

Quality Monitoring of Multi-GNSS Product Series at the CODE Analysis Center



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INTRODUCTION AND OBJECTIVE

Since 1992, the Astronomical Institute of the University of Bern (AIUB) has been operating the Center for Orbit Determination in Europe (CODE). This joint venture is a consortium consisting of the AIUB, the Swiss Federal Office of Topography (swisstopo), the Federal Agency for Cartography and Geodesy (BKG), and the Institute for Astronomical and Physical Geodesy at the Technical University of Munich (IAPG/TUM). CODE contributes to all product lines provided by the International GNSS Service (IGS). To ensure the highest accuracy and reliability, the AIUB has developed a **web-based dashboard that monitors all critical processing steps**. This tool provides the operator in charge with streamlined access to key performance indicators (KPIs). Beyond basic status messages, the system focuses on rigorous internal quality checks for various products, including Earth Rotation Parameters (ERPs) and station coordinates. This information is also the basis for further developments, such as the **enhancement of the FINAL product chain towards Multi-GNSS**.

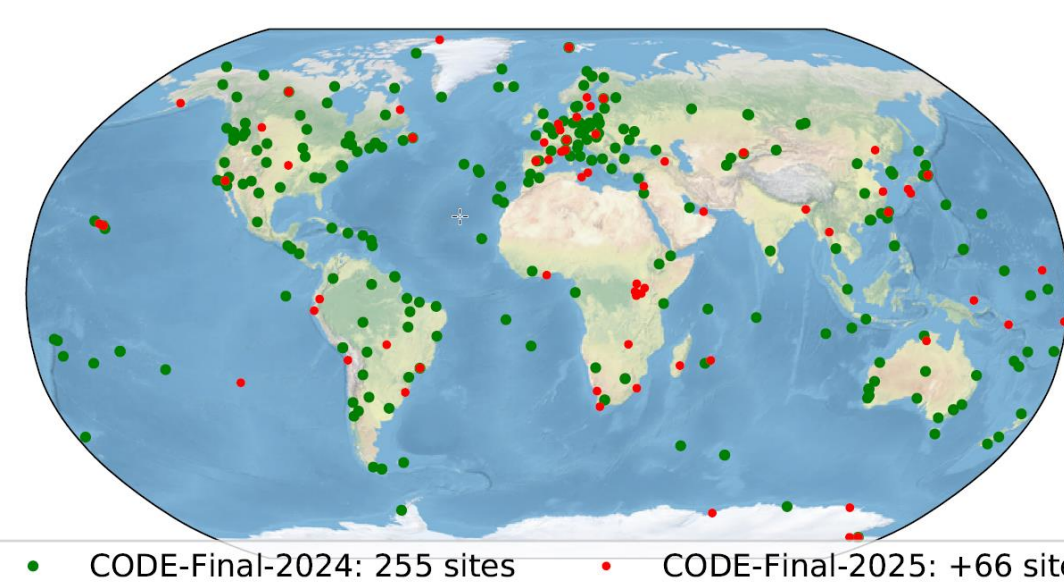
THE CODE DASHBOARD

BPE Monitor for COD (sedna) at 2026-04-29 08:42:02

BPE	Session	Status	HH:MM:SS	Percentage
IGSULTRA	1180:	TBS	00:57:03	
PPPFINAL	1170:	finished	04:45:09	
IGSRAPID	1180:	running	01:26:04	86.4%
IGSIONO	1150:	finished	01:32:30	
RCLKGNSS	1180:	running	00:51:37	41.1%
IGSFIND	1150:	finished	06:01:04	
RAPIONO	1180:	finished	00:16:23	
IGSFIND3D	1140:	finished	01:05:13	
DCBIONO	1180:	running	00:56:43	78.9%
IGSFIND7	1080:	TBS	04:14:28	
CCDPRED	1218:	finished	00:00:58	
CONCAT	1140:	finished	00:57:29	
CONC_NRT	1180:	finished	00:58:32	
SLRPRED2	1190:	finished	00:03:03	
FCLKGNSS	1140:	finished	03:47:27	
SLRQL	1128:	TBS	00:01:16	
POLE_UPD	1190:	finished	00:00:35	
EPNFINAL	1080:	TBS	03:02:19	
MGEXORB	1160:	running	00:20:12	30.2%
MCLKGNSS	1140:	finished	01:46:24	



