Surface Water and Ocean Topography (SWOT) Project

SWOT Product Description
Long Name: Level 2 KaRIn high rate pixel cloud vector attribute product
Short Name: L2_HR_PIXCVec

Revision A

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National Aeronautics and Space Administration
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California Institute of Technology

CHANGE LOG

VERSION	DATE	SECTIONS CHANGED	REASON FOR CHANGE
Preliminary	2017-04-26	All	Preliminary version
Initial Release	2019-11-04	All	Initial Release
Initial Release V2	2020-03-31	All	Updates following SME review
Revision A	2022-09-30	All	Revision A, minor updates

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1 Introduction

1.1 Purpose

The purpose of this Product Description Document is to describe the Level 2 Ka-band Radar Interferometer (KaRIn) high rate (HR) pixel cloud (PIXC) vector attribute science data product from the Surface Water Ocean Topography (SWOT) mission. This data product is also referenced by the short name L2_HR_PIXCVec.

1.2 Document Organization

Section 2 provides a general description of the product, including its purpose, and latency.

Section 3 provides the structure of the product, including granule definition, file organization, spatial resolution, temporal and spatial organization of the content, the size and data volume.

Section 4 provides qualitative descriptions of the information provided in the product.

Section 5 provides a detailed identification of the individual fields within the L2_HR_PIXCVec product.

Section 6 provides the references.

Appendix A provides a list of the acronyms used in this document.

1.3 Document Conventions

When the specific names of data variables and groups of the data product are given in the body text of this document, they are usually represented in *italicized text*.

2 Product Description

2.1 Purpose

The L2_HR_PIXCVec product provides data from the high-resolution (HR) mode of the SWOT KaRIn instrument. Data from the KaRIn HR mode are generally produced for inland and coastal hydrology surfaces, as controlled by the reloadable KaRIn HR mask.

The L2_HR_PIXCVec product is complementary to the L2_HR_PIXC product [1]. It provides a less noisy, height-constrained geolocation (latitude, longitude, and height) of the L2_HR_PIXC pixels. Details of the height-constrained geolocation process are described in [2].

The L2_HR_PIXCVec product also provides an identifier associated with each pixel that indicates to which river and/or lake feature the pixel has been attributed, as identified in the Prior River Database (PRD) [3] or in the Prior Lake Database (PLD) [4]. The PRD is used to generate river vector features in the Level 2 KaRIn High Rate River Single Pass Vector Product (L2_HR_RiverSP) [5], and the PLD is used to generate lake vector features in the Level 2 KaRIn High Rate Lake Single Pass Vector Product (L2_HR_LakeSP) [6]. For these lakes, but also unassigned detected features that have not been assigned to any prior water body, an observation identifier is provided in the L2_HR_PIXCVec product, allowing pixels that belong to the same observed feature to be linked.

2.2 Latency

The L2_HR_PIXCVec product is generated with a latency of at most 45 days from data collection. The latency allows for consolidation of instrument calibration and the required auxiliary or ancillary data that are needed to generate this product. Different versions of the product may be generated at different latencies and/or through reprocessing with refined input data, such as an updated version of the prior databases.

3 Product Structure

3.1 Granule Definition

The L2_HR_PIXCVec product is organized into swath-aligned tiles as described in [7]. Nominally, these tiles are approximately 64 km long in the along-track direction and cover either the left or right side of the KaRIn swath (~64 km wide from nadir to the far-range swath edge), although SWOT performance requirements are only applicable from 10–60 km from nadir on each side.

There is a one-to-one correspondence with the tiles of the L2_HR_PIXC product; a more detailed explanation of tiling is given in the associated product description document [1].

3.2 File Organization

The L2_HR_PIXCVec product consists of one file, in NetCDF-4 file format. A description of this file is provided in Table 1 below.

Table 1. Description of the NetCDF file representing the L2_HR_PIXCVec product.

File	Name	Description
1	Level 2 KaRIn high rate pixel cloud vector attribute product	Provides, for each pixel-cloud sample representing water, a less noisy, height-constrained geolocation (longitude, latitude and height) and the identifier of the vector feature to which it has been assigned (river IDs from the PRD, lake ID from the PLD, observation ID for unassigned features and lakes).

The data variables are organized in 1-D arrays in a direct one-to-one mapping with the *pixel_cloud* group of the L2_HR_PIXC product [1].

3.3 File Naming Convention

The L2_HR_PIXCVec product adopts the following file naming convention:

*SWOT_L2_HR_PIXCVec_<CycleID>_<PassID>_<TileID>[L/R]_
<RangeBeginningDateTime>_<RangeEndingDateTime>_<CRID>_<ProductCounter>.nc*

3.4 Spatial Sampling and Resolution

The sampling of the pixels in the L2_HR_PIXCVec product is the same as for the L2_HR_PIXC product. That is, each pixel in the L2_HR_PIXCVec file corresponds one-to-one to a pixel in the *pixel_cloud* group of the L2_HR_PIXC product [1].

