Cryosat Operational Polar Monitoring Product Formats

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1 Change Log

Version	Date	Description
1.0	15-Apr-2015	Initial version
1.1	17-Apr-2015	Added netCDF format
1.2	24-Apr-2015	Added GeoTIFF format for whole Arctic
1.3	03-Feb-2016	Explanation of negative sea ice values in products. Correction to the proj.4 specification of the WGS84 ellipsoid in the projection used in GeoTIFF files.

2 Purpose

This document details product formats provided by the CryoSat Operational Polar Monitoring portal at http://www.cpom.ucl.ac.uk/csopr

3 Sea Ice Products

3.1 Sea Ice Thickness Products

Sea Ice near real time thickness products are currently available in ASCII and netCDF formats in either a whole Arctic 5km resolution or as individual sectors at 1km resolution.

For 5km resolution data, a circular operator of radius 25km is applied when gridding the data and all points receive equal weight.

For the 5km grids, only grid points with sea ice thickness data are included in the file (ie it is a sparse grid).

For the 1km grid all grid points north of 60N are present.

For 1km resolution data, a circular operator of radius 5km is applied when gridding the data and all points receive equal weight. For the 1km grid all grid points north of 60N are present.

Note that negative thickness values are a consequence of negative freeboard measurements (the height of sea ice above water). Large negative freeboard values (values below -0.3 m) are likely to be caused by errors in the retracking applied to sea ice floe waveforms, and are removed from our processing. However, slightly negative freeboards will occur due to random noise in the returns from thin ice floes, caused by radar speckle. These are included to ensure that the average freeboard, and therefore thickness, is not biased high.

3.1.1 Data Citation

Users of this data should cite the following in any publication that uses data or images from this service:

Laxon S. W., K. A. Giles, A. L. Ridout, D. J. Wingham, R. Willatt, R. Cullen, R. Kwok, A. Schweiger, J. Zhang, C. Haas, S. Hendricks,
R. Krishfield, N. Kurtz, S. Farrell and M. Davidson (2013), CryoSat-2 estimates of Arctic sea ice thickness and volume, Geophysical Research Letters, 40, doi:10.1002/grl.50193.

3.1.2 ASCII Thickness Format

All files are provided in compressed gzip format (.gz) to reduce size.

3.1.2.1 File Naming

Whole Arctic 5km resolution:

thk_<*days*>.map.<*DD₁MM₁YY₁*>_<*DD₂MM₂YY₂*>.txt.gz

1km area sectors:

<days>day_x<*X*>y<*Y*>.map. .<*DD₁MM₁YY₁*>_<*DD₂MM₂YY₂*>.txt.gz

where <*days*> is either 02, 14 or 28 days, corresponding to the period covered.

.<*DD₁MM₁YY₁*> is the date of the start of the period covered
<*DD₂MM₂YY₂*> is the date of the end of the period covered

<X> and <Y> are the sector identifiers. There are 36 sectors (as a 6x6 grid) arranged from the bottom left of the Arctic map and spaced every 1110km, such that X=1, Y=1 is the bottom left, and X=6, Y=6 is top right.

3.1.2.2 Data Format

This is an ASCII text file containing 6 columns of data per line. Each line corresponds to a grid location.

The **first** line provides the start and end date of the file:

Column	Field Description	Units
1	Start Day	Day of month
2	Start Month	Month of year
3	Start Year	Year
4	End Day	Day of month
5	End Month	Month of year
6	End Year	Year

Second and each subsequent line provides data at each grid location:

Column	Field Description	Units
1	Latitude	Degrees North
2	Longitude	Degrees East
3	Interpolated value of Sea Ice Thickness	meters (can be negative – see note above)
4	Standard Deviation of values used to form thickness at this location	meters
5	Number of values used to form thickness at this location.	Number of measurements
6	Distance of COG of values used from (lat,lon)	km

Note that the data is in a sparse grid with data points where sea ice thickness measurements are available (5km products) or north of 60N latitude (1km products).

3.1.3 NetCDF Format

The files are formatted to be netCDF v3.6 compatible.

3.1.3.1 File Naming

Whole Arctic 5km resolution:

thk_<*days*>.map.<$DD_1MM_1YY_1$>_<$DD_2MM_2YY_2$>.nc.gz

1km area sectors:

<days>day_x<*X*>y<*Y*>.map. .<$DD_1MM_1YY_1$>_<$DD_2MM_2YY_2$>.nc.gz

where <*days*> is either 02, 14 or 28 days, corresponding to the period covered.

.<$DD_1MM_1YY_1$> is the date of the start of the period covered
<$DD_2MM_2YY_2$> is the date of the end of the period covered

<X> and <Y> are the sector identifiers. There are 36 sectors (as a 6x6 grid) arranged from the bottom left of the Arctic map and spaced every 1110km, such that X=1, Y=1 is the bottom left, and X=6, Y=6 is top right.

