## Editorial

Welcome to the first TCCS newsletter!

The Texas Consortium for Computational Seismology is a joint initiative of the Bureau of Economic Geology (BEG) and the Center for Numerical Analysis at 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. We have had three TCCS meeting so far and we are planning to have the next one in Austin on November 12–13. In this very first issue of TCCS newsletter, you will get to know TCCS participates. You will read about our group's research
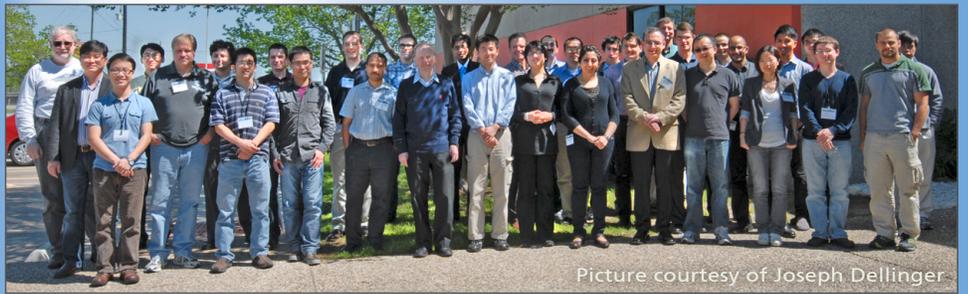
Picture courtesy of Joseph Dellinger

highlights and professional awards, and about supercomputing facilities that TCCS uses. We are looking forward to your feedback, suggestions and request, for sponsorship or research collaboration.

Spring Meeting

The Spring 2012 Research Meeting of the Texas Consortium for Computational Seismology was held in Houston, March 22–23, at the BEG Houston Research Center. Nearly 60 people attended the meeting, including representatives from

12 sponsor companies. In addition to 16 research presentations by TCCS staff, guest lectures were given by Professors Tariq Alkhalifah (KAUST), Omar Ghattas (UT Austin), and Alexander Vladimirsky (Cornell University).

The meeting agenda is available at http://www.beg.utexas.edu/tccs/docs/2012_agenda.pdf

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

TCCS Sponsors

TCCS appreciates the support of its sponsors: BGP, BP, Chevron, CGGVeritas, ConocoPhillips, ExxonMobil, Hess, Saudi Aramco, Schlumberger, Statoil, Total, and Z-Terra.

Companies can join TCCS through two forms of membership:

Gold sponsors are companies that support focused research projects of defined scope and provide funding in significant excess of the sponsor fee mentioned in a following paragraph under "Regular Sponsors."

Benefits of gold membership include

- Active participation in focused, collaborative research projects.

- Timely deliverables in the form of progress reports, software code, and reproducible computational experiments.
- All benefits of the regular sponsorship described next.

Regular sponsors are companies that support the program through a sponsor fee of $45,000 per year.

Benefits of regular membership include

- Invitation to sponsor meetings, at which research results are delivered in the form of oral presentations and company representatives get the chance to interact with students and research personnel.

- Access to publication preprints, complete with open-source software code and reproducible computational experiments.

New Gold Sponsor

TCCS welcomes Statoil as a new Gold Sponsor supporting the focused project, *Extracting Seismic Events by Predictive Painting and Time-Warping*.

In addition, Siwei Li, a Ph.D. student, has won a Statoil fellowship, part of a $5-million research agreement between Statoil and The University of Texas at Austin.

New Regular Sponsor

TCCS welcomes CGGVeritas as a new regular sponsor.

Fast 3-D Helmholtz Solver

The figure *below*, by Jack Poulson displays the real part of the solution of a 3D Helmholtz equation in the SEG/EAGE over-thrust model at 30 Hz, computed with a parallel sweeping precon-ditioner. To the best of our knowl-edge, this is the largest 3D Helm-holtz calculation to date, and the algorithm required only 15 minutes to complete on 8,192 cores.


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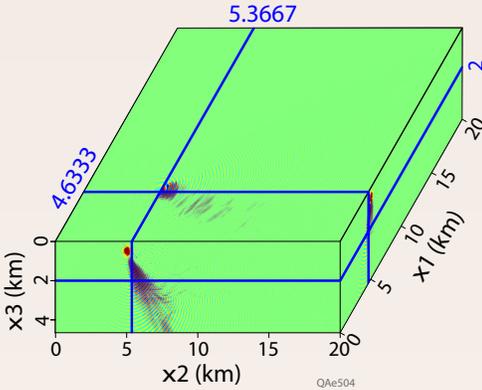
Reverse Time Migration by Fourier Finite Differences

