Welcome to the twentieth *TCCS Newsletter*!

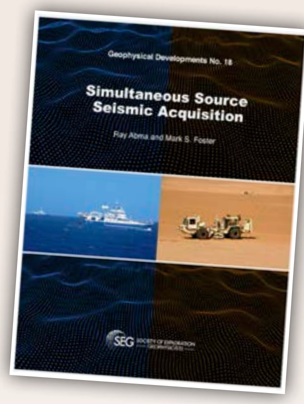
The Texas Consortium for Computational Seismology is a joint initiative of the Bureau of Economic Geology (BEG) and the Oden Institute for Computational Engineering and Science at The University of Texas at Austin. Its mission is to address the most important and challenging research problems in computational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

Hope to See You in Denver

TCCS has submitted 7 expanded abstracts to the **2020 SEG Annual Meeting in Houston**. The submitted papers fall into 4 different subject areas: Machine Learning and Data Analytics: Theory and Special Applications, Acquisition and Survey Design, Seismic Velocity Estimation, and Seismic Processing: Multiples, Noise and Regularization.

SEG21 DENVER, CO 26 SEP–1 OCT 2021 INTERNATIONAL EXHIBITION 91ST ANNUAL MEETING

New Book



The book *Simultaneous Source Seismic Acquisition*, by Ray Abma and Mark S. Foster, is published by Society of Exploration Geophysicists (SEG) and is available on the SEG website.

This book is a practical guide to acquiring and processing simultaneous source seismic surveys. This book covers land and marine simultaneous source acquisition, deblending, and upcoming technologies. Appendixes include checklists, deblending codes, and a description of things that can go wrong and how to fix them.

New Members

We welcome TGS and Equinor as new members of the consortium!

Equinor becomes a Gold Sponsor of TCCS by supporting the project "Using deep learning to accelerate time-lapse seismic data inversion workflow for reservoir parameter estimation in carbon dioxide sequestration studies" as a fellowship for Harpreet Kaur.

TCCS Sponsors

TCCS appreciates the support of its 2021 sponsors: BP, Chevron, ConocoPhillips, Equinor, Saudi Aramco, Sinopec, Shell, and TGS.

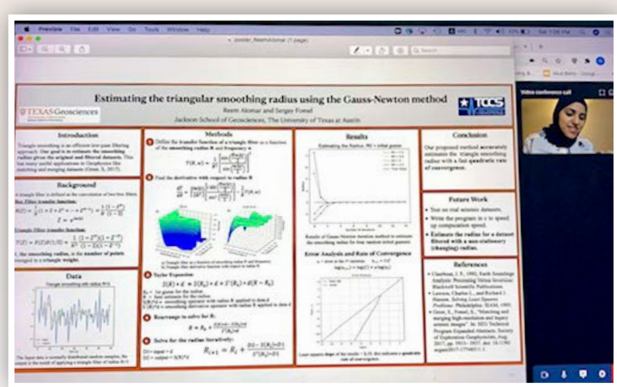
Madagascar Online Conference

On **June 21–27, 2021**, the Madagascar open-source project is planning its first-ever Worldwide Online Conference. The conference registration is open on the Madagascar website.

Spring 2021 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 students, faculty, and research scientists at the Jackson School. The event is sponsored by ConocoPhillips.

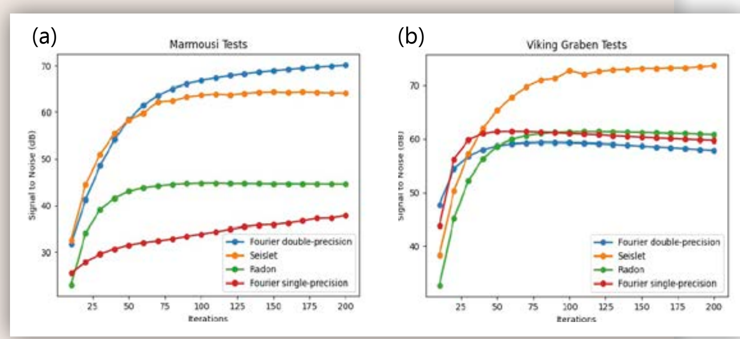
In 2021, Reem Alomar won the second prize among undergraduate students for her presentation "Estimating the triangular smoothing radius using the Gauss-Newton method."



