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Quantification of the Fate of Sloughed Alaskan Seaweed Biomass: Quarter 1 2026 Progress Update Report

April 30, 2026

For: The Southeast Conference

Version	Date	Originator	Checker	Approver	Description
1.0	04/30/2026	Sam Rickerich	Dewhurst	Dewhurst	Quarterly

Information class: Standard

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Executive Summary

Kelson Marine Co. (“Kelson”) is quantifying the fate of sloughed kelp from coastal Alaska mariculture sites to better assess the industry potential for carbon sequestration. Project tasks focus on (1) developing and applying a sloughed kelp transport model for the Gulf of Alaska and (2) making project results accessible through a web-based mapping tool.

Quarter 1 (Q1) 2026 focused on Task 1, including further development of a workplan, literature review, and passive particle tracking experiments.

Outcomes from Q1 2026 include:

- increased detail in the Task 1 workplan to fulfill objectives,
- establishment of nominal water parcel tracks over time and space,
- statistics of particle track net and cumulative distances traveled, and
- initial determination of computational limitations.

Wed 4/29/2026	Task Start	Task Duration	% Done	Oct 2025 - Apr 2026							May 2026 - Nov 2026							De
Task	Start Date	End Date	% Done	O	N	D	Ja	F	Mr	Ap	M	Ju	Jy	Au	S	O	N	D
Quantify Fate of Sloughed Alaskan Seaweed Biomass	10/27/2025	9/30/2026	5%															
Lagrangian particle transport model development ("sloughed kelp transport model")	4/1/2026	8/1/2026	5%															
Quantify typical fate of sloughed kelp particles as a function of location	7/1/2026	9/30/2026	5%															
Online Mapping Tool	8/1/2026	12/31/2026	0%															
Organize and format modeling results for integration into an online mapping tool	9/1/2026	12/31/2026	0%															
Online, web-based GIS layer showing the modeled fate of sloughed kelp biomass by source location.	12/1/2026	12/31/2026	0%															◆
Project Administration and Reporting	10/27/2025	12/31/2026	3%															
Lead reporting, accounting and invoicing, and other oversight tasks		11/30/2026	5%															
Quarterly progress reports	4/1/2026	12/1/2026	11%							◆	◆	◆	◆	◆	◆	◆	◆	◆
Copy of all data generated during the project, in clean and usable formats.	11/1/2026	12/31/2026	0%															◆
Copy of the model itself.	12/31/2026	12/31/2026	0%															◆
Final report detailing project outcomes, including methodology, key assumptions, results (highlighting the most promising locations for kelp sloughing), challenges, lessons learned, and recommendations for future modeling work.	12/1/2026	12/31/2026	0%															◆
Presentation at a virtual venue sponsored by SEC sharing out the results.	12/1/2026	12/31/2026	0%															◆

Project Gantt Chart as of Quarter1 2026

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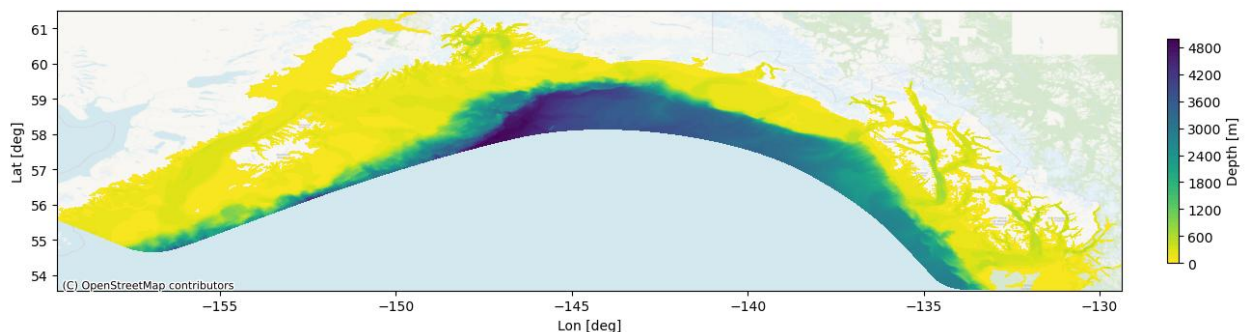
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Introduction

Kelson Marine (“Kelson”) is developing a computer model describing the fate of sloughed kelp from coastal Alaska mariculture sites. Building on Kelson’s Derisking Mariculture Investments project (funded through the Alaska Fisheries Development Foundation and the Alaska Mariculture Cluster), this work will use existing ocean-wave hindcast data and GIS layers to predict where sloughed kelp settles and quantify its potential for carbon sequestration.

Gulf of Alaska Ocean-Wave Model Hindcast Dataset

The multi-year ocean-wave numerical model hindcast is based on a two-way coupled application of the Semi-implicit Cross-scale Hydroscience Integrated System Model (SCHISM; Y. Zhang & Baptista, 2008; Y. J. Zhang et al., 2015, 2016) and the Wind Wave Model III (WWM; (Roland, 2008)) over an unstructured horizontal mesh resolving spatial resolutions of 250 m (farm scale and coastal scale) to 2500 m (open coastal ocean). In the vertical dimension, mesh layers are defined by a location specific terrain following vertical sigma coordinate system (2-35 levels over domain; 19 layers on average). The SCHISM-WWM model of Gulf of Alaska waters is forced at its boundaries by static bathymetry and time and space varying tidal, ocean, wave, atmospheric, and riverine conditions. Internally, the ocean model resolves 3D processes and over time at the resolution of the mesh and parameterizes sub-mesh scale processes (e.g. turbulence, wetting and drying, bottom friction, air-sea exchange). The third-generation spectral wave model captures wind-wave generation, propagation (e.g. nonlinear wave-wave interactions, diffraction), and dissipation (e.g. whitecapping, depth-induced breaking, bottom friction).



Bathymetry of the Gulf of Alaska Ocean-Wave Model

Task 1: Quantify Fate of Sloughed Alaskan Seaweed Biomass

Task 1 Overview

- *KM will develop and apply a Lagrangian particle transport model (“sloughed kelp transport model”) using high-resolution ocean circulation data from the Derisking Mariculture Investments project to simulate the movement and deposition of sloughed kelp fragments across Alaska’s coastal waters.*
- *KM will quantify the typical fate of sloughed kelp particles as a function of location, including estimates of the distribution of sloughed mass across depositional water depths.*

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Workplan for Task 1 Objectives

1. Passive Lagrangian particle tracking with Gulf of Alaska Ocean-Wave Model Hindcast 3D ocean current velocity fields
 - a. Serial experiments
 - b. Parallelized experiments; determine computational limits
2. Develop “sloughed kelp transport model” in OpenDrift
 - a. Model development; continued literature review
 - b. Serial model tests with Gulf of Alaska Ocean-Wave Model Hindcast data
 - c. Parallelized model tests with Gulf of Alaska Ocean-Wave Model Hindcast data
3. Quantify typical fate of sloughed kelp particles
 - a. Parallelized experiments
 - b. Post-process results

Literature Review

Updated literature review and learnings from related ongoing research:

- Met with Oceans 2050 seaweed carbon project (Bigelow Labs) to assess sloughing data.
- Broch et al. (2022), *Dispersal and Deposition of Detritus From Kelp Cultivation*
- Carlson et al. (2026), *Ocean transport and vertical mixing connect Greenland's macroalgae to deep ocean carbon sinks*
- Lee et al. (2025), *Alkalinity (Bicarbonate) Pumping by Coastal Macroalgal Forests*

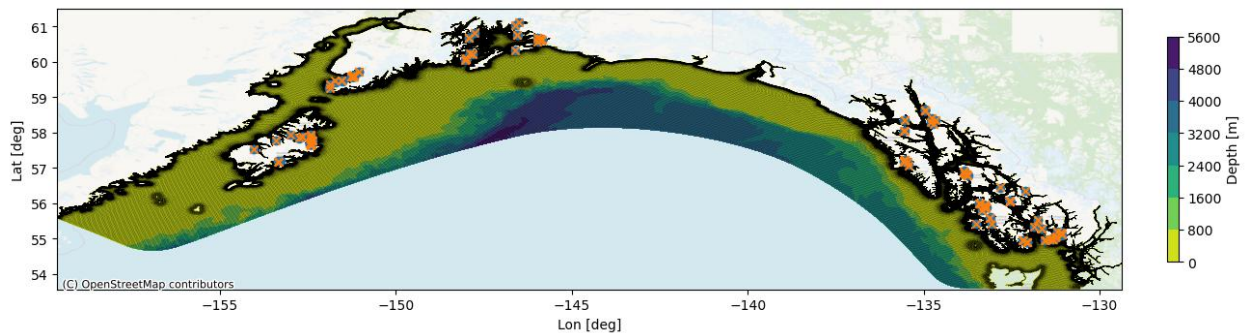
Passive Lagrangian Particle Tacking

Serial Particle Tracking Experiments

Lagrangian particle tracking experiments model the passive movement of infinitesimally small, neutrally-buoyant particle under time-evolving ocean current velocity. The experiments **do not reflect transport of sloughed kelp**, but establish “baseline” intuition on a particle’s trajectory in space and time.

Initial particle tracking experiments utilize existing Alaska aquatic farming permit locations as the representative starting location for 168 particles. Three 90-day particle tracking simulations were conducted with particle “release” at $z=-1$ m from the free surface and a starting time 0, 1, and 2 days from December 31, 2004.

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Ocean Model Horizontal Mesh and Bathymetry, Existing Alaska DNR Aquatic Farming Permit Locations (blue circles), and Starting Locations of Particles (orange 'x')

Computational Observations

Each particle tracking experiments used 1-core and only a maximum of 7.7 GB of memory on the University of Maine HPC – the primary storage location of the Gulf of Alaska Ocean-Wave Model Hindcast dataset. This architecture is a limitation with respect to the goal of determining the typical fate of sloughed kelp particles as a function of location. That is, simulating particles starting from each model node will likely exceed memory limits.

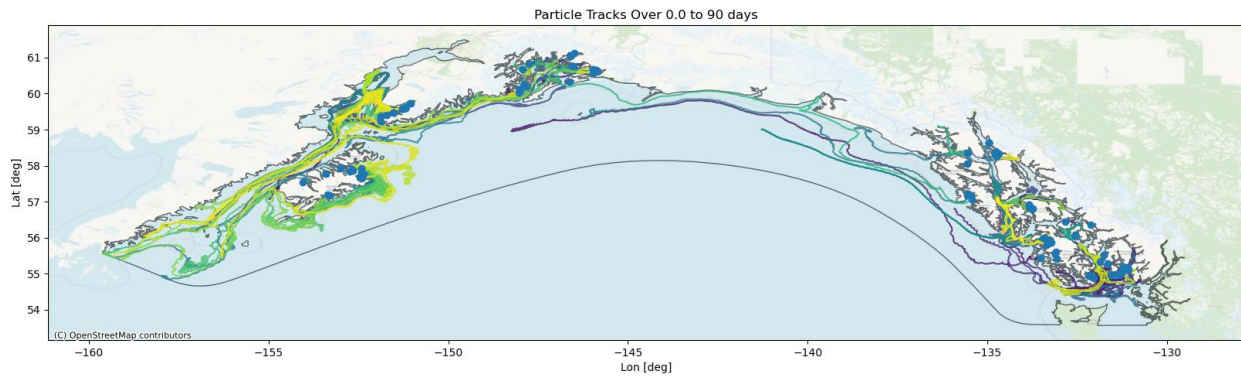
Subsequent experiments will explore computations utilizing parallel architecture and particle starting locations based on node-subsampling that will facilitate scalable repeated particle tracking experiments over time in order to derive the information of interest.

Physical Observations

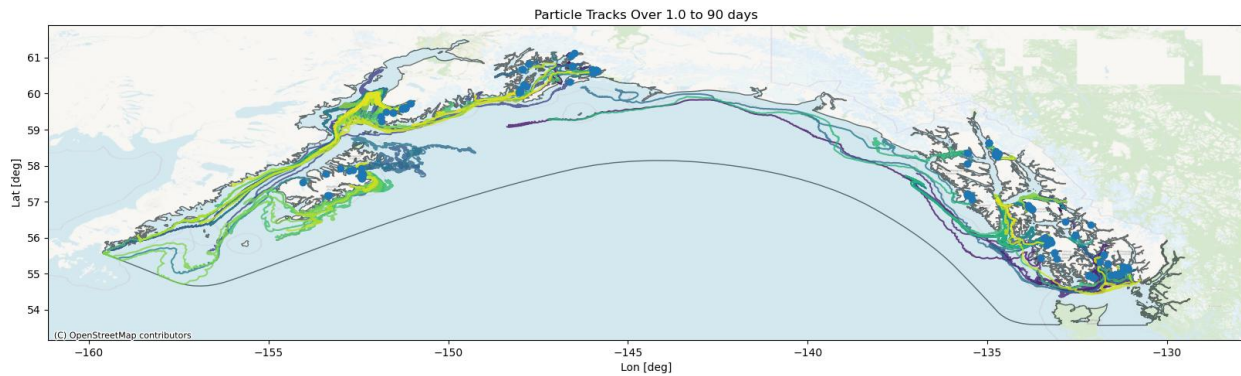
Generally, particle trajectories follow the path of existing general circulation. Secondly, particle trajectories follow the path of periodic tidal currents or synoptic weather events (see appendix figures; elliptical trajectories are characteristic of tidal processes). Summary maps included below for each of the three experiments show a counter-clockwise trajectory following the Alaska Coastal Current for particles that are able to exit the coastal fjord and estuary systems of Prince Williams Sound and Southeast. However, some particles do not exit these coastal environments within the simulation duration. Across experiments, particle track variability exists based on the time of particle release.

When a particle reaches an open boundary in the model, the existing model of particle transport breaks down. This is a limitation that needs to be addressed.

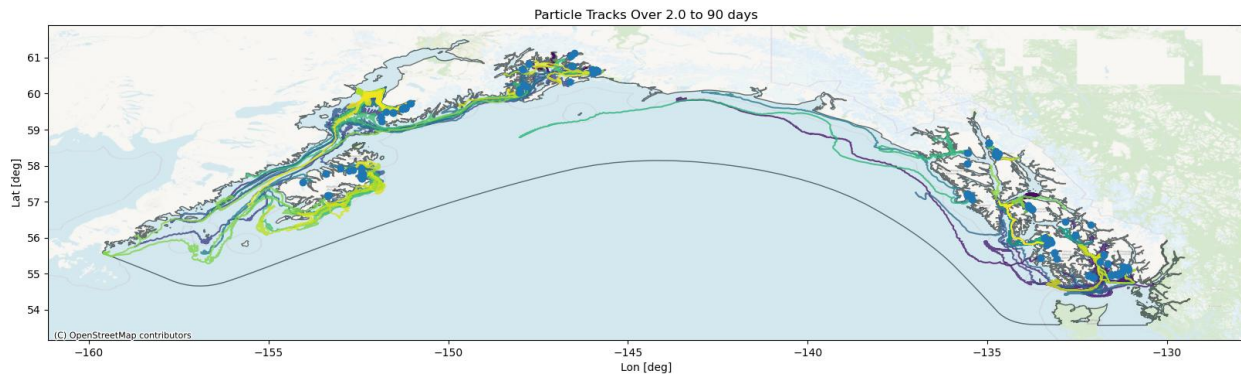
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Passive Particle Tracks over 90-days of Simulated Ocean Currents; release at time 0 s

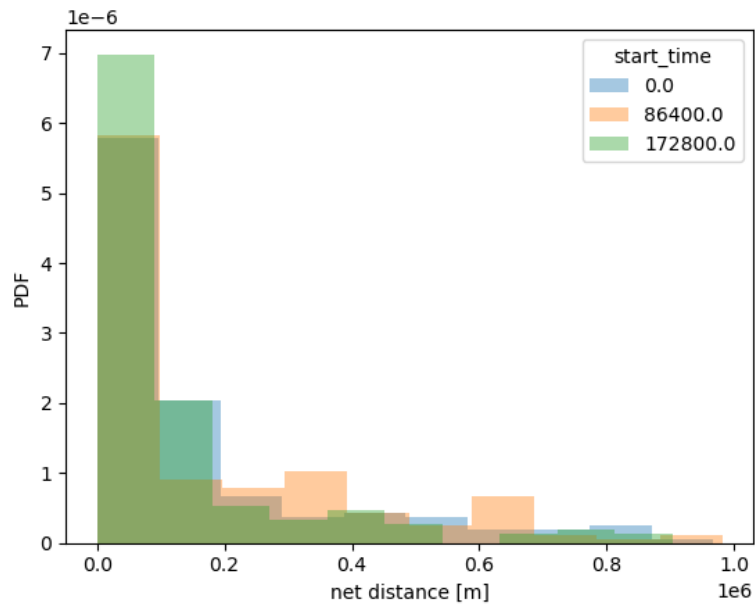


Passive Particle Tracks over 90-days of Simulated Ocean Currents; release at time 86400 s.

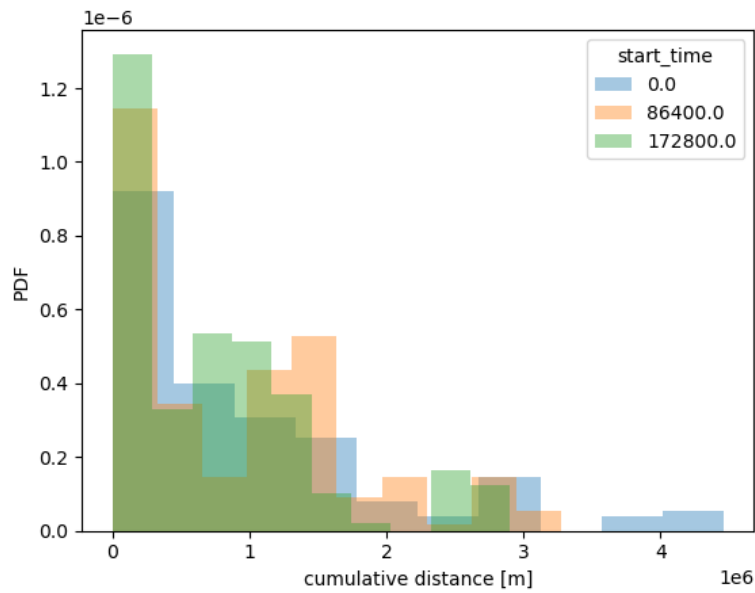


Passive Particle Tracks over 90-days of Simulated Ocean Currents; release at time 172800 s.

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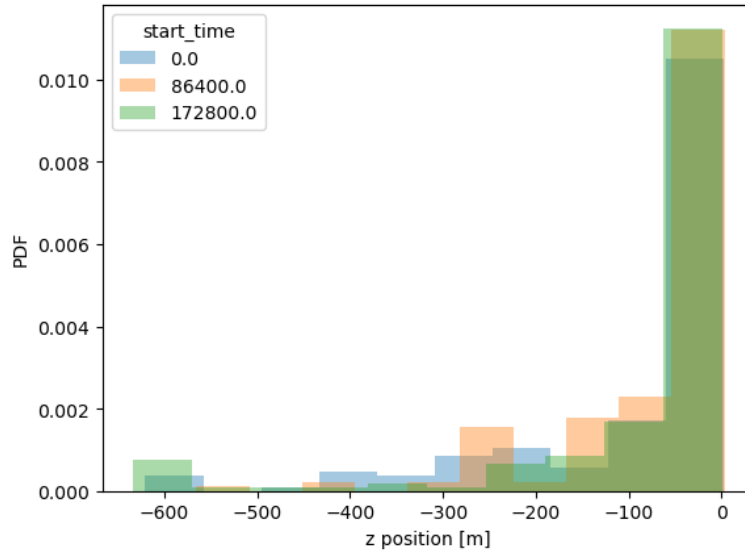


Histograms of Net Distances From Start Positions at End of 90-day Tracks.



Histograms Cumulative Distances Traveled End of 90-day Tracks

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Histograms of Vertical Positions at End of 90-day Tracks

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Mean 90-day Particle Tracking Statistics

Statistic	Net Distance [km]	Cumulative Distance [km]	Final Z Position [m]
Median	77.0	665.0	-26.2
Mean	154.2	888.0	-79.2
Standard Deviation	204.7	876.6	125.8

Task 2: Online Mapping Tool

Task 2 Overview

- *KM will organize and format modeling results for integration into an online mapping tool. The web-based GIS layer will visualize the quantified fate of sloughed kelp particles and calculate, for any selected location, the total expected amount of sloughed kelp biomass and the corresponding carbon sequestered, expressed in clear and interpretable metrics.*
- **Deliverable:**
 - *Online, web-based GIS layer showing the modeled fate of sloughed kelp biomass by source location. This layer will be integrated into the mapping tool currently being developed under the Derisking Mariculture Investments project led by Kelson Marine in partnership with the Alaska Fisheries Development Foundation.*

No Task 2 objectives have been completed to date.

Task 3: Project Administration and Reporting

Task 3 Overview

- *KM will lead reporting, accounting and invoicing, and other oversight tasks.*
- **Deliverables:**
 - *Quarterly progress reports will be submitted to AMC during the project period.*
 - *Copy of all data generated during the project, in clean and usable formats.*
 - *Copy of the model itself.*
 - *Final report detailing project outcomes, including methodology, key assumptions, results (highlighting the most promising locations for kelp sloughing), challenges, lessons learned, and recommendations for future modeling work.*
 - *Presentation at a virtual venue sponsored by SEC sharing out the results. Presentation to include Power Point or similar slides.*

No deliverables exist at this time beyond quarterly progress reporting.

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Table 1 Status of Task 3 Deliverables

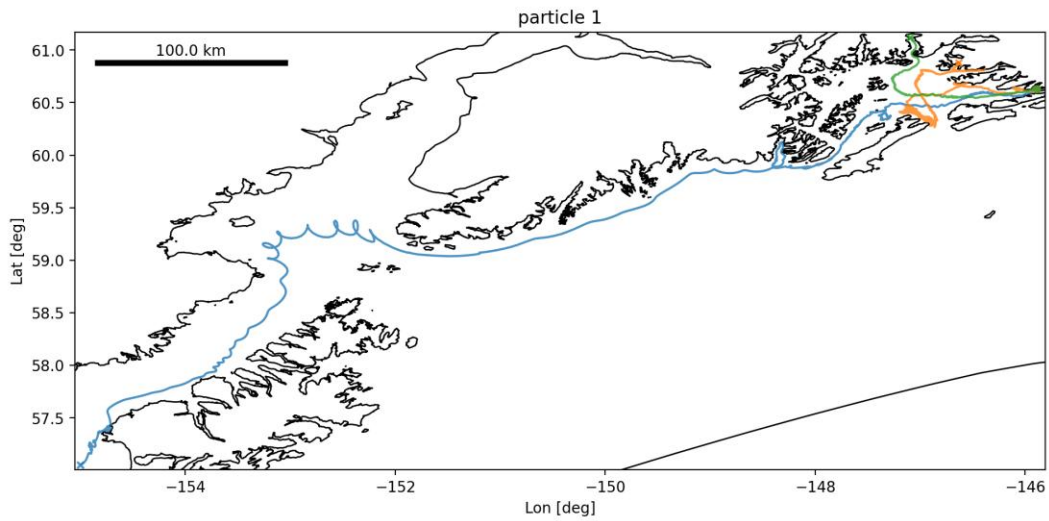
Deliverable	Status	Notes
Quarterly Progress Reports	Q1 2026 report submitted	
Project Data		Preliminary data subject to change; can provide interim upon request
Sloughing Model	N/A	
Final Report	N/A	
SEC Sponsored Presentation	N/A	

References

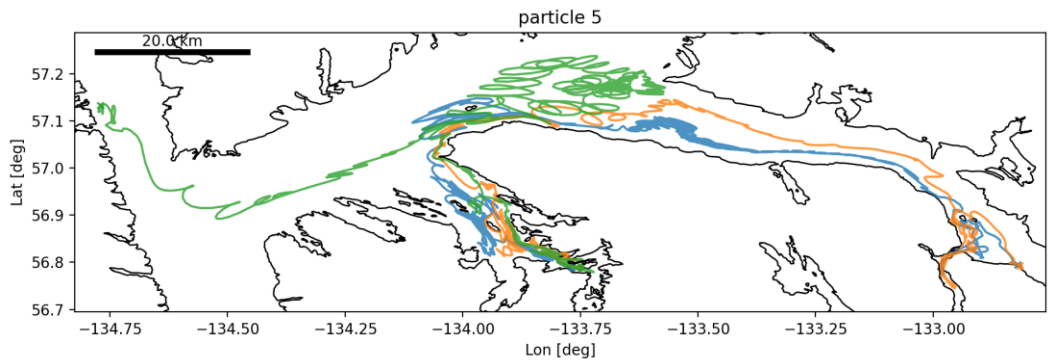
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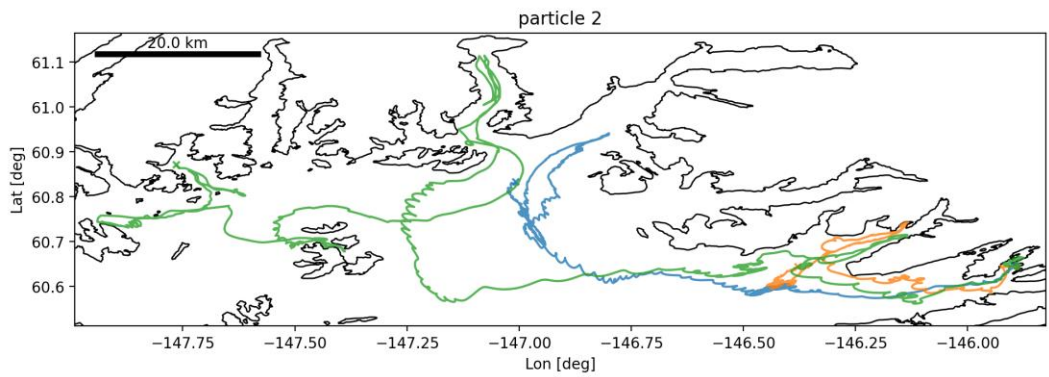
Appendix A: Passive Particle Tracks by Particle ID



Particle ID 1 Tracks

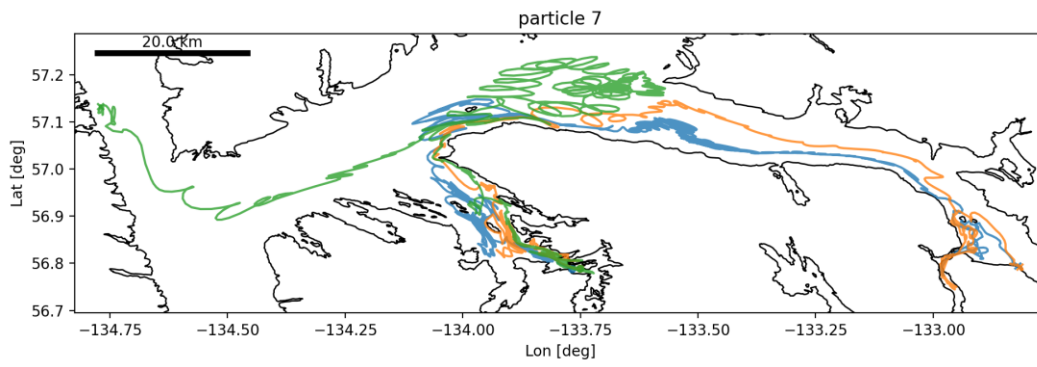


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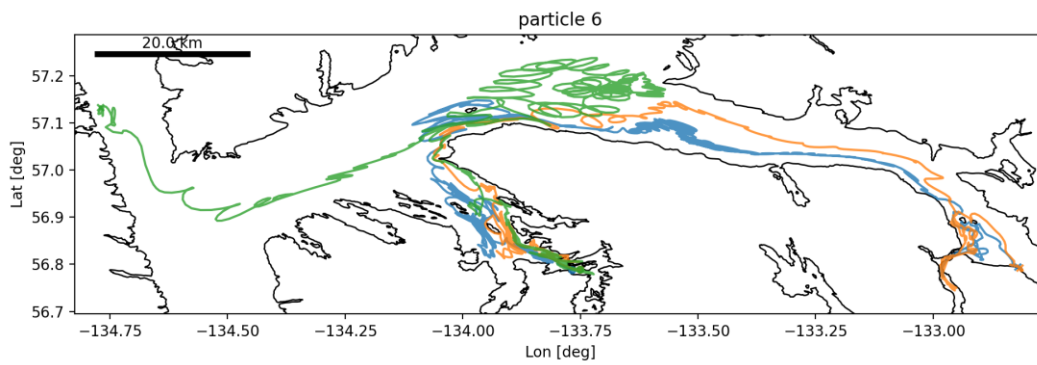


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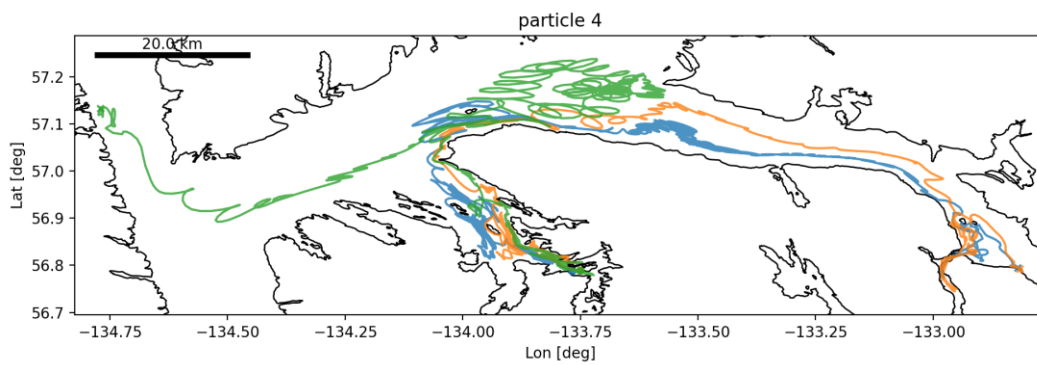
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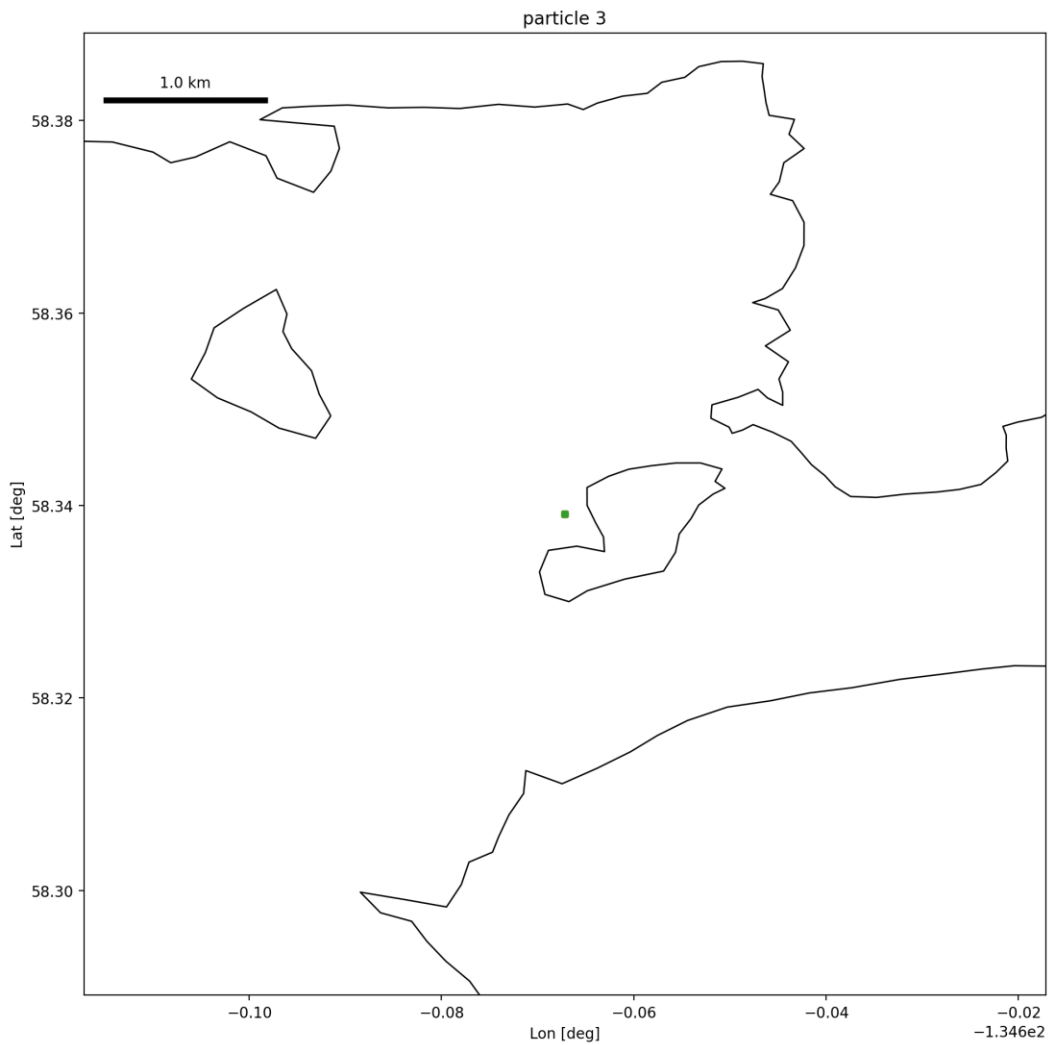


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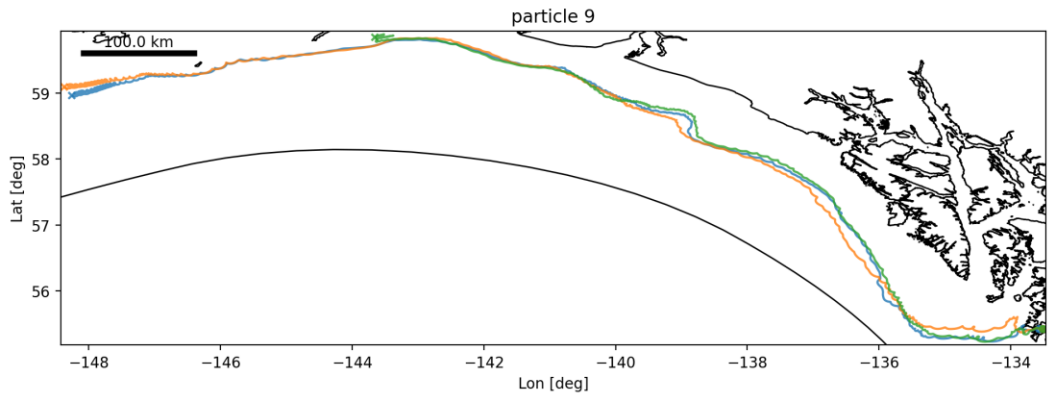


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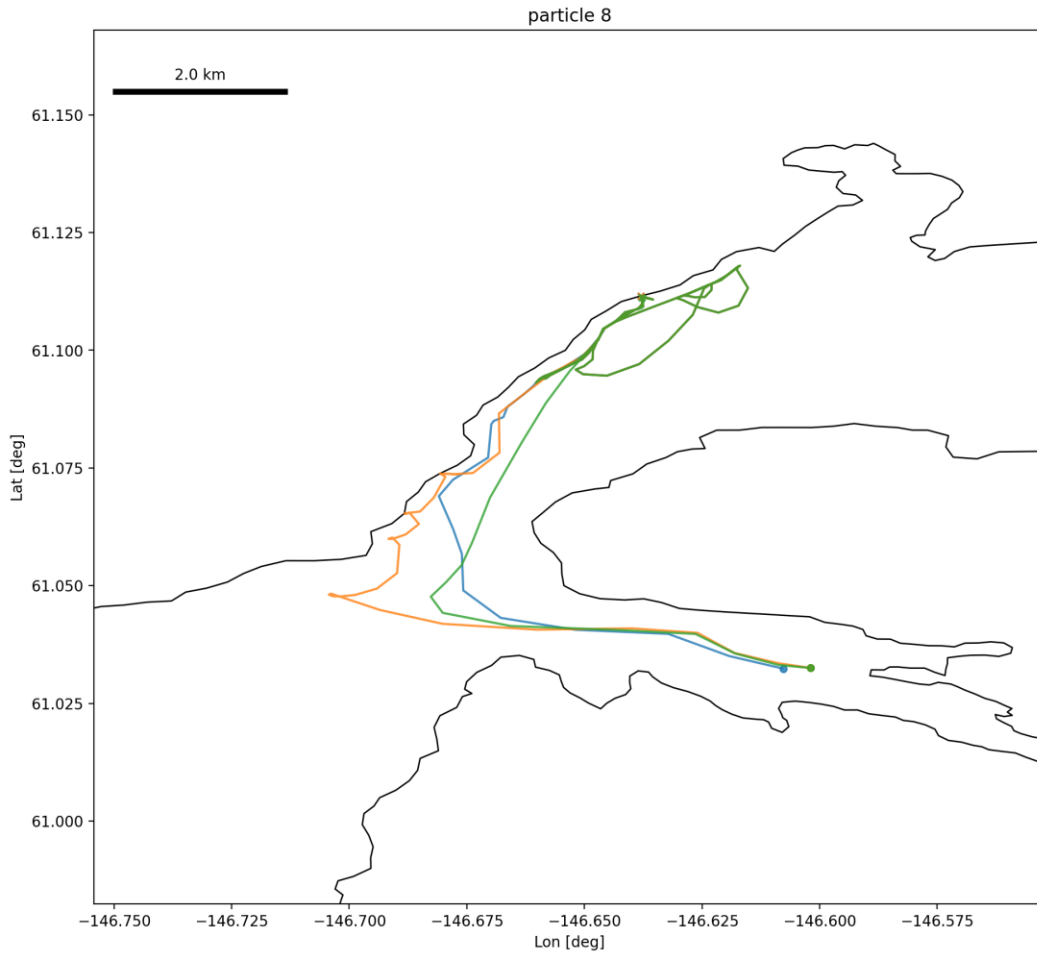


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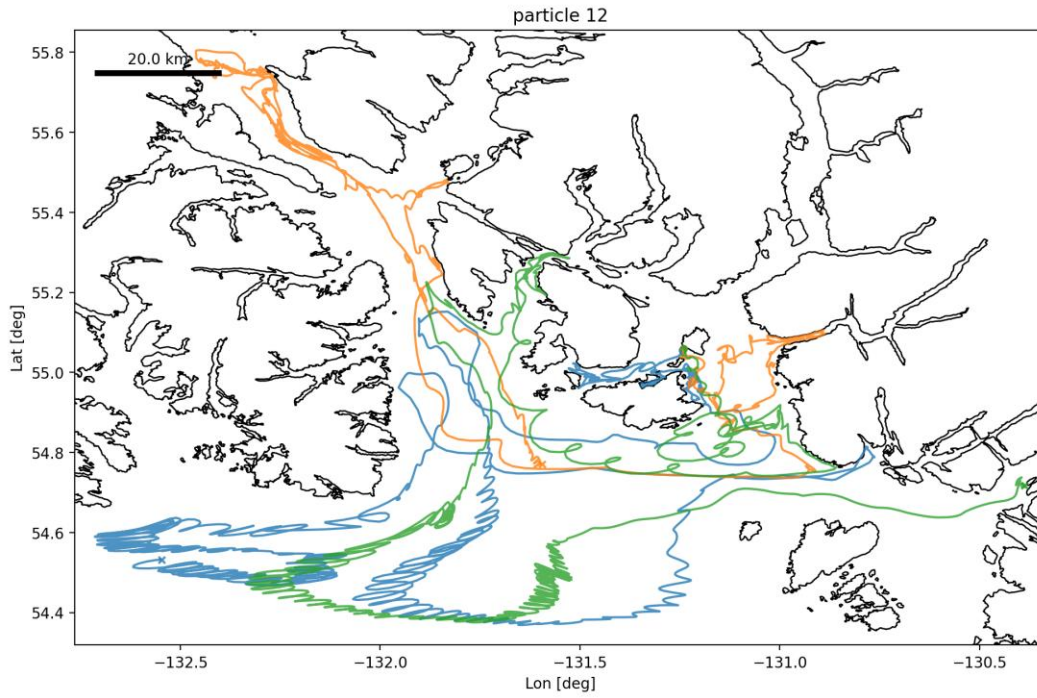
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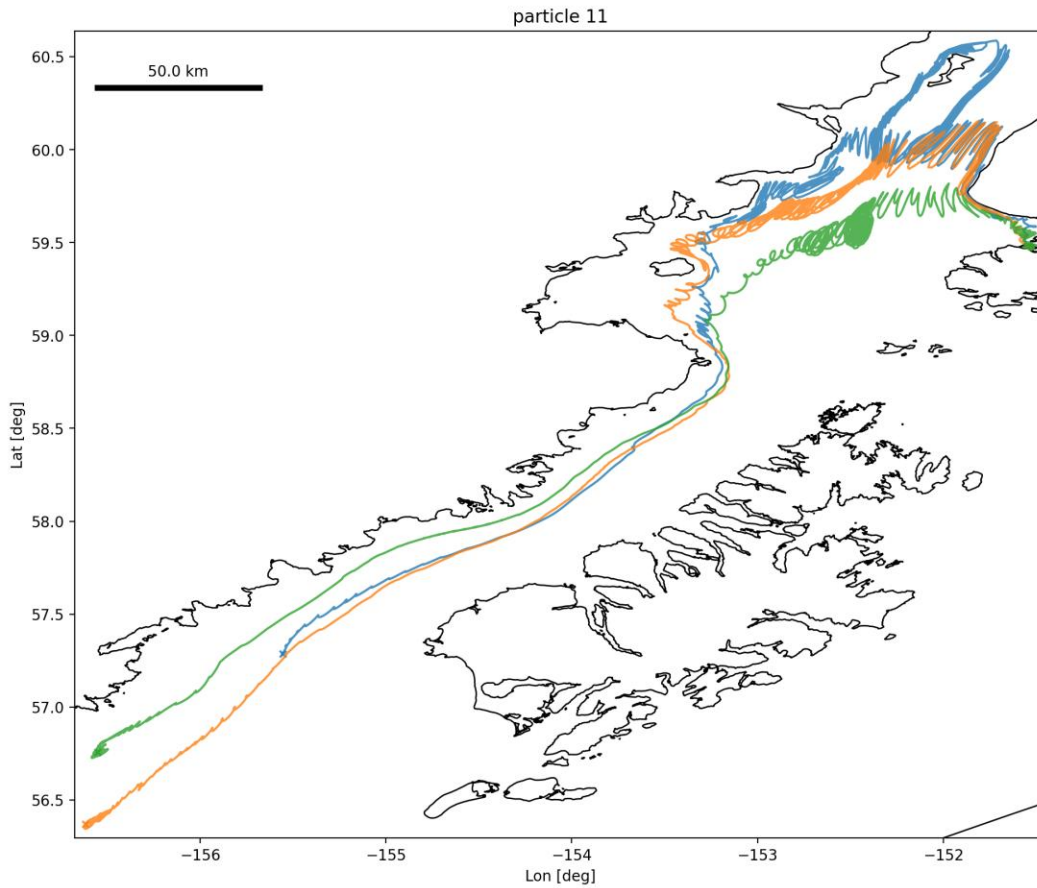


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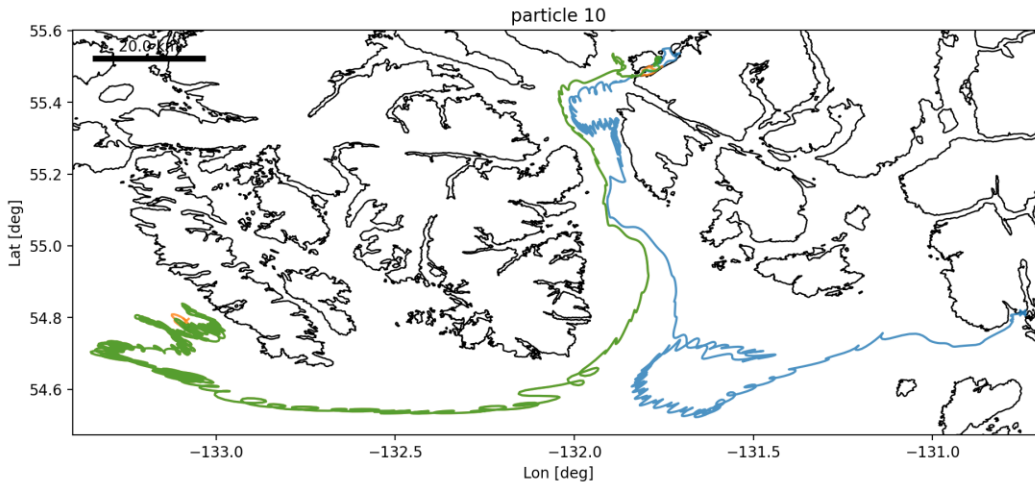


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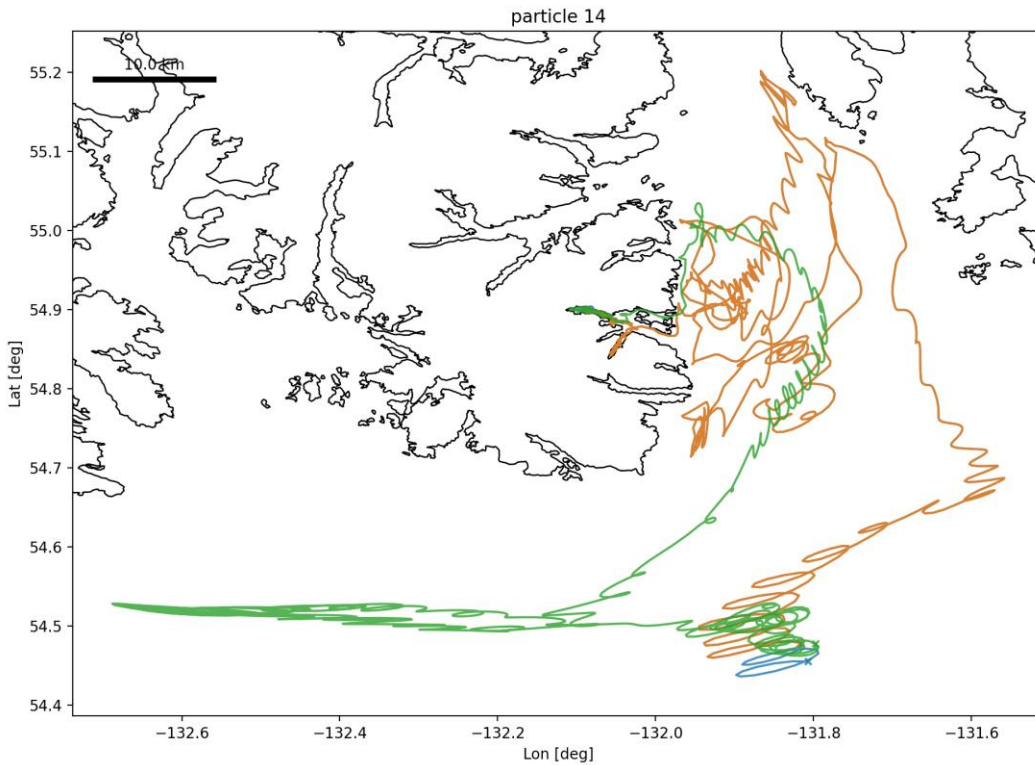


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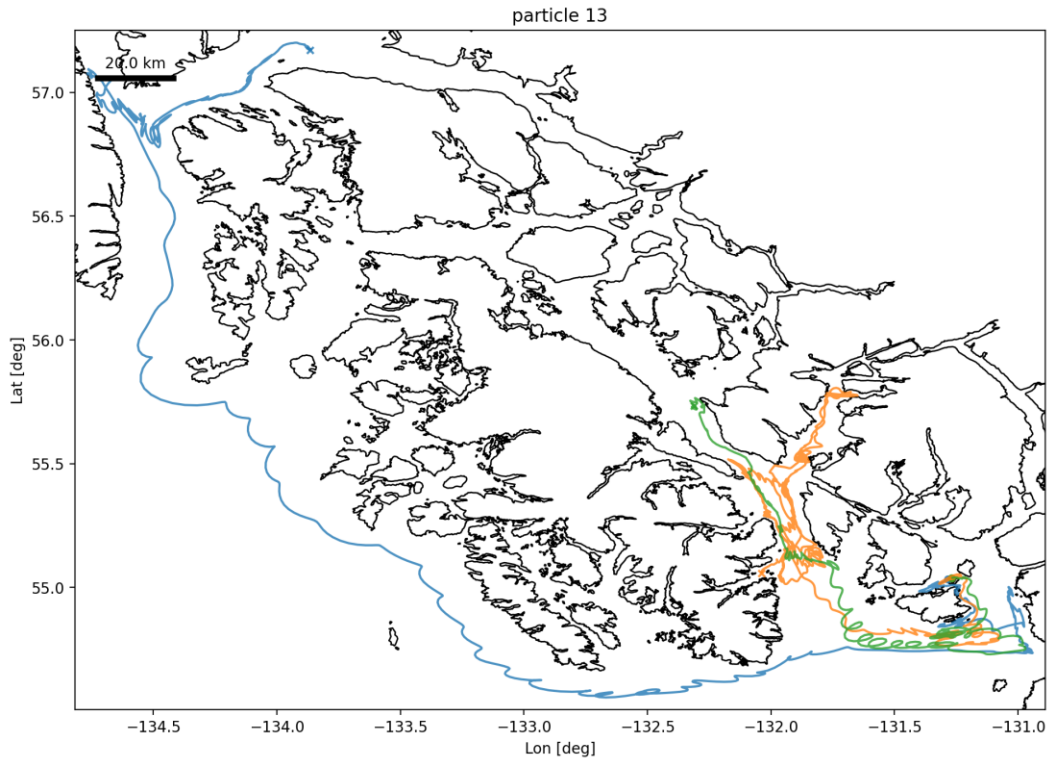


