



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

CSRC Coordinating Council Fall Meeting

La Jolla, CA

October 24, 2013

SOPAC/CSRC Group



- Director: Yehuda Bock
- Researcher: Jennifer Haase
- Coordinator: Maria Turingan
- Analysis: Peng Fang
- Lead Programmer: Mindy Squibb
- System Administrator: Anne Sullivan
- SCIGN and CRTN Engineer: Glen Offield
- Graduate Students: Diego Melgar, Dara Goldberg, Jessie Saunders
- Postdoctoral Researchers: Jianghui Geng & Yuval Reuveni
- Consultant: John Canas, PLS



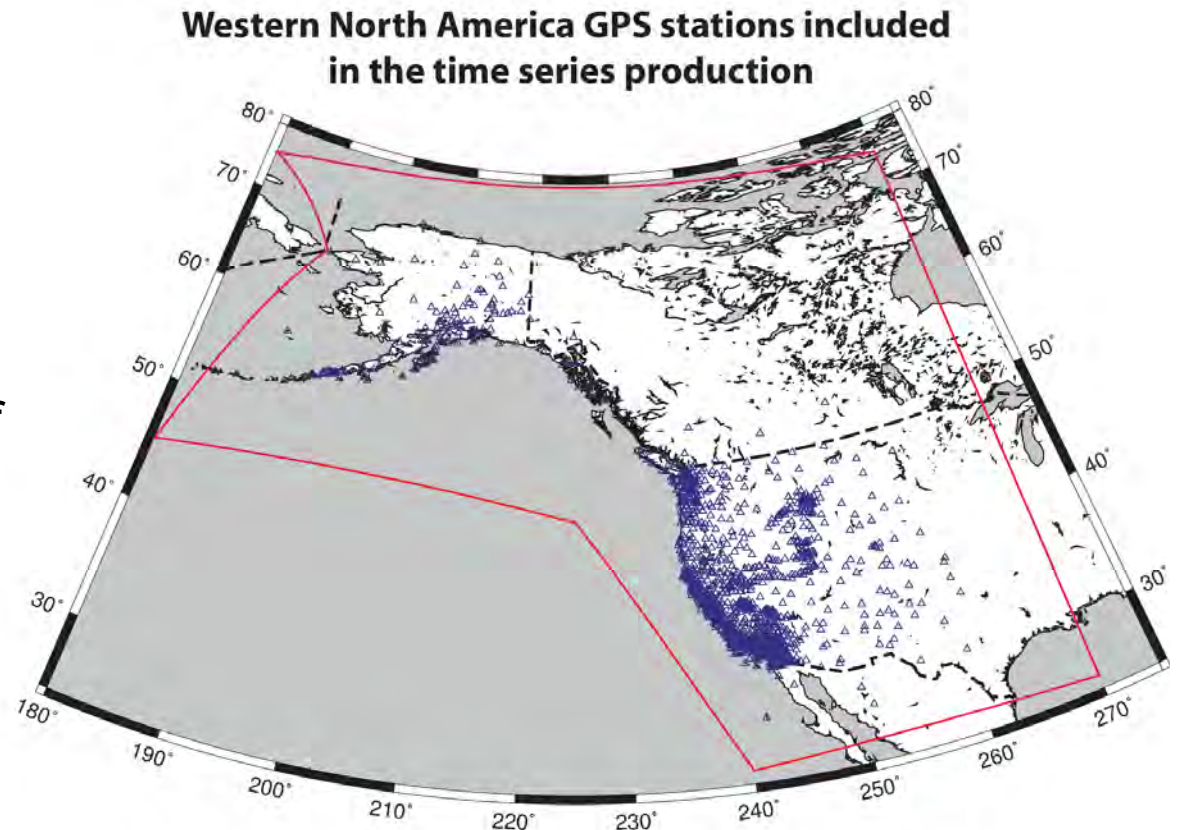
CSRC Executive Committee



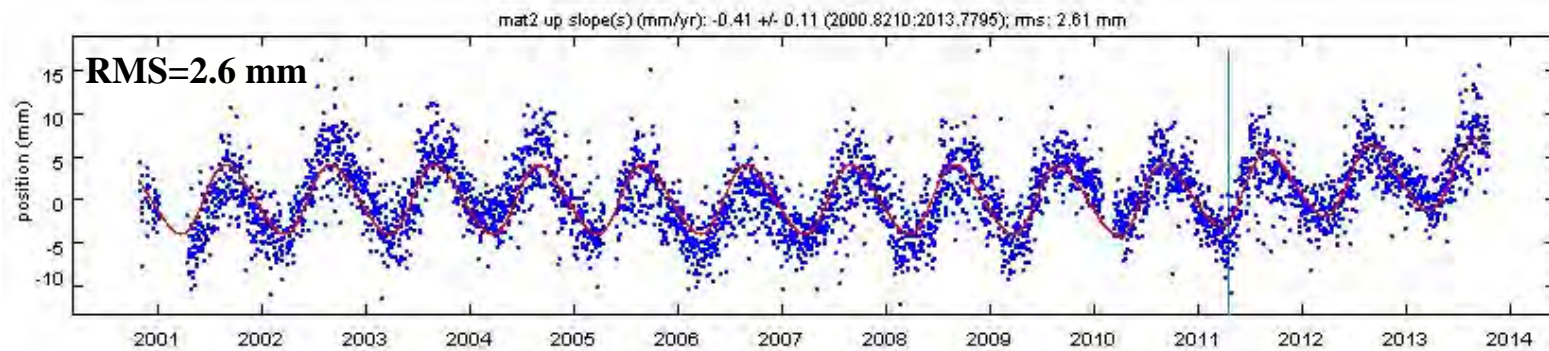
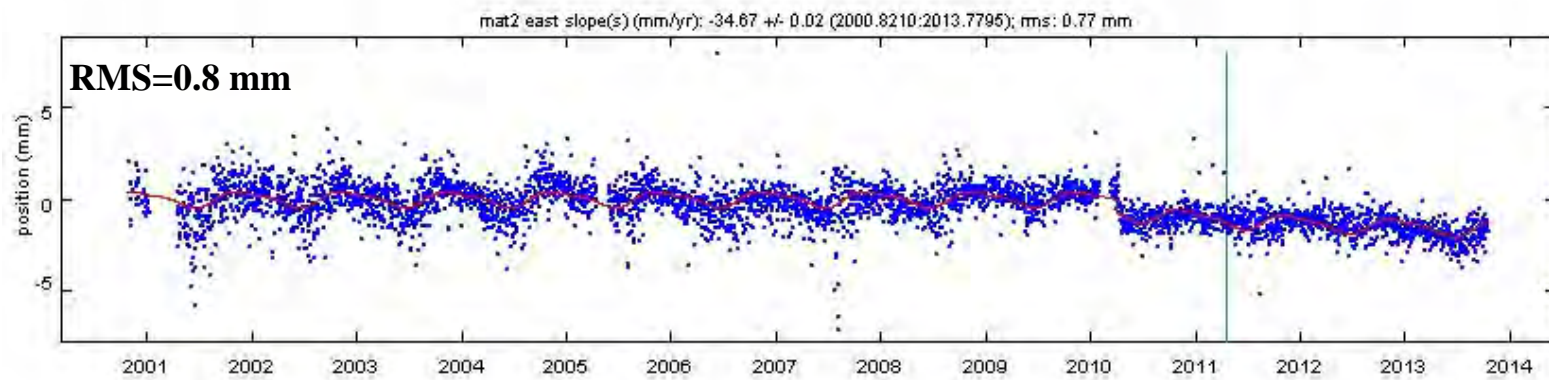
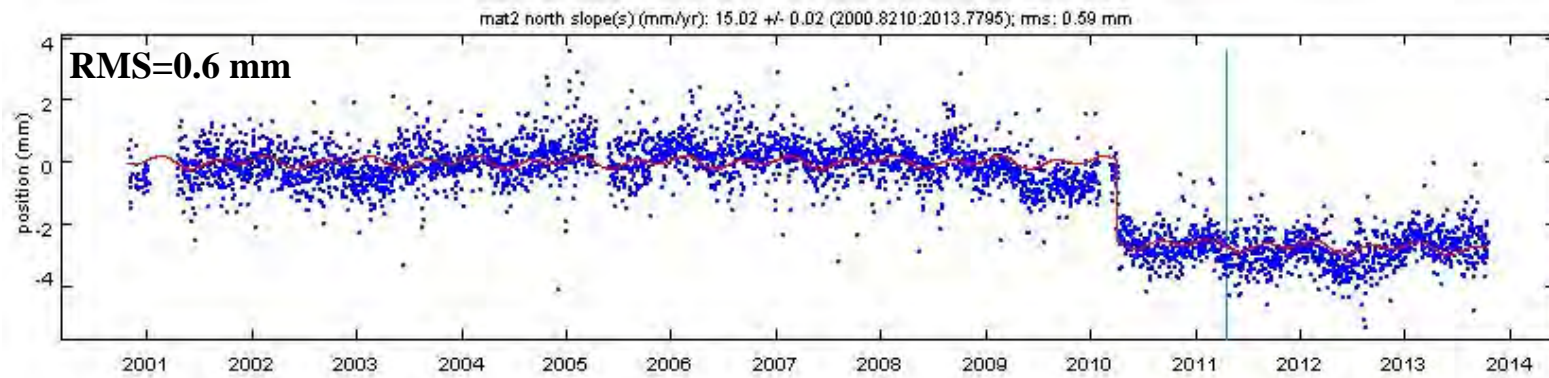
- *Chairperson:* Rich Maher
- *Vice-Chairperson:* Scott Martin
- *Secretary:* Thomas Dougherty
- *Treasurer:* Bill Hofferber
- *Member:* Armand Marios
- *Member:* Brian Wiseman
- *Member:* Greg Helmer
- *Member:* Dave Olander
- *Past Chairperson:* Art Andrew

