IGS Classic Products, Status and Towards the Future

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IGS Core Product Series

Series	ID	Latency	Issue times (UTC)	Data spans (UTC)	Remarks
Ultra-Rapid (predicted half)	IGU	real-time	@ 03:00, 09:00, 15:00, 21:00	+24 hr @ 00:00, 06:00, 12:00, 18:00	● for real-time apps ● GPS & GLONASS ● issued with prior IGA
Ultra-Rapid (observed half)	IGA	3 - 9 hr	@ 03:00, 09:00, 15:00, 21:00	-24 hr @ 00:00, 06:00, 12:00, 18:00	● for near real-time apps ● GPS & GLONASS ● issued with following IGU
Rapid	IGR	17 - 41 hr	@ 17:00 daily	±12 hr @ 12:00	● for near-definitive, rapid apps ● GPS only
Final	IGS	12 - 19 d	weekly each Thursday	±12 hr @ 12:00 for 7 d	● for definitive apps ● GPS & GLONASS

Popularity of IGS Core Products (1/2)

- download statistics @ NASA/CDDIS (06/2010 thru 06/2012) -

- **>3.6 million file downloads per month!**
  - **total for all product lines (IGS, IGL, IGR, IGU, and experimental IGV)**
- **5 biggest users of CDDIS/IGS files:**
  - **United States @ 64.3%**
    - **from >11,300 IP addresses**
  - **Indonesia @ 19.3%**
    - **from ~250 IP addresses**
  - **Canada @ 1.64%**
  - **Sweden @ 1.57%**
  - **Belgium @ 1.16%**
- **Overall, which products are downloaded most/least?**

Courtesy: C. Noll (NASA/CDDIS)

Popularity of IGS Core Products (2/2)

- download statistics @ NASA/CDDIS (06/2010 thru 06/2012) -

- **Some details over past 6 months**

Product	GNSS	Total Hits	SP3 (%)	ERP (%)	CLK (%)	SNX (%)	SUM (%)
IGU/IGA	GPS	11,711,506 (≈ 4 * 2,927,877 daily)	93.7	3.1			3.2
IGS+IG1	GPS	1,359,656	60.7	6.8	24.8	5.8	2.0
IGR	GPS	887,986	65.6	8.7	16.9		6.4
IGL	GLO	225,515	99.1		0.3		0.6
IGV	GPS & GLO	223,562	95.0				5.0

Courtesy: C. Noll (NASA/CDDIS)

IGS Core Product Accuracies (2011)

Series	ID	Product Types	Accuracies	Output Intervals
Ultra-Rapid (predicted half)	IGU	• **GPS orbits**	~ 5 cm (1D)	15 min
		• **GLONASS orbits**	~10 cm (1D)	15 min
		• **GPS SV clocks**	~3 ns RMS / ~1.5 ns Sdev	15 min
		• **EOPs: PM + dLOD**	~250 µas / ~50 µs	6 hr
Ultra-Rapid (observed half)	IGA	• **GPS orbits**	~ 3 cm (1D)	15 min
		• **GLONASS orbits**	~5 cm (1D)	15 min
		• **GPS SV clocks**	~150 ps RMS / ~50 ps Sdev	15 min
		• **EOPs: PM + dLOD**	<50 µas / ~10 µs	6 hr
Rapid	IGR	• **GPS orbits**	~2.5 cm (1D)	15 min
		• **GPS SV & station clocks**	~75 ps RMS / ~25 ps Sdev	5 min
		• **EOPs: PM + dLOD**	<40 µas / ~10 µs	daily
Final	IGS	• **GPS orbits**	<2.5 cm (1D)	15 min
		• **GLONASS orbits**	<5 cm (1D)	15 min
		• **GPS SV & station clocks**	~75 ps RMS / ~20 ps SDev	30 s (SVs) + 5 min
		• **EOPs: PM + dLOD**	<30 µas / ~10 µs	daily
		• **Terrestrial frames**	~2 mm N&E / ~5 mm U	weekly

see *Rotational Errors in IGS Orbit and ERP Products*, by J. Ray
Thursday AM @ 08:30

