



# The IGS Real-Time Service: *A Spur to Innovation*

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# IGS-RTS...

*A new service to support scientific & other precise PNT applications*



# IGS Real-Time Service (RTS)



- International effort of many contributions
- Maintain & extend real-time infrastructure (data transfer, broadcasting, product generation, combination, quality control)
- Develop necessary data formats & transmission protocols together with RTCM SC104
- Launched on April 1, 2013... *after many years of study*
- Currently GPS + experimental GLONASS real-time orbit & clock products
- Open data & open standards policy
- Working towards Operational Service & multi-GNSS capability
- **Supports scientific & other PP applications**

# IGS-RTS Web Site... <http://rts.igs.org/>



Network

Products

Working Groups

Resources

About

Search

## Real-time Service

Network

User Access

Products

Monitoring

Contributors

Information

The International GNSS Service (IGS) has ensured the availability of open access, high-quality GNSS data products since 1994. These products enable access to the definitive global reference frame for scientific, educational, and commercial applications - a tremendous benefit to the public.

Through the Real-time Service (RTS), the IGS extends its capability to support applications requiring real-time access to IGS products. RTS is a GNSS orbit and clock correction service that enables precise point positioning (PPP) and related applications, such as time synchronization and disaster monitoring, at worldwide scales. RTS is based on the IGS global infrastructure of network stations, data centers and analysis centers that provide world standard high-precision GNSS data products.

The RTS is currently offered as a GPS-only beta service for the development and testing of applications. The Russian GLONASS is initially provided as an experimental product and will be included within the service when the RTS reaches its full operating capability at the end of 2013. Other GNSS constellations will be added as they become available.

This service is made possible through partnerships with Natural Resources Canada (NRCan), the German Federal Agency for Cartography and Geodesy (BKG), and the European Space Agency's Space Operations Centre in Darmstadt, Germany (ESA/ESOC). Support is provided by 160 station operators, multiple data centers, and 10 analysis centers around the world.

The RTS is operated by the IGS as a public service. Users are offered open and readily available access through subscription.

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### Network

Map

### Products

Data

Formats

### Analysis

GPS

GLONASS

### Resources

Mailing List

Knowledge Base

FTP

Events

### Social

Facebook

Google+

Instagram

LinkedIn

### About

Centers

Contact Us

Organization

Strategic Plan

# IGS-RTS Tracking Network...



 GPS+GLO  GPS

**150+ stations**

# IGS-RTS Products... <http://rts.igs.org/products>



Note:

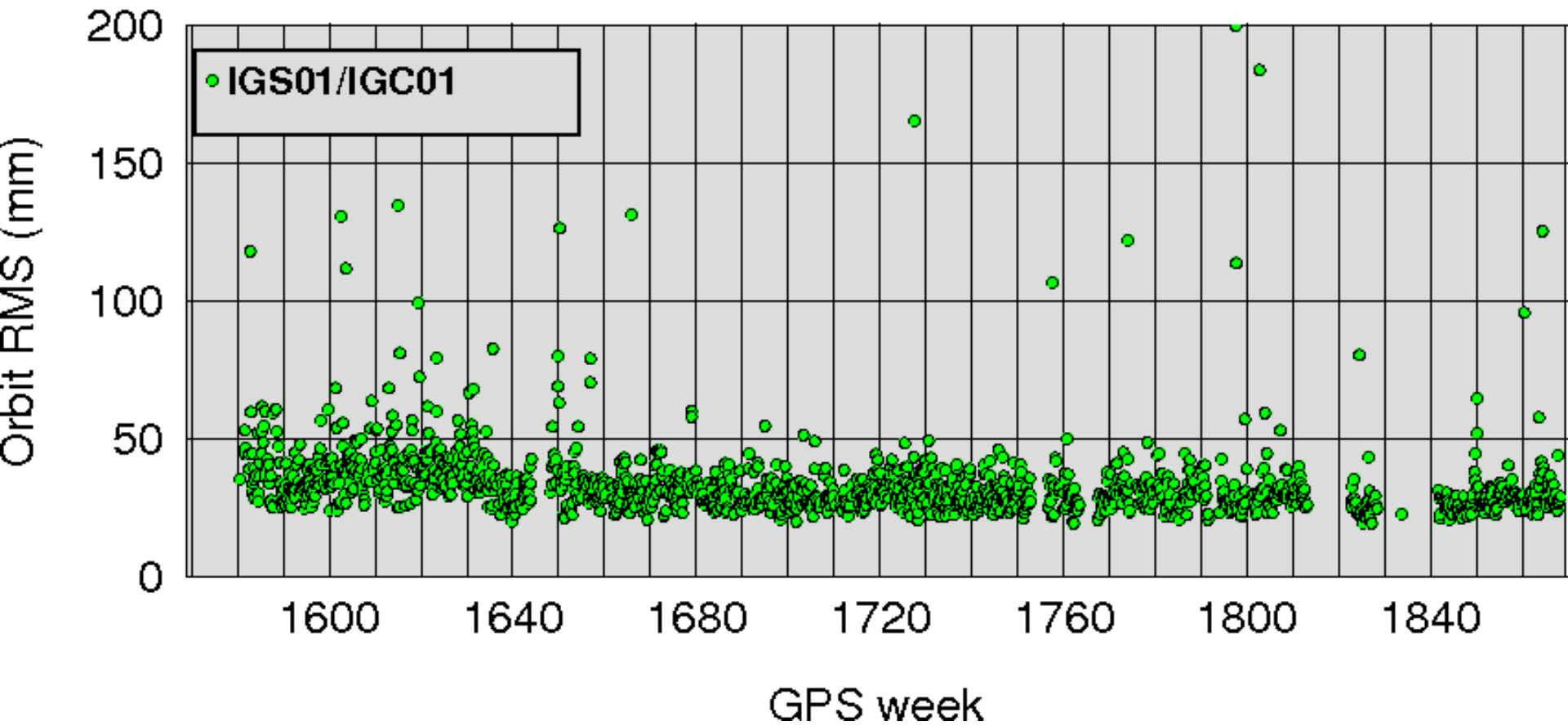
- **IGS01/IGC01 (GPS-only) and IGS02 (GPS-only) streams**
- **IGS03 (GPS+GLONASS) “experimental” stream**
- **RTCM-SSR message streams**
- **Reference frame is ITRF2008**
- **Stream access via BKG NTRIP Client (BNC) or RTKLIB**
- **Register for user access (via web site)**
- **Products:**

Stream Name	Description	Ref Point	RTCM Messages	Provider / Solution ID	Bandwidth kbits	Software
IGS01	Orbit/Clock Correction, Single-Epoch Combination	APC	1059 (5),1060 (5)	258 / 1	1.8/sec	ESA/ESOC
IGC01	Orbit/Clock Correction, Single-Epoch Combination	CoM	1059 (5),1060 (5)	258 / 9	1.8/sec	ESA/ESOC
IGS02	Orbit/Clock Correction, Kalman Filter Combination	APC	1057 (60), 1058 (10), 1059 (10)	258 / 2	0.6/sec	BKG
IGS03	Orbit/Clock Correction, Kalman Filter Combination	APC	1057(60), 1058(10), 1059(10), 1063(60), 1064(10), 1065(10)	258 / 3	0.8/sec	BKG

APC: Antenna Phase Center CoM: Center of Mass, (not compliant with current RTCM-SSR standard). The figures in brackets next to each RTCM message ID denote the message sample interval in seconds.



