



Fran Boler, Chuck Meertens, Dave Phillips, and Christine Puskas and many others in the IT, Data Archive, and Data Management Teams at UNAVCO

UNAVCO GEODETIC DATA SYSTEMS NGNLA WORKSHOP MAY, 2015





*<u>UNAVCO Geodetic Data Infrastructure</u> Open data Data Management IT Future directions and drivers

*Cyberinfrastructure
Web services APIs
GSAC
RESTful services
Collaboration across domains, institutions, and borders
Future directions and drivers

*Data Quality Metadata management Techniques for QC and QA Stations health and data quality Future directions and drivers

OUTLINE





UNAVCO GEODETIC DATA: SOURCES TO USERS



Data: Sources to Users

- Manage or Access Sources
- Data Operations
- Data Products and Services
- Data Management and Archiving
- Cyberinfrastructure





UNAVCO GPS Data Policy

Archiving of data

data, including sponsor and provider contact information. Accessibility

that is specified by the sponsor, typically in the award letter. Attribution

and their sponsors, acknowledgment of UNAVCO and its sponsors, and to adherence to professional and ethical standards.

OPEN DATA POLICY

- All UNAVCO-facilitated GPS and other GNSS data and metadata must be archived at UNAVCO upon collection. Data providers are responsible for providing attribution information with submitted
- Metadata will be made publicly available when placed in the archive. Data will be made publicly available when placed in the archive, unless an investigator has documented a period of exclusive us
- By accessing data from the UNAVCO archive, users agree to appropriate attribution to providers





DIGITAL OBJECT IDENTIFIERS FOR DATA

Attribution Using Data Set Digital Object Identifiers

UNAVCO is publishing DOIs for data sets (campaign and station).

home 🤉 data 🔹 doi

Data Set Digital Object Identifier Search

Mammoth

DOI Search

Found 5 Results

Mammoth/Mojave 1994: Mammoth

Citation: Miller, M. Meghan, Golombek, Matthew P., Dokka, Roy K., 1997, Mammoth/Mojave 1994: Mammoth, UNAVCO, GPS Data Set, doi:10.7283/T5D798B5

Mammoth/Mojave 1994: Combined Sites

Citation: Miller. M. Meghan, Golombek, Matthew P., Dokka, Roy K., 1997, Mammoth/Mojave 1994: Combined Sites, UNAVCO, GPS Data Set, doi:10.7283/T5RF5RZP

Mammoth/Mojave 1994: Mojave

Citation: Miller, M. Meghan, Golombek, Matthew P., Dokka, Roy K., 1997, Mammoth/Mojave 1994: Mojave, UNAVCO, GPS Data Set, doi:10.7283/T5MS3QNP

Mammoth 1995

Citation: Miller, M. Meghan, Humphreys, Eugene, Dokka, Roy K., Webb, Frank H., 1995, Mammoth 1995, UNAVCO, GPS Data Set, doi:10.7283/T5C8276B

Mammoth/Mojave 1994

Aggregation of Multiple Data Sets Citation: Miller, M. Meghan, Golombek, Matthew P., Dokka, Roy K., 1997, Mammoth/Mojave 1994, UNAVCO, GPS Data Set, doi:10.7283/T57H1GGM

home - data - doi - doi:10.7283

GPS Data Set Citation Summary

Identifier: Title: Authors: Published: Publisher: Description: Date Range: Citation: Related Publications:

Data Availability: Data Access:

See Also:

10.7283/T5W66HPD Mojave 1997 M. Meghan Miller, Eugene Humphreys, Roy K. Dokka and Frank H. Webb 2001 UNAVCO, Inc. Campaign 1997-06-23 through 1997-07-19 Miller, M. Meghan , Humphreys, Eugene , Dokka, Roy K. and Webb, Frank H., 2001, Mojave 1997, UNAVCO, GPS Data Set, doi:10.7283/T5W66HPD Timothy Dixon, Fred Farina, Charles DeMets, Francisco Suarez Vidal, John Fletcher, Meghan Miller, Osvaldo Sanchez, Bertha Marquez-Azua, Paul Umhoefer, New Kinematic Models for Pacific-North America Motion from 3 Ma to Present: Evidence for a "Baja California shear zone". Geophysical Research Letters. v.27, p. 3961-3964, doi:10.1029/1999GL900405, 2000 M. Meghan Miller, Daniel J. Johnson, Timothy H. Dixon, and Roy K. Dokka, 2001, Refined kinematics of the Eastern California shear zone from GPS observations, 1993-1998. Journal of Geophysical Research. v. 106, p. 2245-2264, doi:10.1029/2000JB900328. S. C. McClusky, S. C. Bjornstad, B. H. Hager, R. W. King, B. J. Meade, M. M. Miller, F. C. Monastero and B. J. Souter, 2002, Present day kinematics of the Eastern California Shear Zone from a geodetically constrained block model. Geophysical Research Letters, v. 28, p. 3369-3372, doi:10.1029/2001GL013091. Kenneth E. Austin and M. Meghan Miller, 2002, The co-seismic displacement fields for the 1992 Landers and 1999 Hector Mine earthquakes in California, from regional GPS observations. The Hector Mine, California, earthquake of 16 October 1999, Bulletin of the Seismological Society of America, v. 92, p. 1365-1376, doi:10.1785/0120000931. Available by request http://www.unavco.org/data/gps-gnss/data-access-methods/dai2/dai2.html#scope=Campaign;groupingMod=Equals;grouping=Mojave 1997;dataStartDate=1997 Jun 23;dataEndDate=1997 Jul 19; UNAVCO Data Policy UNAVCO Attribution Policy Background information, DOI for Data at UNAVCO





Figure 3.2-1. Geodetic Data Services work flow. The generalized workflow for data systems planned for GAGE, includes roles of subawardees and partners. The GAGE Facility will develop internal consistency and integration of data work flow to maintain and enhance its core services, to develop a new data system for TLS, to provide improved access to community data held at the facility for data users and external partners, and to develop mechanisms to acquire, track, manage and disseminate products and related provenance metadata that will enable the broadest possible use. Cyberinfrastructure developments enhance capabilities for data handling, distribution and visualization both within and external to GAGE.