IGS Ultra Orbit Predictions Compared to Rapids

IGU 6hr Prediction Differences (mm @ GPS altitude)										
	dX	dY	dZ	RX	RY	RZ	SCL	RMS	wRMS	Medi
2008	2.9	0.4	0.3	-4.2	-1.1	0.7	-3.0	>>>	24.6	18.4
±	4.5	4.4	3.6	20.8	22.6	35.8	3.2	>>>	6.4	2.9
2009	3.5	-0.6	0.3	0.3	0.8	3.1	-0.7	28.9	21.3	15.6
±	4.7	4.9	3.4	13.9	16.4	27.3	2.6	19.7	8.0	2.6
2010	3.4	0.4	-0.3	1.9	-0.4	2.3	-1.0	28.7	21.5	15.6
±	5.2	4.9	3.2	14.0	16.5	25.7	2.6	31.2	13.5	2.6
2011	2.5	0.5	-1.1	2.2	-0.9	2.1	-0.2	27.0	20.5	15.3
±	5.2	5.4	3.2	14.1	16.8	22.4	2.3	24.4	6.6	2.6

IGU 24hr Prediction Differences (mm @ GPS altitude)										
2008	1.0	1.0	-0.0	-5.8	-3.5	-2.9	-3.2	72.6	52.6	33.9
±	2.0	1.9	3.9	31.6	35.7	61.4	2.7	42.4	15.4	6.4
2009	1.1	0.3	-0.1	-0.5	-0.6	-0.9	-1.3	64.7	47.3	30.2
±	1.8	2.0	3.8	22.0	31.3	52.1	1.9	33.3	16.3	6.0
2010	0.6	0.9	-1.4	5.5	-2.9	0.1	-1.8	70.3	47.0	30.1
±	2.1	2.0	3.8	23.8	32.6	50.1	2.1	171.7	25.3	5.7
2011	0.6	1.4	-2.1	5.9	-3.2	-2.4	-0.5	59.4	45.3	30.5
±	1.9	2.1	3.6	25.6	31.9	42.8	1.7	25.2	14.1	5.4

* rotations are equatorial @ GPS altitude; 24hr predictions from 00 UTC IGUs only

IGS Ultra Orbit Predictions Compared to Rapids

due to UT1 prediction errors

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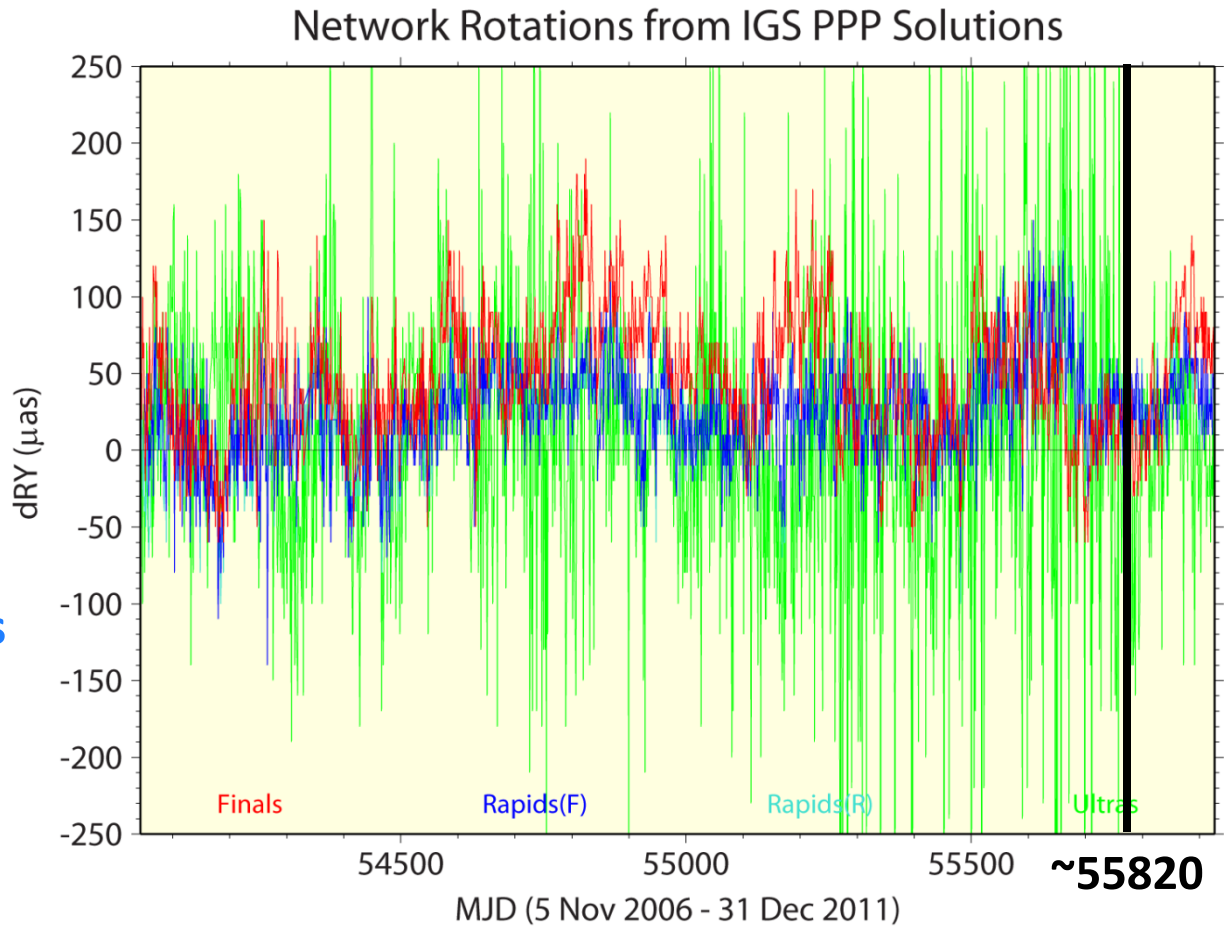
Persistent Rotational Scatter in IGU products

