Crustal stress and deformation in southern California from seismic anisotropy

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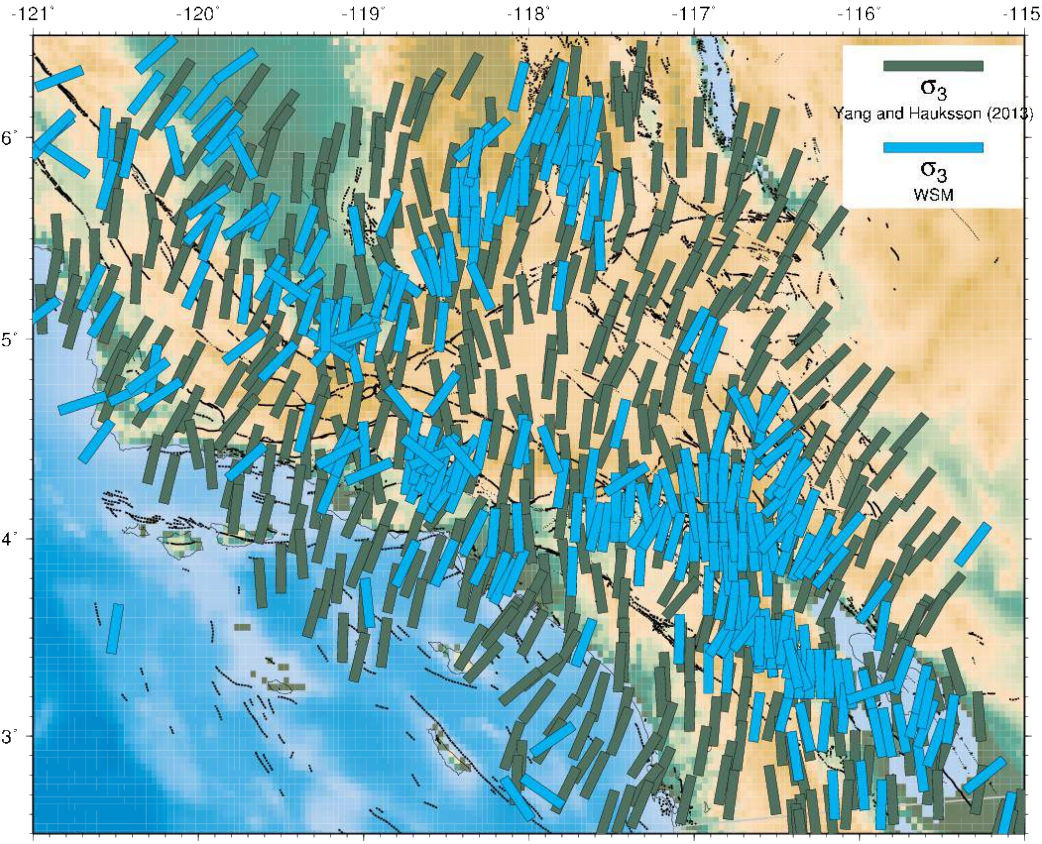
CSM-0.1 vs. WSM: what did we learn?

comparison of different orientational fields

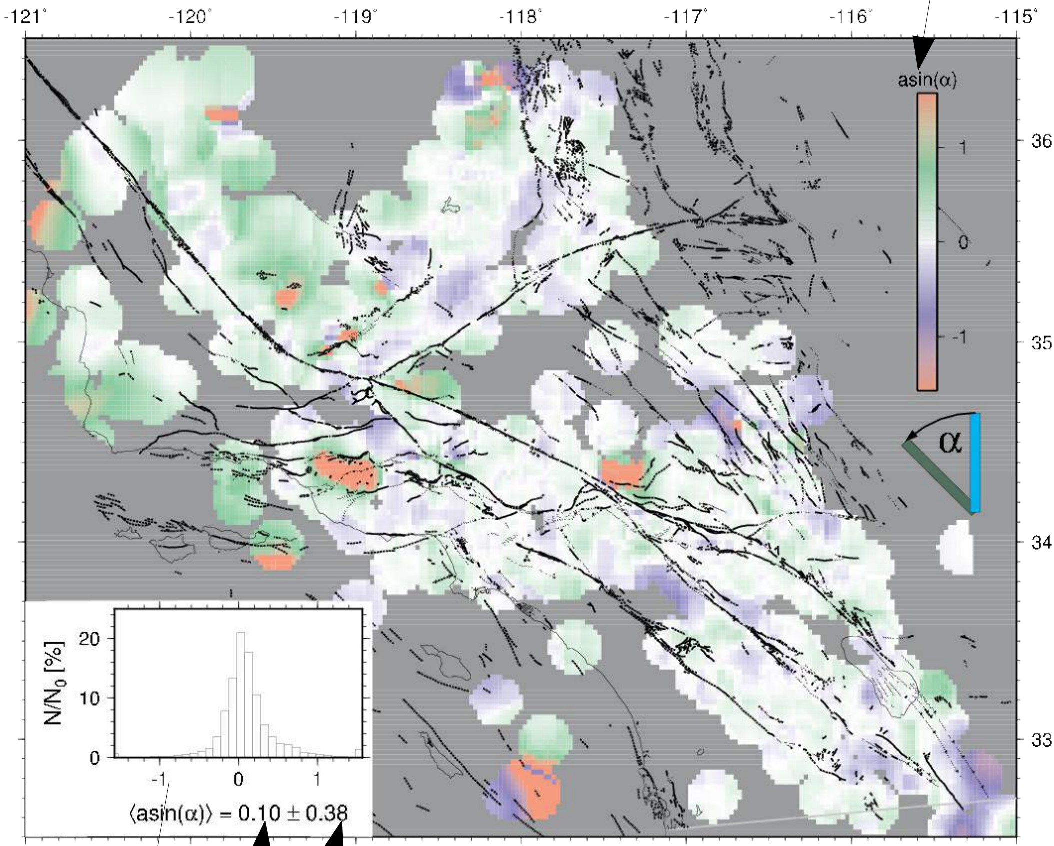


major compressive axes
(of the horizontal stress tensor components)

Baseline for comparison between stress models

orientational misfit
(blue: second field CCW, green: CW from first field)

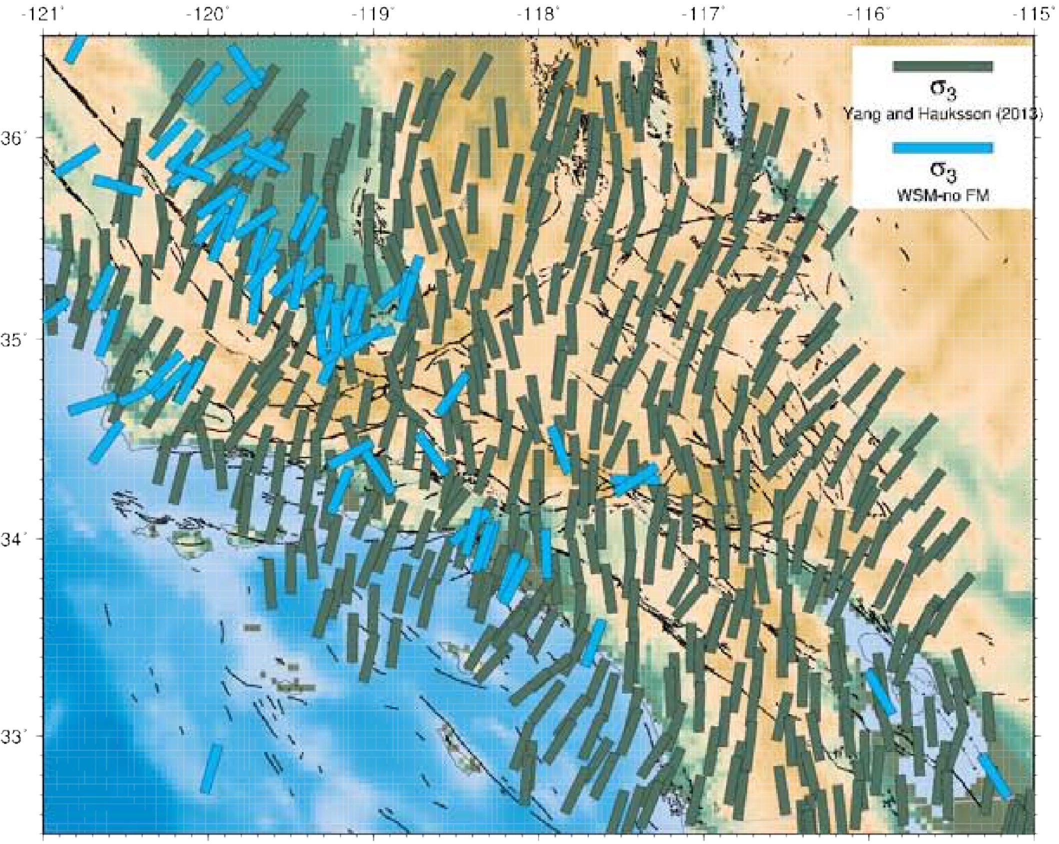
radians

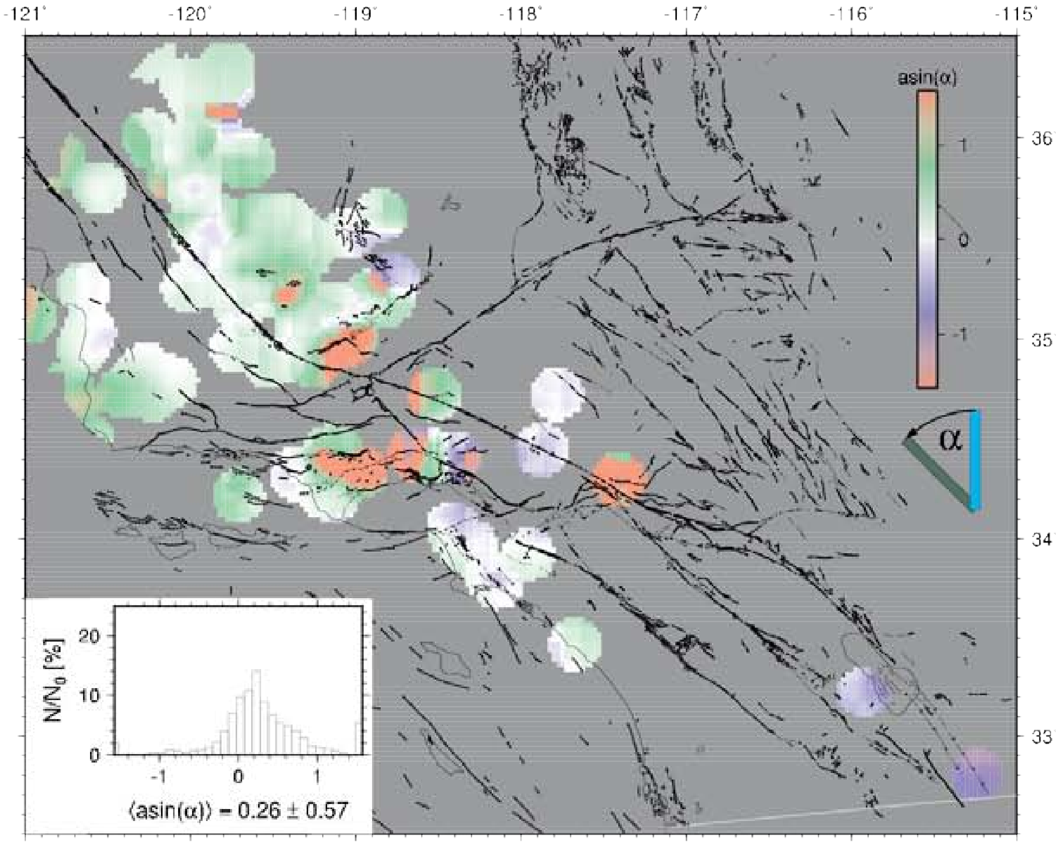


mean (~same azimuth),
STD ~ 0.38 (~ 21º)