INSTRUMENT	LEVEL	PRODUCT	FORMAT	PRODUCT GENERATION FREQUENCY	PRODU DISTRIB
		Standard-Rate (15-sec) raw data	T00	Hourly, sub-daily or daily	UNAVCO/ UNAVCO
		High-Rate (1-sps, 5-sps) raw data	T00	Hourly (upon request)	UNAVCO/ UNAVCO
		Real-Time raw data	BINEX, RTCM	Real-time	UNAVCO/ UNAVCO
	0	Community continuous raw data	Varies	Hourly, sub-daily or daily	Community PI's/UN
		Survey-mode raw data	Varies	Varies	UNAVCO, Commu Pl's/UNAVCO
		Metadata	Database	Varies	UNAVCO
		Standard-Rate quality checked data	RINEX	Daily	UNAVCO/UNAVCO
Global Positioning System (GPS)		High-Rate quality checked data	RINEX	Varies	UNAVCO/UNAVCO
Receiver	1	Real-Time quality checked data	RINEX	Daily, varies	UNAVCO/UNAVCO
		Community continuous quality checked data	RINEX	Daily, varies	UNAVCO/UNAVCO
		Survey-mode (campaign) quality checked data	RINEX	Daily, varies	UNAVCO/UNAVCO
		Station position solutions	SINEX	Daily, 15-days, 3-months	MIT*, CWU*, NMT
		Station position time series	ASCII	Daily, 15-days, 3-months	MIT*, CWU*, NMT
	2	Station position velocity estimates	ASCII	Varies	MIT*, CWU*, NMT
	2	Station position offsets for significant events (e.g. coseismic)	ASCII	Varies	MIT*, CWU*, NMT
		Station position quality assurance parameters	ASCII	Varies	UNR (Blewitt)/UNA
		Tropospheric Delay Parameters	ASCH	Daily	MIT*, CWU*, NMT*
		20-sps, 1-sps, 10-min raw strain series	Bottle, SEED	Hourly, daily	UNAVCO/DMC*, N
		30 min, 1 hour instrument health series	Bottle, SEED	Hourly, daily	UNAVCO/DMC*, N
	0	1-sps, 30-min environmental series	Bottle, SEED	Hourly, daily	UNAVCO/DMC*, N
		Borehole geophysical logs, samples	Varies	During installation	UNAVCO/UNAVCO
Borehole Strainmeter (BSM)		Station metadata	Database	Varies	UNAVCO
		2a Corrected and scaled strain and environmental series	XML, ASCII	Daily, bi-weekly	UNAVCO/DMC*, N UNAVCO
	2	2b Corrected and scaled strain and environmental series	XML, ASCII	4-months	UNAVCO/DMC*, N UNAVCO
		Station notebooks	PDF	Varies	UNAVCO
	0	1-sps raw strain, instrument health, and environmental series	Ice-9, SEED	Daily	UCSD*/DMC*, NC
Laser Strainmeter /LSM)		Station metadata	Database	Varies	Subawardee (UCS
caser otrainmeter (com)	2	Corrected and scaled strain and environmental series	XML, ASCII	Bi-weekly, 4-months	UCSD*/DMC*, NC
		Station notebooks	ASCII	Varies	Subawardee (UCS
		100-sps raw data	SEED	Streaming	UNAVCO/DMC*
Borehole Seismometer	0	200-sps raw data	SEED	Streaming (some	UNAVCO/DMC*
		Seismic Metadata	DATALESS SEED	Varies	UNAVCO
Pore Pressure Meter	0	1 sps raw	SEED, ASCII	Streaming, Daily	UNAVCO/DMC*, U
	0	1-sps raw	ASCII	Streaming	UNAVCO/UNAVCO
Tiltmeter	0	1-min raw	ASCII	Daily	UNAVCO/UNAVCO
	0	Scanner data (raw proprietary format)	Varies	Varies	UNAVCO/UNAVCO
Terrestrial Laser Scanning (TLS)	2	Point cloud data (merged, aligned, georeferenced,	ASCII, LAS, other	Varies	UNAVCO/UNAVCO
	3	Point cloud data (unfiltered, filtered)	ASCII, LAS, other	Static	NCALM/OpenTopo
Airborno Locor Coopping (ALC)	3	Digital elevation model (unfiltered, filtered)	Varies	Static	NCAL M/OpenTopo
Airborne Laser Scanning (ALS)	3	Hillshade image (unfiltered, filtered)	GeoTIFF	Static	NCALM/OpenTopo
Satellite Synthetic Aperture Radar	0	Raw SAR sensor data	CEOS, ENV1	Varies (orbit dependent)	ESA, NASA (ASF)
(SAR)	1	Slant range single look complex (SSC) data	COSAR	Varies (orbit dependent)	DLR/UNAVCO**
	0	Temperature, humidty, barometric pressure, other	T00	Hourly/Daily	UNAVCO/UNAVCO
	1	Temperature, humidty, barometric pressure, other	RINEX	Hourly/Daily	UNAVCO/UNAVCO
Meteorlogic Sensor	2	Soil mosture, snow depth, snow-water equivalent, NLDAS, SNOTEL, vegetation index,	ASCII	Hourly/Daily	Community PI (Lar
	2	Time series, maps, animations	Varies	Hourly/Daily	Community PI /I ar

* Supported by UNAVCO subaward. ** UNAVCO re-distributes data to authorized users.

