Review of the September 2009 SIV Workshop

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Use of dynamic models

- Can inversions resolve questions in earthquake physics?
  - Does slip penetrate below the seismogenic layer in big earthquakes?
    - Cracks vs. pulses
- Collaboration opportunity with other groups in SCEC (dynamic code validation, UCERF)
- Everyone wanted a simple, but dynamic model for the first SIV inversion problem.

CSEP-style testing center

- Allows us to run many "experiments" with little additional effort
- All codes set up similarly:
  - Same station locations (many stations, experiments may only use a subset)
  - Same Green's function & fault geometry
  - Input and output files in standard format
- Testing center developer ($) makes python wrappers for each code
  - Validate that code produces expected answer on simple test problem

Testing Metrics

- Modelers wanted to see many metrics used
  - Metrics for each source parameter (slip, rupture time, etc.)
  - Metrics that combine multiple source parameters (e.g. 3D correlation of slip velocity field in time)
- Modelers want to know testing metrics ahead of time

Source Model Format

Graves' format is a good start, but...

- **Proposed formats: plain ascii files, following exactly specified requirements**
  - Source model files →
  - Seismogram files ↓

```
% ------------------------------------------------------------
% POINT-SOURCE MODEL 1
% used as input for Source Inversion Validation (SIV)
%
% XPOS      ZPOS      ZABS      YPOS      TON       RISE      SS-AMP    DS-AMP
%  km        km        km        km       sec        sec       cm        cm
% ------------------------------------------------------------
  -1.00,     9.00,   9.0000,   0.0000,   0.4714,    0.100,    0.0140,    0.0000
  -0.50,     9.00,   9.0000,   0.0000,   0.3727,    0.100,    0.0290,    0.0000
   0.00,     9.00,   9.0000,   0.0000,   0.3333,    0.100,    0.0370,    0.0000
   0.50,     9.00,   9.0000,   0.0000,   0.3727,    0.100,    0.0290,    0.0000
   1.00,     9.00,   9.0000,   0.0000,   0.4714,    0.100,    0.0140,    0.0000
  -1.00,     9.50,   9.5000,   0.0000,   0.3727,    0.100,    0.0290,    0.0000
  -0.50,     9.50,   9.5000,   0.0000,   0.2357,    0.100,    0.0610,    0.0000
   0.00,     9.50,   9.5000,   0.0000,   0.1667,    0.100,    0.0780,    0.0000
   0.50,     9.50,   9.5000,   0.0000,   0.2357,    0.100,    0.0610,    0.0000
   1.00,     9.50,   9.5000,   0.0000,   0.3727,    0.100,    0.0290,    0.0000
  -1.00,    10.00,  10.0000,   0.0000,   0.3333,    0.100,    0.0370,    0.0000
  -0.50,    10.00,  10.0000,   0.0000,   0.1667,    0.100,    0.0780,    0.0000
   0.00,    10.00,  10.0000,   0.0000,   0.0001,    0.100,    0.1000,    0.0000
   0.50,    10.00,  10.0000,   0.0000,   0.1667,    0.100,    0.0780,    0.0000
   1.00,    10.00,  10.0000,   0.0000,   0.3333,    0.100,    0.0370,    0.0000
  -1.00,    10.50,  10.5000,   0.0000,   0.3727,    0.100,    0.0290,    0.0000
  -0.50,    10.50,  10.5000,   0.0000,   0.2357,    0.100,    0.0610,    0.0000
   0.00,    10.50,  10.5000,   0.0000,   0.1667,    0.100,    0.0780,    0.0000
   0.50,    10.50,  10.5000,   0.0000,   0.2357,    0.100,    0.0610,    0.0000
   1.00,    10.50,  10.5000,   0.0000,   0.3727,    0.100,    0.0290,    0.0000
  -1.00,    11.00,  11.0000,   0.0000,   0.4714,    0.100,    0.0140,    0.0000
  -0.50,    11.00,  11.0000,   0.0000,   0.3727,    0.100,    0.0290,    0.0000
   0.00,    11.00,  11.0000,   0.0000,   0.3333,    0.100,    0.0370,    0.0000
   0.50,    11.00,  11.0000,   0.0000,   0.3727,    0.100,    0.0290,    0.0000
   1.00,    11.00,  11.0000,   0.0000,   0.4714,    0.100,    0.0140,    0.0000
```

```
Synthetic Seismograms for model SIVps1
Observer #  8, Station s25
XPOS =  -15.0000, YPOS = 40.0000
NPTS =  4096, DT = 0.0200
Velocity seismograms in cm/sec
    X (EW)      Y(NS) comp      U-D comp
    -0.00000      -0.00000      -0.00000
    -0.00000      -0.00000      -0.00000
    -0.00000      -0.00000      -0.00000
    -0.00000      -0.00000      -0.00000
    -0.00000      -0.00000      -0.00000
    -0.00000      -0.00000      -0.00000
    -0.00000      -0.00000      -0.00000
    -0.00000      -0.00000      -0.00000
    -0.00000      -0.00000      -0.00000
    -0.00000      -0.00000      -0.00000
    -0.00000      -0.00000      -0.00000
    -0.00000      -0.00000      -0.00000
    -0.00000      -0.00000      -0.00000
    -0.00000       0.00000       0.00000
     0.00000       0.00000       0.00000
     0.00000       0.00000       0.00000
     0.00000       0.00000       0.00000
```

