Welcome to the 26th *TCCS Newsletter*!

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

Presentations at IMAGE 2023

TCCS members will make several presentations at IMAGE 2023 in Houston. The presentations fall into several subject areas: Acquisition, Borehole, Full-Waveform Inversion, Machine Learning and Data Analytics, Seismic Processing, and Seismic Modeling and Theory.

August 29	1:20–1:45	Denoise and Deblend (SP P3)	S. Fomel	Plane-wave destruction beyond aliasing
	1:45–2:10	Denoise and Deblend (SP P3)	S. Fomel	Revisiting stacking
	1:45–2:10	Geomechanics and Geophysics (BH 3)	H. Corzo-Pola, S. Saleh and S. Fomel	Near-optimal well-log correlation sequences using reinforcement learning
	2:35–3:00	Theoretical Developments in Seismic Modeling and Wave Phenomena 3 (SMT 3)	S. Fomel	Autoregressive shaping regularization
August 30	8:00–8:25	Low Carbon Solution (MLDA 5)	R. Gao, S. Fomel and Y. Chen	CO_2 sequestration reservoir distribution evaluation with 4D seismic data
	8:50–9:15	Cycle Skipping (FWI 3)	T. Masthay and B. Engquist	Optimal transport for elastic source inversion
	1:20–1:45	Machine Learning for Wellbore Applications (BH P2)	J. Lee, Y. Chen, R. Dommisse, A. Savvaidis, and D. Huang	Predicting S-wave sonic logs using machine learning with conventional logs for the Delaware Basin, Texas
August 31	2:35–3:00	Compressive Sensing and Novel Methods (ACQ 4)	R. Abma and S. Fomel	Extracting amplitudes lower than the natural receiver sensitivity

Fall Meeting

The Fall 2023 Research Meeting of the Texas Consortium for Computational Seismology will take place in Austin on November 16–17. Hosted by the Bureau of Economic Geology, it will be held at The University of Texas at Austin, J.J. Pickle Research campus.

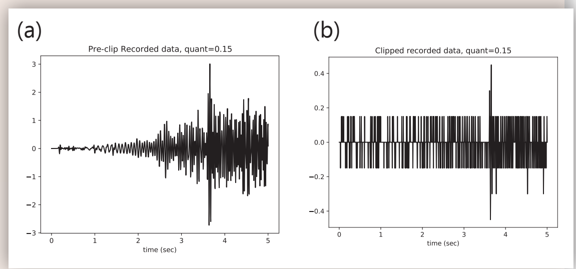
Representatives of participating companies are invited to register for the meeting by following the link at http://tccs.beg.utexas.edu.

EAGE Hackathon

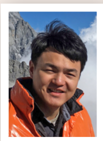
In June 2023, **Sergey Fomel** participated in the natural language processing hackathon at the European Association of Geoscientists and Engineers (EAGE) 84th annual meeting. He teamed up with Steven Braun from Chevron, and their team won the Audience Choice Award. The team developed code that used the ChatGPT API to automatically extract keywords, produce summaries for almost 900 EAGE extended abstracts, and perform clustering data analysis based on the extracted keywords. The EAGE AI Committee organized the hackathon with AkerBP, Dell, Equinor, NVIDIA, and SLB sponsorship.

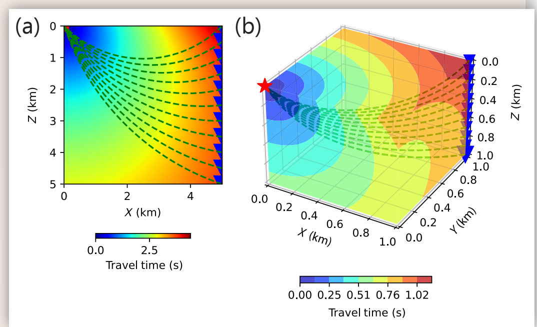
TCCS Sponsors

TCCS appreciates the support of its 2023 sponsors: Aramco, BP, Chevron, ConocoPhillips, ExxonMobil, Petrobras, PetroChina, Sinopec, and TGS.

