Aquarius Level-2 Data Product
Version 1.2
October 25, 2011

1.0 Introduction

This document describes the specifications of the Aquarius LeveL-2 archive products, which are produced and distributed by the NASA Goddard Space Flight Center's Aquarius Data Processing System (ADPS). The products are implemented in the Hierarchical Data Format (HDF), and HDF terminology is used in this document.

These specifications are given in terms of the logical implementation of the products in HDF and are not a physical description of file contents. Therefore, HDF software must be used to create or read these products.

An Aquarius Level-2 product is generated from one Aquarius Level-1A data file. It contains physical measurements as computed from the Level-1A raw data, either at the instrument or the observed surface locations along with coordinates of viewed locations and navigation data. This product is stored as one physical HDF file.

Each product contains data from one orbit of Aquarius data. An orbit is defined as starting when the SAC-D spacecraft passes the South Pole. An orbit may be downlinked multiple times (either to the CONAE ground stations at Cordoba or other stations supported by CONAE). The best quality data will be selected for each orbit during the Level 0 to 1A data processing and used to create the input Level 1A file.

This is the current draft of this document, and is based on the understanding of the current Aquarius instrument documentation. All information herein is open to revision.

2.0 Naming Convention

The form of a Level-2 file name is Qyyyydddhhmmss.L2_ttt_vvvv, where Q is for Aquarius, yyyydddhhmmss are the concatenated digits for the UTC year, day of the year, hours, minutes, and seconds of the first sample (block) in the product, ttt is the type of data in the product, and vvvv is the processing version. Examples of file names are:

Q2001103221441.L2_SCI_V1.0 for standard science data products version 1.0.

3.0 Global Attributes

For global attributes that have constant values specific to this product type, the value is given.

3.1 Mission and Documentation

Product Name (character): the name of the product file (without path).

Title (character): "Aquarius Level-2 Data".

Data Center (character): "NASA/GSFC Aquarius Data Processing Center".

Mission (character): "SAC-D Aquarius".

Mission Characteristics (character): "Nominal orbit: inclination = 98.0 (Sun-synchronous); node = 6 PM (ascending); eccentricity = <0.002; altitude = 657 km; ground speed = 6.825 km/sec".

Sensor (character): "Aquarius".

Sensor Characteristics (character): "Number of beams = 3; channels per receiver = 4; radiometer frequency = 1.413 GHz; scatterometer frequency = 1.26 GHz; bits per sample = 16; instantaneous radiometer field-of-view = 6.5 degrees; instantaneous scatterometer field-of-view = TBS degrees; science data block period = 1.44 sec."

Data Type (character): "SCI"

Replacement Flag (character): "ORIGINAL" if this is the first version of this product delivered to the DAAC; otherwise, it is set to the name of the product to be replaced (superseded) by the present product.

Software ID (character): identifies version of the operational software used to create this product.

Processing Version (character): identifies the version of the products; identical to the version string in the file name, e.g. V1.0.

Processing Time (character): local time of generation of this product; concatenated digits for year, day-of-year, hours, minutes, seconds, and fraction of seconds in the format of YYYYDDDHHMMSSFFF.

Input Files (character): the name of the Level-1A file (without path) from which the current product was created. This information is stored in the product as part of its processing history.

RAD_ANCILLARY_FILEn (character): the names of the ancillary data files (without path) used to process the radiometer data, where **n** = 1, 2, or 3. Depending on the timing of the Aquarius granule with respect to the ancillary data times, there may be either 2 or 3 sets of data with corresponding instances of this attribute. This information is stored in the product as part of its processing history.

Scatterometer Ancillary Files (character): the names of the ancillary files (without path) used to process the scatterometer data. This information is stored in the product as part of its processing history.

Radiometer Calibration Files (character): the names of the radiometer calibration coefficient files (without path) used to process the radiometer data. This information is stored in the product as part of its processing history.

Radiometer Data Tables (character): the names of the radiometer look-up table files (without path) used to process the radiometer data. This information is stored in the product as part of its processing history.

Scatterometer Coefficient Files (character): the names of the scatterometer coefficient files (without path) used to process the scatterometer data. This information is stored in the product as part of its processing history.

Processing Control (character): input and processing control parameters used to generate the product. Vertical bars or carriage return characters serve as parameter information delimiters. This information is stored in the product as part of its processing history.

