

Technical Notes

NOAA/NESDIS LSA CryoSat Interim Geophysical Data Record (IGDR)

Last Update: 15 March 2014

Orbit

92° inclination, reaches latitudes of 88°; 369-day exact repeat with 85-day, 29-day, and 3-day sub-cycles.

Data Coverage

At the present time, the NOAA IGDR product only contains data for those areas where CryoSat-2 is operating in its Low Rate Mode (LRM) as a conventional altimeter, not a Synthetic Aperture Radar or Delay-Doppler altimeter. Thus gaps in passes may occur where CryoSat-2 employs its other operating modes. We will investigate the possibility of filling these gaps in the future.

Processing

The NOAA IGDRs differ in several important respects from the near real-time (FDM) and off-line (LRM) conventional mode altimeter data currently produced by ESA:

- the 20 Hz waveforms are retracked to compute range, SWH, and sigma-0.

The following are also added:

- a higher precision DORIS MOE orbit, kindly provided by CNES.
- a complete set of wet and dry tropospheric corrections interpolated from ECMWF meteorological grids.
- an updated dynamic atmospheric correction (MOG2D). Dynamic atmospheric corrections are produced by CLS Space Oceanography Division using the Mog2D model from Legos and distributed by Aviso, with support from Cnes (<http://www.aviso.oceanobs.com/>).
- a complete set of JPL GIM ionosphere corrections.
- all other geophysical corrections normally provided by RADS (Radar Altimeter Database System).

Latency

New IGDRs are added daily, at approximately 20:50 UTC. On day N at 20:40 UTC data is added for passes crossing the equator between N-2 at 22:40 UTC and N-1 at 22:40 UTC. Thus the new data will be between about 1.9 and 0.9 days old. In contrast to other RADS data sets that are regularly reprocessed, this data is delivered once and later replaced with retracked LRM data when these become available. The data will also be redelivered in case of the discovery of errors.

Availability

The data can be obtained in NetCDF format (see Appendices A and B) from the NOAA LSA anonymous ftp site (<ftp://ftp.star.nesdis.noaa.gov/pub/sod/lsa/cs2iqdr/>), or the RADS rsync server (rsync://rads.tudelft.nl:rads) or web site (<http://rads.tudelft.nl/rads/rads.shtml>) both hosted by the Delft University of Technology. The data is subdivided into sub-cycles of 29 or 27 days such that the passes with the same number most closely align. Thirteen sub-cycles make one 369-day exact repeat cycle.

Data Use Policy

The data are distributed at no cost to the users to promote scientific utilization of the data with the stipulation that the users of the data agree to follow the policy described below:

1. The data are produced on a best effort basis.
2. In publications, presentations, or on web pages based on LSA data the following acknowledgment should be included: “*Altimetry data are provided by the NOAA Laboratory for Satellite Altimetry.*”

References

Retracking CryoSat waveforms for Near-Real-Time ocean forecast products and platform attitude

(http://www.star.nesdis.noaa.gov/sod/lsa/NearRealTime/presentations/AGU2011-WHFSmith_NRT_CS2.pdf)

Near-Real-Time Wave, Wind, and Sea Surface Height from CryoSat FDM/L1B data

(http://www.aviso.oceanobs.com/fileadmin/documents/OSTST/2011/oral/02_Thursday/Splinter%20%20NRT/05%20WHFSmith_NRT_CS2.pdf)

Retracking range, SWH, sigma-naught, and attitude in CryoSat conventional ocean data

(http://www.aviso.oceanobs.com/fileadmin/documents/OSTST/2011/oral/01_Wednesday/Splinter%201%20IP/03%20Smith%20WHFSmith_IP_CS2_2.pdf)

Validation of Retracked CryoSat Data Over Open Ocean

(http://www.aviso.oceanobs.com/fileadmin/documents/OSTST/2011/oral/01_Wednesday/Splinter%201%20CV/07%20Scharroo_CryoSat_L1R_CalVal.pdf)

Acknowledgements

This work was made possible through the generous help from ESA, CNES, for providing DORIS MOE orbits, and ECMWF, for use of their meteorological fields.