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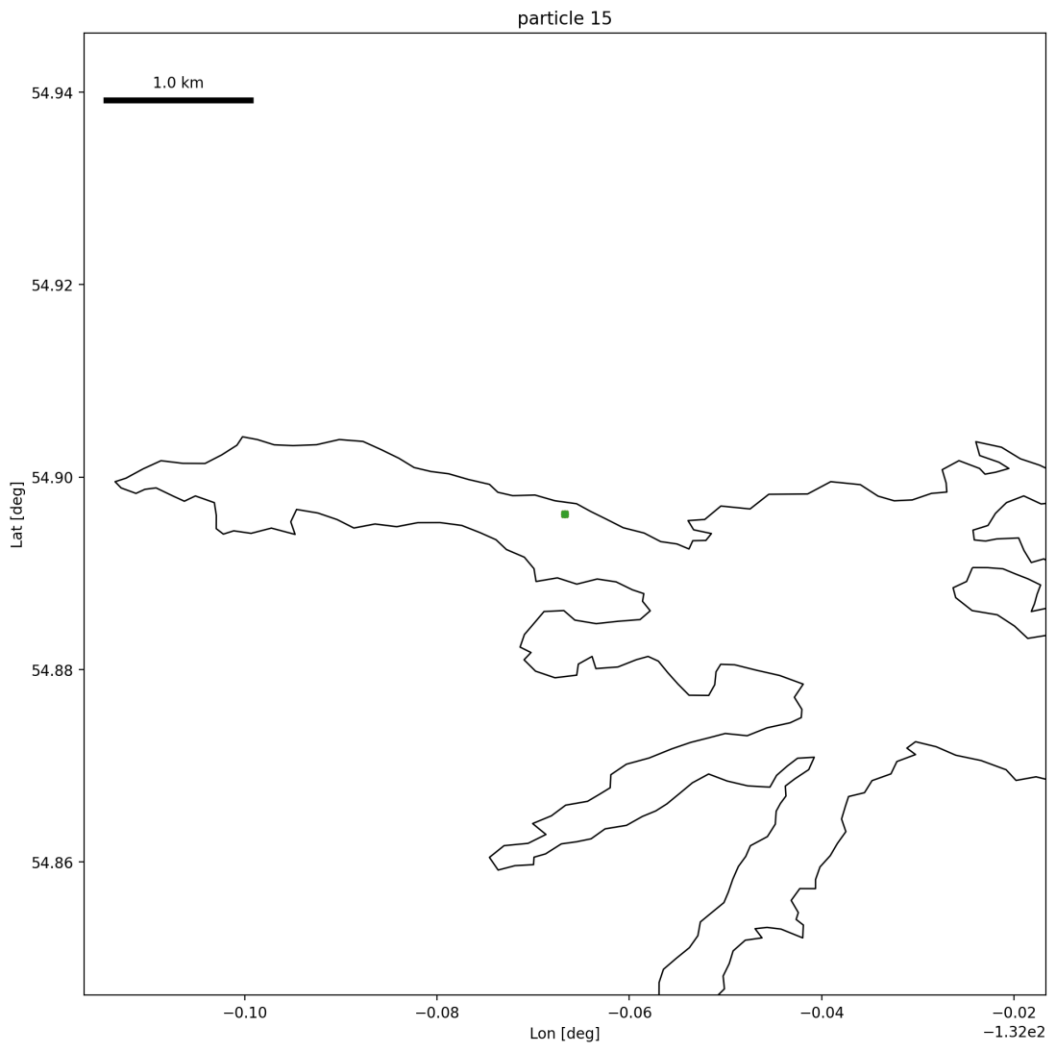
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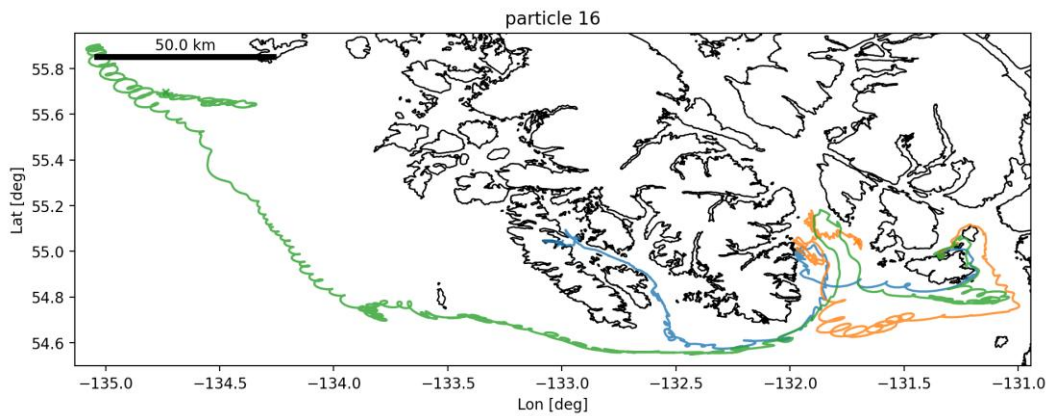


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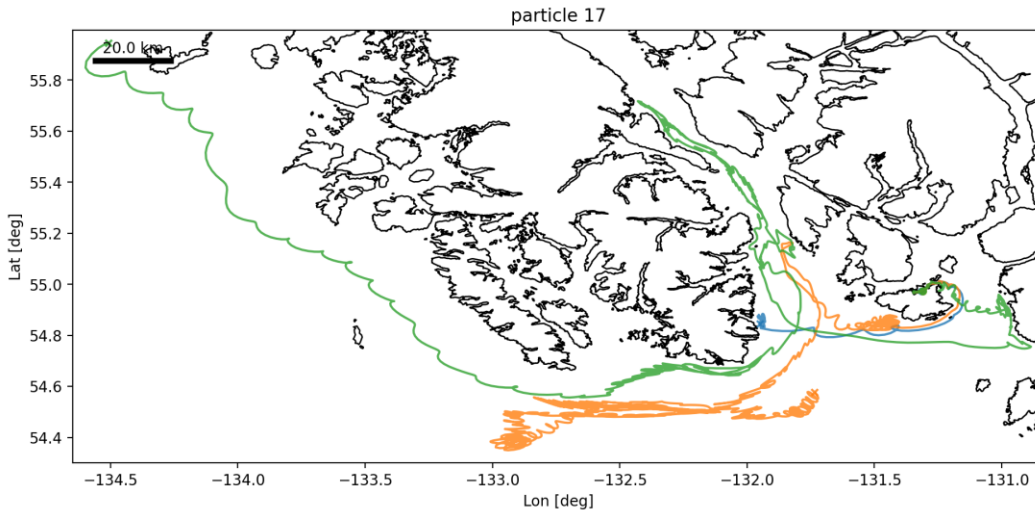


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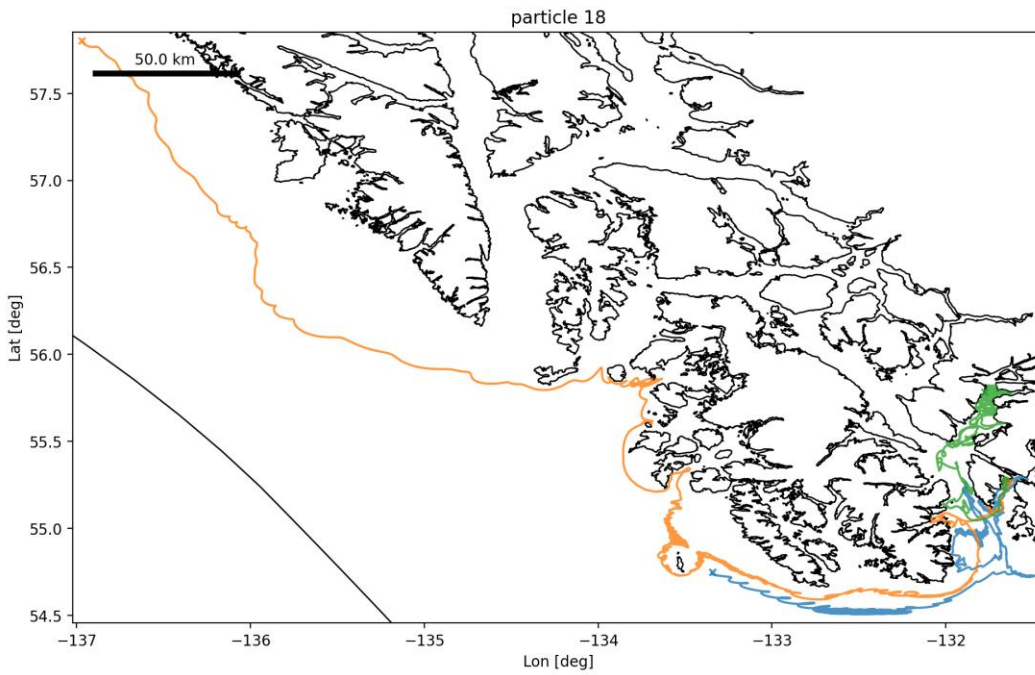


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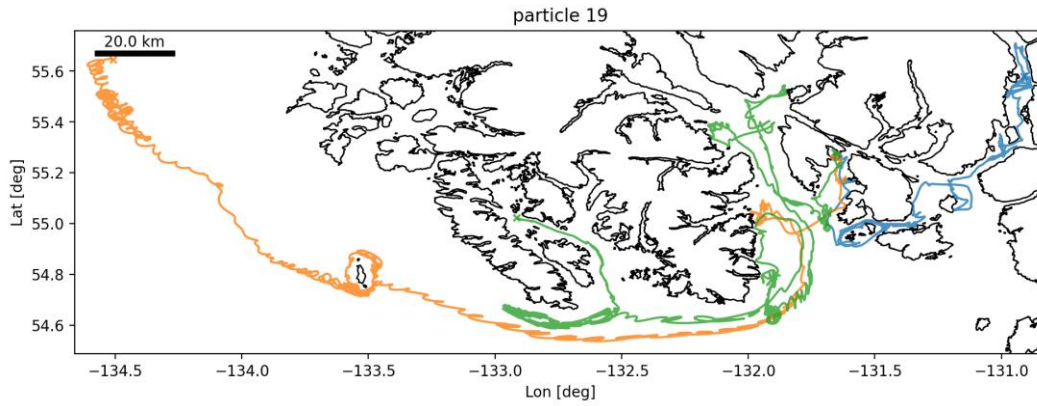


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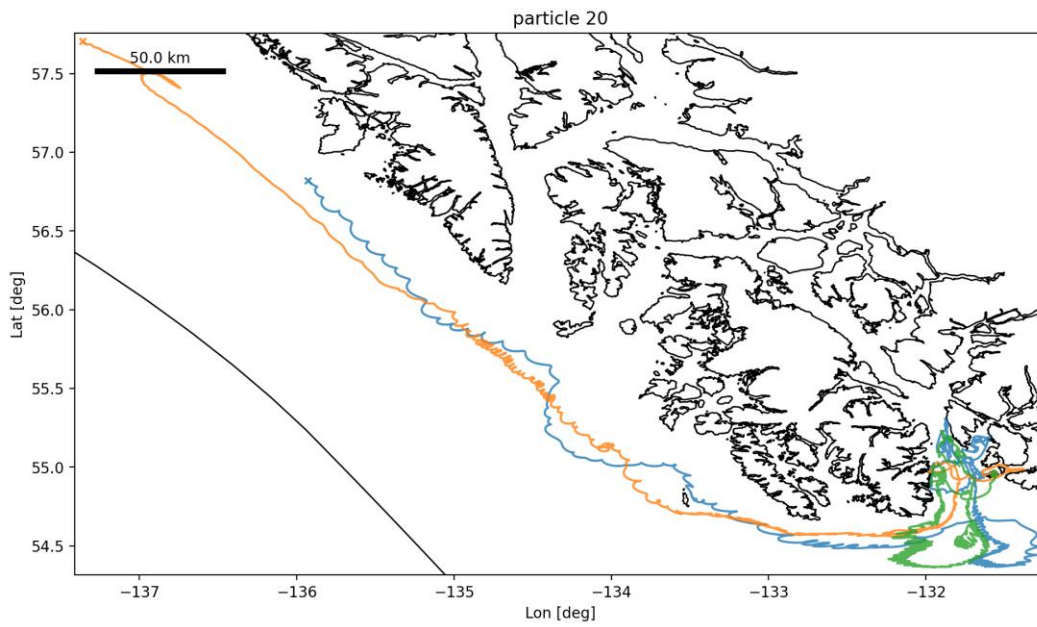


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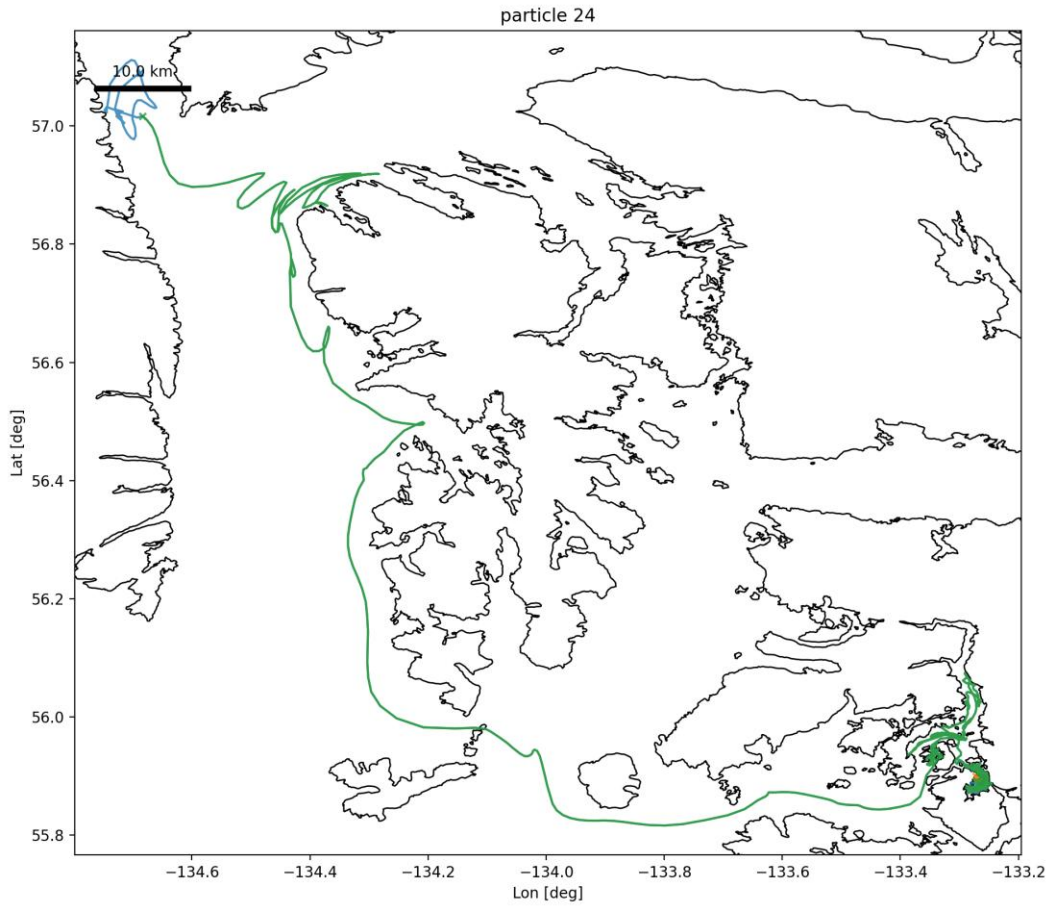


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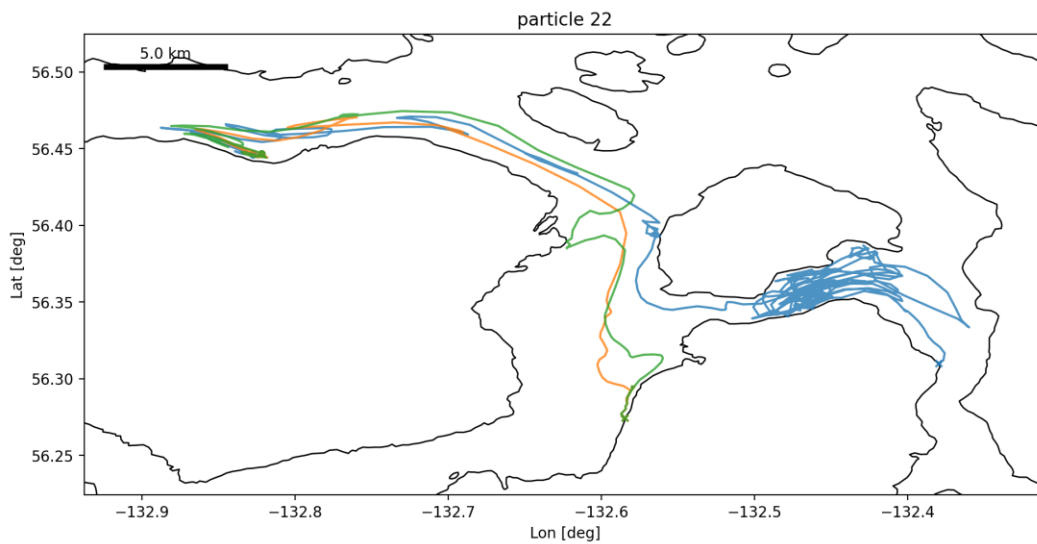


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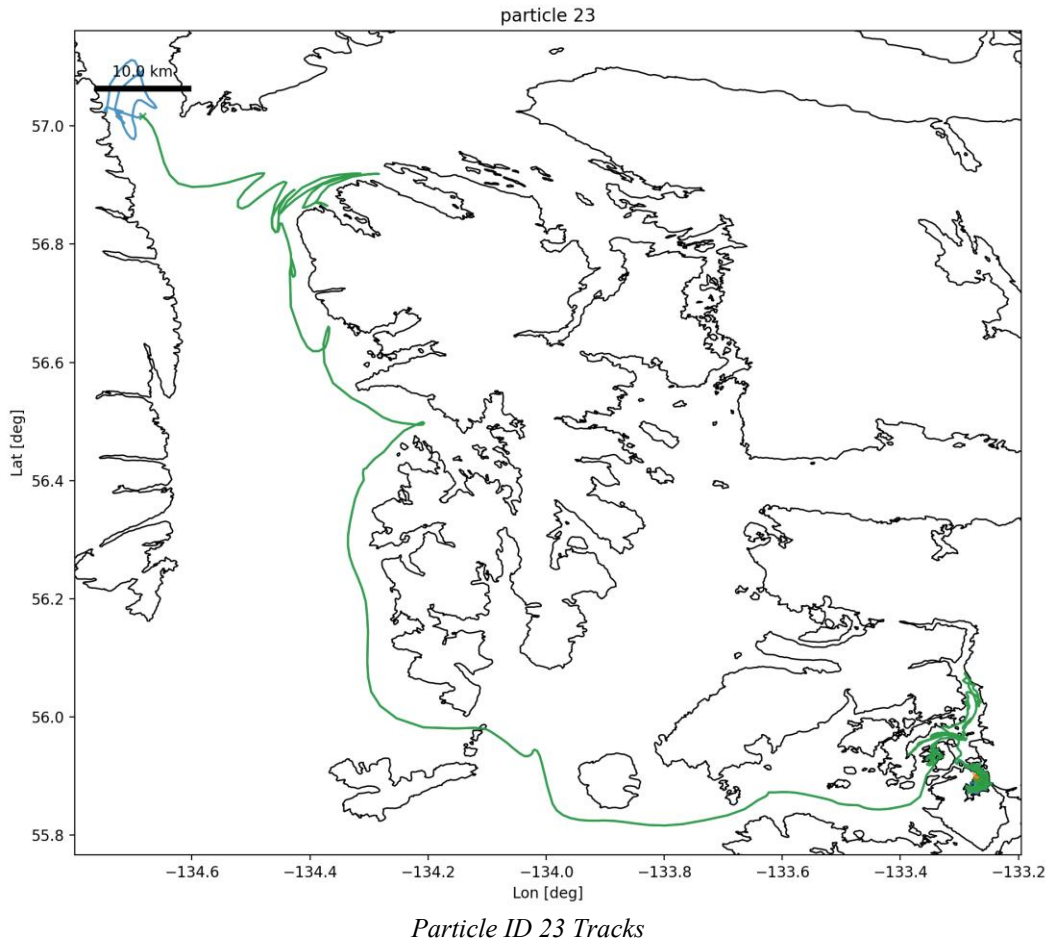


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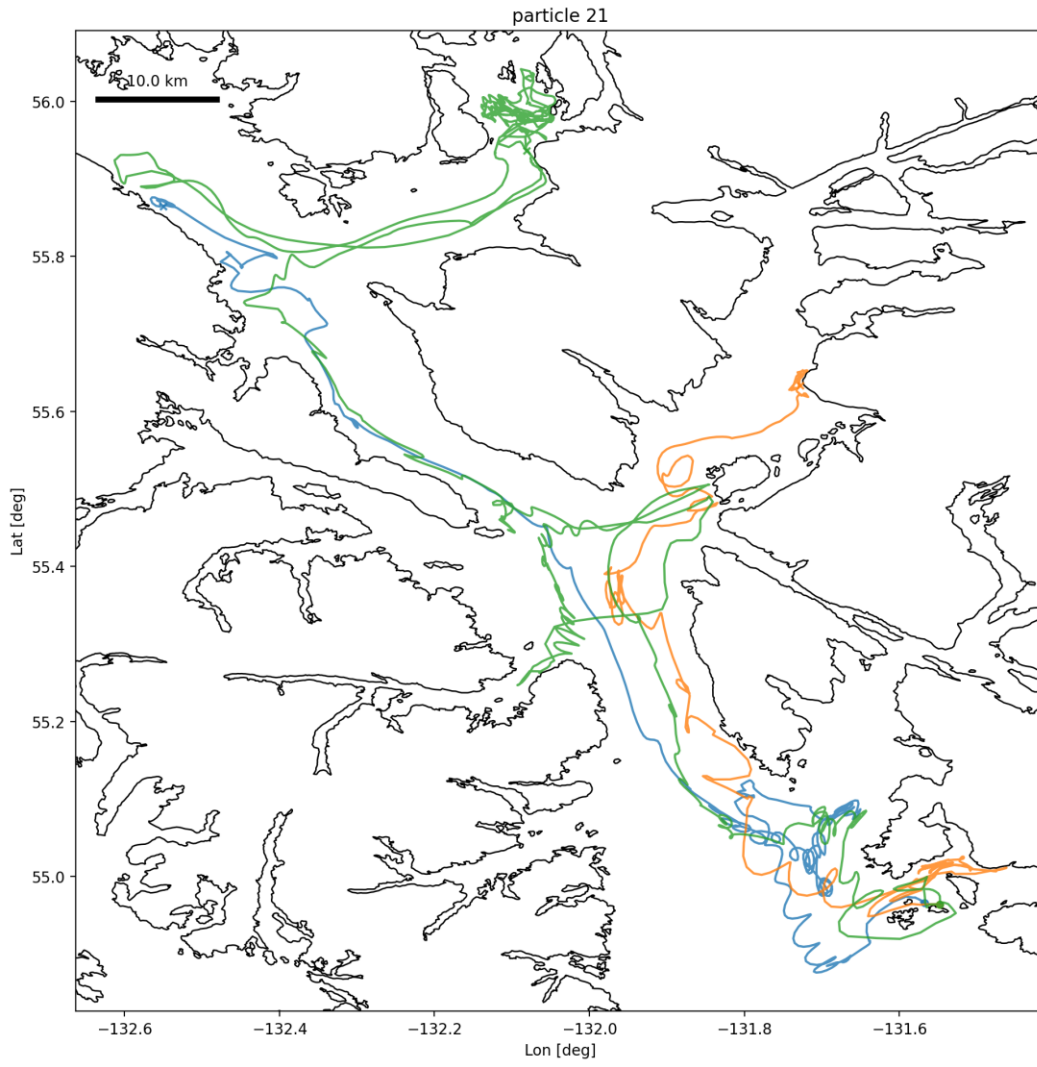


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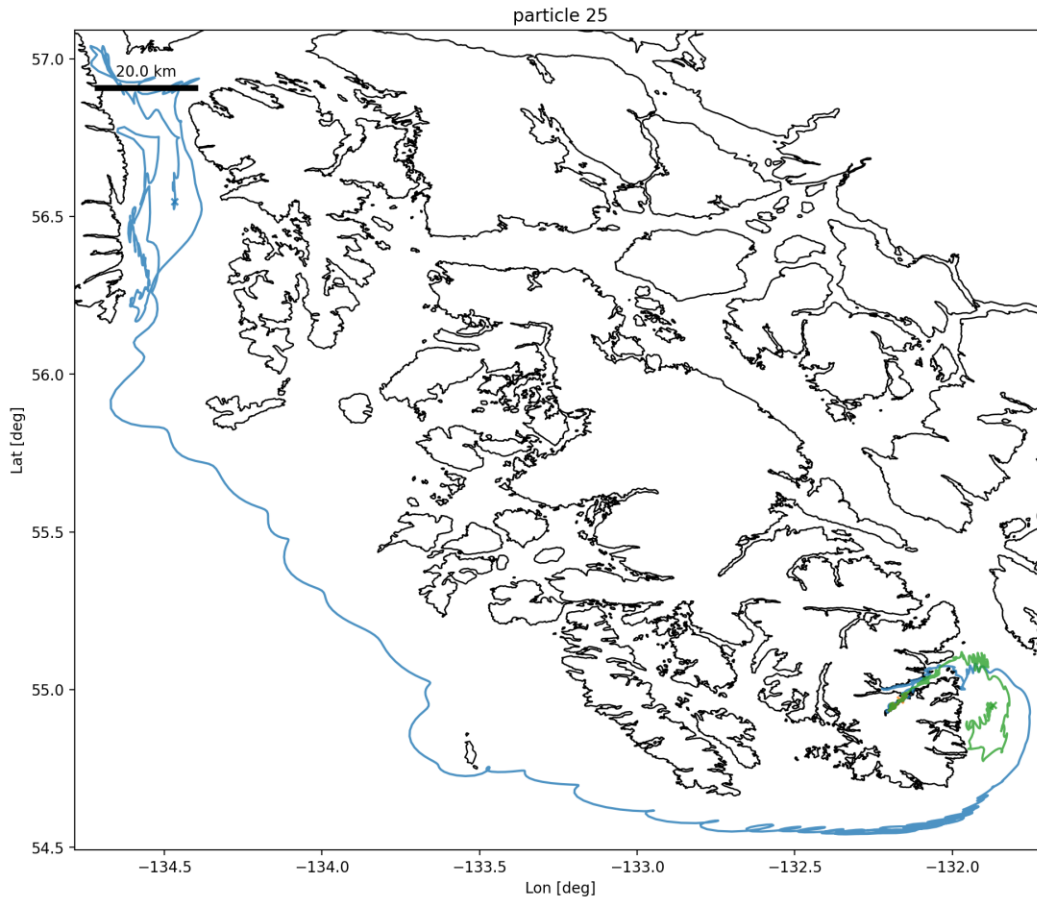


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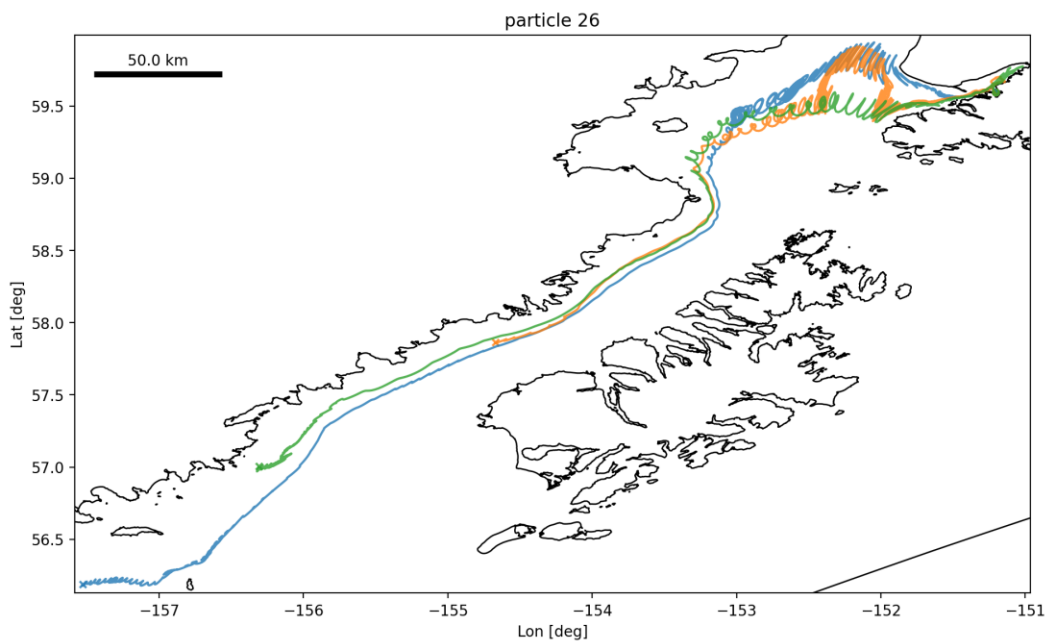


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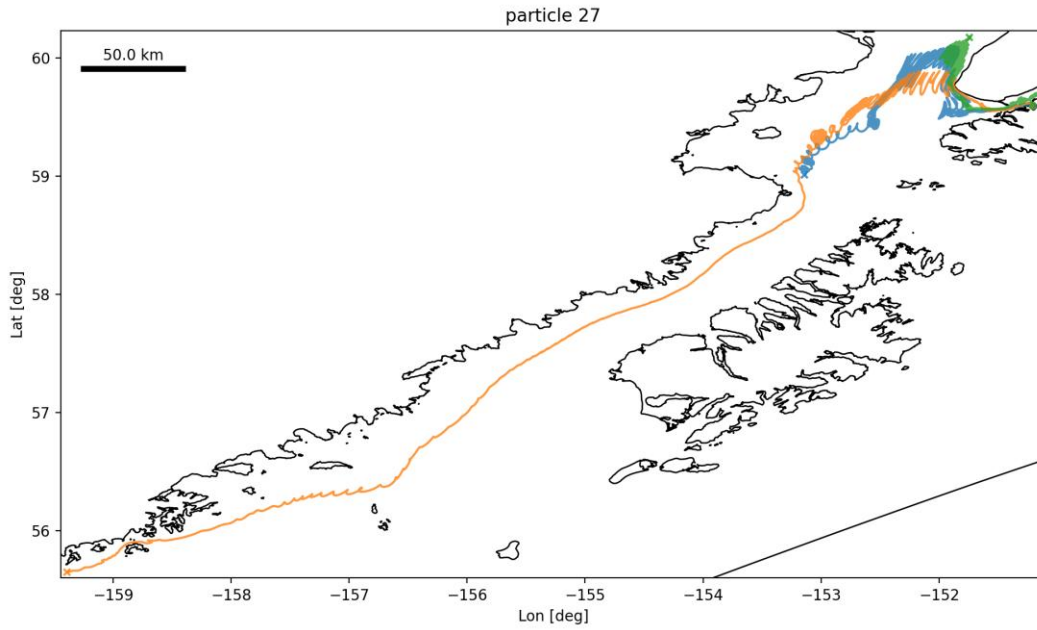


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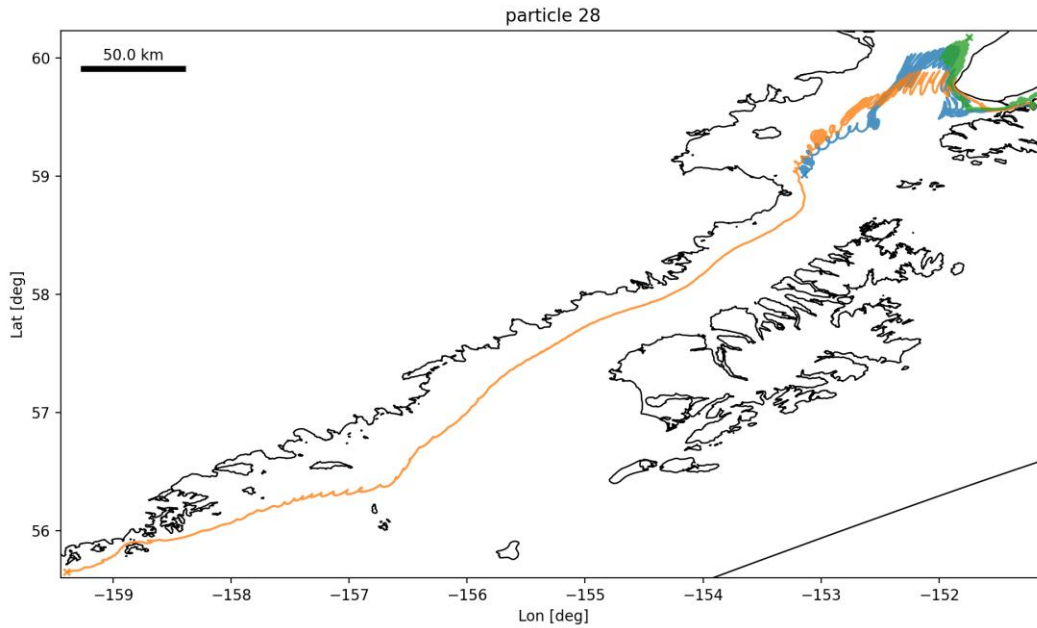


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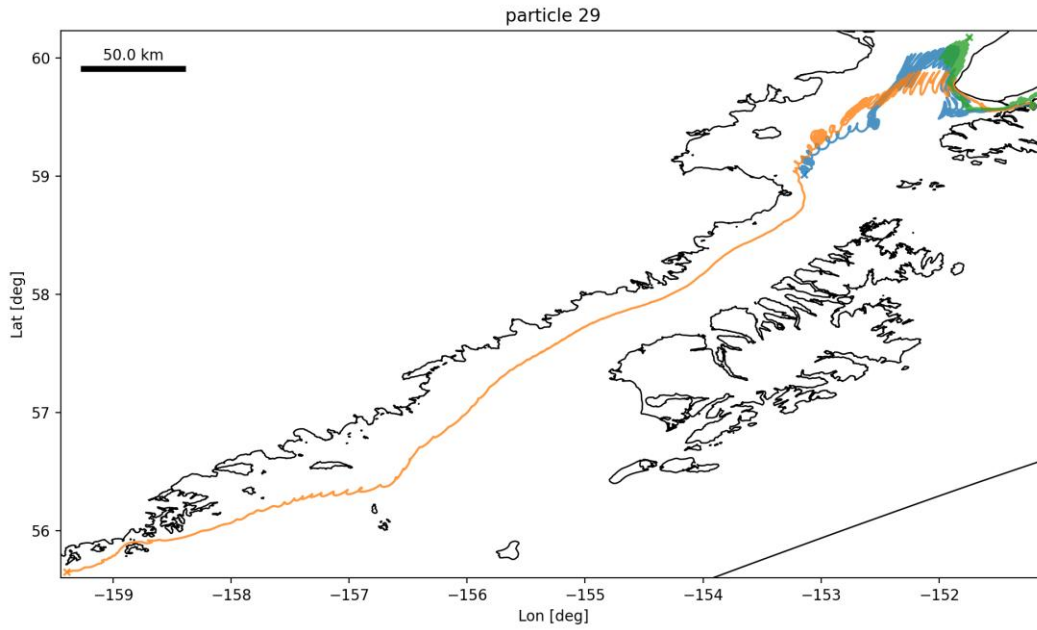


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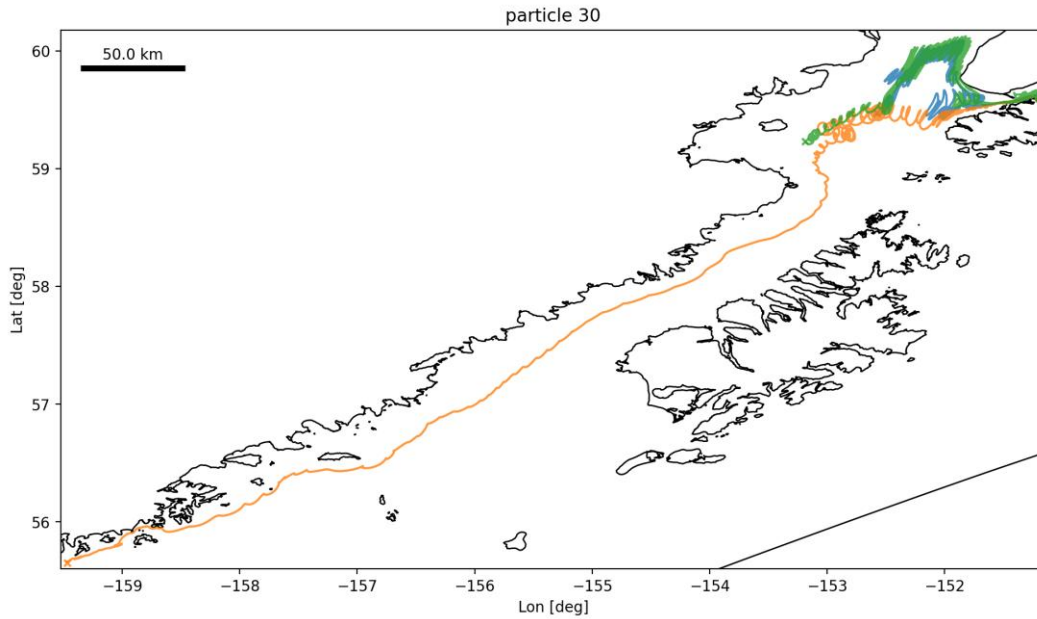


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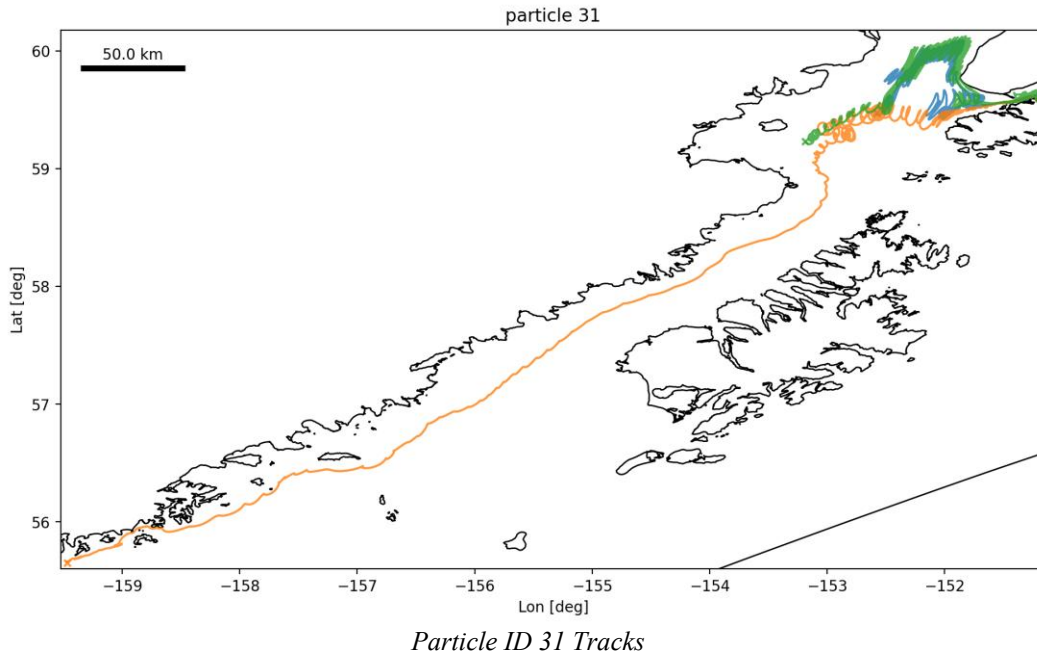


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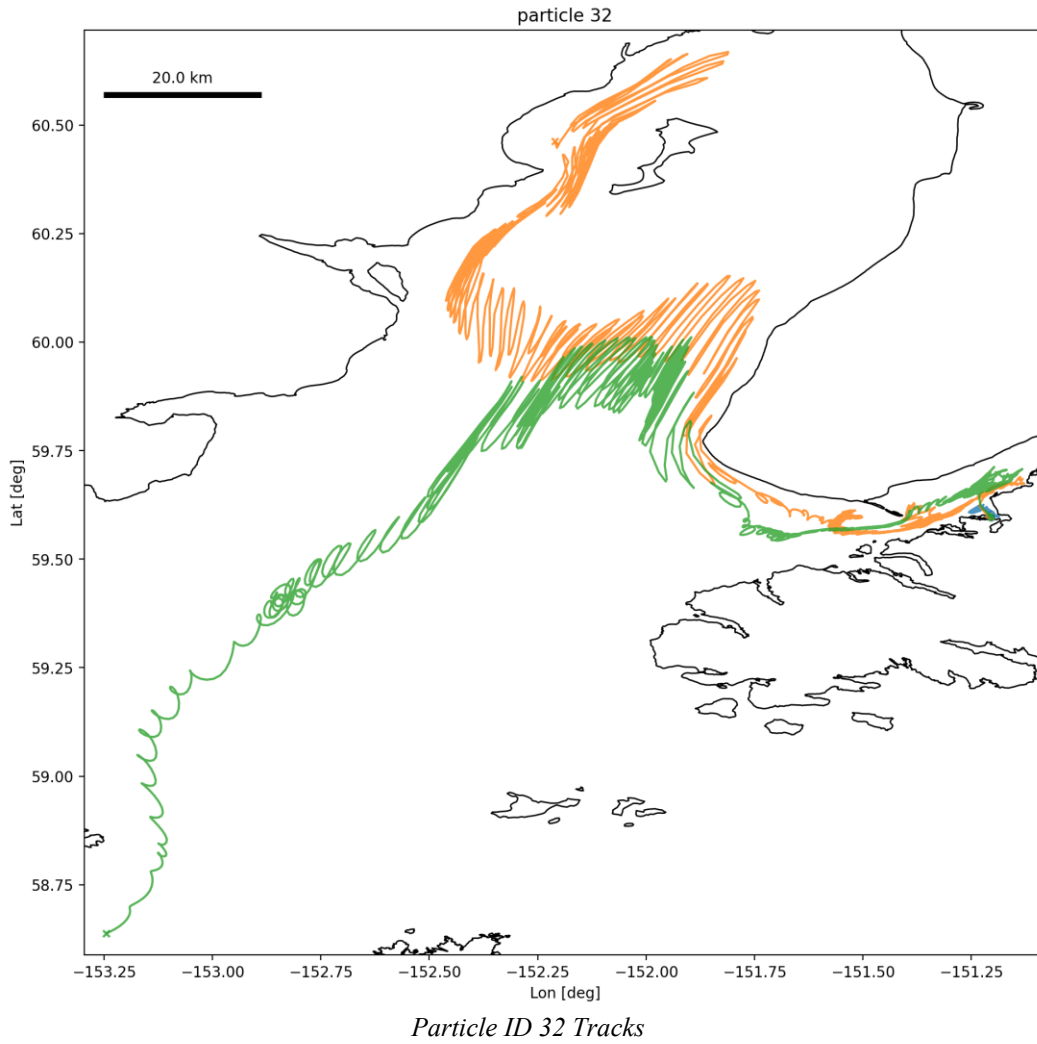


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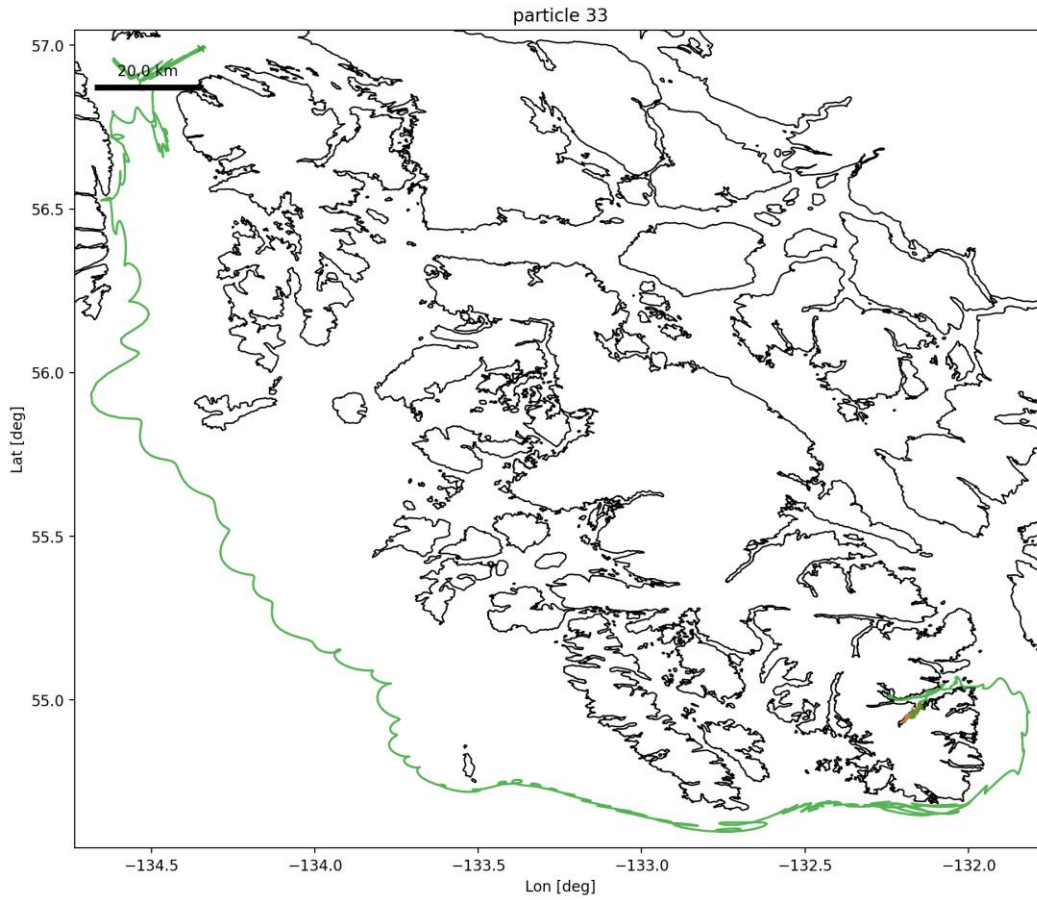
Kelson Marine Co. | Quantification of the Fate of Sloughed Alaskan Seaweed Biomass: Quarter 1 2026 Progress Update Report



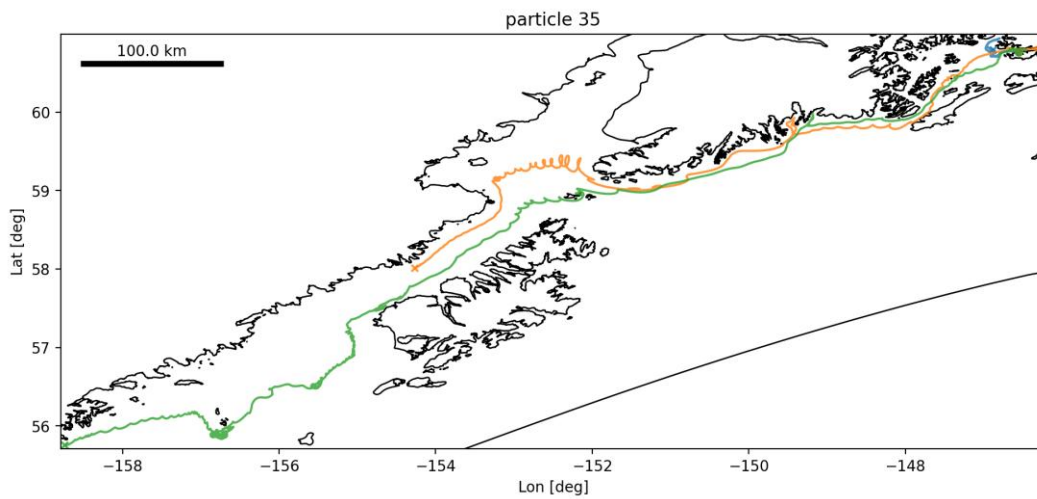
Kelson Marine Co. | Quantification of the Fate of Sloughed Alaskan Seaweed Biomass: Quarter 1 2026 Progress Update Report



Kelson Marine Co. | Quantification of the Fate of Sloughed Alaskan Seaweed Biomass: Quarter 1 2026 Progress Update Report

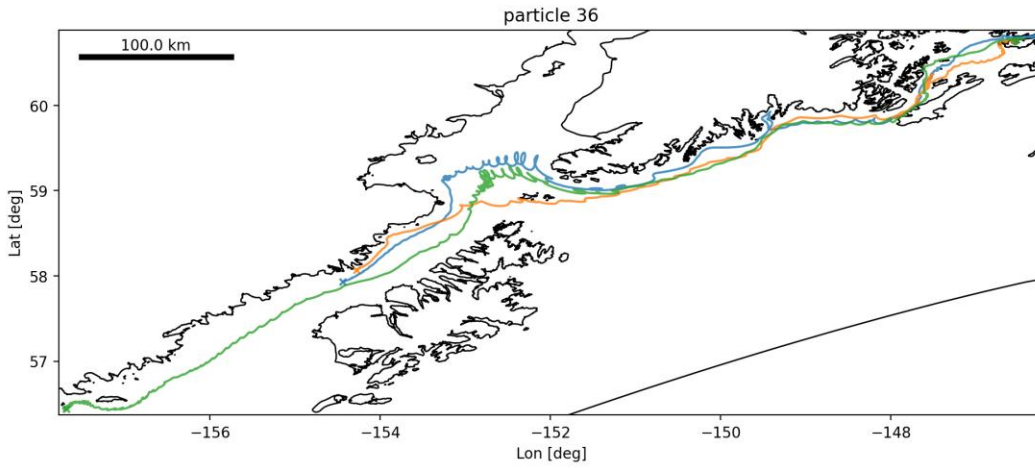


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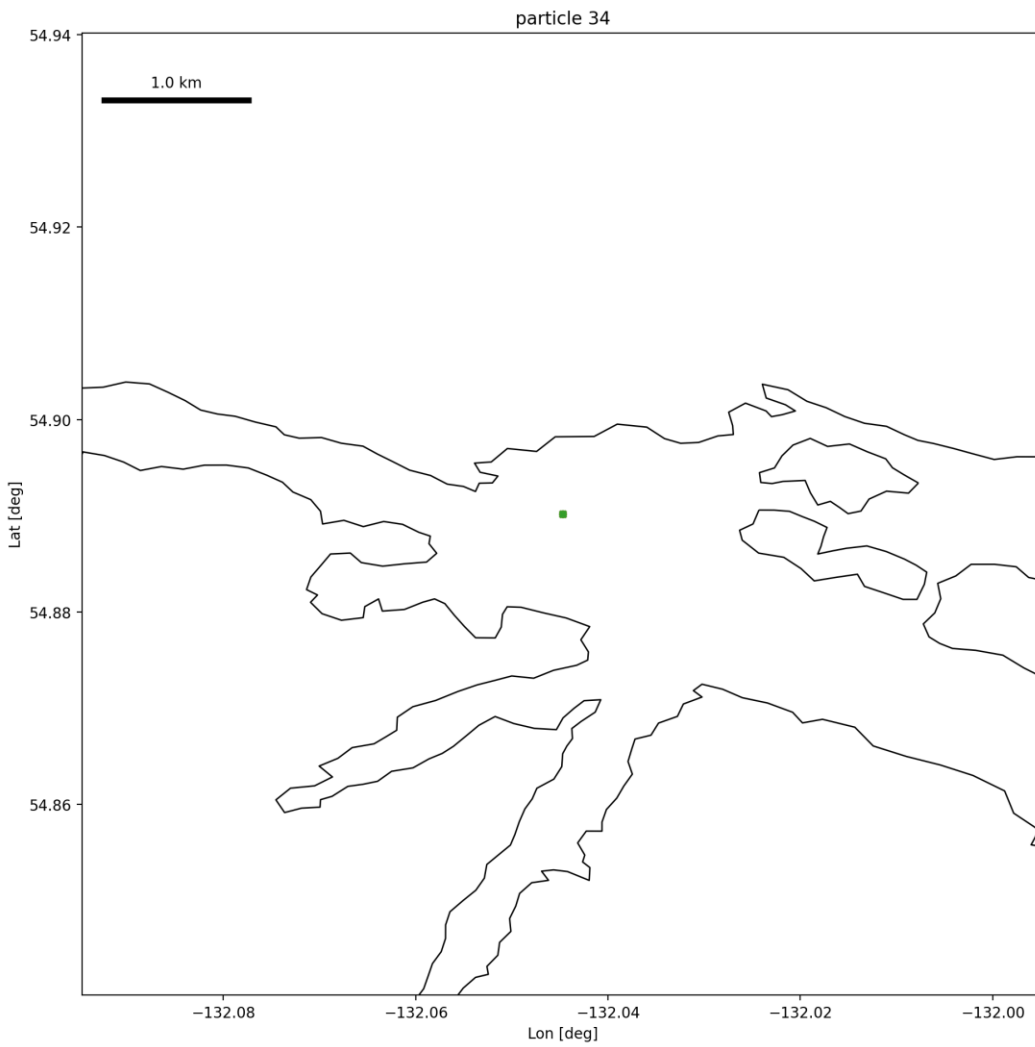


