Quarterly Report
Massachusetts Institute of Technology
GAGE Facility GPS Data Analysis Center Coordinator
And
GAGE Facility GAMIT/GLOBK Community Support

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Period: 2014/10/01-2014/12/31

Table of Contents

Summary

Under the GAGE Facility Data Analysis subcontract, MIT has been combining results from the New Mexico Tech (NMT) and Central Washington University (CWU). In this report, we show analyses of the data processing for the period 09/15/2014 to nominally 12/14/2014, time series velocity field analyses for the GAGE reprocessing analyses (1996-2014), earthquake effects during the interval (no detectable events this quater), position offsets from antenna changes, comparison between results from the previous quarter. Because the quarterly reports are due near the start of the month and the data used in the finals processing has an age between 2-3 weeks, early in the month the finals results the last two weeks of the previous month are not available. For this quarter the last finals results were for November 11, 2014. This end date is earlier than would be normal but cluster installation and failures at the NMT analysis center have delayed the submission of solutions. We have added an analysis of the sites with large position RMS and have tried to associate processes with the higher RMS values. We also added one new velocity map (Figure 14) that shows the motions between Yellowstone and Cascadia subduction zone. We call this region west-central United States.
Associated with the report are the ASCII text files that are linked into this document.

Under the GAGE Facility GAMIT/GLOBK Community Support we report on activities during this quarter.

GPS Analysis of Level 2a and 2b products

Level 2a products: Rapid products

Final and rapid level 2a products have been in general generated routinely during this quarter. The description of these products, the delivery schedule and the delivery list remain unchanged from the previous quarter and will not be reported here. The finals, 12-week and 26-week supplemental runs are late being delivered due to cluster failures at NMT.

Level 2a products: Final products

The final products are generated weekly and are based on the final IGS orbits. The description of these products, the delivery schedule and the delivery list remain unchanged from the previous quarter and will not be reported here. Data volumes being transferred also remains the same since the average number of sites is about the same. In this quarter 1871 sites were processed compared to 1888 for the previous quarter.

Level 2a products: 12-week, 26-week supplement products

Each week we also process the Supplemental (12-week latency) and six month supplemental (26-week latency) analyses from the ACs. The delivery schedule for these products is also unchanged. Again due to the NMT cluster problems, these solutions are 3-4 weeks behind that the moment.

Analysis of Final products: Sept 15, 2014 and Nov 22, 2014 (nominal Dec 13, 2014)

Each month, we submit reports of the statistics of the PBO combined analyses and estimates of the latest velocity fields in the NAM08 reference frame based on the time series analysis of data between 1996 and month preceding the report (we need to allow 2-3 weeks for the generation of the final products). For this report, we generated the statistics using the ~3 months of results generated between Sept 15, 2014 and Nov 22, 2014. These results are summarized in table 1 and figures 1-3.

For the three months of the final position time series generated by NMT, CWU and combination of the two (PBO), we fit linear trends and annual signals and compute the RMS scatters of the position residuals in north, east and up for each site in the analysis. Our first analysis of the distribution of these RMS scatters by analysis center and the combination. Table 1 shows the median (50%), 70% and 95% limits for the RMS scatters for PBO, NMT and CWU. The median horizontal RMS scatters are less than 1.1 mm for all centers and as low as 0.8 mm for NMT and PBO north component. The up RMS scatters are less than 4.4 mm and as low as 3.2 mm. These statistics are similar to last quarter. In the NAM08 frame realization, scale changes are not estimated. If scale changes were estimated, the up scatter would be reduced but the sum of scale change RMS and the lower height scatter would equal the values shown in Table 1. The detailed histograms of the RMS scatters are shown in Figures 1-3 for PBO, NMT and CWU.

Table 1: Statistics of the fits of 1871, 1870 and 1870 sites for PBO, NMT and CWU analyzed in the finals analysis between Sept 15, 2014 and Nov 22, 2014. Histograms of the RMS scatters are shown in Figure 1-3.

Center	North (mm)	East (mm)	Up (mm)
Median (50%)			
PBO	0.8	0.8	3.8
NMT	0.8	0.9	3.7
CWU	1.1	1.0	4.4
70%			
PBO	1.0	1.0	4.3
NMT	1.0	1.1	4.3
CWU	1.3	1.2	5.1
95%			
PBO	1.9	1.9	6.5
NMT	1.9	2.0	4.3
CWU	2.2	2.1	7.8

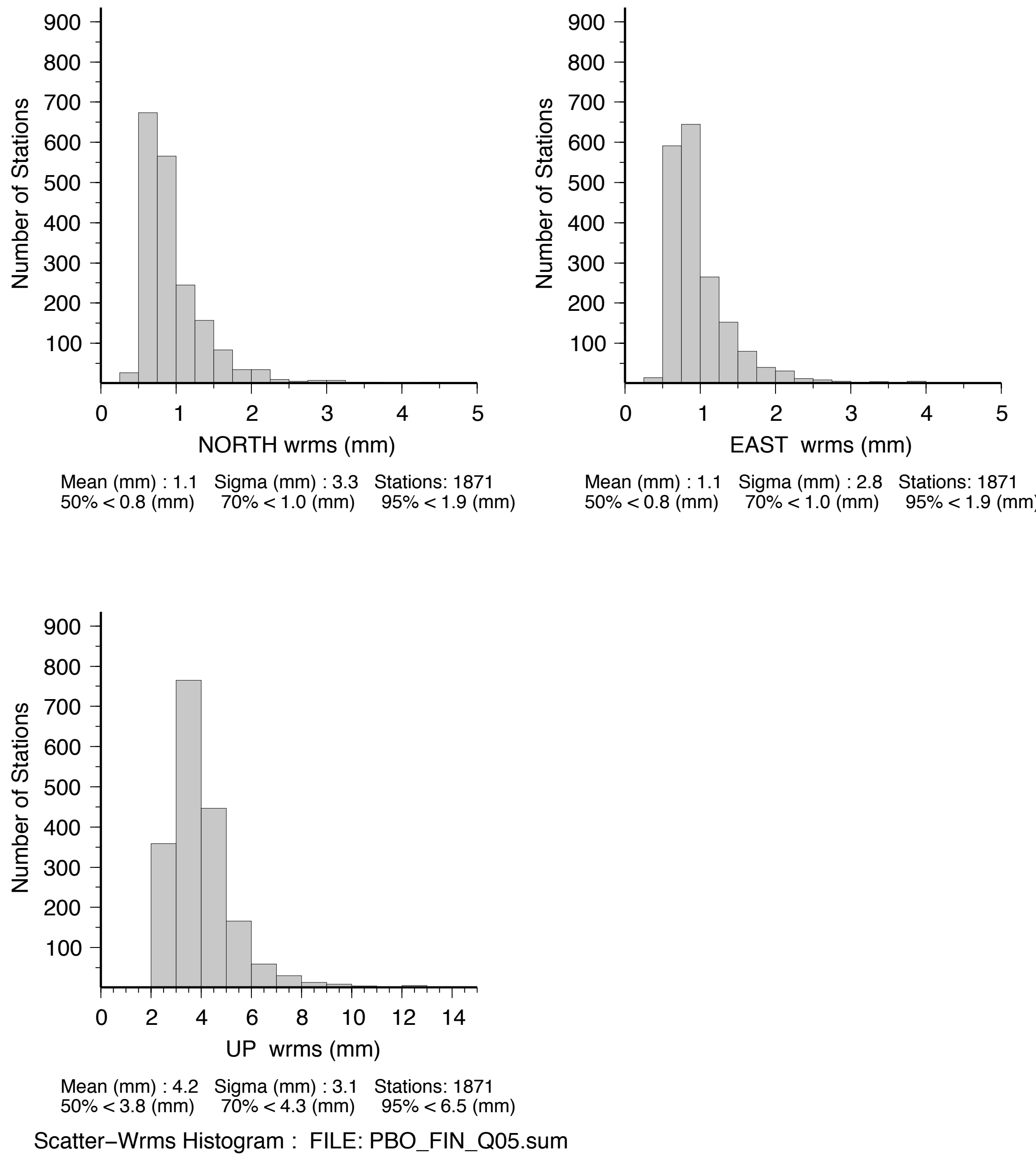

Figure 1: PBO combined solution histograms of the North, East and Up RMS scatters of the position residuals for 1888 sites analyzed between Sept 15, 2014 and Nov 22, 2014. Linear trends and annual signals were estimated from the time series.

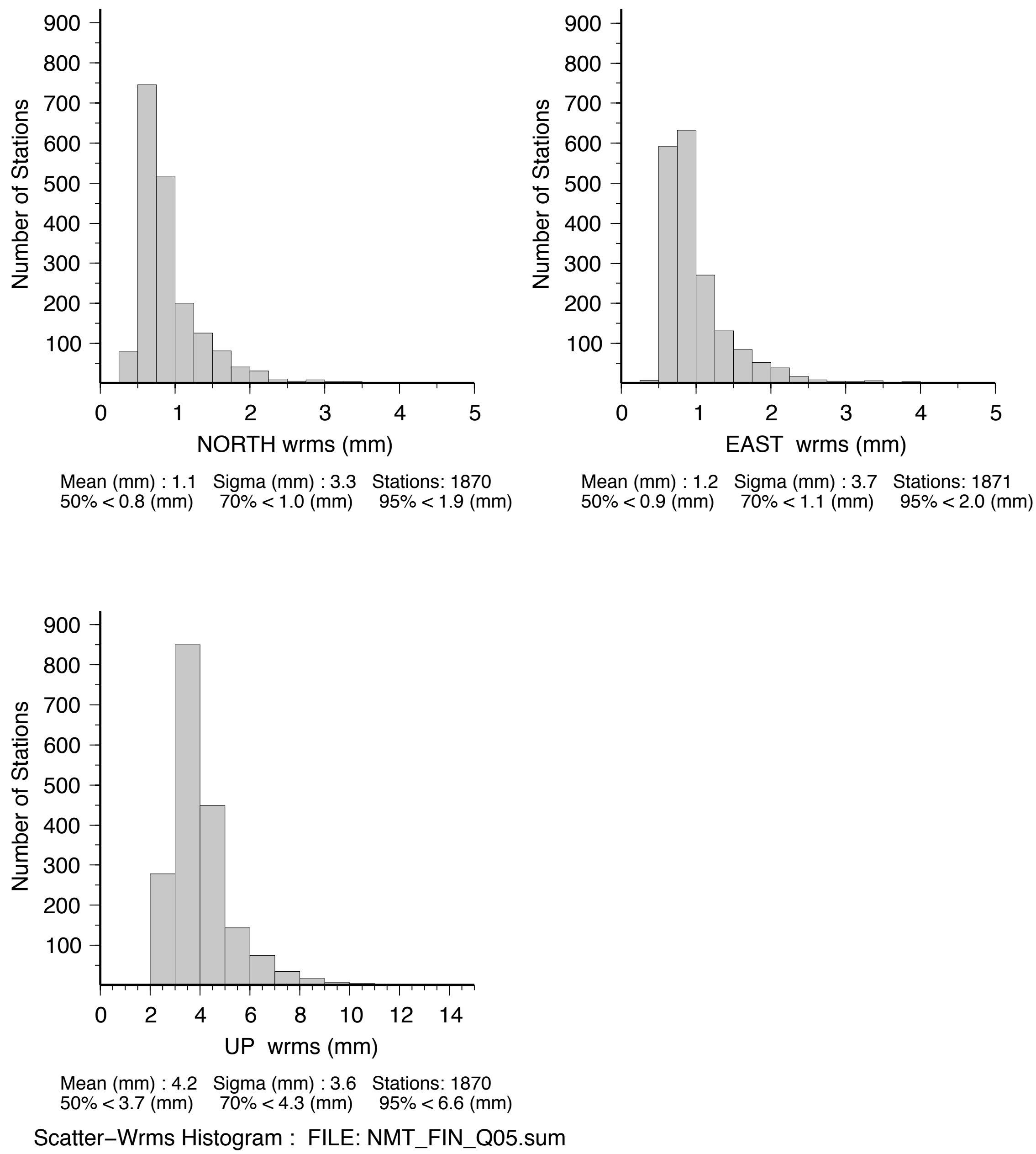

Figure 2: NMT combined solution histograms of the North, East and Up RMS scatters of the position residuals for 1887 sites analyzed between Sept 15, 2014 and Nov 22, 2014. Linear trends and annual signals were estimated from the time series.

