Squeezing SARIn capabilities for complex scenarios: L1 & L2 processing improvements

Albert Garcia-Mondéjar, Roger Escolà, Eduard Makhoul, Pablo Nilo García, Maria José Escorihuela, and Mònica Roca

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Outline

1. **Introduction**
2. Processing Chain - Algorithm details
3. Results
4. L1BS twisted - New point of view
5. Conclusions

1. Introduction

- Objective: Explore the CR2 SARIn data to its maximum expression.

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- 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**:
    - Development and implementation of the SARIn L1BS algorithms.
    - Validation of the data.

Outline

1. Introduction
2. **Processing Chain - Algorithm details**
   - 2.1 3D Phase Difference and Coherence
   - 2.2 Filtering
   - 2.3 Segmentation
   - 2.4 Characterisation
   - 2.5 Retracking choice
3. Results
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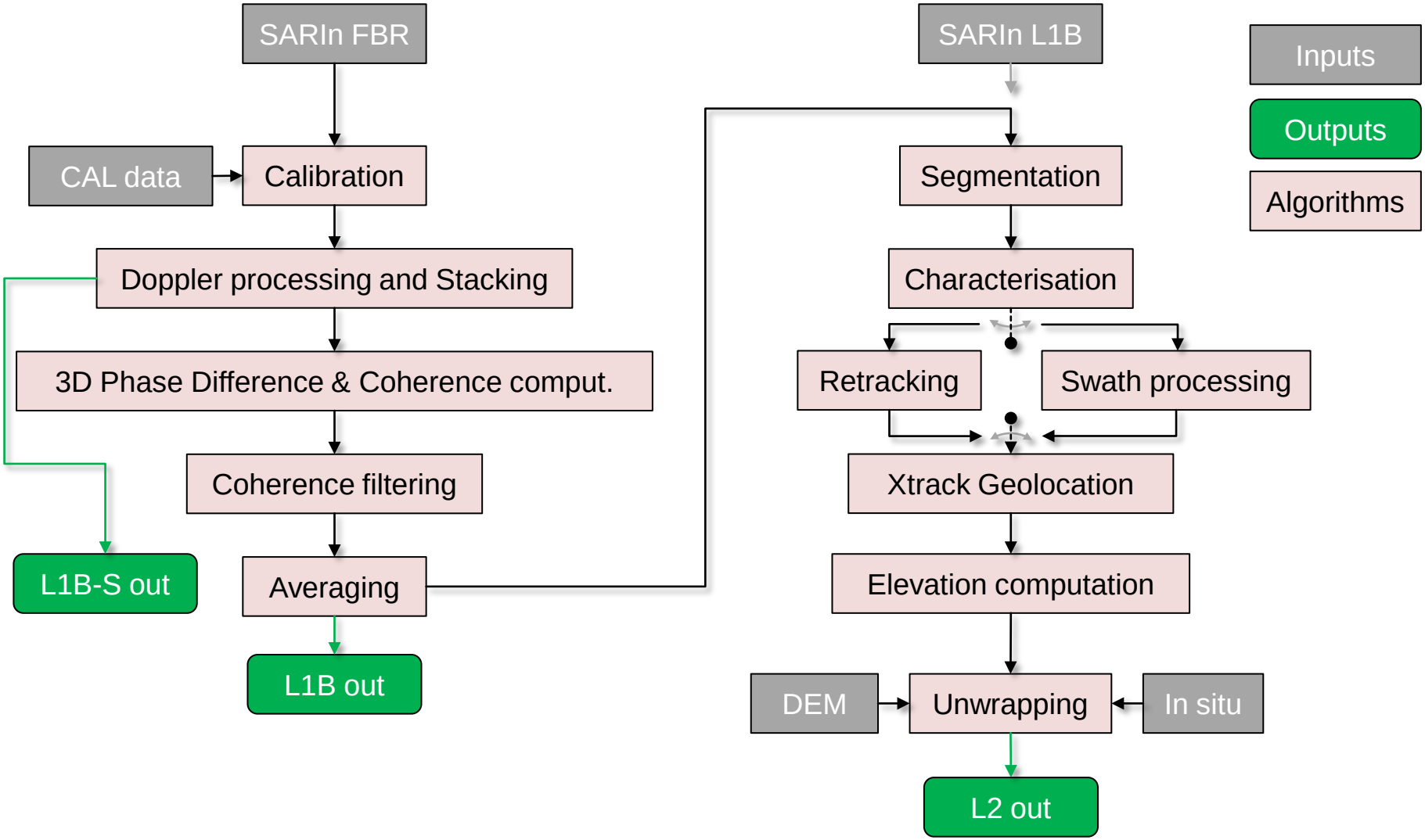
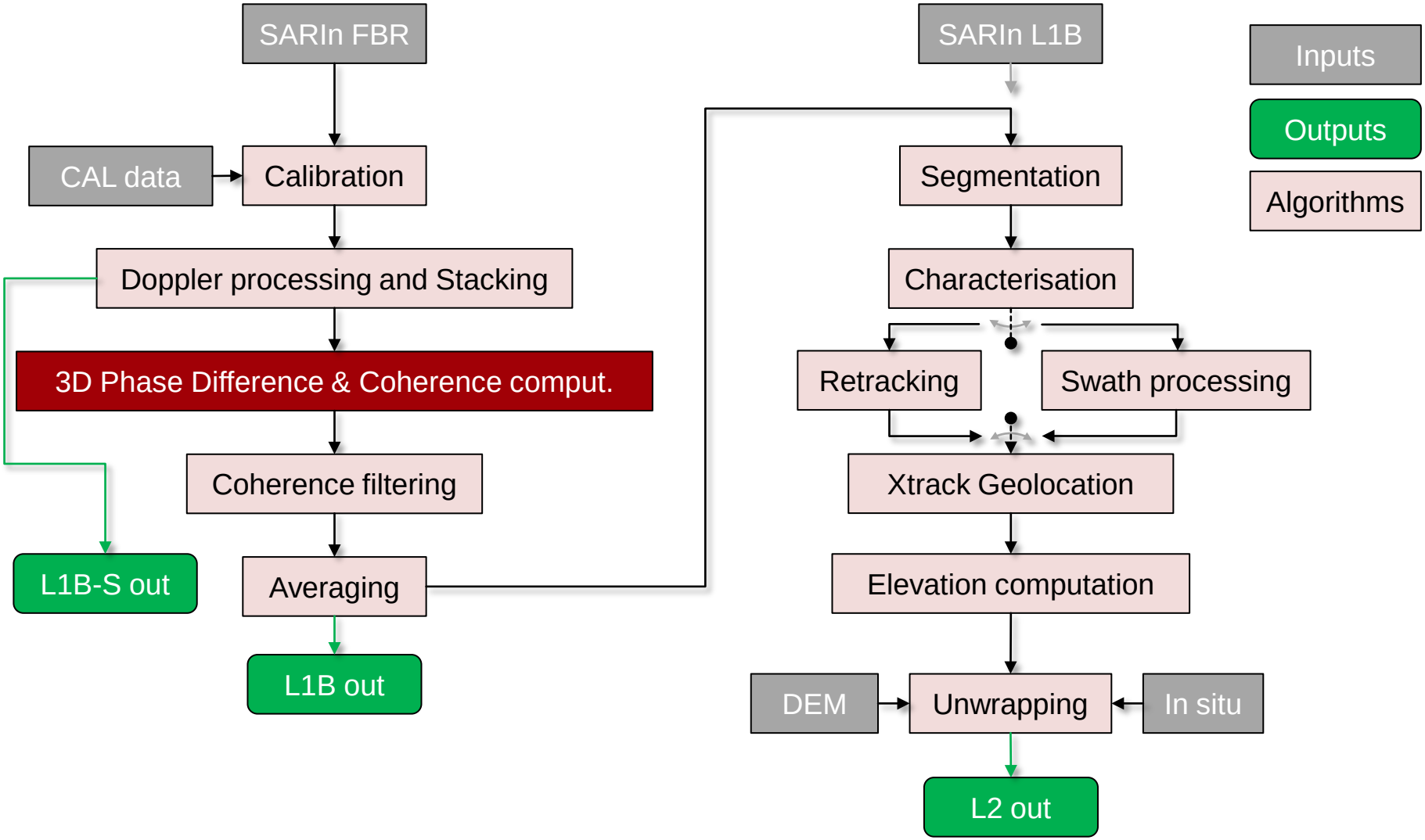
2. Processing Chain