In terms of resolution, the additional smoothing involved in the height-constrained geolocation, leads to stronger spatial correlation in the variables of the L2_HR_PIXC. The height-constrained geolocation algorithm tends to preserve water-land boundaries, but height variations over a water body (reach or lake) are unlikely to be resolvable.

3.5 Temporal Organization

The temporal organization of the L2_HR_PIXCVec product follows the same conventions as the *pixel_cloud* group of the L2_HR_PIXC product [1].

3.6 Spatial Organization

The indexing in the 1-D arrays of the L2_HR_PIXCVec product is the same as in the *pixel_cloud* group of the L2_HR_PIXC product. That is, the pixel with index *i* in L2_HR_PIXCVec product corresponds to the pixel with index *i* in the L2_HR_PIXC product [1].

3.7 Volume

Table 2 provides the expected volume of the L2_HR_PIXCVec product. These data volume estimates assume that no NetCDF compression is applied.

The values provided in Table 2 are based on the same assumptions as for the L2_HR_PIXC product [1]:

1. Along-track extent of 64 km, with approximately 22 m along-track posting (approximately 4 effective looks), which corresponds to about **3000 pixels** in the along-track direction of the underlying 2-D arrays.
2. 64 km extent for each swath in the cross-track direction, which corresponds to about **4600 single-range-look pixels** (this is the approximate length of the full range window; KaRIn performance is generally best near the center of the swath and degrades quickly outside the central 50 km of each half swath).
3. Over continental surfaces, approximately **10%** of the pixels are expected to be kept on average for a given scene (same assumption as for the sizing of the L2_HR_PIXC product). (For reference, an upper-bound on the data volume if 100% of the pixels are kept is also given in Table 2)

Together this results in ~13,800,000 pixels per tile. In the L2_HR_PIXCVec product, there are 11 variables with a total of **78 bytes per pixel**. For each tile, this results in 13,800,000*78*0.1 = 109 MB (max ~1090 MB if the whole scene is water).

Table 2. Description of the data volume of the L2_HR_PIXCVec product.

Part	Name	Expected Mean Volume (10% water) / Tile (MB)	Maximum Volume (100% water) / Tile (MB)
1	Level 2 KaRIn high rate pixel cloud vector attribute product	103	1027

4 Qualitative Description

The L2_HR_PIXCVec product contains additional information on the pixels of the L2_HR_PIXC product [1] that are computed after the pixels are associated with river and/or lake vector features.

The L2_HR_PIXC product contains the measured height, geolocation, and classification data from KaRIn. The L2_HR_PIXCVec product provides a height-constrained geolocation (latitude, longitude, and height) for each pixel, in which the coordinates have been further regularized (smoothed) in comparison with those of the L2_HR_PIXC product.

The L2_HR_PIXCVec product also provides identifiers (IDs) associated with each pixel that indicate to which river and/or lake features the pixel has been assigned, as identified in the Prior River Database (PRD) [3] and/or in the Prior Lake Database (PLD) [4], respectively. The L2_HR_PIXCVec product is therefore strongly linked to two other products:

- The L2_HR_RiverSP product [5] specifically provides data for river reaches identified in the PRD. Each reach is divided into a number of nodes in the PRD. In the PRD, each river feature has a unique reach and node ID, denoted *reach_id* and *node_id*, respectively.
- The L2_HR_LakeSP product [8] specifically provides data for lakes identified in the PLD. In the PLD, each lake feature has a unique ID, denoted *lake_id*. The L2_HR_LakeSP product also contains another identifier, *obs_id,* which provides the link to the pixels that belong to each observed water feature, including unassigned features (not identified in the PRD nor PLD). The *obs_id* also indicates the associated L2_HR_PIXC pixel cloud tile [9] that covered the observed water feature.

Note that for lakes connected to rivers in the PRD, pixels may be associated with both river and lake features simultaneously. This is described in Sections 4.4 and 4.5 below.

Unless otherwise specified, quantities are given in SI (MKS) units.

4.1 Projection in the Slant Plane

The *azimuth_index* and *range_index* variables are copied from the L2_HR_PIXC product [1]. These are the indices of the pixel cloud sample in the 2-D interferogram array (i.e. in radar geometry) for the pixel-cloud tile. Azimuth refers to the along-track dimension, and range refers to the slant-range or cross-track dimension.