CGPS Data & Metadata

- RINEX files archived at SOPAC from over 2500 stations in Western NA, including PBO, SCIGN, BARD, WCDA and PANGA stations, other plate boundaries & globally
- Earliest CGPS data are from 1991
- Use a common source of metadata to reduce systematic errors – challenge to keep current
- RINEX data processed independently at JPL (GIPSY software) and SOPAC (GAMIT software)
- Combination daily position time series is produced & updated weekly



MAT2 Time Series (North, East, Up)



Significant Earthquakes in Western North America (1996-2013)

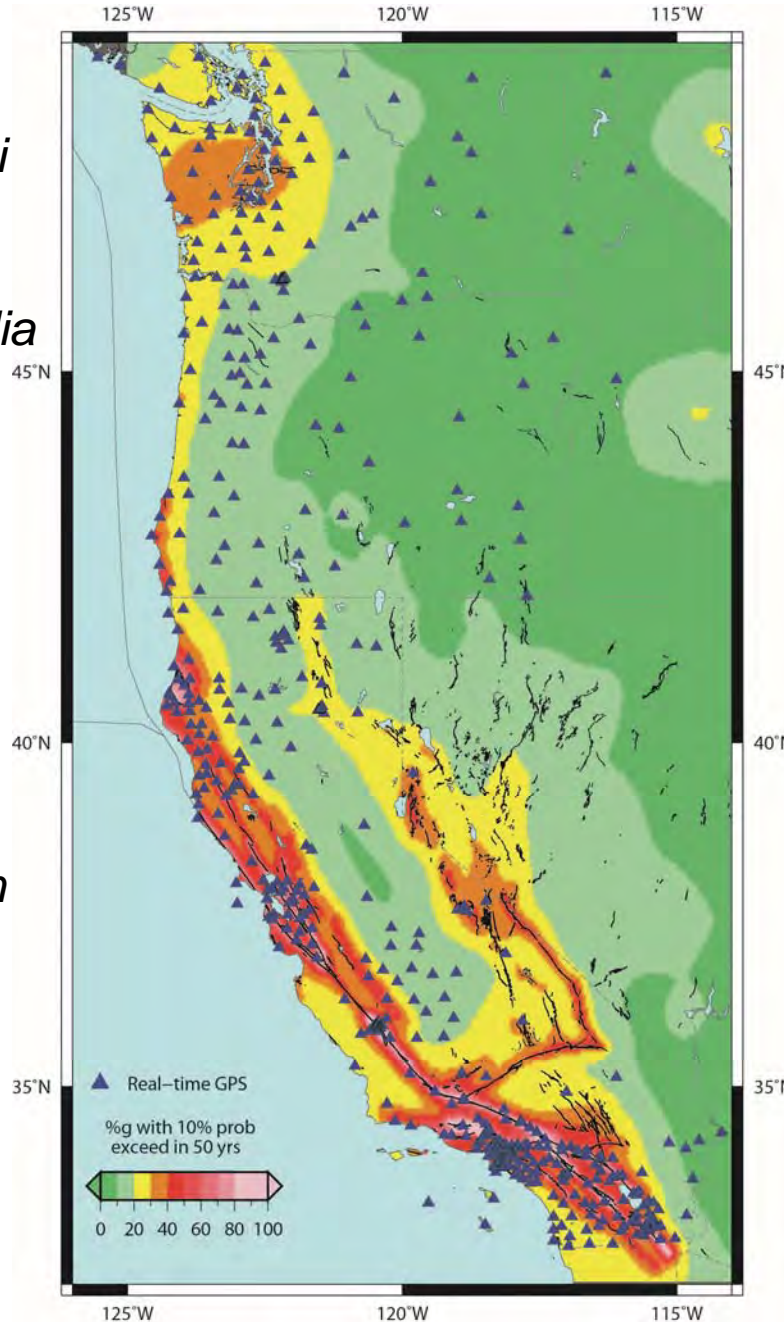
10/16/1999	Hector Mine, Southern California	7.1	142	exp	OPRD: 6 km	LAND: 408 km
2/29/2001	Nisqually Fault, Seattle	6.8	4	exp	RPT1: 30 km	HUSB: 340 km
11/3/2002	Denali, Alaska	7.9	12	exp	GNAA: 136 km	KEN1: 441 km
12/22/2003	Cambria, San Simeon, Central California	6.5	23	log	P278: 4 km	ORES: 131 km
6/28/2004	Queen Charlotte Fault	6.8	4	exp	AC64: 1023 km	AC63: 1139 km
9/28/2004	Parkfield, Central California	6.0	28	log	P281: 4 km	CUHS: 115 km
6/12/2005	Anza, Southern California	5.2	0		AZRY: 8 km	
6/15/2005	Gorda Plate, CA	7.2	5	exp	CME1: 188 km	P170: 216 km
6/16/2005	Yucaipa, Southern California	4.9	0		CRFP: 15 km	
9/2/2005	Obsidian Buttes Swarm, Salton Trough	5.1	3	exp	GLRS: 5 km	DHLG: 31 km
10/3/2006	Superstition Hill Seismic Swarm - silent slip	4.7	0		CRRS: 16 km	
10/31/2007	Alum Rock, San Jose, California	5.6	1	none	MHCB: 7 km	
7/29/2008	Chino Hills, California	5.5	1	none	TWMS: 4 km	
1/10/2010	Eureka Earthquake, Offshore Northern Califor	6.5	11	exp	P159: 45 km	P156: 95 km
2/4/2010	Offshore Northern California, Humboldt Coun	5.9	0		P159: 60 km	
4/4/2010	El Mayor-Cucapah, Northern Baja California	7.2	208	exp	P500: 62 km	P567: 485 km
6/15/2010	Aftershock, El Mayor-Cucapah	5.7	7	exp	P481: 16 km	P496: 31 km
7/7/2010	Borrego Springs, Southern California	5.4	3	exp	P490: 13 km	P742, P484: 14 k
8/26/2012	Brawley Swarm, Imperial Valley	5.3, 5.4	2	none	P506: 8 km	P498, P499

Earthquake Hazards for the West Coast

Earthquake/tsunami of the magnitude of Tohoku-oki is possible on Cascadia Subduction Zone

Increasing risk of large earthquake on the Hayward fault

Overdue large earthquake on the southern San Andreas fault



500+ stations of the real-time continuous GPS stations comprising the READI network (including CRTN). The network stations are overlain on a USGS seismic hazard map showing areas forecast to have a 10-percent probability of exceeding a certain level of ground shaking within the next 50 years. Areas in shades of red have the strongest shaking, while areas in green shades have the weakest shaking.

