

Space debris measurements with EISCAT radars—the first 1000 hours

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In the framework of a series of three ESA contracts since 2000, we have developed and implemented a method to use the EISCAT ionospheric research radars, located in northern Scandinavia and on Svalbard, to measure space debris in parallel with the standard EISCAT ionospheric measurements. When the work was terminated, due to lack of resources, in the spring 2006, we had accumulated about 10 000 debris events in about 800 measurement hours in 2004 and 2005. Space debris monitoring does not interfere with the standard EISCAT measurements, but takes both the transmission schemes and the antenna pointing directions as given and makes the best use of those. To allow dedicated amplitude-domain data processing in debris detection, we use a special digital receiver back-end in parallel with EISCAT's standard receiver. We implement coherent pulse-to-pulse integration by computing the radar ambiguity function from a segment of transmission and reception that typically covers coherently a few tens of pulses, 0.2–0.3 seconds. On the EISCAT 930 MHz radar, with about 3 hour false alarm time, 0.2 s coherent integration gives nominally 50% probability of detection of a 2.0 cm sphere at 1000 km range while on the 500 MHz EISCAT Svalbard radar, the corresponding minimum diameter is 2.7 cm. For the former system, the typical detection rate over LEO is 15–20 events per hour, on Svalbard, about twice as much. The peak detection rate, around 1000 km altitude, is between two and three events per hour per 50 km altitude bin at 930 MHz. Several issues complicate the interpretation of these data. First, it is difficult to achieve quantitative control on the integration loss in the coherent integration, especially in the common case of multi-frequency transmission. For quantitative comparison of our data with debris models, it seems mandatory to re-detect the events with non-coherent integration (since we routinely save the raw data of all events this is entirely possible). Second, none of the EISCAT antennas is equipped with a monopulse feed, so the target's path across the radar beam is not known, only a lower bound for the radar cross section can be estimated; and an unknown proportion of the events represent side-lobe detections. Third, the dominant pointing direction in EISCAT is towards south at about 70–80 degrees elevation, which makes it difficult to estimate Doppler-inclination. Nevertheless, the relatively large amount of data available from this new debris sensor, taken with two wavelengths at two high latitude locations often during long continuous measurements (weeks) and sometimes with multiple pointing directions, appears likely to present an interesting challenge for the debris models.