histogram of misfit in sampled regions

CSM-0.1 vs. WSM – no FM



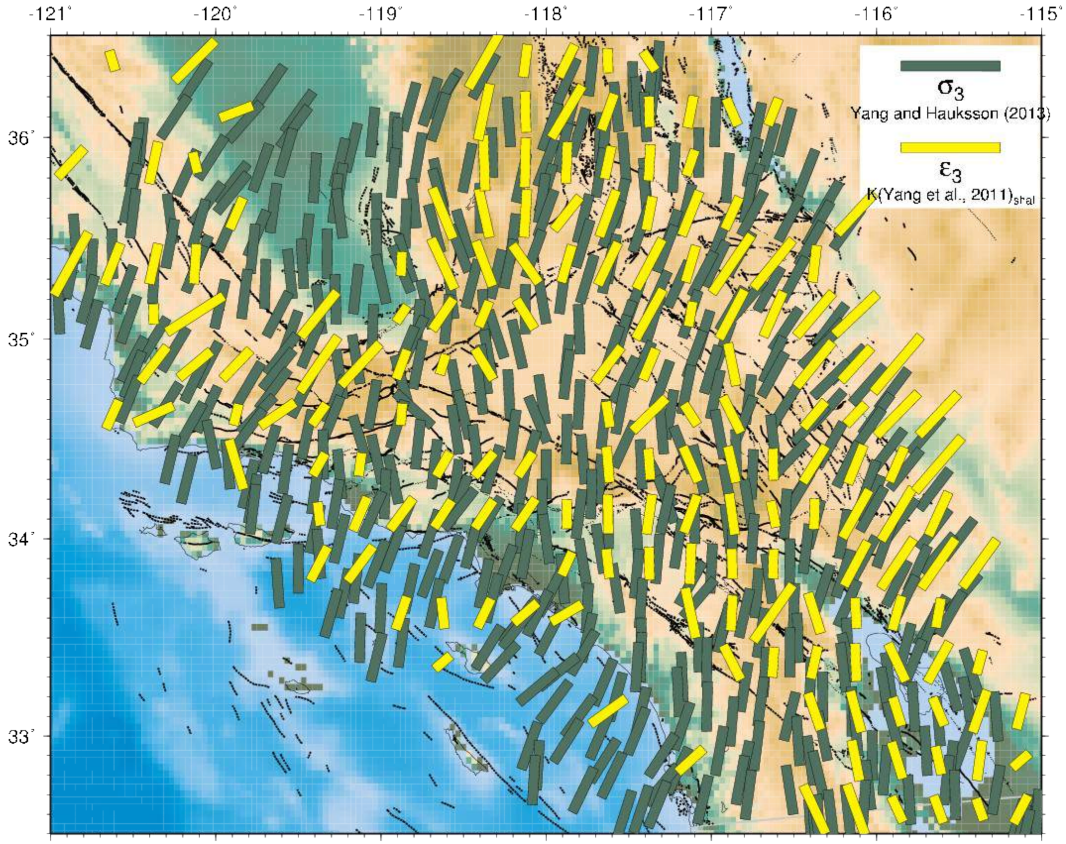


Major compressive axis

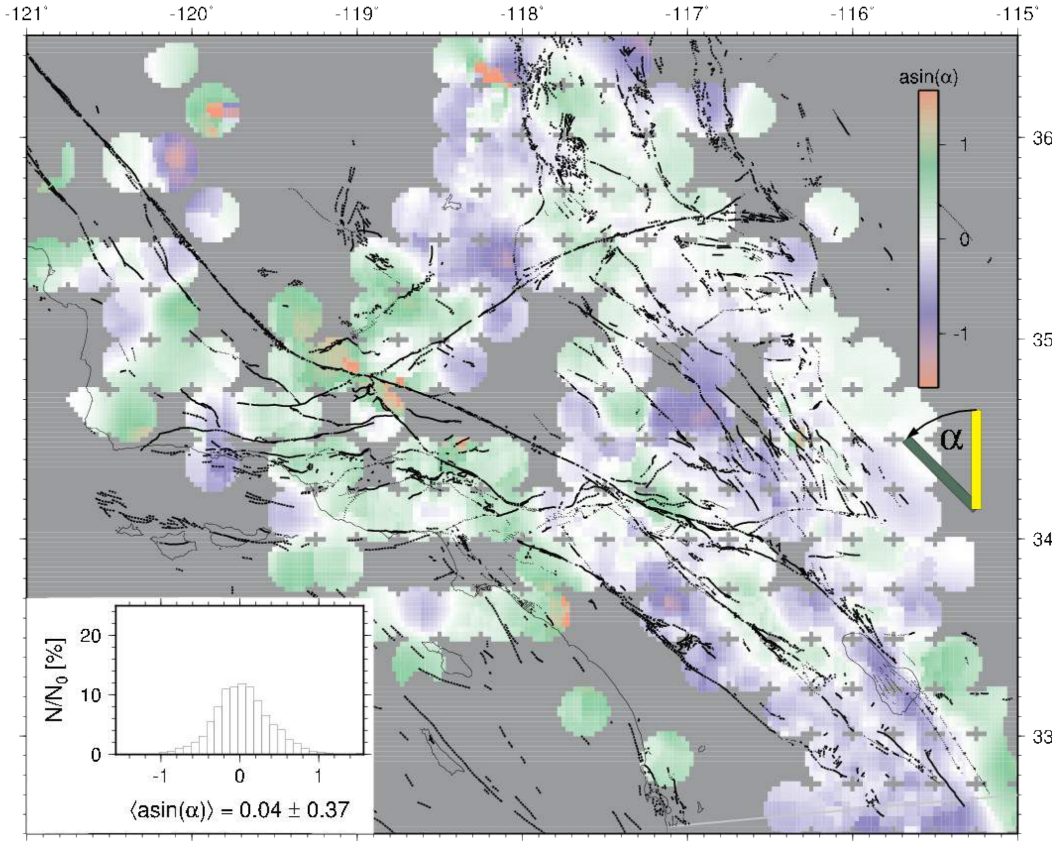
Limited scope for “validation”

CCW deviation with non FM WSM

Seismic: Michael vs. Kostrov

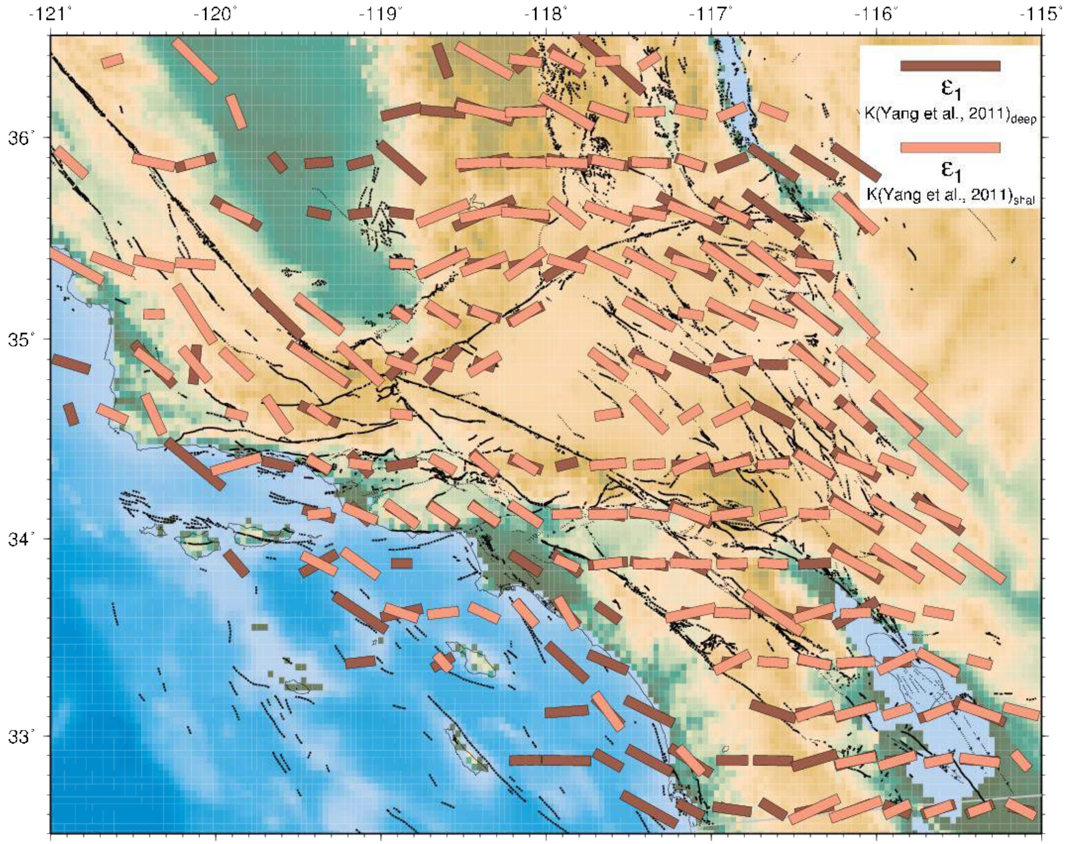


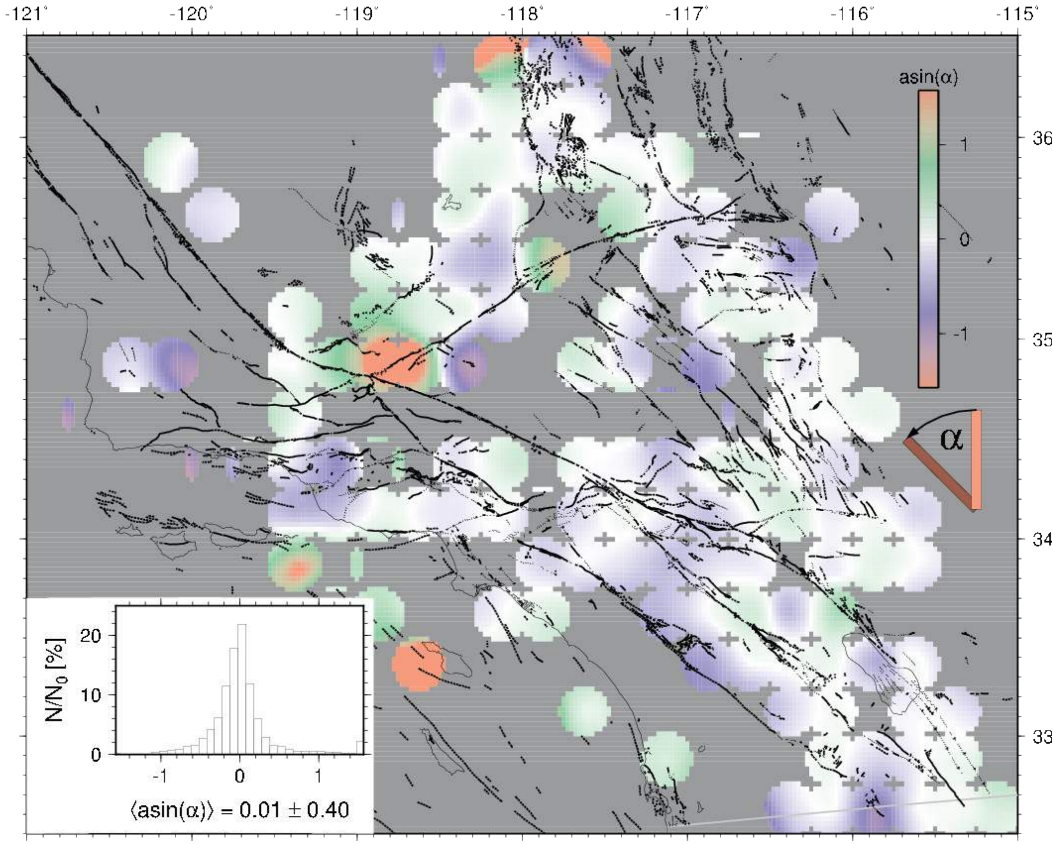
Major compressive axis



same mean, STD ~ 0.37 (~ 21°)
(comparable to match with WSM)

Seismic: shallow vs. deep Kostrov

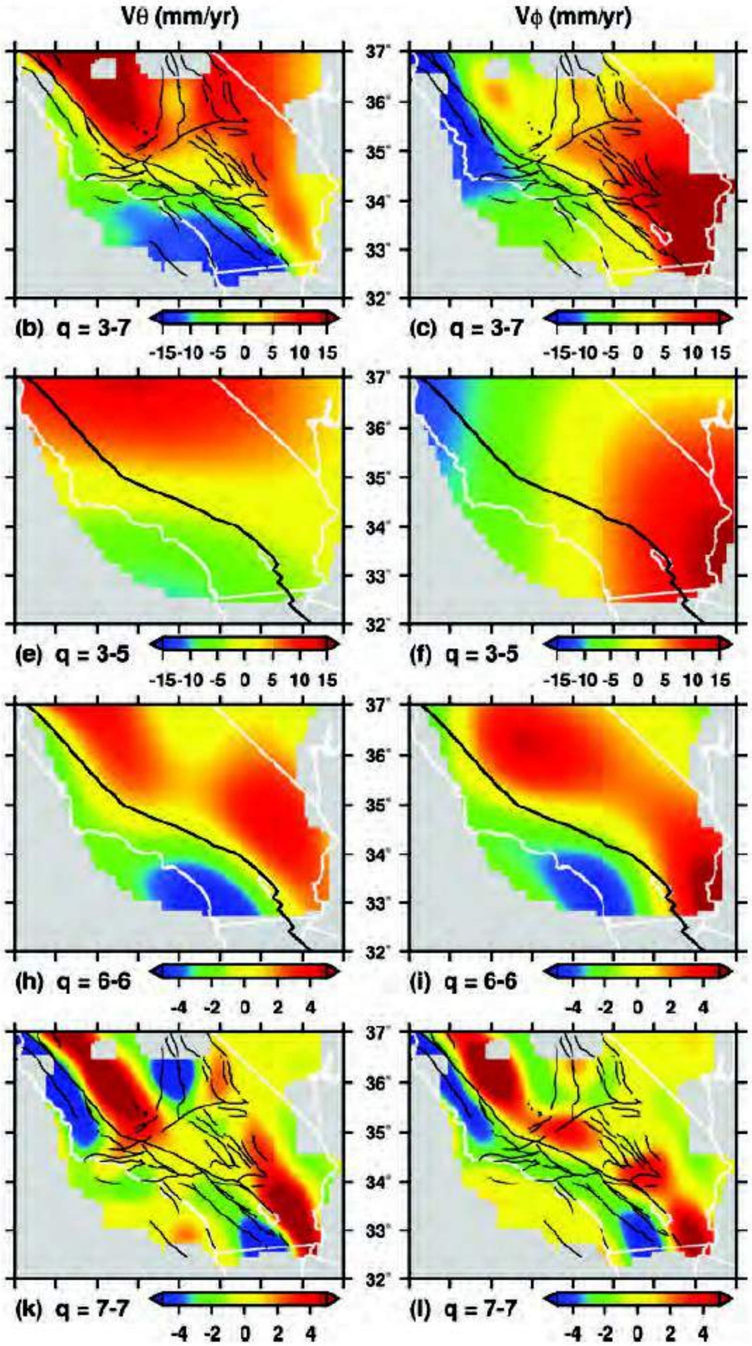




Major extensional axis

same mean, STD ~ 0.4 (~ 23°)
No meaningful patterns?

