WRF MODEL ASSESSMENT TO THE WIND PROFILE AND THERMODYNAMIC CHARACTERISTICS DURING THE CHUVA PROJECT - ALCANTARA STATION 2010 -

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- Evaluate the ARW-WRF model performance to the wind prediction before rocket launchings at Alcantara Launching Center (CLA), as well as its confidence in hours intervals, by comparison against observations.

- Vertical wind structure can cause:
  - deviation of the trajectory of the rocket;
  - contingencies in the project;
  - accidents.

- Analysis up to 5000 m (height of most likely influence of the wind).

Location:

- 2° S;

- near the coastline of the Equatorial Atlantic Ocean;

- mostly flat topography;

- 40 m coastal cliff.

Rainy season (January to June, mainly in March and April)

- precipitation governed by ITCZ;

- weak sea breeze;

   weaker winds

- basically the trade winds;

- predominantly easterly to 5000 m altitude, with seasonal rotation from southeast to northeast, according to the ITCZ, and northeasterly near the surface.

Fisch (1999)

Barros and Oyama (2008)

- 3 nested domains, square and centered at Alcântara;

- 100 x 88 x 76 points = 900 x 264 x 76 km^2;

- Horizontal resolution: 9, 3, 1 km;

- 42 vertical levels;

- Terrain resolution: 30" USGS;

- Initial and boundary conditions:

  GFS (NCEP), 0,5° x 0,5°, 6-hourly;

- Two-way nesting;
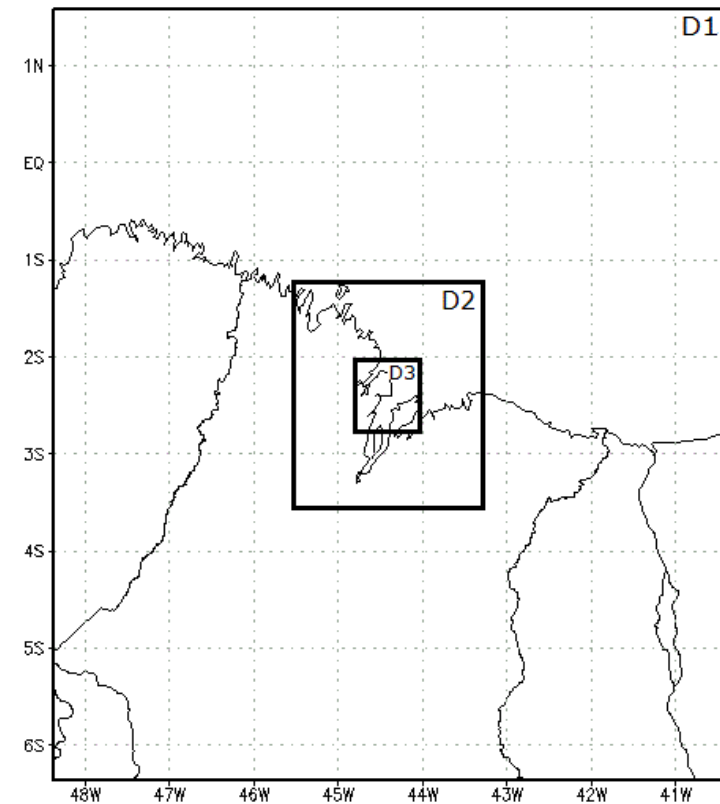
- Time-step: 5*dx;

- Spin-up time: 6 h;

- 72 h, model output every 6 hours.

