Flux comparisons from the Goldstone radar, Haystack radar, and HAX radar prior, during, and after the last solar maximum

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The continual monitoring of the low Earth orbit (LEO) environment using highly sensitive radars is essential for an accurate characterization of the dynamic debris environment. This environment is continually changing or evolving since there are new debris sources, previously unrecognized debris sources, and debris loss mechanisms that are dependent on the dynamic space environment. Such radar data are used to supplement, update, and validate existing orbital debris models.

NASA has been utilizing radar observations of the debris environment for over a decade from three complementary radars: the NASA JPL Goldstone radar, the MIT Lincoln Laboratory (MIT/LL) Long Range Imaging Radar (known as the Haystack radar), and the MIT/LL Haystack Auxilary radar (HAX). All of these systems are high power radars that operate in a fixed staring mode to statistically sample orbital debris in the LEO environment. Each of these radars is ideally suited to measure debris within a specific size region. The Goldstone radar generally observes objects with sizes from 2mm to 1cm. The Haystack radar generally measures from 5mm to several meters. The HAX radar generally measures from 2cm to several meters. These overlapping size regions allow a continuous measurement of cumulative debris flux versus diameter from 2mm to several meters for a given altitude window. This paper will discuss the analysis of Haystack, HAX, and Goldstone data from 1998 through 2005. These years correspond to periods before, during, and after the peak of the last solar cycle. Additionally, the flux as a function of altitude for debris sizes greater than 5mm will be described using Haystack and Goldstone radar data before, during, and after the last solar cycle. These analysis results include error bars that represent statistical sampling errors, and are detailed in this paper.