

Airborne Operations in the Age of GNSS Jamming

The Lithuanian Experience

GNSS interference, short weather windows and changing access to survey areas

Airborne survey work in Lithuania

- Power-line and forest inspection, terrain data and national mapping.
- Aeronautical obstacle management and local orthophoto mosaics.
- Work spans large survey blocks and linear corridors, with different seasonal priorities.

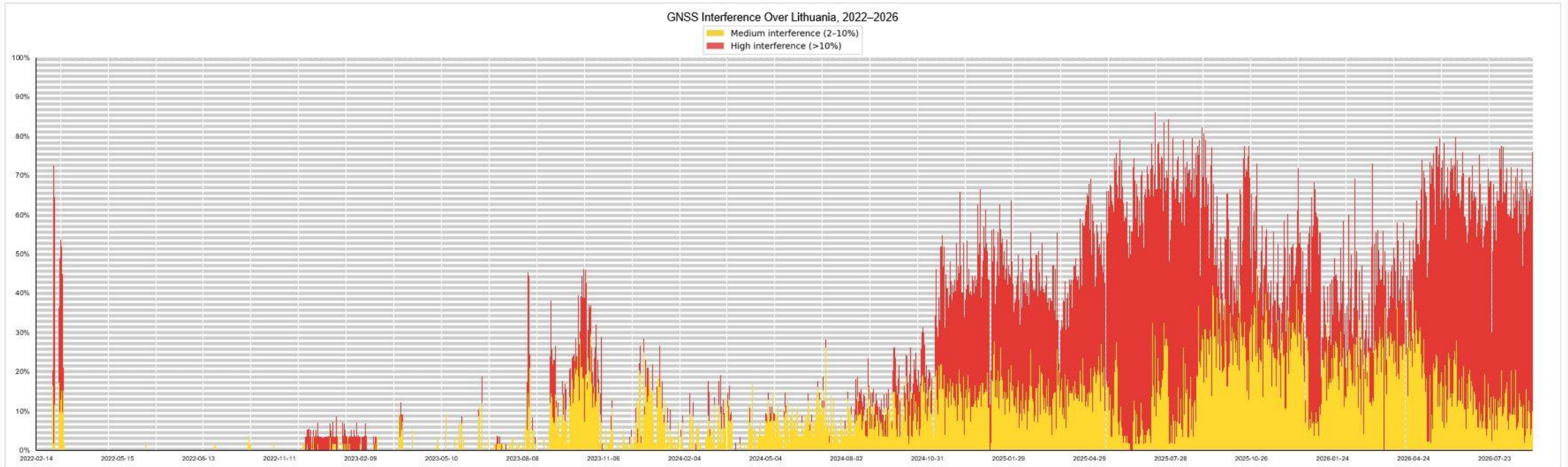
RIEGL VQ580II / VUX-240-24 / VUX-1LR
Applanix AP+50
Phase One IXU-1000RS/ SONY ILX-LR1

Equipment and applications from the Applied Aviation Association outline.

GNSS interference changes the acquisition plan

- Line following becomes less dependable when navigation data disappears or shifts.
- A completed flight can still leave survey segments unsuitable for processing.
- Receiver recovery does not immediately establish that acquisition quality has recovered.

GNSS interference has become a persistent constraint



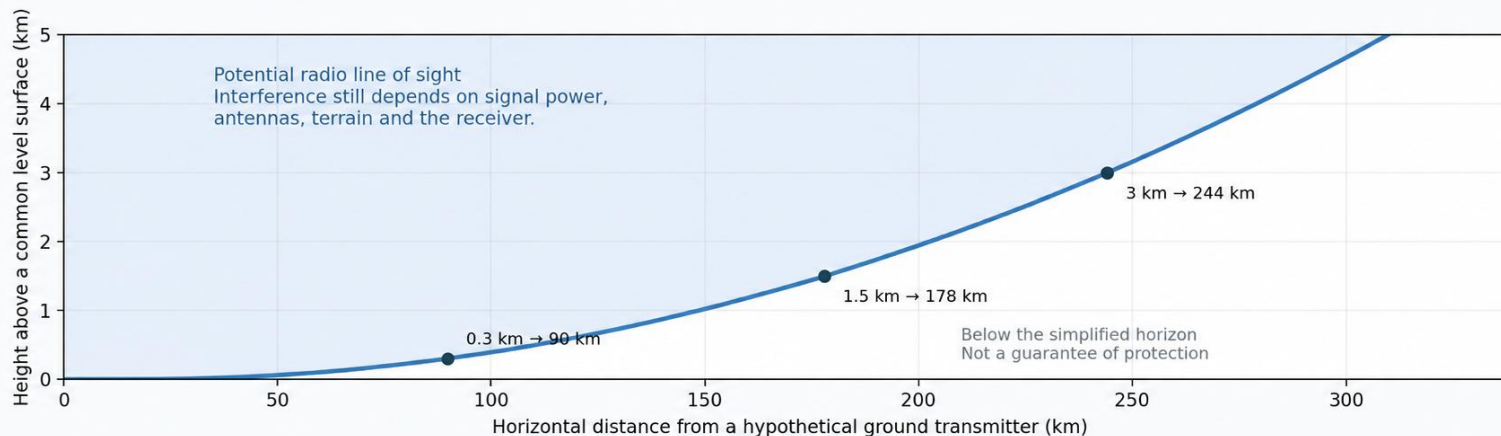
The supplied record shows sustained high-interference periods from late 2024.