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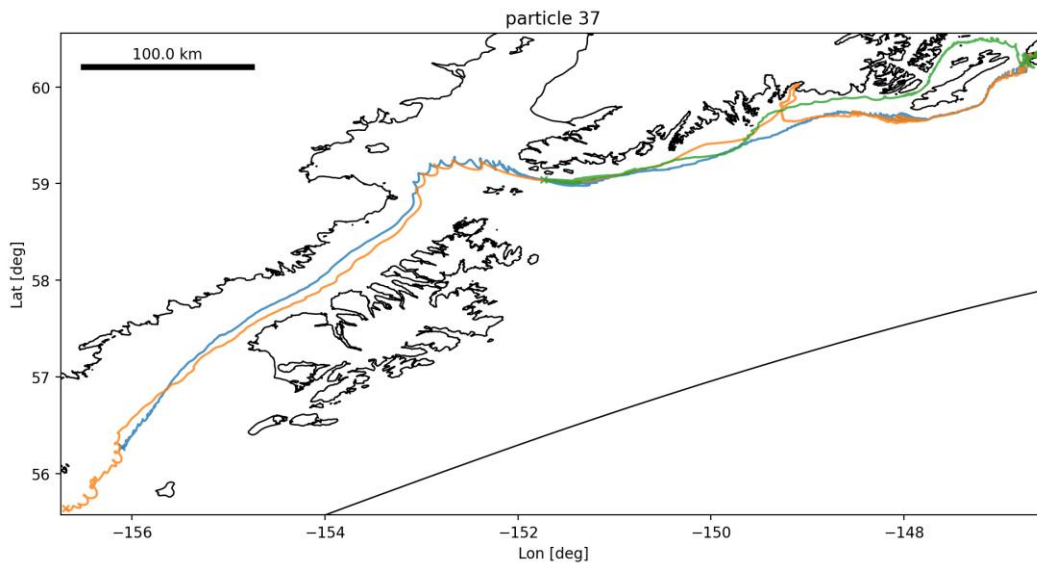


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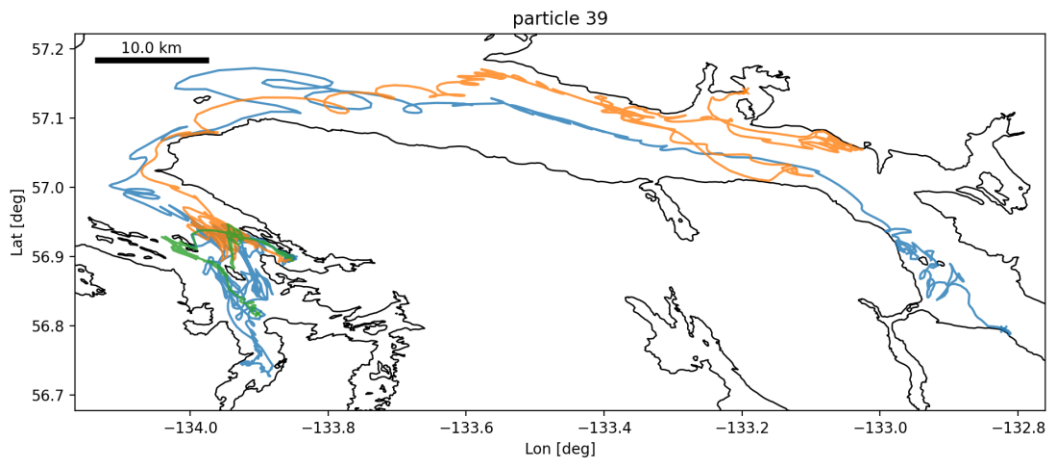


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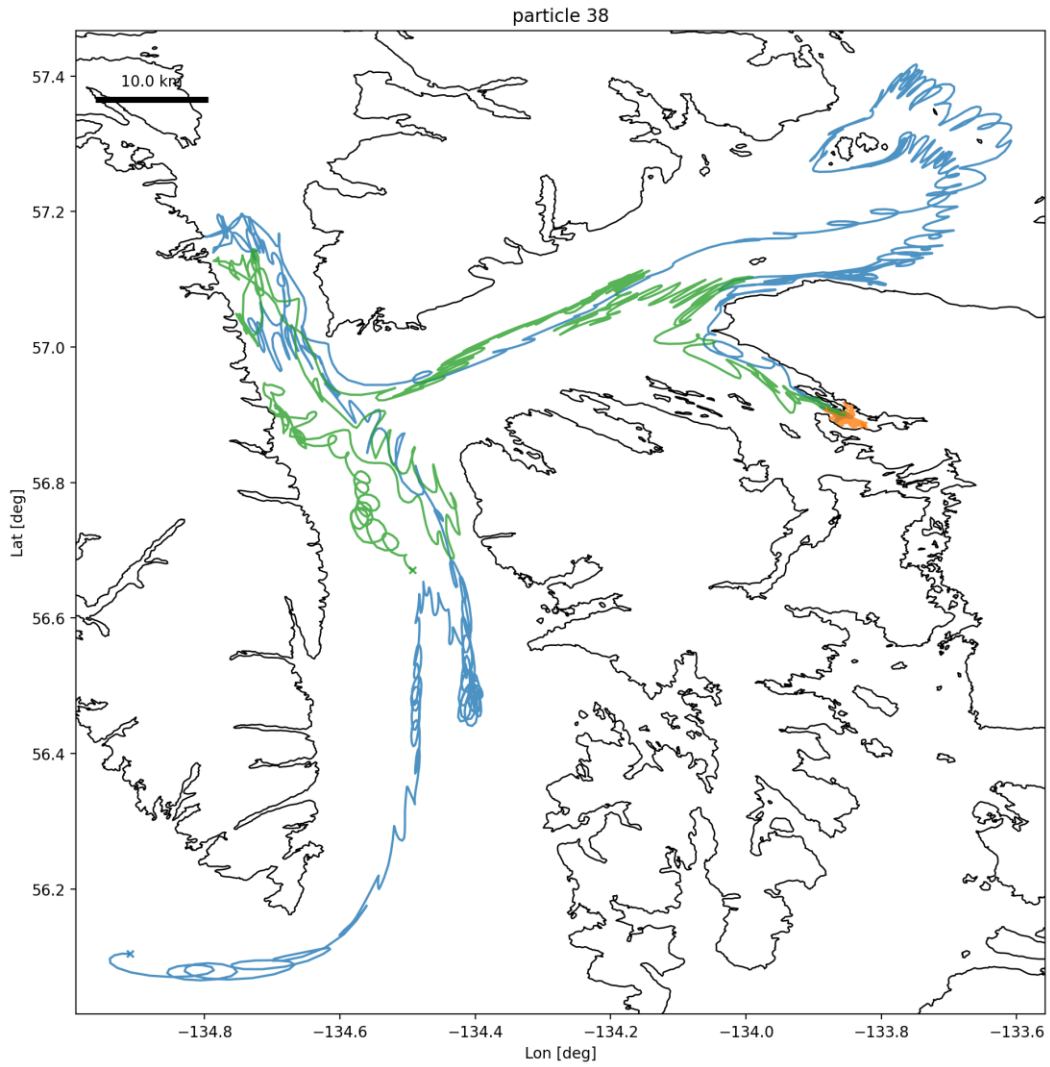


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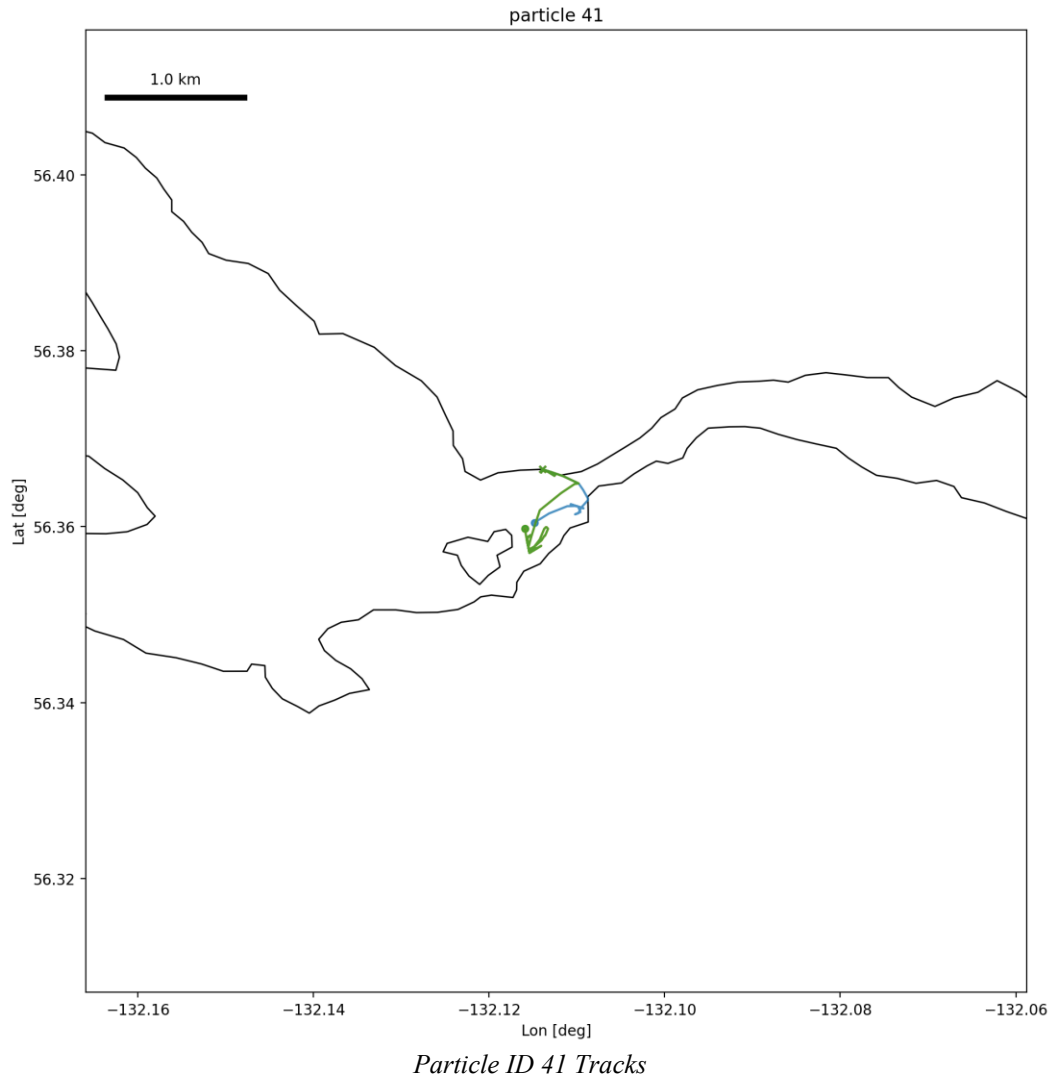
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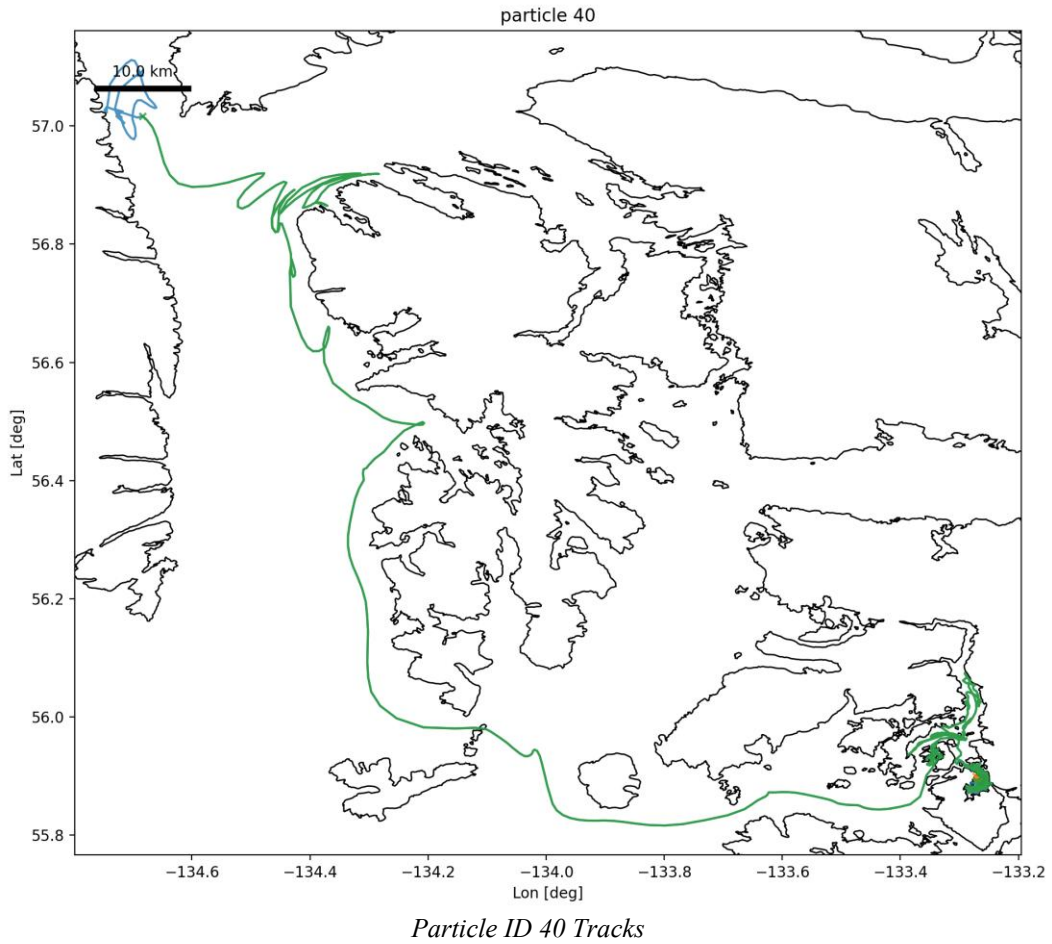


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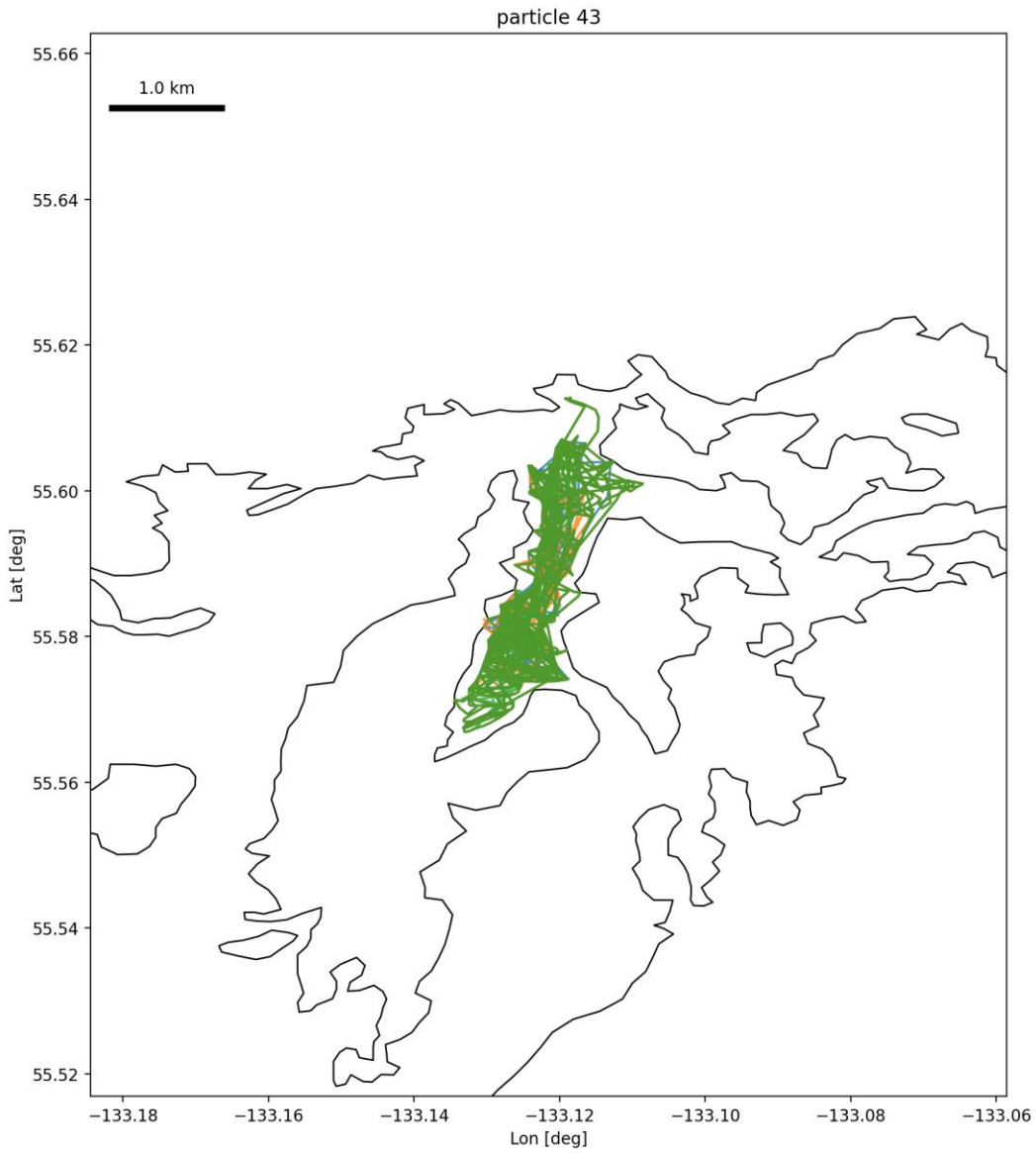
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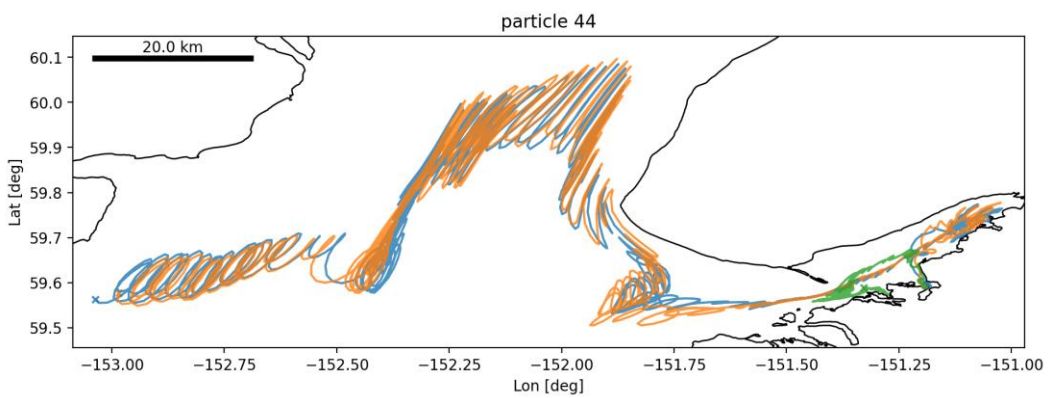
Kelson Marine Co. | Quantification of the Fate of Sloughed Alaskan Seaweed Biomass: Quarter 1 2026 Progress Update Report



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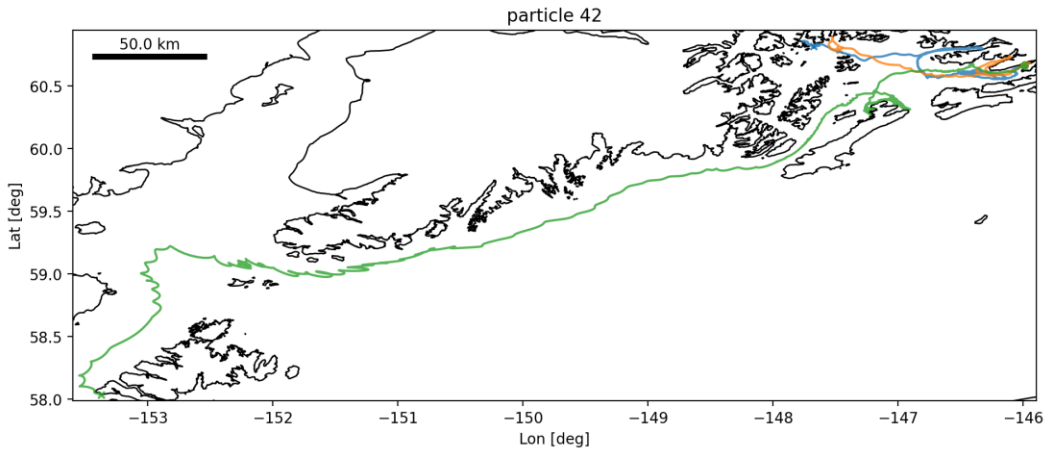


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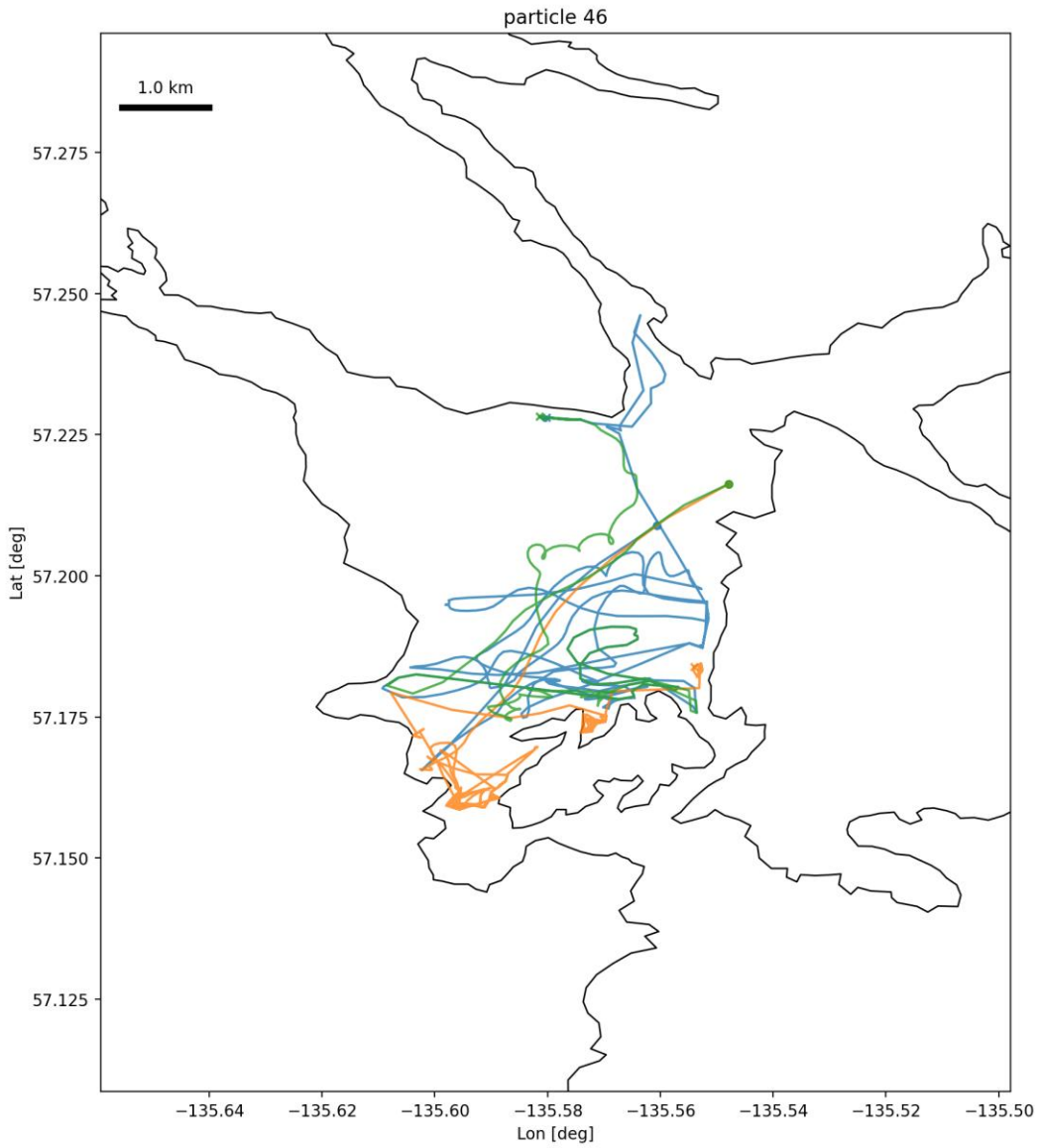
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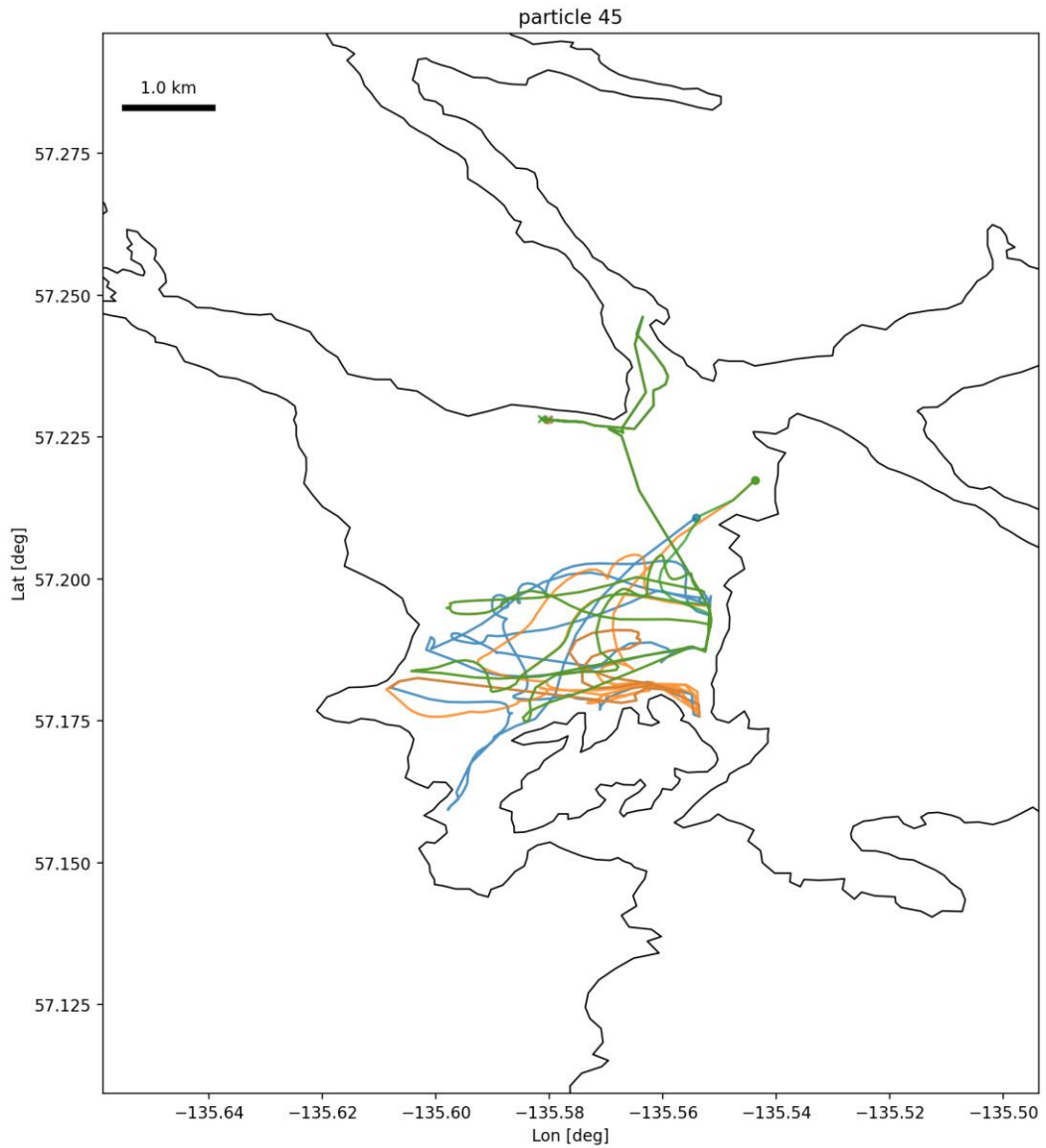
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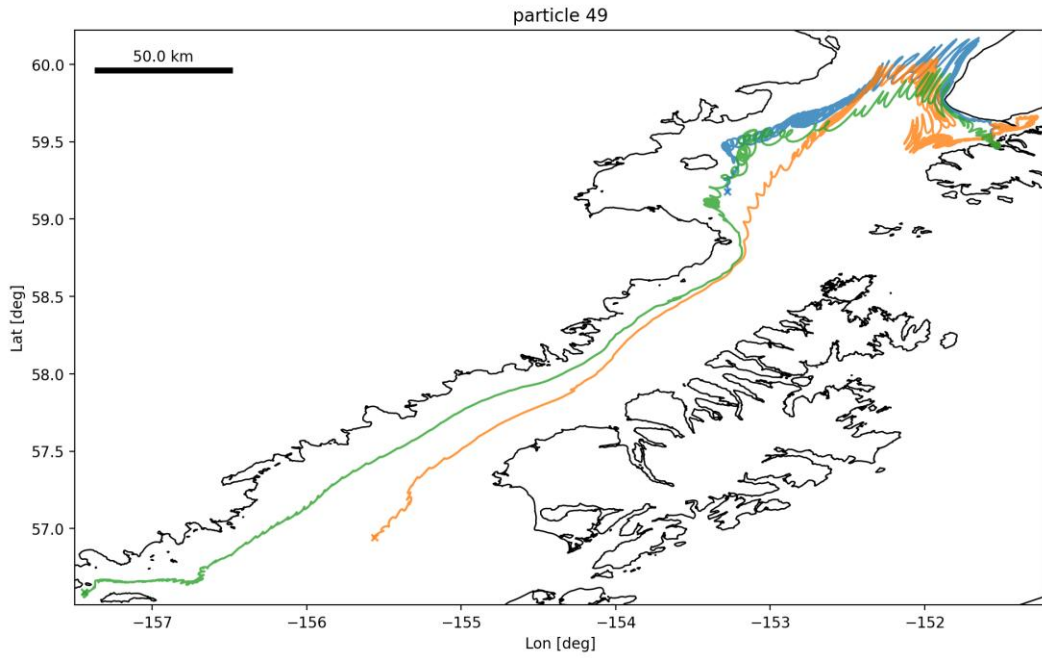
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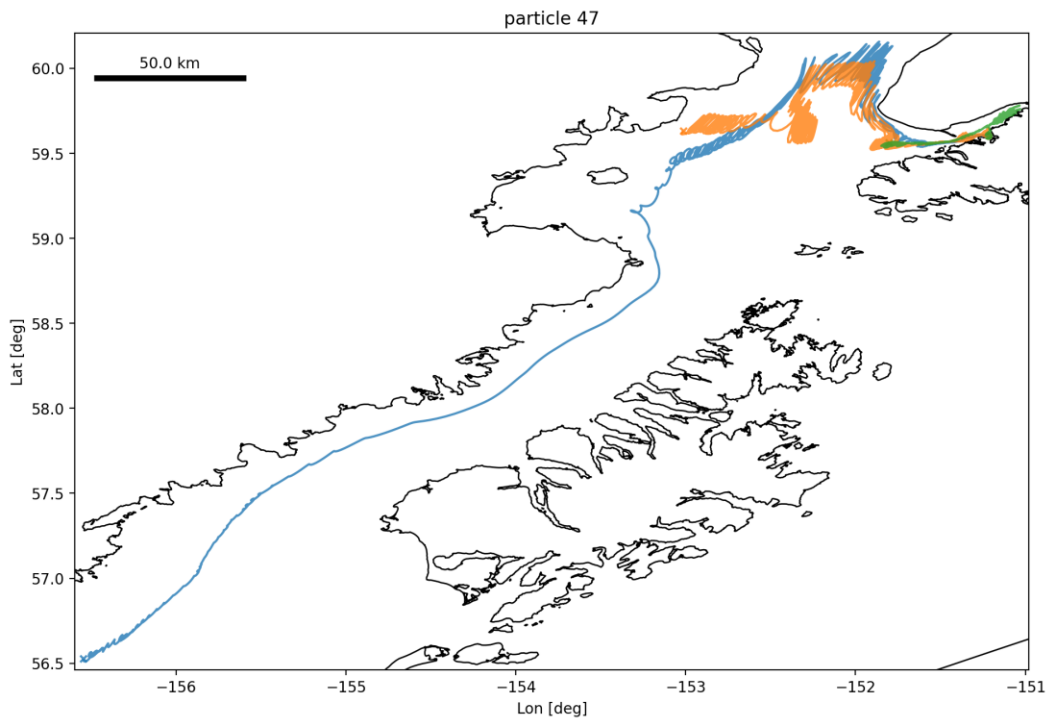


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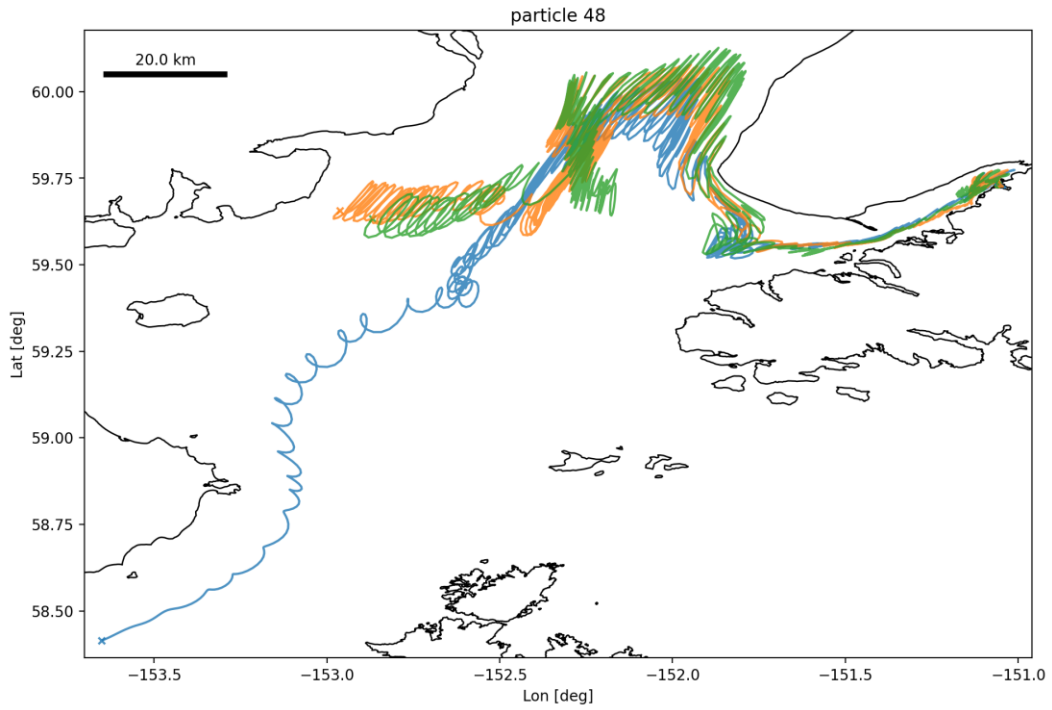


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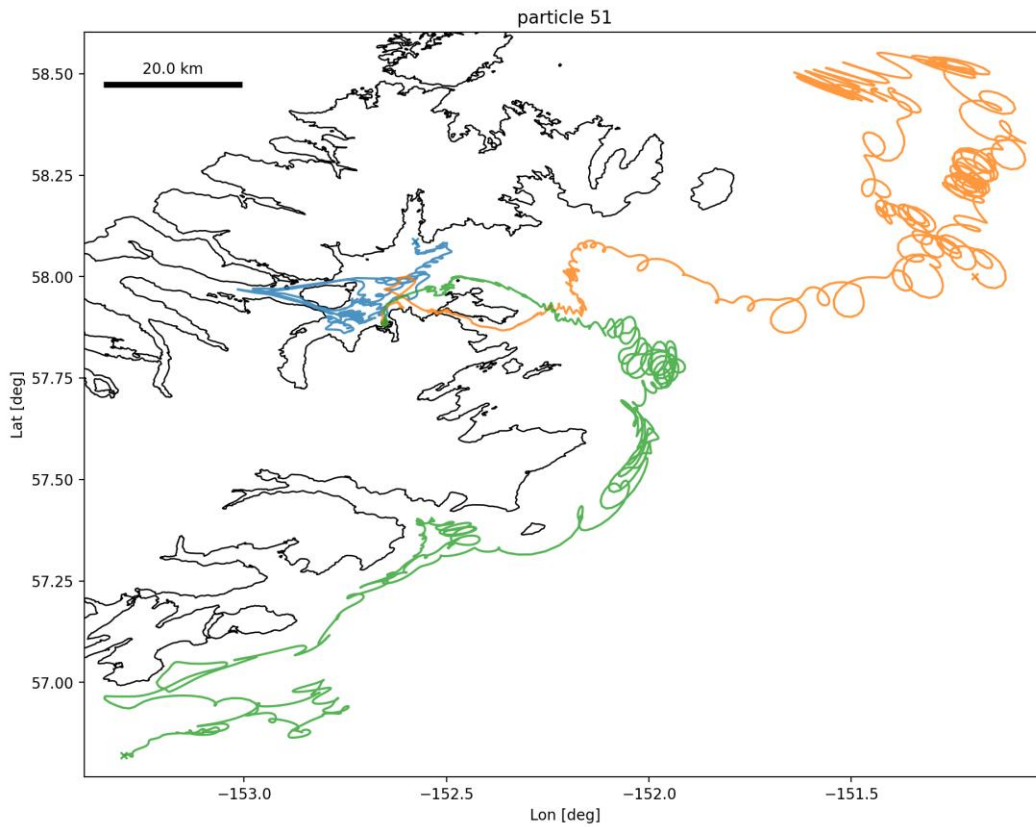


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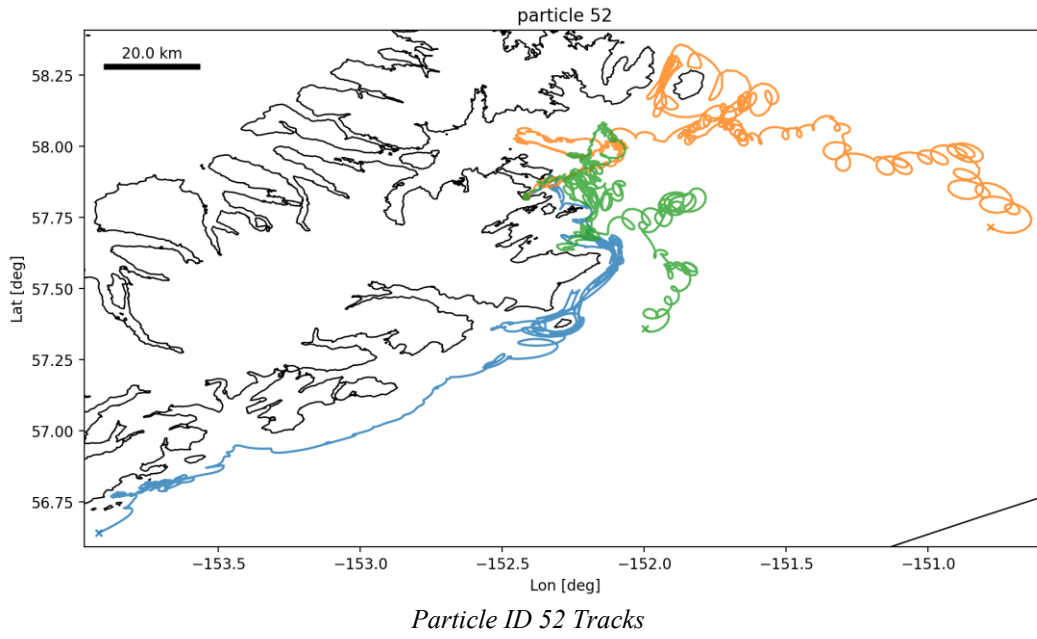


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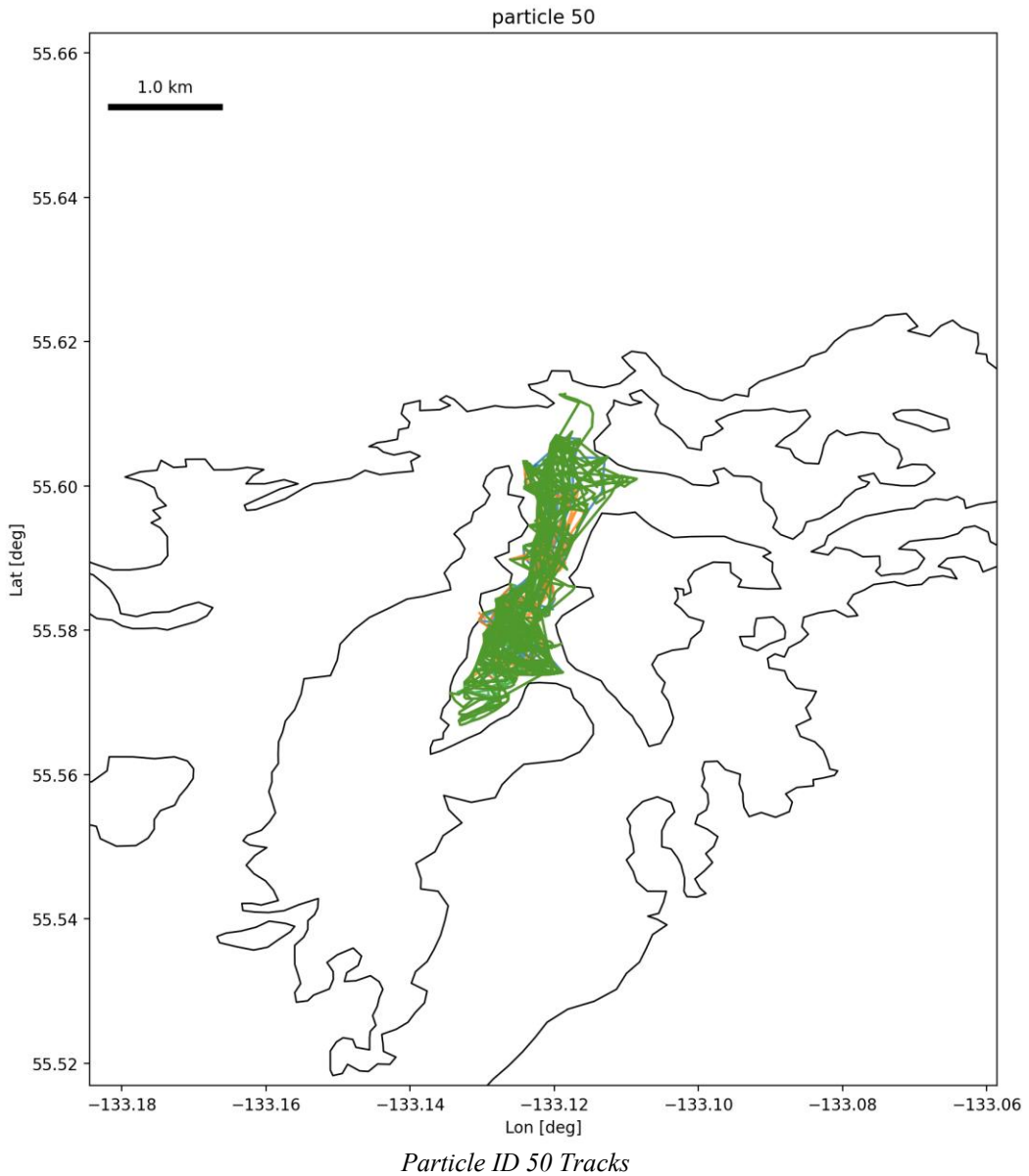


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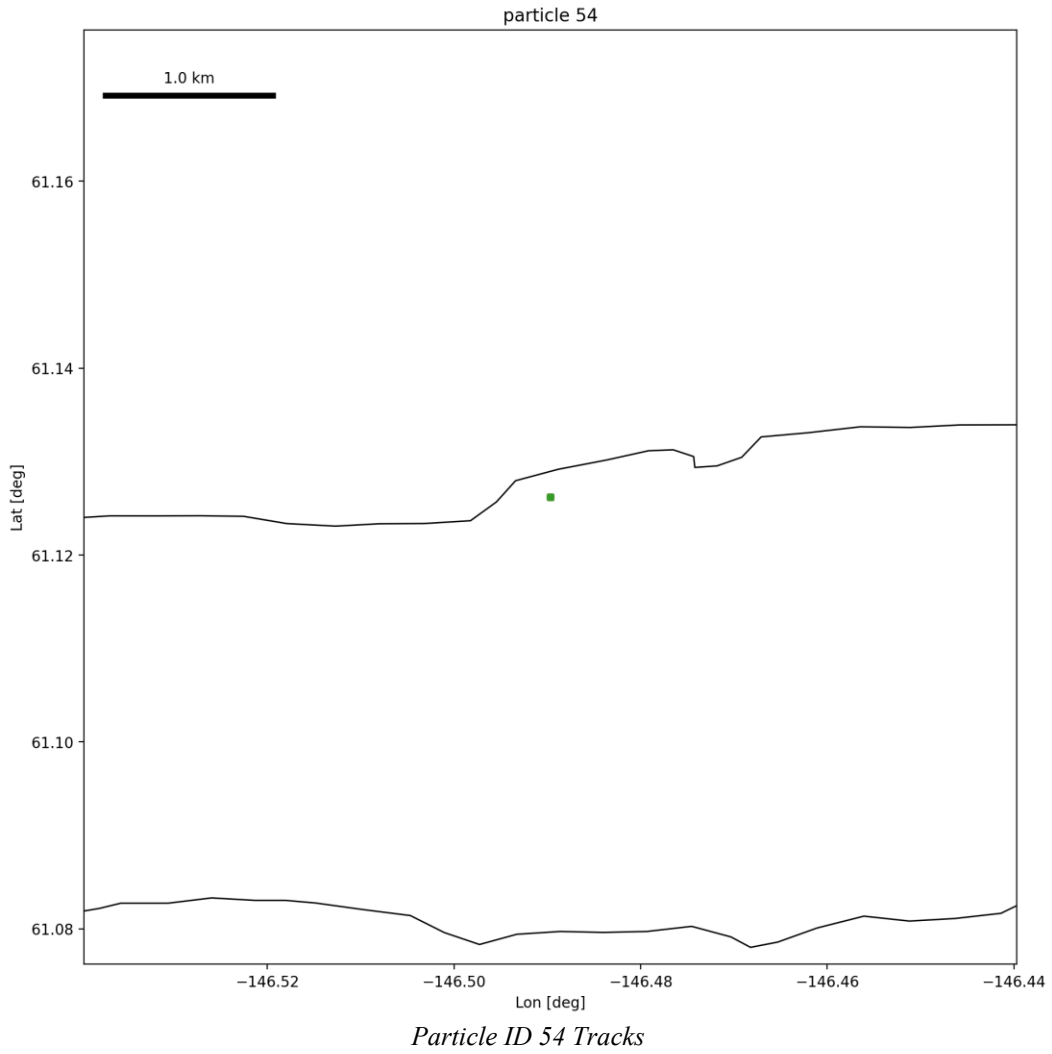
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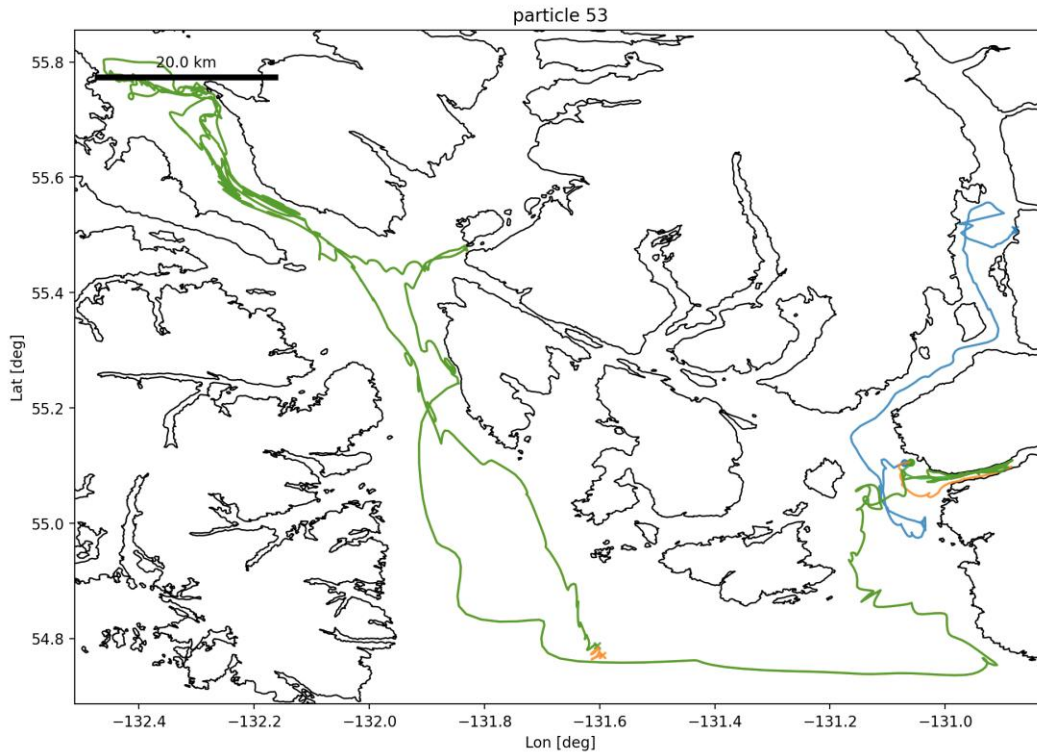
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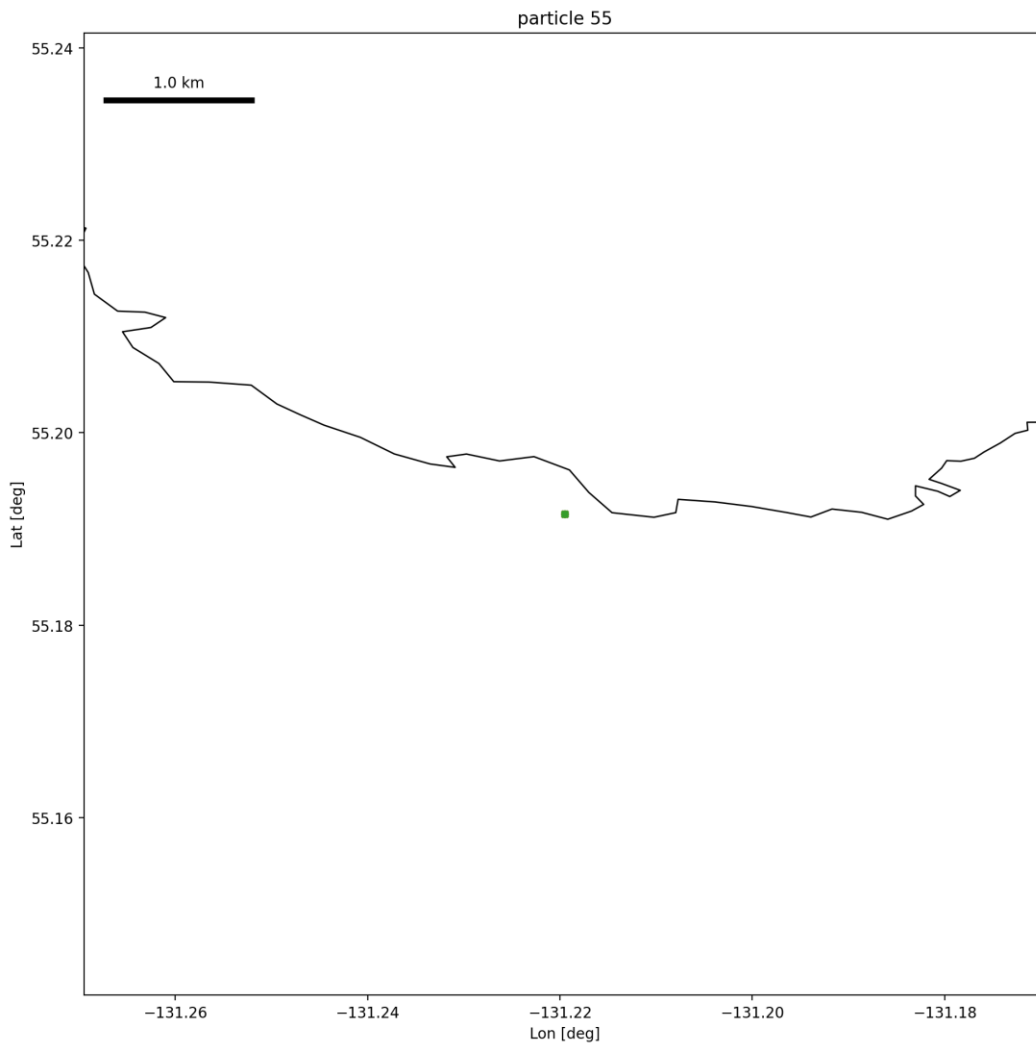


