

The CODE MGEX orbit and clock solution.

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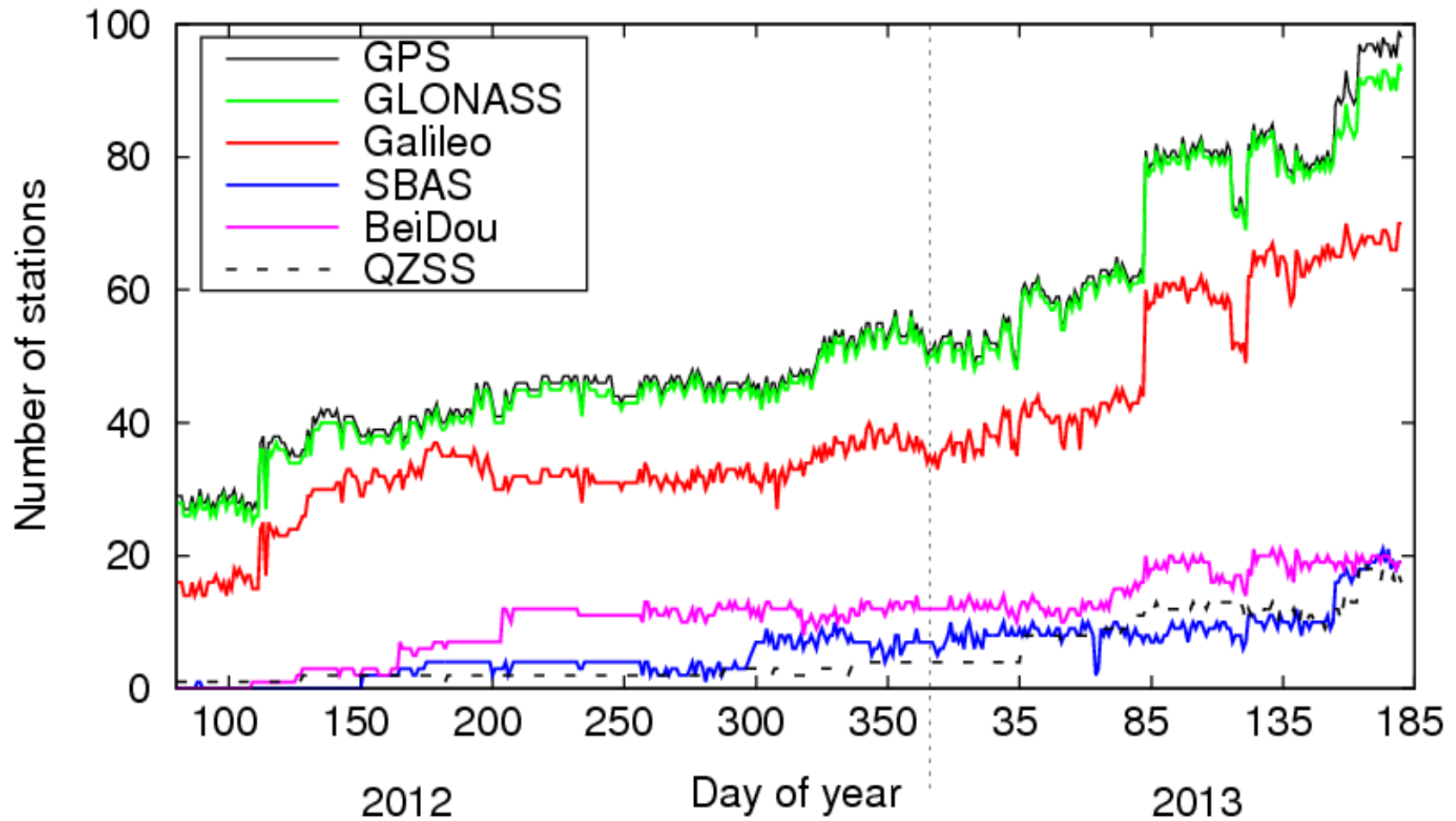
- MGEX network and data
- CODE MGEX orbit solution
- CODE MGEX clock solution
- Precise point positioning (PPP)
- Summary

MGEX network and data

- Data sources: **IGS**: CDDIS, BKG, IGN (MGEX plus RINEX3 directories); **EUREF**: BKG (RINEX3 directory)
- Number of daily files/stations: about 100 files per day in mid 2013
- RINEX versions: 2.11, 2.12, 3.00, 3.01, 3.02
- For some stations RINEX2 and RINEX3 are available
- Established IGS stations and new stations
- Public access to MGEX monitoring results via FTP:
=> <ftp://ftp.unibe.ch/aiub/mgex/>

MGEX network and data

Satellite systems being monitored (RINEX3 files):

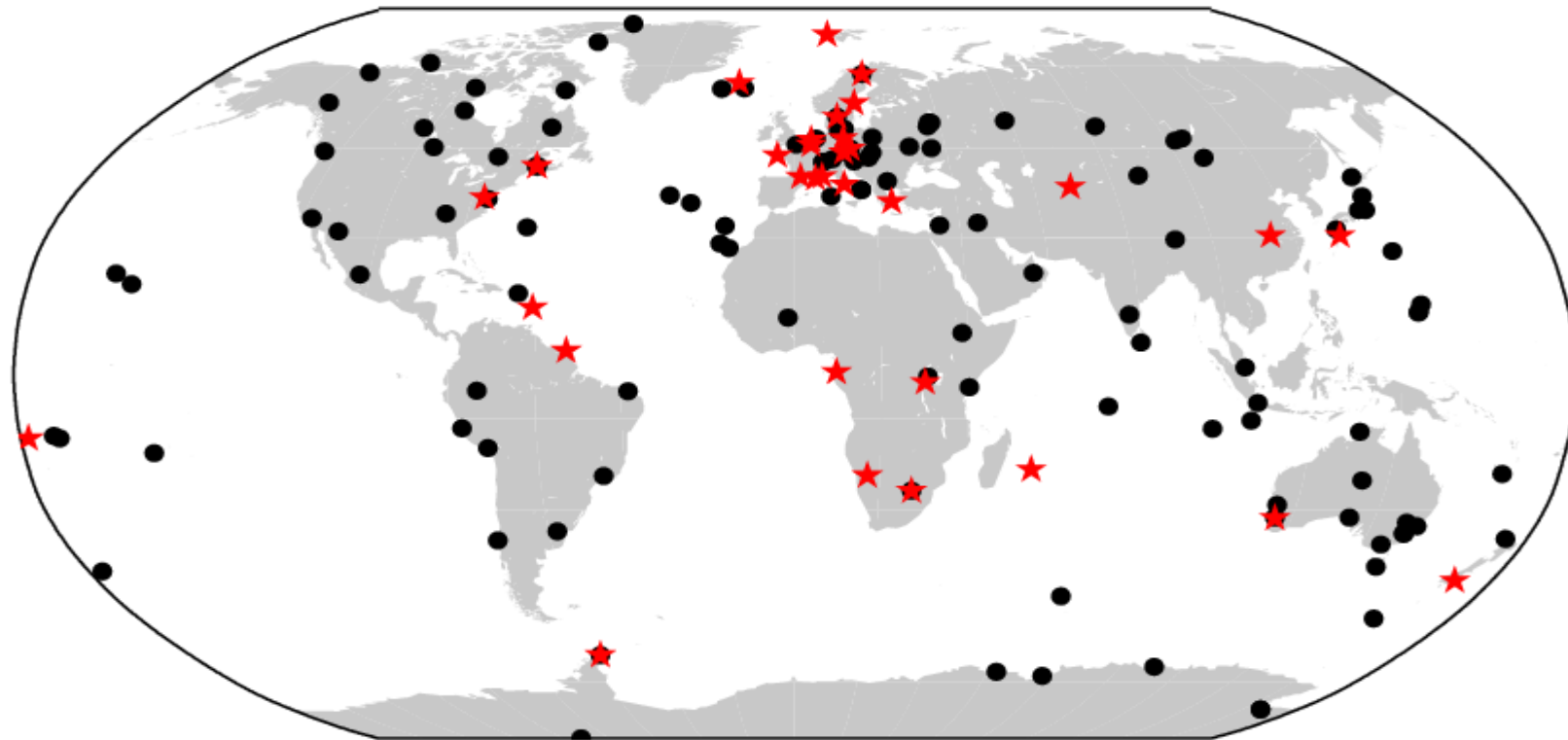


CODE MGEX orbit solution: overview

GNSS considered:	GPS + GLONASS + Galileo (up to 60 satellites)
Processing mode:	post-processing
Timespan covered:	GPS-weeks 1689-1746 (DOY 12/146-13/180)
Number of stations:	150 (GPS + GLONASS), 30 - 40 (Galileo)
Processing scheme:	double-difference network processing (observable: phase double differences)
Signal frequencies:	L1+ L2 (GPS + GLONASS), E1 (L1) + E5a (L5) (Galileo)
Orbit characteristic:	3-day long arcs
Reference frame:	IGS08 (until week 1708); IGB08 (since week 1709)
IERS conventions:	IERS2003 (until 1705); IERS2010 (since 1706)
Product list:	daily orbits (SP3) and ERPs
Distribution:	ftp://cddis.gsfc.nasa.gov/gnss/products/mgex/
Designator:	comwwwwd.???.Z

CODE MGEX orbit solution: station selection

Number and distribution of tracking stations contributing to the CODE MGEX orbit solution (late 2012)



