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CODE

New GNSS Bias Products from CODE

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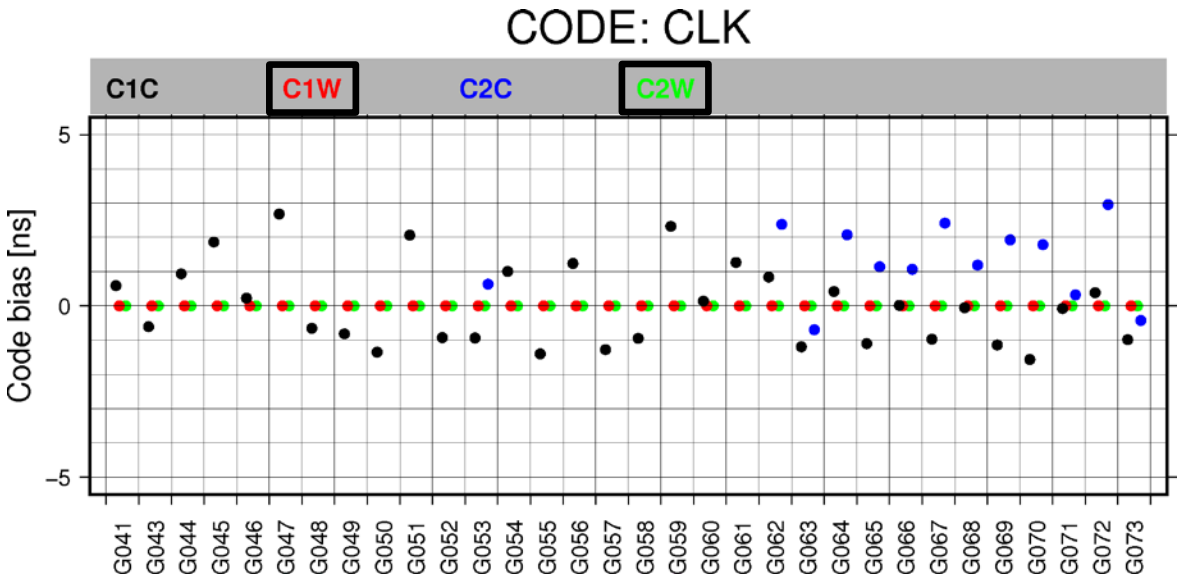
New GNSS bias handling at CODE

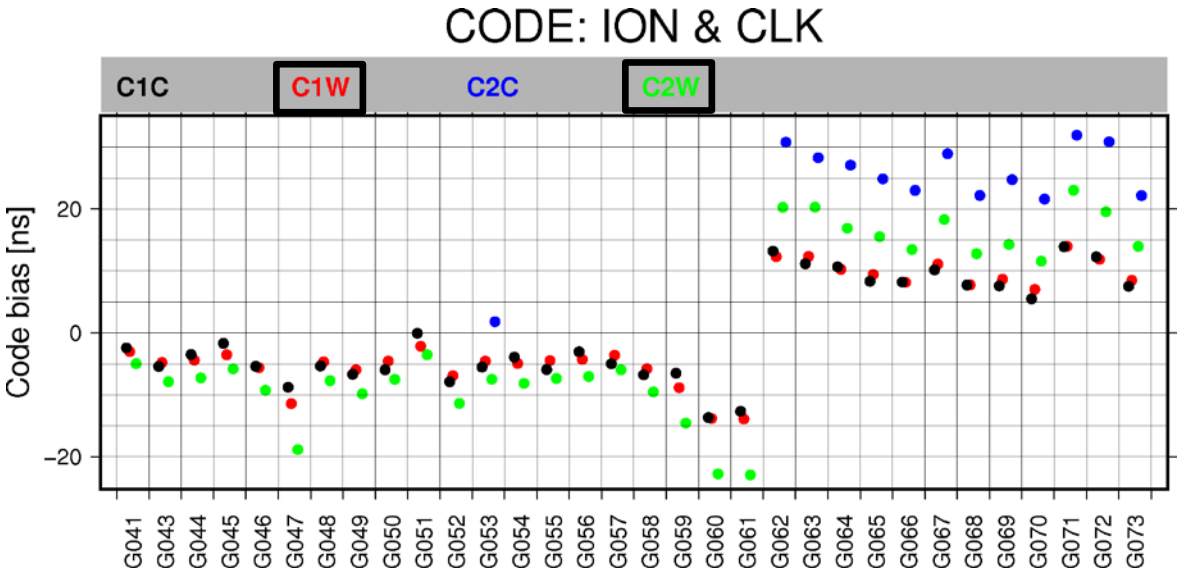
- A refined GNSS bias handling to cope with all available GNSS systems and signals has been implemented and activated (in May 2016) in all IGS analysis lines at CODE.
- As part of this major revision, processing steps relevant to bias handling and retrieval were reviewed and completely redesigned.
- Our new bias implementation allows to combine bias results at normal-equation (NEQ) level. We are thus able to combine bias results obtained from *clock* and *ionosphere* analysis, and, moreover, to compute coherent long-term code bias solutions.
- The new bias results are provided in *Bias-SINEX Format Version 1.00*. Example: ftp.aiub.unibe.ch/CODE/CODE.BIA
- The bias parameters are treated specific to each observable type involved (at a *pseudo-absolute* level).
- CODE IGS analysis: as of 15 May 2016 (W1897-) (CLK&ION)
- CODE MGEX analysis: as of 29 January 2017 (W1934-) (CLK)

Observable-specific code bias estimates for GPS code observable types (using the RINEX3 nomenclature) and GPS SV numbers

