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AGU

CST Centro de Ciência do Sistema Terrestre

INPE

South American Monsoon System: Past, Present, and Future:

A33D-01 Developments on the functioning, characteristics and variability of the South American Monsoon System: Past, Present and Future:

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With the help of

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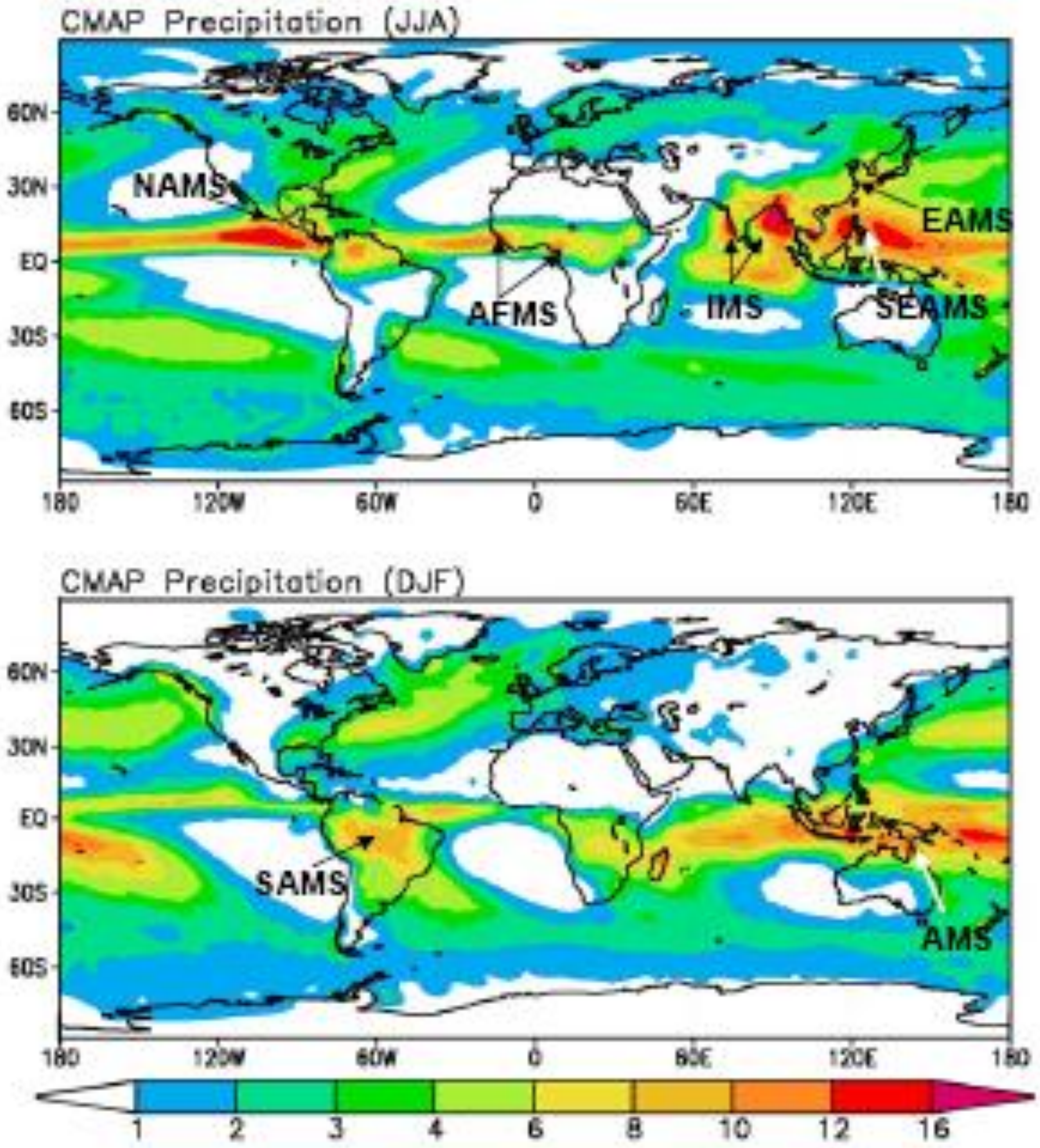
Precipitation (mm/day) during 1979-2002



Monsoon regions of the world

Abbreviation for monsoon systems

NAMS: North American Monsoon System
AFMS: African Monsoon System
IMS: Indian Monsoon System
SEAMS: Southeast Asia Monsoon System
EAMS: East Asia Monsoon System
SAMS: South American Monsoon System
AMS: Australian Monsoon System

The annual cycle of convection over the Americas

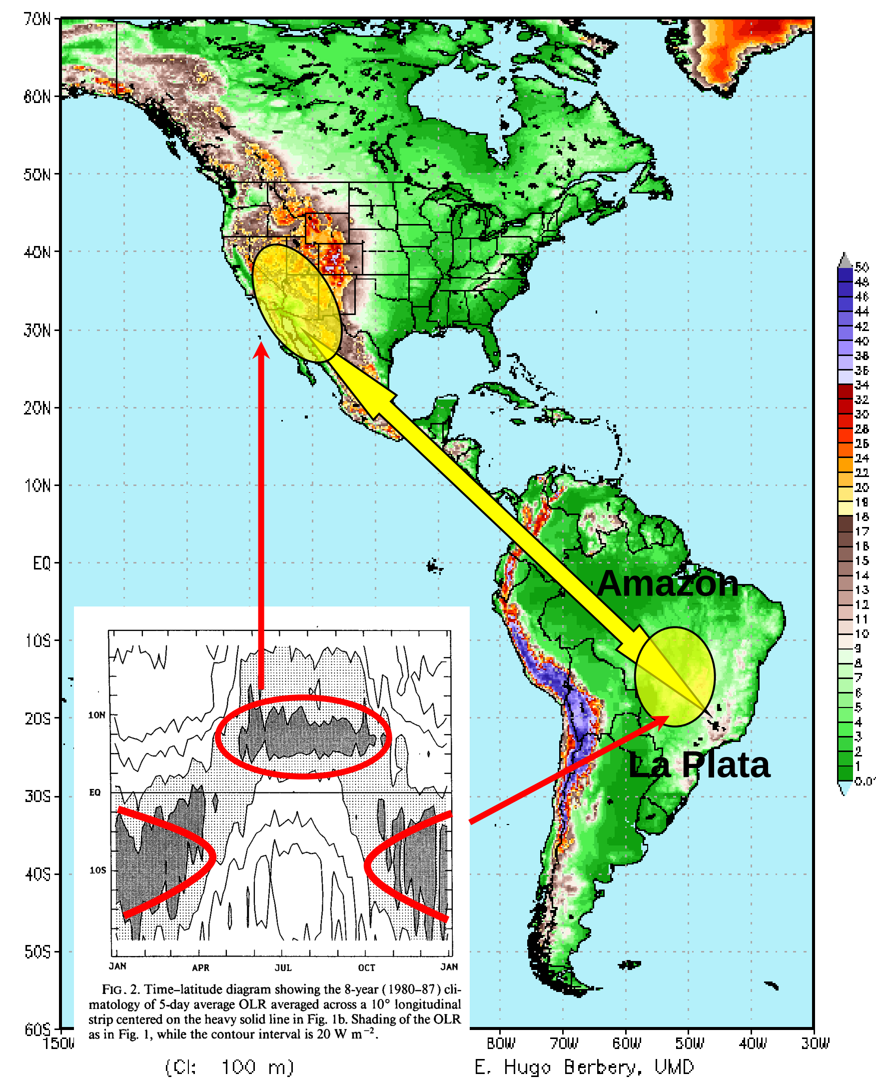


FIG. 2. Time–latitude diagram showing the 8-year (1980–87) climatology of 5-day average OLR averaged across a 10° longitudinal strip centered on the heavy solid line in Fig. 1b. Shading of the OLR as in Fig. 1, while the contour interval is 20 W m^{-2}.