*** Data products are generated from combination of GPS observations (multipath), meteorologic observations, direct soil and vegetation measurements, etc.

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Data management functions are the same independent of volumes.



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		Real-Time raw data	BINEX, RTCM	Real-time	UNAVCO/ UNAVCO
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		Metadata	Database	Varies	UNAVCO
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Receiver		Community continuous quality checked data	RINEX	Daily, varies	UNAVCO/UNAVCO
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		Station position velocity estimates	ASCII	Varies	MIT*, CWU*, NMT*
	2	Station position offsets for significant events (e.g. coseismic)	ASCII	Varies	MIT*, CWU*, NMT*
		Station position quality assurance parameters	ASCII	Varies	UNR (Blewitt)/UNA
		Tropospheric Delay Parameters	ASCH	Daily	MIT*, CWU*, NMT*
		20.ene 1.ene 10.min row strain sorias	Bottle SEED	Hourly daily	UNAVCOIDMC* N
		30 min, 1 hour instrument health series	Bottle, SEED	Hourly, daily	UNAVCO/DMC*, N
	0	1-sps. 30-min environmental series	Bottle, SEED	Hourly, daily	UNAVCO/DMC*, N
		Borehole geophysical logs, samples	Varies	During installation	UNAVCO/UNAVCO
Borehole Strainmeter (BSM)		Station metadata	Database	Varies	UNAVCO
borenole strainmeter (bSM)		2a Corrected and scaled strain and environmental	XML, ASCII	Daily, bi-weekly	UNAVCO/DMC*, N
	2	2b Corrected and scaled strain and environmental series	XML, ASCII	4-months	UNAVCO/DMC*, N UNAVCO
		Station notebooks	PDF	Varies	UNAVCO
	0	1-sps raw strain, instrument health, and environmental series	Ice-9, SEED	Daily	UCSD*/DMC*, NCE
		Station metadata	Database	Varies	Subawardee (UCS
Laser Strainmeter (LSM)		Corrected and scaled strain and environmental series	XML, ASCII	Bi-weekly, 4-months	UCSD*/DMC*, NCE
		Station notebooks	ASCII	Varies	Subawardee (UCS
		100-sos raw data	SEED	Streaming	UNAVCO/DMC*
Borehole Seismometer	0	200-sos raw data	SEED	Streaming (some	UNAVCO/DMC*
	1	Seismic Metadata	DATALESS SEED	Varies	UNAVCO
Pore Pressure Meter	0	1 sps raw	SEED, ASCII	Streaming, Daily	UNAVCO/DMC*, U
	0	1-sps raw	ASCII	Streaming	UNAVCO/UNAVCO
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Terrestrial Lasor Secondary (TLS)	U	Scanner data (raw, proprietary format)	varies	vanes	UNAVCO/UNAVCO
Terrestrial Laser Scanning (TLS)	2	Point cloud data (merged, aligned, georeferenced, unfiltered)	ASCII, LAS, other	Varies	UNAVCO/UNAVCO
	3	Point cloud data (unfiltered, filtered)	ASCII, LAS, other	Static	NCALM/OpenTopo
Airborne Laser Scanning (ALS)	3	Digital elevation model (unfiltered, filtered)	Varies	Static	NCALM/OpenTopo
	3	Hillshade image (unfiltered, filtered)	GeoTIFF	Static	NCALM/OpenTopo
Satellite Synthetic Aperture Radar	0	Raw SAR sensor data	CEOS, ENV1	Varies (orbit dependent)	ESA, NASA (ASF)/
(SAR)	1	Slant range single look complex (SSC) data	COSAR	Varies (orbit dependent)	DLR/UNAVCO**
	0	Temperature, humidty, barometric pressure, other	T00	Hourly/Daily	UNAVCO/UNAVCO
	1	Temperature, humidty, barometric pressure, other	RINEX	Hourly/Daily	UNAVCO/UNAVCO
Meteorlogic Sensor	2	Soil mosture, snow depth, snow-water equivalent, NLDAS, SNOTEL, vegetation index, precipitation***	ASCII	Hourly/Daily	Community PI (Lar
	2	Time series, maps, animations	Varies	Hourly/Daily	Community PI (Lan

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*** Data products are generated from combination of GPS observations (multipath), meteorologic observations, direct soil and vegetation measurements, etc.

