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NATIONAL REPORT

National Report of Sweden to the EUREF 2024 Symposium

– Geodetic Activities at Lantmäteriet

1. Introduction

Lantmäteriet, the Swedish mapping, cadastral and land registration authority, is responsible for the national geodetic infrastructure. The work is based on the geodetic strategic plan (Lantmäteriet, 2018) and some of the main activities in the field of geodetic reference frames are

- the operation and development of SWEPOS™, the Swedish national network of permanent reference stations for GNSS, as well as SWEPOS-based services,
- contributions of SWEPOS data to international initiatives such as EPN, EPOS and IGS as well as international analyses of GNSS data,
- the implementation and sustainability of the Swedish national reference frame SWEREF 99 and the national height system RH 2000 (ETRS89 and EVRS realisations respectively), and
- improvements of Swedish geoid models.

2. Contributions from Lantmäteriet to EPN

The number of SWEPOS stations included in EPN is 28. Seven of the original SWEPOS stations have been included since the very beginning of EPN. These stations are Onsala, Mårtsbo, Visby, Borås, Skellefteå, Vilhelmina and Kiruna (ONSA, MAR6, VIS0, SPT0, SKE0, VIL0 and KIR0). The other 21 stations are represented by an additional monument located at the original SWEPOS stations.

Daily and hourly data are delivered for all stations, while real-time data are delivered from 13 stations.

Lantmäteriet operates the NKG EPN AC on behalf of the Nordic Geodetic Commission (NKG). The NKG AC contributes with final weekly and daily solutions, as well as rapid daily solutions, using the Bernese GNSS Software version 5.4 (Dach et al., 2015). The EPN sub-network processed by the NKG EPN AC consists of 108 reference stations (May 2024) concentrated to northern Europe.

The NKG EPN AC participates in the EPN Repro3, processing data from a total of 125 stations, i.e., its present sub-network as well as former EPN stations of the sub-network. Preparations started after the EUREF 2023 Symposium, and the processing could start late October 2023. Currently, troubleshooting, elimination of large outliers and re-processing is going on, to refine the results and include as many observations as possible.

Lantmäteriet is also leading the EPN Deformation Models working group.

3. EPN-related GNSS Analysis

Lantmäteriet takes an active part in the work of the NKG GNSS Analysis Centre (Nordic Geodetic Commission, 2024). The project aims at a dense velocity field in the Nordic and Baltic area. Consistent and combined solutions are produced based on national processing using the Bernese GNSS Software, following the EPN analysis guidelines. Lantmäteriet is responsible for the combination of the daily and weekly solutions from the national sub-networks.

The transition to version 5.4 of the Bernese GNSS Software and other related changes and testing have taken much time during 2023. As a result, the operational solutions of the Swedish sub-network were first back on schedule by the end of 2023.

A second reprocessing of the full NKG network, including all Nordic and Baltic countries, is ongoing and will be consistent with EPN Repro3. The Swedish part is in a preparatory stage but will soon start. Reprocessed and operational solutions will contribute to the EPN densification project.

Lantmäteriet is one of the analysis centres in E-GVAP, as the Nordic GNSS Analysis Centre, performing data processing for approximately 750 GNSS stations mainly in Sweden, Finland, Norway and Denmark (Lindskog et al., 2017). Since October 2022, 29 stations from Estonia were also included. Two near real-time (NRT) ZTD products, i.e., NGA1 and NGA2, are currently provided. Both products are obtained from the Bernese GNSS Software version 5.4 using a network solution. The NGA1 product is updated every hour while the NGA2 product is updated every 15 minutes. Due to the limited access to real-time data, the NGA2 product is currently only provided for all Swedish stations, 3 Norwegian and 18 Finnish stations.

4. SWEPOS – the National Network of Permanent Reference Stations for GNSS

SWEPOS is the Swedish national network of permanent GNSS stations operated by Lantmäteriet; see SWEPOS's website.

The purposes of SWEPOS are

- providing single- and dual-frequency data for relative GNSS measurements,
- providing DGNSS corrections and RTK data for distribution to real-time users,

- acting as the continuously monitored foundation of SWEREF 99,
- providing data for geophysical research and for meteorological applications,
- monitoring the integrity of the GNSS systems.

