Mars Reconnaissance Orbiter

Mars Climate Sounder
Derived Data Record (DDR)
Software Interface Specification

Version 1.2
October 25, 2012

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California Institute of Technology
## CHANGE LOG

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### ACRONYMS AND ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ASCII</td>
<td>American Standard Code for Information Interchange</td>
</tr>
<tr>
<td>CODMAC</td>
<td>Committee on Data Management and Computation</td>
</tr>
<tr>
<td>DDR</td>
<td>Derived Data Record</td>
</tr>
<tr>
<td>EDR</td>
<td>Experiment Data Record</td>
</tr>
<tr>
<td>FOV</td>
<td>Field of View</td>
</tr>
<tr>
<td>GDS</td>
<td>Ground Data Systems</td>
</tr>
<tr>
<td>ICD</td>
<td>Interface Control Document</td>
</tr>
<tr>
<td>ISO</td>
<td>International Standards Organization</td>
</tr>
<tr>
<td>JPL</td>
<td>Jet Propulsion Laboratory</td>
</tr>
<tr>
<td>Kbyte</td>
<td>Kilobytes</td>
</tr>
<tr>
<td>LSB</td>
<td>Least Significant Byte</td>
</tr>
<tr>
<td>MB</td>
<td>Mega Bytes</td>
</tr>
<tr>
<td>MCS</td>
<td>Mars Climate Sounder</td>
</tr>
<tr>
<td>MRO</td>
<td>Mars Reconnaissance Orbiter</td>
</tr>
<tr>
<td>MSB</td>
<td>Most Significant Byte</td>
</tr>
<tr>
<td>NASA</td>
<td>National Aeronautics and Space Administration</td>
</tr>
<tr>
<td>OBA</td>
<td>Optics Bench Assembly</td>
</tr>
<tr>
<td>ODL</td>
<td>Object Description Language</td>
</tr>
<tr>
<td>PMIRR</td>
<td>Pressure Modulator Infrared Radiometer</td>
</tr>
<tr>
<td>PDS</td>
<td>Planetary Data System</td>
</tr>
<tr>
<td>RAM</td>
<td>Random Access Memory</td>
</tr>
<tr>
<td>RDR</td>
<td>Reduced Data Record</td>
</tr>
<tr>
<td>RSDS</td>
<td>Raw Science Data Server</td>
</tr>
<tr>
<td>SIS</td>
<td>Software Interface Specification</td>
</tr>
<tr>
<td>TBD</td>
<td>To Be Determined</td>
</tr>
<tr>
<td>TDS</td>
<td>Telemetry Delivery Subsystem</td>
</tr>
<tr>
<td>URL</td>
<td>Universal Resource Locator</td>
</tr>
<tr>
<td>UTC</td>
<td>Universal Time Coordinate</td>
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## GLOSSARY

<table>
<thead>
<tr>
<th>TERM</th>
<th>DEFINITION</th>
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<tr>
<td>Meta-Data</td>
<td>Selected or summary information about data. PDS catalog objects and data product labels are forms of meta-data for summarizing important aspects of data sets and data products.</td>
</tr>
<tr>
<td>Profile</td>
<td>The vertical distribution, as a function of atmospheric pressure, of some physical property, such as temperature or water vapor amount</td>
</tr>
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</table>
1. INTRODUCTION

1.1 Purpose and Scope
The purpose of this data product Software Interface Specification (SIS) is to provide users of the Mars Climate Sounder (MCS) Derived Data Record (DDR) with a detailed description of the product and a description of how it was generated, including data sources and destinations. The document is intended to provide enough information to enable users to understand the MCS DDR data product. The users for whom this document is intended are software developers of the programs used in generating the DDR products and scientists who will analyze the data, including those associated with the Mars Reconnaissance Orbiter (MRO) Project and those in the general planetary science community.

1.2 Contents
This data product SIS describes how the MRO MCS instrument acquires its data, and how the data are processed, formatted, labeled, and uniquely identified. This document discusses standards used in generating the product and software that may be used to access the product. The data product structure and organization is described in sufficient detail to enable a user to read the product. Finally, an example of a product label is provided.

1.3 Applicable Documents and Constraints
This data product SIS is responsive to the following MRO documents:

This SIS is also consistent with the following Planetary Data System documents:

1.4 Relationships with Other Interfaces
The MCS Derived Data Record (DDR) products are derived from the MRO/MCS Reduced Data Product (RDR) data sets. And the completeness and quality of
the RDR data sets will affect the coverage and/or quality of the DDR products.

2. DATA PRODUCT CHARACTERISTICS AND ENVIRONMENT

2.1 Instrument Overview

The Mars Climate Sounder is a follow-on experiment to PMIRR, the Pressure Modulator Infrared Radiometer lost with the Mars Observer spacecraft, and to PMIRR2, lost with the Mars Climate Orbiter. MCS observes radiation with 21 detectors in each of nine spectral bands; eight thermal infrared channels are used to characterize atmospheric temperature, pressure, water vapor, and condensates, while the remaining spectral channel (operating in the visible and near infrared, 0.3-3.0 microns) is used primarily to understand the effects of solar radiation on the Martian energy budget.

MCS looks near the horizon of Mars at the atmospheric limb to observe the atmosphere in 21 vertically stacked samples simultaneously, with measurements centered approximately 5 kilometers (3 miles) apart at the limb. From these observations vertical distributions (“profiles”) of temperature, pressure, water vapor, dust, and condensates are determined. These profiles can be combined into daily, three-dimensional global maps for both daytime and nighttime. Analyzing these profiles and derived maps should lead to a better understanding of Martian weather and, eventually, of Martian climate.

2.1.1 Hardware Overview

The Mars Climate Sounder is a nine channel infrared radiometer employing filter radiometry. These channels are distributed between two identical, boresighted telescopes, and an articulated elevation/azimuth mount allows the telescopes to view the surface of Mars, the limb of Mars, space, and calibration targets. The instantaneous field-of-view (FOV) response of each channel is defined by a linear, 21-element, thermopile detector array at the telescope focal plane, and its spectral response is defined by a focal plane bandpass filter.

The MCS structure consists of an instrument optics bench assembly (OBA), an elevation/azimuth yoke, and an instrument mount. The OBA contains all of the instrument optical subassemblies, and is suspended from the yoke (Figure 1). Elevation and azimuth motors mounted on the yoke drive instrument articulation. The OBA is temperature controlled, and internal temperature gradients are minimized by design. Radiometric calibration is provided by views of blackbody and solar targets mounted on the yoke. The electronics subassemblies control signal processing, instrument operation and articulation, command processing, and data processing and are distributed between the OBA and the yoke. Figure 1 shows the mechanical configuration of the instrument with the major components
indicated. Figure 2 gives a schematic representation of the optical layout.

Figure 1. Instrument Configuration
Figure 2. Optics Assembly (Telescopes A & B)
The detector arrays for channels A1 through A6 are located in the focal plane of telescope A. The detector arrays for channels B1 through B3 are located in the focal plane of telescope B.

