



Updated: 2026/10/05

SWOT LR Level-3 Wind & Wave product version 3.0

*changes, rationale,
expected improvements,
and known issues*



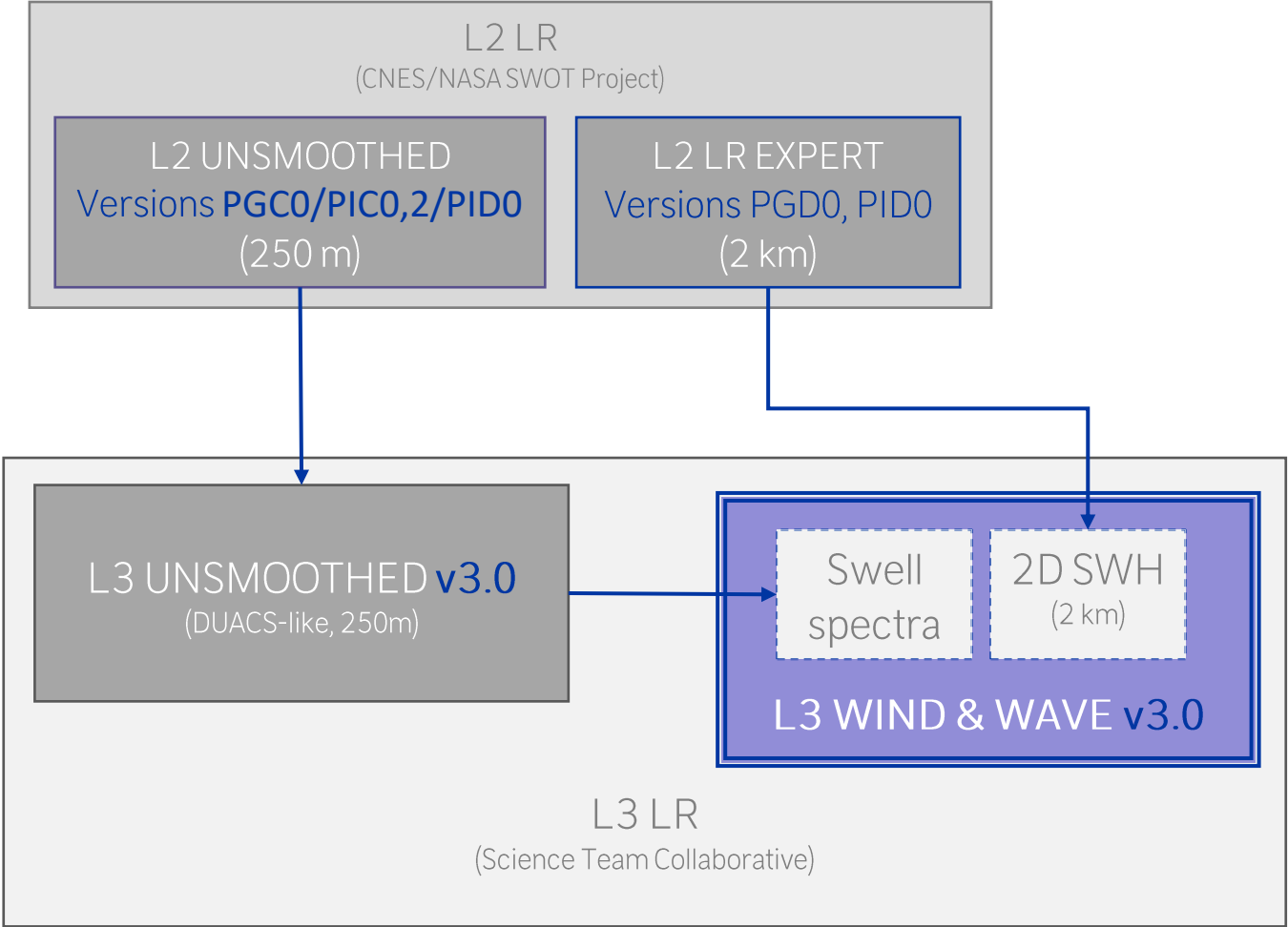
*SWOT Science Team DESMOS PROJECT
with contributions from the
VAGUES Science Team community*

Products evolution overview

- Previous and first release : v2.0.1
 - ~1 year of data is available at AVISO website
 - Wave spectrum, estimated from LR heights, for wavelengths greater than ~500 m
 - Wave parameters for one only swell partition detected per spectrum
- **New release : v3.0 in October 2026**
 - Full mission reprocessing with v3.0 algorithms
 - New calibrated swath SWH dataset included
 - More than one swell partition detected per spectrum
 - New quality flags
- Reminder: this is a collaborative product made by and for the Science Team.
YOUR feedback (positive or negative), your inputs and needs are most needed to guide the definition of future releases

If you need help with the L3, feel free to contact the AVISO helpdesk:
aviso-swot@altimetry.fr