By May 2024 SWEPOS consisted of totally 483 stations, of which 62 are of a higher class, the so-called class A, and the remaining 421 stations are of class B, see Figure 1. Four class A stations have been established since the EUREF Symposium in 2023.

Figure 1: To the left: Sveg is one of the SWEPOS class A stations. It has an old monument (established in 1993) as well as an additional monument (2011). To the right: Gustavsberg is a SWEPOS class B station with a roof mounted GNSS antenna established mainly for network RTK purposes.

The class A stations are monumented on bedrock and have redundant equipment for GNSS observations, communications, power supply etc. Class B stations are mainly established on top of buildings for network RTK purposes. They have the same instrumentation as the class A stations (dual-frequency multi-GNSS receivers with choke ring antennas), but with somewhat less redundancy.

Five of the original 21 SWEPOS stations (ONSA, MAR6, VIS0, SPT0 and KIR0) are included in the IGS network, as well as three of the additional monuments with newer steel grid masts (ONS1, MAR7 and KIR8).

A few years ago, 16 of the fundamental stations still had old antennas (Ashtech choke ring or AOAD/M_T) from the early 1990s and therefore we started an antenna exchange program in 2021. The exchange has been dormant for a while, mainly due to the promising development of antenna heaters. Before the winter 2023/2024 new antennas with antenna heater were installed at two fundamental stations (KIR0, SUN0). At each fundamental station there is a pillar and a mast station and there are still four pillars which have antennas that are planned to be exchanged. The antenna at ONSA (AOAD/M_B) will remain until it breaks. At least 16 of the antennas of the masts will be exchanged, from LEIAR25.R3 LEIT to TPSCR.G5 OSOS. The exchange will probably be completed within approximately two years. In the northern part of Sweden, the antennas will have antenna heaters attached.

5. SWEPOS Services

SWEPOS provides real-time services of centimetre-level uncertainty (Network RTK) and metre-level uncertainty (DGNSS), as well as data for post-processing in RINEX format. An automated post-processing service, based on the Bernese GNSS Software, is also available.

Good coverage of the Network RTK service has been obtained in border areas and along the coasts through exchange of data from permanent GNSS stations between the Nordic countries. Several stations operated by the Norwegian Mapping Authority and the Danish Agency for Data Supply and Infrastructure are included in the service together with stations from private operators in Denmark, and Finland as well as Sweden.

The Network RTK service has, in May 2024, approximately 11 250 subscriptions, which means some 1 500 additional users since the EUREF Symposium in 2023. Lantmäteriet also has cooperation agreements with seven international GNSS service providers using data from SWEPOS stations for their services. This is done to increase the use of SWEPOS data as well as optimising the benefits of the geodetic infrastructure.

The real-time services utilise Trimble Pivot Platform GNSS Infrastructure Software and are operating in virtual reference station mode. The Network RTK service distributes data for GPS, Glonass, Galileo and Beidou-3 using RTCM MSM.

All RINEX data from the Swepos stations that have been backed-up on tape have now been transferred onto disk for easier access. The plan is to also make the data available to external users, as the 1 Hz RINEX data is of interest for a lot of scientific studies, e.g., ionospheric studies.

5.1 An Updated SWEPOS Post-Processing Service

SWEPOS has recently upgraded its online GNSS Post-Processing Service, which is used to calculate precise coordinates in the national reference frame SWEREF 99. Originally developed in year 2000 and updated in 2015, this service was rebuilt from scratch and released to users on 9 April, 2024.

The new system has a modern, modular architecture that uses the latest software technology, making it easier to develop and maintain. It includes better error handling to reduce the workload of the SWEPOS support staff.

In terms of processing capabilities, the service now supports all versions of RINEX files, from 2.x to 4.x. Users can calculate coordinates in both the SWEREF 99 and ITRF2020 frames, either using a nationwide service based on SWEPOS reference stations or through project-adapted services for large infrastructure projects. The most important model update in the GNSS calculation is the change of antenna table to IGS20.atx, which contains updated and more accurate antenna phase center corrections based on newer data, and improved modeling techniques.

