Journal of Geophysical Research: Solid Earth

Supporting Information for

Assessing Margin-Wide Rupture Behaviors along the Cascadia Megathrust with 3-D Dynamic Rupture Simulations

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Introduction

The supplementary information contained in this document presents additional figures that clarify or extend the results of the 3-D dynamic rupture simulations for the Cascadia megathrust. Specifically, S1 shows the along-margin profile of static stress drop, slip at the top of the megathrust (deformation front) for the smooth rupture model shown in figure 3. A plot showing the overall Slab2 geometry dip angle is also presented. S2 shows how a smooth stress-drop model can generate a down-dip rupture front in the episodic tremor and slip region. S3 presents example stress gradients between the smooth, Gaussian and Gamma rupture models and the typical subsidence amplitudes they produce. S4 shows an example rupture history of a Gamma simulation and describes how rupture speed can be significantly slowed in central Cascadia. S5 shows how a 20 km locking depth can also fit 1700 A.D. subsidence measurements well. S6 presents a conceptual model with heterogeneous Dc=1m patches along-strike and its influence on synthetic waveform spectra.

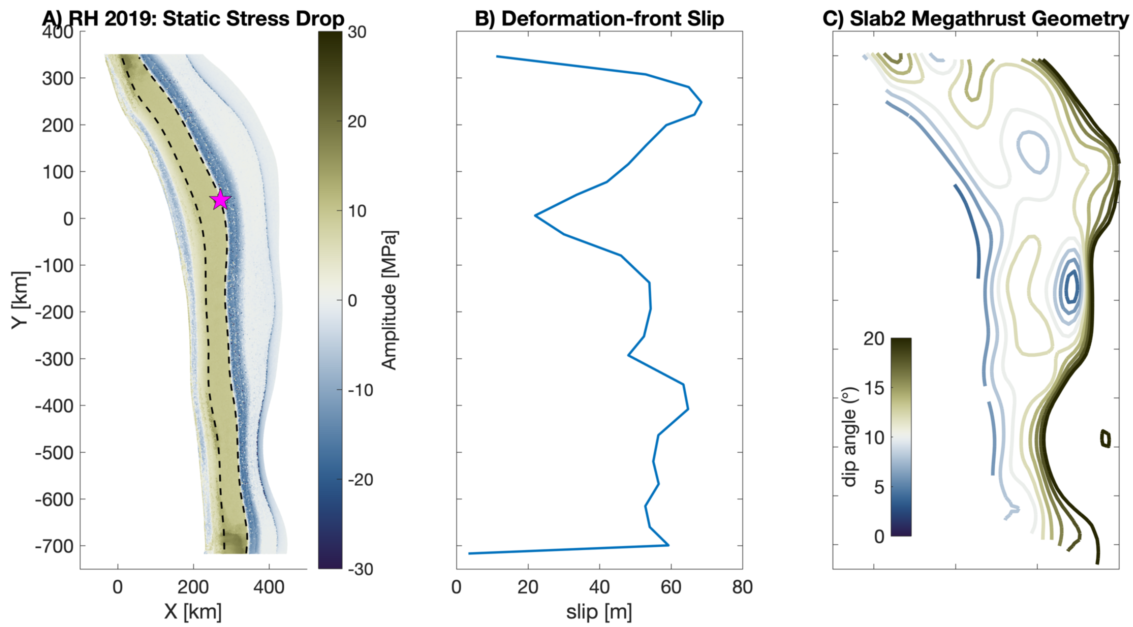

Figure S1. Static stress change, slip, and geometrical parameters for the smooth model presented in Figure 3 in the main text. A) Static stress drop (defined as initial minus final shear stress stress). Magenta star denotes epicenter and heavy dashed lines signify the 10 and 20 km depth contours. B) Slip distribution at the top of the Cascadia megathrust (deformation front). C) Megathrust dip angle contoured in 2-degree increments from 2 – 20 degrees to accentuate the slab curvature in the central Cascadia region.

