Interpolating WSM stress-directions in southern California by the Bird & Li [1996] method

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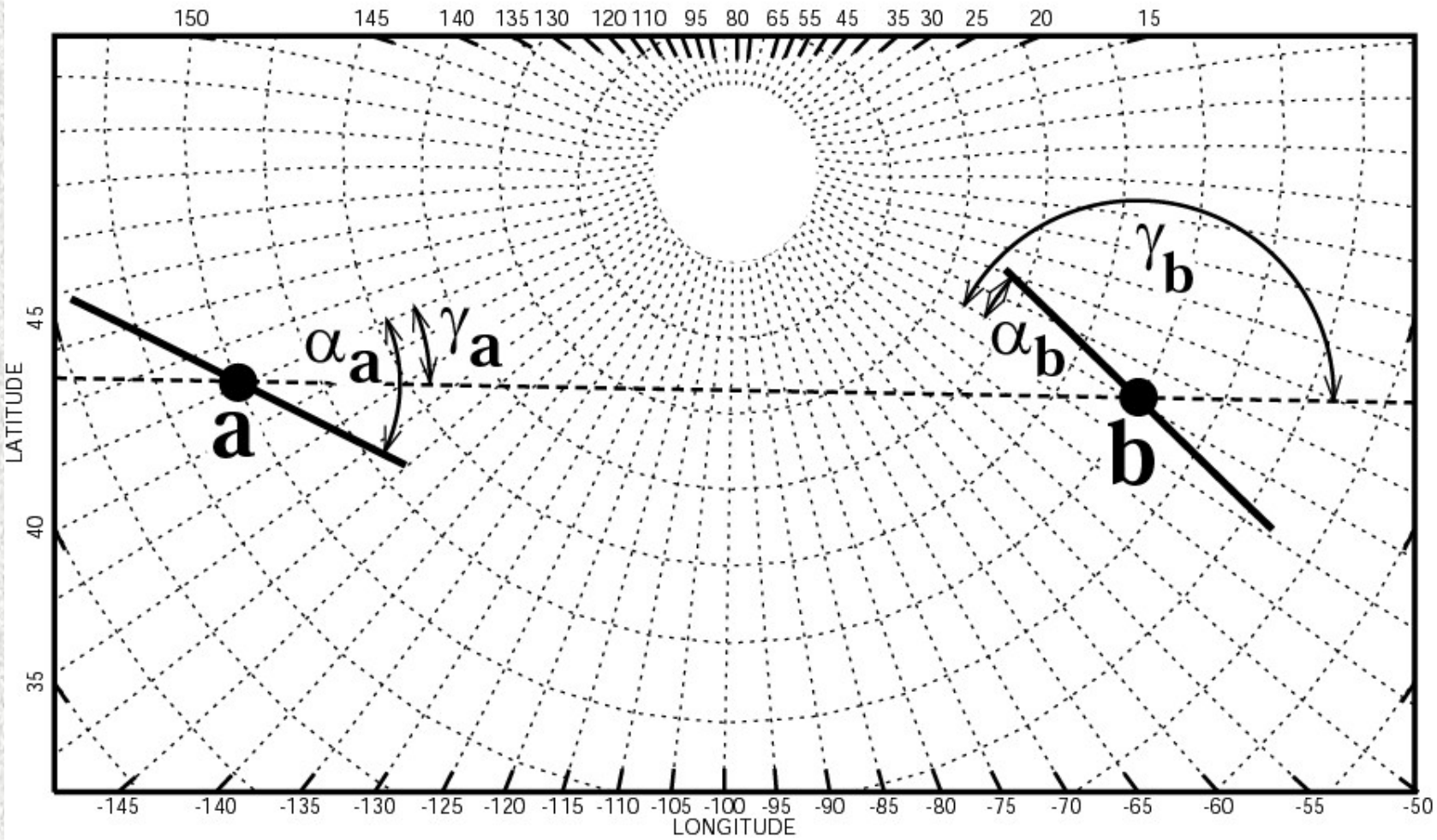
HOW We Interpolate Stress Directions

1. Define the discrepancy between two σ_{1h} directions on the sphere.
2. From all possible data pairs, form histograms to learn the probability distributions of discrepancies at various distances.
3. Make data quasi-independent by pre-averaging directions within each cluster.
4. Probability distribution at interpolation point is approximately the product of the functions based on each cluster individually.
5. Select most likely σ_{1h} and 90%-confidence limits from probability distribution.


150
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LATITUDE
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LONGITUDE
a
b
α_a
γ_a
α_b
γ_b

