Dynamics and Predictability of Rainy Season Onset and Demise for South America in Observations and GCM Simulations: ECHAM4.5 and CPTEC/COLA

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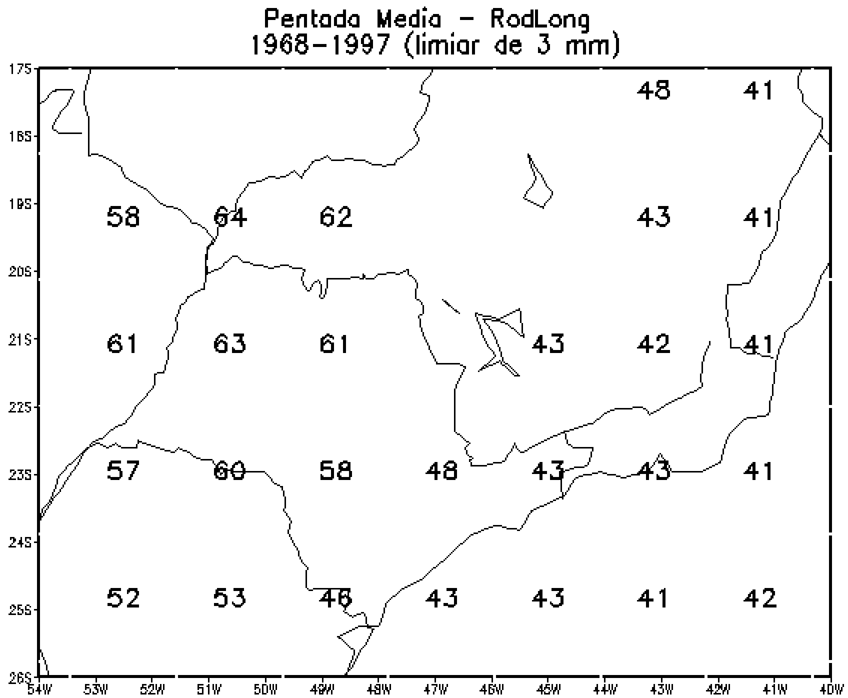
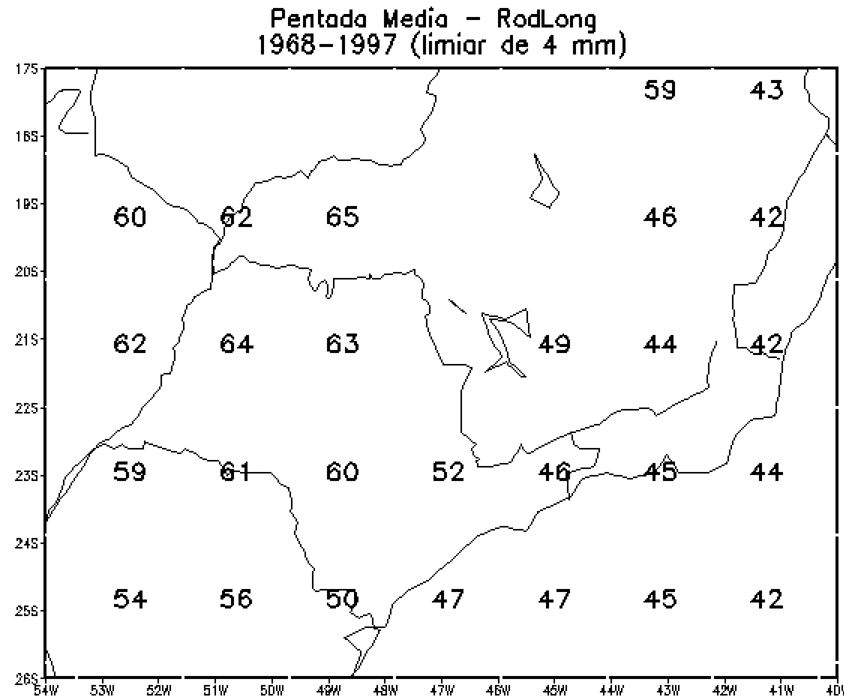
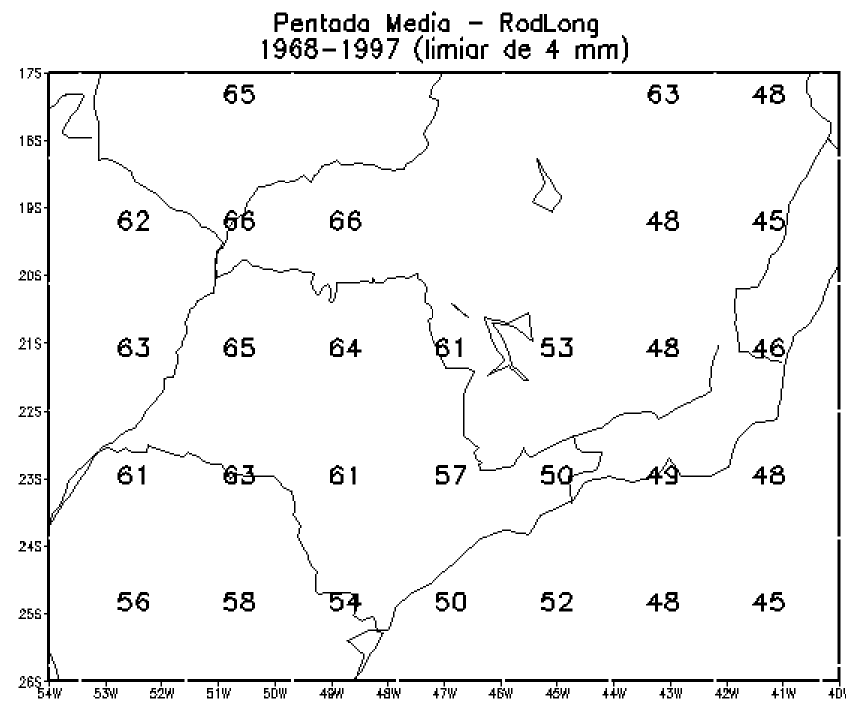




	3 mm	4 mm	5 mm
Média	46	50	54
Desvio	2	2	2



Pêntadas médias do início da estação chuvosa na região central do Brasil, para o período de 1968 a 1997, baseados em dados pentadais de precipitação com limiares de 3 mm, 4 mm e 5 mm. Os números representa a pêntada média em cada ponto da grade.

Important:

a) The variability of the initiation (and of the end) of the rainy season is important for determining calendar season rainfall totals (when the initiation or end occurs during the season of interest).

b) When there is a relationship between seasonal rainfall anomalies and sea surface temperature (SST), it is almost always through the relationship between SST and the variation of the starting or ending date.

-Focus: diagnosing the ability of 2 AGCMs to capture the timing of the onset and demise of the rainy season over tropical South America, on understanding and comparing with observations the dynamics and thermodynamics of model onset and end, and on the possibility of improving model calendar season totals by correcting biases (and other errors) in the timing of the rainy season.

-Ensemble runs from four AGCMs are analyzed to determine the importance of the timing of the rainy season on seasonal anomalies, the role of dynamics and thermodynamics on onset and end, and to document to what extent na accurate simulation of the rainy season depends on the proper timing of its onset and end.

-Further, the influence of SST variations on the timing of the model rainy season will be examined to determine if AGCM predictions of onset have any practical value.

-The study employs daily station observations and simulated daily fields from two AGCMs; the ECHAM-4.5 and the CPTEC/COLA, which are now used in producing seasonal forecast ensembles.

- We analyze (for the period 1976-1999) an ensemble of at least 8 runs with each model, forced with observed SSTs, and a 50 year run of the CCM-3 and the CPTEC/COLA which was run with climatological SSTs.

-The onset of the rainy season in S. America is generally concurrent with a reversal or major change in the wind field, an abrupt rise in precipitation and water vapor, and a drastic change in other variables (e.g., kinetic energy). Partly for this reason, different criteria have been used to define onset and retreat over different tropical regions in S. America (Marengo et al. 2001, Rao et al 2001, Liebmann and Marengo 2001, Gan et al. 2004, Wu and Wang 2000, Alves et al., 2005....)

-Data used for onset and end identification: surface meteorological station data (e.g., precipitation, dewpoint temperature), radiosonde data or global reanalyses (e.g., wind field), and satellite outgoing longwave radiation (OLR) data, and precipitable water. Some of these datasets has serious limitations- >the relationship between OLR data and precipitation over land is not as good as that over ocean; and the relationship becomes much worse at daily time scales (e.g., Xie and Arkin 1998;).

-Marengo et al. (2001) found statistical relationships between tropical SST and onset and end in the central Amazon and near the mouth of the Amazon river. SST anomalies were not found to be related to onset in the southern Amazon→. Near the equator SST influence on onset may be important because the contrast between land and sea temperatures is small (consistent with Fu et al. 2002, 2004)

-Liebmann and Marengo (2001), using daily rainfall data, found that the timing of onset has a major influence on calendar season totals (when onset is within the calendar season of interest). They also found that when SST anomalies are related to seasonal rainfall anomalies, it is usually through the influence of SST on the timing of the rainy season.

