

Past, Present, and Future of 2D Site Response with Soil Heterogeneity

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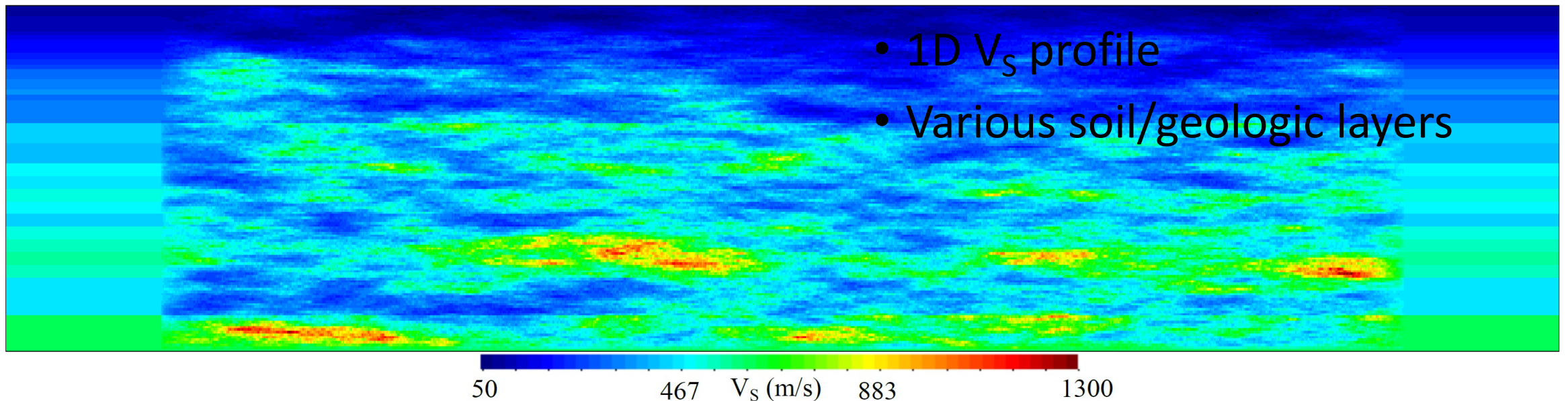
Felipe Kuncar

DT1 Kick-off meeting

29 July 2021

Introduction

- 1D structure extended to 2D (no lateral variability in soil layers)
- Represents “random” geologic structure missed by site characterisation
 - Limited number of explorations
 - Averaging of V_S across a soil layer (surface wave testing)

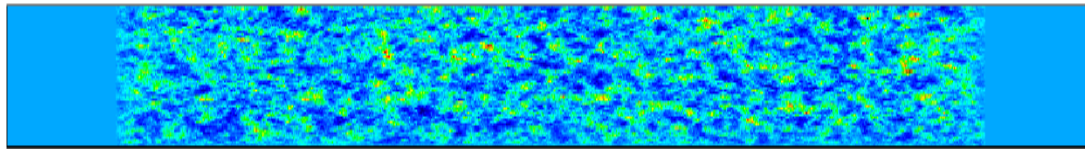


Past: Parametric Analysis

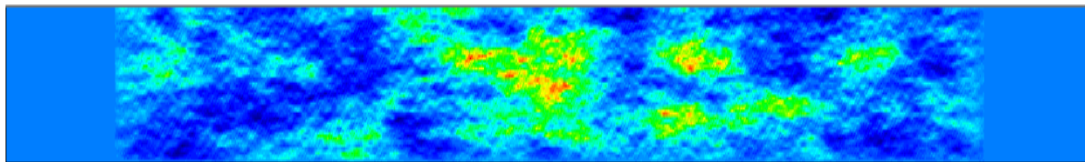
- To understand influence of random field input parameters on site response
- Using a simple, idealised, single-layer profile

