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WRF MODEL PHYSICS OPTIONS AND SENSITIVITY ASSESSMENT

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EXECUTIVE SUMMARY

The Weather Research and Forecasting (WRF) model is a powerful numerical weather prediction model widely used for predicting weather and climate behavior. For ensuring the accuracy and reliability of the model, it is crucial to compare different physical parametrization schemes that represent complex physical processes in the atmosphere and select the most suitable ones.

In this study, the WRF model will be used for dynamic downscaling global climate models (GCMs) from CMIP6 for Türkiye. The aim is to optimize the combinations of different physics schemes available in the WRF model, in order to achieve successful precipitation simulations tailored for the geography of Türkiye.

Sixty different WRF scenarios were created, including combinations of Cumulus (CU: non-activated CU Scheme, Kain-Fritsch Scheme, Betts-Miller-Janjic Scheme and Tiedtke Scheme), microphysics (MP: Kessler Scheme, Purdue Lin Scheme, WRF Single-moment 6-class Scheme, Thompson Scheme, and Morrison Double-moment Scheme), and planetary boundary layer (PBL: YSU, Mellor-Yamada-Janjic and ACM2) schemes. Simulations were conducted from November 1, 2019, to December 31, 2020, with a two-month spin-up period included.

Precipitation data obtained from simulations were compared with daily precipitation observations from meteorological stations in Türkiye for the year 2020. Statistical performance metrics such as root mean square error (RMSE), Pearson correlation coefficient (R) and Kling-Gupta efficiency metric (KGE) were calculated for each scenario. Sensitivity analysis considered correlations between scenarios and stations across Türkiye.

According to the results, one scenario notably outperformed others in representing the precipitation regime in Türkiye, especially along the Mediterranean coast, inland parts of the Aegean region, the western Black Sea region and the Thrace part of the Marmara region. This scenario also exhibited the best performance during the winter season and showed consistent values throughout the year, with higher correlations observed over the Southeastern Anatolia region.

This study forms a significant foundation for identifying the most appropriate physics options in the WRF model according to precipitation for conducting regional climate simulations over Türkiye.