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NUMERICAL STUDY OF THE PRODUCTION OF INTENSE RAINFALL IN THE SERRA DO MAR PAULISTA REGION

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INTRODUCTION

Rainfall in the Serra do Mar region (located near the coast of São Paulo) is strongly influenced by convective systems that occur in this region. The local circulation of the Serra do Mar is affected by the proximity the sea, vegetation type and complex topography.

OBJECTIVE

Two episodes of heavy rains that occurred in the Serra do Mar region were studied in this work by means of numerical simulations using the Eta model. This study investigates the role of local circulation, the convection scheme and the interactions between convection and the surface fluxes in the development of heavy rainfall.

METHODOLOGY

•The Eta model (Mesinger et. al, 1988) was integrated with 5-km horizontal resolution and 50 vertical levels, using the domain in Figure 1, for February 2008 and March 2009.

•The convection precipitation is generated by the Kain-Fritch scheme (Kain, 2004) and microphysics by Ferrier scheme (Ferrier et al., 2002).

•The land-surface processes are solved by the NOAH scheme (Chen et al., 1997).

•The radiation package was developed by GFDL.

•The initial condition were taken from ERA Interim reanalysis (Simmons et al., 2006). The lateral boundaries were updated every 6 hours from ERA Interim reanalysis.

• Experiments

Names	Description
Control run	no change in the configuration described above
Experiment 1	the urban vegetation was included in the vegetation map used by Noah surface scheme (Figure 1)
Experiment 2	sensitivity tests were applied to the trigger function of the Kain-Fritsch cumulus parameterization scheme (Figure 2)
Experiment 3	inclusion of urban vegetation + change in trigger function of the KF scheme

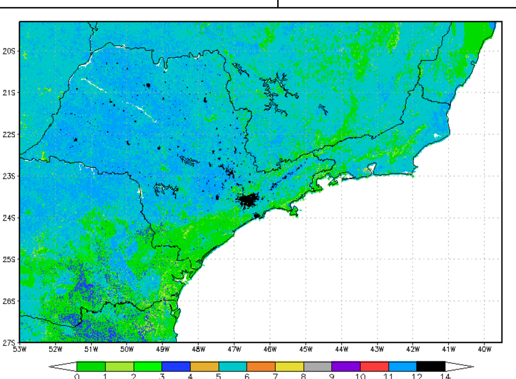


Figure 1 - Vegetation map used in Experiment 1 with 12 vegetation types of Dorman and Sellers (1989) and the inclusion of urban vegetation (in black).

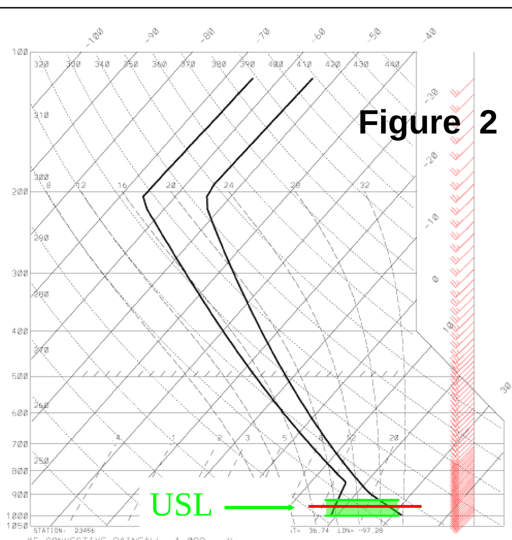


Figure 2 - Thermodynamic diagram schematic showing the updraft source layer (USL) of 50hPa in the control run in green. The red line represents the reduction of the USL to 30hPa in experiment 2.
Source: Adapted from Kain e Baldwin, 2006.

RESULTS

•The case of February 2008

• Heavy rains occurred on 10, 11 and 12 February 2008;

• According to the synoptic analysis of the CPTEC/INPE on 11th-February there were a frontal system acting upon the ocean and coastline of the southern region, as shown by the extensive cloud band of gray tone in the satellite image (Figure 2a);

• This synoptic situation shows that the extreme events that occurred during this period in SP and RJ were not associated with the system of large scale, therefore, its formation occurred predominantly due to factors thermodynamic and dynamic locals (Figure 2b).