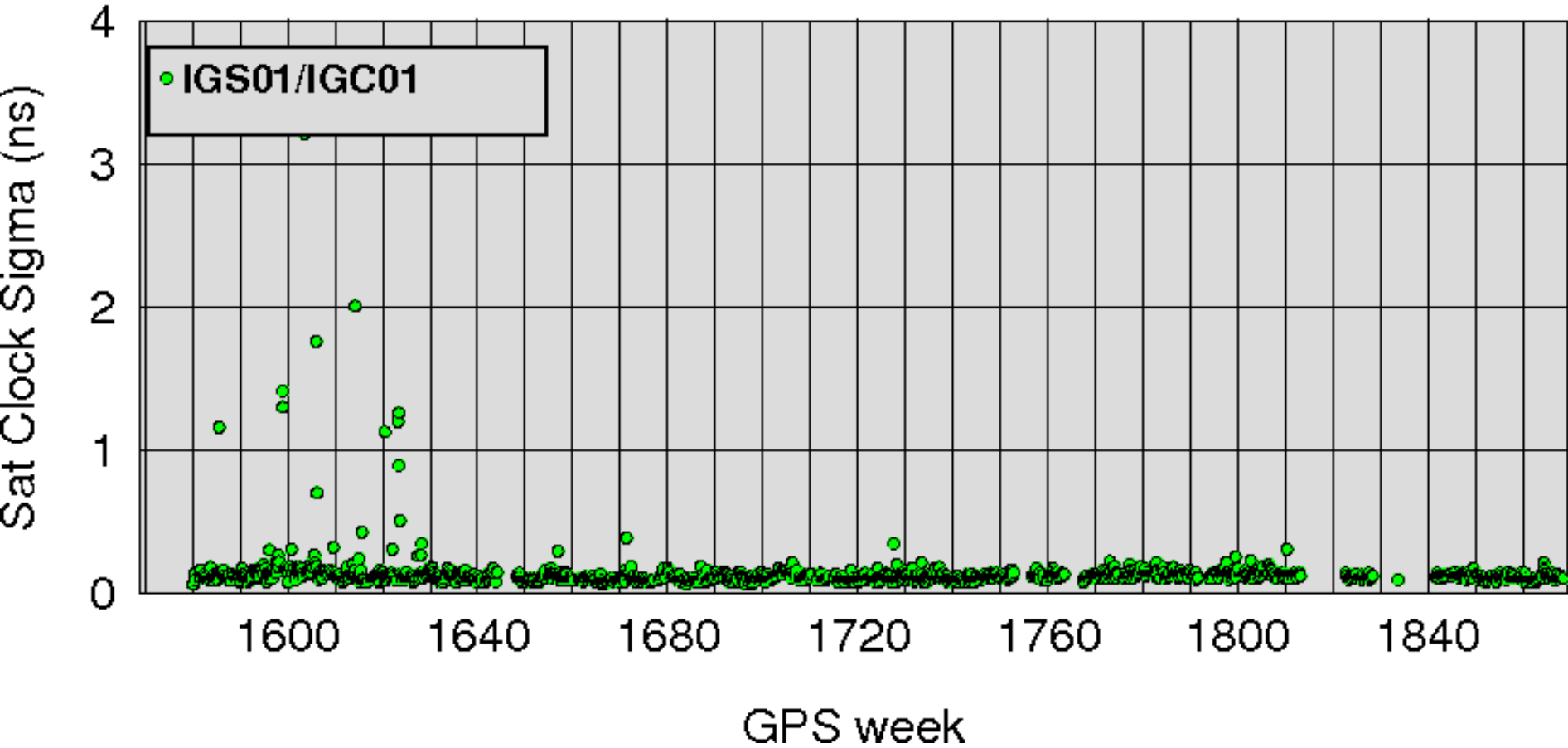
# IGS01/IGC01 Products (1)



<http://www.igs.org/rtm/monitor>

**GPS Wk 1869**

# IGS01/IGC01 Products (2)



<http://www.igs.org/rt/monitor>

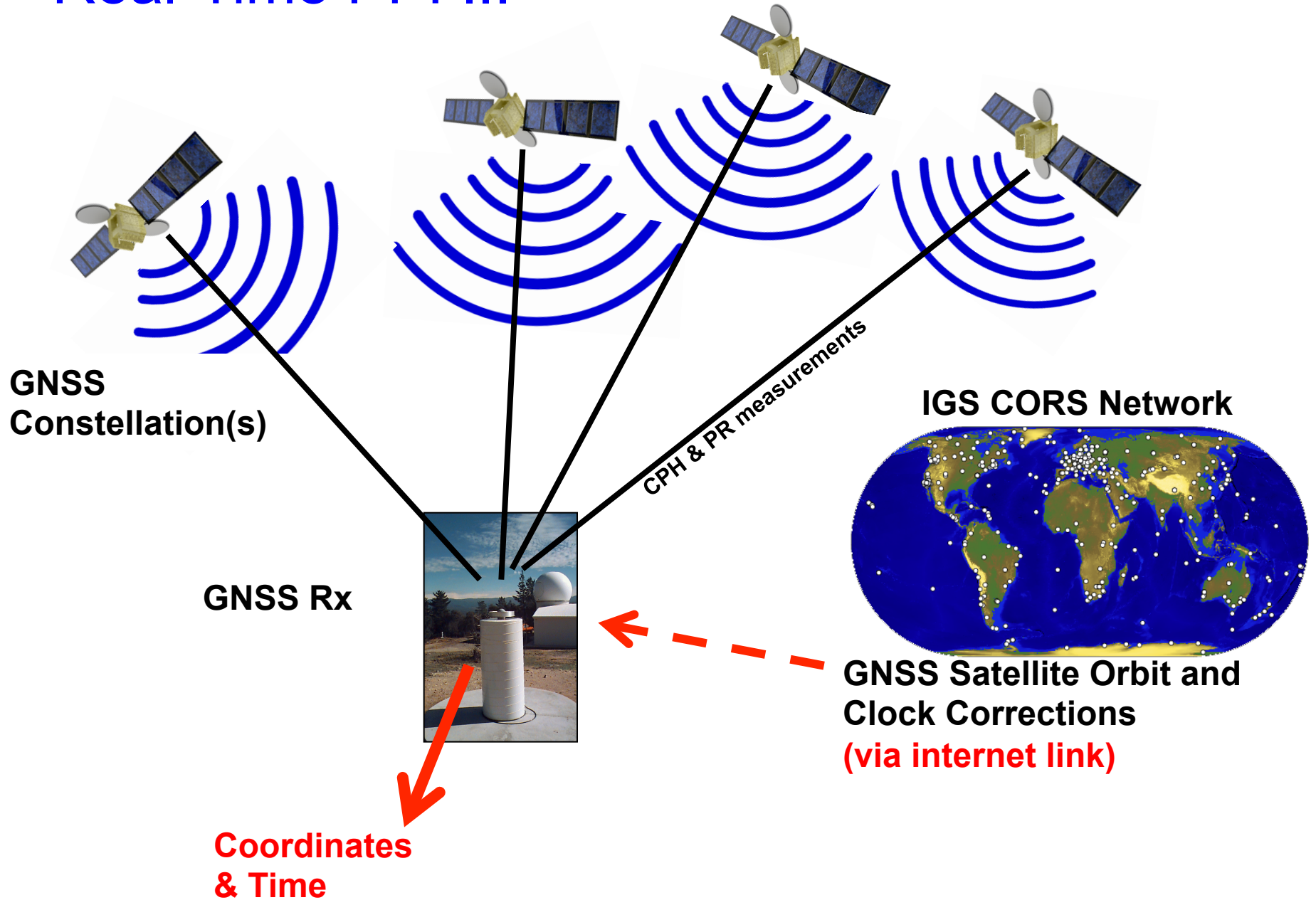
**GPS Wk 1869**



IGS-RTS...

