Universidade de São Paulo
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South American Monsoon Challenges for the South American Monsoon Predictability

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WCRP
Climate
rch Programme

Fourth Joint WCRP/WWRP Monsoon Panel's Webinar Series on "American Monsoons"
24 April 2024

South American Monsoon System

SAMS → Strong seasonal differences.

↓

Winter: Dry
Summer: Wet → Two systems: ITCZ and SACZ

↓

Rainy season:
SE: early October

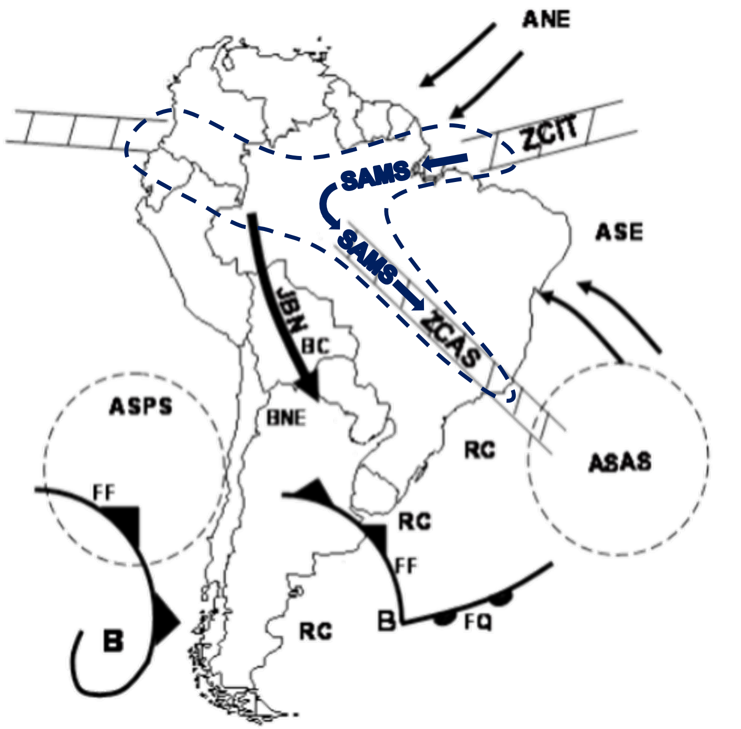


Fig. 1. Schematic representation of atmospheric systems in the lower troposphere operating in South American. Adpted from Reboita et al. (2010; pg. 199).

Contribution: Leila Carvalho

Users' wish list - Agribusiness

- Climate Smart Farming:
  - How can we fit 2 or 3 crops during the year , under natural climate variability? Or how to optimize produtivity in permanent crops/livestock using climate information?
    - Need specialized advise to choose sowing dates, crop variety , combination of different crops during the year,
      - Information on the overall behavior of the wet season,
      - Prediction in the S2S scale,
      - Weather prediction for planning regular operations such as spraying, fertilizing, weed control etc.
      - Increasing demand for nowcasting !
- Sustainable Agriculture:
  - Environmental certification:
  - Carbon farming

Increasing value!!

- Climate change impacts;
  - Impact of changes of the monsoon characteristics on different farm activities

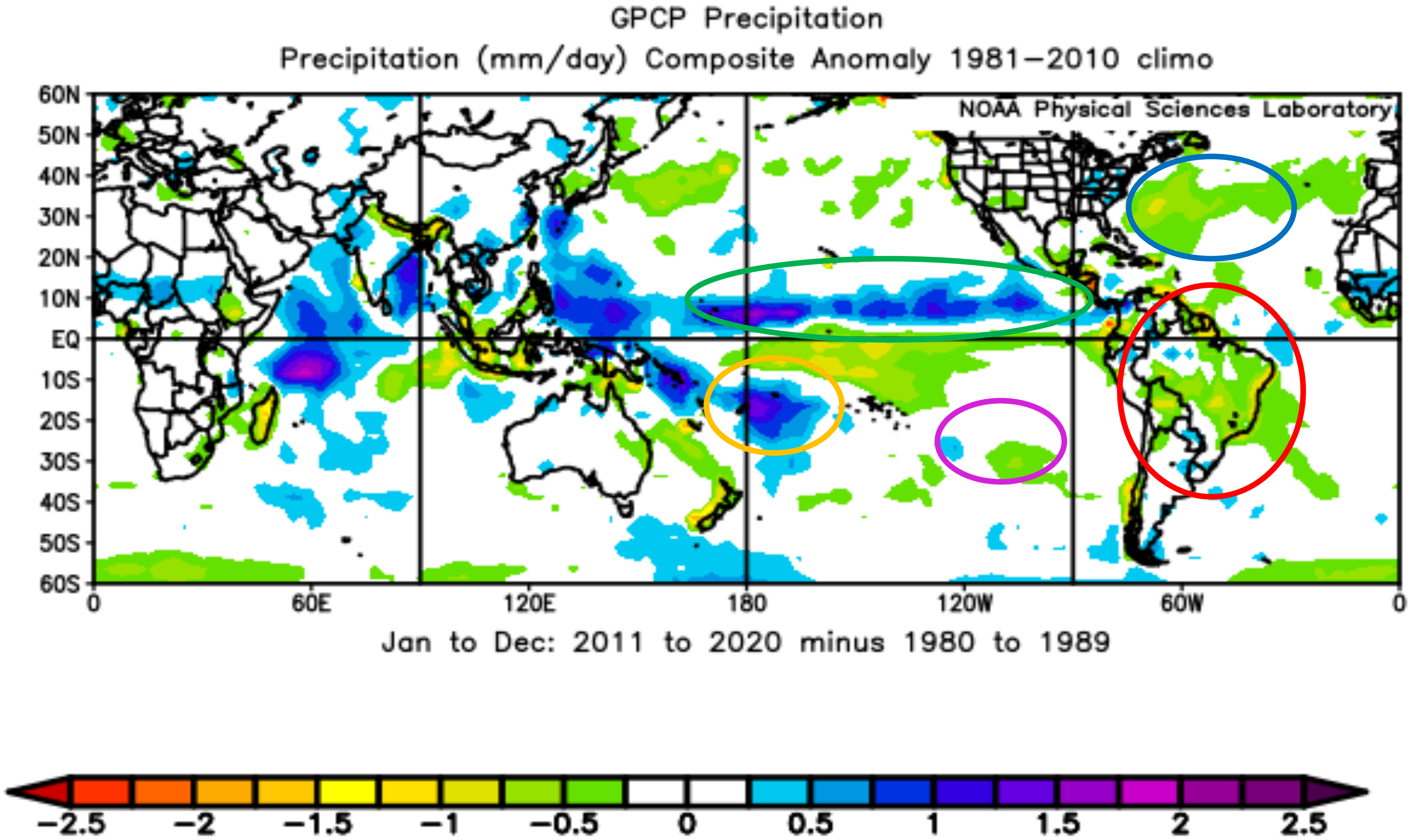
User's wish list – Reneable Energy Sources

- Commercial Use: (energy price) few weeks , few months
  - Future Energy Market:
    - S2S (weeks) -> Seasonal
- Operational Use:
  - Dispatch
  - Maintenance
    - Thunderstorms, lightning, hail,
    - Hydrometeorological forecasting – e,g. dam safety, urban impacts etc,
- Multiple colocated reneable energy sources
  - Hidro/Wind/Solar/Biomass –
    - Challenge: which source should be activated?
- Environmental Certification
  - Dealing with extremes
  - Future climate
- Planning for future instalations
  - Traditional activity

National Services provides general regional info , not responding to specific user demands

Heavy use of AI, coupled with modeling products

Changes in annual precipitation
(2011-2020) - (1980-1989)



