



Director's Report

Yehuda Bock

Scripps Orbit and Permanent Array Center (SOPAC)

California Spatial Reference Center (CSRC)

Institute of Geophysics and Planetary Physics

Scripps Institution of Oceanography

University of California San Diego

Ontario, CA

October 2, 2014

SOPAC/CSRC Group



- Director: Yehuda Bock
- Researcher: Jennifer Haase
- Coordinator: Maria Turingan
- Analysis: Peng Fang
- Programmers: Mindy Squibb, Bob Cunningham
- System Administrator: Anne Sullivan
- CRTN Engineer: Glen Offield
- Graduate Students: Diego Melgar (PhD in August), Dara Goldberg, Jessie Saunders
- Postdoctoral Researcher: Jianghui Geng, Yuval Reuveni
- Consultant: John Canas, PLS



CSRC Executive Committee



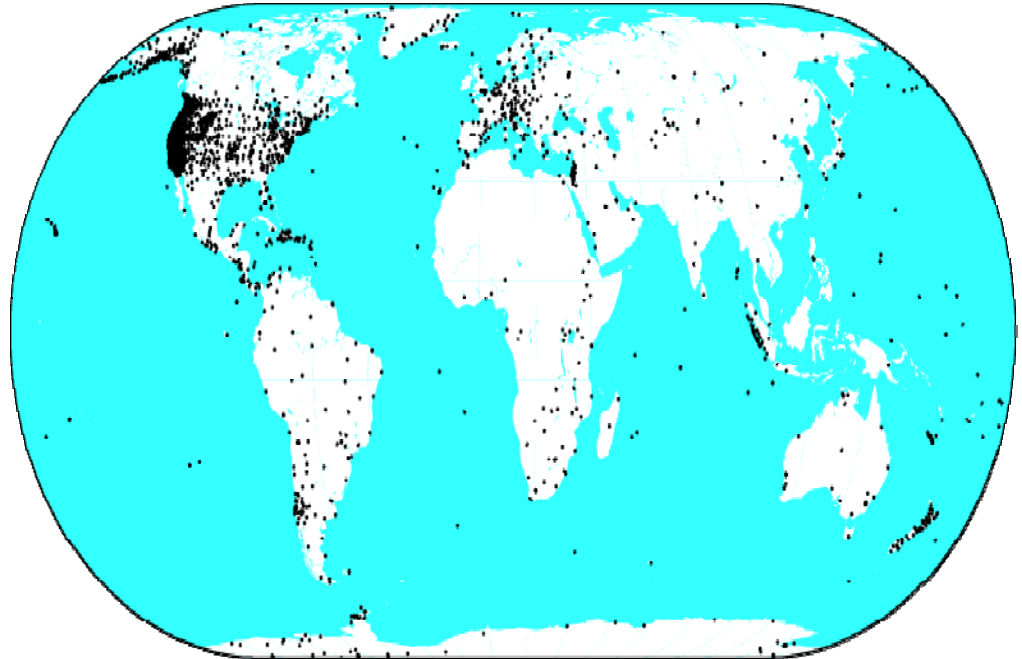
- *Chairperson:* Richard C. Maher
- *Vice-Chairperson:* Scott P. Martin
- *Secretary:* Thomas Dougherty
- *Treasurer:* Jim McNeil (Bill Hofferber)
- *Member:* Bryan Banister (Armand Marios)
- *Member:* Larry Gill (Brian Wiseman)
- *Member:* Greg Helmer
- *Member:* David B. Olander

Non-elected:

- *Past Chairperson:* Art Andrew
- *UCSD representative:* John Orcutt
- *Director of IGPP:* Guy Master
- *NGS Southwest Region Advisor,* TBN
- *CSRC Director,* Yehuda Bock

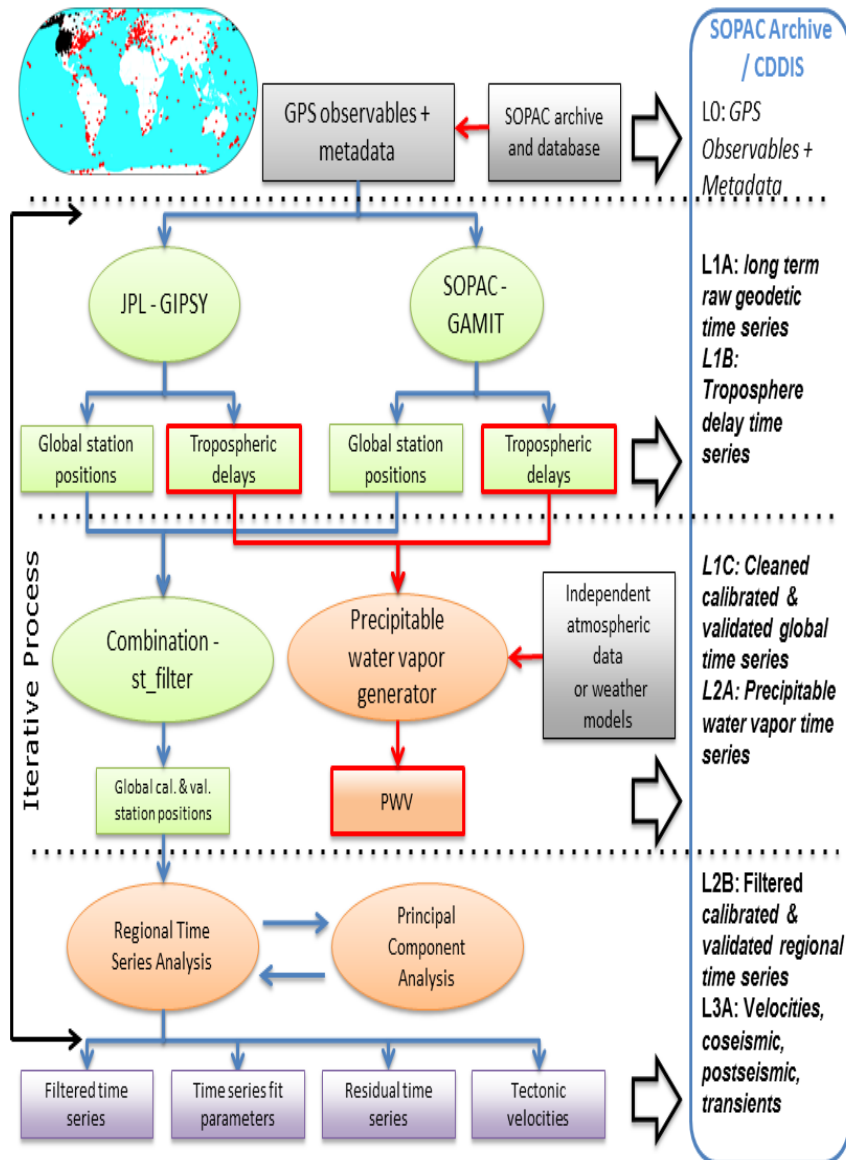
CGPS Data & Metadata

- RINEX files analyzed at SOPAC from over 3000 stations in Western NA, including PBO, SCIGN, BARD, WCDA and PANGA stations, other plate boundaries & globally
- Earliest analyzed CGPS data are from 1992
- Use a common source of metadata to reduce systematic errors – challenge to keep current, in process of extensive quality control effort in anticipation of rerun in latest ITRF version
- RINEX data processed independently at JPL (GIPSY software) and SOPAC (GAMIT software)
- Combination daily position time series is updated weekly

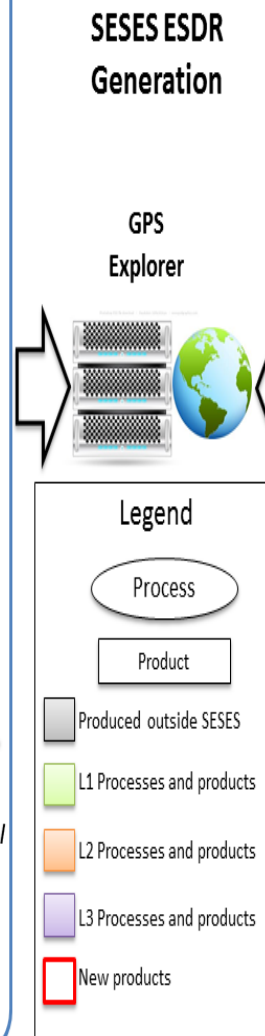


Hierarchy of Earth Science Data Records: Combination Products

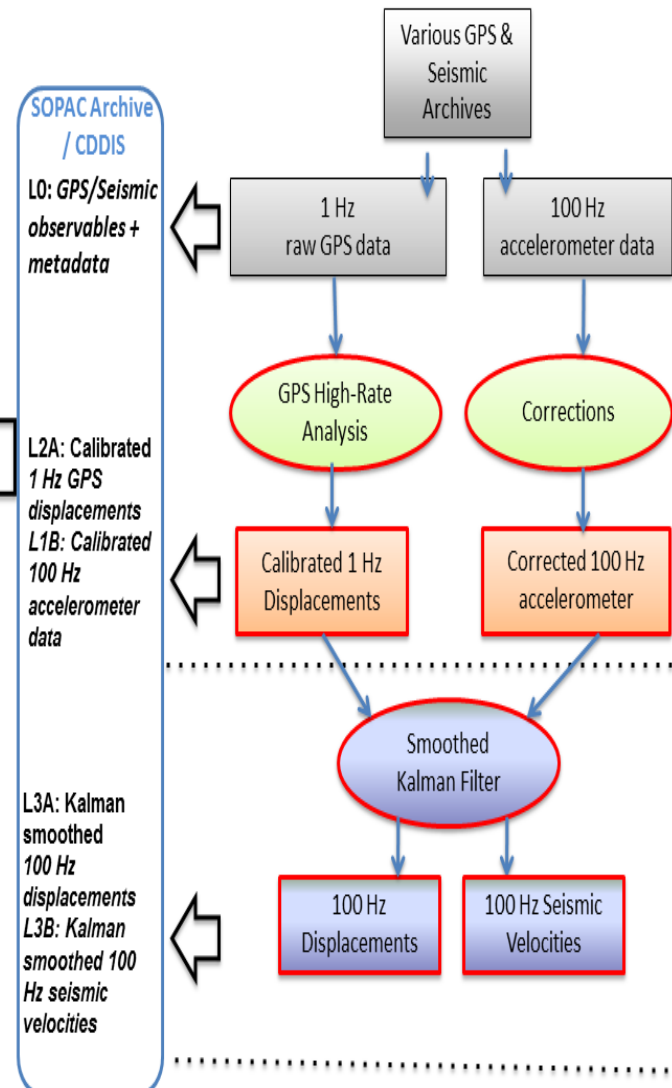
Daily Coordinate Time Series: Two Decades



Visualization: GPS Explorer



Seismogeodetic Database: 2003-2013

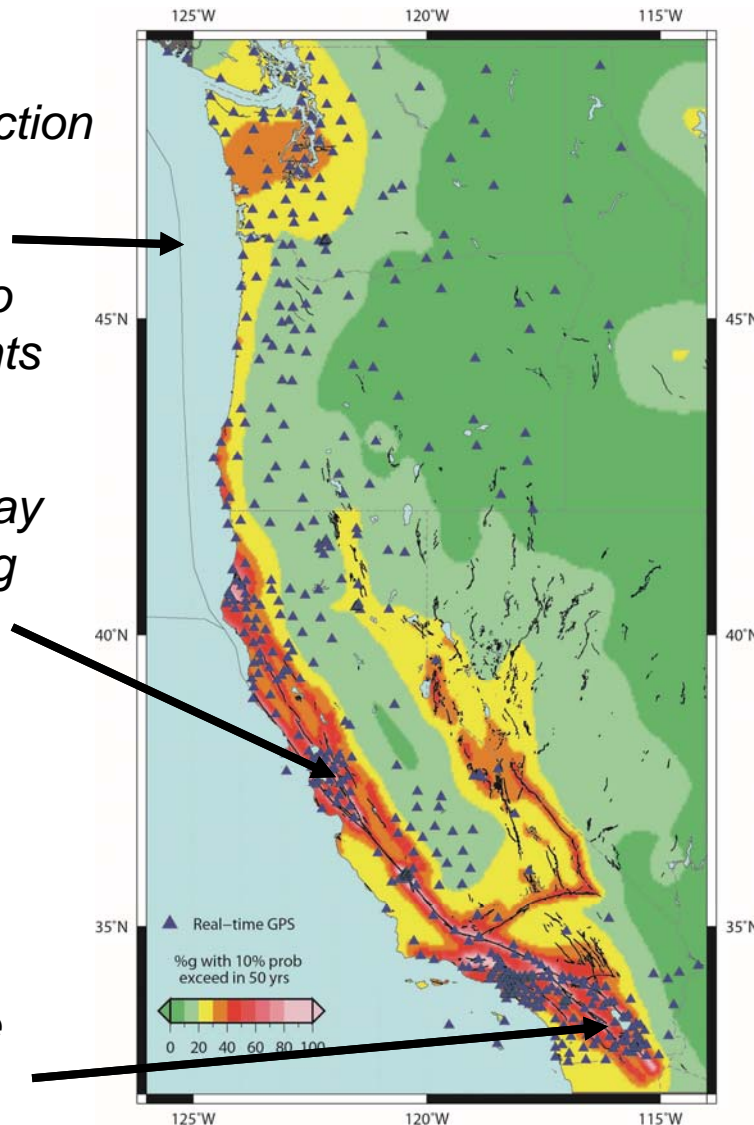


Earthquake Hazards for the West Coast

Cascadia Subduction Zone – Mw 9.0 earthquake & tsunami similar to 2011 Japan events

