

Significant Motions Between GPS Sites in the New Madrid Region: Implications for Seismic Hazard

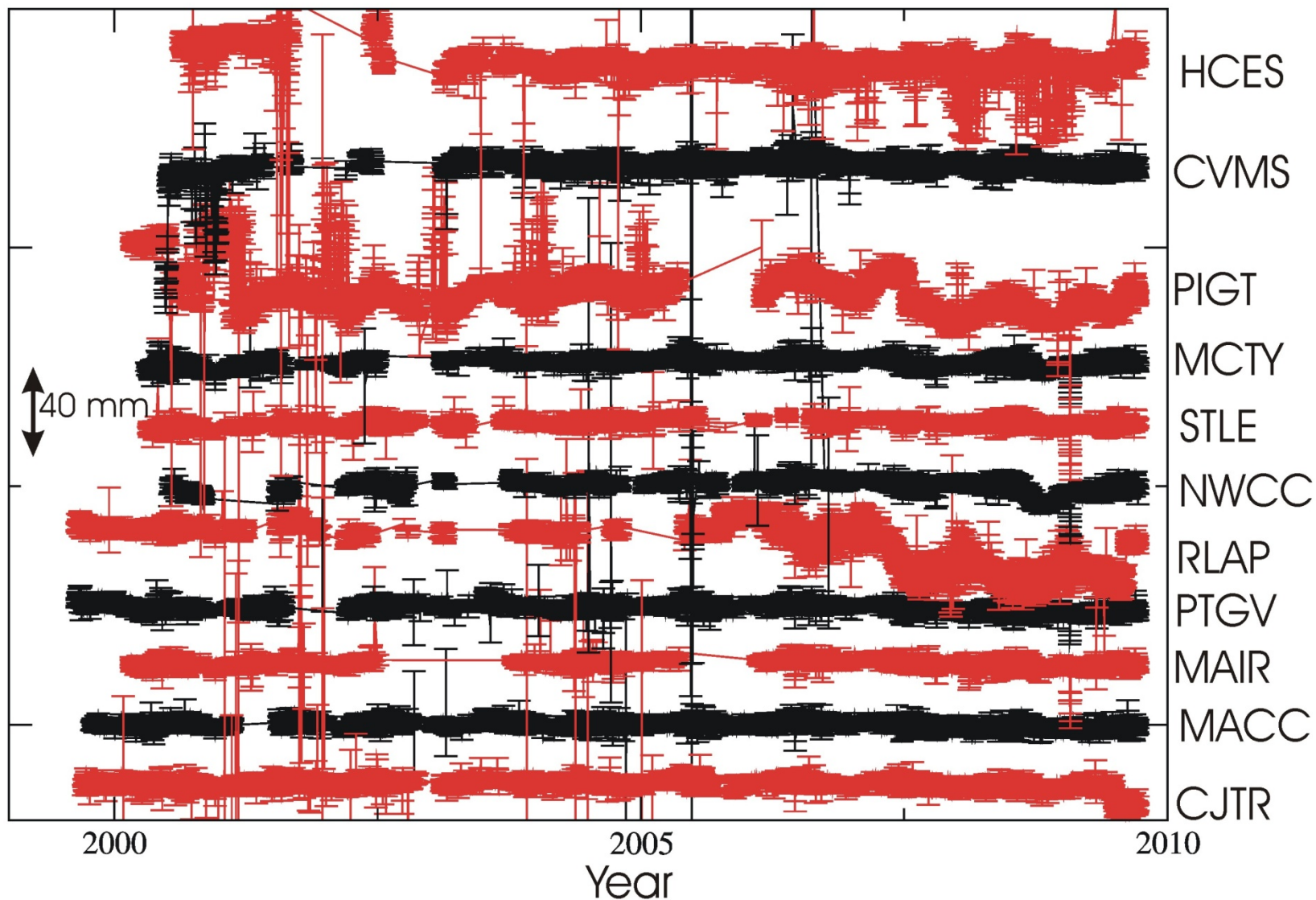
(Frankel, Smalley, and Paul, in press, BSSA April 2012 issue)

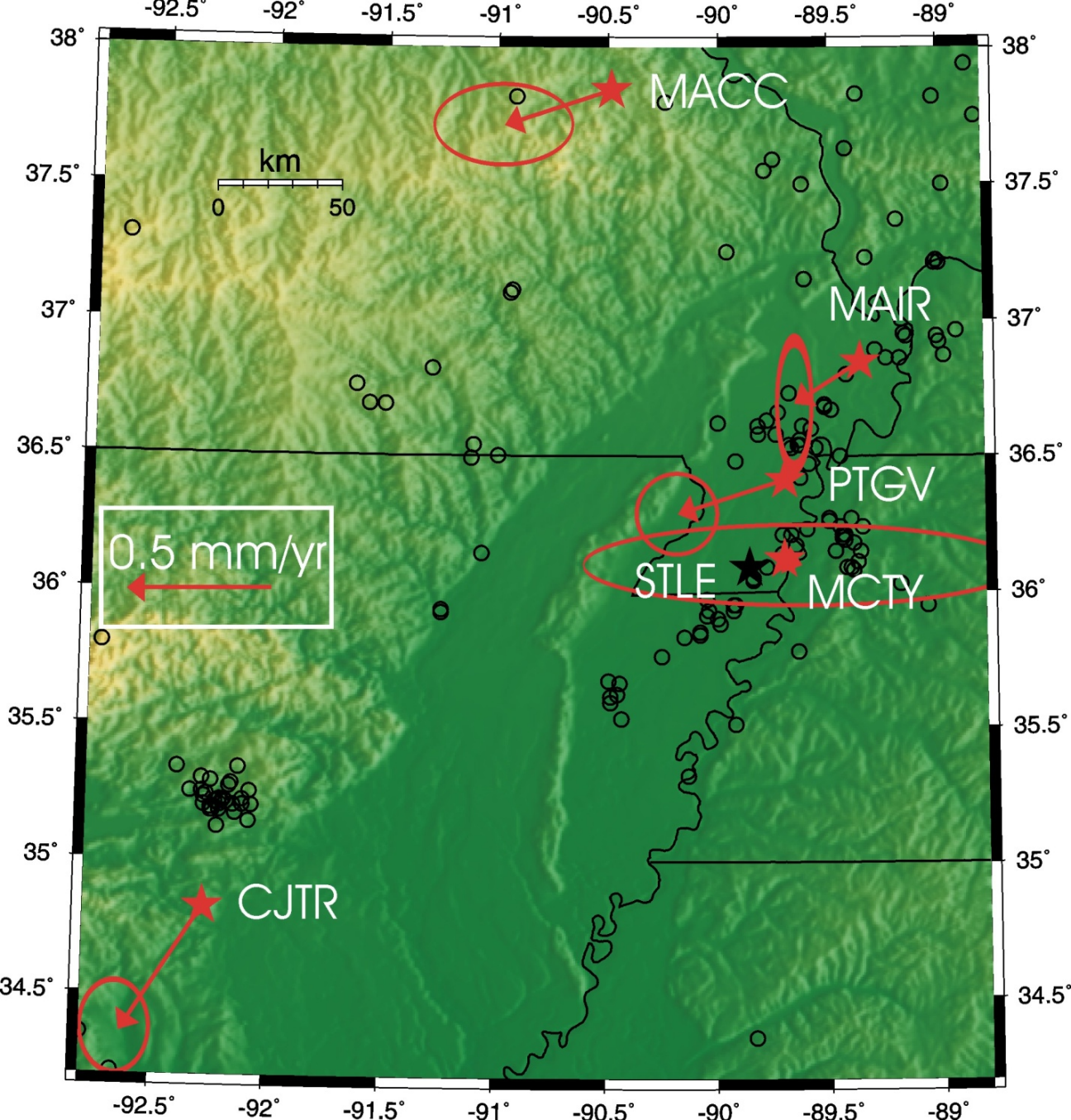
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U.S. Geological Survey
Seattle, WA

