0,27	-0,50	77
dec53-febv54	0,20	-0,65	84
dec54-feb55	0,03	-0,30	81
dec12-feb13	0,14	-1,17	58
dec13-feb14	-0,02	-0,72	65

On the worst hydrological events registered in Northeast Brazil, positive AMO (Atlantic Multidecadal Oscilation) + negative PDO (Pacific Decadal Oscilation) has corresponded to NAE (Natural Affluent Energy) below 100%

Climate Change?

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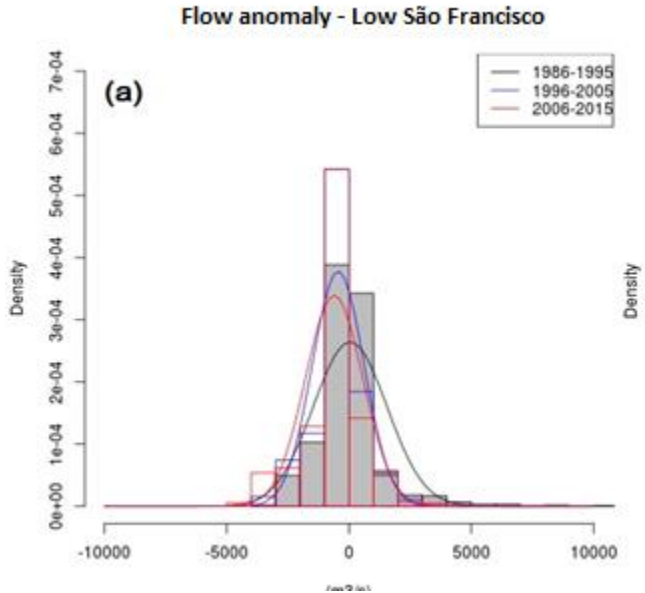

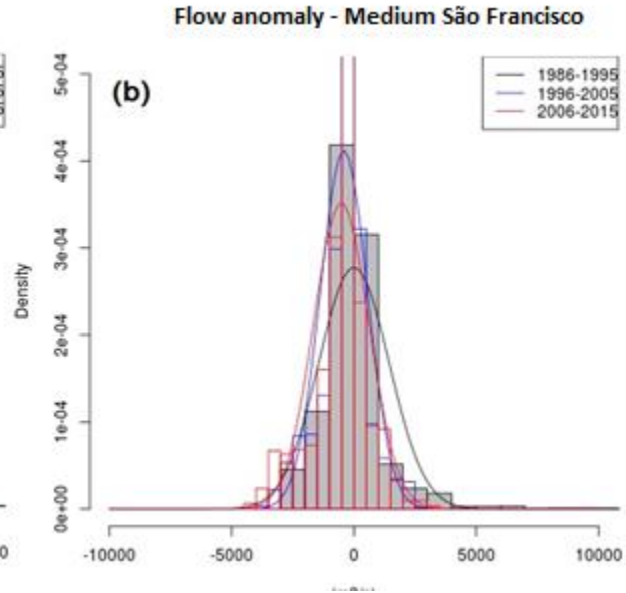

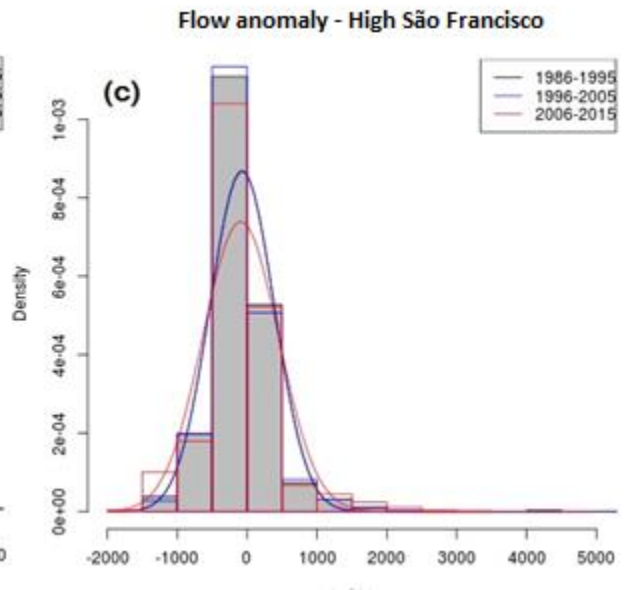

Conclusions

- *Preliminary results indicate that areas located in the north and northeast of Brazil have larger correlation with Atlantic indexes and areas in the south and southeast have larger correlation with ENSO related indexes.*

- *Relevant MJO (>1) increases precipitation on phases 1 to 4 in center-south Brazil, and decreases precipitation in the whole country on phases 7 and 8.*

- *Northeast Brazil, representing in the electric sector by the São Francisco River, has been presenting an increasing flow decrease in the last 30 years, which may be associated to the irregular precipitation regime, or also the improper use of the waters.*

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