TRIP contribution to SEAM

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TRIP contributions to SEAM

1. Provided benchmark modeling software
2. Identified modeling accuracy issues
3. Assisted in vendor qualification QC, spot checks of production run

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IWAVE - public domain 3D acoustic modeling

Initial discovery (2007): no *public domain* modeling code existed with critical features:

- high order FD operators to control grid dispersion on coarse grids
- high efficiency absorbing boundary conditions, optional on all boundaries
- 1D, 2D, 3D
- domain decomposed via MPI, scalable to 1000's of cores
- optional multithread execution
- SEGY trace output
- portable, robust, (moderately) modern software design

Public domain important - benchmark activities must be *transparent* to serve SEAM goals

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IWAVE - public domain 3D acoustic modeling

IWAVE - designed and implemented by Igor Terentyev, with assistance from Tanya Vdovina and WWS (and more recently Xin Wang) with all of these features.

- maximally standard software dependencies - ISO C99, MPI 1, OpenMP
- staggered grid velocity/pressure formulation, 2nd order in time, 2nd - 14th order in space
- implements NPML absorbing BCs, optional on all faces
- implements (original) SEAM source calibration principle for acoustic point source (option): produces prescribed wavelet at prescribed offset in 3D free space with high accuracy
- most details of memory allocation, interprocessor communication *computed*, minimal user interaction with parallelism

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IWAVE - public domain 3D acoustic modeling

- borrows trace i/o code from SU, grid i/o design from RSF/Madagascar
- superior command-line parser
- quasi-object-oriented

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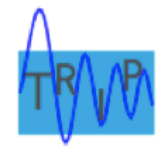
IWAVE - public domain 3D acoustic modeling

Version 1.0 released at SEG Workshop 29 Oct 09



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IWAVE - simulation framework and acoustic simulator

IWAVE is a software framework for construction of regular grid finite difference and finite element methods for time-dependents partial differential equations. It includes utility software for parameter parsing, spatial vectors and constants, and interaction with MPI; i/o methods for regularly gridded data and seismic trace data, sampling operators, definitions of distributed spatial arrays and groupings of arrays defining discretized models, and initialization and destruction functions for all of these data structures.

Along with IWAVE comes a complete application, a solver for variable density acoustic wave propagation in 1, 2 or 3 spatial dimensions. This application outputs pressure traces at specified sample rates and geometry, and/or movie frames of pressure. The code uses staggered grid finite difference schemes of order 2 in time and 2k in space, k=1,...,7, derived from pressure-velocity form of acoustodynamics. Either pressure-free (reflecting) or absorbing (PML) boundary conditions may be specified on boundary faces of the simulation hypercube. The code may be used in either serial or parallel mode (the latter via domain decomposition and MPI).

Authors: Igor S. Terentyev, Tetytana Vdovina, William W. Symes, Xin Wang

See here for use instructions for the acoustic application, and documentation for parts of IWAVE (will become more complete in the coming months)

See here for download info, and here for installation instructions

See release notes for log information on the current and prior releases.

Construction of IWAVE was supported in part by the Society of Exploration Geophysicists through its SEG Advanced Modeling (SEAM) project, and by the sponsors of The Rice Inversion Project.

--- WWS, October 09

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IWAVE - public domain 3D acoustic modeling

Ongoing development:

- Version 1.1 in prep: completed documentation, more source options, movie output, various bug fixes
- IWAVE is a *framework* - modular software production environment. Xin: creating a user interface for stencil specification - controls all memory allocation, communication setup (next talk)
- additional packages in preparation: nonstaggered const density AWE (Igor), various schemes for elasticity (Xin)
- designed to conform (loosely) to TSOpt timestepping simulator structure (Marco), enabled C++ wrapper design to form foundation of waveform inversion package (Dong)

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Intrinsic limitations on FD accuracy

D. Brown 1984: regular grid finite difference methods are all 1st order accurate, regardless of formal truncation order

In fact, 1st order error = large. Analyzed, documented in various reports in this volume (WWS & Vdovina 09, SEG abstracts). Character of error - time shift. Discrete wave does not "know" location within grid cell - unimportant for slowly varying models, dominates error for models with discontinuities (eg. SEAM GoM subsalt).

