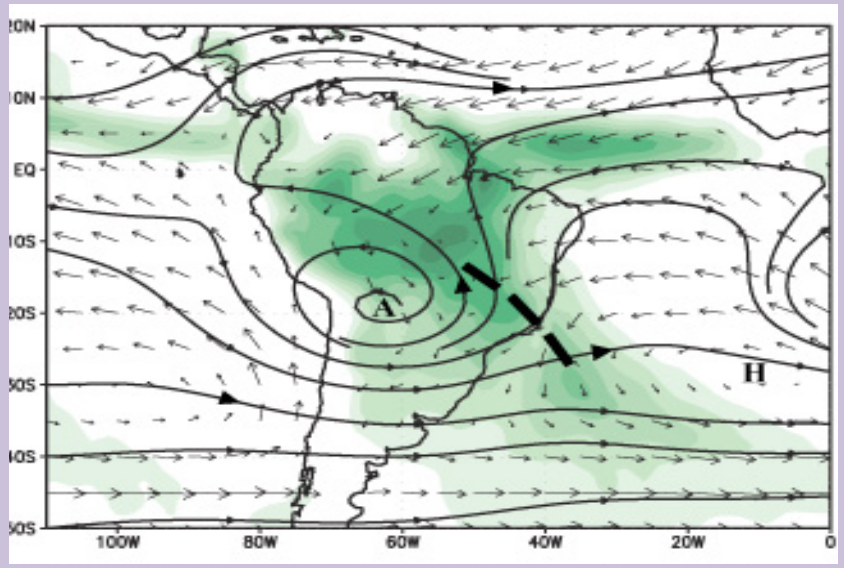
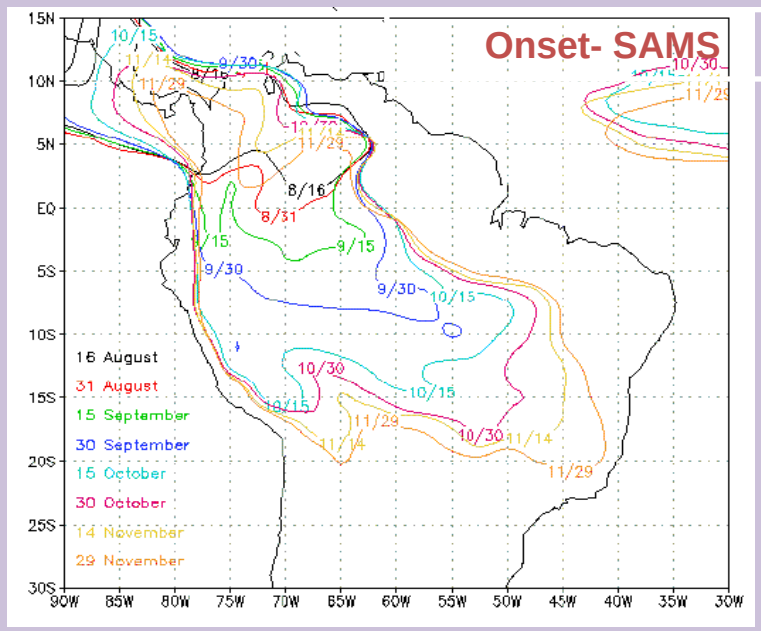
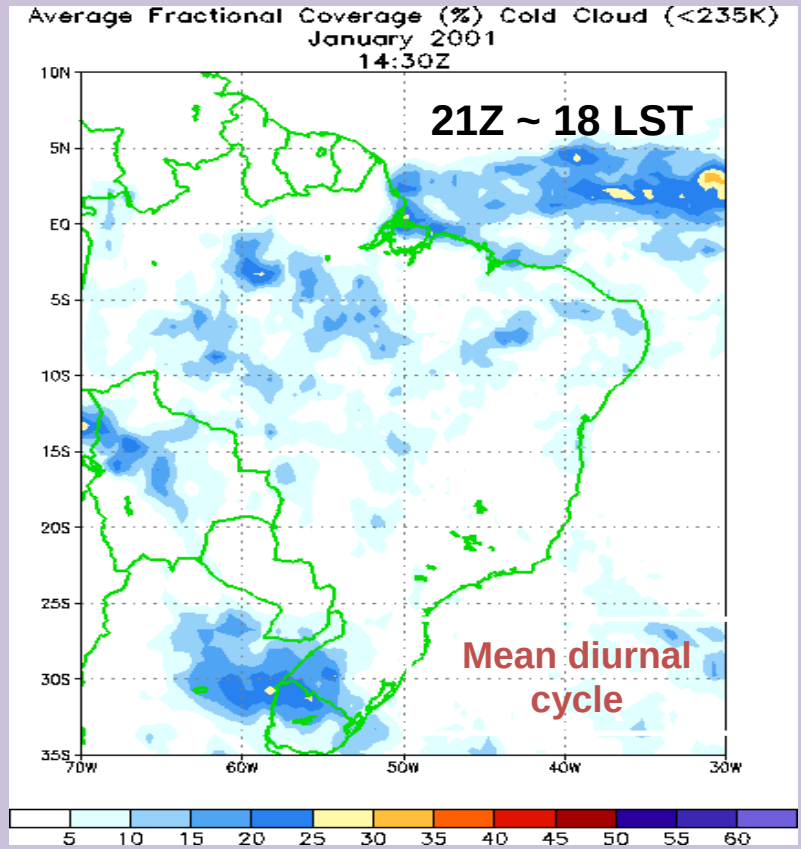
Monsoon Experiment in South America (MESA)
Chair: J. Marengo



HYPOTHESIS:
The SAMS provides a physical basis for determining the degree of predictability on short- and long timescales over the region.





MONSOON EXPERIMENT SOUTH AMERICA (MESA)

MESA PRIORITY RESEARCH AREAS (PRA):

Better understanding and simulation of:

- diurnal and mesoscale processes (PRA-I);
- intraseasonal variability (PRA-II)
- interannual and longer time variability (including ACC) (PRA-III)
- monsoon evolution and variability (PRAs-I, II, III).

YEAR (2001+)	01	02	03	04	05	06	07	08	09	10	11….
SALLJEX Planning	…-------|										
SALLJEX Preparations		----------|									
SALLJEX Data Collection			----------|								
SALLJEX Post-field activities				----------|						
Planning of ANDEX								----------			
Further studies using SALLJEX data								----------			
MESA and extremes								----------			
MESA and ACC								----------			
MESA and Paleomonsoons								----------			
MESA Principal Research	… ----------										
MESA Data Management			----------								

MESA GOALS

The Monsoon Experiment in South America (MESA) an internationally coordinated joint CLIVAR-GEWEX program aimed at providing:

-a better understanding of the South American monsoon system and its variability,

-a better understanding of the role of that system in the global water cycle

-improved observational data sets, and

-improved simulation and prediction (and climate change projections) of the monsoon and regional water resources.