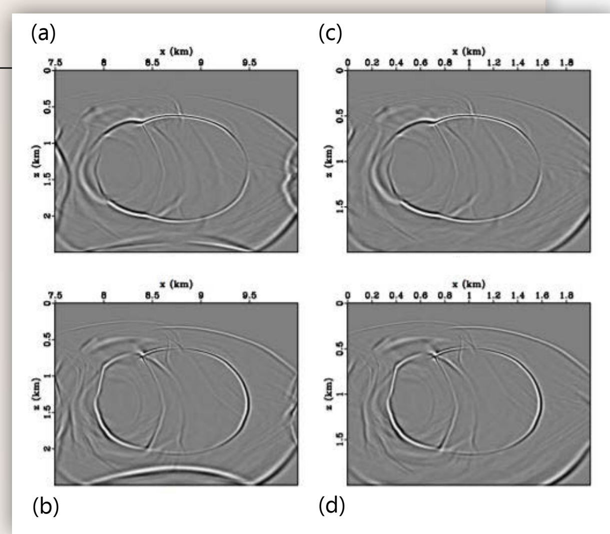
Reem Alomar with her poster "Estimating the triangular smoothing radius using the Gauss-Newton method."

Research Highlights

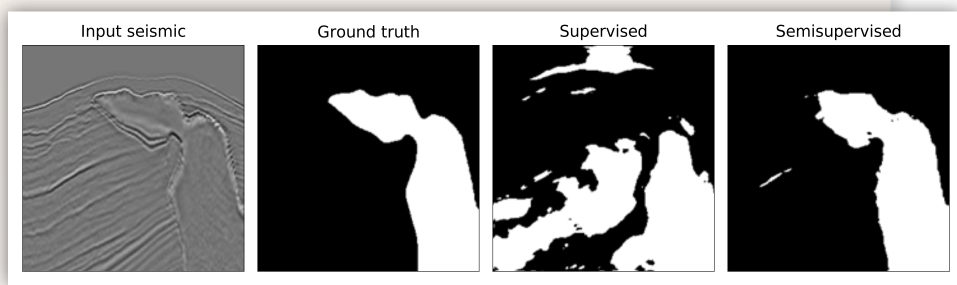
Raymond Abma has been working on comparing the deblending quality produced by various transforms used in the deblending algorithms. It appears that the seislet transform does well on the real data from the Viking Graben, while both the Fourier transforms and seislet transforms do well on the Marmousi synthetic data. The reasons for the differences in the separation quality on the different data sets and on the different transforms are not clear yet. The seislet transform needs more iterations on the real Viking Graben data than on the synthetic Marmousi data.



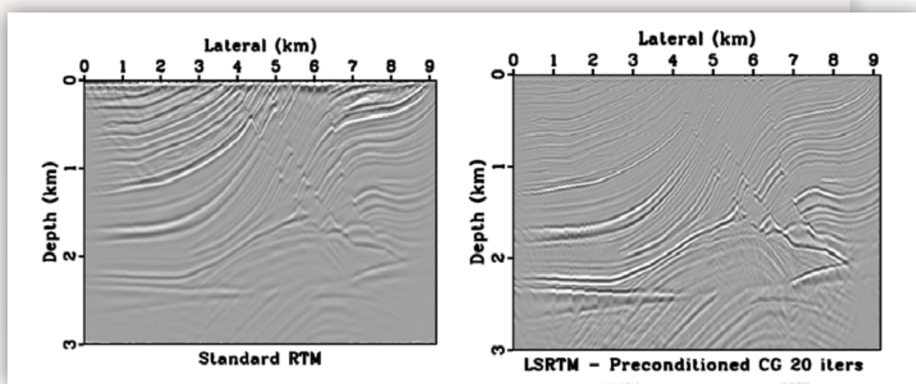
Harpreet Kaur has been working on implementing a deep learning framework to simulate the effect of boundary conditions for wave propagation in anisotropic media. The network is trained using a few shot locations and time slices, enabling the network to learn how to remove boundary reflections and simulate wave propagation for unbounded media. The proposed approach overcomes the challenges associated with stability of conventional implementation of boundary conditions for strongly anisotropic media, especially in the case of tilted transverse isotropic media. The figure shows one of the test slices with horizontal and vertical components of the seismic wavefield: (a) and (b) with boundary reflections, (c) and (d) reflections from boundaries removed using the proposed method.



Zhicheng Geng has been working on a semisupervised deep learning method for salt segmentation, which requires only a small amount of labeled data. The proposed method adopts the mean teacher method and combines the supervised loss with an unsupervised consistent loss to encourage consistent predictions from the network when the input image is augmented differently. We train and validate our novel semisupervised method on both synthetic and real data sets. Figure shows the segmentation results from both supervised and semisupervised methods on the SEAM salt data set.



