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EU PARTNERSHIP FOR LOCAL CLIMATE ACTION IN TÜRKİYE PROJECT

WRF WEAK AND STRONG SCALING PERFORMANCE ASSESSMENT

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EXECUTIVE SUMMARY

In order to ensure the efficient use of high-performance computing (HPC) systems for climate simulations, both weak and strong scaling tests were conducted. These tests aim to determine the optimal core counts and run times required to complete climate model simulations efficiently within the project framework.

Weather Research and Forecasting (WRF) model is utilized as the regional climate model in this project. WRF is widely used as both a numerical weather prediction and regional climate model, producing more realistic results compared to alternatives, especially in small-scale atmospheric and land surface analyses. Its reliability, high performance, extensive user support, and comprehensive user guide are notable features.

The WRF model and its preprocessing system (WPS) have been tested on the TRUBA and Karolina HPC systems. During these tests, a daily data output of 3.54 TB was generated, and through advanced processing codes, it was reduced by 92% to 290 GB. Based on previous experience, it was decided to parallelize climate models and post-processing codes in this project, enabling simultaneous data processing and simulation processes. Customized scripts developed using Linux Shell Scripting will automatically evaluate output files and execute advanced post-processing codes. The aim is to achieve an efficient workflow by reducing dataset sizes using advanced post-processing codes written in NCL and R languages.

In tests conducted on the Karolina HPC system, the WRF model compiled with Intel compilers showed superior performance compared to the model compiled with GNU compilers. In addition, strong and weak scaling tests were employed to measure the scalability of the model. The strong scaling test evaluates the maintenance of performance with increasing processor counts while keeping problem size constant, whereas the weak scaling test measures the model's ability to sustain performance as both problem size and processor count are proportionally increased. These scaling tests were conducted at various resolutions and with different core counts to assess the model's scalability on the HPC systems.

The performance tests analyzed numerous results from simulations run at different resolutions and for wide and narrow domains. The test outcomes illustrated how the WRF model performed under different combinations of cores and resolutions.

Considering all factors including previous HPC experience, comprehensive performance benchmark tests, Input/Output (I/O) constraints, performance-oriented optimizations, expanded workspace, the number and duration of simulations, and MareNostrum5 HPC capabilities, it was estimated that approximately 100,000,000 core-hours of computational resource would be required for the calculation of all simulations (11 days/model-years) x (24 hours/day) x (112x2 cores) x (8x150 + 5x85 model-years) = 96.1 million core-hours, followed by a subsequent advanced post-processing processes.