Procedure

- Adjusted GPS position time series so that they were relative to stable North America
- Calculated differential time series between stations
- Used John Langbein's code `est_noise6ac` to determine rates and standard errors, using three component noise model of white, flicker (power spectrum proportional to $1/k$), and random walk noise (power spectrum proportional to $1/k^2$)
- GPS time series provided by Bob Smalley and J. Paul, Univ. of Memphis, who operate this network; similar results found using time series derived by Eric Calais, Purdue Univ.

East component



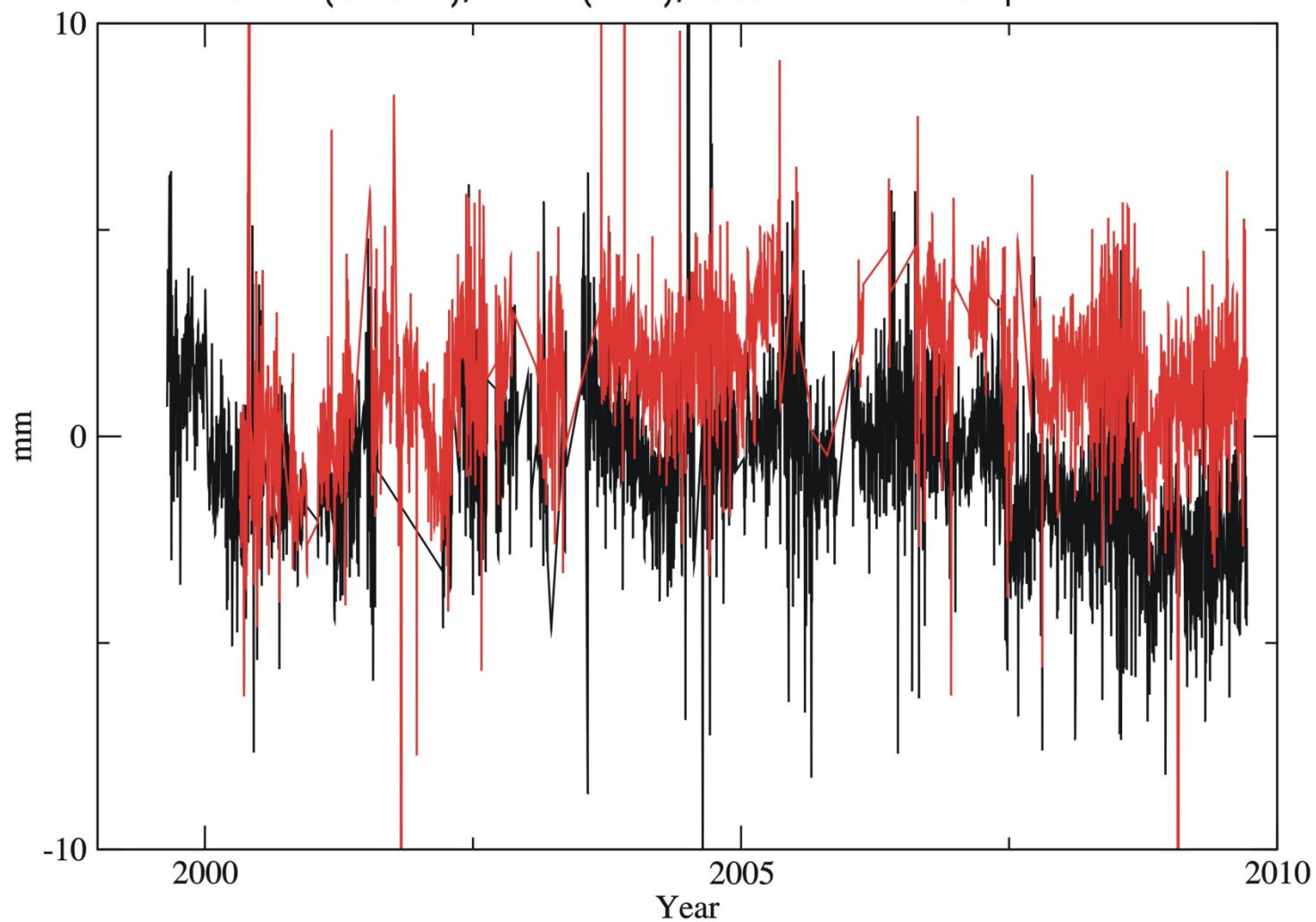


Motions with respect to station STLE
 Ellipses are 95% confidence bounds
 Using method of Langbein (2004)