MESA OBJECTIVES

MESA is directed towards a better understanding and improved simulation of:

-Diurnal cycle and seasonal evolution of the SAMS
-3-dimensional description of the low-circulation east of the Andes.
-Mesoscale convective processes
-Role of aerosols from biomass burning in SAMS
-Dynamics of the SA see-saw pattern
-ITCZ-SACZ interaction
-Influence of MJO on SAMS
-Relative roles of internal vs forced low-frequency variability
-Land surface forcing – Impacts of land use change
-Role of remote and local SST – South Atlantic
-Global response to SAMS forcing
-Sources and limits of predictability on SAMS region
-Interdecadal variability and Anthropogenic Climate Change (ACC)
-Extremes: drought and floods
-Paleo monsoons (with PAGES)

MESA deliverables

Deliverables:

- More comprehensive understanding of South American climate variability and predictability;
- Strengthened multinational scientific collaboration across SAMS
- Observing system design for monitoring and predicting the SAMS
- Measurably improved climate models that predict SAMS (including extremes)
- Climate change issues and impacts in society. Applications for agriculture, human health and hydroelectricity generation.
- Past climate change in the SAMS

MESA Milestones 2009-2010

- FY09 –Assessment of extreme event frequency changes in the regional climate change scenarios for South America (from IPCC) and their impact on agricultural activities, development of MESA Climate Indices, MESA Science and Implementation Plan finished. Integration with Pan WCRP monsoon initiative. Collaboration with national and international climate change programs (INCT-Climate Change, RedeClima, FAPESP projects)

- FY09-10 –Paleo-monsoon studies and planning of activities together with PAGES.

- FY10 - Evaluate the impact of soil moisture and land use changes in simulations and predictions/GHG concentration changes

- FY10 – Hydrological studies in SAMS, seasonal climate predictions and climate change.Preparation for ANDEX

  - …Ultimate goal: Integrated view of the American Monsoon Systems, related interhemispheric connection, monsoon predictability and prediction

MESA Activities in the context of CLIVAR "Imperatives"

-Anthropogenic Climate Change (IPPCC AR4, downscaling)

- Natural variability versus forced change
  - Climate sensitivity and feedbacks
  - Regional phenomena
  - Extremes

- Decadal Variability, Predictability and Prediction (need development)
  - Determine predictability
  - Mechanisms of variability
  - Role of the oceans (impact of ocean variations on land T, P, etc.)
  - Adequacy of observing system
  - Initialization
  - Prediction uncertainty
  - Drought

- Intraseasonal and Seasonal Predictability and Prediction (need development)
  - Monsoons (and ENSO, TAV, …)
  - MJO/ISV
  - Prediction uncertainty

MESA Activities

-Improved atmosphere and ocean component models

- Analysis and Evaluation
- Process studies

– Data Synthesis, Analysis, Reanalysis and Uncertainty

- Ocean
- Coupled data assimilation systems

– Ocean observing system (emphasis on E. Pacific and SW. Atlantic)

- Advocacy for sustained observations
- Development, implementation and system design

– Capacity Building (IAI, INPE, CLARIS-LPB.....)

- Topical workshops
- Summer schools for students and young scientists
- Expert Training

MONSOON EXPERIMENT IN SOUTH AMERICA (MESA)
SCIENCE AND IMPLEMENTATION PLAN
(being updates May 2009)

Executive Summary
Part 1: MESA Scientific Objectives
Part 2: Scientific Rationale
Part 3: The MESA Program
- 3.1 PRAs Framework
  - 3.1.1 SAMS Life cycle
  - 3.1.2 Diurnal and mesoscale variability
  - 3.1.3 Intraseasonal variability
  - 3.1.4 Interannual and interdecadal variability
  - 3.1.5 Long-term climate variability and Climate Change
- 3.2 MESA Modeling and Data Assimilation
- 3.3 MESA and the South Atlantic
- 3.4 Unified View of the American Monsoon Systems
- 3.5 Project structure and Timeline

Part 4: MESA Field Component
- 4.1 SALLJEX-Lessons learned
- 4.2 ANDEX-Planning

Part 5: Dataset development and Data management
Part 6: Programmatic Context
- 6.1 The La Plata Basin (LPB) Regional Hydroclimate Project
- 6.2 Project infrastructure
- 6.3 Education and Training
- 6.4 Link with other programs

Connection between Spring Conditions and Peak Summer Monsoon Rainfall in South America

