TEXAS TECH UNIVERSITY
National Wind Institute™

June 2017 — Issue 95

Letter from the Interim Director

Daan Liang, Ph.D., P.E., Interim Director, NWI.

One of the most appreciated services NWI provides to our faculty affiliates is gap funding: When an existing grant has expired and a new one hasn't come in, we make sure that graduate students, research associates, and technicians will be paid without interruption.

By doing so, our researchers are able to maintain their capacity to execute the grants when they are awarded, as well as laying groundwork for future proposals. Such an "insurance policy" reflects the collective strength of the Institute, giving researchers extra confidence that they would not have otherwise as individuals.

Due to budget cuts to multiple research and education programs, essential functions/ supports such as gap funding are at risk of being reduced or eliminated. Our leadership, working with advisory board members, are actively looking for creative ways to reorganize staff, increase efficiency, and raise funds from additional sources.

One area in which we have been more engaged in lately is philanthropy. We are building a close relationship with the Office of Corporation and Foundation Relations of Texas Tech University System which is extremely helpful in making contact with potential donors and project sponsors.

Two visits are being planned this fall by major energy companies who have expressed a keen interest in our expanding footprint in renewable energy (wind, solar, battery, power grid) and robust educational programs (BSWE, Ph.D., continuing education). In addition, we receive legislative assistance from the federal relation team to be more proactive in applying for federal funding. Aided by our strength in radar technology and *in-situ* observation, we are looking at landing major contracts in the next 6 to 12 months from both federal and state agencies.

Lastly, I'm happy to report that the value of our research awards stands at $3.4m as of the end of June, already exceeding the total for the entire FY16 by 24%.

Two areas – wind energy and smart grid – easily beat last year's numbers while the other two - severe storm, and wind engineering – have recorded 11% and 156% increases respectively!

The diversification and robustness of our research portfolio continues allowing us to grow through tough funding cycles while at the same time, allowing us to pursue emerging opportunities especially related to defense, national security, and agriculture.

Go Raiders!
Daan Liang, Interim Director

RESEARCHERS ATTEND OFF-SHORE CONFERENCE

Brian Hirth, **Jerry Guynes** and **John Schroeder** recently traveled to London to attend the Offshore Wind Energy 2017 Conference, and presented a paper titled "A Dual-Doppler Radar System to Document Offshore Wind Plant Complex Flows" in the Sensing Offshore Wind session. The paper summarized the first measurements from an offshore wind plant complex flow study led by DONG Energy. TTU partnered with SmartWind Technologies to develop and deploy the radar technology to study DONG Energy's Westermost Rough wind plant, and the radars have been in operation since the summer of 2016.

Some take-away points from the conference include that many in industry now believe offshore wind turbine wake modeling has become very advanced and sophisticated, far reducing the concerns that once stood most prominent in the industry. However, concerns have now shifted to understanding broader scaled influences on the wind plants, such as the impact of stability, land/roughness heterogeneity, array edge effects, and wind plant to wind plant interactions. These concerns are not well understood at the moment and not well modeled.

(Above) - Dr. John Schroeder.

BSWE GRADUATES TAKE THE STAGE

NWI is proud to have a large group of graduates who recently successfully completed the BSWE program. **Kendall Merkel** was the Spring 2017 honor graduate with the highest ranking GPA, and was selected to be the banner bearer at the commencement ceremony.

(Left L-R) - Andrew Buchok (NWI Instructor), Todd Miller (BSWE), Wyatt Zalatoris (BSWE), LaDonna Mild (BSWE), Julio Recendiz (BSWE), Christopher Rodriguez (BSWE), and Matt Saldana (NWI Instructor).