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W. HEMISPHERE GPS DATA ARCHIVED

Campaign GPS (yellow)

Continuous GPS (red)



Produced by UNAVCO/Mencin 2015











Functions

- Accept Incoming Data
- Format, Extract Metadata, QC
- Associated Metadata Tracking
- Archiving for Long-term Preservation
- Data Products and Services
- Distribution
- Cyberinfrastructure





<u>Scale</u>

- 2,700 Active Stations
- Delivery intervals: Sub-hourly, Hourly, Sub-daily, Daily, Intermittent
- Streams
- Data rates (sec): 0.1, 0.2, 1, 2, 5, 10, 15, 30
- ~20,000 incoming files per day
- ~10^6 operations per day (e.g. compress, cp, db request, filter)







IT Infrastructure

- Servers: Physical & Virtual Machines
- RAIDs, Storage Area Network
- Software
- Failover systems onsite and offsite
- Onsite and offsite backup
- Cloud services







Infrastructure







2011: UNAVCO's Internal "Cloud"

FUTURE DIRECTIONS AND DRIVERS



2020: Commercial Cloud Provider? NSF Science Cloud? Digital Object Identifiers for Data





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Web services APIs
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RESTful services
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Future directions and drivers

*Data Quality Metadata management Techniques for QC and QA Stations health and data quality Future directions and drivers

OUTLINE





DATA ACCESS & CYBERINFRASTRUCTURE



Data Access Traditional

- Data and Products via FTP
- Web User Interfaces For Search
- Visualization

Data Access - Next Generation

- APIs
- Cross-domain Standardization

GPS DATA PRODUCT LEVELS

Level O		Raw data fro Metadata fo
Level I		Quality-chec Translated fi Metadata fo
Level 2a		Loosely cons Metadata fo
Level 2b	P780 (Cerrillos_PR2008) NOAM_08 Processed Daily Positions (Outliers Removed)	GPS time se GPS station Event files (c Metadata fo
Level 3	Station nwot	Derived proc community

om instruments or GPS sites, sensors, and raw data

tked data f(Raw to RINEX)

or QC, RINEX

strained GPS position solutions and processing files or processing

ries of daily data in multiple reference frames velocity solutions in multiple reference frames coseismic offsets) or processed data

ducts from processed data from the geodesy

DATA AND PRODUCT ACCESS

Data Access

- Raw data through products
- Products available as files by direct ftp or through web UI data cart
- Products available via web services: time series, reformatting
- Metadata viewable through web user interfaces
- Visualization
- Metadata accessible through web services in csv, SINEX, site log XML, JSON

SPBG - Site detail page							Open in ne	w window 🗆 💌
Monument/Site	SPBG Barrier Glacie	r (]	2	APP (ST	1. And	11. 7	and -	100
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View metadata

Interactive plotting

ACCESS EXAMPLES

Select stations

000

Visualization

☆ franboler — ₩3

Frans-MacBook-Air:~ franboler\$ /usr/bin/curl http://www.unavco.org/ws/gps/data/position/P109/beta?re
fframe=snf01\&starttime=2013-01-01T00:00:00\&endtime=2013-01-05T00:00:00
P109 columns: date, north mm, east mm, vertical mm, north std. dev. mm, east std. dev. mm, vertica
l std. dev. mm
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2013-01-02T00:00:00, -15.79, -68.09, 14.67, 1.22, 1.13, 4.42 2013-01-03T00:00:00, -16.90, -62.72, 10.36, 1.17, 1.09, 4.22 2013-01-04T00:00:00, -16.13, -65.85, 10.09, 1.21, 1.13, 4.43 2013-01-05T00:00:00, -16.45, -62.60, 9.05, 1.24, 1.13, 4.47 Frans-MacBook-Air:~ franboler\$

Web service delivers time series

UNAVCO

>>>/usr/bin/curl http://facility.unavco.org/gsacws/gsacapi/site/search/ sites?output=site.csv\&site.type=gnss.site.continuous \&site.interval=interval.normal $\&bbox.north=59.42\bbox.south=59.32\bbox.west=-153.6\bbox.east=-153.3$

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WEB SERVICES API FOR DATA SEARCH

Retrieve station metadata

WEB SERVICES FOR DATA ACCESS

>>/usr/bin/curl http://facility.unavco.org/gsacws/gsacapi/file/search?file.sortorder=descending\& \&site.type=gnss.site.continuous\&file.type=gnss.data.rinex.navigation\&file.type=gnss.data.rinex. \&file.datadate.from=2014-07-25\&file.datadate.to=2014-07-25

#fields=site_4char_ID[type='string'],Data_Type[type='string'],MD5[type='string'],FileSize[unit='by HH:mm:ss'],URL[type='string'],dataStartTime[type='date' format='yyyy-MM-dd HH:mm:ss'],dataStopTime HH:mm:ss'],sampleInterval[unit='s']

Comma-separated value file. Missing metadata values have nothing between commas. Generated by UNAVCO GSAC on 2015-05-25 18:00:31 +0000

CHIS, GNSS RINEX Observation (Hatanaka Unix Compressed), 1a4601f5e68f144485a0252044fd0ea2, 834349, 20 2014/206/chis2060.14d.Z,2014-07-25 00:00:00,2014-07-25 23:59:30,30.0,

CHIS, GNSS Navigation, 72ef3c6dc2034160da0ae7fbb439c5fd, 38070, 2014-10-29 00:00:00, ftp://data-out.una 00:00:00,2014-07-25 23:59:30,30.0,

CHIS, GNSS Navigation, 94fcf8be653a6c5db18a89d534fae230, 37599, 2014-10-29 00:00:00, ftp://data-out.una 00:00:00,2014-07-25 23:59:30,30.0,

