Department of Scientific Computing

Fall 2020

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Scientific Computing welcomes Kevin Speer

Professor Kevin Speer joined the department this year, coming to Scientific Computing from the Geophysical Fluid Dynamics Institute where he has held leadership posts since 2003.

Speer received the Ph.D. in physical oceanography from a joint program between Massachusetts Institute of Technology and Woods Hole Oceanographic Institution where he served as research fellow until graduation in 1988. From there, he began a decade-long research career in Europe, first spending two years in a postdoctoral associate position at IFREMER, the French Research Institute for Exploitation of the Sea in Brest, France, followed by a stint as research scientist at the Institut für Meereskunde in Kiel, Germany. Speer returned to IFREMER for seven years before coming to Florida State in 1999.

A prolific writer, author and presenter, Professor Speer teaches courses in oceanography, marine field methods, earth systems and fire dynamics. He serves as Director of GFDI.

You study global ocean circulation and the dynamics of hydrothermal plumes. As a scholar, what questions at the intersections of these areas interest you?

Most of my work these days concerns the circulation of the Southern Ocean, and the link between flow in the deep ocean and that on the Antarctic continental shelves. With partners, we have a NSF project and carried out an expedition to one of the few remaining unexplored areas of the ocean surrounding the continent, the Bellingshausen Sea and shelf. Numerous ice shelf cavities exist in this region and we have been studying the incursion of warm salty ocean water onto the shelf where it melts the ice. This forms buoyant plumes of relatively fresh water that rise toward the surface and generate a coastal current. My recently graduated student Ryan Schubert is about to submit a paper on this current, which was observed for the first time. Plumes are a common theme through both ocean and, recently, fire dynamics research. Wildland fires, meaning fires both in control and out of control (as we see dramatically now in the west) generate plumes of hot gases and smoke. The nature of the spread is related to both the radiant heat but also the convective motions generated by the interaction of the background wind with the fires and plumes. With colleagues here in DSC and Engineering we have a project to observe and develop new computational models of fire spread and behavior.

All of these geophysical phenomena in the ocean and fire environment involve turbulent fluxes as a fundamental transport process. I am very positive about our new relationship with the DSC to look to future modeling and advanced computational methods to solve some of these complex problems of fluid flow in the natural setting, whether liquid or gas. These problems are very different from the typical engineering fluids problems that are highly constrained, or weather and climate problems at much larger scales. They are closer to boundary layer and complex interface type problems that are at the forefront of computational research.

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Brandon Gusto wins SMART Scholar Award

Ph.D. student Brandon Gusto enjoying an Austrian sunset.

Brandon Gusto, a Scientific Computing doctoral student, received a 2020 SMART Program award from the Department of Defense (DoD). SMART, the Science, Mathematics, and Research for Transformation Scholarship-for-Service Program, is a combined educational and workforce development opportunity for post-secondary students at any level to gain technical skills in critical STEM fields. The award is generous and comprehensive: it offers full tuition, an annual stipend, summer internships, health insurance, an allowance for miscellaneous expenses, and an experienced mentor. This competitive award culminates in full-time employment at a Department of Defense facility.

> "The end goal of this numerical study is to identify the conditions necessary for deflagration-to-detonation transition."

Gusto is studying computational fluid dynamics under the direction of Professor Tomek Plewa; his research is in the development of adaptive methods for problems in turbulent combustion. "Tomek will still supervise my research, but during internship and later employment I will specifically be working with folks in the Sensors and Sonar Systems Branch of the Naval Undersea Warfare Center," Gusto said.

With staff along both U.S. coasts and Japan, the Sensors and Sonar Systems Branch works on surface ship and submarine SONAR advance development, undersea distributed network systems, unmanned surface vehicle mission modules, low power telemetry, precision heading sensors, engineering measurement programs, cluster projects, littoral combat ship, airborne mine neutralization systems, and advanced processing build/advanced capability build.

In his research application to the DoD, Gusto proposed the study of a scalable, adaptive, high-fidelity, and computationally efficient approach to modeling the multi-physics aspects of turbulent combustion. Having already developed and applied a novel multiresolution algorithm with increased efficiency for certain types of combustion problems, Gusto now works to improve the algorithm and build on its functionality.

