Workflow for monitoring gravitational focal length changes of the HartRAO 26 m radio telescope's main reflector

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SUMMARY

Several telescope-related effects can interfere with VLBI (Very Long Baseline Interferometry) measurements and influence the signal path of the received radio signal. This, in turn, has an impact on the calculation of the station coordinates of the VLBI telescope and additional results that are calculated using VLBI observations, such as Earth rotation parameters or the International Terrestrial Reference Frame (ITRF). It is therefore necessary to determine such effects and correct the signal path for each individual VLBI observation. In addition to temperature influences, gravitational effects have a significant impact on the delay of the incoming signal. One gravitational effect is the overall deformation of the main reflector. For most telescopes, the main reflector has the shape of a rotational paraboloid with only the focal length describing its appearance. Consequently, changes in the focal length affect the length of the signal path and must therefore be determined to correct the delay observations.

This study investigates gravitational focal length changes of the 26 m radio telescope at the Hartebeesthoek site (HartRAO) in South Africa. It belongs to the South African Radio Astronomy Observatory (SARAO). For this purpose, laser scan data of 88 different telescope positions as two-face measurements were recorded in April 2024. In contrast to other deformation monitoring tasks, the null hypothesis is that the shape of the object is a rotational paraboloid when pointing at zenith, while in other positions this shape is kept as much as the construction constraints permit.

This paper deals with the measurement concept and the analysis. The analysis reveals local surface deformations, including noticeably tilted panels, and shows that the focal length increases with elevation. It is shown that the repeatability of the method is 0.6 mm, given by the standard deviation of several zenith positions.