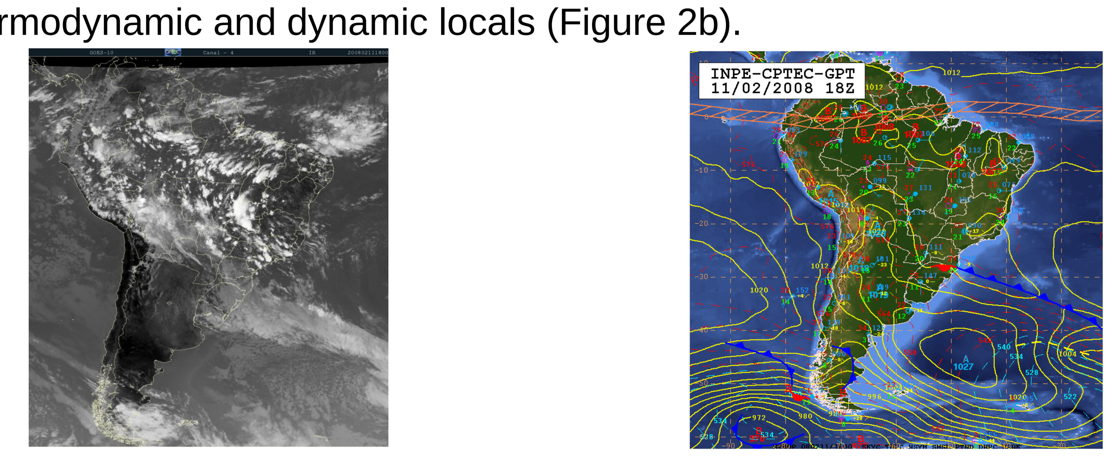


Figure 3 – Infrared satellite image (GOES-10) and synoptic analysis on 11 February, 2008 at 18Z

RESULTS

•Analysis of Experiments

•The accumulated precipitation on the 11, 12, and 13 (figure 4) show more intense cores on the coast of SP, RJ, and between SP and RP (only on day 11).

•The convective precipitation in the control run shows that the model located precipitation maximum cores, but in terms of quantity was not satisfactory (figure 5).

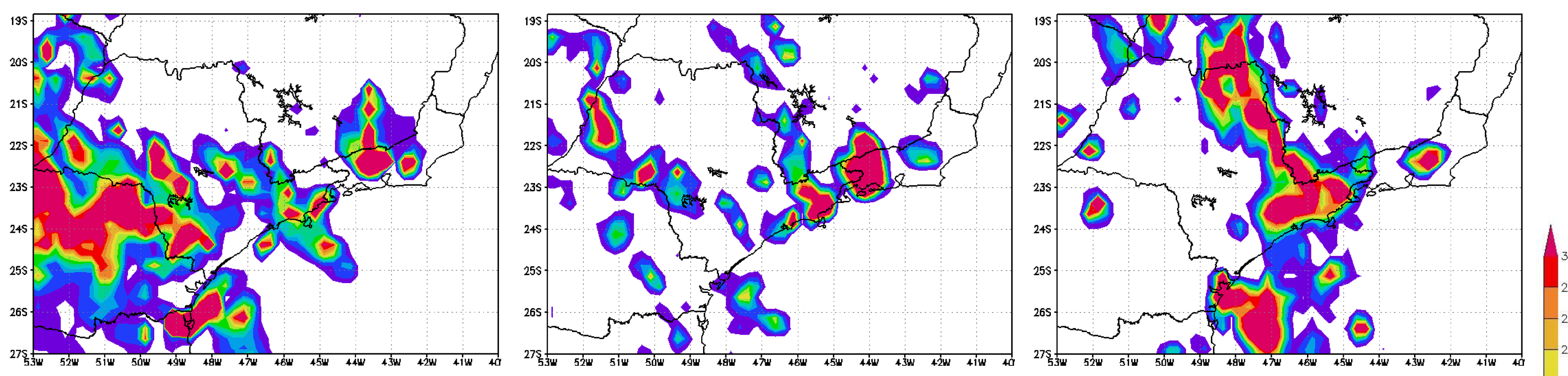


Figure 4 - Precipitation estimated by TRMM satellite, accumulated in 24h at 12Z on 11, 12 and 13 February.