Each MCS spectral channel (Figure 3) has 21 FOVs defined by the individual detectors of the corresponding linear array. Nominal detector FOV dimensions, linear array length and linear array spacing in both focal planes are specified in Figure 4.
2.2 Data Product Overview

The MCS software collects 192 sixteen-bit science measurements from the focal plane interface electronics every 2.048 seconds, along with associated instrument engineering and housekeeping measurements. The science and housekeeping data are organized into data packets that are transmitted to the spacecraft at the same 2.048-second spacing. The data packets are downlinked to the MRO Ground Data System (GDS) and placed into the Raw Science Data Server (RSDS). MCS software queries the data from the RSDS and assembles them into RDR data tables, each covering a 4 hour time period. Over the course of the mission, Derived Data Records (DDRs) in the form of NASA Level 2 data products (retrieved geophysical profiles) are generated from the RDRs.

The DDR data will consist of profiles of successfully retrieved geophysical parameters, estimated retrieval and observation errors, and the geometry information to properly locate the profiles in space and time.
Each MCS DDR data product will consist of four files:

1. An ASCII formatted detached PDS label.
2. A detached PDS format file that describes the associated DDR metadata using a PDS Table object.
3. A detached PDS format file that describes the DDR data product using a PDS Container object.
4. An ASCII tabular data file containing the retrieved profiles.

These are described in Appendix A. Each MCS DDR table will cover 4 hours and be approximately 4 MB in size, but may be significantly smaller depending on the number of successful retrievals.

2.3 Data Processing

2.3.1 Data Processing Level

This document uses the Committee on Data Management and Computation (CODMAC) data level numbering system to describe the processing level of the DDR data product. MCS DDR data products are considered CODMAC “Level 5”, equivalent to NASA level 2. The DDR data files are generated from CODMAC Level 4 or “Resampled Data”, which are the time-ordered instrument science data. Refer to Table 1 for a definition of the CODMAC and NASA data processing levels.

<table>
<thead>
<tr>
<th>NASA</th>
<th>CODMAC</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packet data</td>
<td>Raw – Level 1</td>
<td>Telemetry data stream as received at the ground station, with science and engineering data embedded.</td>
</tr>
<tr>
<td>Level-0</td>
<td>Edited – Level 2</td>
<td>Instrument science data (e.g., raw voltages, counts) at full resolution, time ordered, with duplicates and transmission errors removed.</td>
</tr>
<tr>
<td>Level 1A</td>
<td>Calibrated - Level 3</td>
<td>Level 0 data that have been located in space and may have been transformed (e.g., calibrated, rearranged) in a reversible manner and packaged with needed ancillary and auxiliary data (e.g., radiances with the calibration equations applied).</td>
</tr>
<tr>
<td>Level 1B</td>
<td>Resampled - Level 4</td>
<td>Irreversibly transformed (e.g., resampled, remapped, calibrated) values of the instrument measurements (e.g., radiances, magnetic field strength).</td>
</tr>
<tr>
<td>Level 2</td>
<td>Derived - Level 5</td>
<td>Geophysical parameters, generally derived from Level 1 data, and located in space and time commensurate with instrument location, pointing, and sampling.</td>
</tr>
<tr>
<td>Level 3</td>
<td>Derived - Level 5</td>
<td>Geophysical parameters mapped onto uniform space-time grids.</td>
</tr>
</tbody>
</table>
2.3.2 Data Product Generation

The MCS DDR data products will be generated by the MCS Instrument Team at JPL. Due to the atmospheric structure resulting in radiance profiles with insufficient information as well as limitations in the retrieval (inversion) algorithm, profiles do not exist for some of the limb observations in the RDR data set.

2.3.3 Data Flow

MCS science and engineering telemetry are transferred to the MRO Project RSDS. Once transferred, the MCS software automatically processes the telemetry into Level 0 EDR data products. MCS software generates the Level 1B products from the Level 0 data. The MCS DDR data products are generated from the Level 1B data and then archived locally at the MCS operation center.

After an initial data validation period, the MCS team will assemble the data products and ancillary files into archive volumes and will transfer the assembled volume to the Atmospheres Node. The MCS DDR archive will be made available via data releases scheduled at three-month intervals as specified in the Mars Reconnaissance Orbiter Project Data Archive Generation, Validation and Transfer Plan (see Applicable document #2).

2.3.4 Labeling and Identification

The data set ID provided by the PDS for the MCS DDR data product is: MRO-M-MCS-5-DDR-V1.0. The version number is incremented should the entire DDR data set be revised. The data set name is "MRO MARS CLIMATE SOUNDER LEVEL 5 DDR V1.0".

The naming convention for the tables and detached labels follow the time-organization of the data and use the following naming convention (e.g. “2007070800_DDR.TAB):


yyyymmddhh_DDR.TAB; where:

    yyyy = year in which the data was acquired
    mm = month of the year in which the data was acquired
    dd = day of the month in which the data was acquired
    hh = hour of the day in which the data was acquired

Each MCS DDR data product has a detached PDS label in a separate file of the same name, extension .LBL: e.g. “2007070800_DDR.LBL”. The PDS format files for each DDR data product will be MCS_DDR1.FMT for the metadata and MCS_DDR2.FMT for the profiles.
2.4 Standards Used in Generating Data Products

2.4.1 PDS Standards


2.4.2 Time Standards

The PDS label for an MCS DDR uses keywords denoting time values, such as start time, stop time, start spacecraft clock count, and stop spacecraft clock count. Each time value standard is defined according to the PDS keyword definition. See Appendix A.

In the data product label, Start Time and Stop Time values are stored in PDS compliant UTC date format, in the pattern YYYY-MM-DDTHH:MM:SS.SSS (four digit year, two digits for month, day, hour, minute and second, and three digits for decimal fractional second). Spacecraft clock start and stop count time values are stored in decimal seconds from the epoch 1980.

2.4.3 Coordinate Systems

All positions and vectors in the MCS DDR product files are specified in Areocentric spherical coordinates. All coordinates follow the MRO mission convention and use north latitude and east longitude.

2.4.4 Data Storage Conventions

The MCS DDR data files are stored as fixed-length ASCII tables. The detached PDS labels for MCS DDR's are stored as ASCII text, as are the format files. Each record is terminated with a carriage return followed by a line feed.

2.5 Data Validation

MCS DDR products will be validated before being released to the PDS. Validation is accomplished in two parts: validation for scientific integrity and validation for compliance with PDS standards. MCS Team members are expected to conduct validation for scientific integrity in the course of their analysis of the products. Science validation is meant to ensure that data products contain the expected measurements and that they are otherwise suitable for analysis. The details of the science validation process are the responsibility of the MCS Team.

Validation for PDS compliance will be performed by the PDS Atmospheres Node and is meant to ensure that data products conform to PDS standards and to the
specifications in this SIS.

