Short-period benchmark

Benchmark results for “short-period” simulation

Komatitsch and Tromp (2002a,b) carefully benchmarked the spectral-element simulations of global seismic waves against normal-mode seismograms. Version 4.0 of SPECFEM3D_GLOBE has been benchmarked again following the same procedure.

Short-period benchmark

We present here a ‘short-period’ (periods longer than 9 s) simulation of a deep event in transversely isotropic PREM without the ocean layer and including the effects of self-gravitation and attenuation (Figures C.3, C.4 and C.5).

Normal-mode synthetics

The normal-mode synthetics are calculated with the code QmXD using mode catalogs with a shortest period of 8 s generated by the code OBANI. No free-air, tilt, or gravitational potential corrections were applied (Dahlen and Tromp, 1998). We also turned off the effect of the oceans in QmXD.

Results

The normal-mode and SEM displacement seismograms are first calculated for a step source-time function, i.e., setting the parameter half duration in the CMTSOLUTION ?le to zero for the SEM simulations. Both sets of seismograms are subsequently convolved with a triangular source-time function using the processing script UTILS/seis_process/process_syn.pl.

They are also band-pass ?ltered and the horizontal components are rotated to the radial and transverse directions (with the script UTILS/seis_process/rotate.pl). The match between the normal-mode and SEM seismograms is quite remarkable for the experiment with attenuation, considering the very different implementations of attenuation in the two computations (e.g., frequency domain versus time domain, constant Q versus absorption bands).

You can download this benchmark example: See benchmark_examples.tar.gz in /groups/seismology/wiki/SPECFEM3DGLOBE/Longperiodbenchmark.

To unzip the tar ball file, type:

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tar -zxvf benchmark_examples.tar.gz
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Further tests can be found in the EXAMPLES directory. It contains the normal-mode and SEM seismograms, and the parameters (STATIONS, CMTSOLUTION and Par_file) for the SEM simulations.

