Satellite-derived waterline
- coastal evolution monitoring in Québec -

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Coastal change from space

The Canadian coast is the world's longest, of more than 240 000km, with a wide type diversity and ecological specificity (ice-foot, sea-ice, permafrost).

Satellite derived products are well suited to cover such a large area

in relation to the Coastal zone exposure to erosion due to

i. climate change and
ii. intense anthropic activities.

Coastal change from space

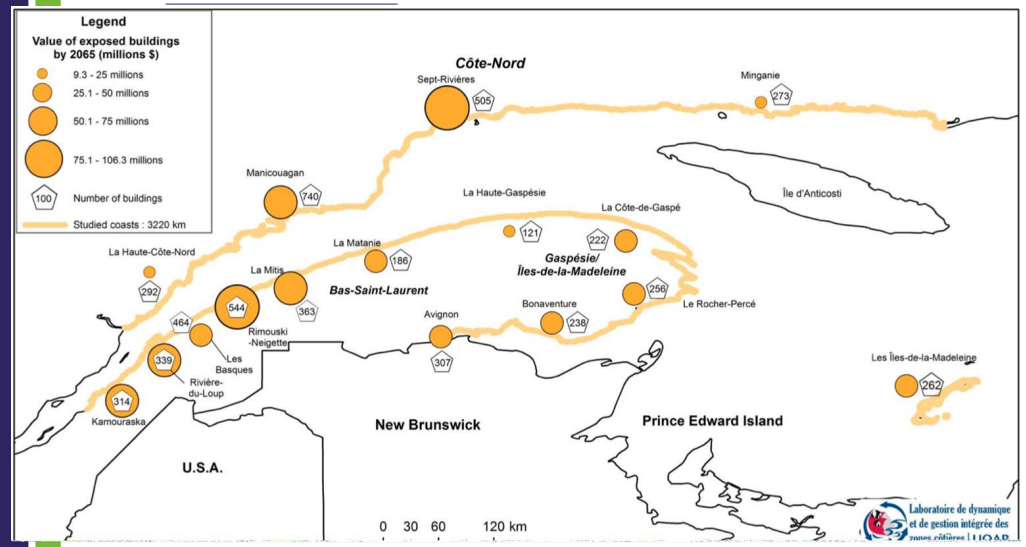
- Coastal zone are more exposed to erosion due to
  i. climate change and
  ii. intense anthropic activities.

- The ***Gulf of St. Lawrence*** region is amongst the regions of the world where the trend of <u>sea-level rise</u> has been the highest

  Erosion is aggravated by the <u>loss of coastal/sea ice</u> (i.e. longer ice-free period) and increased temperatures (warming condition) that lead to <u>permafrost thaw</u>

- In ***Canada*** & ***Québec***, no public agency for monitoring coastal erosion → delegation/ studies are conducted mostly by academia

Coastal change from space



In ***Québec***, more than 3.220 km of coastline under study and in need of permanent monitoring

A recent research report (May 2015) gives an overview of transport infrastructure and buildings that will be exposed to erosion from 2015 to 2065 if no adaptation measures are implemented

- The potential economic loss for the considered period, is estimated at $1.5 billion

  when near shore infrastructure at risks, adaptation solution is relocation.

[Bernatchez et al., 2015]

Coastal change from space

In addition to EO products delivered by Argans Ltd in the frame of ESA Coastal Change project, ie ***Instantaneous waterlines, Datum corrected shoreline, Ecosystems classification***,

specific EO products have been developed by Arctus and Hatfield (a Vancouver company) with support of Argans Ltd such as: ***Ice-foot detection, sea-ice classification, coastal ecosystem/seagrass mapping.***