Tharit Tangkijwanichakul has been working on the inverse Hessian estimation to accelerate least-squares reverse time migration (LSRTM). The method he is studying is called the Chain of Operators and is based on the hypothesis that the complex operator (inverse Hessian) can be approximated through the chain of weights in time/space and frequency domain. Tests on synthetic data show that when used as a preconditioner, the approximated inverse Hessian accelerates the convergence of LSRTM, improves amplitude balancing, and yields a high-resolution image.



Papers Accepted and Published 2020–2021

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

Accepted

Y. Chen and S. Fomel, 2021, Non-stationary local signal-and-noise orthogonalization: Geophysics, accepted.

Y. Chen, S. Fomel, H. Wang, and S. Zu, 2021, 5D de-aliased seismic data interpolation using non-stationary prediction error filter: Geophysics, accepted.

G. Huang, X. Chen, J. Li; O. Saad, Y. Chen, S. Fomel, C. Luo, and H. Wang, 2021, The slope attribute regularized high-resolution prestack seismic inversion: Surveys in Geophysics, accepted.

N. Pham and S. Fomel, 2021, Uncertainty and interpretability analysis of encoder-decoder architecture for channel detection: Geophysics, accepted.

Published 2021

Y. Chen, O. Saad, G. Huang, Y. Chen, A. Savvaidis, S. Fomel, and N. Pham, 2021, SCALODEEP: A highly generalized deep learning framework for real-time earthquake detection: Journal of Geophysical Research–Solid Earth, v. 126, e2020JB021473.

S. Fomel and H. Kaur, 2021, Wave-equation time migration: Geophysics, v. 86, 1JF–V89.

H. Kaur, N. Pham, and S. Fomel, 2021, Seismic data interpolation using deep learning with generative adversarial networks: Geophysical Prospecting, v. 69, 307–326.

Y. Shi, X. Wu, and S. Fomel, 2021, Interactively tracking seismic geobodies with a deep learning flood-filling network: Geophysics, v. 86, A1–A5.

Published 2020

B. Engquist and D. Peterseim, 2020, Computational multiscale methods: Oberwolfach Reports, v. 16, 2099–2181.

B. Engquist, K. Ren, and Y. Yang, 2020, The quadratic Wasserstein metric for inverse data matching: Inverse Problems, v. 36, 055001.

Z. Geng, X. Wu, S. Fomel, and Y. Chen, 2020, Relative time seislet transform: Geophysics, v. 85, V223–V232.

Z. Geng, X. Wu, Y. Shi, and S. Fomel, 2020, Deep learning for relative geologic time and seismic horizons: Geophysics, v. 85, WA87–WA100.

H. Kaur, S. Fomel, and N. Pham, 2020, Seismic ground-roll noise attenuation using deep learning: Geophysical Prospecting, v. 68, 2064–2077.

H. Kaur, N. Pham, and S. Fomel, 2020, Improving resolution of migrated images by approximating the inverse Hessian using deep learning: Geophysics, v. 85, WA173–WA183.

D. Merzlikin, S. Fomel, and X. Wu, 2020, Least-squares diffraction imaging using shaping regularization by anisotropic smoothing: Geophysics, v. 85, S313–S325.

N. Pham, X. Wu, and E. Naeini, 2020, Missing well log prediction using convolutional long short-term memory network: Geophysics, v. 85, WA159–WA171.

Y. Shi, X. Wu, and S. Fomel, 2020, Waveform embedding: automatic horizon picking with unsupervised deep learning: Geophysics, v. 85, WA67–WA76.

Y. Sripanich, S. Fomel, J. Trampert, W. Burnett, and T. Hess, 2020, Probabilistic moveout analysis by time warping: Geophysics, v. 85, U1–U20.

X. Wu, Z. Geng, Y. Shi, N. Pham, S. Fomel, and G. Caumon, 2020, Building realistic structure models to train deep convolutional neural networks for seismic structural interpretation: Geophysics, v. 85, WA27–WA39.

Q. Xu, B. Engquist, M. Solaimanian, and K. Yan, 2020, A new nonlinear viscoelastic model and mathematical solution of solids for improving prediction accuracy: Scientific Reports, v. 10, Article 2202.