4.2 Well-done Layer

The L2_HR_PIXCVec product contains pixel-wise location and height information that is consistent with the water-feature level of smoothing that is computed in creating the the river and lake vector products. This so called “well-done” layer (as opposed to the “rare” and “medium” layers in the L2_HR_PIXC product [1]) is obtained by height-constrained geolocation [2] and is intended

- for expert users who want to examine the details of how the corresponding river, lake, and raster products are generated,

- for applications requiring very little noise in the pixel locations (e.g., polygonization of complex river planforms), or
- for visualizing the two-dimensional structure of the water features, assuming heights consistent with those reported in the vector products.

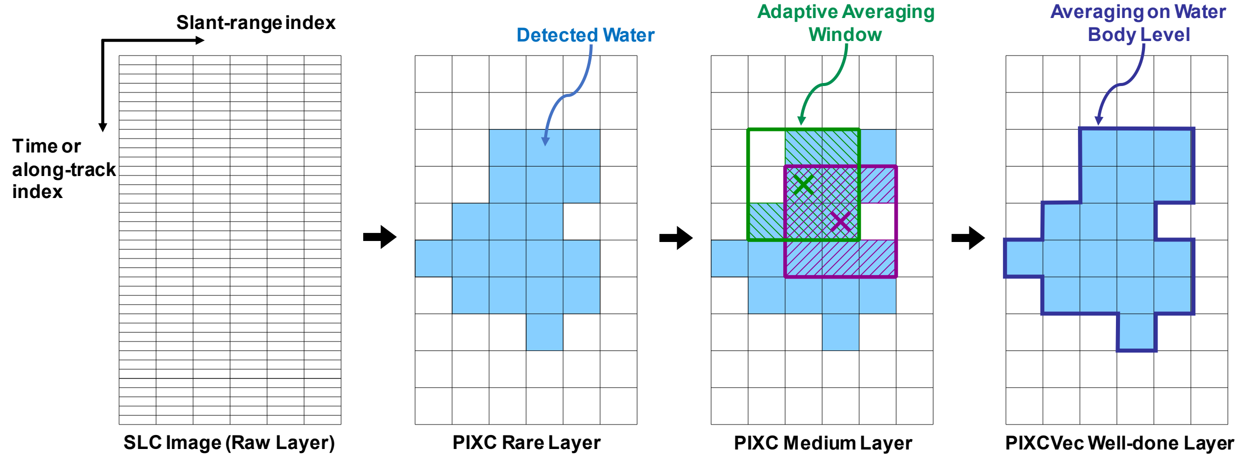

Figure 1. Notional illustration of the relationships between the posting and information content of the (left to right) SLC "raw", PIXC "rare" and "medium", and PIXCVec "well-done" layers, as projected in the slant plane.

The pixel geolocations are made less noisy by constraining the heights in the L2_HR_PIXC products per water body (river reach or lake). While the medium geolocations in the L2_HR_PIXC product are computed using a system of equations based on range, Doppler, and interferometric phase, the well-done geolocations [2] in the L2_HR_PIXCVec product are computed using a similar system of equations in which the interferometric phase is replaced by the constrained height. This provides a less noisy geolocation that is consistent with the average height and slope in the river and lake vector products. The height-constrained geolocation is performed differently for rivers and lakes:

- Rivers: Water pixels are assigned to PRD nodes regularly spaced along the river centerline in the PRD. The average node heights are computed and regularized at the reach level (using a linear fit), and interpolated back to the individual pixels along the centerline.
- Small lakes: For lakes below a certain area threshold (typically several km^2), the average height of the entire lake is used.
- Large lakes: For lakes above the area threshold, a polynomial 2D fit (typically second-order) is computed using the medium heights of the pixels in radar geometry coordinates.

Because of the additional smoothing, and the fact that the posting of the L2_HR_PIXC product is maintained, the height-constrained geolocations of the L2_HR_PIXCVec product have a very strong spatial correlation.

In cases where it is important to preserve fine-scale water topography features, the moderately smoothed (medium) heights from L2_HR_PIXC product can be used in combination with the more regularized (well-done) latitudes and longitudes from the L2_HR_PIXCVec product.

The height-constrained geolocation is given only for water pixels; it is void (fill value) for land pixels included in a buffer around the detected water pixels, as indicated by the pixel *classification* values in the L2_HR_PIXC product [1].

Note that the heights (water surface elevations) given in the *wse* variables of the L2_HR_RiverSP and L2_HR_LakeSP products are reported with respect to the geoid, not the ellipsoid. Additionally, *wse* values in the L2_HR_RiverSP and L2_HR_LakeSP products have tidal effects (solid-Earth or body tide, geocentric pole tide, and geocentric load tide) corrected. In the L2_HR_PIXCVec product, the *height_vectorproc* variable is given with respect to the ellipsoid, without the correction of tide contributions, consistent with the *height* variable of the L2_HR_PIXC product.

