Welcome to the 22nd TCCS Newsletter!
The Texas Consortium for Computational Seismology is a joint initiative of the Bureau of Economic Geology and the Oden Institute for Computational Engineering and Sciences 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.

Hope to See You in Houston
TCCS has submitted nine expanded abstracts to the 2022 IMAGE meeting in Houston. The submitted papers fall into different subject areas: machine learning and advanced data analytics, inversion algorithms, borehole geophysics and geomechanics, seismic data processing, and seismic theory.

Spring 2022 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 and research scientists at the Jackson School. The event is sponsored by ConocoPhillips.

In 2022, Reem Alomar won the second prize among undergraduate students for her presentation "Noise Attenuation by Least-Squares Non-Stationary Triangle Smoothing."

Professional Award
Sergey Fomel is being awarded by SEG with an honorary membership. Such membership is "conferred upon persons who, by unanimous vote of the Honors and Awards Committee and the Board of Directors, have made distinguished contributions, which warrants exceptional recognition, to exploration geophysics or a related field or to the advancement of the profession of exploration geophysics through service to the Society."

TCCS Sponsors
TCCS appreciates the support of its 2022 sponsors: BP, Chevron, ConocoPhillips, Equinor, ExxonMobil, Petrobras, PetroChina, Saudi Aramco, Sinopec, Shell, and TGS.

TCCS will deliver the Spring 2022 report individually to each sponsoring company in online meetings, starting from April 15.

The regular in-person meetings will resume in fall 2022 with a meeting in Austin.

New Member
We welcome PetroChina as a new member of the consortium!
**Tyler Masthay** has been working on the application of optimal transport to elastic full-waveform inversion for source detection. The Wasserstein-2 metric, a form of optimal transport metric, is attractive for full-waveform inversion due to its convexity with respect to shifts and dilations. This property does not hold for the $L_2$ misfit. Pictured here is a comparison of the Wasserstein-2 and $L_2$ differences between a reference waveform and a shifted version of that waveform. The horizontal axis shows the P-wave shift and the vertical axis the S-wave shift. In this example, we see a nonconvex $L_2$ landscape and a convex Wasserstein-2 landscape, showing the potential of Wasserstein-2 for mitigating cycle skipping.

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**Nam Pham** has been working on generating seismic images with corresponding fault labels using generative adversarial networking (GAN). The method has two steps: generating fault systems and generating seismic images with faults as a condition. The model generating seismic images also learns characteristics of seismic images with an encoder. During inference, it takes the field seismic data as an input and generates seismic images that have characteristics of training images and field data. The proposed method can be used to augment the training data for a neural network to pick faults in seismic images. (a) Generated fault systems. (b) Generated seismic images using shallow sections of field data as style. (c) Generated seismic images using deep sections of field data as style.

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**Reem Alomar** has been working on a fast and accurate method to estimate the nonstationary triangle smoothing radius for matching seismic data sets. The analytical derivative of the smoothing operator is used to compute the gradient for inversion in an iterative Gauss-Newton approach. The figure shows an application of the proposed method to implement nonstationary triangle smoothing as a low-cost edge-preserving filter. A time horizon with added random noise is displayed in (a). The result of applying a nonstationary triangle filter defined by nonstationary radius values in (b) is displayed in (c).

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**Yangkang Chen** has been working on an efficient real-time microseismic source localization method based on machine learning. The manually or automatically picked arrival-time differences between different stations and a reference station after a microseismic event and the actual station locations are fed into the well-trained model for a fast and accurate location prediction. The proposed method is efficient enough to be widely applied for the real-time monitoring of hydraulic fracturing. The figure shows a synthetic test of the new RFloc3D method: (a) Velocity model. (b) Acquisition geometry. (c) Uncertainty analysis result. 100 independent tests are repeated for 200 events to evaluate the uncertainty of the RFloc3D method considering the errors in the velocity model and arrival-time picking.


G. Huang, X. Chen, O. Saad, and Y. Chen, S. Fomel, A. Savvaidis, and Y. Chen, 2022, High-resolution and robust microseismic grouped imaging and grouping strategy analysis: Geophysical Prospecting, accepted.


S. Zu, H. Cao, S. Fomel, and Y. Chen, 2022, Robust local slope estimation by deep learning: Geophysical Prospecting, accepted.


N. Pham and S. Fomel, 2021, Uncertainty and interpretability analysis of encoder-decoder architecture for channel detection: Geophysics, v. 86, O49–O58.


The TCCS group consists of people from five countries. Our research staff includes two principal investigators, seven Ph.D. students, one M.S. student, one undergraduate student, and two visiting scientists:

Raymond Abma (Visiting Scientist)
Reem Alomar (B.S., 4th year)
Yangkang Chen (Research Scientist)
Héctor Corzo Pola (M.S., 2nd year)
Björn Engquist (PI)

Sergey Fomel (PI)
Rebecca Gao (Ph.D., 2nd year)
Zhicheng Geng (Ph.D., 5th year)
Ben Gremillion (Ph.D., 3rd year)
Mike Jervis (Visiting Scientist)

Harpreet Kaur (Ph.D., 5th year)
Tyler Masthay (Ph.D. 5th year)
Nam Pham (Ph.D., 3rd year)
Yiran Shen (Ph.D., 5th year)

For more information, see http://www.beg.utexas.edu/tccs/staff.
Joining TCCS and pursuing a Ph.D. under the guidance of Professor Fomel has been one of the best decisions of my life. Having moved to the States with many expectations, I was highly impressed with the unique research environment that TCCS offers. The multidisciplinary domain of TCCS that encourages collaboration between researchers from geoscience, computational science, and mathematics was not only resourceful but even helped me grow as a geoscientist. It was particularly uplifting for a newcomer to amalgamate into this wonderful group that cherishes integrity, curiosity, creativity, and fosters independent thinking amongst its researchers. Professor Fomel always encouraged me to work on challenging research problems and learn from the experts in different fields. Through these experiences, I gained valuable insights into the intricate details of different projects. The close industrial collaborations at TACC also proved vital in my quest to better understand the impact of my research projects. The unparalleled computational resources at TACC empowered me to efficiently scale up the ideas. I feel fortunate to be a part of TCCS and I believe that the experiences that I gained during my time here will remain as a learning curve that I wish to pursue and associate with even after the end of my term.

Zhicheng Geng
It was the best decision in my life to join TCCS, and I will never regret it. Dr. Fomel is a perfect supervisor, collaborator, and researcher. He makes significant contributions to the geophysics community through Madagascar, in which you can find the spirit of reproducibility and brilliant ideas everywhere. I will continue to benefit in my future career from what I learned from him during the past five years. Being part of TCCS, I am fortunate enough to work with colleagues who are so creative, productive, and talented. We together create an encouraging, motivating, and collaborative research environment, which builds the foundation of TCCS’s success.