L3 LR Wind Wave v3.0 upstream version dependencies



L3 LR Wind Wave v3.0 changes in a nutshell

New variables

- Swath SWH at 2 km posting
- New quality flag variables and states

Algorithms

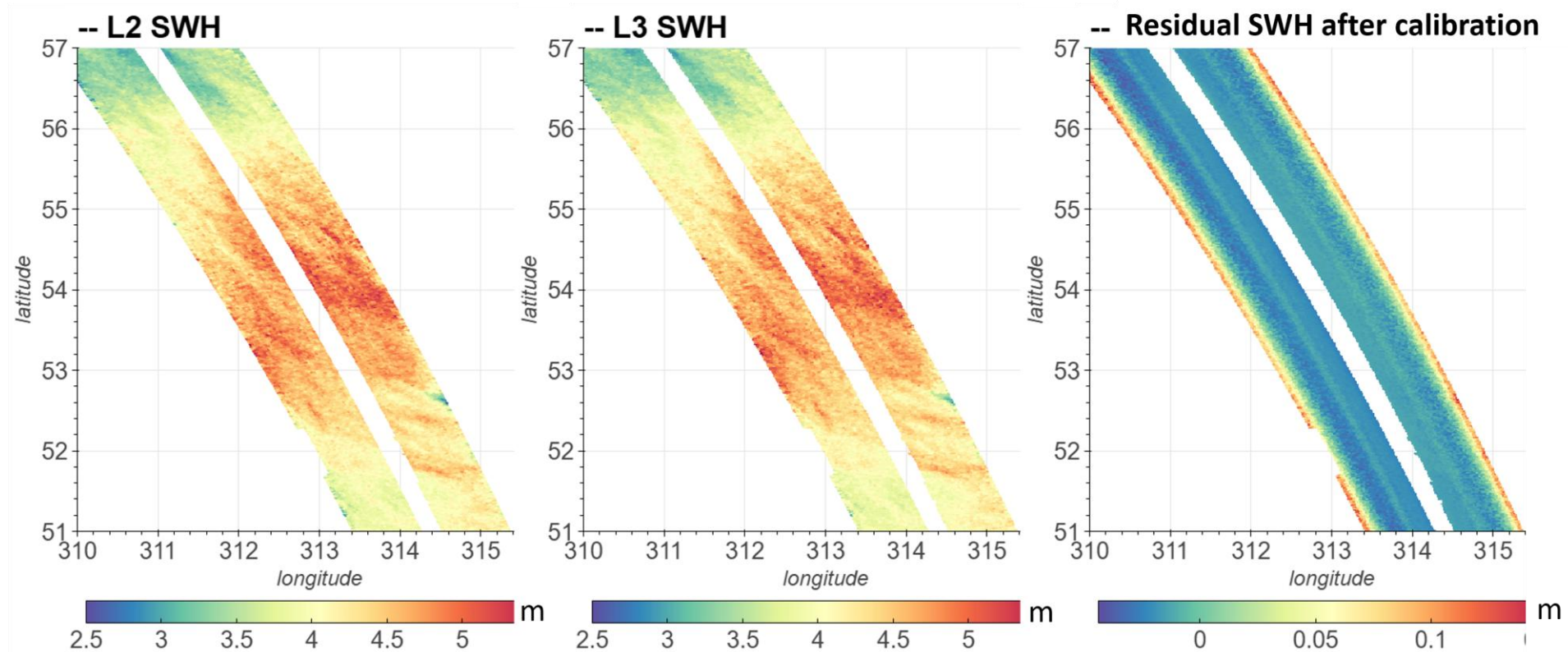
- Orbital calibration of the swath SWH
- Additional quality flags accepted and improved gap-filling approach for input SSHA and sigma0 datasets
- New partitioning algorithm for SWOT spectrum for identifying multiple swell regimes in one spectrum
- Resolution of the wave direction ambiguity not anymore based on model inputs but on the cross-spectrum between heights and backscatter

Other changes

- Changes in products structure and variable names
- Enforcement of an odd number of frequency bins and ensure symmetric frequency bands

New variables: Calibrated swath SWH variable (1/3)

- The L2 swath SWH variable shows systematic instrumental errors varying over long time scales (sun-related beta angle), until L2 PID0 version
- The v3 of the SWOT L3 WIND WAVE product uses the empirical calibration proposed by A. Bohe at the SWOT ST 2025 meeting (Bohe et al. 2025b) to provide a SWH dataset corrected for this long-time scale errors



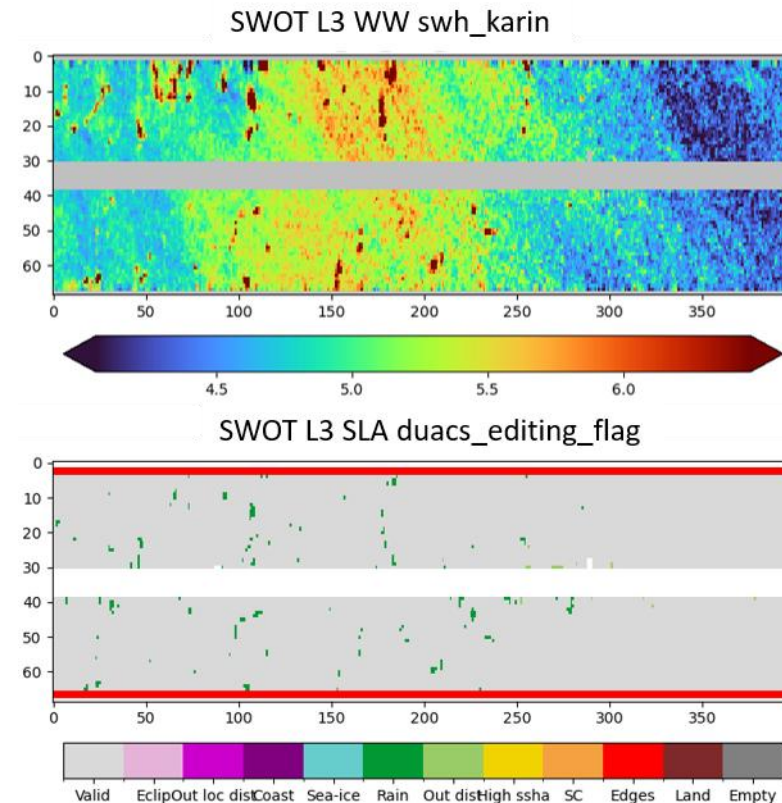
New variables: Calibrated swath SWH variable (2/3) – Recommended editing

- No dedicated quality flag is proposed for the swath SWH variable in this v3.0, but is planned for a future release
- In the meantime, users are advised to use the following quality flags from other products, by order of priority, whenever applicable:

Product	Flag dataset	Quality states/values not recommended for use
SWOT L3 Ocean Topography 2km v3.0	duacs_editing_flag	• 10 – suspected coastal pixels • 20 – sea ice pixels • 25 – rain cells • 50 – abnormally high SSHa values • 70 – pixels impacted by spacecraft events • 100 – edges of swath • 101 – pixels over land • 102 – no SSHa values available
SWOT L2 Expert 2km, version D (PGD0, PID0, PID2)	swh_karin_qual	• Bit #5 – suspect state, probable rain • Values > 65536 – degraded states