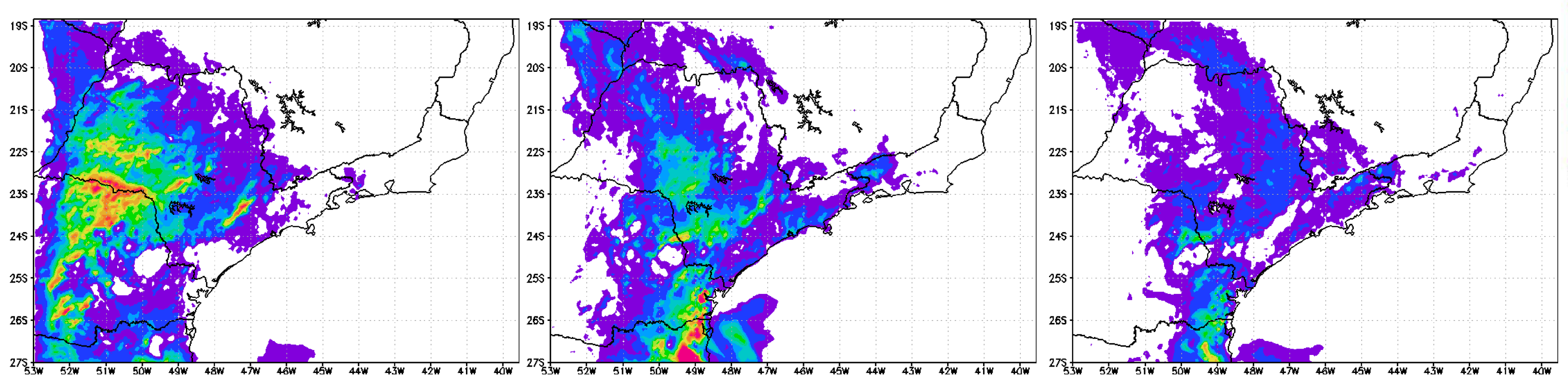


Figure 5 - Convective precipitation (mm/d) from the control run, accumulated in 24h at 12Z on 11, 12 and 13 February.

•On experiment 1 there was an increased the precipitation for the control run, especially in places where the urban vegetation type was included;

•The results of experiment 2 showed that the model was more sensitive to surface conditions and generally improved the locations and amounts of the simulated convective precipitation.

