

# SWEPOONLINE GNSS post-processing service

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EUREF Sumposium, Barcelona, Spain 5-7 June 2024





## WHAT IS THE SWEPOS POST-PROCESSING SERVICE?





- An online service for the estimation of high precision GNSS positions in SWEREF99 &
- Users<sup>0</sup> with subscription
  - GNSS measurement any where in Sweden
  - Upload RINEX file via web
  - Order calculations
- SWEPOS postprocessing service
  - Validates user RINEX
  - Selects reference stations
  - Bernese engine
  - Anubis engine
  - GNSS calculations results and Data quality report via email

The service was initially developed in the early 2000s but was fully modernized in 2023-2024 (not renewed but rewritten from scratch).



## USER

- Mandatory
  - Subscription to the postprocessing servic
  - GNSS measurement within Sweden
  - Supported GNSS antenna
- GNSS data
  - In RINEX (2.x, 3.x, 4.x)
  - GPS/GLO/GAL
    - GPS is mandatory
  - Minimum 30-min data
  - Maximum 2-days in one RINEX
  - Data can date back to 1997-01-01
- Selection
  - Service type
  - Reference frame
  - GNSS

| 1. Upload F   | Rinex   |  |  |  |
|---|---|--|--|--|
|   | Select files on your computer to upload to your Swepos account. It is possible to upload a maximum of 5 files at a time. Only observation files in Rinex format are allowed.  |  |  |  |
| Select files to   | upload:   |  |  |  |
| Choose file.  | Välj filer 🏦  |  |  |  |
| Upload date fr  | rom: Upload date to:  |  |  |  |
| 2024-05-30  | Uppladdningsdatum till  |  |  |  |
| No files four   | nd  |  |  |  |
| 2. Selection of calculation service and control of Rinex file |   |  |  |  |
|   | Before you order a new job, your Rinex file needs to be checked. Select a Rinex file and click "Check File". In the box "Result of Rinex check" you can see if there are any inaccuracies in the file.  |  |  |  |
| Select the cal  | culation service:   |  |  |  |
| Regular cal   | culation service        Check File  |  |  |  |
| 3. Results of the Rinex inspection                            |   |  |  |  |
| Select a file   | e in step three to check.   |  |  |  |
| 4. Order a r  | new calculation job   |  |  |  |
|   | Mark an approved file in the list above and choose a reference system for the profit and loss report before<br>ordering a calculation.  |  |  |  |
|   | Select GNSS. Observations from selected GNSS will be used in the calculations. The GNSS that are<br>mandatory are already ticked. Other systems are optional. The settings in the selected calculation service<br>control which systems can be selected. Restrictions may also exist in other cases; see the message<br>"Results of the Rinex check". |  |  |  |
|   | Select GNSS:  |  |  |  |
| Select referen  | ice system: 🗆 GPS   |  |  |  |

Order calculation

Glonass
Galileo

Select Reference System



### SERVICE TYPES



- Ordinary Post Processing Service
- Project adapted Post Processing Service
- RINEX quality report
  - SweposQC





The project adapted service replaced horizontal control network in the projects

#### 270-km coastal railway between Umeå and Luleå.



### **PROCESSING SETTINGS**

- SWEREF 99 coordinates calculation
  - Bernese GNSS software, CODE products
  - Coordinates of a new point relative to 6-8 stations, considering station geometry, up to few hundreds of KMS, stations within 10-20 kms
  - Two-frequency observation is a requirement
  - Bernese Processing Settings
    - STAR-based baseline from the new point
    - Multi-GNSS (GPS+GLO+GAL)
    - L3, L1
    - Hourly troposphere parameters VMF3,
       Troposphere parameters not always estimated
    - 3 degrees cut-off
    - 30s observation sampling
    - IGS20.atx antenna models
    - ITRF20 solution fitted to SWEREF99 of SWEPOS stations with Helmert-transformation
- RINEX Quality report
  - Anubis and Inhouse QC tool