Fourier finite differences (FFD), a method for seismic wave extrapolation and reverse time migration (RTM) has been developed by Xiaolei Song in her Ph.D. thesis. The seismic image *below*, depicts the result of using FFD for RTM in BP's 2007 benchmark model, which exhibits strong TTI anisotropy.
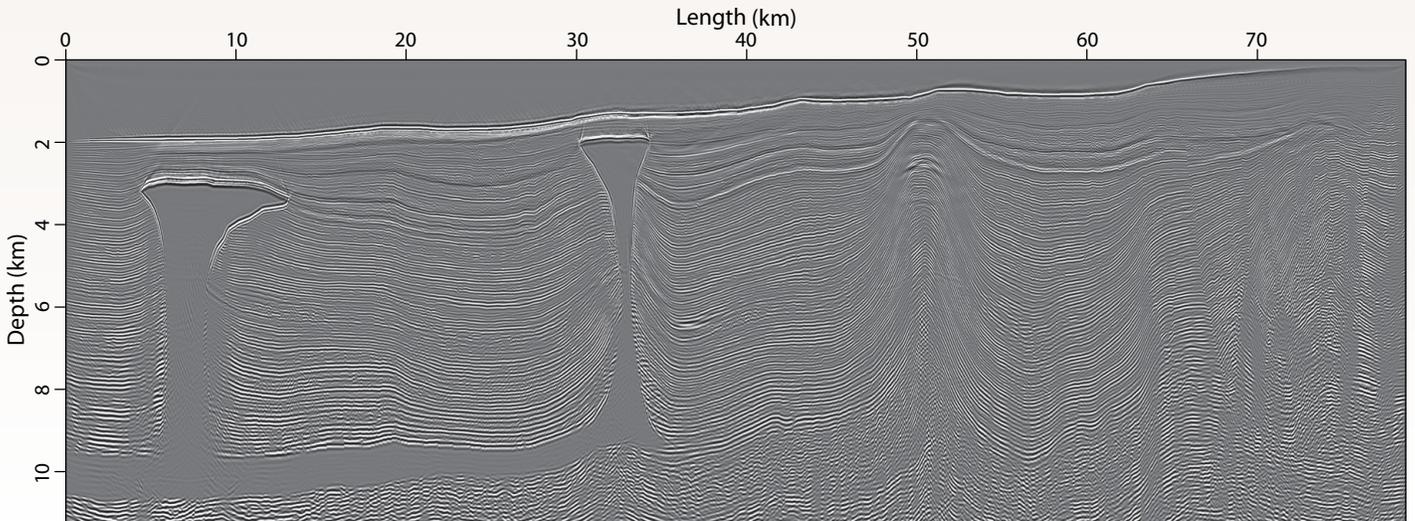
Diffraction Imaging

Alexander Klokov is working on diffraction imaging. The seismic images, *right*, show (a) a conventional time-migrated image for real data and (b) a diffraction image. The diffraction image reveals the fractured layer at time levels between 4.4 and 5 s.

(a)

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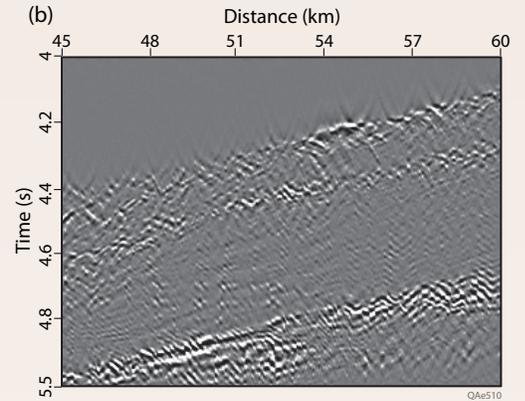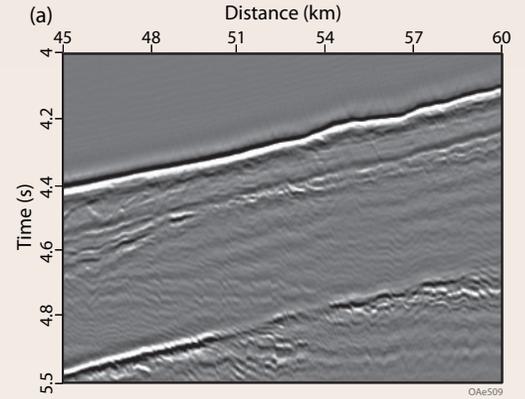
Phase-Space Seismic Imaging

Vladimir Bashkardin's Ph.D. project is devoted to phase-space traveltime computation and multiple-arrival angle-domain Kirchhoff migration. The colorful figure, *right*, displays the escape location volume computed in phase space using the escape equations for Marmousi model. Each point in this volume corresponds to a subsurface location (x,z) and a take-off angle θ (measured from the vertical direction). Computed values show where in the x axis a ray, that originates at (x,z) location and take-off angle θ, exits on the boundary of the model.

