

Welcome to the ninth TCCS Newsletter!

The Texas Consortium for Computational Seismology is a joint initiative of the Bureau of Economic Geology (BEG) and the Institute for Computational Engineering and Science (ICES) at The University of Texas at Austin. Its mission is to address the most important and challenging research problems in computational geophysics as experienced by the energy industry, while educating the next generation of research geophysicists and computational scientists.

In this newsletter, you will find the latest updates on our research highlights, professional awards, upcoming workshops, and staff changes.

TCCS Sponsors

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Spring Meeting

The Spring 2016 Research Meeting of TCCS will take place in Houston, Texas, on April 13–15 at the BEG Houston Research Center.

Presentations and report materials from the meeting are available to the sponsors at the members' area of the website: <http://www.beg.utexas.edu/tccs/private/index.php>

See You in Dallas, Texas



TCCS has submitted 25 expanded abstracts to the 2016 SEG Annual Meeting in Dallas. The submitted

papers fall into nine different subject areas: Anisotropy, Full Waveform Inversion, Interpretation, Passive Seismic, Seismic Inversion, Seismic Processing: Interpolation and Regularization, Seismic Processing: Migration, Seismic Processing: Noise Attenuation, and Time Lapse.

New Project

Zhiguang Xue has been awarded a Statoil fellowship in support of his project "Elastic Multi-parameter Waveform Inversion for



Subsalt Imaging." The Statoil Fellows program is made possible by an agreement between Statoil and UT Austin.

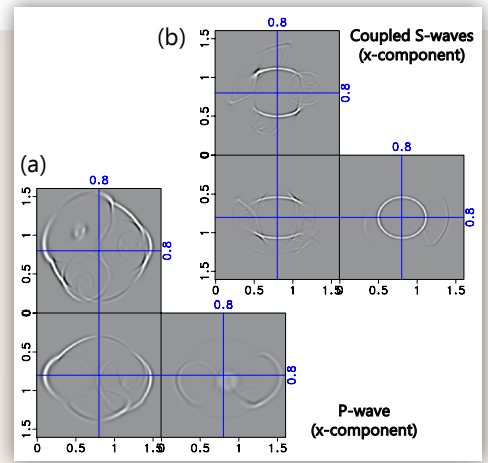


Research Highlights



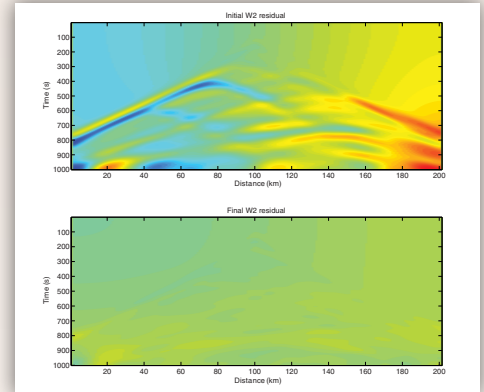
Junzhe Sun has developed low-rank one-step and two-step wave extrapolation operators in general anisotropic and heterogeneous media. The method is derived from the analytical solution of the elastic wave equation in homogeneous media and uses low-rank approximation to efficiently apply the

mixed domain Fourier Integral Operator in the heterogeneous case. The formulation is closely connected to elastic wave mode decomposition and is capable of propagating waves free of numerical dispersion and instability. The one-step formulation involves an analytic wave field that provides information about wave propagation direction. The figures demonstrate propagation of (a) P-wave, and (b) coupled S-waves in an orthorhombic model.



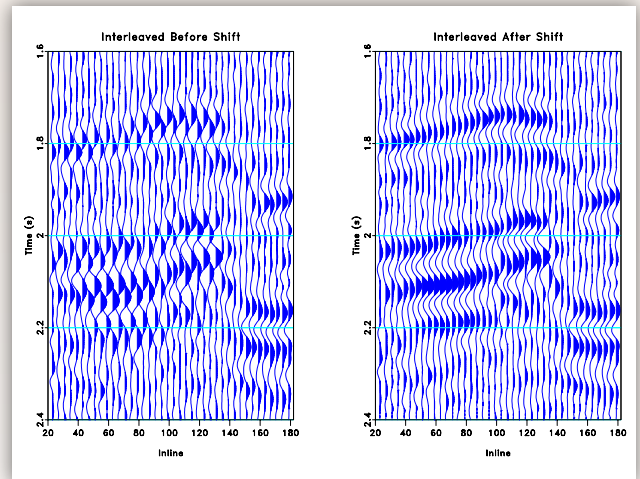
Yunan Yang has been studying the quadratic Wasserstein metric as a new misfit function for full waveform inversion (FWI). The Wasserstein metric matches the observed data and the predicted data by the optimal map, which takes the information geometry of the data sets into consideration. Compared with the traditional

least-squares norm, the new misfit function avoids cycle skipping and local minima. Yunan used mathematical theorems in optimal transport to prove the convexity of the quadratic Wasserstein metric in several aspects. Numerical examples illustrate the properties and feasibility of Wasserstein-based FWI using a gradient-based algorithm.