Appendix A: Sample NetCDF Data Headers & Variables

```
netcdf c2p0317c022 {
dimensions:
    time = 1802 ;
variables:
    double time(time) ;
        time:long_name = "time" ;
        time:units = "seconds since 1985-01-01 00:00:00" ;
        time:field = 101s ;
    int lat(time) ;
        lat:_FillValue = 2147483647 ;
        lat:long_name = "latitude" ;
        lat:units = "degrees_north" ;
        lat:scale_factor = 1.e-07 ;
        lat:field = 201s ;
    int lon(time) ;
        lon:_FillValue = 2147483647 ;
        lon:long_name = "longitude" ;
        lon:units = "degrees_east" ;
        lon:scale_factor = 1.e-07 ;
        lon:field = 301s ;
    int alt_cnes(time) ;
        alt_cnes:_FillValue = 2147483647 ;
        alt_cnes:long_name = "orbital altitude" ;
        alt_cnes:units = "m" ;
        alt_cnes:scale_factor = 0.0001 ;
        alt_cnes:add_offset = 700000. ;
        alt_cnes:coordinates = "lon lat" ;
        alt_cnes:field = 404s ;
    short alt_rate(time) ;
        alt_rate:_FillValue = 32767s ;
        alt_rate:long_name = "orbital altitude rate" ;
        alt_rate:units = "m/s" ;
        alt_rate:scale_factor = 0.002 ;
        alt_rate:coordinates = "lon lat" ;
        alt_rate:field = 501s ;
    int range_ku(time) ;
        range_ku:_FillValue = 2147483647 ;
        range_ku:long_name = "altimeter range corrected for instr. effects" ;
        range_ku:units = "m" ;
        range_ku:scale_factor = 0.0001 ;
        range_ku:add_offset = 700000. ;
        range_ku:coordinates = "lon lat" ;
        range_ku:field = 601s ;
    short dry_tropo_ecmwf(time) ;
        dry_tropo_ecmwf:_FillValue = 32767s ;
        dry_tropo_ecmwf:long_name = "ECMWF dry tropospheric correction" ;
        dry_tropo_ecmwf:units = "m" ;
        dry_tropo_ecmwf:scale_factor = 0.0001 ;
        dry_tropo_ecmwf:coordinates = "lon lat" ;
        dry_tropo_ecmwf:field = 701s ;
    short wet_tropo_ecmwf(time) ;
        wet_tropo_ecmwf:_FillValue = 32767s ;
        wet_tropo_ecmwf:long_name = "ECMWF wet tropospheric correction" ;
        wet_tropo_ecmwf:units = "m" ;
        wet_tropo_ecmwf:scale_factor = 0.0001 ;
        wet_tropo_ecmwf:coordinates = "lon lat" ;
        wet_tropo_ecmwf:field = 802s ;
    short iono_bent(time) ;
        iono_bent:_FillValue = 32767s ;
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iono_bent:long_name = "model ionospheric correction (Bent)" ;
iono_bent:units = "m" ;
iono_bent:scale_factor = 0.001 ;
iono_bent:coordinates = "lon lat" ;
iono_bent:field = 902s ;
short iono_gim(time) ;
iono_gim:_FillValue = 32767s ;
iono_gim:long_name = "ionospheric correction, JPL GIM" ;
iono_gim:units = "m" ;
iono_gim:scale_factor = 0.0001 ;
iono_gim:coordinates = "lon lat" ;
iono_gim:field = 906s ;
short inv_bar_static(time) ;
inv_bar_static:_FillValue = 32767s ;
inv_bar_static:long_name = "static inverse barometric correction from ECMWF" ;
inv_bar_static:units = "count" ;
inv_bar_static:scale_factor = 0.0001 ;
inv_bar_static:coordinates = "lon lat" ;
inv_bar_static:field = 1002s ;
short inv_bar_mog2d(time) ;
inv_bar_mog2d:_FillValue = 32767s ;
inv_bar_mog2d:long_name = "total inverse barometer correction, MOG2D" ;
inv_bar_mog2d:units = "m" ;
inv_bar_mog2d:scale_factor = 0.0001 ;
inv_bar_mog2d:coordinates = "lon lat" ;
inv_bar_mog2d:field = 1004s ;
