AVISO and PODAAC
User Handbook

IGDR and GDR
Jason Products
# DOCUMENTATION CHANGE RECORD

<table>
<thead>
<tr>
<th>Issue.</th>
<th>Rev.</th>
<th>Dates</th>
<th>Pages</th>
<th>Modifications</th>
<th>Visa</th>
</tr>
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<tbody>
<tr>
<td>2</td>
<td>0</td>
<td>14 April 2003</td>
<td>All</td>
<td>Initial release to users</td>
<td>N Picot</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Inline with products named JA1_GDR_2Pa generated since the beginning of the mission</td>
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<tr>
<td>2</td>
<td>1</td>
<td>October 2004</td>
<td>See change bars</td>
<td>Modification on 20Hz field management.</td>
<td>N Picot</td>
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<td>Implemented on IGDR data starting with cycle 102 and on GDR/SGDR data starting with cycle 91. No impact on the 1 Hz data.</td>
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<tr>
<td>3</td>
<td>0</td>
<td>07 December 2005</td>
<td>See change bars</td>
<td>Accounting for all evolutions included in GDR v2 version.</td>
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<td>Inline with products named JA1_GDR_2Pb</td>
<td>S. Desai</td>
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<td>Implemented on IGDR data starting on October, 24th 2005 (i.e. first day of cycle 140) and on GDR/SGDR data starting on cycle 136 (for the routine processing)</td>
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<td>4</td>
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<td>June 2008</td>
<td>See change bars</td>
<td>Accounting for all evolutions included in GDR_C version.</td>
<td>N Picot</td>
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<td>Accounting for evolution regarding mog2D correction inside IGDR products.</td>
<td>S. Desai</td>
</tr>
<tr>
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<td>Inline with products named JA1_GDR_2Pc and JA1_IGD_2Pc</td>
<td>J. Hausman</td>
</tr>
<tr>
<td></td>
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<td>Implemented on IGDR data starting on June, 17th (i.e JA1_IGD_2PcP237_121 ) and on GDR/SGDR data starting on cycle 233 (for the routine processing).</td>
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<td>4</td>
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<td>Septembe r 2008</td>
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<td>POE standard modification (Time variable Gravity terms of order &gt; 1 removed)</td>
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<td>Correction of GDR_C version scope (instrumental corrections have been updated)</td>
<td>S. Desai</td>
</tr>
<tr>
<td>Issue</td>
<td>Rev</td>
<td>Dates</td>
<td>Pages</td>
<td>Modifications</td>
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<td>Inline with products named JA1_GDR_2Pc and JA1_IGD_2Pc.</td>
<td></td>
</tr>
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1. Product evolution history

1.1. Models and Standards History

Three versions of the Jason-1 Interim Geophysical Data Records (IGDRs) and Geophysical Data Records (GDRs) have been generated to date. These versions are identified by the version numbers “a”, “b” and “c” in the name of the data products. For example, version “a” GDRs are named “JA1_GDR_2Pa”, version “b” GDRs are named “JA1_GDR_2Pb”, and version “c” GDRs are name “JA1_GDR_2Pc”. All three versions have the same data record format as described in this handbook and differ only in the models and standards that they adopt.

**Version “a”** I/GDRs are the first version released soon after launch.

**Version “b”** I/GDRs were first implemented operationally from the start of cycle 140 for the IGDRs and cycle 136 for the GDRs. Reprocessing to generate version “b” GDRs for cycles 1-135 was performed in 2006 to generate a consistent data set.

**Version “c”** I/GDRs were first implemented operationally from June, 17th 2008 for the IGDRs (i.e. starting with product JA1_1GD_2PeP237_121) and cycle 233 for the GDRs. The standards for the precise orbit ephemeris (POE) on the I/GDRs were subsequently modified and implemented operationally from August, 12th 2008 for the IGDRs and cycle 240 for the GDRs. Reprocessing to generate a consistent set of version “c” GDRs for cycles 1-239 will be performed in 2008/2009. Version “c” I/GDR products are generated without the file extension (e.g., .CNES, .NASA) which was used on the version “a” and “b” products.

NOTE: All version “c” I/GDRs with the modified POE standard have file generation times of August 12, 2008 and onwards. Version “c” GDR products with file generation times prior to August 12, 2008 (e.g., cycles 220-239) adopted a previous POE standard, and should therefore be replaced with products generated after this date.

The table below summarizes the models and standards that are adopted in these versions of the Jason I/GDRs. Sections 1.2 and 1.3 provide more details on some of these models.
<table>
<thead>
<tr>
<th>Model</th>
<th>Product Version &quot;a&quot;</th>
<th>Product Version &quot;b&quot;</th>
<th>Product Version &quot;c&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>JA1_GDR_2Pa&lt;ccc&gt;<em>&lt;ppp&gt;.CNES or JA1_GDR_2Pa&lt;ccc&gt;</em>&lt;ppp&gt;.NASA</td>
<td>JA1_GDR_2Pb&lt;ccc&gt;<em>&lt;ppp&gt;.CNES or JA1_GDR_2Pb&lt;ccc&gt;</em>&lt;ppp&gt;.NASA</td>
<td>JA1_GDR_2Pe&lt;ccc&gt;_&lt;ppp&gt;.NASA</td>
</tr>
<tr>
<td>Orbit</td>
<td>JGM3 Gravity Field DORIS tracking data for IGDRs. DORIS+SLR tracking data for GDRs.</td>
<td>EIGEN-CG03C Gravity Field DORIS tracking data for IGDRs. DORIS+SLR+GPS tracking data for GDRs.</td>
<td>EIGEN-GL04C Gravity Field DORIS tracking data for IGDRs. DORIS+SLR+GPS tracking data for GDRs.</td>
</tr>
<tr>
<td>Altimeter Retracking</td>
<td>MLE3 + 1st order Brown model</td>
<td>MLE4 + 2nd order Brown model.</td>
<td>Identical to Version “b”</td>
</tr>
<tr>
<td>Altimeter Instrument Corrections</td>
<td>Consistent with MLE3 retracking algorithm.</td>
<td>Consistent with MLE4 retracking algorithm.</td>
<td>Updated, using a new altimeter simulator chain and correction of an anomaly on SWH instrumental correction tables, A new correction is available in the product to account for the apparent datation bias (field 28). Users are advised to add this correction to the Ku-band altimeter range, as it is not a component of the net instrument correction that has already been applied to the provided Ku-band range</td>
</tr>
<tr>
<td>Dry Troposphere Range Correction</td>
<td>From ECMWF atmospheric pressures.</td>
<td>From ECMWF atmospheric pressures and model for S1 and S2 atmospheric tides.</td>
<td>From ECMWF atmospheric pressures and model for S1 and S2 atmospheric tides. Uses new ECMWF delivery</td>
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## Chapter 1- PRODUCT EVOLUTION HISTORY

<table>
<thead>
<tr>
<th>Model</th>
<th>Product Version(^a)</th>
<th>Product Version(^b)</th>
<th>Product Version “c”(^c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet Troposphere Range Correction from Model</td>
<td>From ECMWF model</td>
<td>From ECMWF model</td>
<td>to correct for spurious oscillation effects.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Back up model for Ku-band ionospheric range correction</td>
<td>Derived from DORIS measurements.</td>
<td>Derived from DORIS measurements.</td>
<td>Identical to Version “b”</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sea State Bias Model</td>
<td>Empirical model derived from cycles 19-30 of version “a” data.</td>
<td>Empirical model derived from cycles 1-100 of MLE3 altimeter data with version “b” geophysical models</td>
<td>Empirical model derived from cycles 1-100 of GDR_B products (e.g. MLE4 with a skewness set to -0.1, instrument corrections tables, and precise orbit ephemeris), but with version “c” geophysical models</td>
</tr>
<tr>
<td>Mean Sea Surface Model</td>
<td>GSFC00.1</td>
<td>CLS01</td>
<td>Identical to Version “b”</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Along Track Mean Sea Surface Model</td>
<td>None (set to default)</td>
<td>None (set to default)</td>
<td>None (set to default)</td>
</tr>
<tr>
<td>Geoid</td>
<td>EGM96</td>
<td>EGM96</td>
<td>Identical to Version “b”</td>
</tr>
<tr>
<td>Bathymetry Model</td>
<td>DTM2000.1</td>
<td>DTM2000.1</td>
<td>Identical to Version “b”</td>
</tr>
<tr>
<td>Mean Dynamic Topography</td>
<td>None (was a spare)</td>
<td>None (was a spare)</td>
<td>RIO 2005 solution</td>
</tr>
<tr>
<td>Inverse Barometer Correction</td>
<td>Computed from ECMWF atmospheric pressures</td>
<td>Computed from ECMWF atmospheric pressures after removing S1 and S2 atmospheric tides.</td>
<td>Identical to Version “b” but using new ECMWF delivery to correct for spurious oscillation effects</td>
</tr>
<tr>
<td>Non-tidal High-frequency Dealiasing Correction</td>
<td>None (set to default)</td>
<td>Mog2D ocean model on GDRs, none (set to default) on IGDRs. Ocean model forced by ECMWF atmospheric pressures after removing S1 and S2 atmospheric tides.</td>
<td>High resolution Mog2D model for both IGDR and GDR products.</td>
</tr>
<tr>
<td>Tide Solution 1</td>
<td>GOT99</td>
<td>GOT00.2 + S1 ocean tide . S1 load tide ignored.</td>
<td>Identical to Version “b”</td>
</tr>
<tr>
<td>Tide Solution 2</td>
<td>FES99</td>
<td>FES2004 + S1 and M4 ocean tides. S1 and M4 load tides</td>
<td>FES2004 + S1 and M4 ocean tides. S1, K2 and loading</td>
</tr>
</tbody>
</table>
## Chapter 1- PRODUCT EVOLUTION HISTORY

<table>
<thead>
<tr>
<th>Model</th>
<th>Product Version &quot;a&quot;</th>
<th>Product Version &quot;b&quot;</th>
<th>Product Version “c”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equilibrium long-period ocean tide model</td>
<td>From Cartwright and Taylor tidal potential.</td>
<td>From Cartwright and Taylor tidal potential.</td>
<td>Identical to Version “b”</td>
</tr>
<tr>
<td>Non-equilibrium long-period ocean tide model</td>
<td>None (set to default)</td>
<td>Mm, Mf, Mtm, and Msqm from FES2004.</td>
<td>Identical to Version “b”</td>
</tr>
<tr>
<td>Solid Earth Tide Model</td>
<td>From Cartwright and Taylor tidal potential.</td>
<td>From Cartwright and Taylor tidal potential.</td>
<td>Identical to Version “b”</td>
</tr>
<tr>
<td>Pole Tide Model</td>
<td>Equilibrium model</td>
<td>Equilibrium model.</td>
<td>Identical to Version “b”</td>
</tr>
<tr>
<td>Wind Speed from Model</td>
<td>ECMWF model</td>
<td>ECMWF model</td>
<td>Identical to Version “b”</td>
</tr>
<tr>
<td>Altimeter Wind Speed Model</td>
<td>Derived from TOPEX/POSEIDON data.</td>
<td>Derived from version “a” Jason-1 GDR data.</td>
<td>Identical to Version “b”</td>
</tr>
<tr>
<td>Rain Flag</td>
<td>Derived from TOPEX/POSEIDON data.</td>
<td>Derived from version “a” Jason-1 GDRs.</td>
<td>Derived from version “b” Jason-1 GDRs using the AGC instead of sigma naught values</td>
</tr>
<tr>
<td>Ice Flag</td>
<td>Climatology table</td>
<td>Climatology table</td>
<td>New flag based on the comparison of the model wet tropospheric correction and of a radiometer bi frequency wet tropospheric correction (derived from 23.8 GHz and 34.0 GHz), accounting for a backup solution based on climatologic estimates of the latitudinal boundary of the ice shelf, and from altimeter wind speed.</td>
</tr>
</tbody>
</table>
1.2. Models and Editing on Version"a" Products

Note: the following 3 fields are not available in products version "a":

- High frequency fluctuations of the sea surface topography (hf_fluctuations_corr)
- Along-track mean sea surface (mss_tp_along_trk)
- Non-equilibrium ocean tide (ocean_tide_neq_lp)

The corresponding fields (number 71, 75 and 80) are set to the default value.

1.2.1. Mean Sea Surface

The GSFC00.1 MSS model is computed from satellite altimetry data from a variety of missions. These include, 6 years of T/P data (Cycles 11 to 232), multi-years of ERS-1/2 35 day repeat cycle data (ERS-1 Phase C: Cycles 1 to 18, Phase G: Cycles 1 to 13; ERS-2: Cycles 1 to 29)], GEOSAT GM and ERM data, and ERS-1 168 day data. The model is computed on a 2' grid oceanwide between the latitudes of ±80 degrees. The 2' grid of the GSFC00.1 model is interpolated to provide the mean sea surface (see parameter mss) at the location of each altimeter measurement, and an interpolation quality flag (see parameter interp_flag) indicates the quality of this interpolation. Note that a static inverse barometer correction reference to a constant mean pressure of 1013.3 mbar was applied to the sea surface height data that contributed to the original GSFC00.1 MSS model. However, a global mean pressure of 1010.9 mbar is more consistent with the inverse barometer correction that is provided on the JASON-1 (I)GDR. For this reason the JASON-1 (I)GDR provide values from a modified GSFC00.1 model that has a bias of 23.9 mm added to it (see section 4.9). The model provides the mean sea surface height reference to the reference ellipsoid. Refer to http://magus.stx.com/mssh/mssh.html for more details on the original GSFC00.1 model.

1.2.2. Along-Track Mean Sea Surface Model

The JASON-1 (I)GDR provide a parameter for a MSS model that is specifically generated along the T/P ground track (see parameter mss_tp_along_trk). No specific model has been chosen for this parameter and it is therefore set to a default value.

1.2.3. Geoid

JASON-1 (I)GDR use the EGM96 geopotential to compute the geoid [Lemoine et al., 1998]. The EGM96 geopotential model has been used to calculate point values of geoid undulation on a 0.25 x 0.25 degree grid that spans the latitude range +85.0 deg. to -85.0 deg. The EGM96 model is complete to spherical harmonic degree and order 360, and has been corrected appropriately so as to refer to the mean tide system as far as the permanent tide is concerned [Rapp et al., 1991]. The k2 Love number used in this conversion was 0.3. The geoid undulations are given with respect to an ideal geocentric mean Earth ellipsoid, whose semi-major axis remains undefined (i.e., there is
no zero-degree term in the spherical harmonic series of these geoid undulations). The flattening of this reference ellipsoid is $f=1/298.257$ so that values are consistent with constants adopted for T/P.

Since the geoid undulations have been computed from an expansion to degree 360, the resolution of the undulations will be on the order of 50km. Data used to derived the EGM96 model include surface gravity data from different regions of the globe, altimeter derived gravity anomalies from the GEOSAT Geodetic Mission, altimeter derived anomalies from ERS-1, direct satellite altimetry from T/P, ERS-1 and GEOSAT, and satellite tracking to over 20 satellites using satellite laser ranging, GPS, DORIS, the Tracking and Data Relay Satellite System (TDRSS), and TRANET.

More information on EGM96 can be found at http://cddisa.gsfc.nasa.gov/926/egm96/egm96.html

1.2.4. Bathymetry Model

The value of the parameter is determined from the DTM2000.1 model from N. Pavlis and J. Saleh [personal communication, 2000] of the Raytheon ITSS/Goddard Space Flight Center. The model is provided globally with a 2’ resolution. The heritage of DTM2000.1 goes back to the OSU-JAN98 database [Pavlis and Rapp, 1990] and the JGP95E database [Chapter 2 of Lemoine et al., 1998]. The bathymetric information in DTM2000.1 (originating from Smith and Sandwell’s [1994] global sea floor topography) has significant differences with the ETOPO5 bathymetric model. The mean and standard deviation of these differences is 10 m and 270 m, respectively.

1.2.5. Ocean Tide Models

The two geocentric tide values provided on the JASON-1 (I)GDR, ocean_tide_sol1 and ocean_tide_sol2, are computed with diurnal and semidiurnal ocean and load tide values predicted by the GOT99.2 and FES99 models, respectively. Similarly, the two load tide values provided on the JASON-1 (I)GDR, load_tide_sol1 and load_tide_sol2, provide the load tide values predicted by the GOT99.2 and FES99 models, respectively.

Both models are interpolated to provide the geocentric ocean and load tides at the location of the altimeter measurement, and an interpolation quality flag is provided on the (I)GDRs to indicate the quality of this interpolation (see interp_flag.)

GOT99.2 Ocean Tide Model

The GOT99.2 model is an empirical model of the diurnal and semidiurnal ocean tides (see ocean_tide_sol1). This model was developed by R.D. Ray at the Goddard Space Flight Center, [Ray, 1999]. The model is based on over six years (232 repeat cycles) of sea surface height measurements by the T/P satellite altimeter. The model benefits from the use of prior hydrodynamic models, several in shallow and inland seas, as well as the global finite-element model FES94.1 [Le Provost et al., 1994]. The GOT99.2 model is based on the least squares harmonic analysis of the T/P sea surface height data that estimates coefficients for the Q1, O1, P1,
K1, N2, M2, S2, and K2 tidal constituents (among others), and accounts for nodal modulations of all lunar tides. The GOT99.2 model coefficients have been estimated from sea surface heights that have applied an inverse barometer correction that is based on daily means of the atmospheric pressure, rather than the 6 hourly fields that are typically used to determine the dry troposphere correction on the T/P data products. Daily means of the atmospheric pressure eliminate atmospheric loading effects on the ocean at the S1 and S2 frequencies from the applied inverse barometer correction. In doing so, the S2 tides predicted by the GOT99.2 model actually include this atmospheric loading effect on the oceans.

**FES99 Ocean Tide Model**

The FES99 model is a finite-element hydrodynamic model, constrained with tide gage and past altimeter data [Le Provost, 2001] (see ocean_tide_so12.)

It is based on the resolution of the tidal barotropic equations on a global finite element grid without any open boundary condition, which leads to solutions independent of in situ data (no open boundary conditions and no data assimilation). The accuracy of the 'free' solutions was improved by assimilating tide gauge and TOPEX/Poseidon (T/P) altimeter information through a revised representer assimilation method. A careful selection of in situ tide gauge data from different data banks allowed to build a collection of about 700 data values for each of the eight computed waves (M2, S2, N2, K2, 2N2, K1, O1 and Q1). These data were assimilated to produce the FES98 version, which is independent of altimetry. To improve FES98 in deep ocean, T/P data were also assimilated. For the eight main constituents of the tidal spectrum (M2, S2, N2, K2, 2N2, K1, O1, and Q1), approximately 700 tide gauges and 687 T/P altimetric crossover data sets harmonically analysed, were assimilated. An original algorithm was developed to calculate the tidal harmonic constituents at crossover points of the T/P altimeter database. Additional work was performed for the S2 wave by reconsidering the inverted barometer correction. 19 minor constituents have also been added by admittance as well as 3 long period constituents to complete the spectrum. They are both distributed on a 0.25°x0.25° grid interpolated from the full finite element solutions.

**1.2.6. Sea Surface Height Bias Recommendation**

The estimate for the absolute bias in the Jason-1 sea-surface height measurements (SSH) is \(+131 \pm 5 \text{ mm (formal error)}\). This estimate was based on 50 overflights of three principal calibration sites: 1) Corsica Island [Bonnefond et al., 2002], 2) Harvest oil platform off the coast of central California [Haines et al., 2002], and 3) Bass Strait, Australia [Watson et al., 2002]. The sense of this bias is such that SSH measurements formed from the Jason (I)GDR data are spuriously high. Users electing to correct for the bias, e.g., to better align Jason-1 and T/P data, should subtract 131 mm from the SSH measurements.

It should be noted that the bias reflects the combination of the mean errors from all of the corrections that are used to compute sea surface height. The bias provided above is intended for sea surface height measurements that are computed with the standard (I)GDR corrections.
1.2.7. Data Editing Criteria

The following editing criteria are a recommended guideline for finding good records from the (I)GDR version a to calculate the sea level anomaly from the Ku band range. The user should review these criteria before using them and may wish to modify them!

First, check the following conditions to retain only ocean data and remove any bad, missing, or flagged data (note that the parameters are listed in order as they appear in the data record):

- `surface_type = 0` /* open oceans or semi-enclosed seas */
- `alt_echo_type = 0` /* ocean-like */
- `rad_surf_type = 0` /* ocean */
- `qual_1hz_alt_data = 0` (all bits) /* Ku band range is good */
- `qual_1hz_alt_instr_corr = 0` (all bits) /* Ku band range instrument correction is good */
- `qual_1hz_rad_data = 0` (all bits) /* brightness temperatures (all channels) are good */
- `orb_state_flag = 3` /* adjusted (preliminary/precise) orbit */
- `altitude` not equal default value
- `range_ku` not equal default value
- `model_dry_tropo_corr` not equal default value
- `rad_wet_tropo_corr` not equal default value
- `iono_corr_alt_ku` not equal default value
- `sea_state_bias_ku` not equal default value
- `mss` not equal default value
- `inv_bar_corr` not equal default value
- `ocean_tide_soll` not equal default value
- `solid_earth_tide` not equal default value
- `pole_tide` not equal default value
- `ecmwf_meteo_map_avail = 0` /* ECMWF meteorological map available */
- `tb_interp_flag = 0 or 1` /* radiometer interpolation flag is good */
- `rain_flag = 0` /* no rain */
- `ice_flag = 0` /* no ice */
- `interp_flag bit 0 = 0` /* mss interpolation flag is good */
- `interp_flag bit 1 = 0` /* ocean_tide_soll interpolation flag is good */
- `interp_flag bit 3 = 0` /* meteorological data interpolation flag is good */
In addition to checking the above conditions, it is also recommended to filter the data as follows to retain only the most valid data:

- **Number of valid points (range_numval_ku) ≥ 10**
- 0 mm ≤ RMS of 1/sec range (range_rms_ku) ≤ 200 mm
- -10 000 mm ≤ (sea level anomaly) ≤ 10 000 mm
- -2500 mm < dry tropospheric correction (model_dry_tropo_corr) < -1900 mm
- -500 mm ≤ wet tropospheric correction (rad_wet_tropo_corr) ≤ -1 mm
- -400 mm ≤ ionospheric correction (iono_corr_alt_k) ≤ 40 mm
- -5000 mm ≤ sea state bias correction (sea_state_bias_ku) ≤ 0 mm
- -5000 mm ≤ ocean tide correction (ocean_tide_sol1) ≤ +5000 mm
- -1000 mm ≤ solid earth tide correction (solid_earth_tide) ≤ +1000 mm
- -150 mm ≤ pole tide correction (pole_tide) ≤ +150 mm
- -500 mm ≤ equilibrium tide correction (ocean_tide_eq_lp) ≤ +500 mm
- -2 000 mm ≤ inverse barometer (inv_bar_corr + hf_fluctuations_corr) ≤ +2 000 mm
- 0 mm ≤ significant waveheight (swh_ku) ≤ 11 000 mm
- 7 dB ≤ sigma naught (sig0_ku) ≤ 30 dB
- 0 m/s ≤ altimeter wind speed ≤ 30 m/s
- -0.2 deg² ≤ square of off nadir angle from waveforms (off_nadir_angle_ku_wvf) ≤ 0.5 deg²

To restrict study to deep water, apply a limit, e.g., water depth of 1000m or greater, using the bathymetry parameter (ocean depth in meters.)

Additional empirical tests may be used to refine data editing and remove spurious data:

- -2 m ≤ Difference of significant waveheight (swh_c - swh_ku) ≤ 2 m
  - swh_rms_ku / (MAX(swh_ku, 1))\(1/3\) < 18
  - swh_rms_c / (MAX(swh_ku, 1))\(1/3\) < 44
  - range_rms_ku / (MAX(swh_ku, 1))\(1/3\) < 100
  - range_rms_c / (MAX(swh_ku, 1))\(1/3\) < 170
  - sigma0_rms_ku < 0.2 dB
  - sigma0_rms_c < 0.26 dB
1.3. Models and Editing on Version “b” Products

Note: the following field is not available in version "b" products:

- Along-track mean sea surface (mss_tp_along_trk)

The corresponding field (number 71) is set to the default value.

1.3.1. Mean Sea Surface

The CLS01_MSS model is computed from satellite altimetry data from a variety of missions. The table below lists the main characteristics of the model.