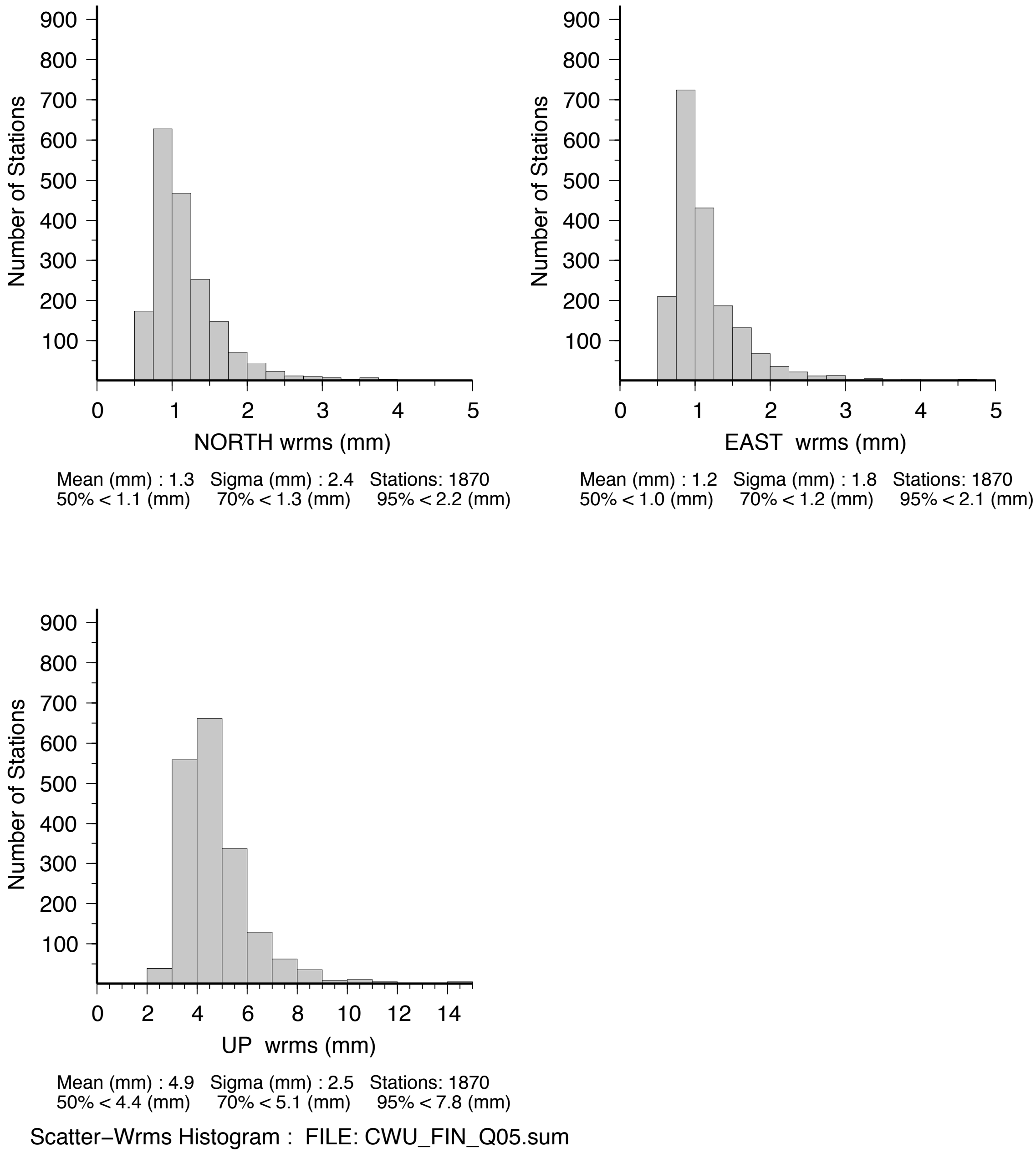

Figure 3: CWU combined solution histograms of the North, East and Up RMS scatters of the position residuals for 1885 sites analyzed between Sept 15, 2014 and Nov 22, 2014. Linear trends and annual signals were estimated from the time series.

For the PBO combined analysis, we also evaluate the RMS scatters of the position estimates by network type. The figures below are based on our monthly submissions but here we use nominally 3 months of data to evaluate the RMS scatters. In Table 2, we give the median, 70 and 95 percentile limits on the RMS scatters. The geographical distributions of the RMS scatters by network type are shown in Figures 4-9. The values plotted are given in PBO_FIN_Q05.tab. There are 1871 sites in the file. Only ~69 values are used here because of the missing last 3-weeks of results. The contents of the files is of this form:

```
Tabular Position RMS scatters created from PBO_FIN_Q05.sum
ChiN/E/U are square root of chisquared degree of freedom of the fits.
Values of ChiN/E/U near unity indicate that the estimated error
bars are consistent the scatter of the position estimates

.Site      #     N (mm)  ChiN      E (mm)  ChiE   U (mm)  ChiU      Years
 1LSU     69       0.9   0.57       1.1    0.68     3.5   0.54      11.58
 1NSU     69       0.8   0.47       0.7    0.43     3.1   0.46      10.85
 1ULM     69       0.7   0.45       0.7    0.44     3.3   0.55      11.44
 7ODM     69       0.8   0.43       0.8    0.50     3.1   0.45      13.59
 …
 ZLA1     68       1.4   0.63       1.2    0.64     4.6   0.55      11.47
 ZME1     68       0.9   0.44       0.8    0.40     4.6   0.57      11.70
 ZNY1     68       0.8   0.35       0.8    0.43     4.0   0.51      11.85
 ZSE1     68       1.2   0.48       0.9    0.46     4.5   0.55      11.85
 ZTL4     68       0.8   0.40       0.8    0.43     3.9   0.49      12.05
```

Table 2: RMS scatter of the position residuals for the PBO combined solution between Sept 15, 2014 and Nov 22, 2014 divided by network type. The division of networks is based on the JAVA script unavcoMetdata.jar with network codes PBO, Nucleus, Mid-SCIGN_USGS , America_GAMA, Expanded_PBO, COCONet and Expanded_PBO

Network	North (mm)	East (mm)	Up (mm)	#Sites
Median (50%)				
PBO	0.8	0.8	3.5	896
NUCLEUS	0.7	0.8	3.3	209
USGS SCIGN	0.8	0.9	3.4	108
Expanded	0.9	0.9	4.1	554
GAMA	0.6	0.8	3.8	12
COCO Net	1.4	1.6	6.3	92
70 %				
PBO	1.0	1.0	4.0	
NUCLEUS	0.9	0.9	3.7	
USGS SCIGN	1.0	1.1	3.8	
Expanded	1.1	1.1	4.6	
GAMA	0.6	0.9	4.2	
COCO Net	1.7	1.9	7.0	
95%				
PBO	1.8	1.7	5.8	
NUCLEUS	1.4	1.3	5.3	
USGS SCIGN	1.4	1.5	4.7	
Expanded	1.8	1.9	6.2	
GAMA	1.0	2.0	5.1	
COCO Net	2.8	3.1	9.5	

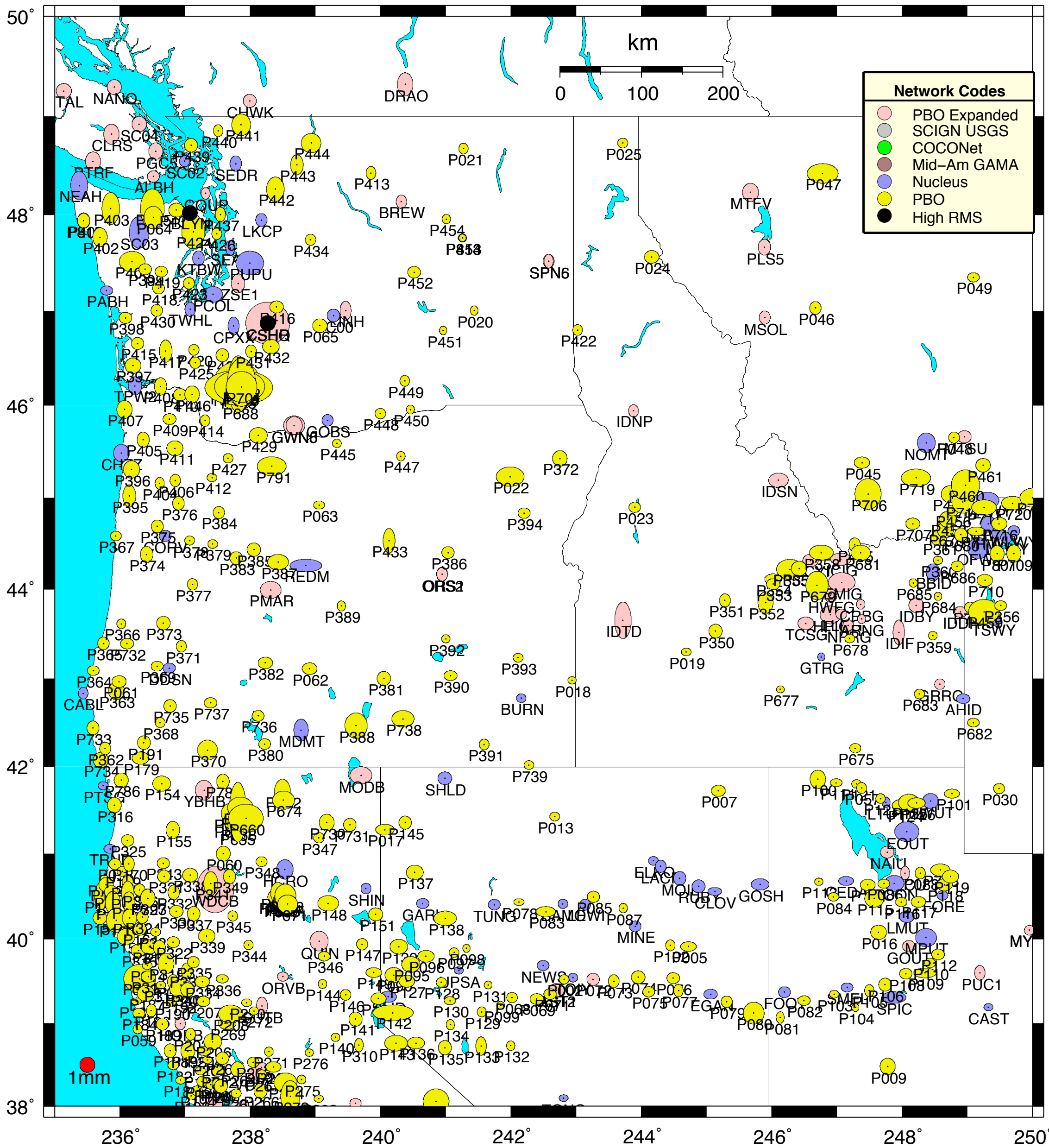

Figure 4: Distribution of the RMS scatters of horizontal position estimates from the PBO combined analysis for the Northern Western United States. The color of the ellipses that give the north and east RMS scatters denotes the network given by the legend in the figure. The small red circle shows the size of 1 mm scatters. Sites shown with black circles have combined RMS scatters in north and east greater than 5 mm or are sites that have no data during this 3-month interval.

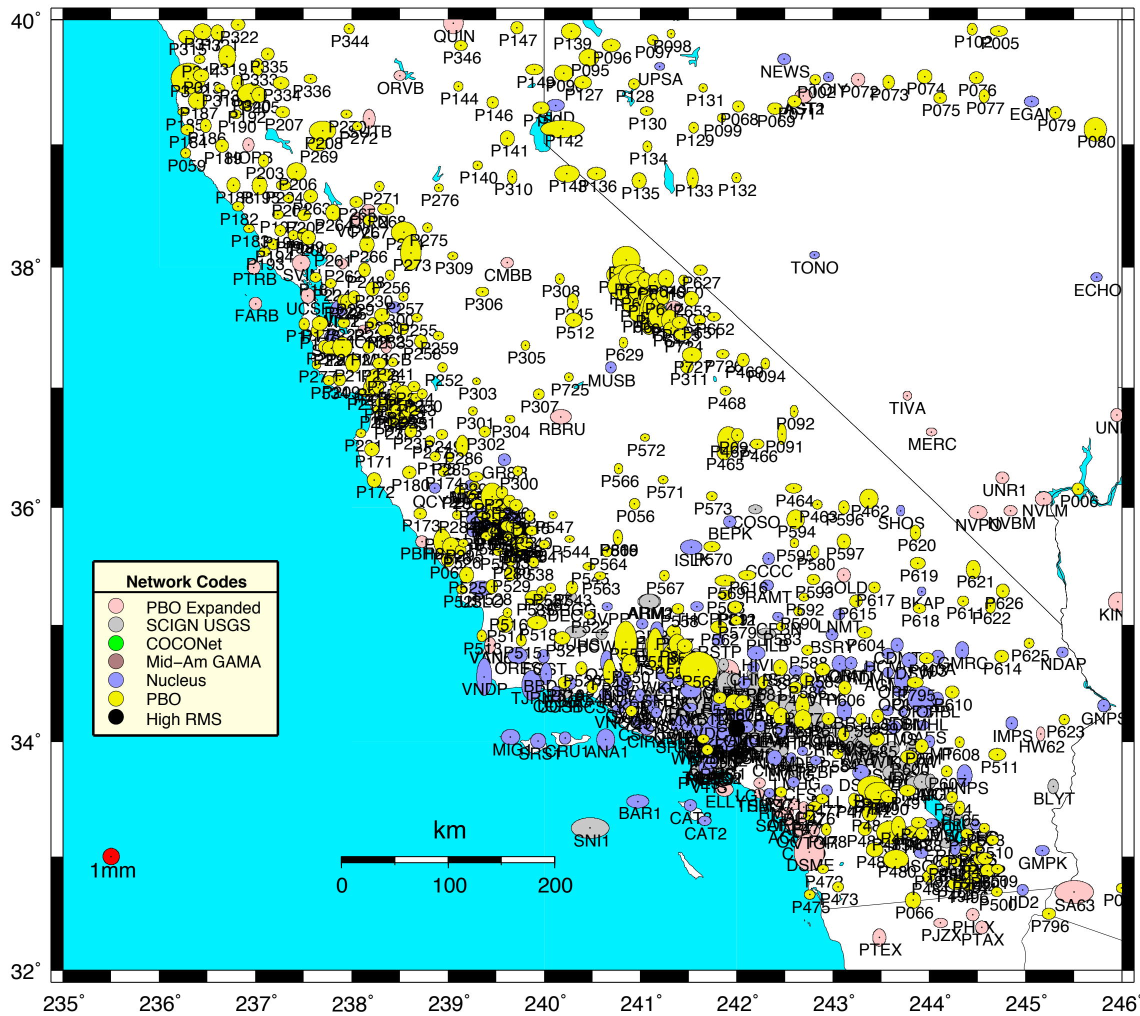

Figure 5: Same as Figure 4 except for the Southern Western United States. Black circles in the Yucca mountain region have no data during this 3-month period.

