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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 slip at the top of the megathrust (deformation front) for the smooth rupture model shown in figure 3. 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 waveforms.

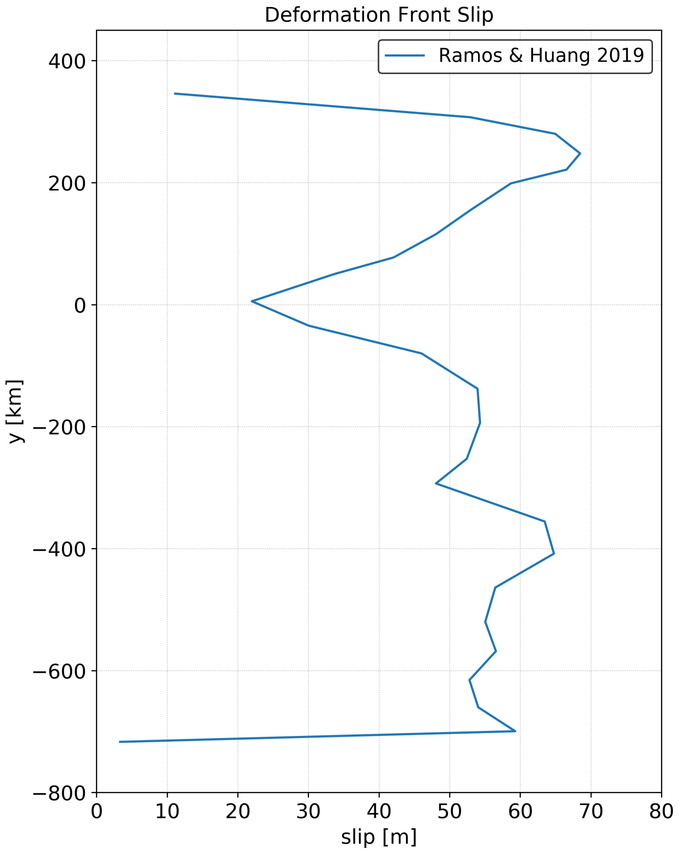

Figure S1. Slip at the deformation front for the smooth model presented in Figure 3 of the main text.

