MESA Modeling and Data Assimilation

MESA modeling group:

I. Cavalcanti, A. Seth, C. Saulo, B. Kirtman, V. Misra

MESA modeling objectives

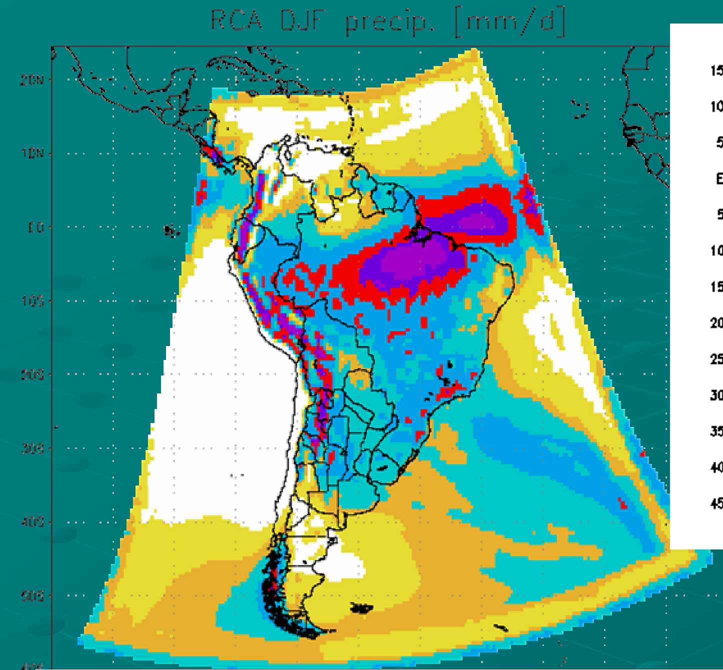
- *Model Assessment*
- *Model Development*
- *Hypothesis Testing*

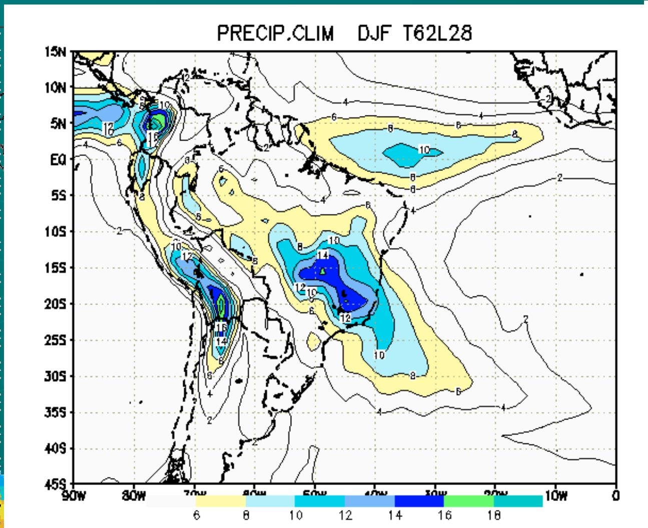
RESULTS OF SOME ACTIVITIES

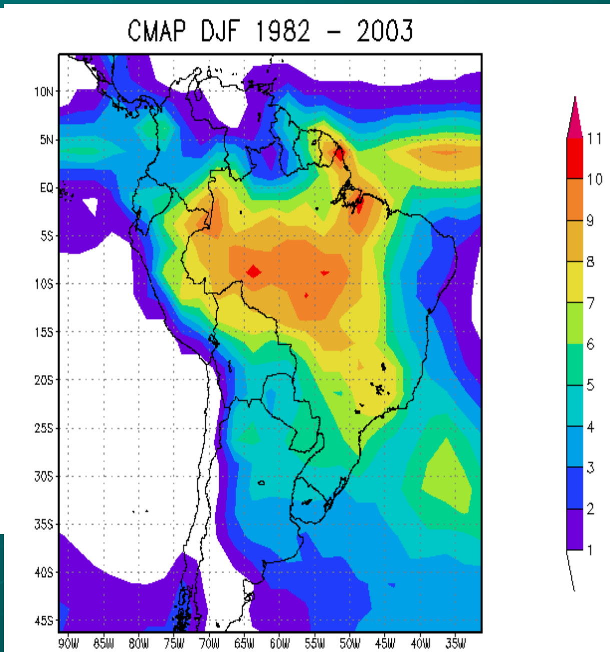
Model assessments

- Verify the ability of models to simulate and predict features of the SAMS
- Identify model deficiencies
  - the diurnal cycle in both regional and global models
  - the annual cycle
  - intra-seasonal variability
  - inter-annual variability
  - decadal variability (IPCC models)
  - 20th century observed climate trends (IPCC models)
  - simulation and predictability during SALLJEX
  - simulation of extremes.

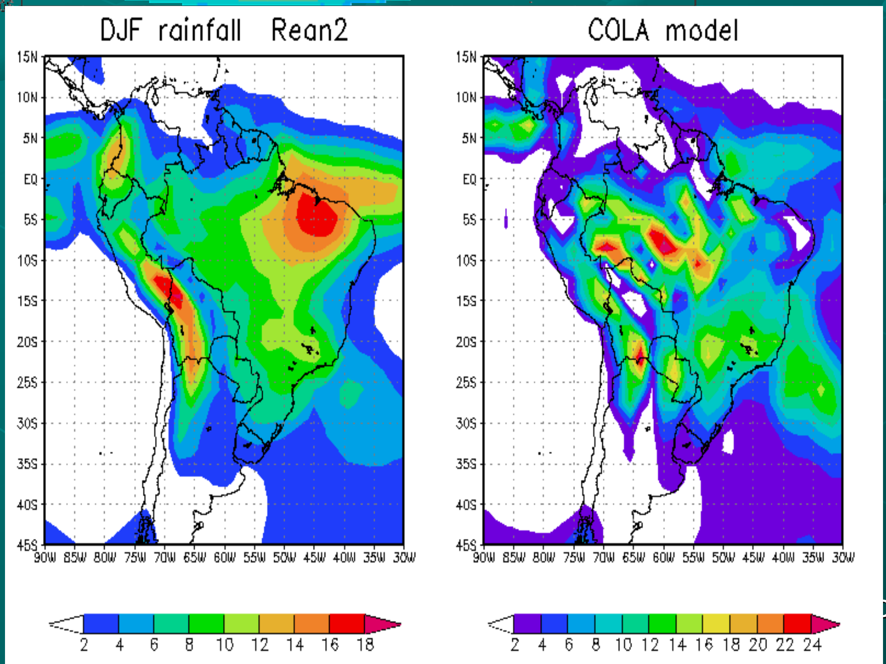
Model Assessment







DJF



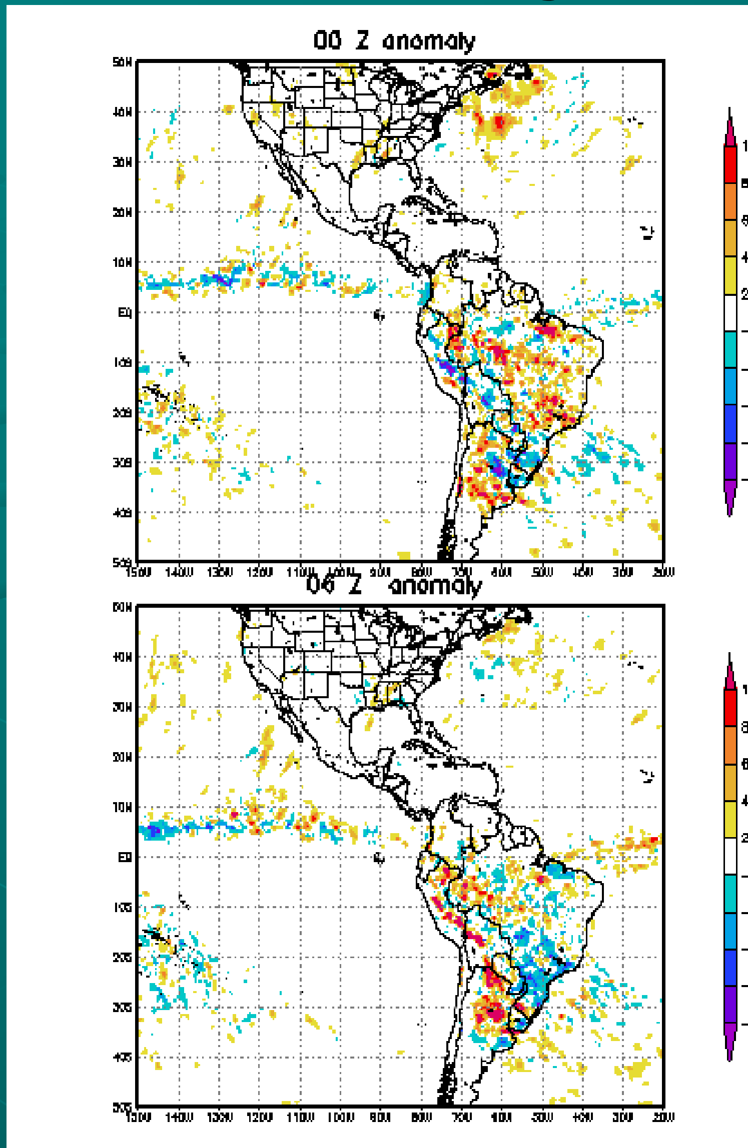
From J N-Paegle et al (VPM8, 2005)

