Strong ground motion simulations with empirical Green's functions: the 2009 L'Aquila earthquake

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Kinematic Source Inversion

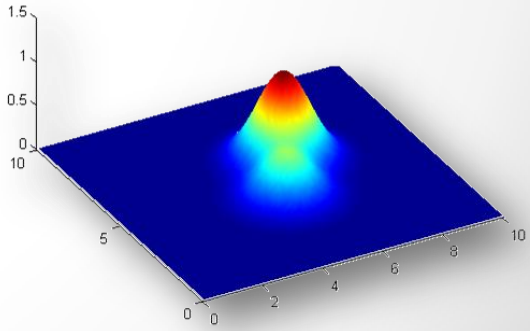
Inverse problem is solved using the 2-step strategy proposed in Lucca et al. 2012.
Considering the representation theorem in the frequency domain:

$$u_k(\underline{x},\omega) = \iint_S s_i(\underline{\xi},\omega)\,\frac{\partial G_{ik}(\underline{\xi},\omega;\underline{x})}{\partial \xi_i}$$

Green tractions are computed via a Discrete wavenumber- finite-element method (Olson et al. , 1984)

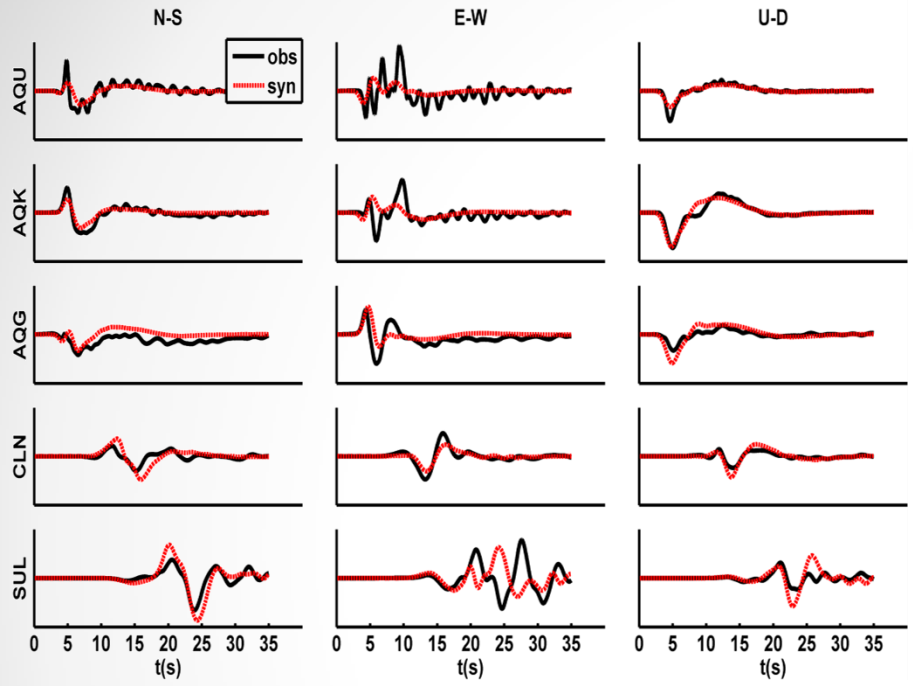
To obtain the source parameter, we solve the forward problem and compare synthetics with real data

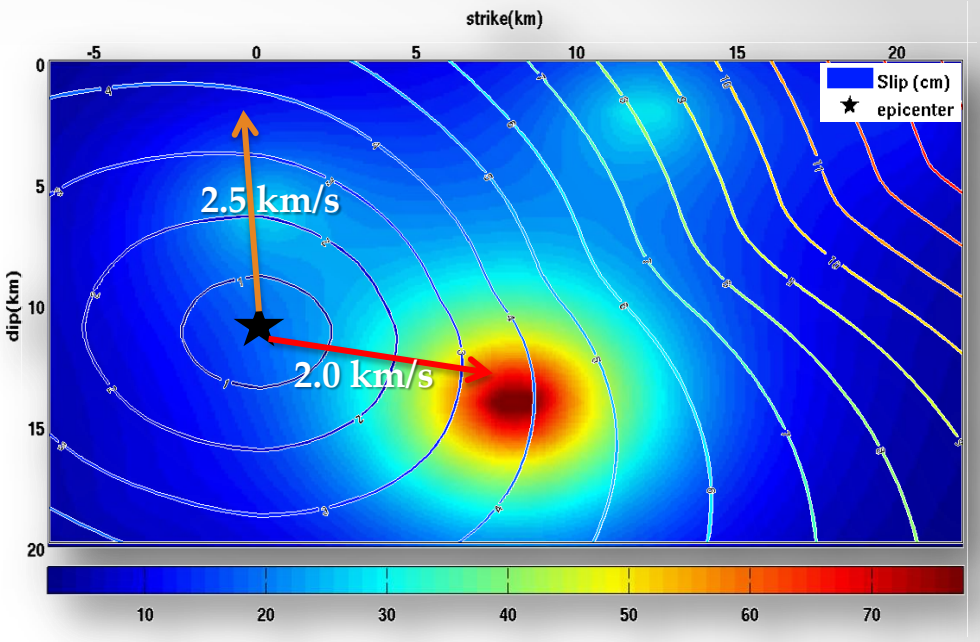
We inverted for
- Slip Distribution
- Rupture Velocity

