How far will it go?
The estimation of oil spill extents from surface drifter data

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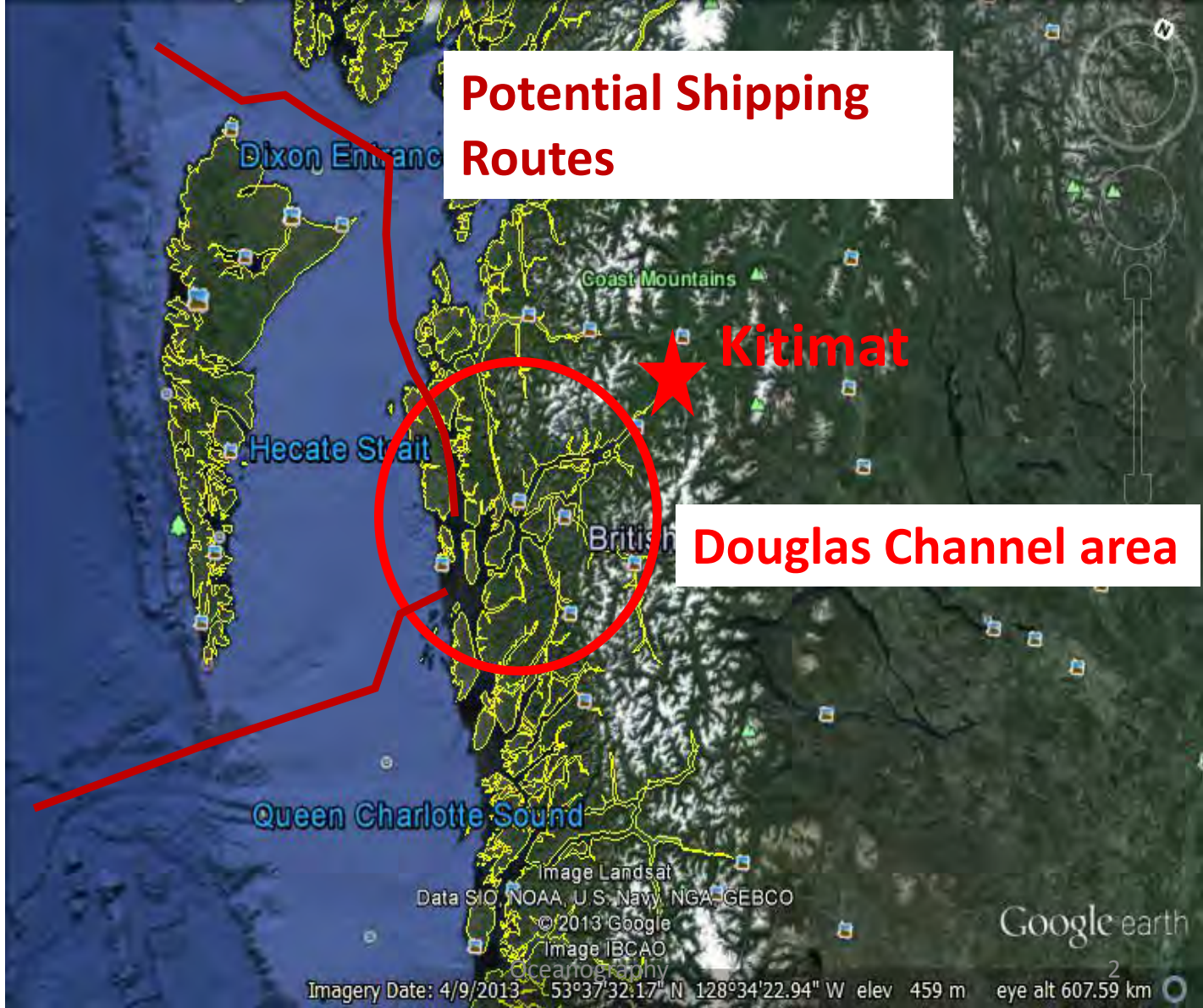
University of Victoria

25 Years of PICES:
Celebrating the Past, Imagining the Future

November 2-13, 2016
San Diego, USA

North Pacific Marine
Science Organization
2016 Annual Meeting

PICES 25

Potential Shipping Routes

Kitimat

Douglas Channel area

Surface Circulation Trackers
(sponge bobbers)

Global Coverage (orange area)

1 Vibration sensor in the SPOT Trace1 senses motion and it activates.

2.69 in (6.83 cm)

2.02 in (5.13 cm)