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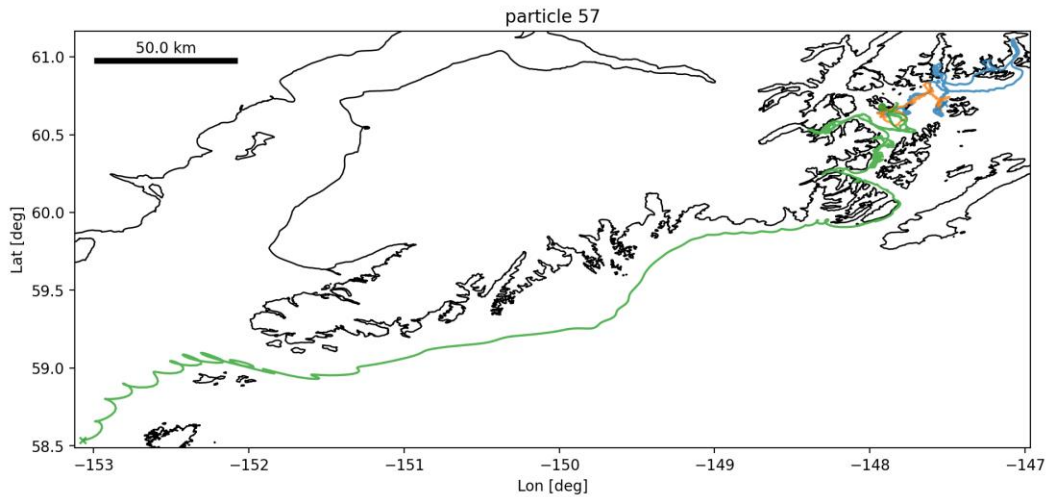


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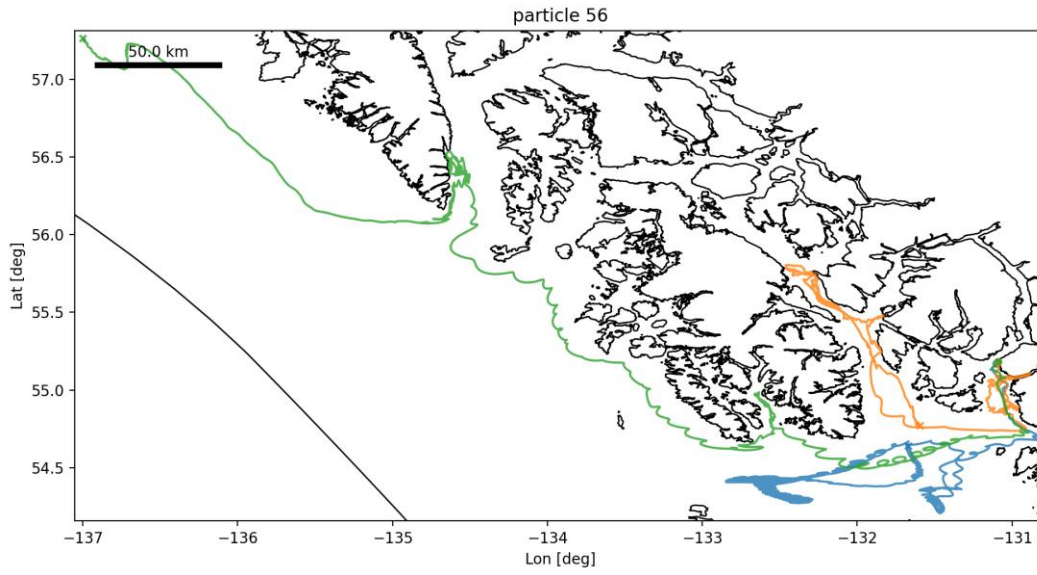


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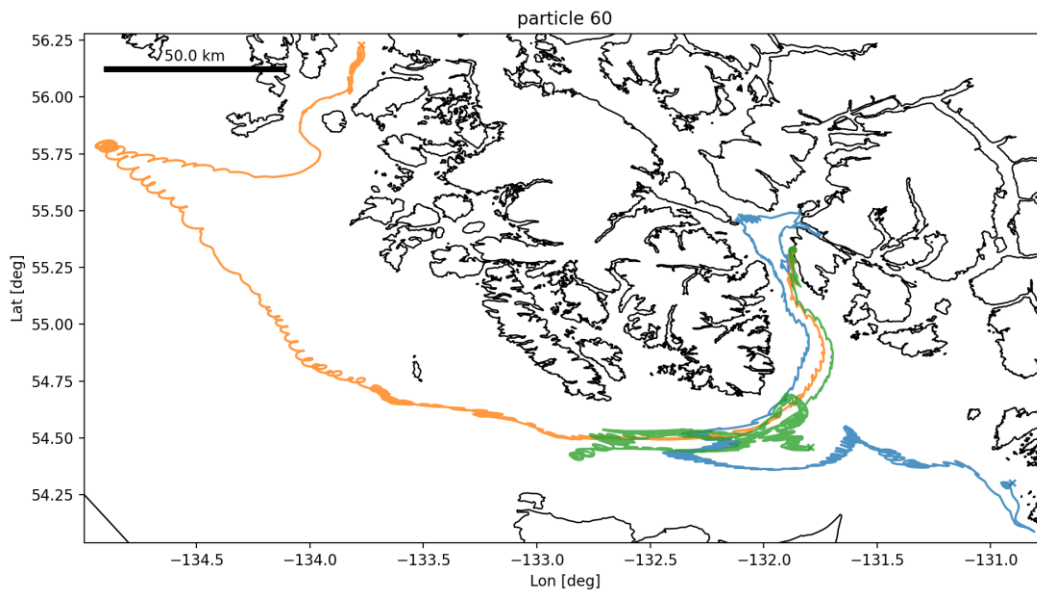


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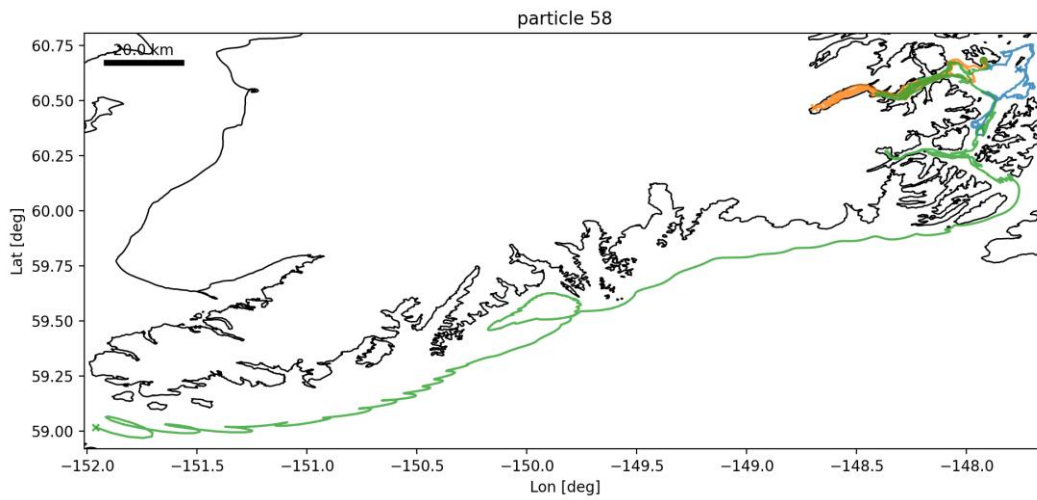


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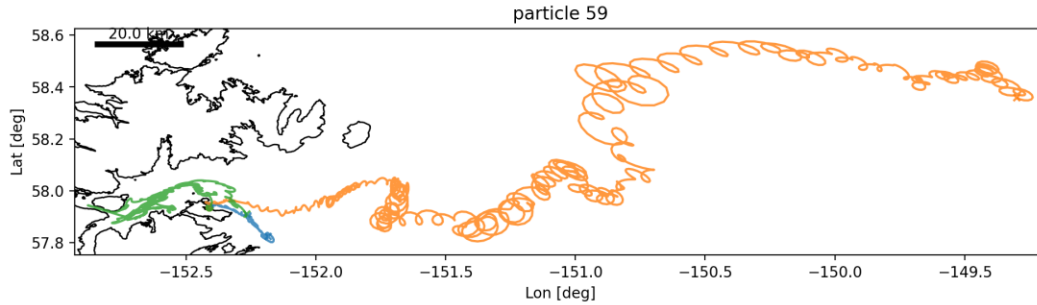


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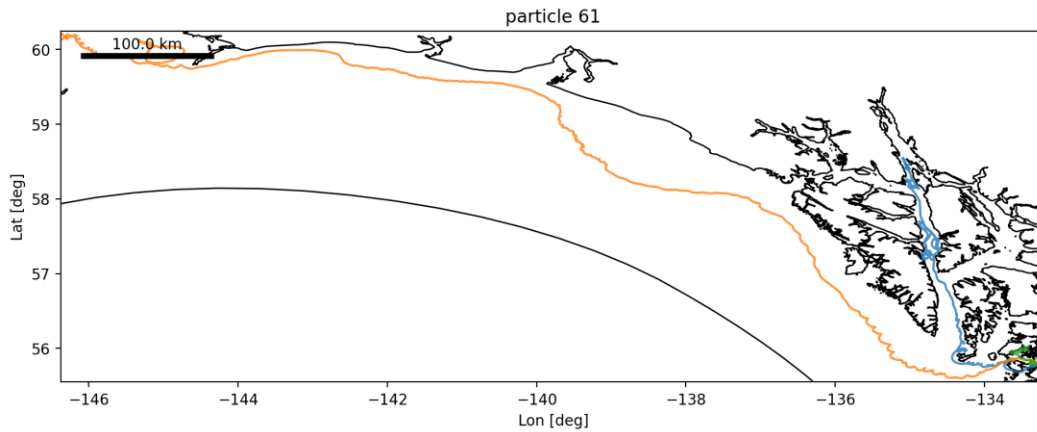
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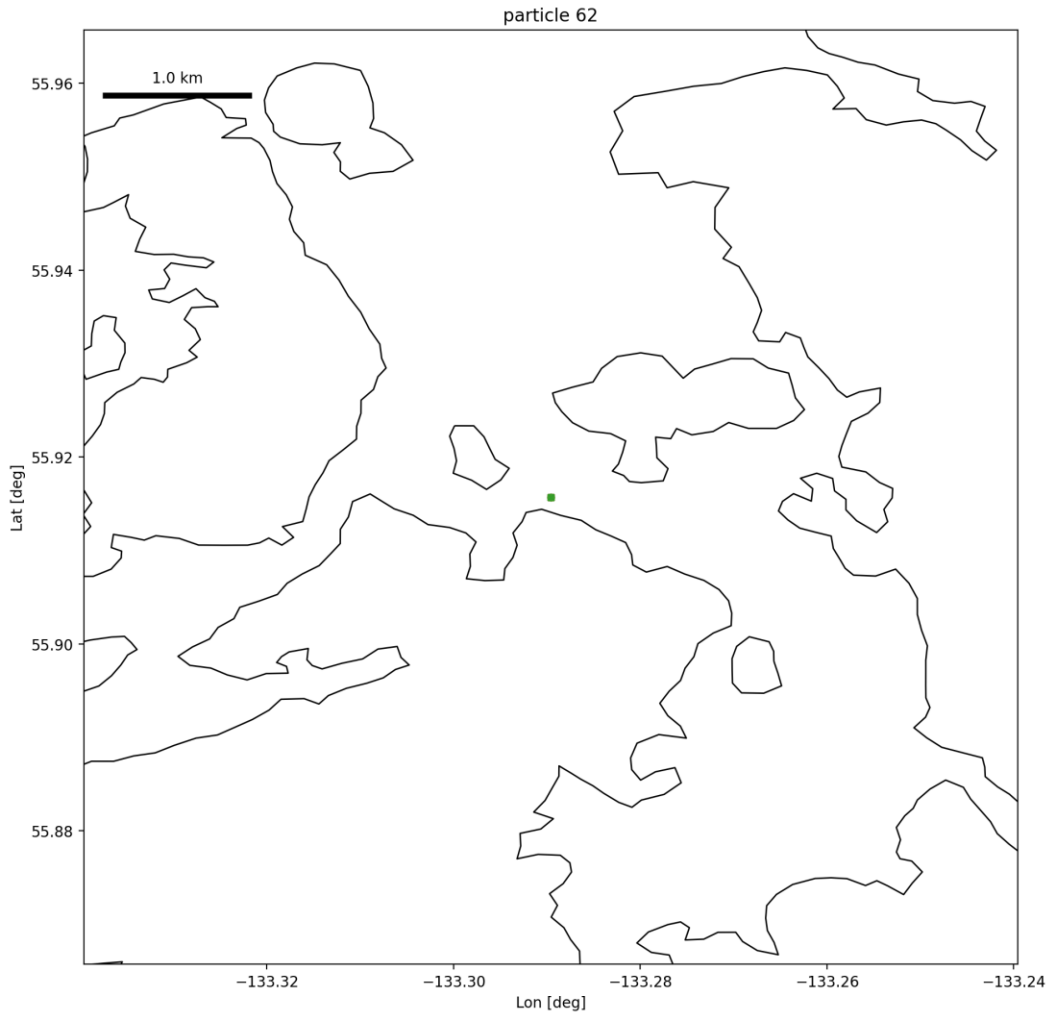


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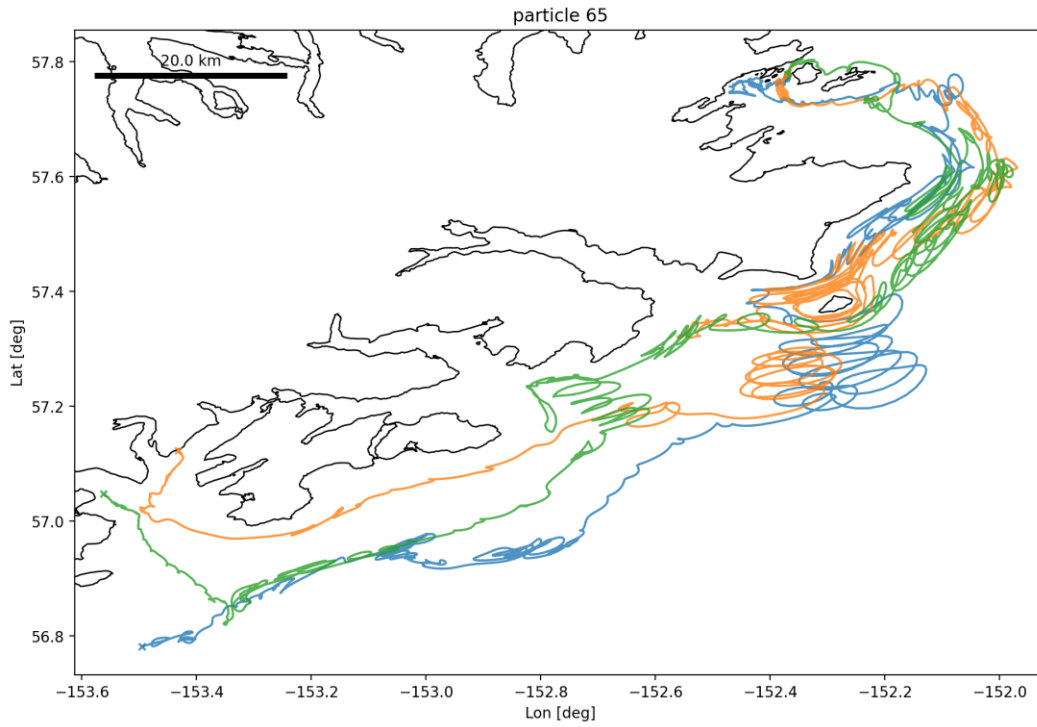
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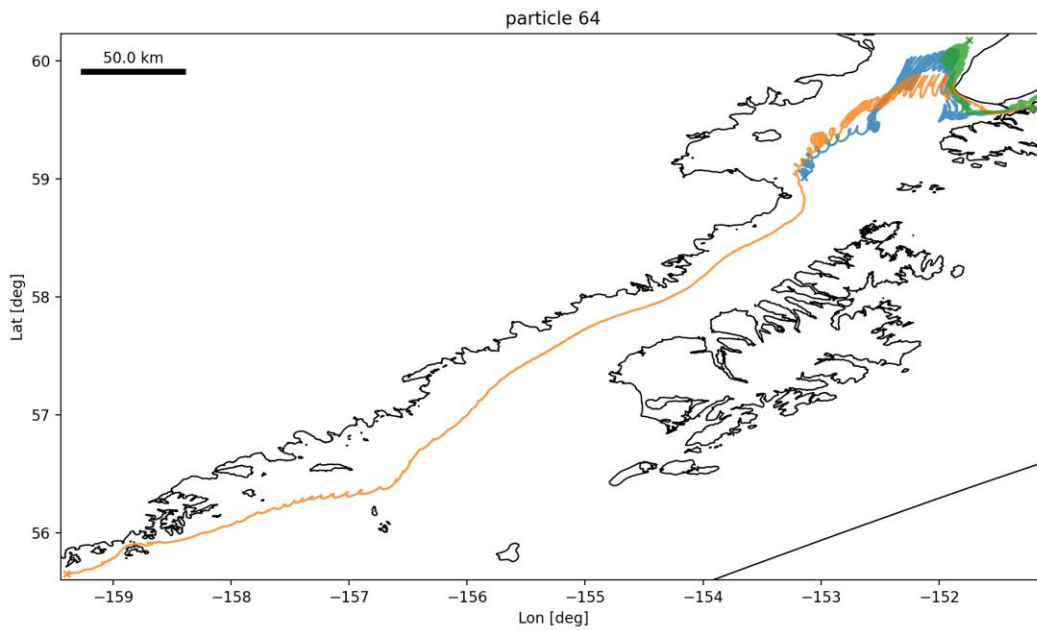


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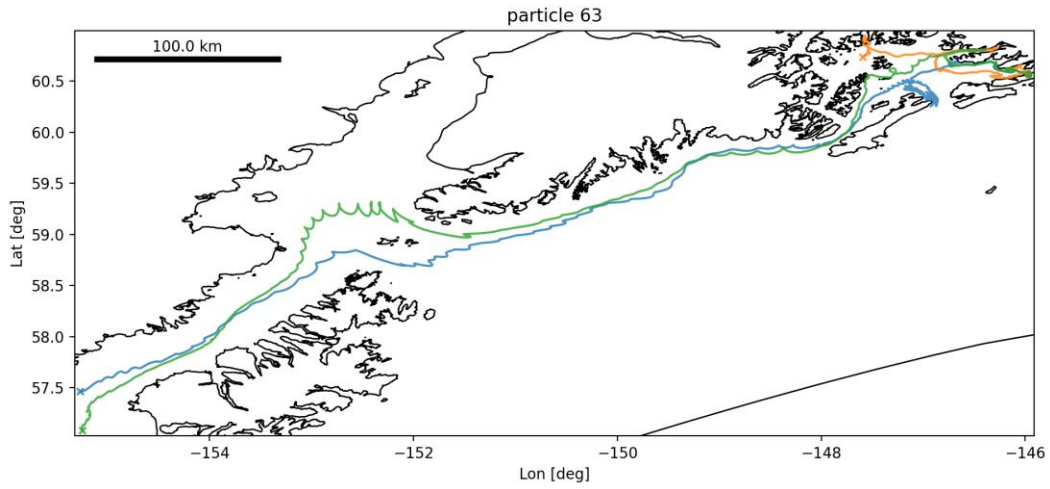


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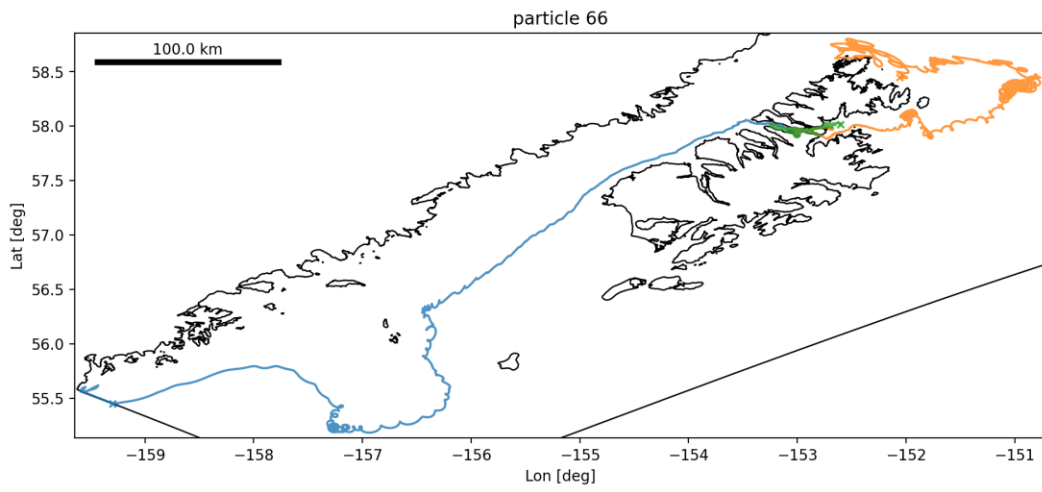


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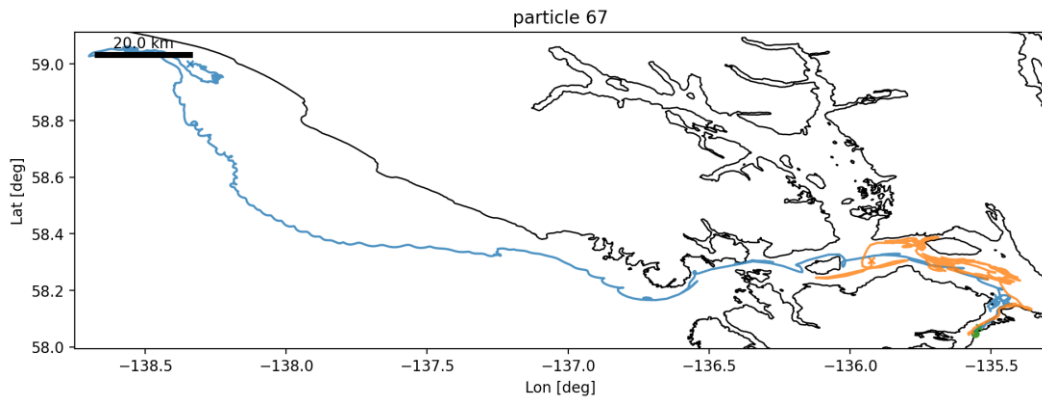
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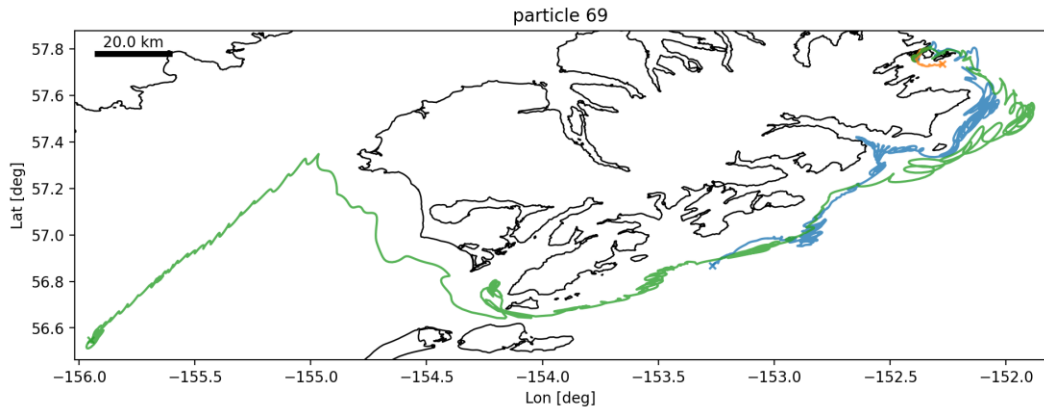


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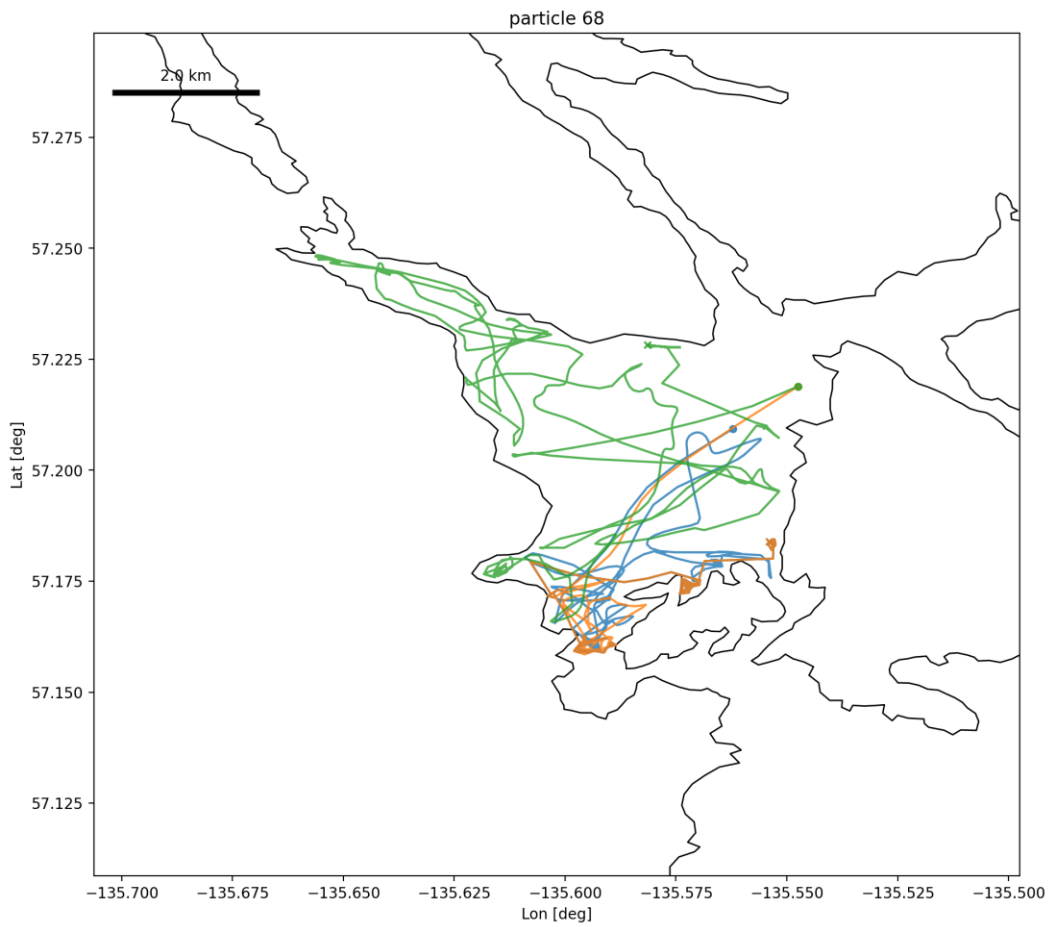


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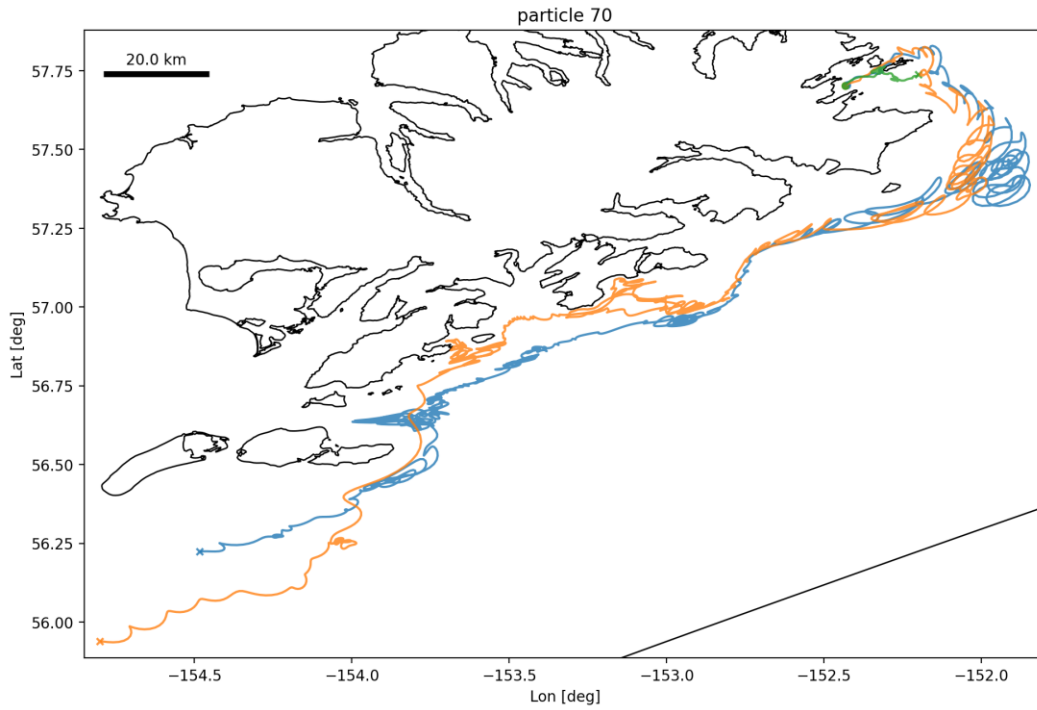


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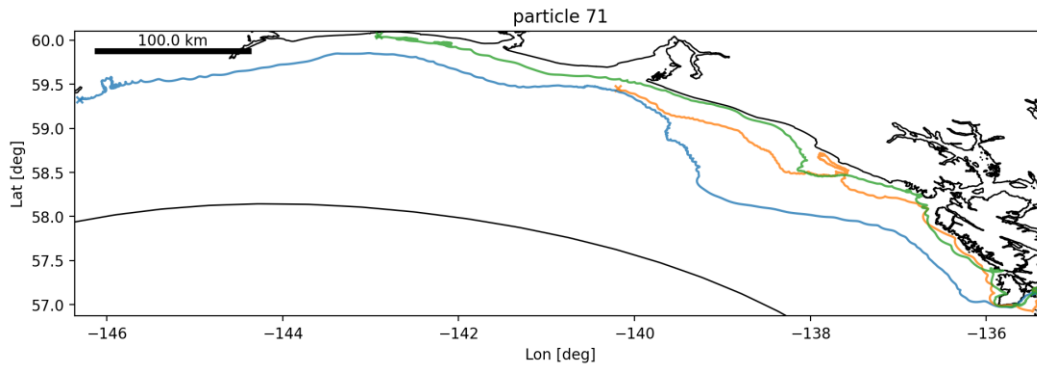


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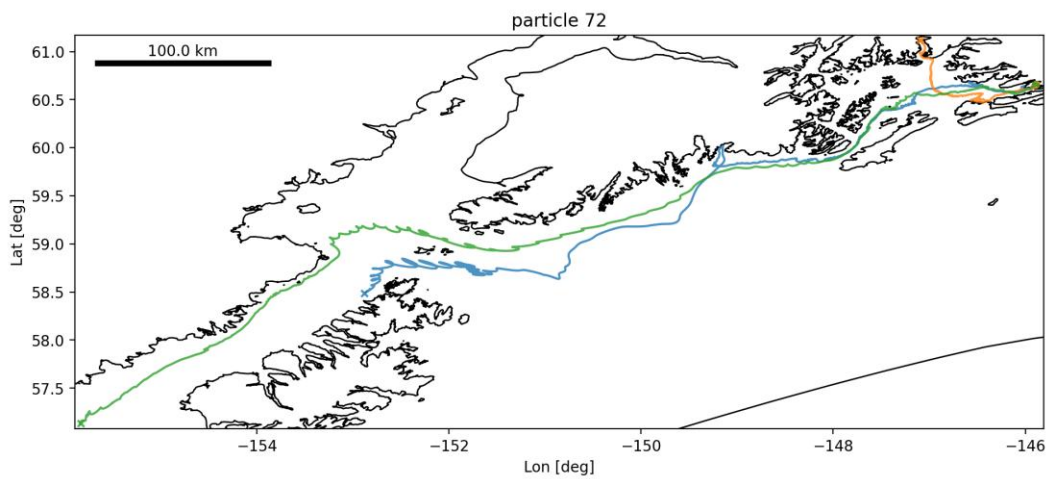
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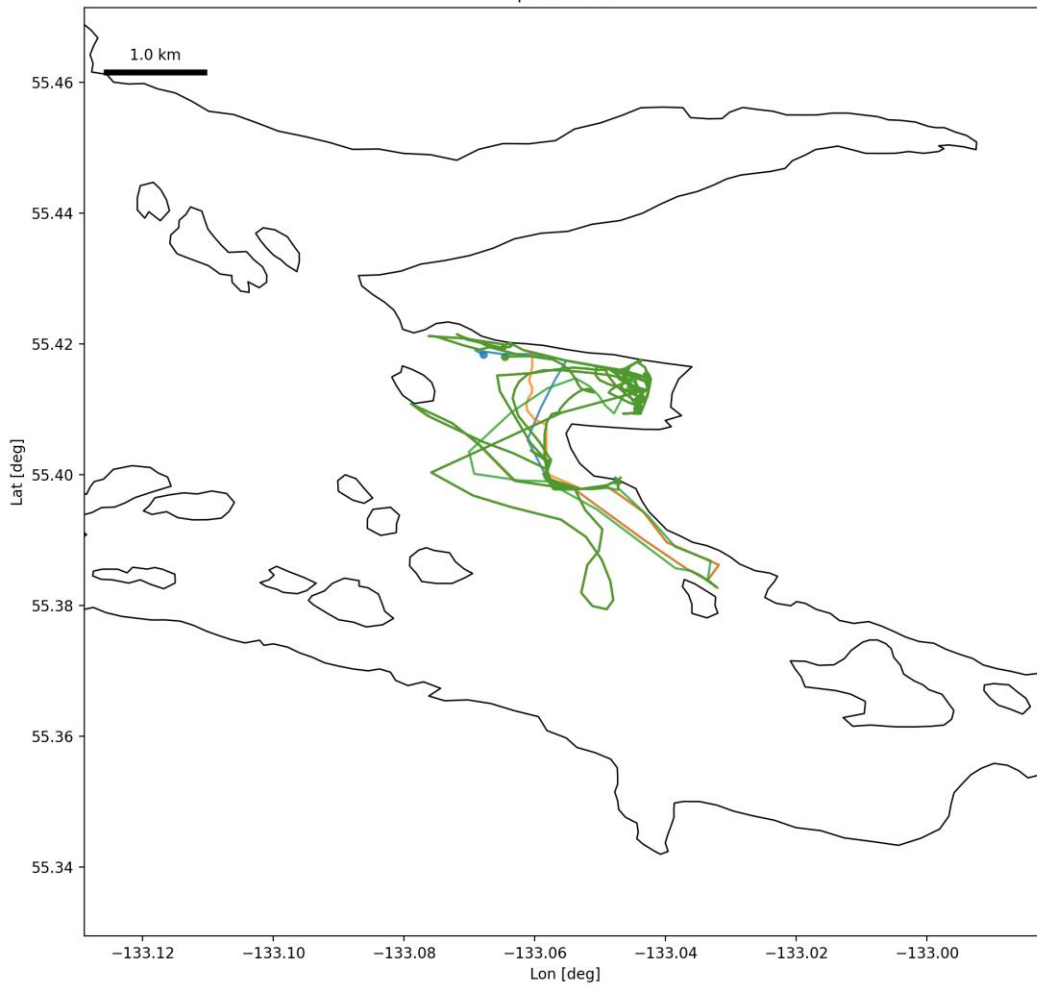
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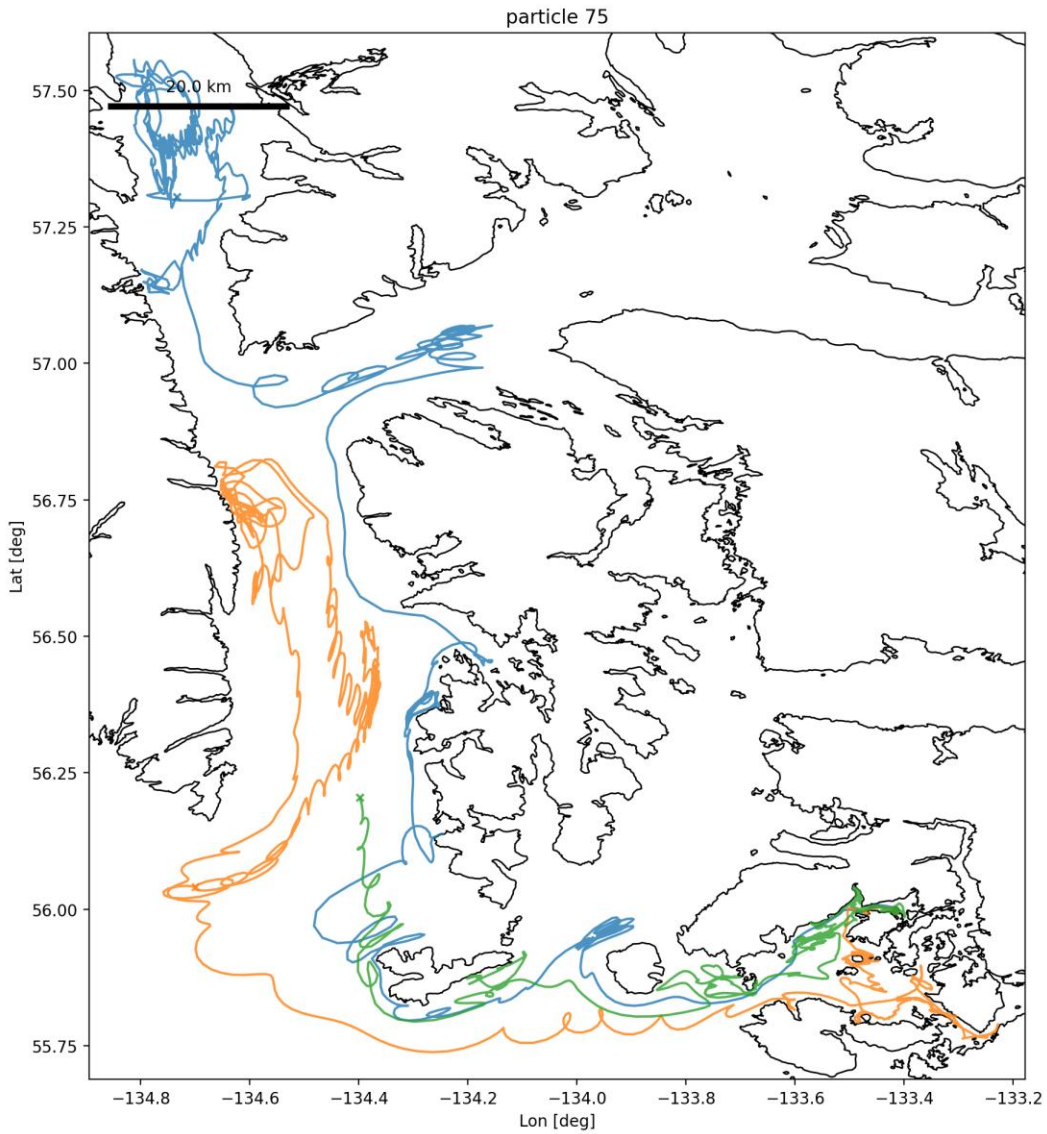
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particle 74



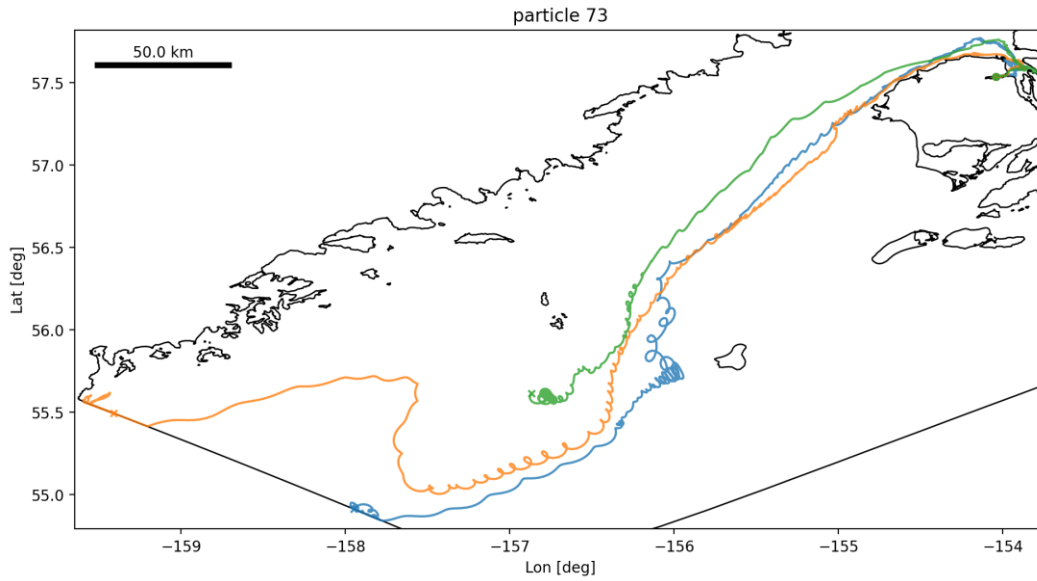
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Kelson Marine Co. | Quantification of the Fate of Sloughed Alaskan Seaweed Biomass: Quarter 1 2026 Progress Update Report

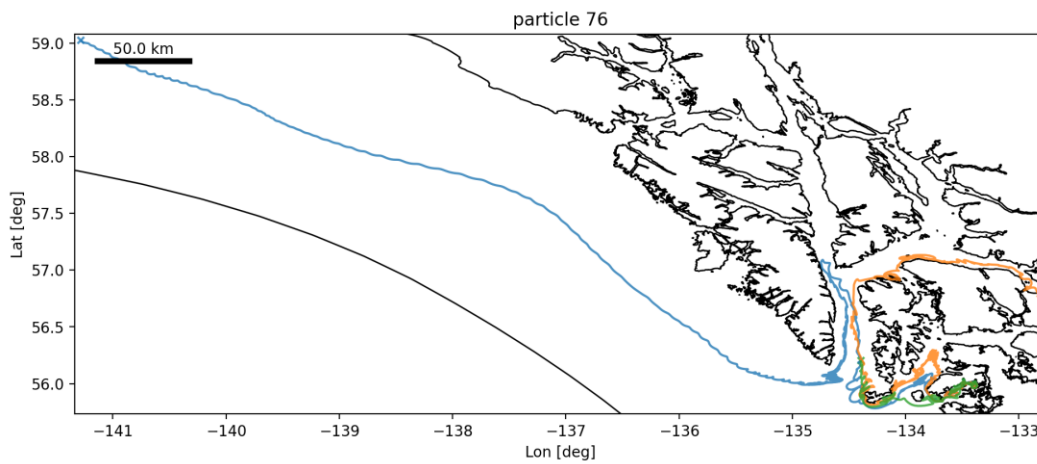


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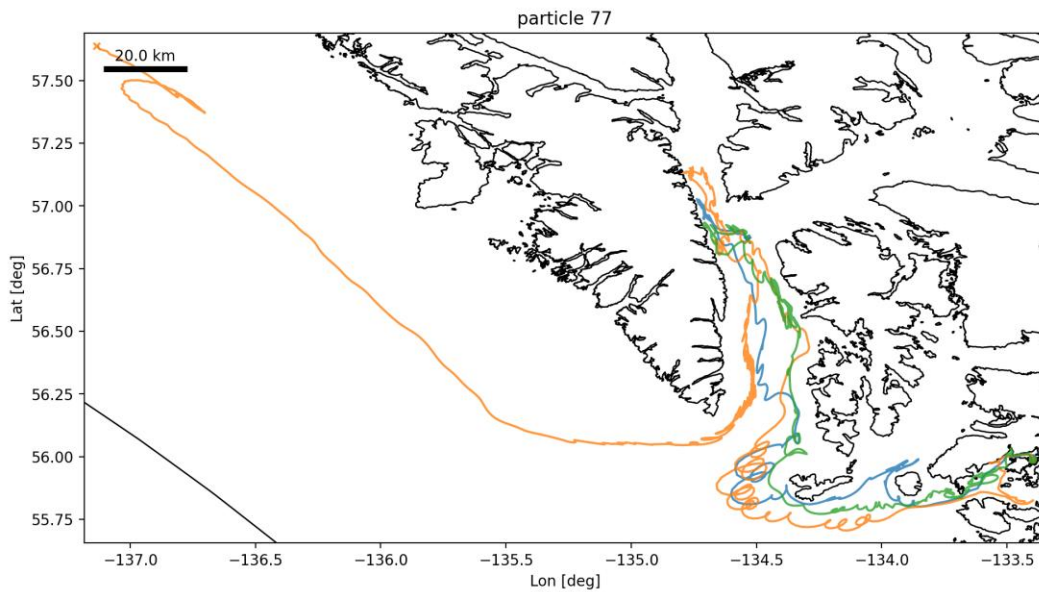


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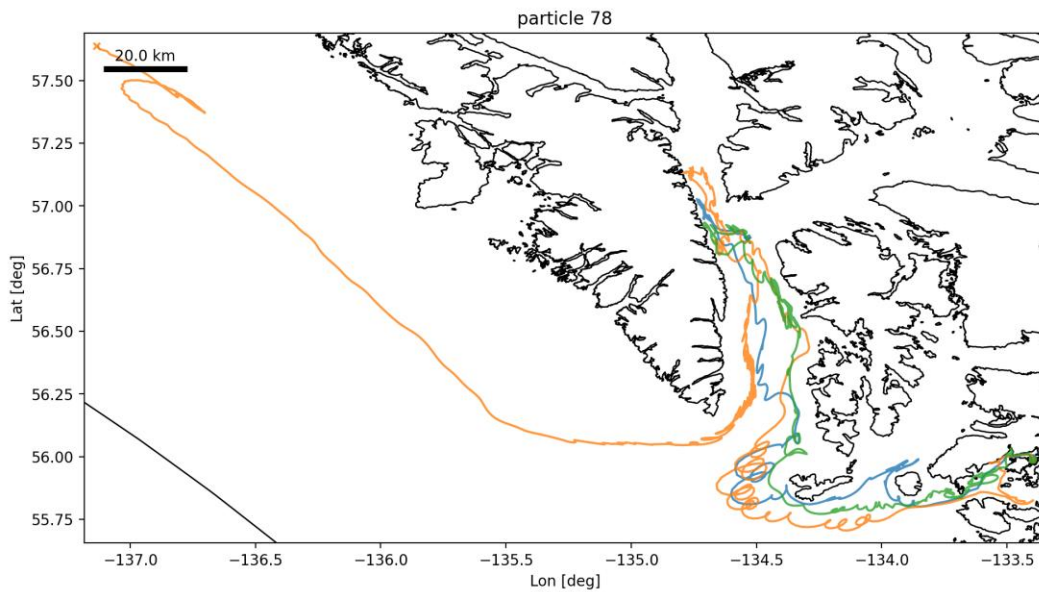


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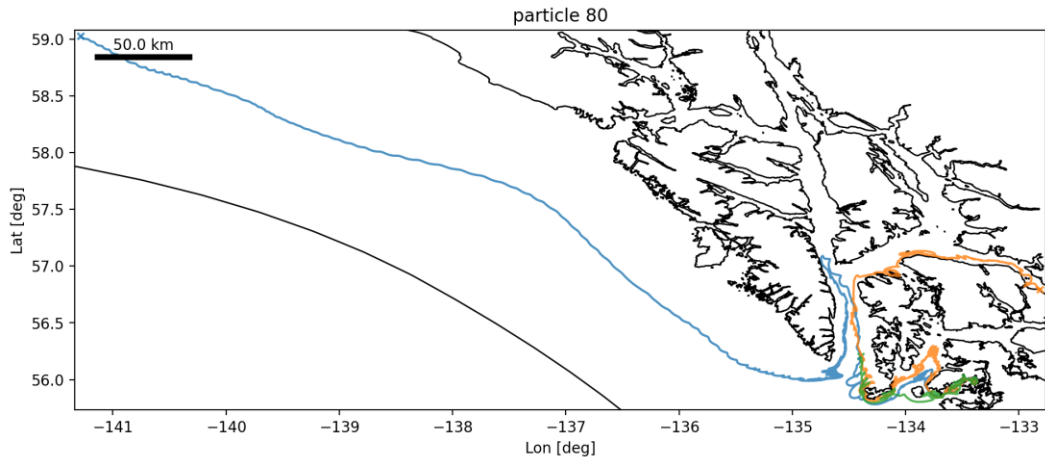


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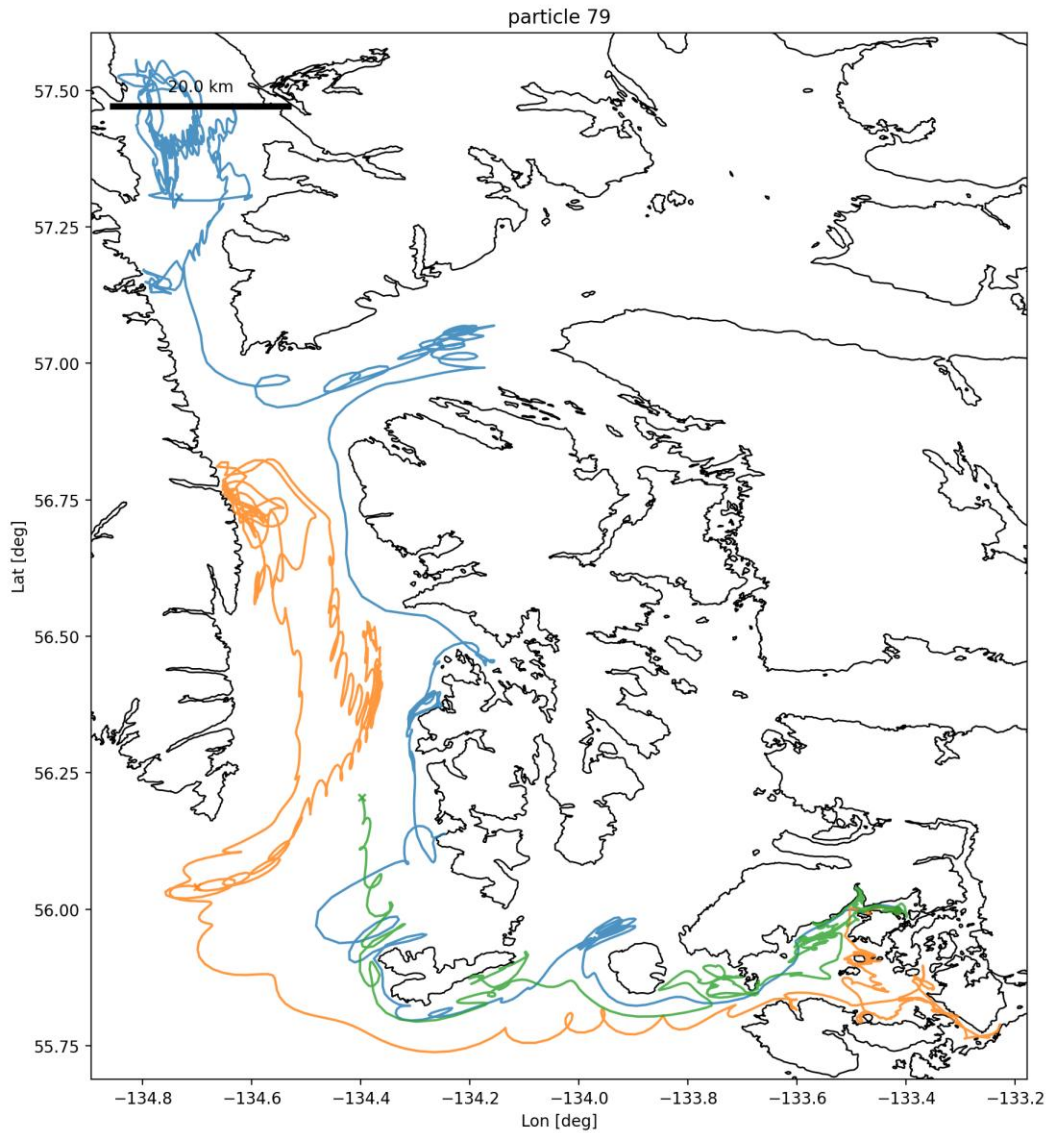