● GPS: 145-150

● GLONASS: 125

★ Galileo: 30-35

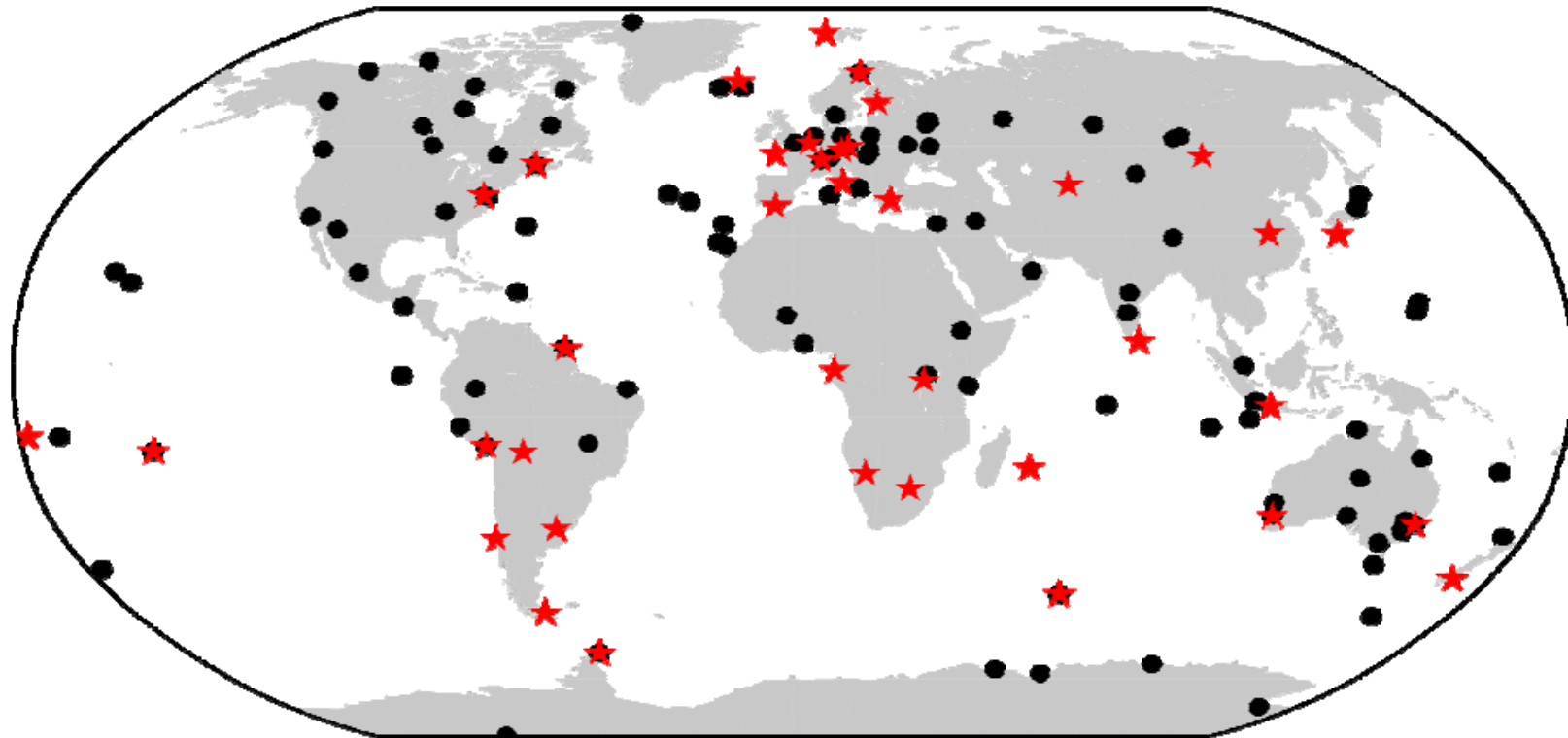
=> 22000 - 25000 SD
obs. per Sat/d

=> 18000 - 20000 SD obs.
per Sat/d

=> 1500 - 5000 SD obs.
per Sat/d

CODE MGEX orbit solution: station selection

Number and distribution of tracking stations contributing to the CODE MGEX orbit solution (mid 2013)