PTGV 0.39 ± 0.14 mm/yr
 MACC 0.37 ± 0.24 (EW)
 CJTR 0.52 ± 0.16
 MAIR 0.23 ± 0.06 (EW)

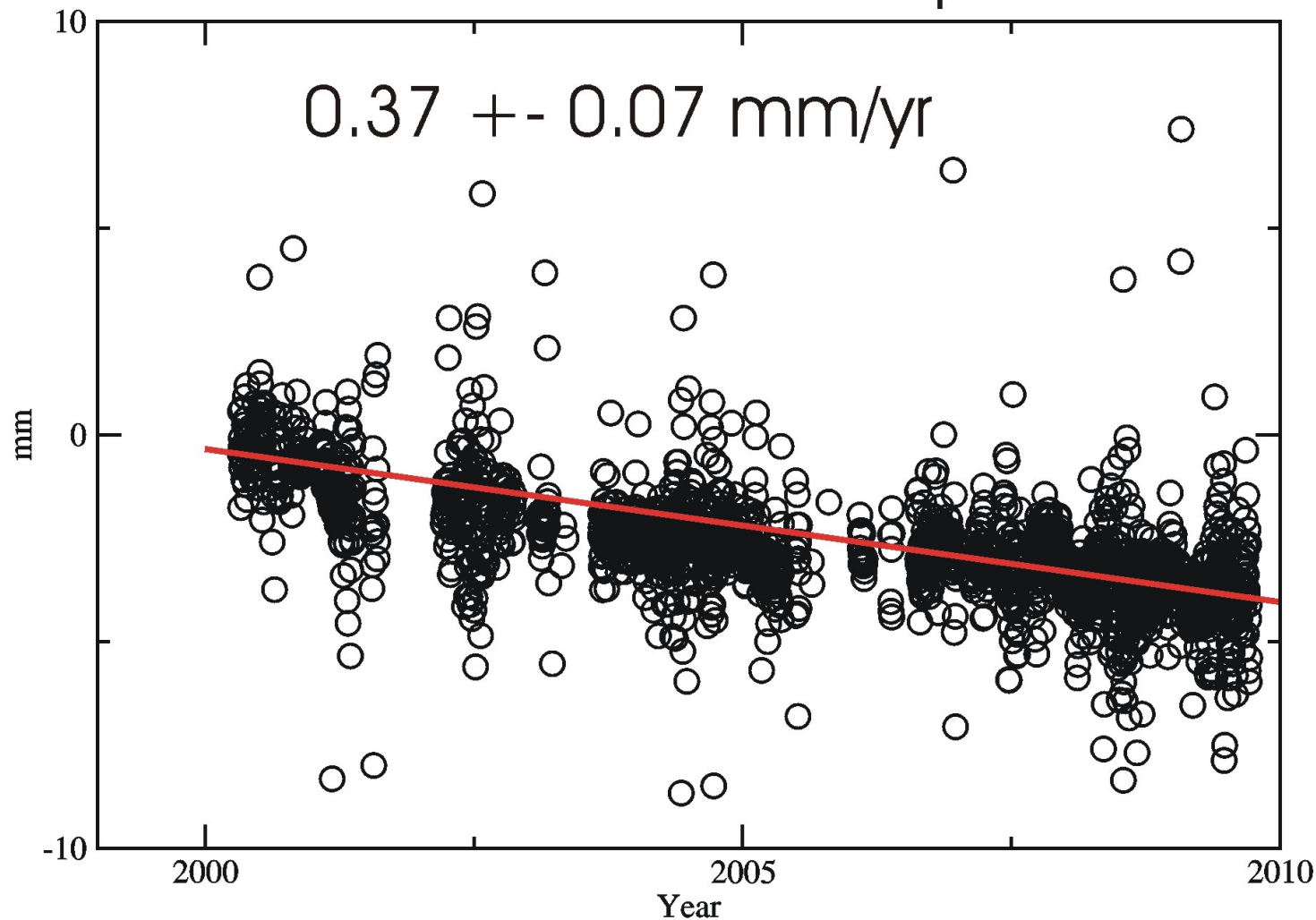
Strain of 5×10^{-9} /yr,
 four times higher than maximum limit stated by Calais and Stein (2009)

