Predicting changes on benthic estuarine assemblages from Marine Ecoregions of Brazil through decadal climatology

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In review at ECSS

Fomento

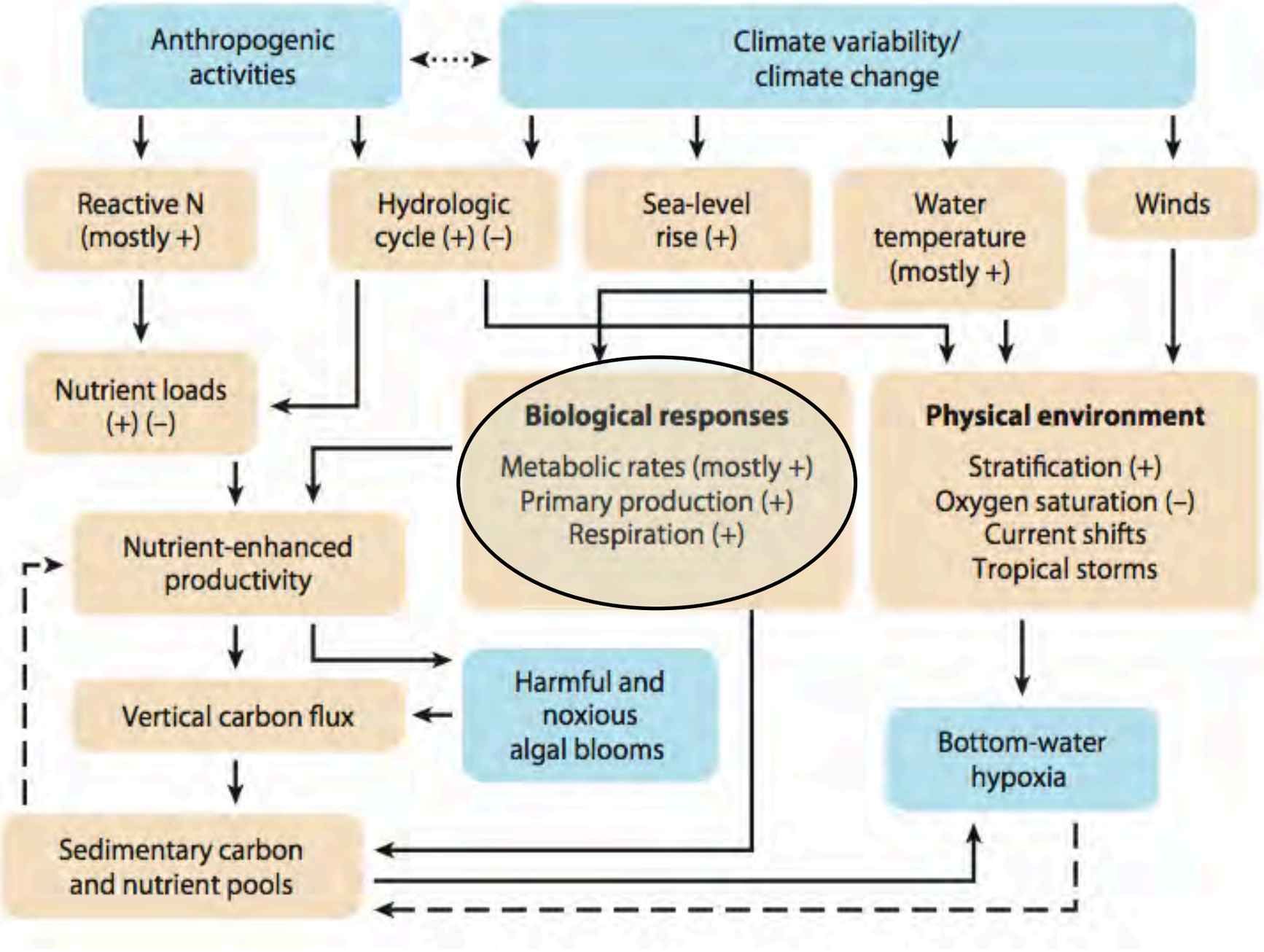
Vínculo

Piraquê-Mirim-Açu estuary, ES

Brief status of estuarine ecosystems in Brazil

1. Brazil has over 200 estuaries with an wetland ecosystem area of over 5,000,000 ha;
2. Widespread local impacts (e.g. pollution) and difficult management of resources, despite their ecosystem services (e.g. food, climate);
3. Benthic assemblages over intertidal mudflats and vegetated habitats are historically studied and mediate important biogeochemical processes;
4. Climate change will further impact these ecosystems, but we have very low understanding of these effects

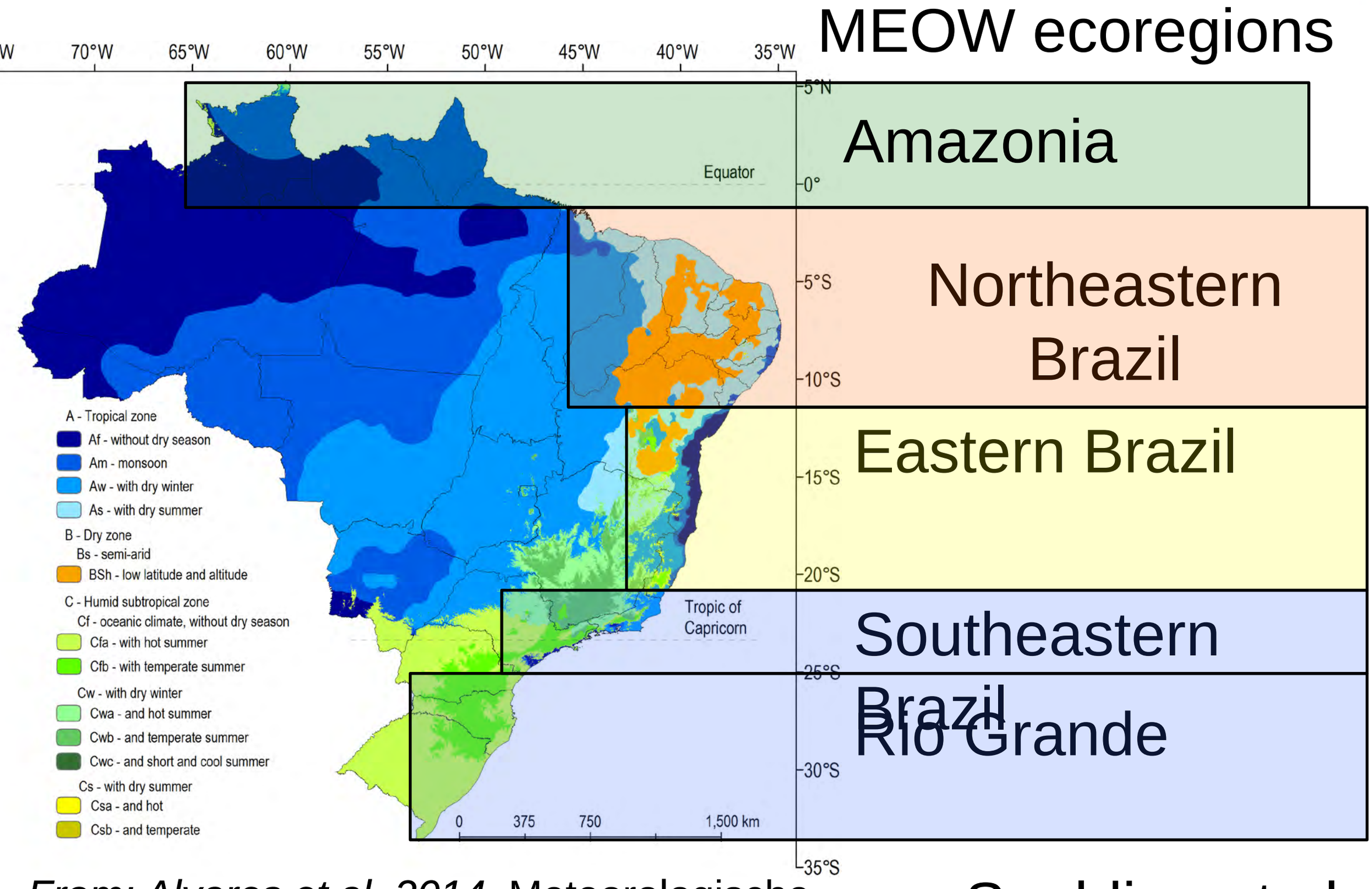
Conceptual human and climate interactions



(…) Increasingly, climate-mediated shifts in species distributions are creating novel or emerging no-analog ecosystems consisting of species with little or no shared evolutionary history(…) Doney et al. 2012

Rabalais et al., 2010, Doney et al., 2012

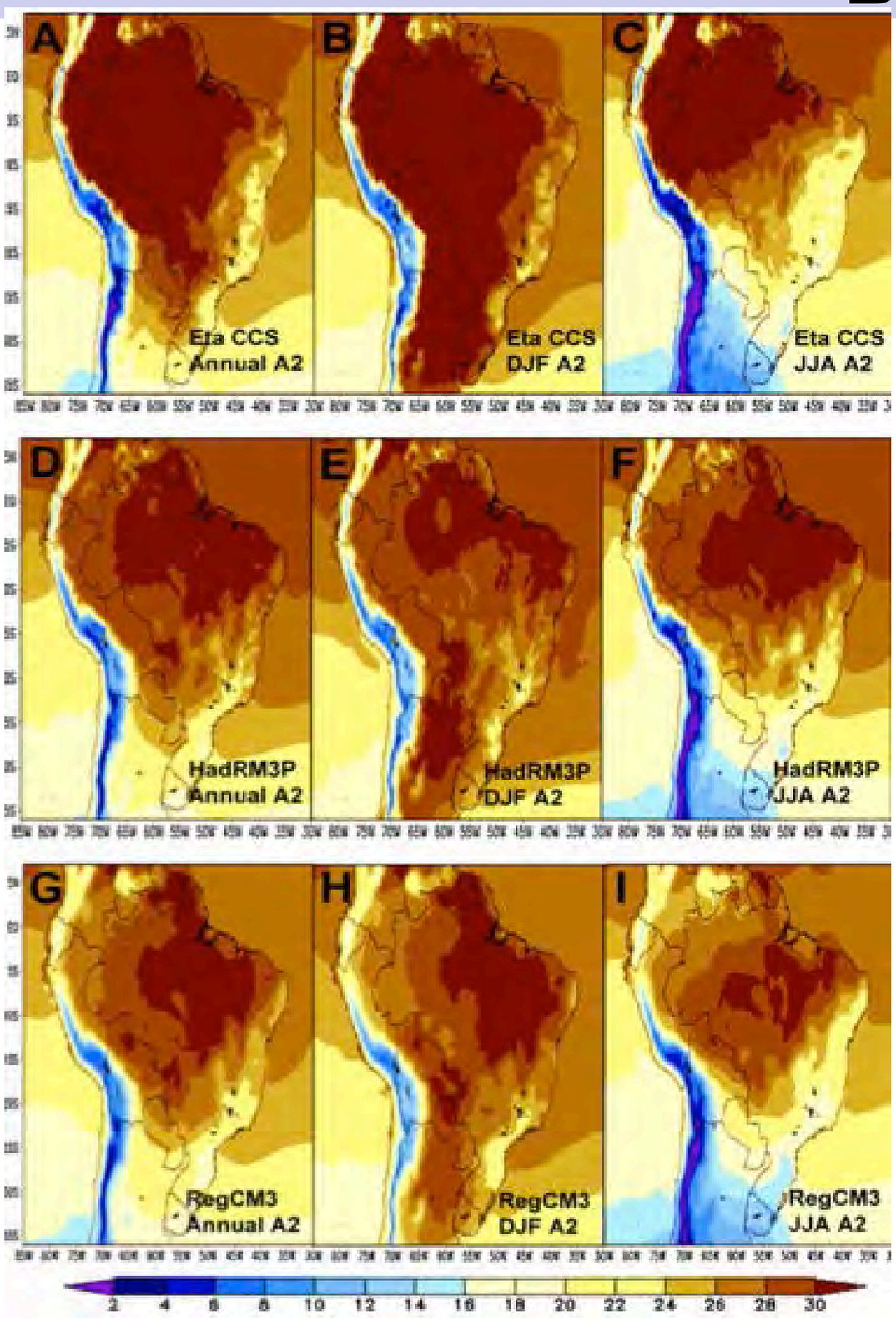
Climate along Marine Ecoregions of Brazil



