Swath Processing Improvements of CryoSat-2 for the Study of Ice Caps and Mountain Glaciers

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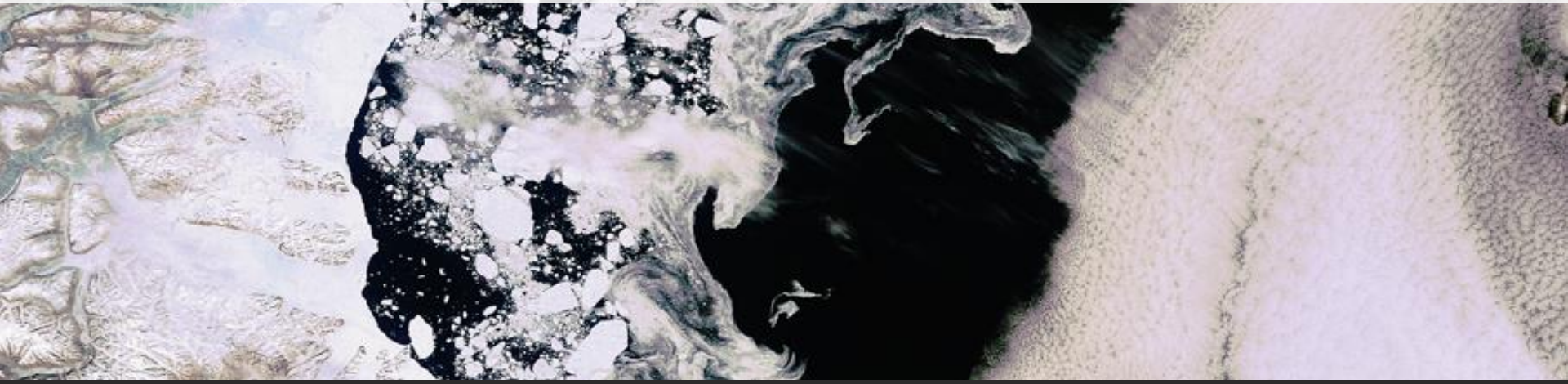

Research and services provider enterprise in the Earth Observation Field

Outline

1. Introduction
2. Processing Chain
3. Validation
4. Future improvements
5. Conclusions

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1. **Introduction**
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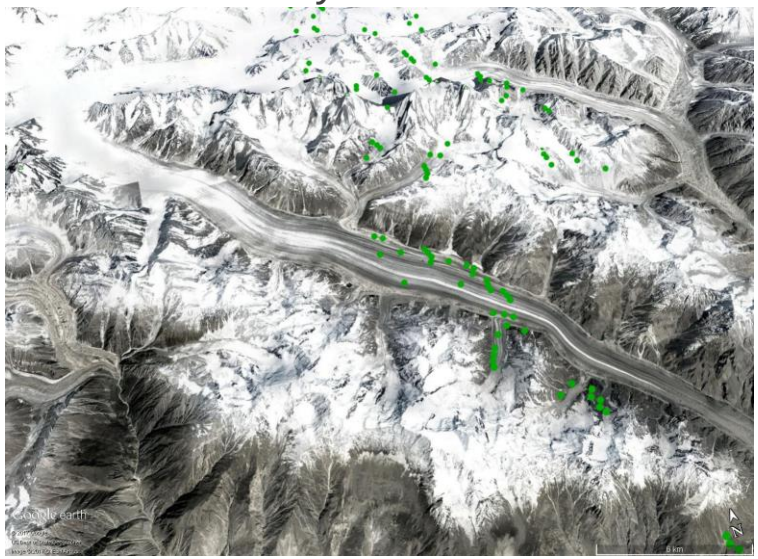
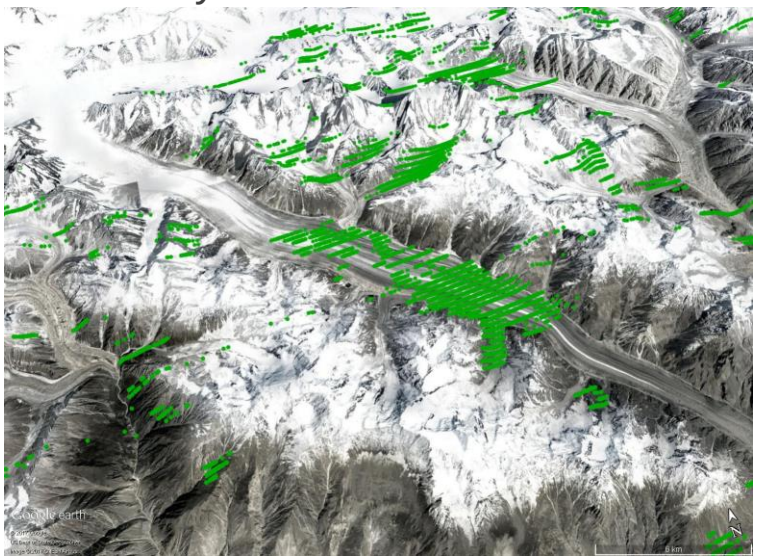
- Swath processing - Single track comparison (Karakoram Glacier)

Nominal CryoSat-2 SARIn L2

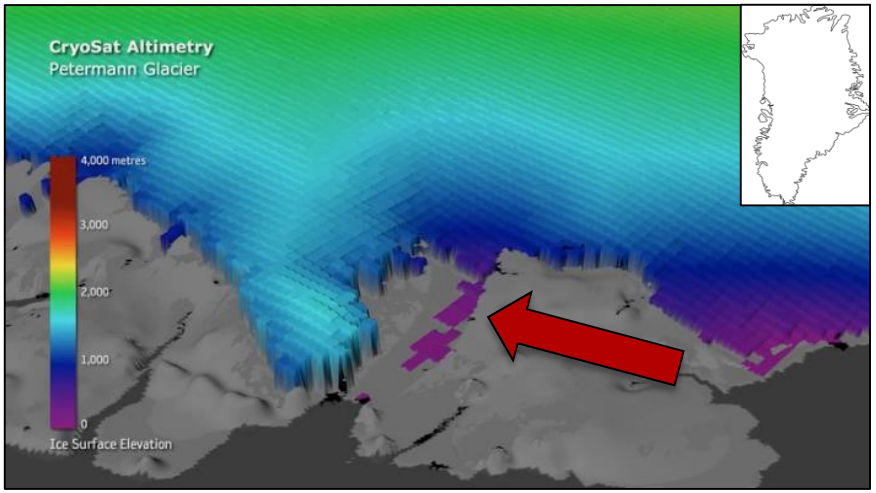


CryoSat-2 Swath SARIn

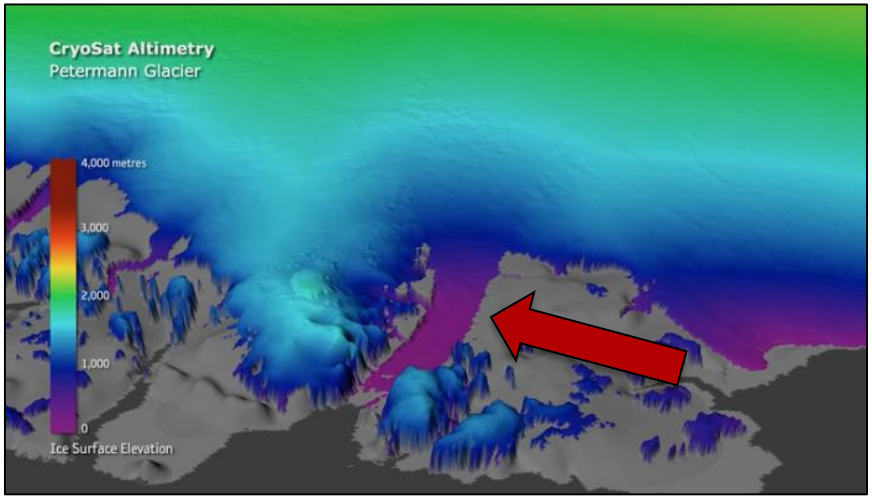


- Swath processing - Combined dataset comparison

Nominal CryoSat-2 SARIn L2



CryoSat-2 Swath SARIn



1. Introduction

- Objective: Explore the CR2 SARIn data to its maximum expression.
- Swath processing can be improved.
- Projects involved in the design and implementation of the processing chain.
  - **Dragon 3**: Lakes of the Tibet Plateau:
    - Identification of the main issues of the SARIn mode over complex scenarios.
  - **S6 GPP** + **DeDop**:
    - Design and implementation of the SAR processing chain
  - **CryoSat+Topography**:
    - Development and implementation of the SARIn L2 algorithms
  - **CryoSat+Mountain Glaciers (MOGLA)**:
    - Development and implementation of the SARIn L1BS algorithms.
    - Validation of the data.