Upscaling issue - need to incorporate subgrid info. Understand this for nonstaggered CD AWE (Igor), but still research topic for VD AWE & more general wave problems (Tommy, Xin)

Upshot: original accuracy requirements for SEAM vendors (within 5% of benchmark) had to be scaled back (to "strong resemblance")

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Participation in QC

Vendor qualification phase: assisted with evaluation of vendor submissions

Production phase: spot checks (ongoing)

Example: shot near boundary of survey

IWAVE run at UT TACC (Teragrid), 2048 cores, 7 hrs

Display: N-S inline 7km E-W offset

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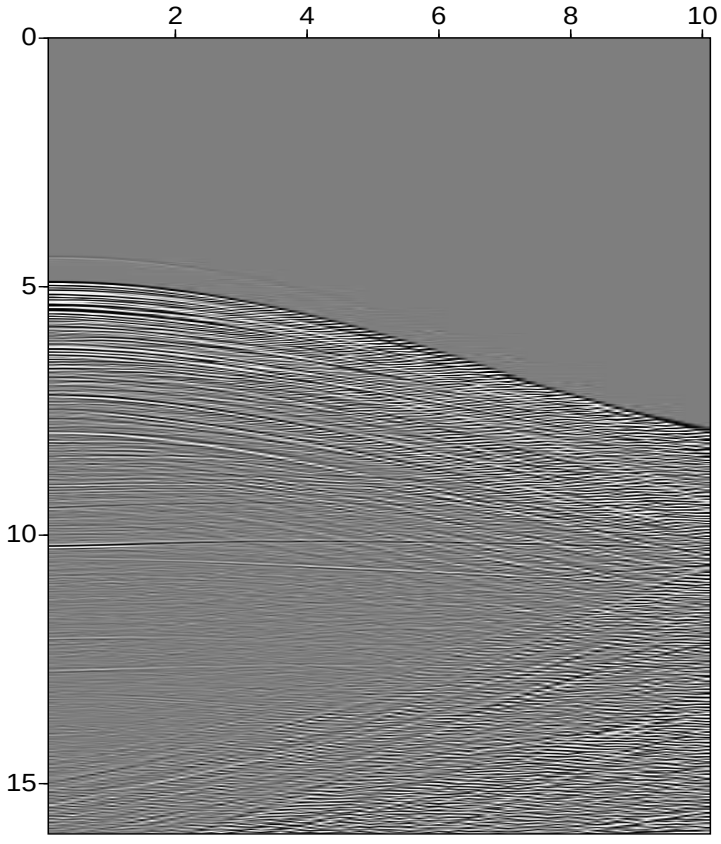
Participation in QC



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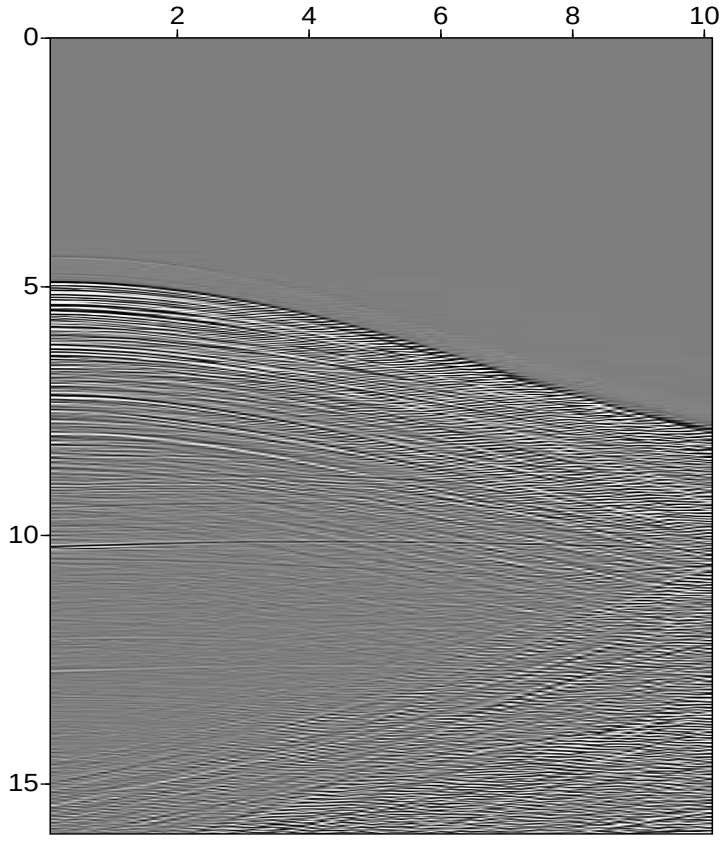

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