

Supplementary Materials for

**Tsunamigenic earthquake at the Sunda trench promoted by aseismic slip after a  
previous megathrust event**

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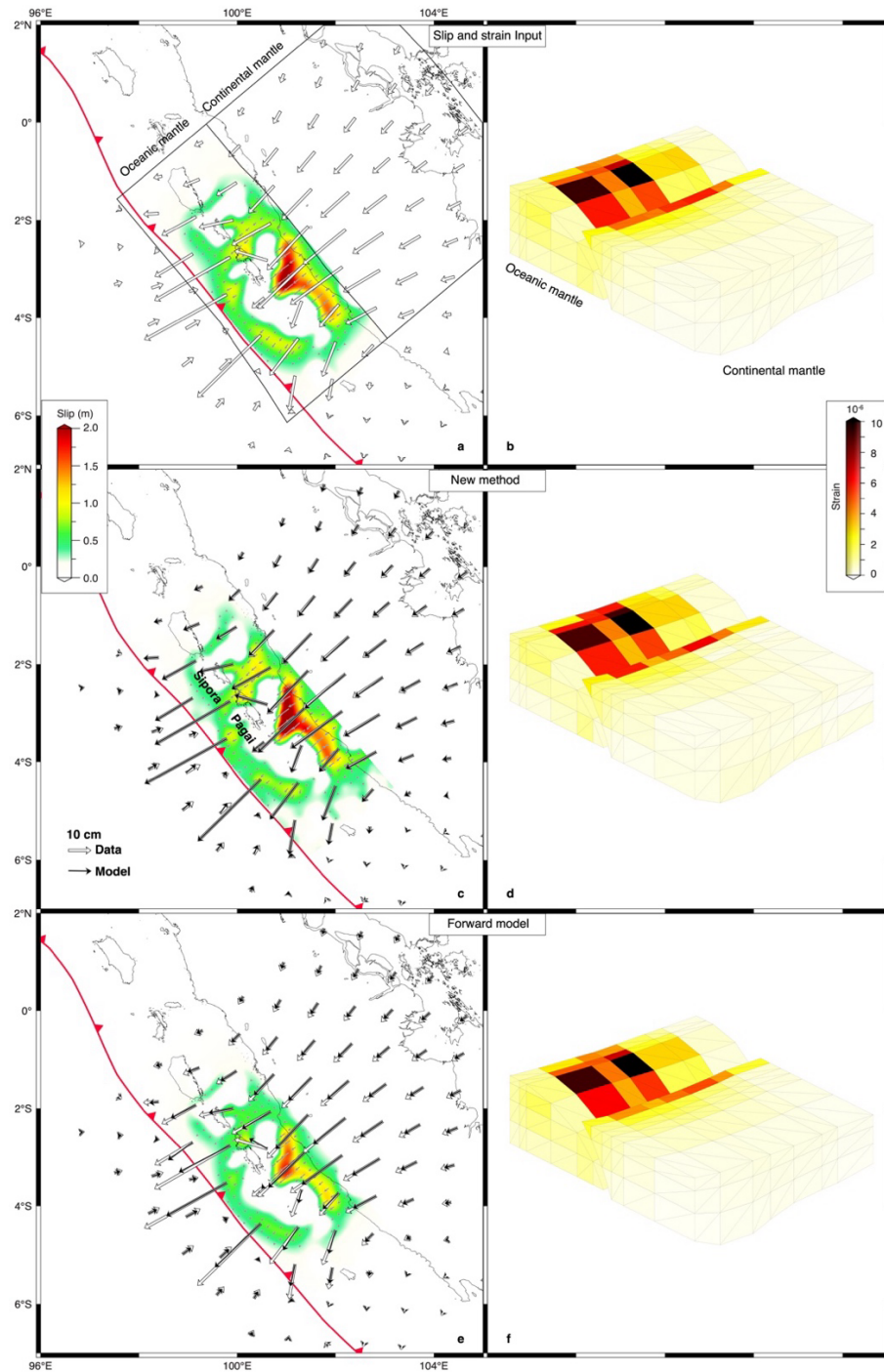
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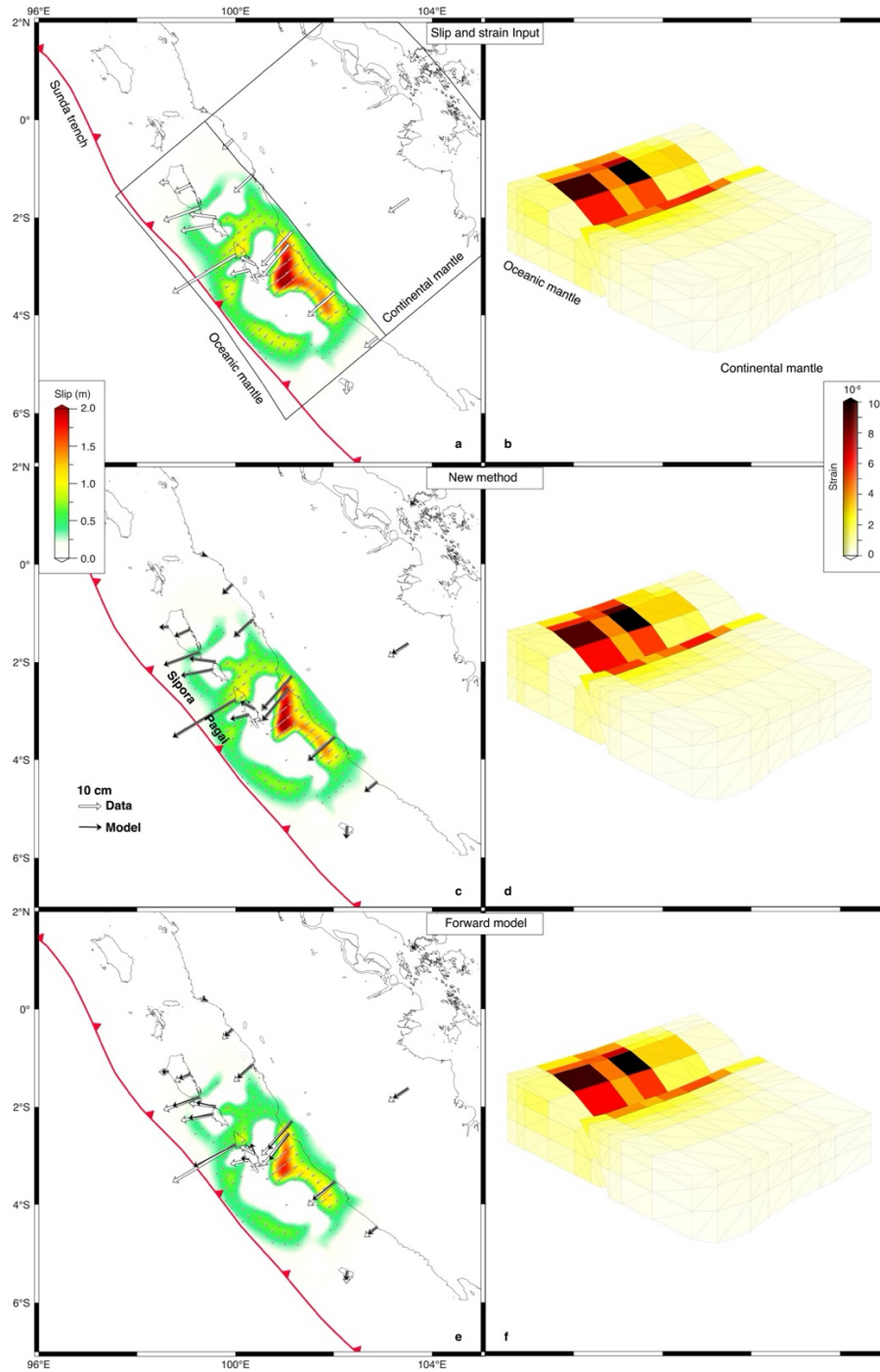
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This document contains Supplementary Figures 1-12.