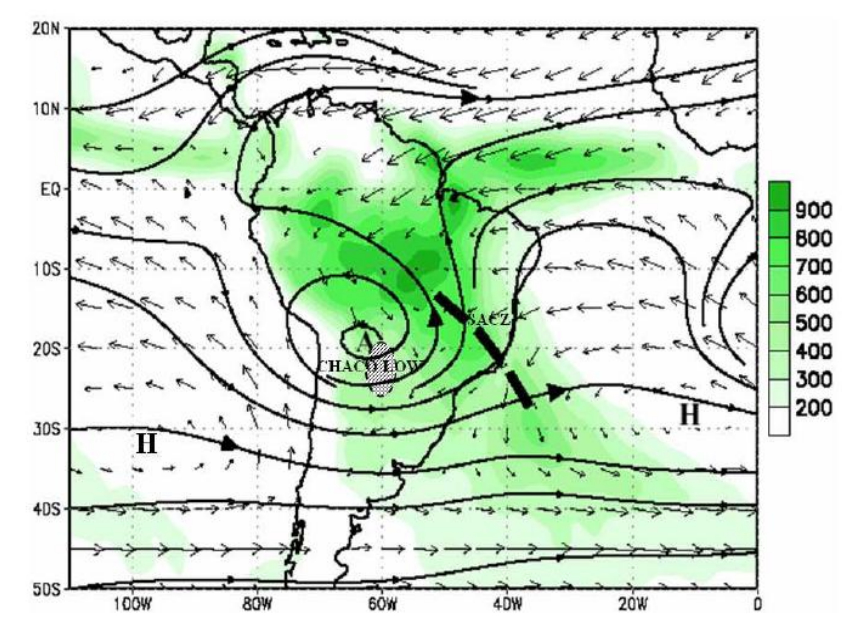
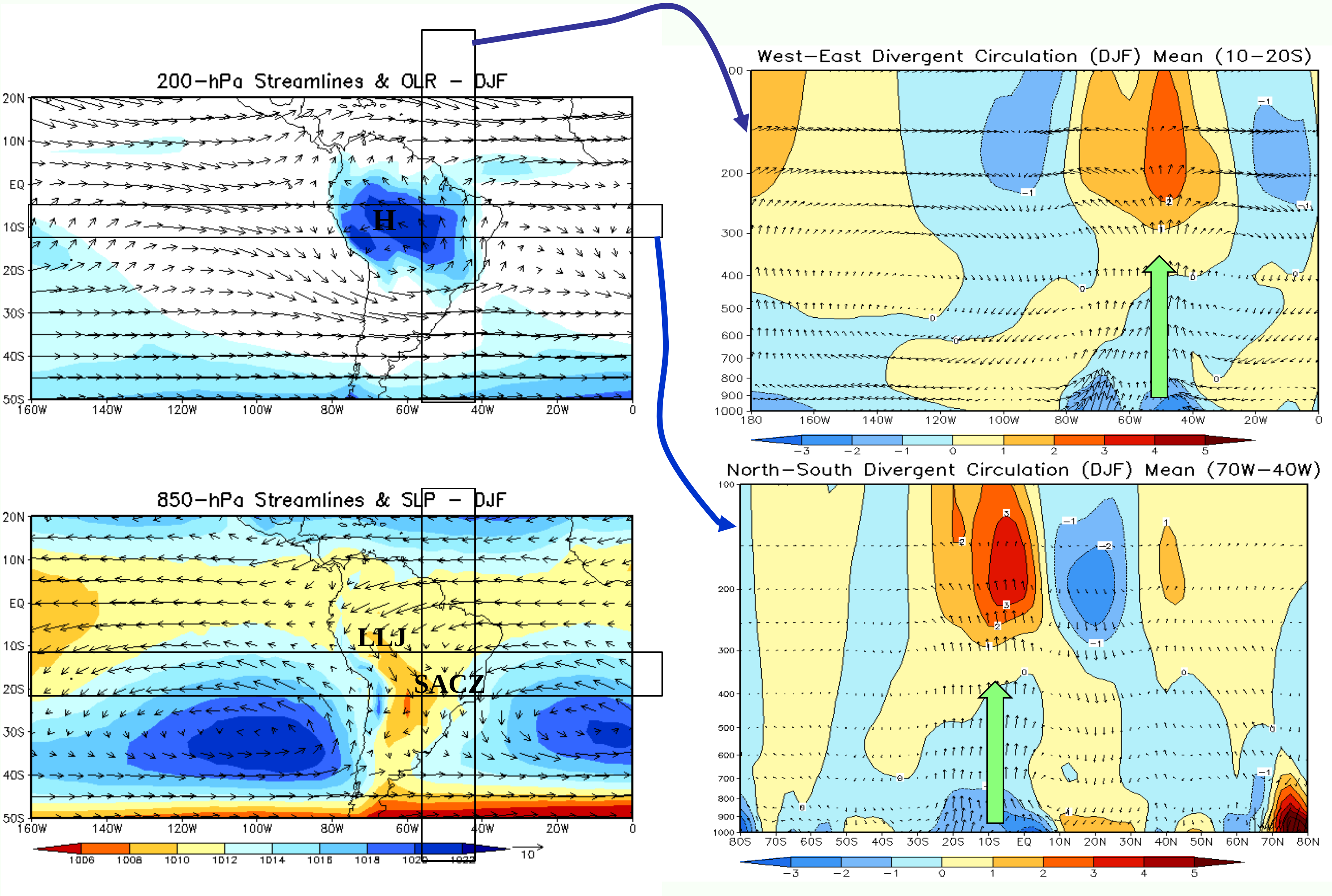
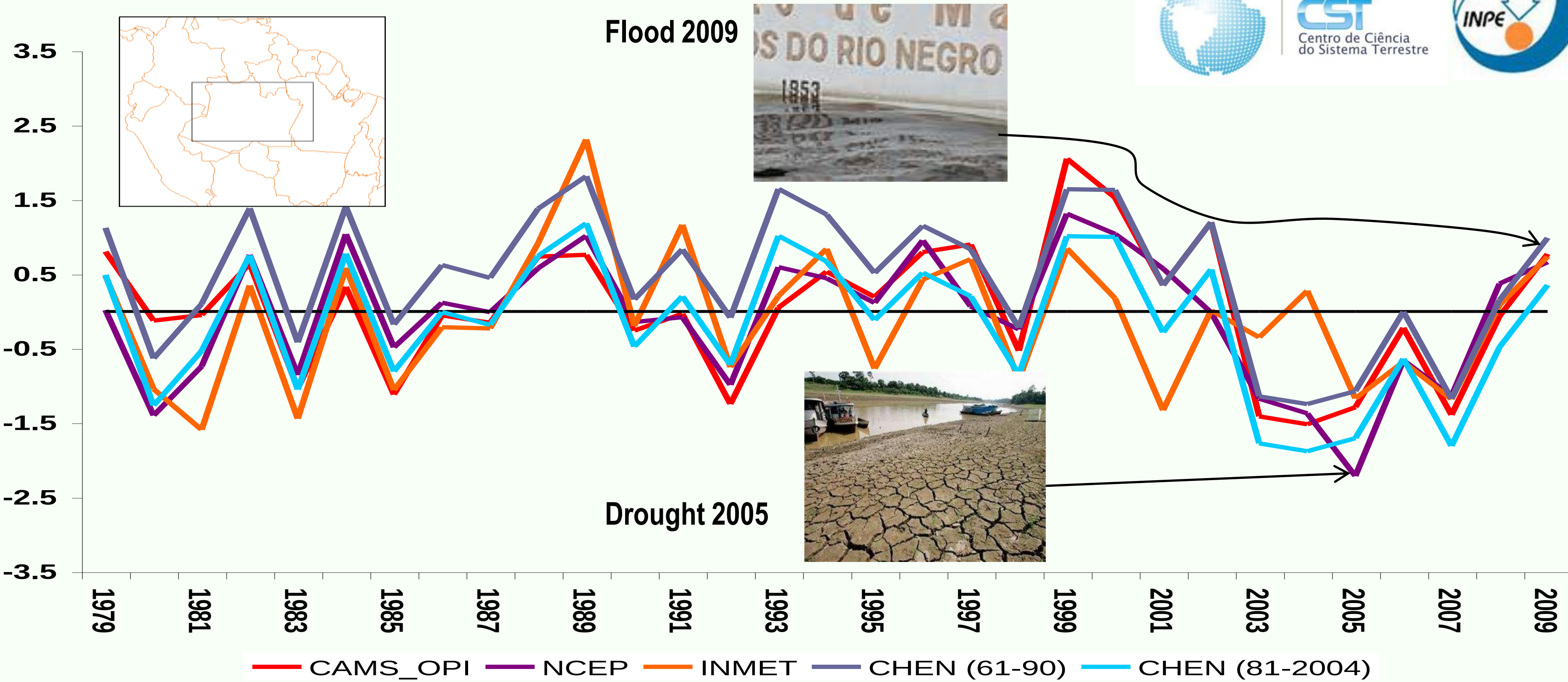