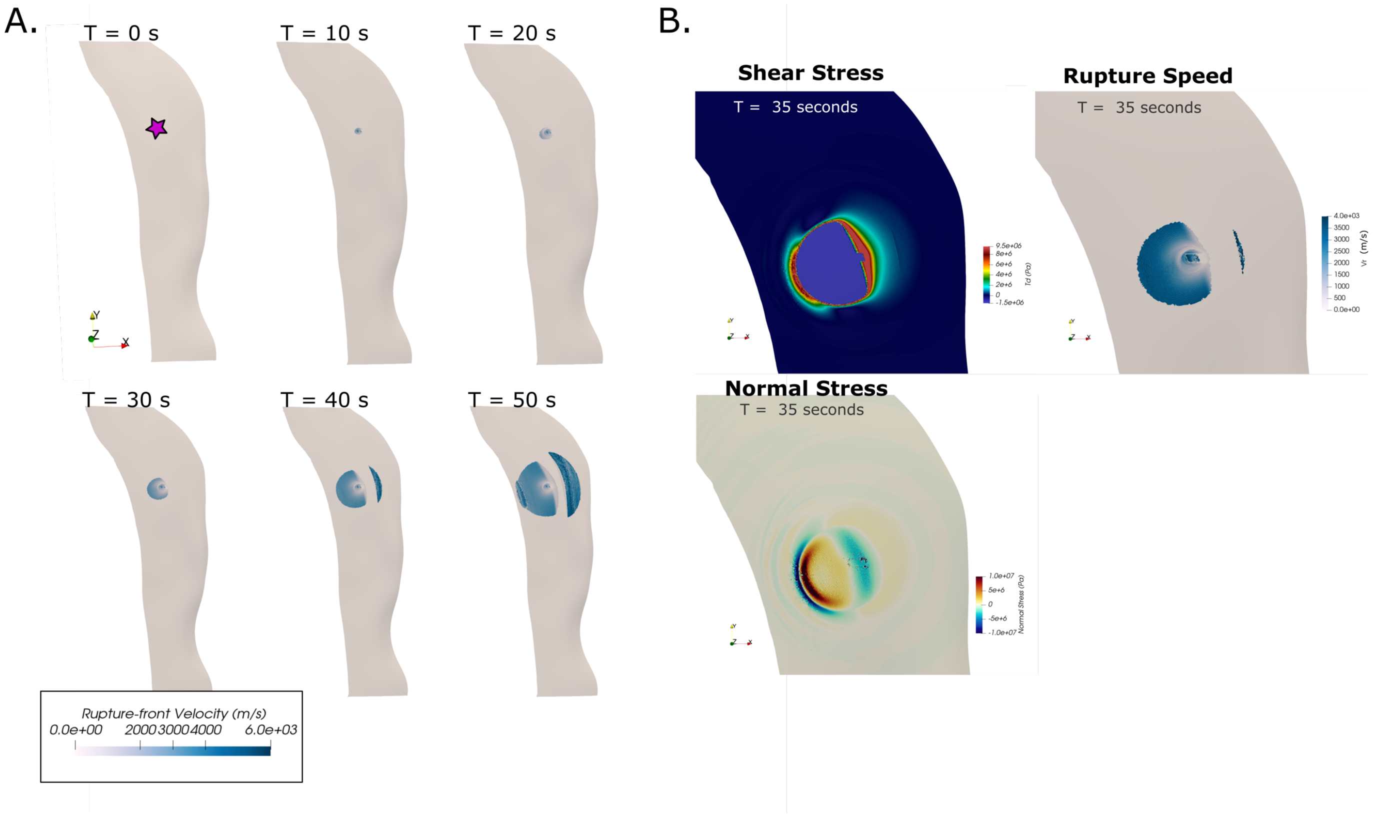

Figure S2. Snapshots of the rupture speed and stresses for the smooth model shown in Figure 3. A) Rupture speed as a function of time for 0 – 50 seconds into the simulation. A down-dip rupture front emerges in the ETS region of the megathrust between 30 and 40 seconds. B) Rupture front speed and instantaneous 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.