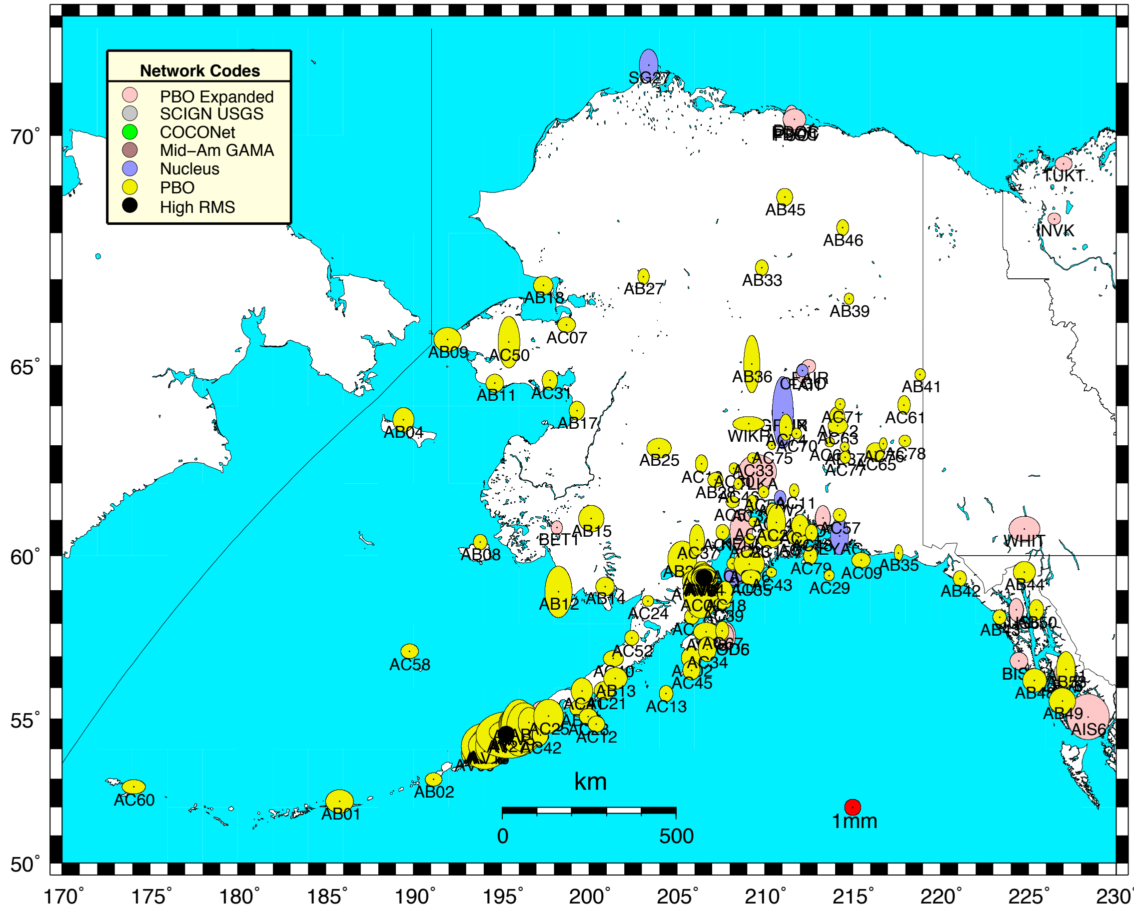

Figure 6: Same as Figure 4 except for the Alaskan region.

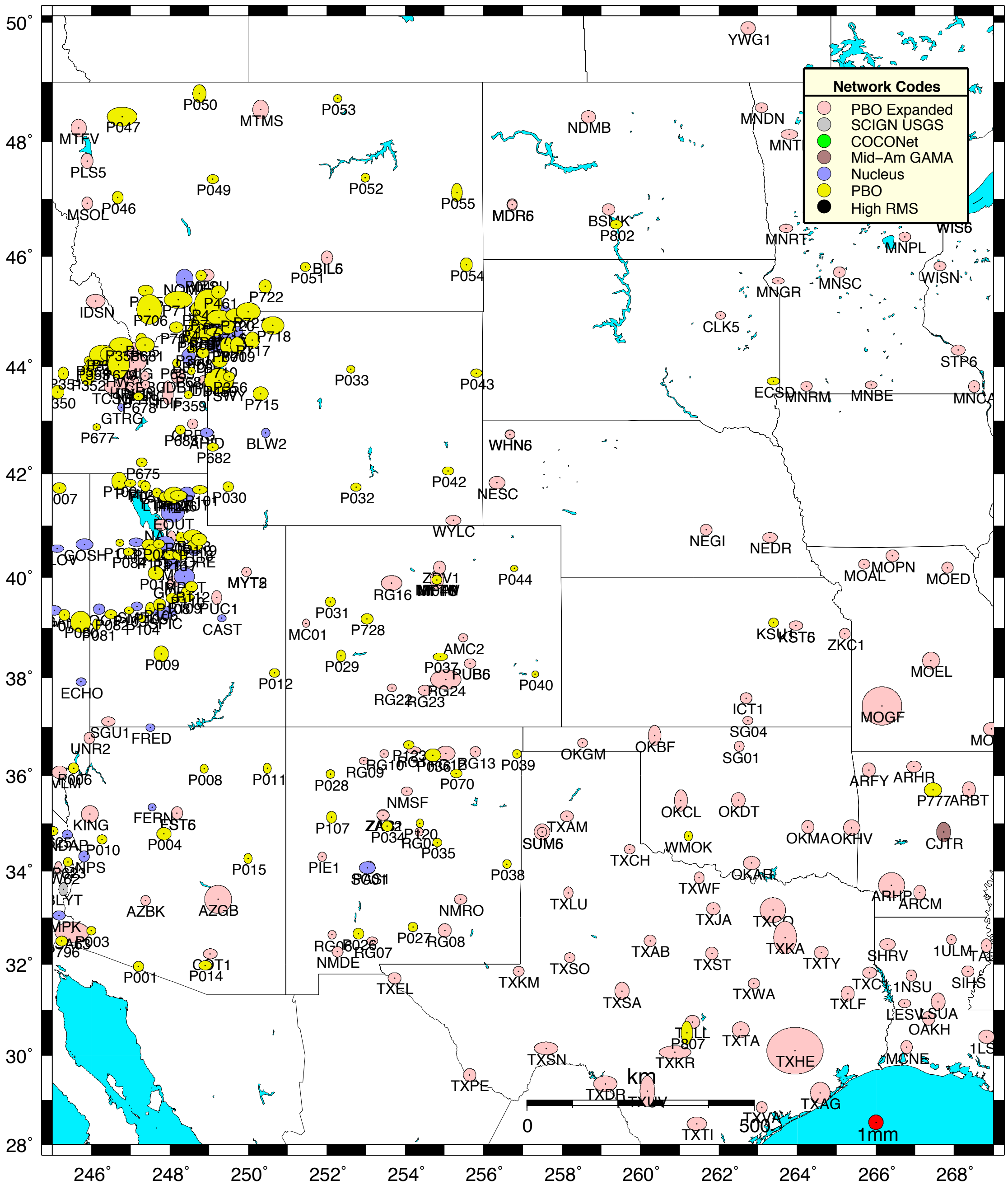

Figure 7: Same as Figure 4 except for the Central United States

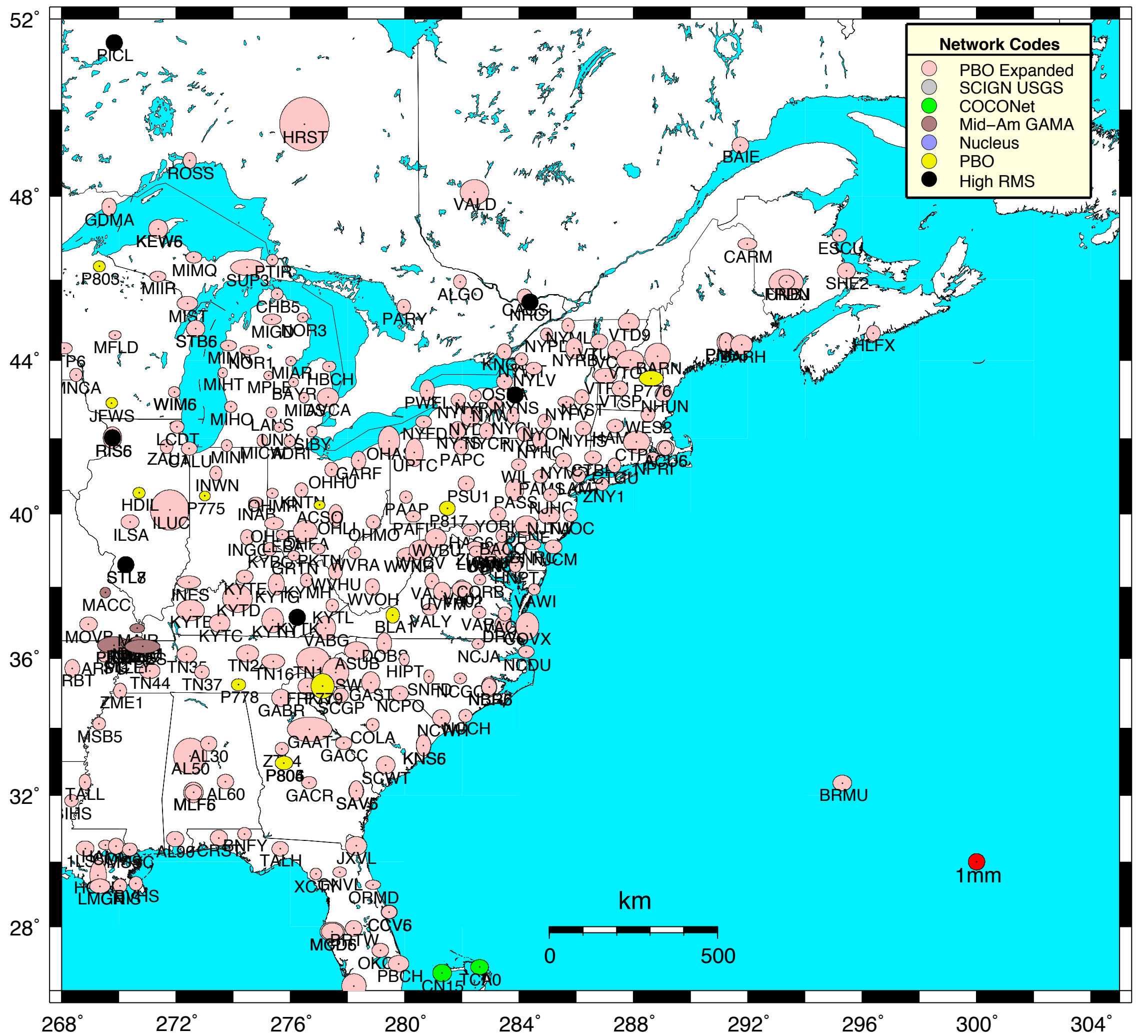

Figure 8: Same as Figure 4 except for the Eastern United States

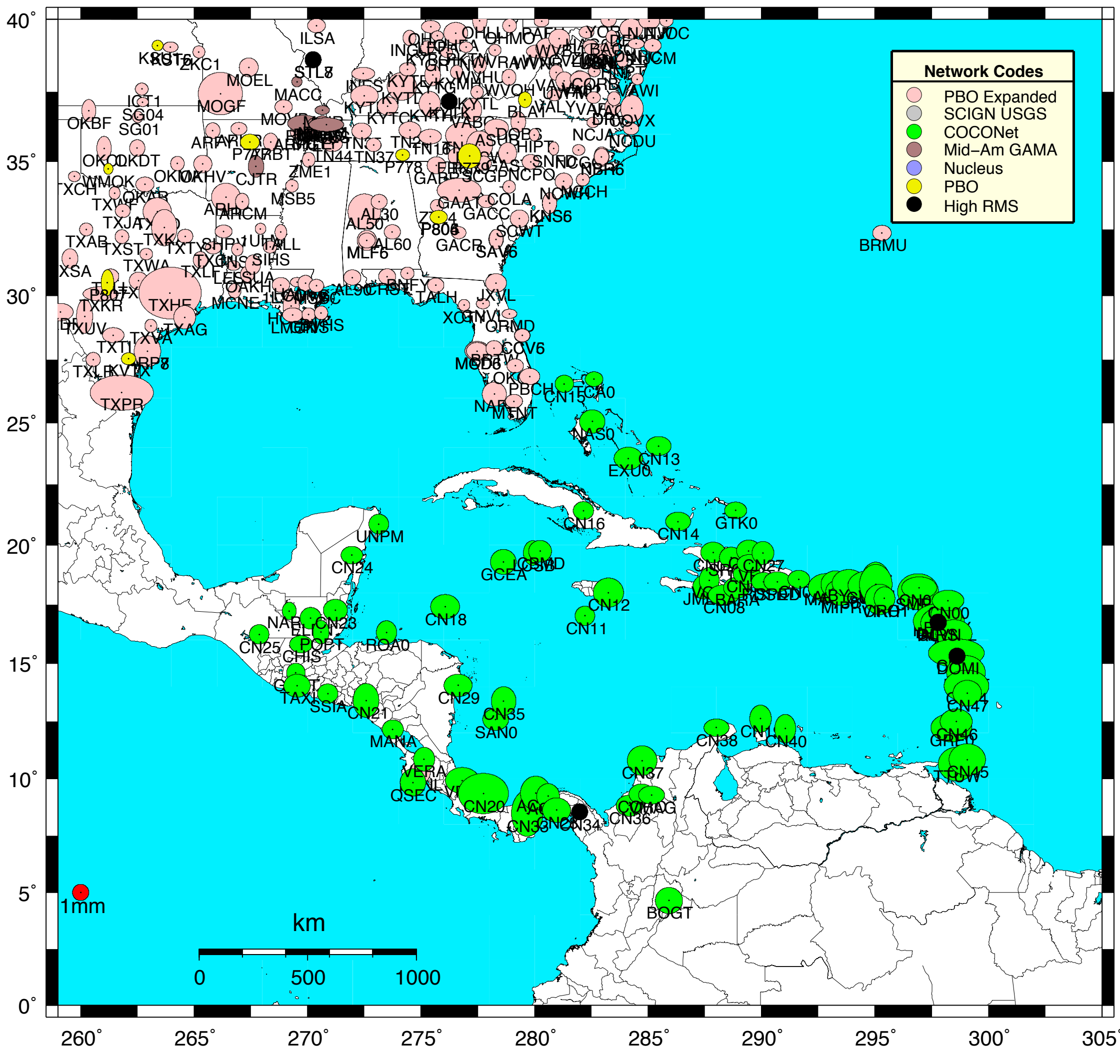

Figure 9: Same as Figure 4 except for the Caribbean region.

