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On the potential of lunar observations in regular geodetic VLBI sessions

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Artificial radio sources on the surface of the Moon enable us to observe lunar based transmitters with geodetic VLBI. Although during the last years a few dedicated VLBI experiments have already been carried out, the question still remains how and to what extend new information can be derived from observing such targets. Therefore, we perform Monte Carlo simulations using the c5++ software in order to evaluate how the inclusion of lunar observations into regular VLBI schedules would impact classical Earth-related target parameters of geodetic VLBI such as station coordinates and Earth Orientation Parameters, as well as how it would extend the possibilities to determine selenoidic parameters. Our study is based on modified IVS-R1 observing schedules, originally created by the International VLBI Service for Geodesy and Astrometry (IVS) to determine Earth Orientation Parameters, thus representing state-of-the-art VLBI observing programs.

Based on our simulations, we demonstrate that an artificial radio source on the surface of the Moon can be located with both, accuracy and precision of better than 50 cm when observed along with quasars in the regular IVS-R1 session schedules. Moreover, we show that geodetic VLBI has the potential to improve our knowledge of lunar physical models and/or help to verify or update lunar ephemerides. We will discuss how the quality and quantity of lunar observations affect the uncertainty of the position of a non-moving artificial radio source located on the surface of the Moon and we highlight the factors limiting the determination of its position. Furthermore, we will reveal the impact of Moon VLBI observations on the determination of the Earth Orientation Parameters and VLBI station positions. We will also test the concept of VLBI lunar observations with simulations that reflect VGOS performance in terms of observation precision, number of scans and future network configurations. Thus, our simulations will provide valuable insights that motivate the scheduling and observation of lunar targets along with standard quasar targets and therefore are expected to stimulate new observing concepts for geodesy as well as planetary science.