σ_{InVs} – Most influential

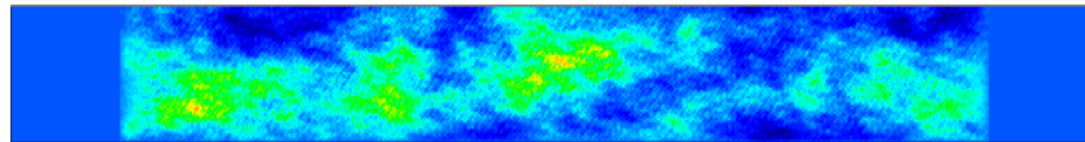
$r_H = 5$ m



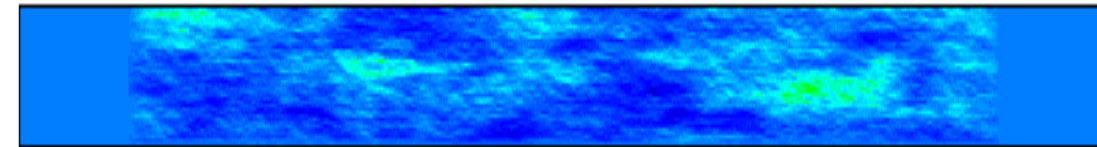
$r_H = 50$ m



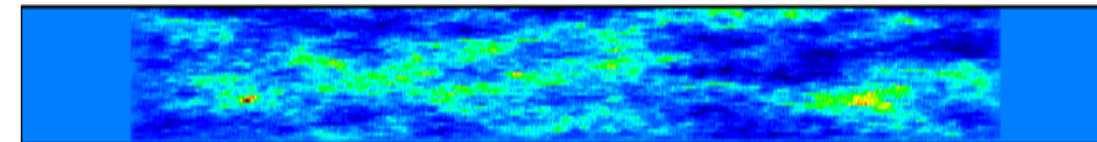
$r_H = 100$ m



$\sigma_{InVs} = 0.175$