*Enables RT-Precise Point Positioning*

# Real-Time PPP...



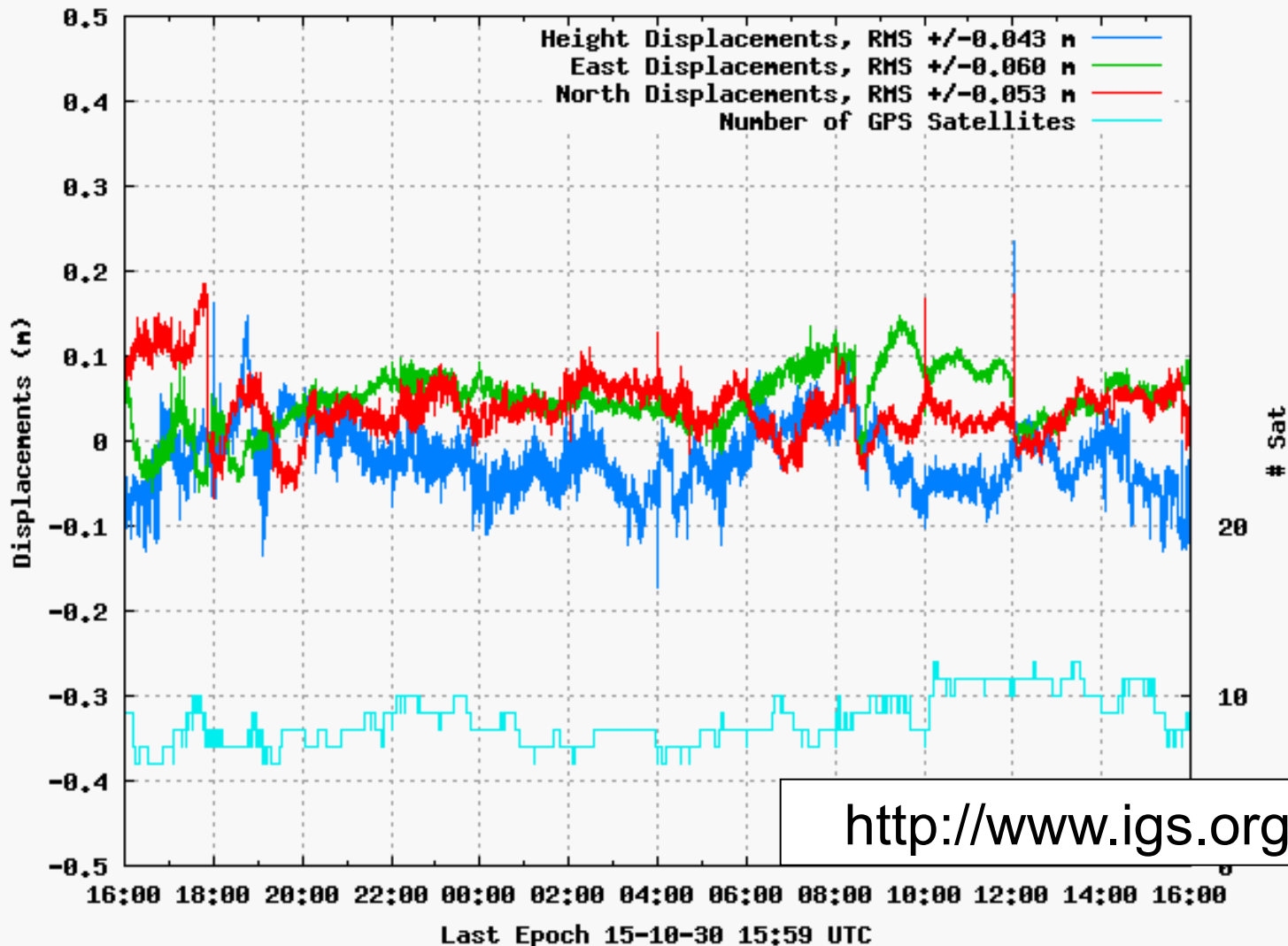
# IGS-RTS IGS01...

## *RT-PPP GPS-only Results*



Frankfurt a.M.