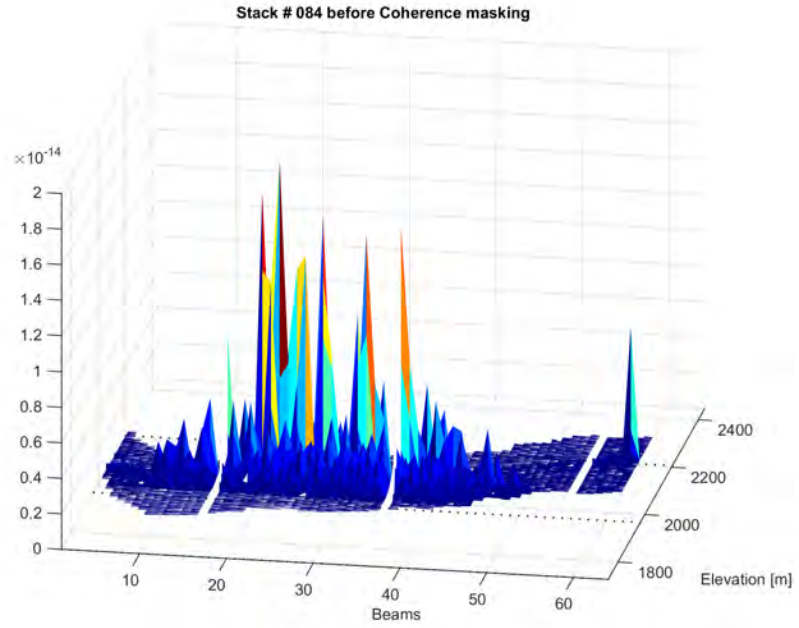
2.1 3D Interferometry



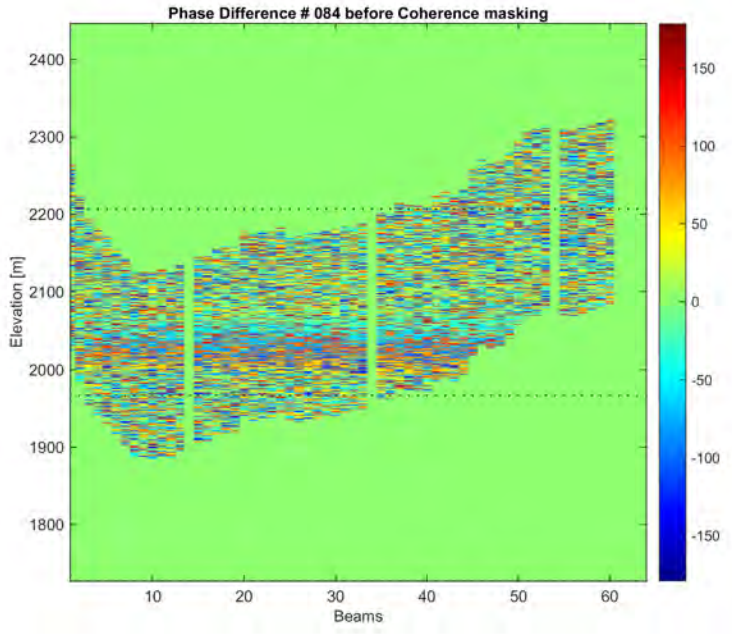
2.1 3D Interferometry

- 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



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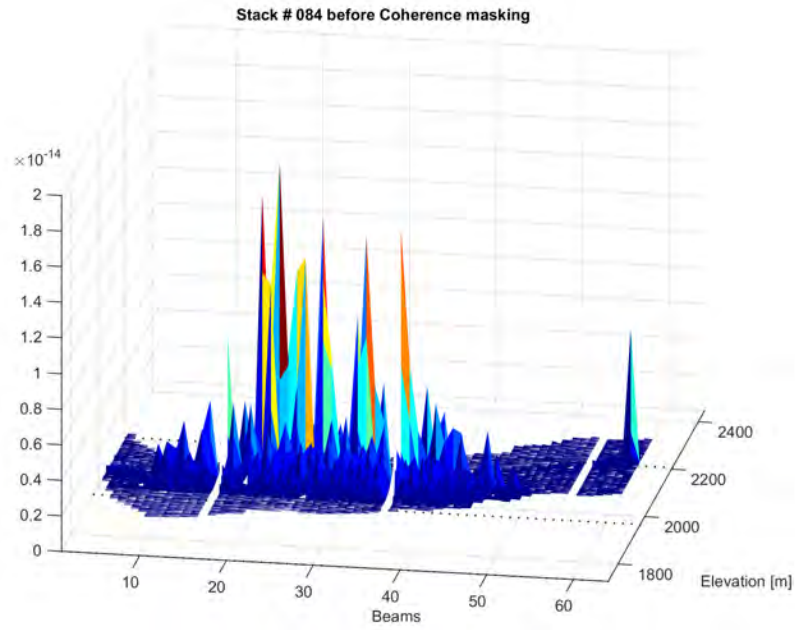
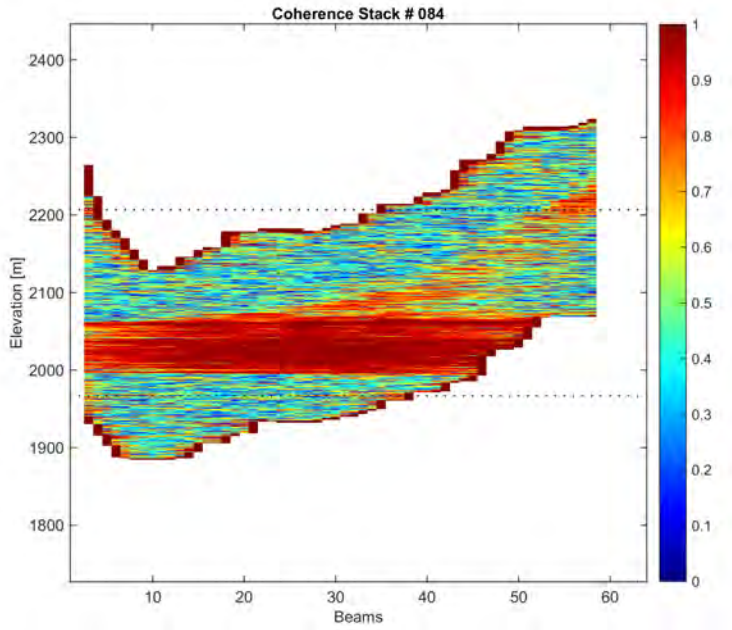
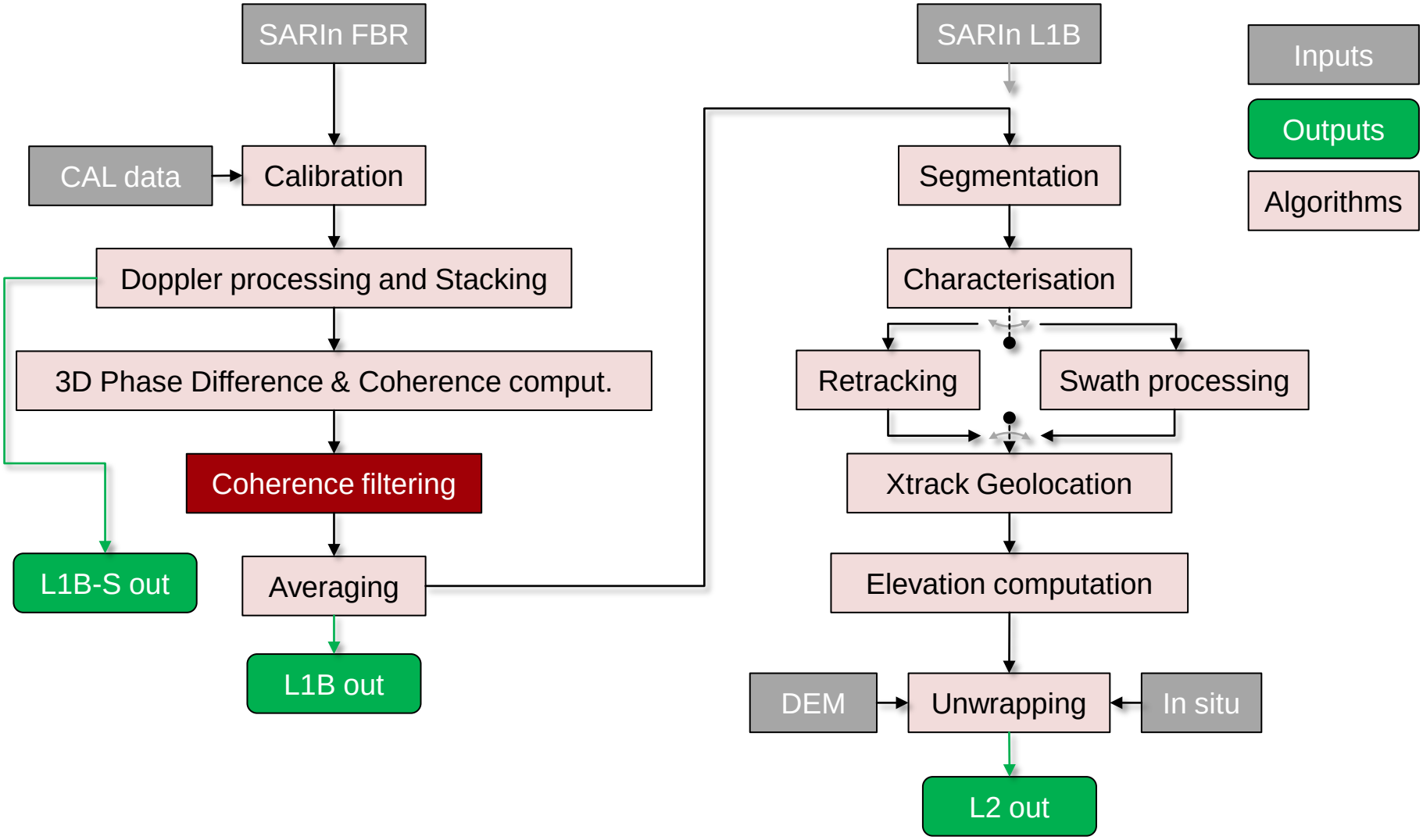