- Proliant **HP** DL380 G7 Server:

  – Processor: Intel 6-core

  – RAM: 32 Gb

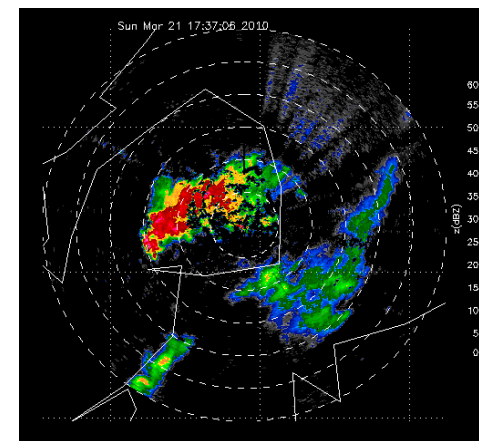 – HD: 2 x 300 Gb (operational system)

  – 4 x 1 Tb (storage)

Observations data from CHUVA Project – Alcantara station, 2010:

- soundings;

- radar X-band mode PPI.

- From March 19 to March 25

Vaisala Radiosonde, RS92-SVG
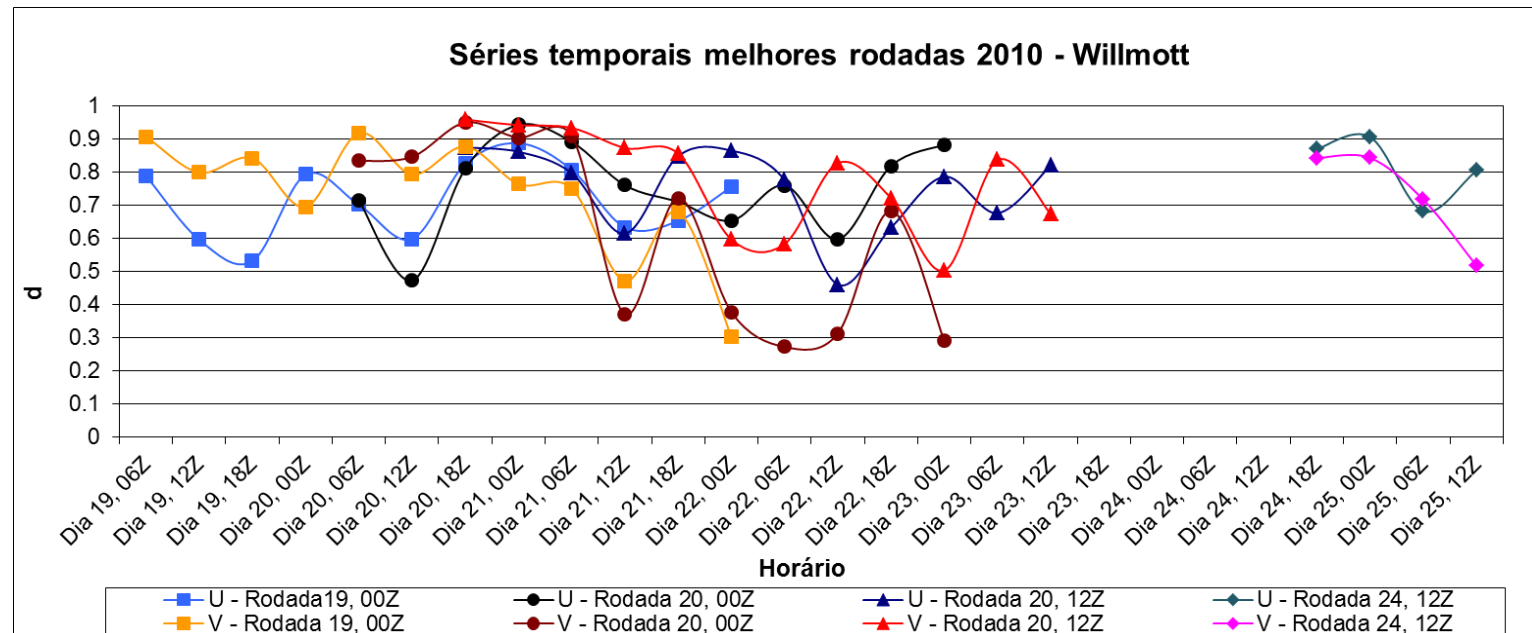

Radar X-band, PPI mode.

