USGS Award Number	G09AP00013
Title of award	Constraining Central US Deformation Models with Continuous GPS Data
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Co-Principal Investigator	Robert Smalley, Jr. rsmalley@memphis.edu 3876 Central Ave, Memphis TN 38152
Term covered by the award	Jan 1, 2000 - Dec 31, 2009
Geodetic Project Web Site	http://www.ceri.memphis.edu/~gps

Abstract:

Analysis of GAMA (GPS Array for Mid-America) Continuous GPS data from 2000 – 2004, suggested statistically significant motion between two of the sites straddling the Reelfoot fault scarp. These results were extensively debated with an alternate interpretation that the GPS measurements indicate no or insignificant motion between the GPS monuments. In view of this an increasing number of non-plate tectonic models have been proposed to explain the seismicity of the New Madrid seismic zone, which is not explained by the plate tectonic paradigm. One of the features of most of these models is some sort of focusing, in both space and time, of the causative dynamics in the small region about the New Madrid seismic zone (and after the recent earthquake on the Illinois-Indiana border, the adjacent Wabash Valley seismic zone). Ten years of continuous GPS data from 11 sites and two years of continuous GPS data from two new sites were analyzed using GAMIT/GLOBK using the MIT final orbits. Results continue to suggest GPS data is unable to unmask the presence of a possibly and statistically significant deformation in the New Madrid Seismic zone. A very informative and useful website has been put in place that even allows downloading of processed GPS time series from all these 13 sites.

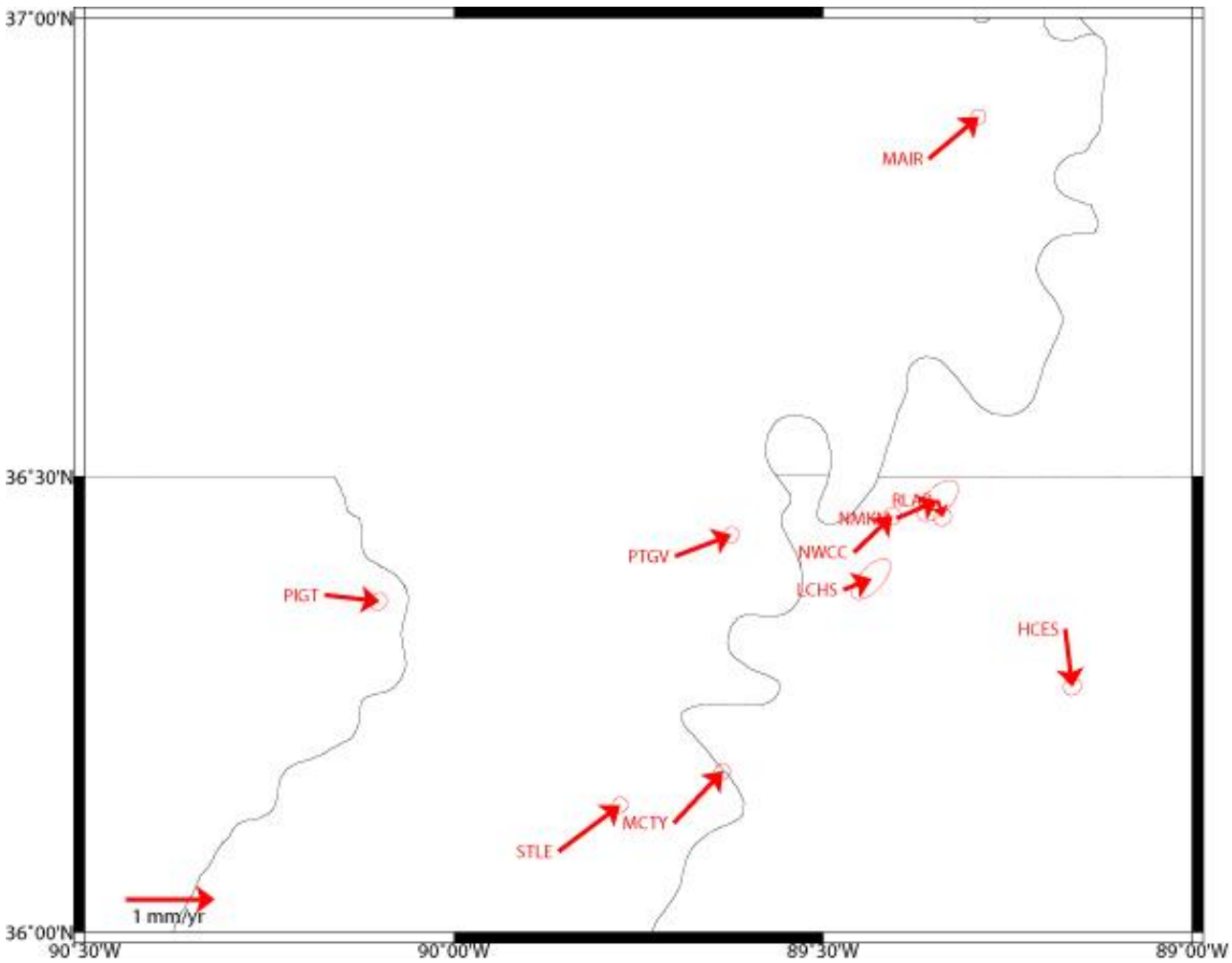
Accomplishments:

GPS data from 13 continuous sites in the New Madrid network along with 10 other IGS sites in North America were processed using the GAMIT software and MIT orbits to get the coordinates. The resulting h-files were then combined with those of MIT to get the position time series using the GLRED program. Earlier to this processing run, the first eight years of data was processed using IGS final orbits and IGS h-files. Later the same data was processed using orbits and hfiles developed by the Ohio State University. We found that this third and latest run using MIT orbits and h-files were more superior with no random cosmetic jumps in the time series.

There was an antenna problem at RLAP site that resulted in the monument moving aggressively in the horizontal. Cracks in the ground surface deceived us to believe that the all important RLAP site has been damaged permanently. Fortunately the site is back to normal once the antenna was replaced however the relative velocities across the reelfoot fault are deprived of a better velocity value in spite of more data. There is now a need for some more data at RLAP and so also at NMKM and LCHS to have a fresh look at the velocities across the reelfoot crap. In larger scale, however, GPS results do not show any signs of significant deformation.

Longitude Deg	Latitude Deg	Evel (mm/yr)	Nvel (mm/yr)	Esig	Nsig	CorEN	Site
-89.172	36.333	0.080	-0.650	0.090	0.090	0.090	HCES
-89.345	36.474	0.060	-0.190	0.090	0.090	0.100	RLAP
-89.357	36.847	0.560	0.470	0.080	0.080	0.050	MAIR
-89.400	36.454	0.460	0.200	0.210	0.210	0.590	NMKM
-89.458	36.417	0.430	0.410	0.090	0.090	0.070	NWCC
-89.472	36.376	0.310	0.120	0.200	0.210	0.650	LCHS
-89.644	35.541	0.170	0.370	0.090	0.090	0.120	CVMS
-89.700	36.413	0.630	0.240	0.080	0.080	0.040	PTGV
-89.702	36.120	0.550	0.580	0.080	0.080	0.050	MCTY
-89.858	36.089	0.690	0.520	0.080	0.080	0.050	STLE
-90.175	36.370	0.610	-0.070	0.090	0.090	0.100	PIGT
-90.485	37.845	0.610	0.480	0.080	0.080	0.050	MACC
-92.273	34.822	0.560	0.130	0.080	0.080	0.050	CJTR

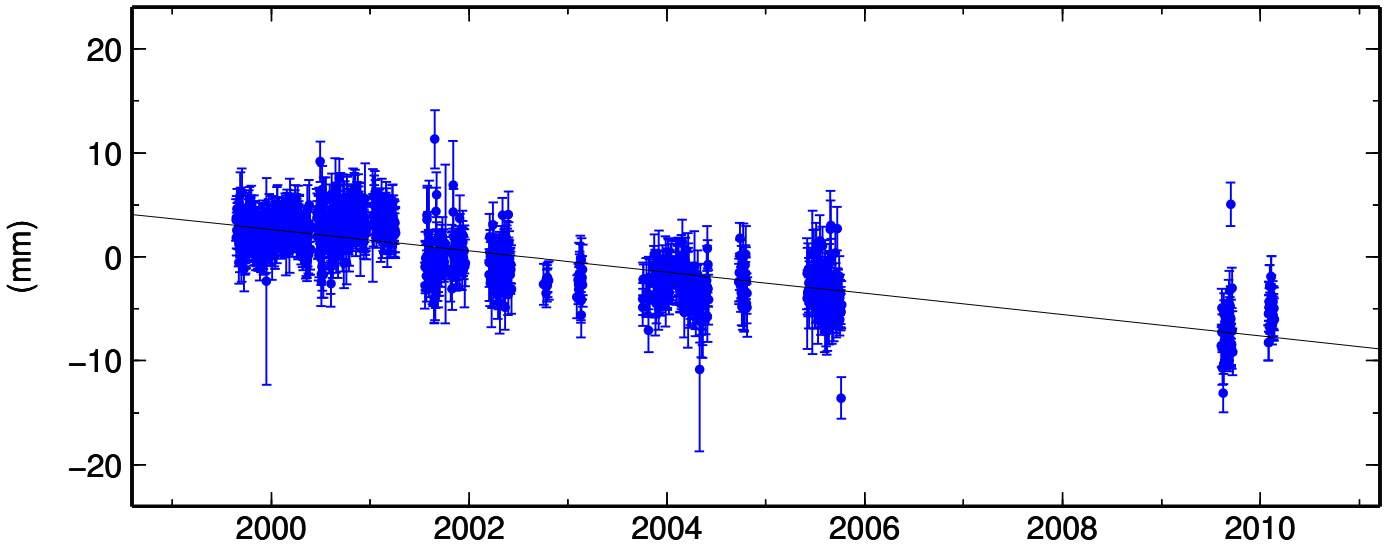
Velocities of the GAMA sites with North American Plate Velocity removed are shown in table above and a plot below.



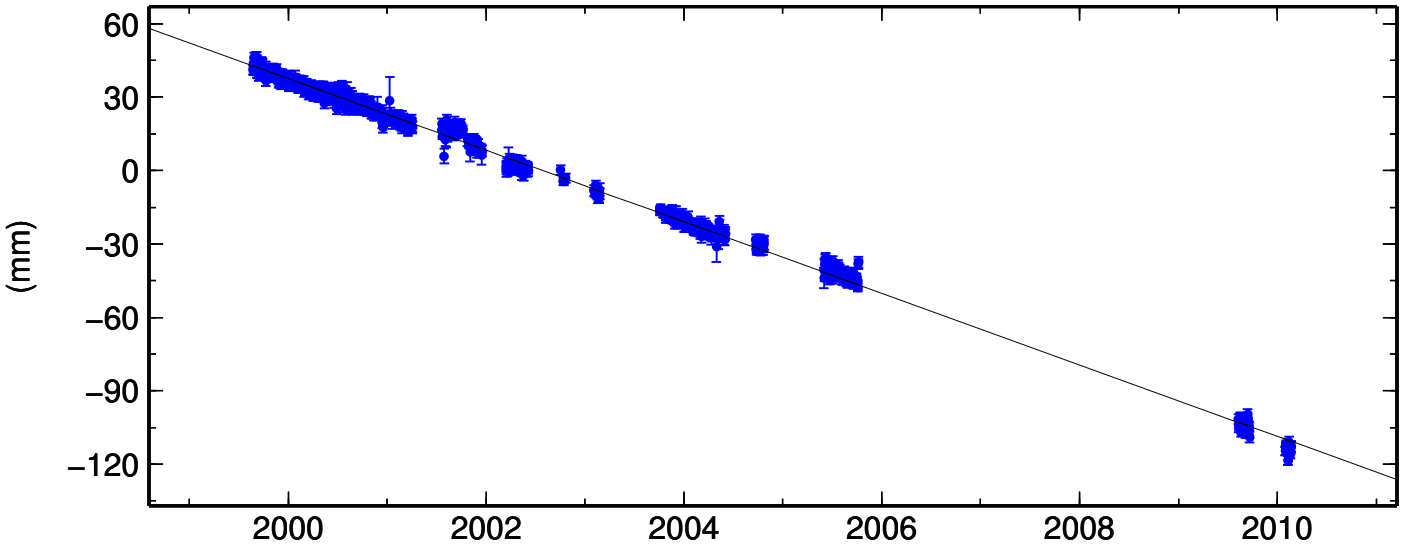
GLOBK was used to estimate the velocities in the stable North American plate. Later the plate motion at these sites as estimated from the plate motion calculators at UNAVCO website, the North American Plate velocity removed from each site.

CERI GPS website has been updated as part of this project. Apart from showing the pictures of the 13 sites and other instrument and monument details, the website allows time series data to be downloaded for further analysis. Velocities are plotted and updated regularly and the velocities are given in a table for future analysis by those interested. In a few weeks automatic data analysis will be in place with time series plots and data updated every fortnight. Velocities will be updated every two months. Further velocity analysis will involve weekly and monthly combinations. Time series plots are show in the 13 pages for 13 New Madrid sites.