A data set must also pass a peer review before it is accepted by PDS. The MCS Team and the PDS Atmospheres Node will convene a peer review committee made up of scientists and data engineers. The committee will examine the data set to make sure it is complete and meets the product specifications as defined in the SIS. The committee will include a PDS representative to ensure that the data set is in compliance with PDS standards.

3. DETAILED DATA PRODUCT SPECIFICATIONS

3.1 Data Product Structure and Organization

The DDR data products will be located in the DATA directory of the DDR volume. The files will be grouped into directories with one directory per day. Each directory name will be in the format YYYYMMDD. Within each directory, there will be up to 6 data product files and the corresponding labels. The labels will point to the corresponding data files, and contain pointers to format labels detailing the column layout of the data files. The data product file names will be in the format YYYYMMDDHH_DDR.TAB for the data tables, and YYYYMMDDHH_DDR.LBL for the labels.

The individual profiles are stored in time order in the data file. Each profile contains 106 records (or rows). The first record/row (in the format described by MCS_DDR1.FMT) contains information that pertains to the entire profile. This includes timestamps, geometry, surface and column geophysical quantities, quality flags and pointers to the source RDR records. This is referred to as the profile "meta-data" record. The next 105 records/rows (each in the format described by MCS_DDR2.FMT) are the 105 pressure surfaces and contain the (geophysical and geographic) profile quantities. The second profile in the data file then follows, starting with its meta-data record and block of 105 level records. This continues throughout the file with one meta-data record and 105 layer records for each profile.

3.2 Data Format Descriptions

The MCS DDR data product file is a fixed record-length ASCII table. Descriptions of the data contained within the table columns are provided below:

<table>
<thead>
<tr>
<th>Column #</th>
<th>Name</th>
<th>Data Type</th>
<th>Length</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>ASCII_INTEGER</td>
<td>1</td>
<td>A quality indicator: 0 means this record contains valid data</td>
</tr>
<tr>
<td>2</td>
<td>DATE</td>
<td>CHARACTER</td>
<td>14</td>
<td>Date of profile (UTC)</td>
</tr>
</tbody>
</table>
The MRO Spacecraft Clock of profile, without partition, including decimal thousandths of a second.

Solar Longitude of Mars (deg).

Distance from the center of Mars to the center of the Sun (km).

MRO Orbit Number.

Geometry quality:
- 0 = good.
- 3 = undetermined attitude information
- 4 = Pointing is incorrect and geometry is not fixed
- 5 = Pointing may be incorrect and geometry is not fixed
- 6 = Pointing is incorrect and geometry was fixed

The Mars-centric north latitude of the Sun, in degrees

The Mars-centric east longitude of the Sun, in degrees

The angular separation, in degrees, between the vector from the center of Mars to the scene point (see below) and the vector from the center of Mars to the Sun

Mars Local True Solar Time of the profile in fraction of sol.

Latitude of the center of the profile (deg), see the next section for the latitude of specific pressures.

Longitude of the center of the profile (deg), see the next section for the longitude of specific pressures.

The distance, in kilometers, from the center of Mars to the center of the profile.

The distance, in kilometers, from the center of the profile to the local MOLA elevation.

MOLA aeroid radius at the center point of the profile (km)

Latitude of the surface point for the profile, or if there is no surface sounding (see column 46, SURF_QUAL) the latitude of the tangent point for the lowest line-of-sight that does not intersect the surface (deg).

Longitude of the surface point for the profile, or if there is no surface sounding (see column 46, SURF_QUAL) the longitude of the tangent point for the lowest line-of-sight that does not intersect the surface (deg).

The distance, in kilometers, from the center of Mars to the surface point. If there is no surface sounding (see column 46, SURF_QUAL), this is the distance from the center of Mars to the tangent point for the lowest line-of-sight that does not intersect the surface. In either case, this is also the radius of the altitude grid for the profile.

Surface temperature (K).

Surface temperature uncertainty (K).

Near surface atmospheric temperature (K).
<table>
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<th>Type</th>
<th>Width</th>
<th>Description</th>
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<td>T_NEAR_SURF_ERR</td>
<td>ASCII_REAL</td>
<td>16</td>
</tr>
<tr>
<td>26</td>
<td>DUST_COLUMN</td>
<td>ASCII_REAL</td>
<td>12</td>
</tr>
<tr>
<td>27</td>
<td>DUST_COLUMN_ERR</td>
<td>ASCII_REAL</td>
<td>16</td>
</tr>
<tr>
<td>28</td>
<td>H2OVAP_COLUMN</td>
<td>ASCII_REAL</td>
<td>15</td>
</tr>
<tr>
<td>29</td>
<td>H2OVAP_COLUMN_ERR</td>
<td>ASCII_REAL</td>
<td>19</td>
</tr>
<tr>
<td>30</td>
<td>H2OICE_COLUMN</td>
<td>ASCII_REAL</td>
<td>15</td>
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<tr>
<td>31</td>
<td>H2OICE_COLUMN_ERR</td>
<td>ASCII_REAL</td>
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<tr>
<td>32</td>
<td>CO2ICE_COLUMN</td>
<td>ASCII_REAL</td>
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<td>33</td>
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<td>34</td>
<td>P_SURF</td>
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<td>PQUAL</td>
<td>ASCII_INTEGER</td>
<td>7</td>
</tr>
<tr>
<td>41</td>
<td>TQUAL</td>
<td>ASCII_INTEGER</td>
<td>7</td>
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<td>42</td>
<td>DUST_QUAL</td>
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<td>H2OVAP_QUAL</td>
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<tr>
<td>45</td>
<td>CO2ICE_QUAL</td>
<td>ASCII_INTEGER</td>
<td>13</td>
</tr>
<tr>
<td>46</td>
<td>SURF_QUAL</td>
<td>ASCII_INTEGER</td>
<td>10</td>
</tr>
<tr>
<td>47</td>
<td>OBS_QUAL</td>
<td>ASCII_INTEGER</td>
<td>10</td>
</tr>
</tbody>
</table>

