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Title: YEARLY REPORT FOR THE PERIOD Jan-Dec 2012 IC PROJECT W12c_spewave " Source Physics Experiment modeling"

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YEARLY REPORT FOR THE PERIOD Jan-Dec 2012

IC PROJECT W12c_spewave " Source Physics Experiment modeling"

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Scientific and Programmatic Impact:

The Office of Nuclear Detonation Detection identifies characterization of the explosion source as a fundamental research area. Our ability to characterize explosion sources from earthquakes relies on empirical laws that are not covering all the possible cases of location, site structure and yields of possible explosions. Our empirical knowledge needs to be completed by a physical understanding of seismic wave generation. NA22 has funded the LANL SPE seismic project to develop a new source model under the Ground-Based Nuclear Explosion Monitoring Research and Development (GNEM-R&D) Program. NA22 also funds computational support of the seismic source model development. Hydrodynamic computations using realistic material response models combined with a comprehensive series of field experiments provided by the SPE program are needed for test and validation of the new seismic source models. The following three essential elements, (1) model development, (2) numerical simulations of non-linear material response, and (2) field experimentation, will be brought to bear on a predictive capability for broadband P and S wavefields with a sound physical basis for seismic monitoring applications.This research will advance our ability to address yield estimation for UNE conducted in proliferant nations and provide a better understanding of the coupling of explosion sources to the seismic wavefield.

This IC project will allow LANL to stay at the forefront of explosion modeling because accurate modeling of seismic waves generated by explosion sources requires the combination of a number of key technologies. Both the complex material response of the source region and the transmission characteristics to the farfield must be appropriately captured.
The most faithful representation of source-region dynamics is provided by so-called "strong motion" or **hydrodynamic codes**, to which belongs CASH. These codes can simulate the dynamics of the energetic medium and the nonlinear response of the nearby material based on first-principles conservation laws. CASH can explicitly account for complicated geometries, such as sub-surface geological features, in situ stress, voids and topography. Our last development efforts have focused on utilizing accurate numerical analysis techniques so that material response can be confidently simulated from the near-source, strong shock zone out to the small-strain and ultimately the elastic regime. SPECFEM3D is 3D full-waveform wave propagation code based on t**he spectral element method (SEM) that is a particular case of high-order and tensorized finite elements method**. SPECFEM3D has shown remarkable accuracy to solve the wave propagation for geophysical models at different scale (Komatitsch and Vilotte, 1998; Komatitsch and Tromp, 1999) thanks to the exponential convergence of

spectral element combined with the geometrical flexibility of finite elements. We will use SPECFEM3D to model of far field wave propagation at the explosion site taking into account the effects of intrinsic attenuation, arbitrary surface topography, and a general subsurface distribution of geologic materials with differing properties.

Summary of Computational Effort Accomplished:

The w12c_spewave project was awarded 50K CPU-hrs on lobo, mustang and moonlight for development purpose. We used part of these CPU-hrs to develop and validate a coupling interface between the 2 codes CASH and SPECFEM3D. The 2 codes are now coupled which will allow the scientific work to start (see viewgraphs). The whole time-series of the displacement wavefield predicted by CASH are recorded and fed into SPECFEM3D. Technical details that have to be overcome are (1) the selection of a minimum subset of points on the coupling interface that are necessary to the correct coupling between the two codes (2) writing of a "translating" function between the two numbering programs of the 2 codes and of an interpolation function when the 2 meshes do not conform (3) I/O processing designed to minimize use of disk space and/or memory latency during the execution. More work is needed to fully optimize (2)& (3) specially when we will consider large size problems.

Publications/Presentations:

Our work for w12c_spewave was purely development and we have no publications/presentation to report.

Financial Impact:

- Current funding to the lab (DOE):
  Source of funding: DOE NA-22
  Project Title: Source Physics Experiment (SBC1)
  Annual Direct Costs: $2,500K/yr
  Time frame: 10/01/2010 – 09/30/2014

Supporting Viewgraphs:
See viewgraphs on the ppt.