Recent progresses on the ICESat-2/ CryoSat-2 resonant orbits for sea-ice

IDEAS-QA4EO workshop #2

Antoine Laforge

Work context

- Recruited by **Serco** Sept-2020
- Joined **QA4EO** team: Polar and Coastal altimetry
- Collaboration and collocation in **LEGOS**, Toulouse
- Two Work Packages defined for 18 months
- **PROJECT:** Polar/Coastal altimetry new study with LEGOS

WP2331

Title: Low level IS-2/CS-2 tandem phase along-track comparison

KO: Nov 2020 **Duration**: 6 months

WP2333

Title: Multi-mission inter-comparison of LEGOS and ESA sea ice freeboard products: snow depth

KO: April 2021 **Duration:** 12 months

Scientific context: Cryo2Ice (1)

Periodic alignment of the two polar altimetric missions

- Characteristics
  - ✓ **16th July 2020** CryoSat-2 orbit modification
  - ✓ Collocated track every **~1.5 days** over **Arctic**
  - ✓ **3000 Km** / **few hours** apart
- Missions

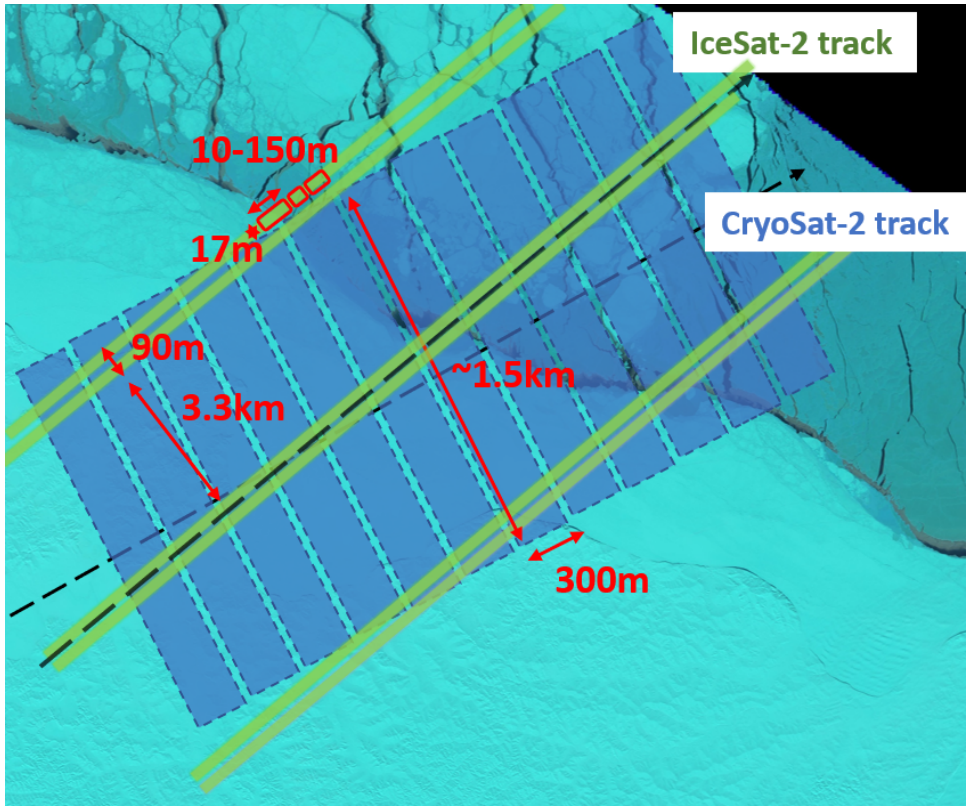
Missions		Launched	Expected end	Main Payload
CryoSat-2 (ESA)		April 2010	2022-2025 (12-15y)	Ku-band SAR (SIRAL)
IceSat-2 (NASA)		Sept 2018	2021-2025 (3-7y)	LIDAR (ATLAS)

Credit: NASA's Goddard Space Flight Center

Scientific context: Cryo2Ice (2)

Two major differences: **Footprint** and penetration

		CryoSat-2	IceSat-2
Main payload		Ku-band SAR (λ~2.2 cm)	3 pairs of beams counting photons LIDAR (λ~532nm)
Footprint	**ALT**	300m	10-150m
	ACT	~1.5km	~17m
Penetration		Penetration in Snow	No penetration



Credit: Sentinel-2A (ESA)

Scientific context: Cryo2Ice (2)

