



GAGE GNSS Products

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Abstract: The GAGE facility component of the Earthscope Consortium generates and distributes Global Navigation Satellite System (GNSS) data and products generated from the Network of the Americas (NOTA) and the Antarctica Network (ANET). In this poster, we review the types of GNSS products distributed by the GAGE facility and where to access these products. The time series products for both North America and Antarctica are generated on a range of time scales with latencies ranging from 24-hrs to 2-3 weeks for the highest quality solutions (most complete set of models used). Derived velocity field, earthquake coseismic and post-seismic estimates, discontinuities and stochastic noise models are generated monthly to annually depending on the type of analysis. The figure (lower right) shows the rate of change of heights at the North American sites from the latest full GAGE velocity solution released in February 2023. The full description of the methods used to generate GAGE GNSS products is given in Herring et al. [2016].

Herring, T.A., T. I. Melbourne, M. H. Murray, M. A. Floyd, W. M. Szeliga, R. W. King, D. A. Phillips, C. M. Puskas, M. Santillan, and L. Wang, (2016) Plate Boundary Observatory and Related Networks: GPS Data Analysis Methods and Geodetic Products, *Rev. Geophys.*, 54, doi:10.1002/2016RG000529. <http://onlinelibrary.wiley.com/doi/10.1002/2016RG000529/full>

Processing flow:

Central Washington University processes GPS data from of order 1900 stations in the North America region (NOTA) and up to 50 sites in Antarctica. For NOTA processing there are

- "rapid" orbit, 1-day latency;
- "final" orbit 2-3 week latency, higher order modeling used;
- 6-week and 12-week supplemental runs to added missed stations.

Velocity solutions: Monthly based on time series; Yearly based on full reference frame realization.

Offsets from antenna changes, earthquakes and unknown reasons: Monthly Earthquakes added as needed. Rapid, final processing based on 2-days before and after event; full Kalman filter time series processing monthly.

Post-seismic logarithmic function terms added as needed.

Product Access:

Derived Product directory at unavco.org. **Level 2** are time-series, velocities, offsets and events (earthquakes)

<https://www.unavco.org/data/gps-gnss/gps-gnss.html>

GPS/GNSS Data Products			Access Method / Product Format			
Data Product Level	Description	Generation Frequency	Creator	File Server	Web Graphical Interface	Web Service
Level 1	Standard rate data (15-sec)	Daily, varies	UNAVCO	RINEX	RINEX	n/a
	High rate data (1-, 2-, 5-sps)	Varies	UNAVCO	RINEX	RINEX	n/a
	Survey-mode (campaign) data	Daily, varies	UNAVCO	n/a	RINEX	n/a
Level 2	Position solution time series	Daily	MIT	ASCII.CSV	ASCII.CSV	ASCII.CSV
	Velocity solutions	Monthly	MIT	ASCII	ASCII	ASCII.CSV
	Position offsets (e.g. coseismic)	Varies	MIT	ASCII	n/a	n/a
	Events (e.g. coseismic)	Varies	MIT	ASCII	n/a	n/a
	Tropospheric parameter estimates	Daily	CWU	ASCII	n/a	n/a
	Position solution QA parameters	Daily, varies	UNR	ASCII	ASCII	n/a
	Position solutions (loose)	Daily	CWU	SINEX	SINEX	n/a
Position solutions (constrained)	Daily	MIT	SINEX	SINEX	n/a	

Position solution time series

<https://data.unavco.org/archive/gnss/products/position/>

Index of position
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[DIR]1NSU/ 2023-03-20 23:58 -
[DIR]1ULM/ 2023-03-20 23:58 -
...
[DIR]P162/ 2023-03-20 23:58 -

IGS14 and older NAM08 and IGS08 products are available as well. CSV files are simple ANEU values. URL can be generated to directly download files with wget or curl: https://data.unavco.org/archive/gnss/products/position/P162/P162.cwu.final_nam14.pos
New token-based access will soon be necessary to access products. <https://gitlab.com/earthscope/public/earthscope-cli/blob/main/README.md>

Index of P162
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[TXT]P162.cwu.rapid_nam14.pos 2023-03-20 22:58 6.0K Station position time series column delimited ASCII file
[TXT]P162.cwu.final_nam14.pos 2023-03-19 00:49 1.6M Station position time series column delimited ASCII file

Velocity solutions:

<https://data.unavco.org/archive/gnss/products/velocity/> (Add ?C=M;O=D to sort by date)

Index of velocity
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[TXT]cwu.snaps_nam14.txt 2023-03-17 13:11 9.0K Plain text file
[TXT]cwu.snaps_igs14.vel 2023-03-17 13:11 879K GAGE Network velocity column delimited ASCII file
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Index of rel_20221224
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[]All_PBO.rw 2023-02-03 21:07 211K
[]All_PBO.stab 2023-02-03 21:07 34K
[]All_PBO_ants.eq 2023-02-03 21:07 494K
[]All_PBO_edits.eq 2023-02-03 21:07 6.8M
[]All_PBO_eqs.eq 2023-02-03 21:07 168K
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[TXT]cwu.final_igs14.20221224.vel 2023-02-03 20:05 1.9M GAGE Network velocity column delimited ASCII file
[TXT]cwu.final_nam14.20221224.vel 2023-02-03 19:56 1.9M GAGE Network velocity column delimited ASCII file
..

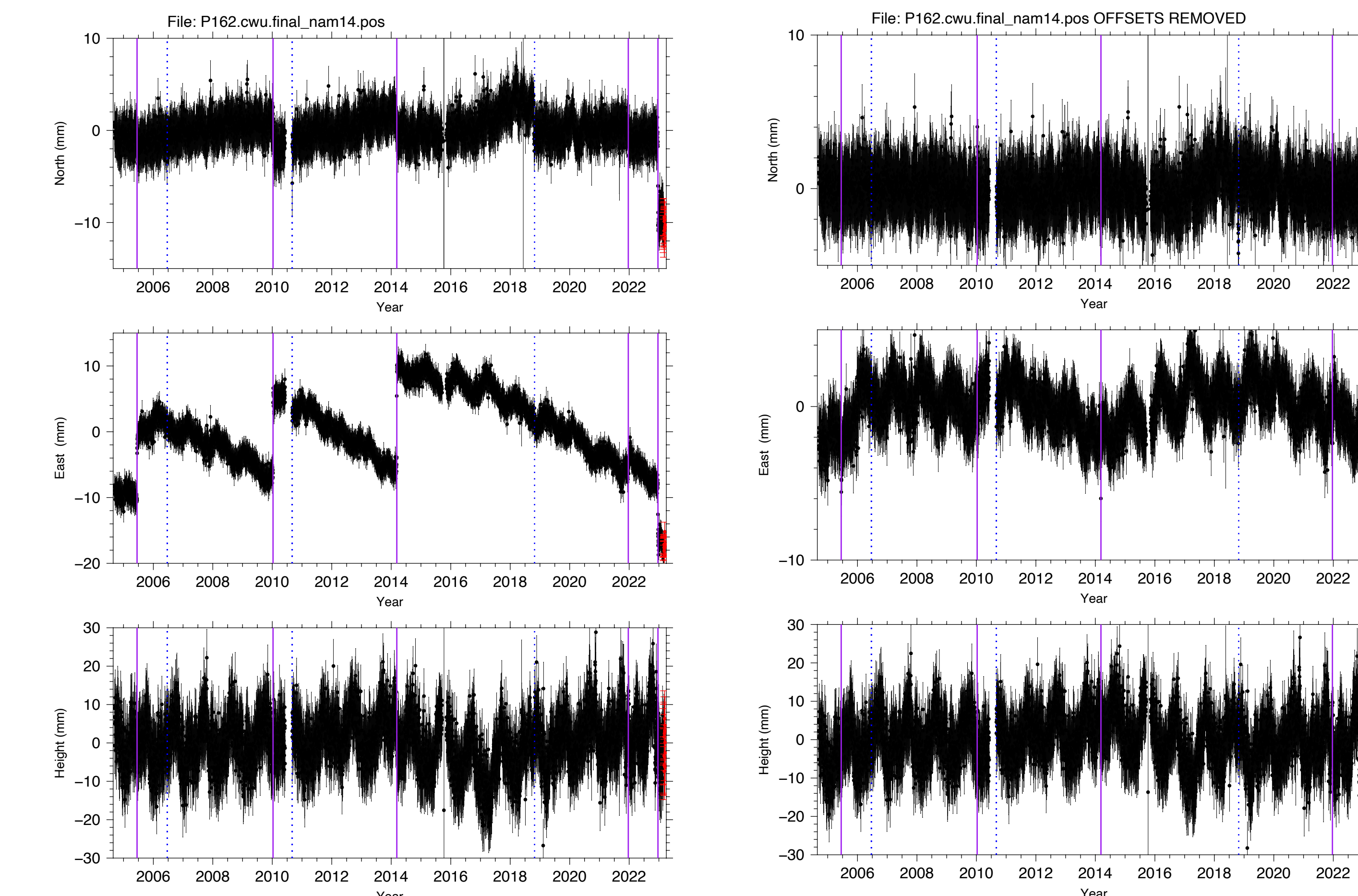
Snapshot velocity fields (snaps) are computed monthly based on time series analyses. Earthquake and other offsets estimated at the same time. Full velocity fields with reference frame realization generated yearly. Results are accessible in rel_YYYYMMDD folder. Latest is rel_20221224. Release notes: https://www.unavco.org/data/gps-gnss/derived-products/docs/GAGE_GNSS_Velocity_Field_Release_Notes_20221224.pdf