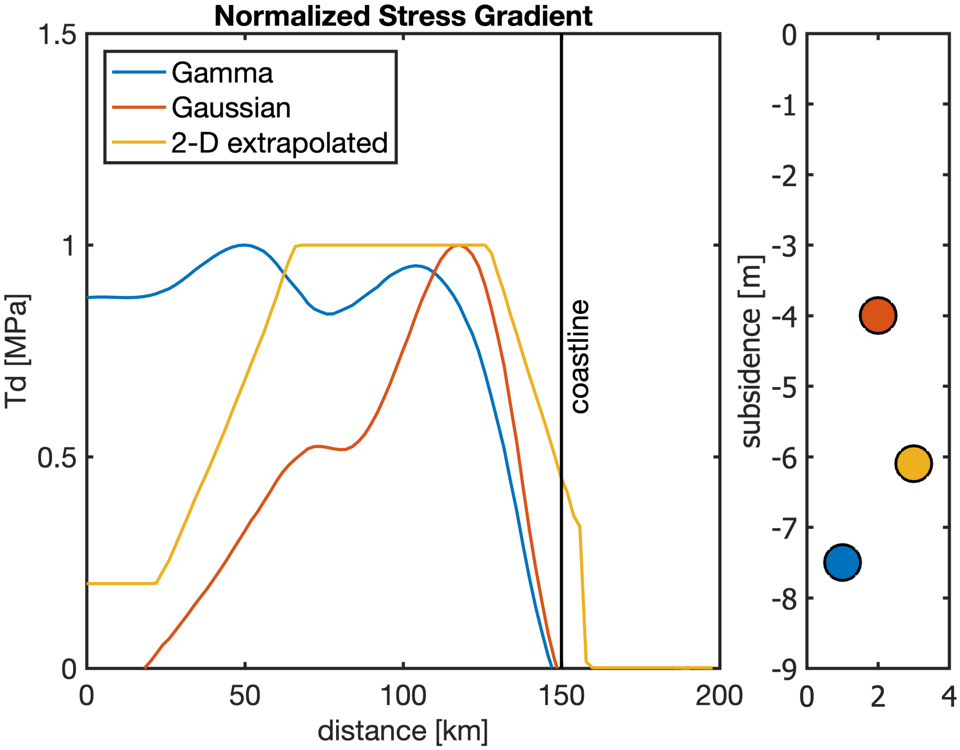

Figure S3. Example along-dip shear stress gradients between smooth and coupling models (left) and typical subsidence amplitudes predicted for each stress gradient (right). Distance is measured from the deformation-front and the location of the coastline is shown for reference.

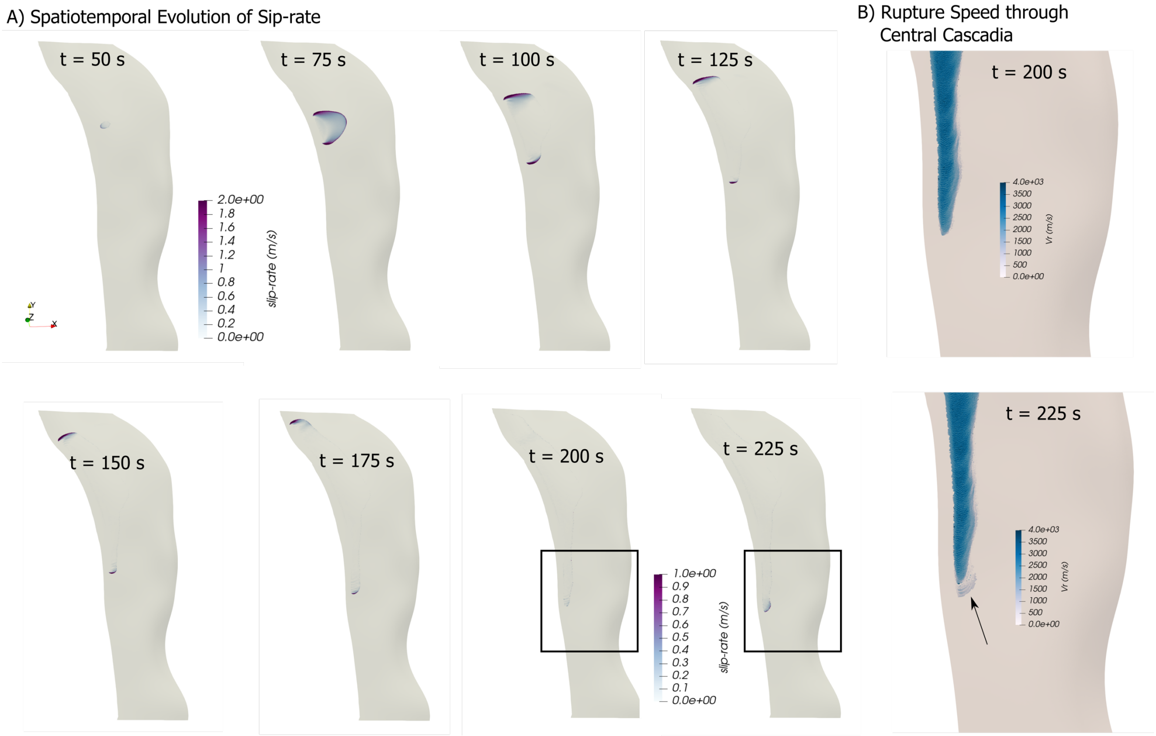

Figure S4. Slow rupture speed of Gamma models. A) Snapshots of the slip-rate at 25 second increments. Black box denotes zoom-in shown in B. B) Rupture velocity at the last two time steps to show how the rupture can dramatically slow-down in the central Cascadia region.