<table>
<thead>
<tr>
<th>Name</th>
<th>CLS01</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference ellipsoid</td>
<td>T/P</td>
</tr>
<tr>
<td>Referencing time</td>
<td>1993-1999 (7 years)</td>
</tr>
<tr>
<td>period</td>
<td></td>
</tr>
<tr>
<td>Domain</td>
<td>Global (80°S to 82°N) - Oceanwide where altimetric data are available. EGM96 elsewhere and on continents.</td>
</tr>
<tr>
<td>Spatial resolution</td>
<td>Regular grid with a 1/30° (2 minutes) spacing (i.e. ~4 km)</td>
</tr>
<tr>
<td>Grid</td>
<td>10800 points in longitudes / 4861 points in latitude</td>
</tr>
</tbody>
</table>

MSS determination technique

Local least square colocation method on a 6' grid where altimetric data in a 200-km radius are selected. Estimation on a 2' grid based on SSH-EGM96 values (remove/restore technique to recover the full signal). The inverse method uses local isotropic covariance functions that witness the MSS wavelength content.

### 1.3.2. Along-Track MSS Model
No modifications from version "a" to version "b". Refer to section 1.2.2 for details

### 1.3.3. Geoid
No modifications from version "a" to version "b". Refer to section 1.2.3 for details.

### 1.3.4. Bathymetry Model
No modifications from version "a" to version "b". Refer to section 1.2.4 for details.

### 1.3.5. Ocean Tide Models
The two geocentric tide values provided on the JASON-1 (I)GDR, ocean_tide_sol1 and ocean_tide_sol2, are computed with diurnal and semidiurnal ocean and load tide values predicted by the GOT00.2 and FES2004 models, respectively.

Both geocentric ocean tide fields (fields #77 and #78) also include the load tides from the respective models (also provided separately in fields #81 and #82), and the equilibrium long-period ocean tide (also provided separately in field #79). These two fields (#77 and #78) now also include the S1 oceanic response to atmospheric pressure based on the model from Ray and Egbert (2004). The FES2004 model now also includes the M4 ocean tide. Note that the load tide fields (fields #81 and #82) only include the load tides from the GOT00.2 and FES2004 models, and do not contain the load tides from the S1, M4, or equilibrium long-period ocean tides.

Both models are interpolated to provide the geocentric ocean and load tides at the location of the altimeter measurement, and an interpolation quality flag is provided on the (I)GDRs to indicate the quality of this interpolation (see interp_flag.)
GOT00.2 Ocean Tide Model

Solution GOT00.2 [Ray, 1999] used 286 10-day cycles of Topex and Poseidon data, supplemented in shallow seas and in polar seas (latitudes above 66deg) by 81 35-day cycles of ERS-1 and ERS-2 data. The solution consists of independent near-global estimates of 7 constituents (Q1,O1,K1,N2,M2,S2,K2, with P1 inferred). An a priori model was used that consisted of the hydrodynamic model FES94.1 of Le Provost et al., and several other local hydrodynamic models, including Mike Foreman's in the Gulf of Alaska. Some effort was devoted to removing the boundary problems in FES94.1, although this was not 100% successful. The ERS data appear most useful in the Norwegian and Barents Seas.

See ftp://geodesy.gsfc.nasa.gov/dist/ray/GOT00.2

FES2004 Ocean Tide Model

The FES2004 model is a finite-element hydrodynamic model, constrained with tide gage and past altimeter data [Le Provost, 2001] (see ocean_tide_so12.)

It is based on the resolution of the tidal barotropic equations on a global finite element grid without any open boundary condition, which leads to solutions independent of in situ data (no open boundary conditions and no data assimilation). FES2004 is the last update of the FES solution. Maregraphic and reprocessed TP and ERS crossover data are assimilated in the FES2002 hydrodynamical solution. The altimeter data reprocessing consists in a new atmospheric forcing response correction (mog2D-G) applied to the data before the harmonic analysis. FES2004 includes the M2, S2, N2, K2, 2N2, K1, O1, P1, Q1 tides. 4 hydrodynamical long period tides and the non-linear M4 tide are also included in the distribution package. A new prediction algorithm is associated with FES2004. This algorithm use an admittance method to extends the prediction spectrum up to 36 tidal constituents. The FES2004 model also provides non-equilibrium models for the Mm, Mf, Mtm, and Msqm tidal components, which are provided by the parameter ocean_tide_neq_lp (field #80).

See http://www.legos.obs-mip.fr/en/share/soa/cgi/getarc/v0.0/index.pl.cgi?contexte=SOA&donnees=mareae&produit=model_e_fes

1.3.6. Sea Surface Height Bias Recommendation

The estimate for the absolute bias in the Jason-1 sea-surface height measurements (SSH) is +131 ± 5 mm (formal error). This estimate was based on 50 overflights of three principal calibration sites: 1) Corsica Island [Bonnefond et al., 2002], 2) Harvest oil platform off the coast of central California [Haines et al., 2002], and 3) Bass Strait, Australia [Watson et al., 2002]. The sense of this bias is such that SSH measurements formed from the Jason (1)GDR data are spuriously high. Users electing to correct for the bias, e.g., to better align Jason-1 and T/P data, should subtract 131 mm from the SSH measurements.

It should be noted that the bias reflects the combination of the mean errors from all of the
corrections that are used to compute sea surface height. The bias provided above is intended for sea surface height measurements that are computed with the standard (I)GDR corrections.

1.3.7. Data Editing Criteria

The following editing criteria are a recommended guideline for finding good records from the (I)GDR version b to calculate the sea level anomaly from the Ku band range. The user should review these criteria before using them and may wish to modify them!

First, check the following conditions to retain only ocean data and remove any bad, missing, or flagged data (note that the parameters are listed in order as they appear in the data record):

- surface_type = 0 /* open oceans or semi-enclosed seas */
- alt_echo_type = 0 /* ocean-like */
- rad_surf_type = 0 /* ocean */
- qual_1hz_alt_data = 0 (all bits) /* Ku band range is good */
- qual_1hz_alt_instr_corr = 0 (all bits) /* Ku band range instrument correction is good */
- qual_1hz_rad_data = 0 (all bits) /* brightness temperatures (all channels) are good */
- orb_state_flag = 3 /* adjusted (preliminary/precise) orbit */
- altitude not equal default value
- range_ku not equal default value
- model_dry_tropo_corr not equal default value
- rad_wet_tropo_corr not equal default value
- iono_corr_alt_ku not equal default value
- sea_state_bias_ku not equal default value
- mss not equal default value
- inv_bar_corr not equal default value
- ocean_tide_soll not equal default value
- solid_earth_tide not equal default value
- pole_tide not equal default value
- ecmwf_meteo_map_avail = 0 /* ECMWF meteorological map available */
- tb_interp_flag = 0 or 1 /* radiometer interpolation flag is good */
- rain_flag = 0 /* no rain */
- ice_flag = 0 /* no ice */
- interp_flag bit 0 = 0 /* mss interpolation flag is good */
- interp_flag bit 1 = 0 /* ocean_tide_soll interpolation flag is good */
- interp_flag bit 3 = 0 /* meteorological data interpolation flag is good */
In addition to checking the above conditions, it is also recommended to filter the data as follows to retain only the most valid data:

- **Number of valid points (range_numval_ku) ≥ 10**
- **0 mm ≤ RMS of 1/sec range (range_rms_ku) ≤ 200 mm**
- **-130 000 mm ≤ (altitude – range_ku) ≤ 100 000 mm**
- **-2500 mm < dry tropospheric correction (model_dry_tropo_corr) < -1900 mm**
- **-500 mm ≤ wet tropospheric correction (rad_wet_tropo_corr) ≤ -1 mm**
- **-400 mm ≤ ionospheric correction (iono_corr_alt_k) ≤ 40 mm**
- **-500 mm ≤ sea state bias correction (sea_state_bias_ku) ≤ 0 mm**
- **-5000 mm ≤ ocean tide correction (ocean_tide_sol1) ≤ +5000 mm**
- **-1000 mm ≤ solid earth tide correction (solid_earth_tide) ≤ +1000 mm**
- **-150 mm ≤ pole tide correction (pole_tide) ≤ +150 mm**
- **0 mm ≤ significant waveheight (swh_ku) ≤ 11 000 mm**
- **7 dB ≤ sigma naught (sig0_ku) ≤ 30 dB**
- **0 m/s ≤ altimeter wind speed ≤ 30 m/s**
- **-0.2 deg² ≤ square of off nadir angle from waveforms (off_nadir_angle_ku_wvf) ≤ 0.64 deg²**
  - **sigma0_rms_ku < 1.0 dB**
  - **sig0_numval_ku > 10**

To restrict studies to deep water, apply a limit, e.g., water depth of 1000m or greater, using the bathymetry parameter (ocean depth in meters.)

Additional empirical tests may be used to refine data editing and remove spurious data:

- **-2 m ≤ Difference of significant waveheight (swh_c - swh_ku) ≤ 2 m**
  - **swh_rms_ku / (MAX(swh_ku, 1))^{1/3} < 18**
  - **swh_rms_c / (MAX(swh_ku, 1))^{1/3} < 44**
  - **range_rms_ku / (MAX(swh_ku, 1))^{1/3} < 100**
  - **range_rms_c / (MAX(swh_ku, 1))^{1/3} < 170**
  - **sigma0_rms_c < 0.26 dB**
1.4. Models and Editing on Version “c” Products

Note : the following field is not available in version "c" products:

- Along-track mean sea surface (mss_tp_along_trk)

The corresponding field (number 71) is set to the default value.

1.4.1. Orbit

The table below displays the Jason-1 and Envisat precise orbit determination (POD) standards underlying the computation of the orbit altitude data on the GDR-C data products.

<table>
<thead>
<tr>
<th></th>
<th>GDR-B</th>
<th></th>
<th>GDR-C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Jason-1</td>
<td>Envisat</td>
<td>Jason-1</td>
</tr>
<tr>
<td>Time Span</td>
<td>Cycle 1 to 232</td>
<td>Cycle 41 (arc 171) to 67 (arc 305)</td>
<td>Complete reprocessing</td>
</tr>
<tr>
<td>Reference System</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polar motion and UT1</td>
<td>IERS bulletin C04 with IERS 1996 daily and sub-daily corrections</td>
<td>IERS bulletin C04 consistent with ITRF2005, with IERS 1996 sub-daily corrections</td>
<td></td>
</tr>
<tr>
<td>Doris coordinates</td>
<td>DPOD2000</td>
<td></td>
<td>DPOD2005</td>
</tr>
<tr>
<td>SLR coordinates</td>
<td>ITRF 2000 (with minor corrections for a few SLR stations)</td>
<td>SLRF2005, including station biases</td>
<td></td>
</tr>
<tr>
<td>Displacement of reference points</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earth tides</td>
<td>IERS 2003 Solid Earth tides</td>
<td></td>
<td>Unchanged</td>
</tr>
<tr>
<td>Ocean loading</td>
<td>FES 1999 (SLR only)</td>
<td></td>
<td>FES 2004 (SLR and Doris)</td>
</tr>
<tr>
<td>Pole tides</td>
<td>Solid Earth Pole tide from IERS2003 (SLR only)</td>
<td>Solid Earth Pole tide from IERS2003 (SLR and DORIS)</td>
<td></td>
</tr>
<tr>
<td>Satellite reference</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass and center of gravity</td>
<td>Post-Launch values + variations generated by Control Center</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attitude Model</td>
<td>Quaternions from control center, completed by nominal yaw steering law when necessary</td>
<td>Nominal law</td>
<td>Unchanged</td>
</tr>
<tr>
<td>Gravity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gravity field (static)</td>
<td>EIGEN-CG03C</td>
<td>EIGEN-GL04S</td>
<td></td>
</tr>
<tr>
<td>Gravity field (time varying)</td>
<td>Drifts from EIGEN-CG03C, on zonal harmonics up to degree 4</td>
<td>Annual+Semianual 50x50 from EIGEN-GL04S-ANNUAL (Drifts are unchanged wrt to GDR-B orbits)</td>
<td></td>
</tr>
<tr>
<td>Earth tides</td>
<td>IERS 2003 Solid Earth tides</td>
<td></td>
<td>Unchanged</td>
</tr>
<tr>
<td>Pole tide</td>
<td>Solid Earth Pole tide from IERS2003</td>
<td></td>
<td>Solid Earth and Ocean Pole tide from IERS2003</td>
</tr>
<tr>
<td>Ocean tides</td>
<td>FES 2004 (all principal constituents, with admittance)</td>
<td></td>
<td>Unchanged</td>
</tr>
</tbody>
</table>
### GDR-B

#### Jason-1
- Haurwitz & Cowley

#### Envisat
- None

#### Atmospheric tides

#### Atmospheric gravity
- Sun, Moon, Venus, Mars and Jupiter third bodies

#### Third bodies
- Sun, Moon, Venus, Mars and Jupiter third bodies

### GDR-C

#### Jason-1
- NCEP-derived 20x20 field at 6 hr interval (AGRA service at GSFC)

#### Envisat
- Unchanged

### Surface forces and empiricals

#### Radiation Pressure model
- Thermo-optical coefficient from pre-launch box and wing model, with smoothed Earth shadow model

#### Updates in coefficients of +Y,-Y and +X sides and in the value of the body-fixed X-force
- Unchanged

#### Radiation pressure scale coefficient
- Fixed to 0.97 (set to minimize the amplitude of 1/rev empiricals)

#### Adjusted, with a priori constraint
- Unchanged

#### Earth radiation
- Knocke-Ries albedo and IR satellite model

#### Atmospheric density model
- DTM 94, with best available solar activity

#### MSIS86 model, with best available solar activity
- Unchanged

#### Drag coefficients
- Adjusted every two revolutions, with apriori loose constraint

#### 1/rev empiricals
- Every 12 hours (depending on GPS availability)

#### Every 24 hours
- Unchanged

### Doris

#### Troposphere correction
- CNET1 model, vertical bias adjusted per pass

#### Frequency
- 1 frequency bias adjusted per pass

#### South Atlantic Anomaly
- SAA model applied before the instrument change

#### Not applicable
- SAA model applied over the entire series

#### Weight
- 1.5 mm/s (for Jason-1: underweighting of the SAA stations)

#### Datation bias (to compensate for along-track inconsistency of Doris orbits wrt SLR/GPS measurements)
- 6.0 msec

#### 6.5 msec

#### 6.0 msec before instrument change (cycle 91) and 8,8 after

#### Unchanged

### SLR

#### Troposphere correction
- Marini-Murray

#### Mendes-Pavlis

#### Retrorreflector correction
- Constant ranging correction

#### Elevation dependent ranging correction

#### Constant ranging correction

#### Biases
- Bias per pass solved for a few stations

#### Fixed biases consistent with SLRF2005, bias per pass solved for a few stations

#### Weight
- Globally 10 cm (some SLR stations underweighted)

#### Unchanged

### GPS

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*SMM-MU-M5-OP-13184-CN (AVISO)*  
JPL D-21352 (PODAAC)  
*Edition 4.1*  
October, 2008  
16
### Chapter 1- PRODUCT EVOLUTION HISTORY

<table>
<thead>
<tr>
<th></th>
<th><strong>GDR-B</strong></th>
<th><strong>GDR-C</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Jason-1</strong></td>
<td><strong>Envisat</strong></td>
</tr>
<tr>
<td>Constellation ephemeris and clocks</td>
<td>JPL precise solution at IGS</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Sampling for POD</td>
<td>5 min</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Phase correction diagrams</td>
<td>Receiver only</td>
<td>Not applicable</td>
</tr>
<tr>
<td>phase windup correction</td>
<td>Applied</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Phase ambiguity</td>
<td>Floating ambiguity adjusted per pass</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Receiver clock</td>
<td>Adjusted at every epoch</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Weight</td>
<td>Phase: 1 cm / Code: 1 m</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

The modifications to the POD standards—especially the change from the ITRF2000 to ITRF2005 reference frame and the use of time variable and atmospheric gravity—can result in significant geographically correlated differences between the orbit altitudes reported on the GDR-B and GDR-C data products. At specific locations, these differences can be as large as 5 cm. In a global RMS sense, however, the differences are typically at the 1-2 cm level (with global mean of < 1 mm).

### 1.4.2. Mean Sea Surface
No modifications from version "b" to version "c". Refer to section 1.3.1 for details

### 1.4.3. Along-Track MSS Model
No modifications from version "b" to version "c". Refer to section 1.2.2 for details

### 1.4.4. Geoid
No modifications from version "b" to version "c". Refer to section 1.2.3 for details.

### 1.4.5. Bathymetry Model
No modifications from version "b" to version "c". Refer to section 1.2.4 for details
1.4.6. Ocean Tide Models
S1, K2 and loading tides have been updated on the FES 2004 model
Refer to section 1.3.5 for details on the GOT and FES models

1.4.7. Mean dynamic Topography
Field number 76 was a spare in version "a" to version "b", it is now used to provide the RIO05
Mean Dynamic Topography model.

The issue of estimating a global Mean Dynamic Topography (MDT) is to reference the altimeter
Sea Level Anomalies (SLA), computed relative to a 7 year (1993-1999) mean profile, in order to
obtain absolute measurements of the ocean dynamic topography.
Required MDT has to be consistent with altimeter physical content and shall therefore correspond
to the mean over 1993-1999 of the geostrophic, barotropic and baroclinic ocean circulation.

1.4.8. Sea Surface Height Bias Recommendation (To be updated)
The estimate for the absolute bias in the Jason-1 sea-surface height measurements (SSH)
is TBD mm (formal error). This estimate was based on 50 overflights of three principal calibration
sites: 1) Corsica Island [Bonnefond et al., 2002], 2) Harvest oil platform off the coast of central
California [Haines et al., 2002], and 3) Bass Strait, Australia [Watson et al., 2002].
The sense of this bias is such that SSH measurements formed from the Jason (I)GDR data are spuriously high.
Users electing to correct for the bias, e.g., to better align Jason-1 and T/P data, should subtract
TBD mm from the SSH measurements. Expert users, of course, commonly compute and remove
their own SSH bias (relative), tailored to their specific application and/or region.

It should be noted that the bias reflects the combination of the mean errors from all of the
corrections that are used to compute sea surface height. The bias provided above is intended for
sea surface height measurements that are computed with the standard (I)GDR corrections.

1.4.9. Data Editing Criteria
No modifications from version "b" to version "c". Refer to section 1.3.7 for details.

1.4.10. Altimeter instrument corrections tables
The altimeter instrument correction tables have been updated using a new version of the altimeter
simulator. This allows the Jason-1 and Jason-2 altimeter correction tables to be aligned with each
other. As a result, altimeter range, SWH, and sigma0 measurements reported on the GDR-C
products are slightly different than the corresponding measurements on GDR-B, even though
identical retracking algorithms (MLE4) were used to generate both products.

The differences in reported altimeter range (Ku) are typically < 5 mm for individual measurements
and < 1 mm for the global mean. The magnitude of the instrumental correction terms is depicted
in the following figure for GDR-B and GDR-C (labelled “2005” and “2008” respectively).
In addition, the instrument correction tables for SWH were improperly implemented on the GDR-B products. This has been corrected in the GDR-C products. The resulting differences between SWH measurements reported on the GDR-B and GDR-C products are typically < 5 cm with a global average of approximately 3 cm. The figure below illustrates the SWH corrections tables for the GDR-B and GDR-C data products, respectively labelled “2005” and “2008”.

Modifications to the altimeter instrument correction tables and updated JMR calibration coefficients both contribute to differences between the sigma0 values provided on the GDR-B and GDR-C data products. These differences are typically < 0.05 dB with a global average of approximately 0.03 dB.
1.4.11. Sea State Bias Model

As noted in Table 1 above, the sea state bias (SSB) model on the GDR-C products has been empirically derived from MLE4-retracked altimeter data, and is therefore self-consistent with the reported altimeter measurements, except for the impact of the altimeter instrument correction updates noted above. (This was not the case with GDR-B). Users need to be aware that the SSB model on the GDR-C will shift the globally averaged SSH lower by 3-4 cm relative to GDR-B.
2. INTRODUCTION

JASON-1 is a follow-on mission to the highly successful TOPEX/POSEIDON (T/P) mission. The satellite is named after the leader of the Argonauts' famous quest to recover the Golden Fleece. The JASON-1 mission is jointly conducted by the French Space Agency, "Centre National d'Etudes Spatiales" (CNES) and the United States National Aeronautics and Space Administration (NASA).

2.1. Handbook Purpose

The purpose of this document is to assist users of the CNES/NASA JASON-1 Geophysical Data Record (GDR) and Interim Geophysical Data Record (IGDR) products by providing a comprehensive description of GDR content and format. Both products have the same format. We will so refer to (I)GDR in this document when the information is relevant for both products. Let us recall that the GDR is identical to the IGDR except for the following points:

- a more precise orbit is used (impacts on altitude field, Doppler, …)
- improved pole location data are used (Pole Tide update)
- an improved high frequency ocean dealiasing model is used
- it is a fully validated product

Section 6 provides a list of all fields from the IGDR that could be updated in the GDR.

The document also provides an overview of the JASON-1 mission and a description of the measurements and corrections. More information on data algorithms and sensors can be found in JASON-1 project documents (see Reference list in appendix B for the “Algorithms Definition, Accuracy and Specification” documents).

The geographical arrangement for distributing the JASON-1 data products to the international scientific community is covered by a CNES-NASA agreement. Both centers will disseminate all (I)GDR data. JASON-1 data are distributed through two agencies:

  ’Archivage, Validation et Interprétation des données des Satellites Océanographiques” is the French multi-satellite databank dedicated to space oceanography, developed by CNES.

- PO.DAAC : http://podaac.jpl.nasa.gov
  The Physical Oceanography Distributed Active Archive Center is one element of the Earth Observing System Data and Information System (EOSDIS), developed by NASA.
2.2. **Handbook Overview**

This is a combination of a guide to data usage and a reference handbook, so not all sections will be needed by all readers.

Section 1 provides information of product evolution history

Section 2 provides background information about the (I)GDR and this document.

Section 3 is an overview of the JASON-1 mission.

Section 4 is an introduction to using the JASON-1 data.

Section 5 is an introduction to the JASON-1 altimeter algorithms.

Section 6 provides a description of the content and format of the JASON-1 (I)GDRs.

Section 7 provides a detailed description of each field of the (I)GDR header records.

Section 8 provides a detailed description of each field of the (I)GDR science records.

Appendix A contains acronyms.

Appendix B contains references.

Appendix C describes how to order information or data from AVISO and PO.DAAC and lists related Web sites.

2.3. **Document reference and contributors**

When referencing this document, please use the following citation:


Other contributors include:

P. Callahan, R. Benada, and V. Zlotnicki from JPL

J. Lambin, F. Boy and T. Guinle from CNES
2.4. Conventions

2.4.1. Vocabulary

In order to reduce confusion in discussing altimeter measurements and corrections, the following terms are used in this document as defined below.

DISTANCE and LENGTH are general terms with no special meaning in this document.

RANGE is the distance from the satellite to the surface of the Earth, as measured by the altimeter. Thus, the altimeter measurement is referred to as "range" or "altimeter range," not height.

ALTITUDE is the distance of the satellite or altimeter above a reference point. The reference point used is the reference ellipsoid. This distance is computed from the satellite ephemeris data.

HEIGHT is the distance of the sea surface above the reference ellipsoid. The sea surface height is the difference of the altimeter range from the satellite altitude above the reference ellipsoid.

2.4.2. Orbits, Revs and Passes

An ORBIT is one circuit of the earth by the satellite as measured from one ascending node crossing to the next. An ascending node occurs when the subsatellite point crosses the earth's equator going from south to north. A REVOLUTION or REV is synonymous with orbit.

The (I)GDR data is organized into pass files in order to avoid having data boundaries in the middle of the oceans, as would happen if the data were organized by orbit. A PASS is half a revolution of the earth by the satellite from extreme latitude to the opposite extreme latitude. For JASON-1, an ASCENDING PASS begins at the latitude -66.15 deg and ends at +66.15 deg. A DESCENDING PASS is the opposite (+66.15 deg to -66.15 deg). The passes are numbered from 1 to 254 representing a full repeat cycle of the JASON-1 ground track. Ascending passes are odd numbered and descending passes are even numbered.

2.4.3. Reference Ellipsoid

The "reference ellipsoid" is the first-order definition of the non-spherical shape of the Earth as an ellipsoid of revolution with equatorial radius of 6378.1363 kilometers and a flattening coefficient of 1/298.257 (same reference ellipsoid as used by the T/P mission.)

2.4.4. Correction Conventions

All environmental and instrument corrections are computed so that they should be added to the quantity which they correct. That is, a correction is applied to a measured value by

\[ \text{Corrected Quantity} = \text{Measured Value} + \text{Correction} \]

This means that a correction to the altimeter range for an effect that lengthens the apparent signal path (e.g., wet troposphere correction) will be computed as a negative number. Adding this...
negative number to the uncorrected (measured) range will reduce the range from its original value toward the correct value.

