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Discussions

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Interactive comment on "Simulation of seismic waves at the Earth crust (brittle-ductile transition) based on the Burgers model" *by* J. M. Carcione et al.

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Review of Manuscript SE-2013-86

Comments to the authors:

The paper represents a first approach towards establishing the dynamic equations governing wave propagation in media described by Burgers model. The creep and relaxation functions are derived from the rheological model which, together with the stress-strain relation and Newton's law, results in a coupled equation system describing wave propagation. The equations derived are 2D, both for the P-SV and SH propagation modes and convincing examples are given which support the correctness of the

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approach and its potential usefulness.

General comments

The manuscript is interesting and overall well written. The topic is relevant enough and the results are promising. Nevertheless, some issues should be addressed by the authors in a revised manuscript. I will, in the following, first address the main issues, whose resolution is important for encouraging publication, and some other small issues which would help improve the quality of the manuscript.

Main issues

The introduction to the concepts of mean and octahedral stresses seem a bit unnecessary for the mathematical derivations pursued in the manuscript, including Figure 2. The whole section describing them can be removed. The sole influence of the octahedral stress concept is in the computation of the viscosity. I suggest just giving a reference to the reader at this stage of the manuscript, just like a reference is given for the Burger's model.

In any case, Figures 1 and 2 should have been labeled 2 and 1, in the order of appearance in the manuscript.

After equation 4, a statement on how Q is computed from the moduli's imaginary and real parts is necessary. Then Qo is just the minimum Q for all frequencies.

Some of the subindexes are confusing. First of all, numerical subindexes are used for the rheological mechanisms (e.g. equation 9) but also for the Cartesian coordinates (e.g. equation 13). Equation 17 mixes both types of subindexes, for example. This could be very easily fixed by using explicit x and z subindexes where this is what the authors refer to.

Similarly, stresses and relaxation times could use clearer symbols. The octahedral stresses can be identified by a sigma, just like all other stresses in the discussion. No confusion is possible if the subindexes are kept (xx, zz, xz and 0). In this way, tau can

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be reserved for relaxation times.

In equations 21, 22 and 23, please specify the different c, alpha and Q values for P and S waves, either explicitly or with an index. Alternative, move the sentence defining v as either vp and vs to the beginning of paragraph 10 in page 9, for easier reading.

In the BDT example, we are missing some parameters. In particular we need the numerical values involved in equations 6 and 7 to fully describe the media properties used.

In chapter 6, you should specify explicitly that Runge-Kutta is the time-integration scheme. Additional, more original, references to RK and to the pseudo-spectral method in seismology should be given too.

A final comment, that I believe is of great importance for readers, is knowing how difficult would it be to use an equivalent viscoelastic (GMB or GMZ) model for the same purposes of the article. This means using effective vp, vs, Qp and Qs values obtained from equations 21 and 23 for a narrow bandwidth and using them as an input to a standard GMB or GMZ viscoelatic model. This would imply not re-coding already existing algorithms at the cost of having a less precise fidelity to Burgers model physics. A discussion on this topic would be very interesting.

Minor issues

Please substitute "Green function" with "Green's function" throughout the manuscript. After equation A5, the word "hermicity" seems misplaced. In page 6 paragraph 10, please specify that the shear modulus becoming zero is a consequence of applying zero viscosity to equation (3). In page 6, before equation 7, you should specify that "it" is the creep rate, for clarity When talking about the "equation of motion", I think it is preferable to use the term in plural "equations of motion" because, regardless of using a vector form, you are describing an equation system. The word "recasted" should change to "recast". In page 11, at the first line of chapter 7, "a" should change to "an".

In page 13, you should specify that you predict P- and S- wave propagation instead of P- relative to S-wave propagation. In the Appendix, G1 and G3 are not dependent on r but rather on x,z (and density, in fact).

Conclusions

Given the reasons mentioned above, I think the paper only needs a minor revision before being published. I am looking forward to reading a new and improved version of the manuscript.

Best regards Josep de la Puente

Please also note the supplement to this comment:
http://www.solid-earth-discuss.net/6/C656/2014/sed-6-C656-2014-supplement.pdf

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