CHIS, GNSS RINEX Meteorology, 593448712f76cec832b5a4661bf4e5bd, 19038, 2014-10-29 00:00:00, ftp://data-2014-07-25 00:00:00,2014-07-25 23:59:30,30.0,

Retrieve data/product files metadata and URL

Cross-Institution Federation

DATA ACCESS: FEDERATION WITH WEB SERVICES

RESTFUL WEB SERVICES FOR PRODUCTS

get /g	ps/data/position/{station}/v1		Get the position tim	e series for the specified sta
Implement Retrieves the	tation Notes daily position time series for the station identified	by four character id.		
Returns: Dat	teTime, North(mm), East(mm), Vertical(mm), North	Std. Dev.(mm), East Std. Dev.(mm), Vertical Std	. Dev.(mm), Solutio	n
Response (lass			
string				
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Parameter	Value	Description	Parameter Type	Data Type
station	P378	The four character station identifier.	path	string
reference	rame nam08 🗘	The reference frame.	query	string
starttime	2006-01-01T00:00:00	An ISO 8601 datetime indicating the start of the search range.	query	Date
endtime	2012-03-01T00:00:00	An ISO 8601 datetime indicating the end of the search range.	query	Date
tsFormat	iso8601 (default)	The output time format. unixEpochMs is the no. of milliseconds from 1970-01-01T00:00:00.	query	string
stdDevRang	je false (default)	Provides the values calculated by adding and subtracting 1 standard deviation from each corresponding value.	query	boolean
Response I	Messages			
HTTP Status (Tode Reason	Response Model		
404	Invalid Station Id supplied.			

UNAVCO

Try it out! Hide Response

Request URL

http://web-services.unavco.org:80/gps/data/position/P378/v1?referenceFrame=nam08&starttime=2006-01-01T00%3A00%3A00&endtime=2012-0

Response Body

```
# P378: DateTime, North(mm), East(mm), Vertical(mm), North Std. Dev.(mm), East Std. Dev.(mm), Vertical Std. Dev.(mm), Quality
2007-06-27T00:00:00, -21.55, -11.61, -1.73, 3.74, 2.27, 10.70, repro
2007-06-28T00:00:00, -23.01, -13.45, 1.32, 1.68, 1.31, 5.52, repro
2007-06-29T00:00:00, -21.10, -12.62, -9.94, 1.78, 1.38, 5.85, repro
2007-06-30T00:00:00, -22.42, -12.67, -1.16, 1.44, 1.13, 4.75, repro
2007-07-01T00:00:00, -22.11, -12.95, 3.07, 1.58, 1.24, 5.21, repro
2007-07-02T00:00:00, -21.65, -14.02, 1.53, 1.76, 1.37, 5.78, repro
2007-07-03T00:00:00, -22.29, -13.70, 2.36, 1.46, 1.15, 4.81, repro
2007-07-04T00:00:00, -21.81, -13.69, 2.97, 1.47, 1.16, 4.84, repro
2007-07-05T00:00:00, -21.72, -12.76, -2.23, 1.85, 1.42, 6.00, repro
2007-07-06T00:00:00, -21.53, -13.42, -1.51, 1.62, 1.30, 5.36, repro
2007-07-07T00:00:00, -21.07, -12.97, -1.37, 1.71, 1.37, 5.64, repro
2007-07-08T00:00:00, -22.30, -13.29, -0.78, 1.64, 1.34, 5.47, repro
2007-07-09T00:00:00, -22.11, -12.38, -1.04, 1.44, 1.17, 4.79, repro
2007-07-10T00:00:00, -23.06, -12.40, 0.82, 1.81, 1.44, 6.01, repro
2007-07-11T00:00:00, -22.08, -14.33, 7.00, 1.69, 1.34, 5.61, repro
2007-07-12T00:00:00, -20.96, -12.88, 0.04, 1.91, 1.51, 6.33, repro
2007-07-13T00:00:00, -21.97, -13.89, 2.76, 1.92, 1.54, 6.41, repro
2007-07-14T00:00:00, -23.45, -13.71, 7.51, 1.85, 1.47, 6.13, repro
2007-07-15T00:00:00, -21.78, -12.73, 7.18, 1.99, 1.58, 6.62, repro
2007-07-16T00:00:00, -22.31, -13.14, 5.29, 1.89, 1.50, 6.27, repro
2007-07-17T00:00:00, -22.94, -12.67, 5.35, 1.96, 1.55, 6.51, repro
2007-07-18T00:00:00, -22.96, -13.49, 5.19, 1.94, 1.53, 6.41, repro
```

Retrieve Position Time Series, Velocities, or Metadata

2007-07-19T00:00:00, -22.22, -13.06, 0.75, 1.60, 1.28, 5.31, repro

EarthCube

FUTURE DIRECTIONS AND DRIVERS

Cyberinfrastructure for Interoperability

- Cross-institution (GSAC in the US: SOPAC, CDDIS, UNAVCO)
- Cross-borders (GSAC within EPOS: France, Italy, Greece, Iceland, Spain...) (GSAC within Regional Data Centers COCONet, TLALOCNet)
- Cross-domain (EarthCube, COOPEUS, and GEO)

*<u>UNAVCO Geodetic Data Infrastructure</u> Open data Data Management IT Future directions and drivers

*Cyberinfrastructure
Web services APIs
GSAC
RESTful services
Collaboration across domains, institutions, and borders
Future directions and drivers

*Data Quality Metadata management Techniques for QC and QA Stations health and data quality Future directions and drivers