Realtine-PPP Displacements for FFMJ5 using IGS01 - (C) BKG



<http://www.igs.org/rt/monitor>

# IGS-RTS IGS03...

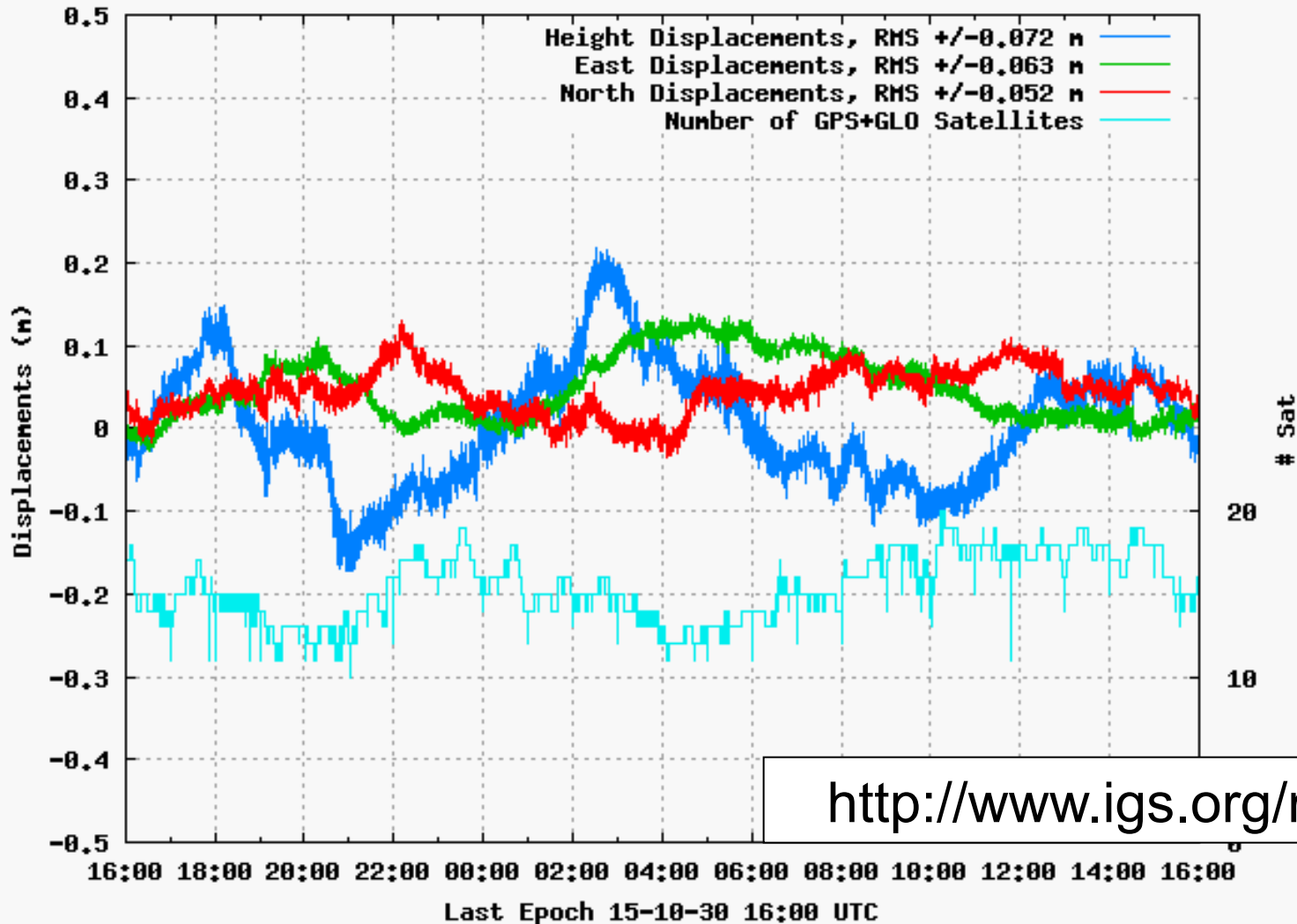
## RT-PPP GPS+GLONASS Results



IGS

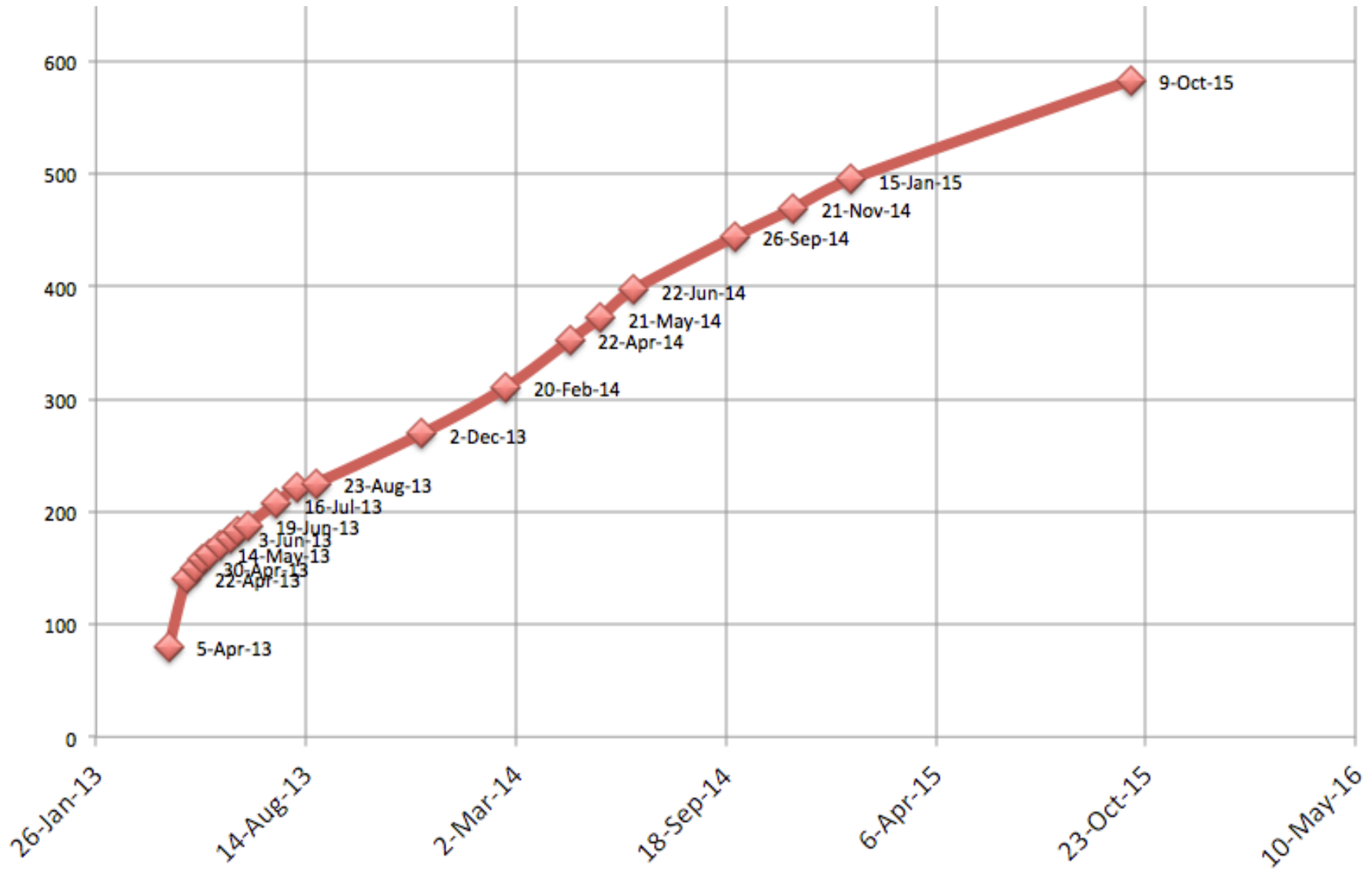
Frankfurt a.M.

Realtine-PPP Displacements for FFMJ5 using IGS03 - (C) BKG  
Presently Combined From: CLK11 CLK91 CLK80



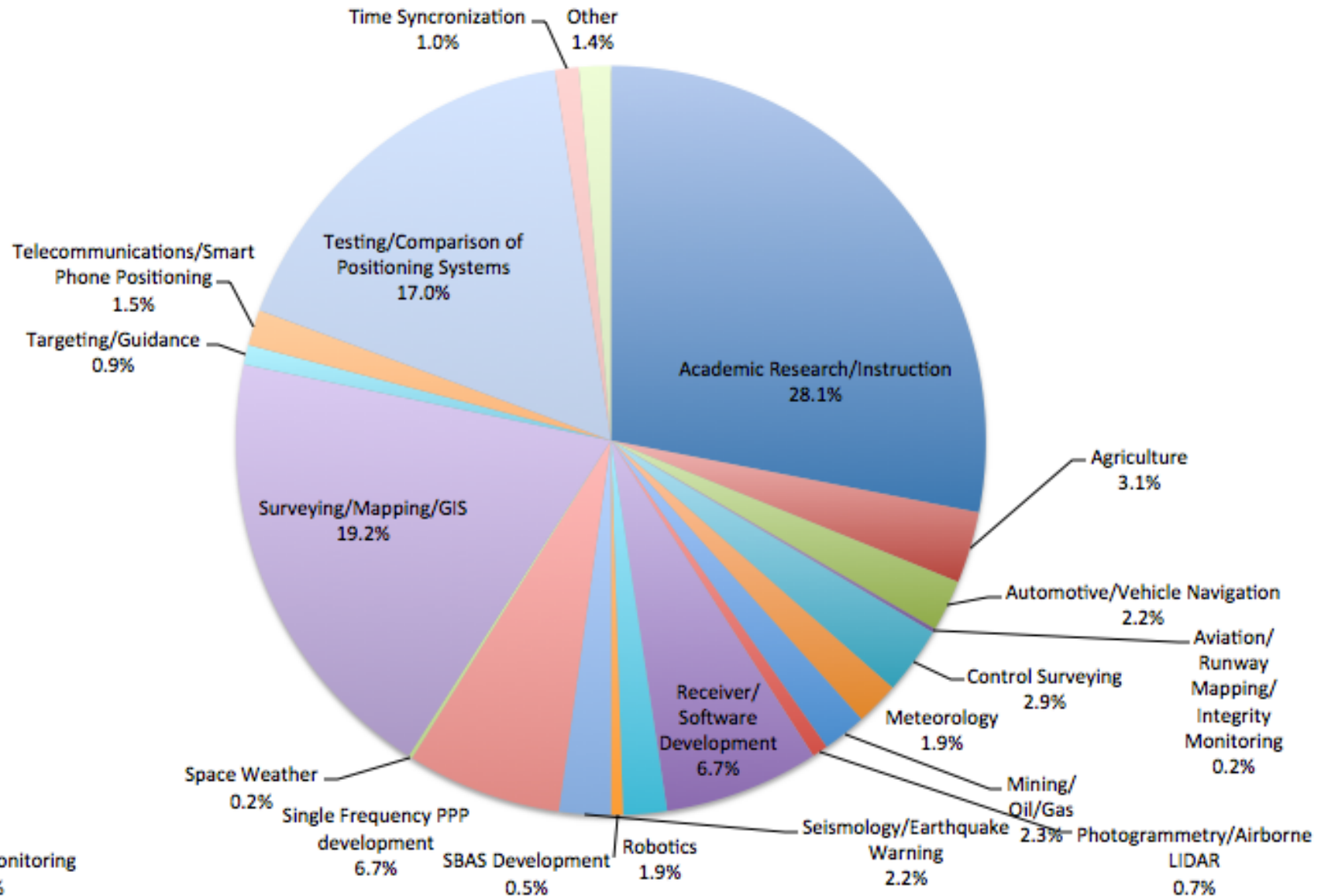
# IGS-RTS... *who is using it?*

- 80 user registrations within days of launch
- 583 user registrations by 9 October 2015, from 72 countries



