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A Case Study of ARW-WRF Model Sensitivity to Convective Parameterization Options during a South Atlantic Convergence Zone Event

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The South Atlantic Convergence Zone (SACZ) plays a major role in distributing precipitation over eastern Tropical South America and Southwestern Atlantic. It is one of the most prominent features associated with active phases of the South American Monsoon System (SAMS), covering an area of great importance in the economical scenario and high populational density. Thus, a better understanding of how numerical models represent this phenomena and its major features has significant value.

Since numerical models handle precipitation and cloud processes through parameterizations, this study presents the results of experiments performed with the Advanced Research Weather Research and Forecasting Model (ARW-WRF, version 3.6) using different options for convective schemes to depict a SACZ case from 31 January 2008 to 08 February 2008. The microphysics option was fixed (WRF Single-Moment 3-Class Scheme) and three convective schemes were tested: Kain-Fritsch (KF), Betts-Miller-Janjic (BMJ) and Arakawa-Schubert (AS).

To evaluate the results, observational data from Instituto Nacional de Meteorologia (INMET) stations were acquired, as well as satellite observations from the Tropical Rainfall Measuring Misson (TRMM) project, and results from the precipitation analysis provided by the Global Precipitation Climatology Project (GPCP). There are some discrepancies between the INMET stations results and the TRMM and GPCP datasets, due to the lack of stations in the north and central western areas. Most of INMET stations are concentrated in the Brazilian southeastern region. Over the adjacent South Atlantic Ocean, only the TRMM and GPCP datasets are used for evaluation.

When compared to the observational references, results from the KF test showed a proper placement for the described SACZ event. However, this experiment presented an overestimate of the precipitation, specially in the continental area. This can result from the representation of detrainment processes over the cloud column feeding back hydrometeors for the microphysics parameterization and/or a higher sensitivity of the scheme to trigger mechanisms.

Regarding the other configurations, even though the SACZ precipitation band represented in both the BMJ and the AS experiments is dislocated southward from its observation position, the precipitation amount presents itself in good agreement with the reference datasets. The structure displacement can also be associated with the convective parameterizations triggers, usually related to instability in the grid column. And a better representation of the precipitation amount could be caused by a better performance in stabilizing the grid column and preventing the microphysics parameterization from creating unrealistic grid-scale convection.

Discrepancies between the experiments show that improvements of simulations performance for this event requires an effort in understanding how parameterizations represent sub-grid phenomena and how they interact with each other through sensitivity tests.