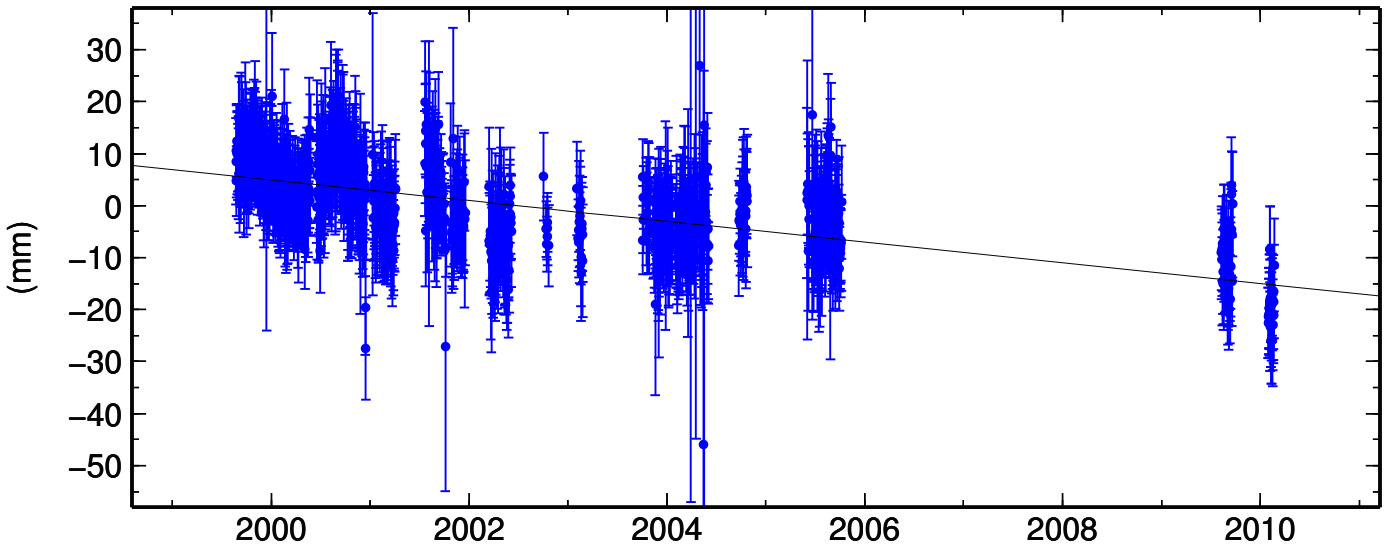
RLAP North Offset 4060293.201 m
rate(mm/yr)= −1.02 ± 0.02 nrms= 0.98 wrms= 2.0 mm # 1090



RLAP East Offset 24227547.555 m
rate(mm/yr)= −14.62 ± 0.02 nrms= 1.00 wrms= 2.0 mm # 1087