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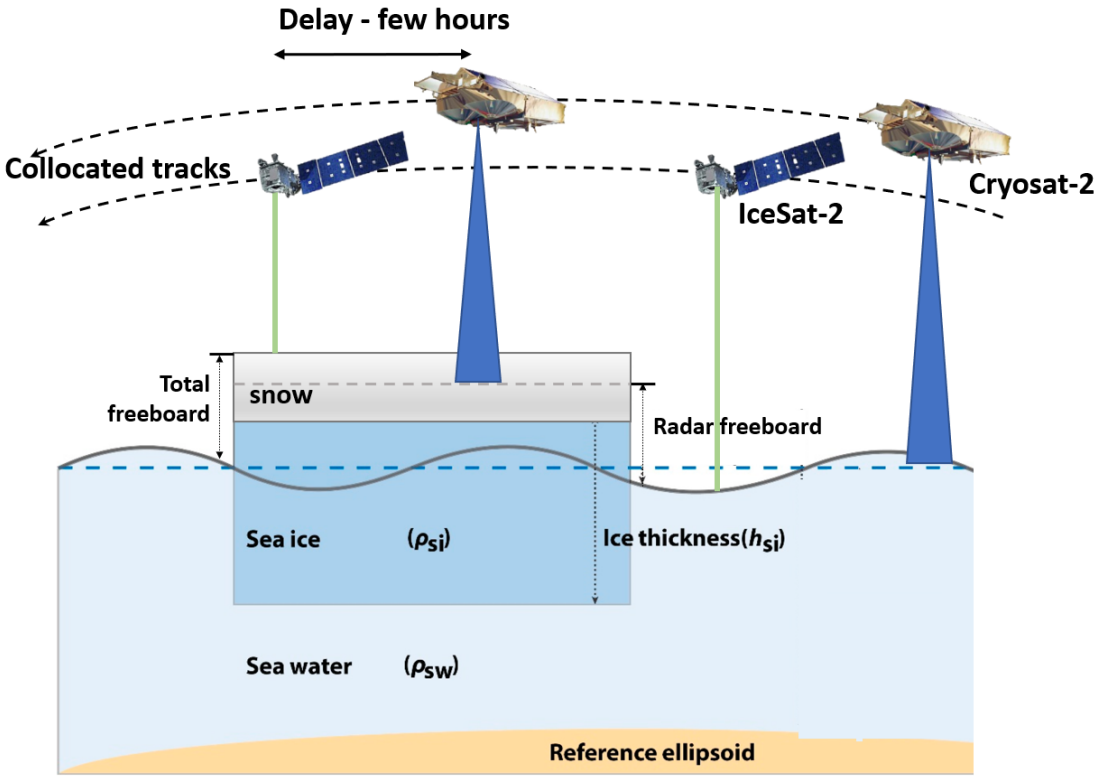


Credit: Adapted from Lee et al (2016)

Work objectives

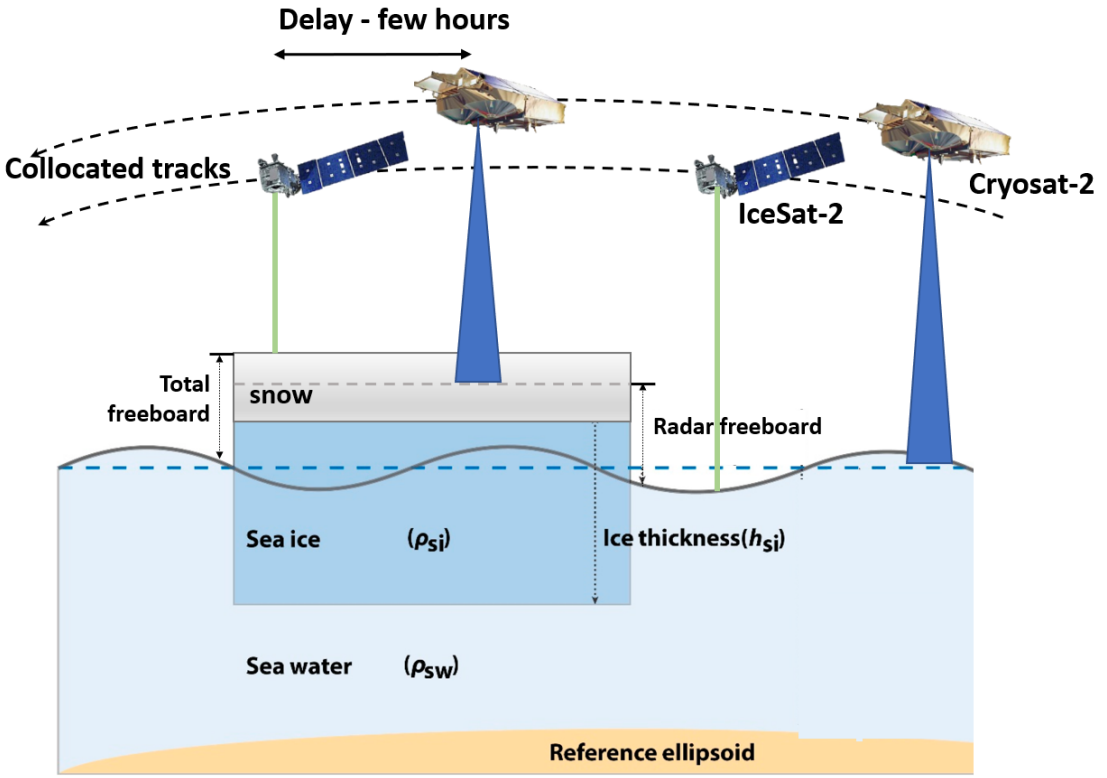
Task1: Developing a comparison protocol between CS2/IS2