0 = Standard observations, forward in-track viewing (Azimuth = 180 deg).
1 = Limb staring observations (reduced calibration quality), forward in-track viewing (Azimuth = 180 deg).
<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<td>REF_SCLK_0</td>
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<td>ASCII_REAL</td>
<td>14</td>
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<td>50</td>
<td>REF_SCLK_2</td>
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<td>14</td>
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<td>REF_SCLK_3</td>
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<td>ASCII_REAL</td>
<td>14</td>
</tr>
<tr>
<td>53</td>
<td>REF_SCLK_5</td>
<td>ASCII_REAL</td>
<td>14</td>
</tr>
<tr>
<td>54</td>
<td>REF_SCLK_6</td>
<td>ASCII_REAL</td>
<td>14</td>
</tr>
<tr>
<td>55</td>
<td>REF_SCLK_7</td>
<td>ASCII_REAL</td>
<td>14</td>
</tr>
<tr>
<td>56</td>
<td>REF_SCLK_8</td>
<td>ASCII_REAL</td>
<td>14</td>
</tr>
<tr>
<td>57</td>
<td>REF_SCLK_9</td>
<td>ASCII_REAL</td>
<td>14</td>
</tr>
<tr>
<td>58</td>
<td>REF_DATE_0</td>
<td>CHARACTER</td>
<td>14</td>
</tr>
<tr>
<td>59</td>
<td>REF_UTC_0</td>
<td>CHARACTER</td>
<td>15</td>
</tr>
<tr>
<td>60</td>
<td>REF_DATE_1</td>
<td>CHARACTER</td>
<td>14</td>
</tr>
<tr>
<td>61</td>
<td>REF_UTC_1</td>
<td>CHARACTER</td>
<td>15</td>
</tr>
<tr>
<td>62</td>
<td>REF_DATE_2</td>
<td>CHARACTER</td>
<td>14</td>
</tr>
<tr>
<td>63</td>
<td>REF_UTC_2</td>
<td>CHARACTER</td>
<td>15</td>
</tr>
<tr>
<td>64</td>
<td>REF_DATE_3</td>
<td>CHARACTER</td>
<td>14</td>
</tr>
<tr>
<td>65</td>
<td>REF_UTC_3</td>
<td>CHARACTER</td>
<td>15</td>
</tr>
</tbody>
</table>

The MRO Spacecraft Clock, without partition, including decimal thousandths of a second; record n [0 to 9] from RDR used in the retrieval.

Date of measurement (UTC); record n [0 to 9] from RDR used in the retrieval.

Time of measurement (UTC); record n [0 to 9] from RDR used in the retrieval.

The MRO Spacecraft Clock, without partition, including decimal thousandths of a second; record n [0 to 9] from RDR used in the retrieval.

The MRO Spacecraft Clock, without partition, including decimal thousandths of a second; record n [0 to 9] from RDR used in the retrieval.

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The MRO Spacecraft Clock, without partition, including decimal thousandths of a second; record n [0 to 9] from RDR used in the retrieval.

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The MRO Spacecraft Clock, without partition, including decimal thousandths of a second; record n [0 to 9] from RDR used in the retrieval.

The MRO Spacecraft Clock, without partition, including decimal thousandths of a second; record n [0 to 9] from RDR used in the retrieval.
<table>
<thead>
<tr>
<th>Column #</th>
<th>Name</th>
<th>Data Type</th>
<th>Length</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>ASCII_INTEGER</td>
<td>1</td>
<td>A quality indicator: 0 means this record contains valid data.</td>
</tr>
<tr>
<td>2</td>
<td>PRES</td>
<td>ASCII_REAL</td>
<td>13</td>
<td>Pressure surface for this layer of the profile (Pa). The pressures were calculated from ( p(i) = p_0 \times \exp(-0.125 \times (i - 10)), \ i = 1...10 ) where ( p_0 = 610 ).</td>
</tr>
<tr>
<td>3</td>
<td>T</td>
<td>ASCII_REAL</td>
<td>8</td>
<td>Temperature on the pressure surface (K).</td>
</tr>
<tr>
<td>4</td>
<td>T_ERR</td>
<td>ASCII_REAL</td>
<td>8</td>
<td>Temperature uncertainty on the pressure surface (K).</td>
</tr>
<tr>
<td>5</td>
<td>DUST</td>
<td>ASCII_REAL</td>
<td>11</td>
<td>Dust opacity per km on the pressure surface at 463 wavenumbers (or 21.6 microns).</td>
</tr>
<tr>
<td>6</td>
<td>DUST_ERR</td>
<td>ASCII_REAL</td>
<td>11</td>
<td>Dust opacity uncertainty on the pressure surface (opacity per km at 463 wavenumbers or 21.6 microns).</td>
</tr>
<tr>
<td>7</td>
<td>H2OVAP</td>
<td>ASCII_REAL</td>
<td>11</td>
<td>Water vapor volume mixing ratio on the pressure surface.</td>
</tr>
<tr>
<td>8</td>
<td>H2OVAPE误</td>
<td>ASCII_REAL</td>
<td>11</td>
<td>Water vapor uncertainty on the pressure surface (volume mixing ratio, ppm).</td>
</tr>
<tr>
<td>9</td>
<td>H2OICE</td>
<td>ASCII_REAL</td>
<td>11</td>
<td>Water ice opacity per km on the pressure surface at 843 wavenumbers (or 11.9 microns).</td>
</tr>
<tr>
<td>10</td>
<td>H2OICE_ERR</td>
<td>ASCII_REAL</td>
<td>11</td>
<td>Water ice opacity uncertainty on the pressure surface (opacity per km in at 843 wavenumbers or 11.9 microns).</td>
</tr>
<tr>
<td>11</td>
<td>CO2ICE</td>
<td>ASCII_REAL</td>
<td>11</td>
<td>CO2 ice opacity per km on the pressure surface at 607 wavenumbers (or 16.5 microns).</td>
</tr>
<tr>
<td>12</td>
<td>CO2ICE_ERR</td>
<td>ASCII_REAL</td>
<td>11</td>
<td>CO2 ice opacity uncertainty on the pressure surface (opacity per km in at 607 wavenumbers or 16.5 microns).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>surface (opacity per km at 607 wavenumbers or 16.5 microns).</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>ALT</td>
<td>ASCII_REAL</td>
<td>8</td>
<td>Altitude of the pressure surface above the surface point (DDR1, column 21) (km).</td>
</tr>
<tr>
<td>14</td>
<td>LAT</td>
<td>ASCII_REAL</td>
<td>10</td>
<td>Latitude of the center of the measurement region on the pressure surface (deg).</td>
</tr>
<tr>
<td>15</td>
<td>LON</td>
<td>ASCII_REAL</td>
<td>10</td>
<td>Longitude of the center of the measurement region on the pressure surface (deg).</td>
</tr>
</tbody>
</table>
3.3 Label and Header Descriptions

Each MCS DDR data product is described by a detached PDS label in a separate file with the same name, extension "LBL". A label file is stored in the same directory as the data file it describes.

A PDS label is object-oriented and describes the objects in the data file. The PDS label contains keywords for product identification and for data object definitions. The label also contains descriptive information needed to interpret or process the data objects in the file.

PDS labels are written in Object Description Language (ODL) [7]. PDS label statements have the form of "keyword = value". Each label statement is terminated with a carriage return character (ASCII 13) and a line feed character (ASCII 10) sequence to allow the label to be read by many operating systems. Pointer statements with the following format are used to indicate the location of data objects in the file:

```
^TABLE = filename,location
```

where the caret character (^, also called a pointer) is followed by the name of the specific data object. The 'location' is the starting record number (counting from one) for the data within the file, e.g.

```
^TABLE = ("2005091216_DDR.TAB", 5)
```

The data files themselves will usually contain rows of embedded headers, marked by the ‘#’ symbols, which are used for file comments.