● GPS: 145-150

● GLONASS: 125

★ Galileo: 30-40

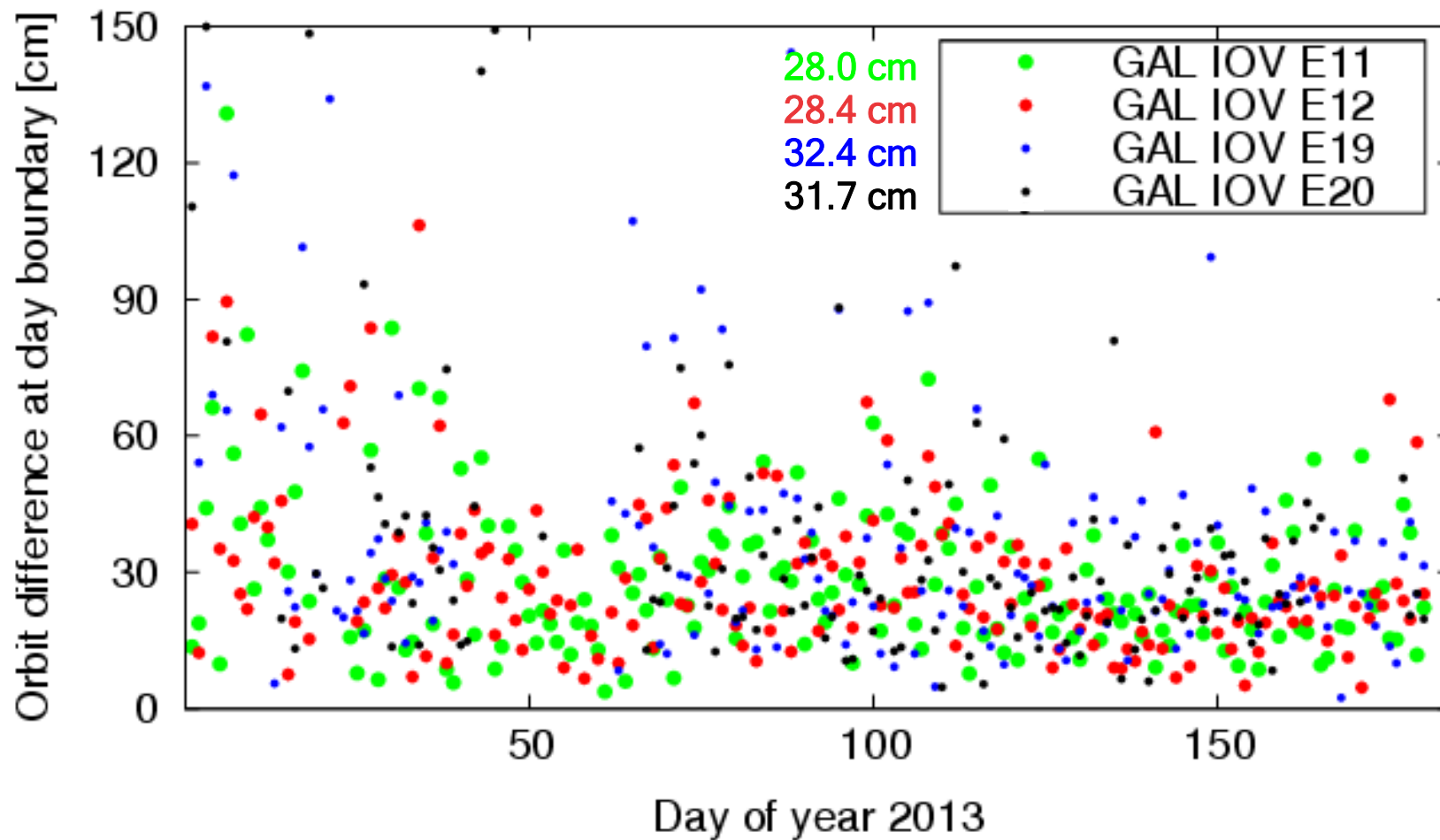
=> 22000 - 25000 SD
obs. per Sat/d

=> 18000 - 20000 SD obs.
per Sat/d

=> 4000 - 6500 SD obs.
per Sat/d

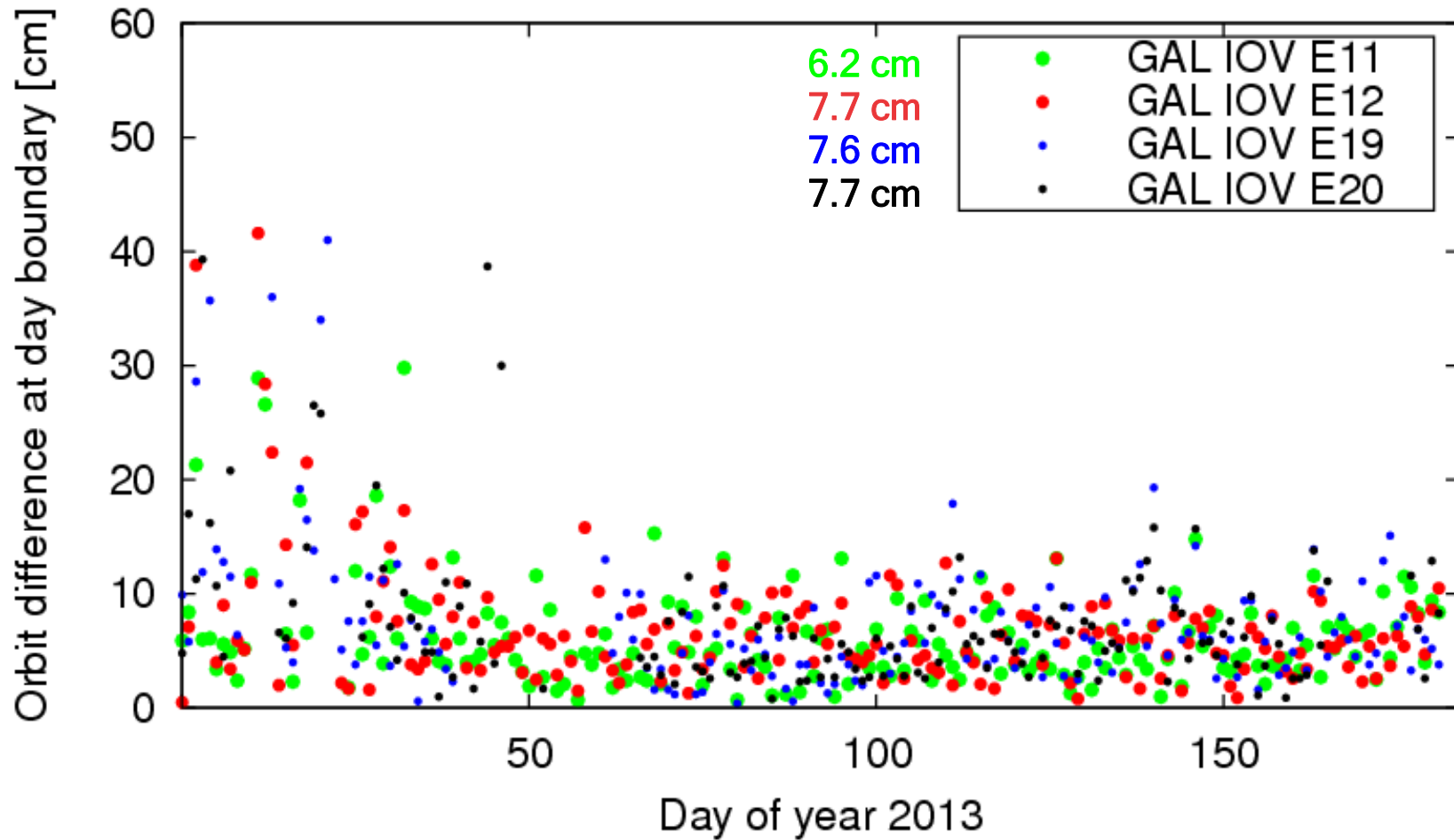
Orbit validation: overlaps

Arclength: 1 day



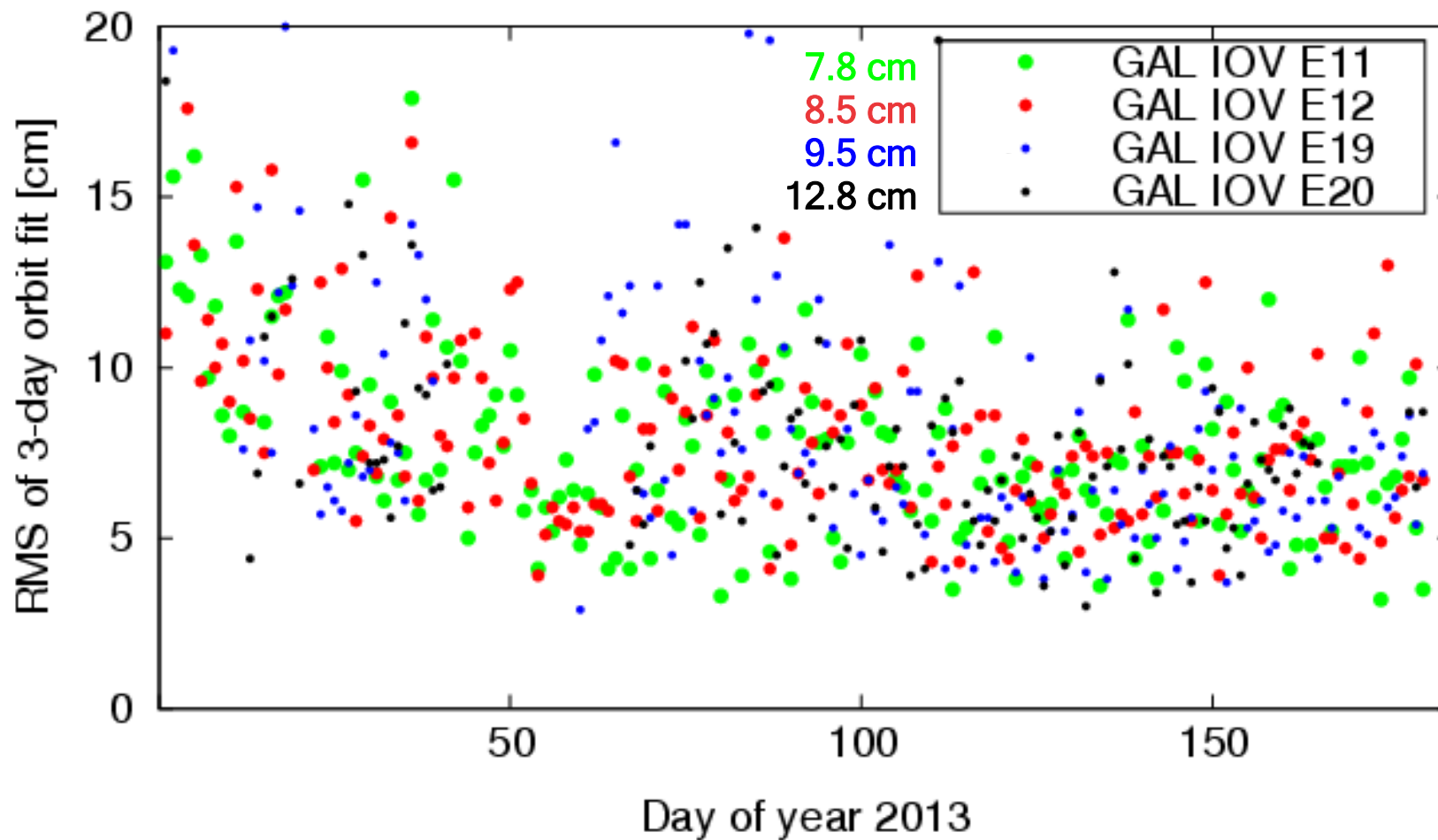
Orbit validation: overlaps

Arclength: 3 days



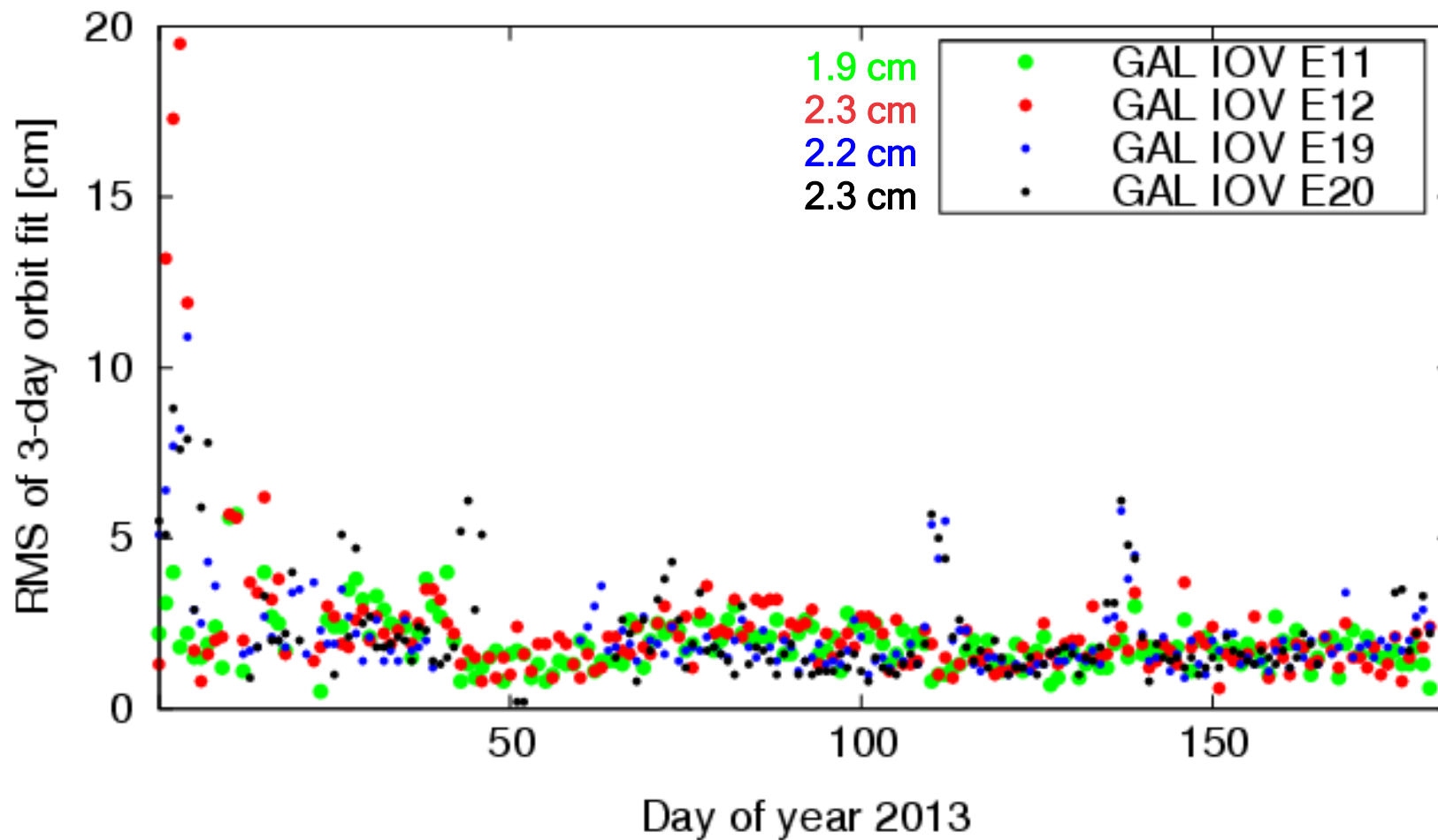
Orbit validation : 3-day orbit fit

Arclength: 1 day, satellite-wise



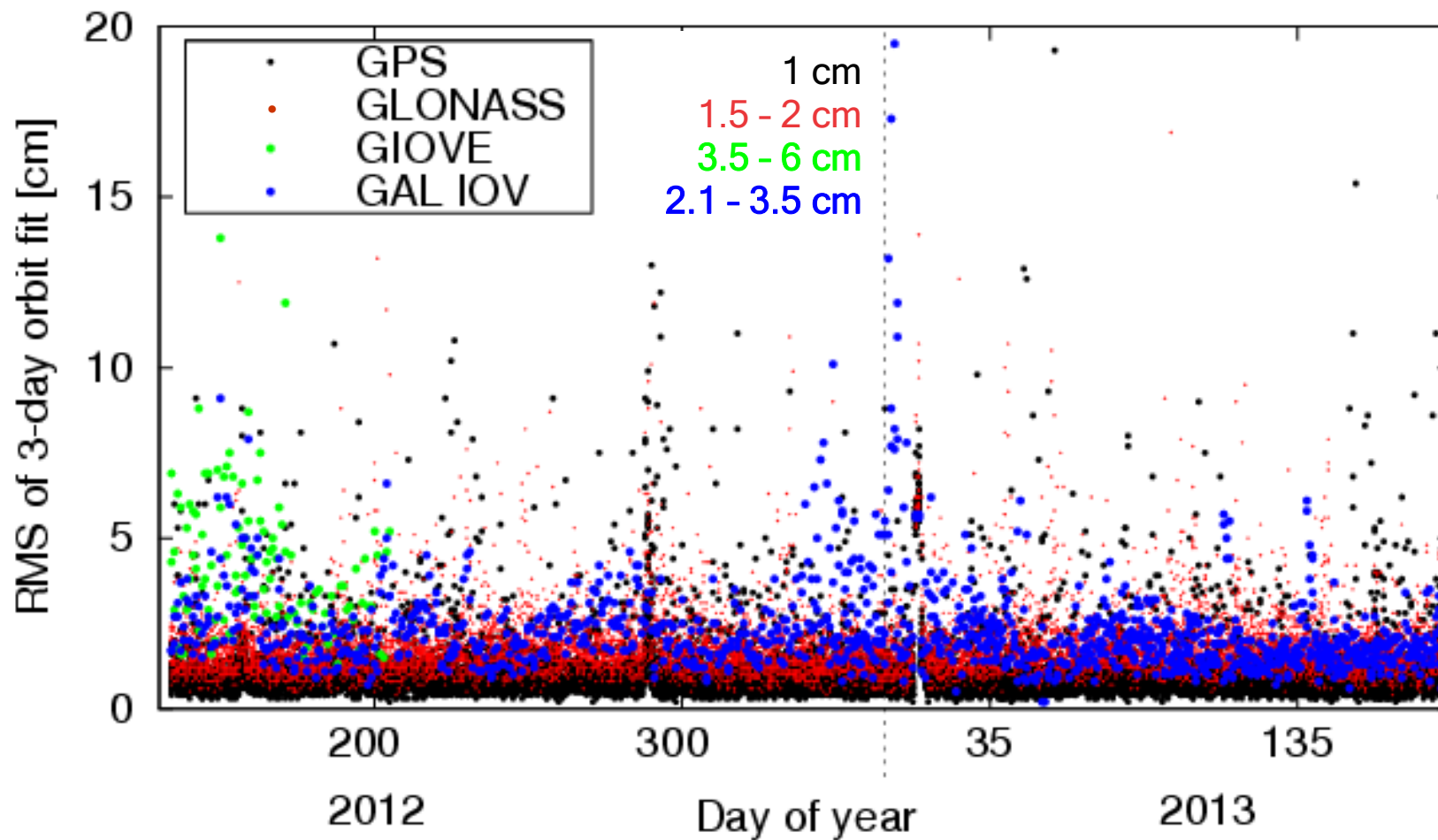
Orbit validation : 3-day orbit fit

Arclength: 3 days , satellite-wise



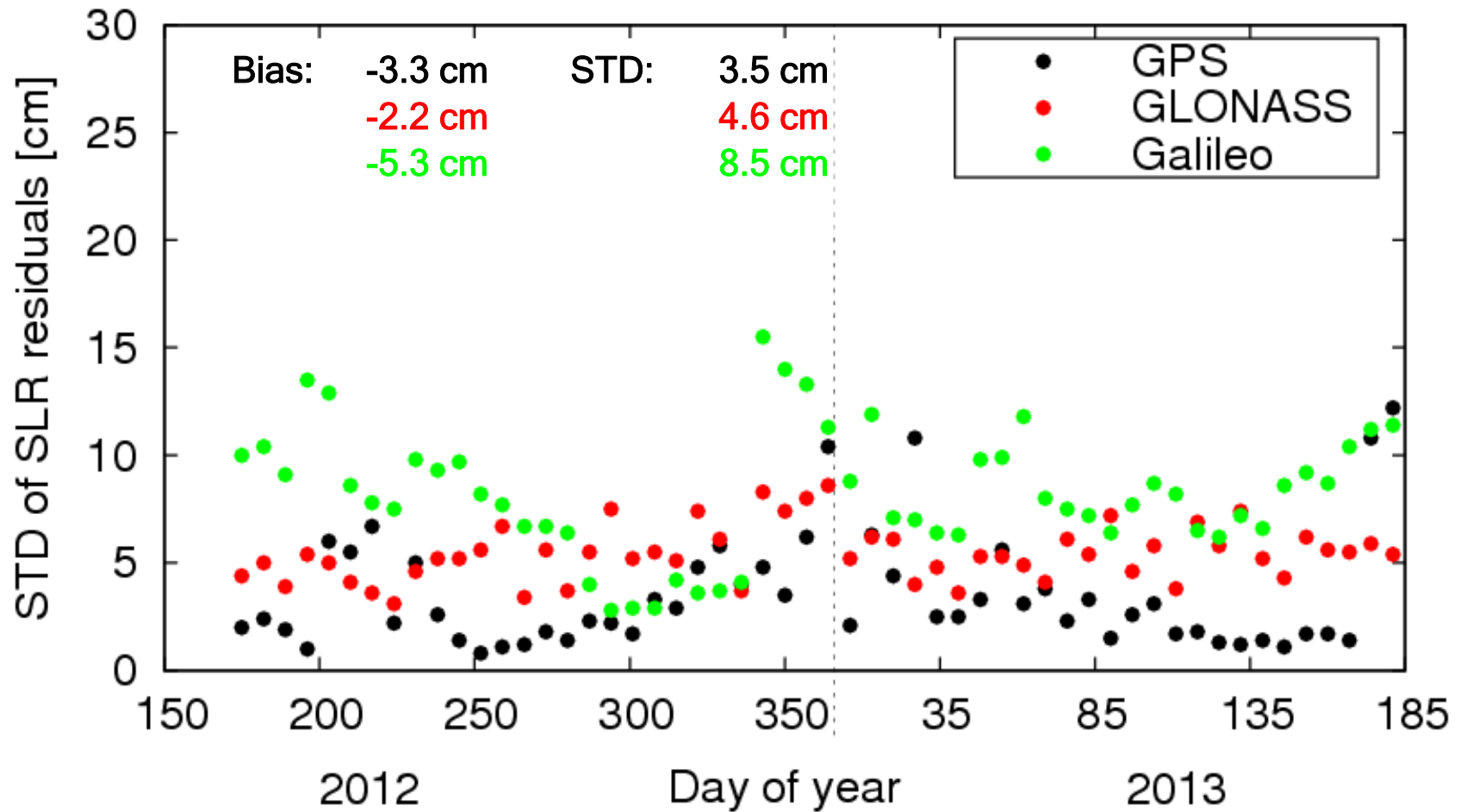
Orbit validation : 3-day orbit fit

