

MODIS/Aqua, AIRS, MLS and CloudSat Tracks Intercomparison. (NASA/GES DISC, A-Train Data Depot)

The intent of this document is to offer initial glimpse at the ground tracks formed by the fields of view (FOV) of some of the A-Train participating instruments. All of them are complex enough, and thus detailed knowledge of their ground coverage is not possible to be acquired by going through this one document only. We focus on the FOV because in the end this is what is important when merging science retrievals from multiple instruments into one realistic picture of atmosphere, rather than the platform location.

Thus, note the use of the expression “FOV” here. The tracks pictured below are not necessarily the ground tracks of the platforms carrying the instruments. Rather, they depict the geolocations assigned by retrieval algorithms to data that in general are radiances and reflectances at Level 1B, and final science parameters at Level 2, of processing. This distinction is particularly important for the MLS instrument, where the 3000 km boresight of the instrument results in correspondingly 3000-km separation between the platform ground point and the retrieval FOV at any time. In the case of CloudSat, the Level 1B FOV is not that of one projected antenna footprint on the ground. Rather, that FOV results form aggregation of about 600 pulses, sometimes called “bursts”, and thus the along-track axis of the FOV is larger than the projected antenna footprint. All that said, the case of MODIS and OMI is one of those where the nadir FOV is nevertheless a good approximation of respectively Aqua and Aura ground racks.

Another note relates to the imaging plane of scanning instruments like MODIS, AIRS, MLS, and OMI. MLS is distinct in that it scans in vertical direction in a plane close to tangent to the platform track. Thus its resultant cross-track width is about one FOV, that is about 10 km, and that width is mostly coming from the antenna pattern. MODIS, AIRS, and OMI, however, are imaging in the nadir cross-track plane. Whether using a cross-track scanning mirror (MODIS and AIRS), or a push-broom mode with wide-field of view telescope (OMI), these imagers yield wide cross-track swaths, that may have more than thousand of frames (pixels) across-track, that can cover more than 2000 km. For the sake of clarity of the presentation, however, we ignore the cross-track dimension of these imagers, and depict only tracks of singular, “collocated”, FOVs, thus emphasizing the relations between FOV sizes and locations.

Real data from **August 6, 2006**, are used throughout this presentation.