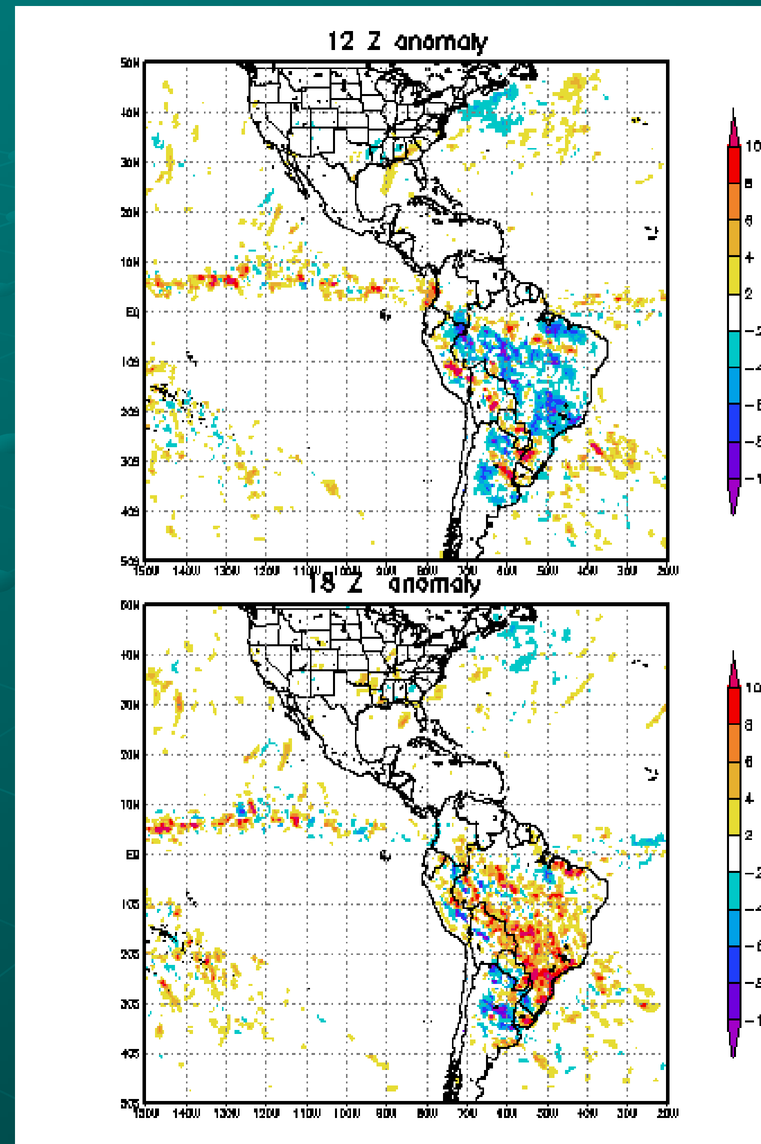
Cavalcanti 2006

Menendez 2006

DJF precipitation averages from R-1 and 2 do not reproduce the continental maximum at 50-65W. This is not the case for the COLA model. All three estimates have spurious orographic effects over the Andes.

Diurnal Cycle CMORPH data





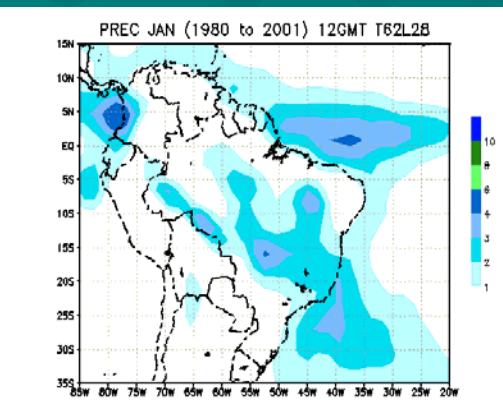
the diurnal cycle in both regional and global models

DJF

CPTEC/COLA AGCM **(1980-2001)**

REGIONAL ETA **(1996-2000)**

12 GMT



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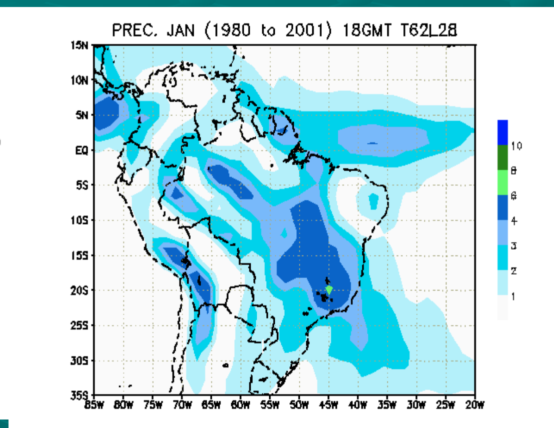

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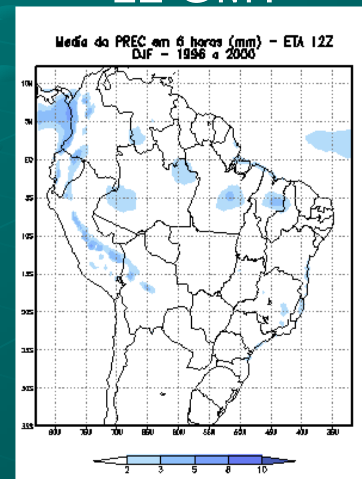

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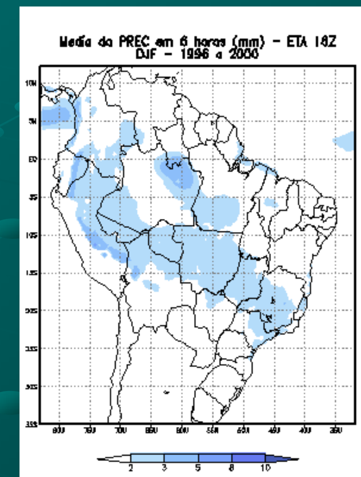

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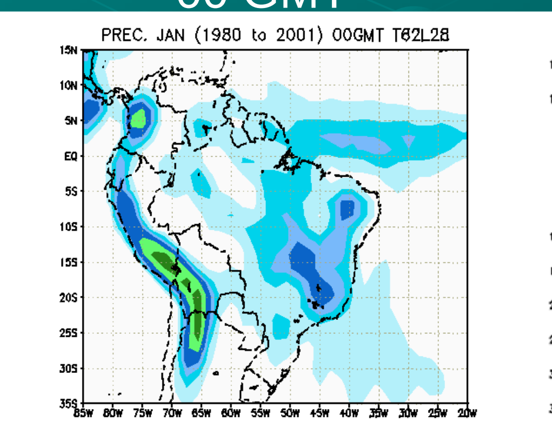

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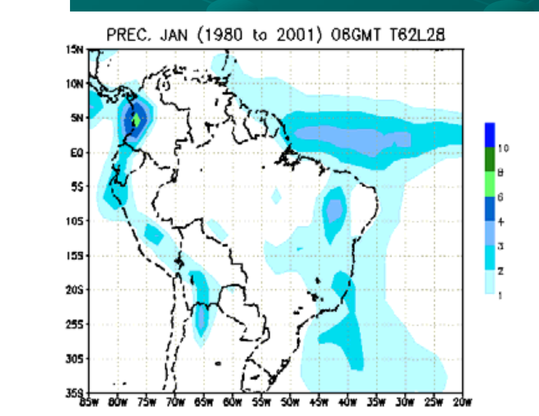

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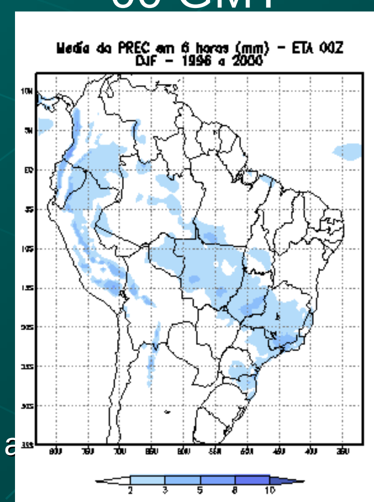

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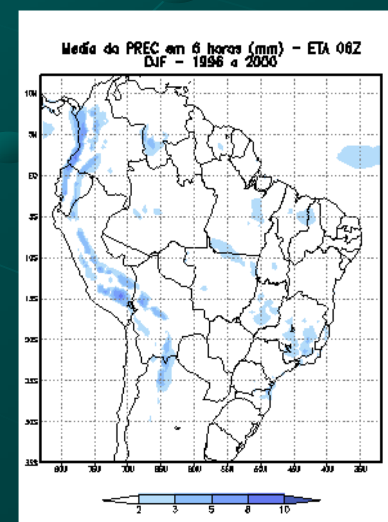


Cavalcanti, 2006

Important discrepancies between models

Model Bias: (1979-1998) - Obs.		Precipitation (%)		
		Mean	Minimun	Maximun
AMZ	DJF	-2.2	-33.7 (10)	31.4 (10)
	MAM	-11.8	-28.6 (16)	10.7 (4)
	JJA	-22.1	-56.4 (17)	43.3 (3)
	SON	1.2	-56.7 (8)	37.3 (12)
	ANN	-7.7	-30.6 (12)	25.5 (8)
SSA	DJF	2.4	-42.4 (8)	41.6 (12)
	MAM	-14.4	-49.9 (16)	11.2 (4)
	JJA	3.8	-29.4 (10)	64.8 (10)
	SON	-1.4	-43.8 (11)	51.6 (9)
	ANN	-2.8	-38.0 (12)	32.2 (8)

