



CLEV2ER Land Ice and Inland Water

AO/1-11449/22/I-AG

Software Release Note

[DD-SRN]

Ref: CRIS-TN-LIG-GS-5102

CLEV2ER-LIIW GPP Software Version 1.0.0

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Change Log

Issue	Author	Change	Status	Date
0.2.6	A.Muir	release of v0.2.6 of the GPP Software	Completed	29/6/24

0.3.4	A.Muir	release of v0.3.4 of the GPP Software for TC1	Completed	8/7/24
1.0.0	A.Muir	First major release at end of phase-1 for AR1	Completed	22/9/25

Acronyms and Abbreviations

AD	Applicable Document
ADF	Auxiliary Data File
CLEV2ER	CRISTAL LEVel-2 procEssor prototype and R&D
DEM	Digital Elevation Model
GLWD	Global Lakes and Wetland Database
GPP	Ground Processor Prototype
GSWE	Global Surface Water Experiment
IODD	Input Output Data Definition
RAM	Random Access Memory
SUM	Software User Manual
TDS	Test Data Set

Reference Documents

Ref. Id	Doc. Title	Date	Version
RD1	Input/Output Data Definition V1, DD-IODD (CRIS-DS-LIG-GS-1103)	03/2024	1.1
RD2	Requirements Specifications, (CRIS-RS-LIG-GS-1001)	03/2024	1.1
RD3	Software User and Installation Manual (CRIS-MA-LIG-GS-5101)	09/2025	1.0
RD4	Algorithm Theoretical Basis Description (CRIS-DS-LIG-GS-2101)	06/2024	1.2

Table of Contents

Change Log	1
Acronyms and Abbreviations	2
Reference Documents	2
Table of Contents	3
1 Introduction	4
1.1 Purpose and Scope	4
2 Release Version Summary	4
3 Installation	5
4 Delivery Components	5
5 Dependencies of this Version	7
5.1 Software Dependencies	7
5.1.1 Operating System Dependencies	7
5.1.2 Docker Installation	7
5.1.3 Native Installation	7
5.1.4 Python Package Dependencies	8
5.1.5 Hardware Requirements of this Version	13
6 Problems Solved in this Version	14
7 Known Issues in this Version	14
8 ADF/TDS Versions Included in this Release	15
8.1 ADF Included	15
8.2 Common ADF	17
8.2.1 Physical Constants	17
8.2.2 Mission Characterization	17
8.2.3 Geoids	17
8.3 Land Ice ADF	18
8.3.1 DEMs	18
8.3.2 Dilated Ice Masks	19
8.3.3 Glaciological Basin Ids	20

8.3.4	Mean Sea Surface	21
8.3.5	Ice Surface Type	21
8.3.6	Surface Slope & Roughness Data	22
8.3.7	Elevation Uncertainty LUTs	23
8.3.8	Tide Models	23
8.4	Inland Waters ADF	24
8.4.1	Hydrology Mask	24
8.4.2	Global Surface Water Occurrence (GSWE)	24
8.4.3	Inland Waters Surface Type (GLWD3)	24
8.4.4	Neural Net	25
8.5	CRISTAL L1b (Transcoded)	25
8.5.1	L1b Transcoded from CryoSat-2	25
8.5.2	L1b Transcoded from Sentinel-6	26
9	Version History	27

1 Introduction

1.1 Purpose and Scope

This is the Software Release Note for v1.0.0 of the CLEV2ER Land Ice and Inland Waters GPP software.

The purpose of a Software Release Note is to detail the delivered L2 GPP software version in terms of dependencies, known/solved problems and status with respect to its approved baseline.

2 Release Version Summary

This Version: 1.0.0, release date: 22/9/2025

Version 1.0.0 is the first major release as part of Phase-1 of the CLEV2ER Land Ice and Inland Waters for Acceptance Review #1.

See [chapter 9](#) for the version history of previous releases.

3 Installation

Software installation procedures are detailed in the CLEV2ER Land Ice and Inland Waters **Software User and Installation Manual** (DD-SUM), [RD-03]. The installation scripts for each install method are provided on the release portal.

4 Delivery Components

The GPP software is delivered in several different package options for:

- Native Install (on supported Linux OS).
- Docker Install.
- An external ADF/TDS package.

For both install options, there is also the option to install:

- Land Ice GPP only.
- Inland Waters GPP only.
- Both Land Ice and Inland Waters GPPs in one package.

The GPP packages for this release comprising of the above options are available for download from the project release portal:

Release Portal: http://www.cpom.ucl.ac.uk/downloads/clev2er_liiw

Links within the portal are provided below for this release, however it is recommended to follow the install procedures detailed in the software user manual (DD-SUM) rather than manually download files from these links.

