WRF simulations of extreme rainfall cases in Manaus, Brazil: Assessing the performances of cumulus and microphysics schemes

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1 - MAIN PURPOSE

The main issue of the present work was to evaluate the WRF performance in simulating three extreme rainfall events occurred in Manaus (figure 1) during the transition season (dry to wet).

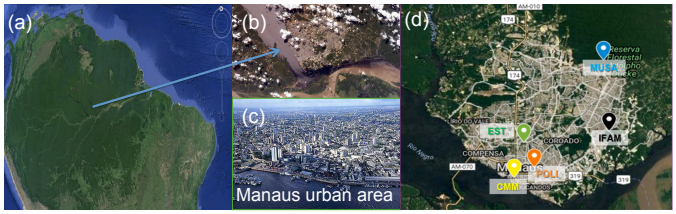

Fig. 1 - Part of South America (a), Location of Manaus city (b), Manaus urban area (c) and location of surface meteorological stations (EST, CMM, POLI, IFAM and MUSA).

2 - DATA AND METODOLOGY

Data of atmospheric pressure, temperature, precipitation and specific humidity from 5 meteorological surface stations (Fig. 1d) locate over the urban area of Manaus were used in order to be compared with WRF output. Data from meteorological surface stations were measured each 5 minutes, while model output data is available in time step frequency. The domain of integrations and main model configurations used in this study are available in Table 1 and Figure 2.

3 - WRF SIMULATIONS AND CONFIGURATIONS

WRF V3.8	Configurations
Period of Simulations	12 UTC Sep 10 2013 – 06 UTC Oct 12 2013 12 UTC Sep 29 2013 – 06 UTC Oct 01 2013 12 UTC Sep 08 2016 – 06 UTC Oct 10 2016
Number of Domains	4
Horizontal Resolution	27, 9, 3 and 1 km
Number of Levels	37 (10 hPa is the model highest level)
Initial and Boundary Conditions	CFSR (0.5° × 0.5° each 6 hours) / Reynolds SST
Convective Parameterization	Kain-Fritsch, Betts-Miller, Grell-Devenyi
Microphysics Scheme	CAM 5.1, Eta (Ferrier), KESSLER, MILBRANDT, MORRISON, SBU-Ylin, Thompson, WDM5, WDM6, WSM3 and WSM5
Planetary Boundary Layer	YSU
Longwave Radiation	RRTM
Shortwave Radiation	Dudhia 89
Surface Physics	NOAH
Urban Surface	Urban Canopy Model

Table 1 – Characteristics of WRF experiments.

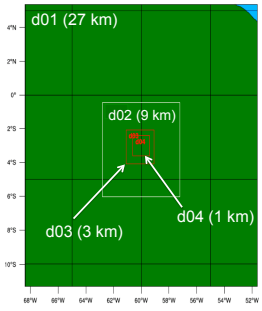

Fig. 2 - Domain of simulations.

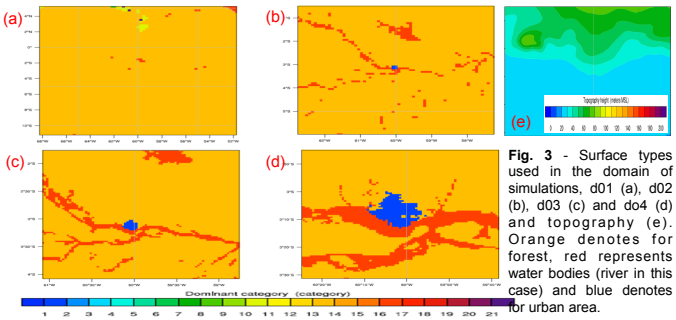

Fig. 3 - Surface types used in the domain of simulations, d01 (a), d02 (b), d03 (c) and do4 (d) and topography (e). Orange denotes for forest, red represents water bodies (river in this case) and blue denotes for urban area.