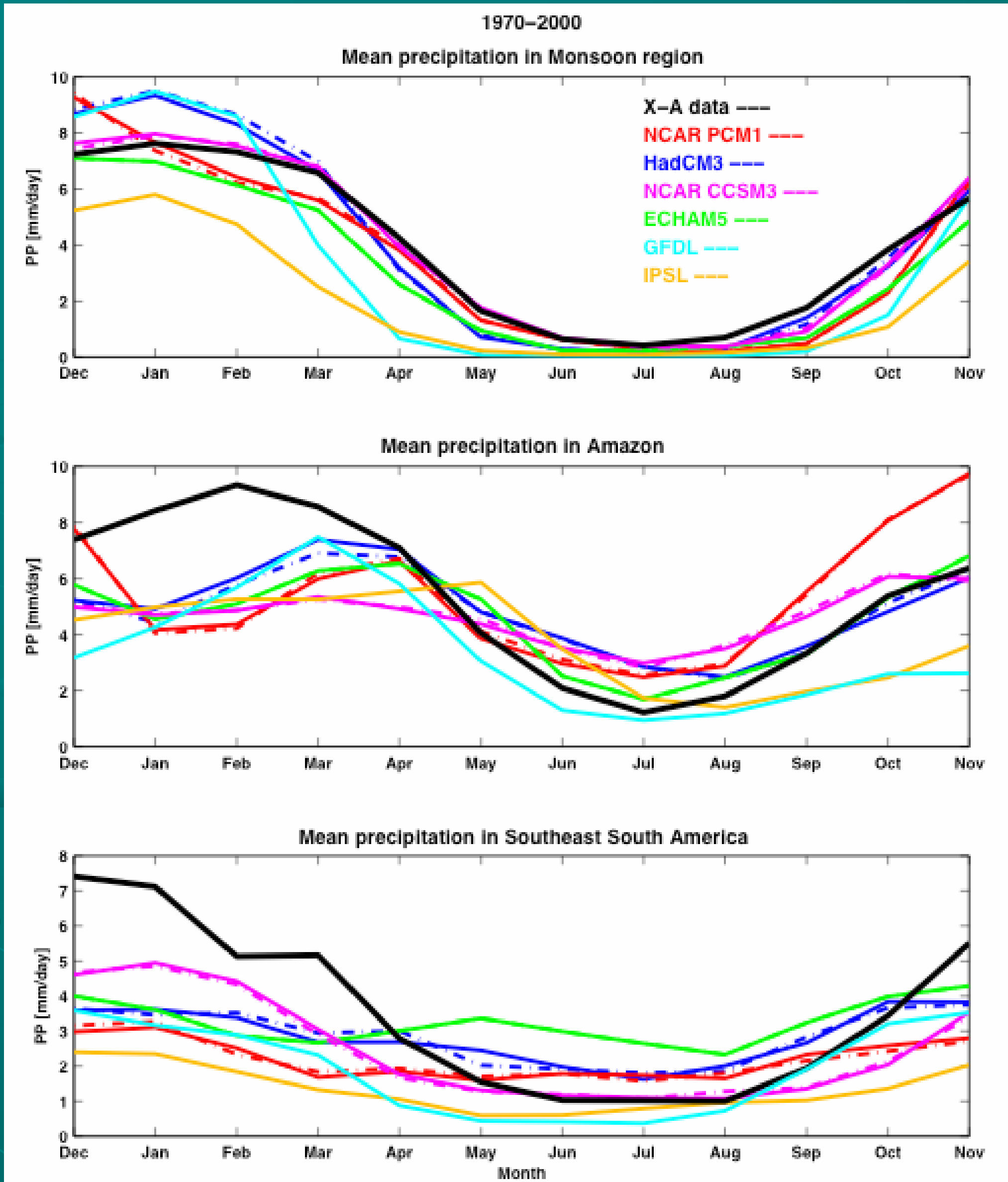
IPCC AR4 AOGCMs -20 models, 65 runs- present climate (period 1979-1998) (Menendez 2005)

South American Monsoon Precipitation and Moisture Flux in the SRES A2 Scenario

Maisa Rojas (U Chile, Santiago)
Anji Seth (U Connecticut, Storrs)
Sara Rauscher (ICTP, Trieste)

Acknowledgement: IPCC AR4 Modeling Groups and WG I for coordinating, archiving and making accessible the model integrations.

1970-2000 Monthly Precipitation

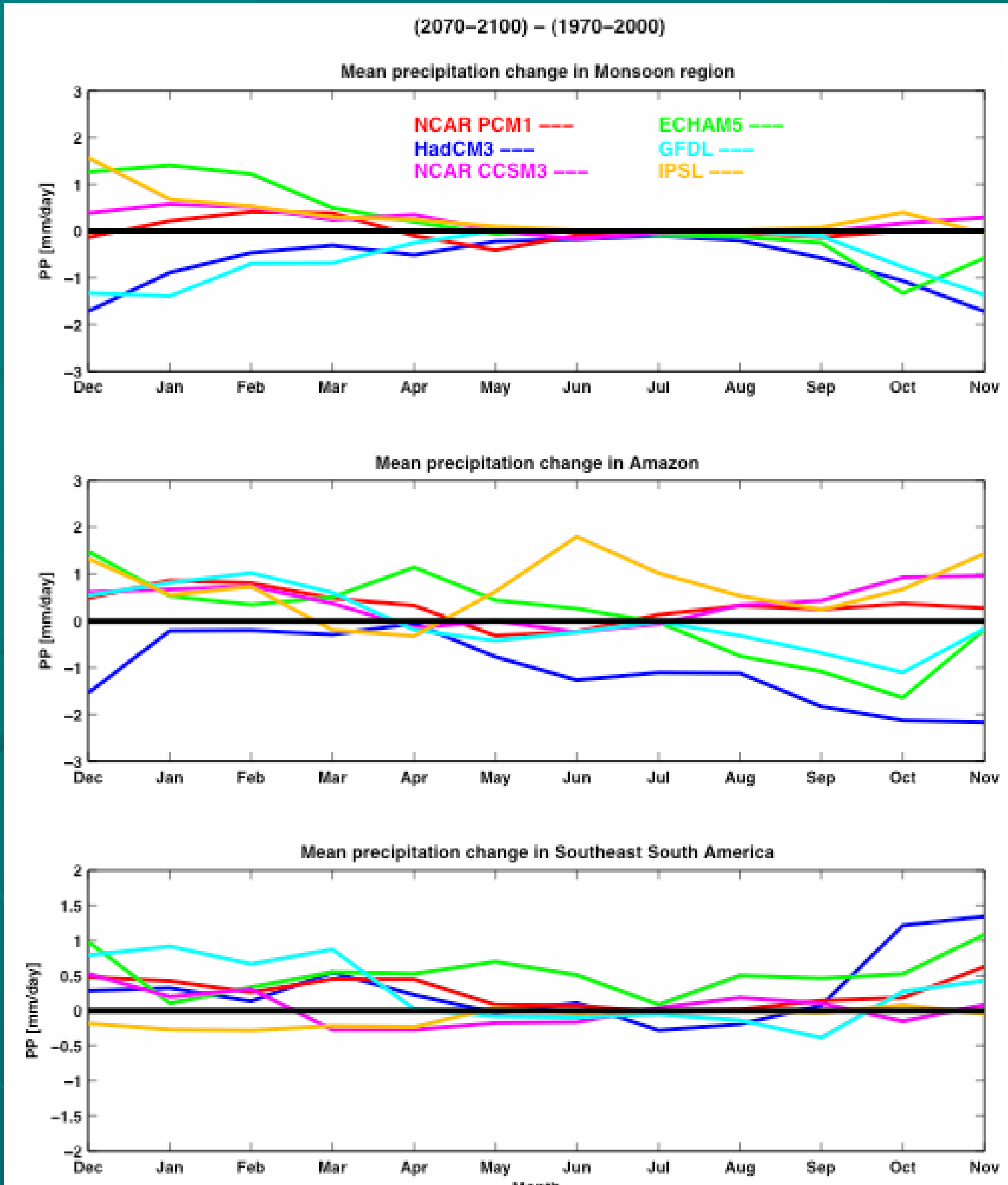


Monsoon: models capture the annual cycle.

Amazon: models simulate spurious semi-annual cycle, and delay/underestimate observed late summer (JFM) maximum.

Southeast: models underestimate summer rains (NDJF), reduce the amplitude of the annual cycle.