Install Type	File	Size
Native Install	clev2er_liiw_both-1.0.0.tar.gz	710MB
	clev2er_liiw_li-1.0.0.tar.gz	451MB
	clev2er_liiw_iw-1.0.0.tar.gz	615MB
	SHA256 checksums (in order): 4c48c91d79b9686bde55f9061802a41af831c577f40f6fae54019fcae5c00369 402de5abff2774d360a03c4111b795a02687eddbc347ebee49b60406d2309dc9 33ec974837573a1be5a82363fb4f22b413f87fbbd2e60f777b47f3728a1fde7e	
Docker Install	clev2er_liiw_liiw-1.0.0.docker.tar.gz	2.1GB
	clev2er_liiw_li-1.0.0.docker.tar.gz	2.1GB
	clev2er_liiw_iw-1.0.0.docker.tar.gz	2.1GB
	clev2er_liiw_liiw_with_tds-1.0.0.docker.tar.gz	38GB
	clev2er_liiw_li_with_tds-1.0.0.docker.tar.gz	28GB
	clev2er_liiw_iw_with_tds-1.0.0.docker.tar.gz	12GB
	SHA256 checksums (in order): 7c4dee6b46c3f87342fd930b6963c4070e06177a7ebf41a56584a45522f2a080 af4ea0afa5c67da54d7f9b589e3c654995e44756104310ba1df298b52f7ba855 12e26c486ea507a10eea9b0c8ea0625bc723460b83ddc7dfec29fcel10bf8e018 271d9322f248a68ffc47b9033a76bc60ce1c94e65ddbb9ca2c9d4d876902aacf 7d9e4a7c22e2aac6fb64473efe062b61d8885d63d9124a4548d70f695826c7cc 5ffecd514297eda6e4a3b5335a6c96f3dd838652c0ac5ec3dbac2579a39c8937	
ADF/TDS Package	testdata_external_both_1.0.0.tar.gz	36GB
	testdata_external_li_1.0.0.tar.gz	26GB
	testdata_external_iw_1.0.0.tar.gz	16GB
	SHA256 checksum: 5154b4a8060ecc555b542c0b1b5b13571c125529a2c0dc0995e578bc8134baab 5e6d4fb848526089b48d73e8ca9b42edcbb310cd11632e25a7c705152c99f53e	

ec0dec5fe48929c3f9e0b70281260fb541e290765043d4bd9d31
f2d109f9dfc

5 Dependencies of this Version

This section defines the software and hardware dependencies of this release.

5.1 Software Dependencies

5.1.1 Operating System Dependencies

This release is designed to install and operate on:

Operating System	Version
Linux	Any Linux released since 2020 Target release: Ubuntu 24.04 LTS
MacOS*	macOS >= 12.4

*system tested on MacOS, but not a requirement, so only supported on a best effort basis.

5.1.2 Docker Installation

For Docker installations of this software release all dependencies are pre-built in the container. For key dependencies used to build the Docker image please refer to the dependencies listed for a native installation.

Software Dependency	Version
Docker	Docker Engine or Docker Desktop installed >= version 26.1.3
curl	latest (>= 7.6) for downloading release packages

5.1.3 Native Installation

For native installation (on supported operating systems) of the CLEV2ER GPP software for this release, the key software dependencies are:

Software Dependency	Version
Python	3.11.x
Poetry	latest (>= 2.1)
curl	latest (>= 7.6) for downloading release packages
ncdump	latest (optional), for verification/validation
pv	latest (optional). This optional package improves the installation progress readability.

5.1.4 Python Package Dependencies

Python package dependency requirements for this version are provided in the following table. Note that package dependencies are automatically managed by the Poetry dependency manager within this project.

Package	Version
about-time	4.2.1
affine	2.4.0
alive-progress	3.3.0
anyio	4.10.0
appnope	0.1.4
argon2-cffi-bindings	25.1.0
argon2-cffi	25.1.0
arrow	1.3.0
asciitree	0.3.3
asttokens	3.0.0
async-lru	2.0.5
attrs	25.3.0
babel	2.17.0
beautifulsoup4	4.13.5
bleach	6.2.0
blosc2	3.7.2
bottleneck	1.6.0
cartopy	0.22.0
certifi	2025.8.3
cffi	2.0.0
cftime	1.6.4.post1
charset-normalizer	3.4.3
click-plugins	1.1.1.2
click	8.2.1
cligj	0.7.2
cloudpickle	3.1.1
codetiming	1.4.0
colorama	0.4.6
comm	0.2.3
contextily	1.6.2
contourpy	1.3.3
cycler	0.12.1
dask	2025.9.0
debugpy	1.8.16
decorator	5.2.1
defusedxml	0.7.1
deprecated	1.2.18