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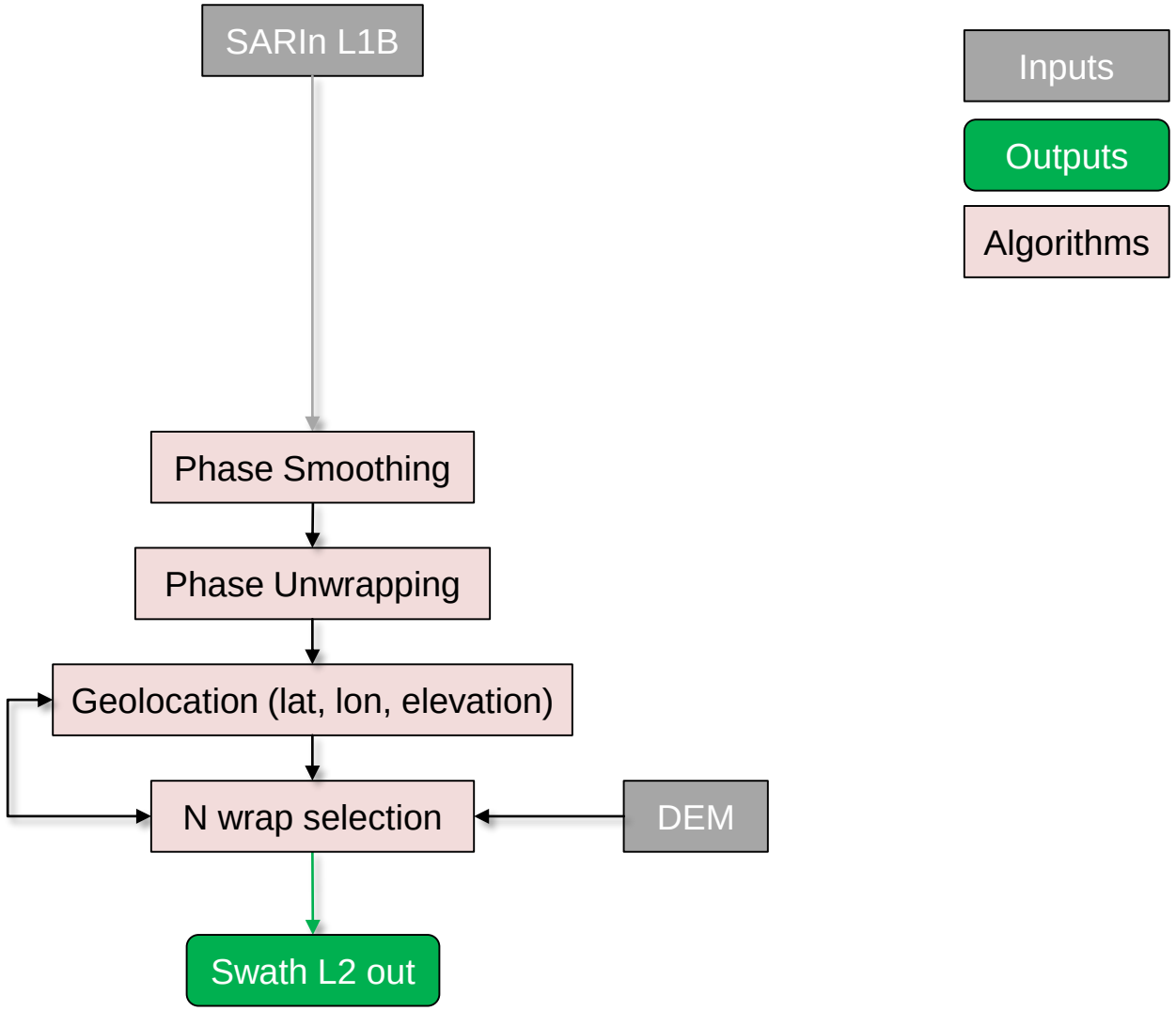
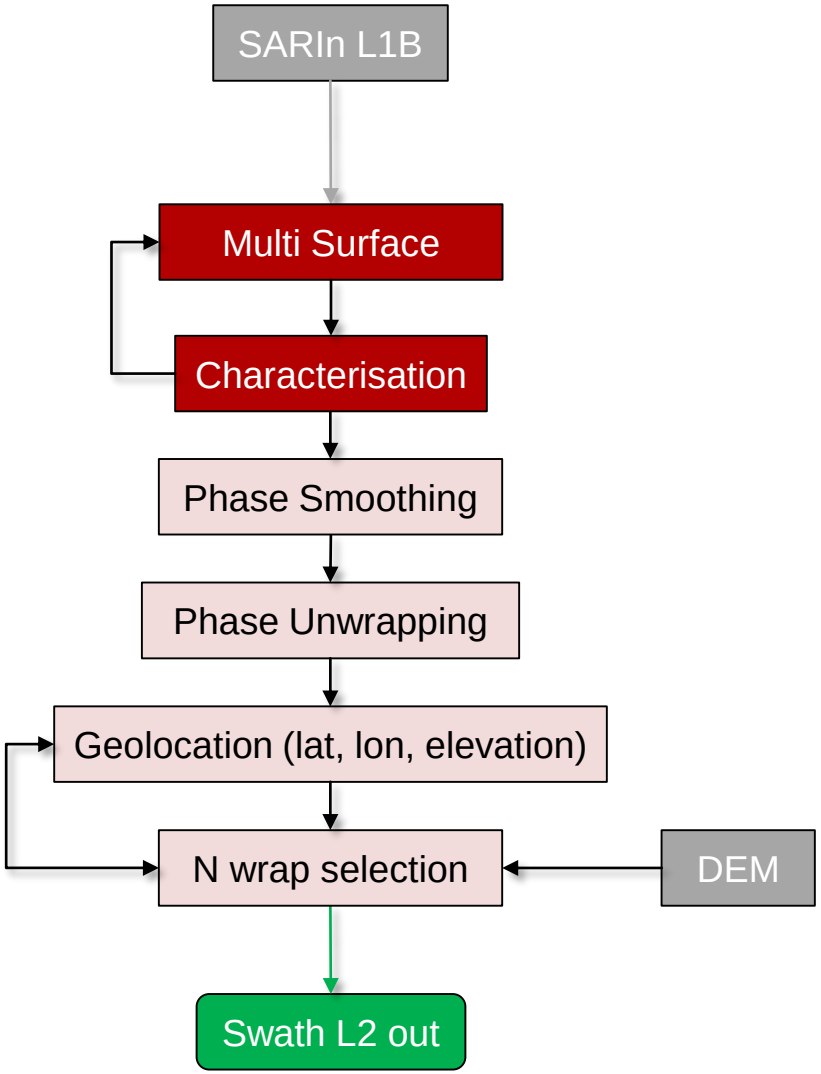
2. Processing Chain