(2070-2100)-(1970-2000) Monthly Precipitation

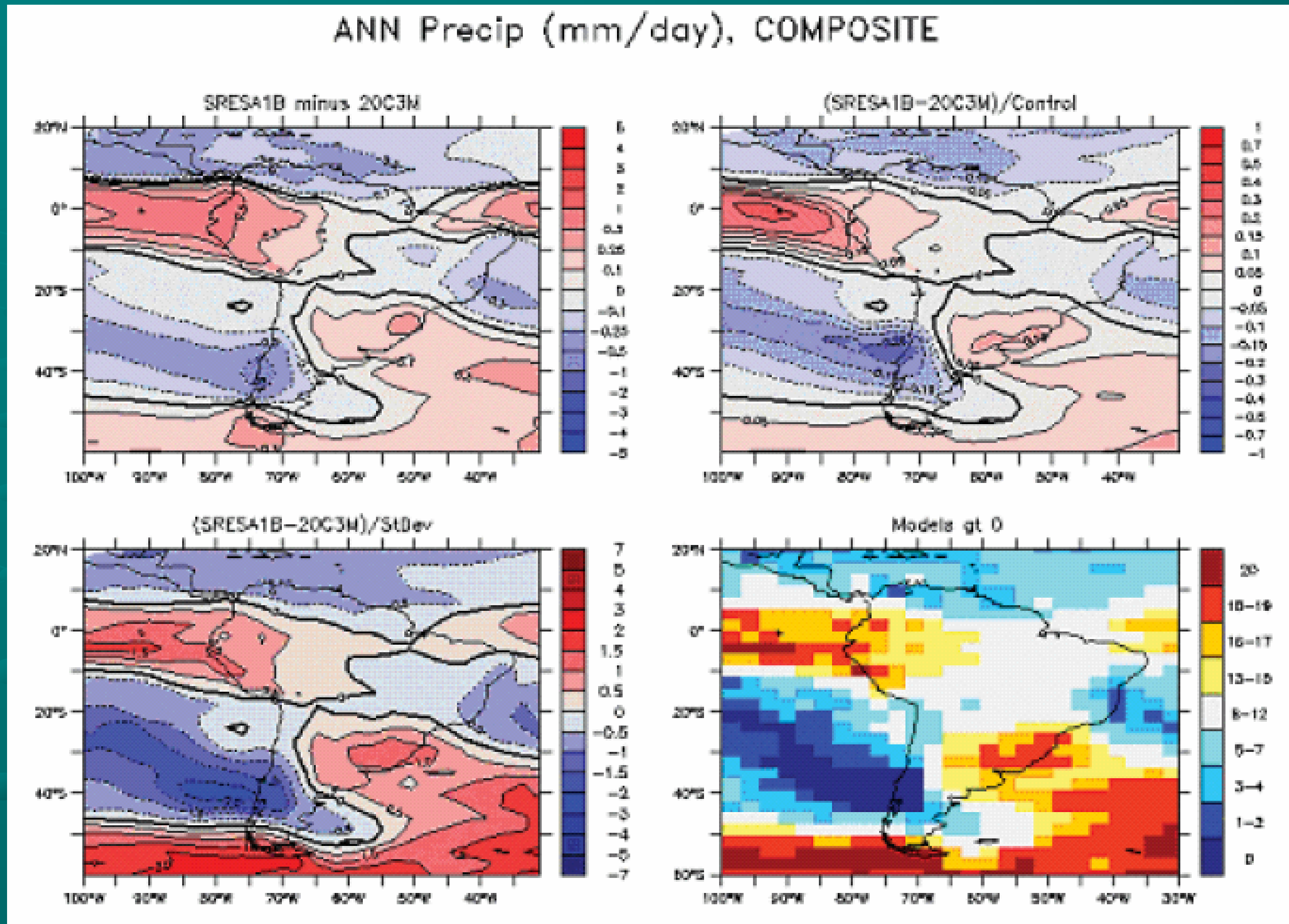


Monsoon: Little agreement among models during rainy season (NDJFM). Drier early rainy season (SON), wetter late rainy season (JFM)?

Amazon: Little agreement among models during onset of rains (SON). Most models suggest increased precipitation during middle/late rainy season (DJFM).

Southeast: General model agreement towards increased precipitation, especially in spring (OND).

IPCC AR4 AOGCMs: A1B scenario projections (2079-2098)



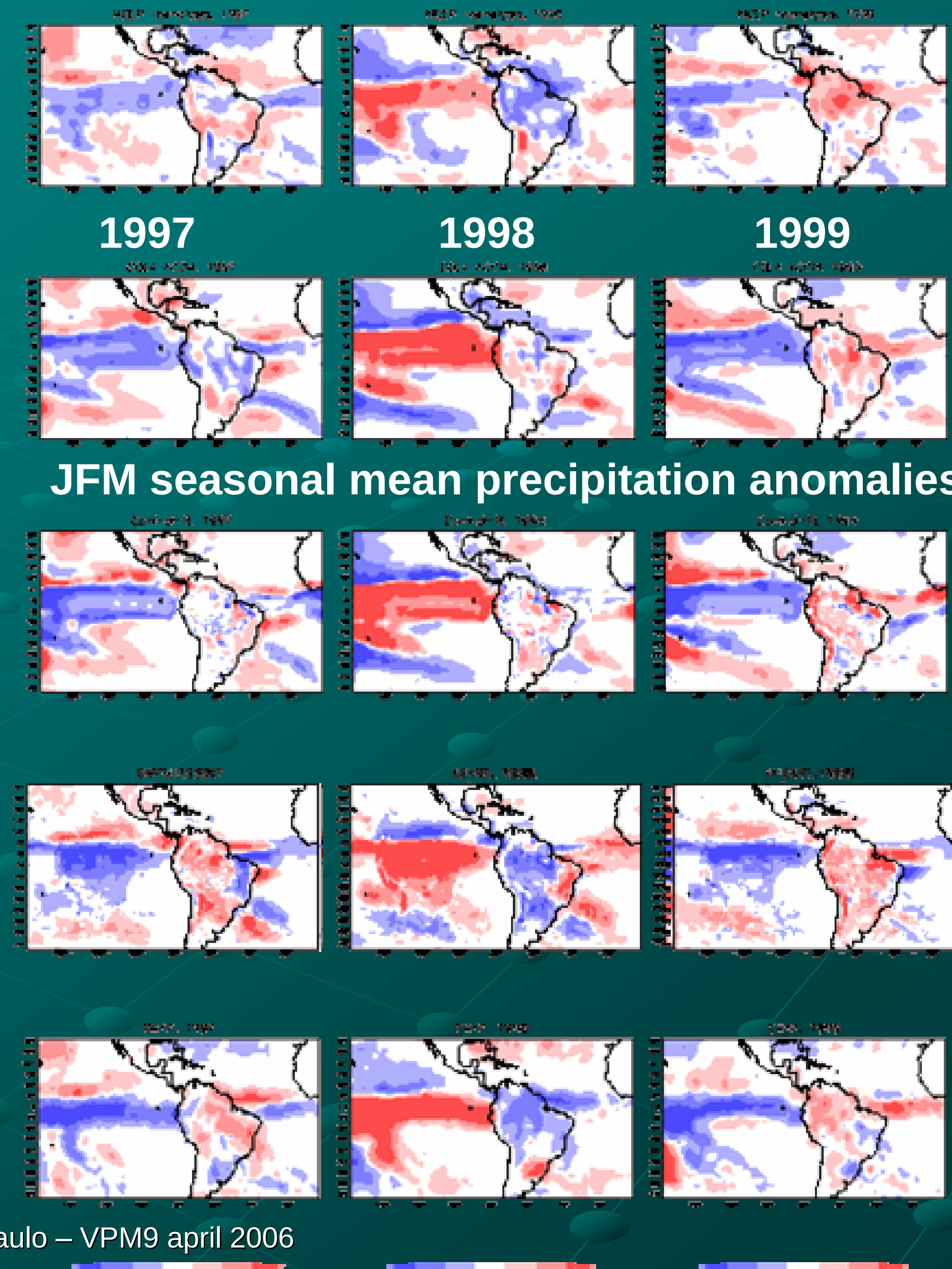
- About 70% (40%) of the models project a wetter climate in austral summer and autumn (winter and spring) in AMZ, while about 50%-60% of all the models project a wetter climate in SSA all over the year. (Menendez 2005)

Model development

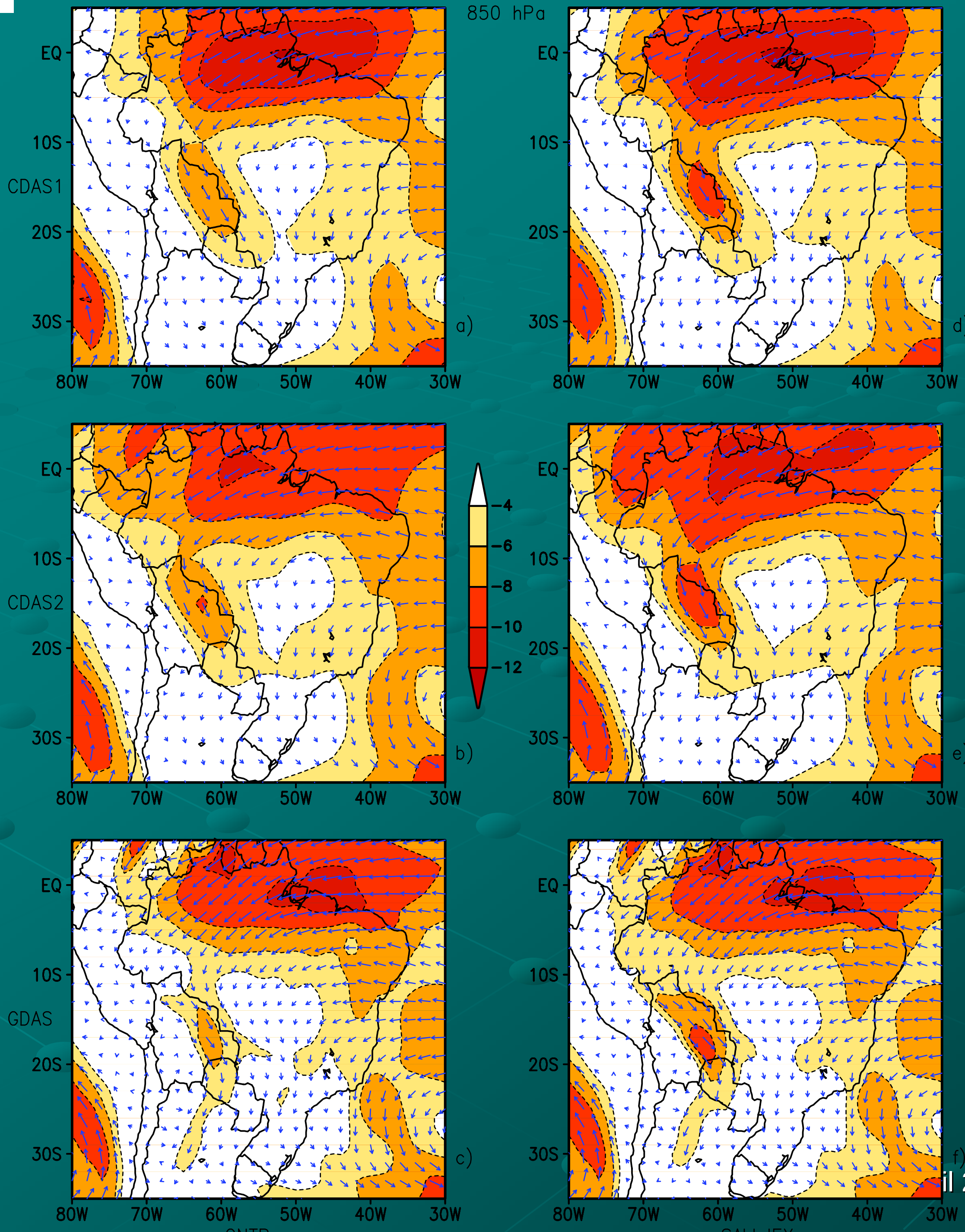
- Improve the seasonal prediction and weather forecasting over South America
- Stimulate the development of physical parameterizations
- Implement data assimilation