San Francisco Bay Area – Increasing risk of large earthquake on Hayward fault

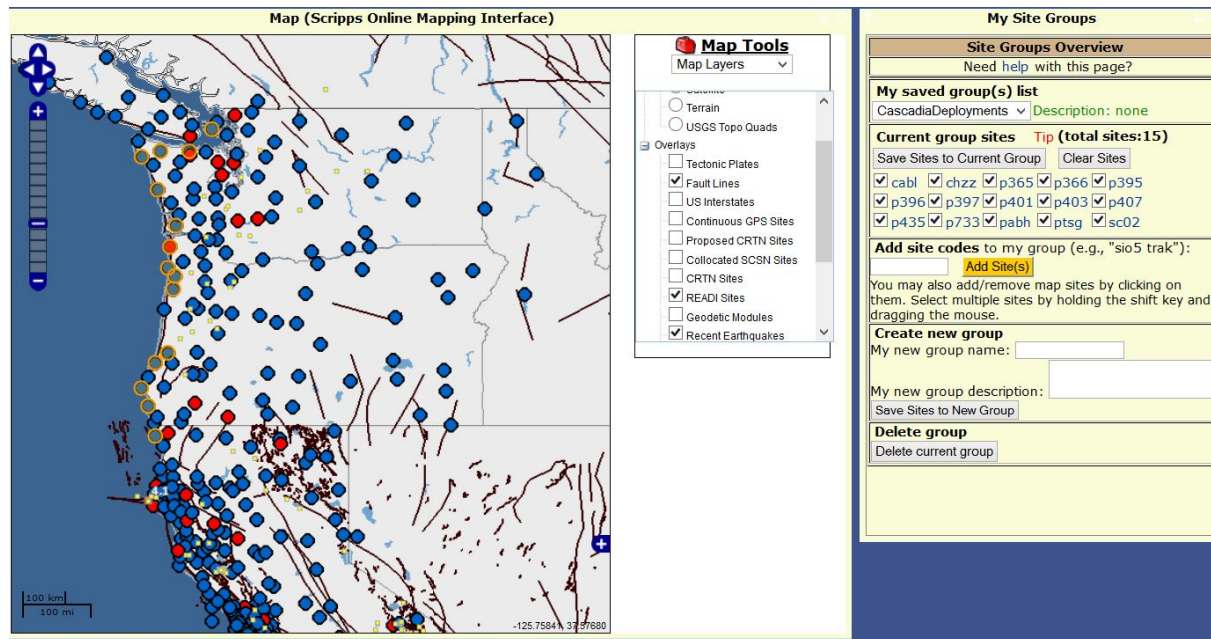
Southern San Andreas fault – overdue for large earthquake



- **Real-Time Earthquake Analysis for Disaster mitigation network (READI):** ~600 GPS stations, a NASA driven project
- Super set of GPS networks maintained by (sorted according to largest to smallest number of stations):
 - UNAVCO/PBO
 - CWU/PANGA
 - USGS/Pasadena-SCIGN & Menlo Park
 - UC Berkeley/BARD
 - Scripps Institution of Oceanography/SCIGN
 - California Department of Transportation/CSVSRN

<http://sopac.ucsd.edu/projects/realtime/READI/>

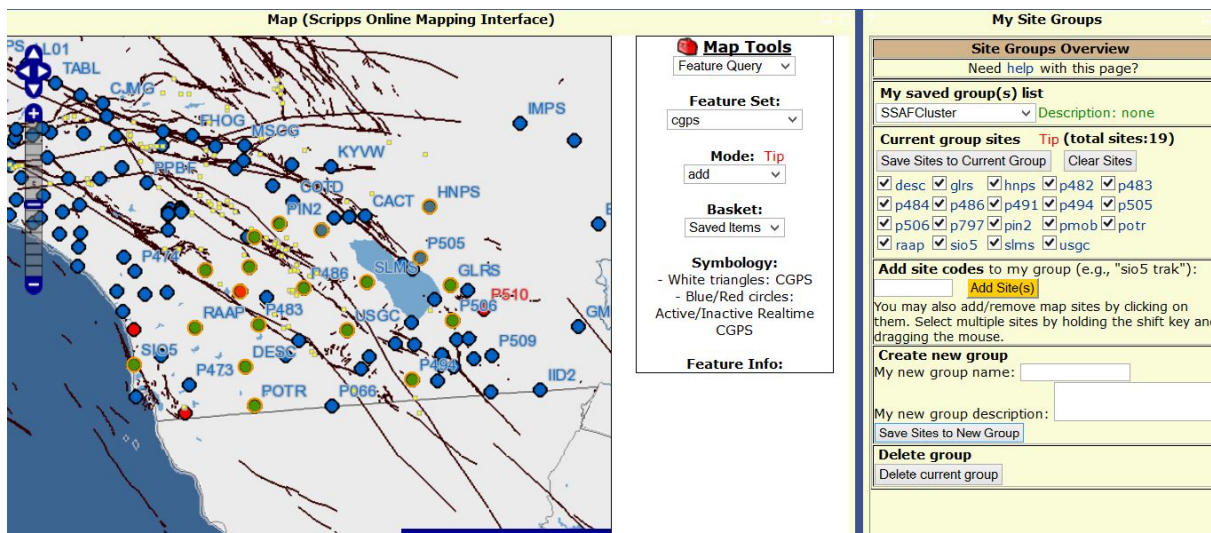
READI Clusters: Cascadia & Southern San Andreas Fault



Casacadia Cluster

Focused on Cascadia event:

15 PBO Stations: SC02, P435, P403, P401, PABH, P397, P407, CHZZ, P396, P395, P366, P365, CABL, P733, PTSG

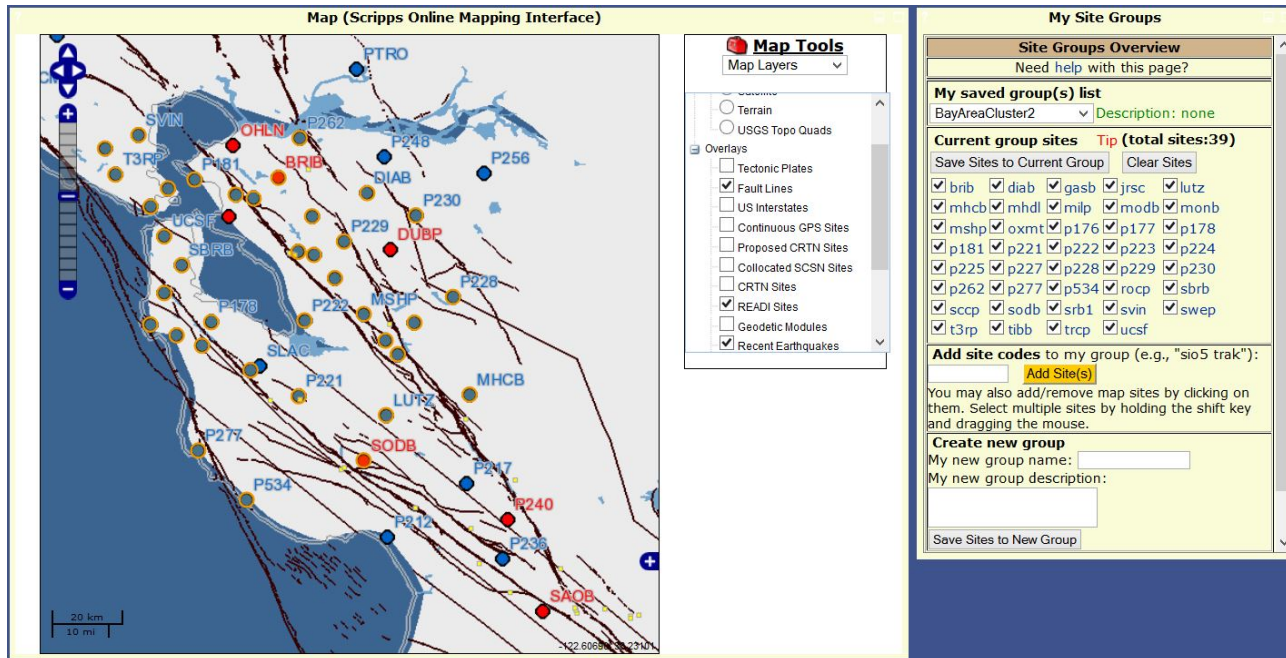


SSAF Cluster

Focused on southern San Andreas fault event:

(All stations with SIO seismogeodetic upgrade)
19 Stations (12 PBO, 6 SIO, 1 MWD): DESC, GLRS, HNPS, P482, P483, P484, P486, P491, P494, P505, P506, P797, PIN2, PMOB, POTR, RAAP, SIO5, SLMS, USGC

READI Clusters: San Francisco Bay Area



Bay Area Cluster

Focused on Hayward fault event:

39 stations (17 BARD, 16, PBO, 6 USGS):

brib, diab, gasb, jrsc, lutz, mhcb, mhd, milp, modb, monb, mshp, oxmt, p176, p177, p178, p181, p221, p222, p223, p224, p225, p227, p228, p229, p230, p262, p277, p534, roc, sbrb, sccp, sodb, srb1, svin, swep, t3rp, tibb, trcp, ucsf

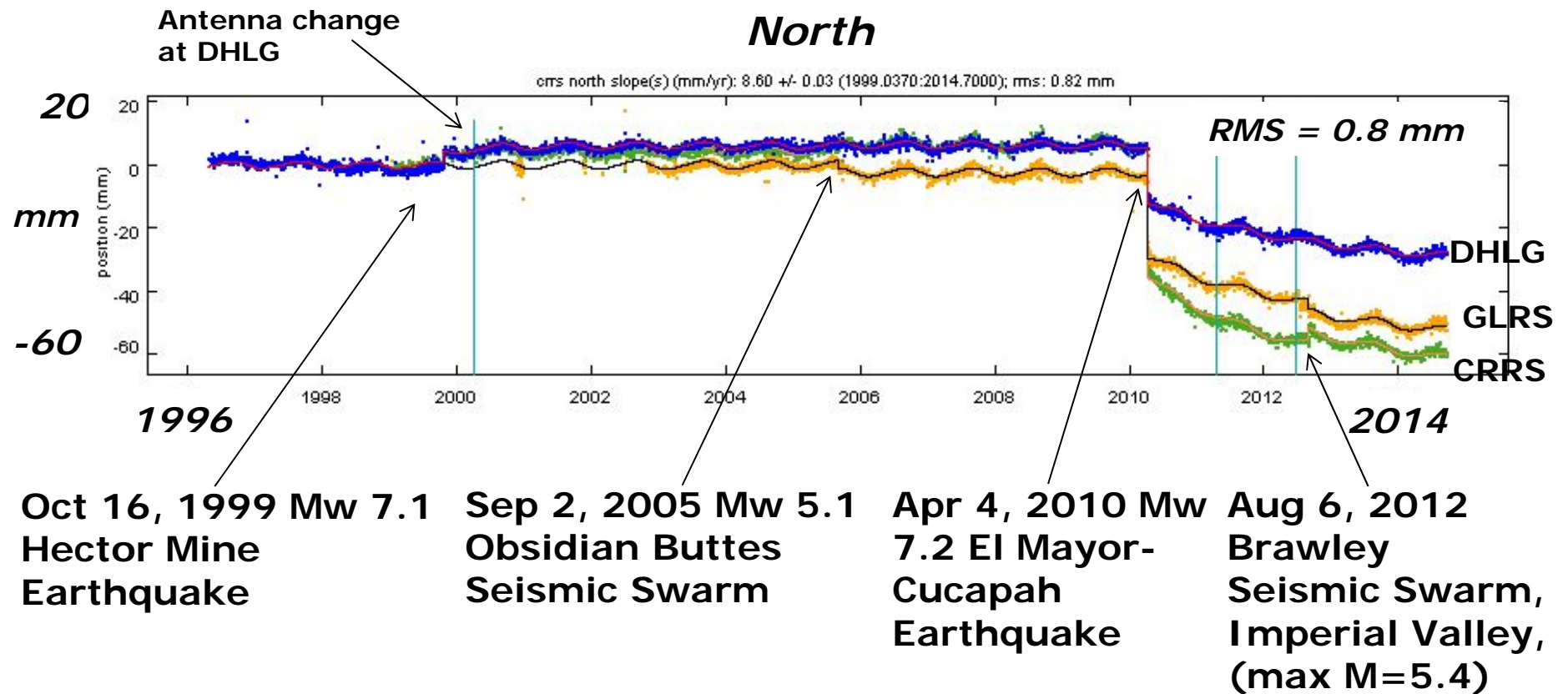
Note: 10 SIO Geodetic Modules and MEMS Accelerometer to be installed by PBO in Bay Area (seismogeodetic upgrades)

