PDS\_VERSION\_ID = PDS3

LABEL\_REVISION\_NOTE = "

 For New Horizons, this LABEL\_REVISION\_NOTE is used to keep track of

 when the template is used to generate a DATASET.CAT file for a

 data set.

 Brian Carcich

 - Publication date: 2016-10-31

 - NH-internal archive software version: V2.0

 "

RECORD\_TYPE = STREAM

INSTRUMENT\_HOST\_NAME = "NEW HORIZONS"

OBJECT = DATA\_SET

 DATA\_SET\_ID = "NH-P-REX-2-PLUTO-V1.0"

 OBJECT = DATA\_SET\_INFORMATION

 START\_TIME = 2015-04-08T18:16:33.775

 STOP\_TIME = 2015-11-20T01:01:59.874

 DATA\_SET\_DESC = "

 Data Set Overview

 =================

 This data set contains Raw data taken by New Horizons

 Radio Science Experiment

 instrument during the PLUTO mission phase.

 The REX instrument measures the amplitude and phase of radio signals

 captured by the New Horizons high-gain antenna. The main investigation

 is an occultation experiment which uses radio signals transmitted from

 Earth to probe the atmosphere and ionosphere of Pluto and Charon.

 Ancillary investigations include measurements of the 4 cm wavelength

 radiothermal emission from planets or other radio sources. Phase data

 may also be combined with Pluto encounter tracking data, derived from

 the Radio Science Subsystem separately from REX and to be archived in

 separate non-REX data set(s), to infer the influence of gravitational

 fields on the spacecraft as it moves through the Pluto system. As of

 July, 2016, disposition of tracking data is TDB (tracking data have not

 been archived).

 The main investigation requires coordinated use of the Earth-based

 transmitters and the spacecraft receiver as the two physical elements

 of the REX instrument. The 'Ground Element' comprises DSN (Deep Space

 Network) hardware and operations facilities on Earth, and the 'Flight

 Element' includes signal processing hardware and software onboard the

 spacecraft.

 Unless inclusion of tuning profiles for one-way uplink transmissions is

 noted below, this data set includes only samples taken and measurements

 made by the REX system hardware on-board the New Horizons spacecraft --

 either of one-way uplink signals or of 4cm-wavelength thermal emission.

########################################################################

########################################################################

REQUIRED UNDERSTANDING: THE REX AND THE NEW HORIZONS (NH) REGENERATIVE

RANGING TRACKER [DEBOLTETAL2005] ARE

 \*\*\*\*\*SEPARATE\*\*\*\*\* AND \*\*\*\*\*INDEPENDENT\*\*\*\*\*

SUBSYSTEMS THAT BOTH USE THE RADIO FREQUENCY (RF) AND TELECOMMUNICATIONS

SUBSYSTEMS. TRACKING DATA WILL NOT BE ARCHIVED IN REX DATA SETS.

########################################################################

########################################################################

 During the Pluto Charon Encounter mission phase starting in January, 2015,

there were several sub-phases: three Approach sub-phases, (AP1, AP2 and AP3);

a CORE sequence for the Pluto flyby on 14 July, 2015, (Day Of Year 195),

sometimes also referred to as NEP (Near-Encounter Phase); and three Departure

sub-phases (DP1, DP2, DP3). This data set includes only the Approach data plus

a subset of the CORE and departure data that had been downlinked by the end

of January, 2016. The rest of the Pluto data will be delivered in future

versions of this data set according to the schedule worked out by the Project

and NASA.

 On Approach during April, May and June of 2015, REX executed only tests and

calibration sequences: test patterns; an Operational Readiness Test (ORT) on

08 April of the surface temperature doublescan (THERMSCAN) and of the Pluto

and Charon occulations; ride-alongs with several PEPSSI plasma rolls, which

were performed with Deep Space Network (DSN) uplink tones for USO

characterization; and a high-power uplink test with the 34m antenna DSS-26.

The timings of the plasma roll USO characterizations were planned so that the

Z axis was oriented toward the Sun during rolls about the Y axis (HGA

boresight) pointed to Earth: this 'Z to Sun' attitude duplicated the

orientation that would occur during the Pluto and Charon occultations in the

CORE sequence.