Gan et al. (2004) Onset and end of the rainy season in SAMS

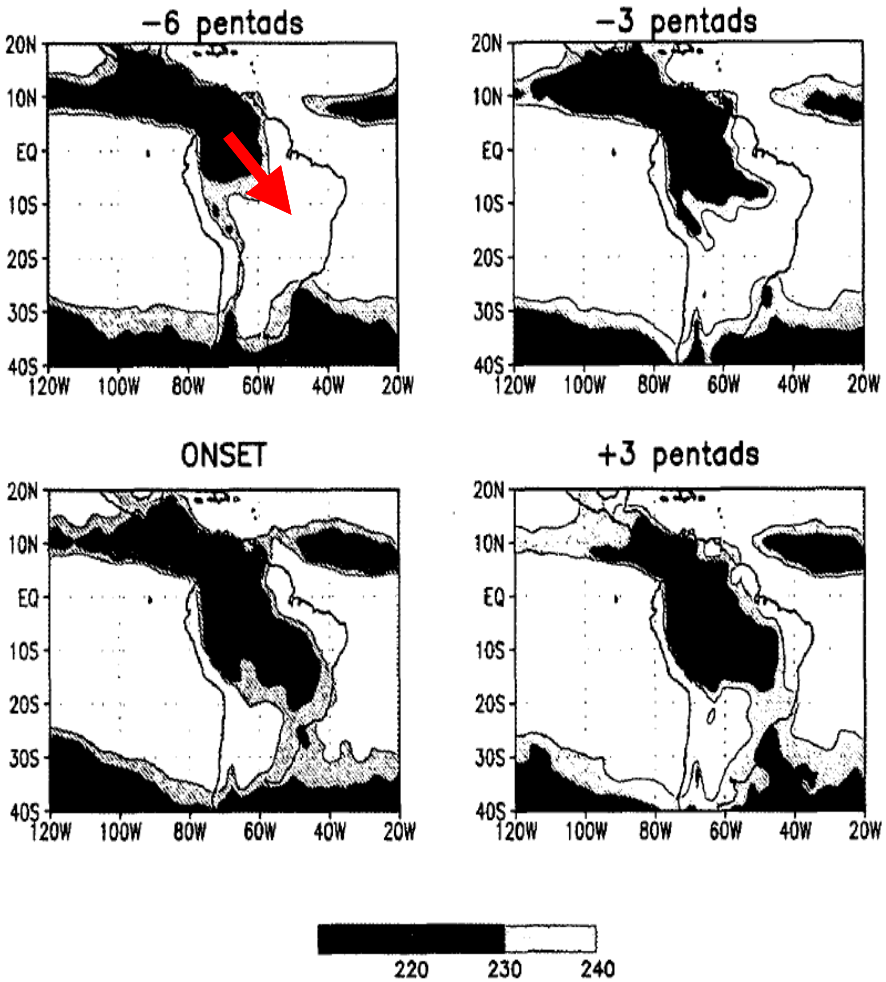


FIG. 10. OLR (W m^{-2}) composites for the period prior to and immediately following the rainy season onset.

Onset

End

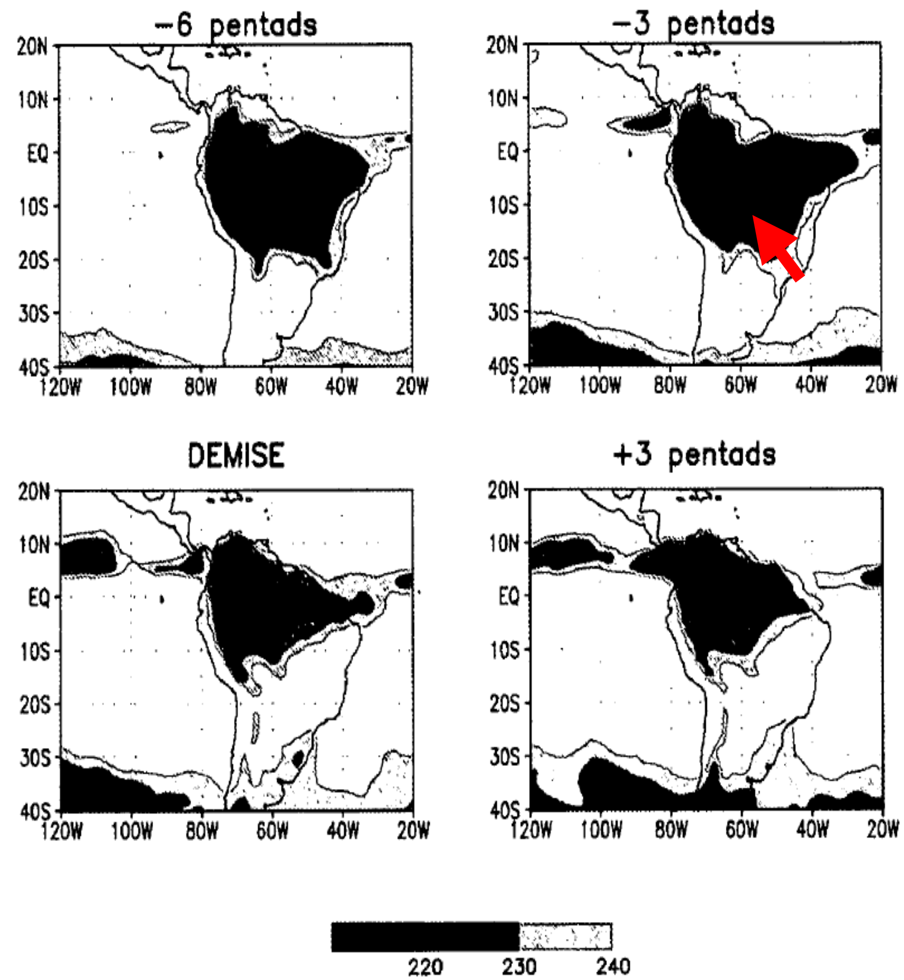
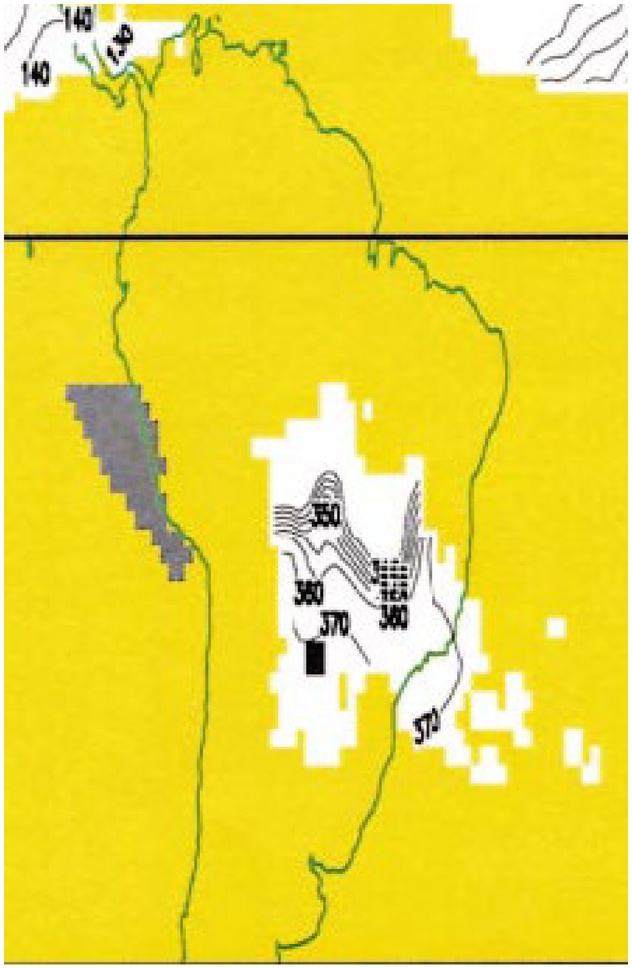
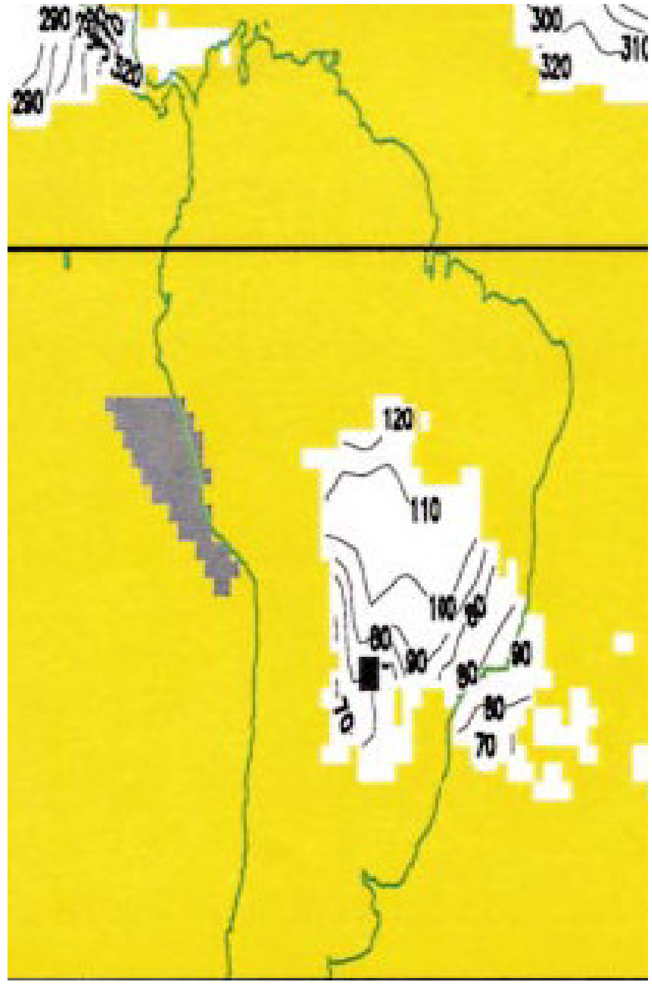


FIG. 11. As in Fig. 10 but for the rainy season demise.