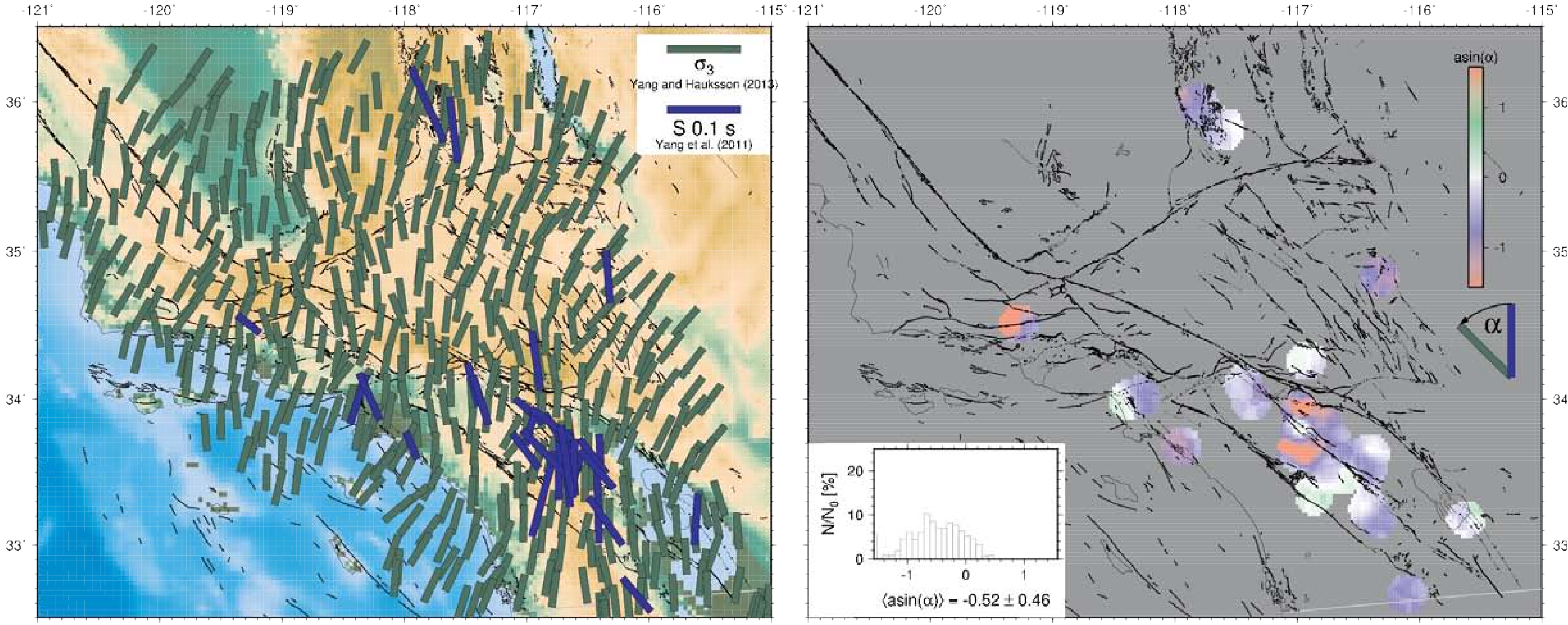
Multi-scale, fault-less models



- Should use Corne Kreemer's compilation + PBO and Tape et al.'s (2009) wavelet dependent analysis
- compare with stress models

Tape et al. (2009)

S anisotropy vs. Michael stress



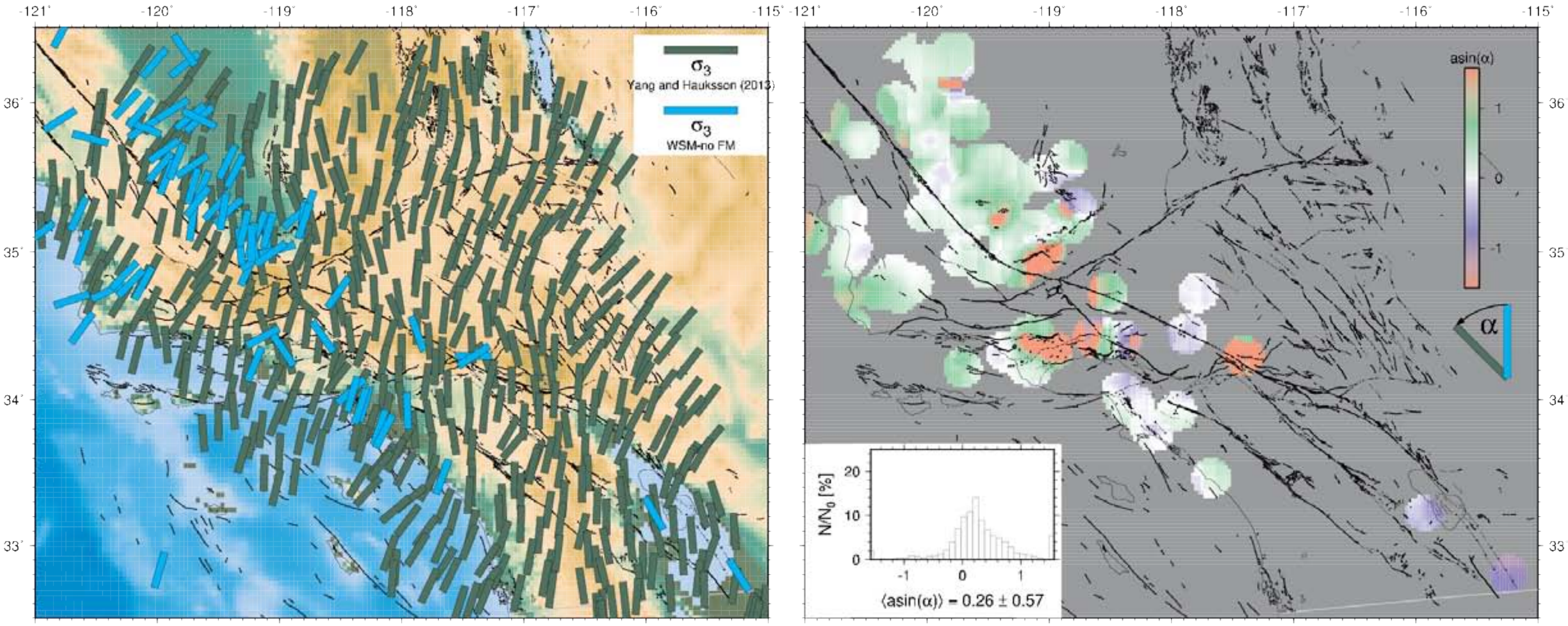
Major compressional axis

Splits more fault aligned, stress more N-S

Assumption: *S* splits see upper crustal, SPO anisotropy via alignment of cracks in stress field

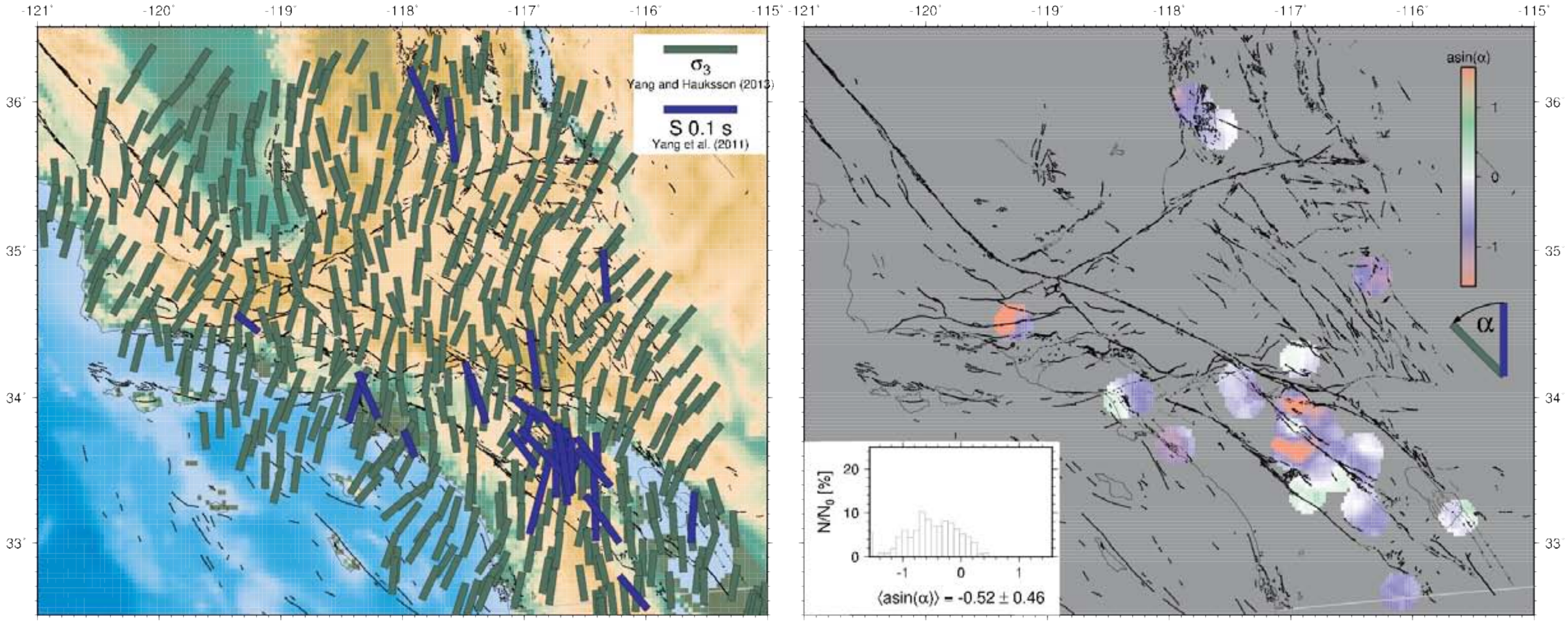
cf. Yang et al. (2011)