CLK: ionosphere-free LC

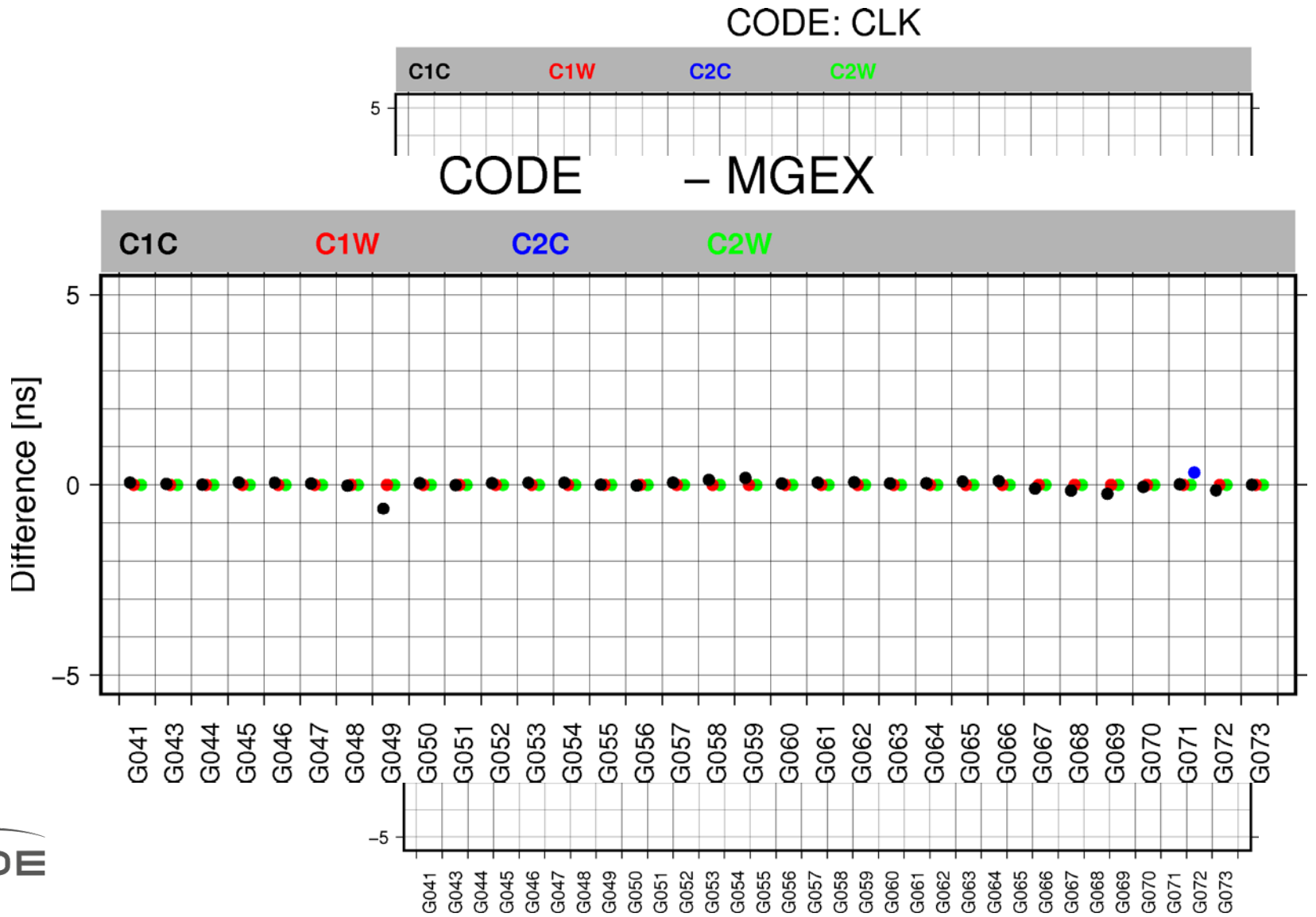


CLK: ionosphere-free LC
&ION: geometry-free LC

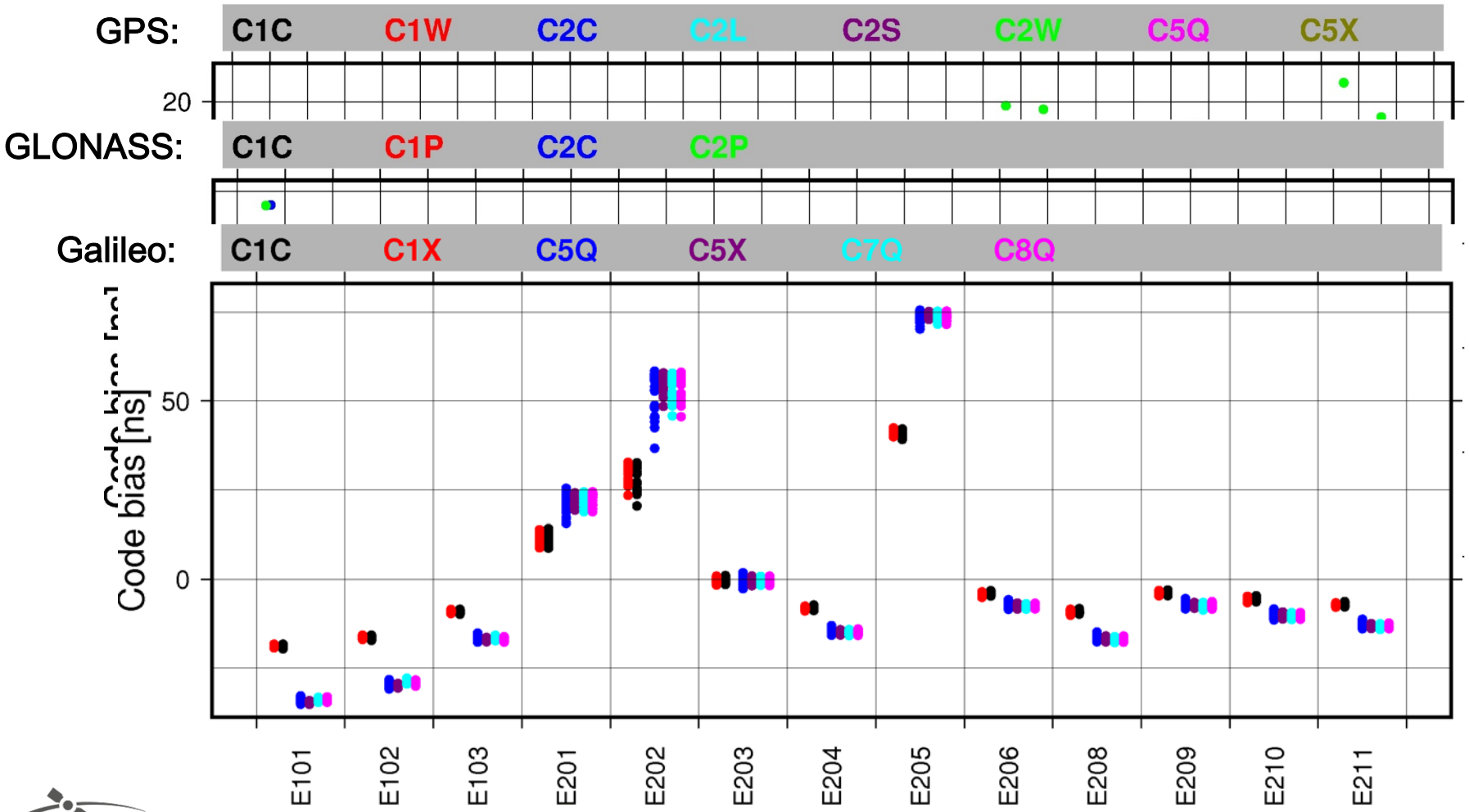


Note that G062-G073 correspond to Block IIF satellite generations.

Observable-specific code bias estimates for GPS code observable