Impact of Nesting Techniques Over Short-Term WRF Forecast Accuracy

A. Cem Çatal[1], Aysu Arık[1], M. Tuğrul Yılmaz[1], and İsmail Yücel[1]

[1]Middle East Technical University, Graduate School of Natural and Applied Sciences, Department of Civil Engineering, Ankara, Türkiye

Motivation of the Study

- In the domain of mesoscale meteorology, the selection of nesting configurations within the Weather Research and Forecasting (WRF) model has a great importance.
- Comparative analysis of three different nesting configurations is investigated, single domain (no-nesting), one-way nesting, and two-way nesting.
- Accuracy of WRF-based short-term (24 to 48 hours) temperature, wind, and precipitation hourly forecasts over a 30-day period in November 2021 is investigated utilizing ground-station based observations.
- This study contributes to the optimization of nesting configurations in WRF mesoscale weather predictions, aiding decision-making processes reliant on accurate short-term forecasts.

Study Area

Figure 1. Study Area

The input dataset:

- The input dataset with a 25 km spatial resolution is used as the initial boundary condition for the analysis**.**

Nested Simulation Methodology :

- For single domain simulation, spatial resolution of 25 km is downscaled to 4 km resolution.
- In nested simulations, 25 km resolution is first downscaled to 12 km, then 4km.

WRF Simulation Configurations

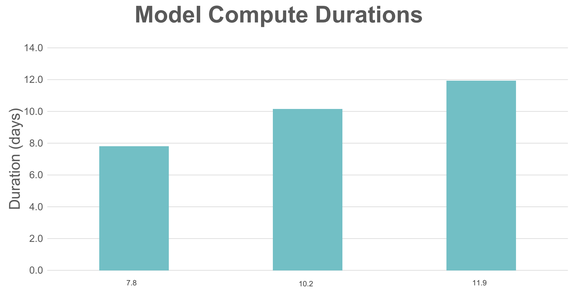

Figure 2. Computational Costs

- To compare the computational cost efficiency, 28 CPU cores are utilized to run each of the three simulations
- Nested runs, especially two-way nesting, demand higher computational time.