# IGS-RTS... *who is using it?*

## Current RTS User Statistics by Application



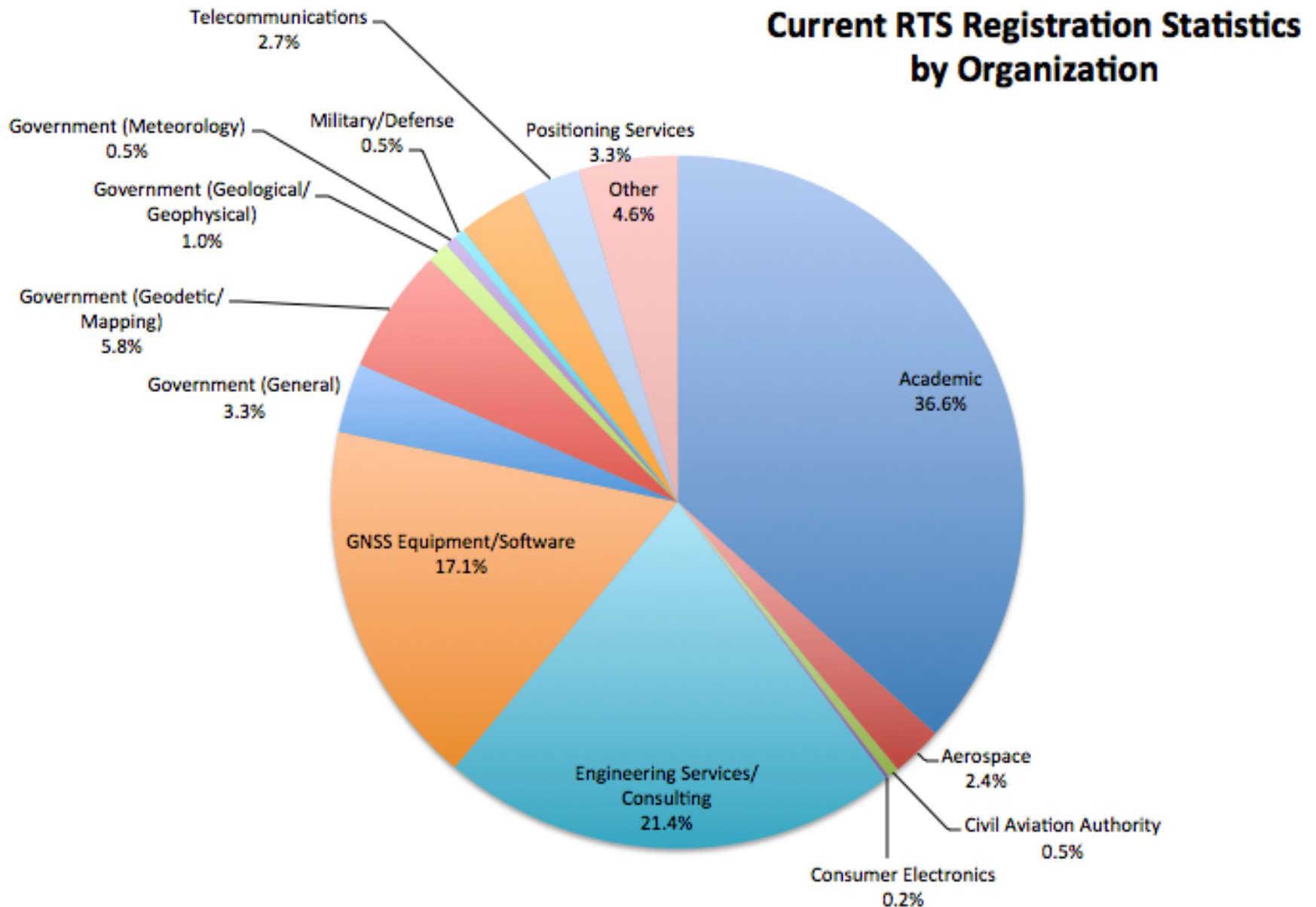
# IGS-RTS... *who is using it?*



RTS User Statistics by Application	Statistics as of:																				
	9-Oct-15																				
	30-Apr-13	7-May-13	14-May-13	24-May-13	3-Jun-13	10-Jun-13	19-Jun-13	9-Jul-13	16-Jul-13	6-Aug-13	23-Aug-13	2-Dec-13	20-Feb-14	22-Apr-14	21-May-14	22-Jun-14	26-Sep-14	21-Nov-14	15-Jan-15	9-Oct-15	Current
Academic Research/Instruction	24	24	24	24	25	25	27	32	36	43	43	60	76	88	93	99	116	123	131	164	164
Agriculture	4	4	4	4	4	4	4	4	5	5	5	5	7	9	9	9	10	12	14	18	18
Automotive/Vehicle Navigation	1	1	1	2	2	2	2	2	2	2	2	3	5	7	7	8	10	11	12	13	13
Aviation/Runway Mapping/Integrity Monitoring	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Control Surveying	2	2	2	2	2	2	2	2	3	4	5	7	7	8	8	10	14	14	15	17	17
Meteorology	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4	5	7	8	8	11	11
Mining/Oil/Gas	1	1	1	1	3	3	3	3	3	4	4	5	8	9	9	14	10	11	11	11	11
Photogrammetry/Airborne LIDAR	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	2	2	2	4	4	4
Radiation Monitoring	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Receiver/Software Development	9	9	9	9	9	9	9	10	10	10	10	16	18	20	21	23	26	28	33	39	39
Robotics	2	2	2	2	2	2	2	2	2	2	2	2	2	3	5	5	7	7	8	11	11
SBAS Development	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	3	3	3
Seismology/Earthquake Warning	7	7	7	7	7	7	7	8	8	8	8	9	9	11	11	11	11	11	11	13	13
Single Frequency PPP development	16	16	16	16	17	19	19	21	21	22	22	23	24	27	30	31	32	34	35	39	39
Space Weather	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
Surveying/Mapping/GIS	30	34	36	39	39	42	43	44	45	50	50	58	65	70	75	79	85	89	92	112	112
Targeting/Guidance	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5
Telecommunications/Smart Phone Positioning	4	5	5	5	5	5	5	5	5	5	5	5	6	7	7	7	7	7	7	9	9
Testing/Comparison of Positioning Systems	37	41	41	44	46	46	48	48	48	48	50	56	59	65	69	69	84	88	92	99	99
Time Synchronization	4	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Other	3	3	3	3	3	3	3	4	4	4	4	4	5	6	6	7	7	8	8	8	8
	150	161	163	170	177	183	188	199	206	221	224	269	310	350	370	394	444	469	495	584	584



# IGS-RTS... *who is using it?*



# IGS-RTS... *who is using it?*



RTS User Statistics by Organization	Statistics as of:																				
	9-Oct-15																				
	5-Apr-13	7-May-13	14-May-13	24-May-13	3-Jun-13	10-Jun-13	19-Jun-13	9-Jul-13	16-Jul-13	6-Aug-13	23-Aug-13	2-Dec-13	20-Feb-14	22-Apr-14	21-May-14	22-Jun-14	26-Sep-14	21-Nov-14	15-Jan-15	9-Oct-15	Current
Academic	23	41	41	43	44	45	46	54	59	66	66	85	103	115	122	127	145	156	168	214	214
Aerospace	4	2	2	2	2	2	2	3	3	3	3	3	5	7	7	9	9	10	13	14	14
Civil Aviation Authority	1	1	1	1	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3
Consumer Electronics	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Engineering Services/Consulting	25	44	44	48	51	53	54	56	57	59	60	70	76	83	88	97	105	112	114	125	125
GNSS Equipment/Software	15	36	36	36	38	39	41	42	42	45	46	53	59	65	70	73	81	84	87	100	100
Government (General)	-	4	4	4	4	4	4	4	4	4	4	5	7	9	10	11	12	13	14	19	19
Government (Geodetic/Mapping)	2	10	12	13	13	15	15	15	16	17	18	20	24	24	24	27	30	30	31	34	34
Government (Geological/Geophysical)	3	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	6	6	6	6	6
Government (Meteorology)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	3	3	3	3
Military/Defense	0	1	1	1	1	1	1	1	1	2	2	2	2	3	3	3	3	3	3	3	3
Positioning Services	2	2	2	2	2	2	3	2	2	2	2	4	5	8	9	11	11	12	13	19	19
Telecommunications	2	5	5	5	5	5	5	5	5	5	5	5	6	8	8	8	11	12	13	16	16
Other	2	10	10	10	10	10	10	11	11	11	11	15	16	20	20	20	25	25	27	27	27
	80	161	163	170	177	183	188	200	207	221	224	269	310	350	370	370	444	469	495	584	584

IGS-RTS...