CSM-0.1 does not work

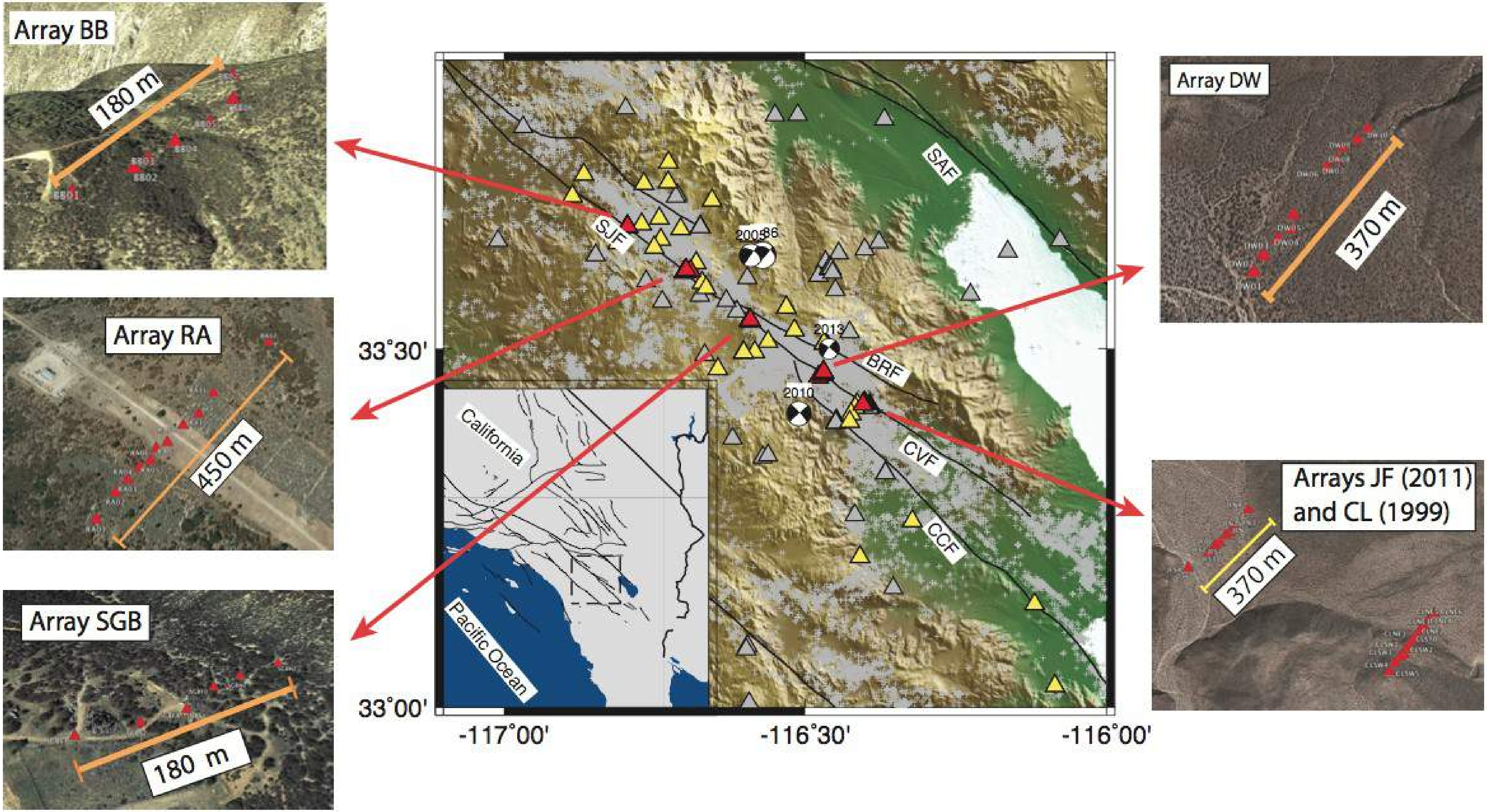


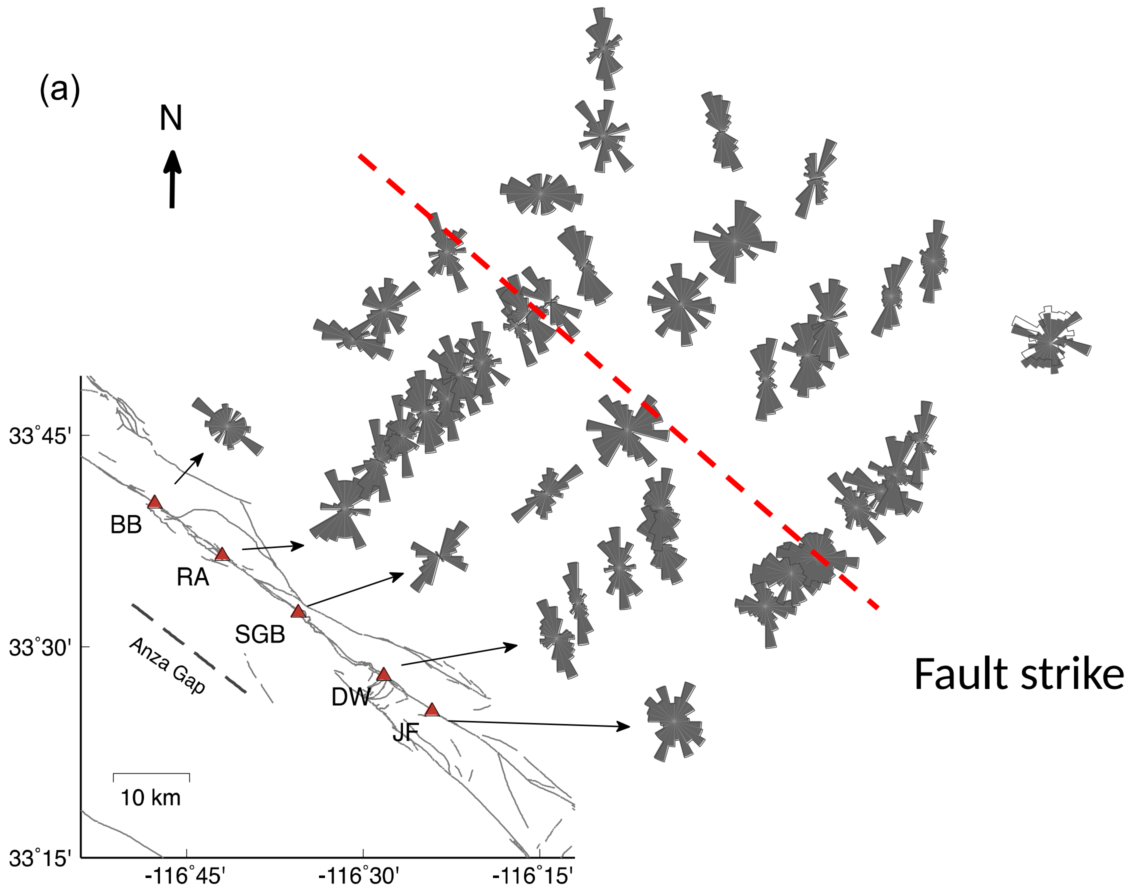
WSM no FM
comparison

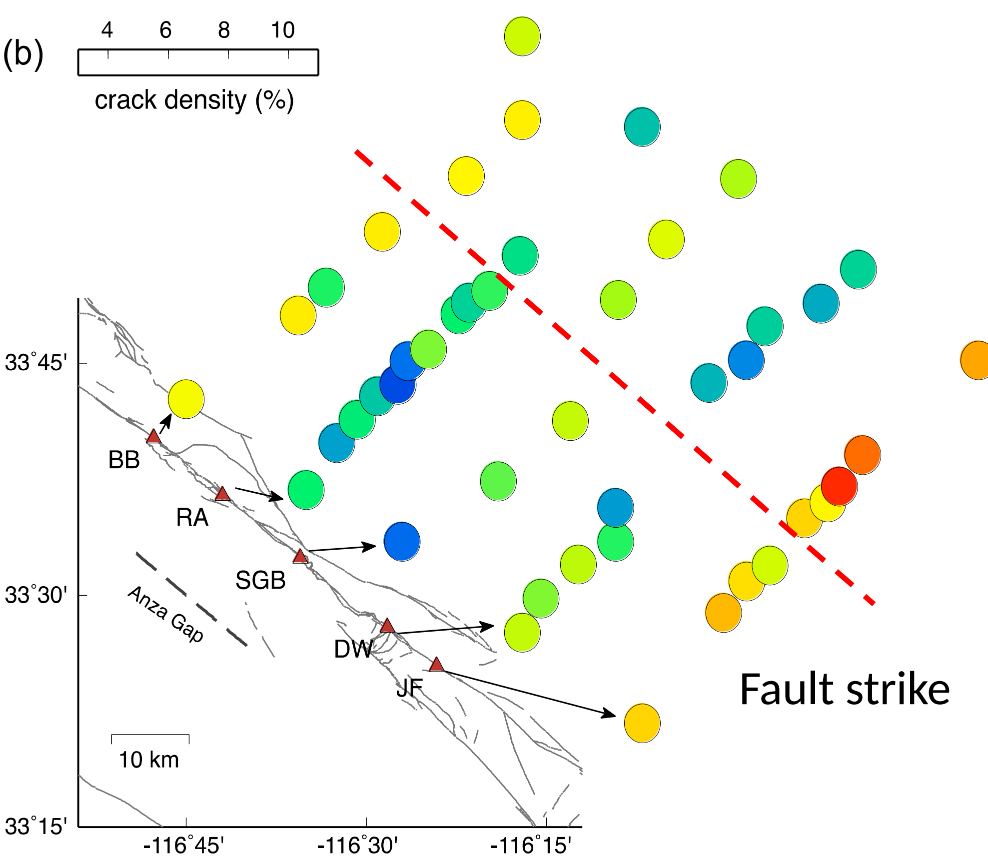
S splitting
comparison



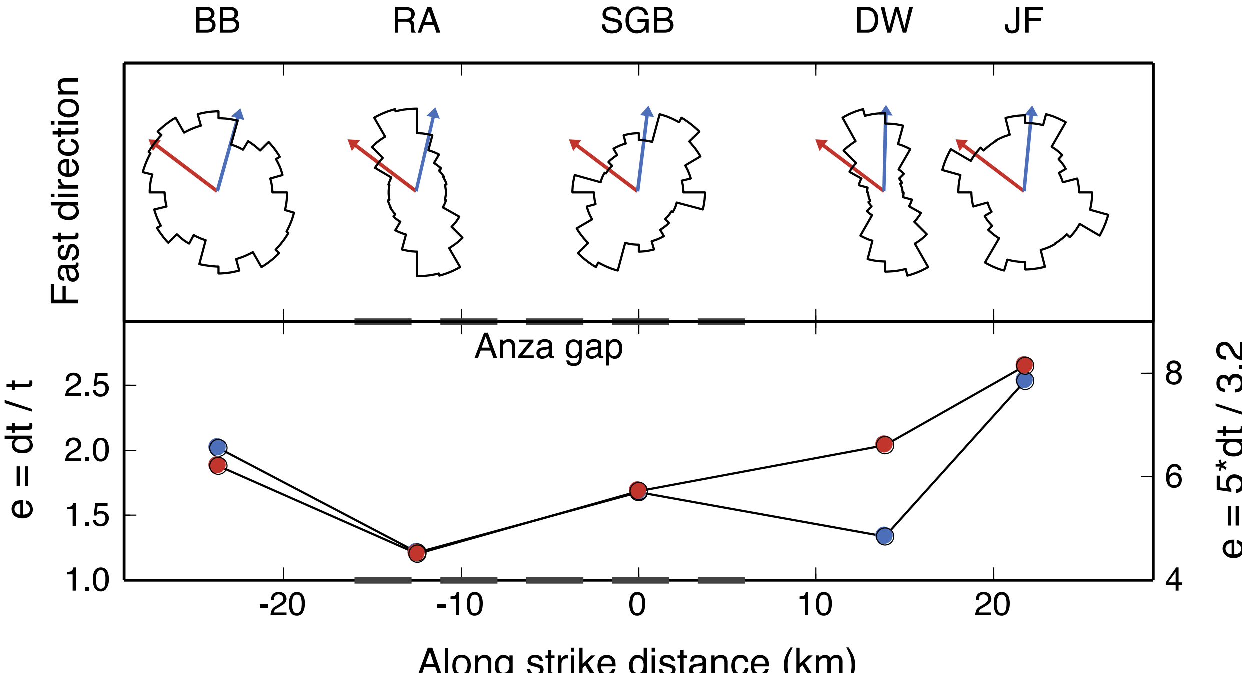
Shear Wave Anisotropy Along the San Jacinto Fault
(Li et al., in prep; Yang et al., in revision)