Zeng (2004) Onset and end of rainy season in SAMS for 1988-1997.



Onset



End

An objective criterion is proposed to define, for the first time, globally unified summer monsoon onset (or retreat) dates using a precipitable water data have also been used to refine the definition of monsoon regions on a grid-cell-by-cell basis.

Methodology

The proposed study will involve comparing daily GCM output with data from a dense network of gauge-based observations of rainfall covering northern South America.

The models to be used are the ECHAM-4.5, and the CPTEC/COLA AGCM.

We análise at least 8 members of an ensemble model using observed SST for the years 1976-1999

As a starting point the definition employed by Liebmann and Marengo (2001) is used be used. In this definition onset essentially occurs when rainfall exceeds its local annual climatology. Is sort of resolves the false onset

A preliminary analysis suggests that the AGCMs are capable of producing a realistic onset. The average onset date over South America (in areas with data). Onset is defined using the equation:

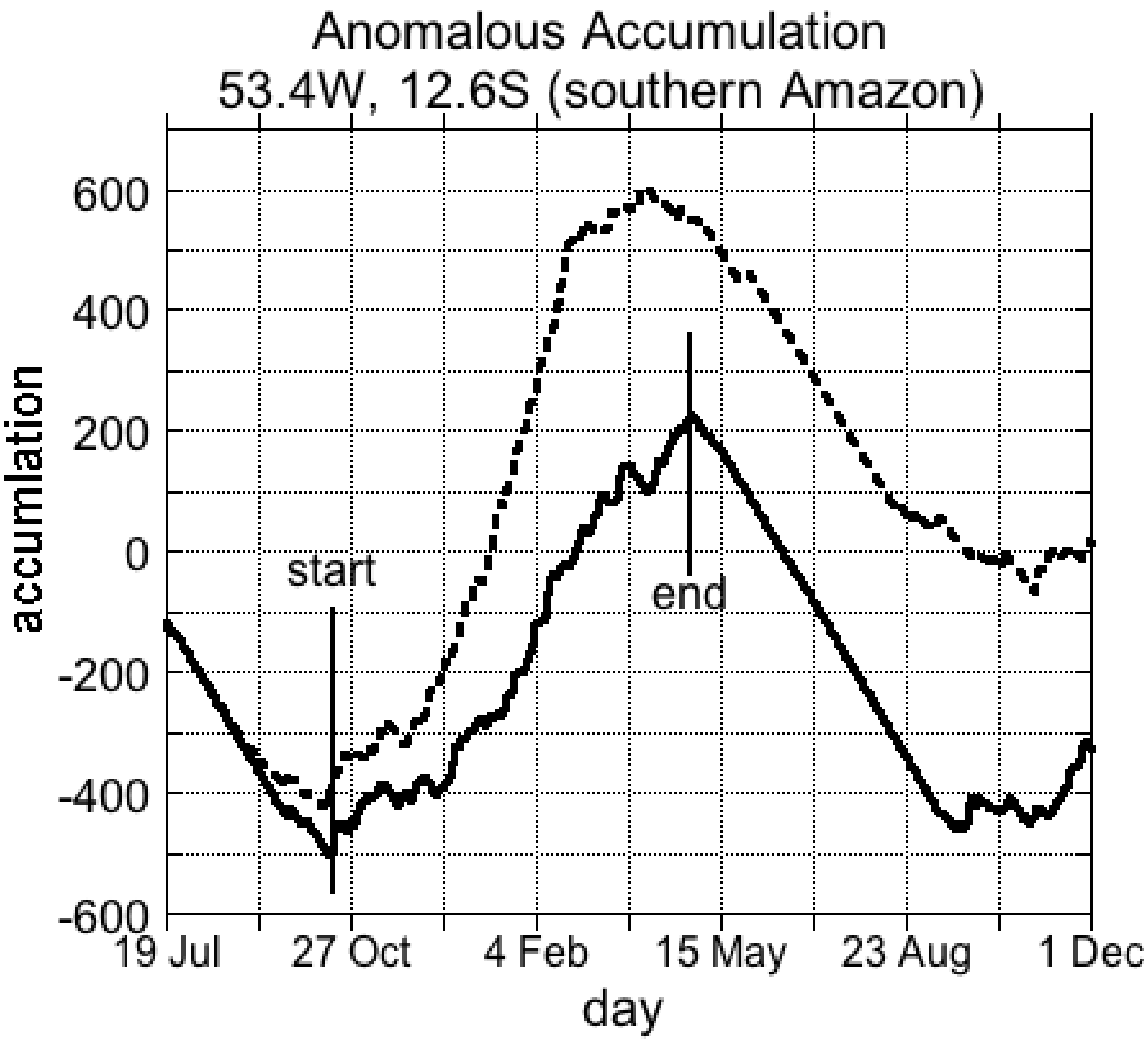
$$A(day) = \sum_{n=1}^{day} \left(R(n) - \overline{R} \right)$$

