EVALUACIÓN DE LA RESPUESTA DEL MODELO WRF A DIFERENTES CONFIGURACIONES FÍSICAS EN EL MODO DE CONVECCIÓN PERMITIDA PARA ANDALUCÍA

ASSESSMENT OF WRF MODEL RESPONSE TO DIFFERENT PHYSICS CONFIGURATIONS IN CONVECTION-PERMITTING MODE FOR ANDALUSIA

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SUMMARY

Convection Permitting Models (CPMs) are a significant advancement for conducting climate simulations with fine-scale resolution (<4 km). Microphysics (MP) and cumulus (CU) dynamics play crucial roles in climate patterns at these scales. Evaluating CPM performance in regions with complex terrain is vital for understanding their response to diverse topographical and climatic conditions. This study focuses on analyzing simulations conducted using the WRF model over Andalusia, a complex region encompassing coastal areas, plains, and mountainous terrain. The experiments were based on two nested domains, one (d01) covering the Iberian Peninsula and the other (d02) focusing on Andalusia. A total of 12 schemes were run, combining three MP options (THOMPSON, WSM6 and WSM7) with four CU options (G3, GF, KF and OFF). Results show that simulations with GF or OFF in d01 exhibited superior performance, while THOMPSON performed better in high mountain regions. The WSM7-GF scheme emerged as the optimal configuration for Andalusia.

To conduct climate simulations with fine-scale resolution, Convection Permitting Models (CPMs) represent a significant advancement, enabling finer spatial resolution than 4 km. At these scales, certain processes, such as microphysics (MP) and cumulus (CU) dynamics, play a relevant role in climate patterns. Furthermore, assessing the CPM's performance in regions with complex terrain is crucial for understanding its response to diverse topographical and climatic conditions. Hence, this study focuses on analyzing simulations conducted using the Weather Research and Forecasting (WRF) model in its version 4.3.3 (Skamarock et al., 2021) over the diverse landscape of Andalusia, in the southern part of the Iberian Peninsula (IP), a complex region encompassing coastal areas, plains, and mountainous areas, previously studied by other authors (Argüeso et al., 2012; García-Valdecasas Ojeda et al., 2020; Garrido et al., 2020). In this context, precipitation and temperature variables were analyzed spatially and temporally throughout the year 2018, which was notably rainy in Andalusia.

The experiments conducted by WRF were based on two "one-way" nested domains (Messmer et al., 2021). On the one hand, the parent domain (d01) covers the entire IP with a spatial resolution of 5 km. On the other hand, the nested domain (d02) covers the region of Andalusia with a spatial resolution of 1 km. To analyze the model's response to different parameterizations, a total of 12 configuration schemes were run, combining three MP options (THOMPSON, WRF single moment 6-class (WSM6), and WRF single moment 7-class (WSM7)) with four CU options (Grell 3D (G3), Grell-Freitas (GF), Kain-Fritsch (KF) for d01, and the deactivated cumulus parameterization (OFF)). The study involved comparing precipitation and temperature with various observational datasets (gridded, station-based, and satellite-derived) using different metrics and time aggregations (hourly, daily, and monthly).

The primary findings indicate that simulations utilizing the Grell-Freitas (GF) or deactivated cumulus parameterization (OFF) in d01 showed superior performance compared to reference datasets. Conversely, while THOMPSON performed better in high mountain regions, it generally displayed less agreement with reference datasets compared to WSM6 and WSM7. Respect to annual cycle, GF and OFF CU show better performance, than the others, while THOMPSON, WSM6, and WSM7 depends on the altitude regions. Regarding temperature, the results showed significant similarity, highlighting the importance of focusing on precipitation outcomes. The WSM7-GF scheme emerged as the most optimal configuration for the Andalusia region, emphasizing its

effectiveness in both capturing complex meteorological patterns and representing properly the temporal series of this complex area.

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