COHERENCE

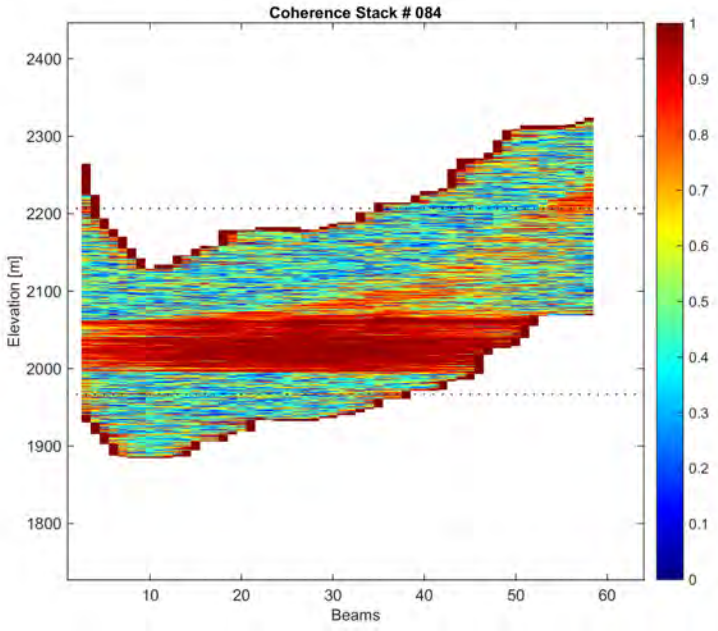


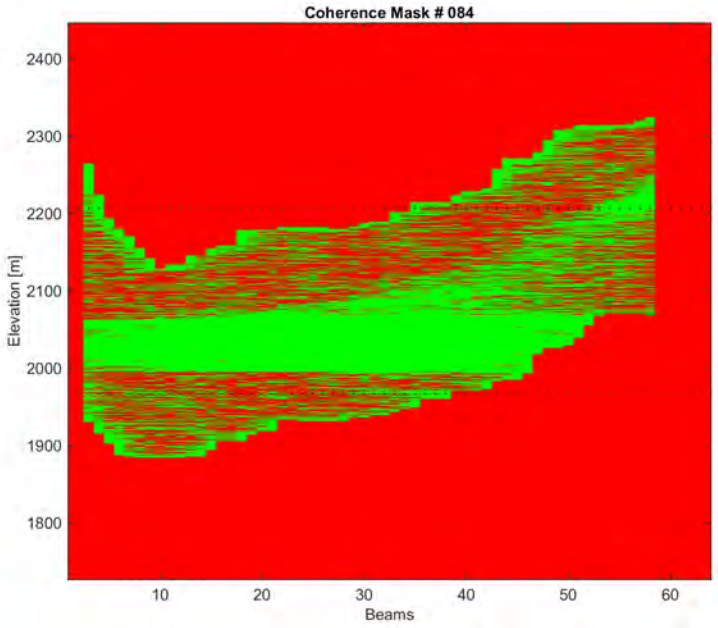
2.2 Filtering



2.2 Filtering

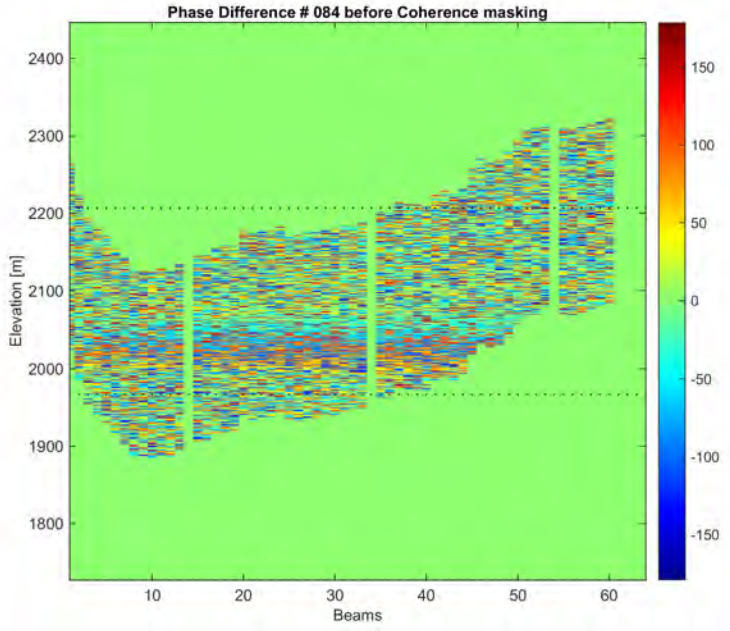
- The coherence is used to build a mask by setting to 0 all samples lower than the threshold.

