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Cross-scale interactions and feedbacks in the nesting domain of the MM5 model

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Multi-scale interactions and associated physical processes are common features of the atmospheric flow. Their spatial and temporal behavior presents a challenge to understand and predict the state of the flow at finer and broader scales. The objective of this study is to focus on capabilities of various parameterization schemes in the MM5 model to simulate system interactions and feedbacks in nesting domains. Two-way nesting allows us to track the occurrence and consequence of affecting smaller scale processes explicitly produced at a finer resolution domain to larger scales at a coarser resolution one. The quantitative estimations of model errors in a two-level nesting domain are compared against the similar ones in a single-level domain. Various combinations of parameterization schemes for cumulus, PBL, moisture and radiation are used to identify the one that provides the least difference between the model state and reanalysis ERA40 considered as the reference state. Basic attributes of model errors are measured to determine spatial structures, vertical profiles, geographical regions and synoptical patterns. The results show that feedbacks from finer to larger scales usually lead to better behavior in the simulated state. However, this is mainly true for the atmospheric properties characterized by smooth patterns with large scale structure functions, such as geopotential and temperature. Contrary, the humidity model error in the nesting mode is sensitive to the choice of a parameterisation scheme. In some cases feedbacks from finer scale processes simulated in the nesting domains toward larger scales lead to increase in the model error. This effect is especially remarkable for humidity fields in the middle troposphere.

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