~ 14'000 graphic files
 ~ 530 html files
 ~ 60 ascii files
Direct link

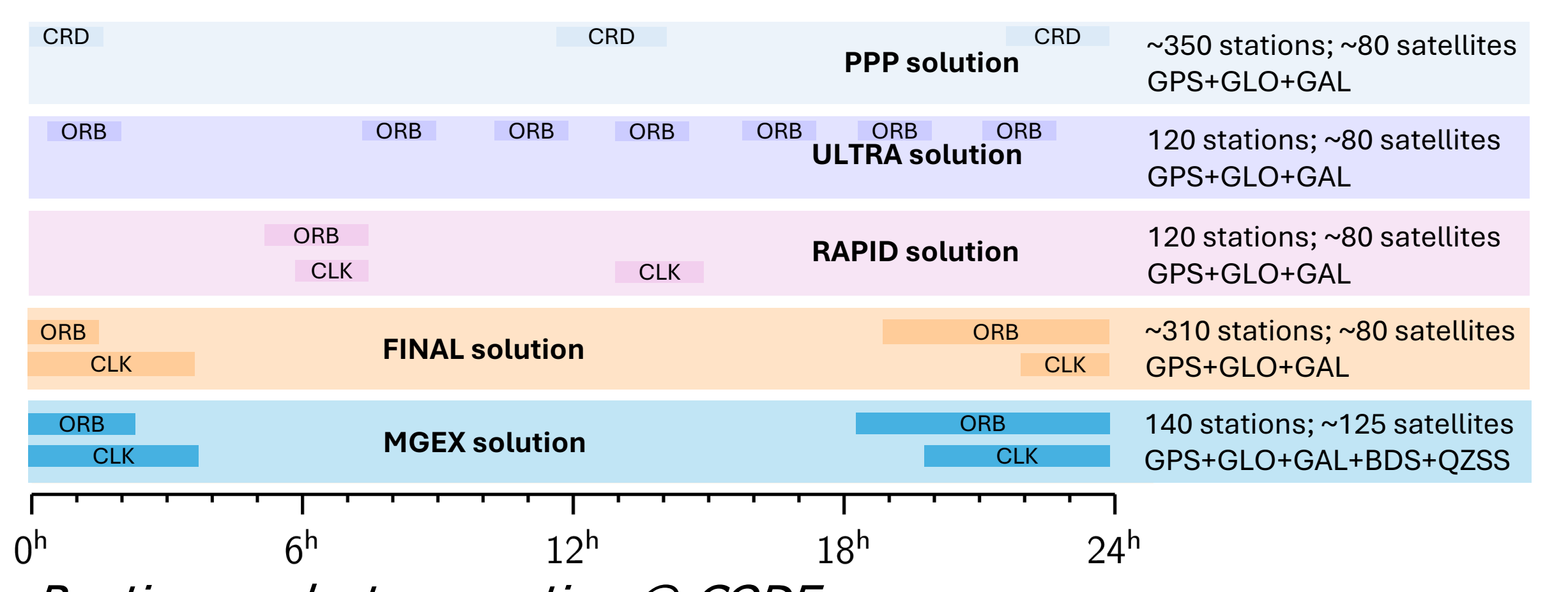


66 new stations in FINAL since Autumn 2025

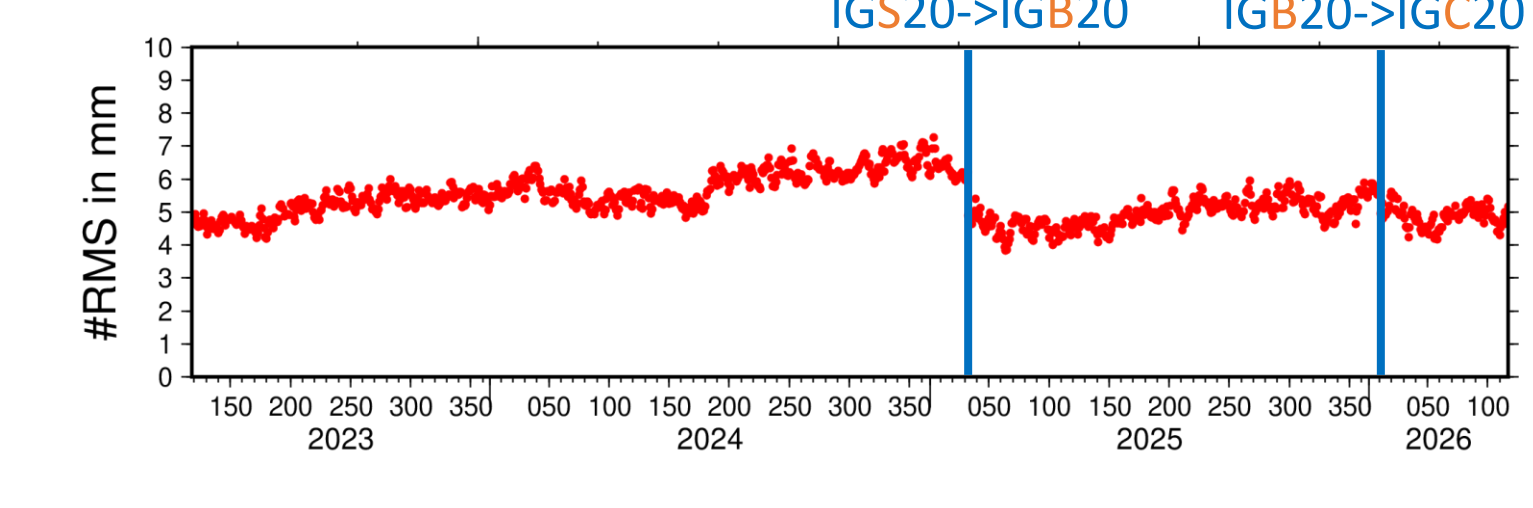
Processes, Date tools: Cronjobs | Calendar | Date conversions
 Further information: Backup Server OK | Nodes OK | Atp OK | Disk Status OK | Server status
 System monitoring: CPU/BPE | System key values
 Cluster monitoring (VPN): Cluster command | Service portal | Cluster key values
 Datapool checks: Current (0 files) | Month
 Station information: LOG | RXS | FIN | MGX | RAP | ION | CLK | EPN | KIN-PPP | PPP
 Log changes (0 changes) | Current STA entries | Repeatabilities (3 sites)
 Satellite information: Satellite CRX file | Current satellite tracks
 Satellite checks: Current | Month | History since 2021
 COD (wk 2414) | COE (wk 2414)
 Visualizations: IGSRAP | IGSFIN | MGEX | ION | PPP | IGSRAP history