2 It acquires information from the GPS satellite constellation, (up to 24 Middle Earth Orbit Satellites).
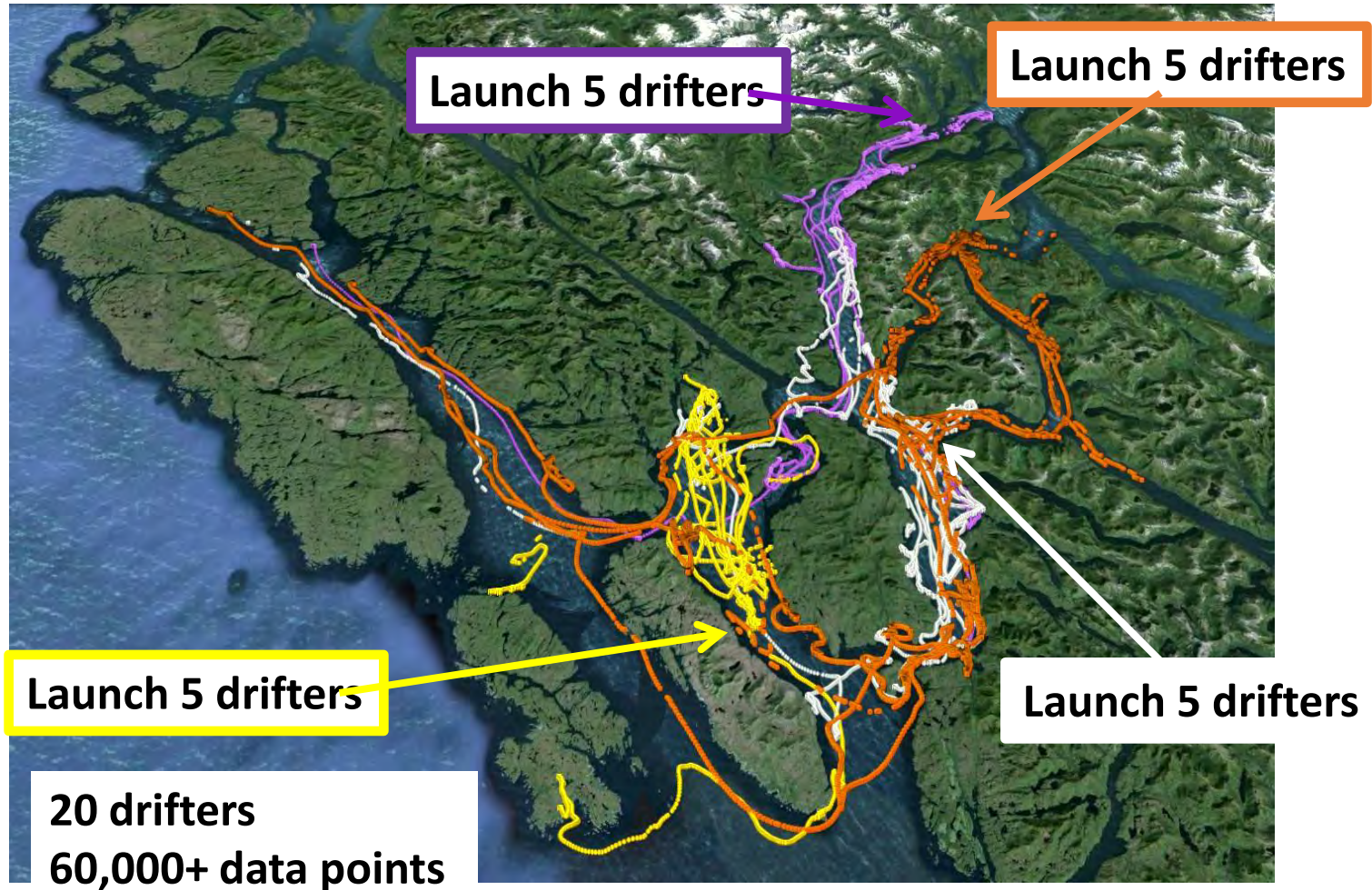
3

Our experience tracking SPOTs; locally walking, driving, kayaking; Paulatuk ski-doing; StnP – the open ocean; test launches Saanich Inlet & Juan de Fuca Strait; drifter studies in Douglas Channel, Cowichan Bay, Strait of Georgia, Hecate Strait.
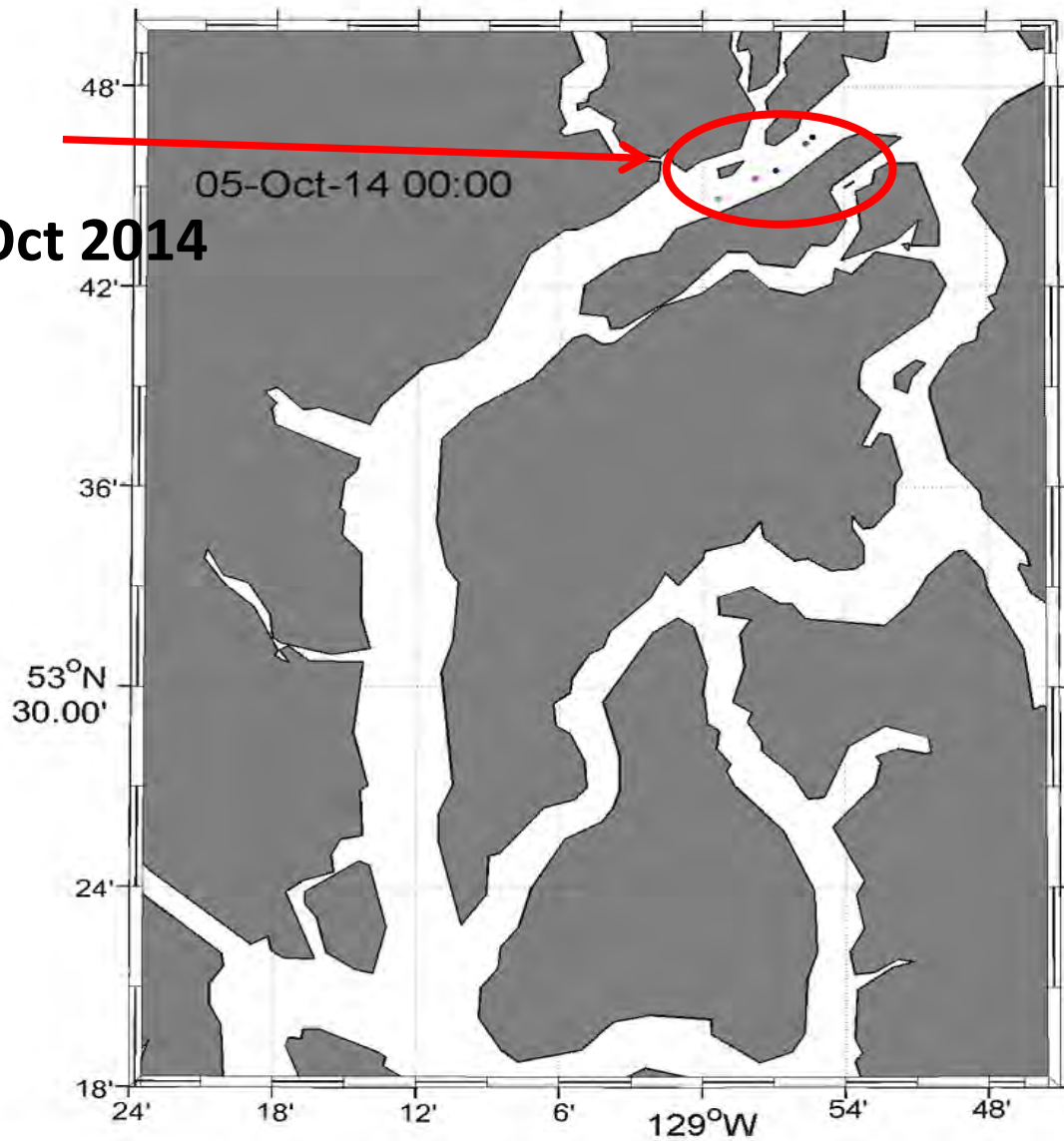
To date 84 buoys deployed.