Note: Both CWU and SIO are in the process of building up the infrastructure to process all READI stations, and to perform a real-time combination

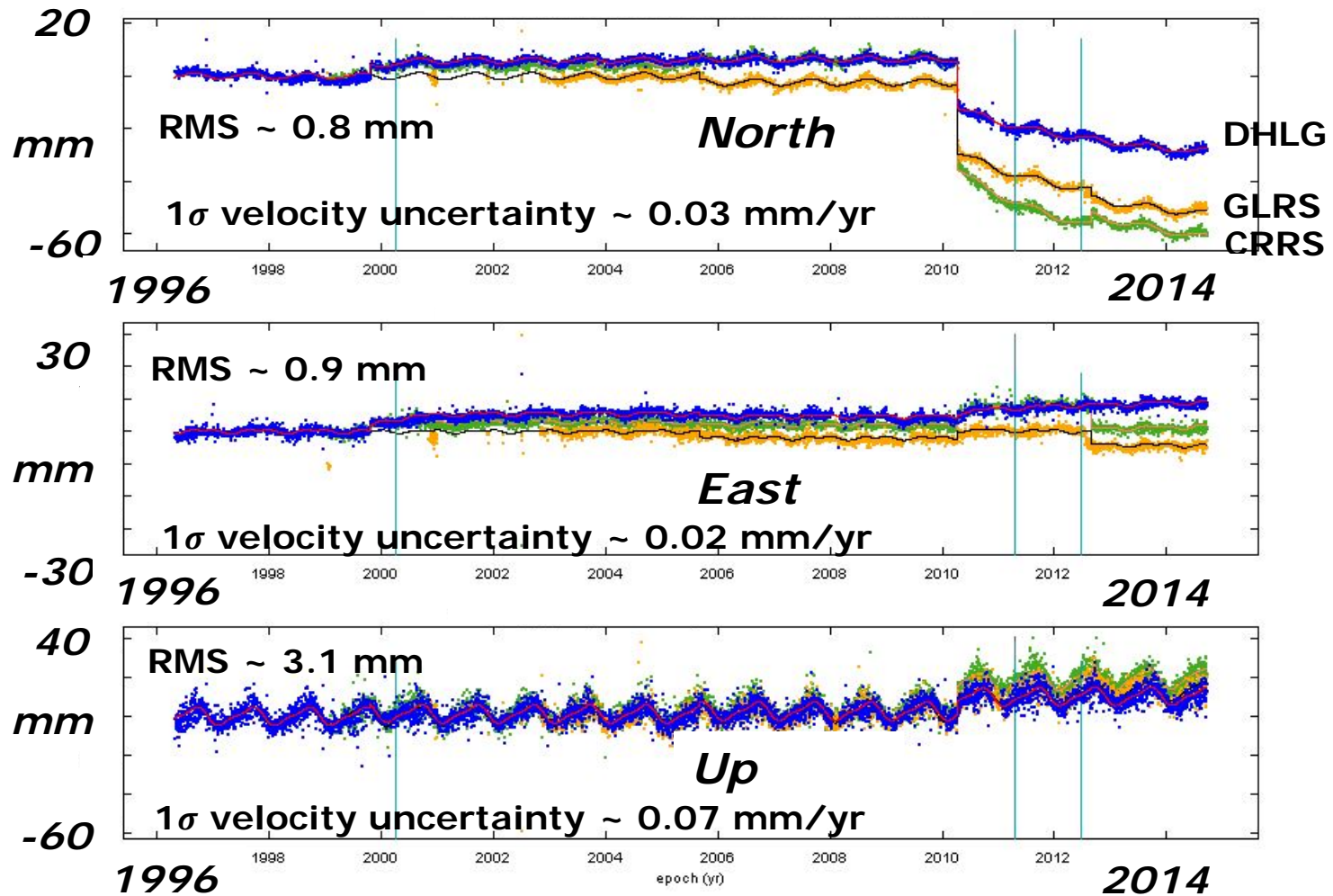
Significant Earthquakes in Western U.S. and Canada, Alaska (1992-2014)

	Date (UTC)	Earthquake/Volcano Eruption	Mw	Time (UTC)	Epicenter Latitude	Epicenter Longitude	Depth (km)
*	6/28/1992	Landers Earthquake, Southern California	7.3	11:57	34.13°N	116.26°W	
	6/10/1996	Adak, Aleutians	7.9	4:03			
*	10/16/1999	Hector Mine, Southern California	7.1	9:46:44			
	2/28/2001	Nisqually Fault, Seattle	6.8	18:54			
	11/3/2002	Denali, Alaska	7.9				
*	12/22/2003	Cambria, San Simeon, Central California	6.5		35.71° N	121.10°W	
	6/28/2004	Queen Charlotte Fault	6.8	9:49	53.987° N	133.61°W	
	7/19/2004	130 km from Campbell River, British Columbia	6.4	8:01			23.0
*	9/28/2004	Parkfield, Central California	6.0		35.81°N	120.37°W	
*	6/12/2005	Anza, Southern California	5.2		33.533°N	116.578°W	14.1
*	6/15/2005	Gorda Plate, CA	7.2				
*	6/16/2005	Yucaipa, Southern California	4.9				
*	9/2/2005	Obsidian Buttes Swarm, Salton Trough	5.1				
*	10/3/2006	Superstition Hill Seismic Swarm - silent slip	4.7				9.2
*	10/31/2007	Alum Rock, San Jose, California	5.6				
*	7/29/2008	Chino Hills, California	5.5		33.95°N	117.76°W	
*	1/10/2010	Eureka Earthquake, Offshore Northern California	6.5				
*	2/4/2010	Offshore Northern California, Humboldt County	5.9		40.42°N	124.92°W	
*	4/4/2010	El Mayor-Cucapah, Northern Baja California	7.2	22:40:41	32.128°N	115.303°W	
*	6/15/2010	Aftershock, El Mayor-Cucapah	5.7		32.698°N	115.924°W	
*	7/7/2010	Borrego Springs, Southern California	5.4		33.417°N	116.483°W	
*	8/26/2012	Brawley Seismic Swarm, Imperial Valley	5.3, 5.4				9.2
*	10/21/2012	Central California	5.3	6:55:09	36.310°N	120.856°W	
	1/5/2013	Southeastern Alaska	7.5	8:58:19	55.368°N	134.621°W	9.8
*	3/10/2014	Northern California offshore Ferndale	6.9	5:18:12	40.821°N	125.1277°W	7.0
*	3/27/2104	La Habra, Northwest Orange County	5.1				
	4/23/2014	near Port Hardy, Canada	6.6	3:10:09	49.8459°N	127.444°W	11.4
*	8/24/2014	South Napa	6.1	10:20:44	38.215°N	122.318°W	10.7
	9/15/2014	near Willow Alaska	6.2	17:51:17	61.9527°N	151.785°W	103.0

Time Series (18+ years) Affected by Earthquakes



Uncertainties (18+ years)



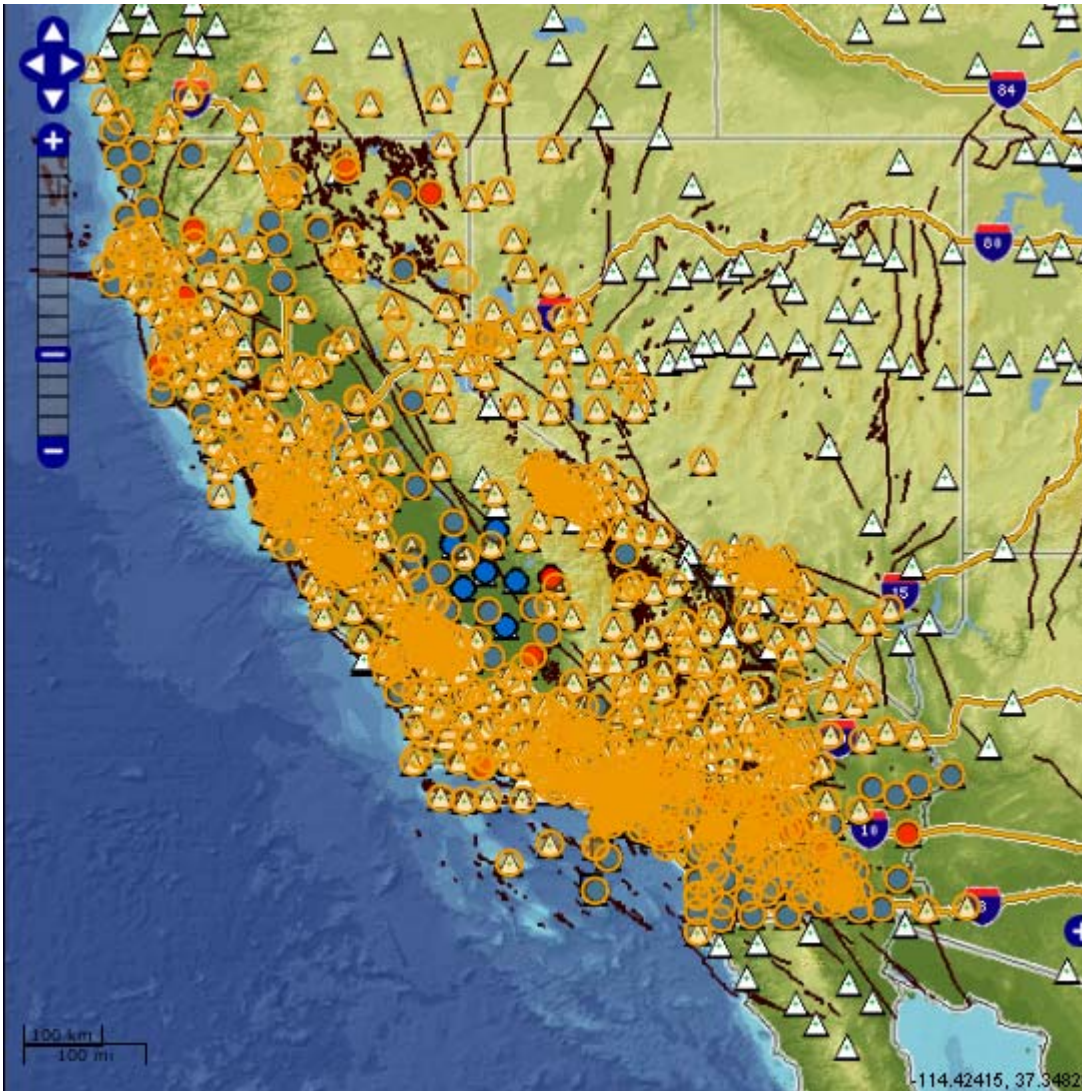
GPS/GNSS Positioning – Reference Frames

- The natural reference frame of GPS/GNSS is an Earth-Centered Earth-Fixed Reference Frame (ITRF)
- ITRF is defined by the positions and velocities of a global network of space geodetic tracking stations, to account for plate tectonic motions
- Precise GPS orbits (IGS) and broadcast ephemeris are with respect to ITRF (currently ITRF2008)

In California:

- We experience tectonic motion, earthquakes, subsidence, and volcanic activity so the reference network is deforming, while surveyors would like a static datum
- Multiple reference frames in use are tied to North America and the National Spatial Reference System (e.g., NAD83)
- Multiple epoch dates are in use
- Multiple positioning sources are available

CSRS Coordinate Epoch (2011.00)



- 830 CGPS stations (766@epoch 2009.00; 551@epoch 2007.00) – includes observations until 2011.2918
- Provisional coordinates estimated for new CRTN stations (e.g., SF Bay Area, Central Valley)
- ITRF2005 coordinates & velocities (update to ITRF2008 with planned reprocessing)
- NAD83(NSRS2007) coordinates & velocities
- Includes uncertainties to comply with California Public Resources Codes

<http://csrc.ucsd.edu/input/csrc/csrsEpoch2011.00.xls>

SECTOR Epoch-Date Coordinates (New Version – October 2012)

SECTOR: Scripps Epoch Coordinate Tool and Online Resource

[SECTOR Info](#)

Input Parameters

Coordinate

Source: SOPAC

Type: Unfiltered

[View Sites for this source](#)

