The Role of Horizontal Grid Spacing on Transport and Mixing of Passive Tracers over Complex Terrain

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Both observations and high-resolution modeling have shown that the planetary boundary layer (PBL) depth varies considerably over complex terrain. Currently, regional-to-continental scale carbon dioxide (CO_2) budgets are estimated using coarse global models that have horizontal grid spacings on the order of 50-100 km. Such models lack terrain variability, but a correct simulation of the PBL is crucial for accurate estimates of CO_2 budgets, especially because studies have indicated that a large part of the U.S. gross primary production of CO_2 is from mountainous regions. Duine and De Wekker (2017) showed that convective boundary layer (CBL) depths are overestimated in coarse grid domains over complex terrain (see Figure 1). This is a consequence of the terrain smoothing in the coarse grid, and the poor representation of physical and dynamical processes associated with mountainous terrain. In this poster, we investigate in detail how differences in the representation of physical and dynamical processes in atmospheric models with different horizontal grid spacings affect the mixing transport of passive tracers over complex terrain. In addition, we investigate how these differences may impact the estimation of CO_2 budgets. We use the Weather Research & Forecasting (WRF) model in quasi-idealized simulation settings with prescribed CO_2 surface fluxes. By changing systematically the horizontal grid spacing in terrain with varying complexities, we are able to investigate the relative importance of various physical and dynamical processes in the simulation of carbon budgets in complex terrain. A better understanding and representation of these processes in coarse atmospheric models would lead to an improved quantification of North American and global carbon sources and sinks.

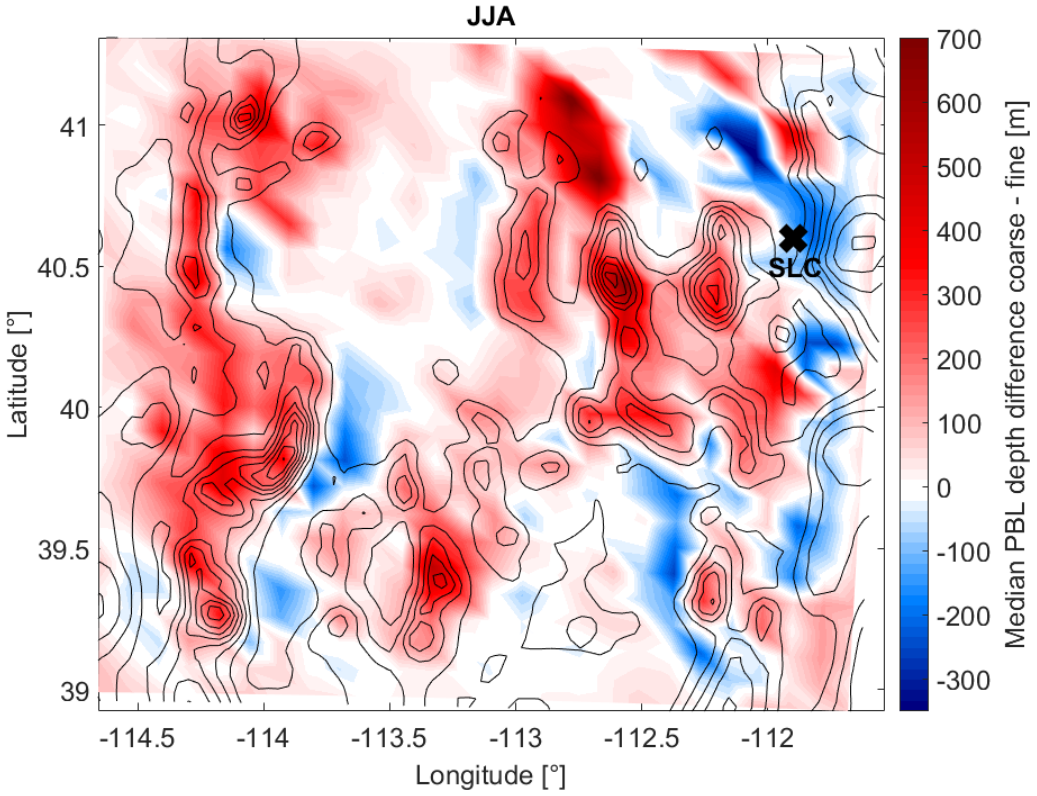

Figure 1. The differences in PBL depths (colors) between simulations with horizontal grid spacings of 10 km (coarse grid) and 3.3 km (fine grid) for Utah and the period of July 2012 – June 2014, summer months only, on top of the fine grid domain terrain elevation (contours). The 'x' denotes the location of Salt Lake City (SLC). Adopted from Duine and De Wekker (2017), under review.