M.S. Defense Announcement
Ben Ascher
Monday, December 4, at 2:00 pm

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December 4, 2023
2:00 pm

Defense
ATS Large Classroom (101 ATS) or Teams

Post Defense Meeting
Riehl Conference Room (211 ACRC)

Committee:
Susan van den Heever (Advisor)
Russ Schumacher
Daniel McGrath (Geosciences)

Effects of Land Surface-Atmosphere Interactions Within Two Convective Storm Regimes

Convective storms, which are driven in part by atmospheric thermodynamic instability, come in a range of shapes and sizes and bring a variety of impacts both at the surface and throughout the atmosphere. Often these storms initiate as a result of lifting within the Planetary Boundary Layer (PBL), the behavior of which is strongly affected by the characteristics of the land surface below them. To examine the effects of land surface properties on convective storm behavior and impacts, we have conducted two high-resolution mesoscale modeling studies. The first study examined the impact of Lake Huron on convective lake-effect snow over Lake Erie, while the second analyzed the effects of heterogeneous vegetation cover on deep convection in an idealized coastal environment.

Our findings in the first study revealed that Lake Huron initiates lake-effect snow bands which persist over land between Lake Huron and Lake Erie and then reintensify after moving over Lake Erie. The persistent band “kickstarts” convection over Lake Erie and increases snowfall over and downwind of Lake Erie compared to when Lake Huron is not present. We also found that areas of snow-free land can act as a “brown lake” and initiate lake effect-like convection on their own. An area of snow-free land upwind of Lake Erie fulfilled a similar role to Lake Huron in enhancing convection and snowfall downwind of Lake Erie. Such findings may have important implications for improved short-term forecasting of the location and intensity of heavy snowfall.

The results in our second study indicated that heterogeneous land surfaces enhance convective storm activity over certain vegetation types and suppress it over others. In particular, we found an increase in precipitation over forests surrounded by pasture lands and suburban regions, while the precipitation over the pasture and suburban regions is suppressed. We also discovered that circulations induced by these heterogeneous land surfaces appear to be more important to the location and timing of convective initiation than a sea breeze which forms in the simulations. Finally, we concluded that cold pools produced by convective storms reinforce the land surface-induced circulations, thereby allowing these circulations to collide in the center of the forested region, where they initiate intense convection which subsequently produces heavy rainfall.