Site Response in Sedimentary Basins of Wellington: Through the Lens of Spatial Correlation

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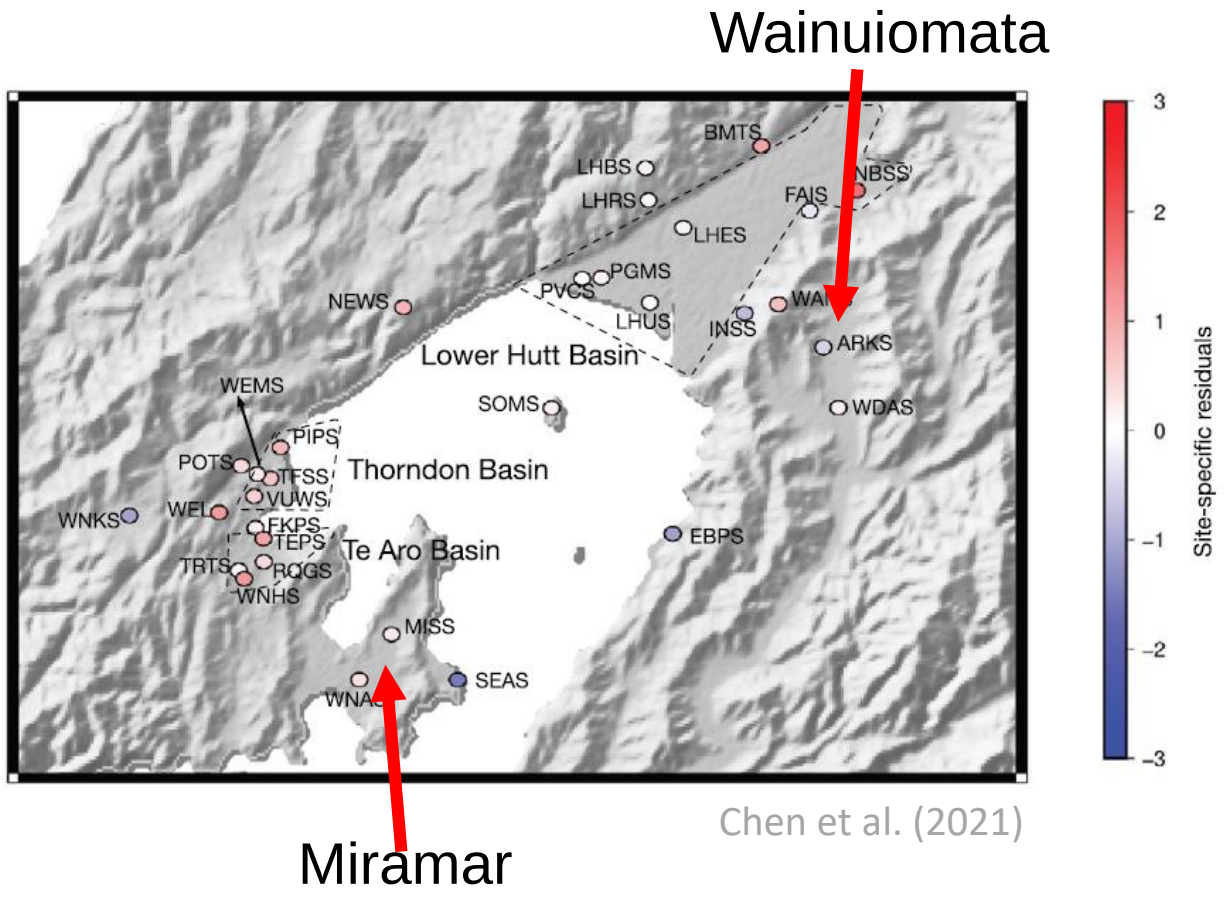
QuakeCoRE
NZ Centre for Earthquake Resilience

Outline of Presentation

- Previous work on spatial correlation in Wellington
- Analysis of site residuals in Wellington basins and valleys:
  - Resemblance within specific geomorphic features
  - Dependence on site period (T_{site})
- 2D basin response analyses:
  - 2D cross-sections from 3D Vs model
  - Spatial variability (or correlation) of basin amplification factors
  - Dependence on scale of geomorphic feature and bedrock geometry

Previous Spatial Correlation Work in Wellington

- Chen, Bradley and Baker (2021) calculated the spatial correlation for sites in the Wellington region:
  - Within-event residual
    - Uncentered
  - Between basin subregions only:
    - Te Aro
    - Thorndon
    - Lower Hutt
  - Between basin and non-basin sites in Wellington



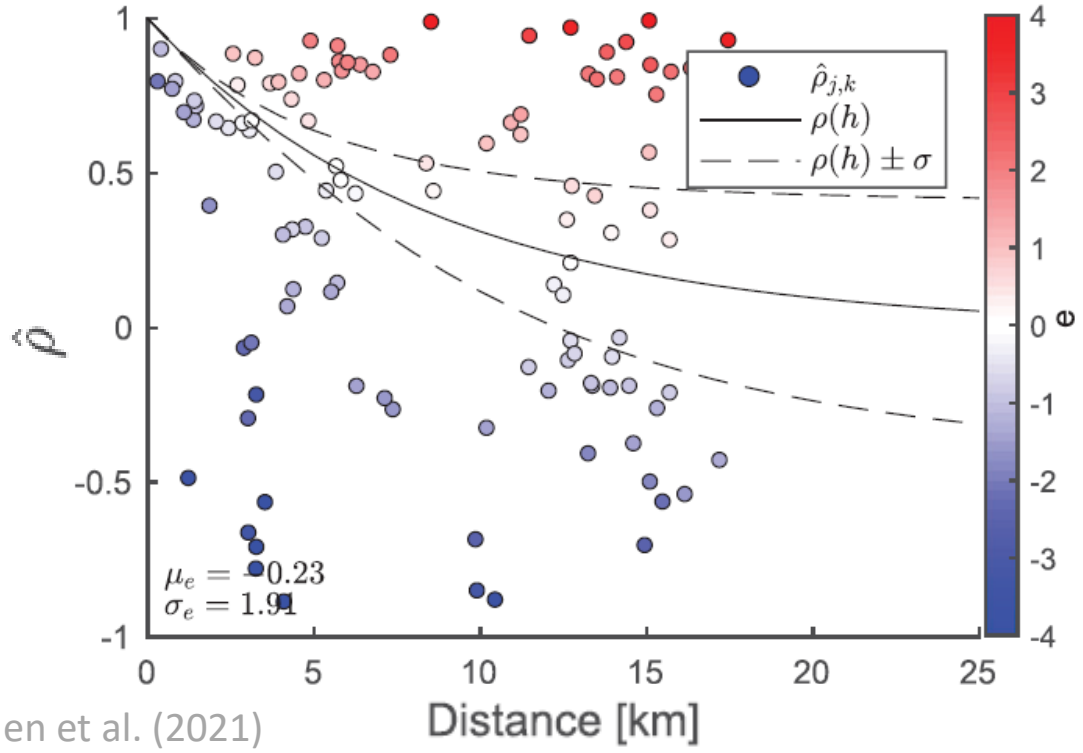
Chen et al. (2021)

