

# PNT Moni Monthly QC Report

GEONET Observation Quality — Free Tier

|                     |                                   |
|---------------------|-----------------------------------|
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Independent third-party evaluation — no manufacturer or government affiliation, no sponsors, no advertising. The methodology is immutable after publication.

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## i Note

**Methodology Version:** 1.2.0 · **QC Tool:** teqc 2019Feb25 · **convbin:** RTKLIB 2.4.2  
· **Stations:** 1,303 · **Days covered:** 31 · [<https://pntmoni.com/methodology/qc/v1.2.0>](<https://pntmoni.com/methodology/qc/v1.2.0>)

# 1 Revision History

| Version | Date       | Notes                                                                                                                                                                                                             |
|---------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.0     | 2026-09-11 | Initial publication.                                                                                                                                                                                              |
| 1.1     | 2026-09-27 | Appendix GNSS system notices (NAGU/NANU/NAQU) completed: previously missed notices added (Galileo from the full-year notice archive; follow-up GPS/QZSS notices reflected). 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 August 2026. It is the **free-tier deliverable** of the PNT Moni 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 (Phase 1+).

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>](<https://pntmoni.com/methodology/qc/v1.2.0>).

## 3 Methodology

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This section summarises the methodology; the full document is [<https://pntmoni.com/methodology/qc/v1.2.0>](<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 1,303 continuously-operating GEONET reference stations active for August 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

1,303 GEONET stations reporting in August 2026

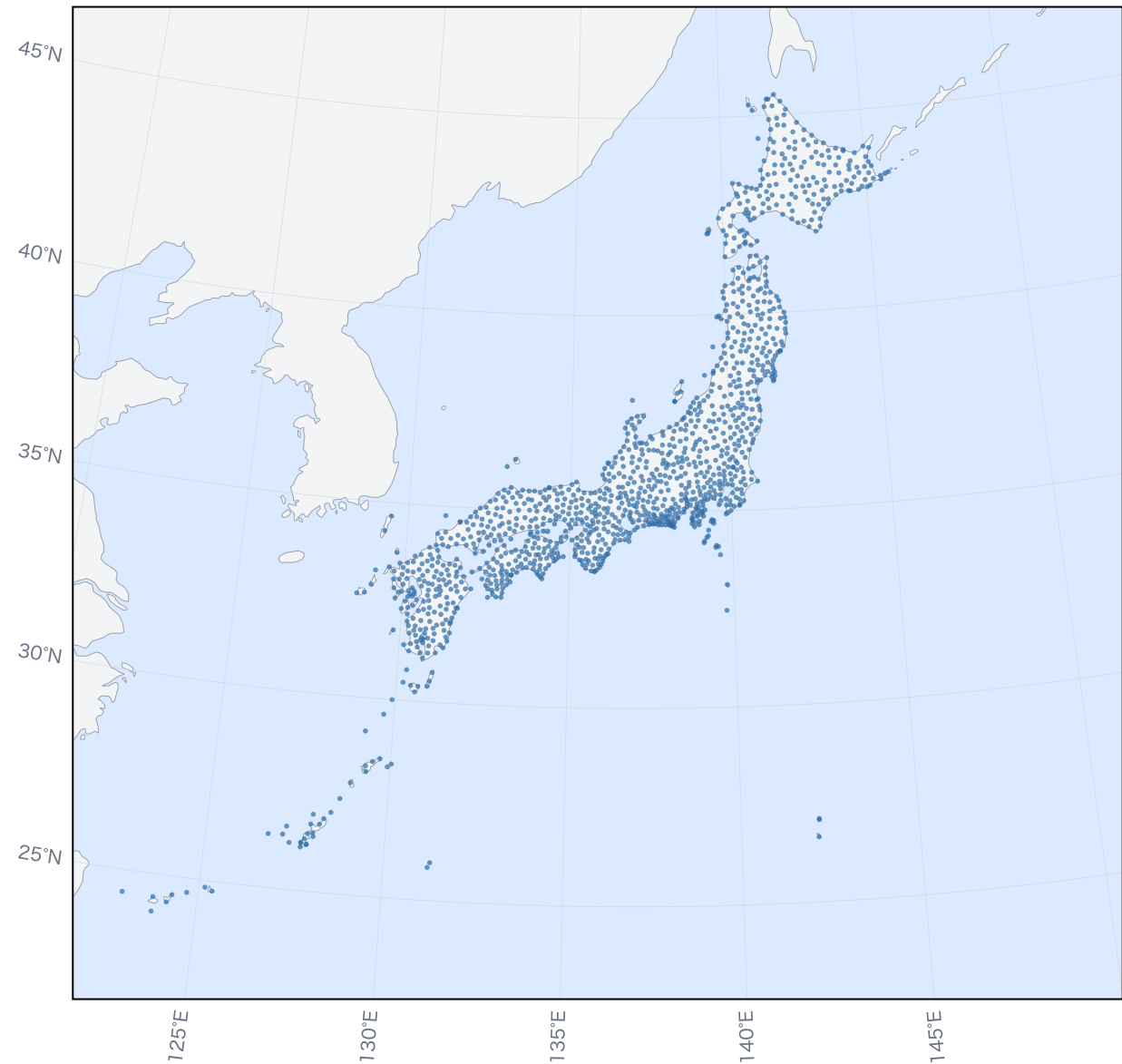


Figure 1: GEONET reference stations covered in this report.

## 4 Executive Summary

| Table 1                                                   |             |
|-----------------------------------------------------------|-------------|
| Metric                                                    | August 2026 |
| National data availability (epoch coverage, daily mean)   | 99.93 %     |
| National visibility (>10° track completeness, daily mean) | 95.41 %     |
| L1 C/A multipath — station-month median                   | 0.199 m     |
| L1 C/A SNR — station-month median                         | 43.8 dB-Hz  |
| Stations reporting                                        | 1,303       |
| Days covered                                              | 31          |



Tip

**Bottom line.** The GEONET network operated at high observation fidelity throughout August 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?