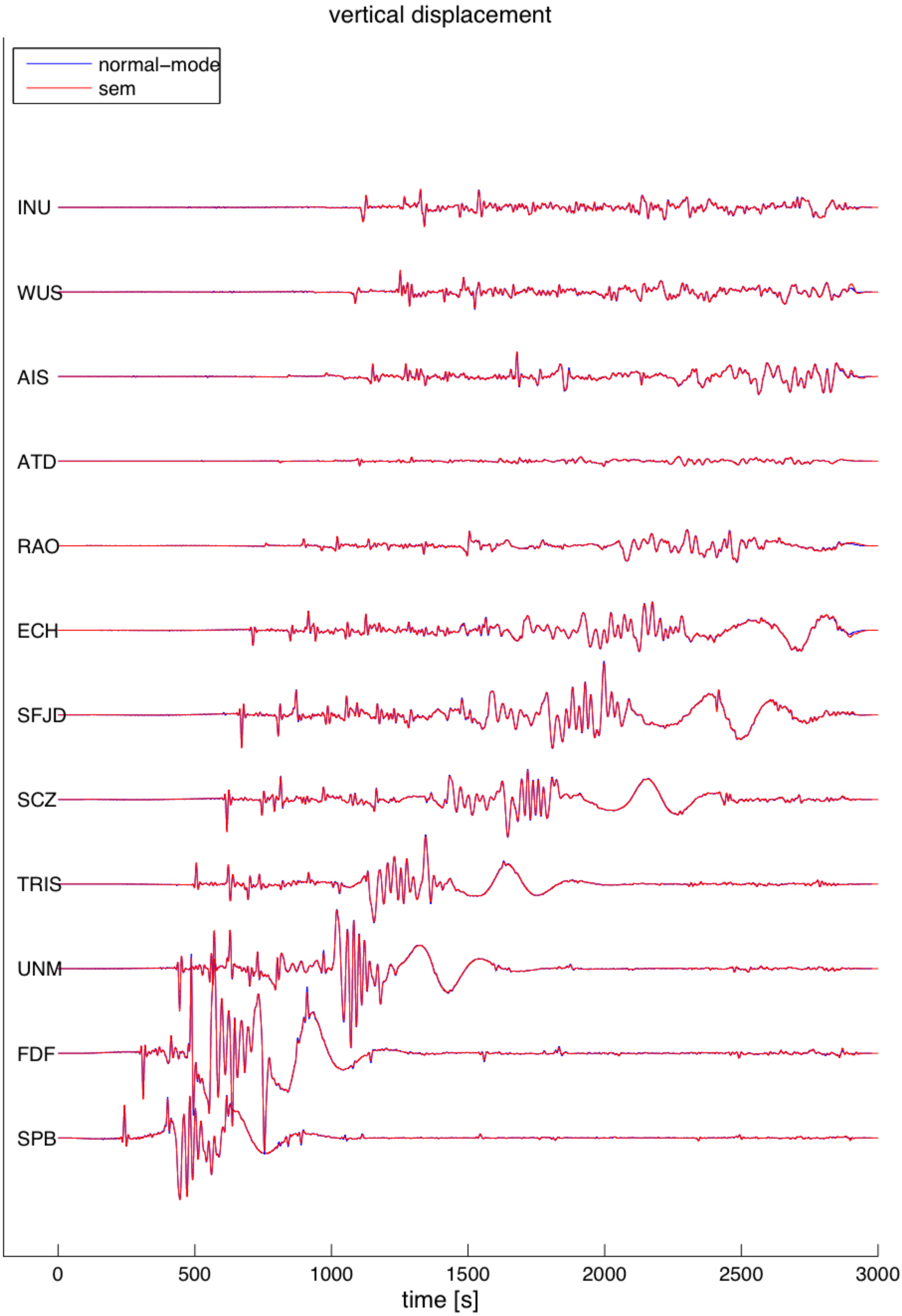
