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Visualization

Here we calculate the Jacobian matrix G for 50,000 observation points over 4,000 km^3, and 2621 triangles, as well as the strain at every observation point due to slip on the fault. (Note that this is a forward model, so we just multiply G by a vector containing the magnitudes of slip on TDE elements during the earthquake. These slip magnitudes are taken from inversions based on GPS surface velocities done by our research group.) These strain outputs are the final outputs of the python codes. These outputs are our end goal for the project. In this case, we use the matrix G to run a forward model to calculate strain. However, these codes will also be very useful in future projects, when we need to invert a similar G to solve for slip on TDEs at depth after another large earthquake.

We used Matlab to visualize our output. In Matlab, we multiply our strain vector by a Young's Modulus for the upper crust (typically ~30 GPa) and plot the resulting stress values in three dimensions. In Figure 1, we show a visualization of the calculated compressive stress changes in the east-west direction after the Tohoku-Oki earthquake in series of horizontal cross sections, from a depth of 1 km to a depth of 100 km. The coastlines of Japan and Korea are shown in grey, and the discretized fault is shown in black. Note that with our parallelized code, JapanStrains_3.py, we have calculated stresses at 50,000 points in the crust. In the visualization below, we only plot the stress values at about 1000 points. By putting these calculations on the GPU, we have a complete picture (more complete than is possible to show in a visualization) of the stress changes in the upper crust after this large earthquake. Figure 1 shows only the compressive stress changes in the east-west direction; there are five other independent components of the three dimensional stress tensor that we also calculate.

A visualization of the stress changes for the six independent components of the three dimensional stress tensor all the same depth after the earthquake is shown in Figure 2. The coastlines of Japan and Korea are shown in grey, and the discretized fault is shown in black.

These stress fields contain some singularities which are mathematically known to exist, but are hard to predict. Usually researchers deal with this by modifying these observation locations slightly to avoid the singularity. This is one reason why being able to do these calculations in a few minutes instead or in a day is so valuable.

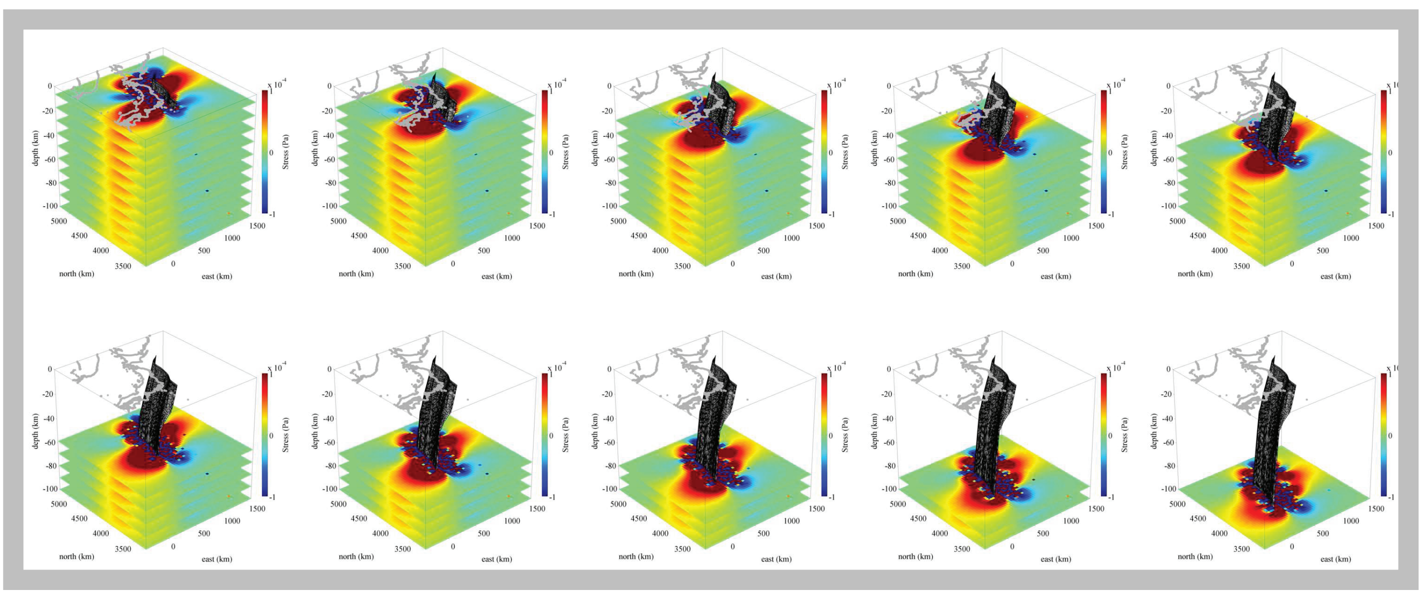

FIGURE 1. A visualization of the stress changes in the upper crust after the Tohoki-Oki earthquake in a series of horizontal cross sections, from a depth of 1 km to a depth of 100 km. The coastlines of Japan and Korea are shown in grey, and the discretized fault is shown in black.