Arclength: 3 days, GNSS-wise



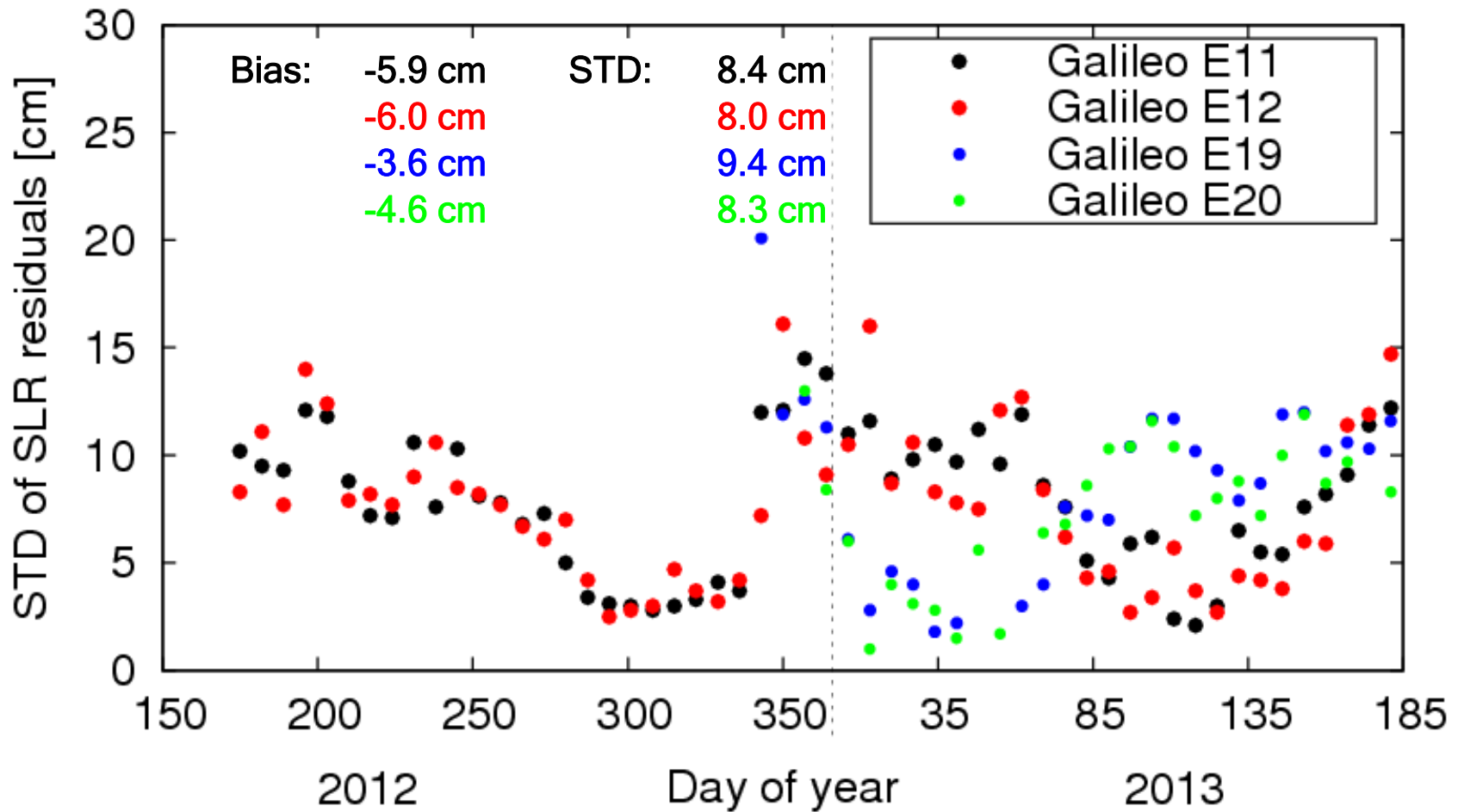
Orbit validation: SLR residuals

STD of SLR residuals per week: GNSS-wise



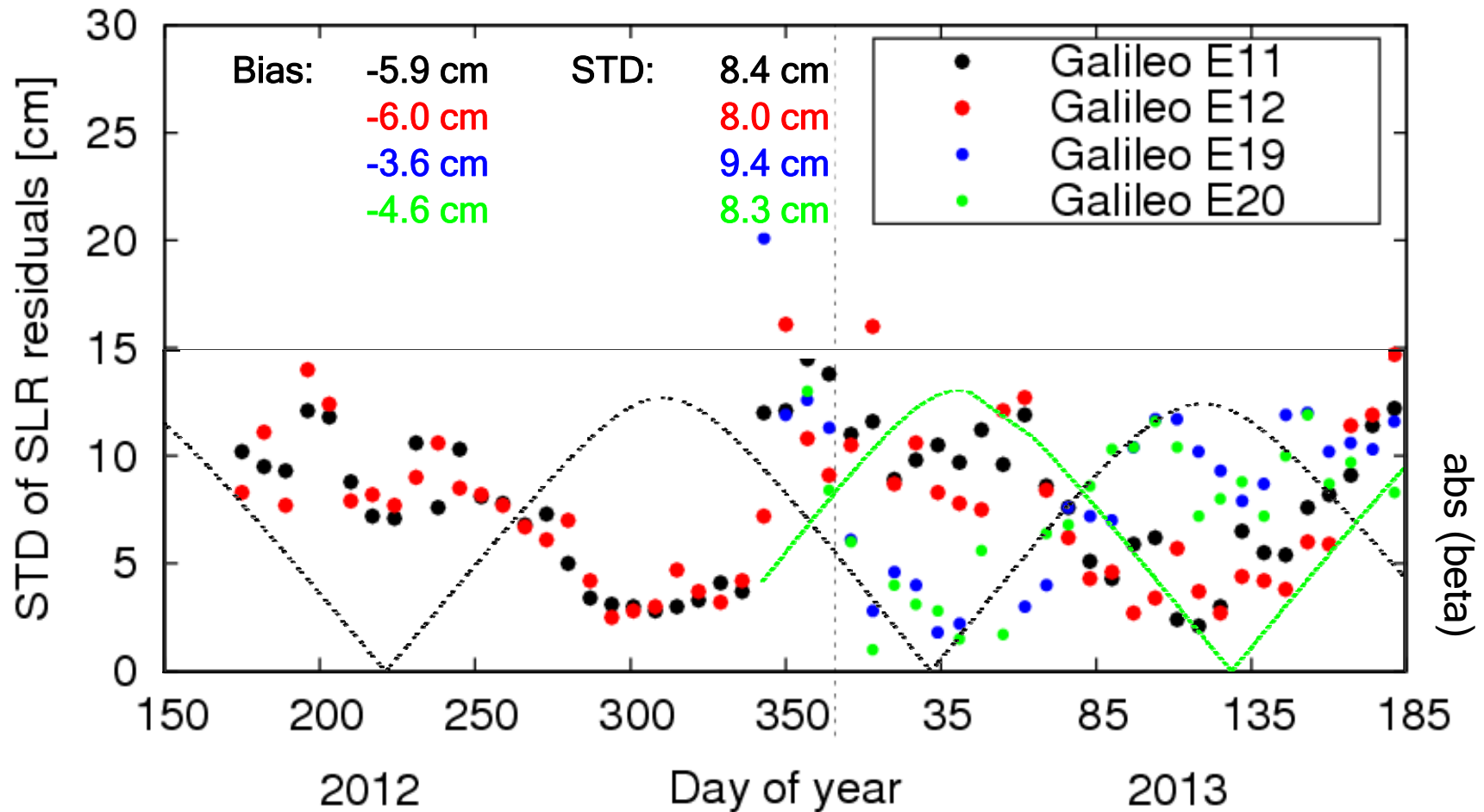
Orbit validation: SLR residuals

STD of SLR residuals per week: satellite-wise



Orbit validation: SLR residuals

STD of SLR residuals per week: correlation with beta angle



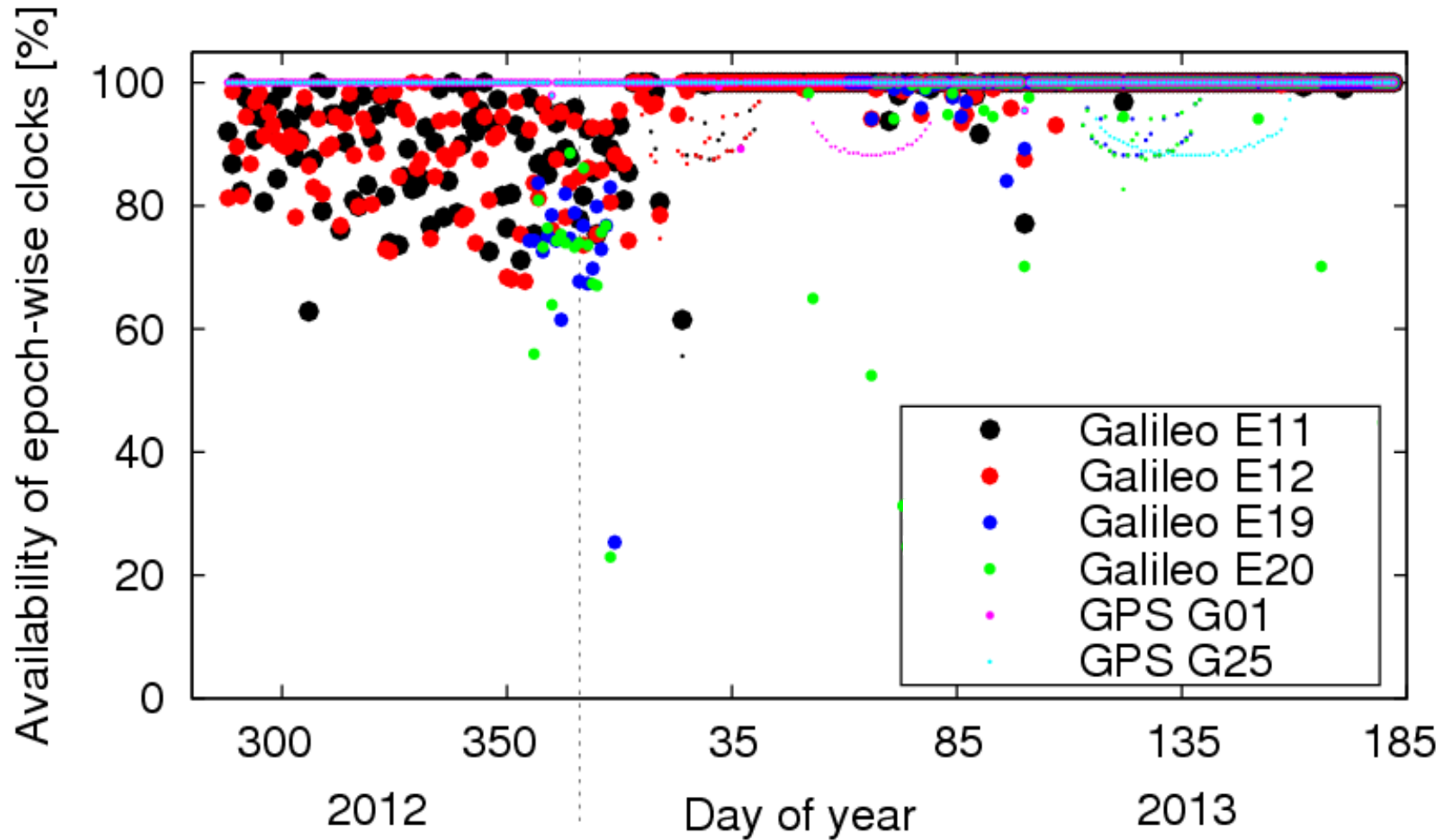
CODE MGEX clock solution

GNSS considered:	GPS + Galileo (up to 36 satellites)
Processing mode:	post-processing
Timespan covered:	GPS-weeks 1710-1746 (DOY 12/288-13/180)
Number of stations:	150 (GPS), 30 -40 (Galileo)
Processing scheme:	zero-difference network processing (observable: code+phase undifferenced)