New features include the ability to order a comprehensive RINEX data quality control report (called SweposQC), improved validation of user-supplied RINEX files, more detailed reporting, support for multi-GNSS (can process Galileo data, in addition to GPS and Glonass) and better selection of reference networks based on geometry. Coordinate calculations are performed using Bernese GNSS Software version 5.4, while RINEX validation and data quality reporting rely on in-house QC software and G-Nut/Anubis (Vaclavovic & Dousa, 2016).

5.2 Development of SWEPOS data Quality Monitoring

SWEPOS performs various activities to ensure the quality and reliability of GNSS data. This includes continuous monitoring of data quality and station coordinates in near real-time, daily, and long-term. As part of these efforts, SWEPOS has developed a system to check the quality of data in near real-time and detect any disturbances in the GNSS signals that may be caused by various sources (Abraha et al., 2024). By doing this, SWEPOS can identify any unusual or problematic patterns that may affect the quality of the data. This system uses hourly RINEX files and monitors the signal levels of GPS, GLONASS, Galileo, and Beidou frequencies. If a disturbance is detected, a disturbance status map is generated, and an alert is sent to a dedicated team within SWEPOS to further investigate the issue and find a solution. This system has proven successful in identifying critical disturbances at several SWEPOS stations.

There is a plan to improve the detection system by considering more parameters and enable real-time monitoring by the end of 2024. A website for disturbance status information will be launched, and the information will also be made available via an API.

5.3 Development of an Updated Ionospheric Monitoring Service

With the upcoming solar cycle maximum, there is a need to improve SWEPOS Ionosphere Monitor. Desired improvements include

- increased spatial resolution
- support for GNSS constellations other than GPS
- improved cycle slip detection and repair
- access service via an API, in addition to a website presentation.
- subscription to alerts when ionospheric variability is high
- presentation of variability per satellite.

The spatial variability of the ionosphere can significantly impact the performance of network RTK positioning. Network RTK relies on estimating atmospheric effects at the user's location, and larger ionospheric variability can lead to greater discrepancies between real and estimated conditions.

During periods with high solar activity the spatial variability of the ionosphere also tends to be higher, which makes an upgraded ionospheric monitor extra relevant for the upcoming solar maximum.

The planned upgrade will for this reason, just as the current ionosphere monitor, prioritise assessing ionospheric variability.

6. Reference Frame Management – SWEREF 99

SWEREF 99 was adopted by EUREF as the Swedish realisation of ETRS89 in 2000 (Jivall & Lidberg, 2000) and is used as the national geodetic reference frame since 2007. SWEREF 99 is defined using SWEPOS class A stations (see chapter 4) and equivalent stations in our neighbouring countries.

The coordinates at the SWEPOS stations are regularly updated for antenna/ radom changes and in connection to introduction of new antenna model tables. Coordinates consistent with igs20.atx were calculated during the last year.

By defining SWEREF 99 by active reference stations we are exposed to rely on the positioning services of SWEPOS, like the Network RTK service. All alterations of equipment and software as well as movements at the reference stations will in the end affect the coordinates.

To be able to check all these alterations, approximately 300 nationally distributed passive so-called consolidation points (SWEREF 99 class 1) are used. Each year, 50 of them are remeasured with static GNSS following a yearly programme. All SWEREF 99 class 1 points have been re-processed after the update of SWEREF 99 in 2021 (Jivall & Lilje, 2021).

7. Maintenance of the National Levelling Network

The third precise levelling of the mainland of Sweden lasted 1979–2003, resulting in the new national height system RH 2000 in 2005 (Ågren et al., 2007).

Our assessment is that RH 2000 will be the national height system for many years to come and that it will be based on levelling. The reason is that the precision of height determination with GNSS (height above the ellipsoid) is not as accurate as the levelling technique. Therefore, the maintenance of the height control network needs to be continued for the foreseeable future.

Since the beginning of the 1990s, a systematic inventory and updating of the network is performed continuously. All benchmarks are visited but since benchmarks founded in bedrock and nodal points are more valuable for the perseverance of the network, destroyed points are replaced according to specific criteria. This approach ensures that a sufficient number of destroyed benchmarks are replaced, securing the sustainability of the network and at the same time keeping costs down.