Time series:

Standard format is "pos" files that contain headers, Cartesian XYZ coordinates with differences from nominal values with full covariance matrix, Geodetic latitude, longitude and ellipsoidal height with NEU differences from nominal value with full covariance matrix and a record descriptor.

Example below shows a site from near the Mendocino Triple Junction. Left frame: is the raw time series with just a linear trend removed; Right frame: Linear trend and offsets from https://data.unavco.org/archive/gnss/products/offset/cwu.kalts_nam14.off offset file removed. Offsets are shown below figures. Purple solid lines are earthquakes, blue dotted lines are due to antenna changes.

Plots from: http://geoweb.mit.edu/~tah/ACC_GAGE/ web site is updated daily and shows sites with anomalous rapid solutions. Red points are rapid solution (Recently many sites show outliers due to snow effects.)

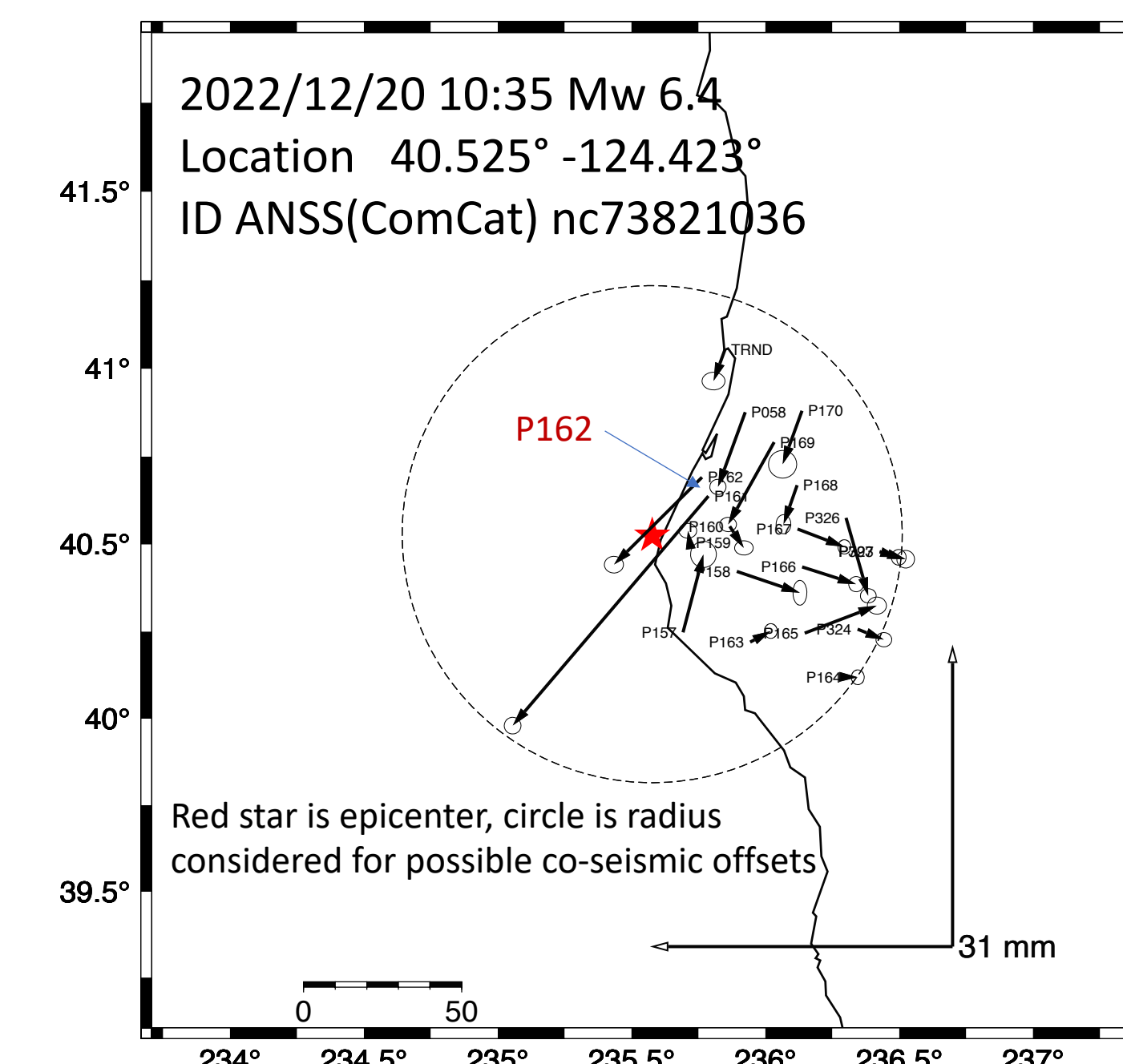


