Welcome to the 32nd *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 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.

Fall Meeting

The Fall 2026 Research Meeting of the Texas Consortium for Computational Seismology will take place in Austin on October 29–30. Hosted by the Bureau of Economic Geology, it will be held at the University of Texas at Austin, J.J. Pickle Research campus.

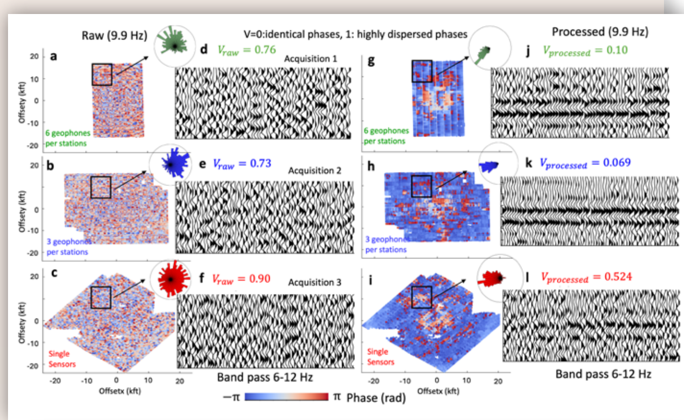
Representatives of participating companies are invited to register for the meeting by following the link at https://tccs.beg.utexas.edu/.