Signal frequencies:	L1+L2 (GPS); E1(L1)+E5a (L5) (Galileo)
A priori information:	orbits, ERPs, coordinates, and troposphere from CODE MGEX orbit solution introduced as known
Reference frame:	IGb08
IERS conventions:	IERS2010
Product list:	epoch-wise (300s) satellite and station clock corrections in daily clock RINEX files; daily GPS-Galileo inter-system biases for mixed stations in Bernese DCB and BIAS-SINEX (BIA) format
Distribution:	ftp://cddis.gsfc.nasa.gov/gnss/products/mgex/
Designator:	comwwwwd.???.Z

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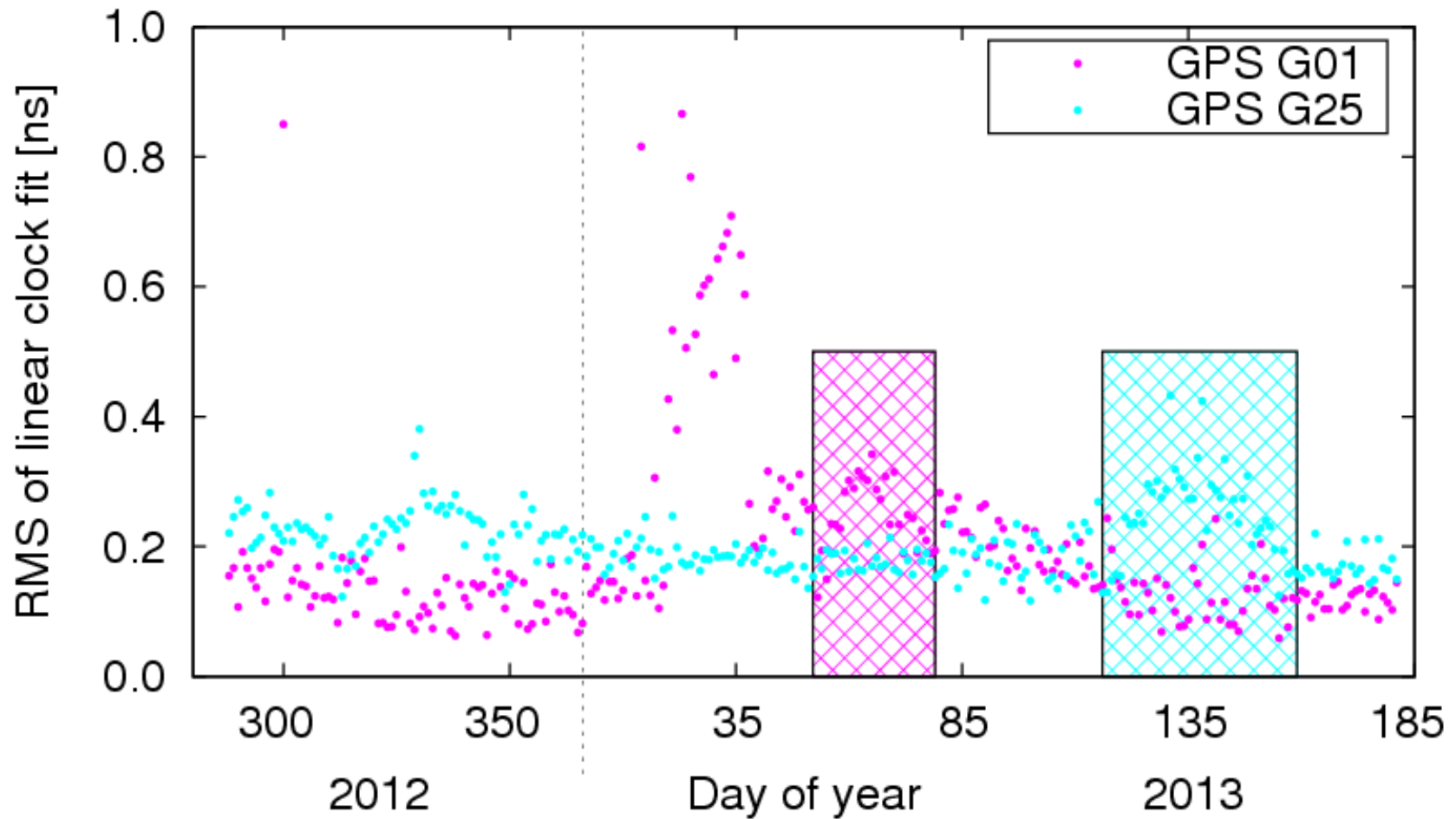
CODE MGEX clock solution