Sites

☒ Single site: SIO5

☐ List of sites: (space delimited, max=20)

☐ Sites by array: ARGN (15) [View Sites for this array](#)

☐ All

Date

☒ 2012-10-25

☐ 2012 366

☐ 2012.0000

Output

display as: html table below

degrees as: decimal degrees

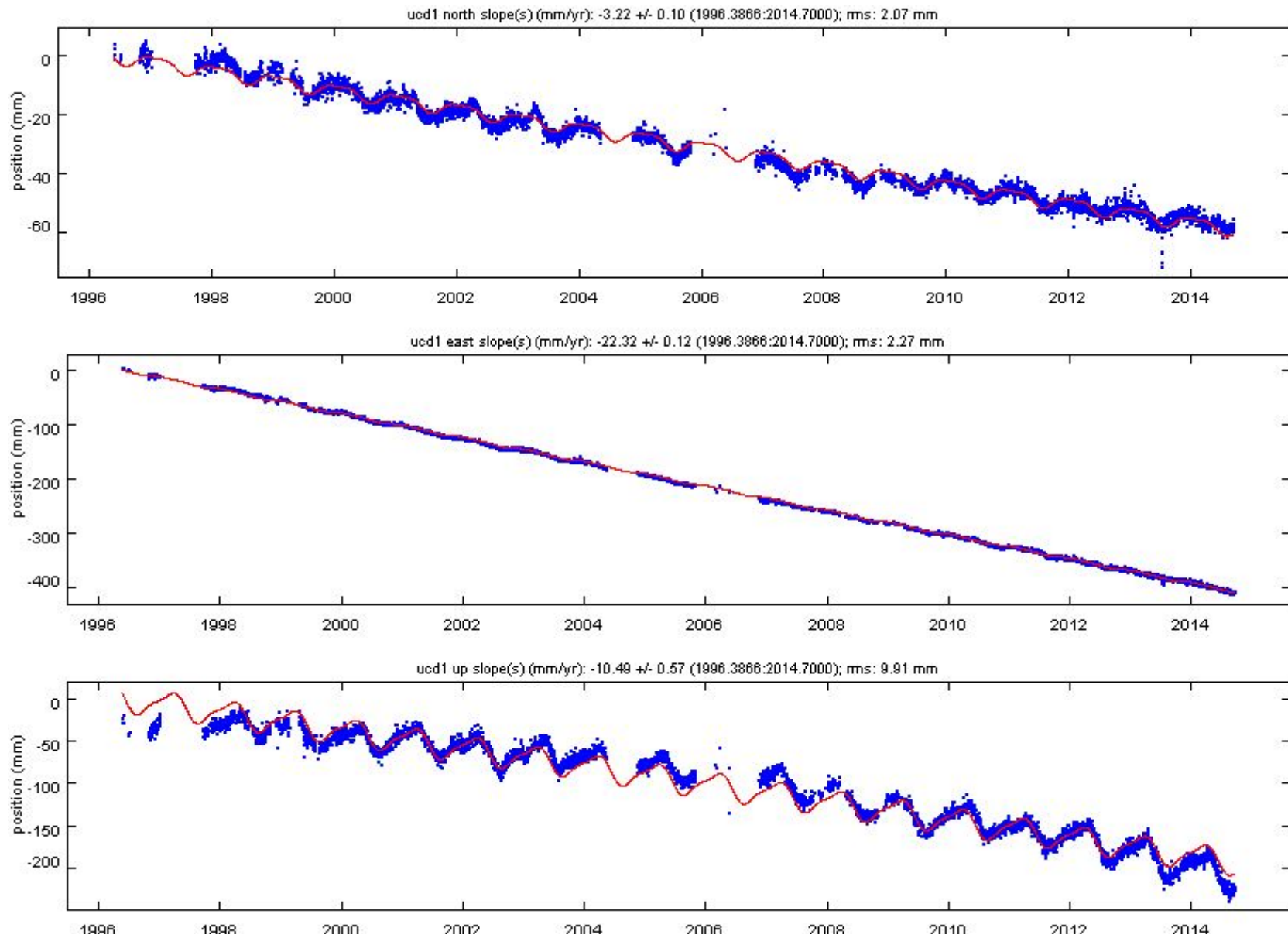
datum: WGS84 and NAD83

[Get Coordinates](#)

2012.8156		ITRF2008			WGS84			NAD83			
Site	X (m)	Y (m)	Z (m)	Lat (deg)	Lon (deg)	Height (m)	Lat (deg)	Lon (deg)	Height (m)	Model Terms	
sio5	-2456115.2761	-4768905.6501	3439232.5033	32.84073522	-117.24969111	185.51872841	32.84073202	-117.24967700	186.2665	<input checked="" type="radio"/>	
map	+/- 0.0015	+/- 0.0023	+/- 0.0018	+/- 0.0012	+/- 0.0011	+/- 0.0029					

<http://sopac.ucsd.edu/processing/coordinates/>

Case Study – UCD1



Case Study – UCD1

Case Study: 8 cm height discrepancy reported by Jim Frame at UCD1 – he uses it as a reference station for his local surveys

The BARD site log and JPL/SOPAC GPS analysis are consistent. The antenna height is zero as defined in the log as the bottom of the preamp of the choking antenna. There is an offset noted in the log to a physical reference point of 8.3 cm but the CSRC 2011.00 coordinates were published based on an antenna height of zero.

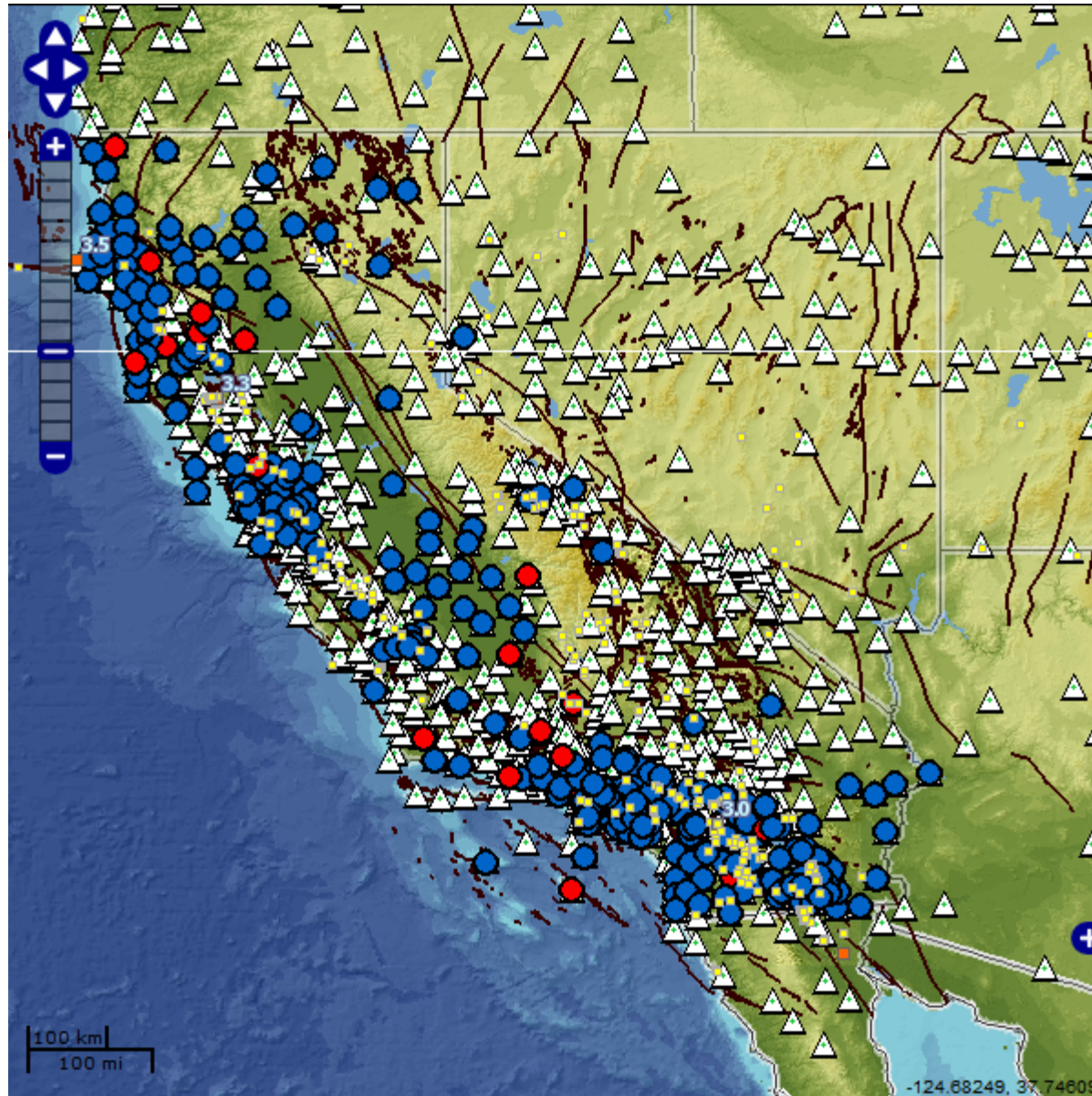
Most likely your problem is the subsidence of UCD1 from the published 2011.00 epoch to today's date of 6.9 cm. Compound that with peak to peak seasonal effects of about 4 cm, that should add up to your problem (see attached time series shots from GPS Explorer). So on any given day, your coordinates may differ by 5-9 cm compared to the published/transmitted coordinates. Obviously, you'll need to take all this into account when doing your survey work.

The antenna height is zero as defined in the log as the bottom of the preamp of the choking antenna. The offset noted in the log to a physical reference point of 8.3 cm. CSRC 2011.00 coordinates were published based on an antenna height of zero. (similar situation for MHCB)

Published CSRC NAD83/NSRS2007 2011.00	38 32 10.449957	-121 45 4.380424	0.092		
SECTOR 2011.00 coordinates, run at 9/15/20	38 32 10.450037	-121 45 4.380384	0.085	0.006	
SECTOR 2011.00 coordinates, run at 9/15/20	38 32 10.451231	-121 45 4.381673	0.023	0.069	
UCD1 vertical velocity	-10.49 +- 0.54 mm/yr				
	0.0105	3.90	0.0410		
Peak to peak seasonal	0.0400			0-8 cm on any given day	

The state needs to publish a new set of epoch date coordinates that will minimize these types of problems (at least for a while), but it will not change the fact that UCD1 is not a great monument and is subsiding at a significant rate.

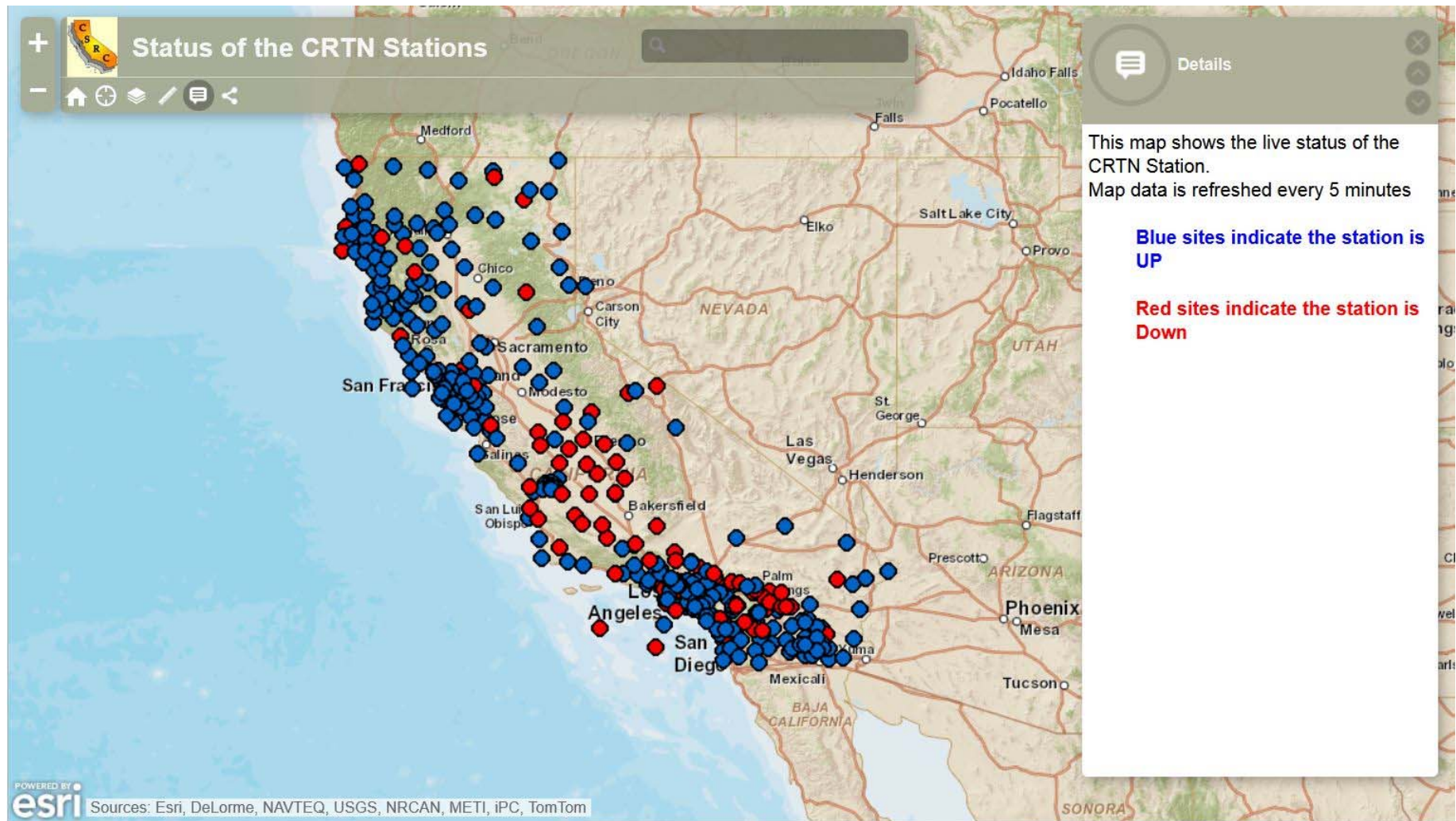
California Real Time GPS Network (CRTN)