Example:

\[
\text{Corrected Range} = \text{Measured Range} + \text{Range Correction}
\]

2.4.5. Time Convention

Times are UTC and referenced to January 1, 1958 00:00:00.00, sometimes abbreviated UTC58.

A UTC leap second can occur on June 30 or December 31 of any year. The leap second is a sixty-first second introduced in the last minute of the day. Thus, the UTC values (minutes:seconds) appear as: 59:58 ; 59:59 ; 59:60 ; 00:00 ; 00:01

In Section 6 reference will be made to UTC1 and UTC2. These are ASCII expressions of UTC times expressed using the following format:

- UTC1 format gives time in seconds and is recorded with 19 characters. The format is:
  
  YYYY-MM-DDTHH:MM:SS

- UTC2 format gives time in seconds and is recorded with 26 characters. The format is:
  
  YYYY-MM-DDTHH:MM:SS.XXXXXX

where

- YYYY = year
- MM = month (01 to 12)
- DD = day of month (01 to 31)
- HH = hours (00 to 23)
- MM = minutes (00 to 59)
- SS = seconds (00 to 59 or 60 for UTC leap second)
- XXXXXX = microseconds

2.4.6. Unit Convention

All distances and distance corrections are reported in tenths of millimeters (10⁻¹ mm).

2.4.7. Flagging and Editing

In general, flagging consists of three parts: instrument flags (on/off), telemetry flags (preliminary flagging and editing) and data quality flags (geophysical processing flags).
Instrument flags provide information about the state of the various instruments on the satellite.

Telemetry flags are first based on instrument modes and checking of telemetry data quality. Only severely corrupted data are not processed. Flag setting is designed to get a maximum amount of data into the Sensor Data Records (part of the SGDR products). Science data are processed only when the altimeter is in tracking mode.

Quality flags are determined from various statistical checks on the residuals after smoothing or fitting through the data themselves. These flags are set if gaps in the data are detected, or residuals have exceeded predetermined thresholds, or if the gradients of the data exceed predetermined thresholds.

### 2.4.8. Default Values

Data elements are recorded as 1, 2, or 4 byte (signed or unsigned) integers. When a parameter is unavailable (e.g. missing data) then the parameter value is set to a default value. Default values are defined to be the maximum possible value for the storage type. For example, a signed 2-byte integer has a default value of 32 767, and an unsigned integer has a default value of 65535. Furthermore, if a parameter value was determined to be out of range of the possible values of the storage type, then the sign of the parameter value is retained. This is accomplished by setting the parameter value to the maximum (minimum) value available to the storage type if the original value was found to be larger (smaller) than this maximum (minimum).

The following are the maximum (default) and minimum values for the various storage types and sizes:

<table>
<thead>
<tr>
<th>Data Storage Type</th>
<th>Size</th>
<th>Minimum Value</th>
<th>Maximum (Default) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>signed integer</td>
<td>1 byte</td>
<td>-128</td>
<td>$2^{7} - 1 = 127$</td>
</tr>
<tr>
<td>unsigned integer</td>
<td>1 byte</td>
<td>0</td>
<td>$2^{8} - 1 = 255$</td>
</tr>
<tr>
<td>bitfield</td>
<td>1 byte</td>
<td>0</td>
<td>$2^{8} - 1 = 255$</td>
</tr>
<tr>
<td>signed integer</td>
<td>2 bytes</td>
<td>-32768</td>
<td>$2^{15} - 1 = 32 767$</td>
</tr>
<tr>
<td>unsigned integer</td>
<td>2 bytes</td>
<td>0</td>
<td>$2^{16} - 1 = 65535$</td>
</tr>
<tr>
<td>bitfield</td>
<td>2 bytes</td>
<td>0</td>
<td>$2^{16} - 1 = 65535$</td>
</tr>
<tr>
<td>signed integer</td>
<td>4 bytes</td>
<td>-2147483648</td>
<td>$2^{31} - 1 = 2147483647$</td>
</tr>
<tr>
<td>unsigned integer</td>
<td>4 bytes</td>
<td>0</td>
<td>$2^{32} - 1 = 4294967295$</td>
</tr>
</tbody>
</table>

### 2.4.9. Bit Fields Order

Regarding the bitfield notation, the convention is to number the bits from right to left:

- the least significant bit (LSB) at location 0 and the most significant bit (MSB) at location 7, for a one byte bitfield
- the least significant bit (LSB) at location 0 and the most significant bit (MSB) at location 15, for a two byte bitfield
- the least significant bit (LSB) at location 0 and the most significant bit (MSB) at location 31, for a four byte bitfield

This convention is represented below for one and two bytes bitfield.

One Byte

<table>
<thead>
<tr>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSB</td>
<td>LSB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Two bytes

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----|----|----|----|----|----|---|---|---|---|---|---|---|---|---|---|---|
| MSB | LSB |

2.4.10. Byte Order

All data files are generated according to the big endian byte-ordering convention, which stores the most significant byte in the lowest memory address (the word is stored 'big-end-first').

Most Unix systems are big endian. Motorola 680x0 microprocessors (and therefore Macintoshes), Hewlett-Packard PA-RISC, and Sun SuperSPARC processors are big endian. The Silicon Graphics MIPS and IBM/Motorola PowerPC processors are both little and big endian (bi-endian). The Intel 80X86 and Pentium and DEC Alpha RISC processors are little endian. Windows NT and OSF/1 are little endian.

**Warning: depending upon your computer, you may need to swap bytes.**

**Note that both the AVISO and PODAAC ftp servers provide sample data products in binary and ascii format to allow users to verify correct usage of read software. These servers also provide read software in various programming languages.**
3. JASON-1 MISSION OVERVIEW

JASON-1 is jointly conducted by the French Space Agency, "Centre National d'Etudes Spatiales" (CNES), and the United States' National Aeronautics and Space Administration (NASA) for studying the global circulation from space. The mission uses the technique of satellite altimetry to make precise and accurate observations of sea level for several years. JASON-1 was launched on 7 December 2001.

3.1. JASON-1 Mission

JASON-1 is a follow-on mission to the highly successful TOPEX/POSEIDON (T/P) mission. The main goal of this mission is to measure the sea surface topography at least at the same performance level of T/P. This provides an extended continuous time series of high-accuracy measurements of the ocean topography from which scientists can determine the general circulation of the ocean and understand its role in the Earth's climate. In addition to the primary JASON-1 IGDR and GDR data products provided with a 2-3 and 30 day latency, respectively, JASON-1 also supports the preparation of operational ocean services by providing a non-validated near-real-time (3 hour latency) JASON-1 data product, the Operational Sensor Data Record (OSDR). JASON-1 is the first in a twenty-year series of satellites to take over from T/P, marking the start of operational satellite altimetry.

The JASON-1 mission supports new research programs such as the Climate Variability and Predictability program (CLIVAR) and the Global Ocean Data Assimilation Experiment (GODAE).

3.2. JASON-1 Requirements

The major elements of the mission include a satellite carrying an altimetric system for measuring the height of the satellite above the sea surface; a precision orbit determination system for referring the altimetric measurements to geodetic coordinates; a data analysis and distribution system for processing the satellite data, verifying their accuracy, and making them available to the scientific community; and a Principal Investigator program for scientific studies based on the satellite observations.

The JASON-1 mission shall be designed in a way that allows an optimum continuation of the T/P scientific mission. This means that the error budget and orbit characteristics (repeat period, inclination, altitude) of JASON-1 shall be identical to those of T/P. To ensure that science and mission goals are accomplished by the JASON-1 mission, the following requirements were established.

3.2.1. Accuracy of Sea-level Measurements

Requirements for the JASON-1 (I)GDR are derived directly from the post-launch T/P error budget, with the JASON-1 system required to be at least as good as the T/P system. Each
measurement of sea level shall have an accuracy of ±4.2 cm for the GDR products and 5.2 cm for the IGDR (1 standard deviation) over 1 second averages for typical oceanic conditions of 2 m significant wave height and 11 dB sigma-naught. This error budget includes the altimeter noise, uncertainties in corrections of atmospheric path delays, sea-state related biases, and orbit error.

The following table provides a summary of error budget at the end of the verification phase.

<table>
<thead>
<tr>
<th></th>
<th>IGDR (3 days)</th>
<th>GDR (30 days)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Spec</td>
<td>Performance</td>
</tr>
<tr>
<td>Altimeter noise (cm)</td>
<td>1.7</td>
<td>1.6</td>
</tr>
<tr>
<td>(H1/3=2m, σ=11dB)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sea State Bias (% H1/3)</td>
<td>1.2%</td>
<td>1% *</td>
</tr>
<tr>
<td>Ionosphere (cm)</td>
<td>0.5**</td>
<td>0.5**</td>
</tr>
<tr>
<td>Dry Tropo (cm)</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td>Wet Tropo (cm)</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Corrected Range (RSS, cm)</td>
<td>3.3</td>
<td>3</td>
</tr>
<tr>
<td>(H1/3=2m, σ=11dB) 1Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orbit (radial component) (cm)</td>
<td>4</td>
<td>2.5</td>
</tr>
<tr>
<td>Corrected Sea Surface Height (RSS,cm)</td>
<td>5.2</td>
<td>3.9</td>
</tr>
<tr>
<td>(H1/3=2m, σ=11dB) 1 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wave Height H1/3 (m or % H1/3, whichever is greater)</td>
<td>0.5 or 0.4 *** or 0.5 or 0.4 *** or</td>
<td></td>
</tr>
<tr>
<td>10%</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>Wind Speed (m/s)</td>
<td>1.7</td>
<td>1.5 ***</td>
</tr>
</tbody>
</table>

* improvement studies in progress
** after filtering over 100 km
*** after bias calibration

### 3.2.2. Sampling Strategy

Sea level shall be measured along a fixed grid of subsatellite tracks such that it will be possible to
investigate and minimize the spatial and temporal aliases of surface geostrophic currents and to minimize the influence of the geoid on measurements of the time-varying topography.

3.2.3. Tidal Aliases

Sea level shall be measured such that tidal signals will not be aliased into semiannual, annual, or zero frequencies (which influences the calculation of the permanent circulation) or frequencies close to these.

3.2.4. Duration and coverage

Sea level shall be measured for a minimum of three years, with the potential to extend this period for an additional two years.

The JASON-1 satellite shall overfly the reference T/P ground tracks. The grid of subsatellite tracks shall extend in latitude at least as far south as the southern limit of the Drake Passage (62 deg) and the subsatellite tracks that comprise the grid will cross at sufficiently large angles that the two orthogonal components of surface slope can be determined with comparable accuracy.

3.2.5. Data Reduction and Distribution

A system to process and distribute data to the Principal Investigators shall be tested, documented, and in operation at the time of launch. A minimum of 95% of the oceanic data that could be acquired by the spacecraft shall be acquired with no systematic gaps, processed and made available for scientific investigations. The intent is to collect and process all data continuously. Small amounts of data could be lost during adjustments of the satellite's orbit, during tests of the altimeter's performance, and during various other such events.

3.3. Satellite Description

The 500 kg satellite consists of a multi-mission PROTEUS (Plate Forme Reconfigurable pour l'Observation de la TErre, les telecommunication et les Utilisations Scientifiques) platform and a JASON-1 specific payload module. The platform provides all housekeeping functions including propulsion, electrical power, command and data handling, telecommunications, and attitude control. The payload module provides mechanical, electrical, thermal, and dynamical support to the JASON-1 instruments.
Figure 1 JASON-1 satellite

JASON-1 Characteristics

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satellite mass</td>
<td>500 kg</td>
</tr>
<tr>
<td>Satellite power</td>
<td>450 W</td>
</tr>
<tr>
<td>Platform mass</td>
<td>270 kg</td>
</tr>
<tr>
<td>Platform power</td>
<td>300 W</td>
</tr>
<tr>
<td>Payload mass</td>
<td>120 kg</td>
</tr>
<tr>
<td>Payload power</td>
<td>147 W</td>
</tr>
<tr>
<td>Altimeter mass</td>
<td>55 kg</td>
</tr>
<tr>
<td>Altimeter power</td>
<td>78 W</td>
</tr>
<tr>
<td>Launch Vehicle</td>
<td>Dual Delta II</td>
</tr>
<tr>
<td>Launch Site</td>
<td>Vandenberg Air Force Base</td>
</tr>
</tbody>
</table>

3.3.1. Sensors

The science and mission goals are carried out with a satellite carrying five science instruments, three from CNES and two from NASA.
- Dual-frequency Ku/C band Solid State Radar Altimeter (POSEIDON-2) (CNES)

  The Poseidon-2 altimeter, operating at 13.575 GHz (Ku band) and 5.3 GHz (C band), is the primary sensor for the JASON-1 mission. The measurements made at the two frequencies are combined to obtain measurements of the altimeter range, wind speed, significant wave height, and the ionospheric correction. The Poseidon-2 package consists of dual redundant altimeter units each of which has low mass and low power consumption.

- Dual-frequency Doppler Orbitography and Radiopositioning by Satellite (DORIS) tracking system receiver (CNES)

  The DORIS Precise Orbit Determination (POD) system uses a two-channel, two-frequency (401.25 MHz and 2036.25 MHz) Doppler receiver on the satellite to observe the tracking signals from a network of approximately 50 ground transmitting beacons. It provides all-weather global tracking of the satellite for POD and a correction for the influence of the ionosphere on both the Doppler signal and altimeter signals. The DORIS on-board package includes the receiver itself, the ultra-stable oscillator, and an omnidirectional antenna located on the nadir face of the satellite. It includes a dual beacon receiving capability and an on-board real time function (Détermination Immédiate d'Orbite par Doris Embarque, or DIODE) to compute the orbit ephemeris with an accuracy of 30 cm (1 standard deviation).

- Three-frequency JASON-1 Microwave Radiometer (JMR) (NASA)

  The JMR measures the sea surface microwave brightness temperatures at three frequencies (18.7 GHz, 23.8 GHz and 34.0 GHz) to provide the total water vapor content in the troposphere along the altimeter beam. The 23.8 GHz channel is the primary channel for water-vapor measurement and is a redundant channel on the JMR. The 18.7 GHz channel provides a correction for wind-induced effects in the sea surface background emissions, and the 34.0 GHz channel provides a correction for cloud liquid water. The measurements are combined to obtain the error in the satellite range measurements caused by pulse delay due to the water vapor.

- Laser Retroreflector Array (LRA) (NASA)

  The LRA is placed on the nadir face of the satellite and reflects signals from a network of 10 to 15 satellite laser tracking stations. It supports the JASON-1 Calibration and Validation function for POD.

- Turbo Rogue Space Receiver (TRSR) (NASA)

  The TRSR is an advanced codeless sixteen-channel Global Positioning System (GPS) receiver developed by the Jet Propulsion Laboratory (JPL). The on-board package is comprised of dual redundant TRSR units and choke ring antennae. The GPS data are intended to provide supplementary positioning data in support of the POD function and/or to improve gravity field models.
3.3.2. Orbit

The JASON-1 satellite will fly the same ground-track as the original T/P with a 254 pass, 10-day exact repeat cycle. The JASON-1 and T/P satellites were phased approximately 70 seconds apart during the calibration phase. On August 15, 2002 (cycle 365 pass 111) the T/P satellite began its “drift phase” by moving to a new orbit in preparation for the Tandem Mission. The drift phase lasted until September 16, 2002 ending with cycle 368, pass 171. Data for cycle 368, pass 172 and later are on the final fixed tandem mission ground track, which is interleaved with the JASON-1 ground track, providing improved temporal and spatial coverage. Orbital characteristics and the equator crossing longitudes for JASON-1 are given below. Figure 2 is a plot of the ground track on a world map.

Mean classical orbit elements

<table>
<thead>
<tr>
<th>Element</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semi-major axis</td>
<td>7,714.43 km</td>
</tr>
<tr>
<td>Eccentricity</td>
<td>0.000095</td>
</tr>
<tr>
<td>Inclination</td>
<td>66.04 deg</td>
</tr>
<tr>
<td>Argument of periapsis</td>
<td>90.0 deg</td>
</tr>
<tr>
<td>Inertial longitude of the ascending node</td>
<td>116.56 deg</td>
</tr>
<tr>
<td>Mean anomaly</td>
<td>253.13 deg</td>
</tr>
</tbody>
</table>

Auxiliary data

<table>
<thead>
<tr>
<th>Element</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference (Equatorial) altitude</td>
<td>1,336 km</td>
</tr>
<tr>
<td>Nodal period</td>
<td>6,745.72 sec</td>
</tr>
<tr>
<td>Repeat period</td>
<td>9.9156 days</td>
</tr>
<tr>
<td>Number of revolutions within a cycle</td>
<td>127</td>
</tr>
<tr>
<td>Equatorial cross-track separation</td>
<td>315 km</td>
</tr>
<tr>
<td>Ground track control band</td>
<td>± 1 km</td>
</tr>
<tr>
<td>Acute angle at Equator crossings</td>
<td>39.5 deg</td>
</tr>
<tr>
<td>Longitude of Equator crossing of pass 1</td>
<td>99.9249 deg</td>
</tr>
<tr>
<td>Inertial nodal rate</td>
<td>-2.08 deg/day</td>
</tr>
<tr>
<td>Orbital speed</td>
<td>7.2 km/s</td>
</tr>
<tr>
<td>Ground track speed</td>
<td>5.8 km/s</td>
</tr>
</tbody>
</table>
This orbit overflies two verifications sites. The prime CNES verification site is located at Cape Senetosa on the island of Corsica (8° 48' E, 41° 34' N (ascending pass 85). The prime NASA verification site is located on the Harvest oil platform near Pt. Conception, California (239° 19' E, 34° 28' N) (ascending pass 43).

A satellite orbit slowly decays due to air drag, and has long-period variability because of the inhomogeneous gravity field of Earth, solar radiation pressure, and smaller forces. Periodic maneuvers are required to keep the satellite in its orbit. The frequency of maneuvers depends primarily on the solar flux as it affects the Earth's atmosphere, and there are expected to be one maneuver (or series of maneuvers) every 40 to 200 days.

Each orbit maintenance maneuver is performed as two thrusts on pass 254 cycle N and 1 cycle N+1 (see plot below). Orbit computation is optimised to minimize the orbit error during such periods. Science data are taken during orbit maintenance maneuvers and will be distributed (see orb_state_flag, in section 8.2).
Figure 2 Plot of the ground track on a world map (example given for cycle 142 of the T/P mission.)
EQUATOR CROSSING LONGITUDES (IN ORDER OF PASS NUMBER)

<table>
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### 3.3.3. The JASON-1 Project Phases

The satellite mission has two phases:

The first phase, the calibration/validation phase, began when the satellite reached the operational orbit and the satellite and sensor systems were functioning normally. This phase continued until the data received from the sensors were satisfactorily calibrated and verified. The phase began shortly after launch. A preliminary calibration/validation workshop was held June 2002. A second calibration/validation workshop was held October 2002, where Jason-1 to TOPEX/POSEIDON cross validation was extensively discussed: recommendations were issued both on TOPEX/POSEIDON and Jason-1 science processing algorithms.
The second phase, the operational phase, began April 2003 when all necessary algorithm and processing changes were implemented to have Jason-1 performances at the same level as TOPEX/POSEIDON.

3.4. Data Processing and Distribution

Processing centers, called respectively CNES SSALTO and NASA JPL POCC, include functions such as science data processing, data verification and precision orbit determination.

Processed data are placed in National archives for further distribution to the scientific community. There are three levels of processed data:

1. Telemetry data (raw data),
2. Sensor Data Records (engineering units),
3. Geophysical Data Records (geophysical units).

Geophysical data records are sent as they become available to AVISO and PO.DAAC for processing, archiving, managing, and distribution to PIs and the wider scientific community.

The operational sensor data record (OSDR), which is a non-validated product that uses orbits computed by the on-board DORIS Navigator (DIODE) and does not perform ground retacking of the altimeter waveforms, are available with a latency of 3-5 hours. The interim geophysical data record (IGDR), which is also a non-validated product but that uses a preliminary orbit and applies ground retacking, are available by pass with a latency of 2-3 days. The geophysical data record (GDR), which is a fully validated product that uses a precise orbit and applies ground retacking, are available by repeat cycle with a latency of 30 days.
4. USING THE (I)GDR DATA

4.1. Overview

This section will give the reader a guide to the use of the JASON-1 (I)GDR data. Remember that this is research data. While this handbook tries to be correct and complete, nothing can replace the information to be gained at conferences and other meetings of those using these data. Information is also available on the PODAAC and AVISO web servers. The reader must proceed with caution and at his or her own risk. Please direct questions and comments to the contacts given on the last page of this handbook.

The instruments on JASON-1 make direct observations of the following quantities: altimeter range, ocean significant wave height, ocean radar backscatter cross-section (a measure of wind speed), ionospheric electron content in the nadir direction, tropospheric water content, and position relative to the GPS satellite constellation. Ground based laser station and DORIS station measurements of the satellite location and speeds are used in precision orbit determination (POD). The DORIS stations also measure the ionospheric electron content along the line of sight to the satellite. All of these measurements are useful in themselves, but they are made primarily to derive the sea surface height with the highest possible accuracy. Such a computation also needs external data (not collected aboard JASON-1), e.g., atmospheric pressure, etc. In addition, instrument health and calibration data are collected onboard and used to make corrections to the main measurements and to monitor the instrument stability on the long term.

This (I)GDR contains all relevant corrections needed to calculate the sea surface height. For the other "geophysical variables" in the (I)GDR: ocean significant wave height, tropospheric water content, ionospheric electron content (derived by a simple formula), and wind speed, the needed instrument and atmospheric corrections have already been applied.

The following sections explain the rationale for how the corrections should be applied.

4.2. Conventions

In this section references are made to specific (I)GDR parameters by name. For example, surface_type is a flag parameter indicating, among other things, whether or not the data point is over open ocean. All parameters are described in alphabetical order in Section 8.

WARNING: Default values are given to data when computed values are not available (See Section 2.4.8) so you must screen parameters to avoid using those with default values. Also you must check flag values. The related flags are given with the parameter in Section 8 although some discussion of flags appears in this section.

4.3. Altimeter Range

The main data of the (I)GDR are the altimeter ranges. The (I)GDR provides ranges measured at
Ku band (range\_ku) and C band (range\_c). The Ku band range is used for most applications. The reported ranges are corrected for instrument effects, including the instrument corrections (net\_instr\_corr\_ku and net\_instr\_corr\_c) but not the apparent datation bias (pseudo\_datation\_bias\_corr\_ku). Instrument corrections are separately reported for each of the Ku and C band ranges (net\_instr\_corr\_ku and net\_instr\_corr\_c). Users are advised to also apply the apparent datation bias to the reported ku-band range. The reported ranges must be corrected for path delay in the atmosphere through which the radar pulse passes and the nature of the reflecting sea surface. Recall all range corrections are defined so they should be ADDED to the range. The corrected range is given by

Corrected Range = range + wet troposphere correction + dry troposphere correction + ionosphere correction + sea state bias + datation bias correction

**Wet troposphere correction** Use JMR correction (rad\_wet\_tropo\_corr).

**Dry troposphere correction** Use model correction (model\_dry\_tropo\_corr).

**Ionosphere correction** Use altimeter ionosphere correction (iono\_corr\_alt\_ku to correct range\_ku). (IMPORTANT: See Section 4.7 "Smoothing the Ionosphere Correction").

**Sea State Bias** Use sea state bias correction (sea\_state\_bias\_ku to correct range\_ku).

NOTE: The ionosphere and sea state bias corrections are both frequency dependent. Therefore Ku band corrections should only be applied to Ku band ranges, and C band corrections should only be applied to C band ranges. Section 4.8 explains how the C band ionosphere correction can be derived from the Ku band ionosphere correction (iono\_corr\_alt\_ku), while the C band sea state bias correction is provided as sea\_state\_bias\_c.

### 4.4. Sea Surface Height

Sea surface height (SSH) is the height of the sea surface above the reference ellipsoid. It is calculated by subtracting the corrected range (see above) from the Altitude:

Sea Surface Height = Altitude - Corrected Range

**Corrected Range** is defined above.

**Altitude** - Orbit altitude (see parameter altitude)
4.5. Sea Level Anomaly

The sea level anomaly (SLA), also referred to as Residual Sea Surface, is defined here as the sea surface height minus the mean sea surface and minus known geophysical effects, namely tidal and inverse barometer. It is given by:

\[
\text{Sea Level Anomaly} = \text{Sea Surface Height} - \text{Mean Sea Surface} - \text{Tide Effects} - \text{Inverse Barometer} - \text{High Frequency Wind Response}
\]

Sea Surface Height is defined above.