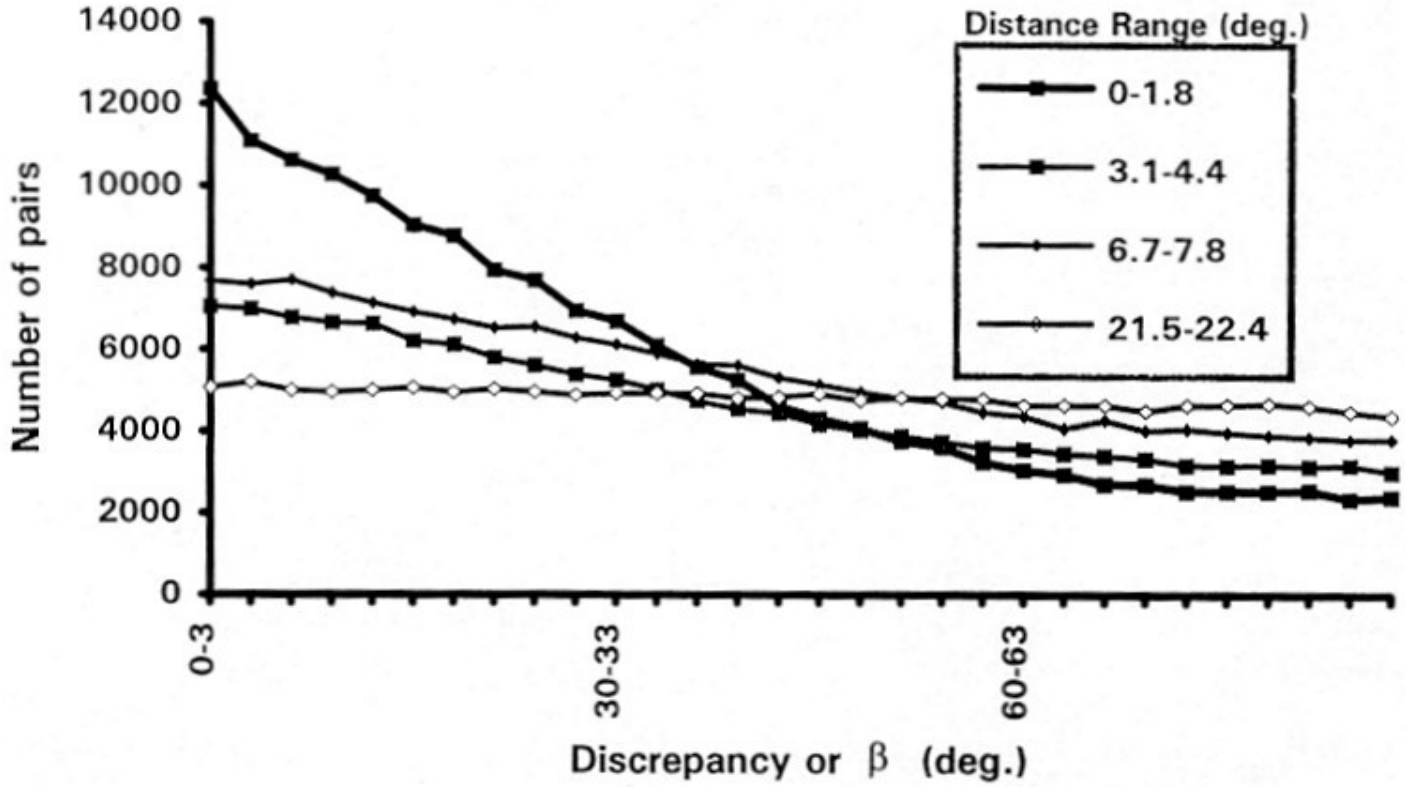


Figure 2. Histograms of the frequency of different angular discrepancies (β) between pairs of $\hat{\sigma}_{1h}$ direction data, at four different angular separations θ. Notice that large discrepancies are frequent even at the shortest distances. These histograms reflect all 6000 data of the World Stress Map, regardless of assigned quality.

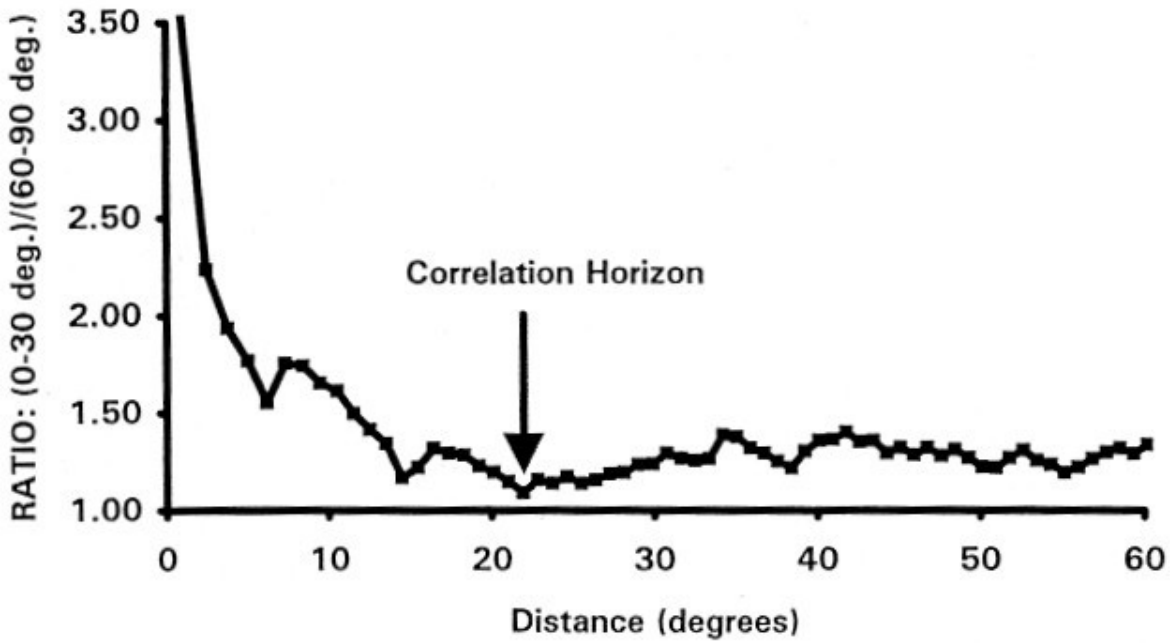
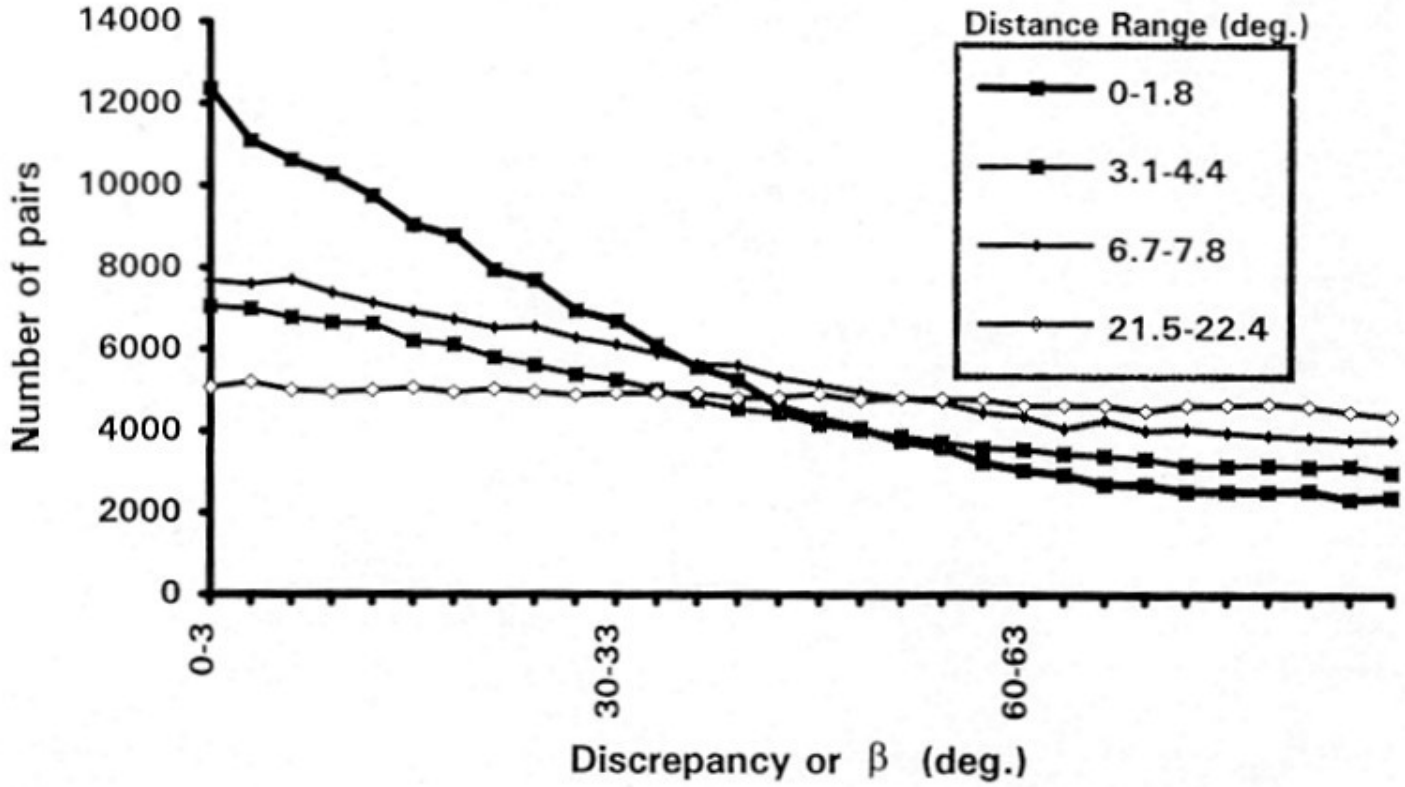


