How Perturbing Ocean Floor Disturbs Tsunami Waves

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AGU FALL MEETING
New Orleans
11-15 Dec. 2017 What will *you* discover?

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Background

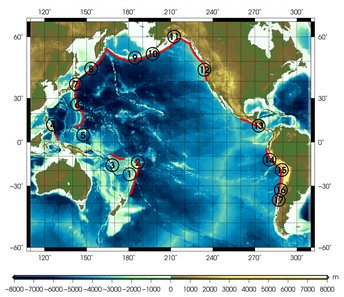
The distribution of tsunami amplitudes in the open ocean is controlled by fault geometry and bathymetry. Although detailed studies have considered heterogeneity effects in earthquake tsunami sources, little or no attention has been paid to the effects of physical resolution of bathymetry on tsunami waveforms in the far field.

Regardless of the simulation method, on one hand, it is desirable to include detailed bathymetry features in the simulation grids in order to predict tsunami amplitudes as accurately as possible, but on the other hand, large grids result in long simulation times. It is therefore, of interest to investigate the amount of details in bathymetry grids physically controlling the most important features in tsunami amplitudes, with implications in terms of a sufficiency level – if any – for grids in numerical simulations.

Method

We design **pure thrust** earthquake sources at 17 locations along the most commonly tsunamigenic trenches. We then simulate tsunamis from these events on smoothed bathymetries using the MOST algorithm (Titov *et al.*, 2016).

ALL 17 SOURCES



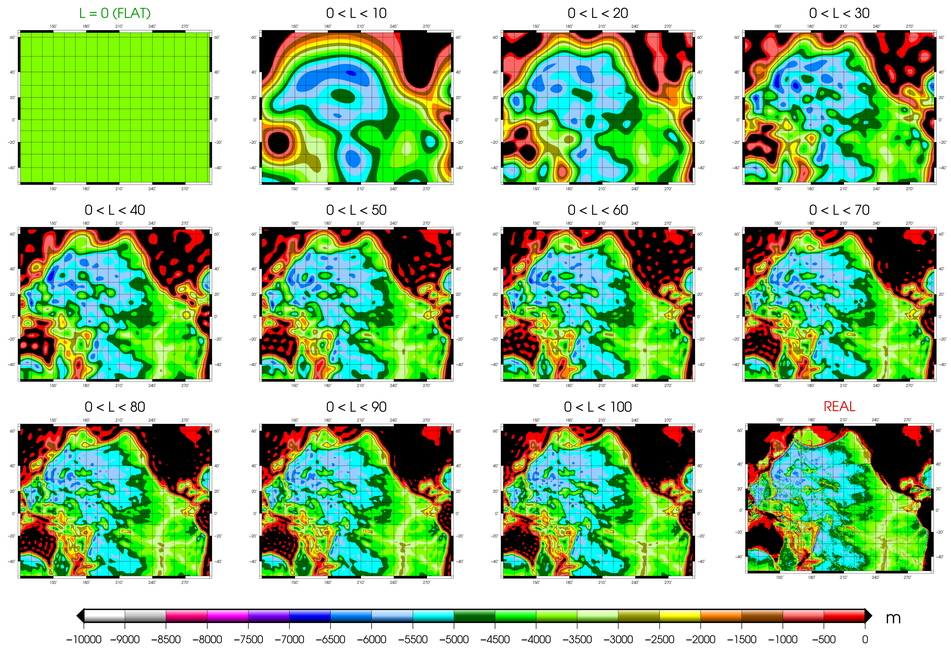
Mansinha & Smylie's (1971) algorithm ⟶ Earthquake Static Deformation

Spherical harmonic expansion ⟶ Smooth bathymetry

MOST algorithm ⟶ Simulate tsunamis

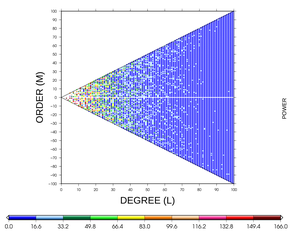
Spherical Harmonic Expansion of the Pacific Bathymetry

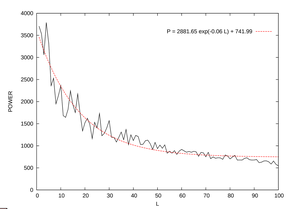
We use a spherical harmonics series approach to decompose the bathymetry of the Pacific ocean into its components down to a resolution of 4° ($L = 100$) and create bathymetry grids by accumulating the resulting terms.



WHAT IS SUFFICIENT?

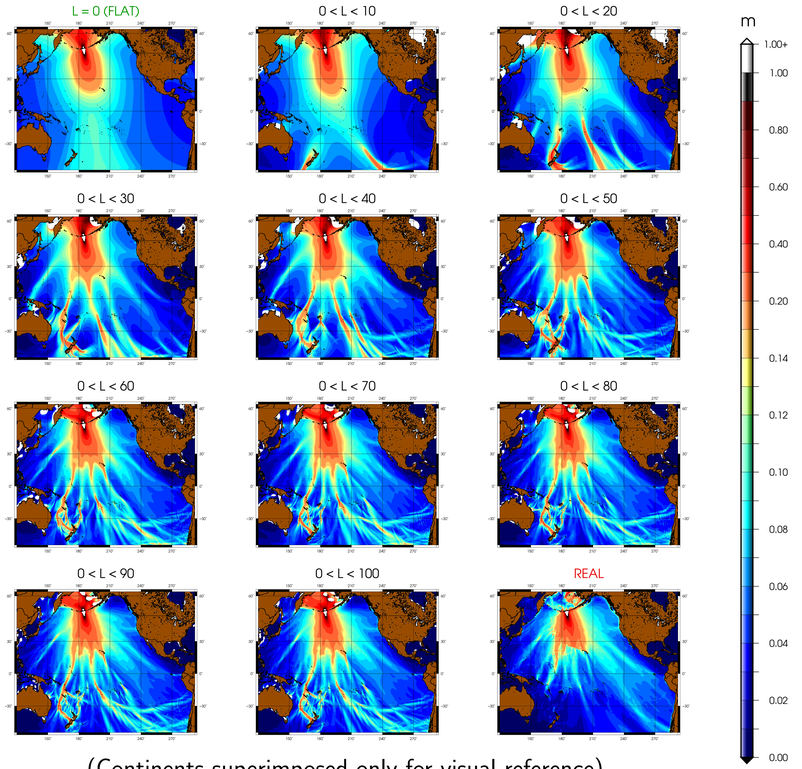
1. Step back & blink: Judge for yourself.
2. Use Power Spectrum





MOST OF VARIATIONS IN BATHYMETRY at $L \lesssim 40$

Hydrodynamic Simulations (Aleutian – 1957)



(Continents superimposed only for visual reference)

Step back & blink: WHAT IS SUFFICIENT?

Conclusion

Our preliminary results show that the main far-field components of tsunami propagation can be obtained by considering only the first 40 degrees of the spherical expansion of bathymetry.

REFERENCES

Mansinha, L. & Smylie, D., 1971. The displacement fields of inclined faults, *Bulletin of the Seismological Society of America*, **61**(5), 1433–1440.

Titov, V. V., Kânoğlu, U., and Synolakis, C. E., 2016. Development of MOST for real-time tsunami forecasting, *Journal of Waterway, Port, Coast and Oceanic Engineering*, **142**, 031160041031160041 6.

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