Drier

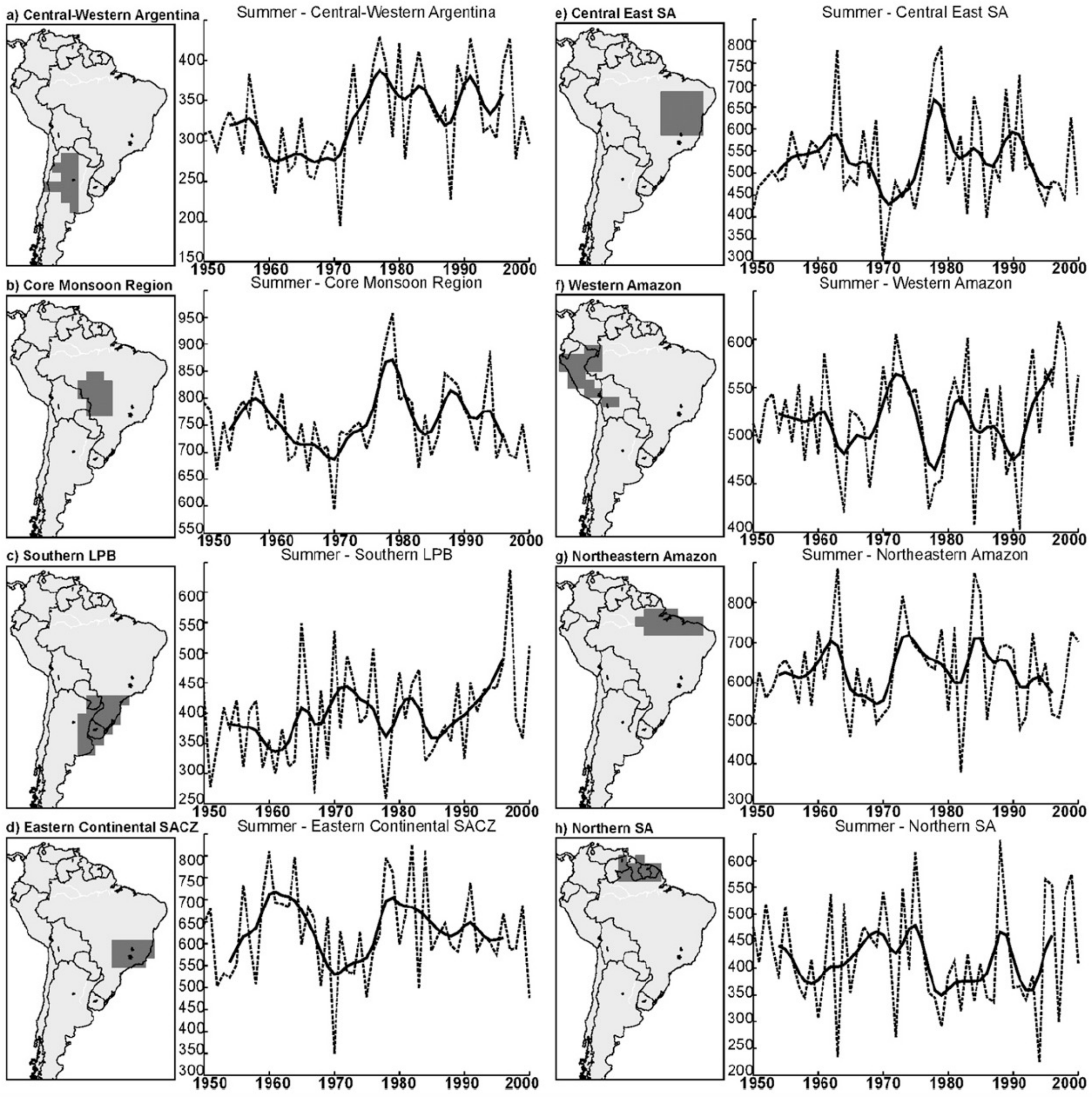
Wetter

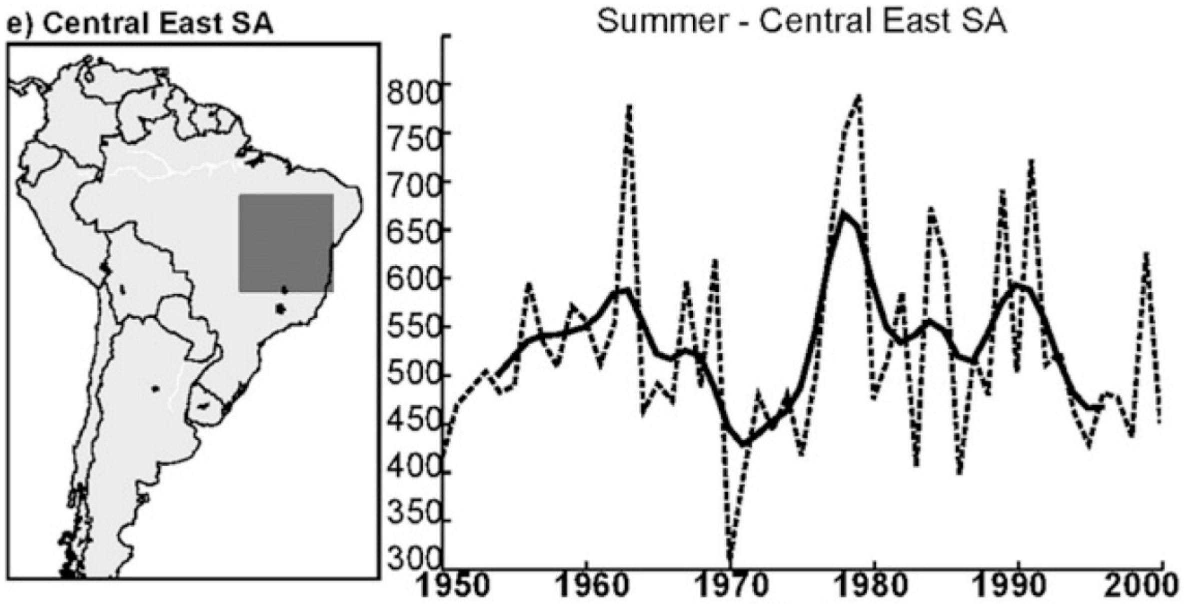
Product
NOAA

Interdecadal Variability of the South American Precipitation in the Monsoon Season

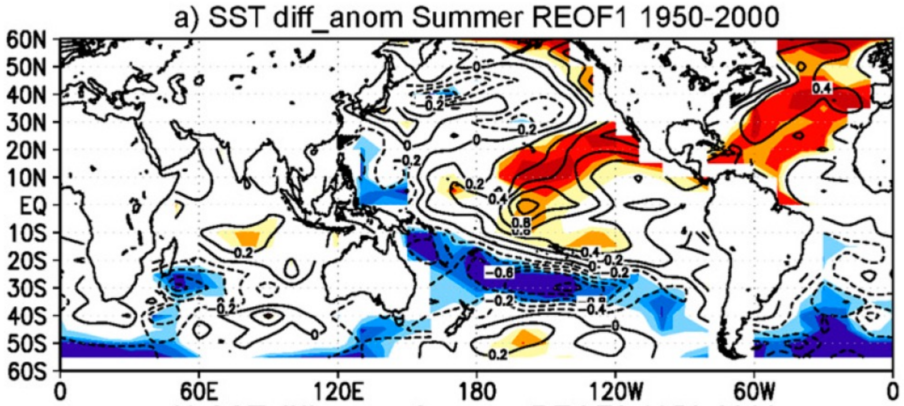
ALICE M. GRIMM AND JOÃO P. J. SABOIA

Department of Physics, and Post Graduate Program on Water Resources and Environmental Engineering, Federal University of Paraná, Curitiba, Brazil





Demonstra que a variabilidade decenal das chuvas de verão estão relacionadas com anomalias de temperatura da água do mar no Atlântico e Pacífico



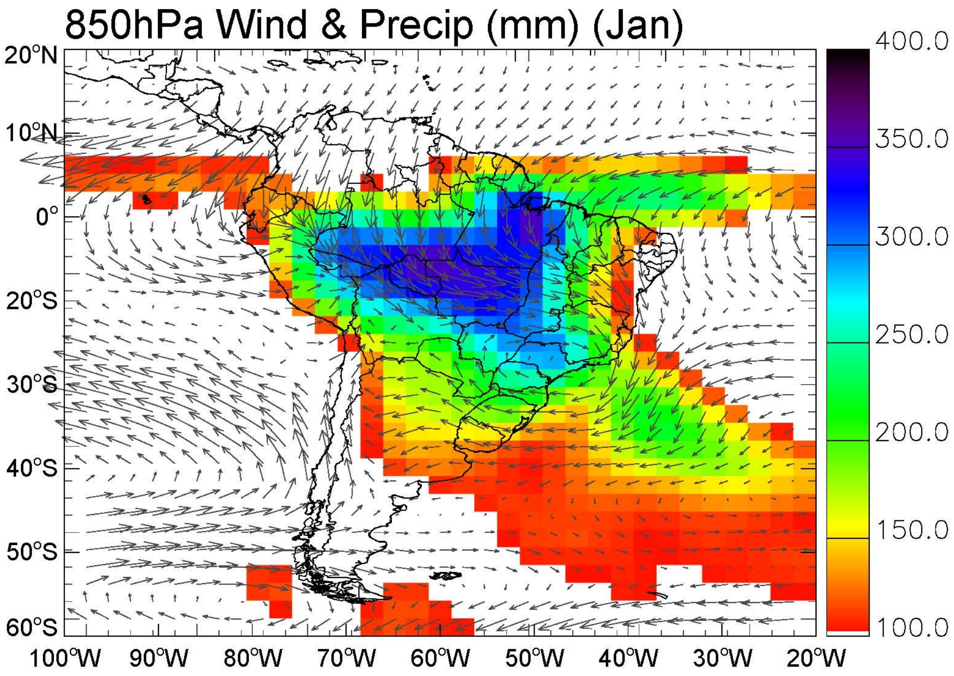
Some conclusions about the mechanisms that are altering the behavior of the rainy season in SA in recent decades

- Strong connection with Atlantic variability: particularly with the AMO index (multidecadal) - > it also influences the equatorial mode (Atlantic dipole – mainly NE.
- AMO has been in a positive phase for approximately 20-25 years. It may take another 4 to 8 years to change phase

- Connection with the Pacific: ENSO – scales of 3-7 years, 8 – 20 years and on the order of 50 years. PDO is negative but tends to change sign more quickly than AMO.

