Main features and lifecycle of the South America Monsoon System-Model Results

Iracema Fonseca de Albuquerque Cavalcanti

Center of Weather Forecasting and Climate Studies/ National Institute of Space Research (CPTEC/INPE)

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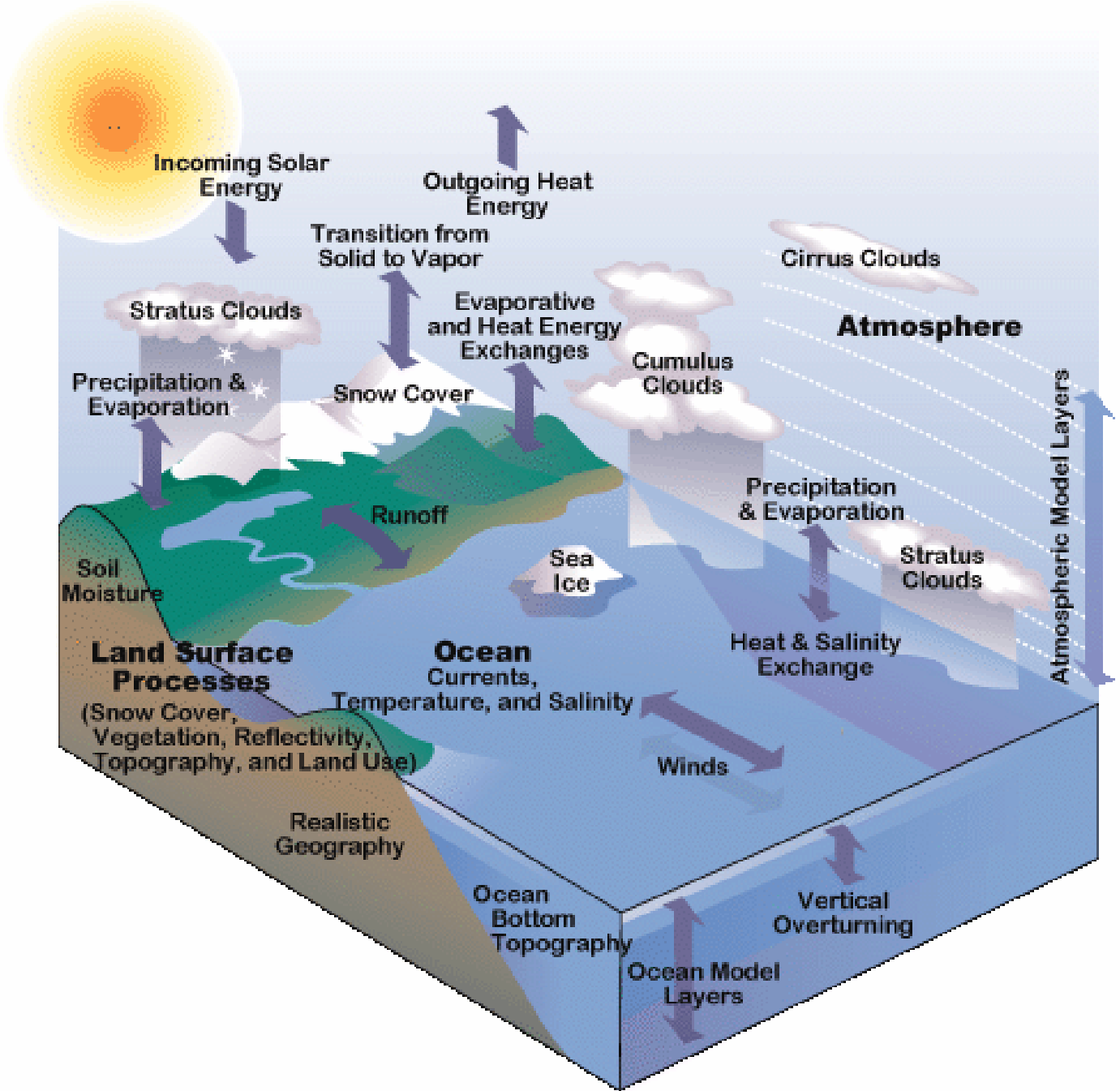
Climate models

- A climate model contains a set of programs that uses equations related to the dynamics, physics and chemistry in the atmosphere and ocean to represent the real climate.

- Dynamical processes: related to wind, pressure, temperature
- Physical processes: related to radiation, convection, surface processes
- Chemistry processes: reactions in the atmosphere and ocean

Complex System



Interactions

Ocean-atmosphere
Land-atmosphere

Atmospheric model
prescribed SST

Coupled atmosphere-ocean model-
interactions

Earth System model-
includes other processes –dynamic vegetation, carbon cycle, biogeochemistry, etc

Representation of SAMS by the following Models

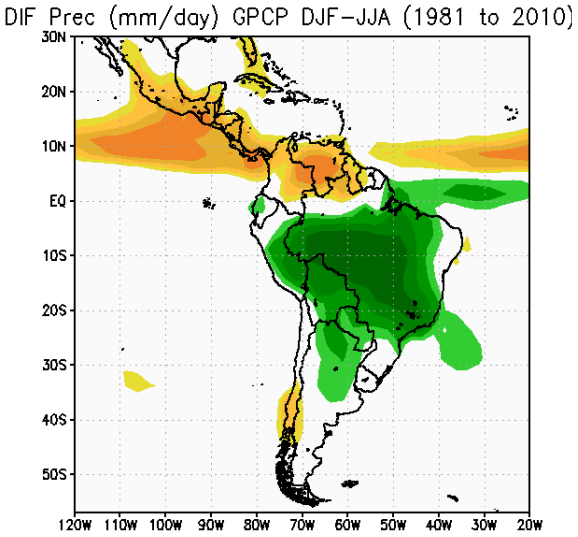
- Atmospheric Global Circulation Model: CPTEC/INPE
- Earth System Model- HadGEM2-ES
- Regional Eta Model

- CMIP5 models

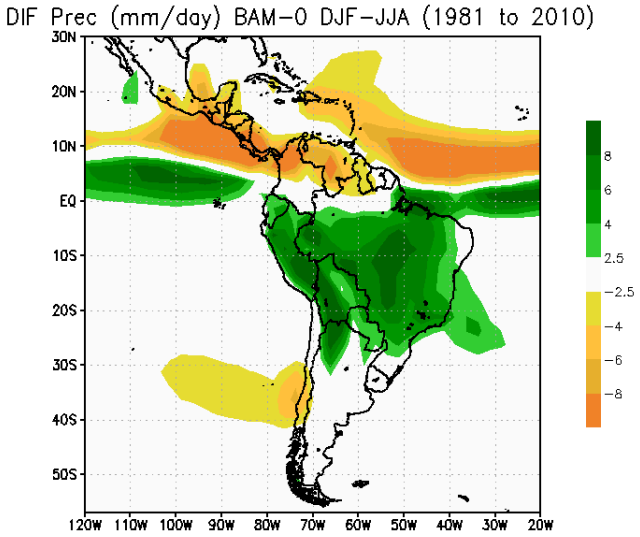
South American Monsoon System (SAMS)

Precipitation Difference DJF-JJA Monsoon regions: dif>=2.5 mm/day

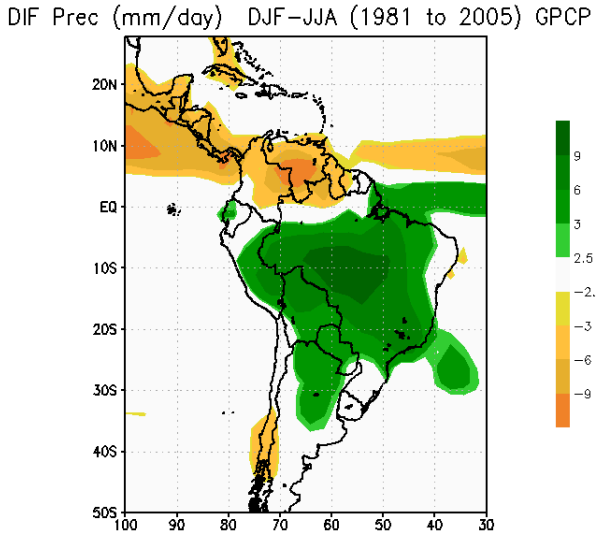
GPCP



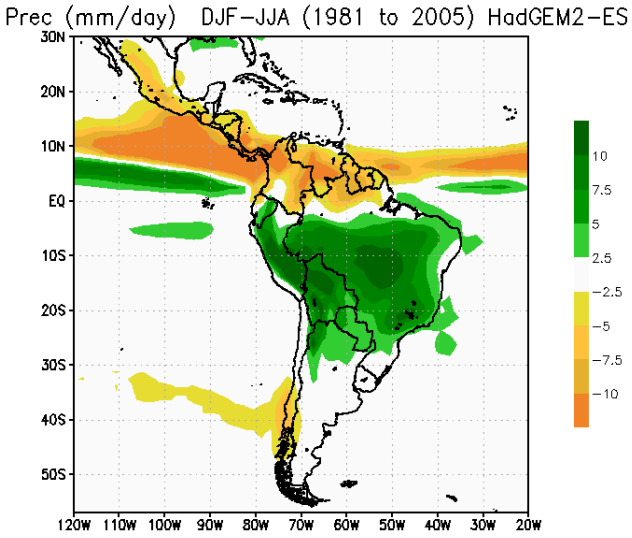
CPTEC/INPE AGCM



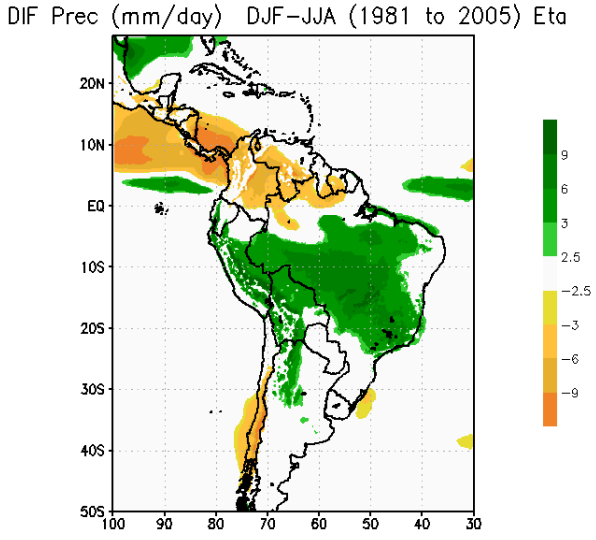
GPCP



HadGEM2-ES



ETA-Had



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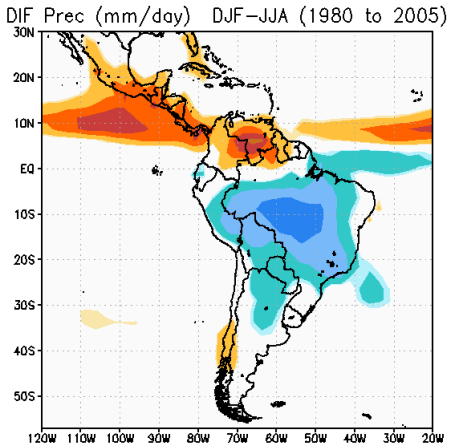
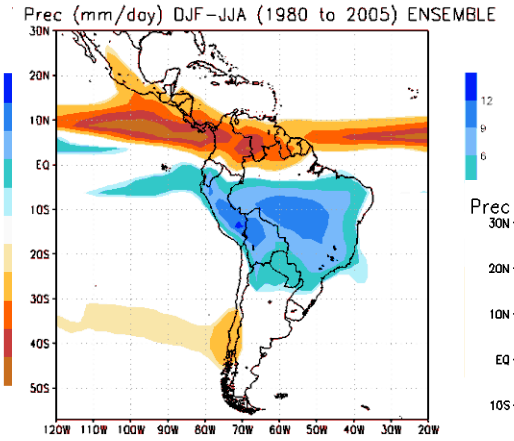
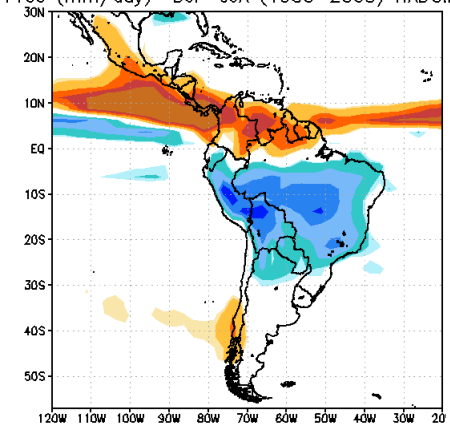


ENSEMBLE

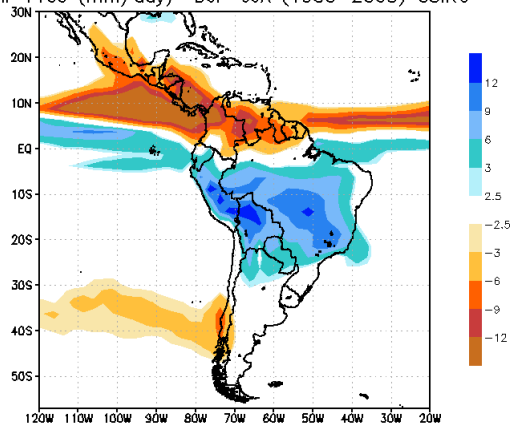


[HadGEM2-ES, CSIRO, IPSL, MRI and MIROC],

HadGEM2-ES



CSIRO



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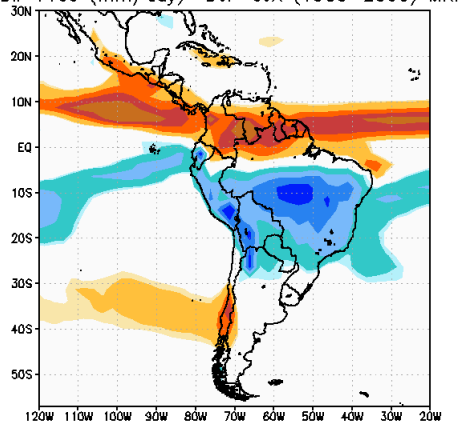
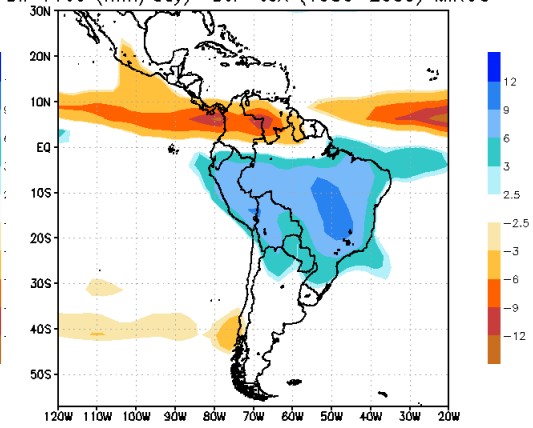
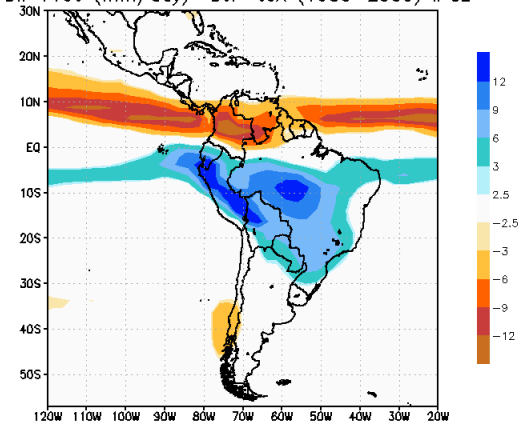


