Operations to Research to Operations Experiences with a North Carolina State-National Weather Service Collaborative Science, Technology, and Applied Research (CSTAR) Project

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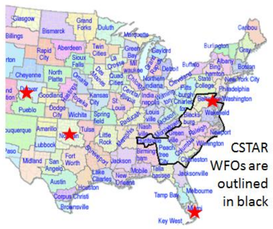
The Project

- A three year NOAA Collaborative Science, Technology, and Applied Research (CSTAR) project sought to address several critical forecast problems affecting much of the Southeast and Mid-Atlantic. The project is entitled “Improving Understanding and Prediction of Hazardous Weather in the Southeastern United States: Landfalling Tropical Cyclones and Convective Storms”

- The overall project was comprised of five focus areas…
  - Improving inland gridded forecasts of tropical cyclone winds and wind gusts
  - Tropical cyclone initial conditions
  - High-shear low-CAPE severe weather
  - Inland QPF associated with tropical cyclones
  - High-resolution Mid-Atlantic Ensemble (HME)

- Project collaborators were from North Carolina State University, 11 National Weather Service (NWS) Weather Forecast Offices (WFOs), 3 national Centers including SPC, WPC, and NHC, a NOAA laboratory, and the Warning Decision Training Branch. More than 60 individual collaborators participated.



National centers, the WDTB and a NOAA lab are shown with a star

Collaborative Design and the Pathway to Success

- Built off a long history of successful collaboration between the NWS and NC State dating back to the 1970s that has established a level of trust between operational and academic partners.

- Recognition that Operations to Research to Operations (O2R2O) is not a one way loop to close but a relationship with two way interaction and regular communication.

- Sought forecaster input early on by surveying operational needs at each of our collaborative WFOs to identify key forecast challenges that research led by academic partners could mitigate

- Identified common themes that matched academic expertise and interests resulting in a focus on tropical cyclones and convection.

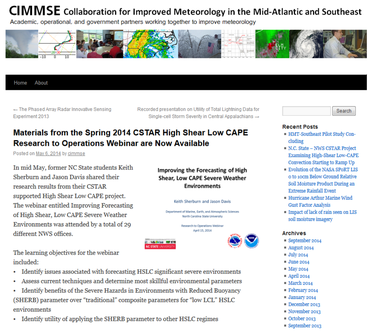
- Resulted in a diverse group of collaborators that included 3 national centers and WFOs from multiple NWS regions.

- Identified and recruited students that have strong operational interests and a desire to interact with the NOAA/NWS. A total of 18 former NC State students who participated in previous CSTAR projects are currently employed by NOAA (or as a NOAA contractor).

- Collaborative Investigators (CI) from the NWS were identified to lead and champion the operational (NWS) aspect of each project in cooperation with the Principal Investigator (PI) and student from NC State.

- Routine engagement between academic and operational collaborators was planned via regular monthly and quarterly conference calls, webinars, site visits, workshops and a blog.

- The research to operations plan was designed to include a broad set of approaches including workshops, webinars, conference presentations, journal articles, diverse training materials, AWIPS and GFE smart tools and procedures, and facilitated training from the Warning Decision Training Branch.



Example R2O blog entry on CIMMSE.

Major Scientific Accomplishments and Results

- Devised and tested a new forecasting/nowcasting parameter for High-Shear Low-CAPE (HSLC) environments, the Severe Hazards in Environments with Reduced Buoyancy, or “SHERB” index (Sherburn and Parker 2013).

- Discovered statistically significant differences in azimuthal shear between HSLC tornadic and non-tornadic vortices within 60 km of the radar, particularly near the surface (Davis and Parker 2013).

- A climatology of observed inland TC wind speed distributions for the eastern U.S. was compared to idealized models, NWS digital forecasts, and NHC H*Wind products. This comparison was applied to produce a statistical-dynamical model that WFOs can use to determine land decay and gust factors for TC winds (Tyner et al. 2013).

- Simulations of Hurricane Ernesto (2006) revealed that the removal of the tropical cyclone had little impact on the intensity of a predecessor rain event (Dale et al. 2012).

- Demonstrated that a High-Resolution Mesoscale Ensemble (HME) modeling system could be achieved via a confederation of WFOs and partners that could provide useful information to operational forecasters.

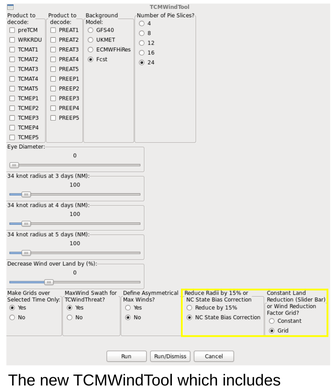
O2R2O Example - Hurricane Arthur Wind Forecasts

- Based on CSTAR research, developers at ESRL were asked to modify the TCMWindTool and add two features including: 1) the ability to use a Modified Rankine Error Function (MREF) wind model which acts as a bias correction to the TCM wind guidance and 2) the integration of the CSTAR project methodology of creating grids of wind reductions and then integrating these into the TCMWindTool output.