- Swath processing



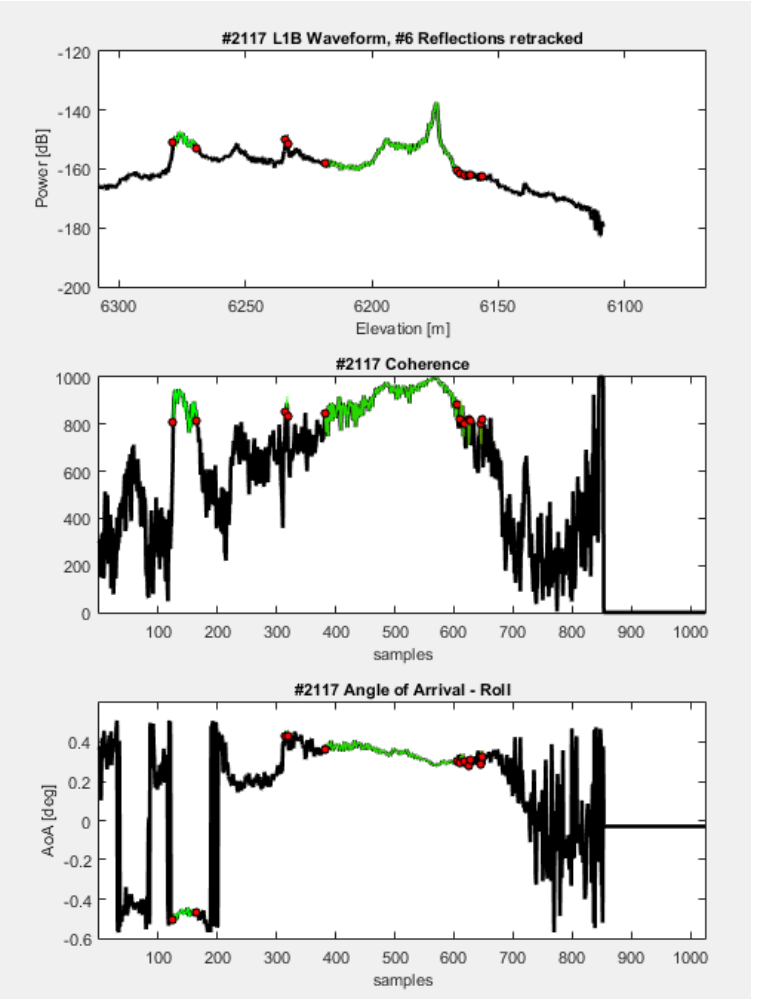
2. Processing Chain



2. Multi Surface

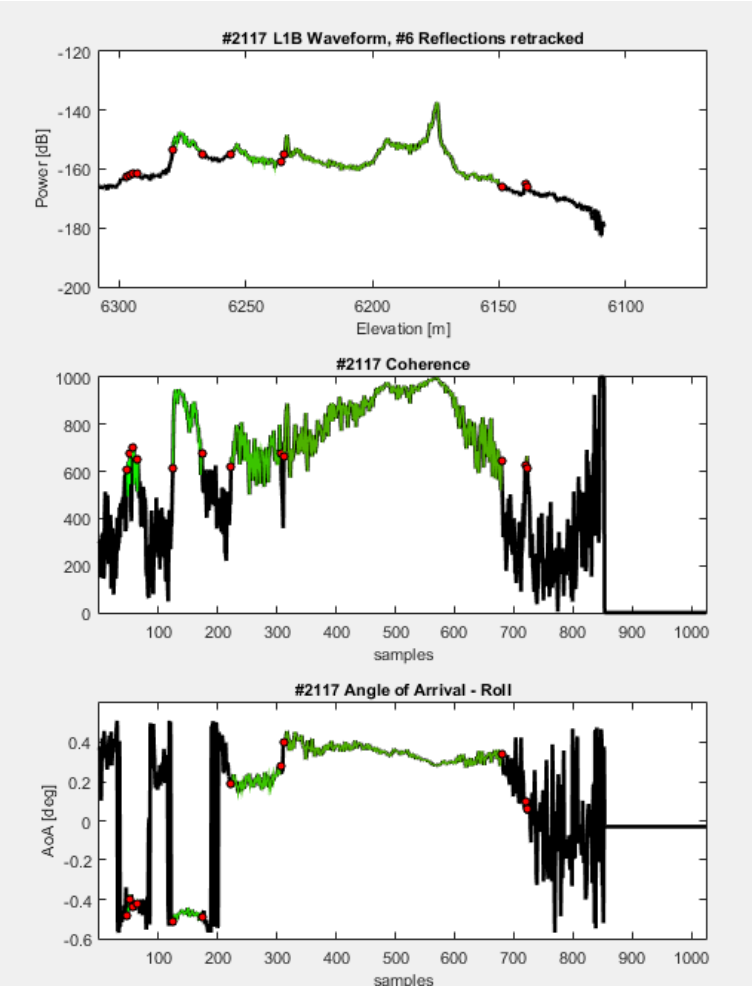
- The waveforms are divided in different sections based on the coherence and power.
- Then the different sections are characterised (peakiness, mean values, variability).

Coherence 0.8

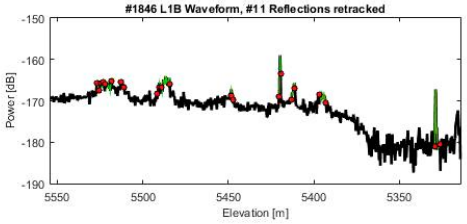


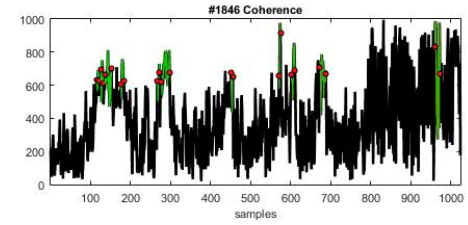
2. Multi Surface

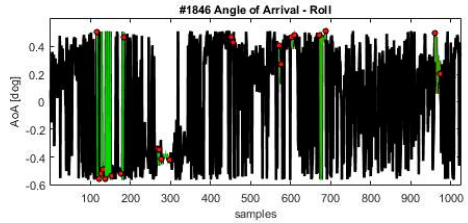
- The waveforms are divided in different sections based on the coherence and power.
- Then the different sections are characterised (peakiness, mean values, variability).
- The coherence threshold is relaxed to include more measurements without degrading the quality.
- The slope and the noise of the interferometric phase are key factors