Chen et al. (2021)

Spatial Correlation for SA(T = 1 s)

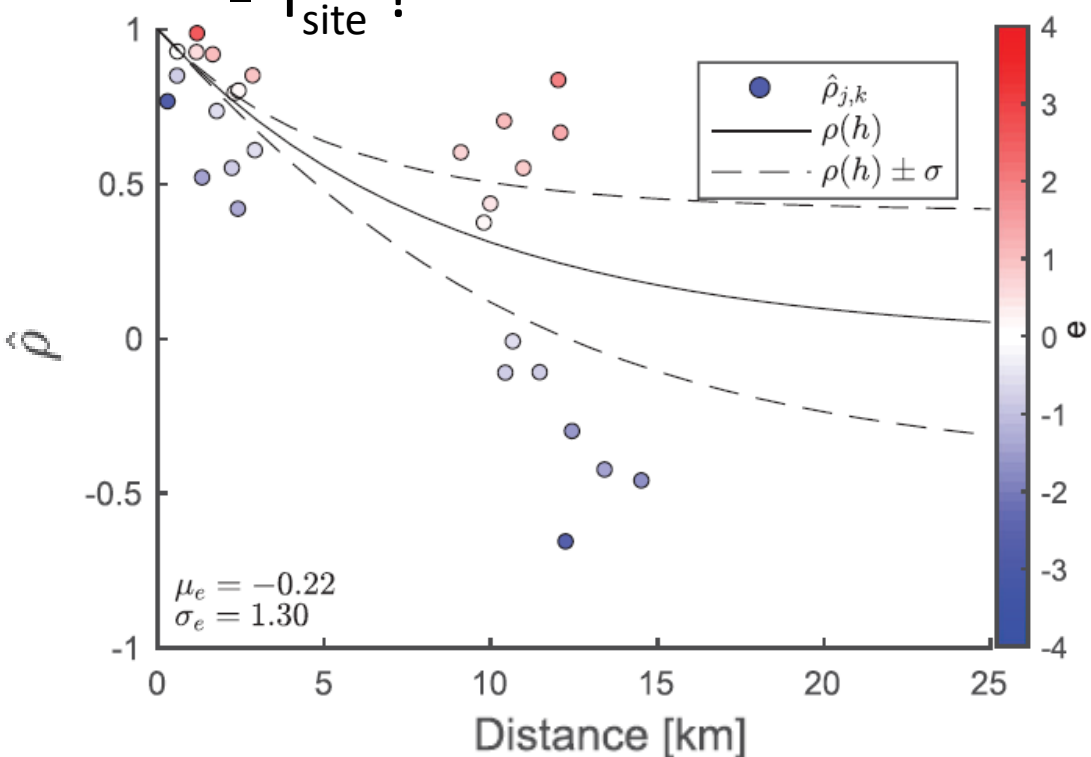
Basin and non-basin sites:

- Significant scatter
- Effect of surface geology
  - e.g. rock vs basin site



Basin sites only:

- Better agreement with model
- Still variability within bins
  - V_{S30} ?
  - T_{site} ?



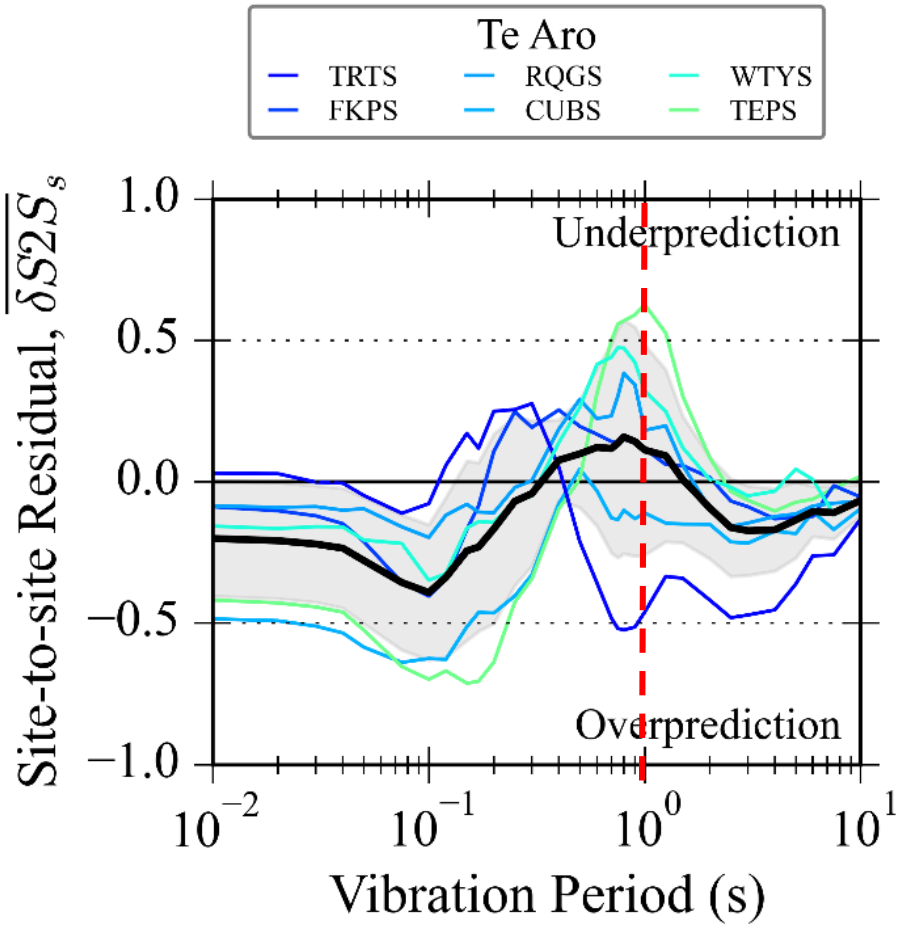
Chen et al. (2021)

Residual Analysis for Wellington Basins de la Torre et al. (2023)

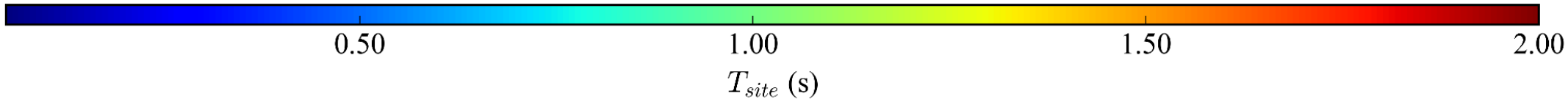
- Evaluate the performance of 2022 NZ NSHM GMMs in Wellington.
- Develop non-ergodic site-response adjustment factors for GMMs.
- Subdivided Wellington sites into several geomorphic features:
  - Basins: Te Aro, Thorndon, Lower Hutt, Upper Hutt
  - Valleys: Wainuiomata, Miramar, Karori, Porirua

- Can the GMMs capture the full site response of basin sites?
- Are residuals correlated within basin and valley sub-regions?
- Can we develop regional mean adjustment factors?