Mission planning increasingly needs an alternative block or a return window.

Source: GNSS interference record over Lithuania, 2022–2026.

Higher altitude extends potential GNSS interference exposure

GNSS interference: altitude and scale in Lithuania



Illustrative radio-horizon model: $d \approx 4.12(\sqrt{h_1} + \sqrt{h_2})$, heights in metres; transmitter height = 20 m.
Standard refraction, smooth Earth, no terrain screening. This is geometry, not measured GNSS outage coverage.
Method: EUROCONTROL GNSS Interference Testing Guidelines, edition 2.0 (2023), §2.1.1.

Radio line of sight

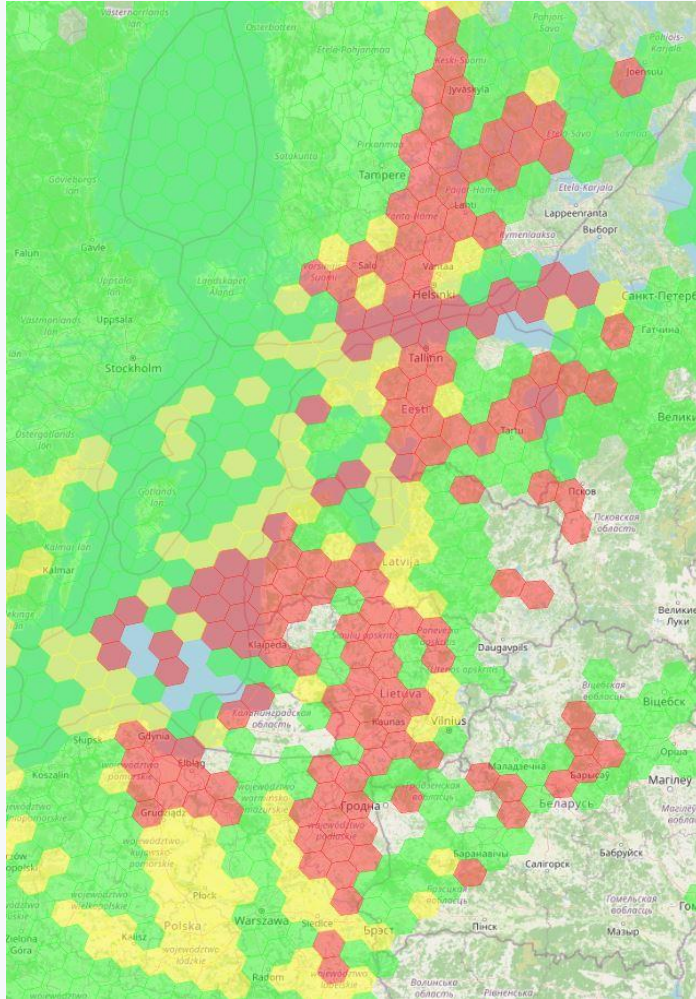
$$d \approx 4.12 (\sqrt{h_1} + \sqrt{h_2})$$

d in km; h_1 and h_2 in m.
Aircraft and transmitter heights above a common level surface.

Higher flight levels can bring more distant ground transmitters into radio view.

Actual disruption also depends on transmitter power, antennas, terrain and receiver resilience.

