P. 137 REFLECTIVITY CLIMATOLOGY FOR CENTRAL SÃO PAULO

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1. INTRODUCTION

The Z-R relationship is central to the quantification of precipitation based on weather radar. In spite of the efforts in the last three decades, a comprehensive characterization of the uncertainties between radar and rain gage measurements has not been reached and an intensification of those efforts is expected (Krajewiski et al, 2010). An statistical approach to the problem was proposed by Calheiros and Zawadski (1987) based on equating probabilities. Bringi and Chandrasekar (2001), e.g., provide a clear and concise interpretation of such technique. One key component of the method is the cumulative probability function of Z, which is matched to the corresponding function for R to derive the Z into R conversion relation. The present work deals with cumulative probabilities derived from reflectivity data for the radars at Bauru (BRU, Lat: 22.35^0 S; Lon: $49,02^0$ W, 624m amsl) and Presidente Prudente (PPR, Lat: $22,12^0$ S; Lon: $51,38^0$ W, 420m amsl) operated by the IPMet–Meteorological Research Institute, UNESP–Bauru - spanning an approximate 18-year period. Curves are classified according to different criteria, in particular by daily intervals. Regarding the latter, previous work (Calheiros and Gomes, 2011) based on a limited set of data indicated that stratification by daily intervals has a substantial impact, at least for important hydrological applications. In that work BRU mean area rainfall data, computed with both a single Z-R and a set of Z-R relationships representative of different daily intervals, were inputted to a regional catchment rainfall-runoff relationship. The resulting hydrograph based on the stratified relationships was much closer to the historical flow curve. Climatological curves for BRU and PPR were considered vis-à-vis the corresponding rainfall climatology based on the regional network rain gage data. Plans for the continuation of the work are presented.

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2. DATA

Radar data are reflectivity values composing CAPPIs at approximately 3.5 km height a.g.l., generated every 7.5 or 15 minute depending upon the interval within the period of 1993 to 2010 explored in the study. CAPPIs extend to 240 km range and are part of the set of operational products from IPMet´s Nowcasting center. Original reflectivity values are for each unitary area @ 1 x 1 km² structured in a 480 x 480 matrix in which is inscribed the 240 km circle. It should be noted that the radar data in the CAPPIs result from the raw reflectivity values which undergo a polar-to- Cartesian conversion (Einfalt et al, 2004) and the process of CAPPI generation, involving averaging . Finally, CAPPI data is averaged to compose 2 x 2 km² unitary areas that are used in this study. This averaging is required for properly matching to rain gage data when deriving Z-R relationships.

3. PROCESSING AND RESULTS

For the results presented in this work the following cumulative probability files, i.e., P(Z´>=Z /Zo) were compiled (all times are LT):

a) For each critical rainy period December-to-March, starting in Dec 93 and ending in MAR 10, for daily intervals, 0-6h, 6-14h, 14-19h and 19-24h, for BRU and PPR
b) For each month from January to December, starting in JAN 94 and ending in JAN 10, for daily intervals 0-6h, 6-14h, 14-19h and 19-24h, for BRU

c) For the rainy season, October-March, and the dry season, April-September, starting JAN 94 and ending MAR 10, for daily intervals 0-6h, 6-14h, 14-19h an 19-24h, for BRU

d) For the months of January ("peak' of rainy season) and August ("peak" of dry season) in the period 1994 – 2010, for daily intervals 0-6h, 6-14h, 14-19h and 19-24h, for BRU

The choice of the daily intervals is based on the distribution along the day of the precipitation accumulated each hour in the radar coverage area, as described in Calheiros and Tepedino (2006).

Figure 1(a) indicates the positions of the radars and the radar ranges, and the isohyets map for January-to-March from rain gage data. Figure 1(b) shows the year-to-year cumulative probability curves for PPR and BRU, for the 14-19h daily interval.