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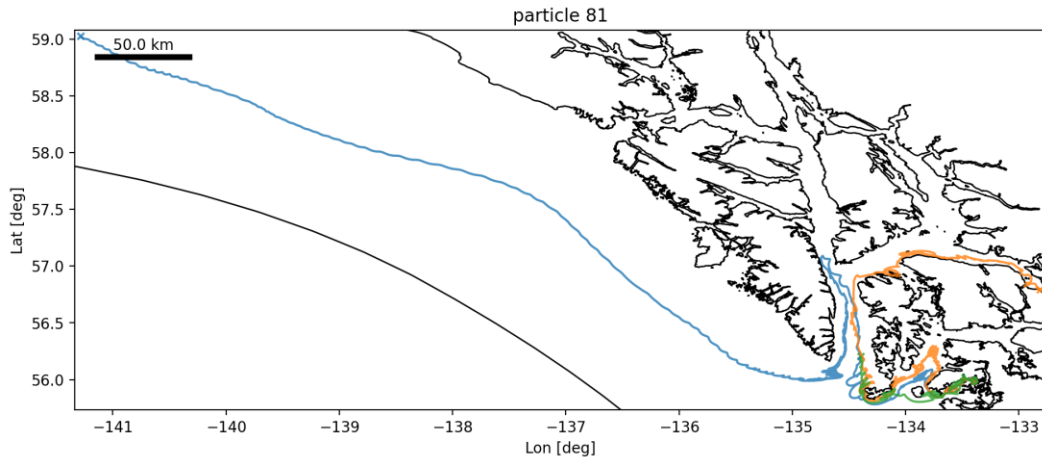


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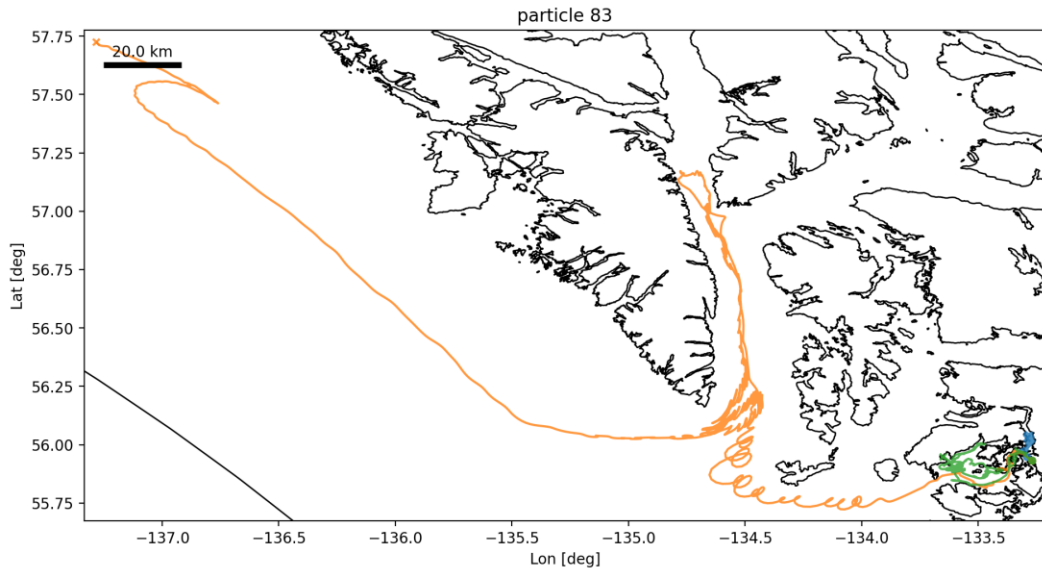


Kelson Marine Co. | Quantification of the Fate of Sloughed Alaskan Seaweed Biomass: Quarter 1 2026 Progress Update Report

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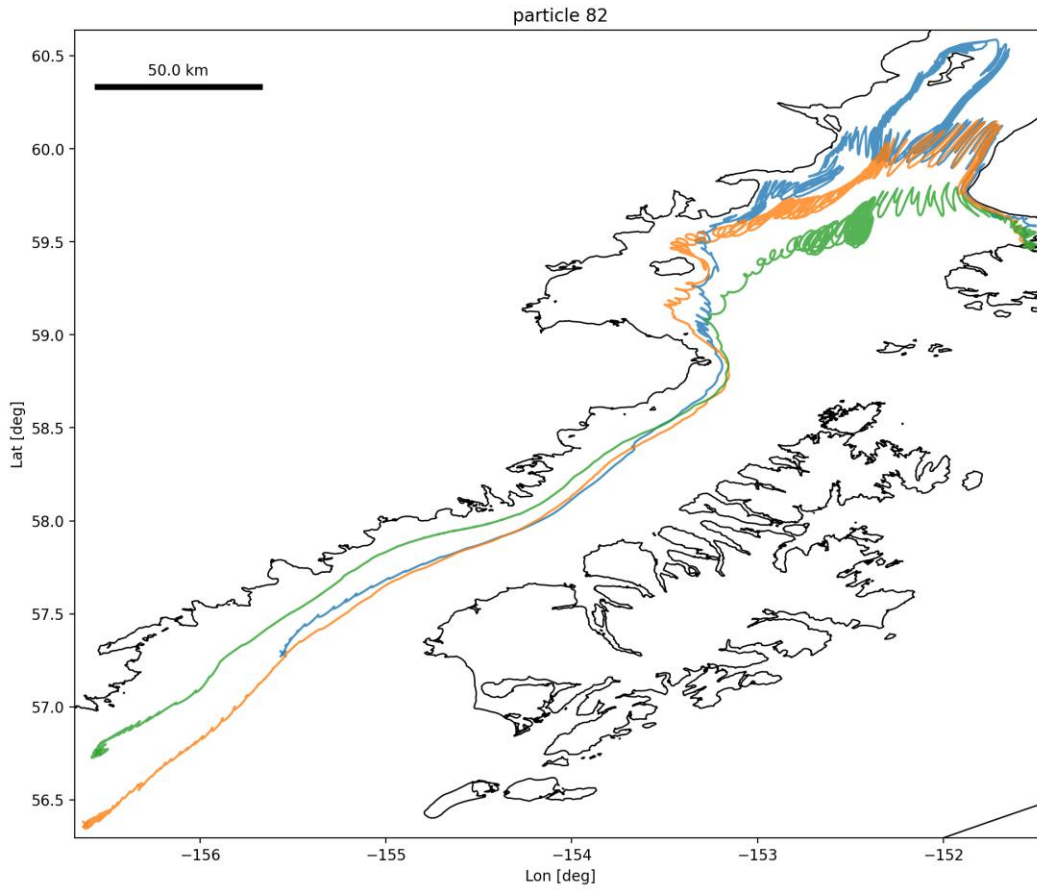


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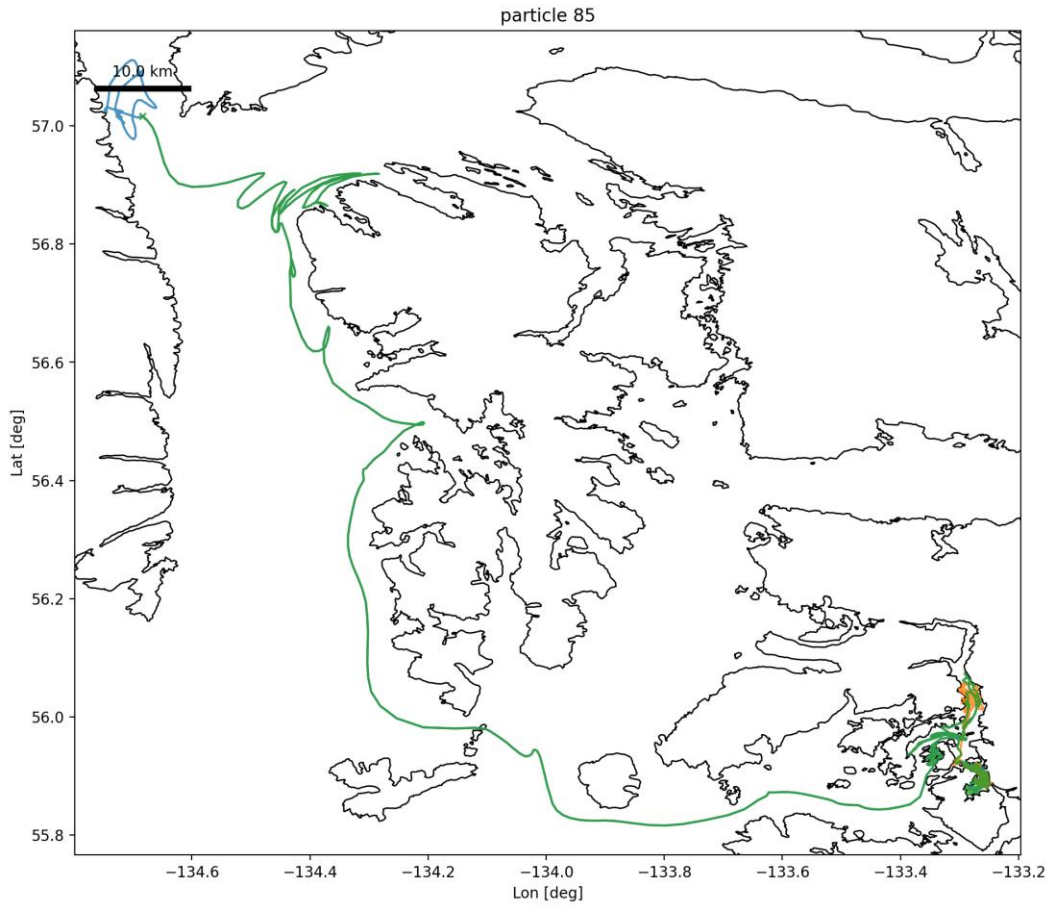
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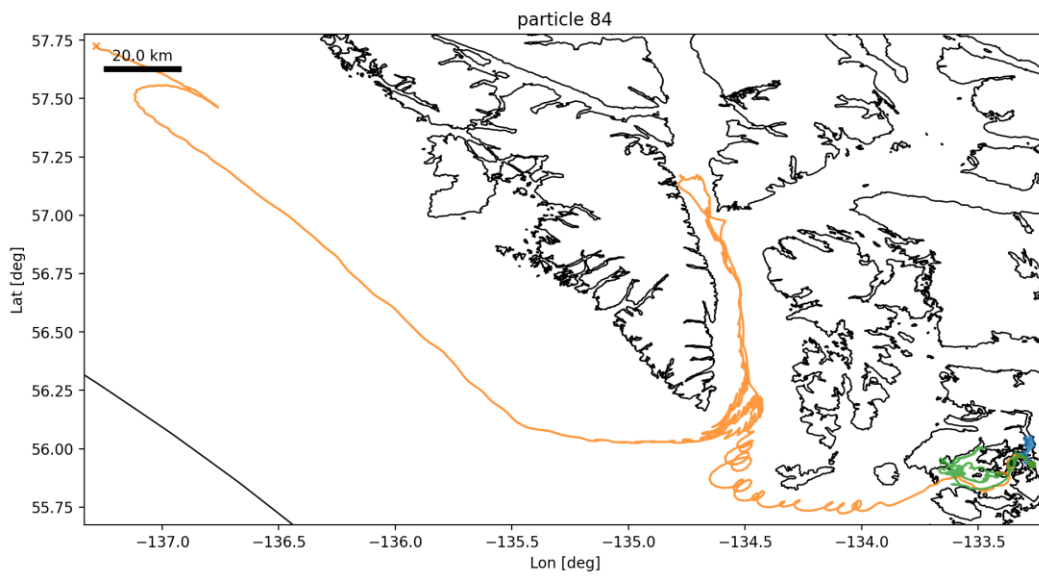


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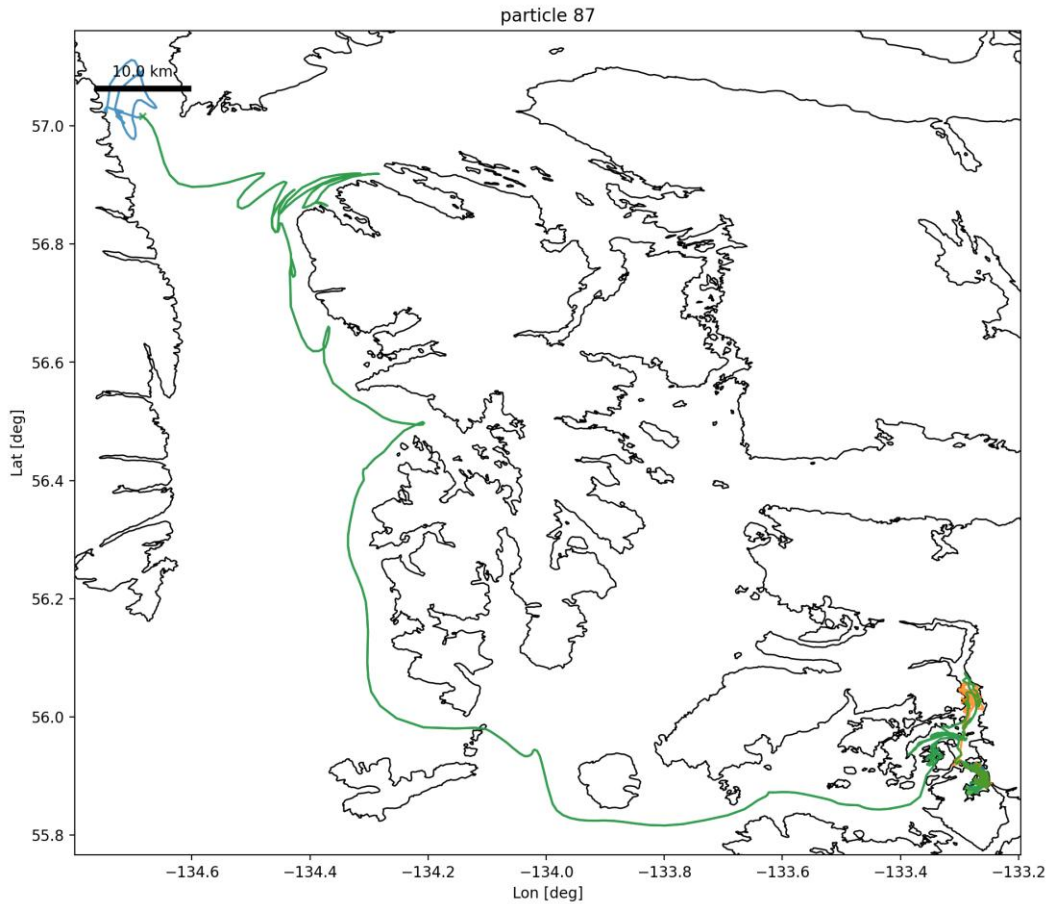


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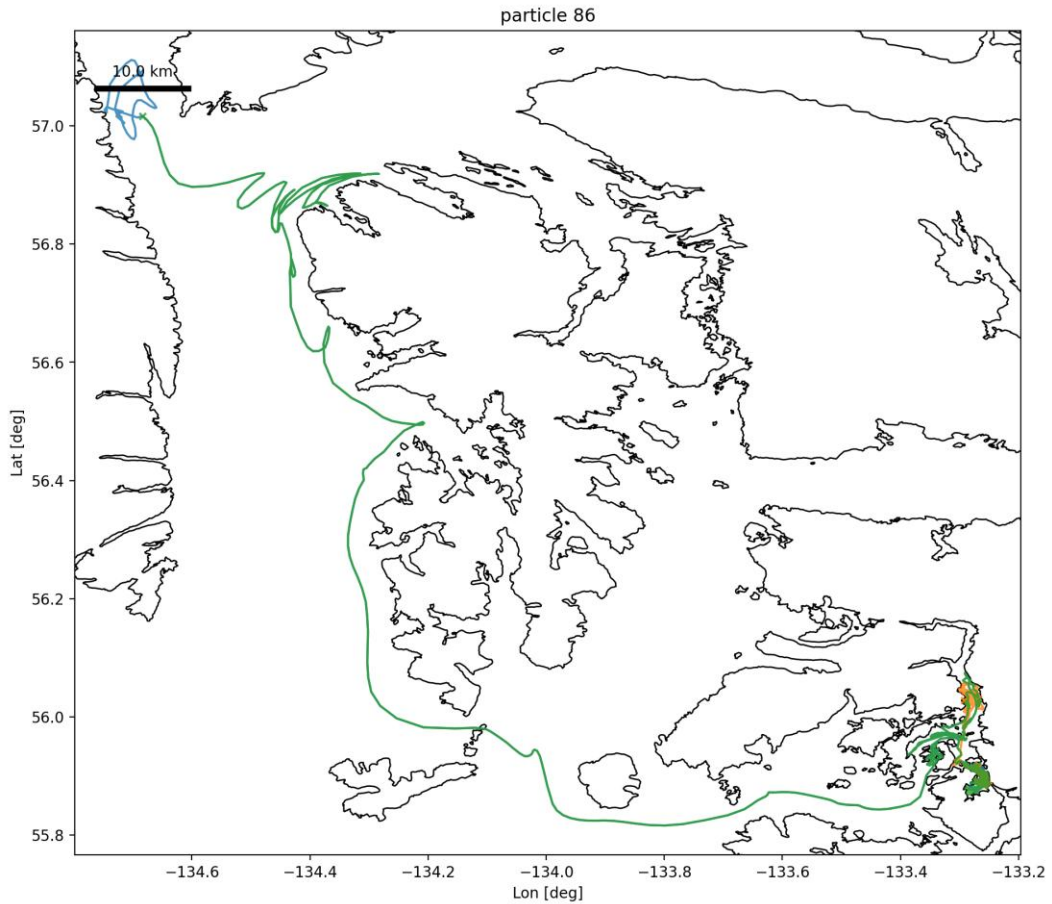
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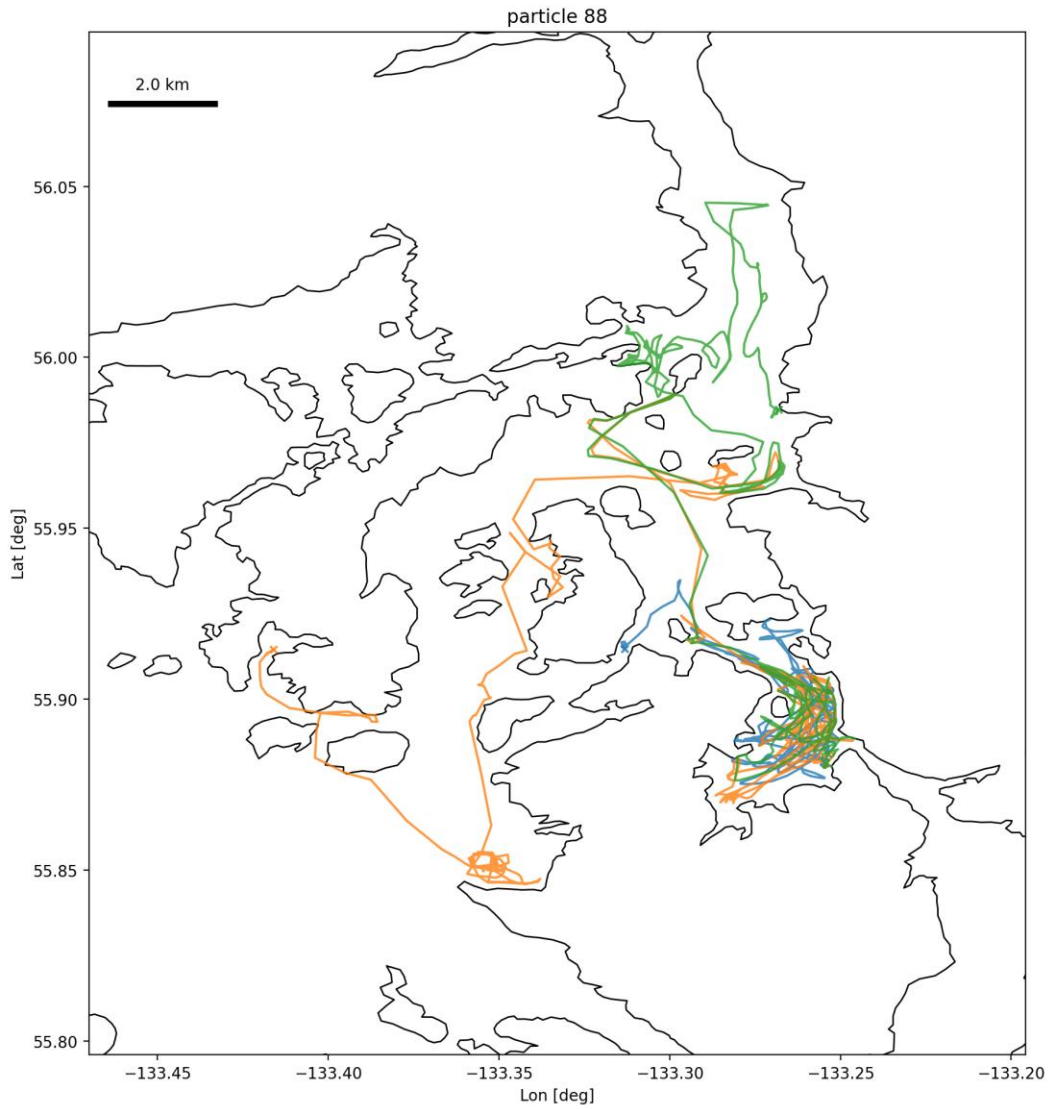
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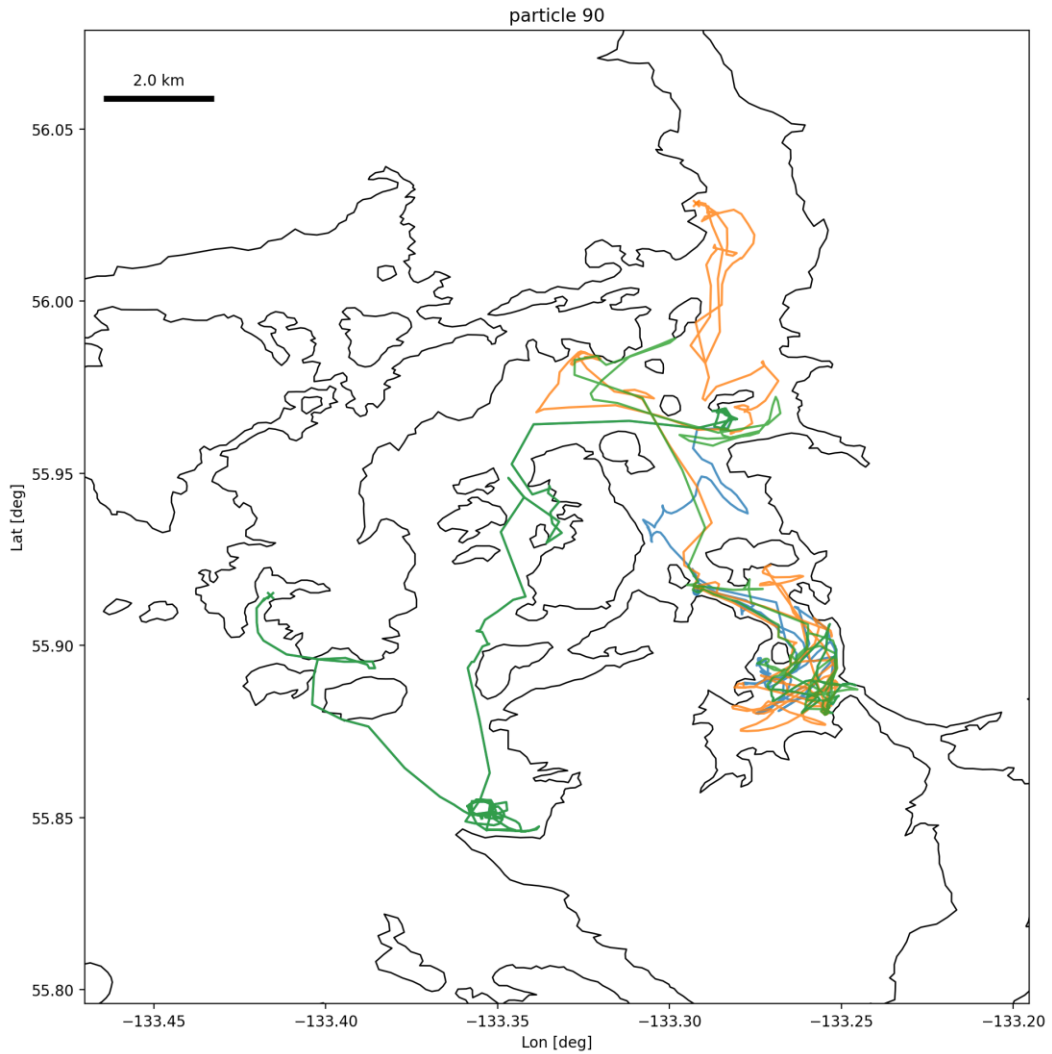
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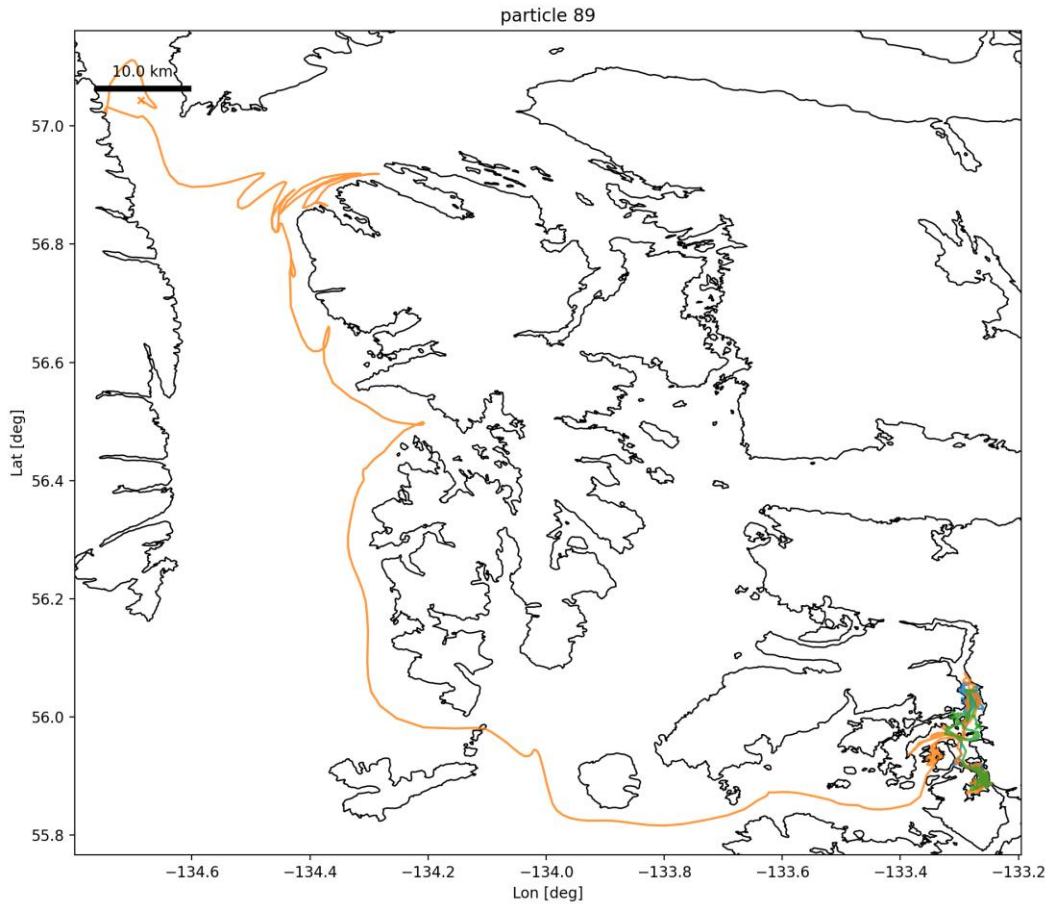
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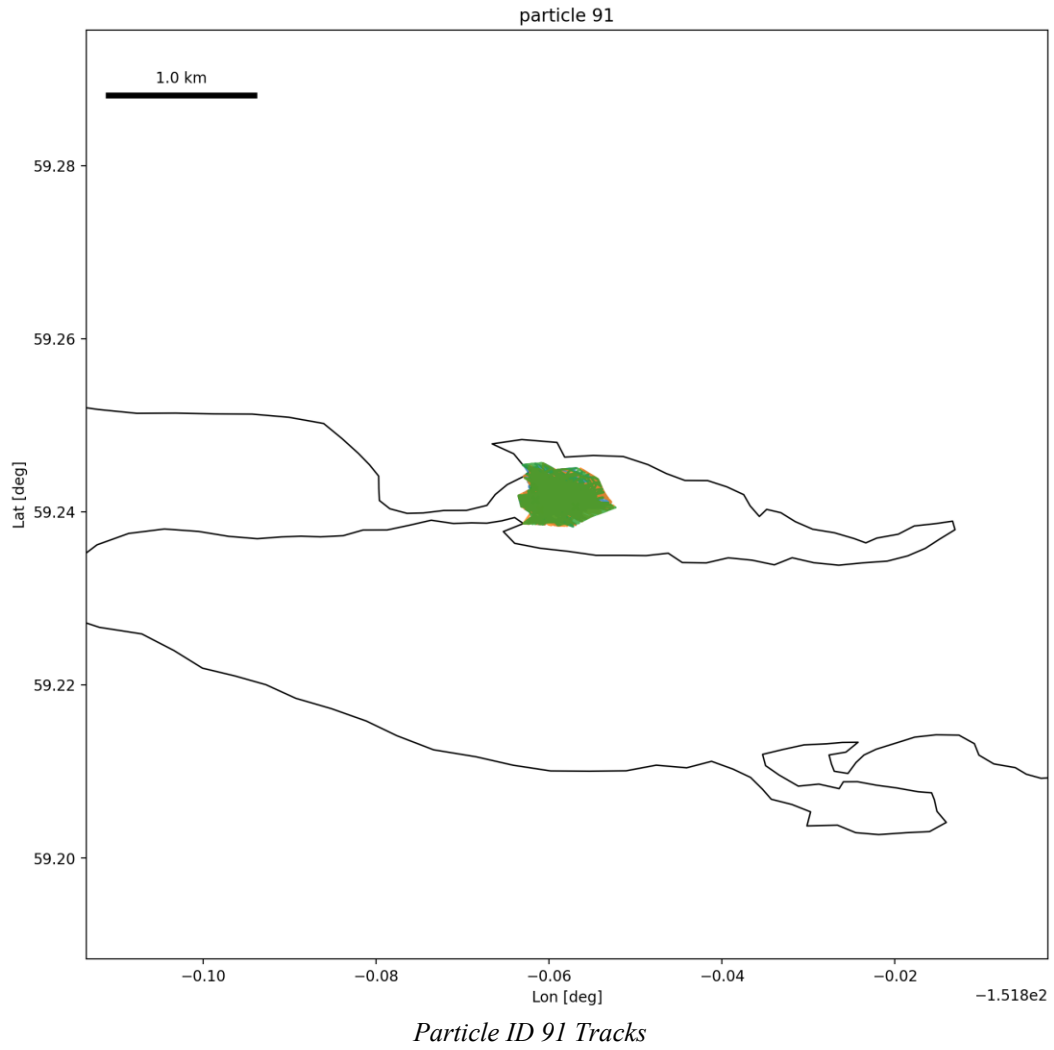
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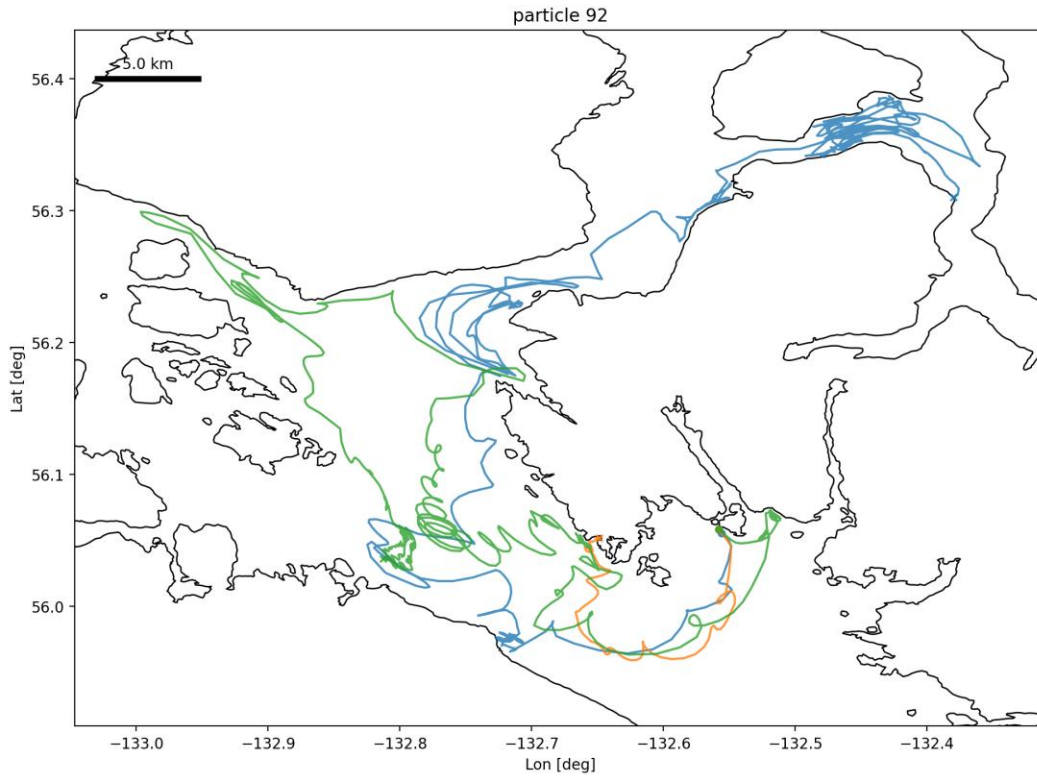


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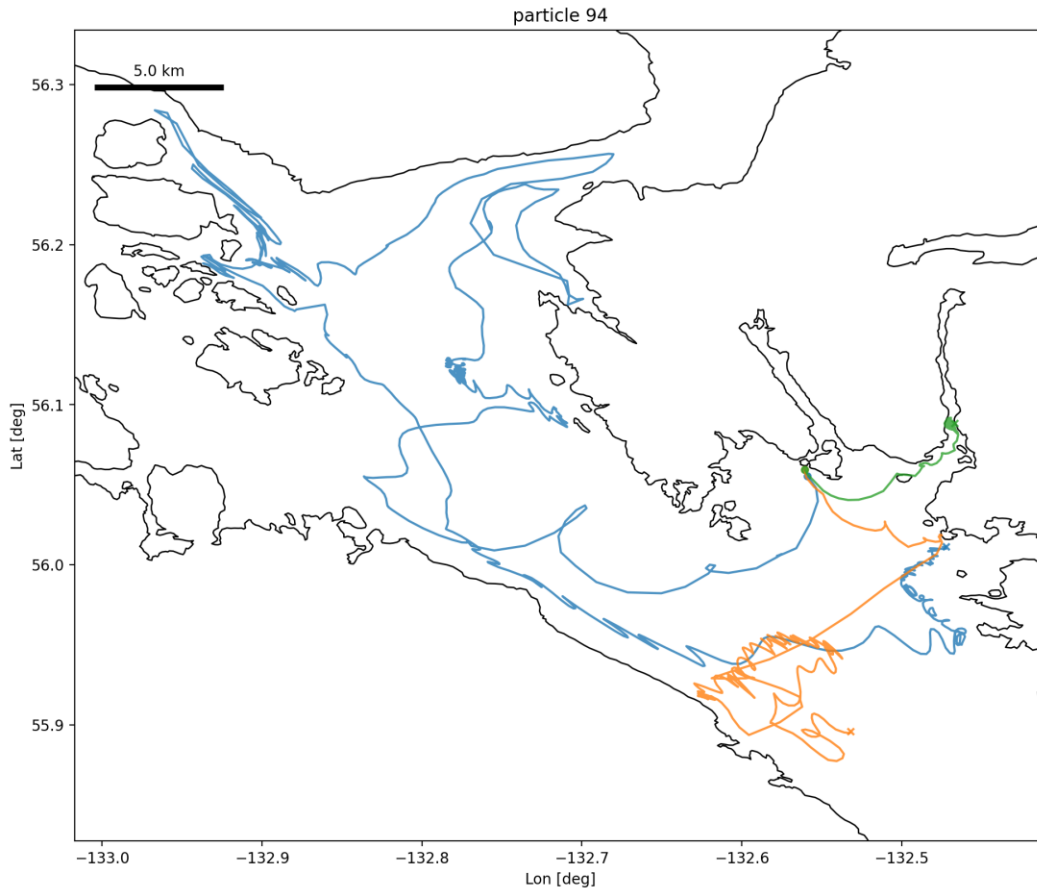


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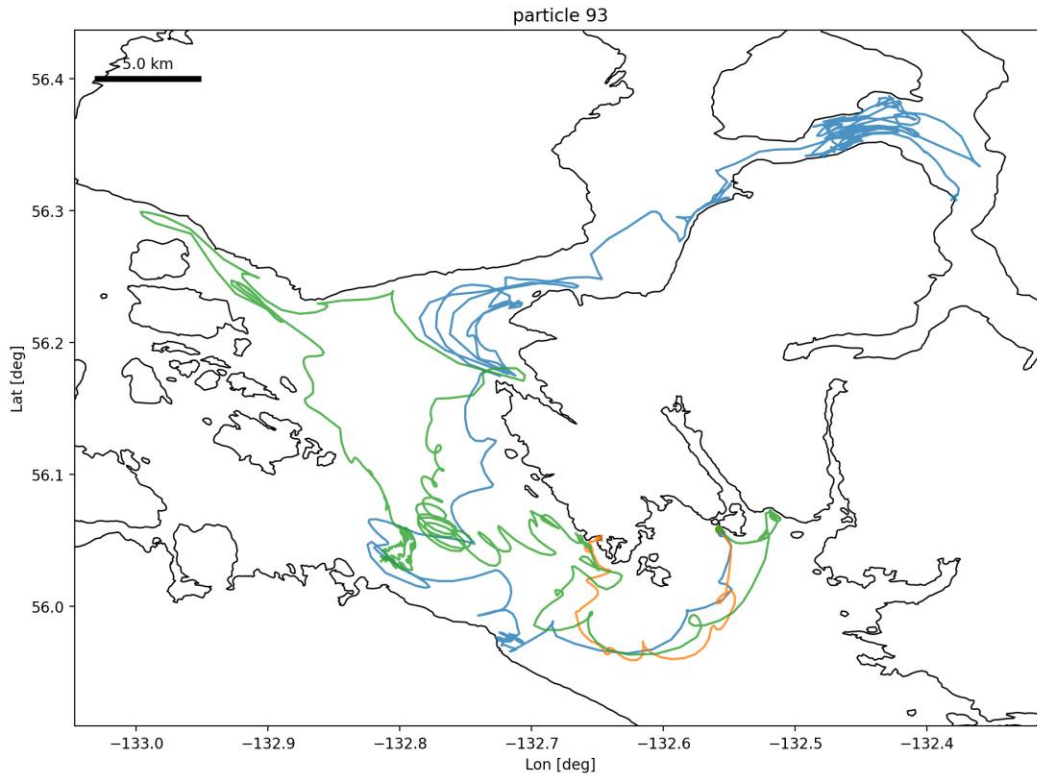
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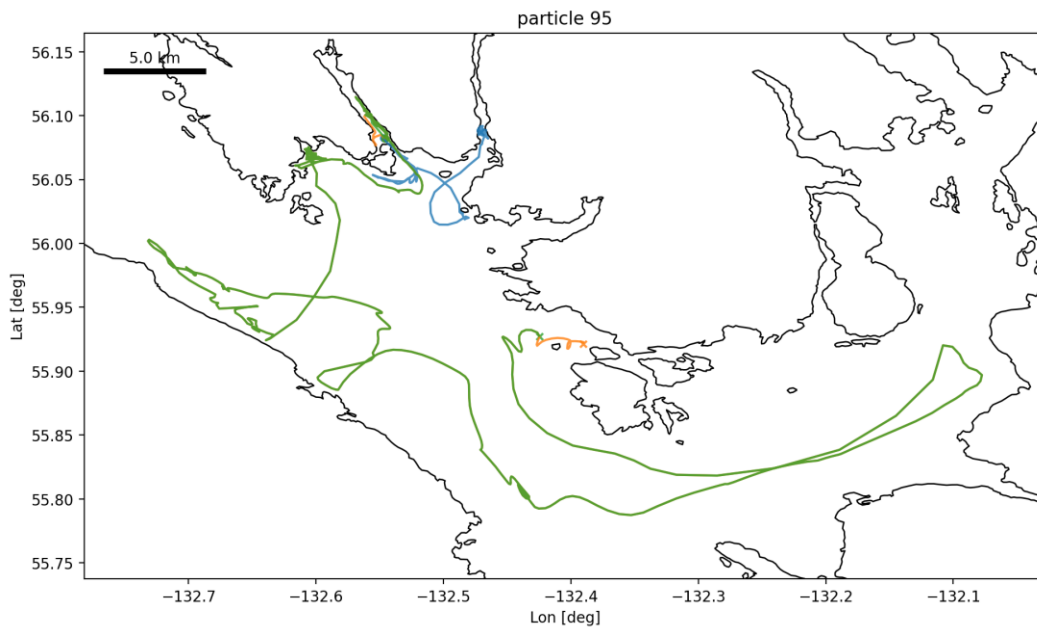


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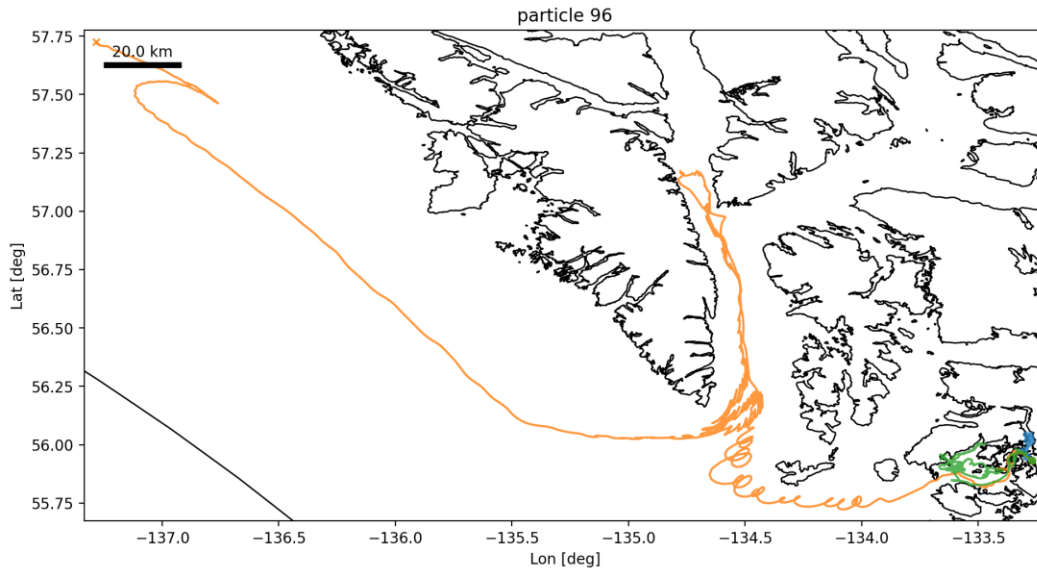


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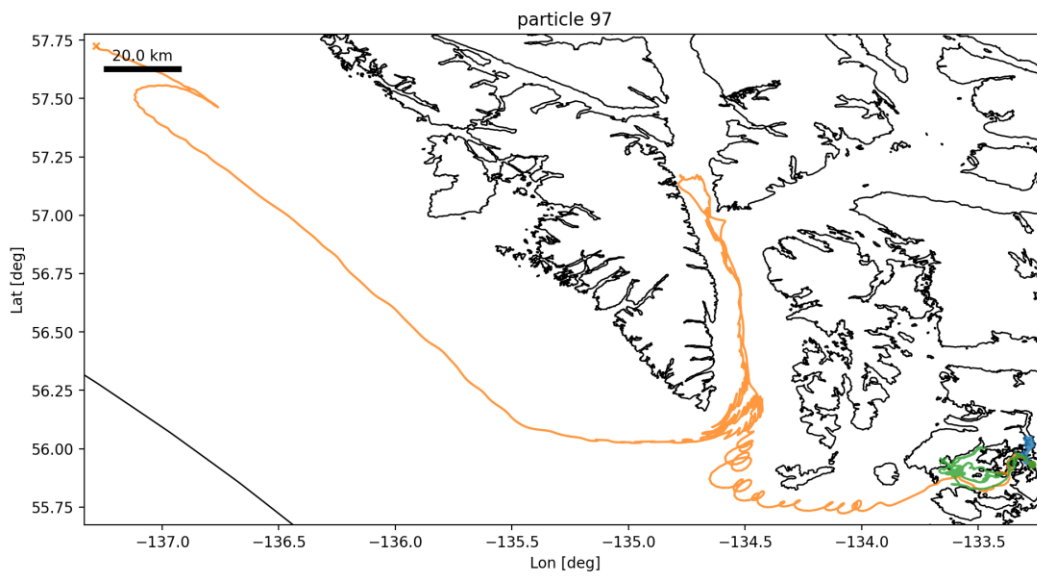


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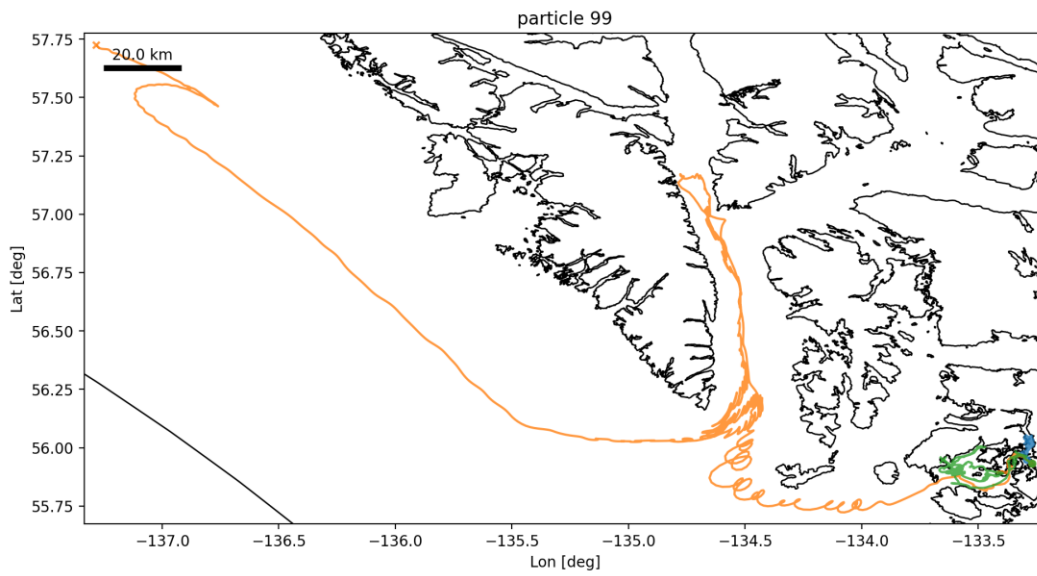


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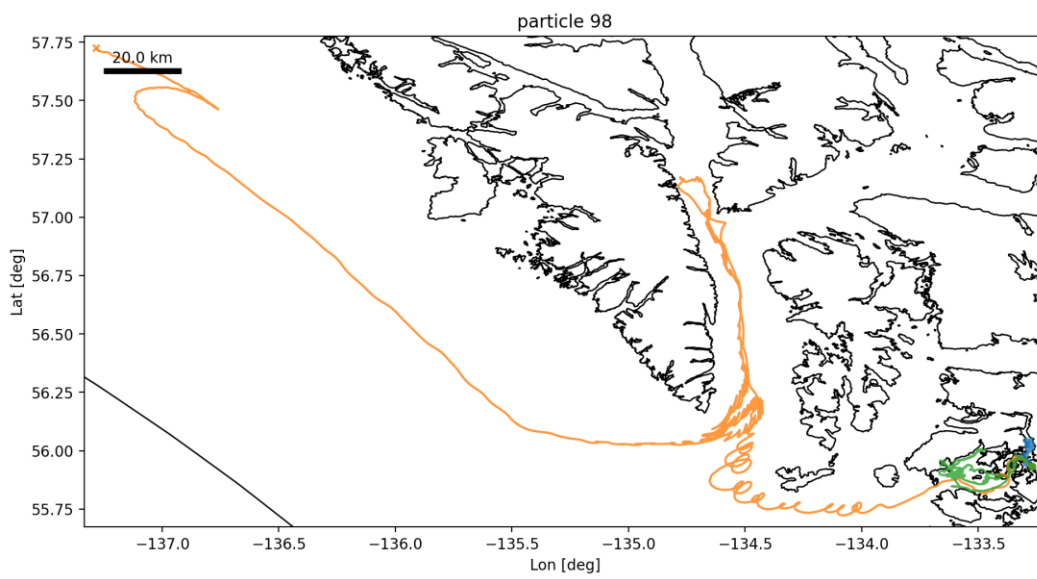