*Geoscience & geospatial applications*

# *IGS-RTS spurring innovation...*

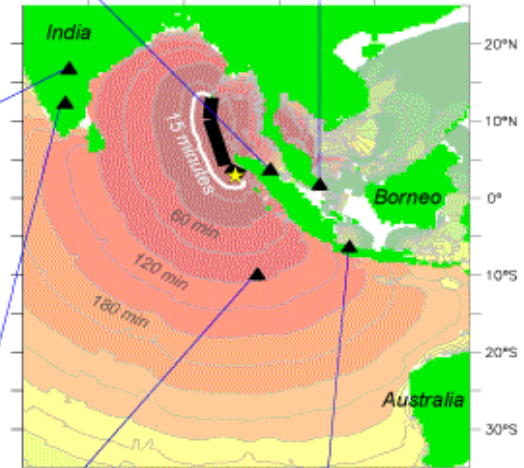
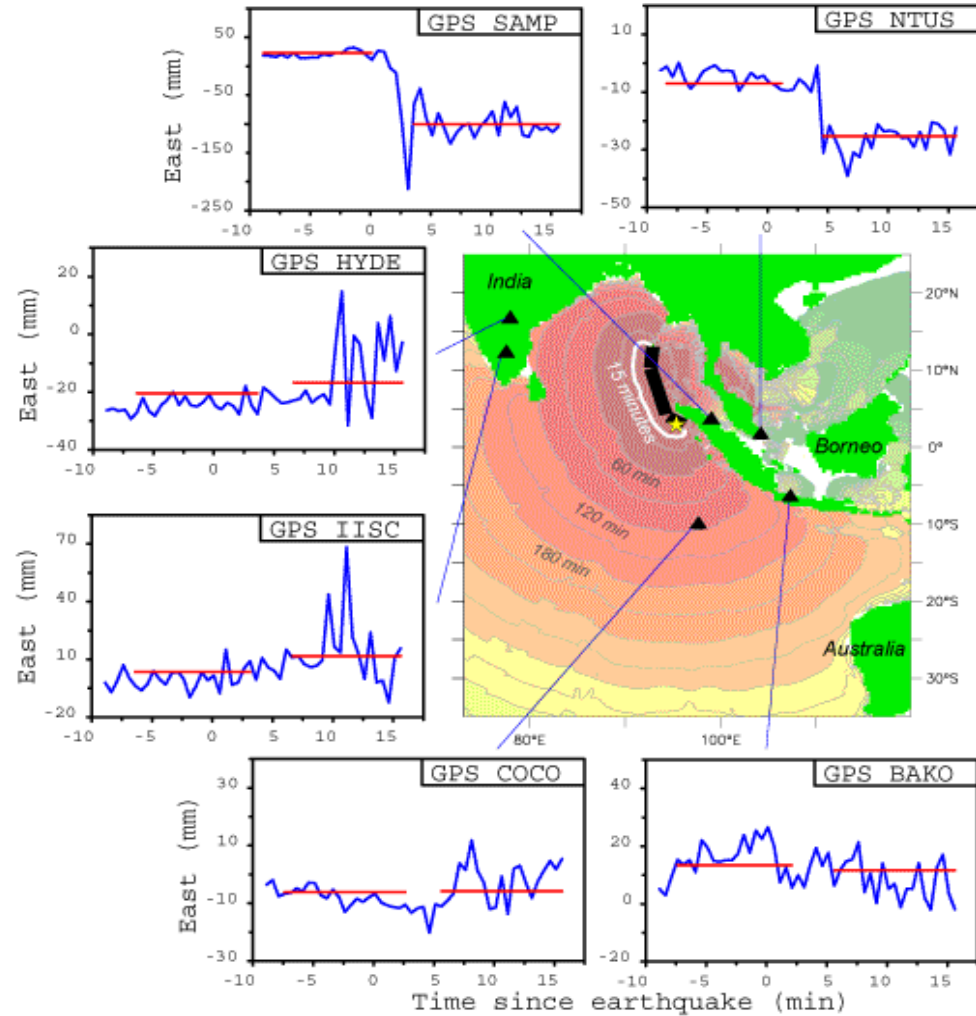
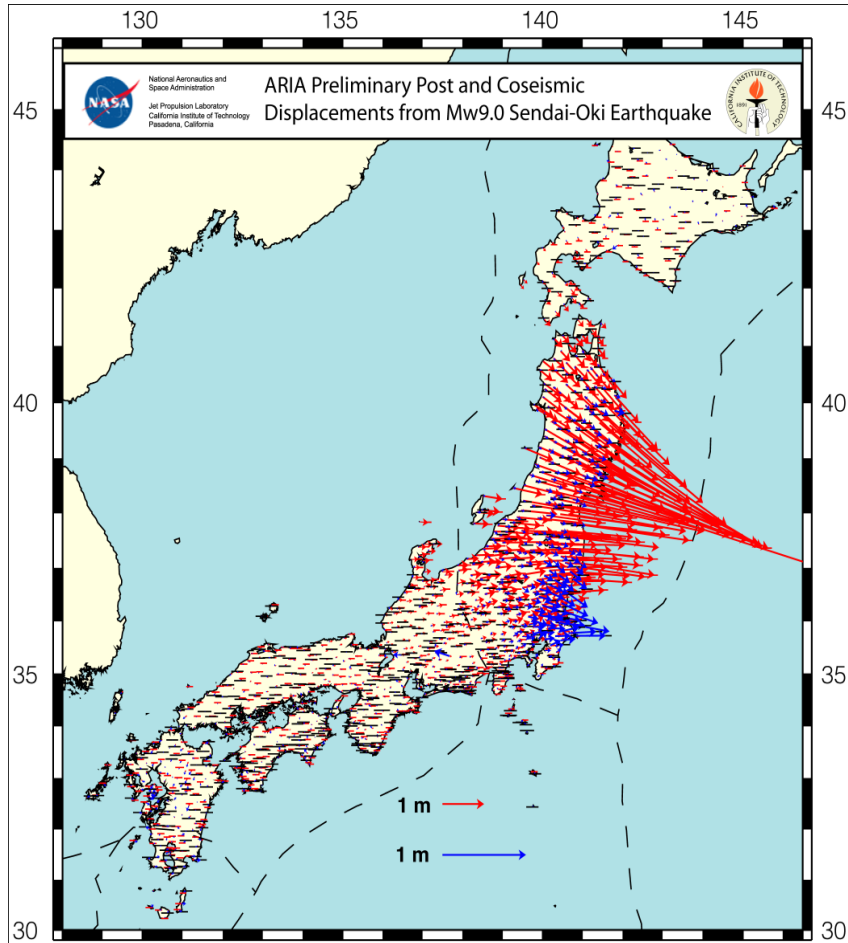
- Geohazard... seismic displacements, tsunami prediction
- (Near-)real-time comparison of UTC(k)'s... time transfer
- IGMA parameter estimation... orbits, clocks, etc
- Atmospheric remote sensing, meteorology
- Precise orbit determination
- Geodesy, datum studies/monitoring, kinematic positioning
- Buoys, wave height measuring, hydrography
- Surveying, mapping, UAV platforms, agriculture, etc
- Performance statistics... intercomparisons, RTK v PPP v SBAS
- Testing, demonstrations, investigations... manufacturers, academic
- Low-cost GNSS receiver studies
- Intelligent Transport System (ITS) positioning
- Outdoor robotics, wearables, IoT
- Education
- ...