 From the day of encounter, this data set includes data from two CORE

observations: (1) the bi-static radar THERMSCAN data, which measured DSN

uplink signal reflected off of Pluto during the flyby; (2) the Pluto

occultation data for both ingress and egress.

 There is also a backup USO Stability characterization observation taken in

November, 2015, to replace an attempt in the weeks after encounter that failed

due to a DSN misconfiguration.

 This data set also includes uplink tuning profile data in, and extracted

from, Tracking and Navigation Files (TNFs) for all CORE observations.

Although uplink data signals were sent from the Ground Element to REX during

the Approach sub-phase, tuning profiles for those signals are not provided as

they are not needed to analyze those REX Approach observations comprising

instrument checkout, characterization and calibration activities.

 Every observation provided in this data set was taken as a part of a

 particular sequence. A list of these sequences has been provided in

 file DOCUMENT/SEQ\_REX\_PLUTO.TAB.

 N.B. Some sequences provided may have no corresponding observations.

 For a list of observations, refer to the data set index table. This

 is typically INDEX.TAB initially in the INDEX/ area of the data set.

 There is also a file SLIMINDX.TAB in INDEX/ that summarizes key

 information relevant to each observation, including which sequence

 was in effect and what target was likely intended for the

 observation.

 Known issues in REX data

 ========================

 The following item assumes familiarity with the REX, REX terminology

 and the required reading and other documentation provided with this

 data set.

 Time tag anomalies in ROF sequences

 -----------------------------------

 REX places ten incrementing time tags in each REX Output Frame (ROF).

 The time tags can be used both to identify any breaks in a sequence of

 ROFs, and to determine the time between any two ROFs within a

 sequence.

 The normal sequence for time tags is to start at zero in the first ROF

 and increment ten times per ROF, so the first time tag of the second

 ROF is 10, that of the third ROF is 20, etc. In practice, the first

 and last ROFs in a sequence do not always show simple zero starts and

 clean finishes, respectively, indicating data corruption in just those

 ROFs. There is no indication of corruption elsewhere in ROF streams,

 and REX commanding ensures there are always adequate ROFs before and

 after any observation, so discarding starting and ending ROFs in a

 sequence based on simple inspection of time tags is the way to handle

 this issue.

 For more detail, refer to the REX Instrument Description section in

 the SOC Instrument Interface Control Document (ICD).

 Version

 =======

 This is VERSION 1.0 of this data set.

 Processing

 ==========

 The data in this data set were created by a software data

 processing pipeline on the Science Operations Center (SOC) at

 the Southwest Research Institute (SwRI), Department of Space Operations.

 This SOC pipeline assembled data as FITS files from raw telemetry

 packets sent down by the spacecraft and populated the data labels

 with housekeeping and engineering values, and computed geometry

 parameters using SPICE kernels. The pipeline did not resample

 the data.

 Data

 ====

 The observations in this data set are stored in data files using

 standard Flexible Image Transport System (FITS) format. Each FITS

 file has a corresponding detached PDS label file, named according

 to a common convention. The FITS files may have image and/or table

 extensions. See the PDS label plus the DOCUMENT files for a

 description of these extensions and their contents.

 This Data section comprises the following sub-topics:

 - Filename/Product IDs

 - Instrument description

 - Other sources of information useful in interpreting these Data

 - Visit Description, Visit Number, and Target in the Data Labels

 Filename/Product IDs

 --------------------

 The filenames and product IDs of observations adhere to a

 common convention e.g.

