Space debris observation potential with EISCAT 3D

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Abstract

We investigate the capabilities of the next generation ionospheric research radar EISCAT 3D (E3D) for space debris observations. We have used the current projected design of E3D as basis of this study. To model the performance of E3D for space debris observations, we have included basic radar equation based error analysis for range and range-rate observations. Because the radar will be multi-static, it is also capable of observing instantaneous three-dimensional vector velocities and positions by observing round-trip range and range-rate between the transmitter and three receiver sites. We have included error estimates for both of the the three-dimensional position and three-dimensional vector velocity observations. To estimate the fraction of total debris that can be observed with E3D, we have used the MASTER model. We have also investigated effects of radio wave propagation. E3D uses a relatively low VHF frequency (233 MHz), which experiences more radio wave propagation effects than more conventional higher frequency space surveillance radars. Our modeling shows that ionospheric ray-bending and group delay are severe enough that these effects need to be modeled in order to determine accurate orbital elements. As EISCAT 3D is an ionospheric research radar, there will be high quality ionospheric electron density measurements that can be utilized for radio propagation modeling.