Site	YYYY	MM	DD	HR	MN	dN (mm)	sN (mm)	dE (mm)	sE (mm)	dU (mm)	sU (mm)	TYPE	Description
P162	2006	06	20	19	37	-0.46	2.31	0.32	1.83	-2.78	8.33	Break	AN Antenna swap TRM29659.00 to TRM29659.00
P162	2010	09	02	16	46	4.56	3.68	0.37	2.84	1.37	13.69	Break	AN Antenna swap TRM29659.00 to TRM29659.00
P162	2018	10	27	00	00	-2.98	0.32	-1.41	0.41	4.03	1.10	Break	AN Antenna swap TRM29659.00 to TRM29659.00
P162	2005	06	15	02	50	-0.81	0.33	10.51	0.43	-4.84	1.15	OffBq	EQ 06 Location 41.27263 233.83800 ID ANSS(ComCat) usp000d25
P162	2010	01	10	00	27	-2.83	0.33	11.15	0.42	3.11	1.16	OffBq	EQ 18 Location 40.73929 235.34864 ID ANSS(ComCat) nc71338066
P162	2014	03	10	05	19	-2.20	0.32	15.40	0.41	-5.75	1.13	OffBq	EQ 29 Location 40.93397 234.63808 ID ANSS(ComCat) nc72182046
P162	2021	12	20	11	11	-1.71	0.32	1.39	0.41	1.14	1.15	OffBq	EQ 65 Location 40.39020 -124.23900 ID ANSS(ComCat) nc73666291
P162	2022	12	20	10	35	-8.97	0.35	-9.02	0.40	-4.03	1.27	OffBq	EQ 69 Location 40.52500 -124.42300 ID ANSS(ComCat) nc73821036