- About half of total IGU error
- Reduced since mid-Sep. 2011 (MJD 55820), when combi. toler. changed
- Possible sources
  - errors in *a priori* EOPs
  - poor IGU clocks
  - rotational mis-alignment of IGU orbits



- Currently testing new orbit combination approach in IGV

Initial Results from New Testing in IGV

- **Operational IGU**
  - GPS only (5/9 ACs – WHU & NGU new; used only for comparison)
  - uses all 48h (observed & predicted) parts to align AC orbits
- **Experimental IGV**
  - mixed GPS (5/9 ACs) & Glonass (4/4 ACs)
  - uses first 24h (observed) part to align AC orbits
    - detailed results are mixed – slight degradation w.r.t. IGR?
    - rotational misalignments still significant

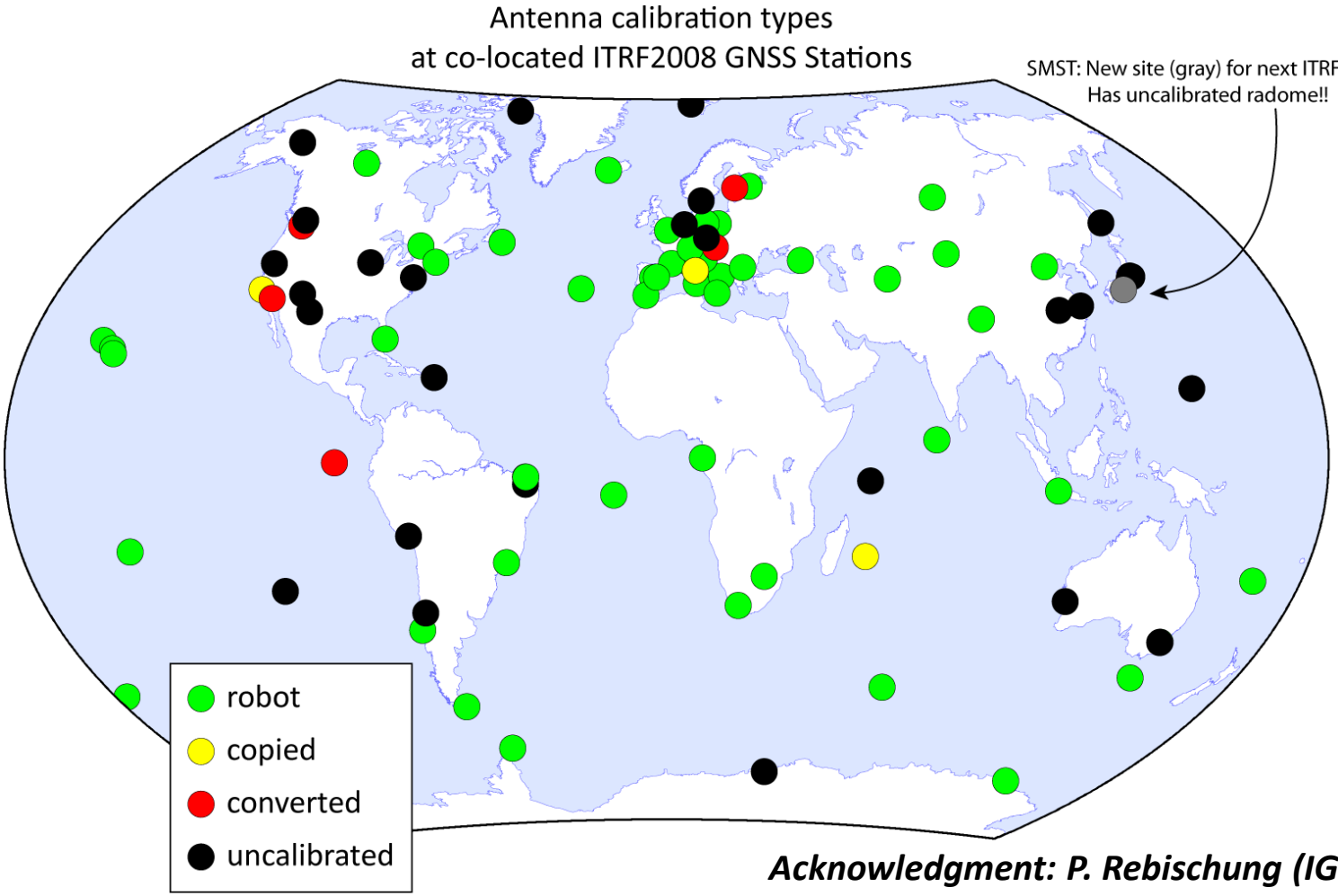
	TX [mm]	TY [mm]	TZ [mm]	RX [uas]	RY [uas]	RZ [uas]	SCL [ppb]	RMS [mm]	WRMS [mm]
igu-igr	0.90	-0.15	-0.40	17.83	-15.55	-2.43	0.001	9.07	8.12
+ / -	1.10	1.00	1.33	25.30	19.35	56.94	0.050	1.69	1.37
igv-igr	0.87	-0.10	-0.66	24.33	-21.50	5.56	-0.020	9.23	8.33
+ / -	1.15	1.02	1.20	25.47	20.00	64.74	0.044	1.58	1.35