Mean Sea Surface See discussion below in this section and in Section 5.

Tide Effects See discussion below in this section and in Section 5.

Inverse Barometer Use inv_bar_corr (also see Section 5.)

High Frequency Wind Response Use hf_fluctuations_corr (also see Section 5.)

The SLA then contains information about

1. real changes in ocean topography related to ocean currents
2. dynamic response to atmospheric pressure
3. differences between tides and the tide models
4. differences between the mean sea surface model and the true mean sea surface at the JASON-1 location
5. unmodeled or mismodeled measurement effects (skewness, sea state bias, altimeter errors, tropospheric corrections, ionospheric correction, etc.)
6. orbit errors

Of course, there is also random measurement noise. Understanding the first four items as a function of space and time is the purpose of JASON-1.

4.5.1. Geophysical Surface - Mean Sea Surface or Geoid

The geophysical fields Geoid (geoid) (actually geoid undulation, but called simply geoid) and Mean Sea Surface (mss) are distances above the reference ellipsoid, as is the Sea Surface Height. These values are for the location indicated by latitude and longitude. If the values of these fields are needed at a different location within the current frame, along-track interpolation may be done using the high rate (20/second) range and altitude values.
As the geoid is derived from the mean sea surface, the latter is the better-known quantity. The residual surface with respect to the geoid is sometimes called the "dynamic topography" of the ocean surface.

The (I)GDR provides a choice of two models for the mean sea surface: a global model (see parameter mss) that is derived globally using various sources of data; and a model derived exclusively along the T/P ground track from T/P sea surface height data (see parameter mss_tp_along_trk).

See also discussions of mean sea surface and geoid in Section 5.

### 4.5.2. Tide Effects

The total tide effect on the sea surface height is the sum of three values from the (I)GDR:

\[
\text{Tide Effect} = \text{Geocentric Ocean Tide} + \text{Solid Earth Tide} + \text{Pole Tide}
\]

(See also section 5.8 and subsections)

**Geocentric Ocean Tide** The geocentric ocean tide provided on the (I)GDR is actually the sum total of the ocean tide with respect to the ocean bottom, and the loading tide height of the ocean bottom.

\[
\text{Geocentric Ocean Tide (on (I)GDR)} = \text{Ocean Tide} + \text{Load Tide}
\]

The (I)GDR provides a choice of two geocentric ocean tide values, ocean_tide_sol1 and ocean_tide_sol2. Each uses a different model for the sum total of the ocean tide and loading tide heights from the diurnal and semidiurnal tides, but both include an equilibrium representation of the long-period ocean tides at all periods except for the zero frequency (permanent tide) term. Note that the (I)GDR also explicitly provides the loading tide height from each of the two models that are used to determine the two geocentric ocean tide values, load_tide_sol1, load_tide_sol2. Of course, the geocentric ocean tide values and loading tide values should not be used simultaneously, since the loading tide height would be modeled twice.

**Solid Earth Tide** Use solid_earth_tide (NOTE: Zero frequency (permanent tide) term also not included in this parameter.)

**Pole Tide** Use pole_tide

The tide values all have the same sign/sense in that positive numbers indicate that the surface is farther from the center of the Earth.
4.6. Mean Sea Surface and Adjustment of the Cross Track Gradient

To study sea level changes between two dates, it is necessary to difference sea surface heights from different cycles at the exact same latitude-longitude, so that the not well-known time-invariant geoid cancels out. However, the (I)GDR samples are not given at the same latitude-longitude on different cycles. They are given approximately every 1 sec along the pass (about 6 km, the time difference and distance vary slightly with satellite height above the surface), and the satellite ground track is allowed to drift by ± 1 km. This introduces a problem: on different cycles the satellite will sample a different geoid profile. This effect is the so-called cross-track geoid gradient, and Brenner and Koblinsky [1990] estimated it at about 2 cm/km over most of the ocean, larger over continental slopes, reaching 20 cm/km at trenches. Even if the passes repeated exactly, one would have to interpolate along the pass (say, to a fixed set of latitudes) because a 3 km mismatch in along pass position would cause approximately a 6 cm difference in the geoid, which would mistakenly be interpreted as a change in oceanographic conditions.

Both problems are simultaneously solved if the quantity one interpolates along a given pass is the difference

\[ \text{residual}_\text{height} - \text{mean}_\text{sea}_\text{surface} \]

Then the real geoid changes across the track are automatically accounted for (to the extent the MSS model is close to the true geoid) because the MSS is spatially interpolated to the actual satellite lat-lon in the (I)GDR. The residual_height term above is the residual sea surface height after applying all the tidal, atmospheric and ionospheric corrections, etc. Otherwise, those need to be interpolated separately.

One possible approach is to interpolate along track to a set of common points, a "reference" track. The reference could be

1. an actual pass with maximum data and/or minimum gaps or
2. a specially constructed fixed track (see below).

The procedure is

1. For each common point, find neighboring points in the pass of interest (POI).
2. In the POI, interpolate along track to the common point, using longitude as the independent variable, for each quantity of interest - sea surface height (see above), mean sea surface, geoid, tides, etc.
3. As stated above, the quantity to compare at each common point is

\[ \text{dSSH} = \text{interpolated POI SSH} - \text{interpolated POI MSS} \]
(4) Other geophysical corrections must be applied to dSSH, depending on the type of investigation.

The geoid model in the (I)GDR could be substituted for MSS model, but its use will result in reduced accuracy in the interpolation because the resolution of the geoid undulation is lower than that of the MSS (limited by the 360 x 360 geoid model).

Desirable features of a fixed reference track include

(1) equal spacing of points (good for FFT)
(2) independent variable = (point longitude - pass equator crossing longitude)
(3) equator is a point (simplifies calculation of item 2)
(4) point density similar to original data density.

With these specifications, it is possible to make only two fixed tracks, one ascending and one descending, which will serve for all passes. The template pass is then shifted by the equator crossing longitude found in the header (Equator_Longitude) of each pass. Recall that Equator_Longitude is from a predicted orbit (not updated during GDR processing). Improved accuracy can be obtained by interpolating in the latitude, longitude values. When one interpolates to the reference track, it is good practice to check that the interpolated latitude from the data records used is close to the latitude on the reference track.

4.7. **Smoothing Ionosphere Correction**

The ionospheric (range) correction is expected to be negative, but positive values are allowed up to +40 mm to accommodate instrument noise effects. To reduce the noise, it is recommended to average over 100 km or more [Imel, 1994], which usually results in negative numbers.

Ionospheric averaging is not being done to data provided on the (I)GDR in order to provide a reversible correction, which the users may smooth as desired. In order to use a smoothed ionospheric correction, do the following:

1. Smooth iono_corr_alt_ku as desired. Care should be taken regarding flagged data, editing criteria, and in the case of data (land) gaps. Typical/maximum smoothing scales are 100-150 km (20-25 frames) for local times between 06 and 24 hours and 150-200 km (25-35 frames) for local times between 00 and 06 hours. The shorter (longer) smoothing time is also more appropriate during times of high (low) solar activity.

2. Apply the smoothed ionospheric correction to sea surface height as shown earlier.

It is not recommended that this approach be applied to iono_corr_doris_ku, which is smoothed as a result of the model used.
4.8. Total Electron Content from Ionosphere Correction

To calculate Ionospheric Total Electron Content, TEC, use the following formula:

\[ \text{Ionospheric Total Electron Content} = -(dR*f^2)/40.3 \]

where

Ionospheric Total Electron Content is in electrons/m².

dR = Ku band ionospheric range correction from the (I)GDR in meters (iono_corr_alt_ku or iono_corr_doris_ku)

f = frequency in Hz (for the Ku band this is 13.575 GHz)

Note that the TEC could then be converted to a C band ionosphere range correction using the same formula above, but with the C band frequency of 5.3 GHz.

4.9. Range Compression

Each 1Hz frame of the Poseidon-2 Ku and C band range measurements (range_ku and range_c) are derived from the linear regression of the respective valid 20 Hz range measurements (range_hi_rate_ku and range_hi_rate_c). An iterative outlier detection scheme is adopted in this linear regression and the resulting 20 Hz measurements are identified by setting the corresponding bit in the parameters (range_mapvalpts_ku/ range_mapvalpts_c) to 1. Measurements not considered as outliers have the corresponding bit in parameters (range_mapvalpts_ku/range_mapvalpts_c) set to 0. The number of valid 20 Hz measurements that are used to derive each of the 1 Hz measurements is provided on the (I)GDRs (range_numval_ku and range_numval_c), as are the root-mean-square of the differences between the valid 20 Hz measurements and the derived 1 Hz measurement (range_rms_ku and range_rms_c). Specialized applications, such as over land, ice, lakes or rivers, may require that the users perform their own compression algorithm on the 20 Hz measurements.

4.10. Timetags for Twenty per Frame Ranges

The Poseidon-2 20Hz measurements are equally spaced in each frame. The time tag of the first 20 Hz measurement in the frame is determined by adding an offset, Time_Shift_Mid_Frame (found in the (I)GDR header) to the 1 Hz time tag (defined by time_day, time_sec, time_microsec). The time tag of each subsequent 20 Hz measurement in the frame is determined by adding the time interval between two consecutive 20 Hz measurements, Time_Shift_Interval (found in the (I)GDR header).

\[
\text{Time tag of nth 20 Hz measurement} = 1 \text{ Hz Time Tag (from time_day, time_sec, time_microsec)} + \text{Time_Shift_Interval}
\]
\(-\) Time\_Shift\_Mid\_Frame
\(+\ (n-1) \times \) Time\_Shift\_Interval

where \( n = 1 \) to 20.
5. ALTIMETRIC DATA

This section presents a short discussion of the main quantities on the (I)GDR.

An excellent overview of the theoretical and practical effects of radar altimetry is the “Satellite Altimetry” Chapter by Chelton et al [2001]. Copies can be obtained from PO.DAAC (see contact points at the end of this document.)

5.1. Precision Orbits

CNES has the responsibility for producing the orbit ephemerides for the JASON-1 data products. The JASON-1 IGDRs provide a preliminary orbit that has radial accuracies better than 4 cm (RMS), while the GDRs provide a precise orbit that has radial accuracies better than 2.5 cm (RMS). DORIS tracking data are used to compute the preliminary orbit, while DORIS, laser ranging and GPS tracking data are used to compute the precise orbit.

5.2. Altimeter Range

An altimeter operates by sending out a short pulse of radiation and measuring the time required for the pulse to return from the sea surface. This measurement, called the altimeter range, gives the distance between the instrument and the sea surface, provided that the velocity of the propagation of the pulse and the precise arrival time are known. The dual frequency altimeter on JASON-1 performs range measurements at the Ku and C band frequencies (see range_c and range_c), enabling measurements of the range and the total electron content (see discussion below on ionosphere). While both range measurements are provided on the (I)GDR (see range_ku and range_c), the Ku band range measurement has much higher accuracy than the C band measurement.

The range reported on the JASON-1 (I)GDR has already been corrected for a variety of calibration and instrument effects, including calibration errors, pointing angle errors, center of gravity motion, and terms related to the altimeter acceleration such as Doppler shift and oscillator drift. The sum total of these corrections also appears on the (I)GDR for each of the Ku and C band ranges (see net_instr_corr_ku and net_instr_corr_c).

A new correction has been added in version “c”, this correction accounts for apparent altimeter datation bias as illustrated by M. Ablain et al during the 2006 and 2007 OSTST meetings. An apparent altimeter datation bias of 400 microseconds has been estimated. This results with a North/South bias related to Doppler velocity. This correction, pseudo_datation_bias_corr_ku, should be added to the Ku-band altimeter range (see section 4.3). This correction is not a component of the net instrumental correction on Ku band range, net_instr_corr_ku.

5.3. Geoid

The geoid is an equipotential surface of the Earth's gravity field that is closely associated with the
location of the mean sea surface. The reference ellipsoid is a bi-axial ellipsoid of revolution. The center of the ellipsoid is ideally at the center of mass of the Earth although the center is usually placed at the origin of the reference frame in which a satellite orbit is calculated and tracking station positions given. The separation between the geoid and the reference ellipsoid is the geoid undulation (see geoid parameter).

The geoid undulation, over the entire Earth, has a root mean square value of 30.6m with extreme values of approximately 83m and -106m. Although the geoid undulations are primarily long wavelength phenomena, short wavelength changes in the geoid undulation are seen over seamounts, trenches, ridges, etc., in the oceans. The calculation of a high resolution geoid requires high resolution surface gravity data in the region of interest as well as a potential coefficient model that can be used to define the long and medium wavelengths of the Earth's gravitational field. Surface gravity data are generally only available in certain regions of the Earth and spherical harmonic expansions of the Earth's gravitational potential are usually used to define the geoid globally. Currently, such expansions are available to degree 360 and in some cases higher.

For ocean circulation studies, it is important that the long wavelength part of the geoid be accurately determined. New geopotential models have become available that are an improvement over the JGM3 and OSU91A models (JGM3 is described in Tapley et al., 1994; OSU91A is described in Rapp et al., 1991.)

5.4. Mean Sea Surface

A Mean Sea Surface (mss) represents the position of the ocean surface averaged over an appropriate time period to remove annual, semi-annual, seasonal, and spurious sea surface height signals. A MSS is given as a grid with spacing consistent with the altimeter and other data used in the generation of the grid values. The MSS grid can be useful for data editing purposes; for the calculation of along track and cross track geoid gradients; for the calculation of gridded gravity anomalies, for geophysical studies; for a reference surface to which sea surface height data from different altimeter missions can be reduced, etc. The JASON-1 (I)GDR provides for two models of the MSS (see parameters mss and mss_tp_along_trk). The first is a global MSS model that is generated from multiple satellite altimetry missions, and the second is a model specifically generated along the T/P ground track.

Longer time spans of data that become available in the future, along with improved data handling techniques could improve the current MSS models. Care must be given to the retention of high frequency signal and the reduction of high frequency noise.

5.5. Geophysical Corrections

The atmosphere and ionosphere slow the velocity of radio pulses at a rate proportional to the total mass of the atmosphere, the mass of water vapor in the atmosphere, and the number of free electrons in the ionosphere. In addition, radio pulses do not reflect from the mean sea level but from a level that depends on wave height and wind speed. The errors due to these processes cannot be ignored and must be removed. Discussions of these effects are given in Chelton et al.
5.5.1. Troposphere (dry and wet)

The propagation velocity of a radio pulse is slowed by the "dry" gasses and the quantity of water vapor in the Earth's troposphere. The "dry" gas contribution is nearly constant and produces height errors of approximately -2.3 m. The water vapor in the troposphere is quite variable and unpredictable and produces a height calculation error of -6cm to -40cm. However, these effects can be measured or modeled as discussed below.

The gases in the troposphere contribute to the index of refraction. In detail, the refractive index depends on pressure and temperature. When hydrostatic equilibrium and the ideal gas law are assumed, the vertically integrated range delay is a function only of the surface pressure, see Chelton et al. [2001]. The dry meteorological tropospheric range correction is principally equal to the surface pressure multiplied by -2.277mm/mbar, with a small adjustment also necessary to reflect a small latitude dependence (see model_dry_tropo_corr parameter).

\[
\text{model\_dry\_tropo\_corr} = -2.277P_{\text{atm}} \times (1 + 0.0026 \times \cos(2\phi))
\]

where \(P_{\text{atm}}\) is surface atmospheric pressure in mbar, \(\phi\) is latitude, and \(\text{model\_dry\_tropo\_corr}\) is the dry troposphere correction in mm. There is no straightforward way of measuring the nadir surface pressure from a satellite, so it is determined from model assimilated weather data from the European Center for Medium Range Weather Forecasting (ECMWF). The uncertainty of the ECMWF atmospheric pressure products is somewhat dependent on location. Typical errors vary from 1 mbar in the northern Atlantic Ocean to a few mbars in the southern Pacific Ocean. A 1-mbar error in pressure translates into a 2.3 mm error in the dry tropospheric correction.

The amount of water vapor present along the path length contributes to the index of refraction of the Earth's atmosphere. Its contribution to the delay of the radio pulse, the wet tropospheric delay, can be estimated by measuring the atmospheric brightness near the water vapor line at 22.2356 GHz and providing suitable removal of the background. The Jason-1 Microwave Radiometer (JMR) measures the brightness temperatures in the nadir path at 18.7, 23.8 and 34.0 GHz: the water vapor signal is sensed by the 23.8 GHz channel, while the 18.7 GHz channel removes the surface emission (wind speed influence), and the 34 GHz channel removes other atmospheric contributions (cloud cover influence) [Keihm et al., 1995]. Measurements are combined to obtain the error in the satellite range measurement due to the water vapor effect (see rad_wet_tropo_corr parameter). The uncertainty is less than 1.2 cm RMS [e.g. Cruz Pol et al., 1998 and Ruf et al., 1994].

The ECMWF meteorological model also calculates a value of the wet tropospheric delay, and an interpolated value from this model is also provided on the (I)GDR as a backup to the measurement from the JMR (see model_wet_tropo_corr). This backup will prove useful when sun glint, land contamination, or anomalous sensor behavior makes the JMR measurement of the wet tropospheric delay unusable.

The ECMWF meteorological fields are interpolated to provide the model dry and wet tropospheric corrections at the time and location of the altimeter measurement (see...
model_dry_tropo_corr and model_wet_tropo_corr) and an interpolation quality flag is provided on the (I)GDR to indicate the quality of this interpolation (see interp_flag).

5.5.2. Ionosphere

At the frequencies used by the POSEIDON-2 altimeter, the propagation velocity of a radio pulse is slowed by an amount proportional to the density of free electrons of the Earth's ionosphere, also known as the total electron content (TEC). The retardation of velocity is inversely proportional to frequency squared. For instance, it causes the altimeter to slightly over-estimate the range to the sea surface by typically 0.2 to 20 cm at 13.6 GHz. The amount varies from day to night (very few free electrons at night), from summer to winter, and as a function of the solar cycle (fewer during solar minimum.) (For treatments of this correction, see Chelton et al. [2001], Imel [1994], and Callahan [1984]. Also, see Sec 3.8 on smoothing the ionospheric correction.)

Because this effect is dispersive, measurement of the range at two frequencies allows it to be estimated. Under typical ocean conditions of 2-meter significant wave height the Ku band ionospheric range correction that is determined from the dual frequency measurements from the altimeter is expected to have an accuracy of ±0.5 cm (see iono_corr_alt_ku parameter).

The ionospheric path delay can also be inferred from GPS ionospheric maps computed by various centers. For the Jason-1 mission, the JPL Global Ionosphere Model (GIM) maps are used to estimate the ionospheric correction at the Ku band frequency (see http://iono.jpl.nasa.gov/gim.html). The GIM-derived ionospheric path delay correction provided on the JASON-1 GDR (see iono_corr_gim_ku) is considered to be a backup to the nominal dual frequency altimeter measurement, and has an accuracy of approximately 2 cm depending on solar activity. While this rms difference is small viewed globally, there are larger differences in some regions, related to lack of GPS data over the ocean.

5.5.3. Ocean Waves (sea state bias)

Unlike the preceding effects, sea-state effects are an intrinsic property of the large footprint radar measurements. The surface scattering elements do not contribute equally to the radar return; troughs of waves tend to reflect altimeter pulses better than do crests. Thus the centroid of the mean reflecting surface is shifted away from mean sea level towards the troughs of the waves. The shift, referred to as the electromagnetic (EM) bias, causes the altimeter to overestimate the range (see Rodriguez et al., [1992]). In addition, a skewness bias also exists from the assumption in the onboard algorithms that the probability density function of heights is symmetric, while in reality it is skewed. Finally, there is a tracker bias, which is a purely instrumental effect. The sum of EM bias, skewness bias, and tracker bias is called 'sea state bias' (see sea_state_bias_ku and sea_state_bias_c parameters.)

The accuracy of sea state bias models remains limited and continues to be a topic of research. The current most accurate estimates are obtained using empirical models derived from analyses of the altimeter data. Based on the results of Gaspar et al. [1994 and 1996] and others, the initial algorithms for JASON-1 compute the sea state bias from a bilinear interpolation of a table of sea state biases versus significant wave height and wind speed, based on new parametric fits by Labroue [2002 and 2006]. For a typical significant wave height (SWH) of 2 meters, the error in
the sea state bias correction is approximately 1-2 cm, i.e., 0.5 to 1.0% of the effect. Because of the general paucity of data, the empirical model is not defined in some SWH-wind speed regimes, and the sea state biases in these regimes are returned as default values.

In addition to the Ku and C band sea state bias corrections [sea_state_bias_ku and sea_state_bias_c], the JASON-1 (I)GDRs also provide a composite sea state bias correction parameter. The use of a composite sea state bias introduces a formulation for the sea surface height that is independent of the ionospheric correction. The classical equation for retrieving altimetric sea surface heights (ignoring frequency independent effects) is:

\[
SSH = H - [R_{Ku} + SSB_{Ku} + Iono\_Alt_{Ku}]
\]  

(1)

where H, R_Ku, SSB_Ku, and Iono_Alter_Ku are the satellite orbit, the Ku-band range measurement, sea state bias correction and ionospheric correction, respectively. However, the ionospheric correction is computed from the differences between the Ku and C band ranges after being corrected for sea state bias effects:

\[
Iono\_Alt_{Ku} = \Delta f_{Ku}^* [(R_{Ku} + SSB_{Ku}) - (R_{C} + SSB_{C})]
\]  

(2)

where

\[
\Delta f_{Ku} = (f_{C}*f_{C})/((f_{Ku}*f_{Ku}) - (f_{C}*f_{C}))
\]  

(3)

Inserting (2) into (1) provides an alternative formulation of the sea surface height that is independent of the ionospheric correction (again, ignoring frequency independent effects):

\[
SSH = H - [(1 + \Delta f_{Ku})*R_{Ku} + \Delta f_{Ku}*R_{C} + SSB\_comp]
\]  

(4)

where

\[
SSB\_Comp = [(1 + \Delta f_{Ku})*SSB_{Ku} - \Delta f_{Ku}*SSB_{C}]
\]  

(5)

Equation (4) then provides an alternative formulation of the sea surface height that is independent of the ionospheric correction, but dependent on a composite sea state bias, SSB_Comp. Equation (1) makes use of an ionospheric correction, and the computation of the ionospheric correction implies knowledge of the Ku and C band sea state biases. However, the Ku and C band sea state biases are usually determined from sea surface height crossover techniques and therefore themselves dependent on the ionospheric correction. The advantage of using equation (4) is that it makes use of a single sea state bias, the composite sea state bias, that can also be determined from classical crossover minimization techniques but without any dependence on the ionospheric correction. Both equations (2) (and therefore equation (1)) and (4) make use of noisy C-band measurements.

5.6. Rain Flag

Liquid water along the pulse's path reduces the energy returned to the altimeter, mainly at Ku band. In heavy rain, there are competing effects from attenuation and surface changes. The small-
scale nature of rain cells tends to produce rapid changes in the strength of the echo as the altimeter crosses rain cells. Both effects degrade the performance of the altimeter. Data contaminated by rain should be rare (most are located in the west equatorial Pacific) and are consequently tagged and ignored (see rain_flag parameter).

The rain flag on the JASON-1 (I)GDR is set if integrated liquid water content measured by the JMR is larger than a specified threshold, and if the difference between the measured Ku backscatter coefficient and an expected Ku backscatter coefficient, estimated from the C-band backscatter which is much less affected by rain, is larger than either a specified threshold or a specified multiple of the uncertainty in the expected backscatter coefficient [Tournadre and Morland, 1998].

5.7. Ice Flag

The range measurement from the altimeter is likely to have larger errors when the pulse is reflected off ice surfaces. Of course, the ice surface is not at sea level, but some unknown distance above it. For this reason the JASON-1 (I)GDR provides an ice flag (see ice_flag parameter) to indicate when the data point is likely to be over ice. The ice flag is set if a climatological map predicts ice at the given location, and if the wind speed derived from the altimeter measurement is less than 1 m/s, i.e., the backscatter is larger than normally expected from the ocean.

5.8. Tides

Tides are obviously a significant contributor to the observed sea surface height [LeProvost, 2001]. While they are of interest in themselves, they have more variation than all other time-varying ocean signals. Since they are highly predictable, they are removed from the data in order to study ocean circulation. The T/P orbit was specifically selected (inclination and altitude) so that diurnal and semidiurnal tides would not be aliased to low frequencies.

There are several contributions to the tidal effect: the ocean tide, the load tide, the solid Earth tide and the pole tide. The ocean tide, load tide and solid Earth tide are all related to luni-solar forcing of the Earth, either directly as is the case of the ocean and solid Earth tide, or indirectly as is the case with the load tide since it is forced by the ocean tide. The pole tide is due to variations in the Earth’s rotation and is unrelated to luni-solar forcing.