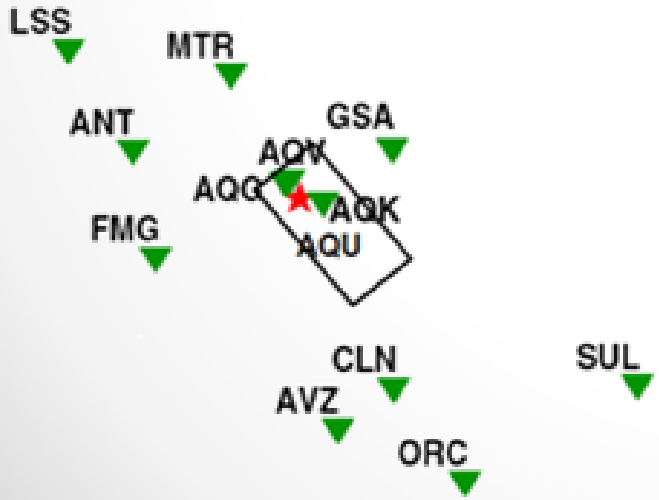


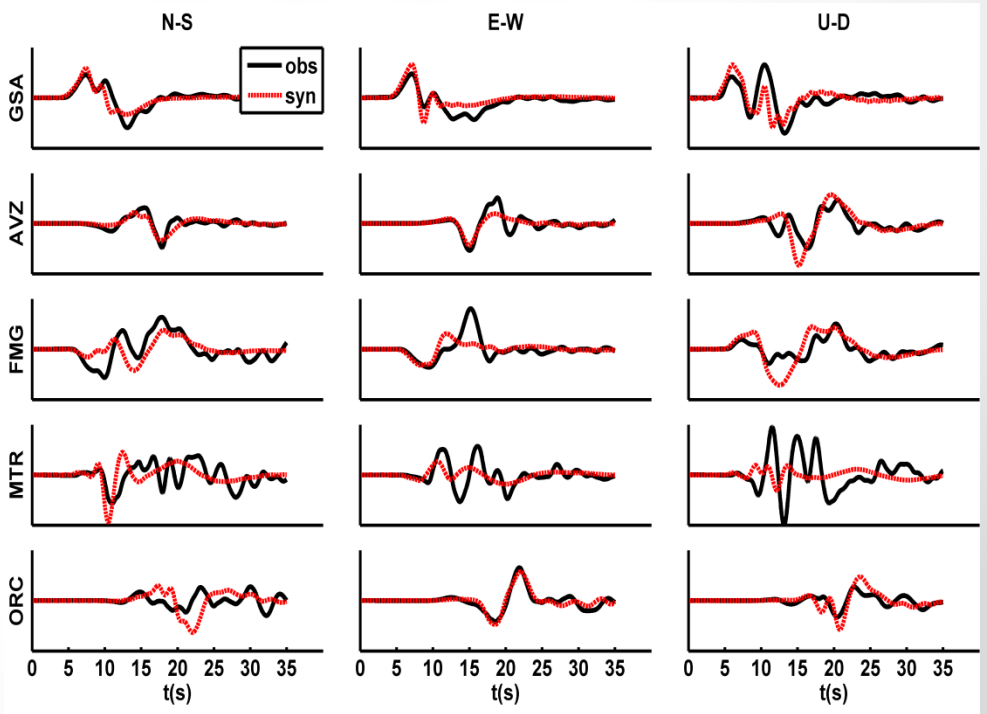
Rise Time is fixed at 1s

Source Model



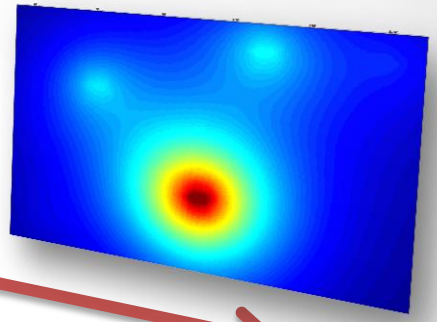






Broadband Simulation

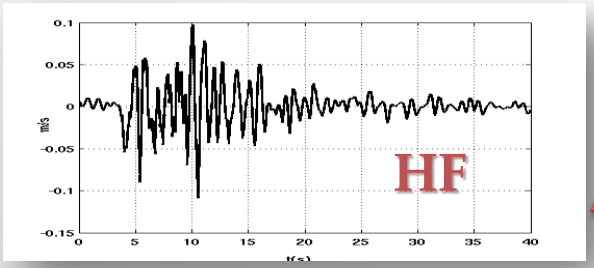
Kinematic source model

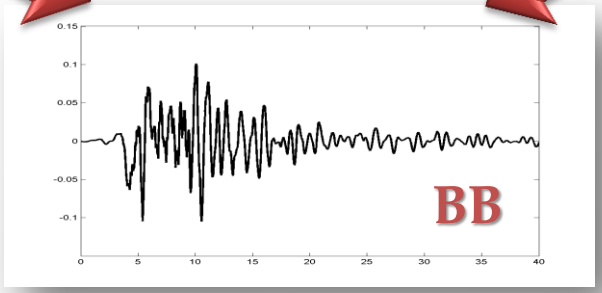