Presentations at IMAGE 2026

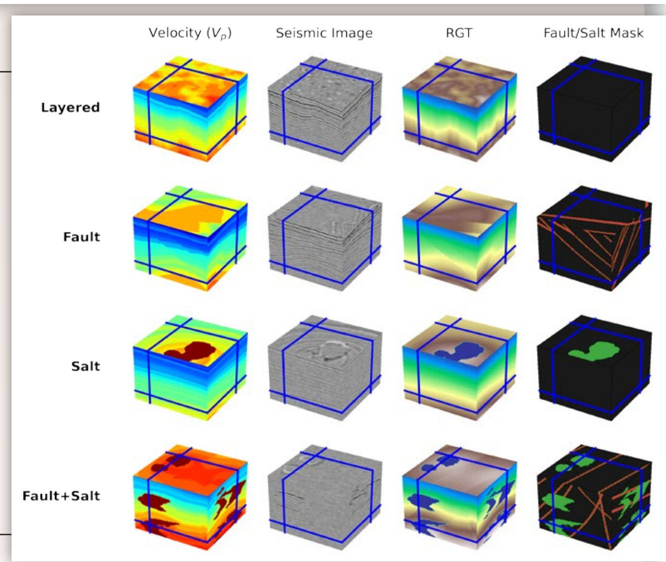
Tuesday, August 18	10:45	FWI 3: Cycle Skipping and Novel Misfit Functions	Y. Shen, B. Engquist	Hybrid Sobolev Misfit for Multi-Parameter Full Waveform Inversion
	10:20	SP P1: Resolution Enhancement, Diffractions and Adaptive Subtraction	C. Li	Adaptive multiple suppression via physics based deep learning prediction
	13:20	ACQ 2: Offshore Acquisition and Monitoring	R. L. Abma	Making simultaneous source data better than single source data
	13:20	EM P1: Machine Learning Methods and Reservoir Surveillance	S. Swaminadhan[1]*, A. Bakulin[1], D. Alumbaugh[2], S. Fomel[1]	Feasibility of crosswell electrical resistivity tomography for monitoring hydrogen storage in the saline sandstone aquifer at the Devine test site, Texas
	13:45	SP 3: Deblending and Simultaneous-Source Separation	C. Li*, Y. Chen	Deep learning matching for direct off-the-time-grid deblending
	15:40	DAS P2: Reservoir Monitoring	A. Titova[1]*, A. Bakulin[1], J. Badger[2]	Prestack reflection response of trenched DAS versus OBN and streamer for the Gulf Coast model
	15:40	DMLA P5: Seismic Interpretation 1	T. Q. Agbaje[1]*, Y. Chen[1], A. Sansal[2], N. Pham[2]	Enhancing seismic fault picking using denoising diffusion probabilistic model (DDPM)-based data augmentation
	16:30	USC 3: Gulf Coast Reservoir Characterization and Stratigraphic Frameworks	O. A. Hezam[1], A. Bakulin[2], A. Titova[2]*, S. Fomel[2]	Broadband ambient seismic noise recorded on a submarine telecom DAS cable along the Texas Gulf Coast: spectral levels and spatial variability
Wednesday, August 19	8:00	ACQ 4: Survey Design and Modeling	A. Bakulin	Rolling Variable-Density Acquisition: A Targeted Solution to the Near-Offset Noise Cone
	8:00	SS 17: Novel Passive Seismic Case Studies	A. Titova[1]*, A. Bakulin[1], S. Gelinsky[2]	Shear-velocity estimation from passive, uncorrelated records of DAS Scholte waves off the Texas coast
	9:15	SP 5: Emerging Technologies: Quality Control and Distributed Acoustic Sensing	A. Bakulin[1]*, I. Silvestrov[2]	Seismic Acquisition and Processing as a Coupled System: A Data-Driven Audit from Prestack Noise to Stack Signal
	10:45	TL 2: Acquisition, Processing and Analysis	A. Bakulin[1]*, I. Silvestrov[2]	Data-driven SNR and repeatability assessment of submarine DAS for monitoring and characterization
	10:20	FWI P1: Deep Learning	S. Swaminadhan*, S. Fomel, C. Li, Y. Chen	Improved deep-learning-matching full waveform inversion on the Viking Graben dataset
	10:20	FWI P2: Diffusion Models	C. Li*, Y. Chen	Geologically guided full waveform inversion via diffusion model based adaptive regularization
	11:35	SP 6: Interpolation, Reconstruction and 4D Regularization	C. Li[1]*, S. Fomel[1], S. Swaminadhan[1], H. Corzo Pola[2], Y. Chen[1]	A physics-informed self-supervised approach to dealiased data reconstruction
	13:20	INT P6: Geohazards and Energy Transition	A. Titova[1]*, A. Bakulin[1], C. N. Schuba[1], I. Silvestrov[2]	Resolving subtle structural relief with ultra-dense 3D seismic for hydrogen storage at the Devine site
	13:20	ACQ 6: Land Seismic Challenges	A. Rohatgi[1]*, A. Bakulin[1], H. Odhwani[2], S. Fomel[1]	Quantifying offset-dependent seismic prestack data quality using data-driven metrics across different acquisition geometries
	14:10	SG 3: Rock Mechanics and Deformation	T. Q. Agbaje*, S. Fomel, Y. Chen	Physics-driven prediction of sub-seismic fracture likelihood from fault-induced stress fields using elastic dislocation modeling
	14:10	SP 7: Tomography and Full-Waveform Inversion	C. Li*, Y. Chen	Eikonal equation based traveltime tomography using direct smoothness regularization
	15:40	ACQ P5: Case Study	A. Titova[1]*, A. Bakulin[1], I. Silvestrov[2]	Optimal migration aperture for compact ultra-dense land surveys: Insights from field data
	15:40	ACQ P2: Land Seismic Methods	R. L. Abma	Applications of geophysical exploration methods to gravitational wave detection
	15:40	DMLA P10: Seismic Interpretation 2	S. T. Mensah*, S. Fomel	StrataFlux: A Local, Invertible Attribute for Relative Geologic Time Estimation from Seismic Data
Thursday, August 20	8:00	INT 5: Interpretation Methods	C. Li[1]*, S. Fomel[1], M. Zhang[2], Y. Chen[1]	Accelerated high-resolution local slope estimation based on automatic differentiation
	10:20	SP 10: Bandwidth Enhancement, including Q Compensation	A. Rohatgi[1]*, A. Bakulin[1], A. Peterson[2], S. Fomel[1]	Reducing phase variability in prestack seismic using circular-statistics based phase masking
	11:10	SP 10: Bandwidth Enhancement, including Q Compensation	A. Rohatgi*, A. Bakulin, S. Fomel	Diagnosing seismic prestack processing efficiency and bandwidth through frequency-dependent phase stability
	10:20	FWI P8: Elastic and Imaging	C. Li*, Y. Chen	Robust elastic full wave inversion regularized by dynamic deep learning matching
	11:35	S. Swaminadhan*, A. Bakulin, S. Fomel, Y. Chen	S. Swaminadhan*, A. Bakulin, S. Fomel, Y. Chen	Scalable surface wave inversion using physics-guided variational autoencoders
	11:35	DAS 2: Surface and Multicomponent	A. Bakulin[1]*, A. Titova[1], S. Fomel[1], S. Mao[1], I. Silvestrov[2]	Passive seismic observations on a 65-km telecommunication DAS cable in shallow waters along the Texas Gulf Coast
	15:10	AAS 8: Amplitude Versus Offset Inversion	C. Li*, H. Tang	Structural guided prestack AVA inversion with a learned diffusion regularization
	16:25	AAS 8: Amplitude Versus Offset Inversion	S. Gao*, S. Fomel, Y. Chen	Structure-Aware Deep Learning for AVO Inversion
Friday, August 21	8:35	W-15: Seismic Signal Processing in the AI Era: Integration or Replacement?	A. Rohatgi	Interpretable Phase Attributes for Hybrid DSP-AI Seismic Workflows
	10:15	W-1: 4D FWI for Reservoir Monitoring	Y. Shen	Diffusion-Guided Full Waveform Inversion: Generative Priors for Seismic Imaging and Time-Lapse Monitoring
	10:30	W-7: Combined Active and Passive Seismic Monitoring of Subsurface Processes	A. Titova	Combined Active and Passive Monitoring Using Offshore Telecom DAS: Insights from Ocean Waves, Scholte Waves, and Teleseismic Events
	13:30	W-4: Applying lessons learned from Oil & Gas Geophysics to Energy Transition Challenges	Q. Ji	Extending Interferometric Monitoring from Broadband Networks to DAS: Early Lessons and Emerging Opportunities
	15:30	W-14: Optical fibers: What is next? Acquisition, Data, and Products	A. Bakulin	From Telecom Cables to Redeployable Arrays: Emerging Fiber-Optic Sensing Concepts for Imaging, Monitoring, and Environmental Intelligence