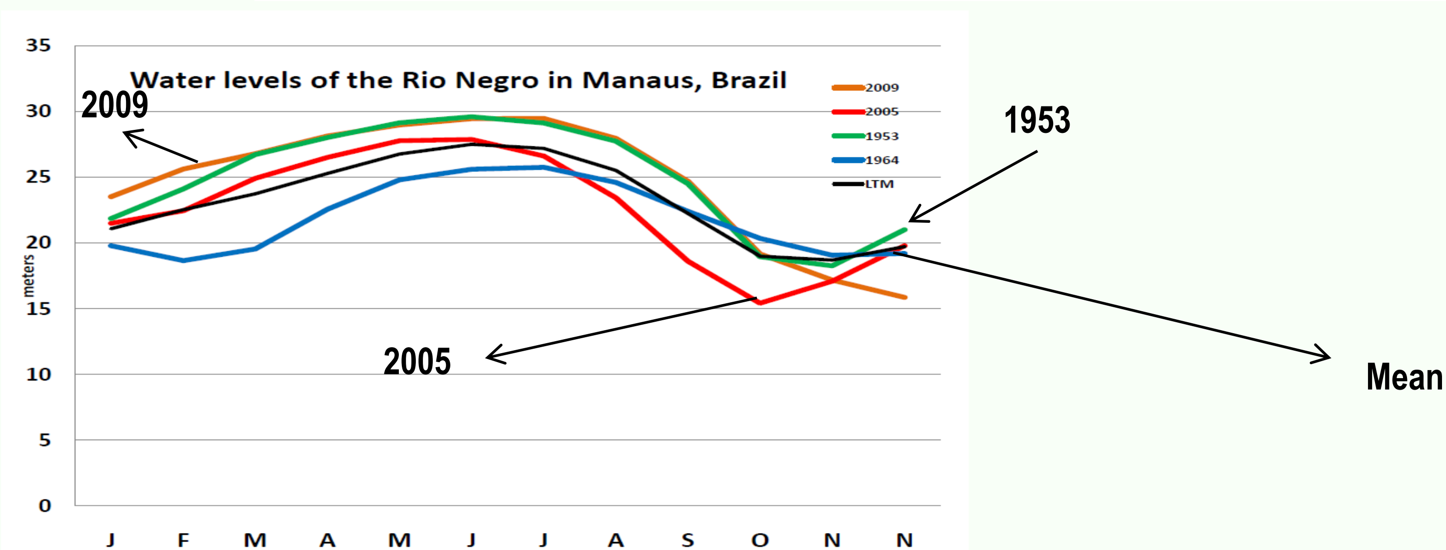
Fig. 2. Main features of the SAMS. December-February mean (1979-1995) 925 hPa vector wind and 200 hPa streamlines from the NCEP/NCAR reanalysis archive, and merged satellite estimates and station observations of precipitation (mm, shading). The position of the Bolivian High (A) and the subtropical Atlantic and Pacific surface high pressure centers (H) are indicated. The approximate axis of the South Atlantic Convergence Zone is indicated by the heavy dashed line (adapted from V. Kousky and M. Halpert).

Present time-Circulation, convection and rainfall fields in South American during the warm season DJF

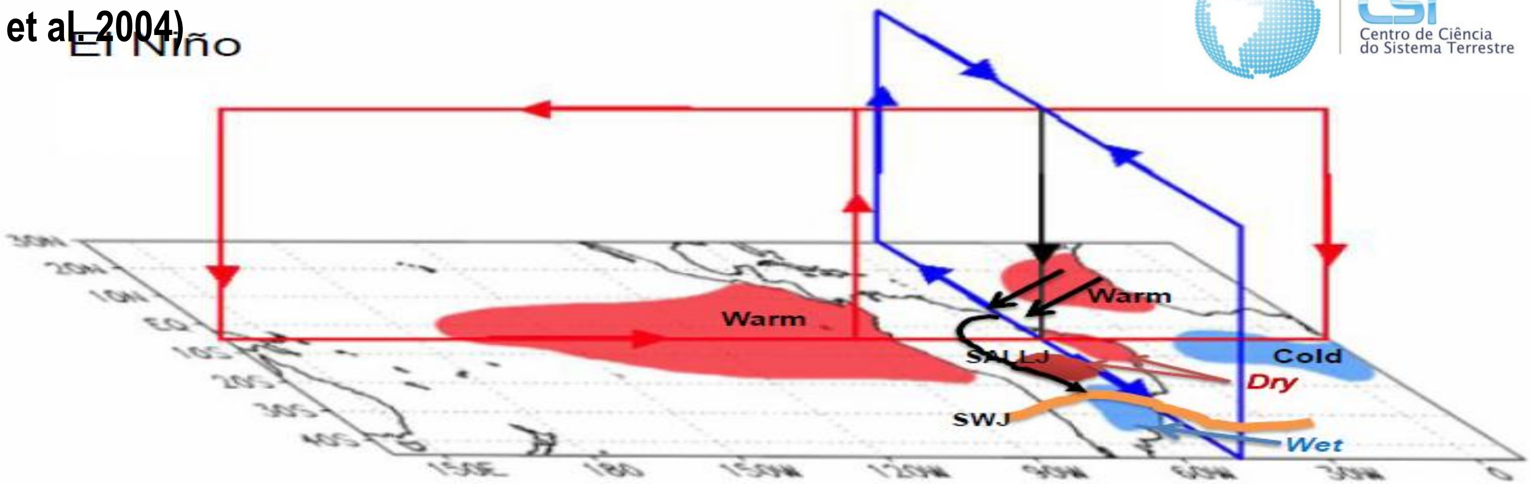


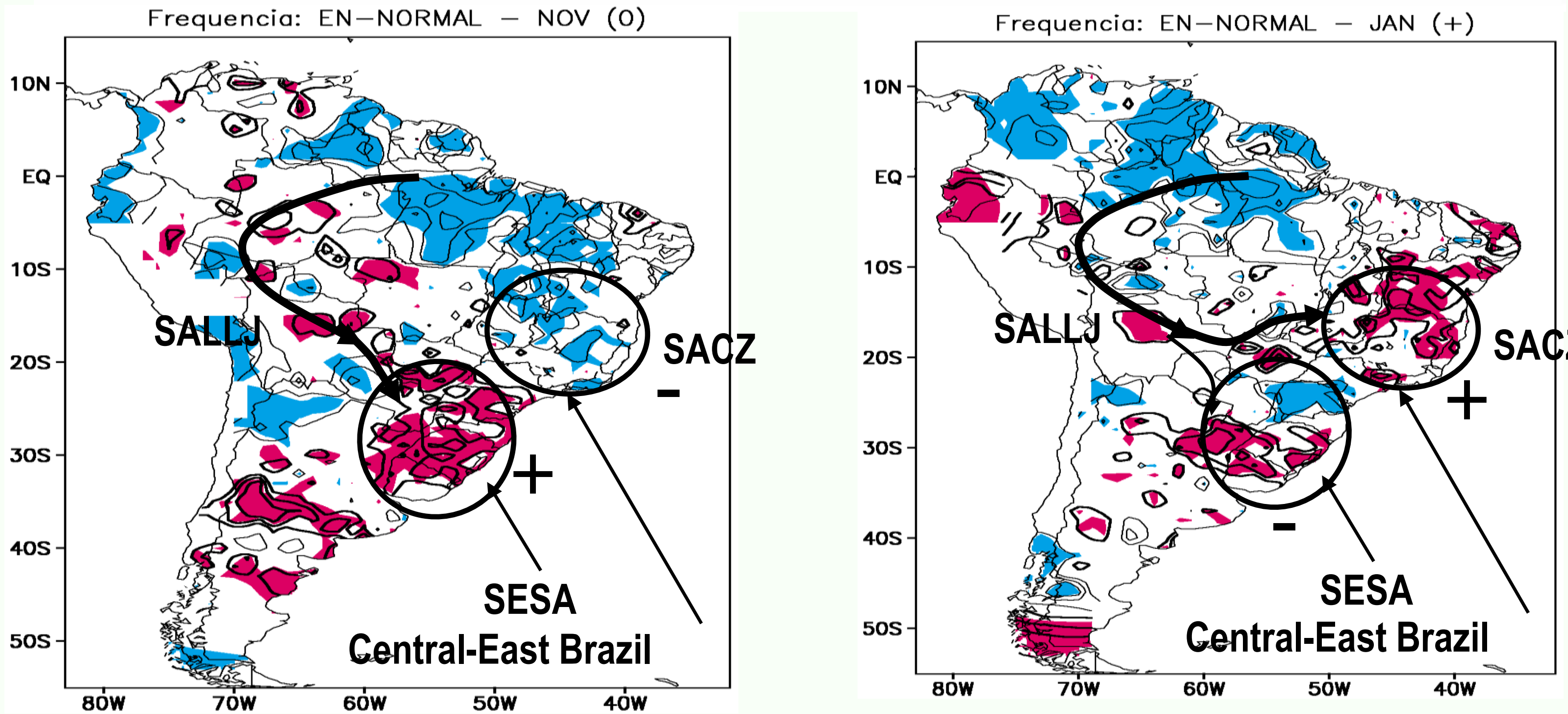
Normalized rainfall departures central Amazonia January-March