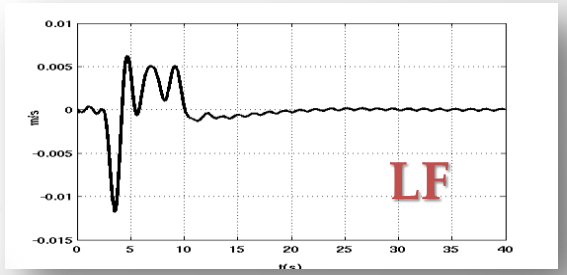
HF simulations (f > 0.5 Hz)
3D Empirical Green's Functions

LF simulations
(f < 0.5 Hz)
1D/3D Numerical
Green's Functions

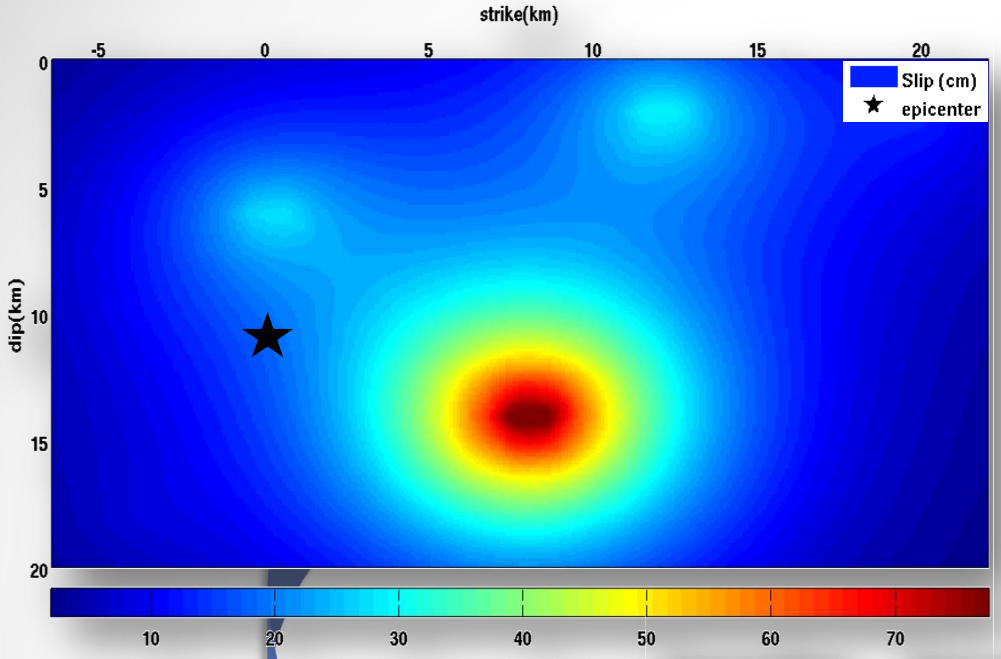
BB (0 < f < 5-10 Hz)
Combine LF+HF
With matched filter



