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DRY PERIODS OVER EASTERN BRAZIL

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1. Introduction

Since 1999 the Climate Prediction Center (CPC) has been routinely producing gridded real-time daily analyses of precipitation over South America, with the help of many institutions in the region. In parallel CPC has also been actively engaging agencies in South America to obtain historical station data, which can be used to create historical gridded daily analyses. These retrospective analyses are important for computing basic statistics such as mean daily/monthly rainfall, extremes, probabilities of wet and dry days, etc. As additional station data become available, CPC performs reanalyses to include those data into the historical gridded daily analyses.

In this paper we present examples of how the historical gridded daily analyses (most recent version for Brazil- v2005, for the period 1977-2004) can be used in studies of climate and climate variability, with an emphasis on dry days and dry periods.

2. Dry-day Climatology

The 1977-2004 average percent of days, for which precipitation is less than 1 mm (dry days), is shown for each month in Fig. 1. A pronounced annual cycle in percentages is evident over the southern Amazon basin, where values range from more than 90% during June – August (dry season) to less than 10% during December – March (wet season). A weaker annual cycle is observed over Northeast Brazil, a semi-arid region with a short rainy season (February-April), where throughout the year more than 50% of the days are dry. Southeast Brazil also has a marked seasonal cycle, with a distinct dry season (May-September) and wet season (November-March).

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There is a lack of a seasonal cycle in southern Brazil, where 40-60% of the days are dry throughout the year.

The probability of experiencing a sequence of dry days during the austral summer (DJF) is shown in Fig. 2. The eastern and extreme northern portions of Brazil are the most likely areas to experience dry periods (2 consecutive days or more). For example, in extreme southern Brazil there is a 30% chance of experiencing three consecutive dry days (top right panel in Fig. 2). In Northeast Brazil there is a 50% of experiencing three consecutive dry days and a 30% chance of experiencing eight consecutive dry days. Note that there is only about a 2% chance of experiencing 2 consecutive dry days in the southern Amazon basin (near 10ºS, 60ºW).

We now focus on the two index regions, NEBR (6º-14ºS, 39º-47ºW) and SEBR (14º-22ºS, 42º-50ºW) shown in Fig. 3. Those regions were chosen because they include five major water reservoirs: Sobradinho in NEBR region, and Três Maria, Emborcação, Itumbiara and Furnas in SEBR region. Those reservoirs are of great importance for energy production is Brazil.

The probability of experiencing a specified number of dry days per month in each of these regions is shown in Fig. 4. For NEBR (right panels in Fig. 4) there is an increase in probability with increasing number of days for the months May-September, with the greatest probability occurring at the maximum number of days in the month (completely dry month). For November-April the probability is nearly the same for a broad range of days, suggesting considerable variability in the region from year to year.

For SEBR (left panels in Fig. 4) in June-August (the dry season) a pronounced peak occurs at 30 or 31 days (month completely dry). During September-October and April-May (transition seasons) the peak in probabilities lies in the range of 15-28 days. During November-March (rainy season) the peak in probabilities lies between 3 and 11 days. During the wet season the peak in probabilities is sharpest in December (3-6 days) and broadens in January through March. Thus, SEBR has an increasing chance of experiencing a large number of dry days during the January-March than in December.

3. Interannual Variability

The rainy season for central and southeastern Brazil begins during September-October and extends through April. Rather than use the standard calendar year, which would included portions of two different rainy seasons, we decided to use the water year, defined as 1 July - 30 June. This period includes a single rainy season for nearly all of Brazil, except southern Brazil and the northwestern Amazon basin (no well-defined wet or dry seasons), and coastal sections of Brazil between 5ºS and 20ºS where rainfall peaks during May-July.

The total water-year (July-June) precipitation time-series for NEBR and SEBR are show in Fig. 5. Both time series show interannual variability, with total rainfall of +/- 20% of the long-term mean. The driest water years for NEBR are 1981-82, 1992-93, and 1997-98. The last two years featured El Niño conditions in the tropical Pacific, which are usually associated with below-average rainfall in NEBR. For SEBR the driest years are 1988-89, 1994-95, 1995-96, 1997-98 and 2000-01. There is an apparent downward trend in precipitation between 1981-82 and 1988-89, but no evidence of a trend after 1988-89. For SEBR there does not appear to be a strong relationship with either El Niño or La Niña.

