

Supplementary Information for “USArray Shear Wave Splitting Shows Seismic Anisotropy from Both Lithosphere and Asthenosphere”

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Our selected method to analyze *SKS*-wave seismograms is a multi-event method (C2000) (Chevrot, 2000; Monteiller and Chevrot, 2010), which requires each station to have sufficient back-azimuthal distribution of earthquake events in order to observe variation of splitting intensity to calculate splitting parameters, ϕ , and δt for that station. A typical back-azimuthal distribution of earthquake epicenters at any USArray-TA station is shown in Fig. DR1. In the article, we only show comparisons between *SKS* splitting results with absolute plate motions (APM) computed from the model HS3-NUVEL 1A (Gripp and Gordon, 2002) with a fixed hotspot frame of reference (Fig.2 in our article), but here we show our splitting measurements (ϕ) in comparison with APM directions of North America computed from six additional models (Fig. DR2), the HS2-NUVEL 1A (Gripp and Gordon, 1990; DeMets et al., 1994) (Fig. DR2a), the deep source model (Cuffaro and Doglioni, 2007) (Fig. DR2b), the Global Strain Rate Map with APM model, (GSRM-APM-1) (Kreemer, 2009) (Fig. DR2c), the no-net-rotation, the NNR-NUVEL 1A model (DeMets et al., 1994) (Fig. DR2d), the Gripp and Gordon Style model with the Pacific plate velocity of 20 cm yr^{-1} (S20) (Crespi et al., 2007) (Fig. DR2e), and the shallow source model (Cuffaro and Doglioni, 2007) (Fig. DR2f). We calculate average angle differences between ϕ and the models' APM shown as histograms in the insets of Fig. DR2a-S2f. Comparing these histograms, we find that our measured ϕ s are in good agreement with APM directions calculated from the HS2-NUVEL 1A model, and the deep source model. This comparison further strengthens the hypothesis that the source of most anisotropy is simple shear in the asthenosphere (Vinnik et al., 1992) at the base of the North American continent, but the regions of ϕ - ϕ_{APM} deviation reflect either significant contributions to splitting intensity from the North American lithosphere (Silver and Chan, 1988, 1991) or deviations of asthenospheric deformation from the simple shear model. Fig. DR3 shows our measurements plotted over flow models at different depths 150, 200, 250 and 300 km. These models (Becker et al., 2014) show

good agreement to global SKSanisotropy measurements, but the model flow directions and our measurements do not agree well (mean difference of 33° , at a depth of 200 km and greater deviation at other depths), possibly due to relatively lower resolution of the model and the difficulty in modeling the influence of variable continental lithosphere (hence the focus of Becker et al. (2014) on comparison with oceanic anisotropy).



Figure DR1: Backazimuthal distribution of earthquake epicenters recorded at station J10A in Idaho. Beach ball patterns depict focal mechanisms associated with earthquake sources from the Global Centroid-Moment-Tensor (CMT) Project (www.globalcmt.org). Green beach balls represent events that are initially analyzed, and red beach balls are events that give usable splitting intensity measurements by the last step of analysis (also shown in the next figure, Fig. DR2). This represents typical backazimuthal distribution of earthquake epicenters recorded at any USArray-TA station in this study.