Among the group were the following students:

- Noah Frank Andrade III
- Randall Ty Boatright
- George H. Chen
- Sean Alexander Curran
- William Joseph Cushwa
- Drew Alexander Davidson
- Alex Jordan DeHoog
- Chantry Cole Dunlap
- Eric John Granville Garcia
- Anna Lee Haag
- Austin Dauray Howard
- Andrew Joseph Hoye
- Kiefer Alexander Jennings
- Patrick Anthony McCoy
- Zachery Lee McNutt
- Cesar Mendoza
- Kendall Nicole Merkel
- LaDonna June Mild
- Todd Alan Miller
- Julio Cesar Recendiz
- Christopher Ryan Rodriguez
- Daniel Alan Wentworth
- Wyatt Spencer Zalatoris

NWI GRANTS AND CONTRACTS — JUNE 2017

NWI/GLEAMM: Ensemble Subsetting within Optimized Ensembles to Improve Probabilistic Prediction of Severe Convection
National Oceanic and Atmospheric Administration

Brian C. Ancell (Geosciences)	50%	$74,696
Christopher C. Weiss (Geosciences)	50%	$74,696

FM Global Summer Internship (Changda Feng)
FM Global

Xinzhong Chen (CECE)	100%	$17,247

PUBLICATIONS—JUNE 2017

Cao. C., D. Ye, J. Hangfu, S. Qaio, **C. Li**, and L. Ran (2017). "Ultra Sub-wavelength Gigahertz Resonator for Constructing Silicon-substrate Metamaterials." Phoenix, AZ: 2017 IEEE 17TH Topical Meeting on Silicon Monolithis Integrated Circuits in RF Systems (SIRF). 76-78. Jan 15-18.

Munoz-Ferreras, J.-M., Z. Peng, R. Gomez-Garcia, and **C. Li** (2017). "A Frequency-Multiplexed Doppler-plus-FMCW Hybrid Radar Architecture: Theory and Simulations." Phoenix, AZ: 2017 IEEE Topical Conference on Wireless Sensors and Sensor Networks (WISNET). 8-10. Proceedings.

Munoz-Ferreras, J.-M., Z. Peng, Y. Tang, R. Gomez-Garcia, and **C. Li** (2017). "Doppler-Radar-Based Short-Range Acquisitions of Time-Frequency Signatures from an Industrial-Type Wind Turbine." Phoenix, AZ: 2017 IEEE Topical Conference on Wireless Sensors and Sensor Networks (WISNET). Jan 15-18. 5-7. Proceedings.

Tang, Y., Z. Peng, and **C. Li** (2017). "An Experimental Study on the Feasibility of Fall Prevention using a Wearable K-band FMCW Radar,." Boulder, CO: 2017 United States National Committee of URSI National Radio Science Meeting (ISNC-URSI NRSM). Jan. 04-07.

Zhao, H., H. Honh, L. Sun, L. Yusheng, **C. Li**, and Z. Zhu (2017). "Noncontact Physiological Dynamics Detection Using Low-power Digital-IF Doppler Radar." *IEEE Transactions on Instrumentation and Measurement* 66 (7):1780-1788; 10.1109/TIM.2017.2669699.

Zhu, A., C. Wang, K. Xu, Z. Wang, D. Ye, Y. Sun, S. Qiao, **C. Li**, and L. Ran (2017). "Non-Foster Immittance Observed in the Full-Range Frequency Response." *Microwave and Optical Technology Letters* 59 (8): 2045-2048. 10.1002/mop.30665.

DOCTORAL STUDENT RECOGNIZED FOR PULSED POWER RESEARCH

(Above) - Shelby Lacouture, doctoral student in Electrical Engineering studying under Dr. Stephen Bayne.

Senior Research Associate and one of TTU's electrical engineering doctoral students, **Shelby Lacouture**, was recently recognized for his research at the biennial IEEE International Pulsed Power Conference held June 18-22 in Brighton, England.

Awarded the Arthur H. Guenther Pulsed Power Student Award from the Pulsed Power Science and Technology Committee, Shelby received a $1,000 prize and a certificate to recognize "outstanding contributions as a student in pulsed power engineering, science or technology", according to the official website.

Shelby is a graduate student studying under **Dr. Stephen Bayne** (EE), and studies the design and build of multiple pulsed power systems, and the design and prototyping of a 3-D static magnetic field imager.

Also of note, Shelby was also recognized with the 2017 Innovation Award from the TechConnect World Innovation Conference held recently in Washington, D.C.. According to its website, the TechConnect conference is an annual event designed to accelerate the commercialization of innovations out of the lab and into industry.

Shelby's research, titled "Electric Current and Magnetic Field Imaging System," may have come up with a solution that allows for the construction of an image of electric current similar to how thermal imaging works, and could result in very broad applications across numerous sciences, such as examining the current flow in circuit boards, wiring or large semi-conductor devices.