JASON-1 (I)GDRs do not explicitly provide values for the pure ocean tide, but instead provide values for a quantity referred to as the geocentric ocean tide, which is the sum total of the ocean tide and the load tide. Values of the load tide that were used to compute the geocentric ocean tide are also explicitly provided, so the pure ocean tide can be determined by subtracting the load tide value from the geocentric ocean tide value. Note that the permanent tide is not included in either the geocentric ocean tide or solid Earth tide corrections that are provided on the JASON-1 (I)GDR.

5.8.1. Geocentric Ocean Tide

As mentioned above, the geocentric ocean tide is a quantity sometimes used to refer to the sum
total of the ocean tide and the load tide. The JASON-1 (I)GDR provides two choices for the
diurnal and semidiurnal ocean and load tides as predicted by a particular model,
and an equilibrium representation of the long-period ocean tides at all periods except for the zero
frequency (constant) term. The two load tide values provided on the GDR, load_tide_soll and
load_tide_sol2, provide the respective load tide values that were used to compute
ocean_tide_soll and ocean_tide_sol2.

5.8.2. Long period Ocean Tide

The long-period ocean tides are a subject of continuing investigation. To first order, they can be
approximated by an equilibrium representation. However, the true long-period ocean tide
response is thought to have departures from an equilibrium response that increase with decreasing
period. The two principal long-period ocean tide components Mf and Mn, with fortnightly and
monthly periods respectively, are known to have departures from an equilibrium response with
magnitudes less than 1-2 cm.

The JASON-1 (I)GDR explicitly provides a value for an equilibrium representation of the long-
period ocean tide that includes all long-period tidal components excluding the permanent tide
(zero frequency) component (see parameter ocean_tide_equil). Note that both geocentric ocean
tide values on the (I)GDR (ocean_tide_soll and ocean_tide_sol2) already include the equilibrium
long-period ocean tide and should therefore not be used simultaneously.

The JASON-1 (I)GDR provides a parameter for a non-equilibrium representation of the long-
period ocean tides (see parameter ocean_tide_neq_lp). This parameter is provided as a correction
to the equilibrium long-period ocean tide model so that the total non-equilibrium long period
ocean tide is formed as a sum of ocean_tide_equil and ocean_tide_neq_lp.

5.8.3. Solid Earth Tide

The solid Earth responds to external gravitational forces similarly to the oceans. The response of
the Earth is fast enough that it can be considered to be in equilibrium with the tide generating
forces. Then, the surface is parallel with the equipotential surface, and the tide height is
proportional to the potential. The two proportionality constants are the so-called Love numbers.
It should be noted that the Love numbers are largely frequency independent, an exception occurs
near a frequency corresponding to the K1 tide constituents due to a resonance in the liquid core
[Wahr, 1985 and Stacey, 1977].

The JASON-1 (I)GDR computes the solid earth tide, or body tide, as a purely radial elastic
response of the solid Earth to the tidal potential (see parameter solid_earth_tide.) The adopted
tidal potential is the Cartwright and Tayler [1971] and Cartwright and Edden [1973] tidal
potential extrapolated to the 2000 era, and includes degree 2 and 3 coefficients of the tidal
potential. The permanent tide (zero frequency) term is excluded from the tidal potential that is
used to compute the solid earth tide parameter for the JASON-1 (I)GDR. The elastic response is
modeled using frequency independent Love numbers. The effects of the resonance in the core is
accounted for by scaling the tide potential amplitude of the K1 tidal coefficient and some
5.8.4. Pole Tide

The pole tide is a tide-like motion of the ocean surface that is a response of both the solid Earth and the oceans to the centrifugal potential that is generated by small perturbations to the Earth's rotation axis. These perturbations primarily occur at periods of 433 days (called the Chandler wobble) and annual. These periods are long enough for the pole tide displacement to be considered to be in equilibrium with the forcing centrifugal potential. The JASON-1 (I)GDR provides a single field for the radial geocentric pole tide displacement of the ocean surface (see pole_tide parameter), and includes the radial pole tide displacement of the solid Earth and the oceans.

The pole tide is easily computed as described in Wahr [1985]. Modeling the pole tide requires knowledge of proportionality constants, the so-called Love numbers, and a time series of perturbations to the Earth's rotation axis, a quantity that is now measured routinely with space techniques. Note that the pole tide on the IGDR and GDR may differ, since the pole tide on the GDR is computed with a more accurate time series of the Earth's rotation axis.

5.9. Inverse Barometer Effect

As atmospheric pressure increases and decreases, the sea surface tends to respond hydrostatically, falling or rising respectively. Generally, a 1-mbar increase in atmospheric pressure depresses the sea surface by about 1 cm. This effect is referred to as the inverse barometer (IB) effect.

The instantaneous IB effect on sea surface height in millimeters (see parameter inv_bar_corr) is computed from the surface atmospheric pressure, $P_{\text{atm}}$ in mbar:

$$\text{inv\_bar\_corr} = -9.948 \times (P_{\text{atm}} - P)$$

where $P$ is the time varying mean of the global surface atmospheric pressure over the oceans.

The scale factor 9.948 is based on the empirical value [Wunsch, 1972] of the IB at mid latitudes. Some researchers use other values. Note that surface atmospheric pressure is also proportional to the dry tropospheric correction, and so the parameter inv_bar_corr approximately changes by 4 to 5 mm as model_dry_tropo_corr changes by 1 mm (assuming a constant mean global surface pressure). The uncertainty of the ECMWF atmospheric pressure products is somewhat dependent on location. Typical errors vary from 1 mbar in the northern Atlantic Ocean to a few mbars in the southern Pacific Ocean. A 1-mbar error in pressure translates into a 10 mm error in the computation of the IB effect.

Note that the time varying mean global pressure over the oceans, $P$, during the first eight years of the T/P mission had a mean value of approximately 1010.9 mbar, with an annual variation about this mean of approximately 0.6 mbar. However, the T/P data products provided a static inverse barometer correction referenced to a constant mean pressure of 1013.3 mbar.

$$\text{IB(T/P)} = -9.948 \times (P_{\text{atm}} - 1013.3)$$

Sea surface heights that are generated after applying an inverse barometer correction referenced
to a mean pressure of 1013.3 mbar are therefore approximately \(-9.948*(1010.9-1013.3) = 23.9\) mm lower than those that are generated after applying an inverse barometer correction referenced to a time varying global mean pressure, and the difference between the two sea surface heights has an annual variation of approximately \(9.948*0.6 = 6\) mm.

5.9.1. Barotropic/Baroclinic Response to Atmospheric Forcing

The High Frequency Wind and Pressure Response correction, \(\text{hf\_fluctuations\_corr}\), complements the Inverted Barometer (IB) correction. Like both tides and IB, the ocean response to wind and pressure (after removing the IB part) has energy at periods shorter than the 20 day implied by the \(~10\) day repeat cycle of JASON-1. This correction can be thought of as a departure from the IB response to pressure, although strictly it is the difference between the response to wind and pressure minus the IB. "Ali and Zlotnicki [2000] compute this response with a barotropic model that is forced by NCEP operational wind and pressure. The model output is filtered in time to pass frequencies shorter than 20 days. See also Stammer et al. [1999] and Tierney et al. [2000]."

The parameter \(\text{hf\_fluctuations\_corr}\) is provided as a correction to the inverse barometer correction \(\text{inv\_bar\_corr}\).

5.10. Sigma 0

The backscatter coefficients, \(\text{sigma0\ Ku}\) and \(\text{C}\) values (see parameters \(\text{sig0\_ku}\) and \(\text{sig0\_c}\)), reported on the (I)GDR are corrected for atmospheric attenuation using \(\text{atmos\_sig0\_corr\_ku}\) and \(\text{atmos\_sig0\_corr\_c}\) (see Sec 7). Note that "unbiased" \(\text{sigma0}\) values are recorded on the Jason-1 data products. A bias of approximately \(-2.26\) dB in the Ku band and \(-0.28\) dB in the C band has been applied to the provided \(\text{sigma0}\) for any geophysical algorithms that require use of \(\text{sigma0}\). These biases have been determined from comparisons to \(\text{sigma0}\) from the Topex altimeter.

5.11. Wind Speed

The model functions developed to date for altimeter wind speed have all been purely empirical. The model function establishes a relation between the wind speed, and the sea surface backscatter coefficient and significant wave height. A wind speed is calculated through a mathematical relationship with the Ku-band backscatter coefficient and the significant wave height (see \(\text{wind\_speed\_alt}\)) using the Vandemark and Chapron algorithm. The wind speed model function is evaluated for 10 meter above the sea surface, and is considered to be accurate to 2 m/s.

A wind speed is also computed through an empirical relationship to brightness temperatures measured by the JMR [Keihm et al., 1995] (see \(\text{wind\_speed\_rad}\)). The coefficients of this relationship have been determined from the regression of island radiosonde data computations combined with seasonal and latitude dependent wind speed statistics.

Finally, a 10-meter (above surface) wind vector (in east-west and north-south directions) is also provided on the JASON-1 (I)GDR (see parameters \(\text{wind\_speed\_model\_u}\) and \(\text{wind\_speed\_model\_v}\)). This wind speed vector is determined from an interpolation of the
ECMWF meteorological model. The best accuracy for the wind vector varies from about 2 m/s in magnitude and 20 degrees in direction in the northern Atlantic Ocean, to more then 5 m/s and 40 degrees in the southern Pacific Ocean.

NOTE: The QuikSCAT and NSCAT scatterometer winds are calculated at 10 m. ERS-1/2 scatterometer winds are reported at 19.5 m.

5.12. **Bathymetry Information**

The JASON-1 (I)GDR provides a parameter bathymetry that gives the ocean depth or land elevation of the data point. Ocean depths have negative values, and land elevations have positive values. This parameter is given to allow users to make their own "cut" for ocean depth.
6.(I)GDR general description

The (I)GDR is an offline geophysical product generated from operational and science telemetry from Poseidon-2, processed DORIS, GPS and laser data for the orbit, and telemetry from the JASON-1 Microwave Radiometer (JMR). Unlike the OSDR, the (I)GDR contains all environmental and geophysical corrections. Instrumental corrections have been applied to (I)GDR data. Furthermore dedicated ground retracking is performed on the waveforms to improve the accuracy of the product. The IGDR is a non-fully validated product which contains data for both bands (Ku and C) at a rate of 1 Hz and 20 Hz. It is structured in pass files (pole to pole structure).

The GDR is identical to the IGDR except for the following points:

- a more precise orbit is used
- improved pole location data are used
- an improved high frequency ocean dealiasing model is used
- it is a fully validated product

The following fields are therefore recomputed for the GDR:

- latitude (latitude)
- longitude (longitude)
- altitude (altitude, orb_state_flag and alt_hi_rate)
- orbital altitude rate (orb_alt_rate)
- net sum of the instrumental corrections (update of the Doppler correction) (net_instr_corr_ku and net_instr_corr_c)
- corrected ground retracked altimeter ranges (range_ku and range_c)
- altimeter ionospheric correction (iono_corr_alt_ku)
- High frequency dealiasing correction (hf_fluctuations_corr)
- pole tide height (pole_tide)
6.1. Content
A pass-file contains a header (73 records) and 3360 scientific data records maximum. Whereas the header is recorded in ASCII type, the data part is recorded in a UNIX binary integer type. A scientific data record contains 96 fields, each stored as one, two or four bytes, or spare (1 byte).

6.2. Header description
The information included in the header are encoded in ASCII and follow the SFDU CCSDS rules. They cover the followings areas:
- generation of the product
- sensors
- processing information
- data flow of the product
- product confidence data
- reference of the auxiliary data used to generate the product
6.3. Data description

The information included in the data record cover the following areas:

- time tag
- location and surface type
- quality information and sensors status
- orbit
- altimeter range
- altimeter range corrections
- significant wave height
- significant wave height corrections
- backscatter coefficient
- backscatter coefficient corrections
- off nadir angle
- brightness temperatures
- geophysical parameters
- environmental parameters
- flags

Most of this information is provided at 1 Hz rates, while some parameters like orbit and altimeter range are also provided at 20 Hz rates.
7. HEADER ELEMENTS

Section 7.1 describes the format of the header elements and section 7.2 defines each element of
the header in alphabetical order by the following characteristics:

<table>
<thead>
<tr>
<th>Definition</th>
<th>Element definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Element type</td>
<td>An element type can be bitfield, integer, real or a string.</td>
</tr>
<tr>
<td>Byte length</td>
<td>Size of elements in 8-bit bytes.</td>
</tr>
<tr>
<td>Storage type</td>
<td>A storage type can be signed (signed integer), unsigned (unsigned integer), bit (contiguous sequence of bits) or character (contiguous sequence of ASCII characters).</td>
</tr>
<tr>
<td>Unit</td>
<td>Unit of measure including scale factor, UTC(^1) or none (/)</td>
</tr>
<tr>
<td>Field number</td>
<td>field number in the header part</td>
</tr>
<tr>
<td>Comment</td>
<td>Other comment if any.</td>
</tr>
</tbody>
</table>

When an item can not be filled, there is N/A which stands for not applicable.

\(^1\) Any time variable recorded in CCSDS headers has UTC2 format as defined in section 2.4.5.
7.1. Header overview

The header is composed of 73 records which are described in the table below. Generally, each record is constituted by:

- one keyword followed by a Separator (if any)
- the value of the fields (if any)
- followed by a semicolon and a newline (if any)

In the table below:

- "offset" is the offset in bytes to access directly to the record
- "total bytes" is the total length of the record expressed in bytes
- "Keyword_format" is the format of the keyword (string) including the separator
- "Keyword_content" is the value of the keyword set on the GDR
- "Keyword_separator" is the value of the separator (set to "none" if not used)
- Value_format is the format of the field (string, set to "none" if not used)
- Semicolon is a semicolon character (if set to "y" in the table otherwise set to "n")
- Newline is a newline character (if set to "y" in the table otherwise set to "n")

Below is an example of the first 18 lines of the header:

```
CCSD3ZF000010000001CCSD3VS00006PRODUCER
Product_File_Name = JA1_GDR_2PDP001_070;
Producer_Agency_Name = CNES;
Processing_Center = SSALTO;
File_Data_Type = GDR;
Reference_Document = SMM-ST-M-EA-10879-CN Issue 3.1;
Reference_Software = CMAV9.1 02/G3OS4;
Operating_System = SunOS 5.7;
CCSDDS$MARKERPRODUCERCSSD3KS00006PASSFILE
Mission_Name = Jason-1;
Altimeter_Sensor_Name = POSEIDON-2;
Radiometer_Sensor_Name = JMR;
DORIS_Sensor_Name = DORIS-2 GM;
Acquisition_Station_Name = Kiruna;
Cycle_Number = 1;
Absolute_Revolution_Number = 35;
Pass_Number = 70;
```
### AVISO and PODAAC User Handbook
#### IGDR and GDR Jason Products

#### Chapter 7 - HEADER ELEMENTS

<table>
<thead>
<tr>
<th>Field number</th>
<th>Offset</th>
<th>Total bytes</th>
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<th>Keyword</th>
<th>Content</th>
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<th>Value Format</th>
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<th>Semicolon</th>
<th>NewLine</th>
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Total 3520

*
7.2. Header content (alphabetical order)

Absolute_Pass_Number
Definition: Absolute pass number i.e., pass number computed since beginning of cycle 1
Element type: String
Byte length: 5
Storage type: Character
Unit: /
Field number: 21
Comment: /

Absolute_Revolution_Number
Definition: Absolute orbit number i.e., orbit number computed since beginning of cycle 1
Element type: String
Byte length: 5
Storage type: Character
Unit: /
Field number: 19
Comment: /

Acquisition_Station_Name
Definition: Name of the station where the raw data have been acquired (directly derived from Level 1.0 product)
Element type: String
Byte length: 20
Storage type: Character
Unit: /
Field number: 17
Comment: /

Altimeter_Level1
Definition: Name of the altimeter Level 1.0 input file
Element type: String
Byte length: 40
Storage type: Character
Unit: /
Field number: 43
Comment: /

Altimeter_Sensor_Name
Definition: POSEIDON-2
Element type: String
Byte length: 10
Storage type: Character
Unit: /
Field number: 14
Comment: /
**Average_Pressure**

**Definition:** Average global pressure from meteorological fields over oceans (unit : 10 Pa)  
The nearest meteorological field to the first measurement of the pass is used to compute this average pressure

- **Element type:** String
- **Byte length:** 5
- **Storage type:** Character
- **Unit:** <daPa>
- **Field number:** 39
- **Comment:** /

**Bathymetry_Topography_Map**

**Definition:** Name of the bathymetry/topography model

- **Element type:** String
- **Byte length:** 20
- **Storage type:** Character
- **Unit:** /
- **Field number:** 71
- **Comment:** /

**CCSDSSMARKER_AUXFILES**

**Definition:** /

- **Element type:** String
- **Byte length:** 0
- **Storage type:** Character
- **Unit:** /
- **Field number:** 72
- **Comment:** /

**CCSDSSMARKER_MEASFILE**

**Definition:** /

- **Element type:** String
- **Byte length:** 0
- **Storage type:** Character
- **Unit:** /
- **Field number:** 45
- **Comment:** /

**CCSDSSMARKER_PASSFILE**

**Definition:** /

- **Element type:** String
- **Byte length:** 0
- **Storage type:** Character
- **Unit:** /
- **Field number:** 41
- **Comment:** /
### CCSDSSMARKERPRODUCER
- **Definition:** /  
- **Element type:** String  
- **Byte length:** 0  
- **Storage type:** Character  
- **Unit:** /  
- **Field number:** 11  
- **Comment:** /  

### CCSD3KS00006PASSFILE
- **Definition:** /  
- **Element type:** String  
- **Byte length:** 0  
- **Storage type:** Character  
- **Unit:** /  
- **Field number:** 12  
- **Comment:** /  

### CCSD3SS00006AUXFILES
- **Definition:** /  
- **Element type:** String  
- **Byte length:** 0  
- **Storage type:** Character  
- **Unit:** /  
- **Field number:** 46  
- **Comment:** /  

### CCSD3SS00006MEASFILE
- **Definition:** /  
- **Element type:** String  
- **Byte length:** 0  
- **Storage type:** Character  
- **Unit:** /  
- **Field number:** 42  
- **Comment:** /  

### CCSD3VS00006PRODUCER
- **Definition:** /  
- **Element type:** String  
- **Byte length:** 0  
- **Storage type:** Character  
- **Unit:** /  
- **Field number:** 2  
- **Comment:** /
Chapter 7 - HEADER ELEMENTS

CCSD3ZF000010000001
  Definition : /
  Element type : String
  Byte length : 0
  Storage type : Character
  Unit : /
  Field number : 1
  Comment : /

Cycle_Number
  Definition : Cycle number. First Jason-1 cycle was on January, 15th 2002. Tools to convert from cycle and pass number to UTC date are available on PODAAC and AVISO web servers.
  Element type : String
  Byte length : 5
  Storage type : Character
  Unit : /
  Field number : 18
  Comment : /

DORIS_Sensor_Name
  Definition : DORIS-2 GM
  Element type : String
  Byte length : 10
  Storage type : Character
  Unit : /
  Field number : 16
  Comment : /

DORIS_TEC_Map
  Definition : Name of the file containing the Total Electronic Content calculated from DORIS measurements. (Set to blank if the file was not available or not used for the product generation.)
  Element type : String
  Byte length : 61
  Storage type : Character
  Unit : /
  Field number : 51
  Comment : /

DORIS_USO
  Definition : Name of the file containing the on-board Doris frequency shift
  Element type : String
  Byte length : 61
  Storage type : Character
  Unit : /
  Field number : 52
  Comment : /
Chapter 7 - HEADER ELEMENTS

Equator_Longitude
Definition: Longitude in degrees of equator crossing (format xxx.xx)
Element type: String
Byte length: 7
Storage type: Character
Unit: <deg>
Field number: 23
Comment: /

Equator_Time
Definition: UTC date & time of equator crossing (CCSDS UTC2 format defined in paragraph 2.4.5)
Element type: String
Byte length: 26
Storage type: Character
Unit: /
Field number: 22
Comment: /

FCST3IF0011400000001
Definition: /
Element type: String
Byte length: 0
Storage type: Character
Unit: /
Field number: 73
Comment: /

File_Data_Type
Definition: Type of data (IGDR or GDR or SGDR)
Element type: String
Byte length: 4
Storage type: Character
Unit: /
Field number: 6
Comment: /

First_Measurement_Latitude
Definition: Latitude in degrees of first measurement in the product (format +xx.xx or - xx.xx)
Element type: String
Byte length: 6
Storage type: Character
Unit: <deg>
Field number: 26
Comment: /
Chapter 7 - HEADER ELEMENTS

First_Measurement_Longitude
Definition: Longitude in degrees of first measurement in the product (format xxx.xx)
Element type: String
Byte length: 7
Storage type: Character
Unit: <deg>
Field number: 28
Comment: /

First_Measurement_Time
Definition: UTC date & time of first measurement in the product (CCSDS UTC2 format defined in paragraph 2.4.5)
Element type: String
Byte length: 26
Storage type: Character
Unit: /
Field number: 24
Comment: /

Geoid_Map
Definition: Name of the geoid model
Element type: String
Byte length: 20
Storage type: Character
Unit: /
Field number: 69
Comment: /

Header_Padding
Definition: Blank characters added to force header size to be a multiple of data record length
Element type: String
Byte length: 186
Storage type: Character
Unit: /
Field number: 40
Comment: /

JMR_BT_Averaging
Definition: Name of the file containing the characterization data for the JMR radiometer used to compute the along track average brightness temperatures
Element type: String
Byte length: 61
Storage type: Character
Unit: /
Field number: 50
Comment: /
JMR_Main_Beam
Definition: Name of the file containing the characterization data for the JMR radiometer, used to compute the brightness temperatures from the antenna temperatures

Element type: String
Byte length: 61
Storage type: Character
Unit: /
Field number: 49
Comment: /

JMR_Retrieval_Coefficients
Definition: Name of the file containing the geophysical coefficient for the JMR used to compute the geophysical parameters from the brightness temperatures

Element type: String
Byte length: 61
Storage type: Character
Unit: /
Field number: 61
Comment: /

LAND_SEA_Mask_Map
Definition: Name of the file containing the Land/Sea mask map

Element type: String
Byte length: 61
Storage type: Character
Unit: /
Field number: 62
Comment: /

Last_Measurement_Latitude
Definition: Latitude in degrees of last measurement in the product (format +xx.xx or -xx.xx)

Element type: String
Byte length: 6
Storage type: Character
Unit: <deg>
Field number: 27
Comment: /

Last_Measurement_Longitude
Definition: Longitude in degrees of last measurement in the product (format xxx.xx)

Element type: String
Byte length: 7
Storage type: Character
Unit: <deg>
Field number: 29
Comment: /
### Last_Measurement_Time
**Definition:** UTC date & time of last measurement in the product (CCSDS UTC2 format defined in paragraph 2.4.5)
- **Element type:** String
- **Byte length:** 26
- **Storage type:** Character
- **Unit:** /
- **Field number:** 25
- **Comment:** /

### Mission_Name
**Definition:** Jason-1
- **Element type:** String
- **Byte length:** 7
- **Storage type:** Character
- **Unit:** /
- **Field number:** 13
- **Comment:** /

### MSS_Map
**Definition:** Name of the Mean Sea Surface model
- **Element type:** String
- **Byte length:** 20
- **Storage type:** Character
- **Unit:** /
- **Field number:** 70
- **Comment:** /

### MTO_Fields
**Definition:** Name of the MTO model from which meteorological parameters have been derived
- **Element type:** String
- **Byte length:** 20
- **Storage type:** Character
- **Unit:** /
- **Field number:** 56
- **Comment:** /

### NEQ_Tide
**Definition:** Name of the dynamic model for long period tides
- **Element type:** String
- **Byte length:** 20
- **Storage type:** Character
- **Unit:** /
- **Field number:** 68
- **Comment:** /
### Ocean_Pass_Data_Count

**Definition:** Number of 1 Hz measurements over ocean in the product  
**Element type:** String  
**Byte length:** 5  
**Storage type:** Character  
**Unit:** /  
**Field number:** 31  
**Comment:** /

### Ocean_PCD

**Definition:** Product confidence data in percentage (ratio of the altimeter data declared OK to the total number of ocean measurements where data integrity is determined using the quality flag for the 1 Hz altimeter data (altimeter + radiometer + environmental parameters))  
**Element type:** String  
**Byte length:** 3  
**Storage type:** Character  
**Unit:** <%>  
**Field number:** 32  
**Comment:** /

