

Norwegian Mapping Authority Analysis Center Biennial Report 2019–2020

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Abstract During 2019 and 2020, the Norwegian Mapping Authority has continued the development of the analysis software **Where** that began in 2015. NMA started to contribute to the operational analysis of R1 and R4 sessions in 2019 and has contributed to the ITRF2020. Work has also been done to scan the antenna dish at NYALES20 to model the effect of gravitational deformation. The operational analysis is expected to continue, and special attention will be given to the analysis of data from Ny-Ålesund in the near future.

1 General Information

The Norwegian Mapping Authority (NMA) has been an Associate Analysis Center within the IVS since 2010. The Analysis Center is operated by the Geodetic Institute at NMA with main offices in Hønefoss, Norway. NMA is a governmental agency with approximately 800 employees, and the IVS activities at NMA are completely funded by the Norwegian government.

NMA is using the analysis software **Where**, which is developed at NMA. **Where** and its companion library **Midgard** is freely available as an open source at GitHub.^{1,2} At the moment **Where** is capable of analyzing single sessions of VLBI data, but work is also

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¹ <https://kartverket.github.io/where>

² <https://kartverket.github.io/midgard>

underway to analyze weekly SLR data and some special applications of GNSS.

1.1 Staff

The Geodetic Institute at NMA has approximately 50 employees. Some of the responsibilities include maintaining the national reference frame, geoid, and height system. The Geodetic Institute also provides a network-RTK positioning service and operates the VLBI stations in Ny-Ålesund [2].

The Analysis Center is organized under a small section named Global Geodesy, and in April 2020 Hans Christian Munthe-Kaas replaced Laila Løvhøiden as the section manager. The VLBI analysis group is small and listed in Table 1. Development of SLR analysis is led by Ingrid Fausk, and development of GNSS applications is led by Michael Dähnn.

Table 1 VLBI analysis group.

Name	Role
Ann-Silje Kirkvik	Developer and analyst
Åsmund Skjæveland	Analyst
Leo Olsen	Analyst

2 Activities during the Past Years

The years 2019–2020 have certainly been a special period. While 2019 was pretty normal, 2020 was not. In Norway the whole country went into lockdown on the

12th of March due to the global pandemic with the novel coronavirus. Everyone that was able was sent home and had to work from home. Despite these challenges, the operations of the Analysis Center and related activities have managed fairly well.

2.1 Analysis Center

Towards the end of 2018 analysis results obtained using **Where** were finally comparable with analysis results from other established analysis software packages [1]. And in March 2019 the first submissions for the operational daily SINEX solution started. Shortly afterwards, the version 4 VGOSDB which **Where** relies upon to do the analysis became unavailable for approximately two months, but the regular analysis and submissions resumed in May of the same year. Since then, the analyzed R1 and R4 sessions submitted by NMA have been included in the combined IVS solution. The submitted solutions can be found at the IVS Data Centers with the solution code 2019a. But, on request from the IVS Combination Center (CCIVS), NMA switched to a new solution (2020a) from the 22nd of October 2020 and onwards. The 2020a solution is updated with the same models used for the ITRF2020.

The operational R1 and R4 analysis is to some degree automated, but there is still significant room for improvement. The observation files are downloaded automatically, and the analysis is also started automatically when a new observation file has been added or an old one has been updated. Files which contain a priori information needed by the analysis are also downloaded and updated automatically. After the automated analysis is complete some key parameters are investigated. These are parameters such as variance factor, root mean square, and parameter estimates. If any of these parameters is outside normal values human interaction is needed. If everything is normal the solution is also delivered automatically. The operational analysis is managed by Åsmund Skjæveland.

2.2 ITRF2020

The main activity during these past two years has been preparation for an analysis of sessions for ITRF2020. **Where** had to be updated to support the new models that were required. These models are available from version 1.0.4 of **Where** and include:

- New mean pole-tide model;
- New high frequency EOP model;
- ICRF3 and galactic aberration, and
- Gravitational deformation of VLBI antennas.

The IVS contribution to the ITRF2020 includes approximately 6,500 S/X sessions and 38 VGOS sessions. This was the first time all of these sessions were analyzed with **Where**, and it was a substantial task to investigate these sessions to look for clock breaks, outliers, and other potential problems. See Figure 1 for a screenshot from **There** (the graphical companion program to **Where**) of a sample session from the ITRF2020. The final ITRF2020 submission from NMA was delivered at the beginning of 2021. Development of **Where** and analysis for ITRF2020 has been done by Ann-Silje Kirkvik.