Research Highlights

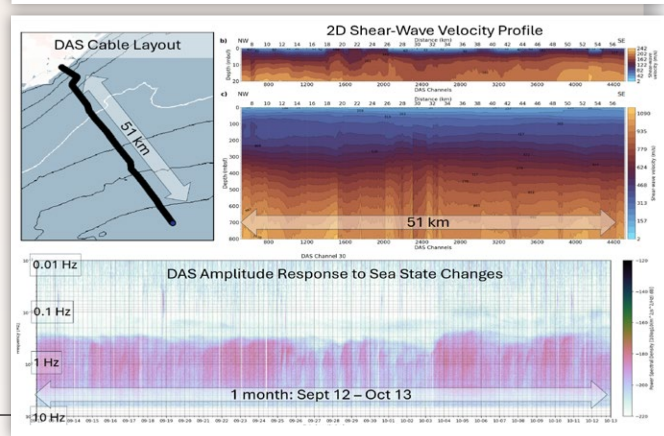
Akshika Rohatgi proposes quantifying and reducing phase variability in seismic data, with an emphasis on understanding how near-surface scattering and acquisition geometry introduce phase perturbations and reduce seismic coherence. She uses circular phase statistics to characterize the distribution and variability of seismic phase within local neighborhoods and to develop phase variance as a quantitative seismic quality-control attribute. As illustrated here, different acquisition configurations exhibit varying levels of phase variability, and different processing techniques can substantially improve phase coherence. This framework provides a way not only to evaluate seismic data quality but also to measure processing effectiveness and to understand the impact of acquisition design and near-surface effects on seismic phase.

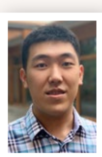


Sujith Swaminadhan is developing GeoFWI3D, a benchmark dataset of structurally diverse 3D velocity models to advance deep-learning-assisted full-waveform inversion (FWI). The project examines practical challenges in 3D FWI, including computational cost, cycle skipping, sensitivity to initial models, and convergence to local minima. Using geologically plausible models, Sujith has evaluated optimization algorithms, objective functions, and computational trade-offs that influence inversion quality. GeoFWI3D will support research on machine-learning methods for model initialization, surrogate modeling, and direct velocity estimation. The goal is to enable reproducible evaluation of hybrid workflows that combine data-driven predictions with physics-based refinement in realistic, complex geological settings.