Active processes

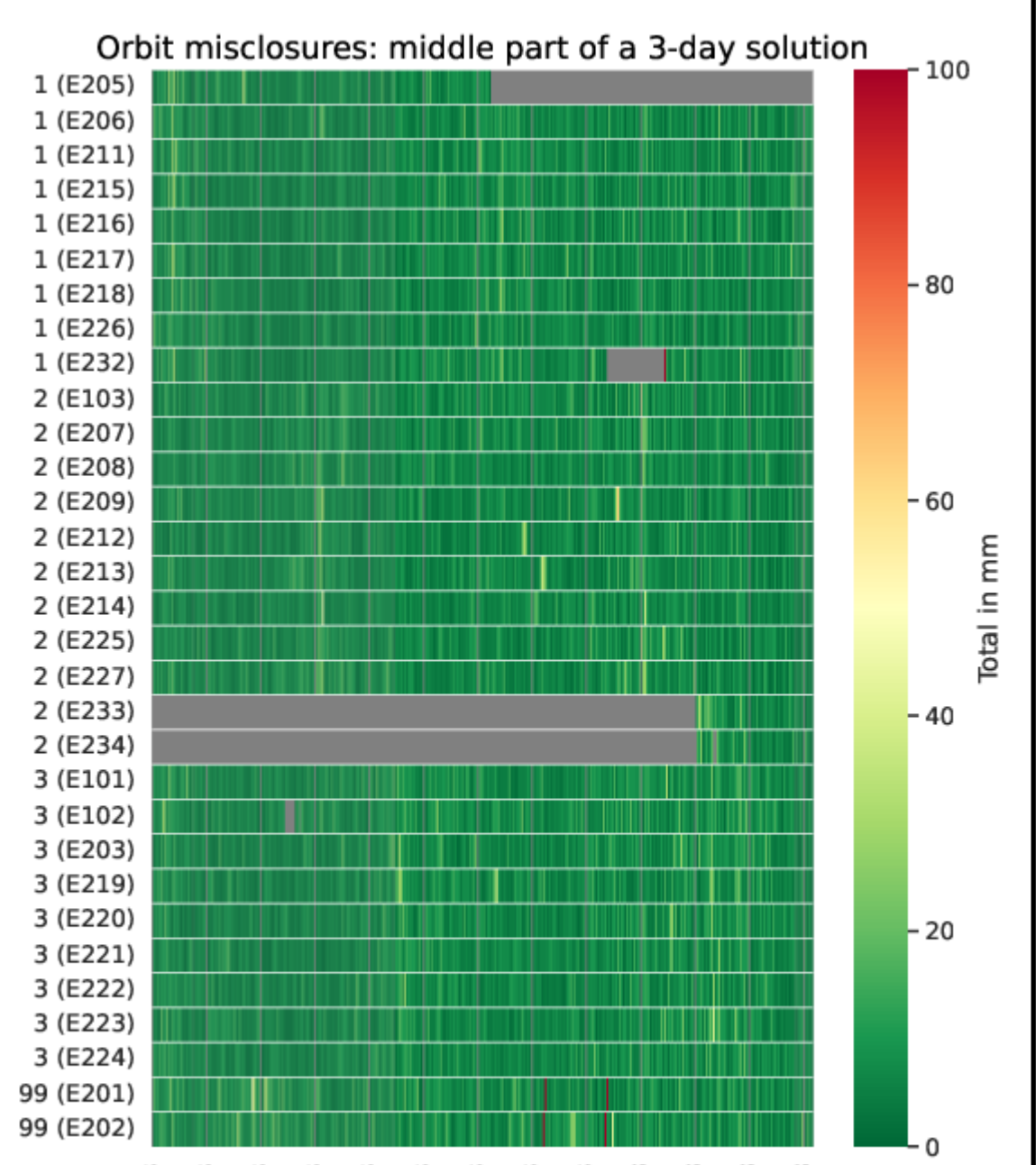
Access to system performance, long-time KPI values of CODE processes