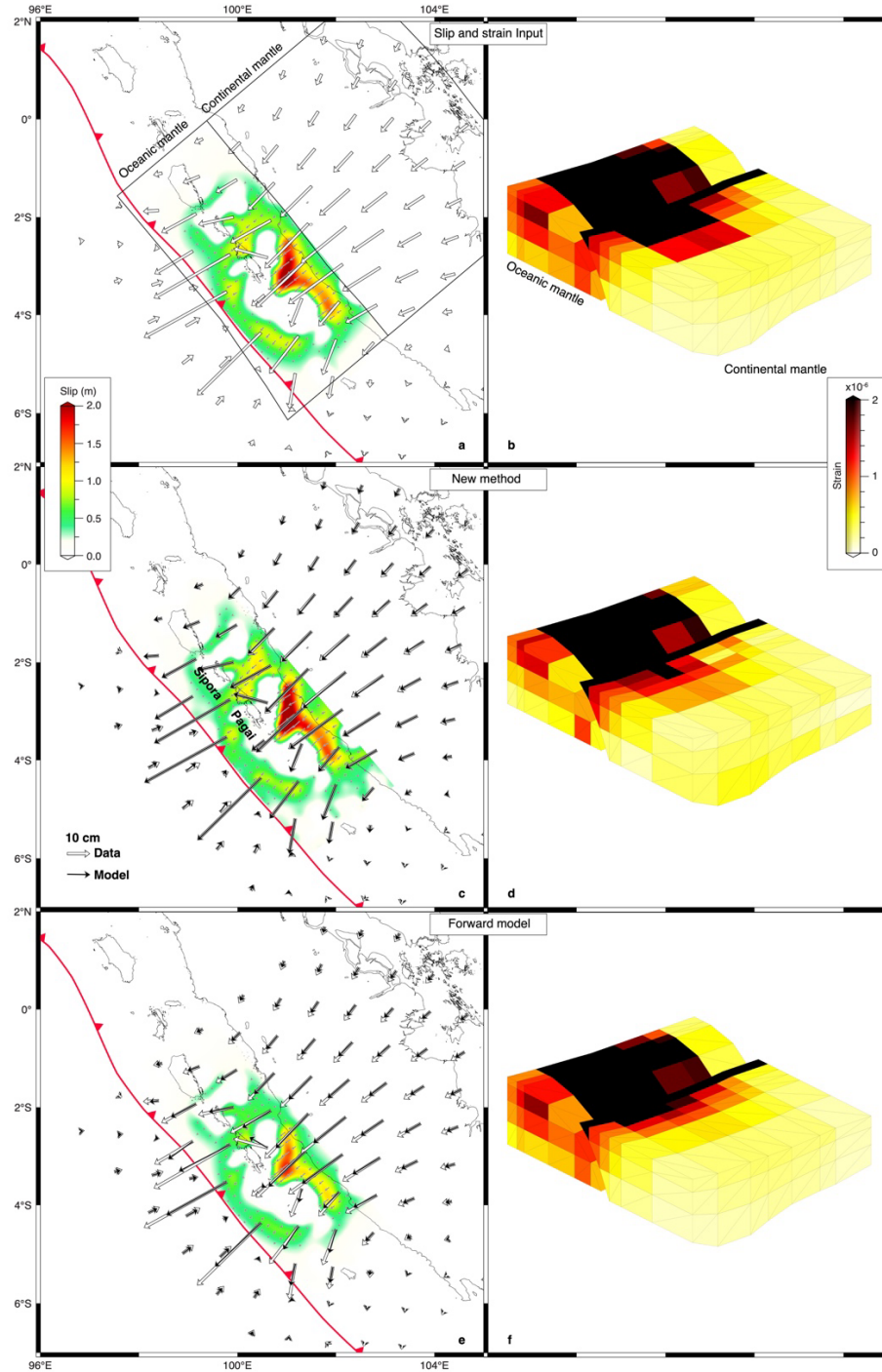


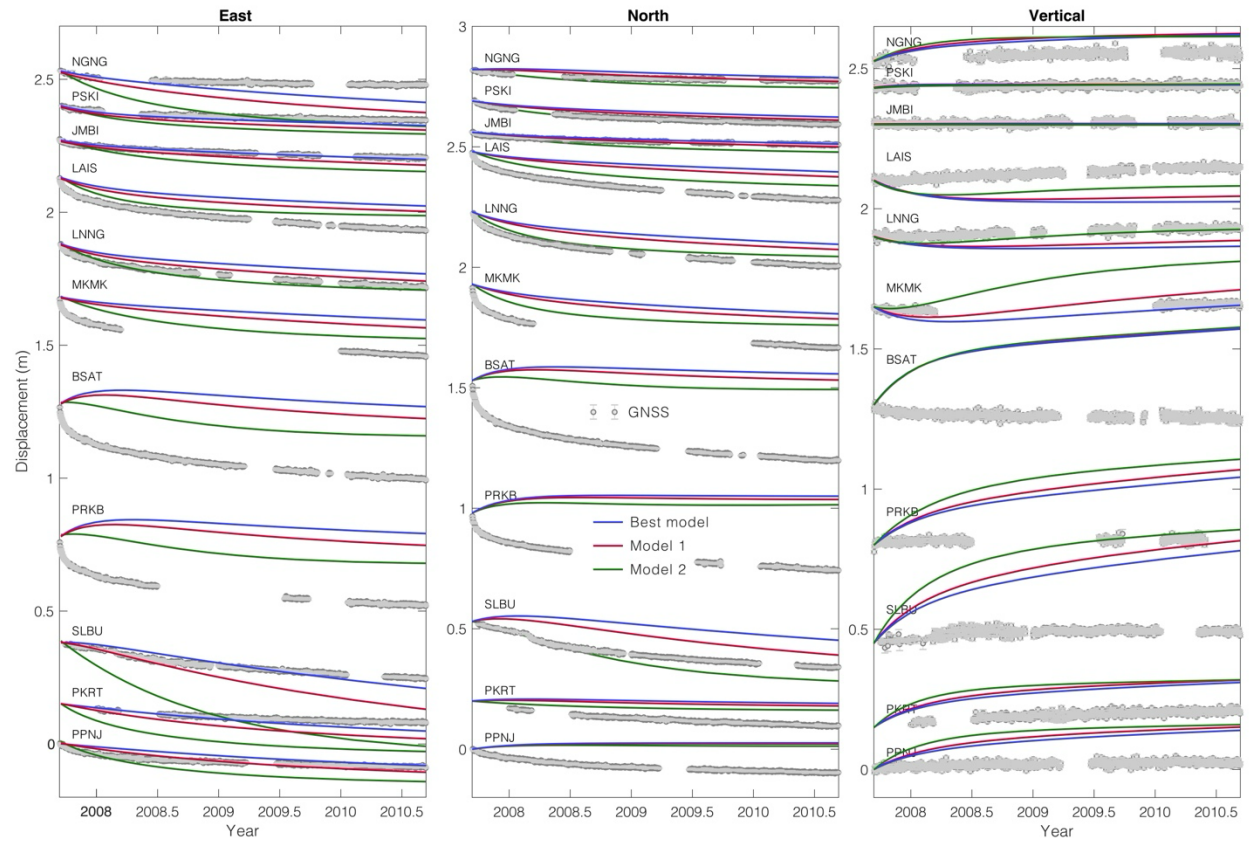
**Supplementary Figure 1. Comparison of synthetic displacements, slips and strains between forward model and the new method using a relatively dense synthetic network. (a) and (b) show**

the slip, strain and surface displacements input, black boxes in **(a)** show the modelled region of the oceanic and continental mantle; **(c)** and **(d)** present the slip, surface displacements and, strain estimated by the new method; **(e)** and **(f)** present the slip, surface displacements and, strain estimated by the forward model.