### Ocean_Tide_Sol_1

**Definition:** Name of the ocean tide model #1  
**Element type:** String  
**Byte length:** 20  
**Storage type:** Character  
**Unit:** /  
**Field number:** 63  
**Comment:** /

### Ocean_Tide_Sol_2

**Definition:** Name of the ocean tide model #2  
**Element type:** String  
**Byte length:** 20  
**Storage type:** Character  
**Unit:** /  
**Field number:** 64  
**Comment:** /

### Operating_System

**Definition:** ID of the operating system  
**Element type:** String  
**Byte length:** 20  
**Storage type:** Character  
**Unit:** /  
**Field number:** 9  
**Comment:** /
### Orbit_Data
**Definition:** Name of the file containing the orbit ephemeris (MOE for IGDR, POE for GDR)
- **Element type:** String
- **Byte length:** 61
- **Storage type:** Character
- **Unit:** /
- **Field number:** 53
- **Comment:** /

### ORF_Data
**Definition:** Orbit Revolution File used to create the pass file products
- **Element type:** String
- **Byte length:** 61
- **Storage type:** Character
- **Unit:** /
- **Field number:** 57
- **Comment:** /

### Pass_Data_Count
**Definition:** Number of 1 Hz measurements in the product
- **Element type:** String
- **Byte length:** 5
- **Storage type:** Character
- **Unit:** /
- **Field number:** 30
- **Comment:** /

### Pass_Number
**Definition:** Pass number within the cycle
- **Element type:** String
- **Byte length:** 3
- **Storage type:** Character
- **Unit:** /
- **Field number:** 20
- **Comment:** /

### PF_Corrections
**Definition:** Name of the file containing the platform corrections (mispointing relative to the subsatellite point distance between antenna center of phase and center of gravity)
- **Element type:** String
- **Byte length:** 61
- **Storage type:** Character
- **Unit:** /
- **Field number:** 54
- **Comment:** /
POLE_LOCATION
Definition : Name of the file containing the pole location data
Element type : String
Byte length : 61
Storage type : Character
Unit : /
Field number : 55
Comment : /

POSEIDON-2_Characterization
Definition : Name of the file containing the characterization data for the POSEIDON-2 altimeter
Element type : String
Byte length : 61
Storage type : Character
Unit : /
Field number : 47
Comment : /

POSEIDON-2_Composite_SSB
Definition : Name of the file containing the composite Sea state bias coefficients for Poseidon-2
Element type : String
Byte length : 61
Storage type : Character
Unit : /
Field number : 60
Comment : /

POSEIDON-2_LTM
Definition : Name of the file containing the Long Term Monitoring values for the POSEIDON-2 altimeter
Element type : String
Byte length : 61
Storage type : Character
Unit : /
Field number : 48
Comment : /

POSEIDON-2_OB_RET_Correction_Tables
Definition : Name of the file containing the on-board retracking coefficient corrections (for level1B and level2 processing)
Element type : String
Byte length : 61
Storage type : Character
Unit : /
Field number : 58
Comment : /
POSEIDON-2_SSB
Definition : Name of the file containing the Sea state bias coefficients for Poseidon-2
Element type : String
Byte length : 61
Storage type : Character
Unit : /
Field number : 59
Comment : /

Processing_Center
Definition : Center (SSALTO or JSDS)
Element type : String
Byte length : 6
Storage type : Character
Unit : /
Field number : 5
Comment : /

Producer_Agency_Name
Definition : Name (CNES or NASA)
Element type : String
Byte length : 4
Storage type : Character
Unit : /
Field number : 4
Comment : /

Product_Creation_Time
Definition : UTC date & time of product generation (CCSDS UTC2 format defined in paragraph 2.4.5) i.e., 2000-06-21T04:20:00.000000
Element type : String
Byte length : 26
Storage type : Character
Unit : /
Field number : 10
Comment : /

Product_File_Name
Definition : Name of the product (i.e., JA1_IGD_2PvPcecc_ppp)
Element type : String
Byte length : 40
Storage type : Character
Unit : /
Field number : 3
Comment : /
<table>
<thead>
<tr>
<th>Table 7.1: Contents of Header Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Radiometer Level1</strong></td>
</tr>
<tr>
<td><strong>Definition:</strong> Name of the radiometer Level 1.0 input file</td>
</tr>
<tr>
<td><strong>Element type:</strong> String</td>
</tr>
<tr>
<td><strong>Byte length:</strong> 40</td>
</tr>
<tr>
<td><strong>Storage type:</strong> Character</td>
</tr>
<tr>
<td><strong>Unit:</strong> /</td>
</tr>
<tr>
<td><strong>Field number:</strong> 44</td>
</tr>
<tr>
<td><strong>Comment:</strong> /</td>
</tr>
<tr>
<td><strong>Radiometer Sensor Name</strong></td>
</tr>
<tr>
<td><strong>Definition:</strong> JMR</td>
</tr>
<tr>
<td><strong>Element type:</strong> String</td>
</tr>
<tr>
<td><strong>Byte length:</strong> 3</td>
</tr>
<tr>
<td><strong>Storage type:</strong> Character</td>
</tr>
<tr>
<td><strong>Unit:</strong> /</td>
</tr>
<tr>
<td><strong>Field number:</strong> 15</td>
</tr>
<tr>
<td><strong>Comment:</strong> /</td>
</tr>
<tr>
<td><strong>Range Offset</strong></td>
</tr>
<tr>
<td><strong>Definition:</strong> Offset to be added to the altitude and to the range to retrieve the absolute values of these parameters (i.e., 1300 km)</td>
</tr>
<tr>
<td><strong>Element type:</strong> String</td>
</tr>
<tr>
<td><strong>Byte length:</strong> 4</td>
</tr>
<tr>
<td><strong>Storage type:</strong> Character</td>
</tr>
<tr>
<td><strong>Unit:</strong> &lt;km&gt;</td>
</tr>
<tr>
<td><strong>Field number:</strong> 38</td>
</tr>
<tr>
<td><strong>Comment:</strong> /</td>
</tr>
<tr>
<td><strong>Reference Document</strong></td>
</tr>
<tr>
<td><strong>Definition:</strong> ID of the document describing the product (i.e., SMM-ST-M-EA-10879-CN)</td>
</tr>
<tr>
<td><strong>Element type:</strong> String</td>
</tr>
<tr>
<td><strong>Byte length:</strong> 50</td>
</tr>
<tr>
<td><strong>Storage type:</strong> Character</td>
</tr>
<tr>
<td><strong>Unit:</strong> /</td>
</tr>
<tr>
<td><strong>Field number:</strong> 7</td>
</tr>
<tr>
<td><strong>Comment:</strong> /</td>
</tr>
<tr>
<td><strong>Reference Software</strong></td>
</tr>
<tr>
<td><strong>Definition:</strong> ID of the software used to create the product (i.e., CMA Vx.x) and product version using the following nomenclature I/GnOSm, n being the version number of the I/GDR products and m being the version of the OSDR product.</td>
</tr>
<tr>
<td><strong>Element type:</strong> String</td>
</tr>
<tr>
<td><strong>Byte length:</strong> 20</td>
</tr>
<tr>
<td><strong>Storage type:</strong> Character</td>
</tr>
<tr>
<td><strong>Unit:</strong> /</td>
</tr>
<tr>
<td><strong>Field number:</strong> 8</td>
</tr>
<tr>
<td><strong>Comment:</strong> /</td>
</tr>
</tbody>
</table>
### Solid_Earth_Tide
**Definition:** Name of the file containing the Cartwright and Edden tide potential amplitudes for the solid earth tide and the Equilibrium long period ocean tide height calculation
- **Element type:** String
- **Byte length:** 61
- **Storage type:** Character
- **Unit:** /
- **Field number:** 67
- **Comment:** /

### TAI.UTC.Difference
**Definition:** Increment to be applied to UTC to give TAI (dt=TAI-UTC)
- **Element type:** String
- **Byte length:** 4
- **Storage type:** Character
- **Unit:** /
- **Field number:** 34
- **Comment:** the increment is given in seconds.

### Tidal Loading_Sol_1
**Definition:** Name of the loading tide model #1
- **Element type:** String
- **Byte length:** 20
- **Storage type:** Character
- **Unit:** /
- **Field number:** 65
- **Comment:** /

### Tidal Loading_Sol_2
**Definition:** Name of the loading tide model #2
- **Element type:** String
- **Byte length:** 20
- **Storage type:** Character
- **Unit:** /
- **Field number:** 66
- **Comment:** /

### Time_Epoch
**Definition:** Reference used for measurement datation in the product (value=1958-01-01T00:00:00.00000)
- **Element type:** String
- **Byte length:** 26
- **Storage type:** Character
- **Unit:** /
- **Field number:** 33
- **Comment:** /
**AVISO and PODAAC User Handbook**  
**IGDR and GDR Jason Products**  

**Chapter 7 - HEADER ELEMENTS**

**Time_Of_Leap_Second**  
**Definition:** UTC Time at which a leap second occurred in the product. (CCSDS UTC2 format defined in paragraph 2.4.5) Set to 0000-00-00T00:00:00.000000 if not useful  
**Element type:** String  
**Byte length:** 26  
**Storage type:** Character  
**Unit:** /  
**Field number:** 35  
**Comment:** /  

**Time_Shift_INTERVAL**  
**Definition:** Time interval (microseconds) between two 20 Hz waveforms  
**Element type:** String  
**Byte length:** 10  
**Storage type:** Character  
**Unit:** <us>  
**Field number:** 37  
**Comment:** /  

**Time_Shift_Mid_Frame**  
**Definition:** Offset to apply to time to derive the time tag of the first 20 Hz waveform (unit: microsecond)  
**Element type:** String  
**Byte length:** 10  
**Storage type:** Character  
**Unit:** <us>  
**Field number:** 36  
**Comment:** /
8. (I)GDR ELEMENTS

Section 8.1 describes the format of the data elements of the (I)GDR and section 8.2 defines each element of the data records in alphabetical order by the following characteristics:

- **Definition**: Element definition.
- **Element type**: An element type can be bitfield or integer.
- **Byte length**: Size of element in 8-bit bytes.
- **Storage type**: A storage type can be signed (signed integer), unsigned (unsigned integer), bit (contiguous sequence of bits) or character (contiguous sequence of ASCII characters).
- **Dimension**: Dimension (1 or 20 for the high rate fields).
- **Unit**: Unit of measure including scale factor, or none (/).
- **Minimum value**: Typical or approximate minimum element value.
- **Maximum value**: Typical or approximate maximum element value.
- **Default value**: Element value when the measurement is not available or when the element has not been computed ("flag value").
- **Quality flags**: Flags indicating the quality of this element, or none (/). This item exists if the element is not a flag itself.
- **Comment**: Other comment.

When an item cannot be filled, there is N/A which stands for not applicable.
8.1. Data record format

The data part is composed of n records, where n is the number of measurements acquired by the satellite. All of the measurements acquired on board will be included in the level 2 products.

The table below describes briefly one data record. The following convention is used:

- I = Unsigned integer
- SI = Signed integer
- BF = Bit flag
<table>
<thead>
<tr>
<th>Field Number</th>
<th>Record Location</th>
<th>Mnemonic</th>
<th>Content</th>
<th>Type</th>
<th>Dim.</th>
<th>Size</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time Tag</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>time_day</td>
<td>time stamp 1 (number of days from reference date)</td>
<td>I</td>
<td>1</td>
<td>4</td>
<td>Day</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>time_sec</td>
<td>time stamp 2 (seconds within the day)</td>
<td>I</td>
<td>1</td>
<td>4</td>
<td>s</td>
</tr>
<tr>
<td>3</td>
<td>9</td>
<td>time_microsec</td>
<td>time stamp 3 (microseconds)</td>
<td>I</td>
<td>1</td>
<td>4</td>
<td>µs</td>
</tr>
<tr>
<td><strong>Location and Surface Type</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>13</td>
<td>latitude</td>
<td>Latitude</td>
<td>SI</td>
<td>1</td>
<td>4</td>
<td>µdeg</td>
</tr>
<tr>
<td>5</td>
<td>17</td>
<td>longitude</td>
<td>Longitude</td>
<td>I</td>
<td>1</td>
<td>4</td>
<td>µdeg</td>
</tr>
<tr>
<td>6</td>
<td>21</td>
<td>surface_type</td>
<td>surface type</td>
<td>I</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>22</td>
<td>alt_echo_type</td>
<td>altimeter echo type (0 = ocean-like, 1 = non-ocean-like)</td>
<td>BF</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>23</td>
<td>rad_surf_type</td>
<td>radiometer surface type (0 = ocean, 1 = land)</td>
<td>BF</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>Quality information and sensors status</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>24</td>
<td>qual_1hz_alt_data</td>
<td>quality flag for 1 Hz altimeter data</td>
<td>BF</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>25</td>
<td>qual_1hz_instr_corr</td>
<td>quality flag for 1 Hz altimeter instrumental corrections</td>
<td>BF</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>26</td>
<td>qual_1hz_rad_data</td>
<td>quality flag for 1 Hz radiometer data</td>
<td>BF</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>27</td>
<td>alt_state_flag</td>
<td>Altimeter state flag</td>
<td>BF</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>28</td>
<td>rad_state_flag</td>
<td>Radiometer state flag</td>
<td>BF</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>29</td>
<td>orb_state_flag</td>
<td>orbit state flag</td>
<td>I</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>30</td>
<td>qual_spare</td>
<td>spare (to be aligned)</td>
<td>BF</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>Orbit</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>33</td>
<td>altitude</td>
<td>1 Hz altitude of satellite</td>
<td>I</td>
<td>1</td>
<td>4</td>
<td>10^4m</td>
</tr>
<tr>
<td>17</td>
<td>37</td>
<td>alt_hi_rate</td>
<td>Differences between altitudes corresponding to the elementary measurements to that of the averaged measurements</td>
<td>SI</td>
<td>20</td>
<td>4</td>
<td>10^4m</td>
</tr>
<tr>
<td>18</td>
<td>117</td>
<td>orb_alt_rate</td>
<td>orbital altitude rate</td>
<td>SI</td>
<td>1</td>
<td>2</td>
<td>cm/s</td>
</tr>
<tr>
<td>19</td>
<td>119</td>
<td>orb_spare</td>
<td>spare (to be aligned)</td>
<td>I</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>Altimeter Range</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>121</td>
<td>range_ku</td>
<td>1 Hz Ku band range</td>
<td>I</td>
<td>1</td>
<td>4</td>
<td>10^4m</td>
</tr>
<tr>
<td>21</td>
<td>125</td>
<td>range_hi_rate_ku</td>
<td>20Hz Ku band range</td>
<td>SI</td>
<td>20</td>
<td>4</td>
<td>10^4m</td>
</tr>
<tr>
<td>22</td>
<td>205</td>
<td>range_c</td>
<td>1 Hz C band range</td>
<td>I</td>
<td>1</td>
<td>4</td>
<td>10^4m</td>
</tr>
<tr>
<td>23</td>
<td>209</td>
<td>range_hi_rate_c</td>
<td>20Hz C band range</td>
<td>SI</td>
<td>20</td>
<td>4</td>
<td>10^4m</td>
</tr>
<tr>
<td>24</td>
<td>289</td>
<td>range_rms_ku</td>
<td>RMS of the Ku band range</td>
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### Chapter 8 - (I)GDR ELEMENTS

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*IGDR and GDR Jason Products*

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<td>1</td>
<td>1</td>
<td>/</td>
</tr>
<tr>
<td>96</td>
<td>438</td>
<td>flag_spare</td>
<td>spare (to be aligned)</td>
<td>BF</td>
<td>3</td>
<td>1</td>
<td>/</td>
</tr>
</tbody>
</table>
### 8.2. ELEMENTS content (alphabetical order)

**age_c**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition</td>
<td>C band AGC</td>
</tr>
<tr>
<td>Element type</td>
<td>Integer</td>
</tr>
<tr>
<td>Byte length</td>
<td>2</td>
</tr>
<tr>
<td>Storage type</td>
<td>Unsigned</td>
</tr>
<tr>
<td>Dimension</td>
<td>1</td>
</tr>
<tr>
<td>Unit</td>
<td>$10^{-2}$ dB</td>
</tr>
<tr>
<td>Minimum Value</td>
<td>0</td>
</tr>
<tr>
<td>Maximum Value</td>
<td>5 500</td>
</tr>
<tr>
<td>Default Value</td>
<td>65 535</td>
</tr>
<tr>
<td>Quality flag</td>
<td>/</td>
</tr>
<tr>
<td>Comment</td>
<td>/</td>
</tr>
</tbody>
</table>

**age_ku**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition</td>
<td>Ku band AGC</td>
</tr>
<tr>
<td>Element type</td>
<td>Integer</td>
</tr>
<tr>
<td>Byte length</td>
<td>2</td>
</tr>
<tr>
<td>Storage type</td>
<td>Unsigned</td>
</tr>
<tr>
<td>Dimension</td>
<td>1</td>
</tr>
<tr>
<td>Unit</td>
<td>$10^{-2}$ dB</td>
</tr>
<tr>
<td>Minimum Value</td>
<td>0</td>
</tr>
<tr>
<td>Maximum Value</td>
<td>5 000</td>
</tr>
<tr>
<td>Default Value</td>
<td>65 535</td>
</tr>
<tr>
<td>Quality flag</td>
<td>/</td>
</tr>
<tr>
<td>Comment</td>
<td>/</td>
</tr>
</tbody>
</table>

**age_numval_c**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition</td>
<td>number of valid points used to compute C band AGC</td>
</tr>
<tr>
<td>Element type</td>
<td>Integer</td>
</tr>
<tr>
<td>Byte length</td>
<td>1</td>
</tr>
<tr>
<td>Storage type</td>
<td>Unsigned</td>
</tr>
<tr>
<td>Dimension</td>
<td>1</td>
</tr>
<tr>
<td>Unit</td>
<td>/</td>
</tr>
<tr>
<td>Minimum Value</td>
<td>0</td>
</tr>
<tr>
<td>Maximum Value</td>
<td>20</td>
</tr>
<tr>
<td>Default Value</td>
<td>255</td>
</tr>
<tr>
<td>Quality flag</td>
<td>/</td>
</tr>
<tr>
<td>Comment</td>
<td>/</td>
</tr>
</tbody>
</table>
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--

**age_numval_ku**

**Definition:** number of valid points used to compute Ku band AGC  
**Element type:** Integer  
**Byte length:** 1  
**Storage type:** Unsigned  
**Dimension:** 1  
**Unit:** /  
**Minimum Value:** 0  
**Maximum Value:** 20  
**Default Value:** 255  
**Quality flag:** /  
**Comment:** /  

**age_rms_c**

**Definition:** RMS of the C band AGC  
**Element type:** Integer  
**Byte length:** 2  
**Storage type:** Unsigned  
**Dimension:** 1  
**Unit:** $10^{-2}$ dB  
**Minimum Value:** 0  
**Maximum Value:** 250  
**Default Value:** 65 535  
**Quality flag:** /  
**Comment:** Compression of C band high rate elements is preceded by a detection of outliers. Only valid high-rate values are used to compute this element.

**age_rms_ku**

**Definition:** RMS of the Ku band AGC  
**Element type:** Integer  
**Byte length:** 2  
**Storage type:** Unsigned  
**Dimension:** 1  
**Unit:** $10^{-2}$ dB  
**Minimum Value:** 0  
**Maximum Value:** 250  
**Default Value:** 65 535  
**Quality flag:** /  
**Comment:** Compression of Ku band high rate elements is preceded by a detection of outliers. Only valid high-rate values are used to compute this element.

**altitude**

**Definition:** 1 Hz altitude of satellite with respect to reference altitude  
**Element type:** Integer  
**Byte length:** 4  
**Storage type:** Unsigned  
**Dimension:** 1  
**Unit:** $10^{4}$ m  
**Minimum Value:** 300 000 000  
**Maximum Value:** 700 000 000  
**Default Value:** 4 294 967 295  
**Quality flag:** orb_state_flag  
**Comment:** A reference offset is subtracted from the 1Hz altitudes and ranges. The reference offset can be found in the header part
alt_echo_type

Definition: alimeter echo type (0 = ocean-like, 1 = non ocean-like)
Element type: Bitfield
Byte length: 1
Storage type: Unsigned
Dimension: 1
Unit: /
Minimum Value: 0
Maximum Value: 1
Default Value: 255
Quality flag: /
Comment: This element is determined by testing the rms of the high rate range measurements against a threshold as well as the number of valid high rate range measurements against a minimum value.

alt_hi_rate

Definition: Differences between the altitudes corresponding to the 20 Hz measurements with the altitude corresponding to the 1Hz measurement (altitude)
Element type: Integer
Byte length: 4
Storage type: Signed
Dimension: 20
Unit: 10^4 m
Minimum Value: -80 000
Maximum Value: 80 000
Default Value: 2 147 483 6472 147 483 647
Quality flag: /
Comment: These values are required to derive 20 Hz sea surface heights from the 20 Hz range measurements.

alt_state_flag

Definition: alimeter state flag
Element type: Bitfield
Byte length: 1
Storage type: Unsigned
Dimension: 1
Unit: /
Minimum Value: /
Maximum Value: /
Default Value: 255
Quality flag: /
Comment: this field is defined by:

<table>
<thead>
<tr>
<th>Bits</th>
<th>Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Spare</td>
</tr>
<tr>
<td>1</td>
<td>Alimeter operating (0 = side A (nominal POSEIDON-2 altimeter), 1 = side B (redundancy))</td>
</tr>
<tr>
<td>2</td>
<td>Reception bandwidth inversion (0 = Not reversed, 1 = reversed)</td>
</tr>
<tr>
<td>3</td>
<td>Spectrum coding (0 = I and Q, 1 = I^2 + Q^2)</td>
</tr>
<tr>
<td>4</td>
<td>C bandwidth (0 = 320 MHz; 1 = 100 MHz)</td>
</tr>
<tr>
<td>5</td>
<td>Ku/C band sequencing (0 = 3Ku-1C-3Ku, 1 = 2Ku-1C-2Ku)</td>
</tr>
<tr>
<td>6</td>
<td>Ku band status (0 = on, 1 = off)</td>
</tr>
<tr>
<td>7</td>
<td>C band status (0 = on, 1 = off)</td>
</tr>
</tbody>
</table>
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**atmos_sig0_corr_c**  
**Definition:** atmospheric attenuation correction on C band backscatter coefficient  
**Element type:** Integer  
**Byte length:** 2  
**Storage type:** Signed  
**Dimension:** 1  
**Unit:** $10^{-2}$ dB  
**Minimum Value:** 0  
**Maximum Value:** 50  
**Default Value:** 32 767  
**Quality flag:** /  
**Comment:** This value is added to the backscatter coefficient derived from the Automatic Gain Control data (agc_c) to produce sig0_C.

**atmos_sig0_corr_ku**  
**Definition:** atmospheric attenuation correction on Ku band backscatter coefficient  
**Element type:** Integer  
**Byte length:** 2  
**Storage type:** Signed  
**Dimension:** 1  
**Unit:** $10^{-2}$ dB  
**Minimum Value:** 0  
**Maximum Value:** 50  
**Default Value:** 32 767  
**Quality flag:** /  
**Comment:** This value is added to the backscatter coefficient derived from the Automatic Gain Control data (agc_ku) to produce sig0_ku.

