Sensitivity analysis of tsunami heights to shallow bathymetric resolution

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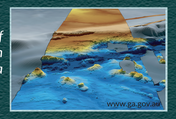
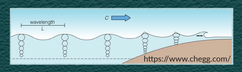
Using high-resolution bathymetry is preferred to have a more accurate model of tsunamis. However, they are often inaccessible & hence, a globally available dataset with coarser resolution is instead commonly used in modelling.

Example of high-resolution data



Satellite-derived coarse bathymetry

Coarser bathymetries tend to artificially smooth the seafloor, which changes the water depths & in turn, affect the modelled tsunami amplification & propagation.



How much the coastal tsunami is changed, however, is not yet quantified.

1 Bathymetries with varying spatial resolutions are generated in four sites

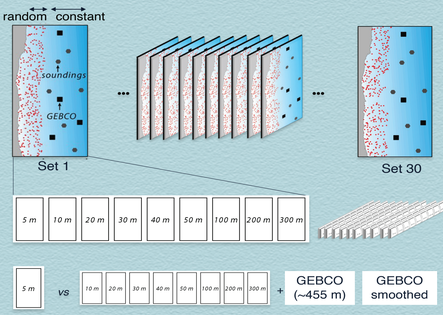
≤ 30 m depth: Extract 30 sets of points from 1-m LiDAR data

coast.noaa.gov/digitalcoast

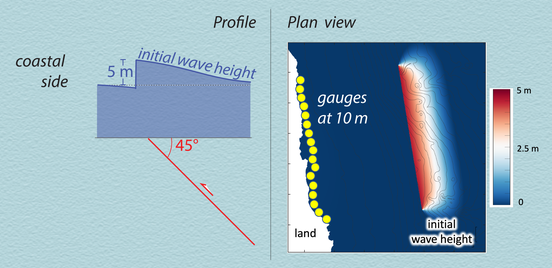
>30 m depth: Extract points from NOAA & GEBCO

Interpolate points

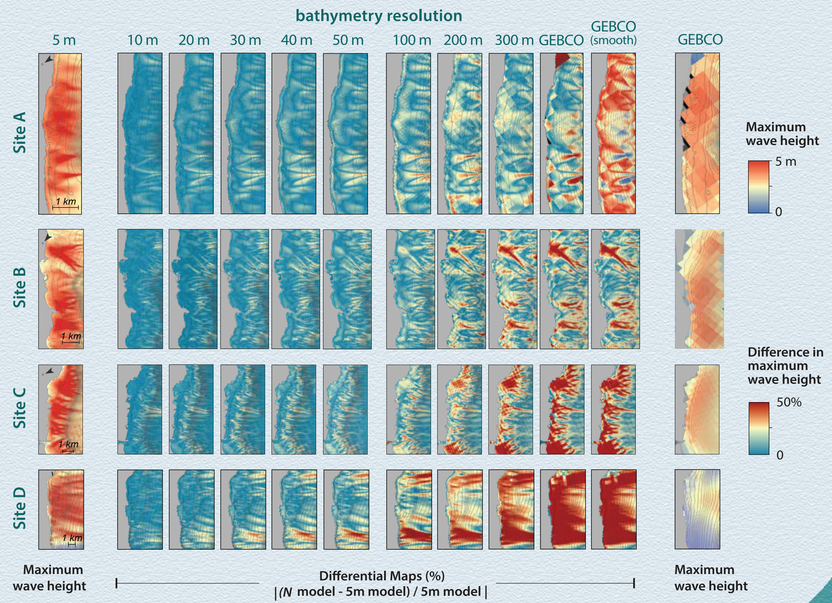
Compare all models to the baseline model, 5 m



2 Tsunami source setup: a hypothetical fault dipping seaward to ensure that the wave propagation is concentrated towards the coast

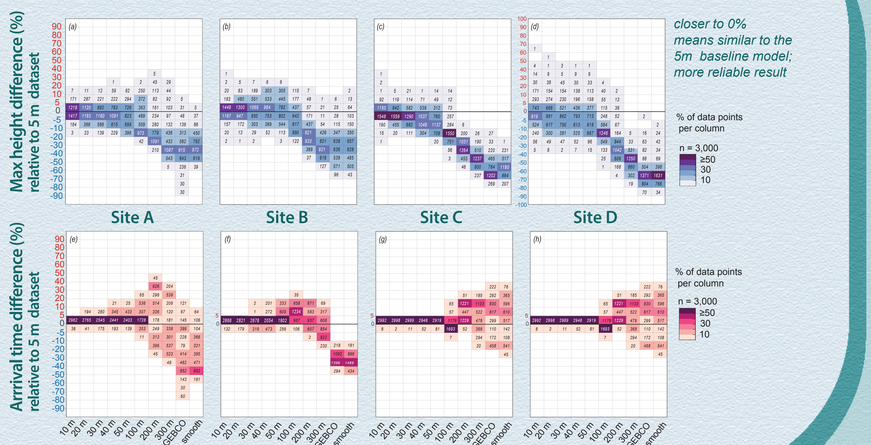


3 Increase in maximum tsunami height underestimation



4 10 – 50 m models generate the most reliable tsunami estimates

Gauge records at 10 m contour



- **10 – 50 m resolution bathymetries**

  Reproduce coastal wave heights reasonably well, with the maximum wave height overestimated by 5% or underestimated by ≤10%

  First wave arriving at the coast ~10% earlier than expected.

- **Coarser bathymetries (≥100 m resolution)**

  Increasing trend of wave height underestimation.

  Wave heights are underestimated by at least 10% & with up to 30%, 40% & 60% underestimation for bathymetric resolutions of 100, 200, and 300 m, respectively.

  More variability in the first wave arrival at the coast, with the first wave arriving either ≤20% later or ≤10% earlier.

- **The GEBCO model underestimated coastal tsunami heights by as much as 70%, with the wave predicted to arrive too early**

We showed that the use of 10 – 50 m resolution bathymetries is enough to generate tsunami heights and arrival time that is within ≤5–10% of my baseline (5 m resolution). We note that this range might vary as more study sites are included, nevertheless, the results suggest that when High-Performance Computing is a limitation, modelers can opt to use a bathymetry with a resolution as coarse as 50 m & still get a result that reasonably approximate a finer resolution. However, higher resolutions will produce more accurate results, so where possible modelers should continue to opt for including available high-resolution data in order to have a realistic representation of the seafloor at the shallow depths.

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Outstanding Student & PhD Candidate Presentation contest

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