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Assessment of parameters describing the signal delay in the neutral atmosphere derived from VGOS R&D sessions

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Abstract. VGOS is the next generation VLBI system for geodetic and astrometric VLBI. It is currently in its build-up phase and by 2022 the VGOS operational network has reached 10 stations. The main goal of the VGOS design is to improve the accuracy and precision of the estimated geodetic parameters by one order of magnitude compared to the so-called legacy S/X VLBI system. One important aspect in this context is the ability to correctly resolve small-scale and rapid variations in the signal propagation delay caused by the neutral atmosphere, which had been identified as one limiting factor in terms of accuracy of geodetic VLBI. VGOS addresses this topic by performing many observations per time unit that cover the local sky at the stations as uniformly as possible.

To achieve this, relatively small, 12-13 m diameter, fast-slewing radio telescopes with reasonably high sensitivity, backends with high sampling capability, and relatively large receiver bandwidths are employed in VGOS. Currently, at least a factor of two in the number of observations per station is achieved within operational VGOS sessions (VO) compared to legacy S/X VLBI. Dedicated VGOS Research and Development (R\&D) sessions achieve an even larger number of observations through minimizing the scan lengths. We analyse these VGOS R\&D sessions and assess the current ability of VGOS to sense small-scale, rapid variations in the signal propagation delay caused by the neutral atmosphere. We compare the VGOS-derived results to corresponding results from simultaneous observation with co-located instrumentation at VGOS sites. Among these is the Onsala Space Observatory which is operationally active with its VGOS twin telescopes since 2019. Onsala operates additionally to its VLBI stations a multitude of co-located GNSS stations, as well as a ground-based microwave radiometer.