elementpath	5.0.4
envyaml	1.10.211231
executing	2.2.1
fasteners	0.20
fastjsonschema	2.21.2
fonttools	4.59.2
fqdn	1.5.1
fsspec	2025.9.0
future	1.0.0
geographiclib	2.1
geopandas	1.1.1
geopy	2.4.1
graphemeu	0.7.2
h11	0.16.0
httpcore	1.0.9
httpx	0.28.1
idna	3.10
imagecodecs	2023.9.18
imageio	2.37.0
importlib-metadata	8.7.0
ipykernel	6.30.1
ipython-pygments-lexers	1.1.1
ipython	9.5.0
ipywidgets	8.1.7
isoduration	20.11.0
jedi	0.19.2
jinja2	3.1.6
joblib	1.5.2
json5	0.12.1
jsonpointer	3.0.0
jsonschema-specifications	2025.9.1
jsonschema	4.25.1
jupyter-client	8.6.3
jupyter-console	6.6.3
jupyter-core	5.8.1
jupyter-events	0.12.0
jupyter-lsp	2.3.0
jupyter-server-terminals	0.5.3
jupyter-server	2.17.0
jupyter	1.1.1
jupyterlab-pygments	0.3.0
jupyterlab-server	2.27.3
jupyterlab-widgets	3.0.15
jupyterlab	4.4.7

kiwisolver	1.4.9
lark	1.2.2
lazy-loader	0.4
loket	1.0.0
lxml	6.0.1
markupsafe	3.0.2
matplotlib-inline	0.1.7
matplotlib	3.10.6
mercantile	1.2.1
mistune	3.1.4
mpmath	1.3.0
msgpack	1.1.1
nbclient	0.10.2
nbconvert	7.16.6
nbformat	5.10.4
ndindex	1.10.0
nest-asyncio	1.6.0
netcdf4	1.6.3
networkx	3.5
notebook-shim	0.2.4
notebook	7.4.5
numcodecs	0.15.1
numexpr	2.12.0
numpy	1.26.4
overrides	7.7.0
packaging	25.0
pandas	2.3.2
pandoc	2.4
pandocfilters	1.5.1
parso	0.8.5
partd	1.4.2
patsy	1.0.1
pexpect	4.9.0
pillow	11.3.0
platformdirs	4.4.0
plotext	5.3.2
plumbum	1.9.0
ply	3.11
prometheus-client	0.22.1
prompt-toolkit	3.0.52
psutil	7.0.0
ptyprocess	0.7.0
pure-eval	0.2.3
py-cpuinfo	9.0.0

pyarrow	20.0.0
pyparser	2.23
pygeodesy	25.9.9
pygments	2.19.2
pyogrio	0.11.1
pyparsing	3.2.3
pyproj	3.6.1
pyshp	2.3.1
python-dateutil	2.9.0.post0
python-json-logger	3.3.0
pytmd	2.2.8
pytz	2025.2
pywin32	311
pywinpty	3.0.0
pyyaml	6.0.2
pyzmq	27.1.0
rasterio	1.4.3
referencing	0.36.2
requests	2.32.5
rfc3339-validator	0.1.4
rfc3986-validator	0.1.1
rfc3987-syntax	1.1.0
rioxarray	0.19.0
rpds-py	0.27.1
s2	0.1.9
s2sphere	0.2.5
schema	0.7.7
scikit-image	0.22.0
scipy	1.16.1
send2trash	1.8.3
setuptools-scm	9.2.0
setuptools	80.9.0
shapely	2.1.1
six	1.17.0
sniffio	1.3.1
soupsieve	2.8
stack-data	0.6.3
statsmodels	0.14.5
tables	3.10.2
terminado	0.18.1
tifffile	2023.12.9
timescale	0.0.9
tinycss2	1.4.0
toml	0.10.2

toolz	1.0.0
tornado	6.5.2
traitlets	5.14.3
types-python-dateutil	2.9.0.20250822
types-toml	0.10.8.20240310
typing-extensions	4.15.0
tzdata	2025.2
uri-template	1.3.0
urllib3	2.5.0
wcwidth	0.2.13
webcolors	24.11.1
webencodings	0.5.1
websocket-client	1.8.0
widetsnbextension	4.0.14
wrapt	1.17.3
xarray	2025.9.0
xmlschema	4.1.0
xmltodict	0.13.0
xyzservices	2025.4.0
zarr	2.18.7
zipp	3.23.0

5.1.5 Hardware Requirements of this Version

Each algorithm chain and related tools (gridding tool) have their own minimum recommended hardware (RAM, CPU) requirement, based on the resources they consume during processing. These have been measured for this release on the following Linux test server using the native install method (see DD-SUM):