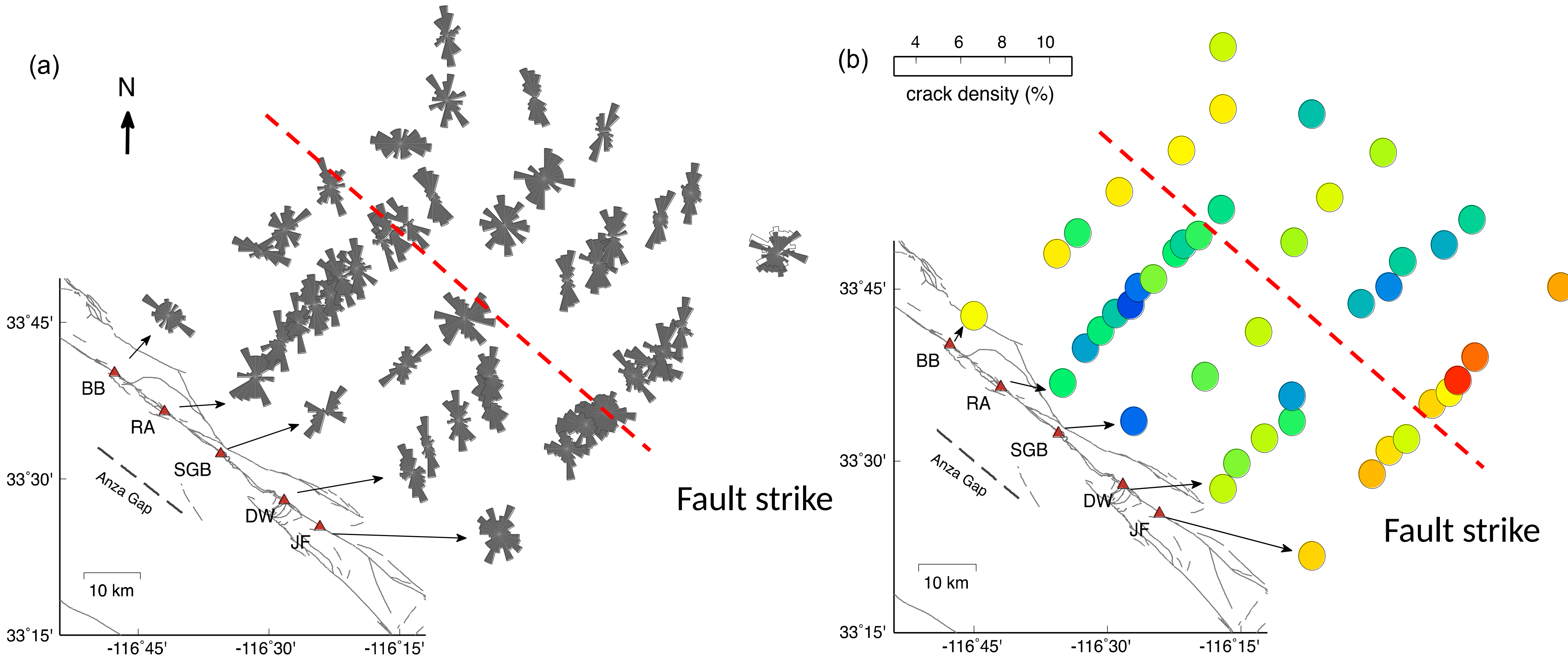


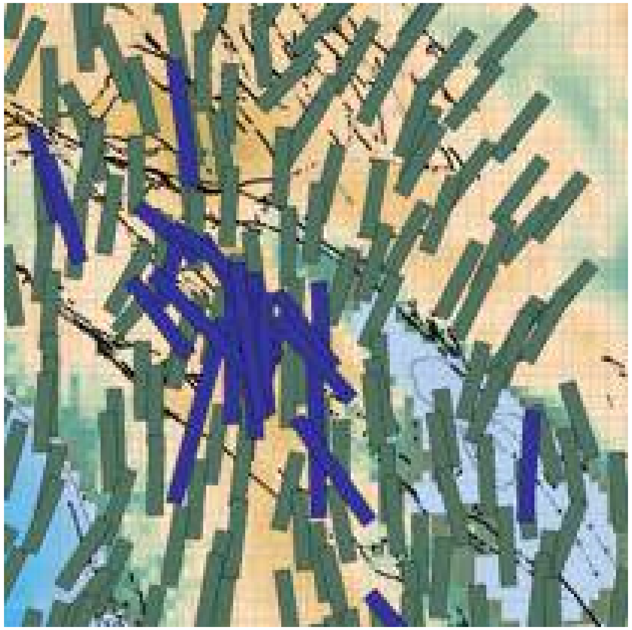


Variations of fast direction (b), and crack densities (b) measured at dense arrays across the San Jacinto Fault. The right two panels show the along-strike variations of the fast direction rose diagrams and mean crack densities.



Li et al./Yang et al.





Variations of fast direction (b), and crack densities (b) measured at dense arrays across the San Jacinto Fault. The right two panels show the along-strike variations of the fast direction rose diagrams and mean crack densities.

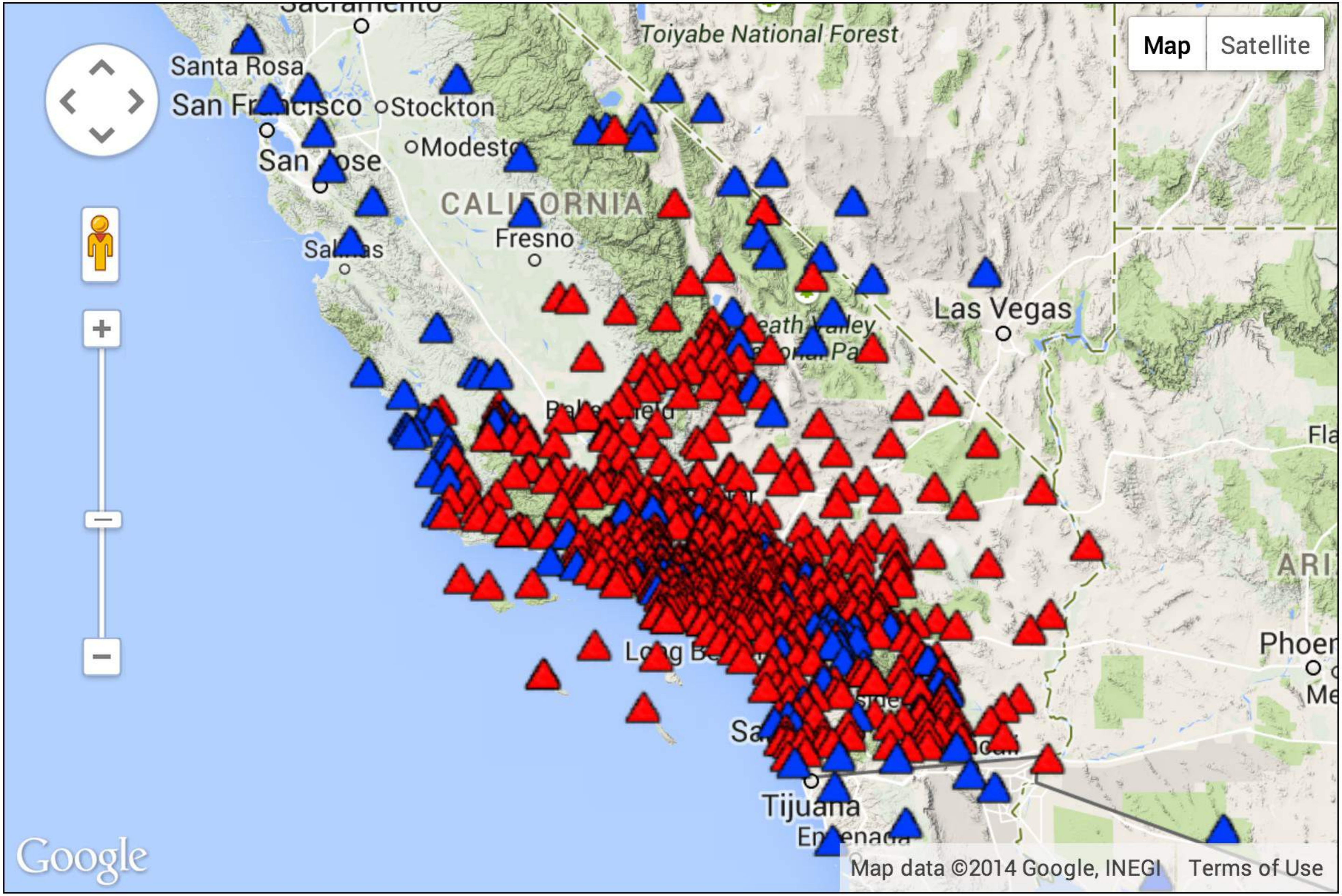
Li et al./Yang et al.

Yang et al. (2011)

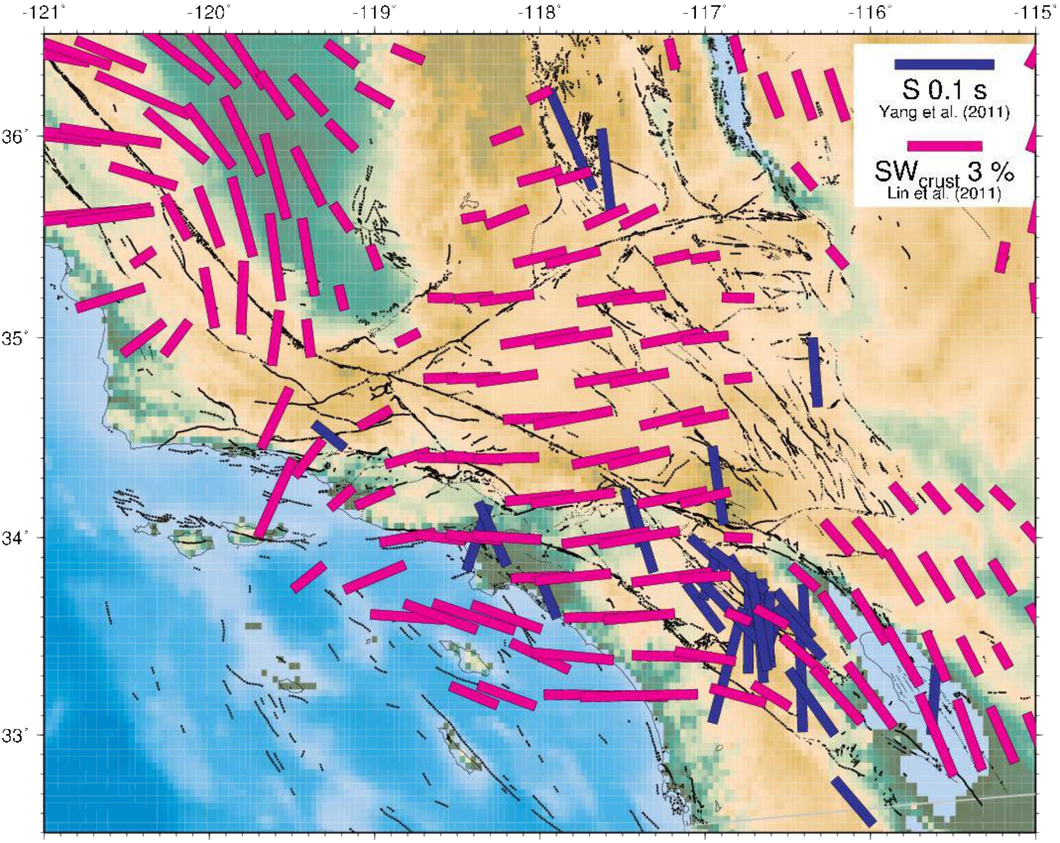
Automatic Measurements of Shear-Wave Anisotropy in Southern Calif.