Analysis of large RMS sites

In Table 3 we give a summary of the qualitative description of the nature of the times series of all the sites with large RMS scatters (black circles shown in Figures 4-9). Snow is often the reason and falls into types: one class where the snow is systematic for a period of time with normal looking results in between and the other class where it is difficult to see any good data in the time series. For example P665 in in first category and P690 is in the second category. For some sites, it is not clear what is happening at the site.

Table 3: Description of time series characteristics of sites with high RMS scatter (black symbols on figures above)

Long (deg)	Lat (deg)	Site	Description
198.2537	58.9508	AB12	Snow with some periods of OK data

197.3865	66.8584	AB18	Strange long period systematics with excursions in 2008 and 20012 (10-15 mm in east)
209.2560	65.0304	AB36	Strange annual
227.1328	56.5848	AB53	Snow events and may be systematic between events.
215.4762	59.8685	AC09	Evolving Rate change 2012-2013
212.0004	60.8487	AC14	Snow events; NE look flat in between but height may have curvature
211.9068	60.5182	AC16	Snow events; but OK in between but height may have curvature as for AC14 (probably annual)
210.6475	60.9292	AC20	Long period N systematic
212.2608	59.8558	AC30	Little data 2007.7-2009.1 with large gap and snow systematic
209.3149	62.6712	AC33	Snow with flat in between (systematic snow).
209.2068	59.3758	AC35	Long period N and E systematic
207.3761	60.0815	AC47	Generally systematic; long lived snow.
179.3013	51.3781	AC66	Curvature offset 14/06/23
289.1134	41.7433	ACU6	Offset 06/12/21
297.7861	16.7408	AIRS	Multi-year variations
228.4008	55.0689	AIS6	Bi-modal data separated by ~5-10 mm NE, EQ like log 2012/10/28 N, 13/01/06 E offset
297.6595	82.4943	ALRT	Lots of variations, does not quite look like snow but maybe.
264.5149	29.3015	ANG1	Slow event ~22 mm N, 6 mm E between 2004/05/26-2004/06/14, offset near end
210.8677	61.5978	ATW2	Clear E offset from Denali Earthquake, 2002 11 3 22 12, but much larger decadal systematic
262.2437	30.3117	AUS5	Unknown break 2002 10 12
206.5553	59.3626	AV04	Bad snow but flat in between
206.5773	59.3629	AV05	Little data between 2004.6-2005 and 2005.6-2006.1, run off at end
194.1022	54.1531	AV13	Some snow intervals each year
206.5718	59.3474	AV20	Snow; bad winter 2008 and 2010
195.4195	54.5717	AV26	Heavily skewed in U and E
195.2768	54.4924	AV27	Maybe snow. Bad in 2009 winter, systematic 2014.
195.4139	54.4724	AV29	Lots of snow
195.6131	54.8467	AV35	Snow but more random in nature. Looks noisy between snow times.
196.2191	54.8315	AV38	Very skewed in N and U. Unknown break: 2011 6 15 6-7 mm in East.
196.0015	54.8113	AV39	Also skewed, systematic, gap 2010.8-2011.5,
300.3909	13.0880	BDOS	Multi-year trends; E 2007-2011 15 mm
223.5204	58.7829	BMCP	Snow most likely but noisy in nature
244.2703	33.3646	BOMG	Multiyear systematic; break 2011 8 18 (looks slow; EQ Postseismic?); offset at El Mayor Cucapah

			(10/04/04).
291.9863	46.8684	CARM	Un-modeled breaks
277.7437	9.3517	CN20	Noisy CWU processing; NMT seems OK.
281.9852	8.5489	CN34	Systematic with maybe a tree growing nearby.
240.3261	34.9426	CUHS	Strong loading signal with change around 2011.0
270.3565	35.5414	CVMS	Bad "antenna" 2013/03/18- 2014/02/26. Firm ware update on 2014/02/26; +8N,-12E offset.
298.6109	15.3062	DOMI	Noisy site. NMT missing at start of data.
250.6167	-27.1482	EISL	Noisy site
297.8057	16.7948	GERD	Slow slip 2006 and 2010.
242.6021	34.2039	GHRP	Some snow but slow slip in 2007-2007.5
249.4640	44.6136	HVWY	Multiyear systematic: Yellowstone.
240.9918	34.3985	KBRC	Even with bad antenna between 2002/12/04-2004/05/25 removed, still multiyear systematic.
208.6498	60.6751	KEN5	Strange multimodal positions in N and E.
208.6498	60.6748	KEN6	Similar behavior to KEN5 suggesting motions are real (on same USCG tower apparently).
267.9549	30.2214	KJUN	Maybe bad antenna between 2004/07/29-2005/01/25 but no log entries. Offset at end of data 2008/08/12,
207.8066	57.6177	KOD1	Strange deviations in 1999.1-1999.9.
207.8066	57.6177	KOD5	No overlap with KOD1 but has similar excursion 2012.1-2012.3 (but KOD6 only partially sees event). USCG site
276.2404	37.1515	KYTK	Systematic with bad antenna: 2013/08/12-2014/01/31; then offset
241.7967	33.7878	LBCH	Bad antenna 2000/01/03-2003/02/03 and replaced. Still multiyear systematic.
278.1928	28.8262	LEES	Un-modeled offset 2011/09/15.
249.5998	44.5651	LKWY	Yellowstone multiyear systematic changes
241.9966	34.1119	LONG	Probably a failing antenna starting Jan 2007. CWU having problems processing data.
285.4171	44.6197	LOZ1	Noisy with N U annual (removed late 2013).
247.7532	41.5921	LTUT	Bad antenna from start 2002/10/23-2008/04/18 large annual in all components
273.7510	12.1489	MANA	Large slow slip events in 2004/10 and 2012/08/27+2012/09/05 (fast EQ)
241.7559	33.9391	MHMS	Most likely bad antenna from 2000/01/12 to 2012/02/15 when it was replaced. ASH701945B_M during bad times.
254.7377	39.9954	NISU	Antenna offsets but no log (ends 2009.5).
243.9323	34.1410	OAES	Failed antenna. 1999/03/05-2007/09/11: Maybe some data until 2000/10/13.
249.1688	44.4511	OFW2	Long period systematic (Yellowstone)
297.7723	16.7504	OLVN	Skewed in E&U, slow type event in 2009.5

262.3462	16.1512	OXTU	Systematic; 2009.8; break 2012/04/23 (gap) ends early 2013.
239.2898	36.2568	P299	Strong ground water signal in all components.
239.7230	36.3044	P300	Very large multiyear deviations (creep on San Andreas?)
237.0366	39.8457	P323	Starts 2007.6 and fails 2008.0; ends 2008.1
244.2679	32.7597	P494	Washer on antenna until 2011/09/21 when removed (no log entry). Strange height systematic.
240.9996	37.6130	P630	Strong N seasonal with trend change mid-2011.
241.0841	37.6053	P631	Very skewed, strong seasonal all components, trend change 2011.8 dNv 11 mm/yr, dUv 13 mm/yr
241.1833	37.5914	P642	Similar to P631 but not soo skewed. Same rate changes.
241.1800	37.6770	P646	Large systematic in East and Up (+-10 mm deviations from linear)
237.8042	41.3448	P656	Large gaps and big snow in 2010, 2011.
238.4742	40.4561	P665	Snow events most years
238.5326	40.4658	P667	Snow events most years
237.8101	46.1800	P690	Snow events: Different in nature to P665 and P667 (more radon and longer % of year)
237.7977	46.2103	P693	Similar to P690 (these sites will be hard to edit)
237.8358	46.1990	P695	Similar to P690 but with long period rate change.
237.8234	46.1876	P697	Similar to P690 but less extreme; long term east variations.
237.7968	46.1898	P699	Similar to P690. Offset in east in mid 2006 (gap) already in All_PBO_unkn.eq file.
249.0664	43.7864	P708	Snow events most years but could be edited (similar to P665)
249.4885	44.7183	P716	Long-term curvature in NE from 2006-2014. Change in rate after gap.
237.8631	46.2446	P792	Gaps in time series with snow events; skewed in N. Maybe break in 2012-04 but hard to tell due gap in data.
269.8248	36.3703	PIGT	Strange bi-modal in 2000 (start until Apr 2001) and then systematic since then with possible rate change Apr 2009 (1 mm/yr N largest)
270.6546	36.4742	RLAP	Bad antenna 2005/10/06-2009/08/10 (replaced at end)
250.3118	31.3683	SA24	Strange seasonal signal plus broken antenna.
321.5405	72.5796	SMM1	Greenland Summit ice site. Trend change after 29 m antenna move 2013/07/09
270.8834	13.6971	SSIA	Data 2000/09/28-2010/07/18 has variable large offset; rate change in 2012 after large gap.
141.8448	43.5286	STK2	Earthquake looking offset 2003/09/25 with "log", unknown offset 2011/03/11 undocumented.

270.2411	38.6113	STL7	Noisy in NE; STL8 looks fine.
209.5797	62.3077	TLKA	Long term systematics and strange seasonal; possible break 2002/11/04 (not documented).
297.8367	16.7643	TRNT	Major slow slip events in 2007, 2010 (same as GERD)
227.0057	69.4382	TUKT	Lots of systematic strange seasonal signals; slow offset E 2013.
261.4357	28.4680	TXTI	Strange multiyear deviations in the North (10mm deviations from linear)
249.7133	44.6395	WLWY	Deviations associated with Yellowstone.

GLOBK Apriori coordinate file and earthquake files

As part of the quarterly analysis we run complete analysis of the time series files and generate position, velocity and other parameter estimates from these time series. These files can be directly used in the GLOBK analysis files sent with the GAGE analysis documentation. These links point to the current earthquake and discontinuity files used in the GAGE ACC analyses: All_PBO_eqs.eq All_PBO_ants.eq All_PBO_unkn.eq. The GLOBK apriori coordinate file All_PBO_nam08.apr is the current estimates based on data analysis in this quarterly report. In these files, comments have a non-blank character in the first column and text after a ! in lines is treated as a comment. The apriori file contains Cartesian XYZ positions and velocities in meters with the epoch of the position in decimal years (day of year divided by days in the specific year). The comments contain the standard deviations of the estimates and are not specifically used in GLOBK (yet). The GEOD lines give geodetic coordinates and not directly used (information only). The EXTENDED lines give the extended parts of the model parameters. Specifically, OFFSETS are NEU position and velocity offsets at the times of discontinuities. The velocity changes are all zero in the PBO analyses. The Type in the comment at the end of line indicates the type of offset. If a name is given then this is an antenna or unknown origin offset. For earthquakes, EQ is the type and two characters after is the code for the earthquake. If postseismic motion is model, then LOG or EXP EXTENDED lines will appear. The time constant of the function is given after the date (days) and the amplitudes in meters in NEU frame is given after that. The comment contains the standard deviations in mm. PERIODIC terms give the period (days) after the date and then cosine and sine terms in NEU. The comment contains the standard deviations. The GLOBK apriori coordinate file contains annual periodic terms but these are not used in the daily reference frame realization.
When interpreting the offsets in the apriori file, it is important to note that these are obtained for a simultaneous analysis of all data from a site. If the residuals to the fit are systematic, the offsets often will not be the same as an offset computed from analysis of shot spans of data on either side of the offset. We are considering adding such an analysis type in the future.

Snapshot velocity field analysis from the reprocessed PBO analysis.

In our monthly reports, we generate "snapshot" velocity fields in the NAM08 reference frame based on the time series analysis of all data processed to that time. For this quarterly report, we generate these velocity estimates for the reprocessed results and the current GAGE analyses that are in the NAM08 reference frame. There 2084 sites in the combined PBO solution, 10 more than last quarter, in the analyses and the statistics of the fits to results are shown in Table 4. In this analysis, offsets are estimated for antenna changes and earthquakes. Annual signals are estimated and for some earthquakes, logarithmic post-seismic signals are also estimated. The full tables of RMS fits along with the duration of the data used are given in the following linked files: pbo_nam08_141122.tab, nmt_nam08_14112.tab and cwu_nam08_141122.tab. The velocity estimates are shown by region and network type in Figures 10-16. The color scheme used is the same as Figures 4-9. The snapshot velocity field files are linked as: pbo_nam08_141122.snpvel, nmt_nam08_141122.snpvel and cwu_nam08_141122.snpvel.

Table 4: Statistics of the fits of 2084, 2081 and 2075 sites analyzed by PBO, NMT and CWU in the reprocessed analysis for data collected between Jan 1, 1996 and Nov 22, 2014.