types and GPS SV numbers from GR (CODE) or GRECJ (MGEX)

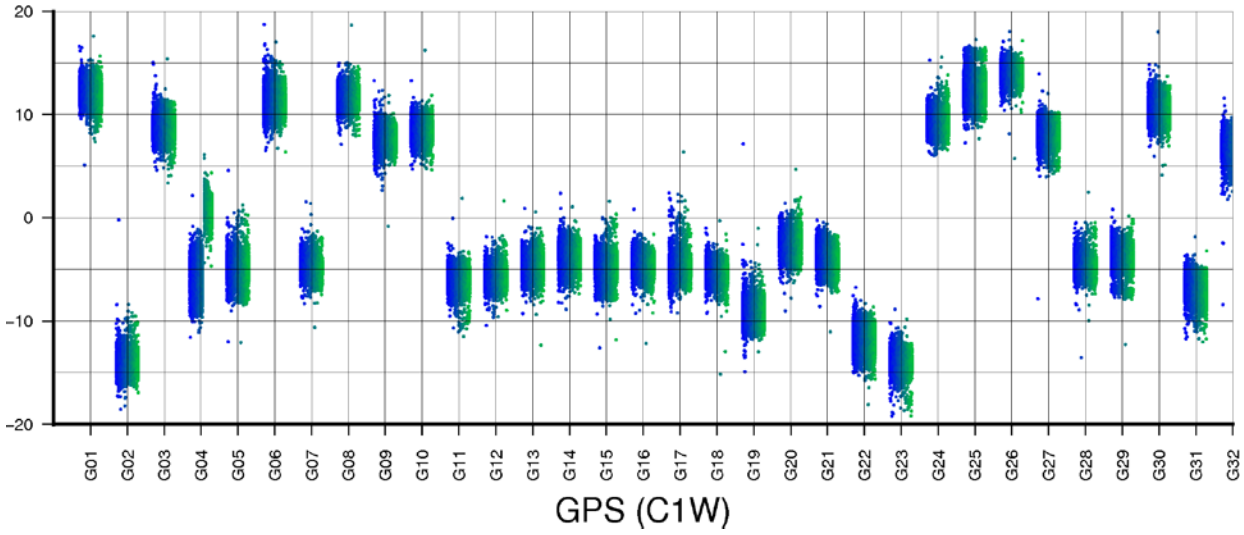


Multi GNSS code bias results from CLK&ION

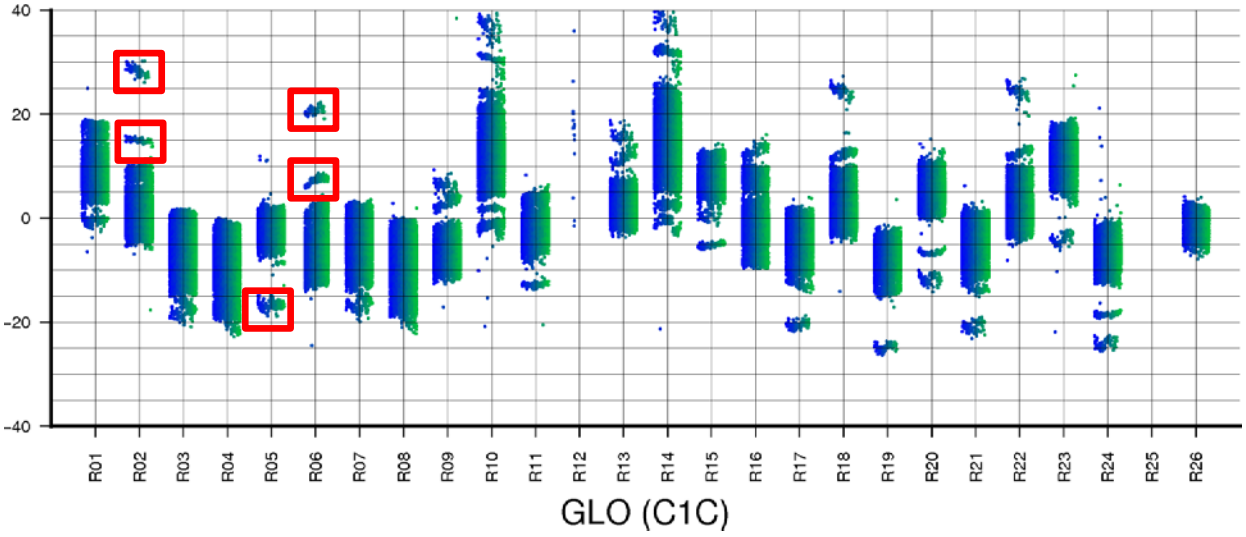


Code bias estimation in “GLONASS mode”: one bias for each station-satellite link

GPS (C1W):