$A(day) =$ Anomalous accumulation

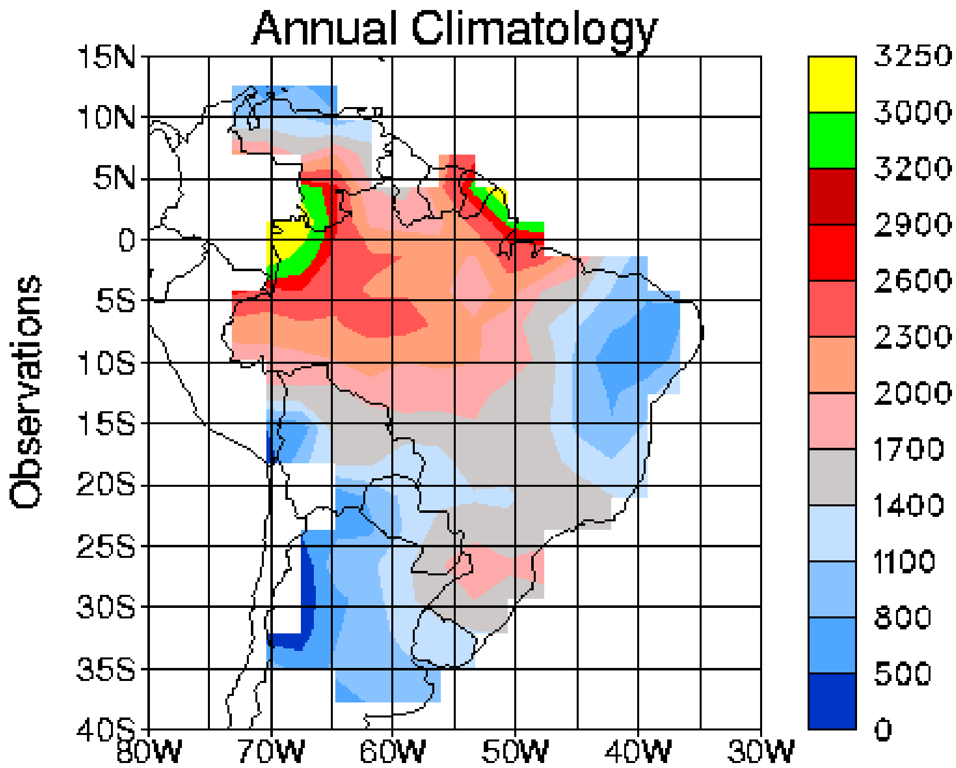
$R(n) =$ daily rainfall

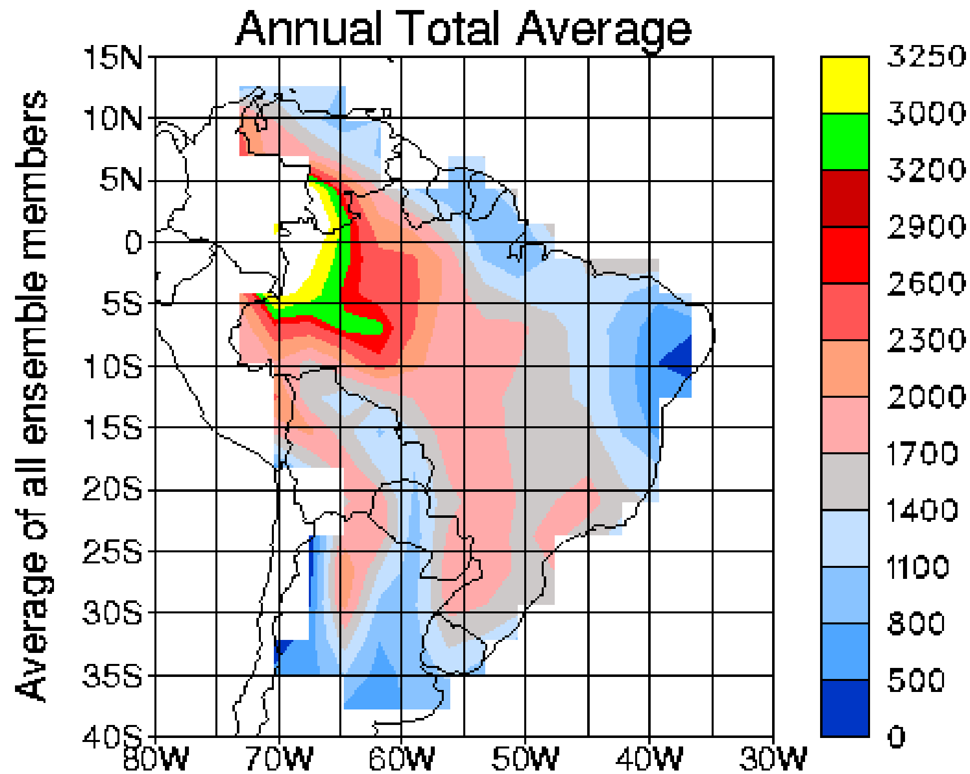
$\overline{R} =$ annual average daily precipitation

The summation begins at an arbitrary day and onset is defined as when the slope becomes positive; that is, when daily precipitation exceeds the annual daily average (Liebmann and Marengo 2001)

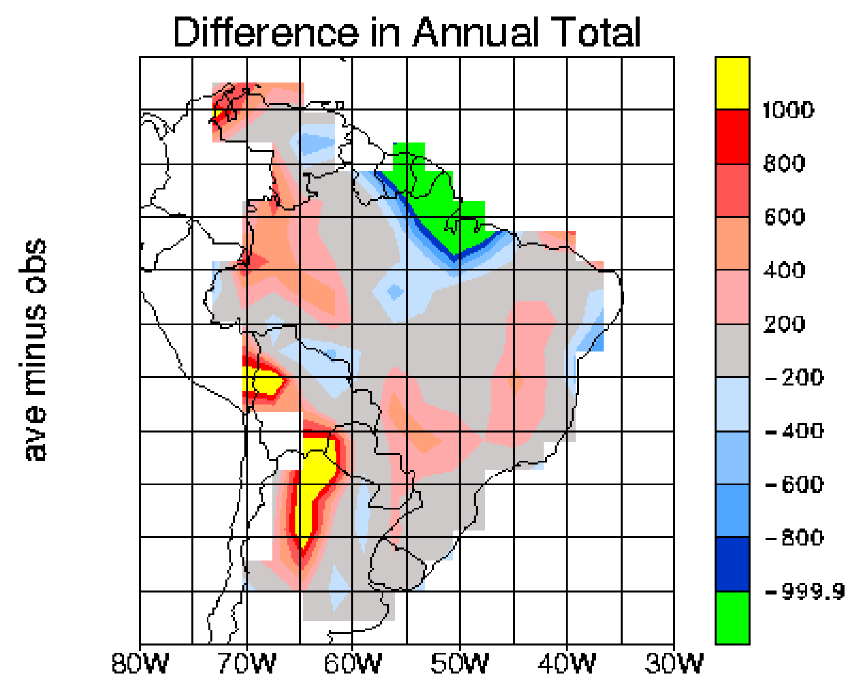


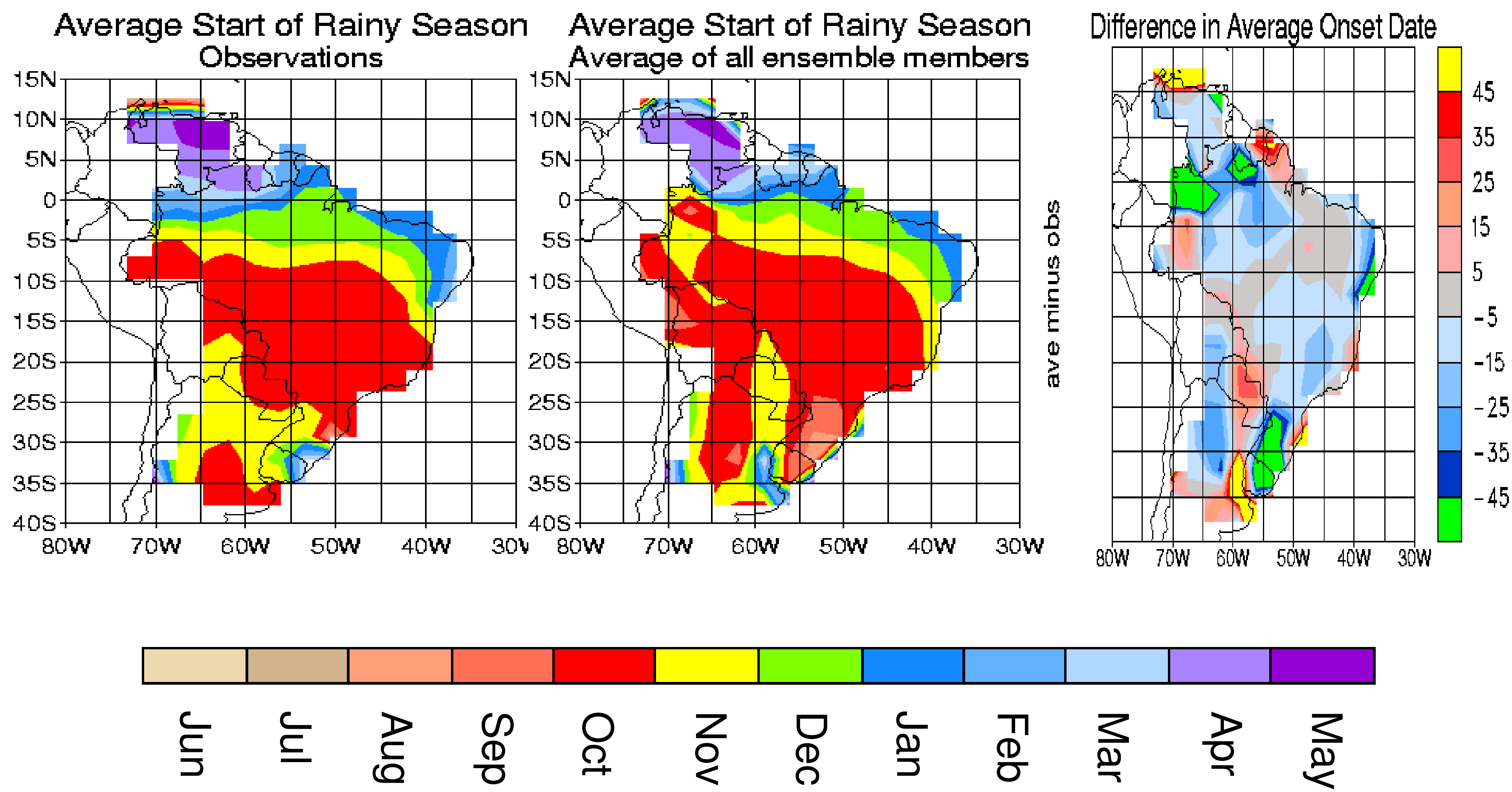
Anomalous accumulation (computed from Eqn. 1) for a single year of observations (dashed curve) and a single model realization (solid curve). Vertical lines indicate the start and end dates of the model wet season.





Annual total precipitation, averaged for the years 1976-2000 on model grid. Dashed lines indicate data perimeter. a) Observed values; b) 24-member ensemble average of the ECHAM 4.5 model; c) Model minus observations expressed as percent of observed.