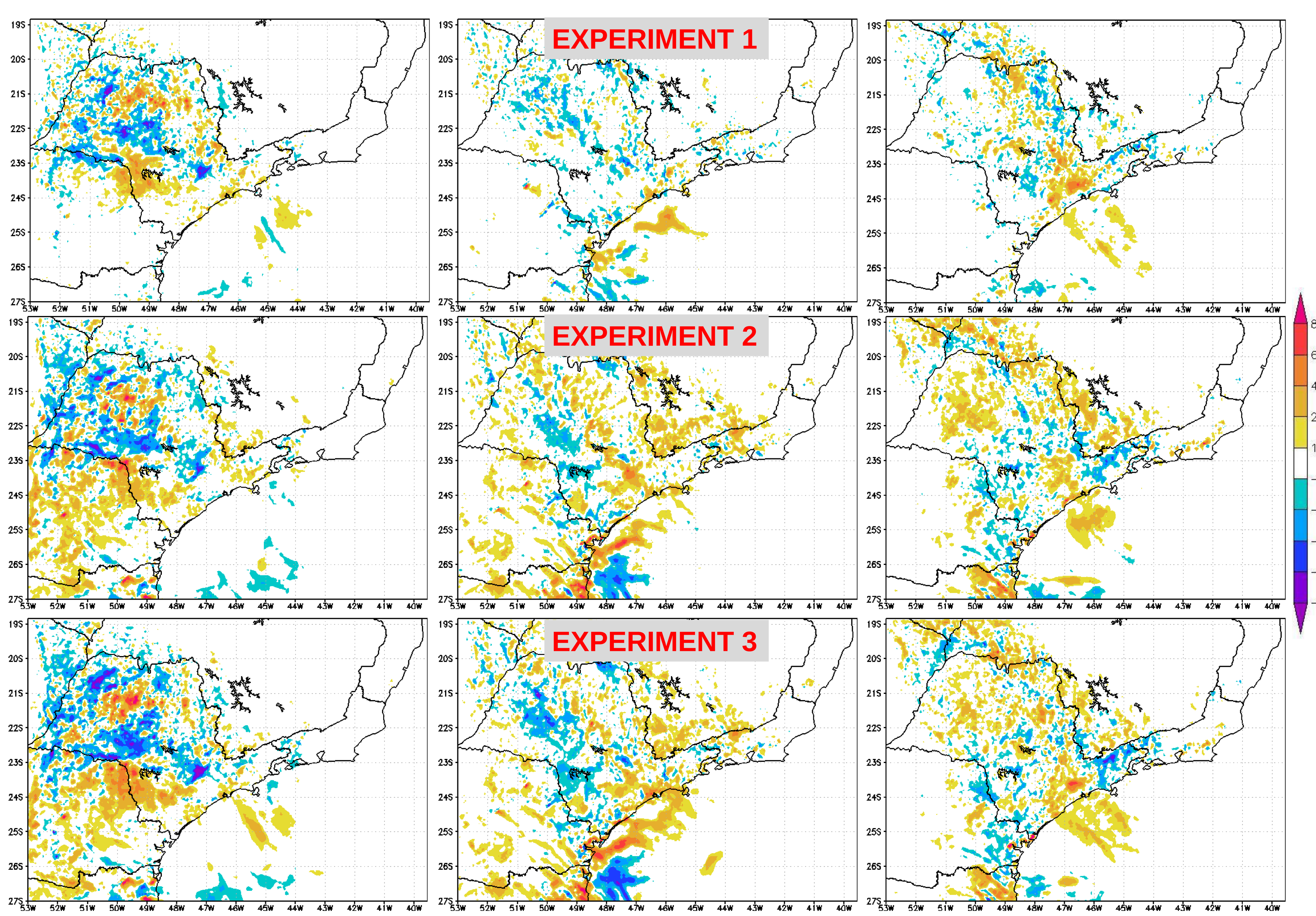


Figure 6 - Difference the convective precipitation (mm/d) between of the experiments and control run, accumulated in 24h at 12Z on 11, 12 and 13 February.

•In experiment with the inclusion of urban vegetation, there was a change in local circulation, intensifying the local sea breeze winds

•In this experiment there was increase the 2-m air temperature and reduction the 2-m dew-point temperature, as well as the fluxes of sensible and latent heat, respectively in relation to control run, especially in places where the urban vegetation type was included.