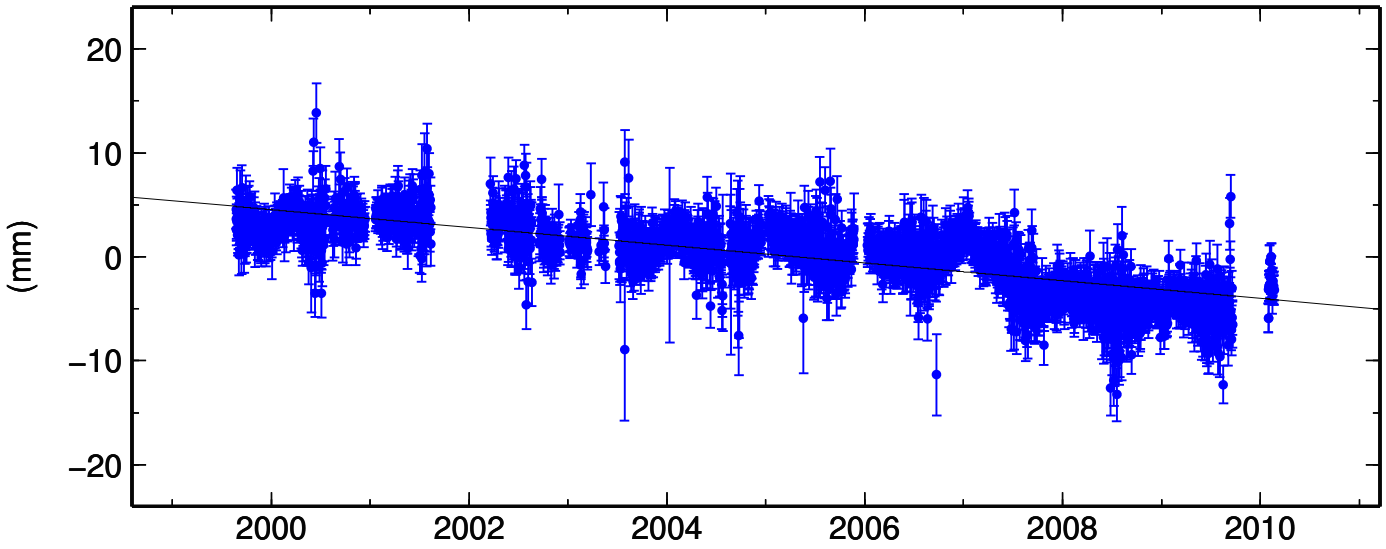


RLAP Up Offset 58.398 m
rate(mm/yr)= −1.99 ± 0.09 nrms= 0.66 wrms= 5.6 mm # 1094



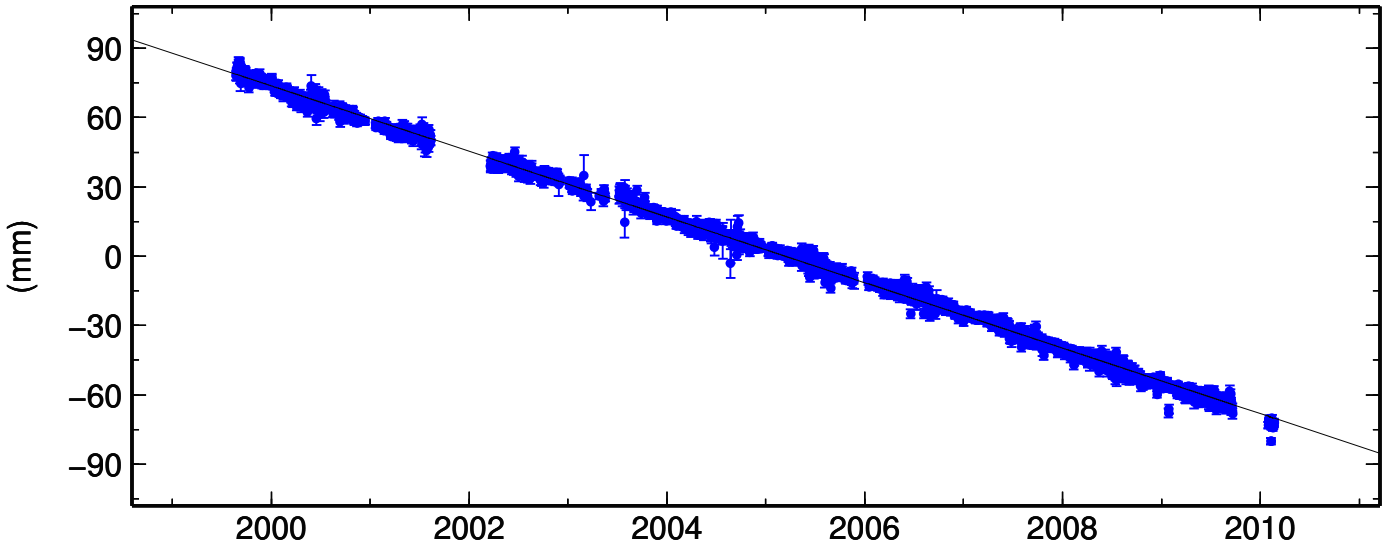
PTGV North Offset 4053529.083 m

rate(mm/yr)= −0.85 ± 0.01 nrms= 1.21 wrms= 1.9 mm # 3001



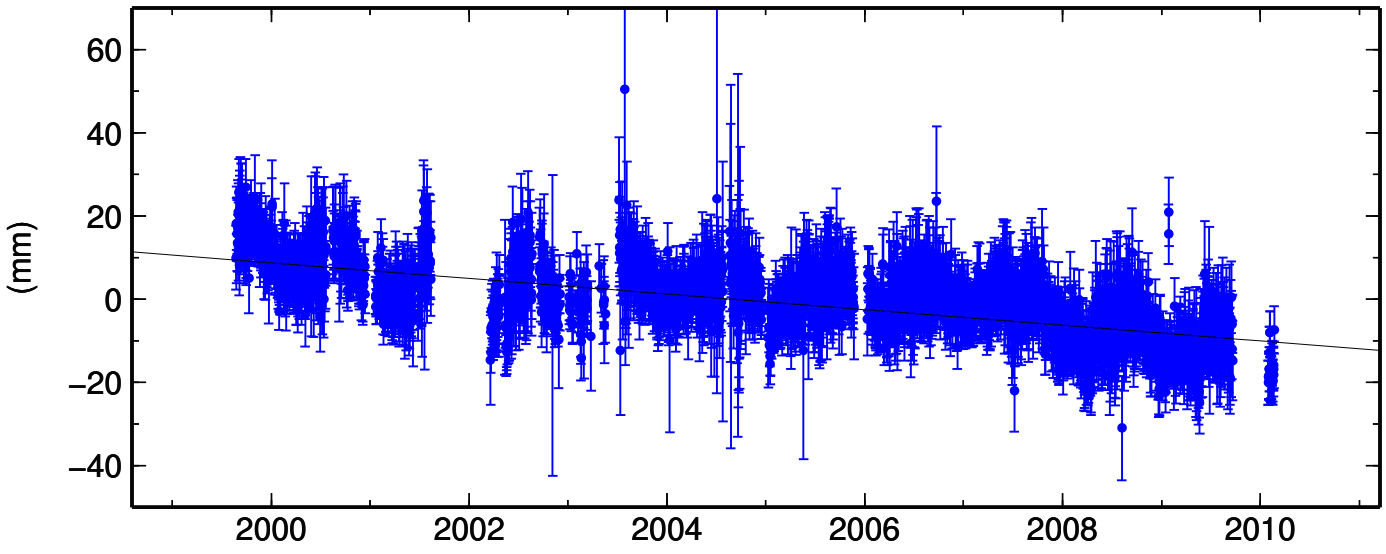
PTGV East Offset 24214606.034 m

rate(mm/yr)= −14.18 ± 0.01 nrms= 1.10 wrms= 1.7 mm # 2999



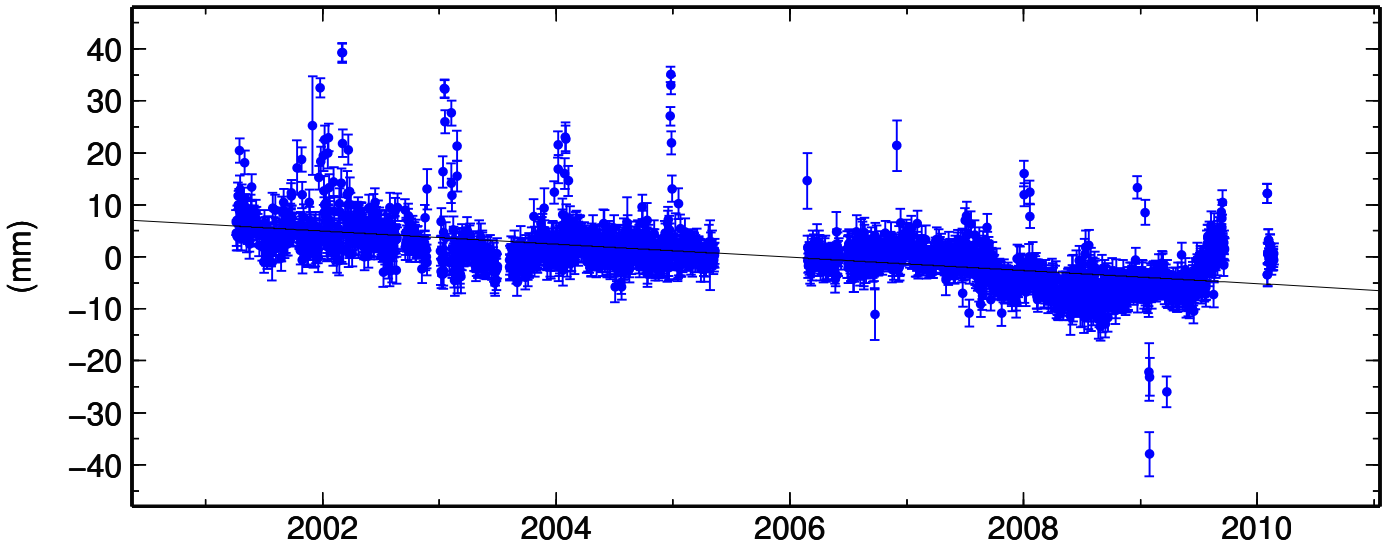
PTGV Up Offset 58.024 m

rate(mm/yr)= −1.87 ± 0.04 nrms= 0.93 wrms= 5.8 mm # 3003



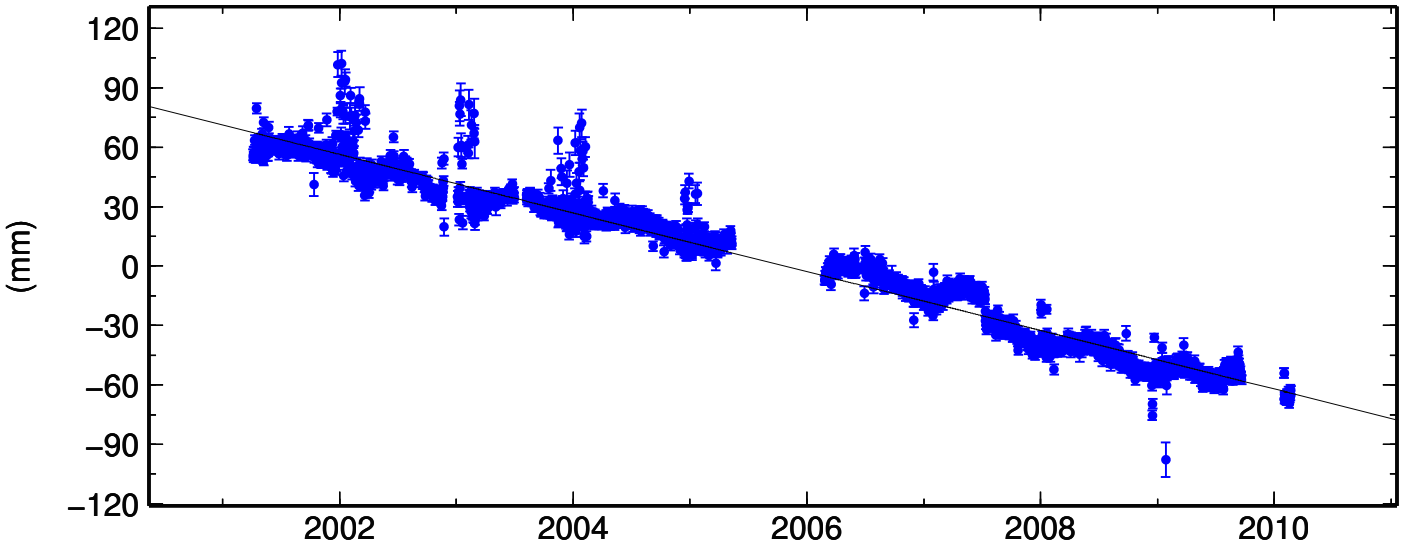
PIGT North Offset 4048722.796 m

rate(mm/yr)= −1.27 ± 0.02 nrms= 1.79 wrms= 4.3 mm # 2490



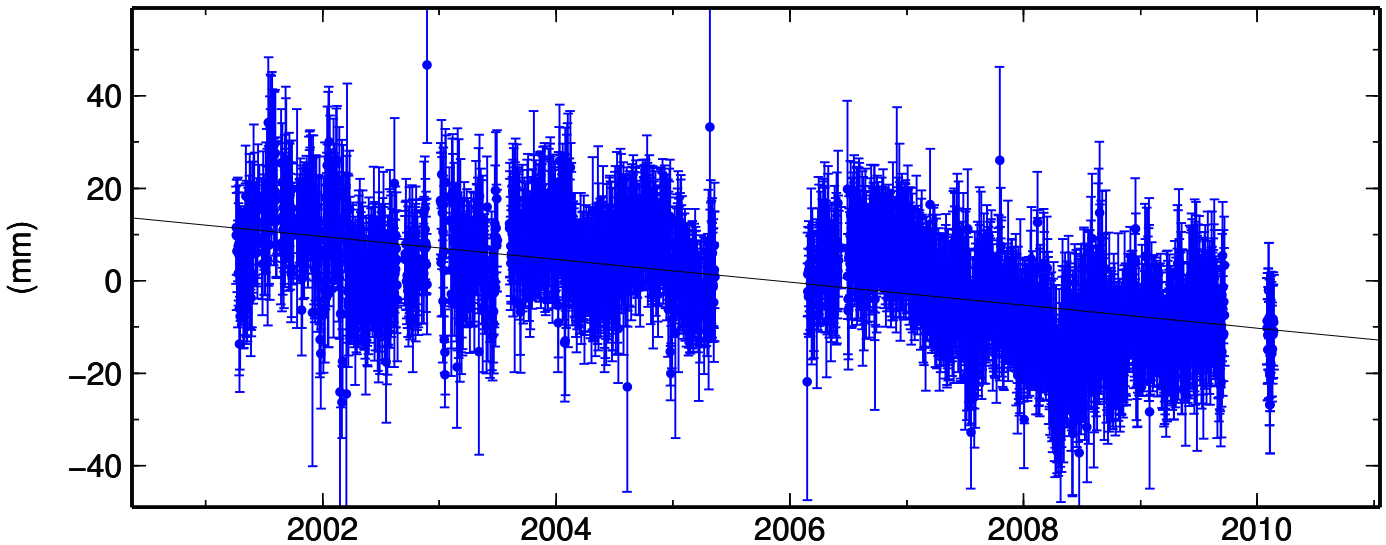
PIGT East Offset 24185373.038 m

rate(mm/yr)= −14.81 ± 0.02 nrms= 2.58 wrms= 6.3 mm # 2483



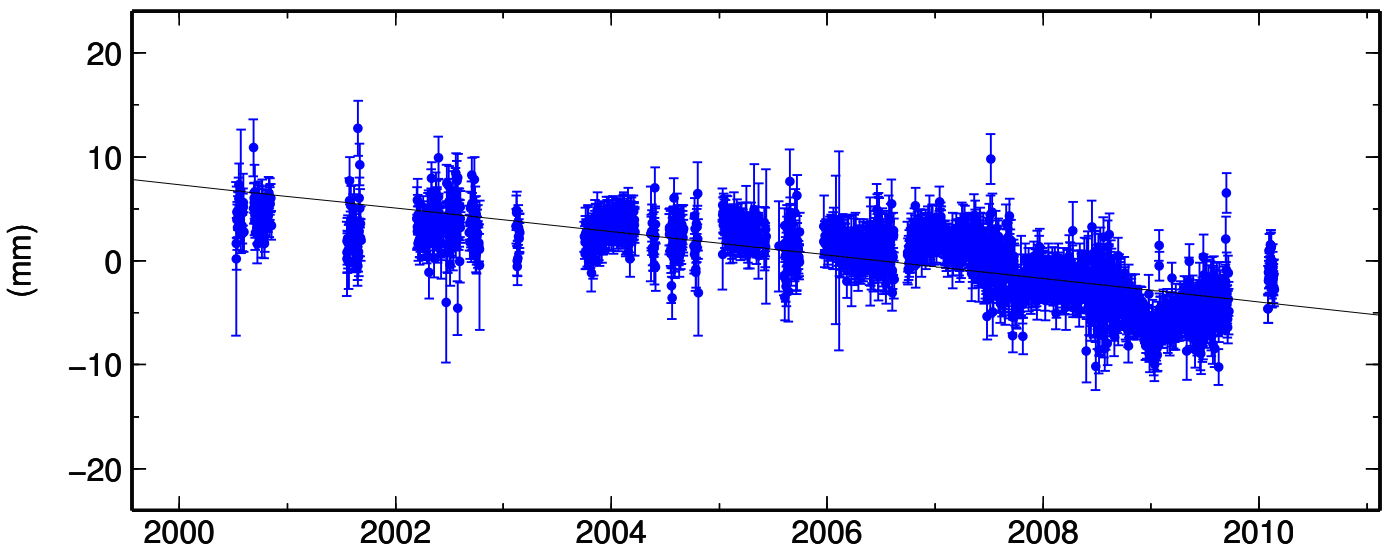
PIGT Up Offset 55.253 m