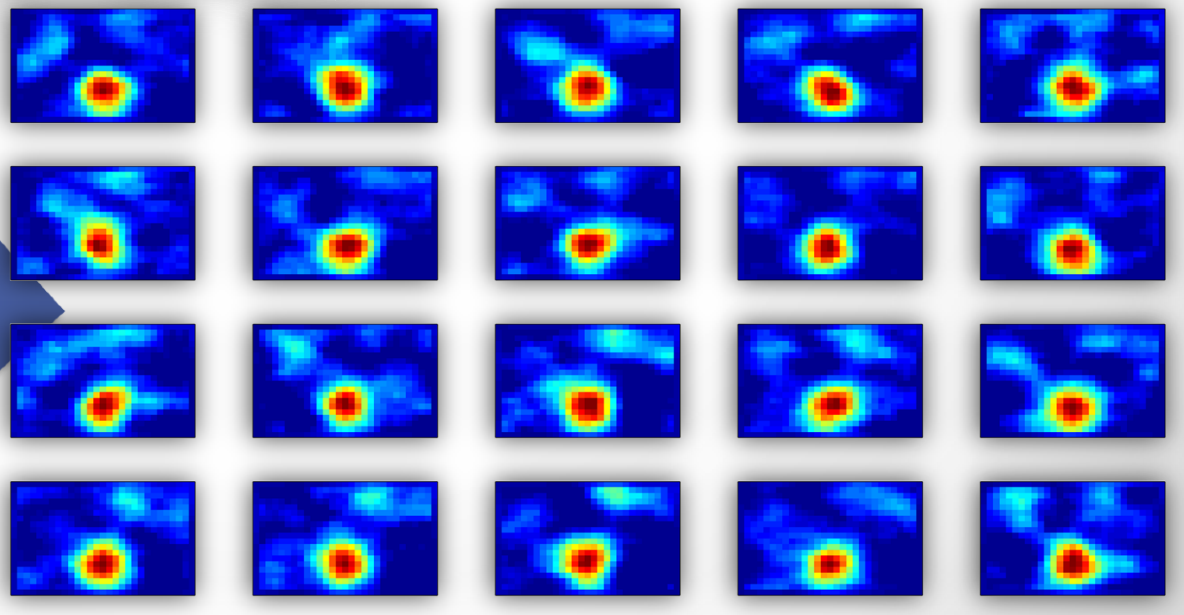




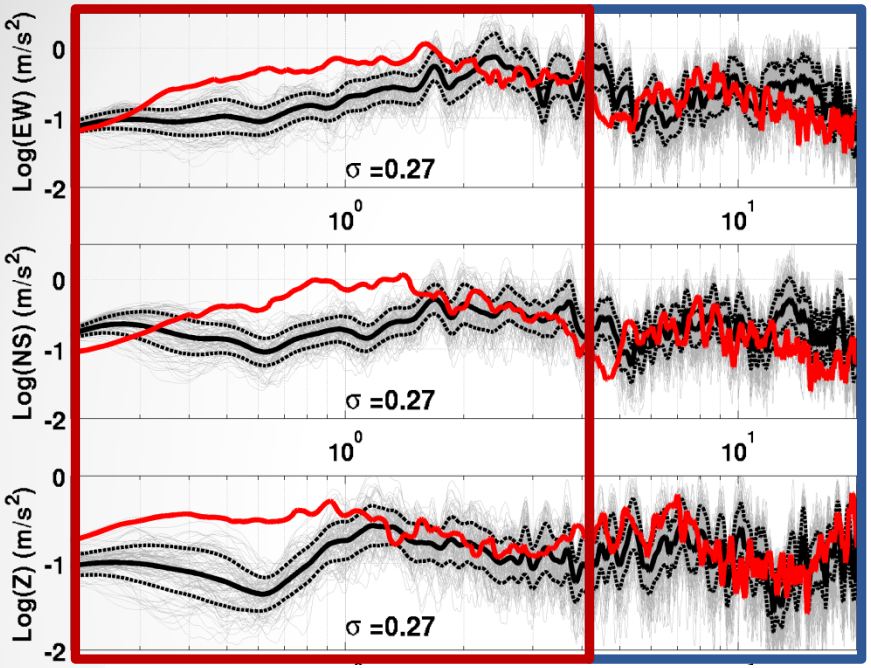
K^{-2} Source Model

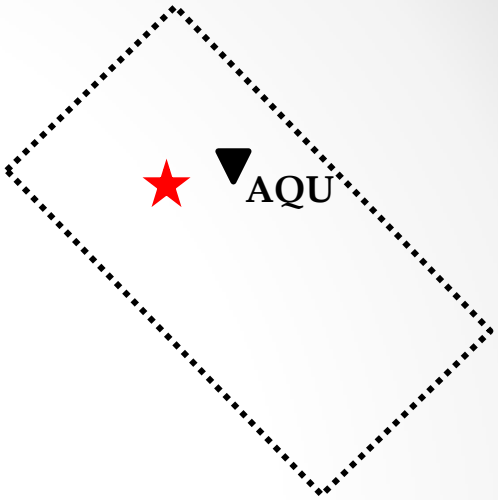