Center	North (mm)	East (mm)	Up (mm)
Median (50%)			
PBO	1.1	1.3	4.7
NMT	1.1	1.3	4.5
CWU	1.4	1.4	5.5
70%			
PBO	1.5	1.6	5.3
NMT	1.5	1.6	5.3
CWU	1.7	1.7	6.3
95%			
PBO	3.3	3.1	8.6
NMT	3.3	3.2	8.2
CWU	3.5	3.3	10.1

Different tolerances are used for maximum standard deviation in each of the figures so that regions with small velocity vectors can be displayed at large scales without the plots being dominated by large error bar points. The standard deviations of the velocity estimated are computed using the GLOBK First-order-Gauss-Markov Extrapolation (FOGMEX) model which aims to account for temporal correlations in the time series residuals. This algorithm is also called the "Realistic Sigma" model.

A direct comparison of the NMT and CWU solutions shows the weighted root-mean-square (WRMS) difference between the two velocity fields is 0.10 mm/yr horizontal and 0.36 mm/yr vertical in direct difference of all sites with in 0.5 meters of each other (2092 comparisons). The χ^2/f of the difference is $(1.28)^2$ for the horizontal and $(1.16)^2$ vertical components. These comparisons are summarized in Table 5. As noted in previous reports, adding small minimum sigmas, computed such that χ^2/f is near unity changes the statistic slightly (Table 5). With the FOGMEX correlated noise model used to compute the velocity sigmas, the comparison statistics are close but still 30% optimistic over expectations. The 10-worst sites P583_GHT, SAV5_GPS, P476_GHT, MACC_GPS, P479_GHT, P486_GHT, P606_GHT, P599_GHT, JNPR_GPS, LST1_GPS. The GHT extension to the 4-character code indicates that these sites are affected by postseismic motion after the 1999 Hector Mine earthquake. The difference in velocity estimates arises from different treatments of the Hector Mine postseismic between the two analyses. The tsfit program has tolerances on the uncertainties on the postseismic log estimates that determine if the parameter is estimated or not. If the uncertainty is too large then it is assumed that there is not enough sensitivity to the parameter (due to the elapsed time from the earthquake to the first data at the site) and the log estimate is removed. For the _GHT sites above, the Hector mine postseismic was treated differently in the two analyses i.e., one case they were estimated and the other not estimated. The SAV5 site appears because there are multiple sites at this location that do not overlap in time. The difference occurs between the (non-overlapping in time) SAV5 and SAV1 sites. The MACC site has different durations of data between the CWU and NMT analyses. CWU has 4743 days of data compared to 531 for NMT. NMT has one estimate in 2005, which allows a velocity estimate with a relatively small uncertainty. JNPR is similar to MACC but in this case CWU has the fewer data. This site has also had errors in its meta data in the past. LST1 is a site used only a small number of times by NMT (92 days) and is close to 1LSU which is used in both the NMT and CWU analyses.

Table 5: Statistics of the differences between the CWU and NMT velocity solutions with no transformation between them. In these comparisons sites with the same names and within 0.5 meters of each other are included and the total number of comparisons is larger than the number of stations. The PBO, NMT and CWU solutions have 2081, 2074 and 2069 sites. WRMS is weighted-root-mean-scatter and NRMS is sqrt(χ^2/f) where f is the number of comparisons.

Solution	#	NE WRMS (mm/yr)	U WRMS (mm/yr)	NE NRMS	U NRMS
All	2092	0.10	0.36	1.28	1.16
Edited -10 worst	2079	0.09	0.36	1.18	1.12
Less than median (0.14 0.41 mm/yr)	1118	0.08	0.28	1.29	1.06
Added minimum sigma NE 0.06 U 0.20 mm/yr					
All	2092	0.14	0.47	1.01	0.96
Edited -10 worst	2079	0.13	0.45	0.90	0.91
Less than median (0.14 0.41 mm/yr)	1178	0.10	0.33	0.83	0.76

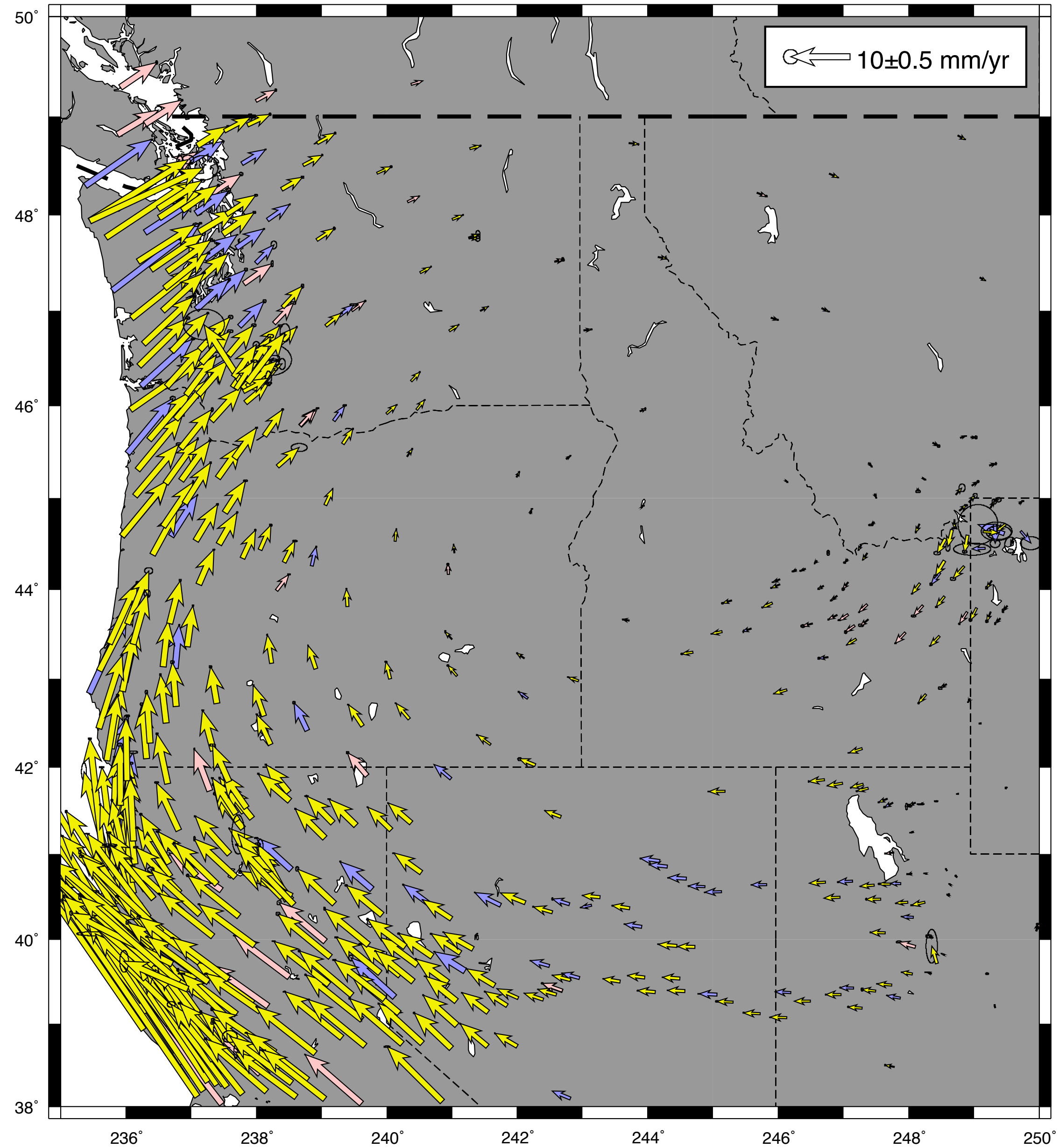

Figure 10: Velocity field estimates from the combined PBO solutions generated using time series analysis and the FOGMEX error model. 95% confidence interval error ellipses are shown. The color scheme of the vectors matches the network type legend in Figure 4. Only velocities with horizontal standard deviations less than 2 mm/yr are shown (this value is reduced from previous reports due the improved velocity sigmas).

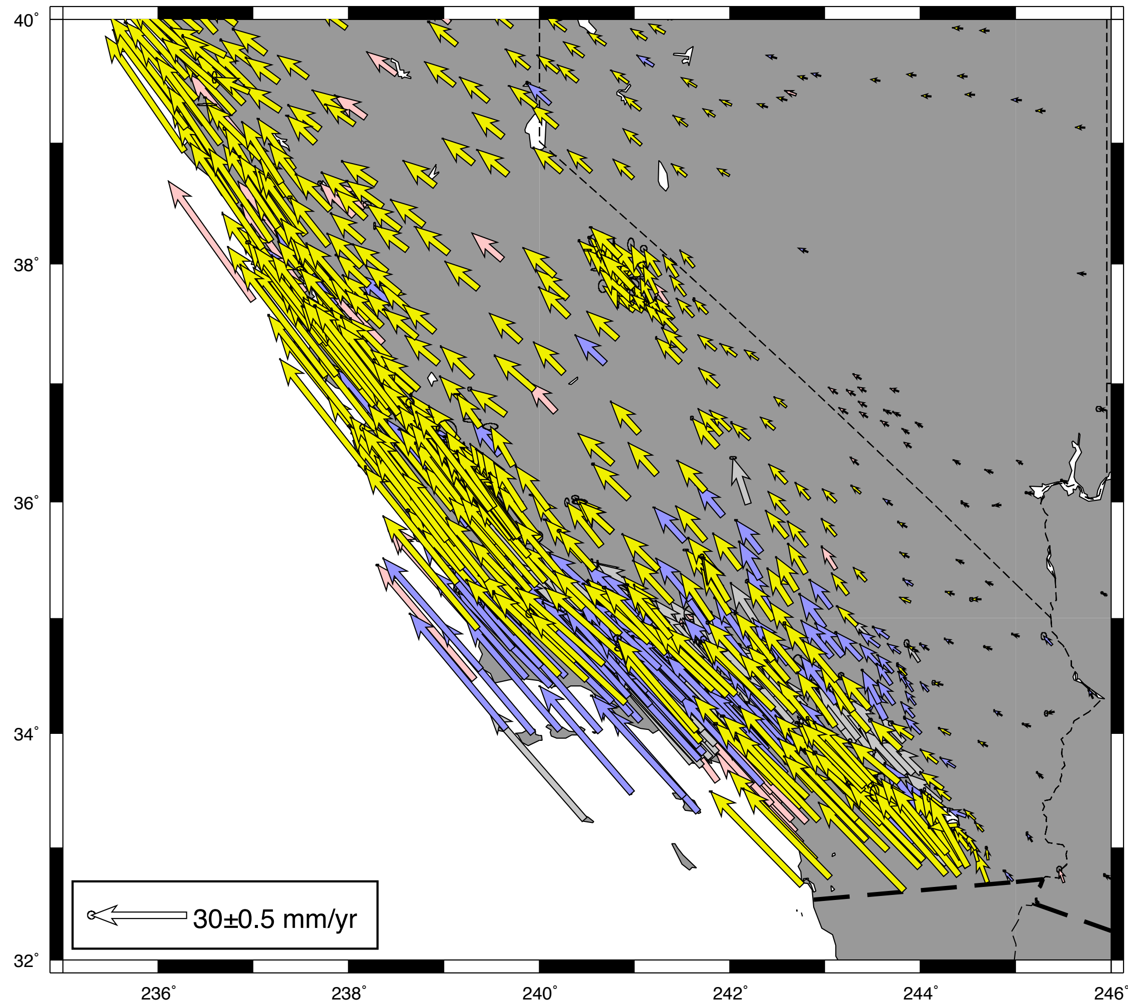

Figure 11: Same as Figure 10 except for South Western United States. Only velocities with horizontal standard deviations less than 2 mm/yr are shown. The anomalous site at latitude 34, longitude -117 is P613 and is effected by the estimation of post-seismic motion after the 2010 Apr 4 El Major Cucupah earthquake.

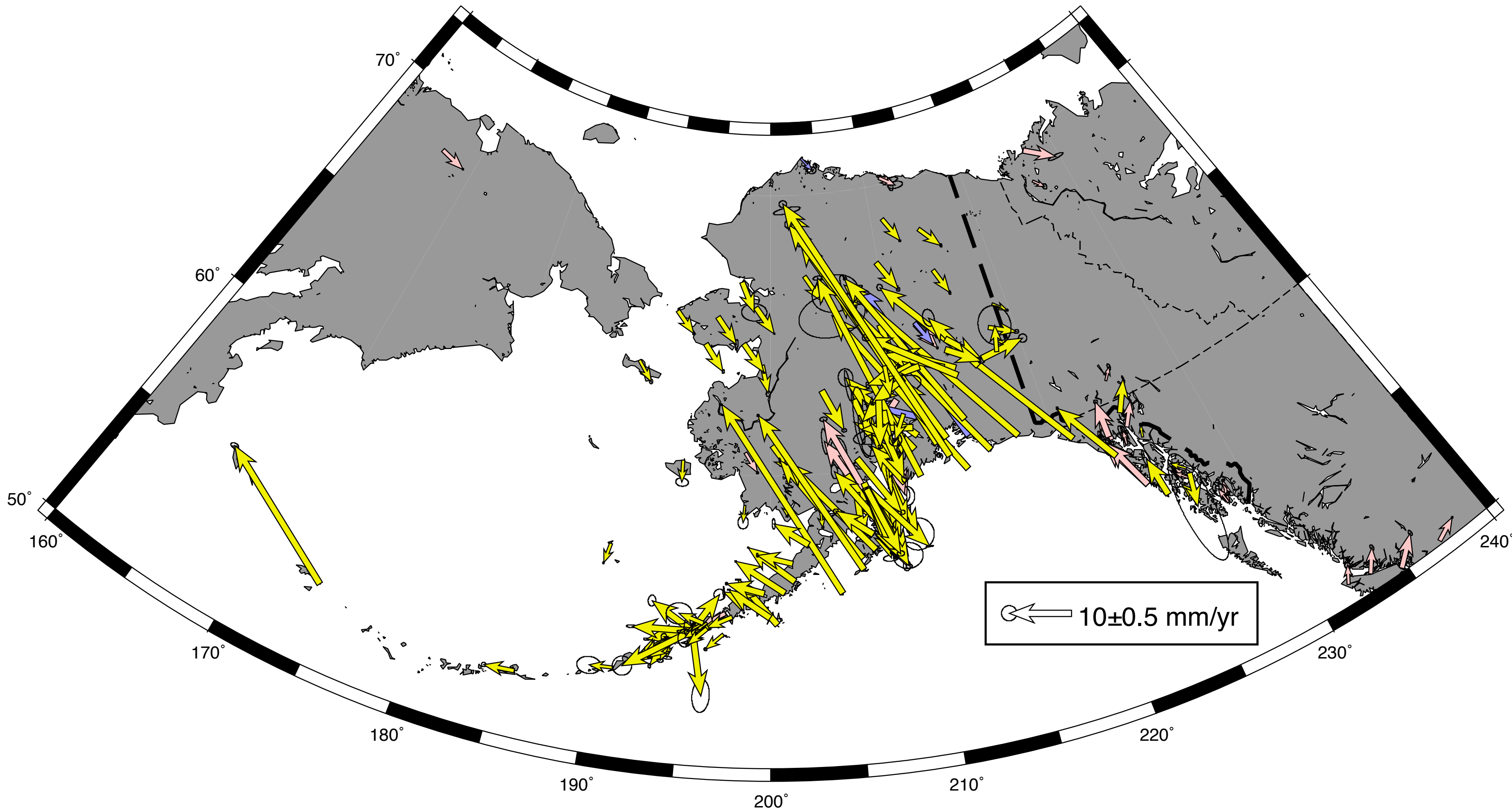

Figure 12: Same as Figure 10 except for Alaska. Only velocities with horizontal standard deviations less than 5 mm/yr are shown. The anomalous vector in Central Alaska is AC55 as the sites does move with anomalous motion. The site was discontinued in mid-2010.

