CloudSat Project
A NASA Earth System Science Pathfinder Mission

Comment on Geolocation & Surface Height error in Epoch 09 data
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(applies to data collected between July 11 2019 to August 26, 2020)

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Starting on July 11 2019 and continuing through August 26 2020, the apparent height of the surface in the radar profiles is not consistent with the Digital Elevation Map (DEM) that has been used with all CloudSat operational products throughout the mission. Figure 1, below shows an example of the mismatch.
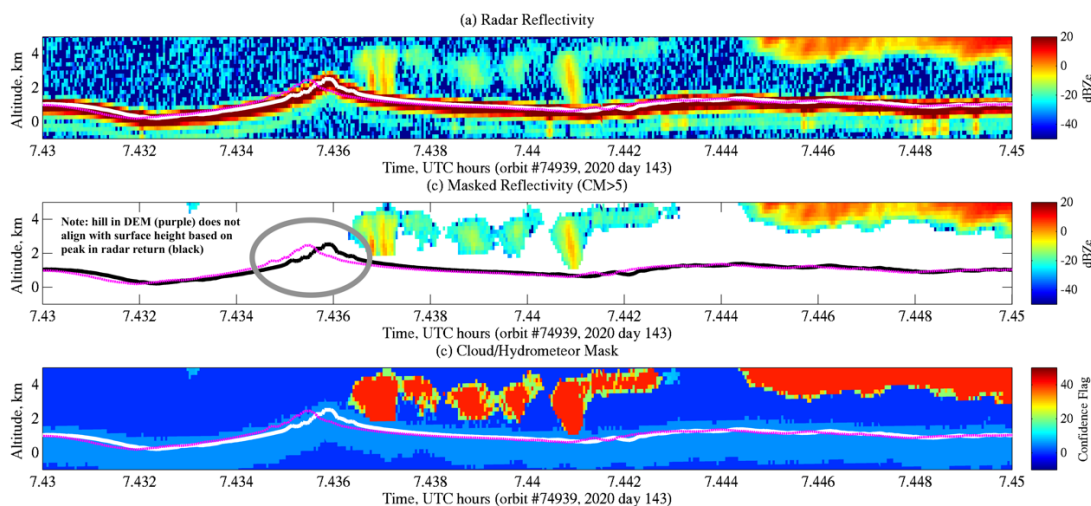

Figure 1 – Example showing mismatch between DEM (purple line) and surface height determined from the radar reflectivity profiles (black or white line depending on panel).

The mismatch is a result of an error in the satellite pointing or timing data or both. While still under investigation, at present the cause has not been isolated.   Rather than further delaying the release of these data, they are being released as-is with the pointing/timing error. Files during this time period are labeled E09 (for Epoch 09). **Fundamentally, this means there is a substantially larger uncertainty in the**

location where the radar beam intersects the surface that may be as large as 10 km.

The extent of the mismatch varies considerably between orbits. Figure 2 below show the sum of the mean squared error between the DEM and the surface height estimated from the radar profile ($sum\ MSE =$ $\sum \sqrt{DEM\_Height^2 - Radar\_Surf\_Height^2}$).
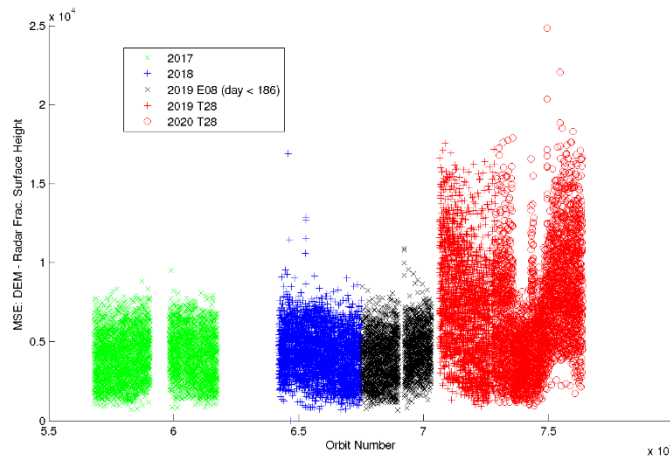

Figure 2- Sum of Mean-Squared Error (MSE) between DEM and radar-based surface elevation on an orbit by orbit basis. The period July 5 2019 to August 26 2020 is shown in red.

In some orbits, the offset is obvious and appears as a shift in the along track position (with offsets as large as 6 columns). Figure 1 is such an example. But in other orbits, the mismatch can not be eliminated by any shift in the along track position and it appears the pointing or timing error is creating a cross track shift. It is not clear if the shift is constant over an individual orbit.

The mismatch has only small effect on the CloudSat 1B-CPR and 2B-GeoProf products. The primary impacts are:

1) The position of the surface is important for the identification of surface clutter. The GeoProf cloud (hydrometeor) mask relies primarily on the surface location as determined from the radar reflectivity observations, and so the error does not generally cause problems in the clutter identification. (Note in example #1, the surface clutter associated with the hill is correctly identified as clutter, mask value = 5). There are however, a small number of radar columns (much less than 1%) where heavy attenuation prevents the surface from being properly identified from the radar observations and the DEM is used in the clutter filtering and can result in errors in the clutter identification.

2) The pointing also affects the land-sea mask, which is based on the DEM. Thus, regions near land/sea boundaries are sometimes being incorrectly flagged.

The impact on downstream CloudSat products has not been investigated, but is expected to be small.