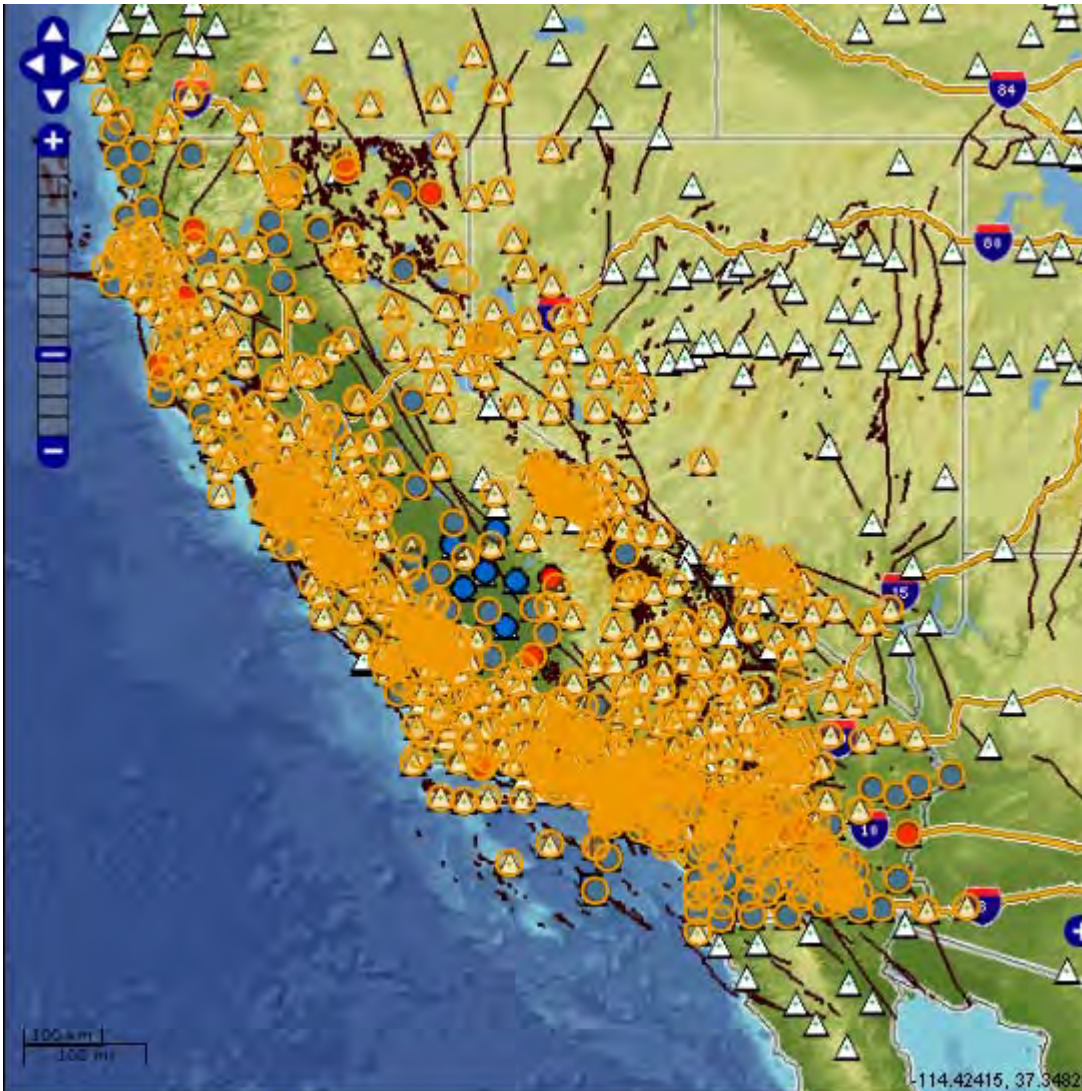
GPS/GNSS Positioning – Reference Frames

- 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 (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>

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

CALIFORNIA SPATIAL REFERENCE CENTER

CSRC | SOPAC | Index | Mail | Forums | General | Reports | Contacts

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

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

SECTOR: Scripps Epoch Coordinate Tool and Online Resource

Input Parameters

Coordinate
Source:
Type:

Sites
☒ Single site:
☐ List of sites: (space delimited, max=20)
☐ Sites by array:
☐ All

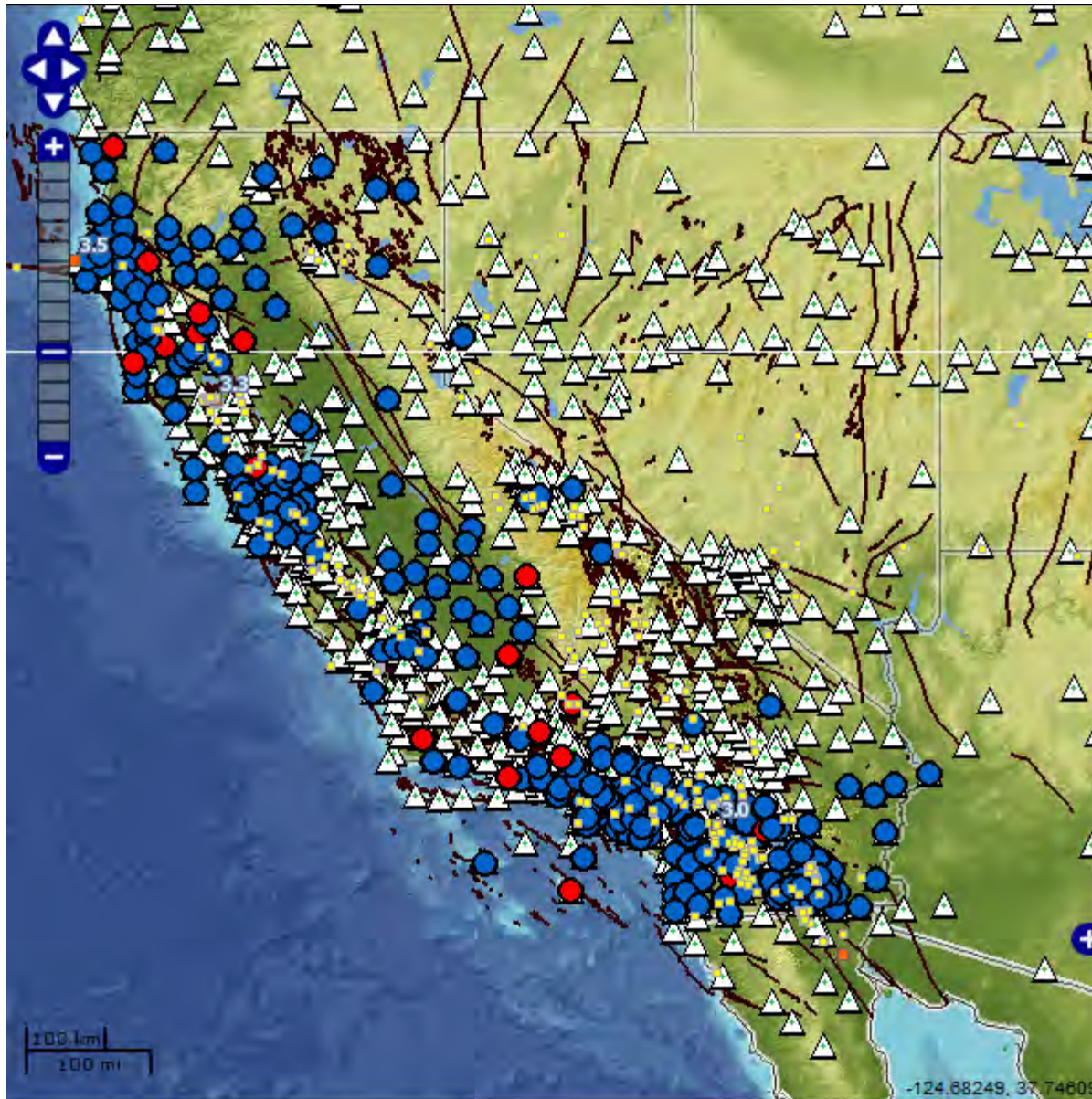
Date
☒ 2012-10-25
☐ 2012
☐ 2012.0000

Output
display as:
degrees as:
datum:

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 map	-2456115.2761 +/- 0.0015	-4768905.6501 +/- 0.0023	3439232.5033 +/- 0.0018	32.84073522 +/- 0.0012	-117.24969111 +/- 0.0011	185.51872841 +/- 0.0029	32.84073202	-117.24967700	186.2665	<input checked="" type="radio"/>	

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

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 339 stations from 2 CRTN servers (SC: 163 stations; NC: 176 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.