Number of stations retrieved : 683

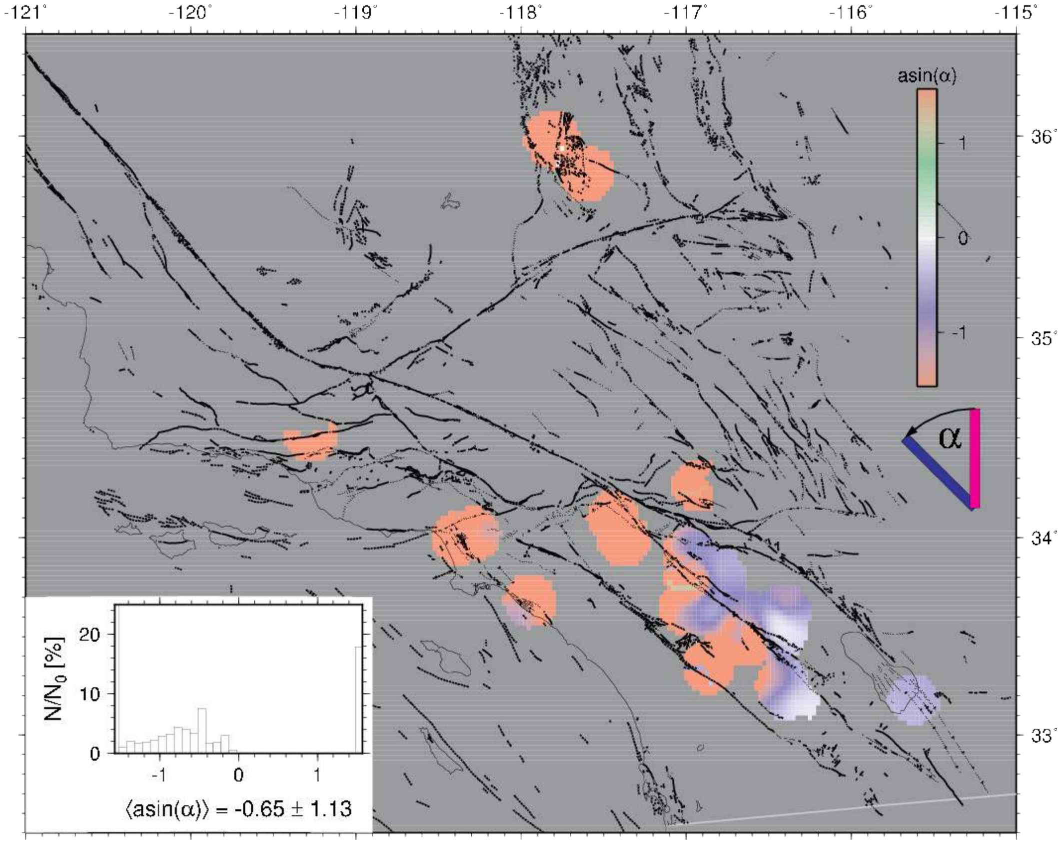
Lat: 37.1778, Lng: -120.7324



S anisotropy vs. crustal anisotropy



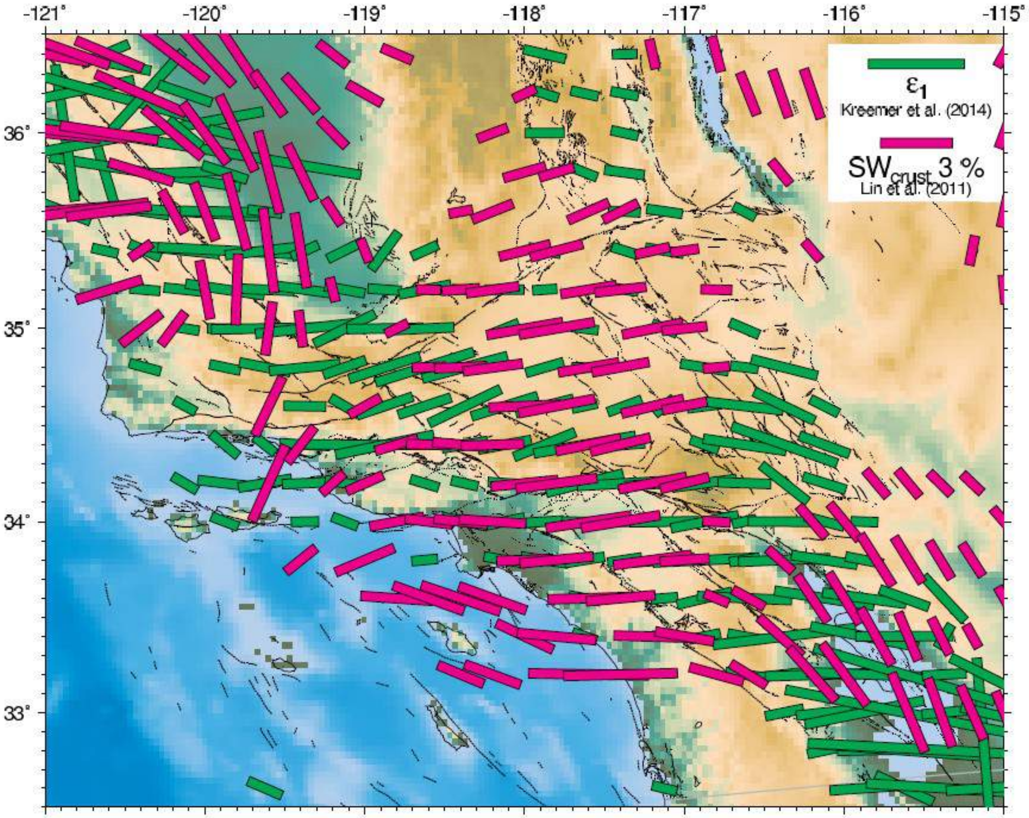
"Fast axes"



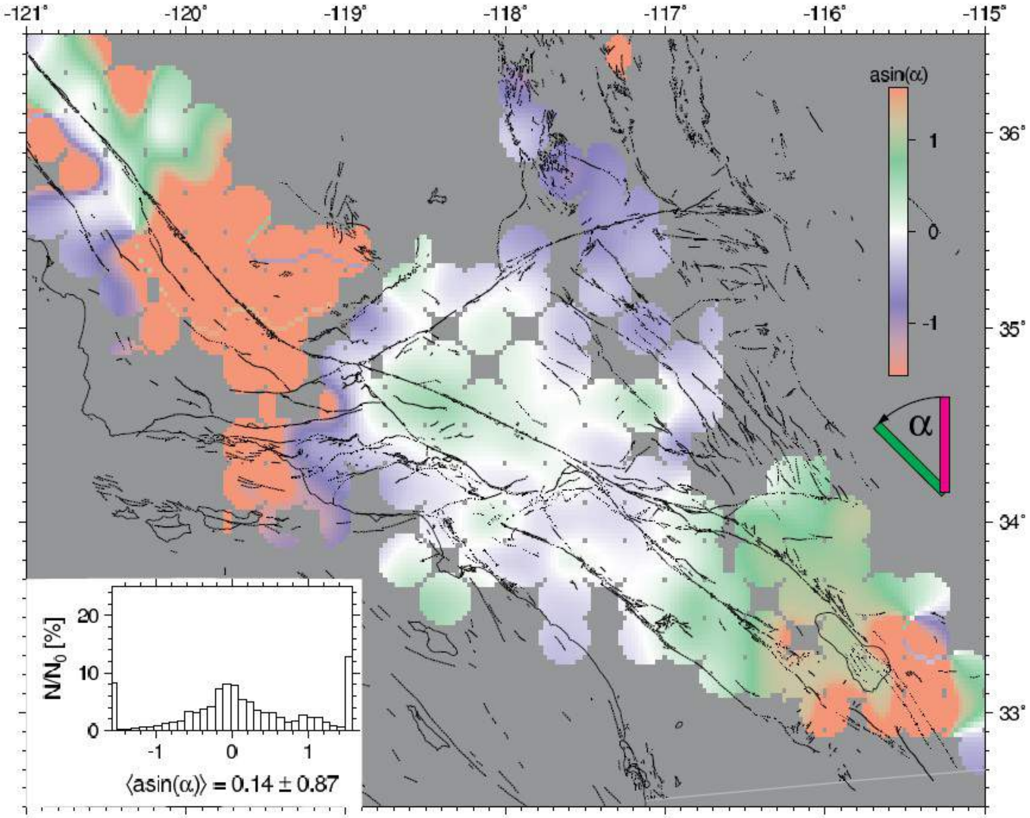
Noise surface wave imaging
(completely different signal)

cf. Lin et al. (2011)

crustal anisotropy vs. GPS stretch

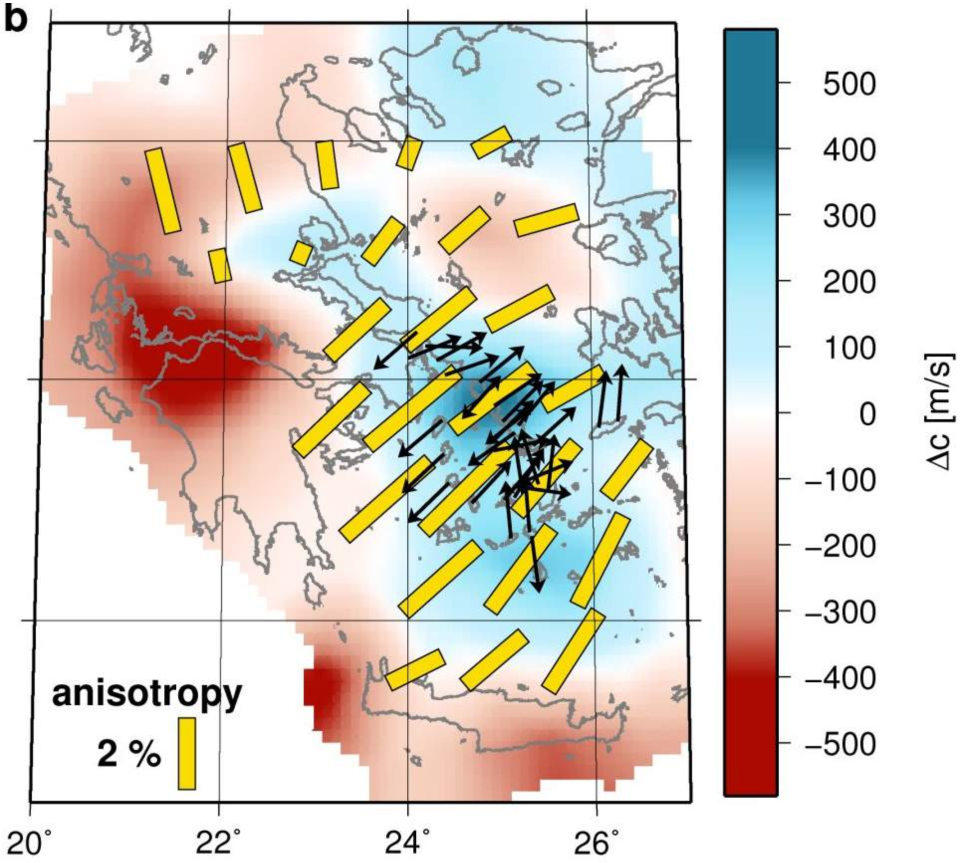


Major extensional axes



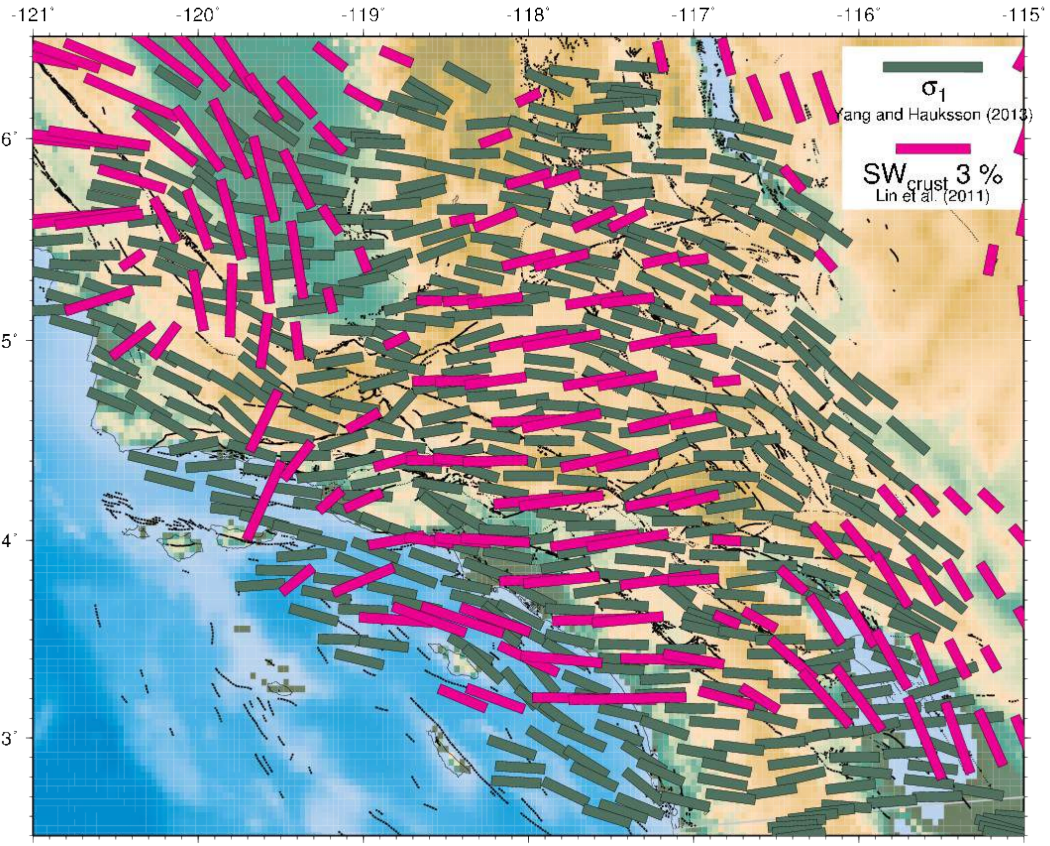
Good match in Big Bend region!

Origin of crustal anisotropy unclear, but alignment with finite extension common?