(Above) - Shelby Lacouture stands by his winning research project at the TechConnect Conference.

The TechConnect Innovation Awards, according to on-line sources, selects the top early-stage innovations from around the world through a review process with rankings based on the potential positive impact the submitted technology will have on a specific sector of the industry.

"Winning the National Innovation Award, while quite an honor in and of itself, also has garnered interest in the technology from several sources," Lacouture said. "It is my sincere hope that this interest will lead to help in developing a more advanced prototype and marketing the technology."

Lacouture, along with Dr. Bayne and **Dr. Argenis Bibao**, a Research Assistant Professor, have formed a start-up company called Energetrix Engineering, LLC, where the technology is licensed.

Lacouture said that the inspiration for developing electric current image technology came from his doctoral work with wide-band gap-power semiconductor devices. He theorized the use of a two-dimensional array of three-dimensional vector magnetometers to record the full-vector magnetic field in a plane, using the results to reconstruct an image of electric current flowing into a device or circuit in close proximity to the magnometer array.

He went to say that the idea is similar to that of a thermal camera, where an image of the temperature gradients of an object or objects is constructed in a meaningful way. With this system, scientists would have the ability to measure the complete three-dimensional vector magnetic field in a plane as well.

Excerpts taken with permission. George Watson, TTU.

UNDERSTANDING TORNADOES

Text by Sally Logue Post, Office of the Vice-President for Research, TTU.

Texas Tech researchers are working to find the best ways to predict deadly tornadoes

Chasing storms is serious business – sometimes it's seriously dangerous. Storm chasers want to get close enough to see the storm, while staying far enough away for safety.

Some storm chasers are working in the moment to help make determinations about the severity of an approaching storm to better warn the people in its path. Others, like Texas Tech's Christopher Weiss, have a more long-term game plan they are trying to better understand how tornadoes form.

Tornadoes are deadly and destructive. The National Weather Service (NWS) reports that nationally tornadoes killed 36 people and injured 924 in 2015. The storms caused almost $268 million dollars in damaged property and crops.

The VORTEX-SE project is the second such project for Texas Tech's wind scientists. A team led by Christopher Weiss took part in VORTEX2 in 2010.

Better understanding of how tornadoes develop inside a thunderstorm is an important part of helping the NWS better warn of an impending danger.

Weiss, an associate professor of atmospheric science, and his colleagues at Texas Tech are working on two fronts this spring using drones and more traditional measurement tools to learn better how to predict the unpredictable.

Weiss and his team are spending two months in the Southeastern U.S., primarily based in northern Alabama, looking at how and why tornadoes form in that part of the country. Texas Tech is one of several universities participating in VORTEX-SE or the Verification of the Origins of Rotation in Tornadoes Experiment-Southeast. The project looks not only at the conditions that produce storms, but also how the weather service predicts and warns the public about storms.

This is the second year of the congressionally mandated project initiated after a severe tornado outbreak in the region in 2011. NWS statistics show that Alabama was particularly hit hard with 145 tornadoes touching, more than twice the 10 year average for tornadoes in the state. Those 2011 storms killed 242 people and injured 2,113. Of the 145 tornadoes, 109 occurred in April.

While some researchers believe that an area's environment and terrain might affect the development of tornadoes, there is not a lot of information collected to verify that theory.

"The Southeast has fewer tornadoes than we see in Texas," Weiss said. "But it seems the tornadoes that do develop are deadlier. We don't know if that is from a lack of visibility because the area is heavily wooded and mountainous, or if they are coming out of storms that have lower predictability of producing tornadoes."

Texas Tech's four-person team is contributing three elements to the project: a mobile sounding unit that can measure humidity and temperature in the atmosphere; portable lightning mapping array stations and mobile StickNets, 24 student-developed observation stations.

Developed in 2005 by Texas Tech students, the platforms were named StickNets for their resemblance to a stick figure. The mobile devices can be quickly set up by two people and can measure temperature, pressure and humidity. StickNet has been used to measure both tornadoes and land falling hurricanes.

"We can hammer the StickNets into the ground ahead of the storm to take these critical measurements and then we can pull our people out of harm's way," Weiss said.