Clock availability: impact of station distribution



CODE MGEX clock solution

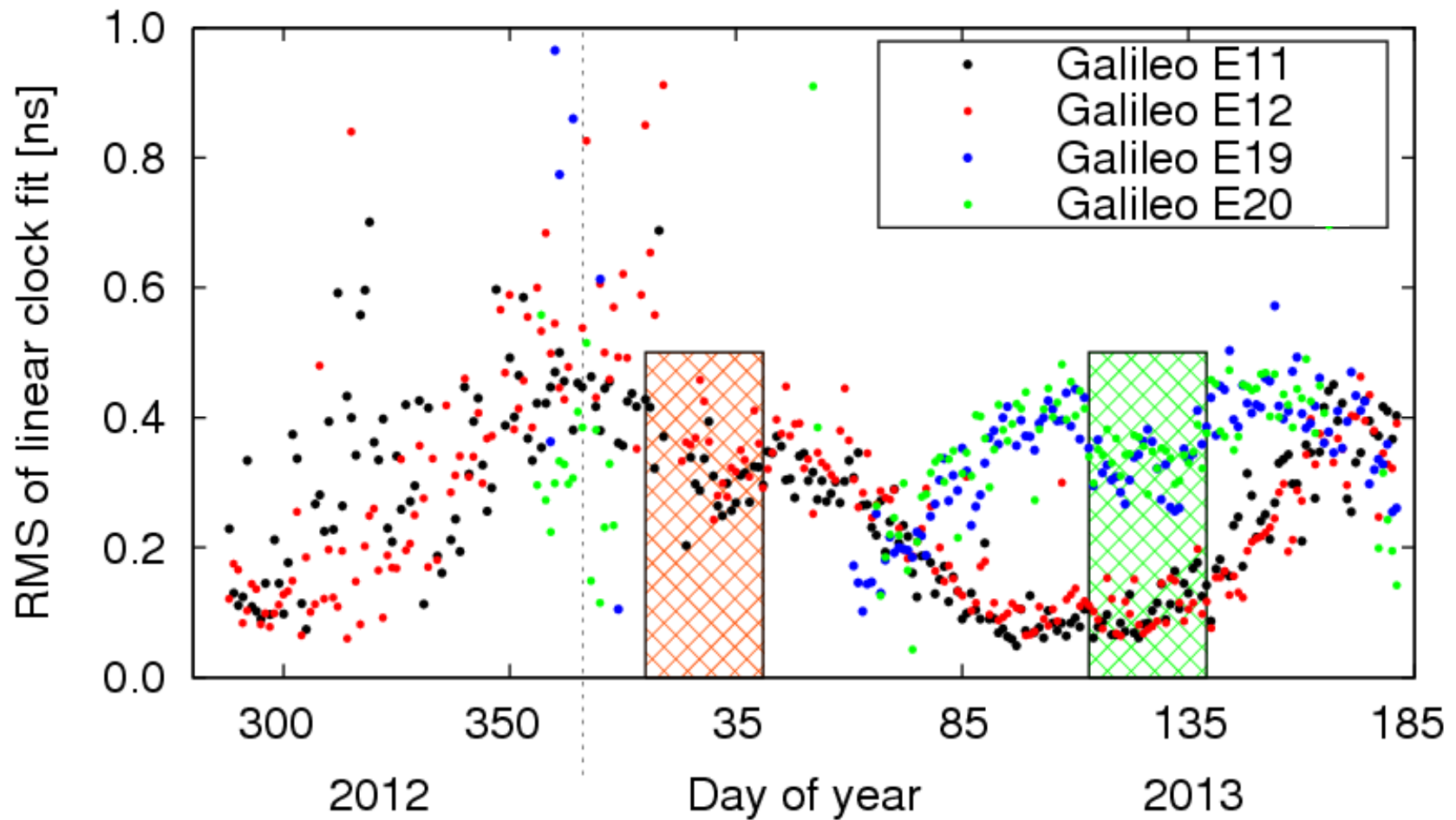
GPS-IIF: impact of sun eclipse



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CODE MGEX clock solution

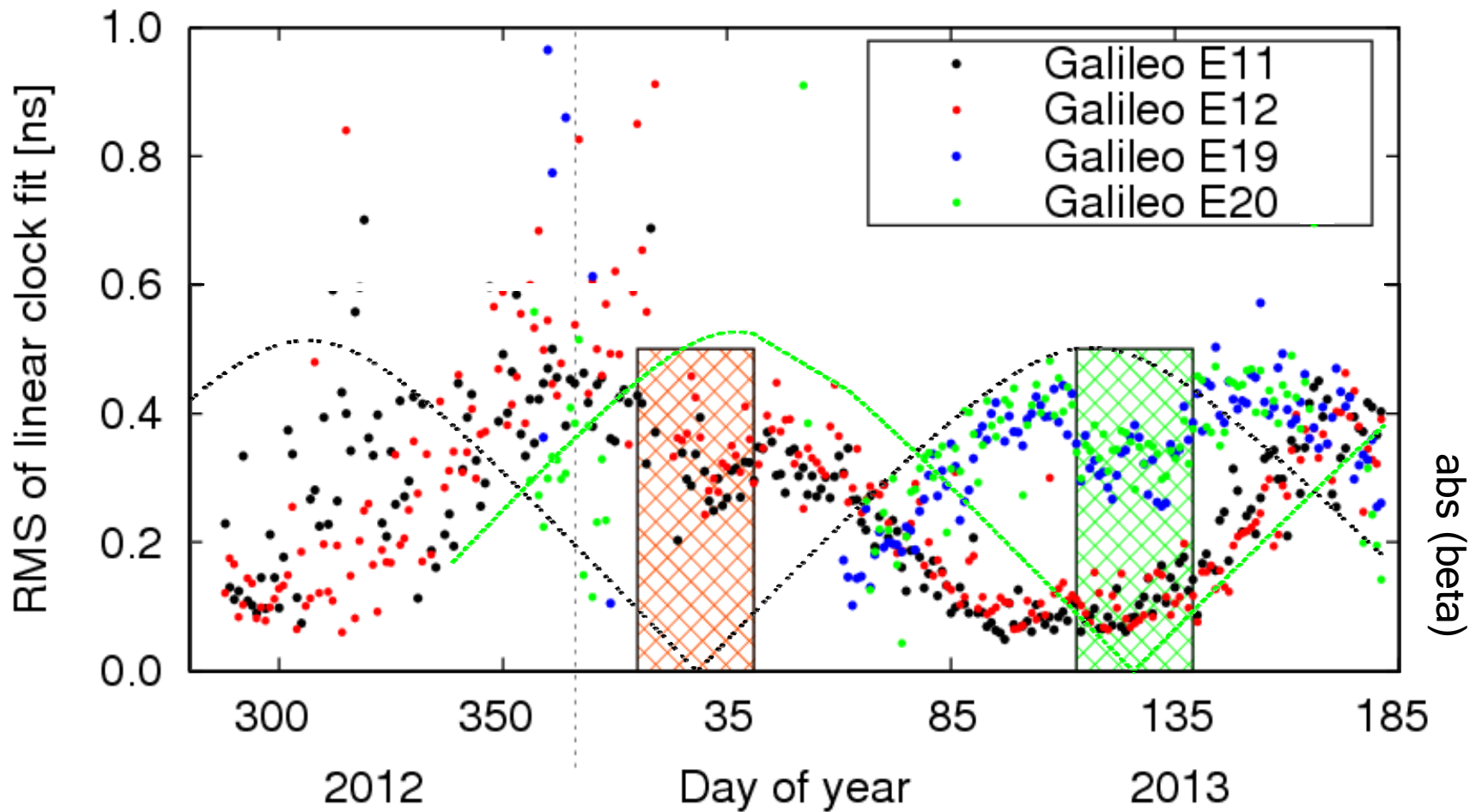
Galileo IOV: impact of sun eclipse



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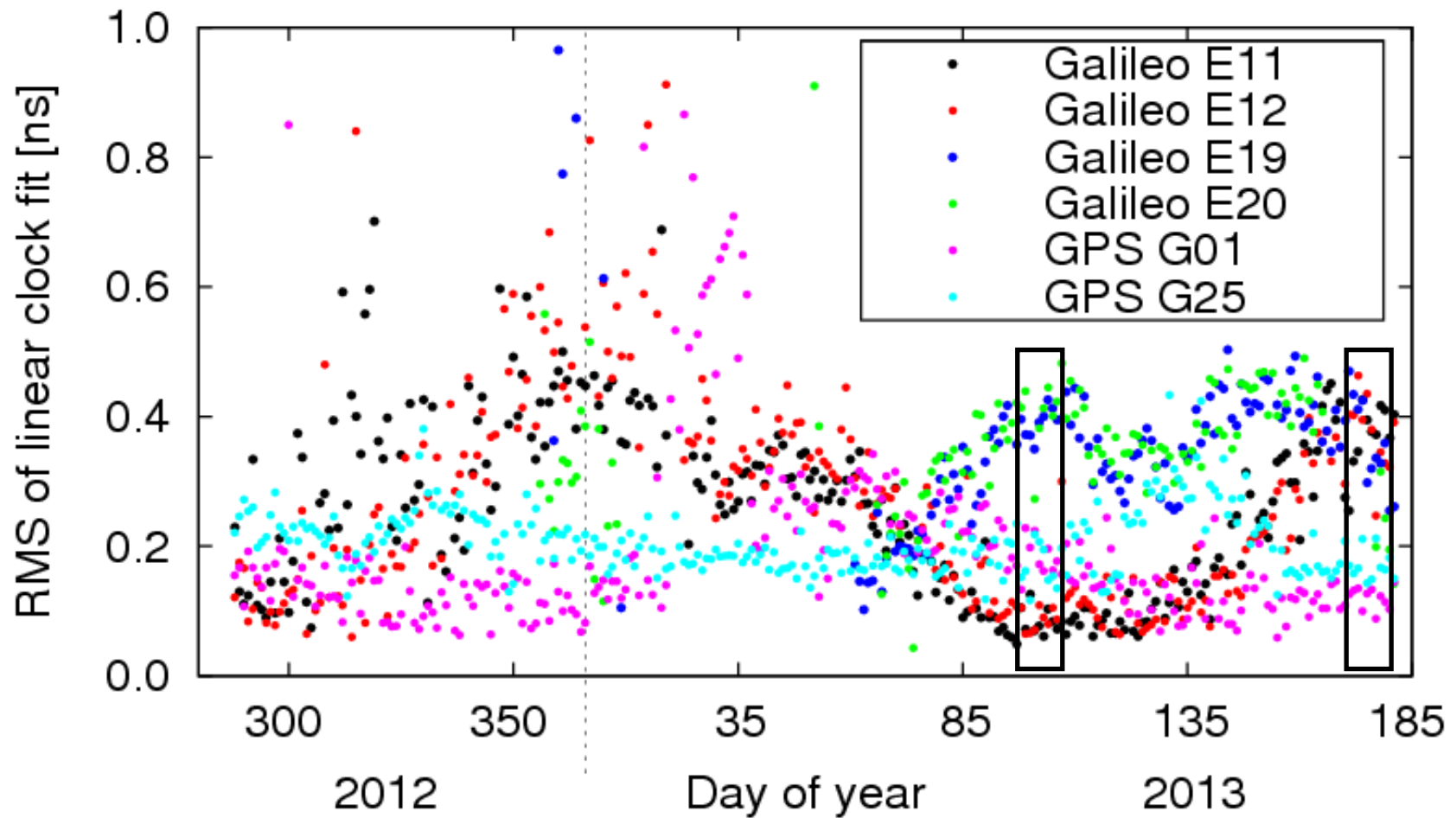
CODE MGEX clock solution

