

Explanation of the OSIRIS-REx OLA L2a V20 and V21 collections

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The OSIRIS-REx OLA L2a collection consist of two collections – V20 and V21.

Each of the individual L2a files in the collection consist individual OLA scans with coordinates referenced to each other and to the Bennu-centric coordinate system. They are derived from the raw OLA scans by a global matching process described in:

Barnouin, O. S., Daly, M. G., Palmer, E. E., Johnson, C. L., Gaskell, R. W., Al Asad, M., Beirhaus, E. B., Craft, K. L., Ernst, C. M., Espiritu, R. C., Nair, H., Neumann, G. A., Nguyen, L., Nolan, M. C., Mazarico, E., Perry, M. E., Philpoll, L. C., Roberts, J. H., Steele, R. J., Seabrook, J., Susorney, H. C. M., Weirich, J. R., and Lauretta, D. S. (2018 Submitted). Digital terrain mapping by the OSIRIS-REx mission. *Planetary and Space Science*.

Seabrook, J., Daly, M., Barnouin, O., Johnson, C., Nair, A., Bierhaus, E., Boynton, W., Espiritu, R., Gaskell, R., Palmer, E., Nguyen, L., Nolan, M., and Lauretta, D. (2019). Global shape modeling using the OSIRIS-REx scanning laser altimeter. *Planetary and Space Science*, 177:104688.

and the provided draft Seabrook et al. paper Building a high-resolution digital terrain model of Bennu from laser altimetry data.

The process described in the first two papers describe the basic assembly of the L2 scans into a self-consistent asteroid model. This model must be placed into the Bennu reference frame. In this case, this was done by matching using an iterative closest point algorithm to another model (SPC V42) with its prime meridian corrected by the flight navigation team.

During the mission, a mirror calibration problem was identified that resulted in a long-wavelength shape error. The initial correction was a single-axis expansion of the mirror coordinates that resulted in the V20 model. This resulted in the correction of the long-wavelength shape problem with the overall shape matching the camera images. The V20 model can be created by assembling all the V20 L2a files using the Bennu-centric cartesian coordinates that differentiate the L2a data from the L2 data.

Subsequent investigation and analysis resulted in a two-dimensional higher-order correction that resulted in, essentially, the same overall shape but improved the registration of each scan (L2a file) to the others. So the fine-scale topography is improved. This is the V21 model and the V21 L2a files that make it up.

To summarize, the L2a files come from the globally self-consistent models, registered to Bennu-space using the model used by flight dynamics. This provides the L2a coordinates for each individual L2a files. The L2a formats are described in the OSIRIS-REx Laser Altimeter (OLA) Uncalibrated / Calibrated Data Product Software Interface Specification UA-SIS-9.4.4-302. Details of the product generation may be found in Section 4.3.2.4 and the product format in Section 5.2.6.

The V20 L2a files are provided for reference as multiple manuscripts are based on these products. There is no known use-case for using the V20 files over the V21 files. We recommend the V21 files for all new analyses.