 REX\_0123456789\_0X7B0\_ENG.FIT

 ^^^ ^^^^^^^^^^ ^^^^^ ^^^\\_\_/

 | | | | ^^

 | | | | |

 | | | | +--File type (includes dot)

 | | | | - .FIT for FITS file

 | | | | - .LBL for PDS label

 | | | | - not part of product ID

 | | | |

 | | | +--ENG for CODMAC Level 2 data

 | | | SCI for CODMAC Level 3 data

 | | |

 | | +--Application ID (ApID) of the telemetry data

 | | packet from which the data come

 | | N.B. ApIDs are case-insensitive

 | |

 | +--MET (Mission Event Time) i.e. Spacecraft Clock

 |

 +--Instrument designator

 Note that, depending on the observation, the MET in the data filename

 and in the Product ID may be similar to the Mission Event Time (MET)

 of the actual observation acquisition, but should not be used as an

 analog for the acquisition time. The MET is the time that the data are

 transferred from the instrument to spacecraft memory and is therefore

 not a reliable indicator of the actual observation time. The PDS label

 and the index tables are better sources to use for the actual timing of

 any observation. The specific keywords and index table column names for

 which to look are

 \* START\_TIME

 \* STOP\_TIME

 \* SPACECRAFT\_CLOCK\_START\_COUNT

 \* SPACECRAFT\_CLOCK\_STOP\_COUNT

 Instrument Instrument designators ApIDs \*\*

 =========== ================================== =============

 REX REX 0X7B0 - 0X7B3 \*

 \* Not all values in this range are in this data set

 \*\* ApIDs are case insensitive

 There are other ApIDs that contain housekeeping values and

 other values. See SOC Instrument ICD (/DOCUMENT/SOC\_INST\_ICD.\*)

 for more details.

 Here is a summary of the types of files generated by each ApID

 (N.B. ApIDs are case-insensitive) along with the instrument

 designator that go with each ApID:

 ApIDs Data product description/Prefix(es)

 ===== ===================================

 0x7b0 - REX Lossless Compressed Data (CDH 1)/REX

 0x7b1 - REX Packetized Data (CDH 1)/REX

 0x7b2 - REX Lossless Compressed Data (CDH 2)/REX

 0x7b3 - REX Packetized Data (CDH 2)/REX

 Instrument description

 ----------------------

 Refer to the following files for a description of this instrument.

 CATALOG

 REX.CAT

 DOCUMENTS

 REX\_SSR.\*

 SOC\_INST\_ICD.\*

 Other sources of information useful in interpreting these Data

 --------------------------------------------------------------

 Refer to the following files for more information about these data

 NH Trajectory tables:

 /DOCUMENT/NH\_MISSION\_TRAJECTORY.\* - Heliocentric

 Visit Description, Visit Number, and Target in the Data Labels

 ---------------------------------------------------------------

 The observation sequences were defined in Science Activity Planning

 (SAP) documents, and grouped by Visit Description and Visit Number.

 The SAPs are spreadsheets with one Visit Description & Number per row.

 A nominal target is also included on each row and included in the data

 labels, but does not always match with the TARGET\_NAME field's value in

 the data labels. In some cases, the target was designated as RA,DEC

 pointing values in the form ``RADEC=123.45,-12.34'' indicating Right

 Ascension and Declination, in degrees, of the target from the

 spacecraft in the Earth Equatorial J2000 inertial reference frame.

 This indicates that the target was either a star or that the target's

 ephemeris was not loaded into the spacecraft's attitude and control

 system. In either of those cases the spacecraft could not be pointed

 at the target by a body identifier, and an inertial pointing value had

 to be specified as Right Ascension and Declination values. PDS-SBN

 practices do not allow putting a value like RADEC=... in the PDS

 TARGET\_NAME keyword's value. In those cases the PDS TARGET\_NAME value

 is set to CALIBRATION. TARGET\_NAME may be N/A (Not Available or Not

 Applicable) for a few observations in this data set; typically that

 means the observation is a functional test so N/A is an appropriate

 entry for those targets, but the PDS user should also check the

 NEWHORIZONS:OBSERVATION\_DESC and NEWHORIZONS:SEQUENCE\_ID keywords in

 the PDS label, plus the provided sequence list (see Ancillary Data

 below) to assess the possibility that there was an intended target.

 Ancillary Data

 ==============

 The geometry items included in the data labels were computed

 using the SPICE kernels archived in the New Horizons SPICE

 data set, NH-X-SPICE-6-PLUTO-V1.0.