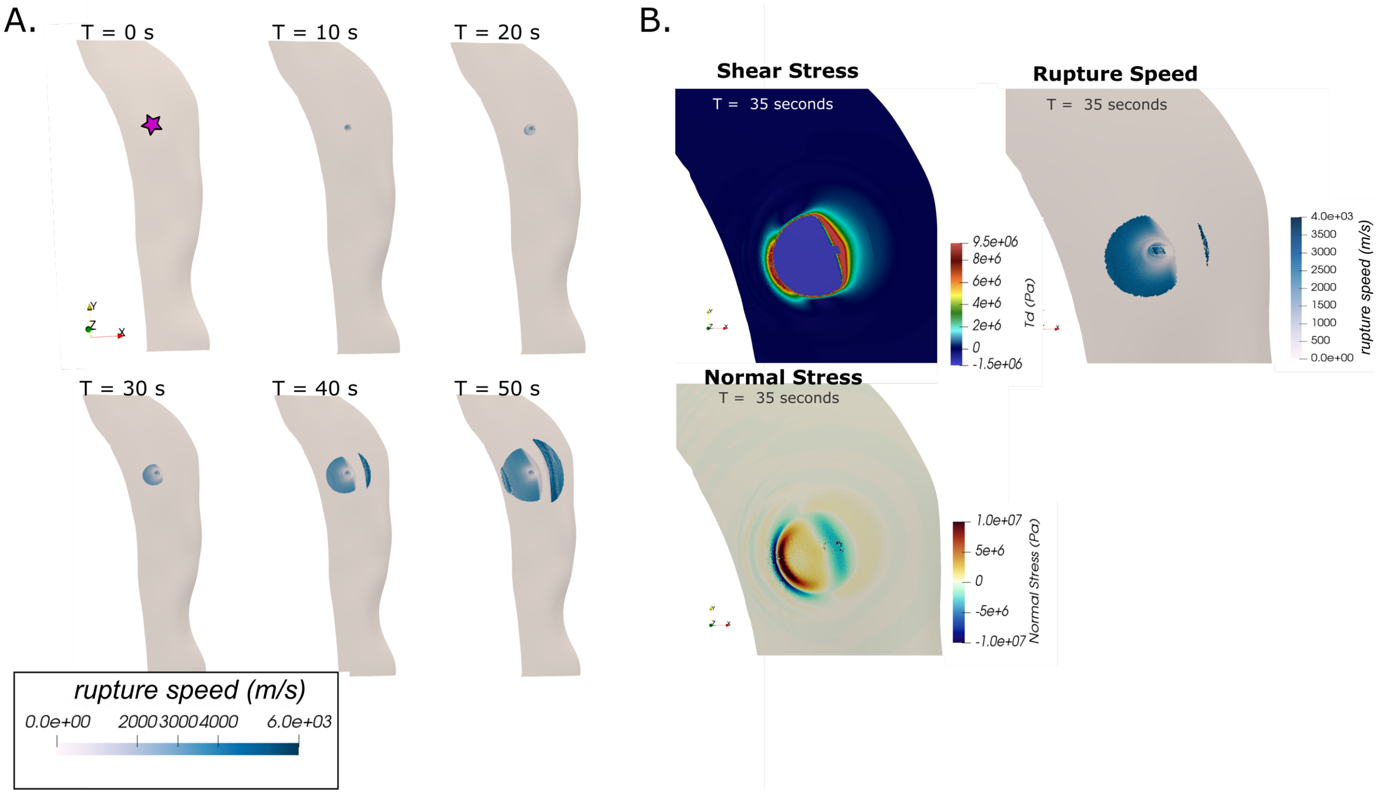

Figure S2. Snapshots of the rupture speed and stresses for the smooth model shown in Figure 3. A) Rupture speed as a function of time for 0 – 50 seconds into the simulation. A down-dip rupture front emerges in the ETS region of the megathrust between 30 and 40 seconds. B) Rupture speed and instantaneous stress (normal and shear) conditions at T = 35 seconds. The down-dip rupture front is most likely due to dynamic unclamping (positive shear and normal stress perturbations) made possible because of the incredibly low fault strength in the ETS region.