The variables of the well-done layer are the following:

- *latitude_vectorproc*, *longitude_vectorproc*: Coordinates giving the horizontal location of the observed pixel after the geolocation improvement process [2]. The latitude is a geodetic latitude with respect to the reference ellipsoid, whose parameters are given in the global attributes of the product (*ellipsoid_semi_major_axis* and *ellipsoid_flattening*). Positive latitude values increase northward from the equator. Longitude values range between -180° and +180°.

- *height_vectorproc*: Height of the observed pixel after the height-constrained geolocation process [2]. The height is given with respect to the reference ellipsoid, whose parameters are given in the global attributes of the product. The reported height is computed from the medium-layer L2_HR_PIXC *height* variable and follows the same representation conventions.

For connected lakes, which are represented both in the L2_HR_RiverSP and L2_HR_LakeSP products, the above variables are based on the L2_HR_LakeSP processing [6].

Figure 2 gives an example of the effect of the height-constrained geolocation.

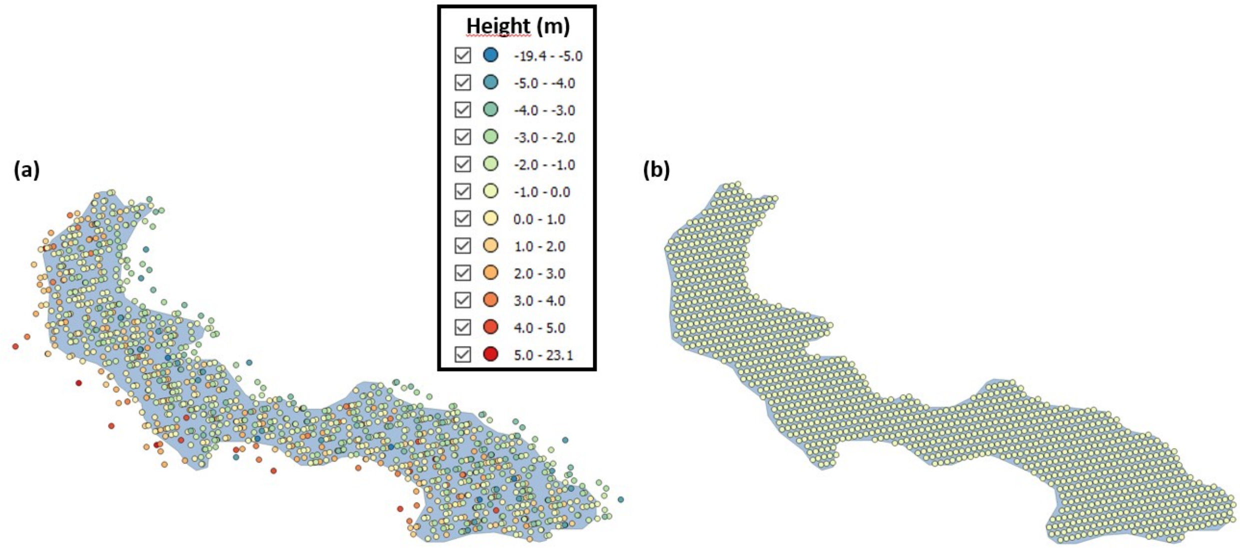

Figure 2. Effect of height-constrained geolocation for a simple case. (a) Noisy geolocation in the medium layer of the L2_HR_PIXC product. (b) Height-constrained geolocation in the well-done layer of the L2_HR_PIXCVec product.

4.3 Prior Database Identifiers

Each water pixel assigned to a particular river and/or lake in the vector products is tagged with the corresponding database identifiers from the PRD and/or the PLD. These identifiers are represented in the following three variables:

- *reach_id:* Identifier of the river reach from the PRD to which the water pixel has been assigned,
- *node_id*: Identifier of the river node from the PRD to which the water pixel has been assigned,
- *lake_id*: Identifier of the lake from the PLD to which the water pixel has been assigned.

Pixels belonging to lakes and unassigned water features have an observation identifier:

- *obs_id*: Tile-specific identifier of the feature to which the water pixel belongs if the pixel is considered during the creation of the lake product.

Most water pixels belong to one single feature. Figure 3 highlights pixel attributes depending upon the water body type:

- Rivers: Only the *reach_id* and *node_id* variables are populated (green pixels in Figure 3),
- Disconnected lakes: Only the *obs_id* and *lake_id* variables are populated (red pixels in Figure 3),
- Connected lakes: In the particular case where the feature is a lake connected to a river in the PRD, it is referenced in both the PLD and PRD. In this specific case, *reach_id*,

node_id, *obs_id* and *lake_id* will be populated (yellow pixels in Figure 3).