CRTN is a multipurpose statewide real-time network that utilizes the existing geophysical CGPS infrastructure in California. Started in 2003, 1 Hz RTCM 3.0 data are available from 369 stations from 2 CRTN servers (SC: 170 stations; NC: 199 stations) at SIO with a latency of ~ 0.4 s. Data directly collected from SCIGN/PBO stations via UCSD's HPWREN, and from servers at UNAVCO/PBO, USGS Pasadena, UC Berkeley, Caltrans, Orange County, and Metropolitan Water District.

NAD83(NSRS2007) coordinates transmitted, with station metadata in RTCM 3.0 format

CRTN – ESRI Interface (CLSA account)



Courtesy CLSA, Ryan Hunsicker (chair of the GIS Committee of CLSA), Rich Maher

CRTN – NTRIP

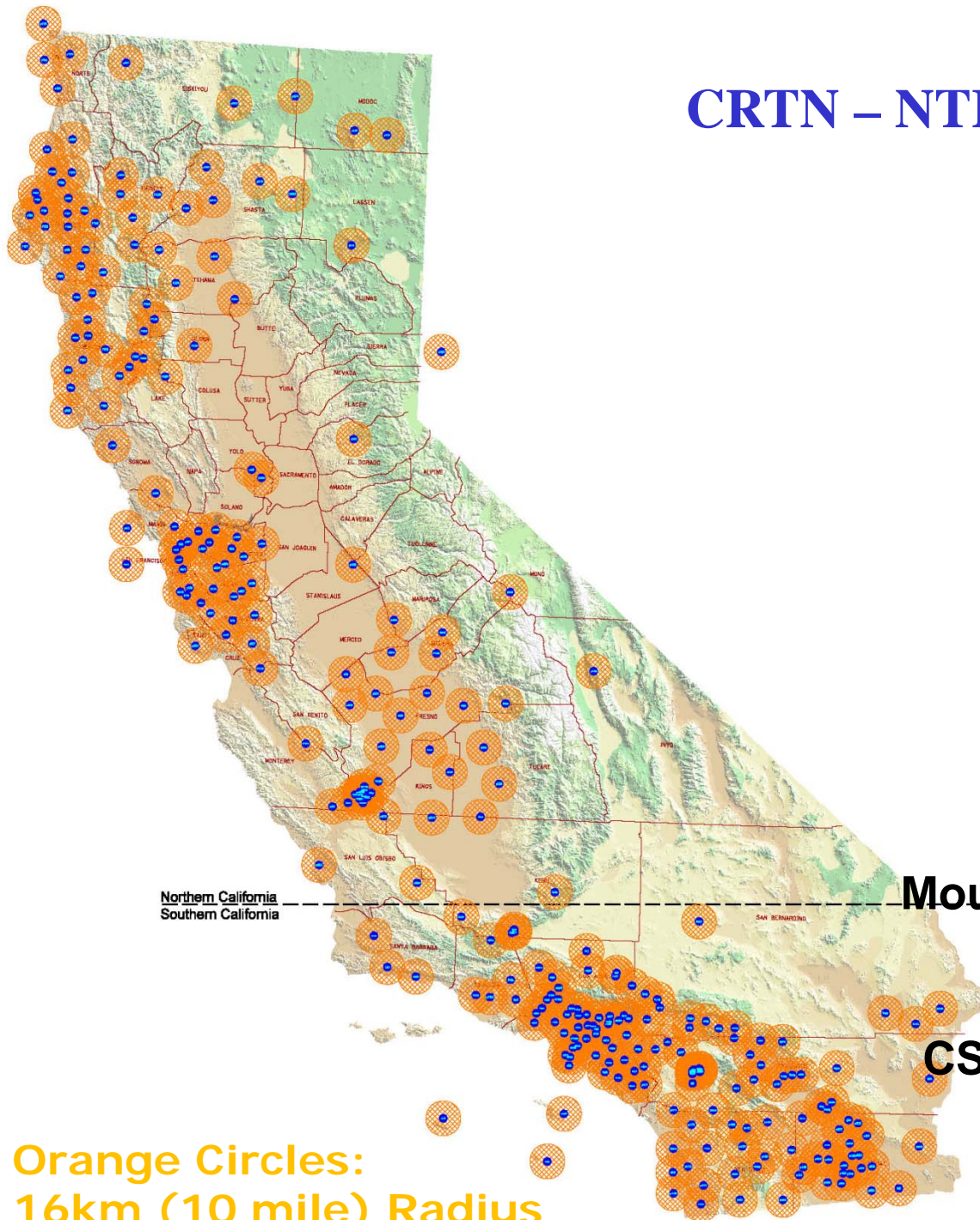
Northern California
IP: 132.239.154.101
Port: 2103
(199 stations)

Southern California
IP: 132.239.152.72
Port: 2103
(170 stations)

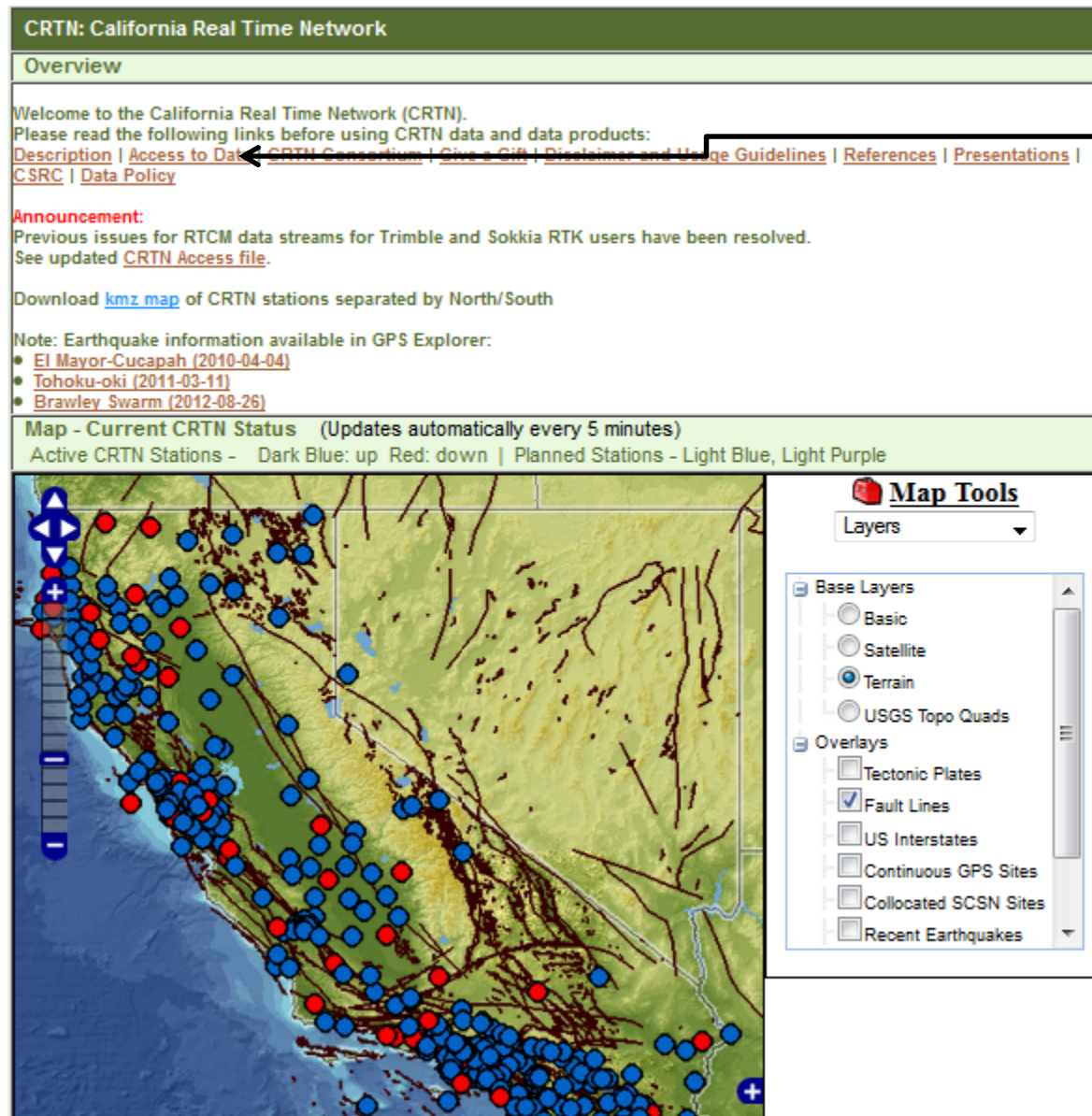
RTCM 3.0

Mountpoints: “SITE_ RTCM3”
SITE=4-character code

CSRC 2011.00 Epoch NAD83
(NSRS2007) Coordinates



<http://sopac.ucsd.edu/projects/realtime/CRTN/>



NTRIP access and
Epoch 2011.00
NAD83(NSRS2007)
coordinates

<http://csrc.ucsd.edu/>

CALIFORNIA SPATIAL REFERENCE CENTER

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Enter CSRC Data Portal | Maps | Projects

CSRC Data Portal help

Information for your California GPS projects:
Access to CRTN Data and Coordinates
[CSRS Epoch 2011.00](#)
[CSRS Epoch 2009.00](#)
[CSRS Epoch 2007.00 \(updated\)](#)
[CSRS Epoch 2007.00](#)

via SITE CODE / NGS PID

via MAP BROWSER

or VIEW PORTAL RESOURCES

Featured links:

[CRTN PS10](#)
Current CRTN and CSRN Maps

[CRTN Stations\(kmz\)](#)
Google Earth Map showing all current active real-time CGPS stations available via NTRIP

[CRTN All Stations\(pdf\)](#)
Map showing all current active real-time CGPS stations available via NTRIP

[CRTN Backbone\(pdf\)](#)
Map showing proposed CRTN Backbone network as well as NGS CORS stations

[CSRN 2011.00 Epoch](#)
Map showing all CGPS stations included in the 2011.00 Epoch adjustment

[CRTN Data Policy](#)

CRTN Metrics: [Logins](#) [Stations](#)

News more

[CSRC Presentations](#)

California Spatial Reference Center (CSRC) Coordinating Council Spring Meeting
Thursday May 16th, 2013
10:00 AM to 3:00 PM
9:30-10:00 AM meet and greet, orientation and light breakfast
Lunch will be provided around noon
Martin Johnson House (Bldg T29), Scripps Institution of Oceanography (SIO), UCSD
8840 Biological Grade, La Jolla, CA 92037
[Map](#)

California Real-Time Network (CRTN) Workshop presented by the California Land Surveyors Association (CLSA) with CSRC

Announcement:

Forums

Published Coordinates

Real-Time Map

Various CRTN Maps

Presentations

Relevant CRTN Metadata

Essential:

- Coordinates of CGPS stations – CSRS Epoch 2011.00 NAD83 (NSRS2007)
- Type/manufacturer of antenna
- Type/manufacturer of receiver
- Antenna reference point (ARP)
- Antenna offsets from reference point (height, mainly)

Optional:

- Receiver serial number
- Antenna serial number

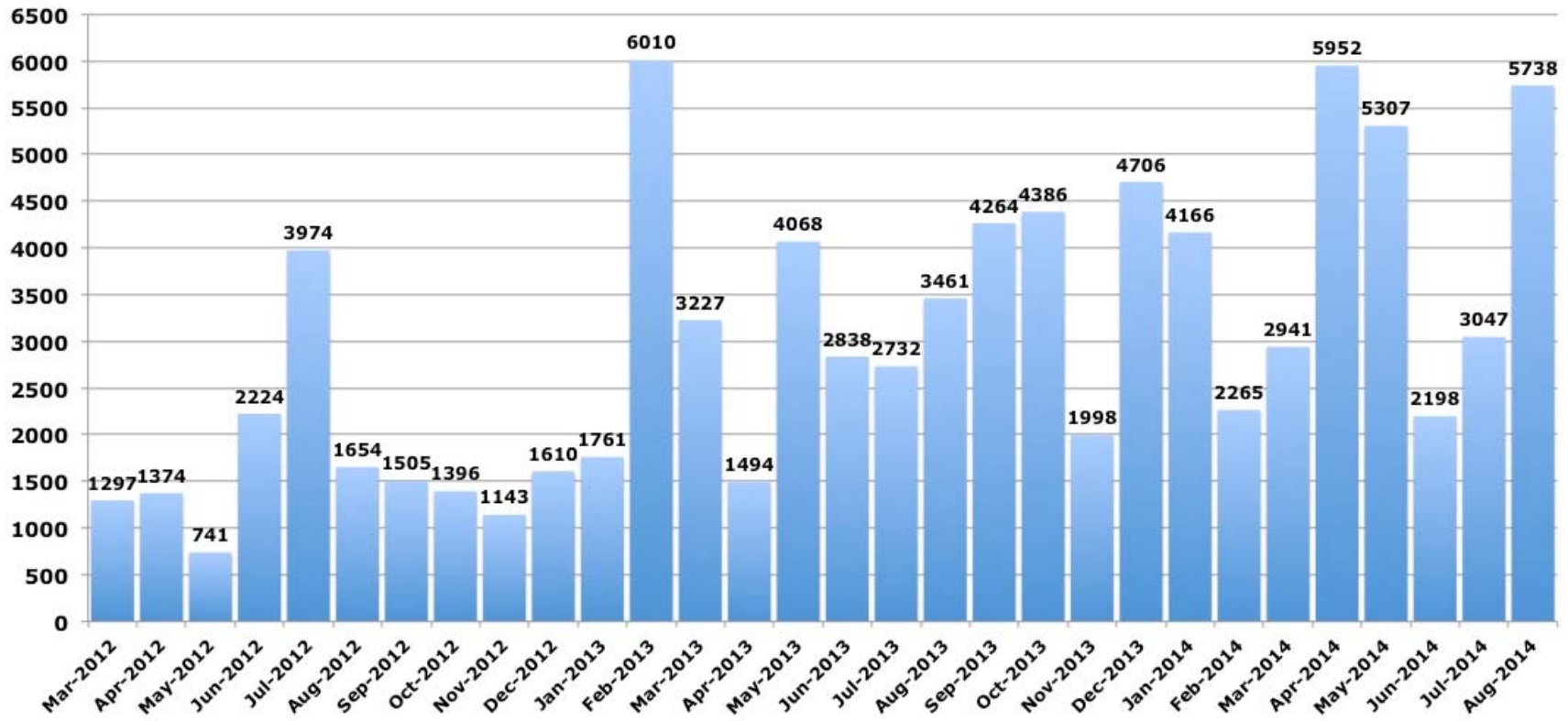
Transmitted in RTCM 3.0 message for real-time stations

CRTN – Single Base User

- An NTRIP account (username & password) is required, and requested by emailing the CSRC director (ybock@ucsd.edu)
- To date 315 companies/agencies registered (up from 268 in April, 2013) – 15 multi-account users (CRTN Consortium & Contributors) users
- Recent accounts (not including many surveyors & engineers)
 - FST Sand and Gravel
 - C.W. Crosser Construction, Inc.
 - California American Water
 - Mercury Data Systems (North Carolina company doing bus stop survey in LA)
 - Honda Research Institute USA, Inc. (high precision ground-truth navigation data)
 - Wildlands (Ecosystem & Mitigation Banking)
 - CSR (produces consumer grade GNSS chipsets, Santa Ana)

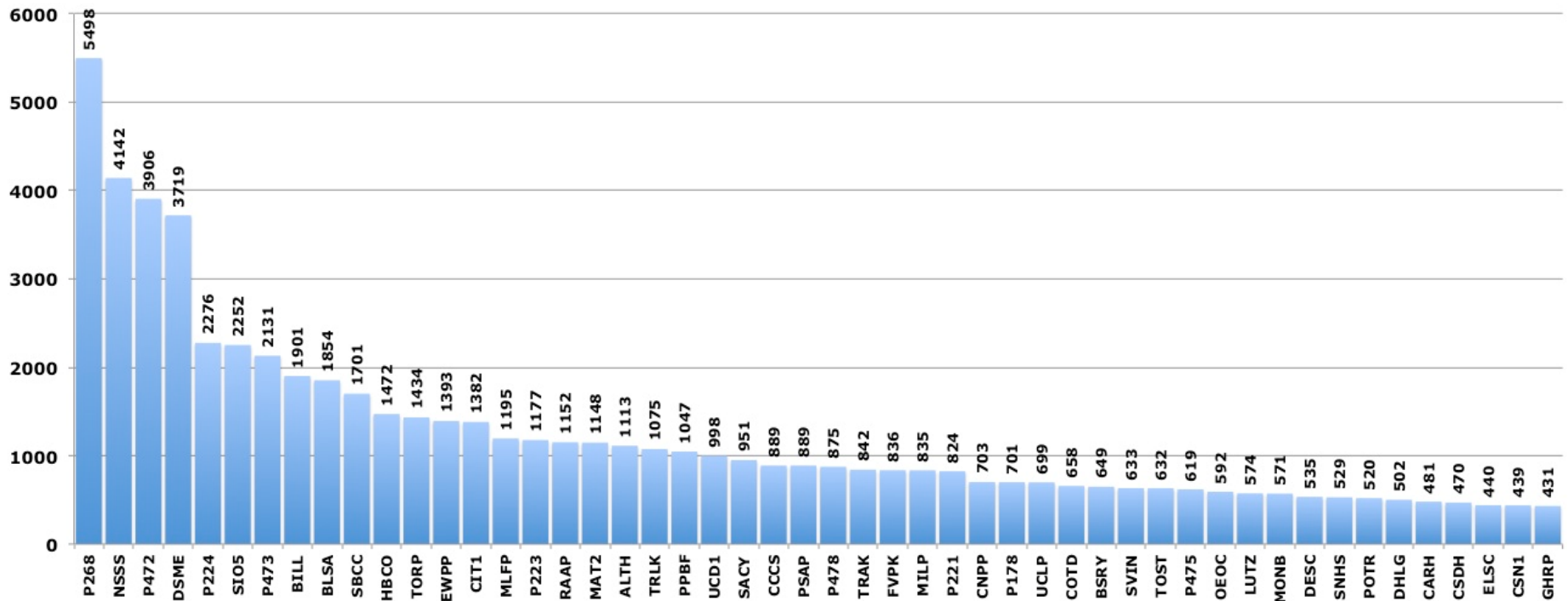
CRTN Metrics

Number of CRTN NTRIP Connections by Login (NTRIP Accounts = 267)



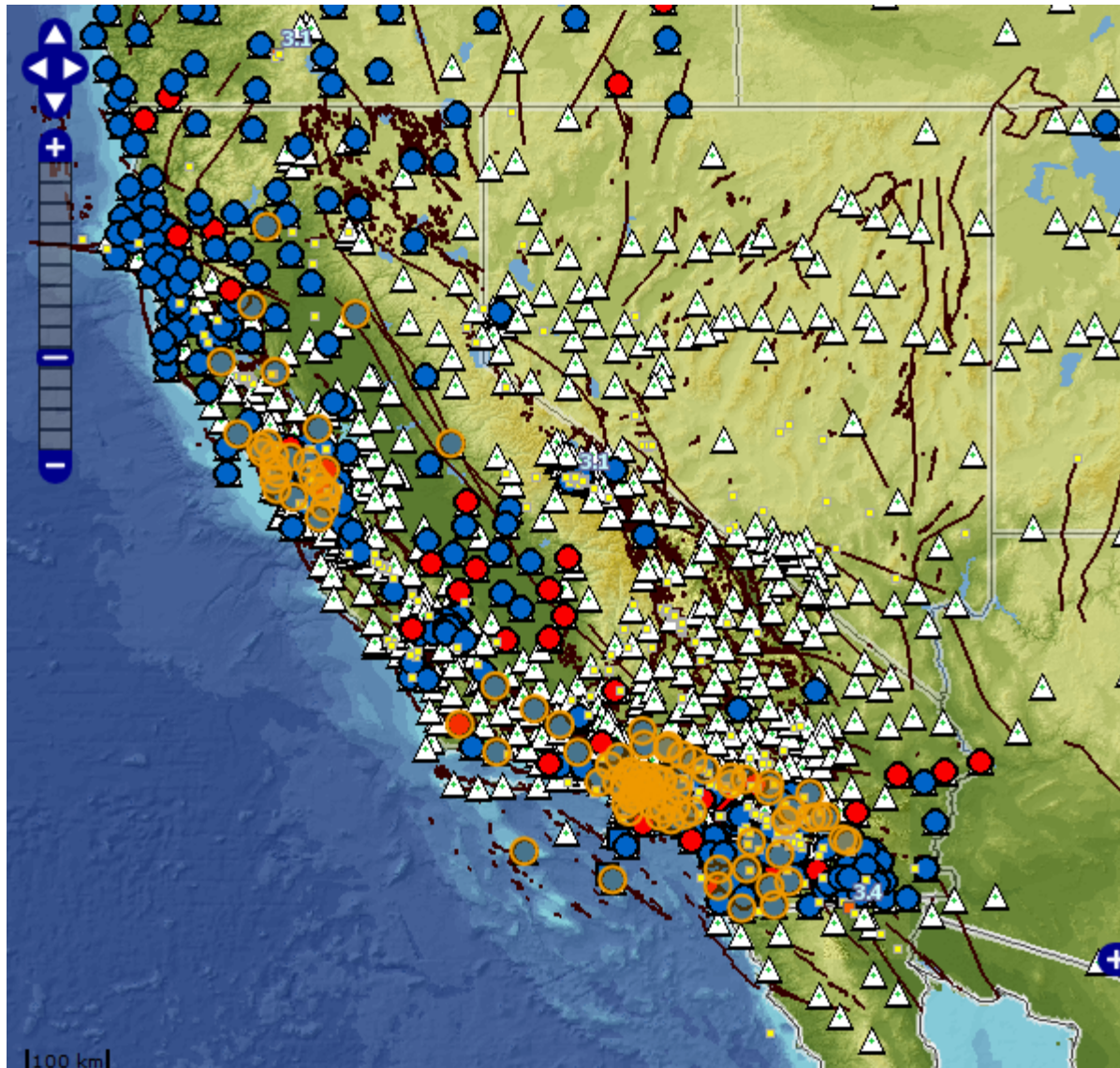
CRTN Metrics

**Cumulative Number of CRTN NTRIP Connections by Station
from February 2012 to August 2014 (Top 50 Stations with Total Connections ≥ 431)**



Notes: PBO sites, UCD1, TRLK, NSSS

GNSS Upgrades



- Topcon NET-G3A GNSS capable receivers at 96 CRTN stations
- Only 23 of these stream GLONASS data – all in southern California by CRTN Consortium members
- No progress in extending capability to USGS and BARD Topcon receivers, in southern California, the greater SF Bay Area and northern California
- Good outcome from PBO Workshop last week regarding GNSS upgrades at real-time PBO stations
- SOPAC is archiving 24-hour RINEX files with GLONASS data

CRTN – Members

Current Consortium Members:

1. City of Los Angeles, Department of Public Works, Bureau of Engineering, Tony Pratt
2. Riverside County Flood Control and Water Conservation District, Jim McNeill, Gary Poor
3. Orange County Public Works, Art Andrew
4. San Diego County, Department of Public Works, Terry Connors
5. Riverside County Transportation Department, Ed Hunt, Tim Rayburn
6. Santa Clara Valley Water District, Thomas Dougherty
7. City of Long Beach, Gas and Oil, Kimberley Holtz
8. California Land Surveyors Association, Michael McGee
9. California Spatial Reference Center, Rich Maher
10. Scripps Institution of Oceanography, UCSD, Yehuda Bock

Contributing Members:

1. East Bay Municipal Water District, Steve Martin
2. Rail Surveyors and Engineers Incorporated, Cody Festa
3. East Bay Regional Parks, Duncan Marshall
4. RBF Consulting, Company of Michael Baker Corporation, Greg Helmer
5. PSOMAS, Jeremy Evans

CRTN Community Notices

	Topic	Topic Starter	Replies	Last Post
	CRTN CVSRN stations	ybock	0	03-04-2013 07:24 AM
	UNAVCO Network Upgrades and Outages	Maria Turingan	0	02-11-2013 04:00 PM
	All RTCM3 streams okay	ybock	0	01-29-2013 10:12 AM
	QCRN & CVSRN updates	ybock	0	12-10-2012 10:21 AM
	New CRTN Stations	ybock	0	11-20-2012 09:17 PM
	Topcon RTCM3 and GLONASS Tracking	ybock	0	08-13-2012 09:42 AM
	GLONASS satellites available in San Diego	ybock	0	07-31-2012 11:17 AM
	SOPAC 20th Anniversary and Your Feedback	Maria Turingan	0	07-06-2012 12:30 PM
	RTCM streams for Trimble/Sokkia Users	ybock	0	06-01-2012 10:37 AM
	Transition to NTRIP	ybock	0	03-13-2012 03:41 PM
	Update from UNAVCO	Maria Turingan	0	02-28-2012 04:09 PM
	UNAVCO-PBO outage	Maria Turingan	0	02-28-2012 01:39 PM
	Extension to March 1	ybock	0	02-12-2012 11:10 AM
	Important: Access to CRTN Data after Feburary 17th	ybock	0	01-26-2012 10:30 AM
	Important CRTN changes	ybock	0	01-17-2012 10:48 AM
	CRTN NTRIP Servers and RTCM3.0	ybock	0	01-05-2012 12:19 AM

UBBFriend: Email this page to someone!