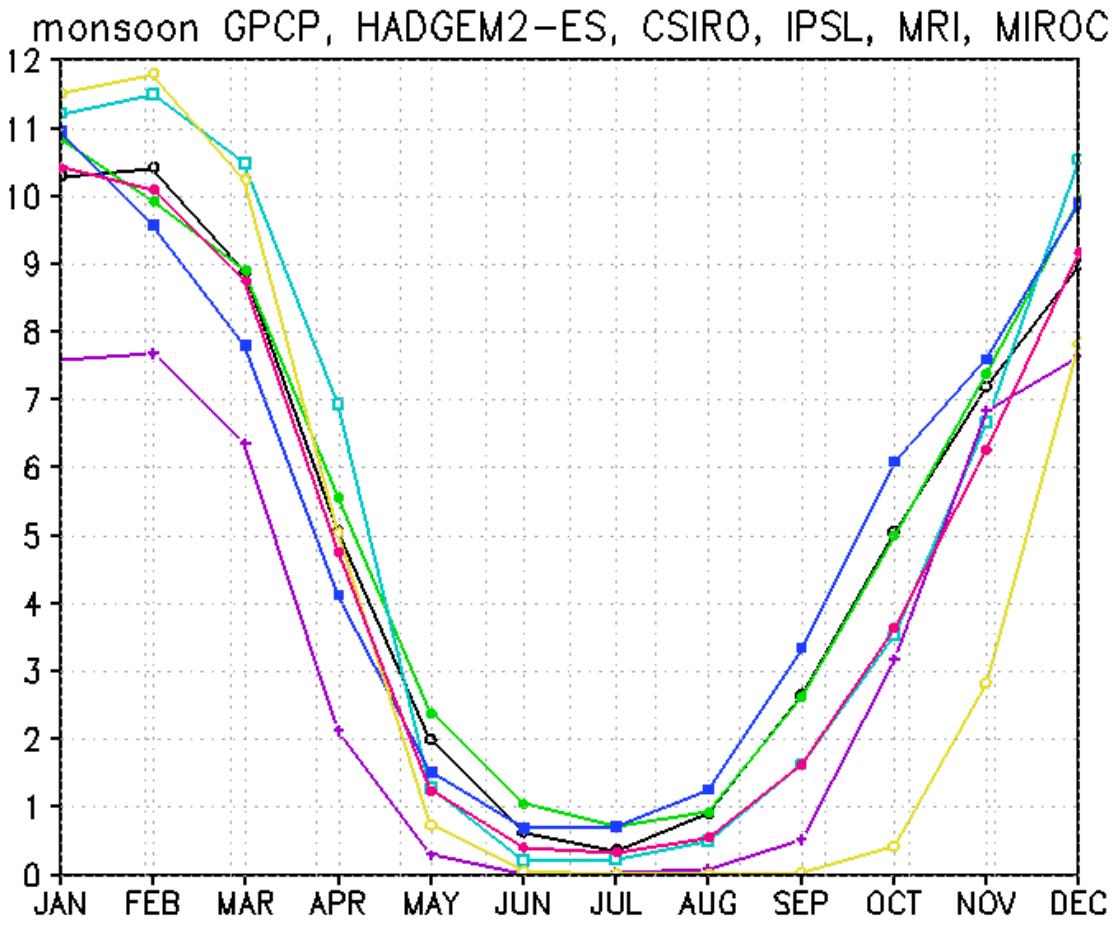
MIROC



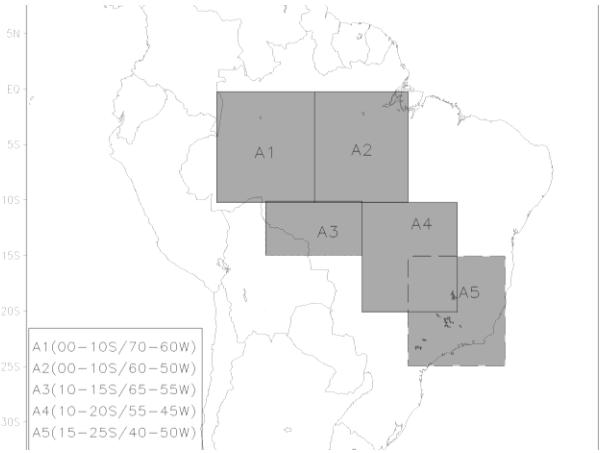
IPSL



Annual Cycle of precipitation in the SAMS core

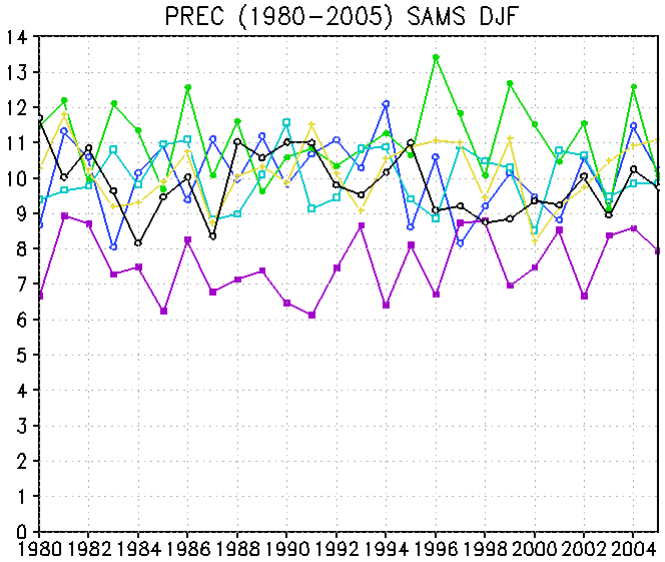


GPCP:black
HADGEM2_ES:blue
MRI: green
CSIRO:cian
MIROC:lilac
IPSL:yellow
ENSEMBLE:red

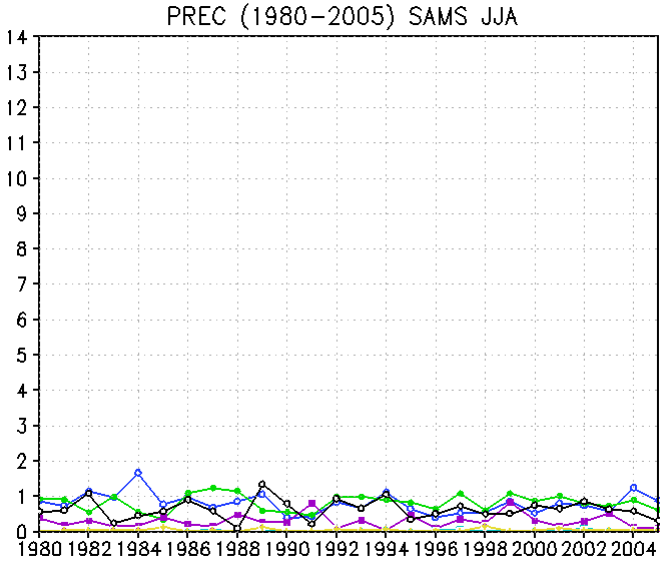


Interannual variability

DJF

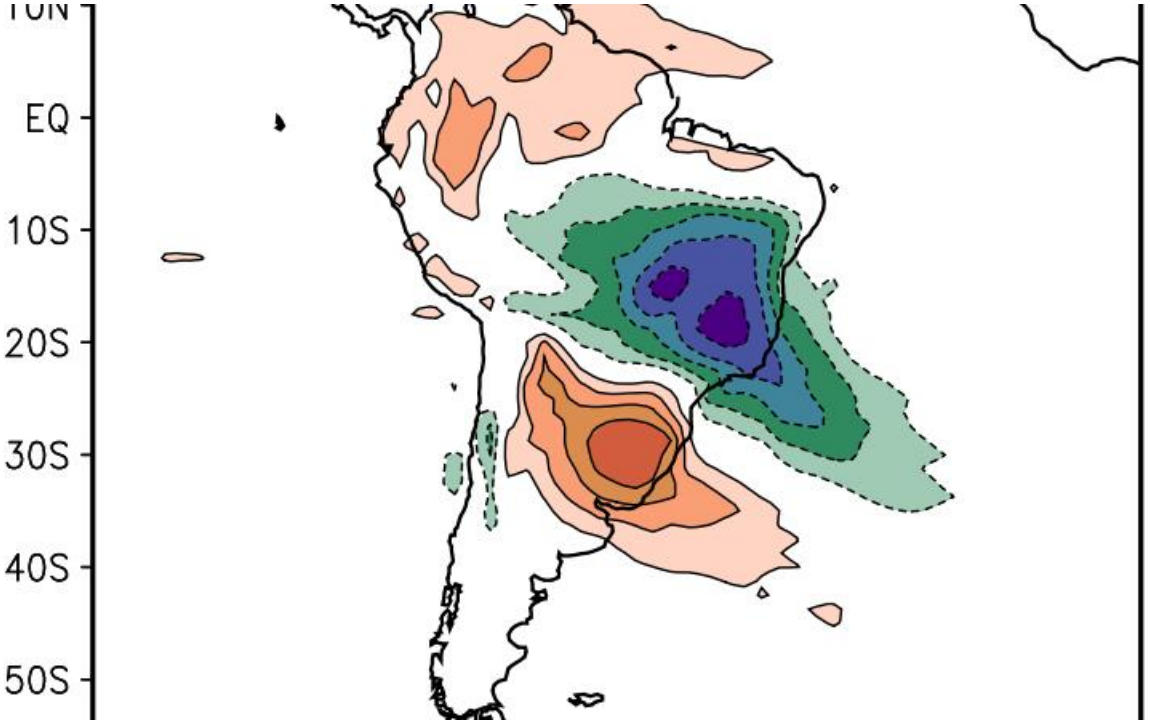


JJA

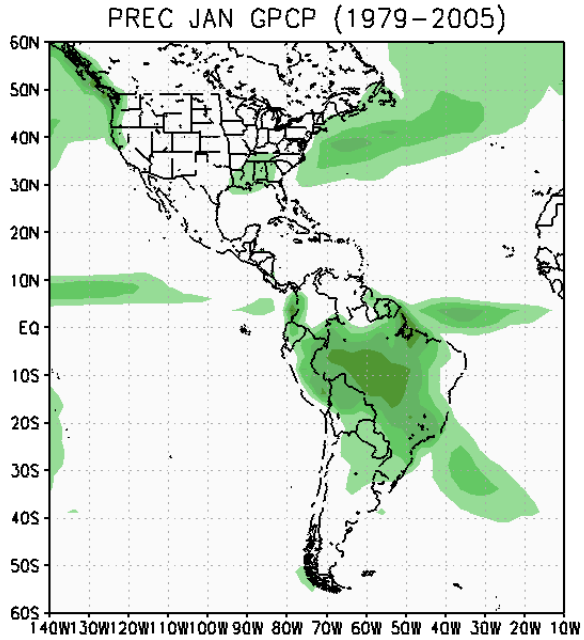


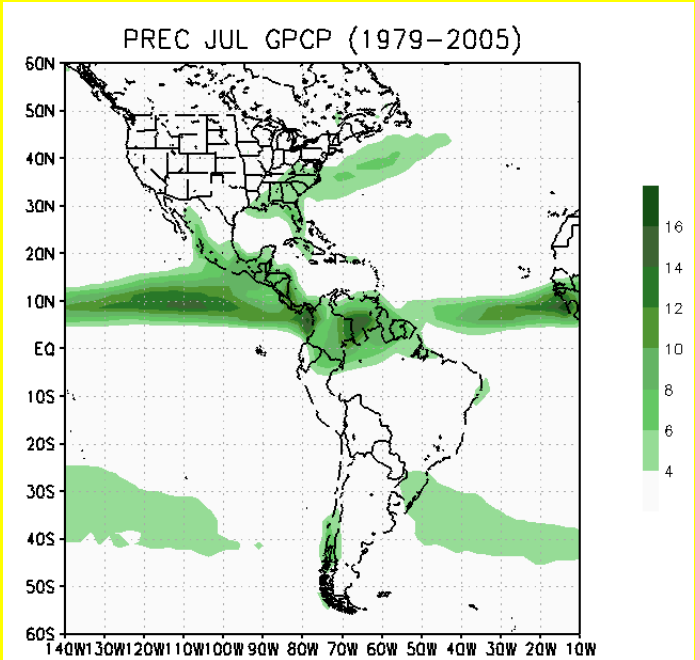
GPCP:black
HADGEM2_ES:blue
MRI: green
CSIRO:cian
MIROC:lilac
IPSL:yellow