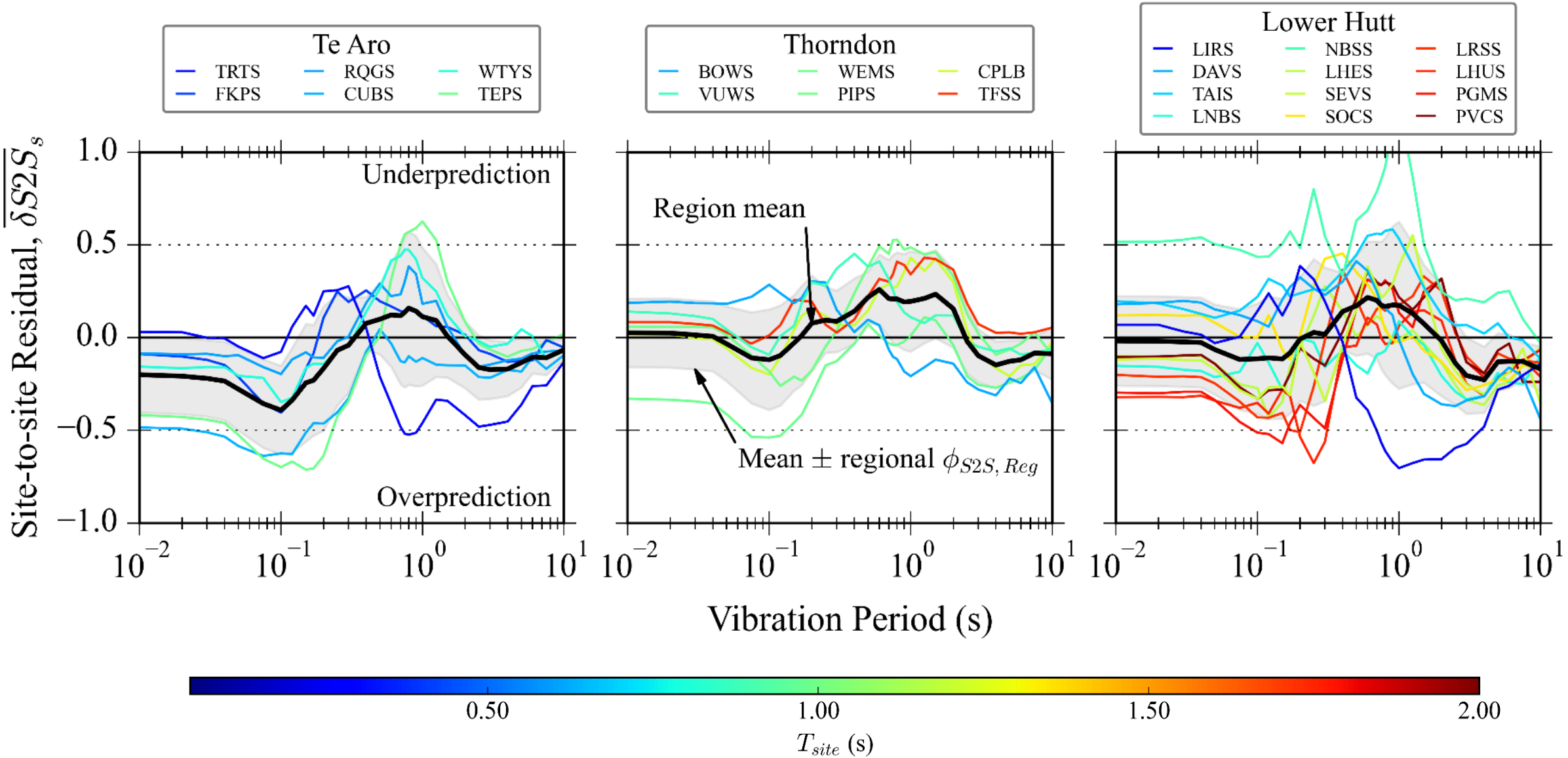
Site-to-Site Residuals for Basin Sub-regions



- For T = 1 second:
  - Some resemblance in δS2S between some sites
  - High standard deviation between all sites
- Position of peak scales with site period