- Recent combination of positive AMO with negative PDO reinforces negative signal for the quality of the rainy season in Central Brazil/SE

Monsoon length, onset and demiss:
Large Scale Index for South America Monsoon (LISAM)
(Silva and Carvalho 2007)



LISAM index was designed to characterize the ONSET, DEMISE, DURATION, AMPLITUDE, BREAKS AND ACTIVE PHASES of SAMS based in circulation, precipitation, moisture and temperature

L. M. V. CARVALHO *et al.*

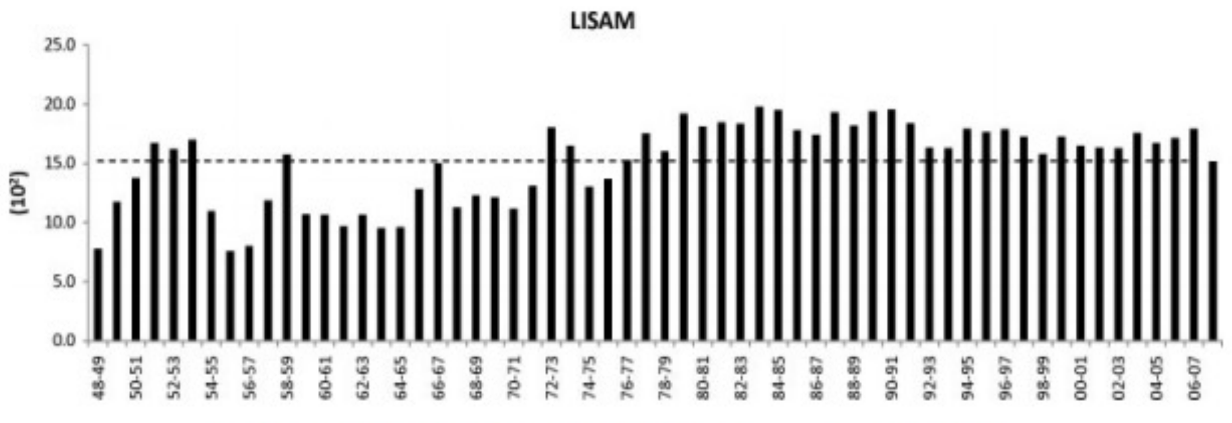


Figure 3. LISAM amplitude (see text for definition) during 1948–2008 (dimensionless).

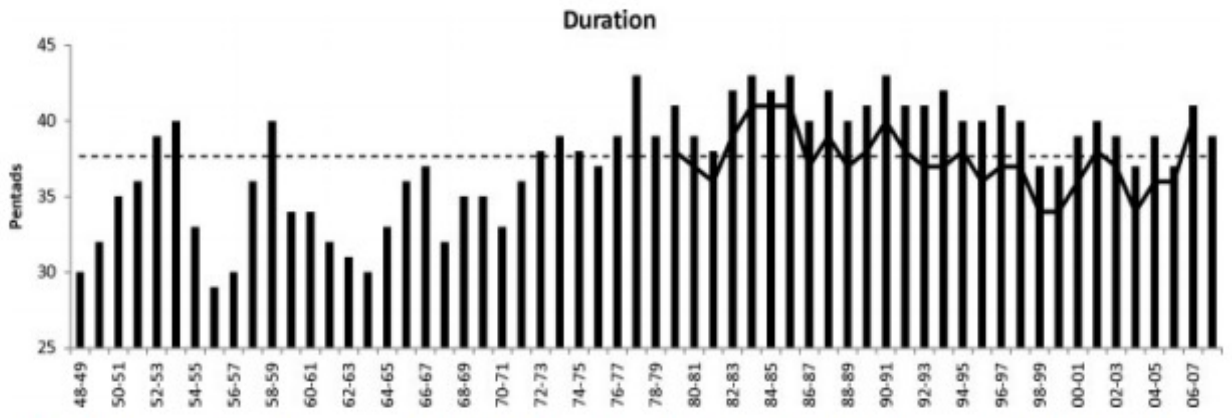
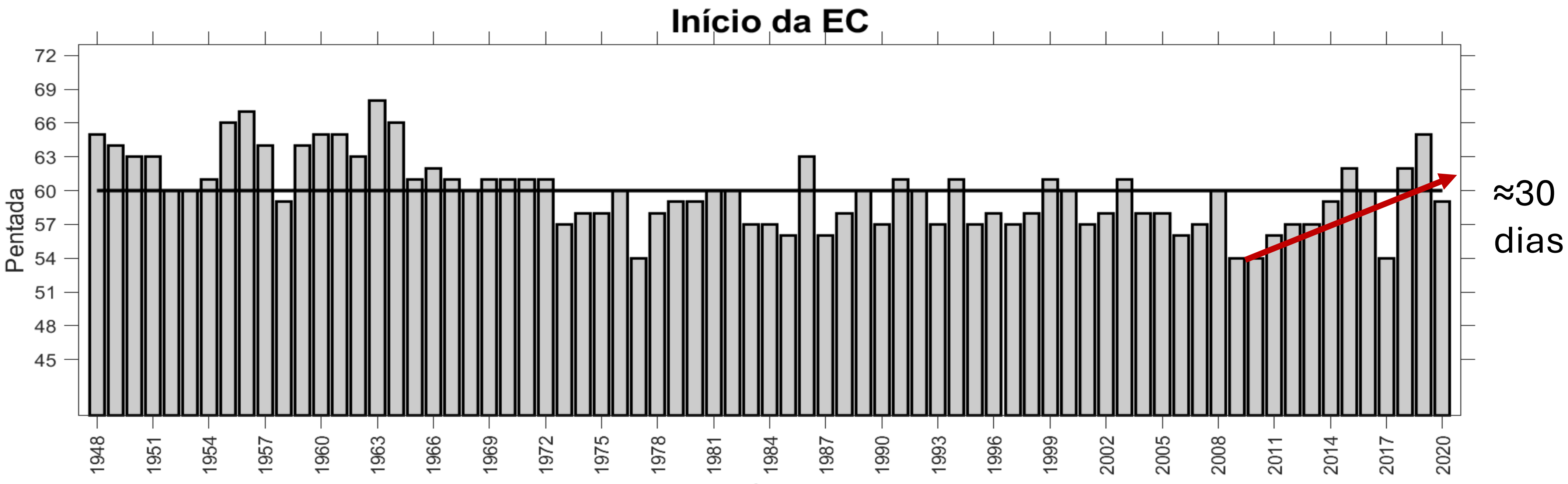
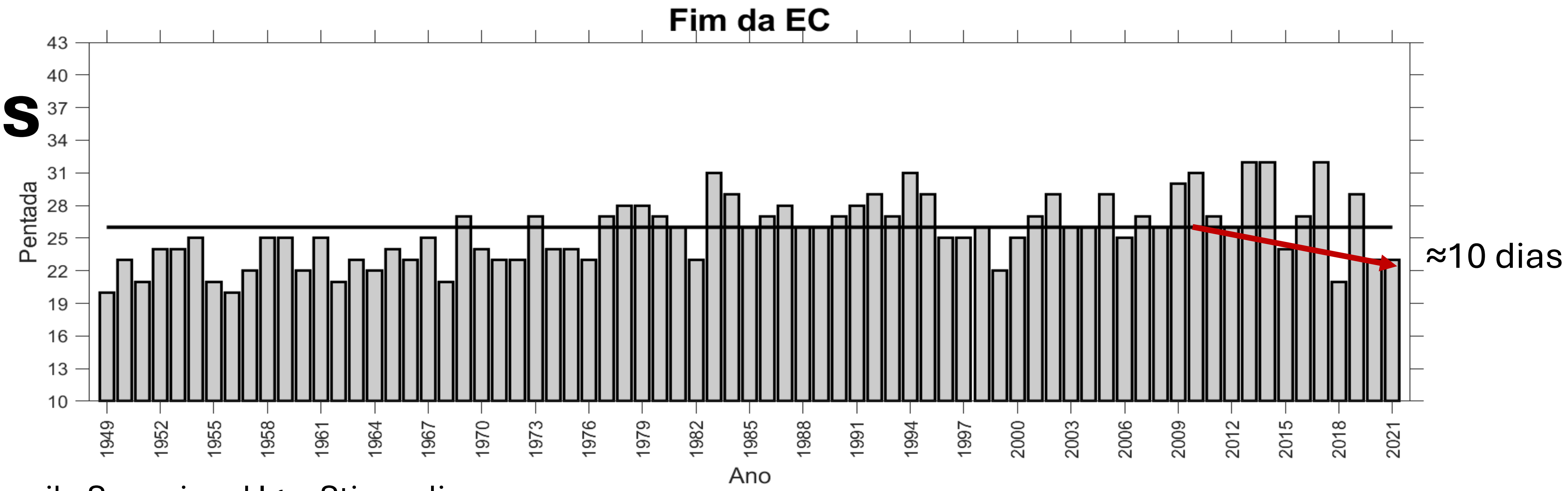


Figure 4. SAMS duration. Vertical bars correspond to LISAM derived with all fields from NNR; solid line is for LISAM GPCP-NNR combined (1979–2008). Duration is given in pentads and horizontal dashed line is the long-term averages (38 pentads).