CRTN – NTRIP

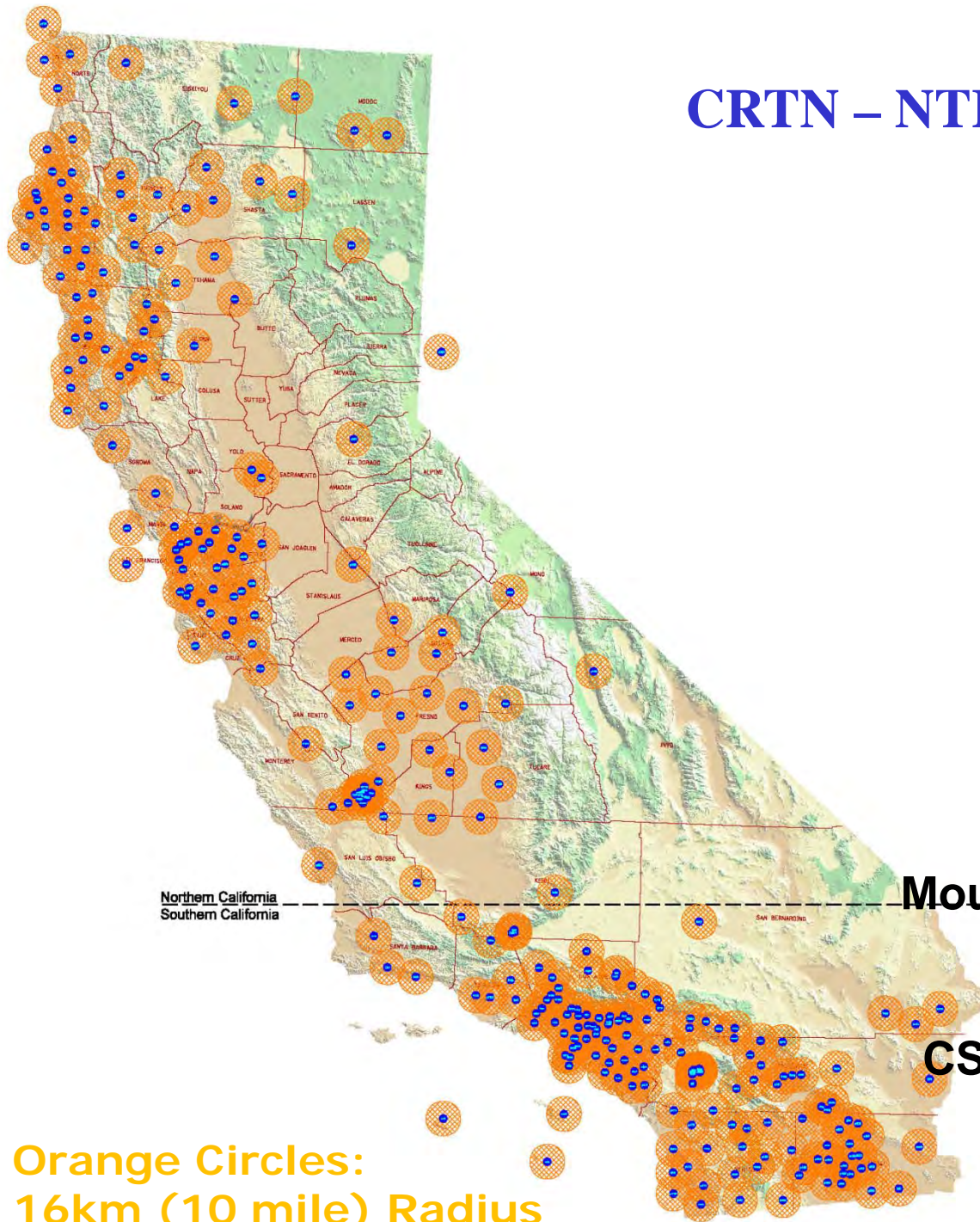
Northern California
IP: 132.239.154.101
Port: 2103
(176 stations)

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

RTCM 3.0

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

CSRC 2011.00 Epoch NAD83
(NSRS2007) Coordinates



CRTN – Google Earth & Maps

Google Earth/ Google Maps

Featured links:



Current CRTN and CSRN Maps

[CRTN North/South Stations\(kmz\)](#)

Google Earth Map showing all current active real-time CGPS stations available via NTRIP separated by North/South

[CRTN All Stations\(pdf\)](#)

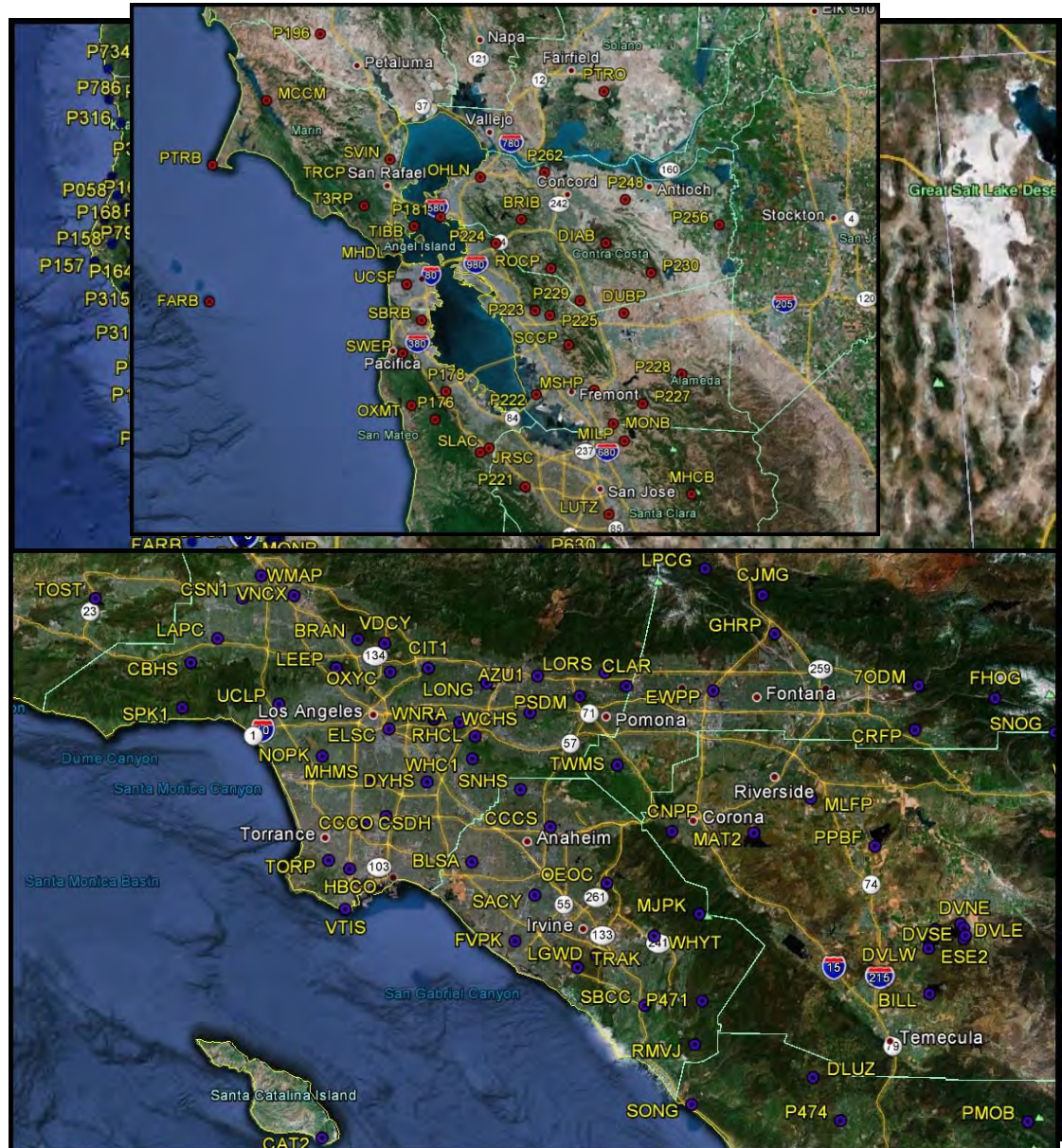
Map showing all current active real-time CGPS stations available via NTRIP

[CRTN Backbone\(pdf\)](#)