short tide_solid(time) ;
tide_solid:_FillValue = 32767s ;
tide_solid:long_name = "solid earth tide" ;
tide_solid:units = "m" ;
tide_solid:scale_factor = 0.0001 ;
tide_solid:coordinates = "lon lat" ;
tide_solid:field = 1101s ;
short ocean_tide_got00(time) ;
ocean_tide_got00:_FillValue = 32767s ;
ocean_tide_got00:long_name = "ocean tide" ;
ocean_tide_got00:units = "m" ;
ocean_tide_got00:scale_factor = 0.001 ;
ocean_tide_got00:coordinates = "lon lat" ;
ocean_tide_got00:field = 1207s ;
short load_tide_got00(time) ;
load_tide_got00:_FillValue = 32767s ;
load_tide_got00:long_name = "load tide" ;
load_tide_got00:units = "m" ;
load_tide_got00:scale_factor = 0.001 ;
load_tide_got00:coordinates = "lon lat" ;
load_tide_got00:field = 1307s ;
short tide_pole(time) ;
tide_pole:_FillValue = 32767s ;
tide_pole:long_name = "pole tide" ;
tide_pole:units = "m" ;
tide_pole:scale_factor = 0.0001 ;
tide_pole:coordinates = "lon lat" ;
tide_pole:field = 1401s ;
short swh_ku(time) ;
swh_ku:_FillValue = 32767s ;
swh_ku:long_name = "significant wave height" ;
swh_ku:units = "m" ;
swh_ku:scale_factor = 0.001 ;
swh_ku:coordinates = "lon lat" ;
swh_ku:field = 1701s ;
short sig0_ku(time) ;
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sig0_ku:_FillValue = 32767s ;
sig0_ku:long_name = "backscatter coefficient" ;
sig0_ku:units = "dB" ;
sig0_ku:scale_factor = 0.001 ;
sig0_ku:coordinates = "lon lat" ;
sig0_ku:field = 1801s ;
short sig0_sdr(time) ;
sig0_sdr:_FillValue = 32767s ;
sig0_sdr:long_name = "automatic gain control" ;
sig0_sdr:units = "dB" ;
sig0_sdr:scale_factor = 0.001 ;
sig0_sdr:coordinates = "lon lat" ;
sig0_sdr:field = 1803s ;
short range_rms_ku(time) ;
range_rms_ku:_FillValue = 32767s ;
range_rms_ku:long_name = "std dev of range" ;
range_rms_ku:units = "m" ;
range_rms_ku:scale_factor = 0.0001 ;
range_rms_ku:coordinates = "lon lat" ;
range_rms_ku:field = 2002s ;
short range_rms_c(time) ;
range_rms_c:_FillValue = 32767s ;
range_rms_c:long_name = "std dev of retracker range correction" ;
range_rms_c:units = "m" ;
range_rms_c:scale_factor = 0.0001 ;
range_rms_c:coordinates = "lon lat" ;
range_rms_c:field = 2004s ;
byte range_numval_ku(time) ;
range_numval_ku:_FillValue = 127b ;
range_numval_ku:long_name = "number of valid 20-Hz measurements" ;
range_numval_ku:units = "count" ;
range_numval_ku:coordinates = "lon lat" ;
range_numval_ku:field = 2101s ;
short flags(time) ;
flags:_FillValue = 32767s ;
flags:long_name = "engineering flags" ;
flags:units = "count" ;
flags:coordinates = "lon lat" ;
flags:field = 2601s ;
short drange_ku(time) ;
drange_ku:_FillValue = 32767s ;
drange_ku:long_name = "retracking correction to altimeter range (applied)" ;
drange_ku:units = "m" ;
drange_ku:scale_factor = 0.0001 ;
drange_ku:coordinates = "lon lat" ;
drange_ku:field = 2701s ;
short drange_cal(time) ;
drange_cal:_FillValue = 32767s ;
drange_cal:long_name = "internal calibration correction to altimeter range (applied)" ;
drange_cal:units = "m" ;
drange_cal:scale_factor = 0.001 ;
drange_cal:coordinates = "lon lat" ;
drange_cal:field = 2702s ;
short drange_fm(time) ;
drange_fm:_FillValue = 32767s ;
drange_fm:long_name = "Doppler correction to altimeter range (applied?)" ;
drange_fm:units = "m" ;
drange_fm:scale_factor = 0.001 ;
drange_fm:coordinates = "lon lat" ;
drange_fm:field = 2704s ;