- Unassigned features: Only the *obs_id* variable is populated (blue pixels in Figure 3).

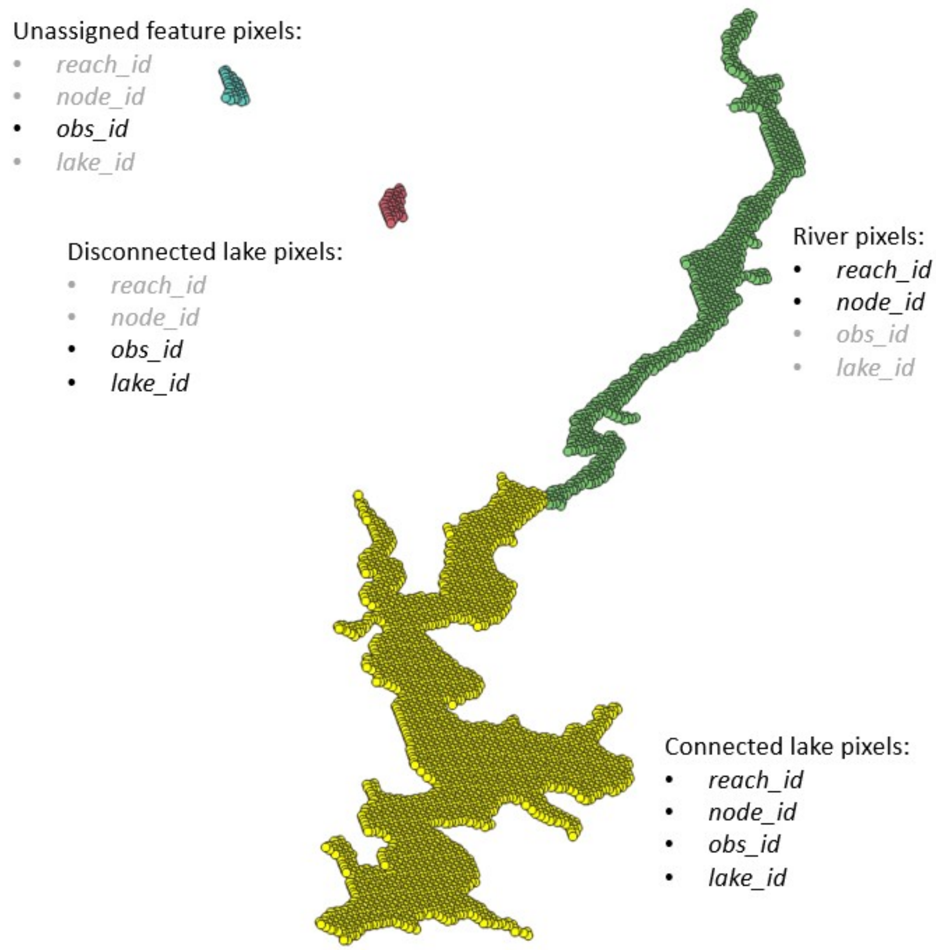

Figure 3. Pixel attributes depending on the water feature type. Green = river: only *reach_id* and *node_id* from PRD are populated. Blue = unassigned feature (i.e. not in PLD nor PRD): only *obs_id* is populated. Red = known disconnected lake (in PLD): only *obs_id* and *lake_id* are populated. Yellow = connected lake (both in PLD and PRD): *reach_id*, *node_id*, *obs_id*, and *lake_id* are populated.

Water features that are smaller than 1 ha will not have a *lake_id* nor an *obs_id* in the PIXCVec product (just fill values), as they are not represented in the L2_HR_LakeSP product.

For land pixels (i.e., land buffer around detected water bodies), the prior database and observation identifiers are void (fill value).

All four identifiers are represented as strings (character arrays) of a certain length, as described in sections 5.2.2 and 5.2.3. The way the different identifiers are coded is further explained in [6].

4.4 Ice Flagging

Climatological and dynamic ice flagging in the L2_HR_PIXCVec product is inherited from the river and lake vector products. Therefore, all the pixels belonging to the same water body have the same flag value.

- *ice_clim_f*: Climatological ice cover flag indicating whether the pixel is ice-covered on the day of the SWOT observation based on external climatological information (not the SWOT measurement). Values of 0, 1, and 2 indicate that the surface is not ice covered, may or may not be partially or fully ice covered, and fully ice covered, respectively. A value of 255 indicates that this flag is not available.
- *ice_dyn_f*: Dynamic ice cover flag indicating whether the pixel is ice-covered on the day of the observation based on analysis of external satellite optical data near the time of the SWOT observation (not based directly on the SWOT measurement). Values of 0, 1, and 2 indicate that the surface is not ice covered, partially ice covered, and fully ice covered, respectively. A value of 255 indicates that this flag is not available. Due to the latency of computing the dynamic ice flag, this value may be completely null filled in some processing versions of the data product. When available, *ice_dyn_f* is likely to be more reliable than *ice_clim_f* given that it is based on optical satellite observations representative of the surface conditions at the time of the SWOT observation.