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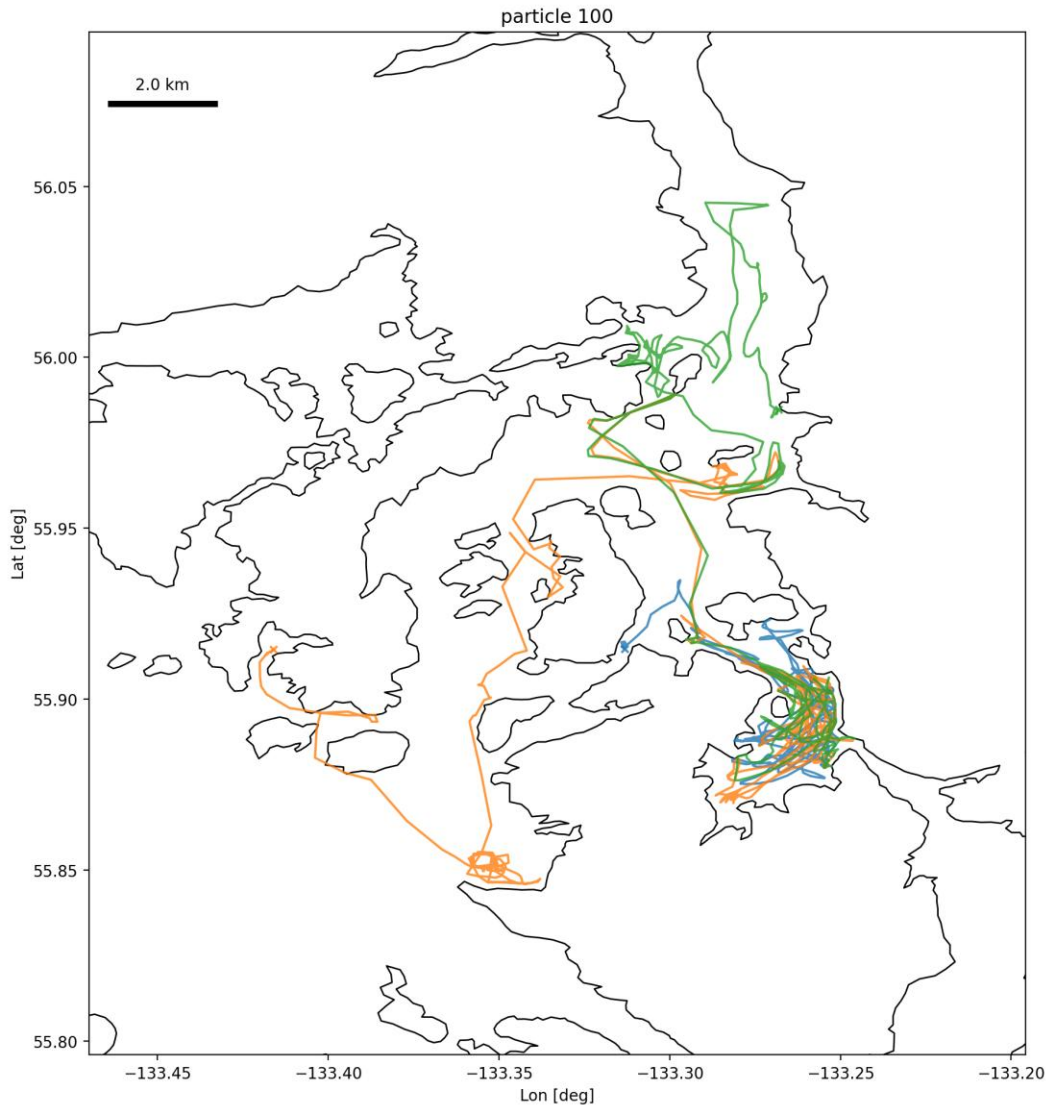


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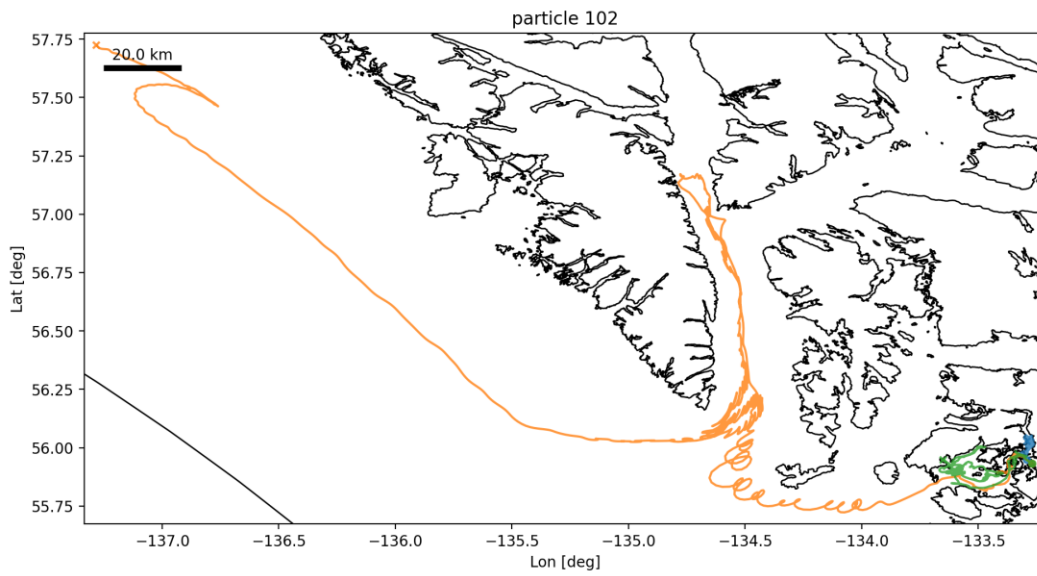
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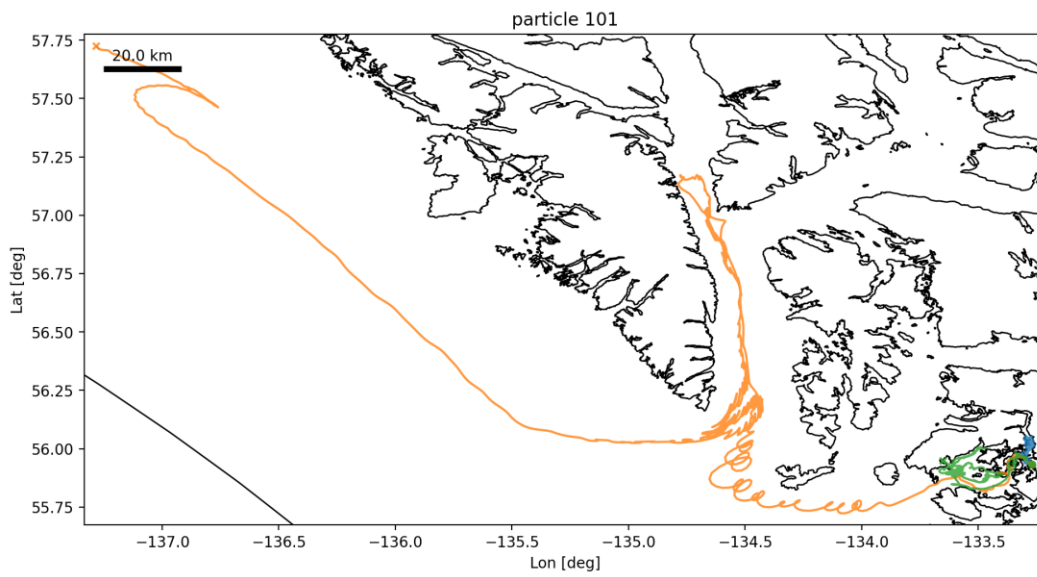


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Kelson Marine Co. | Quantification of the Fate of Sloughed Alaskan Seaweed Biomass: Quarter 1 2026 Progress Update Report

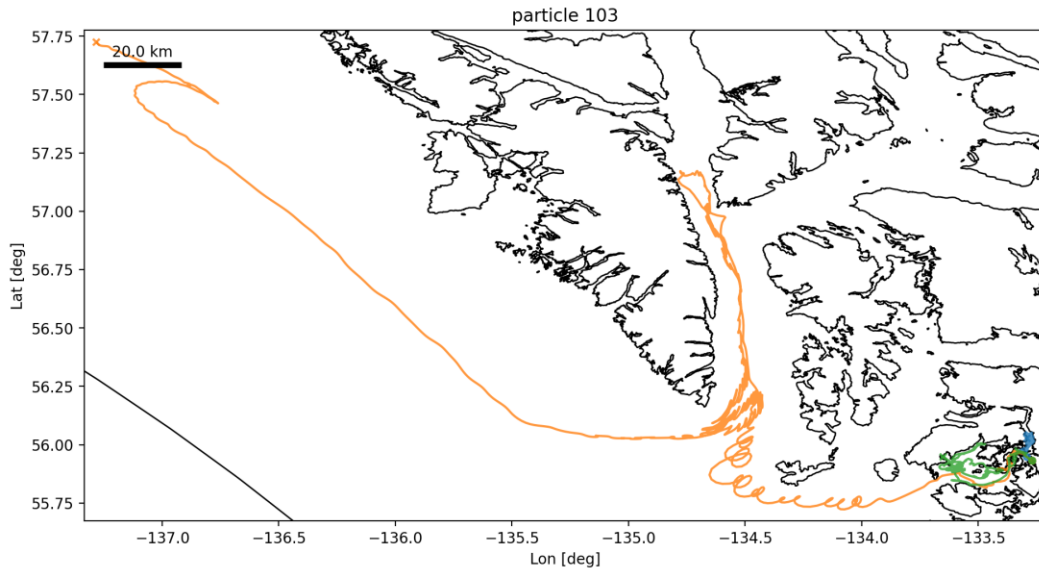


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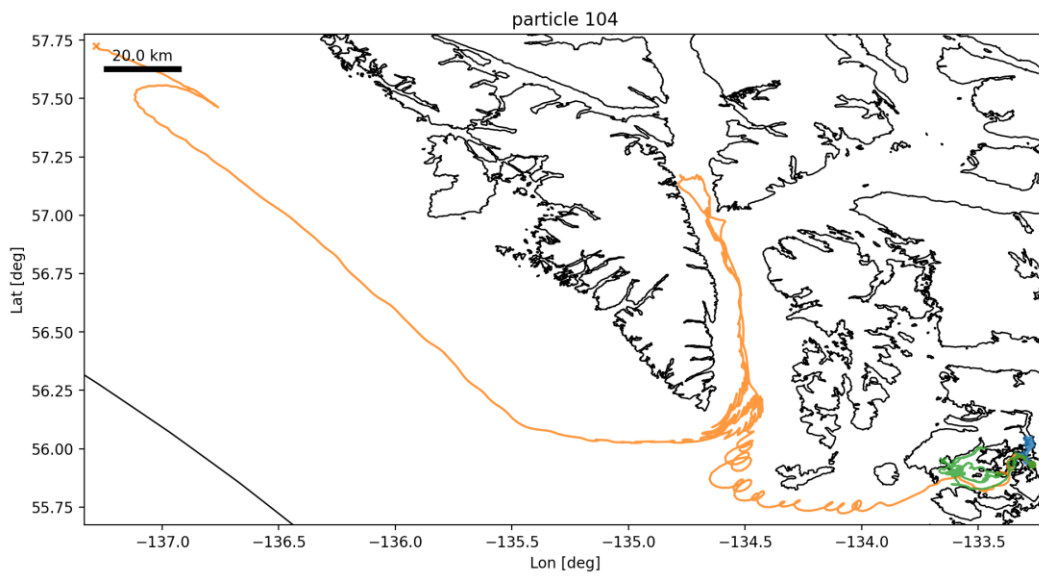


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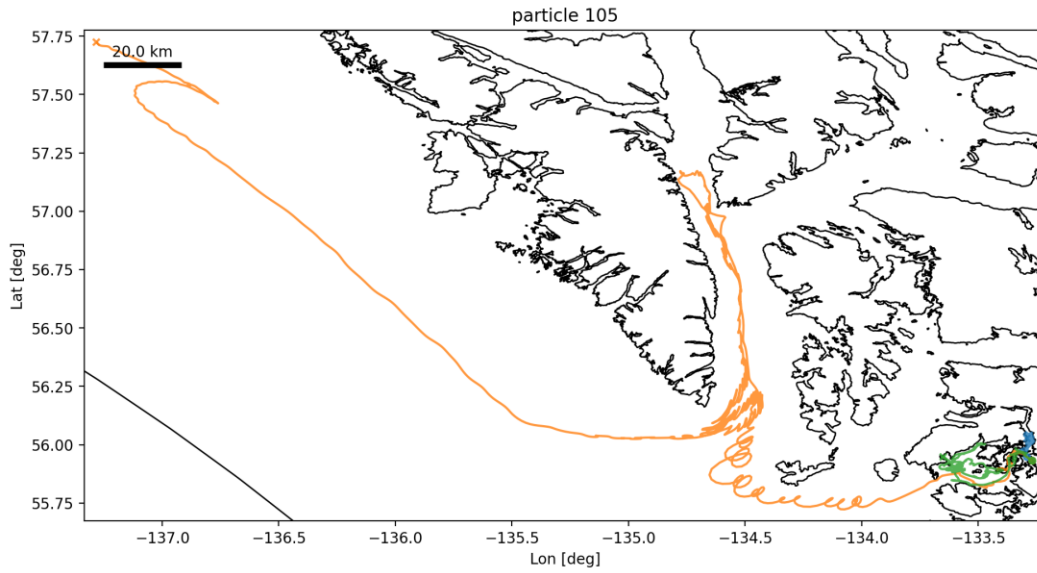


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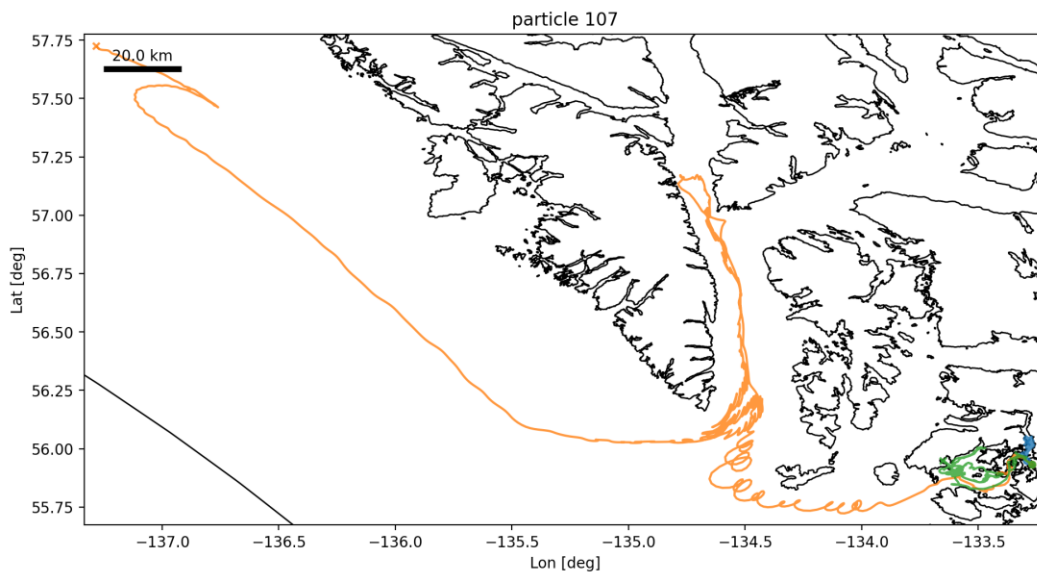


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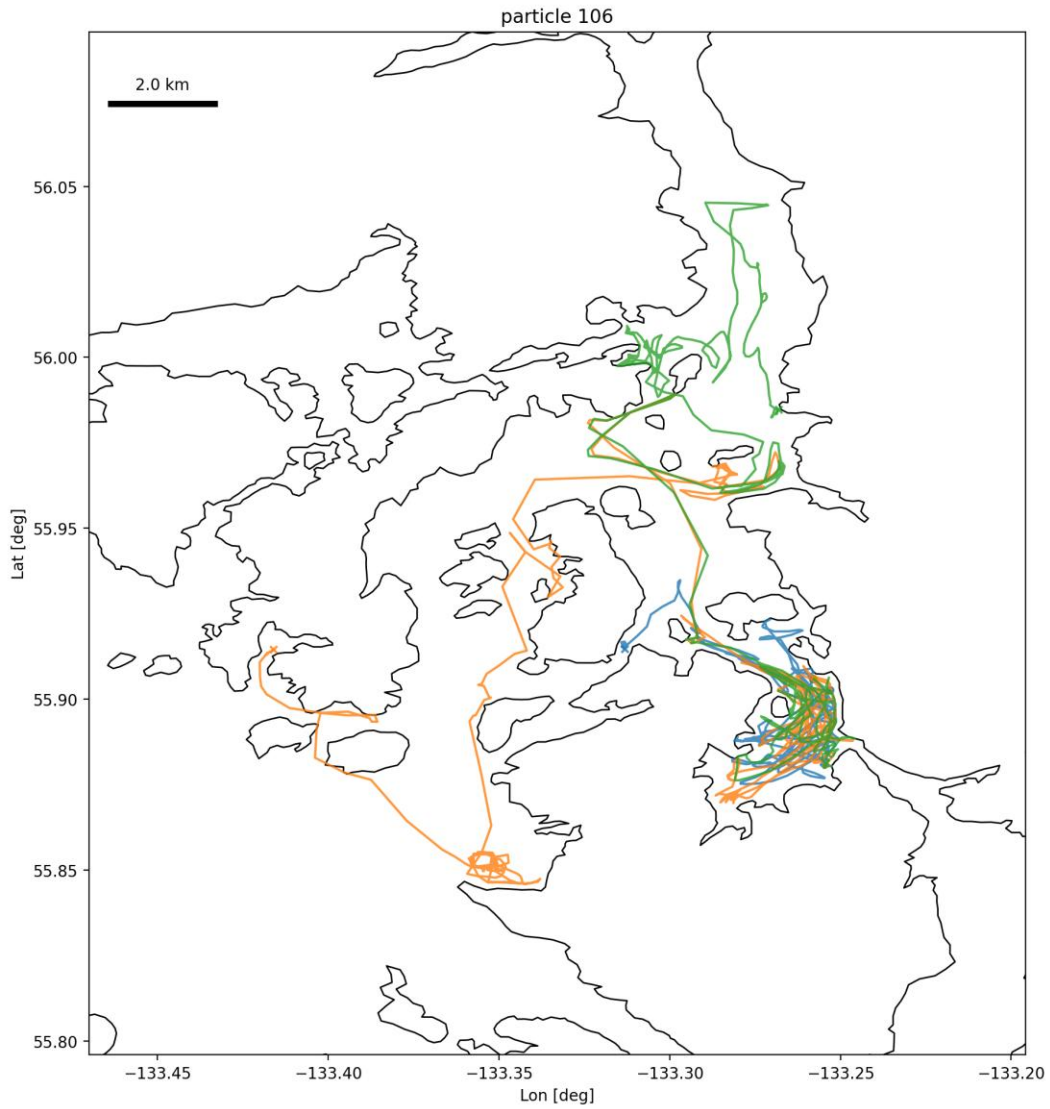


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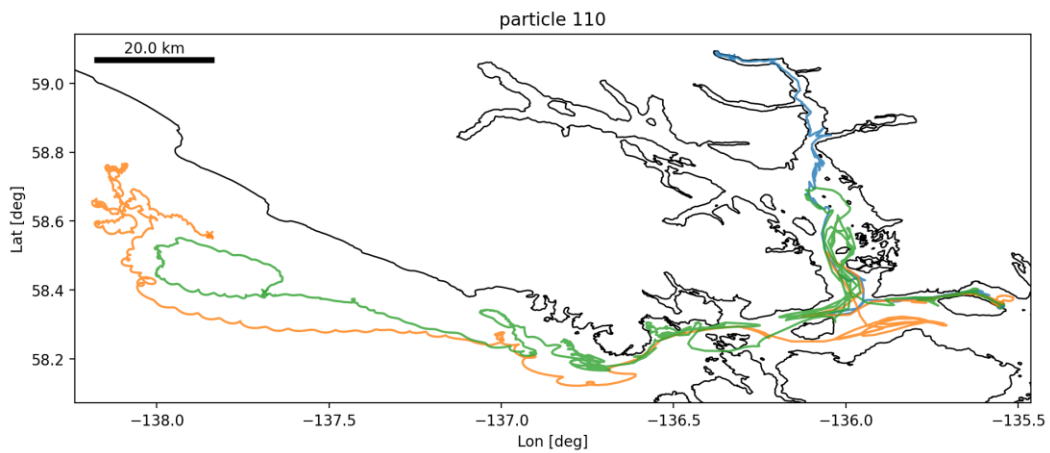


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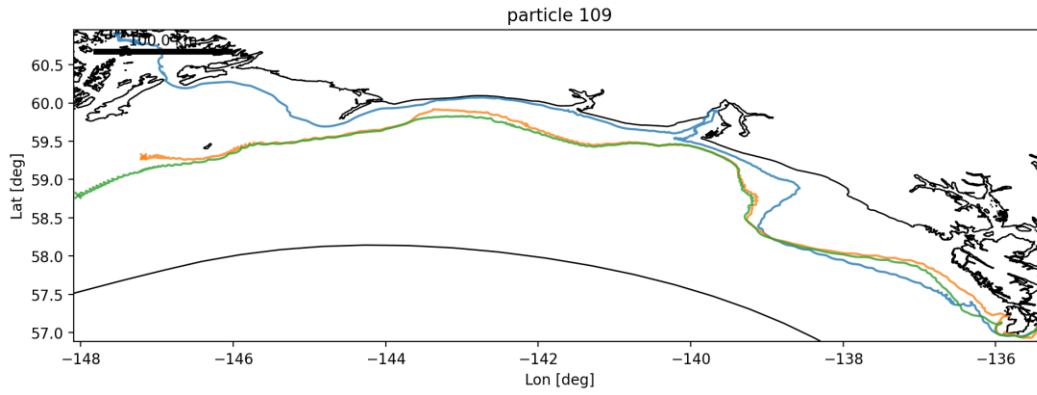


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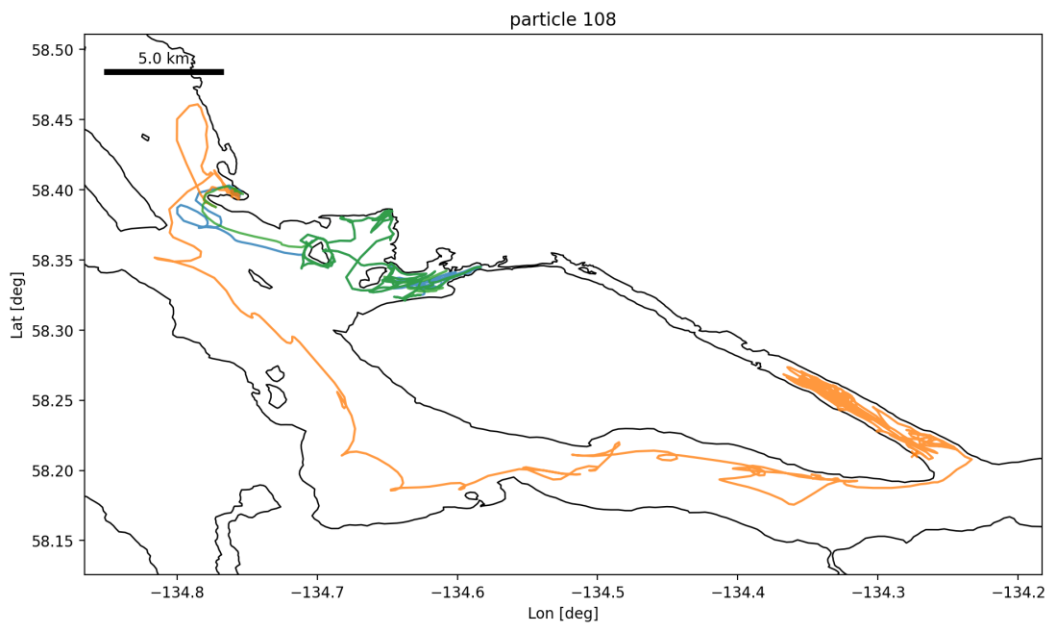


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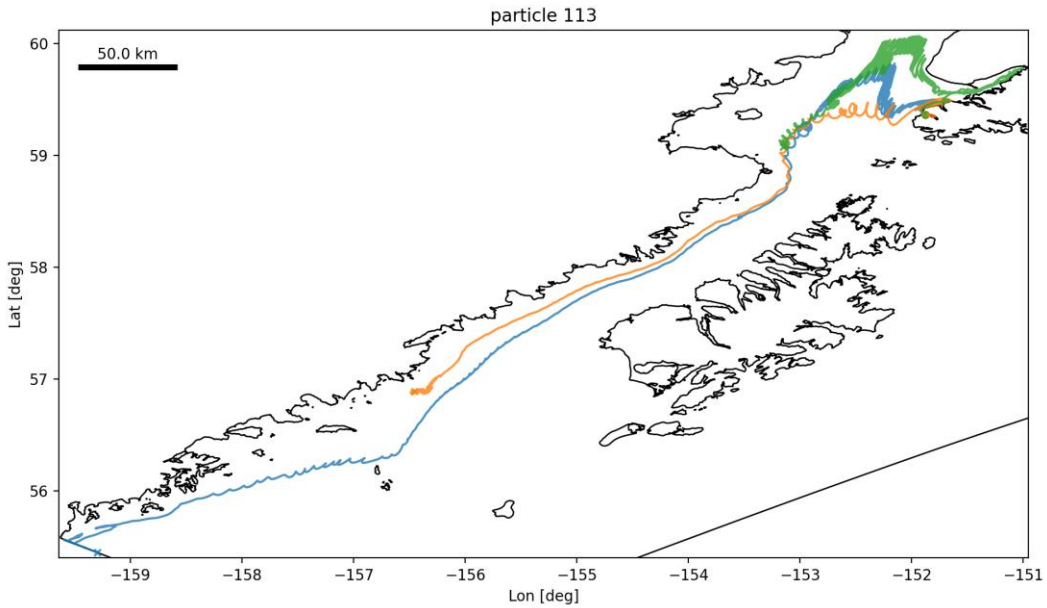


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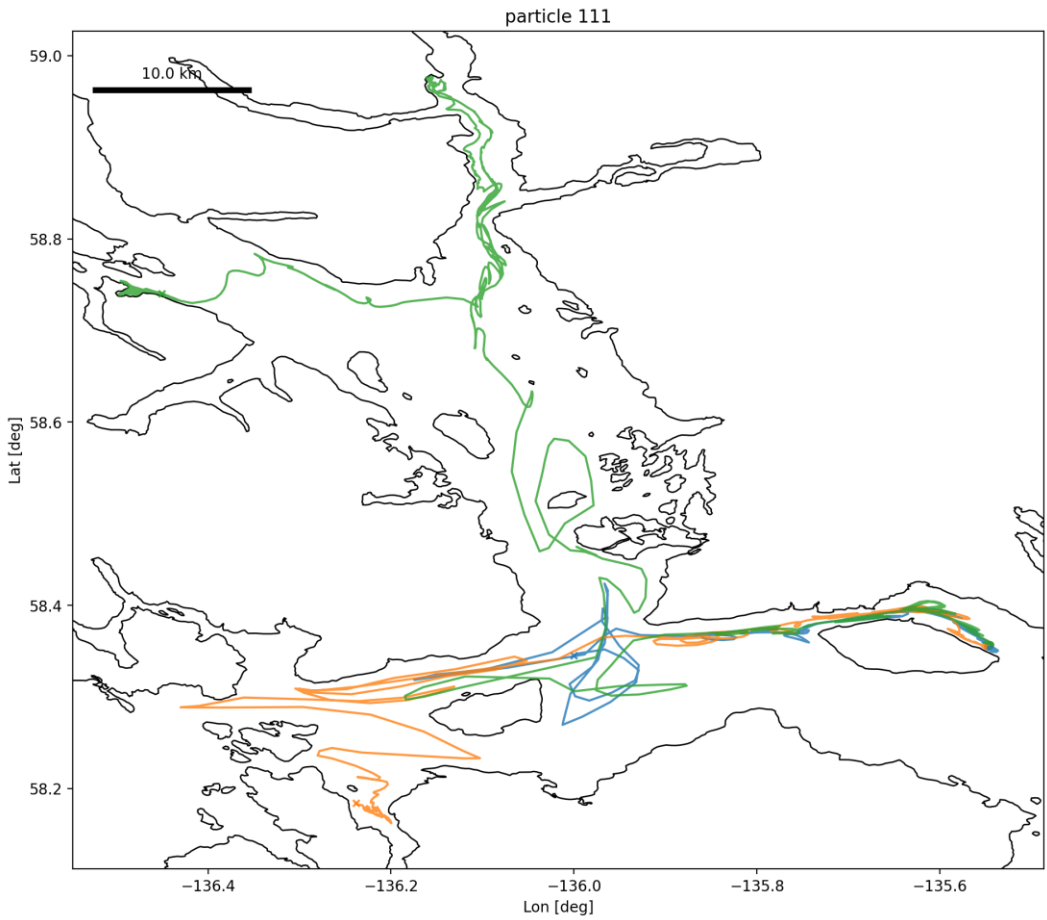


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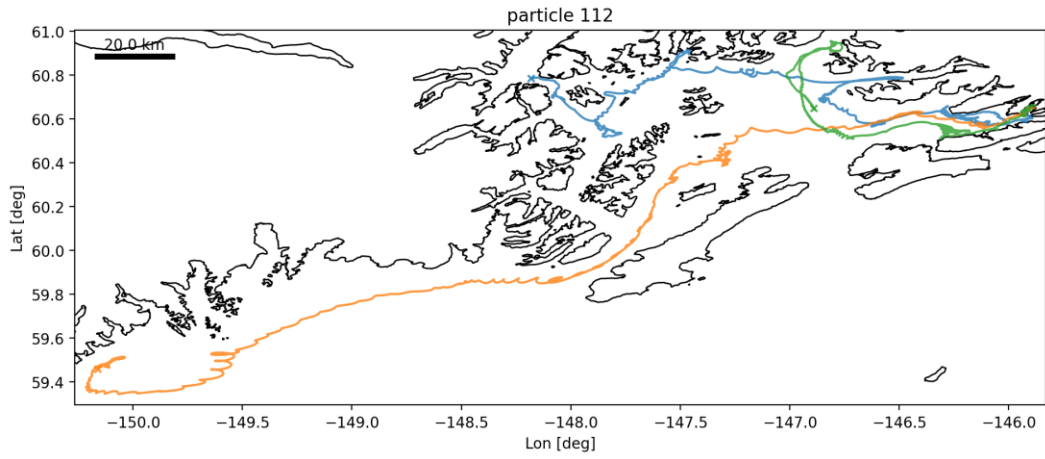


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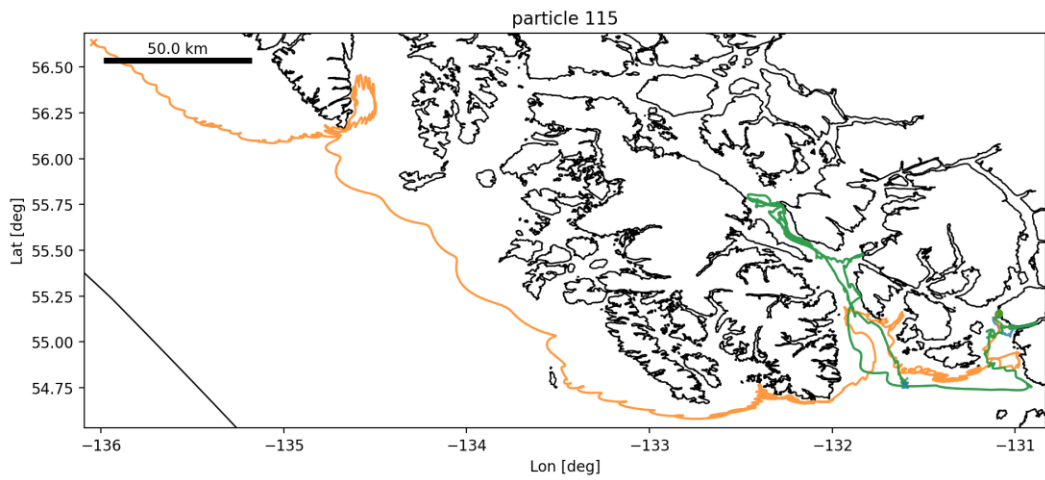


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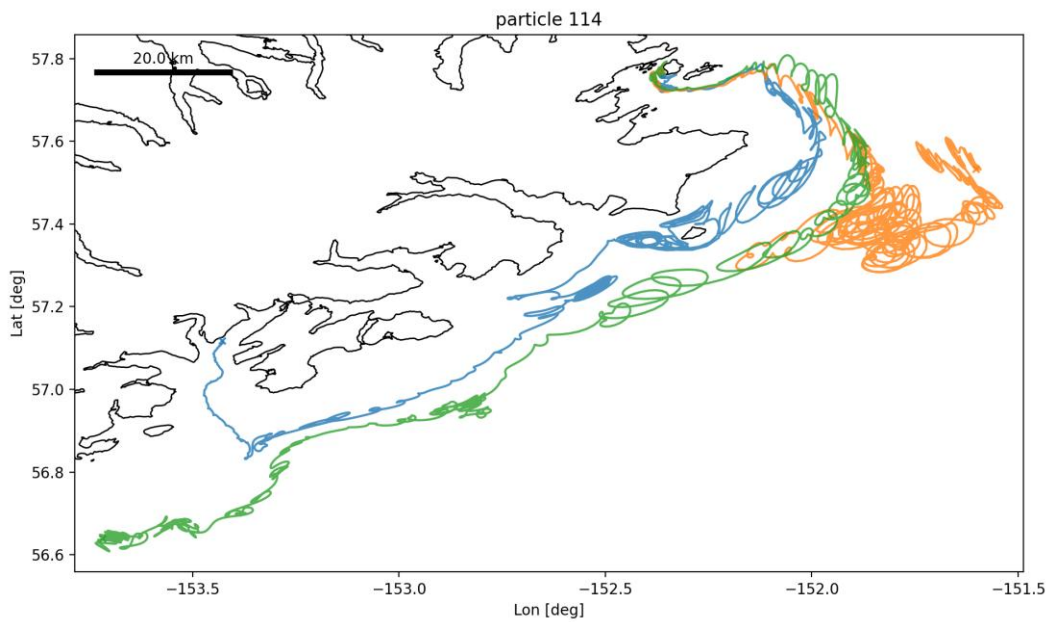
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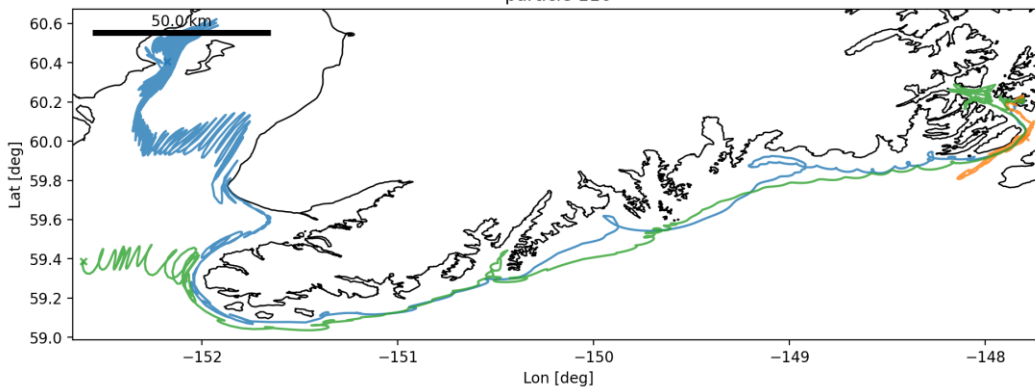
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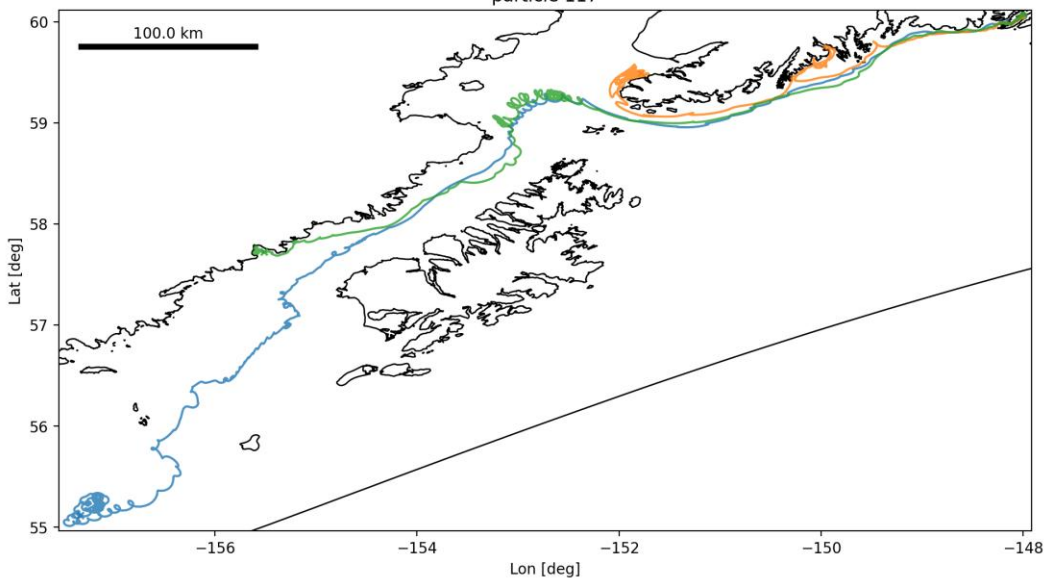
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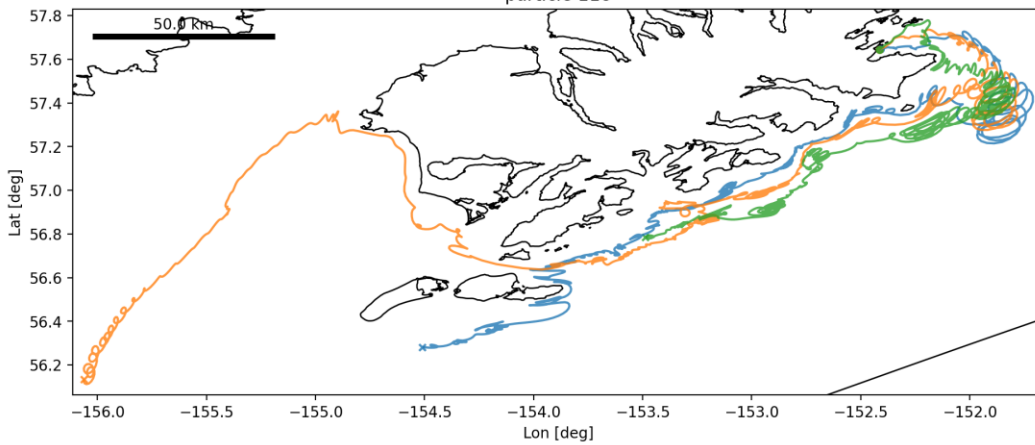
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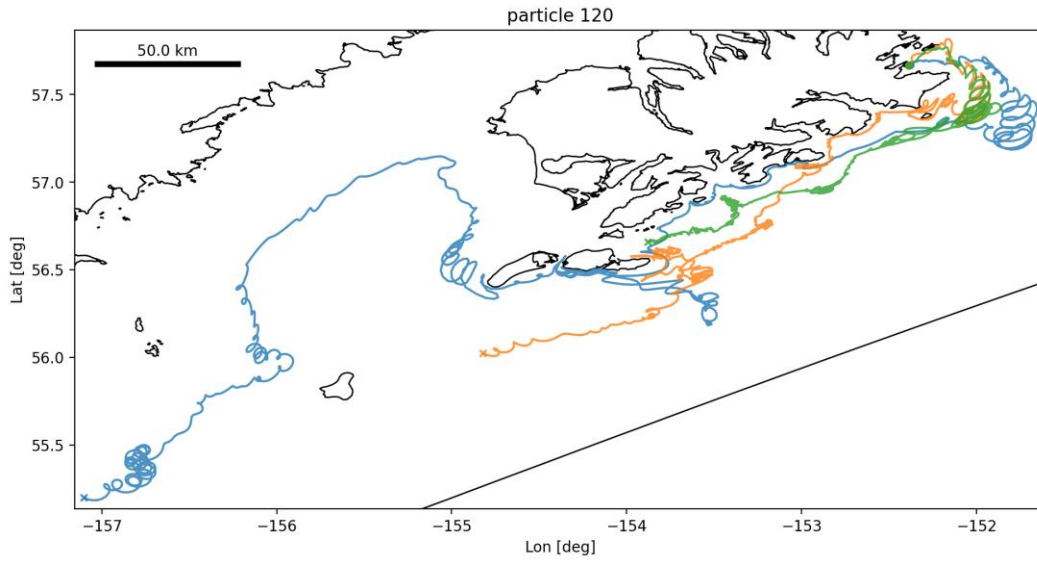
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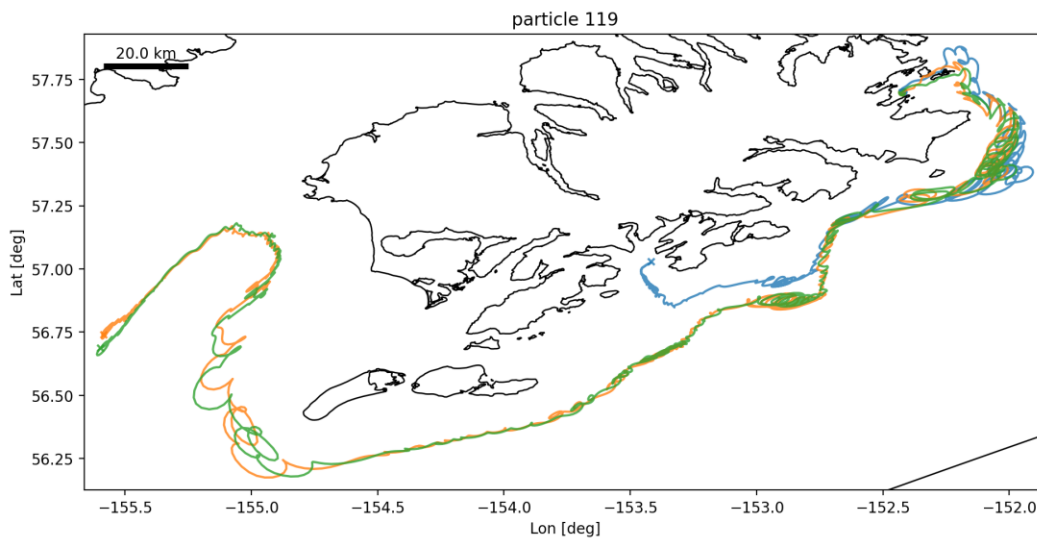


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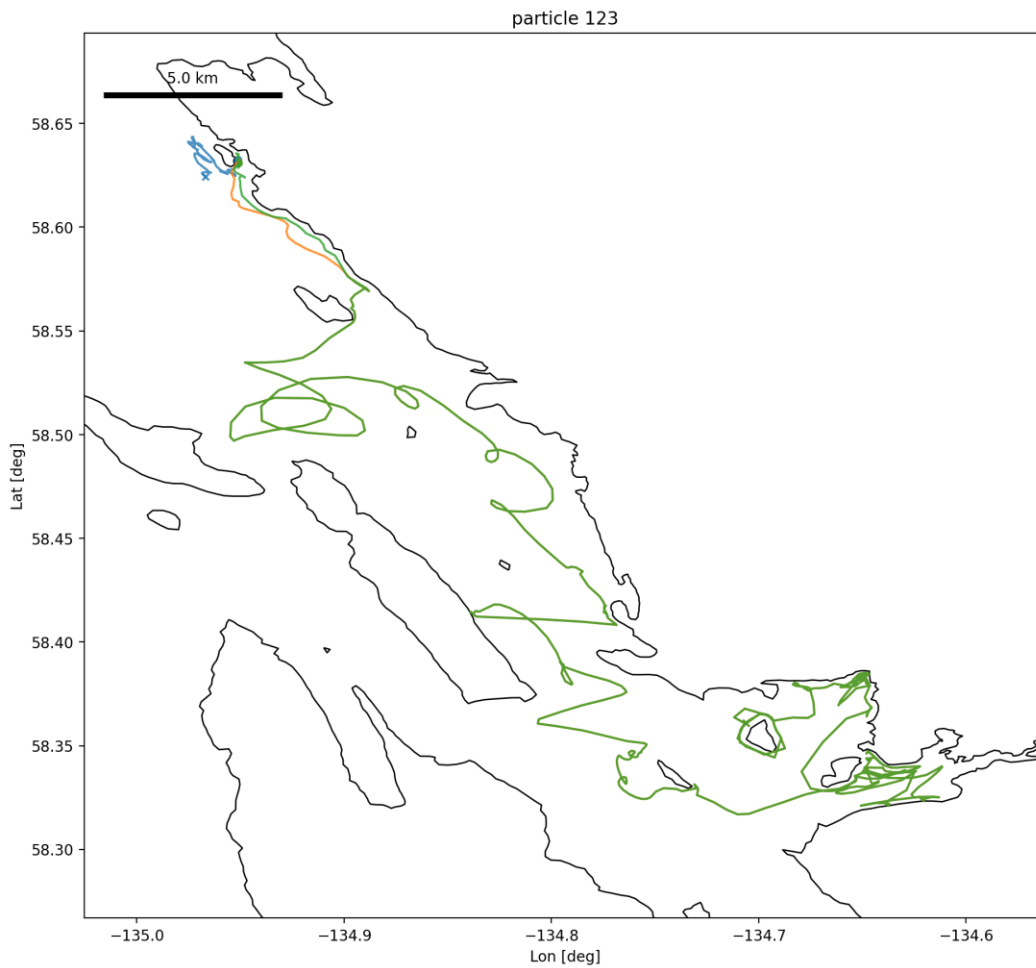


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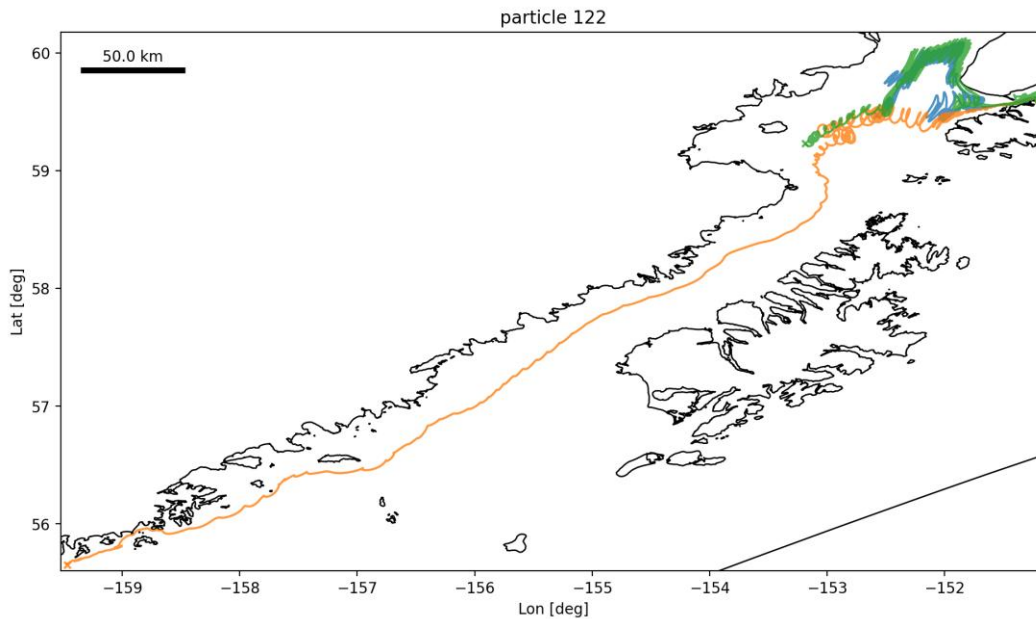


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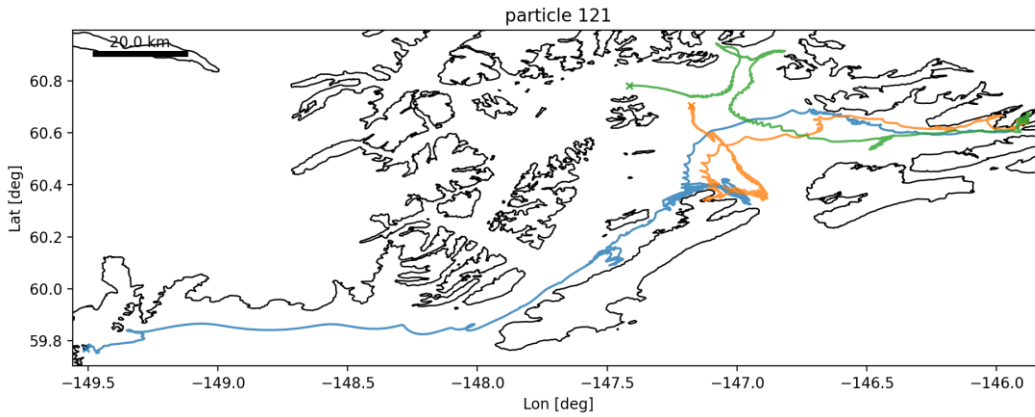


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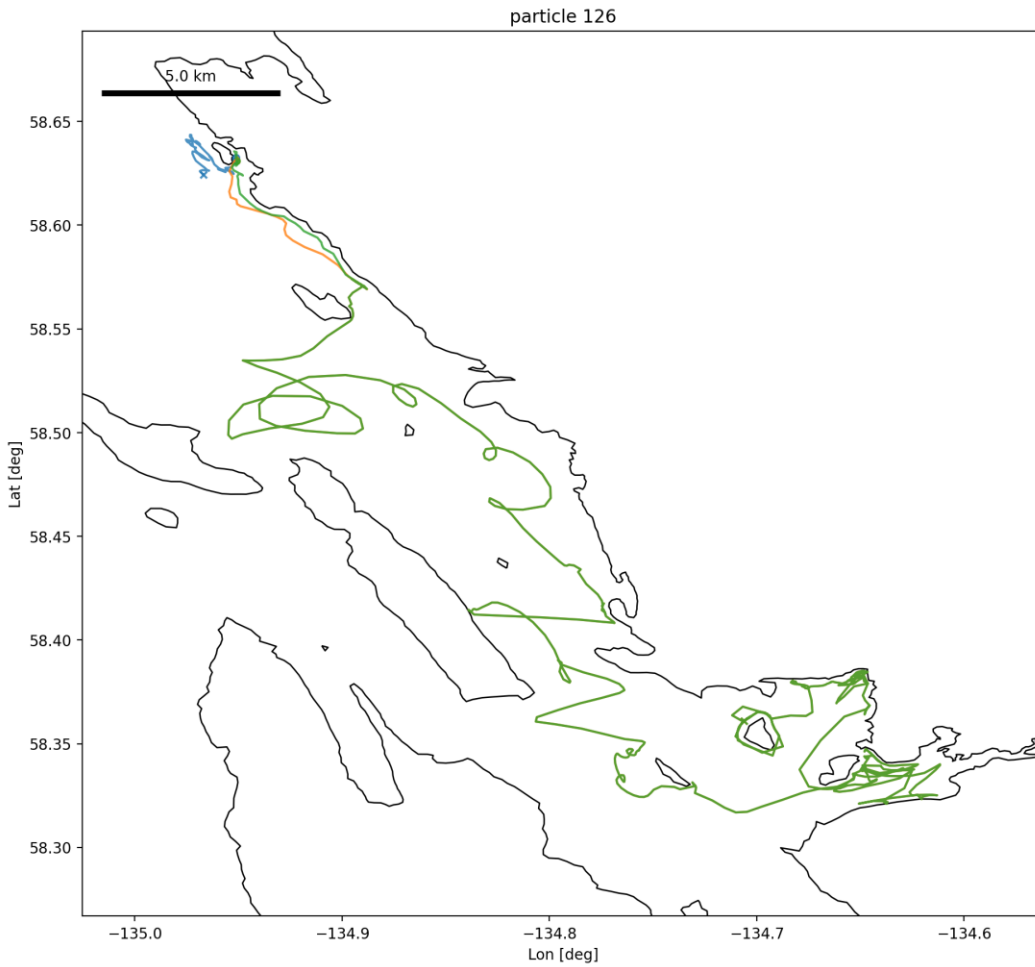