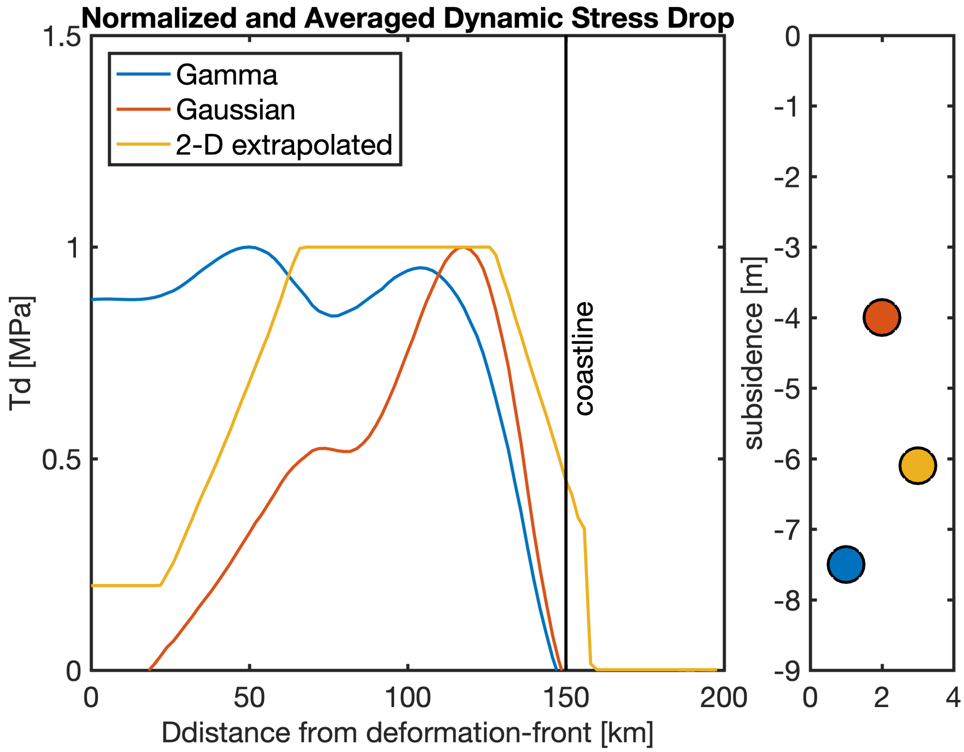

Figure S3. Example along-dip stress profiles between the smooth and coupling models (left). Typical subsidence amplitudes predicted for each stress gradient are also shown (right). Location of the coastline is shown for reference.

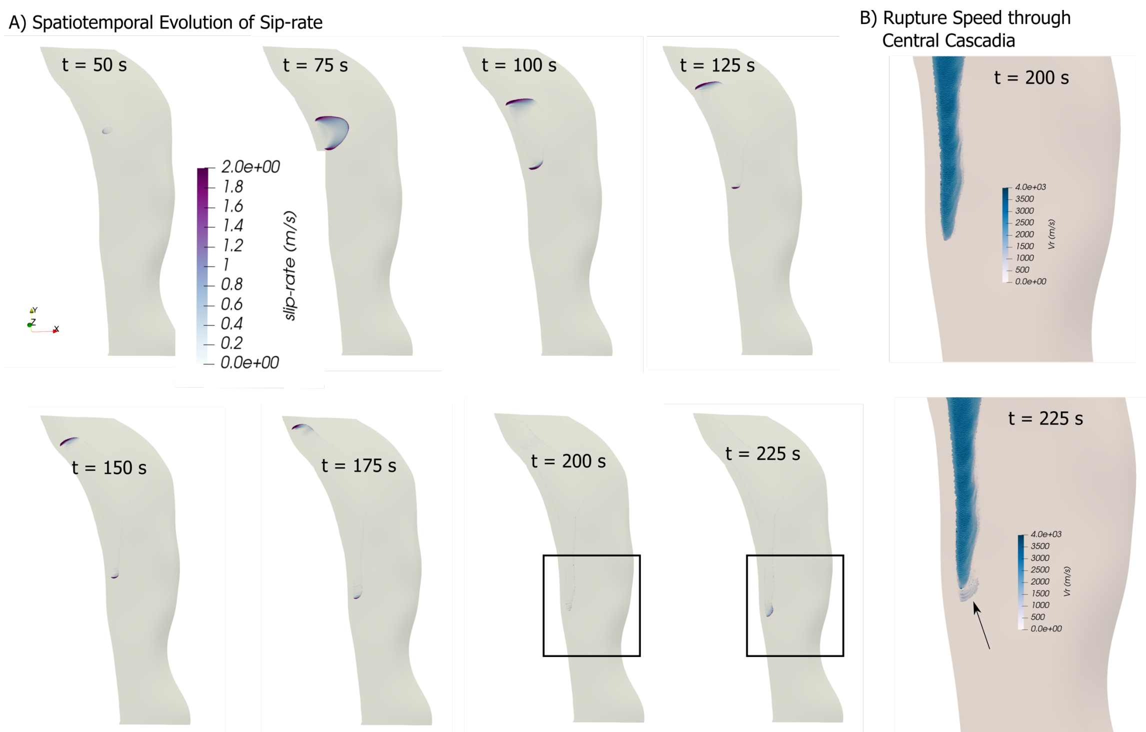

Figure S4. Slow rupture speed of Gamma models. A) Snapshots of the slip-rate at 25 second increments. Black box denotes zoom-in shown in B. B) Rupture velocity at the last two time steps to show how the rupture can dramatically slow-down in the central Cascadia region.