# IGS-RTS Geodetic Applications



- Enables RT-PPP at global scales for scientific applications, atmospheric & space weather forecast, multi-GNSS performance monitoring, & more...
- E.g. rapidly detecting, locating & characterising hazardous events such as earthquakes, tsunamis, landslides, etc.
- **Contributes to IAG's GGOS Focus Area 2 "Geohazards Monitoring"**

# Pre-, Co-, Post-Seismic Displacement... *GNSS CORS, rapid measurement analysis*

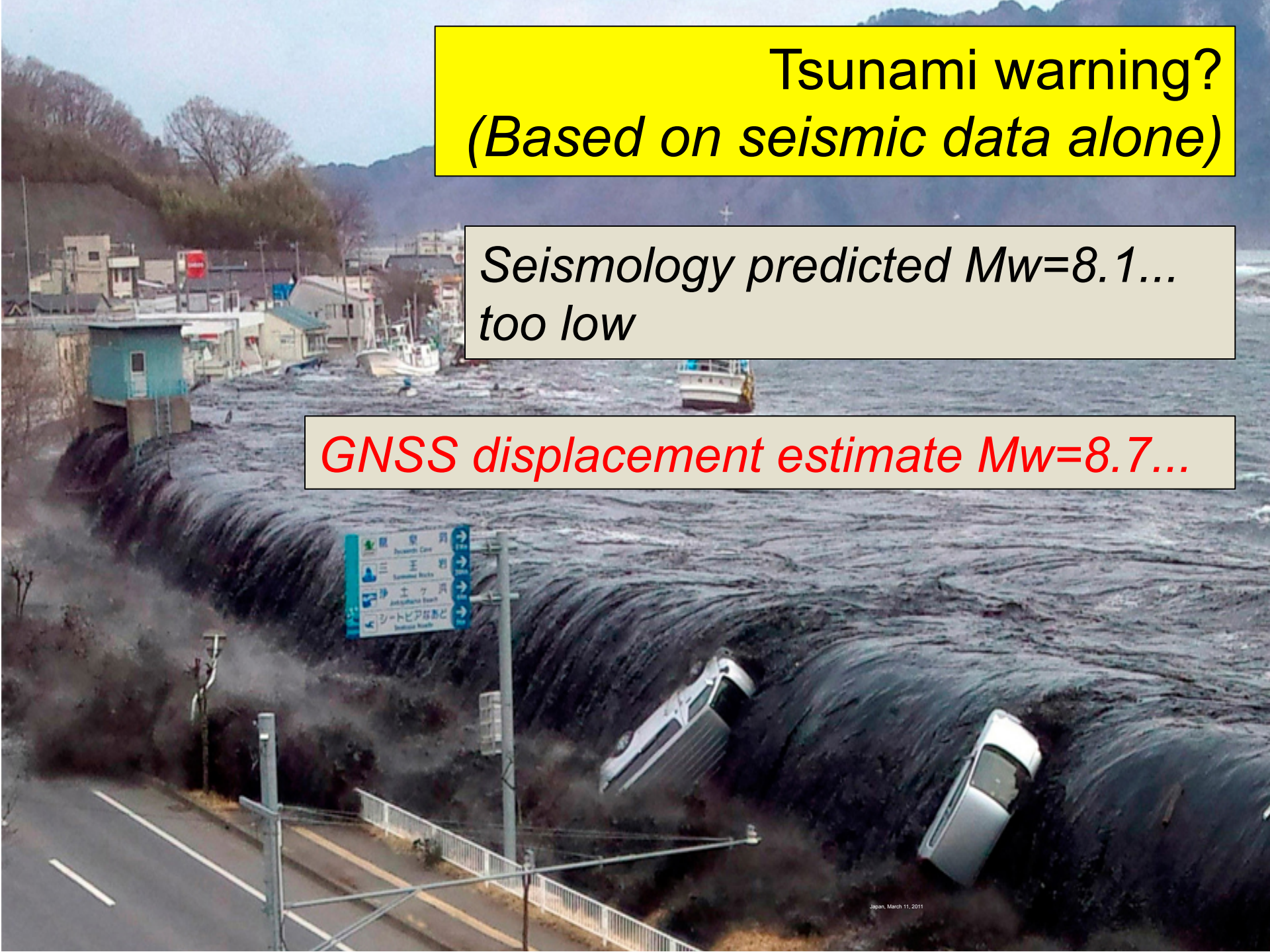




# Tsunami warning? *(Based on seismic data alone)*

*Seismology predicted  $M_w=8.1$ ...  
too low*

*GNSS displacement estimate  $M_w=8.7$ ...*

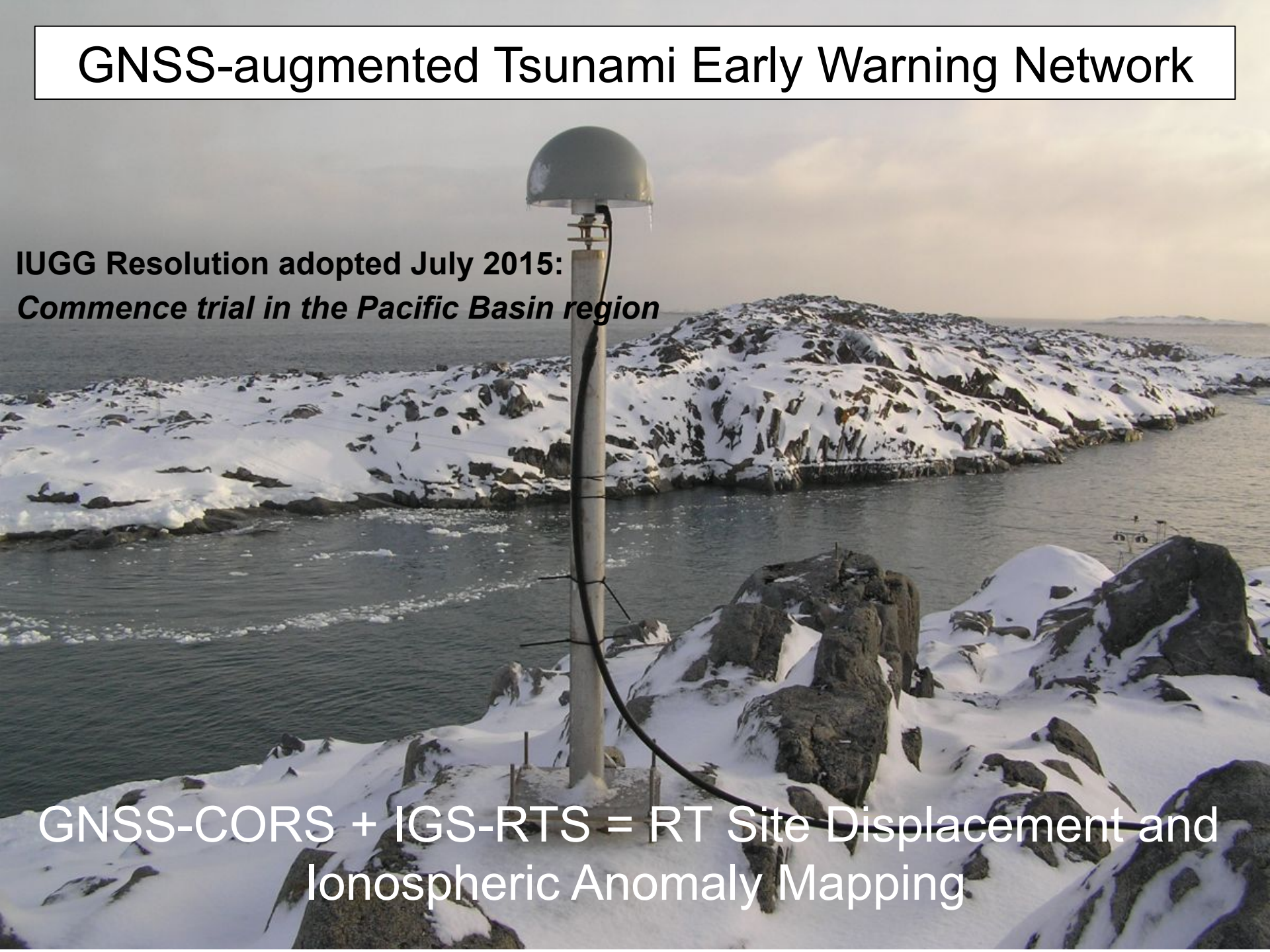




