

Welcome to the seventh 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 Sciences (ICES) at UT 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 our latest updates on our research highlights, professional awards, and visiting scientists.

See You in New Orleans



TCCS submitted more than 30 expanded abstracts to the 2015 SEG Annual Meeting in New Orleans. The submitted papers fall into 11

different subject areas: Acquisition, Anisotropy, Full Waveform Inversion, Interpretation, Passive Seismic, Reservoir Characterization, Seismic Modeling, Seismic Processing: Migration, Seismic Processing: Noise Attenuation, Seismic Processing: Interpolation and Regularization, and Seismic Theory.

TCCS Sponsors

TCCS appreciates the support of its sponsors: BP, CGG, Chevron, ConocoPhillips, ExxonMobil, FairfieldNodal, Saudi Aramco, Schlumberger, Statoil, and Total.

New Sponsors

TCCS welcomes FairfieldNodal as the new sponsor joining the program and appreciates its support.



Spring Meeting

The Spring 2015 Research Meeting of TCCS was held in Houston on March 23–24. Nearly 60 people attended the meeting, including representatives from 10 sponsor companies. 22 research presentations at the meeting included presentations by TCCS staff and a guest lecture by WenZhan Song (Georgia State).

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>

New Projects

We appreciate the support of BP for the project "Phase Correction of Prestack Seismic Data Using Local Attributes".



Yanadet Sripanich was awarded a Statoil fellowship in support of his project "Characterization of Fractured Shale Reservoirs Using Anelliptic

Parameters". The Statoil Fellows program is made possible by an agreement between Statoil and UT Austin. Another TCCS student supported under this program is Junzhe Sun, with his project "Lowrank Reverse Time Migration for Subsalt Imaging".

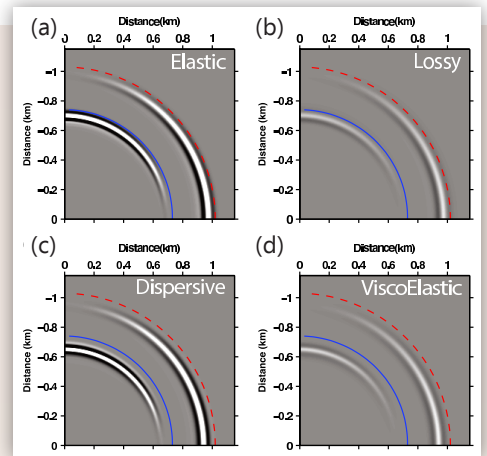


Research Highlights



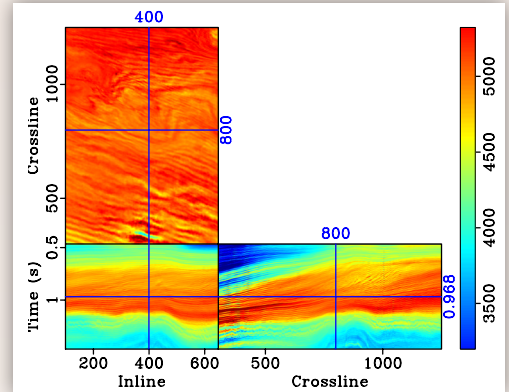
Tiejuan Zhu has proposed a theory and modeling of viscoelastic wave propagation based on fractional Laplacians. The proposed formulation has two features. First, it simulates P- and S-waves that approximately exhibit frequency-independent Q behaviors. Second, it has the decoupled P- and S-wave

attenuation operators. Wave propagation can therefore be simulated in three scenarios: only amplitude loss effect, only phase dispersion effect, or both effects, which is illustrated in the figure. For practicality in seismic inverse problems, we can also design a viscoelastic back-propagation approach that can correct for both P- and S-attenuation effects, which can be achieved by reversing the sign of both P- and S-attenuation operators.



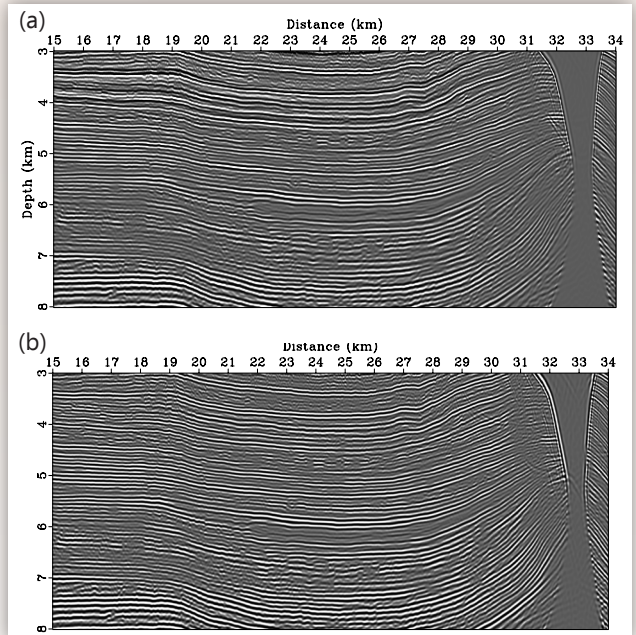
Parvaneh Karimi has developed a new method for integration of well-log and seismic data, which honors both seismic image structures and the relationship of seismic amplitudes or other attributes to well-log properties to provide useful clues in the interpolation process. The result of image-

guided interpolation of acoustic impedance is used as the detailed initial model in the acoustic impedance inversion, which results in a reliable full-bandwidth impedance image consistent with the geological events present in the seismic image, in contrast to the impedance image obtained by using a simple initial model.