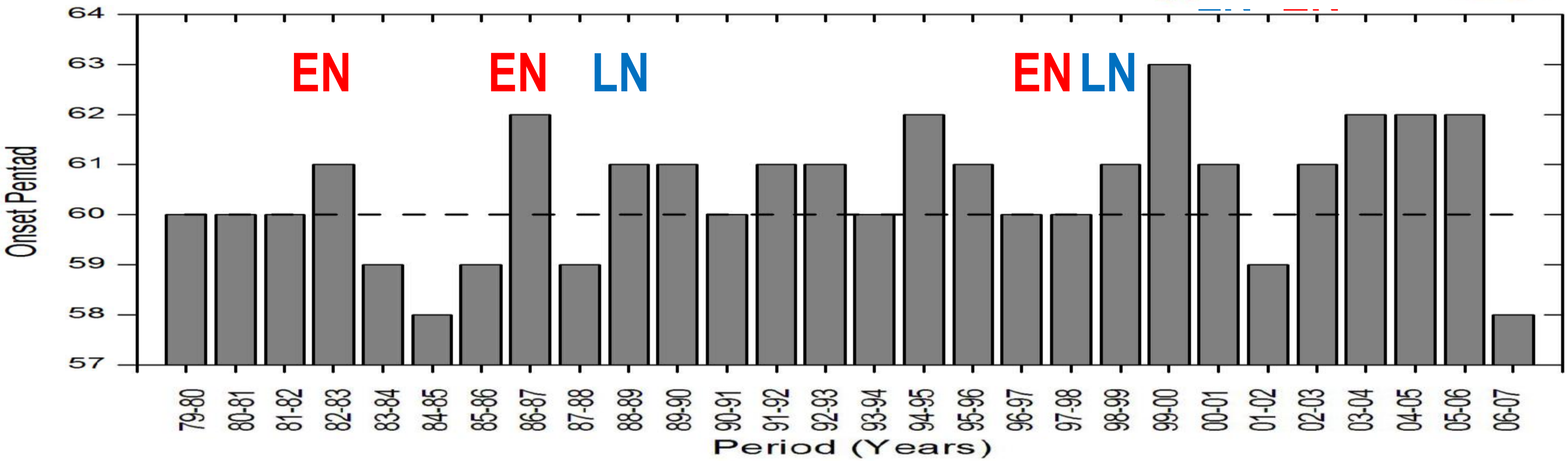
Anomalies of the Walker and Hadley circulation (Ambrizzi et al. 2004)



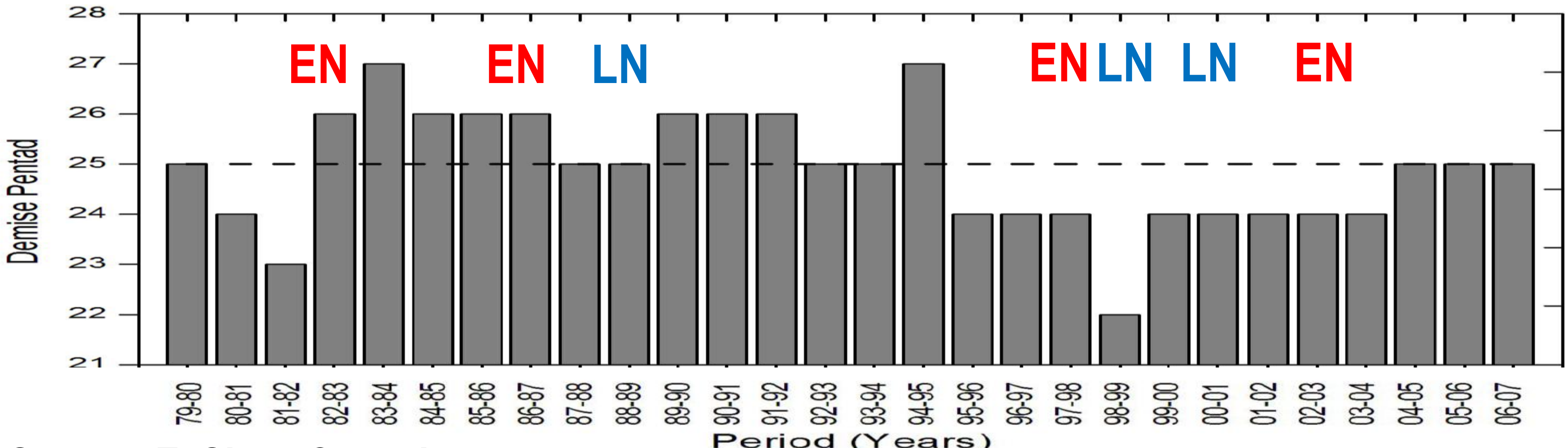


Differences between numbers of extreme rainfall events in El Niño years and neutral years in November (left panel) and January (right panel). (Grimm and Tedeschi 2009).