3.1.3.2 NetCDF File Format

NetCDF is a self-describing format, which can be shown from its header:

```
// global attributes:
Title = "Arctic Sea Ice Thickness Product from CryoSat" ;

dimensions:
      length = <variable> ;
variables:
      short start_day ;
                        units = "day of month(1-31)" ;
      short start_month ;
                        units = "month of year (1-12)" ;
      short start_year ;
                        units = "years YYYY" ;
      short end_day ;
                        units = "day of month (1-31)" ;
      short end_month ;
                        units = "month of year (1-12)" ;
      short end_year ;
```

units = "years YYYY" ;
short ndays ;
units = "days" ;
short grid_spacing ;
units = "km" ;
float latitude(length) ;
units = "degrees north" ;
float longitude(length) ;
units = "degrees east" ;
float thickness(length) ;
units = "meters" ;
long_name = "sea ice thickness" ;
float thk_stdev(length) ;
units = "meters" ;
long_name = "standard deviation of thickness at location" ;
int n_thk(length) ;
units = "number of measurements" ;
long_name = "number of thickness measurements used" ;
float cog_dist(length) ;
units = "km in the projected plane" ;
long_name = "distance of centre of gravity from operator centre" ;

Note that the data is in a sparse grid with data points where sea ice thickness measurements are available (5km products) or north of 60N latitude (1km products).

3.1.4 GeoTIFF Format

3.1.4.1 File Naming

Whole Arctic 5km resolution:

thk_<*days*>.map.<$DD_1MM_1YY_1$>_<$DD_2MM_2YY_2$>.tif

1km area sectors:

<days>day_x<*X*>y<*Y*>.map. .<$DD_1MM_1YY_1$>_<$DD_2MM_2YY_2$>.tif

where <*days*> is either 02, 14 or 28 days, corresponding to the period covered.

.<$DD_1MM_1YY_1$> is the date of the start of the period covered
<$DD_2MM_2YY_2$> is the date of the end of the period covered

<X> and <Y> are the sector identifiers. There are 36 sectors (as a 6x6 grid) arranged from the bottom left of the Arctic map and spaced every 1110km, such that X=1, Y=1 is the bottom left, and X=6, Y=6 is top right.

3.1.4.2 File Format

GeoTIFF files are a TIFF raster image format with added geographic data embedded as tags, allowing precise geo-location of pixels in the image.

For the 5km resolution whole Arctic thickness maps, the TIFF image is stored as an image array of 1335x1335 8-bit pixels. Pixel spacing is 5km.

Pixel values are scaled in 2cm sea ice thickness increments as follows:

Pixel 8-bit Value	**Sea Ice Thickness**
0	0.00m
1	0.02m
2	0.04m
…	
250	5.00m
251-255	not used

The projection used to map the data is a polar stereographic projection defined by the PROJ.4 (http://trac.osgeo.org/proj) projection string:
<Proj=stere +lat_0=90 +lon_0=**0.0** +lat_ts=70.0 +a=6378137 +b=6356752.314 +e= 0.081819191+units=m>
where

Parameter	Description
lat_0	latitude of origin degrees N
lon_0*	Longitude of origin (central meridian)
Lat_ts	Latitude of standard parallel degrees N
Ellipsoid	WGS84
a	Semi-major axis radius (m)
b	Semi-minor axis radius (m)
e	Eccentricity
Projection units	meters
Scaling factor	1

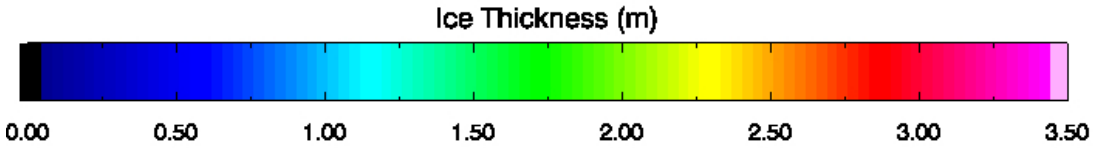
* note that the projection central meridian is 0 degrees and not -45.0 as is also commonly used for Arctic polar stereo projections such as EPSG:3413.

Image positioning within the projection (x,y) plane is defined by:

Upper left	X (m)	Y (m)
Upper left	-3335000.00	3335000.00
Lower left	-3335000.00	-3335000.00
Upper right	3335000.00	3335000.00
Lower right	3335000.00	-3335000.00

Center	0.0	0.0

GeoTIFF images are provided with a colour palette to match the website's thickness maps.



Note that pixel values (176-250) corresponding to thickness > 3.5m are displayed as pink.