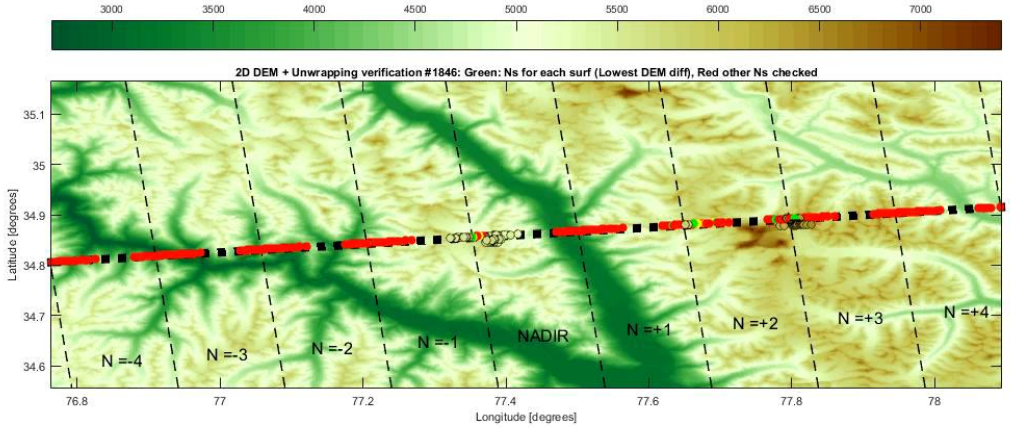
2. Multi Surface + Swath

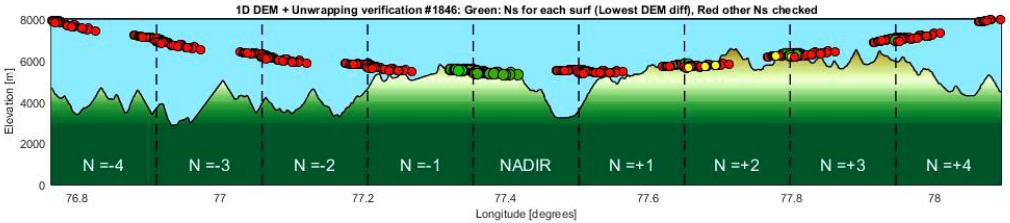


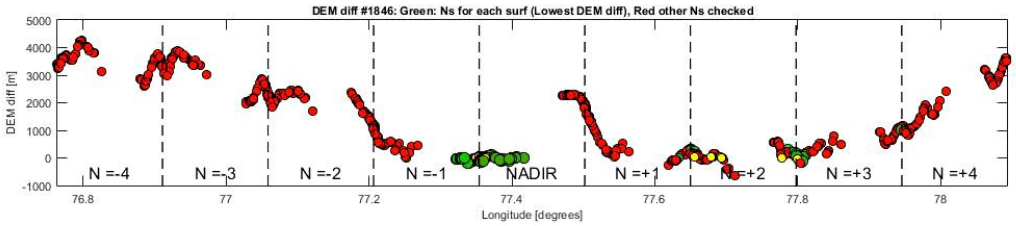




init	Ns	Best Wrap	Mean Elev. diff	std Elev. diff
117	5	2	197.9503	53.4896
126	7	-1	108.0757	461.6539
137	17	2	216.3898	54.3970
177	8	2	203.3427	49.7281
268	6	-1	75.1938	79.5940
278	21	-1	23.3472	34.2572
451	6	3	15.6368	95.2696
571	5	0	8.3225	64.6886
602	10	0	13.1307	53.7442
673	16	3	81.0056	374.4812
960	14	0	48.4131	51.5589







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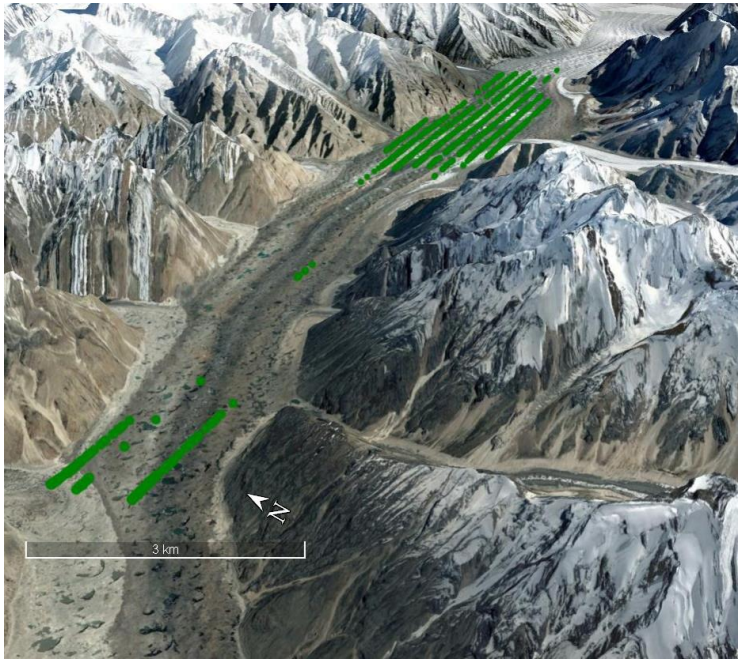
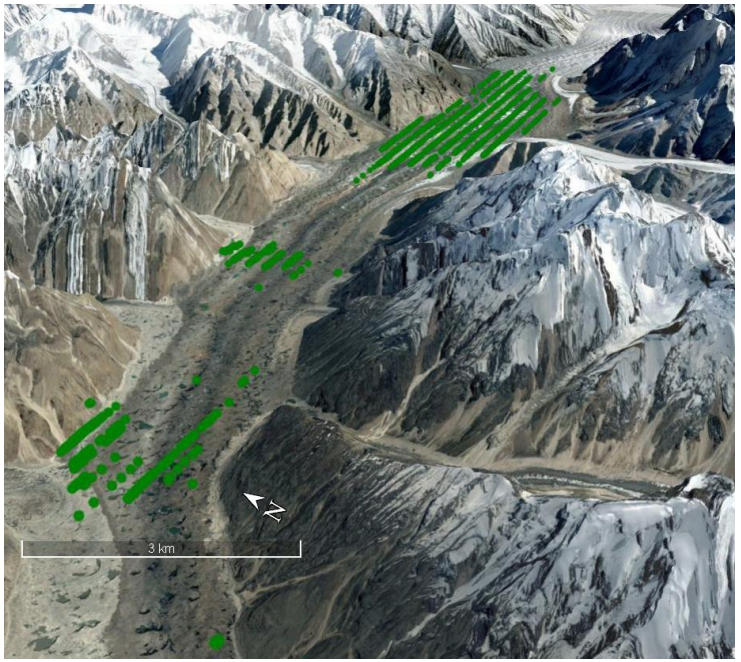
3. Validation Karakoram

- Comparison with DEM over Karakoram Glacier 2010-2012



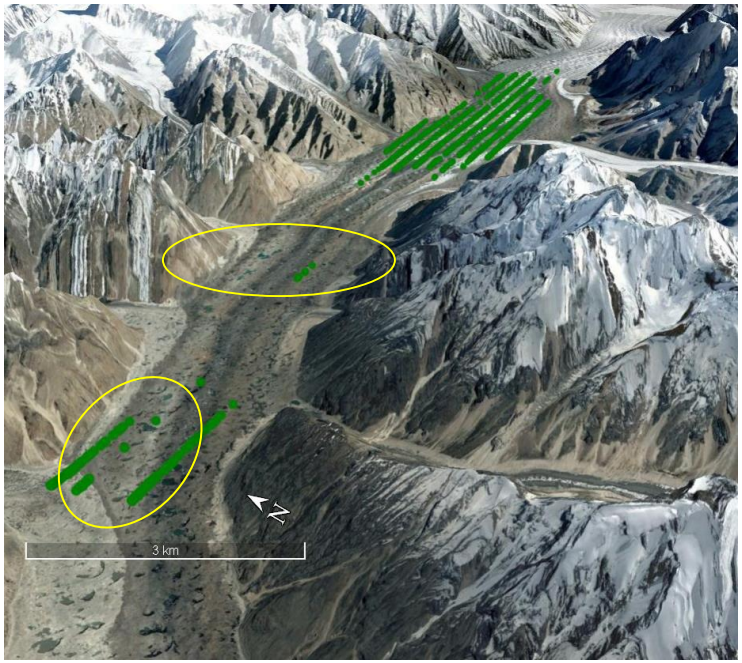
Nominal Swath processing



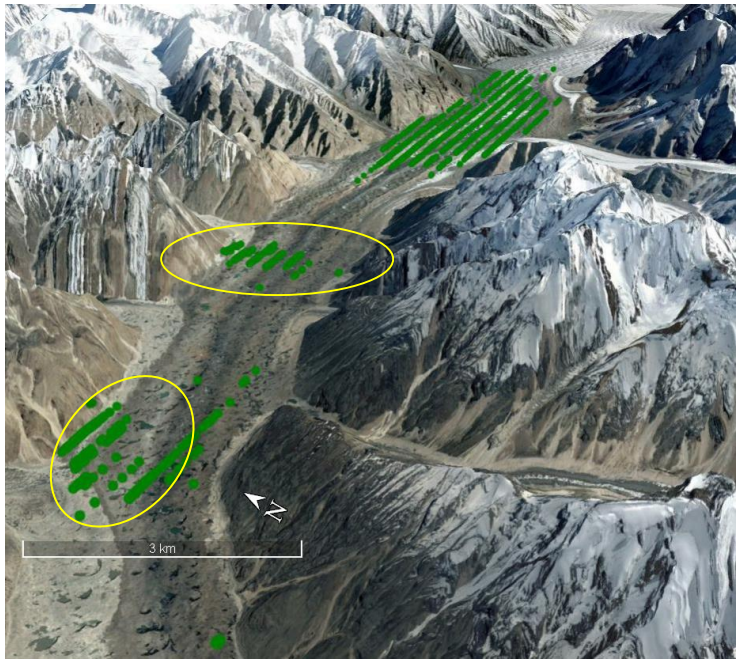
Improved Swath processing

3. Validation Karakoram

Nominal Swath Processing	Difference with DEM	Improved SwathProcessing
-4.99 m	mean	-4.28 m
11.57 m	RMS	10.99 m
2808	# measurements	3162 (12%)