100 uas ≈ 13 mm @ GPS

Based on 3 weeks: 1693 thru 1696

Other Challenges: Uncalibrated Radomes

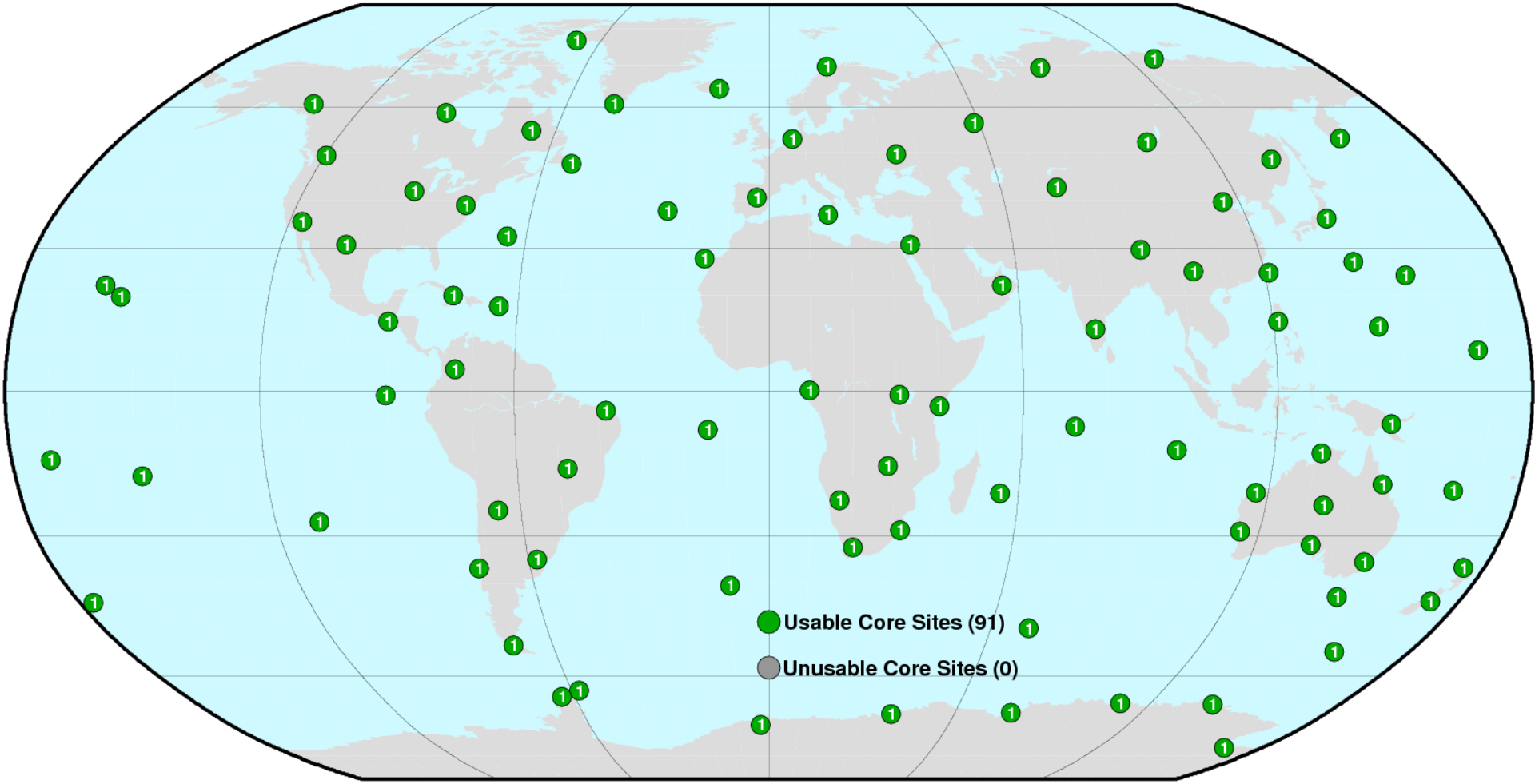
- **28/92 (≈ 30%) co-located sites have an uncalibrated radome**
  - **nearly half (13/28) operated by JPL**



Acknowledgment: P. Rebischung (IGN/LAREG)