Onset

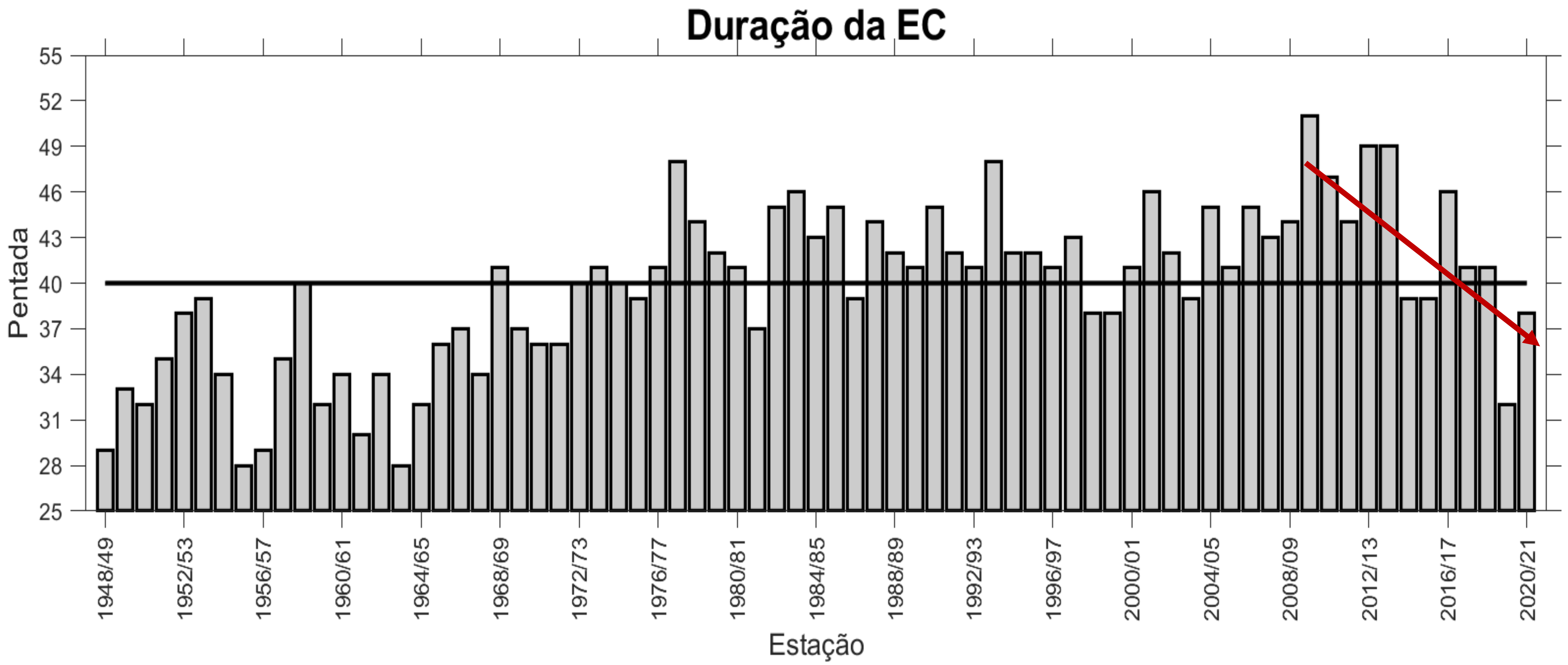


Demiss



Contribution: Camila Saucci and Igor Stivaneli

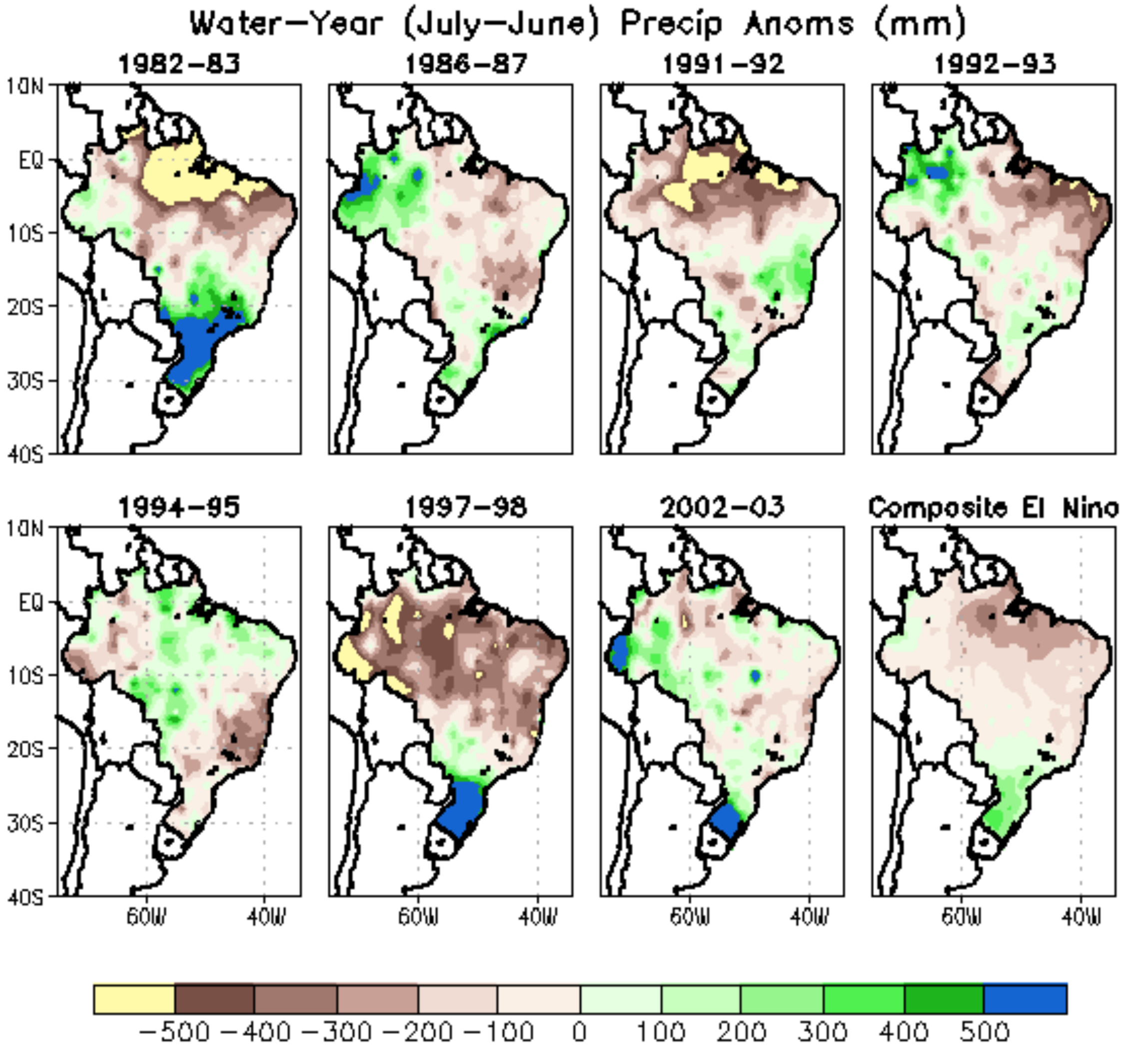
Duration

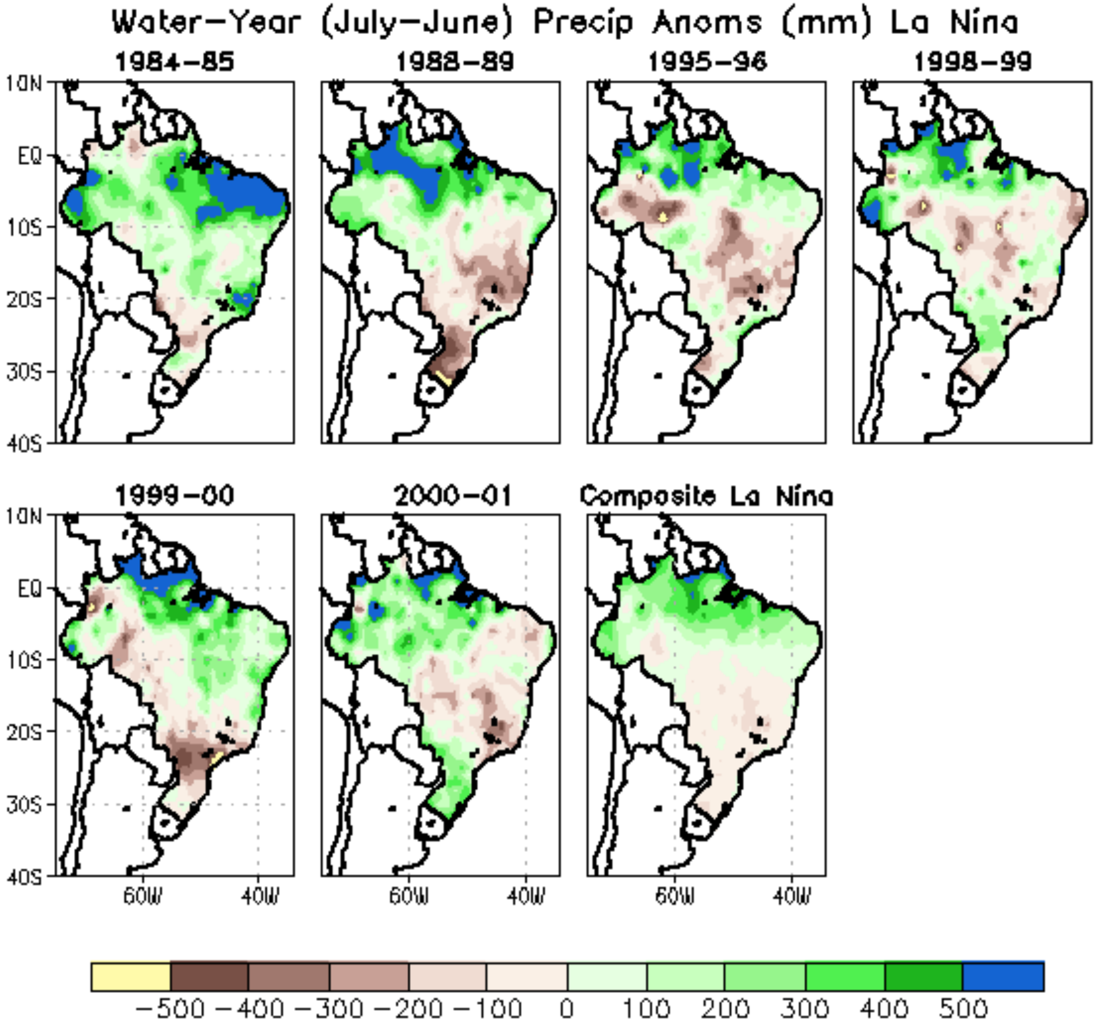


