Topographic amplification of ground motions at Mt Pleasant, Christchurch: observation and numerical simulation

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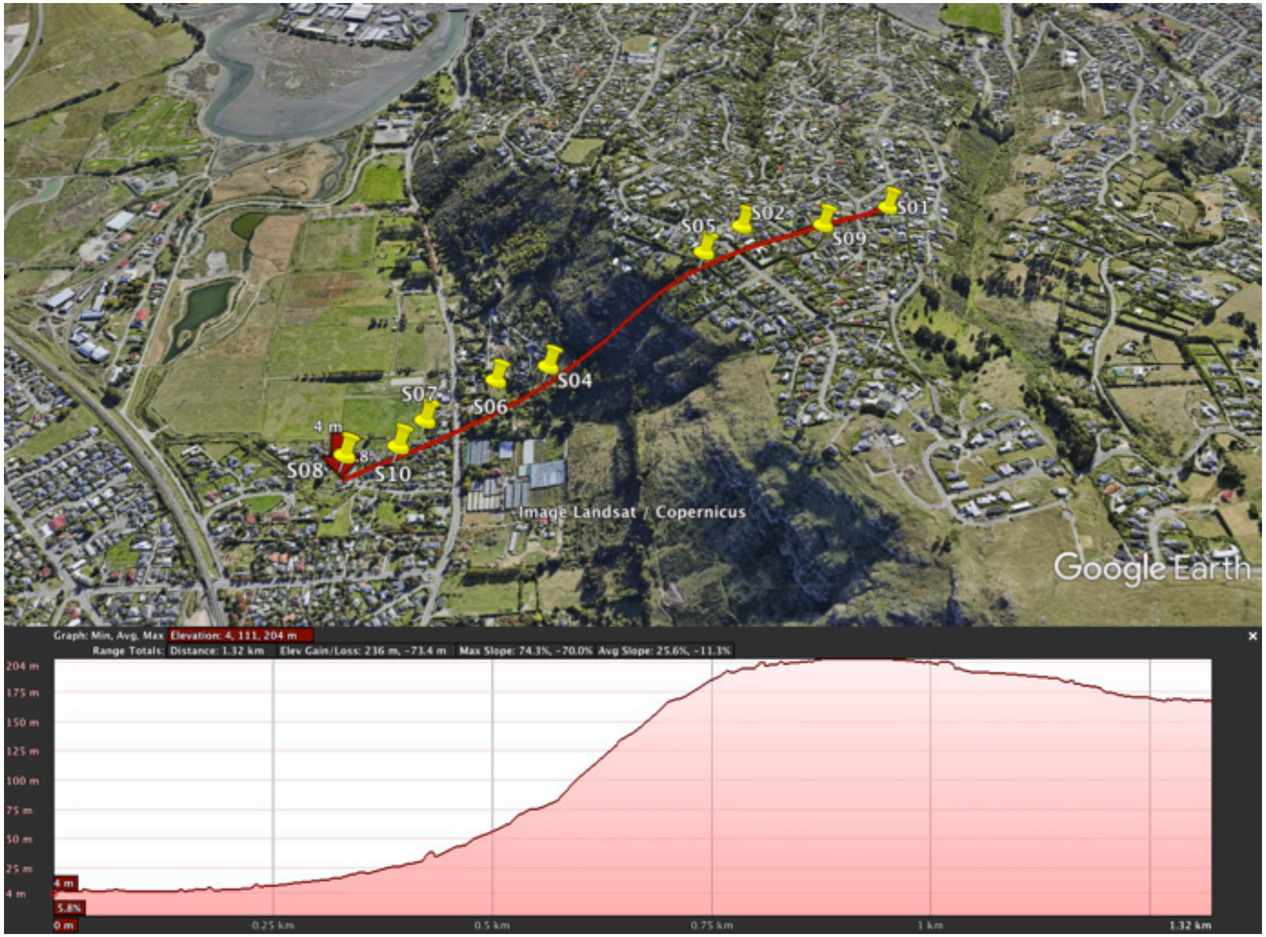
Objectives