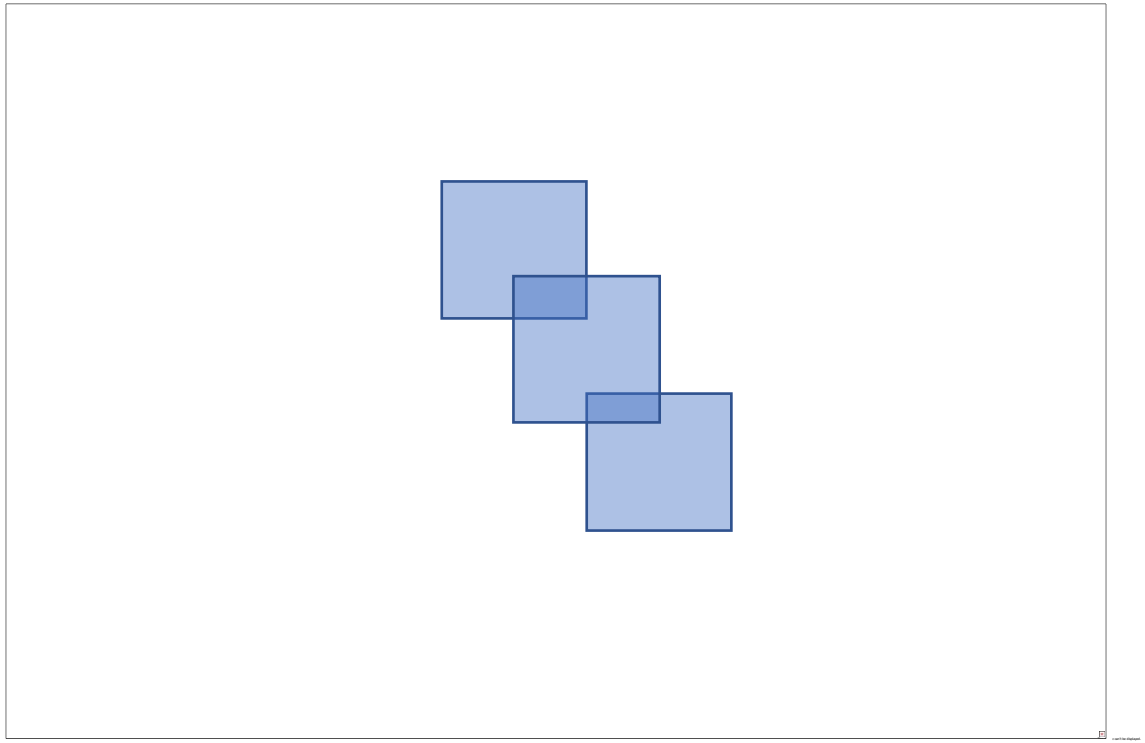
so as to deliver adapted products/services for monitoring coastal dynamics to end-users and communities in Canada