From: Alvares et al, 2014, Meteorologische Zeitschrift, 22 (6): 711–728

Spalding et al., 199

Current large-scale modelling of climate effects in Brazil



- Higher temperatures at all MEOW's

Marengo et al, 2010, Clim Dyn, 35: 1073

IPCC A2 scenario (2070-2100)

Current large-scale modelling of climate effects in Brazil

Mean monthly rainfall
(1977-2006)

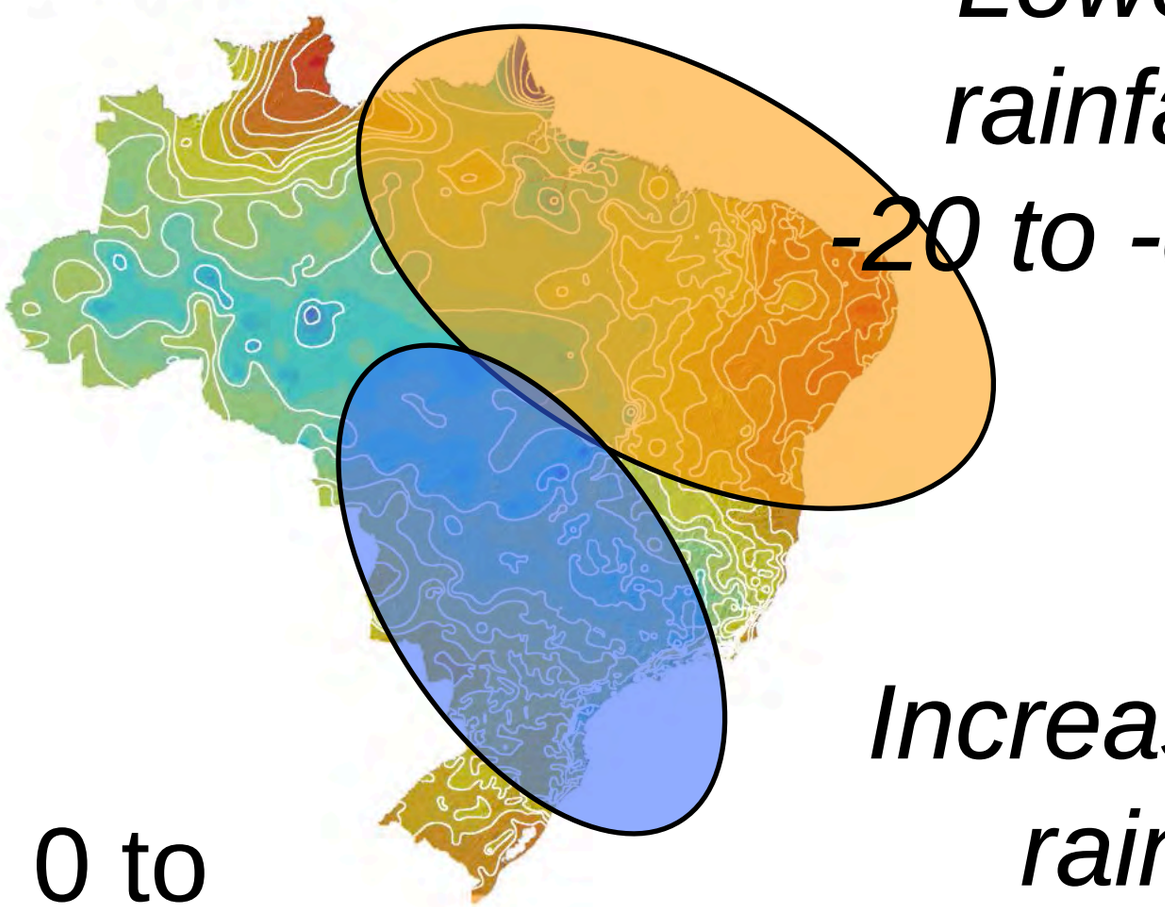
Summer (Jan)

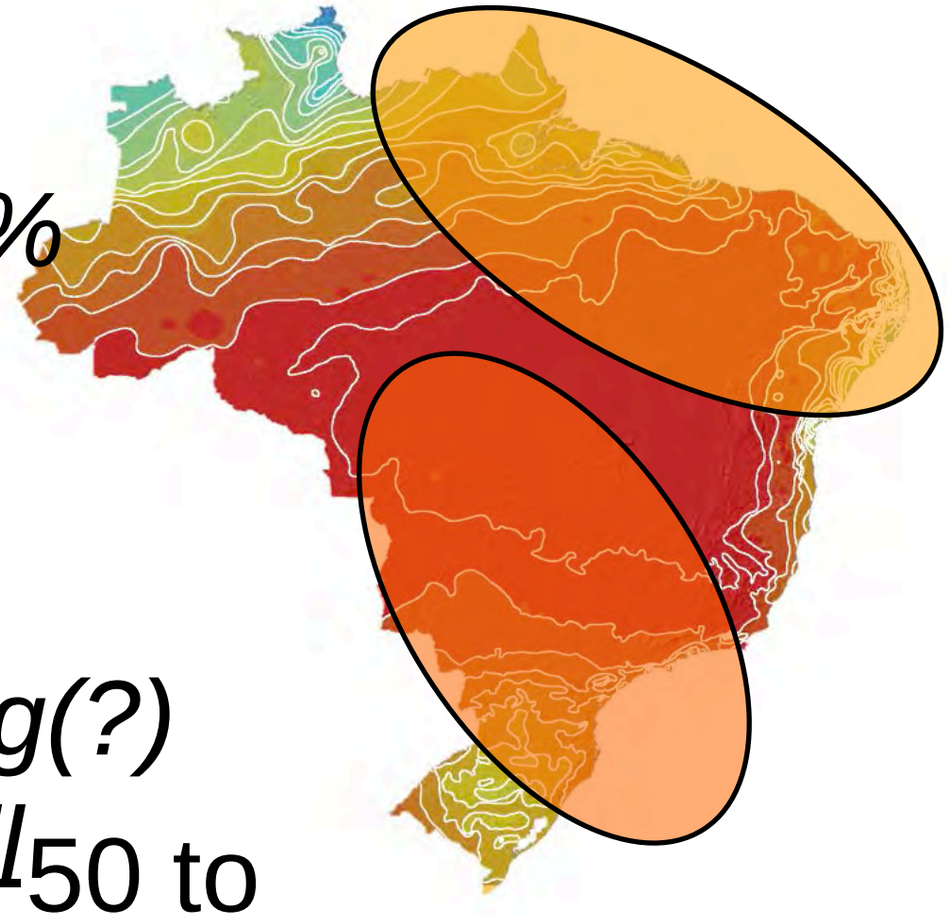
Winter (Jul)

Lower rainfall
-20 to -80%

Increasing(?) rainfall
50 to +30%

0 to +70%





From: CPRM, MME Brazil

Marengo et al, 2010, Clim Dyn, 35: 1073

IPCC A2 scenario (2070-2100)

Objectives and Methods

Review past meteorological trends and biogeographic patterns of estuarine benthic assemblages to access vulnerability to climate impacts

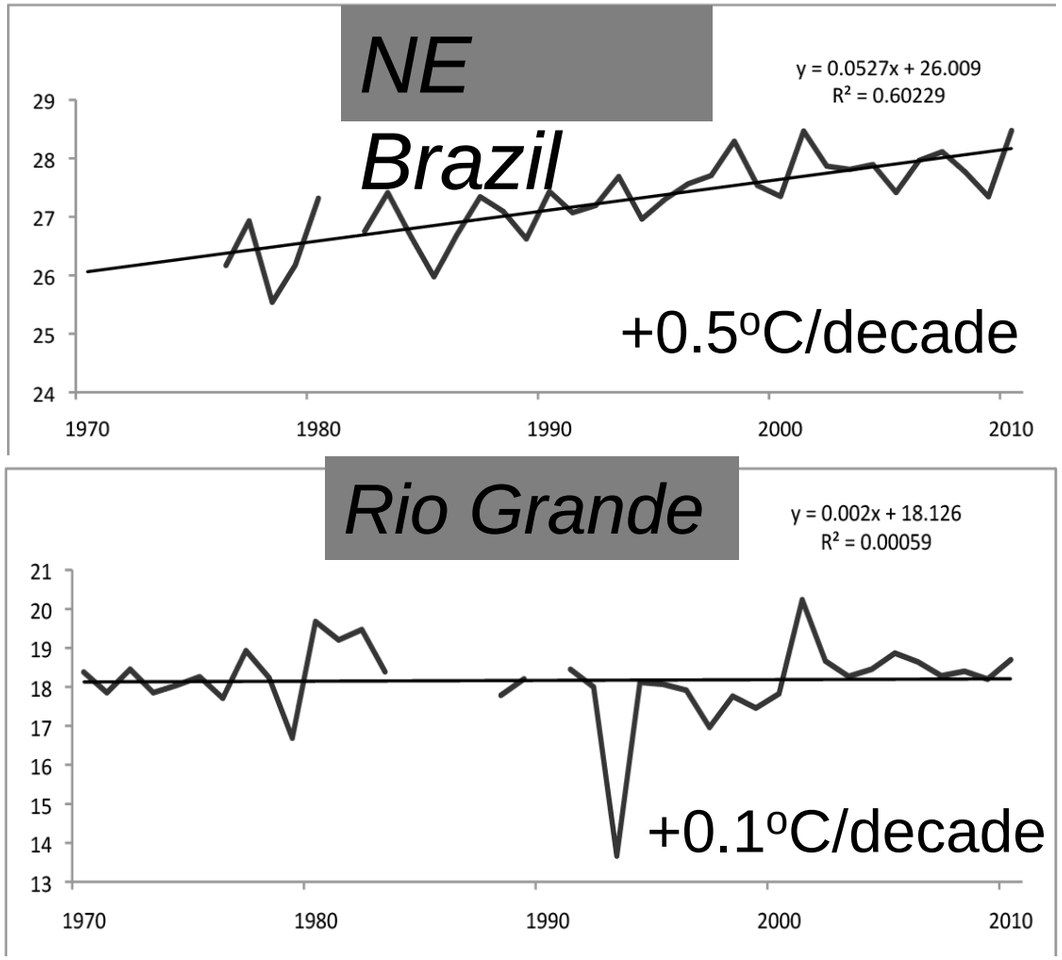
- Analyzed 40 yr decadal oscillations in T and Rainfall across MEOW's (evaluate current changes)