 Every observation provided in this data set was taken as part of a

 particular sequence. A list of these sequences has been provided in

 file DOCUMENT/SEQ\_REX\_PLUTO.TAB. In addition, the

 sequence identifier (ID) and description are included in the PDS label

 for every observation. N.B. While every observation has an associated

 sequence, every sequence may not have associated observations. Some

 sequences may have failed to execute due to spacecraft events (e.g.

 safing). No attempt has been made during the preparation of this data

 set to identify such empty sequences, so it is up to the user to

 compare the times of the sequences to the times of the available

 observations from INDEX/INDEX.TAB to identify such sequences.

 Time

 ====

 There are several time systems, or units, in use in this dataset:

 New Horizons spacecraft MET (Mission Event Time or Mission Elapsed

 Time), UTC (Coordinated Universal Time), and TDB Barycentric

 Dynamical Time.

 This section will give a summary description of the relationships

 among these time systems. For a complete explanation of these

 time systems the reader is referred to the documentation

 distributed with the Navigation and Ancillary Information

 Facility (NAIF) SPICE toolkit from the PDS NAIF node, (see

 http://naif.jpl.nasa.gov/).

 The most common time unit associated with the data is the spacecraft

 MET. MET is a 32-bit counter on the New Horizons spacecraft that

 runs at a rate of about one increment per second starting from a

 value of zero at

 19 January, 2006 18:08:02 UTC

 or

 JD2453755.256337 TDB.

 The leapsecond adjustment (DELTA\_ET = ET - UTC) was 65.184s at

 NH launch, and the first three additional leapseconds occured

 in at the ends of December, 2009, June, 2012, and June, 2015.

 Refer to the NH SPICE data set, NH-J/P/SS-SPICE-6-V1.0, and the

 SPICE toolkit docmentation, for more details about leapseconds.

 The data labels for any given product in this dataset usually

 contain at least one pair of common UTC and MET representations

 of the time at the middle of the observation. Other portions

 of the products, for example tables of data taken over periods

 of up to a day or more, will only have the MET time associated

 with a given row of the table.

 For the data user's use in interpreting these times, a reasonable

 approximation (+/- 1s) of the conversion between Julian Day (TDB)

 and MET is as follows:

 JD TDB = 2453755.256337 + ( MET / 86399.9998693 )

 For more accurate calculations the reader is referred to the

 NAIF/SPICE documentation as mentioned above.

 Reference Frame

 ===============

 Geometric Parameter Reference Frame

 -----------------------------------

 Earth Mean Equator and Vernal Equinox of J2000 (EMEJ2000) is the

 inertial reference frame used to specify observational geometry items

 provided in the data labels. Geometric parameters are based on best

 available SPICE data at time of data creation.

 Epoch of Geometric Parameters

 -----------------------------

 All geometric parameters provided in the data labels were computed at

 the epoch midway between the START\_TIME and STOP\_TIME label fields.

 Software

 ========

 The observations in this data set are in standard FITS format

 with PDS labels, and can be viewed by a number of PDS-provided

 and commercial programs. For this reason no special software is

 provided with this data set.

 Contact Information

 ===================

 For any questions regarding the data format of the archive,

 contact

 New Horizons REX Principal Investigator:

 Ivan Linscott, Stanford University

 Len Tyler

 David Packard Building - Room 331 (MC 9515)

 350 Serra Mall

 Stanford, CA 94305-4020

 USA

 "

 CONFIDENCE\_LEVEL\_NOTE = "

 Confidence Level Overview

 =========================

 During the processing of the data in preparation for

 delivery with this volume, the packet data associated with each

 observation were used only if they passed a rigorous verification

 process including standard checksums.

 In addition, raw (Level 2) observation data for which adequate

 contemporary housekeeping and other ancillary data are not available

 may not be reduced to calibrated (Level 3) data. This issue is raised

 here to explain why some data products in the raw data set,

 NH-P-REX-2-PLUTO-V1.0,

 may not have corresponding data products in the calibrated data set,

 NH-P-REX-3-PLUTO-V1.0.