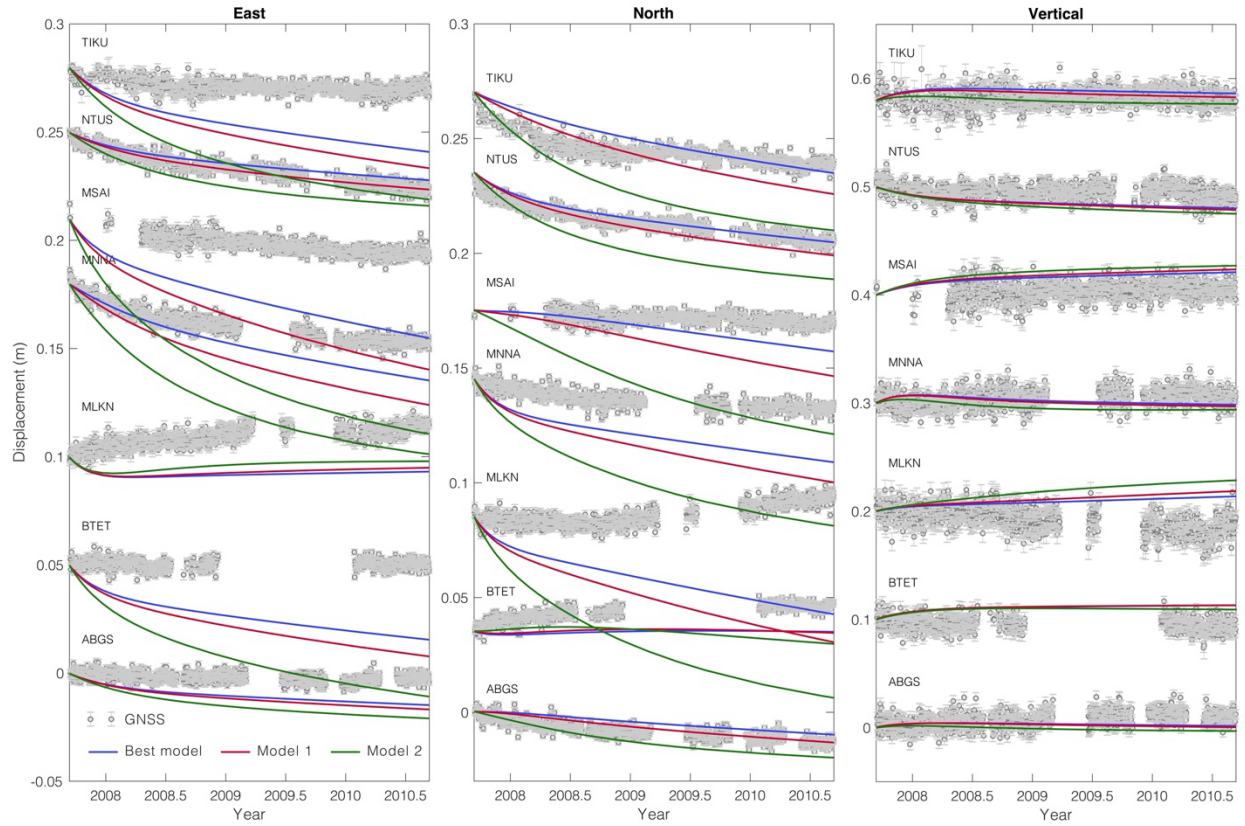


**Supplementary Figure 2. Comparison of synthetic displacements, slip and strain between the forward model and the new method using the SuGAR network. (a) and (b) show the slip, strain and surface displacements input, black boxes in (a) show the modelled region of the oceanic and continental mantle; (c) and (d) present the slip, surface displacements and, strain estimated by the new method; (e) and (f) present the slip, surface displacements and, strain estimated by the forward model.**