(b)

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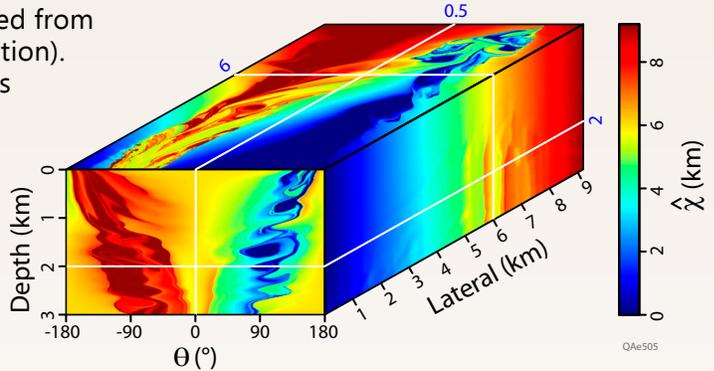
Professional Awards

TCCS researchers received several professional awards in 2011 and 2012:

Professor Björn Engquist is the 2011 recipient of the Peter Henrici Prize. This prize is awarded every 4 years jointly by Eidgenössische Technische Hochschule-Zürich (ETH Zurich) and the Society for Industrial and Applied Mathematics (SIAM) for original contributions to applied and numerical analysis and/or for exposition appropriate for applied mathematics and scientific computing.

Björn Engquist was awarded the 2012 George David Birkhoff Prize in Applied Mathematics jointly from AMS and the Society for Industrial and Applied Mathematics. The Birkhoff Prize is awarded every 3 years for outstanding contributions to applied mathematics in the highest and broadest sense.

The Schlumberger Award 2011 was presented to Sergey Fomel in recognition of his pioneering work on the subjects of seismic imaging with developments in angle gathers, azimuth-moveout correction, velocity-independent processing, and velocity continuation.

Seismic Wave Extrapolation Using Lowrank Symbol Approximation by Sergey Fomel, Lexing Ying, and Xiaolei Song was recognized as Best Poster Paper during the SEG Annual Meeting in San Antonio, September 2011.

Lexing Ying received the 2011 Feng Kang Prize of Scientific Computing from the Chinese Academy of Sciences. Since 1995, the Feng Kang Prize of Scientific Computing has honored young Chinese scientists in China and abroad for their significant contributions in the broad areas of scientific computing every other year.

Supercomputing Facilities

TCCS uses the high-performance computing resources available at the Texas Advanced Computing Center (TACC) at UT Austin for large-scale computations.

Sun Constellation Linux Cluster: Ranger

The Ranger system is comprised of 3,936 16-way SMP compute nodes providing 15,744 AMD Opteron processors for a total of 62,976 compute cores, 123 TB of total memory and 1.7 PB of raw global disk space. It has a theoretical peak performance of 579 TFLOPS. Each node contains 32 GB of memory.

Dell Linux Cluster: Lonestar

Lonestar contains 22,656 cores within 1,888 Dell PowerEdgeM610 compute blades (nodes), 16 PowerEdge R610 compute-I/Oserver-nodes, and 2 PowerEdge M610 (3.3GHz) login nodes. Each compute node has 24GB of memory, and the login/development nodes have 16GB. The system storage includes a 1000TB parallel (SCRATCH) Lustre file system, and 276TB of local compute-node disk space (146GB/node).


Currently, TACC, in partnership with Dell and Intel, is in the process of building a new computer cluster called Stampede.

Altogether, Stampede will have a peak performance of 10 petaflops, 272 TB of total memory, and 14 PB (14 million GB) of disk storage.

