NZ 100m Simulation Validation

Purpose: This page provides the details on the NZ 100m Simulation Validation project which will attempt to perform ground motion simulation validation for small and moderate Mw earthquakes, active shallow crustal and subduction.

This project will attempt to use the current workflow and science of the ground motion simulations although many aspects may not be optimal for areas which are currently exploratory (moderate Mw), or have not yet been explored (subduction). Table 1 below lists the issues related to each section which should be addressed and subsequently tested (potentially with lower resolution exercises) before the production run is commenced.

Table 1. List of issues to be addressed towards the validation exercise and suggested solutions.

Item	Issue	Suggestion	Notes	Checkbox
Workflow				
Stability	Everyone generally works with something not on master, so there can be issues with compatibility between repos.	Can we pull everything relevant from master and check that everything actually works?		
Newest IM calc changes	FAS, RotD50 and RotD100 additions had changes to several repos and changes many output files with with more components and potentially blank spaces. Would be good to know it all works on master.	Completing the above and doing proper verification of outputs should sort this. (BB: Can also consider not doing these to start with, then running them later)	**Not done by default. Good to go without.**	Done
Duplicate stations	Are we currently duplicating stations?	Install one that should have duplicates to check.		Done
New vs old workflow	Results with new workflow may not be necessarily compatible with results from old workflow. Different fd statlist, different sim durations, VMs etc.	Rerun everything on new workflow.	**Version 20.3.3.X: Simulation**	Done
New stations	If we're running new simulations for all events, should we take the opportunity to add in any more stations?	(BB: Yes, good idea)	**Decided to not add structural arrays.** **Added a few strong motion stations (based on scraping ftp and fdsn records). A lot were not new stations (installed ~2016?) but had no recordings previously.**	Done
Sim binary versions	Should we use emod3d version 3.0.4 or 3.0.8? Should we use hb_high version 5.4.5 or 6.0.3?	Probably emod3d 3.0.8. Should probably do validation of old runs with hb_high 6.0.3 to see how much difference it makes for point sources and then decide. Could do both if we had to in the end.	**hb_high 5.4.5.3 (velocity boundary fix)** **emod3d 3.0.8**	Done
HPC storage	We need to make sure we have enough space in terms of TB and inodes.		**For 400m grid, we don't believe this will be an issue, can judge accordingly for 100 /200m grid run after.** **Robin to clean up his run directory.**	Done
Auto submitter	Sometimes stops when there are still jobs to run.	Can someone check this? This one did EMOD3D, HF, and rrup but not BB, IM_calc and clean_up. Had to start the auto submitter again to do those. /nesi/nobackup/nesi00213/RunFolder /Validation/v20p3p11	**Only seemed to happen for 1 event runs.** **Run autosubmitter once more at end should mitigate this anyway.**	Done
Corehour estimation	EMOD3D 3.0.8 has longer simulation times due larger time before rupture initiation. Causes time out sometimes.	Decide on how to revise CH est.	**Claudio or other.**	
Observed Ground Motions				
Events to simulate	Need to determine prospective events.	Determine range of Mw and depth, identify how many ground motions each have. (BB: Mw=3.5-7 (above 7 multi-fault is important, unless it would be possible to manually 'add' pre-existing faults into the workflow (e.g. Darfield and Kaik) want to avoid that for now); (BB: Depth - my gut feeling is shallower than 200km atm).	1. **Screen gcmt for Mw 3.5-7.** 2. **Determine number of records per event (HQ and/or total) and curtail list appropriately.** 3. **Generate Srf and VMs with Mw-CD filter further reducing events to simulate.**	
Source				

Model choice for Mw range	Should we continue to use PS for Mw <= 5.0 and FF for Mw > 5.0? Do we want to go above Mw 7.0?	Probably same range for PS and FF. Don't know about going above Mw 7.0. (BB: I think as you have it at the moment is good. If it is possible we could do PS for Mw<5.5 and FF for Mw>F (i.e. have a 0.5unit overlap))	I think go with PS: 3.5 - 5.0 FF: 5.1 - 7.0 Any "overlap" can be done ad hoc and swapped in post-processing.	Done
FF	What model of genslip do we use? What aspect ratio?	I think use latest version of genslip 5.4.2 and the non-square aspect ratio. Work to date hasn't been rigorous but it's probably the best option.	**Robin - Awaiting email to Rob about subfaults above ground due to roughness.** **I did some testing on this. It seems to snap to something (probably top grid point) up to a certain amount above the ground surface (~500m above ground surface for 400m grid run).** **Therefore good to use genslip 5.4.2.**	Done
Depth range	What range of depths do we want to do?	Plot CDF with depth + additional investigations. (BB: Depth - my gut feeling is shallower than 200km atm).	**Done according to "Events to simulate" item.**	Done
NZVM				
Max nz value	Maximum number of nodes on z direction currently set may be limiting for subduction earthquakes (I hit the limit when I did 50m grid runs).	Need to change in source code and recompile. Will depend on how deep we expect to go.	Robin and Jason - Changed and recompiled.	Done
NZVM version	We should use 2.03? The only difference between 2.02 and 2.03 is Waikato-Hauraki basin.	Should do a quick check to make sure everything is good.	Did not get round to it. Maybe I'll do it this weekend.	
Vs30				
Missing Kaiser Vs30 values	Kaiser et al. (2017) only has Vs30 values for 340 of ~380 stations.	Use our values for the others but trim them out in analyses in post-processing? (BB: Yes, I agree; that gives us the option post-analysis to play with both options).	Viktor **Robin should be able to pull the real station values out of the nonuniform grid file Viktor produced.**	Done

