pntmoni

MONTHLY QC REPORT

pntmoni Monthly Report

GEONET quality monitoring (QC) — Free edition

Reporting period	**2026-09**
Published	**2026-10-21**
Methodology version	**v1.2.0**
Config hash	**cfg:2065944a2c5c4e9b**
Dataset	**sha256:4c5273ad…3d62 (30 files)**

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ℹ Note

Methodology Version: 1.2.0 · **QC Tool:** teqc 2019Feb25 · **convbin:** RTKLIB 2.4.2 · **Stations:** 1,301 · **Days covered:** 30 · https://pntmoni.com/methodology/qc/v1.2.0

1 Revision History

Version	Date	Notes
1.0	2026-10-21	Initial publication.
1.1	2026-10-21	Brand written as pntmoni; subtitle aligned with the website. No change to QC metrics or aggregates

2 Introduction

This monthly report summarises the **observation-quality** state of the GEONET (GNSS Earth Observation Network) reference-station network operated by the Geospatial Information Authority of Japan (GSI), for September 2026. It is the **free-tier deliverable** of the pntmoni (from "PNT Monitor") monitoring service: a national, aggregate view that lets operators, researchers and users of GNSS-augmentation services see how the underlying observation infrastructure performed.

The report is intentionally limited in scope. It does **not** include:

- Per-station drill-downs or named station lists (Pro-tier).
- Positioning-domain accuracy or TTFF results — those appear in the full Monthly Report.
- Integrity indicators, ionospheric/tropospheric correction diagnostics, or cross-engine comparisons (planned).

The data and methods used to produce this report are openly documented and reproducible from publicly available GEONET inputs. §Methodology below summarises them; the full methodology document is https://pntmoni.com/methodology/qc/v1.2.0.

3 Methodology

This section summarises the methodology; the full document is https://pntmoni.com/methodology/qc/v1.2.0.

Data sources (methodology §2): GEONET RINEX 3.02 observation and broadcast-navigation files (30-second sampling, 24-hour daily files), retrieved from GSI's archive under the Public Data License 1.0. All 1,301 continuously-operating GEONET reference stations active for September 2026 are included.

QC pipeline (methodology §3):

```
RINEX 3 (GEONET)
  ↓ convbin (RTKLIB 2.4.2)            v3 → v2.11 conversion
  ↓ teqc 2019Feb25                    +qc -R +L2C_L2 +L5
  → .{yy}S summary per station/day
  ↓ pntmoni-pipeline qc summarize     parse + wide Parquet
  → data/processed/qc_summary/...     1 row × 639 cols per station-day
```

QZSS LNAV broadcasts use the post-2024 health-flag encoding of IS-QZSS-PNT-006 §4.1.2.3(4); the pipeline masks the L1C/B health bit before passing the QNAV to teqc so that L1C/A-broadcasting QZS satellites are correctly QC'd (methodology §2.1).

Metrics (methodology §4): the four core families established in **Shiono & Kubo (2025)** (ION GNSS+ 2025) and extended in **Shiono & Kubo (2026)** (NAVIGATION, doi:10.33012/navi.762) — **Visibility, SNR, Multipath, and Cycle Slips** — plus data availability. The Galileo E5b family (`SN7`, `MP17`, `MP71`) is reported as informative reference only, not part of the absolute-evaluation baseline. Symbol-by-symbol definitions are in the Appendix glossary.

Aggregation (methodology §5): all multipath, SNR and slip figures are computed from teqc's 5° elevation bins with an elevation mask of 15° applied (15 of 19 bins kept); multipath/SNR values are obs-count weighted across the kept bins, slip totals are summed. This matches both Shiono & Kubo (2025) and the elmask used by the positioning engines (CLASLIB, RTKLIB).

3.1 Evaluation Network

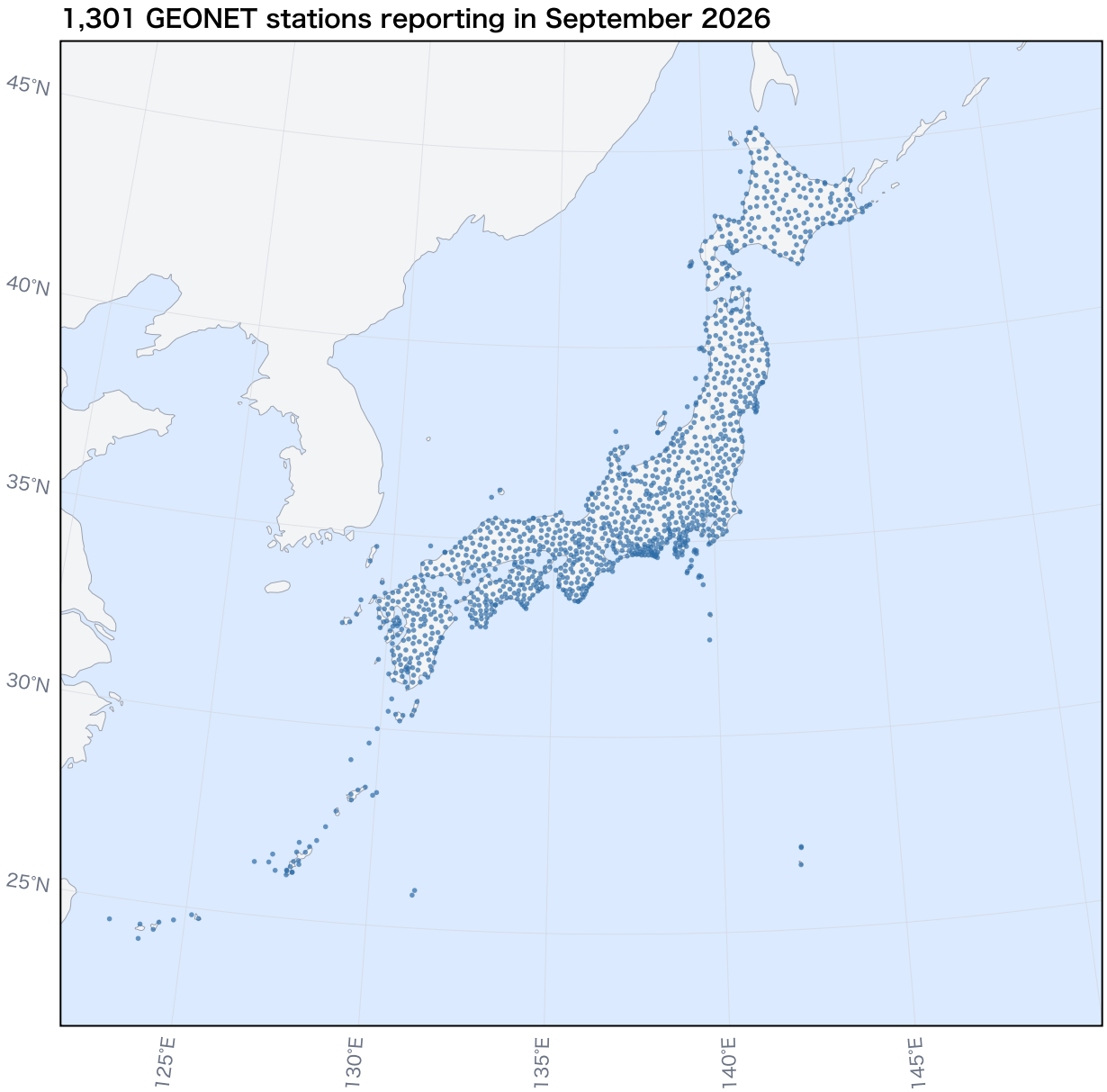


Figure 1: GEONET reference stations covered in this report.

