Understanding the land-atmosphere interactions at grid and subgrid scales in E3SM

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Land-atmosphere interactions significantly affect turbulent mixing processes in the planetary boundary layer (PBL), influencing clouds, precipitation, and the climate. The coupling between the two components impacts the response of the Earth system to external forcings, and the coupling strength varies as climate changes. Traditional coupling between land and atmosphere in Earth system models (ESMs) neglects the heterogeneity at subgrid scale, potentially producing biases in the characteristics of the planetary boundary layer (PBL) over complex land surfaces. In this study, we assess the coupling strength as well as the PBL properties in the U.S. Department of Energy’s Energy Exascale Earth System Model (E3SM). We perform sensitivity tests to understand the sensitivity of the coupling strength, turbulence characteristics, and cloud properties on climate scenarios, modell tunings, and surface heterogeneity. These results provide insights into improving land-atmosphere coupling in the next generation E3SM.