WP1

- Evaluate existing CryoSat-2 Sea-ice products:
  - Sea level
  - Surface classification
  - roughness
- Elaborate CryoSat-2 sea-ice product most adapted for the comparison
  - Estimation of Ku-band penetration

WP2

- Assess on footprint impact
- Estimate Ku-band penetration (snow-depth)



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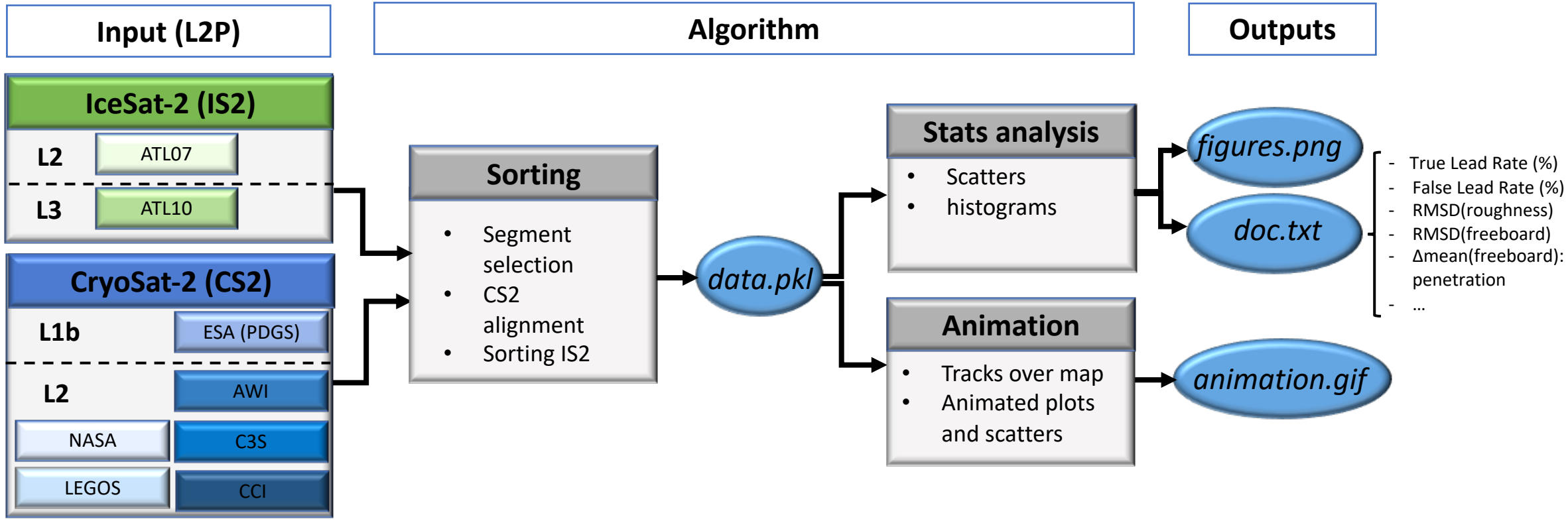
IS2/CS2 Comparison protocol