Routine product generation @ CODE



Reference alignment (RAPID)



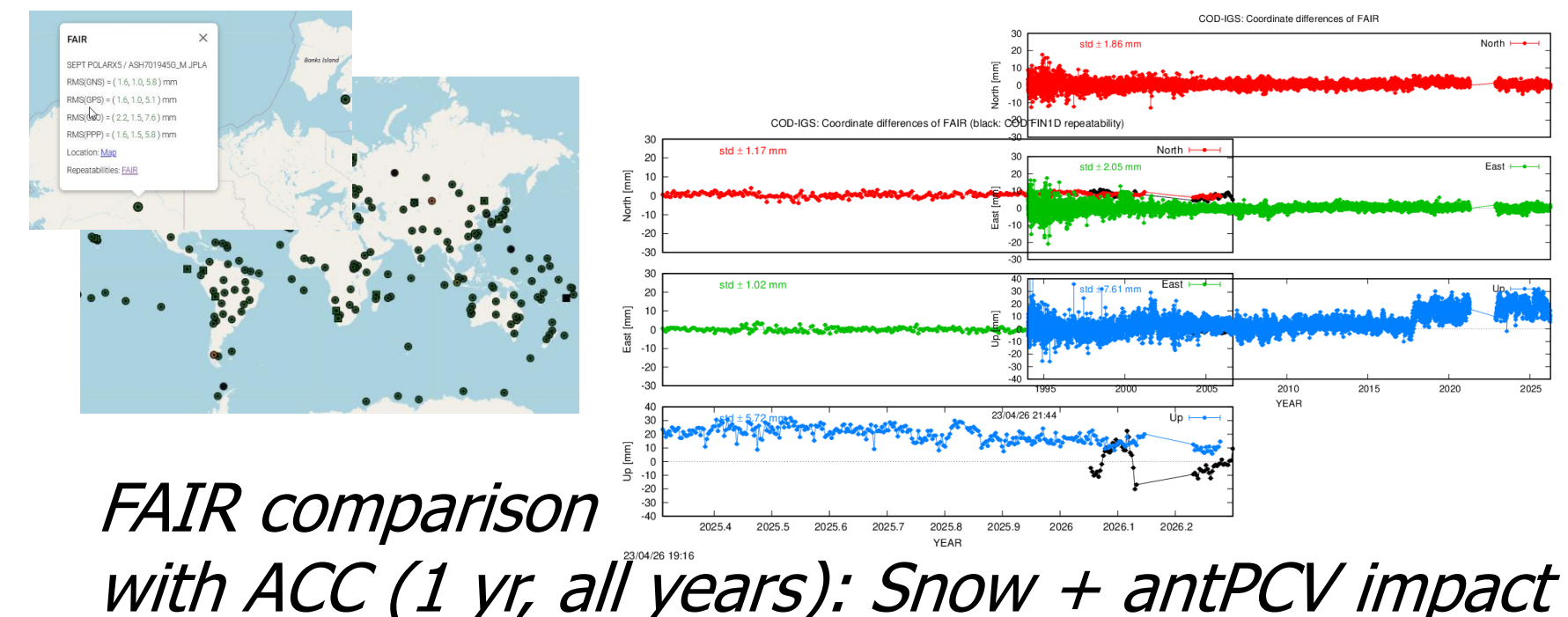
Orbit quality measures by system – example GAL

Check at 2026-04-29 08:42:11

BPE	Session	Status	Finished at YYYY-MM-DD HH:MM:SS	Protocol short long	Additional info, KPI value plots
IGSULTRA	1180:	TBS	2026-04-29 03:16:00	short long	rxn sat cpu
IGSRAPID	1180:	running	2026-04-28 16:24:21	short long	rxn sat plt
RCLKGNSS	1180:	running	2026-04-28 16:22:26	short long	rxn sat plt
PPPFINAL	1170:	finished	2026-04-29 03:26:36	short long	orx plt
IGSIONO	1150:	finished	2026-04-28 20:00:20	short long	orx plt
IGSFIND	1150:	finished	2026-04-29 02:29:47	short long	rxn sat plt
FCLKGNSS	1140:	finished	2026-04-29 07:24:29	short long	rxn sat plt
MGEXORB	1160:	running	2026-04-28 22:06:08	short long	plt
MCLKGNSS	1140:	finished	2026-04-28 23:54:53	short long	rxn sat plt
EPNFINAL	1080:	TBS	2026-04-23 11:32:21	short long	

