Geophysical Research Abstracts
Vol. 20, EGU2018-10647, 2018
EGU General Assembly 2018

Linking Land-Atmosphere-Cloud Interactions using Large-Eddy Simulations of Shallow to Deep Convective Cloud Transitions over the Central United States

Larry K. Berg (1), Jerome D. Fast (1), William I. Gustafson (1), Heng Xiao (1), Satoshi Endo (2), Tami Toto (2), Andrew Vogelmann (2), Sheng-Lun Tai (1), Yun Qian (1), and Maoyi Huang (1)

(1) Pacific Northwest National Laboratory, United States (larry.berg@pnnl.gov), (2) Brookhaven National Laboratory, United States

The US Department of Energy's Atmospheric Radiation Measurement (ARM) Holistic Interactions of Shallow Clouds, Aerosols, and Land-Ecosystems (HI-SCALE) field campaign conducted from April 24 to May 21 and August 28 to September 24 provides a detailed set of aircraft and surface measurements that enable a more complete understanding of land-atmosphere-cloud interactions and improved parameterizations of the lifecycle of shallow clouds. On August 30, 2016 shallow cumulus formed over the surface site located in the central United States around 1145 LST and two aircraft missions were conducted to obtain in situ measurements of boundary-layer and cloud. Satellite images indicated that shallow convection initially formed over eastern and southeastern Oklahoma around 0945 LST and spread over the entire state and southeastern Kansas over the next two hours. As the day progressed, shallow clouds transitioned to short-lived deeper convection that produced precipitation in some areas, forming cold pools that suppressed surrounding shallow convection. A complex population of convective clouds was observed over Oklahoma by the late afternoon, suggesting that this day would be useful to evaluate the performance of explicit and parameterized representations of convective clouds in regional and global models. In this study, we utilize two sets of Large-Eddy Simulations (LESs) conducted using the Weather Research and Forecasting (WRF) model for August 30, 2016. One set of simulations is taken from the LES ARM Symbiotic Simulation and Observation (LASSO) product. The LASSO LES domain is 14.5 km wide, uses periodic boundary conditions, and has an ensemble of simulations that use different large-scale forcings. In contrast, the other set of simulations use a much larger domain that is $\sim$120 km wide and a nested grid approach so that the model can represent a more complex evolution of the surface properties, surface fluxes, environmental forcing, and cloud population. Both sets of simulations are evaluated using routine in situ and remotely-sensed ARM observations and HI-SCALE aircraft observations, including surface heterogeneity, surface fluxes, vertical velocity distribution, cloud depth, and cloud fraction. The LASSO LES was unable to represent the observed transition of shallow convection to deeper convection that was observed near the SGP site. While the larger LES domain contained regions where shallow convection transitioned to deep convection, the transition occurred later than observed. Our study suggests that future research should be devoted to identifying improved methodologies for representing temporally evolving and spatially heterogeneous cloud conditions in both LES and regional scale models