HadGEM2-ES

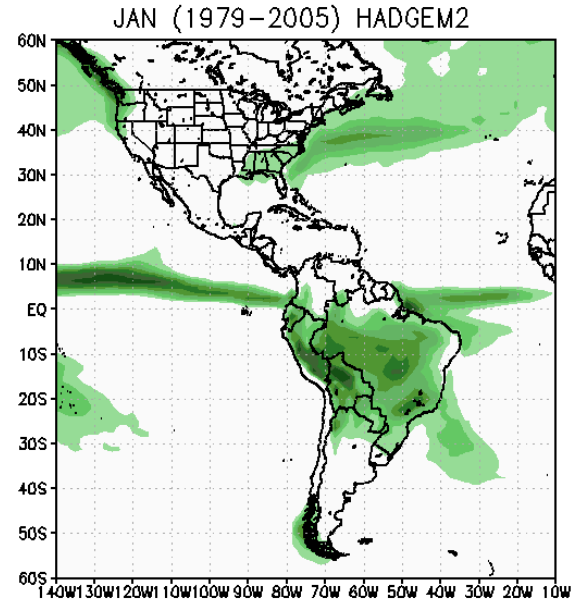


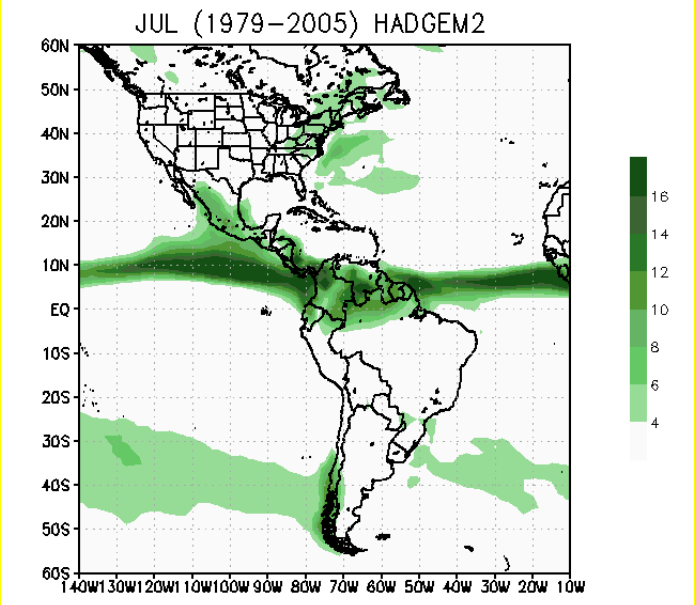
JAN SAMS NAMS JUL





GPCP



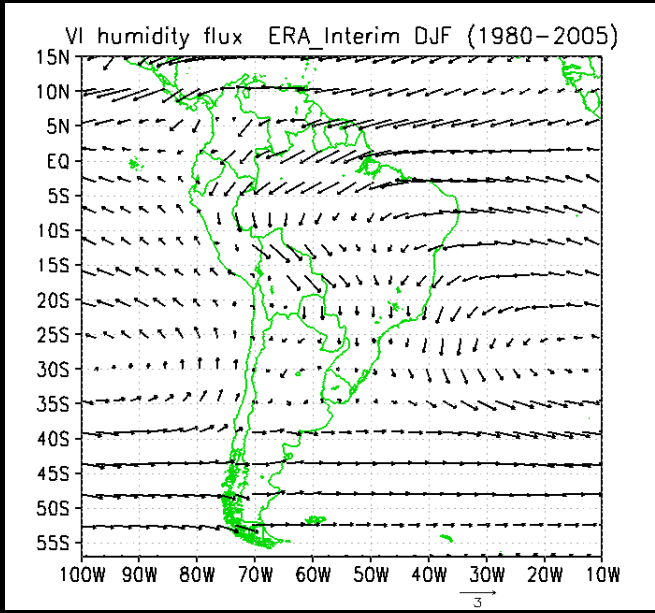


HADGEM2

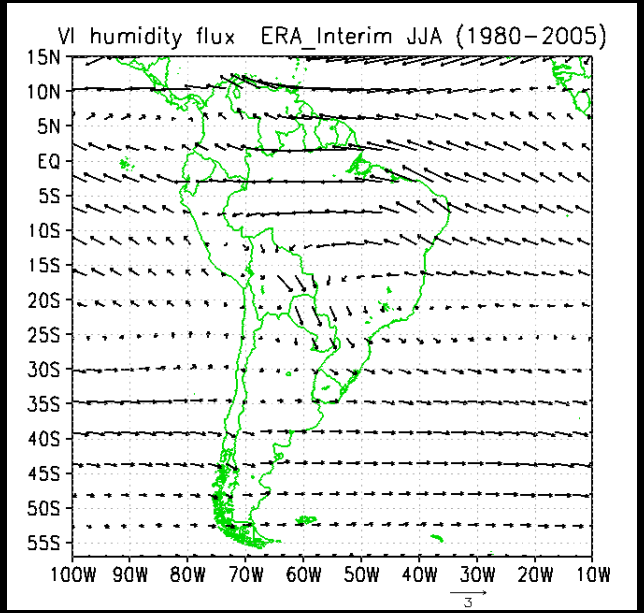
DJF

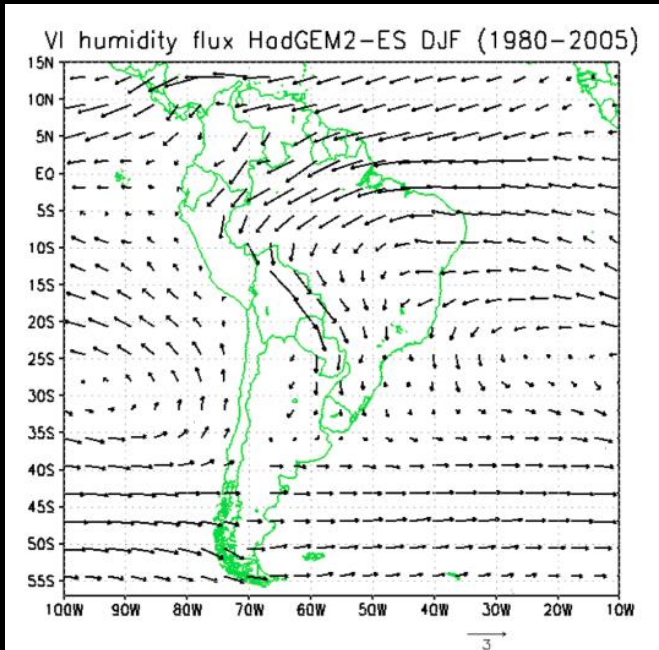
VI humidity flux

JJA

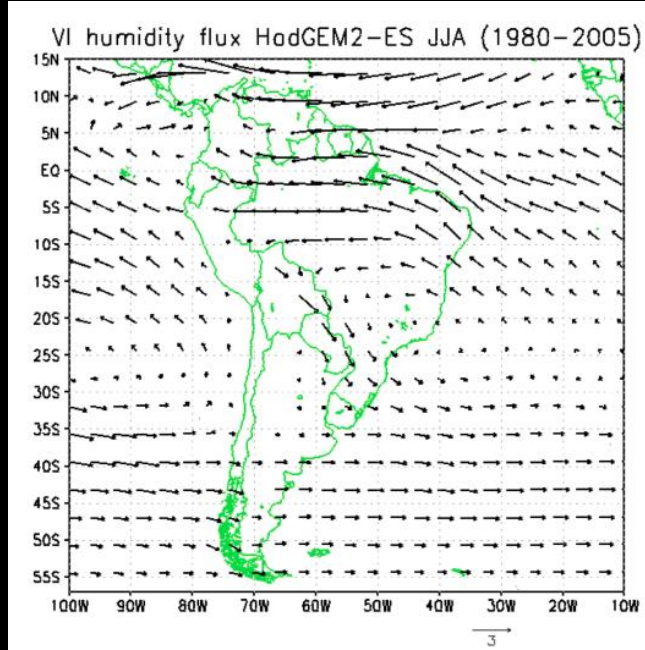


ERAI



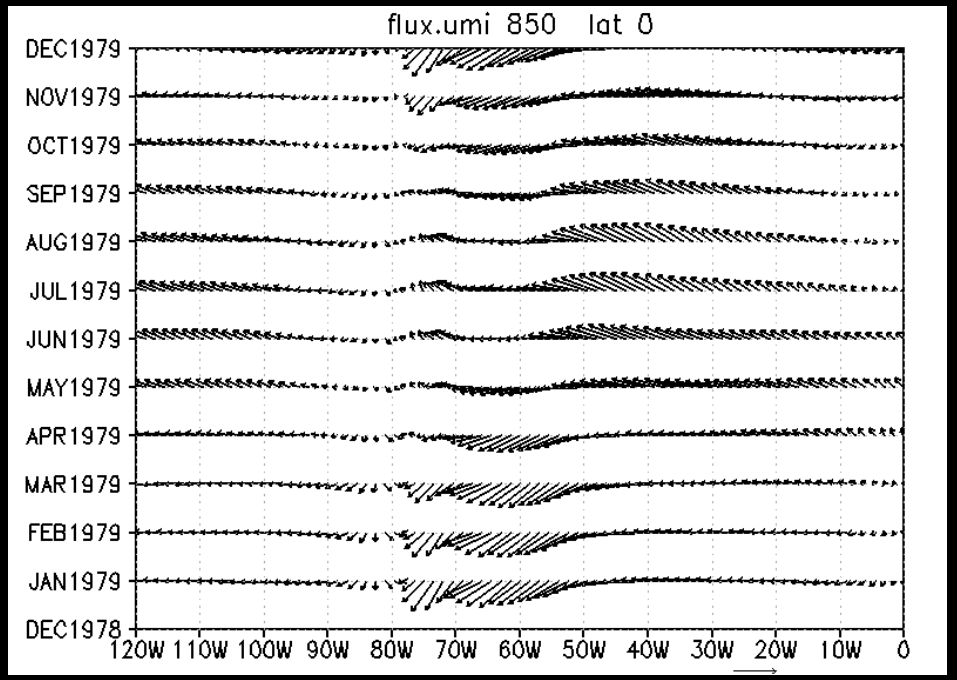


HadGEM2-ES

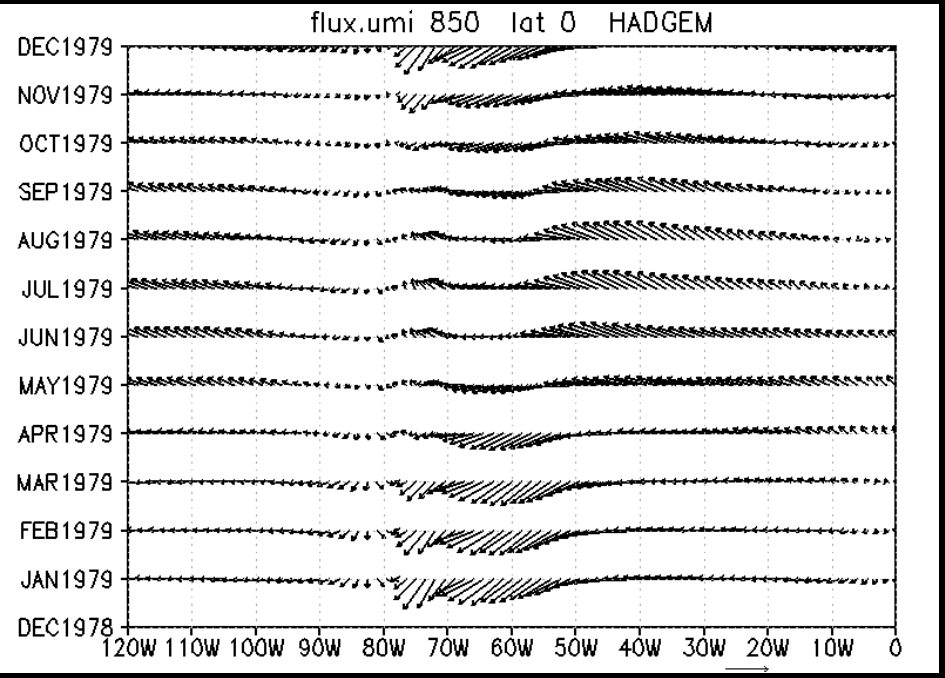


850 hPa Humidity Flux at equator

ERAINT



HADGEM2 (1979-2005)