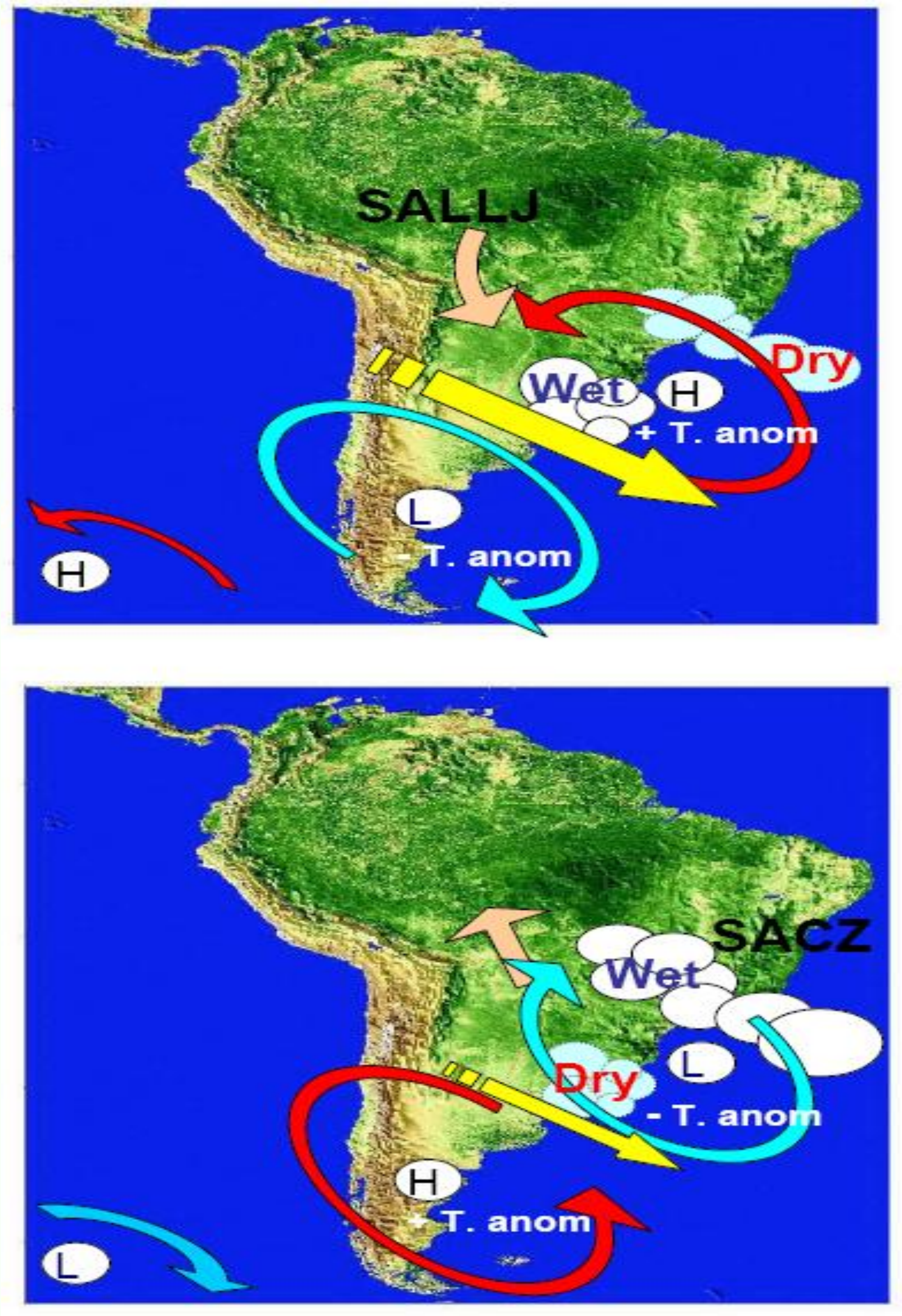
a) Onset SAMS



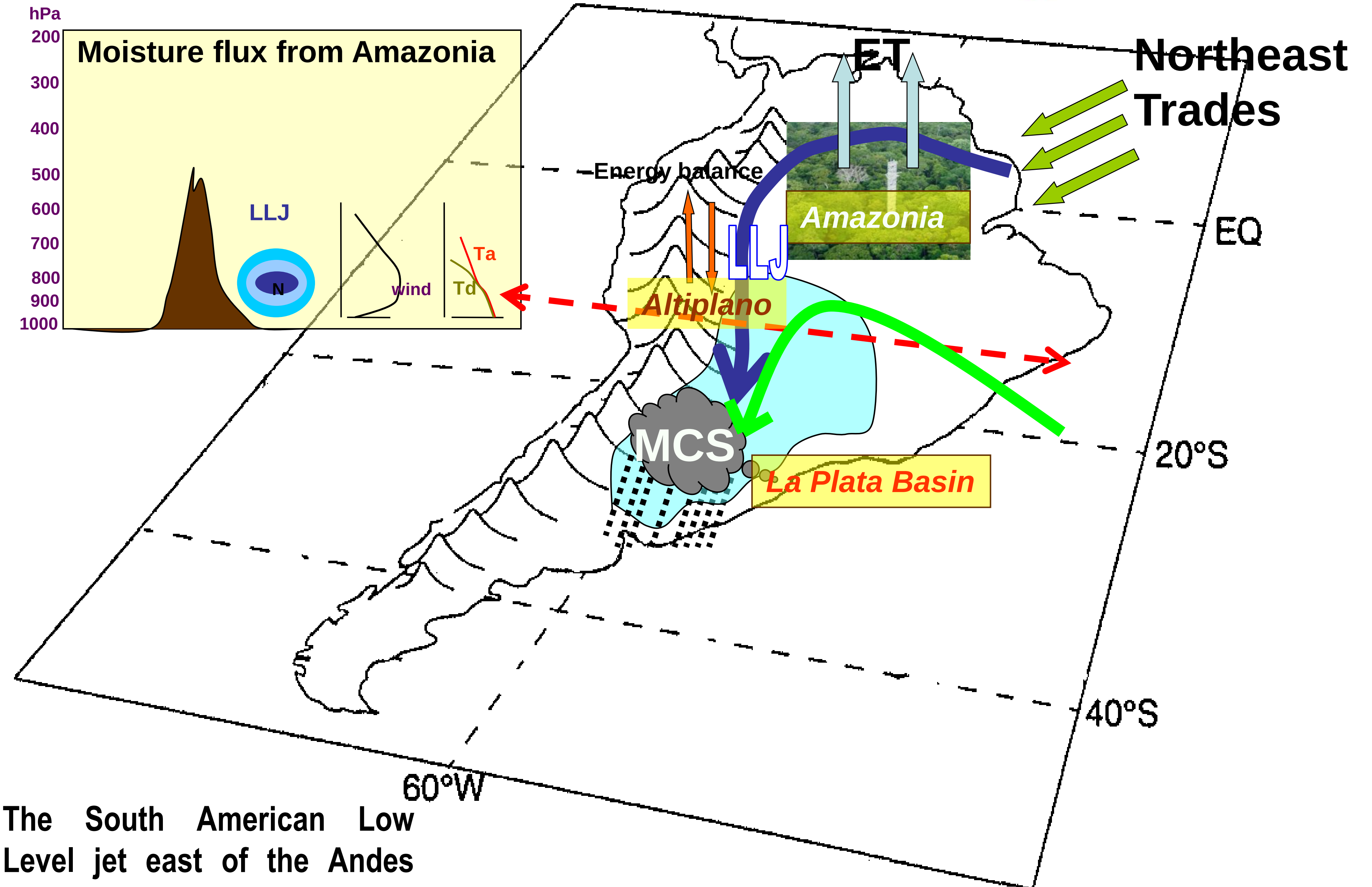
b) Demise SAMS



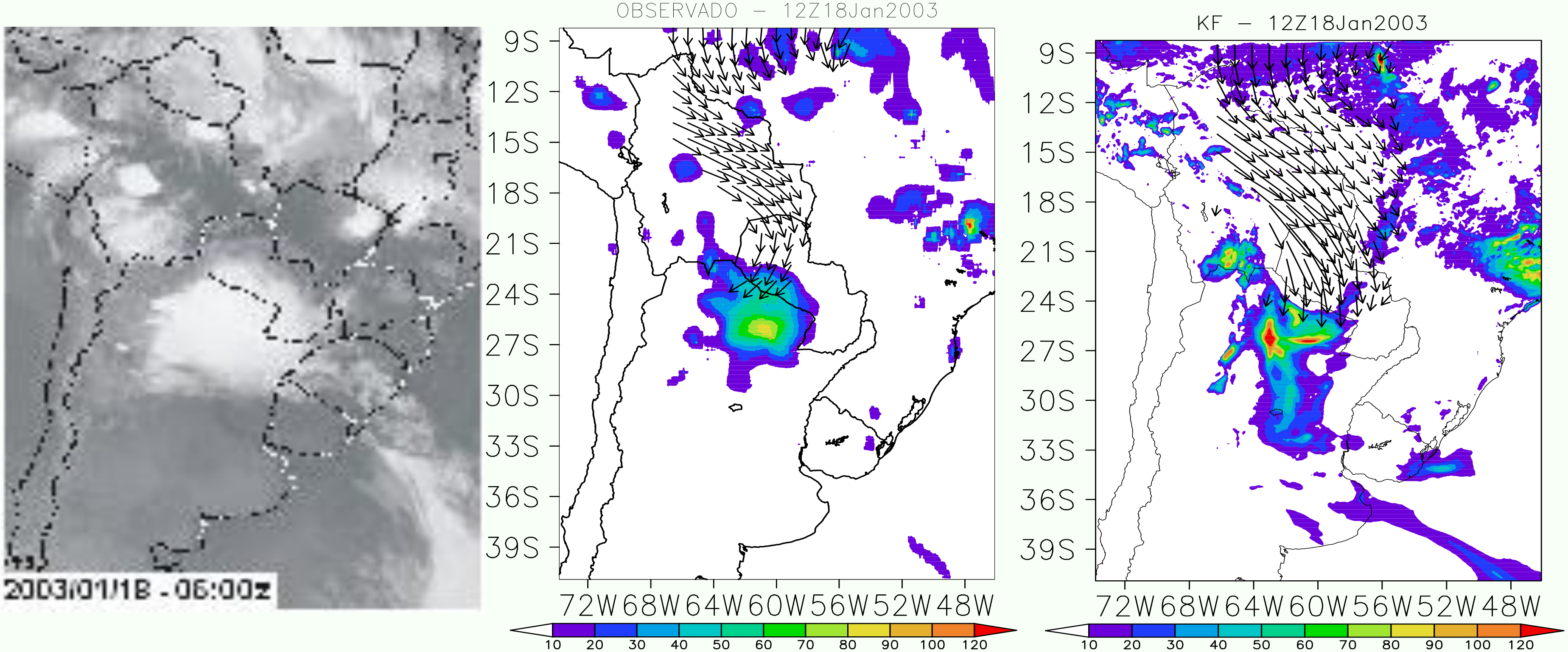
Source: E. Silva, Carvalho



Typical circulation features of the SAMS accompanying wet and dry conditions over Southeastern South America and interaction between SACZ and the SALLJ-linked to Atlantic Ocean variability (Diaz and Aceituno 2003)



The South American Low Level jet east of the Andes (Marengo et al 2004)