Scatterometer Processing Control (character): additional scatterometer input and processing control parameters used to generate the product. Vertical bars or carriage return characters serve as parameter information delimiters. This information is stored in the product as part of its processing history.

Drift Correction H (4-byte float, array size **Number of Beams**): bias correction applied to Radiometer Ta H polarization for this orbit. This information is stored in the product as part of its processing history.

Drift Correction V (4-byte float, array size **Number of Beams**): bias correction applied to Radiometer Ta V polarization for this orbit. This information is stored in the product as part of its processing history.

3.2 Data Time

Start Time (character): start UTC of the first block of the orbit; concatenated digits for year, day-of-year, hours, minutes, seconds, and fraction of seconds in the format of YYYYDDDHHMMSSFFF.

End Time (character): start UTC of the last block of the orbit; concatenated digits for year, day-of-year, hours, minutes, seconds, and fraction of seconds in the format of YYYYDDDHHMMSSFFF.

Node Crossing Time (character): UTC of acscending node crossing; concatenated digits for year, day-of-year, hours, minutes, seconds, and fraction of seconds in the format of YYYYDDDHHMMSSFFF.

Cycle Start Time (character): UTC of the start of the 7-day cycle containing this orbit; concatenated digits for year, day-of-year, hours, minutes, seconds, and fraction of seconds in the format of YYYYDDDHHMMSSFFF. ***(This field is not currently implemented).***

Start Year (4-byte integer): UTC year of first block of the orbit.

Start Day (4-byte integer): UTC day-of-year of first block of the orbit.

Start Millisec (4-byte integer): UTC milliseconds-of-day of the first block of the orbit.

End Year (4-byte integer): UTC year of last block of the orbit.

End Day (4-byte integer): UTC day-of-year of last block of the orbit.

End Millisec (4-byte integer): UTC milliseconds-of-day of the last block of the orbit.

3.3 Data Characteristics

See the Aquarius Instrument to Aquarius Ground System Interface document for explanations of characteristics in the data packet.

Number of Blocks (4-byte integer): number of Aquarius science blocks in the orbit at 1.44-second intervals.

Missing Blocks (4-byte integer): missing blocks count in the product (if needed).

Number of Beams (4-byte integer): 3; number of antenna beams.

Radiometer Polarizations (4-byte integer): 4; number of polarizations in raw radiometer data; order is V, +45, -45, H.

Radiometer Subcycles (4-byte integer): 12; the number of 120 msec subcycles in a 1.44 second science block.

Radiometer Signals per Subcycle (4-byte integer): 5; see TBD for explanation.

Scatterometer RX Polarizations (4-byte integer): 2; number of scatterometer receive polarizations; order is V, H; last dimension of the **scat_rfi_flags** array (Section 4.2)

Scatterometer Subcycles (4-byte integer): 8; the number of 180 msec subcycles in a 1.44 second science block.

Max Radiometer Flags (4-byte integer): 4; last dimension of the **radiometer_flags** array (Section 4.2).

3.4 File Metrics

Percent Water (4-byte float): percent of data in this product not contaminated by land.

Percent RFI (4-byte float): percent of data with RFI flag set.

Cold Sky Calibration (character): “Yes” or “No”; indicates whether a cold sky calibration maneuver was performed during the orbit.

3.5 Orbit Coordinates

Latitude Units (character): "degrees North"; units used for all latitude values in this product.

Longitude Units (character): "degrees East"; units used for all longitude values in this product.

Orbit Number (4-byte integer): orbit number from the start of the mission.

Orbit Node Longitude (4-byte real): longitude of scene's orbit ascending node (longitude at equatorial crossing of PM-side node).

Cycle Number (4-byte integer): number of the weekly cycle from the start of the mission; started at the date given by the **Cycle Start Time**. Cycle 1 will be defined at the start of science data collection; all data collected during the Aquarius commissioning phase will be indicated as Cycle 0. Each cycle will contain 103 orbits.

Pass Number (4-byte integer): pass (orbit) number within the weekly cycle (1 to 103).

4.0 Data Objects

The following groups of data objects -- Block Attributes, Aquarius Flags, Aquarius Data, Navigation, and Converted Telemetry -- contain data that are functions of blocks. That is, each data object within these groups has data for each block and is therefore dimensioned by the value of the global attribute, **Number of Blocks**.