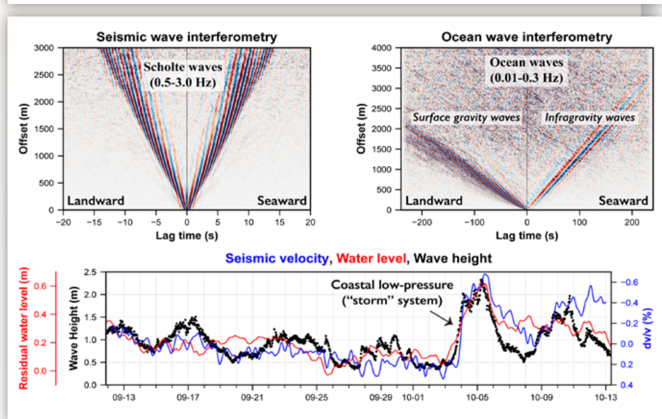


Anna Titova has been developing a broadband, multi-aperture Scholte-wave imaging workflow that integrates passive seismic and ocean-wave phenomena from raw DAS records to estimate the shear-wave velocity of shallow-water marine sediments. The workflow yields a pseudo-2D shear-wave velocity model extending horizontally from the shore to 51 km offshore across the Texas shelf and vertically from near the seafloor to approximately 2 km depth. The model shows broad, shallow, low-velocity anomalies consistent with softer incised-valley fill within stiffer Pleistocene deposits. Anna's ongoing work focuses on monitoring marine sediment properties using passive seismic attributes extracted from ambient noise via amplitude-preserving processing.





Qing Ji is developing ambient-noise interferometry workflow for Distris developing an ambient-noise interferometry workflow for Distributed Acoustic Sensing (DAS) data to monitor changes in seismic wave speed over time. Interferometry extracts coherent wave signals from continuous ambient noise to produce virtual-source gathers suitable for inversion. In addition to seismic Scholte waves, the persistent imprints of ocean waves recorded by the seabed fiber cable deployed along the shallow-water Gulf Coast also enable retrieval of virtual-source gathers of ocean waves. During the recording period, a coastal low-pressure system ("storm") induced a sudden drop in seismic wave speed (dv/v), as observed through phase changes in time-lapse gathers. The estimated dv/v aligns with increased ocean wave heights and water levels, prompting further investigation into coupling between shallow water and seabed sediments.



Papers Accepted and Published 2025–2026

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

Published 2026

A. Bakulin, A. Titova, I. Silverstrov, and J. Badger, Sub-Wavelength Seabed Stiffness Control of Seismic Amplitude Modulation in Seafloor DAS: Geophysical Research Letters, 53, e2025GL121434.

S. Gao, S. Fomel, and Y. Chen, 2026, Automated CO2 plume detection from time-lapse seismic using local orthogonalization and deep learning: The Leading Edge, 45, 304–314.

E. Landa and S. Fomel, 2026, Time Reversal Full Wavefield Inversion: From waveform misfit to wavefield focus: Geophysical Prospecting, v. 74, e70237.

C. Li, Y. Shen, S. Fomel. U. Waheed, A. Savvaidis, Y. Chen, 2026, GeoFWI: A large velocity model dataset for benchmarking fu-waveform inversion using deep learning: Journal of Geophysical Research–Machine Learning and Computation, e2025JH001037.

C. Li, S. Fomel, and Y. Chen, 2026, DLM-FWI: Deep learning matching filtering for full waveform inversion: Geophysical Journal International, v. 245, ggag019.

A. Rohatgi, A. Bakulin, and S. Fomel, 2026, Amplitude-invariant phase masking for coherence recovery in scattered wavefields: Journal of the Acoustical Society of America Express Letters, 6, 074801.

Published 2025

A. Bakulin, I. Silvestrov, R. Smith, and P Golikov, 2025, Smart DAS uphole acquisition system: bridging the gap between surface seismic and borehole geophysics for imaging and monitoring in complex near-surface environments, Geophysical Monograph Series, v 289, 109–131.

A. Bakulin, S. Swaminadhan, R. Burnstad, J. Badger, M. Shuster, M. Delshad, and M.Hotan, 2025, Engineering 4D seismic monitoring: A data-driven blueprint from the Devine hydrogen test site, The Leading Edge; 44 (10), 778–790.