2.3 Gravitational Deformation Model for NYALES20

Because gravitational deformation of VLBI antennas was to be included in the analysis for the ITRF2020 and the other operational products in the near future, NMA started to investigate the possibilities of doing a laser scanning of the antenna at the station NYALES20. This station has a long time series going back to 1994 and has participated in many sessions over the years and is therefore an important station in the network.

NMA did not have the equipment or resources to do this job without aid and therefore came to an agreement with the Swedish company RISE³, which had experience doing a similar job for the station ONSALA60. This work was led by Torbjørn Nørbech (retired) from NMA with the assistance of the personnel at the station.

The original plan was to do the scanning in May 2020, but travel restrictions all over the world made it

³ www.ri.se

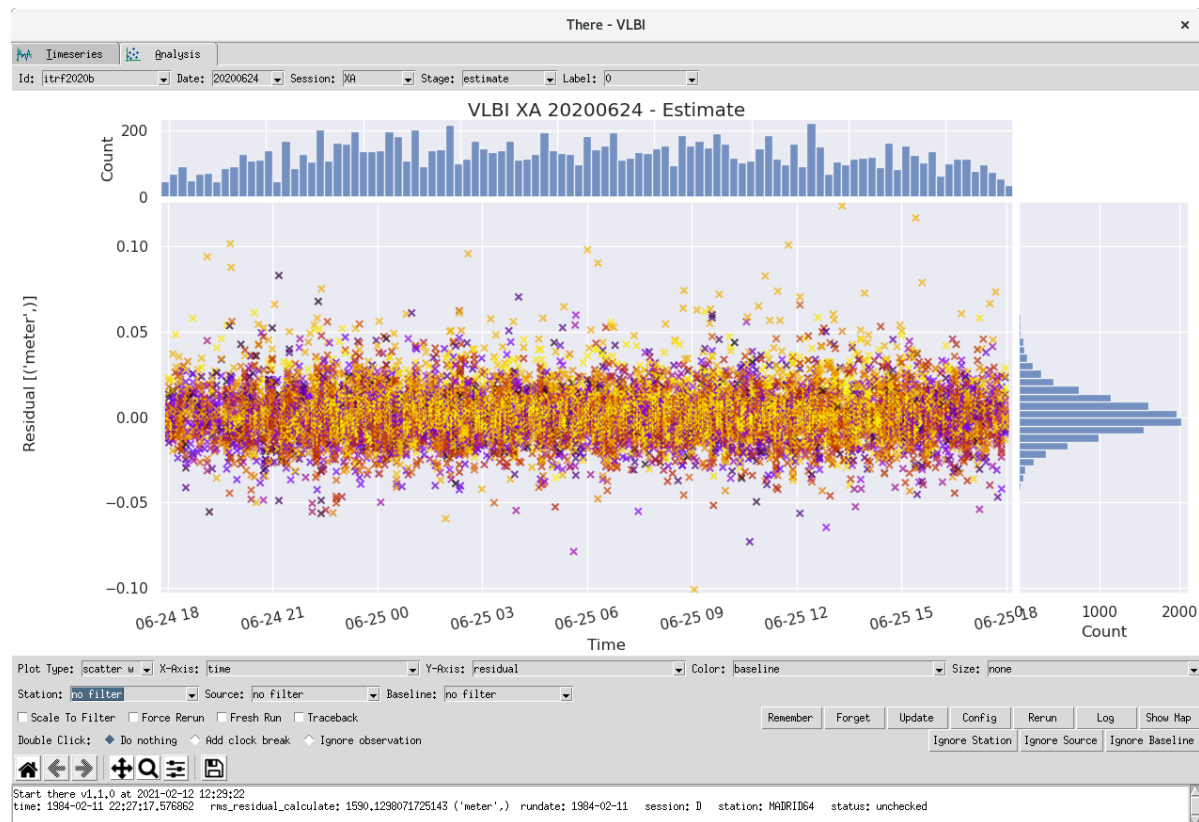


Fig. 1 Postfit residuals (before outlier rejection) for the mixed mode session RD2005 (20JUN24XA), one of thousands of sessions analyzed for the ITRF2020.

impossible to stick with the original plan. The scanning was postponed to the end of August 2020, and the deformation model became available at the beginning of November. The model is ready to be applied for the rapid operational products whenever the IVS chooses to do so. The modelled deformation can be seen in Figure 2, where the black line dL is the total change in path length. RISE is working on a publication to document the work that has been done.