Operating System:	Rocky Linux 8.10 (Green Obsidian)
CPE OS Name:	cpe:/o:rocky:rocky:8:GA
Kernel:	Linux 4.18.0-553.5.1.el8_10.x86_64
Architecture:	x86-64
Cores:	128
Model name:	INTEL(R) XEON(R) GOLD 6548Y+
CPU max MHz:	4100.0000
CPU min MHz:	800.0000
RAM:	1.0Ti

The follow table shows some typical minimum memory and cpu requirements of the GPPs and gridding tools, using representative test tracks, processed by this release on the Linux test server. Use of multiple processing cores (>16) recommended (but not required) and can speed up processing significantly when suitably configured, and as described in the DD-SUM.

GPP Chain	Peak Memory Usage (RAM) per L1b file	Minimum/Recommended number of processing cores	Criteria Used
landice	1354 MB	1/16+	Antarctic HR SIC L1b test track ¹
landice_swath	2542 MB	4/16+	Antarctic HR SIC L1b test track ¹
inlandwaters	1617MB	1/16+	HR SAC River Po test track ²
land ice gridding tool (poca)	1029MB	1/16+	5km Antarctica grid with Antarctic HR SIC L1b test track ¹
land ice gridding tool (swath)	1020MB	1/16+	5km Antarctica grid with Antarctic HR SIC L1b test track ¹

¹ Antarctic HR SIC L1b test track:

testdata/cristal/l1b/transcoded/cs2/sin/antarctica/CRA_IR_1B_HR_SIC_20190504T122545_20190504T122725_20250820T172430_0099_012_01595_____ISRD_SIR_____.NC

² River Po HR SAC L1b test track:

testdata/cristal/l1b/transcoded/cs2/sar/rivers/CRA_IR_1B_HR_SAC_20240603T010739_20240603T010949_20250822T163031_0129_029_06784_____ISRD_SIR_____.NC

6 Problems Solved in this Version

This is the first full release of the software. Subsequent release notes will detail problems solved relative to this release.

7 Known Issues in this Version

This section details the known issues at time of release of this version.

Issue #	Component	Description
1	GPP inlandwaters:alg_iw_lit_rtk	LIT retracker provided as development version only. Awaiting further specification of this algorithm's configuration and test scenarios in phase-2.
2	GPP landice (poca)	Due to transcoding issues/delays in this phase, not yet tested on Sentinel-3 transcoded L1b
3	GPP landice (poca)	Due to transcoding issues/delays in this phase, not yet tested on Altika transcoded L1b
4	GPP landice (poca)	Not yet tested on HR Fully Focussed (FF) transcoded L1b due to lack of availability
5	GPP landice_swath	Not yet tested on HR Fully Focussed (FF) transcoded L1b due to lack of availability
6	GPP landice (poca), TDS	No CATS2008a or FES2022 polar tide corrections applied when processing transcoded CS2 L1b. All corrections sourced from transcoded GEOCORR ADF.
7	GPP landice_swath GPP landice (POCA)	Two different Greenland ArcticDEM 100m DEMs versions are used (v3.0 for Swath, v4.1 POCA). Would be better to consolidate by using only one version.

8 ADF/TDS Versions Included in this Release

In this section we detail the ADF and TDS files included in

- the GPP software package's \$CLEV2ER_BASE_DIR/**testdata** directory
- additional ADF/TDS package (for large files or datasets > 1GB) which is linked during installation to \$CLEV2ER_BASE_DIR/**testdata_external**

8.1 ADF Included

This section details the Auxiliary Data Files (ADF) included in the testdata, and testdata_external directories. These directories are organized as follows:

testdata/ [for files <= 100MB]

```
|—— adf
|   |—— common
|   |   |—— geoids
|   |—— inlandwaters
|   |   |—— global_water_occurrence
|   |   |—— neural_net
|   |   |—— surface_masks
|   |   |—— surface_type
|   |—— landice
|   |   |—— dems
|   |   |—— dilated_icesheet_masks
|   |   |—— glaciological_basin_ids
|   |   |—— mss
|   |   |—— slope_data
|   |   |—— surface_type
|   |   |—— uncertainty_tables
```

testdata_external/ [for files > 100MB]

```
|—— adf
```

- |—— **inlandwaters**
 - | |—— global_water_occurrence
- |—— **landice**
 - | |—— dems
 - | |—— slope_data
- |—— **landice_swath**
 - | |—— pytmd_tide_models

8.2 Common ADF

This section details Auxiliary Data Files (ADF) common to all GPP chains and tools.