72 h prediction simulations *x* observations data compared by:

- bias;

- RMSE;

- Willmott's index of agreement (1981) (d̲)

- Total wind speed ("*vel*") + U and V components.

- Calculated every 6 hours.

- No superiority was noted among the components U and V with respect to the Willmott index.

- Willmott ranged between 0.45 ~ 0.95 for U and 0.30 ~ 0.95 for V.

Séries temporais melhores rodadas 2010 - Willmott

- But, for errors, U has values generally larger.

- The wind bias ranged from 1.20 to 3.80 m/s for U and 0.70 ~ 3.30 for V. The *vel* value achieved the maximum of 2.80 m/s.

Séries temporais melhores rodadas 2010 - *bias*

- Finally, about RMSE, U ranged from 1.50 to 4 m/s and V, smaller, between 1 ~ 3.50 m/s. The *vel* value was between 1.50 ~ 3.40 m/s (not shown).

Séries temporais melhores rodadas 2010 - RMSE
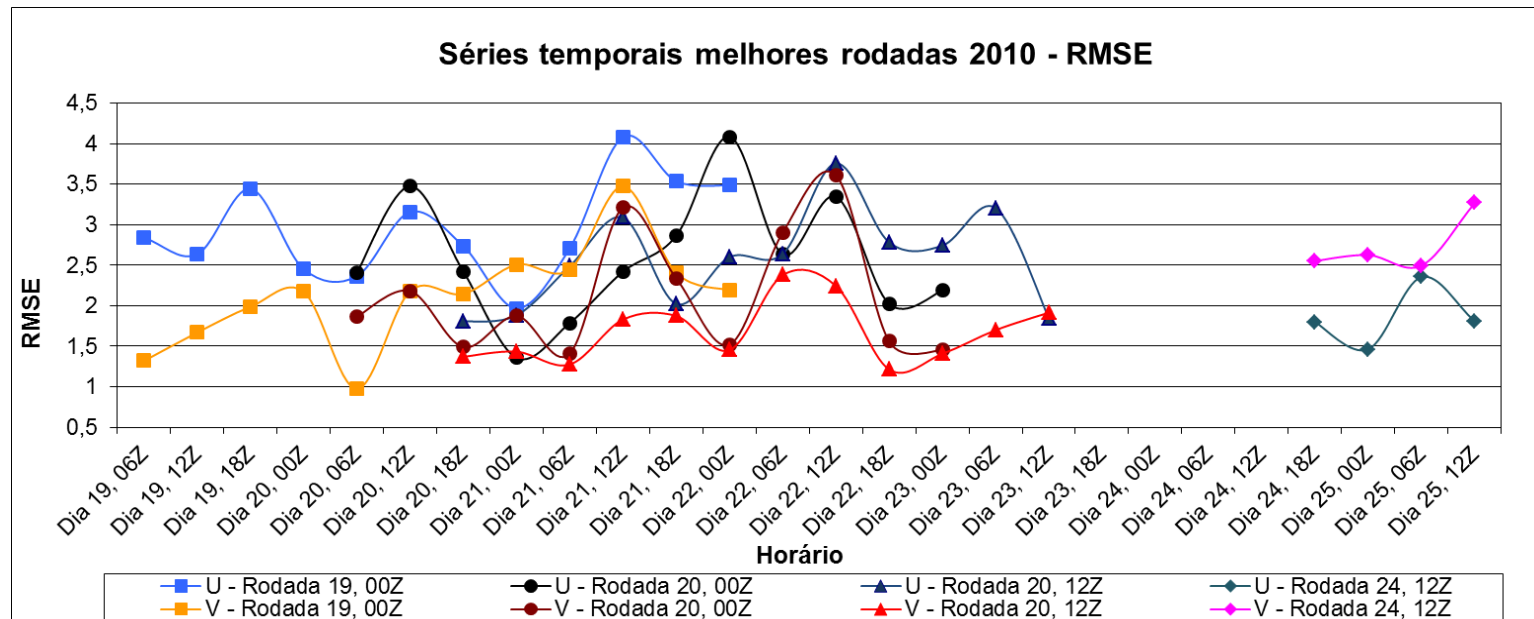
Pure variable, with no statistical index applied → mean variables in the middle layer up to 5000 m.
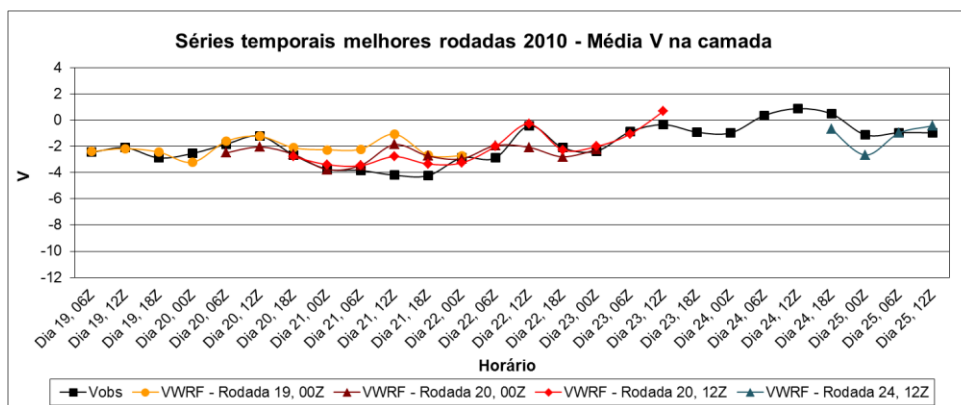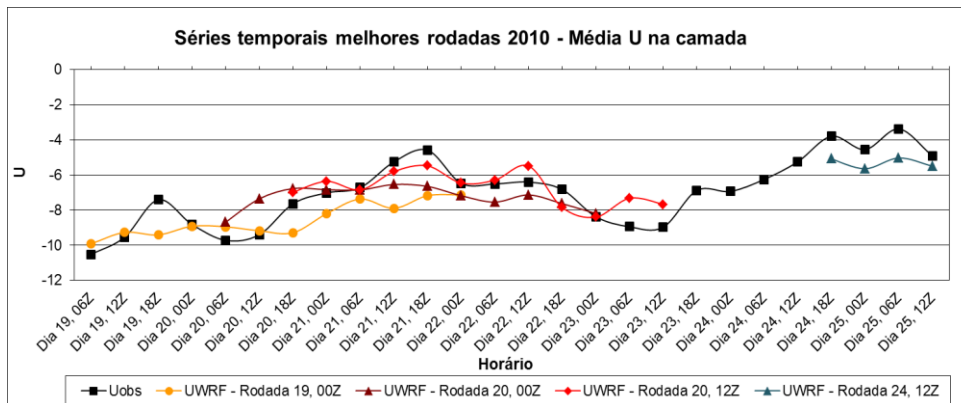
For this period, the WRF overestimated the U component of up to 3 m/s, with an average of 0.7 m/s.