OUTLINE

ENGINEERING METADATA MANAGEMENT

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Site/Marker Name:	LACE 15.0	sec LACE	39,4575	-120,4417	2007 Jun 07 00:00	2012 Sep 24 00:00	MAGNET	Equipment & Configuration	Longitude: -115.70 Elevation: 1666.0/	J38 0 m
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	LAKE 15.0	sec LAKE	39,9361	-119.3753	2006 Jul 07 00:00	2013 Jul 10 00:00	MAGNET	Citation/Attribution	Archived File Me	etadata
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UNAVCO

Attention to Engineering Metadata

- Installation standards ("pre metadata")
- Definition
- Tools to gather
- Timeliness
- Business rules
- Automated consistency checks
- Human verification

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Гесtonic Plate: <u>Help</u>	Select One 🔽	/ 3SNA 3SNA 3SNA	∨ R100 OLD ∨ R100-30 ∨ R100-30T 12
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and Eatablishes

METADATA ENTRY TOOLS

Tools to facilitate

- Image: March
 2010
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- Timeliness
- Business rules
- Internal consistency checks
- Standards

RINEX VERSION / TYPE UBSERVATION DATA G (GPS) 2.11tegc 2010Mar4 UNAVCO Archive Ops 20100307 02:07:44UTCPGM / RUN BY / DATE Solaris 5.10|UltraSparc IIIi|cc -xarch=v9 SC5.8|=+|*Sparc COMMENT BIT 2 OF LLI FLAGS DATA COLLECTED UNDER A/S CONDITION COMMENT ALUT MARKER NAME MARKER NUMBER • When is the right time to access OBSERVER / AGENCY Robert B. Smith University of Utah 4539258391 REC # / TYPE / VERS TRIMBLE NETRS 1.1-3 0220335602 TRM29659.00 SCIT ANT # / TYPE -1788072.1001 -4511503.4868 4129277.8016 APPROX POSITION XYZ metadata? 0.0000 ANTENNA: DELTA H/E/W 0.0000 0.0000 ALUT Site Information Form (site log) -1 WAVELENGTH FACT L1/2 International GPS Service 7 Ll # / TYPES OF OBSERV L2 31 52 C1 ₽2 P1 See Instructions at: 30.0000 INTERVAL ftp://igscb.jpl.nasa.gov/pub/station/general/site]RINEX file created by UNAVCO GPS Archive. COMMENT For more information contact archive@unavco.org COMMENT 0. Form Monument ID: 19258 COMMENT • Where should it be obtained? UNAVCO 4-char name: ALUT COMMENT 4-char name from Log or data file: ALUT COMMENT Prepared by (full name) : Susan Jeffries Monument location: 40.58390772 -111.620214888 2824.077 COMMENT : 2008-04-08 Date Prepared Visit ID: 86961 COMMENT Report Type : UPDATE End of DB comments COMMENT If Update: SNR is mapped to RIMEX snr flag value [0-9] : alut_20060907.log COMMENT Previous Site Log COMMENT L1 & L2: min(max(int(snr_dBHz/6), 0), 9) Modified/Added Sections : (n.n.n.n...) 6 0 0 0.000000 GPS TIME OF FIRST OBS END OF HEADER 10 3 6 0 0 0.0000000 0 6623620631616614611 Site Identification of the GNSS Monument 1. Site Name : Alta, Utah : ALUT Four Character ID Monument Inscription 1 IERS DOMES Number : (A9) CDP Number : (A4) #fields=ID[type='string'], station_name[type='string'], latitude, longitude, ellip_height[unit='m'], monument_description[type='string'], IERSDOMES[type='string'], session_start_time[type='date' format='yyy : PERMANENT STATION UNSPE MM-ddTHH:mm:ss zzzz'], session_stop_time[type='date' format='yyyy-MM-ddTHH:mm:ss zzzz'], antenna_type[type='string'], antenna_SN[type='string'], Ant_dZ, Ant_dN, Ant_dE, receiver_t Monument Description Height of the Monument : (m) e[type='string'], firmware_version[type='string'], receiver_SN[type='string'], sample_interval, city_locale[type='string'], state_prov[type='string'], country[type='string'], X, Y, Z, agencyname[type='string'] Monument Foundation UBERGROWBE etpackname[type='string'],metpackSN[type='string'],site_count Foundation Depth : (m) # Generated by UNAVCO GSAC Repository on 2015-03-31T15:42:29 Marker Description U385380438 Missing times (no characters) may mean 'not removed' or 'no change.' # Date Installed : 2005-07-20 # The CSV convention for point data is CF for CSV. See http://ramadda.org/repository/entry/show/Home/RAMADDA+Information/Development/CF+for+CSV?entryid=23652828-c6f4-482b-bb2f-041dae14542e Geologic Characteristic : (BEDROCK/CLAY/CONGLOME 1LSU, Louisiana State University, 30.4074, -91.1803, -6.44, shallow foundation mast, 2003-04-23T00:00:00, 2003-12-05T23:59:45, ASH701945E_M, SCIS, 620024327, 0.0000, 0.0000, 0.0000, ASHTECH