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Field Data Collection and Analysis Cool-Season Tornadic QLCSs in the Tennessee

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RCEU Summer 2018 Project Proposal

Title: Field Data Collection and Analysis Cool-Season Tornadic QLCSs in the Tennessee Valley

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I previously mentored students during the 2016 & 2017 UAH RCEU program. The 2016 RCEU student used the research to spearhead her senior capstone program, as well as presented her work at the Werner Von Braun Memorial Symposium, and the American Meteorological Society Annual Meeting. The 2017 RCEU student will be using his research for his senior capstone project next year. He has presented his RCEU research at the RCEU research forum, and will be presenting it at the NOAA VORTEX-SE science workshop next week. He used the data analysis skills developed during the RCEU to perform data analysis on the solar eclipse, which was presented at the Werner Von Braun Memorial Symposium last month.

Project Summary:

A significant number of tornado events in the Southeastern U.S. and Tennessee Valley occur during the cool season (November – March) embedded in quasi-linear convective systems (QLCSs). Knowledge and direct detection of the fast-evolving tornadoes is currently quite sparse, and thus is the primary focus of the on-going NOAA-funded Verifications Of Rotation in Tornadoes Experiment – SouthEast (VORTEX-SE), of which UAH SWIRLL is the central base of operations. Understanding the interaction between QLCSs and the night-time stable nocturnal boundary layer (NBL) is critical to improve forecasts and direct radar detection of QLCS tornadoes.

This proposed RCEU project will leverage high resolution data collected by UAH faculty, staff, and students as part of the VORTEX-SE field campaign during the winter/spring of 2017-2018. Additionally, the selected student will participate in VORTEX-SE field deployments as part of the student crews for the UAH Mobile Alabama X-band Radar (MAX) and Mobile Integrated Profiling System (MIPS) prior to the RCEU period to collect data on tornadic QLCSs as these storm systems propagate across North Alabama. Measurements from multiple UAH radar platforms (MAX, MIPS, & ARMOR radar systems) provide a unique opportunity to integrate external data from the environment outside the convective system with internal QLCS measurements. These integrated data will allow for a better understanding of the QLCS and NBL evolution, and the internal mechanisms that drive rotation and development of tornadoes in QLCSs.

Figure 1: The Mid-day Tornadic QLCS during the April 27th, 2011 tornado outbreak that produced 7 tornadoes in Limestone and Madison counties as shown from the UAH ARMOR Radar. a) Radar Reflectivity of the entire QLCS. b) Zoomed-in view of the ARMOR Radar Reflectivity hook echoes producing the tornadoes. C) Zoomed-in view of the ARMOR Radar Correlation Coefficient showing two simultaneous tornado debris signatures.
**Student Prerequisites**

The student should be (a) sophomore standing or higher, (b) have completed ESS 112 (Severe and Hazardous Weather) and ESS 301 (Intro to Earth & Atmos Physics), and (c) be a member of the UAH Profile Sounding Team for Operational and Research Meteorology (UPSTORM). The ideal candidate will have participated in UAH SWIRLL severe weather research deployments, already be an UPSTORM team lead, and have a working knowledge of balloon data and Python programming. It is expected that the RCEU project will be the selected student’s sole focus for the summer term, thus other internships are prohibited and other employment is discouraged.

**Student Duties**

To ensure the student has the background to conduct weather balloon and radar research, as well as manageable undergraduate deliverables, a structured, scale-up three-phase approach has been designed during the summer term (the student will have the opportunity to participate in voluntary field data collection in the February, March, & April prior to the RCEU Summer term).

**Phase 1:** The first two weeks will focus on 1) *iMET and Windsond weather balloon instruments and data*, and 2) developing the student’s background on tornado environments and wind flow in complex terrain through an intensive literature review. The student will meet with an experienced faculty and graduate student mentors to receive training on the iMET and Windsond systems, participate in mock deployments of these systems. [2 weeks]

**Phase 2:** The next four weeks will focus on 1) *weather balloon and radar data analysis software / techniques*, and 2) *cataloging VORTEX-SE Intensive Observation Periods (IOPs)* and collecting data from collaborators at other universities / research labs. The student will be instructed by mentors on weather balloon / radar software (RAOB, SHARPpy, Proftool wind profiling software, GR2Analyst and *Python-based radar tools*), and radar analysis techniques (editing, dealiasing, gridding, and *multiple-Doppler syntheses*). The student will perform quality control of weather balloon data for upload to the NOAA VORTEX-SE data catalog. [4 weeks]

**Phase 3:** The final portion of the project will focus on performing *advanced analyses on the boundary layer wind flow* for VORTEX-SE IOP case events. The student will analyze the evolution of the boundary layer wind shear through data from weather balloon soundings and the UAH mobile radar systems, note changes in BL structure as storms move through the UAH instrument network, and then perform multiple-Doppler syntheses on any storms that produce tornadoes. [6 weeks]

**Benefit to the Student:** The student will be provided with the unique opportunity to be involved with the entire hands-on process of instrument operation, data collection, data quality control, and data analysis. Upon project completion, the student will present research findings at the Von Braun Memorial Symposium, as well as an American Meteorological Society conference (Mesoscale or Severe Local Storms). These experiences will make the student a strong candidate for graduate school GRA funding, NSF / NASA fellowships, and internships / employment with NASA and NOAA.

**Mentor Supervision and Interaction**

Ryan Wade, as well as an experienced senior graduate student (Dustin Conrad), will supervise the RCEU student for the duration of the project. During the first 2-4 weeks, both the faculty and graduate student mentors will meet with the student every day (see above) to ensure that appropriate background knowledge and instrument training are being successfully achieved. It is expected that the student will become more independent after the first few weeks, thus the mentors will alternate daily meetings for the last 6-8 weeks of the project (meeting frequency and length will change as needed). The RCEU student will attend research group meetings to allow the student to interact with other research group members, thereby gaining exposure to other research projects. Additionally, the student will be stationed for the summer in the UAH SWIRLL Research Operations Center with other RCEU / REU students from the Knupp, Carey, and Bitzer research groups. These RCEU / REU students will interact with one another, participate in group radar training sessions, attend seminar talks, and participate in other planned group team building exercises. Experience from this collaborative RCEU environment will be used as a demonstrated proof of concept for an upcoming NSF Site REU proposal.