18–22 September 2017, Pula, Croatia
ECSS2017-104

Above-ground thermodynamic observations in supercell thunderstorms obtained from pseudo-Lagrangian drifters

Paul Markowski, Yvette Richardson, and Scott Richardson
Pennsylvania State University, Meteorology & Atmospheric Science, University Park, United States (pmarkowski@psu.edu)

Reliable, above-ground, thermodynamic observations in convective storms are conspicuously missing. These missing observations, and the errors/uncertainty in the thermodynamic fields in simulations (owing to the extreme sensitivity to the microphysics parameterization), are routinely cited as being among the most important hurdles to furthering our understanding of vorticity generation and amplification in potentially tornadic storms. All indications are that tornado formation in supercell thunderstorms is sensitive to the thermodynamic characteristics of the rain-cooled, vorticity-rich air that emanates from downdrafts. Though automobile-borne observing systems have enabled great strides in our understanding of the importance of the thermodynamic characteristics in tornadogenesis, such ground-based observations can only provide information at the bottom of downdraft trajectories, and only where there are roads. Thermodynamic observations above the ground within the outflow of storms have been elusive owing to the intrinsic difficulty in obtaining in situ observations, and retrievals of the buoyancy field from dual-Doppler-derived wind fields are just not sufficiently accurate owing to the extreme sensitivity of the retrievals to observation errors and boundary conditions.

In the last few years, additional observations have been obtained from unmanned aeronautical vehicles (UAVs), but such observations are generally unavailable in the most hazardous parts of the storm, which also tend to be the most scientifically interesting (e.g., the area immediately north and northeast of the low-level mesocyclone, where heavy rain, large hail, severe turbulence, and low visibility preclude UAV operation). Morever, U.S. Federal Aviation Administration regulations still severely restrict UAV operations at the present time. Regarding dropsondes, they are expensive (particularly when considering the cost of the flight time for the mother aircraft) and their use is extremely restricted over land by the FAA. It also would be very difficult to get dropsondes into key areas given that the mother aircraft (typically manned) would be unable to fly through the accompanying harsh environments (e.g., heavy rain, large hail, and severe turbulence).

At Penn State University, we have been exploring the feasibility of obtaining above-ground thermodynamic observations in storms using specially designed pseudo-Lagrangian drifters. We can track up to 32 drifters simultaneously. At the conference, we will present data from our first-ever deployments of this observing system, which will take place in the U.S. Great Plains region in the spring of 2017.