rate(mm/yr)= −2.48 ± 0.09 nrms= 0.72 wrms= 7.8 mm # 2493



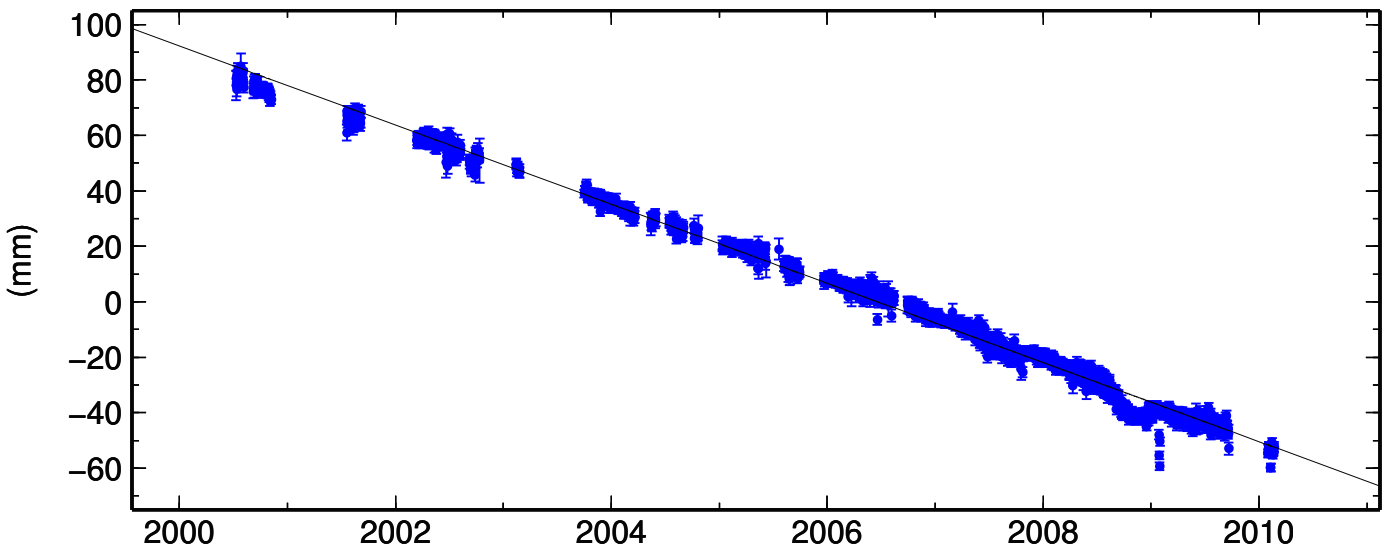
NWCC North Offset 4053879.121 m

rate(mm/yr)= −1.13 ± 0.02 nrms= 1.33 wrms= 2.2 mm # 2028



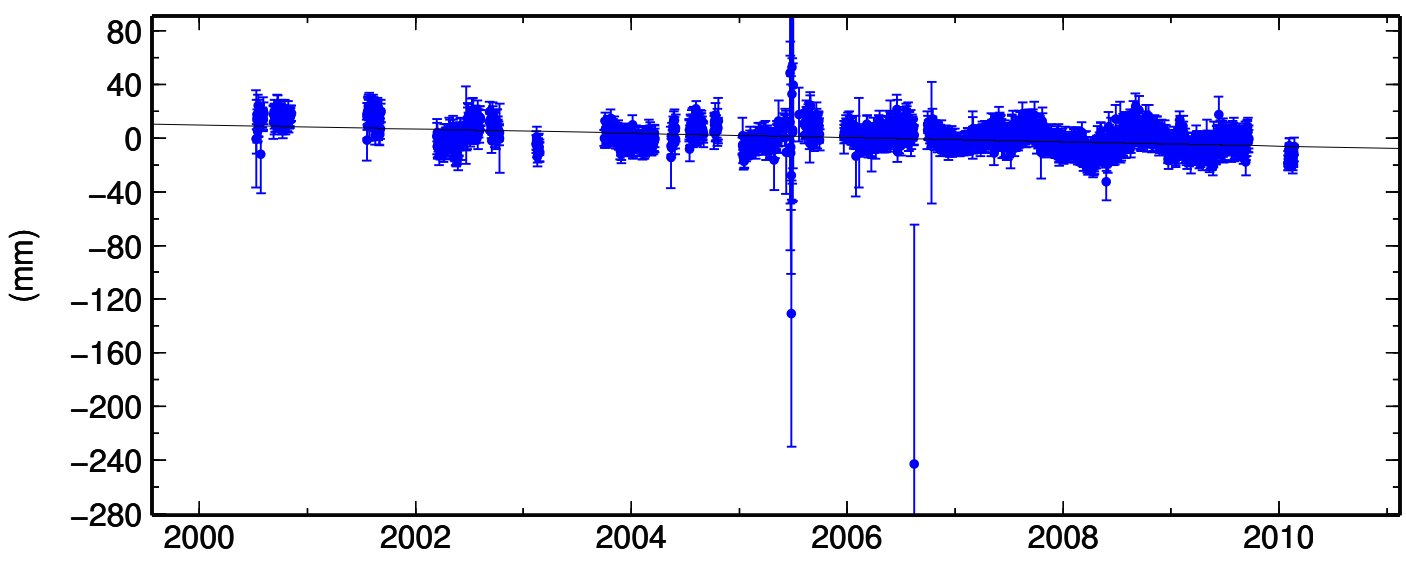
NWCC East Offset 24235337.188 m

rate(mm/yr)= −14.27 ± 0.02 nrms= 1.71 wrms= 2.8 mm # 2026



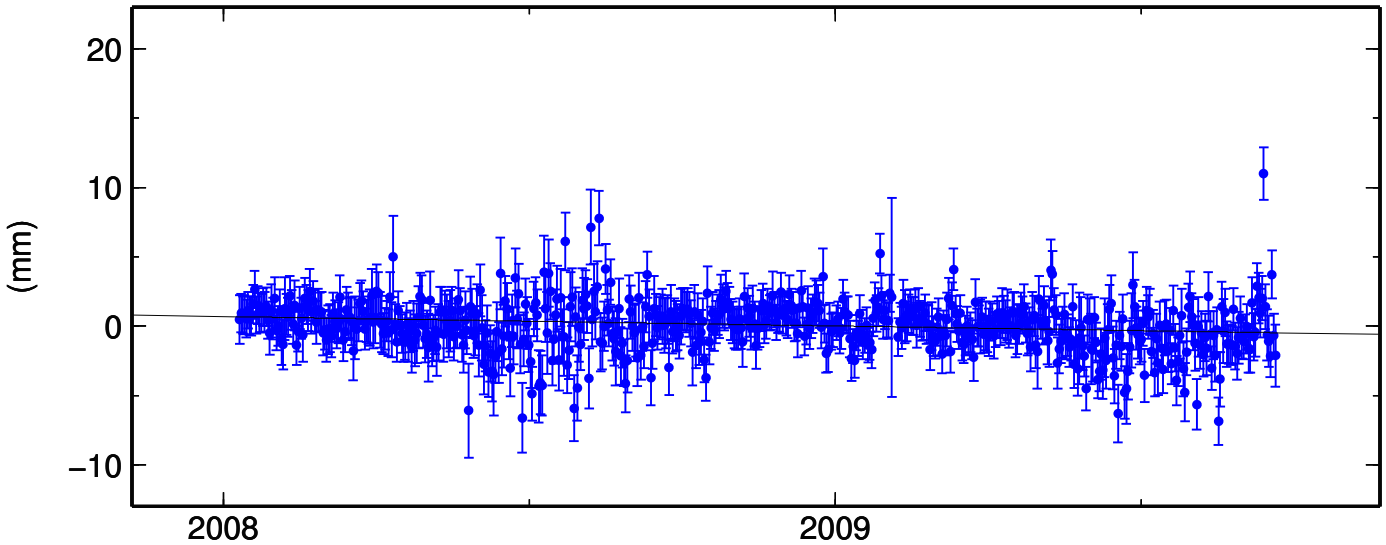
NWCC Up Offset 64.833 m

rate(mm/yr)= −1.59 ± 0.06 nrms= 1.00 wrms= 6.9 mm # 2041



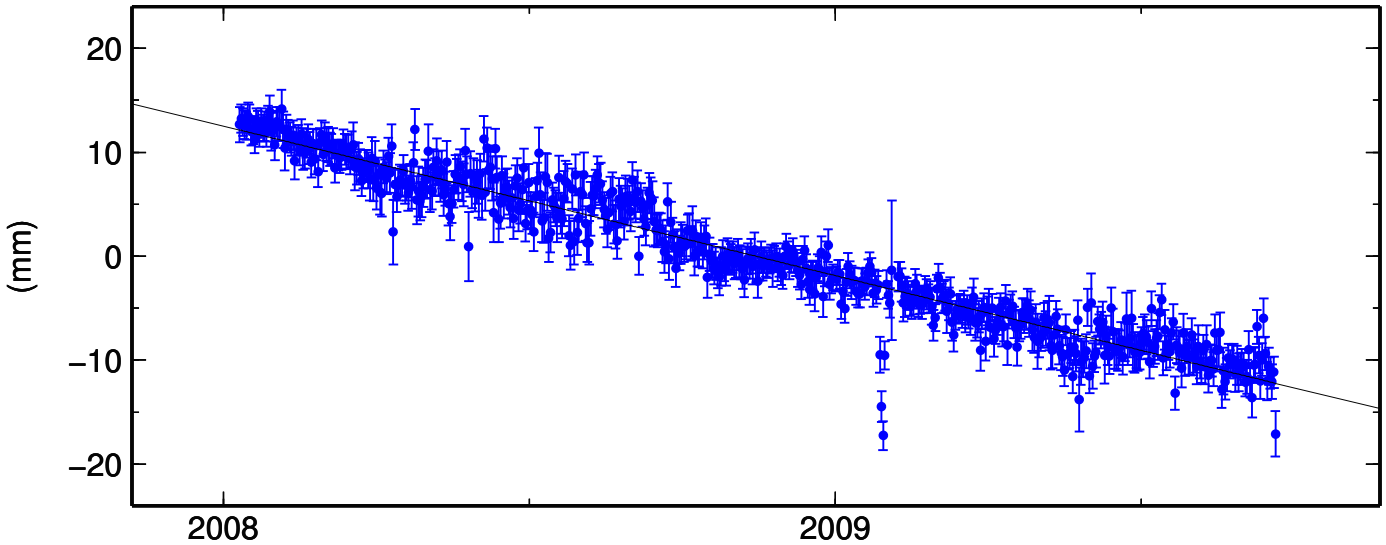
NMKM North Offset 4058091.143 m

rate(mm/yr)= −0.68 ± 0.13 nrms= 0.97 wrms= 1.6 mm # 616



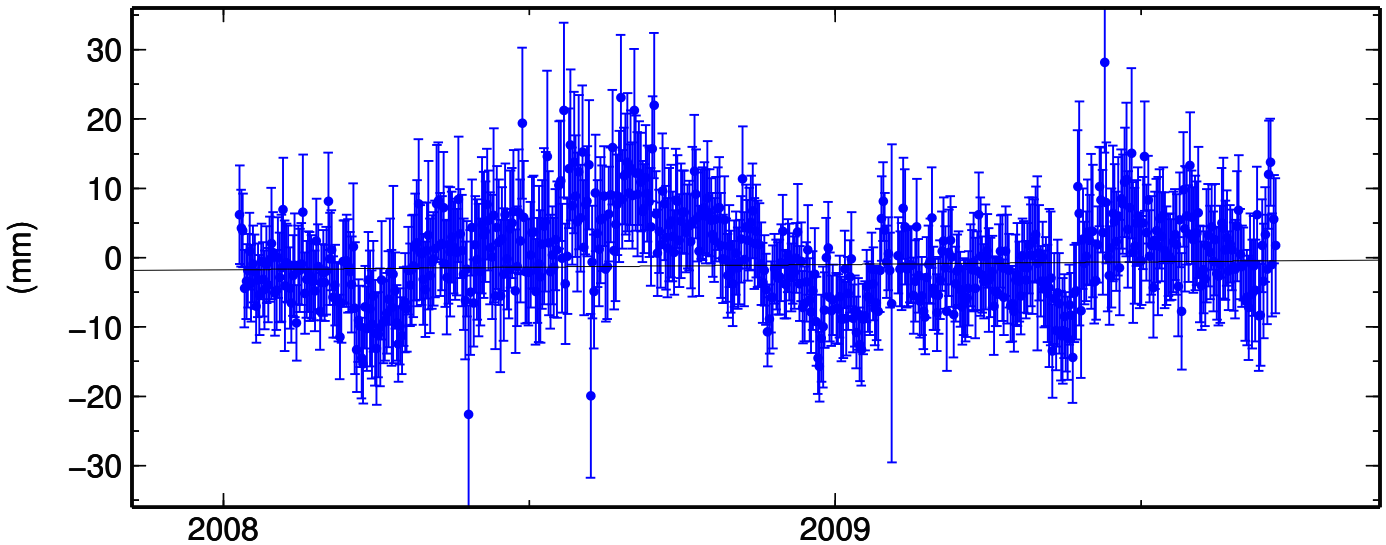
NMKM East Offset 24228894.991 m

rate(mm/yr)= −14.38 ± 0.13 nrms= 1.08 wrms= 1.7 mm # 616



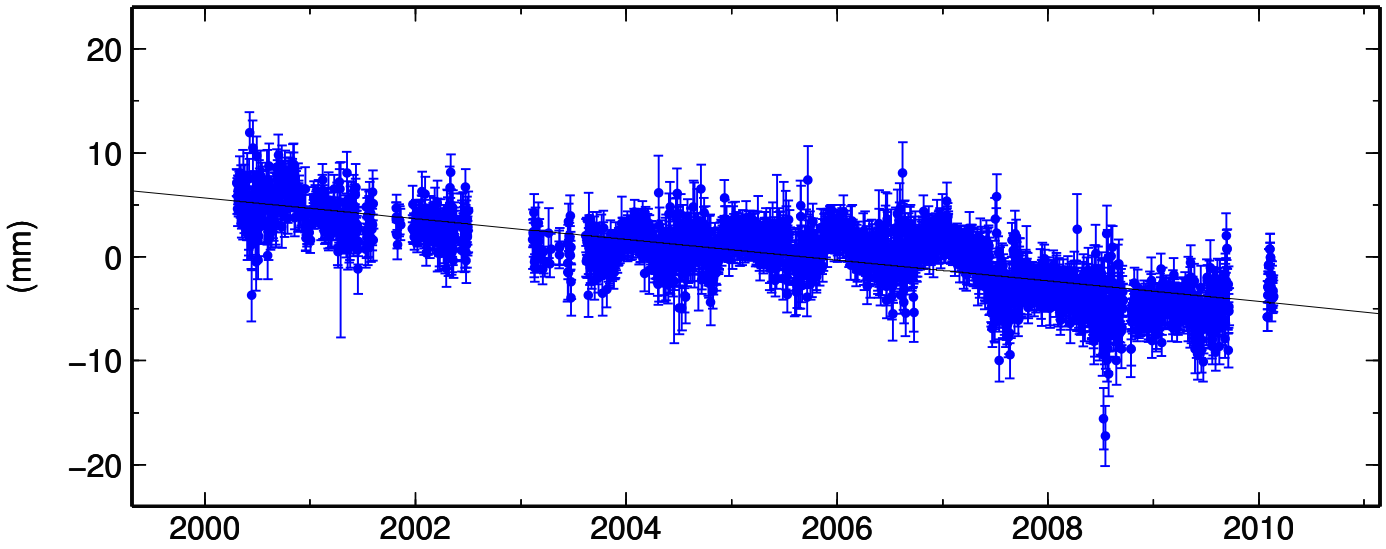
NMKM Up Offset 59.936 m

rate(mm/yr)= 0.76 ± 0.55 nrms= 0.89 wrms= 5.8 mm # 616



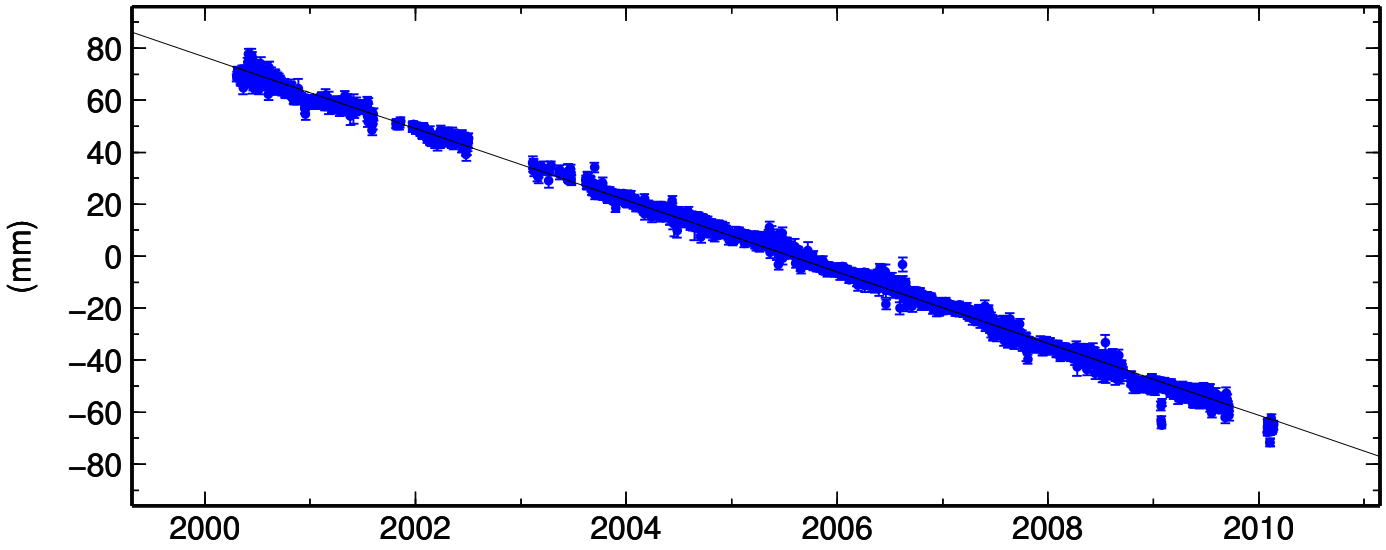