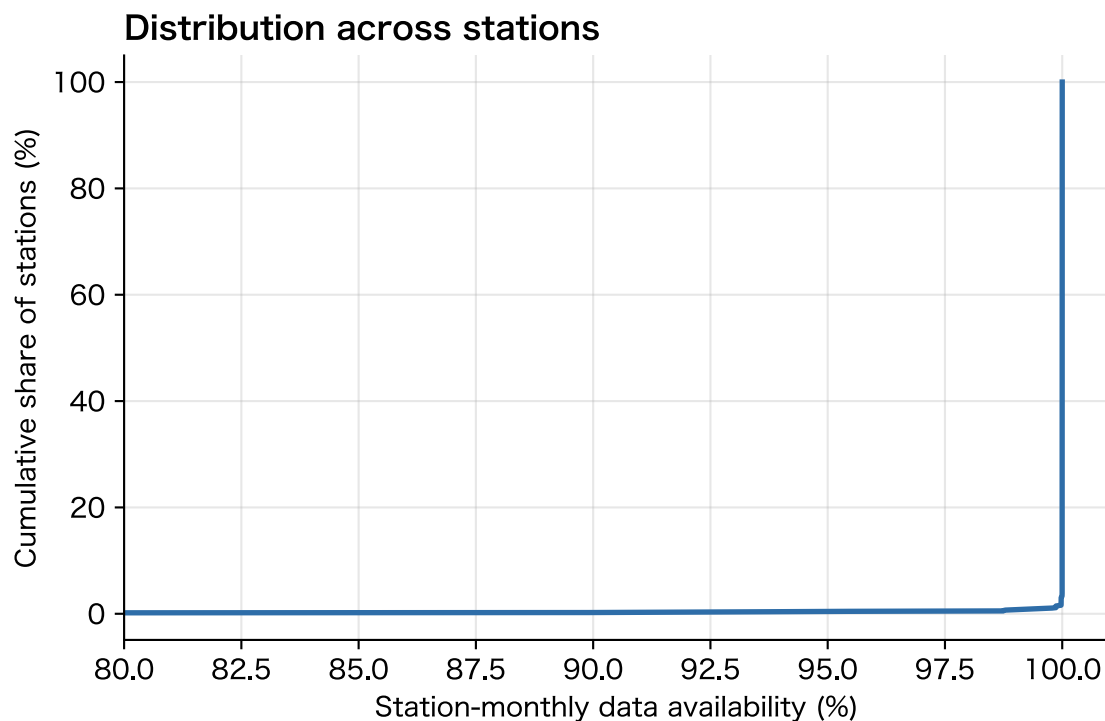


Figure 2: Data availability — fraction of the 2,880 nominal daily epochs with logged observations.

Table 2

| Statistic       | Station-monthly data availability |
|-----------------|-----------------------------------|
| 5th percentile  | 100.00 %                          |
| Median          | 100.00 %                          |
| 95th percentile | 100.00 %                          |
| Best station    | 100.00 %                          |
| Worst station   | 39.15 %                           |

#### 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?

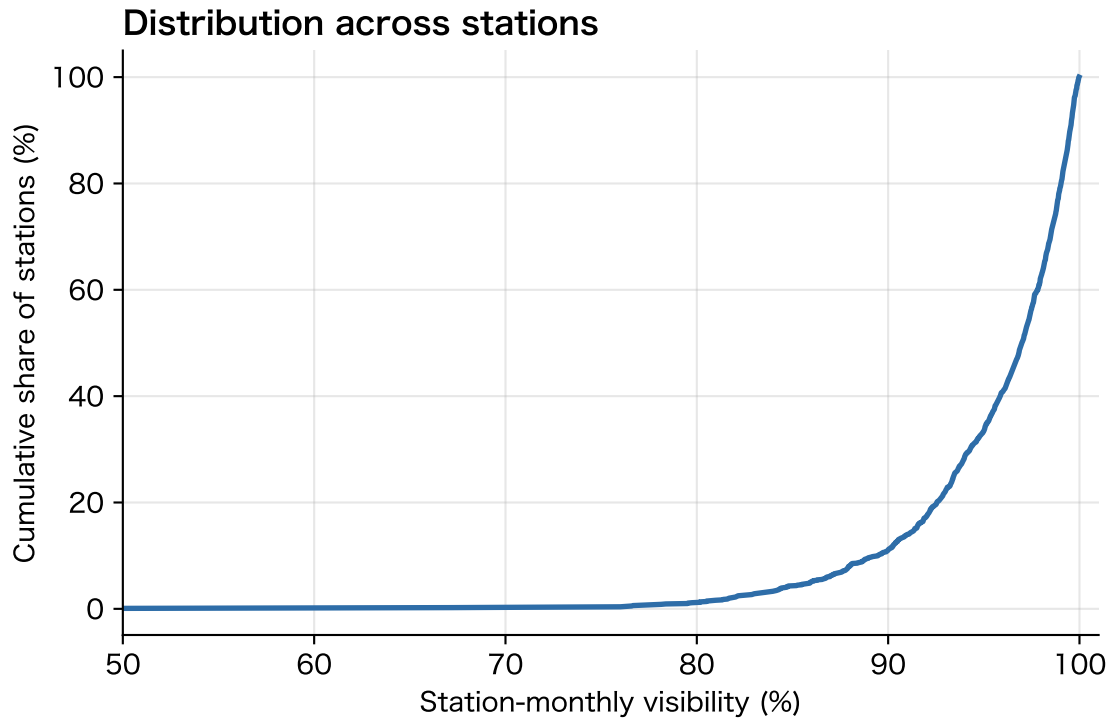


Figure 3: Visibility — Complete obs / Possible obs above 10° elevation, per teqc.

Table 3

| Statistic       | Station-monthly visibility |
|-----------------|----------------------------|
| 5th percentile  | 85.98 %                    |
| Median          | 97.00 %                    |
| 95th percentile | 99.70 %                    |
| Best station    | 99.97 %                    |
| Worst station   | 48.76 %                    |

## 5.2 Distribution of Metrics

### 5.2.1 Signal-to-noise ratio

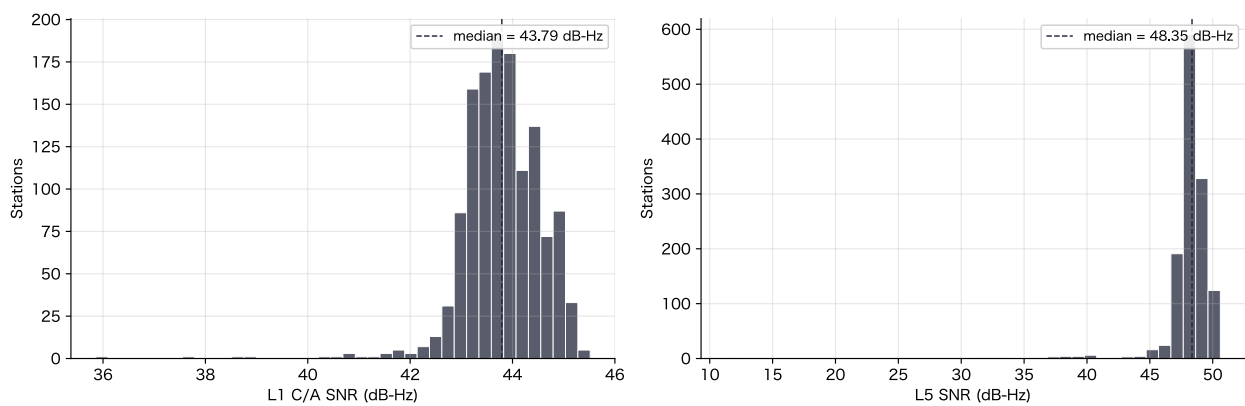


Figure 4: SNR distributions — L1 C/A and L5 (Shiono & Kubo 2025 core baseline).