New variables: Calibrated swath SWH variable (3/3) – Known features

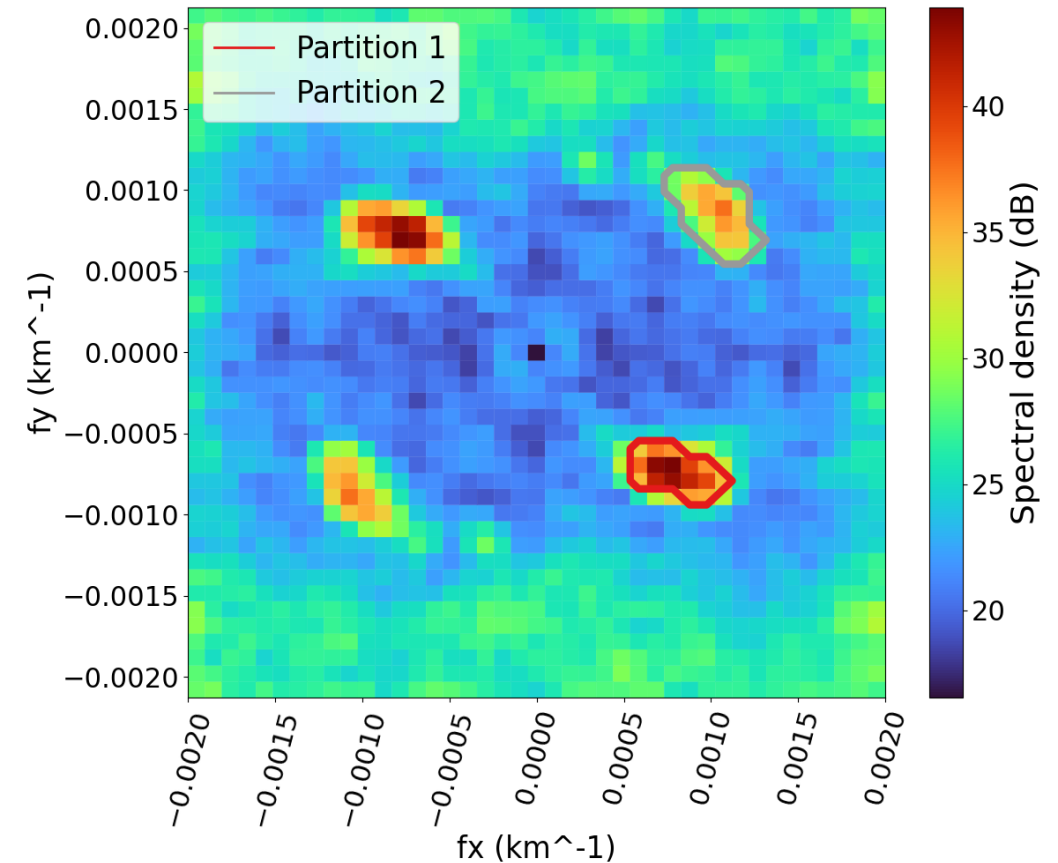
- Four main features have been identified in the SWH variable to date:
 - Reduced performance for low SWH (<1 m) and far range due to retrieval sensitivity from interferometric correlation at these regimes
 - Remaining instrumental errors at suborbital scales, appearing as along-track artifacts in SWH maps
 - Drastic underestimation of SWH close to the coast, when strong backscatter gradients are present
 - Rain corrupted measurements
- In consequence, users are advised to:
 - use very low SWH values with caution
 - use SWH located at far range pixels with caution (far range pixels can be identified using the `cross_track_distance` variable in the product)
 - edit SWH pixels for the quality values recommended in the previous slide
- The current editing strategy is imperfect; rain-contaminated data are expected to be only partially removed



Example of rain signatures in the SWOT L3 WW swh_karin dataset and editing capacity of the external SWOT L3 SLA duacs_editing_flag dataset

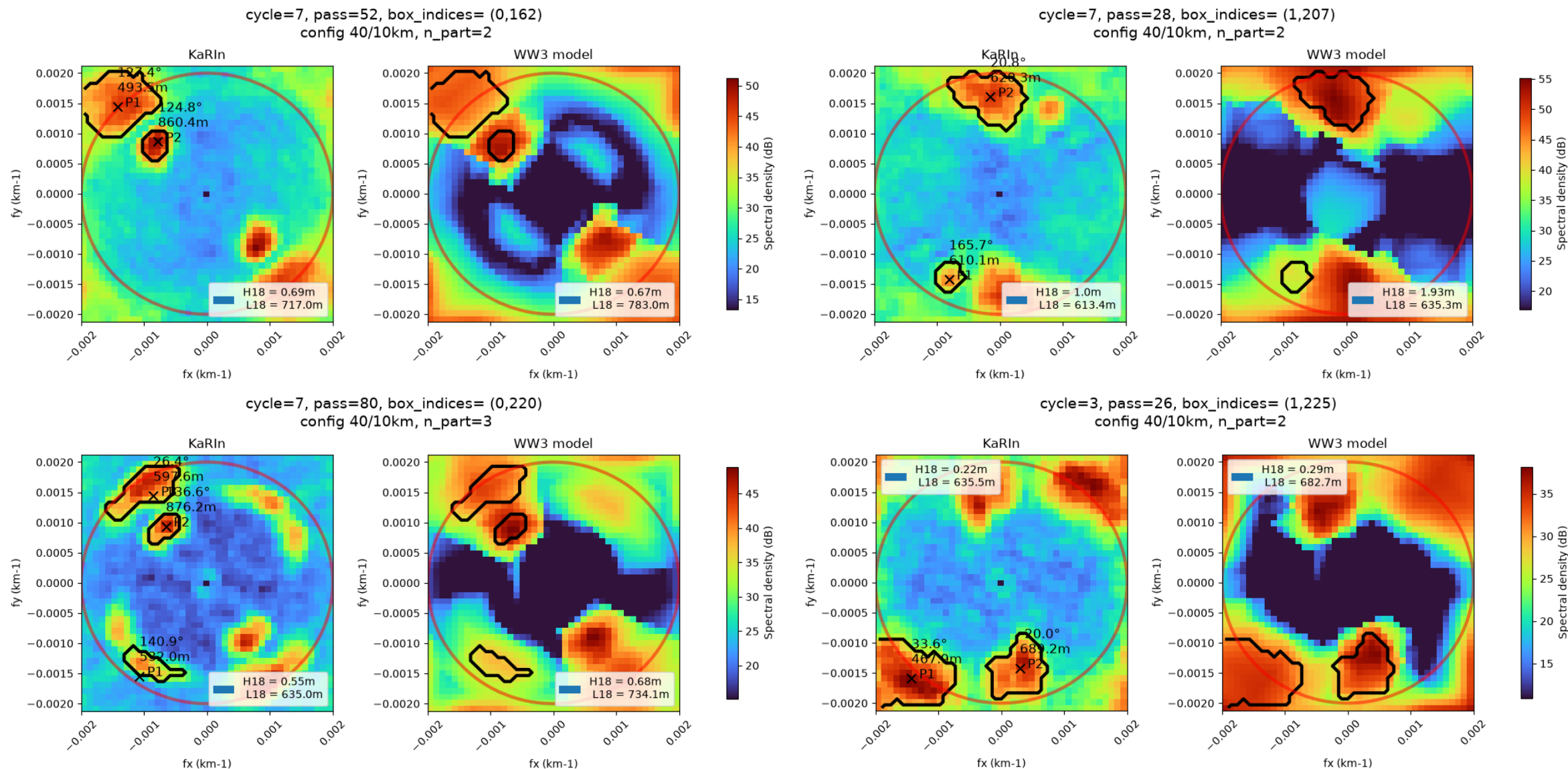
New algorithms: New spectral partitioning algorithm (1/3)