Nominal Swath processing



Improved Swath processing

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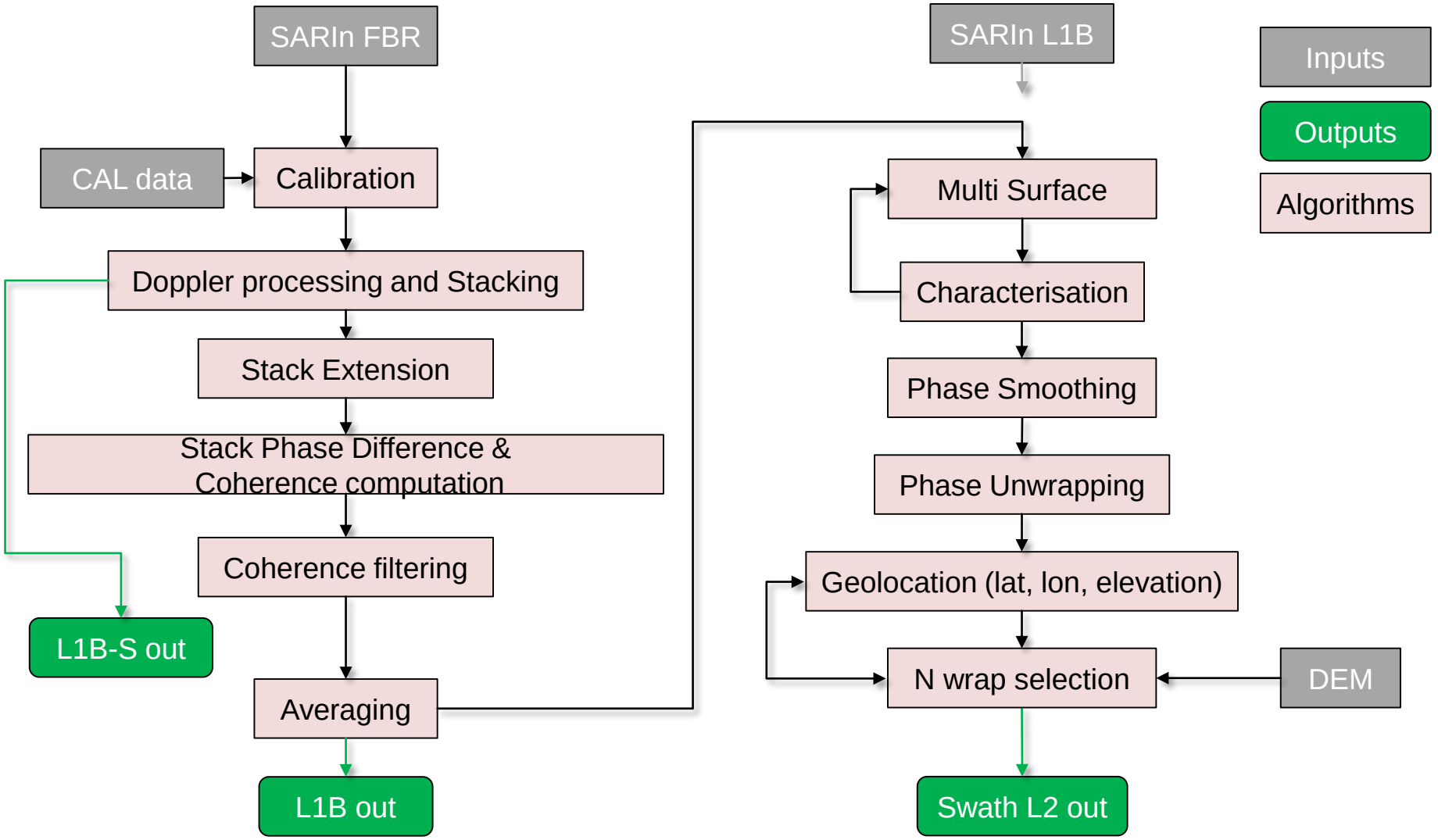
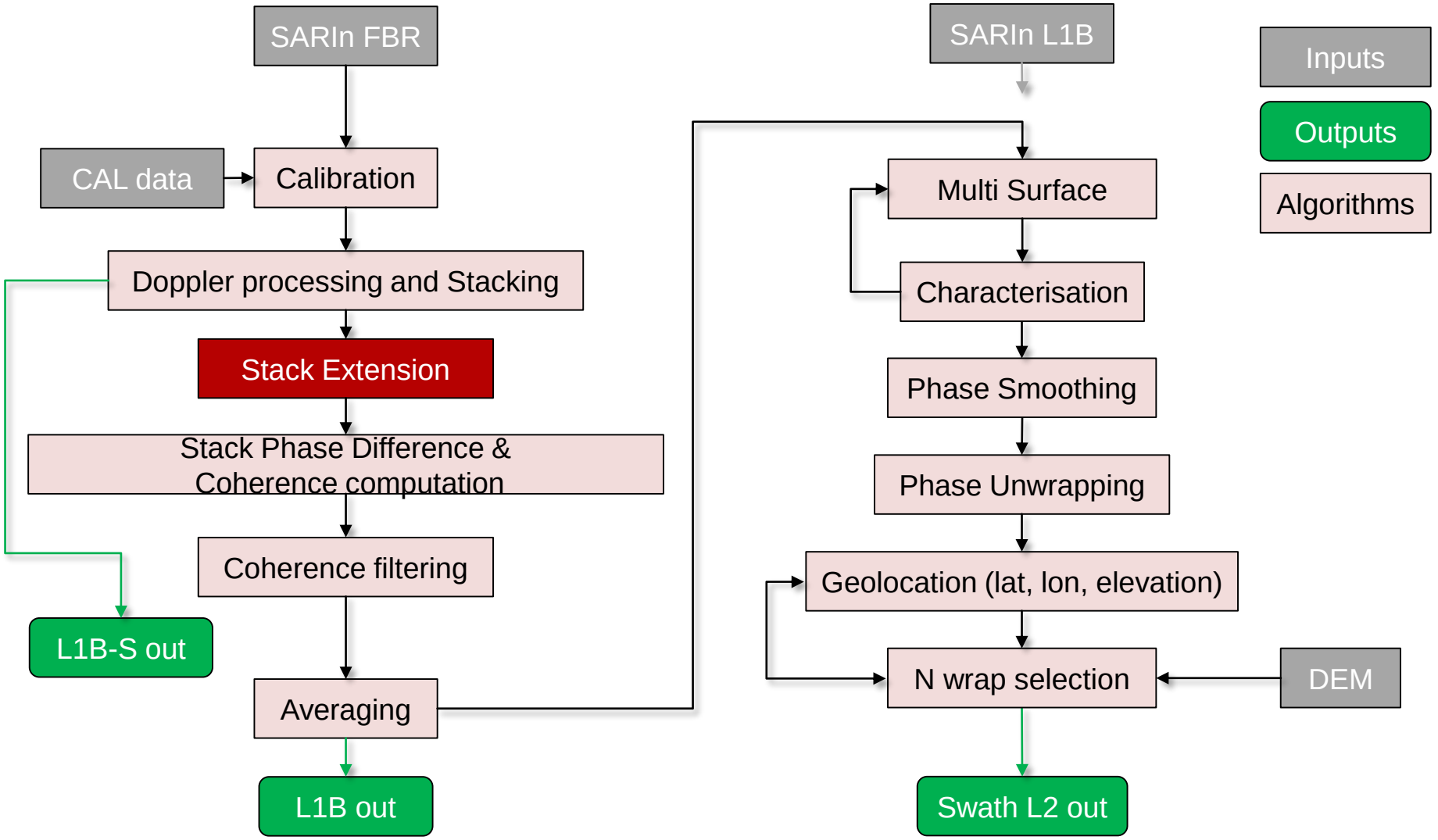
4. Processing Chain