OBS history +- 7 days:
 1087: +C07 -C08 -C39
 1088: -C40
 1089: +C13 +C14 +C39 -C45 -C49 -C50
 1180: +C11 +C12 +C38 -C43 -C44 -C47
 1111: -C12 -C48

Current changes in satellite observations



FAIR comparison with ACC (1 yr, all years): Snow + antPCV impact

Access to short and long protocols, graphics of KPIs

Station checks: Log changes (1 changes) | Repeatabilities (5 sites)
 System status: Backup Server NOK | Nodes OK | Atp FULL | Disk status | Server status
 System status: Backup Server OK | Nodes OK | Atp OK | Disk status | Server status
 IGSRAPID 0280: error 2026-01-20 15:14:14 short long rxn | sat | plt

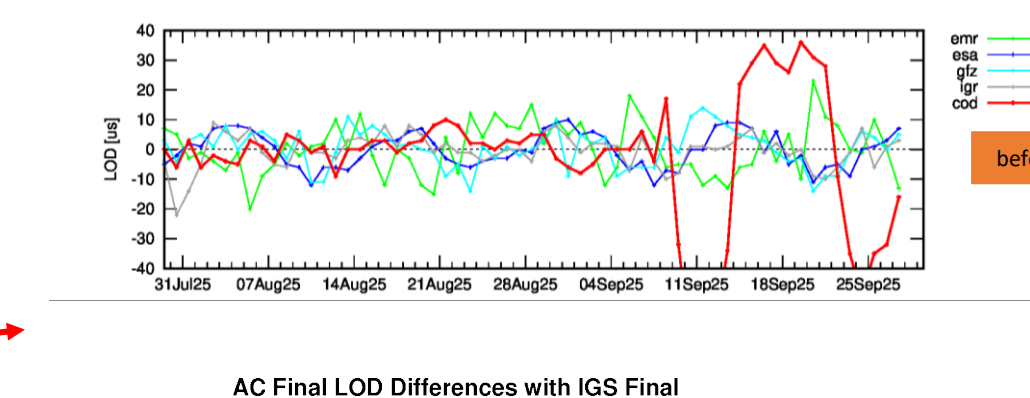
Example notifications

Products

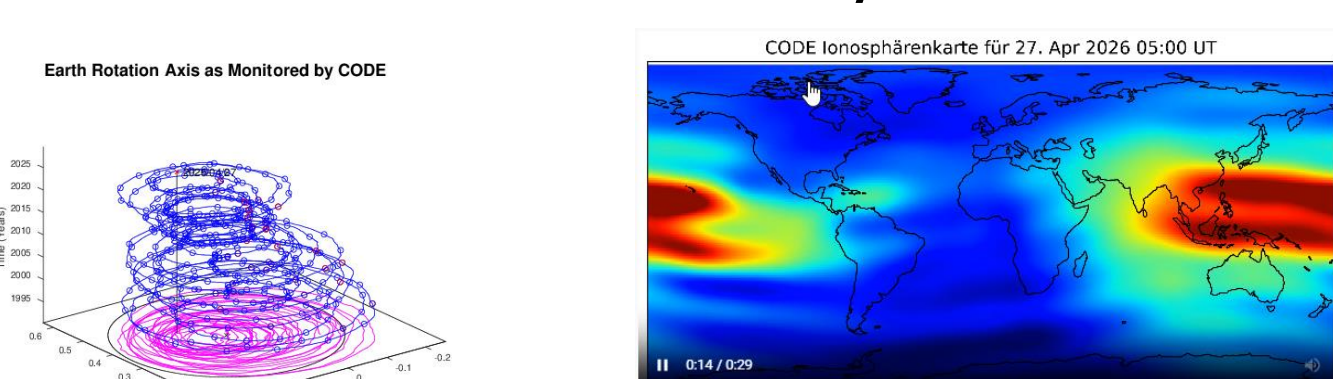
Validation with IGS (1): ORB/ERP for ULT, RAP, FIN @ ACC
 Validation with IGS (2): CRD/ERP Final @ TRFrameCC
 Validation with IGS (3): ORB/CLK Final analysis @ MGEX
 Validation with IGS (4): CLK RAP | CLK FIN @ WCC
 Product docu: Content | CODE AC file | CODE IGS Report
 Product download: Operational | MGEX | Repro 2020 | Operational on S3
 Products elsewhere: BKG | CDDIS | BKG_EP_N | BEV_EP_N | EPN_1D | EPN_7D
 BSW user download: BSW54 | BSW52