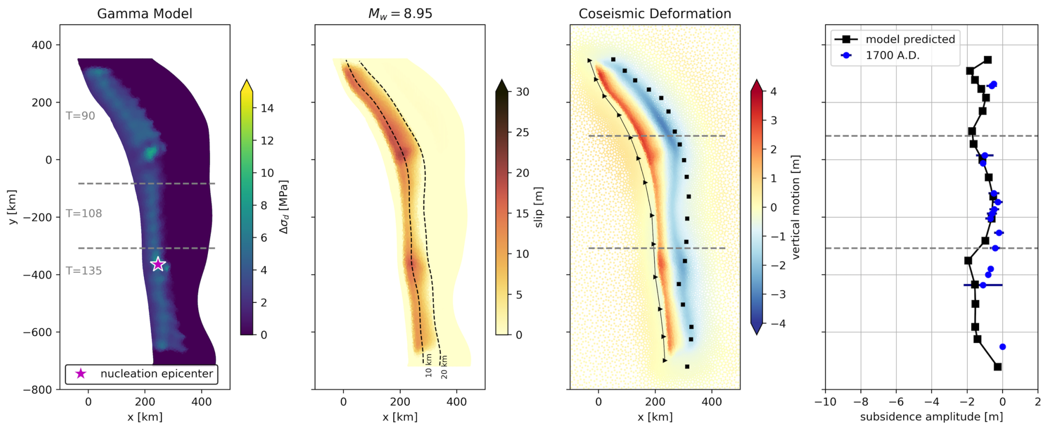

Figure S5. Deeper locking depth (20 km) alternative to fitting 1700 A.D. subsidence. A) Gamma coupling model dynamic stress-drop distribution. B) Final slip distribution. C) Predicted uplift and subsidence. D) Along-strike subsidence comparison between modeled (black squares) and 1700 A.D. observations (blue squares).

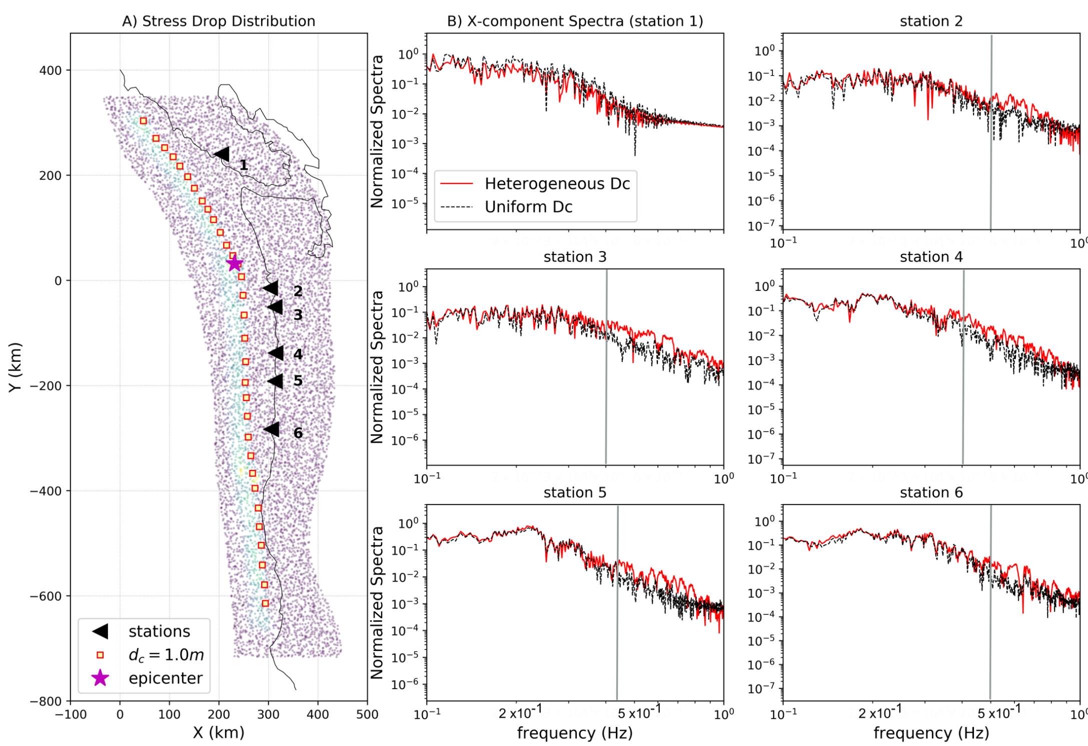

Figure S6. Dynamic rupture simulation comparing the influence of heterogeneous Dc distributions on synthetic recordings. In this model, Dc asperities are set to 1 m whereas the rest of the megathrust has Dc = 2 m. A) Background dynamic stress drop model showing Dc positions and receiver locations. B) Synthetic seismograms with heterogeneous (red traces) and uniform (black traces) Dc distributions. In all plots, the normalized, horizontal x-component spectra is shown. The solid gray line denotes the frequency at which the heterogeneous Dc model begins to generate higher frequency content relative to the uniform Dc model. Station 1 north of the epicenter does not show the same feature.