As in Section 4.4, the value of these two flags depends upon the water body type:

- Rivers: The values of *ice_clim_f* and *ice_dyn_f* are copied from the values associated with the *reach_id* in the PRD.
- Connected lakes and disconnected lakes: The values of *ice_clim_f* and *ice_dyn_f* are copied from the values associated with the *lake_id* in the PLD.
- Unassigned features: The values of *ice_clim_f* and *ice_dyn_f* are null-filled.

5 Detailed Product Description

The L2_HR_PIXCVec adopts a NetCDF-4 file format and conventions. This is a self-documenting format that contains metadata as global attributes, dimensions, variables, and attributes for variables. Global attributes are defined at the root. Variable attributes only apply to the associated variable. The NetCDF command "ncdump –h product.nc" can be used to view the header of the product, which describes the content of the product.

5.1 NetCDF Variables

Variables are used to store the various measurements. Each variable is assigned a name and a particular data type. Variables can be scalar values (i.e. 0 dimension), or can have one or more dimensions. Each variable then has attributes that provide additional information about the variable. Descriptions of variable data types and variable attributes are provided in Table 3 and Table 4 below, respectively.

Table 3. Variable data types in NetCDF products.

Data Type	Description
char	characters
byte	8-bit signed integer
unsigned byte	8-bit unsigned integer
short	16-bit signed integer
unsigned short	16-bit unsigned integer
int	32-bit signed integer
unsigned int	32-bit unsigned integer
long	64-bit signed integer
unsigned long	64-bit unsigned integer
float	IEEE single precision floating point (32 bits)
double	IEEE double precision floating point (64 bits)

Table 4. Common variable attributes in NetCDF files.

Attribute	Description
_FillValue	The value used to represent missing or undefined data. (Before applying add_offset and scale_factor).
add_offset	If present, this value should be added to each data element after it is read. If both scale_factor and add_offset attributes are present, the data are first scaled before the offset is added.
calendar	Reference time calendar
comment	Miscellaneous information about the data or the methods to generate it.
coordinates	Coordinate variables associated with the variable
flag_meanings	Used in conjunction with flag_values. Describes the meanings of each of the elements of flag_values.
flag_values.	Used in conjunction with flag_meanings. Possible values of the flag variable.
institution	Institution which generates the source data for the variable, if applicable.
leap_second	UTC time at which a leap second occurs within the time span of data within the file.
long_name	A descriptive variable name that indicates its content.

quality_flag	Names of variable quality flag(s) that are associated with this variable to indicate its quality.
scale_factor	If present, the data are to be multiplied by the value after they are read. If both scale_factor and add_offset attributes are present, the data are first scaled before the offset is added.
source	Data source (model, author, or instrument)
standard_name	A standard variable name that indicates its content.
tai_utc_difference	Difference between TAI and UTC reference time.
units	Unit of data after applying offset (add_offset) and scale_factor.
valid_max	Maximum theoretical value of variable before applying scale_factor and add_offset (not necessarily the same as maximum value of actual data)
valid_min	Minimum theoretical value of variable before applying scale_factor and add_offset (not necessarily the same as minimum value of actual data)

5.2 KaRIn HR Pixel Cloud Vector Attribute File

5.2.1 Global Attributes

Global attributes for the L2_HR_PIXCVec product are provided in Table 5 below.

Table 5. Global attributes of L2_HR_PIXCVec product.

Attribute	Format	Description
Conventions	string	NetCDF-4 conventions adopted in this product. This attribute should be set to CF-1.7 to indicate that the product is compliant with the Climate and Forecast NetCDF conventions.
title	string	Level 2 KaRIn high rate pixel cloud vector attribute product
short_name	string	L2_HR_PIXCVec
institution	string	Name of producing agency.
source	string	The method of production of the original data. If it was model-generated, source should name the model and its version, as specifically as could be useful. If it is observational, source should characterize it (e.g., 'Ka-band radar interferometer').
history	string	UTC time when file generated. Format is: 'YYYY-MM-DD hh:mm:ss : Creation'
platform	string	SWOT
references	string	SWOT Science Algorithm Software Design: Level 2 KaRIn high rate lake single pass science algorithm software, SWOT-DD-CDM-0565-CNES, Revision A, May 31, 2022
reference_document	string	SWOT Product Description: Level 2 KaRIn high rate pixel cloud vector attribute product, SWOT-TN-CDM-0677-CNES, Revision A, May 31, 2022
product_version	string	Version identifier of this data file
crid	string	Composite release identifier (CRID) of the data system used to generate this file
pge_name	string	PGE_L2_HR_LakeSP
pge_version	string	Version identifier of the product generation executable (PGE) that created this file