Author	Topic: CRTN CVSRN stations
ybock Member Member # 17 Member Rated: ★★★★★	posted 03-04-2013 07:24 AM <p> CRTN transmits RTCM3.0 data streams obtained from the Caltrans' Central Valley Spatial Reference Network (CVSRN) server. We now stream data from all 22 stations (P056, P300, P302, P544, P566, RBRU, ALTH, CRCN, *DONO, RAPT, CHOW, DOND, DLNO, LEBC, LEMA, *MULN, TEHA, TAFT, TRLK, SHP5, *JLN5, SIMM). The stations with an asterisk are not currently available. We've also updated the transmitted Epoch 2011.00 NAD83 (NSRS2007) coordinates for those stations that were not part of the Epoch 2011.00 adjustment (except for JLN5 from which we have not yet obtained any data). As such they should be considered as provisional. See http://sopac.ucsd.edu/input/realtime/CRTN_Access.xls, which will be updated later today, for details. The changes are reflected in the CRTN Northern California NTRIP source table @ http://132.239.154.101:2103/. Thanks to Anthony Believ who pointed out a problem with our RBRU coordinates and to Eric Adney and Bryan Banister at Caltrans for their assistance. Please notify us of any problems that you may experience. --Yehuda </p> <p> Posts: 215 Registered: Feb 2005 IP: Logged </p>

<http://sopac.ucsd.edu/ubbcgi/ultimatebb.cgi?category=6>

Forums

If we don't know something is wrong we can't fix it!

UBB.classic

SOPAC Geophysical Forums

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» [Today's Active Topics](#) «

» You are not logged in. [Login](#) or [register](#)

Registered Members: 1247
Welcome to our newest member: [Bob MacKenzie](#)

SOPAC Geophysical Forums Recent Visitors: 50

50 guest(s)

Forum Categories

Total Forums in Category

[MEASURES/REASoN](#)

7

[SOPAC](#)

7

[GSAC](#)

1

[CSRC](#)

California Spatial Reference Center. Includes forums on CSRC website, height modernization projects, and PGM (Pocket GPS Manager).

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[CRTN](#)

The California Real Time Network provides real-time GPS connectivity in California. Enter the forum to view general notices or participate in discussions pertaining to CRTN.

3

[SOMI](#)

Discussion, feature requests, bug reports and announcements for the SOPAC Online Mapping Interface (SOMI).

6

[GPS Explorer](#)

Discussion, feature requests, bug reports and announcements for GPS Explorer.

7

CRTN

[Contact Us](#) | [SOPAC Homepage](#)

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Forum	Topics	Posts	Last Post	Moderators
CRTN The California Real Time Network provides real-time GPS connectivity in California. Enter the forum to view general notices or participate in discussions pertaining to CRTN.				
 CRTN Community Notices CRTN notices of community-wide relevance. All messages posted here (by moderator) go to the crtm-l@gpsmail.ucsd.edu mailing list. Go to the CSRC to register.	86	90	 CRTN CVSRN stations (ybock) 03-04-2013 07:24 AM	crtm-l administrator
 CRTN General Discussion CRTN-related topics, user-specified and updated. Topics may be posted here by any user.	26	71	 Re: Single Data Stream or... (ybock) 04-10-2012 09:51 PM	ybock , Marti , mindy , Maria Turingan , Anne Sullivan
 RYO Format Discussion of the RYO format, streaming and conversion.	0	0		no one

Icon Legend



New Posts Since Your Last Visit



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Seismogeodesy & GPS Meteorology



**GPS station
(1-10 Hz)**

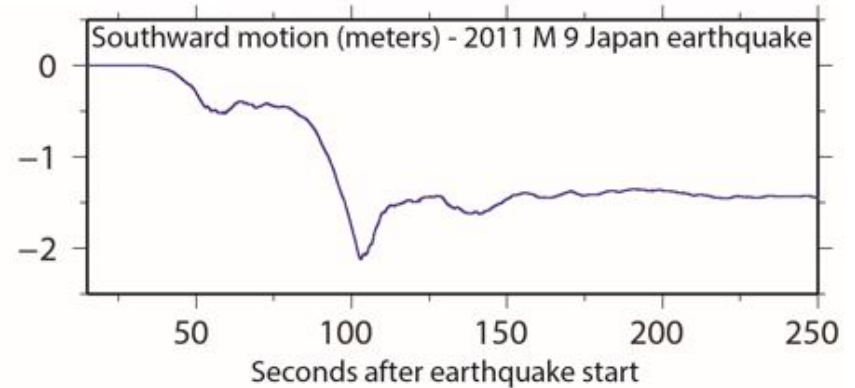
+



**Accelerometer
(100-200Hz)**

=

***Continuous measure of
seismic displacements
and velocities***



**GPS
(1-300 s)**

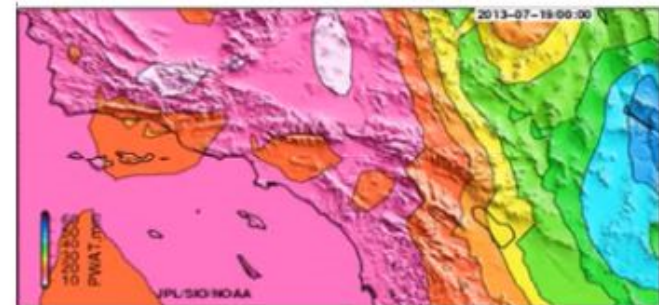
+



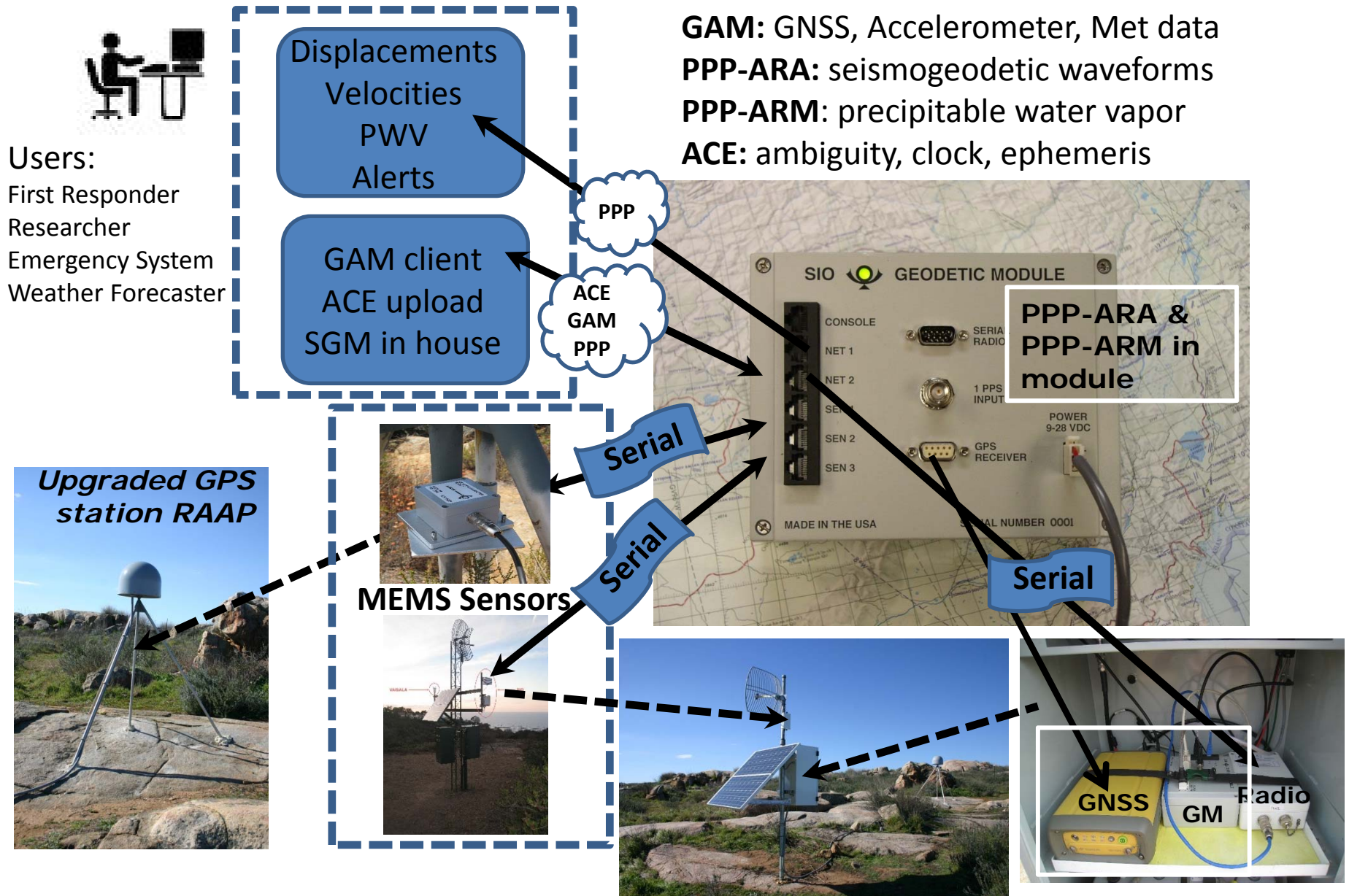
**Meteorological Sensors
(pressure, temperature)**