Downscaling techniques

Vasubandhu Misra, 8ISCHMO



Experiment	Feature
COLA AGCM	AGCM seasonal integration at T42
CONTROL-B	RSM nested into COLA AGCM in conventional manner
EXPT	RSM runs with Scale Selective Bias Correction applied on anomaly nested variables of winds and surface pressure.



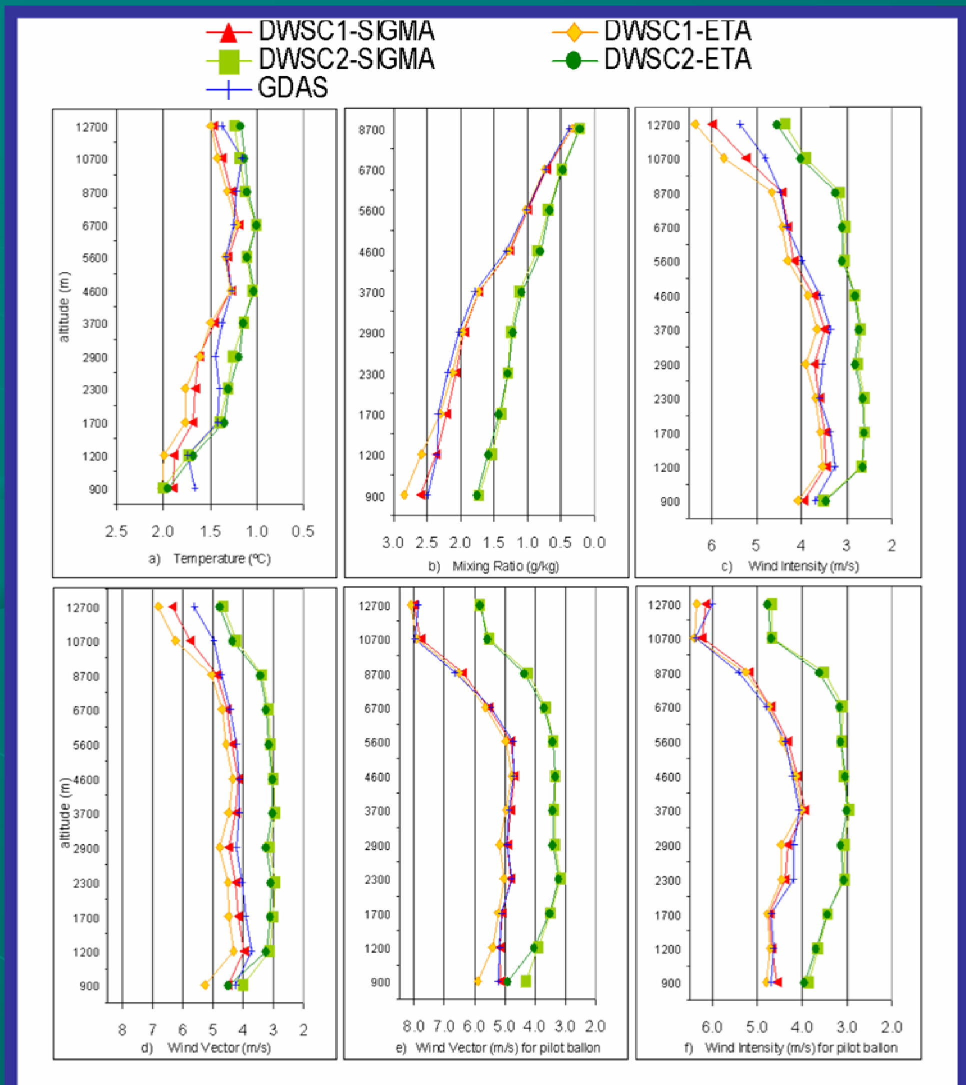
il 2006

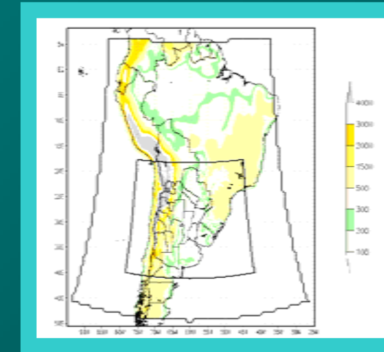
Data Assimilation: a) global

Mean low-level wind (vector) and wind speed magnitude (shaded) at 850 hPa for january 15 to February 15, 2003. a) CDAS1, b) CDAS2, c) GDAS, d) CDAS1rp, e)CDAS2rp and f) GDASrp. Values are in m/s.

- Herdies et al, 2006 submitted J. of Climate

Data Assimilation: b) regional





- Enriched analyses were generated ingesting all available data during SALLJEX, following a downscaling methodology, using the Regional Atmospheric Modeling System (RAMS), Version BRams 3.2

Skabar and Nicolini, 8SCHMO

- These enriched analyses are currently applied to study evolution of convection during SALLJ events providing a much better resolution of the preconditioning processes that gradually buildup the environment that promotes organized deep convection over subtropical South America.

Integration of models:

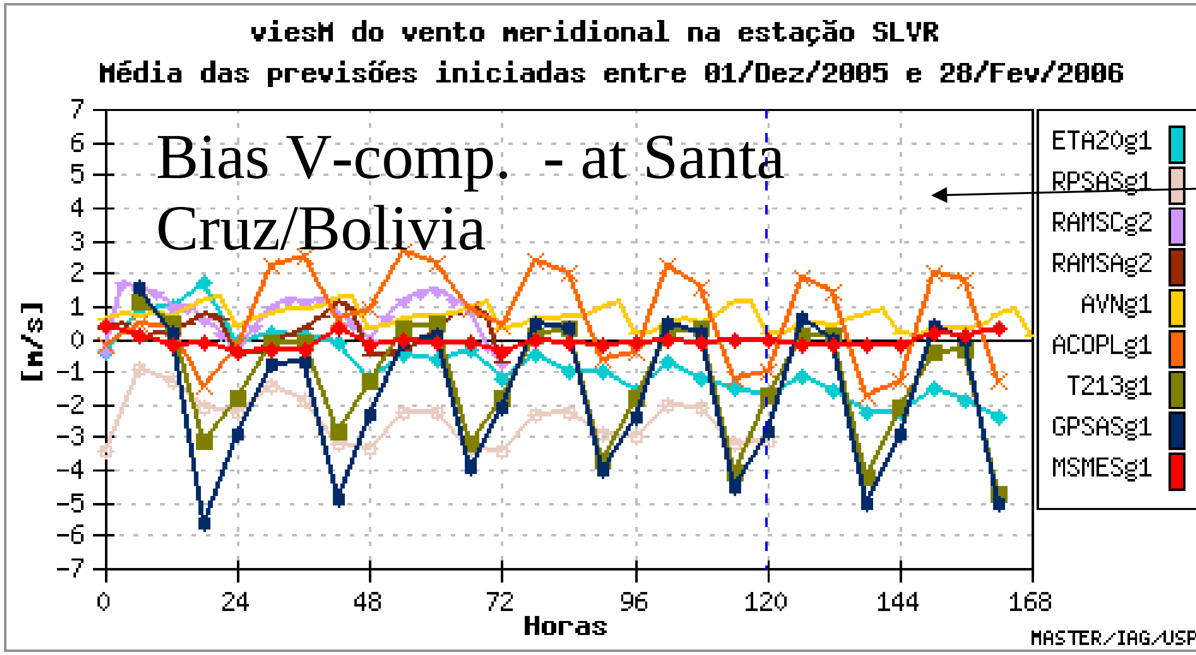
Concept of Super Model Ensemble

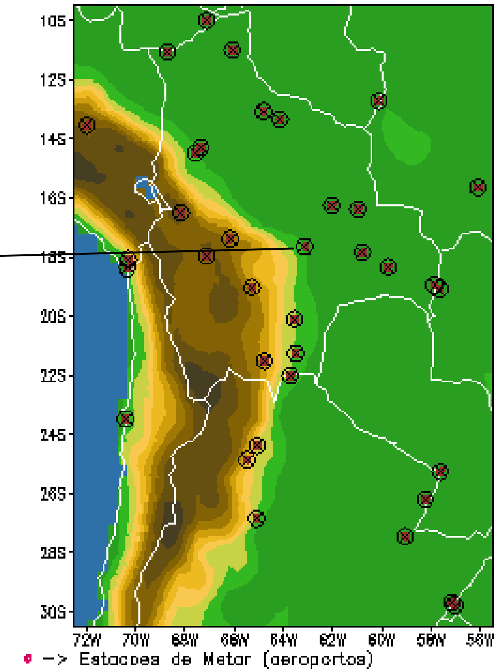
Several models are available:

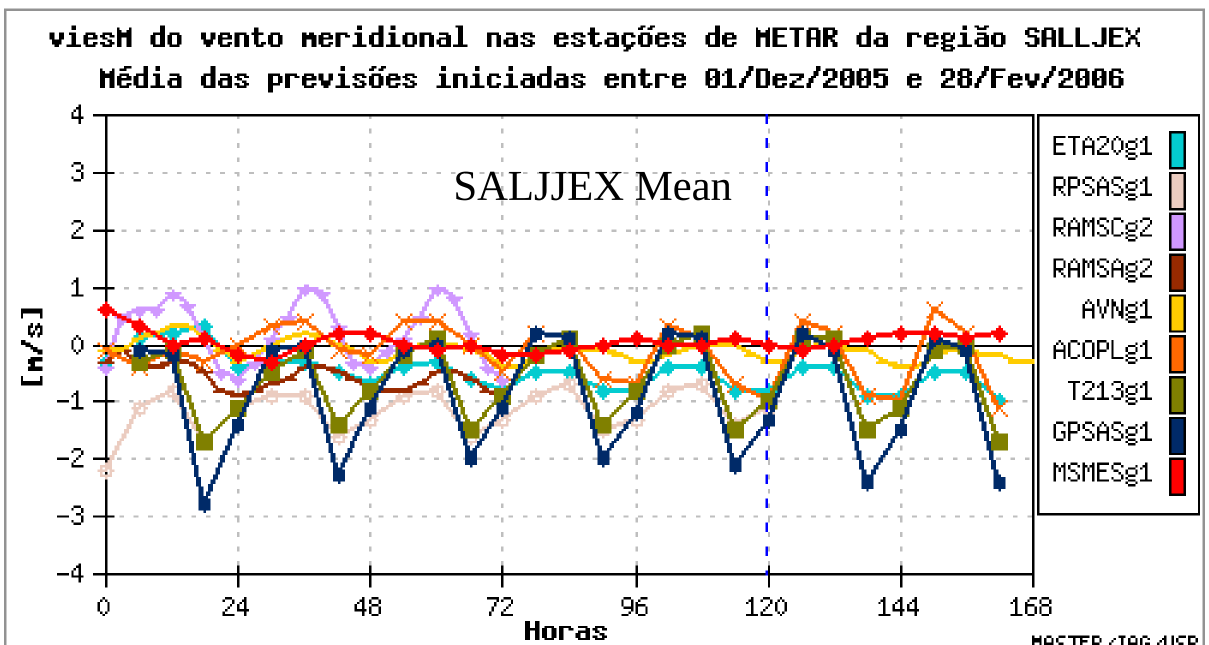
global, (CPTEC, NCEP, ECMWF, UKMO,…) ;

Regional models in S. America: CPTEC (ETA,BRAMS), INMET (DWD regional model), MASTER (BRAMS), SIMEPAR (ARPS, BRAMS), UFRJ (MM5, WRF,RAMS), FURGS (BRAMS), EPAGRI (BRAMS), LNCC (ETA), CIMA/UBA (WRF), aprox. 14 models !…

Differences in physical processes parameterization, data assimilation, data source …





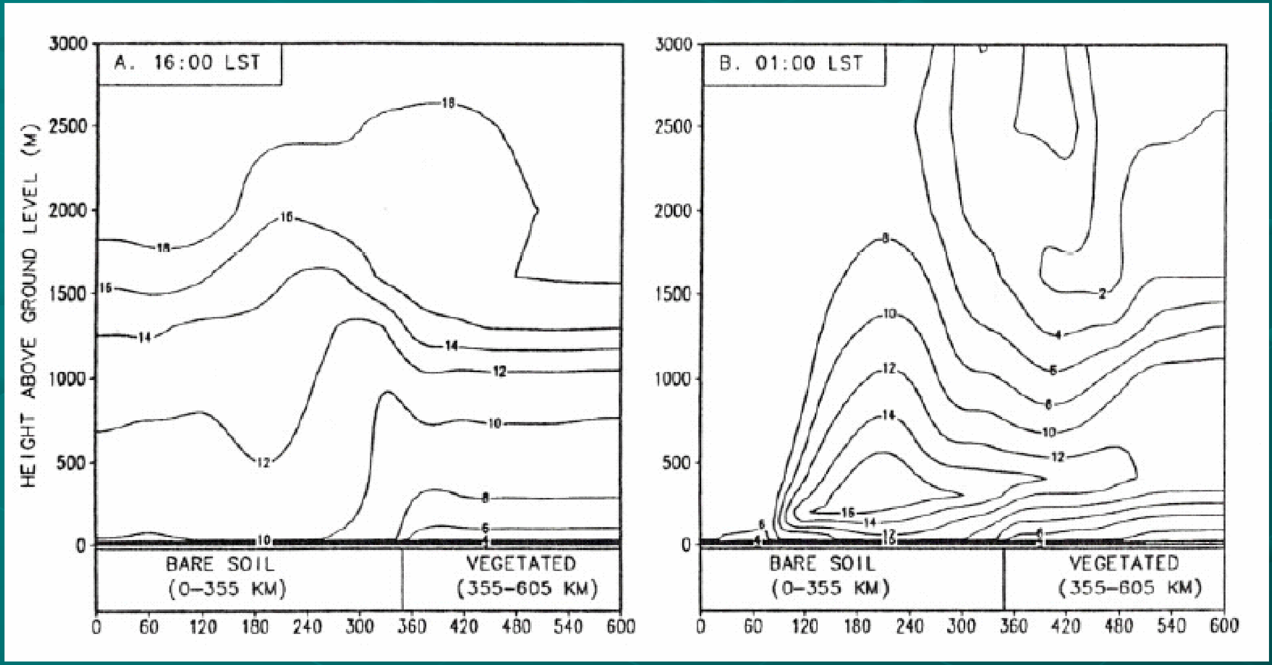


Meridional Wind Component Bias up to 7days forecast MESMES is the optimal statistical combination of all available forecasts (near zero bias)

Evaluate scientific hypotheses to meet MESA science objectives.

- The hypothesis testing should include but may not be limited to
  - Synergy between SALLJ and MCS,
  - Mechanism for the NW Argentina heat low,
  - Sensitivity to soil moisture,
  - Coupled simulation in the region of the SACZ,
  - Local and remote (global) influence of SAMS.

Land-surface impact



- The major mechanisms for the LLJ are the horizontal temperature gradient caused by land surface heterogeneities and the oscillation of the frictional effect.

- Wu and Raman 1997: Experiments with the NCSU mesoscale model, with idealized conditions and initial geostrophic southerly wind constant with height (10 m/s). Initial time = 08 LST