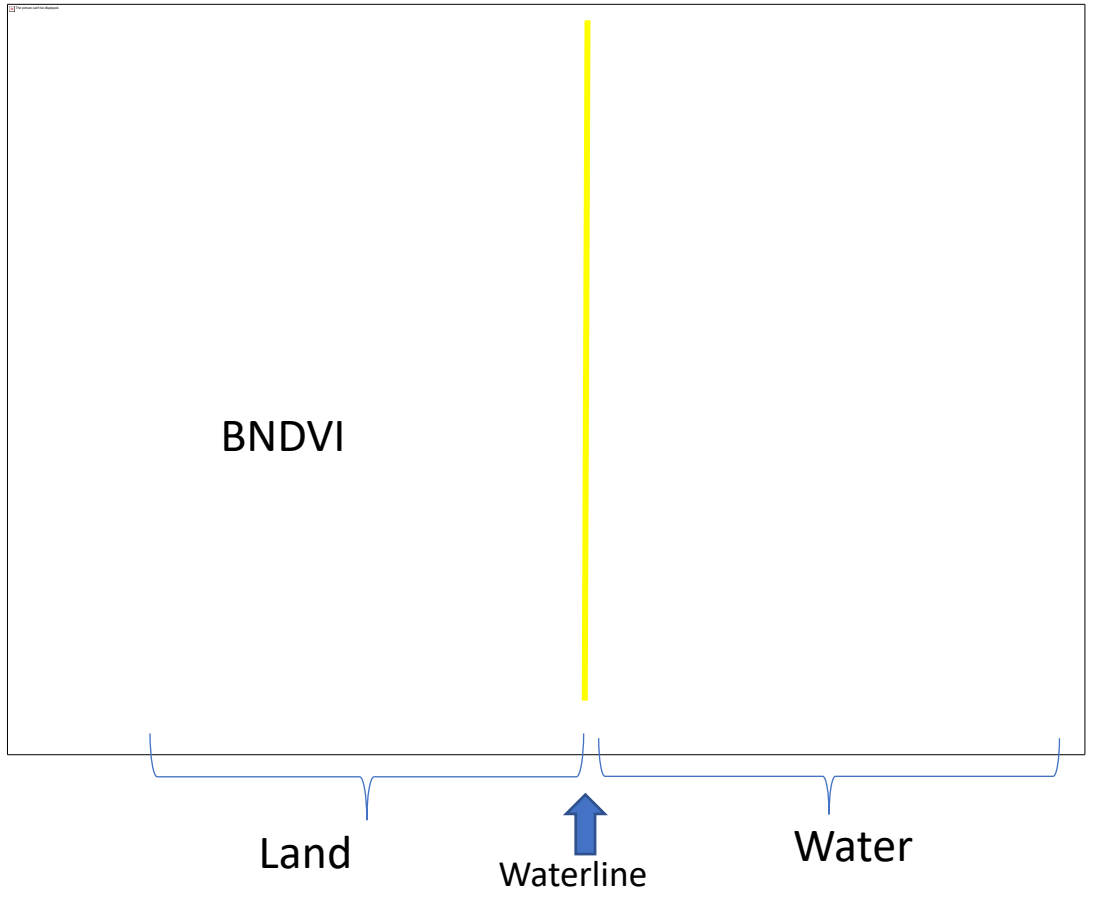
The BASICS: satellite derived waterline

Validation of the satellite derived waterlines using in situ data

Satellite derived waterline

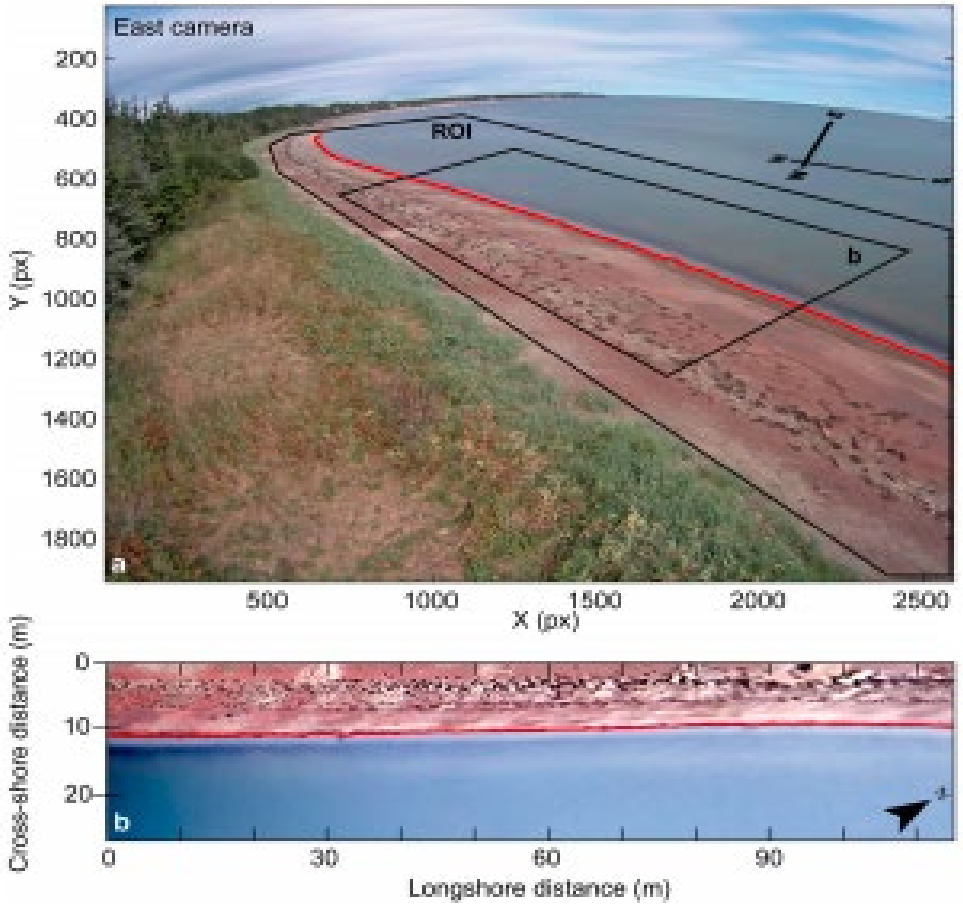
Argans Ltd developed an adaptative detection processor applied to optical remote sensing





In situ waterline extraction

- ground control points (GCP) for horizontal projection
- Five-minute video segments merged to get rid of wave run-up and swash
- Waterline represents the local minimum of the (**B** + **G**/**R**) ratio over the entire area of interest