short swh_rms_ku(time) ;
swh_rms_ku:_FillValue = 32767s ;

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    swh_rms_ku:long_name = "std dev of significant wave height (20-Hz)" ;
    swh_rms_ku:units = "m" ;
    swh_rms_ku:scale_factor = 0.001 ;
    swh_rms_ku:coordinates = "lon lat" ;
    swh_rms_ku:field = 2802s ;
short sig0_rms_ku(time) ;
    sig0_rms_ku:_FillValue = 32767s ;
    sig0_rms_ku:long_name = "std dev of backscatter coefficient (20-Hz)" ;
    sig0_rms_ku:units = "dB" ;
    sig0_rms_ku:scale_factor = 0.001 ;
    sig0_rms_ku:coordinates = "lon lat" ;
    sig0_rms_ku:field = 2902s ;
short attitude_pitch(time) ;
    attitude_pitch:_FillValue = 32767s ;
    attitude_pitch:long_name = "platform pitch angle" ;
    attitude_pitch:units = "degrees" ;
    attitude_pitch:scale_factor = 0.0001 ;
    attitude_pitch:add_offset = -0.0962 ;
    attitude_pitch:coordinates = "lon lat" ;
    attitude_pitch:field = 3006s ;
short attitude_roll(time) ;
    attitude_roll:_FillValue = 32767s ;
    attitude_roll:long_name = "platform roll angle" ;
    attitude_roll:units = "degrees" ;
    attitude_roll:scale_factor = 0.0001 ;
    attitude_roll:add_offset = -0.0848 ;
    attitude_roll:coordinates = "lon lat" ;
    attitude_roll:field = 3007s ;
short attitude_yaw(time) ;
    attitude_yaw:_FillValue = 32767s ;
    attitude_yaw:long_name = "platform yaw angle" ;
    attitude_yaw:units = "degrees" ;
    attitude_yaw:scale_factor = 0.0001 ;
    attitude_yaw:coordinates = "lon lat" ;
    attitude_yaw:field = 3008s ;
short mqe(time) ;
    mqe:_FillValue = 32767s ;
    mqe:long_name = "mean quadratic error of waveform fit" ;
    mqe:units = "count" ;
    mqe:scale_factor = 0.001 ;
    mqe:coordinates = "lon lat" ;
    mqe:field = 3409s ;
short noise_floor_ku(time) ;
    noise_floor_ku:_FillValue = 32767s ;
    noise_floor_ku:long_name = "noise floor" ;
    noise_floor_ku:units = "dB" ;
    noise_floor_ku:scale_factor = 0.001 ;
    noise_floor_ku:add_offset = -20. ;
    noise_floor_ku:coordinates = "lon lat" ;
    noise_floor_ku:field = 3411s ;
short noise_floor_rms_ku(time) ;
    noise_floor_rms_ku:_FillValue = 32767s ;
    noise_floor_rms_ku:long_name = "std dev of noise floor" ;
    noise_floor_rms_ku:units = "dB" ;
    noise_floor_rms_ku:scale_factor = 0.001 ;
    noise_floor_rms_ku:coordinates = "lon lat" ;
    noise_floor_rms_ku:field = 3412s ;
byte flags_star_tracker(time) ;
    flags_star_tracker:_FillValue = 127b ;
    flags_star_tracker:long_name = "star tracker" ;
    flags_star_tracker:units = "count" ;
    flags_star_tracker:coordinates = "lon lat" ;

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        flags_star_tracker:field = 3413s ;
short tide_equil(time) ;
    tide_equil:_FillValue = 32767s ;
    tide_equil:long_name = "long-period equilibrium ocean tide" ;
    tide_equil:units = "m" ;
    tide_equil:scale_factor = 0.0001 ;
    tide_equil:coordinates = "lon lat" ;
    tide_equil:field = 3901s ;
int alt_eiggl04s(time) ;
    alt_eiggl04s:_FillValue = 2147483647 ;
    alt_eiggl04s:long_name = "EIGEN-GL04S/MOE orbital altitude" ;
    alt_eiggl04s:units = "m" ;
    alt_eiggl04s:scale_factor = 0.0001 ;
    alt_eiggl04s:add_offset = 700000. ;
    alt_eiggl04s:coordinates = "lon lat" ;
    alt_eiggl04s:field = 414s ;
short ssb_hyb(time) ;