- Analyzed benthic assemblage data (NonatoBase for polychaeta) from over 50 estuaries distributed across MEOW's (proxy for ecosystem function)

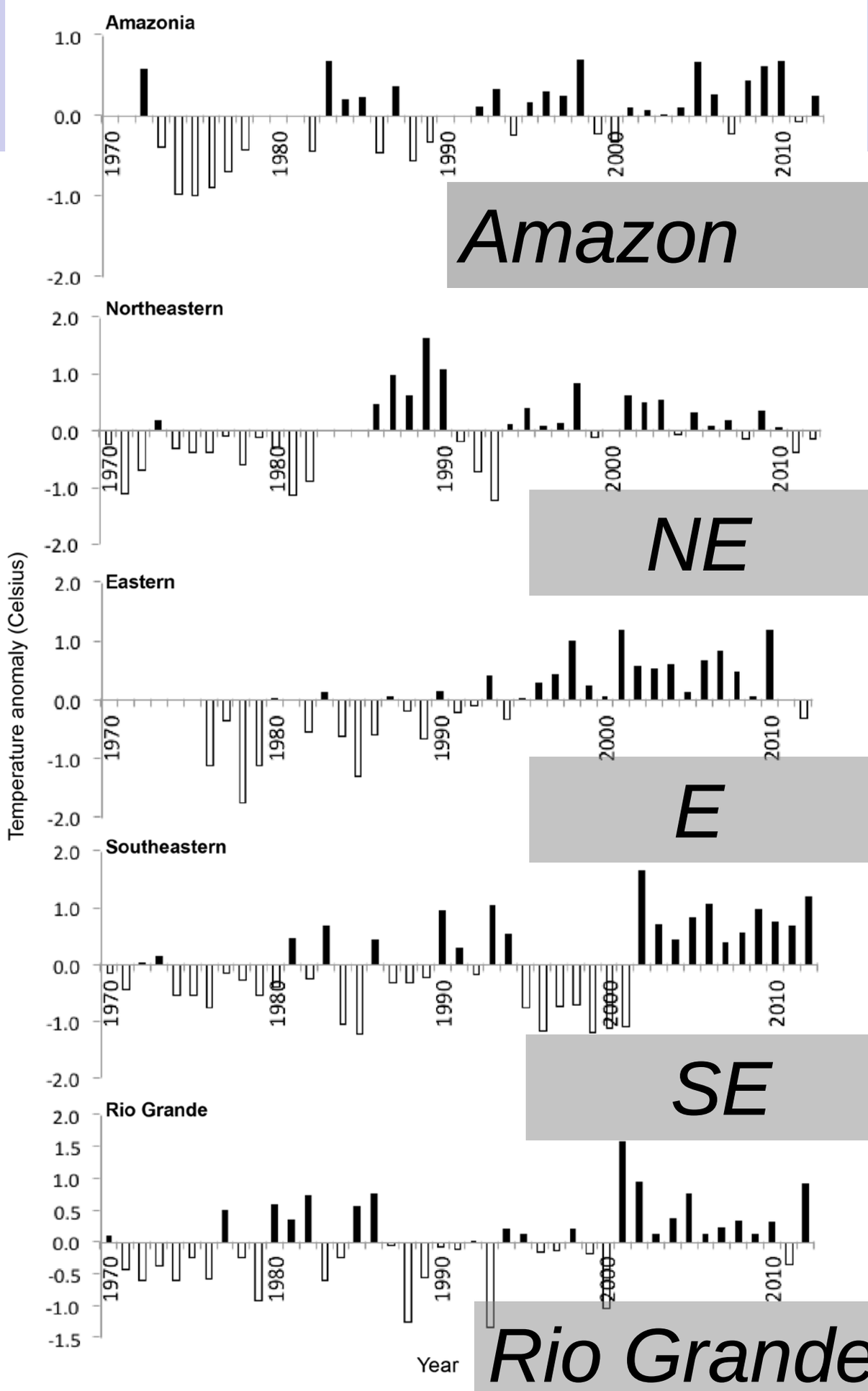
- Compared assemblage similarity from estuaries within and across MEOW's during the last 40yr (>70% 2000's)

Nonatobase: http://nonatobase.ufsc.br

Regional scales of an estuary

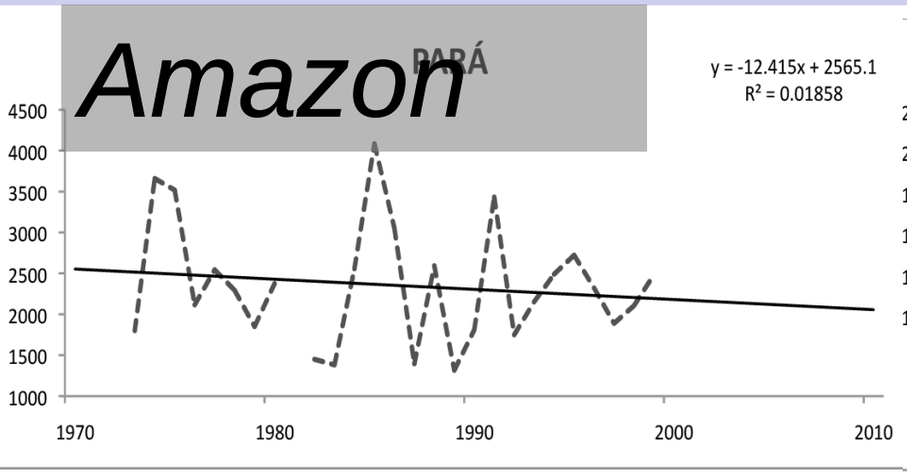


- Temperature increases during the last 40yr at all Brazilian MEOW's, with high regional variability
- Higher positive anomalies in the Temperate MEOW's

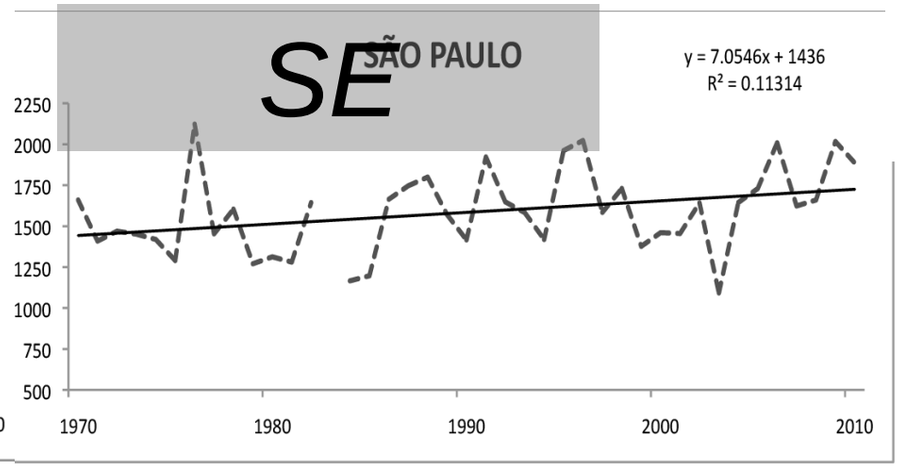


Results and discussion (Rainfall)