"I plan to continue improving the algorithm and expanding its area of applicability," Gusto stated. "I submitted a manuscript for publication earlier this year. In this work my adviser and I applied the algorithm to the well-resolved two-dimensional simulation of compressibly driven turbulence.

"I plan to continue improving the algorithm and expanding its area of applicability."
----- Brandon Gusto

United States Navy entrance gate, Newport, RI.

The end goal of this work is to accelerate certain parts of our simulation code while still maintaining the accuracy required to make basic science discoveries related to combustion physics. In particular, with our research group's simulations we attempt to identify the conditions necessary for deflagration-to-detonation transition, or DDT, to occur in the stellar medium. DDT is the process whereby subsonic burning (deflagration) is accelerated and evolves into a supersonic reactive wave (detonation). However, these types of problems are incredibly demanding in terms of computational resources, so we hope to accelerate these calculations with my multiresolution algorithm."

Gusto's fellowship began this fall term and will continue for the next four years. Beginning with the Fall 2020 semester, Gusto is taking classes and doing research. "I am starting this Fall (getting paid to do research and take classes) and then I will have my first internship during Summer of 2021. The SMART scholarship funds my remaining Ph.D. program, and as soon as I graduate I go to work for them full time for the same number of years as I was funded. After graduation (Spring 2022), I will begin working directly for the Navy as a full-time employee for at least two years.

The U.S. Navy is sponsoring Gusto, and he will work at the Naval Undersea Warfare Center (NUWC) Newport in Newport, Rhode Island, the Navy's full-spectrum research, development, test and evaluation, engineering and fleet support center for submarines, autonomous underwater systems, and offensive and defensive weapons systems associated with undersea warfare.

"My specific role is not fully determined yet, but I will be assisting in the development of novel algorithms for their unique research ap-

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Spotlight on Ava Dodd - SC Senior /Idea Grant Winner

Ava Dodd, Scientific Computing senior.

I am currently a senior and will graduate with my Bachelor's degree in Computational Science in the spring. I love studying machine learning techniques and algorithms. A broad field of research such as medical, law enforcement, animal conservation, and retail all utilize machine learning to improve their work. It is exciting to be at the forefront of technology that is rapidly changing how we think and conduct research. In particular, I have been working with algorithms used to detect objects and patterns from pictures and videos.

I began my research with Dr. Jonathan Adams during fall of 2019. I learned how to train the machine learning algorithm, YOLOv3, to detect objects, people, and marine life in the ocean. We aimed to test if transfer learning sped up the learning time for the algorithm to detect objects. Since it was already trained to detect people, learning to detect people submerged in water took a significantly less amount of time than detecting objects it had never seen before. The speed and increased accuracy of the predictions proved the importance of transfer learning. I became familiar with how to preprocess data, train the model, test the model, and how to make refinements based on the results.

After becoming familiar with object detection, my research group and I continued this work by applying to the 2020 IDEA Grant. This summer, we researched how to improve visual object detection systems through the use of synthetic data. My research team, composed of fellow undergraduates Erin Murphy and John Sutor, and I were awarded the 2020 Steve Madden Undergraduate Research Award for $6,000 for our proposed research. Throughout our research, we found the most difficult process was finding enough clear, precise data that could be used to train the algorithm. We aimed to create our own training data using Blender, a 3D modeling software. Using this software, we generated images of loggerhead turtles that could be used to train an algorithm so that it could be used to perform abundance counts on sea turtle nests without disrupting them.

It's been a long and exciting process to work in a growing field of research to improve machine learning processes that already exist. This combined with the prospect of helping sea turtle researchers conduct studies in a less invasive manner has been a very rewarding experience. We plan to continue our research throughout the year as we come across new findings that improve the efficiency of machine learning and AI. I love working on this research and have learned so many new skills I plan to carry with me into my career once I graduate. I found this to be an excellent way to utilize all the things I learned in the classroom in new and exciting ways.