4 Executive Summary

Table 1

Metric	September 2026
National data availability (epoch coverage, daily mean)	99.98 %
National visibility (>10° track completeness, daily mean)	95.26 %
L1 C/A multipath — station-month median	0.200 m
L1 C/A SNR — station-month median	43.8 dB-Hz
Stations reporting	1,301
Days covered	30

Tip

Bottom line. The GEONET network operated at high observation fidelity throughout September 2026, with the headline metrics tracking expectations for a healthy reference network. See §National Overview for the distributions and trends behind these summary numbers.

5 National Overview — Observation Quality

5.1 Data Availability & Visibility

5.1.1 Data Availability

Epoch-level coverage: did the station log data every 30 seconds?

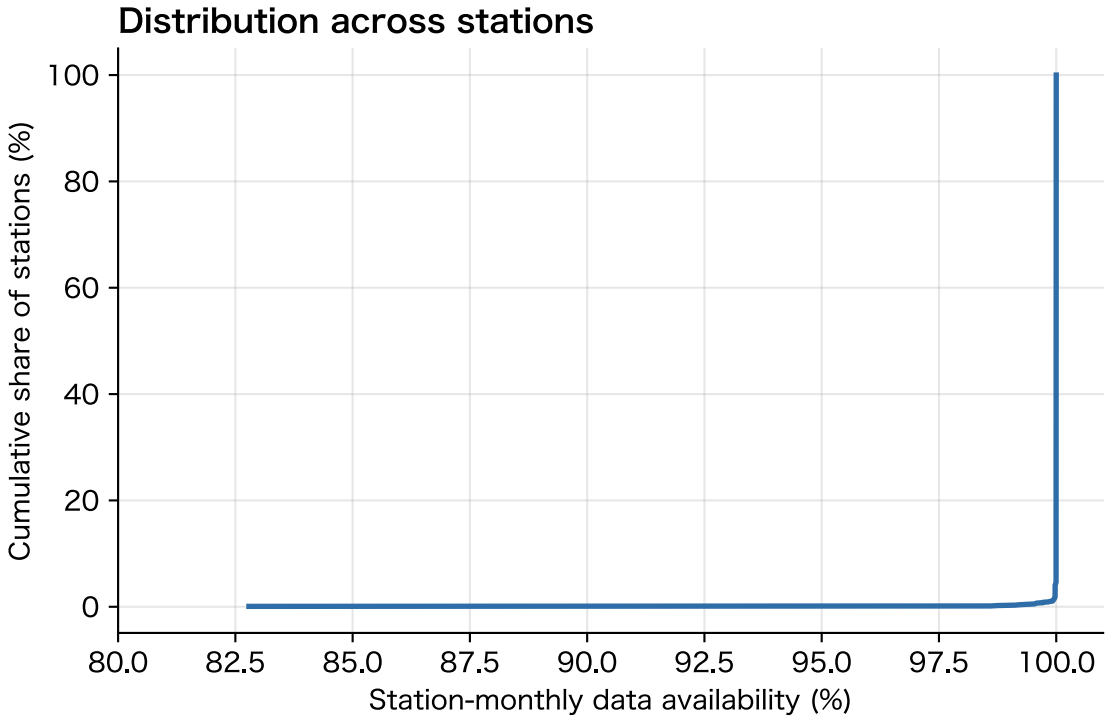


Figure 2: Data availability — fraction of the 2,880 nominal daily epochs with logged observations.

Table 2

Statistic	Station-monthly data availability
5th percentile	100.00 %
Median	100.00 %
95th percentile	100.00 %
Best station	100.00 %
Worst station	82.79 %

5.1.2 Visibility (可視率)

Sat-track completeness above 10° elevation: when the station was up, did it actually track the satellites it should have seen?

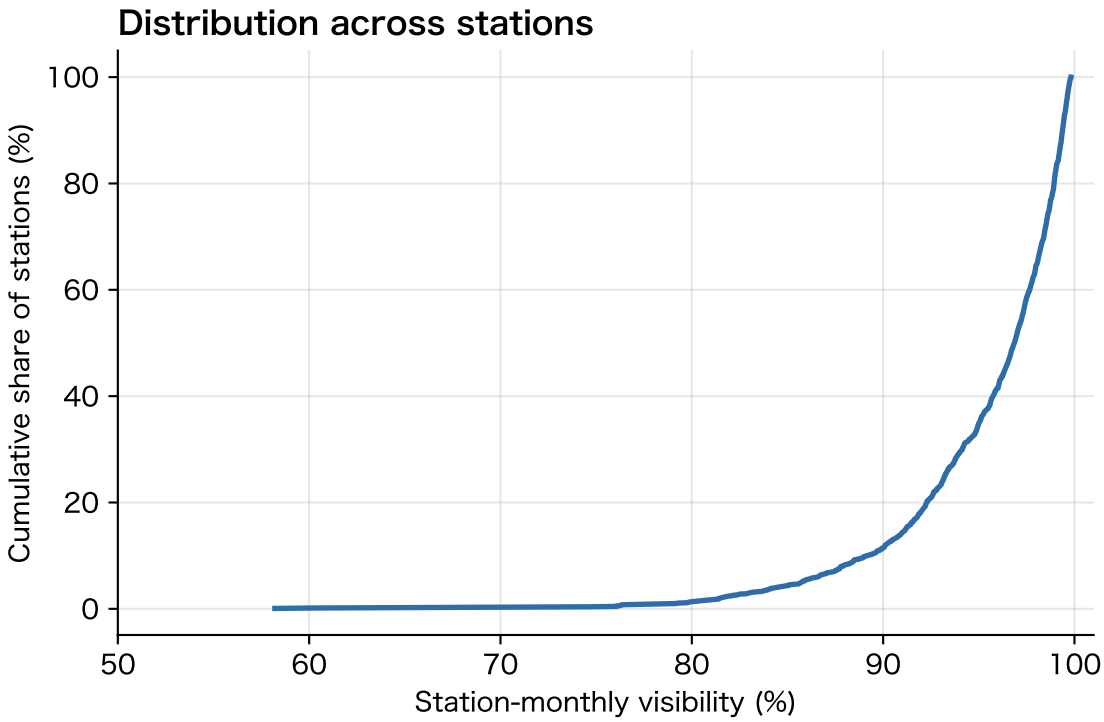


Figure 3: Visibility — Complete obs / Possible obs above 10° elevation, per teqc.

Table 3

Statistic	Station-monthly visibility
5th percentile	85.76 %
Median	96.87 %
95th percentile	99.58 %
Best station	99.82 %
Worst station	58.21 %

5.2 Distribution of Metrics

5.2.1 Signal-to-noise ratio

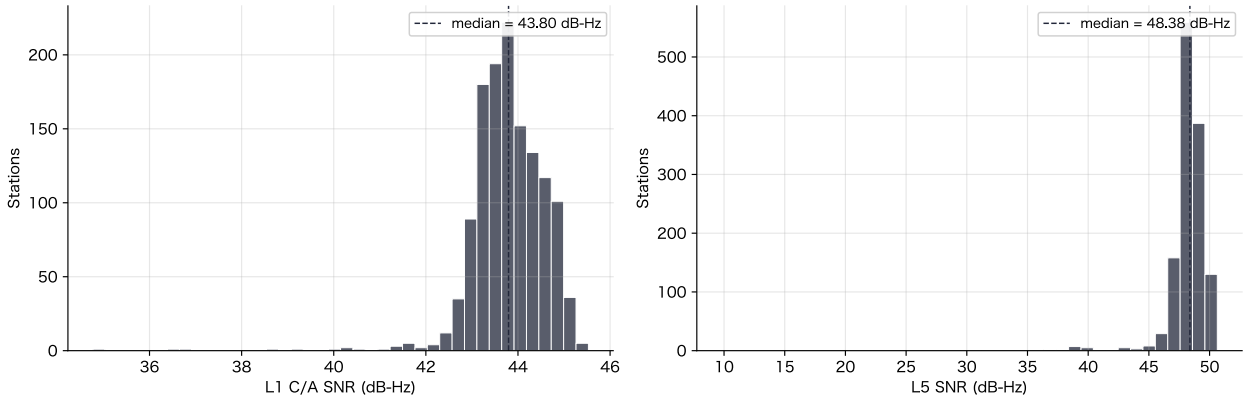


Figure 4: SNR distributions — L1 C/A and L5 (Shiono & Kubo 2025 core baseline).