Attribute	Format	Description
contact	string	Contact information for producer of product. (e.g., 'ops@jpl.nasa.gov').
cycle_number	short	Cycle number of the product granule.
pass_number	short	Pass number of the product granule.
tile_number	short	Tile number in the pass of the product granule.
swath_side	string	'L' or 'R' to indicate left and right swath, respectively.
tile_name	string	Tile name using format PPP_TTTS, where PPP is a 3-digit pass number with leading zeros, TTT is a 3-digit tile number within the pass, and S is a character 'L' or 'R' for the left and right swath, respectively.
continent_id	string	Two-letter identifier of the continents of the product granule, separated by a semi-column.
continent_code	string	One-digit (C) code of the continents of the product granule, separated by a semi-column.
time_granule_start	string	Nominal starting UTC time of product granule. Format is: YYYY-MM-DDThh:mm:ss.ssssssZ
time_granule_end	string	Nominal ending UTC time of product granule. Format is: YYYY-MM-DDThh:mm:ss.ssssssZ
time_coverage_start	string	UTC time of first measurement. Format is: YYYY-MM-DD hh:mm:ss.ssssssZ
time_coverage_end	string	UTC time of last measurement. Format is: YYYY-MM-DD hh:mm:ss.ssssssZ
geospatial_lon_min	double	Westernmost longitude (deg) of granule bounding box
geospatial_lon_max	double	Easternmost longitude (deg) of granule bounding box
geospatial_lat_min	double	Southernmost latitude (deg) of granule bounding box
geospatial_lat_max	double	Northernmost latitude (deg) of granule bounding box
inner_first_longitude	double	Nominal swath corner longitude for the first range line and inner part of the swath (degrees_east)
inner_first_latitude	double	Nominal swath corner latitude for the first range line and inner part of the swath (degrees_north)
inner_last_longitude	double	Nominal swath corner longitude for the last range line and inner part of the swath (degrees_east)
inner_last_latitude	double	Nominal swath corner latitude for the last range line and inner part of the swath (degrees_north)
outer_first_longitude	double	Nominal swath corner longitude for the first range line and outer part of the swath (degrees_east)
outer_first_latitude	double	Nominal swath corner latitude for the first range line and outer part of the swath (degrees_north)
outer_last_longitude	double	Nominal swath corner longitude for the last range line and outer part of the swath (degrees_east)
outer_last_latitude	double	Nominal swath corner latitude for the last range line and outer part of the swath (degrees_north)
xref_l2_hr_pixc_file	string	Names of input Level 2 high rate water mask pixel cloud files.
xref_l2_hr_pixcvecriver_file	string	Name of input Level 2 high rate pixel cloud vector attribute river file.
xref_prior_river_db_file	string	Name of input prior river database file.
xref_prior_lake_db_file	string	Name of input prior lake database file.
xref_reforbittrack_files	string	Names of input reference orbit track files.
xref_param_l2_hr_laketile_file	string	Name of input Level 2 high rate lake tile processor configuration parameters file.
ellipsoid_semi_major_axis	double	Semi-major axis of reference ellipsoid in meters.
ellipsoid_flattening	double	Flattening of reference ellipsoid.

5.2.2 Dimensions

Two kinds of dimensions are used in the L2_HR_PIXCVec product. One dimension is used for all of the variables, corresponding to the number of pixels. For the identifier variables, which are stored as 2-D character arrays, there is one additional dimension related to the number of characters (digits) in each identifier. These dimensions are provided in Table 6 below.

Table 6. Dimensions used in the L2_HR_PIXCVec product.

Dimension Name	Value
points	Number of pixels in the pixel cloud data.
nchar_reach_id	Number of characters in the reach_id identifier, i.e. 11
nchar_node_id	Number of characters in the node_id identifier, i.e. 14
nchar_lake_id	Number of characters in the lake_id identifier, i.e. 10
nchar_obs_id	Number of characters in the obs_id identifier, i.e. 13

5.2.3 Variables

The variables in the L2_HR_PIXCVec product with their respective attributes are provided in Table 7 below.

Table 7. Variables in the L2_HR_PIXCVec product.