MCTY North Offset 4020817.861 m

rate(mm/yr)= −1.00 ± 0.01 nrms= 1.26 wrms= 1.9 mm # 2779



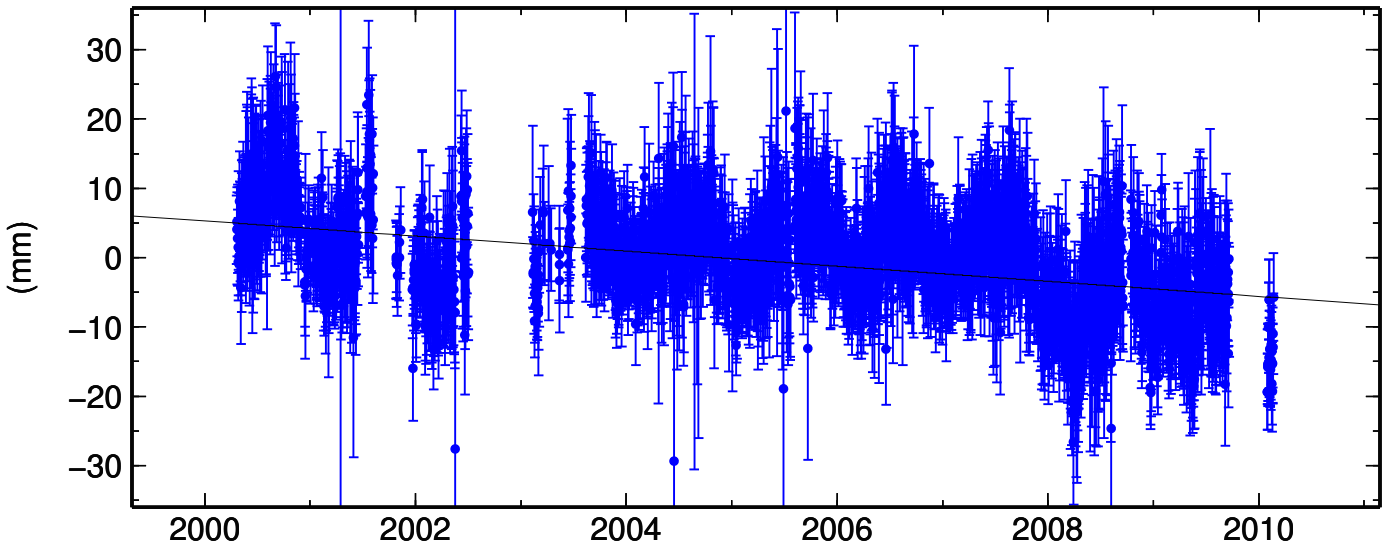
MCTY East Offset 24306046.070 m

rate(mm/yr)= −13.78 ± 0.01 nrms= 1.27 wrms= 1.9 mm # 2778



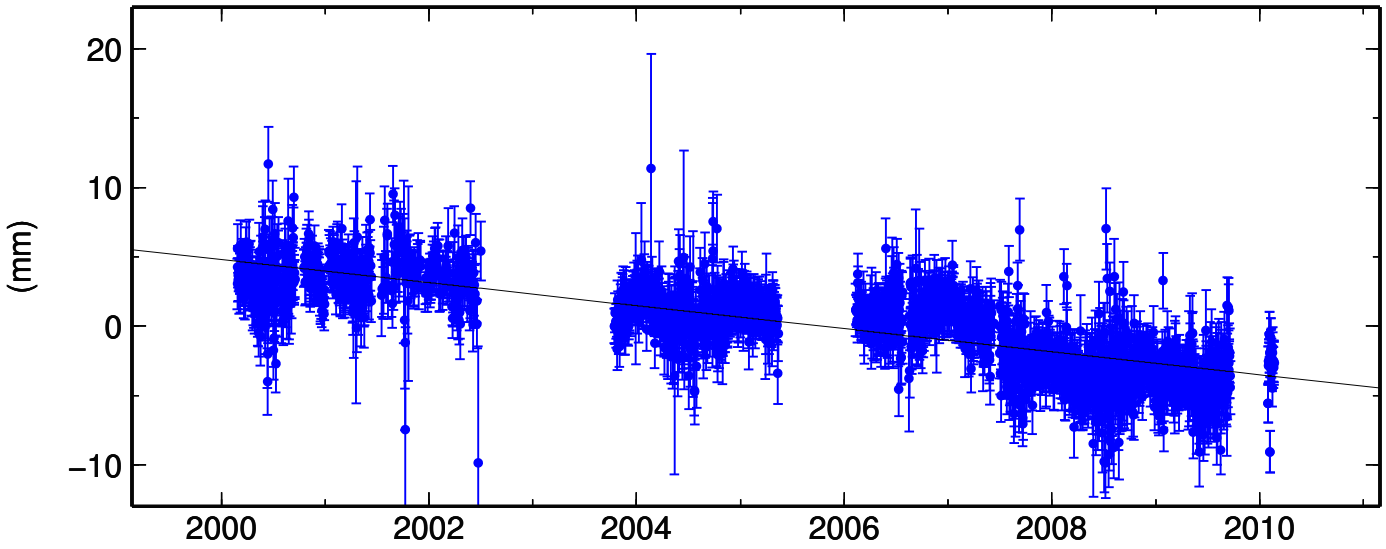
MCTY Up Offset 51.687 m

rate(mm/yr)= −1.09 ± 0.04 nrms= 0.92 wrms= 5.7 mm # 2781



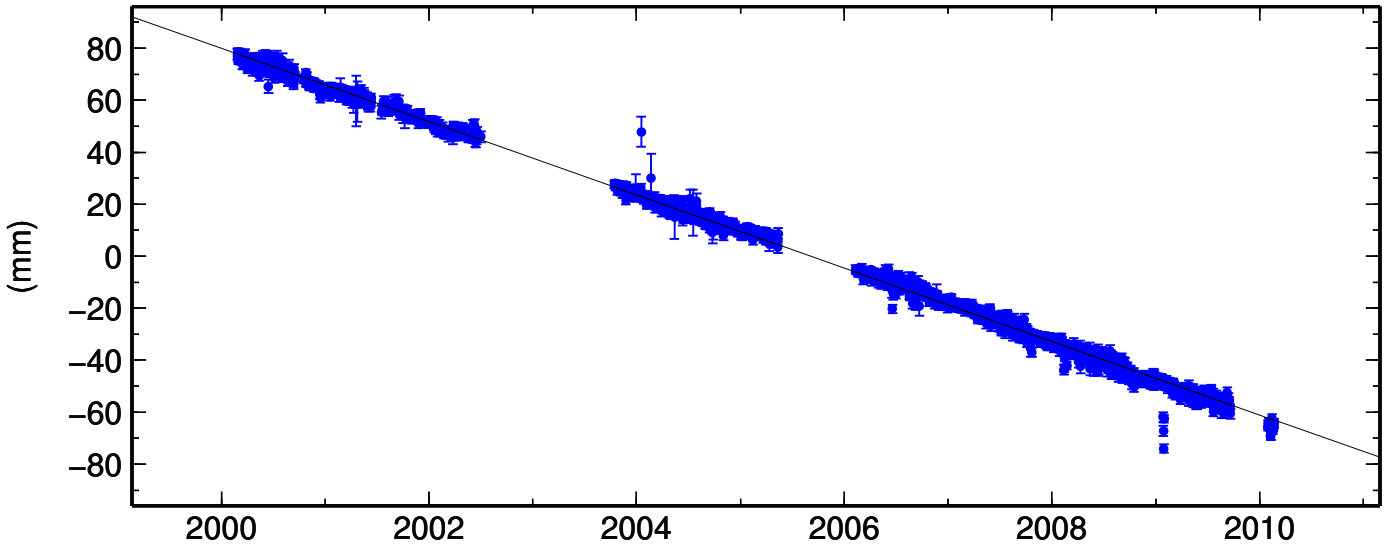
MAIR North Offset 4101742.078 m

rate(mm/yr)= −0.83 ± 0.01 nrms= 1.08 wrms= 1.7 mm # 2365



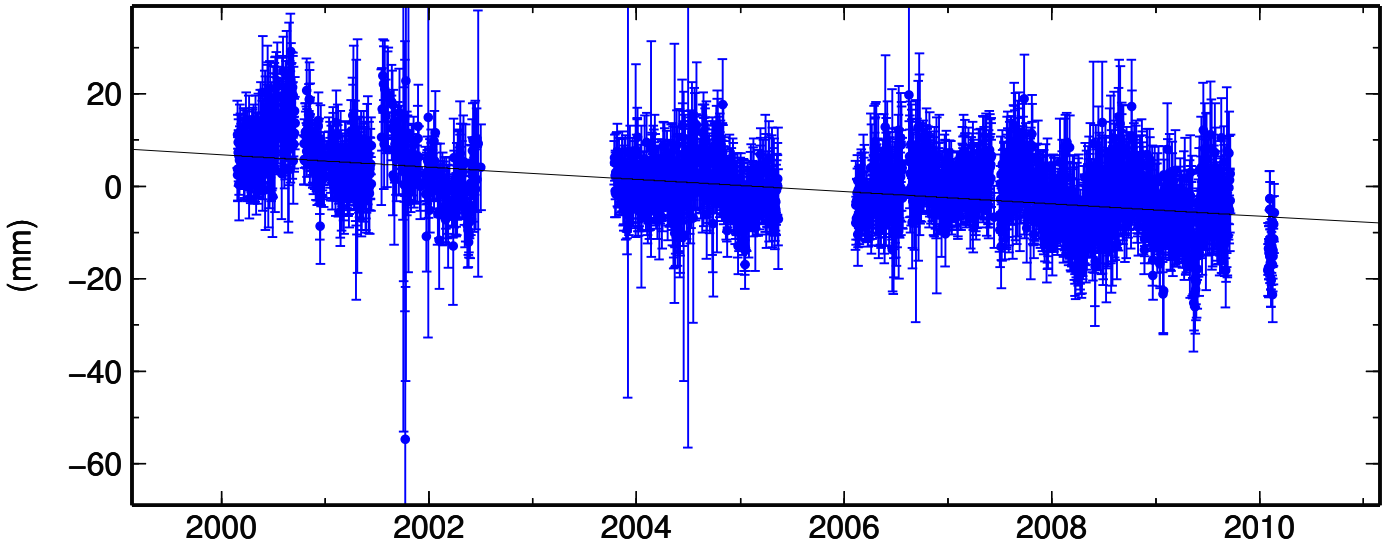
MAIR East Offset 24109609.925 m

rate(mm/yr)= −14.10 ± 0.01 nrms= 1.16 wrms= 1.8 mm # 2359



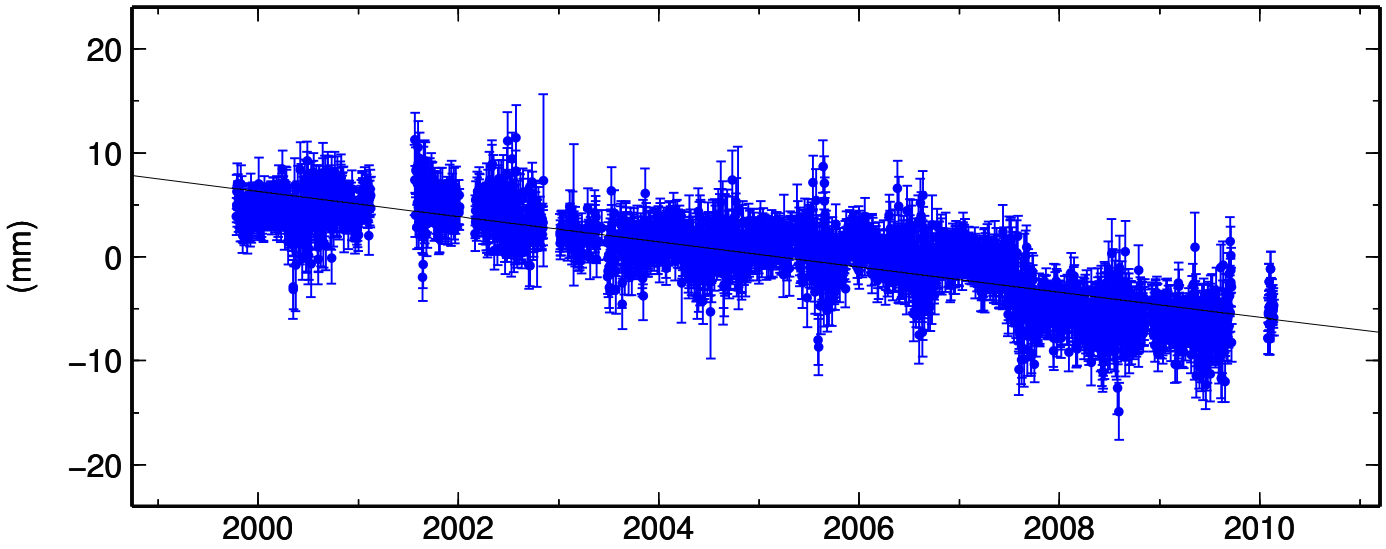
MAIR Up Offset 67.389 m

rate(mm/yr)= −1.32 ± 0.05 nrms= 0.81 wrms= 5.3 mm # 2371



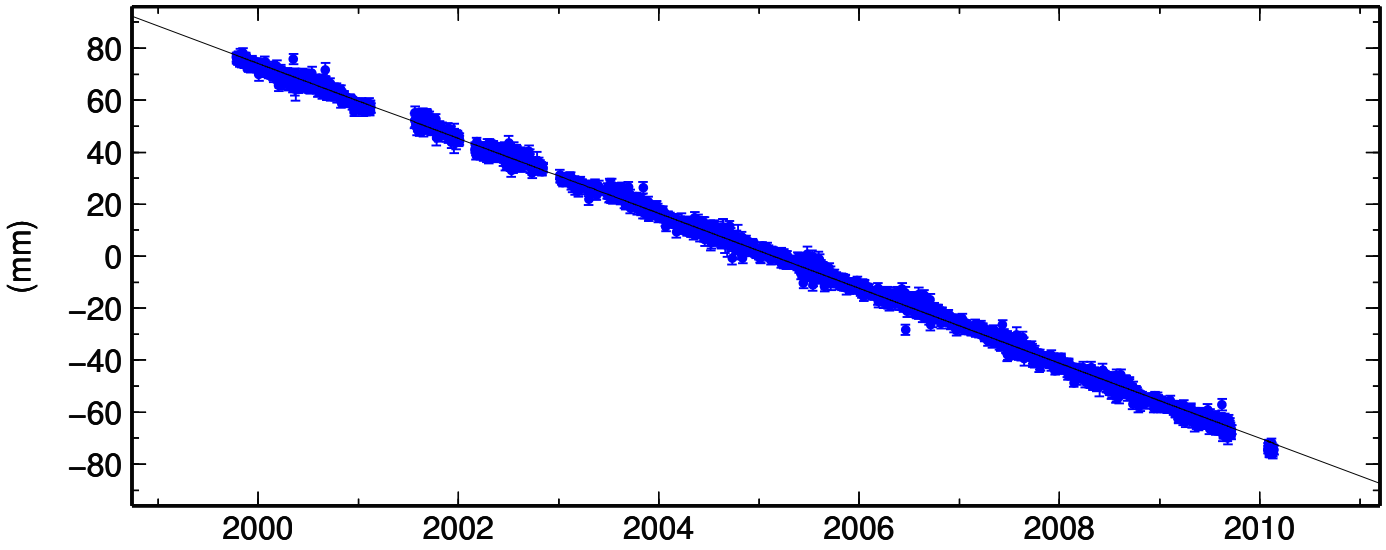
MACC North Offset 4212895.355 m

rate(mm/yr)= −1.21 ± 0.01 nrms= 1.12 wrms= 2.0 mm # 3144