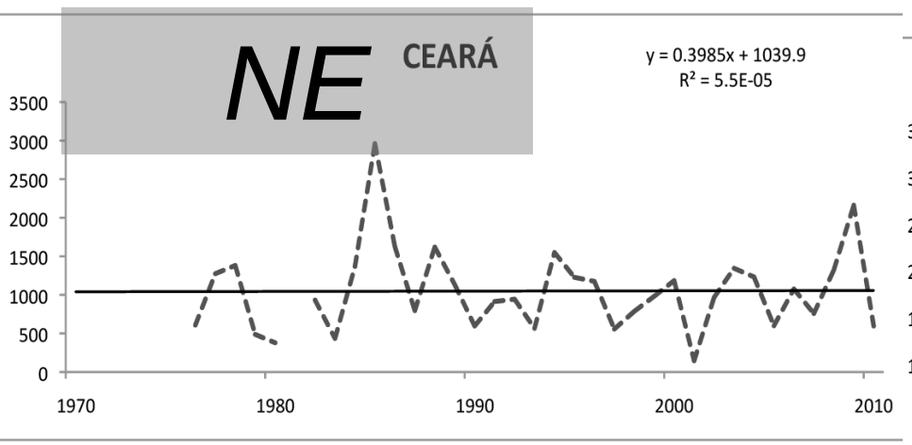
Amazon

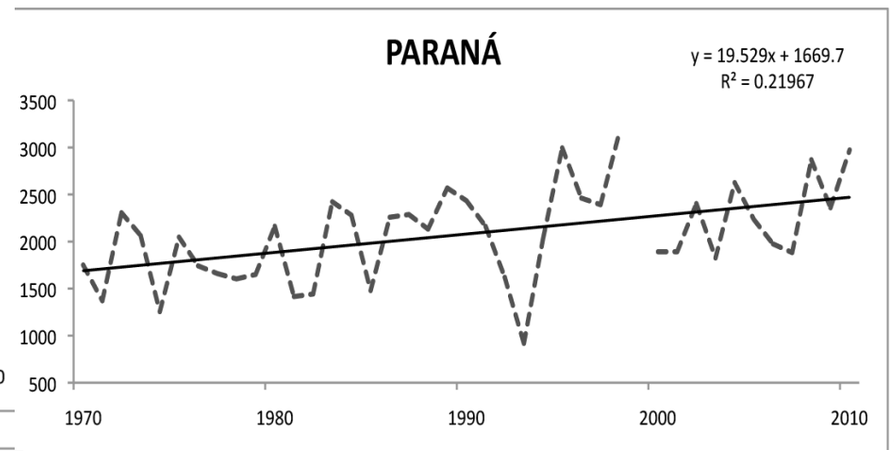


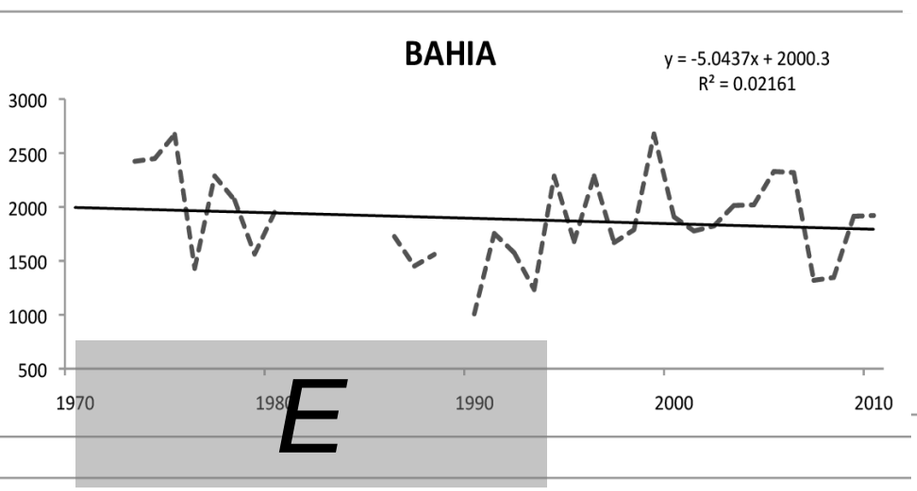
SE

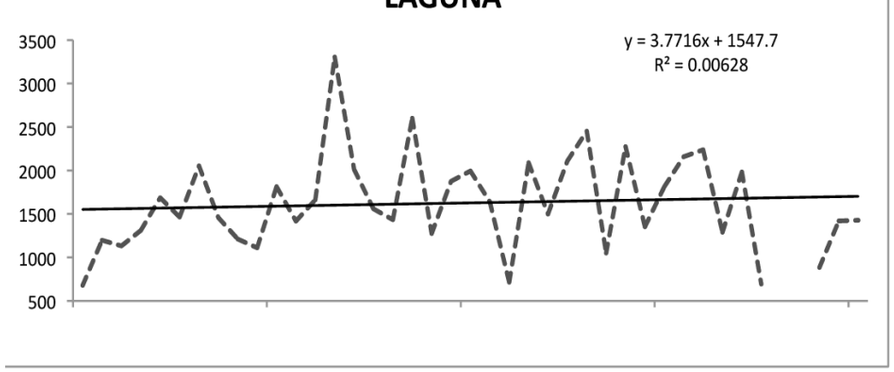


NE

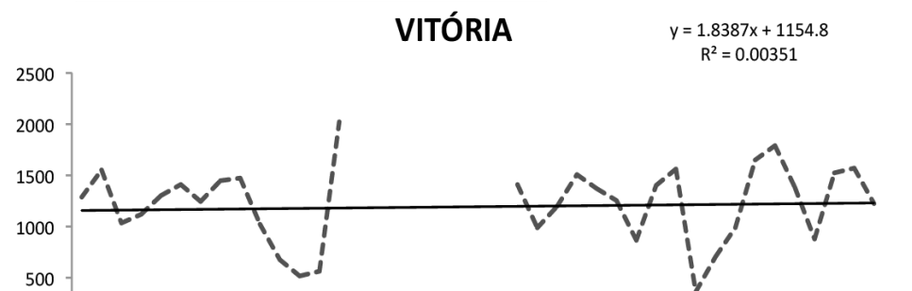


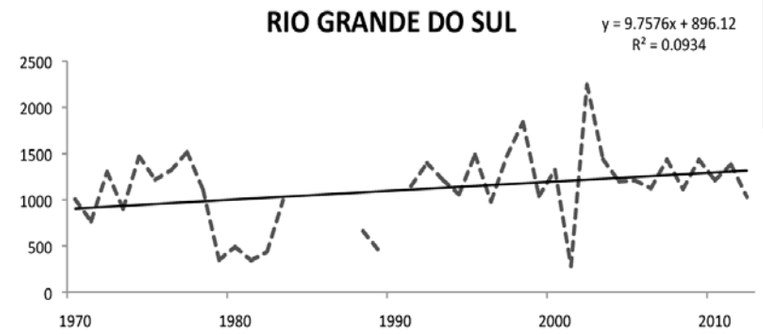






E



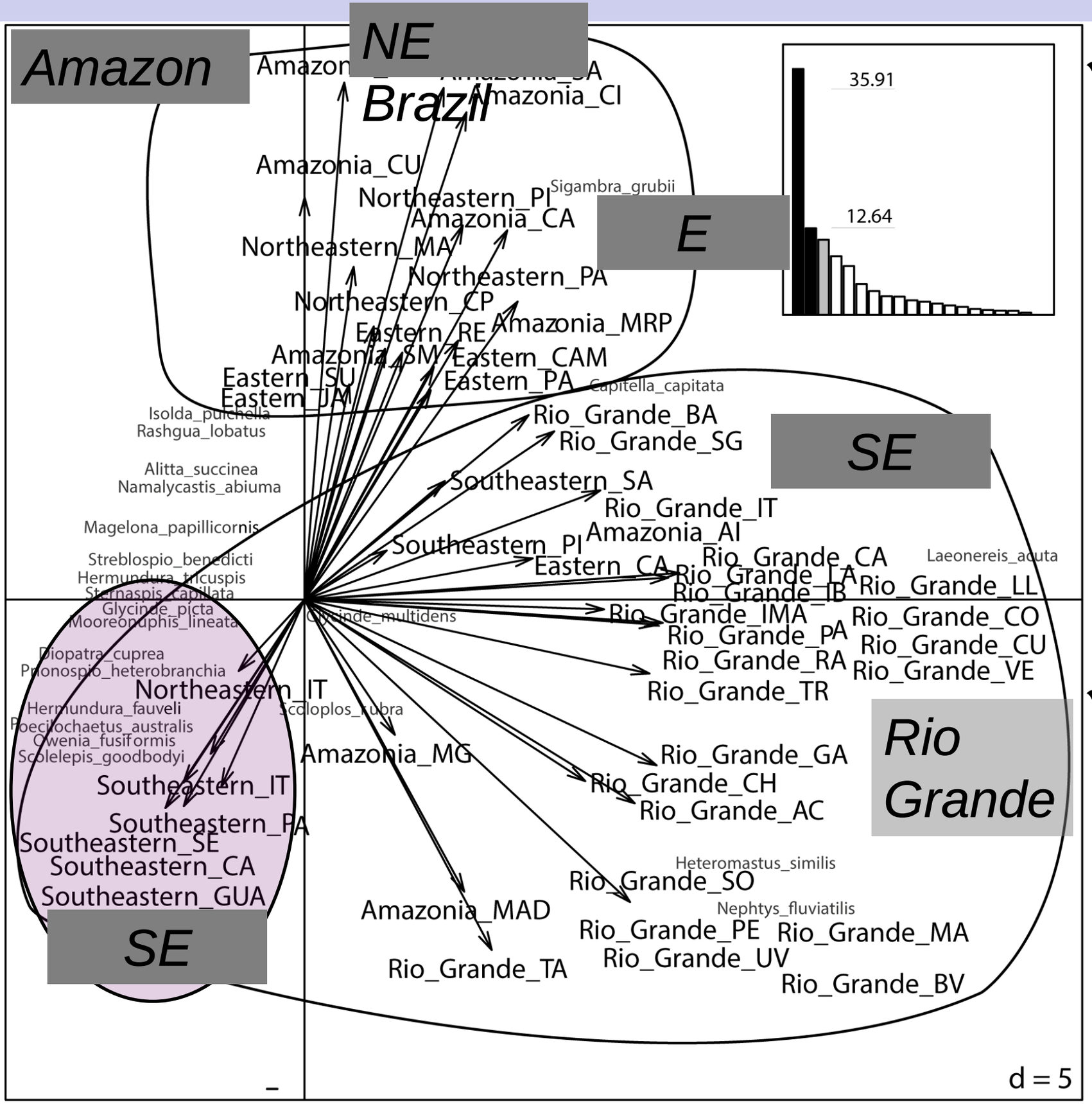


Rio Grande

+ 12.43 mm.y^{-1};
F=9.62, p=0.003

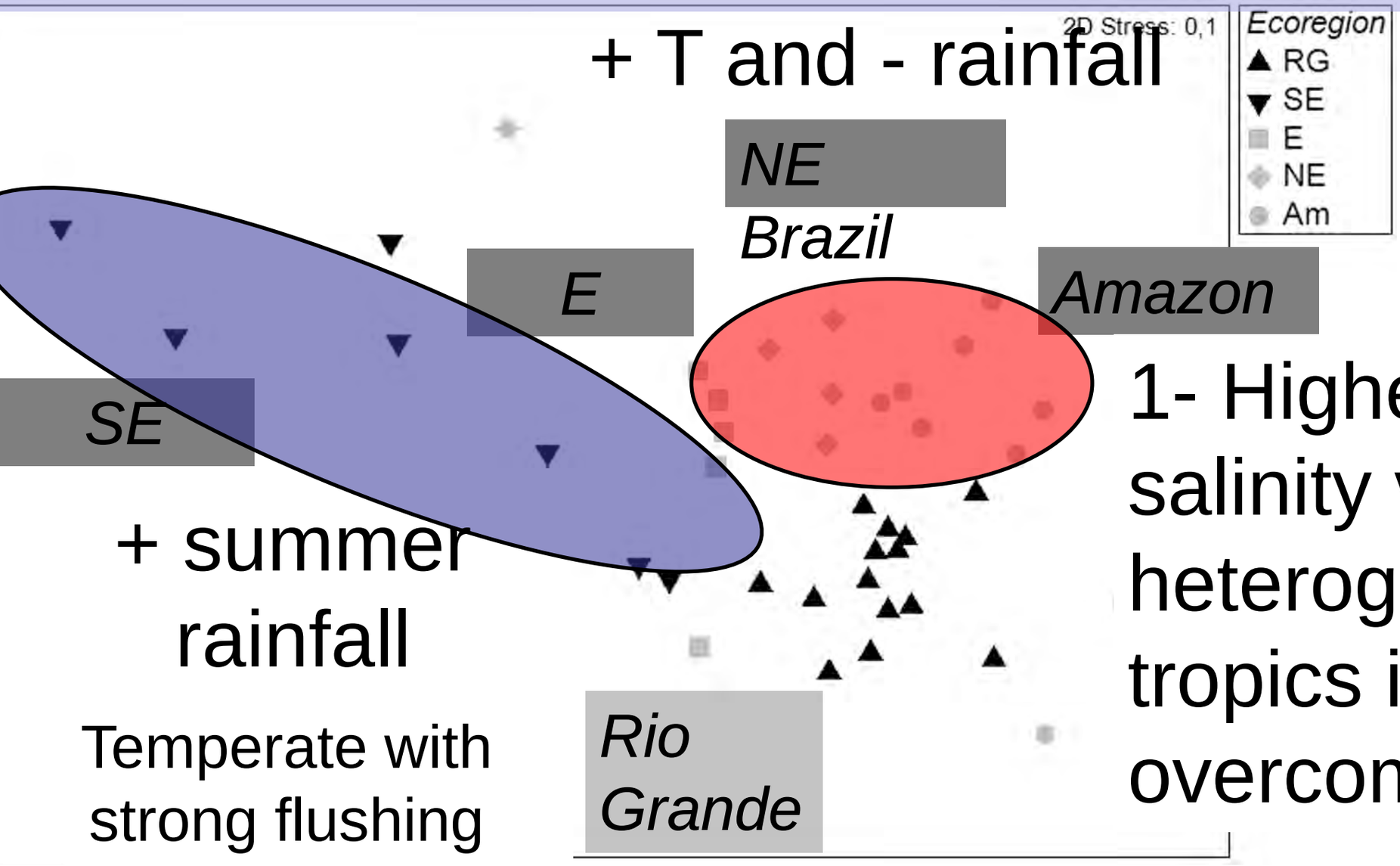
- Only SE Brazil had significant rainfall increases, but still local effects are preeminent
- Maybe an effect of increased heavy storms in SE