PTGV (black), STLE (red), east-west component



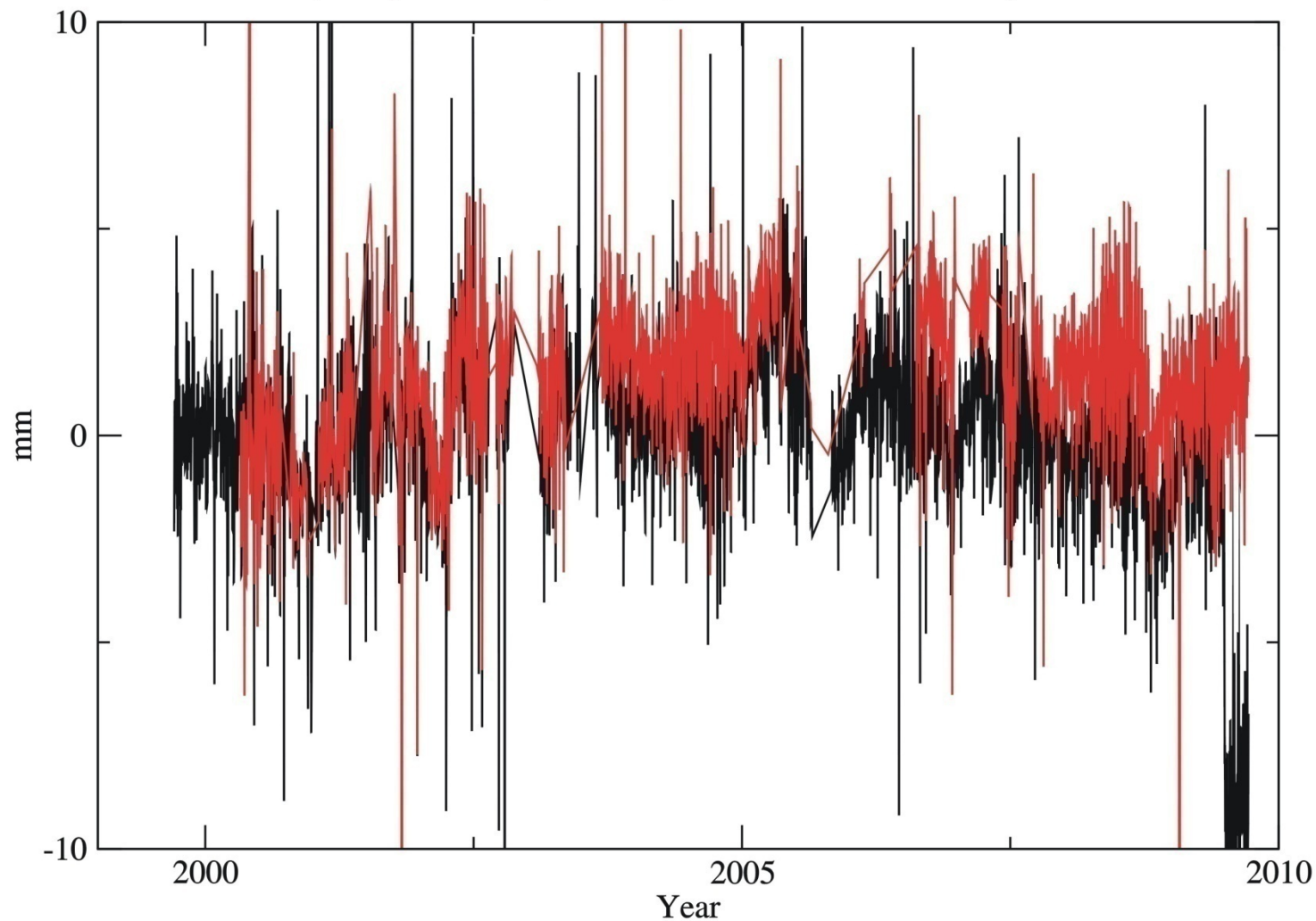
Motions relative to stable NA

PTGV - STLE east component

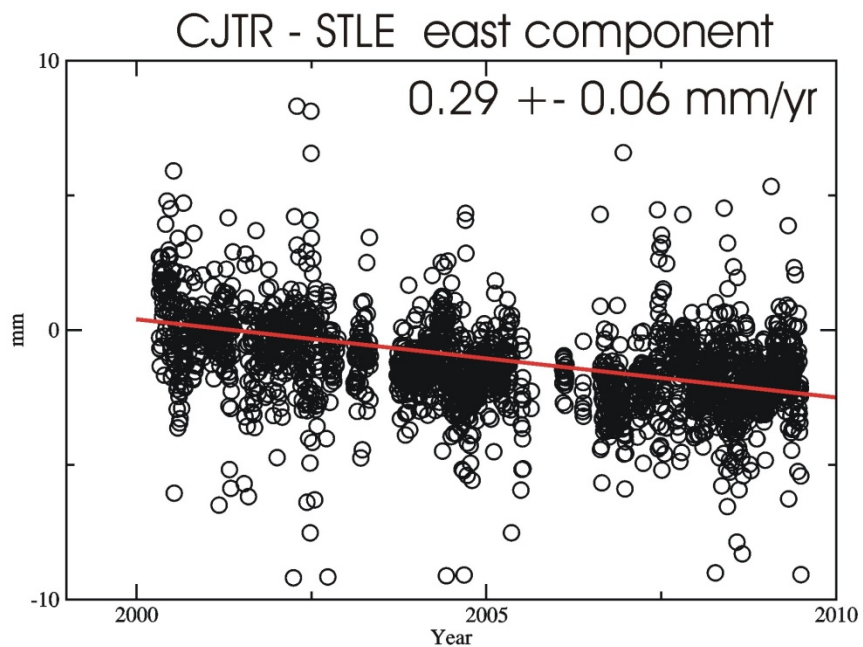
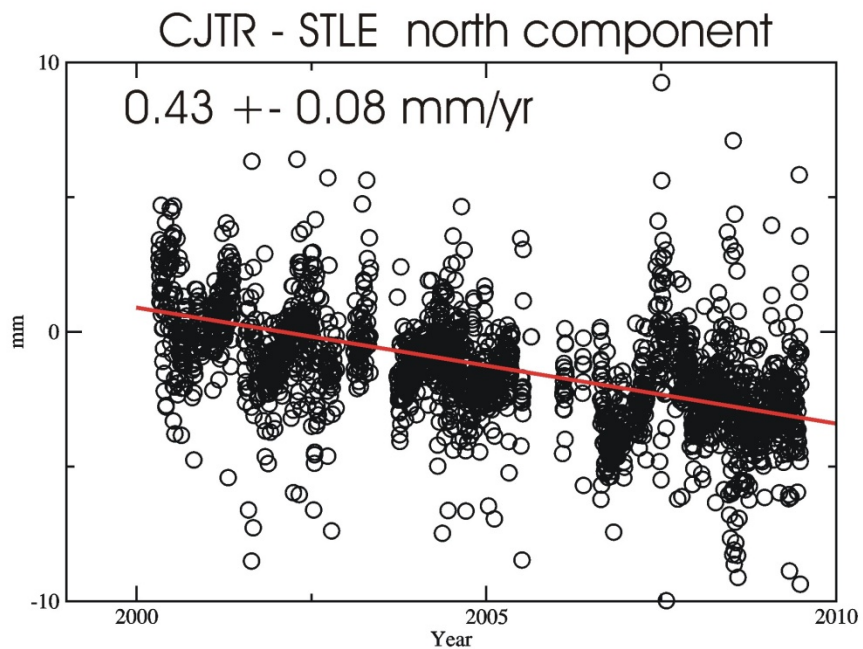


+ - is one standard error, derived from model with white noise, flicker noise, and random walk, using Max Likelihood Estimation method of Langbein (2004)