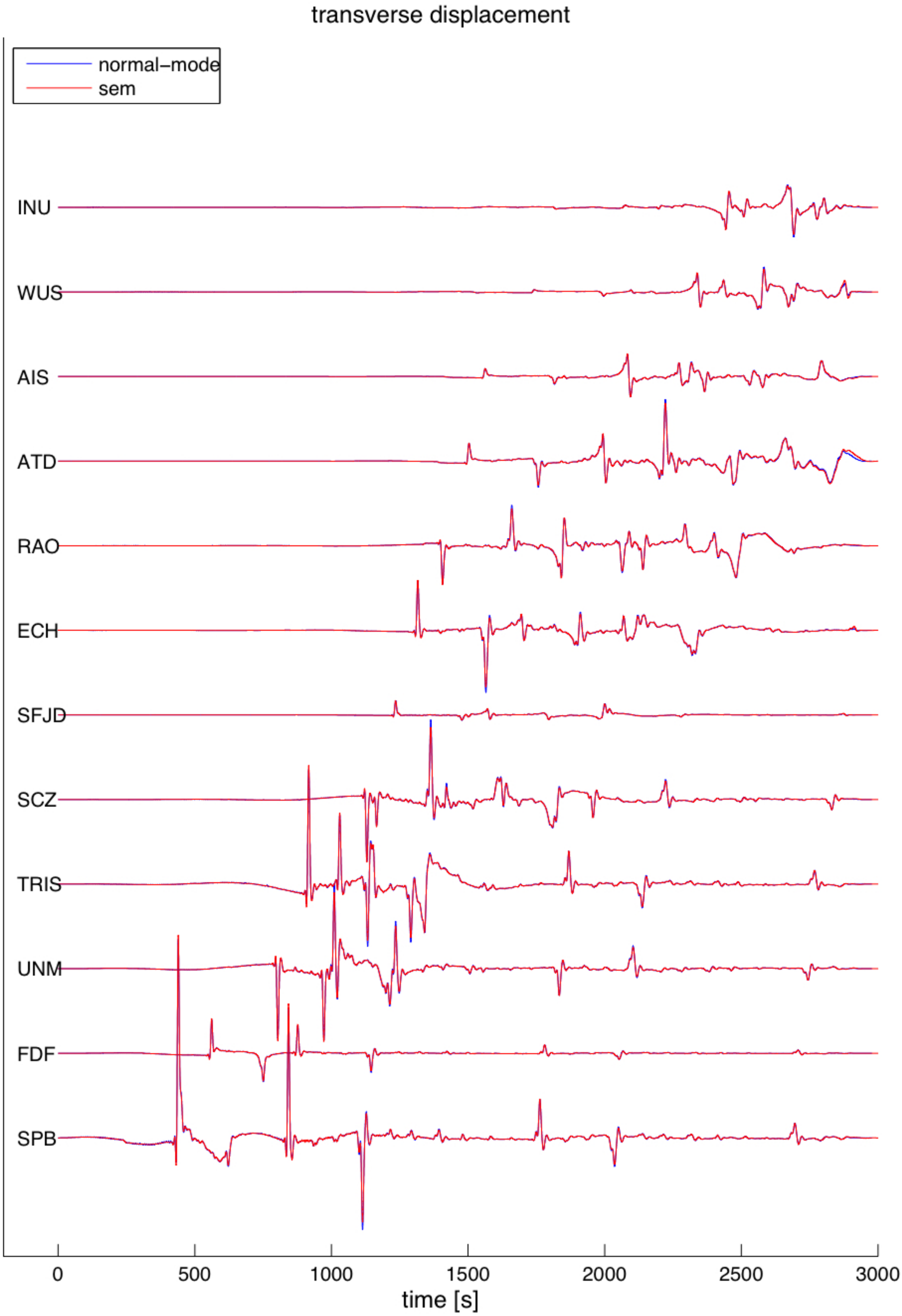