GNSS interference is a regional planning issue



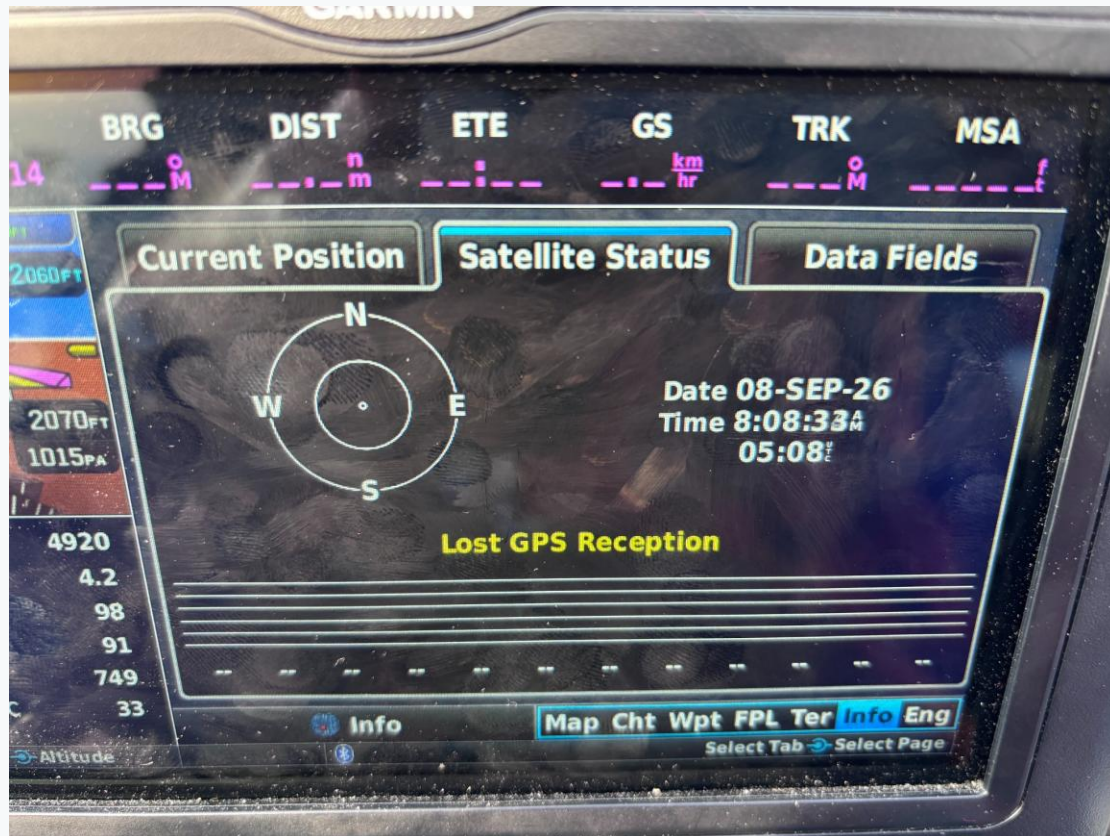
A pattern extending across borders

The supplied snapshot shows affected areas across the Baltic region and neighbouring countries.

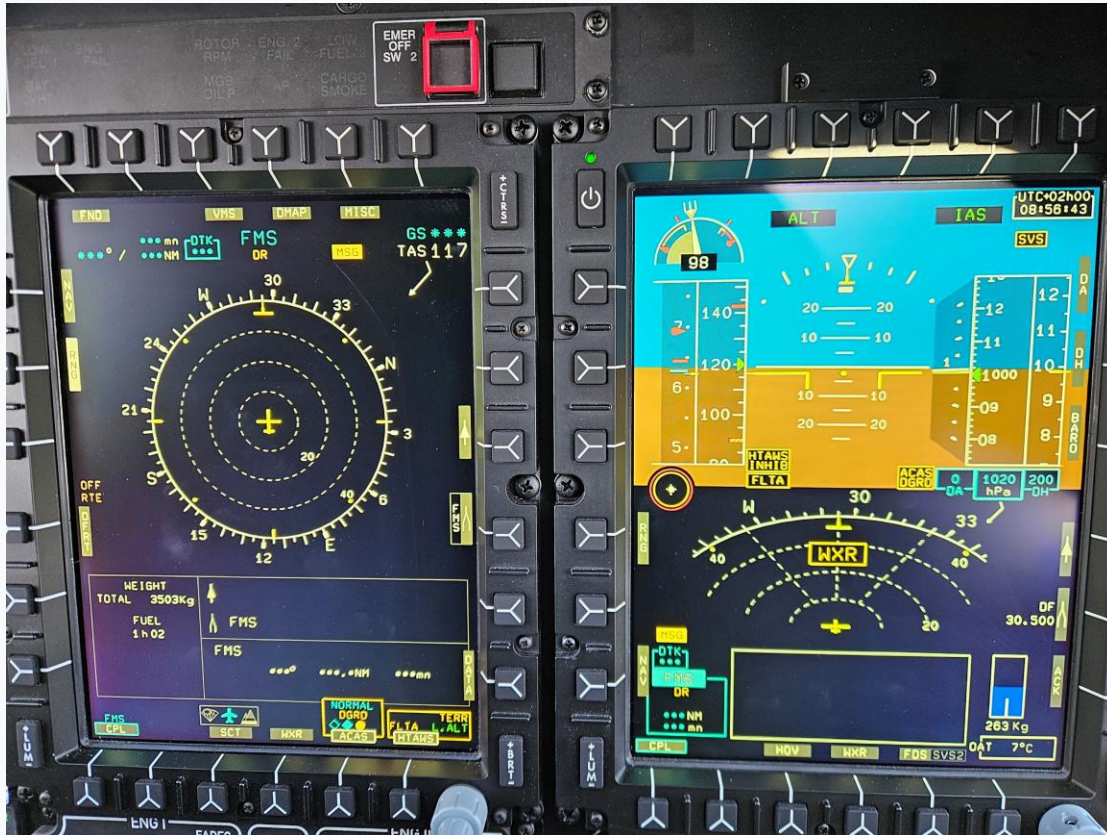
Aircraft-reported navigation quality provides regional context for route and survey planning.

The map does not resolve flight altitude. Local exposure still needs to be assessed for the planned mission.

Cockpit examples from the supplied record



Cockpit examples from the supplied record



Sources: Applied Aviation Association - SBGS LTU

Cockpit examples from the supplied record



Navigation data unavailable

GPS warning and blank navigation fields interrupt normal line guidance.