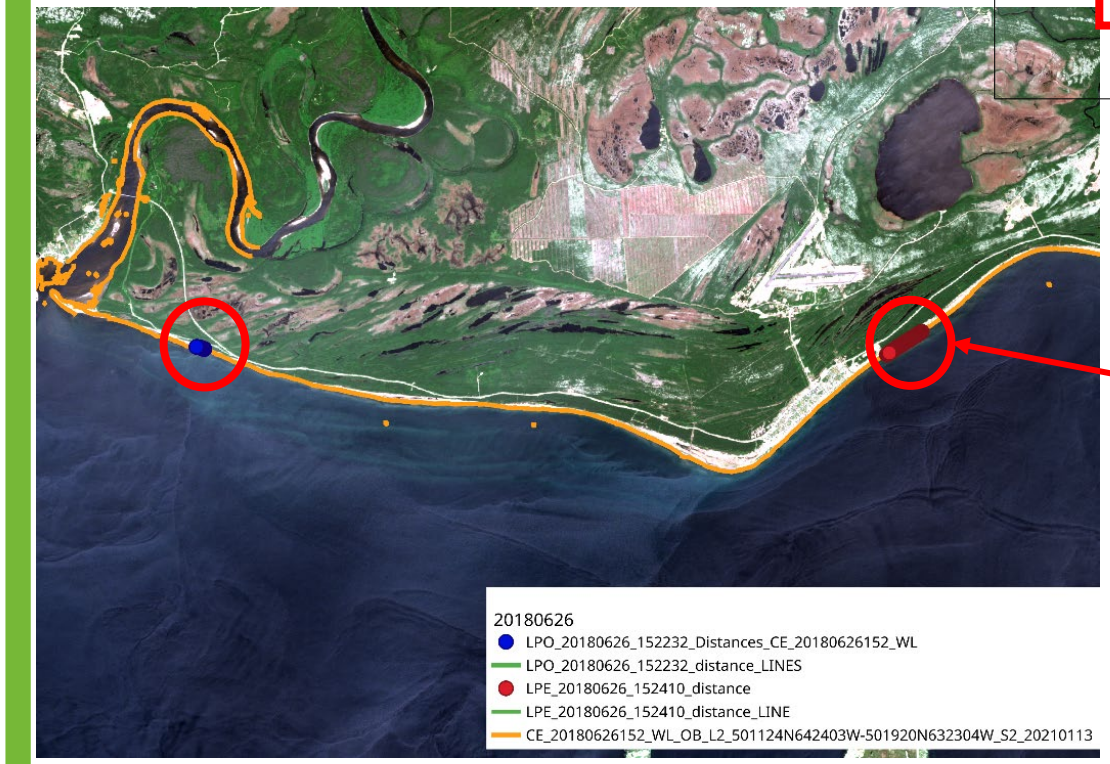


Didier, D.; Bernatchez, P.; Augereau, E.; Caulet, C.; Dumont, D.; Bismuth, E.; Corn L.; Floc'h, F.; Delacourt, C. ***LiDAR Validation of a Video-Derived Beachface Topography on a Tidal Flat.*** *Remote Sens. 2017, 9, 826. https://doi.org/10.3390/rs9080826*

Region of interest

St-Jean River/Mingan village:

- 2 cameras (East/West)

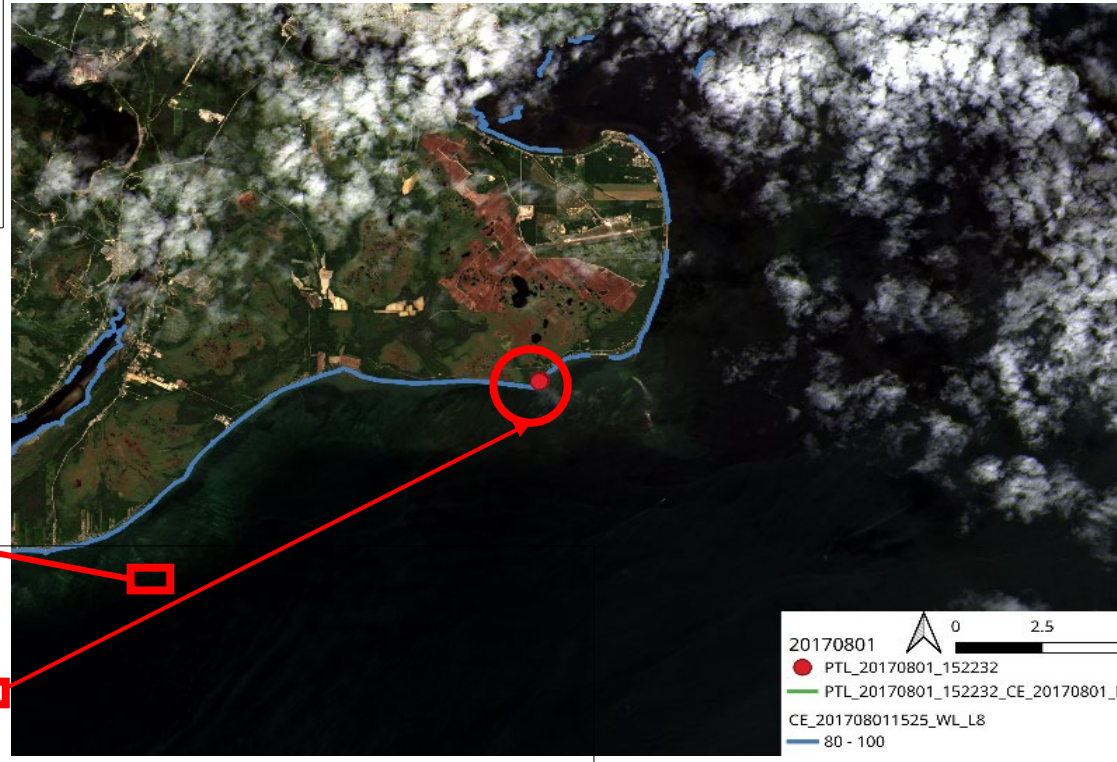


Major road and infrastructure at risks.