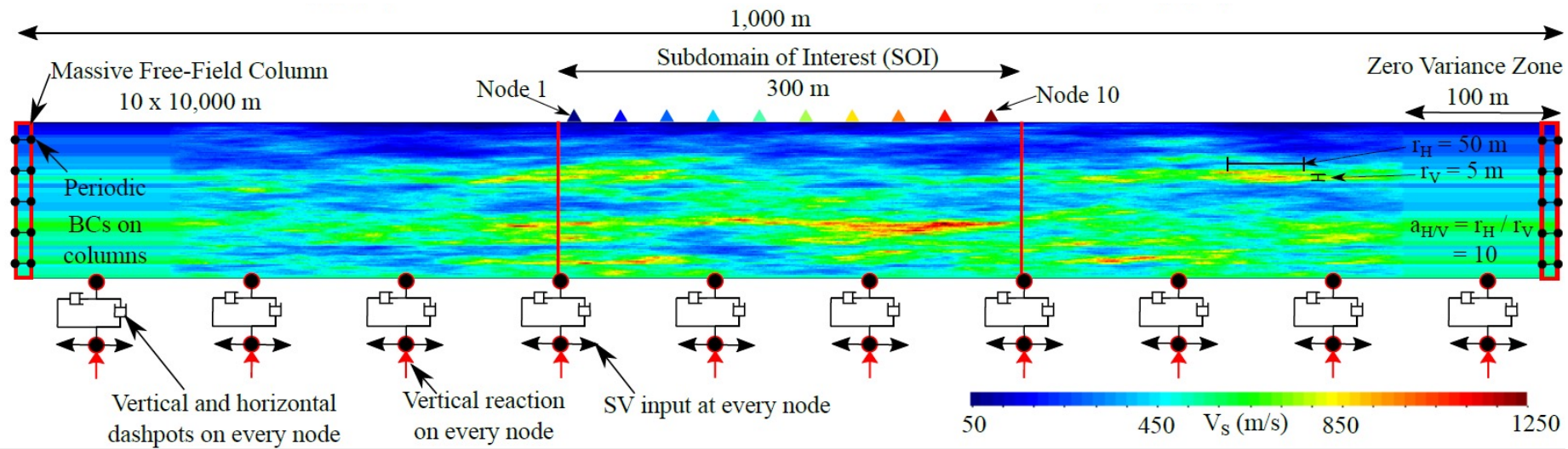


$\sigma_{InVs} = 0.325$



Present: Application to Vertical Array Sites

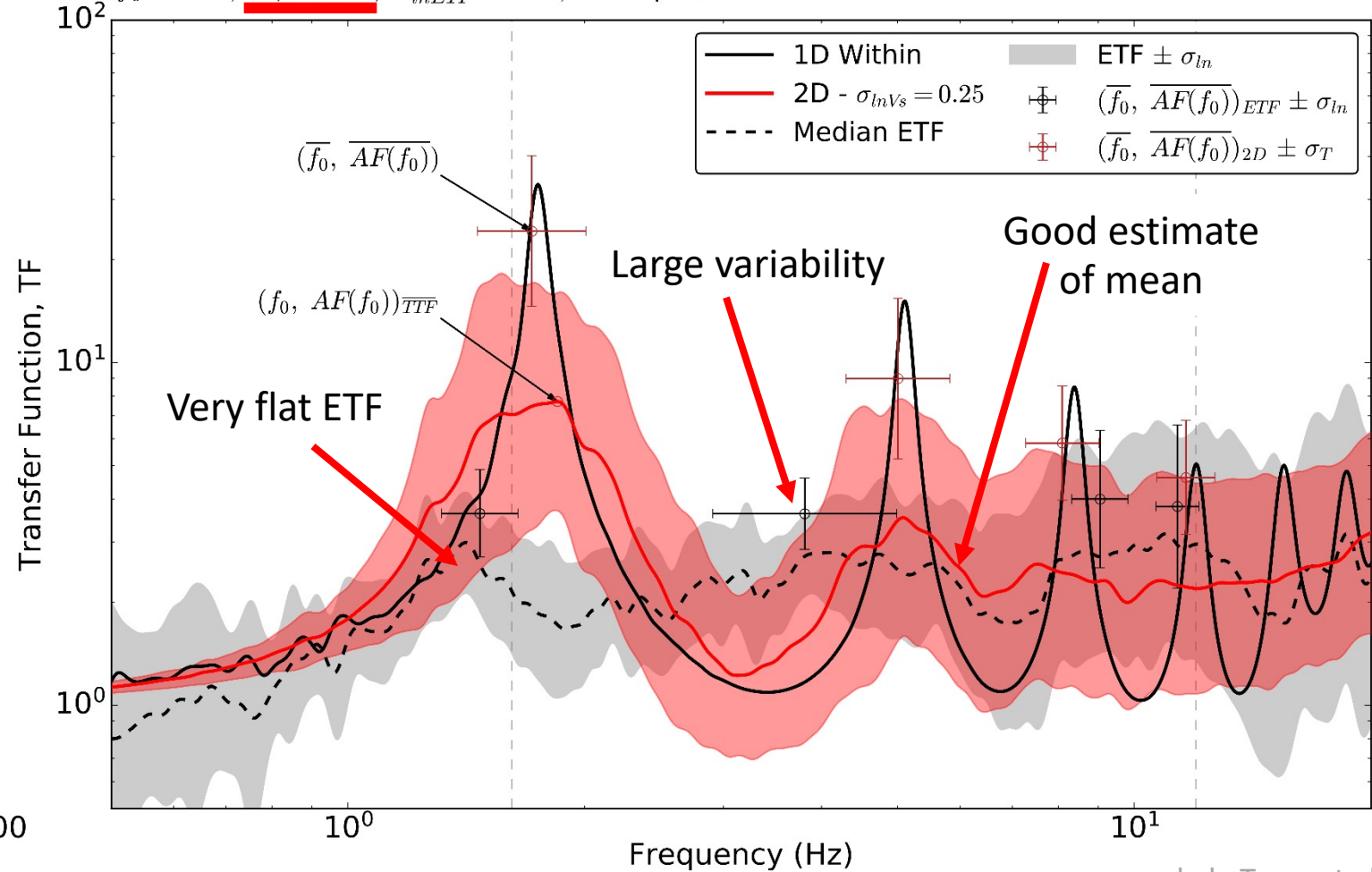
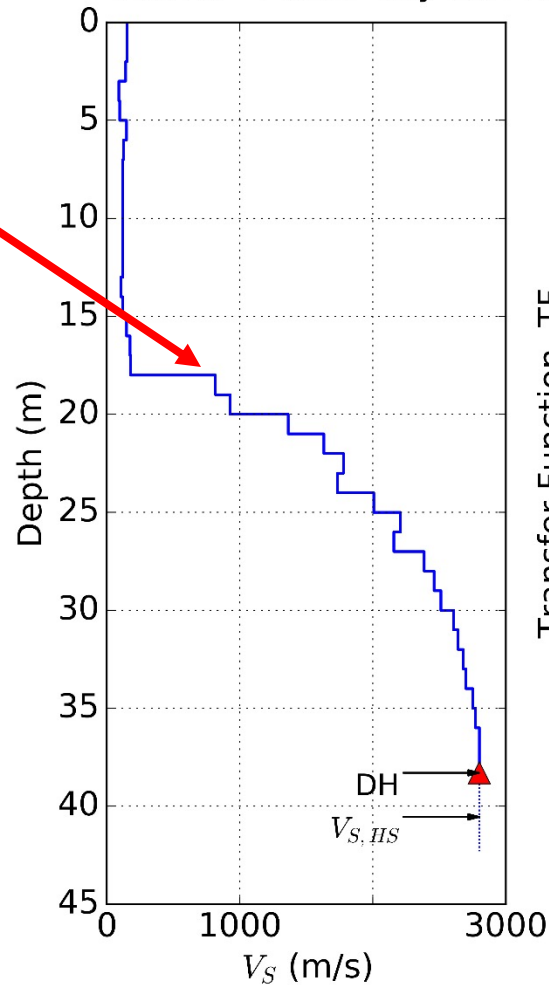
- Database of 21 vertical array sites in California (Afshari et al. 2019)
- Extension of 2D method to multi-layered profiles
- Boundary conditions for recorded “within” motions
 - Theoretically should use rigid base
 - Compliant base preferred for heterogeneous models



