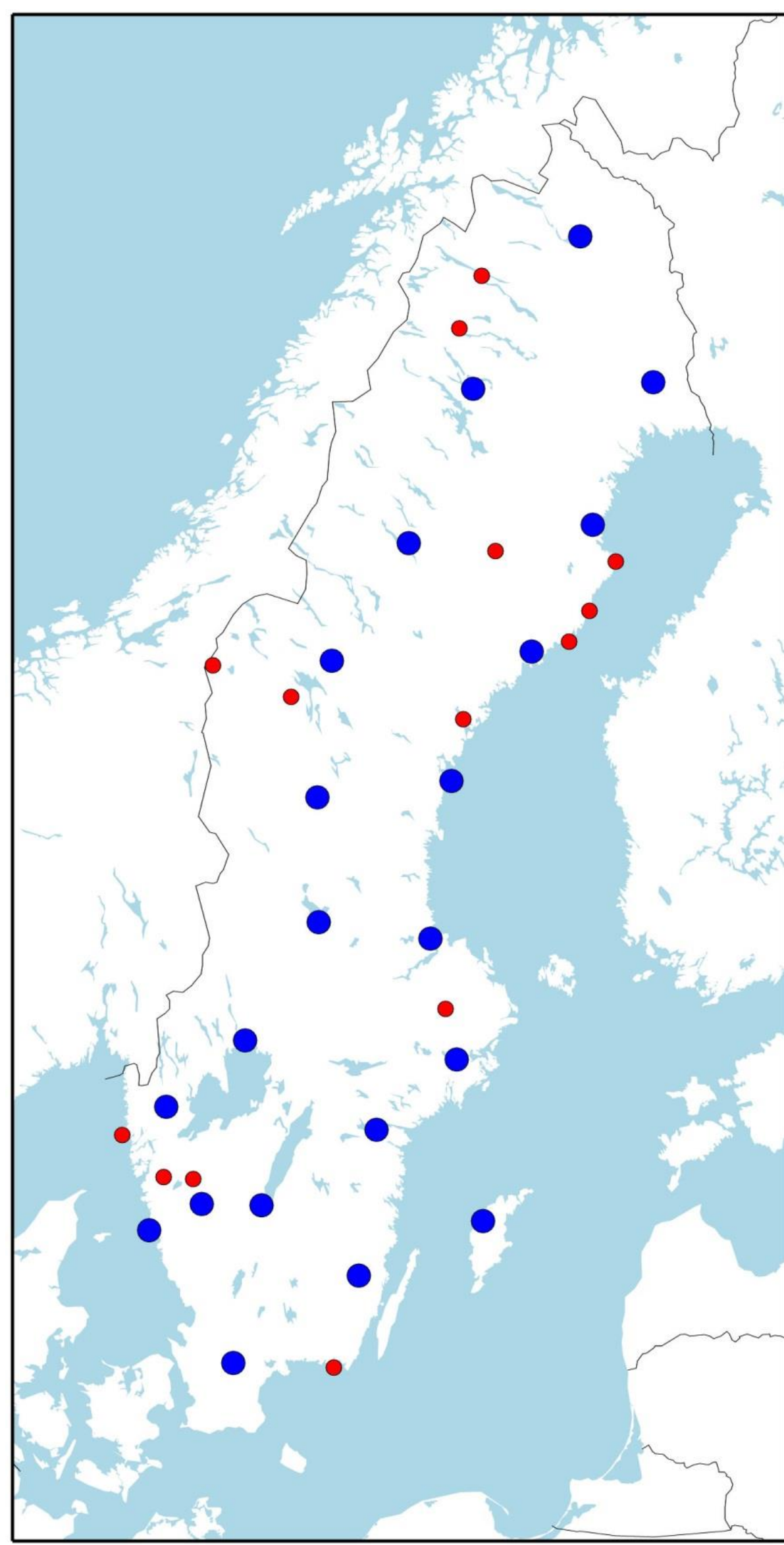


SWEPOS® Post Processing Service

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SWEPOS Post Processing Service is an online service for calculation of high precision coordinates in the national reference frame, SWEREF 99. It is based on the Bernese GNSS Software and uses static GNSS-data for a single new point and data from surrounding SWEPOS-stations. The service was developed already in 2000 and was at that time an important complement to SWEPOS Network RTK-service before this service covered the whole nation, but it is still an important tool to easily achieve high precision SWEREF 99 coordinates and is used when the uncertainty from SWEPOS Network-RTK not is sufficient. SWEPOS Post Processing Service is used as an alternative to control surveying in many large infrastructure projects in Sweden and also internally by Lantmäteriet