STLE (red), CJTR (black), east-west component



Original GPS time series provided by Robert Smalley, Univ. of Memphis

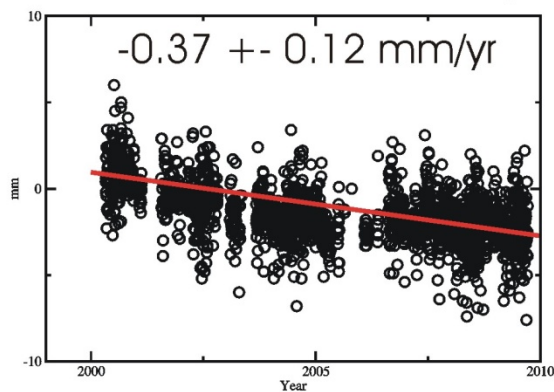


Uncertainty on rates is given as one standard error

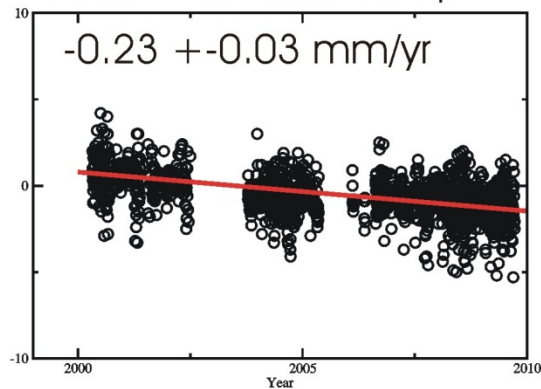
Used noise model of White, flicker, and random walk (Langbein, 2004)

Uncertainty on rates are one standard error (sigma)

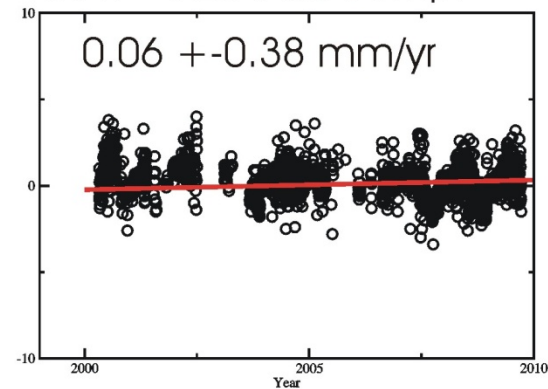
MACC - STLE east comp.



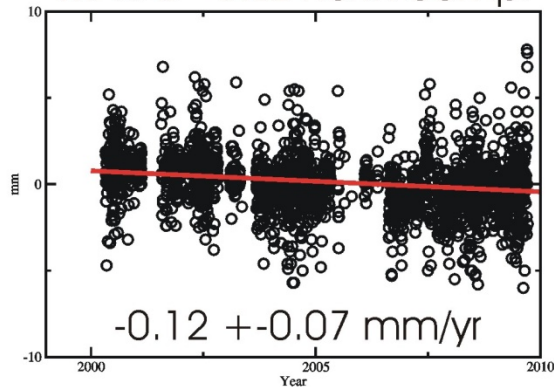
MAIR - STLE east comp.



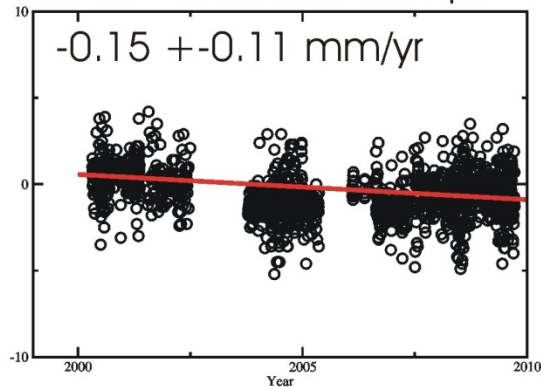
MCTY - STLE east comp.



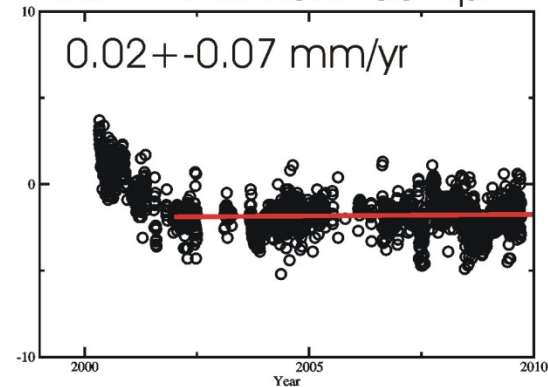
MACC - STLE north comp.