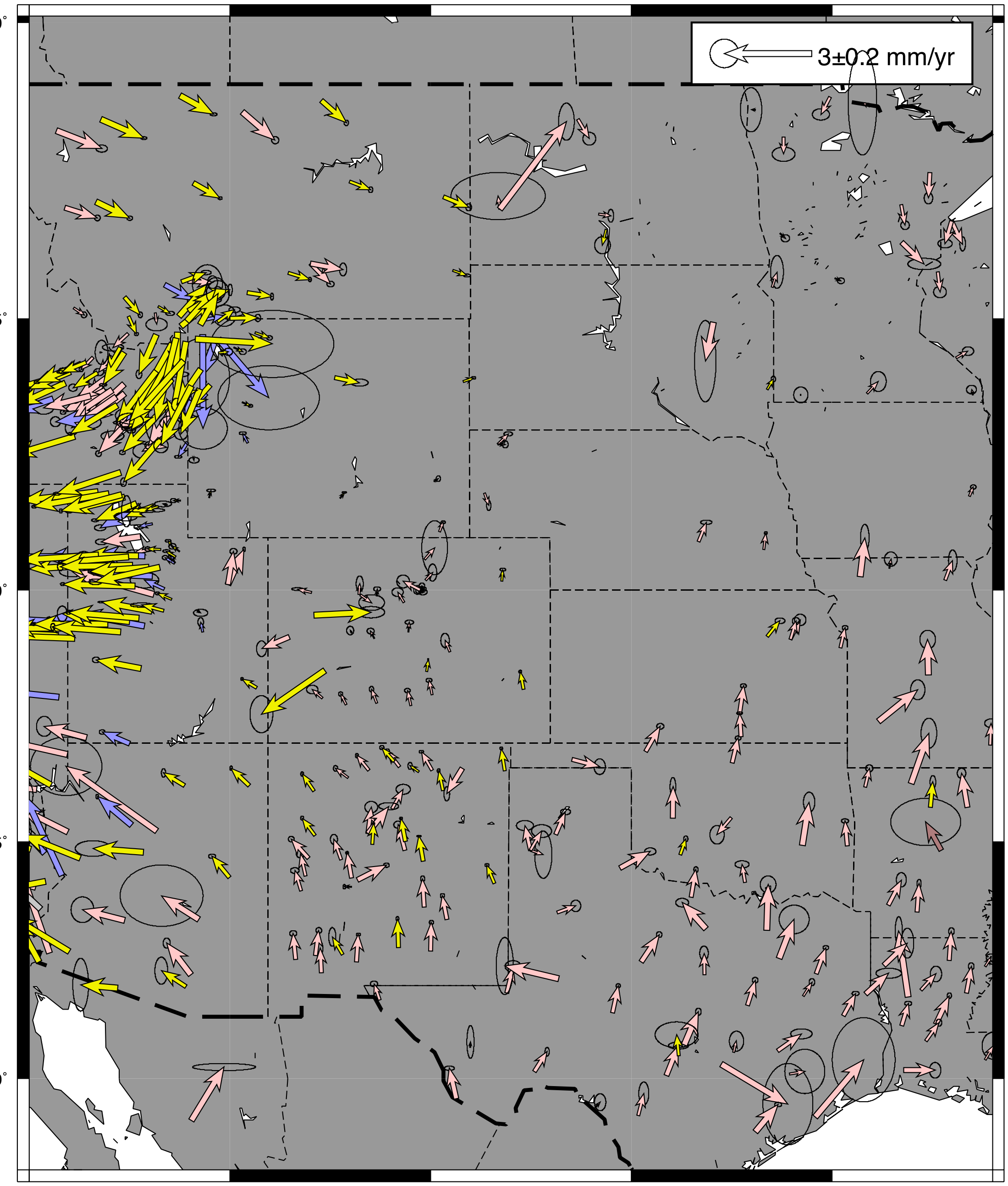

Figure 13: Same as Figure 10 except for Central United States. Only velocities with horizontal standard deviations less than 1 mm/yr are shown.

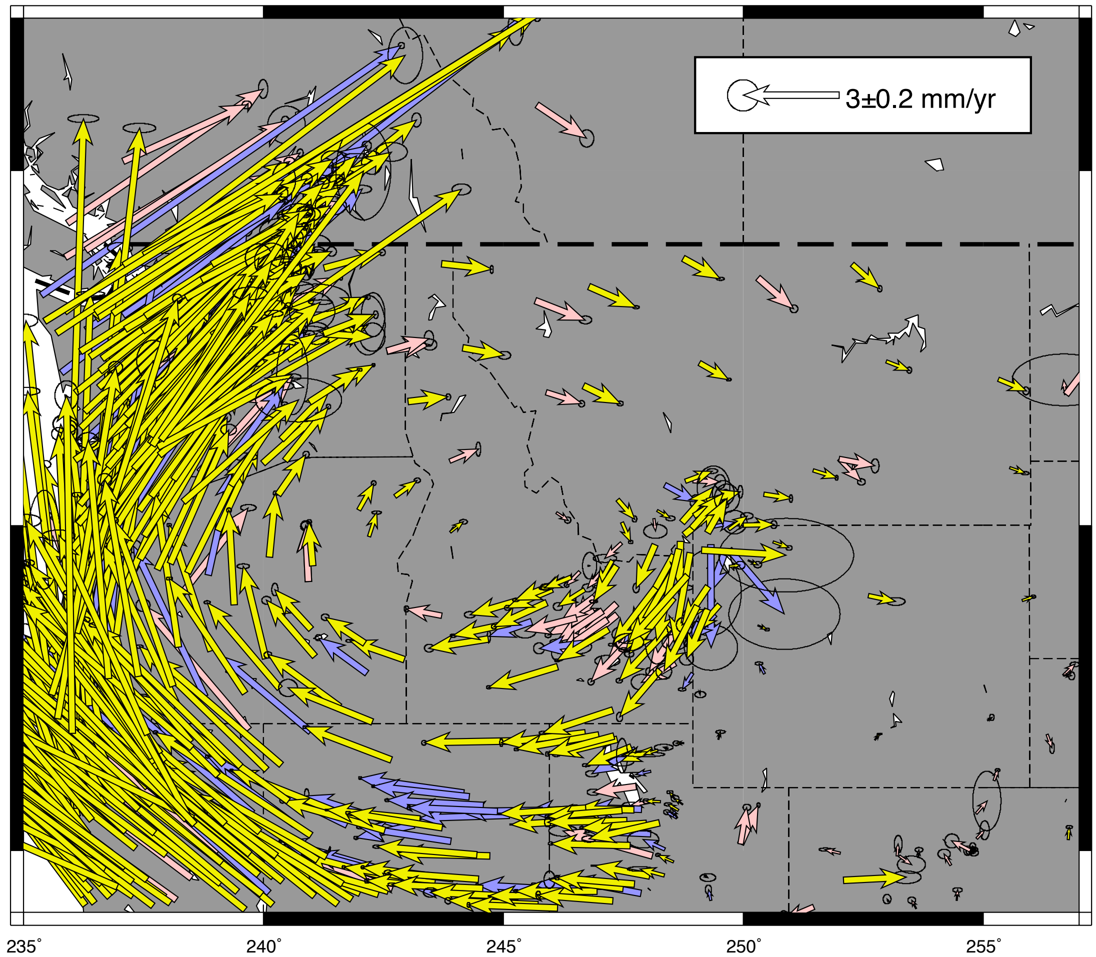

Figure 14: Same as Figure 10 except for Western Central United States. Only velocities with horizontal standard deviations less than 1 mm/yr are shown. Anomalous vectors at longitude 250^{o} are in the Yellowstone National Park and most likely are showing volcanic processes. The PBO sites P711 and P713 in Yellowstone show anomalous velocities.

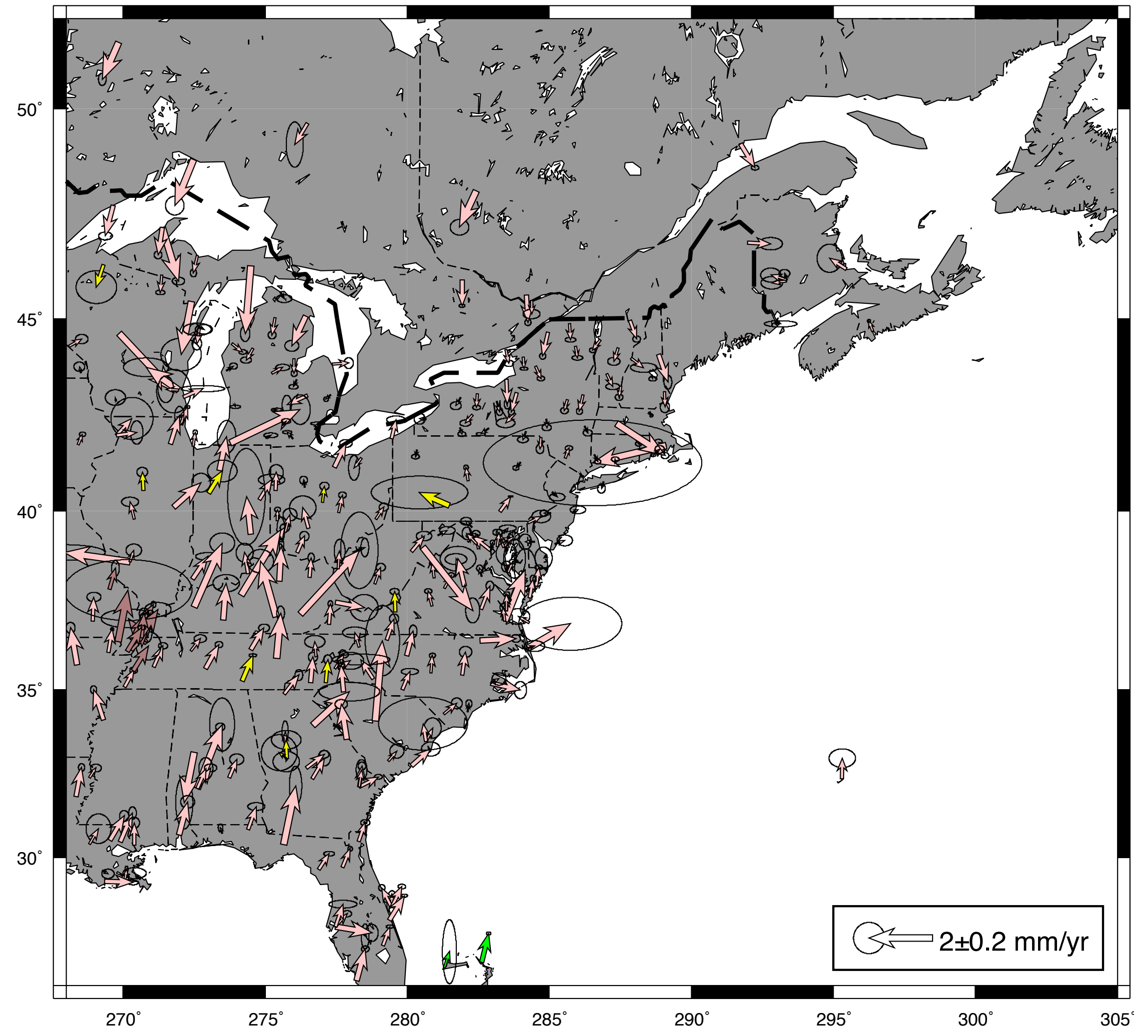

Figure 15: Same as Figure 10 except for the Eastern United States. Only velocities with horizontal standard deviations less than 2 mm/yr are shown. The systematic western velocity of sites in the Northeast is being investigated although profiles from Canada to the Gulf of Mexico indicate that horizontal glacial isostatic adjustment (GIA) horizontal signals may be seen in the velocity results. If this is the case, the North America Euler pole from ITRF2008 may be affected by these motions. The large vector is LST1 which has only a short span of data.