2.4 Other News

The Analysis Center at IGN (Spain), which is using **Where**, has also started operational analysis of R1 and R4 sessions. IGN has also recently hired José Carlos Rodríguez, who has experience with SLR analysis from his previous work, and he has been a helpful resource for Ingrid Fausk with the development of the

SLR analysis in **Where**. To facilitate this cooperation the complete SLR code for **Where** was also released at GitHub in version 1.1.0. The SLR analysis is not complete, and the results should not be used for anything yet, but input on how to improve the analysis is welcome.

3 Current Status

The global pandemic is still upon us, and as much work as possible is still done from home. The operational analysis is going smoothly, and the ITRF2020 submission is complete.

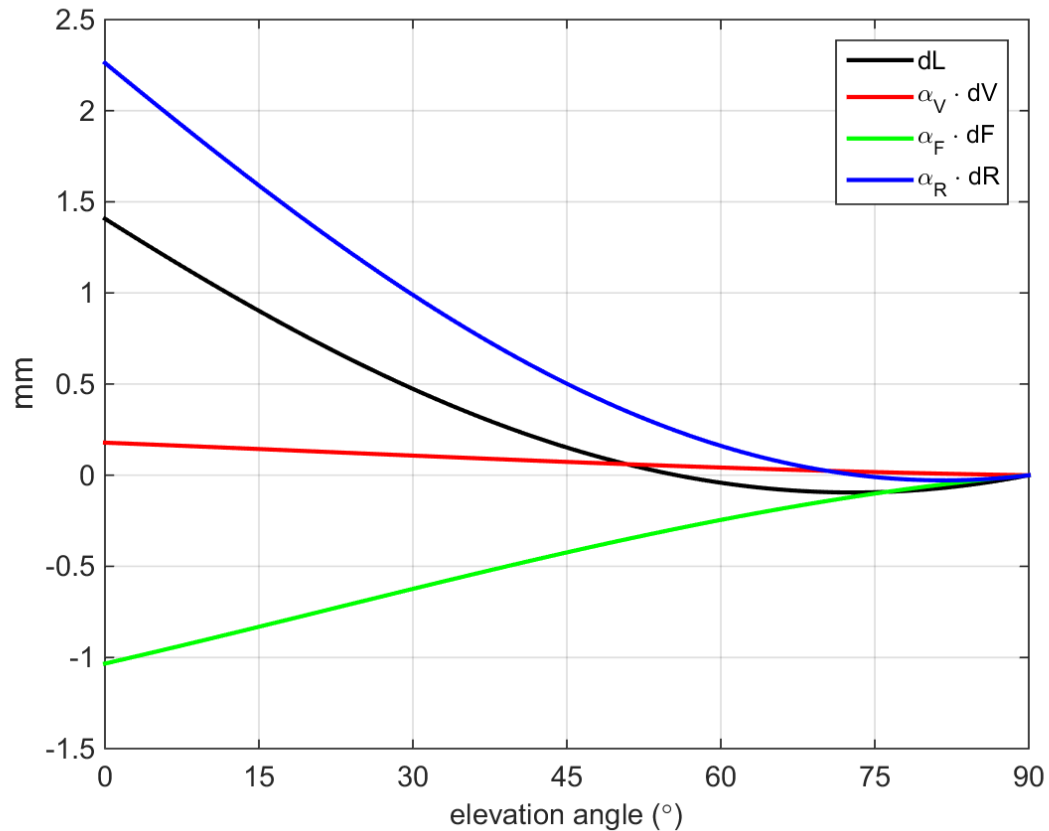


Fig. 2 Gravitational deformation of the NYALES20 antenna. Provided by RISE.

4 Future Plans

NMA will continue with the operational analysis of R1 and R4 sessions. With the completion of ITRF2020, the focus will shift towards investigating the upcoming sessions from Ny-Ålesund: both the future VGOS sessions from NYALE13N and the S/X sessions from NYALES20 and NYALE13S. The latter will be useful for comparing the computed baseline with the measured local tie vector.

References

1. A-S. Kirkvik, “Norwegian Mapping Authority Analysis Center 2017—2018 Report”, in *International VLBI Service for Geodesy and Astrometry 2017+2018 Biennial Report*, edited by K. L. Armstrong, K. D. Baver, and D. Behrend, NASA/TP-2020-219041, pp. 225–229, 2020.
2. P. Kupiszewski et al., “Ny-Ålesund Geodetic Observatory”, in *International VLBI Service for Geodesy and Astrometry 2019+2020 Biennial Report*, edited by K. L. Armstrong, D. Behrend, and K. D. Baver, this volume.