Average Start of Rainy Season
Observations
Average Start of Rainy Season
Average of all ensemble members
Difference in Average Onset Date
ave minus obs
15N
10N
5N
0
5S
10S
15S
20S
25S
30S
35S
40S
80W
70W
60W
50W
40W
30W
45
35
25
15
5
-5
-15
-25
-35
-45
Jun
Jul
Aug
Sep
Oct
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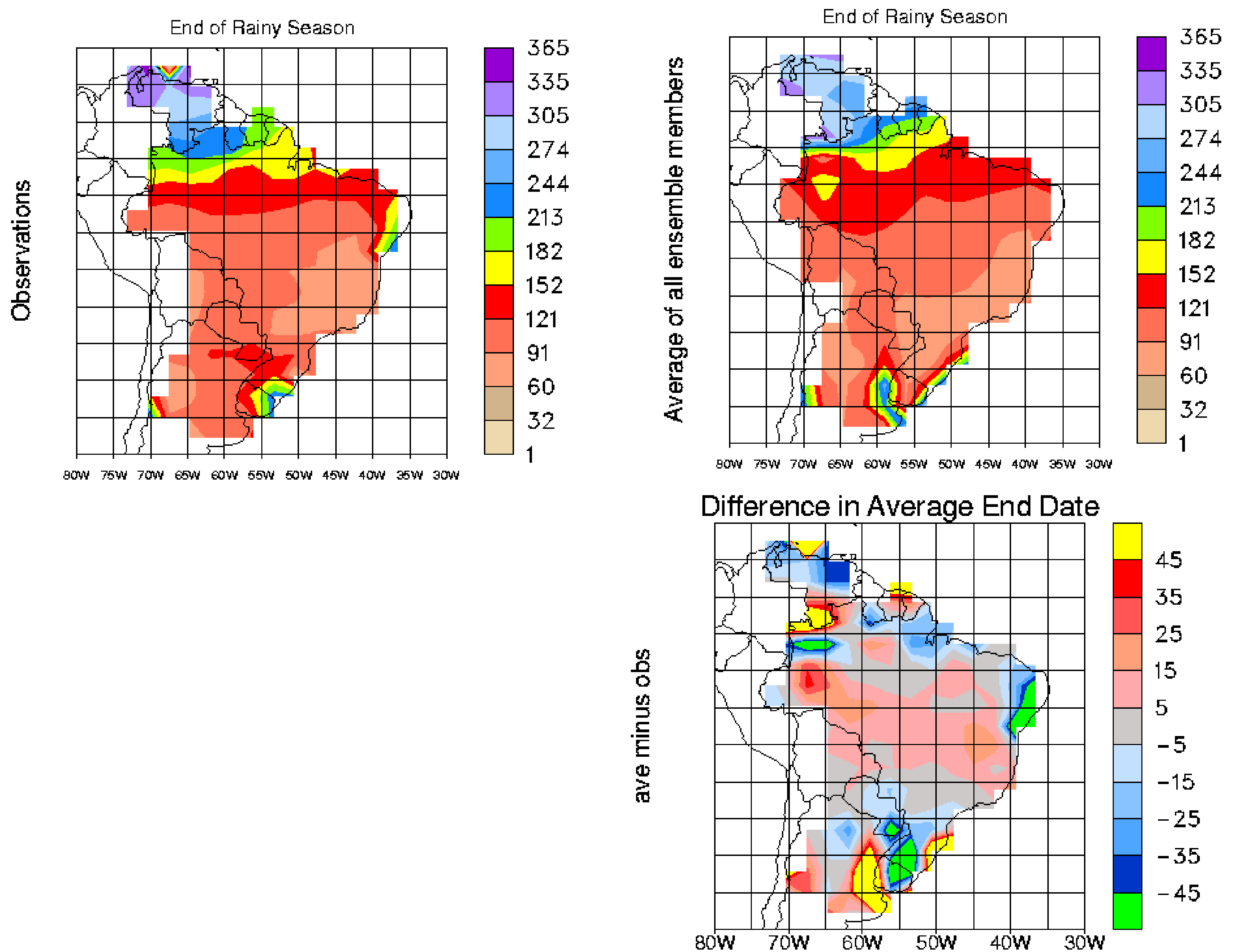
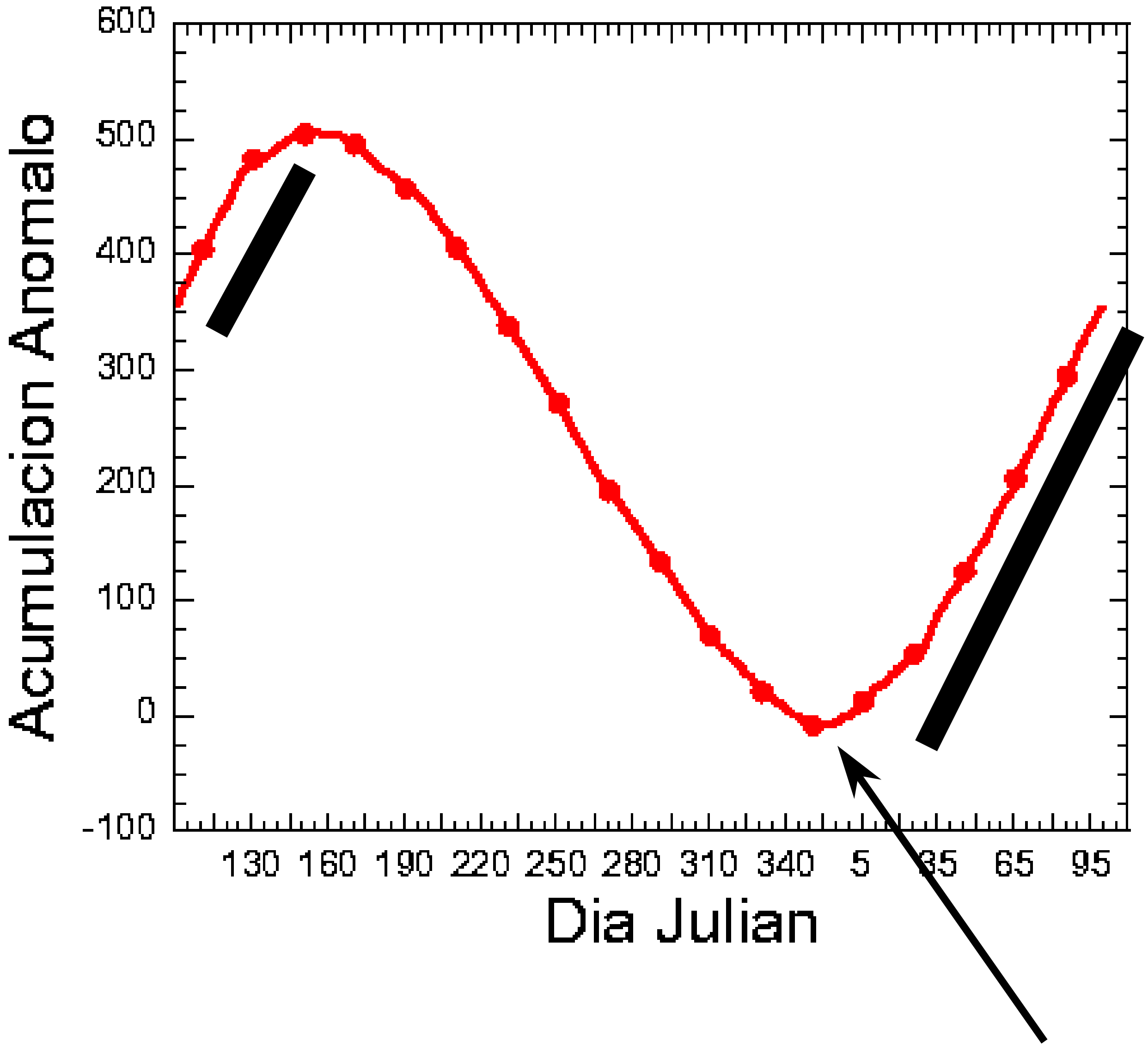
Jan
Feb
Mar
Apr
May

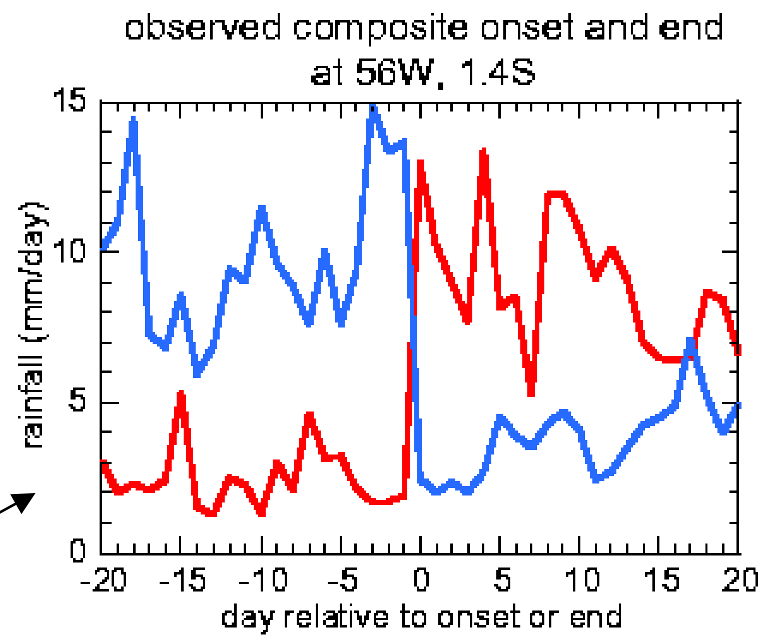

End of Rainy Season
Observations
365
335
305
274
244
213
182
152
121
91
60
32
1
80W 75W 70W 65W 60W 55W 50W 45W 40W 35W 30W
End of Rainy Season
Average of all ensemble members
365
335
305
274
244
213
182
152
121
91
60
32
1
80W 75W 70W 65W 60W 55W 50W 45W 40W 35W 30W
Difference in Average End Date
ave minus obs
45
35
25
15
5
-5
-15
-25
-35
-45
80W 70W 60W 50W 40W 30W