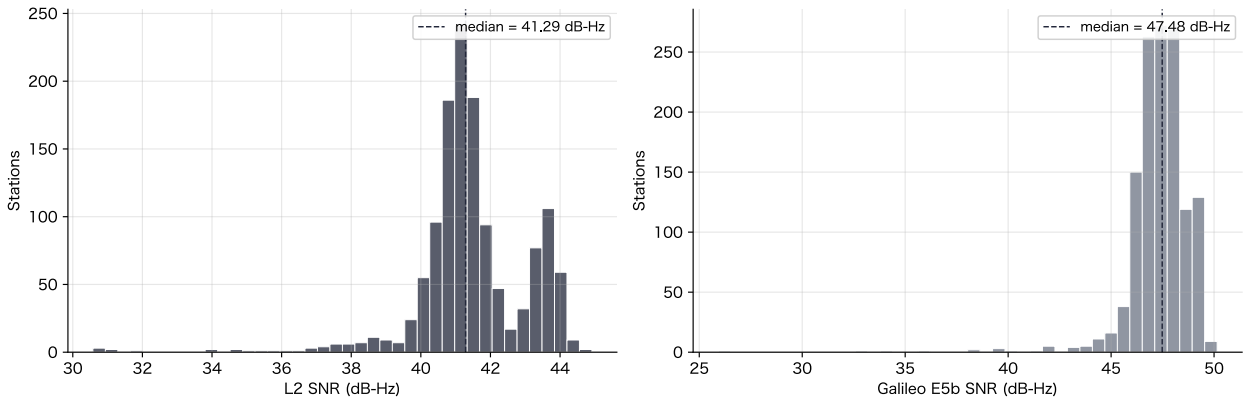


Figure 5: SNR distributions — L2 (core) and Galileo E5b (reference; not part of the absolute-qualification baseline).

5.2.2 Multipath

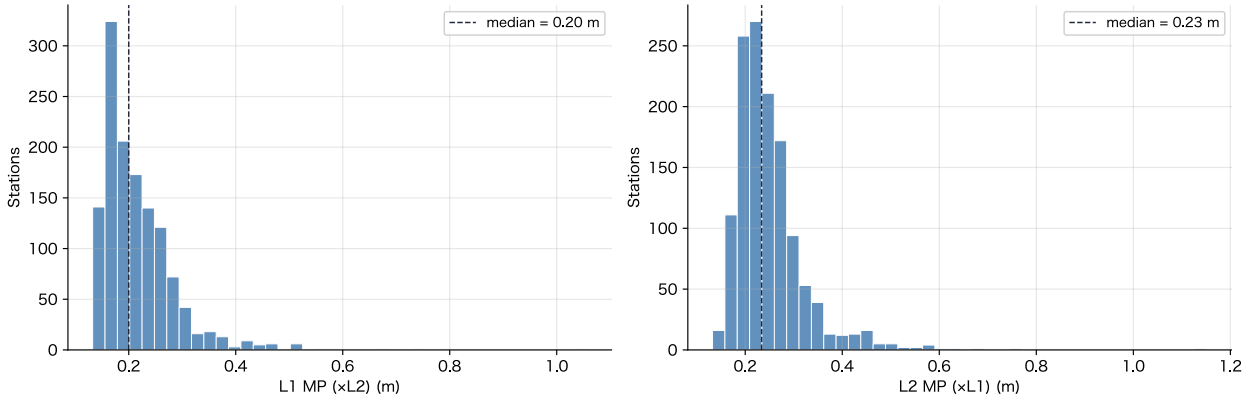


Figure 6: Multipath RMS distributions — L1/L2 pair (MP12 = L1 multipath using L2 partner; MP21 = L2 multipath using L1 partner). Shiono & Kubo 2025 core baseline.

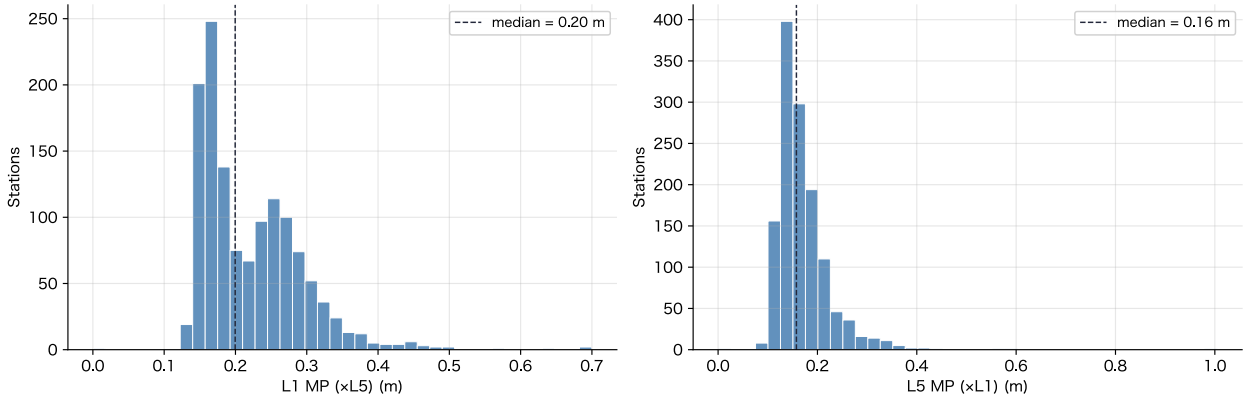


Figure 7: Multipath RMS distributions — L1/L5 pair (MP15 = L1 multipath using L5 partner; MP51 = L5 multipath using L1 partner). Core baseline.

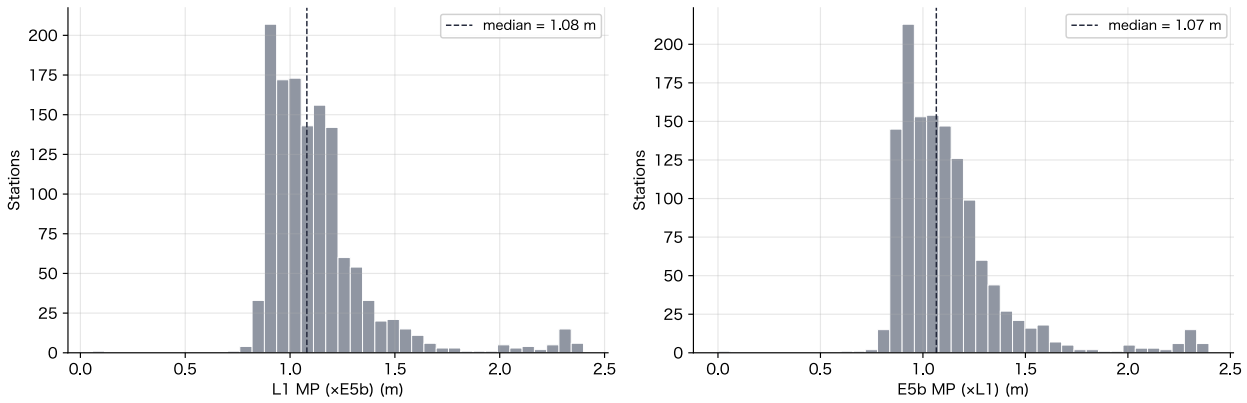


Figure 8: Reference multipath RMS distributions — L1/Galileo E5b pair (MP17/MP71). Larger numerical scale due to the L1/E5b frequency-pair coefficient. Not part of the absolute-qualification baseline (E5b exhibited too much site-to-site variance to function as a qualification metric in Shiono & Kubo 2025).