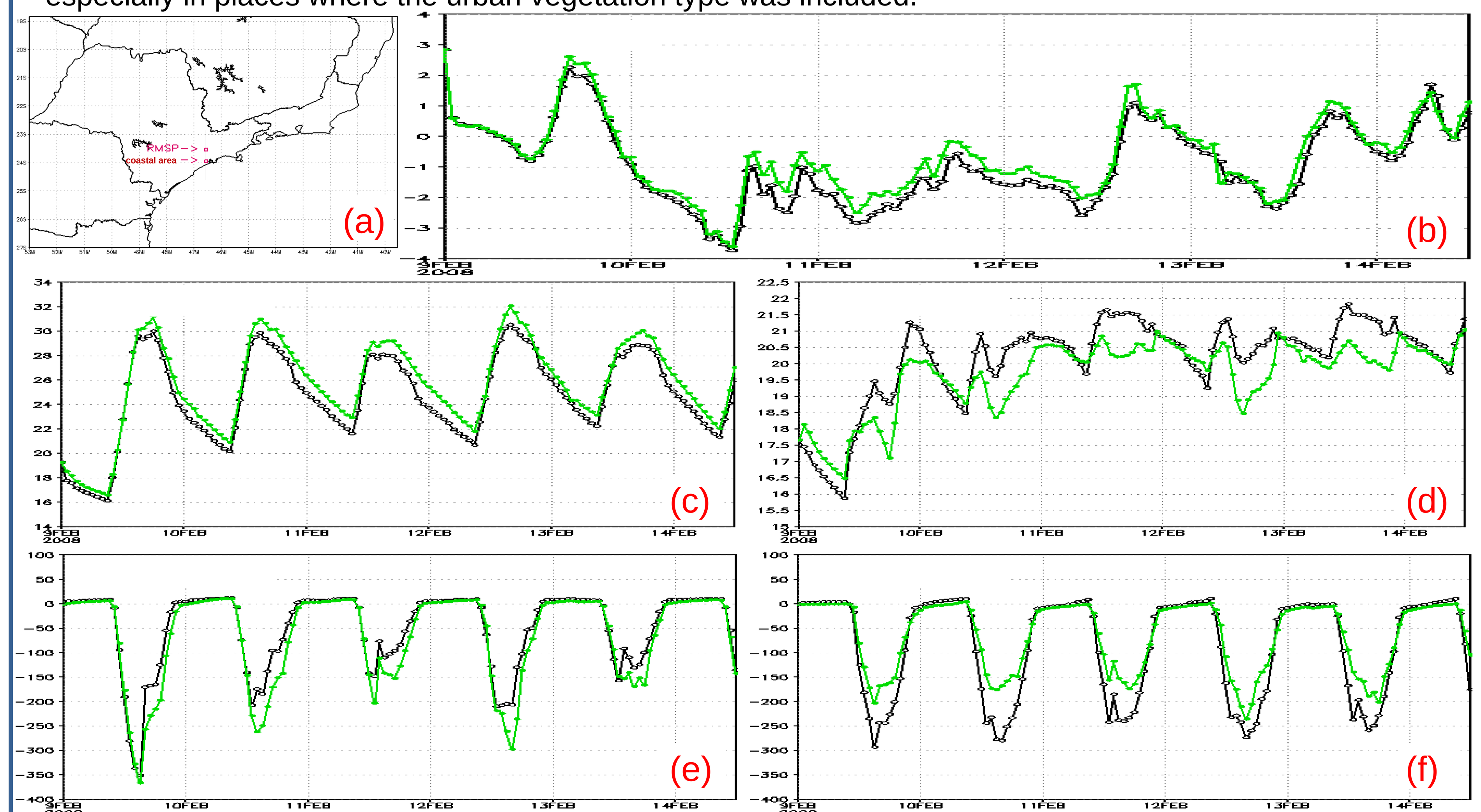
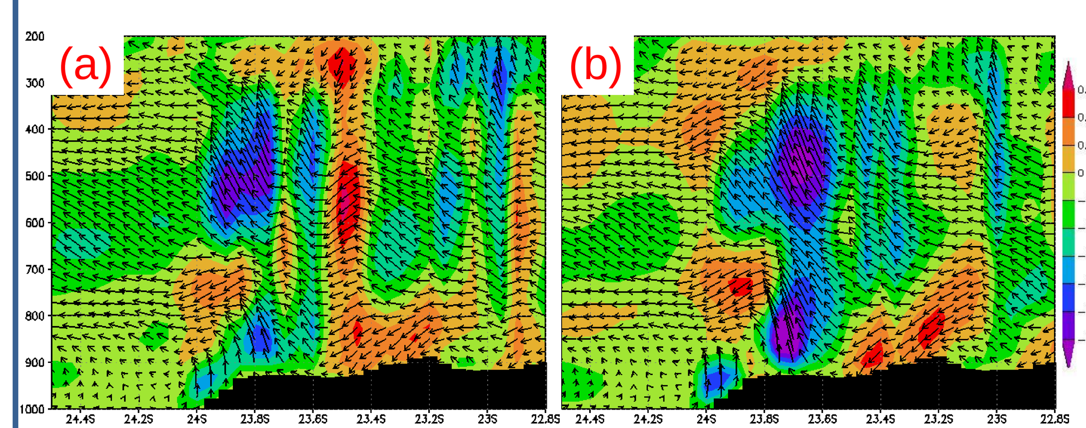


Figure 7 – (a) The schematic of locations RMSP (São Paulo Metropolitan Region) and coastal area, and cross-section line AB over the state SP. The time series of (b) meridional wind at the coastal area and (c) air temperature at 2m,, (d) dew-point temperature at 2m, (e) sensible heat flux, and (f) latent heat flux over location RMSP for control run (black line) and experiment 1 (green Line).



•On the 12th, there was an increase in the upward motion in experiment 1 for the control run mainly on the urban area. This intensification of the sea breeze and the vertical movement favors the formation of convective systems.

Figure 8 – The cross-section through line AB in Fig. 7a. The vector represent the wind. The shaded area represents the Omega (Pa/s) (a) of control run, and (b) of experiment 1, for the day 12 February at 18Z.

CONCLUSIONS

•The experiment with the inclusion of urban vegetation modified the 2-m air and dew-point temperatures, as well as the local circulation, and consequently, the precipitation for the control run, especially in places where the urban vegetation type was included. This showed that the formation of convective precipitation in this region is strongly influenced by the thermodynamic effects that the urban heat island promotes on hot days, in weak large scale forcing conditions.

•The results of experiments with changes in the trigger function showed that with the modification to shallower updraft source layers (USL), the model was more sensitive to surface conditions and generally improved the locations and amounts of the simulated convective precipitation. However, by increasing the dependence of the trigger function to grid point vertical movement, results were not considered satisfactory (figure not shown).

•Results of last experiment showed a small improvement of 850-hPa temperature (figure not shown) and precipitation over the control run. These results showed the importance of more accurate description of land cover combined with adjusted parameters of the convection scheme to improve the simulation of heavy rainfall.

ACKNOWLEDGMENTS

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