e.g. when coordinates at new SWEPOS-stations are determined. SWEPOS Post Processing Service does actually comprise a number of services: the original ordinary service which is a nation wide service based on SWEPOS fundamental stations and several local services mainly established for large infrastructure projects, so called project adapted services. The system for SWEPOS Post Processing Service was completely renewed during 2015 (new supporting programs, use of SWEPOS database and upgrading to version 5.2 of the Bernese GNSS Software).

SWEPOS Ordinary Post Processing Service



In the ordinary service the new point is determined relative to the 5 closest SWEPOS fundamental stations (blue) and other close by class A stations (red). Baselines are defined as a star from the new point.

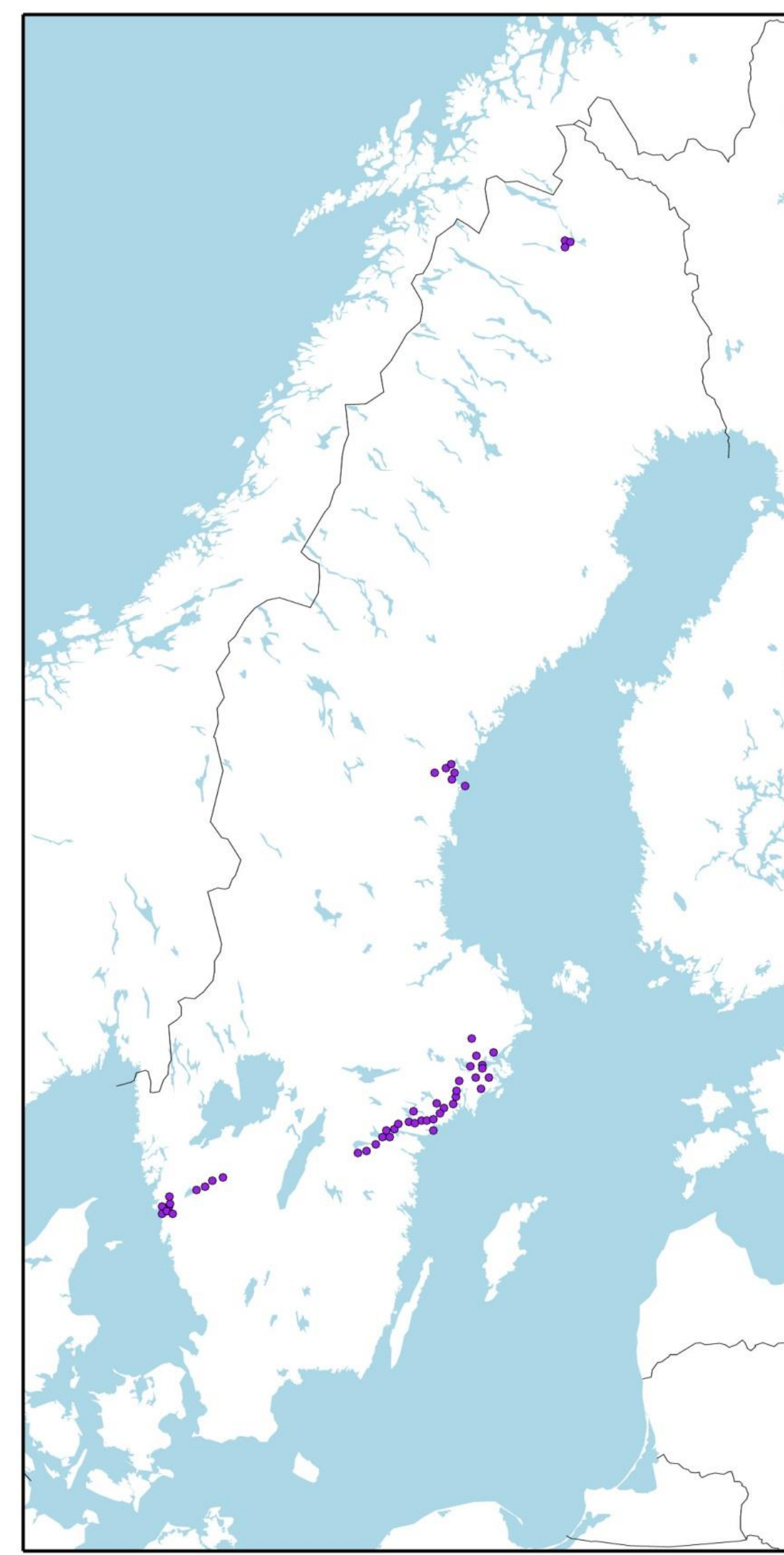
The GNSS processing is performed with the following options:

- GPS or GPS+GLO (user option)
- Ionosphere free linear combination
- Hourly troposphere parameters GMF
- Ionosphere model if available
- 10 deg cut-off
- IGB08.atx
- IGB08/ITRF2008

The solution in IGB08/ITRF2008 is reduced to epoch 1999.5 with the velocity model NKG_RF03vel (modelling the land up-lift).

Finally it is fitted to the SWEREF 99 coordinates (valid for the observation day) of the SWEPOS-stations with a Helmert-transformation (6 parameters).

SWEPOS Project Adapted Post Processing Services



At present there is 9 project adapted services in operation for large infrastructure projects and one local service in Stockholm. The project adapted processing services have replaced horizontal control networks in the projects.

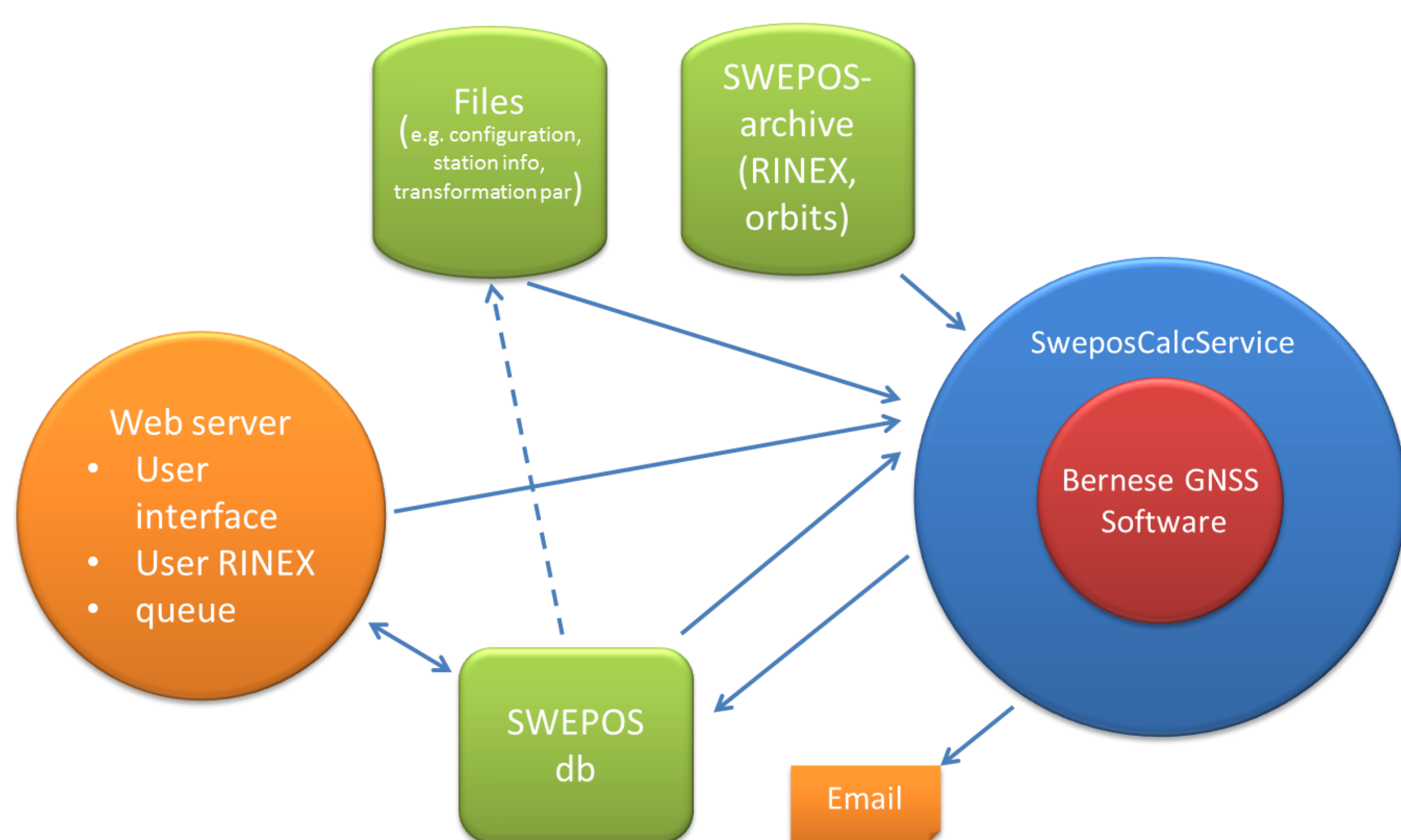
All SWEPOS-stations within 10 or 20 km (service dependent) are processed but just the baselines with satisfactory ambiguity resolution are used for the final alignment to SWEREF 99.