Figure 3. Ratio of the number of pairs with "small" discrepancy ($0° \leq \beta < 30°$) to the number of pairs with "large" discrepancy ($60° \leq \beta < 90°$), in a particular annulus, as a function of range angle θ. Notice that the near-field correlation dies out by 22°, which we call the "correlation horizon." The weak far-field correlation may indicate a component of globe-girdling compression or tension, or it may simply be an artifact of the uneven sampling of Earth; we will not use this part of the distribution in interpolation. These statistics reflect all 6000 data of the World Stress Map, regardless of assigned quality.



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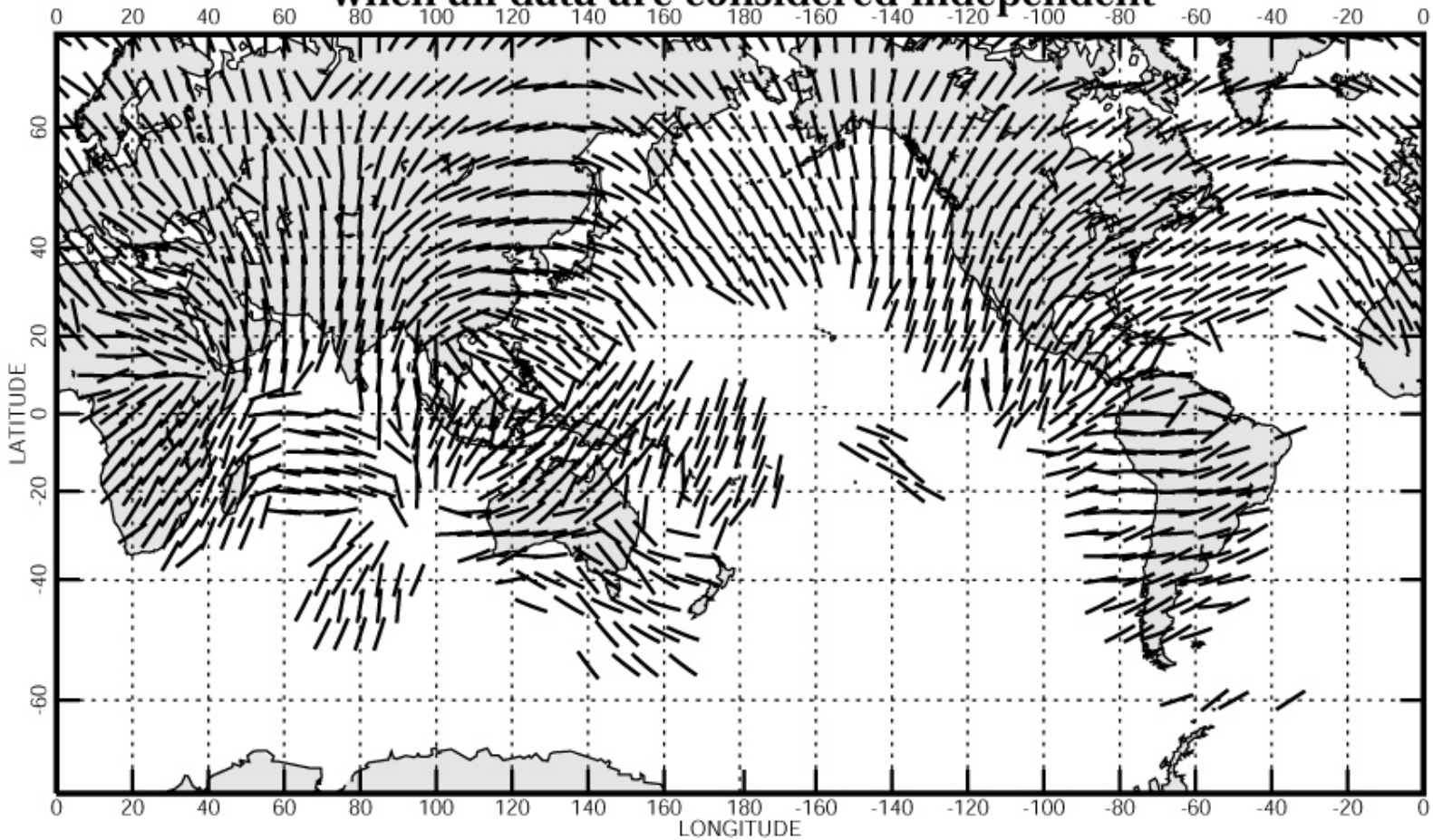
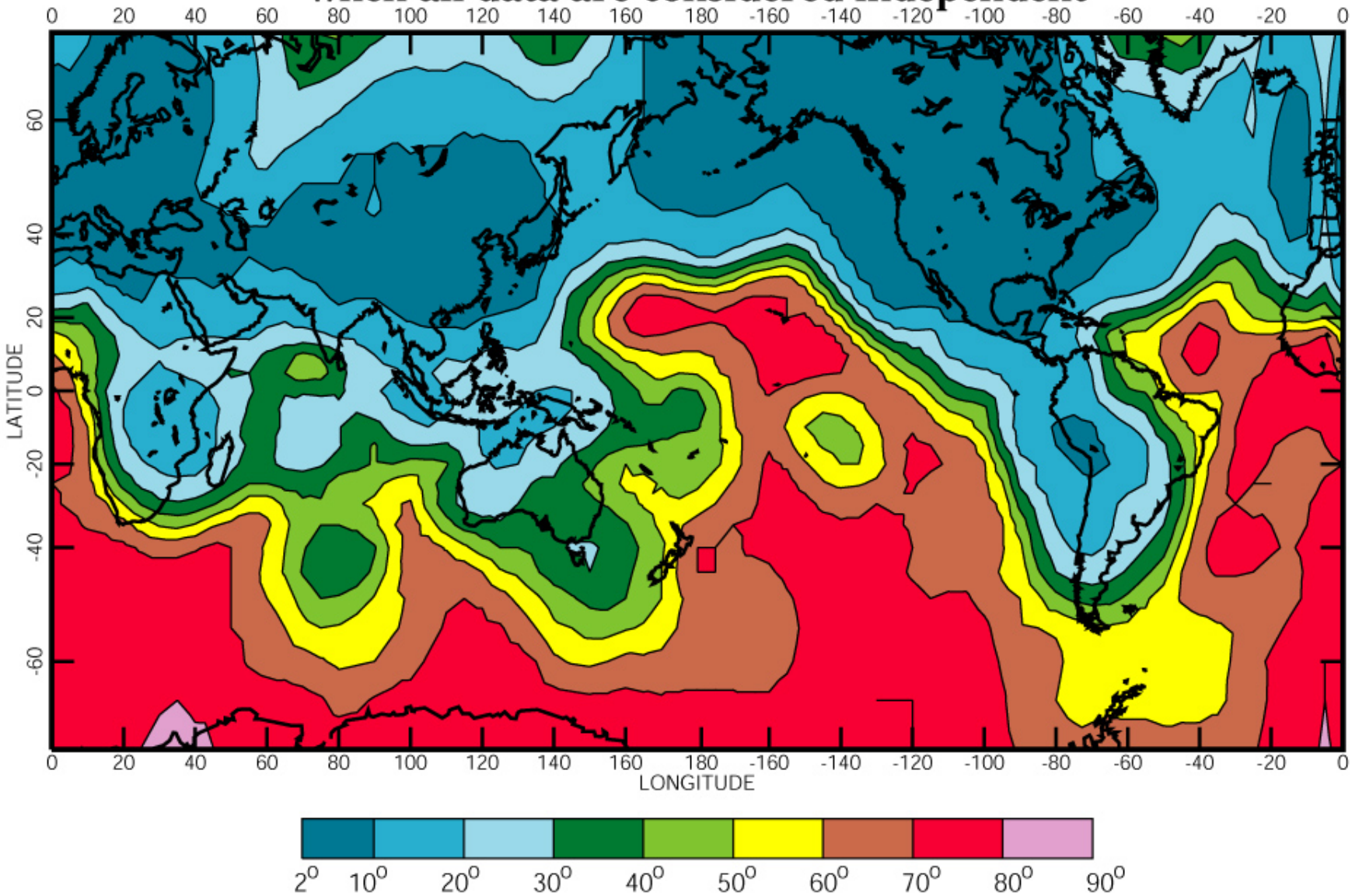
Most Compressive Horizontal Stress Direction S_{1h}
(where known to better than ±45° with 90% confidence)
when all data are considered independent