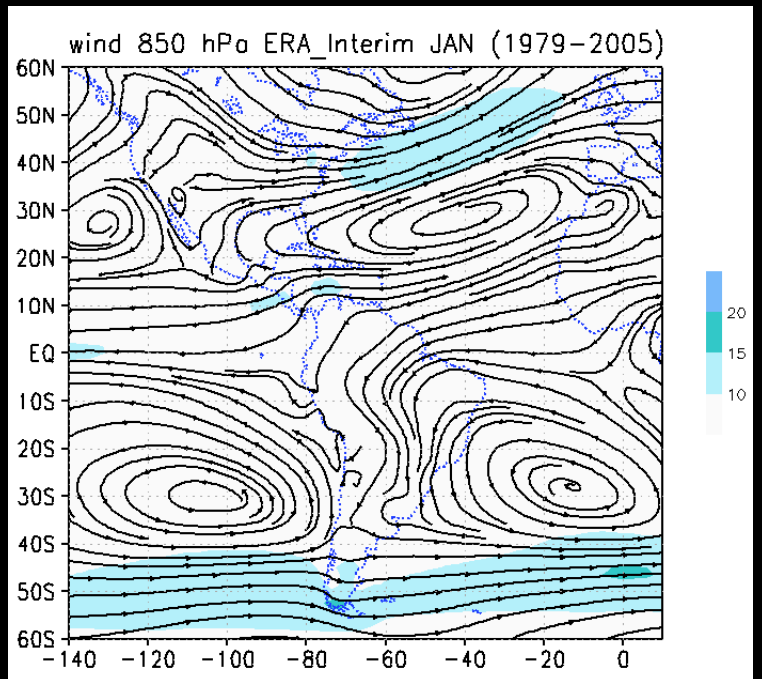
JAN

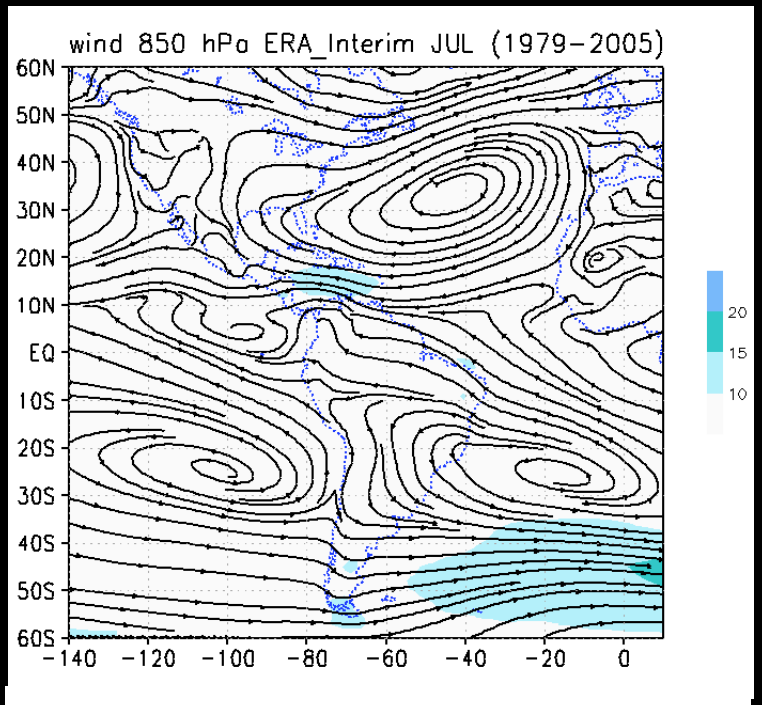
JUL

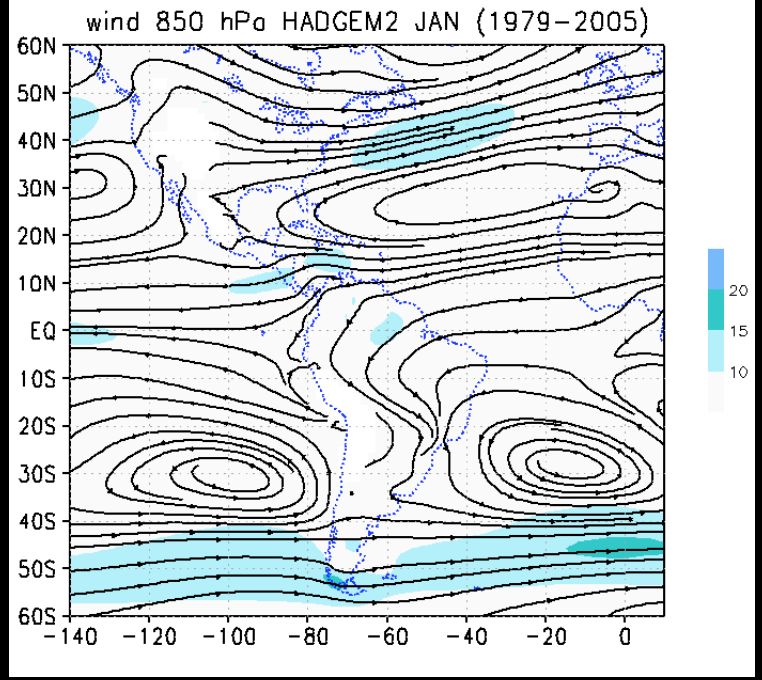
850 hPa

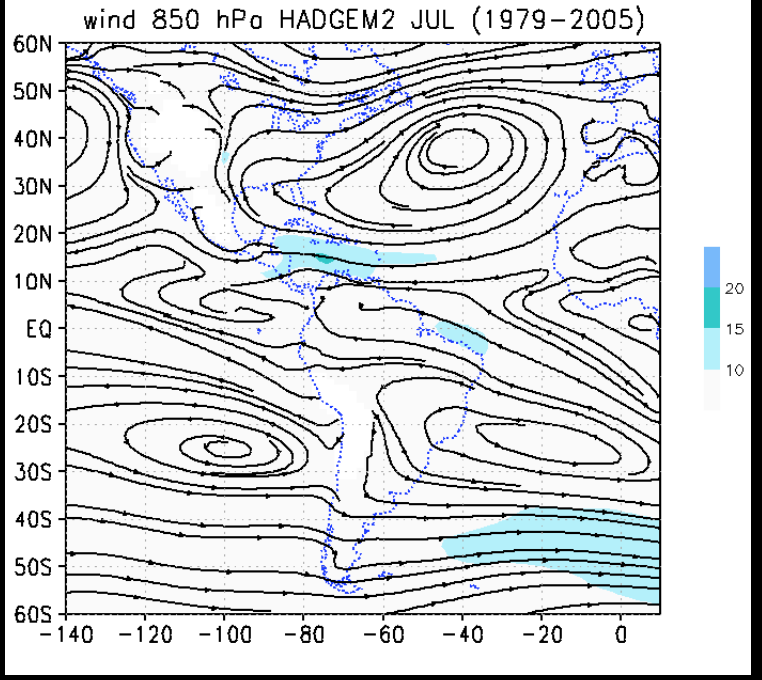
ERA INTERIM

HADGEM2



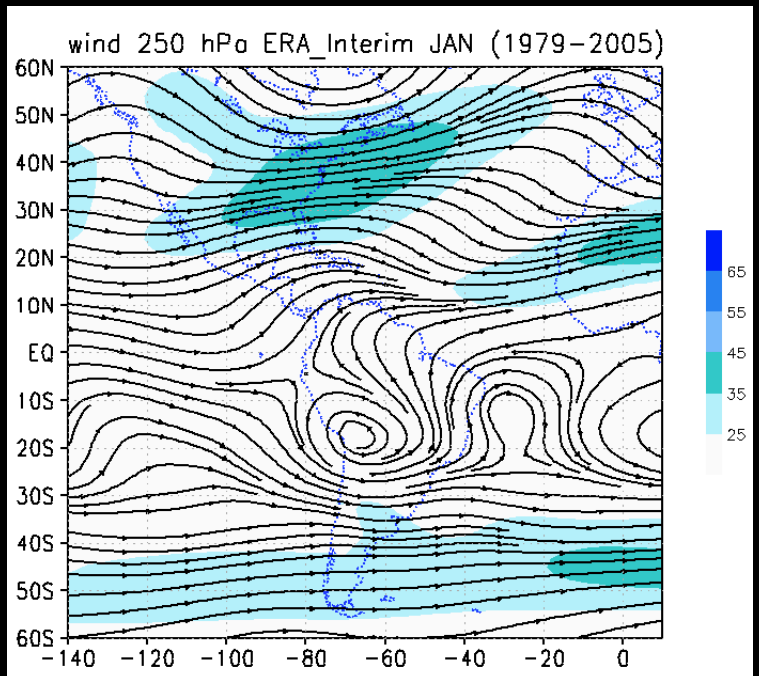






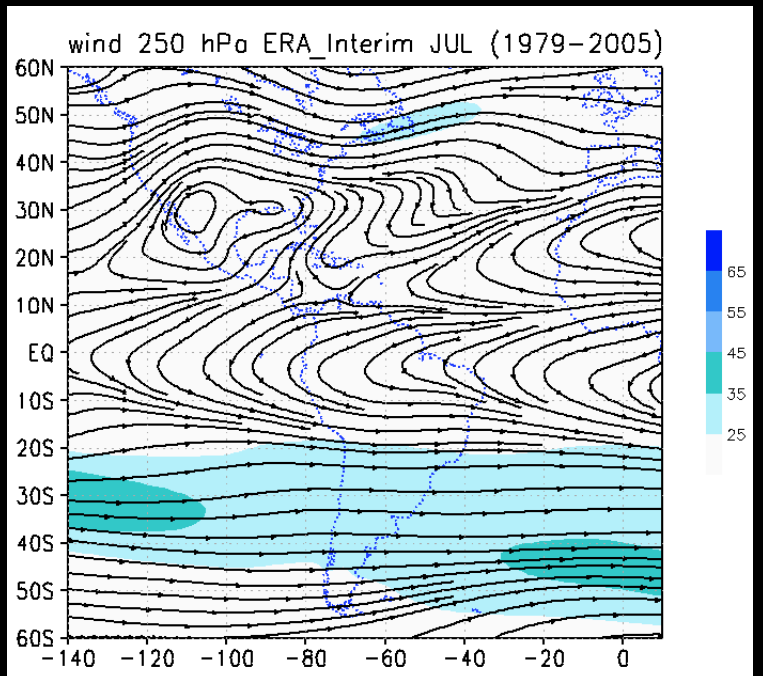
JAN

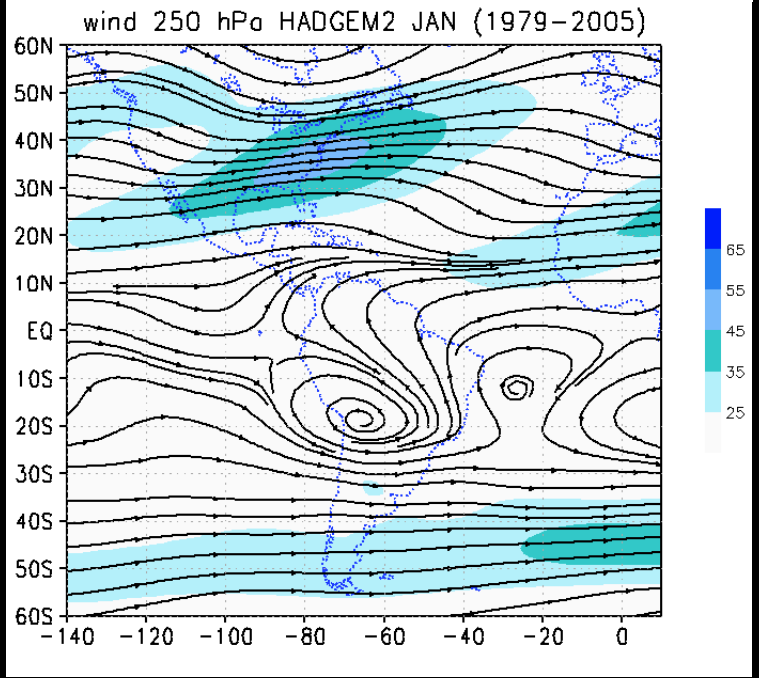
JUL



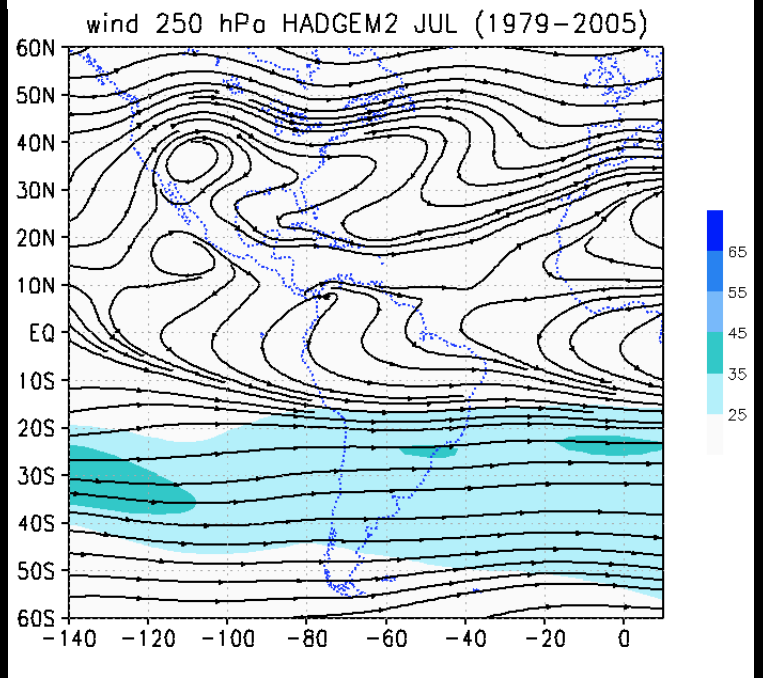
250 hPa

ERA INTERIM





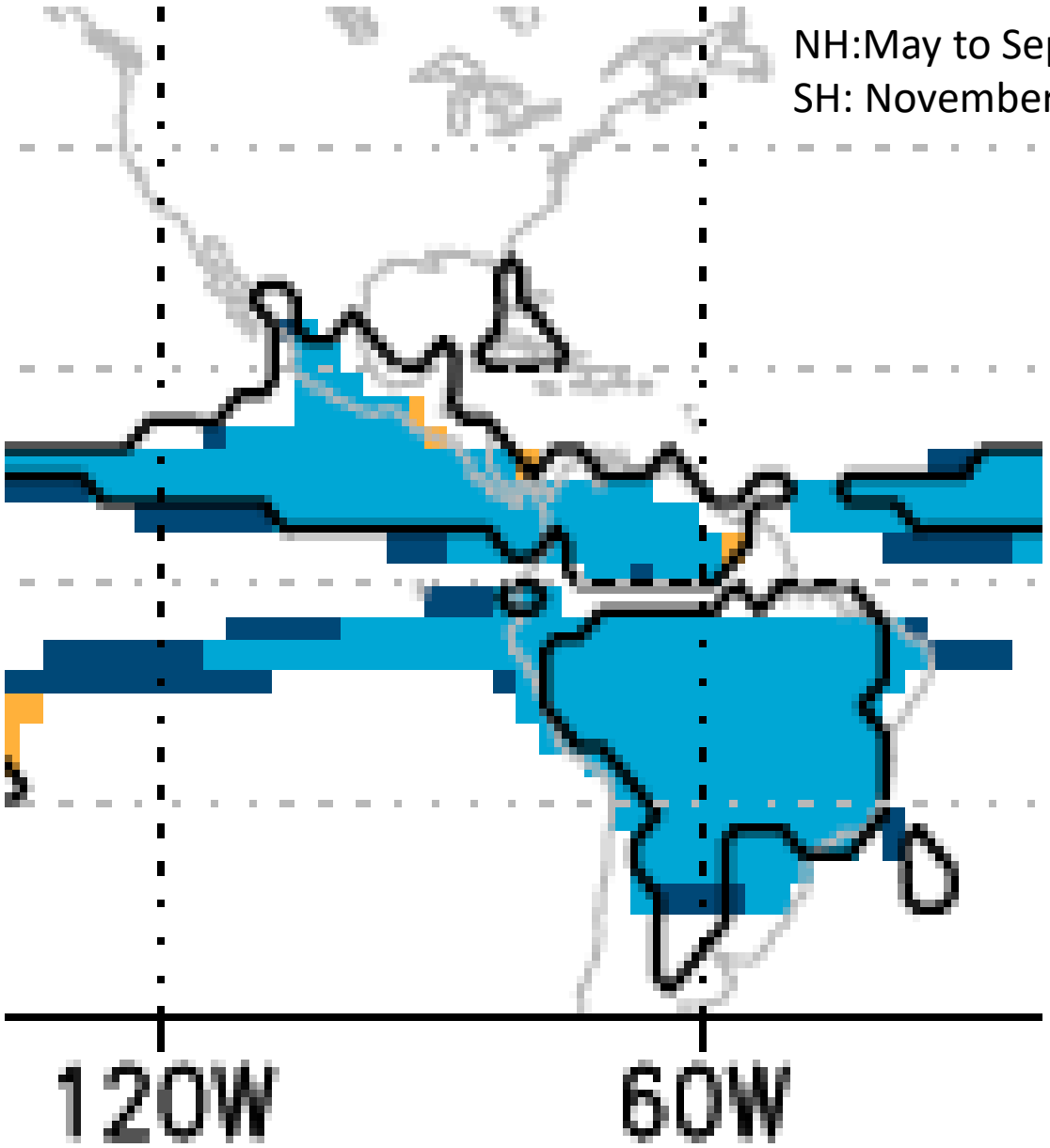
HADGEM2



American Monsoon regions

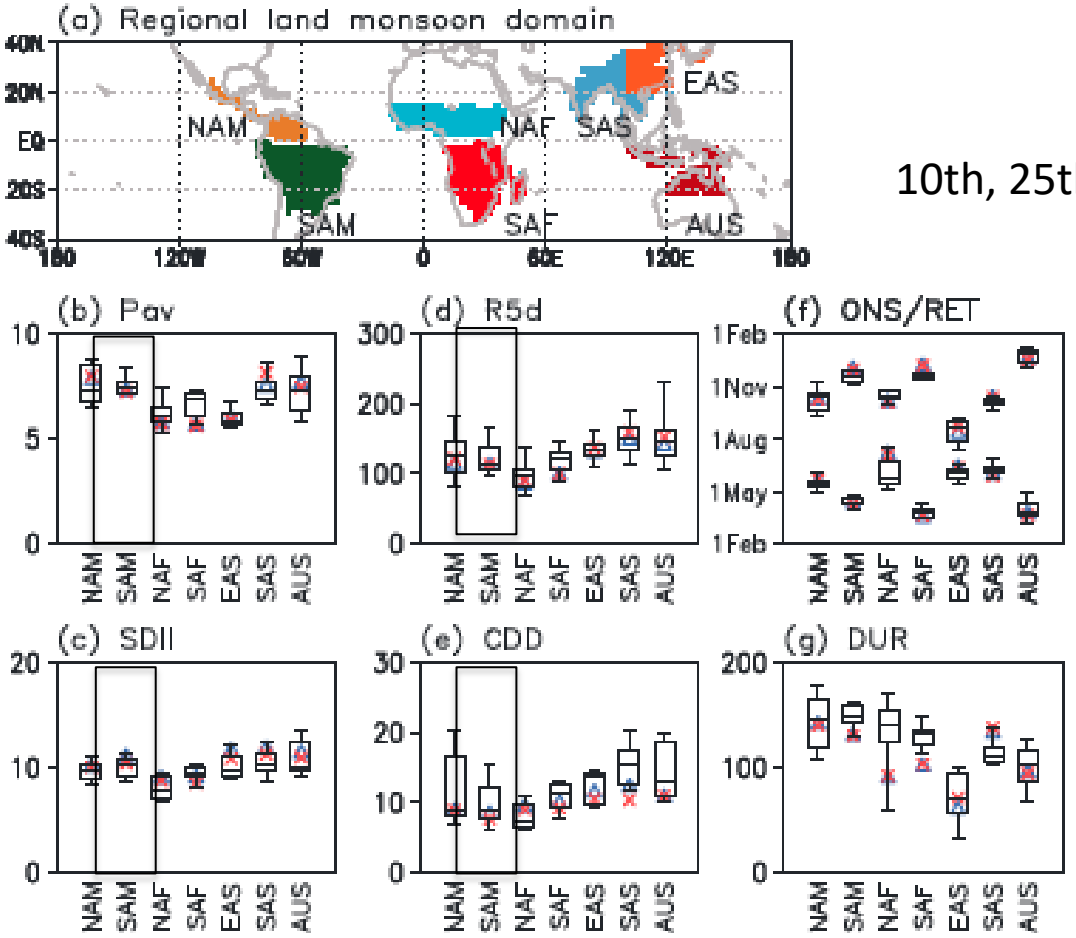
Precipitation difference>= 2.5 mm/day

NH:May to September -November to March
SH: November to March-May to September



29 CMIP5 models

Kitoh et al. (2103)



10th, 25th, 50th, 75th, and 90th percentiles

21 models

Red and blue crosses: TRMM and GPCP

PAV:average precipitation

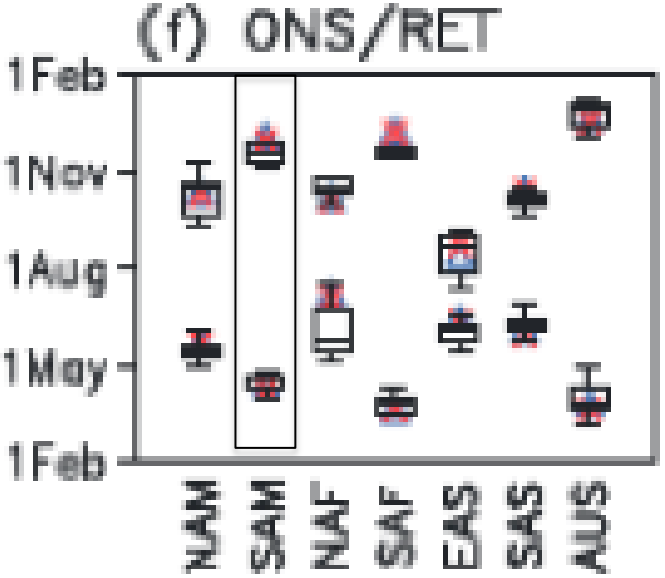
R5d: seasonal maximum 5 day precipitation total

SDII: simple precipitation daily intensity index

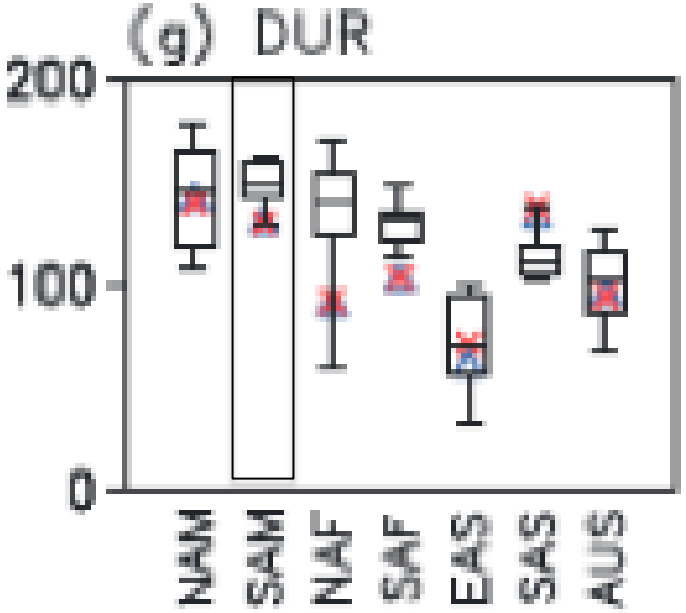
CDD: seasonal maximum consecutive dry days

Kitoh et al. (2103)

the onset (retreat) date is defined as the date when the relative precipitation first exceeds (last drops below) 5 mm/day and the duration is defined as their difference.



regionally averaged relative climatological mean daily precipitation is the difference between the climatological daily precipitation and the precipitation of the July dry month (SAMS)