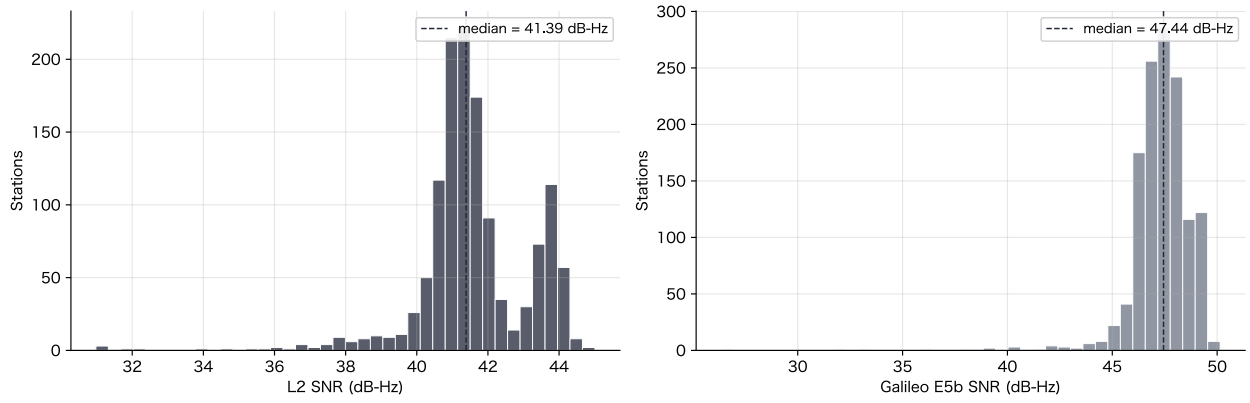


Figure 5: SNR distributions — L2 (core) and Galileo E5b (reference; not part of the absolute-qualification baseline).

## 5.2.2 Multipath

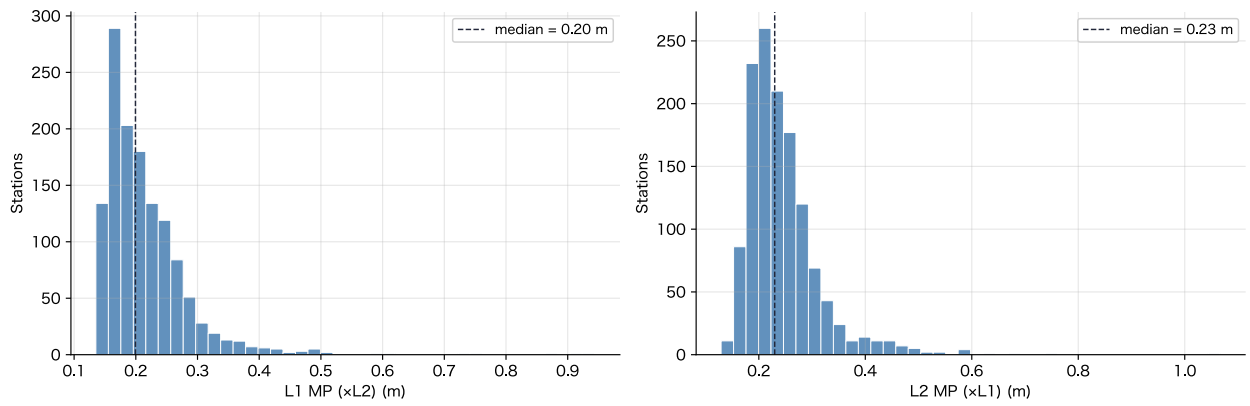


Figure 6: Multipath RMS distributions — L1/L2 pair (MP12 = L1 multipath using L2 partner; MP21 = L2 multipath using L1 partner). Shiono & Kubo 2025 core baseline.

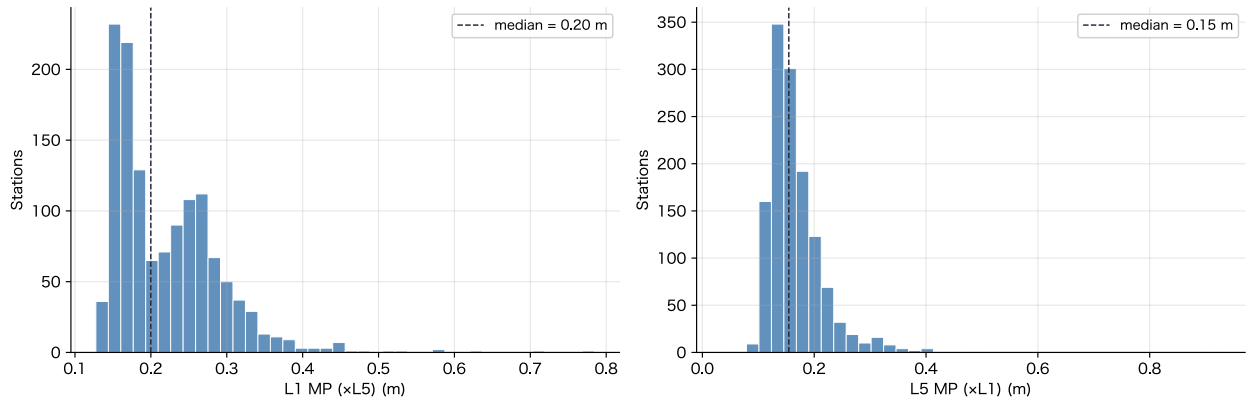


Figure 7: Multipath RMS distributions — L1/L5 pair (MP15 = L1 multipath using L5 partner; MP51 = L5 multipath using L1 partner). Core baseline.

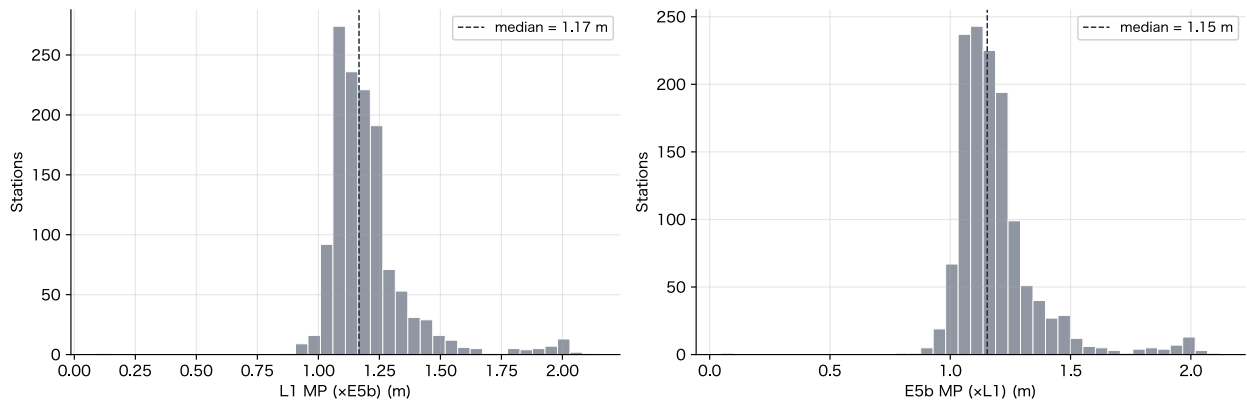


Figure 8: Reference multipath RMS distributions — L1/Galileo E5b pair (MP17/MP71). Larger numerical scale due to the L1/E5b frequency-pair coefficient. Not part of the absolute-qualification baseline (E5b exhibited too much site-to-site variance to function as a qualification metric in Shiono & Kubo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

