EXTREMES RAINFALL CASES OVER RIO DE JANEIRO: ESTABLISHIMENT OF ATMOSPHERIC INDICATORS THRESHOLDS

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ABSTRACT

This paper aims at establishing thresholds for atmospheric indicators on days of occurrence of large accumulated daily rainfall, named in this work as extreme rainfall. The objective is to characterize the values of these indicators, specifically for the municipality of Rio de Janeiro, so that, when forecasted by numerical models, they properly represent the dynamic and thermodynamic patterns favorable to the occurrence of extreme rainfall over the region and can assist operational forecasters in the "warning time". To calculate these indicators, the Weather Research and Forecasting Model (WRF) with spatial resolution of 10km and integrated for 72 hours was used. The atmospheric indicators considered in this paper are: K index, TT index, CK index, CITT index, lapse rate between 500 and 700hPa (LR), divergence at 850hPa (CON) and 250hPa (DIV), vertical motion (W) at 500hPa and sea level pressure (P). Results showed that the thresholds represented more accurately and supports better the identification of the places which are more prone to form intense convective systems that lead to a large accumulated precipitation over Rio de Janeiro.

1. INTRODUCTION

Knowledge and forecast of convective systems associated with large accumulated daily rainfall (extreme rainfall) have shown to be vital over the last years once these systems are responsible for floods, landslides, flooding, and even loss of life .

Thus, this study aimed to examine cases of extreme daily rainfall in the city of Rio de Janeiro in the period 1997-2008, to calculate the indicators of severe weather from the simulations carried out by the Weather Research and Forecasting model (WRF - MICHALAKES , et al., 2001), seeking the establishment of thresholds that characterize the behavior of these indicators for the municipality, as an aid in the increasing of the proportions of "hit rates" and the reduction of "false alarms" in the forecast of thermodynamic and dynamic characteristics responsible for extreme rainfall.

2. METHODOLOGY

In this study, the extreme rainfall cases analyzed were the ones in which values of daily rainfall exceed the relevant threshold to the percentile of 99%, in at least three stations, the rainfall network stations in the city of Rio de Janeiro in the period 1997-2008 (Fundação GEORIO). Thus, there were 84 cases of extreme daily rainfall.

Table 1 - Threshold for total daily rainfall percentile corresponding to 99% for each of the thirty stations of Fundação GEORIO during 1997-2008.

Station	Threshold (mm)	Station	Threshold (mm)
Anchieta	40,8	Madureira	38,2
Bangu	41,4	Mendanha	48,6
Cachambi	40,4	Penha	35,7
Campo Grande	37,6	Piedade	45,0
Cidade de Deus	43,8	Rio Centro	55,6
Copacabana	46,2	Santa Cruz	42,4
Gericinó	43,0	Santa Tereza	54,0
Grajaú	48,6	São Conrado	72,4
Grota Funda	56,9	Saúde	43,3
Guaratiba	39,9	Sepetiba	47,4
Ilha do Governador	46,4	Sumaré	99,4
Irajá	38,8	Tanque	41,8
Intanhangá	65,4	Tijuca	63,3
Itaúna	43,0	Urca	42,6
Jardim Botânico	59,0	Vidigal	55,8

Figure 1 shows the region over which the model was integrated, and, in red, it is marked the region where atmospheric indicators were calculated.

The WRF model has been integrated with spatial resolution of 10 km per 72 hours, beginning one day before and ending one day after the occurrence of each event of heavy rainfall in the city of Rio de Janeiro, with the objective to characterize well the evolution of atmospheric parameters present at these events.

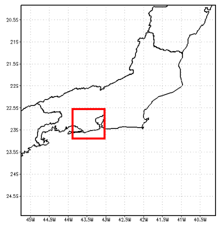

Figure 1 - Region where atmospheric indicators of extreme daily rainfall were calculated.

3. RESULTS

All the 120 grid points within the region bounded in red in Figure 1 were analyzed, in all cases on the days of extreme rainfall during the period 1997-2008. Statistical parameters have been calculated for each of the atmospheric indicators and then threshold values were established for each of them. The thresholds of atmospheric indicators of extreme rainfall are shown in Table 2.

Table 2 - Thresholds of indicators of extreme rainfall for the city of Rio de Janeiro.

Index	Maximun	Minimum	Median	Quartile 1	Quartile 3
CITT	2450,91	-3370,67	26,65	-87,08	154,38
CK	2007,17	-2677,87	18,28	-61,36	110,49
CONV	61,87	-79,68	0,64	-2,07	3,71
DIV	91,70	-30,15	0,05	-1,66	1,84
K	42,83	4,19	31,75	27,96	34,72
TT	52,75	27,70	42,93	39,72	44,69
LR	8,38	4,01	5,86	5,62	6,10
P	1027,06	1004,41	1013,39	1010,81	1016,44
W	4,56	-0,88	0,00	-0,02	0,03

It can be seen in Table 1 that the probability of extreme daily rainfall in the city of Rio de Janeiro is higher for cases in which the atmospheric severe weather indicators are below the first quartile (negative values, for example, CK, CITT and CONV or to the ones in which its value reduction convection environment, such as, pressure) or are above the third quartile (positive values, for example, K, TT, LR, DIV and MV).

Thus, based on sampling data of this study, local moments which have, for example, K index above 34.7 ° C, TT above 44.7 ° C, CK below -61.4 ° C * 10-6 / s CITT below -87.1 ° C * 10-6 / s, CONV below -2.1 * 10-6 / s, DIV above 1.842 * 10-6 / s, LR above 6.1 ° C / km, and SLP below 1010hPa MV above 0.034 m / s are most conducive to the occurrence of extreme precipitation (Table 1).

4. CONCLUSIONS

The values of indicators of severe weather found in this paper for all days of the occurrence of extreme rainfall in the city of Rio de Janeiro in the period 1997-2008, together with their thresholds (Table 2) obtained from numerical modeling, more properly characterize a conducive environment to storm formation than the pre-established to severe storms such as the ones found in the literature for other places in the world.

5. BIBLIOGRAPHIC REFERENCES

MICHALAKES, J., S. Chen, J. DUDHIA, L. Hart, J. KLEMP, J. MIDDLECOFF, and W. SKAMAROCK (2001): *Development of a Next Generation Regional Weather Research and Forecast Model. Developments in Teracomputing: Proceedings of the Ninth ECMWF Workshop on the Use of High Performance Computing in Meteorology.* Eds. Walter Zwieflhofer and Norbert Kreitz. World Scientific, Singapore. pp. 269-276.

POLIFKE DA SILVA, F. and M. G. A. JUSTI DA SILVA (2011): Indicadores de Tempestades Severas para o Município do Rio de Janeiro in *XXXI Jornada Giulio Massarani de Iniciação Científica, Artística e Cultural (UFRJ).*