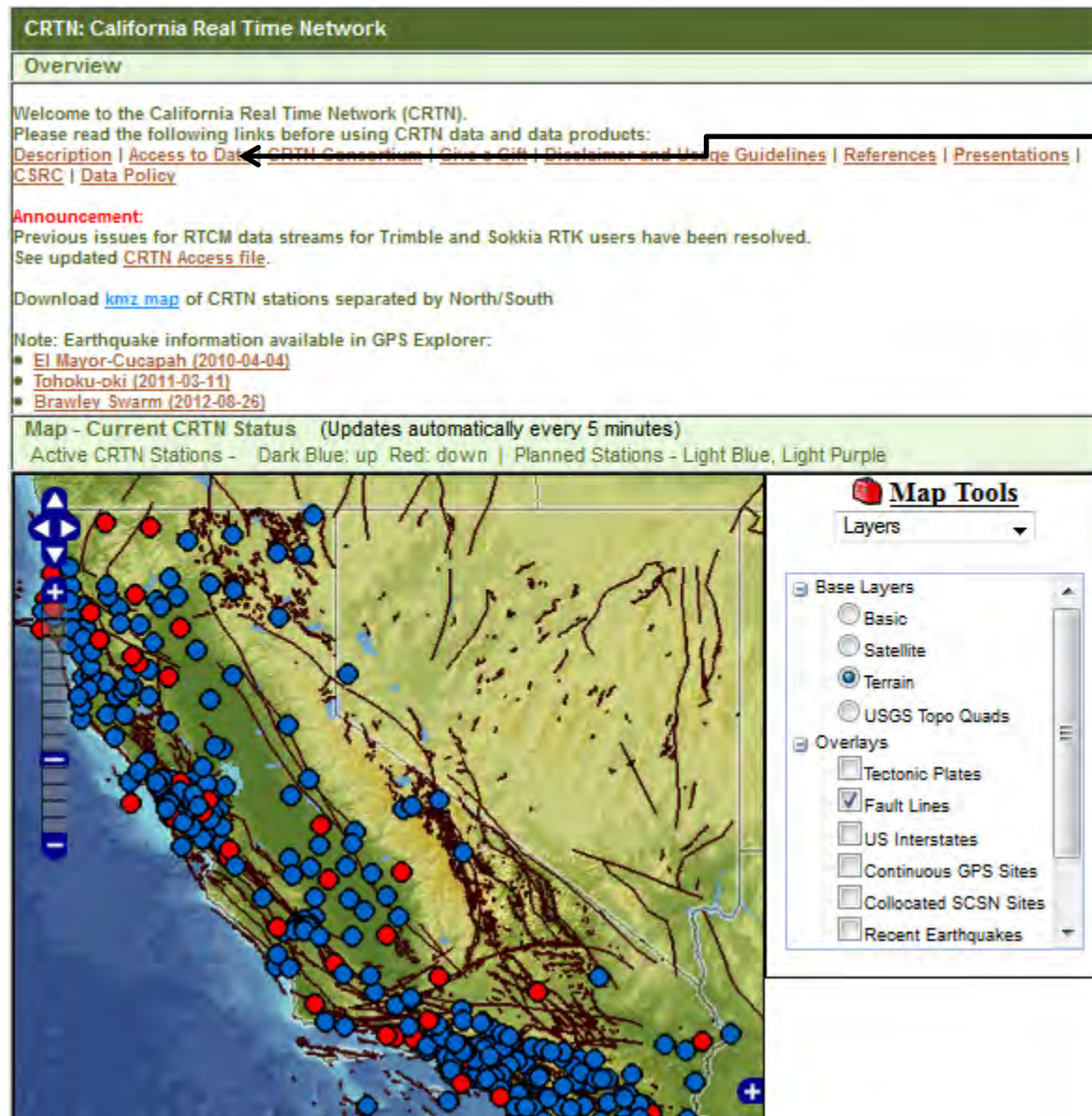
Map showing proposed CRTN Backbone network as well as NGS CORS stations

[CSRN 2011.00 Epoch](#)

Map showing all CGPS stations included in the 2011.00 Epoch adjustment

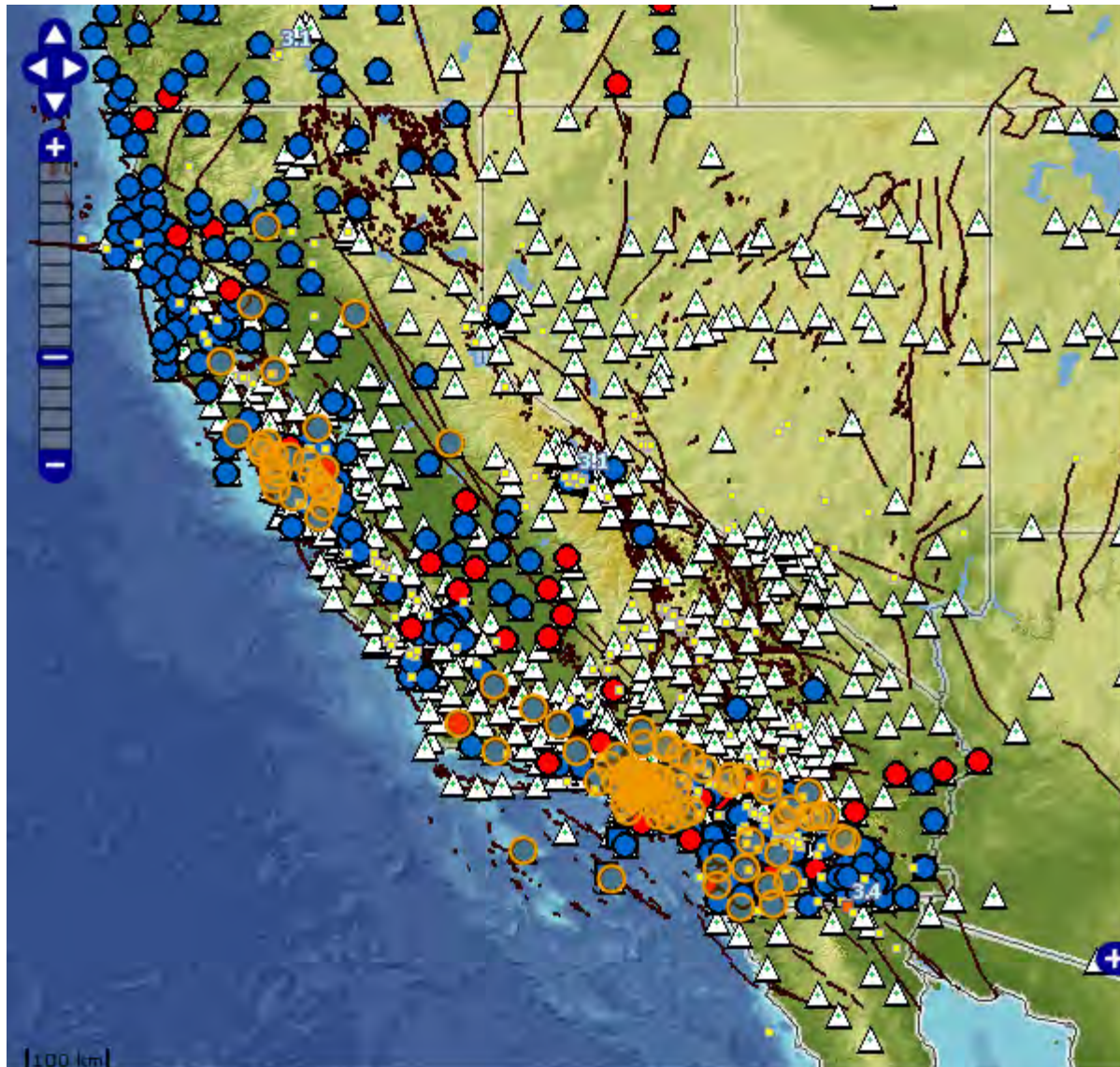


<http://sopac.ucsd.edu/projects/realtime/CRTN/>



NTRIP access and
Epoch 2011.00
NAD83(NSRS2007)
coordinates

Topcon GNSS Receivers



- 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

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
	QCRTN & 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: ★★★★★	<p> posted 03-04-2013 07:24 AM </p> <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.</p> <p>--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

[login](#) | [register](#) | [search](#) | [faq](#) | [forum home](#)

» [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).

16

[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](#)

POWERED BY UBB.classic™ 6.7.2

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 crtn-l@gpsmail.ucsd.edu mailing list. Go to the CSRC to register.	86	90	 CRTN CVSRN stations (ybock) 03-04-2013 07:24 AM	crtn-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

 No New Posts Since Your Last Visit

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

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)