GPS Time / Date / Position is transmitted to Globalstar satellite constellation, (up to 32 Low Earth Orbit Satellites), and then to ground stations for distribution.

October 2014 Deployment in Douglas Channel area

Launch 5 drifters

Launch 5 drifters

Launch 5 drifters

Launch 5 drifters

20 drifters
60,000+ data points

5 drifters
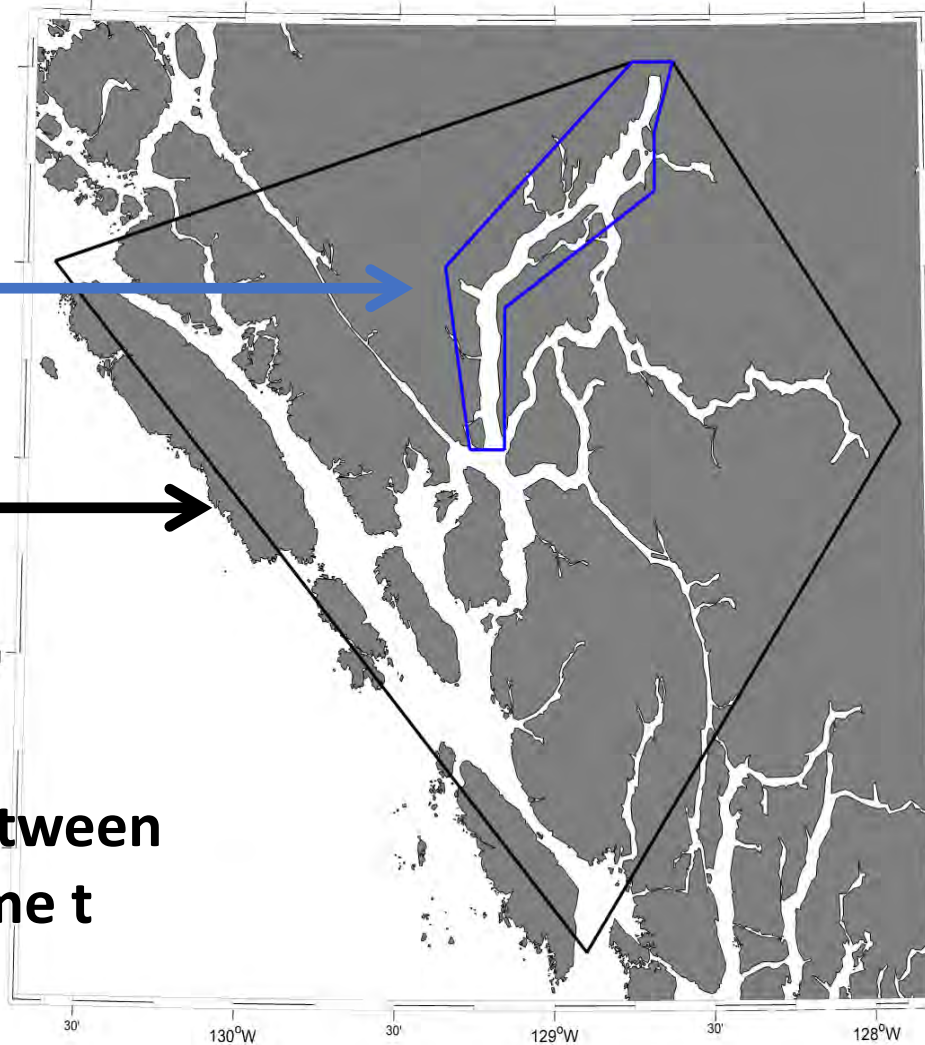**Deployed 5 Oct 2014**

05-Oct-14 00:00

Domains for initial analysis

Douglas Channel (DC)

All

Displacement
The distance between the drifter at time t and t+dt

Displacement

Percent

Distance (km)