4.1 Block Attributes

The following data objects belong to the group "Block Attributes". Attributes of the objects are shown in **bold**.

sec (8-byte float, array size **Number of Blocks**): **long_name** = "Block time, seconds of day"; **valid_range** = (0.d0,86399.999999d0); **units** = "seconds"; mid-block times of Aquarius physical parameter values in seconds of day.

secGPS (8-byte float, array size **Number of Blocks**): **long_name** = "Block time, GPS time"; **units** = "seconds"; block times of Aquarius physical parameter values in seconds since the GPS epoch (0 hours UTC on 6 January 1980).

rad_samples (2-byte integer array size **Number of Blocks** x **Number of Beams** x **Radiometer Polarizations**): **long_name** = "Number of radiometer samples per average"; number of radiometer samples used per block, beam and polarization in the radiometer parameter averages in the **Aquarius Data** group (section 4.3). Samples that are flagged for RFI interference (see **rad_rfi_flags** below) are not used in the averages. Note that the 20-msec DPU averages are counted as 2 samples.

scat_samples (2-byte integer array size **Number of Blocks** x **Number of Beams**): **long_name** = "Number of scatterometer samples per average"; number of scatterometer samples used per block and beam in the scatterometer parameter averages in the **Aquarius Data** group (section 4.3). Samples that are flagged for RFI interference (see **rad_rfi_flags** below) are not used in the averages.

4.2 Aquarius Flags

The following data objects belong to the group "Aquarius Flags". These represent the non-nominal data conditions that are detected for the radiometer and scatterometer measurements for each block and beam. Attributes of the objects are shown in **bold**.

rad_rfi_flags (byte, array size **Number of Blocks** x **Number of Beams** x **Radiometer Polarizations** x **Radiometer Subcycles**): **long_name** = "Radiometer RFI flags"; Radio frequency interference flags for each radiometer measurement in the block. The 6 MSBs of each entry represent the individual radiometer short accumulations, at each beam and polarization, during each subcycle in a block. The 7^{th} bit represents the CND RFI flag. Each bit is set to 1 if RFI was detected for that measurement. The LSB is zero fill.

scat_rfi_flags (byte, array size **Number of Blocks** x **Number of Beams** x **Scatterometer RX Polarizations**): **long_name** = “Scatterometer RFI flags”; Radio frequency interference flags for each scatterometer measurement in the block. The 8 bits of each entry represent the individual scatterometer measurements collected during the 8 scatterometer subcycles. This flag is stored for each receive polarization (V, H), beam, and block. Each bit is set to 1 if RFI was detected for that signal.

radiometer_flags (4-byte integer, array size **Number of Blocks** x **Number of Beams** x **Max Radiometer Flags**): **long_name** = "Radiometer data quality flags"; each bit represents a data quality condition that was detected for that beam and block. All flags are two bits, with the first bit indicating moderate contamination and the second bit, severe contamination. The number of elements used in the last dimension varies according to the **No. of Flags** value in Table 1 as follows: 1 = no polarization sensitivity; 2 = (V, H); 3 = (V, H, 3rd Stokes); 4 = (V, +45, -45, H). This object has attributes **f01_name**, … **f32_name** that provide the names of the algorithms (listed in Table 1) used in determining the setting of the corresponding bits in **radiometer_flags** (the least significant bit being the first bit). The algorithms associated with these names, and the use of the corresponding bits as masks or as flags, are described in TBD.

scatterometer_flags (4-byte integer, array size **Number of Blocks** x **Number of Beams**): **long_name** = "Scatterometer data quality flags"; each bit represents a data quality condition that was detected for that beam and block. The 4-bit flags correspond to each of the 4 polarization channels (in order HV, VV, VH, HH), and the 2-bit flags indicate severity, with the first bit indicating moderate contamination and the second bit, severe. This array has attributes **f01_name**, … **f32_name** that provide the names of the algorithms (also listed in Table 2) used in determining the setting of the corresponding bits in **scatterometer_flags** (the least significant bit being the first bit). The flag definitions for each bit are given in Table 2.