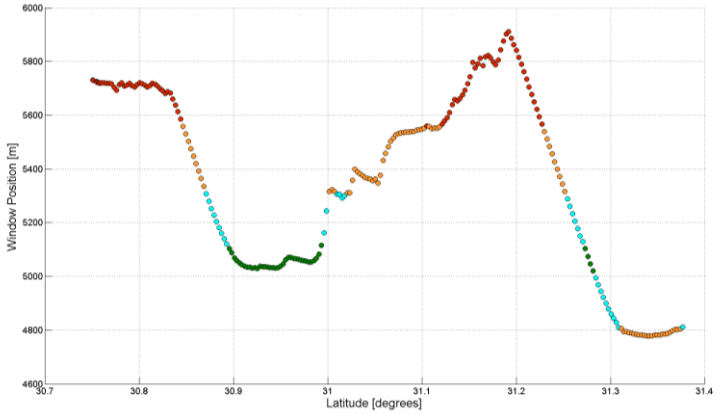


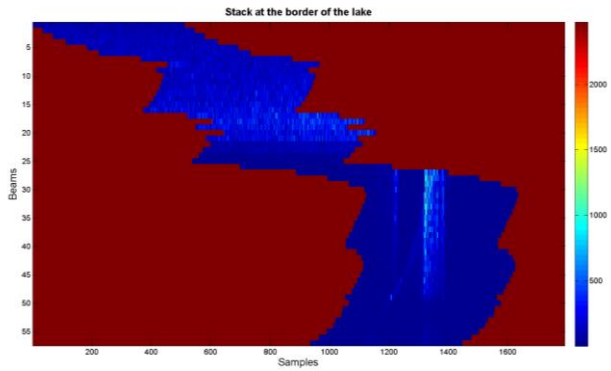
4. Processing Chain

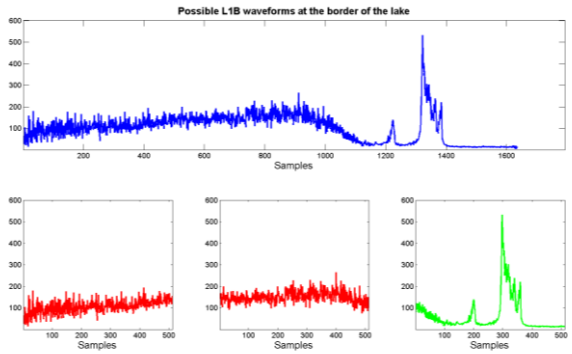


4.1 Stack Extension

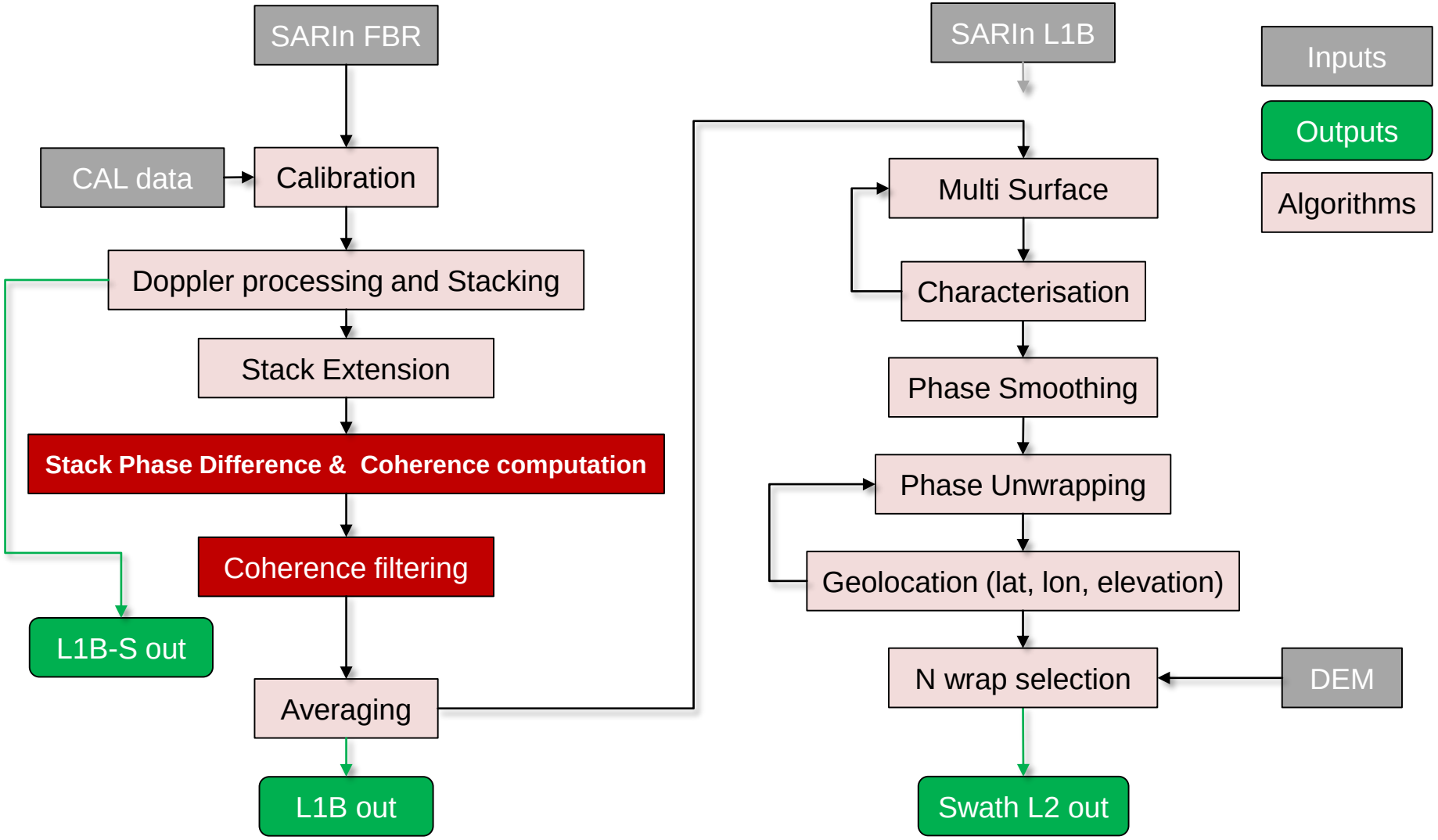
- L1B Waveform size can be increased as the different beams contributing should have followed the terrain.
  - Example with L1B waveform with 1600 samples as the range variation of the stack is 400 meters.