Beach equipped with camera

Manicouagan Peninsula:

- 1 camera



Matchup

Date of In-situ acquisition	Time of In-situ acquisition	Date of satellite acquisition	Time of satellite acquisition	Date time difference	Sensor
20161010	15:12:25	20161010	15:19:00	**0:06:35**	L8
20170801	15:22:32	20170801	15:25:00	**0:02:28**	L8
20170902	15:22:34	20170902	15:18:00	**0:04:34**	L8
20171013	15:12:24	20171013	15:19:00	**0:06:36**	L8
20180423	15:12:27	20180423	15:18:00	**0:05:33**	L8
20180509	15:12:27	20180509	15:18:00	**0:05:33**	L8

Methodology

Manicouagan Peninsula (2016-2017-2018)

- max 00:06:36 time difference
- Landsat 8 data only

Matchup

Date of In-situ acquisition	Time of In-situ acquisition	Date of satellite acquisition	Time of satellite acquisition	Date time difference	Sensor
20160622	15:02:30	20160622	15:05:00	**0:02:30**	L8
20160708	15:02:35	20160708	15:06:00	**0:03:25**	L8
20170517	15:22:28	20170517	15:26:00	**0:03:32**	S2
20170625	15:02:29	20170625	15:05:00	**0:02:31**	L8
20170828	15:02:26	20170828	15:06:00	**0:03:34**	L8
20170914	15:22:29	20170914	15:26:00	**0:03:31**	S2
20180527	15:02:31	20180527	15:05:00	**0:02:29**	L8
20180606	15:23:27	20180606	15:26:00	**0:02:33**	S2
20180626	15:24:10	20180626	15:26:00	**0:01:50**	S2
20180916	15:02:41	20180916	15:05:00	**0:02:19**	L8

Date of In-situ acquisition	Time of In-situ acquisition	Date of satellite acquisition	Time of satellite acquisition	Date time difference	Sensor
20180527	15:02:28	20180527	15:05:00	**0:02:32**	L8
20180606	15:22:33	20180606	15:26:00	**0:03:27**	S2
20180626	15:22:32	20180626	15:26:00	**0:03:28**	S2
20180916	15:02:29	20180916	15:05:00	**0:02:31**	L8

St-Jean River/Mingan village:

- East (6 Landsat/4 Sentinel2)

St-Jean River/Mingan village:

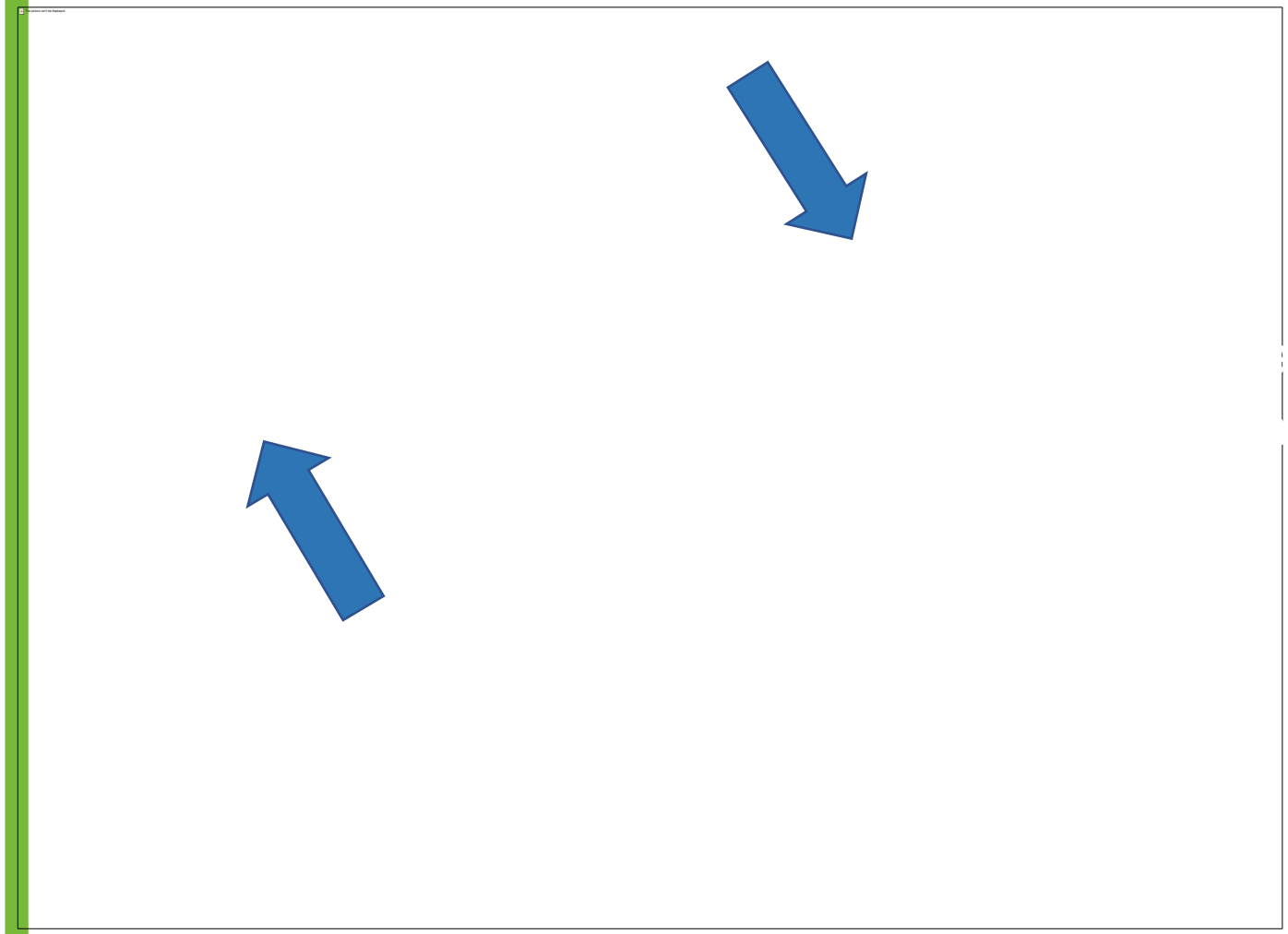
- West (2 Landsat/2 Sentinel2)