Results and discussion – benthic assemblages



- ✓ Clear biogeographic segregation between Tropical Atlantic and Warm Temperate SW Atlantic ME realms
- ✓ Higher within region variability in the SE – local impacts vs. spatial or temporal heterogeneity?

Results and discussion



1- Higher T effects or salinity variance = less heterogeneity in the tropics if tolerance is overcome

2- Effects of high seasonal variability and frequency of extreme events? leads to homogeneity at local scales, but heterogeneity regionally?

1st Tropical cyclone, 2004

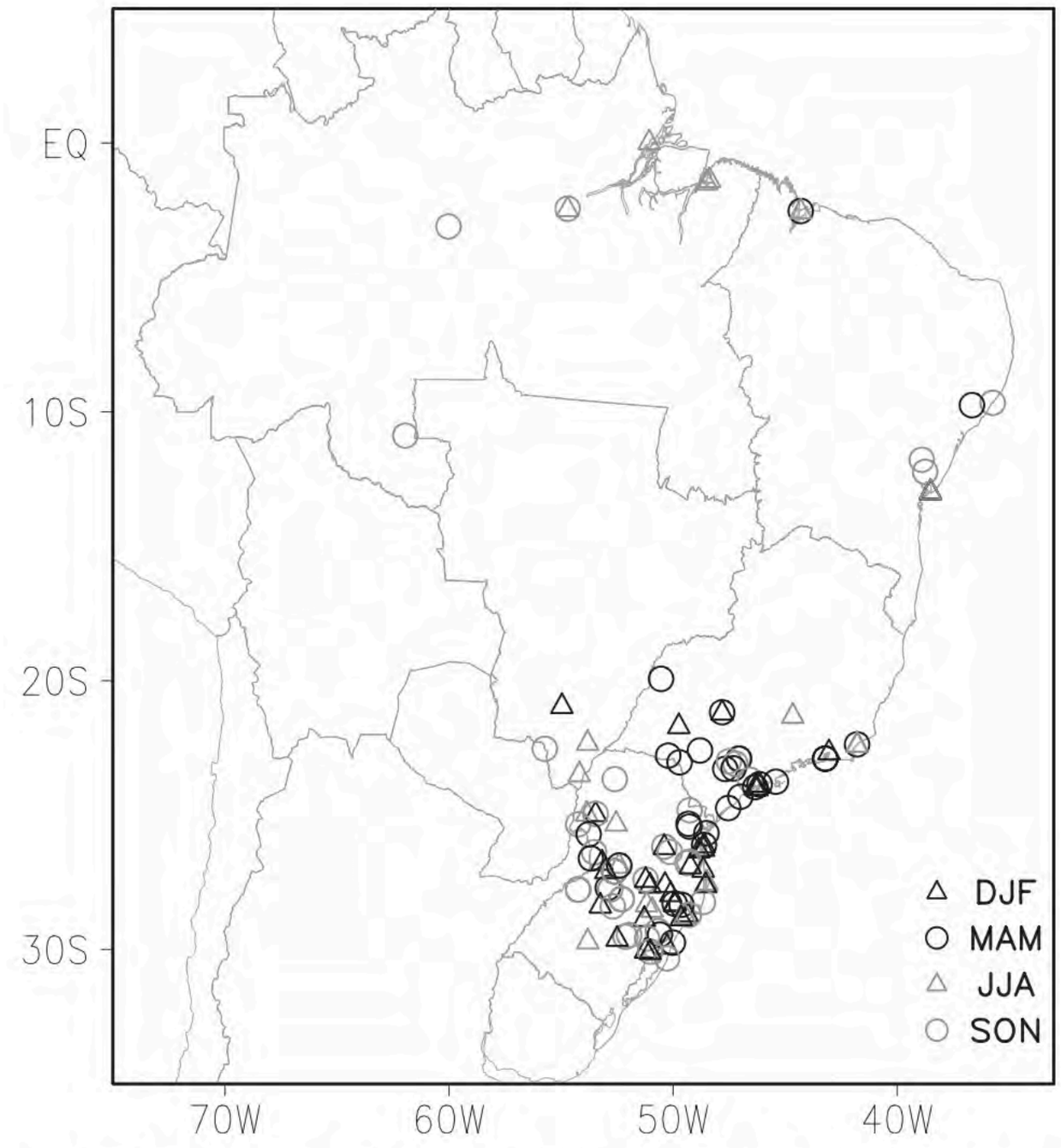
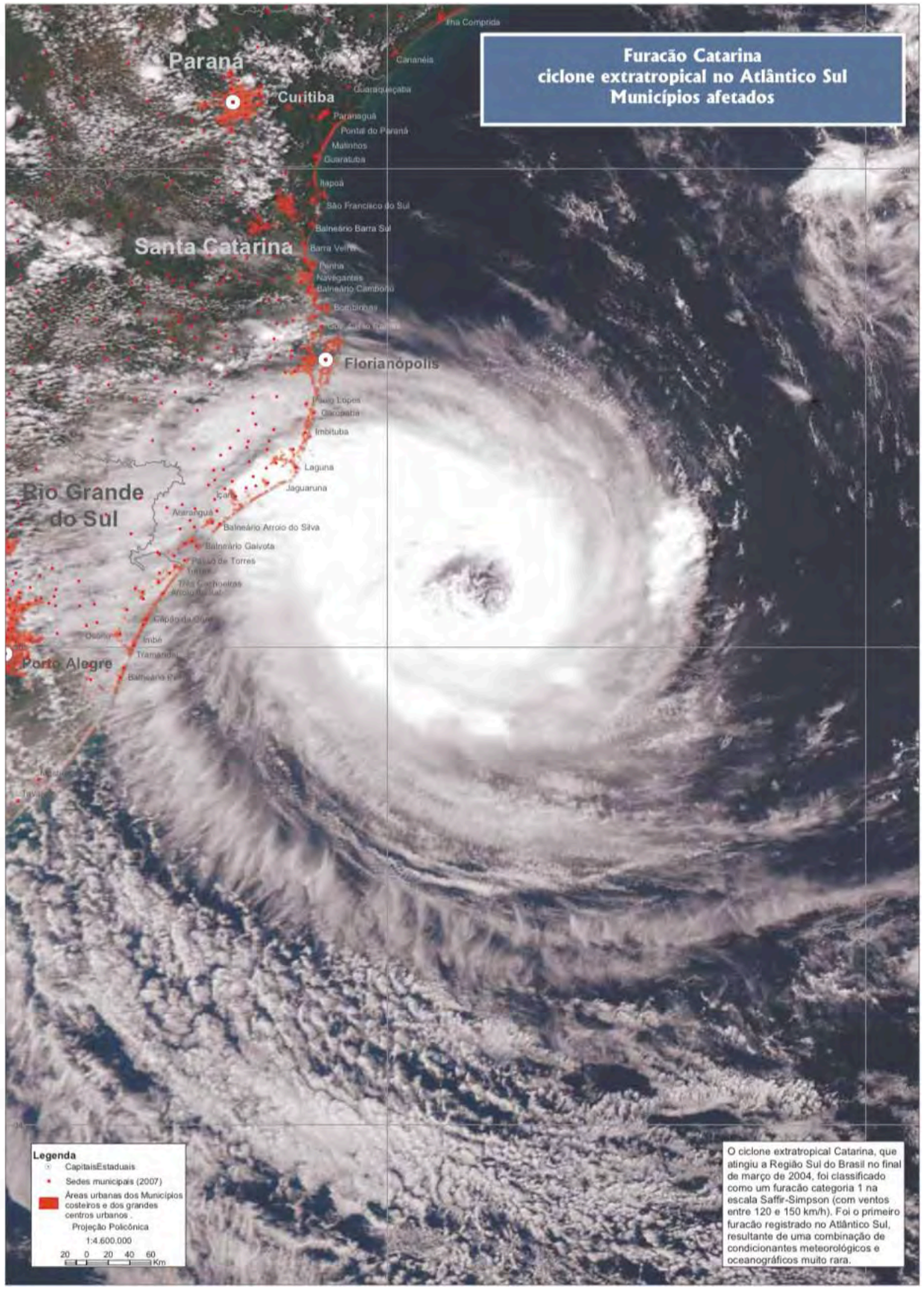


FIG. 3. Location and season of tornadoes and waterspouts reports (funnel clouds have not been plotted). December–February (DJF) is summer, March–May (MAM) is fall, June–August (JJA) is winter, and September–November (SON) is spring.