4 - RAINFALL CASES

Three extreme rainfall events were selected to this study. All of them occurred during September month, which is a month in the transition of dry to wet season (SON). All the events were related to squall line propagation. Events of these kind bring a lot of rainfall amount in a short time interval (~ ½ hour). Usually, they provoke almost what is expected to the entire month and in some cases the rainfall quantity exceeds what is expected to the entire month. The first rainfall case occurred in 11th September, 2013. The second event occurred in 30th September, 2013 and the last one occurred in 09th September, 2016.

5 - RESULTS

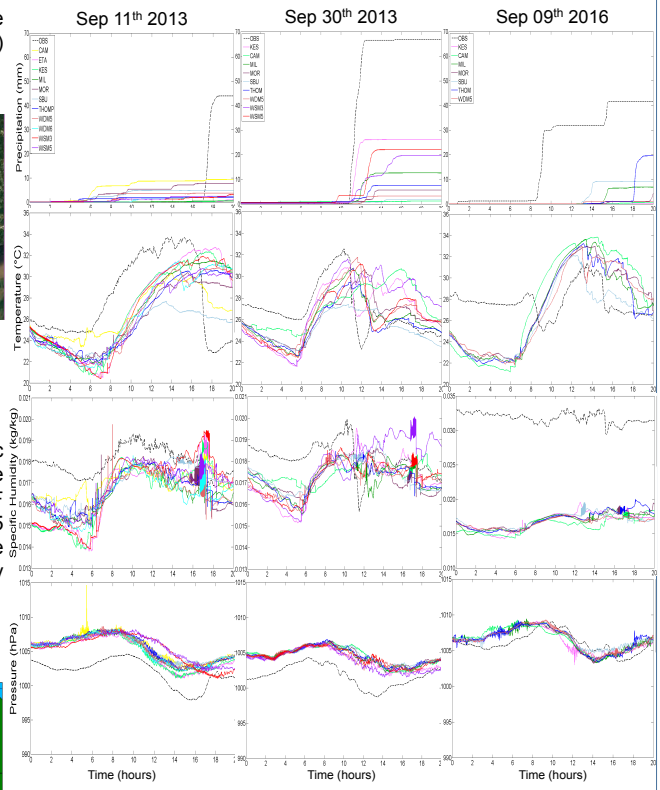

Fig. 4 – Time evolution of model results versus observations from surface meteorological stations for each selected rainfall cases (11/Sep/2013, 30/Sep/2013 and 09/Sep/2016). Variables analyzed are accumulated rainfall, temperature, specific humidity and pressure. Variables from surface meteorological stations were registered each 5 minutes, while model results were output each model time step. It was used the domain d04 (1 km resolution) for comparison purposes.

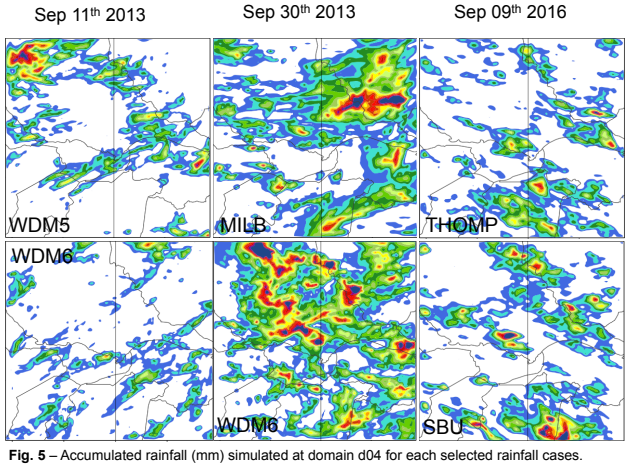

Fig. 5 – Accumulated rainfall (mm) simulated at domain d04 for each selected rainfall cases.

5 – CONCLUDING REMARKS

Results for this study show that WRF model "fails" in simulate both the time of rainfall initiation and the rainfall quantity. The model simulations underestimate the rainfall quantity for all rainfall cases. The model anticipated the rainfall initiation in the case study of Sep 11th, it delayed the rainfall in the case of 09th Sep and and it get a good performance in the case of Sep 30th . In the case of temperature, the model presented a good performance for the case of Sep 30th. For accumulated rainfall, WRF model reached a good performance for the case of Sep 30th, 2013.

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