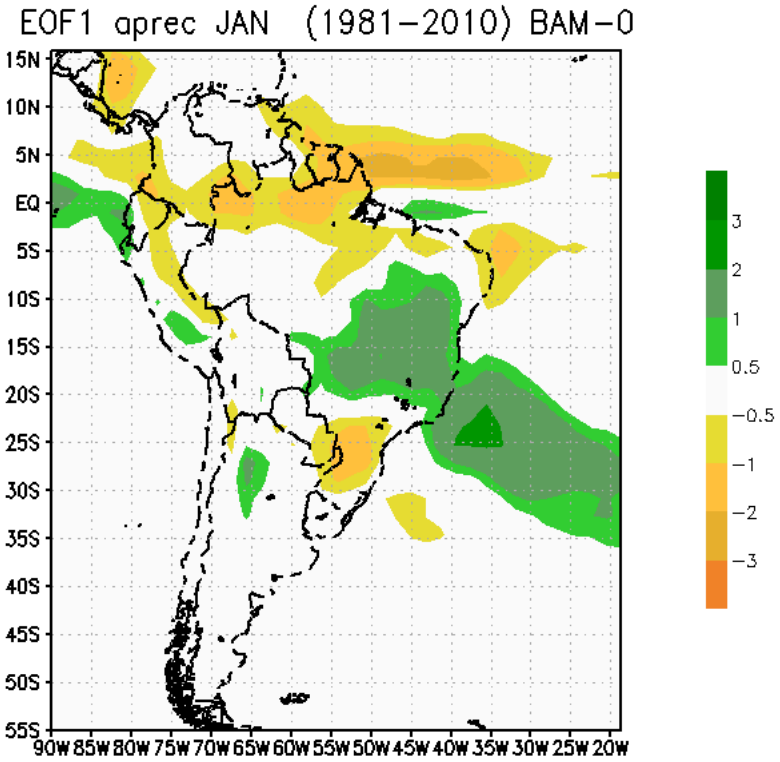


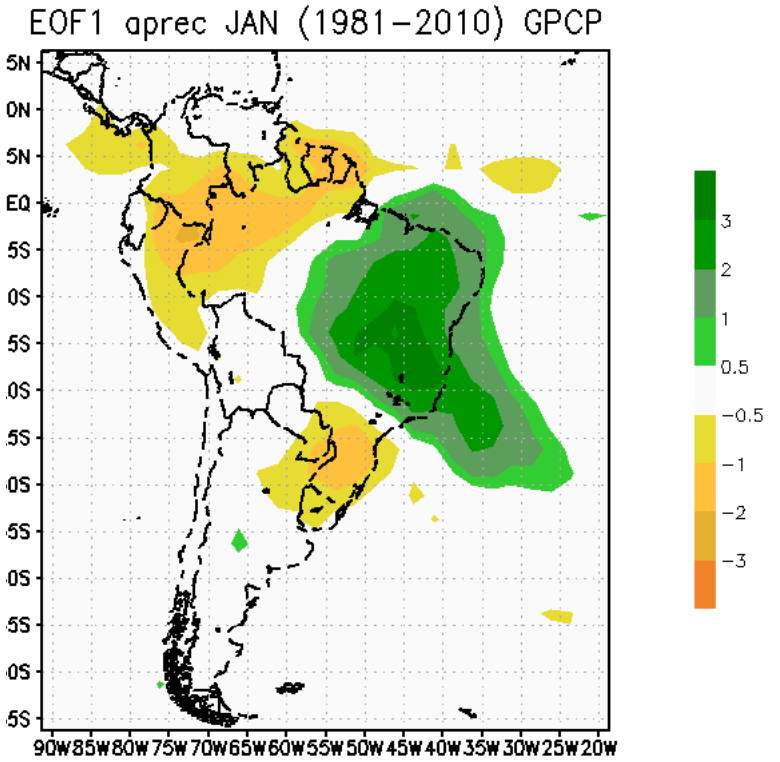
ONS: monsoon onset date

RET: retreat date

DUR: duration

CPTEC/INPE AGCM





Dominant mode of precipitation variability

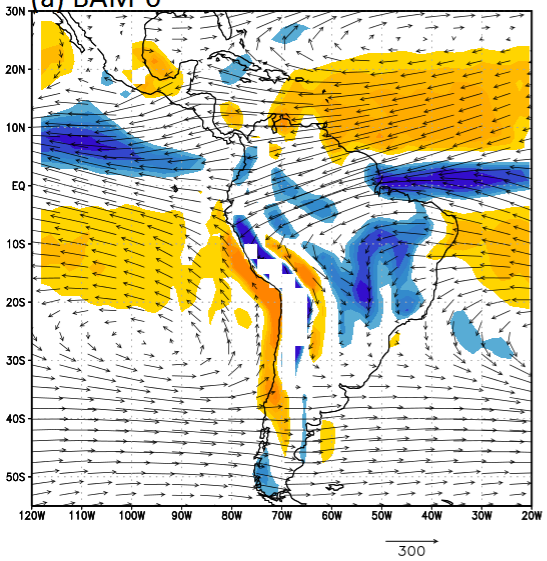
V.I. Humidity Flux and divergence

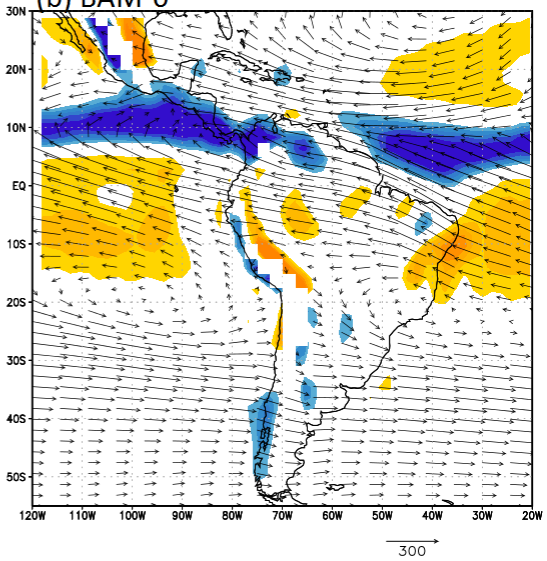
DJF

JJA

(a) BAM-0

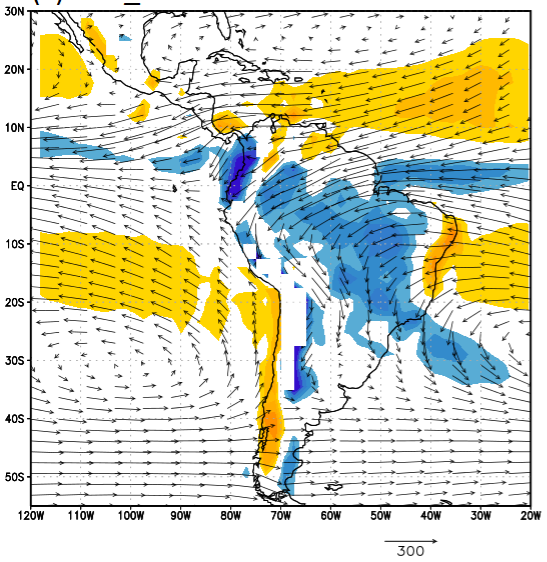
(b) BAM-0

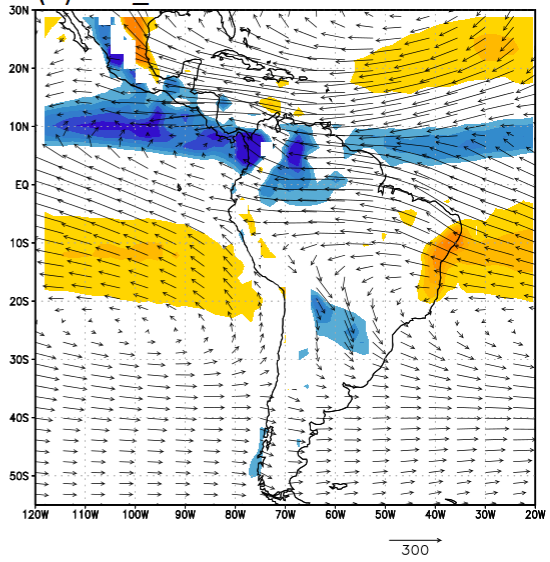


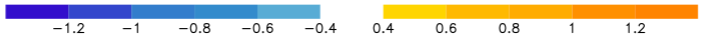


(c) ERA_I

(d) ERA_I





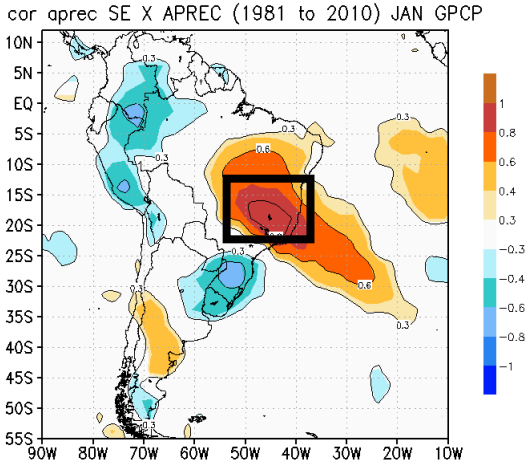


CPTEC/INPE AGCM

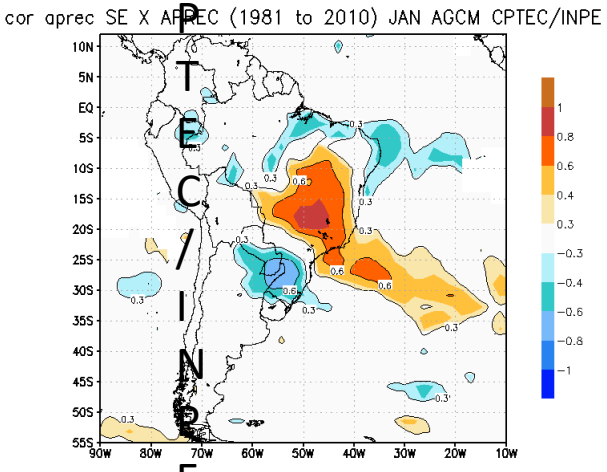
ERA-I

Correlation between SE precipitation and other grid points

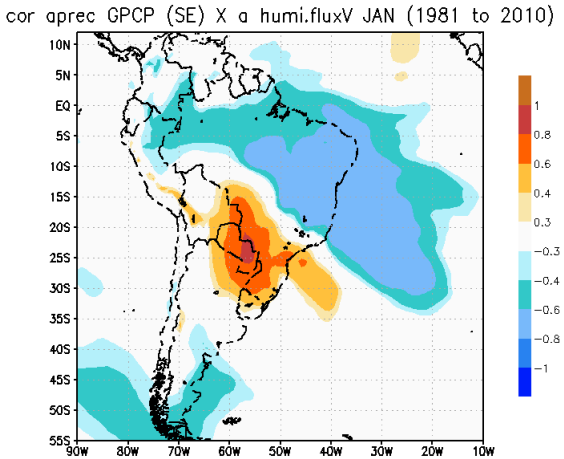
GPCP

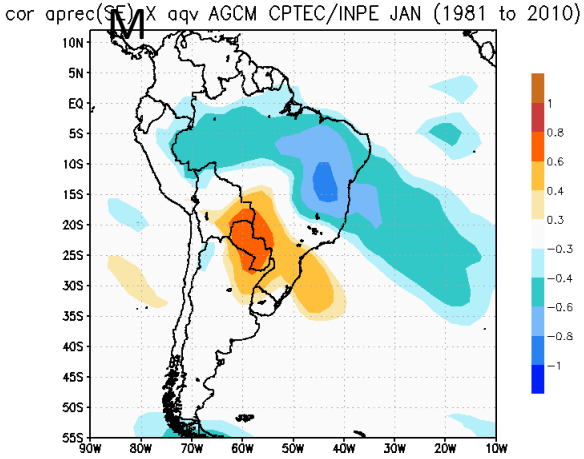


CPTEC/INPE AGCM

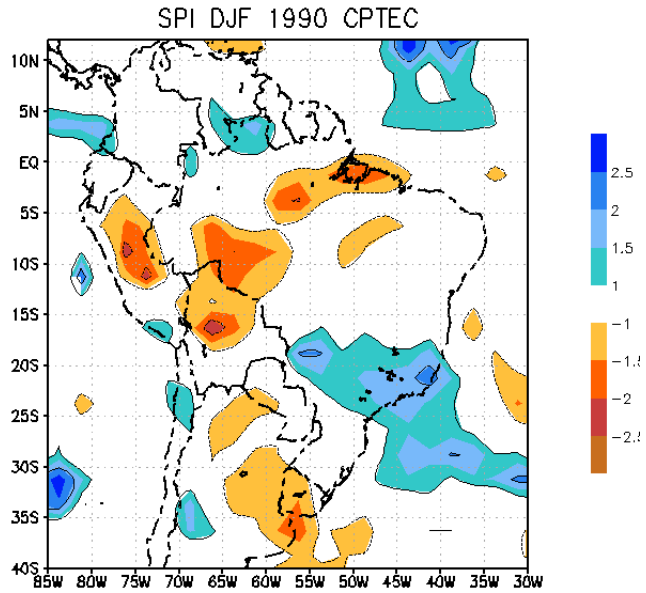


Correlation between SE precipitation and meridional humidity flux

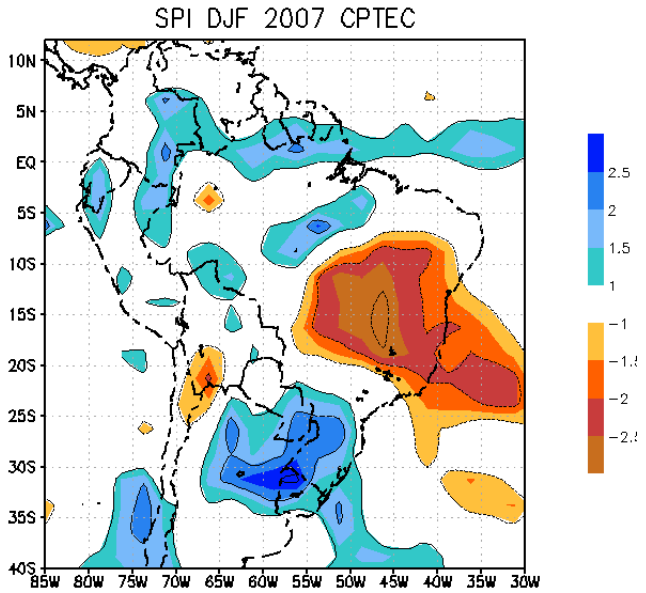


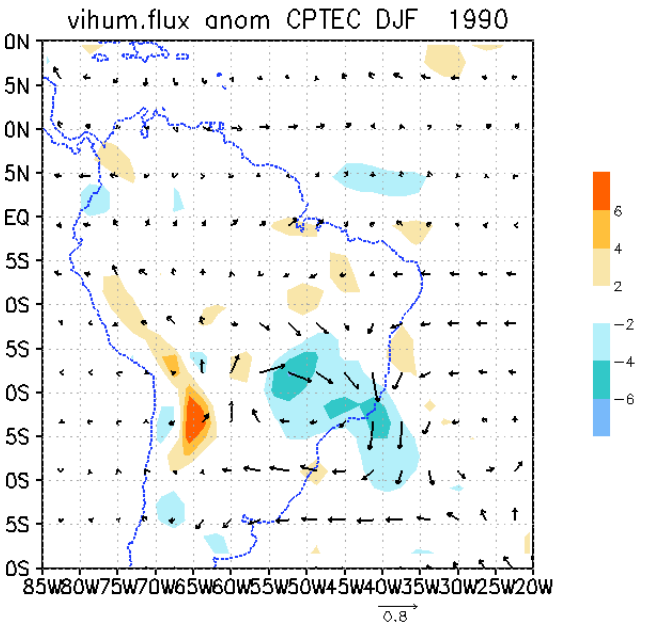


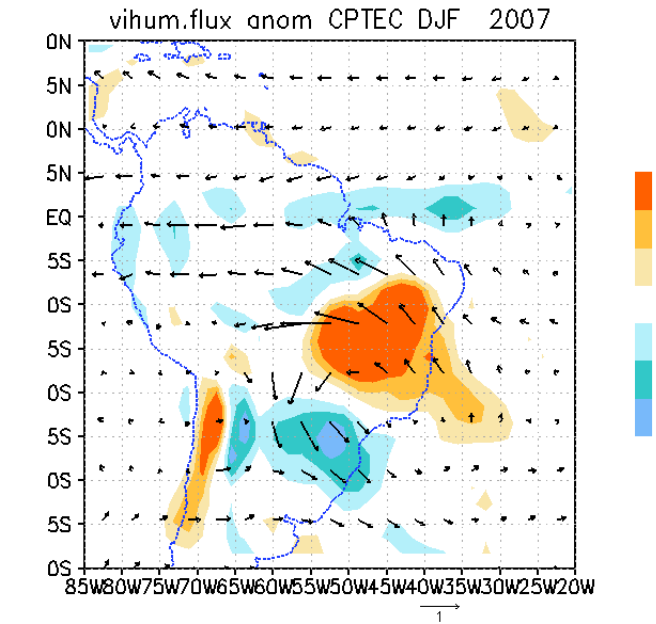