Table 1. Conditions indicated for the pixel associated with the setting of individual bits in **radiometer_flags**. These correspond to the algorithm names given by the attributes.

Bits Set	Condition Indicated	No. of Flags	Algorithm Name
1 – 2	RFI	4	RFI
3 – 4	Rain in main beam(*)	2	RAIN
5 – 6	Land contamination	1	LAND
7 – 8	Sea ice contamination	1	ICE
9 – 10	Wind and foam contamination	1	WINDFOAM
11 – 12	Unusual antenna brightness temperature	2	TEMP
13 – 14	Mean direct solar flux contamination	2	FLUX
15 – 16	Mean reflected solar flux contamination	2	FLUX
17 – 18	Peak direct solar flare contamination(*)	2	FLARE
19 – 20	Peak reflected solar flare contamination(*)	2	FLARE
21 – 22	Illuminated ocean in main beam	3	DAYLIT
23 – 24	Moon contamination	2	MOON
25 – 26	Galactic background contamination	2	GALACTIC
27 – 28	Gain jump(*)	4	GAIN
29 – 32	Spares		

(*) Not currently implemented

Table 2. Conditions indicated for the pixel associated with the setting of individual bits in **scatterometer_flags**. These correspond to the algorithm names given by the attributes.

Bit Set = 1	Condition Indicated	Algorithm Name
(MSB) 31 – 28	RFI corruption of signal (V-pol bits 31:30, H-pol bits 29-28)	RFI
27 – 26	Rain in main beam	RAIN
25 – 22	Negative power computed for TOA sigma-0	NEGSIG
21 – 20	Non-nominal attitude or cold sky maneuver	BADATT
19 – 16	Successful Faraday rotation removal	FARADAY
15 – 12	Negative power computed for TOI (antenna) sigma-0(*)	
11	Overall quality	
10 – 00 (LSB)	Spares	

(*) Not currently implemented

4.3 Aquarius Data

The Aquarius computed physical parameters in the Level-2 product are stored in data objects belong to the group “Aquarius Data". The complete list of available parameters is given in Tables 3 (Radiometer), 4 (Scatterometer), 5 (Ancillary data) and 6 (SAC-D Microwave Radiometer (MWR)). The values in Tables 5 and 6 are interpolated in space and time to the Aquarius beam footprints. The actual parameters stored in each file are selectable at run-time. For each parameter, the values of the attributes **long_name**, **units**, and **valid_range** are given. Each data object has dimensions **Number of Blocks** x **Number of Beams**.

Table 3. Available Radiometer Parameters for Aquarius Level-2 Products.

Name	Long Name	Valid Range	Units
rad_TaH	Radiometer Ta H polarization		Kelvin
rad_TaV	Radiometer Ta V polarization		Kelvin
rad_Ta3	Radiometer Ta 3rd Stokes		Kelvin
rad_TfH	Radiometer Ta H polarization (rfi filtered)		Kelvin
rad_TfV	Radiometer Ta V polarization (rfi filtered)		Kelvin
rad_Tf3	Radiometer Ta 3rd Stokes (rfi filtered)		Kelvin
rad_toi_H	Radiometer TOI Tb H polarization		Kelvin
rad_toi_V	Radiometer TOI Tb V polarization		Kelvin