Douglas Channel

All
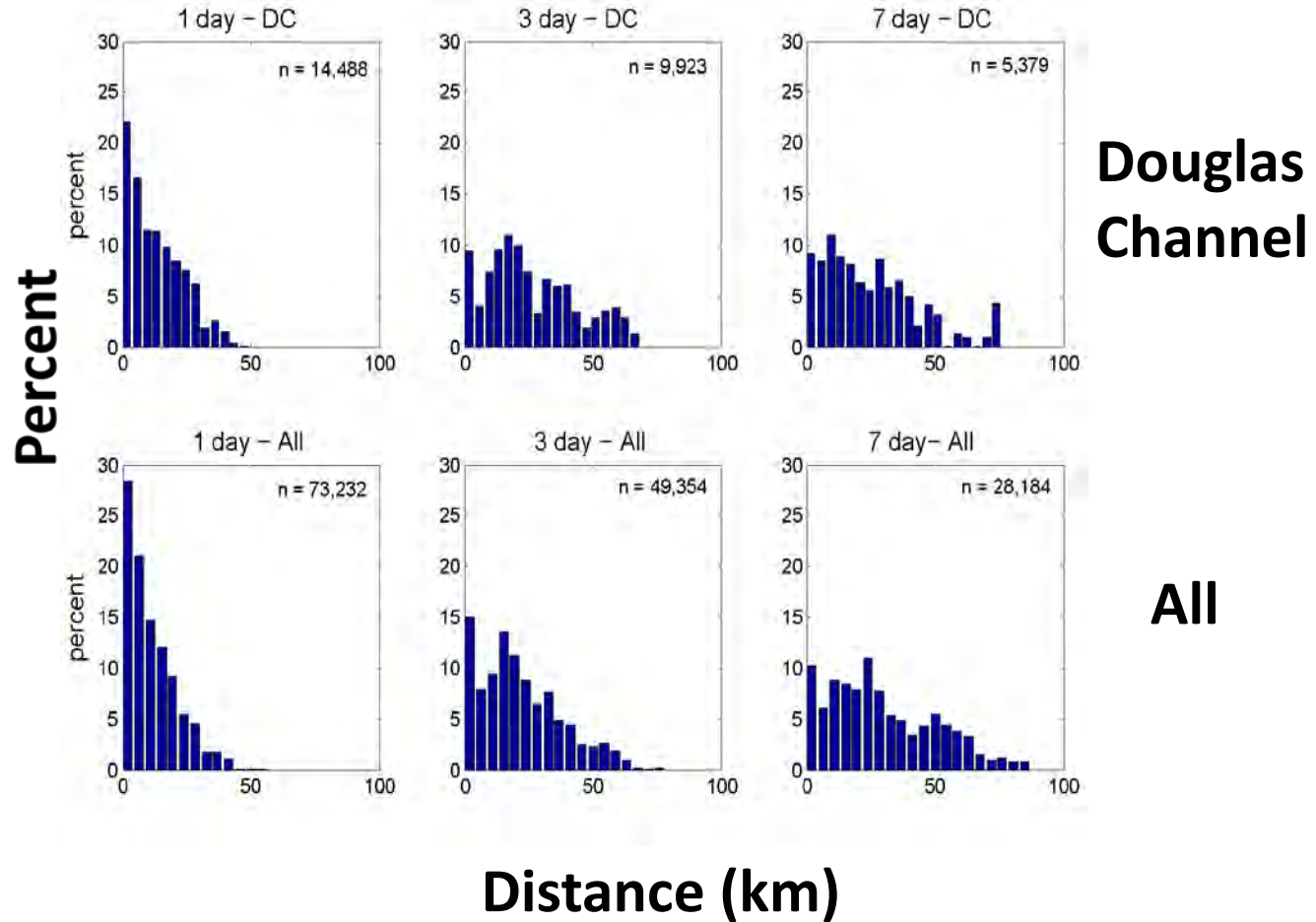
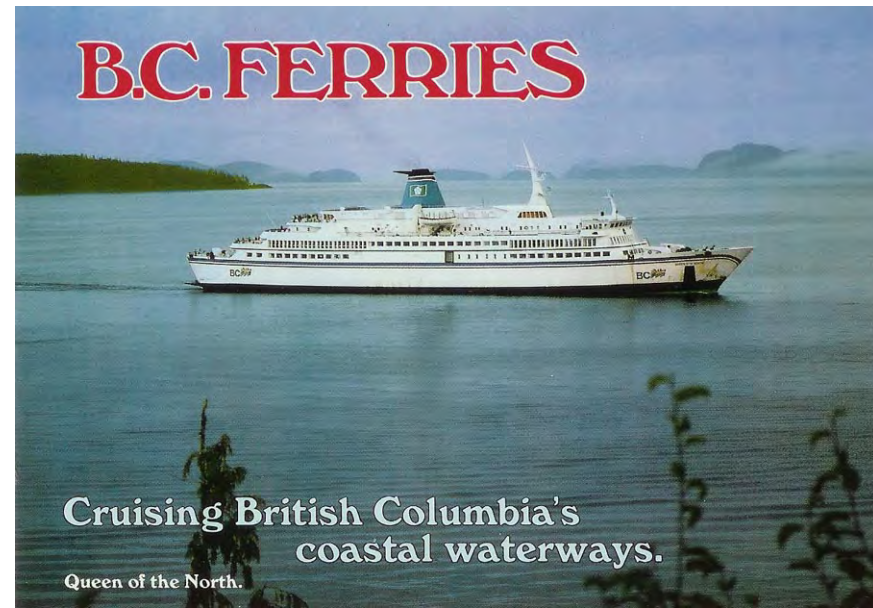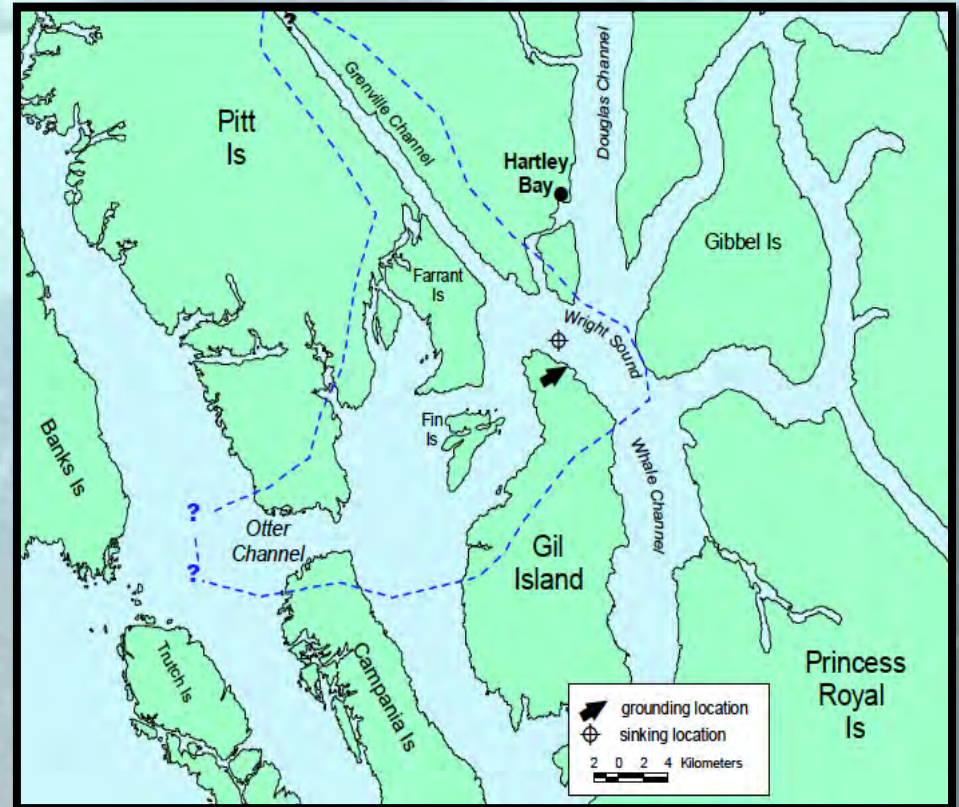# Queen of the North struck Gil Island on March 22, 2006 and sank