8.2.1 Physical Constants

File	CR_AX_GR_CST_AX_00000000T000000_99999999T999999_20240201T000000 CPOM SIR_V01.XML
Description	Physical Constants
Location	testdata/adf/common
Format	XML
Source	MSSL

8.2.2 Mission Characterization

File	CRA_IR__CHDN_AX_00000000T000000_99999999T999999_20240201T000000 CPOM SIR_V01.XML
Description	CRISTAL-A Mission Characterization
Location	testdata/adf/common
Format	XML
Source	MSSL

File	CS2_MISSION_TRANSCODED_CHDN_AX.XML
Description	CryoSat-2 Mission Characterization
Location	testdata/adf/common
Format	XML
Source	MSSL

File	S6_MISSION_TRANSCODED_CHDN_AX.XML
Description	Sentinel-6 Mission Characterization
Location	testdata/adf/common
Format	XML
Source	MSSL

8.2.3 Geoids

File	egm2008-5.pgm
Description	EGM2008 Earth Geopotential / Gravitational Model, 5-minute grid
Location	testdata/adf/common/geoids
Format	PGM
Source	GeographicLib / NGA https://sourceforge.net/projects/geographiclib/files/geoids-distrib/egm2008-5.zip
Reference	Pavlis, N. K., Holmes, S. A., Kenyon, S. C., & Factor, J. K. (2012). <i>The development and evaluation of the Earth Gravitational Model 2008 (EGM2008)</i> . Journal of Geophysical Research: Solid Earth, 117(B4). doi:10.1029/2011JB008916. Data: EGM2008 5' geoid grid ("egm2008-5.pgm"), distributed by GeographicLib / NGA.

8.3 Land Ice ADF

This section details Auxiliary Data Files (ADF) specific to landice and landice_swath GPP chains and gridding tools.

8.3.1 DEMs

This section details Digital Elevation Models used by the land ice components of the GPP and gridding tools.

8.3.1.1 Antarctic DEMs

1km resolution:

File/Dir	GaplessREMA1km.zarr, GaplessREMA1km_flipped.zarr
Description	REMA Gapless Antarctic DEM v1, 1km Resolution
Location	testdata/adf/landice/dems/antarctica/rema_gapless_1km/
Format	Zarr
Source	https://doi.org/10.6084/m9.figshare.19122212.v2 , and post-processed to Zarr by MSSL
Reference	Dong, Yuting; Zhao, Ji; Li, Caiyong; Liao, Mingsheng (2022). Gapless-REMA100: A gapless 100-m Reference Elevation Model of Antarctica with voids filled by multi-source DEMs. figshare. Dataset. https://doi.org/10.6084/m9.figshare.19122212.v2
Post-processing	\$CLEV2ER_BASE_DIR/src/clev2er/utills/dems/geotiff_to_zarr.py

100m resolution:

File/Dir	GaplessREMA100.zarr, GaplessREMA100_flipped.zarr
Description	REMA Gapless Antarctic DEM v1, 100m Resolution
Location	testdata_external /adf/landice/dems/antarctica/rema_gapless_100m
Format	Zarr
Source	https://doi.org/10.6084/m9.figshare.19122212.v2 , and post-processed to Zarr by MSSL
Reference	Dong, Yuting; Zhao, Ji; Li, Caiyong; Liao, Mingsheng (2022). Gapless-REMA100: A gapless 100-m Reference Elevation Model of Antarctica with voids filled by multi-source DEMs. figshare. Dataset. https://doi.org/10.6084/m9.figshare.19122212.v2
Post-processing	\$CLEV2ER_BASE_DIR/src/clev2er/utills/dems/geotiff_to_zarr.py

8.3.1.2 Greenland DEMs

1km resolution:

File/Dir	arctic_dem_1km_4.1_zarr
Description	ArcticDEM v4.1, 1km Resolution
Location	testdata/adf/landice/dems/greenland

Format	Zarr
Source	https://www.pgc.umn.edu/data/arcticdem
Reference	<i>Porter, Claire, et al., 2023, "ArcticDEM, Version 4.1", https://doi.org/10.7910/DVN/3VDC4W, Harvard Dataverse, V1</i>
Post-processing	\$CLEV2ER_BASE_DIR/src/clev2er/utis/dems/geotiff_to_zarr.py

100m resolution:

File/Dir	arcticdem_mosaic_100m_v4.1_subarea_greenland.zarr, arcticdem_mosaic_100m_v4.1_subarea_greenland_flipped.zarr
Description	ArcticDEM v4.1, 100m Resolution
Location	testdata_external /adf/landice/dems/greenland/arctic_dem_100m_v4.1
Format	Zarr
Source	https://www.pgc.umn.edu/data/arcticdem
Reference	<i>Porter, Claire, et al., 2023, "ArcticDEM, Version 4.1", https://doi.org/10.7910/DVN/3VDC4W, Harvard Dataverse, V1</i>
Post-processing	\$CLEV2ER_BASE_DIR/src/clev2er/utis/dems/geotiff_to_zarr.py