Silva Dias, 2011

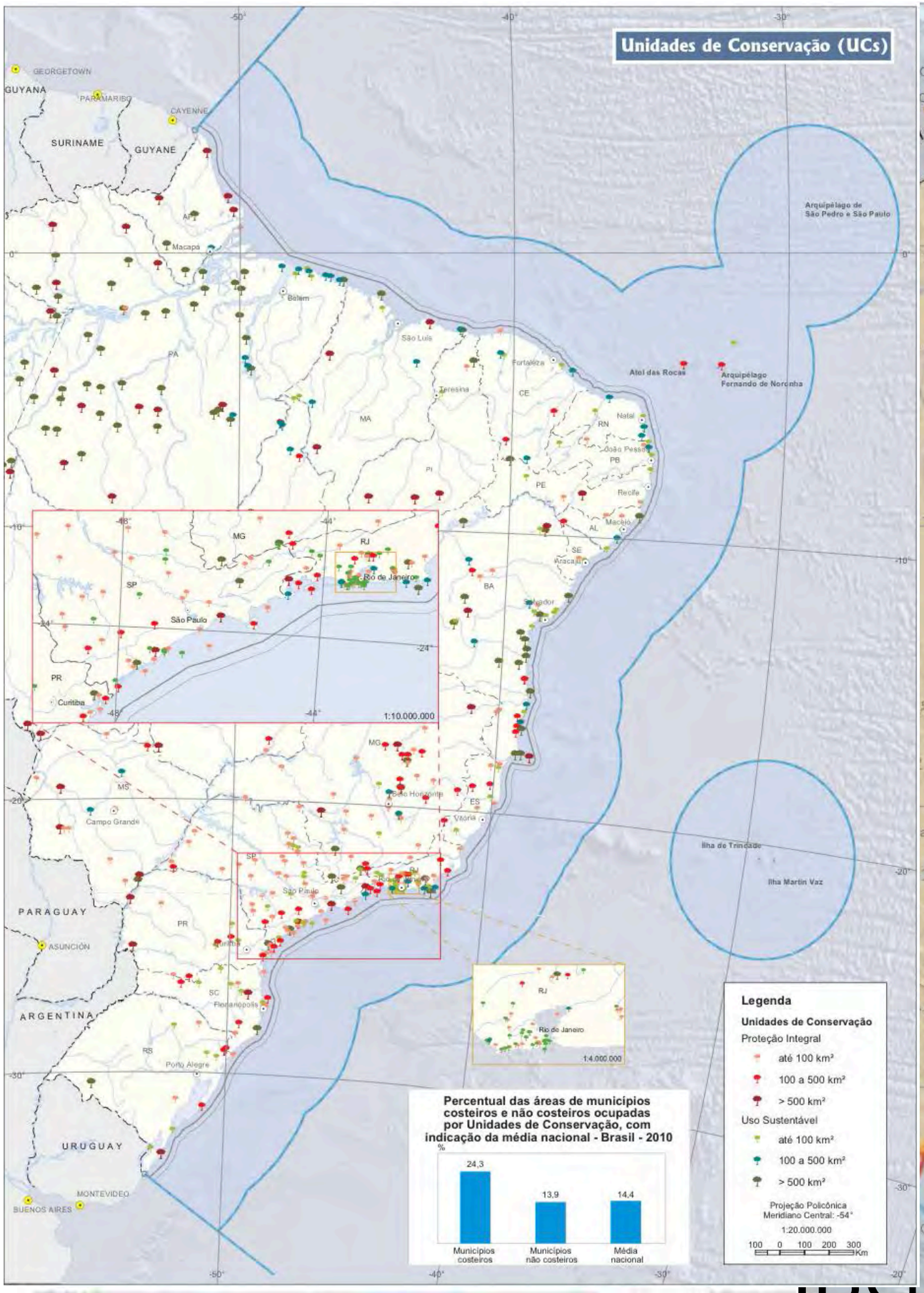


NASA, IBGE, 2011

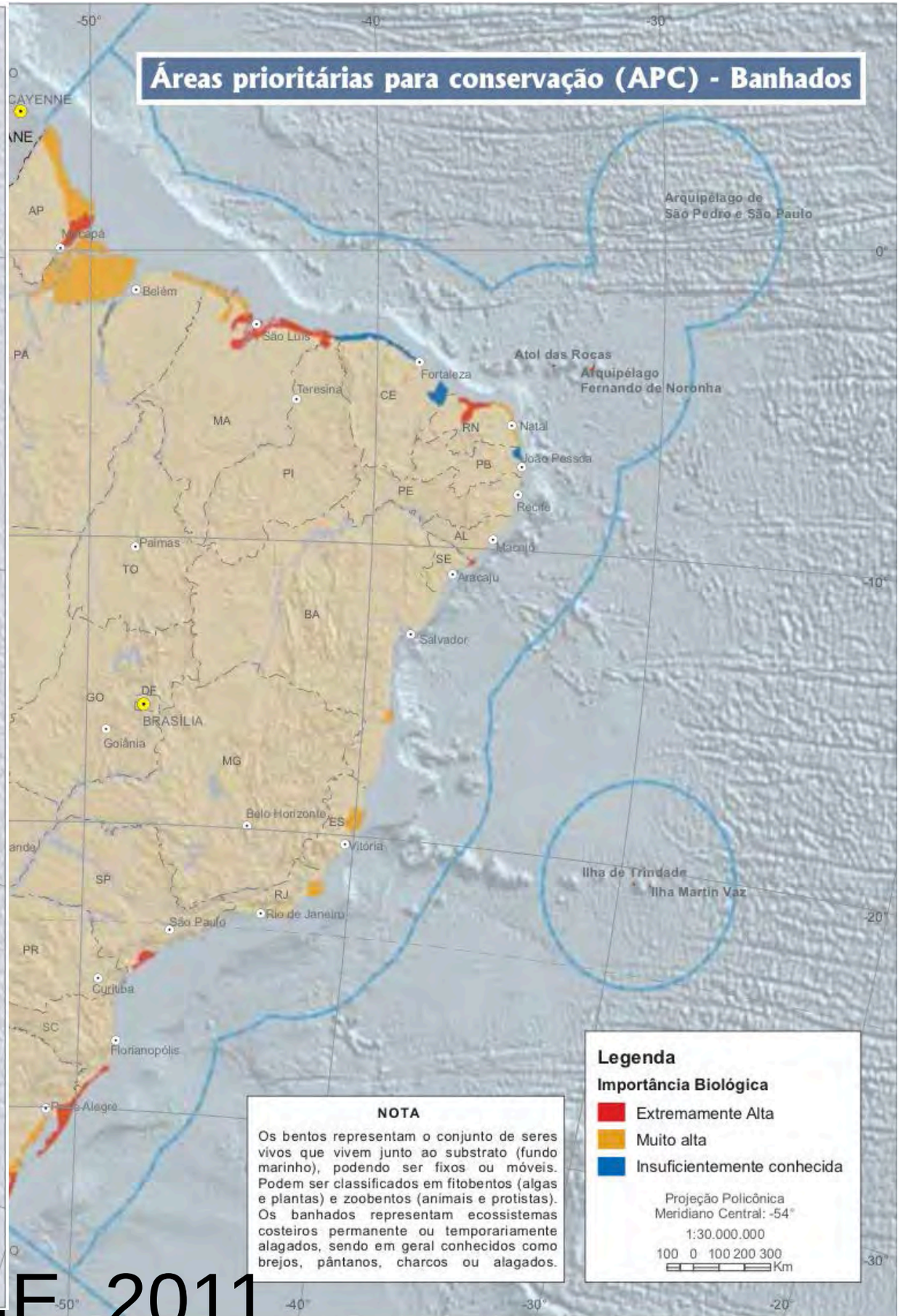
Conclusions and perspectives

1. We need to look at effects of climate in local scales
2. Higher temperatures will likely change estuarine assemblages at broad scales with unknown impacts on services;
3. Salinity matters at local and regional scales: flooding or drought events will impact ecosystems
4. Efforts are needed to increase our capacity to identify patterns across temporal scales;
5. We need hard data and long-term studies on estuaries, and we would like to collaborate and learn from successful programs

Unidades de Conservação (UCs)



Áreas prioritárias para conservação (APC) - Banhados



IBGE, 2011

Fomento

Vínculo

Zonas Costeiras
Rede CLIMA & INCT para Mudanças Climáticas

Obrigado!

angelo.bernardino@ufes.br

www.rebentos.org

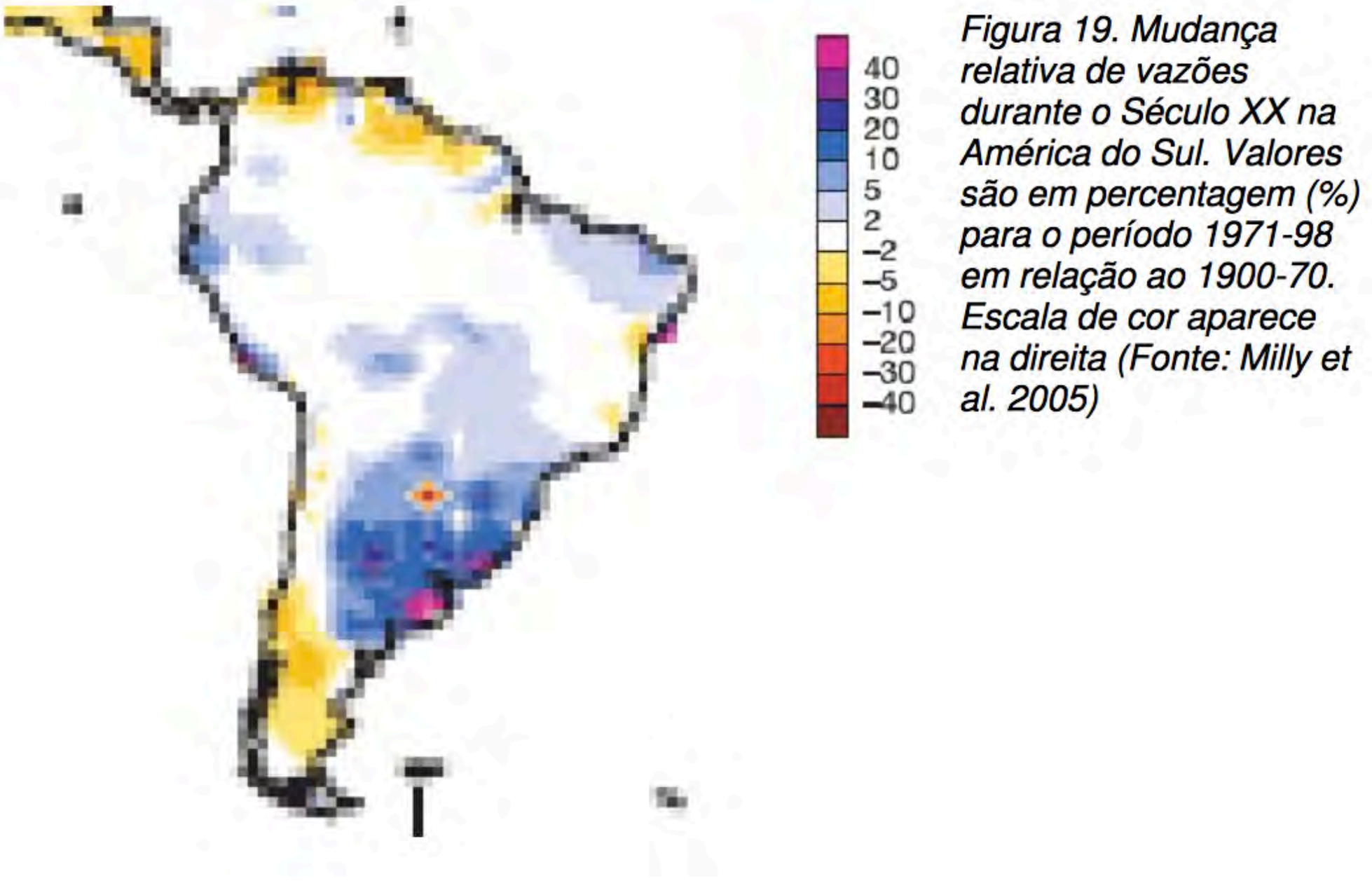


Figura 19. Mudança relativa de vazões durante o Século XX na América do Sul. Valores são em percentagem (%) para o período 1971-98 em relação ao 1900-70. Escala de cor aparece na direita (Fonte: Milly et al. 2005)