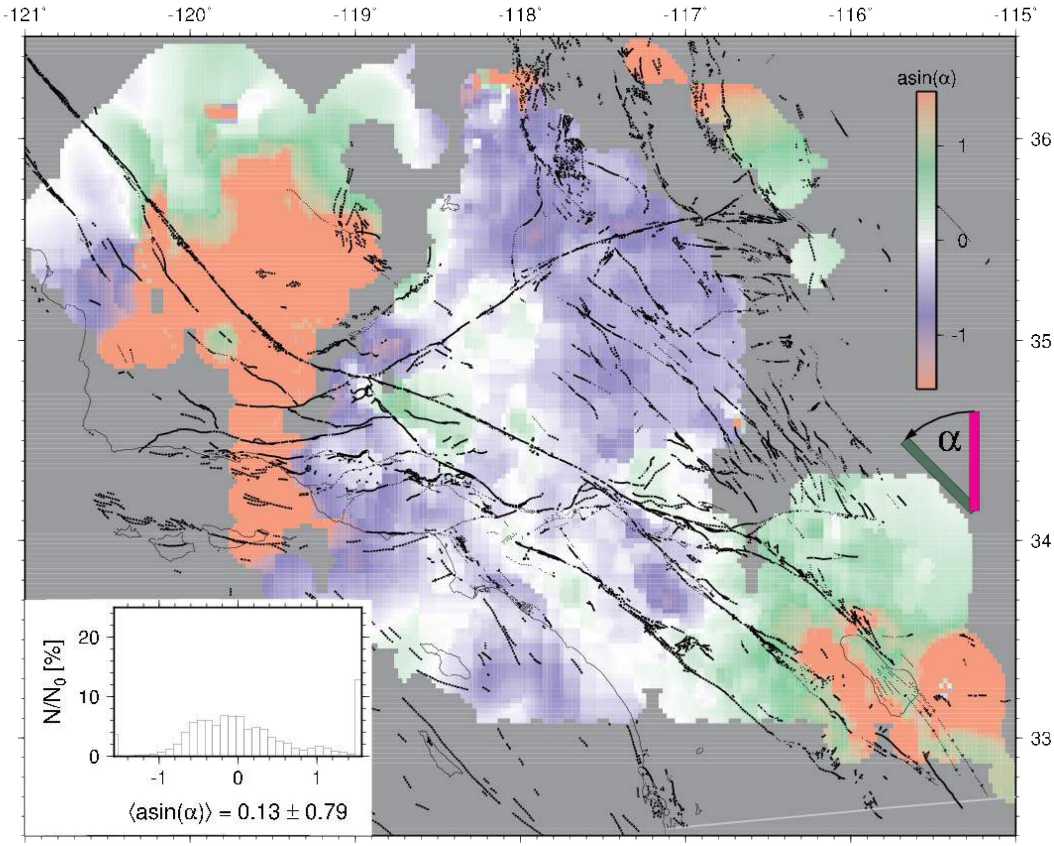


Endrun et al. (2011)

crustal anisotropy vs. Michael stress

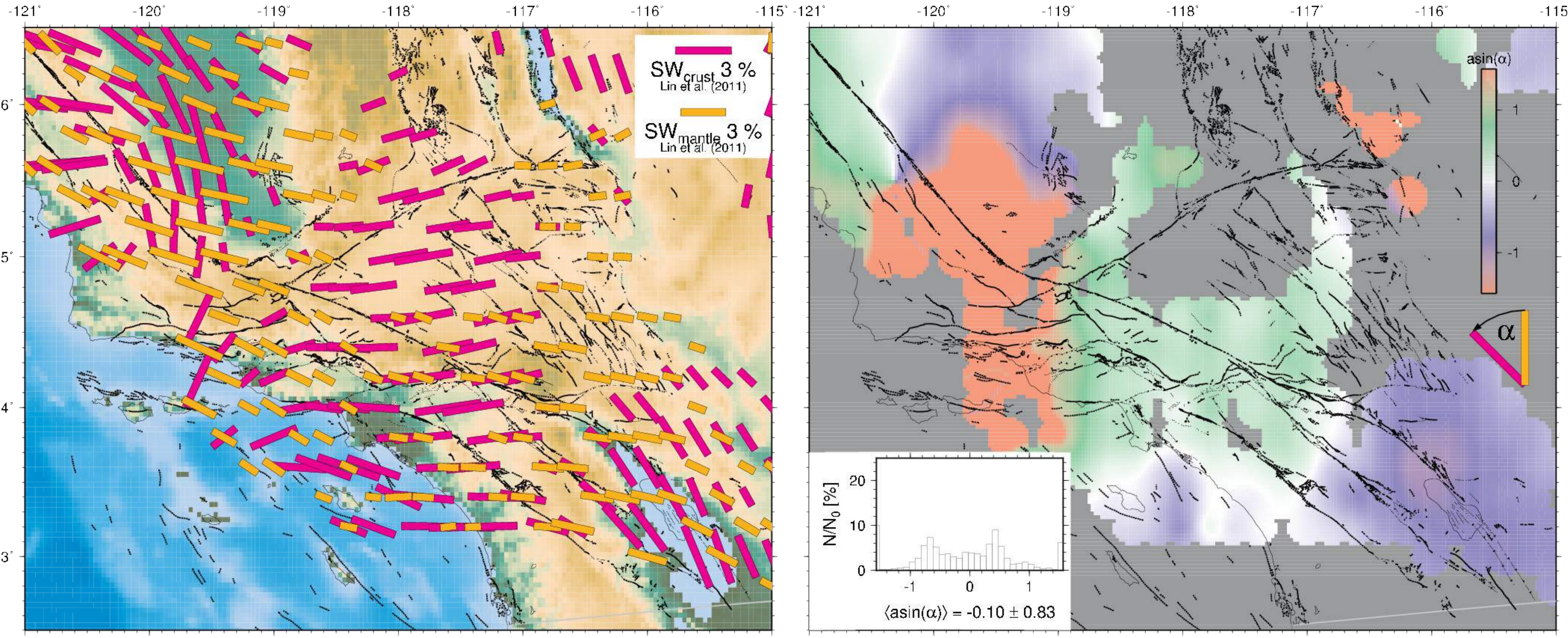


Major extensional axes



Good match in Big Bend region
(again, same for GPS and Kostrov)

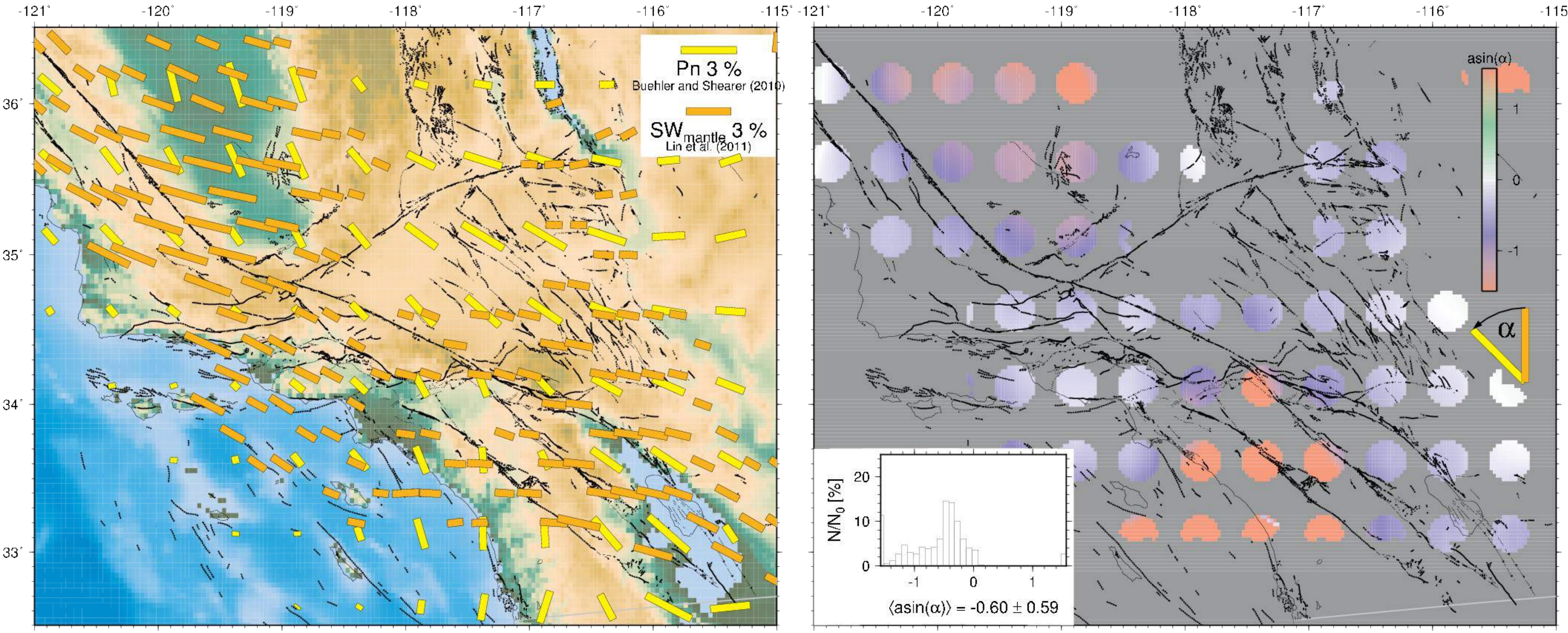
crustal vs. mantle anisotropy



crust and mantle anisotropy from SW imaging

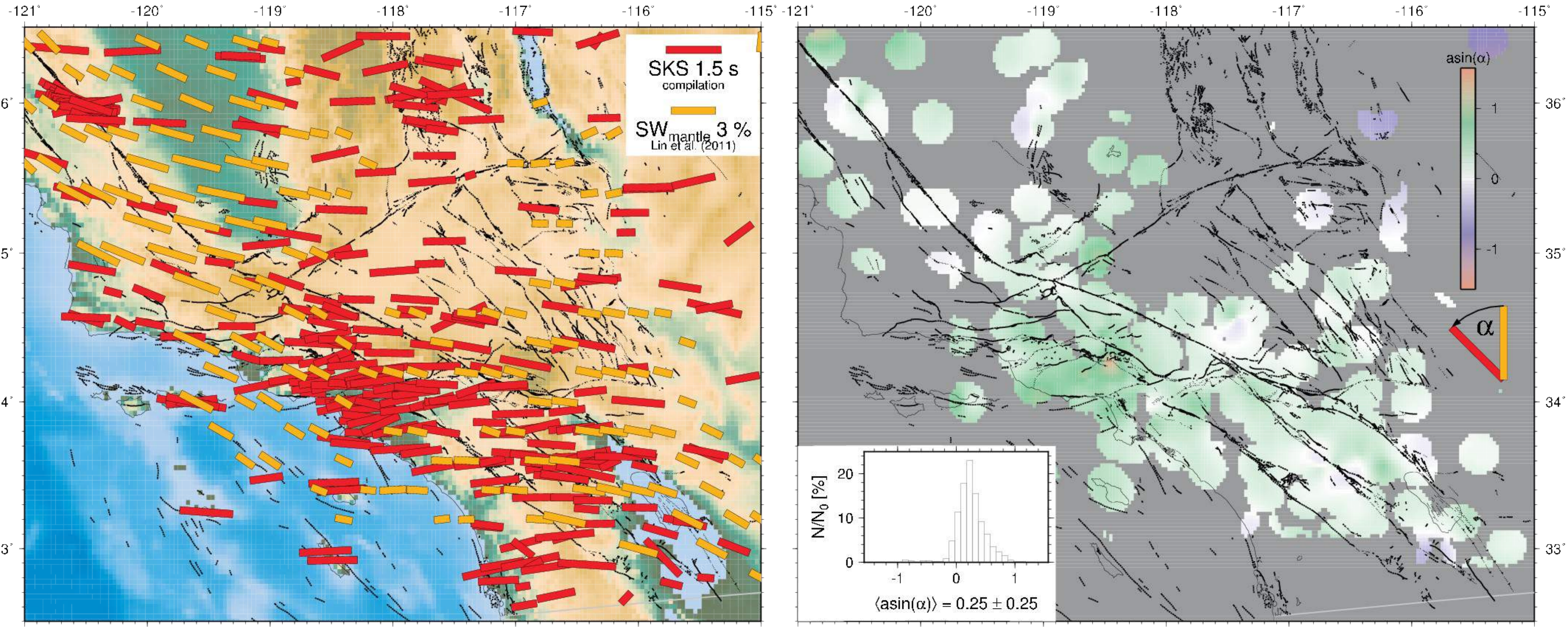
Lin et al. (2011)

Pn vs. mantle anisotropy



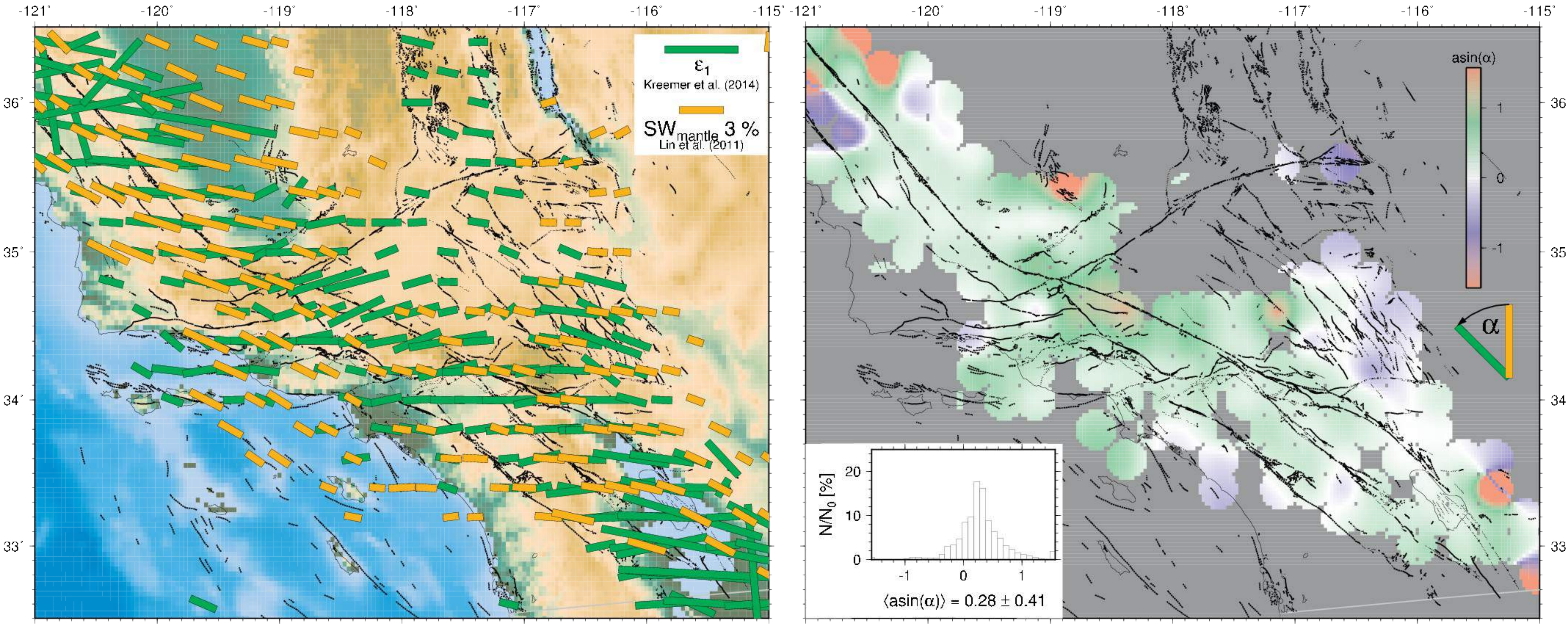
Lin et al. (2011); Buehler and Shearer (2010)