The Water-Year spatial precipitation anomalies (mm) for El Niño and La Niña years are shown in Figs. 6 and 7, respectively. Most of the El Niño years feature dry conditions over the eastern Amazon and northern Northeast Brazil, with the strongest events (1982-83, 1991-92 and 1997-98) showing the largest extent and magnitude of rainfall deficits. Wetter-than-average conditions were observed over southern Brazil during most El Niño episodes. During the 1997-98 El Niño dry conditions covered most of Brazil, with the exception of southern Brazil where much-above average precipitation was observed. The brief El Niño episode of 1994-95 did not have a significant impact on NEBR. However, precipitation was considerably below average over SEBR.

During La Niña episodes wetter-than-average conditions are typically observed over the Amazon basin and Northeast Brazil, while in some cases drier-than-average conditions occurred in southern Brazil. For both El Niño and La Niña episodes, there appears to be more event-to-event variability in the pattern of precipitation anomalies over southern Brazil than over the Amazon basin.

4. Conclusion

We have shown a few examples of how the CPC gridded daily precipitation analysis data set can be used to support climate and climate variability research studies. One might ask “how well do the statistics derived from the gridded analyses compare with individual station data?” This question has been addressed by the authors in a separate paper. The gridded analyses reduce the magnitude of the extreme wet events and increase the number of days with measurable precipitation, due to the smoothing inherent in producing gridded analyses. Our definition of a dry day (precipitation less than 1 mm) was made in an attempt to correct the gridded analysis wet bias for near-zero rainfall days. The CPC gridded daily analysis data set will continue to evolve and improve as additional station data become available.

5. Acknowledgements

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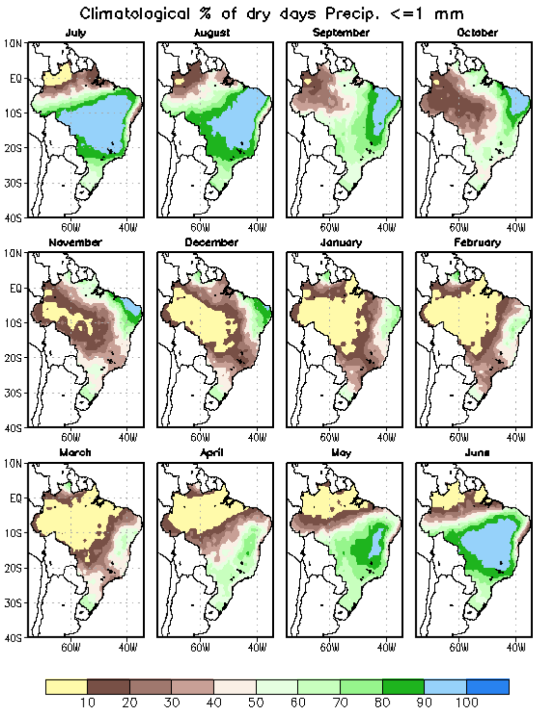

Figure 1. Water-Year average percent of days that are dry (precipitation ≤ 1mm).

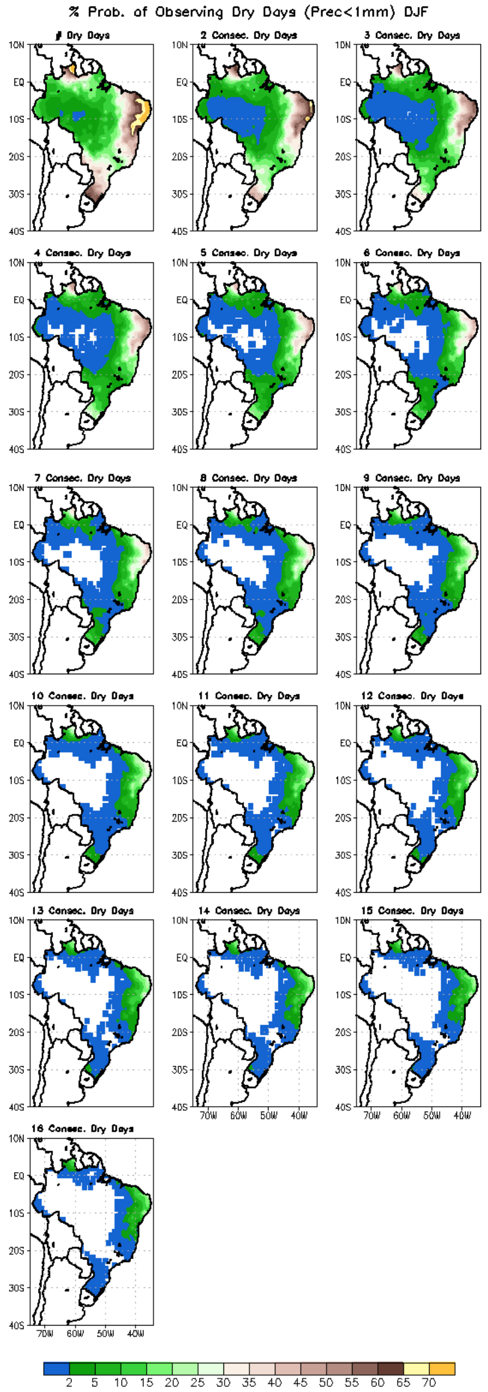

Figure 2. December-February probabilities for consecutive dry days (1, 2, 3,…,16).