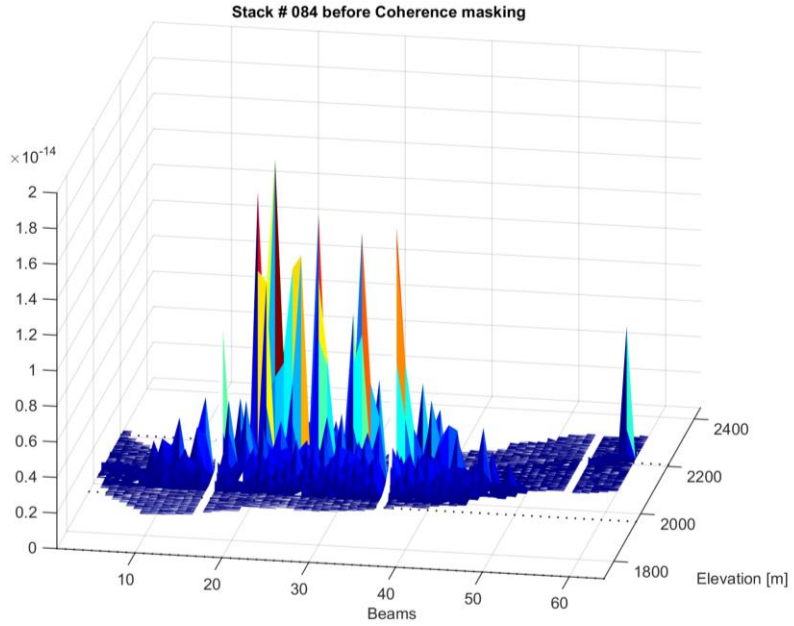


4. Processing Chain

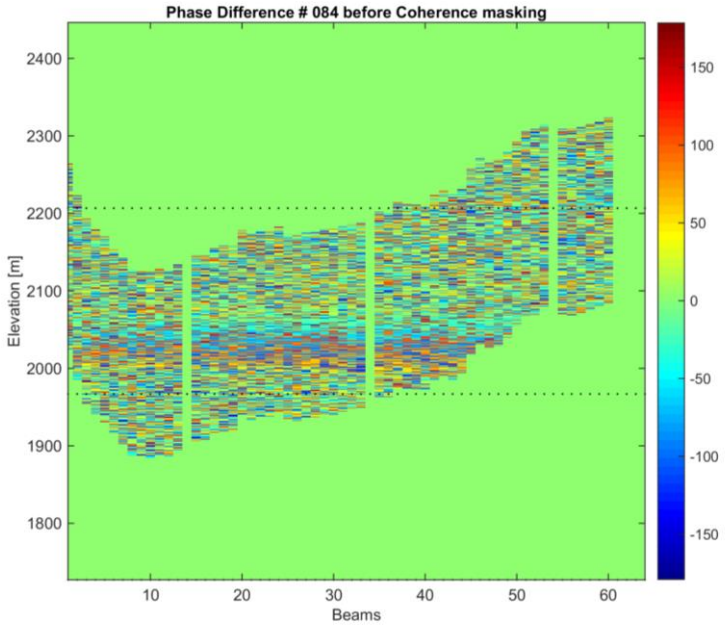


- The coherence and the phase difference can be computed before the averaging process where we have the information for each beam.

STACK POWER



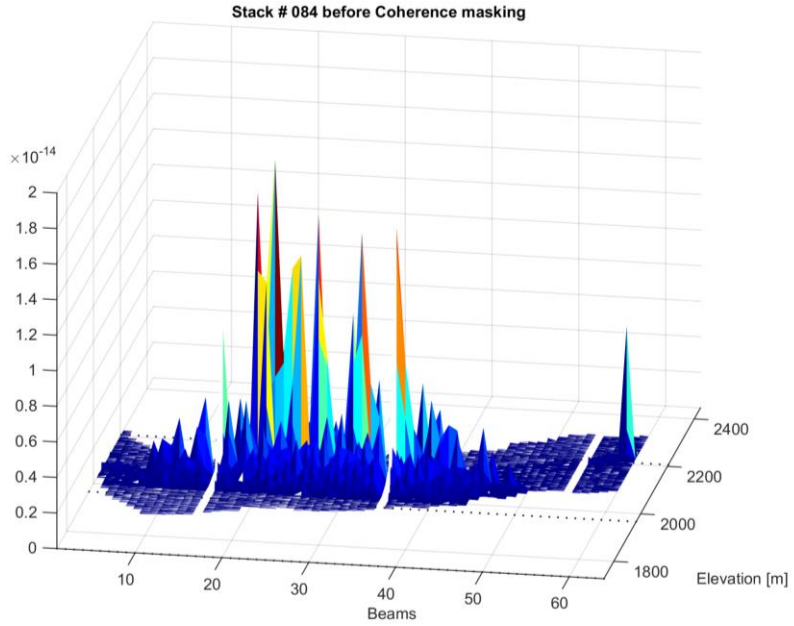
PHASE DIFFERENCE



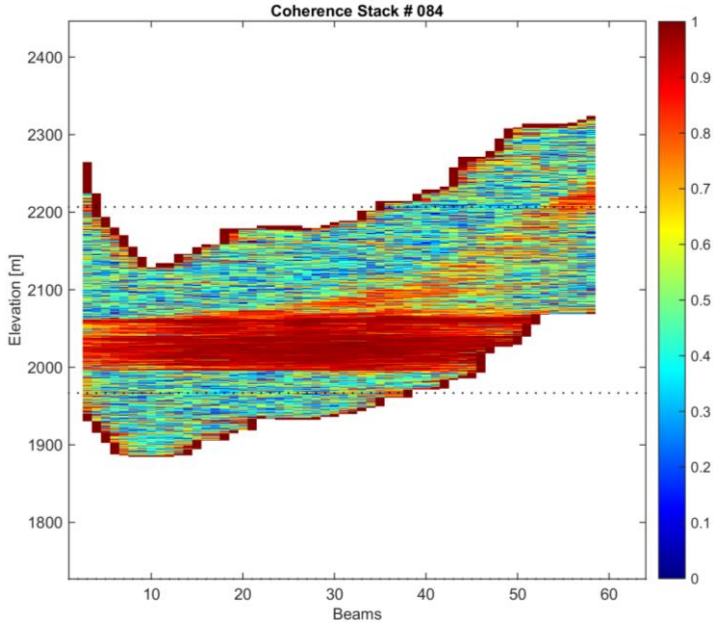
4.2 Stack Interferometry

- The coherence and the phase difference can be computed before the averaging process where we have the information for each beam.