### 5.2.3 Cycle slips

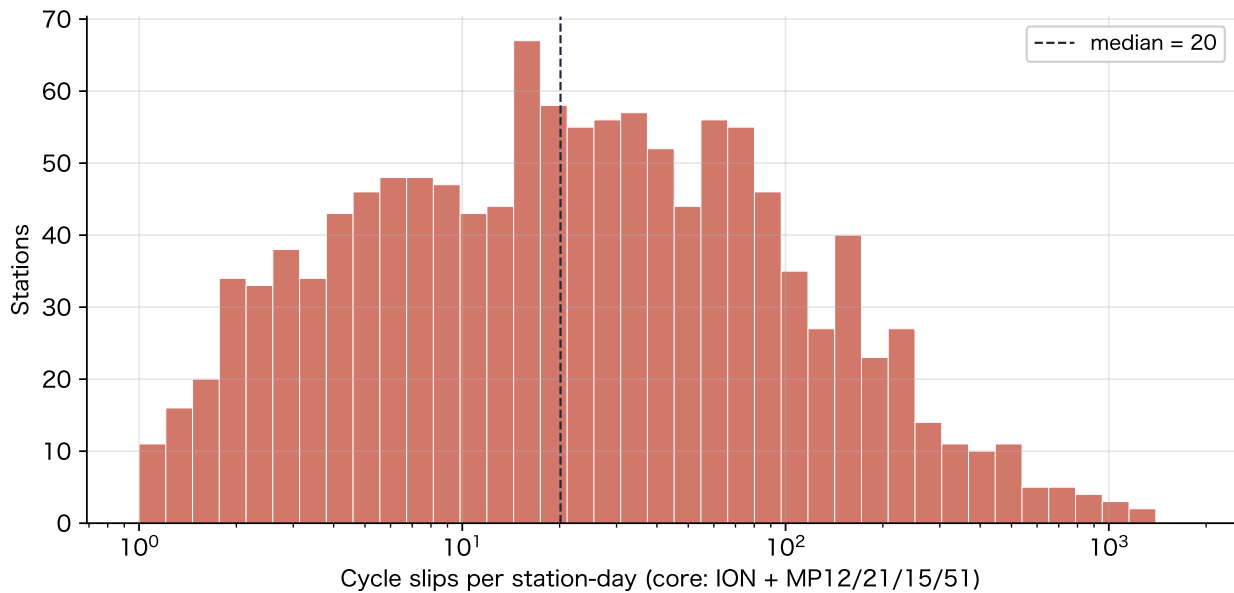


Figure 9: Station-monthly cycle slips (ION + core MP-combination slips, summed across the elmask-15 elevation bins). Paper-aligned definition (Shiono & Kubo 2025 Table 1). Logarithmic binning.

## 5.3 Spatial Distribution

The maps below aggregate the 1,303 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

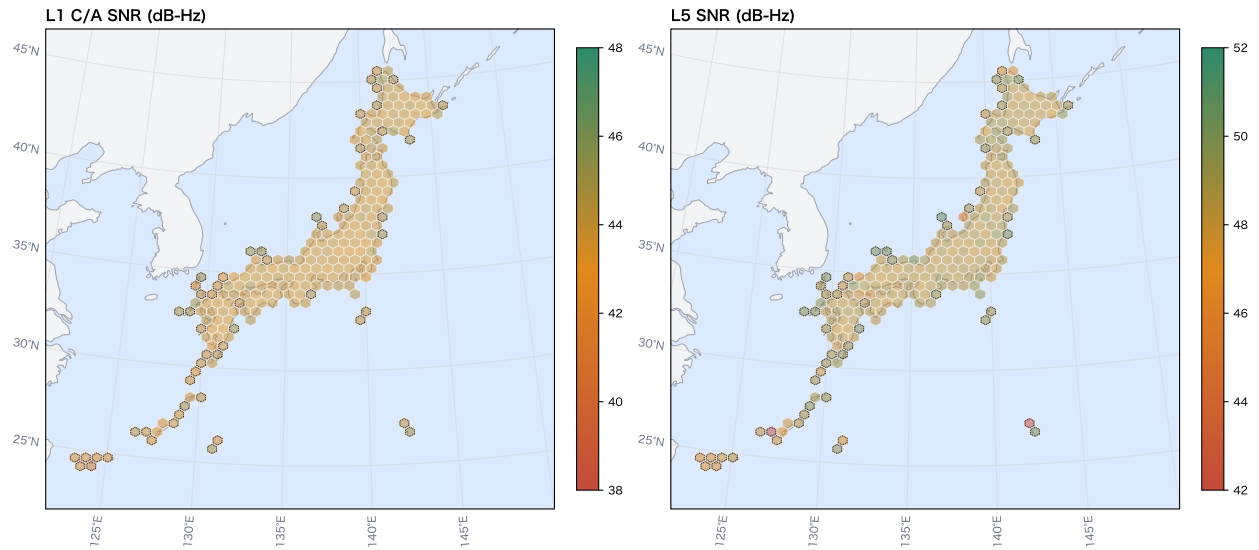


Figure 10: Station-monthly SNR — L1 C/A and L5 (core baseline). Signal-specific colour scales.