Foster City: Strong 2D/3D Effects

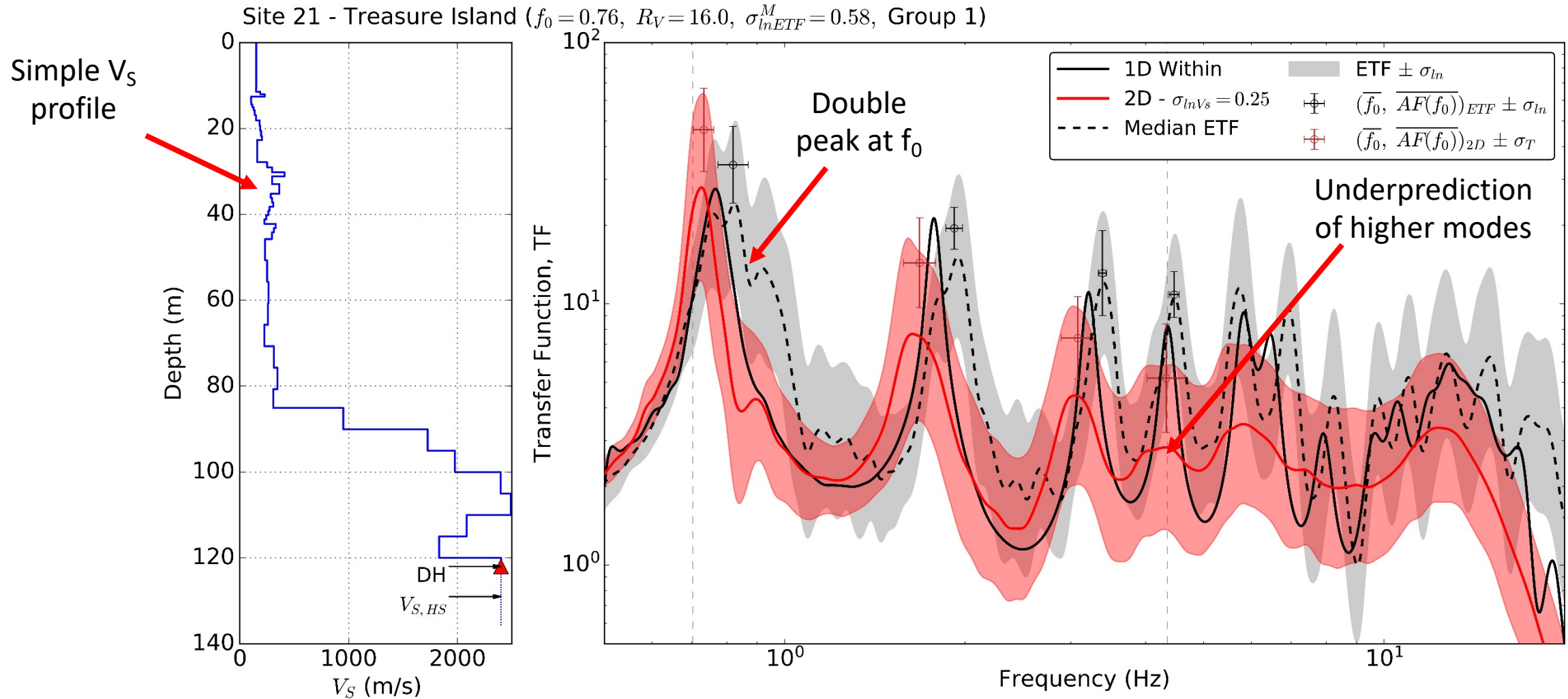
Site 18 - Foster City-San Mateo ($f_0 = 1.75$, $R_V = 22.4$, $\sigma_{lnETF}^M = 0.56$, Group 1)