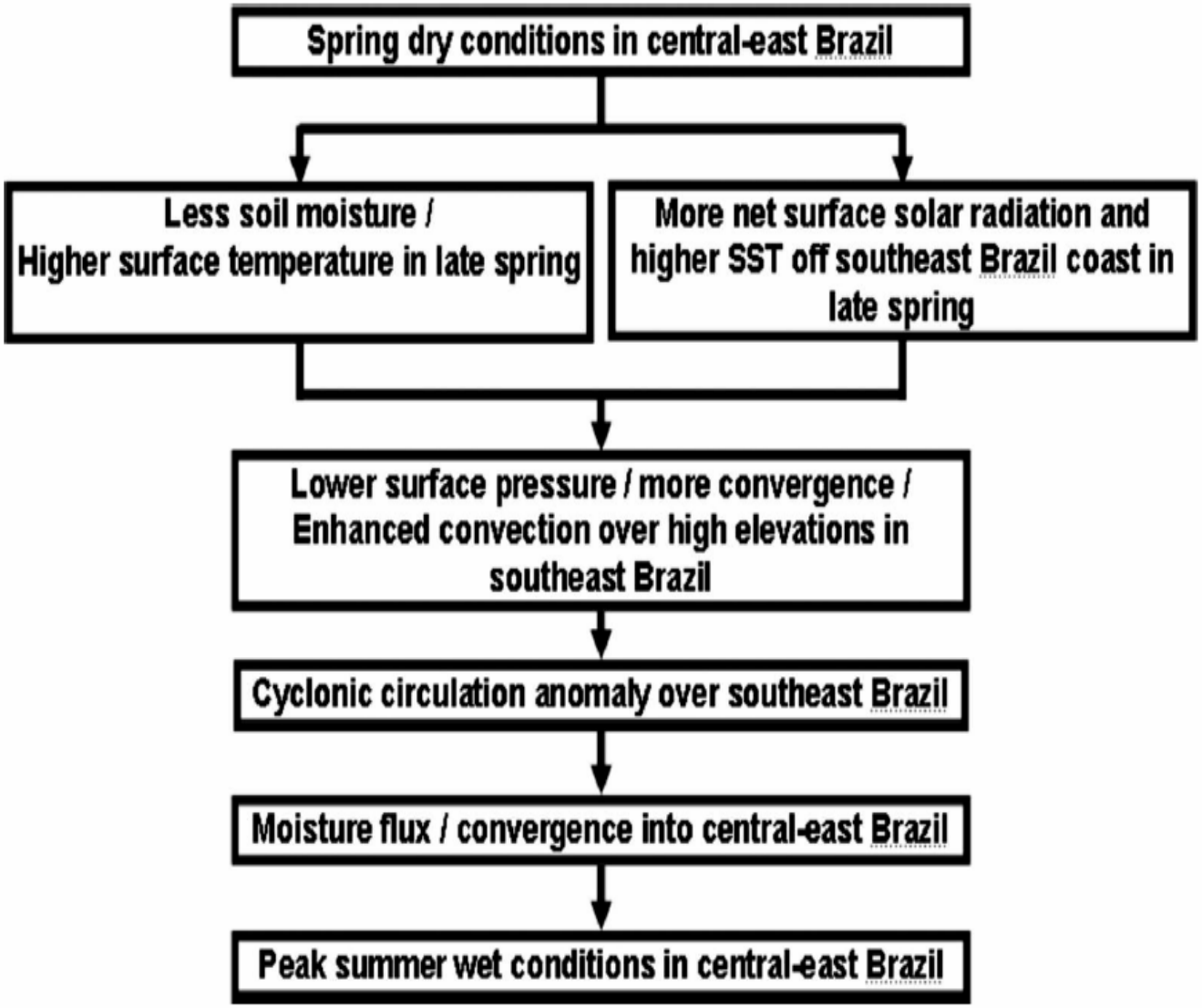
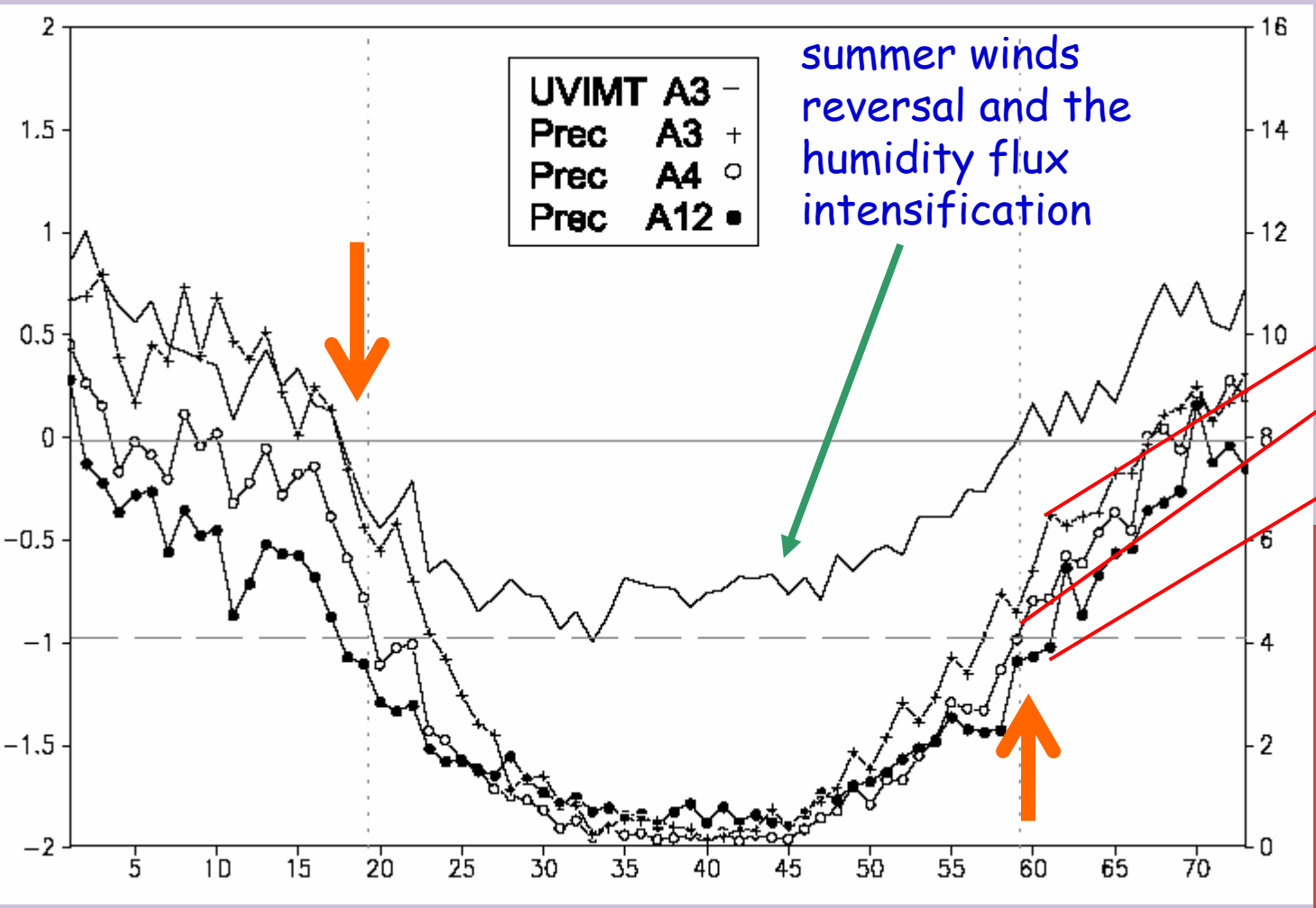
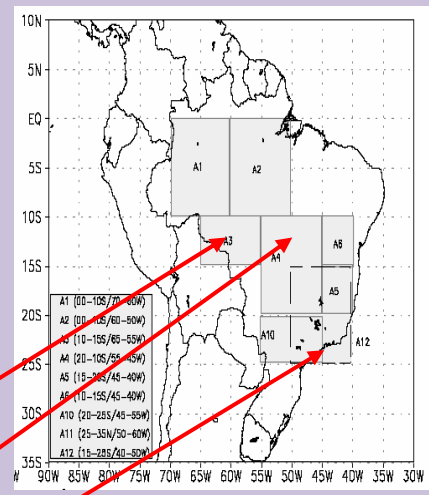


Diagram of the pathway through which spring anomalous dry conditions may lead to subsequent peak summer wet conditions in central-east Brazil (Grimm et al. 2007)

Climatological onset of rainy season in SAMS Area based on integrated moisture transport (A3)





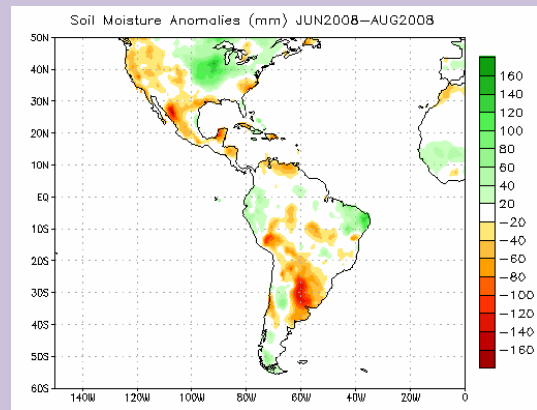
Normalized mean pentads, for the period of 1984 to 2004, of integrated zonal humidity transport from 1000 to 700 hPa and rainfall (Raia and Cavalcanti, 2008?).

Onset of rainy season in SAMS occurs at the end of October (pentad 60: 23rd to 27th) and the demise at the end of March (pentad 18: 27th to 31st).