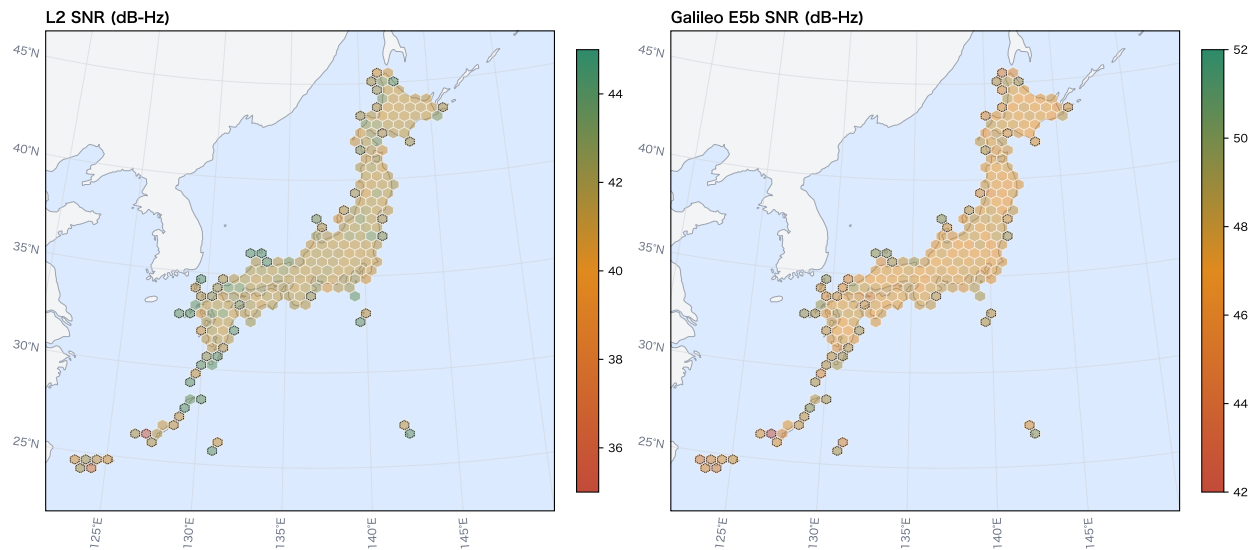


Figure 11: Station-monthly SNR — L2 (core) and Galileo E5b (reference; not part of the absolute-qualification baseline). Signal-specific colour scales.

### 5.3.2 Multipath

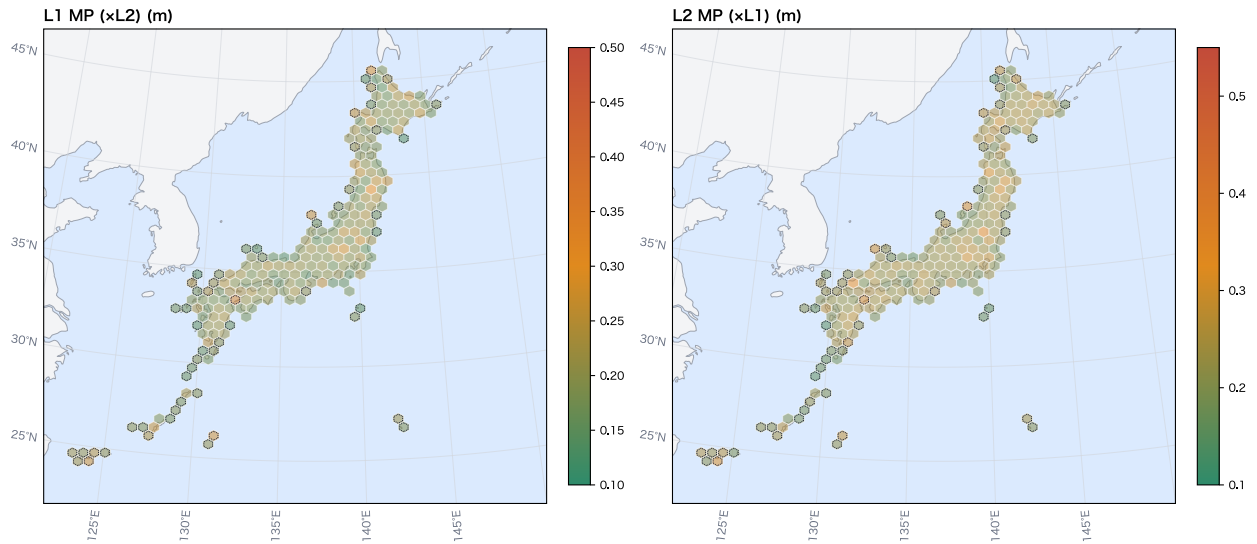


Figure 12: Station-monthly multipath RMS — L1/L2 standard pair (MP12 = L1 multipath using L2 partner; MP21 = L2 multipath using L1 partner).

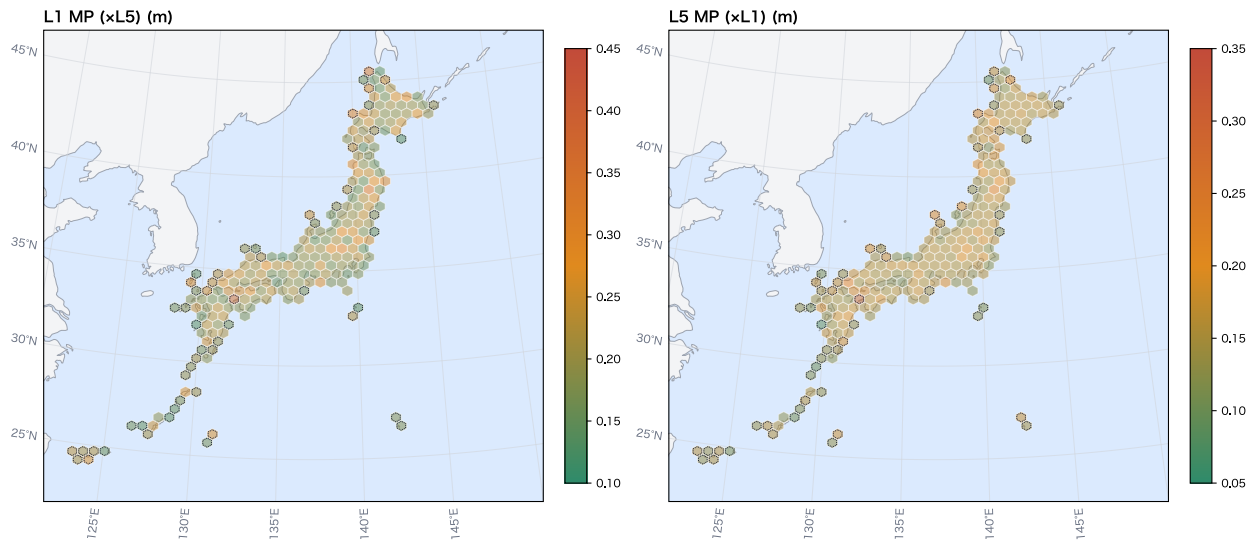


Figure 13: Station-monthly multipath RMS — L1/L5 pair (MP15 = L1 multipath using L5 partner; MP51 = L5 multipath using L1 partner). MP51 typically lower than MP12 — modern L5 signals see less multipath at GEONET sites.