Wet year



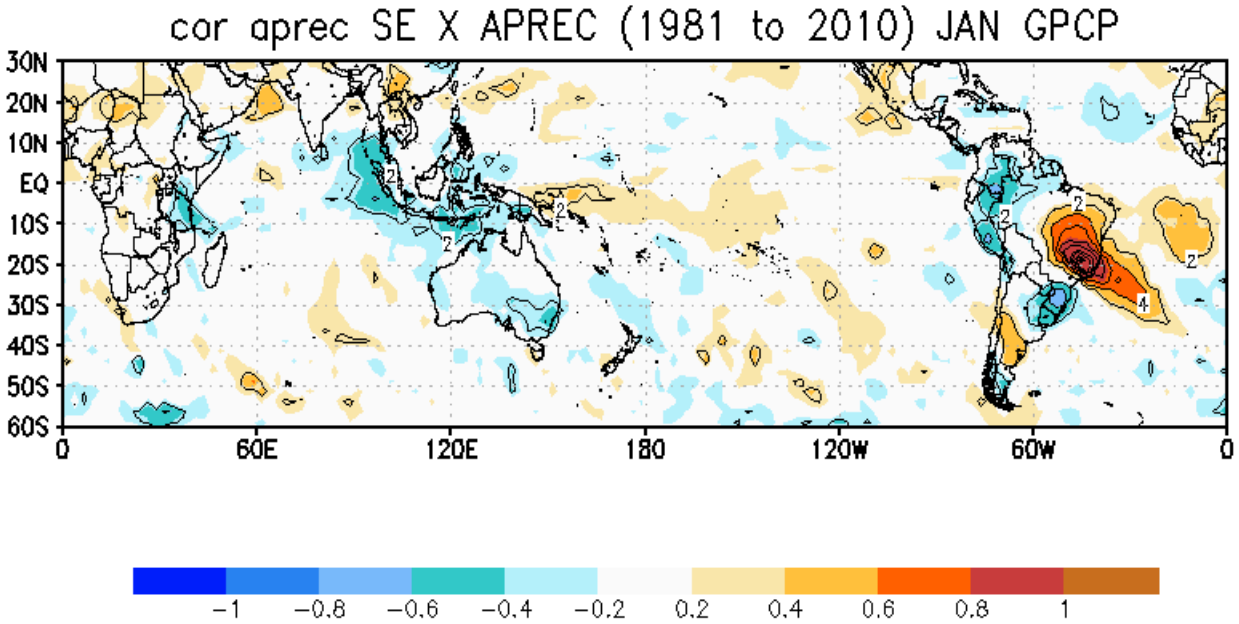
Dry year



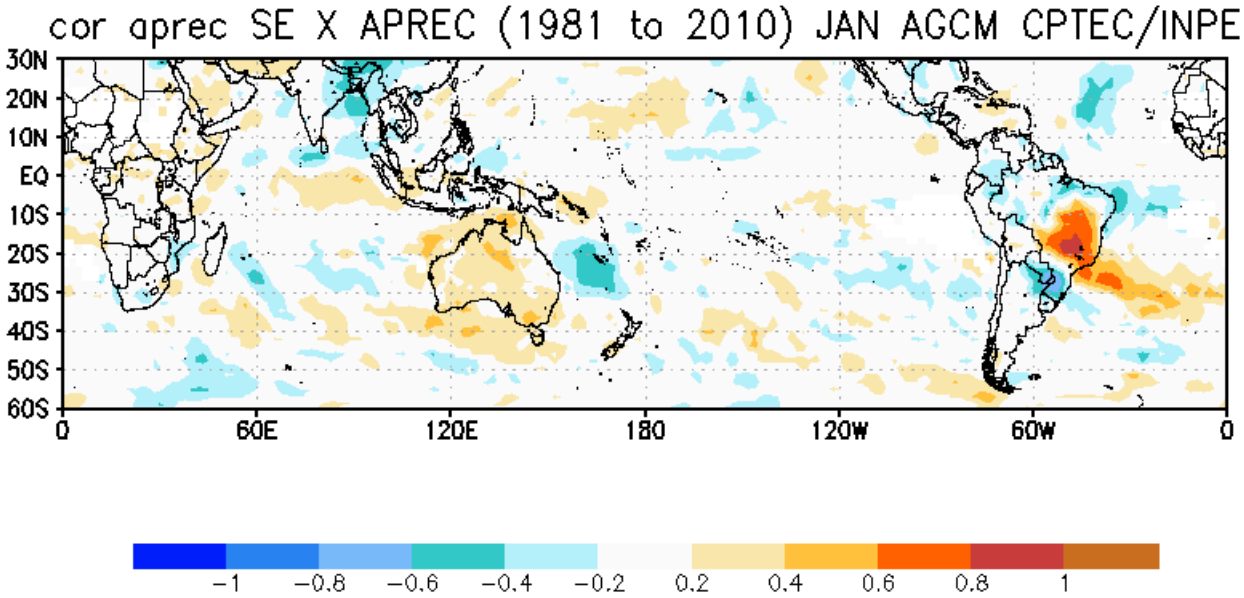




Correlation between SE precipitation and other grid points

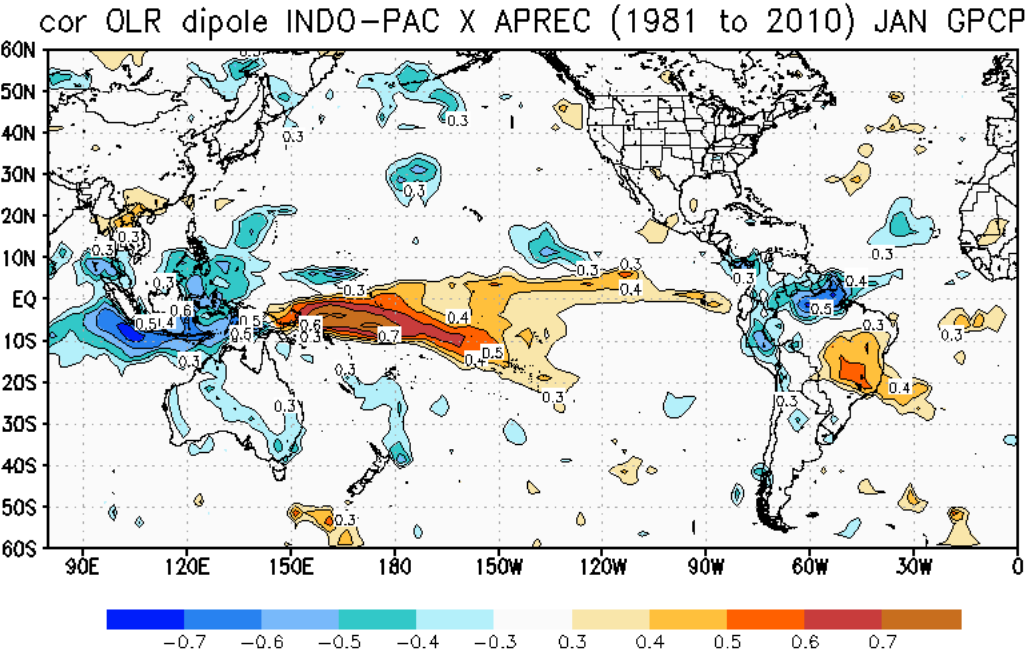


GPCP



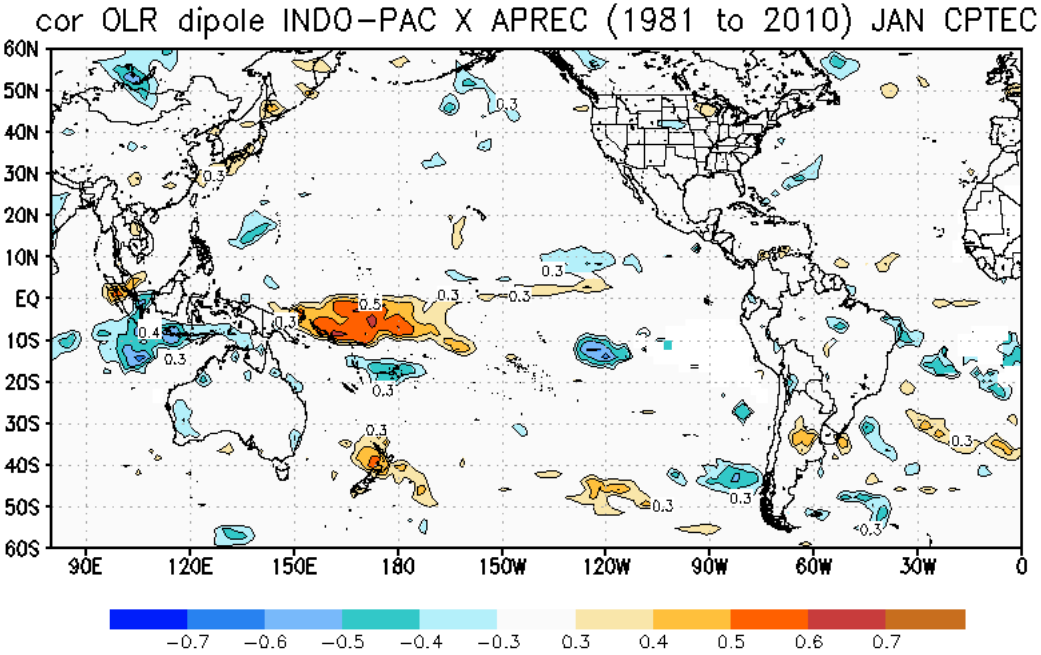
CPTEC/INPE AGCM

Cavalcanti et al. 2017



Correlation between Indo-Pacific OLR dipole and precipitation

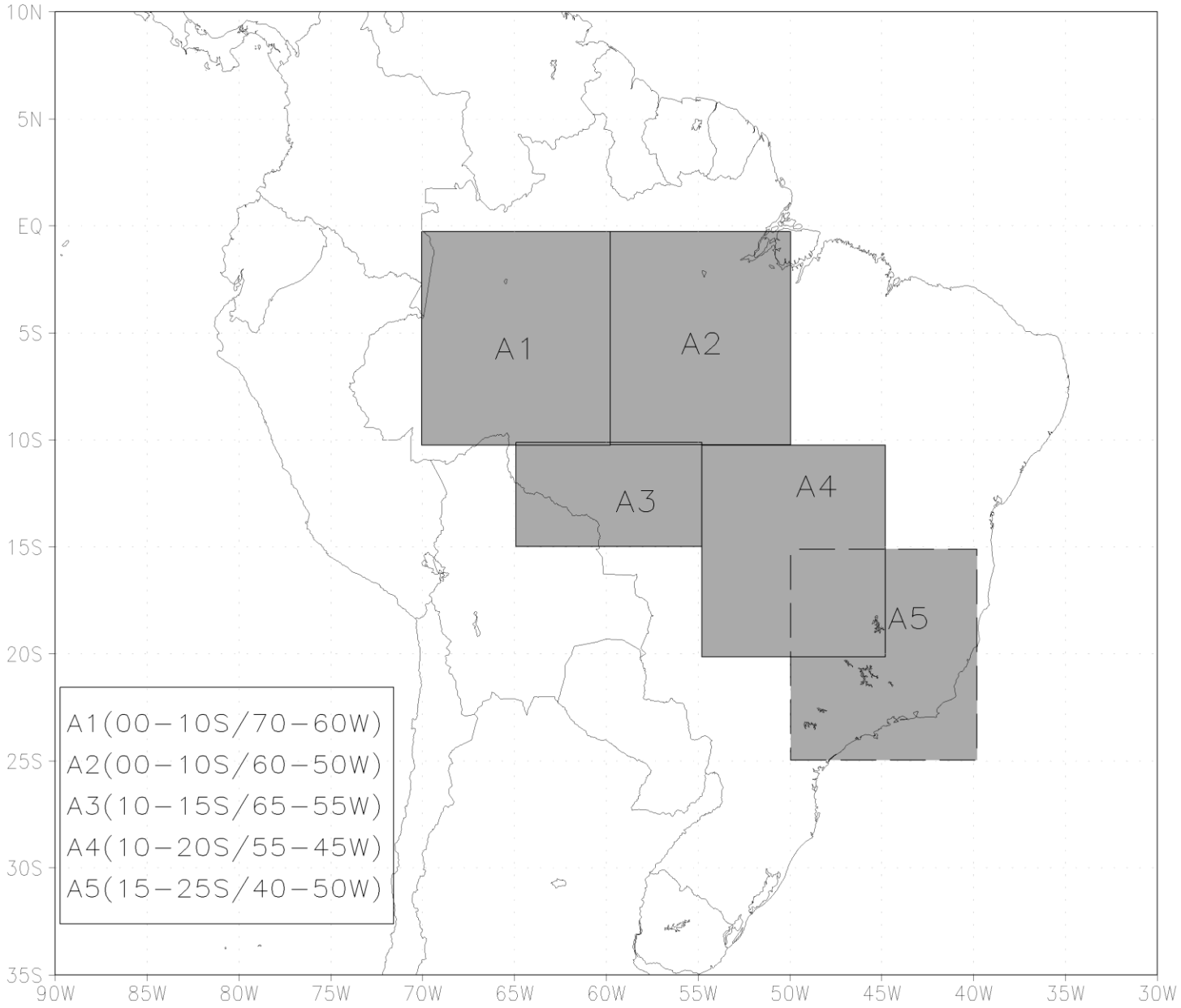
OBSERVED



CPTEC/INPE AGCM

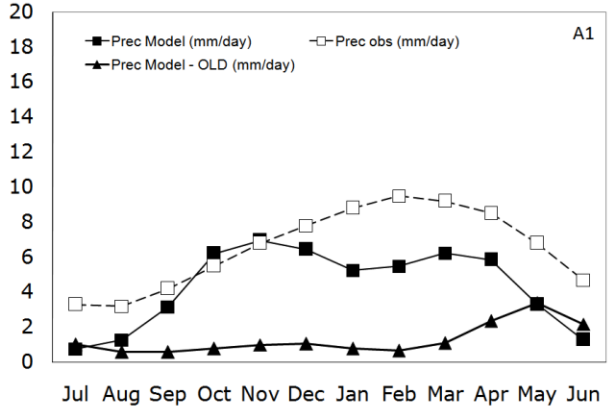
Cavalcanti et al. 2017

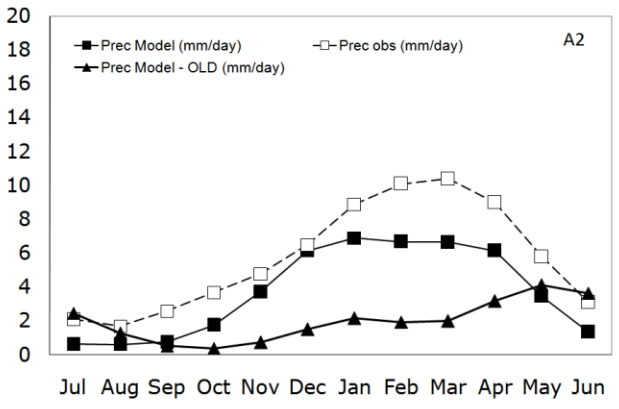
analyzed areas - CPTEC/INPE AGCM

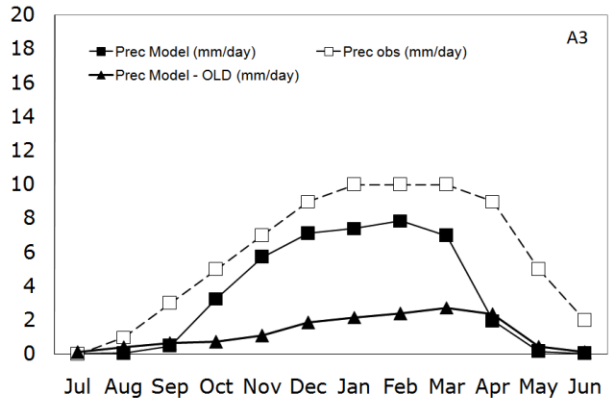


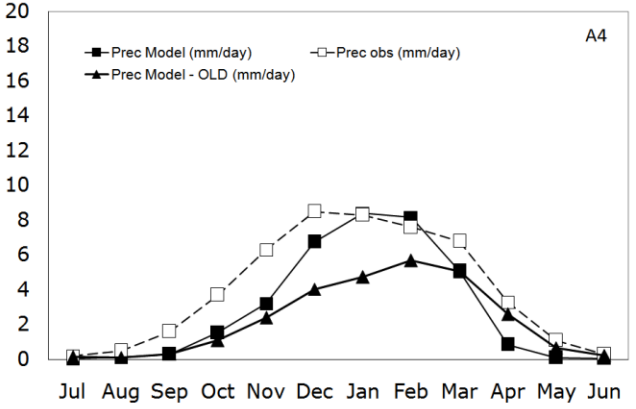
Annual Cycle Precipitation (1980-2000)

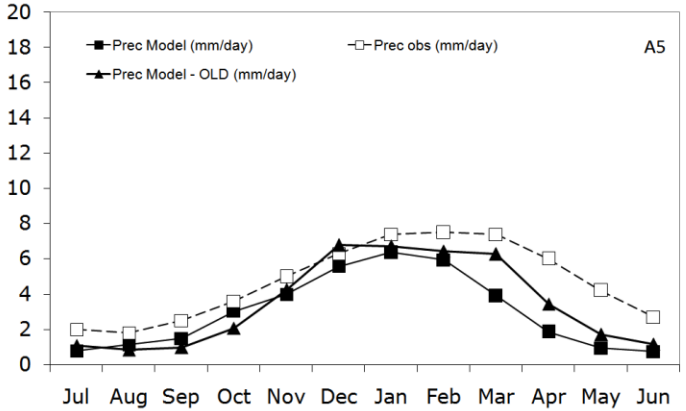
A3







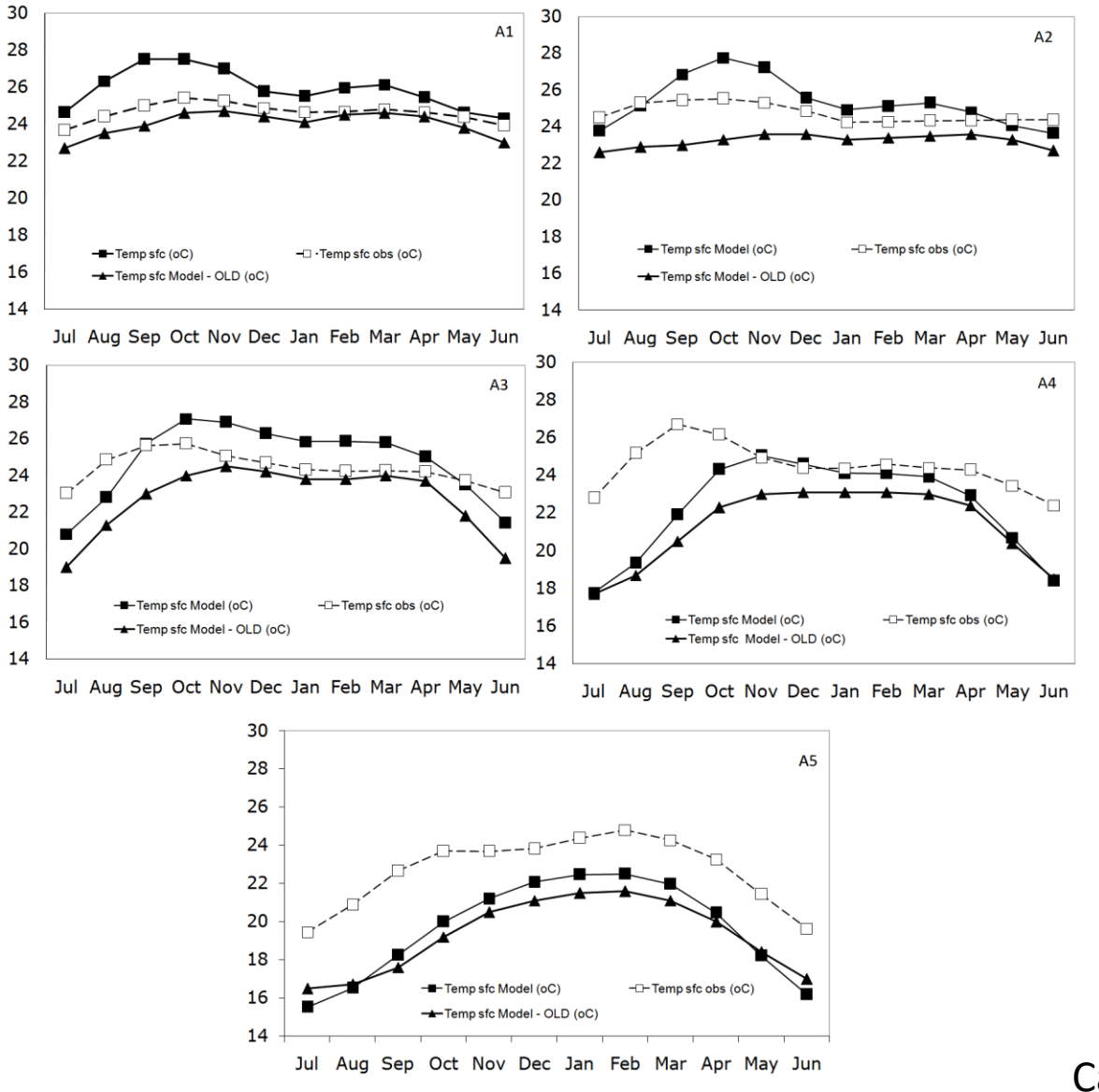




Cavalcanti and Raia 2017

Annual Cycle Temperature (1980-2000)

A3

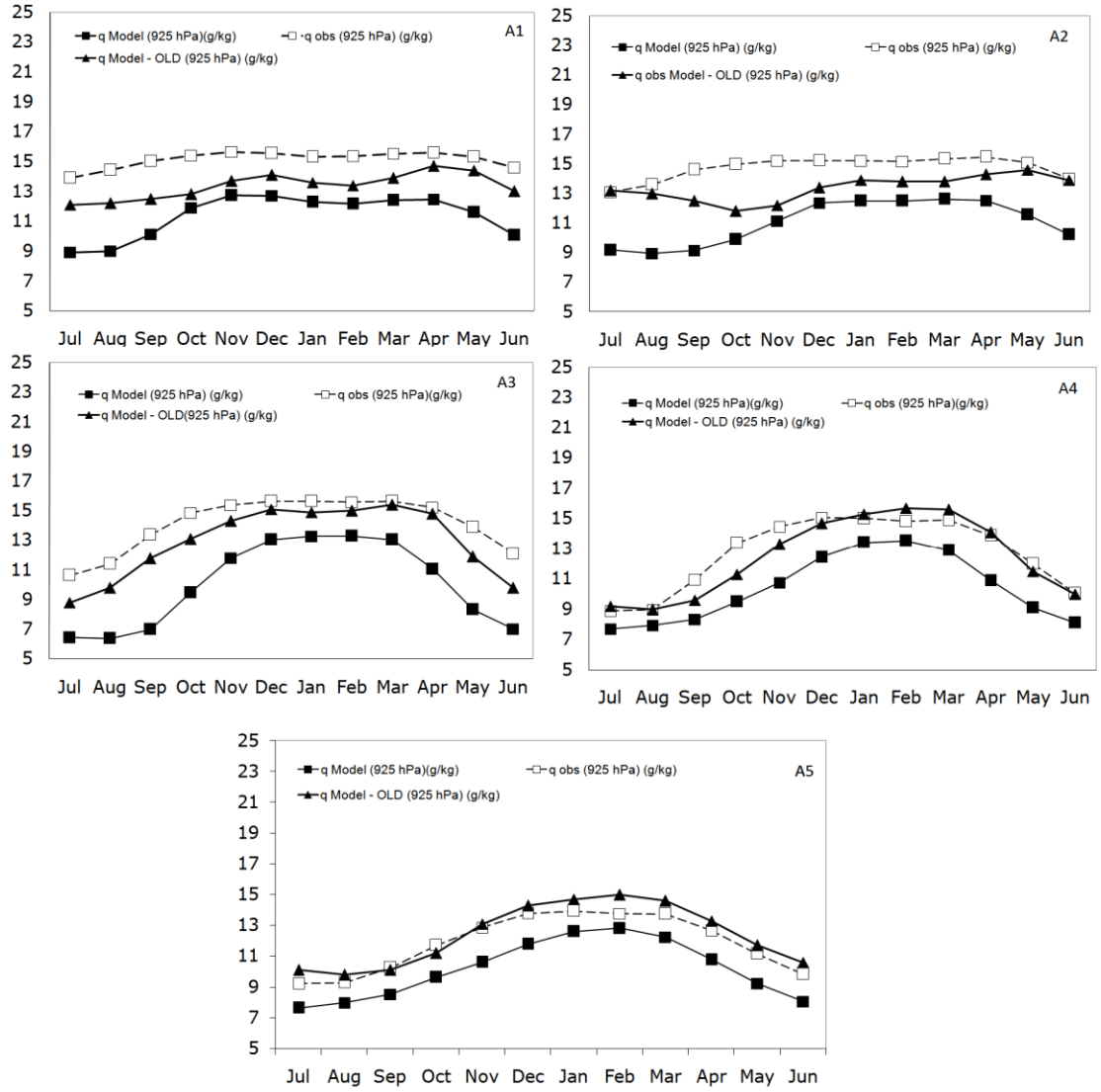


Cavalcanti and Raia 2017

Annual Cycle Specific Humidity 925 hPa (1980-2000)