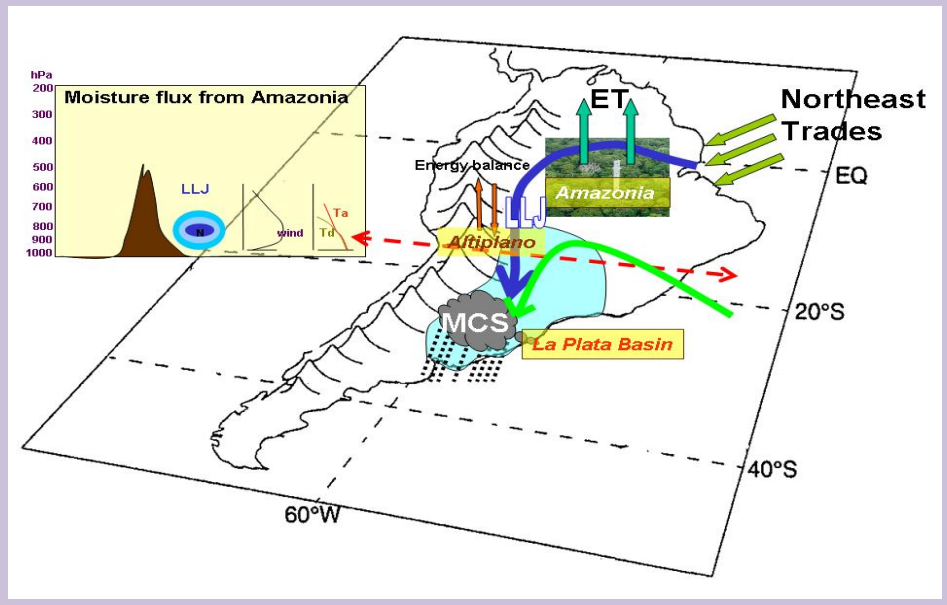
VAMOS Task Force on Extremes

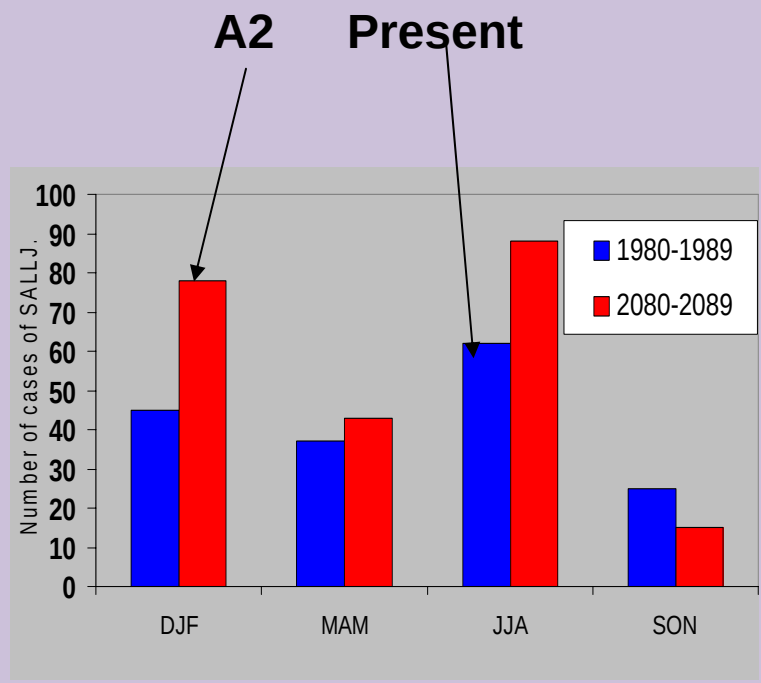
VAMOS is in a unique position to utilize its continental perspective in linking extremes in warm season climate behavior to the circulation structures defined as the monsoon systems.

VAMOS approach constitutes a multi-scale approach to understanding the subtle interplay of processes occurring at different space and time scales within monsoon systems.



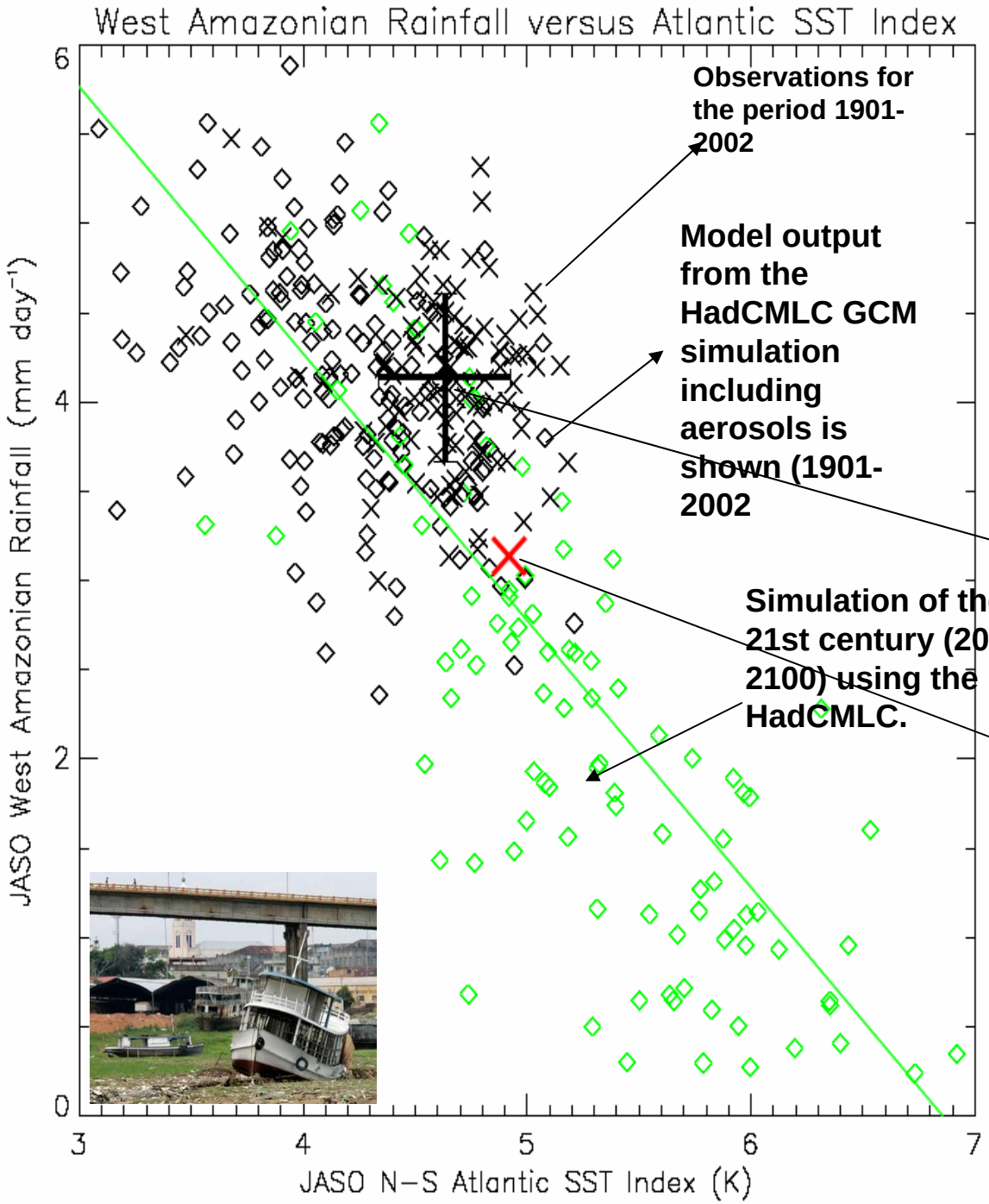
Impacts of climate change in SALLJ





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)