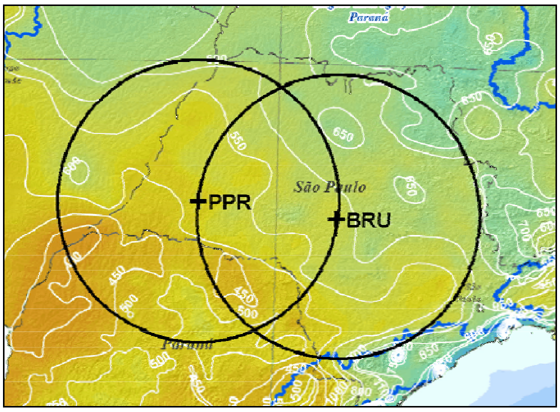


Fig.1a. Rain gage network based rainfall climatology for January-March (mm), from the period 1977-2006, and a sketch of the approximate positions and 240 km radar range for BRU and PPR.

For PPR, from the 14 rainy periods, 9 curves are relatively close together, the one for Dec 94-Mar 95 is unreliable, and those for the critical rainy periods of 00/01, 01/02 and 02/03 are detached up from the main set of curves and are being investigated. Data was not available for 95/96 for this radar.

For BRU, 15 out of the 17 critical rainy periods available feature curves positioned relatively close; periods 00/01 and 07/08 are positioned high detached from the main set; they are being checked.

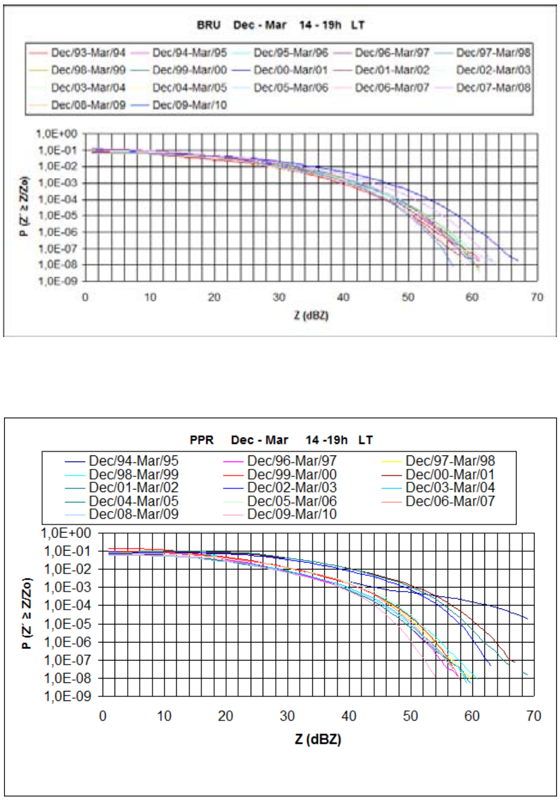
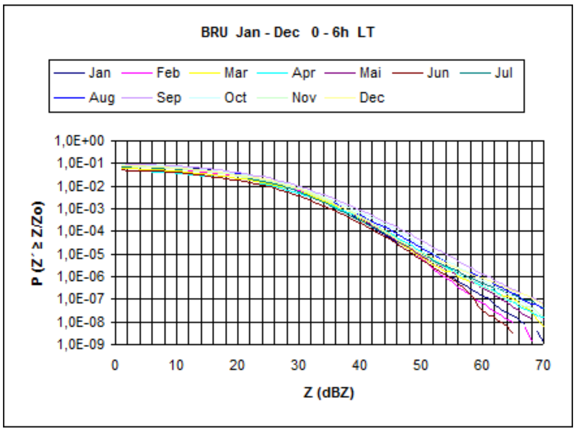


Fig.1b. Cumulative probability curves for the critical rainy season December-to-March, for 1994 to 2010, and for 14-19h, for BRU and PPR, respectively.