#### GNSS processing follows latest EPN standard and guidlines



### **OVERVIEW**





|   | ······································   | RINEX VERSION / TYPE           |
|---|--|--------------------------------|
|   | TPP-4.3.2  | PGM / RUN BY / DATE            |
|   | gfzrnx-2.1.0 ······FILE · PROCESSING ····· 20240312 ·153120 · UTC  | COMMENT                        |
|   | KUNG.0   | MARKER NAME                    |
|   | KUNG.0   | MARKER · NUMBER · · · · · ·    |
|   | SWEPOS   | OBSERVER / AGENCY · · ·        |
|   | 5737R50908 TRIMBLE .NETR9  | REC # / TYPE / VERS            |
|   | A0090829 JAVRINGANT_DM OSOP  | ANT · # · / · TYPE · · · · · · |
|   | 0.07100.00000.0000   | ANTENNA: DELTA H/E/N           |
|   | ···3434083.6281····958104.6747··5270952.7988·····  | APPROX POSITION XYZ            |
|   | $\texttt{E} \cdot \cdot \cdot \texttt{12} \cdot \texttt{C1X} \cdot \texttt{C5X} \cdot \texttt{C7X} \cdot \texttt{C8X} \cdot \texttt{L1X} \cdot \texttt{L5X} \cdot \texttt{L7X} \cdot \texttt{L8X} \cdot \texttt{S1X} \cdot \texttt{S5X} \cdot \texttt{S7X} \cdot \texttt{S8X} \cdot \cdots \cdot \texttt{S1X} \cdot \texttt{S1X} \cdot \texttt{S5X} \cdot \texttt{S7X} \cdot \texttt{S8X} \cdot \cdots \cdot \texttt{S1X} \cdot \texttt$         | SYS / · # · / · OBS · TYPES ·  |
|   | $\texttt{G} \cdot \cdot \cdot \texttt{12} \cdot \texttt{C1C} \cdot \texttt{C2W} \cdot \texttt{C2X} \cdot \texttt{C5X} \cdot \texttt{L1C} \cdot \texttt{L2W} \cdot \texttt{L2X} \cdot \texttt{L5X} \cdot \texttt{S1C} \cdot \texttt{S2W} \cdot \texttt{S2X} \cdot \texttt{S5X} \cdot \cdots \cdot \texttt{S1C} \cdot \texttt{S2W} \cdot \texttt{S2W} \cdot \texttt{S2X} \cdot \texttt{S5X} \cdot \cdots \cdot \texttt{S1C} \cdot \texttt{S2W} \cdot \texttt{S2W} \cdot \texttt{S2X} \cdot \texttt{S5X} \cdot \cdots \cdot \texttt{S1C} \cdot \texttt{S2W} \cdot \texttt{S2W} \cdot \texttt{S2X} \cdot \texttt{S5X} \cdot \cdots \cdot \texttt{S1C} \cdot \texttt{S2W} \cdot $         | SYS / · # · / · OBS · TYPES ·  |
|   | $\texttt{R} \cdot \cdot \cdot \texttt{12} \cdot \texttt{C1C} \cdot \texttt{C1P} \cdot \texttt{C2C} \cdot \texttt{C2P} \cdot \texttt{L1C} \cdot \texttt{L1P} \cdot \texttt{L2C} \cdot \texttt{L2P} \cdot \texttt{S1C} \cdot \texttt{S1P} \cdot \texttt{S2C} \cdot \texttt{S2P} \cdot \cdots \cdot \texttt{S2C} \cdot \texttt{S2P} \cdot \cdots \cdot \texttt{S2C} \cdot \texttt{S2P} \cdot \texttt{S2C} \cdot \texttt{S2P} \cdot \cdots \cdot \texttt{S2C} \cdot \texttt{S2P} \cdot \texttt{S2C} \cdot \texttt{S2P} \cdot \cdots \cdot \texttt{S2C} \cdot \texttt{S2P} \cdot \texttt{S2C} \cdot \texttt{S2P} \cdot \cdots \cdot \texttt{S2C} \cdot \texttt{S2P} \cdot \texttt{S2C} \cdot \texttt{S2P} \cdot \cdots \cdot \texttt{S2C} \cdot \texttt{S2P} \cdot \texttt{S2C} \cdot \texttt{S2C} \cdot \texttt{S2P} \cdot \texttt{S2C} \cdot S$ | SYS / + + / OBS TYPES          |
|   | INITIAL_RINEX_VERSION: 3.04  | COMMENT                        |
|   |  | COMMENT                        |
|   |  | COMMENT                        |
|   |  | COMMENT                        |
|   | THE · COORDINATES · ARE · GIVEN · IN · SWEREF · 99 · (ETRS · 89) · · · · · · · ·   | COMMENT                        |
|   | 0  | RCV CLOCK OFFS APPL            |
|   |  | LEAP SECONDS                   |
|   | $\cdot 24 \cdot \texttt{R01} \cdot \cdot 1 \cdot \texttt{R02} \cdot - 4 \cdot \texttt{R03} \cdot \cdot 5 \cdot \texttt{R04} \cdot \cdot 6 \cdot \texttt{R05} \cdot \cdot 1 \cdot \texttt{R06} \cdot - 4 \cdot \texttt{R07} \cdot \cdot 5 \cdot \texttt{R08} \cdot \cdot 6$   | GLONASS SLOT / FRQ #           |
|   | $\cdot\cdot\cdot\cdot R09 \cdot - 2 \cdot R10 \cdot - 7 \cdot R11 \cdot \cdot 0 \cdot R12 \cdot - 1 \cdot R13 \cdot - 2 \cdot R14 \cdot - 7 \cdot R15 \cdot \cdot 0 \cdot R16 \cdot - 1$   | GLONASS SLOT / FRQ #           |
|   | $\cdots \cdot R17 \cdots 4 \cdot R18 \cdot - 3 \cdot R19 \cdots 3 \cdot R20 \cdots 2 \cdot R21 \cdots 4 \cdot R22 \cdot - 3 \cdot R23 \cdots 3 \cdot R24 \cdots 2$   | GLONASS SLOT / FRQ #           |
|   | ·C1C···19.070·C1P···19.070·C2C···19.070·C2P···19.070·····  | GLONASS COD/PHS/BIS            |
|   | Ε  | SYS / PHASE SHIFT              |
|   | G  | SYS / PHASE SHIFT              |
| l | R  | SYS / PHASE SHIFT              |
|   |  | INTERVAL                       |
|   | ··2021·····9···17····0····0.00000000·····GPS······   | TIME OF FIRST OBS              |
|   | ··2021·····9····17····23····59···30.0000000·····GPS······  | TIME · OF · LAST · OBS · · · · |
|   |  | END OF HEADER                  |
|   | > 2021 09 17 00 00 00 00 00 000000 0 28 00 00 00000000   |                                |
|   | E0223218399.44523218401.62923218399.8242321840   | 00.902122013557.595.8.         |
|   | E0726445707.66426445711.23426445709.594264457  | 10.645138973135.431.7.         |
|   | E0825058210.17225058212.80125058211.566250582  | 12.262131681797.819.6.         |
|   | E11 · · 23241874 · 750 · · · 23241874 · 316 · · · · 23241872 · 883 · · · · 232418  | 73.828 122136897.172.7.        |