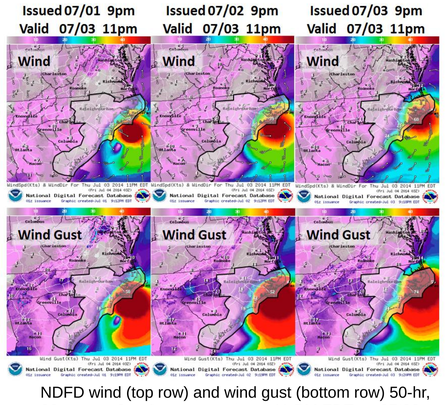
- The new methodology allows for temporal and spatial variation of the gust factors and the common grid improves collaboration, which results in better consistency in the NWS National Digital Forecast Database (NDFD).

- Forecasters at WFOs in Charleston S.C., Newport N.C., Raleigh N.C., and Wilmington N.C. tested these experimental GFE methodologies during Hurricane Arthur (2014). Forecasters provided positive feedback while noting an improved quality of the wind forecasts and much better consistency using this approach when compared to past experiences.

- The new TCMWindTool is shown below to the left. Wind and wind gust forecasts during Hurricane Arthur are shown below and to the right. The forecasts from the WFOs using the CSTAR experimental methodology are highlighted and outlined in black and depict a well collaborated and accurate forecast.



The new TCMWindTool which includes two new CSTAR based options.



NDFD wind (top row) and wind gust (bottom row) 50-hr, 26-hr, and 2-hr forecasts valid at 11 PM EDT on 07/03.

O2R2O Example – SHERB During a HSLC Tornadic QLCS

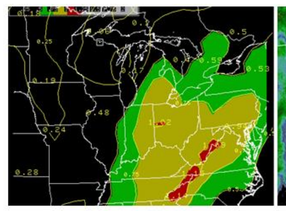
- A key outcome of this CSTAR project is a new experimental parameter (SHERB) to identify the potential for tornadoes and significant severe wind events in HSLC environments.

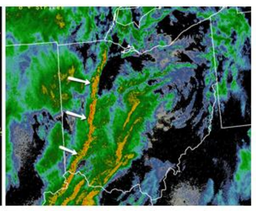
- During the late evening of 31 October 2013, the Ohio Valley experienced a HSLC Quasi Linear Convective System with four confirmed tornadoes in the Wilmington Ohio (WFO ILN) County Warning Area and numerous reports of wind damage.

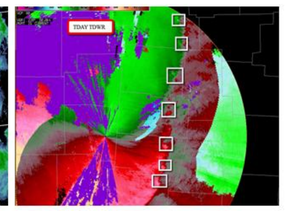
- The environment was characterized by extremely high shear attendant to a 90kt southwesterly low level jet centered near 825 hPa with a narrow ribbon of 100-200 J/kg of surface-based instability ahead of the convective line.

- The SHERB parameter is a product of the 0-3 km shear magnitude, the 0-3 km lapse rate, and the 700-500 hPa lapse rate normalized so that the optimal SHERB threshold is 1. SHERB values above 1 are more likely to be associated with significant severe convection than non-severe convection.

- Forecasts of the SHERB parameter were instrumental in raising awareness of the potential event and its possible magnitude at WFO ILN when traditional severe weather forecasts (SPC Outlooks, CAPE, etc.) were not as suggestive of a higher-end event.


NAM 30-hr forecast of SHERB valid 06 UTC 01 Nov.


Regional radar mosaic imagery valid at 0336 UTC.



Velocity couplets on the TDAY TDWR at 0357 UTC.

Recommended Strategies and Lessons Learned

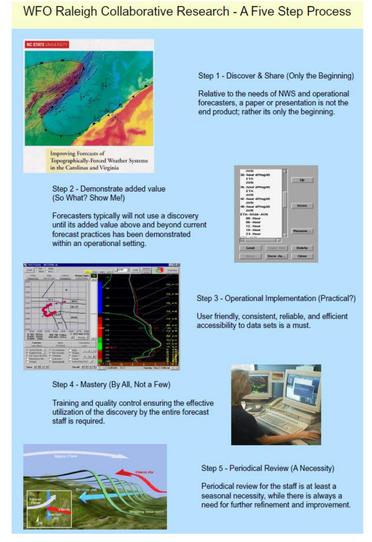
- A relationship of trust and engagement between academic and operational partners serves as a foundation for success.

- The identification of topics with an operational focus and tangible deliverables while balancing the interests of academic partners is essential.

- The role of the Collaborative Investigator has proven critical to lead and champion the operational (NWS) aspect of each project.

- Regular communication and interaction is required between academic and operational partners to ensure commitment and a true collaboration.

- Past experience has led to the development of the NC State-NWS Raleigh 5-Step Process to integrate research into operations shown to the right.



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