Influence of Subgrid Terrain Variability on Simulated Planetary Boundary Layer Depths in Large-scale Transport Models

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The difficulty of modeling atmospheric transport and mixing processes introduces significant uncertainties in the fluxes estimated with inverse carbon transport models. An important diagnostic for vertical transport and mixing is the planetary boundary layer (PBL) depth, the height above the surface up to which surface fluxes of heat, moisture, momentum, and trace gases such as carbon dioxide (CO_2) are transported and mixed on a diurnal time scale. Current transport models used for CO_2-flux estimations are typically run on coarse grid spacing and therefore may miss terrain information needed for a correct CO_2-budget estimation. In an effort to reduce the uncertainty in these large-scale transport models, we compare the PBL depths from a Weather Research and Forecasting (WRF) simulation with coarse grid spacing ('coarse' simulation) with PBL depths from a WRF simulation with fine grid spacing ('fine' simulation) for the same domain size. We focus on a domain with considerable terrain height variability in and around the Salt Lake Valley area and examine the influence of the terrain variability on the PBL depth. We also perform a comparison with PBL depths observations and with PBL depths simulated using TM5, the transport model currently used in CarbonTracker. For a case study (Figure 1), differences in PBL depth between the 'coarse' and the 'fine' simulations become smaller with an increase in terrain height variability. In other words, PBL depth differences are largest for relatively flat terrain in this particular case study. In the poster, we will compare the results of this case study with results for a 2-year period from June 2012 to June 2014. We will also demonstrate the importance of understanding spatio-temporal variability and representativeness of PBL depths over complex terrain for carbon cycle studies.

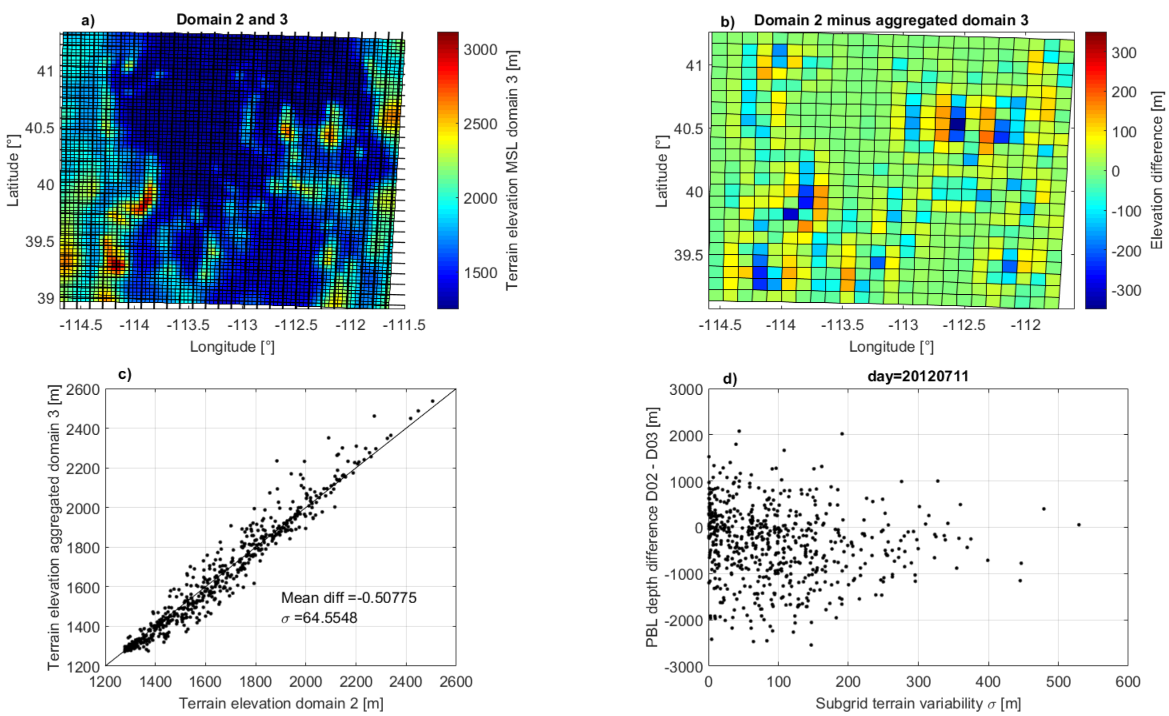

Figure 1. WRF model terrain height and its impact on PBL-depth for the Salt Lake valley area. a): Grid cell representation of domain 2 (thick lines, 10x10 km) and its aggregated domain 3 (thin lines, 3.3x3.3 km). b) and c): Terrain elevation difference between coarse and fine grid spacing (ratio 1:3) where domain 3 is aggregated to domain 2. d) The impact of subgrid terrain variability on afternoon PBL-depth.