# GNSS-augmented Tsunami Early Warning Network

**IUGG Resolution adopted July 2015:**  
***Commence trial in the Pacific Basin region***

**GNSS-CORS + IGS-RTS = RT Site Displacement and  
Ionospheric Anomaly Mapping**



# RT Geodetic Services: *Utilising Over 3000 Pacific Basin GNSS CORS*

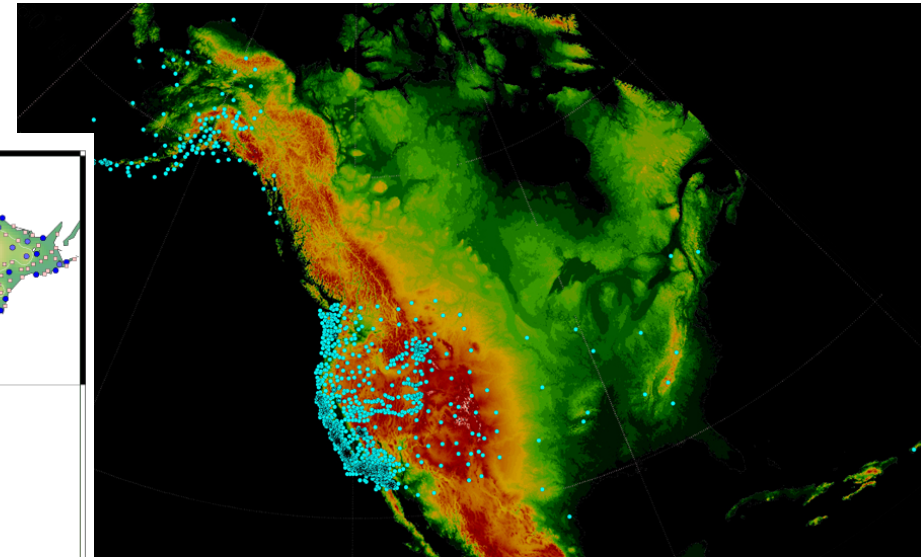
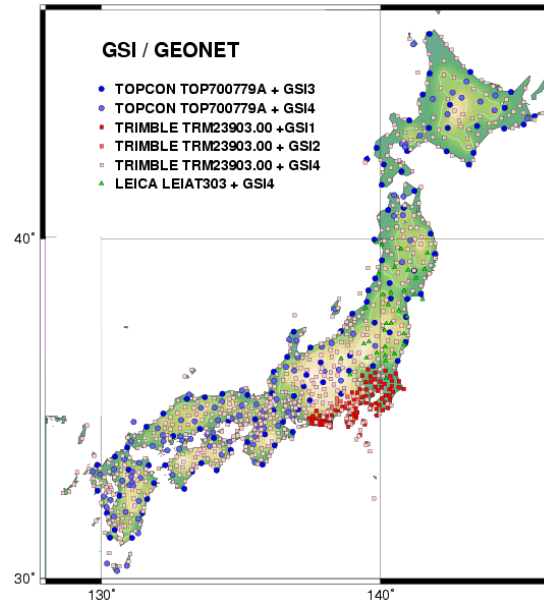
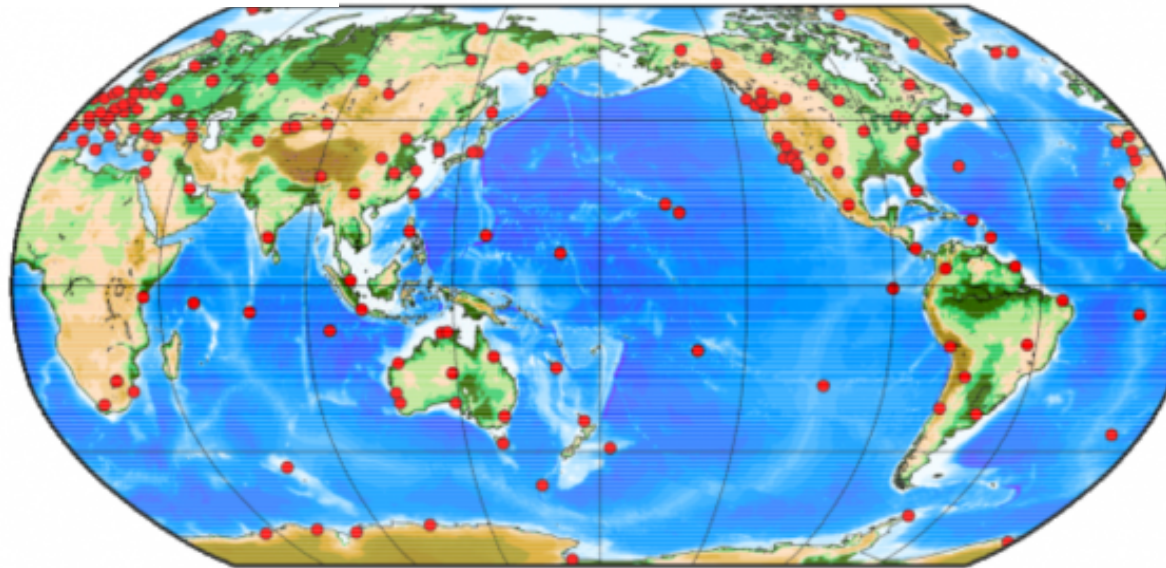
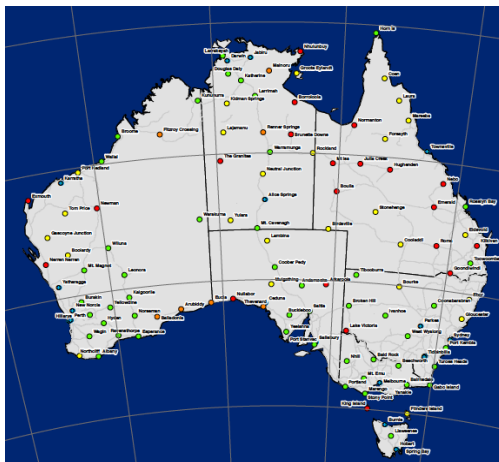


Plate Boundary Observatory



IGS Real-Time Network



The background features a stylized world map with a color gradient from blue on the left to yellow and red on the right. The map is composed of several overlapping, semi-transparent layers. A dark blue horizontal bar is positioned in the upper left quadrant, containing the text 'GNSS Futures'.

# *GNSS Futures*

IGS Workshop  
8–12 February 2016  
Sydney, NSW, Australia



IGS