- Advancing the understanding of the discrepancy in the observed and simulated topographic amplification by simple, yet carefully designed experimentation and simulation
  - Another case study on the role of near surface geology on topographic amplification
  - Showcase the validity and discuss the limitations of 2D numerical simulations
  - Discussion on the coupled effect of near surface geology
  - Discussion on the choice of reference station
  - Discussion on the usefulness of ambient vibration

The selected site

Houses in Mt Pleasant suffered significant damage during the Canterbury earthquakes

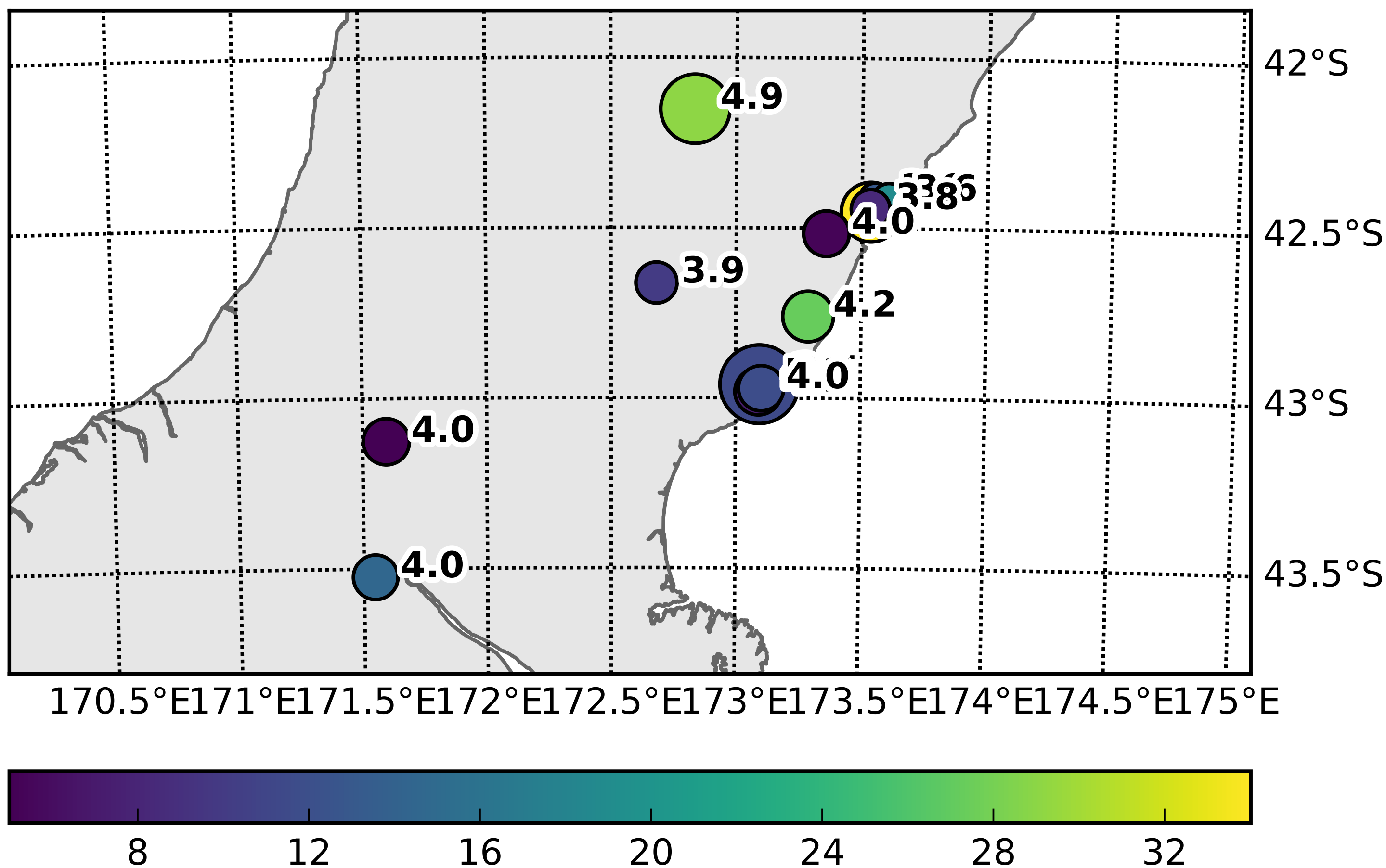
Previous studies had limited success in reproducing observed topographic amplification:
→ Choose a site that has simple geology/geomorphology!