Soil moisture impact

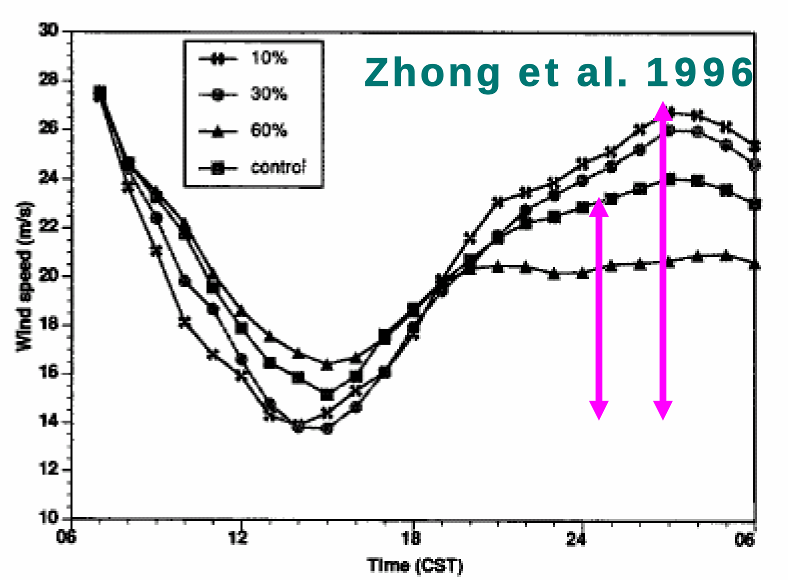
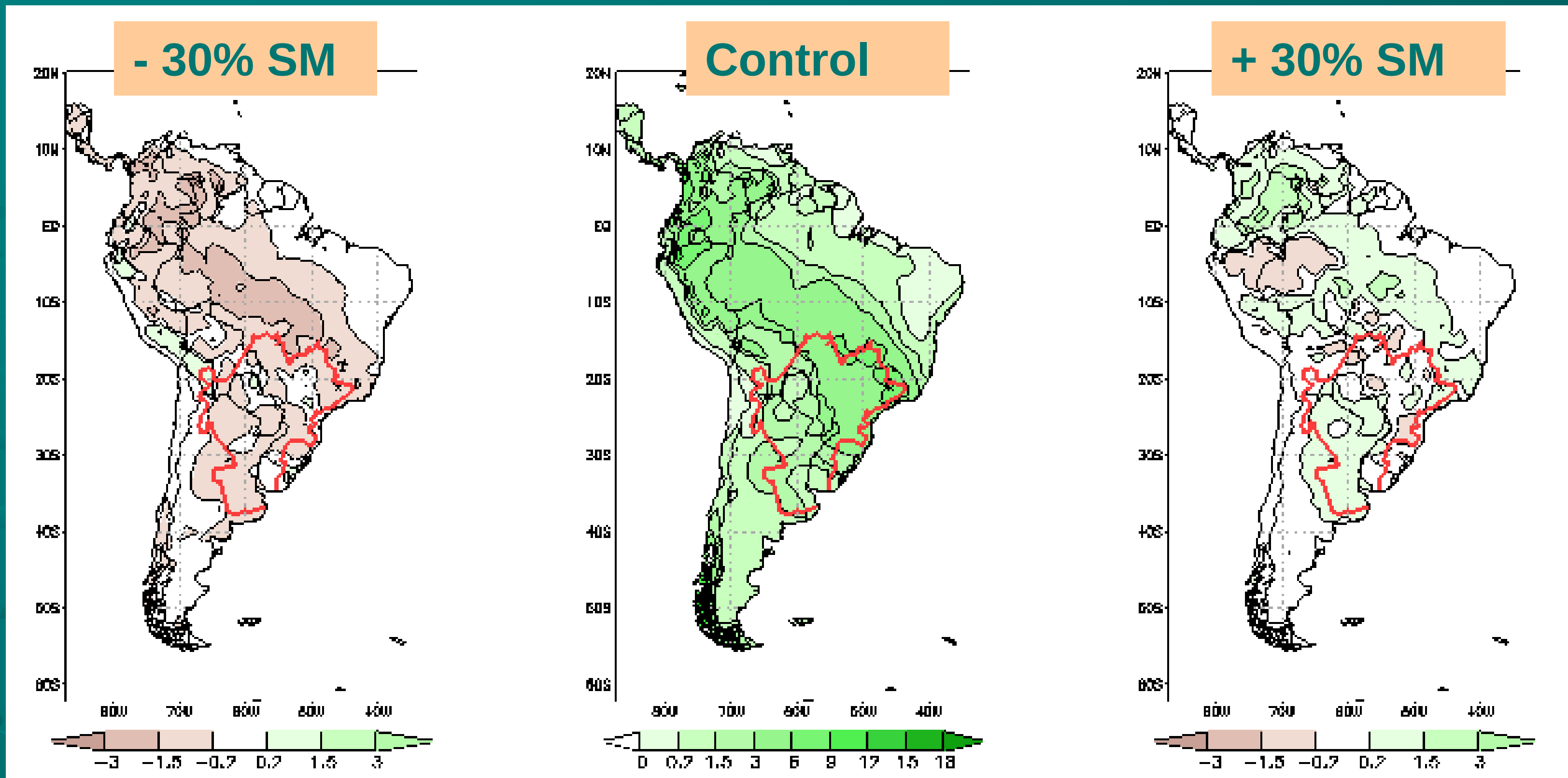


FIG. 17. Same as Fig. 16 but from simulations with different initial soil moisture contents.

Strong impact on the amplitude.

Larger amplitude with drier soil

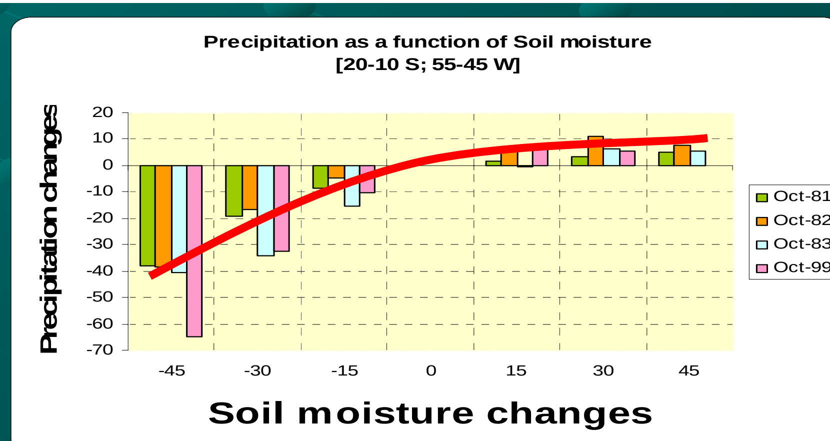
The effect of soil moisture on precipitation