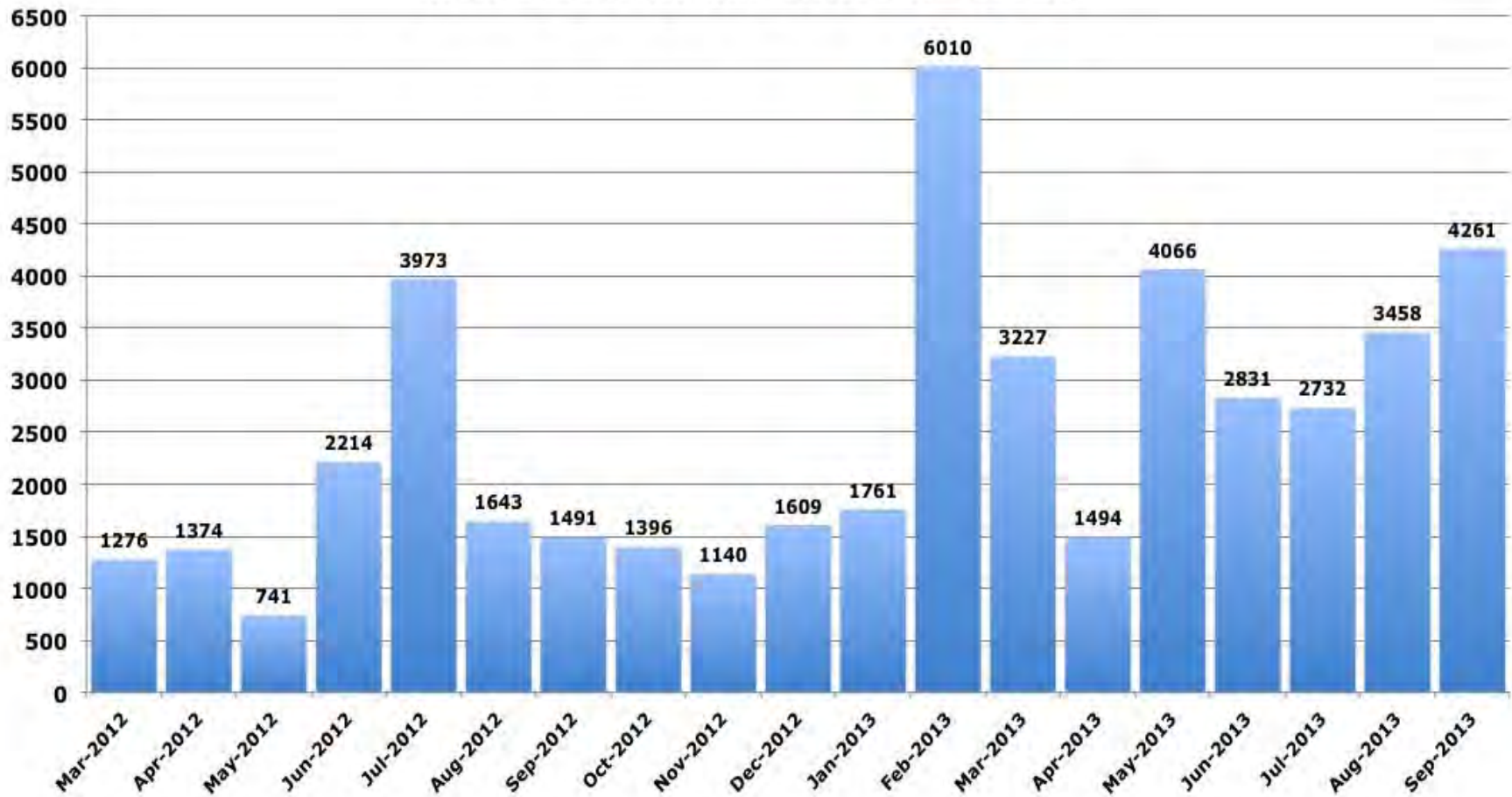
Optional:

- Receiver serial number
- Antenna serial number

Transmitted in RTCM 3.0 message for real-time stations

CRTN Metrics

Number of CRTN NTRIP Connections by Login

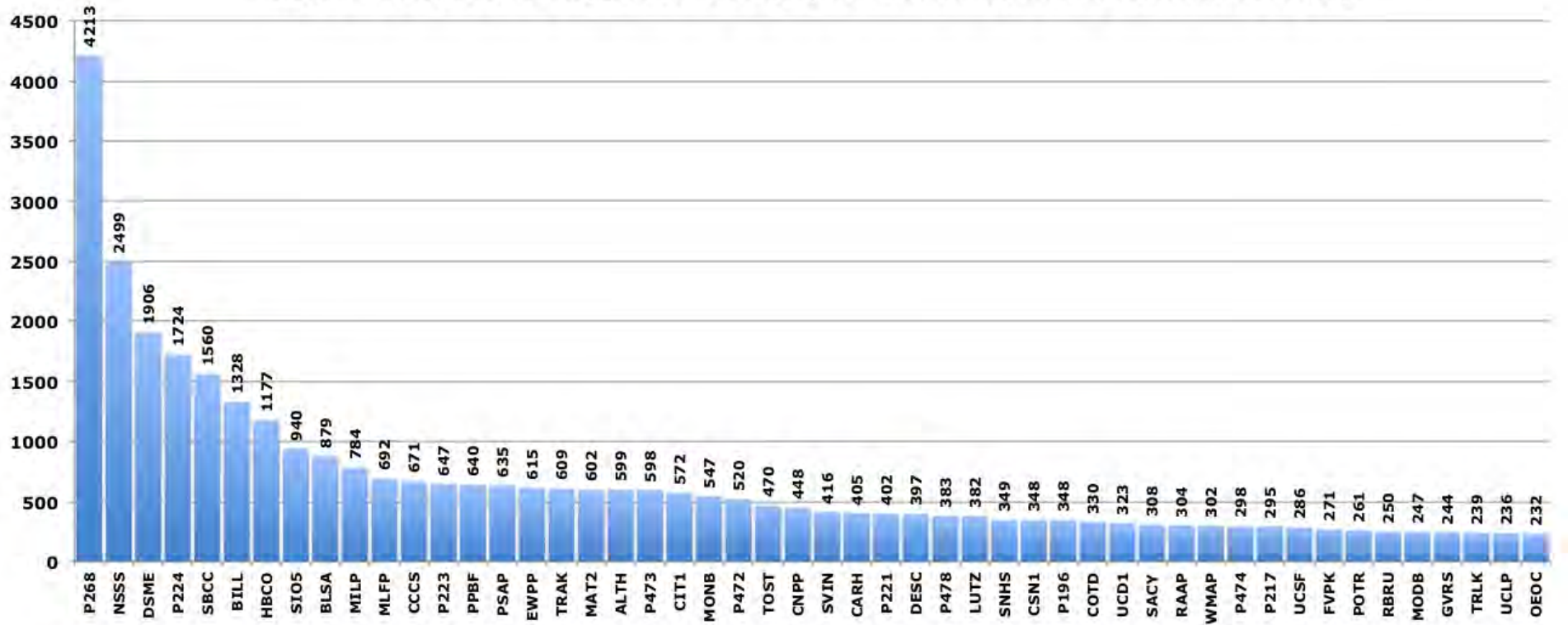


CRTN – Single Base User

- An NTRIP account (username & password) is required, and requested by emailing the CSRC director (ybock@ucsd.edu)
- To date 219 companies/agencies registered (up from 125 in May) – 12 multi-account (CRTN Consortium & Contributors) users
- Highest usage in September, 2013
 - Vessel tracking, dredge pos., hydrographic surveys company: 993 (SF Bay Area)
 - Department of public works (southern California): 365 (4 accounts)
 - Surveying engineering company (southern California): 323
 - Digital mapping company: 252 (central California)
 - Wired and wireless communications company (SF Bay Area): 202
 - Hydrographic engineering and surveying company (Los Angeles): 197

CRTN Metrics

**Cumulative Number of CRTN NTRIP Connections by Station
from February 2012 to September 2013 (Top 50 Stations with Total Connections ≥ 232)**



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, Bill Hofferber, 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, Ken Teich, Ed Hunt, Tim Rayburn
6. Santa Clara Valley Water District, Thomas Dougherty
7. City of Long Beach, Gas and Oil, Kimberley Holtz
8. California Spatial Reference Center
9. Scripps Institution of Oceanography, University of California San Diego, 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

SOPAC Research Highlights

- GPS/seismic integration (seismogeodesy) for earthquake early warning
- Estimation of coseismic tilts
- Successful monsoon and flooding forecasts
- Troposphere and ionosphere maps (basis for statewide “network solution”)

