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ANOMALOUS RAINFALL IN THE NORTHEASTERN BRAZIL IN JANUARY OF 2004: DOWNSCALING USING MODEL WRF

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1. INTRODUCTION

It is a common practice the use of mesoscale models to predict regional weather, although this methodology is seldom used for both climate applications and equatorial regions. In order to better evaluate such potential, the WRF model (ARW Version) was run to simulate two opposite rainfall climatologic patterns over the same equatorial region.

2. METODOLOGY

For this case study, the months of January 2004 and January 2005 were chosen, the first being representative of above average monthly rainfall, and the second below average. The WRF-ARW Model, version 2.1.2 was used with two different physics options sets for each month, options listed on table 1.

Physics	Simulation 1	Simulation 2
Microphysics	WSM 3-class simple ice scheme	WSM 6-class graupel scheme
SW Radiation	Dudhia scheme	Dudhia scheme
LW Radiation	RRTM Scheme	RRTM Scheme
Surface Layer	Monin-Obukhov scheme	Monin-Obukhov (Janjic Eta) scheme
Land-Surface	Thermal diffusion scheme	RUC land-surface model
Boundary Layer	YSU Scheme	Mellor-Yamada-Janjic (Eta) TKE scheme
Cumulus	Kain-Fritsch (new Eta) scheme	Kain-Fritsch (new Eta) scheme

Table 1 – Physics options for each simulation

The model grid was set with twenty kilometers horizontal resolution, fifty by fifty points on the horizontal, 31 levels, centered over Ceará State in Brazil. To feed the model, was used Reanalysis Project data (Kalnay et al., 1996). Since it was a climate application, sea surface temperature was updated during the simulation, providing a more realistic approach.

3. RESULTS

Initially, to ease the evaluation of results, the observed monthly rainfall fields over the studied area, for both January 2004 (a) and January 2005 (b) are on Figure 1.

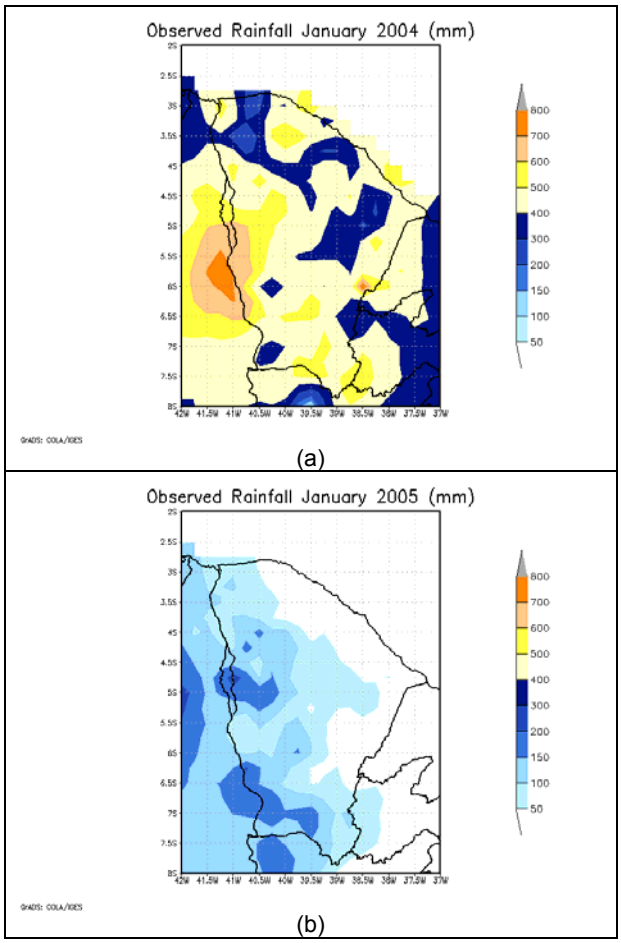

Figure 1 – Observed Monthly Rainfall over Ceará State, for January 2004 (a) and January 2005 (b)

Figure 2 shows the results of Simulation 1 for January 2004 and January 2005. Both years show values way below the observed ones, but 2004 results nearly match the regions of highest rainfall values over continental areas. Initially, only this simulation was planned, but in an attempt to improve the results, even taking longer to run, were chosen more refined physics options, labeled on table 1 as Simulation 2.