Queen of the North Oil Spill

- Passenger vessel struck Gil Island on March 22, 2006 and sank

- 228,000L of diesel spilled (+ 36,600L of engine oil and smaller quantities of other contaminants)

- Various observations of spill extent 48 hours after incident were compiled in assessment report

From Harper et al. 2007

Background Image from huffingtonpost.com

Oil Slick vs. Drifters

- Compared drifter tracks passing within 2km of sinking location to reported observations

- >85% of drifters remain within observation area, cover up to 80% of area depending on season

- Results look quite different when considering drifters passing within 5km

Complete drifter set, 2km radius
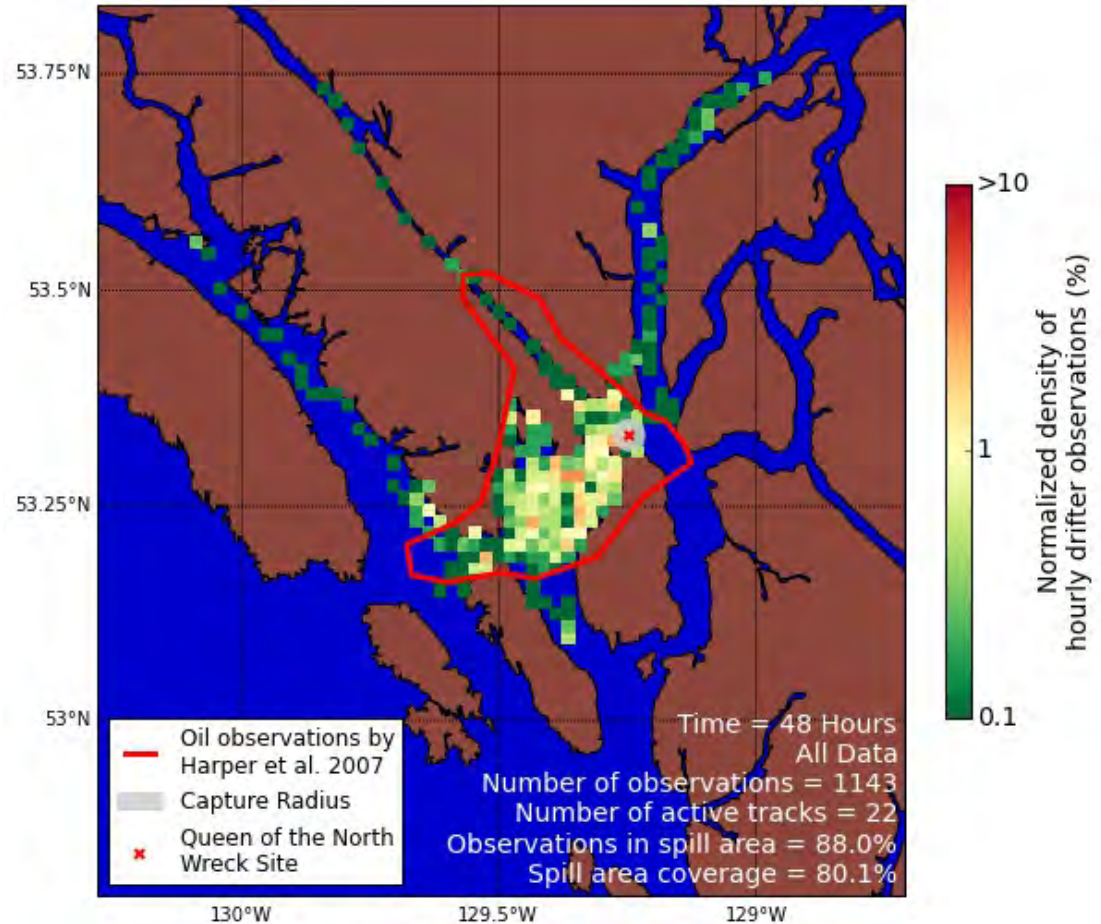
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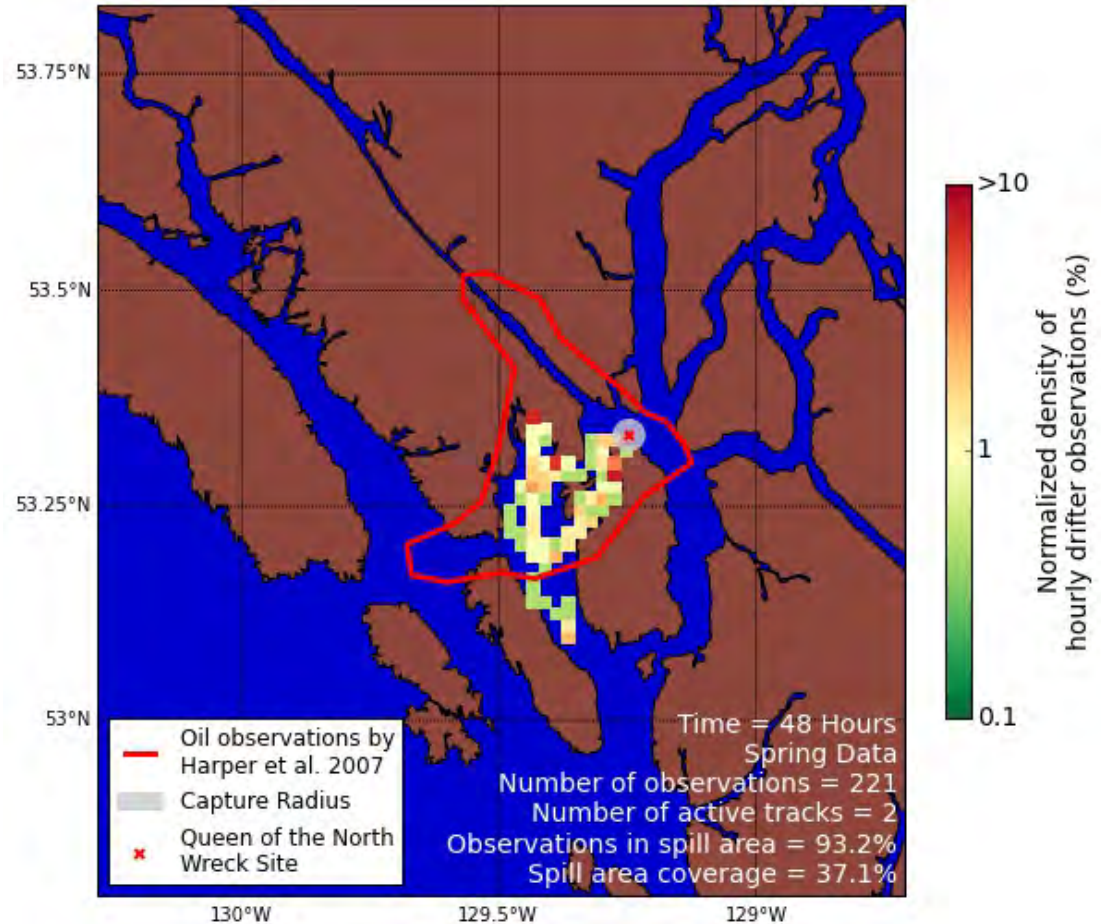- Results look quite different when considering drifters passing within 5km