Marengo

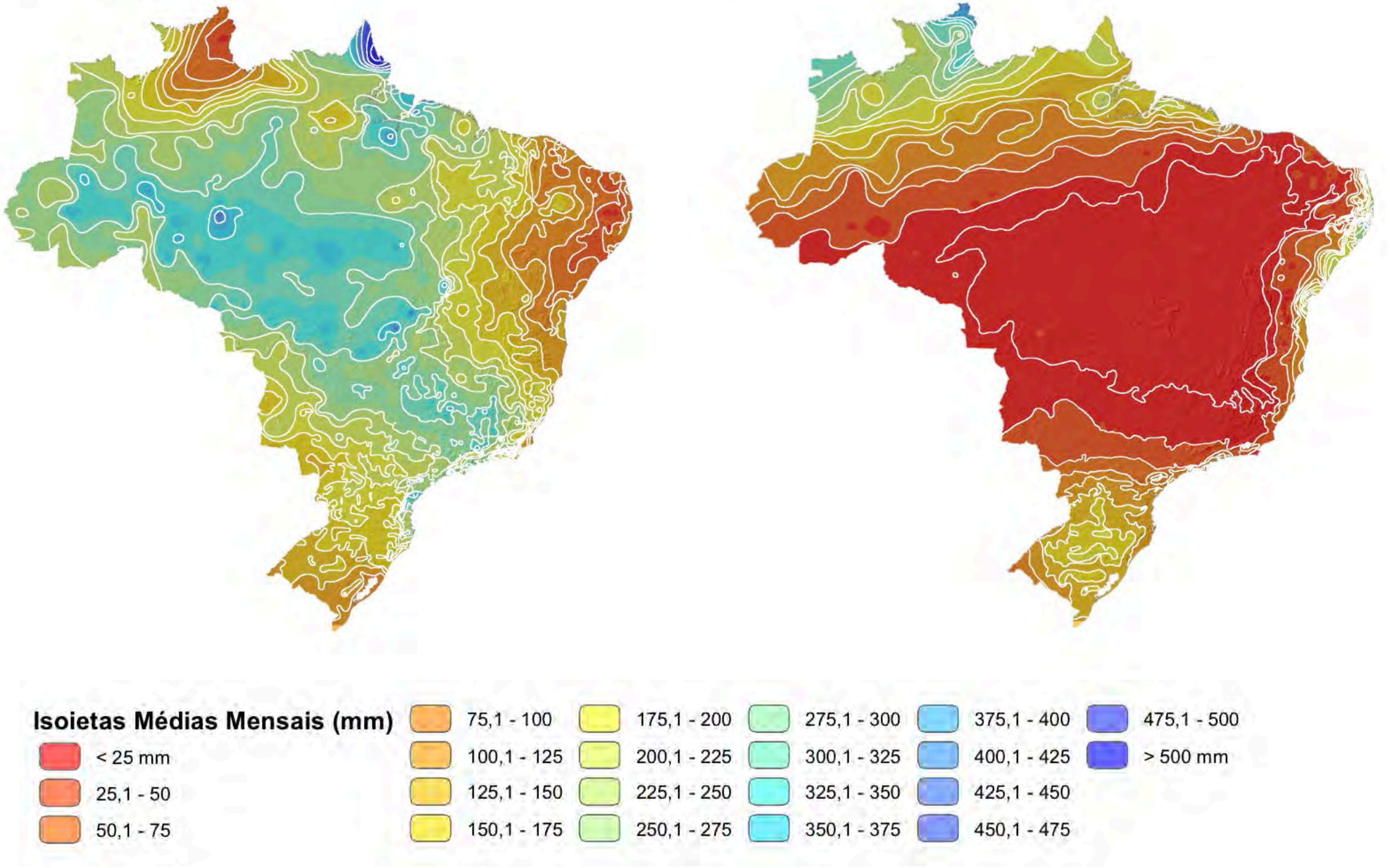
Challenges and caveats

1. Absence of community time-series
2. Other spatial gradients will mask climate-induced changes
3. Various sources of human impacts locally

Results and discussion

Summer (Jan)

Winter (Jul)



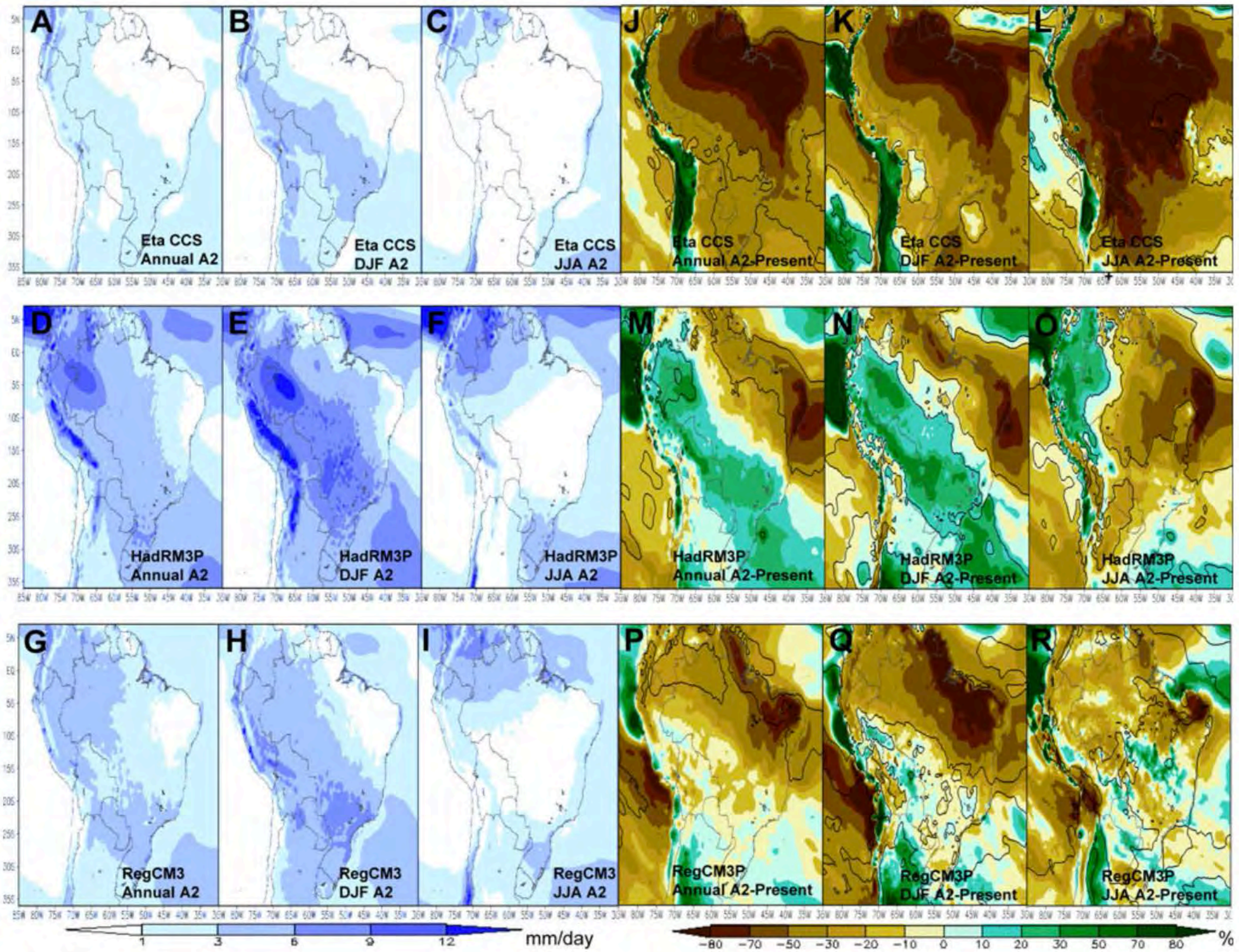
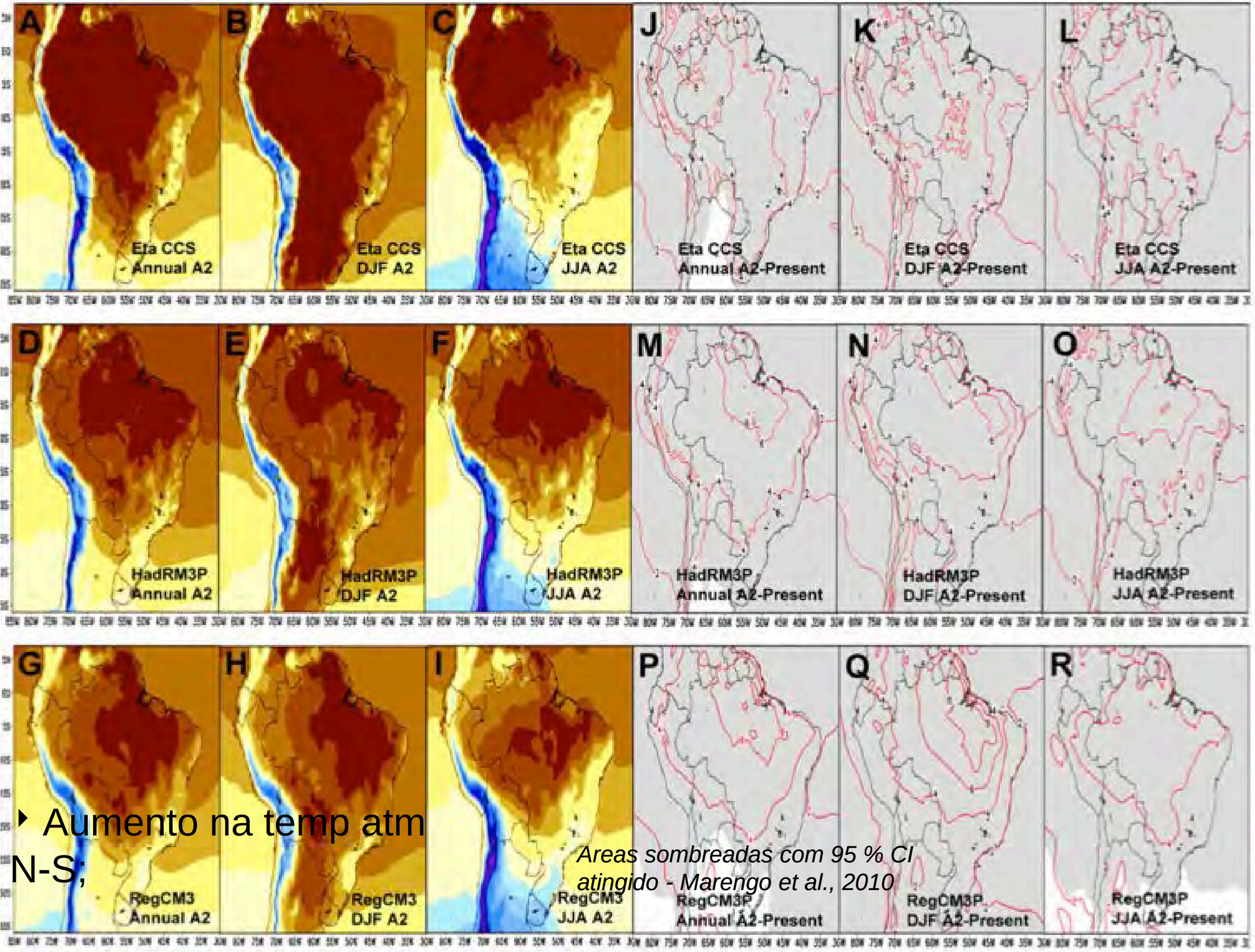