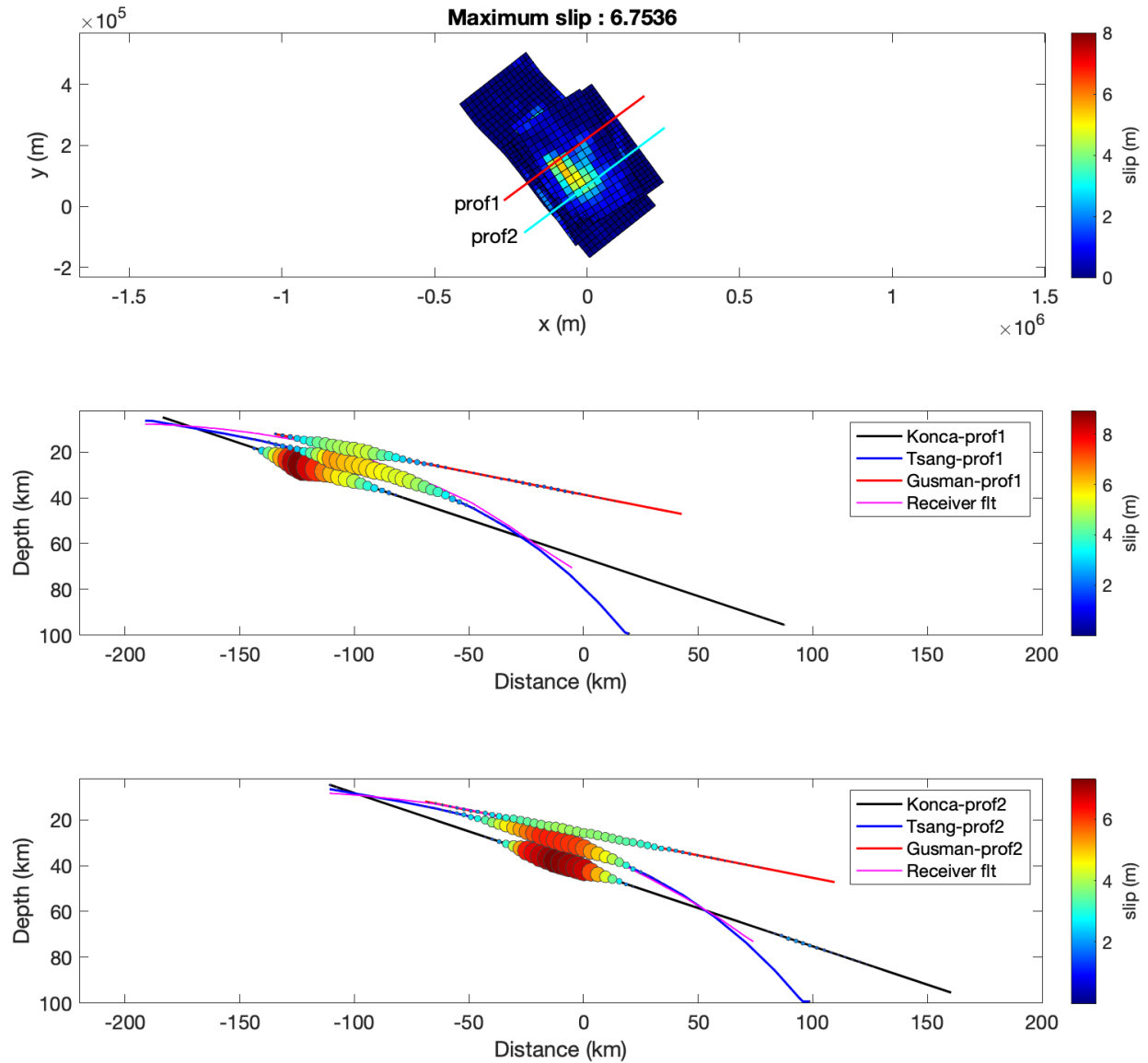




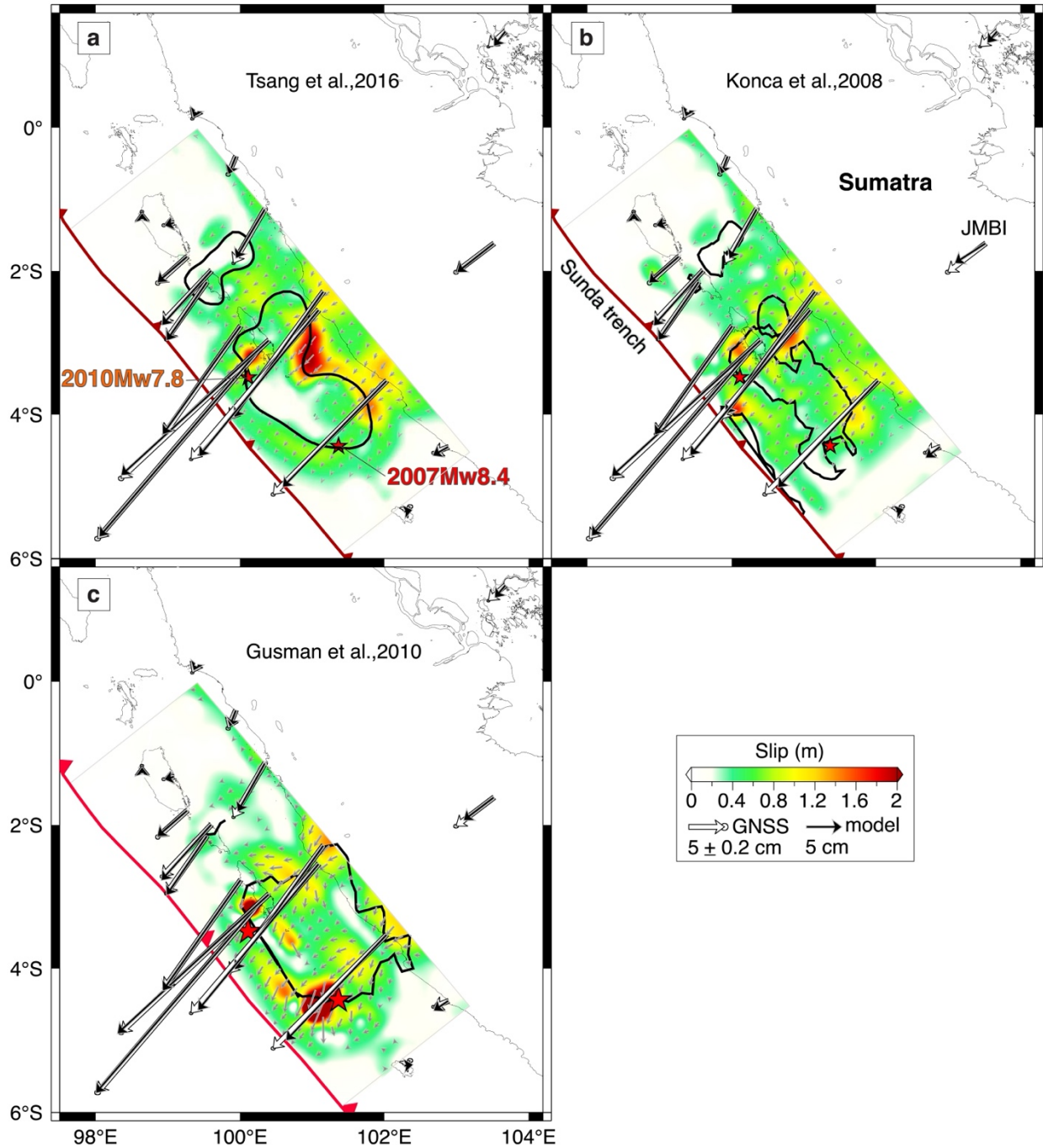
**Supplementary Figure 4. Comparison between the GNSS postseismic time series (far-field) and model predictions by forward models. East, North and Vertical presents the displacement component, respectively.