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been archived).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