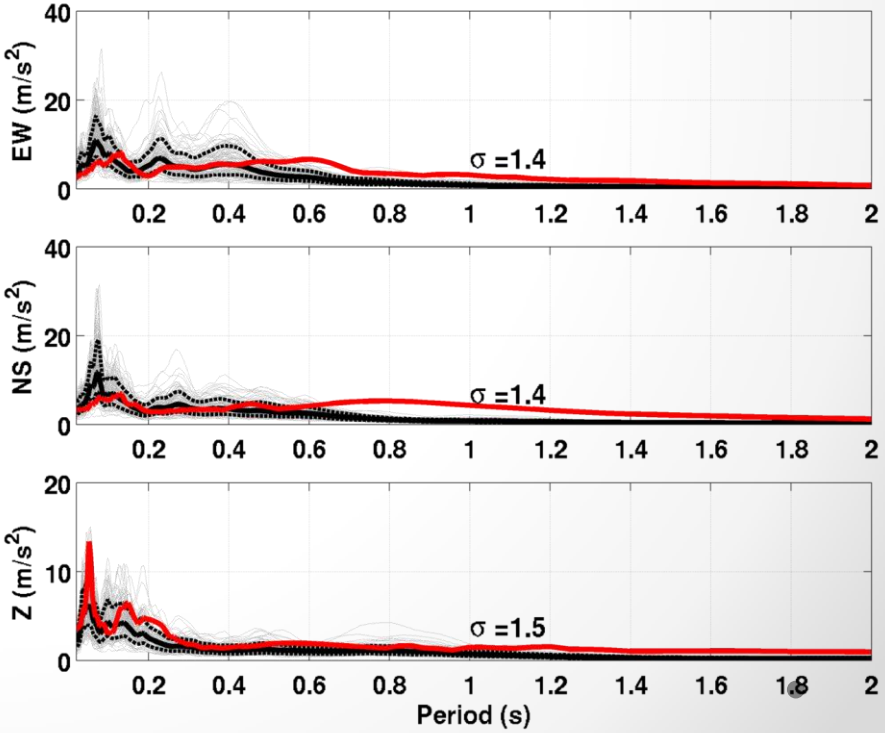
K^{-2} slip distributions obtained summing small asperities with random phases to low frequencies slip model