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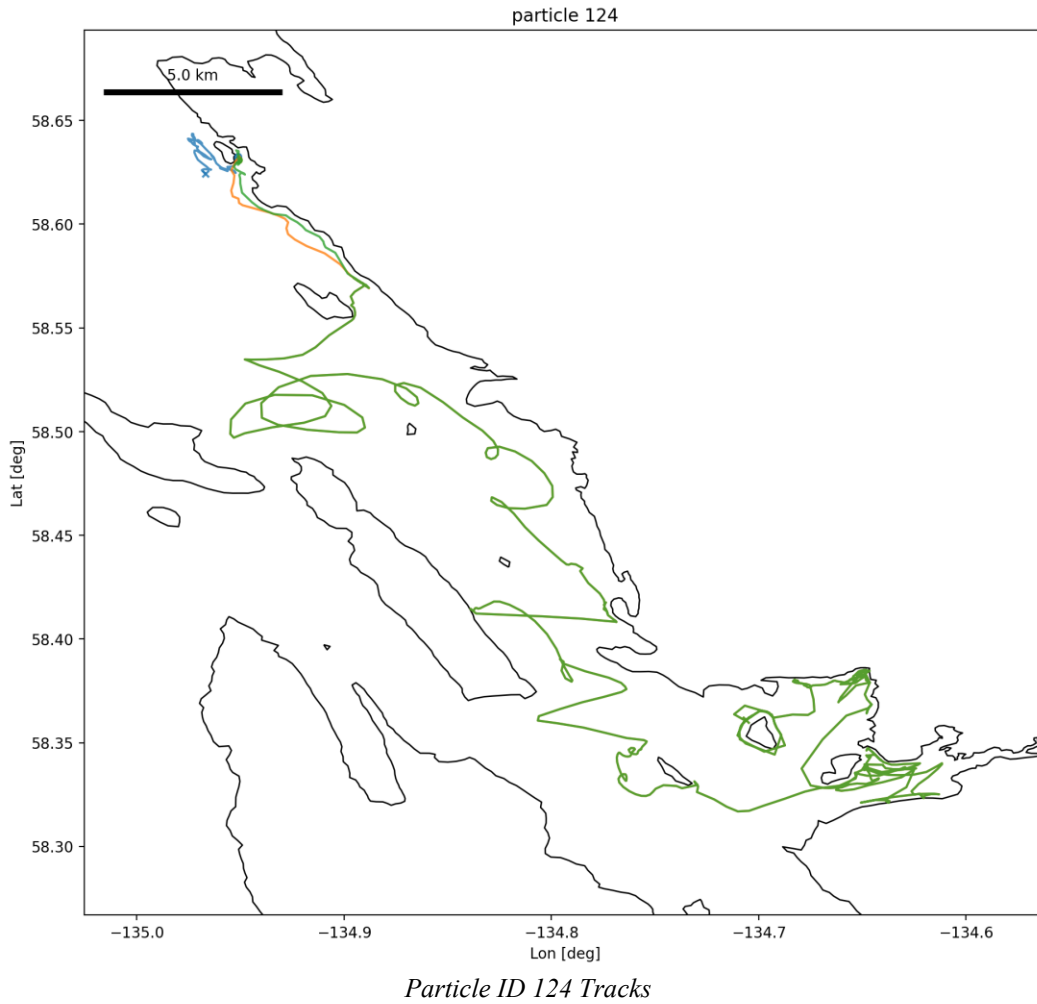


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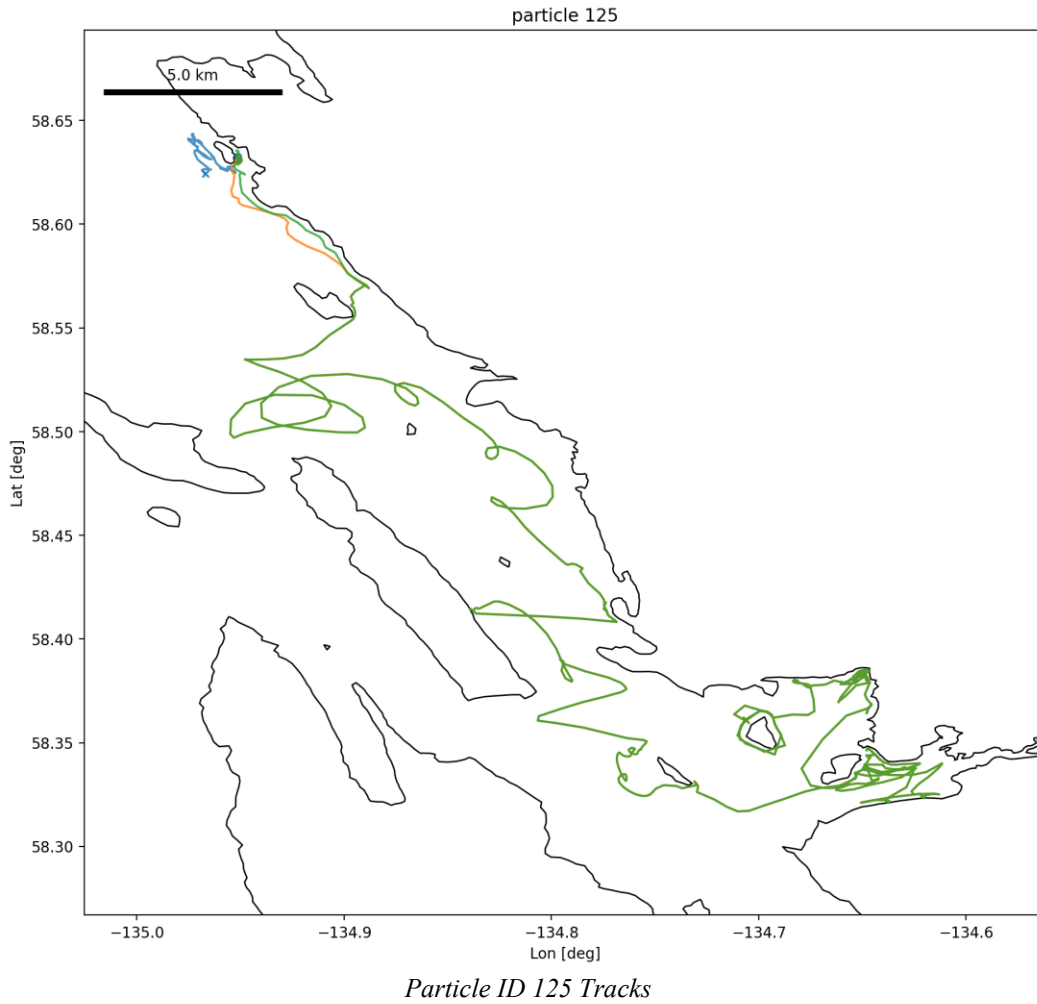


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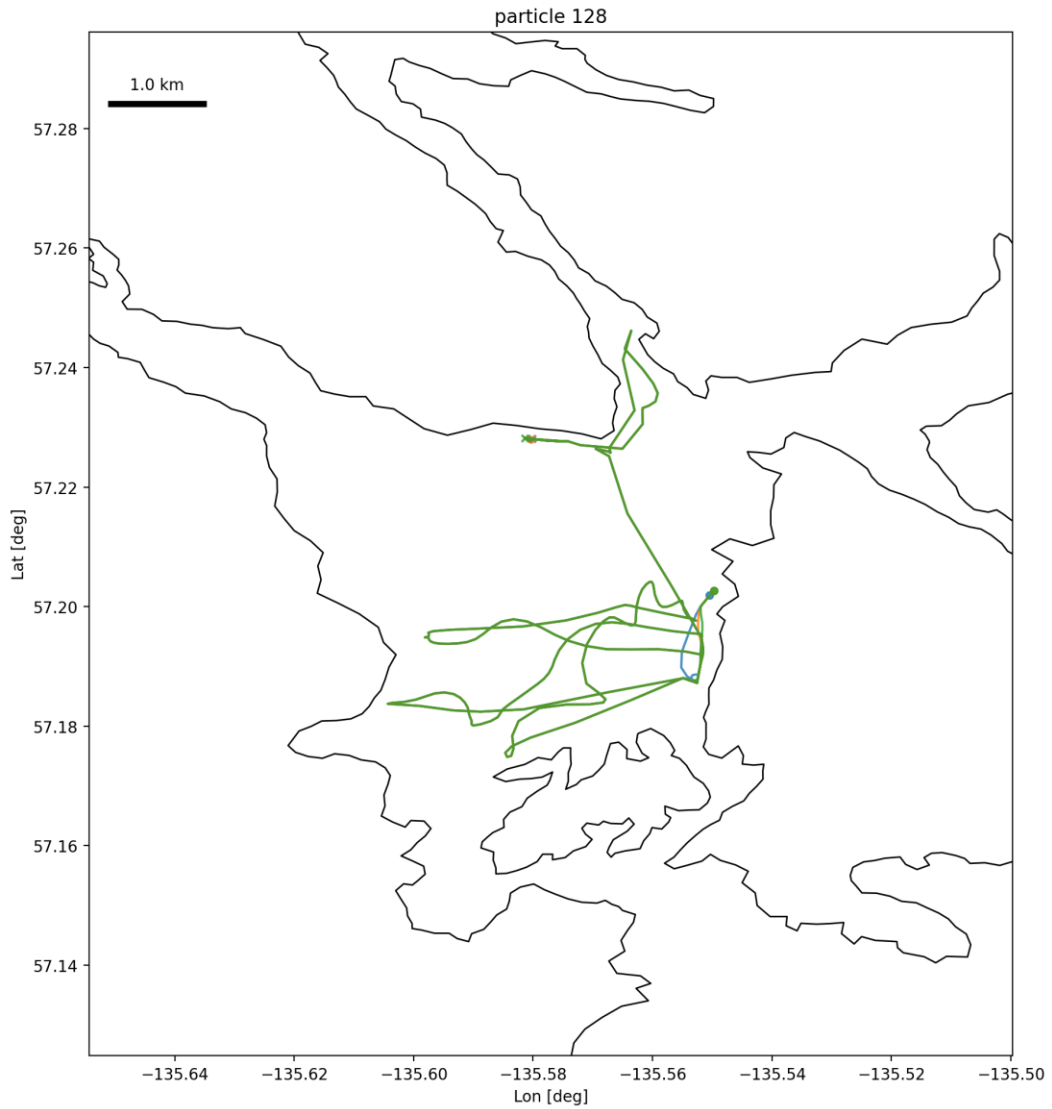
Kelson Marine Co. | Quantification of the Fate of Sloughed Alaskan Seaweed Biomass: Quarter 1 2026 Progress Update Report



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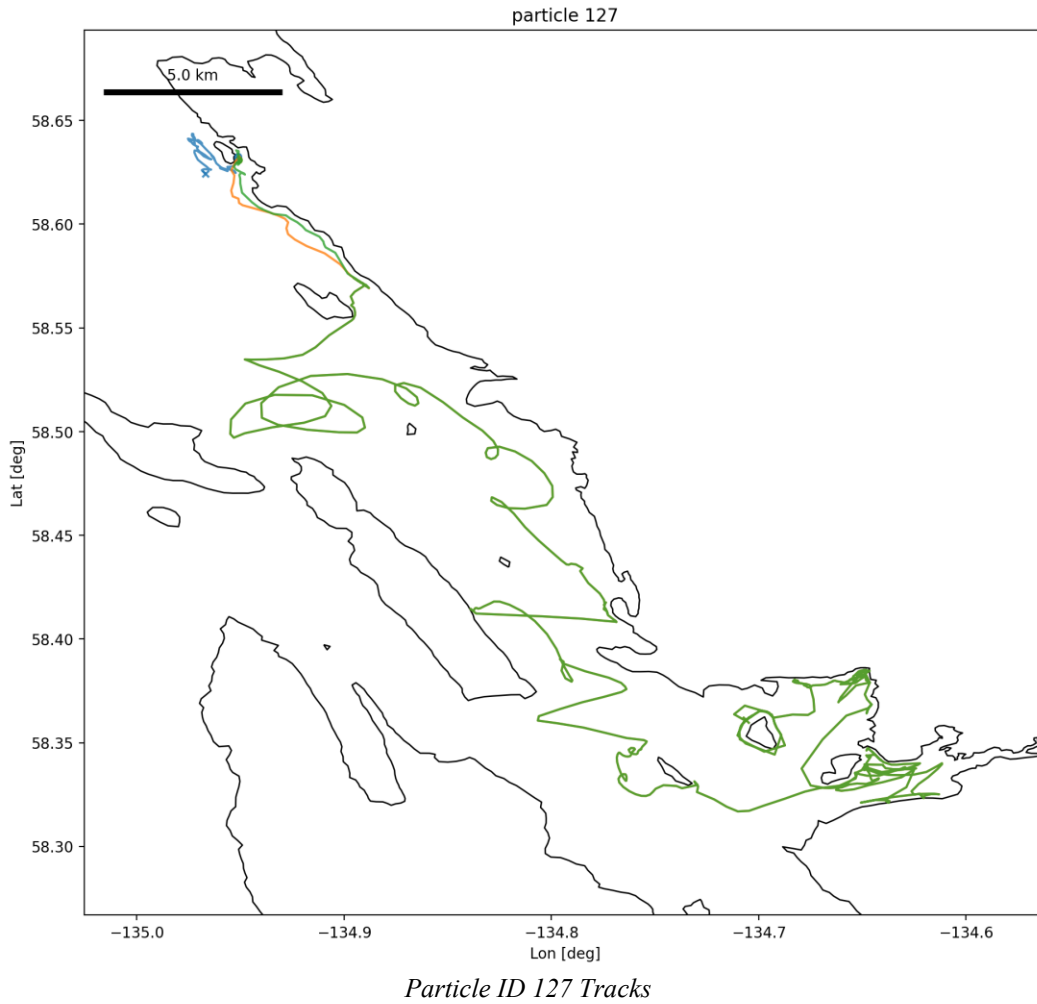


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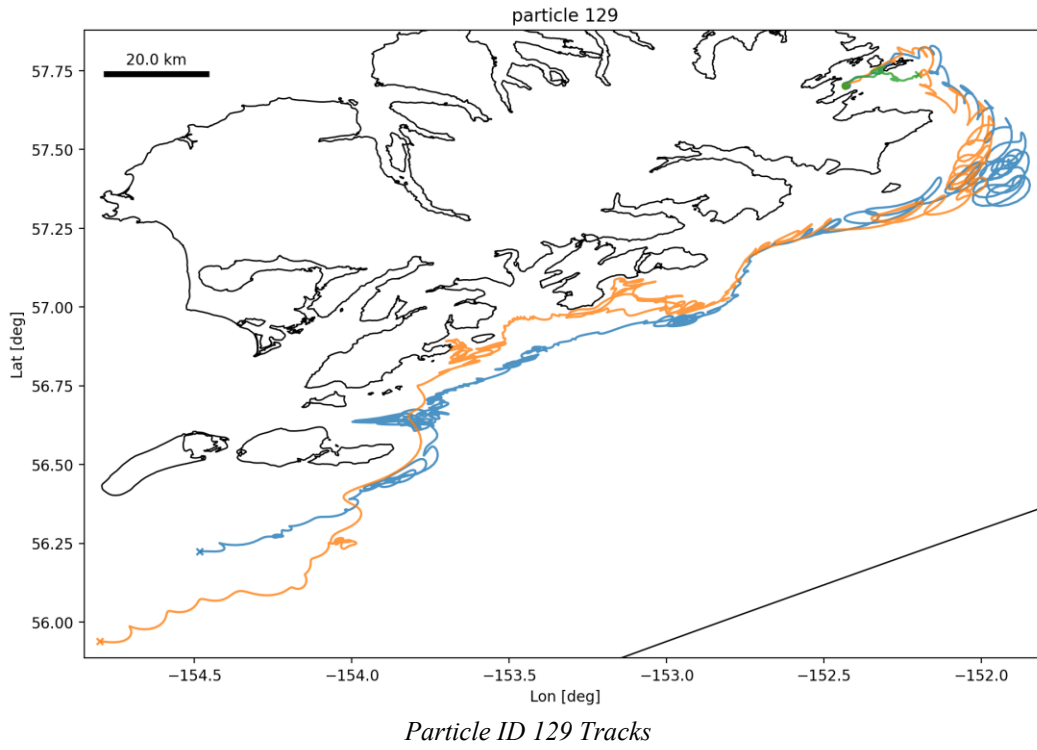


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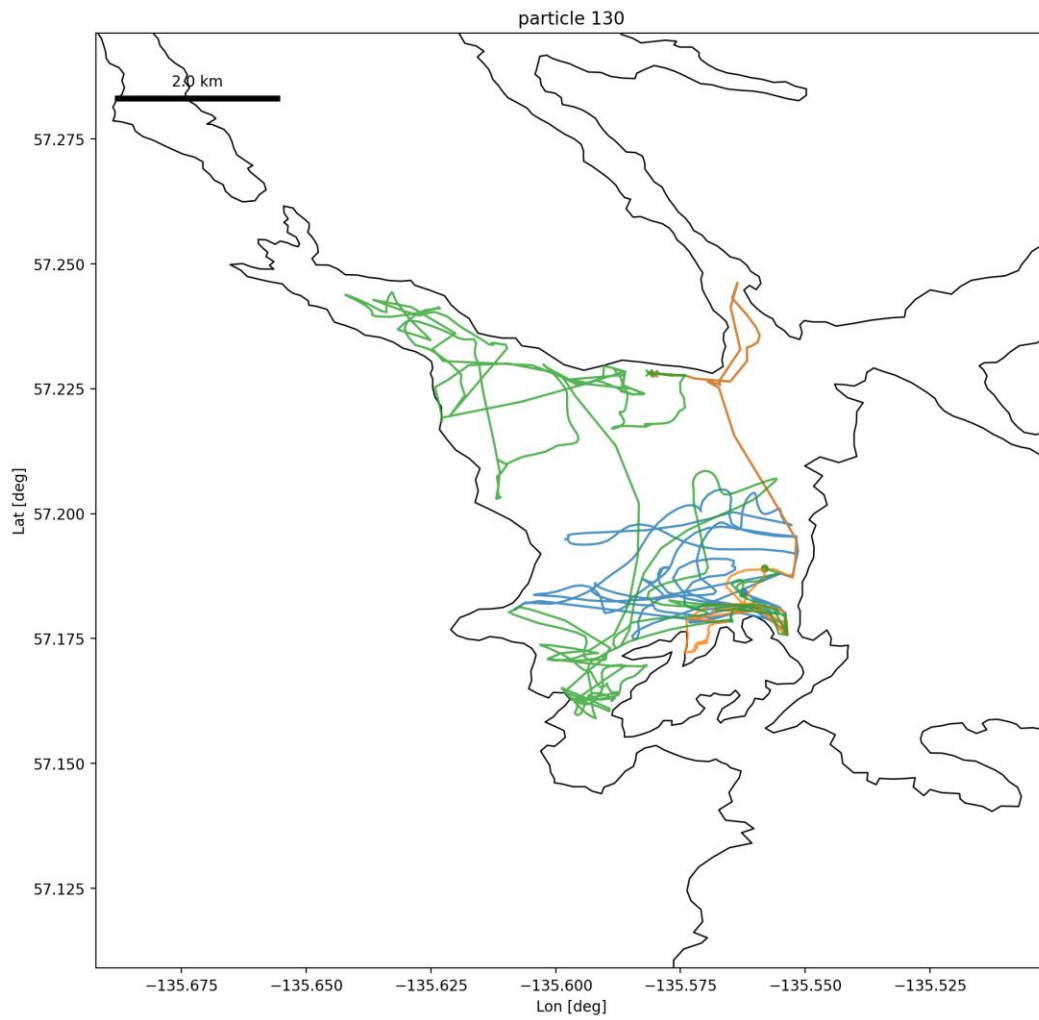
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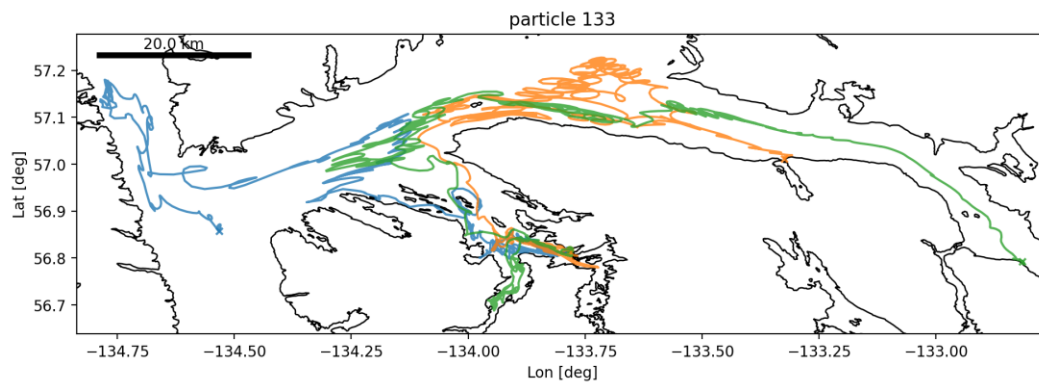
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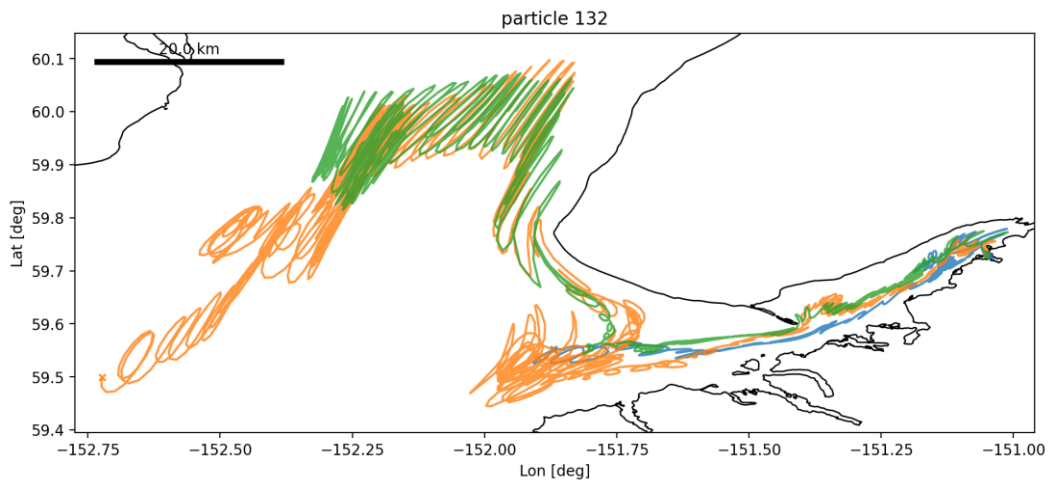


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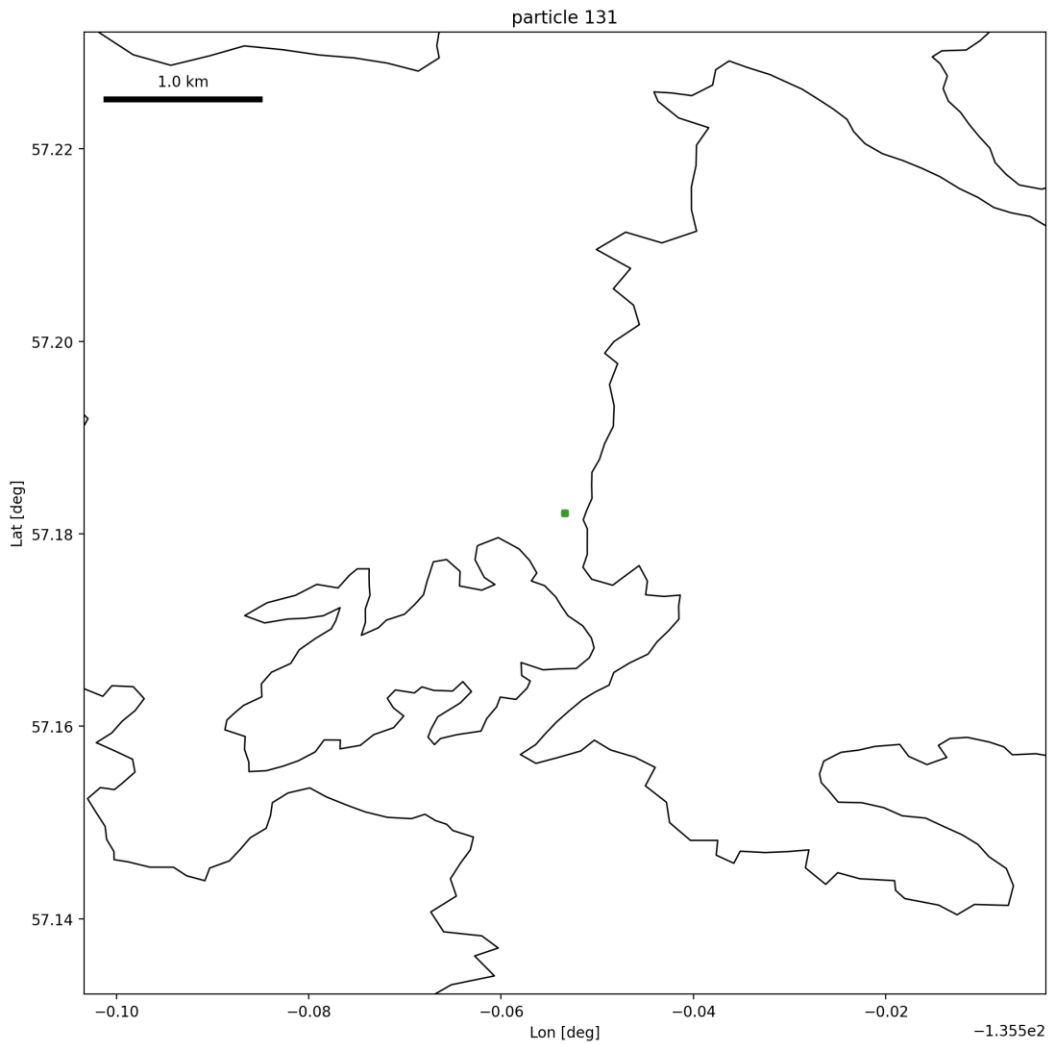


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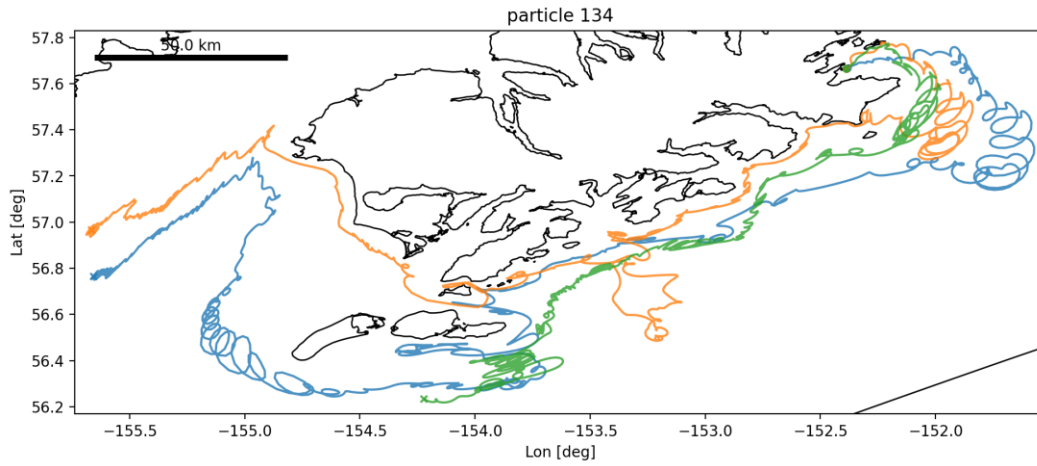


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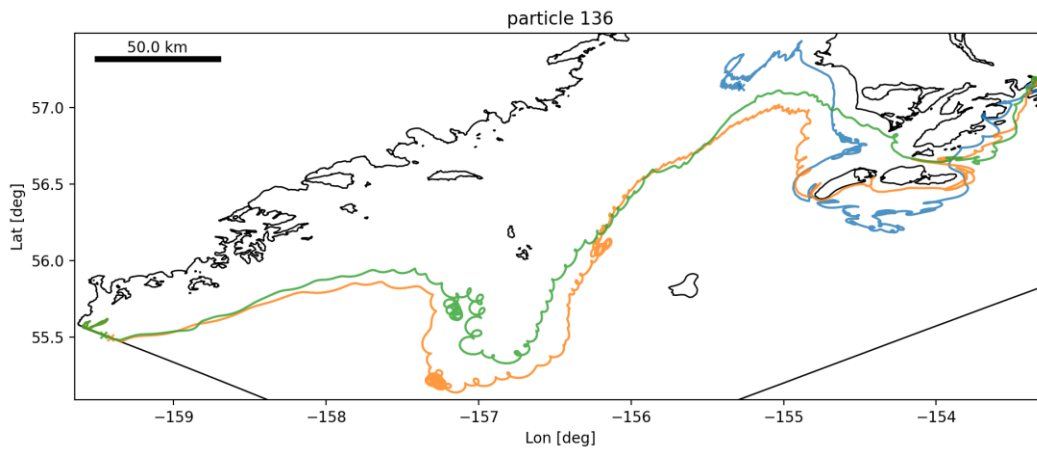


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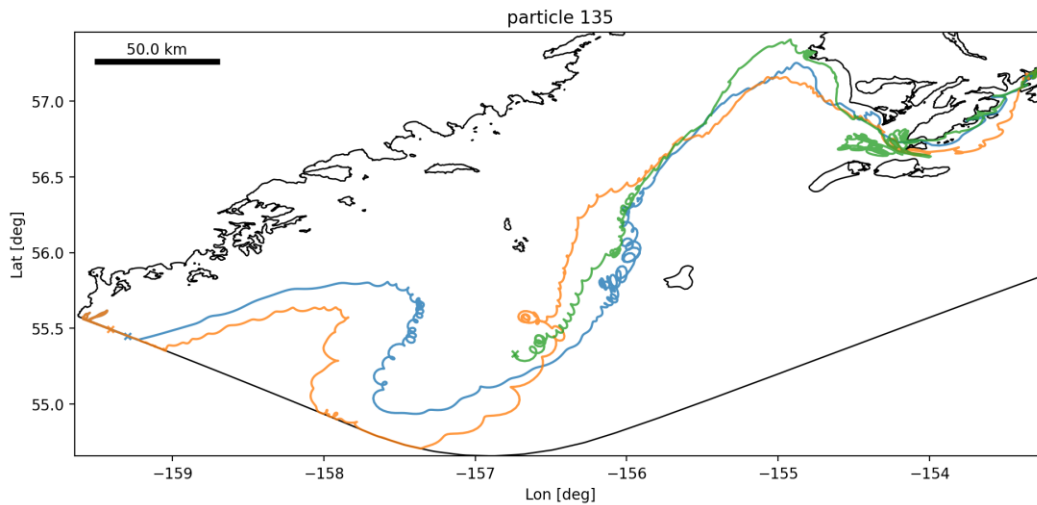
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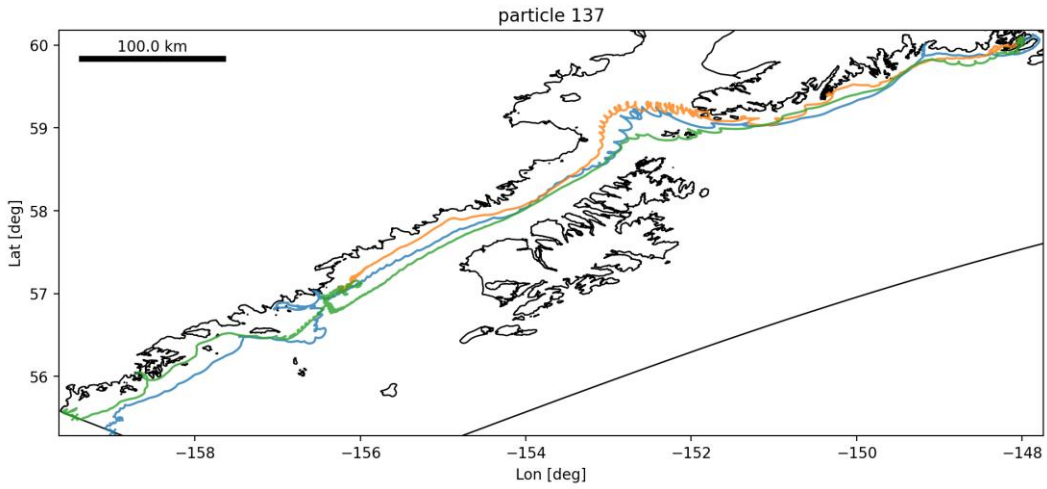


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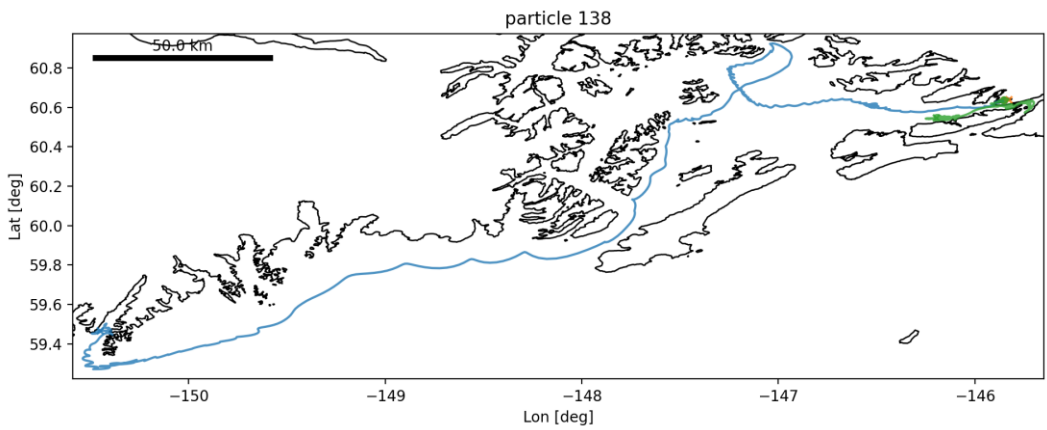


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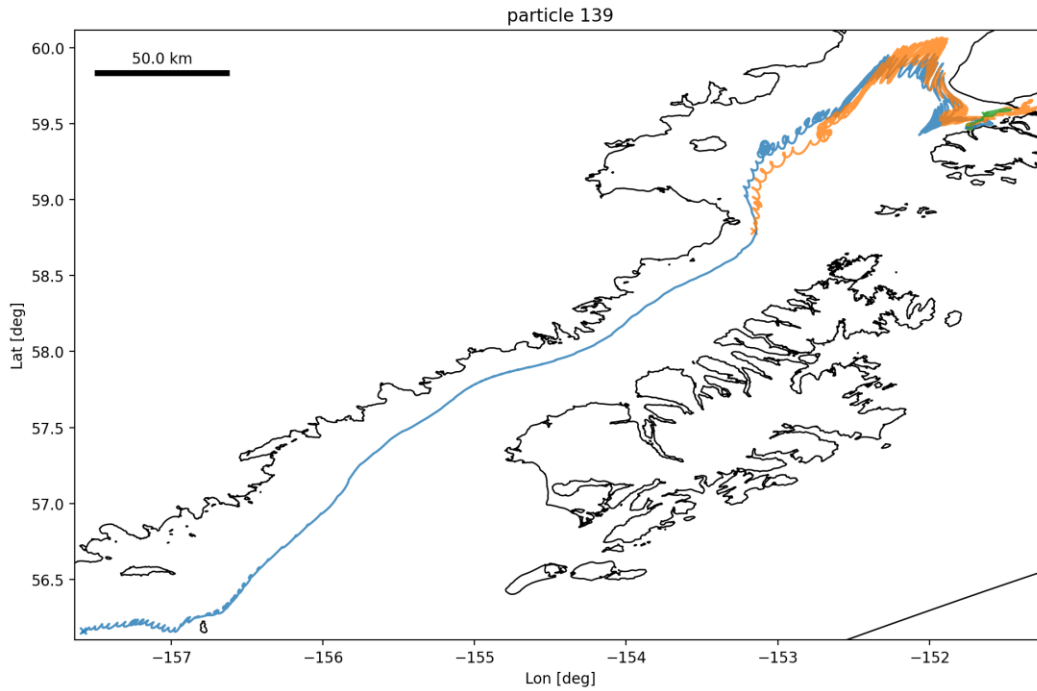


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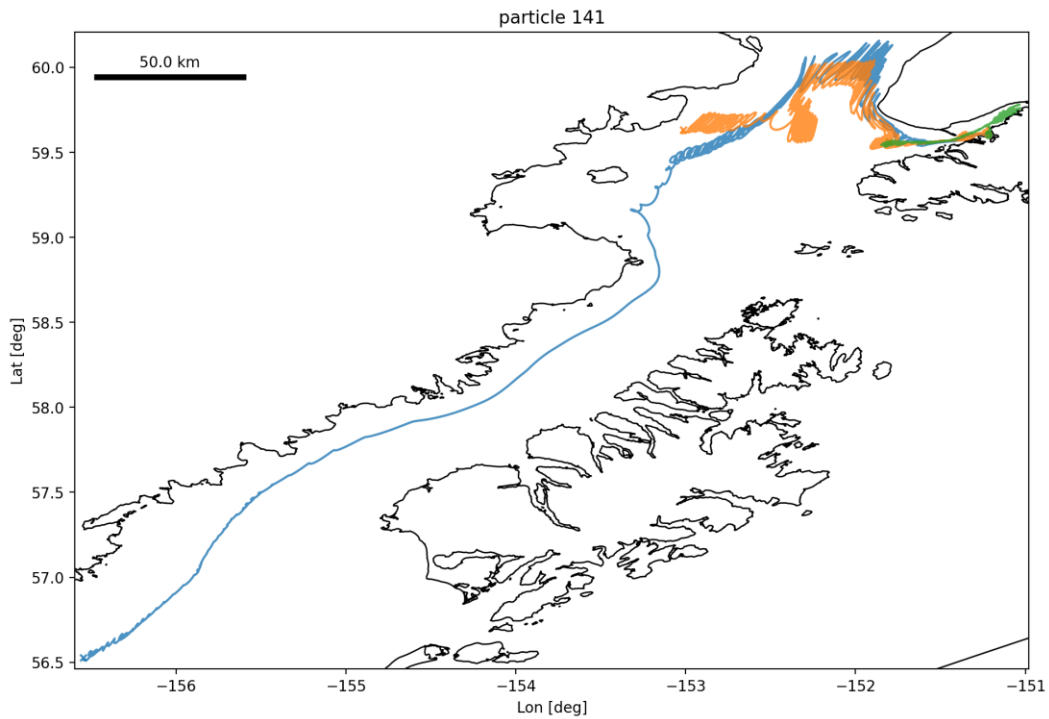


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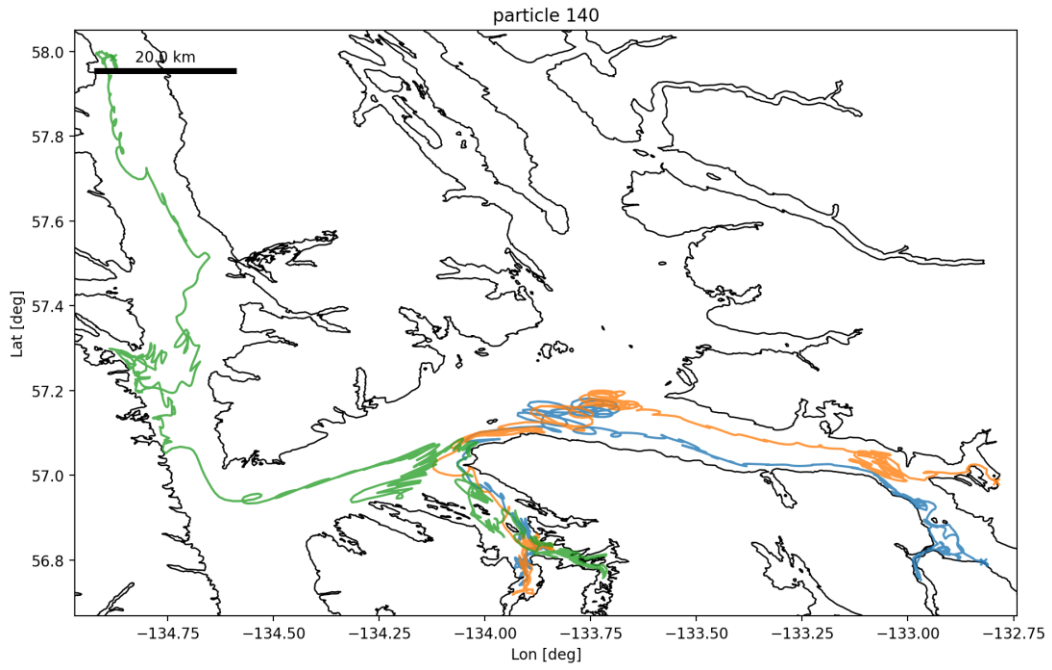


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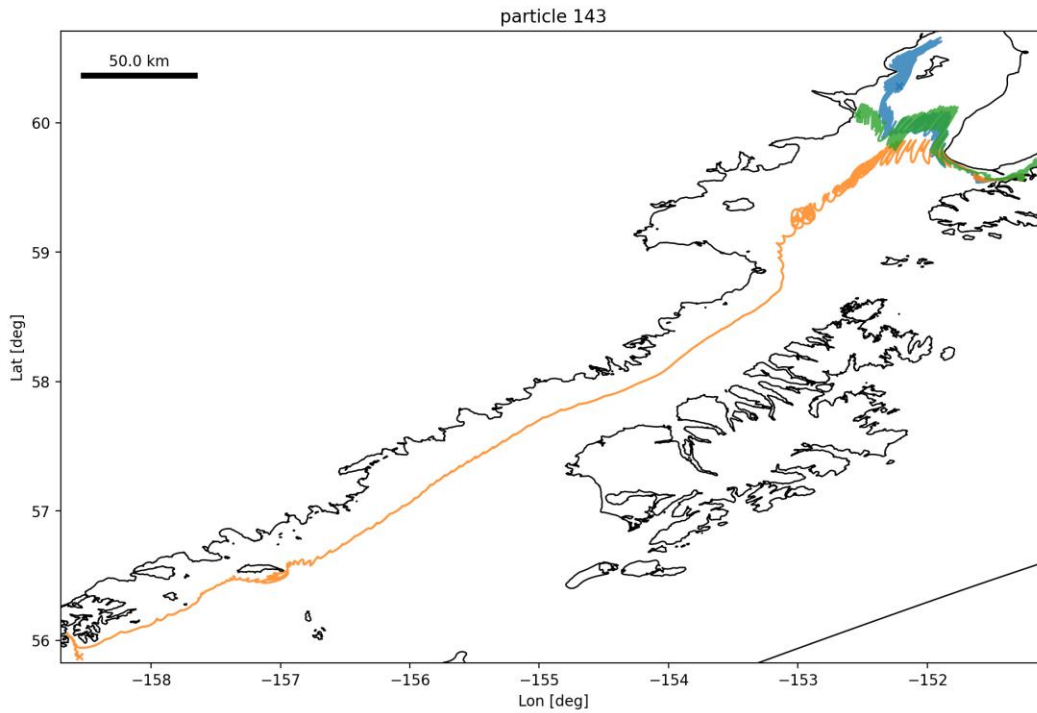


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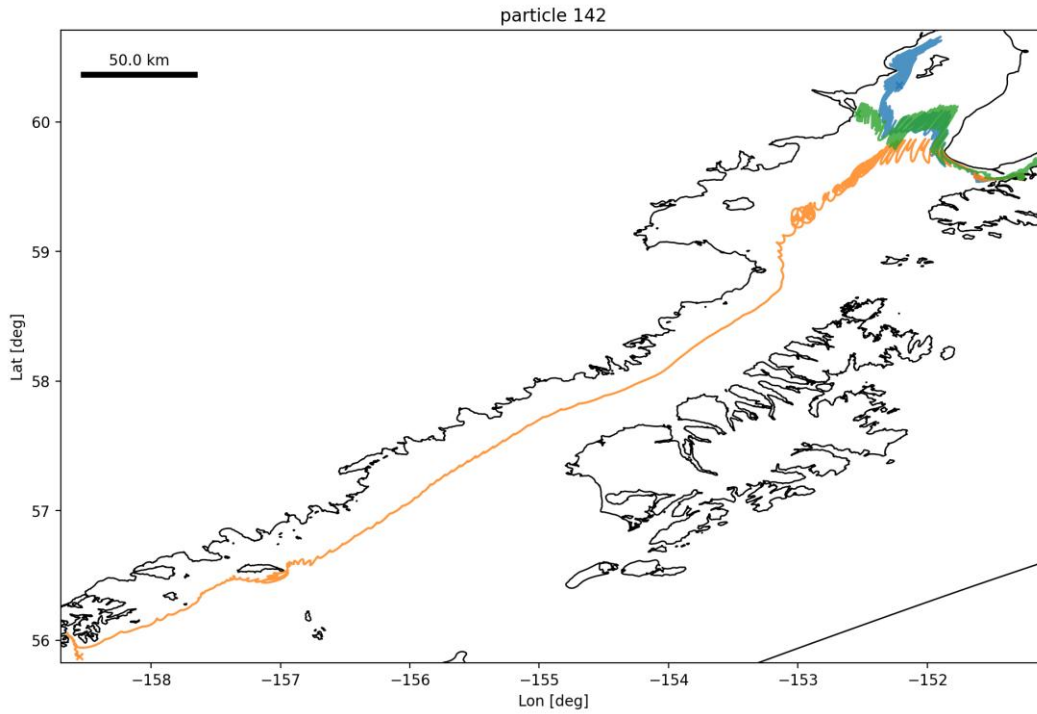


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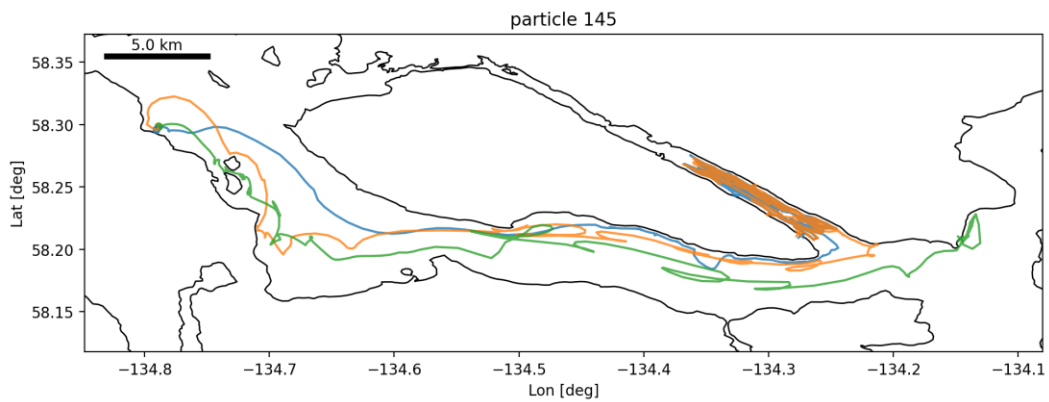


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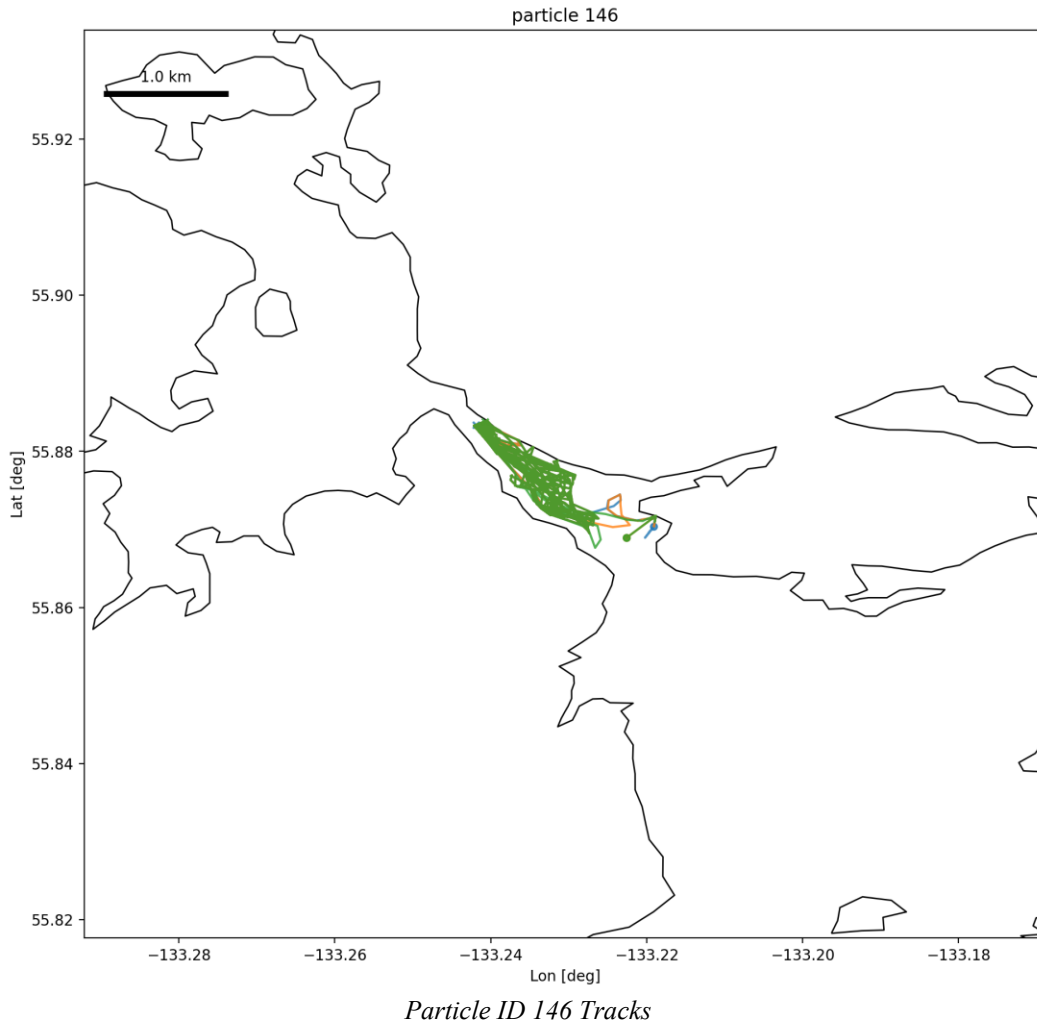


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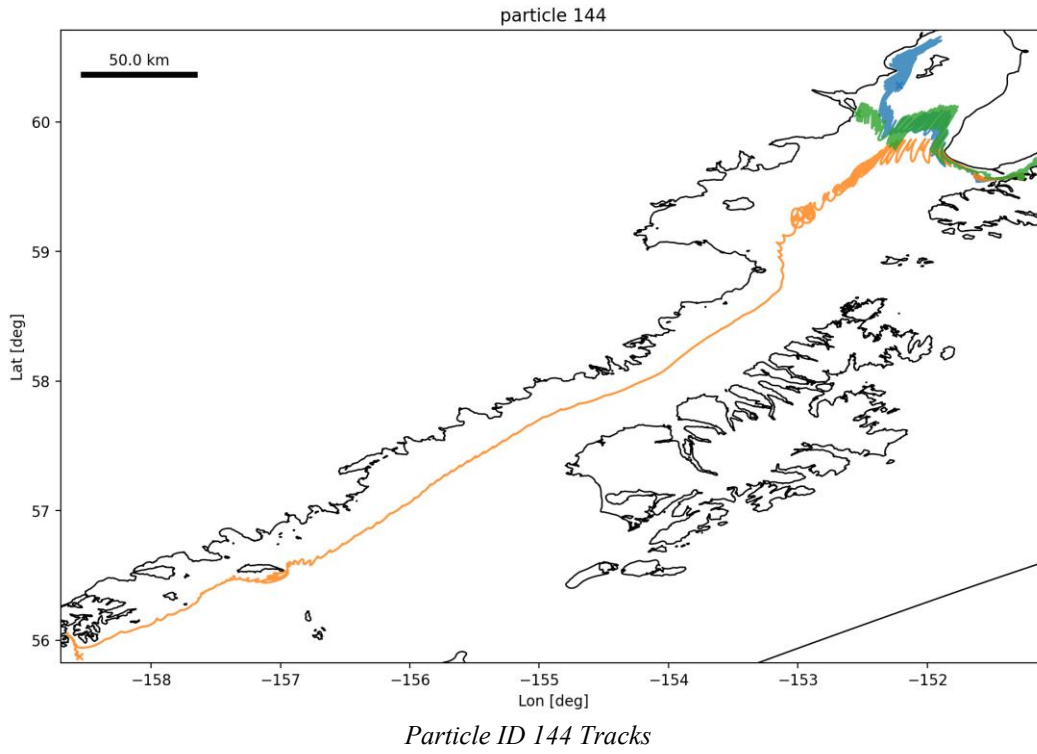