**bathymetry**  
**Definition:** ocean depth/land elevation  
**Element type:** Integer  
**Byte length:** 2  
**Storage type:** Signed  
**Dimension:** 1  
**Unit:** m  
**Minimum Value:** -10 000  
**Maximum Value:** 10 000  
**Default Value:** 32 767  
**Quality flag:** /  
**Comment:** This element is computed from DTM2000.1 database.
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ecmwf_meteo_map_avail

Definition: ECMWF meteorological map availability
Element type: Bitfield
Byte length: 1
Storage type: Unsigned
Dimension: 1
Unit: /
Minimum Value: 0
Maximum Value: 255
Default Value: 0
Quality flag: /
Comment: It is defined on one byte. Possible values are:
0 meaning "2 maps, nominal" (six hours apart)
1 meaning "2 maps, degraded" (more than six hours apart)
2 meaning "1 map, extrapolation used"
3 meaning "no map"

Given the latest definition of the meteorological field processing algorithms, this flag will always be set to 0.

flag_spare

Definition: spare (to be aligned)
Element type: Bitfield
Byte length: 1
Storage type: Unsigned
Dimension: 3
Unit: /
Minimum Value: 255
Maximum Value: 255
Default Value: 255
Quality flag: /
Comment: /

geo_spare

Definition: spare (to be aligned)
Element type: Bitfield
Byte length: 1
Storage type: Unsigned
Dimension: 2
Unit: /
Minimum Value: 255
Maximum Value: 255
Default Value: 255
Quality flag: /
Comment: /
### geoid

<table>
<thead>
<tr>
<th>Definition</th>
<th>geoid height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Element type</td>
<td>Integer</td>
</tr>
<tr>
<td>Byte length</td>
<td>4</td>
</tr>
<tr>
<td>Storage type</td>
<td>Signed</td>
</tr>
<tr>
<td>Dimension</td>
<td>1</td>
</tr>
<tr>
<td>Unit</td>
<td>$10^4$ m</td>
</tr>
<tr>
<td>Minimum Value</td>
<td>-1 500 000</td>
</tr>
<tr>
<td>Maximum Value</td>
<td>1 500 000</td>
</tr>
<tr>
<td>Default Value</td>
<td>2 147 483 647</td>
</tr>
<tr>
<td>Quality flag</td>
<td>/</td>
</tr>
<tr>
<td>Comment</td>
<td>It is computed from the geoid model with a correction to refer the value to the mean tide system i.e. includes the permanent tide (zero frequency). [See section 5.3 for more details].</td>
</tr>
</tbody>
</table>

### hf_fluctuations_corr

<table>
<thead>
<tr>
<th>Definition</th>
<th>High frequency fluctuations of the sea surface topography</th>
</tr>
</thead>
<tbody>
<tr>
<td>Element type</td>
<td>Integer</td>
</tr>
<tr>
<td>Byte length</td>
<td>2</td>
</tr>
<tr>
<td>Storage type</td>
<td>Signed</td>
</tr>
<tr>
<td>Dimension</td>
<td>1</td>
</tr>
<tr>
<td>Unit</td>
<td>$10^4$ m</td>
</tr>
<tr>
<td>Minimum Value</td>
<td>-3 000</td>
</tr>
<tr>
<td>Maximum Value</td>
<td>3 000</td>
</tr>
<tr>
<td>Default Value</td>
<td>32 767</td>
</tr>
<tr>
<td>Quality flag</td>
<td>/</td>
</tr>
<tr>
<td>Comment</td>
<td>See section 5.9 for more details. It is provided as a correction to the inverse barometer correction (inv_bar_corr).</td>
</tr>
</tbody>
</table>

### ice_flag

<table>
<thead>
<tr>
<th>Definition</th>
<th>ice flag (0 : no ice, 1 : ice)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Element type</td>
<td>Bitfield</td>
</tr>
<tr>
<td>Byte length</td>
<td>1</td>
</tr>
<tr>
<td>Storage type</td>
<td>Unsigned</td>
</tr>
<tr>
<td>Dimension</td>
<td>1</td>
</tr>
<tr>
<td>Unit</td>
<td>/</td>
</tr>
<tr>
<td>Minimum Value</td>
<td>/</td>
</tr>
<tr>
<td>Maximum Value</td>
<td>/</td>
</tr>
<tr>
<td>Default Value</td>
<td>255</td>
</tr>
<tr>
<td>Quality flag</td>
<td>/</td>
</tr>
<tr>
<td>Comment</td>
<td>The ice flag is set if a climatological map predicts ice at the given location, and if the wind speed derived from the altimeter measurement is less than 1 m/s [See section 5.7 for more details].</td>
</tr>
</tbody>
</table>
**Chapter 8 - (I)GDR ELEMENTS**

**interp_flag**

**Definition:** interpolation flag

**Element type:** Bitfield

**Byte length:** 1

**Storage type:** Unsigned

**Dimension:** 1

**Unit:** /

**Minimum Value:** /

**Maximum Value:** /

**Default Value:** 255

**Quality flag:** /

**Comment:** this field is defined by:

<table>
<thead>
<tr>
<th>Bits</th>
<th>Indicator (0 = Good and 1 = Bad)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>MSS interpolation flag</td>
</tr>
<tr>
<td>1</td>
<td>ocean tide solution 1 interpolation flag (0=4 points over ocean, 1=less than 4 points)</td>
</tr>
<tr>
<td>2</td>
<td>ocean tide solution 2 interpolation flag (0=4 points over ocean, 1=less than 4 points)</td>
</tr>
<tr>
<td>3</td>
<td>Meteorological data interpolation flag (0=4 points over ocean, 1=less than 4 points)</td>
</tr>
<tr>
<td>4</td>
<td>Spare</td>
</tr>
<tr>
<td>5</td>
<td>Spare</td>
</tr>
<tr>
<td>6</td>
<td>Spare</td>
</tr>
<tr>
<td>7</td>
<td>Spare</td>
</tr>
</tbody>
</table>

**inv_bar_corr**

**Definition:** inverted barometer height correction

**Element type:** Integer

**Byte length:** 2

**Storage type:** Signed

**Dimension:** 1

**Unit:** $10^{-4}$ m

**Minimum Value:** -3 000

**Maximum Value:** 3 000

**Default Value:** 32 767

**Quality flag:** interp_flag (bit #3)

**Comment:** It is computed at the altimeter measurement epoch from the interpolation of 2 meteorological fields that surround the altimeter measurement epoch [See section 5.9 for more details].
iono_corr_alt_ku
Definition: alimeter ionospheric correction on ku band
Element type: Integer
Byte length: 2
Storage type: Signed
Dimension: 1
Unit: $10^4$ m
Minimum Value: -5 000
Maximum Value: 40
Default Value: 32 767
Quality flag: /
Comment: An ionospheric correction must be added (negative value) to the instrument range (range_ku) to correct this range measurement for ionospheric range delays of the radar pulse [See section 4.7 for more details].

iono_corr_doris_ku
Definition: Doris iono correction on ku band
Element type: Integer
Byte length: 2
Storage type: Signed
Dimension: 1
Unit: $10^4$ m
Minimum Value: -5 000
Maximum Value: 0
Default Value: 32 767
Quality flag: /
Comment: An ionospheric correction must be added (negative value) to the instrument range (range_ku) to correct this range measurement for ionospheric range delays of the radar pulse [See section 4.7 for more details].

latitude
Definition: latitude
Element type: Integer
Byte length: 4
Storage type: Signed
Dimension: 1
Unit: $\mu$deg
Minimum Value: -70 000 000
Maximum Value: 70 000 000
Default Value: 2 147 483 647
Quality flag: orb_state_flag
Comment: Positive latitude is North latitude, whereas negative latitude is South latitude [See section 5.1 for more details].
load_tide_sol1

**Definition**: loading tide height for geocentric ocean tide solution 1

- **Element type**: Integer
- **Byte length**: 2
- **Storage type**: Signed
- **Dimension**: 1
- **Unit**: $10^4$ m
- **Minimum Value**: -2 000
- **Maximum Value**: 2 000
- **Default Value**: 32 767
- **Quality flag**: /
- **Comment**: This value has already been added to the corresponding ocean tide height value recorded in the product (ocean_tide_sol1) [See section 5.8 for more details].

load_tide_sol2

**Definition**: loading tide height for geocentric ocean tide solution 2

- **Element type**: Integer
- **Byte length**: 2
- **Storage type**: Signed
- **Dimension**: 1
- **Unit**: $10^4$ m
- **Minimum Value**: -2 000
- **Maximum Value**: 2 000
- **Default Value**: 32 767
- **Quality flag**: /
- **Comment**: This value has already been added to the corresponding ocean tide height value recorded in the product (ocean_tide_sol2) [See section 5.8 for more details].

longitude

**Definition**: longitude

- **Element type**: Integer
- **Byte length**: 4
- **Storage type**: Unsigned
- **Dimension**: 1
- **Unit**: $\mu$deg
- **Minimum Value**: 0
- **Maximum Value**: 359 999 999
- **Default Value**: 4 294 967 295
- **Quality flag**: orb_state_flag
- **Comment**: The longitude corresponds to the East longitude relative to Greenwich meridian [See section 5.1 for more details].

mdt

**Definition**: mean dynamic topography

- **Element type**: Integer
- **Byte length**: 2
- **Storage type**: Signed
- **Dimension**: 1
- **Unit**: $10^4$ m
- **Minimum Value**: -20 000
- **Maximum Value**: 20 000
- **Default Value**: 32 767
- **Quality flag**: /
- **Comment**: This value is computed from the mean dynamic topography model; [See section 1.4.7 for more details].
model_dry_tropo_corr
Definition: model dry tropospheric correction
Element type: Integer
Byte length: 2
Storage type: Signed
Dimension: 1
Unit: $10^4$ m
Minimum Value: -25 000
Maximum Value: -22 000
Default Value: 32 767
Quality flag: interp_flag (bit #3)
Comment: It is computed at the altimeter measurement epoch from the interpolation of 2 meteorological fields that surround the altimeter measurement epoch. A dry tropospheric correction must be added (negative value) to the instrument range to correct this range measurement for dry tropospheric range delays of the radar pulse [See section 5.5.1 for more details].

model_wet_tropo_corr
Definition: model wet tropospheric correction
Element type: Integer
Byte length: 2
Storage type: Signed
Dimension: 1
Unit: $10^4$ m
Minimum Value: -5 000
Maximum Value: 0
Default Value: 32 767
Quality flag: interp_flag (bit #3)
Comment: It is computed at the altimeter measurement epoch from the interpolation of 2 meteorological fields that surround the altimeter measurement epoch. A wet tropospheric correction must be added (negative value) to the instrument range to correct this range measurement for wet tropospheric range delays of the radar pulse [See section 5.5.1 for more details].

mss
Definition: mean sea surface height
Element type: Integer
Byte length: 4
Storage type: Signed
Dimension: 1
Unit: $10^4$ m
Minimum Value: -1 500 000
Maximum Value: 1 500 000
Default Value: 2 147 483 647
Quality flag: interp_flag (bit #0)
Comment: This value is computed from the mean sea surface model; [See section 5.4 for more details].
**mss_tp_along_trk**

- **Definition:** TP along-track mean sea surface
- **Element type:** Integer
- **Byte length:** 4
- **Storage type:** Signed
- **Dimension:** 1
- **Unit:** $10^4$ m
- **Minimum Value:** -1 500 000
- **Maximum Value:** 1 500 000
- **Default Value:** 2 147 483 647
- **Quality flag:** /
- **Comment:** This value is computed from a mean sea surface model that has been specifically derived along the TOPEX/POSEIDON ground track using only T/P data [See section 5.4 for more details]

**net_instr_corr_c**

- **Definition:** net instrumental correction on C band range
- **Element type:** Integer
- **Byte length:** 4
- **Storage type:** Signed
- **Dimension:** 1
- **Unit:** $10^4$ m
- **Minimum Value:** -120 000
- **Maximum Value:** 120 000
- **Default Value:** 2 147 483 647
- **Quality flag:** qual_1hz_alt_instr_corr (bit #1)
- **Comment:** This value has already been added to the 1 Hz C band range recorded in the product (range_c)

**net_instr_corr_ku**

- **Definition:** net instrumental correction on Ku band range
- **Element type:** Integer
- **Byte length:** 4
- **Storage type:** Signed
- **Dimension:** 1
- **Unit:** $10^4$ m
- **Minimum Value:** -120 000
- **Maximum Value:** 120 000
- **Default Value:** 2 147 483 647
- **Quality flag:** qual_1hz_alt_instr_corr (bit #0)
- **Comment:** This value has already been added to the 1 Hz Ku band range recorded in the product (range_ku)
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**net_instr_corr_swh_c**
- **Definition:** net instrumental correction on C band significant waveheight
- **Element type:** Integer
- **Byte length:** 2
- **Storage type:** Signed
- **Dimension:** 1
- **Unit:** \(10^3\) m
- **Minimum Value:** -1 000
- **Maximum Value:** 1 000
- **Default Value:** 32 767
- **Quality flag:** `qual_1hz_alt_instr_corr` (bit #3)
- **Comment:** This value has already been added to the 1 Hz C band SWH recorded in the product (swh_c)

**net_instr_corr_swh_ku**
- **Definition:** net instrumental correction on Ku band significant waveheight
- **Element type:** Integer
- **Byte length:** 2
- **Storage type:** Signed
- **Dimension:** 1
- **Unit:** \(10^3\) m
- **Minimum Value:** -1 000
- **Maximum Value:** 1 000
- **Default Value:** 32 767
- **Quality flag:** `qual_1hz_alt_instr_corr` (bit #2)
- **Comment:** This value has already been added to the 1 Hz Ku band SWH recorded in the product (swh_ku)

**net_instr_sig0_corr_c**
- **Definition:** net instrumental correction on C band backscatter coefficient
- **Element type:** Integer
- **Byte length:** 2
- **Storage type:** Signed
- **Dimension:** 1
- **Unit:** \(10^2\) dB
- **Minimum Value:** -1 000
- **Maximum Value:** 1 000
- **Default Value:** 32 767
- **Quality flag:** `qual_1hz_alt_instr_corr` (bit #5)
- **Comment:** This value has already been added to the 1 Hz C band backscatter coefficient (sig0_c). The AGC (age_c) recorded in the product has also been corrected for this instrumental correction.
net_instr_sig0_corr_ku

Definition: net instrumental correction on Ku band backscatter coefficient
Element type: Integer
Byte length: 2
Storage type: Signed
Dimension: 1
Unit: 10^2 dB
Minimum Value: -1 000
Maximum Value: 1 000
Default Value: 32 767
Quality flag: qual_1hz_alt_instr_Corr (bit #4)
Comment: This value has already been added to the 1 Hz Ku band backscatter coefficient (sig0_ku). The AGC (age_ku) recorded in the product has also been corrected for this instrumental correction.

ocean_tide_eq_lp

Definition: equilibrium long-period ocean tide height
Element type: Integer
Byte length: 2
Storage type: Signed
Dimension: 1
Unit: 10^4 m
Minimum Value: -2 000
Maximum Value: 2 000
Default Value: 32 767
Quality flag: /
Comment: This value has already been added to the two geocentric ocean tide height values recorded in the product (ocean_tide_sol1 and ocean_tide_sol2). The permanent tide (zero frequency) is not included in this parameter because it is included in the geoid and mean sea surface (geoid, mss) [See section 5.8 for more details].

ocean_tide_neq_lp

Definition: non-equilibrium long-period ocean tide height
Element type: Integer
Byte length: 2
Storage type: Signed
Dimension: 1
Unit: 10^4 m
Minimum Value: -2 000
Maximum Value: 2 000
Default Value: 32 767
Quality flag: /
Comment: This parameter is computed as a correction to the parameter ocean_tide_eq_lp. This value can be added to ocean_tide_eq_lp (or ocean_tide_sol1, ocean_tide_sol2) so that the resulting value models the total non equilibrium ocean tide height. [See section 5.8 for more details].
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ocean_tide_sol1
Definition:  geocentric ocean tide height (solution 1)
Element type:  Integer
Byte length:  4
Storage type:  Signed
Dimension:  1
Unit:  $10^4$ m
Minimum Value:  -50 000
Maximum Value:  50 000
Default Value:  2 147 483 647
Quality flag:  interp_flag (bit #1)
Comment:  This value includes the corresponding loading tide (load_tide_sol1) and equilibrium long-period ocean tide height (ocean_tide_eq_lp). The permanent tide (zero frequency) is not included in this parameter because it is included in the geoid and mean sea surface (geoid, mss) [See section 5.8 for more details]

ocean_tide_sol2
Definition:  geocentric ocean tide height (solution 2)
Element type:  Integer
Byte length:  4
Storage type:  Signed
Dimension:  1
Unit:  $10^4$ m
Minimum Value:  -50 000
Maximum Value:  50 000
Default Value:  2 147 483 647
Quality flag:  interp_flag (bit #2)
Comment:  This value includes the corresponding loading tide (load_tide_sol2) and equilibrium long-period ocean tide height (ocean_tide_eq_lp). The permanent tide (zero frequency) is not included in this parameter because it is included in the geoid and mean sea surface (geoid, mss) [See section 5.8 for more details]

off_nadir_angle_ku_wvf
Definition:  square of the off nadir angle computed from Ku waveforms
Element type:  Integer
Byte length:  2
Storage type:  Signed
Dimension:  1
Unit:  $10^4$ deg²
Minimum Value:  0
Maximum Value:  900
Default Value:  32 767
Quality flag:  qual_1hz_alt_data (bit #6)
Comment:  /
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off_nadir_angle_ptf
Definition: square of the off nadir angle computed from platform data
Element type: Integer
Byte length: 2
Storage type: Signed
Dimension: 1
Unit: $10^4$ deg$^2$
Minimum Value: 0
Maximum Value: 900
Default Value: 32 767
Quality flag: qual_1hz_alt_data (bit #7)
Comment: /

orb_alt_rate
Definition: orbital altitude rate
Element type: Integer
Byte length: 2
Storage type: Signed
Dimension: 1
Unit: cm/s
Minimum Value: -1 500
Maximum Value: 1 500
Default Value: 32 767
Quality flag: /
Comment: The reference surface for the orbital altitude rate is the combined MSS/geoid surface CLS01/EGM96. It is used to compute the Doppler correction which is included in the net_instr_corr_ku and net_instr_corr_c parameters.

orb_spare
Definition: spare (to be aligned)
Element type: Integer
Byte length: 1
Storage type: Unsigned
Dimension: 2
Unit: /
Minimum Value: 255
Maximum Value: 255
Default Value: 255
Quality flag: /
Comment: /
orb_state_flag

Definition :          orbit state flag
Element type :        Integer
Byte length :          1
Storage type :        Unsigned
Dimension :           1
Unit :                /
Minimum Value :        0
Maximum Value :        9
Default Value :       255
Quality flag :        /
Comment :             This flag is defined on one byte.
                      It may range from 0 to 9 with the following meaning:
                      0 characterizes a mission operations orbit that is computed during a maneuver period
                      1 stands for an adjusted mission operations orbit
                      2 stands for an extrapolated mission operations orbit
                      3 stands for an adjusted (preliminary/precise) orbit
                      4 indicates that the (preliminary/precise) orbit is estimated during a maneuver period
                      5 indicates that the (preliminary/precise) orbit is interpolated over a tracking data gap
                      6 means that the (preliminary/precise) orbit is extrapolated for a duration less than 1 day
                      7 means that the (preliminary/precise) orbit is extrapolated for a duration that ranges from 1 day to 2 days
                      8 means that the (preliminary/precise) orbit is extrapolated for a duration larger than 2 days, or that the orbit is extrapolated just after a maneuver
                      9 stands for the DORIS DIODE navigator orbit
                      The nominal value is 3.

pole_tide

Definition :          geocentric pole tide height
Element type :        Integer
Byte length :          2
Storage type :        Signed
Dimension :           1
Unit :                10⁻⁴ m
Minimum Value :       -1000
Maximum Value :       1000
Default Value :       32 767
Quality flag :        /
Comment :             [See section 5.8 for more details]
pseudo_datation_bias_corr_ku

Definition: apparent altimeter datation bias.
Element type: Integer
Byte length: 2
Storage type: Signed
Dimension: 1
Unit: 10^4 m
Minimum Value: -10 000
Maximum Value: 10 000
Default Value: 32 767
Quality flag: /
Comment: This correction accounts for apparent altimeter datation bias as illustrated by M. Ablain et al during the 2006 and 2007 OSTST meetings. An apparent altimeter datation bias of 400 microseconds has been estimated. This results with a North/South bias related to Doppler velocity. This correction, pseudo_datation_bias_corr_ku, should be added to the Ku-band altimeter range (see section 4.3). This correction is not a component of the net instrumental correction on Ku band range, net_instr_corr_ku.

qual_1hz_alt_data

Definition: quality flag for 1 Hz altimeter data
Element type: Bitfield
Byte length: 1
Storage type: Unsigned
Dimension: 1
Unit: /
Minimum Value: /
Maximum Value: /
Default Value: 255
Quality flag: /
Comment: this field is defined by:

<table>
<thead>
<tr>
<th>Bits</th>
<th>Indicator (0 = Good and 1 = Bad)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Ku band range</td>
</tr>
<tr>
<td>1</td>
<td>C band range</td>
</tr>
<tr>
<td>2</td>
<td>Ku band SWH</td>
</tr>
<tr>
<td>3</td>
<td>C band SWH</td>
</tr>
<tr>
<td>4</td>
<td>Ku band backscatter coefficient</td>
</tr>
<tr>
<td>5</td>
<td>C band backscatter coefficient</td>
</tr>
<tr>
<td>6</td>
<td>off nadir angle from Ku band waveform parameters</td>
</tr>
<tr>
<td>7</td>
<td>off nadir angle from platform</td>
</tr>
</tbody>
</table>

qual_1hz_alt_instr_corr

Definition: quality flag for 1 Hz altimeter instrumental corrections
Element type: Bitfield
Byte length: 1
Storage type: Unsigned
Dimension: 1
Unit: /
Minimum Value: /
Maximum Value: /
Default Value: 255
Quality flag: /
Comment : this field is defined by :

<table>
<thead>
<tr>
<th>Bits</th>
<th>Indicator (0 = Good and 1 = Bad)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Ku band range instrumental correction</td>
</tr>
<tr>
<td>1</td>
<td>C band range instrumental correction</td>
</tr>
<tr>
<td>2</td>
<td>Ku band SWH instrumental correction</td>
</tr>
<tr>
<td>3</td>
<td>C band SWH instrumental correction</td>
</tr>
<tr>
<td>4</td>
<td>Ku band backscatter coefficient instrumental correction</td>
</tr>
<tr>
<td>5</td>
<td>C band backscatter coefficient instrumental correction</td>
</tr>
<tr>
<td>6</td>
<td>Spare</td>
</tr>
<tr>
<td>7</td>
<td>Spare</td>
</tr>
</tbody>
</table>
qual_1hz_rad_data

Definition: quality flag for 1 Hz radiometer data
Element type: Bitfield
Byte length: 1
Storage type: Unsigned
Dimension: /
Unit: /
Minimum Value: /
Maximum Value: /
Default Value: 255
Quality flag: /
Comment: this field is defined by:

<table>
<thead>
<tr>
<th>Bits</th>
<th>Indicator (0 = Good and 1 = Bad)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>18.7 Ghz brightness temperature</td>
</tr>
<tr>
<td>1</td>
<td>23.8 Ghz brightness temperature</td>
</tr>
<tr>
<td>2</td>
<td>34 Ghz brightness temperature</td>
</tr>
<tr>
<td>3</td>
<td>Spare</td>
</tr>
<tr>
<td>4</td>
<td>Spare</td>
</tr>
<tr>
<td>5</td>
<td>Spare</td>
</tr>
<tr>
<td>6</td>
<td>Spare</td>
</tr>
<tr>
<td>7</td>
<td>Spare</td>
</tr>
</tbody>
</table>

qual_spare

Definition: spare (to be aligned)
Element type: Bitfield
Byte length: 1
Storage type: Unsigned
Dimension: 3
Unit: /
Minimum Value: 255
Maximum Value: 255
Default Value: 255
Quality flag: /
Comment: /

rad_liquid_water

Definition: radiometer liquid water
Element type: Integer
Byte length: 2
Storage type: Signed
Dimension: 1
Unit: $10^2$g/cm$^2$
Minimum Value: 0
Maximum Value: 200
Default Value: 32 767
Quality flag: qual_1hz_rad_data and tb_interp_flag
Comment: This element should not be used over land.
rad_state_flag
Definition: radiometer state flag
Element type: Bitfield
Byte length: 1
Storage type: Unsigned
Dimension: 1
Unit: /
Minimum Value: /
Maximum Value: /
Default Value: 255
Quality flag: /
Comment: This flag is defined as follows:
Bit 0 indicates Mode (0 = Mode 2 (nominal), 1 = Mode 1)
Bit 1 indicates Mode 1 Cal Sequence
(0 = Normal data taking in Mode 1 or Mode 2, 1 = Mode 1 Cal Sequence)
Bits 2 and 3 indicate active 23.8 GHz channel
Bit 2 = Channel 2 (0 = On, 1 = Off)
Bit 3 = Channel 3 (0 = On, 1 = Off)
Bits 4 to 7 are set to 0.
If Bit_2 = Bit_3 = 0, then the 23.8 GHz brightness temperature that is provided and used in the geophysical processing is taken from the nominal channel (Channel 3).
Be aware that if the radiometer is not functioning, this flag will be set to 0. User should test the qual_1hz_rad_data flag which will be set to “bad” in such a case.