Sources: Applied Aviation Association

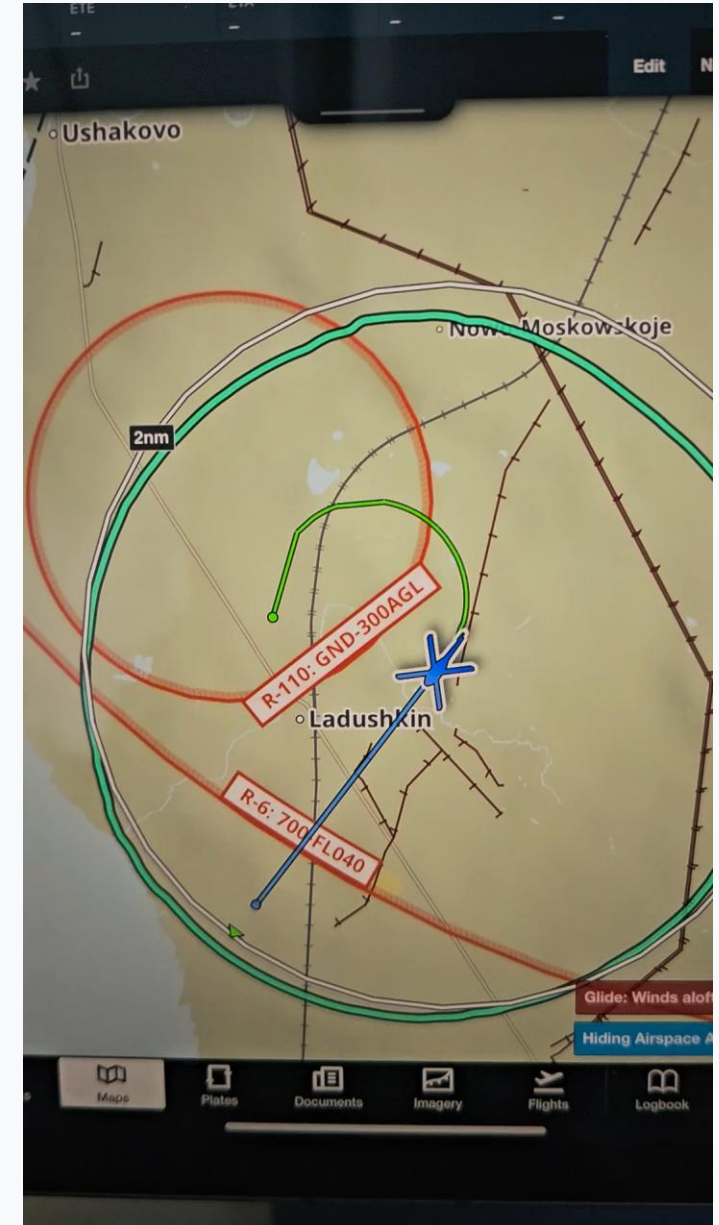


Suspect displayed position

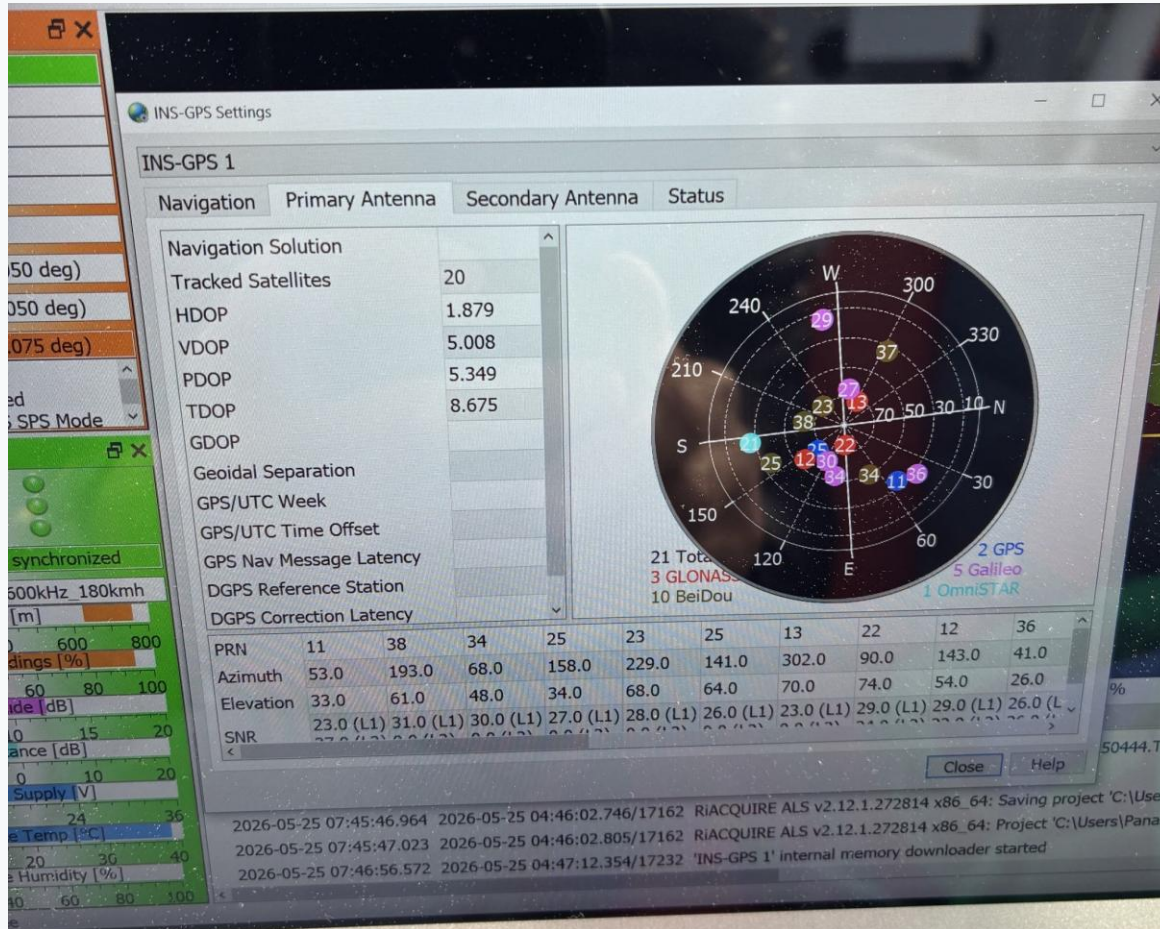
A visible position can still be unreliable for continued survey guidance.