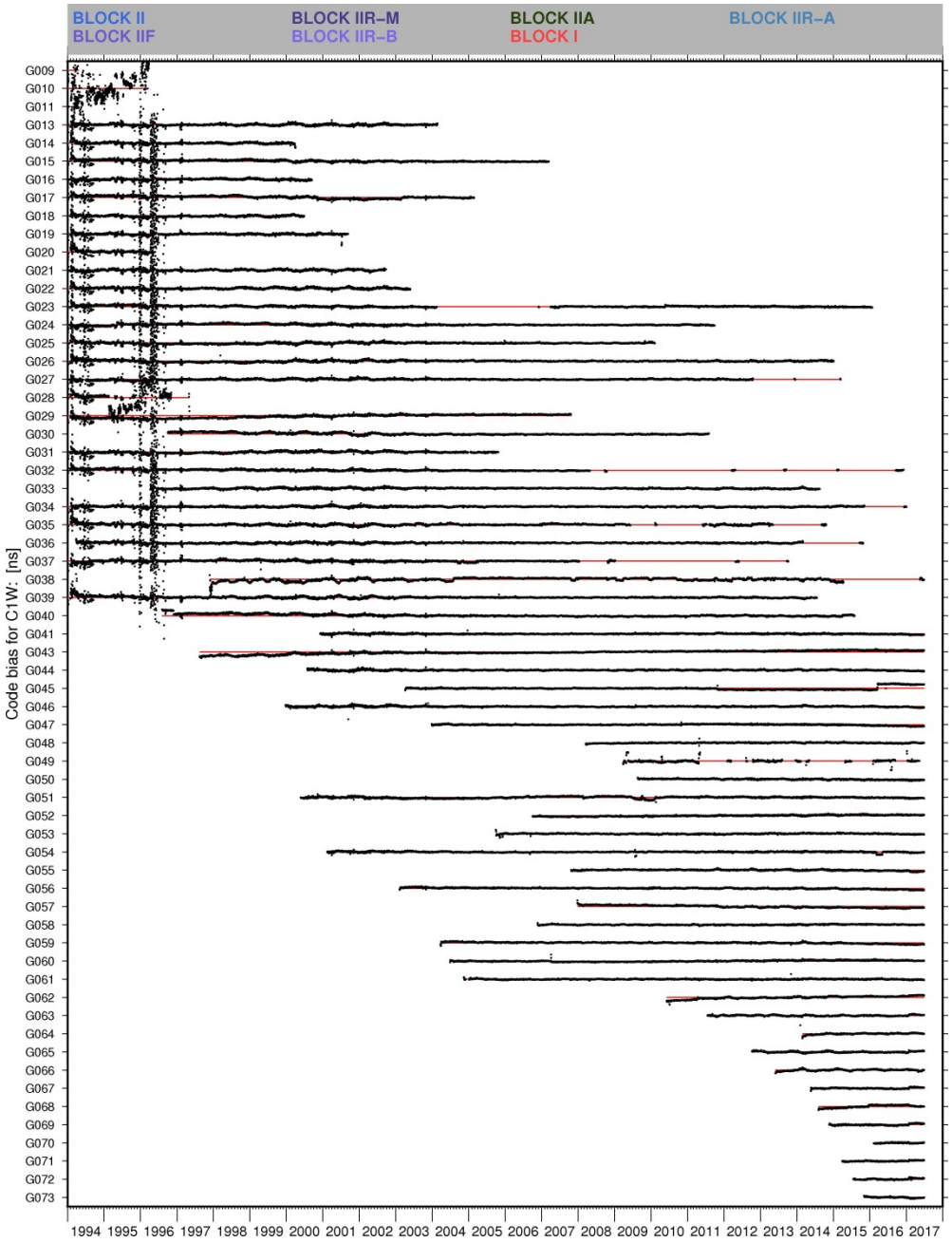
GLONASS (C1C):