The goal of Dodd's team's project is to develop a new method for counting sea turtles that will be more efficient and more accurate than current models (Warden, 2017). The team is using object detection software to reduce the number of counting mistakes and omissions.

IDEA grants fund research, creative projects, and the development or evaluation of new or existing ideas. All undergraduate majors are eligible. See https://cre.fsu.edu/undergradresearch/ideagrants.

Find a related story at https://www.sc.fsu.edu/news-and-events/headlines/1563-computational-science-major-explores-the-future-with-ai

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The common denominator of your research is climate. What do you find most challenging about this topic?

This is a common denominator across the range of work on deep ocean circulation and polar oceanography, and now fire as well. Putting aside the social aspects, and willingness to address the climate issues that some of the younger generation are finding to be motivation for change, a large scientific challenge is the linkage across vast scales of time and space. The energetically dominant scales we see in weather and ocean currents are at 10-100s of kilometers and days to weeks. This is the mesoscale. A great deal of effort these days in ocean research has gone into understanding the role of the "sub" mesoscale flow, in the ocean roughly scales of days and kilometers, on larger-scale flow and air-sea interaction. It turns out that these scales are responsible for significant air-sea heat fluxes hence exert a control on climate despite their relatively small scale. The plumes and structures we are studying off Antarctica are meters to hundreds of meters in dimension but feed flows that carry fresher water thousands of kilometers, which subsequently affects the formation of water masses on the global scale. Similar scale interactions occur in all areas of geophysical fluids.

What are you working on now?

Much of my time now is devoted to working with our fire students, including one of mine now located at the Los Alamos National Labs to study pyroconvection in the atmosphere. We are getting ready to gear up for an observational program starting next summer with instrumentation in prescribed fire to measure air flow and turbulence. The problem of boundary layer turbulence in a fire setting is an exciting new direction.

Kevin Speer pictured at a lab at the Geophysical Fluid Dynamics Institute.

How does your role as director of the Geophysical Fluid Dynamics Institute inform your teaching and scholarship?

The GFDI has a long history of excellence in research and interdisciplinary "fertilization" across departments and programs at FSU and from outside the university. I hope that it can continue and grow in new directions. This experience helps me to see over and over the satisfaction that faculty can get from a place to work out new ideas and exploit old ones, and that when students are directly involved in research from the start - and engaged with others in the same situation - they can flourish and develop a much more mature sense of the scientific effort.

Basically the GFDI depends on the willingness of faculty to bring their skills and research interests together to work on interdisciplinary problems such as fire. Our new Fire Dynamics program has reinvigorated the Institute and at the same time the association with the DSC is leading to a needed change of focus to provide our students with a solid computational foundation.

For more on Speer and the department, go to sc.fsu.edu.

New Grad Students

Originally from Greenville, FL, Jhamieka Greenwood earned an AA degree in 2011 from North Florida Community College. Afterward, she moved to Tallahassee to pursue a chemistry degree at Florida A & M University while working as a student mentor at FSU's College of Medicine S.S.T.R.I.D.E program and being an active member of FAMU's Rattler Association of Chemists. She graduated from FAMU in 2016 with a bachelor's degree in chemistry.


Jhamieka Greenwood

Following graduation, Greenwood began work as a Lab Technician at the Florida Department of Environmental Protection (DEP). Since then, she moved into their chemistry program, receiving promotions from Lab Technician IV to Chemist I to Environmental Specialist II. While working at DEP, Greenwood decided to follow her growing interests in bioinformatics, data mining, and graphics computing by pursuing a computational science degree. Before applying to the department, she took courses in programming, science and mathematics to enhance her programming and math skills.

For hobbies, Greenwood plays video games, enjoys anything Marvel or DC related, learns foreign languages and cultures, and enjoys programming. For future research, she plans to work with Kevin Speer and John Thompson on a new research project to experiment with a GPU hydrodynamics model and a cellular automata model of fire spread.

An FSU grad, Jeremy Quinto is a master's degree student who received his bachelor of science degree in applied and computational mathematics with a minor in physics. Quinto was born in Florida, but moved with his parents to their home country, Belize, when he was 3 years old; he returned to Florida and Florida State after graduating from high school.