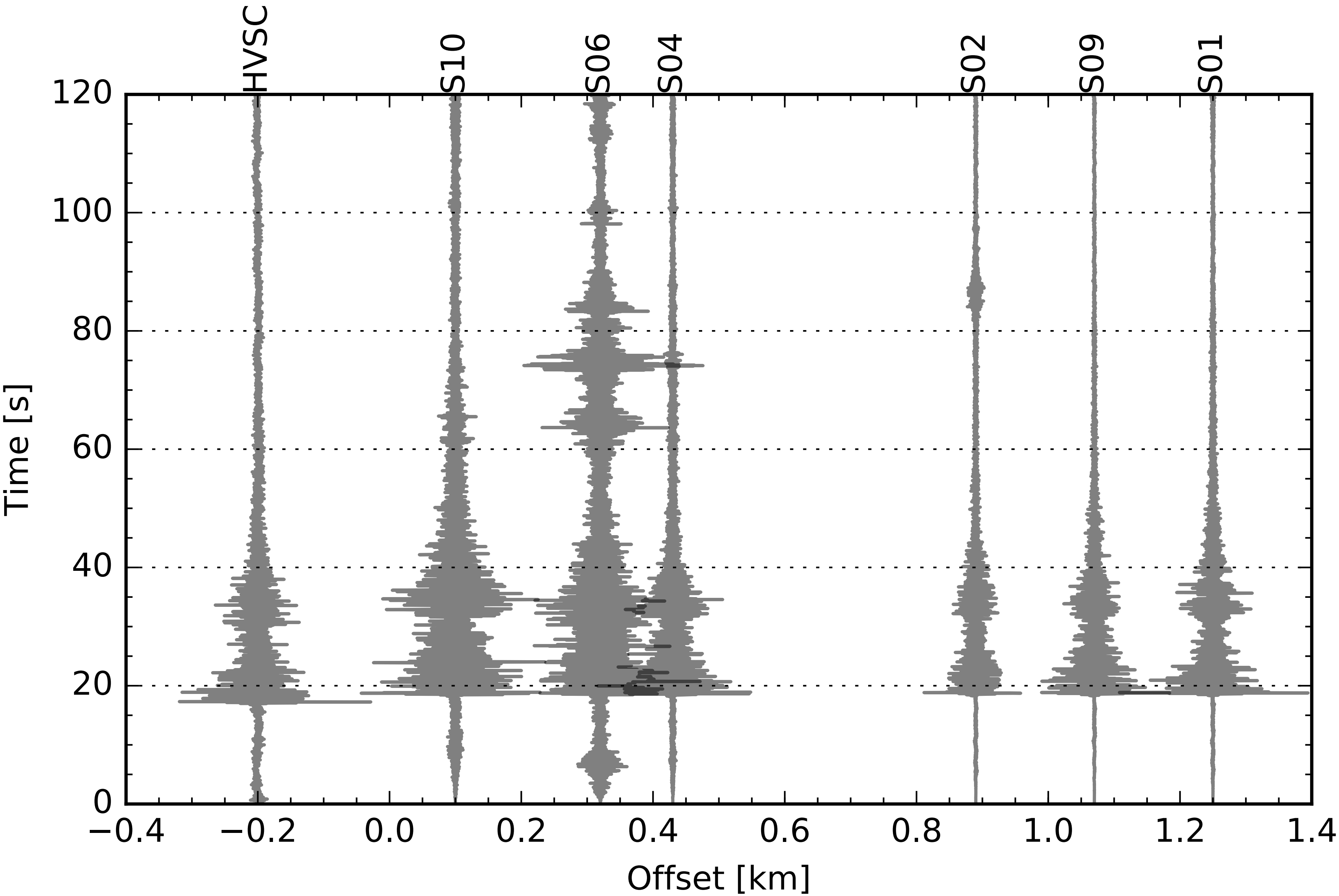
Events during the instrumentation

M > 3.5; Within 1.5 degree radius from Christchurch

16 events (2017-03-01 to 2017-03-29) - Color codes depth, size the magnitude