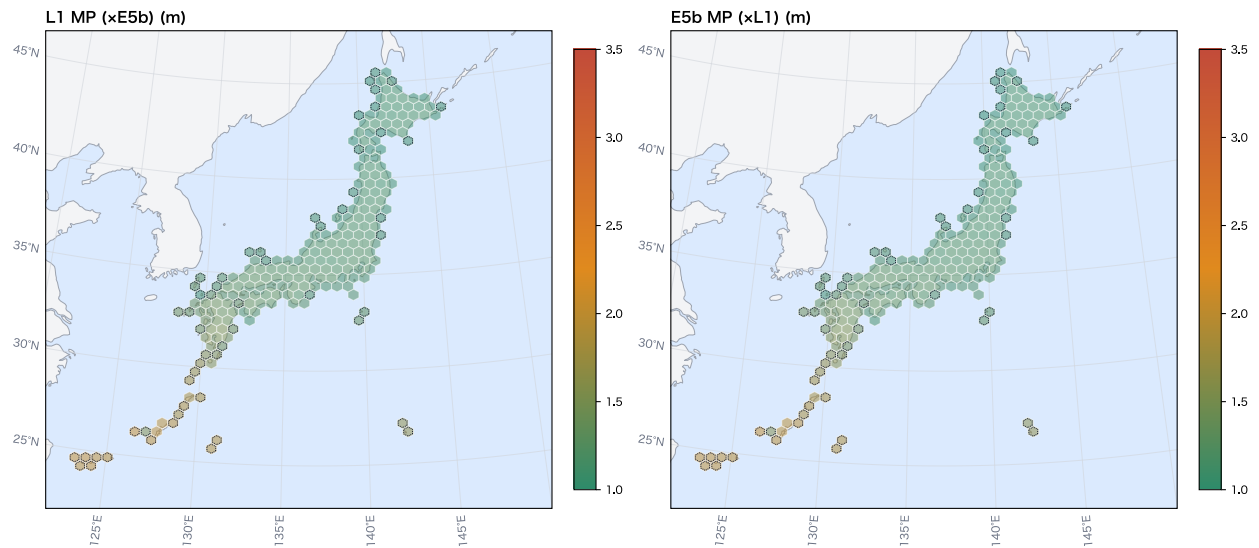


Figure 14: Reference multipath — L1/Galileo E5b pair (MP17/MP71). Larger numerical scale due to the L1/E5b frequency-pair coefficient. Shown for monitoring; not part of the absolute-qualification baseline.

### 5.3.3 Cycle slips

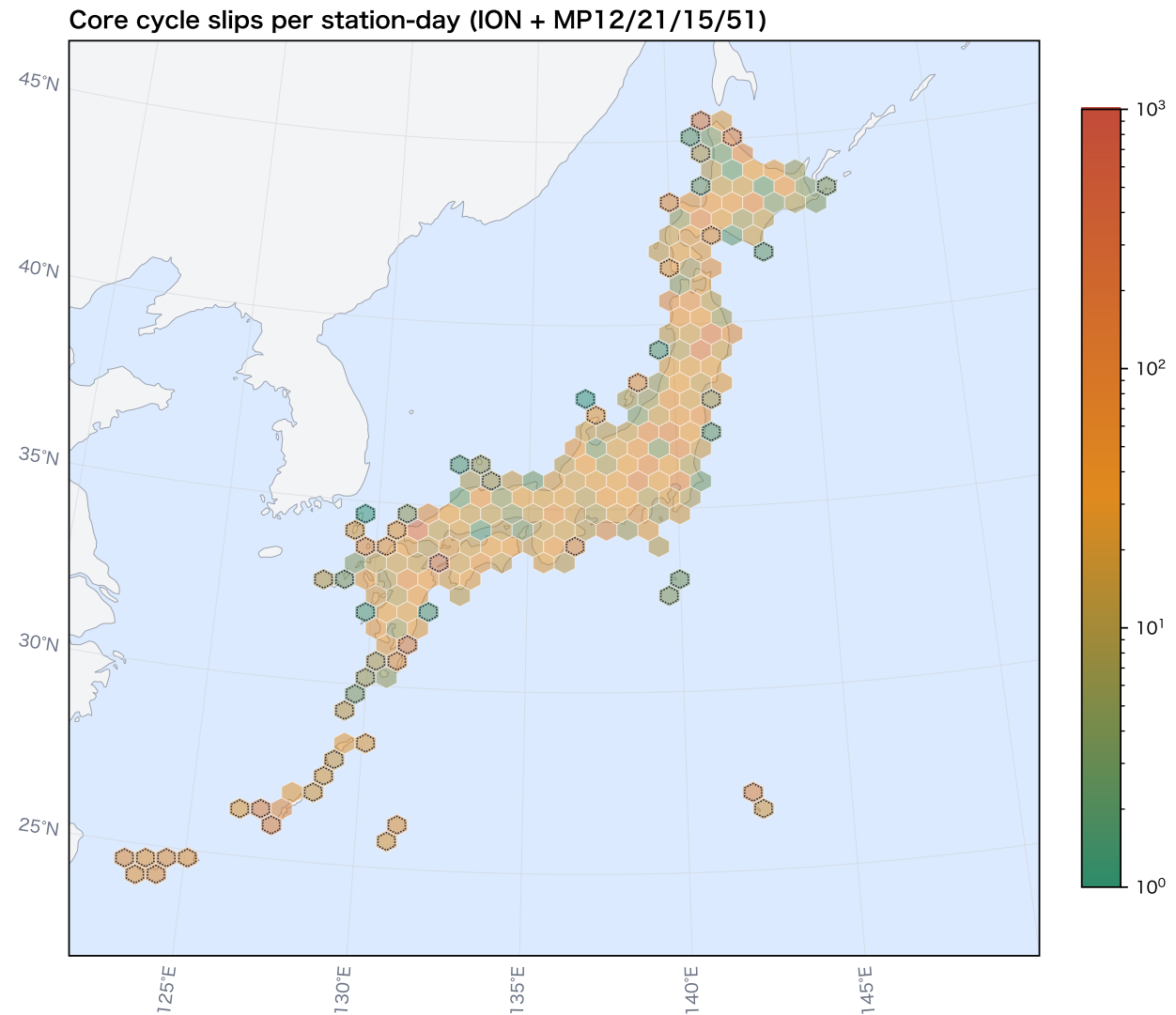


Figure 15: Core cycle slips per station-day (ION + MP12/21/15/51 slips, elmask-15, daily mean over month). Paper-aligned definition. Logarithmic colour scale.