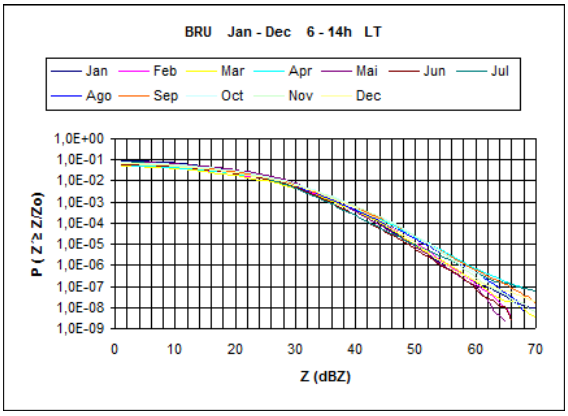
In general, no clear stratification is identified within the main sets of curves, both for BRU and PPR and the sets exhibit comparable spread of the curves. However, the set of curves for BRU is positioned somewhat above that for PPR; ratios around 1.3, 1.2 and 2.1 in probabilities for 30, 40 and 50 dBZ respectively, were estimated for the upper envelope of the sets for BRU and PPR respectively. The relative position of the sets is consistent with the rainfall patterns depicted in Fig.1a.

Figs. 2 (a) through (d) presents the curves for each month for BRU, stratified by daily interval.

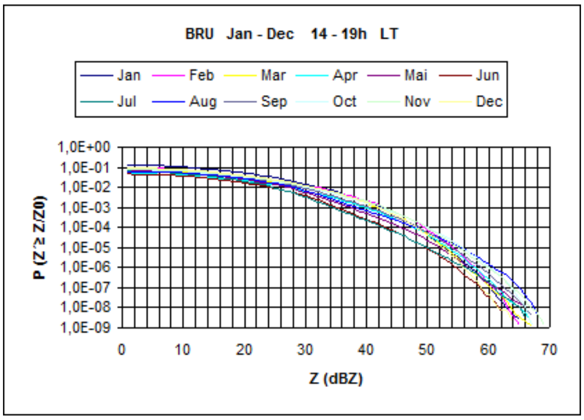
(a)



(b)



(c)



(d)

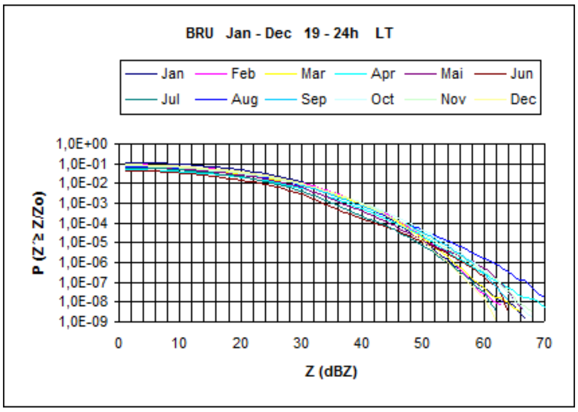


Fig.2. Monthly cumulative probability curves for the daily intervals for (a) 0-6h, (b) 6-14h, (c) 14-19h and (d) 19-24h, respectively.

For the 0-6h interval some degree of stratification is identified; in general, curve for September is the upper envelope while that for June defines the lower limit of the set of curves. For the interval 6-14h no clear stratification is identified. On the other hand, the interval 14-19h presents clear stratification, with the curves for the months of January and February defining the upper limit and that for the month of June defining the lower limit of the sets of curves.

Similar situation but, with a lesser degree of stratification, holds for the 19-24h interval. Comparison of the approximate probability values at 30, 40 and 50 dBZ for the approximately intermediate curve, between envelope curves for each set indicates a defined stratification for the 14-19h daily interval with respect to the intermediate curves for the other three intervals.

Figs. 3 (a) and (b) show the curves for the critical rainy period and the dry semester.

For the critical rainy period curves for 0-6h and 6-14h daily intervals are quite close up to about 55 dBZ. Curve for 19-24h runs above them also to about 55 dBZ. The curve for 14-19h is clearly stratified, situated in the uppermost position in the set of curves.

For the dry semester the disposition of the curves follows the same order, but are practically coincident until about 30 dBZ and the degree of stratification is significantly smaller.

