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The current performance of the VLBI Global Observing System and comparison with legacy geodetic VLBI

Tobias Nilsson*(1), Periklis-Konstantinos Diamantidis(2), Rüdiger Haas(2), and Eskil Varenius(2)
(1) Lantmäteriet – The Swedish Mapping, Cadastral, and Land Registration Authority, Lantmäterigatan 2C, SE-801 82 Gävle, Sweden, http://www.lm.se
(2) Chalmers University of Technology, Onsala Space Observatory, SE-439 92 Onsala, Sweden

The VLBI Global Observing System (VGOS) is the next generation VLBI (Very Long Baseline Interferometry) system for geodesy and astrometry which is currently being deployed [1]. The goal of VGOS is to increase the accuracy of the results for, e.g., station coordinates and Earth Orientation Parameters (EOP) by one order of magnitude, over the legacy (S/X) geodetic VLBI system. To achieve this fast moving antennas (6–12°/s) are used and observing a large bandwidth between 3 GHz and 12 GHz. This makes it possible to do many more observations per unit time than what is possible with the legacy geodetic VLBI system, which should lead to better accuracy.

Since the beginning of 2019, bi-weekly operational VGOS sessions are being observed. It is planned to increase to a weekly observing frequency in the near future, with the long-term aim to have continuous observations 24/7. Currently, nine VGOS antennas are contributing to these sessions, with many more expected to join in over the next couple of years. The VGOS sessions are currently always observed simultaneous to a legacy VLBI session, and typically some of the antennas participating in the legacy sessions are co-located with a VGOS antenna. Thus, this allows for direct comparison of the results from the VGOS and legacy systems. Given that data from a decent amount of VGOS sessions are now available, a proper evaluation of the results from these sessions can be done. In this work we do such an evaluation, focusing on the estimated EOP and the tropospheric delays.

For the EOP we compare the estimates from the VGOS and legacy systems. We compare both the EOP estimated with daily resolution, what is currently the standard estimation interval for EOP, as well as EOP estimated with higher temporal resolution, e.g., hourly. Furthermore, we preform an external evaluation by comparing the polar motion and Length of Day (LoD) estimates to those obtained by GNSS (Global Navigation Satellite Systems). Since the precision of GNSS polar motion and LoD are generally considered to be better than what is obtained from legacy VLBI, this constitute a good reference.

For the tropospheric parameters – the zenith wet delays and horizontal tropospheric gradients – we compare the estimates from the VGOS and the legacy system at places where VGOS and legacy antennas are co-located. At one location, the Onsala Space Observatory, there are even two VGOS antennas co-located, allowing to check the internal consistency of the VGOS estimates. We also perform external validation by comparing the VLBI estimates to those from GNSS. All VGOS stations are co-located with a least one GNSS antenna. Furthermore, we compare the tropospheric parameters to those calculated from numerical weather prediction models, like ERA5 (the fifth generation ECMWF atmospheric reanalysis).

The results of this work provide information on the current performance of the VGOS system. However, we do not expect the expected performance to have been reached yet. Firstly, the size of the VGOS network is sill rather small with only nine operational antennas, all located on the northern hemisphere, while the goal is to have at least twice as many antennas with a good global distribution. Secondly, the antennas are currently not being pushed to their limits; currently they make 30-40 scans/hour, while the goal is 60-120 scans/hour. Nevertheless, we would expect the current performance to be at least as good as the legacy system. Thus, this study will provide information on the initial performance of VGOS, potential issues, and how close we are to achieving the VGOS goals.

References

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