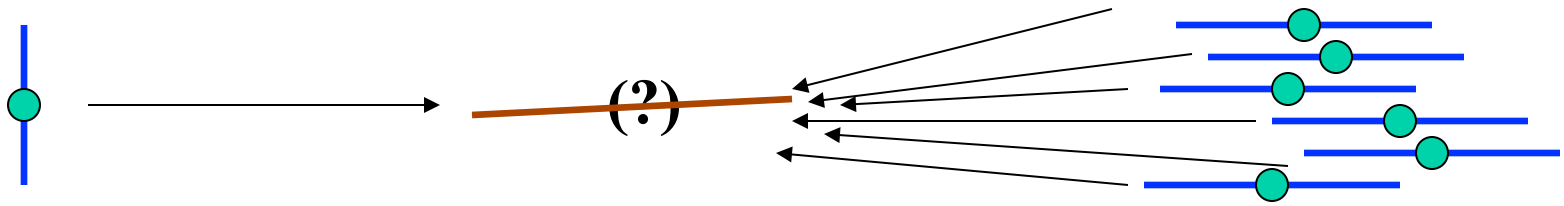


Uncertainty Angle a

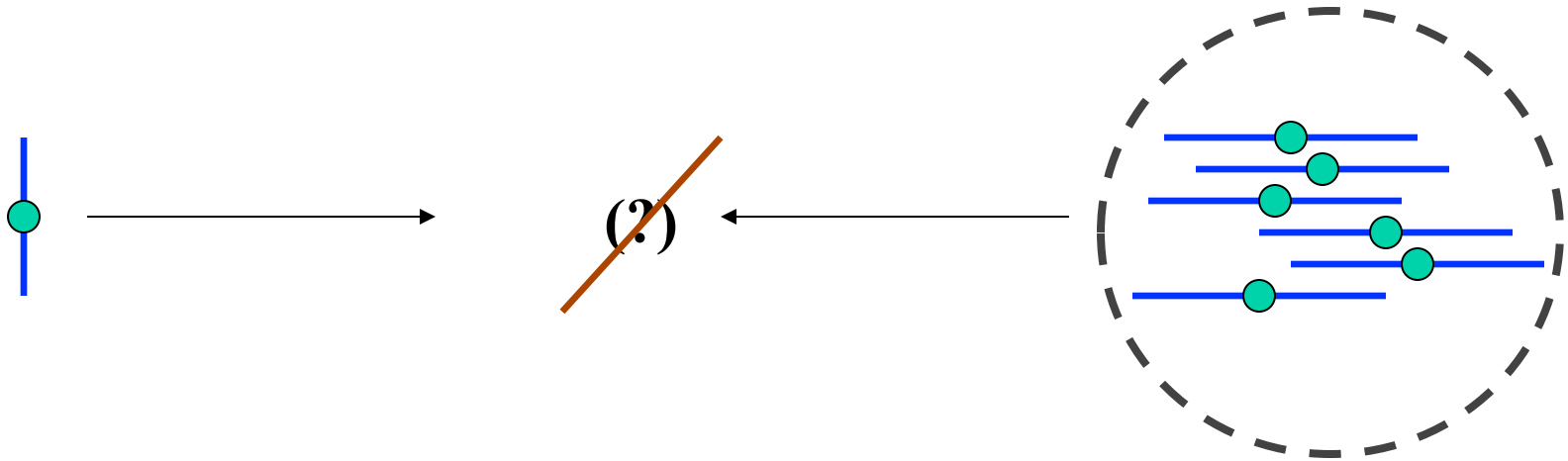
(s_{1h} is known to $\pm$a, with 90% confidence) when all data are considered independent



Without pre-clustering, interpolated direction at test point **(?)** would be strongly biased toward the most frequent azimuth:



With pre-clustering, interpolated direction at test point **(?)** gets ~equal input from various directions:



Most-compressive horizontal principal stress direction, $\hat{\sigma}_{1h}$

(when adjacent data are clusted before interpolation)

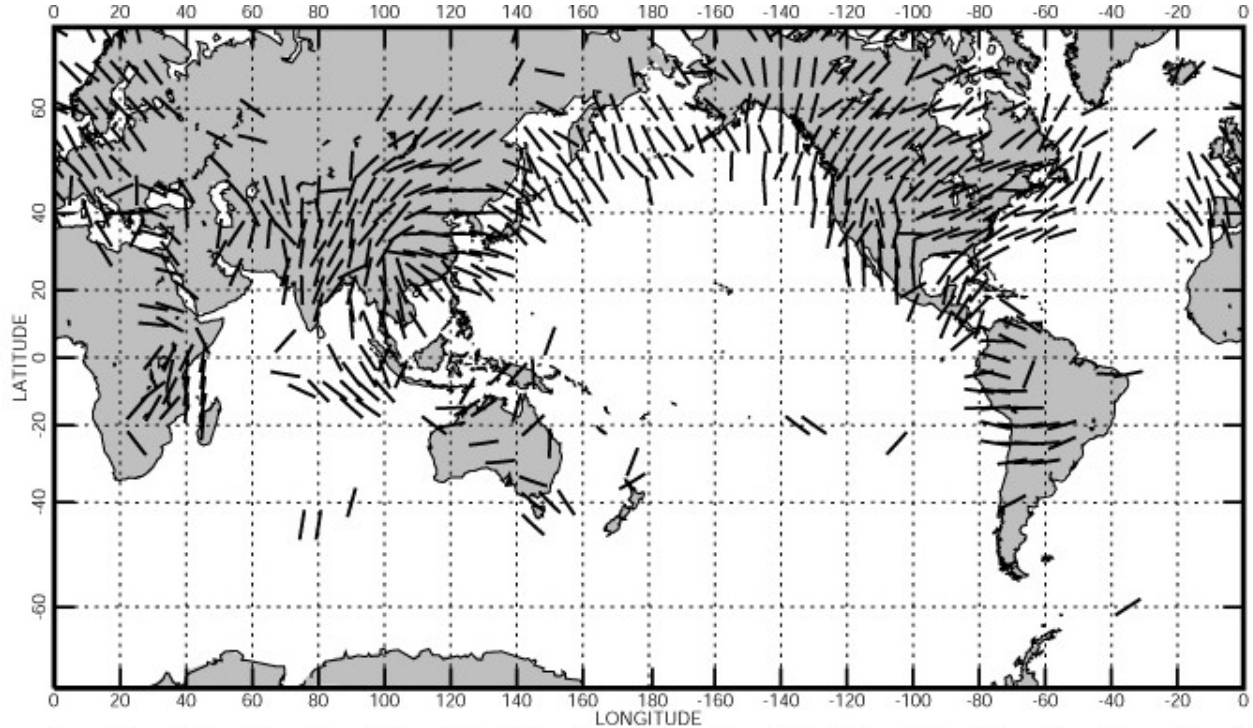
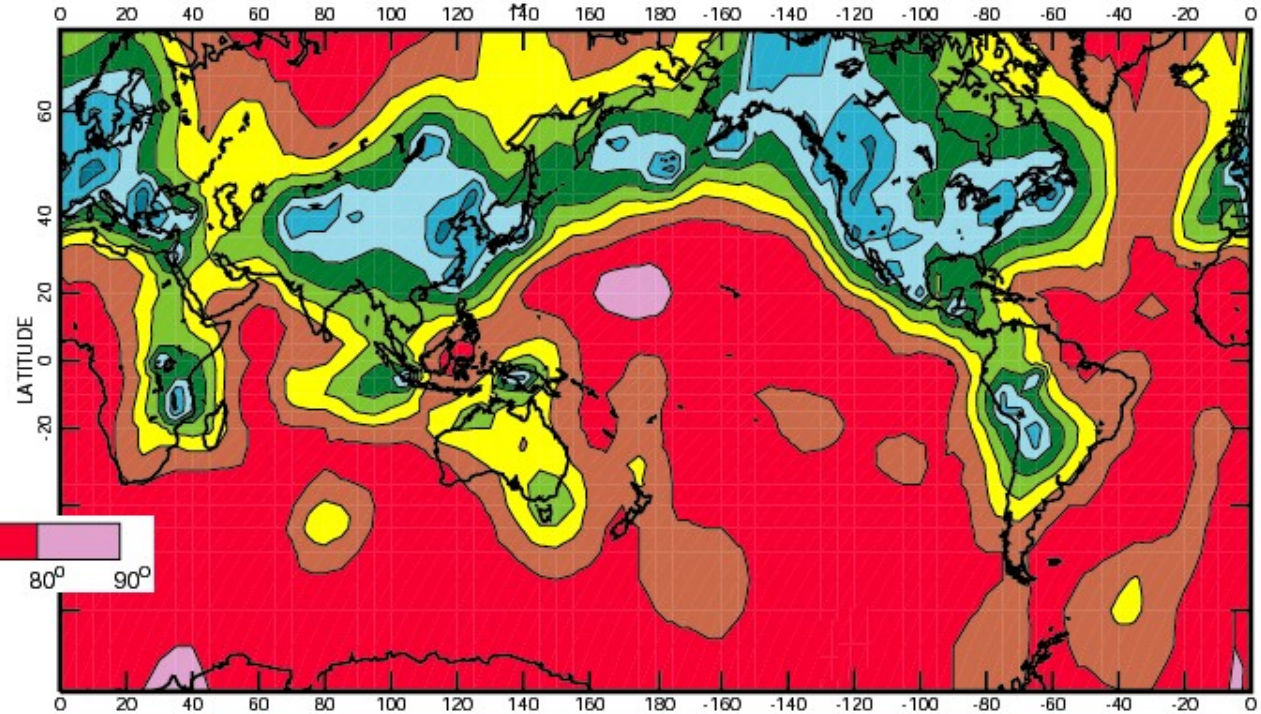
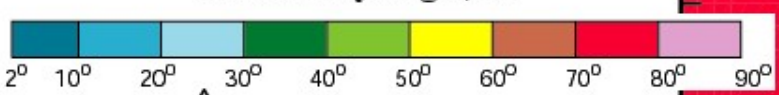