Verification Subset

The following csv contains a set of 10 earthquakes to be used as the verification test subset of events, and a table and plot to summarize the events:

GeoNet_CMT_solutions_Verification_Subset.csv

Table 2. Summary of 10 verification subset events

| PublicID	Date	Latitude	Longitude	strike1	dip1	rake1	Mw	CD	Notes
2012p001403	20120101122700	-43.4625	172.8325	222	53	101	4.8	4	Standard SM in Cant, 4km centroid depth
2014p211339	20140320044100	-43.5949	172.1239	194	69	58	3.5	7	Mw 3.5, smallest Mw considered
3468575	20110221235100	-43.566	172.6909	55	66	129	6.2	4	Chch EQ, unmodified finite fault goes above ground surface
2013p613797	20130816023100	-41.734	174.1522	331	81	21	6.6	15	Grassmere, largest ASC Mw considered
2016p859628	20161114013000	-42.367	173.7613	56	75	114	5.1	10	Smaller Mw, dip-slip EQ with enforced square aspect ratio
2017p636803	20170824144800	-42.336	172.9411	217	81	-137	4	42	Mw 4.0 at ~40km
2017p015402	20170106164600	-37.7189	177.5335	353	70	71	4.9	60	Mw 4.9 at ~60km
2014p422047	20140606034600	-39.46	175.2641	157	79	44	5	102	Mw 5.0 at ~100km
3063166	20090321202800	-37.7863	176.7771	31	75	107	5.1	159	Mw 5.1 at ~150km
2012p923684	20121207181900	-38.3501	176.0593	69	73	115	6.3	156	Mw 6.3 at ~150km
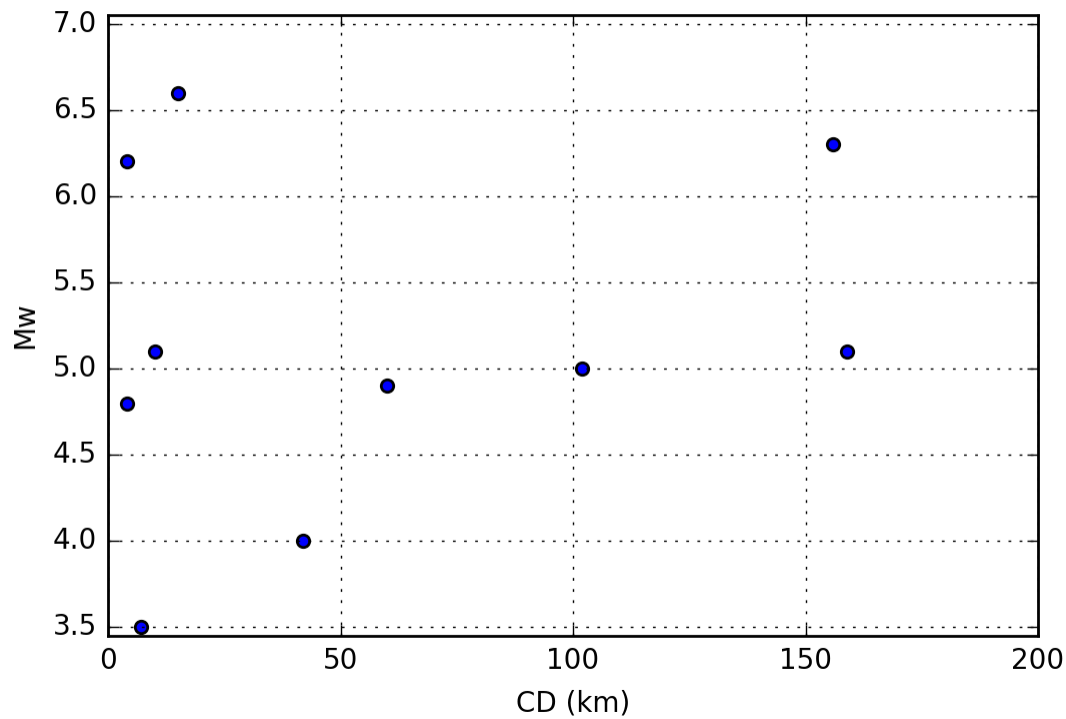
Figure 1. Plot of Mw-CD domain of 10 verification subset events

Run Instructions

Assuming the workflow is verified, the following is a quick list of the tasks required to run validation:

1. Decide on range of Mw and centroid depth to consider.
2. Obtain observed ground motions and screen for quality. (BB: Use standard NNet atm; we can re-pipe with a revised NNet later - as long as we keep sim results at all possible locations).
3. Identify which events are worth simulating based on number of records (probably raw number of records here since CMG NN won't work well with extrapolated cases). (BB: Keep in mind improvements in NNet in near future may increase (or decrease) usable records, so be conservative and simulate more than may be necessary).
4. Make sure compiled NZVM is right code version.
5. Generate Srf and VMs using correct genslip version and NZVM model version.
6. Move Srf and VMs to run directory and install using the correct gmsim version.
7. Check root_params.yaml. Check task_config.yaml for emod3d, HF, BB, IM_calc, cleanup, rrup.
8. Run auto submitter.
9. Collect IM_calc files and perform analyses.