The PDS label will also include “pointers” to two other files that define the table column definitions, in order to avoid repeating the lengthy definitions in every label. The column definition files have the extension “.FMT” and are stored in the LABEL directory of the DDR archive.

An example of MCS DDR label is in Appendix A; an example of the two format files is in Appendix B

4. APPLICABLE SOFTWARE

4.1 Utility Programs

Because the MCS DDR products are formatted as columnar ASCII data, they can be read and manipulated by standard, public-domain software. For this reason, no special utilities are provided.

4.2 Applicable PDS Software Tools
PDS-labeled tables can be viewed with the program NASAView, developed by the PDS and available for a variety of computer platforms from the PDS web site http://pds.nasa.gov/tools/software_download.cfm. There is no charge for NASAView.

4.3 Software Distribution and Update Procedures

None at this time.
APPENDIX A - EXAMPLE OF AN MCS DDR LABEL

PDS_VERSION_ID = PDS3
RECORD_TYPE = STREAM
RECORD_BYTES = 17954
FILE_RECORDS = 171
DESCRIPTION = "This table contains Level 2 geophysical profile data records from the Mars Climate Sounder collected during the orbital operations phase of the Mars Reconnaissance Orbiter mission."

"TABLE = ('2006093000_DDR.TAB', 2855<BYTES>)
DATA_SET_ID = "MRO-M-MCS-5-DDR-V1.0"
MISSION_NAME = "MARS RECONNAISSANCE ORBITER"
INSTRUMENT_HOST_NAME = "MARS RECONNAISSANCE ORBITER"
INSTRUMENT_NAME = "MARS CLIMATE SOUNDER"
PRODUCT_NAME = "MCS DDR"
PRODUCT_ID = "2006093000_DDR.TAB"
TARGET_NAME = "MARS"
START_TIME = 2006-09-30T00:00:11.327
STOP_TIME = 2006-09-30T03:52:23.795
SPACECRAFT_CLOCK_START_COUNT = 844041630.035
SPACECRAFT_CLOCK_STOP_COUNT = 844055562.155
PRODUCT_CREATION_TIME = 2008-05-22T14:23:14
START_ORBIT_NUMBER = 828
STOP_ORBIT_NUMBER = 830
START_SOLAR_LONGITUDE = 113.71489
STOP_SOLAR_LONGITUDE = 113.78916

OBJECT = "TABLE"
INTERCHANGE_FORMAT = ASCII
ROW_BYTES = 17954
ROWS = 171
COLUMNS = 1652
"STRUCTURE = "MCS_DDR1.FMT"

OBJECT = CONTAINER
NAME = FRAME_STRUCTURE
START_BYTE = 1050
BYTES = 161
REPETITIONS = 105
"STRUCTURE = "MCS_DDR2.FMT"
DESCRIPTION = "See MCS_DDR1.FMT & MCS_DDR2.FMT"
END_OBJECT = CONTAINER
END_OBJECT = TABLE
END
APPENDIX B - EXAMPLE OF MCS DDR FORMAT FILES

B.1 Example Metadata Format File

OBJECT               = COLUMN
COLUMN_NUMBER      = 1
NAME               = 1
DATA_TYPE          = ASCII_INTEGER
START_BYTE         = 1
BYTES              = 1
DESCRIPTION        = "A quality indicator: 0 means this record contains valid data"
END_OBJECT           = COLUMN

OBJECT               = COLUMN
COLUMN_NUMBER      = 2
NAME               = DATE
DATA_TYPE          = CHARACTER
START_BYTE         = 3
BYTES              = 14
DESCRIPTION        = "Date of profile (UTC)"
END_OBJECT           = COLUMN

OBJECT               = COLUMN
COLUMN_NUMBER      = 3
NAME               = UTC
DATA_TYPE          = CHARACTER
START_BYTE         = 18
BYTES              = 15
DESCRIPTION        = "Time of profile (UTC)"
END_OBJECT           = COLUMN

OBJECT               = COLUMN
COLUMN_NUMBER      = 4
NAME               = SCLK
DATA_TYPE          = ASCII_REAL
START_BYTE         = 34
BYTES              = 15
DESCRIPTION        = "The MRO Spacecraft Clock of profile, without partition, including decimal thousandths of a second."
END_OBJECT           = COLUMN

OBJECT               = COLUMN
COLUMN_NUMBER      = 5
NAME               = L_S
DATA_TYPE          = ASCII_REAL
START_BYTE         = 50
BYTES              = 10
DESCRIPTION        = "Solar Longitude of Mars (deg)."
END_OBJECT           = COLUMN

OBJECT               = COLUMN
COLUMN_NUMBER      = 6
NAME               = SOLAR_DIST
DATA_TYPE          = ASCII_REAL
START_BYTE         = 61
BYTES              = 14
DESCRIPTION        = "Distance from the center of Mars to the center of the Sun (km)."
END_OBJECT           = COLUMN

OBJECT               = COLUMN
COLUMN_NUMBER      = 7
NAME               = ORB_NUM
DATA_TYPE          = ASCII_INTEGER
START_BYTE         = 76
BYTES              = 8
DESCRIPTION        = "MRO Orbit Number."
END_OBJECT           = COLUMN
OBJECT = COLUMN
COLUMN_NUMBER = 8
NAME = GQUAL
DATA_TYPE = ASCII_INTEGER
START_BYTE = 85
BYTES = 6
DESCRIPTION = "Geometry quality:
  0 = good.
  3 = undetermined attitude information
  4 = Pointing is incorrect and geometry is not fixed
  5 = Pointing may be incorrect and geometry is not fixed
  6 = Pointing is incorrect and geometry was fixed"
END_OBJECT

OBJECT = COLUMN
COLUMN_NUMBER = 9
NAME = SOLAR_LAT
DATA_TYPE = ASCII_REAL
START_BYTE = 92
BYTES = 10
DESCRIPTION = "The Mars-centric north latitude of the Sun, in degrees"
END_OBJECT

OBJECT = COLUMN
COLUMN_NUMBER = 10
NAME = SOLAR_LON
DATA_TYPE = ASCII_REAL
START_BYTE = 103
BYTES = 11
DESCRIPTION = "The Mars-centric east longitude of the Sun, in degrees"
END_OBJECT

OBJECT = COLUMN
COLUMN_NUMBER = 11
NAME = SOLAR_ZEN
DATA_TYPE = ASCII_REAL
START_BYTE = 115
BYTES = 11
DESCRIPTION = "The angular separation, in degrees, between the vector from
the center of Mars to the scene point (see below) and the vector from the center
of Mars to the Sun"
END_OBJECT

OBJECT = COLUMN
COLUMN_NUMBER = 12
NAME = LTST
DATA_TYPE = ASCII_REAL
START_BYTE = 127
BYTES = 9
DESCRIPTION = "Mars Local True Solar Time of the profile in fraction of sol."
END_OBJECT