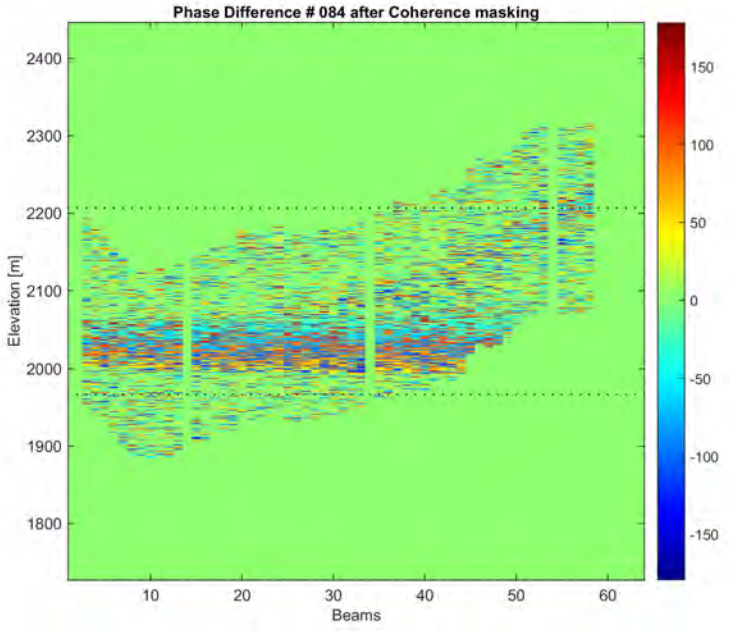




2.2 Filtering

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





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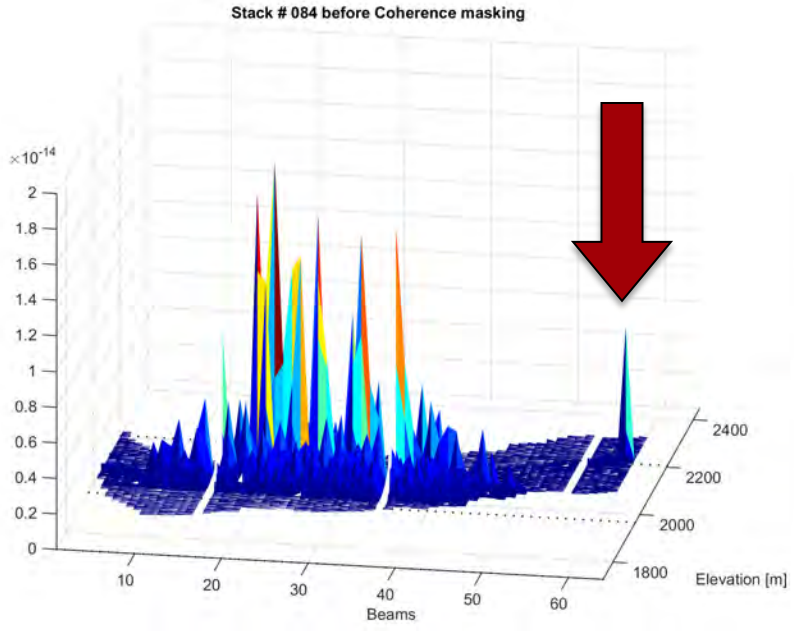
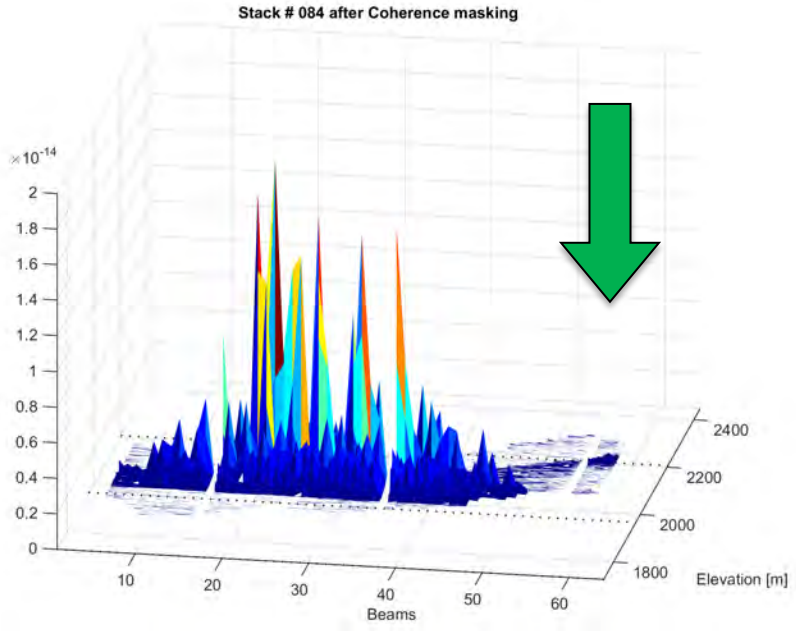
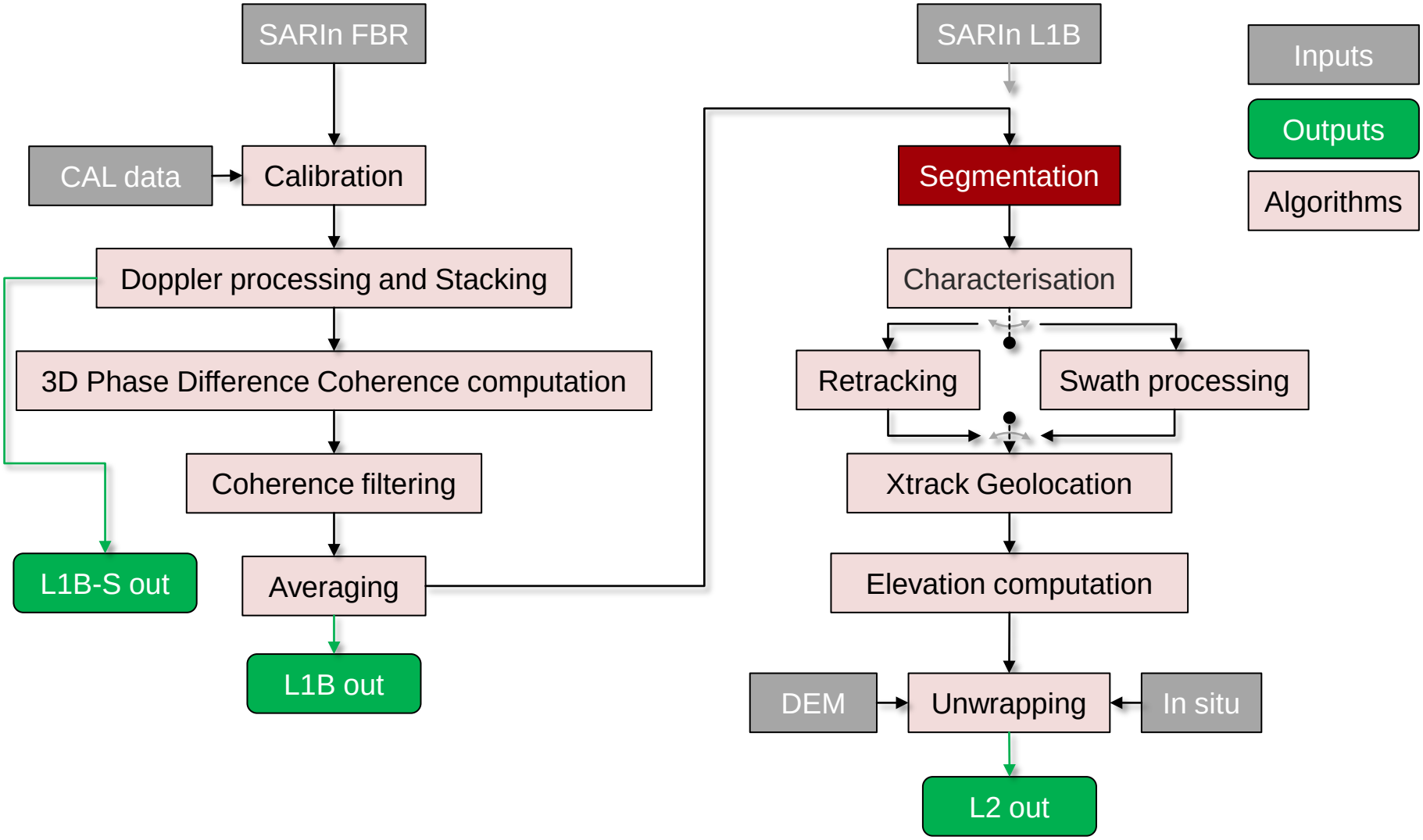


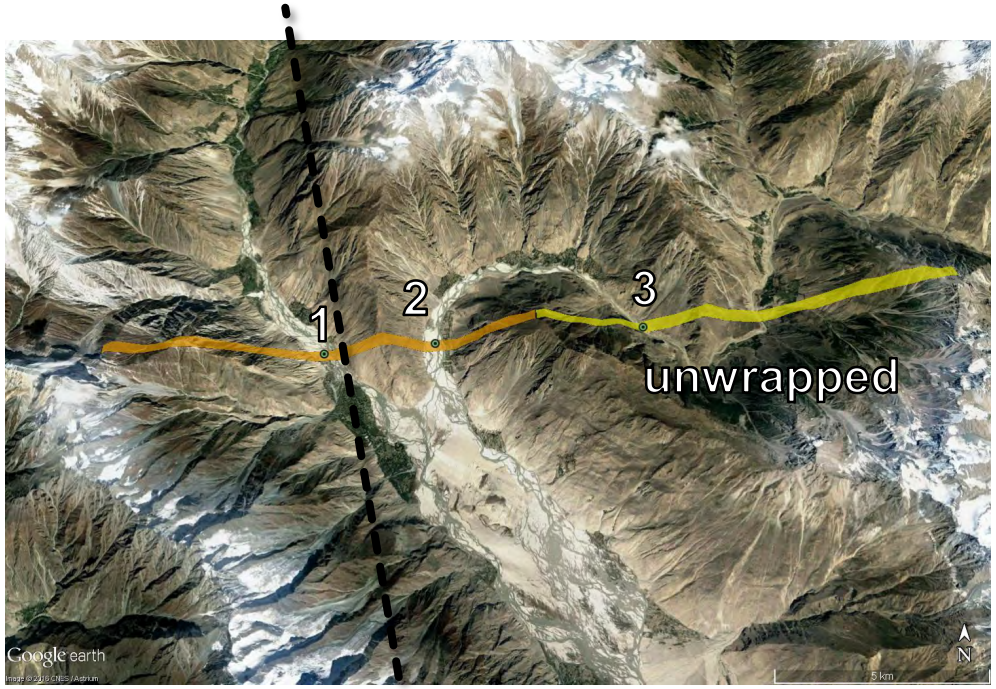


2.3 Segmentation

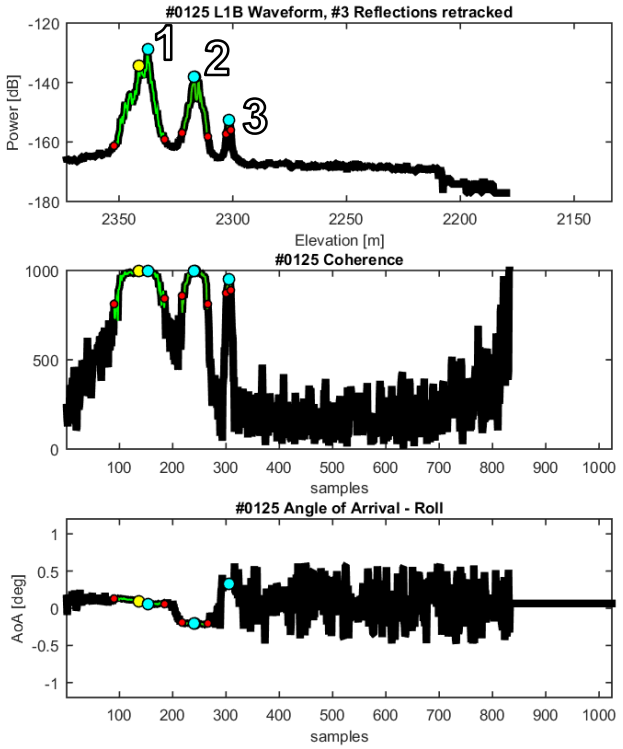


2.3 Segmentation

- The segmentation algorithm splits the waveform in different segments by using the coherence information.
- Record #125: 3 reflexions geo-located with the segments obtained, the last one wrapped