Ex. Antenna translation, downsampling, time span

Ex. Invalid data format, single frequency, Kinematic data, far from project area e.t.c



### Swepos Kvalitetsra

Jobbnamn: SQC240304\_23 Beställare: Kibrom Ebuy Ab E-post: None

Indatafil: 0SOD00SWE\_S\_2 Punktnamn: SODE.0

**Start mättid (UTC):** 2024-01 **Stopp mättid (UTC):** 2024-0 **Fil uppladdad:** 2024-03-04 (

Antenntyp (Rinex-header): JNS Excentricitet Norr/Öst/Upp (m): Mottagare: SEPT POLARX5

#### Resultat från kvalitetskontrollen av rinex-filen



Figur 10: Tidsserier av signal-brusförhållandet för olika satelliter och signaler. Figuren ger information om hur signal-brus-förhållandet ändras över tiden.

**Figur 11:** De övi **gu** på GPS L1 som / oli ga ed (SNR) som funktion av elevationsvinkeln. Normalt är flervägsfelet högre och obj Signal-brusförhållandet lägre för låga elevationsvinklar.



### SGM – Station Geometry Matrix







#### Resultat från Swepos Beräkningstjänst

#### Koordinater för nypunkt



| Punkt  | Norr (m)     |
|--------|--------------|
| LEKS.0 | 6731845.2670 |

ITRF2020 geocentriska kartesiska koordinater

 Punkt
 X (m)

 LEKS.0
 3022572.6487



#### Resultat från Swepos Beräkningstjänst

Jonosfärsaktivitet:







LANTMÄTERIET

5 mm



### **SERVICE PERFORMACE**



#### Service speed

- Service runs on several servers in parallel
- Reduced queue time
- Priority rules
- Results in email in 8 15 minutes
- Realtime job status

- Service accuracy
  - 2-3 hours of data
    - Horizontal I-2cm
    - Vertical 2-3cm
  - 24-hour data, with chock ring antenna
    - Horizontal 6mm
    - Vertical I2mm

#### • Limit values for result evaluation

- Ambiguity resolution > 30%
- Final fix solution RMS < 3mm
- Helmert RMS < 10mm
- Elevation cutoff test, Up difference < 30mm
- Data screening
- Fix vs float solutions
- Troposphere vs No troposphere



- Automated service monitoring, daily automatic job submission from monitoring stations
  - Ensures servers are running
  - Service is running
  - Confirms GNSS products availability
  - Long-term performance monitoring





### SUMMARY OF IMPROVEMENTS IN THE CALCULATION SERVICE

- System architecture
  - Configurability, Future proof concept, Modularized
  - Improved user RINEX validation and error handling
- Calculations
  - Bernese 5.2 to 5.4
  - Transition from IGS14 to IGS20.ATX for antenna models
  - Rinex 2.x to all RINEX versions
    - RINEX 2.X, 3.X, 4.X
  - Multi-GNSS capability
    - GPS, GLONASS, Galileo, BeiDou
  - GNSS support based on antenna calibration
  - Improved reference network selection
  - Rinex quality report Anubis



- Adding Galileo shows improvement, specially when station geometry was bad.
- GPS+Galileo gave better results compared to GPS+GLONASS



### **JOB STATISTICS**

#### SWEPOS® Post Processing Service



### THANKS! WE ARE AVAILABLE AT...

- WEBSITE www.lantmateriet.se
- CONTACT www.lantmateriet.se/kontakt
- PHONE 0771-63 63 63

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