Spring drifter set (March-May), 2km radius

Oil Slick vs. Drifters

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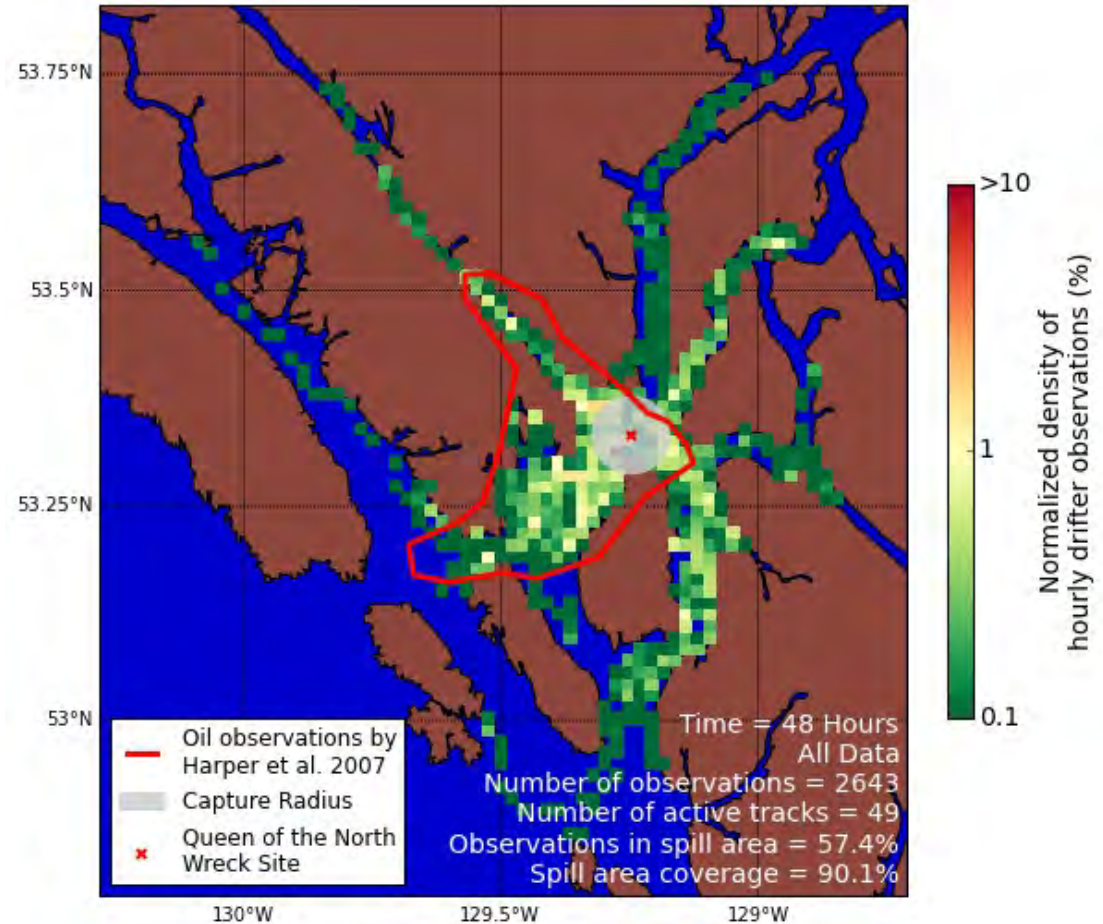- Results look quite different when considering drifters passing within 5km

Complete drifter set, 5km radius

Normalized density of hourly drifter observations (%)

>10

1

0.1

Oil observations by Harper et al. 2007
Capture Radius
Queen of the North Wreck Site