Large impedance at shallow depth



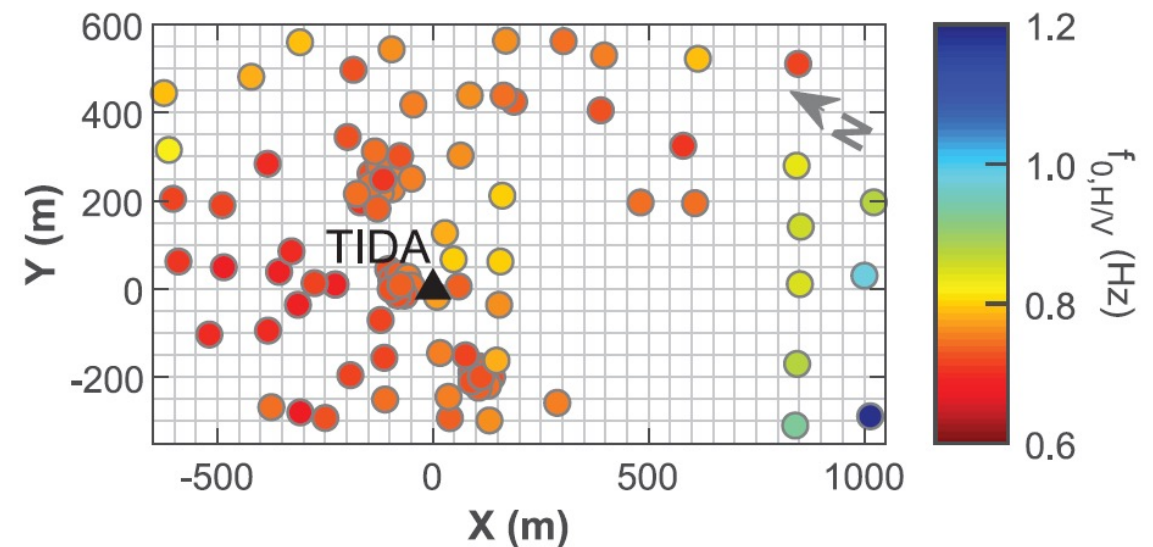
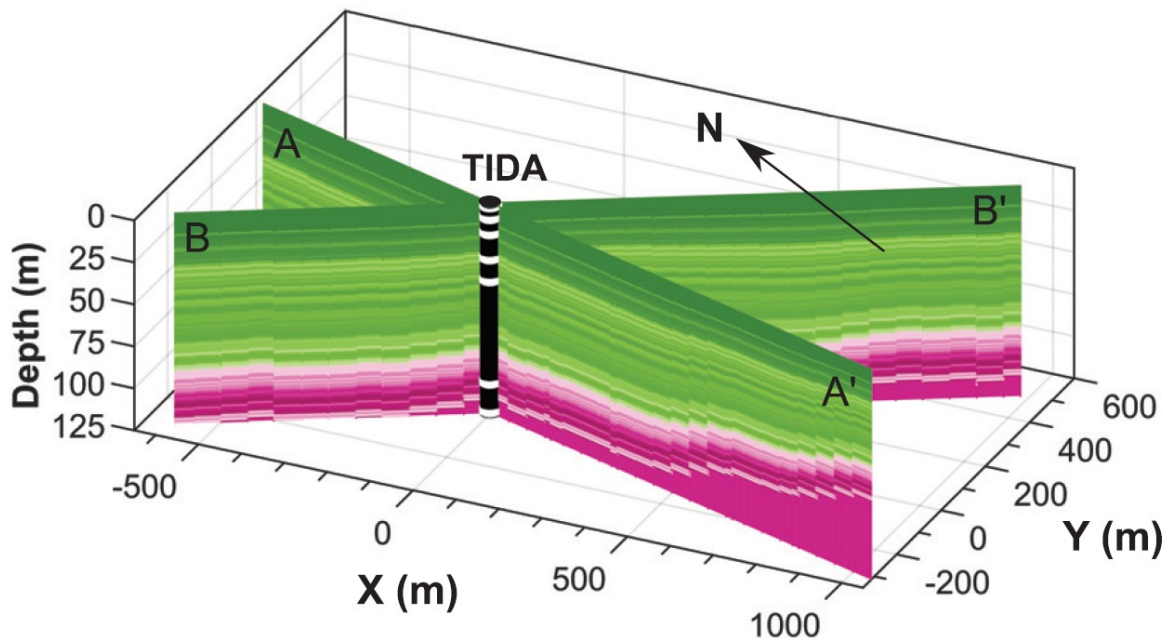
Treasure Island: A 1D Site!