Broadband Simulations

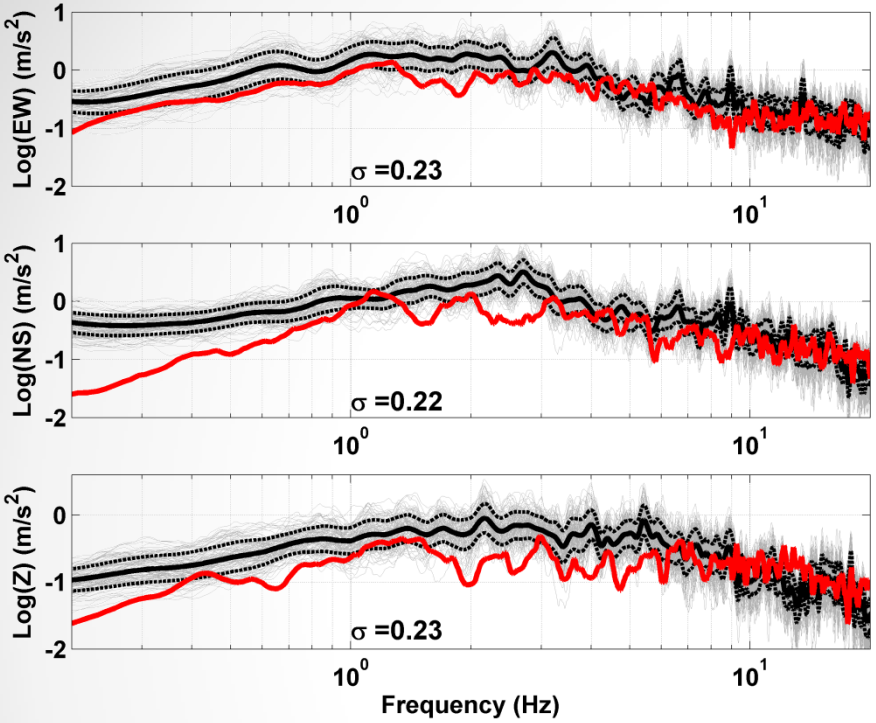


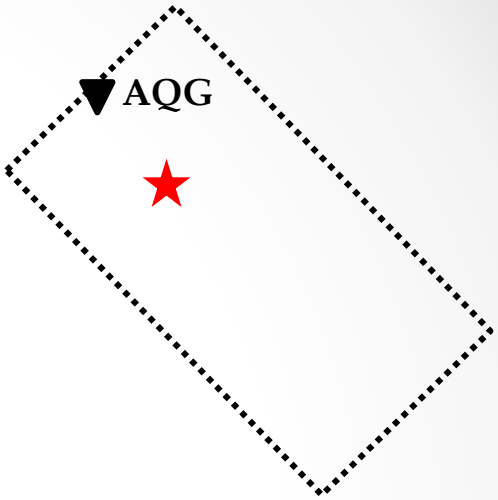


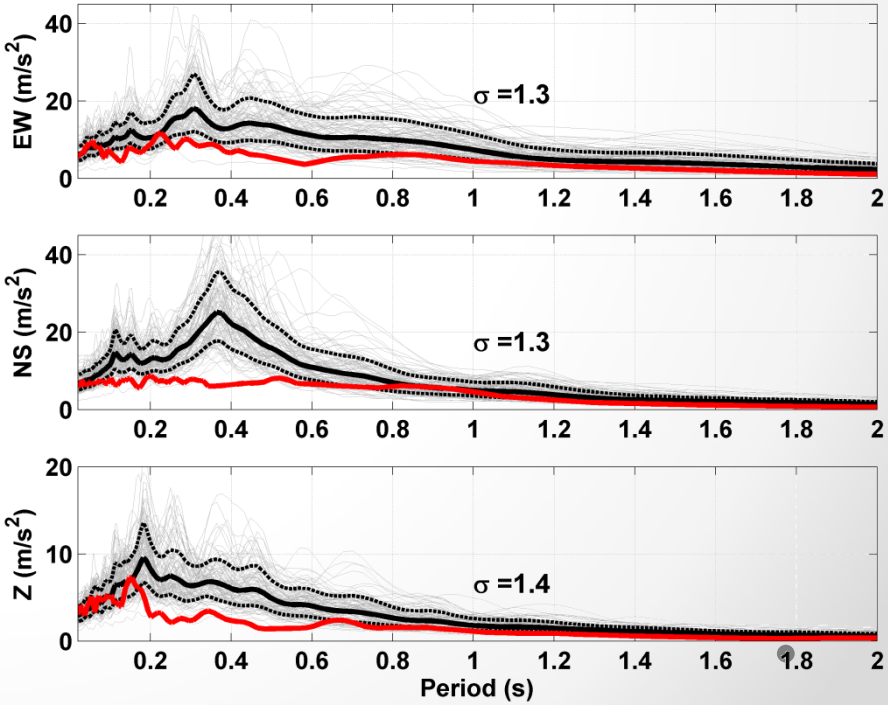


Fourier amplitude spectra and response spectra for AQU station (~2km from the epicenter)

