Documenting Landfast Sea-Ice in Nunavik's Hudson Strait Using RADARSAT-2 and TerraSAR-X

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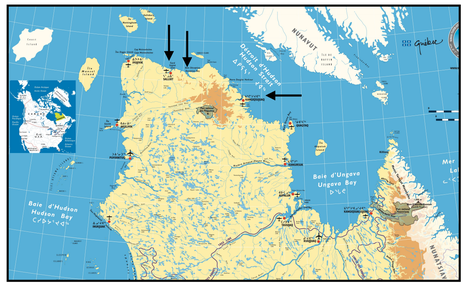
Context and Objectives

This research is part of the Safe Passage CHARS project (Polar Knowledge Canada, 2015-2018). In collaboration with other investigators, Kativik Regional Government and Raglan Mine, a Glencore company, we monitor sea ice in three bays of the Hudson Strait on the northern Nunavik coast : Salluit, Deception Bay and Kangiqsujuaq (Wakeham Bay).



Sea ice plays an important role in traditionnal hunting activities by Inuit in Nunavik. The impacts of climate change have already shortened the period where land can be accessed by ice.

«40 years ago, we could travel on the ice by snowmobile up until July 1st. The ice was thicker back then.»

- Tivi Kiatainaq, Kangiqsujuaq, April 25th 2017

Objectives : Document ice cover dynamics using satellite radar imagery; Compare the ice cover signature in two radar bands; Communicate the data to community members.

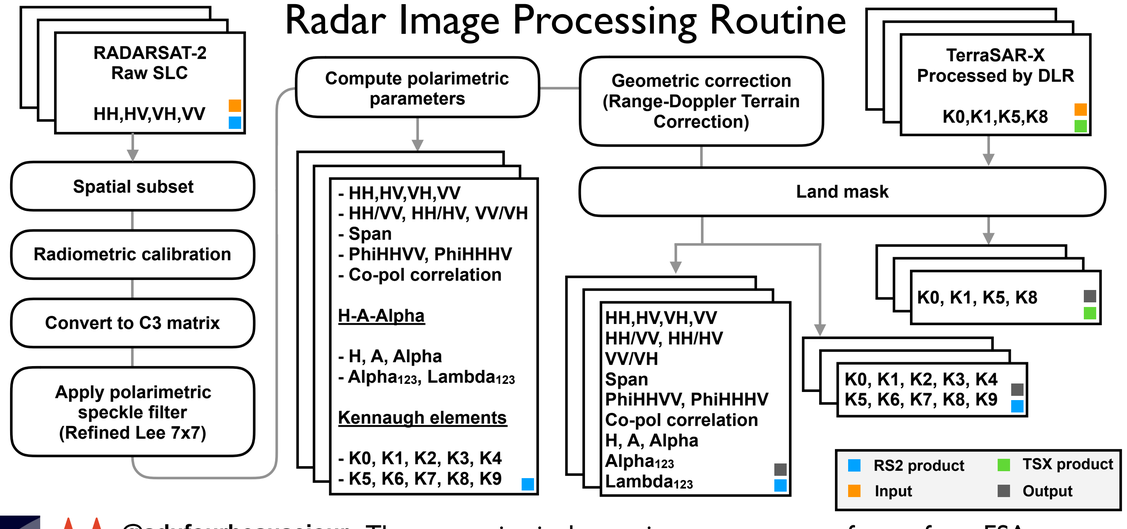
RADARSAT-2

- C-band (5.3 cm)
- Fully polarimetric
- 24 days to revisit, desc.
- Wide-Fine (50 km x 25 km)
- Incidence angle : 35° - 38°
- Resolution : 5.2 x 7.6 m

TerraSAR-X

- X-band (3 cm)
- Dual-pol (VV / VH)
- 11 days to revisit, desc.
- StripMap (15 km x 50 km)
- Incidence angle : 36 °
- Resolution : 1.2 x 6.6 m