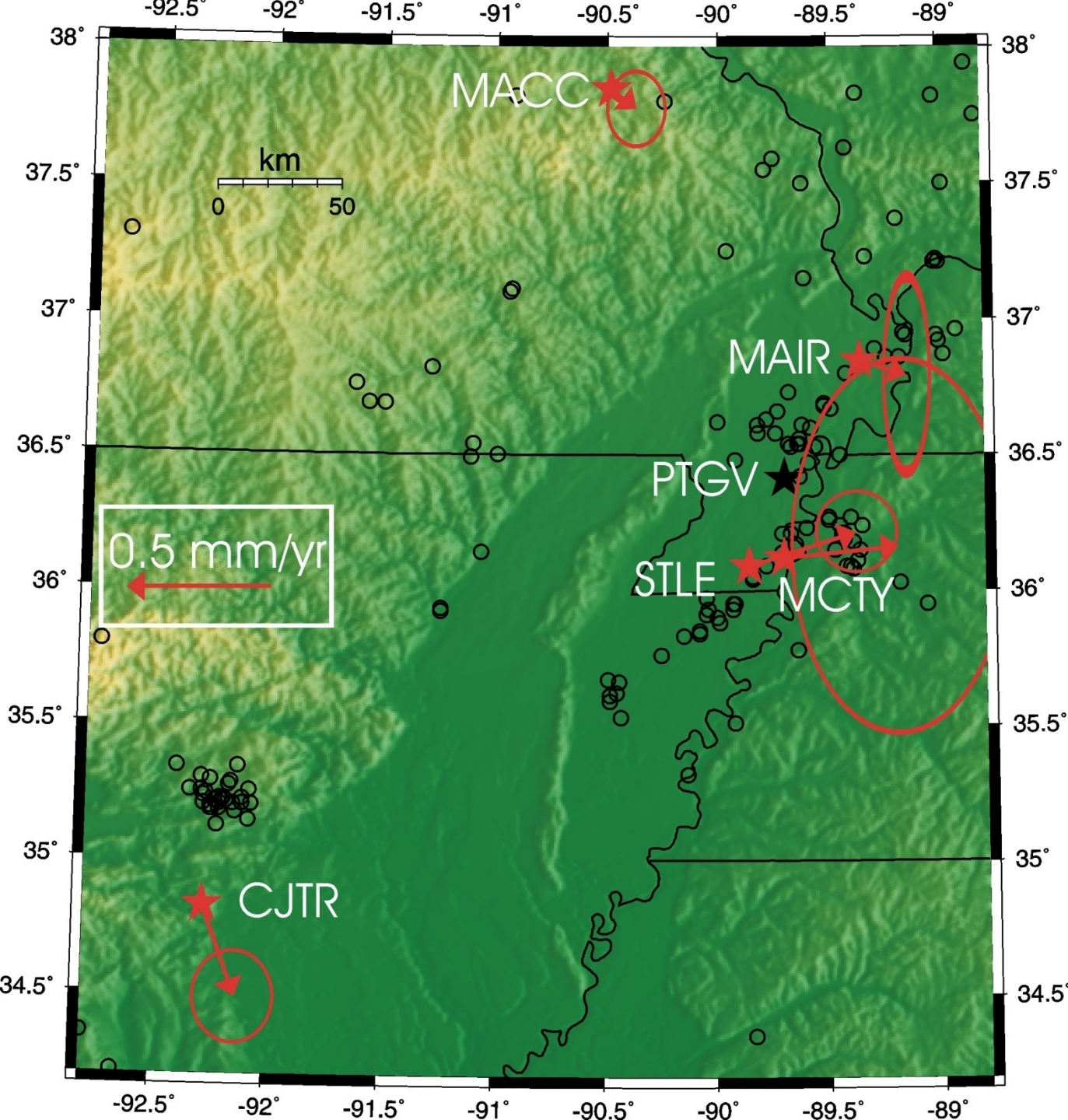


MAIR - STLE north comp.



MCTY - STLE north comp.





Motions with Respect to PTGV

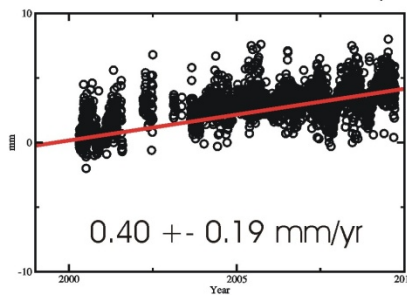
Ellipses are 95% confidence bounds using method of Langbein (2004)

Note that STLE and MCTY show similar motions wrt PTGV

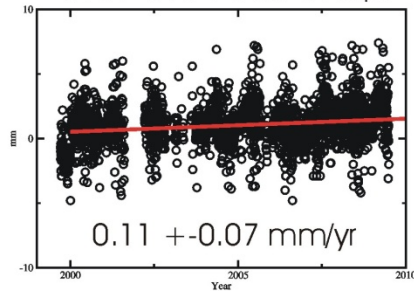
STLE 0.39 ± 0.14 mm/yr
 MCTY 0.40 ± 0.38 (EW)
 CJTR 0.34 ± 0.16
 MAIR 0.17 ± 0.08 (EW)

\pm denotes 2 sigmas

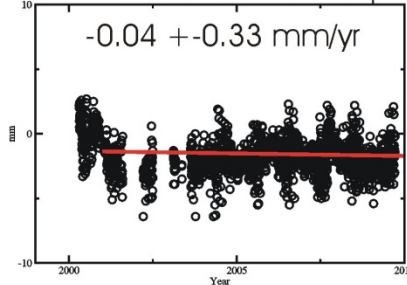
MCTY - PTGV east comp.



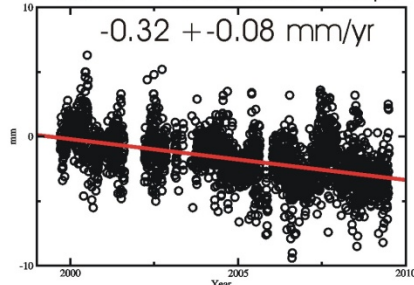
CJTR - PTGV east comp.



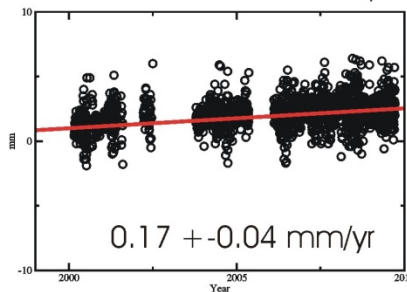
MCTY - PTGV north comp.



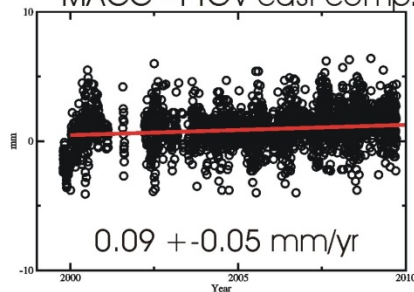
CJTR - PTGV north comp.



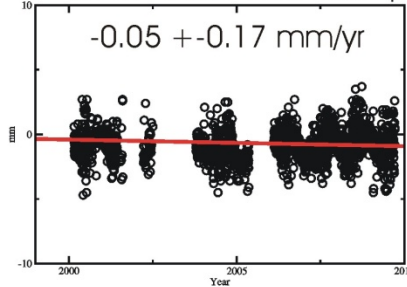
MAIR - PTGV east comp.



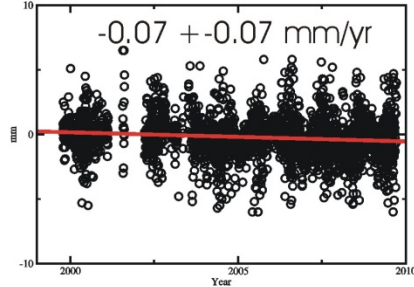
MACC - PTGV east comp.



MAIR - PTGV north comp.