rad_toi_3	Radiometer TOI Tb 3rd Stokes		Kelvin
rad_toa_H	Radiometer TOA Tb H polarization		Kelvin
rad_toa_V	Radiometer TOA Tb V polarization		Kelvin
rad_far_TaH	Radiometer Faraday Angle		Degrees
rad_galact_Ta_dir_V	Radiometer Galactic Direct Corr V polar		Kelvin
rad_galact_Ta_dir_H	Radiometer Galactic Direct Corr H polar		Kelvin
rad_galact_Ta_dir_3	Radiometer Galactic Direct Corr 3rd Stokes		Kelvin
rad_galact_Ta_ref_V	Radiometer Galactic Reflect Corr V polar		Kelvin
rad_galact_Ta_ref_H	Radiometer Galactic Reflect Corr H polar		Kelvin
rad_galact_Ta_ref_3	Radiometer Galactic Reflect Corr 3rd Stokes		Kelvin
rad_solar_Ta_dir_V	Radiometer Solar Direct Corr V polar		Kelvin
rad_solar_Ta_dir_H	Radiometer Solar Direct Corr H polar		Kelvin
rad_solar_Ta_dir_3	Radiometer Solar Direct Corr 3rd Stokes		Kelvin
rad_solar_Ta_ref_V	Radiometer Solar Reflect Corr V polar		Kelvin
rad_solar_Ta_ref_H	Radiometer Solar Reflect Corr H polar		Kelvin
rad_solar_Ta_ref_3	Radiometer Solar Reflect Corr 3rd Stokes		Kelvin
rad_solar_Ta_bak_V	Radiometer Solar Back Scattered V polar		Kelvin
rad_solar_Ta_bak_H	Radiometer Solar Back Scattered H polar		Kelvin
rad_solar_Ta_bak_3	Radiometer Solar Back Scattered 3rd Stokes		Kelvin
rad_TbH	Earth surface Tb H polarization		Kelvin
rad_TbV	Earth surface Tb V polarization		Kelvin
SSS	Sea Surface Salinity		PSU
SSS_error	Sea Surface Salinity error		PSU
SSS_land	Sea Surface Salinity Land Corr		PSU
rad_land_toa_H	Radiometer TOA Land Corr H polar		Kelvin
rad_land_toa_V	Radiometer TOA Land Corr V polar		Kelvin
rad_moon_Ta_ref_V	Radiometer Lunar Reflect Corr V polar		Kelvin
rad_moon_Ta_ref_H	Radiometer Lunar Reflect Corr H polar		Kelvin
rad_moon_Ta_ref_3	Radiometer Lunar Reflect Corr 3rd Stokes		Kelvin
rad_cosmic_Ta(*)	Radiometer Cosmic Ta correction		Kelvin
rad_rain_Tb(*)	Rain effect on brightness temperature		Kelvin
rad_rough_corr(*)	Derived wind and/or roughness correction		
scat_rough_corr(*)	Scatterometer-based TB roughness correction		

(*) Not currently implemented

Table 4. Available Scatterometer Parameters for Aquarius Level-2 Products.

Name	Long Name	Valid Range	Units
scat_VV_ant	TOI Scatterometer NRCS for VV polarization		Db
scat_HH_ant	TOI Scatterometer NRCS for HH polarization		Db
scat_HV_ant	TOI Scatterometer NRCS for HV polarization		Db
scat_VH_ant	TOI Scatterometer NRCS for VH polarization		Db
scat_VV_toa	TOA Scatterometer NRCS for VV polarization		Db
scat_HH_toa	TOA Scatterometer NRCS for HH polarization		Db
scat_HV_toa	TOA Scatterometer NRCS for HV polarization		Db
scat_VH_toa	TOA Scatterometer NRCS for VH polarization		Db
scat_wind_speed	Scatterometer wind speed		m/s
dTB_V	Delta Tb derived from scatterometer data for V polarization and beam		Kelvin
dTB_H	Delta Tb derived from scatterometer data for H polarization and beam		Kelvin
Kpc_VV_ant	Kpc statistical uncertainty for ANT VV NRCS		
Kpc_HH_ant	Kpc statistical uncertainty for ANT HH NRCS		
Kpc_HV_ant	Kpc statistical uncertainty for ANT HV NRCS		
Kpc_VH_ant	Kpc statistical uncertainty for ANT VH NRCS		
Kpc_VV_ant	Kpc statistical uncertainty for TOA VV NRCS		
Kpc_HH_toa	Kpc statistical uncertainty for TOA HH NRCS		
Kpc_HV_toa	Kpc statistical uncertainty for TOA HV NRCS		
Kpc_VH_toa	Kpc statistical uncertainty for TOA VH NRCS		
wind_uncertainty	Estimated wind speed error		m/s
dTB_V_uncertainty	Uncertainty in delta-Tb-V		Kelvin
dTB_H_uncertainty	Uncertainty in delta-Tb-H		Kelvin
scat_tot_toa	TOA Scatterometer (Total)		db
Kpc_total	Statistical uncertainty for total power NRCS		

Table 5. Available Ancillary Parameters for Aquarius Level-2 Products.