Cox et al (2008)

Drought of Amazonia 2005:

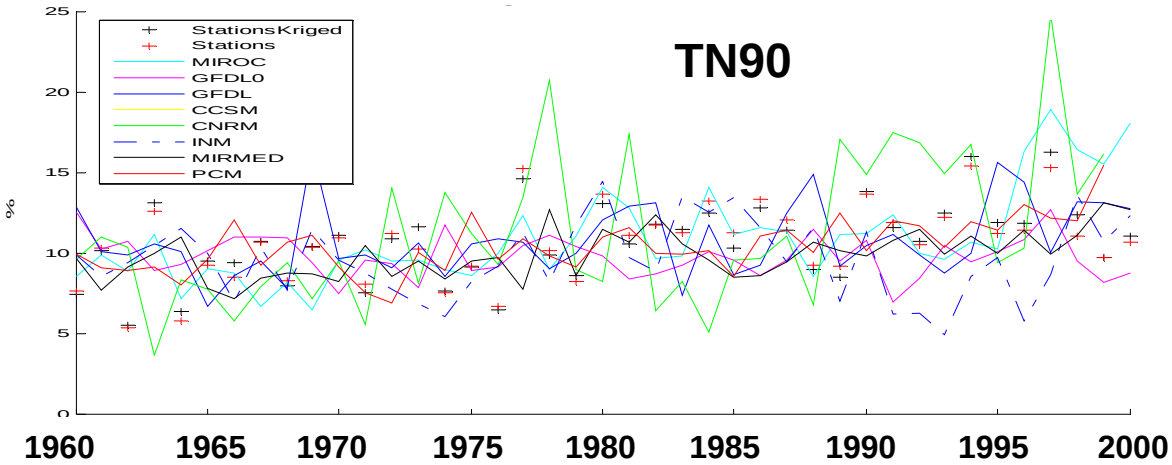
Relationship between July-October anomalies in rainfall in Western Amazonia and in the Index of the north-south SST gradient across the tropical Atlantic ocean (Cox et al. 2007)

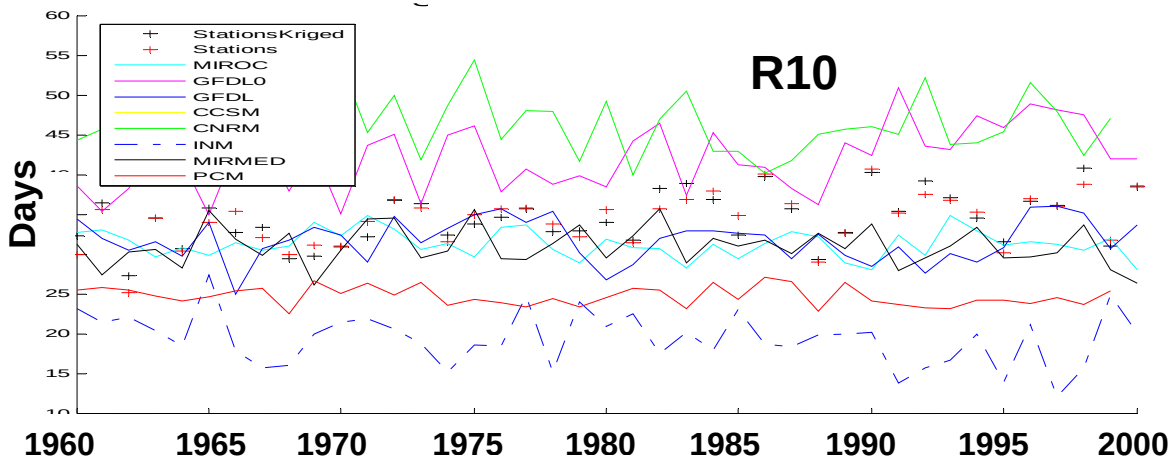
A 2005 drought caused widespread devastation across the Amazon basin. Cox et al. (2008) estimates that by 2025 a drought on this scale could happen every other year and by 2060 a drought could occur in nine out of every ten years.

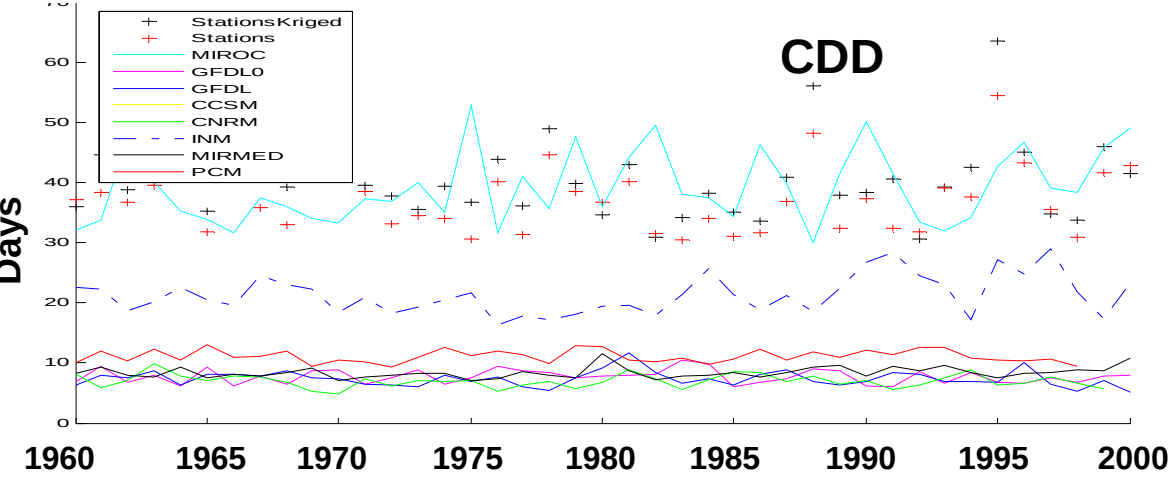
VAMOS ACC working group

The VAMOS Anthropogenic Climate Change (ACC) group seeks to identify relevant scientific issues that need to be better addressed by the VAMOS community in order to make progress on ACC research and impacts in the Americas.