Access to products and its validation

CODE comparisons with IGS ACC
 Ultra comparisons: orb | rep
 Rapid comparisons: orb | rep
 Final comparisons: orb | rep
 IGS Ultra comparisons: orb | rep
 IGS: Rapid comparisons: orb | rep
 IGS: Final comparisons: orb | rep



Product validation: example LOD «outlier» reported by ACC Sep 11, 2025



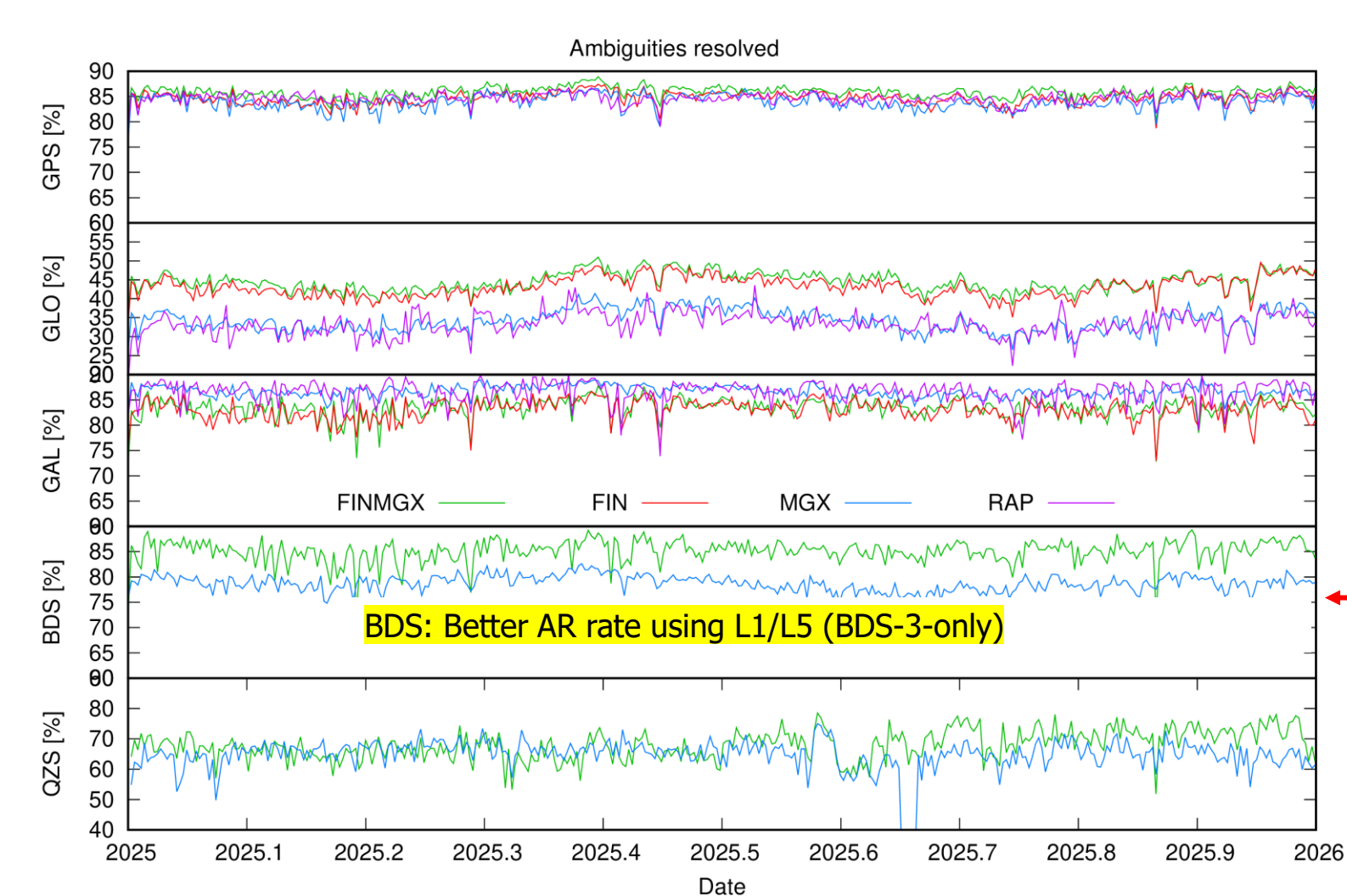
Product visualizations (EOPs, ionosphere, etc.)