Name	Long Name	Valid Range	Units
anc_wind_speed	Ancillary Wind Speed 10m above surface		m/s
anc_wind_dir	Ancillary Wind Direction 10m above surface		Degrees
anc_cwat	Cloud Water		Kg m^{-2}
anc_surface_temp	Surface Temperature		Kelvin
anc_surface_pressure	Surface Pressure		Pascals
anc_SSS	Ancillary sea surface salinity		PSU
anc_trans	Transmittance		
anc_Tb_up	Upwelling atmospheric brightness temperature		Kelvin
anc_Tb_dw	Downwelling atmospheric brightness temperature		Kelvin
anc_sm	Land soil moisture		
rad_land_frac	Fraction of land contamination (radiometer)	0.0 – 1.0	None
rad_ice_frac	Fraction of ice contamination (radiometer)	0.0 – 1.0	None
scat_land_frac	Fraction of land contamination (scatterometer)	0.0 – 1.0	None
scat_ice_frac	Fraction of ice contamination (scatterometer)	0.0 – 1.0	None
rad_exp_TaH	Radiometer Ta H (expected)		Kelvin
rad_exp_TaV	Radiometer Ta V (expected)		Kelvin
rad_exp_Ta3	Radiometer Ta 3rd Stokes (expected)		
anc_mean_flux(*)	Mean solar flux		SFU
anc_peak_flux(*)	Peak solar flux		SFU
anc_SWH(*)	Surface wave height		M
anc_ionosphere(*)	Ionospheric data		
anc_rough_H(*)	Ancillary wind-based roughness, H-pol		
anc_rough_V(*)	Ancillary wind-based roughness, V-pol		
gal_fraction(*)	Fraction of reflected galactic contamination		None

(*) Not currently implemented

Table 6. Available SAC-D MWR Parameters for Aquarius Level-2 Products
(not currently implemented)

Name	Long Name	Valid Range	Units
MWR_23.8_V	23.8 Ghz signal from MWR		
MWR_36.5_H	36.5 Ghz H signal from MWR		
MWR_36.5_V	36.5 Ghz V signal from MWR		
MWR_36.5_P	36.5 Ghz P signal from MWR		
MWR_36.5_M	36.5 Ghz M signal from MWR		
MWR_wind_speed	Surface wind speed from MWR		
MWR_wind_dir	Surface wind direction from MWR		
MWR_rain_rate	Rain rate from MWR		
MWR_ice_flag	Sea ice flag from MWR		
MWR_ice_concen	Sea ice concentration from WMR		

4.4 Navigation

The group "Navigation" includes the spacecraft orbit and attitude information, celestial object locations and the geolocation fields. For the last, there are separate fields for the radiometer, the scattermeter, and the MWR. The spacecraft and celestial object fields are described below, and the geolocation fields are given in Table 7. All of the fields in Table 7 have a data type of 4-byte real and dimensions **Number of Blocks** x **Number of Beams**; the fields beam_elat and beam_elon have an additional dimension of 4 corresponding to the four beam ellipse points. All geolocation fields are computed at the mid-block times represented by the data field **sec** in the **Block Attributes** group.

orb_pos (4-byte real, array size **Number of Blocks** x 3): **long_name** = "Orbital position vector"; **valid_range** = (-7100000.,7100000.); **units** = "meters"; orbit position vector at mid-block times; used to determine spacecraft position for geolocation.

orb_vel (4-byte real, array size **Number of Blocks** x 3): **long_name** = "Orbital velocity vector"; **valid_range** = (-7600.,7600.); **units** = "meters per second"; orbit velocity vector at mid-block times; used to determine spacecraft position for geolocation.

sclon (4-byte real, array size **Number of Blocks**): **long_name** = "Spacecraft nadir point longitude"; **valid_range** = (-180., 180.); **units** = “degrees"; longitude of the spacecraft orbit nadir point.

sclat (4-byte real, array size **Number of Blocks**): **long_name** = " Spacecraft nadir point latitude"; **valid_range** = (-90., 90.); **units** = “degrees"; latitude of the spacecraft orbit nadir point.

scalt (4-byte real, array size **Number of Blocks**): **long_name** = "Spacecraft altitude"; **valid_range** = (650,000., 690,000.); **units** = “meters"; spacecraft orbit altitude.

zang (4-byte real, array size **Number of Blocks**): **long_name** = "Intra-Orbit Angle"; **valid_range** = (0., 360.); **units** = “degrees"; angle within orbit from South pole passage at mid-block times.