St-Jean River/Mingan village:

- max 00:03:34 time difference
- Landsat 8 and Sentinel 2 data

Validation

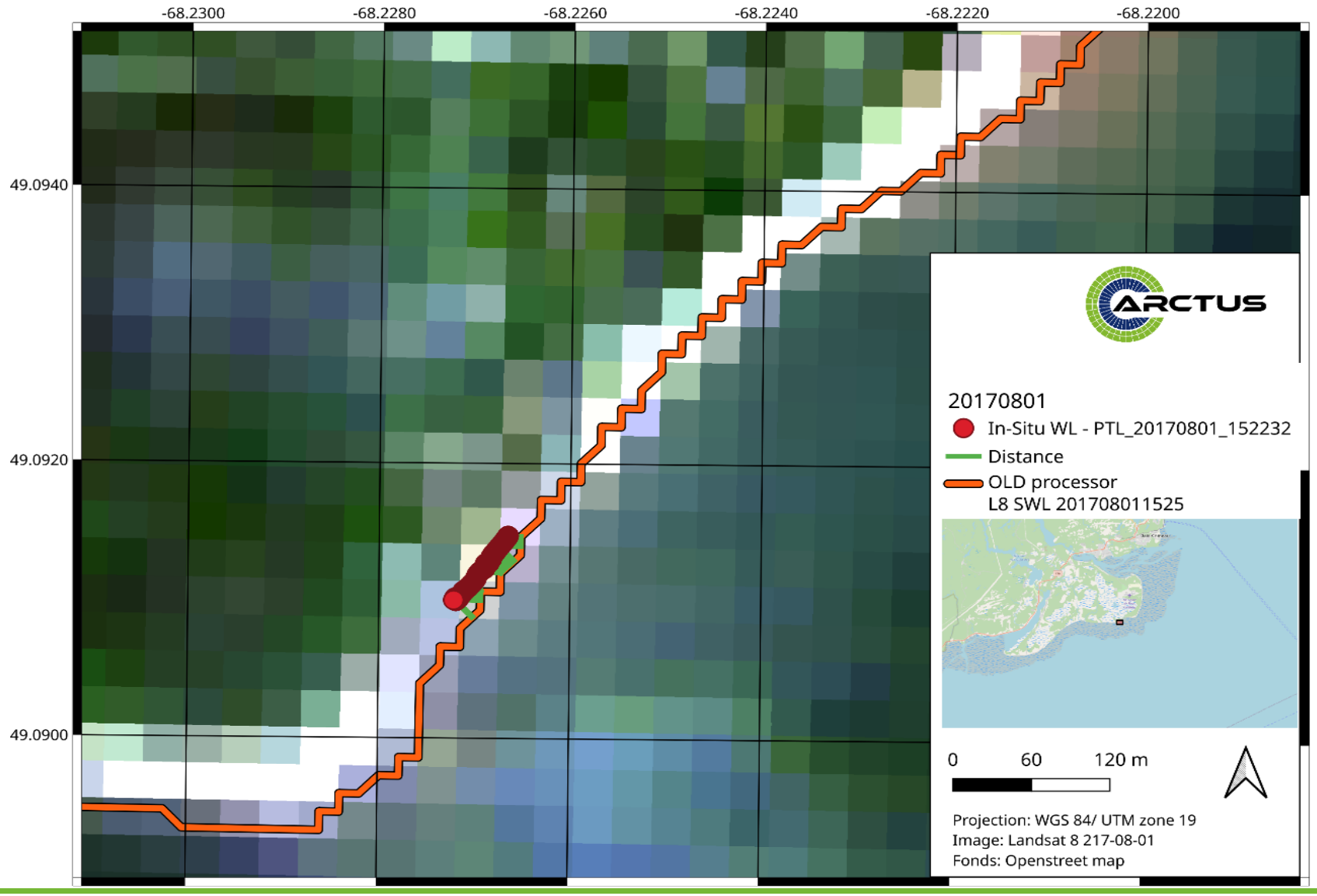
Mingan West



standard imprecision of +/- 1 pixel

discrepancy of 2 pixels due to sand bar close to the beach that « captures » retreating water