When new height benchmarks are demarcated to replace destroyed benchmarks, the levelling of them is done through procurement procedures, which is also the situation for the re-measurements of the 300 consolidation points described in chapter 6.

This year we have implemented a fully digitised benchmark inventory process. In short, the field worker uses a tablet when storing information about the benchmarks. The information is instantly synchronized with the database, using a GIS field application.

8. Geoid Determination

According to Lantmäteriet's strategic plan (Lantmäteriet, 2018), an important goal is to compute a seamless geoid model of high accuracy that fulfils the needs of users both on land and at sea. The current Swedish national geoid model is SWEN17_RH2000, which has been computed by combining the Nordic NKG2015 gravimetric model with Swedish GNSS/levelling data.

As a preparation for the next NKG and SWEN models we are now focusing on new Swedish detail gravity observations collected using Scintrex CG5 and CG6 to fill gaps or replace old data of lower quality.

In the last years, much work has also been spent on improving and densifying the Swedish national GNSS/levelling dataset. The number of stations will increase from 185 to around 300 in 2024. The core of the new, updated dataset is the so-called SWEREF 99 class 1 points for which accurate levelled heights are available in RH 2000. A majority of these SWEREF 99 class 1 points are consolidation points that are redetermined every six years (see chapter 6). This makes it possible to detect and remove unstable points. Since 2019, the levelled normal heights of the GNSS/levelling points are also checked by re-levelling relative to benchmarks in the national precise levelling network. During 2023, 29 points were levelled.

In the autumn of 2023, the Baltic Sea Chart Datum 2000 (BSCD2000) was released (Liebsch et al., 2023). This vertical datum for maritime applications is realised in the Baltic Sea with a geoid model harmonised with national realisations of ETRS89 and EVRS (in Sweden SWEREF 99 and RH 2000). It has been implemented by the Swedish Meteorological and Hydrological Institute for sea level observations and is now also implemented by the Swedish Maritime Administration for nautical charts. Lantmäteriet contributed with gravity observations and gravimetric geoid modelling to the BSCD2000.

In September 2024 an industrial PhD student, financed by Lantmäteriet, will defend his licentiate thesis with the title "Regional realisations of IHRS, the International Height Reference System", at the University of Gävle.

9. Gravity Activities

In Sweden 14 stations are revisited with Lantmäteriet's absolute gravimeter, FG5X-233, with an interval of approximately one to three years. Since 2007, FGX-233 also regularly participates in local, regional and international absolute gravity (AG) intercomparisons to keep track of possible biases.

In 2022, Lantmäteriet arranged, together with Onsala Space Observatory and the Finnish Geospatial Institute, an AG intercomparison at Onsala Space Observatory as a mission issued by the NKG. The intercomparison took place between May and July and gathered 15 different instruments of which 13 gave good results. The results are finished, and the report is in preparation.

In autumn 2023, Lantmäteriet participated in ICAG-2023, the international comparison for absolute gravimeters in Table Mountains, US.

All Swedish absolute gravity stations for FG5 (also known as class A points in the Swedish gravity reference frame RG 2000) are co-located with SWEPOS stations. Ratan, Skellefteå, Smögen, Visby and Onsala are furthermore co-located with tide gauges. Onsala is also co-located with VLBI telescopes and a superconducting gravimeter, which is annually calibrated with FG5X-233 AG observations.

In 2019 the latest realisation of RG 2000, the Swedish gravity reference frame (Engfeldt et al., 2019; Engfeldt, 2019), was computed. After that, about 100 more gravity points have been included in the network by recent high accuracy gravity measurements. Most of these points are gravity points from the old gravity network RG 62 or old points which have served as starting points for detail gravity measurements. Due to this and a few more things, a new realisation of RG 2000 will be computed in the end of this year. Since 2021, Lantmäteriet's detail gravity observations have got a gravity value in RG 2000, regardless of which origin the observations had. The quality of the older detail gravity observations is still under investigation, and more detail gravity observations will be performed during this year and the upcoming years where it is needed.

Lantmäteriet is also participating in the BalMarGrav project, co-funded by the European Union. The aim of this project is to improve the marine gravity data in the south-eastern part of the Baltic Sea. In 2023 Lantmäteriet conducted a marine gravity campaign in Latvian waters together with the Latvian Geospatial Information Agency, the Latvian Coast Guard and Riga Technical University. In 2024 Lantmäteriet conducted a marine gravity campaign in Lithuanian waters together with Vilnius Gediminas Technical University, however this was not included in the BalMarGrav project.