5.2.3 Cycle slips

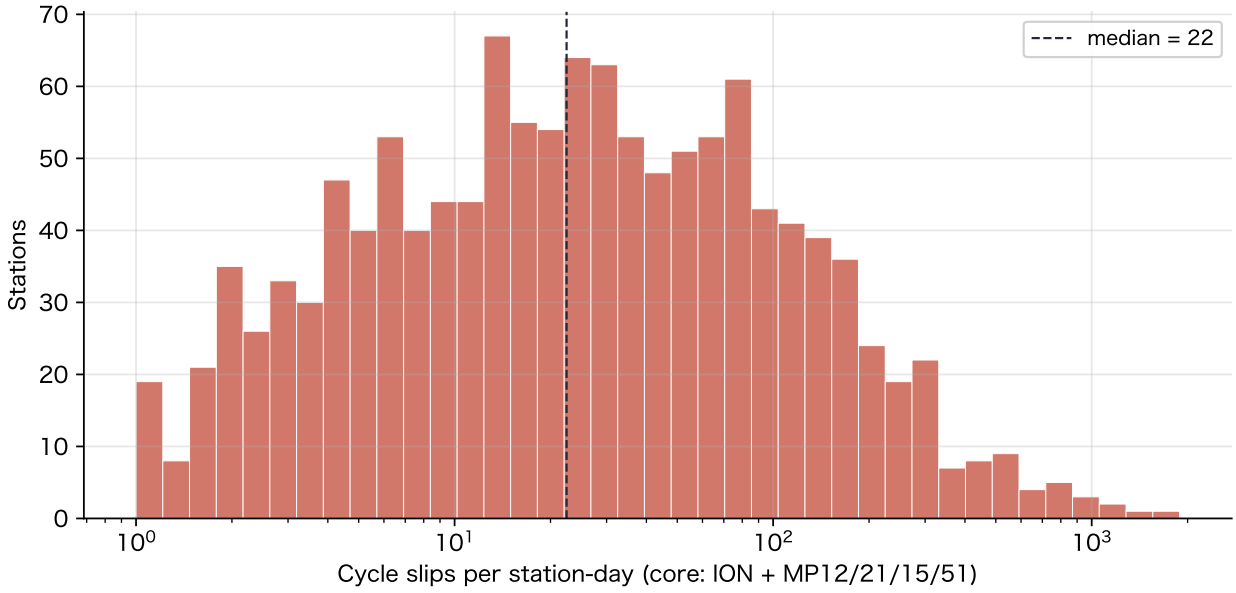


Figure 9: Station-monthly cycle slips (ION + core MP-combination slips, summed across the elmask-15 elevation bins). Paper-aligned definition (Shiono & Kubo 2025 Table 1). Logarithmic binning.

5.3 Spatial Distribution

The maps below aggregate the 1,301 station-monthly values into a national hex grid: each hexagon is **~60 km flat-to-flat** and is coloured by the **median** of the station-monthly values of the stations falling inside it. The grid is drawn on an Albers Equal-Area projection so every cell covers the same ground area, making colour directly comparable across the country and between months. Cells backed by fewer than 3 reporting stations are drawn with a **dotted inner ring** — a reliability marking: their median is statistically thin, so read those cells as indicative rather than representative (methodology §5.3, 2026-07-18 revision).

5.3.1 Signal-to-noise ratio

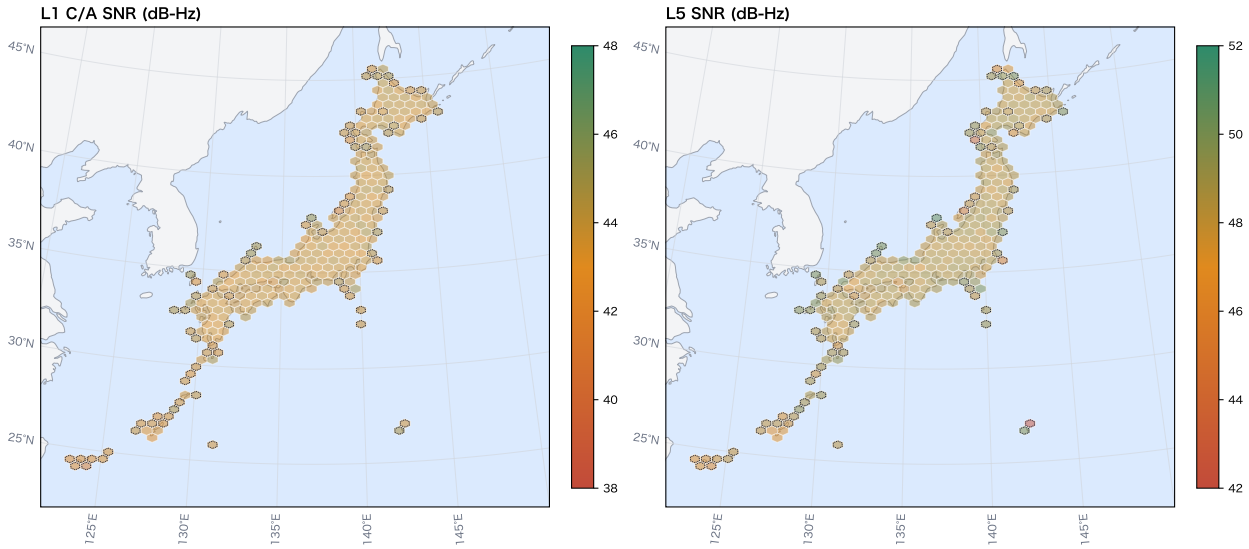


Figure 10: Station-monthly SNR — L1 C/A and L5 (core baseline). Signal-specific colour scales.

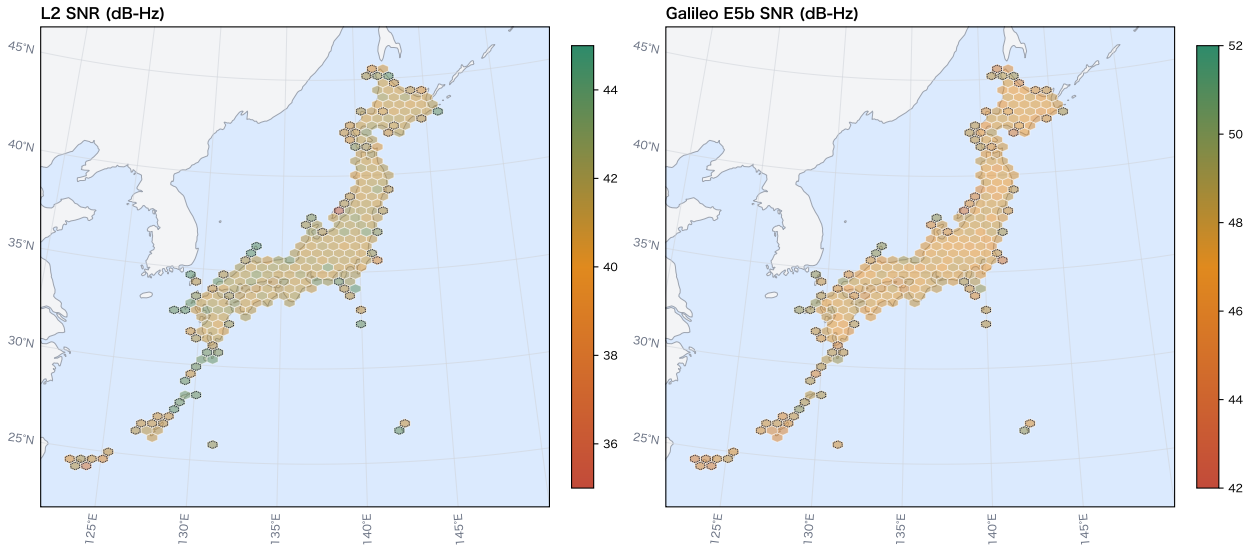


Figure 11: Station-monthly SNR — L2 (core) and Galileo E5b (reference; not part of the absolute-qualification baseline). Signal-specific colour scales.