Swath processing uses v3.0:

File/Dir	arcticdem_mosaic_100m_v3_subarea_greenland.zarr, arcticdem_mosaic_100m_v3_subarea_greenland_flipped.zarr
Description	ArcticDEM v3.0, 100m Resolution
Location	testdata_external /adf/landice/dems/greenland
Format	Zarr
Source	https://www.pgc.umn.edu/data/arcticdem
Reference	<i>Porter, Claire, et al., 2023, "ArcticDEM, Version 3.0", https://doi.org/10.7910/DVN/3VDC4W, Harvard Dataverse, V1</i>
Post-processing	\$CLEV2ER_BASE_DIR/src/clev2er/utis/dems/geotiff_to_zarr.py

8.3.2 Dilated Ice Masks

The purpose of these is to provide masks surrounding Antarctica and Greenland including all areas of floating (ice shelves) and grounded ice, dilated by a configurable distance.

8.3.2.1 Antarctic Dilated Ice Mask

File/Dir	ant_dilated_grid_mask.nc
Description	Mask around Antarctica (grounded and floating ice) dilated by 10km, 500m resolution
Location	testdata/adf/landice/dilated_icesheet_masks
Format	NetCDF4
Source	Bedmachine v2, post-processed by MSSL, https://doi.org/10.5067/FPSU0V1MWUB6

Reference	Morlighem, M. (2022). MEaSURES BedMachine Antarctica. (NSIDC-0756, Version 3). [Data Set]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/FPSU0V1MWUB6 . [describe subset used if applicable]. Date Accessed 09-20-2025
Post-processing	\$CLEV2ER_BASE_DIR/src/clev2er/utl/masks/pre_processors/create_dilated_masks.py (dilation distance configurable by command line).

8.3.2.2 Greenland Dilated Ice Mask

File/Dir	grn_dilated_grid_mask.nc
Description	Mask around Greenland (grounded and floating ice) dilated by 10km, 500m resolution
Location	testdata/adf/landice/dilated_icesheet_masks
Format	NetCDF4
Source	Bedmachine v4, post-processed by MSSL, https://doi.org/10.5067/VLJ5YXKCNGXO
Reference	Morlighem, M. et al. (2021). IceBridge BedMachine Greenland. (IDBMG4, Version 4). [Data Set]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/VLJ5YXKCNGXO . [describe subset used if applicable]. Date Accessed 09-20-2025.
Post-processing	\$CLEV2ER_BASE_DIR/src/clev2er/utl/masks/pre_processors/create_dilated_masks.py (dilation distance configurable by command line).

8.3.3 Glaciological Basin Ids

8.3.3.1 Antarctic Glaciological Basin Ids

File/Dir	rignot_2016_ant_ground_icesheet_basins_2km.nc
Description	2km grid of glaciological basin identifiers over Antarctica
Location	testdata/adf/landice/glaciological_basin_ids
Format	NetCDF4
Source	http://imbie.org/imbie-3/drainage-basins/
Reference	Mouginot J, Rignot E, Scheuchl B, Millan R (2017) Comprehensive annual ice sheet velocity mapping using landsat-8, sentinel-1, and radarsat-2 data. Remote Sensing, 9(4), DOI: 10.3390/rs9040364

8.3.3.2 Greenland Glaciological Basin Ids

File/Dir	mouginot_2019_grn_ground_icesheet_basins_2km.nc
Description	2km grid of glaciological basin identifiers over Greenland
Location	testdata/adf/landice/glaciological_basin_ids
Format	NetCDF4
Source	http://imbie.org/imbie-3/drainage-basins/
Reference	Mouginot J, Rignot E, Scheuchl B, Millan R (2017) Comprehensive annual ice sheet velocity mapping using landsat-8, sentinel-1, and radarsat-2 data. Remote Sensing, 9(4), DOI: 10.3390/rs9040364

8.3.4 Mean Sea Surface

File/Dir	DTU21_MSS_Antarctic_Ice_Shelves.nc
Description	DTU21 Mean Sea Surface
Location	testdata/adf/landice/mss
Format	NetCDF4
Source	https://data.dtu.dk/articles/dataset/DTU21_Mean_Sea_Surface/19383221
Reference	Andersen, Ole Baltazar (2022). DTU21 Mean Sea Surface. Technical University of Denmark. Dataset. https://doi.org/10.11583/DTU.19383221.v2