≈ 50 – 60 days

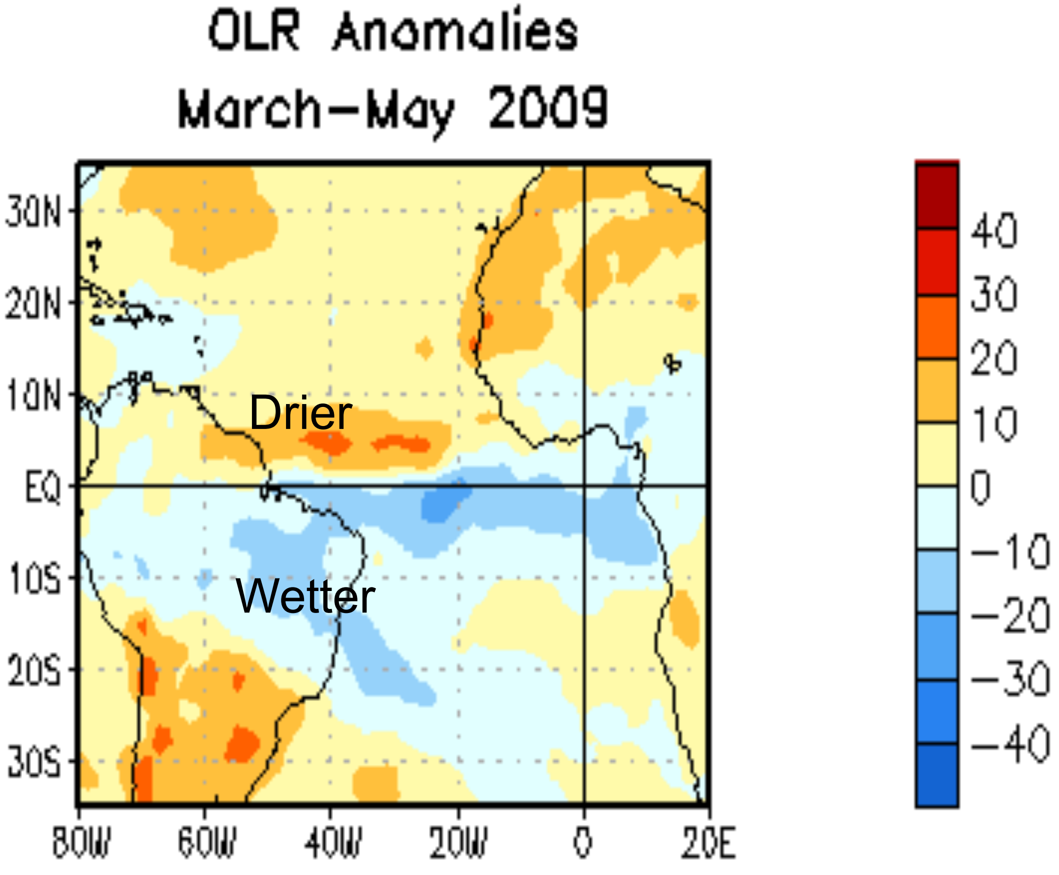
Contribution: Camila Saucci and Igor Stivaneli

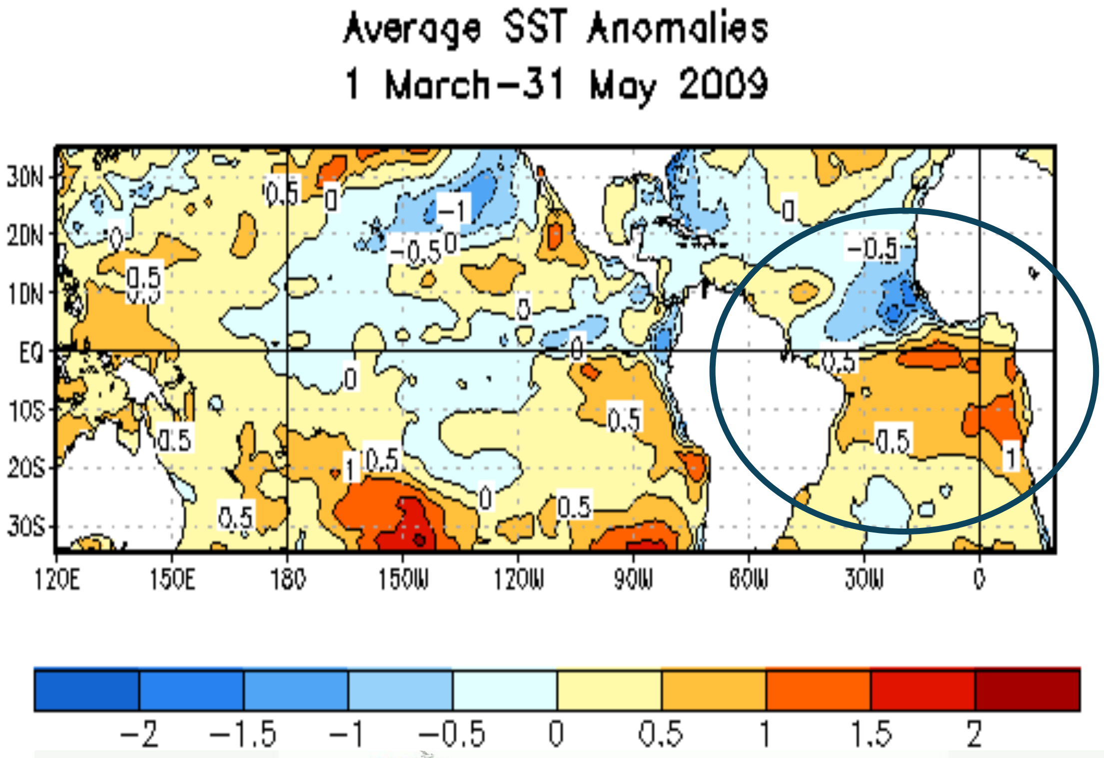
Interanual variability - El Niño/ La Niña