- **OLD** : version-2 relied on the WW3 wave model to identify swell regions: energy clustering was applied to detect one multiple separated energy clusters that were included into a single swell mask at the end.
- **NEW** : In version-3, swell partitions are identified directly from the SWOT spectrum using a watershed-based partitioning algorithm that provides separate masks for distinct energy clusters within the spectrum.
- **Rationale**: allow to successfully distinguish multiple swell systems when present in the same scene and provide associated wave parameters separately



Example of SWOT L3 WW (cycle 5, pass 26) at (208.4°, 42.9°), presented in SWOT referential

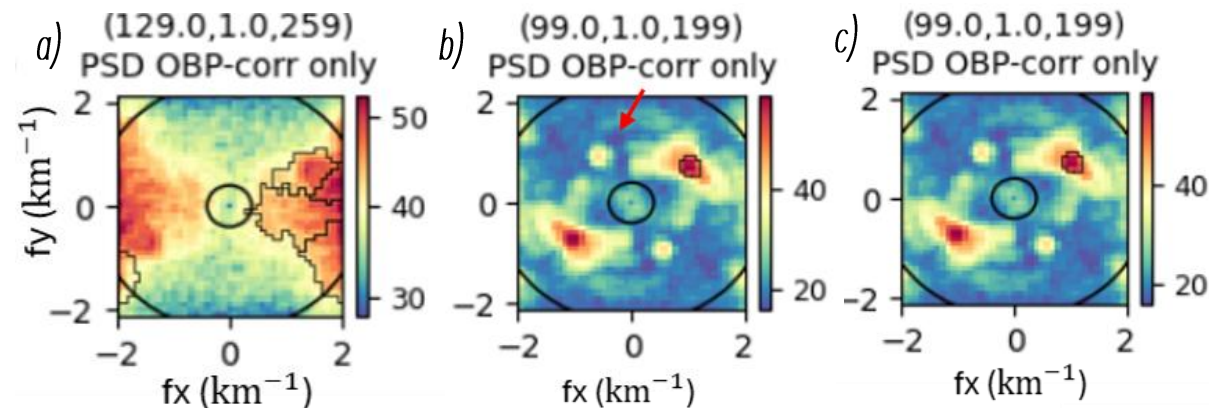
New algorithms: New spectral partitioning algorithm (2/3) - Examples



Examples of SWOT L3 WW spectra datasets, presented in SWOT referential

New algorithms: New spectral partitioning algorithm (3/3) - Limitations

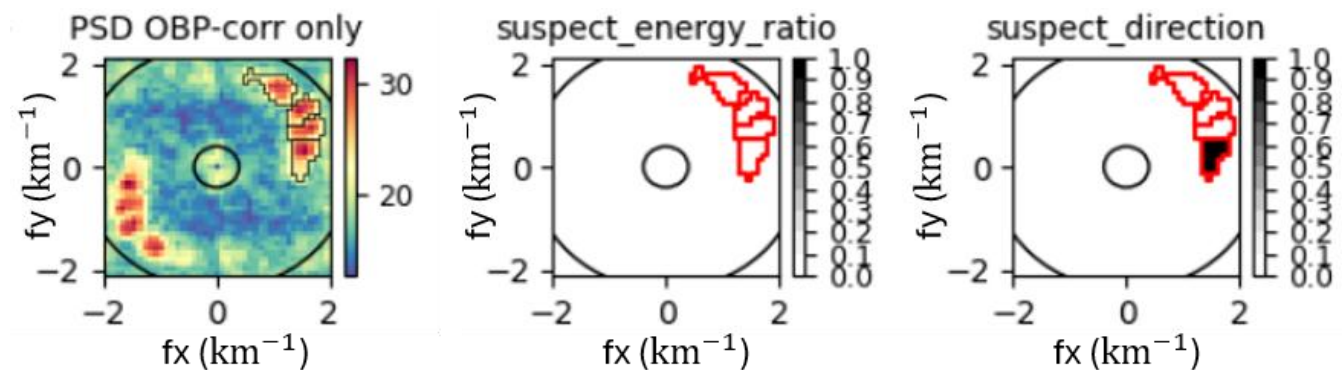
- **Known limitations:** limitations appear at challenging scenarios such as noisy spectral estimations and very low energy swell. They are most commonly reflected in the following situations:
 - a) Multiple partitions might be detected for one unique swell system
 - b) Some swell systems are not detected
 - c) Part of the swell energy is left out of the partition contours



Examples of limitations of the partitioning algorithm as described in the text, extracted from (cycle 5, pass 84, configuration 40 km box /10 km tile)

New algorithms: Resolution of the direction ambiguity directly based on SWOT data

- **OLD** : The L3 v2.0.1 product resolves directional ambiguity using auxiliary model data (WW3).
- **NEW** : The L3 v3.0 resolves directional ambiguity using the phase difference between SSHA and sigma0, based on wave bunching principle.
- **Rationale**: avoid to rely in model data as much as possible
- **Limitations**: directional ambiguity for cross-track swells is resolved with low confidence because they generate little radial orbital motion relative to the radar making the wave bunching signal weak. In practice, this situation is captured by the "suspect_direction" bit of the partitions_quality_flag variable