V is satisfactory.

The rainfall pattern influences the wind pattern, and vice-versa.

- Evaluate the thermodynamic consistency $\rightarrow$ check the daily cycle and the space-temporal coincidence of the rainfall.

- Radar X-band (30 km range operating) x accumulated precipitation in one hour (mm/h)

- WRF model failed to correctly position the cores of rainfall both in space and in time;

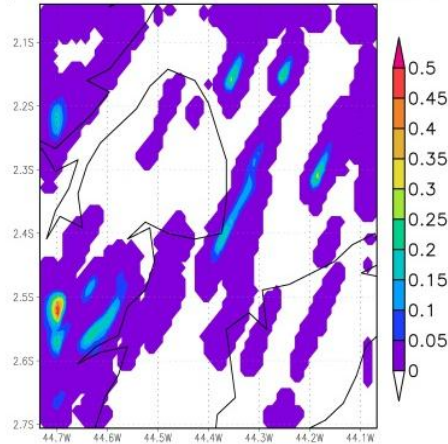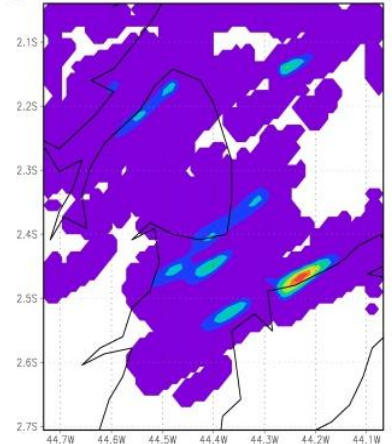- WRF model was not efficient to represent the rainfall intensities;

- Lag time.

Example 1:

- Heavy rainfall observed by radar over CLA for 15 hours almost nonstop;

- None of the rounds that included this time interval was able to represent such an extreme event;
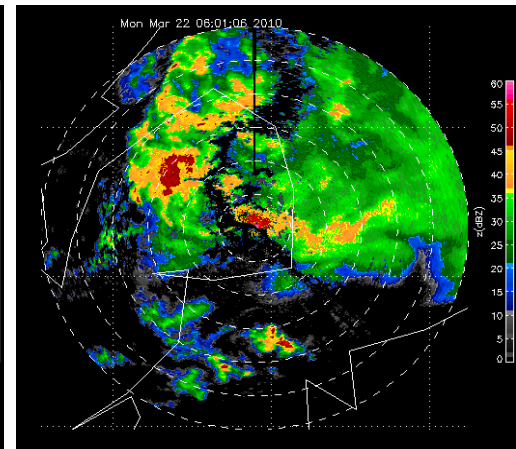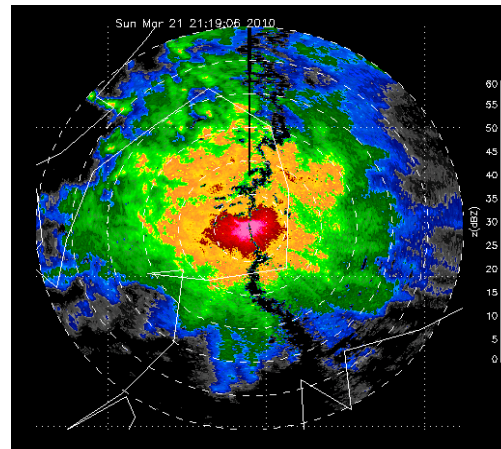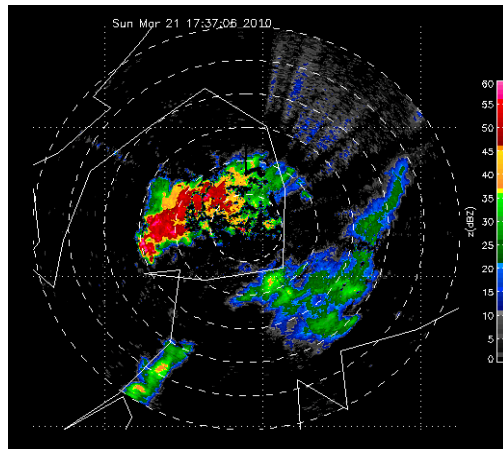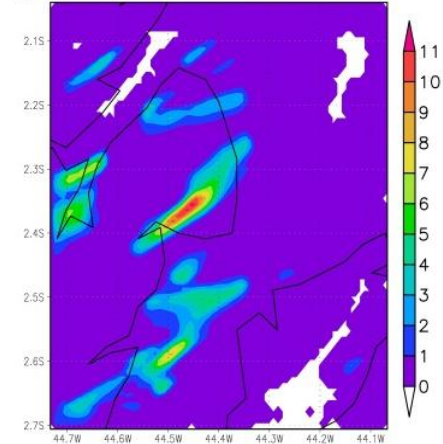
Precipitacao Acumulada em 1 hora, 18Z21MAR2010   Precipitacao Acumulada em 1 hora, 22Z21MAR2010   Precipitacao Acumulada em 1 hora, 06Z22MAR2010