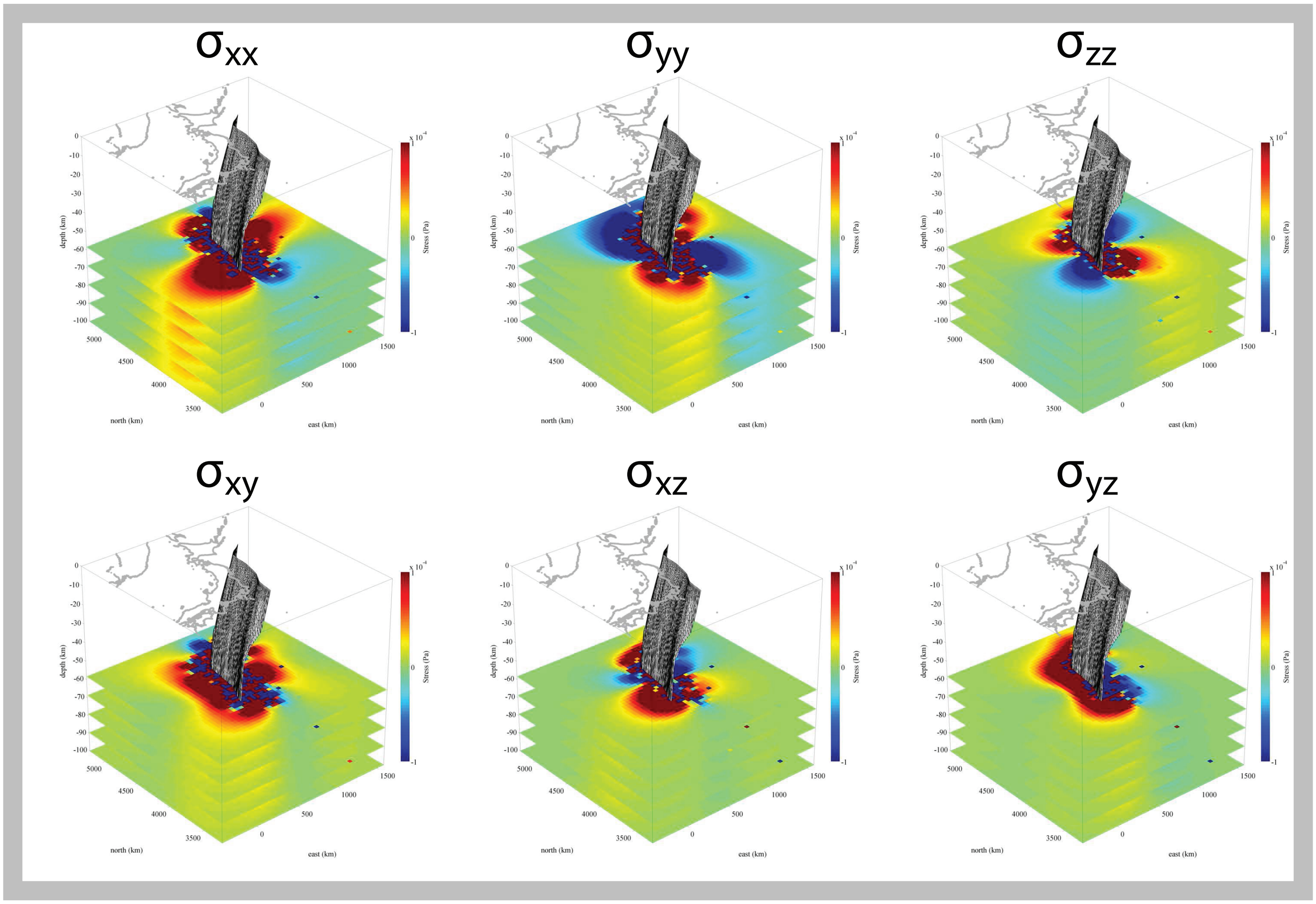

FIGURE 2. A visualization of the stress changes (for the six independent components of the three dimensional stress tensor) in the upper crust after the Tohoki-Oki earthquake in a series of horizontal cross sections all at the same depth. The coastlines of Japan and Korea are shown in grey, and the discretized fault is shown in black.