Quinto's research is focused on cloud computing, specifically serverless computing and its applications regarding machine learning. He works at NewSci, a Tallahassee machine learning startup, and plans to work under the advice of Gordon Erlebacher.


Jeremy Quinto

Recently, Quinto adopted a neighborhood cat and is staying close to home. He enjoys video games and trying to learn and implement new ways to deploy applications to the cloud. He has grown to enjoy brewing tea and treats it as a therapeutic hobby

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Kyle Schueller was born and raised in Michigan, and began attending Michigan Technological University in Houghton in the Fall of 2012. Schueller double majored in applied/computational mathematics and general biology and received his bachelor of science degrees in the spring of 2017. After graduation, he worked in the chemical industry, authoring safety information for silicone based products.

Schueller was also a technology associate in the automotive industry where he implemented software for data management/manipulation. Over the past few years, he has become interested in data science and machine learning and would like to apply these technology tools to the biological and environmental sciences.

Schueller cooks, and enjoys learning about health and nutrition. He is passionate about environmental conservation, and loves spending time in the woods hiking and backpacking.

Sarthak Sharma is a first semester doctoral student from Mumbai City, who comes to Scientific Computing with a masters degree in mechanical engineering from the Indian Institute of Science in Bangalore. In 2015, he completed his undergrad studies at the University of Mumbai in mechanical engineering where he completed a final project on a spherical wheel robotic system that has all degrees of freedom in horizontal planar motion. He is taking courses remotely from India, but expects to arrive on campus to continue and complete his studies as soon as practicable.

Kyle Schueller

Sarthak Sharma

For his masters research [he completed the degree earlier this year], Sharma studied the Organic Rankine Cycle, a renewable energy technology that can be used for solar thermal energy, geothermal energy, biomass energy, and industrial waste heat. Sharma's research interests include artificial intelligence, machine learning, and data science.

For about a year, Sharma worked in the aerospace industry as an engineer in computational fluid dynamics in Airbus India, at Bangalore. He also worked as a researcher in the Centre for Sustainable Technologies and Centre for Atmospheric and Oceanic Sciences, at the Indian Institute of Science, in Bangalore, for more than a year.

In his free time, he enjoys swimming and cycling in the gym, spending time with family and friends, and watching movies. When possible, Sharma contributes to animal welfare and environmental protection activities. He also does volunteer work in the Animal Welfare Group at Indian Institute of Science. Sharma would like to use his doctoral degree to obtain a technical leadership position in the computational industry.

Originally from Kingston, Ontario, Canada, Ph.D. student Liam White received his bachelor of science degree in December 2019 from Nova Southeastern University where he majored in computer science and minored in physics.

White plans to study with Bryan Quaife on data-driven machine learning for prescribed fire. He is interested in how we can leverage our understanding of fire dynamics to prescribe controlled burns as a means of reducing the number and severity of catastrophic wildfires.

White brings with him research experience from two national laboratories – Argonne National Lab in Illinois and Oak Ridge National Lab in Tennessee – where he studied cyber-physical systems. At Argonne, White aided in the development of a secure version of their Hydrogen

Liam White

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plications. There may not be much overlap until I intern for them on site next summer. There I will be working on machine learning and fluid dynamics applications."

Gusto earned dual bachelor of science degrees in mechanical engineering and applied mathematics from Florida State in May 2017. As an undergrad, he held various positions, including work as research assistant at FSU's Aero-Propulsion, Mechatronics and Energy Center, the National High Magnetic Field Laboratory, and Los Alamos National Laboratory. Since becoming a grad student, he worked at NASA Langley Research Center.

For more on Gusto, go to https://people.sc.fsu.edu/~blg13/.

To find out specifics on the SMART Program including when and how to apply, go to smartscholarship.org.

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Refueling Station Analysis Model (HRSAM). At Oak Ridge, he helped in developing the ORNL Slicer 2, the next generation of large-scale 3D printing slicing software.

In his spare time, he camps and takes road trips to Cape Canaveral to watch launches. He enjoys playing squash and golf.

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