Monthly Averaged fields

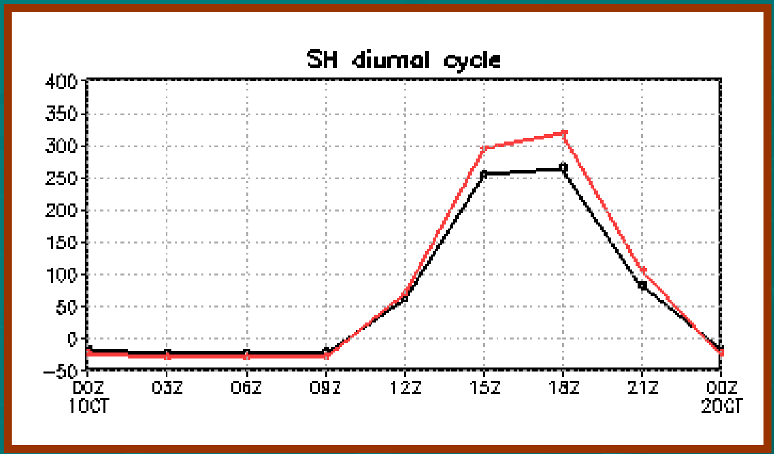
ETA-UMD model

Collini et al. 2006

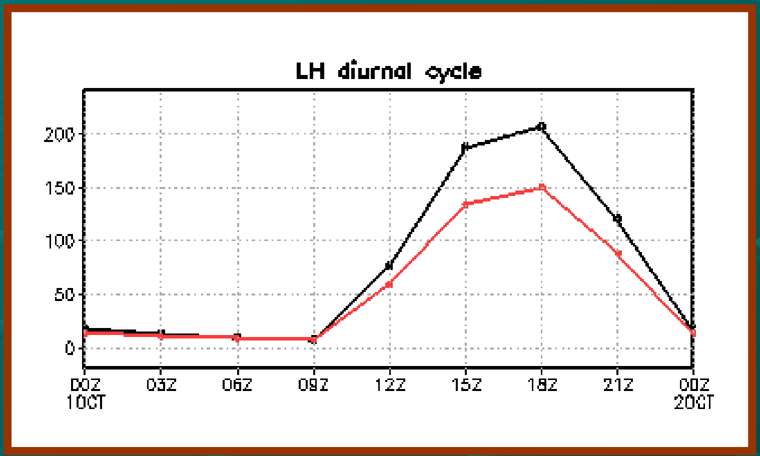


The effect of soil moisture on the diurnal cycle

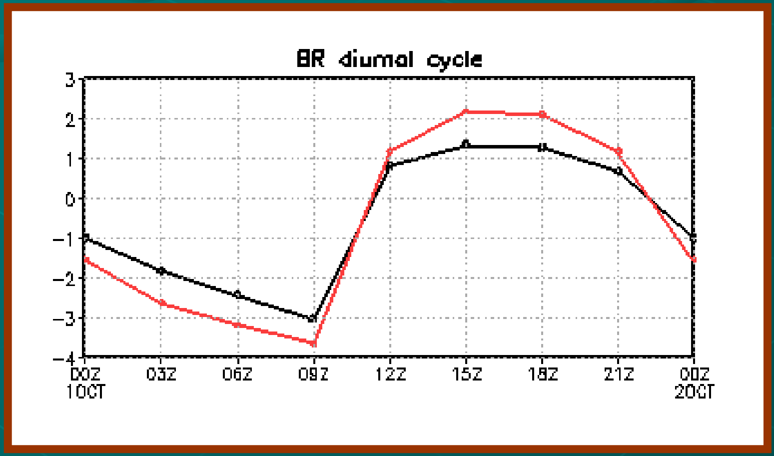
Sensible heat



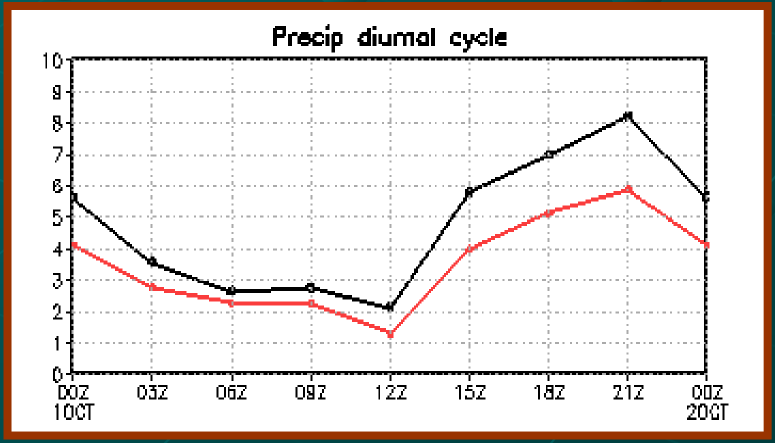
Latent heat



Bowen Ratio



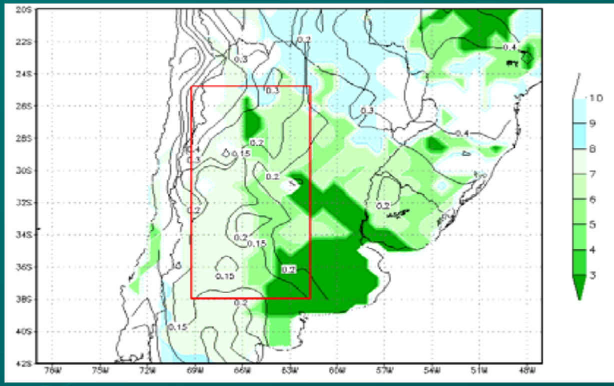
Precipitation

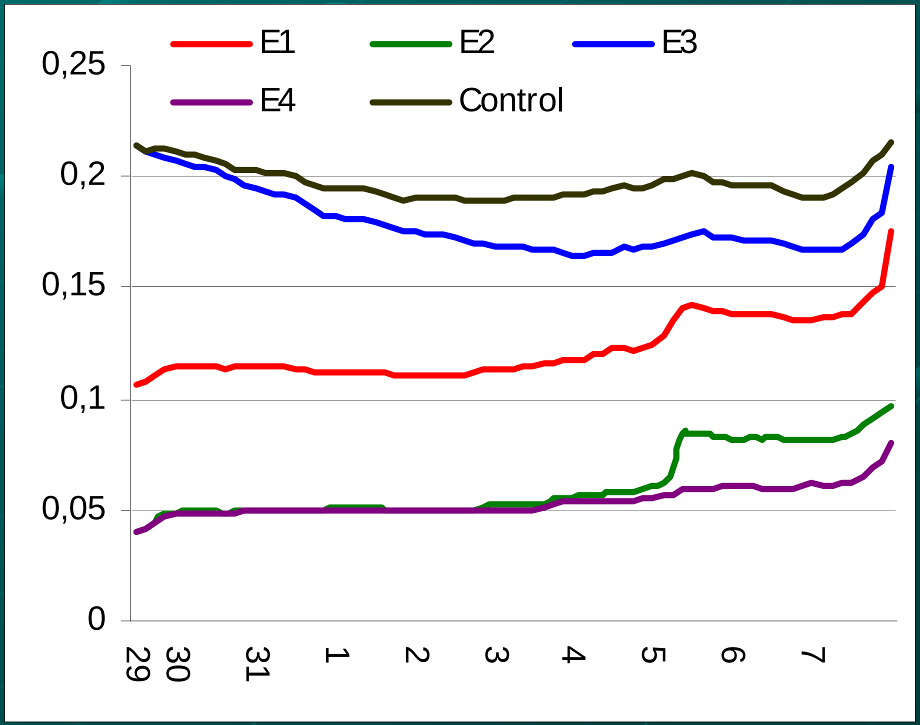


Black: Control
Red: Reduced soil moisture

Averages over (15º S, 75º W) (5º S, 34º W). Collini et al. 2006

Several sensitivity studies employing different land use and soil moisture patterns using the WRF model were performed to analyze how changes in surface conditions alter not only the NAL but also the circulation patterns associated with these events





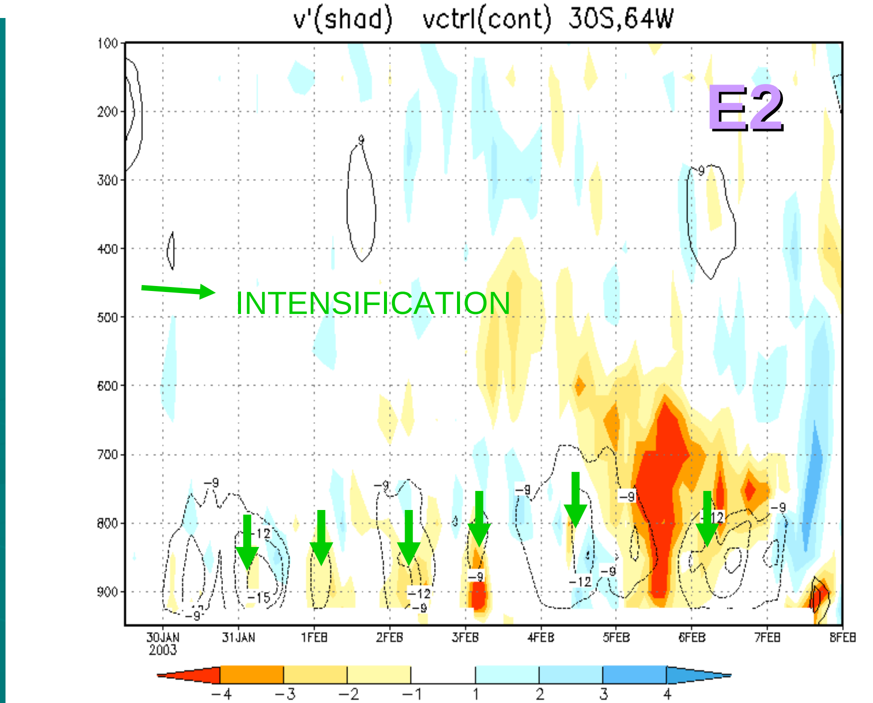
E1: DRY + OBS SOIL

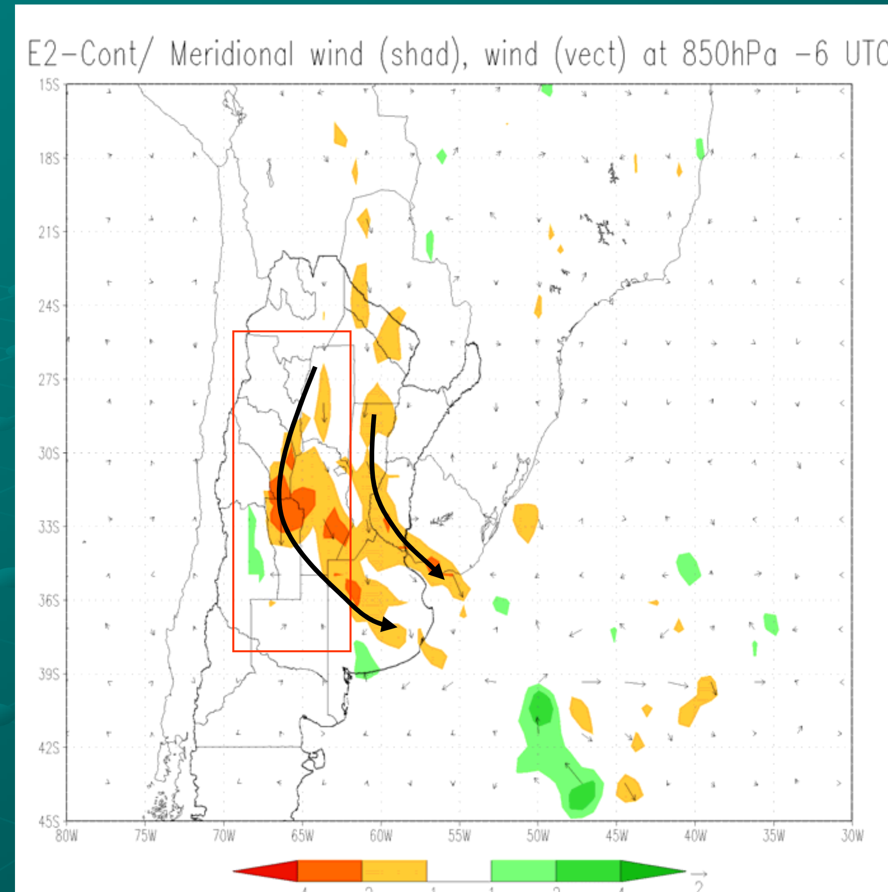
E2: VERY DRY + OBS SOIL

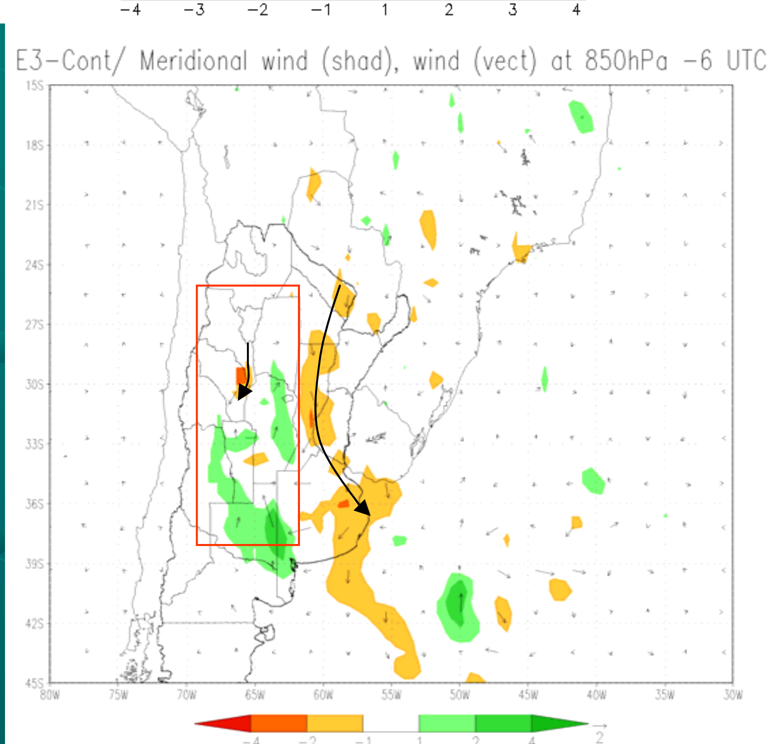
E3: OBS MOIST + BARE SOIL

E4: VERY DRY + BARE SOIL

Ferreira et al., 8SCHMO







Ferreira et al., 8SCHMO