Example I: WRF cumulative rainfall in one hour (mm/h) *x* radar X-band (30 km range operating). Strong core of precipitation over the CLA. Model not represented.
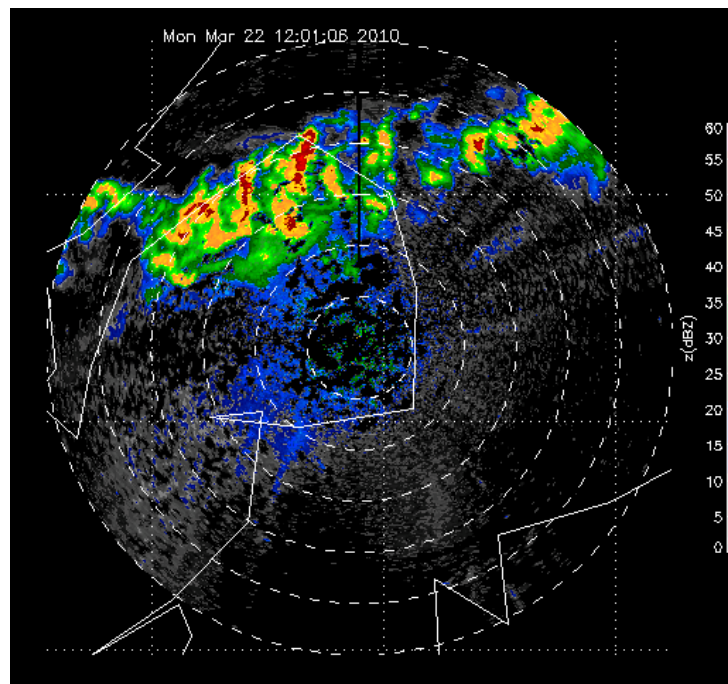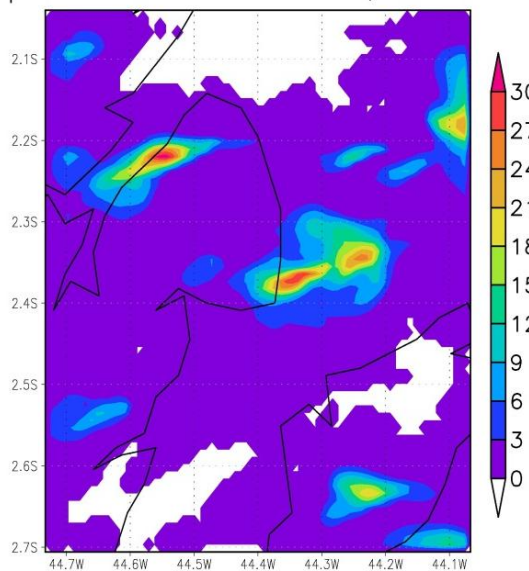
Example 2:

Tracking the trajectory of convective systems that moved over the area of the simulation domain, it was possible to notice a lag of WRF in 2 hours:

–   WRF: 13 UTC, March 22;

–   Radar: between 10 and 12 UTC, March 22.

Precipitacao Acumulada em 1 hora, 13Z22MAR2010

Mon Mar 22 12:01:06 2010

Example 2: Evolution of the system in an hour in WRF and that observed by radar.

- It wasn't possible to obtain a time interval pattern of all simulations where quality prediction was better or worse.

- According to the Willmott index, the model was reasonable to represent the vertical wind profile, within its limitations, with maximum values on the order of 0.90 and, on the average, on the order of 0.70, that were considered satisfactory according to limits found in other studies.

- The WRF model with the default configuration of cloud microphysics, fails to capture the presence of rain in terms of position and intensity. This issue must be better studied in future works.

- These results are part of my Master's degree studies at INPE, completed in February, 2013.

Thanks!

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