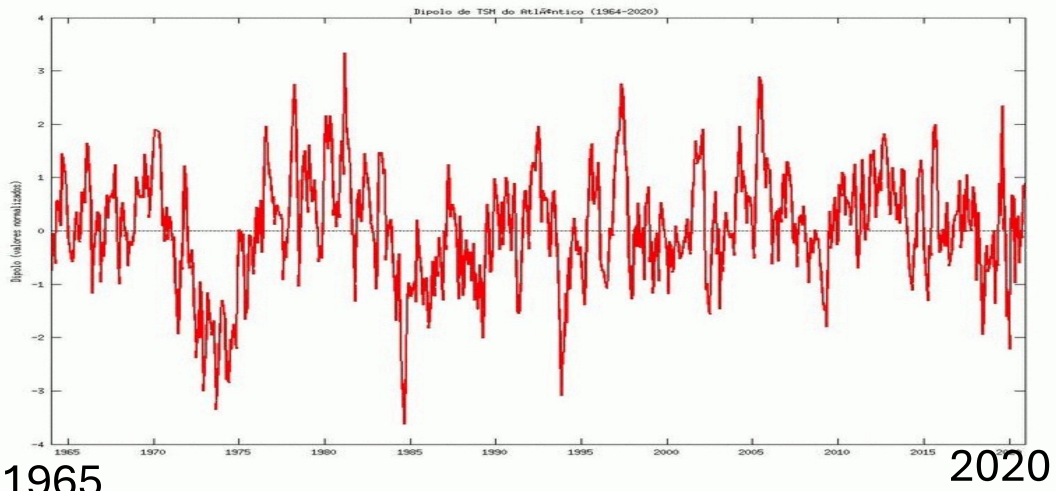




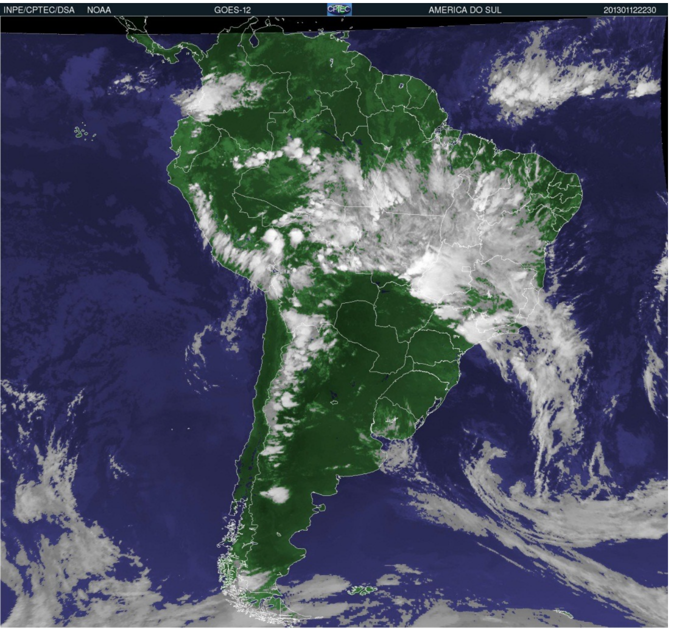
Tropical Atlantic Dipole



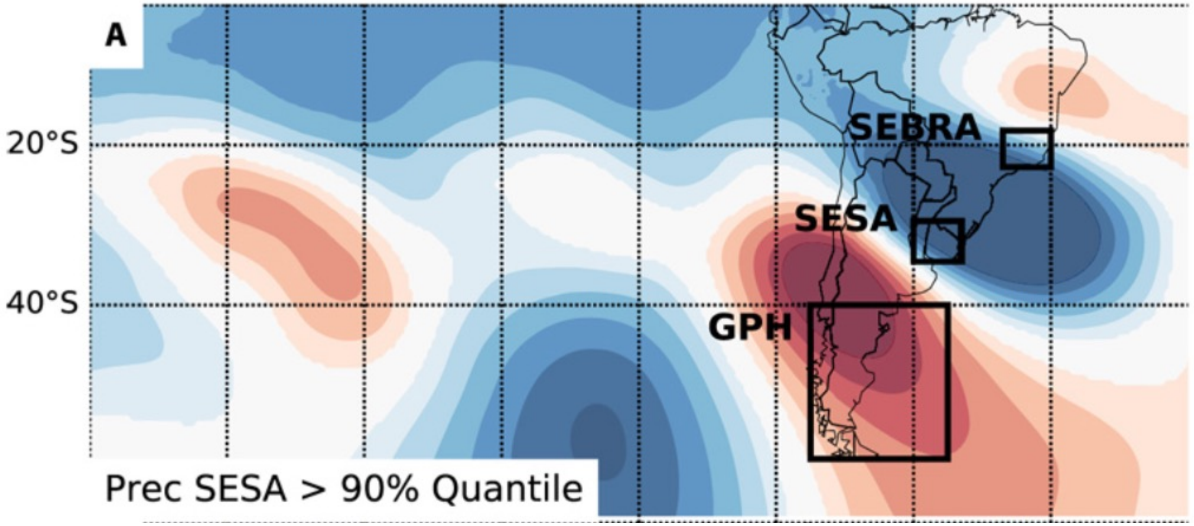


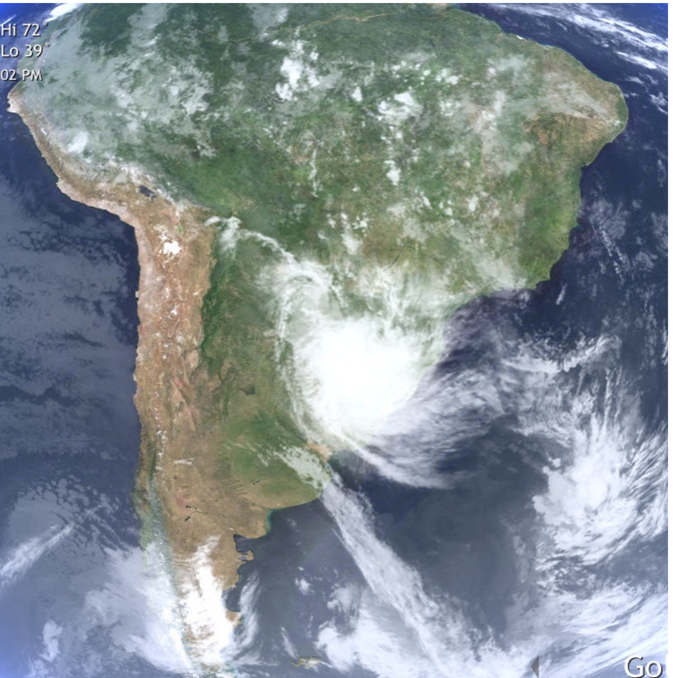


Intraseasonal variations in SAMS

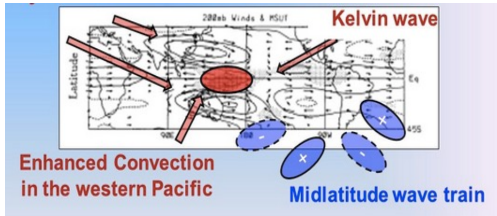


Active phases of the Monsoon (Westerly regime):

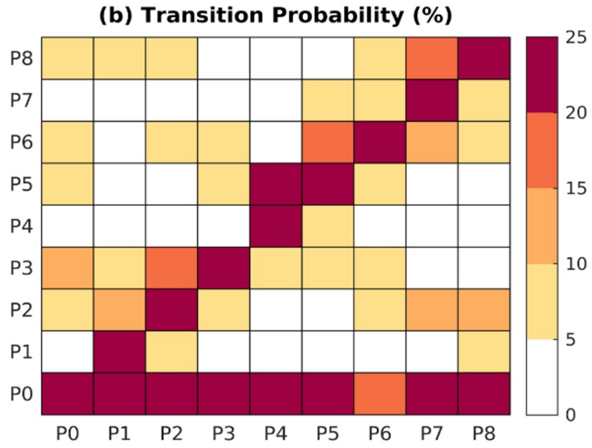


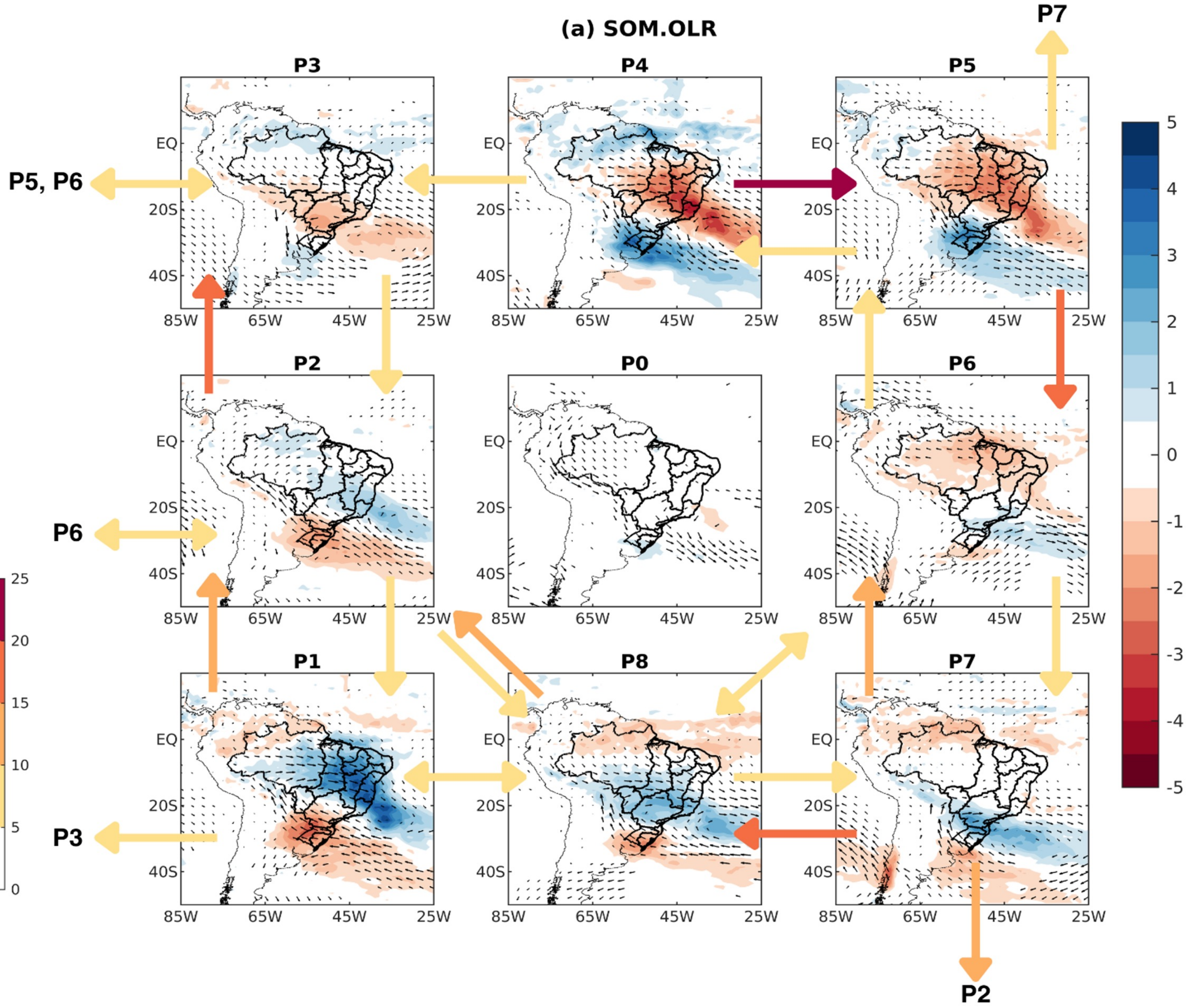


Break phases of the Monsoon (easterly Regime):



SOM.OLR



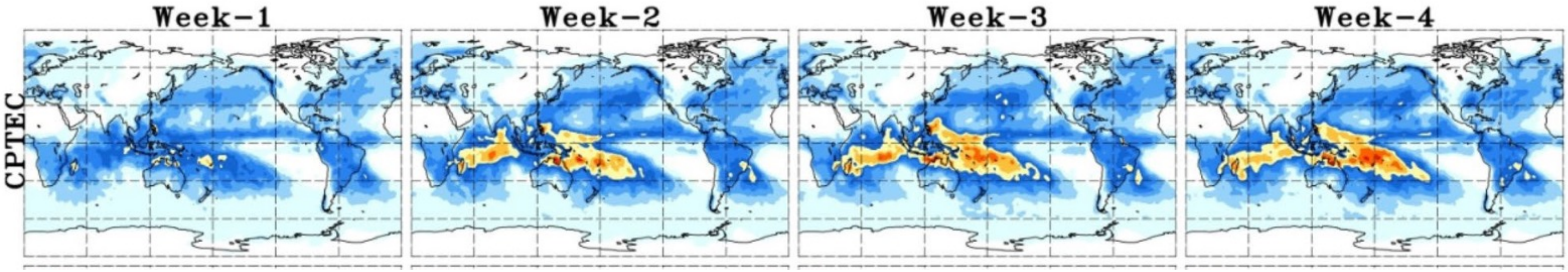


Contribution: Camila Sapucci

Climate Dynamics (2021) 56:2359–2375
https://doi.org/10.1007/s00382-020-05589-5

An inter-comparison performance assessment of a Brazilian global sub-seasonal prediction model against four sub-seasonal to seasonal (S2S) prediction project models