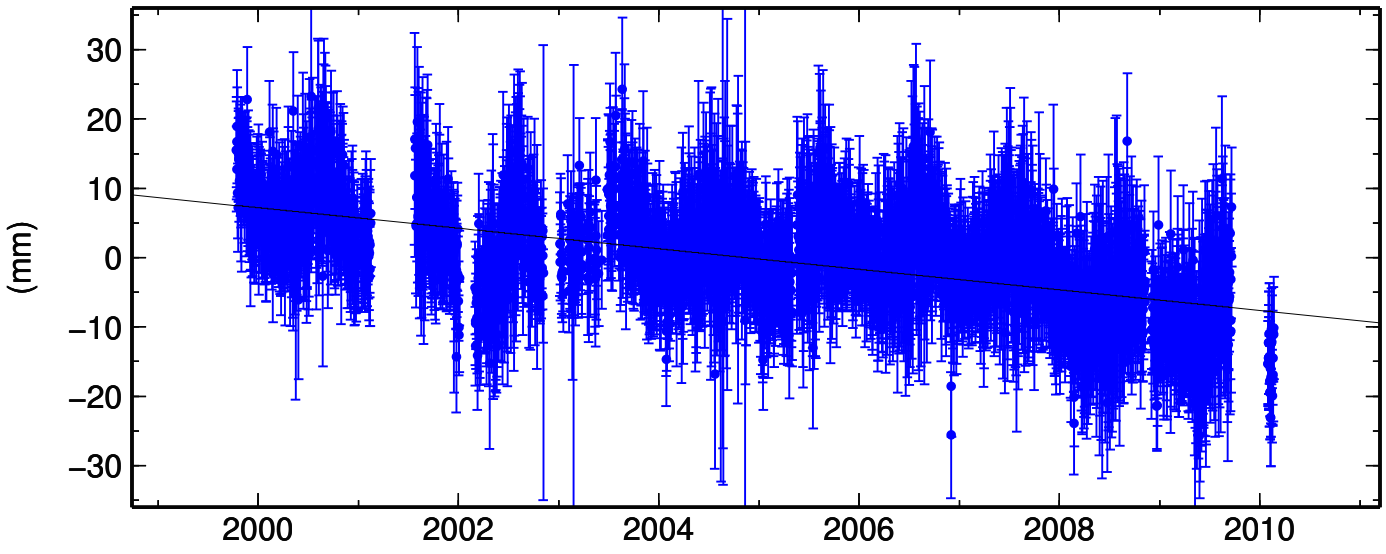
MACC East Offset 23692470.370 m

rate(mm/yr)= −14.41 ± 0.01 nrms= 0.88 wrms= 1.5 mm # 3142



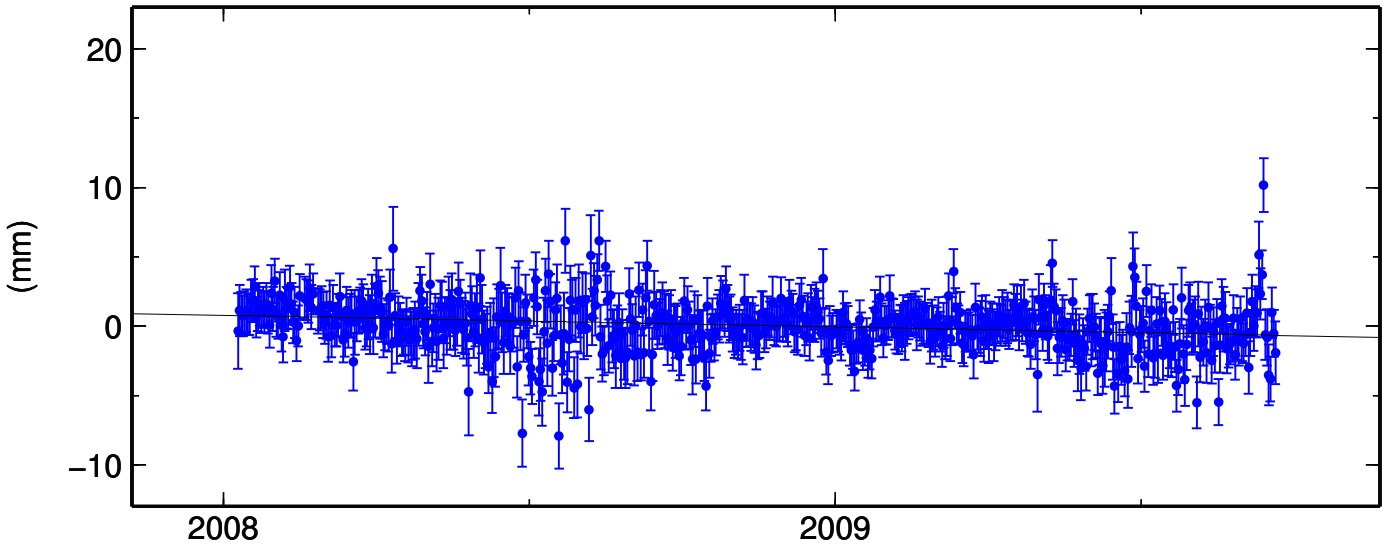
MACC Up Offset 220.011 m

rate(mm/yr)= −1.48 ± 0.04 nrms= 0.70 wrms= 5.2 mm # 3146



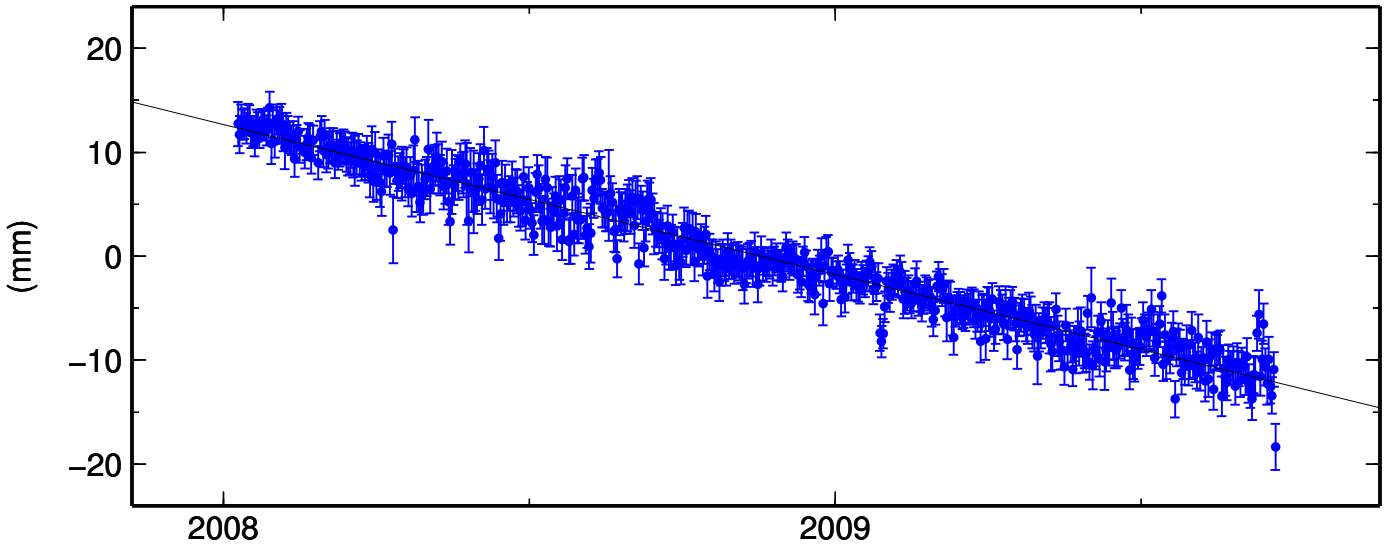
LCHS North Offset 4049404.373 m

rate(mm/yr)= −0.84 ± 0.14 nrms= 0.89 wrms= 1.5 mm # 616



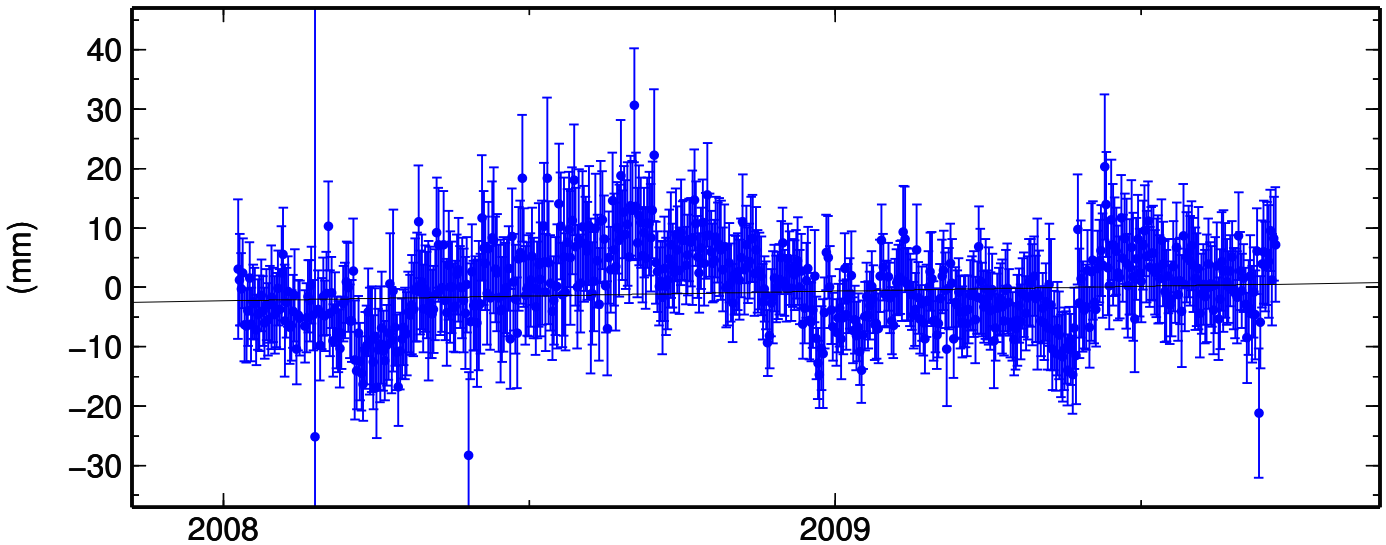
LCHS East Offset 24246607.042 m

rate(mm/yr)= −14.42 ± 0.14 nrms= 0.84 wrms= 1.4 mm # 616



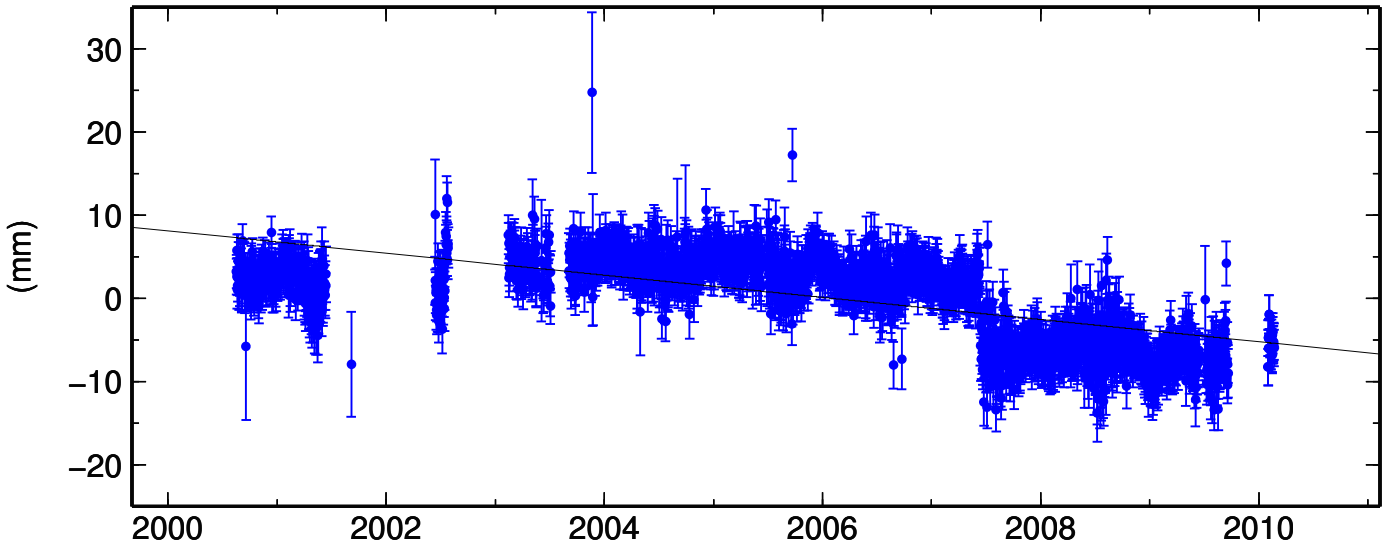
LCHS Up Offset 63.085 m

rate(mm/yr)= 1.63 ± 0.59 nrms= 0.85 wrms= 6.0 mm # 617



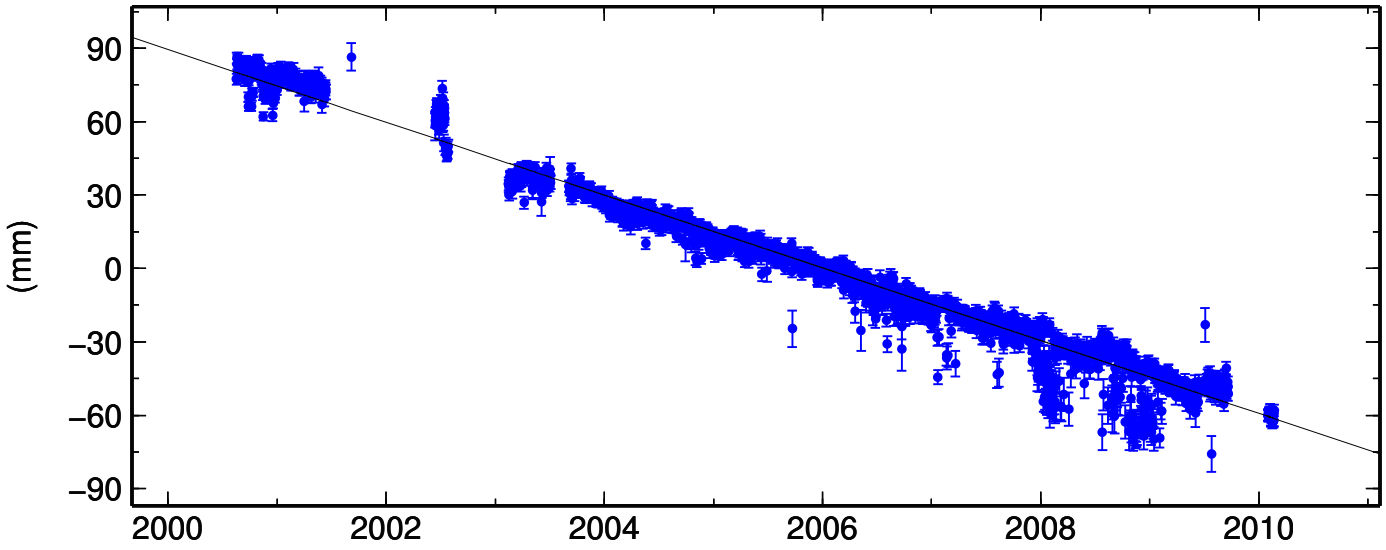
HCES North Offset 4044527.076 m

rate(mm/yr)= −1.33 ± 0.02 nrms= 1.55 wrms= 3.6 mm # 2543



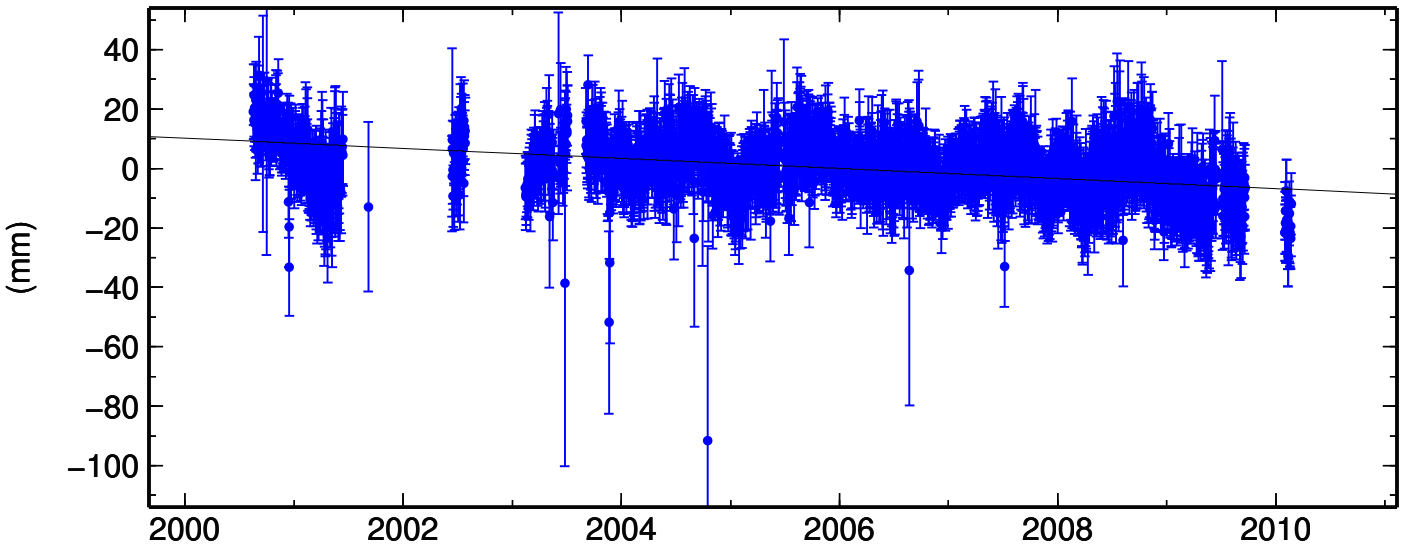
HCES East Offset 24286930.484 m