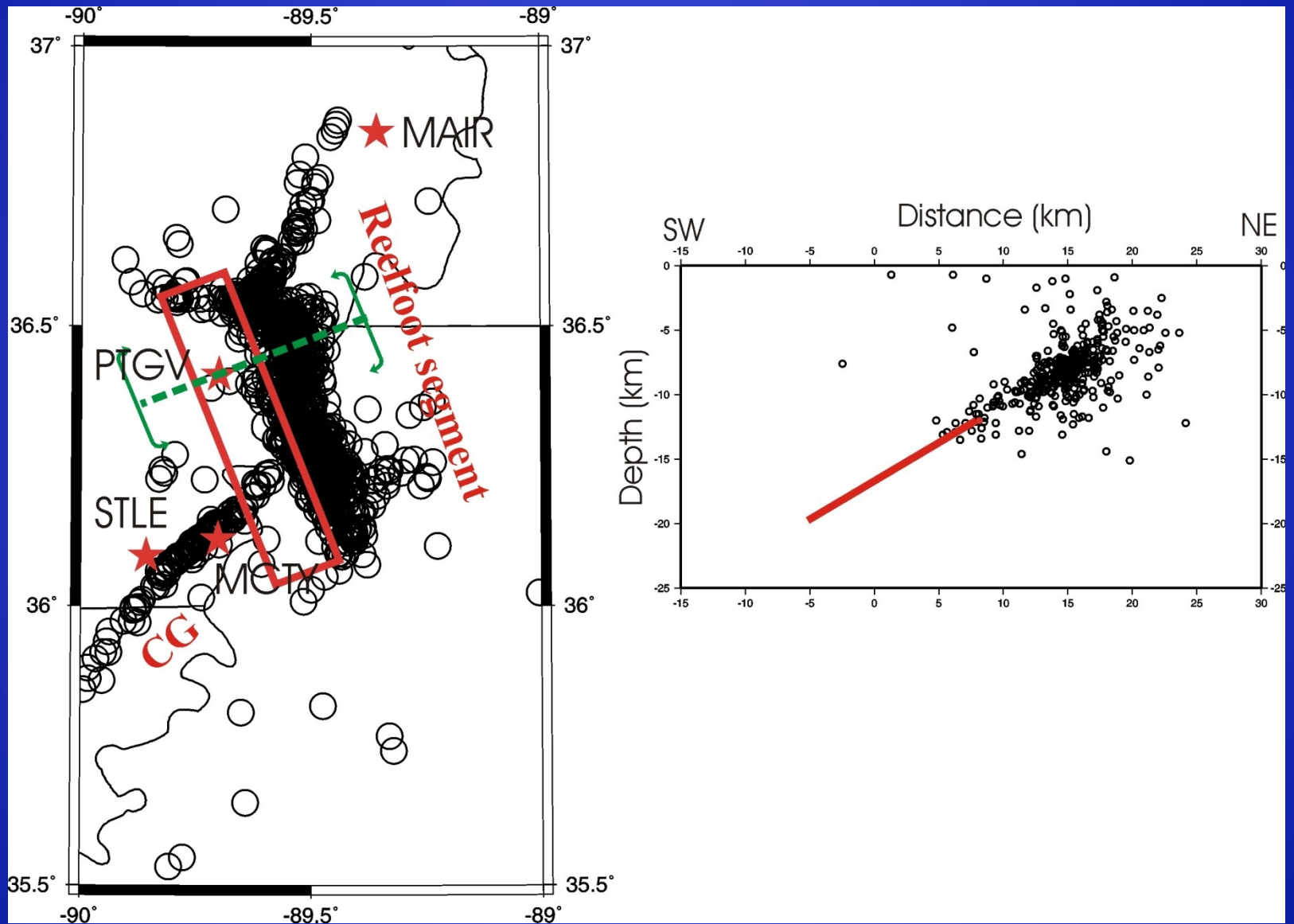
MACC - PTGV north comp.