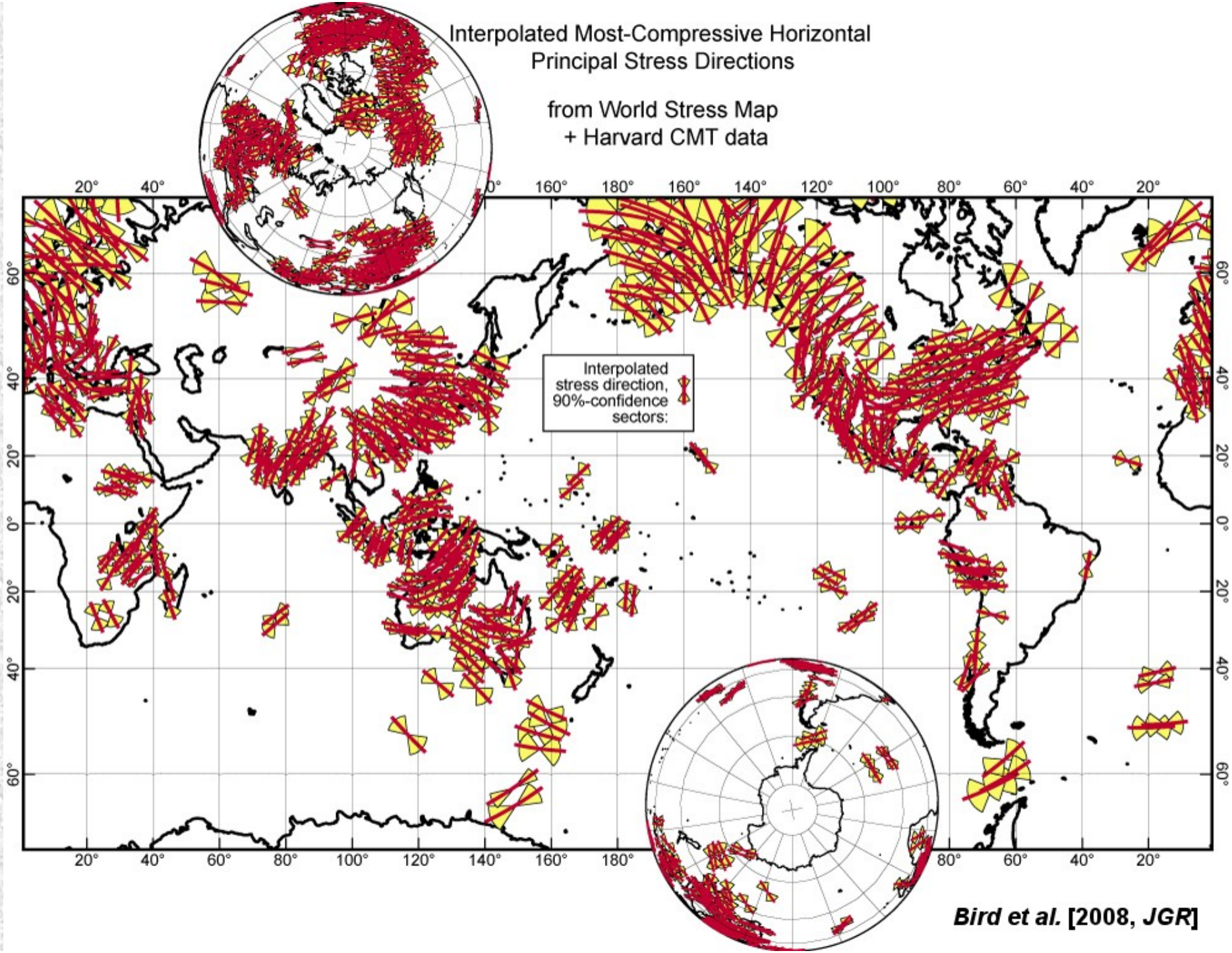
Figure 5
Bird & Li [1996]