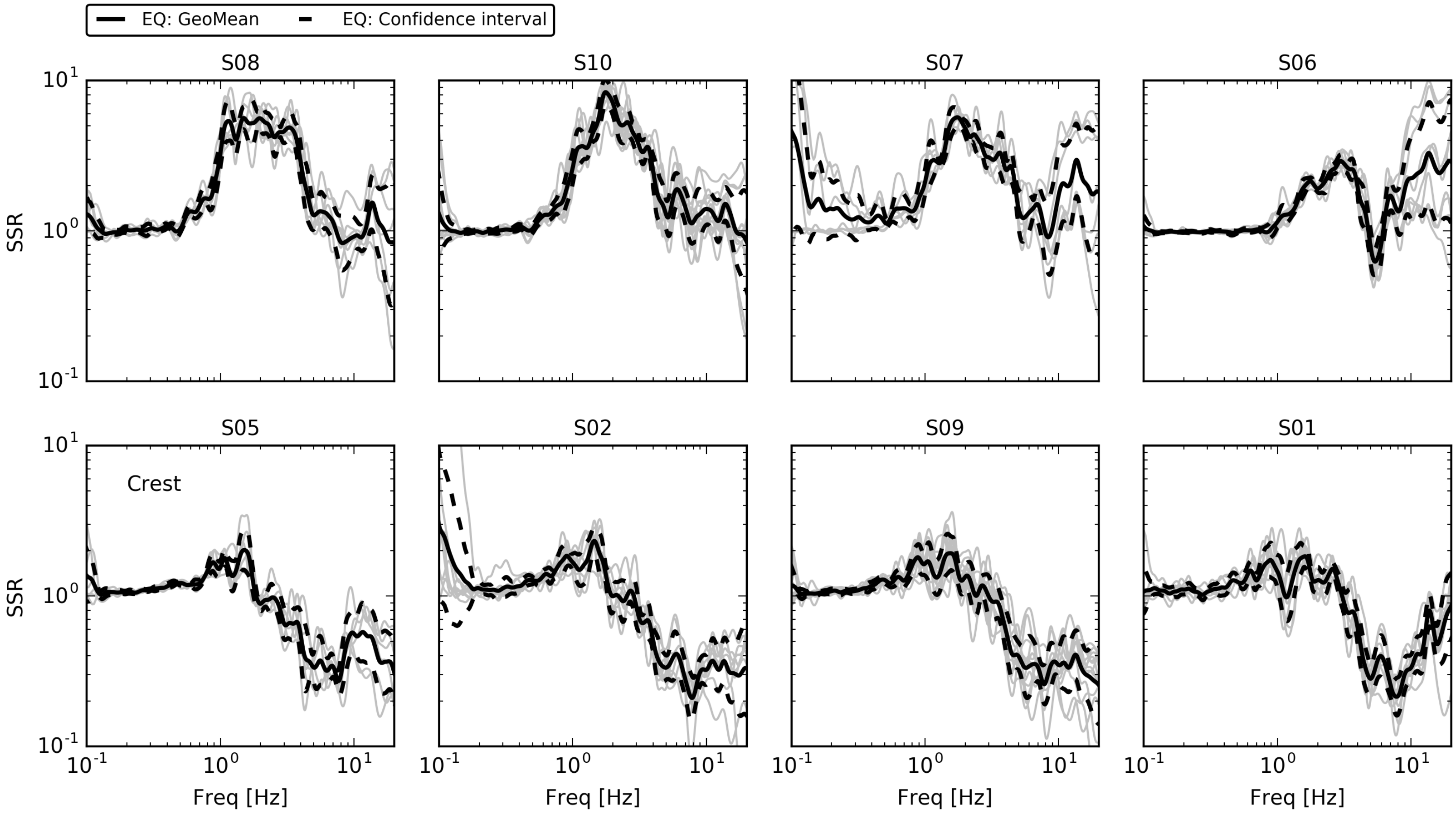


Example record: converted to acceleration



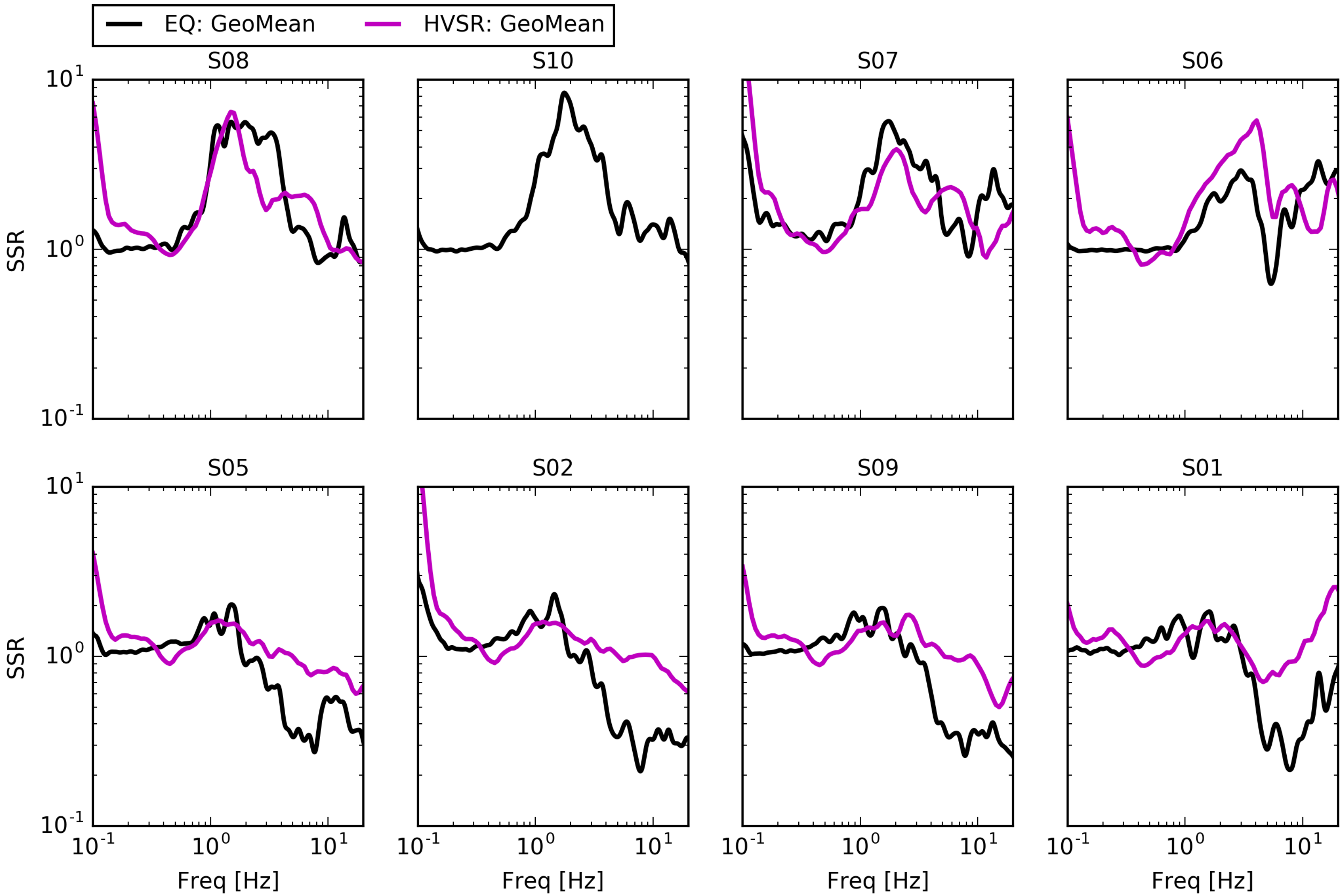
Observed spectral ratios: recorded earthquakes

N61E component, with S04 (at the toe) as the reference station:
→ topographic amplification at *f=Vs/5H*, consistent with previous studies (i.e. Ashford and Sitar 1997)
→ Significant amplification within the valley due to the soil-rock velocity contrast