Spoofing example in the supplied recording

- A moving map may continue to display a position during a suspected spoofing event.
- The operational difficulty is recognising that the displayed motion is no longer dependable.
- A time-marked event record helps connect the cockpit experience with the survey trajectory.



Survey-system status and acquisition decisions



Visible readouts

Tracked satellites: 20

HDOP: 1.879

VDOP: 5.008

PDOP: 5.349

Quality assessment

Satellite count alone does not confirm survey accuracy.

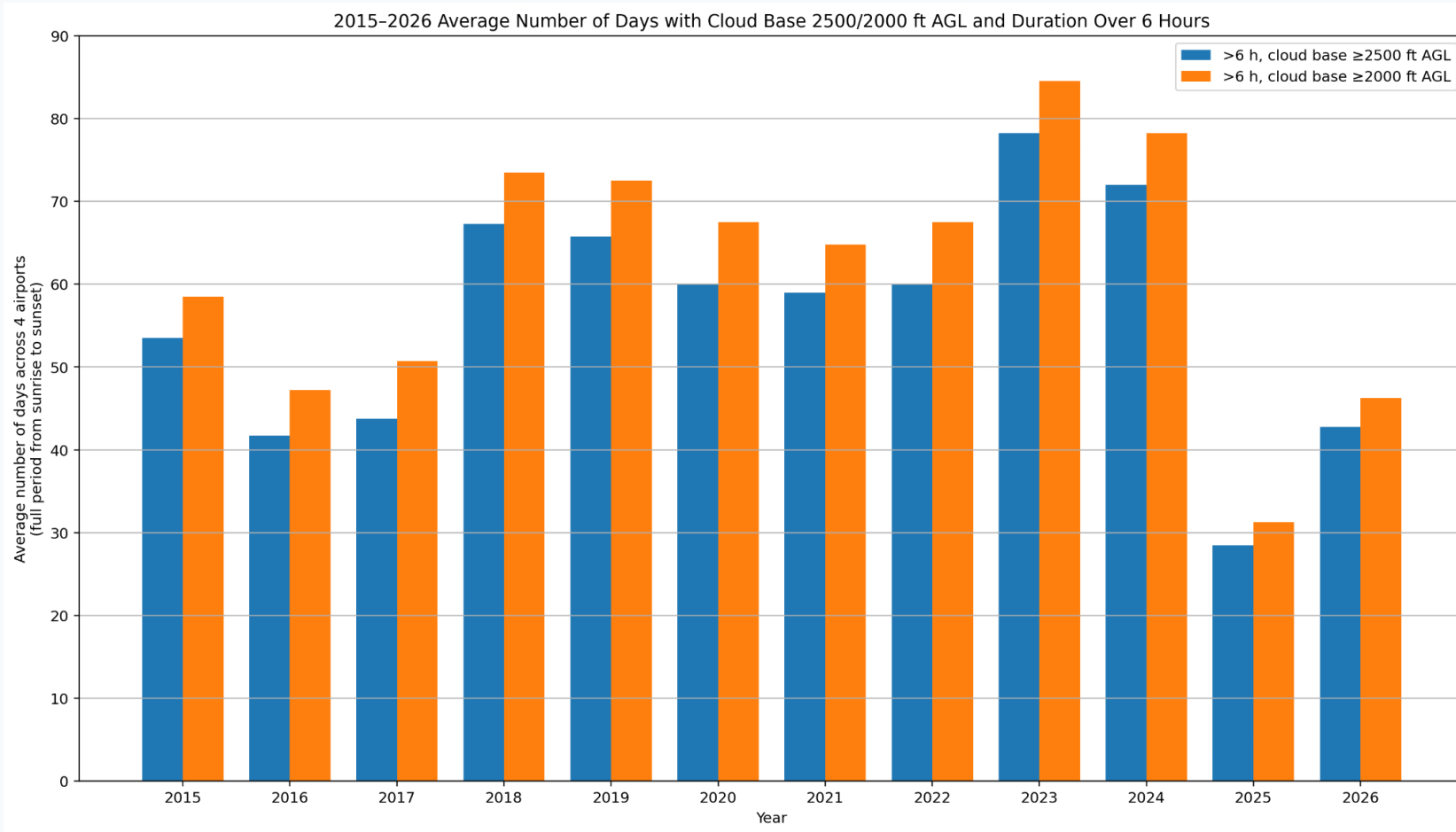
Working with recurring GNSS interference

- Keep an alternative block ready when interference persists over the planned area.
- Combine detector alerts with navigation and survey-system status.
- Review suspect segments early, while the aircraft and crew can still repeat them.