Variables		
int azimuth_index(points)		
	_FillValue	2147483647
	long_name	rare interferogram azimuth index
	units	1
	valid_min	0
	valid_max	999999
	coordinates	longitude_vectorproc latitude_vectorproc
	comment	Rare interferogram azimuth index (indexed from 0).
int range_index(points)		
	_FillValue	2147483647
	long_name	rare interferogram range index
	units	1
	valid_min	0
	valid_max	999999
	coordinates	longitude_vectorproc latitude_vectorproc
	comment	Rare interferogram range index (indexed from 0).
double latitude_vectorproc(points)		
	_FillValue	9.969209968386869e+36
	long_name	height-constrained geolocation latitude
	standard_name	latitude
	units	degrees_north
	valid_min	-80
	valid_max	80
	comment	Height-constrained geodetic latitude of the pixel. Units are in degrees north of the equator.
double longitude_vectorproc(points)		

	_FillValue	9.969209968386869e+36
	long_name	height-constrained geolocation longitude
	standard_name	longitude
	units	degrees_east
	valid_min	-180
	valid_max	180
	comment	Height-constrained geodetic longitude of the pixel. Positive=degrees east of the Greenwich meridian. Negative=degrees west of the Greenwich meridian.
float height_vectorproc(points)		
	_FillValue	9.96921e+36
	long_name	height above reference ellipsoid
	units	m
	valid_min	-1500
	valid_max	15000
	coordinates	longitude_vectorproc latitude_vectorproc
	comment	Height-constrained height of the pixel above the reference ellipsoid.
char reach_id(points, nchar_reach_id)		
	_FillValue	“”
	long_name	identifier of the associated prior river reach
	coordinates	longitude_vectorproc latitude_vectorproc
	comment	Unique reach identifier from the prior river database. The format of the identifier is CBBBBBRRRRT, where C=continent, B=basin, R=reach, T=type.
char node_id(points, nchar_node_id)		
	_FillValue	“”
	long_name	identifier of the associated prior river node
	coordinates	longitude_vectorproc latitude_vectorproc
	comment	Unique node identifier from the prior river database. The format of the identifier is CBBBBBRRRRNNNT, where C=continent, B=basin, R=reach, N=node, T=type of water body.
char lake_id(points, nchar_lake_id)		
	_FillValue	“”
	long_name	identifier of the associated prior lake
	coordinates	longitude_vectorproc latitude_vectorproc
	comment	Identifier of the lake from the lake prior database) associated to the pixel. The format of the identifier is CBBNNNNNNT, where C=continent, B=basin, N=counter within the basin, T=type of water body.
char obs_id(points, nchar_obs_id)		
	_FillValue	“”
	long_name	identifier of the observed feature
	coordinates	longitude_vectorproc latitude_vectorproc
	comment	Tile-specific identifier of the observed feature associated to the pixel. The format of the identifier is CBBTTTSNNNNNN, where C=continent, B=basin, T=tile number, S=swath side, N=lake counter within the PIXC tile.
byte ice_clim_f(points)		
	_FillValue	127
	long_name	climatological ice cover flag
	standard_name	status_flag
	flag_meanings	no_ice_cover uncertain_ice_cover full_ice_cover
	flag_values	0 1 2
	valid_min	0
	valid_max	2
	source	Yang et al. (2020)
	coordinates	longitude_vectorproc latitude_vectorproc

	comment	Climatological ice cover flag indicating whether the pixel is ice-covered on the day of the observation based on external climatological information (not the SWOT measurement). Values of 0, 1, and 2 indicate that the surface is not ice covered, may or may not be partially or fully ice covered, and fully ice covered, respectively. A value of 127 indicates that this flag is not available.
byte ice_dyn_f(points)		
	_FillValue	127
	long_name	dynamical ice cover flag
	standard_name	status_flag
	flag_meanings	no_ice_cover partial_ice_cover full_ice_cover
	flag_values	0 1 2
	valid_min	0
	valid_max	2
	source	Yang et al. (2020)
	coordinates	longitude_vectorproc latitude_vectorproc
	comment	Dynamic ice cover flag indicating whether the pixel is ice-covered on the day of the observation based on analysis of external satellite optical data. Values of 0, 1, and 2 indicate that the surface is not ice covered, partially ice covered, and fully ice covered, respectively. A value of 127 indicates that this flag is not available.

6 References

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Appendix A. **Acronyms**

ATBD	Algorithm Theoretical Basis Document
CNES	Centre National d’Études Spatiales
CRID	Composite Release Identifier
HR	High Resolution
JPL	Jet Propulsion Laboratory
KaRIn	Ka-band Radar Interferometer
LR	Low Resolution
L2	Level 2
NASA	National Aeronautics and Space Administration
PIXC	Pixel Cloud
PLD	Prior Lake Database
PRD	Prior River Database
RD	Reference Document
SP	Single Pass
SWOT	Surface Water Ocean Topography
TAI	International Atomic Time
TBC	To Be Confirmed
TBD	To Be Determined
UTC	Coordinated Universal Time