Uncertainty angle, α

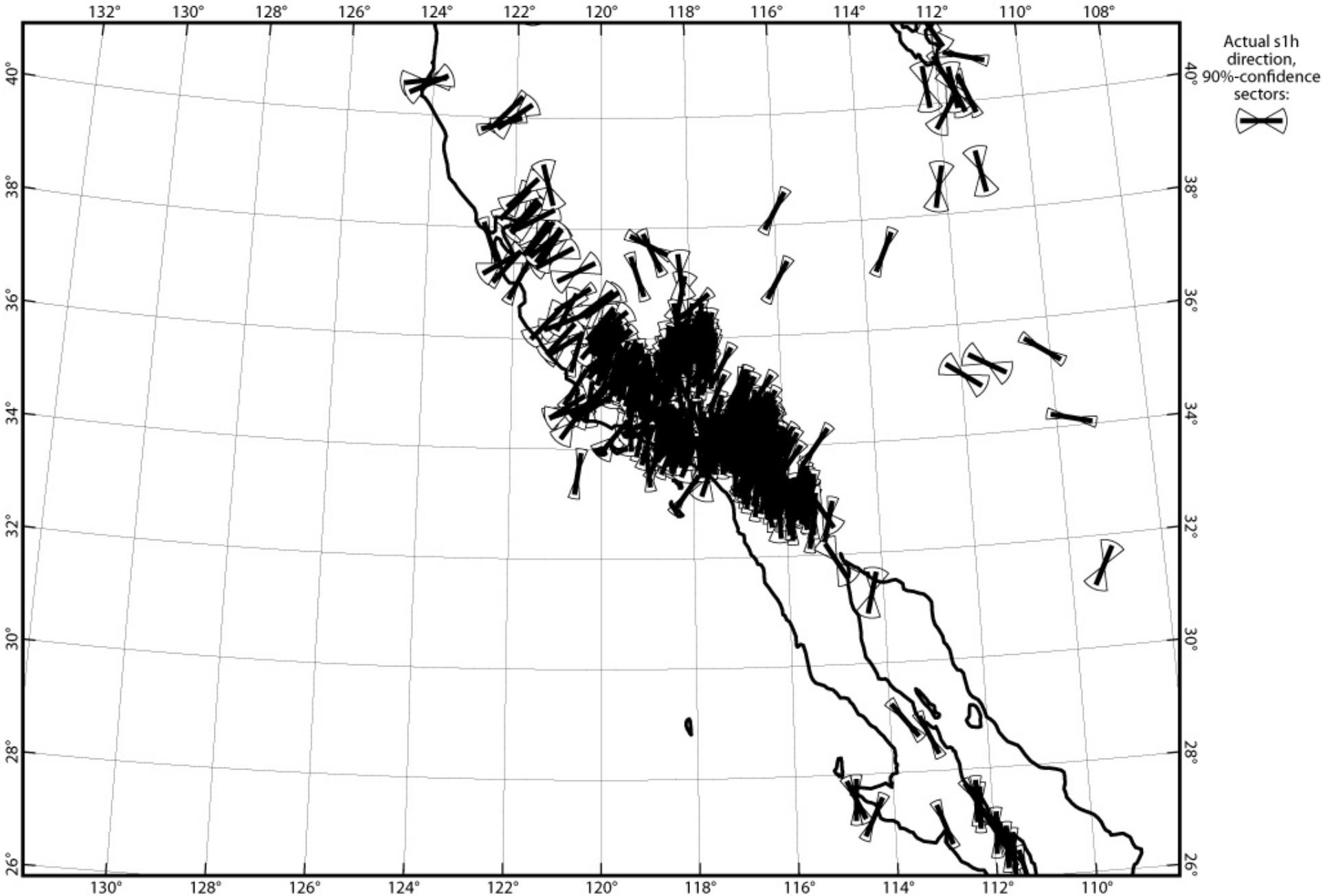


($\hat{\sigma}_{1h}$ is known to +-α with 90%-confidence)