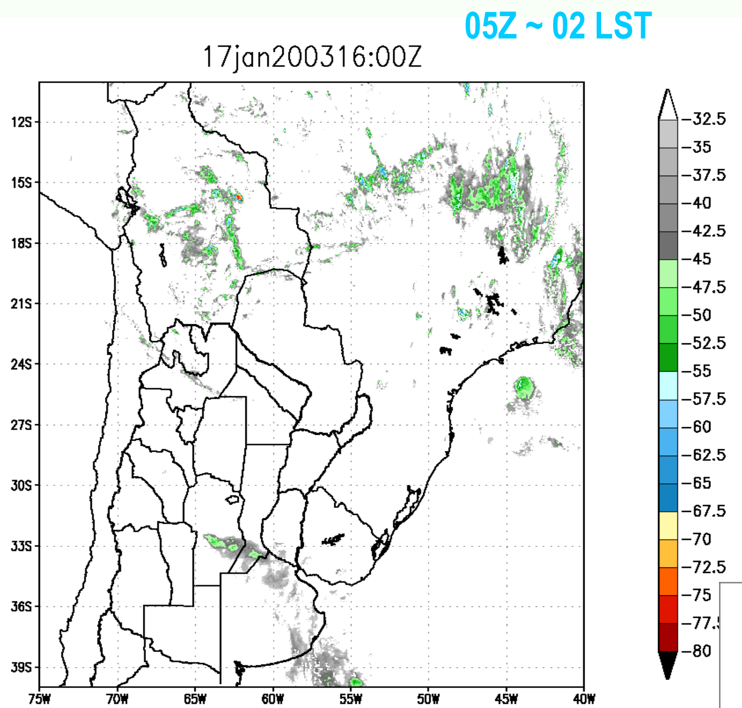


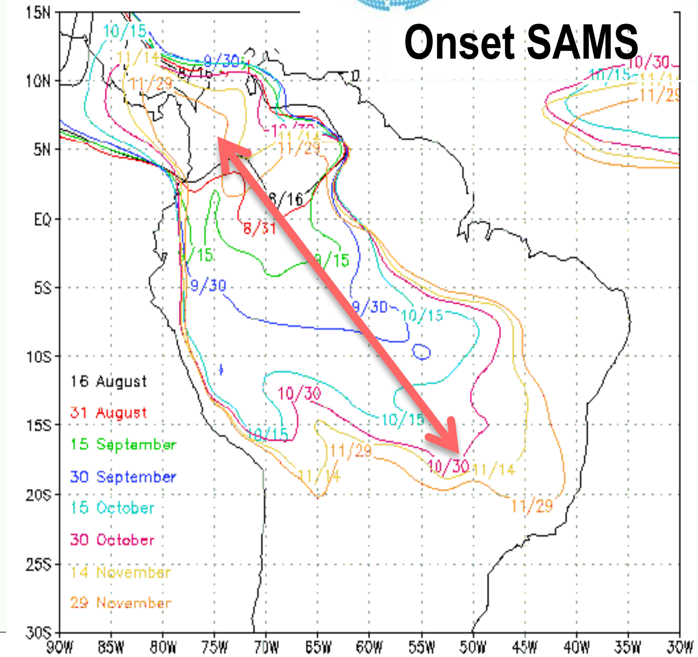
(a) (b) (c)

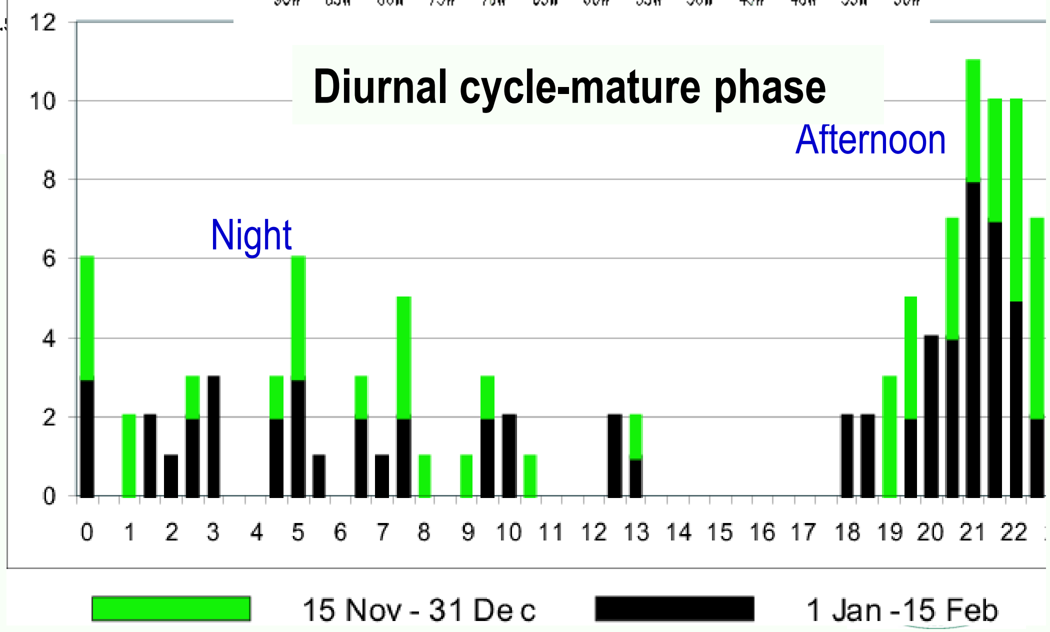
The MCS on 18 Jan 2003, which occurred during SALLJEX, was well simulated by the Eta model with KF convection scheme. (a) Infrared satellite image; (b) observed precipitation and reanalyses 850 hPa wind vector; and (c) simulated precipitation and wind vector from Eta regional model at 10 km resolution. (Rozante and Cavalcanti 2008).

Mesoscale Variability

MCS event on 17 January 2003





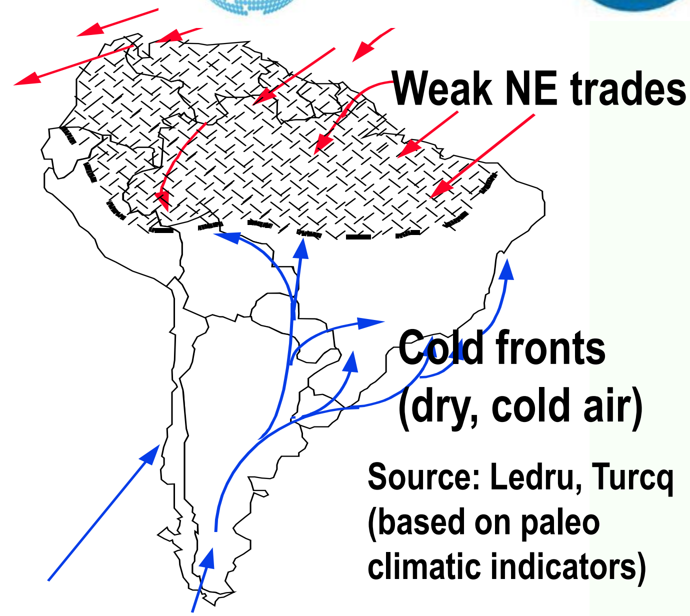


MCS mature stage time occurrence frequency during SALLJEX. Bars in green represent the period November 15 to December 31, in black January 1 to February 15 (Zipser et al. 2004)

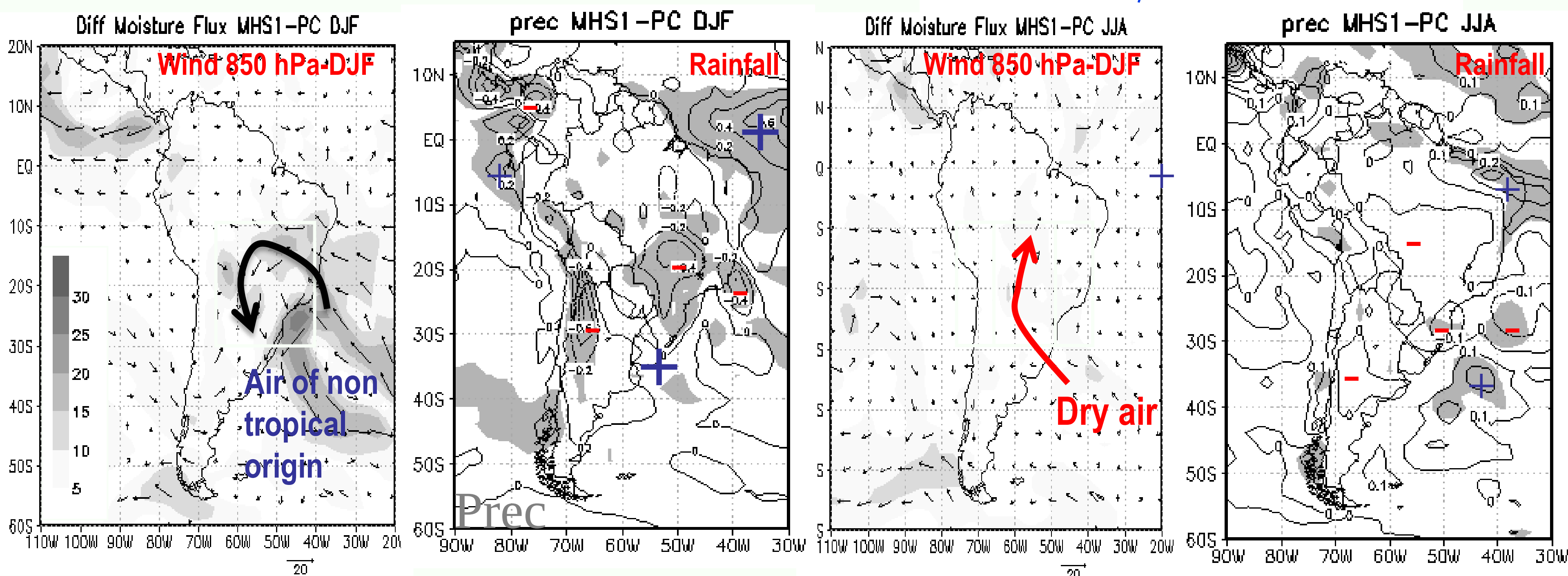
SAMS during the Medium Holocene 8000 BP (Melo and Marengo 2008)