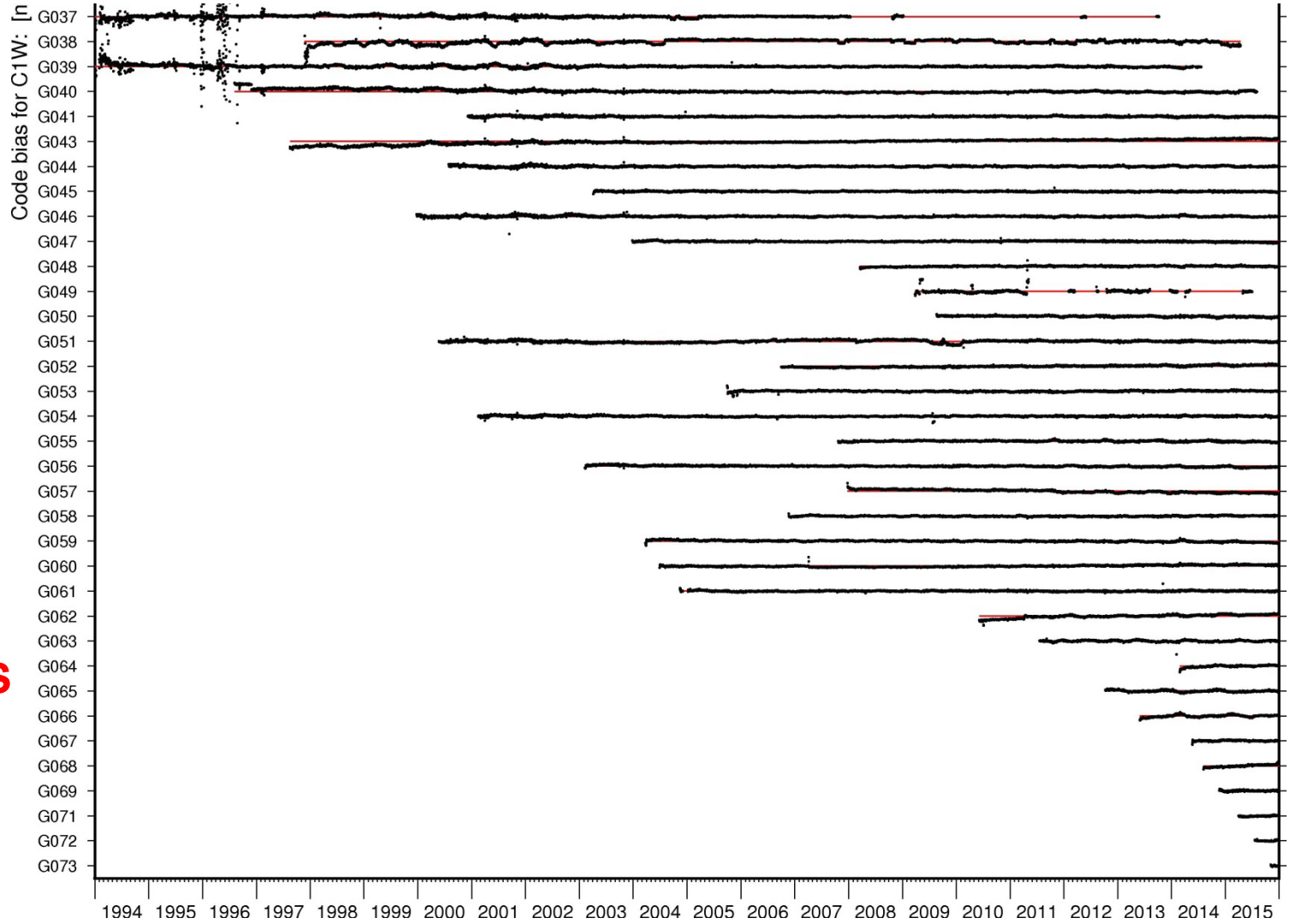
→ TPS NET-G3A

Bias-dedicated 1994-2016 GPS/GLONASS reprocessing effort

- Reprocessed 1994-2016 IGSIONO bias and GIM NEQ results
- Computation of a coherent long-term (1994-2017) code bias solution at NEQ level
- Realignment of all daily code bias solutions (for satellite and receiver bias components)
  - *original*
  - ***no jumps***
  - ***with jumps***