att_ang (4-byte real, array size **Number of Blocks** x 3): **long_name** = “Spacecraft roll, pitch, yaw"; **valid_range** = (-180.,180.); spacecraft attitude Euler angles at mid-block times; relates spacecraft orientation to orbit reference frame.

sund (4-byte real, array size **Number of Blocks** x 3): **long_name** = "Earth-to-Sun unit vector (eci)"; **valid_range** = (-1,1); **units** = "unitless"; direct Sun vector in ECI coordinates at mid-block times.

sunr (4-byte real, array size **Number of Blocks** x 3): **long_name** = "Sun reflection unit vector (eci)"; **valid_range** = (-1,1); **units** = "unitless"; reflected Sun vector in ECI coordinates at mid-block time.

moond (4-byte real, array size **Number of Blocks** x 3): **long_name** = "Earth-to-Moon unit vector (eci)"; **valid_range** = (-1,1); **units** = "unitless"; Moon vector in ECI coordinates at mid-block time.

Table 7. Available Geolocation Parameters for Aquarius Level-2 Products

Name	Long Name	Valid Range	Units
beam_clat	Beam Center Latitude	-90 – 90	Degrees
beam_clon	Beam Center Longitude	-180 – 180	Degrees
cellatfoot	Geodetic Latitudes (3 db)	-90 – 90	Degrees
cellonfoot	Geodetic Longitudes (3db)	-180 – 180	Degrees
beam_ra(*)	Beam Right Ascension (J2000)	-180 – 180	Degrees
beam_dec(*)	Beam Declination (J2000)	-90 – 90	Degrees
celtht	Boresight Earth Incidence Angle	0 – 90	Degrees
celphi	Boresight Earth Azimuth Angle	0 – 360	Degrees
polarization_roll(*)	Polarization roll angle	-90 – 90	Degrees
doppler_shift(*)	Doppler frequency shift		Ghz
sunglt	Sun Glint Angle	-180 – 180	Degrees
suntht	Sun Vector Earth Incidence Angle	-180 – 180	Degrees
sunphi	Sun Vector Earth Azimuth Angle	0 – 360	Degrees
moonglt	Moon Glint Angle	0 – 180	Degrees
glxlat	Galaxy Declination (J2000)	-90 – 90	Degrees
glxlon	Galaxy Right Acension (J2000)	0 - 360	Degrees
scat_beam_clat	Scatterometer Beam Center Latitude	-90 – 90	Degrees
scat_beam_clon	Scatterometer Beam Center Longitude	-180 - 180	Degrees
scat_latfoot	Scatterometer Latitude Footprint	-90 – 90	Degrees
scat_lonfoot	Scatterometer Longitude Footprint	-180 - 180	Degrees
mwr_beam_clat(*)	MWR Beam Center Latitude	-90 – 90	Degrees
mwr_beam_clon(*)	Scatterometer Beam Center Longitude	-180 - 180	Degrees

(*) Not currently implemented

4.4 Converted Telemetry

The following data objects belong to the group "Converted Telemetry". Attributes of the objects are shown in **bold**. This group contains Aquarius temperatures in the **rad_caltemps** object, unpacked from raw telemetry and converted to physical units; and the computed radiometer gain and offset values used to calibrate the antenna brightness temperatures, shown in Table 8. The data objects in the table each have dimensions **Number of Blocks** x **Number of Beams**.

rad_caltemps (4-byte real, array size **Number of Blocks** x 85): **long_name** = "Radiometer calibration temperatures"; Aquarius temperatures used to calibrated the instrument brightness temperatures.

Table 8. Radiometer Calibration Gains and Offsets

Name	Long Name
rad_ghh	Radiometer HH gain
rad_gmU	Radiometer MU gain
rad_gmh	Radiometer MH gain
rad_gmv	Radiometer MV gain
rad_gpU	Radiometer PU gain
rad_gph	Radiometer PH gain
rad_gpv	Radiometer PV gain
rad_gvv	Radiometer VV gain
rad_hmU	Radiometer hMU gain
rad_hpU	Radiometer hPU gain
rad_oh	Radiometer H offset
rad_om	Radiometer M offset
rad_op	Radiometer P offset
rad_ov	Radiometer V offset