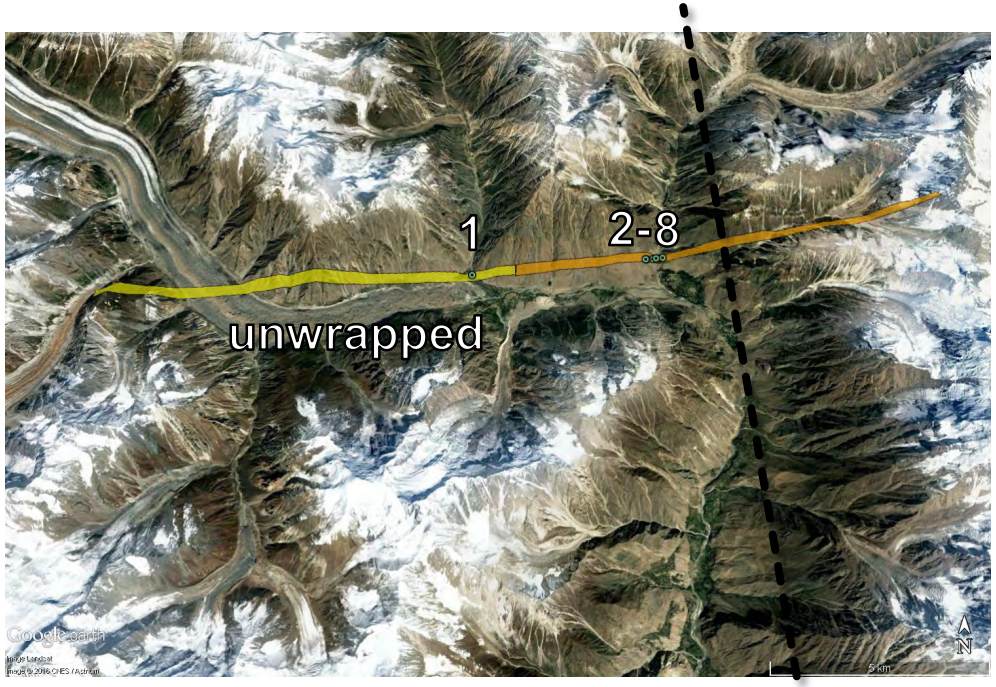


Baltoro Glacier 08/02/2012 - Himalayas



2.3 Segmentation

- The segmentation algorithm splits the waveform in different segments by using the coherence information.
- Record #198: 8 reflexions geo-located with the segments obtained, the first one wrapped.



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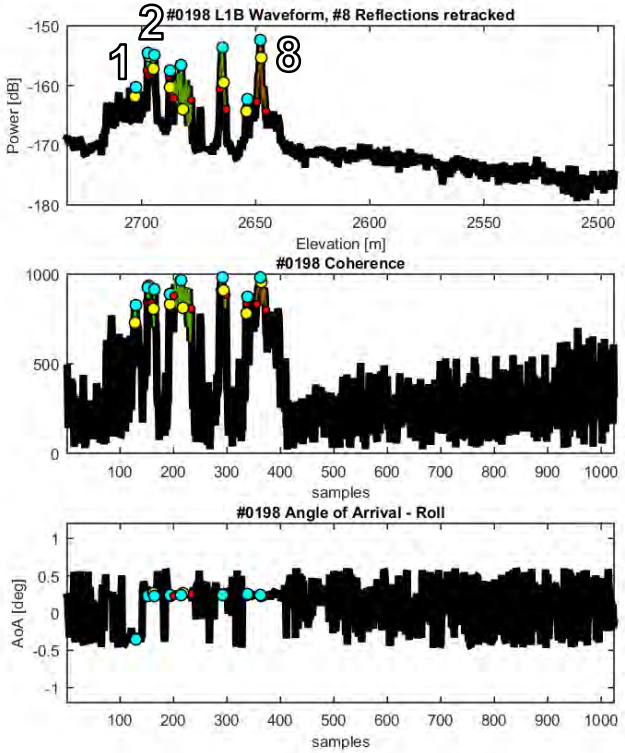
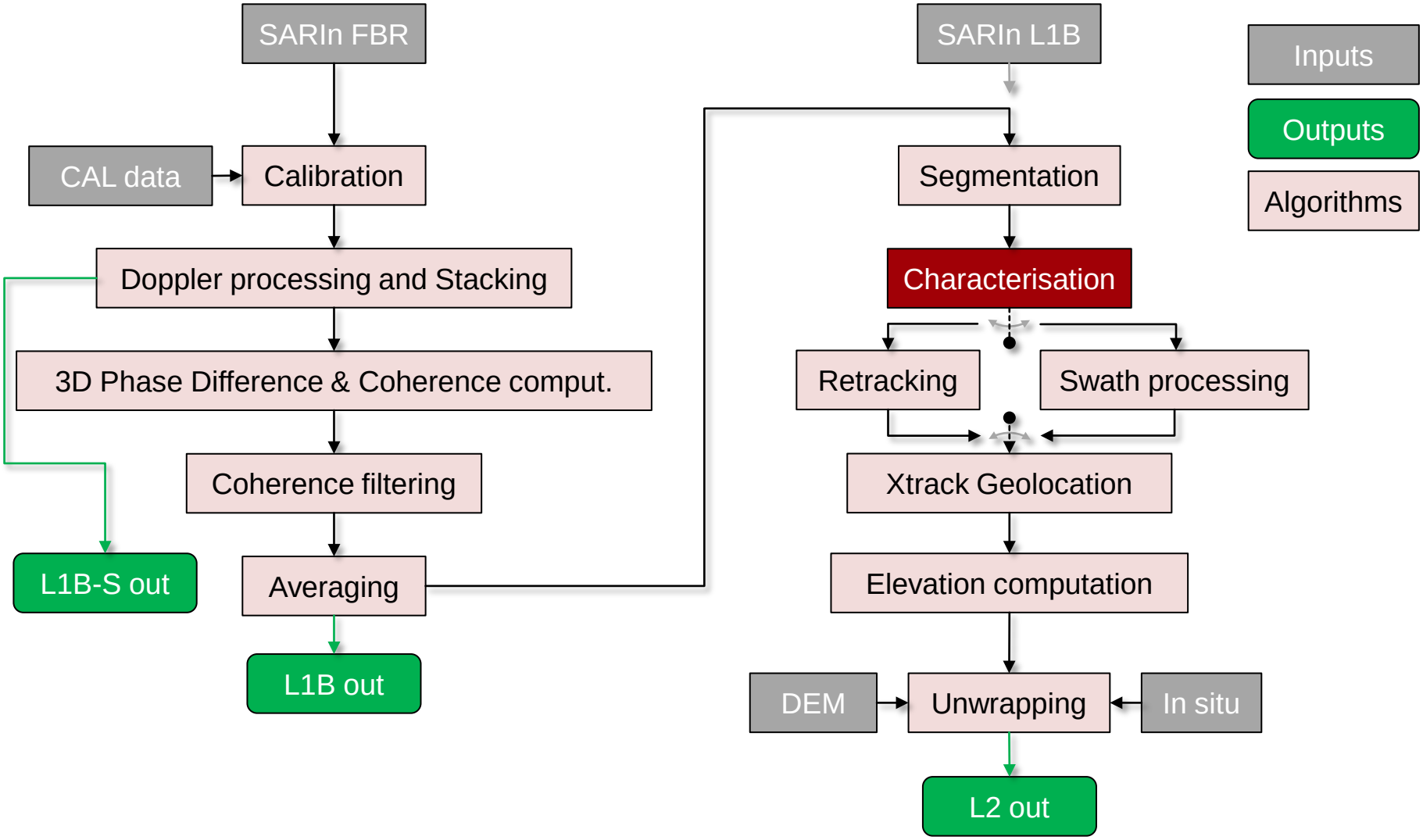