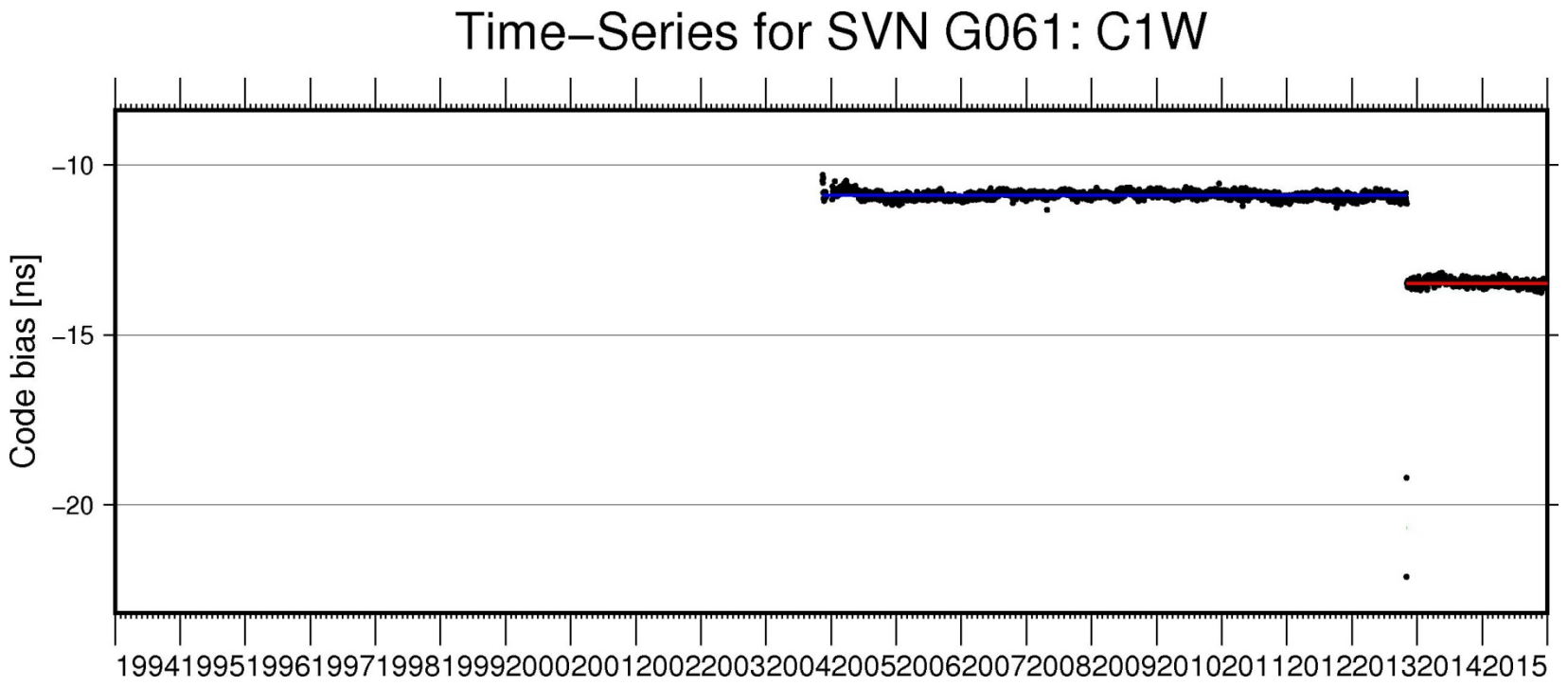


Realigned GPS (G037-G073) satellite (C1W) code bias retrievals for 1994-2015



With jumps

Examples of realigned GPS satellite (C1W) code bias retrievals for 1994-2015

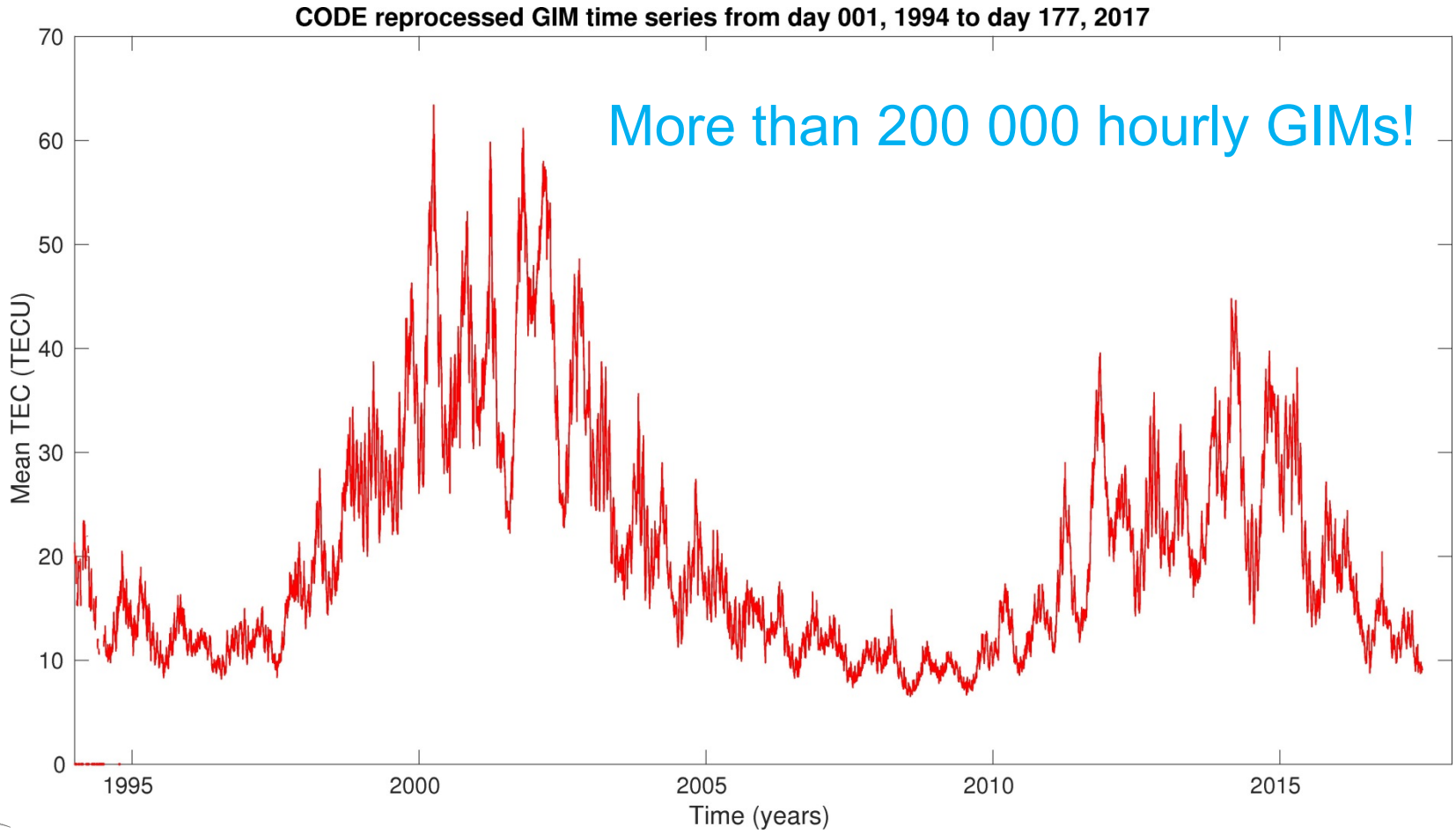


List of selected GPS code bias jumps/events (and associated NANUs)

SATELLITE PROBLEMS: GNSS BIAS JUMPS AND BIAS OUTLIERS

SATELLITE ***	PROBLEM *	ACTION *	FROM YYYY MM DD HH MM SS	TO YYYY MM DD HH MM SS	SVN YYYY:DDD COMMENT
17	5	0	2003 02 25 00 00 00		G017 2003:056 NANU 2003020 (FCSTSUMM 055)
32	5	0	2010 05 24 00 00 00		G023 2010:144 NANU 2010097 (UNUSABLE 141-145)
25	5	0	2005 12 26 00 00 00		G025 2005:360 NANU 2005162 (UNUSUFN 359)
25	5	0	2006 06 22 00 00 00		G025 2006:173 NANU 2006058 (UNUSABLE 138-179)
26	5	0	2011 04 12 00 00 00		G026 2011:102 NANU 2011030 (UNUSABLE 100-102)
27	5	0	2008 11 15 00 00 00		G027 2008:320 NANU 2008138 (UNUSABLE)
14	5	0	2004 12 21 00 00 00		G041 2004:356 -
14	5	0	2007 10 28 00 00 00		G041 2007:301 NANU 2007124 (UNUSABLE 281-282)
14	5	0	2009 07 27 00 00 00		G041 2009:208 -
21	5	0	2010 09 12 00 00 00		G045 2010:255 -
21	5	0	2011 10 29 00 00 00		G045 2011:302 -
11	5	0	2001 09 13 00 00 00		G046 2001:256 NANU 2001120 (UNUSABLE 256)
11	5	0	2009 08 01 00 00 00		G046 2009:213 -
22	5	0	2008 08 13 00 00 00		G047 2008:226 NANU 2008082 (MAINTENANCE 217)
22	5	0	2010 10 30 00 00 00		G047 2010:303 NANU 2010134 (MAINTENANCE 304-305)
20	5	0	2010 02 20 00 00 00		G051 2010:051 NANU 2010033 (UNUSABLE 046-050)
17	5	0	2006 09 13 00 00 00		G053 2006:256 NANU 2006090 (MAINTENANCE)
18	5	0	2006 09 05 00 00 00		G054 2006:248 NANU 2006085 (UNUSABLE)
23	5	0	2007 04 05 00 00 00		G060 2007:095 NANU 2007056 (UNUSABLE)
02	5	0	2013 11 02 00 00 00		G061 2013:306 NANU 2013061 (UNUSUFN 307)
02	5	0	2013 11 04 00 00 00		G061 2013:308 NANU 2013062 (UNUSABLE 307-309)
01	5	0	2014 02 04 00 00 00		G063 2014:035 NANU 2014009 (OUTAGE 034)