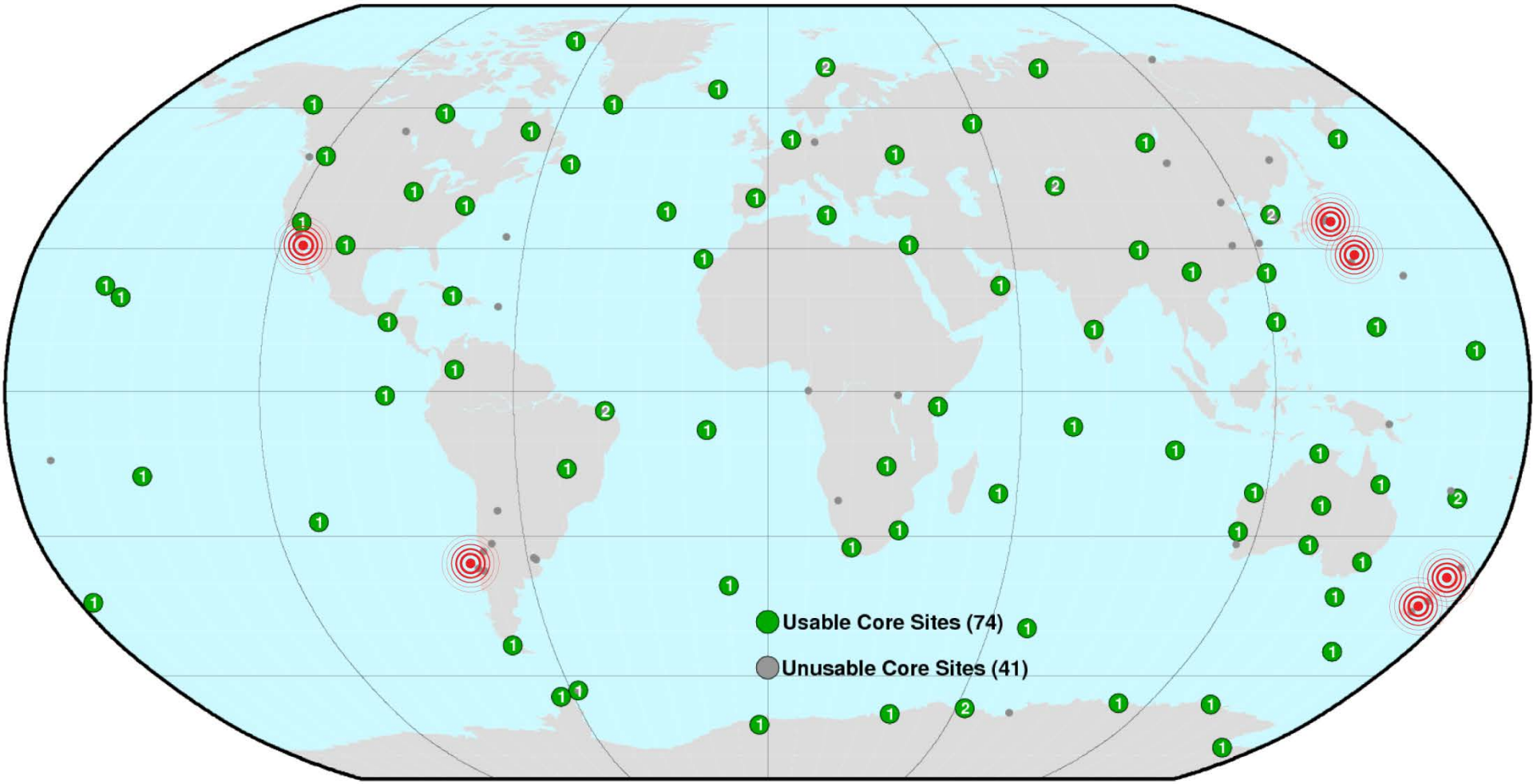
Other Challenges: Loss of IGS08 Core Stations (1/4)

- **Primary core network @ 2009.5 (best case—all data avail.)**



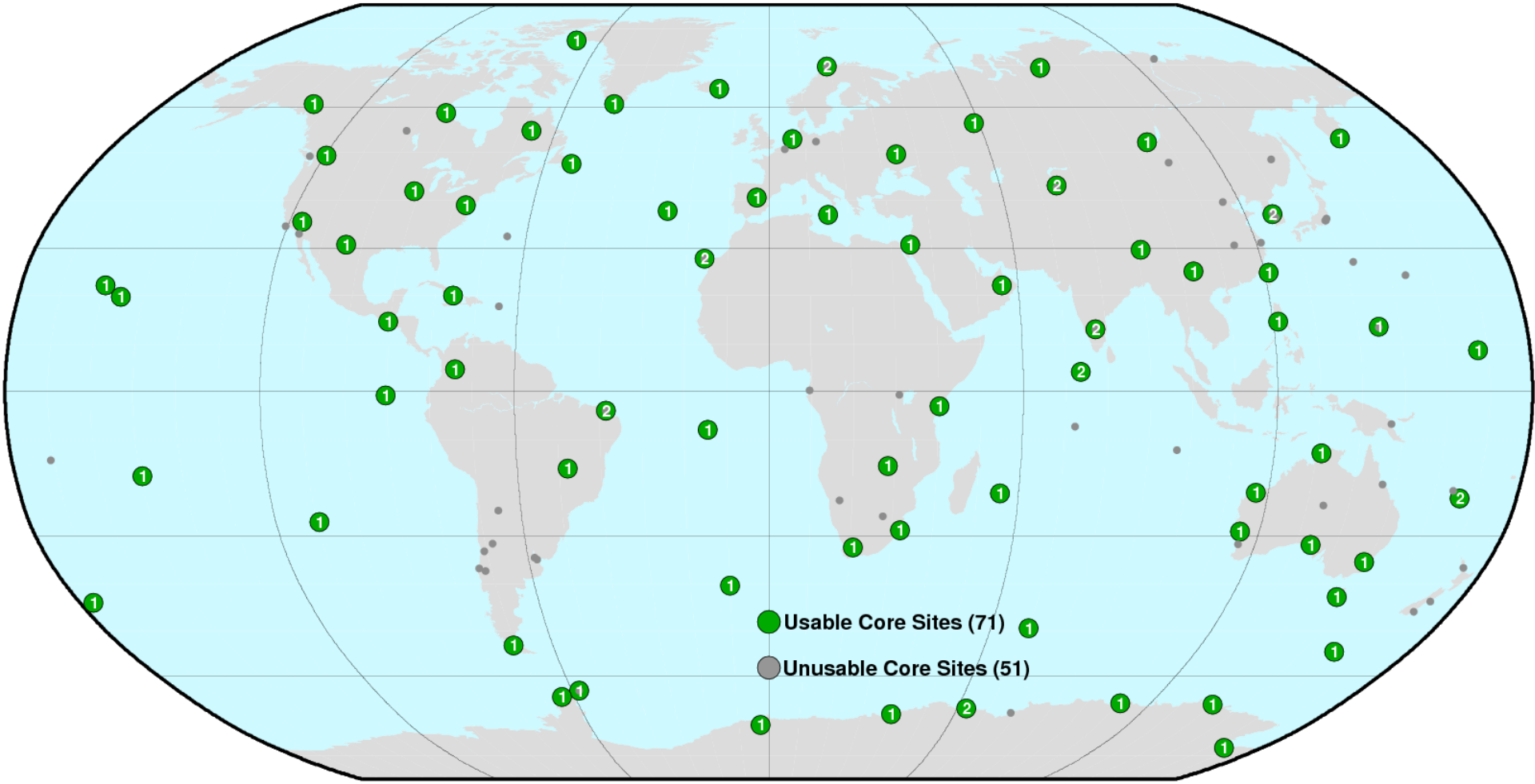
Other Challenges: Loss of IGS08 Core Stations (2/4)