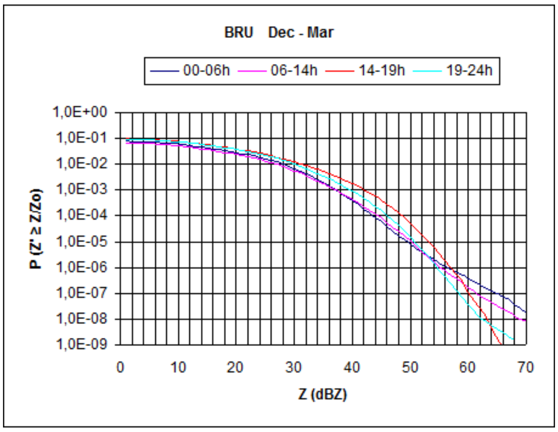


Fig.3a. Cumulative probability curves for the critical rainy period December-March.

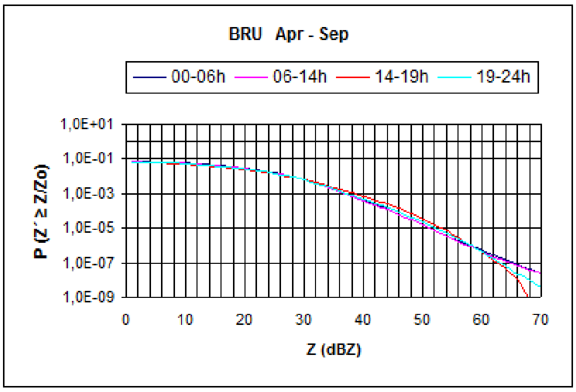


Fig.3b. Cumulative probability curves for the critical dry period April-September.

Fig.4a and 4b present the curves for the "peak" months in the rainy and dry periods.

Verification of individual sets of curves for the "peak" months (sets not shown here separately) shows that curves for January are closer to those for the critical rainy period than curves for August are to those of the dry period. For August curve for 0-6h and is close to that for 6-14h, the same holds for the curves for 14-19h and 19-24h. There is a substantial degree of stratification between the 0-14h and the 14-24h intervals.

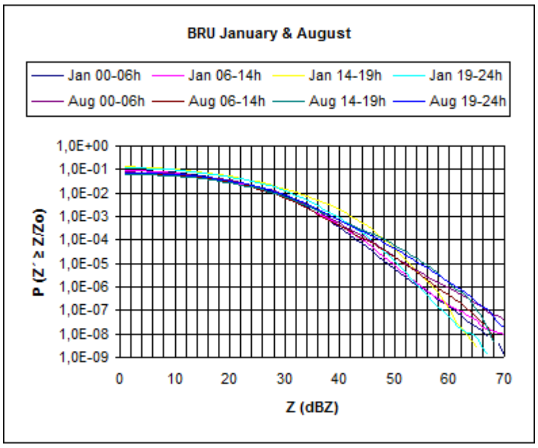


Fig.4 : Cumulative probability curves for the "peak" months: (a) January (rainy period) and (b) August (dry period), and all daily intervals, respectively.

4. COMMENTS AND CONCLUSIONS

In general, the yearly evolution of the cumulative probability curves suggests a relative stability of the structure of precipitation for most of its dynamic range. The consistency of the relative positions of the climatological sets of curves for BRU and PPR with the climatology of rainfall is a validation of the quantitative use of BRU and PPR.

A seasonal stratification is identified in all but the 0-6h daily interval. The peak summer convective activity is well characterized by the substantial degree of stratification during the 14-19h interval, and the by the position of the January and February curves above the curves for the same months, for the other daily intervals.

In the critical rainy period (December-March), stratification is pronounced for the 14-19h daily interval, consistent with the outstanding convective activity in that interval; the 19-24h interval presents a lesser degree of stratification. Intervals 0-6h and 6-14h do not show significant stratification among themselves. They were unified in the before mentioned study of Calheiros and Gomes (2011), involving hydrological use of BRU. For the dry period, the stratification is consistently smaller.

Curves for the “peak” months of January (rainy) and August (dry) indicate January is significantly more representative of the critical rainy period than August is of the dry period.

Work in continuation involves the completion of analysis for PPR and comparisons with BRU. In a next phase, the range stratification of the cumulative probability curves will be explored.

5. REFERENCES

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