**



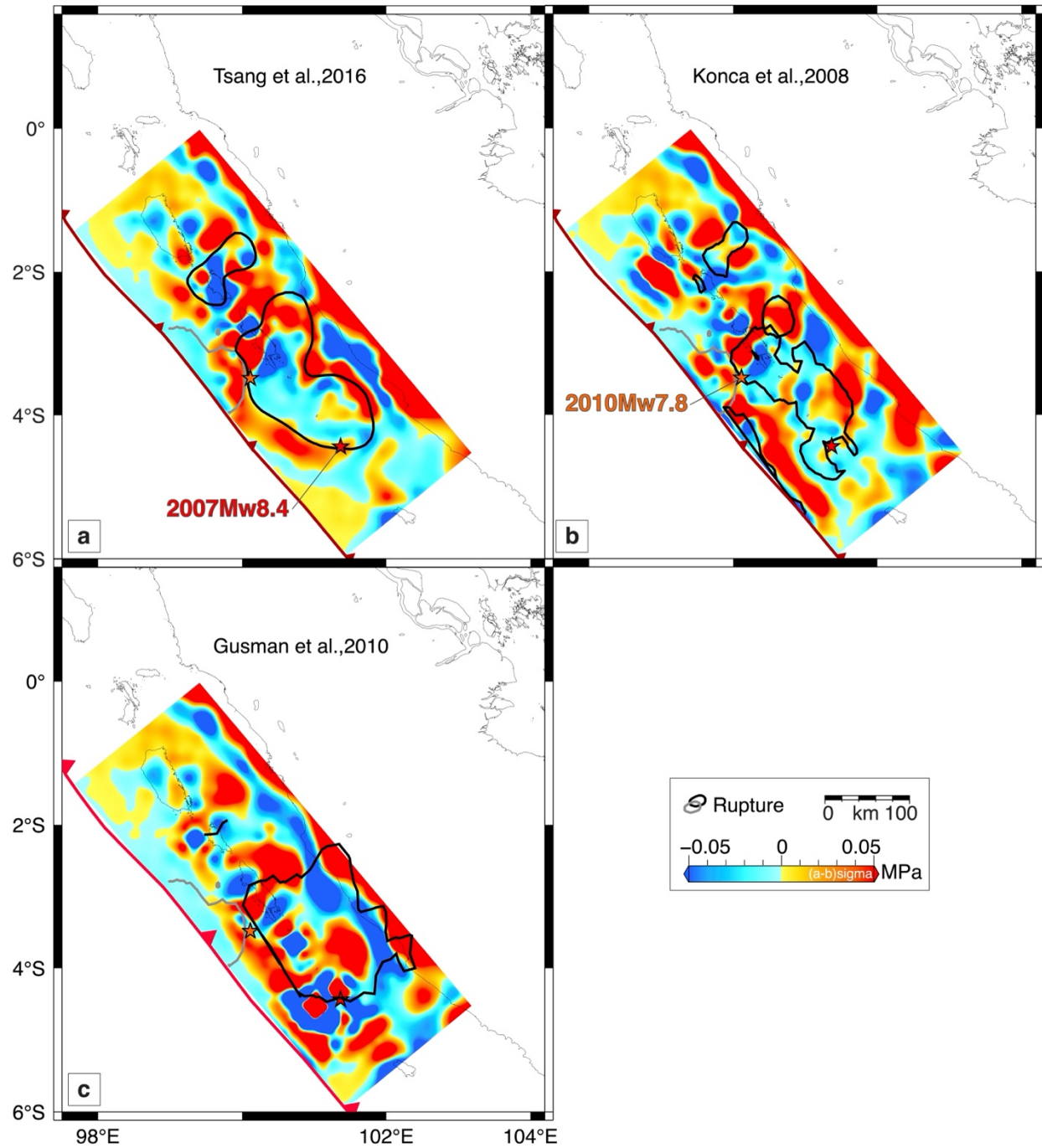
**Supplementary Figure 5. Continued. Comparison between the GNSS postseismic time series (near-field) and model predictions by forward models.** East, North and Vertical presents the displacement component, respectively.