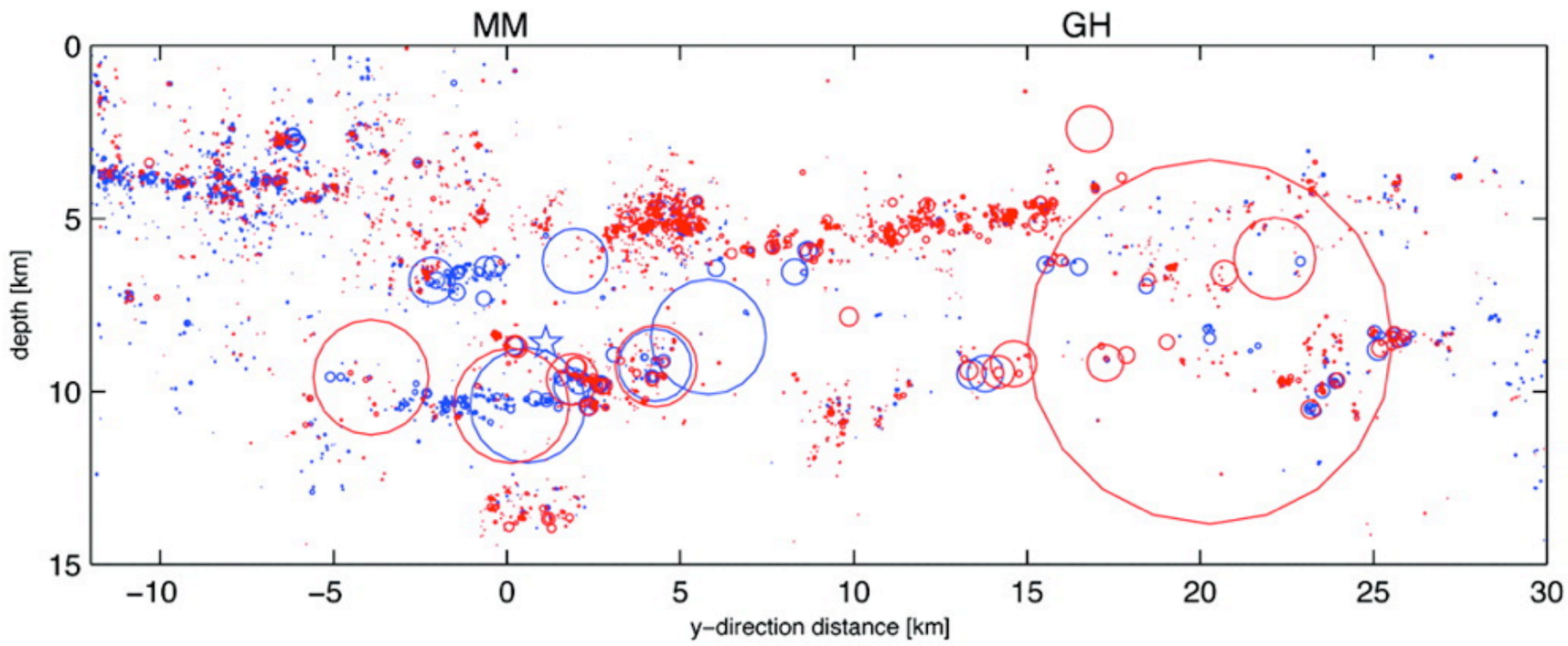
Source Model Format

Graves' format is a good start, but...

- Want everything on a fine grid (250 m?)
  - Modelers should interpolate onto the grid, not the testing center
  - Grid should be fine enough so as not to give away the grid spacing used in forward model
- Should handle arbitrarily complex source-time functions

For the future... real earthquakes?

Could build a source model using small earthquakes as empirical Green's functions (Parkfield would be a good location)



For the future... realistic errors?

Errors are not necessarily nice & Gaussian.
We can model them better:

- Perturb velocity layers
- Perturb fault geometry
- Site effects

Is one model sufficient?

- Many models may fit the data equally well (data fit not a good measure of model fit)

  Our problem is fundamentally different from dynamic code validation (one right answer)

- Submission of multiple models, or error bars/pdfs of source parameters (not popular)
- Synthetics for stations not used in inversion