 Data coverage and quality

 =========================

 Every observation provided in this data set was taken as a part of a

 particular sequence. A list of these sequences has been provided in

 file DOCUMENT/SEQ\_REX\_PLUTO.TAB. N.B. Some sequences

 provided may have zero corresponding observations.

 Refer to the Confidence Level Overview section above for a summary

 of steps taken to assure data quality.

 The Time Tag counter values included with REX data normally increment

 nine times within each data file and once between consecutive frames.

 However, there are sometimes anomalous departures from this behavior at

 the start and end of contiguous runs of data files (see REX.CAT for a

 brief discussion of such an issue related to compression). Files with

 such anomalies are few compared to the total number of data files, and

 excluding those files with anomalous Time Tag data from data analysis

 will not significantly affect the results of the REX investigation.

 Refer to the Science Operations Center/instrument interface control

 document for more detail about REX Time Tags; there is adequate

 information there for users to identify anomalous files.

 In addition, products with Time Tag anomalies are listed in file

 ERRATA.TXT provided with this data set.

 Observation descriptions in this data set catalog

 =================================================

 Some users will expect to find descriptions of the observations

 in this data set here, in this Confidence Level Note. This data

 set follows the more common convention of placing those

 descriptions under the Data Set Description (above, if the user is

 reading this in the DATASET.CAT file) of this data set catalog.

 Caveat about TARGET\_NAME in PDS labels and observational intent

 ===============================================================

 The New Horizons project does not have the resources to rigorously

 determine and check the accuracy of the TARGET\_NAME assignments in

 the PDS labels for the observations in this data set. An automated

 process using heuristics to analyze simulated operation products

 has been put in place to make a best effort attempt to identify

 the target and intent of each observation.

 The user of these PDS data needs to be cautious when using the

 TARGET\_NAME and other target-related parameters stored in this data

 set.

 Review

 ======

 This dataset was peer reviewed and certified for scientific use on

 TBD.

 "

 ABSTRACT\_DESC = "

 This data set contains Raw data taken by the New Horizons

 Radio Science Experiment

 instrument during the

 Pluto encounter

 mission phase. This is VERSION 1.0 of this data set.

 "

 CITATION\_DESC = "

 Tyler, L., NEW HORIZONS

 Raw REX PLUTO ENCOUNTER V1.0,

 NH-P-REX-2-PLUTO-V1.0,

 NASA Planetary Data System, 2016.

 "

 DATA\_OBJECT\_TYPE = "ARRAY"

 DATA\_SET\_COLLECTION\_MEMBER\_FLG = "N"

 DATA\_SET\_NAME = "NEW HORIZONS

 REX PLUTO ENCOUNTER

 RAW V1.0"

 DATA\_SET\_RELEASE\_DATE = 2016-10-31

 DATA\_SET\_TERSE\_DESC = "

 Raw data taken by New Horizons

 Radio Science Experiment

 instrument during the PLUTO mission phase.

 This is VERSION 1.0 of this data set.

 "

 DETAILED\_CATALOG\_FLAG = "N"

 PRODUCER\_FULL\_NAME = "BRIAN CARCICH"

 END\_OBJECT = DATA\_SET\_INFORMATION

 OBJECT = DATA\_SET\_MISSION

 MISSION\_NAME = "NEW HORIZONS"

 END\_OBJECT = DATA\_SET\_MISSION

 OBJECT = DATA\_SET\_REFERENCE\_INFORMATION

 REFERENCE\_KEY\_ID = "DEBOLTETAL2005"

 END\_OBJECT = DATA\_SET\_REFERENCE\_INFORMATION

 OBJECT = DATA\_SET\_TARGET

 TARGET\_NAME = "N/A"

 END\_OBJECT = DATA\_SET\_TARGET

 OBJECT = DATA\_SET\_TARGET

 TARGET\_NAME = "PLUTO"

 END\_OBJECT = DATA\_SET\_TARGET

 OBJECT = DATA\_SET\_HOST

 INSTRUMENT\_HOST\_ID = "NH"

 INSTRUMENT\_ID = "REX"

 END\_OBJECT = DATA\_SET\_HOST

END\_OBJECT = DATA\_SET

END