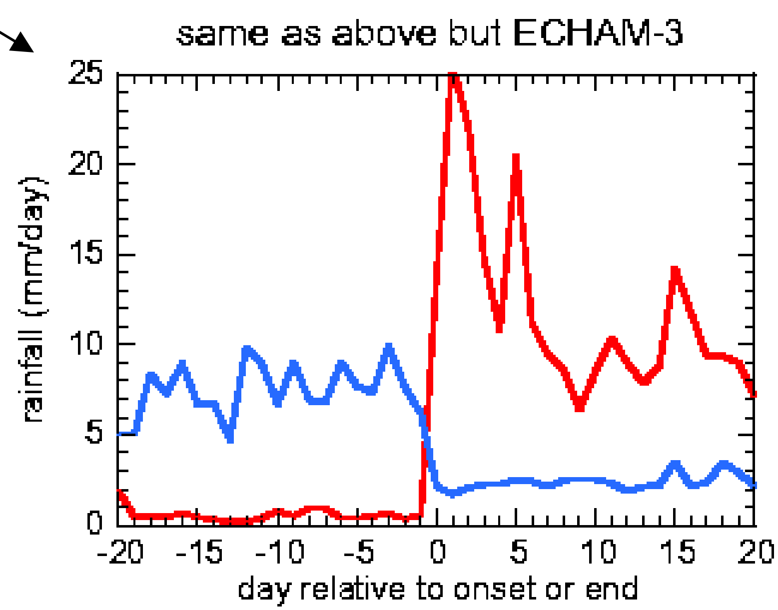
East Central Amazon

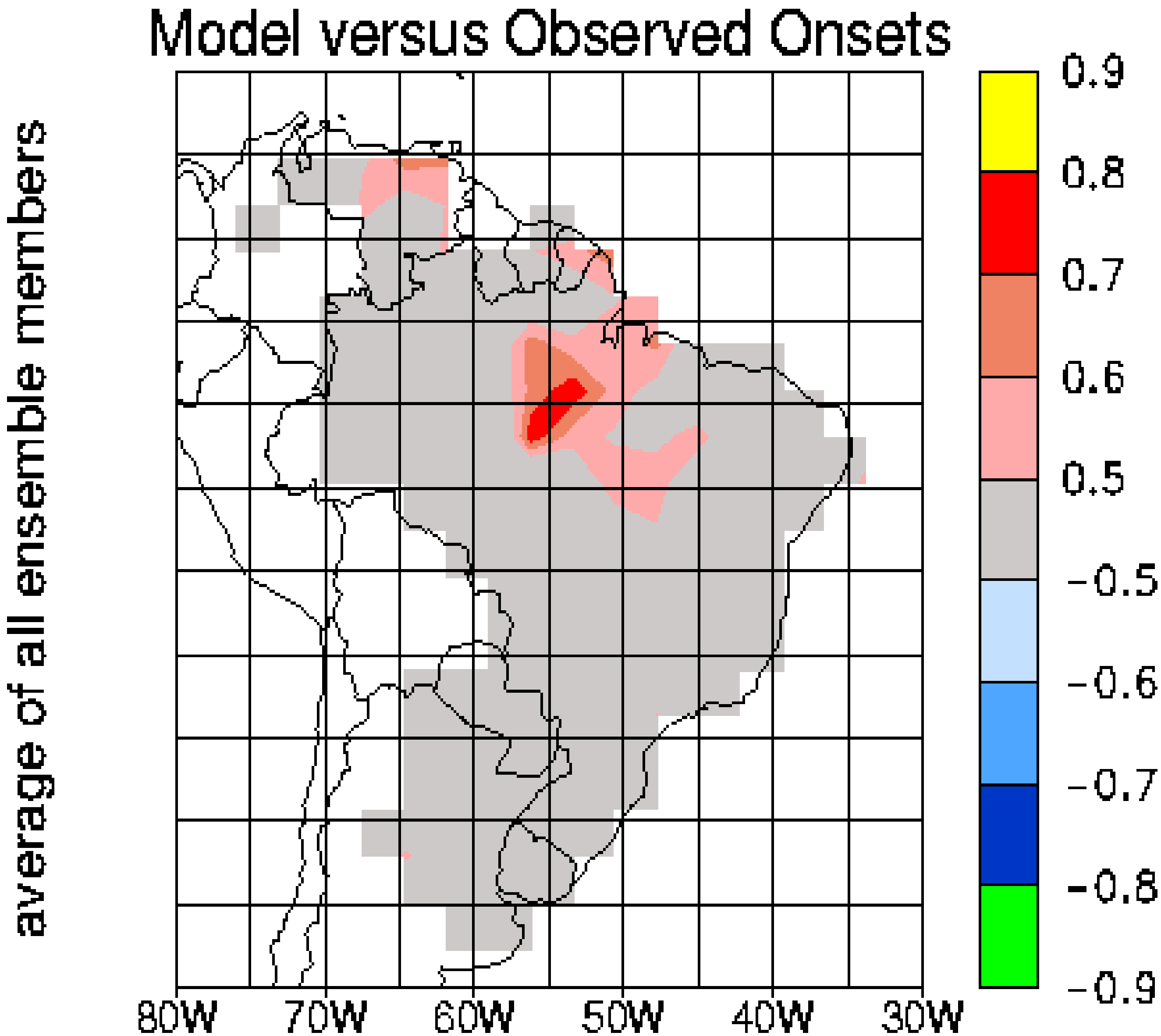


Average date of initiation: 30 December

Note different scales







Correlation between observed and ensemble average onset. Ensemble average is calculated as average of onset of each member

…..in the east central Amazon Basin, the average date of onset is 30 December

Standard Deviation: 28 days

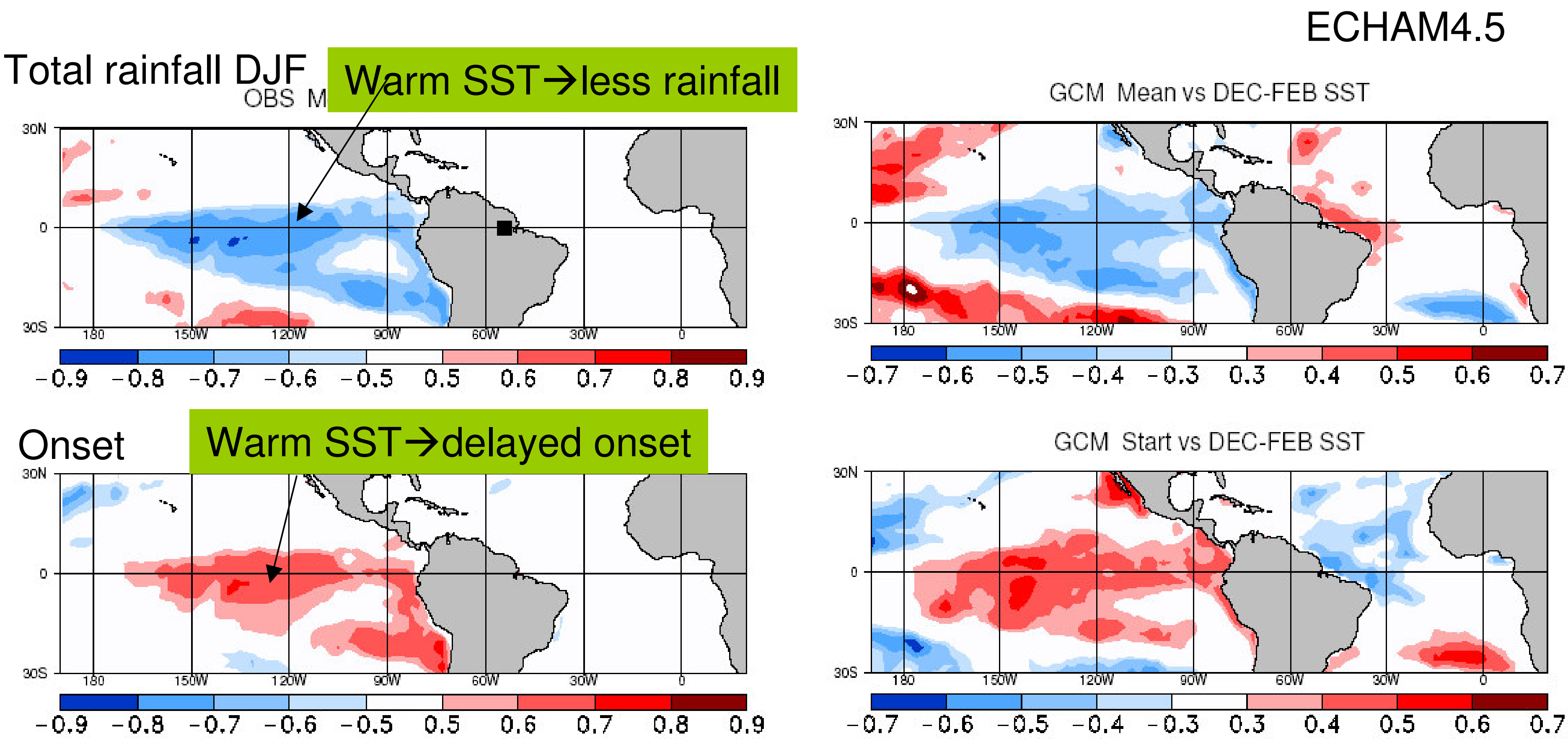
Therefore, usually
the rainy season begins during DJF.