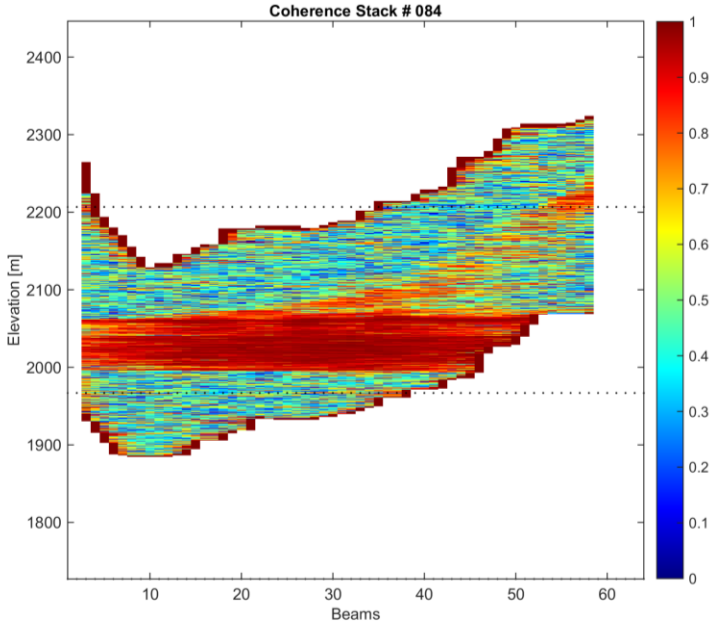
STACK POWER

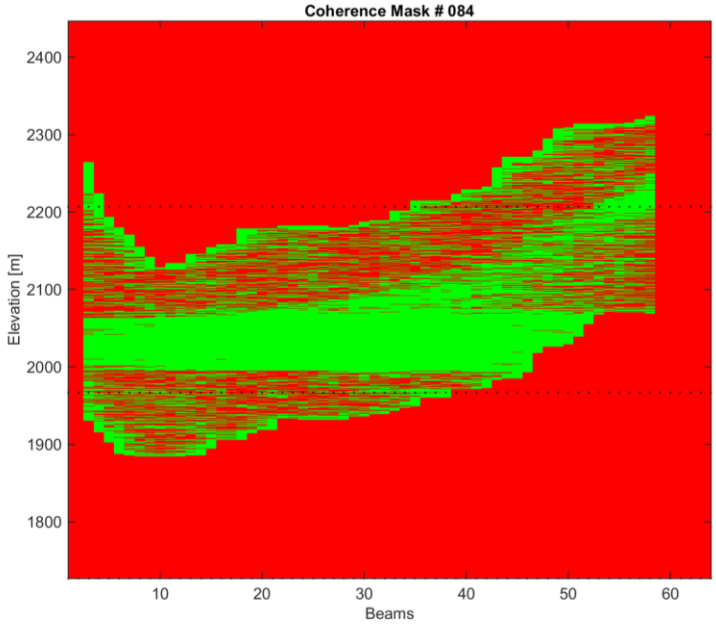


COHERENCE



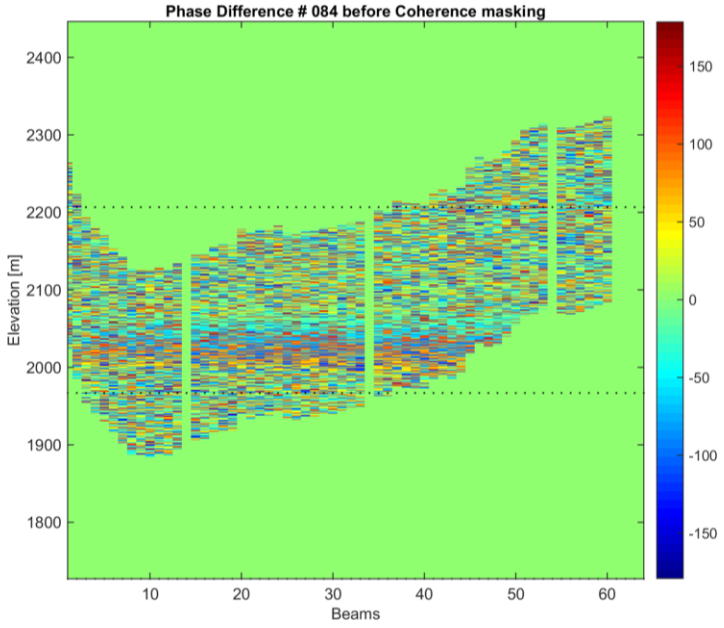
- The coherence is used to build a mask by setting to 0 all samples lower than the threshold.

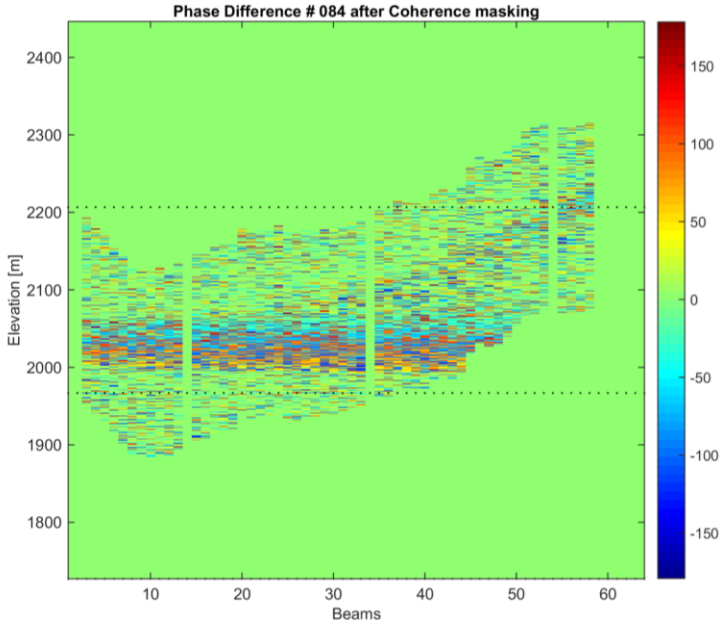




4.3 Filtering

- Then the coherence mask is applied to the power stacks and the interferometric phase difference to reduce the noise over them.





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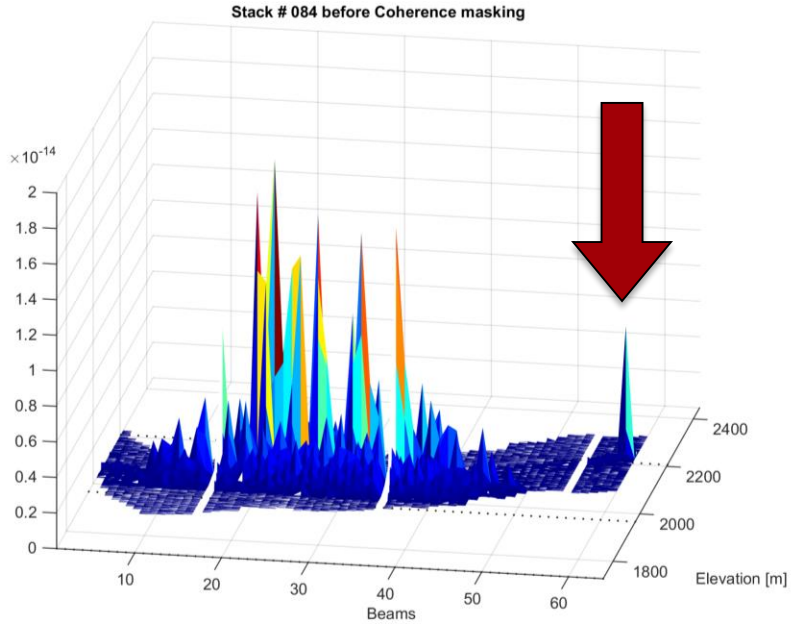

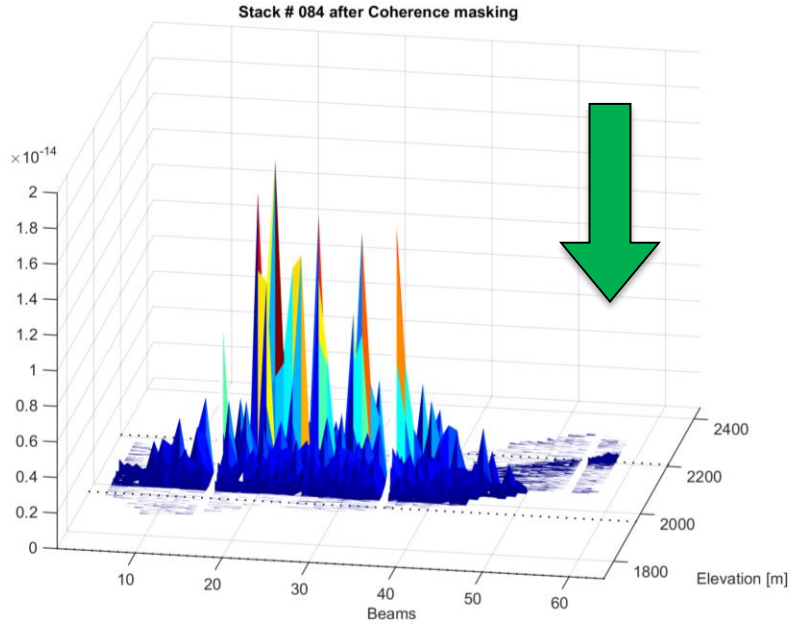

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5. Conclusions

- **Improved Swath Processing defined** and **implemented (multi-surface processing).**

- **Validation** done against **SPOT DEM over Karakoram Glacier** shows improved results (+ number of points with higher precision/accuracy)**.**

- **Future improvements at DDP tested and ready to be added** to the main chain and validated with full period of data.

- Swath processing to be potentially applied to **measure ocean Surface patterns** (eddies/currents → 2D maps sea-surface currents)

THANK YOU

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