CPTEC/INPE AGCM

A3

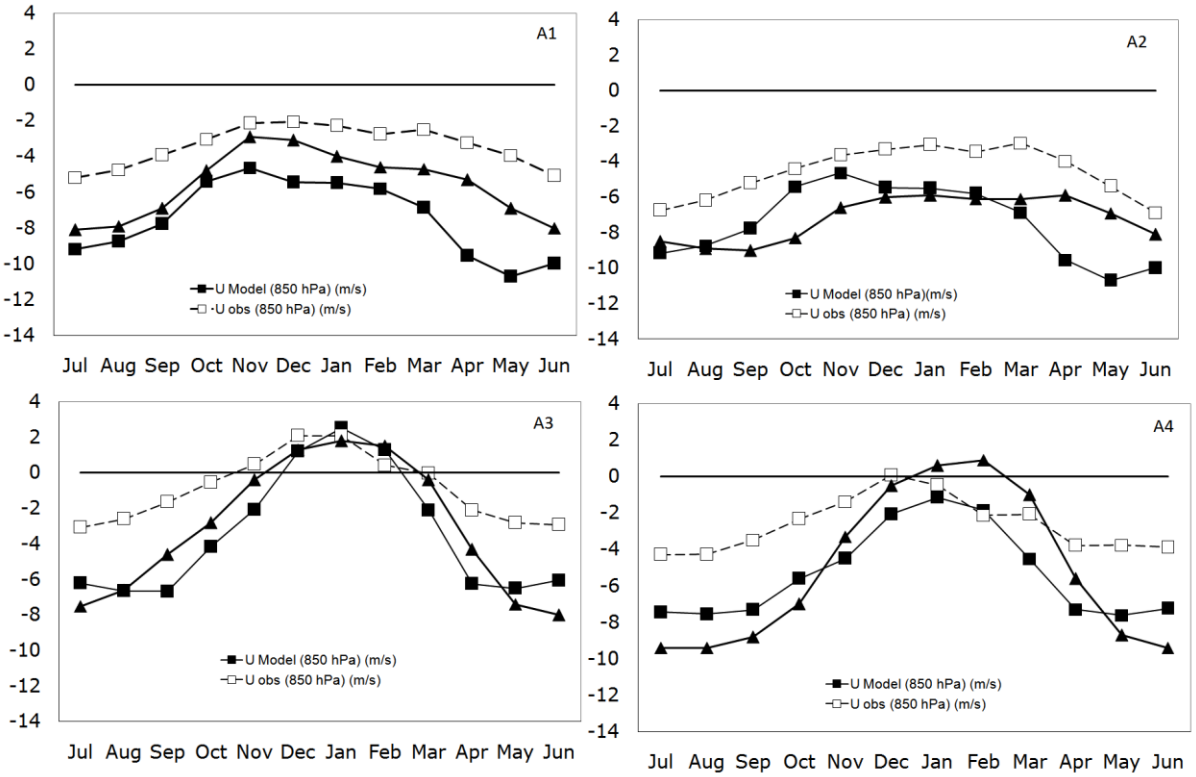


Cavalcanti and Raia 2017

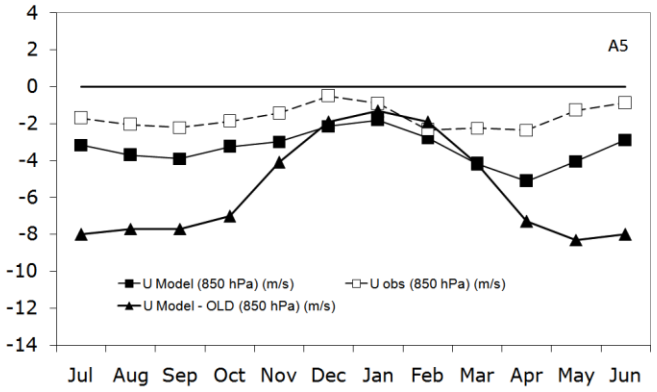
Annual cycle zonal wind at 850 hPa (1980-2000)