Time = 48 Hours
All Data
Number of observations = 2643
Number of active tracks = 49
Observations in spill area = 57.4%
Spill area coverage = 90.1%

Grid System

- Need to decompose drifter motion into meaningful components
  - Traditional N-E system yields little useful information in channels

- Study area split into 16 channels and 18 confluences

- Waypoints spaced ~3km along major channel axis define down-channel direction

- Down-channel azimuths are used to decompose drifter motion into along-/cross-channel components
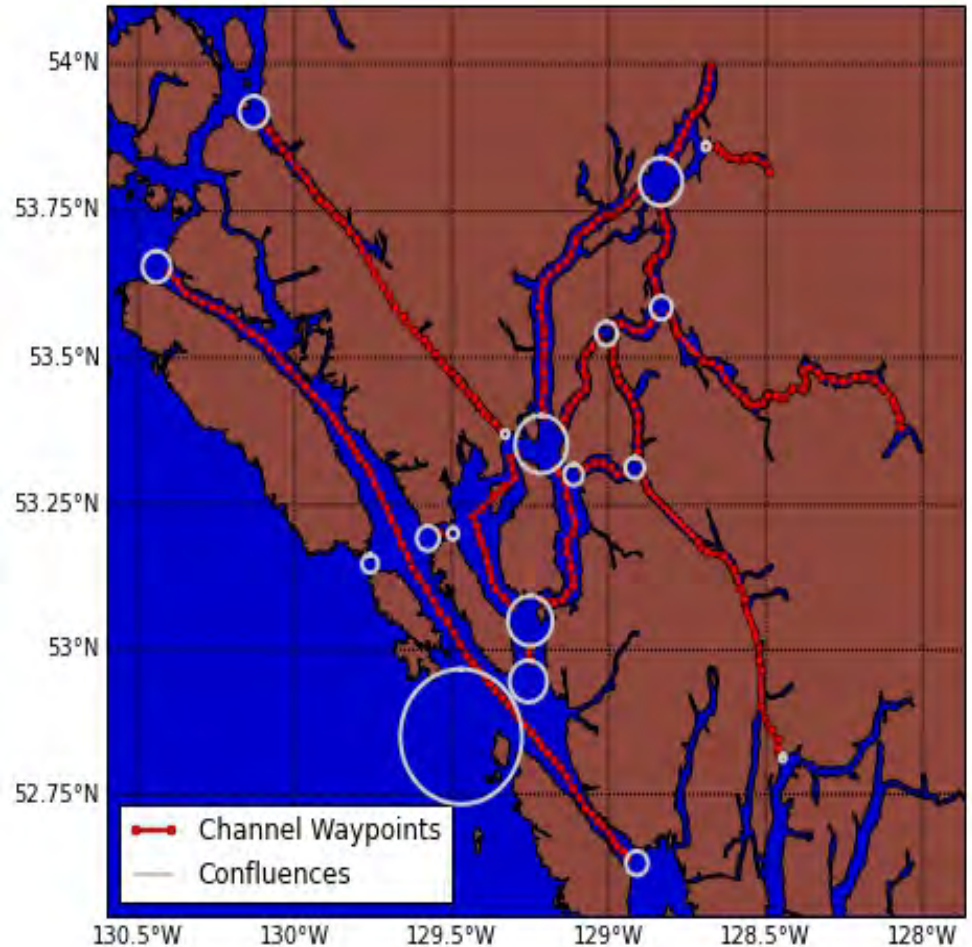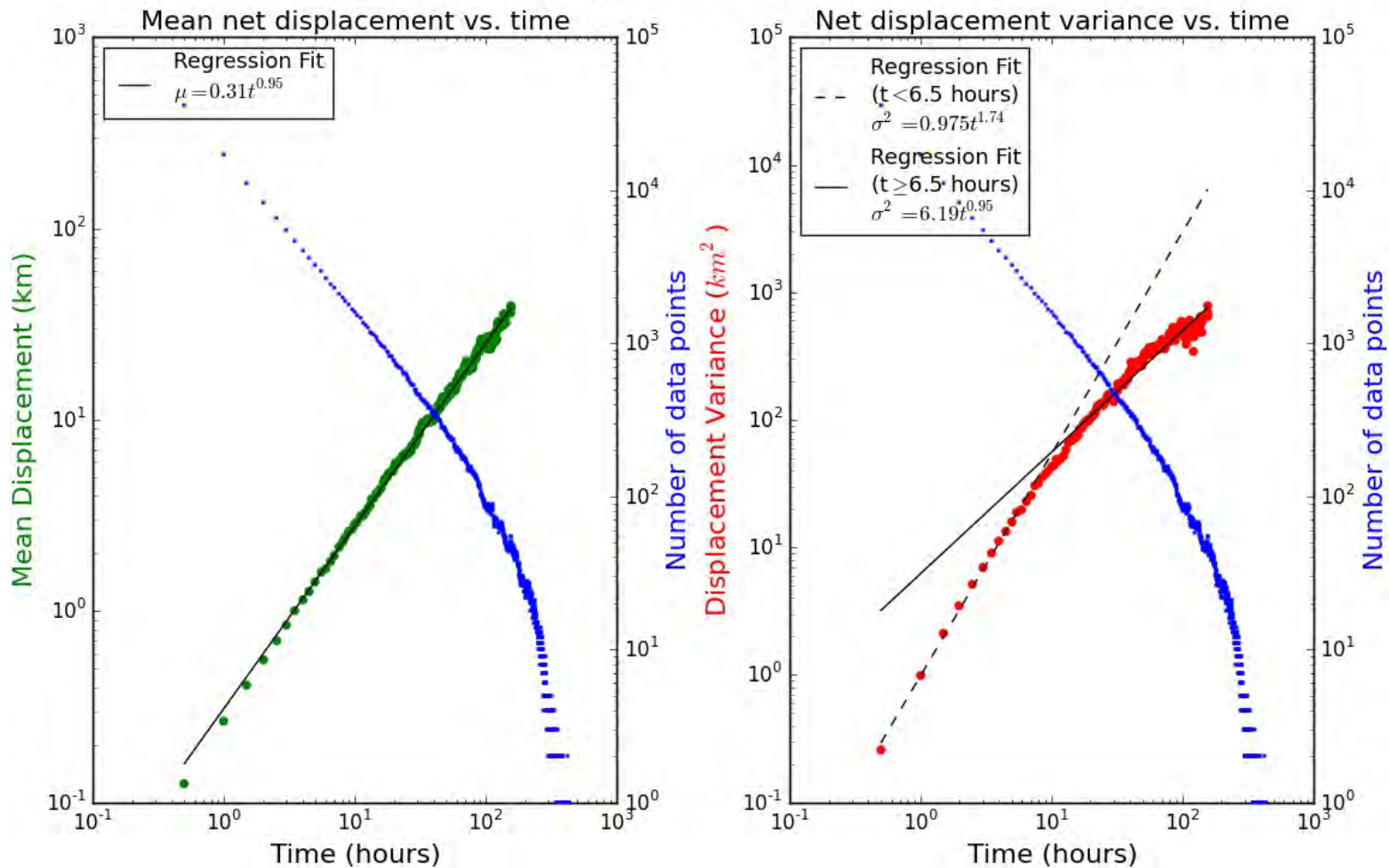
Normalized frequency of along-channel drifter observation distances for All season(s) in System region(s)