Story continues on page 6

UNDERSTANDING TORNADOES (CONT'D FROM P. 5)

Texas Tech is using 24 mobile Sticknet platforms in the VORTEX-SE project. Sticknet is a mobile weather observation station that measures temperature, pressure and humidity near thunderstorms

The lightning mapping stations look at the role lightning might play in tornado development. Eric Bruning, an associate professor of atmospheric science, is interested in the lightning that happens inside a thunderstorm that is not visible to the naked eye.

"The storms in the southeast behave a bit differently than in the Plains," Bruning said. "They are more severe and tend to be more transient when they intensify. When the storms increase, the signal of the lightning looks a little different. We're trying to understand how that might help us determine if a storm will turn tornadic."

The VORTEX projects began in the mid-1990s. Texas Tech was involved in the second VORTEX in 2009 and 2010 which covered the Great Plains states from Texas to South Dakota that are commonly referred to as Tornado Alley.

In addition to VORTEX-SE, Weiss is involved in a project using unmanned aerial vehicles (UAV). In collaboration with the University of Colorado and the University of Nebraska, the National Science Foundation-funded project is designed to help refine and improve prediction of tornadoes.

The researchers are trying to better understand how temperature, pressure and humidity vary near tornadic storms. Using the drone will allow researchers to get closer to the most dangerous parts of a supercell thunderstorm, the parent storm for tornadoes, than they can with traditional ground-based instruments.

"We will try to map the sources of spin in the storm and how that translates into developing tornadoes," Weiss said.

The 10-foot bi-wing UAV is owned by the University of Colorado. While there is some research using UAV, Weiss believes this project is different.

"I think some folks are using UAV technology such as quadcopters," he said. "Our bi-wing craft is more durable and should allow us to get into some of the more dangerous portions of the storm and make critical measurements.

Texas Tech is contributing its mobile KA-band radars to the project. The University of Nebraska will take other surface measurements.

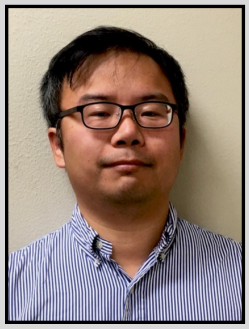
The mobile KA-band radars allows researchers to see into the storms and decide which parts of the storms are important. While the craft will not fly directly into a storm, it stays on the periphery, the radar's information helps direct it to where it needs to gather data.

"The bottom line is to improve understanding of these storms and that will immediately translate into improved lead time on warnings and decrease false warning," Weiss said. "The average tornado warning has about a 75 percent false alarm rate. We're going to err on the side of caution and make sure that people are prepared. But there is a lot that can be done to better understand storms and help us better warn people and save lives."

Used with permission.

If you are interested in having your latest scholarly endeavors featured in the next NWI newsletter, please forward your information (publications, proceedings, conference/workshop attendance, or other news etc.) to Liz Inskip-Paulk (email: Elizabeth.paulk@ttu.edu).

NWI MOVERS AND SHAKERS



NWI is always proud of our students, whether undergraduate or graduate, and wanted to congratulate **Mr. Hoonill Won** (WiSE doctoral candidate) on passing the dissertation review step of his degree plan.

Hoonill presented his dissertation covering the topic of "An Analysis of Multi-Height Wind Fluctuations."

Dr. Song-Lak Kang (ATMO) is Mr. Won's advisor and chair of his committee.

(Left) - WiSE doctoral student, Hoonill Won.

WiSE 2015 alum **Dr. Richard Krupar III** (right) is the newest faculty affiliate at the Center for Disaster Resilience in the Department of Civil and Environmental Engineering in the A. James Clark School of Engineering at the University of Maryland. Dr. Krupar also holds a position in the Department of Fire Protection Engineering as a postdoctoral associate.

As part of his research, Dr. Krupar will be developing a risk matrix to improve emergency management and financial risk decision making during extreme weather events.

Dr. Krupar joined UMD after serving as a postdoctoral research fellow at The University of Queensland in Australia.

(Credit: The Pew Charitable Trusts.)