### i 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

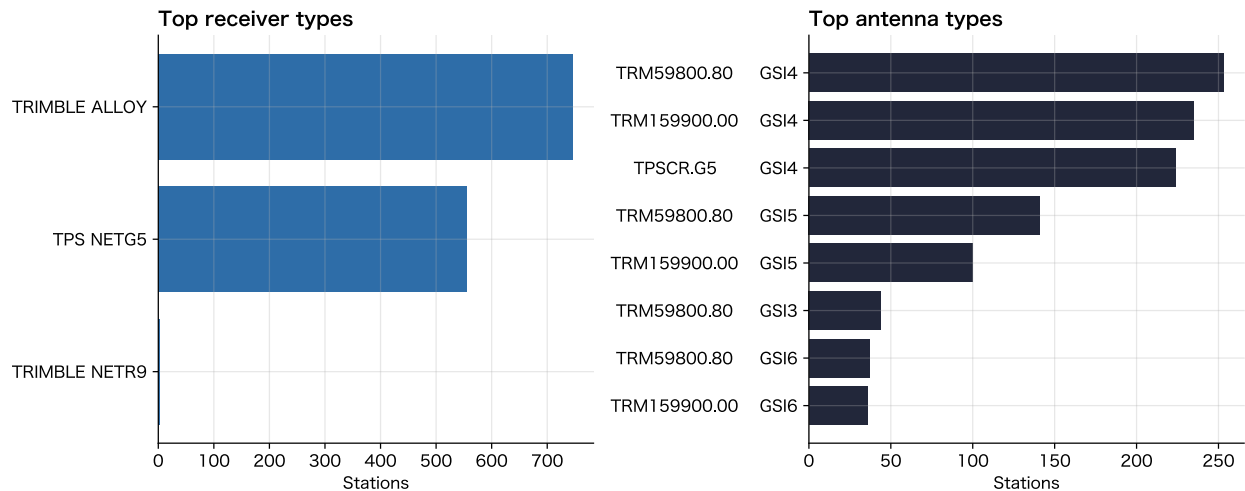


Figure 16

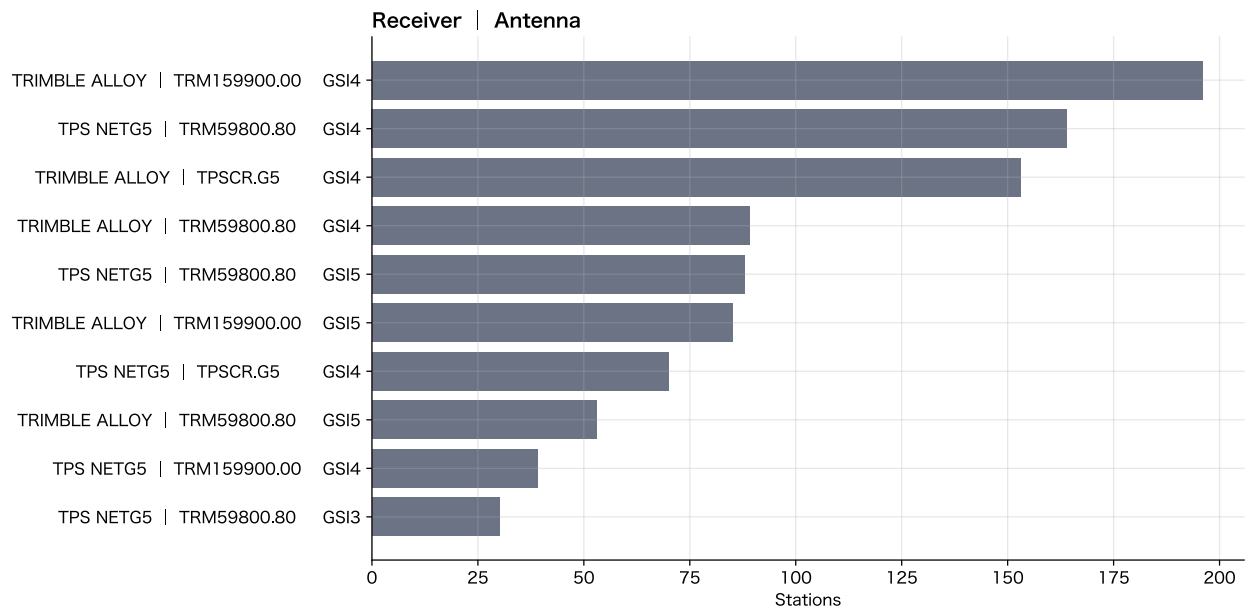


Figure 17: Top 10 receiver x antenna combinations across the network.

Top 10 receiver x antenna combinations cover 74.2 % of 1,303 reporting stations; 46 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**,  $n \approx 91$  daily values per station per qualification cycle) is in place. The qualification criterion is the **99.73rd percentile** ( $3\sigma$ ) of the daily metrics over the rolling 3-month window for each of:

1. **Visibility** —  $\text{Complete obs} / \text{Possible obs} > 10^\circ$
2. **SNR** — mean SNR for L1, L2, L5 (SN1, SN2, SN5)
3. **Multipath** — RMS of MP12, MP21, MP15, MP51
4. **Cycle slips** —  $\text{cycle\_slips\_core}$  (ION + MP12/21/15/51 slips)

The rolling-3-month  $\times$  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 ( $n \approx 91$  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 August 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                    | Satellite     | Notice                        | Event type                 | Severity |
|-------------------------|---------------|-------------------------------|----------------------------|----------|
| 2026-08-04<br>01:30 UTC | QZS           | NAQU 2026221,<br>NAQU 2026224 | scheduled_main-<br>tenance | partial  |
| 2026-08-04<br>23:59 UTC | QZS<br>PRN200 | NAQU 2026214,<br>NAQU 2026226 | scheduled_main-<br>tenance | total    |
| 2026-08-05<br>10:00 UTC | QZS           | NAQU 2026212,<br>NAQU 2026218 | scheduled_main-<br>tenance | partial  |
| 2026-08-07<br>00:30 UTC | GPS<br>PRN5   | NANU 2026059, NANU<br>2026060 | scheduled_main-<br>tenance | total    |
| 2026-08-10<br>23:06 UTC | QZS<br>PRN201 | NAQU 2026227                  | other                      | total    |
| 2026-08-11<br>14:00 UTC | GPS<br>PRN29  | NANU 2026061, NANU<br>2026063 | scheduled_main-<br>tenance | total    |
| 2026-08-13<br>22:45 UTC | GPS<br>PRN24  | NANU 2026062, NANU<br>2026064 | scheduled_main-<br>tenance | total    |
| 2026-08-15<br>09:59 UTC | QZS<br>PRN199 | NAQU 2026223,<br>NAQU 2026228 | scheduled_main-<br>tenance | total    |
| 2026-08-20<br>21:15 UTC | GPS<br>PRN19  | NANU 2026065, NANU<br>2026066 | scheduled_main-<br>tenance | total    |
| 2026-08-25<br>04:59 UTC | QZS<br>PRN200 | NAQU 2026229,<br>NAQU 2026234 | scheduled_main-<br>tenance | total    |
| 2026-08-25<br>10:00 UTC | QZS           | NAQU 2026230,<br>NAQU 2026236 | scheduled_main-<br>tenance | partial  |
| 2026-08-27<br>10:00 UTC | QZS           | NAQU 2026231,<br>NAQU 2026237 | scheduled_main-<br>tenance | partial  |

**12** notice(s) detected for August 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.

| Origin<br>(JST) | Epicentral<br>region | M   | Depth<br>(km) | Max.<br>int. | JMA name | Press release       |
|-----------------|----------------------|-----|---------------|--------------|----------|---------------------|
| 08-23<br>02:00  | 茨城県南部                | 5.9 | 68            | 5 弱          |          | <a href="#">JMA</a> |

## 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); PNT Moni does, however, evaluate the Galileo signals received at GEONET stations.

