Evaluation of the Impact on Terra Incognita for Mesoscale and Microscale WRF Simulations

Raj K. Rai*, Larry K. Berg*, Branko Kosović, Jeffrey D. Mirocha***, Sue Ellen Haupt**, Brandon L. Ennis**** and Caroline Draxl*****

*Pacific Northwest National Laboratory, Richland, Washington, USA
**National Center for Atmospheric Research, Boulder, Colorado, USA
***Lawrence Livermore National Laboratory, Livermore, California, USA
****Sandia National Laboratories, Albuquerque, New Mexico, USA
*****National Renewable Energy Laboratory, Golden, Colorado, USA

Abstract

The term "terra incognita" was coined by Wyngaard (2004) to indicate the range of spatial scales for which the inherent scales of the flow are close to either the model grid spacing or the effective resolution of the model. We anticipate this problem will become more severe as the horizontal grid spacing applied in mesoscale meteorological models, such as the Weather Research and Forecasting (WRF) model shrink to kilometer or sub-kilometer scale. A number of issues related to terra incognita have been documented in the literature, such is a change in the nature of the turbulence from cells to rolls (Ching et al. 2014) or in terms of unrealistic oscillations of the wind speed (Rai et al. 2017), but the impact on subsequent nested domains, such as those required for accurate mesoscale-microscale coupling, has not been fully investigated. Herein, we studied the impact of terra incognita for the convectively driven flow case of SWiFT site (Kelly and Ennis, 2016), Texas by analyzing the meteorological variables obtained from the simulation of nested domains which has the horizontal grid spacing falling within the terra incognita. The horizontal grid spacings were reduced from kilometers (first domain) to meters (third domain) using different grid refinement ratios in both WRF mesoscale and large eddy simulation (LES) mode simulations. The model output was analyzed in terms of spectral densities and proper orthogonal decomposition (POD) energy. The results show that the energy predicted in the WRF mesoscale mode simulation were found to be smaller than the energy predicted in the LES mode simulation for the range of grid spacing used. Furthermore, there was no noticeable difference in the results for the innermost microscale domain driven by outer domains that was configured in either WRF mesoscale or LES mode. In addition, the spectral densities in the inner domain show that a transition from larger to smaller scales occurred as the flow advances from the inflow boundary.

Keywords: A *Mesoscale and microscale simulations, Terra incognita, Weather Research and Forecasting Model*

References

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