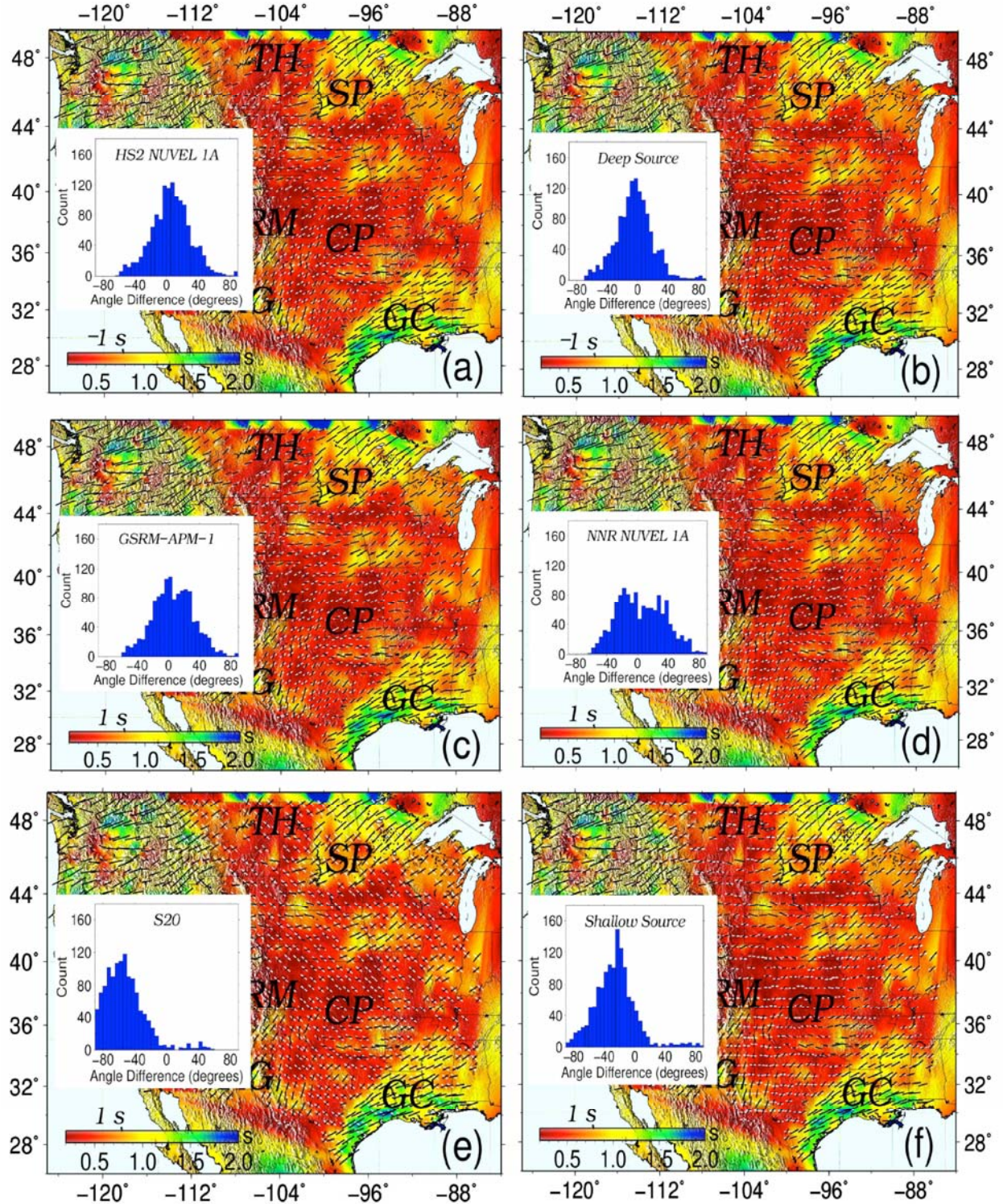


Figure DR2: SKS-wave splitting measurements plotted on top of APM directions of North America computed from six additional models: (a) the HS2-NUVEL 1A model, (b) the deep source model, (c) the GSRM-APM-1 model, (d) the NNR-NUVEL 1A model, (e) the S20 model, and (f) the shallow source model. Insets are histograms showing differences between ϕ and the models' APM directions.