S. Gao, S. Fomel, and Y. Chen, 2025, Improving fluid-induced time-lapse seismic monitoring using local orthogonalization: Geophysics, v. 90, N33–N45.

C. Li, S. Fomel, Y. Chen, R. Dommisse, A. Savvaidis, 2025, FaultVitNet: An vision transformer assisted network for 3D fault segmentation: Journal of Geophysical Research–Machine Learning and Computation, v. 2, e2024JH000488.

C. Li, G. Liu, Z. Wang, Z. Li, S. Fomel, and Y. Chen, 2025, Simultaneous off-the-grid deblending and data reconstruction via unsupervised deep learning: IEEE Transactions on Geoscience and Remote Sensing, v. 63, 5909311.

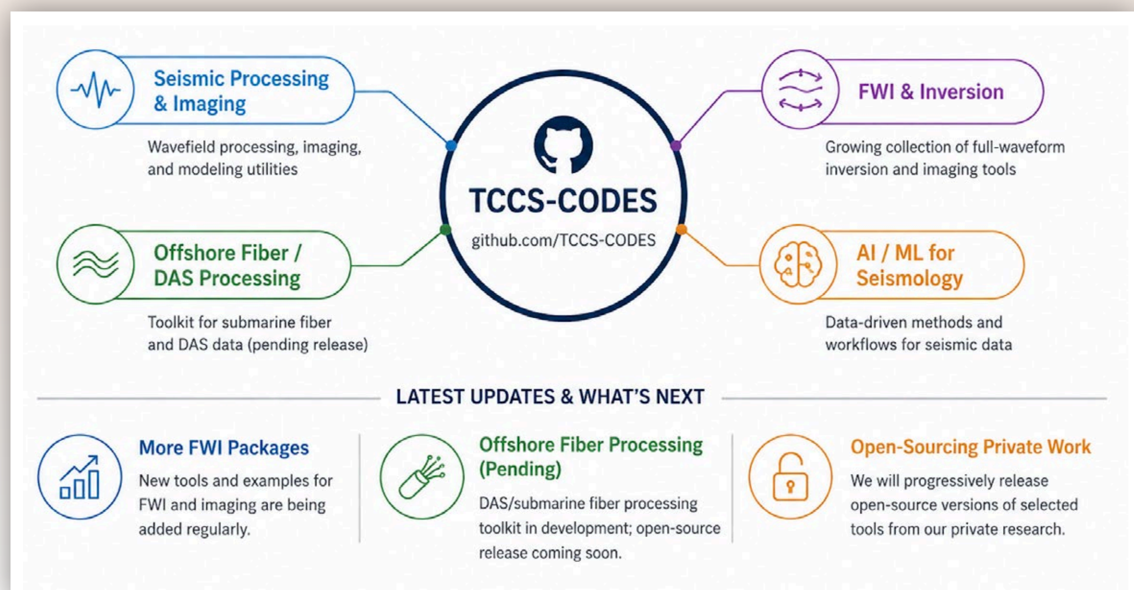
C. Li, G. Liu, L. Yang, S. Fomel, and Y. Chen, 2025, Robust bidirectional Q-compensated denoising for seismic data with adaptive structural regularization: IEEE Transactions on Geoscience and Remote Sensing, v. 63, 5906711.

A.Rohatgi, A. Bakulin, and S. Fomel, 2025, Data-driven analysis of seismic phase using circular statistics: The Leading Edge, v. 44, 683–691.

L. Yang, S. Fomel, S. Wang, W. Li, J. Meng, C. Li, and Y. Chen, 2025, HCTNet: Robust prestack seismic inversion using a hybrid convolutional transformer: Geophysics, v. 90, N17–N32.