"FINMGX" PROTOTYPE

- 1 year of GNSS data (2025) – reprocessing mode
- Current processing options (and not the valid options in 2025)
 - Antenna phase center variations I20_2408.ATX
 - Increased number of stations
 - Observation selection (OBS.SEL) agreed in MGEX in Feb 2026 (BDS-3-only)

Blas convention	S/S	O/F	980
2025 February	C	L1	L2X L5X
	C	L2	L5X
	J	L1	L1X L1X
	J	L2	L2X L2X
2026 February	C	L1	L1X L1X L1X
	C	L2	L2X L5X
	J	L1	L1X L1X L1X
	J	L2	L2X L5X L5X

Processing Options



Ambiguity success rate of CODE chains



Orbit agreements of CODE chain

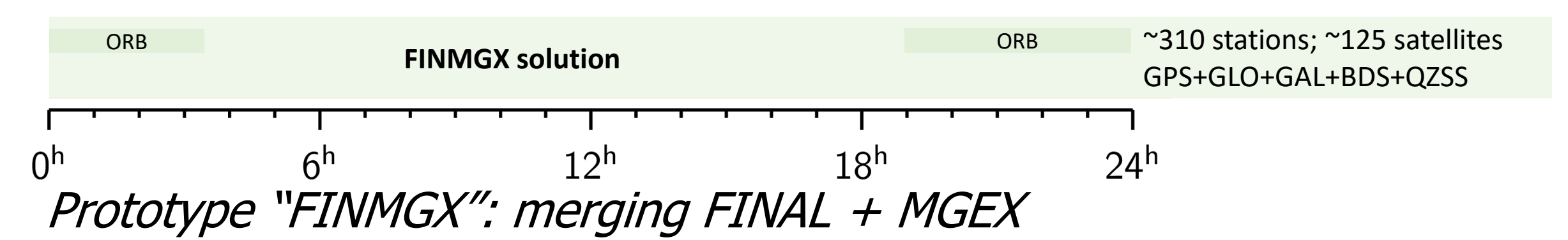
SOLUTION	#station-days	N	E	U
FINMGX (3 days)	106255	1.76	1.65	4.82
FIN (3 days)	97592	1.66	1.72	4.85
MGEX (3 days)	53412	1.89	1.80	5.67

Total coordinate repeatability of CODE chains

SOLUTION-HELMERT	#stations	N	E	U
2025 mean coordinates				
FIN - FINMGX*	338	0.80	0.79	0.95
MGEX - FINMGX**	180	1.98	2.50	2.90

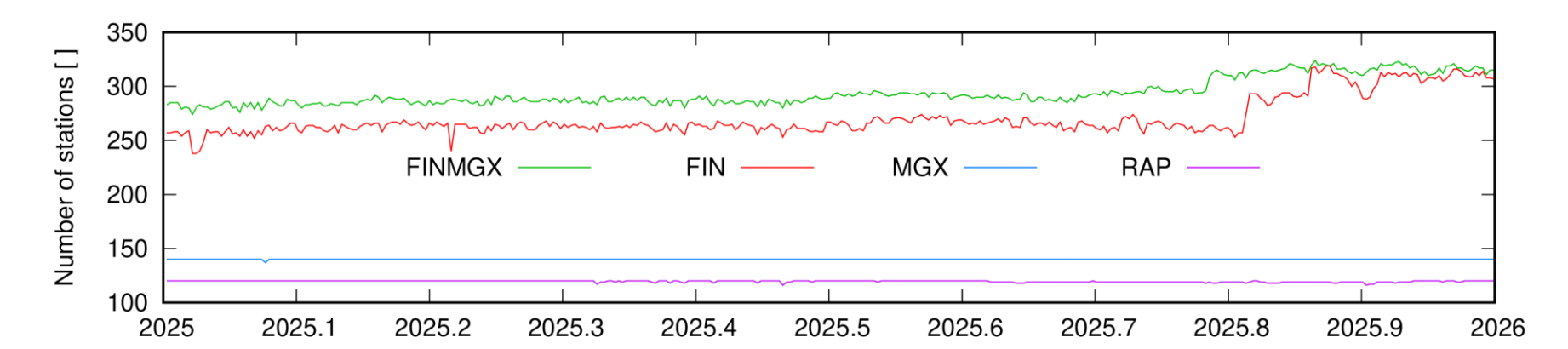
* Excellent agreement of BDS(+QZS) with GPS+GLO+GAL
 ** Several outliers (e.g. IISC, DGAR, ASH701945E_M NONE) up to 5 cm (obviously bad antenna PCV calibration for L2/L5)