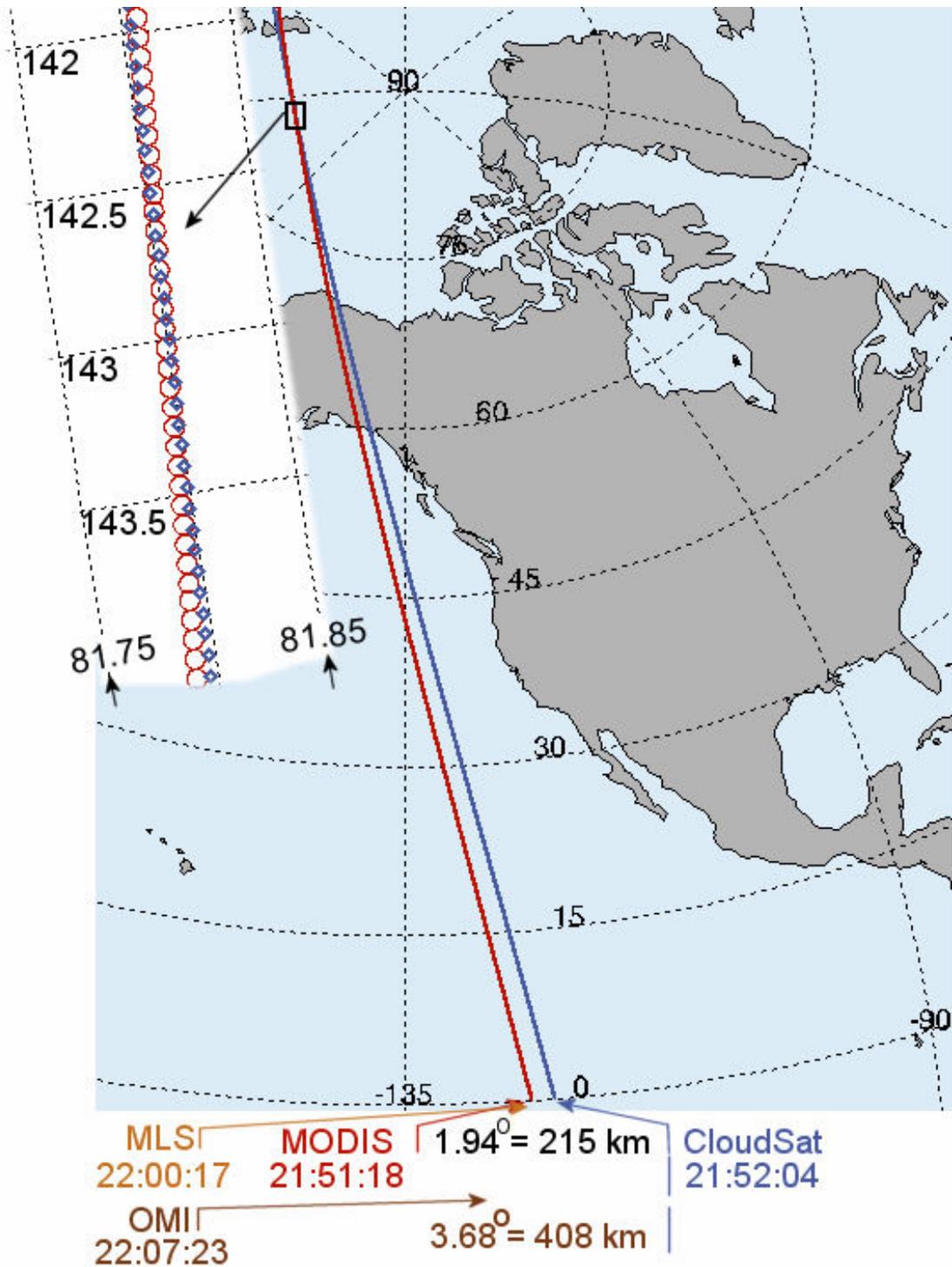


Figure 1. Equatorial longitudinal separations, crossing UTC times, and ground tracks of the MODIS/Aqua nadir pixel and the CloudSat fields of view (FOV), both at processing Level 1B. MLS FOV are practically overlapping with MODIS nadir, and at that scale cannot be distinguished. Even though MLS and OMI are on the same platform (Aura) OMI nadir sees the Equator after MLS, and is trailing CloudSat by 15:19 minutes. This

results in about 408 km separation between OMI nadir and CloudSat FOV at the Equator. The maximum track separation appears at the Equator, and is a complex result of platforms orbital characteristics, and Earth rotation. The cross-track separation is a function of latitude, and the insert shows latitudinal and longitudinal details of the tracks intersection at the North Pole. MODIS/Aqua 1-km FOVs are shown to scale in the insert as red circles, whereas the blue diamonds just show the position of the time stamps (aggregated rays) of CloudSat Level 1B retrieval. The actual size of the CloudSat Level 1B retrieved (resultant) FOV is shown in Fig.2.