Galileo IOV: impact of sun eclipse and beta angle



CODE MGEX clock solution

Linear fit of satellite clocks: GPS-IIF vs. Galileo IOV



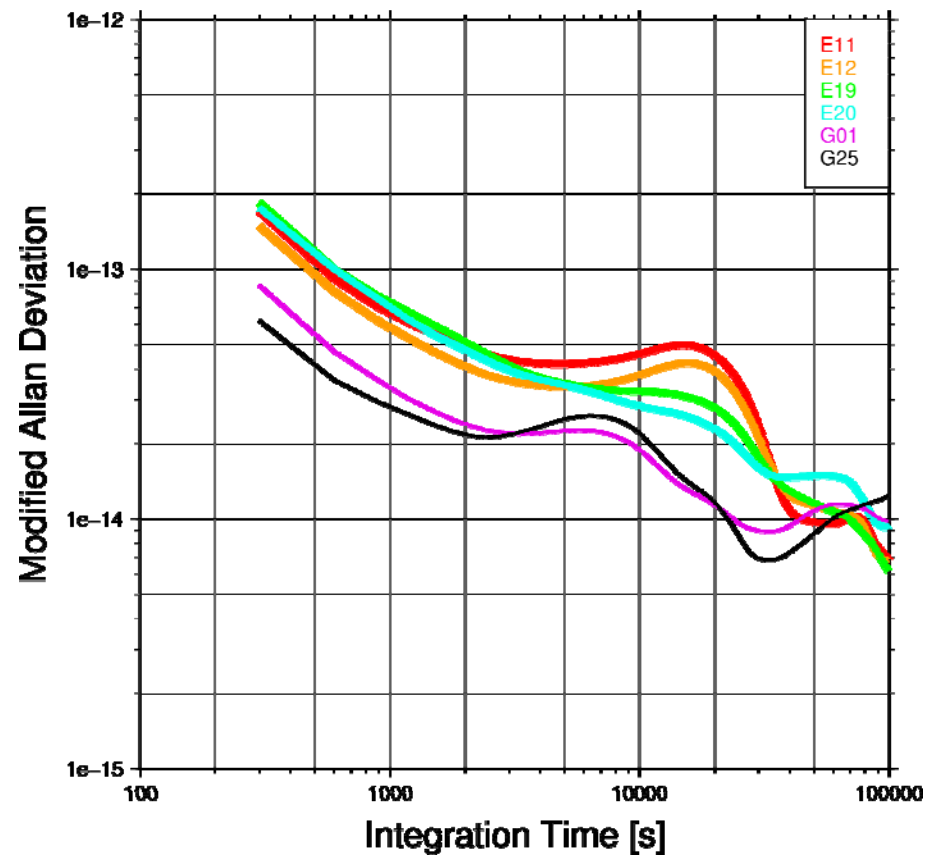
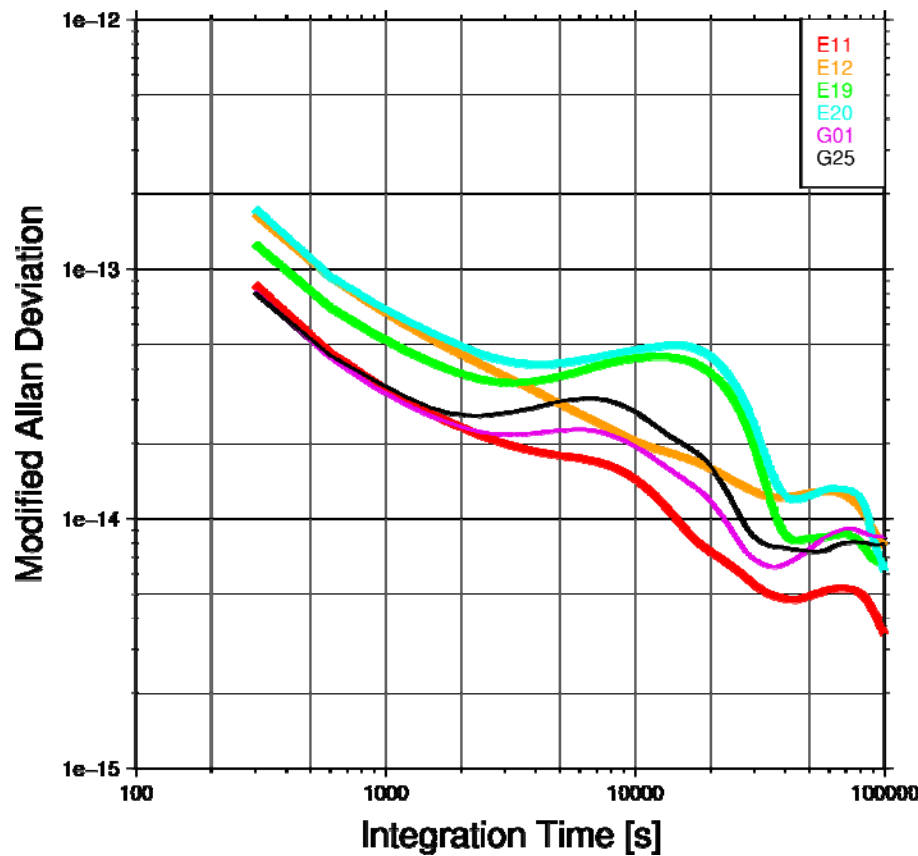
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CODE MGEX clock solution

Modified Allan deviation (5 days, reference clock: BRUX)

DOY 100

DOY 180



PPP, static mode (DOY 75 - 84)

Difference to CODE MGEX network solution (threshold 300 mm):

GPS+Galileo, GPS, GPS (4 SVs), Galileo

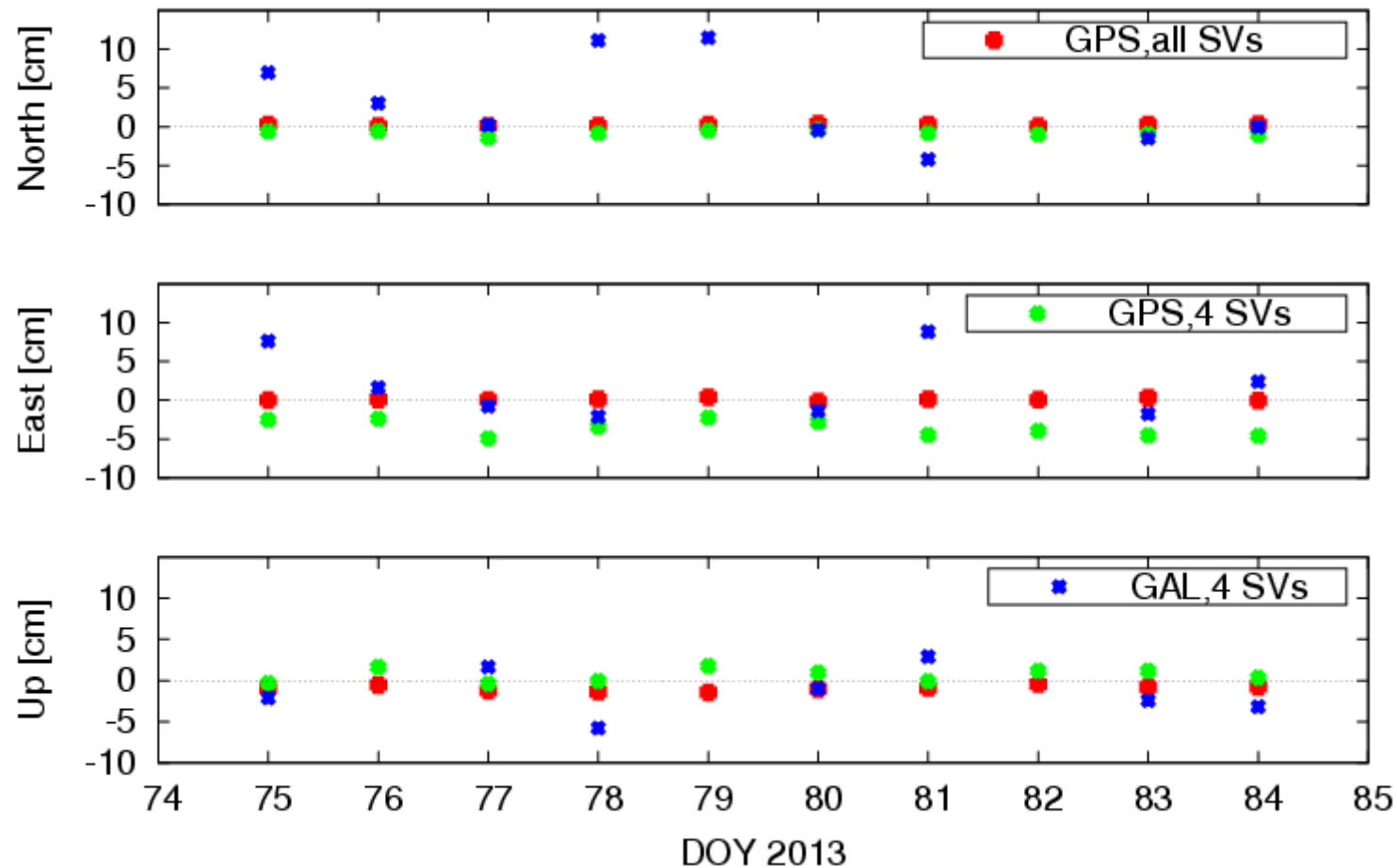
Station	North [mm]		East [mm]		Up [mm]	
	mean	STD	mean	STD	mean	STD
OUS2	3.7	1.7	-2.8	2.1	-8.6	6.0
	3.2	1.3	-1.1	2.0	9.3	6.0
	-11.9	24.0	-19.1	22.3	13.6	27.7
	37.9	135.6	33.8	34.4	-0.3	106.9
RIO2	1.7	1.2	-1.0	2.1	2.8	4.3
	1.9	1.2	1.6	2.0	3.2	3.7
	1.9	3.2	-30.4	21.0	18.2	19.4
	-27.2	62.7	-59.0	86.2	-9.7	50.8
TASH	0.3	1.1	2.8	2.4	1.9	4.1
	-0.4	0.8	1.2	2.0	3.4	4.4
	-3.6	13.1	-6.1	13.6	33.2	18.2
	-17.4	92.1	57.0	77.8	-43.3	101.3
ZIM3	2.4	1.3	2.9	1.9	-9.9	2.8
	2.5	1.0	1.0	1.7	-9.5	3.4
	-8.0	3.1	-36.0	10.4	6.1	8.2
	50.2	83.7	47.4	96.9	-65.9	91.9