=

***Continuous atmospheric
water vapor maps***



Development and deployment of SIO MEMS accelerometers



Work funded by NASA

SIO MEMS Accelerometer Tests

Experiment Configuration

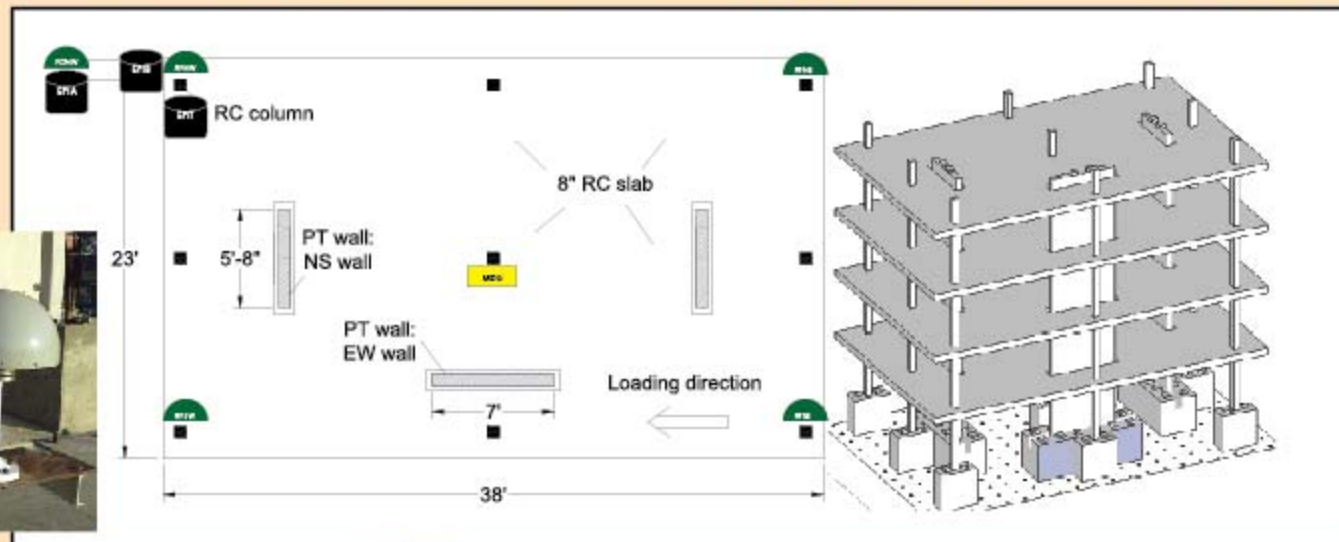
Local Reference site



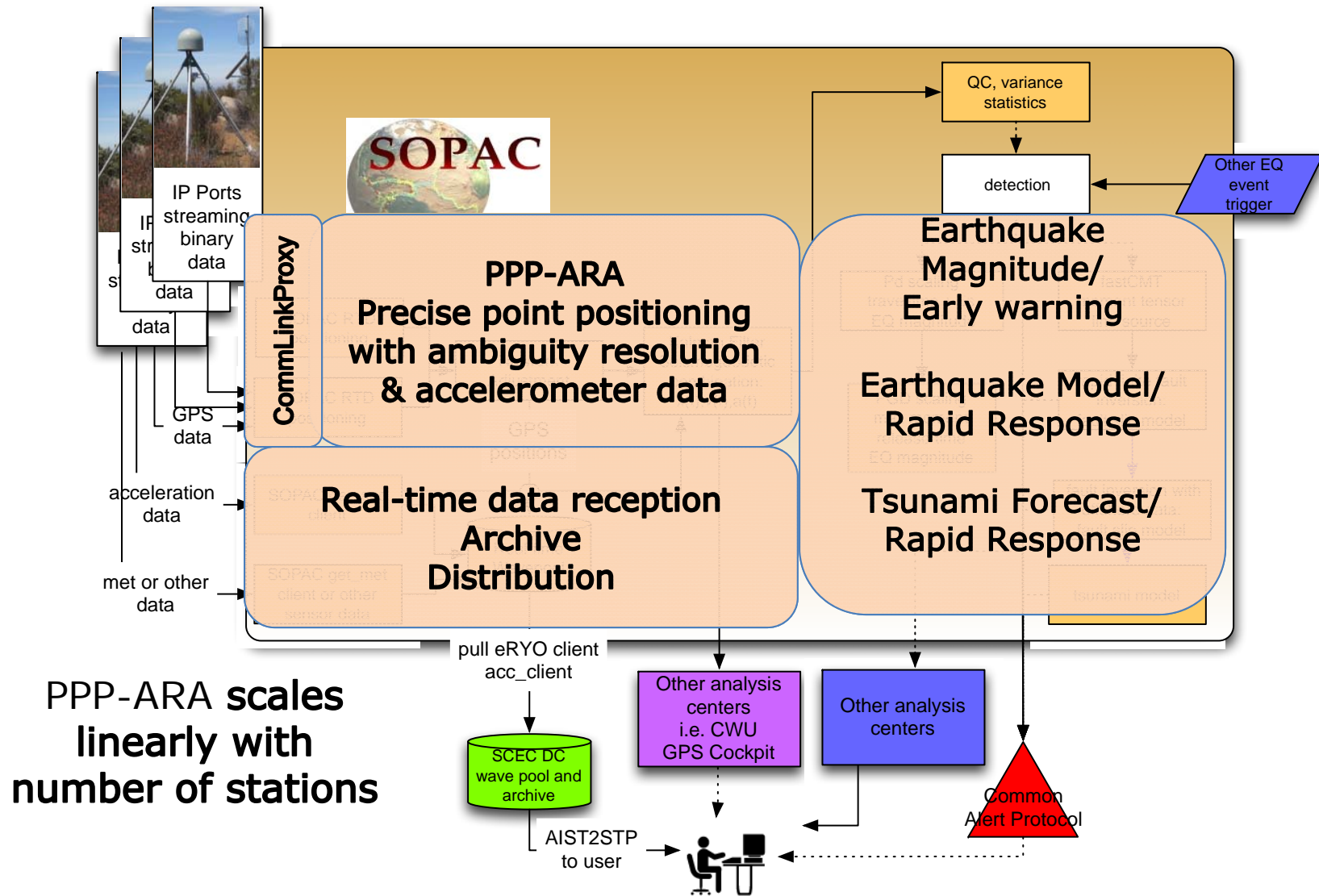
Rooftop NW GPS + MEMS accelerometer and collocated Episensor



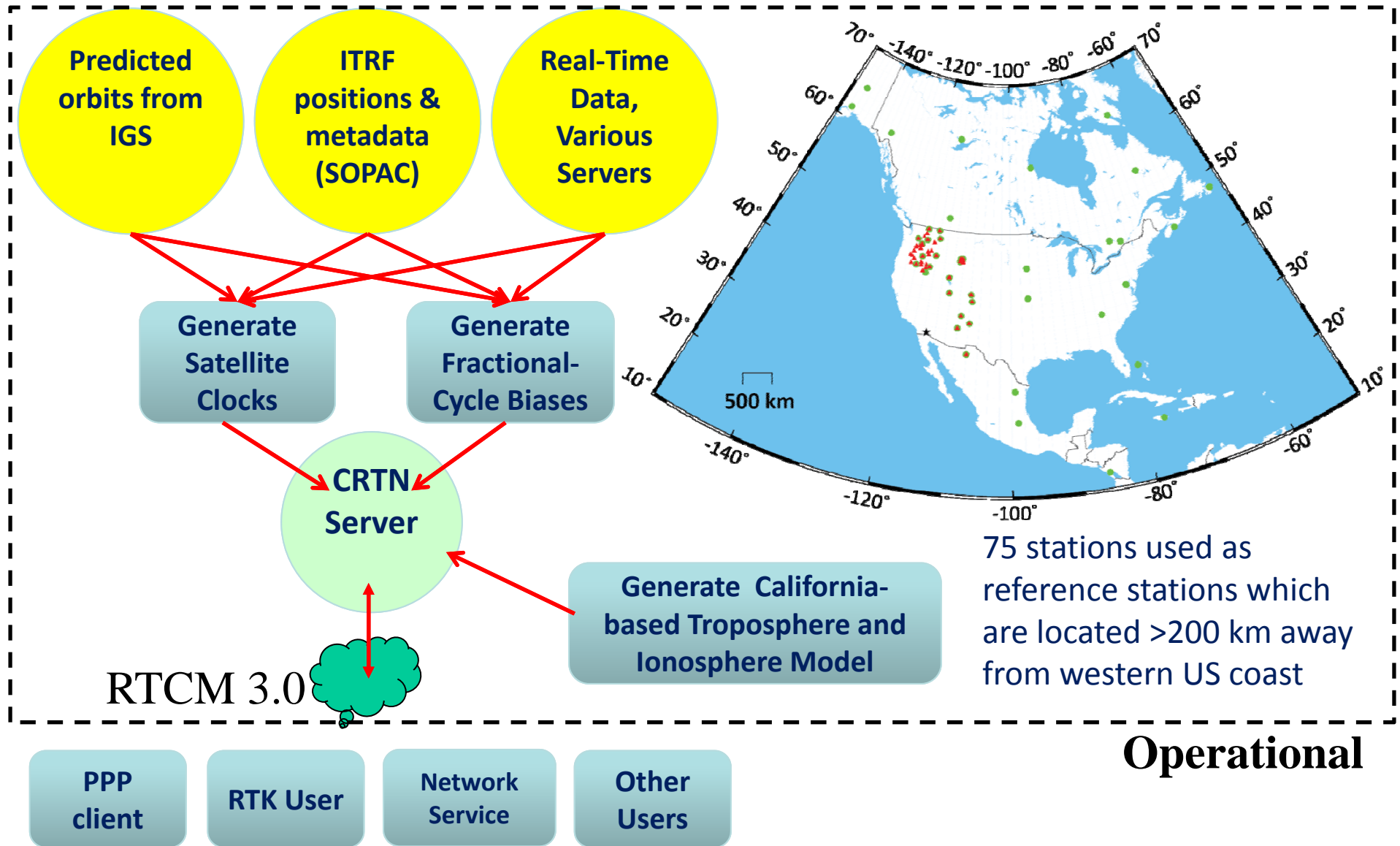
Foundation GPS + MEMS Accelerometer and Episensor



Real-Time Seismogeodetic Monitoring System

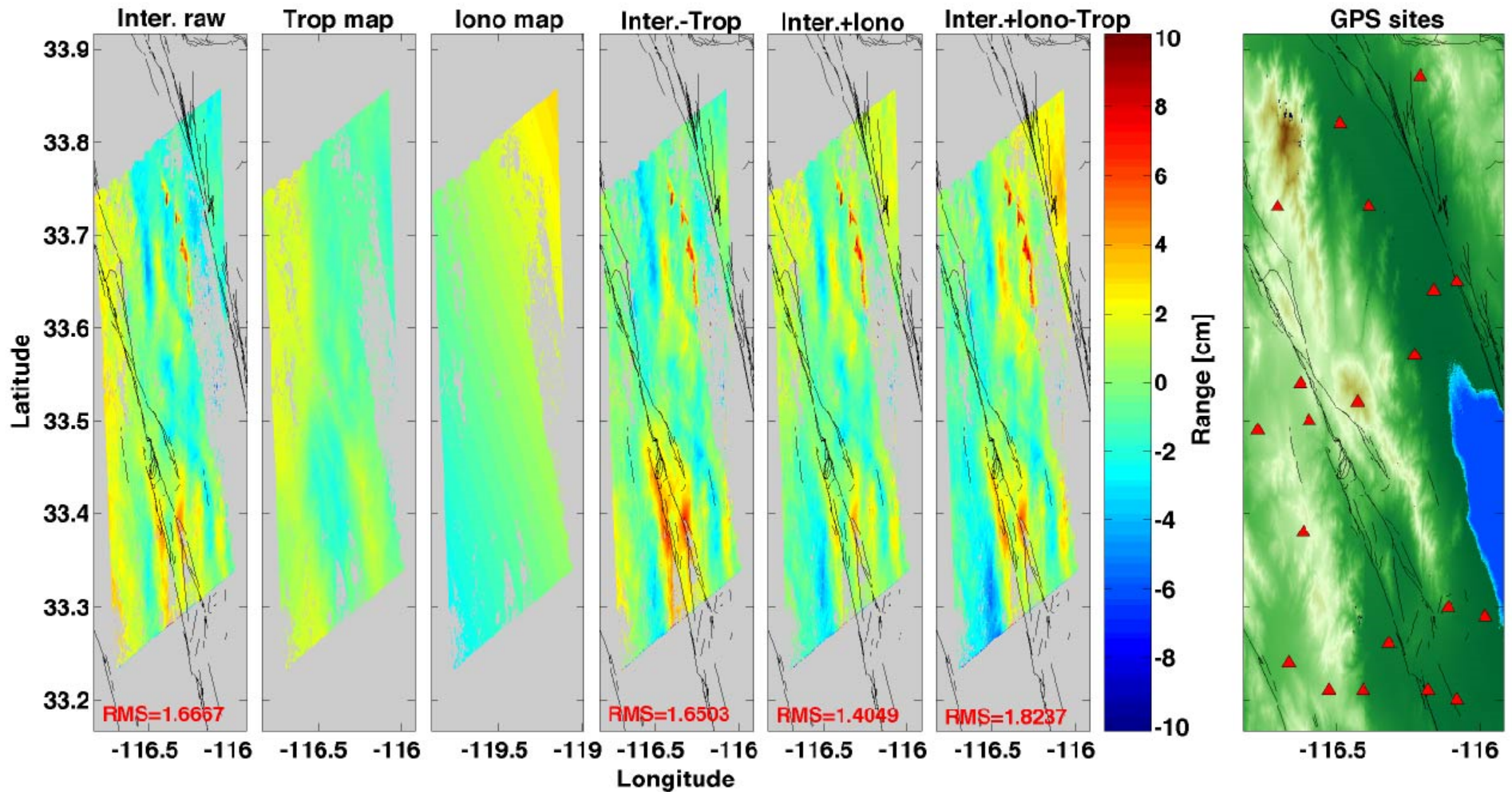


Precise Point Positioning Service for real-time clients implemented by SOPAC



Ionosphere and Troposphere Maps

Case Study 7: 13/11/2007,05/04/2010



Relevant Websites

Scripps Orbit and Permanent Array Center (SOPAC):

<http://sopac.ucsd.edu>

California Spatial Reference Center (CSRC):

<http://csrc.ucsd.edu>

GPS Explorer (create free user account):

<http://geoapp.ucsd.edu>

California Real Time Network (CRTN):

<http://sopac.ucsd.edu/projects/realtime/CRTN>

Real-time Earthquake Analysis for Disaster Mitigation Network (READI):

<http://sopac.ucsd.edu/projects/realtime/READI>



Questions?