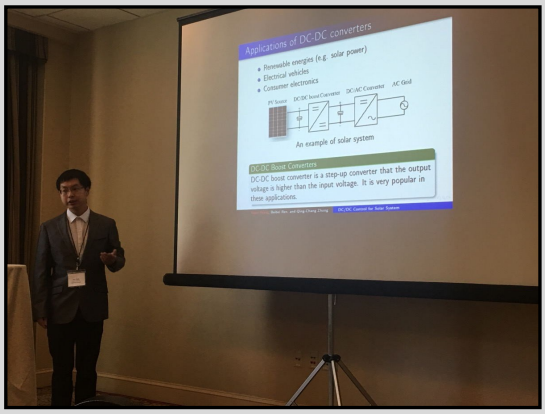
(Left) - WiSE 2010 alum **Dr. Tanya Brown-Giammanco** was recently featured in *Stateline*, the newsletter for the Pew Charitable Trusts in an article focused on a Mobile, Alabama, grant program providing new roofing for the elderly.

Dr. Brown-Giammanco is a researcher at the Institute of Business and Home Safety in Richburg, SC, which has pioneered new method for building resilient houses, now in use in thousands of homes across the U.S.

WiSE doctoral student **Yeqin Wang** (right) recently attended the 2017 American Control Conference (ACC) held in Seattle on May 24-26. Yeqin presented his paper titled, "Robust Control of DC-DC Boost Convertors for Solar Systems".

Yeqin's research focuses on developing an accurate control of DC-bus voltage in the solar system and developing a potential solution to deal with the disturbances from the varying of solar irradiation.

The ACC is an internationally recognized conference that attracts researchers and practitioners engaged in all aspects related to control and automation, and is a premier forum for sharing technical advancements and for networking with international leaders. Congratulations, Yeqin!



(Above) - WiSE Ph.D. student Yeqin Wang presenting his research at the 2017 American Control Conference.

TALK ABOUT THE WEATHER...

Text by Sally Logue Post, Office of the Vice-President for Research, TTU.

From farmers to fire departments, the West Texas Mesonet plays an important role in distributing weather information.

Weather dominates two things in West Texas – conversation and the economy. For farmers, knowing when to plant, how much and when to water is vital to their survival. During the spring, everyone casts a wary eye to the sky looking for a brown cloud of dust or the blue-black clouds that may signal a dangerous thunderstorm.

Texas Tech University's West Texas Mesonet is a network of 104 weather stations covering 70 counties in Texas, New Mexico and Colorado. The system provides real-time weather data via the internet to farmers, the National Weather Service (NWS), fire fighters and anyone who just wants to check in on what Mother Nature is doing today. The website receives more than 70,000 hits per day.

(Above) - Dr. John Schroeder, left, principal investigator and Wes Burgett, operations manager, for the West Texas Mesonet.

How it Works

Each Mesonet station consists of a 33-foot tower with instruments to measure a variety of atmospheric conditions including wind speed, temperature, humidity, rain fall, barometric pressure as well as soil temperature and moisture. The information is sent to a central station office at Texas Tech's National Wind Institute facilities at Reese Technology Center about 12 miles west of the university's campus.

While the science behind the Mesonet measurements is nothing new, meteorologists have used the same measurements for decades. The twist the West Texas Mesonet adds is the ability to push out that data every five minutes via the internet.

"The uses of the data are diverse," said John Schroeder, principal investigator on the project. "Our data can help farmers know when and how much to water or determine if the soil is warm enough to plant. We also archive the data and receive requests from researchers, school students and the general public from across the country looking for data."

The requests run the gamut from small everyday questions to requests involving legal disputes such as the wind data on a specific day in a specific place to help determine why a building collapsed.

"The variability is huge," said Schroeder. "We get about two requests a week. And every time we think we have a handle on our data users, something new pops up that we would never have thought of as a use."

Fire Warning

The Mesonet played a major role in assisting emergency management personnel in fighting massive wildfires in the Texas Panhandle in March 2017. It was the Mesonet station near Amarillo that first alerted officials that a wildfire could be underway.

It just so happened that two separate fires merged right at the Amarillo Mesonet station, triggering a temperature spike to 108 degrees Farenheite and alerting officials to a possible fire.

Continued on page 8.

TALK ABOUT THE WEATHER *(cont'd from page 8)*

"Wildfires are not easy to detect," said Wes Burgett, operations manager for the West Texas Mesonet. "They usually start in areas where there are not a lot of people around. A fire can be seen on satellite or when it's bigger on radar. But it was really dusty that day, making it harder to see. When a fire is moving 50-to-60 miles an hour, by the time it is spotted lives can be in jeopardy."

