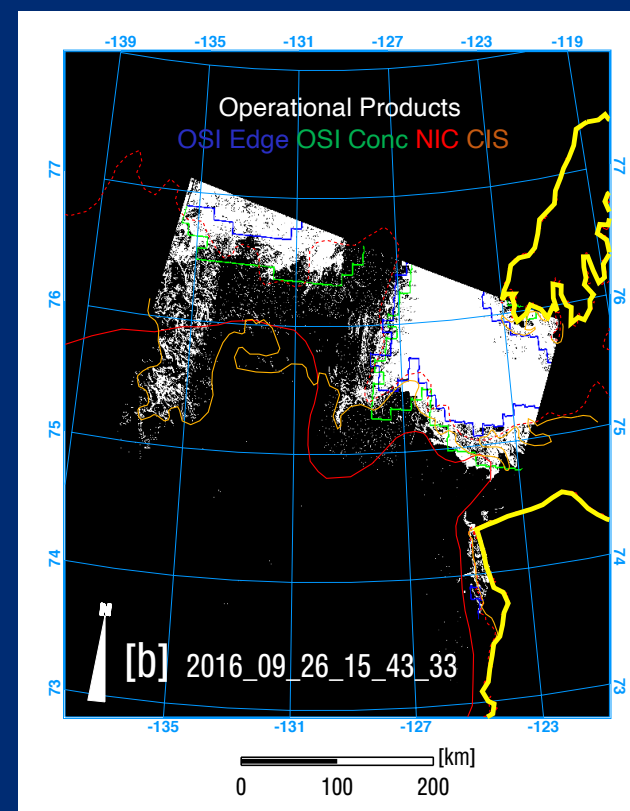


# Active/Passive Multiple Polarization Sea Ice Detection

- Science Driver: The ice edge is the boundary between the liquid and frozen ocean surface. Knowing its location accurately is vital for scientific research into climate, biodiversity, and weather, among others, as well as for human use activities like navigation and fishing.
- Remote Sensing Challenge: For all-weather, high-resolution Synthetic Aperture Radar (SAR), different ages and thicknesses of sea ice have normalized radar cross section ( $\sigma_0$ ) signatures that can be identical to each other and to ocean  $\sigma_0$  signatures from breaking waves, currents, surface slicks, and low pressure systems.
- Synergistic Algorithm Solution: Calculating the Coefficient of Variation (COV), the standard deviation to mean, over small spatial windows of  $\sigma_0$  unified the sea ice signatures to high values, while leaving the ocean pixels unchanged. Although at lower resolution, Passive MicroWave Ice Concentrations (PMWIC) are less sensitive to surface roughness, the source of ocean  $\sigma_0$  variability, so a synergistic combination will refine ice/water identification, while retaining high SAR resolution in the result.



Edge Data Source	Mean Difference [km] from ground truth (CIS* or MASIE+) ice edge	
	2016 test case (left, CIS*)	2018-2019 cases (MASIE-NH+)
OSI-SAF# edge	65.8	104
OSI-SAF# conc	59.3	78.5
Synergistic algorithm	8.4	33.5

\*CIS: Canadian Ice Service, from RADARSAT analysis  
 +MASIE-NH: Multisensor Analyzed Sea Ice Extent-Northern Hemisphere (National Snow and Ice Data Center)  
 #OSI-SAF: Ocean and Sea Ice Satellite Application Facility (EU Meteorology)

- Algorithm Example: The image in the center shows the SAR resolution ice mask for a 2016 case from the Beaufort Sea with ice edges from other manual and operational analyses plotted on it. The “true” ice edge, produced by manual analysis of RADARSAT data, is the orange line (CIS in the legend). It tracks closely the ice/water boundary from the ice mask pixels (white) identified by the synergistic algorithm from Sentinel and AMSR2 data. The two automated ice edges produced at OSI-SAF based on different combinations of scatterometer and passive microwave data are the blue and green lines. The mean distance from the “truth” line to the nearest edge from the automated algorithms is given in the table for both the example case and 200 images from 2018 and 2019.

**Automated ice detection based on a new, high-resolution, synergistic algorithm provides between factors of two and eight improvement in ice edge locations, relative to ground truth, over current automated operational outputs.**