OBJECT = COLUMN
COLUMN_NUMBER = 13
NAME = PROFILE_LAT
DATA_TYPE = ASCII_REAL
START_BYTE = 137
BYTES = 12
DESCRIPTION = "Latitude of the center of the profile (deg), see the next section
for the latitude of specific pressures."
END_OBJECT

OBJECT = COLUMN
COLUMN_NUMBER = 14
NAME = PROFILE_LON
DATA_TYPE = ASCII_REAL
START_BYTE = 150
BYTES = 12
DESCRIPTION = "Longitude of the center of the profile (deg), see the next
section for the longitude of specific pressures."
END_OBJECT
OBJECT = COLUMN
COLUMN_NUMBER = 15
NAME = PROFILE_RAD
DATA_TYPE = ASCII_REAL
START_BYTE = 163
BYTES = 12
DESCRIPTION = "The distance, in kilometers, from the center of Mars to the center of the profile."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 16
NAME = PROFILE_ALT
DATA_TYPE = ASCII_REAL
START_BYTE = 176
BYTES = 12
DESCRIPTION = "The distance, in kilometers, from the center of the profile to the local MOLA elevation."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 17
NAME = LIMB_ANG
DATA_TYPE = ASCII_REAL
START_BYTE = 189
BYTES = 11
DESCRIPTION = "The angle, in degrees, between the local vertical and the MCS arrays during the observations for the profile."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 18
NAME = ARE_RAD
DATA_TYPE = ASCII_REAL
START_BYTE = 201
BYTES = 9
DESCRIPTION = "MOLA asteroid radius at the center point of the profile (km)"
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 19
NAME = SURF_LAT
DATA_TYPE = ASCII_REAL
START_BYTE = 211
BYTES = 10
DESCRIPTION = "Latitude of the surface point for the profile, or if there is no surface sounding (see column 46, SURF_QUAL) the latitude of the tangent point for the lowest line-of-sight that does not intersect the surface (deg)."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 20
NAME = SURF_LON
DATA_TYPE = ASCII_REAL
START_BYTE = 222
BYTES = 11
DESCRIPTION = "Longitude of the surface point for the profile, or if there is no surface sounding (see column 46, SURF_QUAL) the longitude of the tangent point for the lowest line-of-sight that does not intersect the surface (deg)."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 21
NAME = SURF_RAD
DATA_TYPE = ASCII_REAL
START_BYTE = 234
BYTES = 10
DESCRIPTION = "The distance, in kilometers, from the center of Mars to the..."
surface point. If there is no surface sounding (see column 46, SURF_QUAL), this is the
distance from the center of Mars to the tangent point for the lowest line-of-sight that
does not intersect the surface. In either case, this is also the radius of the altitude
grid for the profile."
DATA_TYPE          = ASCII_REAL
START_BYTE         = 343
BYTES              = 19
DESCRIPTION        = "Water vapor column amount uncertainty precipitable-microns,
pr-micron)."
END_OBJECT           = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER      = 30
NAME               = H2OICE_COLUMN
DATA_TYPE          = ASCII_REAL
START_BYTE         = 363
BYTES              = 15
DESCRIPTION        = "Water ice column opacity at 843 wavenumbers (or 11.9 microns)."
END_OBJECT           = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER      = 31
NAME               = H2OICE_COLUMN_ERR
DATA_TYPE          = ASCII_REAL
START_BYTE         = 379
BYTES              = 19
DESCRIPTION        = "Water ice column opacity uncertainty at 843 wavenumbers
(or 11.9 microns)."
END_OBJECT           = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER      = 32
NAME               = CO2ICE_COLUMN
DATA_TYPE          = ASCII_REAL
START_BYTE         = 399
BYTES              = 15
DESCRIPTION        = "CO2 ice column opacity at xxx wavenumbers (or yyy microns)."
END_OBJECT           = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER      = 33
NAME               = CO2ICE_COLUMN_ERR
DATA_TYPE          = ASCII_REAL
START_BYTE         = 415
BYTES              = 19
DESCRIPTION        = "CO2 ice column opacity uncertainty at xxx wavenumbers
(or yyy microns)."
END_OBJECT           = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER      = 34
NAME               = P_SURF
DATA_TYPE          = ASCII_REAL
START_BYTE         = 435
BYTES              = 9
DESCRIPTION        = "Surface pressure (Pa); 100 Pa = 1 mBar"
END_OBJECT           = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER      = 35
NAME               = P_SURF_ERR
DATA_TYPE          = CHARACTER
START_BYTE         = 445
BYTES              = 13
DESCRIPTION        = "Surface pressure uncertainty (Pa); 100 Pa = 1 mBar"
END_OBJECT           = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER      = 36
NAME               = P_RET_ALT
DATA_TYPE          = ASCII_REAL
START_BYTE         = 459
BYTES              = 10
DESCRIPTION        = "Altitude above the 'surface' (column 21) at which pressure is
retrieved (km)."
END_OBJECT           = COLUMN
<table>
<thead>
<tr>
<th>OBJECT</th>
<th>COLUMN</th>
</tr>
</thead>
<tbody>
<tr>
<td>COLUMN_NUMBER</td>
<td>37</td>
</tr>
<tr>
<td>NAME</td>
<td>P_RET</td>
</tr>
<tr>
<td>DATA_TYPE</td>
<td>ASCII_REAL</td>
</tr>
<tr>
<td>START_BYTE</td>
<td>470</td>
</tr>
<tr>
<td>BYTES</td>
<td>11</td>
</tr>
<tr>
<td>DESCRIPTION</td>
<td>&quot;Retrieved pressure (Pa)&quot;</td>
</tr>
<tr>
<td>END_OBJECT</td>
<td>COLUMN</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>COLUMN</th>
</tr>
</thead>
<tbody>
<tr>
<td>COLUMN_NUMBER</td>
<td>38</td>
</tr>
<tr>
<td>NAME</td>
<td>P_RET_ERR</td>
</tr>
<tr>
<td>DATA_TYPE</td>
<td>ASCII_REAL</td>
</tr>
<tr>
<td>START_BYTE</td>
<td>482</td>
</tr>
<tr>
<td>BYTES</td>
<td>10</td>
</tr>
<tr>
<td>DESCRIPTION</td>
<td>&quot;Retrieved pressure uncertainty (Pa)&quot;</td>
</tr>
<tr>
<td>END_OBJECT</td>
<td>COLUMN</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>COLUMN</th>
</tr>
</thead>
<tbody>
<tr>
<td>COLUMN_NUMBER</td>
<td>39</td>
</tr>
<tr>
<td>NAME</td>
<td>RQUAL</td>
</tr>
<tr>
<td>DATA_TYPE</td>
<td>ASCII_INTEGER</td>
</tr>
<tr>
<td>START_BYTE</td>
<td>493</td>
</tr>
<tr>
<td>BYTES</td>
<td>6</td>
</tr>
<tr>
<td>DESCRIPTION</td>
<td>&quot;Radiance Quality Flag&quot;</td>
</tr>
<tr>
<td>END_OBJECT</td>
<td>COLUMN</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>COLUMN</th>
</tr>
</thead>
<tbody>
<tr>
<td>COLUMN_NUMBER</td>
<td>40</td>
</tr>
<tr>
<td>NAME</td>
<td>P_QUAL</td>
</tr>
<tr>
<td>DATA_TYPE</td>
<td>ASCII_INTEGER</td>
</tr>
<tr>
<td>START_BYTE</td>
<td>500</td>
</tr>
<tr>
<td>BYTES</td>
<td>7</td>
</tr>
<tr>
<td>DESCRIPTION</td>
<td>&quot;Pressure retrieval quality flag.&quot;</td>
</tr>
<tr>
<td>END_OBJECT</td>
<td>COLUMN</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
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<tr>
<td>BYTES</td>
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<td>&quot;Temperature retrieval quality flag.&quot;</td>
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<td>BYTES</td>
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<td>DESCRIPTION</td>
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<td>END_OBJECT</td>
<td>COLUMN</td>
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<td>43</td>
</tr>
<tr>
<td>NAME</td>
<td>H2OVAP_QUAL</td>
</tr>
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<td>START_BYTE</td>
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<tr>
<td>BYTES</td>
<td>13</td>
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<tr>
<td>DESCRIPTION</td>
<td>&quot;Water vapor retrieval quality flag.&quot;</td>
</tr>
<tr>
<td>END_OBJECT</td>
<td>COLUMN</td>
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<td>44</td>
</tr>
<tr>
<td>NAME</td>
<td>H2OICE_QUAL</td>
</tr>
<tr>
<td>DATA_TYPE</td>
<td>ASCII_INTEGER</td>
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<td>541</td>
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<tr>
<td>BYTES</td>
<td>13</td>
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<td>DESCRIPTION</td>
<td>&quot;Water ice retrieval quality flag.&quot;</td>
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<td>END_OBJECT</td>
<td>COLUMN</td>
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<table>
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<th>COLUMN</th>
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COLUMN_NUMBER = 45
NAME = CO2ICE_QUAL
DATA_TYPE = ASCII_INTEGER
START_BYTE = 555
BYTES = 13
DESCRIPTION = "CO2 ice retrieval quality flag."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 46
NAME = SURF_QUAL
DATA_TYPE = ASCII_INTEGER
START_BYTE = 569
BYTES = 10
DESCRIPTION = "Surface/near surface retrieval quality flag."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 47
NAME = OBS_QUAL
DATA_TYPE = ASCII_INTEGER
START_BYTE = 580
BYTES = 10
DESCRIPTION = "Quality of the observation set used for the retrieval."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 48
NAME = REF_SCLK_0
DATA_TYPE = ASCII_REAL
START_BYTE = 591
BYTES = 14
DESCRIPTION = "The MRO Spacecraft Clock, without partition, including decimal
thousandths of a second; record n [0 to 9] from RDR used in the retrieval."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 49
NAME = REF_SCLK_1
DATA_TYPE = ASCII_REAL
START_BYTE = 606
BYTES = 14
DESCRIPTION = "The MRO Spacecraft Clock, without partition, including decimal
thousandths of a second; record n [0 to 9] from RDR used in the retrieval."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 50
NAME = REF_SCLK_2
DATA_TYPE = ASCII_REAL
START_BYTE = 621
BYTES = 14
DESCRIPTION = "The MRO Spacecraft Clock, without partition, including decimal
thousandths of a second; record n [0 to 9] from RDR used in the retrieval."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 51
NAME = REF_SCLK_3
DATA_TYPE = ASCII_REAL
START_BYTE = 636
BYTES = 14
DESCRIPTION = "The MRO Spacecraft Clock, without partition, including decimal
thousandths of a second; record n [0 to 9] from RDR used in the retrieval."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 52
NAME = REF_SCLK_4
DATA_TYPE = ASCII_REAL
START_BYTE = 651
BYTES = 14
DESCRIPTION = "The MRO Spacecraft Clock, without partition, including decimal
thousandths of a second; record n [0 to 9] from RDR used in the retrieval.