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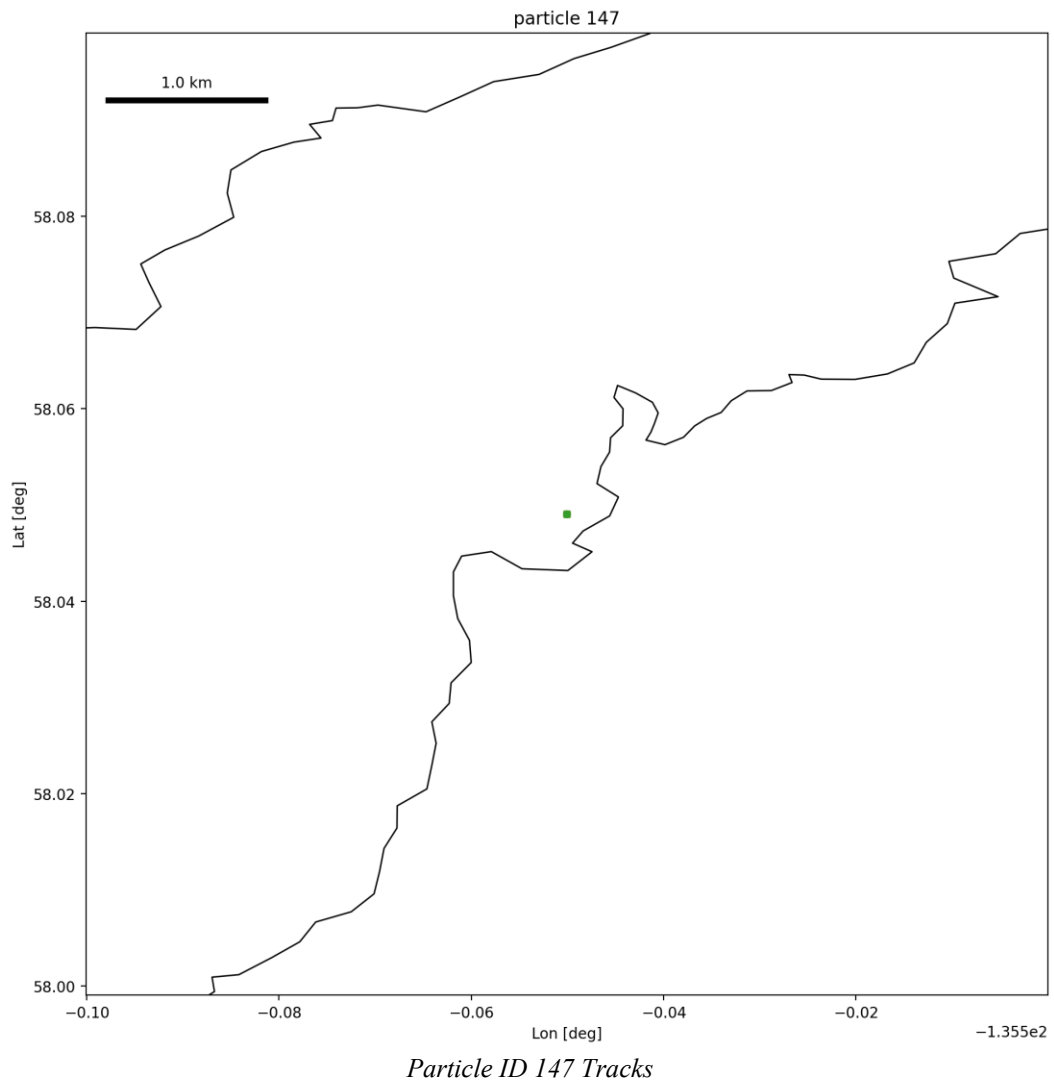
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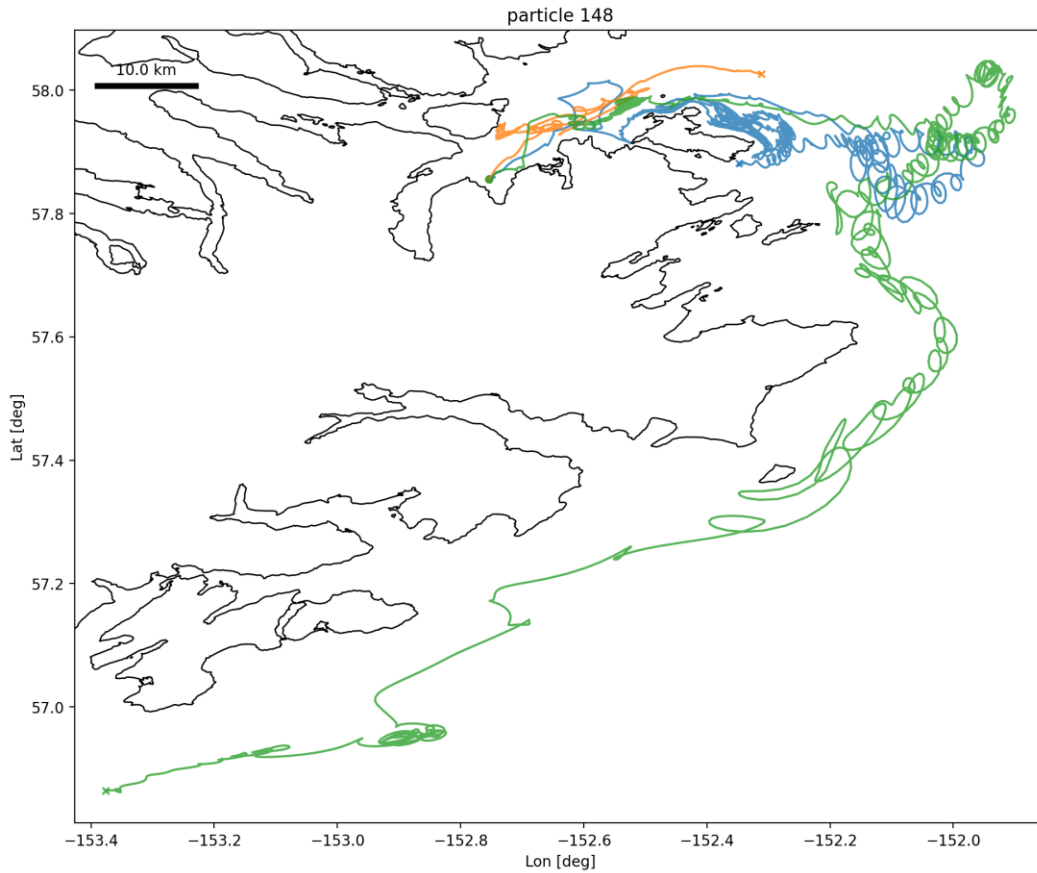
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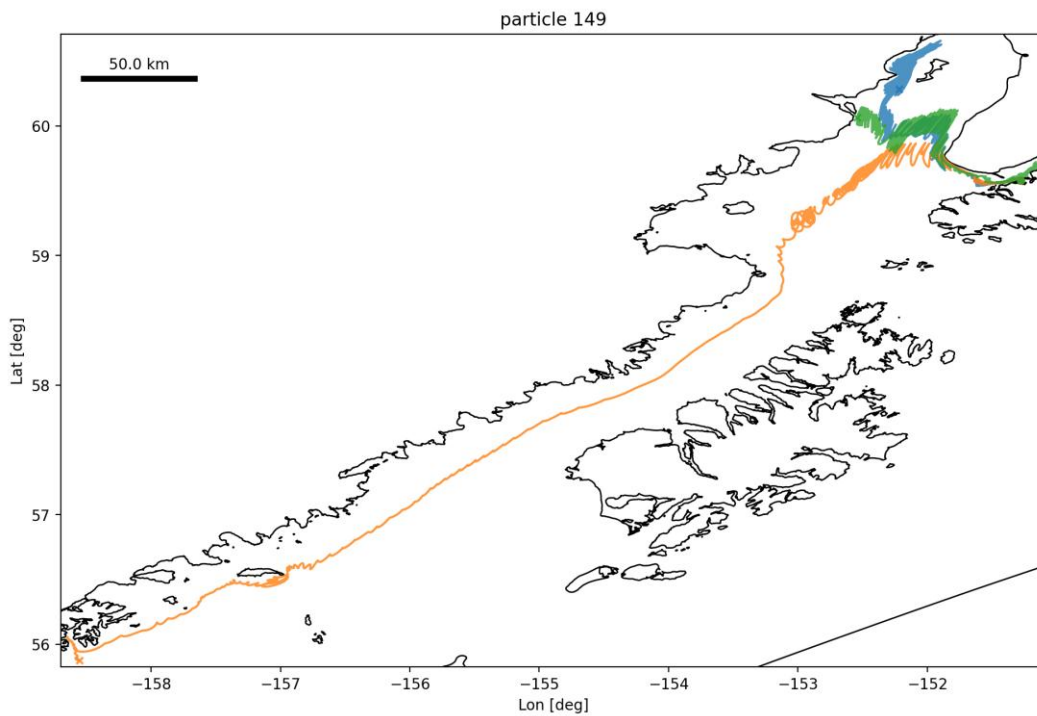
Kelson Marine Co. | Quantification of the Fate of Sloughed Alaskan Seaweed Biomass: Quarter 1 2026 Progress Update Report



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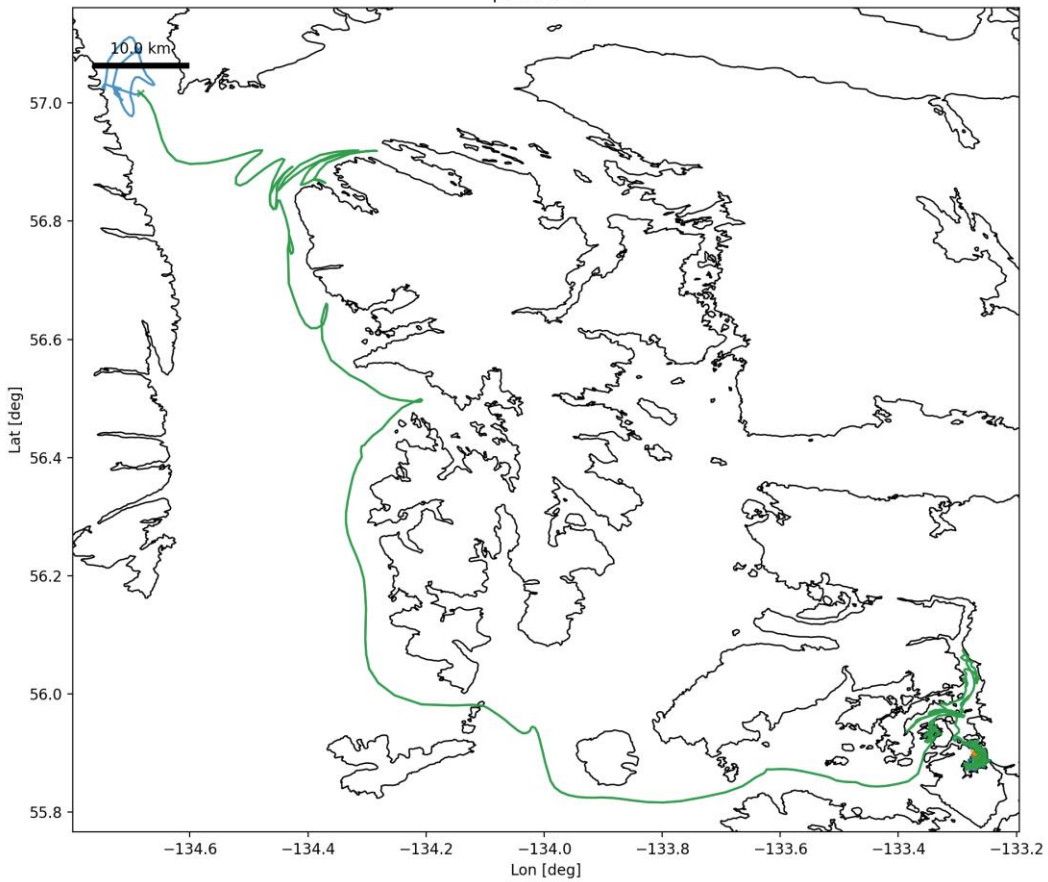
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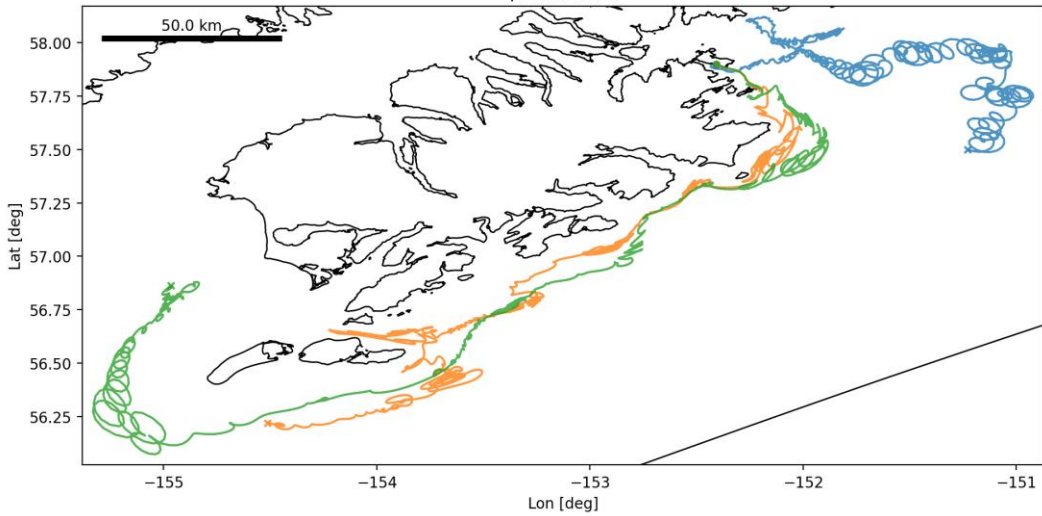
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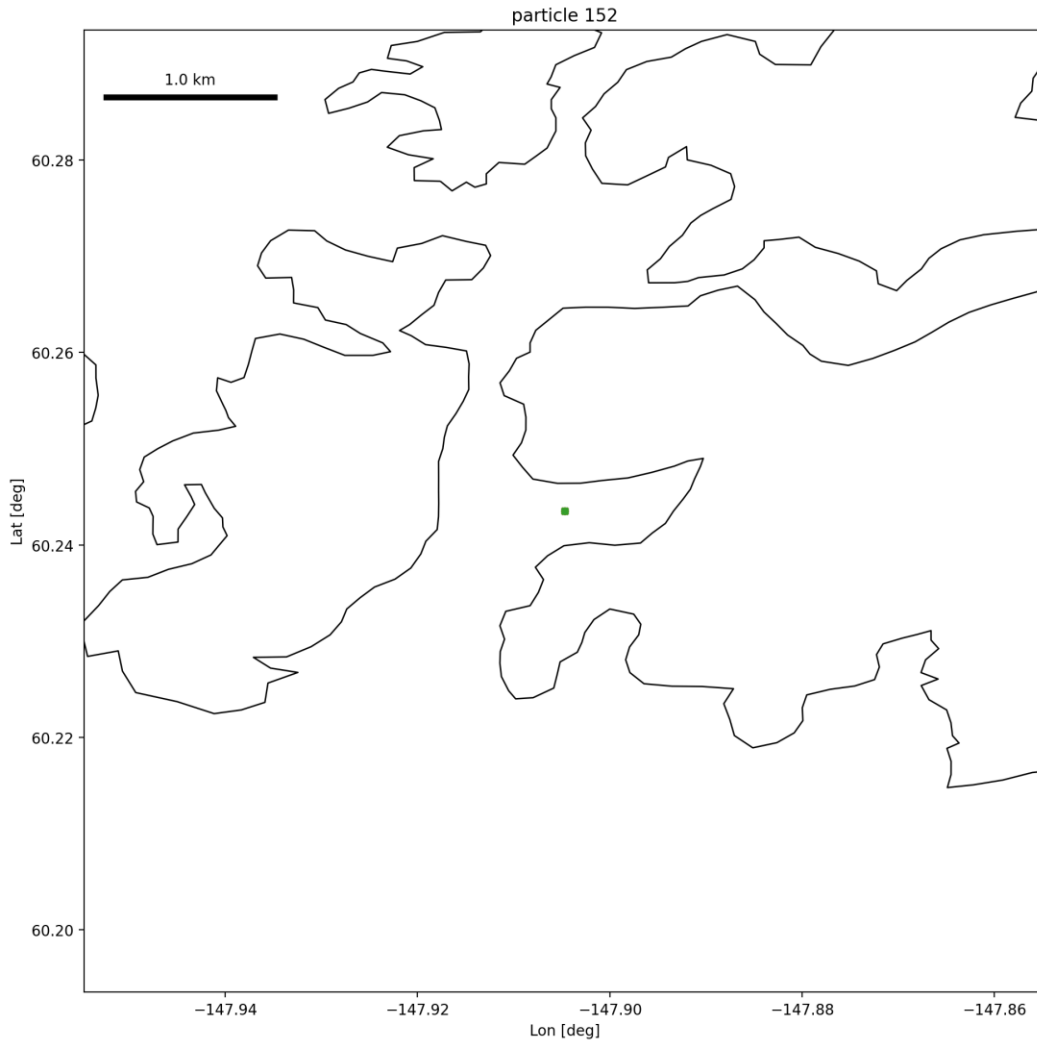
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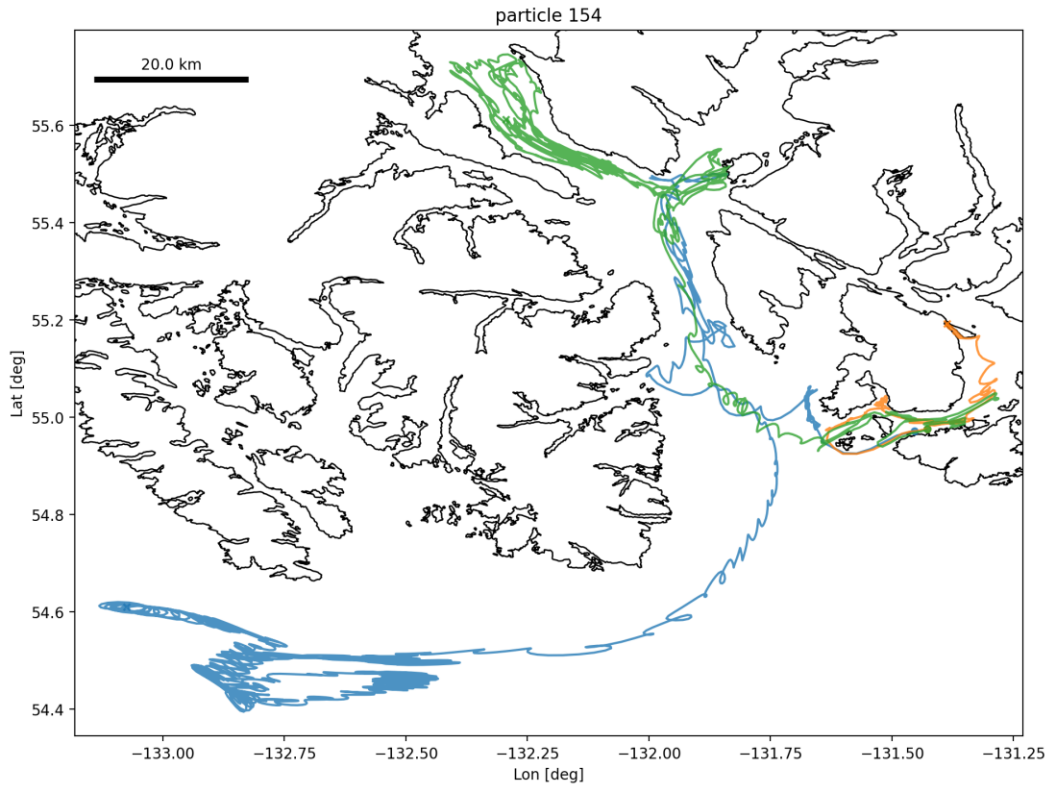
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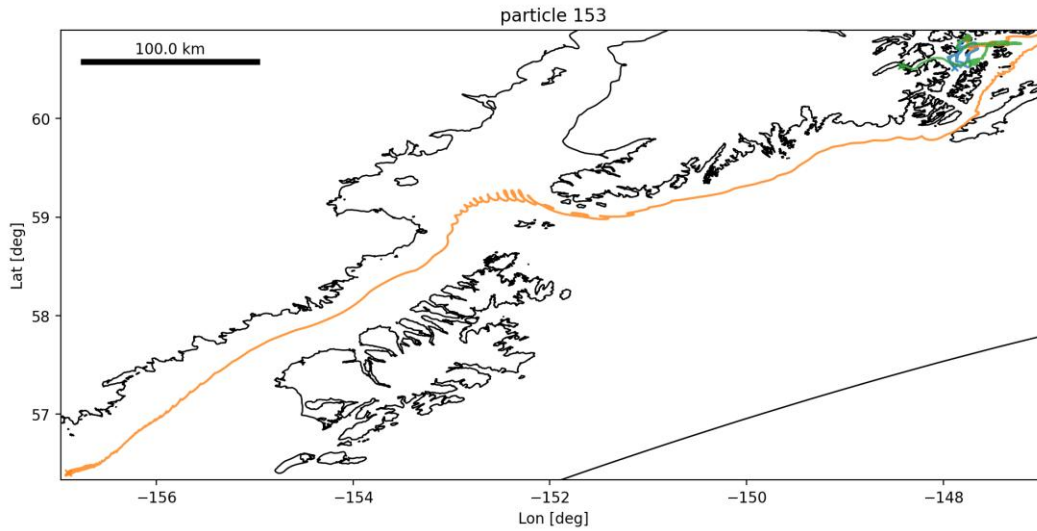


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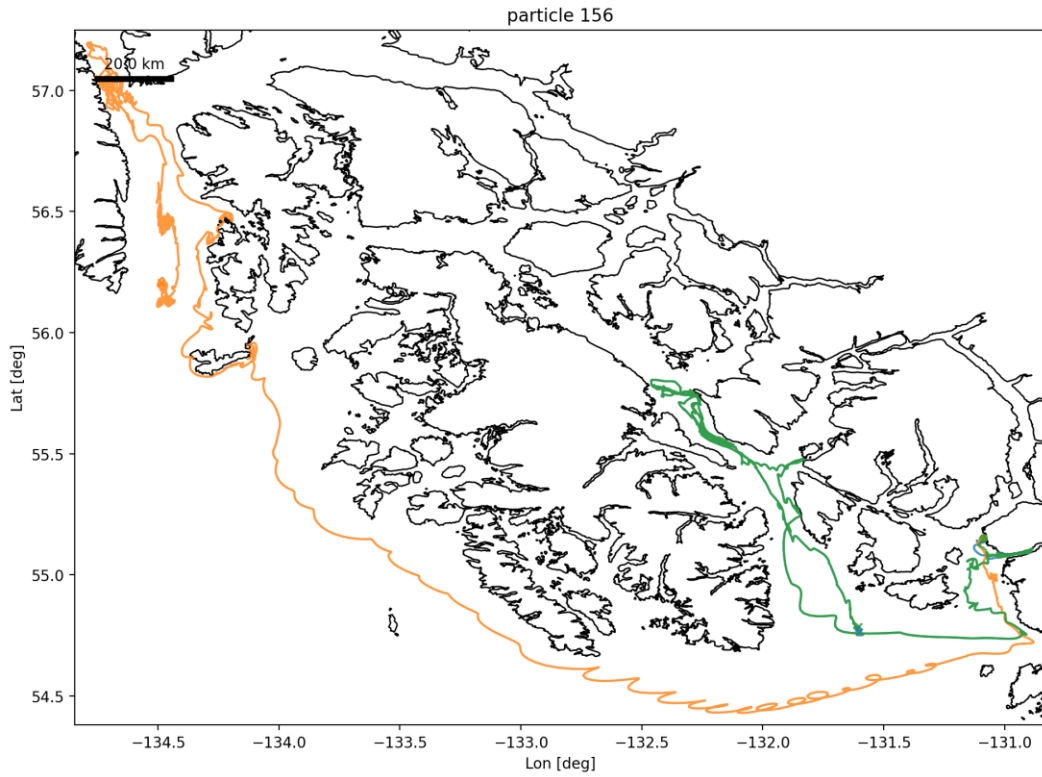


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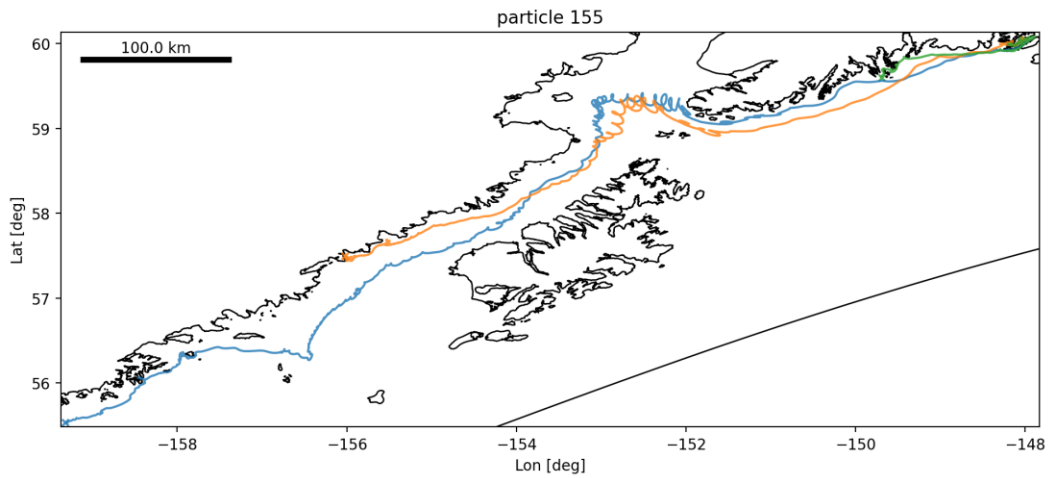


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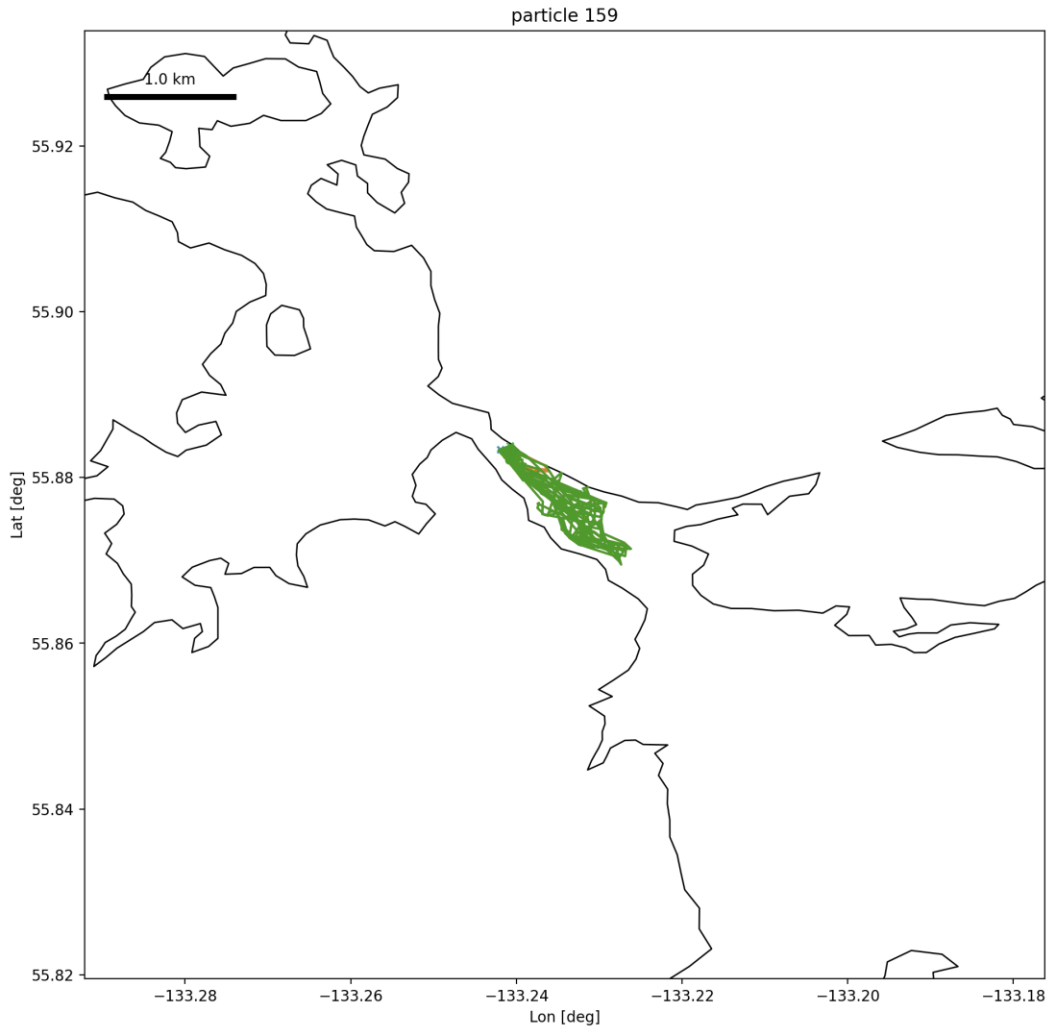


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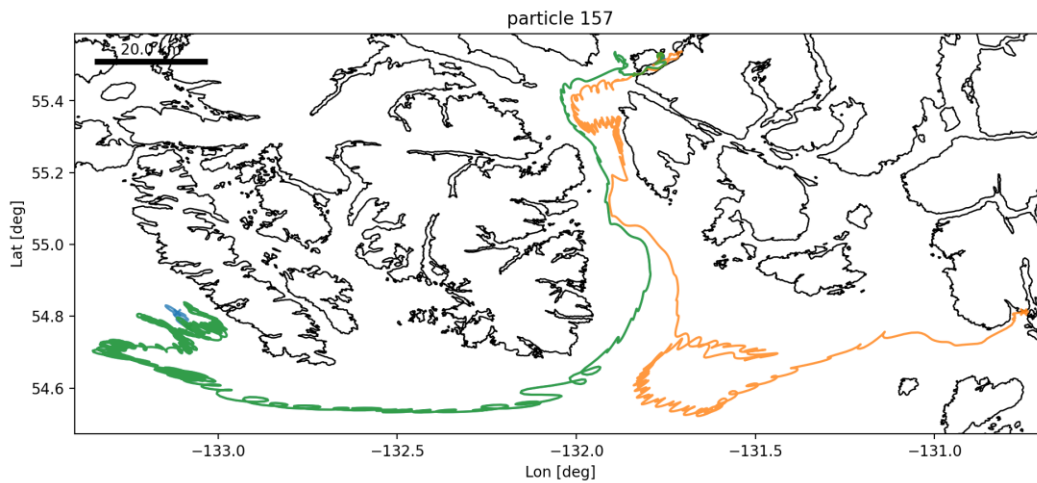


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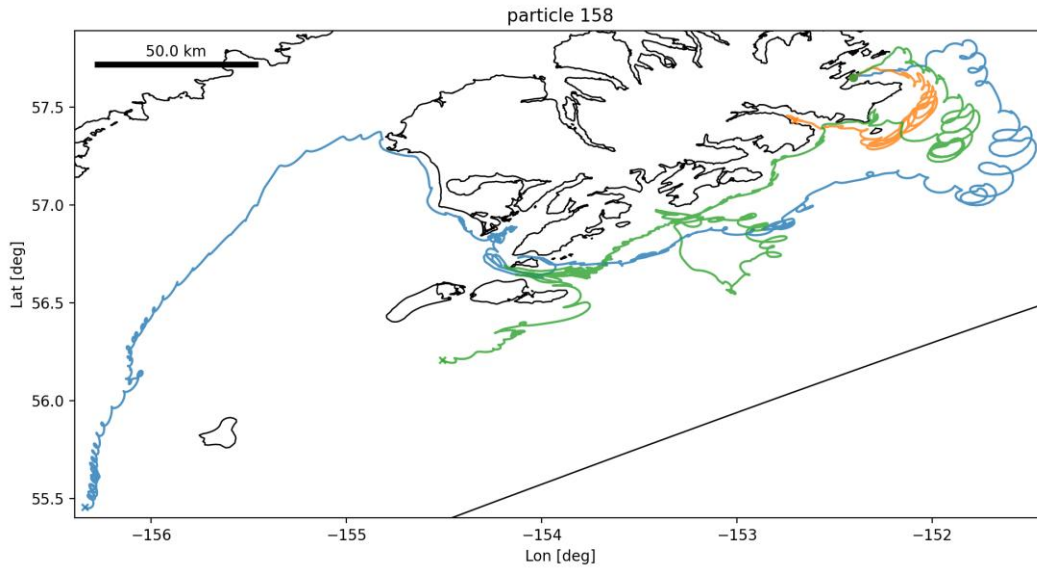


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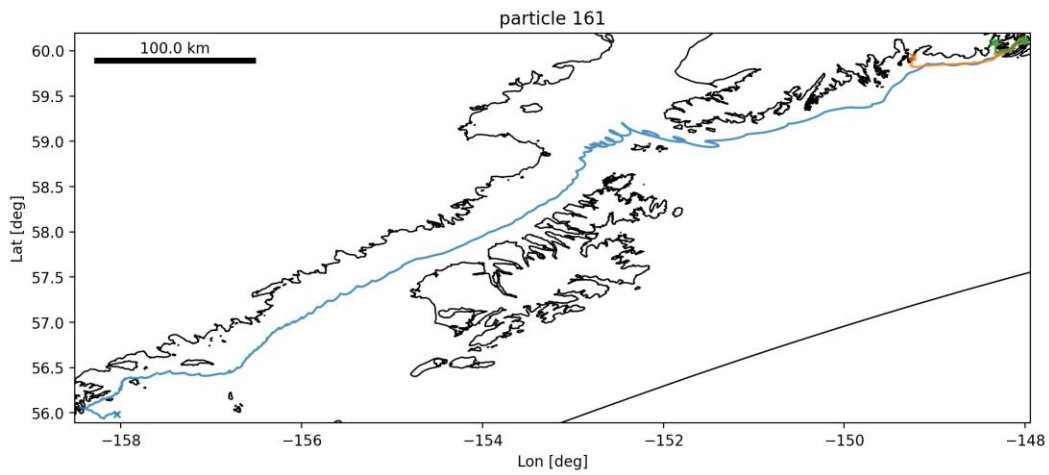


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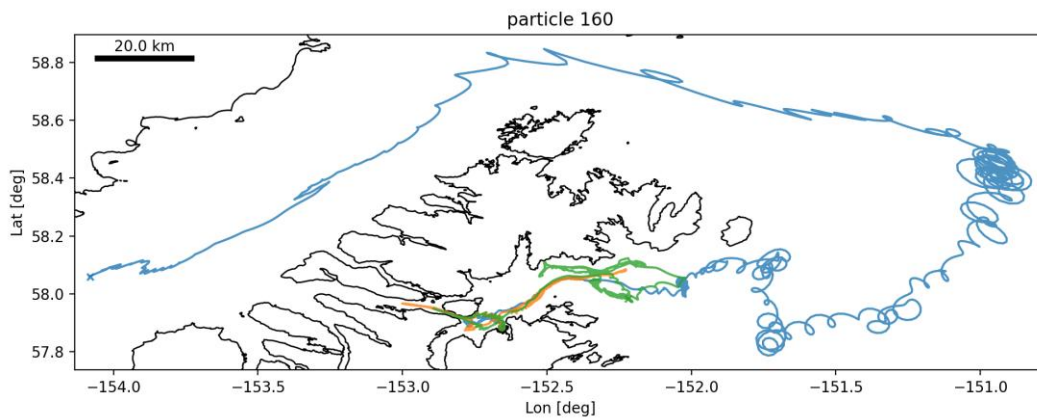
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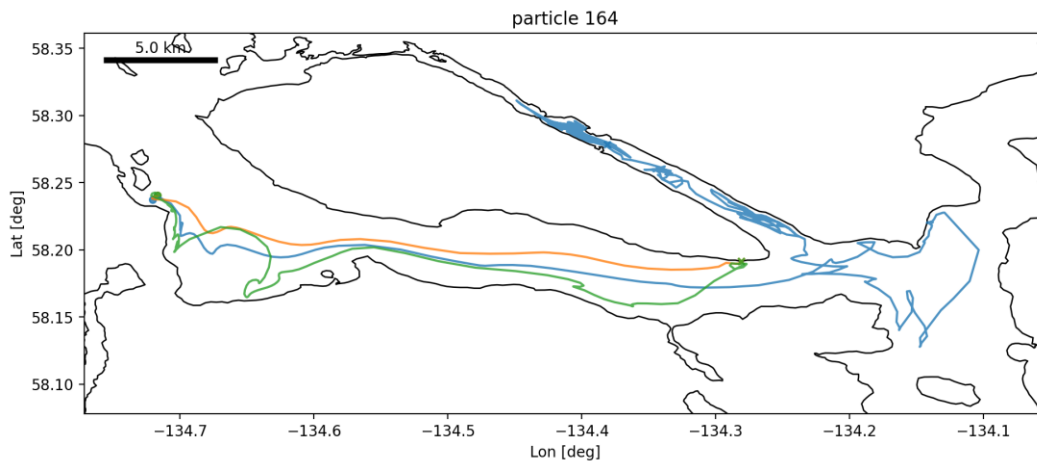


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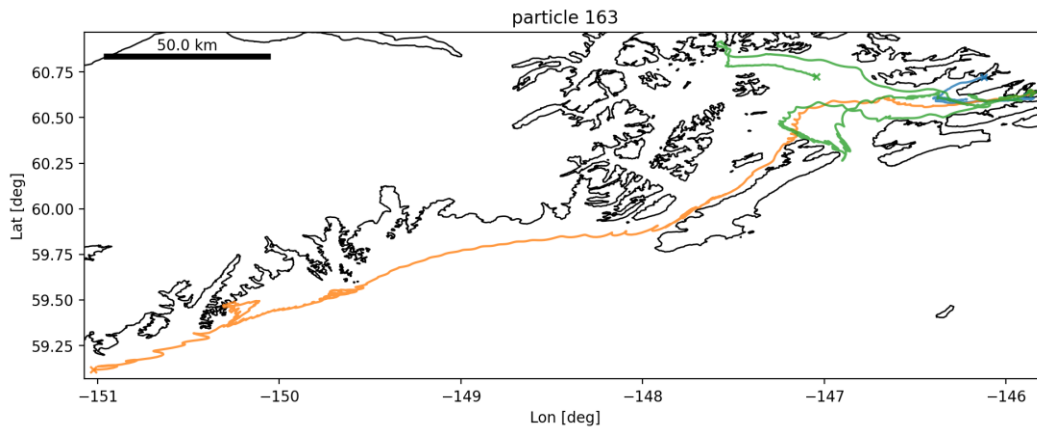


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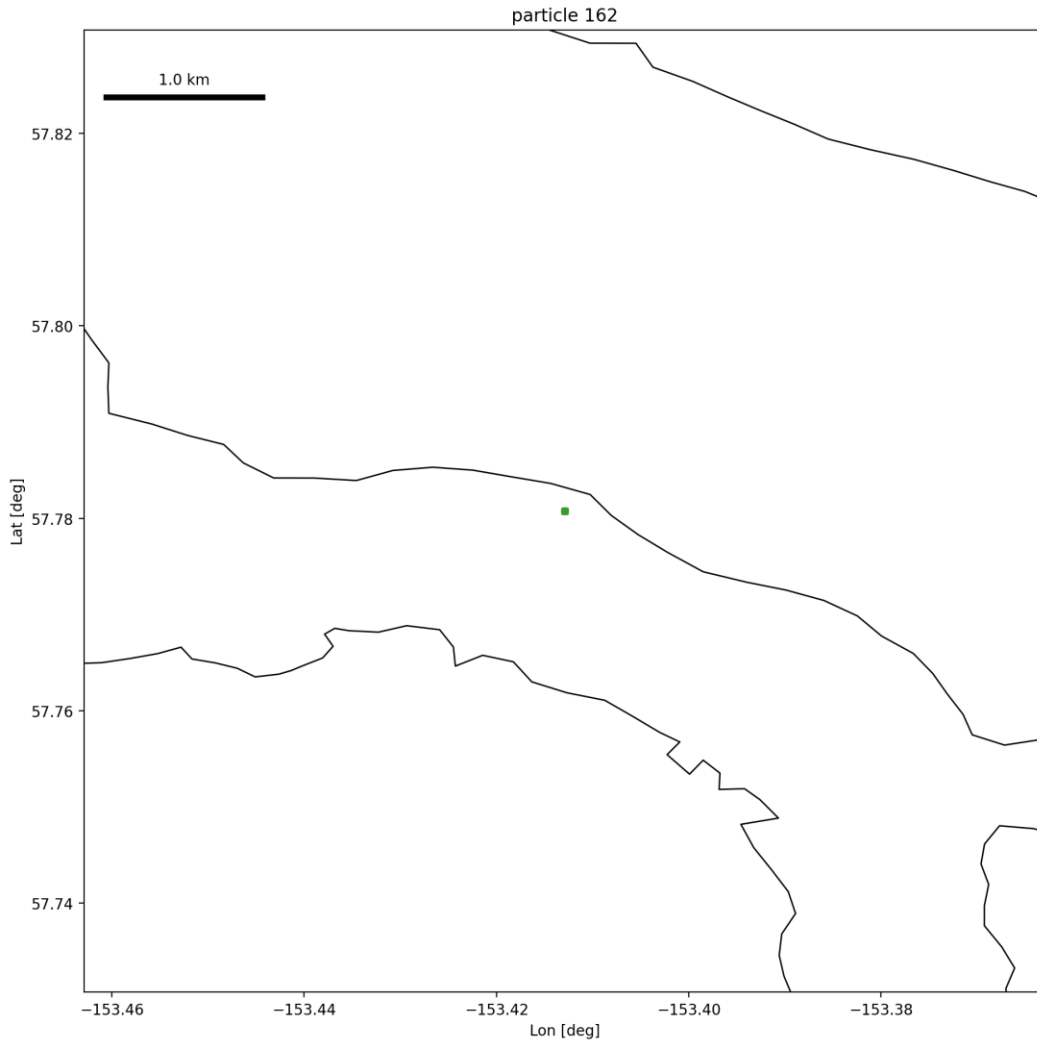


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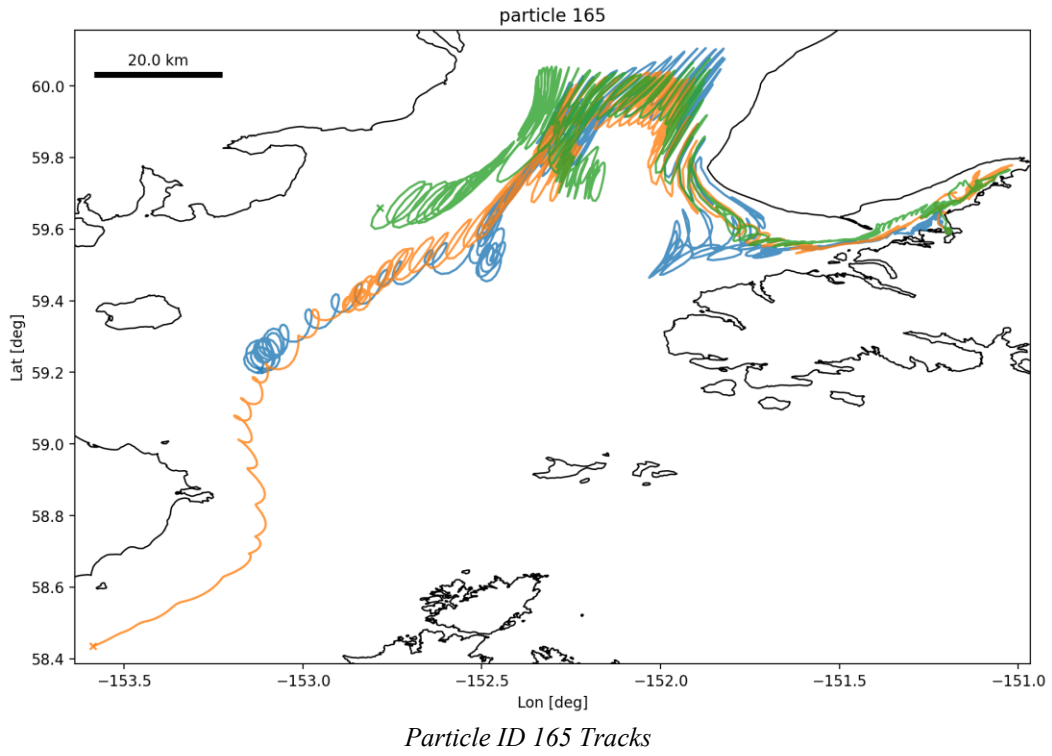
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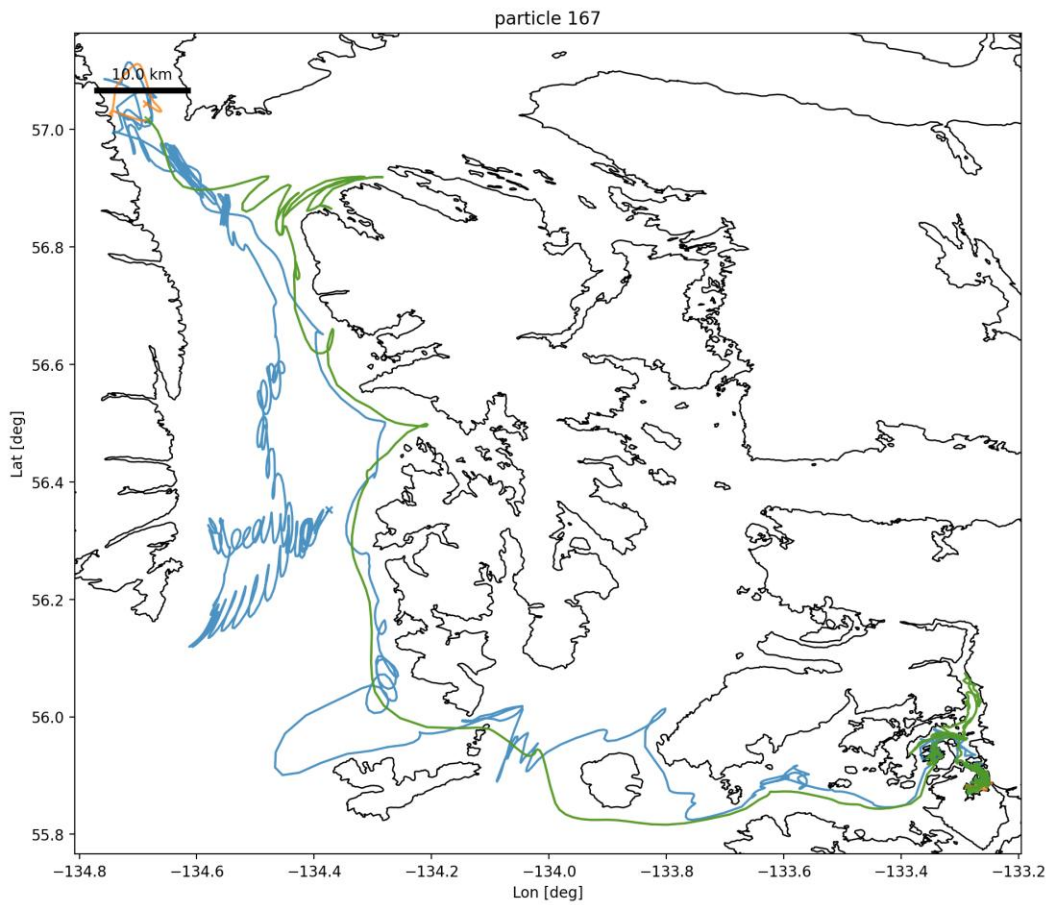


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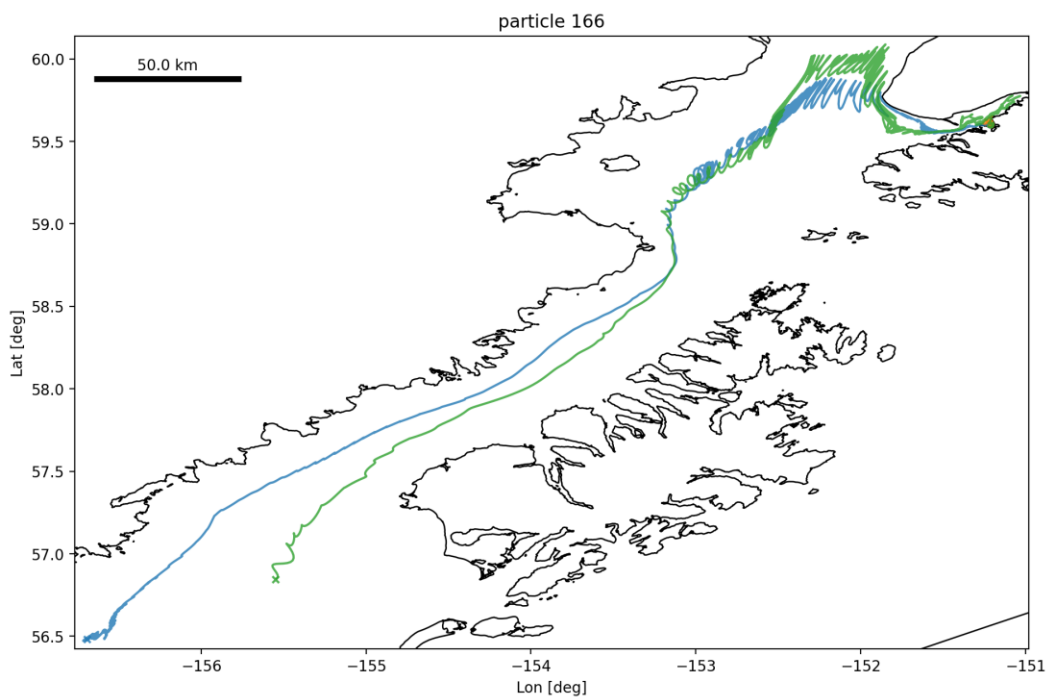
Kelson Marine Co. | Quantification of the Fate of Sloughed Alaskan Seaweed Biomass: Quarter 1 2026 Progress Update Report



Kelson Marine Co. | Quantification of the Fate of Sloughed Alaskan Seaweed Biomass: Quarter 1 2026 Progress Update Report



Particle ID 167 Tracks



Kelson Marine Co. | Quantification of the Fate of Sloughed Alaskan Seaweed Biomass: Quarter 1 2026 Progress Update Report