Some important changes were detected during the MH:

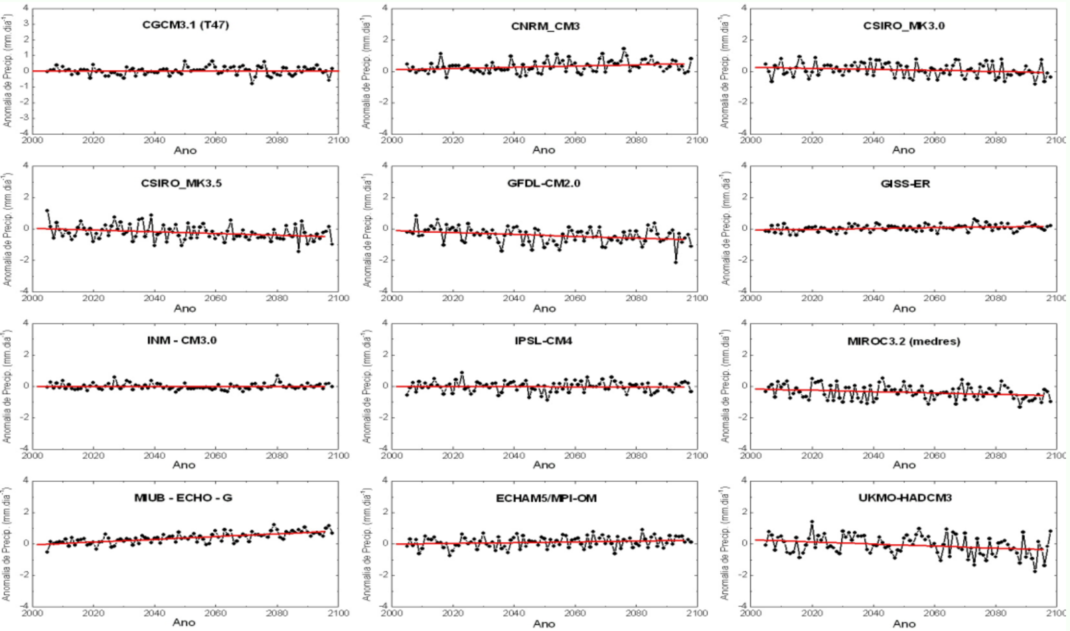
- Possible weakinging of the SAMS
- Increase of the intensity of the circulation of the South Atlantic subtropical high;
- Intensification of the of the northerly flow east of Andes south of 20 S;
- Decreasing in the moisture transport from the Amazon basin to central and south-southeastern Brazil, which can influence the formation and intensity of the South Atlantic Convergence Zone SACZ;



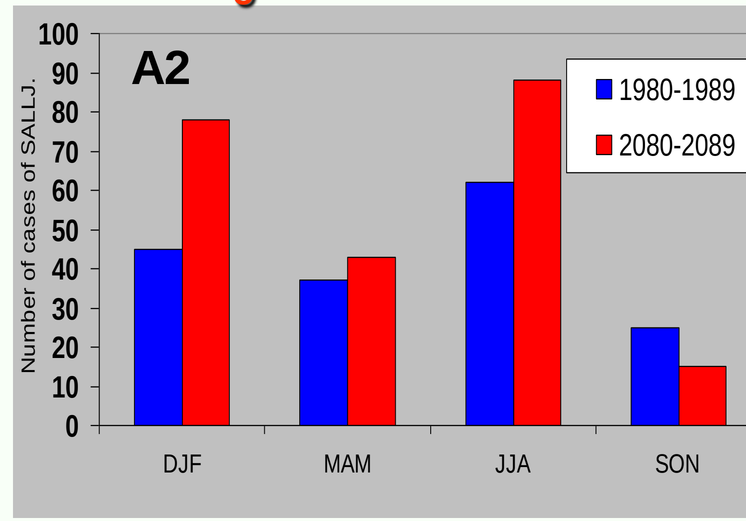
Source: Ledru, Turcq (based on paleo climatic indicators)



Rainfall projectioins in SAMS until 2100, scenario A1B (12 IPCC AR4 models)



SALLJ changes

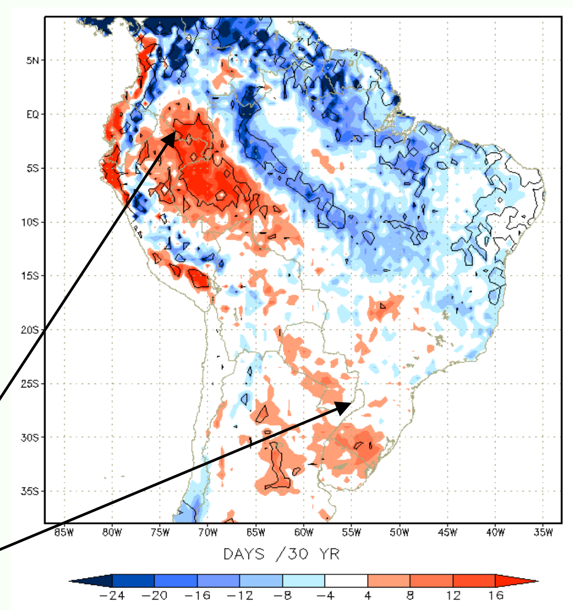


A2 Scenario→R10 HadRM3P index→[(2071-2100)-(1961-90)]

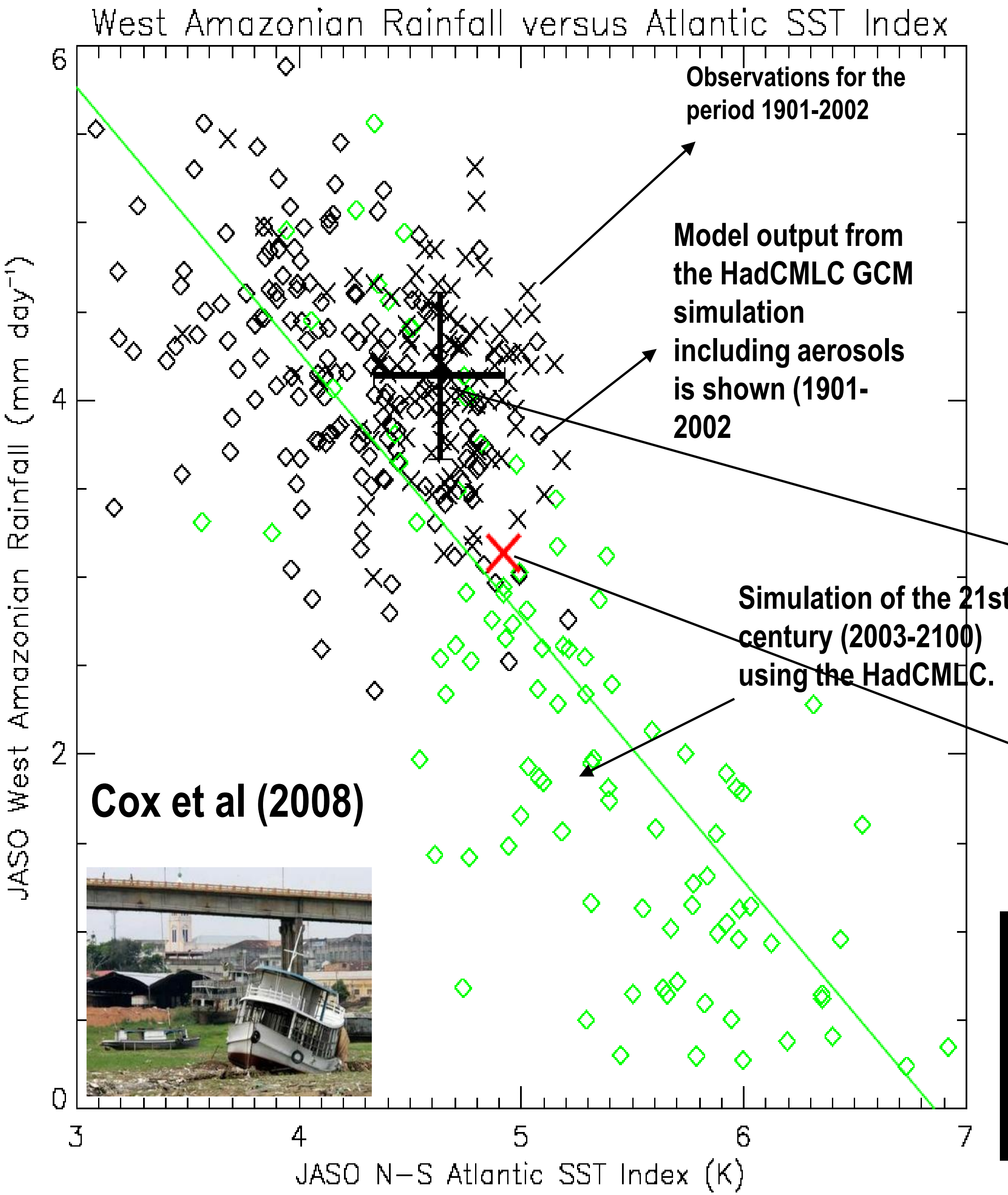
-No clear tendency of rainfall for the future in SAMS