GPS Integration



GPS/GNSS

+



**MEMS
Accelerometer
Module**

=

***Very-high-rate (1-100
Hz) broadband
displacements with 1-2 s
latency and mm accuracy
in three dimensions***



+

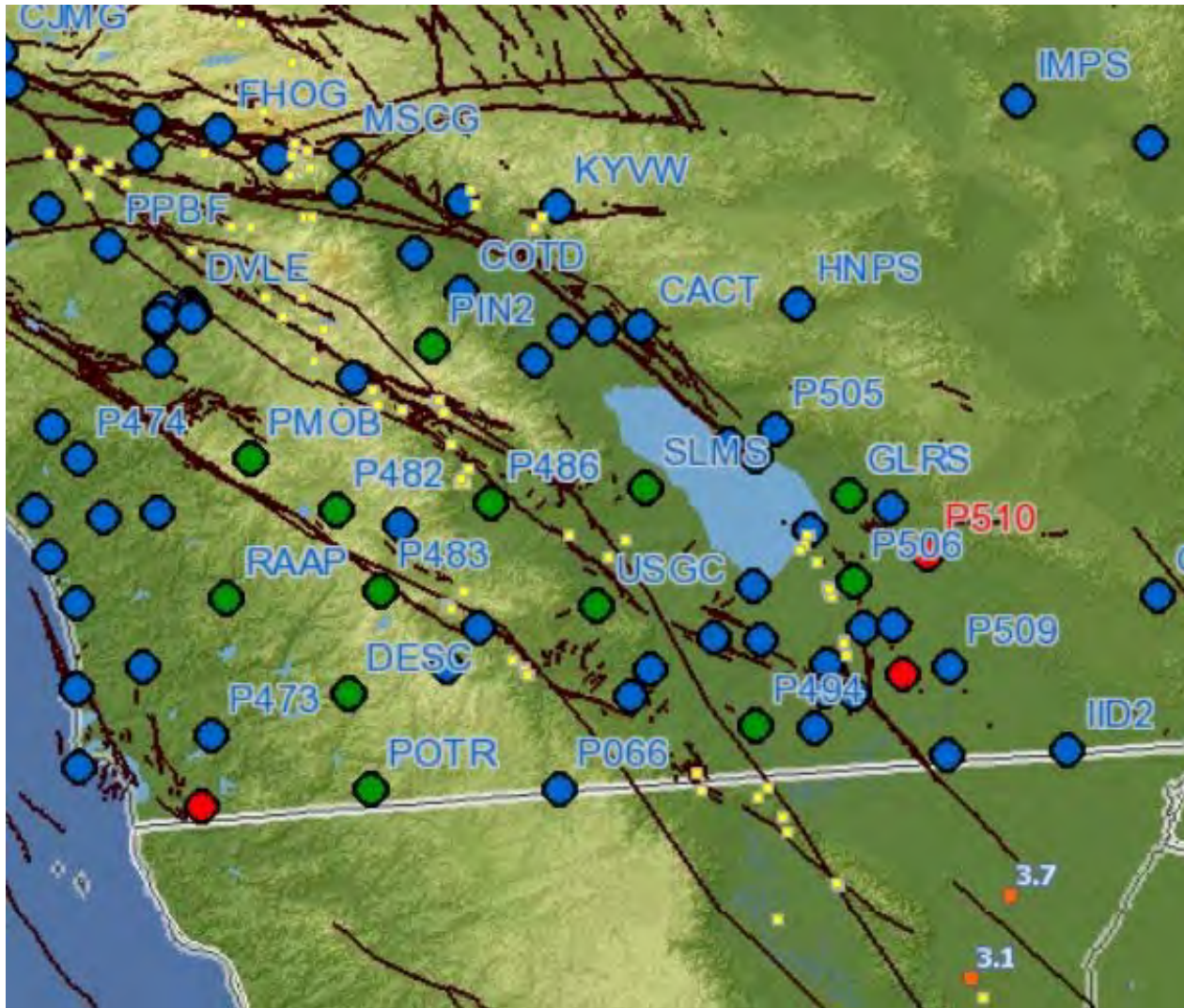


**MEMS Met Sensors
(pressure,
temperature)**

=

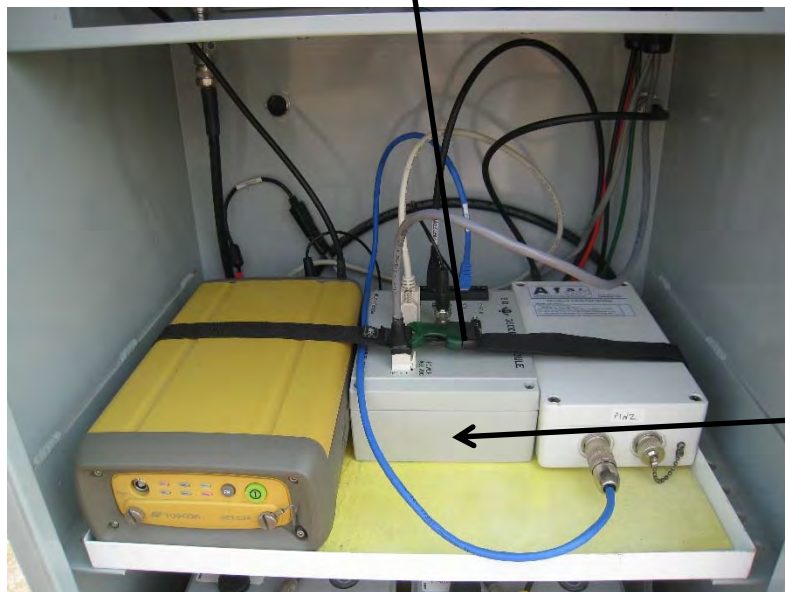
***Continuous mm-level
precipitable water
(integrated water vapor
in troposphere)***

GPS Integration

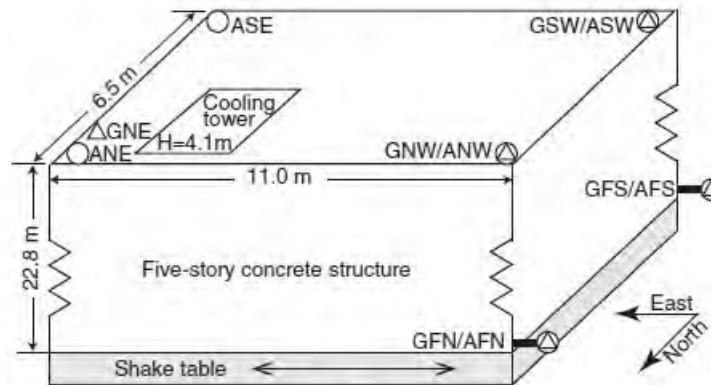
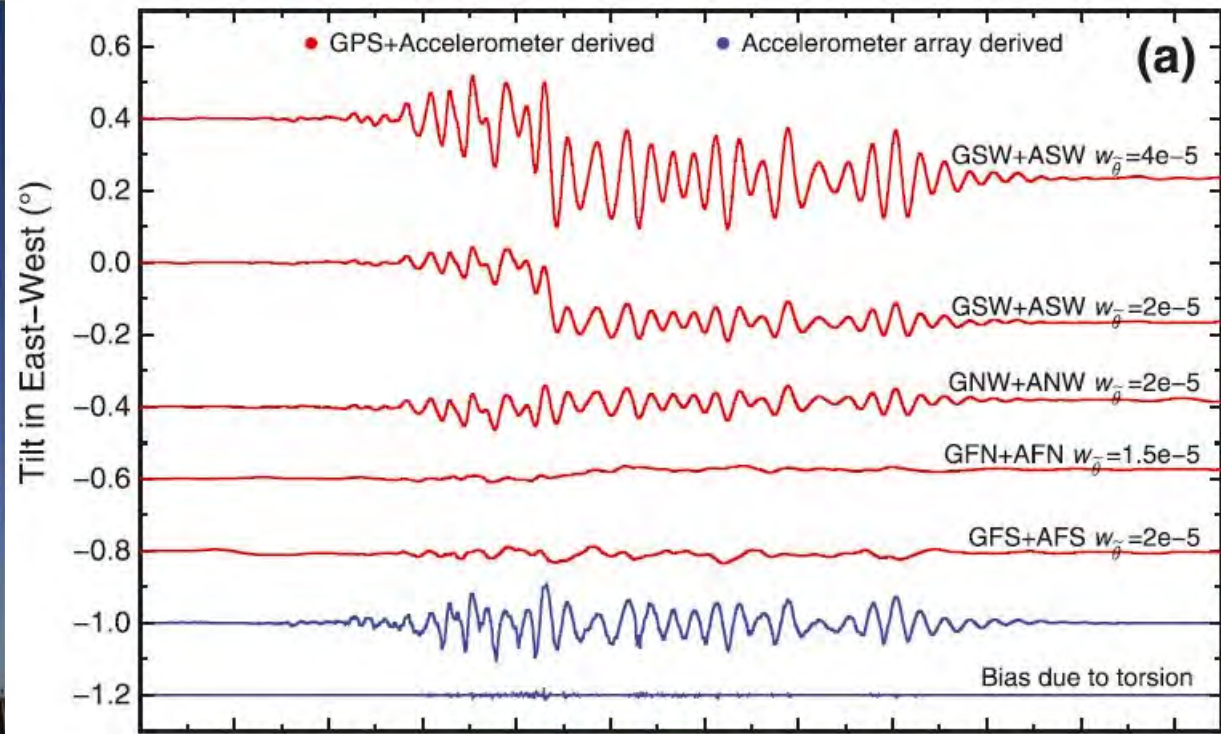