    ssb_hyb:_FillValue = 32767s ;
    ssb_hyb:long_name = "hybrid sea state bias" ;
    ssb_hyb:units = "m" ;
    ssb_hyb:scale_factor = 0.001 ;
    ssb_hyb:coordinates = "lon lat" ;
    ssb_hyb:field = 1504s ;
short wind_speed_alt(time) ;
    wind_speed_alt:_FillValue = 32767s ;
    wind_speed_alt:long_name = "altimeter wind speed" ;
    wind_speed_alt:units = "m/s" ;
    wind_speed_alt:scale_factor = 0.001 ;
    wind_speed_alt:coordinates = "lon lat" ;
    wind_speed_alt:field = 1901s ;
short dist_coast(time) ;
    dist_coast:_FillValue = 32767s ;
    dist_coast:long_name = "distance to coast" ;
    dist_coast:units = "km" ;
    dist_coast:coordinates = "lon lat" ;
    dist_coast:field = 4501s ;
short inv_bar_mog2d_mean(time) ;
    inv_bar_mog2d_mean:_FillValue = 32767s ;
    inv_bar_mog2d_mean:long_name = "mean inverse barometer correction, MOG2D" ;
    inv_bar_mog2d_mean:units = "m" ;
    inv_bar_mog2d_mean:scale_factor = 0.0001 ;
    inv_bar_mog2d_mean:coordinates = "lon lat" ;
    inv_bar_mog2d_mean:field = 1005s ;
int mss_cls01(time) ;
    mss_cls01:_FillValue = 2147483647 ;
    mss_cls01:long_name = "mean sea surface height, MSSCLS01" ;
    mss_cls01:units = "m" ;
    mss_cls01:scale_factor = 0.0001 ;
    mss_cls01:coordinates = "lon lat" ;
    mss_cls01:field = 1605s ;
int mss_cnescls11(time) ;
    mss_cnescls11:_FillValue = 2147483647 ;
    mss_cnescls11:long_name = "mean sea surface height, CNES-CLS11" ;
    mss_cnescls11:units = "m" ;
    mss_cnescls11:scale_factor = 0.0001 ;
    mss_cnescls11:coordinates = "lon lat" ;
    mss_cnescls11:field = 1615s ;
int geoid_egm2008(time) ;
    geoid_egm2008:_FillValue = 2147483647 ;
    geoid_egm2008:long_name = "geoid height, EGM2008" ;
    geoid_egm2008:units = "m" ;
    geoid_egm2008:scale_factor = 0.0001 ;

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        geoid_egm2008:coordinates = "lon lat" ;
        geoid_egm2008:field = 1610s ;
int mss_egm2008(time) ;
    mss_egm2008:_FillValue = 2147483647 ;
    mss_egm2008:long_name = "mean sea surface height, EGM2008" ;
    mss_egm2008:units = "m" ;
    mss_egm2008:scale_factor = 0.0001 ;
    mss_egm2008:coordinates = "lon lat" ;
    mss_egm2008:field = 1611s ;
int mss_dnsc08(time) ;
    mss_dnsc08:_FillValue = 2147483647 ;
    mss_dnsc08:long_name = "mean sea surface height, DNSC08" ;
    mss_dnsc08:units = "m" ;
    mss_dnsc08:scale_factor = 0.0001 ;
    mss_dnsc08:coordinates = "lon lat" ;
    mss_dnsc08:field = 1612s ;
short topo_dnsc08(time) ;
    topo_dnsc08:_FillValue = 32767s ;
    topo_dnsc08:long_name = "topography, DNSC08" ;
    topo_dnsc08:units = "m" ;
    topo_dnsc08:coordinates = "lon lat" ;
    topo_dnsc08:field = 2203s ;
int mss_dtu10(time) ;
    mss_dtu10:_FillValue = 2147483647 ;
    mss_dtu10:long_name = "mean sea surface height, DTU10" ;
    mss_dtu10:units = "m" ;
    mss_dtu10:scale_factor = 0.0001 ;
    mss_dtu10:coordinates = "lon lat" ;
    mss_dtu10:field = 1614s ;
short topo_dtu10(time) ;
    topo_dtu10:_FillValue = 32767s ;
    topo_dtu10:long_name = "topography, DTU10" ;
    topo_dtu10:units = "m" ;
    topo_dtu10:coordinates = "lon lat" ;
    topo_dtu10:field = 2205s ;
byte basin(time) ;
    basin:_FillValue = 127b ;
    basin:long_name = "basin code" ;
    basin:units = "count" ;
    basin:coordinates = "lon lat" ;