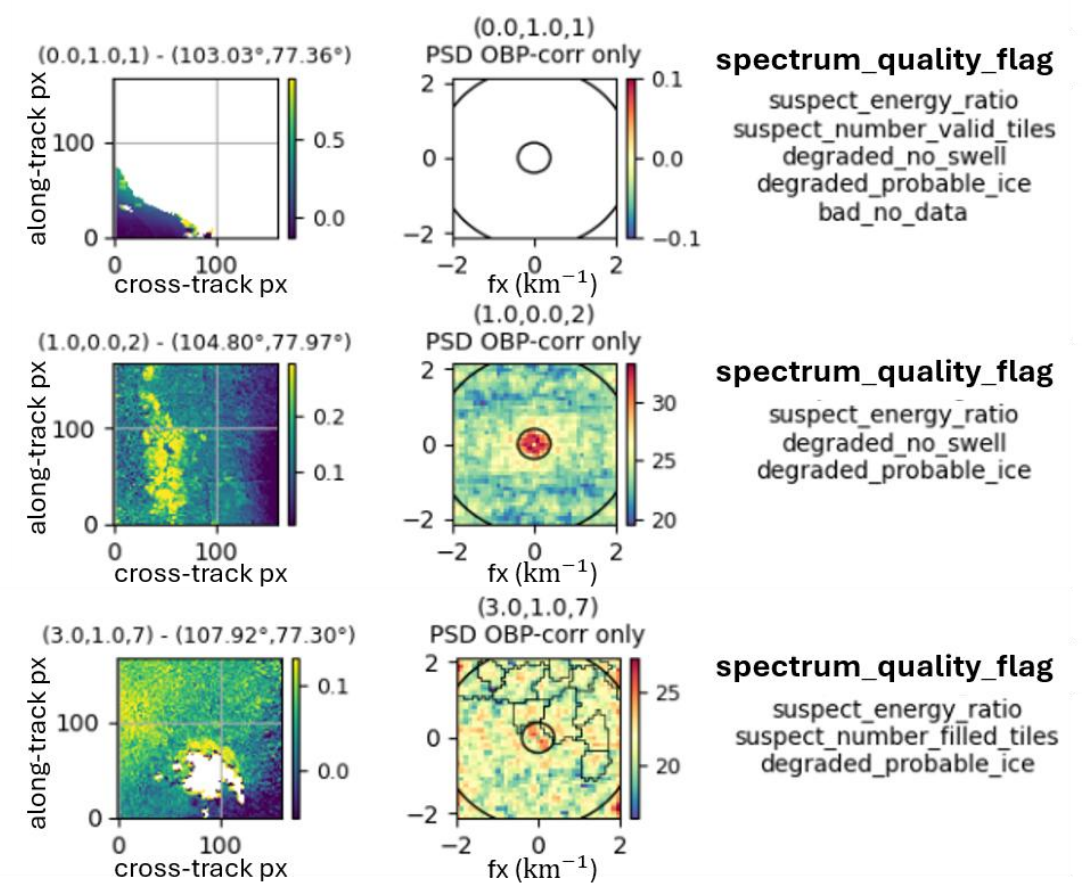


Example of activation of the bit "suspect_partition" (right plot) of the partitions_quality_flag variable for a pure cross-track swell

New variables: spectrum quality flag (1/2)

- The `quality_flag` variable changes its name to `spectrum_quality_flag` and adds new quality states
- The `spectrum_quality_flag` variable is bit-wise: multiple quality states can co-exist

Flag value (#bit)	State	Meaning
0	Good	Good data
1 (#0)	Suspect	Ratio of energy between first partition and whole spectrum is below 50%
2 (#1)	Suspect	Low number of valid tiles (<25%)
4 (#2)	Suspect	A high number of tiles have been gapfilled (>25%)
8 (#3)	Suspect	High inter tiles SSHA variability
256 (#8)	Degraded	Probable absence of swell
512 (#9)	Degraded	Probable ice pollution
1024 (#10)	Degraded	Probable rain pollution
4096 (#12)	Degraded	No matching WW3 model found
32768 (#15)	Bad	Not enough valid pixels (<33%)

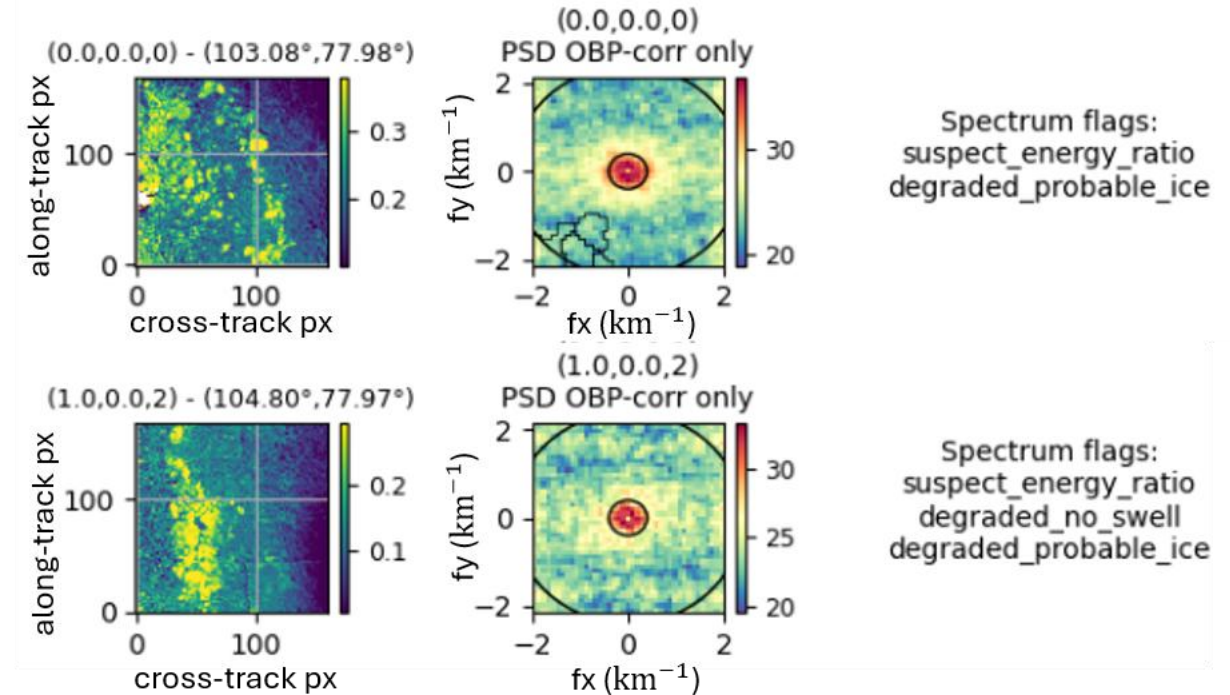


Examples of activation of different `spectrum_quality_flag` states (3^d column) for different L3 spectra (2nd column). The respective SSHA snapshot is included in the 1st column. Detailed information can be found in the handbook.