END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 53
NAME = REF_SCLK_5
DATA_TYPE = ASCII_REAL
START_BYTE = 666
BYTES = 14
DESCRIPTION = "The MRO Spacecraft Clock, without partition, including decimal
thousandths of a second; record n [0 to 9] from RDR used in the retrieval."

END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 54
NAME = REF_SCLK_6
DATA_TYPE = ASCII_REAL
START_BYTE = 681
BYTES = 14
DESCRIPTION = "The MRO Spacecraft Clock, without partition, including decimal
thousandths of a second; record n [0 to 9] from RDR used in the retrieval."

END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 55
NAME = REF_SCLK_7
DATA_TYPE = ASCII_REAL
START_BYTE = 696
BYTES = 14
DESCRIPTION = "The MRO Spacecraft Clock, without partition, including decimal
thousandths of a second; record n [0 to 9] from RDR used in the retrieval."

END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 56
NAME = REF_SCLK_8
DATA_TYPE = ASCII_REAL
START_BYTE = 711
BYTES = 14
DESCRIPTION = "The MRO Spacecraft Clock, without partition, including decimal
thousandths of a second; record n [0 to 9] from RDR used in the retrieval."

END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 57
NAME = REF_SCLK_9
DATA_TYPE = ASCII_REAL
START_BYTE = 726
BYTES = 14
DESCRIPTION = "The MRO Spacecraft Clock, without partition, including decimal
thousandths of a second; record n [0 to 9] from RDR used in the retrieval."

END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 58
NAME = REF_DATE_0
DATA_TYPE = CHARACTER
START_BYTE = 741
BYTES = 14
DESCRIPTION = "Date of measurement (UTC); record n [0 to 9] from RDR used in
the retrieval."

END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 59
NAME = REF_UTC_0
DATA_TYPE = CHARACTER
START_BYTE = 756
BYTES = 15
DESCRIPTION = "Time of measurement (UTC); record n [0 to 9] from RDR used in
the retrieval."