- **Wk 1632: IGS08 adopted; ~22 primary already lost (e-quakes & equip. changes)**



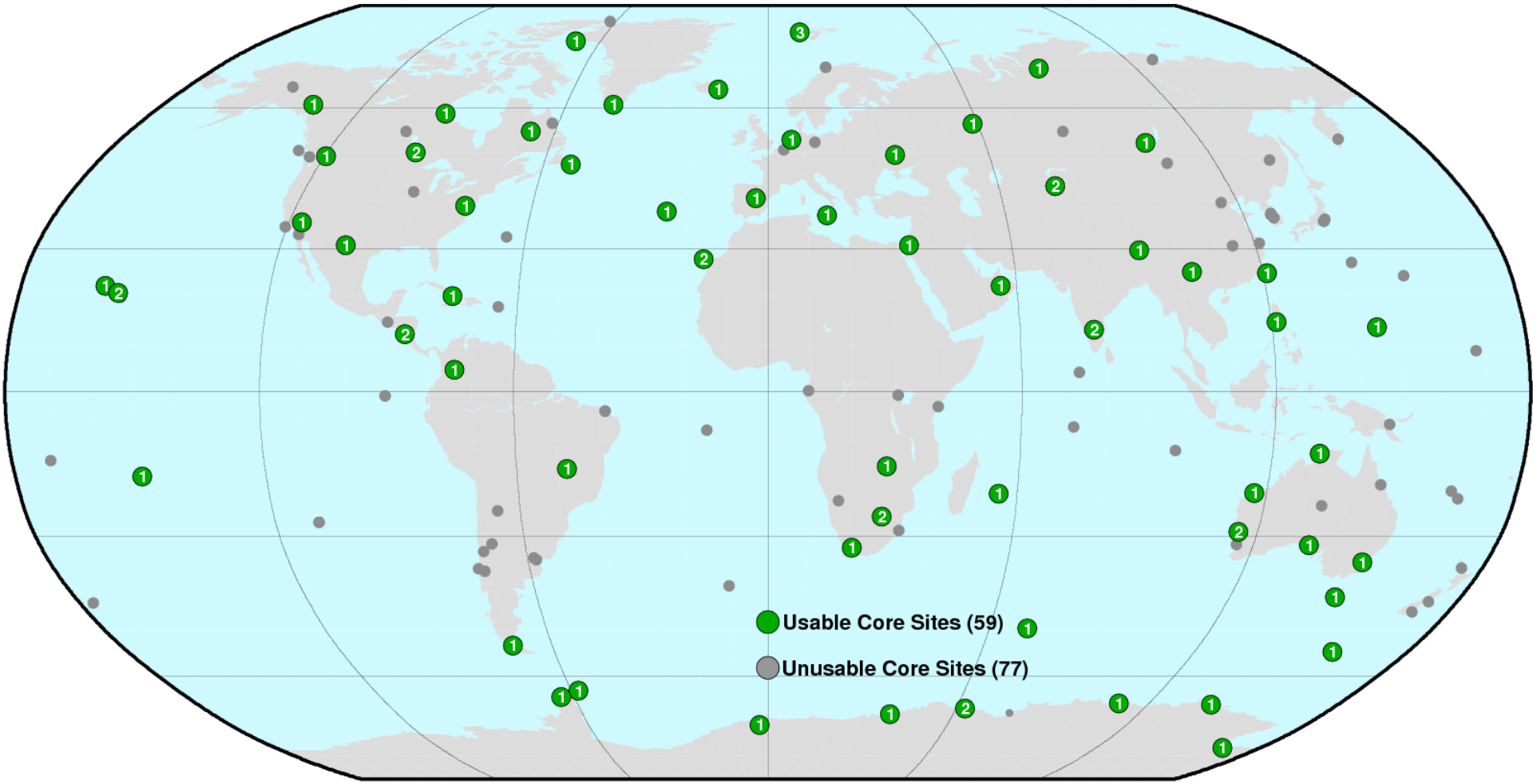
Other Challenges: Loss of IGS08 Core Stations (3/4)