5.3.2 Multipath

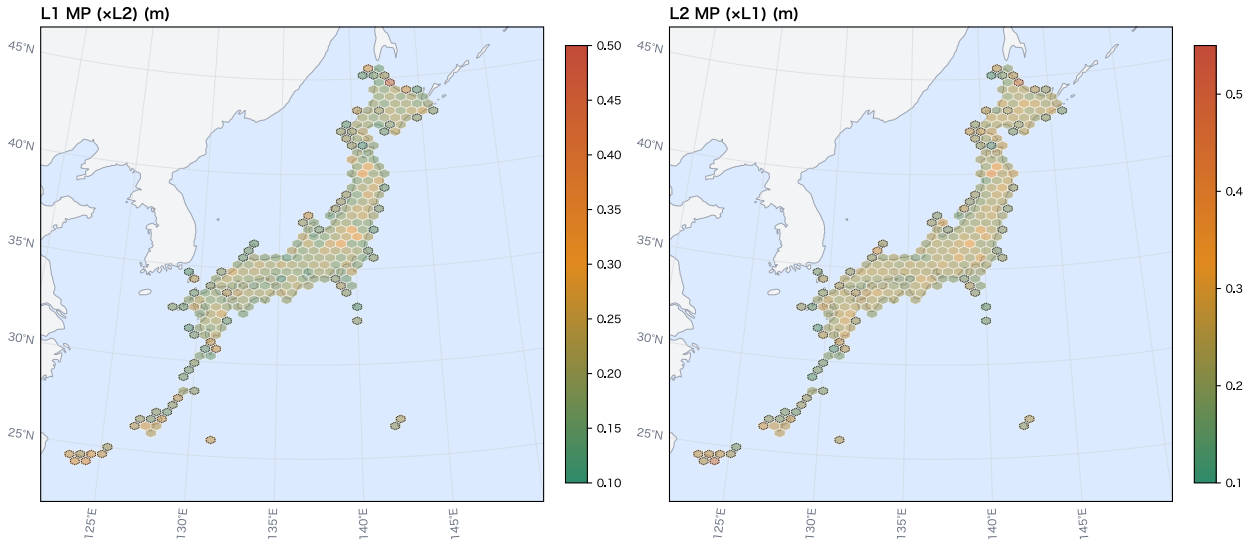


Figure 12: Station-monthly multipath RMS — L1/L2 standard pair (MP12 = L1 multipath using L2 partner; MP21 = L2 multipath using L1 partner).

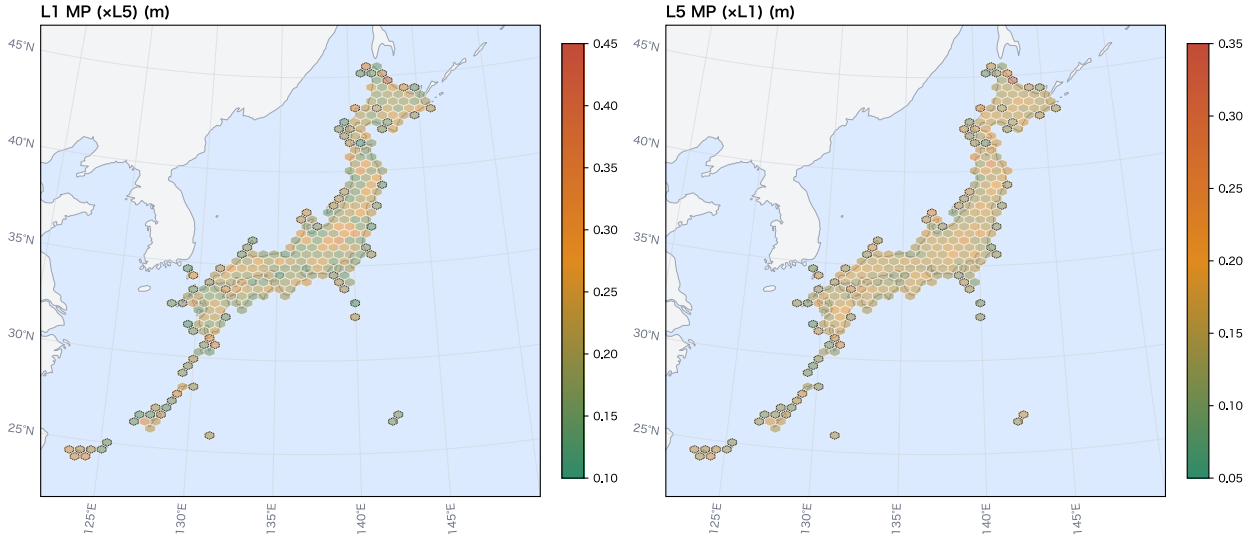


Figure 13: Station-monthly multipath RMS — L1/L5 pair (MP15 = L1 multipath using L5 partner; MP51 = L5 multipath using L1 partner). MP51 typically lower than MP12 — modern L5 signals see less multipath at GEONET sites.

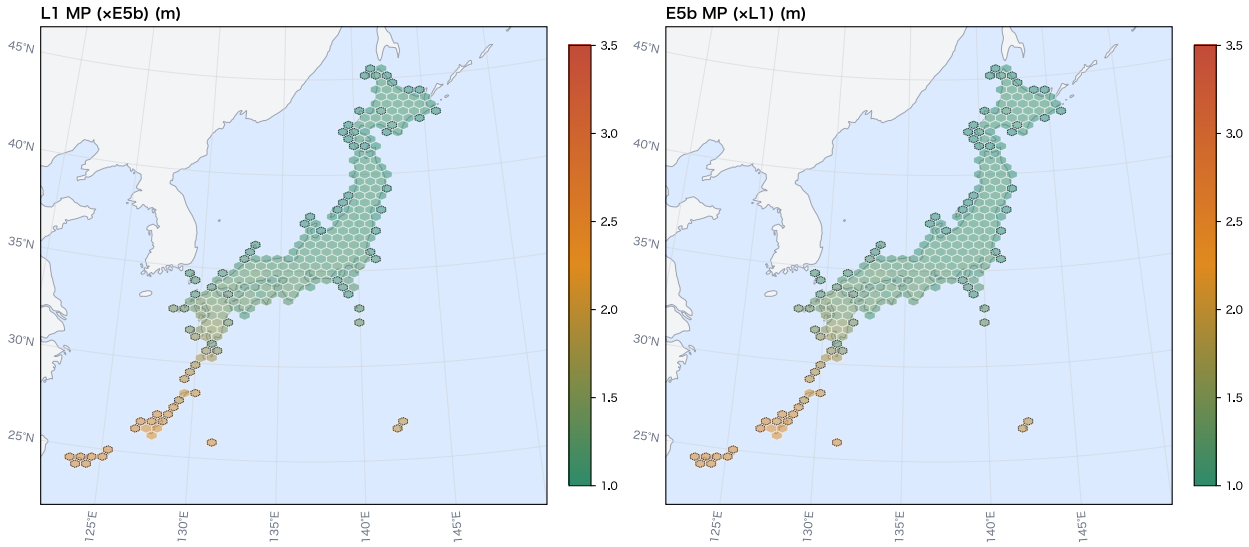


Figure 14: Reference multipath — L1/Galileo E5b pair (MP17/MP71). Larger numerical scale due to the L1/E5b frequency-pair coefficient. Shown for monitoring; not part of the absolute-qualification baseline.