Validation

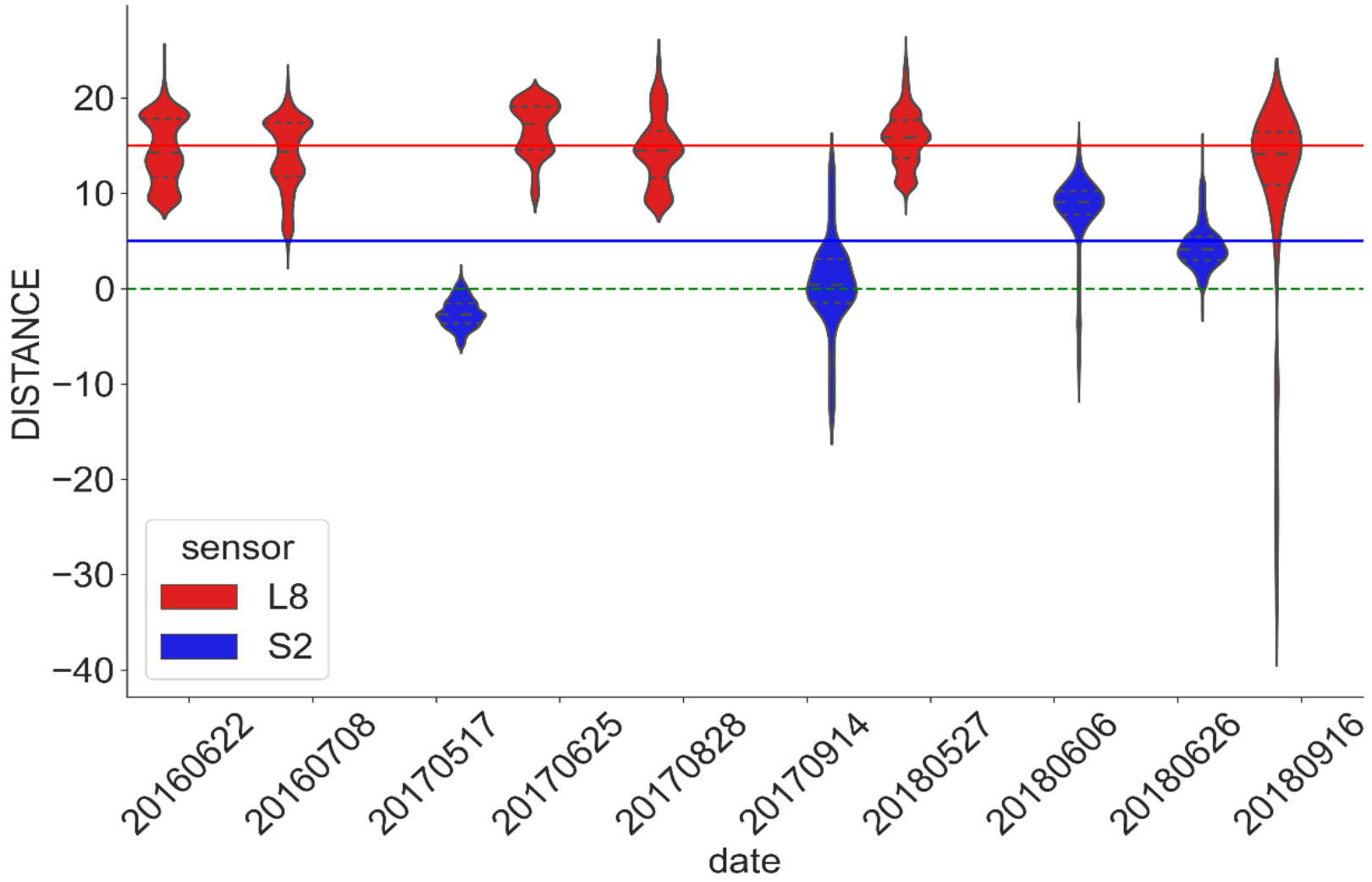


Manicouagan

Results

St-Jean river/Mingan East

Mean distance close to the subpixels resolution (15m to 5 m)