Simulation 2 results can be seen in Figure 3. Values are much closer from observed on average,

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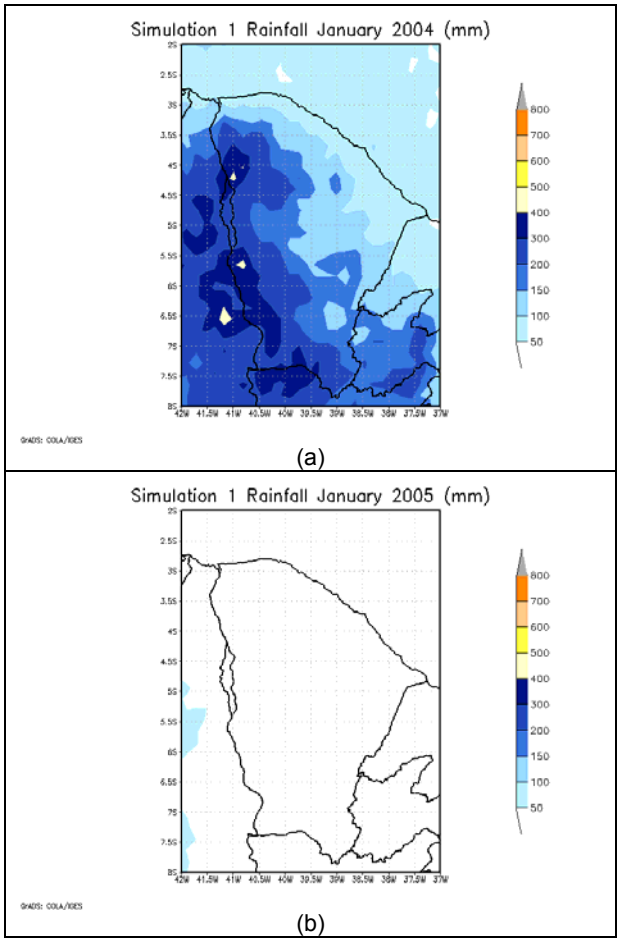

Figure 2 – Simulated monthly rainfall over Ceará state, as obtained thru Simulation 1, for January 2004 (a) and January 2005 (b)

besides depicting the relative highs in a much clearer way. Taking in consideration the differences between simulation 1 and 2, the turbulent and surface related processes, along with a refined microphysics did impact the results considerably, but the reduced precipitation along coastline must be taken in consideration as a negative effect. Also, the improvement for 2005 is remarkably above any expectations, going from absolutely no rainfall on simulation 1, to a near perfect match on simulation 2.

4. CONCLUSIONS

The rainfall modeled values on Simulation 2 showed good agreement with accumulated observed precipitation, over an equatorial region, which is seldom studied with such approach, suggesting the use of mesoscale models, or WRF at least, is possible for both weather forecasts and climate applications. The results obtained are highlighted by the fact that the downscaling made here is rather crude, from approximately 250 kilometers horizontal resolution data (Reanalysis) to 20 kilometers. It suggests that, at least when dealing with precipitation patterns, characteristics pertaining local effects, such as topography, land-use and mesoscale events may be as important as large scale input data.

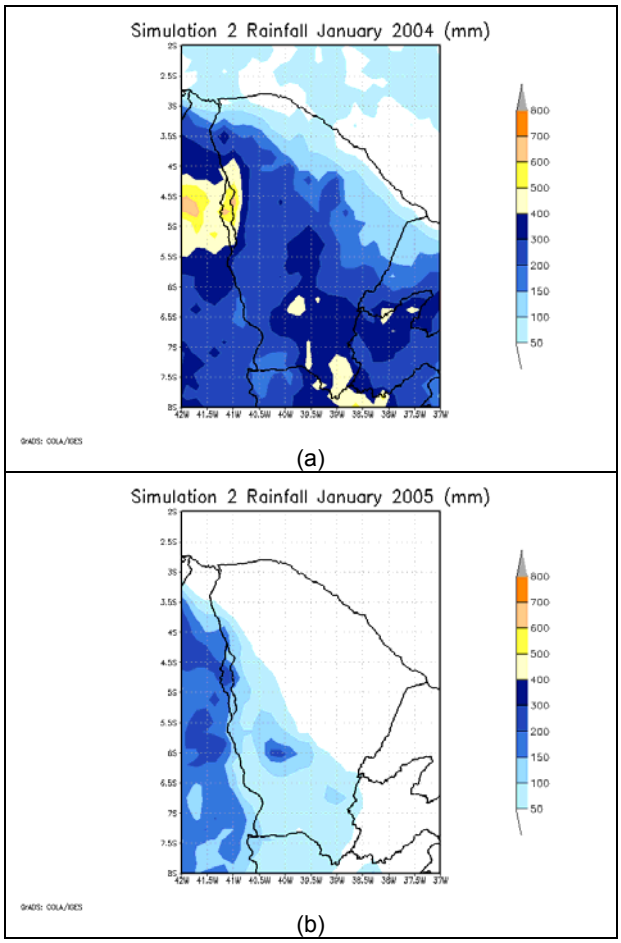

Figure 3 – Simulated monthly rainfall over Ceará state, as obtained thru Simulation 2, for January 2004 (a) and January 2005 (b)

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