Task1: Developing a comparison protocol between CS2/IS2



IS2/CS2 Comparison protocol

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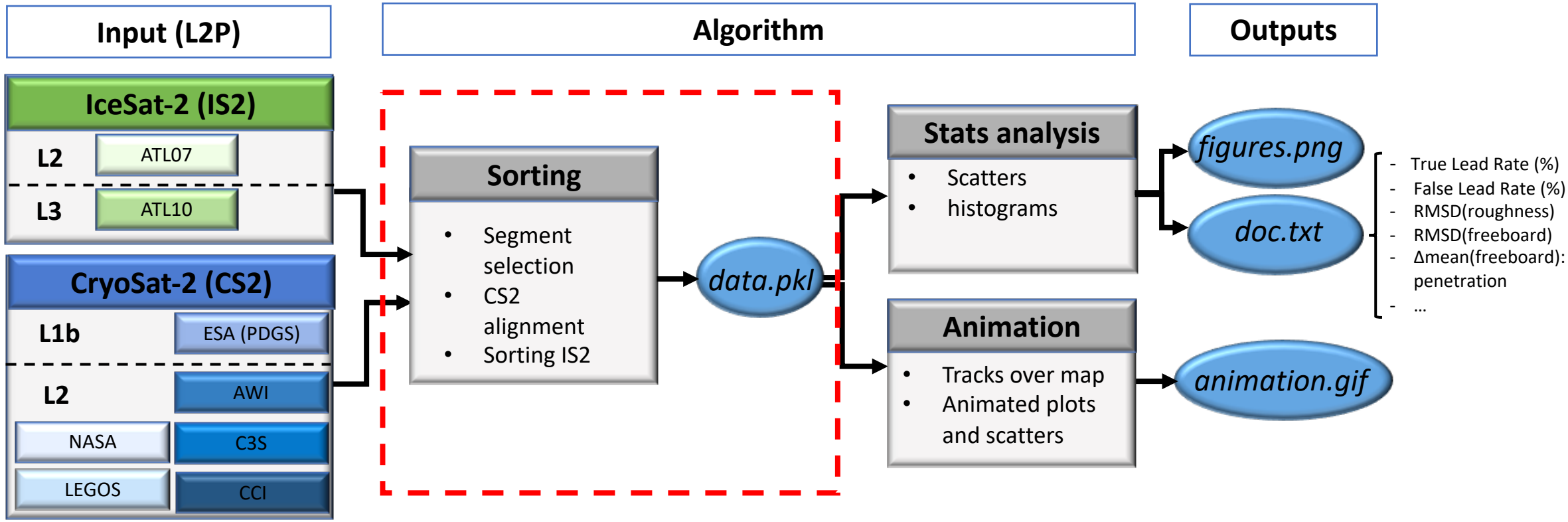


Sorting algorithm

input

track selection

- Associate IS2 data with CS2 ref tracks data using KDtree algorithm
- Select CS2 beam within distance inf to MIN_DIST

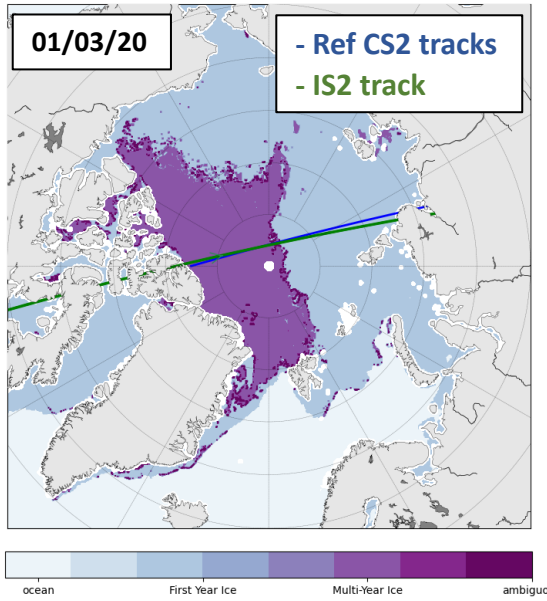
Alignment CS2 data

- In each CS2 products find corresponding data pts in ref tracks

Sorting IS2 data

- Associate each IS2 data pts to CS2 reference points
- Sort IS2 data by order of minimum distance to the CS2 beam center

data.pkl



CS2 ref track:

IS2 beam1:

IS2 beam2:

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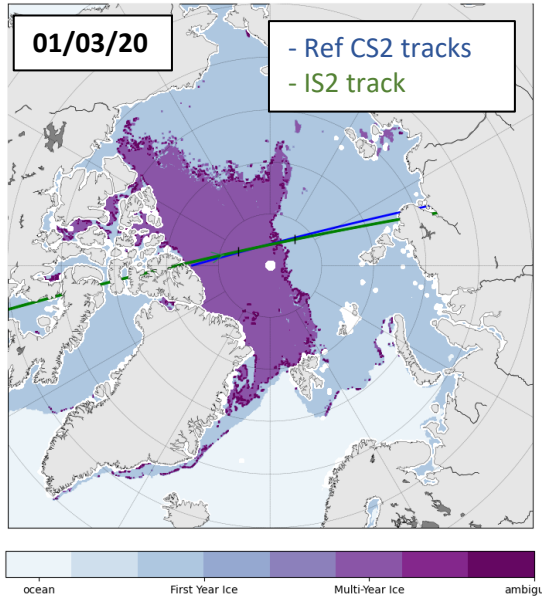