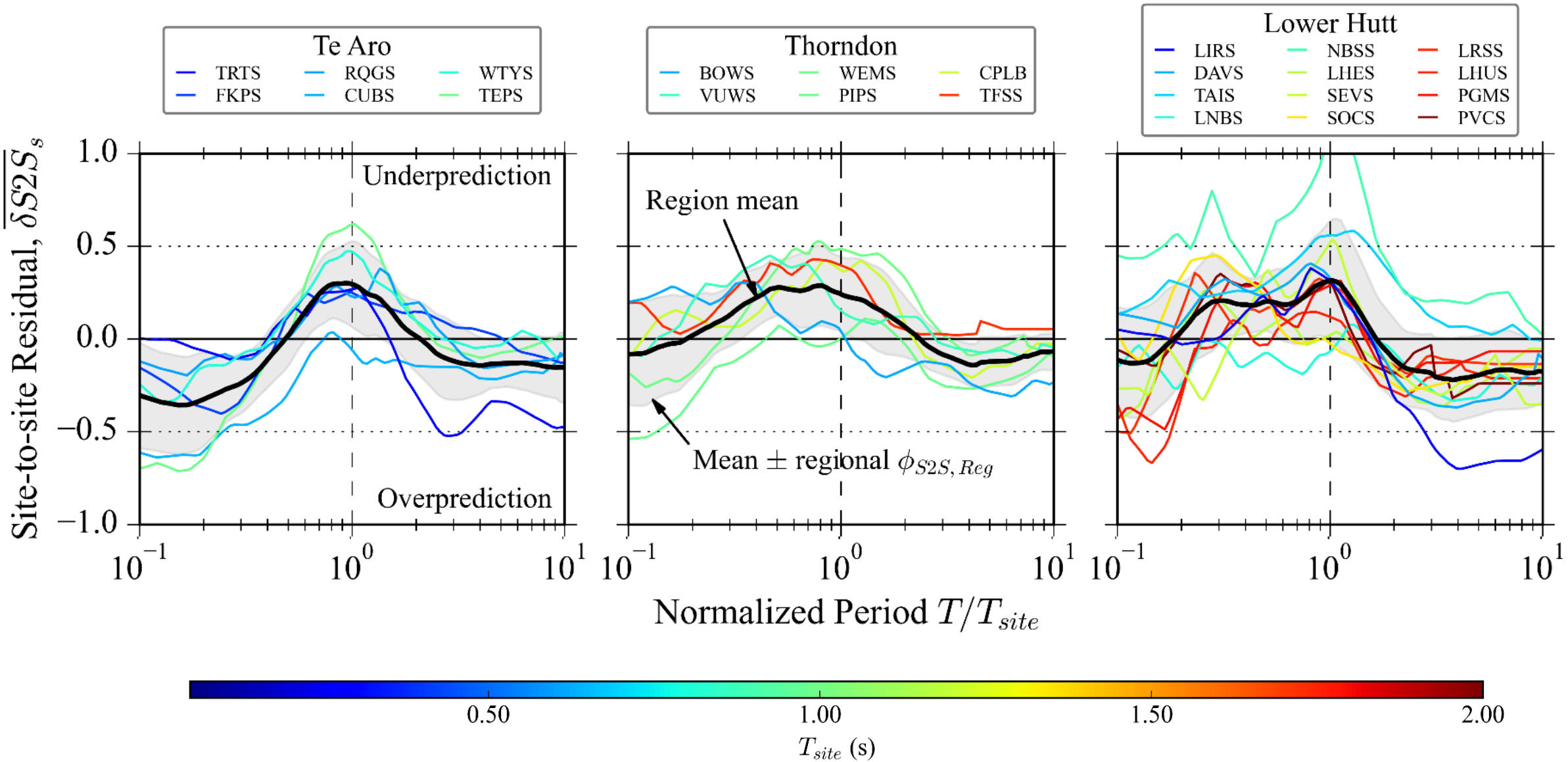


Site-to-Site Residuals for Basin Sub-regions

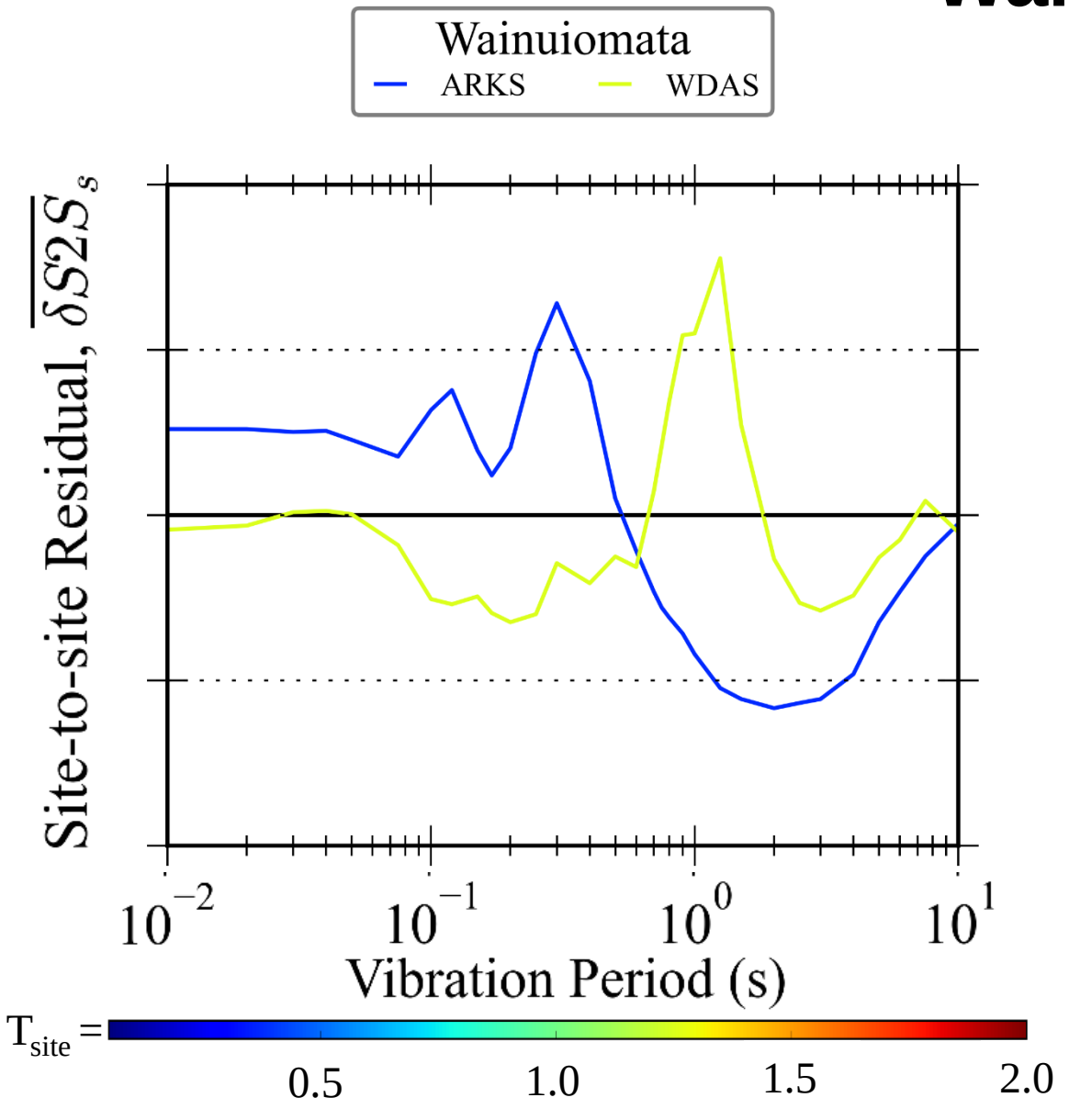