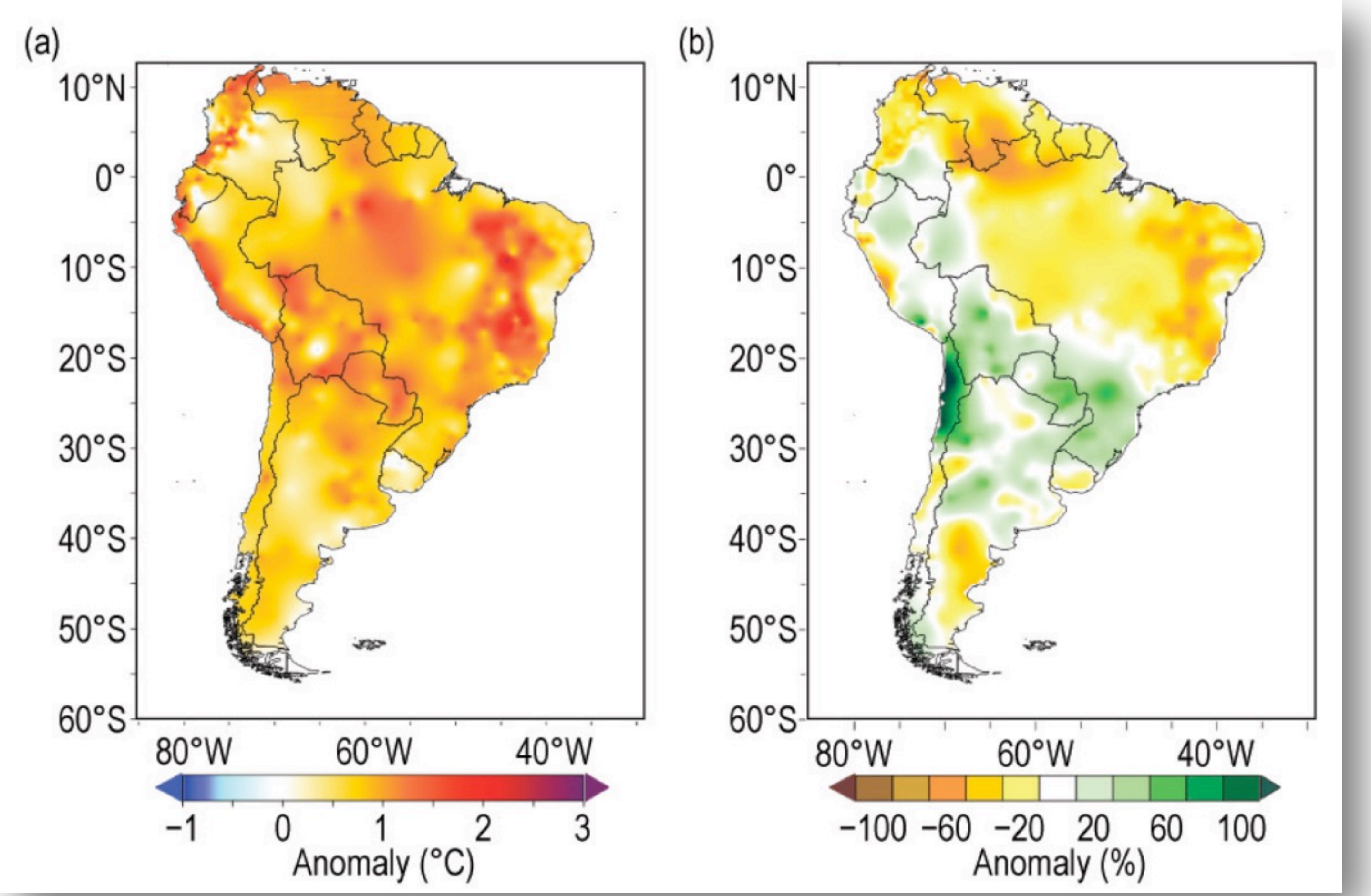
Bruno dos Santos Guimarães[1] · Caio Augusto dos Santos Coelho[1] · Steven James Woolnough[2] · Paulo Yoshio Kubota[1] · Carlos Frederico Bastarz[1] · Silvio Nilo Figueroa[1] · José Paulo Bonatti[1] · Dayana Castilho de Souza[1]



In the consulting companies: Combination of S2S products + AI -> significant improvement

South American (a) temperature anomalies (°C) and (b) precipitation anomalies

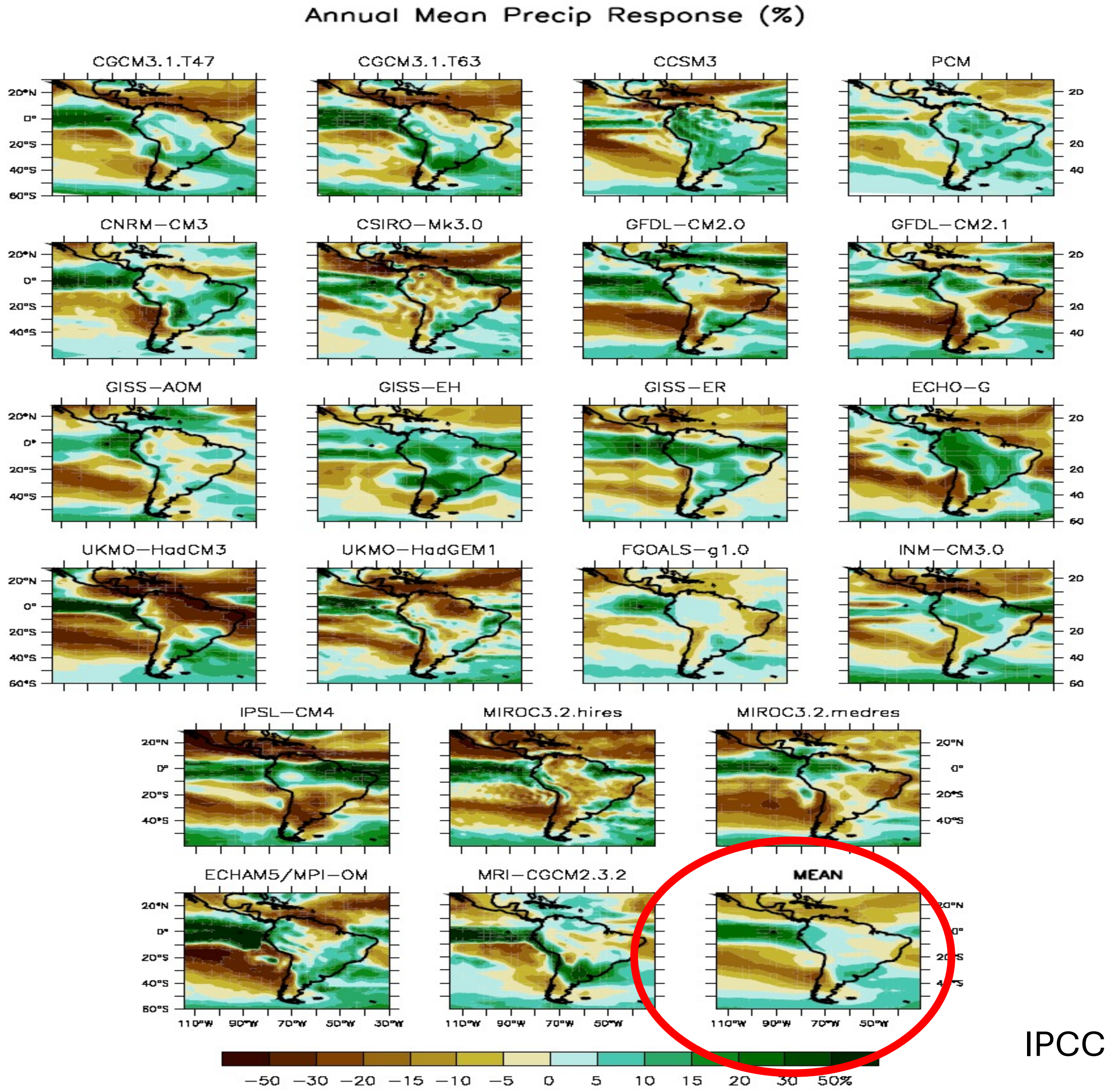
Climate Change



base period: 1981–2010.

Source 2016: State of the Climate in 2015, Bull. Amer. Meteor. Soc., 97 (8), 2016.