File/Dir	DTU21_MSS_Greenland_Floating_Ice.nc
Description	DTU21 Mean Sea Surface
Location	testdata/adf/landice/mss
Format	NetCDF4
Source	https://data.dtu.dk/articles/dataset/DTU21_Mean_Sea_Surface/19383221
Reference	Andersen, Ole Baltazar (2022). DTU21 Mean Sea Surface. Technical University of Denmark. Dataset. https://doi.org/10.11583/DTU.19383221.v2

8.3.5 Ice Surface Type

8.3.5.1 Antarctic Surface Type

File/Dir	BedMachineAntarctica_2020-07-15_v02_mask_only.nc
Description	Surface type grid over Antarctica from Bedmachine v2
Location	testdata/adf/landice/surface_type/antarctica
Format	NetCDF4
Source	Bedmachine v2
Reference	Morlighem, M. (2022). MEaSURES BedMachine Antarctica. (NSIDC-0756, Version 3). [Data Set]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/FPSU0V1MWUB6 . [describe subset used if applicable]. Date Accessed 09-20-2025

8.3.5.2 Greenland Surface Type

File/Dir	BedMachineGreenland-2017-09-20_mask_only.nc
Description	Surface type grid over Antarctica from Bedmachine v3
Location	testdata/adf/landice/surface_type/greenland
Format	NetCDF4
Source	Bedmachine v3
Reference	Morlighem, M. et al. (2021). IceBridge BedMachine Greenland. (IDBMG4, Version 4). [Data Set]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/VLJ5YXKCNGXO . [describe subset used if applicable]. Date Accessed 09-20-2025.

8.3.6 Surface Slope & Roughness Data

8.3.6.1 Antarctic Slope Data

File/Dir	Antarctica_Cryosat2_1km_DEMv1.0_slope.unpacked.tif
Description	surface slope grid for Antarctica derived from CryoSat-2
Location	testdata_external /adf/landice/slope_data/antarctica
Format	TIF
Source	CPOM
Reference	Slater et al, 2018

8.3.6.2 Antarctic Roughness Data

File/Dir	rema_100m_roughness_local_relief_3x3ws_zarr
Description	100m roughness dataset derived from REMA DEM v2
Location	testdata_external /adf/landice/slope_data/antarctica
Format	Zarr
Source	PGC, https://doi.org/10.7910/DVN/EBW8UC
Reference	Howat, Ian, et al., 2022, “The Reference Elevation Model of Antarctica – Mosaics, Version 2”, https://doi.org/10.7910/DVN/EBW8UC , <i>Harvard Dataverse, V1</i>
Post processing	<i>Earthwave, script TBD</i>

8.3.6.3 Greenland Slope Data

File/Dir	grn_awi_2013_dem_slope.nc
Description	surface slope grid for Greenland derived from CryoSat-2
Location	testdata_external /adf/landice/slope_data/greenland
Format	NetCDF4
Source	CPOM
Reference	Helm et al, 2014

8.3.6.4 Arctic Roughness Data

File/Dir	arcticdem_100m_roughness_local_relief_3x3ws_zarr
Description	100m roughness dataset derived from ArcticDEM v3.0
Location	testdata_external /adf/landice/slope_data/greenland
Format	Zarr
Source	PGC https://doi.org/10.7910/DVN/3VDC4W

Reference	<i>Porter, Claire, et al., 2023, "ArcticDEM, Version 3.0", https://doi.org/10.7910/DVN/3VDC4W, Harvard Dataverse, V1</i>
Post processing	<i>Earthwave</i>

8.3.7 Elevation Uncertainty LUTs

8.3.7.1 Antarctic Uncertainty LUT

File/Dir	ant_uncertainty_ku.nc ant_uncertainty_ka.nc
Description	Elevation Uncertainty LUTs for Antarctica
Location	testdata/adf/landice/uncertainty_tables/antarctica
Format	NetCDF4
Source	CPOM
Reference	CLEV2ER LIIW ATBD [RD-04]

8.3.7.2 Greenland Uncertainty LUT

File/Dir	grn_uncertainty_ku.nc grn_uncertainty_ka.nc
Description	Elevation Uncertainty LUTs for Greenland
Location	testdata/adf/landice/uncertainty_tables/greenland
Format	NetCDF4
Source	CPOM
Reference	CLEV2ER LIIW ATBD [RD-04]

8.3.8 Tide Models

8.3.8.1 CATS2008 (Antarctic)

File/Dir	CATS2008_v2023.nc
Description	Circum-Antarctic Tidal Simulation 2008, version 2023
Location	testdata_external /adf/landice_swath/pytmd_tide_models/CATS2008_v2023
Format	NetCDF4
Source	https://www.usap-dc.org/view/dataset/601772
Reference	Howard, S. L., Greene, C. A., Padman, L., Erofeeva, S., & Sutterley, T. (2024) "CATS2008_v2023: Circum-Antarctic Tidal Simulation 2008, version 2023" U.S. Antarctic Program (USAP) Data Center. doi: https://doi.org/10.15784/601772 .