    basin:field = 3601s ;
int tide_ocean_fes04(time) ;
    tide_ocean_fes04:_FillValue = 2147483647 ;
    tide_ocean_fes04:long_name = "ocean tide, FES2004" ;
    tide_ocean_fes04:units = "m" ;
    tide_ocean_fes04:scale_factor = 0.0001 ;
    tide_ocean_fes04:coordinates = "lon lat" ;
    tide_ocean_fes04:field = 1213s ;
short tide_load_fes04(time) ;
    tide_load_fes04:_FillValue = 32767s ;
    tide_load_fes04:long_name = "load tide, FES2004" ;
    tide_load_fes04:units = "m" ;
    tide_load_fes04:scale_factor = 0.0001 ;
    tide_load_fes04:coordinates = "lon lat" ;
    tide_load_fes04:field = 1313s ;
int tide_ocean_got47(time) ;
    tide_ocean_got47:_FillValue = 2147483647 ;
    tide_ocean_got47:long_name = "ocean tide, GOT4.7" ;
    tide_ocean_got47:units = "m" ;
    tide_ocean_got47:scale_factor = 0.0001 ;
    tide_ocean_got47:coordinates = "lon lat" ;
    tide_ocean_got47:field = 1217s ;

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short tide_load_got47(time) ;
    tide_load_got47:_FillValue = 32767s ;
    tide_load_got47:long_name = "load tide, GOT4.7" ;
    tide_load_got47:units = "m" ;
    tide_load_got47:scale_factor = 0.0001 ;
    tide_load_got47:coordinates = "lon lat" ;
    tide_load_got47:field = 1317s ;
int tide_ocean_got48(time) ;
    tide_ocean_got48:_FillValue = 2147483647 ;
    tide_ocean_got48:long_name = "ocean tide, GOT4.8" ;
    tide_ocean_got48:units = "m" ;
    tide_ocean_got48:scale_factor = 0.0001 ;
    tide_ocean_got48:coordinates = "lon lat" ;
    tide_ocean_got48:field = 1219s ;
short tide_load_got48(time) ;
    tide_load_got48:_FillValue = 32767s ;
    tide_load_got48:long_name = "load tide, GOT4.8" ;
    tide_load_got48:units = "m" ;
    tide_load_got48:scale_factor = 0.0001 ;
    tide_load_got48:coordinates = "lon lat" ;
    tide_load_got48:field = 1319s ;
short tide_non_equil(time) ;
    tide_non_equil:_FillValue = 32767s ;
    tide_non_equil:long_name = "long-period non-equilibrium ocean tide" ;
    tide_non_equil:units = "m" ;
    tide_non_equil:scale_factor = 0.0001 ;
    tide_non_equil:coordinates = "lon lat" ;
    tide_non_equil:field = 3902s ;
double ref_frame_offset ;
    ref_frame_offset:long_name = "reference frame offset" ;
    ref_frame_offset:units = "m" ;
    ref_frame_offset:field = 3801s ;
byte dry_tropo_airtide(time) ;
    dry_tropo_airtide:_FillValue = 127b ;
    dry_tropo_airtide:long_name = "dry tropospheric air tide correction" ;
    dry_tropo_airtide:units = "m" ;
    dry_tropo_airtide:scale_factor = 0.0001 ;
    dry_tropo_airtide:coordinates = "lon lat" ;
    dry_tropo_airtide:field = 4901s ;
double inv_bar_global ;
    inv_bar_global:long_name = "global inverse barometer correction" ;
    inv_bar_global:units = "m" ;
    inv_bar_global:field = 1003s ;
short iono_iri2007(time) ;
    iono_iri2007:_FillValue = 32767s ;
    iono_iri2007:long_name = "ionospheric correction, IRI2007" ;
    iono_iri2007:units = "m" ;
    iono_iri2007:scale_factor = 0.0001 ;
    iono_iri2007:coordinates = "lon lat" ;
    iono_iri2007:field = 907s ;
short iono_nic09(time) ;
    iono_nic09:_FillValue = 32767s ;
    iono_nic09:long_name = "ionospheric correction, NIC09" ;
    iono_nic09:units = "m" ;
    iono_nic09:scale_factor = 0.0001 ;
    iono_nic09:coordinates = "lon lat" ;
    iono_nic09:field = 908s ;