Broadband Simulations

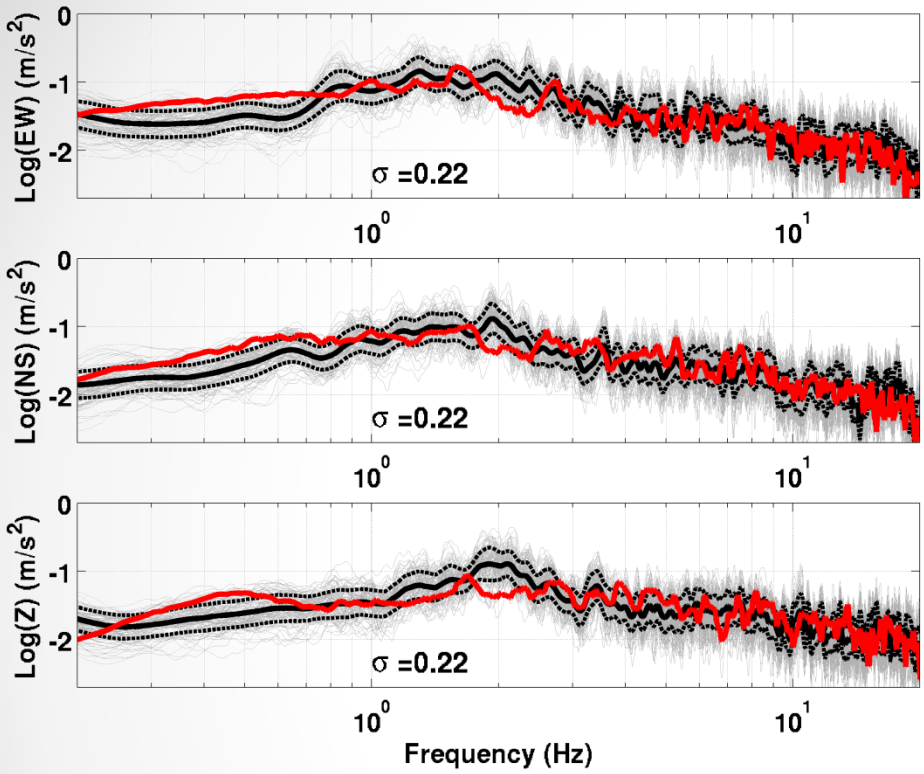


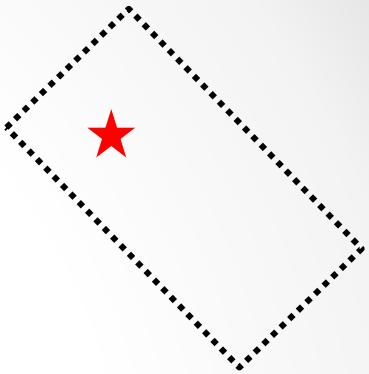


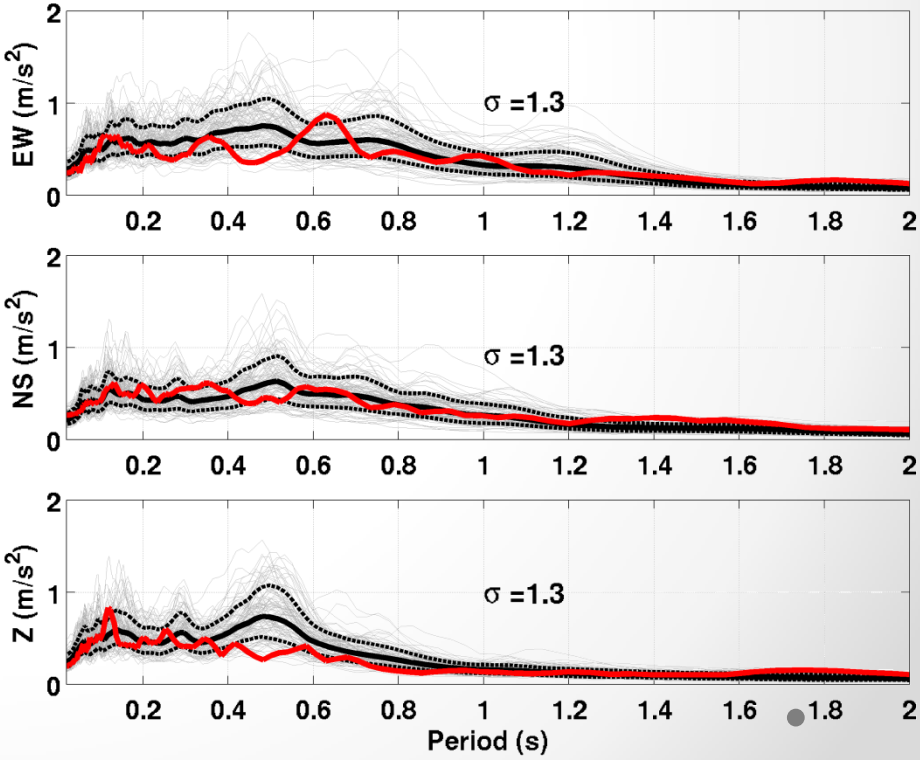


Fourier amplitude spectra and response spectra for AQG station (~5km from the epicenter)