8.3.8.2 FES2022b (Arctic)

File/Dir	*_fes2022.nc
Description	FES2022b (Finite Elements Solution) tidal model
Location	testdata_external /adf/landice_swath/pytmd_tide_models/fes2022b/ocean_tide_20241025
Format	NetCDF4
Source	https://www.aviso.altimetry.fr/en/data/products/auxiliary-products/global-tide-fes/release-fes22.html
Reference	Howard, S. L., Greene, C. A., Padman, L., Erofeeva, S., & Sutterley, T. (2024) "CATS2008_v2023: Circum-Antarctic Tidal Simulation 2008, version 2023" U.S. Antarctic Program (USAP) Data Center. doi: https://doi.org/10.15784/601772 .

8.4 Inland Waters ADF

8.4.1 Hydrology Mask

File/Dir	ThematicLandMask_2p2km_v2.3_compressed.nc
Description	Sentinel-3 thematic Hydrology mask
Location	testdata/adf/inlandwaters/surface_masks
Format	NETCDF4
Source	https://sentiwiki.copernicus.eu/web/altimetry-products#AltimetryProducts-L2Products
Reference	S3 SRAL/MWR Land User Handbook

8.4.2 Global Surface Water Occurrence (GSWE)

File/Dir	occurrence_XXX_YYYv1_4_2021.tif
Description	Global Water Occurrence (GSWE 10°x10° tiles)
Location	testdata_external /adf/inlandwaters/global_water_occurrence
Format	TIFF
Source	Global Surface Water Explorer (GSWE) : https://global-surface-water.appspot.com/download
Reference	Jean-Francois Pekel, Andrew Cottam, Noel Gorelick, Alan S. Belward, High-resolution mapping of global surface water and its long-term changes. Nature 540, 418-422 (2016). (doi:10.1038/nature20584)

8.4.3 Inland Waters Surface Type (GLWD3)

File/Dir	glwd_3.avl,..
Description	Global Lakes and Wetland Database (GLWD3), version 3

Location	testdata/adf/inlandwaters/surface_type/glwd-3
Format	Grid in ArcView/ArcInfo coverage format
Source	https://global-surface-water.appspot.com/download
Reference	Lehner, B. and Döll, P. (2004): Development and validation of a global database of lakes, reservoirs and wetlands. Journal of Hydrology 296/1-4: 1-22.

8.4.4 Neural Net

File/Dir	B_in_NN.txt (Neural network input biases) B_out_NN.txt (Neural network output biases) W_in_NN.txt. (Neural network input weights) W_out_NN.txt (Neural network output weights) List_of_S3_classes.txt (Neural network list of possible classifications)
Description	Neural net data for S3 classification
Location	testdata/adf/inlandwaters/neural_net/s3
Format	ASCII txt
Source	CLS
Reference	CLEV2ER LIW ATBD [RD-04]

8.5 CRISTAL L1b (Transcoded)

Transcoded L1b files used to test the land ice and inland waters GPPs are included in the test data.

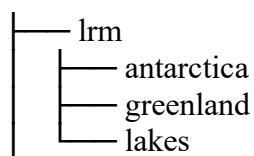
In this release the transcoder version used was 2.5.0.

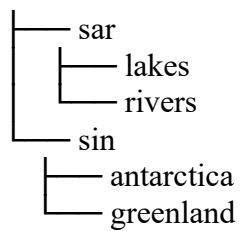
8.5.1 L1b Transcoded from CryoSat-2

A few representative example CRISTAL L1b files, transcoded from CryoSat-2 L1b, are available in the testdata directory:

testdata/cristal/l1b/transcoded/cs2/

This is further organised by CryoSat-2 original instrument mode and by area as follows:

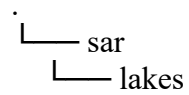




8.5.2 L1b Transcoded from Sentinel-6

L1b files transcoded from Sentinel-6 are available in

testdata/cristal/l1b/transcoded/s6



9 Version History

Version	Date	Description
0.3.4	23/06/2024	Development release for TC1. Algorithm framework + sample algorithms. First version of test harness.
1.0.0	19/09/2025	First major release at end of phase-1 for AR1 Contains complete chains for land ice (POCA) land ice (Swath) inland waters + gridding tools for land ice (POCA) land ice (Swath)