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Development of Web-Based Tools for Real-Time Analysis of Weather Balloon Soundings during Severe/Tornadic Storms in the Tenessee Valley

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RCEU Summer 2019 Project Proposal

Project Title: Development of Web-Based Tools for Real-Time Analysis of Weather Balloon Soundings during Severe / Tornadic Storms in the Tennessee Valley

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Project Description: A significant number of tornado events in the Southeastern U.S. and Tennessee Valley occur during the cool season (Nov – Mar) 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). Understanding the interaction between QLCSs and the rapidly evolving, highly variable boundary layer (BL) atmospheric environment in real-time is critical to improve forecasts and direct radar detection of QLCS tornadoes. This proposed RCEU project will leverage computing resources of the SWIRLL facility with high resolution data collected by UAH faculty, staff, and students as part of the VORTEX-SE field campaigns during the winter/spring of 2017-2018 & 2018-2019. Specific work objectives for the student include 1) quality-control and processing of weather balloon sounding data, 2) development of an online database of sounding data, 3) development of web-based sounding visualization / analysis tools, 4) a case study on a tornadic event from VORTEX-SE. Additionally, the selected student will participate in VORTEX-SE field deployments prior to the RCEU period to assist in weather balloon sounding data collection 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 BL evolution, and the internal mechanisms that drive rotation and development of tornadoes in QLCSs.

Student Duties, Contributions, and Outcomes: 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 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 two weeks will focus on 1) ***weather balloon & radar analysis software***, and 2) ***cataloging VORTEX-SE Intensive Observation Periods (IOPs)*** and building an online database 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 data). The student will perform quality control of balloon data for upload to the NOAA VORTEX-SE data catalog. [2 weeks]

Phase 3: The final portion of the project will focus on performing ***development of web-based tools to visualize / analyze weather balloon sounding profiles in real-time*** for VORTEX-SE IOP case events. The student will work with Joy Marich, a graduate student who has previously developed web-based Python data visualization / analysis tools. The student will spend the final two weeks using the web-based tools to analyze a specific tornado event from the VORTEX-SE project. [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 and web development. Upon project completion, the student will present research findings at the VORTEX-SE science workshop in November and the American Meteorological Society annual conference in January. 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: The student should be (a) sophomore standing or higher, (b) have completed ESS 212 (Severe and Hazardous Weather) and ESS 301 (Intro to Earth & Atmos Physics), and (c) be a member of the UPSTORM student organization. The ideal candidate will have participated in UAH SWIRLL severe weather research deployments and have a working knowledge of balloon data and Python programming. The RCEU project will be the selected student's sole focus for the summer term, thus other internships are prohibited. Ryan Wade and graduate students Joy Marich and 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 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 RCEU. The 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 / NSF REU undergraduate & graduate students.

Prior Awardees

1. Award Year 2016: *Field Data Collection and Analysis of Nocturnal Mesoscale Convective System Initiation & Propagation Mechanisms*

Student Contributions: The student analyzed data collected during the Plains Elevated Convection at Night field experiment in Kansas, participated in the field campaign, launched weather balloons, operated mobile radars, and collaborated with scientists from over 20 government / university labs. Working closely with faculty and graduate students, the student analyzed a case to validate the Nocturnal Mesoscale Convective System's initiation & propagation mechanisms from a solitary wave.

Project Outcomes to the Student: The student learned how to operate weather radars, launch weather balloons, and advanced radar analysis techniques. The student presented at the Von Braun Memorial Symposium and continued this work as her Senior Capstone thesis.

2. Award Year 2017: *Field Data Collection and Analysis Cool-Season Tornadic QLCSs in the Tennessee Valley* **Student Contributions:** The student analyzed data collected during the 2017 VORTEX-SE field project. The student participated in the field project, launched balloons, operated mobile radars, and collaborated with scientists from 12 government / university labs, developed sounding processing Python code that exceeded the quality of processing done by the vendor. The student analyzed a tornadic storm case from the VORTEX-SE field campaign, which contributed to project planning.

Project Outcomes to the Student: The student learned how to operate weather radars, launch weather balloons, and advanced radar analysis techniques. The student presented at the RCEU Research Forum, Von Braun Memorial Symposium and continued this work as his Senior Capstone thesis. This led to the student being hired as a sounding coordinator for the VORTEX-SE 2018-2019 field project.

3. Award Year 2018: *Field Data Collection and Analysis of Tornadic Environment Enhancement by Topography Along the Sand Mountain Plateau*

Student Contributions: The student analyzed data collected during the 2018 VORTEX-SE field project. The student participated in the field campaign, launched weather balloons, operated mobile radars, processed and quality-controlled data. The student radar analyzed the record-breaking hail storm in Cullman from VORTEX-SE field campaign.

Project Outcomes to the Student: The student learned how to operate weather radars, launch weather balloons, and advanced radar analysis techniques. The student presented at the RCEU Research Forum, the VORTEX-SE science meeting, and continues this work as his Senior Capstone thesis. This led to the student being selected as a NOAA Hollings Scholar where he will continue this RCEU work at the NOAA National Severe Storms Laboratory next summer.