Correlations:
Initiation versus DJF total: -0.86

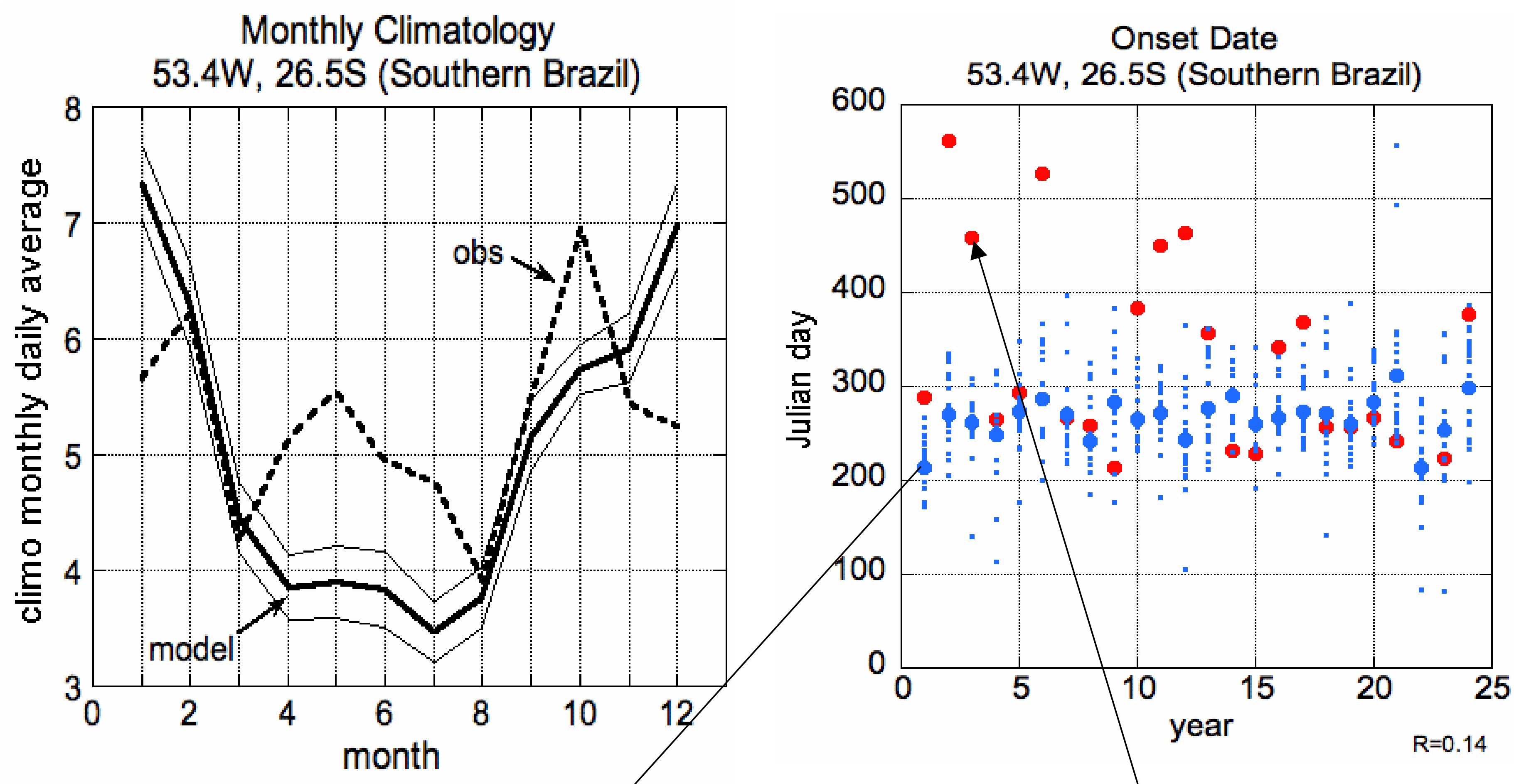
Rate versus DJF total: 0.77

Rate versus initiation date: -0.56

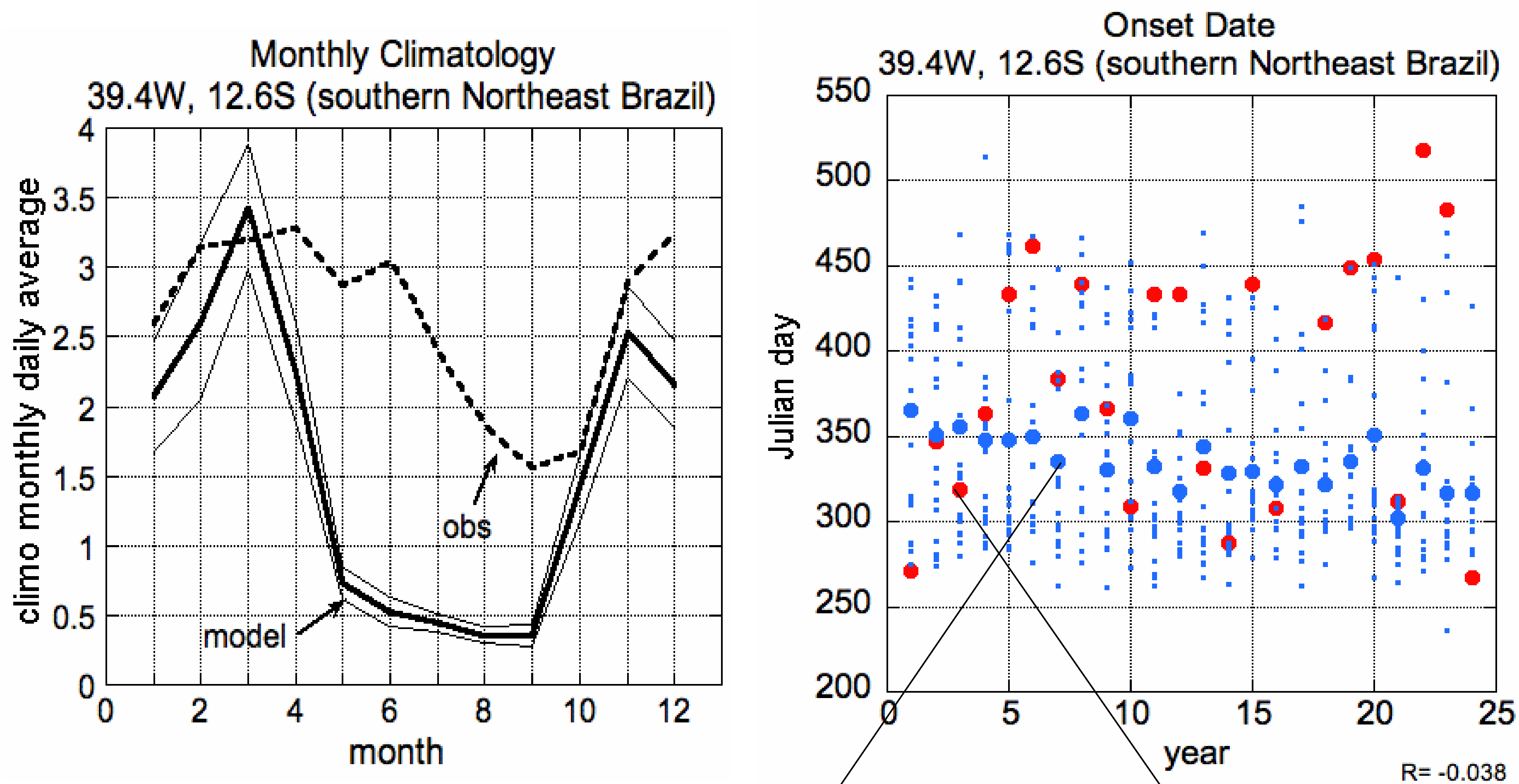
The rate of precipitation is defined as the total between the initiation and the end of February divided by the number of days. Therefore, the variability of the day of initiation Is important in determining the DJF total.