Fig. 8 Projected patterns of rainfall (mm/day) and rainfall change (%) over South America for the A2 scenario, at annual, summer (DJF) and winter (JJA) time scales. **a–i** the projections for 2071–2100 from the Eta CCS, HadRM3P and the RegCM3. **j–r** the differences between the 2071–2100 projections and the 1961–1990 model climatology (in %). Shaded areas represent regions where statistical significance at the 95% level is reached

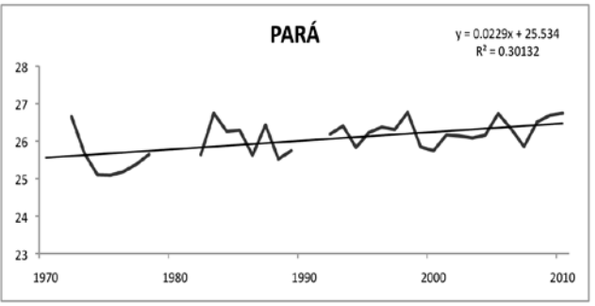
From: Marengo et al, 2010, Clim Dyn, 35: 107

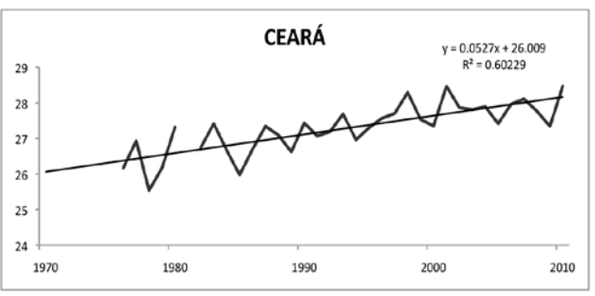


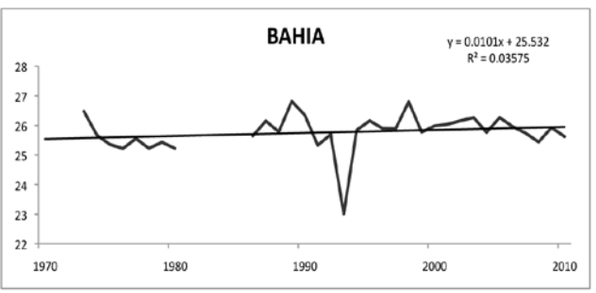
- Aumento na temp atm N-S;

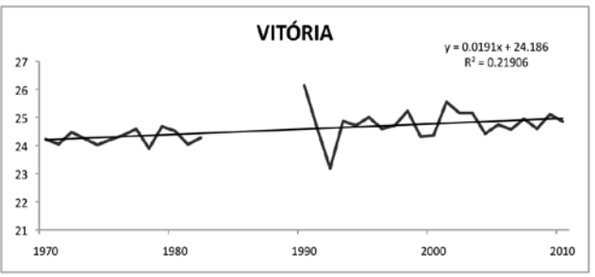
Areas sombreadas com 95 % CI atingido - Marengo et al., 2010

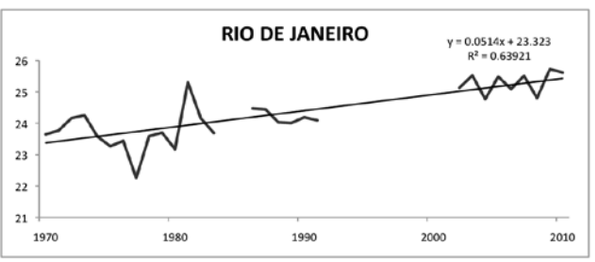
Interannual mean temperatures (oC)



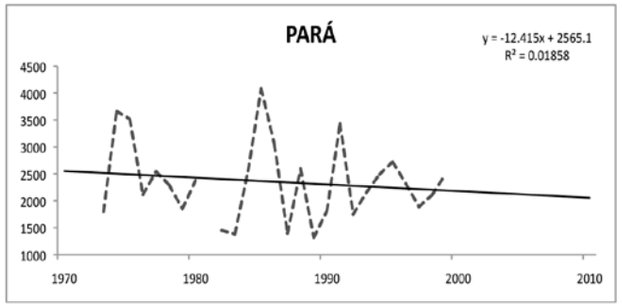


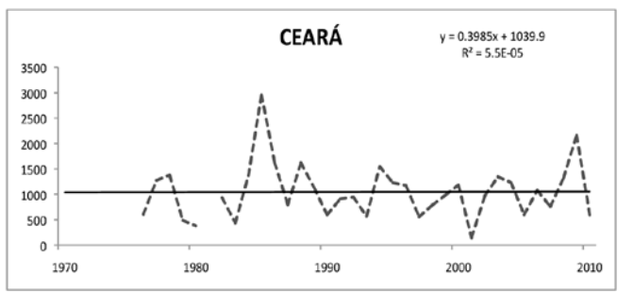


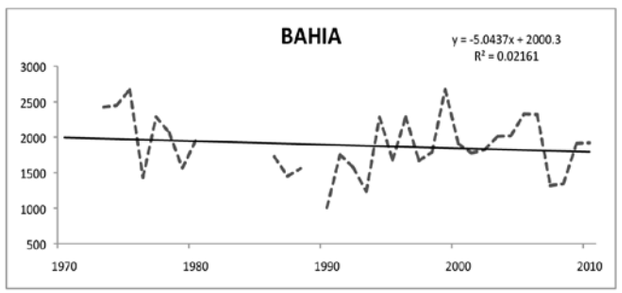


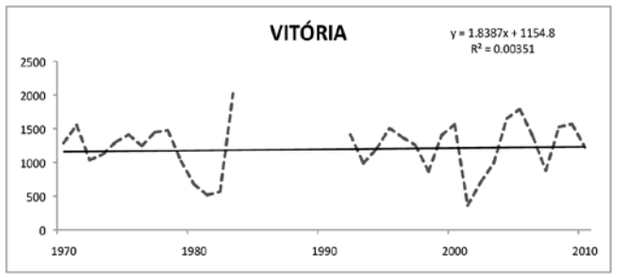


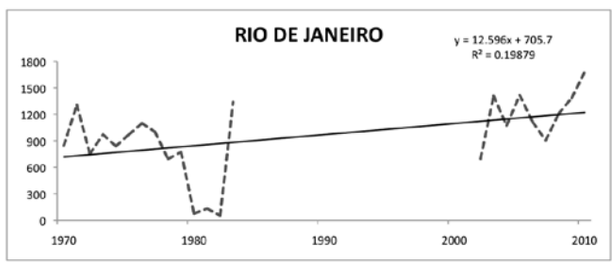
Interannual total precipitation (mm)



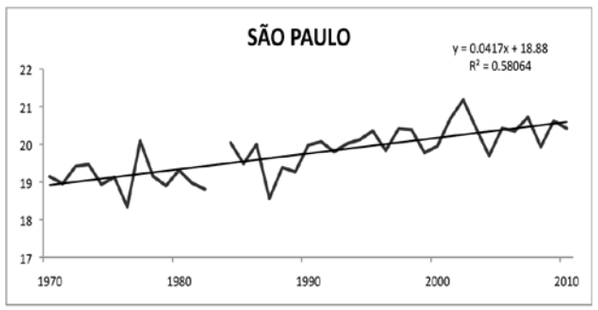


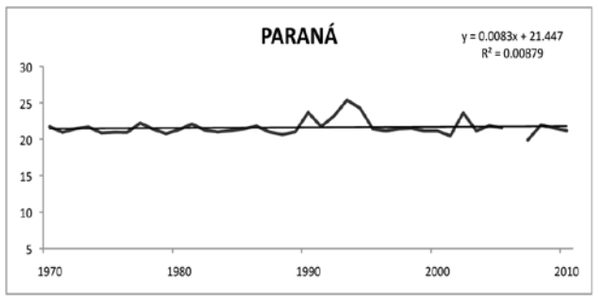


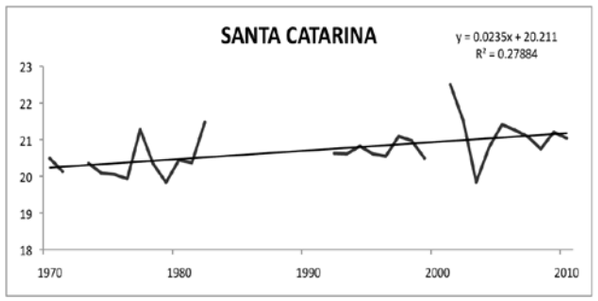


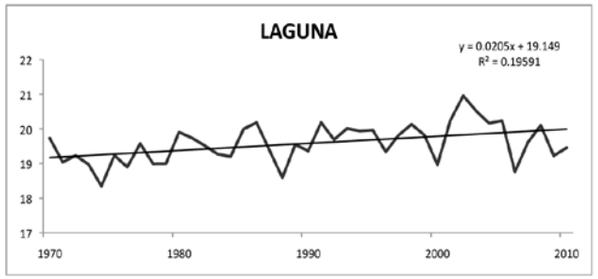


Interannual mean temperatures (oC)









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