10. Geodynamics

Studies of crustal deformation in Fennoscandia by means of continuous GNSS observations have been carried out within the BIFROST effort since more than three decades (Kierulf et al., 2021). The current BIFROST2022 reprocessing of GNSS data, a cooperation of NKG members and Poland, will largely extend the number of stations (several 100s) and observation time span (1 January 2000 – 31 December 2022). Processing with at least three different software is ongoing and first results are expected at the end of 2024. They will be used in the generation of revised official NKG land uplift and deformation models for northern and central Europe.

Lantmäteriet is involved in the EUREF effort on obtaining a high-resolution velocity model for Europe and adjacent areas. The first official EUREF velocity model EuVeM2022 was officially released during the EUREF 2023 Symposium. A new model will be initiated once a new and significantly extended densified EPND velocity field becomes available.

Lantmäteriet contributes to EPOS and is member of the Swedish consortium EPOS-Sweden, which is an infrastructure project supported by the Swedish Research Council. The generation of the strain-rate product has become Lantmäteriet's responsibility within EPOS (Fernandes et al., 2022), which can be downloaded from the EPOS Data Portal.

Lantmäteriet further contributes with GIA modelling studies and data in different fields. A new GIA code for three-dimensional, spherical, compressible earth models was developed (Huang et al., 2023) and different Cartesian model setups were tested regarding their applicability for calculating horizontal GIA motion that can be detected with GNSS (Reusen et al., 2023). An additional incompressible, Cartesian model setup was published (Weerdesteijn et al., 2023), based on the open-source software Aspect. Further geodynamic studies dealt with the detection of water storage changes in the Tibetan Plateau and its surroundings with satellite gravity missions (Xiang et al., 2023a; 2023b) and a structural map for the Gulf of Guinea from gravity data (Pham et al., 2023).

11. InSAR

Since January 2020, Lantmäteriet has installed several compact active transponders (CAT or so-called ECR) and passive corner reflectors (CR) in Sweden. Different designs of the reflectors, used for C-band Sentinel-1 imagery, have been tested and installed. So far 18 passive reflectors and 3 CATs have installed in different parts of the country (see Figure 2 and Table 1). These geodetic devices are very close (within some metres) to the twin (pillar and mast) GNSS stations (see Figure 2) and are planned to make a new and complementary geodetic infrastructure based on InSAR technique. The performance of the multi-year data of the CATs and CRs have been investigated using the GECORIS toolbox (Czikhardt et al., 2021) and our preliminary results show mm-level agreement when time series of the displacements for

CRs and ECRs are compared to the twin GNSS stations. We have planned to install three more corner reflectors this year in the northern part of the country. The main challenge we have faced is getting permissions and settling and/or renewing the agreements with landowners which has slowed down the installations.

Figure 2: Left: The photos show the double back-flipped squared type of corner reflectors installed in Sveg (top) and Östersund (bottom). Right: The map shows the locations of compact active transponders and passive reflectors which are co-located with permanent twin GNSS stations.