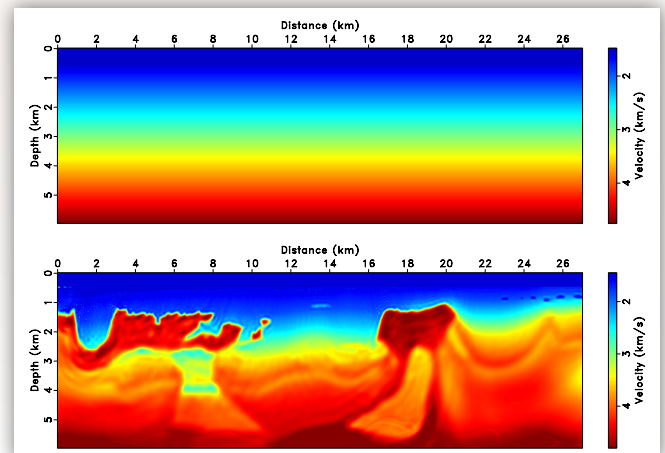
Mason Phillips is working on a method to efficiently measure time shifts and scaling functions between seismic images using amplitude-adjusted plane-wave destruction filters. Plane-wave destruction can efficiently measure shifts of less than a few samples, making this algorithm particularly effective for detecting small shifts. Separating shifts and scales allows shifting functions to be measured more

accurately. When shifts are large, amplitude-adjusted plane-wave destruction can also be used to refine shift estimates obtained by other methods. The proposed algorithm has immediate applications to time-lapse seismic monitoring and multicomponent seismic interpretation.



Zhiguang Xue is working on a method that can mitigate the cycle-skipping problem of FWI. FWI with smoothing kernels minimizes a sequence of modified least-squares objective functions that measure smoothed data residuals. The smoothing strength at each stage of the inversion is different: it begins with strong

smoothing and ends with no smoothing. The figures show the initial model and the final inverted model after 240 iterations using synthetic data generated with a BP 2004 benchmark model and a Ricker wavelet centered at 8Hz.



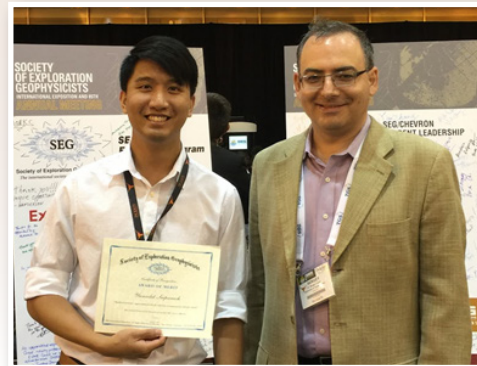
Professional Award

SEG Top 31 Paper



Zhiguang Xue's paper "Full-Waveform Inversion with Sparsity Constraint in Seislet Domain" presented at the 85th Annual Meeting of SEG in New Orleans in 2015 appears on the list of Top 31 SEG Papers. The

paper was co-authored by Hejun Zhu, a former TCCS postdoc, who is currently an assistant professor at UT Dallas. Over the last 4 years, TCCS students have won Best Student Poster and Award of Merit for Best Student Poster (twice) at SEG, and have appeared four times on the Top 31 SEG Papers list.

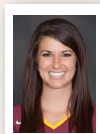


Jackson School Research Symposium

In 2016, more than 130 students participated in the 5th Annual Jackson School Research Symposium. Each spring semester, students of the Jackson School of Geosciences at UT Austin present their research in a day-long poster competition. Throughout the day, faculty, research scientists, and industry representatives evaluate the posters. The goal of the Symposium is to provide cross-disciplinary collaboration among graduate students, undergraduate students, and faculty/research scientists at the

Jackson School. The event is sponsored by ConocoPhillips.

This year, **Kelly Regimbal** won an award for the best presentation by a late-career M.S. student. Her poster was titled "Optimizing CMP Stacking Using the Seislet Transform."



Students from Sergey Fomel's group won the second-place award for the best represented research group.