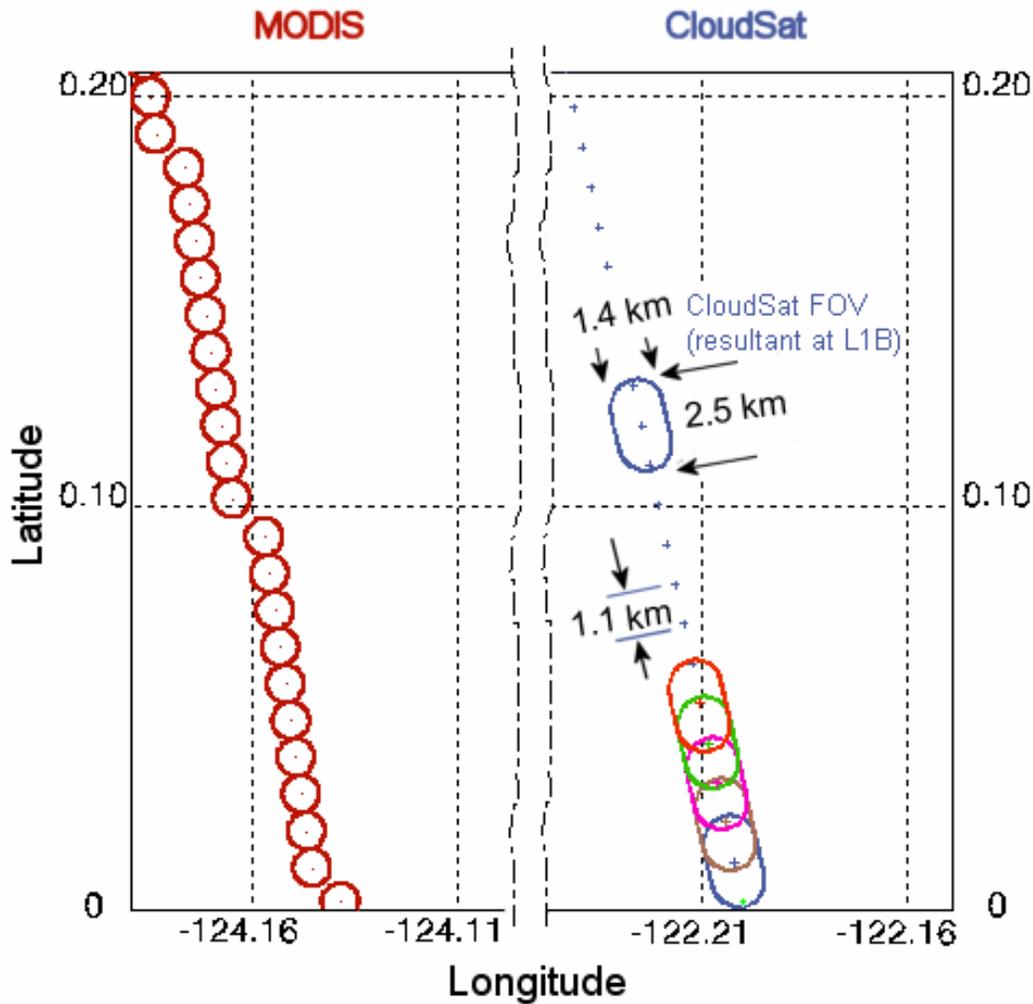


Figure 2. MODIS/Aqua 1-km nadir pixel (red circles) compared with the resultant size of the CloudSat Level 1B FOV, both shown to real scale of the map projections. The CloudSat FOV results from 0.16 sec of aggregation time during which the platform travels 1.1 km, and the radar sends about 600 pulses that are aggregated into one “ray”. Thus one aggregated CloudSat ray is recorded every 1.1 km in Level 1B. Given the radius of the CloudSat raw antenna footprint of 0.7 km, the resultant FOV has a long axis (along-track) of 2.5 km, and a short axis (cross-track) of 1.4 km.