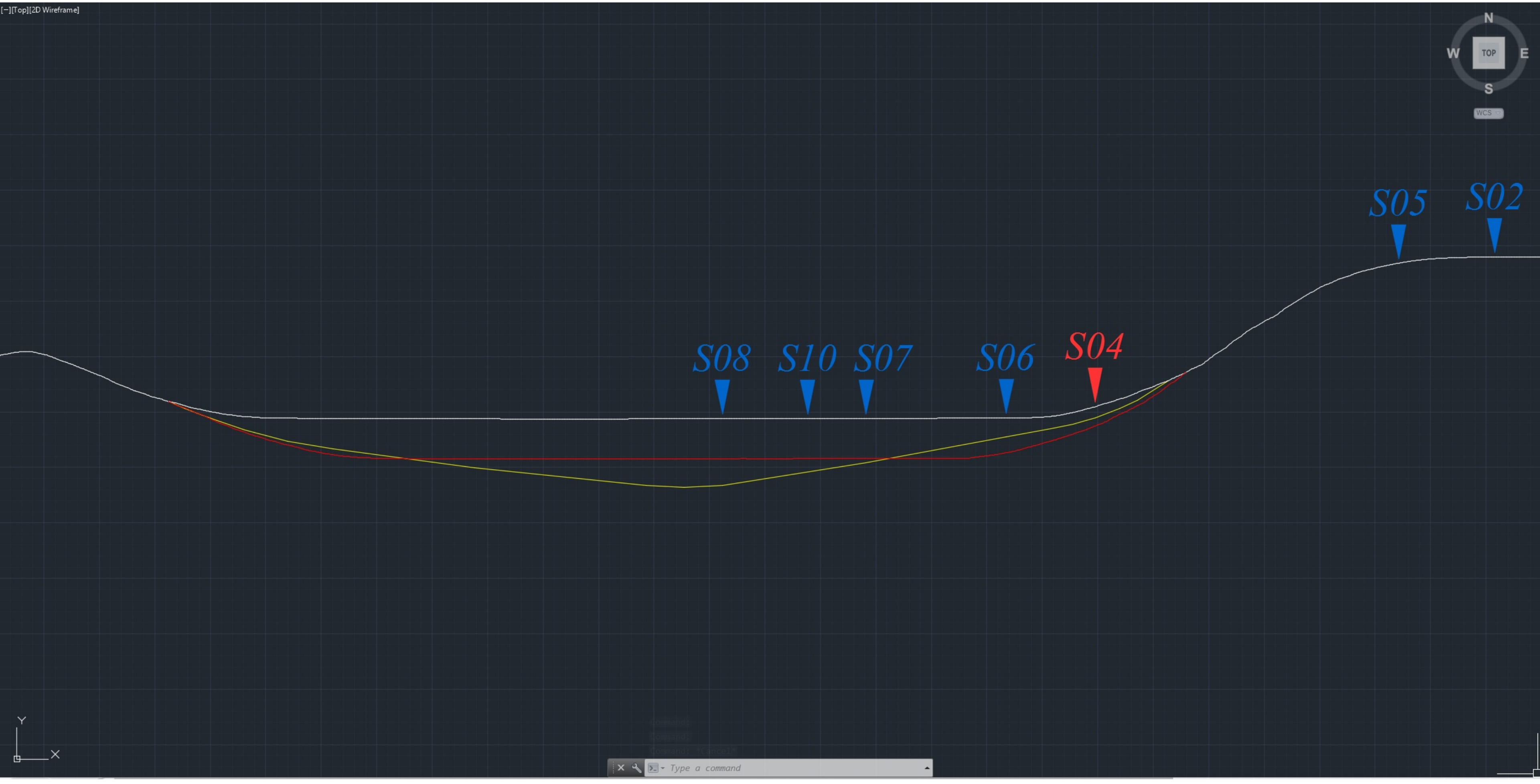
EQ SSR vs ambient vibration HVSR

HVSR broadly consistent with EQ SSR near topographic frequency



Numerical simulation

2D finite difference method using FLAC2D
Assumed Rock, Vs = 1800m/s
Maximum frequency, fmax = 20 Hz
Basin geometry estimated from HVSR; Basin Vs from sCPT