rate(mm/yr)= −14.86 ± 0.02 nrms= 1.72 wrms= 4.2 mm # 2539



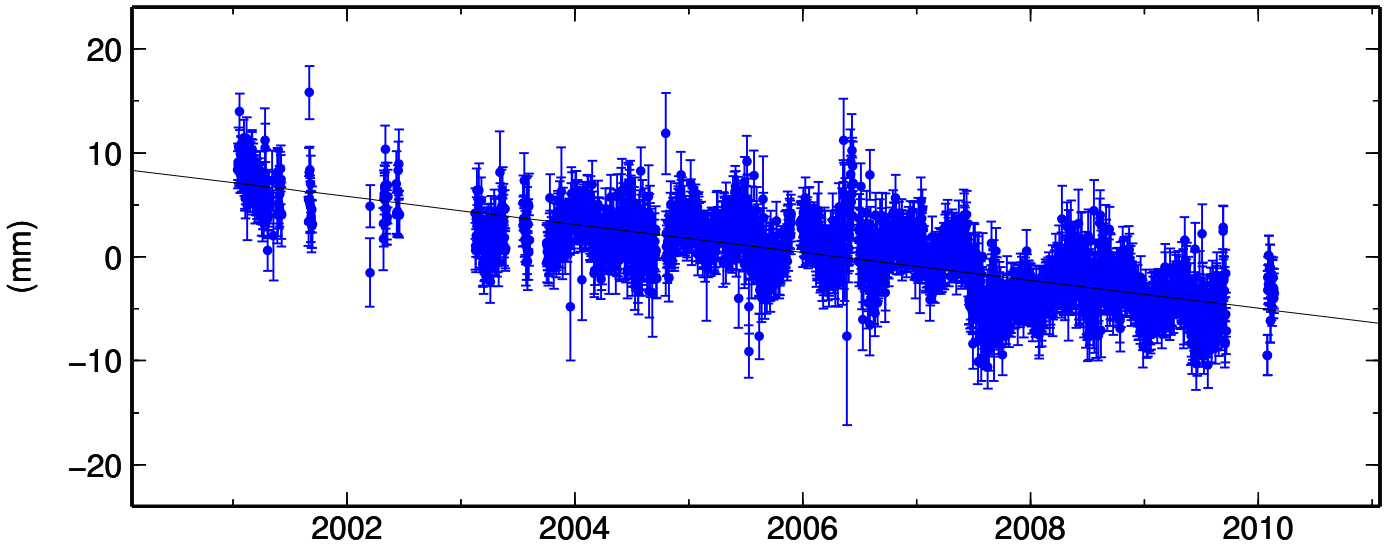
HCES Up Offset 77.941 m

rate(mm/yr)= −1.70 ± 0.08 nrms= 0.68 wrms= 7.2 mm # 2547



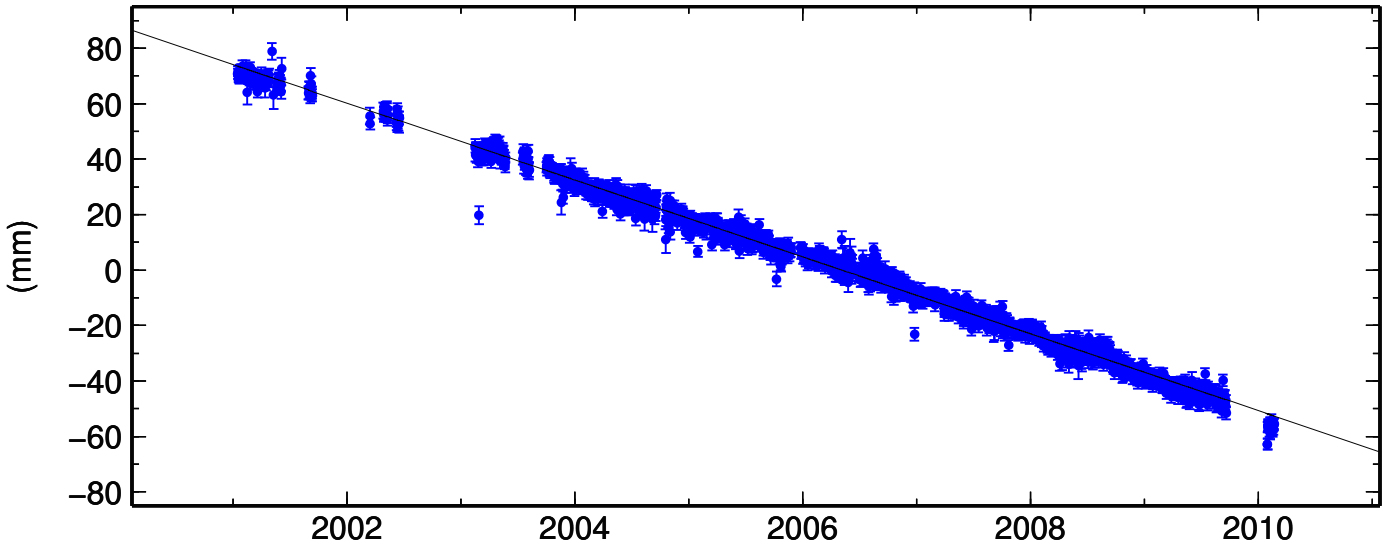
CVMS North Offset 3956452.935 m

rate(mm/yr)= −1.34 ± 0.02 nrms= 1.09 wrms= 2.3 mm # 2339



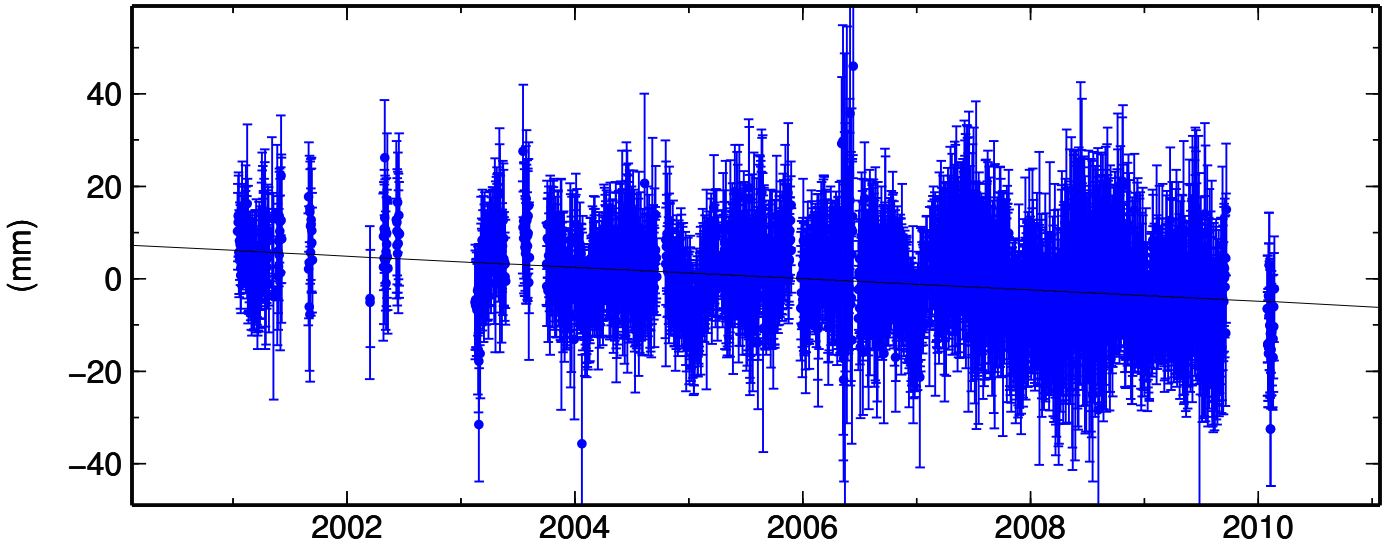
CVMS East Offset 24489259.890 m

rate(mm/yr)= −13.86 ± 0.02 nrms= 1.07 wrms= 2.2 mm # 2337



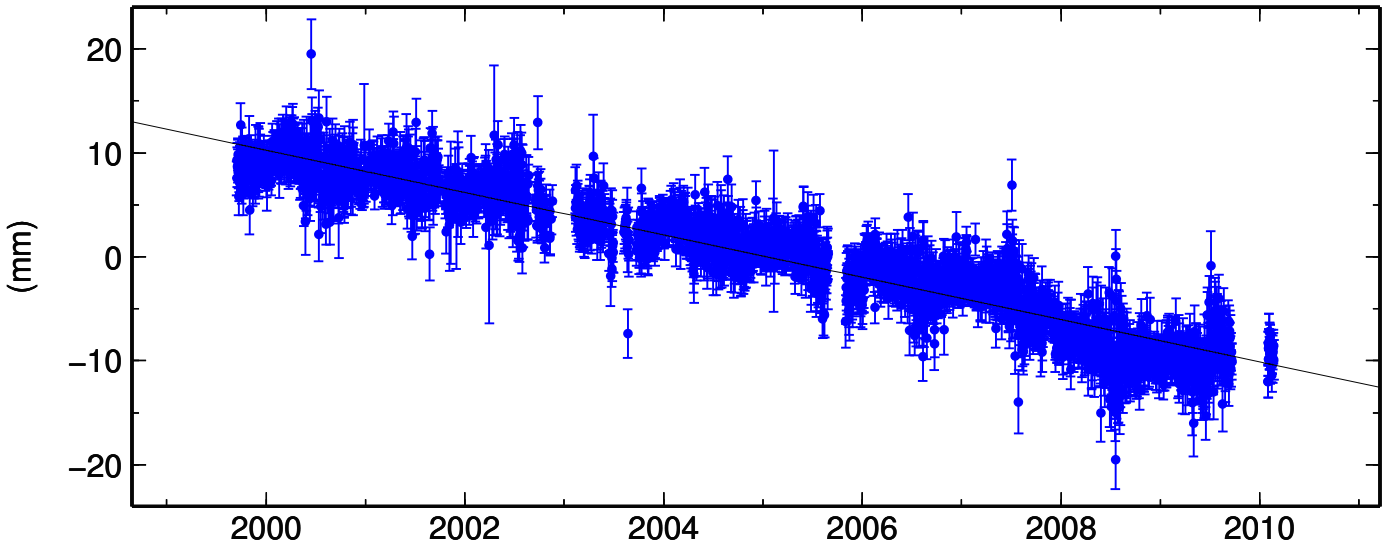
CVMS Up Offset 72.946 m

rate(mm/yr)= −1.22 ± 0.11 nrms= 0.57 wrms= 6.6 mm # 2339



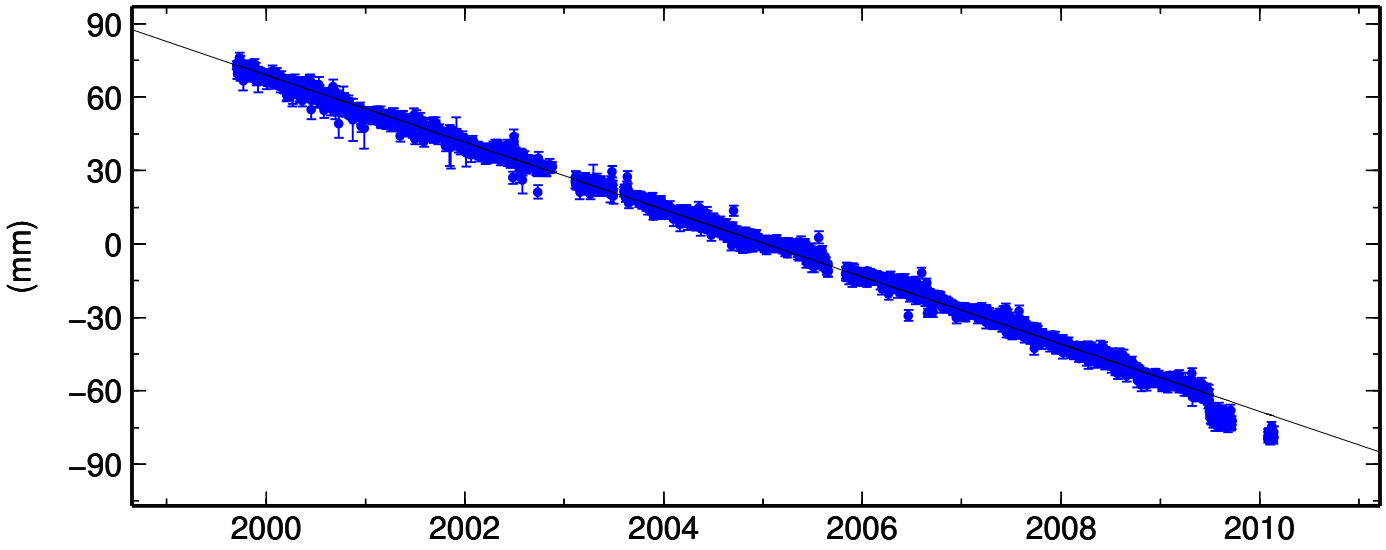
CJTR North Offset 3876333.366 m

rate(mm/yr)= −2.04 ± 0.01 nrms= 1.07 wrms= 1.8 mm # 3194



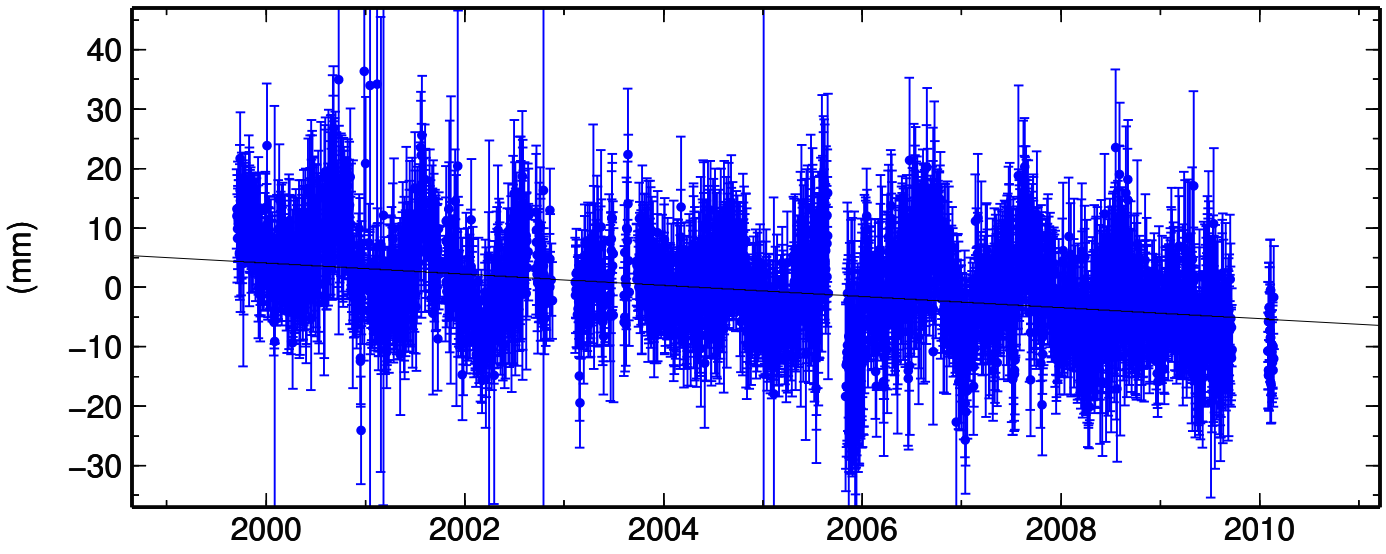
CJTR East Offset 24466573.400 m

rate(mm/yr)= −13.74 ± 0.01 nrms= 1.24 wrms= 2.2 mm # 3190



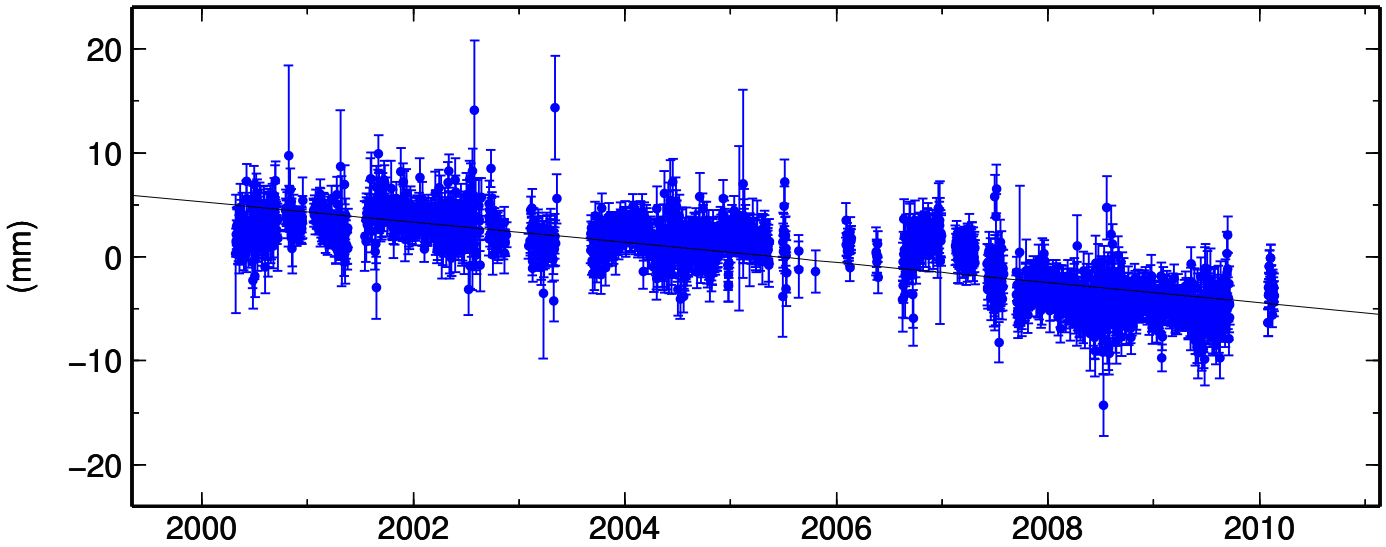