Bias-dedicated 1994-2016 GPS/GLONASS reprocessing effort



Code bias multiplier method

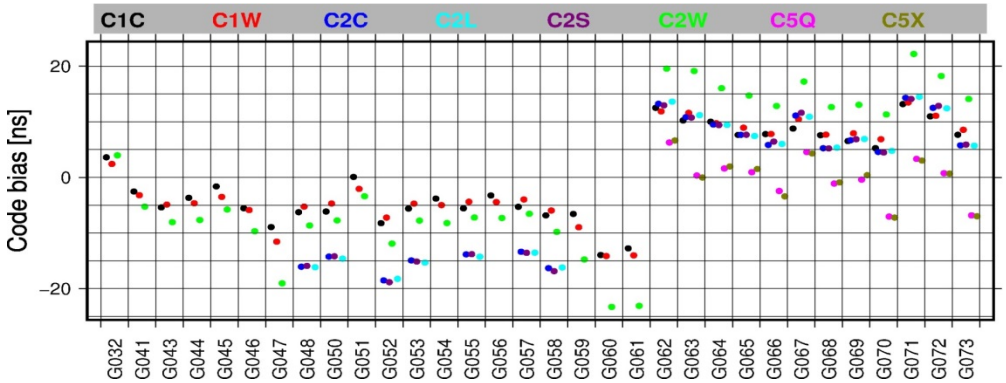
Observable-specific code biases for a station are represented by

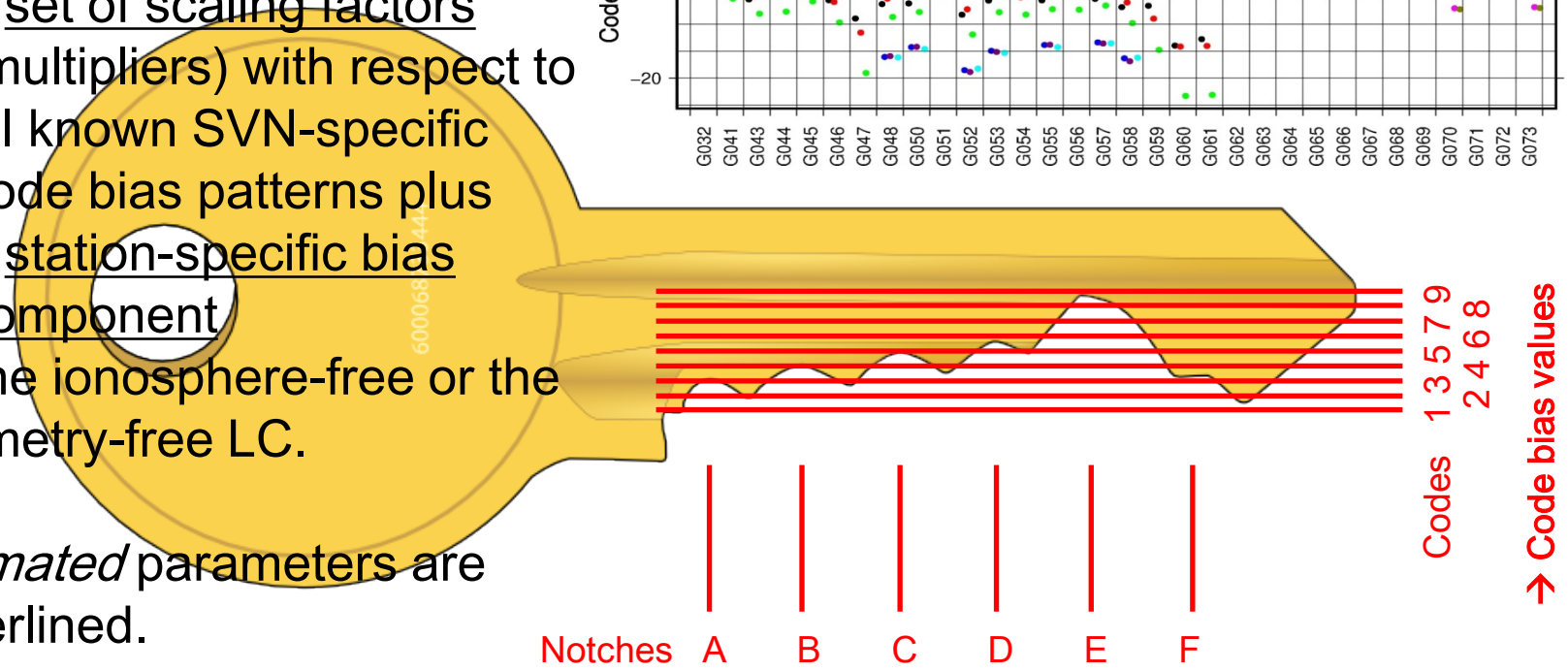
- a <u>set of scaling factors</u> (multipliers) with respect to all known SVN-specific code bias patterns plus
- a <u>station-specific bias component</u>

for the ionosphere-free or the geometry-free LC.

Estimated parameters are underlined.