rad_surf_type
Definition: radiometer surface type (0 = ocean, 1 = land)
Element type: Bitfield
Byte length: 1
Storage type: Unsigned
Dimension: 1
Unit: /
Minimum Value: 0
Maximum Value: 1
Default Value: 1
Quality flag: /
Comment: The radiometer surface type can be set to land (=1) over ocean when the JMR data are not present. The radiometer surface type is then not estimated and set to its default value (=1)

rad_water_vapor
Definition: radiometer water vapour content
Element type: Integer
Byte length: 2
Storage type: Signed
Dimension: 1
Unit: \(10^3\) g/cm²
Minimum Value: 0
Maximum Value: 700
Default Value: 32 767
Quality flag: qual_1hz_rad_data and tb_interp_flag
Comment: This element should not be used over land.
rad_wet_tropo_corr
Definition: radiometer wet tropospheric correction
Element type: Integer
Byte length: 2
Storage type: Signed
Dimension: 1
Unit: $10^4$ m
Minimum Value: -5 000
Maximum Value: 0
Default Value: 32 767
Quality flag: qual_1hz_rad_data and tb_interp_flag
Comment: A wet tropospheric correction must be added (negative value) to the instrument range to correct this range measurement for wet tropospheric range delays of the radar pulse.

rain_flag
Definition: rain flag (0: OK, 1: rain)
Element type: Bitfield
Byte length: 1
Storage type: Unsigned
Dimension: 1
Unit: /
Minimum Value: /
Maximum Value: /
Default Value: 255
Quality flag: /
Comment: [See section 5.6 for more details].

range_c
Definition: 1 Hz C band range with respect to the reference altitude
Element type: Integer
Byte length: 4
Storage type: Unsigned
Dimension: 1
Unit: $10^4$ m
Minimum Value: 300 000 000
Maximum Value: 700 000 000
Default Value: 4 294 967 295
Quality flag: qual_1hz_alt_data (bit #1)
Comment: The reference altitude found in the header should be added to range_c to provide the actual C band range of the satellite. This value has already been corrected for instrument effects using net_instr_corr_c
**range_hi_rate_c**

<table>
<thead>
<tr>
<th>Definition</th>
<th>20 Hz C band range with respect to the reference altitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Element type :</td>
<td>Integer</td>
</tr>
<tr>
<td>Byte length :</td>
<td>4</td>
</tr>
<tr>
<td>Storage type :</td>
<td>Signed</td>
</tr>
<tr>
<td>Dimension :</td>
<td>20</td>
</tr>
<tr>
<td>Unit :</td>
<td>$10^4 \text{m}$</td>
</tr>
<tr>
<td>Minimum Value :</td>
<td>-150 000</td>
</tr>
<tr>
<td>Maximum Value :</td>
<td>150 000</td>
</tr>
<tr>
<td>Default Value :</td>
<td>2 147 483 647</td>
</tr>
<tr>
<td>Quality flag :</td>
<td>/</td>
</tr>
<tr>
<td>Comment :</td>
<td>The reference altitude found in the header should be added to range_hi_rate_c to provide the actual 20Hz C band range of the satellite. This value has already been corrected for instrument effects using net_instr_corr_c</td>
</tr>
</tbody>
</table>

**range_hi_rate_ku**

<table>
<thead>
<tr>
<th>Definition</th>
<th>20 Hz Ku band range with respect to the reference altitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Element type :</td>
<td>Integer</td>
</tr>
<tr>
<td>Byte length :</td>
<td>4</td>
</tr>
<tr>
<td>Storage type :</td>
<td>Signed</td>
</tr>
<tr>
<td>Dimension :</td>
<td>20</td>
</tr>
<tr>
<td>Unit :</td>
<td>$10^4 \text{m}$</td>
</tr>
<tr>
<td>Minimum Value :</td>
<td>-150 000</td>
</tr>
<tr>
<td>Maximum Value :</td>
<td>150 000</td>
</tr>
<tr>
<td>Default Value :</td>
<td>2 147 483 647</td>
</tr>
<tr>
<td>Quality flag :</td>
<td>/</td>
</tr>
<tr>
<td>Comment :</td>
<td>The reference altitude found in the header should be added to range_hi_rate_ku to provide the actual 20Hz Ku band range of the satellite. This value has already been corrected for instrument effects using net_instr_corr_ku</td>
</tr>
</tbody>
</table>

**range_ku**

<table>
<thead>
<tr>
<th>Definition</th>
<th>1 Hz Ku band range with respect to the reference altitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Element type :</td>
<td>Integer</td>
</tr>
<tr>
<td>Byte length :</td>
<td>4</td>
</tr>
<tr>
<td>Storage type :</td>
<td>Unsigned</td>
</tr>
<tr>
<td>Dimension :</td>
<td>1</td>
</tr>
<tr>
<td>Unit :</td>
<td>$10^4 \text{m}$</td>
</tr>
<tr>
<td>Minimum Value :</td>
<td>300 000 000</td>
</tr>
<tr>
<td>Maximum Value :</td>
<td>700 000 000</td>
</tr>
<tr>
<td>Default Value :</td>
<td>4 294 967 295</td>
</tr>
<tr>
<td>Quality flag :</td>
<td>qual_1hz_alt_data (bit #0)</td>
</tr>
<tr>
<td>Comment :</td>
<td>The reference altitude found in the header should be added to range_ku to provide the actual Ku band range of the satellite. This value already has already been corrected for instrument effects using net_instr_corr_ku</td>
</tr>
</tbody>
</table>
### range_mapvalpts_c

<table>
<thead>
<tr>
<th><strong>Definition</strong></th>
<th>map of valid points used to compute C band range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Element type</strong></td>
<td>Bitfield</td>
</tr>
<tr>
<td><strong>Byte length</strong></td>
<td>4</td>
</tr>
<tr>
<td><strong>Storage type</strong></td>
<td>Unsigned</td>
</tr>
<tr>
<td><strong>Dimension</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Unit</strong></td>
<td>/</td>
</tr>
<tr>
<td><strong>Minimum Value</strong></td>
<td>/</td>
</tr>
<tr>
<td><strong>Maximum Value</strong></td>
<td>/</td>
</tr>
<tr>
<td><strong>Default Value</strong></td>
<td>4 294 967 295</td>
</tr>
<tr>
<td><strong>Quality flag</strong></td>
<td>/</td>
</tr>
<tr>
<td><strong>Comment</strong></td>
<td>/</td>
</tr>
</tbody>
</table>

### range_mapvalpts_ku

<table>
<thead>
<tr>
<th><strong>Definition</strong></th>
<th>map of valid points used to compute Ku band range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Element type</strong></td>
<td>Bitfield</td>
</tr>
<tr>
<td><strong>Byte length</strong></td>
<td>4</td>
</tr>
<tr>
<td><strong>Storage type</strong></td>
<td>Unsigned</td>
</tr>
<tr>
<td><strong>Dimension</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Unit</strong></td>
<td>/</td>
</tr>
<tr>
<td><strong>Minimum Value</strong></td>
<td>/</td>
</tr>
<tr>
<td><strong>Maximum Value</strong></td>
<td>/</td>
</tr>
<tr>
<td><strong>Default Value</strong></td>
<td>4 294 967 295</td>
</tr>
<tr>
<td><strong>Quality flag</strong></td>
<td>/</td>
</tr>
<tr>
<td><strong>Comment</strong></td>
<td>Bits 0 to 19 correspond to the first to last 20 Hz measurements 1 = bad, 0 = good</td>
</tr>
</tbody>
</table>

### range_numval_c

<table>
<thead>
<tr>
<th><strong>Definition</strong></th>
<th>number of valid points for C band range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Element type</strong></td>
<td>Integer</td>
</tr>
<tr>
<td><strong>Byte length</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Storage type</strong></td>
<td>Unsigned</td>
</tr>
<tr>
<td><strong>Dimension</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Unit</strong></td>
<td>/</td>
</tr>
<tr>
<td><strong>Minimum Value</strong></td>
<td>0</td>
</tr>
<tr>
<td><strong>Maximum Value</strong></td>
<td>20</td>
</tr>
<tr>
<td><strong>Default Value</strong></td>
<td>255</td>
</tr>
<tr>
<td><strong>Quality flag</strong></td>
<td>/</td>
</tr>
<tr>
<td><strong>Comment</strong></td>
<td>Bits 0 to 19 correspond to the first to last 20 Hz measurements 1 = bad, 0 = good</td>
</tr>
</tbody>
</table>

### range_numval_ku

<table>
<thead>
<tr>
<th><strong>Definition</strong></th>
<th>number of valid points for Ku band range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Element type</strong></td>
<td>Integer</td>
</tr>
<tr>
<td><strong>Byte length</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Storage type</strong></td>
<td>Unsigned</td>
</tr>
<tr>
<td><strong>Dimension</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Unit</strong></td>
<td>/</td>
</tr>
<tr>
<td><strong>Minimum Value</strong></td>
<td>0</td>
</tr>
<tr>
<td><strong>Maximum Value</strong></td>
<td>20</td>
</tr>
<tr>
<td><strong>Default Value</strong></td>
<td>255</td>
</tr>
<tr>
<td><strong>Quality flag</strong></td>
<td>/</td>
</tr>
<tr>
<td><strong>Comment</strong></td>
<td>/</td>
</tr>
</tbody>
</table>
range_rms_c
Definition: RMS of the C band range
Element type: Integer
Byte length: 2
Storage type: Unsigned
Dimension: 1
Unit: $10^4$ m
Minimum Value: 0
Maximum Value: 3 000
Default Value: 65 535
Quality flag: /
Comment: Compression of C band high rate elements is preceded by a detection of outliers. Only valid high-rate values are used to compute this element.

range_rms_ku
Definition: RMS of the Ku band range
Element type: Integer
Byte length: 2
Storage type: Unsigned
Dimension: 1
Unit: $10^4$ m
Minimum Value: 0
Maximum Value: 2 000
Default Value: 65 535
Quality flag: /
Comment: Compression of Ku band high rate elements is preceded by a detection of outliers. Only valid high-rate values are used to compute this element.

range_spare
Definition: spare (to be aligned)
Element type: Integer
Byte length: 1
Storage type: Unsigned
Dimension: 2
Unit: /
Minimum Value: 255
Maximum Value: 255
Default Value: 255
Quality flag: /
Comment: /

sea_state_bias_c
Definition: sea state bias correction in C-band
Element type: Integer
Byte length: 2
Storage type: Signed
Dimension: 1
Unit: $10^4$ m
Minimum Value: -6 000
Maximum Value: 0
Default Value: 32 767
Quality flag: /
Comment: A sea state bias correction must be added (negative value) to the instrument range (range_c) to correct this range measurement for sea state delays of the radar pulse [see section 5.5.3]. This element should not be used over land.
sea_state_bias_comp
Definition: composite sea state bias correction
Element type: Integer
Byte length: 2
Storage type: Signed
Dimension: 1
Unit: $10^4$ m
Minimum Value: -6 000
Maximum Value: 0
Default Value: 32 767
Quality flag: /
Comment: A sea state bias correction must be added (negative value) to the instrument range (combination of range_c and range_ku [see section 5.5.3]) to correct this range measurement for sea state delays of the radar pulse. This element should not be used over land.

sea_state_bias_ku
Definition: sea state bias correction in Ku-band
Element type: Integer
Byte length: 2
Storage type: Signed
Dimension: 1
Unit: $10^4$ m
Minimum Value: -6 000
Maximum Value: 0
Default Value: 32 767
Quality flag: /
Comment: A sea state bias correction must be added (negative value) to the instrument range (range_ku) to correct this range measurement for sea state delays of the radar pulse [see section 5.5.3]. This element should not be used over land.

sig0_c
Definition: C band backscatter coefficient
Element type: Integer
Byte length: 2
Storage type: Unsigned
Dimension: 1
Unit: $10^2$ dB
Minimum Value: 0
Maximum Value: 3 000
Default Value: 65 535
Quality flag: qual_1hz_alt_data (bit #5)
Comment: This value has already been corrected for atmospheric attenuations and instrumental effects using atmos_sig0_corr_c and net_instr_sig0_corr_c [See section 5.10 for more details].
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sig0_ku

Definition : Ku band backscatter coefficient
Element type : Integer
Byte length : 2
Storage type : Unsigned
Dimension : 1
Unit : 10^{-2} dB
Minimum Value : 0
Maximum Value : 3 000
Default Value : 65 535
Quality flag : qual_lhz_alt_data (bit #4)
Comment : This value has already been corrected for atmospheric attenuations and instrumental effects using atmos_sig0_corr_ku and net_instr_sig0_corr_ku [See section 5.10 for more details].

sig0_numval_c

Definition : number of valid points used to compute ku backscatter coefficient
Element type : Integer
Byte length : 1
Storage type : Unsigned
Dimension : 1
Unit : /
Minimum Value : 0
Maximum Value : 20
Default Value : 255
Quality flag : /
Comment : /

sig0_numval_ku

Definition : number of valid points used to compute C backscatter coefficient
Element type : Integer
Byte length : 1
Storage type : Unsigned
Dimension : 1
Unit : /
Minimum Value : 0
Maximum Value : 20
Default Value : 255
Quality flag : /
Comment : /

sig0_rms_c

Definition : RMS of the C band backscatter coefficient
Element type : Integer
Byte length : 2
Storage type : Unsigned
Dimension : 1
Unit : 10^{-2} dB
Minimum Value : 0
Maximum Value : 250
Default Value : 65 535
Quality flag : /
Comment : Compression of C band high rate elements is preceded by a detection of outliers. Only valid high-rate values are used to compute this element.
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sig0_rms_ku
Definition: RMS of the ku band backscatter coefficient
Element type: Integer
Byte length: 2
Storage type: Unsigned
Dimension: 1
Unit: $10^2$ dB
Minimum Value: 0
Maximum Value: 250
Default Value: 65 535
Quality flag: /
Comment: Compression of Ku band high rate elements is preceded by a detection of outliers. Only valid high-rate values are used to compute this element.

solid_earth_tide
Definition: solid earth tide height
Element type: Integer
Byte length: 2
Storage type: Signed
Dimension: 1
Unit: $10^4$ m
Minimum Value: -10 000
Maximum Value: 10 000
Default Value: 32 767
Quality flag: /
Comment: It is calculated using Cartwright and Tayler tables and consists of the second and third degree constituents. The permanent tide (zero frequency) is not included. [See section 5.8 for more details]

surface_type
Definition: surface type
Element type: Integer
Byte length: 1
Storage type: Unsigned
Dimension: 1
Unit: /
Minimum Value: 0
Maximum Value: 3
Default Value: 255
Quality flag: /
Comment: The values of this flag are: 0 = open oceans or semi-enclosed seas; 1 = enclosed seas or lakes; 2 = continental ice; 3 = land. It is computed using a DTM2000 file [see section 1.2.4 for more details].
**AVISO and PODAAC User Handbook**  
*IGDR and GDR Jason Products*  

**Chapter 8 - (I)GDR ELEMENTS**

### swh_c

- **Definition:** C band significant waveheight  
- **Element type:** Integer  
- **Byte length:** 2  
- **Storage type:** Unsigned  
- **Dimension:** 1  
- **Unit:** \(10^{-3}\) m  
- **Minimum Value:** 0  
- **Maximum Value:** 25 000  
- **Default Value:** 65 535  
- **Quality flag:** qual_hz_alt_data (bit #3)  
- **Comment:** This value has already been correct for instrumental effects using net_instr_corr_swh_c.

### swh_ku

- **Definition:** Ku band significant waveheight  
- **Element type:** Integer  
- **Byte length:** 2  
- **Storage type:** Unsigned  
- **Dimension:** 1  
- **Unit:** \(10^{-3}\) m  
- **Minimum Value:** 0  
- **Maximum Value:** 25 000  
- **Default Value:** 65 535  
- **Quality flag:** qual_hz_alt_data (bit #2)  
- **Comment:** This value has already been correct for instrumental effects using net_instr_corr_swh_ku.

### swh_numval_c

- **Definition:** number of valid points used to compute C significant waveheight  
- **Element type:** Integer  
- **Byte length:** 1  
- **Storage type:** Unsigned  
- **Dimension:** 1  
- **Unit:** /  
- **Minimum Value:** 0  
- **Maximum Value:** 20  
- **Default Value:** 255  
- **Quality flag:** /  
- **Comment:** /

### swh_numval_ku

- **Definition:** number of valid points used to compute Ku significant waveheight  
- **Element type:** Integer  
- **Byte length:** 1  
- **Storage type:** Unsigned  
- **Dimension:** 1  
- **Unit:** /  
- **Minimum Value:** 0  
- **Maximum Value:** 20  
- **Default Value:** 255  
- **Quality flag:** /  
- **Comment:** /
Chapter 8 - (I)GDR ELEMENTS

**swh_rms_c**
- **Definition:** RMS of the C band significant waveheight
- **Element type:** Integer
- **Byte length:** 2
- **Storage type:** Unsigned
- **Dimension:** 1
- **Unit:** $10^3$ m
- **Minimum Value:** 0
- **Maximum Value:** 2,500
- **Default Value:** 65,535
- **Quality flag:** /
- **Comment:** Compression of C band high rate elements is preceded by a detection of outliers. Only valid high-rate values are used to compute this element.

**swh_rms_ku**
- **Definition:** RMS of the Ku band significant waveheight
- **Element type:** Integer
- **Byte length:** 2
- **Storage type:** Unsigned
- **Dimension:** 1
- **Unit:** $10^3$ m
- **Minimum Value:** 0
- **Maximum Value:** 2,500
- **Default Value:** 65,535
- **Quality flag:** /
- **Comment:** Compression of Ku band high rate elements is preceded by a detection of outliers. Only valid high-rate values are used to compute this element.

**tb_187**
- **Definition:** 18.7 GHz brightness temperature
- **Element type:** Integer
- **Byte length:** 2
- **Storage type:** Unsigned
- **Dimension:** 1
- **Unit:** $10^2$ K
- **Minimum Value:** 11,000
- **Maximum Value:** 23,000
- **Default Value:** 65,535
- **Quality flag:** qual_1hz_rad_data (bit #0)
- **Comment:** Brightness temperatures are unsmoothed
### Chapter 8 - (I)GDR ELEMENTS

#### tb_238
- **Definition**: 23.8 Ghz brightness temperature
- **Element type**: Integer
- **Byte length**: 2
- **Storage type**: Unsigned
- **Dimension**: 1
- **Unit**: $10^{-2}$ K
- **Minimum Value**: 13 000
- **Maximum Value**: 25 000
- **Default Value**: 65 535
- **Quality flag**: qual_1hz_rad_data (bit #1)
- **Comment**: Brightness temperatures are unsmoothed

#### tb_340
- **Definition**: 34 GHz brightness temperature
- **Element type**: Integer
- **Byte length**: 2
- **Storage type**: Unsigned
- **Dimension**: 1
- **Unit**: $10^{-2}$ K
- **Minimum Value**: 15 000
- **Maximum Value**: 26 000
- **Default Value**: 65 535
- **Quality flag**: qual_1hz_rad_data (bit #2)
- **Comment**: Brightness temperatures are unsmoothed

#### tb_interp_flag
- **Definition**: radiometer brightness temperatures interpolation flag
- **Element type**: Integer
- **Byte length**: 1
- **Storage type**: Unsigned
- **Dimension**: 1
- **Unit**: /
- **Minimum Value**: 0
- **Maximum Value**: 3
- **Default Value**: 255
- **Quality flag**: /
- **Comment**: This flag is defined on one byte. Possible values are:
  - 0 = interpolation with no gap between JMR data
  - 1 = interpolation with gap between JMR data
  - 2 = extrapolation of JMR data
  - 3 = failure of extrapolation and interpolation
time_day
Definition: time stamp 1 (number of days from reference date)
Element type: Integer
Byte length: 4
Storage type: Unsigned
Dimension: 1
Unit: day
Minimum Value: /
Maximum Value: /
Default Value: 4 294 967 295
Quality flag: /
Comment: /

time_microsec
Definition: time stamp 3 (microseconds within seconds)
Element type: Integer
Byte length: 4
Storage type: Unsigned
Dimension: 1
Unit: µs
Minimum Value: 0
Maximum Value: 999 999
Default Value: 4 294 967 295
Quality flag: /
Comment: The complete one per second elapsed time (in seconds) can be obtained as follows:
Seconds since reference date = 86400 * time_day + time_sec + 10^-6 * time_microsec

time_sec
Definition: time stamp 2 (seconds within the day)
Element type: Integer
Byte length: 4
Storage type: Unsigned
Dimension: 1
Unit: s
Minimum Value: 0
Maximum Value: 86 400
Default Value: 4 294 967 295
Quality flag: /
Comment: /

wind_speed_alt
Definition: altimeter wind speed
Element type: Integer
Byte length: 2
Storage type: Unsigned
Dimension: 1
Unit: cm/s
Minimum Value: 0
Maximum Value: 2 500
Default Value: 65 535
Quality flag: /
Comment: This element should not be used over land. [See section 5.11 for more details].
wind_speed_model_u
- Definition: zonal component of the model wind vector (positive eastward)
- Element type: Integer
- Byte length: 2
- Storage type: Signed
- Dimension: 1
- Unit: cm/s
- Minimum Value: -2 500
- Maximum Value: 2 500
- Default Value: 32 767
- Quality flag: interp_flag (bit #3) and ecmwf_meteo_map_avail
- Comment: It is computed at the altimeter measurement epoch from the interpolation of 2 meteorological fields that surround the altimeter measurement epoch. [See section 5.11 for more details].

wind_speed_model_v
- Definition: meridional component of the model wind vector (positive northward)
- Element type: Integer
- Byte length: 2
- Storage type: Signed
- Dimension: 1
- Unit: cm/s
- Minimum Value: -2 500
- Maximum Value: 2 500
- Default Value: 32 767
- Quality flag: interp_flag (bit #3) and ecmwf_meteo_map_avail
- Comment: It is computed at the altimeter measurement epoch from the interpolation of 2 meteorological fields that surround the altimeter measurement epoch. A default value is given when one of the two meteorological fields are not available. [See section 5.11 for more details].

wind_speed_rad
- Definition: radiometer wind speed
- Element type: Integer
- Byte length: 2
- Storage type: Unsigned
- Dimension: 1
- Unit: cm/s
- Minimum Value: 0
- Maximum Value: 2 500
- Default Value: 65 535
- Quality flag: /
- Comment: This element should not be used over land. [See section 5.11 for more details].
A. Acronyms

AVISO  Archivage, Validation et Interprétation des données des Satellites Océanographiques
CCSDS  Consultative Committee on Space Data System
CLIVAR  Climate Variability and Predictability program
CNES  Centre National d’Etudes Spatiales
DIOODE  Détermination Immédiate d’Orbite par Doris Embarque
DORIS  Détermination d’Orbite et Radiopositionnement Intégrés par satellite
ECMWF  European Center for Medium range Weather Forecasting
EM  ElectroMagnetic
EOSDIS  Earth Observing System Data Information System
GDR  Geophysical Data Records
GODAE  Global Ocean Data Assimilation Experiment
GPS  Global Positioning System
IB  Inverse Barometer
IGDR  Interim Geophysical Data Records
JMR  Jason-1 Microwave Radiometer
JPL  Jet Propulsion Laboratory
NASA  National Aeronautics and Space Administration
POD  Precision Orbit Determination
PO.DAAC  Physical Oceanography Distributed Active Archive Center
POE  Precision Orbit Ephemerides
RMS  Root Mean Square
OSDR  Operational Sensor Data Records
SDFU  Standard Formatted Data Units
### Annex A - Acronyms

<table>
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<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>SSB</td>
<td>Sea State Bias</td>
</tr>
<tr>
<td>SSH</td>
<td>Sea Surface Height</td>
</tr>
<tr>
<td>SWH</td>
<td>Significant Wave Height</td>
</tr>
<tr>
<td>T/P</td>
<td>Topex/Poseidon</td>
</tr>
<tr>
<td>TRSR</td>
<td>Turbo Rogue Space Receiver</td>
</tr>
<tr>
<td>UTC</td>
<td>Universal Time Coordinated</td>
</tr>
</tbody>
</table>
B. References

ADAS, «Algorithm Definition Accuracy Specification Vol 1: Jason real time processing»
SMM-ST-M2-EA-11002-CN

ADAS, «Algorithm Definition Accuracy Specification Vol 2: CMA altimeter level 1B processing»
SMM-ST-M2-EA-11003-CN

ADAS, «Algorithm Definition Accuracy Specification Vol 3: CMA radiometer level 1B processing»
SMM-ST-M2-EA-11004-CN

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SMM-ST-M2-EA-11005-CN

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SMM-ST-M2-EA-11006-CN

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SMM-ST-M2-EA-11010-CN

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October 18, 1993.

Annex B - (IGDR ELEMENTS)


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## C. Contacts

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http://podaac.jpl.nasa.gov/DATA_CATALOG/jason1info.html