New variables: spectrum quality flag (2/2) - Limitations

● Limitations:

- The degraded_no_swell state sometimes fails to activate despite the absence of swell in the scene
- The degraded_no_swell state has been designed for the 40/10 km box/tile configuration. Therefore, we recommend:
 - for the 40/5 km configuration: to use the degraded_no_swell state from the 40/10 km configuration
 - for the 10/5 km configuration: to use its own degraded_no_swell state, keeping in mind that it under detects no-swell situations
- The suspect_energy_ratio is activated too often. We recommend that users rather rely primarily on the suspect_energy_ratio state provided in the partitions_quality_flag
- The degraded_probable_rain state fails to recognize part of rain signatures. Its activation follows the respective activation of rain state in the duacs_editing_flag of the L3 Unsmoothed product
- The degraded_probable_ice state fails to recognize part of ice signatures. Its activation follows the respective activation of ice-related states in the duacs_editing_flag of the L3 Unsmoothed product



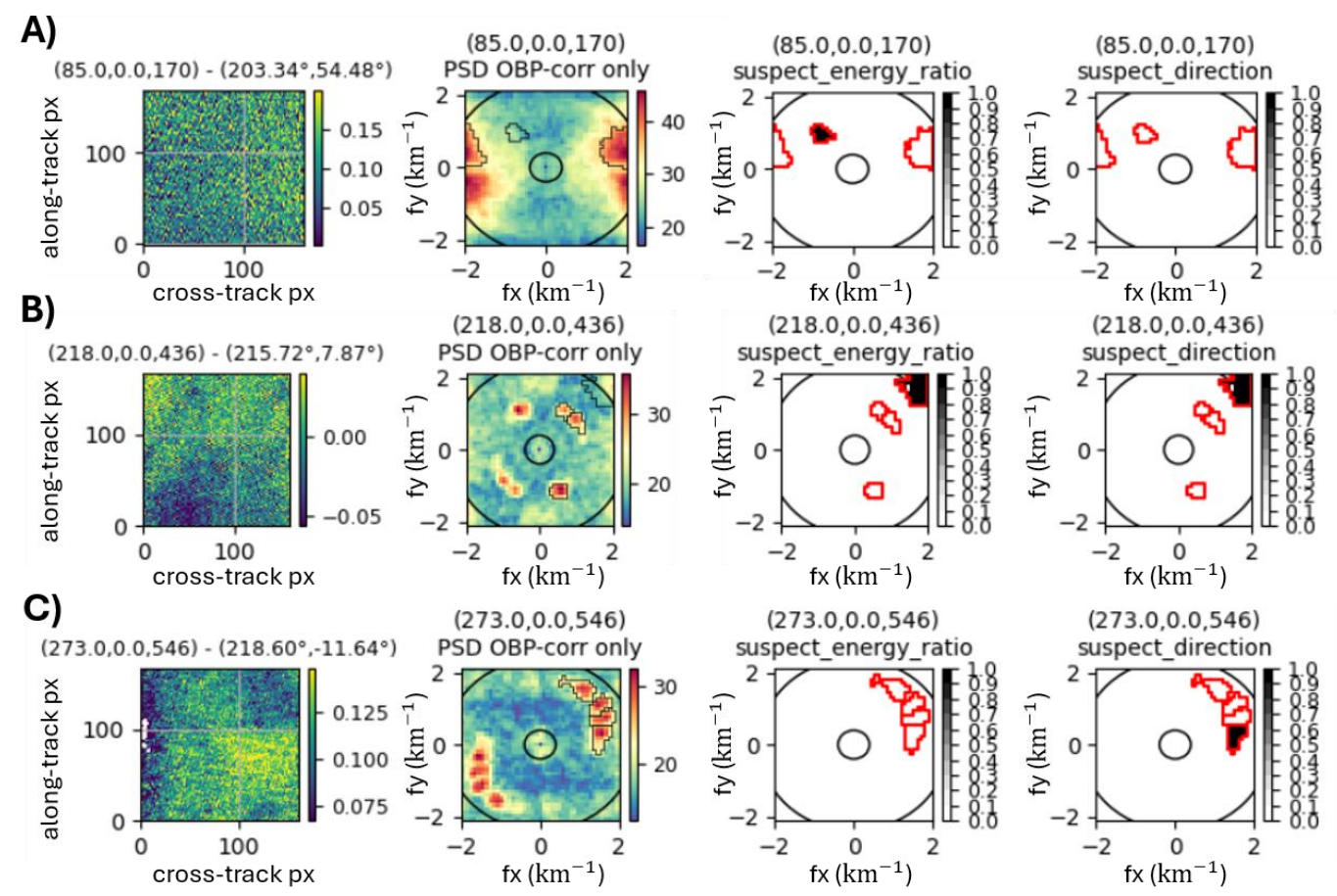
Examples of unsuccessful activation (first line) and successful activation (second line) of the stated degraded_no_swell. The examples are extracted from cycle 5 pass 84 (configuration 40 km box /10 km tile). Detailed information can be found in the handbook.