The value of monitoring lies in faster decisions and fewer unusable flight hours.

Monitoring and detector use come from the Applied Aviation Association outline.

2025 offered far fewer long weather windows



≈60% fewer days

2025 versus 2024,
at both cloud-base
thresholds.

At ≥ 2500 ft AGL

2024: ≈72 days

2025: ≈28–29 days

Less time for continuous
acquisition.

Source: EYVI, EYKA, EYSA, EYPA METAR chart - airport averages. 2026 coverage till 8th of September

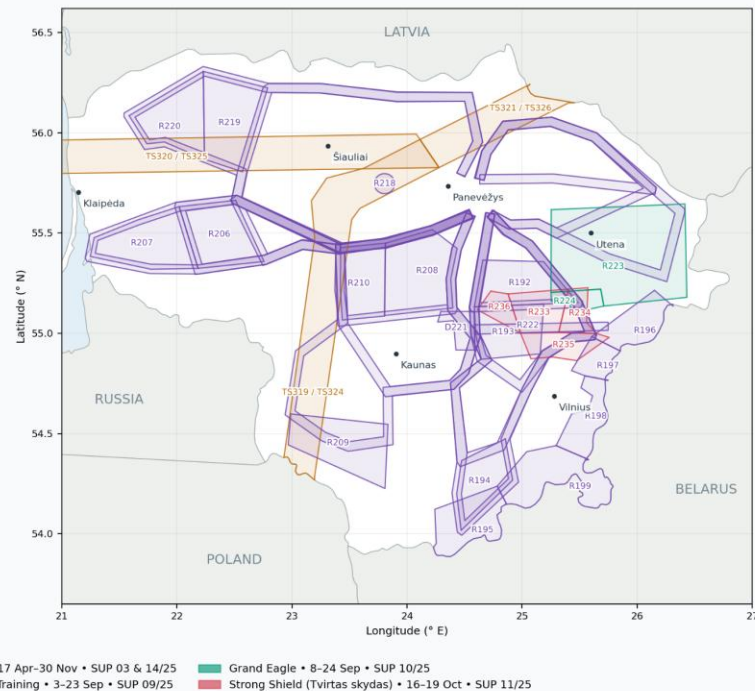
Seasonal requirements narrow the usable weather window

- Orthophoto blocks need suitable illumination and consistent surface conditions across the area.
- Terrain and forestry lidar require the right vegetation and ground conditions for the intended product.
- Snow, flooding and persistent wet conditions can shift work into another seasonal window.
- Wind and turbulence can shorten a nominally suitable day and disrupt continuous strip acquisition.

Military exercise airspace over Lithuania: 2025

Military Exercise Airspace over Lithuania

April–November 2025 | Combined outer boundaries



Temporary airspace use splits acquisition blocks

A suitable weather day may still offer access to only part of the planned survey area.

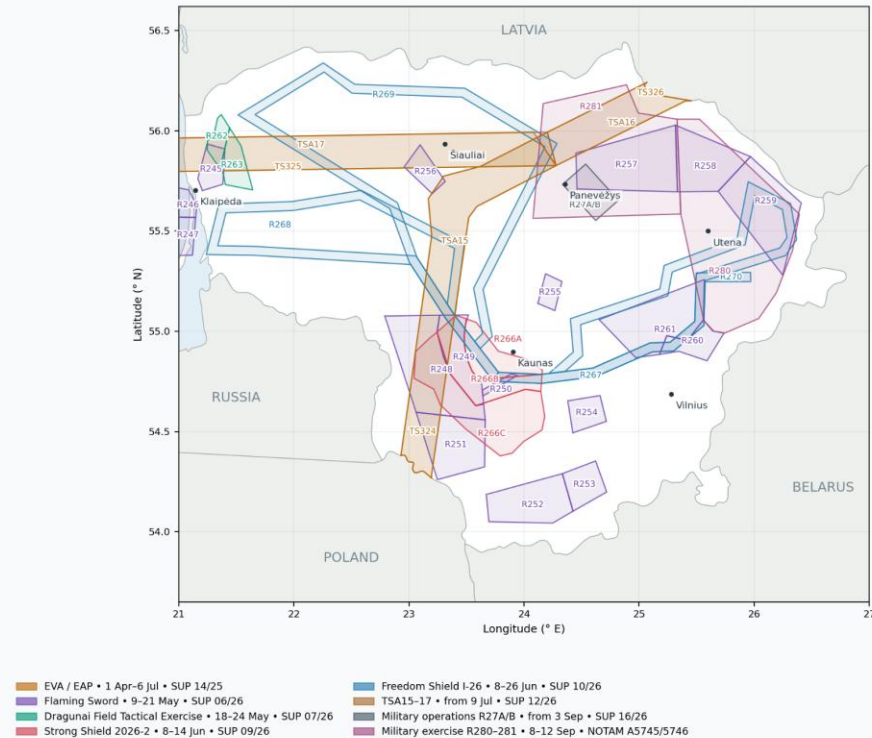
Fragmented access reduces productive time

Shorter strips, extra turns and transit can erode the remaining acquisition window.

The 2026 airspace picture requires new planning

Military Exercise Airspace over Lithuania

April–November 2026 | Combined outer boundaries



Changed areas and activation schedules

A plan that worked in 2025 cannot simply be reused for the 2026 season.