UZ-12, CN00, 2200252004, Bedrock Type : (IGNEOUS/METAMORPHIC/ ,Baton Rouge,Louisiana,United States,,,,,,1 Bedrock Condition : (FRESH/JOINTED/WEATHE 1LSU, Louisiana State University, 30.4074, -91.1803, -6.44, shallow foundation mast, 2003-12-06T07: 36: 15, 2005-06-15T23: 59: 45, ASH701945E_M, SCIS, 620024327, 0.0000, 0.0000, 0.0000, ASHTECH UZ-12, CN00, 2200252006, Fracture Spacing : (1-10 cm/11-50 cm/51-,Baton Rouge,Louisiana,United States,,,,,,1 : (YES/NO/Name of the zo Fault zones nearby 1LSU,Louisiana State University,30.4074,-91.1803,-6.44,shallow foundation mast,,2005-06-16T21:10:40,2005-09-08T23:59:59,ASH701945E_M,SCIS,620024327,0.0000,0.0000,0.0000,ASHTECH UZ-12,CQ00,2200252006, : (multiple lines) Distance/activity ,Baton Rouge,Louisiana,United States,,,,,,1 Additional Information : (multiple lines) 1LSU, Louisiana State University, 30.4074, -91.1803, -6.44, shallow foundation mast, 2006-05-12T00:00:00, 2006-11-10T23:59:30, ASH701945E_M, SCIS, 620024327, 0.0000, 0.0000, 0.0000, TRIMBLE NETRS, 1.1-3, 4549261264 0,Baton Rouge,Louisiana,United States,,,,,,1 Site Location Information 2. 1LSU, Louisiana State University, 30.4074, -91.1803, -6.44, shallow foundation mast, 2006-11-11T00:00:00, 2008-06-20T21:08:00, ASH701945E_M, SCIS, 620024327, 0.0000, 0.0000, 0.0000, TRIMBLE NETRS, 1.1-5, 4549261264 0,Baton Rouge,Louisiana,United States,,,,,,1 City or Town : Alta 1LSU, Louisiana State University, 30.4074, -91.1803, -6.44, shallow foundation mast, 2008-06-23T17:20:30, 2008-11-19T16:59:30, TRM57971.00, NONE, 30765370, 0.0000, 0.0000, 0.0000, TRIMBLE NETRS, 1.2-0, 4635120813, 3 Baton Rouge,Louisiana,United States,,,,,,1 1LSU, Louisiana State University, 30.4074, -91.1803, -6.44, shallow foundation mast, 2008-12-10T12:00:00, 2009-07-26T23:59:30, TRM57971.00, NONE, 30765370, 0.0000, 0.0000, 0.0000, TRIMBLE NETR5, 3.64, 4807K53479, 30 aton Rouge, Louisiana, United States, ,,,,,1 1LSU, Louisiana State University, 30.4074, -91.1803, -6.44, shallow foundation mast, 2009-07-27T00:00:00, 2010-04-11T12:59:30, TRM57971.00, NONE, 30765370, 0.0000, 0.0000, 0.0000, TRIMBLE NETR5, 4.03, 4807K53479, 30 aton Rouge, Louisiana, United States, ,,,,,1 1LSU, Louisiana State University, 30.4074, -91.1803, -6.44, shallow foundation mast, 2010-04-14T16:00:00, 2010-08-25T23:59:30, TRM41249.00, NONE, 60104339, 0.0000, 0.0000, 0.0000, TRIMBLE NETRS, 1.2-0, 4635120799, 30 Baton Rouge, Louisiana, United States, ,,,,,1 1LSU, Louisiana State University, 30.4074, -91.1803, -6.44, shallow foundation mast, 2010-08-26T00:00, 2014-01-14T23:59:30, TRM41249.00, NONE, 60104339, 0.0000, 0.0000, 0.0000, TRIMBLE NETRS, 1.3-0, 4635120799, 3 Baton Rouge, Louisiana, United States, ,,,,,1 1LSU, Louisiana State University, 30.4074, -91.1803, -6.44, shallow foundation mast, 2014-01-15T00:00:00, 2014-07-08T10:59:30, TRM57971.00, NONE, 5000117882, 0.0000, 0.0000, 0.0000, TRIMBLE NETR9, 4.81, 5201K41202, ,Baton Rouge,Louisiana,United States,,,,,,1 1LSU, Louisiana State University, 30.4074, -91.1803, -6.44, shallow foundation mast, 2014-07-30T17:04:30, 2015-03-29T23:59:30, TRM57971.00, NONE, 5000117882, 0.0000, 0.0000, 0.0000, TRIMBLE NETR9, 4.85, 5201K41202, ,Baton Rouge,Louisiana,United States,,,,,,1

METADATA ACCESS

QA/QC AND PROCESSING

- QC preprocessing via TEQC all incoming data
- Selected processing by GAGE Analysis Centers
- Post-processing by University of Nevada Reno

- >1,800 GPS stations analyzed by GAGE AC's
- 1,100 official PBO plus COCONet, SCIGN, TLALOCNet and "Expanded Analysis" stations from complementary networks, mostly NGS CORS
- Daily positions, time series and velocities provided in IGS08 and NAM08 reference frames
- NAM08 has replaced SNF01; realized by rotating ITRF2008 to North America using the Euler vector published by Altimimi et al. (2012); reduces errors from relative phase center models or GIA modeling; ongoing tweaks by ACC...official announcement and documentation coming

EXPANDED GPS DATA ANALYSIS

- >1,800 GPS stations analyzed by GAGE AC's
- 1,100 official PBO plus COCONet, SCIGN, TLALOCNet and "Expanded Analysis" stations from complementary networks, mostly NGS CORS
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EXPANDED GPS DATA ANALYSIS