CPTEC/INPE AGCM

A3



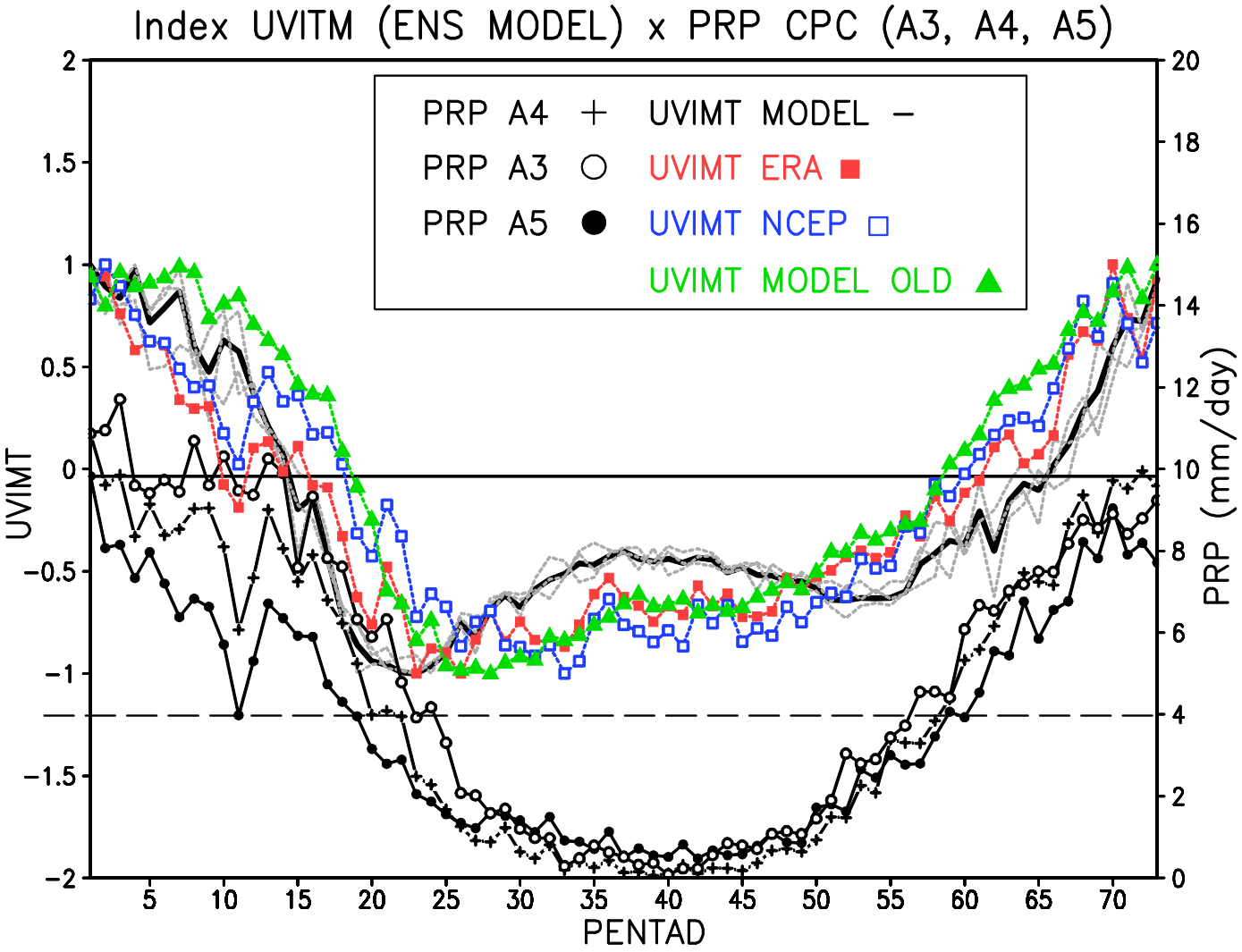
SAMS core



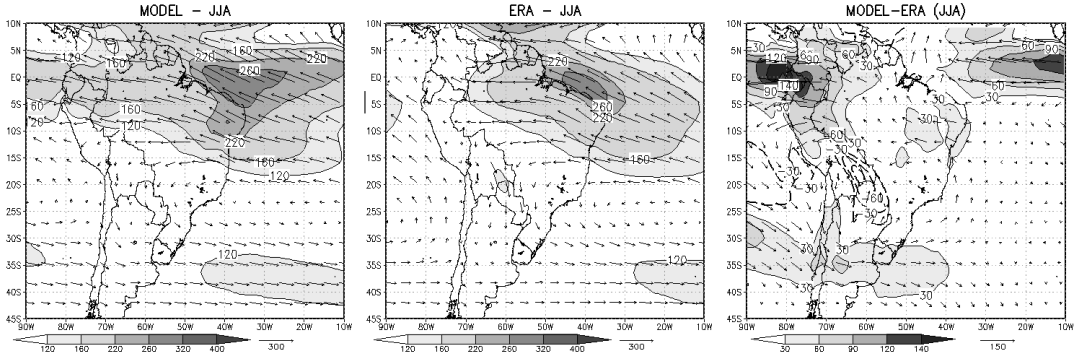
Cavalcanti and Raia 2017

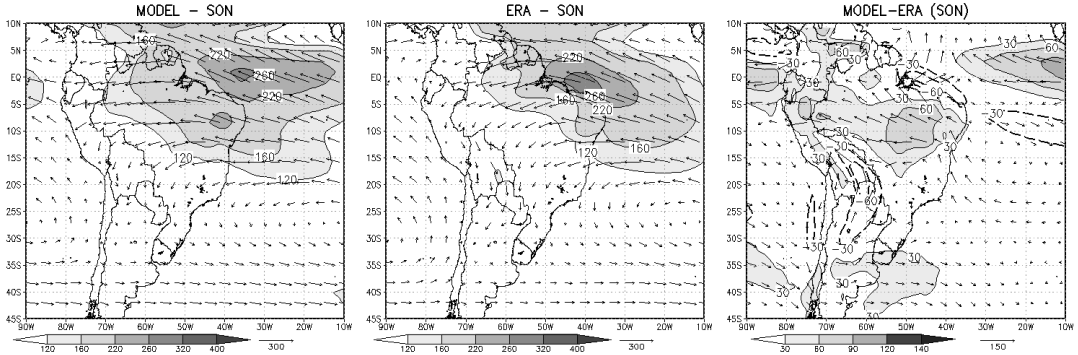
Humidity flux index SAMS core

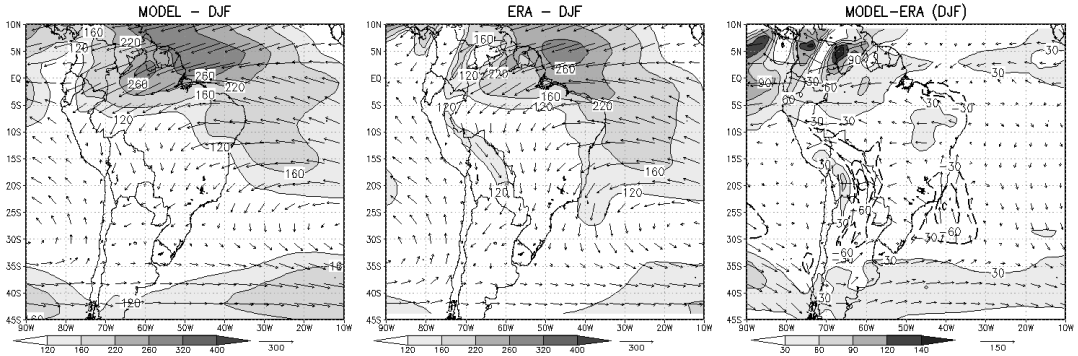
CPTEC/INPE AGCM

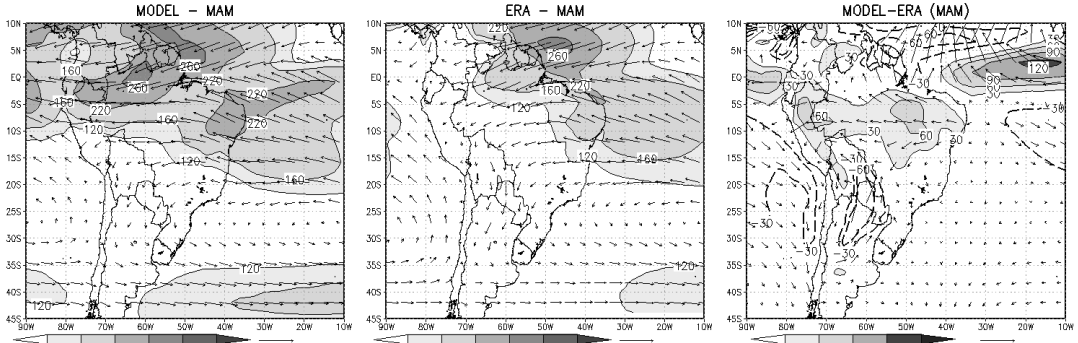


Cavalcanti and Raia 2017









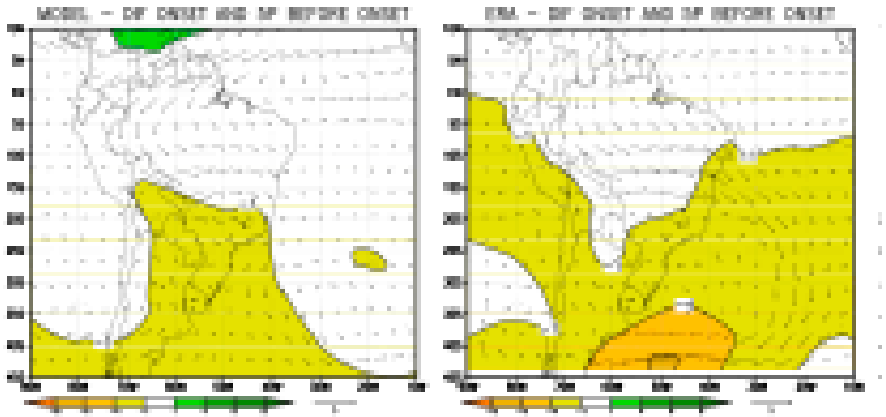
Humidity flux and convergence

CPTEC/INPE AGCM

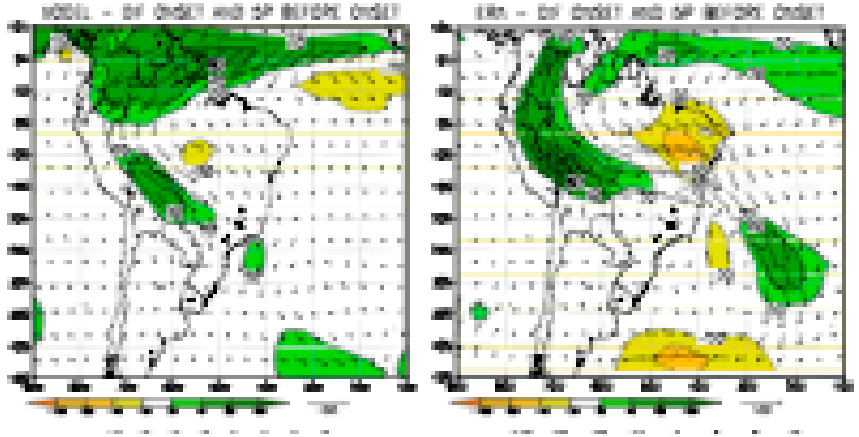
Cavalcanti and Raia 2017

DIF onset-5pentads before

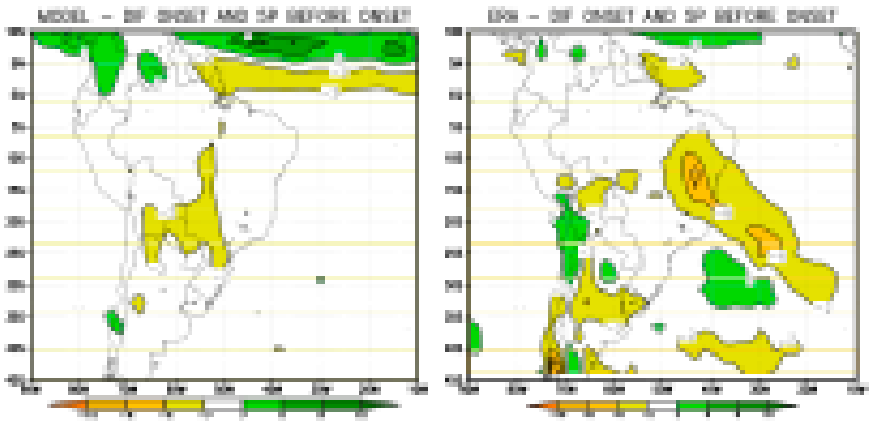
CPTEC/INPE AGCM



Wind 850hPa and SLP



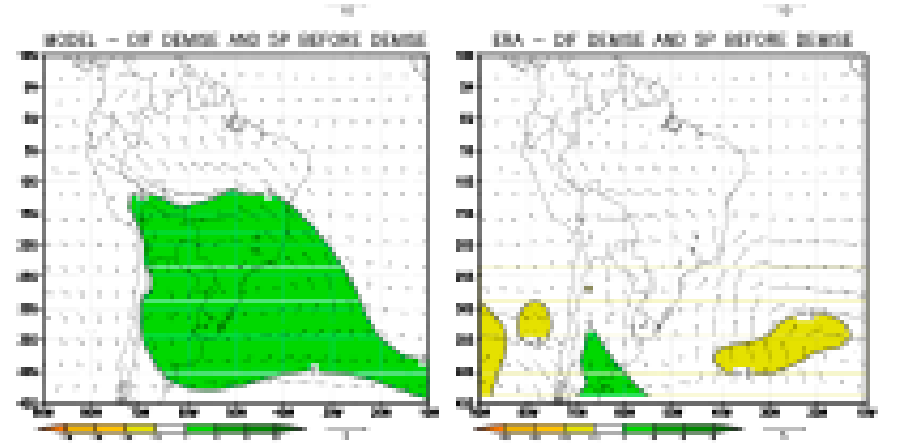
Humidity flux and convergence

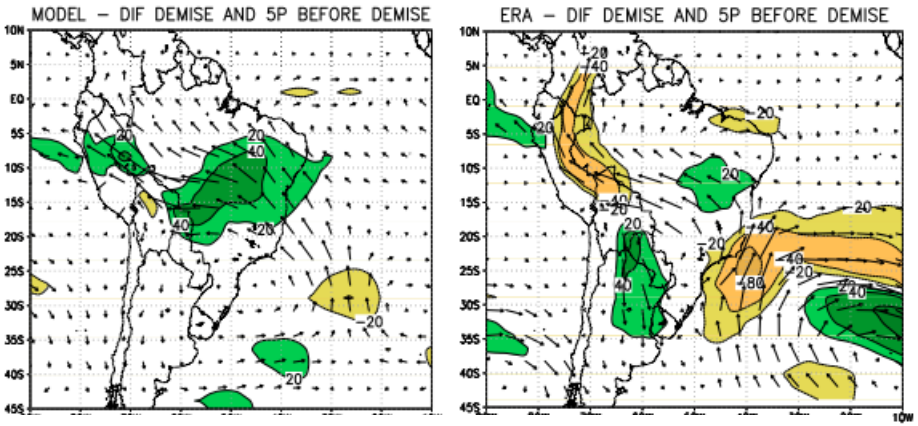


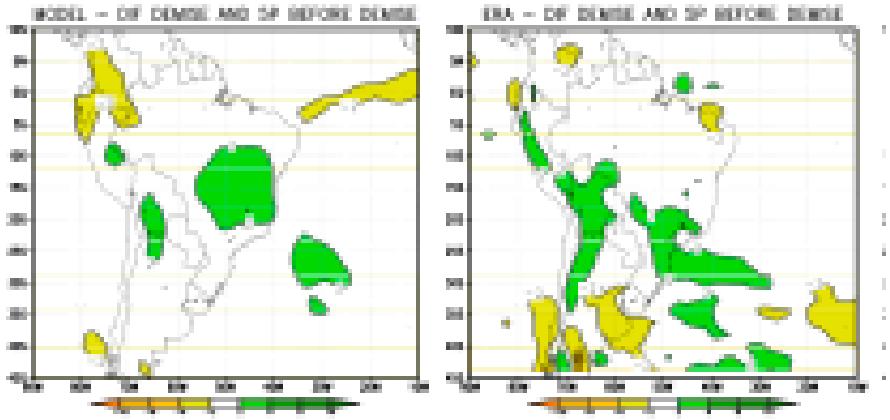
Omega

Cavalcanti and Raia 2017

DIF demise-5pentads before







Wind 850hPa and SLP

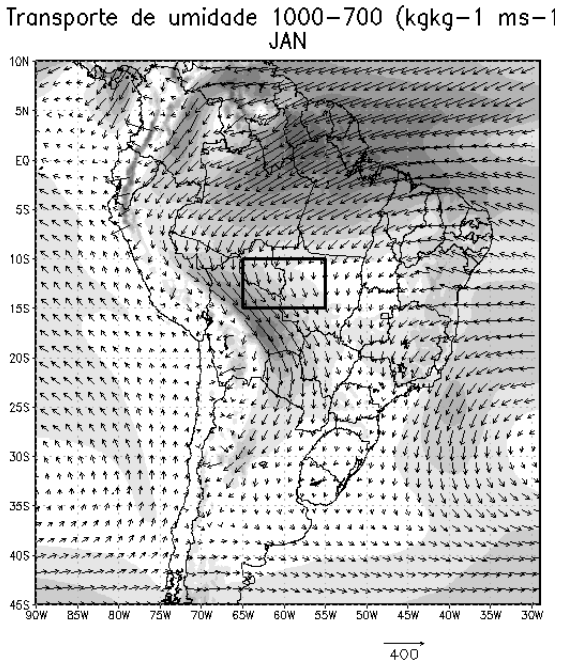
Humidity flux and convergence

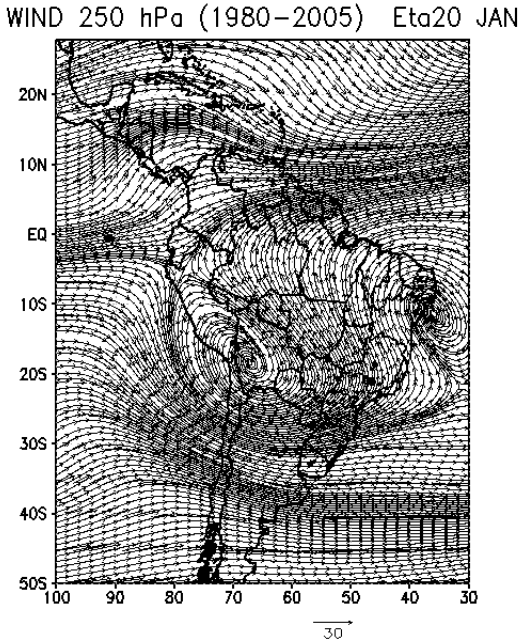
Omega

Cavalcanti and Raia 2017

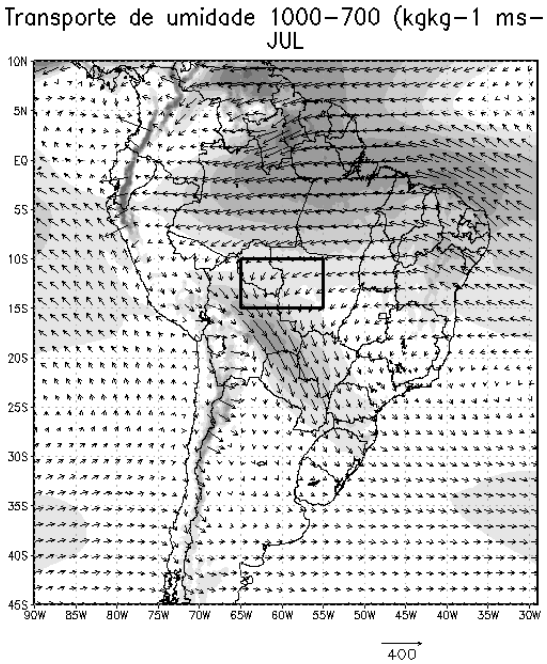
ETA Regional Model

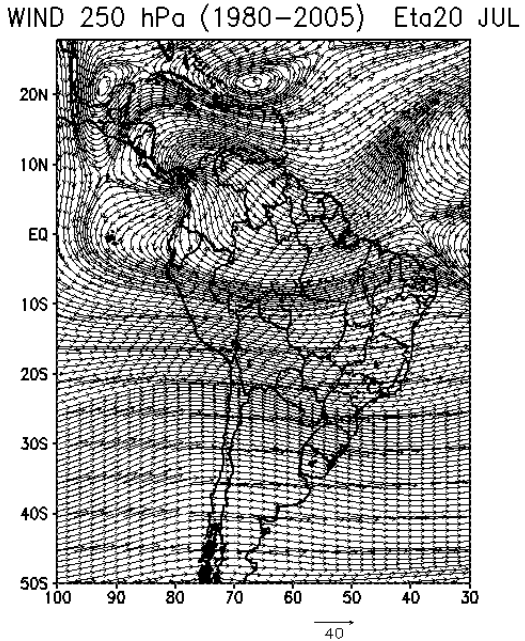
JAN





JUL

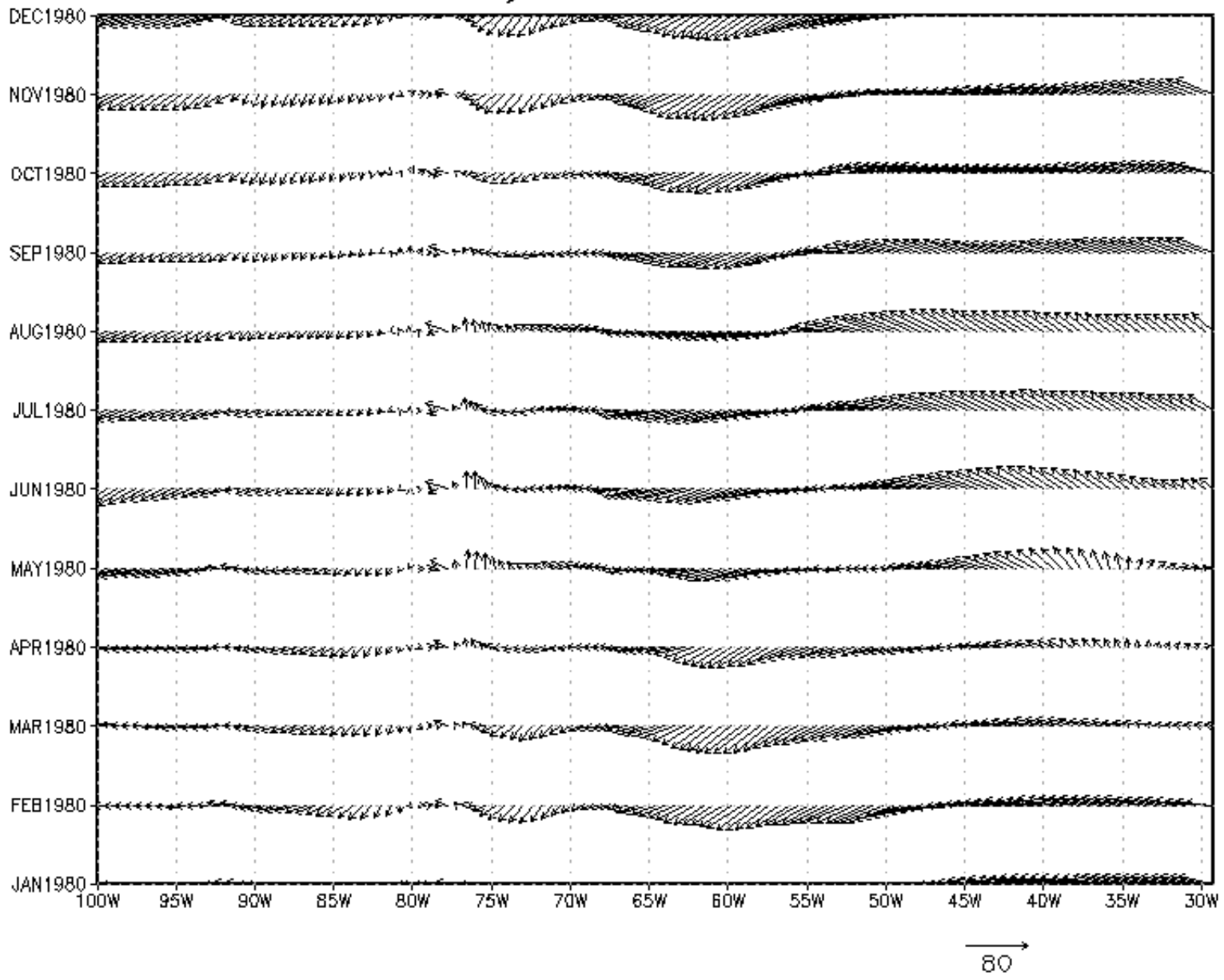




ETA

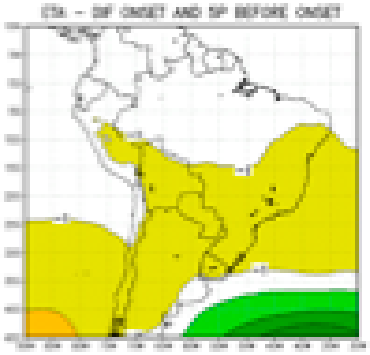
Humidity flux

Wind at 250 hPa


Humidity Flux 850 hPa LAT 0
DEC1980
NOV1980
OCT1980
SEP1980
AUG1980
JUL1980
JUN1980
MAY1980
APR1980
MAR1980
FEB1980
JAN1980
100W
95W
90W
85W
80W
75W
70W
65W
60W
55W
50W
45W
40W
35W
30W
80

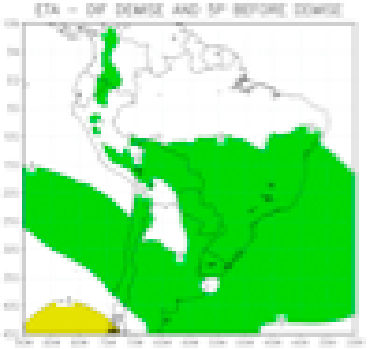
DIF onset-5pentads before

ETA



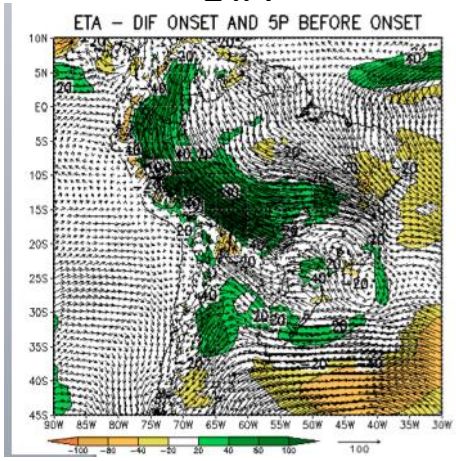
DIF demise-5pentads before

ETA

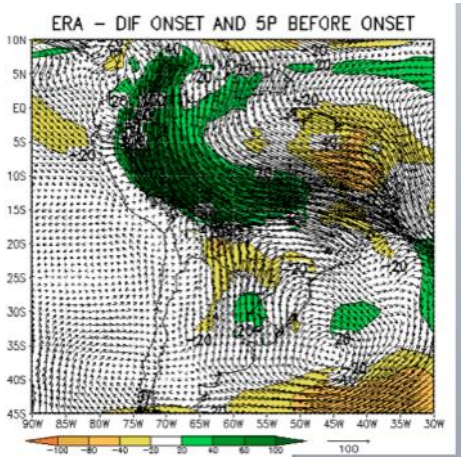


DIF onset-5pentads before

ETA

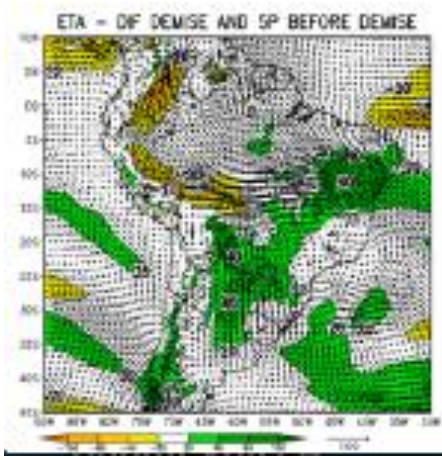


ERA-I



DIF demise-5pentads before

ETA



ERA-

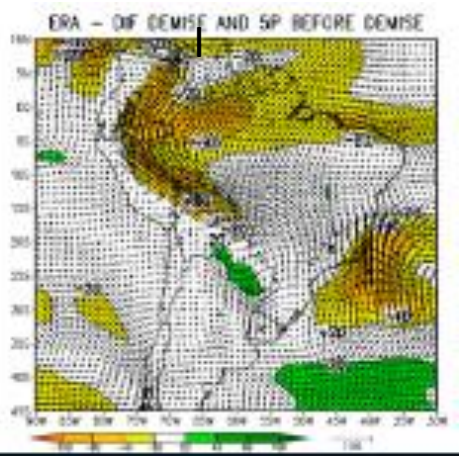


Table 1. The mean onset and demise pentads and duration of SAMS for each member, mean ensemble (new and old model versions) and reanalysis NCEP/NCAR and ERA INTERIM.

1980-2000)

	MODEL				PREVIOUS VERSION				OBSERVATION	OBSERVATION	Gan et al. (2004)	Silva and Carvalho (2007)
	C1	C2	C3	Mean	18	19	20	Mean	Reanalysis NCEP	Reanalysis ERA	Reanalysis NCEP	Reanalysis NCEP
Onset	67	68	66	66	61	60	58	59	60 23-27 October	62 02-06 November	58 13-17 October	61 October 28 – November 1
Demise	15	15	15	15	18	19	20	19	18 27-31 March	16 17-21 March	22 16-20 April	24 26-30 April
Duration	21	20	22	22	30	32	35	33	31	27	37	37

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(1980-2005)	**ETA**	**ERAI**
ONSET	62(02-06NOV)	64 (16-20NOV)
DEMISE	15(12-16MAR)	17(22-26MAR)

Conclusion

- Global and regional models are able to represent the general characteristics of SAMS, the annual cycle, the SACZ dipole feature.

- Deficiencies in intensities of variables

- Humidity flux index : onset in the SAMS core
-
- ONSET : AGCM : pentad 66; ETA : 62

- ERA-I: 62/64 ; NCEP: 58

- Silva and Carvalho: 61 (LISAM)
- Gan et al. 58 (precipitation)

Discussions and future development

- Relation of humidity flux in the SAMS core and precipitation in SE Brazil
- The role of land surface processes- soil moisture, evapotranspiration, fluxes
- Analyses of Climate Simulation – Brazilian Atmospheric Model (BAM)
- Discussion on the criterion of ONSET/DEMISE
- S2S hindcasts to analyze the ONSET/DEMISE