VAMOS approach aims at a better understanding of physical processes (e.g., changes to cloud-radiation feedbacks due to biomass burning; impacts of land cover/land use changes) that complement scenarios of future climate

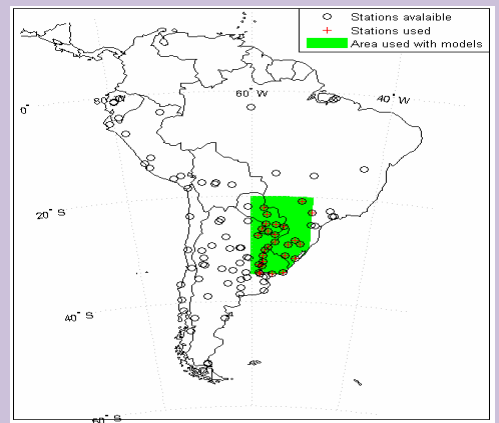






VAMOS and Extremes Observed and simulated trends of warm nights, intense rainfall and dry spells in the LPB region: CLARIS and CLARIS-LPB

Times series of observed and simulated TN90 (warm nights), R10 (intense rainfall events) and CDD (consecutive dry days) indices during 1960-2000 in the LA Plata Bain region of southeastern South America.

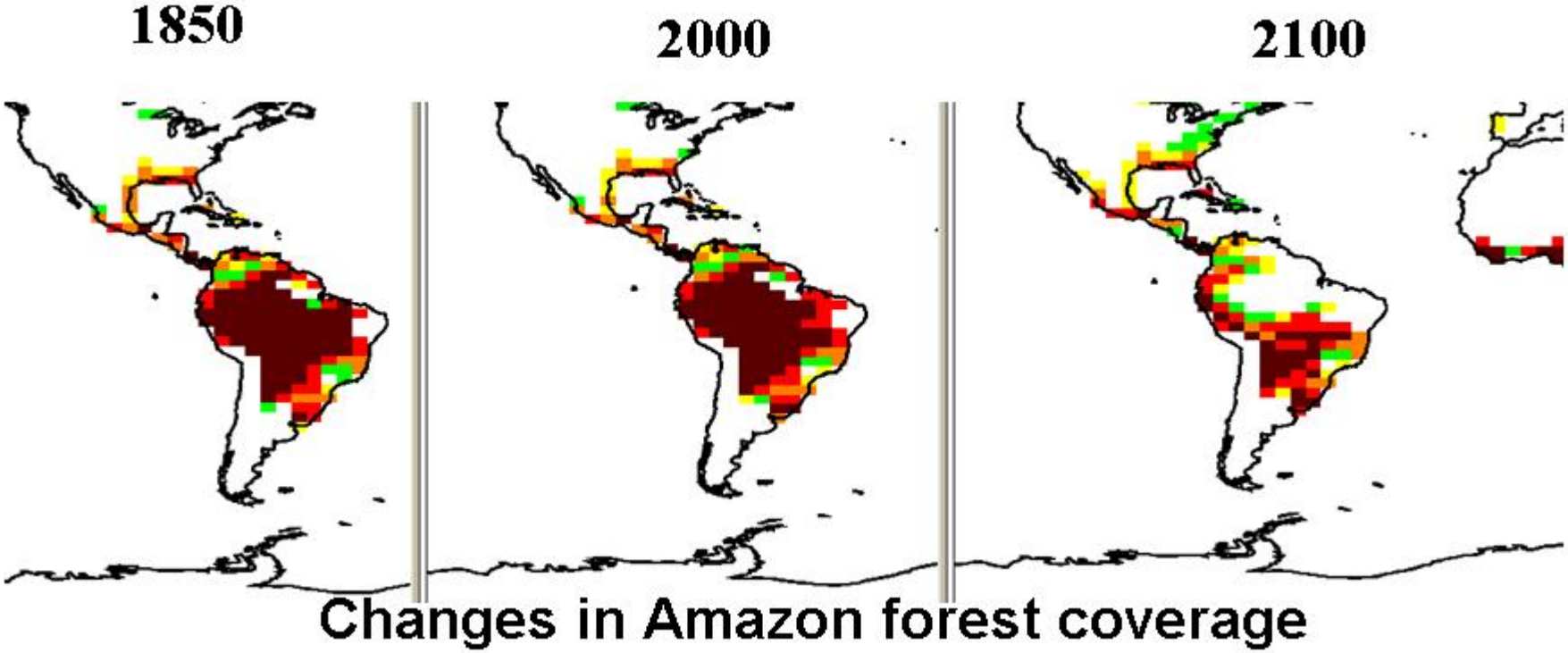


A Review of Amazon dieback: simulations and new studies

- In a complex system, **"tipping point"** represents a level, and if as a consequence of an imposed forcing this level is overpassed, the system may suffer an abrupt change.

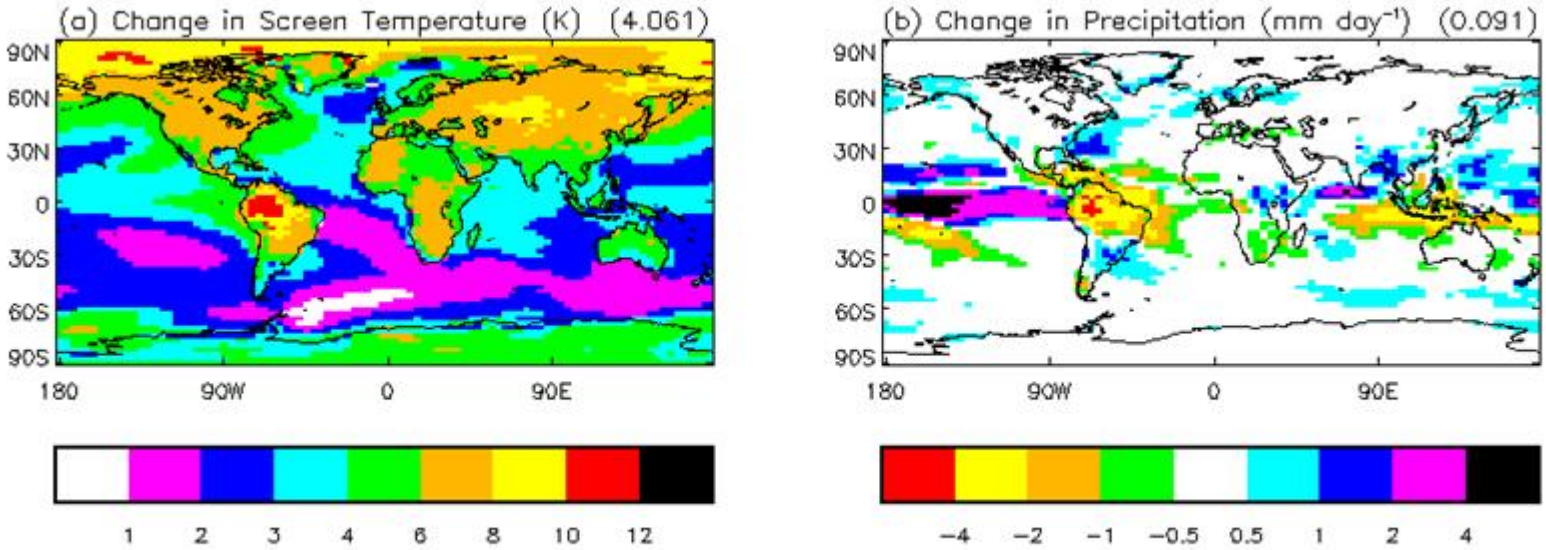
- In the case of the Amazon forest, if warming due to increase in concentrations og GHG (either natural or anthropogenic) is above 3.5 a 4 C, there is a risk of surpassing a "tipping point" leading to savannization.