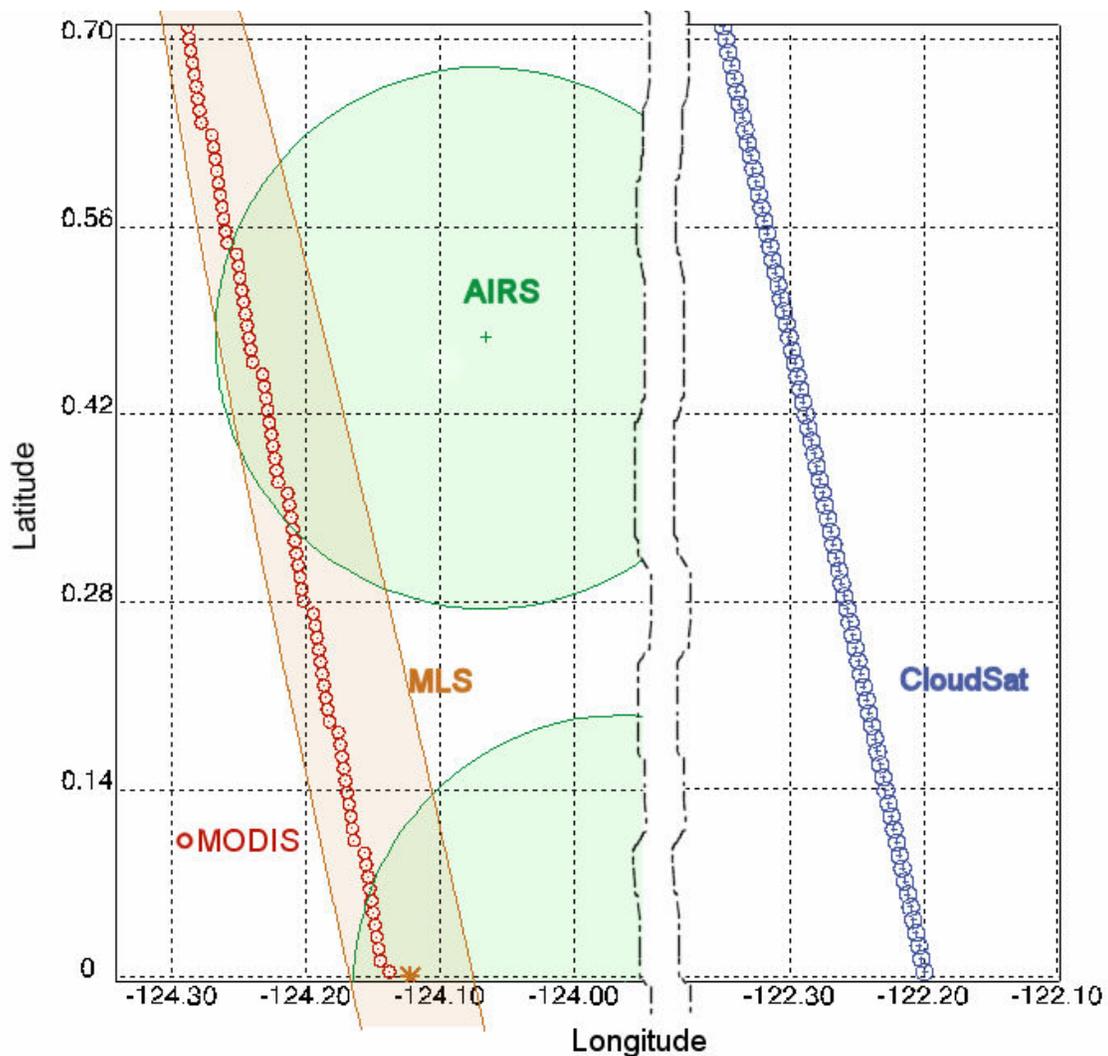


Figure 3. Relative sizes of MODIS Level 1B 1-km nadir pixels, the closest AIRS Level 2 final retrieval pixels, and a MLS FOV. The CloudSat track is presented here as a sequence of raw, 1.4-km diameter, antenna footprints to depict its swath width. (The actual CloudSat FOV size and shape at Level 1B are shown in Fig.2). The MLS FOV is a complex result of the instrument vertical scanning, platform orbital speed, and science retrieval. To acquire a feeling of the complexity of MLS profiles retrieval, Users should refer to: http://mls.jpl.nasa.gov/data/eos_overview_atbd.pdf. For the sake of this simplified presentation, however, the MLS FOV is depicted here as an ellipse drawn to scale of the map portion shown. The asterisk indicates the reported location of that particular MLS retrieved profile.