Deep:
mantle anisotropy vs. SKS anisotropy



Very good alignment,
SKS trends more W-E in central region

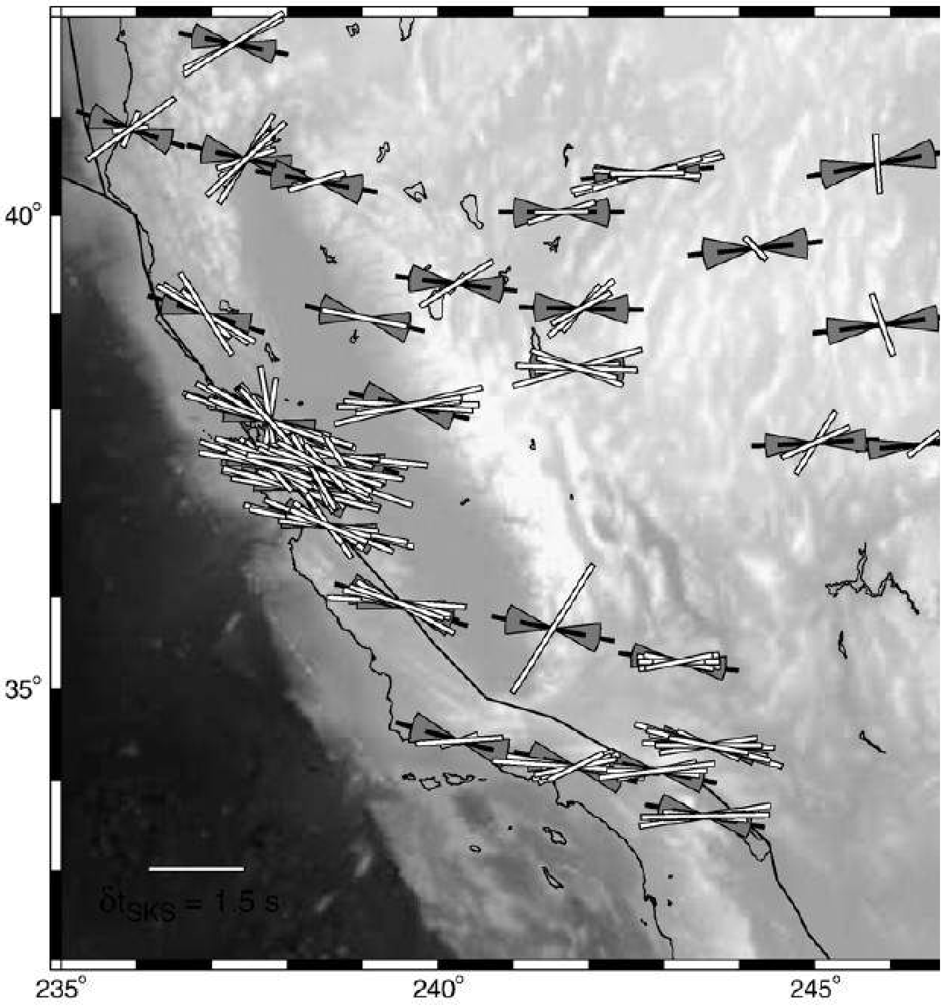
Shallow:
mantle anisotropy vs. GPS stretch

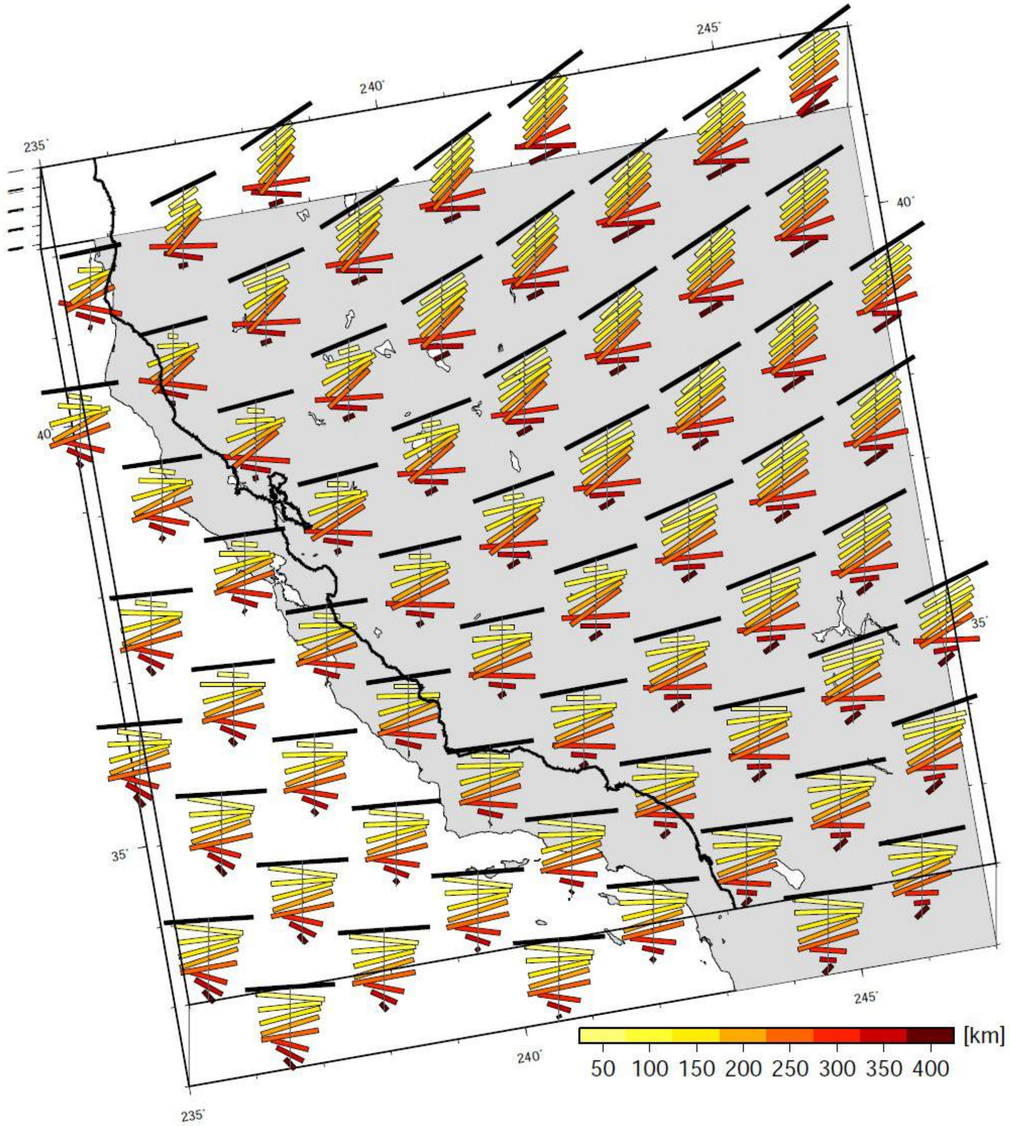


Very good alignment,
GPS trends more W-E in central region

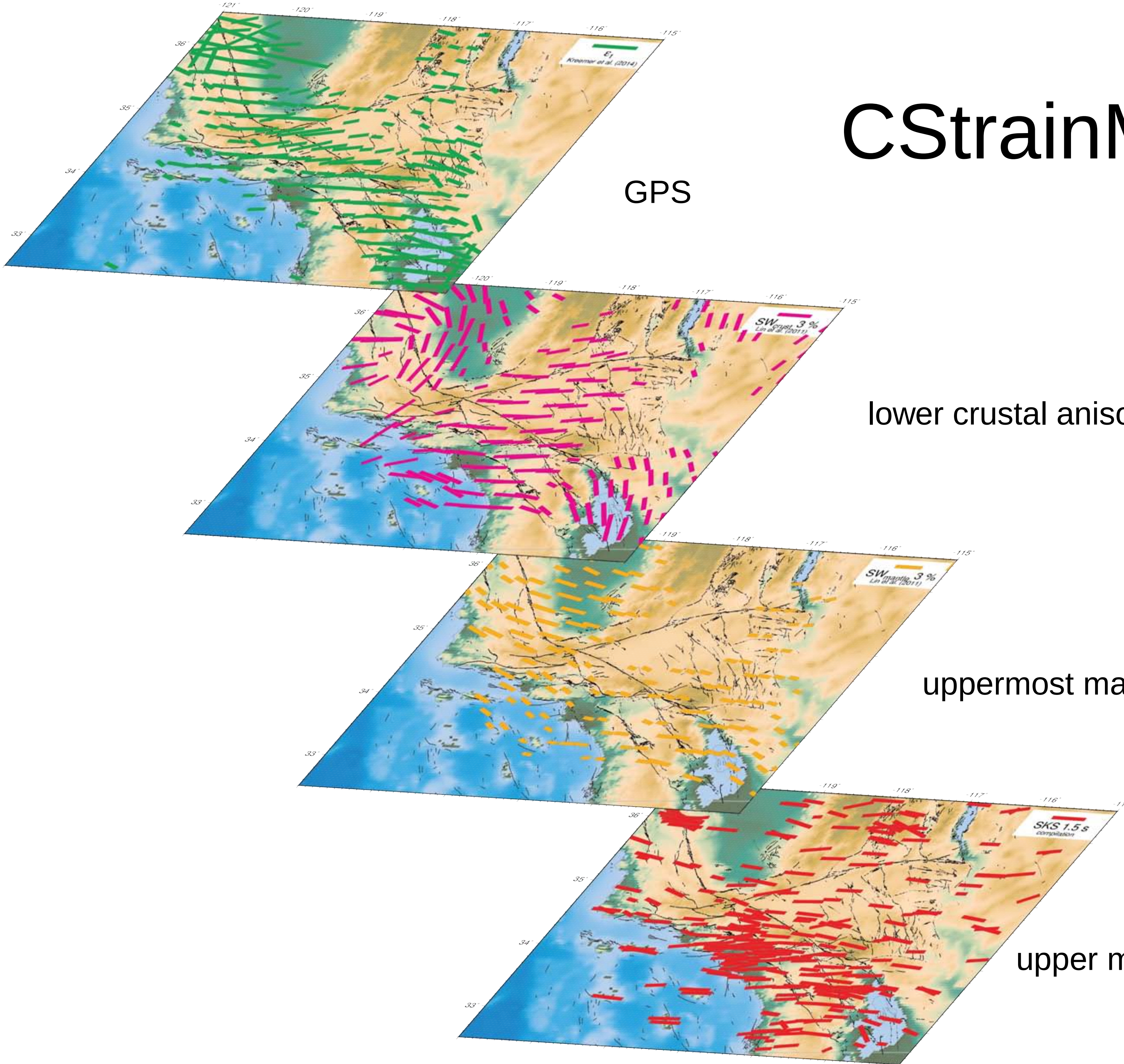
Mantle flow model predictions

T.W. Becker et al. / Earth and Planetary Science Letters 247 (2006) 235–251





CStrainModel



GPS

lower crustal anisotropy

uppermost mantle anisotropy

upper mantle anisotropy

Conclusions

- Need more borehole data, S split compilations (and more modeling, cf. RFP)
- Interesting coherence in terms of finite deformation between surface (GPS), lower crust (SW), uppermost mantle (SW) and upper mantle (*SKS*)
- Can build deformation model
- Fault zone interactions important for merging *S* splits with Michael stress models