Temperature

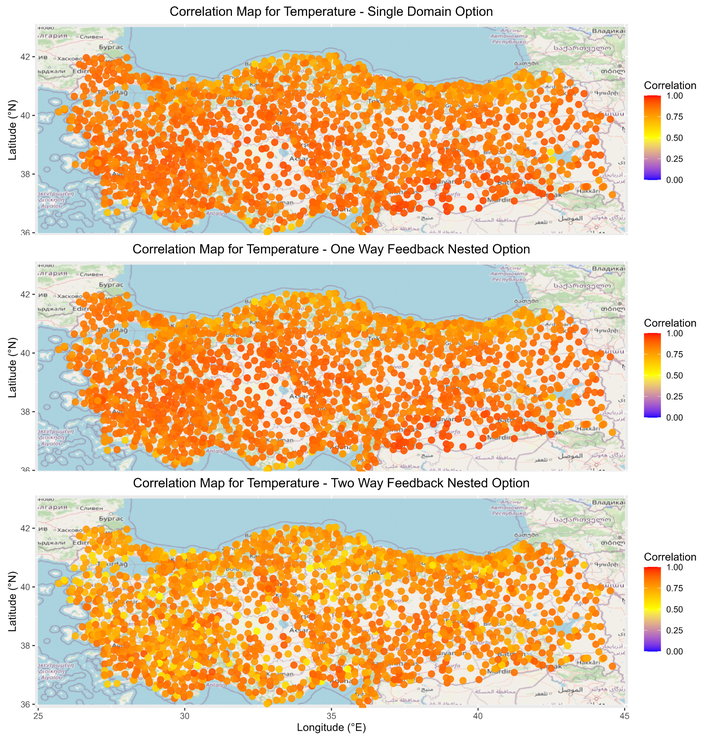

Figure 3. Hourly Temperature Correlation Maps

Precipitation

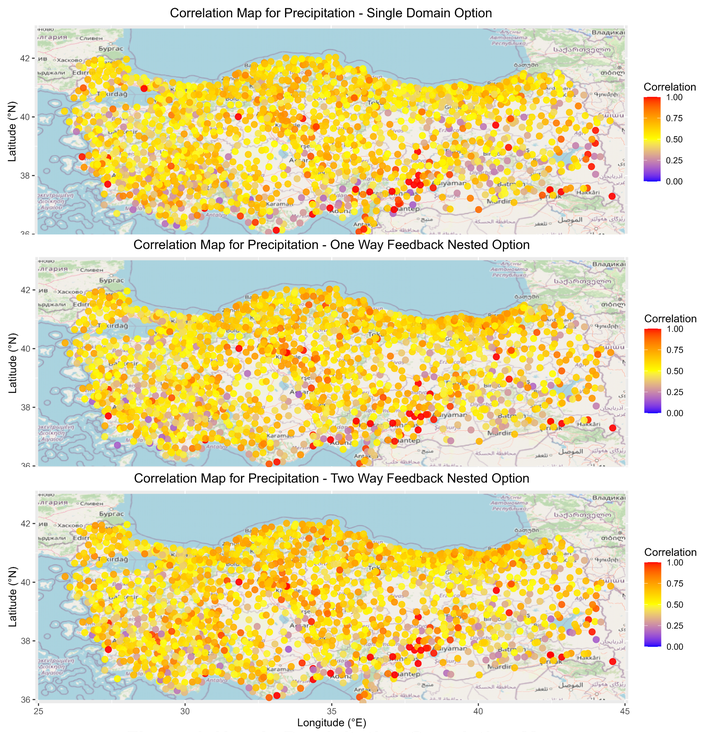

Figure 4. Hourly Precipitation Correlation Maps

Wind

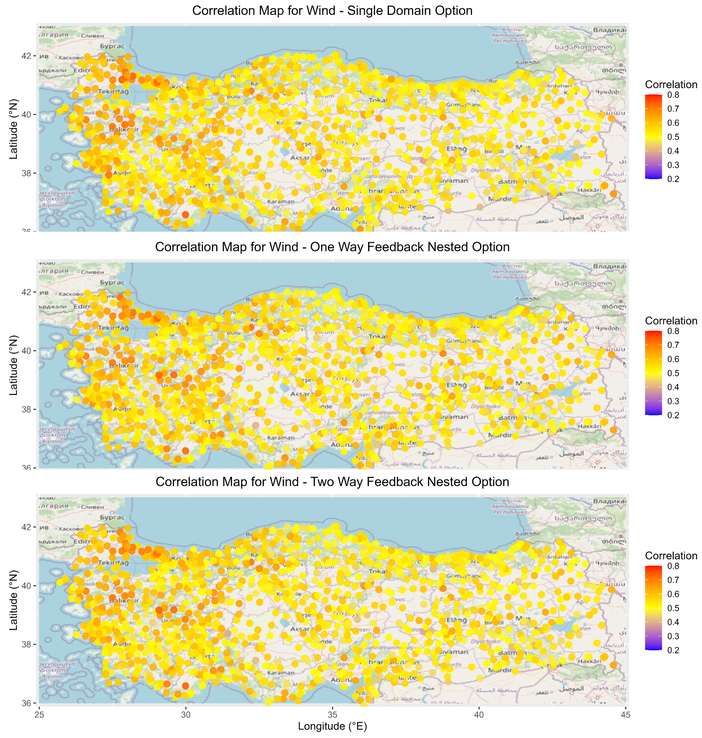

Figure 5. Hourly Wind Correlation Maps

Table 1. Results

	Temperature			Precipitation			Wind		
	Single Domain	One Way	Two Way	Single Domain	One Way	Two Way	Single Domain	One Way	Two Way
Corr. Coef.	0.846	0.842	0.786	0.567	0.577	0.585	0.544	0.546	0.545
RMSE	2.774	2.801	5.391	0.152	0.152	0.152	1.993	1.987	1.968
Std. Error	0.367	0.370	0.455	0.029	0.029	0.029	0.253	0.253	0.252

Conclusions

- In terms of temperature, it is observed that single-domain simulations have the highest correlation coefficient and lowest RMSE values.
- One-way nesting simulation produces comparable results with single-domain simulation; however, it performs worse when considering computational costs.
- Two-way nesting produces significantly worse results compared to the other two simulations, indicating that inclusion of feedback option had a negative impact on the simulation.
- For precipitation, both nested runs exhibit better correlation values, while two-way nesting achieves the highest accuracy.
- For wind, the choice of WRF nesting options does not notably affect the results.

cem.catal@metu.edu.tr

aysu.arik@metu.edu.tr