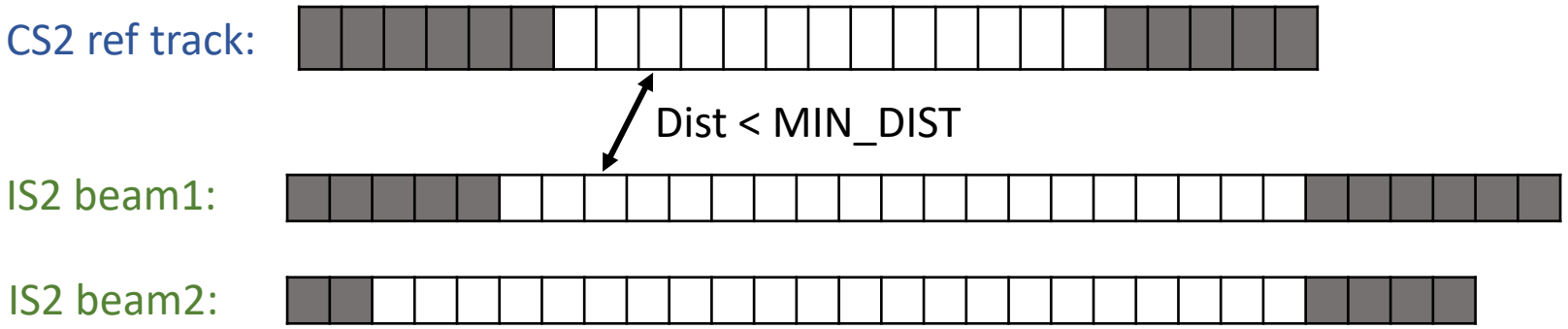

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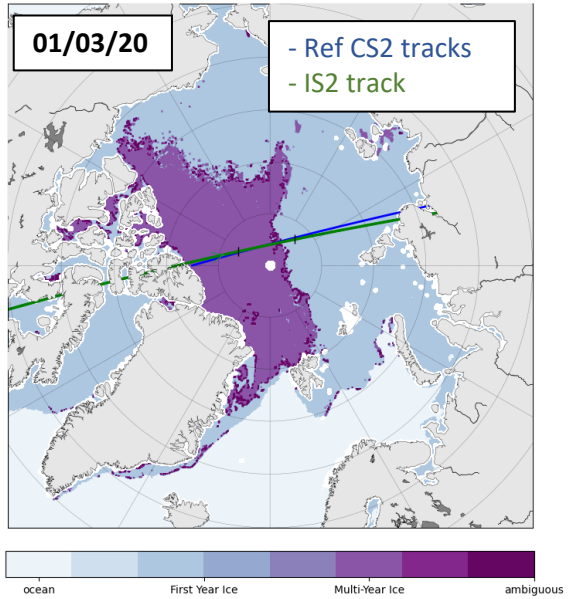