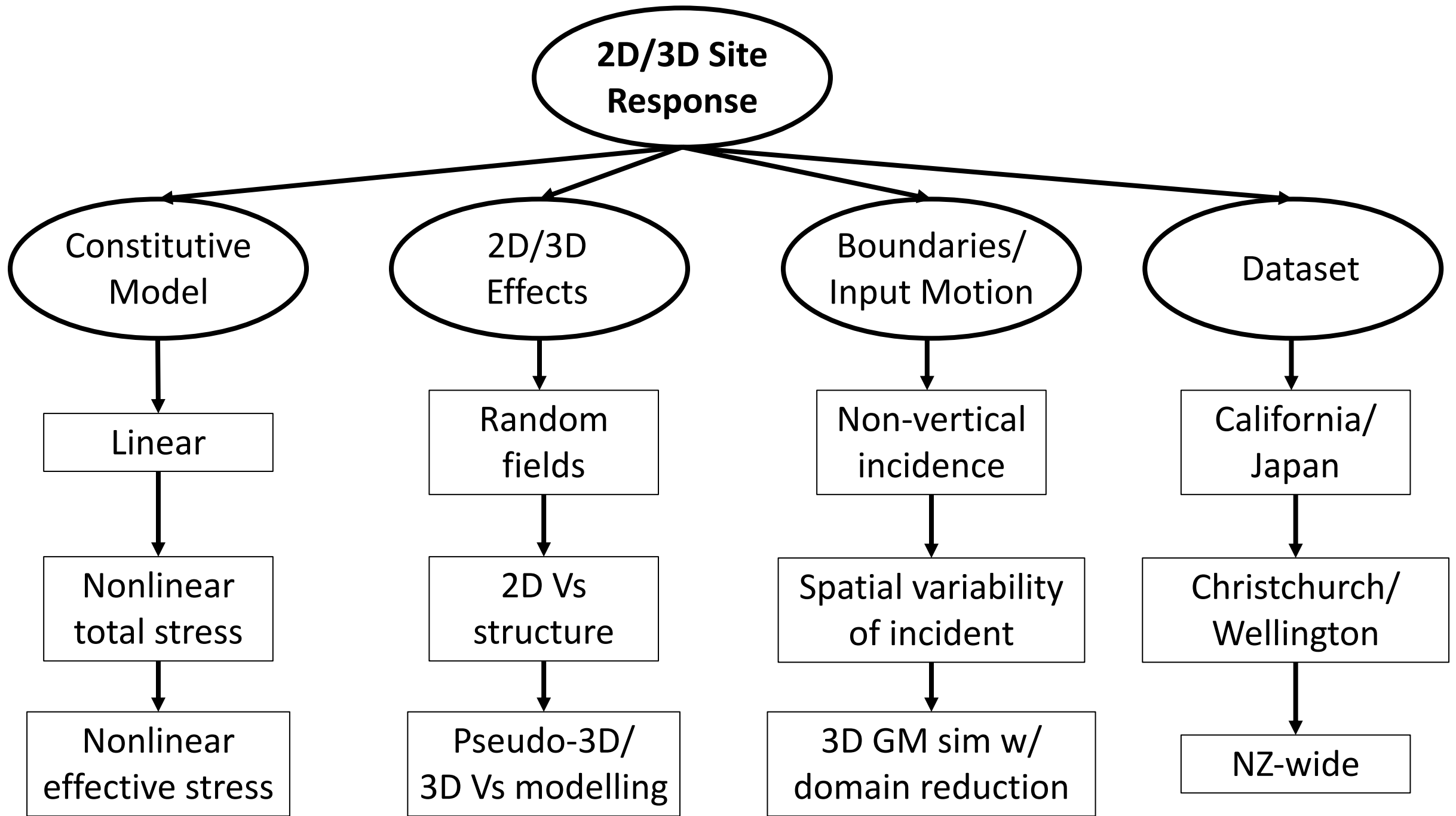
Do features of 1D V_s profile manifest in 2D analyses??



Future: Towards Modelling 2D/3D Structure

- Goal: Model more physics! (2D/3D effects)
- Pseudo-3D Vs modelling approach by Hallal and Cox (2021)
 - Depth to bedrock from Vs measurement scaled by f_0 from H/V
 - Can run 2D cross-sections in current implementation





2D/3D Site Response

Constitutive Model

Linear

Nonlinear total stress

Nonlinear effective stress

2D/3D Effects

Random fields

2D Vs structure

Pseudo-3D/ 3D Vs modelling

Boundaries/ Input Motion

Non-vertical incidence

Spatial variability of incident

3D GM sim w/ domain reduction

Dataset

California/ Japan

Christchurch/ Wellington

NZ-wide