END_OBJECT = COLUMN
OBJECT = COLUMN
COLUMN_NUMBER = 60
NAME = REF_DATE_1
DATA_TYPE = CHARACTER
START_BYTE = 772
BYTES = 14
DESCRIPTION = "Date of measurement (UTC); record n [0 to 9] from RDR used in
the retrieval."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 61
NAME = REF_UTC_1
DATA_TYPE = CHARACTER
START_BYTE = 787
BYTES = 15
DESCRIPTION = "Time of measurement (UTC); record n [0 to 9] from RDR used in
the retrieval."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 62
NAME = REF_DATE_2
DATA_TYPE = CHARACTER
START_BYTE = 803
BYTES = 14
DESCRIPTION = "Date of measurement (UTC); record n [0 to 9] from RDR used in
the retrieval."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 63
NAME = REF_UTC_2
DATA_TYPE = CHARACTER
START_BYTE = 818
BYTES = 15
DESCRIPTION = "Time of measurement (UTC); record n [0 to 9] from RDR used in
the retrieval."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 64
NAME = REF_DATE_3
DATA_TYPE = CHARACTER
START_BYTE = 834
BYTES = 14
DESCRIPTION = "Date of measurement (UTC); record n [0 to 9] from RDR used in
the retrieval."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 65
NAME = REF_UTC_3
DATA_TYPE = CHARACTER
START_BYTE = 849
BYTES = 15
DESCRIPTION = "Time of measurement (UTC); record n [0 to 9] from RDR used in
the retrieval."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 66
NAME = REF_DATE_4
DATA_TYPE = CHARACTER
START_BYTE = 865
BYTES = 14
DESCRIPTION = "Date of measurement (UTC); record n [0 to 9] from RDR used in
the retrieval."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 67
NAME = REF_UTC_4

27
DATA_TYPE = CHARACTER
START_BYTE = 880
BYTES = 15
DESCRIPTION = "Time of measurement (UTC); record n [0 to 9] from RDR used in the retrieval."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 68
NAME = REF_DATE_5
DATA_TYPE = CHARACTER
START_BYTE = 896
BYTES = 14
DESCRIPTION = "Date of measurement (UTC); record n [0 to 9] from RDR used in the retrieval."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 69
NAME = REF_UTC_5
START_BYTE = 911
BYTES = 15
DESCRIPTION = "Time of measurement (UTC); record n [0 to 9] from RDR used in the retrieval."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 70
NAME = REF_DATE_6
DATA_TYPE = CHARACTER
START_BYTE = 927
BYTES = 14
DESCRIPTION = "Date of measurement (UTC); record n [0 to 9] from RDR used in the retrieval."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 71
NAME = REF_UTC_6
DATA_TYPE = CHARACTER
START_BYTE = 942
BYTES = 15
DESCRIPTION = "Time of measurement (UTC); record n [0 to 9] from RDR used in the retrieval."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 72
NAME = REF_DATE_7
DATA_TYPE = CHARACTER
START_BYTE = 958
BYTES = 14
DESCRIPTION = "Date of measurement (UTC); record n [0 to 9] from RDR used in the retrieval."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 73
NAME = REF_UTC_7
DATA_TYPE = CHARACTER
START_BYTE = 973
BYTES = 15
DESCRIPTION = "Time of measurement (UTC); record n [0 to 9] from RDR used in the retrieval."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 74
NAME = REF_DATE_8
DATA_TYPE = CHARACTER
START_BYTE = 989
BYTES = 14
DESCRIPTION = "Date of measurement (UTC); record n [0 to 9] from RDR used in the retrieval."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 75
NAME = REF_UTC_8
DATA_TYPE = CHARACTER
START_BYTE = 1004
BYTES = 15
DESCRIPTION = "Time of measurement (UTC); record n [0 to 9] from RDR used in the retrieval."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 76
NAME = REF_DATE_9
DATA_TYPE = CHARACTER
START_BYTE = 1020
BYTES = 14
DESCRIPTION = "Date of measurement (UTC); record n [0 to 9] from RDR used in the retrieval."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 77
NAME = REF_UTC_9
DATA_TYPE = CHARACTER
START_BYTE = 1035
BYTES = 14
DESCRIPTION = "Time of measurement (UTC); record n [0 to 9] from RDR used in the retrieval."
END_OBJECT = COLUMN
### B.2 Example Data Product Format File

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<td>START_BYTE</td>
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<tr>
<td>BYTES</td>
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<tr>
<td>DESCRIPTION</td>
<td>&quot;A quality indicator: 0 means this record contains valid data.&quot;</td>
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<table>
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<th>OBJECT</th>
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<td>DESCRIPTION</td>
<td>&quot;Pressure surface for this layer of the profile (Pa). The pressures calculated from ( p(i) = p_0 \exp(-.125*(i-10)), ) ( i = 1..100 ) where ( p_0 = 610.)&quot;</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>OBJECT</th>
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</thead>
<tbody>
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<td>BYTES</td>
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<tr>
<td>DESCRIPTION</td>
<td>&quot;Temperature on the pressure surface (K).&quot;</td>
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<td>DESCRIPTION</td>
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<tr>
<td>BYTES</td>
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<tr>
<td>DESCRIPTION</td>
<td>&quot;Dust opacity per km on the pressure surface at 463 wavenumbers (or 21.6 microns).&quot;</td>
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<td>DUST_ERR</td>
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<td>DATA_TYPE</td>
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<tr>
<td>BYTES</td>
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<td>DESCRIPTION</td>
<td>&quot;Dust opacity uncertainty on the pressure surface (opacity per km at 463 wavenumbers or 21.6 microns).&quot;</td>
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<td>DESCRIPTION</td>
<td>&quot;Water vapor volume mixing ratio on the pressure surface.&quot;</td>
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<td>BYTES</td>
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<td>DESCRIPTION</td>
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30
COLUMN_NUMBER = 8
NAME = H2OVAP_ERR
DATA_TYPE = ASCII_REAL
START_BYTE = 71
BYTES = 11
DESCRIPTION = "Water vapor uncertainty on the pressure surface (volume mixing ratio, ppm)."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 9
NAME = H2OICE
DATA_TYPE = ASCII_REAL
START_BYTE = 83
BYTES = 11
DESCRIPTION = "Water ice opacity per km on the pressure surface at 843 wavenumbers (or 11.9 microns)."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 10
NAME = H2OICE_ERR
DATA_TYPE = ASCII_REAL
START_BYTE = 95
BYTES = 11
DESCRIPTION = "Water ice opacity uncertainty on the pressure surface (opacity per km in at 843 wavenumbers or 11.9 microns)."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 11
NAME = CO2ICE
DATA_TYPE = ASCII_REAL
START_BYTE = 107
BYTES = 11
DESCRIPTION = "CO2 ice opacity per km on the pressure surface at xxx wavenumbers (or yyy microns)."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 12
NAME = CO2ICE_ERR
DATA_TYPE = ASCII_REAL
START_BYTE = 119
BYTES = 11
DESCRIPTION = "CO2 ice opacity uncertainty on the pressure surface (opacity per km at xxx wavenumbers or yyy microns)."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 13
NAME = ALT
DATA_TYPE = ASCII_REAL
START_BYTE = 131
BYTES = 8
DESCRIPTION = "Altitude of the pressure surface above the surface point (DDR1, column 21) (km)."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 14
NAME = LAT
DATA_TYPE = ASCII_REAL
START_BYTE = 140
BYTES = 10
DESCRIPTION = "Latitude of the center of the measurement region on the pressure surface (deg)."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 15
NAME = LON
DATA_TYPE = ASCII_REAL
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<tr>
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</tr>
<tr>
<td>DESCRIPTION</td>
<td>&quot;Longitude of the center of the measurement region on the pressure surface (deg).&quot;</td>
</tr>
<tr>
<td>END_OBJECT</td>
<td>COLUMN</td>
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