TCCS Staff

The TCCS group consists of people from 7 countries. Our research staff includes 2 principal investigators, 7 Ph.D. students, 1 M.S. student, 2 undergraduate students, and 2 visiting scientists:

Raymond Abma (Visiting Scientist)
Reem Alomar (B.S., 3rd year)
Héctor Corzo Pola (M.S., 1st year)
Luke Decker (Ph.D., 5th year)
Björn Engquist (PI)
Sergey Fomel (PI)
Rebecca Gao (Ph.D., 1st year)
Zhicheng Geng (Ph.D., 4th year)
Ben Gremillion (Ph.D., 2nd year)
Mike Jervis (Visiting Scientist)
Harpreet Kaur (Ph.D., 4th year)
Nam Pham (Ph.D., 2nd year)
Yiran Shen (Ph.D., 4th year)
Tharit Tangkijwanichakul (B.S., 4th year)

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

Testimonial

Luke Decker

TCCS was a wonderful place to grow and develop as a researcher. The outstanding faculty the University of Texas has in a plethora of disciplines enabled me to take classes directly related to my research interests. The computing resources provided by TACC empowered me to effectively prototype and scale my ideas. The invaluable mentorship provided by industrial sponsors ensured that my projects were impactful. What is truly unique about TCCS is the collaborative environment Professor Fomel has fostered, which values ingenuity, integrity, creativity, curiosity, and kindness, bringing together brilliant and compassionate people in a setting where ideas have the opportunity to germinate and can be cultivated to blossom.

Ph.D. Dissertations

Name	Year	Title	Current Employer
Luke Decker	2021	Parameter Selection in Seismic Data Analysis Problems	Chevron
Yunzhi Shi	2020	Deep Learning Empowers the Next Generation of Seismic Interpretation	Amazon Web Services
Yunan Yang	2018	Optimal Transport for Seismic Inverse Problems	Cornell University
Dmitrii Merzlikin	2018	Diffraction Imaging by Path-Summation Migration	Schlumberger
Zhiguang Xue	2017	Regularization Strategies for Increasing Efficiency and Robustness of Least-Squares RTM and FWI	CGG
Yanadet Sripanich	2017	Seismic Anisotropy Analysis Using Muir-Dellinger Parameters	PTTEP
Junzhe Sun	2016	Seismic Modeling and Imaging in Complex Media Using Low-Rank Approximation	The University of Texas at Austin
Yangkang Chen	2015	Noise Attenuation in Seismic Data from the Simultaneous-Source Acquisition	Zhejiang University
Parvaneh Karimi	2015	Seismic Interpretation Using Predictive Painting	Occidental Petroleum
Christina Frederick	2014	Numerical Methods for Multiscale Inverse Problems	Georgia Institute of Technology
Vladimir Bashkardin	2014	Phase-Space Imaging of Reflection Seismic Data	BP
Siwei Li	2014	Imaging and Velocity Model Building with Linearized Eikonal Equation and Upwind Finite-Differences	Chevron
Jack Poulson	2012	Fast Parallel Solution of Heterogeneous 3D Time-Harmonic Wave Equations	Hodge Star Scientific Computing
Xiaolei Song	2012	Application of Fourier Finite Differences and Lowrank Approximation Method for Seismic Modeling and Subsalt Imaging	BP
Paul Tsuji	2012	Fast Algorithms for Frequency-Domain Wave Propagation	Lawrence Livermore National Laboratory
William Burnett	2011	Multiazimuth Velocity Analysis Using Velocity-Independent Seismic Imaging	ExxonMobil

M.S. Theses

Ben Gremillion	2019	Seismic Data Interpolation with Shaping Inversion to Zero Offset and Least-Squares Flattening	The University of Texas at Austin
Nam Pham	2019	Automatic Channel Detection Using Deep Learning	The University of Texas at Austin
Sean Bader	2018	Seismic and Well Log Data Integration Using Data-Matching Techniques	EOG
Mason Phillips	2017	Geophysical Data Registration Using Modified Plane-Wave Destruction Filters	DownUnder Geosolutions
Kelly Regimbal	2016	Improving Resolution of NMO Stack Using Shaping Regularization	ExxonMobil
Ryan Swindeman	2015	Iterative Seismic Data Interpolation Using Plane-Wave Shaping	Enthought
Luke Decker	2014	Seismic Diffraction Imaging Methods and Applications	Chevron
Shaunak Ghosh	2013	Multiple Suppression in the t-x-p Domain	CGG
Salah Alhadab	2012	Diffraction Imaging of Sediment Drifts in Canterbury Basin	Saudi Aramco
Yihua Cai	2012	Spectral Recomposition and Multicomponent Seismic Image Registration	Shell

B.S. Honors Theses

Tharit Tangkijwanichakul	2021	Chain of Operators for Inverse Hessian Estimation in Least-Squares Migration	PTTEP
Sarah Greer	2018	A Data Matching Algorithm and Its Applications in Seismic Data Analysis	MIT
Lubna Barghouty	2013	Surface-Related Multiple Elimination and Velocity-Independent Imaging of a 2D Seismic Line from the Viking Graben Dataset	MIT
Yanadet Sripanich	2013	An Efficient Algorithm for Two-Point Seismic Ray Tracing	PTTEP