

OSIRIS-Rex Radio Science Bundle Information
Version 2.1 – October 7, 2022 – final lien resolution
Version 2.0 – April 28, 2022
Version 1.0 - June 22, 2020

OSIRIS-REx Radio Science Bundle Organization

The OSIRIS-REx Radio Science Bundle is a PDS4 compliant archive bundle housed at the PDS Small Bodies Node. The bundle contains both raw and derived radio science data products produced during the mission’s Bennu encounter. The structure of the bundle is as follows:

Table 1. OSIRIS-REx Radio Science Bundle Structure

Collection Name	Description	Filename Convention
document	Collection of documents describing the bundled radio science data including the antenna swap history and spacecraft mass history.	Various descriptive names
trk224_trknav	Collection of Tracking and Navigation data files (trk-2-34) acquired during Bennu encounter.	orex_beno_YYYY_DOY_HHMMSS_YYYY_DOY_HHMMSS_XX.tnf first date/time (YYYY_DOY_HHMMSS) = start time second date/time (YYYY_DOY_HHMMSS) = end time XX = DSN Antenna ID e.g.orex_beno_2018_231_141515_2018_231_203500_65.tnf
trk223_ion_vbli	Collection of mission specific Delta Differenced One-way Ranging Ionosphere Media Calibration data files (trk-2-23) acquired during Bennu encounter.	orex_beno_YYYY_DOY_YYYY_DOY_ion.csp first date/time (YYYY_DOY) = start time second date/time (YYYY_DOY) = end time e.g. orex_beno_2021_121_2021_150_ion.csp
trk223_ion_dopr	Collection of mission specific Doppler and range data Ionosphere Media Calibration data files (trk-2-23) acquired during Bennu encounter.	orex_beno_YYYY_DOY_YYYY_DOY_ion.csp, first date/time (YYYY_DOY) = start time second date/time (YYYY_DOY) = end time e.g. orex_beno_2021_121_2021_152_ion.csp
naf018_sff	Collection of Small Forces	orx_r_YYMMDD_YYMMDD_vXX.sff r = reconstructed

Collection Name	Description	Filename Convention
	(data) Files acquired during Bennu encounter.	first date/time (YYMMDD)= start time second date/time (YYMMDD) = end time e.g.orx_r_160909_160913_v01.sff

Additional mission independent Media Calibration, Weather, and Earth Orientation Parameters data can be found in the mission-independent DSN files bundle found at the Geoscience PDS Node: https://pds-geosciences.wustl.edu/dataserv/radio_science.htm. The data files found in this bundle can be used to calibrate radio science data collected from any mission. Specific information can be found in the bundle readme.txt document.

Deep Space Network Files

The OSIRIS-REx mission receives spacecraft tracking data from the Deep Space Network (DSN). Both mission navigators and science team members working on radio science investigations use these data. The OSIRIS-REx navigation and radio science teams receive DSN Tracking and Navigation File (trk-2-34) data, Media Calibration Files (Ionosphere Calibration Files, Troposphere Calibration File, trk-2-23), and Weather Files (trk-2-24) files via secure FTP. Of these files, only the Tracking and Navigation Files and the Ionosphere Calibration files are mission specific. The mission specific files are formatted in standard ways, documented in a series of Software Interface Specifications (SIS) noted in Table 2. All other DSN files are mission independent and can be found in the mission independent DSN files bundle archived at the PDS Geoscience Node (https://pds-geosciences.wustl.edu/radiosciencedocs/urn-nasa-pds-jpl_dsn_mmm/). The DSN SIS documents are not mission specific, they are applicable to all DSN produced data products. The DSN files are transferred to a secure area within the OSIRIS-REx Science Processing and Operations Center (SPOC) data repository. For archival, the mission specific DSN data files are retrieved from the SPOC data repository and prepared for delivery to the Planetary Data System.

Table 2. DSN Data Product SIS References

Data Product	SIS Reference	Availability
Tracking and Navigation Files	TRK 2-34 DSN Tracking System Data Archival Format, DSN No. 820-013, TRK-2-34, Rev N. JPL D-76488. November 7, 2013.	https://pds-geosciences.wustl.edu/radiosciencedocs/urn-nasa-pds-radiosci_documentation/dsn_trk-2-34/dsn_trk-2-34.2013-11-07.pdf
Ionosphere Calibration Files	TRK 2-23 Media Calibration Interface, DSN No. 820-013, TRK-2-23, Rev C. JPL D-16765. March 5, 2008.	https://pds-geosciences.wustl.edu/radiosciencedocs/urn-nasa-pds-radiosci_documentation/dsn_trk-2-23/dsn_trk-2-23.2008-03-05.pdf

The OSIRIS-REx data archive has been designed and implemented in the PDS4 standard as required by the PDS Management Council for missions confirmed for flight after November

1, 2011. A consequence of the change in standard from PDS3 to PDS4 is that data formats that were previously PDS compliant are no longer compliant or present serious labeling challenges. The DSN Tracking and Navigation Files formatted in compliance with their respective SIS documents present such a problem.

The DSN Tracking and Navigation Files (trk-2-34) are natively formatted as a binary collection of approximately 18 different data record types. Not all data record types are present in each file. Each of the data record types can be described in a PDS4 .XML label as a PDS4 Table_Binary object. The difficulty in labeling the natively formatted trk-2-34 files is that data records are not sorted by type, meaning that in a worst-case scenario, the PDS .XML label would be required to have a Table_Binary specification for each data record in the trk-2-34 file, resulting in an XML label file that is hundreds of times larger in size than the data file. To remedy this unwieldy labeling result, the original trk-2-34 files (formatted according to the SIS referenced in Table 2), have been sorted by time and data record type. The resulting files conform to the PDS DSN TRK-2-34 for PDS4 Archiving Interface Document.

Please note that if you are interested in using the TRK-2-34 frequency ramp tables and cannot find that information in the expected data file, it is most likely that the information is in the previous file. Additionally, the 3-way data was not required for the OSIRIS-REx investigation, so the user is cautioned that these data have not been vetted by the OSIRIS-REx radio science team.

Small Forces Files

The OSIRIS-REx navigation team also uses Navigation and Ancillary Information Facility (NAIF) produced Small Forces Files (SFF). These files record the cumulative delta-v effect of attitude thruster firings over a specified time period(s). An estimate of mass loss due to fuel usage may also be included. In some cases, the SFFs may have overlapping time frames. The file that is produced later in time will incorporate any updated SPICE kernels. It is recommended to always use the latest version of data.

The OSIRIS-REx team retrieves these files from the NAIF webserver (<https://naif.jpl.nasa.gov/pub/naif/ORX/misc/sff/>) and stores them in the SPOC data repository. The SFFs are retrieved from the SPOC repository and prepared for delivery to the PDS. The final PDS delivery of these products are through the end of Bennu Encounter (May 10, 2021). It is possible that return cruise SFF files will be archived with extended mission products, but the date of that delivery is not known at this time.

The Small Forces Files are formatted natively as character files with a KEYWORD=VALUE header structure followed by data records in a comma separated variable structure. The full format is described in the Small Forces File Software Interface Specification, Version 3.0, March 15, 2015 (located in the OSIRIS-REx radio science bundle document collection as SIS_NAF018_ORX-SFF_CCv0001.pdf).