Reply to Reviewer 2

We thank the reviewer for their careful read of our manuscript and have replied to the comments below. The reviewer comments are shown in italic font.

115 - The manuscript specifies that only onset times between 6 and 12 MLT are included. A magnetic local time is a geometry which doesn't seem to fit this description. This needs to be clarified. This reference to MLT is again used at line 172. I think this is likely a restriction of the GOES spacecraft location, but it needs to be specified a bit more clearly.

We have modified the text in two locations to indicate that this was a constraint on the GOES spacecraft location when the MLT constraint was mentioned.

217 - "the the" - one of the instances can be deleted

Thank you. This has been corrected.

A general comment to the authors - This is not a criticism or requirement for a publishable text, but it could improve the manuscript or at least illuminate more of the driving physics. The use of long-term averages sweeps some of the physics under the rug. Elements such as a plasmaspheric plume, or the time scales of convection or ion outflow are likely smeared in one day or 12 hour bins. Smaller temporal bins would likely illuminate how some of these elements control the density at geosynchronous.

We agree. This is part of the reason that we considered one-hour bins instead of the usual one-day (or longer) bins. The limitation that we found with one-hour bins is the constraint of available data. Initially, we had hoped to be able to provide insight into some of the more interesting physical processes such as those mentioned, but the limitations on available data when one-hour bins are considered made that impossible.

We have added a few sentences in the second-to-last paragraph of the summary and conclusions in an attempt to provide additional insight into the driving physics:

> “Denton et al. [2016] showed that the ratio of O + /H + changes greatly with solar cycle, with larger amounts of O + occurring during solar maximum (when F 10.7 is elevated). The dependence of the mass density response on F 10.7 suggests that the process responsible for enhancing ρ eq during geomagnetic storms may have a strong sensitivity to the O + /H + ratio.”

Additionally, Dst, is not a direct measure of what is typically driving the plasmasphere. The plasmasphere evolution is more accurately driven by the polar cap index or convection electric field. Since the Dst is a measure of the ring current, it takes time for this to build up after the

onset of a storm therefore the density at GOES will likely start changing before Dst reaches the storm threshold drawn by the authors.

Other elements such as ion outflow or substorm injections which also feed the equatorial magnetosphere with plasma likely do not respond directly to Dst. All this being said, there are strong correlations between the different geomagnetic indices, so although it may not be an exact proxy for the physical driving mechanism, Dst could still be a reasonable indicator of density evolution at geosynch.

Initially we had considered using Kp and the polar cap index, but Kp and Dst provide essentially the same interpretation, and the polar cap index has issues with availability and calibration that would have complicated the interpretation.