<http://www.jsg.utexas.edu/news/2016/02/winners-from-the-5th-annual-student-research-symposium/>

Workshop Announcements

Madagascar School in Zurich



The Madagascar software project is celebrating the 10th anniversary of its public existence with events that include a presentation at the European Association of Geoscientists and Engineers (EAGE) Workshop on **Open-Source Software in**

Applied Geosciences in Vienna—which will feature a special section on geophysics—and a Madagascar school in Zürich, Switzerland, on June 6–7, 2016.

http://www.ahay.org/wiki/Zurich_2016

IWSA



The 17th International Workshop on Seismic Anisotropy (17IWSA) will be held in Horseshoe Bay, Texas, September 18–23, 2016. The IWSA

returns to the United States for the first time in 8 years. The workshop is organized by the Jackson School of Geosciences, UT Austin, with support from PGS, Schlumberger, and SEG.

Study of seismic anisotropy plays an increasingly important role in application to fracture characterization of unconventional reservoirs as well as in many other areas of seismic

exploration and earthquake seismology. The focus of the workshop is the development of better understanding of seismic anisotropy in the earth and the development of practical methods for seismic data processing, imaging, and inversion in the presence of anisotropy.

<http://www.beg.utexas.edu/17IWSA/>

TCCS Staff

The TCCS group consists of researchers from five different countries. Our staff includes principal investigators, postdocs, Ph.D. students, M.S. students, B.S. students, and a senior research fellow:

Björn Engquist (PI)
Sergey Fomel (PI)
Sarah Greer (B.S. 2nd year)
Dmitry Merzlikin (Ph.D. 2nd year)
Mason Phillips (M.S. 1st year)
Kelly Regimbal (M.S. 2nd year)
Karl Schleicher (senior research fellow)
Yunzhi Shi (Ph.D. 1st year)

Yanadet Sripanich (Ph.D. 3rd year)
Junzhe Sun (Ph.D. 4th year)
Zhiguang Xue (Ph.D. 3rd year)
Yunan Yang (Ph.D. 3rd year)
Tieyuan Zhu (postdoc)

For more information, see <http://www.beg.utexas.edu/tccs/staff.php>.

New Faces



Xufei Gong is a Ph.D. candidate from China University of Petroleum (East China). He received his bachelor's degree in applied geophysics from the same university in 2010 and a master's

degree in 2013. Since 2010, he has been working with Professor Qizhen Du on multicomponent data processing. At UT Austin, he is working with Dr. Sergey Fomel as a visiting scholar. His research interests include seismic modeling, wave-equation migration, and HPC techniques.



Sarah Greer is an undergraduate student in the Jackson School of Geosciences with an expected graduation date of May 2018. She is majoring in geophysics, and is also interested in applied and computational mathematics.

Testimonials



Yangkang Chen

The most valuable thing I learned from TCCS in the past three and half years is the high standard of research: not superficial and not irrelevant. We are free to do research

on any topics that are challenging and significant to seismic exploration, which brings TCCS a broad horizon covering almost all aspects in computational seismology. Sergey always tries his best to create an environment where we can learn fast, think in depth, and collaborate with each other easily. The Madagascar open-source platform is the best software package I have ever used; it helped me conduct fast research and accomplish many research achievements. We are pushed to do independent research, but we are also encouraged to discuss and collaborate with different researchers around the world. TCCS transformed me from a student to a real research scientist during my Ph.D. study. My academic life at TCCS is definitely a memory that will be worth recalling my whole life.



Spring 2016 Jackson School Student Research Symposium



Mark Lai

I greatly enjoyed my year and a half working at TCCS and wish that more mathematicians

had more real-world collaborations like these. Geophysicists repeatedly impressed me by their raw mathematical intuition—statements that would take mathematicians months to prove, geophysicists would simply assume to be true, rightly so, and move on!

I developed a new appreciation of this type of guerrilla mathematics and was inspired in the theoretical realm by insights culled by those working on real-world data sets. I deeply admire how geophysics is one of the few fields where research and industry still work closely together.

In addition, Sergey was an outstanding postdoctoral mentor. He was constantly suggesting problems that might be a good fit for my background and interests and provided needed support when I got stuck.

I am very grateful for my time at TCCS and will look back with fond memories on the rich interdisciplinary collaborations.



Ryan Swindeman

Dr. Fomel and the researchers of TCCS helped me transition to geophysics from condensed matter physics. The ability of this collection of researchers and the wonderful community of support that they constitute are what made this process so enjoyable. I'm still impressed by the intelligence and ingenuity of the researchers at TCCS. Their knowledge, passion for work, and contributions are valuable assets to the industry.



Yatong Zhou

Over the past year, I have learned a lot, and I sincerely appreciate the visiting opportunity given to me by TCCS. I have an interdisciplinary background in machine learning and seismic signal processing, and saw the great potential of this interdisciplinary research during my visit. It took me a long time to learn Madagascar, a wonderful seismic processing software platform. Madagascar provided me great opportunities to follow and allowed me to contribute to many frontier research subjects.