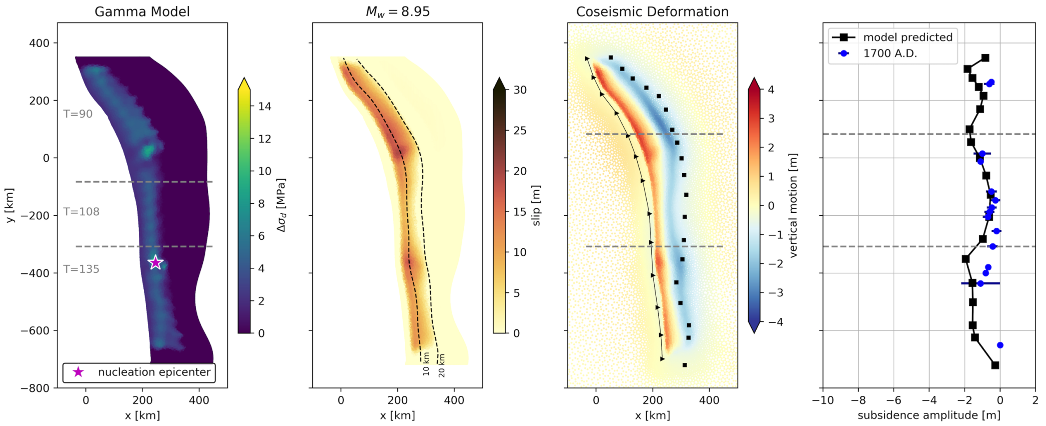

Figure S5. Deeper locking depth (20 km) alternative to fitting 1700 A.D. subsidence. A) Gamma coupling model dynamic stress-drop distribution. B) Final slip distribution. C) Predicted uplift and subsidence. D) Along-strike subsidence comparison between modeled (black) and 1700 A.D. observations (blue).

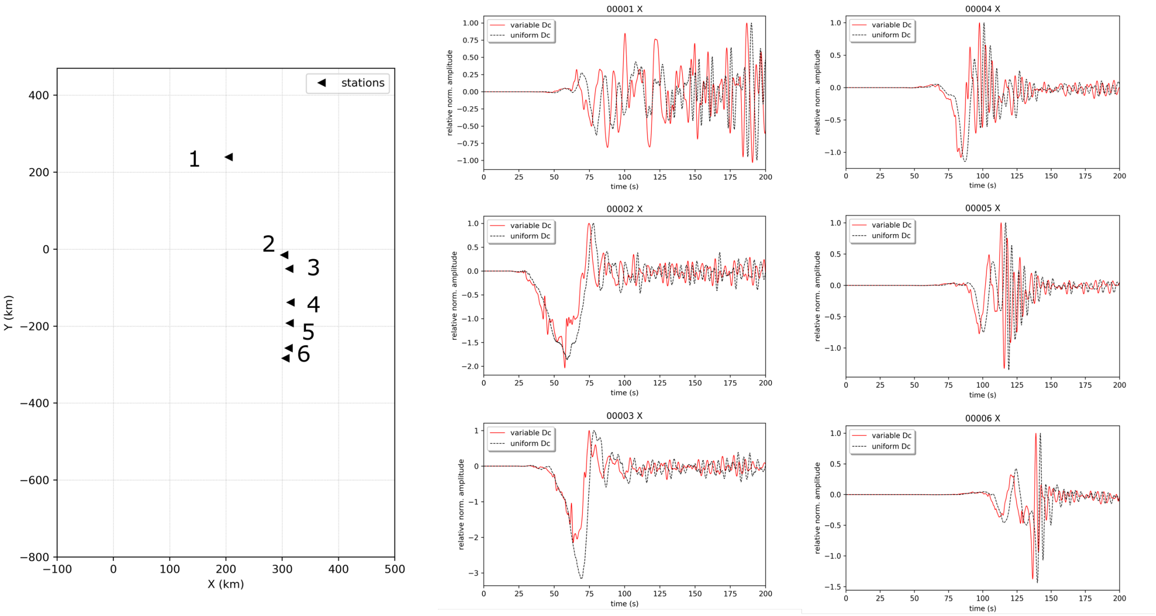

Figure S6. Synthetic seismograms at for a dynamic rupture simulation including (red traces) and excluding (black traces) 1-m Dc asperities near the down-dip locking depth along-strike. In all plots, the horizontal x-component velocity seismogram is shown.