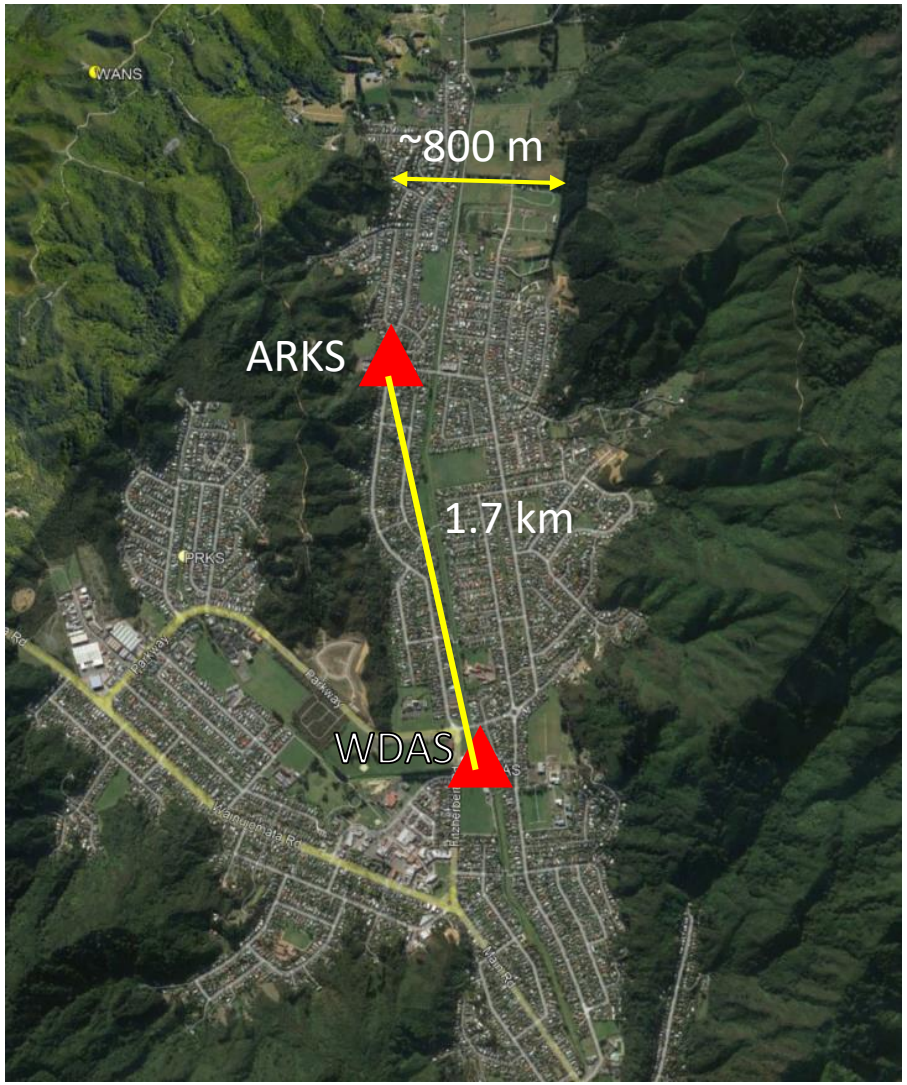
Site-to-Site Residuals for Basin Sub-regions