Climate Change Impact on SAMS

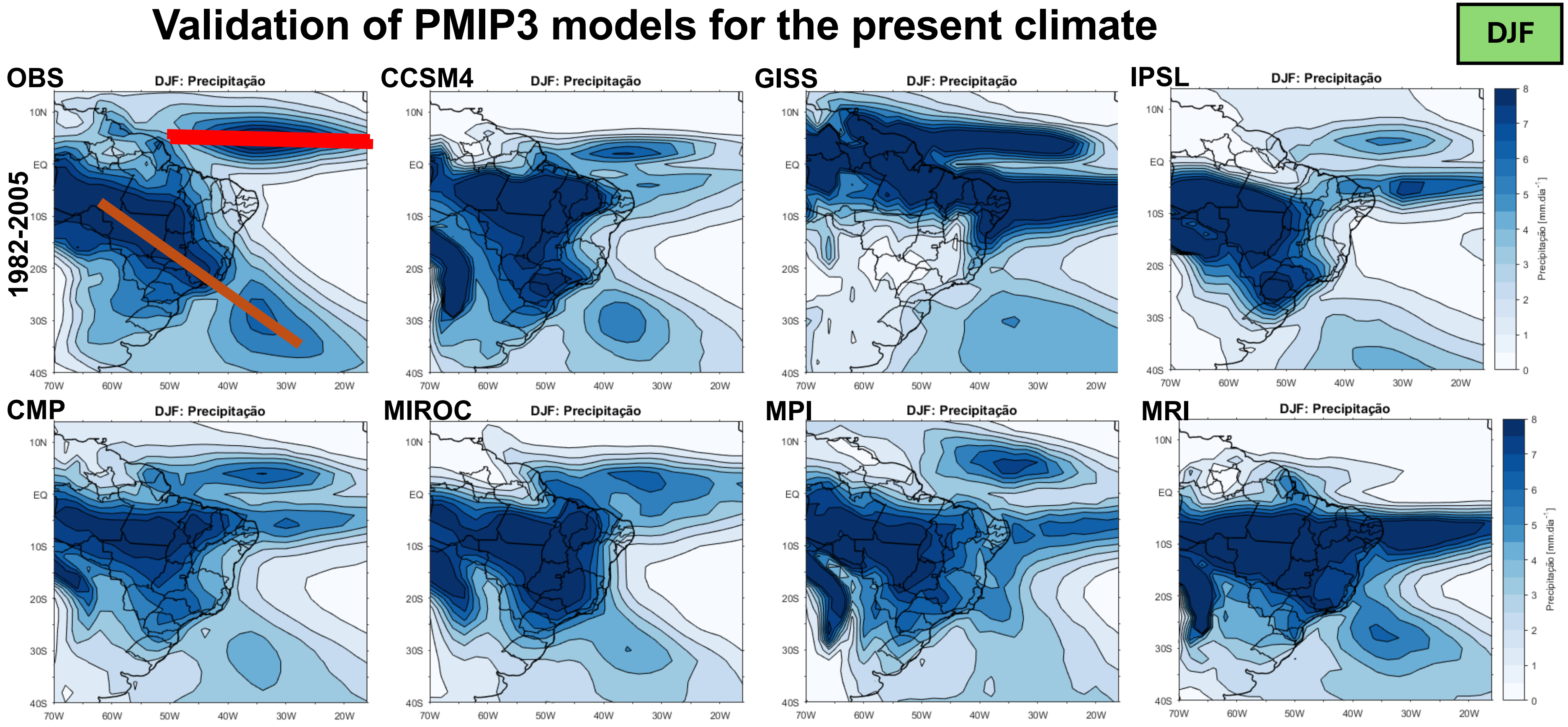


Percent change in precipitation from the years 1980-1999 to 2080-2099 under the A1B scenario. Brown indicates a reduction in precipitation and green an increase. The per cent change in the precipitation averaged over all models is shown in the lower right hand corner.

IPCC-2013

Model Issues concerning predictability: ITCZ – SACZ – Andes effect

Validation of PMIP3 models for the present climate



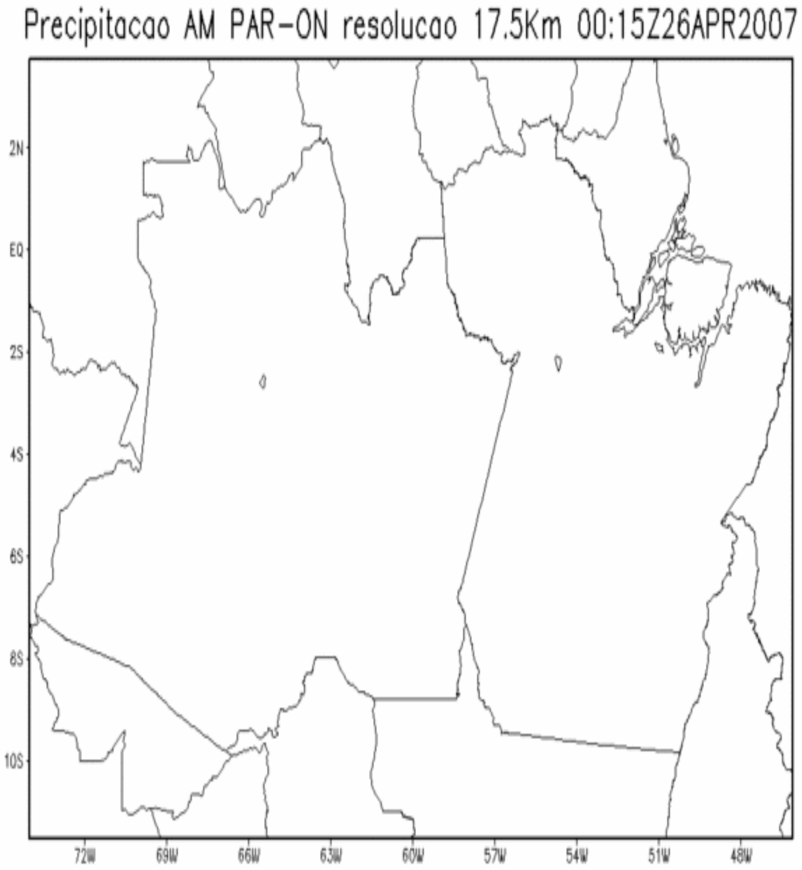
Double ITCZ Latitude

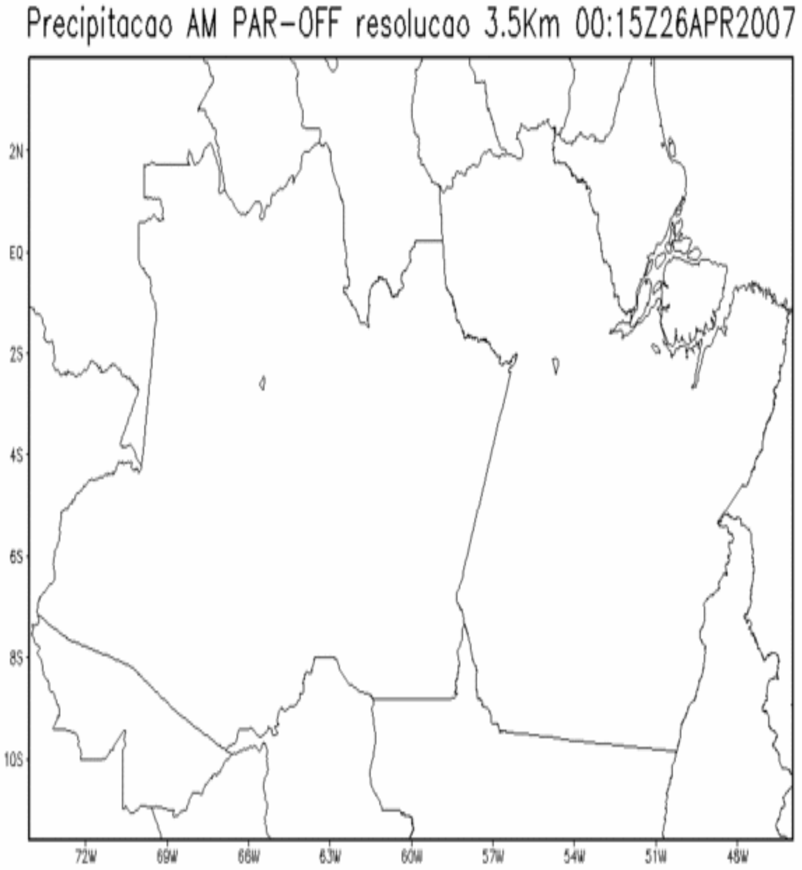
(BOMBARDI; CARVALHO, 2009; JONES; CARVALHO, 2013; KITOH et al., 2013; YIN et al., 2013; CARVALHO; CAVALCANTI,2016)

Another model problem that affects predictability: Clouds in the Amazon

Model CATT-BRAMS

17.5 km ***3.5 km***





Contribution: Saulo Freitas

Convective parameterization: off and on convection

Cloud resolving model

SUMMARY

- Research Challenges to Improve Predictability
  - ITCZ location and intensity: impact of ocean heat transport in the Atlantic (AMOC):
    - Climate change: AMOC versus interhemispheric assimetric impact of global warming
  - South Atlantic Convergence Zone: South American Precipitation Dipole in SE South America
    - Pacific and Atlantic connections
    - Role of soil moisture and vegetation
    - Convective parameterizations X cloud resolving,
  - Andes role: numerical issues concerning steep orography
  - Diurnal variability: cloud aggregation forced by diurnal heating
  - S2S predictability : local control (soil moisture), MJO role, \Rossby Wave trains in the Pacific
  - AI role in improving predictability (need to include conceptual models)

- How can we improve sinergy among players in roder to provide better services to the users?
  - Operational Services. (lack of funding)
  - Academic Community (publish or perish...)
  - Private Consulting Companies (subtantial progress with the use of AI but fierce competition among players)

Urgent need to improve societal view of what we can do provide better predictabilty producst

Thanks!!!

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