5.3.3 Cycle slips

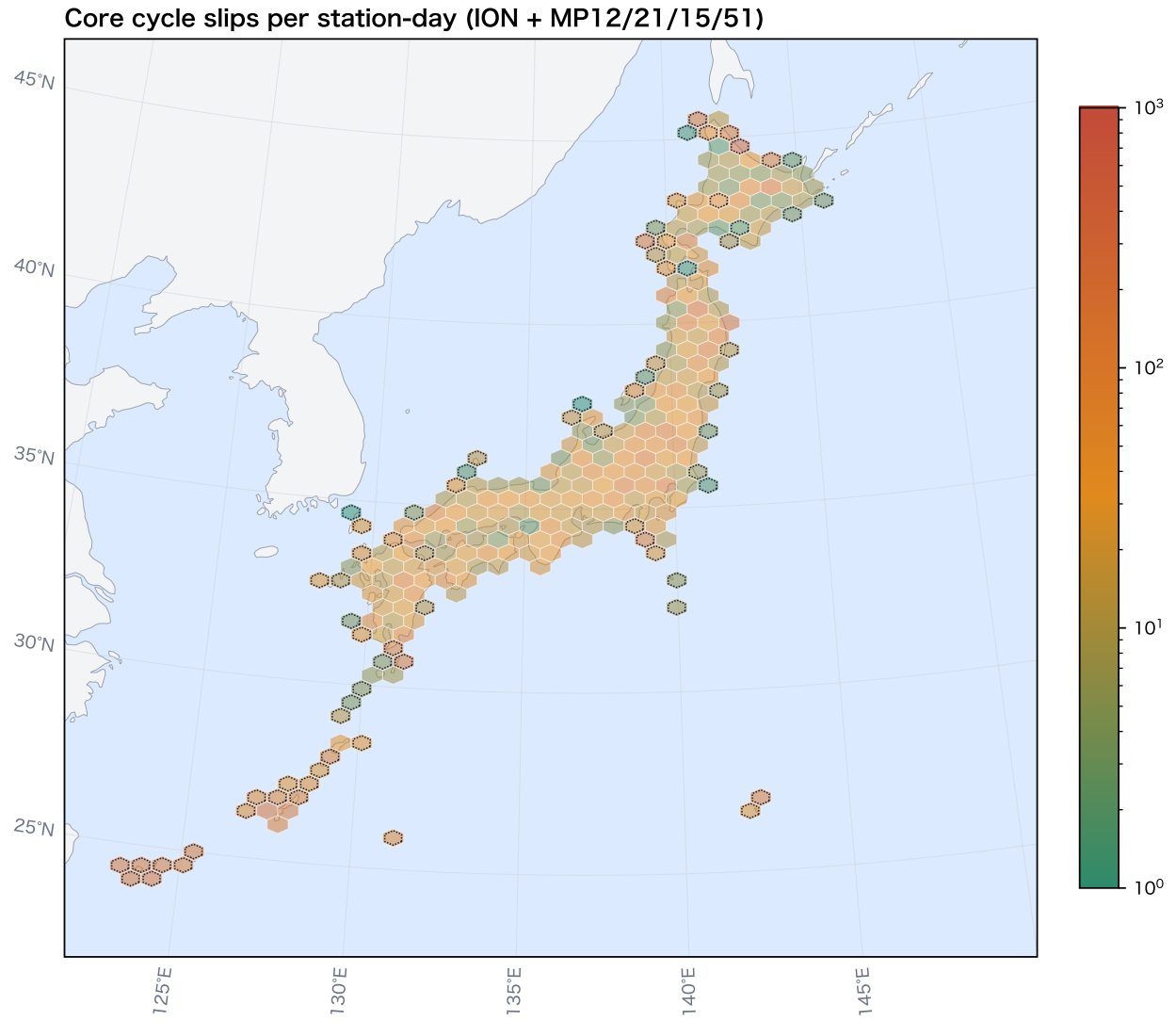


Figure 15: Core cycle slips per station-day (ION + MP12/21/15/51 slips, elmask-15, daily mean over month). Paper-aligned definition. Logarithmic colour scale.

> **Note**
>
> Per free-tier scope, only the hex-aggregated (per-cell median) values are shown — individual station identifiers and per-station values are reserved for the Pro-tier report. Color scales are fixed per signal (see the Appendix glossary) so successive months can be compared at a glance.