Green dots are stations upgraded with Geodetic Modules and MEMS Accelerometer packages

Example of Seismogeodetic Upgrade



Estimation of Coseismic Tilts



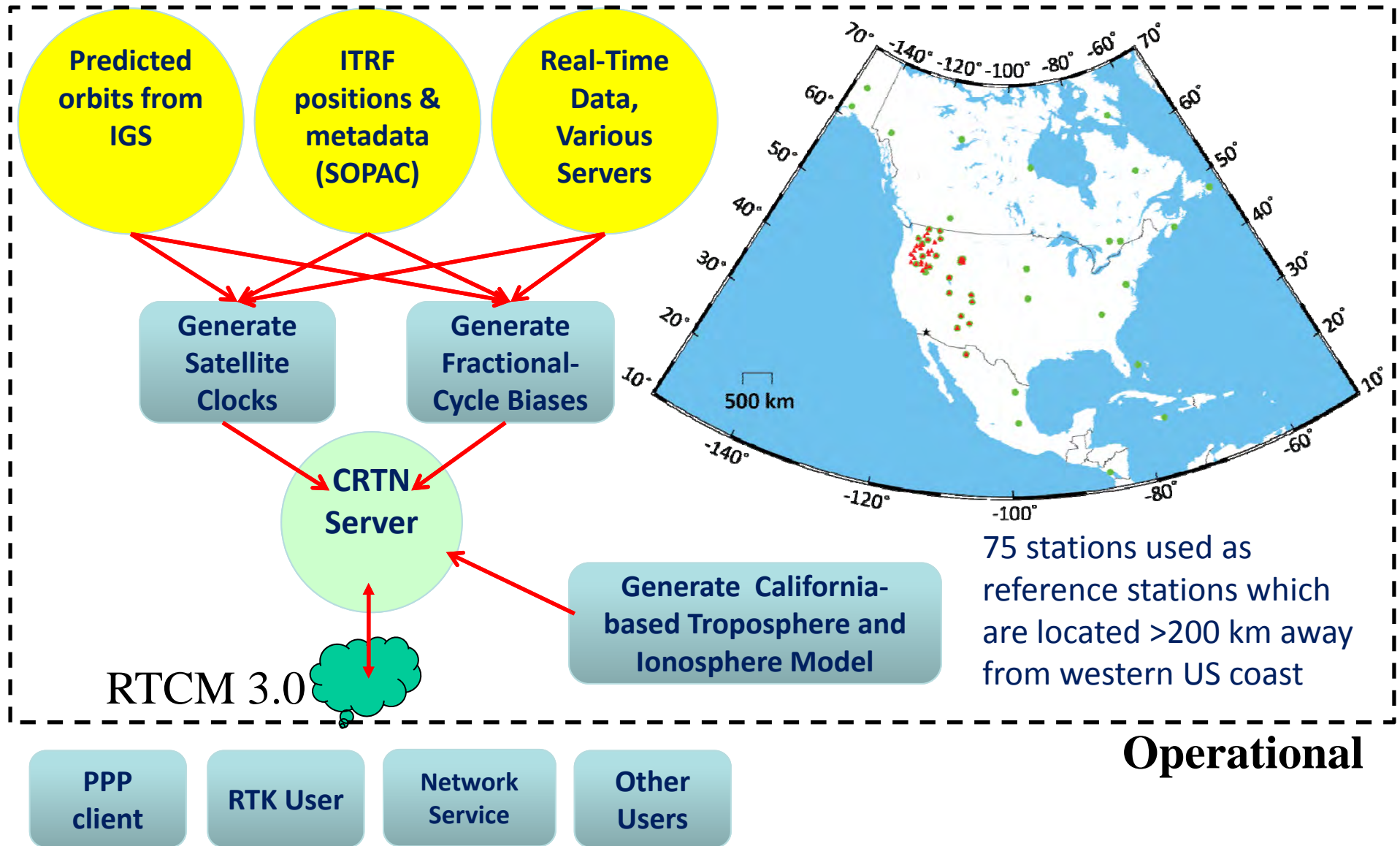
Geng et al., GRL, 2013

Successful Monsoon and Flooding Forecasts

- Successful monsoon and flooding forecasts for event that occurred in the period July 20-22, 2013.
- Use GPS network to track extreme weather events in collaboration with NOAA and U.S. Weather Service Offices in San Diego (Encinitas) and Los Angeles (Oxnard) – four-year project funded by NASA.
- GPS network allows us to measure amount of atmospheric water vapor, the main indicator of extreme weather.
- The Weather Service uses balloon launches every 12 hours from Yuma and San Diego to determine profile of atmospheric water vapor. One of the balloons did not provide data for one Monsoon event, so they used GPS data.

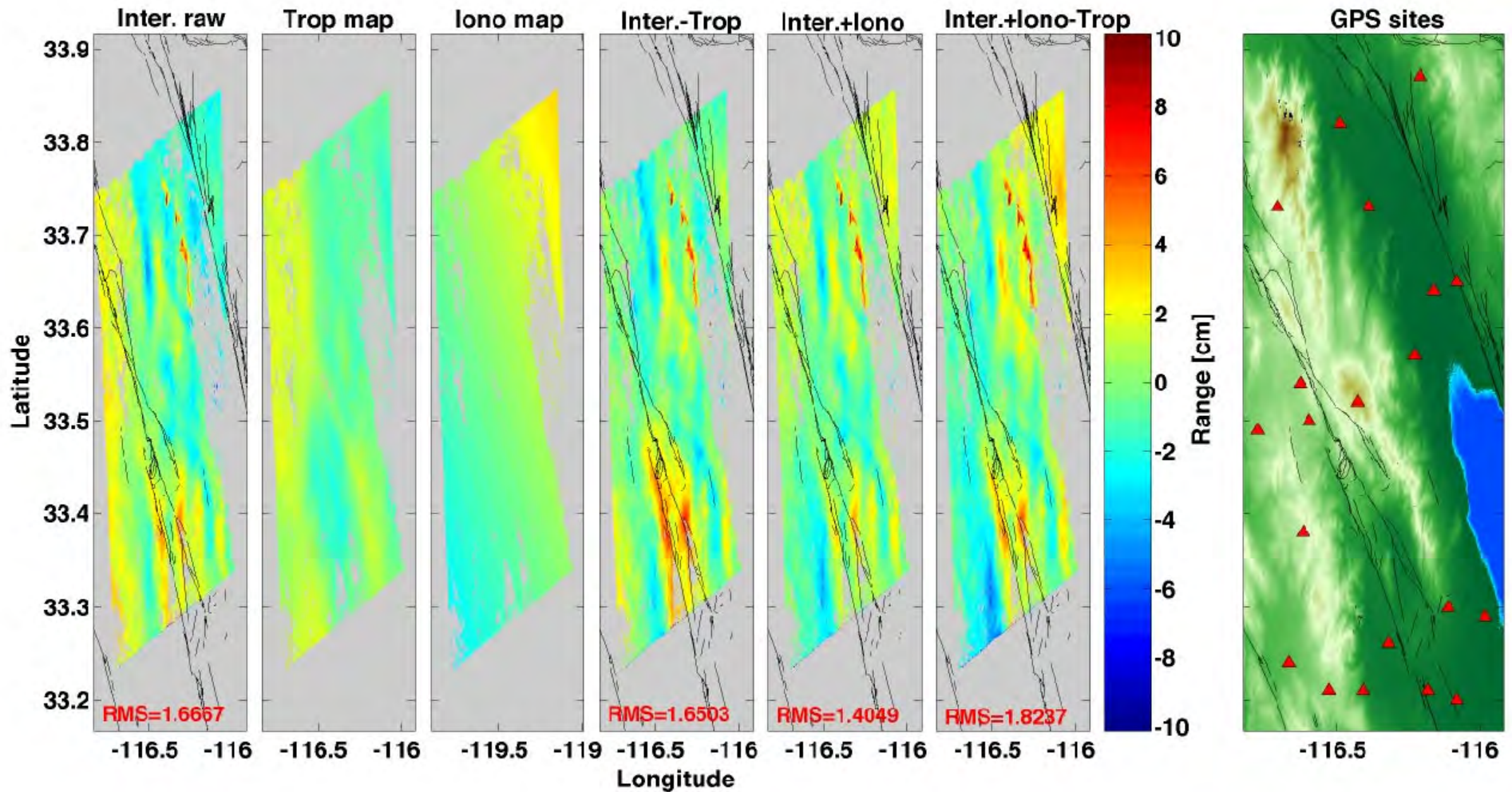
Monsoon Movie

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>



大波 千六景 神奈川沖
波裏

江戶 葛飾 柴田 勝家 画



Questions?