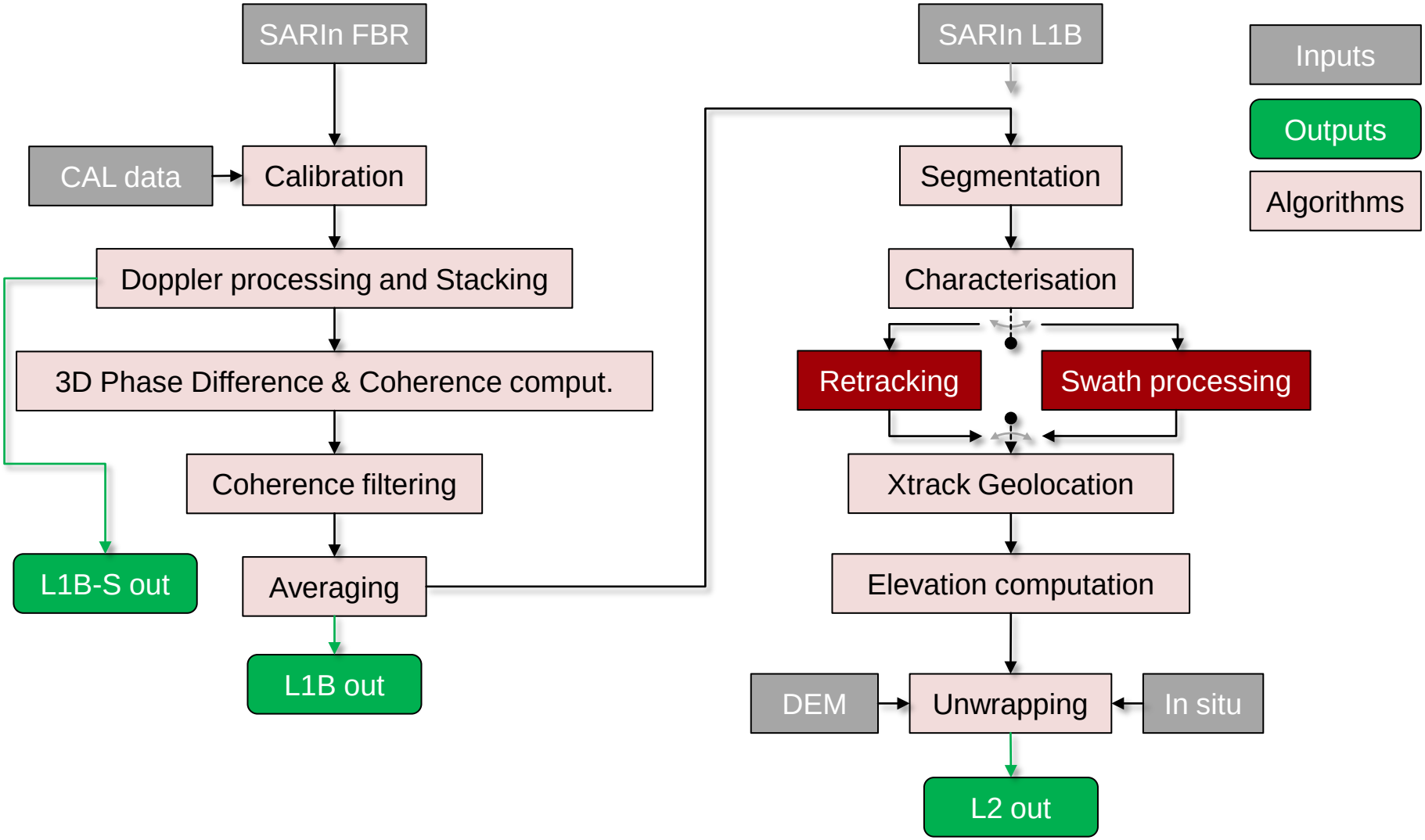
2.4 Characterisation



2.4 Characterisation

- This algorithm is in charge of compute some characteristics and quality parameters of each segment in order to be able to classify and discard them and also help in the unwrapping.
  - Peakiness
  - Peak power
  - Standard deviation of the AoA
  - Slope of the AoA
  - Mean AoA

2.5 Retracking choice



2.5 Retracking choice

1. The Peak retracker will be used on **specular** reflexions
   - High Peakiness, low slope AoA
2. The Swath processing* will be applied when we have a **diffuse** scenario.
   - Low Peakiness
3. Over Coastal regions the Ocean retracker is also considered as an option in the **diffuse** case.
4. Some will be flagged as potencially wrapped.
   - Possitive slope AoA and negative mean AoA
   - Negative slope AoA and positive mean AoA
5. Some of them will be discarded
   - High std AoA
   - Low number of samples

*Hawley R.L., et.al., Ice-sheet elevations from across track processing of airborne interferometric radar altimetry, Geophys. Res. Lett., 36, L25501, doi:10.1029/2009GL040416, 2009.

*Laurence Gray et.al., Interferometric swath processing of CryoSat data for glacial ice topography, The Cryosphere, 7, 1857-1867, doi:10.5194/tc-7-1857-2013

*Gourmelen et.al., Swath processing of CryoSat for the Cryosphere, ESA 2016 Living Planet Symposium, Praga, 2016.

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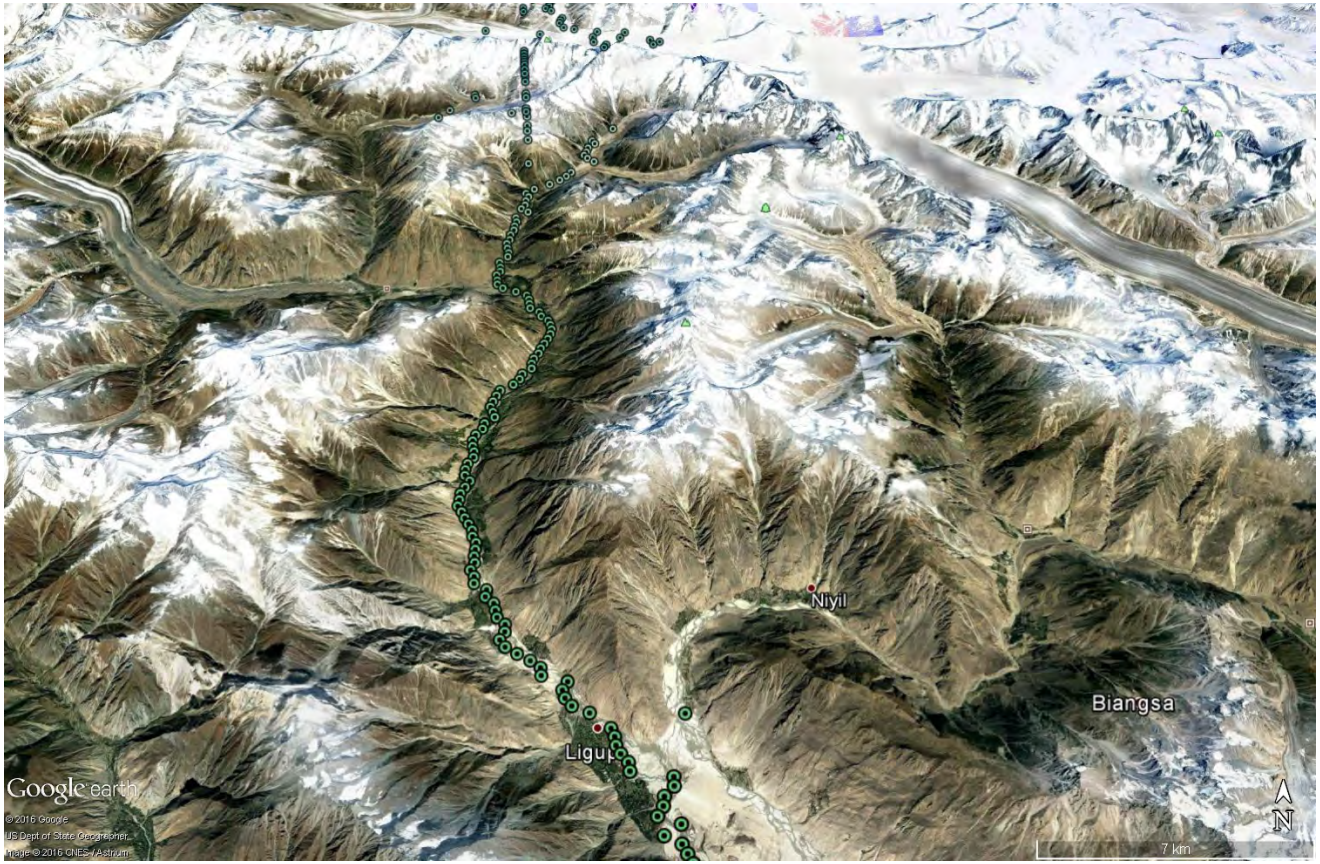
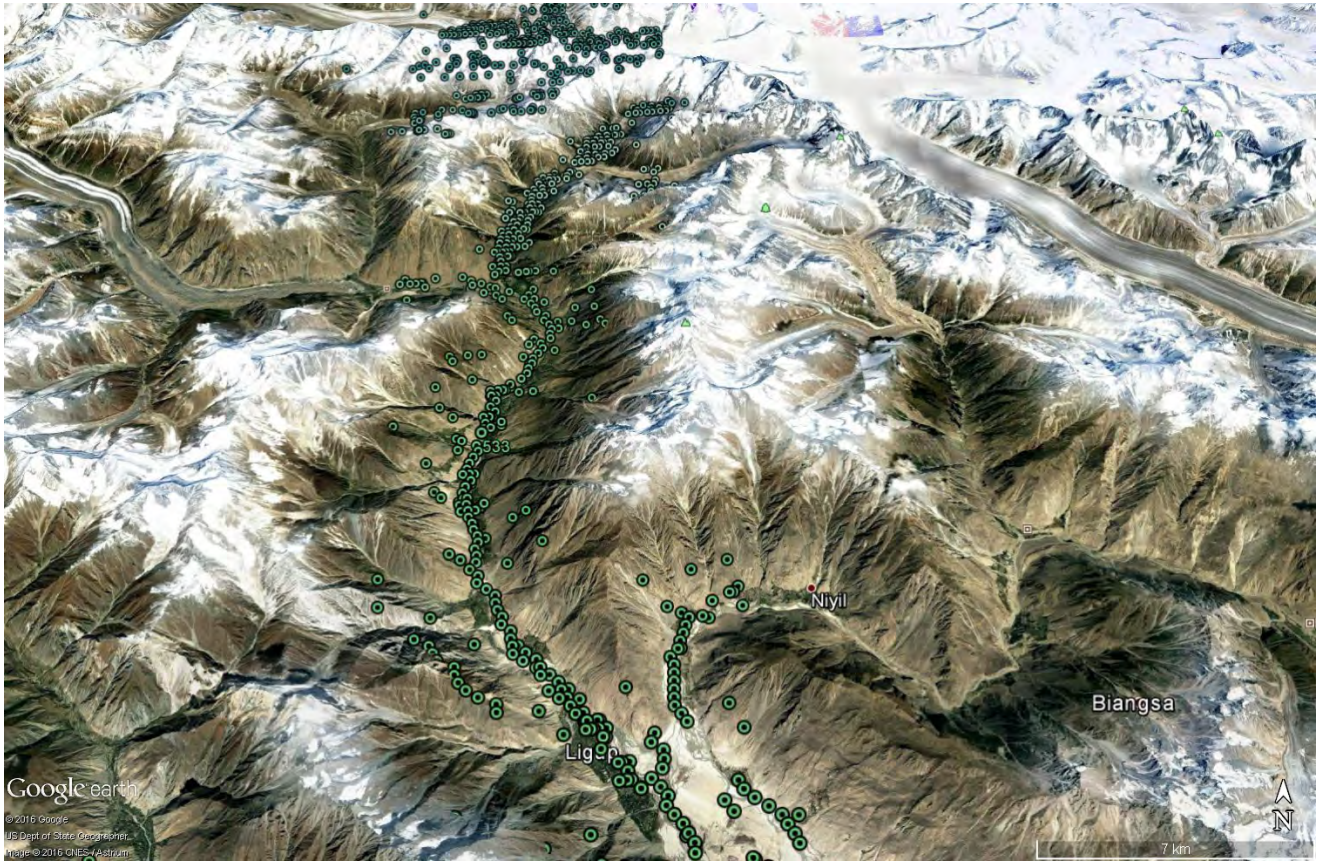
Results Glacier