5.4 Receiver / Antenna Inventory

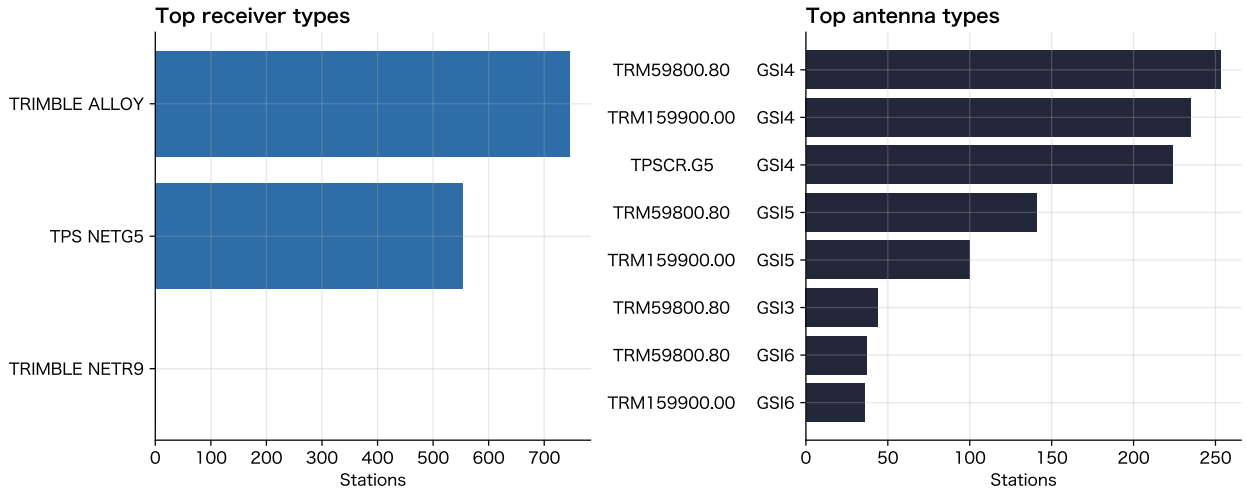


Figure 16

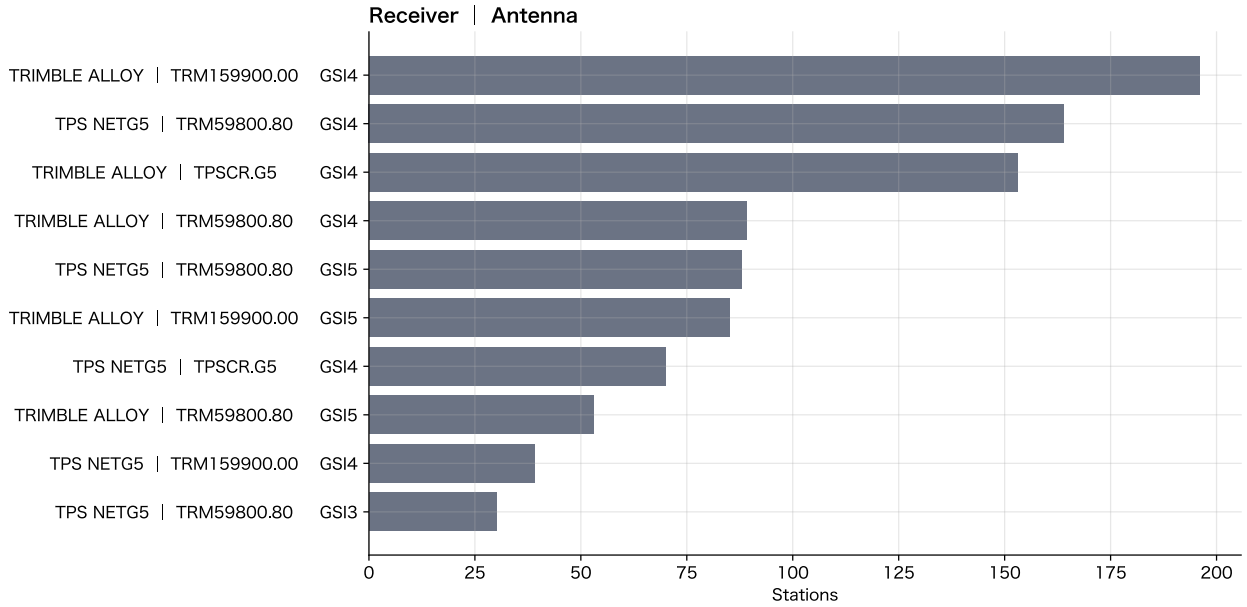


Figure 17: Top 10 receiver × antenna combinations across the network.

Top 10 receiver × antenna combinations cover 74.3 % of 1,301 reporting stations; 45 distinct combinations exist in total.

ℹ Note

Equipment changes vs. previous month are tracked via aggregated counts only (e.g. “N stations changed receiver, M stations changed antenna”); individual station identities are reserved for the Pro-tier report. Month-over-month deltas will appear once a baseline month is established.

5.5 Absolute Station Qualification

ℹ Note

Coming Soon. Absolute station qualification — i.e. classifying each GEONET station as passing or failing the four core QC criteria defined in Shiono & Kubo (2025) — will appear here once the moving-window infrastructure (a **rolling 3-month window at daily granularity**, n ≈ 91 daily values per station per qualification cycle) is in place. The qualification criterion is the **99.73rd percentile** (3σ) of the daily metrics over the rolling 3-month window for each of:

1. **Visibility** — `Complete obs / Possible obs > 10°`
2. **SNR** — mean SNR for L1, L2, L5 (`SN1`, `SN2`, `SN5`)
3. **Multipath** — RMS of `MP12`, `MP21`, `MP15`, `MP51`
4. **Cycle slips** — `cycle_slips_core` (ION + MP12/21/15/51 slips)

The rolling-3-month × daily window is a deliberate operational deviation from the published Shiono & Kubo (2025) weekly-over- rolling-year methodology, adopted for operational timeliness (alignment with the recent-3-months reporting cadence), environmental adaptation, and improved statistical robustness (n ≈ 91 vs. 53).

Per the original study, the **Galileo E5b family (`SN7`, `MP17`, `MP71`) is intentionally excluded** from the qualification set: at the time of the four-year baseline (2021–2024), L1/E5b values exhibited considerably larger site-to-site variance than the L1/L2/L5 pairs, making them unreliable as a pass/fail threshold. They remain in the report as **reference / supplementary monitoring**.

The output of this section will be a national pass-rate (e.g. “1,055 of 1,298 stations passed all four core criteria”) with **aggregate counts only** — individual station names are reserved for the Pro-tier report.

6 Appendix

6.1 GNSS System Events: NAGU / NANU / NAQU

Notices issued against GNSS constellation operations during September 2026, recorded for cross-referencing against observation anomalies and signal availability. Sourced from the official **NAGU** (Galileo, EUSPA/GSC), **NANU** (GPS, USCG-NAVCEN) and **NAQU** (QZSS, QSS) notice feeds.

Table 4: GNSS system notices within the reporting period.

Date	Satel-lite	Notice	Event type	Severity
2026-09-01 10:00 UTC	QZS	NAQU 2026232, NAQU 2026238	scheduled_ maintenance	partial
2026-09-02 05:54 UTC	GAL	NAGU 2026042, NAGU 2026043, NAGU 2026044	other	informa-tional
2026-09-02 09:46 UTC	QZS PRN206	NAQU 2026245	unscheduled_ outage	partial
2026-09-02 09:46 UTC	QZS PRN209	NAQU 2026243	unscheduled_ outage	partial
2026-09-02 09:46 UTC	QZS PRN204	NAQU 2026242	unscheduled_ outage	partial
2026-09-02 09:46 UTC	QZS PRN205	NAQU 2026244	unscheduled_ outage	partial
2026-09-02 09:46 UTC	QZS	NAQU 2026240	unscheduled_ outage	partial
2026-09-02 20:35 UTC	GPS PRN13	NANU 2026067	other	total
2026-09-02 21:54 UTC	GPS PRN25	NANU 2026068, NANU 2026069	other	total
2026-09-06 04:59 UTC	QZS PRN199	NAQU 2026235, NAQU 2026248	scheduled_ maintenance	total
2026-09-11 02:45 UTC	GPS PRN23	NANU 2026070, NANU 2026072	scheduled_ maintenance	total
2026-09-14 21:59 UTC	QZS PRN200	NAQU 2026249, NAQU 2026250	scheduled_ maintenance	total
2026-09-15 18:45 UTC	GPS PRN13	NANU 2026071, NANU 2026074	scheduled_ maintenance	total
2026-09-18 03:00 UTC	GPS PRN1	NANU 2026073, NANU 2026075	scheduled_ maintenance	total
2026-09-24 23:45 UTC	GPS PRN15	NANU 2026076, NANU 2026078	scheduled_ maintenance	total
2026-09-29 06:59 UTC	QZS PRN199	NAQU 2026251, NAQU 2026253	scheduled_ maintenance	total
2026-09-29 22:00 UTC	GPS PRN25	NANU 2026077, NANU 2026080	scheduled_ maintenance	total

17 notice(s) detected for September 2026, collected from the official NAGU (Galileo), NANU (GPS) and NAQU (QZSS) feeds.

6.2 List of Earthquakes

Earthquakes during the reporting period for which the Japan Meteorological Agency issued a press release (in practice: maximum seismic intensity 5-lower or greater), listed for interpreting GEONET observation anomalies. Aftershocks folded into a mainshock's series are shown under it. Source: JMA website (edited); origin times are JST.

September 2026: no earthquake with a JMA press release (max. intensity ≥ 5-lower).

6.3 List of Satellites

A **snapshot of the constellation operators' official status pages** at fetch time (not a period summary — the operator pages are themselves live snapshots). Sources: GPS = USCG NAVCEN, QZSS = QSS, Galileo = GSC Europa. GLONASS is excluded from this report's QC pipeline (per methodology); pntmoni does, however, evaluate the Galileo signals received at GEONET stations.

Fetched at: 2026-10-05 12:06 UTC

6.3.1 GPS

Table 5: GPS satellite constellation status.