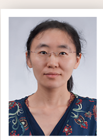


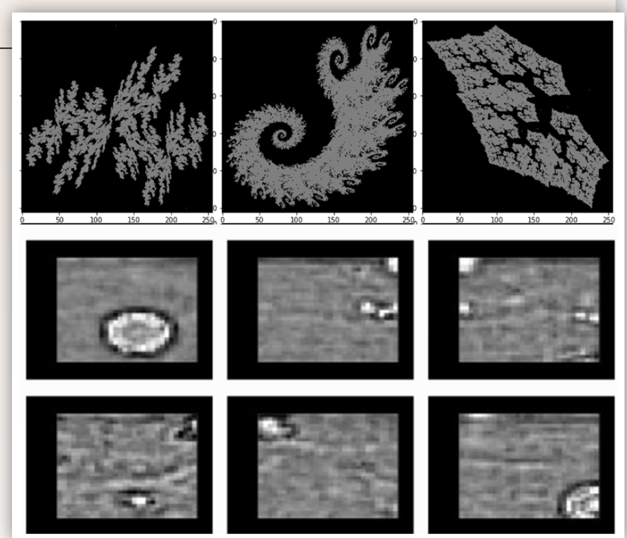
Raymond Abma has been working on extracting faint signals from detectors that would not naturally record such data. This idea was inspired by sign-bit seismic acquisition and has been extended to conventional seismic recording. Weaker signals disrupt stronger signals, and this disruption can be detected when using sources with longer time frames. Figure a shows a simulation of a strong source, while Figure b has a weak source that barely excites the detector. Correlating with a source with a long time extent and repeating the sources can produce results identical to those using a stronger source. While this has obvious applications to seismic exploration, these ideas were inspired by attempts to detect gravitational waves.



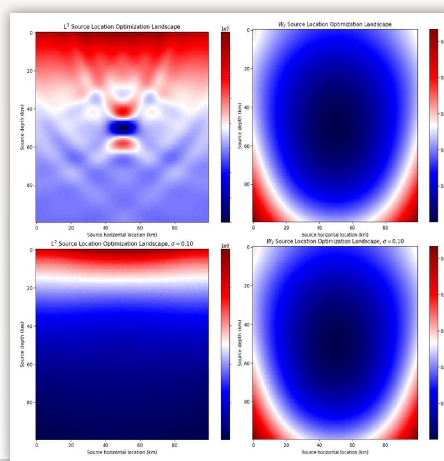


Yangkang Chen has developed a multifunctional open-source package called Pyekfmm for eikonal-based travel-time calculation in 2D and 3D heterogeneous anisotropic media based on the well-documented fast marching method. Unlike previous travel-time calculation packages, Pyekfmm offers a seamless compilation of the backbone C programs in the Python environment through a state-of-the-art pip installation. As a result, users can use the Pyekfmm package for different scientific purposes with the convenience of Python interfaces and the efficiency offered by C programs. Importantly, Pyekfmm allows travel-time calculation in anisotropic media, enabling its exclusive applications in special cases with strong anisotropy.





Rebecca Gao utilizes fractal decomposition and deep learning to enhance geologic structure characterization from seismic images. The process comprises five steps: (1) preprocessing seismic images to accentuate geologic structures; (2) generating fractal images using Iterated Function Systems and labeling them with generating vectors; (3) applying fractal decomposition with wavelet-based multi-scale analysis to extract patterns; (4) developing a modified ResNet-based architecture to recognize geologic structures in decomposed images, training, and validating on a labeled natural image dataset; and (5) fine-tuning the model on labeled seismic datasets with delineated structures of interest. This approach capitalizes on the self-similar nature of fractals to capture complex patterns and improves geologic structure recognition accuracy and efficiency from seismic images.