CJTR Up Offset 126.002 m

rate(mm/yr)= −0.94 ± 0.04 nrms= 0.82 wrms= 6.1 mm # 3202



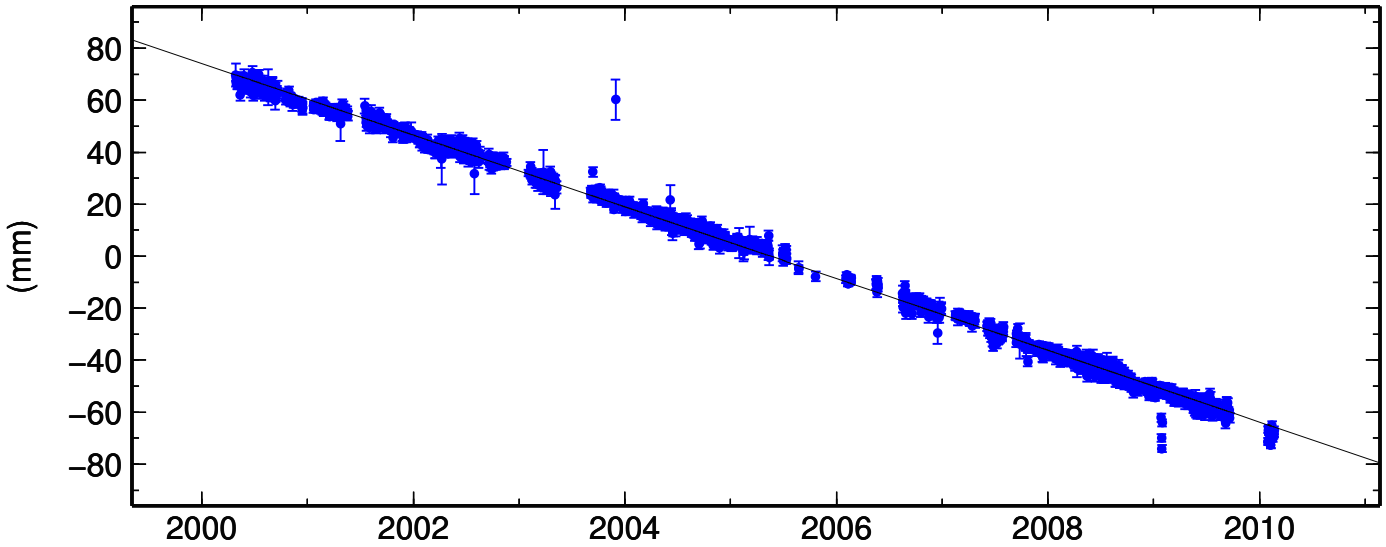
STLE North Offset 4017441.100 m

rate(mm/yr)= −0.97 ± 0.01 nrms= 1.21 wrms= 1.8 mm # 2367



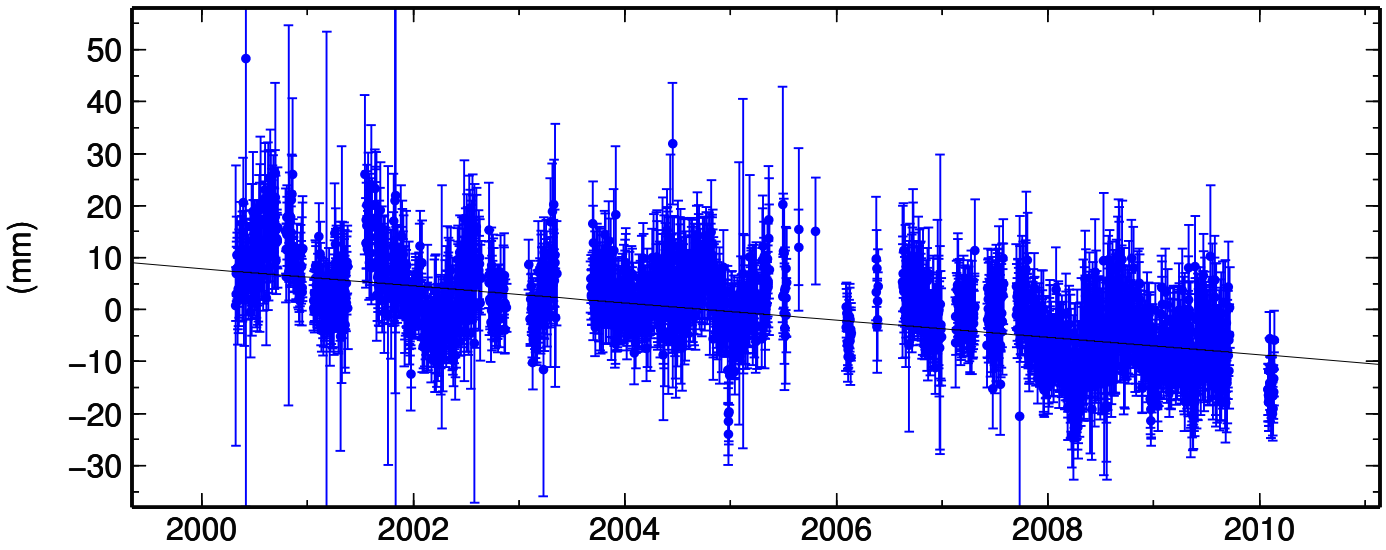
STLE East Offset 24300935.693 m

rate(mm/yr)= −13.79 ± 0.01 nrms= 1.22 wrms= 1.8 mm # 2363



STLE Up Offset 50.349 m

rate(mm/yr)= −1.65 ± 0.04 nrms= 0.93 wrms= 5.5 mm # 2373



Conclusions

After 10 years of continuous GPS data New Madrid Seismic Zone continues to display very little deformation. To look at the deformation across the reelfoot fault one has to wait for few more years to stock some more data from LCHS and NMKM stations along with newly resurrected RLAP and NWCC. Raw data, processed time series and velocities are promptly disseminated on the CERI GPS website. The website is http://www.ceri.memphis.edu/~gps.