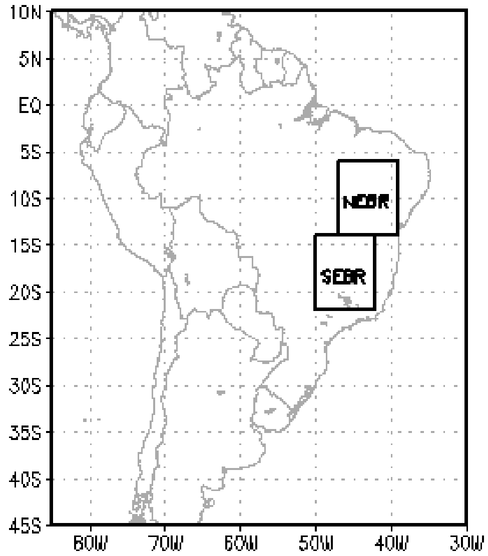

Figure 3. Index Regions.

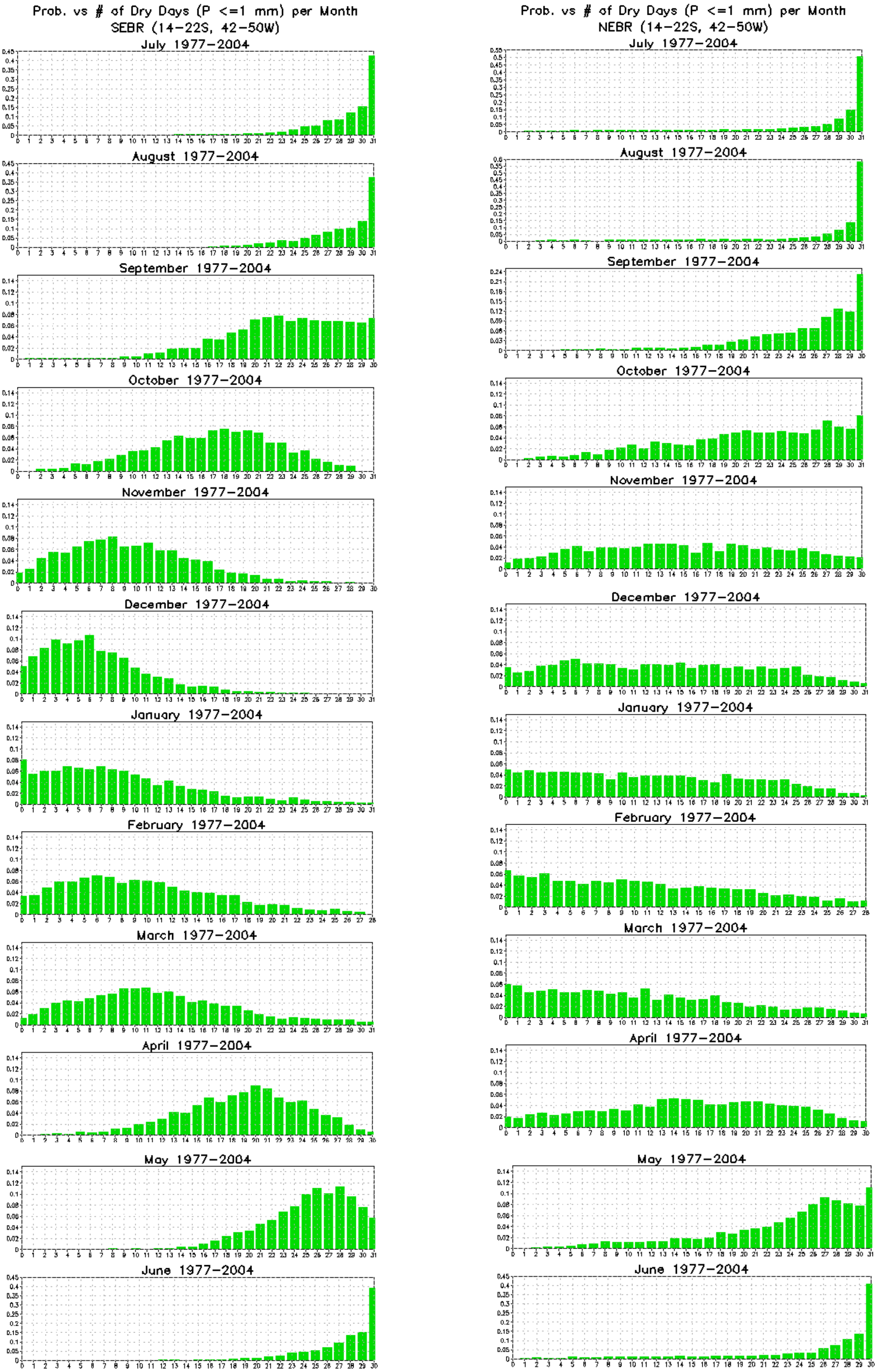

Figure 4. Probabilities versus number of dry days (P≤1mm) per month for NEBR and SEBR for the period 1977-2004.

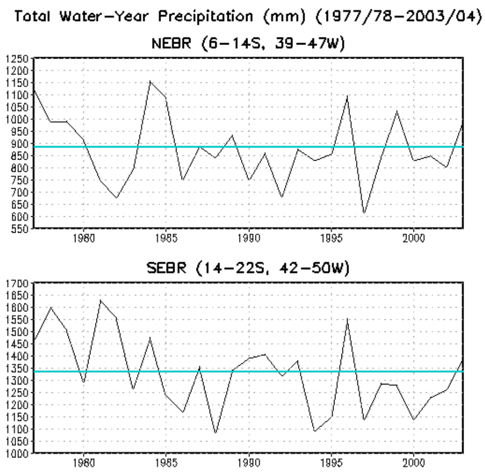