vertical displacement
normal–mode
sem
INU
WUS
AIS
ATD
RAO
ECH
SFJD
SCZ
TRIS
UNM
FDF
SPB
0
500
1000
1500
2000
2500
3000
time [s]

Figure C.3 (bolivia_vertical.pdf (343 KB, uploaded by Lorraine Hwang 2 years 8 months ago)): Normal-mode (blue) and SEM (red) vertical displacements in transversely isotropic PREM considering the effects of self-gravitation and attenuation for 12 stations at increasing distance from the 1994 June 9th Bolivia event located at 647 km depth. The SEM computation is accurate for periods longer than 9 s. The seismograms have been filtered between 10 s and 500 s. The station names are indicated on the left.



transverse displacement
normal–mode
sem
INU
WUS
AIS
ATD
RAO
ECH
SFJD
SCZ
TRIS
UNM
FDF
SPB
0
500
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time [s]

Figure C.4 (bolivia_trans.pdf (198 KB, uploaded by Lorraine Hwang 2 years 8 months ago)): Same as in Figure C.3 for the transverse displacements

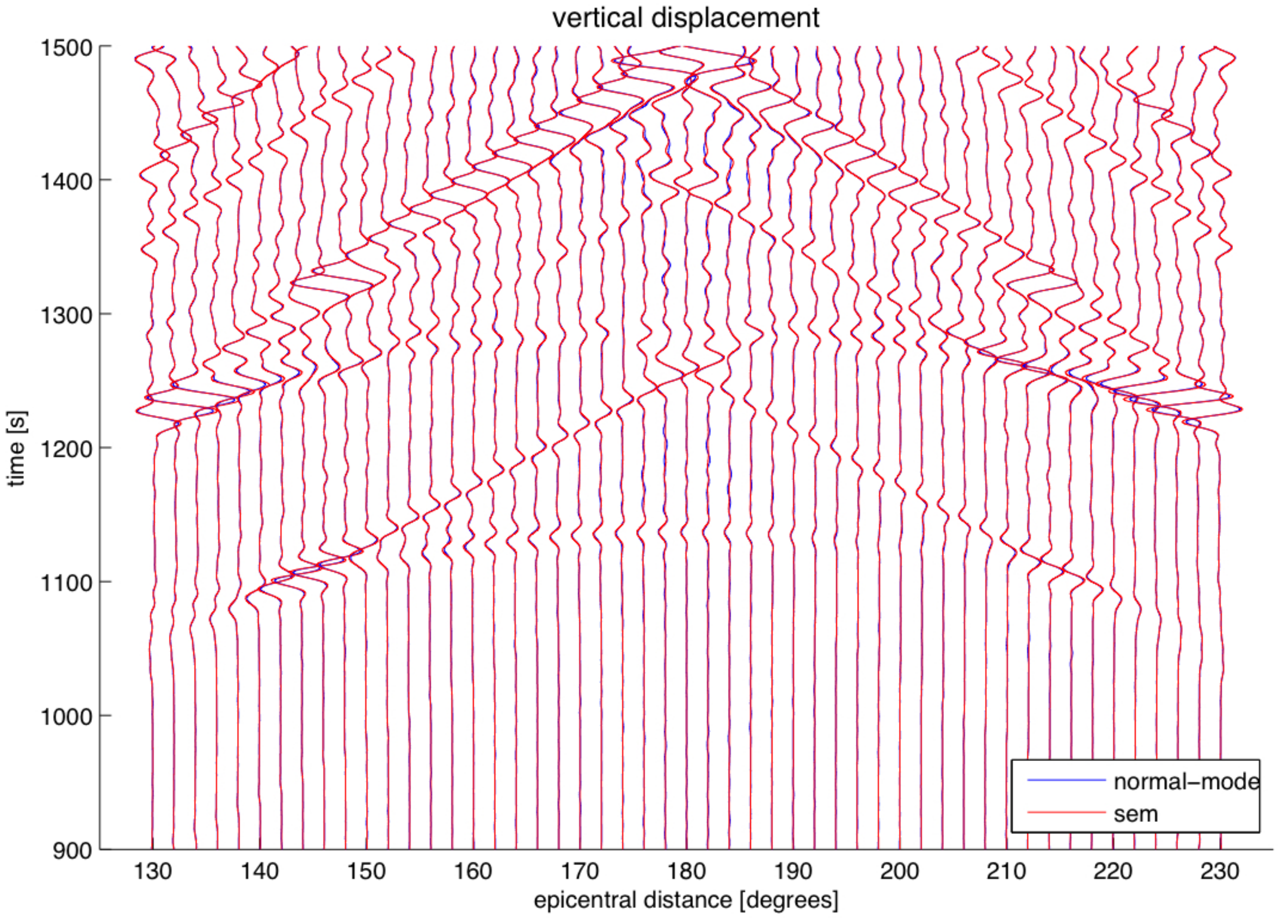

Figure C.5 (pkpdf_all_15s500s.pdf (539 KB, uploaded by Lorraine Hwang 2 years 8 months ago)): Seismograms recorded between 130 degrees and 230 degrees, showing in particular the good agreement for core phases such as PKP. This figure is similar to Figure 24 of Komatitsch and Tromp (2002a). The results have been filtered between 15 s and 500 s.

Important remark:

When comparing SEM results to normal mode results, one needs to convert source and receiver coordinates from geographic to geocentric coordinates, because on the equator the geographic and geocentric latitude are identical but not elsewhere. Even for spherically-symmetric simulations one must perform this conversion because the source and receiver locations provided by globalCMT.org and IRIS involve geographic coordinates.

References

F. A. Dahlen and J. Tromp. Theoretical Global Seismology. Princeton University Press, Princeton, New-Jersey, USA, 1998.

A. M. Dziewonski and D. L. Anderson. Preliminary reference Earth model. Phys. Earth Planet. In., 25:297-356, 1981.

D. Komatitsch and J. Tromp. Spectral-element simulations of global seismic wave propagation-I. Validation. Geophys. J. Int., 149 (2):390–412, 2002a. doi: 10.1046/j.1365- 246X.2002.01653.x.

D. Komatitsch and J. Tromp. Spectral-element simulations of global seismic wave propagation-II. 3-D models,oceans,rotation,and self-gravitation. Geophys. J. Int., 150(1):303–318, 2002b. doi: 10.1046/j.1365-246X.2002.01716.x.