**Fetches at:** 2026-08-05 03:14 UTC

This snapshot was taken 26 days before the end of the reporting period; no snapshot closer to the period exists. Satellite status may have differed during the period — see the NAGU / NANU / NAQU notices above.

### 6.3.1 GPS

Table 5: GPS satellite constellation status.

| PRN | SVN | Block | Slot | Clock | Status         | Notice        |
|-----|-----|-------|------|-------|----------------|---------------|
| G01 | 80  | III   | D2   | RB    | Unusable       | UNUS-<br>ABLE |
| G02 | 61  | IIR   | D1   | RB    | Operational    | FCST-<br>SUMM |
| G03 | 69  | IIF   | E1   | RB    | Operational    | FCST-<br>SUMM |
| G04 | 74  | III   | F4   | RB    | Operational    | FCSTDV        |
| G05 | 50  | IIR-M | E3   | RB    | Operational    | FCSTDV        |
| G06 | 67  | IIF   | D4   | RB    | Operational    | FCSTDV        |
| G07 | 48  | IIR-M | A4   | RB    | Operational    | FCST-<br>SUMM |
| G08 | 72  | IIF   | C3   | RB    | Operational    | FCST-<br>SUMM |
| G09 | 68  | IIF   | F3   | RB    | Operational    | FCST-<br>SUMM |
| G10 | 73  | IIF   | E2   | RB    | Operational    | FCST-<br>SUMM |
| G11 | 78  | III   | D5   | RB    | Unusable       | UNUS-<br>ABLE |
| G12 | 58  | IIR-M | B4   | RB    | Operational    | FCST-<br>SUMM |
| G13 | 43  | IIR   | A5   | RB    | Decommissioned | DECOM         |
| G14 | 77  | III   | B6   | RB    | Operational    | FCST-<br>SUMM |
| G15 | 55  | IIR-M | F2   | RB    | Operational    | FCST-<br>SUMM |
| G16 | 56  | IIR   | B1   | RB    | Operational    | FCST-<br>SUMM |
| G17 | 53  | IIR-M | C4   | RB    | Operational    | FCST-<br>SUMM |

| PRN | SVN | Block | Slot | Clock | Status      | Notice    |
|-----|-----|-------|------|-------|-------------|-----------|
| G18 | 75  | III   | D6   | RB    | Operational | FCST-SUMM |
| G19 | 59  | IIR   | C5   | RB    | Operational | FCST-SUMM |
| G20 | 82  | III   | F5   | RB    | Operational | FCST-SUMM |
| G21 | 81  | III   | E6   | RB    | Operational | FCST-SUMM |
| G22 | 44  | IIR   | B3   | RB    | Operational | FCST-SUMM |
| G23 | 76  | III   | E5   | RB    | Operational | FCST-SUMM |
| G24 | 65  | IIF   | A1   | RB    | Unusable    | UNUS-ABLE |
| G25 | 62  | IIF   | B2   | RB    | Operational | FCST-SUMM |
| G26 | 71  | IIF   | B5   | RB    | Operational | FCST-SUMM |
| G27 | 66  | IIF   | C2   | RB    | Operational | FCST-SUMM |
| G28 | 79  | III   | A6   | RB    | Unusable    | UNUS-ABLE |
| G29 | 57  | IIR-M | C1   | RB    | Operational | FCST-SUMM |
| G30 | 64  | IIF   | A3   | RB    | Operational | FCST-SUMM |
| G31 | 52  | IIR-M | A2   | RB    | Operational | FCST-SUMM |
| G32 | 70  | IIF   | F1   | RB    | Operational | FCSTDV    |

### 6.3.2 QZSS (Michibiki)

Table 6: QZSS satellite constellation status.

| PRNSVN  | Block  | Signals                                 | Status      | Notice |
|---------|--------|-----------------------------------------|-------------|--------|
| J194002 | II-Q   | L1C/A, L1C, L2C, L5, L1S, L5S, L6D, L6E | Operational |        |
| J195004 | II-Q   | L1C/A, L1C, L2C, L5, L1S, L5S, L6D, L6E | Operational |        |
| J196005 | II A-Q | L1C, L2C, L5, L1C/B, L1S, L5S, L6D, L6E | Operational |        |

| PRNSVN  | Block | Signals                                              | Status      | Notice                      |
|---------|-------|------------------------------------------------------|-------------|-----------------------------|
| J199003 | II-G  | L1C/A, L1C, L2C, L5, L1S, L5S, L1Sb, L6D, L6E, Sr/Sf | Operational |                             |
| J200007 | III-G | L1C, L5, L1C/B, L5S, L1Sb, L6D, L6E                  | Outage      | NAQU<br>2026214,<br>2026214 |

### 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 |                 |
| E26 | GSAT0203 | PHM   | Operational |                 |
| E27 | GSAT0217 | PHM   | Operational |                 |
| E28 | GSAT0233 | PHM   | Operational |                 |
| E29 | GSAT0225 | PHM   | Operational |                 |
| E30 | GSAT0206 | PHM   | Operational |                 |

| E#  | GSAT     | Clock | Status      | Notice           |
|-----|----------|-------|-------------|------------------|
| E31 | GSAT0218 | PHM   | Operational |                  |
| E32 | GSAT0234 | PHM   | Operational | USABINIT 2026041 |
| 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>](<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 | <code>data_availability</code> | <code>epochs_w_obs / expected_epochs</code> — 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.                                                                                                                                                                  |
| Visibility (可視率)  | <code>visibility</code>        | <code>Complete obs &gt;10° / Possible obs &gt;10°</code> — fraction of expected satellite-epoch tracks above <code>teqc</code> ’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        | <code>SN1</code>               | Mean signal-to-noise ratio on L1 C/A, in dB-Hz.                                                                                                                                                                                                                                                                                                                           |

| Metric                     | Symbol           | Description                                                                                                                  |
|----------------------------|------------------|------------------------------------------------------------------------------------------------------------------------------|
| 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 $2/(\alpha-1)$ coefficient in the multipath formula is large for the L1/E5b frequency pair, hence the larger numerical values. |

| Metric                      | Symbol               | Description                                                                                                                   |
|-----------------------------|----------------------|-------------------------------------------------------------------------------------------------------------------------------|
| 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. |

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#### 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).