Radar Image Processing Routine

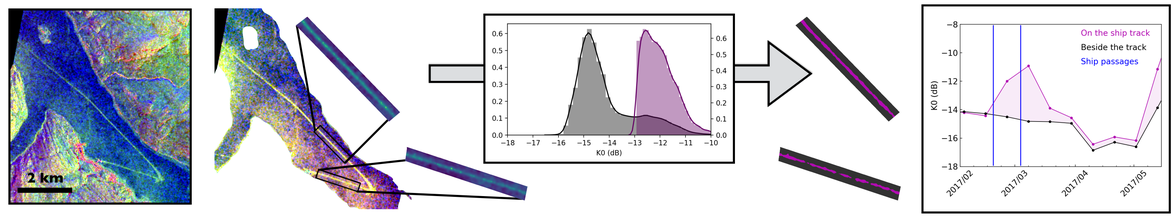


SNAP GitLab **@sdufourbeausejour** **Project : java-snap**

The processing is done using open access software from ESA.

This routine is available online on my GitLab page.

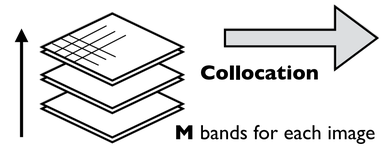
The Signature of Ice-Breaking Transport



1. The track left by ice-breaking ships passing through **Deception Bay** is readily identifiable on TerraSAR-X images. Ships follow the same route throughout the season.
2. A target image is chosen where the track is well-delimited. Pixels associated with the track are identified using **outlier detection** on a subset of the image cropped around the track.
3. The backscattering of the pixels on the ship track is averaged for every image in the time series, compared with neighboring ice unaffected by the ship, and **correlated with ship transits**.

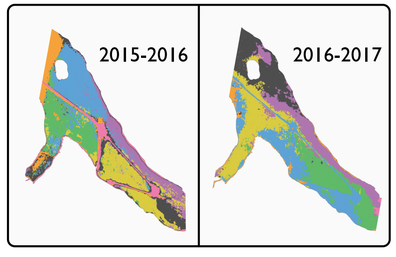
Multi-Temporal Classification of the Ice Cover

Issue : Grouping image pixels together into classes which can be used throughout the season.



N x M dimensional space for clustering

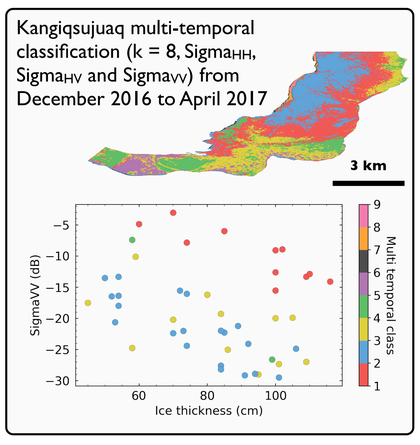
k-means cluster analysis yields a classification of pixels which may take into account diverging paths taken by originally similar ice pixels



Left : TerraSAR-X multi-temporal classes (k = 8, K1, K0 and K5, complete ice season) seperate Deception Bay into well-defined zones.

Right : RADARSAT-2 multi-temporal classes explain the spread observed in backscattering signature for a given ice thickness.

Kangiqsujuaq multi-temporal classification (k = 8, $Sigma_{HH}$, $Sigma_{HV}$ and $Sigma_{VV}$) from December 2016 to April 2017



Future work

1. Explain the time evolution of sea ice backscatter on the ship track as seen with TerraSAR-X and compare it to that of RADARSAT-2.
2. Evaluate the time evolution of other polarimetric parameters
3. Identify physical characteristics of multi-temporal classes

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MINE RAGLAN UNE COMPAGNIE GLENCORE
KATIVIK
Polar Knowledge Canada
Safe Passage Project
Gouvernement du Canada / Government of Canada
ArcticNet
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December 12th 2017, Québec QC
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