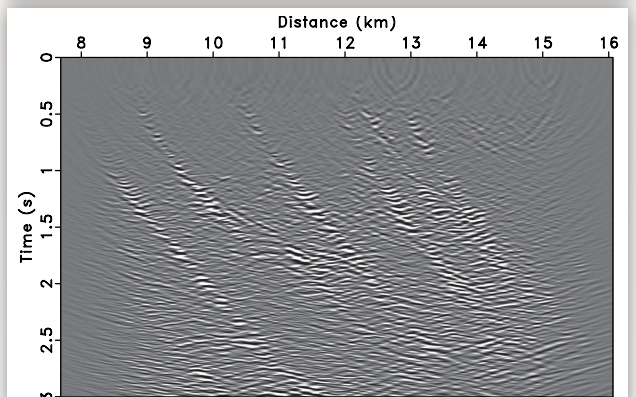
Zhiguang Xue has developed an approach for increasing imaging resolution of reverse-time migration (RTM) by taking advantage of time-shift common-image gathers. The method transforms time-shift gathers computed on a regular grid to an image on a finer grid. Unlike post-imaging interpolation, the RTM interpolation using time-shift gathers tries to honor the character of wavefield

propagation. The figures show the images of a target area in BP-2007 model before (a) and after (b) RTM interpolation with time-shift gathers. The image has been transformed from the computing grid of $dx=12.5m$ and $dz=18.75m$ to the high-resolution grid of $dx=dz=6.25m$.



Dmitrii Merzlikin is working on direct and analytical path-integral evaluation for diffraction imaging purposes. Path-integral formulation allows us to build velocity-independent images of the subsurface without any velocity picking. Stacking of images corresponding to a set of constant migration velocities is a common way to compute a path-integral image. Dmitrii has proposed an equation for direct and analytical path-integral

evaluation. The equation allows computation of path-integral images in one step and is more accurate compared to the stacking approach, which corresponds to an approximate solution of the integral. This path-integral image has been computed using the direct formula with a Gaussian weighting scheme incorporated for resolution improvement.



Professional Award



Björn Engquist has been awarded the 2015 International Council for Industrial and Applied Mathematics (ICIAM) Pioneer Prize. The Pioneer

Prize was established for pioneering work introducing applied mathematical methods and scientific computing techniques to an industrial problem area or a new scientific field of applications. It was created on the initiative of the Society for Industrial and Applied Mathematics (SIAM), and was first awarded in 1999. Carrying a cash award of \$5,000, the Pioneer Prize is presently funded by SIAM.

The award citation says, "Bjorn Engquist has made fundamental contributions in the field of applied mathematics, numerical analysis and scientific computing which have had long lasting impact in the field as well as successful applications in science,

engineering, and industry. Some of his most important pioneering contributions include seminal work on absorbing boundary conditions (ABC), first proposed by Engquist and Majda, for numerical computation of wave propagation. These boundary conditions can be used at the boundary of the computational domain to reduce the artificial reflection of waves effectively. Owing to its simplicity and efficiency, it has been one of the most successful and widely used numerical techniques in the past 30 years and has had significant impact in practical applications such as geophysics, seismology and petroleum industry.

In a second direction, Engquist, with his collaborators, is responsible for the development and analysis of shock capturing methods for nonlinear hyperbolic conservation laws, including the well-known essentially non-oscillatory (ENO) method. These numerical methods have been widely

used in computational fluid dynamics, aerospace engineering, combustion, and other applications.

For the past twenty years, Engquist has been a leader in the field of multi-scale modeling and analysis, where his contributions include numerical homogenization, and the heterogeneous multi-scale method (HMM), among other results."

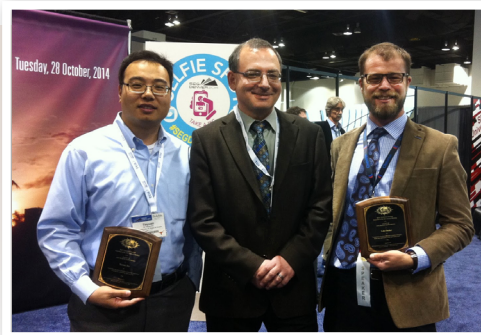
The Pioneer Prize will be presented to Björn at the next ICIAM Congress, the Eighth International Congress on Industrial and Applied Mathematics, in Beijing, China, on August 10–14, 2015.

