Satellite Mega Constellations

Peter Yoachim[1]

[1]*University of Washington, Dept. of Astronomy, Box 351580, Seattle, WA 98195, USA*

(Dated: August 10, 2023)

ABSTRACT

Updates on how satellite mega constellations could impact observations of solar system objects and the overall fraction of pixels that could be lost to satellite streaks. Overall, we continue to find that planned satellite constellations would have a sub-percent impact on the number of pixels lost to streak masks and a sub-percent impact on solar system object detection.

1. INTRODUCTION

Throughout this paper we consider a Gen 2 Starlink satellite constellation as in Hu et al. (2022). This constellation has 30,000 satellites in altitudes ranging from 340 to 614 km. We pair that with the pointing history generated in the baseline 3.0 survey cadence simulation. This 10 year survey simulation has 2.08 million visits and includes high airmass visits in twilight time to search for inner solar system objects.

2. PIXEL IMPACT

After year 1, 8% of all visits would have at least one streak from the constellation. Per image, the mean streak length comes to 15.3 arcmin, so a 1 arcmin streak mask would results in 0.04% of all pixels being lost (assuming 0.2 arcsec per pixel and 3.2 Gpixels per visit).

Some of the most impacted observations are the high airmass observations taken in twilight to detect inner solar system objects. These visits consist of single 15s snaps. Table 2 breaks down the impact of streaks for twilight and non-twilight NEO visits.

2.1. *Toss a Snap*

visits	N visits	at least one streak	total pixels lost with 1 arcmin mask
all	216120	8.4%	0.043%
2x15s	210679	7.4%	0.039%
1x15s (twilight NEO)	5441	45.7%	0.19%
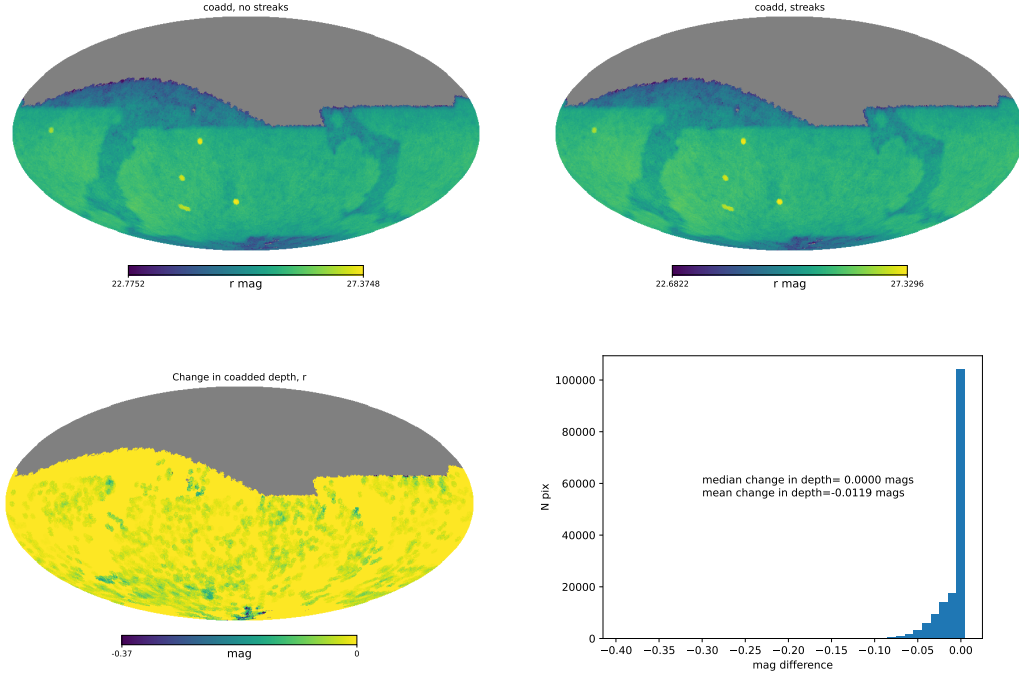
Figure 1. Top Left: Coadded depth in r after 1 year with no streak losses. Top Right: Coadded depth in r where snaps with streaks have been excluded. Bottom Left: Difference between the top images. Bottom Right: Histogram of the depth differences.

We can consider a "worst-case" scenario that if a visit contains a satellite streak, then the snap with the streak is completely discarded and the visit is reduced to a single 15s exposure rather than two 15s exposures. This would result in the 5-σ limiting depth being 0.37 mags shallower than if there was no streak.

In Figure 1, we show the result for rejecting snaps with streaks for the first year of the baseline v3.0 survey in r.

For this subset of exposures (r band in the first year, only 30s visits so no twilight NEO observations), we find that of the 44,000 visits, 5% would be streaked by an illuminated satellite. The majority of the sky would be unaffected, with the mean change in coadded depth being 0.011 mags.

3. SOLAR SYSTEM IMPACT

We can check how satellites could impact discovery of solar system objects.

We use a sample of 10k objects in Vatira-like orbits and find which objects could potentially be observed in the 10 year LSST survey. We then check which of those Vatira detections would intersect with Starlink streaks. For an extremely large 10 arcmin wide streak mask we find 5.7% of the Vatira objects would hit a streak, and for a (still generous) 1 arcmin wide streak mask 0.53% of Vatira observations would hit a streak (6,117 Vatira potential observations drops to 6,068).

The Vatiras are the most sensitive to satellite streaks. When we repeat the experiment for PHA NEOs, only 0.07% of potential detections are lost to a 1 arcmin streak.

Note that these losses do not directly translate to losses in object identification, e.g., if there are 10 observations of an object, and one is lost to a satellite streak, we will probably still be able to fit it's orbit.

APPENDIX

A. REFERENCES

REFERENCES

Hu, J. A., Rawls, M. L., Yoachim, P., & Ivezić, Ž. 2022, ApJL, 941, L15

B. ACRONYMS

Acronym	Description
LSST	Legacy Survey of Space and Time (formerly Large Synoptic Survey Telescope)
NEO	Near-Earth Object
PHA	potentially hazardous asteroids