- **Today: ~71 useable sites (assumes all data are available)**



Other Challenges: Loss of IGS08 Core Stations (4/4)

- **Today: accounting for data availability, ~59 useable core sites**



Summary of Persistent Challenges

- **Rotational errors in all products; largest in IGU**
- **Uncalibrated radomes at co-location sites**
  - one recently available at SMST!! (co-located w/ SLR; unavail. for ITRF2008)

see *Strengths and Weaknesses of the IGS Contribution to ITRF*, by Z. Altamimi
Friday AM @ 9:06

- **Loss of IGS08 core stations**
  - anthropogenic site disturbances (incl. many equip. changes)
  - data loss, and earthquakes & other physical processes
- **Known biases and other systematic errors**
  - harmonic and sub-daily alias errors in all IGS products
  - site-specific errors *[e.g., Wetzell observations by Steigenberger et al., REFAG2010]*

see *BRUX: A New EPN and IGS Reference Station in Brussels*, by W. Aerts
Tuesday PM (1:30 – 3:00)

see *Investigation of Non-Tectonic Signals at GPS Stations*, by C. Meertens
Wednesday AM @ 09:50

Upcoming Events

- **Switch to Finals products based on daily TRF integrations**
  - to facilitate further study of non-tidal loading effects
    - station position RMS increases by factor of 1.0 to 1.5 (mostly in E & U)
    - 0.5 mm RMS increase in orbit
    - 2.5 ps RMS increase over clock ensemble
    - kinematic PPP results show that impact to users is very small
    - CODE orbits & SNX will be included for comparison only
    - may yield better internal consistency due to removal of AC over-constraints
  - see IGSMail #6613 for more details
- **Next reprocessing (details at acc.igs.org/reprocess2.html)**
  - expect to finalize analysis standards this week!
  - should result in improved inter-AC agreement & reduced systematic errors
  - but some issues not likely to be resolved
    - to remain: sub-daily tidal EOP errors & tracking station inadequacies
  - aiming for early 2014 delivery of combined SNX for next ITRF

Recommendations

- Need more Ultra-rapid (IGU & IGV) ACs
- Further study of IGU <-> IGR <-> IGS inconsistencies
- Improve tracking stations, esp at co-location sites
  - remove uncalibrated radomes
  - prevent/eliminate unnecessary antenna changes
  - study electronic instability and other local effects
  - RF and co-located stations to be closely monitored by a dedicated Network Coordinator
- Update IERS model for sub-daily EOP tidal variations
- Finalize analysis standards for repro2 (this week!)
  - RF and co-located stations to be processed with priority
  - AC networks to be as stable & connected (in time) as possible
  - aiming for early 2014 delivery of combined SNX files for ITRF2013
    - consider excluding co-location sites w/ uncalibrated radomes in ITRF combination (ACs should still process their data)

Extra Slides