Normalisation of Period



Spatial Correlation in Narrow Valleys: Wainuiomata





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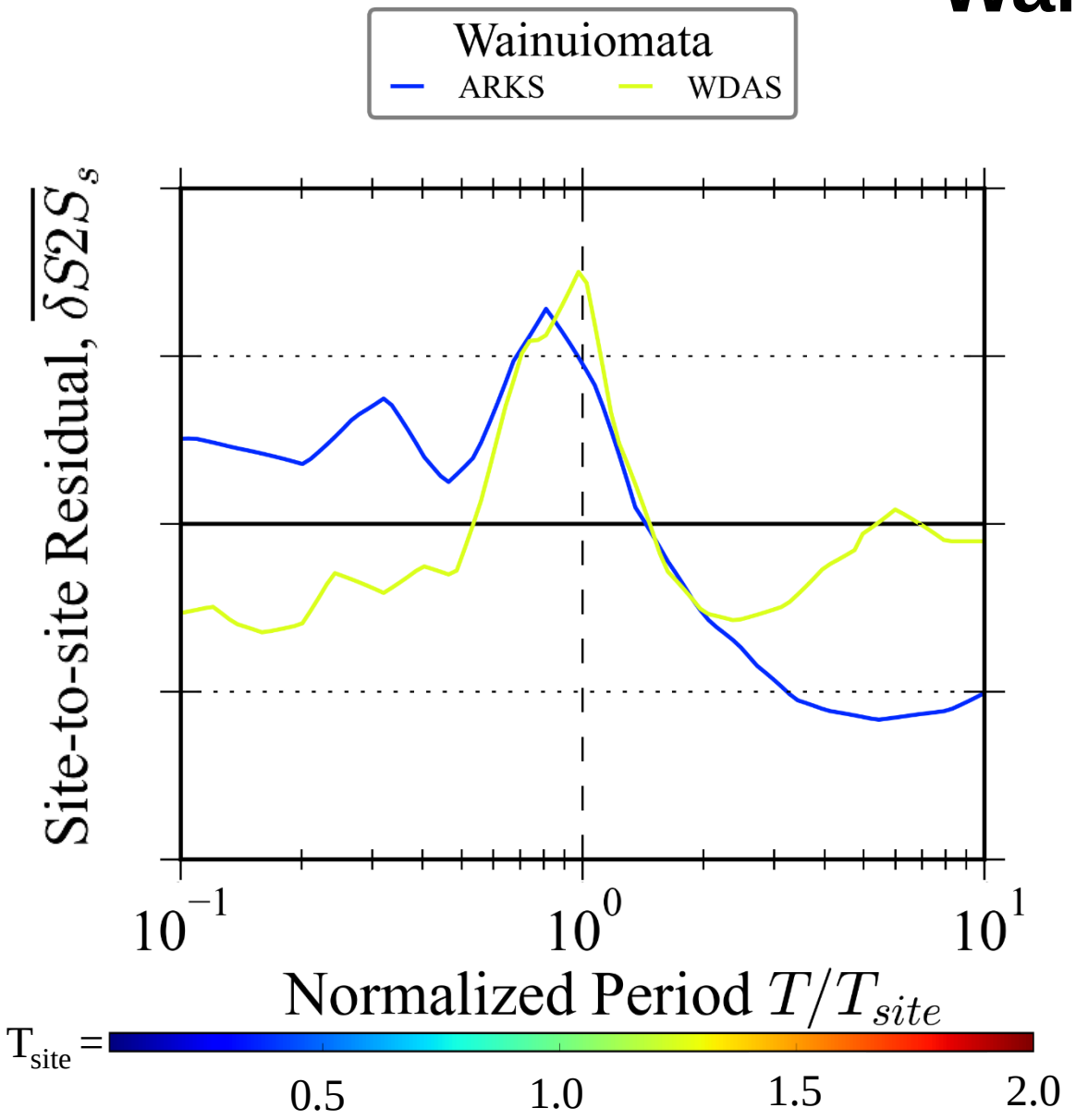
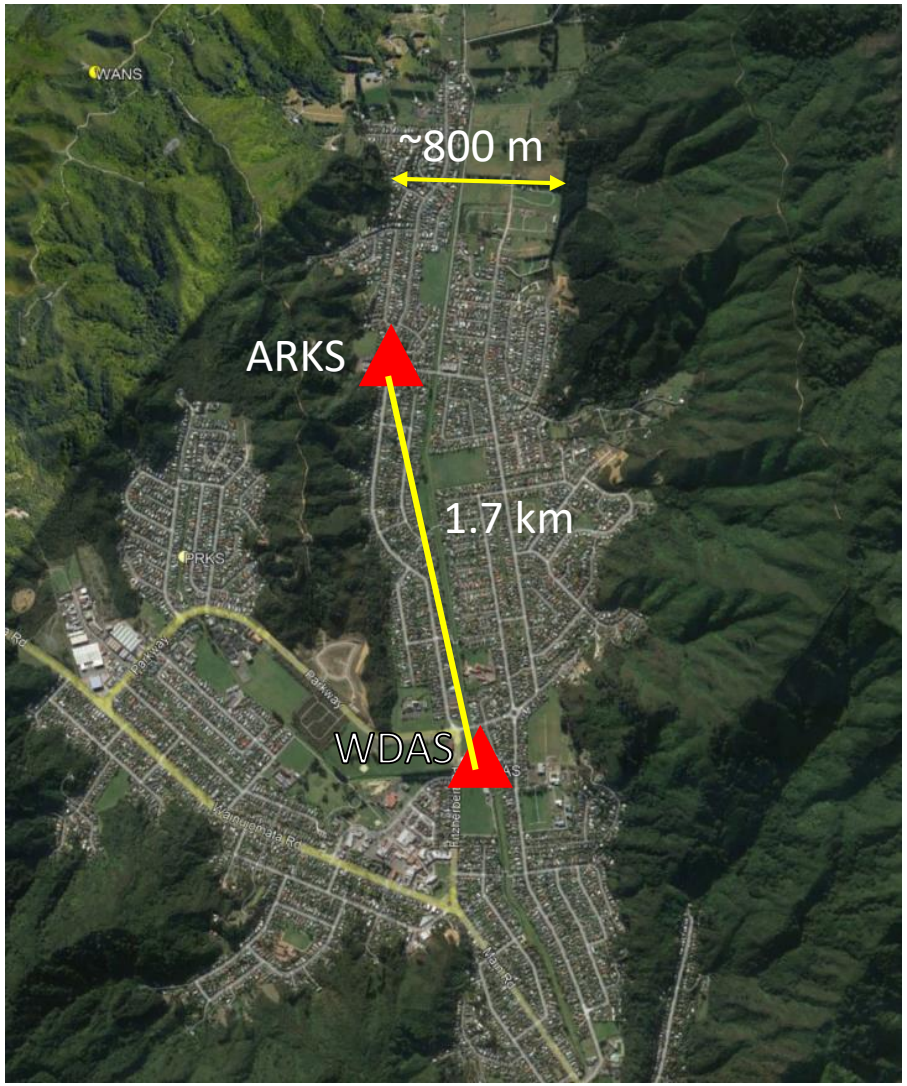
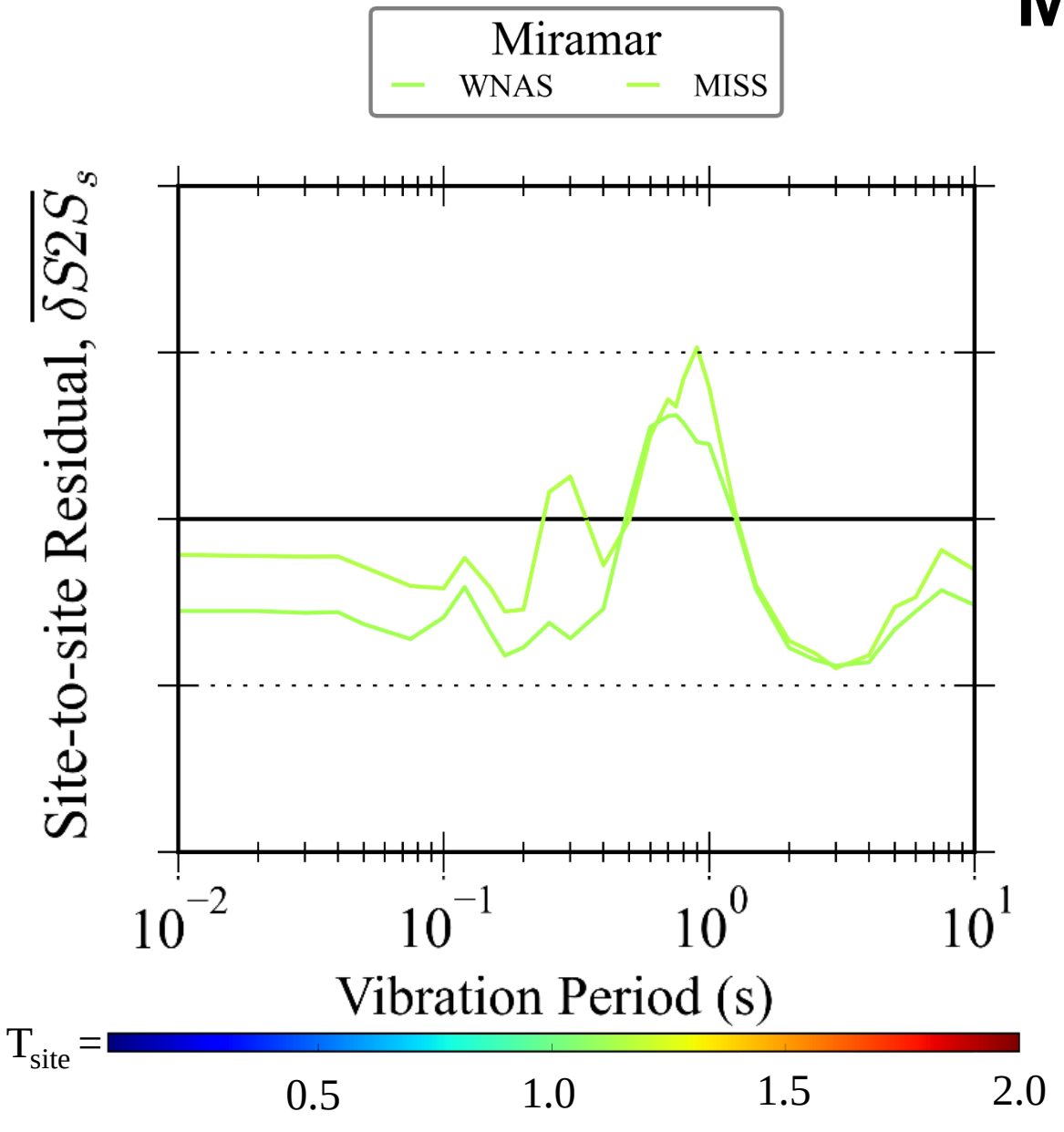