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PPP, static mode (DOY 75 - 84)

Difference to CODE MGEX network solution for station ZIM3:

GPS+Galileo, **GPS**, **GPS (4 SVs)**, **Galileo**



PPP, kinematic mode (DOY 75 - 84)

Difference to CODE MGEX network solution (threshold 10000 mm):

GPS+Galileo, GPS, GPS (4 SVs), Galileo

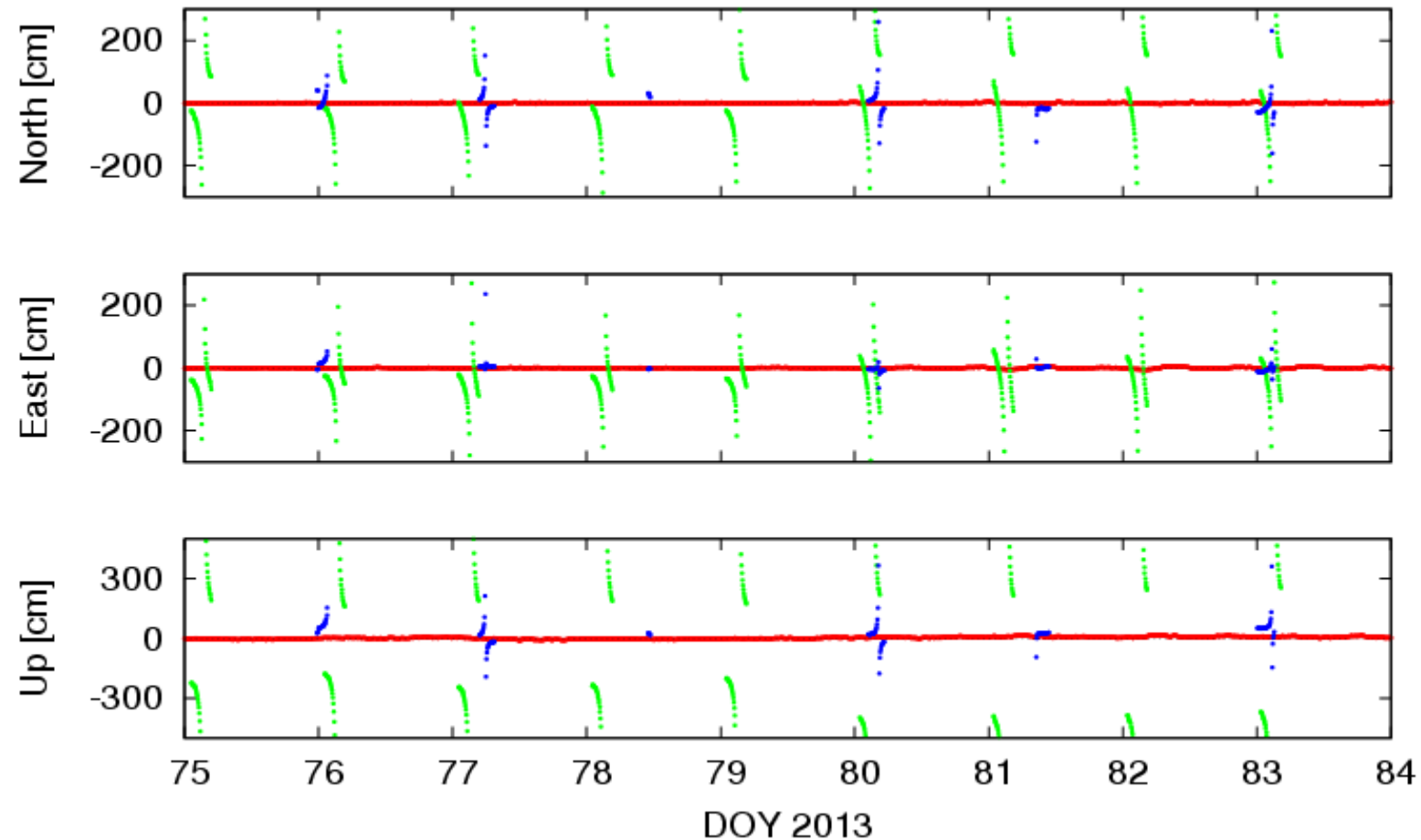
Station	North [mm]		East [mm]		Up [mm]	
	mean	STD	mean	STD	mean	STD
OUS2	3.0	33.0	-7.8	38.1	210.1	112.1
	2.5	38.6	-7.2	47.7	216.8	119.9
	-3132.4	2907.3	-3959.6	3819.2	5066.5	3375.5
	-104.6	1756.6	572.3	1036.7	-191.3	2251.3
RIO2	8.0	36.8	8.2	39.4	181.5	141.6
	7.8	43.9	12.2	47.5	185.7	149.0
	357.8	2034.4	63.0	901.1	557.2	4917.5
	-223.0	1283.7	-18.9	516.1	-549.8	1539.8
TASH	1.5	19.4	0.9	26.6	112.1	92.8
	1.1	21.6	-2.2	29.6	114.2	95.0
	2225.0	2677.2	-2679.8	3040.4	5133.4	3545.8
	-326.2	1229.5	270.9	741.1	-7.2	1393.7
ZIM3	3.0	12.5	3.5	16.5	30.0	54.2
	3.3	13.2	1.0	17.0	30.3	55.1
	265.0	2331.1	-360.0	1634.5	-1129.9	4364.2
	-112.2	690.3	13.8	369.2	246.7	944.6

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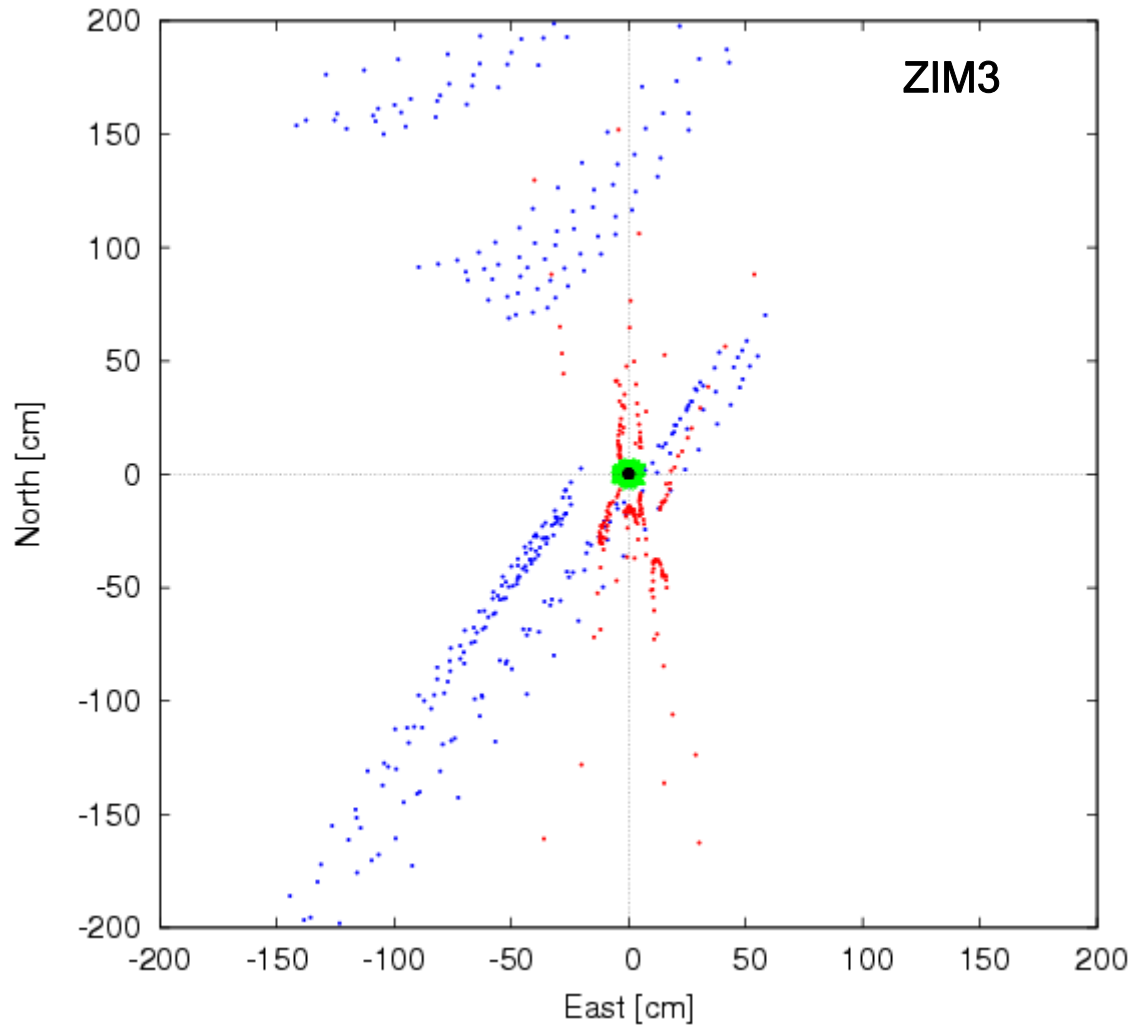
PPP, kinematic mode (DOY 75 - 84)

Difference to network solution: **GPS**, **GPS (4 SVs)**, **Galileo**

Station ZIM3



PPP (DOY 75 - 84)



- x Static
- x Kinematic GPS
- Kinematic Galileo-only
- Kinematic GPS (4 SVs)

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Summary

- RINEX data monitoring for IGS MGEX is well established at CODE (results are available via AIUB anonymous FTP => <ftp://ftp.unibe.ch/aiub/mgex/>)
- CODE provides a MGEX-based, fully integrated, triple-system orbit solution for 2012 and 2013:
GPS+GLONASS+Galileo
- Galileo orbits dramatically benefit from long arcs due to
 - the inhomogeneous station distribution and
 - its long orbit revolution time (>>12h)
- Future: extension to BeiDou, ... planned

Summary

- CODE **GPS+Galileo** clock solutions for late 2012 and first half of 2013 are available
- Galileo-only PPP is in principle already possible
- New batches of MGEX orbit and clock solutions will be provided from time to time
- The CODE MGEX processing is done using Bernese GNSS Software 5.2
- The analysis of IGS MGEX data is very useful for understanding, integration, and exploitation of the new GNSS signals coming in RINEX3 data format.

Thank you
for
your interest!