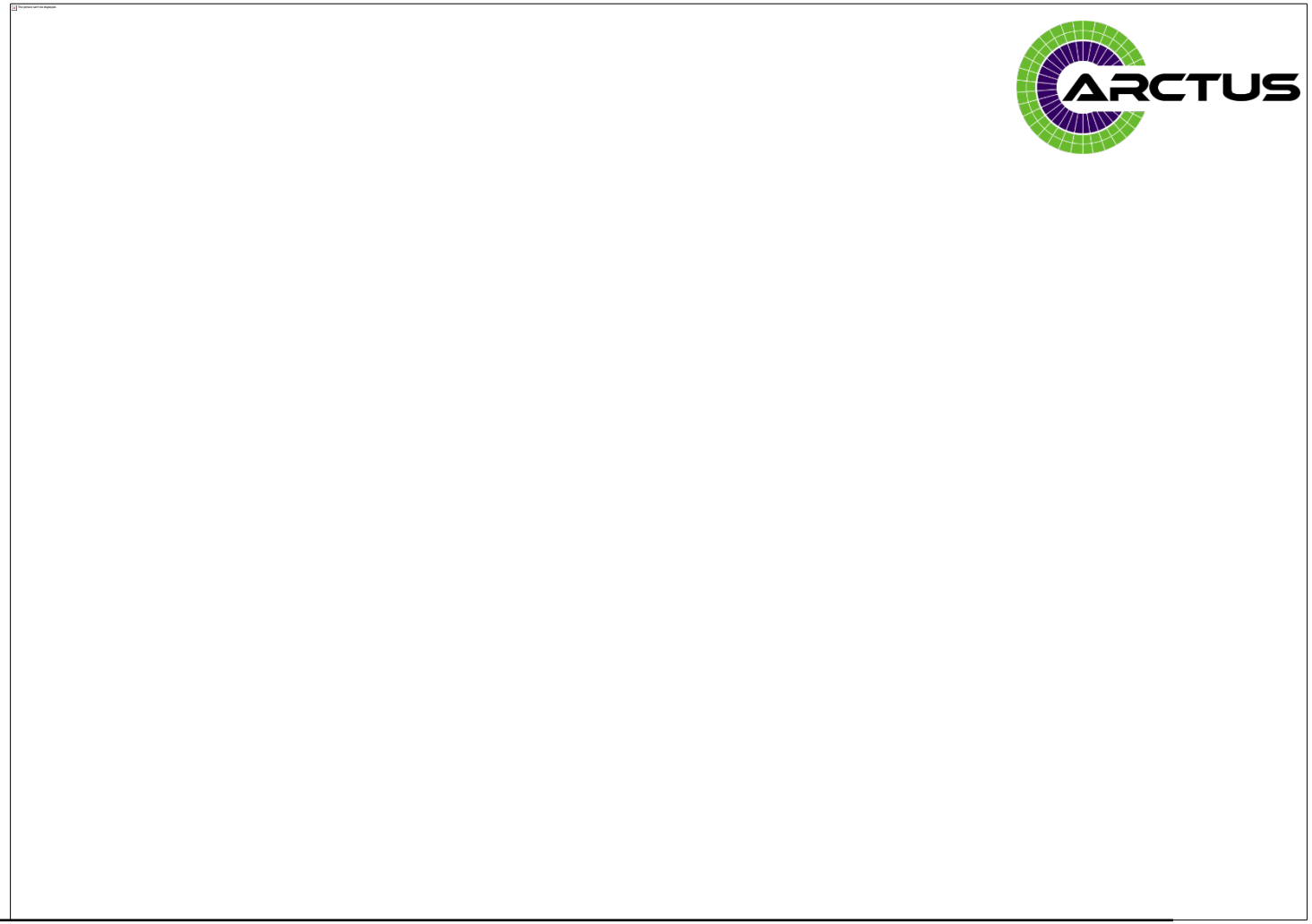


	Sensor	Count	Mean	Std	Min	25%	50%	75%	Max
MEAN	L8	16878	14.80	3.70	1.84	12.54	15.08	17.47	22.42
MEAN	S2	10277	2.92	2.65	-5.19	1.49	2.78	4.35	11.74

Results

St-Jean river/ Mingan West

High variability (positive/negative) between lines (≠ dates).



	Sensor	count	mean	std	min	25%	50%	75%	max
Mean	L8	512	0.66	5.74	-10.14	-3.37	0.66	5.31	13.86
Mean	S2	748	0.82	3.43	-6.31	-1.13	0.55	3.09	9.20

Conclusion

EO-derived waterlines are OK

EO-derived shorelines are validated from time-series of in-situ waterlines

=> EO-derived products are well suited in term of spatial coverage and revisiting time to assess coastal change in Canada.

It’s time now to deliver an operational data/information service to public authorities and local communities.

& further work in Canadian Arctic to assess changes in complex remote environment.

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