Figure 5. Total water-year (July-June) precipitation (mm) for NEBR (top) and SEBR (bottom).

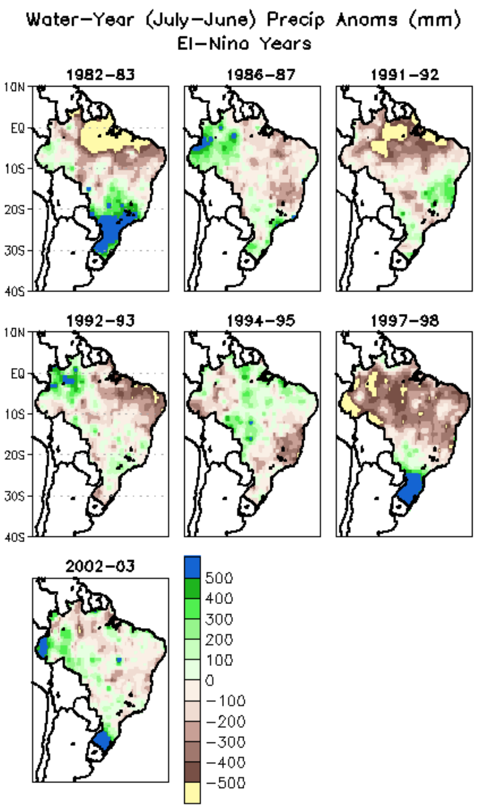

Figure 6. Water-Year (July-June) precipitation anomalies (mm) for El Niño years.

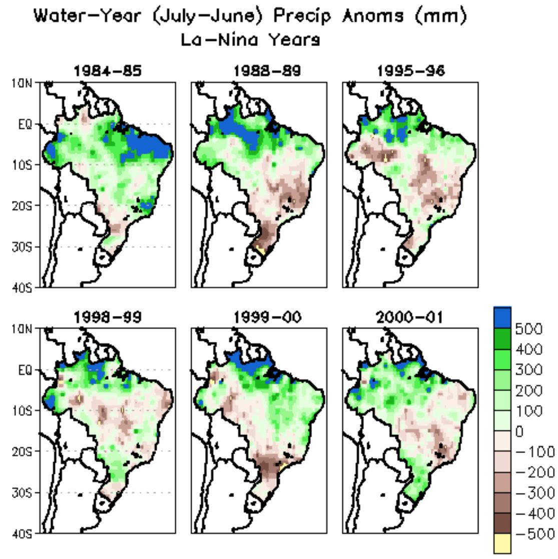

Figure 7. Water-Year (July-June) precipitation anomalies (mm) for La Niña years.