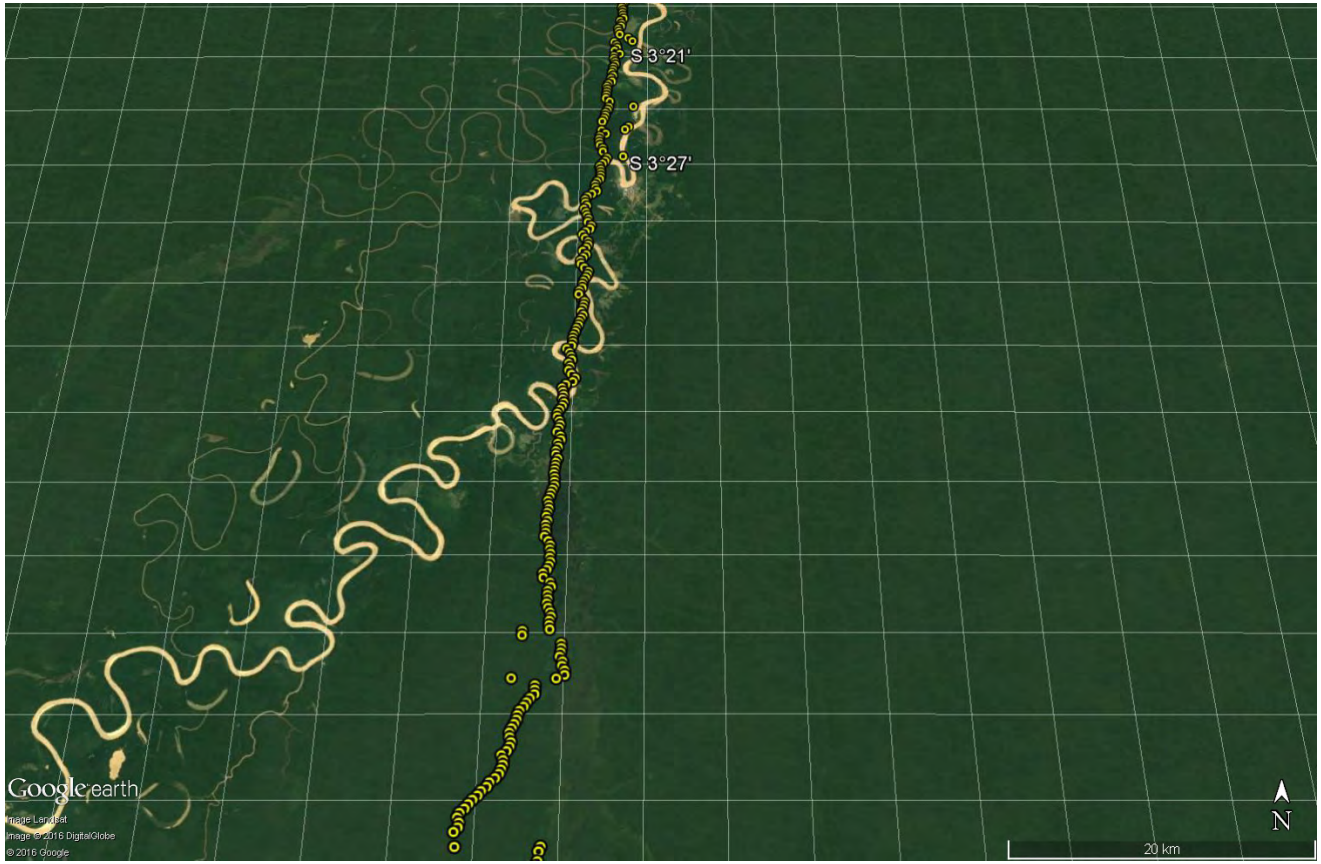
- L2 IPF product – 306 records
- Baltoro Glacier 08/02/2012 - Himalayas

Results Glacier



- L2 enhanced – 1842 records **+600%**
- Baltoro Glacier 08/02/2012 - Himalayas

Results Inland



- L2 IPF product – 3060 records
- Juruá River 16/01/2012 – Amazon Basin

Results Inland

- L2 enhanced – 12721 records +400%
- Juruá River 16/01/2012 – Amazon Basin

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X-Stacks

- Definition: Redistribution of the received energy from the along track dimension (beams) to the Across track using the phase difference information already computed at Stack Level.

- Gives a good feeling of where the different echoes contribute in the Stack data.
- Can be used to estimate the surface reflectivity in the Xtrack domain.
- Can be used to stablish new algorithms to resolve ambiguities easily.

- Baltoro Glacier 08/02/2012 - Record #125: 3 reflexions

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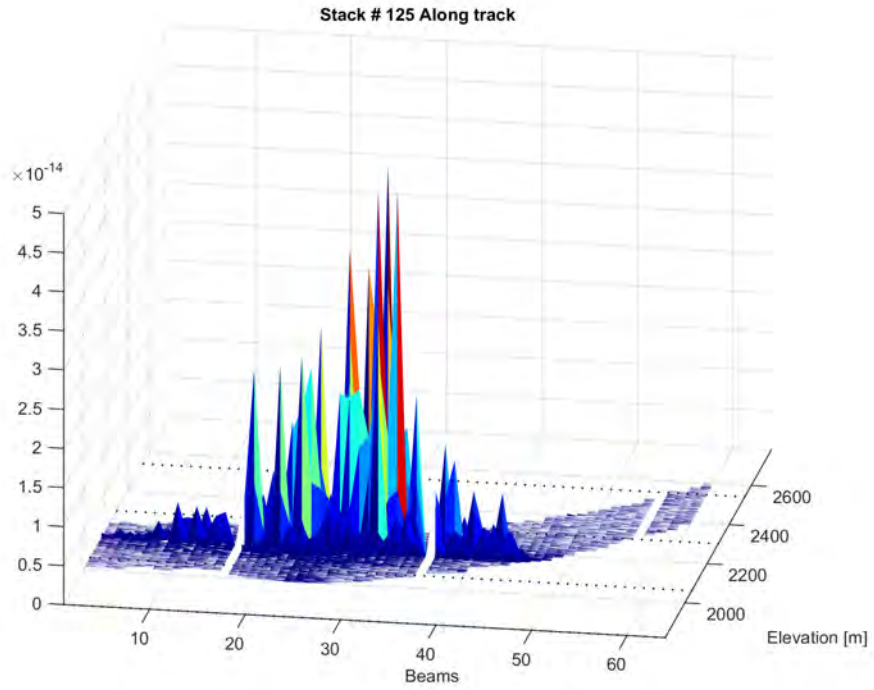