Broadband Simulations

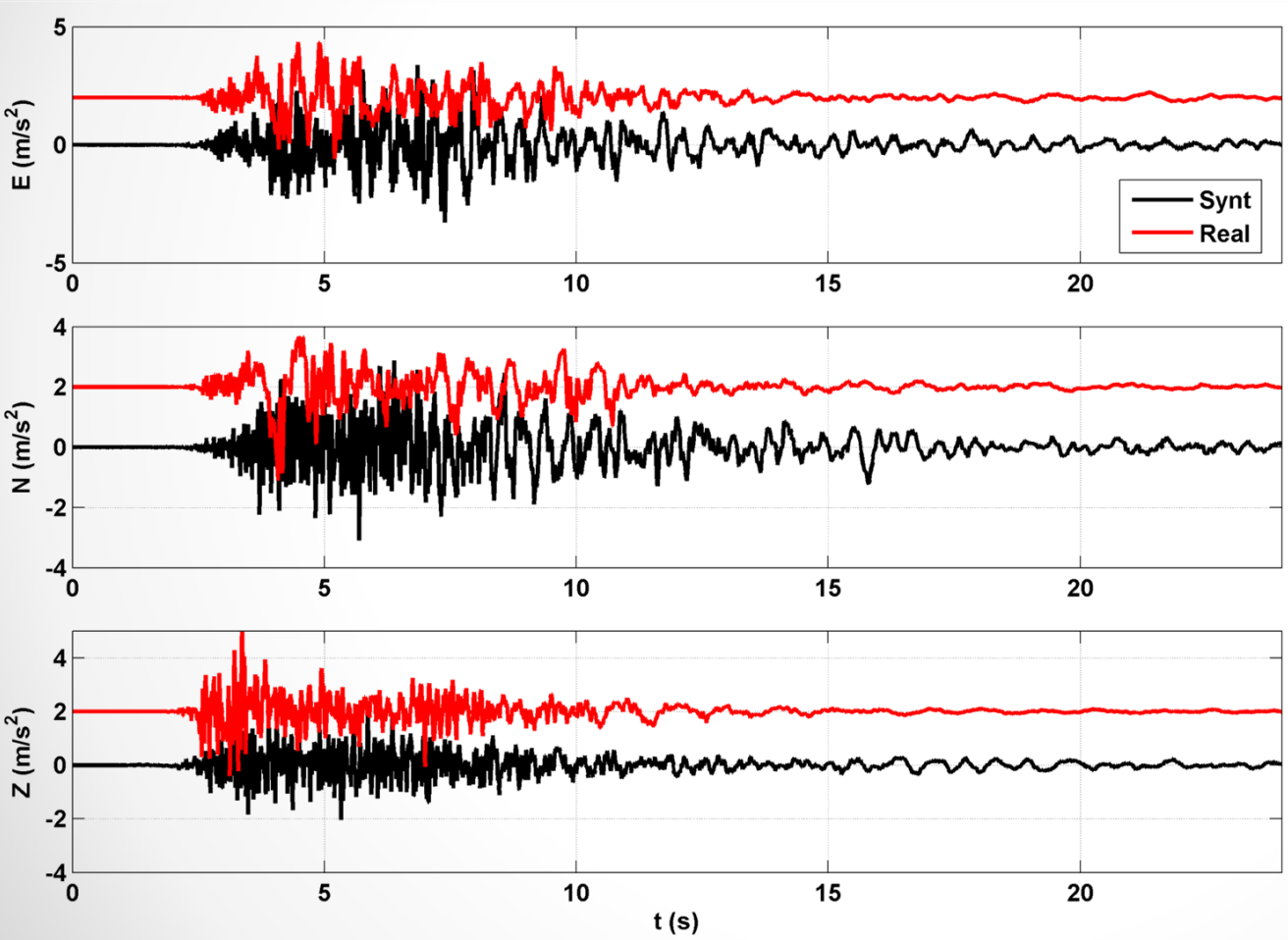


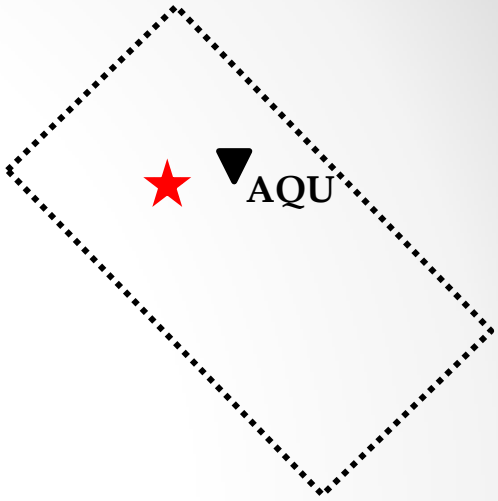




Fourier amplitude spectra and response spectra for FMG station (~25 km from the epicenter)

Broadband Simulations





Conclusions and Future Perspectives

- ✓ We have obtained a broader description of the source which coupled with the EGFs well reproduce the high frequency part of the signals

- ✓ We have to improve kinematic model because:
  - Near fault station are characterized by high frequency peak acceleration that are not reproduced by numerical simulations
  - For stations like AQG, synthetic amplitudes are significantly lower than real ones at low frequency

- ✓ We also have to improve simulations in the ''middle'' frequency range introducing a more complex 3D propagation model for L'Aquila basin