```

```
// global attributes:
```

```

:Conventions = "COARDS/CF-1.0" ;
:title = "RADS 3.0 pass file" ;
:filename = "c2p0317c022.nc" ;

```

```

:mission_name = "CRYOSAT2" ;
:mission_phase = "a" ;
:cycle_number = 22 ;
:pass_number = 317 ;
:equator_longitude = 32.787734 ;
:equator_time = "2011-12-06 21:43:05.101158" ;
:first_meas_time = "2011-12-06 21:18:16.577188" ;
:last_meas_time = "2011-12-06 22:03:25.270421" ;
:log01 = "08-Dec-2011 | time lat lon alt_cnes alt_rate range_ku dry_tropo_ecmwf wet_tropo_ecmwf
iono_bent iono_gim inv_bar_static inv_bar_mog2d tide_solid ocean_tide_got00 load_tide_got00 tide_pole sw_h_ku
sig0_ku sig0_sdr range_rms_ku range_rms_c range_numval_ku flags drange_ku drange_cal drange_fm
sw_h_rms_ku sig0_rms_ku attitude_pitch attitude_roll attitude_yaw mqe noise_floor_ku noise_floor_rms_ku
flags_star_tracker tide_equil | c2l1rrow (2.23): Create RAW data from L1R (1.13) from L1B (SIR1FDM/2.2) data of
2011-12-07 00:09:17" ;
:log02 = "08-Dec-2011 | time lat lon alt_eiggl04s alt_rate eqtime eqlon | radsp_orbit (2.46):
Interpolate orbit" ;
:log03 = "08-Dec-2011 | dry_tropo_ecmwf wet_tropo_ecmwf ssb_hyb wind_speed_alt | radsp_c2
(2.10): Correction of several measurement values" ;
:log04 = "08-Dec-2011 | dist_coast inv_bar_mog2d_mean mss_cls01 mss_cnescls11 | radsp_grid
(2.13): Interpolate surface/topography grids" ;
:log05 = "08-Dec-2011 | geoid_egm2008 | radsp_grid (2.13): Interpolate surface/topography grids" ;
:log06 = "08-Dec-2011 | mss_egm2008 | radsp_grid (2.13): Interpolate surface/topography grids" ;
:log07 = "08-Dec-2011 | mss_dnsc08 topo_dnsc08 | radsp_grid (2.13): Interpolate
surface/topography grids" ;
:log08 = "08-Dec-2011 | mss_dtu10 topo_dtu10 | radsp_grid (2.13): Interpolate surface/topography
grids" ;
:log09 = "08-Dec-2011 | flags | radsp_mask (2.7): Interrogate land/ocean masks" ;
:log10 = "08-Dec-2011 | basin | radsp_basin (2.9): Interrogate basin code" ;
:log11 = "08-Dec-2011 | tide_pole tide_solid tide_ocean_fes04 tide_load_fes04 tide_ocean_got47
tide_load_got47 tide_ocean_got48 tide_load_got48 tide_equil tide_non_equil | radsp_tide (2.23): Evaluate tide
models" ;
:log12 = "08-Dec-2011 | ref_frame_offset | radsp_refframe (2.20): Provide model for reference
frame offset" ;
:log13 = "08-Dec-2011 | dry_tropo_airtide | radsp_meteo (2.34): Interpolate meteorological grids" ;
:log14 = "08-Dec-2011 | dry_tropo_ecmwf wet_tropo_ecmwf inv_bar_static inv_bar_global |
radsp_ecmwf (2.6): Interpolate ECMWF meteorological grids" ;
:log15 = "08-Dec-2011 | iono_gim iono_iri2007 iono_nic09 | radsp_iono (2.8): Include ionospheric
delay models" ;
:log16 = "08-Dec-2011 | inv_bar_mog2d | radsp_mog2d (2.17): Interpolate MOG2D inverse
barometer grids" ;

```

Appendix B: Meaning of Engineering Flags

The engineering flags (netCDF variable "flags") are a 16-bit integer word in which each bit has a particular meaning, depending on whether it is set (1) or not (0). Our convention is the number the bits from 0 (least significant bit) to 15 (most significant bit).

- Bit 2: Continental ice: 1 = ice, 0 = other
- Bit 4: Land/water: 1 = land, 0 = ocean or lake
- Bit 5: Ocean/other: 1 = land or lake, 0 = ocean
- Bit 11: Quality of altimeter range measurement: 1 = bad, 0 = good
- Bit 12: Quality of altimeter SWH measurement: 1 = bad, 0 = good
- Bit 13: Quality of backscatter measurement: 1 = bad, 0 = good

The remaining bits are currently unused and set to 0.