→ Pattern matching

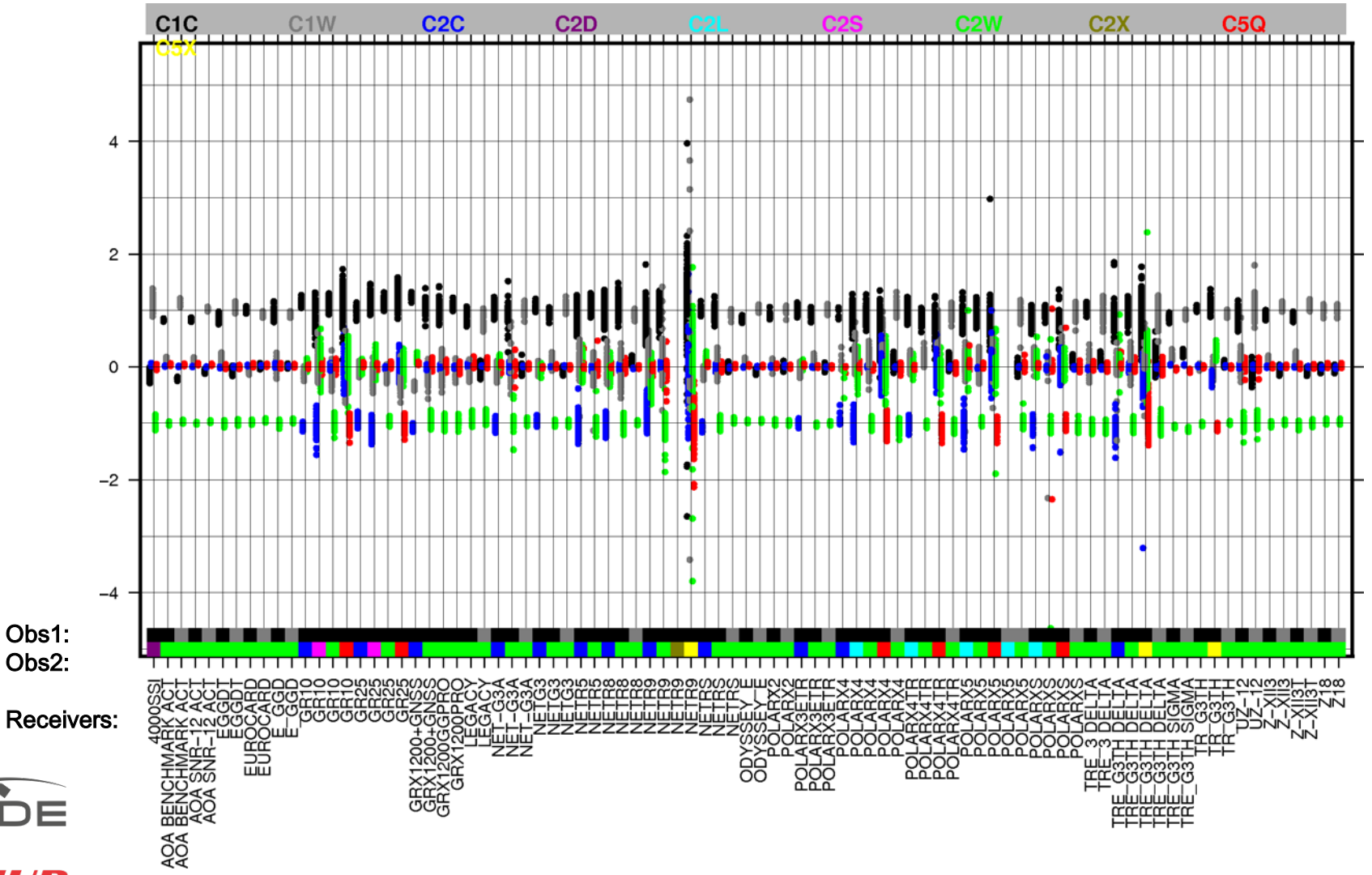




→ SVN numbers

Code: 345693

Code bias multipliers estimated from GPS observation data



Bias SINEX Format Version 1.00

IGS Workshop on GNSS Biases

IGS INTERNATIONAL GNSS SERVICE

Main
Program
Registration
List of participants
Supporting documents
Travel and accommodation
Presentations etc.

Supporting documents for the workshop www.biasws2015.unibe.ch

- **Bias SINEX 0.01**: Proposal for a format to exchange information on GNSS biases
  - Format description (draft only)
- **Bias SINEX 1.00**: Finalized draft version
  - Format description (Proposed DRAFT Nov. 4, 2015)
  - Format description (Updated DRAFT Feb. 7, 2016, for IGSWS2016)
  - Format description (Updated DRAFT Jul. 22, 2016)
  - Format description (**Finalized DRAFT** Dec. 7, 2016, to be used for testing in IGS MGEX)
  - Message concerning naming of biases (Dec. 4, 2015)
- **IONEX 1.0**: Format to exchange ionosphere maps
  - Format description
- **IONEX 1.1**: Format update (concerning multi-GNSS DCBs)
  - Format description (DRAFT)

- ftp://ftp.cddis.eosdis.nasa.gov/pub/gps/products/mgex/1934/
  - COM (V1.00), GBM (V0.01)
- ftp://ftp.cddis.eosdis.nasa.gov/pub/gps/products/mgex/dcb
  - CAS (V0.01), DLR (V1.00)

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Summary and conclusions

- **A refined GNSS bias handling** implemented into the development version of the Bernese GNSS Software (V5.3) and activated at CODE (in May 2016 for IGS, in Feb 2017 for MGEX)
- **CODE IGS** (GR CLK&ION) and **CODE MGEX*** (GRECJ CLK) **code bias** (sliding 30-day and long-term) **combination daily updated**
  - New Bias-SINEX V1.00 supported (old bias formats still provided)
- **Bias-dedicated GPS/GLONASS 1994-2016 reprocessing**
  - computation of a coherent long-term (1994-2017) code bias solution
  - realignment of all daily code bias solutions (for *satellite* and *receiver* bias components) → common code bias datum (!)
- **GLONASS receiver code bias anomalies** → detection tool
- From a GPS DCB multiplier to **a generalized GNSS code bias multiplier method** to verify bias characteristics of RINEX data

Outlook

- Reprocessed CODE (3-day) GIM IONEX results will be made available
- Prototype for multi-GNSS (MGEX) ionosphere/bias analysis is available

Joint splinter meeting: Biases & Clocks/Timing

Thursday, July 6

15:30 – 17:00 Splinter meetings

- Buffon amphi. Orbit Modelling Working Group
- Room 317 Bias and Calibration & Clock Products Working Groups

- Any input is welcome.