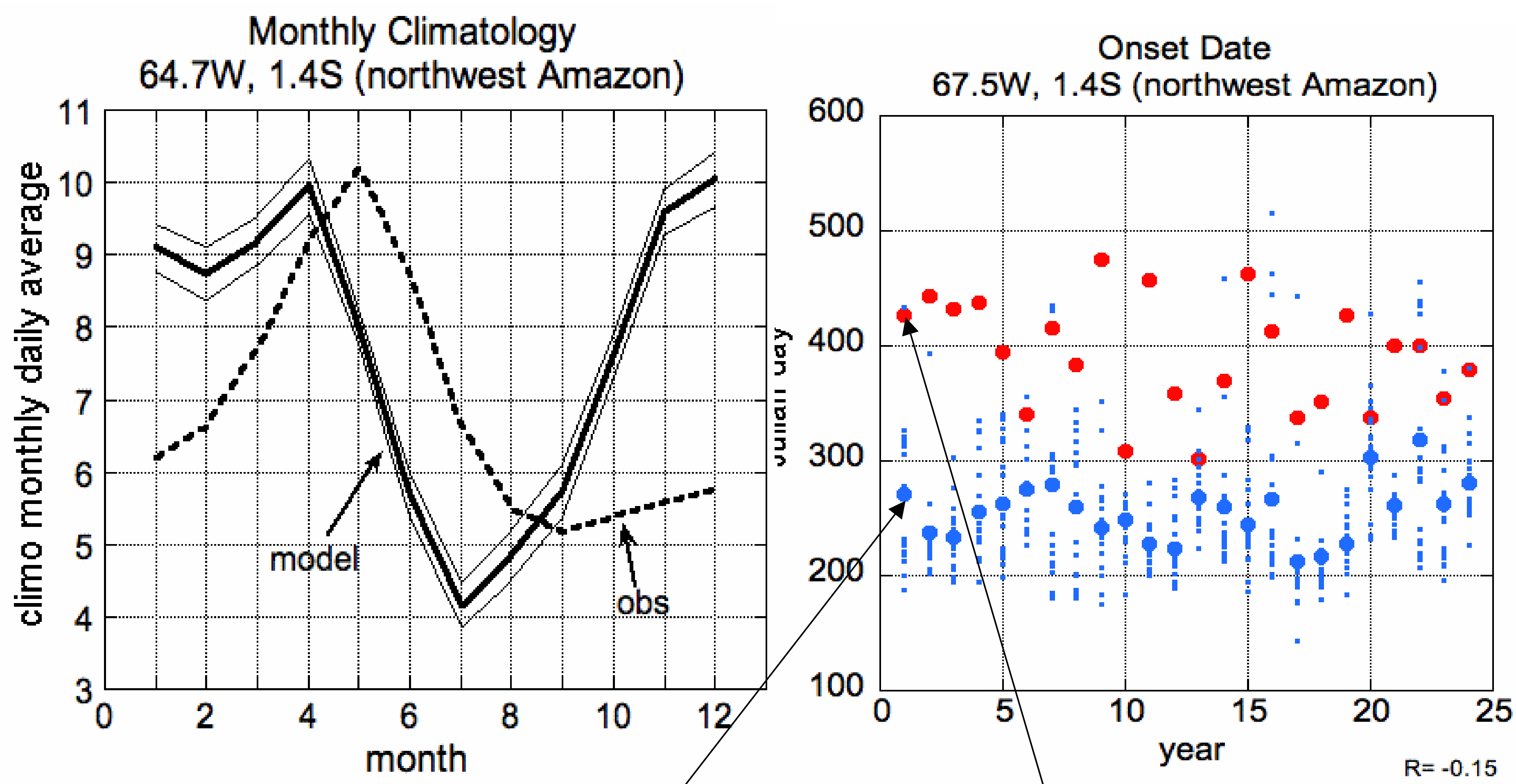
Correlation between DJF SST DJF rainfall and onset date of rainy season at a box centered on 56°W, 1.4°S.



Monthly daily average precipitation at 53.4°W, 26.5°S for observations and ensemble average. Thin curves on either side of ensemble mean represent 1 standard deviation inter-model climatology. b) Onset date for each year at same point for observations and average of each ensemble member. Open circles denote observed date, closed circles denote average over all ensemble members, and dots indicate onset for 18 ensemble members. Graphics limitations prevent showing each ensemble member.



Monthly daily average precipitation at 39.4°W, 12.6°S for observations and ensemble average. Thin curves on either side of ensemble mean represent 1 standard deviation inter-model climatology. b) Onset date for each year at same point for observations and average of each ensemble member. Open circles denote observed date, closed circles denote average over all ensemble members, and dots indicate onset for 18 ensemble members. Graphics limitations prevent showing each ensemble member.



Monthly daily average precipitation at 67.5°W, 1.4°S for observations and ensemble average. Thin curves on either side of ensemble mean represent 1 standard deviation inter-model climatology. b) Onset date for each year at same point for observations and average of each ensemble member. Open circles denote observed date, closed circles denote average over all ensemble members, and dots indicate onset for 18 ensemble members. Graphics limitations prevent showing each ensemble member.

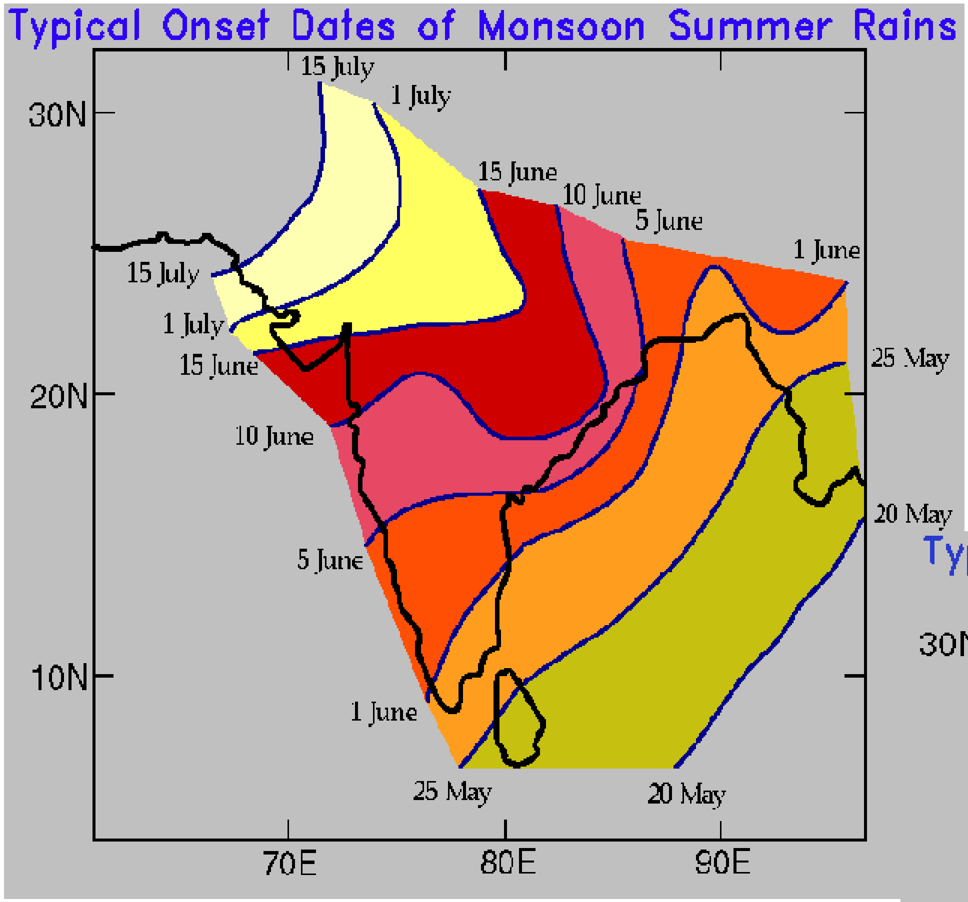
Further work:

Examine CPTEC AGCM ensembles to determine if onset and end of the rainy season are realistic in terms of suddenness, timing, and the thermodynamics and dynamics over South America.

- Are the simulated rainy seasons marked by distinct transitions between dry and wet regimes, as observed?
- Are the ranges of ensemble mean onset and end within those observed? (We expect the standard deviation of onset to be reduced with an ensemble compared to a single run.)
- Is there a systematic bias in onset and end dates that results in biases in seasonal totals? Conversely, are systematic erroneous rainy season rain rates the cause of most of the observed biases in seasonal totals?
- Are the same dynamical mechanisms responsible for onset and end of the rainy season operating in the GCMs as in the atmosphere?

To determine the feasibility of improving seasonal forecasts based on predicted onset (and end).

- Can biases in timing of rainy season be corrected either statistically or by accounting for thermodynamical fields not included in model parameterizations?
- Can seasonal forecasts be improved by including information on timing? Our hypothesis is that timing does contribute substantially to variations in seasonal totals.



Great...!!
But we need something like this for Brazil befire any modeling experience.

Need to integrate all observational studies in something than can be used operationally for all users and meteorologists for monitoring onset and end and their observational aspects.