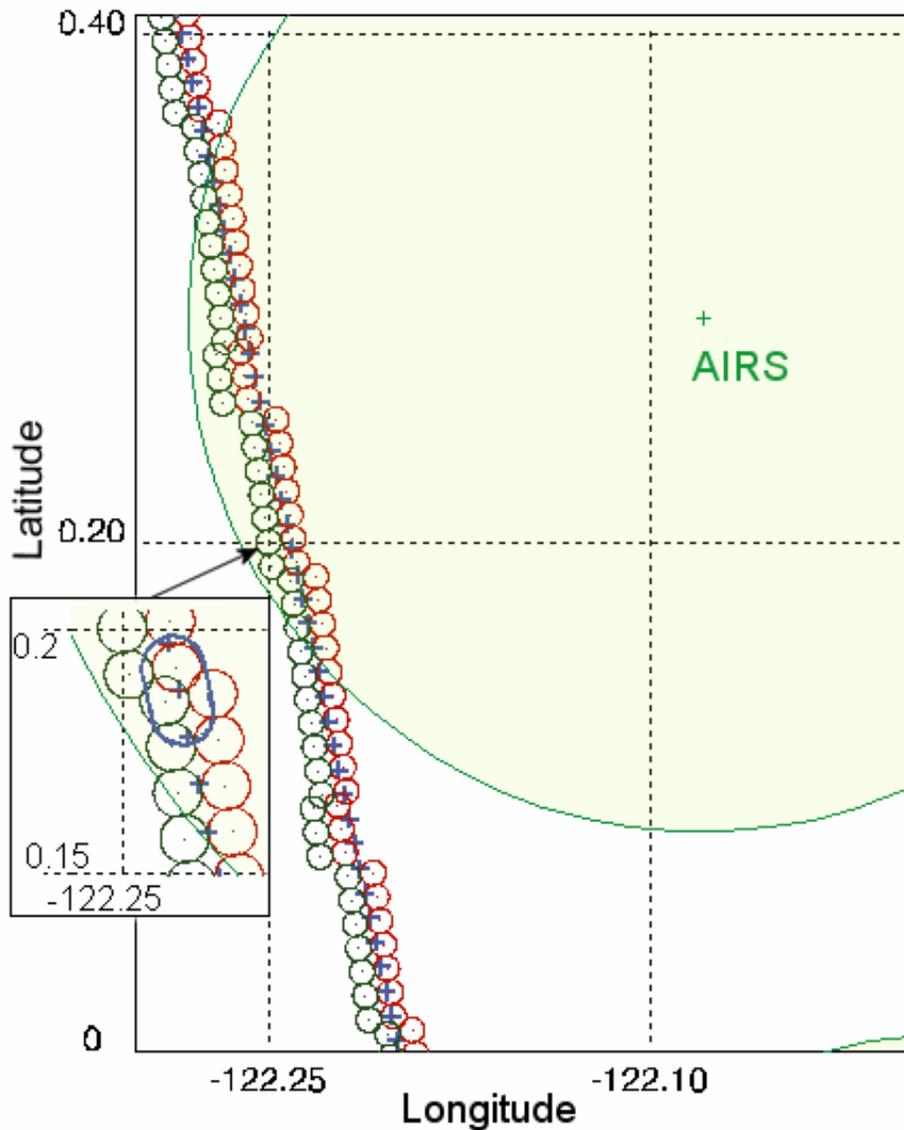


Figure 4. Parts of the collocated MODIS/Aqua operational subset (circles), relative to the positions of the CloudSat Level 1B FOV (crosses), and the closest AIRS Level 2 final retrievals. One actual CloudSat FOV is shown to scale in the inset for comparison. Red circles represent the median MODIS pixels in the collocated subset, i.e. frame #6, while greens are frame #5, if the narrow-swath subset is taken. The subset MODIS pixels depicted here are of 1.1-km size: given the farthest separation of MODIS nadir and CloudSat at the Equator, Fig.1, the collocated subset here is about 200 pixels from the nadir. The separation of the closest AIRS pixel from the CloudSat track clearly draws attention, and Figs.5 and 6 are provided to reveal closer details.