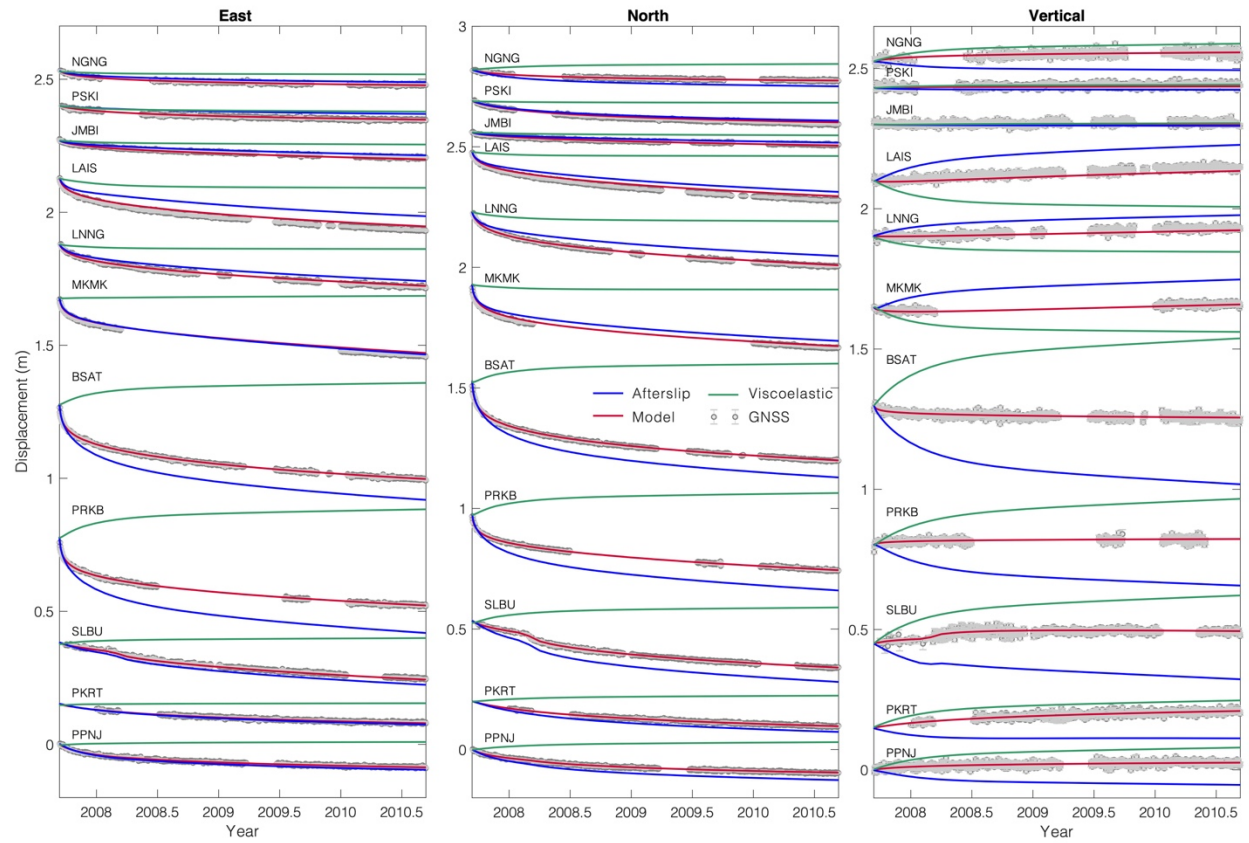


**Supplementary Figure 6. Coseismic models used for experimental tests on how they affect the afterslip and frictional properties estimates on the fault.** Upper panel: slip models from Tsang et al., 2016<sup>1</sup>, Konca et al., 2008<sup>2</sup>, and Gusman et al., 2010<sup>3</sup>; Middle panel: slip and geometry differences of these models along crossing profile 1 (upper panel); Bottom panel: same as the middle panel but along profile 2 (upper panel). Receiver fit: the fault geometry used for modeling afterslip on the megathrust.