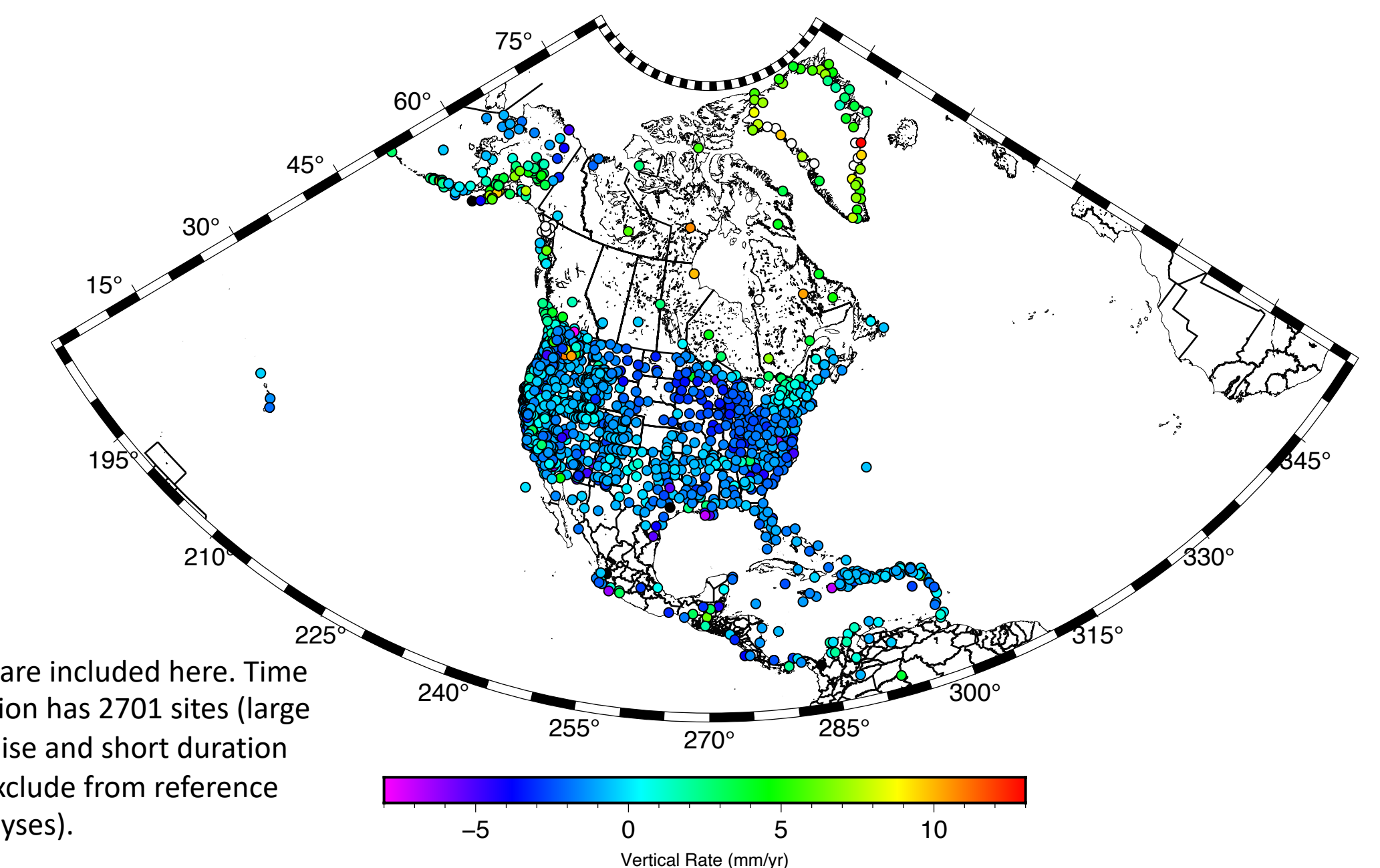
Ancillary products: Event Files

<https://data.unavco.org/archive/gnss/products/event/>

Index of event
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[]cwu_010228_1855_eqni_coseis_kalts.evt 2023-03-17 13:11 1.7K Event ASCII file
[]cwu_010228_1855_eqni_coseis_kalts.ps 2023-03-17 13:11 62K Vector graphic
..
[]cwu_221220_1035_eq69_coseis_final.ps 2023-01-08 13:40 58K Vector graphic
[]cwu_221220_1035_eq69_coseis_kalts.evt 2023-03-17 13:11 2.5K Event ASCII file
[]cwu_221220_1035_eq69_coseis_kalts.ps 2023-03-17 13:11 63K Vector graphic
[]cwu_221220_1035_eq69_coseis_rapid.evt 2022-12-24 02:44 2.6K Event ASCII file
[]cwu_221220_1035_eq69_coseis_rapid.ps 2022-12-24 02:44 58K Vector graphic



Event files are generated for earthquakes that generate displacements at NOTA sites greater than 1 mm. Initial estimates are generated when two full days of data after an event have been processed. Updated estimates are released once final orbit processing is complete. Both analyses use the difference of the two-day averaged positions below and after the earthquake. The Kalman filter time series analysis (kalts) uses all data with correlated process noise model to estimates all offsets, possible postseismic signals, linear trend and annual sinusoids. Earthquake, antenna and unknown origin offsets in the time series for all sites are given in a single cwu_kalts.nam14.off file (link in Time Series block).



2194 sites are included here. Time series version has 2701 sites (large process noise and short duration sites are excluded from reference frame analyses).

Above: Vertical motions from the annual rel_20221224 solution. The release notes give details about the solution and the figure. Below: Horizontal motions in an Antarctica fixed reference frame from the same release.