- A recent study by Sampaio et al. (2008) identified another "tipping point", when the deforested area reached 40-50% level, leading also to savannization



Changes in Amazon forest coverage

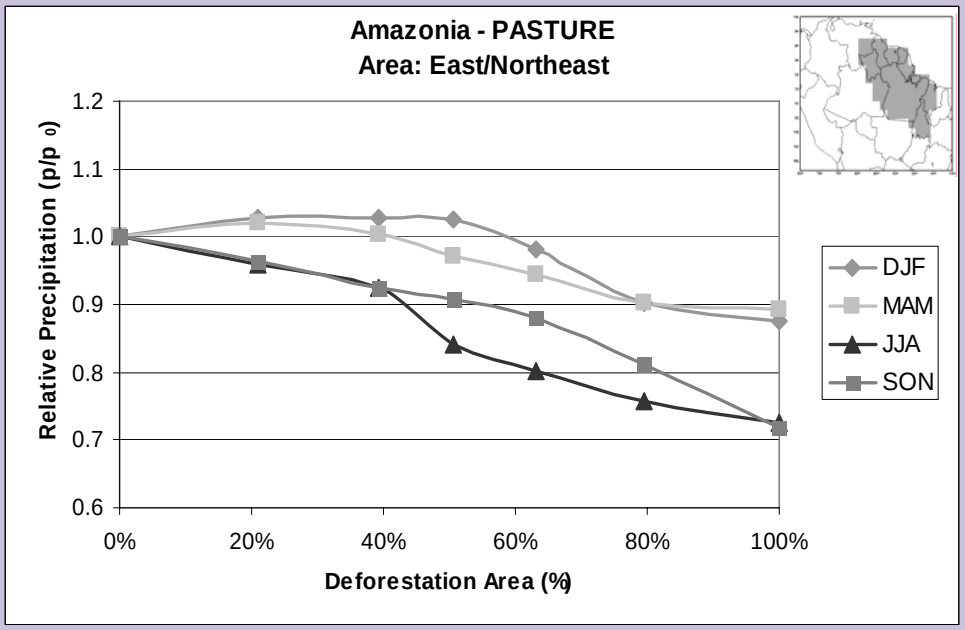
Sources: P. Cox, R. Betts



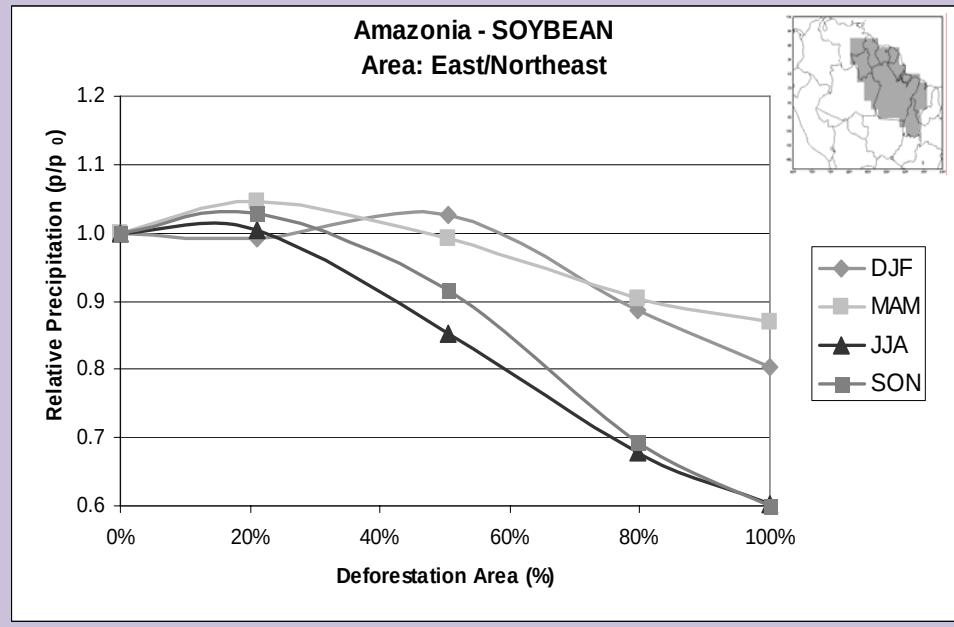
Interative CO_2 and dynamic vegetation 2090s - 1990s

Precipitation

PASTURE



SOYBEAN



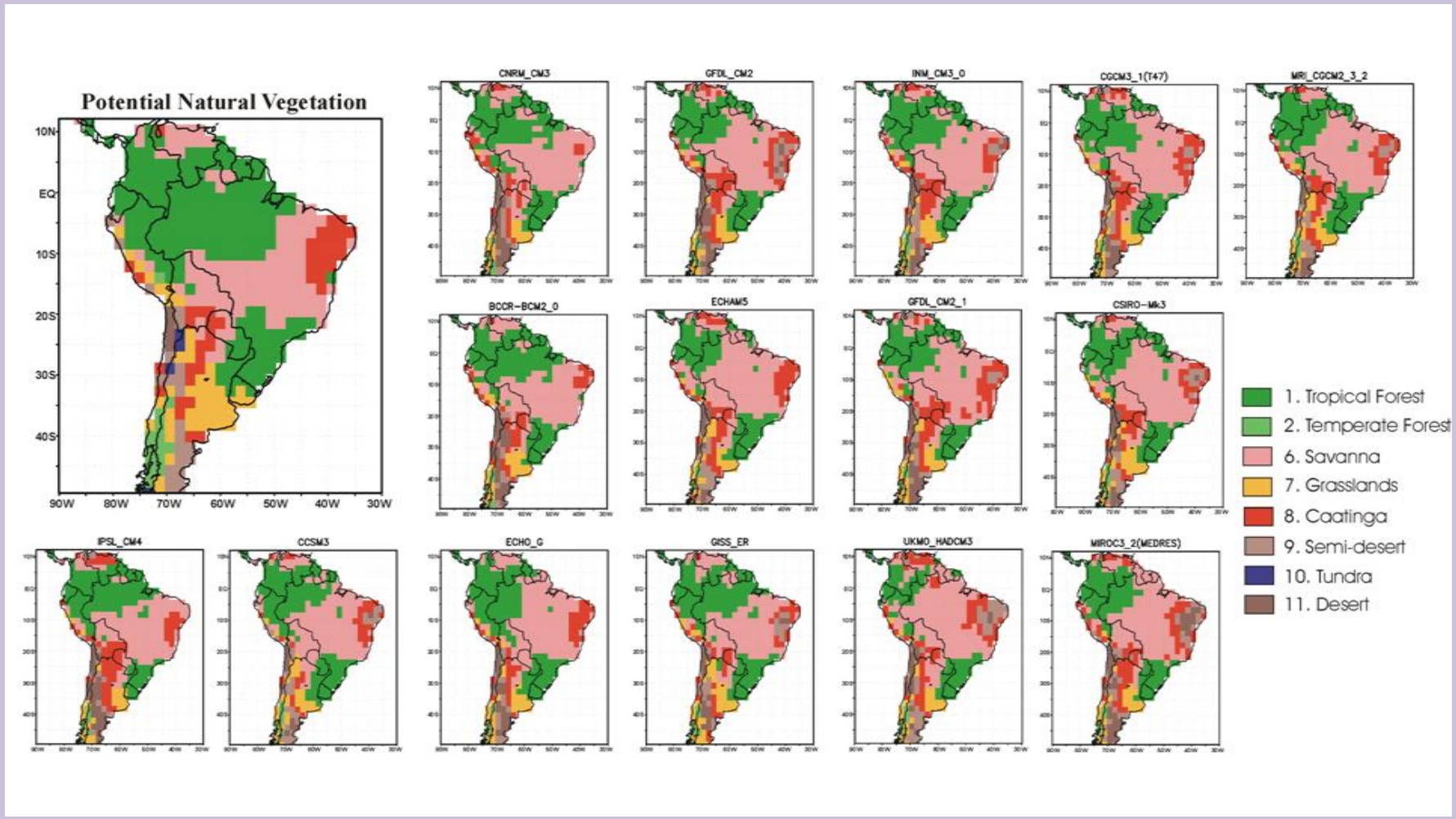
Precipitation Anomaly (%)