New variables: partitions quality flag

- New `partitions_quality_flag` variable
- The `partitions_quality_flag` variable is bit-wise: multiple quality states can co-exist

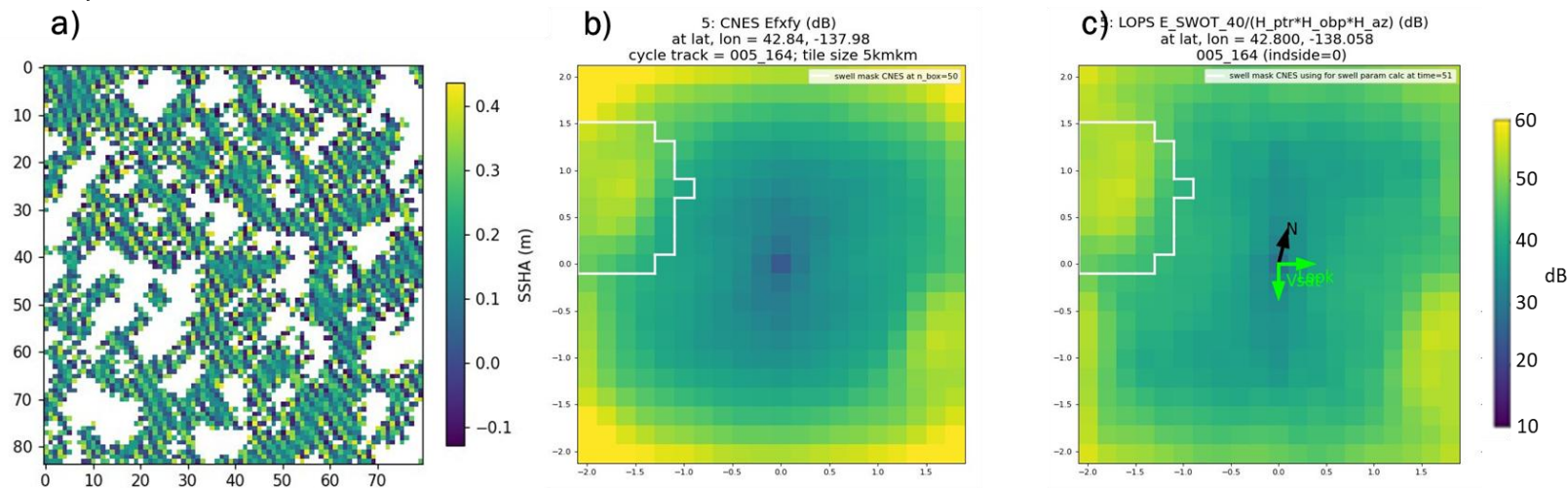
Flag value (#bit)	State	Meaning
0	Good	Good data
1 (#0)	Suspect	Ratio of energy between the partition and the background is below 20%
2 (#1)	Suspect	The directional ambiguity has been resolved, but confidence remains low.
32768 (#15)	Bad	No partitions detected

- The `suspect_energy_ratio` state is activated when the power contrast between the partition and the background is weak, suggesting that the partition probably does not contain a true swell (cases A and B).
- The `suspect_direction` state points cases where the direction ambiguity was difficult to resolve (cases B and C). As expected, this state seems to be systematically activated for cross-track swells (case C)



New algorithms: quality flags accepted for input SSHA and sigma0 datasets

- **OLD** : In the L3 v2.0.1 product, input SSHA pixels were not selected if flag #5 of the duacs_editing_flag variable was activated. This resulted in wave groups being edited in many areas
- **NEW** : In L3 v3.0 flag #5 and flag values related to ice presence are now accepted. The possible presence of ice is reported as a bit state within the spectrum quality flag.
- **Rationale**: avoid rejecting wave groups and avoid rejecting pixels erroneously flagged as "ice". The user will have the choice to consider or not "ice" pixels

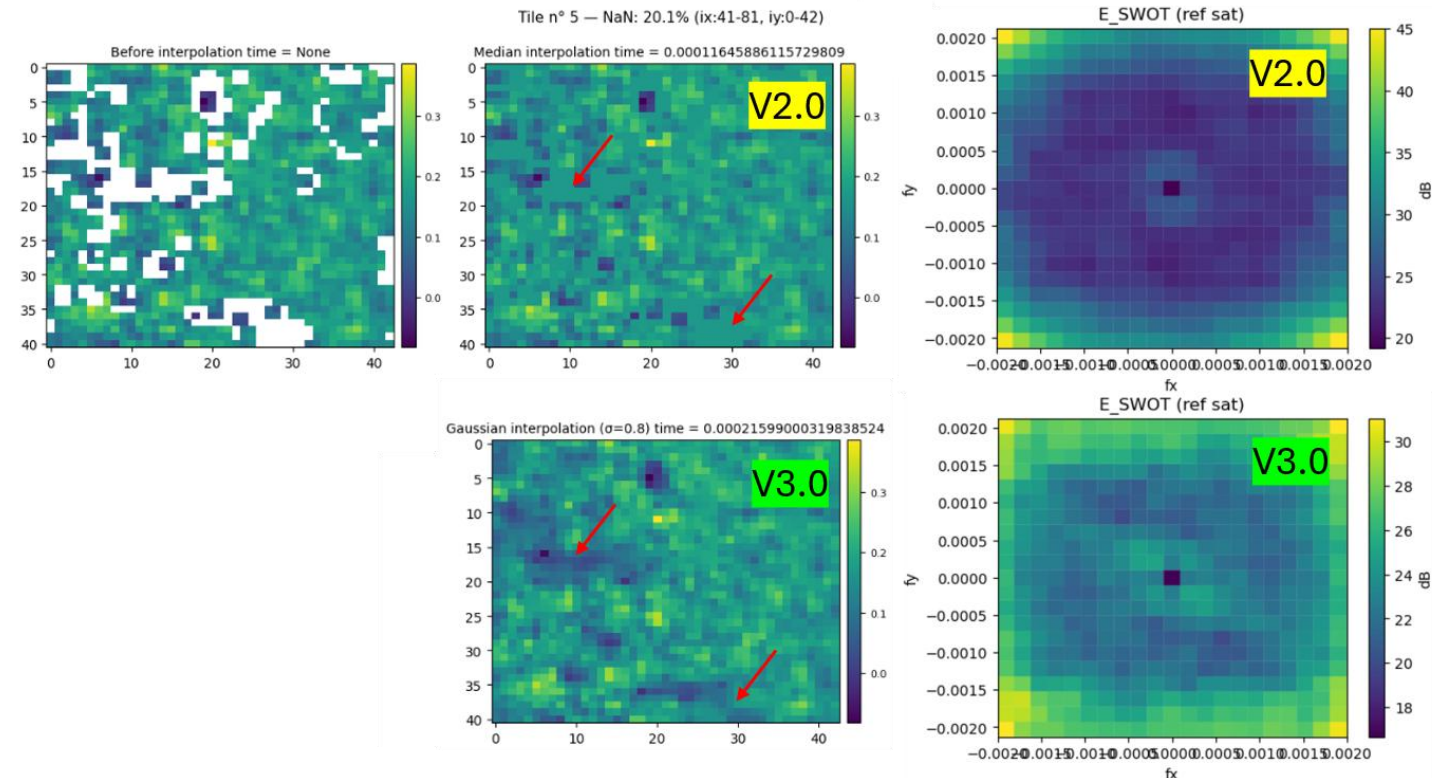


a) Snapshot of SSHA with masked pixels (in white) according to the quality flag values described used in v2.0. b) L3 WW spectrum over this region. c) Spectrum of heights if no masking was applied to the SSHA matrix