For more information, see http://www.tacc.utexas.edu/stampede

TCCS Staff

The TCCS research staff includes Principal Investigators, Postdocs, Ph.D. students, M.S. students, a B.S. Honors student, and a Senior Research Fellow:
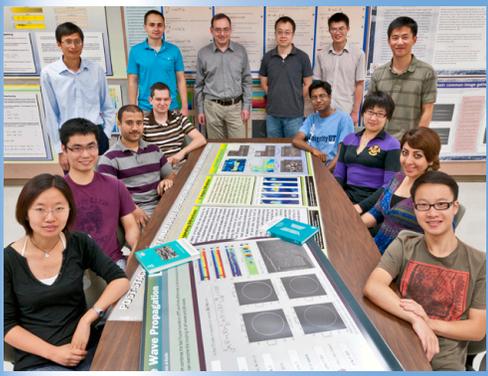
Salah Al-Hadab (M.S. 2nd year)
Vladimir Bashkardin (Ph.D. 5th year)
Yihua Cai (M.S. 2nd year)
Björn Engquist (PI)
Sergey Fomel (PI)
Shaunak Ghosh (Ph.D. 1st year)
Jingwei Hu (Postdoc)
Parvaneh Karimi (Ph.D. 2nd year)
Alexander Klokov (Postdoc)
Siwei Li (Ph.D. 3rd year)
Jack Poulson (Ph.D. 3rd year)
Karl Schleicher (Senior Research Fellow)
Yanadet Sripanich (B.S. Honors)
Paul Tsuji (Ph.D. 2nd year)
Xiaolei Song (Ph.D. 4th year)
Haizhao Yang (Ph.D. 2nd year)
Lexing Ying (PI)

First TCCS graduate student
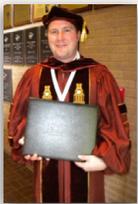
Recent alumni of the program are Will Burnett, currently a geophysicist at ExxonMobil, and Nick Tanushev, currently the Chief Scientist at Z-Terra. Will defended his Ph.D. thesis, *Multiazimuth Velocity Analysis Using Velocity-Independent Seismic Imaging,* and received a Ph.D. in Geological Sciences in the spring of 2011. Nick was a Postdoctoral Fellow working with Björn Engquist on Gaussian beam methods.

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

Research Visitors

Alexander Vladimirsky spent the fall 2011 semester with TCCS on sabbatical from Cornell University, where he holds an Associate Professor position in the Department of Mathematics.

"TCCS is a fairly unique group, spanning the range from very concrete practical problems in seismology to fundamental mathematical questions. The group does a great job of bridging the gap between the industry and academia. As an applied mathematician, I find my interactions with TCCS members to be both rewarding and stimulating. There is a wealth of interesting math problems, many smart people who truly care about solving them, and obvious opportunities to make the difference."

Alexander's research interests include numerical analysis, partial differential equations, dynamical systems, and algorithms on graphs.

Zhonghuan Chen, a Ph.D. student from Tsinghua University, is collaborating with Sergey Fomel at TCCS during 2011–2012, under the sponsorship of the China Scholarship Council.

"TCCS group works on both theory and application of methods in seismic data analysis. Using Madagascar, has made this group's research system so unique in different ways such as, managing experiments and distributing research results. I am so glad I found this opportunity to work with this group because I can concentrate on my research interest and do research more efficient."

He is interested in wavefield separation, seismic modeling, and statistics.

Jiubing Cheng, an Associate Professor from Tongji University, who was awarded a fellowship under the State Scholarship Fund, will spend 1 year at TCCS. His research interests include wave propagation, imaging and velocity model building in anisotropic media, fracture characterization based on azimuth-preserved local angle-domain seismic imaging, rock-facies classification and hydrocarbon prediction by integration of statistical rock physics and seismic inversion, and geophysical technique for shale-gas exploration and development.

See you in Copenhagen and Las Vegas

TCCS staff will make several presentations at the 2012 EAGE Annual Meeting in Copenhagen.

TCCS submitted 14 expanded abstracts to the 2012 SEG Annual Meeting in Las Vegas. The submitted papers fall into seven different categories: Anisotropy, Interpretation, Seismic Modeling, Migration, Multiples, Noise Attenuation, and Seismic Velocity Estimation.

Wednesday June 6	13:30	A. Klokov and S. Fomel	Y025 Diffraction Imaging in the Dip-angle Domain - Viking Graben Case Study (*Case Studies in Seismic Diffraction Imaging & Interpretation*, Auditorium 12)
Wednesday June 6	15:30	X. Song and S. Fomel	P215 Lowrank Finite-differences and Lowrank Fourier Finite-differences for Seismic Wave Extrapolation (*Seismic Modelling I - Recursive Methods*, Posterbox 6)
Thursday June 7	14:20	X. Song and T. Alkhalifah	P353 Modeling of Pseudo-acoustic P-waves in Orthorhombic Media with Lowrank Approximation (*Wavefield Modeling III*, Posterbox 8)
Friday June 8	12:40	S. Fomel	Madagascar Software Package Six Years Later (Workshop 16, *Open-source E+P Software - Six Years Later*)
Friday June 8	13:05	K. Schleicher	Open Data Library with Open Software Scripts (Workshop 16, *Open-source E+P Software - Six Years Later*)