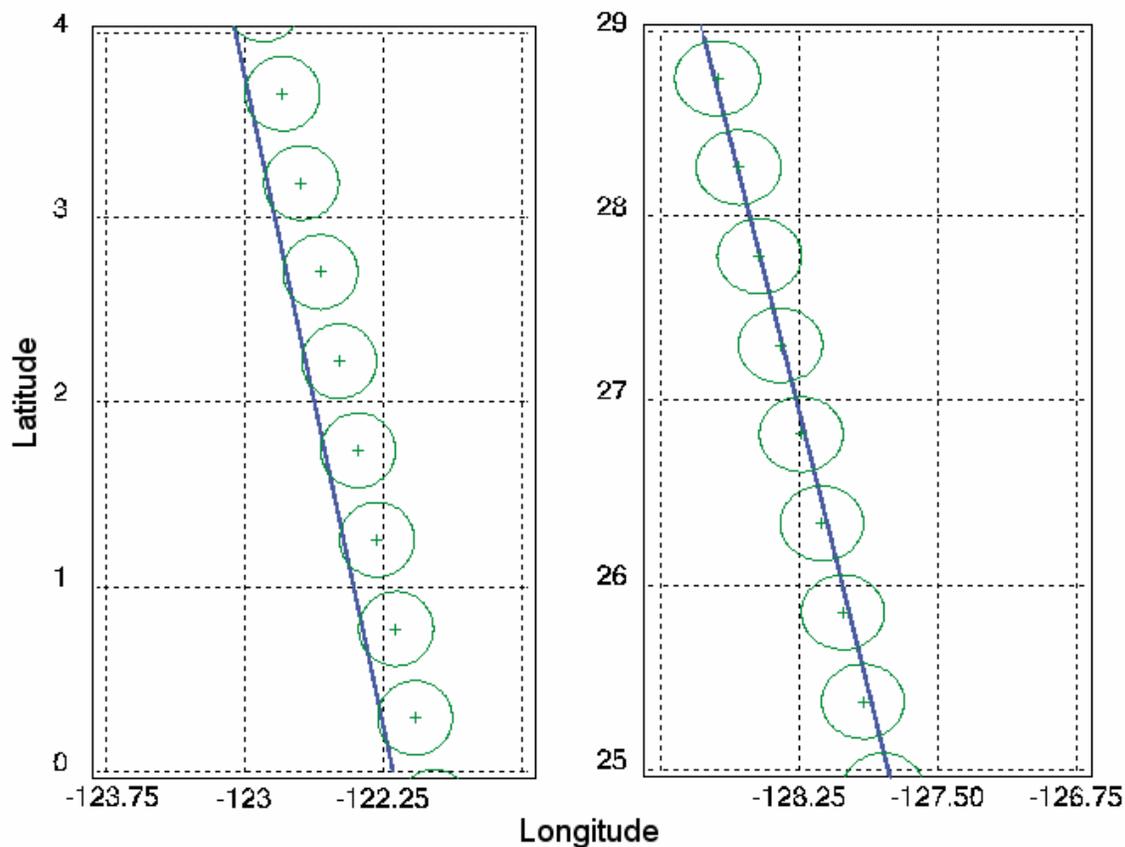


Figure 5. Separation of the CloudSat swath, shown to scale and thus appearing as thick blue line at that scale, and the closest AIRS final retrieval FOV (green ellipses). I.e. each circle is the one, out of the 30 cross-track FOVs, closest to the center of the CloudSat track. By “final retrieval” we mean the Level 2 AIRX2RET data type. The closest AIRS FOV is about 20-km off the CloudSat track at the Equator. However, thanks to their orbital declinations, the Aqua and CloudSat ground tracks separation is a function of latitude, Fig.1. This results in varying separation between the pair of closest AIRS and CloudSat FOVs, Fig.6.

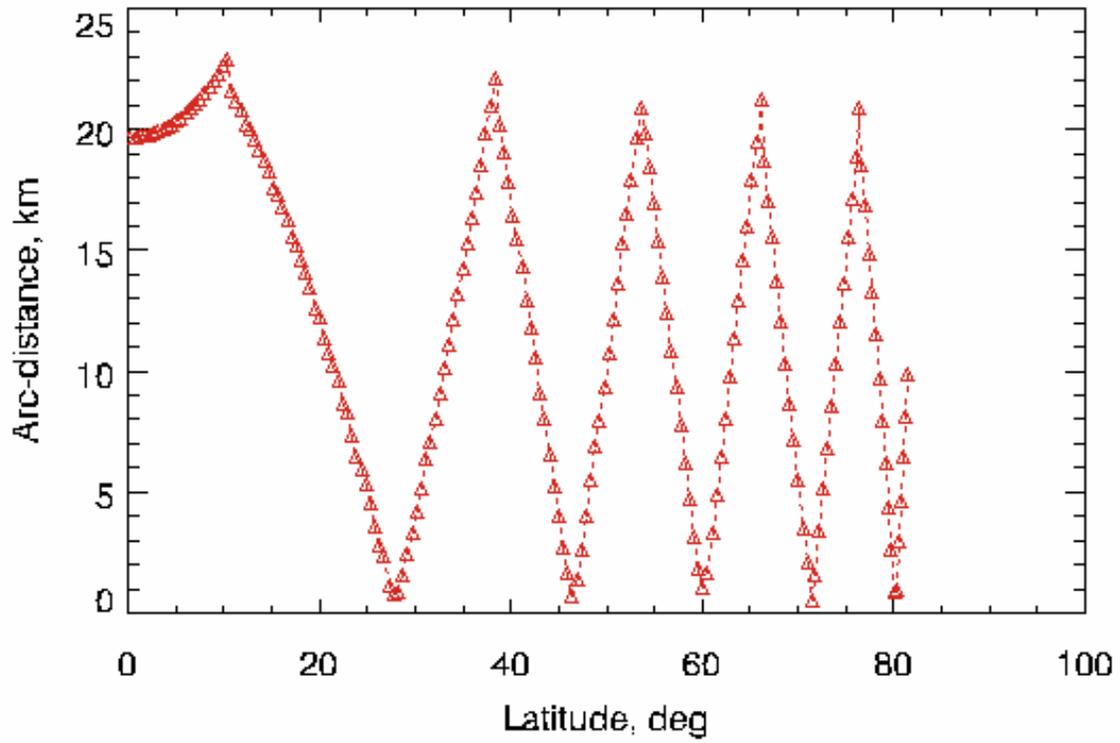


Figure 6. Variation of the arc-distance between CloudSat and the closest AIRS FOV's in the final retrieval.