- PBO network data analysis expanding by 500+ stations in eastern US
- COCONet in Caribbean
- TLALOCNet in Mexico

EXPANDED NETWORKS ANALYSIS

- - Earthquake offsets

Total GPS station apparent deformation is the sum of many contributing factors including:

- Regional tectonic deformation
- Local site geology
- Co-seismic offsets
- Post-seismic viscoelastic relaxation
- Volcanic inflation/deflation
- Glacial isostatic adjustment
- Ocean and atmospheric loading
- Continental water (surface, ground)
- Seasonal snow and ice (hydrologic loading)

GPS Station Data Quality Assessment (prepared by Christine Puskas)

GPS STATIONS - SIGNALS AND DATA QUALITY

- Equipment changes, damage or failure
- Antenna phase center errors
- Metadata errors
- Monument instability
- Anthropogenic processes such as ground water pumping or water storage in reservoirs

- Multiple methods for assessing quality and health at a station:
- Preprocessing (TEQC) - Signal-to-noise ratio - Multipath
- Post-processing quality parameters - Produced by University of Nevada-Reno - Hosted at UNAVCO
- GAGE Analysis Center internal quality checks - Random walk noise
 - Processing statistics (RMS, elevation angle noise)
- Visual inspection of time series Note: Station Health != Station Quality Station health: operation of equipment, telemetry

Evaluating GPS Station Quality

Station quality: standards to evaluate "goodness" of station position solutions

TEQC

- Daily QC files at ftp://data-out.unavco.org/pub/rinex/qc
- Plots at station home pages/station health tab
- Signal-to-Noise (SNR)
 - Measure signal strength
 - Values usually depend on instrument health

Multipath

- Measure reflected signals
- Values depend on antenna type, local environment
- Use to assess state of health and environment

Evaluating GPS Station Quality

UNR quality assurance parameters

- Produced by UNR GPS processing
 - NASA-funded product that includes PBO network data and is archived at UNAVCO
 - Several parameters derived during processing - RMS values, formal errors, chi-square
- Daily QA files at ftp://data-out.unavco.org/pub/products/unr_qa
- CSV files to be plotted by user - by site: time history for each station - by date: snapshot for all stations on given date
- Reflect station health, quality

UNR GPS Data QA.

I. Map view of scaled error of PBO stations.

2. Larger view of QA time series for P677.

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AC quality checks

- Processing statistics available through SINEX files at UNAVCO ftp archives: ftp://data-out.unavco.org/pub/products/sinex
- Time series analysis random walk noise - To be published soon with analysis methods (will be available from UNAVCO web site) - Numeric values to describe NEU components - Account for station offsets, post-seismic decay

Example: PI32

- Horizontal RW = 0.004 (one of the best)
- Station history
 - Antenna change in February 2014
 - Receiver firmware change in February 2011

Evaluating GPS Station Quality

- Antenna problems affect SNR and QA parameters but do not affect time series
- Antenna replacement produces time series offset

Example: AB53

- Horizontal RW = 52.288 (bad)
- Station history - Offset by Jan 5, 2013 M7.5 Craig earthquake

Evaluating GPS Station Quality

Snow causes spikes in time series, MP, QA parameters

Example: HVWY

- Horizontal RW = 51.864 (bad)
- Station history
 - Receiver change September 2006
 - Yellowstone Lake swarm Dec 2008-Jan 2009

L1 & L2 Multipath and Signal-to-Noise

Volcanic station in Yellowstone caldera Measured ~12 cm uplift from 2004-2010, followed by subsidence, then uplift again Nonlinear deformation

- Quality evaluation is complicated
- UNAVCO engineers, PBO Analysis centers, UNR each spend time and resources on quality assessments
- QA parameters, MP, SNR are starting points
 Cross-check against time series
- Cross-check against station maintenance history
- Some familiarity with GPS processing
- Knowledge of environmental factors (snowfall, groundwater pumping, volcanism, etc.)

Evaluating GPS Station Quality

Maintenance Wildfire Protection AV27, Unimak Island WLWY, Yellowstone

Christine Puskas OWNER Stations - 9:14 AM

Quality Analysis for CN48

CN48 was installed on the island of Dominica in October 2014 (Figure 1). The GAGE GPS Analysis Center Coordinator (Tom Read more (117 lines)

Figure 5. Cycle slips for CN48 and nearby stations DOMI and ABMF on January 1, 2015. Cyc slips were determined from the Melbourne-Wubbena combination. When slip occurred at a giv point in time, the elevation and azimuth of the satellite with the interrupted signal are plotted. I are color coded by time. More slips occur to the south because ionospheric scintillation is stron near the equator, and all these GPS stations are at low enough latitudes to experience scintillatic Scintillation usually occurs in the hours after sunset. Note that GPS receivers record time in UT but CN48 is at UTC-5 hours, so dark blue and pink colors correspond to the local hours betwee. sunset and midnight. CN48 experienced additional slips when it failed to lock to a satellite. tominica (left). The states is located on a grasty di

Add a comment...

STATION STORIES

Data Quality

Metadata

Improvements in tools for recording metadata in the field Improved standards for metadata sharing Better metadata obtained at the time it is needed

Preprocessing QC for GNSS - solve this for the new signals, constellations

Processing and Post-processing Big data Complex station histories More input from data users and processors

FUTURE DIRECTIONS AND DRIVERS