PRN	SVN	Block	Slot	Clock	Status	Notice
G01	80	III	D2	RB	Operational	FCSTSUMM 2026075
G02	61	IIR	D1	RB	Operational	FCSTSUMM 2026031
G03	69	IIF	E1	RB	Operational	FCSTSUMM 2026054
G04	74	III	F4	RB	Operational	FCSTDV 2025073
G05	50	IIR-M	E3	RB	Operational	FCSTMX 2026082
G06	67	IIF	D4	RB	Operational	FCSTDV 2025090
G07	48	IIR-M	A4	RB	Operational	FCSTMX 2026081
G08	72	IIF	C3	RB	Operational	FCSTSUMM 2025038
G09	68	IIF	F3	RB	Operational	FCSTSUMM 2026017
G10	73	IIF	E2	RB	Operational	FCSTSUMM 2025002
G11	78	III	D5	RB	Operational	UNUSABLE 2026049
G12	58	IIR-M	B4	RB	Operational	FCSTDV 2026083
G13	83	III	A5	RB	Operational	FCSTSUMM 2026074
G14	77	III	B6	RB	Operational	FCSTSUMM 2025054

PRN	SVN	Block	Slot	Clock	Status	Notice
G15	55	IIR-M	F2	RB	Operational	FCSTSUMM 2026078
G16	56	IIR	B1	RB	Operational	FCSTSUMM 2025066
G17	53	IIR-M	C4	RB	Operational	FCSTSUMM 2026046
G18	75	III	D6	RB	Operational	FCSTSUMM 2024042
G19	59	IIR	C5	RB	Operational	FCSTSUMM 2026066
G20	82	III	F5	RB	Operational	FCSTSUMM 2026033
G21	81	III	E6	RB	Operational	FCSTSUMM 2026040
G22	44	IIR	B3	RB	Operational	FCSTSUMM 2026036
G23	76	III	E5	RB	Operational	FCSTSUMM 2026072
G24	65	IIF	A1	RB	Operational	FCSTSUMM 2026064
G25	62	IIF	B2	RB	Operational	FCSTSUMM 2026080
G26	71	IIF	B5	RB	Operational	FCSTSUMM 2026056
G27	66	IIF	C2	RB	Operational	FCSTSUMM 2026043
G28	79	III	A6	RB	Operational	UNUSABLE 2026044
G29	57	IIR-M	C1	RB	Operational	FCSTSUMM 2026063
G30	64	IIF	A3	RB	Operational	FCSTSUMM 2025087
G31	52	IIR-M	A2	RB	Operational	FCSTSUMM 2026021
G32	70	IIF	F1	RB	Operational	FCSTDV 2026047

6.3.2 QZSS (Michibiki)

Table 6: QZSS satellite constellation status.

PRN	SVN	Block	Signals	Status	Notice
J194	002	II-Q	L1C/A, L1C, L2C, L5, L1S, L5S, L6D, L6E	Operational	
J195	004	II-Q	L1C/A, L1C, L2C, L5, L1S, L5S, L6D, L6E	Operational	
J196	005	II A-Q	L1C, L2C, L5, L1C/B, L1S, L5S, L6D, L6E	Operational	
J199	003	II-G	L1C/A, L1C, L2C, L5, L1S, L5S, L1Sb, L6D, L6E, Sr/Sf	Operational	
J200	007	III-G	L1C, L5, L1C/B, L5S, L1Sb, L6D, L6E	Operational	
J201	008	III-G	L1C, L5, L1C/B, L5S, L1Sb, L6D, L6E	Outage	

6.3.3 Galileo

Table 7: Galileo satellite constellation status.

E#	GSAT	Clock	Status	Notice
E01	GSAT0210	RAFS	Unusable	GENERAL 2023048
E02	GSAT0211	PHM	Operational	
E03	GSAT0212	PHM	Operational	
E04	GSAT0213	RAFS	Operational	
E05	GSAT0214	PHM	Operational	
E06	GSAT0227	PHM	Operational	
E07	GSAT0207	PHM	Operational	
E08	GSAT0208	PHM	Operational	
E09	GSAT0209	RAFS	Operational	
E10	GSAT0224	PHM	Operational	
E11	GSAT0101	RAFS	Operational	
E12	GSAT0102	RAFS	Operational	
E13	GSAT0220	PHM	Operational	
E14	GSAT0202	RAFS	Unusable	GENERAL 2021008
E15	GSAT0221	PHM	Operational	
E16	GSAT0232	PHM	Operational	
E18	GSAT0201	PHM	Unusable	GENERAL 2021008
E19	GSAT0103	RAFS	Operational	
E21	GSAT0215	PHM	Operational	
E22	GSAT0204	RAFS	Unusable	GENERAL 2017045
E23	GSAT0226	PHM	Operational	
E25	GSAT0216	PHM	Operational	

E#	GSAT	Clock	Status	Notice
E26	GSAT0203	PHM	Operational	
E27	GSAT0217	PHM	Operational	
E28	GSAT0233	PHM	Operational	
E29	GSAT0225	PHM	Operational	
E30	GSAT0206	PHM	Operational	
E31	GSAT0218	PHM	Operational	
E32	GSAT0234	PHM	Operational	
E33	GSAT0222	PHM	Operational	
E34	GSAT0223	PHM	Operational	
E36	GSAT0219	PHM	Operational	

Reproducibility. This report is generated by the open-source `pntmoni-pipeline` toolchain from the publicly available GEONET archive. Methodology 1.2.0 · QC tool teqc 2019Feb25 · convbin RTKLIB 2.4.2 — versioned alongside the report.

6.4 Metric Glossary

Symbol-by-symbol definitions of the metrics used throughout this report, as established in Shiono & Kubo (2025, 2026). The full methodology document is https://pntmoni.com/methodology/qc/v1.2.0.

6.4.1 Core metrics (absolute-evaluation baseline)

These are the four families used in the paper's Table 1 station selection and are the **basis for the planned absolute station qualification** (see §5.6).

Metric	Symbol	Description
Data availability	`data_availability`	`epochs_w_obs / expected_epochs` — fraction of the day's 2,880 nominal 30-second epochs where the station logged at least one observation. Measures whether the station was up and recording.

Metric	Symbol	Description
Visibility (可視率)	`visibility`	`Complete obs >10° / Possible obs >10°` — fraction of expected satellite-epoch tracks above teqc's 10° elevation mask that were actually obtained. Measures track completeness when the station was operating: low values indicate antenna obstructions, RF interference, or receiver issues even on a station that logs data every epoch.
L1 C/A SNR	`SN1`	Mean signal-to-noise ratio on L1 C/A, in dB-Hz.
L2 SNR	`SN2`	Mean signal-to-noise ratio on L2 (P-code or L2C), in dB-Hz.
L5 SNR	`SN5`	Mean signal-to-noise ratio on L5, in dB-Hz.
Multipath (L1, L2 partner)	`MP12`	RMS of the L1 multipath combination using L2 as partner, in metres.
Multipath (L2, L1 partner)	`MP21`	RMS of the L2 multipath combination using L1 as partner, in metres.
Multipath (L1, L5 partner)	`MP15`	RMS of the L1 multipath combination using L5 as partner, in metres.
Multipath (L5, L1 partner)	`MP51`	RMS of the L5 multipath combination using L1 as partner, in metres.
Cycle slips (core)	`cycle_slips_core`	Sum of teqc-reported ION slips and the four core MP-combination slips (`MP12 + MP21 + MP15 + MP51`). Paper-aligned definition.

6.4.2 Reference / supplementary monitoring (Galileo E5b)

These are reported as **informational reference**. They are not part of the absolute-qualification baseline because the L1/E5b frequency pair exhibits considerably larger site-to-site variance than the L1/L2/L5 pairs and was therefore not adopted as a qualification metric in Shiono & Kubo (2025).

Metric	Symbol	Description
Galileo E5b SNR	`SN7`	Mean signal-to-noise ratio on E5b (1207.140 MHz), in dB-Hz.
Multipath (L1, E5b partner)	`MP17`	RMS of the L1 multipath combination using E5b as partner, in metres. The `2/(α−1)` coefficient in the multipath formula is large for the L1/E5b frequency pair, hence the larger numerical values.
Multipath (E5b, L1 partner)	`MP71`	RMS of the E5b multipath combination using L1 as partner, in metres.
Cycle slips (extended)	`cycle_slips_extended`	`cycle_slips_core` plus `MP17` and `MP71` slips. Useful when assessing receivers that track Galileo E5b; not used in qualification.

Note

Sources & terms of use: GEONET data is distributed by GSI under PDL 1.0 (source: GSI GEONET data service). Satellite operational notices are sourced from the official feeds (GPS = USCG NAVCEN, QZSS = QSS, Galileo = GSC Europa).