***Bird et al.* [2008, *JGR*]**

World Stress Map 2008 (qualities A & B, downloaded 2011.05)
sUCERF3.nki



World Stress Map 2008 (qualities A & B, downloaded 2011.05)
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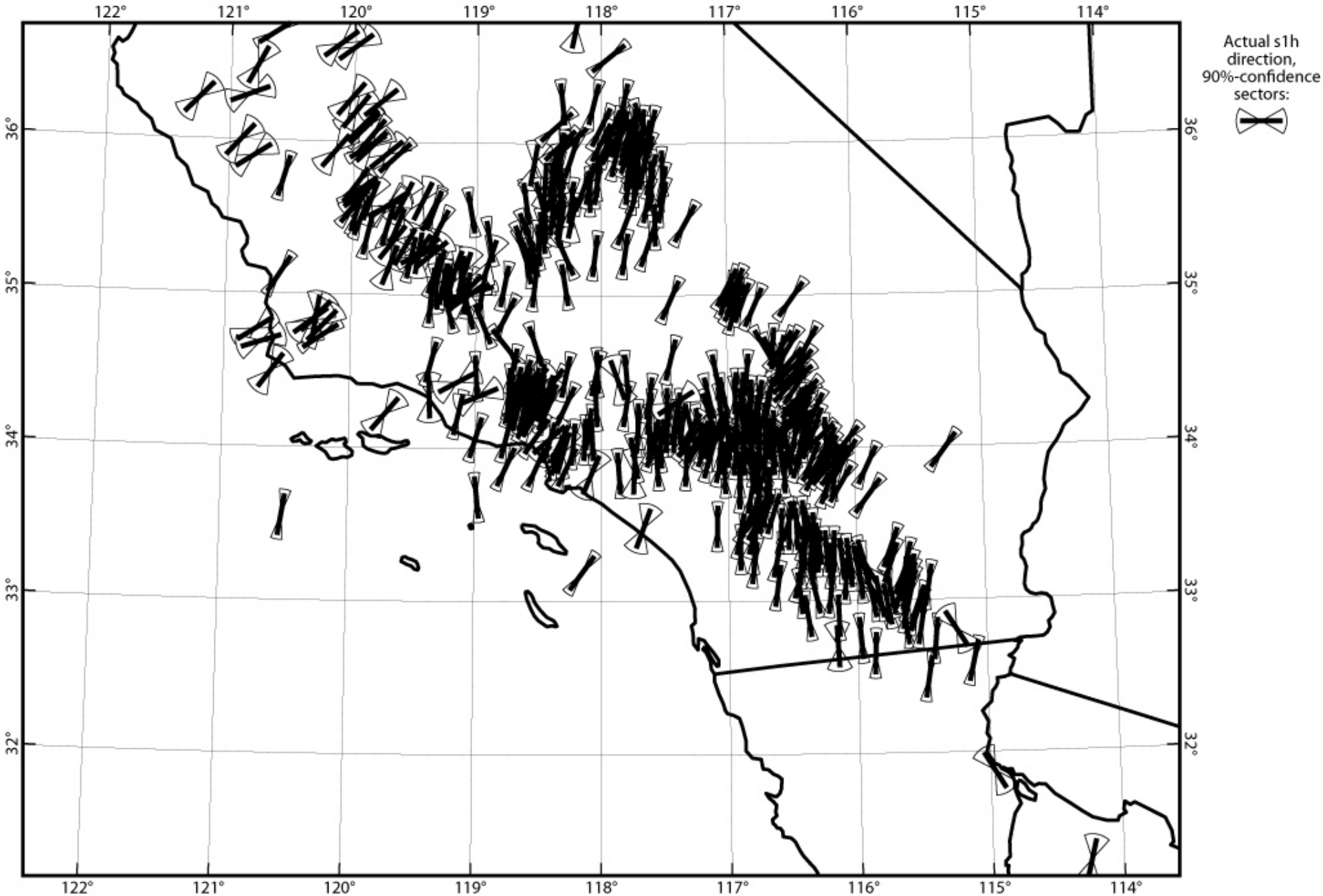
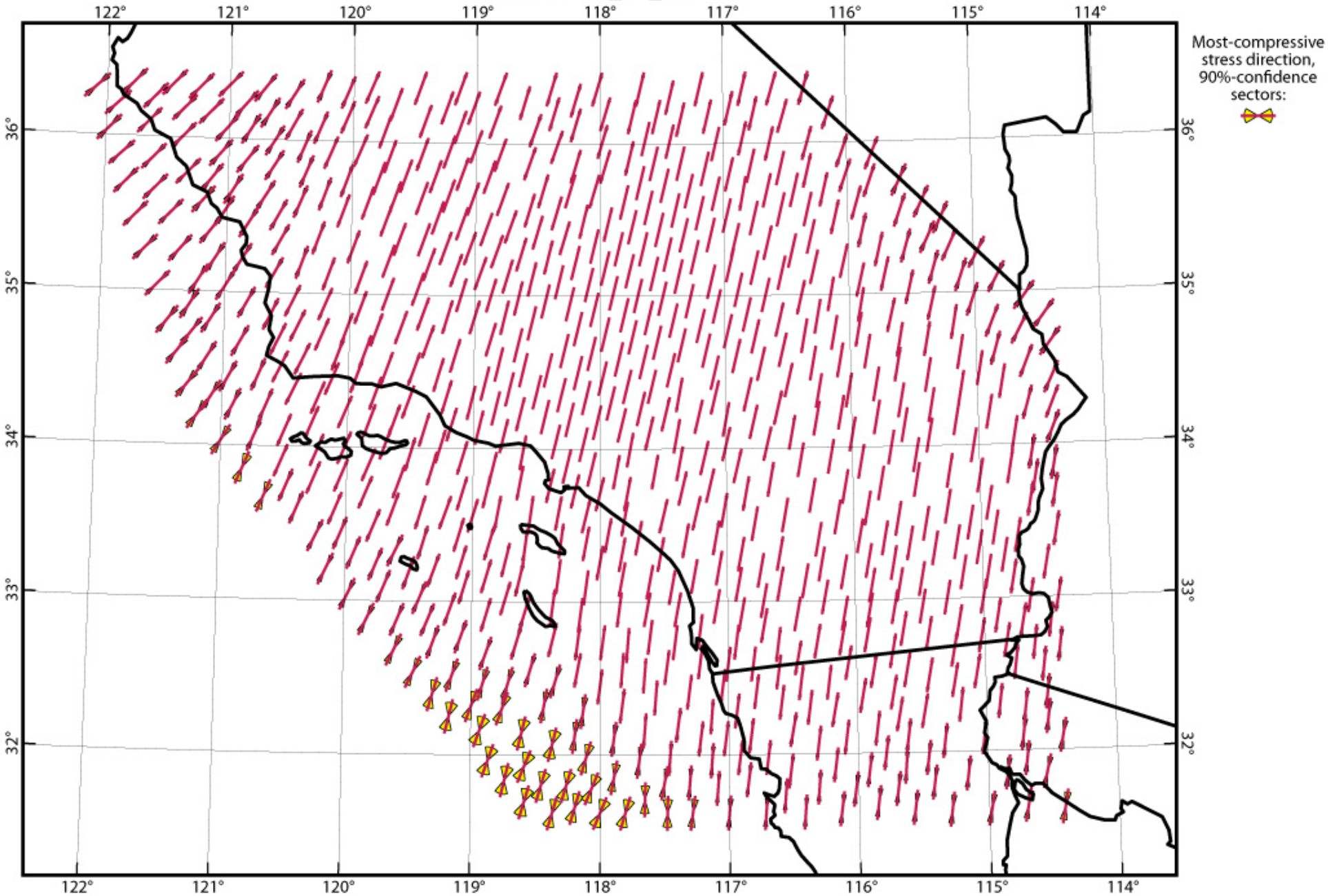


(1/100) of Most-Compressive Horizontal Stress Directions
BirdAndLi1996_for_CSM.txt



SHmax trend (degrees); depth=1 km