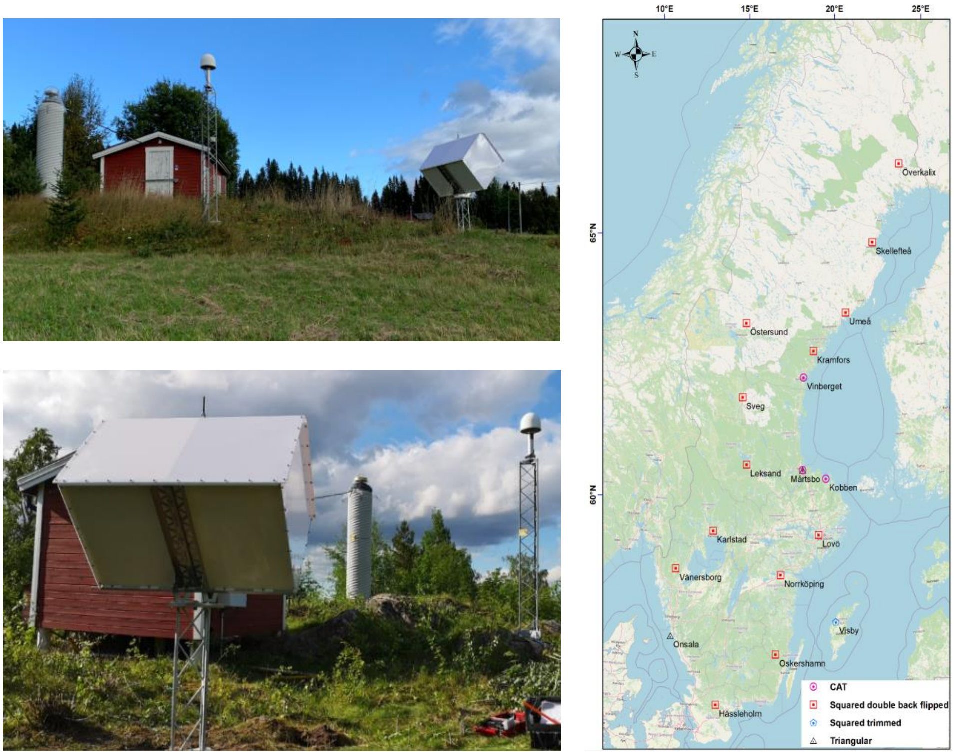

Table 1: Installed corner reflectors and transponders in different locations in Sweden (coordinates are given in SWEREF 99).

ID	Latitude	Longitude	Location	Passive/ Active	Date of Installation	Type	Orientation
ECR01	60.5951	17.2585	Mårtsbo	Active	7-Jan-2020	Electronic transponder	Asc and Desc
ECR02	60.4099	18.2303	Kobben	Active	1-Jun-2020	Electronic transponder	Asc and Desc
ECR03	62.3739	17.4279	Vinberget	Active	1-Oct-2020	Electronic transponder	Asc and Desc
CR01	57.3949	11.922	Onsala	Passive	1-Jun-2021	Triangular	Asc
CR02	57.395	11.9222	Onsala	Passive	10-Sep-2021	Triangular	Desc
CR03	60.5946	17.2596	Mårtsbo	Passive	14-Sep-2021	Triangular	Asc
CR04	58.5900	16.2451	Norrköping	Passive	4-Nov-2021	Double back-flipped squared	Asc and Desc
CR05	57.654	18.3671	Visby	Passive	11-May-2022	Squared trimmed	Desc
CR06	57.654	18.3671	Visby	Passive	11-May-2022	Squared trimmed	Asc
CR07	62.0173	14.7000	Sveg	Passive	14-Jun-2022	Double back-flipped squared	Asc and Desc
CR08	63.4427	14.8579	Östersund	Passive	1-Sep-2022	Double back-flipped squared	Asc and Desc
CR09	63.5781	19.5096	Umeå	Passive	21-Oct-2022	Double back-flipped squared	Asc and Desc
CR10	64.8792	21.0485	Skellefteå	Passive	23-Oct-2022	Double back-flipped squared	Asc and Desc

ID	Latitude	Longitude	Location	Passive/ Active	Date of Installation	Type	Orientation
CR11	59.4441	13.5056	Karlstad	Passive	10-May-2023	Double back-flipped squared	Asc and Desc
CR12	58.6931	12.035	Vänersborg	Passive	12-May-2023	Double back-flipped squared	Asc and Desc
CR13	57.0656	15.9968	Oskarshamn	Passive	13-May-2023	Double back-flipped squared	Asc and Desc
CR14	62.8754	17.9277	Kramfors	Passive	21-Jun-2023	Double back-flipped squared	Asc and Desc
CR15	66.3178	22.7733	Överkalix	Passive	10-Aug-2023	Double back-flipped squared	Asc and Desc
CR16	56.0921	13.7180	Hässleholm	Passive	27-Sep-2023	Double back-flipped squared	Asc and Desc
CR17	60.7221	14.8773	Leksand	Passive	14-May-2024	Double back-flipped squared	Asc and Desc
CR18	59.3378	17.8292	Lovö	Passive	17-May-2024	Double back-flipped squared	Asc and Desc