More than one block needs to be ready

Pre-arranged alternatives make it easier to use short access and weather opportunities.

The main constraint is the overlap of available windows

- Good weather has limited value when GNSS quality prevents usable acquisition.
- Stable GNSS is insufficient when the target block is unavailable for the required altitude or time.
- Delayed access can leave too little time for transit and a complete acquisition block.

Weather, GNSS conditions and airspace access must coincide for long enough to complete useful coverage.

Operational flexibility needs advance preparation

- Prepare alternative blocks with permissions and acquisition settings already resolved.
- Allow for aircraft, equipment and crew transfers between survey bases.
- Use reserve capacity where it can respond within the remaining weather window.
- Agree on seasonal priorities, partial delivery and reflight decisions with the client.

**Include prohibited/restricted/dangerous areas, border-zone permissions, military activity, airport operations and drone-related changes in daily preparation.
A backup plan is useful only when it can be activated in time.**

Technical measures support the operational response

- Combine multi-frequency and multi-constellation reception with inertial support.
- Assess anti-jamming equipment in the installed survey configuration.
- Use trajectory review and available image or lidar constraints to isolate recoverable segments.
- Judge each measure by accepted coverage, recovery time and the amount of reflight avoided.

Alternative positioning remains a development direction

Starlink signals of opportunity

An additional positioning source to investigate, with airborne performance and integration still requiring validation.

MLAT

An independent aircraft-position input where coverage, data access and timing support the intended use.

It works for aircraft navigation under the conditions encountered in Lithuania.

MLAT derives position from Mode S signal arrival times

On board: Mode S transponder

Receives selective interrogations at 1030 MHz and transmits replies at 1090 MHz.

A unique 24-bit address identifies the aircraft. Replies can carry identity and pressure-altitude data.

Mode S supports identification; MLAT supplies the ground-derived position.

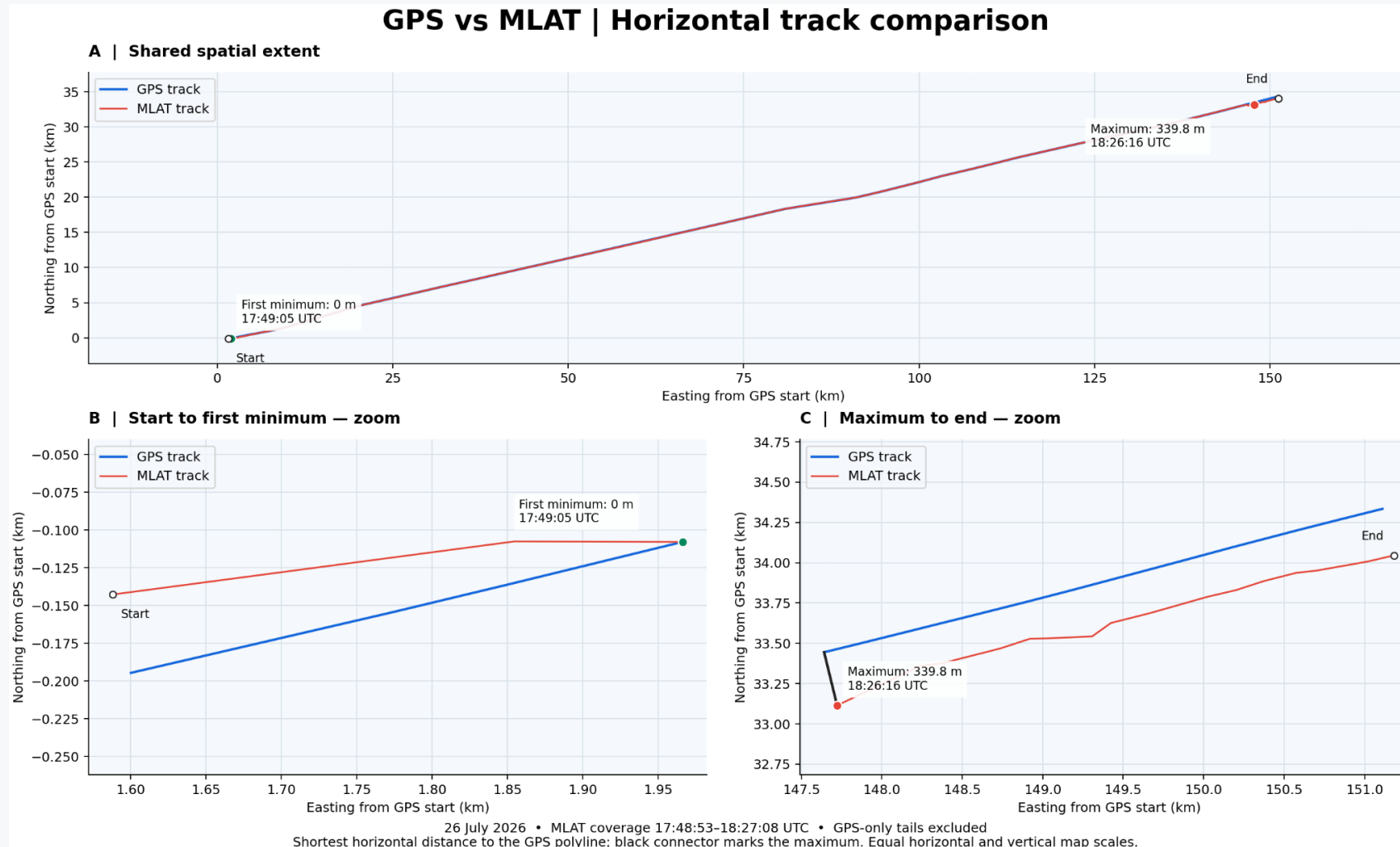
On the ground: multilateration

Several synchronised receivers time the same 1090 MHz transmission.