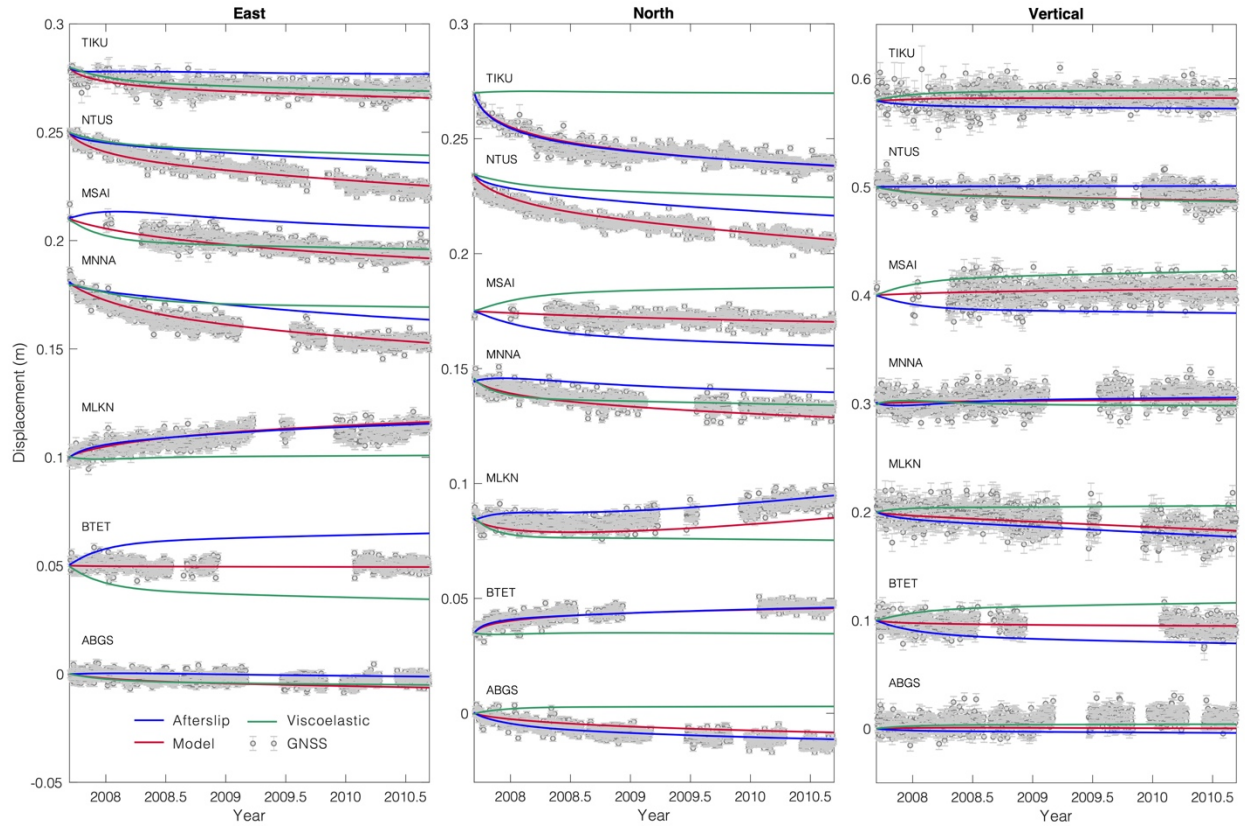


**Supplementary Figure 7. Afterslip comparison between different coseismic models (Figure 6).** (a), (b) and (c) shows the afterslip model estimated from Tsang et al., 2016<sup>1</sup>, Konca et al., 2008<sup>2</sup>, and Gusman et al., 2010<sup>3</sup>, respectively. Black contours show the rupture patch of the corresponding coseismic slip model.