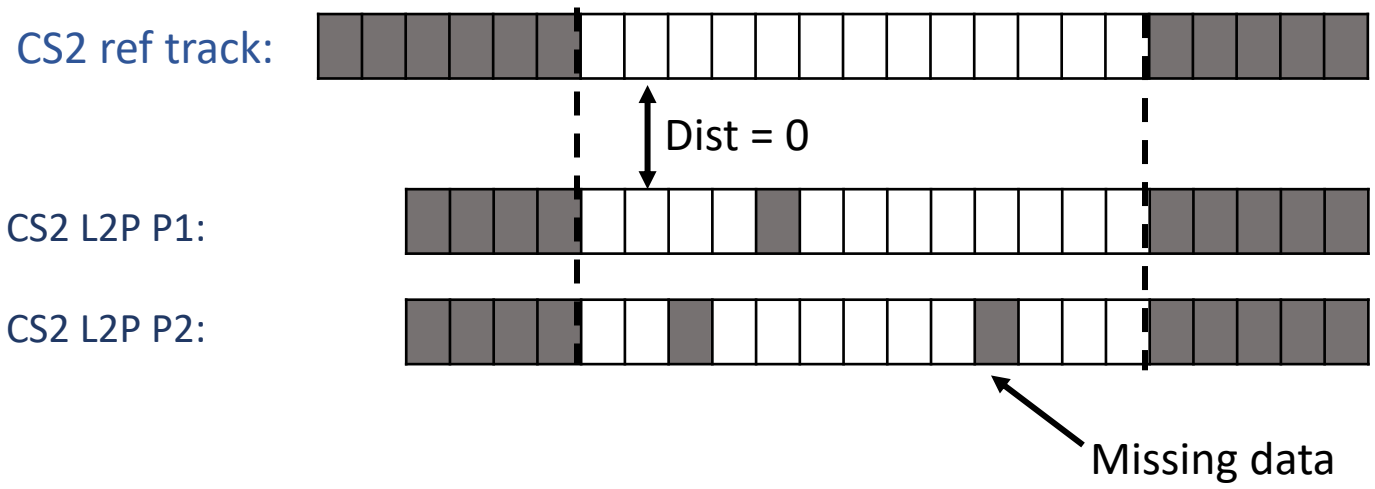

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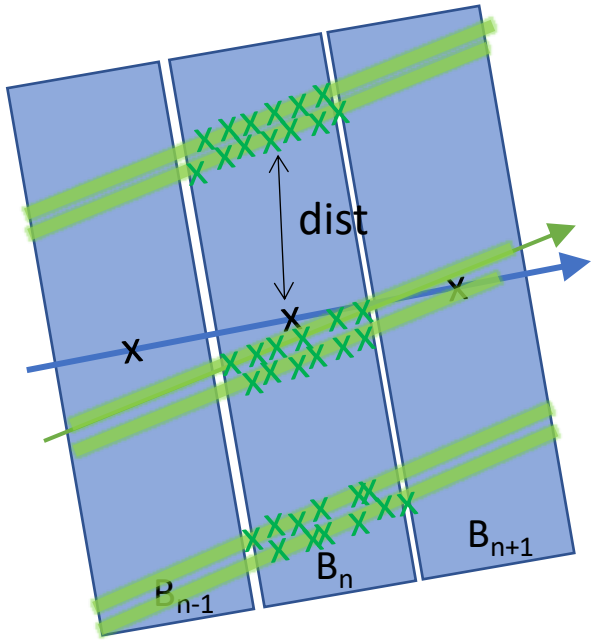
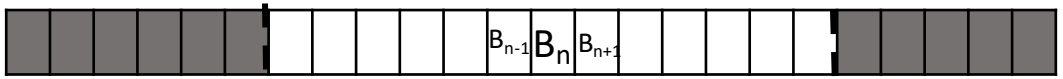
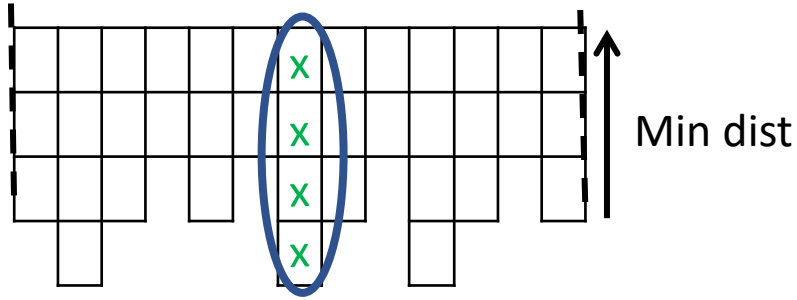


CS2 ref track:

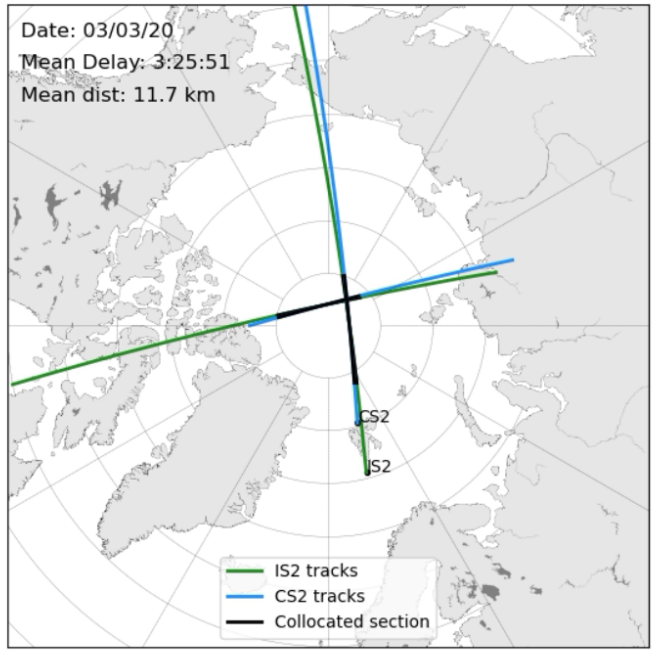


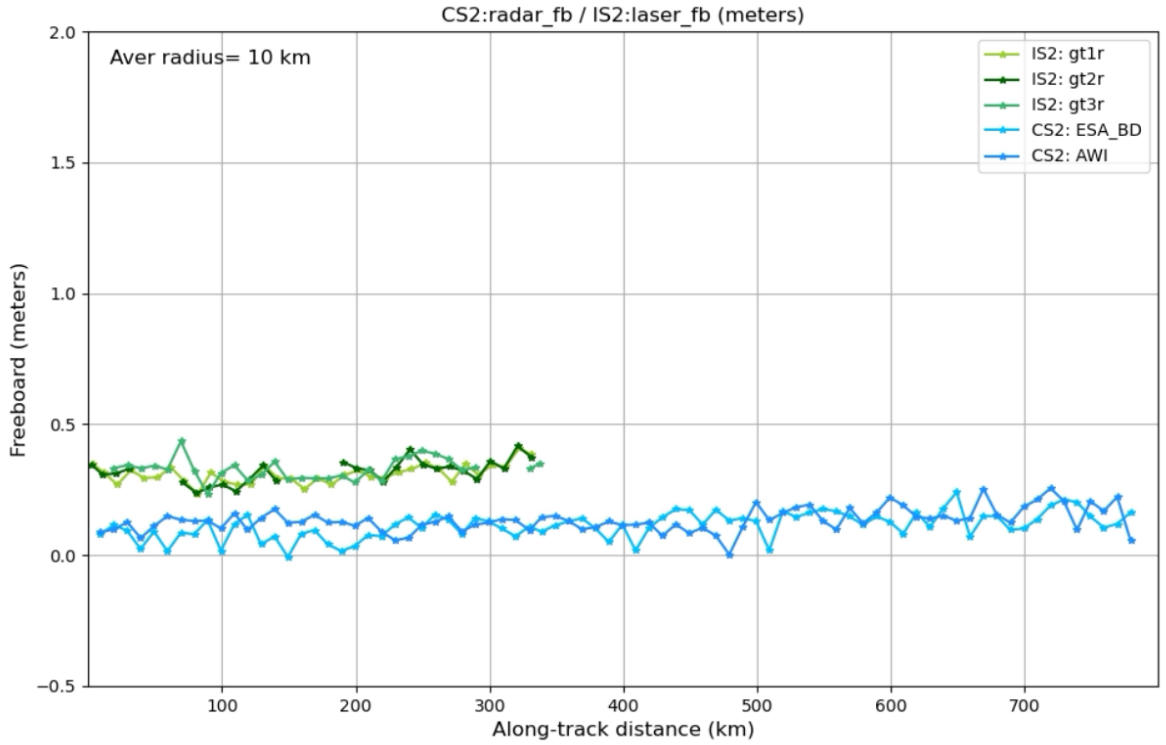
IS2 data:



Animation

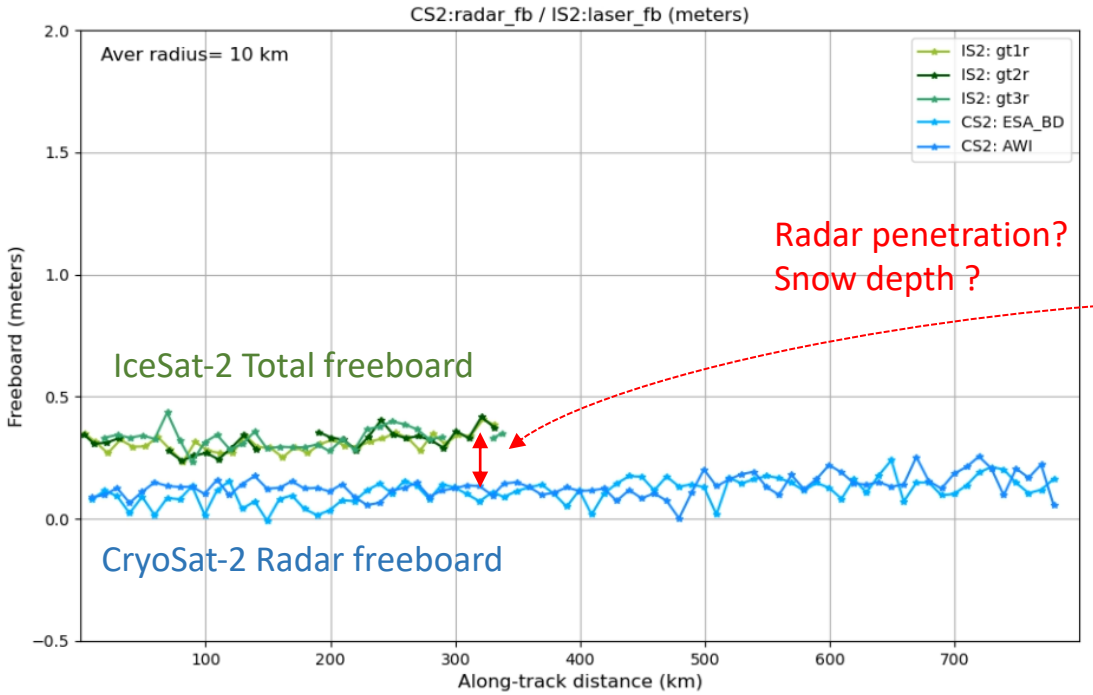
Near collocated tracks from March 2020: very preliminary work