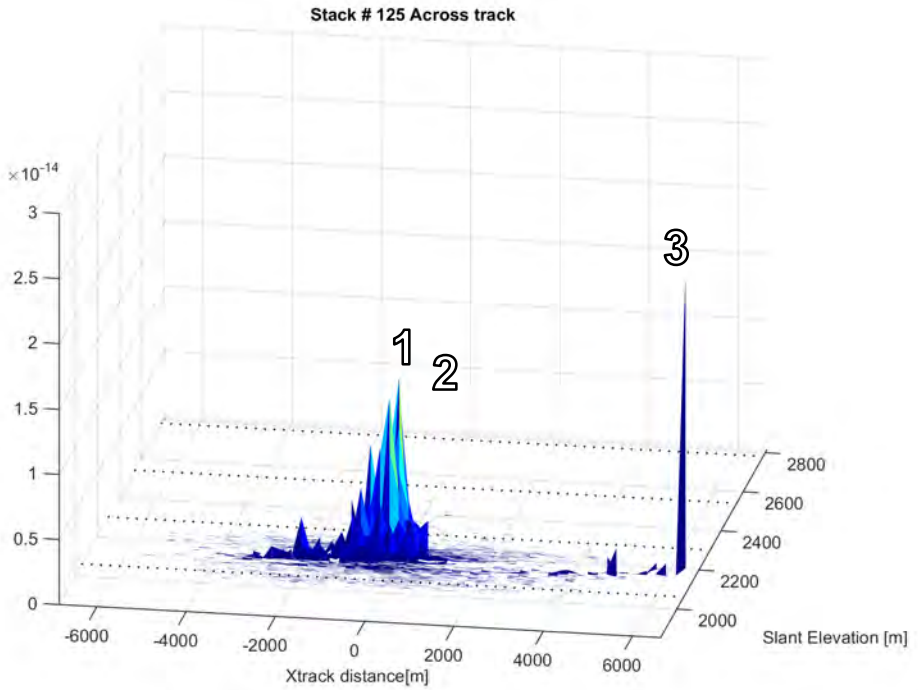

- Baltoro Glacier 08/02/2012 - Record #198: 8 reflexions

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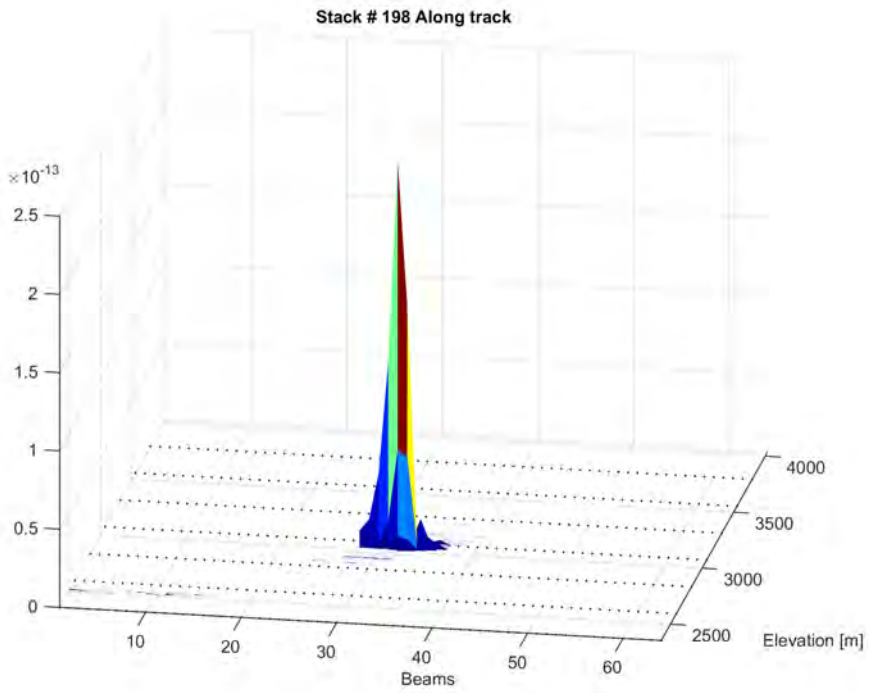
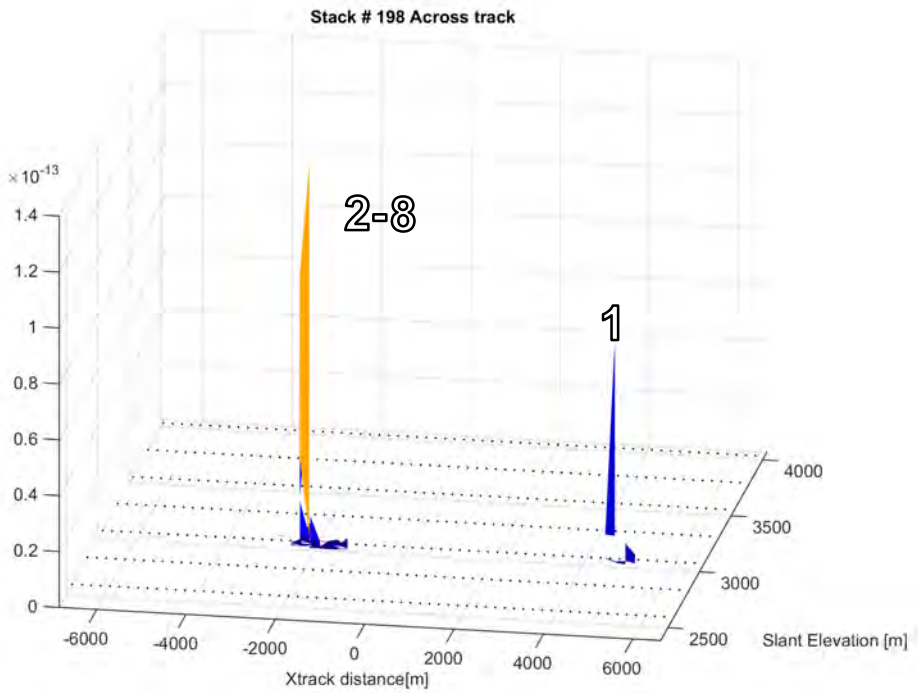
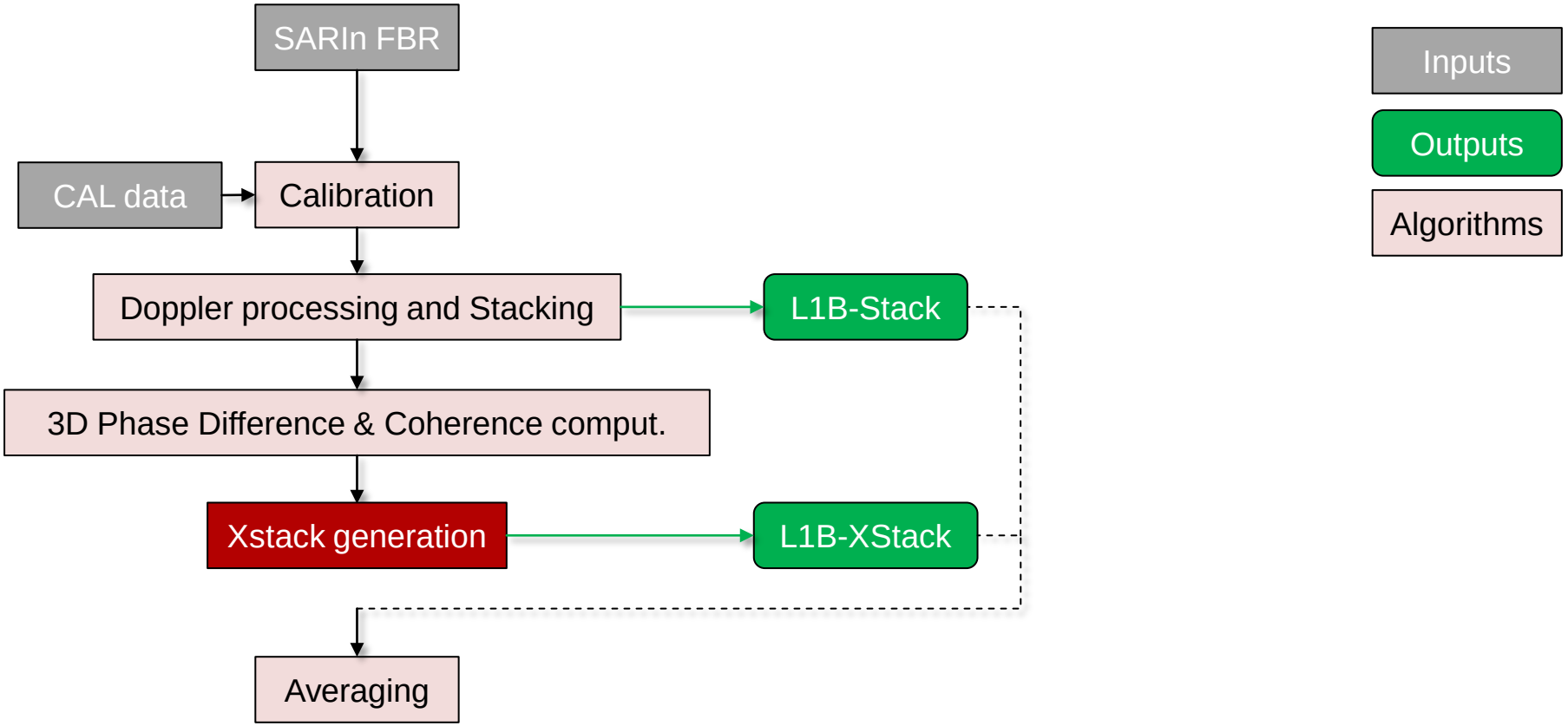




X-Stacks



- IMPORTANT: The averaging, multilooking, can be performed either to classical Stacks [range bins, doopler beams], to the new Xstacks [range bins, xtrack distance bins] giving **THE SAME L1b waveform**.

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Conclusions

- A huge improvement on the number of points is obtained compared with the current processing Baseline C. Around **6 times more** on complex scenarios. This is directly translated into an increasing of the spatial coverage (and also a reduction on the revisit time).

- The unwrapping procedure has been enhanced correcting the geolocation of the wrapped measurements.

- The thresholds used as a configuration parameters have to be validated with larger datasets in order to get the proper values for every type of region: (ice, water, land ….)

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THANK YOU