Spatial Correlation in Narrow Valleys: Miramar



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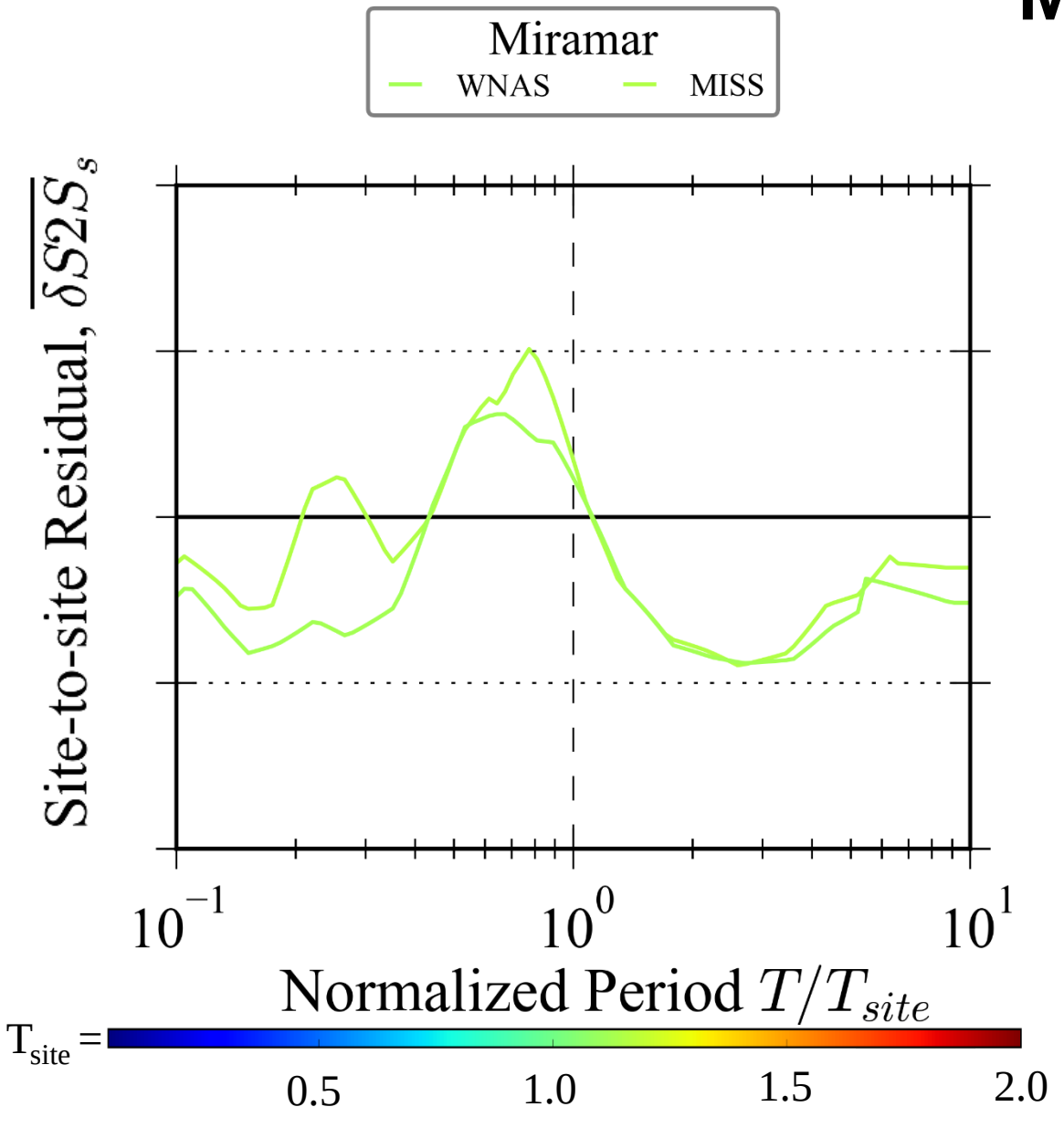
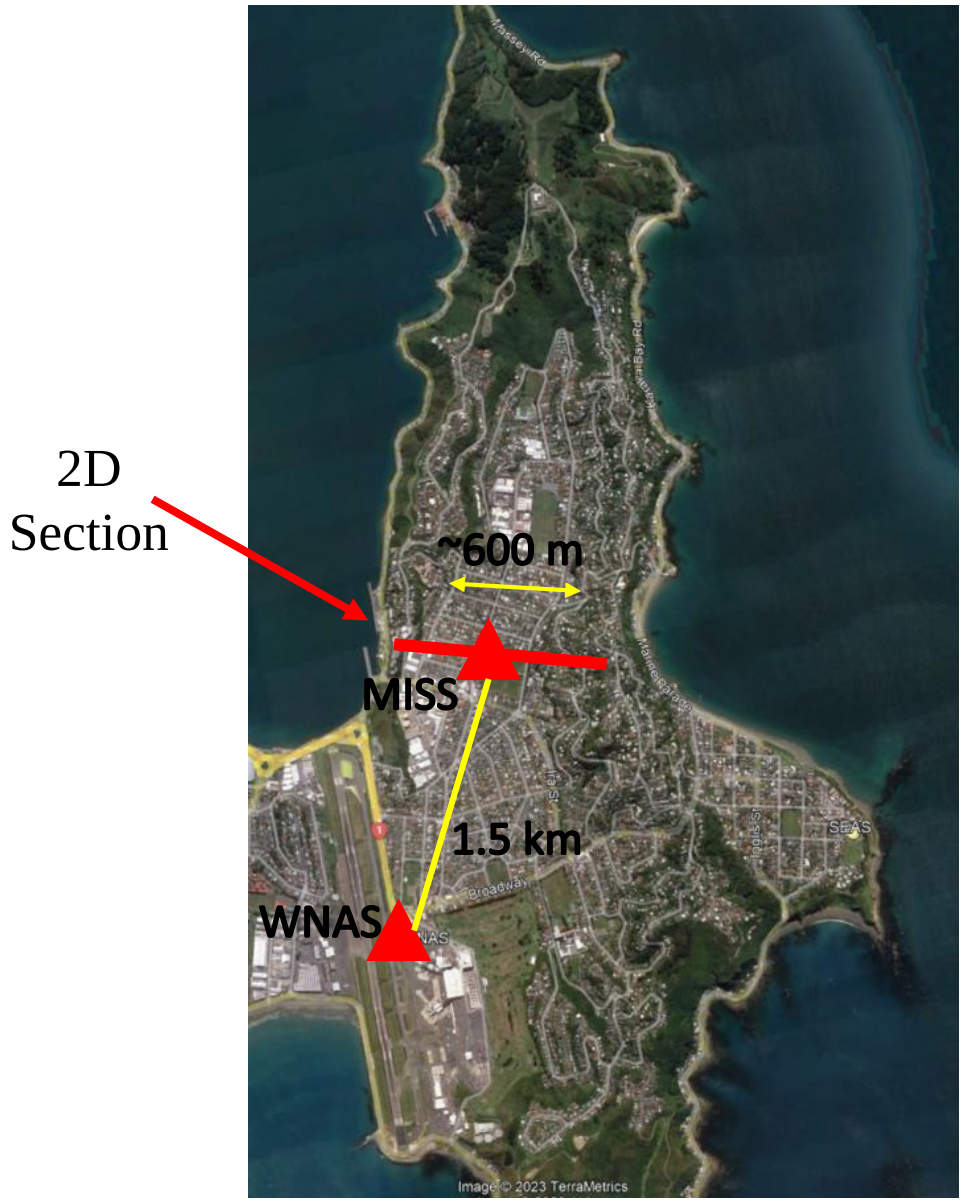
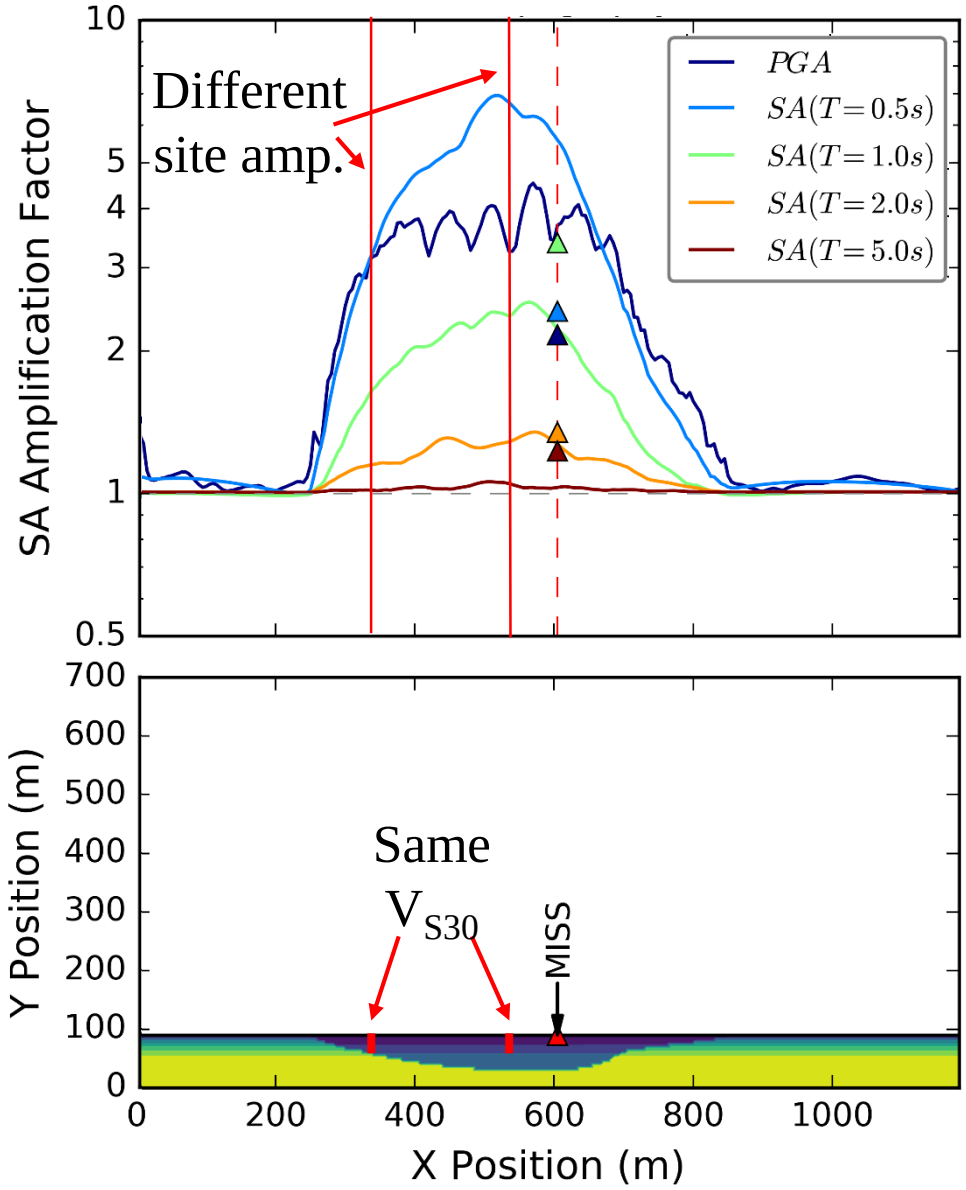
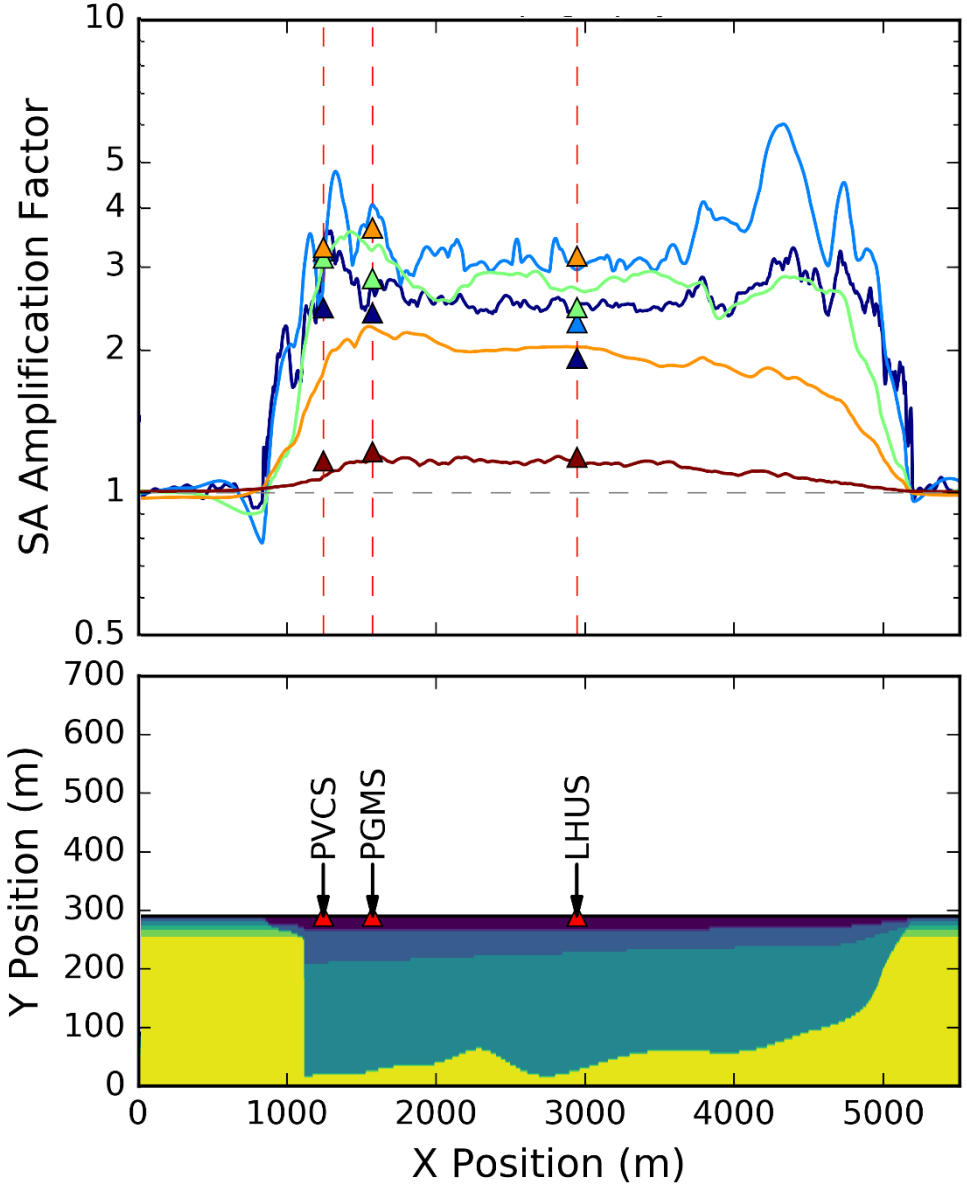




Spatial Correlation in 2D Site Response

Narrow Valley vs Wide Basin





Conclusions

- Higher correlation for sites within the same geomorphic feature
- Still a on dependence:
  - T_{site}
  - Scale of geomorphic feature
  - Geometry of bedrock surface
- Can we incorporate this into the spatial correlation framework?