A conference on Numerical and Multiscale Issues for Partial and Integral Differential Equations will take place in Austin on October 14–17. This event will be hosted by ICES and dedicated to Bjorn Engquist's pioneer work and accomplishments.

SEG Top 30 Papers

Four of the papers presented by TCCS staff at the 84th Annual Meeting of SEG in Denver in 2014 appear on the list of Top 30 SEG Papers: *Anelliptic approximations for qP velocities in orthorhombic media* and *Modified anelliptic approximations*

for qP velocities in transversely isotropic media by **Yanadet Sripanich**, *Random noise attenuation using local similarity* by **Yangkang Chen**, and *Transforming prestack seismic data by Gardner continuation* by **Sergey Fomel**.



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, judges composed of 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.

In 2015, at the 4th Annual Jackson School Research Symposium, more than 140 student posters were

presented. A special award for the best represented research group was given to students from Sergey Fomel's group.



http://www.jsg.utexas.edu/research_symposium/

TCCS Staff

The TCCS group consists of people from six different countries who have come together to move science forward. Our research staff includes Principal Investigators, Postdocs, Ph.D. students, M.S. students, B.S. students, and a Senior Research Fellow:

Yangkang Chen (Ph.D., 3rd year)
Björn Engquist (PI)
Sergey Fomel (PI)
Brittany Froese (Postdoc)
Parvaneh Karimi (Ph.D., 5th year)
Mark Lai (Postdoc)

Dmitrii Merzlikin (Ph.D., 1st year)
Mason Phillips (B.S., 4th year)
Kelly Regimbal (M.S., 1st year)
Karl Schleicher (Senior Research Fellow)
Yanadet Sripanich (Ph.D., 2nd year)
Junzhe Sun (Ph.D., 3rd year)
Ryan Swindeman (M.S., 2nd year)
Yunan Yang (Ph.D., 2nd year)
Zhiguang Xue (Ph.D., 2nd year)
Hejun Zhu (Postdoc)
Tieyuan Zhu (Postdoc)

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



Visiting Professors



Wen Zhang Song is a Professor of Computer Science and Director of

Sensorweb Research Laboratory at Georgia State University. His research mainly focuses on cyber-physical systems and computing for geophysical imaging, smart grid, and smart health, where decentralized sensing, computing, communication, and security play a critical role and need a transformative study. Dr. Song has led several major interdisciplinary research projects

on those issues with \$7 million+ grant support from NSF, NASA, USGS, and industry since 2005. His work on volcano monitoring sensor network was featured in MIT Technology Review, Network World, Scientific America, New Scientist, National Geographic, etc. Dr. Song is a recipient of NSF CAREER Award (2010), Outstanding Research Contribution Award (2012) by GSU Computer Science, and Chancellor Research Excellence Award (2010) by WSU Vancouver. He was also a recipient of the 2004 National Outstanding Oversea Student Scholarship

by China during his Ph.D. study. Dr. Song serves several premium conferences and journals, such as IEEE Transaction on Parallel and Distributed Systems.



Yatong Zhou is a Professor and Dean of Department of Electronic and

Information Engineering at Hebei University of Technology, Tianjin, China. He received his Ph.D. degree in Information and Communication Engineering from Xi'an Jiaotong University, China, in 2006.

He worked previously at the Bureau of Geophysical Prospecting (BGP), CNPC and the Institute of Geology and Geophysics, Chinese Academy of Sciences as a postdoctoral fellow. He has visiting experiences at the Peking University and Wake Forest University. His research mainly focuses on machine learning, intelligent information processing, and seismic signal processing. His current research interests are seismic data regularization, Bayesian inference, and kernel based learning.

Testimonials



Jianwei Ma

It was an honor visiting TCCS from March to September, 2014, as a T. J. Oden Faculty Fellow. I have an

interdisciplinary background on applied mathematics, seismic exploration, and mechanics. The TCCS provides a perfect platform for me to exchange ideas with computational scientists and geophysicists. I enjoyed the collaboration with Sergey and Yangkang on sparsity transform and denoising of seismic data. After I left the TCCS, we still keep in touch with each other. In

January 2015, Sergey and I (together with Mauricio Sacchi and Ru-shan Wu) co-organized an International Workshop on Mathematical Geophysics at Harbin, China. In August, 2015, Sergey and I will co-organize a minisymposium at The International Congress on Industrial and Applied Mathematics (ICIAM) 2015, Beijing. I look forward to future collaborations between the two groups.



Lubna Barghouty

Joining the TCCS happened through participating in the Undergraduate Honors Research Program at the

Jackson School of Geosciences. Having Dr. Sergey Fomel as my research adviser, I was not aware that I had become a member of an amazingly talented, motivated, and specialized research group. Not only is the TCCS impressive in its academic and technical accomplishments, but also in its tight collaboration and sharing of ideas and constructive criticism. I became to know how important it is to have a supportive academic family that you can learn from and share your knowledge with. During my rich experience with TCCS, I gained the soft and technical skills that strengthened my desire and ability to conduct higher level research in the near future.