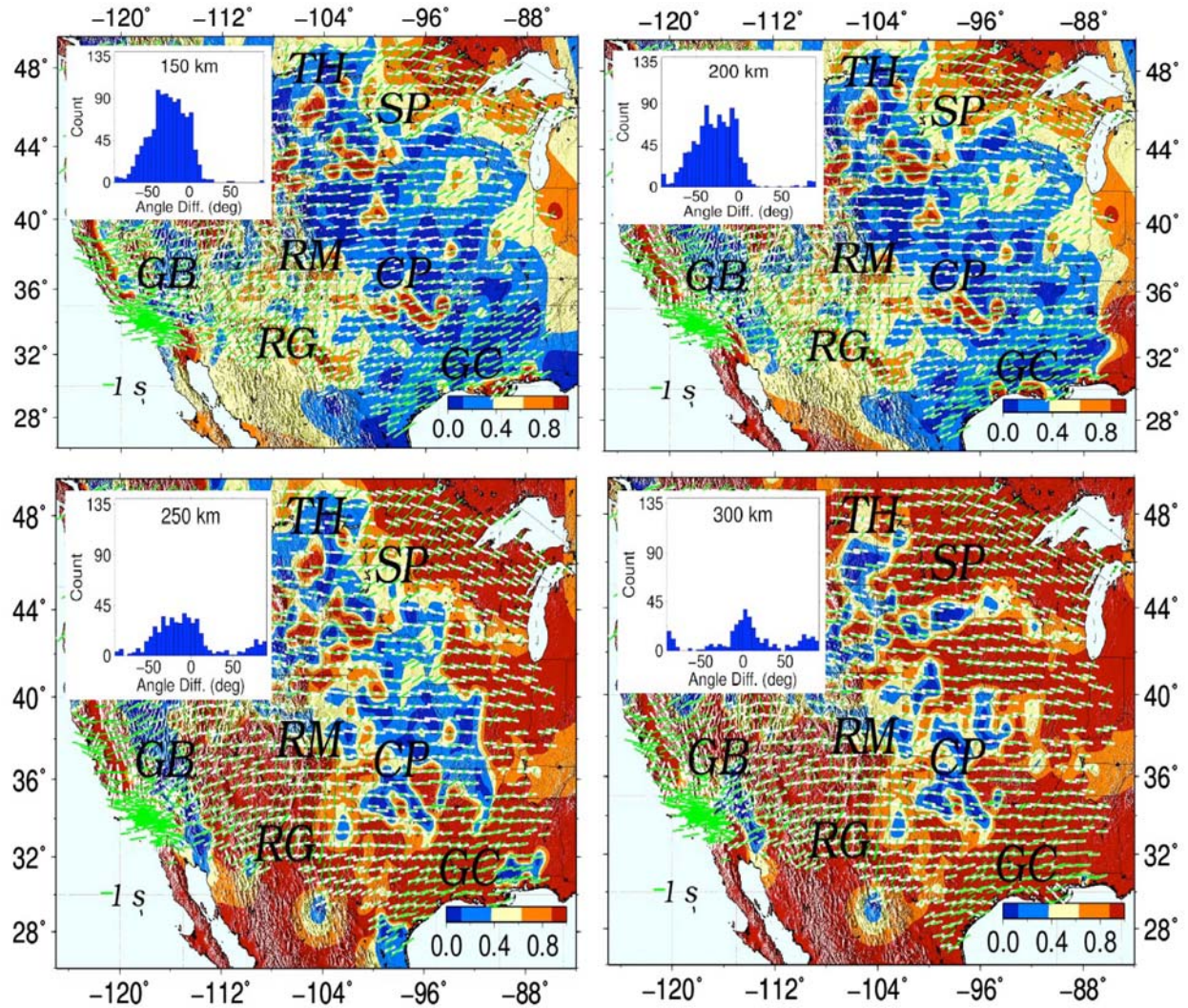


Figure DR3: SKS-wave splitting measurements (green lines) and predicted anisotropic fast axis directions of North America computed from the model of Becker et al. (2014) (white lines) plotted on top of the scaled difference between the measured ϕ values and the predicted anisotropic fast axis calculated at station locations at different depths: (a) 150 km, (b) 200 km, (c) 250 km, and (d) 300 km. Colors represent the calculated scaled difference D (see article text for definition). Insets are histograms showing differences between ϕ and the models' fast axis directions.

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