By the time the Panhandle wildfires were contained, about 500,000 acres had burned, four people had died, and thousands of head of livestock were killed or displaced. The Mesonet allowed emergency personnel to make decisions.

"Our data looks at the atmospheric set up – will an incoming front change the wind direction and will it change the way we expect?" said Schroeder. "The network is feeding constant data into the system, to help make decisions that can help position people and equipment or evacuate those who may be in danger."

Officials with the NWS in Amarillo said, "WTM data was invaluable for our partners as we used the Amarillo 9NNE site and several other WTM sites to brief firefighters on wind direction and wind shifts during the outbreak."

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NWI INSTRUCTOR SELECTED AS SERVICE-LEARNING FACULTY FELLOW

(Above) - NWI Instructor Kyle R. Jay.

NWI offers one of the most innovative undergraduate programs in the state, and to support that claim, Kyle Jay, one of our BSWE instructors, was recently selected to serve as a 2017-2018 Service-Learning Faculty Fellow.

"We are pleased that Mr. Kyle Jay has been selected for this program," reported Dr. Andy Swift, NWI Associate Director of Education. "Getting students involved with the community and regional issues creates a broader learning environment than the usual academic classroom setting, and builds stronger university-community relationships."

According to the official website, the TTU Service-Learning Faculty Fellows (SLFF) program "fosters a community of scholars who integrate the philosophy, pedagogy, and process of service learning into each component of their professional lives—research, teaching, and service."

SLFF is a "learning experience intended to promote individual service learning skills that will better the university," and is open to all permanent full-time faculty, including instructors.

Fellowships last for 9 months, and each participant will receive a $1,000 stipend and a part-time graduate assistant for the semester in which the service learning course is taught.

NWI CO-FOUNDER FEATURED ON *TEXAS STANDARD* RADIO

(Above) - Dr. Kishor Mehta, Horn Professor and NWI co-founder.

NWI co-founder and Horn Professor, **Dr. Kishor Mehta**, (left) was recently featured in a radio program about wind hazards on the Texas Standard, the widely-respected national daily news show that comes out of Austin, Texas. The show's website describes it as "grounded in the best traditions of American journalism: fact-based, independent and politically-neutral reporting."

Dr. Mehta was featured as one of the leading researchers who helped to develop the Enhanced Fujita Scale (or EF Scale) to more accurately measure the impact of tornadoes.

As the program reports, "we realized as engineers that [the Fujita Scale] was relating damage to wind speed," Dr. Mehta said. "In some cases, particularly in the F3, F4, and F5 [events], the wind speeds were very high. It really did not take that type of wind speed to do the type of damage we were seeing. In addition, we needed a lot more definition of the type of buildings that were damaged."

If you're interested in hearing the show featuring Dr. Mehta, please check the Texas Standard website.

RESEARCH UPDATE: GLEAMM

The Global Laboratory for Energy Asset Management and Manufacturing (GLEAMM) project combines the research and commercialization expertise of Texas Tech University with the field testing, certification and development expertise of Group NIRE, a for-profit energy development company. GLEAMM was established thanks to a $13 million investment by the State of Texas. The GLEAMM Team is a collaboration of university innovators, industry leaders and for-profit testing, certification and manufacturing facilities focused on protecting, enhancing and managing energy transmission and distribution on the electric grid.

GLEAMM

GLOBAL LABORATORY FOR ENERGY ASSET MANAGEMENT AND MANUFACTURING

Texas Tech, in partnership with Group NIRE, plans to leverage this investment to test, certify, research, develop and support the manufacturing of new electrical grid technologies and next-generation power electronic devices for public and private partners. The testing and certification will take place at Reese Technology Center, where a shared field testing environment between Texas Tech and Group NIRE, is being constructed. Eventually, a microgrid will be constructed that includes a diesel generator, a solar array, OPAL RT modeling system, Phasor Measurement Unit (PMU) systems, SCADA (controller) system, reconfigurable resistive and inductive loads, batteries, and a controls building.

The Texas Tech solar array was commissioned in May 2017 and is producing power at a rate of approximately 500 kWh per day. The PMU systems are producing data and the OPAL RT modeling system is being utilized to simulate the dynamic interconnection of the system components.

Used with permission. GLEAMM.