Season	All Pasture	All Soybean
JJA	**-27.5%**	**-39.8%**
SON	**-28.1%**	**-39.9%**

The reduction in precipitation is larger during the **dry season**, and is more evident when the deforested area is larger than 40% !

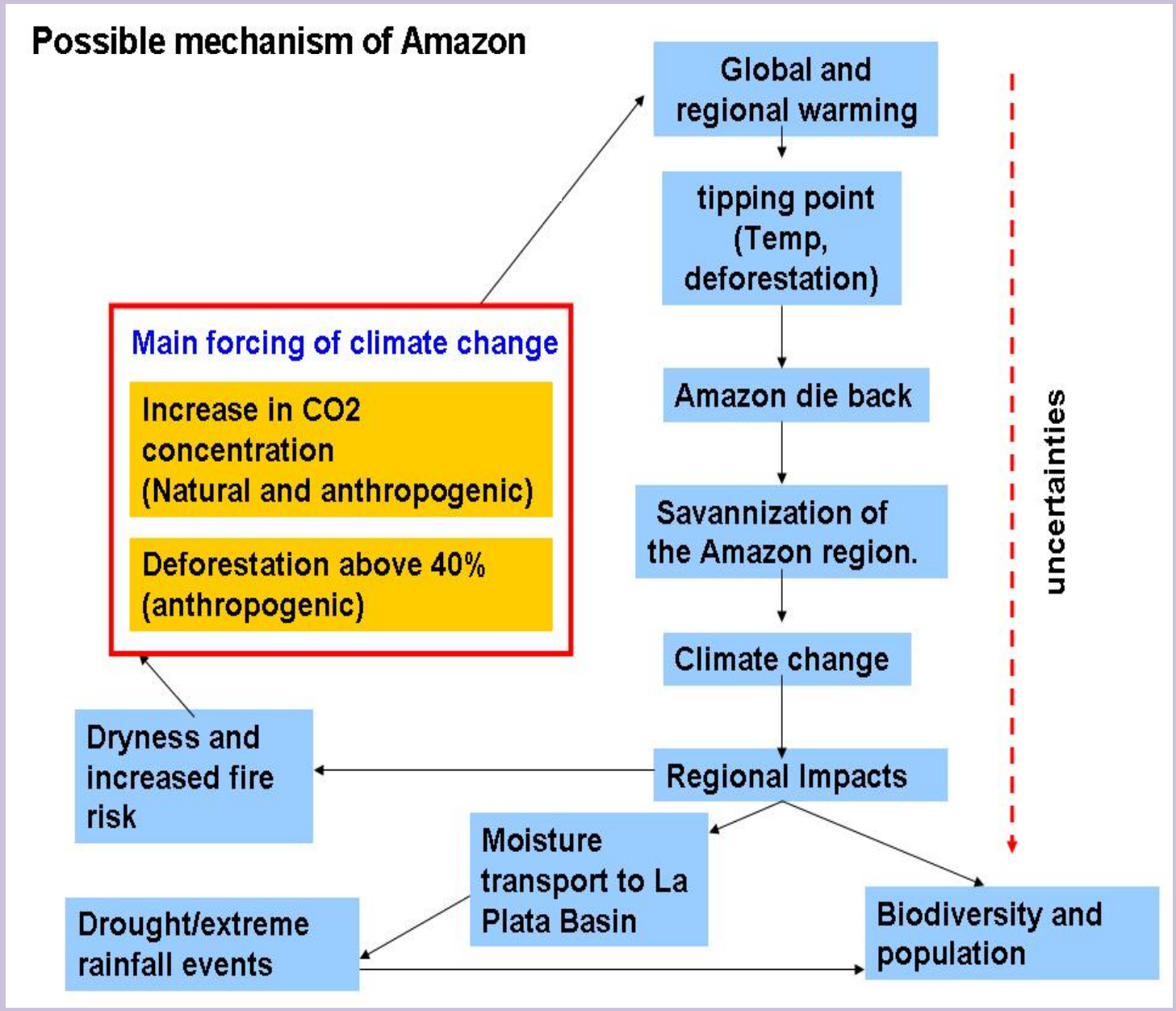
Sampaio et al., 2007

VAMOS and Anthropogenic Climate Change
Future projections of potential vegetation changes in IPCC AR4 models



Projected distribution of natural biomes in South America for 2090–2099 from 15 IPCC AR4 AOGCMs for the A2 emissions scenarios. The top left plot represents the current potential biomes (they represent the potential biomes, but not the actual vegetation distribution, which is a result of historical land use and land cover change.

VAMOS and Anthropogenic Climate Change
Possible mechanism of Amazon die back and savannization of Amazonia



Simplified mechanism of the Amazon die back and possible impacts on regional climate

MESA 2009 ACTIVITIES

Field Programs and Datasets

- SALLJEX Data Base updated.
- SALLJEX Value Added Products (NCEP/NCAR reanalysis and CPTEC analyses enhanced with SALLJEX data)
- Improving Climate monitoring and flux towers (LBA, Pantanal)
- Planning of ANDEX
- Development of climate change scenarios of regional climate and hydrology
- Diagnosis of impact of the land use change in the Basin

Diagnostic, Modeling, data assimilation and Applications Studies

- Synthesis of SALLJEX scientific results
- Diurnal cycle of precipitation
- Nature and predictability of intraseasonal oscillations in eastern South America.
- Improvement in model predictability in SAMS region using simple super-model ensemble
- Seasonal to interannual prediction model assessment in the SAMS region (joint activity with WGSIP)
- Long term and interdecadal variability in the SAMS area
- Assessment of the expected impact of climate change due to anthropogenic activities on the functioning of the SAMS (Diagnostic studies using IPCC-AR4 simulations)