Tyler Masthay has been working on applying optimal transport to elastic full-waveform inversion for source inversion. The Wasserstein-2 metric (W^2) is attractive for full-waveform inversion due to its (a) convexity with respect to shifts and dilations and (b) its noise insensitivity. The figure demonstrates (a) and (b) through comparison of optimization landscapes for W^2 and L^2 misfits as functions of source location for a homogeneous medium. The plots show the misfit between seismograms of a forward simulation at a given location and a reference location of (50 km, 50 km), where we expect a global minimum. As follows from comparing the left and right columns, the W^2 landscape is markedly more convex than the L^2 landscape, demonstrating (a). Comparing the top and bottom rows, we see that L^2 is sensitive to Gaussian additive noise; the global minimum is no longer captured. However, the W^2 landscape remains stable under the additive Gaussian noise, underscoring the noise insensitivity property (b).

Papers Accepted and Published 2022–2023

http://tccs.beg.utexas.edu/publications

Accepted

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N. Pham and S. Fomel, 2023, Seismic data augmentation for automatic fault picking using deep learning: Geophysical Prospecting, accepted.

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TCCS Staff

The TCCS group consists of researchers from seven different countries (China, Ghana, India, Mexico, Russia, Sweden and USA). Our research staff includes two principal investigators, research scientists, and students:

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

Raymond Abma (Visiting Scientist)
Yangkang Chen (Research Scientist)
Hector Corzo Pola (Ph.D. 1st year)
Björn Engquist (PI)
Rebecca Gao (Ph.D. 4th year)
Rui Gong (Ph.D. 1st year)
Sergey Fomel (PI)
Tyler Masthay (Ph.D. 7th year)
Shirley Mensah (Ph.D. 1st year)
Akshika Rohatgi (Ph.D. 1st year)
Yiran Shen (Ph.D. 7th year)
Sujith Swaminadhan (Ph.D. 1st year)

20th anniversary of Madagascar and the Madagascar School in Mexico

Sergey Fomel started the Madagascar Open-Source Software Project at UT Austin in 2003 with support from multiple collaborators. The project became public in 2006 with beta-version 0.9. In version 4.0, Madagascar remains popular worldwide as a powerful tool for multidimensional data analysis and reproducible computational experiments. In the tradition of annual schools and workshops, the next Madagascar workshop will take place at the Annual Meeting of the Mexican Geophysical Union (RAUGM) in Puerto Vallarta, Mexico, Oct. 29–Nov. 3, 2023. Participants will receive an overview of the software fundamentals, guidance on processing seismic data using Madagascar, and instructions on seamlessly integrating Madagascar and LaTeX to publish their research.

MADAGASCAR

50th anniversary of the Oden Institute

The Oden Institute for Computational Engineering and Sciences will celebrate 50 years of interdisciplinary research and education leadership with a full-day symposium. The symposium will be held at UT Austin's Main Campus on September 21, 2023. For more information, visit https://oden.utexas.edu/50th-anniversary/

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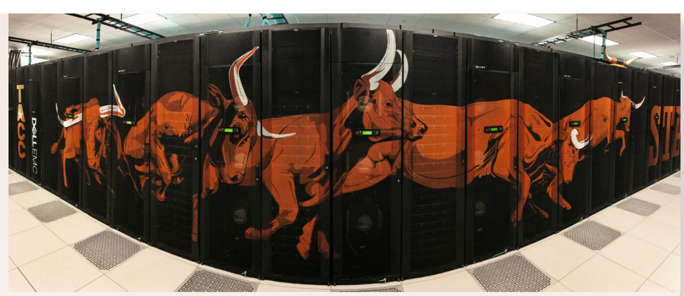
Stampede3, a new supercomputer at TACC



The Texas Advanced Computing Center (TACC) recently announced Stampede3, a new powerful supercomputer enabling ground-breaking open science research projects. Made possible by a $10 million award for computer hardware from the NSF, the new system will be delivered in Fall 2023 and will go into production in early 2024. Stampede3 will provide a new 4-petaflop capability for high-end simulation and a new graphics processing unit/AI subsystem for AI/ML and other GPU-friendly applications for the total of 1,858 computer nodes with more than 140,000 cores, more than 330 terabytes of RAM, 13 petabytes of new storage, and almost 10 petaflops of peak capability.

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