New algorithms: Improvement of the gap-filling approach in input datasets

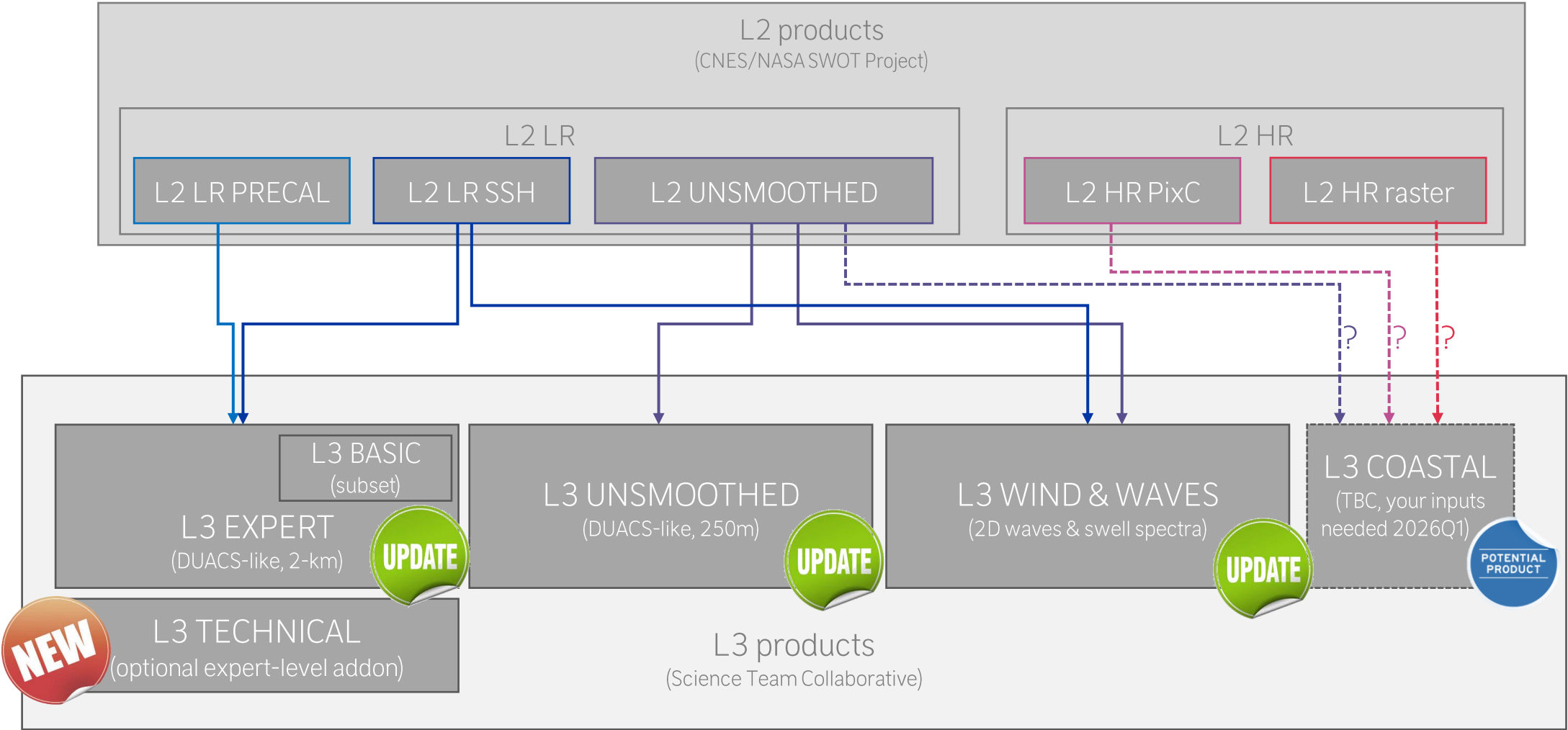
- **OLD:** In v2.0.1, non-valid pixels were gap-filled using the median of the valid pixels in the same box. Although computationally efficient, this approach introduced strong spatial discontinuities and could significantly affect the spectral estimation.
- **NEW:** In v3.0, non-valid pixels are gap-filled using a Gaussian filter ($\sigma = 0.8$, selected based on a sensitivity analysis). non-valid values after gap-filling are rejected.
- **Rationale:** reduce artificial spatial discontinuities that artificially inflates spectral energy at small wavelengths

Illustration of the impact of the gap-filling approaches used in v2.0 (second column) and v3.0 (third column). The plot of first column depicts the input SSHA used in this example, edited for the v2.0 flag values



L3 KaRIn products general information

Level-3 products family picture and upstream dependencies



Thank you for your attention !



L3 Wind & Wave product access

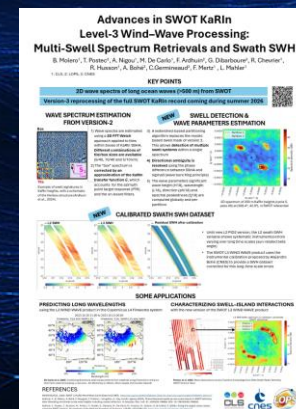
<https://doi.org/10.24400/527896/a01-2024.016>

<https://doi.org/10.24400/527896/a01-2024.017>

Handbook: https://www.aviso.altimetry.fr/fileadmin/documents/data/tools/hdbk_SWOT_L3_LR_WIND_WAVE.pdf

Your feedback is very welcome: let us know!

AVISO helpdesk for SWOT
aviso-swot@altimetry.fr



Reference poster
publication for
SWOT L3
Wind-Wave
version-3