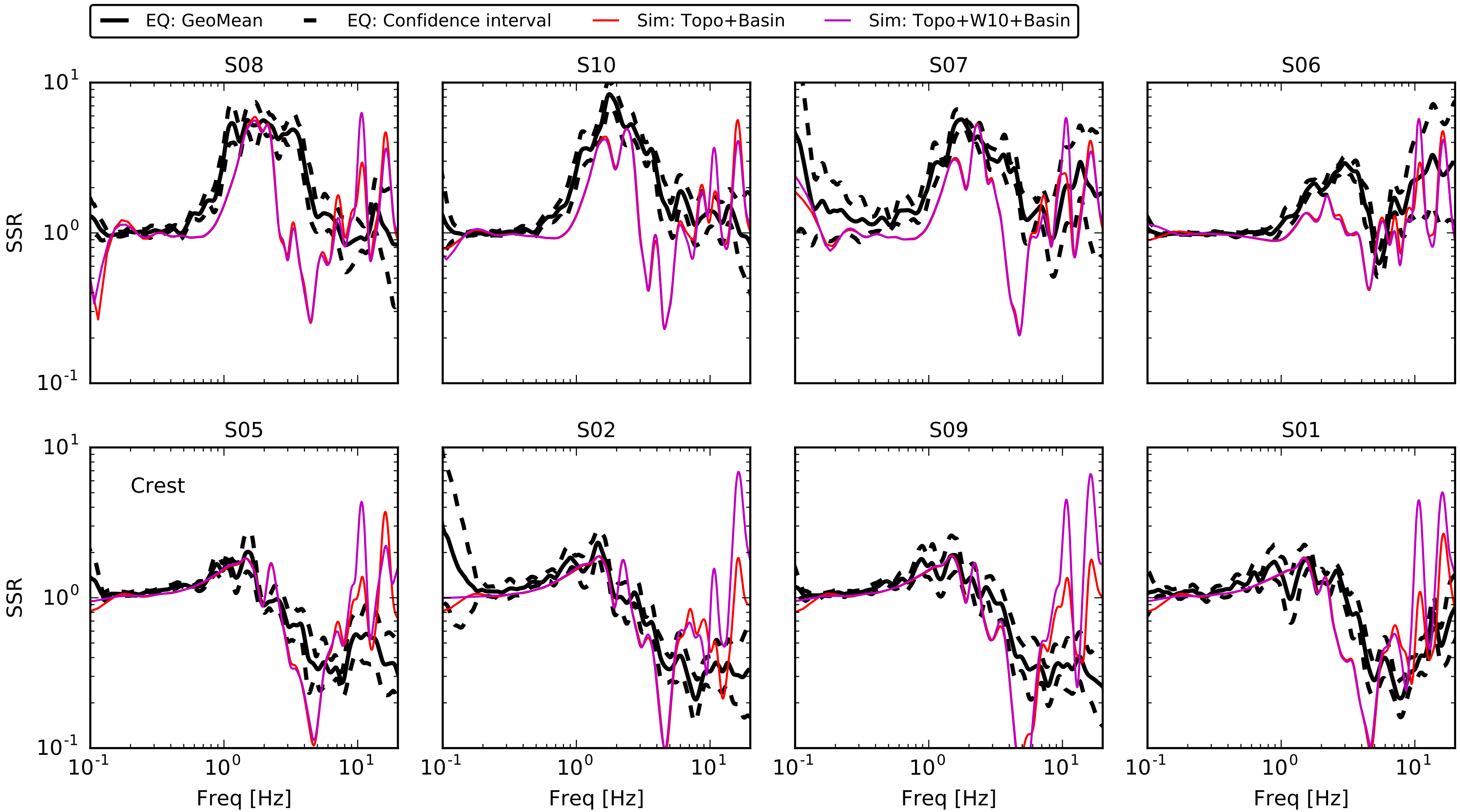


Observed vs simulated spectral ratios

N61E component, with S04 (at the toe) as the reference station:

→ Simulation consistently reproduces the SSR up to f=3Hz

→ Possibly inconsistent Vs profile near the basin edge; possible 3D effects



Conclusions

- Standard spectral ratios from EQ recording are consistent with numerical simulations and with the previous studies
- Sites within the basin show strong amplification of motions
- HVSR are broadly consistent with observed and simulated spectral ratios

Work in progress

- Numerical analysis of out-of-plane component
- The coupled effect of near surface geology
- Discussion on the choice of the reference station
- Discussion on the usefulness of ambient vibration (SSR and HVSR)