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High Spatiotemporal Resolution Planetary Boundary Layer Dynamics Across the Israeli Coast—Mountain—Valley Terrain Unraveled by WRF Simulations

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Jerusalem (Jer, Israel) is located on a mountain (~800m above sea-level), between the Eastern Mediterranean coast, to the west, and the Jordan valley (~400m below sea-level), to the east. This coast—mountain—valley (iCMV) complex terrain structure has a relatively smooth contour line. Nevertheless, the corresponding boundary layer dynamics (BLD) has not yet been fully unraveled for the summer season, which is characterized by a persistent synoptic regime. In this work we use the Weather Research and Forecasting (WRF) model, together with ceilometer measurements, to decipher the detailed mesoscale evolution of the iCMV BL during the late summer period of Sep. 5-15, 2017, where the maximal BL depth in Jer vary in the range 500-1500m. We first validate the BL height (BLH) simulated by 4 WRF BL parameterizations. Accordingly, the MAE is around 120m and 180m for the coastal and Jer areas, respectively. An analysis of the modeled daytime iCMV BL evolution shows that the topography, sea-breeze, and the synoptic regime conspire to produce the following pattern: In the morning, the topography and the radiation forcing induce a surface-flow-convergence (SurFCon), above which the BLH is locally elevated. The initial SurFCon position, relative to Jer, depends on the synoptic flow. Afterwards, as the sea-breeze propagates inland, it advects the SurFCon eastward. The locally-elevated BLH collapses in the late afternoons when it reaches the valley. Generally, the weaker, or easterly, the synoptic flow is, the more likely the initial location of the elevated BLH (SurFCon) will be west to Jer, and during noontime it will pass through Jer, which probably experiences a higher daily maximum BLH. On the other hand, during a westerly synoptic flow the SurFCon is located east to Jer at all times. Thus, the city experiences relatively lower daily maximum BLH, in contrast to the coastal plains. Furthermore, we conclude that the surface synoptic classification cannot serve as a BLH predictor for Jer. This conclusion should be validated for BLD throughout the year.