A tiled land cover composition approach in the Model for Prediction Across Scales-Atmosphere (MPAS-A): Implications for meteorology and atmospheric deposition

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Parameterization of subgrid-scale variability of land cover characterization (LCC) has been an active area of research. The unified National Center for Atmospheric Research (NCAR), Oregon State University, the U.S. Air Force, and National Centers for Environmental Prediction's (NCEP's) Office of Hydrology ("Noah") land surface model has been widely developed, applied, and evaluated in its parent atmospheric grid model, the Weather Research and Forecasting (WRF) model, and has also been widely used with the Community Multiscale Air Quality (CMAQ) model for air quality studies. Furthermore, the Noah tiling (or mosaic) approach to sub-grid scale LCC in the regional WRF model has shown improved model performance and less sensitivity to the spatial grid resolution for meteorological predictions compared to the dominant (i.e., most abundant tile) approach. The Noah implementation in the global Model for Predictions Across Scales-Atmosphere (MPAS-A), however, only uses the dominant LCC approach. This results in an oversimplification in regions of highly heterogeneous LCC (e.g., urban/suburban settings), which is also impacted by the gradually refining meshes in MPAS for global to mesoscale applications. Thus, in this work we implement the WRF/Noah mosaic approach as an option in MPAS-A/Noah, version 6.0, and assess the impacts of MPAS-A/Noah mosaic on meteorological predictions for two gradually refining meshes (92-25 and 46-12 km) focused on the conterminous U.S for January and July 2016. Compared to the dominant approach, results show that using the mosaic LCC leads to pronounced global changes in 2-m temperature and

moisture for the 92-25 km mesh due to changes in clouds, surface energy budget, and sensible/latent heat flux partitioning, and 10-m wind speed due to momentum roughness length changes. The mosaic LCC also reduces biases in 2-m temperature and specific humidity in the central and western U.S. for the 92-25 km mesh, while reducing the sensitivity of predicted 2-m temperature to the finer 46-12 km mesh resolution in the eastern U.S. Analysis of impacts of MPAS-A/Noah mosaic on model performance of vertical profiles (e.g., temperature and humidity), clouds, solar radiation, and precipitation are ongoing, and these results will also be presented. To our knowledge, this is the first implementation and assessment of a mosaic/tiling approach to LCC in such a global model. We conclude the presentation with an exploratory discussion of the potential implications of MPAS-A/Noah-Mosaic for next generation global air quality and state-of-science atmospheric deposition models using CMAQ, which are ongoing development projects at the U.S. Environmental Protection Agency.