TCCS-CODES is Growing

The TCCS-CODES repository is growing into an open-source hub for computational seismology, connecting research innovations with reproducible and reusable software. Recent development has expanded beyond our existing seismic processing and machine-learning tools, with more packages for full-waveform inversion (FWI) and advanced seismic imaging being added. **We are also developing an offshore fiber/DAS processing toolkit**, with an open-source release planned after further testing and documentation. Looking ahead, we plan to progressively release open-source versions of selected tools developed through our private research projects, making mature methods more accessible to the broader geophysics community. Some of the latest additions include **SeismicInterpretation** and **DataAnalysis** (Julia notebooks from Sergey Fomel's courses), **Rohatgi-etal-** (Julia notebooks for Akshika Rohatgi's reproducible papers), **Deblend_ selfsim** (Ray Abma's deblending tools), **FC-DDPM** (Tolulope Agbaje's Fault-Conditioned Denoising Diffusion Probabilistic Models), **DM-FWI**, **DL-AWI**, and **DLM-FWI** (Chao Li's FWI codes), and **SGDS-FWI** (Yiran Shen's Split Gibbs Diffusion Scheme for FWI).



TCCS Staff

The TCCS team includes researchers and students from eight countries, led by four principal investigators and supported by research scientists.

Raymond Abma (Visiting Scientist)
Roy Burnstad (Visiting Scientist)
Tolulope Agbaje (Ph.D. 4th year)
Andrey Bakulin (PI)
Yangkang Chen (PI)
Björn Engquist (PI)
Moses Falowo (Ph.D. 1st year)
Sergey Fomel (PI)
Odai Hezam (M.S. 2nd year)
Qing Ji (Post-doc)
Chao Li (Post-doc)
Shirley Mensah (Ph.D. 4th year)
Akshika Rohatgi (Ph.D. 4th year)
Yiran Shen (Post-doc)
Sujith Swaminadhan (Ph.D. 4th year)
Anna Titova (Post-doc)

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

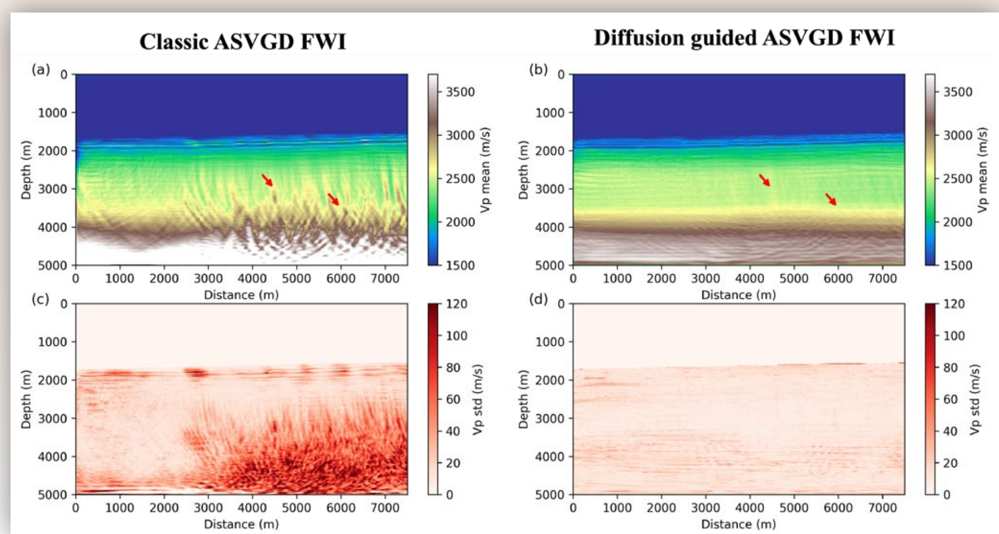

TCCS group members

TCCS Sponsors

TCCS appreciates the support of its 2026 sponsors: Aramco, BP, Chevron, Diamondback Energy, ExxonMobil, Oxy, Shell, and TGS.

Diffusion-Guided ASVGD-FWI

Chao Li has been working on a diffusion-regularized annealed Stein variational gradient descent (ASVGD) framework for Bayesian full waveform inversion. ASVGD uses an ensemble of velocity models to estimate both the subsurface structure and posterior uncertainty, but conventional handcrafted priors often fail to represent complex geology. Our method uses a pretrained diffusion model as an implicit geological regularizer that guides particles toward plausible velocity models while preserving data consistency and ensemble diversity. Numerical results show improved inversion stability, fewer nonphysical artifacts, more realistic mean models, and better-focused uncertainty estimates in complex or poorly constrained regions.



QAf421