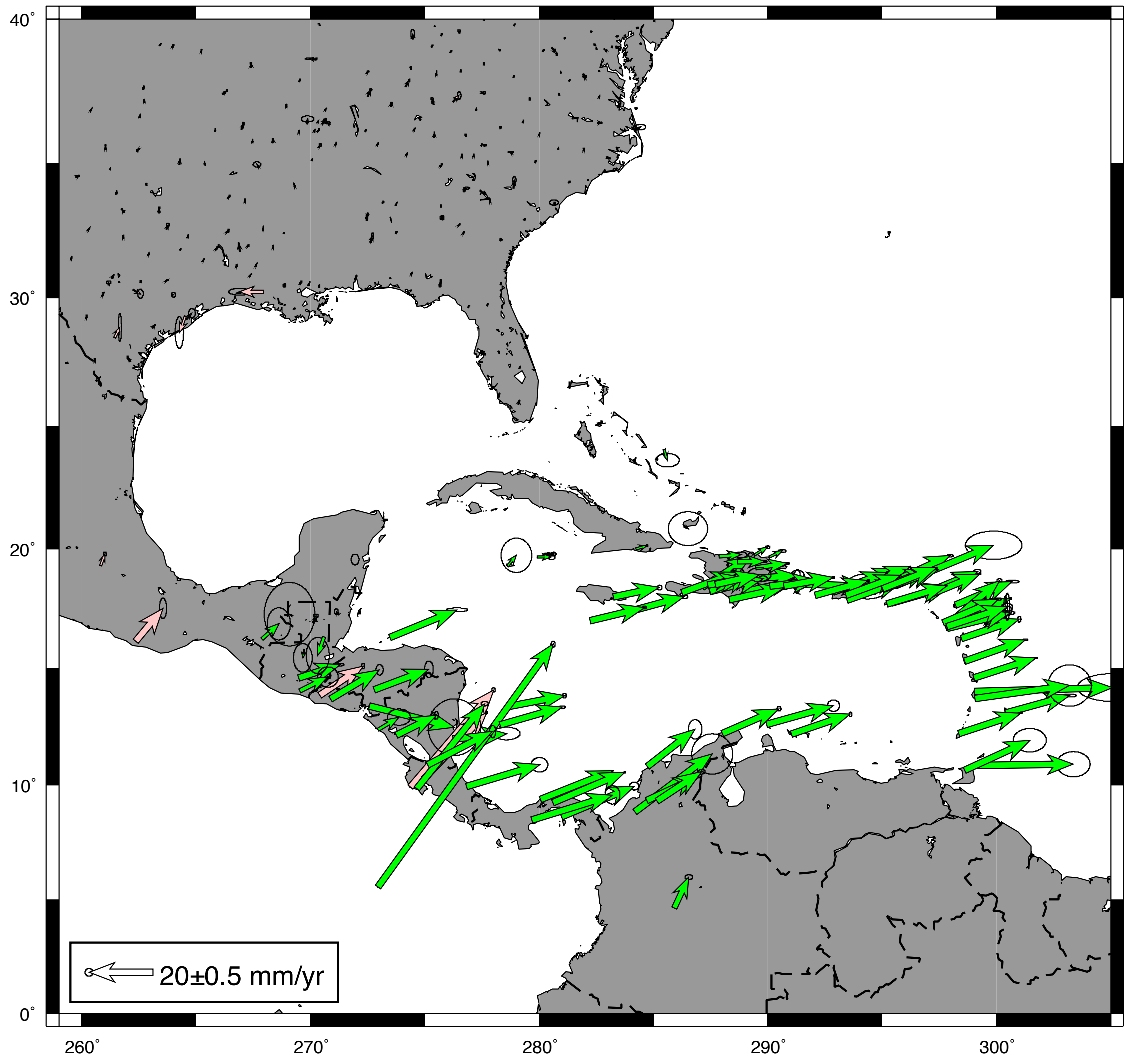

Figure 16: Same as Figure 10 except for the Caribbean region. Only velocities with horizontal standard deviations less than 5 mm/yr are shown (reduced from last quarter). The site in pink in Louisiana is LST1 which has a very span of data in 2006.

Earthquake Analyses: 2014/09/01-2014/11/30.

We use the NEIC catalog to search for earthquakes that could cause coseismic offsets at the sites analyzed by the GAGE analysis centers. We examined the following earthquakes. In these output, each earthquake that might have generated coseismic displacements is numbered and the "SEQ Earthquake # n" starts the block of information about the earthquake. The EQ MM lines, give site name, distance from hypocenter (km), maximum distance that could cause coseismic offsets > 1 mm, and the "CoS" (coseismic offset) value is the possible offset in the mm. The eq_def lines give the event number, latitude, longitude, radius of influence, and depth of event followed by the date and time of the event. If an event is found to be significant, the event number is modified to reflect the total number of events so far included in the PBO analyses. Large events are often given a two-character code to reflect their location (e.g., PA is Parkfield).

In September/October 2014 we investigated the following events.

```
The following earthquakes we examined to see if there were any co-seismic
offsets.
* EQDEFS for 2014 09 11 to 2014 10 14 Generated Mon Oct 20 09:34:07 EDT 2014
* Proximity based on Week_All.Pos file
* ------------------------------------
* SEQ Earthquake # 1
* EQ 147 AB01_GPS       1.52       9.30 CoS       27.6 mm
* EQ_DEF M3.9 1km NE of Atka
 eq_def 01   52.2083 -174.1839      9.3 8 2014 09 14 22 48    0.001
 eq_rename 01
 eq_coseis 01  0.001 0.001 0.001      0.001      0.001      0.001
* ------------------------------------
* SEQ Earthquake # 2
* EQ 432 AB28_GPS      54.82      61.90 CoS        5.2 mm
* EQ 432 AC46_GPS      15.88      61.90 CoS       61.4 mm
* EQ 432 AC51_GPS      49.75      61.90 CoS        6.3 mm
* EQ 432 AC55_GPS      49.00      61.90 CoS        6.5 mm
* EQ 432 AC80_GPS      50.07      61.90 CoS        6.2 mm
* EQ_DEF M6.2 98km WNW of Willow
 eq_def 02   61.9449 -151.8159     61.9 8 2014 09 25 17 52    0.242
 eq_rename 02
 eq_coseis 02  0.001 0.001 0.001      0.242      0.242      0.242
* ------------------------------------
* SEQ Earthquake # 3
* EQ 443 P631_GPS       7.87       8.70 CoS        0.0 mm
* EQ 443 P639_GPS       1.63       8.70 CoS        0.0 mm
* EQ 443 P642_GPS       7.51       8.70 CoS        0.0 mm
* EQ 443 P646_GPS       3.76       8.70 CoS        0.0 mm
* EQ_DEF M3.5 10km E of Mammoth Lakes
 eq_def 03   37.6533 -118.8517      8.7 8 2014 09 26 03 33    0.000
 eq_rename 03
 eq_coseis 03  0.001 0.001 0.001      0.000      0.000      0.000
* ------------------------------------
* SEQ Earthquake # 4
* EQ 445 P631_GPS       7.78       8.70 CoS        0.0 mm
* EQ 445 P639_GPS       1.69       8.70 CoS        0.0 mm
* EQ 445 P642_GPS       7.33       8.70 CoS        0.0 mm
* EQ 445 P646_GPS       3.86       8.70 CoS        0.0 mm
* EQ_DEF M3.5 9km E of Mammoth Lakes
 eq_def 04   37.6517 -118.8513      8.7 8 2014 09 26 04 22    0.000
 eq_rename 04
 eq_coseis 04  0.001 0.001 0.001      0.000      0.000      0.000
* ------------------------------------
* SEQ Earthquake # 5
* EQ 447 P631_GPS       7.18       8.70 CoS        0.0 mm
* EQ 447 P639_GPS       0.87       8.70 CoS        0.0 mm
* EQ 447 P642_GPS       7.71       8.70 CoS        0.0 mm
* EQ 447 P646_GPS       4.47       8.70 CoS        0.0 mm
* EQ_DEF M3.5 9km E of Mammoth Lakes
 eq_def 05   37.6518 -118.8608      8.7 8 2014 09 26 04 22    0.000
 eq_rename 05
 eq_coseis 05  0.001 0.001 0.001      0.000      0.000      0.000
* ------------------------------------
* SEQ Earthquake # 6
* EQ 828 P644_GPS       8.77       8.80 CoS        0.0 mm
* EQ_DEF M3.6 25km SE of Mammoth Lakes
 eq_def 06   37.4767 -118.7822      8.8 8 2014 10 13 00 14    0.000
 eq_rename 06
 eq_coseis 06  0.001 0.001 0.001      0.000      0.000      0.000
```

There are data around each of these events but none of the sites showed any discernible offsets at the times of these earthquakes.   No new earthquake events were added this month.

In October/Novemer 2014, the following events were investigated

```
The following earthquakes we examined to see if there were any co-seismic
offsets.
* SEQ Earthquake # 1
* EQ 99 P644_GPS       8.77      8.80 CoS        0.0 mm
* EQ_DEF M3.6 25km SE of Mammoth Lakes
 eq_def 01   37.4767 -118.7822      8.8 8 2014 10 13 00 14    0.000
 eq_rename 01
 eq_coseis 01  0.001 0.001 0.001      0.000      0.000      0.000
* ---------------------------------
* SEQ Earthquake # 2
* EQ 153 CN21_GPS     123.28     324.50 CoS       17.1 mm
* EQ 153 CN22_GPS     118.14     324.50 CoS       18.6 mm
* EQ 153 MANA_GPS     207.94     324.50 CoS        6.0 mm
* EQ 153 SNJE_GPS     219.11     324.50 CoS        5.4 mm
* EQ 153 SSIA_GPS     169.17     324.50 CoS        9.1 mm
* EQ 153 TAXI_GPS     304.41     324.50 CoS        2.8 mm
* EQ 153 TEG2_GPS     200.38     324.50 CoS        6.5 mm
* EQ_DEF M7.3 74km S of Intipuca
 eq_def 02   12.5263  -88.1231    324.5 8 2014 10 14 03 52    4.064
 eq_rename 02
 eq_coseis 02  0.001 0.001 0.001      4.064      4.064      4.064
* ---------------------------------
* SEQ Earthquake # 3
* EQ 338 P157_GPS       5.81      10.30 CoS        3.8 mm
* EQ_DEF M4.2 32km SW of Rio Dell
 eq_def 03   40.2673 -124.3727     10.3 8 2014 10 19 14 25    0.002
 eq_rename 03
 eq_coseis 03  0.001 0.001 0.001      0.002      0.002      0.002
* ---------------------------------
* SEQ Earthquake # 4
* EQ 824 P664_GPS       8.21       9.20 CoS        0.9 mm
* EQ 824 P665_GPS       7.39       9.20 CoS        1.2 mm
* EQ 824 P666_GPS       7.84       9.20 CoS        1.0 mm
* EQ 824 P667_GPS       7.30       9.20 CoS        1.2 mm
* EQ 824 P671_GPS       4.31       9.20 CoS        3.4 mm
* EQ_DEF M3.9 23km WNW of Chester
 eq_def 04   40.4007 -121.4792      9.2 8 2014 11 11 08 36    0.001
 eq_rename 04
 eq_coseis 04  0.001 0.001 0.001      0.001      0.001      0.001
```

Event number 2 above generates the largest possible displacements but the two nearest sites CN21 and CN22. At the time of the monthly report, neither of these two stations had results after the event. Data from CN21 has now been processed and show ~3mm offset at the time of event but shows a similar magnitude jump, with opposite sign, on 2014/09/29. When only the co-seismic offset is estimated along with a linear trend, the estimated co-seismic offset is <1mm. CN22 data is still not available and at this time we have decided not to include an earthquake event for this earthquake. The other sites with possible offsets did not show any significant offsets.

None of the other events showed any coseismic offsets and so no new events were added this month.