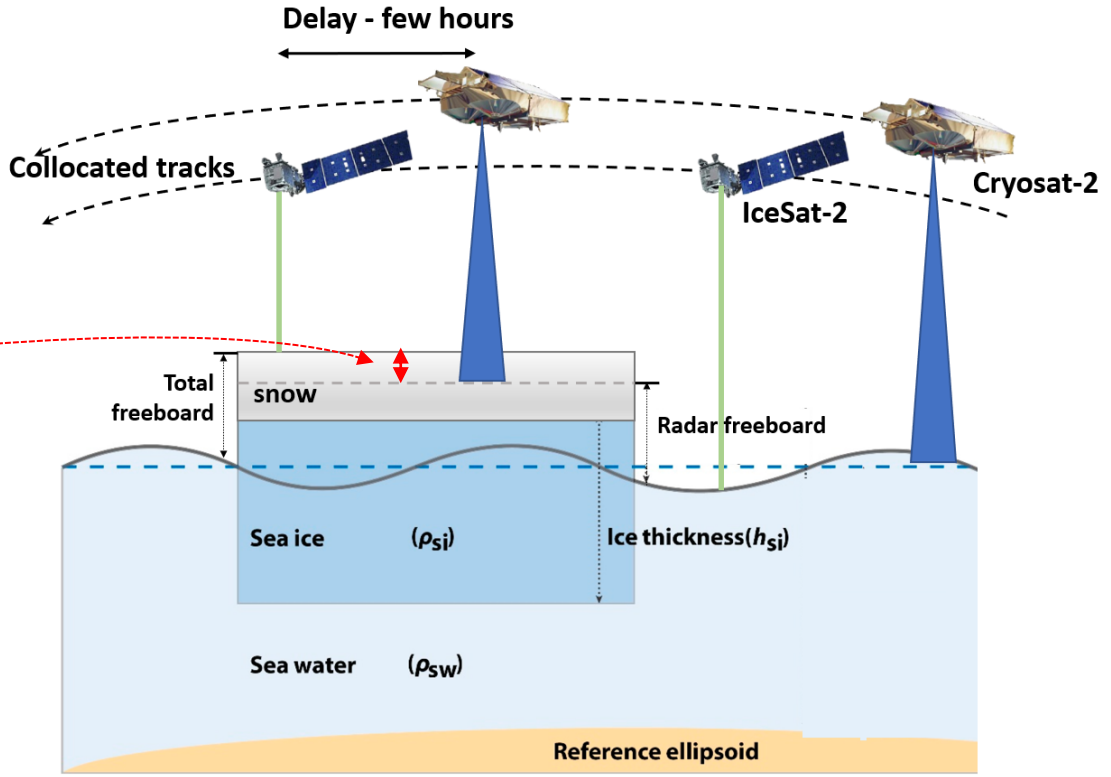




First observations

IS2/CS2 Freeboard differences: Ku-band radar penetration? Snow Depth?





Future work/considerations

The project just started, still a lot to do !

- **Retrieve and gather along-track winter data** (Oct20-..): CS2 (not publicly available), IS2 (Not available yet)
- **Evaluate CryoSat-2 sea-ice products**: C3S, CCI, LEGOS, AWI, CPOM…ect
- Produce **animations** for advertising on Cryo2Ice project
- **Tune a CryoSat-2 sea-ice solutions** most adapted for the comparison for new scientific purposes: Ku-band penetration, impact of footprint..
- **Scientific paper**