Arrival-time differences define distance differences. The processor solves for aircraft position.

An unconstrained 3D solution needs at least four receivers with suitable geometry.

GPS and MLAT follow the same route, with local departures

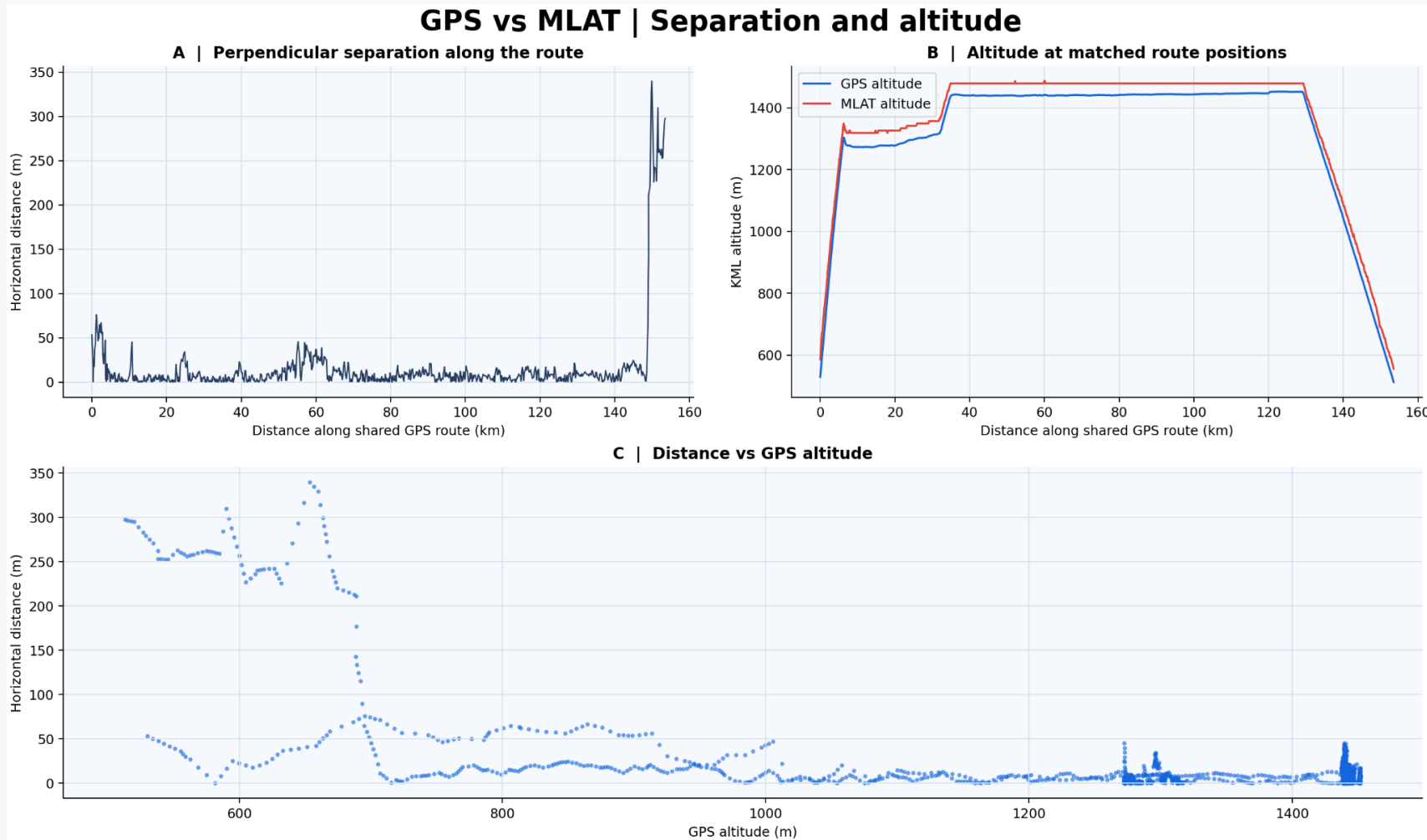


Close agreement en route

The overview shows similar horizontal paths across the common route.

Maximum separation near the route end. The enlarged panels reveal differences hidden at overview scale.

MLAT agreement weakens in the lower-altitude segments



≈11 m

Reported mean difference from GPS under medium coverage.

Departures at lower altitude are consistent with reduced receiver visibility and weaker geometry.

Lessons from the Lithuanian experience

Reliable delivery depends on the ability to change the acquisition plan quickly.

GNSS interference requires close monitoring and early review of suspect segments.
Short weather windows make readiness and seasonal priorities more important.
Airspace constraints make alternative blocks and coordination essential.

The operational target is usable coverage and timely delivery.