The GNSS-processing is performed with similar options as the ordinary service. The differences are:

- L1 instead of ionosphere free linear combination.
- troposphere parameters are not always estimated

The final alignment to SWEREF 99 is made using a 3-parameter Helmert fit after reduction for the land up-lift with NKG_RF03vel.

System overview



- The Web server is taking care of the communication with the user including checking of the uploaded RINEX-file and the queue of ordered jobs.
- SWEPOS database holds tables for the different services and jobs as well as station and coordinate information for the SWEPOS-stations.
- The SWEPOS archive comprises the RINEX-files from SWEPOS as well as necessary orbit, EOP files fetched from CODE (Center of Orbit Determination in Europe).
- The program SWEPOS CalcService prepares all data that are needed for the processing, starts the processing in the Bernese GNSS Software and finally takes care of the result and compiles an output-file.
- The coordinate computation is performed by the Bernese GNSS Software version 5.2 using the Bernese Processing Engine (BPE).
- A processing report including calculated coordinates in SWEREF 99 and RH2000 (and local system for some of the project adapted services), input-options (e.g. used orbits, antenna models, ionosphere model), quality parameters (e.g. ambiguity resolution and rms of the Helmert fit) as well as a map with the Helmert residuals is send by email to the user and is also available at the web server.

Results from testing

The ordinary service gives a standard uncertainty of 1 cm in horizontal and 2 cm in height (in SWEREF 99) with an observation time of at least 2 hours if a Dorne Margolin choke ring antenna is used. For 24 hour sessions the corresponding values are approximately 5 mm and 1 cm. For heights in RH2000 the uncertainty of the geoid model SWEN08_RH2000 (10-15 mm) has to be considered. For the project adapted services 1-2 hours observation time gives a standard uncertainty of 6-8 mm in horizontal and 11-13 mm in height (in project specific system and levelled heights).

In connection to the establishment of the latest project adapted service different options were tested with the following conclusions:

- The coordinate differences between GPS and GPS+GLONASS are negligible in case of two hour sessions on stations with a good environment.
- The correction for land up-lift was not significant for the project adapted service but was included anyway as it might have an impact in the future.
- The use of an ionosphere model in the project adapted services reduce the scale effect and makes it unnecessary to solve a scale factor in the Helmert-fit.

Jobs statistics

1422 jobs (besides our own testing) have been processed during the last year (2015.08.15-2016.08.15). The main part belongs to the ordinary service (907) and 70% of them are external (the other 30% are mainly preliminary coordinate determination on new or altered SWEPOS-stations). The SWEREF-service is a version of the ordinary service that we use internally for monitoring the SWEREF 99-system (so called consolidation points).