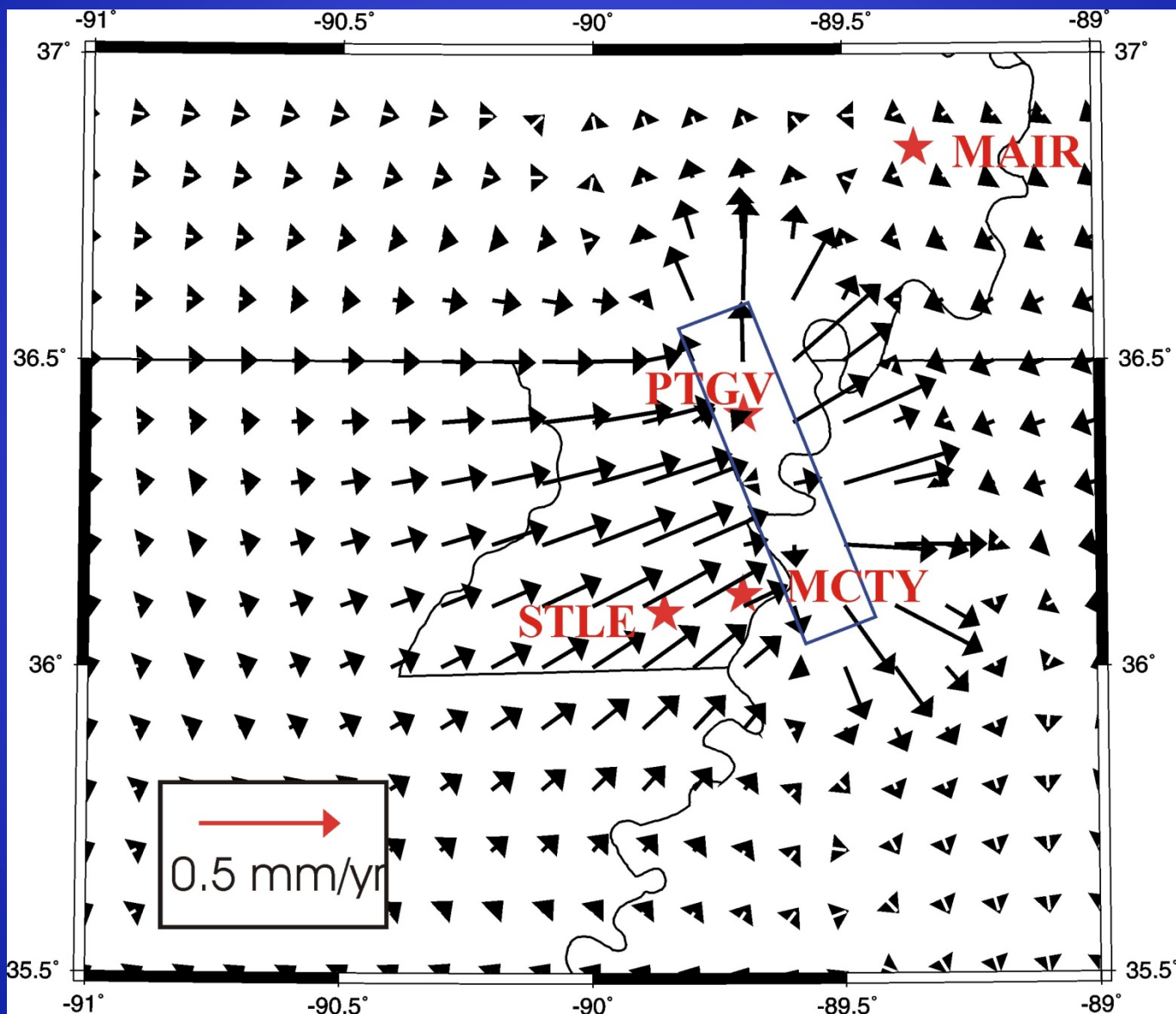
Motions with respect to PTGV

Uncertainty on rates are one standard error (sigma)

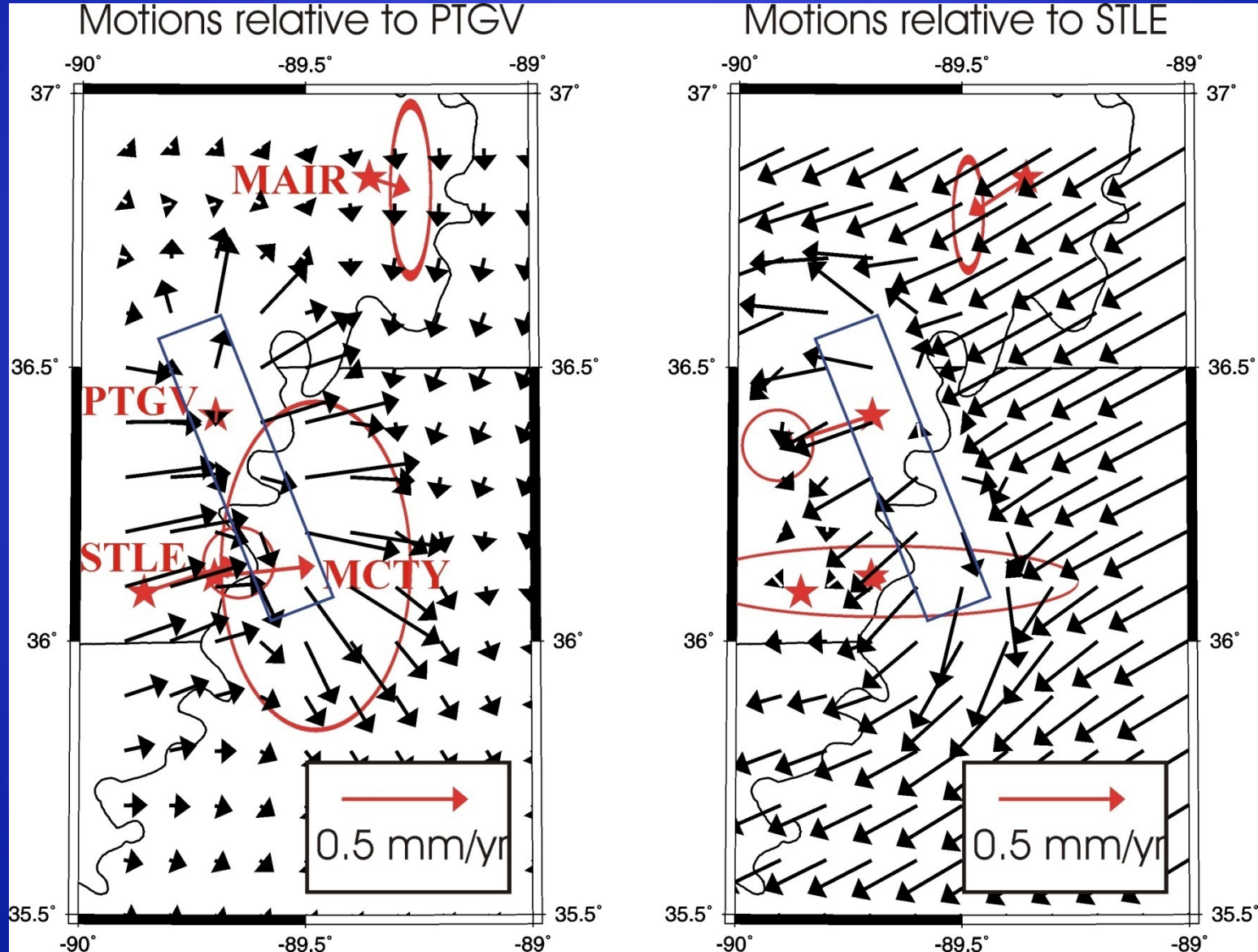
Model of deep interseismic creep on Reelfoot Fault at 12–20 km depth (hypocenters from Chiu et al., 2002)



Predicted motions relative to stable North America for 4 mm/yr creep on deep portion of Reelfoot Fault



Comparison of predicted (black) and observed motions (red). Best fit is for 4 mm/yr of deep slip . Enough slip for M7.3 earthquake on shallow portion of RF every 500 years



Conclusions

- There is significant motion of 0.3–0.5 mm/yr between some of the stations in the New Madrid area; strains of 5×10^{-9} /yr between PTGV and STLE or MCTY
- This observed surface deformation is consistent with a model of slip of 4 mm/yr on the Reelfoot fault at depths of 12–20 km
- If this slip rate is constant in time, it produces enough slip over 500 years for a M7.3 earthquake on the shallow portion of the Reelfoot fault; requires that strain in shallow portion of fault has been loaded in the past