In November/December 2014, the following events were investigated but none show co-seismic offsets.

```
* EQDEFS for 2014 11 11 to 2014 12 15 Generated Mon Dec 22 14:25:01 EST 2014
* Proximity based on Week_All.Pos file
* ----------------------------------
* SEQ Earthquake # 1
* EQ 18 P664_GPS       8.21       9.20 CoS        0.9 mm
* EQ 18 P665_GPS       7.39       9.20 CoS        1.2 mm
* EQ 18 P666_GPS       7.84       9.20 CoS        1.0 mm
* EQ 18 P667_GPS       7.30       9.20 CoS        1.2 mm
* EQ 18 P671_GPS       4.31       9.20 CoS        3.4 mm
* EQ_DEF M3.9 23km WNW of Chester
 eq_def 01   40.4007 -121.4792      9.2 8 2014 11 11 08 36    0.001
 eq_rename 01
 eq_coseis 01  0.001 0.001 0.001      0.001      0.001      0.001
* ----------------------------------
* SEQ Earthquake # 2
* EQ 479 P234_GPS       7.93       8.90 CoS        0.0 mm
* EQ 479 P235_GPS       1.34       8.90 CoS        0.0 mm
* EQ 479 P238_GPS       8.20       8.90 CoS        0.0 mm
* EQ 479 P787_GPS       4.72       8.90 CoS        0.0 mm
* EQ 479 P788_GPS       8.35       8.90 CoS        0.0 mm
* EQ_DEF M3.6 4km S of San Juan Bautista
 eq_def 02   36.8077 -121.5303      8.9 8 2014 11 20 06 22    0.000
 eq_rename 02
 eq_coseis 02  0.001 0.001 0.001      0.000      0.000      0.000
* ----------------------------------
* SEQ Earthquake # 3
* EQ 480 P232_GPS       9.93      10.30 CoS        1.3 mm
* EQ 480 P233_GPS      10.21      10.30 CoS        1.2 mm
* EQ 480 P234_GPS       7.74      10.30 CoS        2.1 mm
* EQ 480 P235_GPS       1.13      10.30 CoS      100.7 mm
* EQ 480 P238_GPS       8.74      10.30 CoS        1.7 mm
* EQ 480 P787_GPS       4.18      10.30 CoS        7.3 mm
* EQ 480 P788_GPS       8.46      10.30 CoS        1.8 mm
* EQ_DEF M4.2 4km S of San Juan Bautista
 eq_def 03   36.8058 -121.5360     10.3 8 2014 11 20 06 27    0.002
 eq_rename 03
 eq_coseis 03  0.001 0.001 0.001      0.002      0.002      0.002
* ----------------------------------
* SEQ Earthquake # 4
* EQ 573 AC23_GPS       9.16       9.80 CoS        0.8 mm
* EQ_DEF M4.1 5km SSW of Soldotna
 eq_def 04   60.4490 -151.0377      9.8 8 2014 11 23 17 33    0.001
 eq_rename 04
 eq_coseis 04  0.001 0.001 0.001      0.001      0.001      0.001
* ----------------------------------
* SEQ Earthquake # 5
* EQ 751 AC33_GPS      11.83      13.70 CoS        3.2 mm
* EQ_DEF M4.8 50km NNW of Talkeetna
 eq_def 05   62.7236 -150.4850     13.7 8 2014 11 29 04 15    0.007
 eq_rename 05
 eq_coseis 05  0.001 0.001 0.001      0.007      0.007      0.007
* ----------------------------------
* SEQ Earthquake # 6
* EQ 892 MSCG_GPS       8.49       8.80 CoS        0.0 mm
* EQ 892 SGPS_GPS       8.06       8.80 CoS        0.0 mm
* EQ 892 WWMT_GPS       2.09       8.80 CoS        0.0 mm
* EQ_DEF M3.6 10km NW of Garnet
 eq_def 06   33.9632 -116.6347      8.8 8 2014 12 04 16 54    0.000
 eq_rename 06
 eq_coseis 06  0.001 0.001 0.001      0.000      0.000      0.000
* ----------------------------------
* SEQ Earthquake # 7
```

```
* EQ 921 P233_GPS       8.51       9.40 CoS        0.9 mm
* EQ 921 P235_GPS       3.23       9.40 CoS        6.1 mm
* EQ 921 P238_GPS       8.28       9.40 CoS        0.9 mm
* EQ 921 P787_GPS       5.86       9.40 CoS        1.9 mm
* EQ 921 P788_GPS       6.44       9.40 CoS        1.5 mm
* EQ_DEF M3.9 5km SSE of San Juan Bautista
 eq_def 07   36.7942 -121.5168      9.4 8 2014 12 06 02 17    0.001
 eq_rename 07
 eq_coseis 07  0.001 0.001 0.001      0.001      0.001      0.001
* ----------------------------------
* SEQ Earthquake # 8
* EQ 964 VLCN_GPS      91.03     110.60 CoS        5.2 mm
* EQ_DEF M6.6 20km ESE of Punta de Burica
 eq_def 08    7.9691  -82.6940    110.6 8 2014 12 08 08 55    0.675
 eq_rename 08
 eq_coseis 08  0.001 0.001 0.001      0.675      0.675      0.675
```

No significant offset were found for these events although their may be a height signal associated with event EQ_DEF M4.2 4km S of San Juan Bautista located at 36.8058 -121.5360 on 2014 11 20 06 27. P235 sits almost directly about the reported hypocenter. There is no data from VLCN after the earthquakes (or since 2013/08/24) so we can't tell if there is an offset.

Antenna Change Offsets: 2014/09/01-2014/11/30

The follow antenna changes were investigated and reported on in the MIT ACC monthly reports.

```
 Site      Date             From            To
KING   2014  9  9 22 30    TRM33429.20+GP TRM57971.00
NYHC   2014  9  4 14 16    LEIAT504       LEIAR10
NYON   2014  9  3 14 56    LEIAT504       LEIAR10
P171   2014  9 23 22  2    TRM29659.00    TRM59800.00
CN02   2014 10 14  0  0    SCIT Dome      NONE
NYBT   2014 10  7 19 30    LEIAT504       LEIAR10
NYFV   2014 10  1 14 30    LEIAT504       LEIAR10
NYWL   2014 10  7 15 51    LEIAT504       LEIAR10
P005   2014 10 31 23  4    TRM29659.00    TRM59800.80
P426   2014 10 14 20  6    TRM29659.00    TRM59800.80
P482   2014 10 10 20 47    TRM29659.00    TRM59800.80
P483   2014 10 10 18 11    TRM29659.00    TRM59800.00
P486   2014 10  9  0  0    TRM29659.00    TRM59800.80
P494   2014 10 11 16 54    TRM41249.00    TRM59800.80
P217   2014 11 25  0 22    TRM29659.00    TRM59800.80
P247   2014 11  5 23 58    TRM29659.00    TRM59800.80
P374   2014 11 12 13 52    TRM29659.00    TRM59800.80
VABG   2014 11 14 15  0    TRM41249.00    TRM57971.00
```

The analyses of the effects of these changes were reported in the monthly reports.
KING: There is a gap in the data of about 2-weeks at the time of the antenna change. The change in position was dN -4.01 +- 0.34, dE -4.96 +- 0.35 dU 15.20 +- 1.19 mm. There are some systematics that might bias these estimates.
NYHC: There are some outliers of up to 10cm in height as the ACs included this change in their analyses. Removing these outliers, results in a change in position of dN 5.39 +- 0.32, dE -1.97 +- 0.32, dU 14.50 +- 1.55 mm. The offsets appear significant.

NYON: Again there are some outliers in the finals as the Acs incorporated this change. After the change the offset are dN 0.19 +- 0.25, dE -0.82 +- 0.29, dU 2.10 +- 1.20 mm when an annual signal (5 mm amplitude in height) is estimated. These offsets are very small compared to the ones at NYHC for the same antenna type shifts
P171: The change in position here is dN 4.62 +- 0.28, dE 2.70 +- 0.21, dU 0.84 +- 0.84 mm. There are some short period (few month) systematics that could be effecting these estimates. The estimates are reduced to ~2 mm in N and 0.8 mm in E when only data around the break are used (2014-08-23 - 2104-10-17).
CN02: No apparent offset
NYBT: Large 7.70 +- 0.31 mm offset in North, Up 5.6 +- 1.5 mm, East offset is much smaller -0.33 +- 0.30 mm
NYFV: Large offsets but only a few days of somewhat lower quality data after the antenna change N 9.86 +- 1.34 mm E -3.59 +- 1.25 mm and U 46.42 +- 6.00 mm. The height offset does not look robust. Given the potential failure of the site after the change, these estimates are likely unreliable.
NYWL: Somewhat smaller offsets: N -3.14 +- 0.33 mm, E 2.18 +- 0.29 mm and U 7.81 +- 1.54 mm.
P005: Offsets N 1.72 +- 0.29 mm, E -1.46 +- 0.34 mm and U 5.47 +- 2.12 mm.
P426: Offsets N -0.72 +- 0.36 mm, E -0.80 +- 0.34 mm and U 5.06 +- 2.28 mm
P482: Offsets N -3.06 +- 0.24 mm, E 3.59 +- 0.25 mm and U -0.05 +- 1.34 mm
P483: Offsets N -3.97 +- 0.19 mm, E 6.87 +- 0.30 mm and U 0.42 +- 1.14 mm. The east offset here can be seen in the time-series, North is fairly clear as well.
P486: Offsets N 0.18 +- 0.23 mm, E 4.05 +- 0.28 mm and U -2.78 +- 1.56 mm. East offset is clear in the time-series.
P494: Offsets N -1.88 +- 0.20 mm, E 2.11 +- 0.24 mm and U 17.90 +- 1.16 mm. Height offset is clear in the time-series.

P217: is generating low quality position estimates after the antenna change suggesting the new antenna is not functioning correctly.
P247: shows offsets in NEU of 0.14 +- 0.27; -2.89 +- 0.24; 5.09 +- 0.91 mm. The height offset maybe smaller because of the ACs did not immediately up the antenna model.
P374: may have a small North offset of 1.44 +- 0.37 mm, EU offsets are -0.28 +- 0.31; 2.79 +- 1.17 mm
VABG has mostly a height offset. Offset estimates are NEU 1.29 +- 0.39, -0.93 +- 0.36. -8.66 +- 1.40 mm. The height offset is apparent in the timeseries. The magnitudes of the North East offsets depend on how the time-series is analyzed.

We have updated our metadata for the loss of the radome at CN02 to reflect this change but we have not added a discontinuity because within the noise level of the positions from this site, no offsets can be seen in the timeseries.

We have added the following unknown cause discontinuities and data edits to the PBO analyses. If there is no end date in time range, the change is ongoing. Site renames which end is _XPS are delete renames when more than one day of data are processed i.e., the data are not used in velocity solutions nor do they appear in the time series files. In some cases here these entries will record the failure time of an antenna that is later noted in the site logs to have changed.

Rename	Date Range	Explanation
# Added TAH Fri Oct 31 13:59:11 EDT 2014		
rename P259 P259_XPS	2007 03 15 00 00 2007 06 29 00 00	Broken radome that was replaced.
# Added TAH Tue Nov 18 11:19:24 EST 2014 These values have RealSigma NRMS > 99.999		
rename AC64 AC64_XPS	2006 06 14 00 00 2006 09 19 00 00	Broken antenna, replaced 2006 09 19.
rename ACU6 ACU6_APS	2002 11 03 00 00	Un-documented offset.
rename NOR1 NOR1_APS	2010 06 15 00 00	Un-documented offset (-14,-24,3 NEU mm)
rename OKMA OKMA_APS	2004 11 15 00 00	Change with receiver change (-57, 49,-4 NEU mm)
rename P699 P699_APS	2006 06 17 00 00	Lots of snow effects but this looks like offset (-60,-47,-13 NEU mm).
rename SA24 SA24_XPS	2012 04 23 00 00 2012 08 02 00 00	Broken antenna, replaced 2012 08 02
# Added TAH Tue Dec 23 14:02:18 EST 2014		
rename CARM CARM_APS	2010 8 27 0 0 2010 10 18 24 0	No Log changes
rename CARM CARM_BPS	2010 10 18 24 0	
# Added TAH 2014-12-29 12:40:34		
rename AUS5 AUS5_APS	2002 10 12 0 0	
rename AV38 AV38_APS	2011 6 15 0 0	Possible highly skewed in North and Up.
rename CVMS CVMS_XPS	2013 3 17 24 0 2014 2 26 0 0	Antenna goes bad;
rename CVMS CVMS_APS	2014 2 26 0 0	Offset when fixed, firmware update this day.
rename KBRC KBRC_XPS	2002 12 4 0 0 2004 5 25 0 0	Bad antenna; replaced 2004 5 25
rename KYTK KYTK_XPS	2013 8 12 0 0 2014 1 31 0 0	Look like bad anteanna and then offset
rename KYTK KYTK_APS	2014 1 31 0 0	Offset but not documented.
rename LBCH LBCH_XPS	2000 1 3 0 0 2003 2 3 0 0	Bad antenna and then replaced.
rename LEES LEES_APS	2011 9 15 0 0	Break; no log entry
rename LTUT LTUT_XPS	2002 10 22 0 0 2008 4 18 0 0	Bad antenna with large annual in all components.
rename NISU NISU_APS	2006 3 31 0 0 2006 4 20 0 0	Look like antenna changes but no log entry
rename NISU NISU_BPS	2006 4 20 0 0	As above

	2006 6 14 24 0	
rename NISU NISU_CPS	2006 6 14 24 0	As above
rename OAES OAES_XPS	2000 10 13 0 0 2007 9 11 0 0	Antenna bad for this whole interval
rename RLAP RLAP_XPS	2005 10 6 0 0 2009 8 10 0 0	Bad antenna (replaced at end)

Re-reprocessing

All of the reprocessing and missing SINEX files should now be at UNAVCO. We are continuing to monitor the files in our product area compared to those that are available in the UNAVCO ftp area.

Script updates

No major changes have been to the scripts. The monthly reporting script was changed to output the RMS scatter of all sites rather than just PBO and NUCLEUS sites.

We have added a new format conversion to tscon (the program that converts different Cartesian time series files available from JPL, UNR and USGS to PBO format) to allow the conversion of the NASA Measures program combined time series. The common files can then be compared in tsview and parameter fits made with tsfit. We have added a Kalman filter option to tsview (Matlab) and tsfit (Fortran) programs. The process noise models for the Kalman filter are based on the same algorithms to generate the radom walk process noise values used in globk. We are currently updating the GGMatlab web site with the new tsview executable programs for UNIX and MacOSX systems. All these programs are part of the GAMIT/GLOBK distributions or will soon be added to the incremental_updates directory.

GAMIT/GLOBK Community Support

During this quarter we continued the modifications to support GNSS observations other than GPS. The initial code will allow only one type of GNSS at a time to be processed with GAMIT, but the solution (h-) files from the GAMIT processing can be combined in GLOBK, thus allowing multiple-system contribut6ions to the estimation of site coordinates. We plan to complete the structural changes early in the next quarter and then work on system-specific models for the satellites' motion and yaw. During this quarter we added support for five receivers and six antennas, and continued to update our files containing precise a priori coordinates and discontinuities for over 1800 global continuous tracking stations, and global grid files for atmospheric loading and meteorological data.

There were no UNAVCO-sponsored data-analysis workshops during this period, we continue to spend 5-10 hours in email support of users.. During the quarter we issued 21 royalty-free licenses to educational and research institutions, including one to a US university departments (NCALM at the University of Houston).