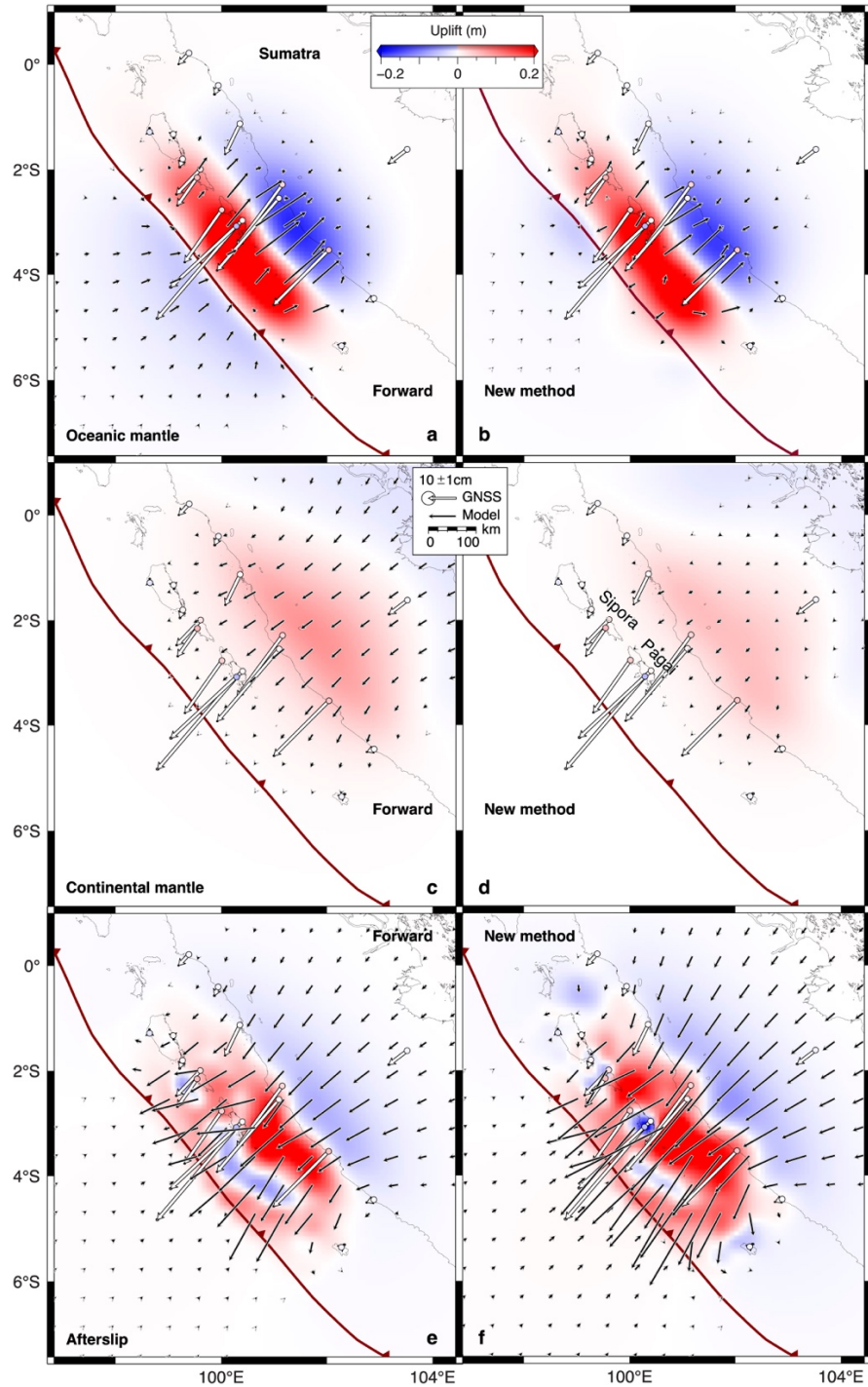




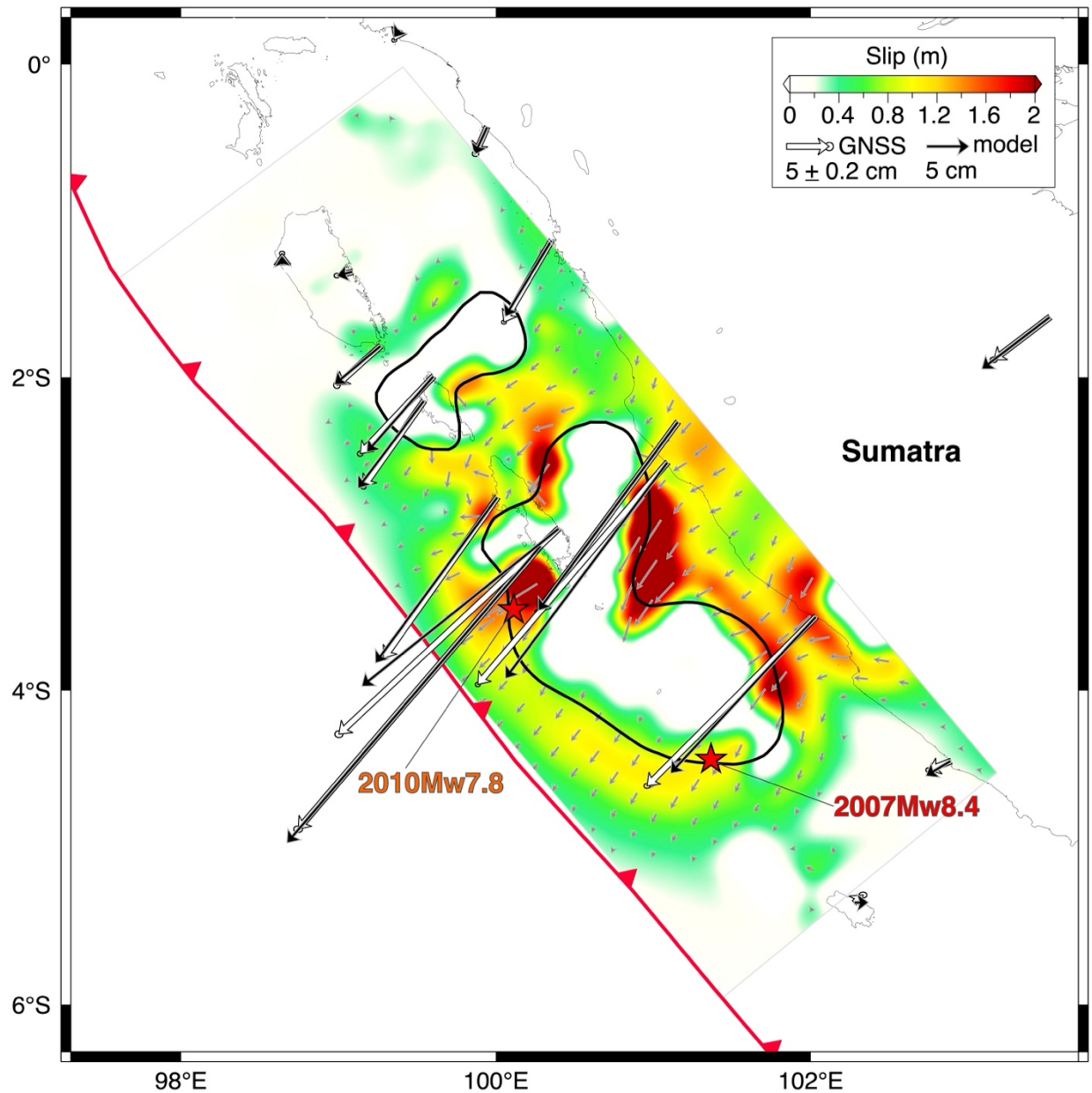
**Supplementary Figure 9. Comparison between the GNSS postseismic time series (near-field) and model predictions by the new method. East, North and Vertical presents the displacement component, respectively.**



**Supplementary Figure 10. Continued. Comparison between the GNSS postseismic time series (far-field) and model predictions by the new method.** East, North and Vertical presents the displacement component, respectively.



**Supplementary Figure 11. Comparison of postseismic surface displacements from afterslip and viscous flow in the mantle between the forward model and the new method. (a), (c) and (e) postseismic displacements from oceanic mantle, continental mantle and afterslip predicted by the forward model, respectively; (b), (d) and (f) postseismic displacements from oceanic mantle, continental mantle and afterslip predicted by the new method, respectively.**



**Supplementary Figure 12. Afterslip estimated by the hybrid approach with the coseismic rupture area penalized.**

### Supplementary References

1. Tsang, L. L. H. *et al.* Afterslip following the 2007 Mw 8.4 Bengkulu earthquake in Sumatra loaded the 2010 Mw 7.8 Mentawai tsunami earthquake rupture zone. *J Geophys Res Solid Earth* **121**, 9034–9049 (2016).

2. Konca, A. O. *et al.* Partial rupture of a locked patch of the Sumatra megathrust during the 2007 earthquake sequence. *Nature* **456**, 631–635 (2008).
3. Gusman, A. R., Tanioka, Y., Kobayashi, T., Latief, H. & Pandoe, W. Slip distribution of the 2007 Bengkulu earthquake inferred from tsunami waveforms and InSAR data. *J Geophys Res Solid Earth* **115**, (2010).
4. Yue, H. *et al.* Validation of linearity assumptions for using tsunami waveforms in joint inversion of kinematic rupture models: Application to the 2010 Mentawai Mw 7.8 tsunami earthquake. *J Geophys Res Solid Earth* **120**, 1728–1747 (2015).