-More LLJ events in the warmer climates (A2 scenario) as compared to the present, especially during summer DJF. Wind may be more intense and moisture transport can be more intense, and this would imply more frequent intense rainfall events in Southeastern South America

Soares and Marengo (2008), Marengo et al (2009)



Projected Increase in frequency of intensity of extreme rainfall events until 2100 (R10 index)-HadRM3P A2



Drought of Southern Amazonia 2005:

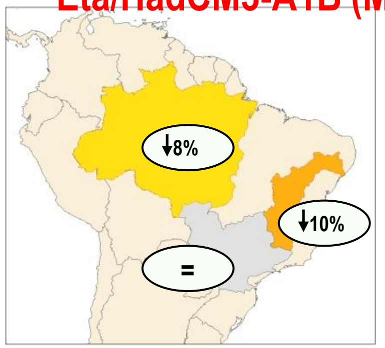
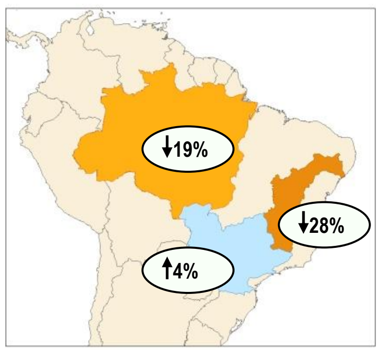
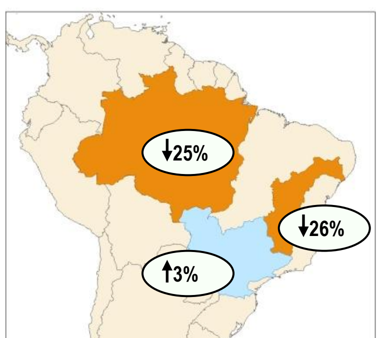
Relationship between July-October anomalies in rainfall in Western Amazonia and in the Index of the north-south SST gradient across the tropical Atlantic ocean (Cox et al. 2007)

Mean and STDV of the observation,

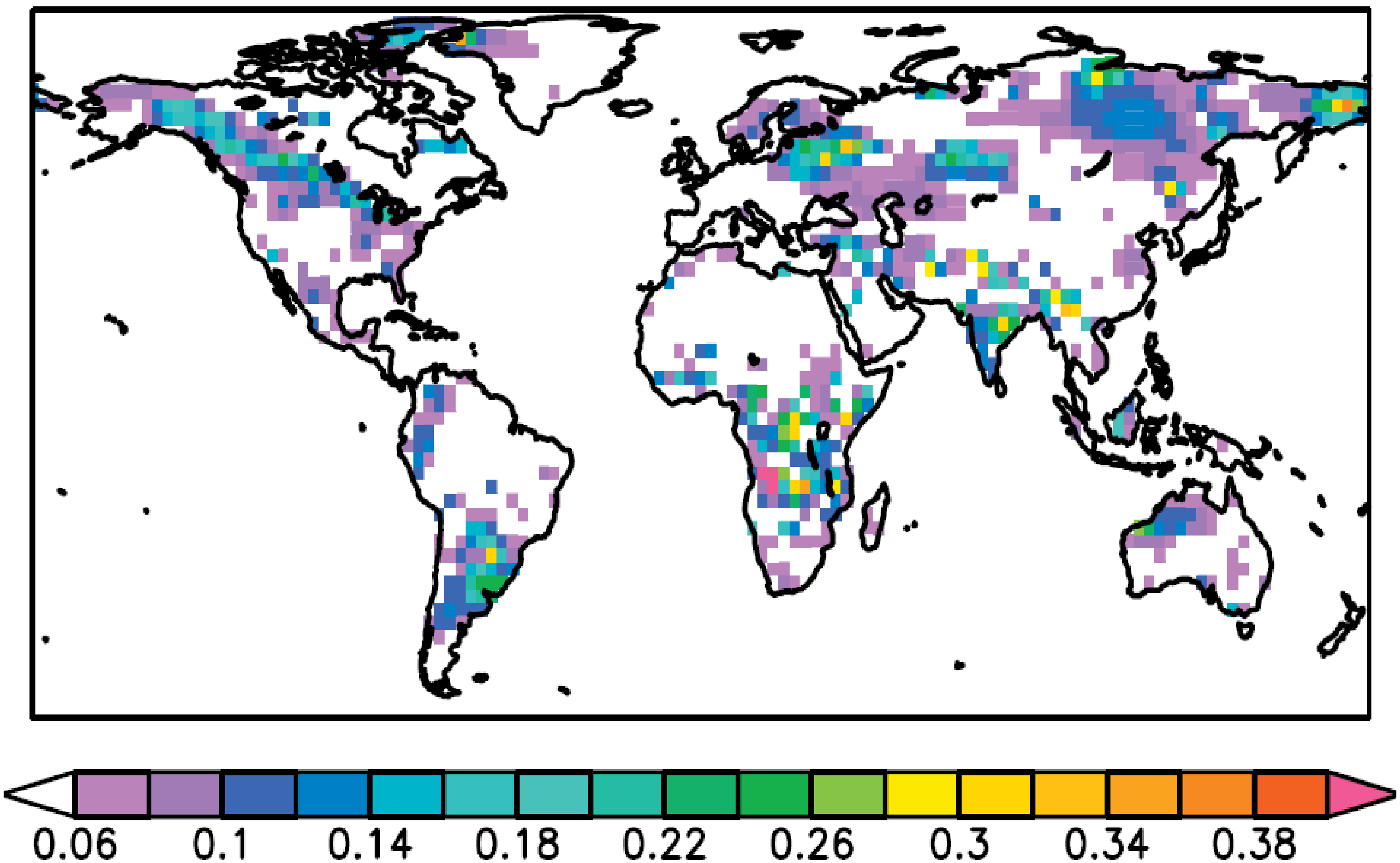
Mean and STDV estimated values for the 2005 Amazon drought

A 2005 drought caused widespread devastation across the Amazon basin. Cox et al. (2008) estimates that by 2025 a drought on this scale could happen every other year and by 2060 a drought could occur in nine out of every ten years.

Eta/HadCM3-A1B (Marengo et al 2010)

Decade (30-year mean centred on)	% change in summer (DJF) rainfall relative to 1961-90 mean	Change in annual mean temperature in the basins and Brazil	Change in annual mean temperature: Global	Atmospheric CO2 concentrations
2020s		AMZ:+2.0 C SF: +1.9 C PAR: +1.8 C +1.7 C	+1.3 C	418 ppm
2050s		AMZ:+3.6 C SF: +3.2 C PAR: +3.8 C +3.0 C	+2.5 C	523 ppm
2080s		AMZ:+4.9 C SF: +4.1 C PAR: +4.1 C +4.2 C	+3.3 C	638 ppm

Ratio of the magnitude of the near surface temperature response to land cover change over the magnitude of the response to GHGs concentrations increase, for the B2 scenarios (Voldoire 2006)→ key importance of land surface changes, perhaps more important than the increase in the GHG concentration



Research gaps and needs:

-Observational gaps (continuous monitoring and field experiments)
-Diurnal cycle and seasonal evolution of the SAMS
-3-dimensional description of the low-circulation east of the Andes.
-Mesoscale convective processes and formation of MCS
-Role of aerosols from biomass burning in SAMS varability and functioning
-Dynamics of the SA see-saw pattern (SALLJ-SACZ)
-ITCZ-SACZ interaction
-Influence of MJO on SAMS
-Relative roles of internal vs forced low-frequency variability
-Land surface forcing – Impacts of land use and land use change
-Role of remote and local SST – South Atlantic
-Global response to SAMS forcing
-Onset and demise of the rainy season in SAMS (variability in various time scales)
-Sources and limits of predictability on SAMS region
-Interdecadal variability and Anthropogenic Climate Change
-Extremes: drought and floods l(seasonal) and short term
-Hydrological models and water resources management
-Climate change projections: uncertainties and limitations
-Paleo monsoons (modeling and reconstructions with PAGES)