12. Other Activities

12.1 Monitoring of EGNOS

Lantmäteriet is one of the partners in the GEMOP – Galileo and EGNOS Monitoring of Performances – project. The project is funded by the European Union Agency for the Space Programme (EUSPA) to monitor the performance of the Galileo and EGNOS positioning systems. Lantmäteriet participates in the work package of local position performance assessment and the goal is to monitor the position obtained by SWEPOS class A stations in Överkalix and Visby using EGNOS corrections. The safety of life analysis of the data is done by Lantmäteriet. At the end of each quarter, we perform the following tasks:

- Daily monitoring and assessment of the availability of the data and the processing.
- Quality check and analysis of the results.
- Prepare quarterly KPIs for CNES, which is the French national space agency, to produce quarterly synthesis reports.

12.2 DINPAS

DINPAS – Digital Infrastructure Enabling Accurate Positioning for Autonomous Systems – is an R&D project funded by Vinnova, Sweden's innovation agency. The project started in October 2021 and involved partners are RISE, AstaZero, Combitech, Ericsson, IBG, Katla Aero, Lantmäteriet, Telia and u-blox.

The aim of the DINPAS project is to evaluate the requirements of future autonomous airports in terms of reliable, precise positioning as well as scalability to large numbers of devices, to benefit the next generation of industrial digital solutions. The targeted implementation (including software for generating GNSS State Space Representation (SSR) corrections, 3GPP-based delivery, and navigation device) will be used for evaluating relevant performance.

Both static and dynamic test measurements using SSR corrections have been compared to using OSR (Observation Space Representation). The position using the different GNSS techniques is well within 2 dm (95%) in open sky environment in both 2D and height and fulfil the positional requirement identified in the project for autonomous airports.

There have been some challenges with the 3GPP-based delivery of the corrections though, and the project has been extended by one year until September 2024 to be able to solve these issues.

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Acronyms and Abbreviations

Table 2: Explanations of acronyms and abbreviations used in the report, in alphabetical order.

Acronym or abbreviation	Explanation
3GPP	3rd Generation Partnership Project
AC	Analysis Centre
AG	Absolute Gravity
API	Application Programming Interface
BIFROST	Baseline Inferences for Fennoscandian Rebound Observations Sea level and Tectonics
BSCD	Baltic Sea Chart Datum
CAT	Compact Active Transponder
CODE	Centre for Orbit Determination in Europe
CR	Corner Reflector
DGNSS	Differential GNSS
DINPAS	Digital Infrastructure Enabling Accurate Positioning for Autonomous Systems
ECR	Electronic Corner Reflector
E-GVAP	The EUMETNET GNSS water vapour programme
EGNOS	European Geostationary Navigation Overlay Service
EPN	EUREF Permanent GNSS Network
EPND	EPN Densification
EPOS	European Plate Observing System
ETRS	European Terrestrial Reference System
EUSPA	European Union Agency for the Space Programme
EVRS	European Vertical Reference System
FAMOS	Finalising Surveys for the Baltic Motorways of the Sea
GEMOP	Galileo and EGNOS Monitoring of Performances
GIA	Glacial Isostatic Adjustment
GNSS	Global Navigation Satellite Systems

Acronym or abbreviation	**Explanation**
GPS	Global Navigation System
IBG	Independent Business Group
ICAG	International Comparison of Absolute Gravimeters
IGS	International GNSS Service
IHRS	International Height Reference System
InSAR	Interferometric Synthetic Aperture Radar
KPI	Key Performance Indicator
MSM	Multiple Signal Message
NGAA	Nordic GNSS Analysis Centre [for E-GVAP]
NKG	Nordic Geodetic Commission (Swedish: *Nordiska kommissionen för geodesi*)
NRT	Near Real-Time
OSR	Observation Space Representation
OSOS	Onsala Space Observatory Dome, Short model
QC	Quality check
R&D	Research and Development
RINEX	Receiver Independent Exchange format
RISE	Research Institutes of Sweden
RTCM	Radio Technical Commission for Maritime Services
RTK	Real-Time Kinematic
SSR	State Space Representation
VLBI	Very Long Baseline Interferometry
ZTD	Zenith Total Delay