Coordinate differences of CODE chains

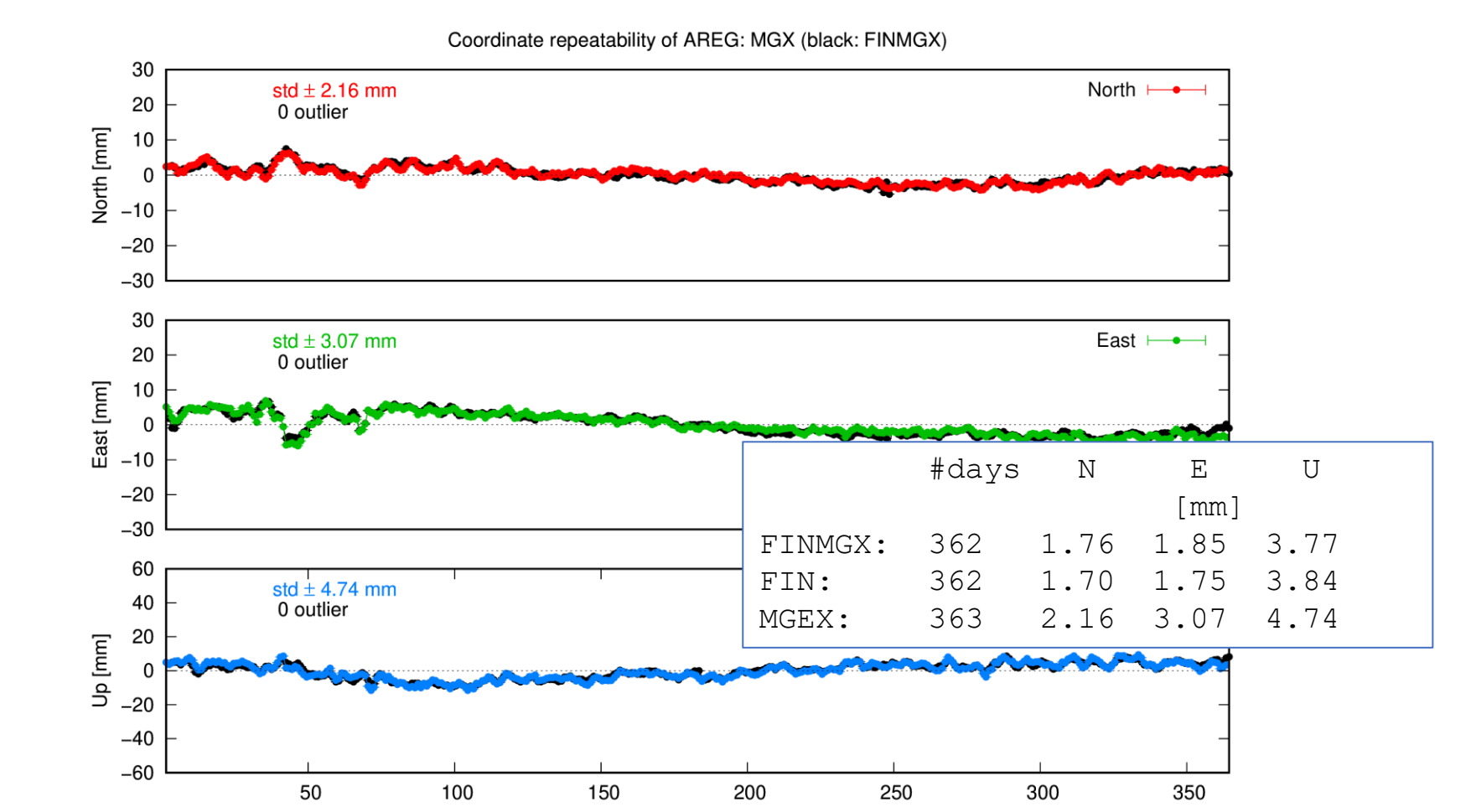


Prototype "FINMGX": merging FINAL + MGEX

σ rms [mm] w.r.t FINMGX: FIN MGX
 σ GPS: 9.7 20.0
 σ GLO: 16.0 34.4
 σ GAL: 10.0 21.2
 σ BDS: 42.3
 σ QZS: 148.9



Statistical values in CODE chains



Coordinate repeatability AREG (Peru) in CODE chains

CONCLUSIONS

The dashboard has been continuously enhanced over the past three years, with a specific focus on condensing complex data into intuitive, readable figures. This poster provides an overview of the CODE dashboard's functionality and demonstrates the benefits of its integrated quality checks through selected examples. Furthermore, it offers insights into the operational workflows required for multi-GNSS product generation. By sharing details of the CODE quality control framework, this contribution aims to foster technical discussions among IGS Analysis Centers. A prototype of CODE's final processing scheme was successfully enhanced to also generate Multi-GNSS products from data of year 2025 and showed the impact and benefits of processing only BDS-3 satellites.