Bin size = 0.5 hours x 2.0 km
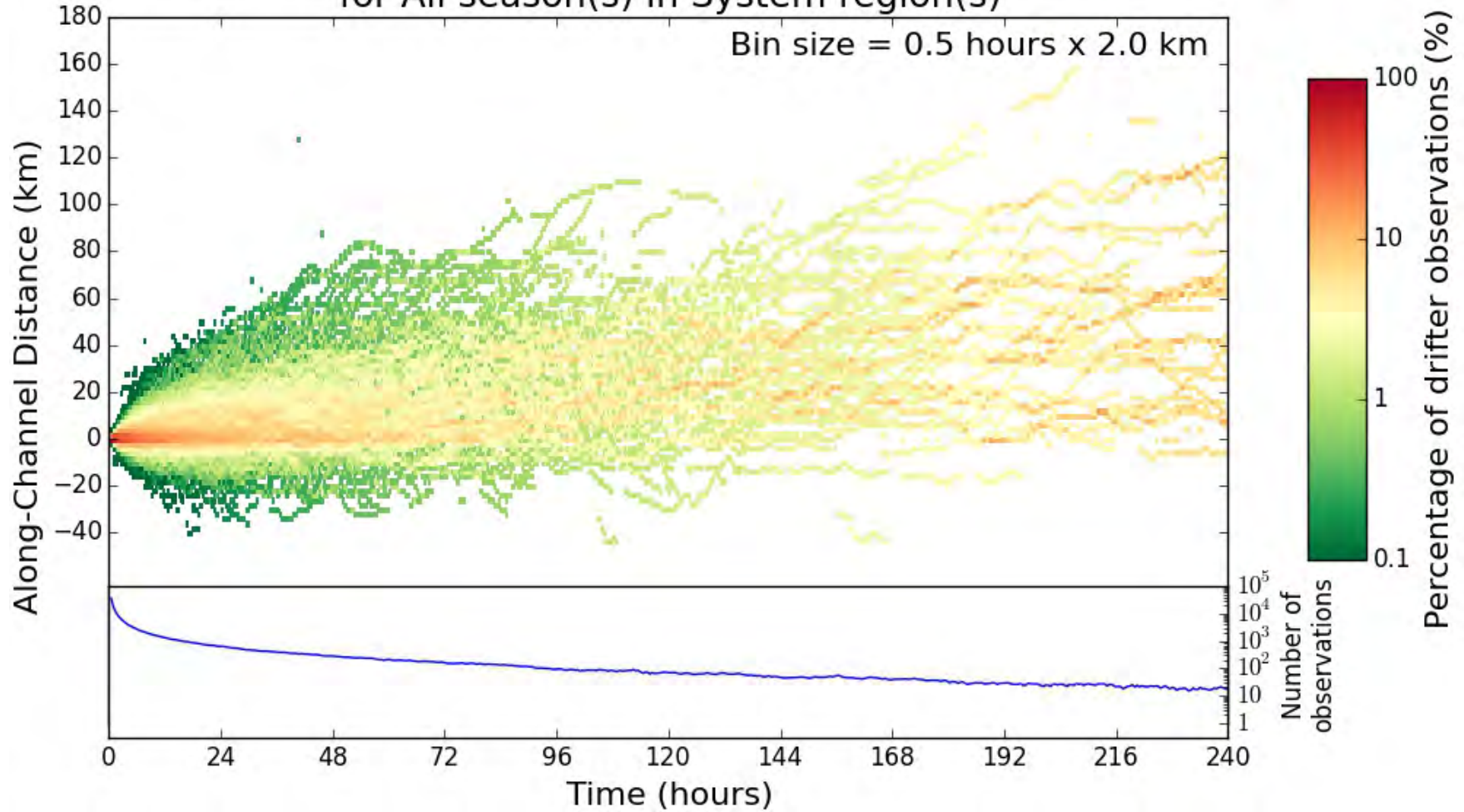
Mean and variance of net displacement vs. time for drifters in System region(s) during All season(s)

Inverse Gamma Distribution Model

$$P(x) = \frac{\beta^\alpha e^{-\frac{\beta}{x}}}{x^{\alpha+1}\Gamma(\alpha)}$$

$$\alpha(t) = \frac{(E(x))^2}{Var(x)} + 2 \approx 0.1t^{0.16} + 2 \text{ for } t \leq 6.5 \text{ hours}$$

$$\approx 0.016t^{0.95} + 2 \text{ for } t > 6.5 \text{ hours}$$

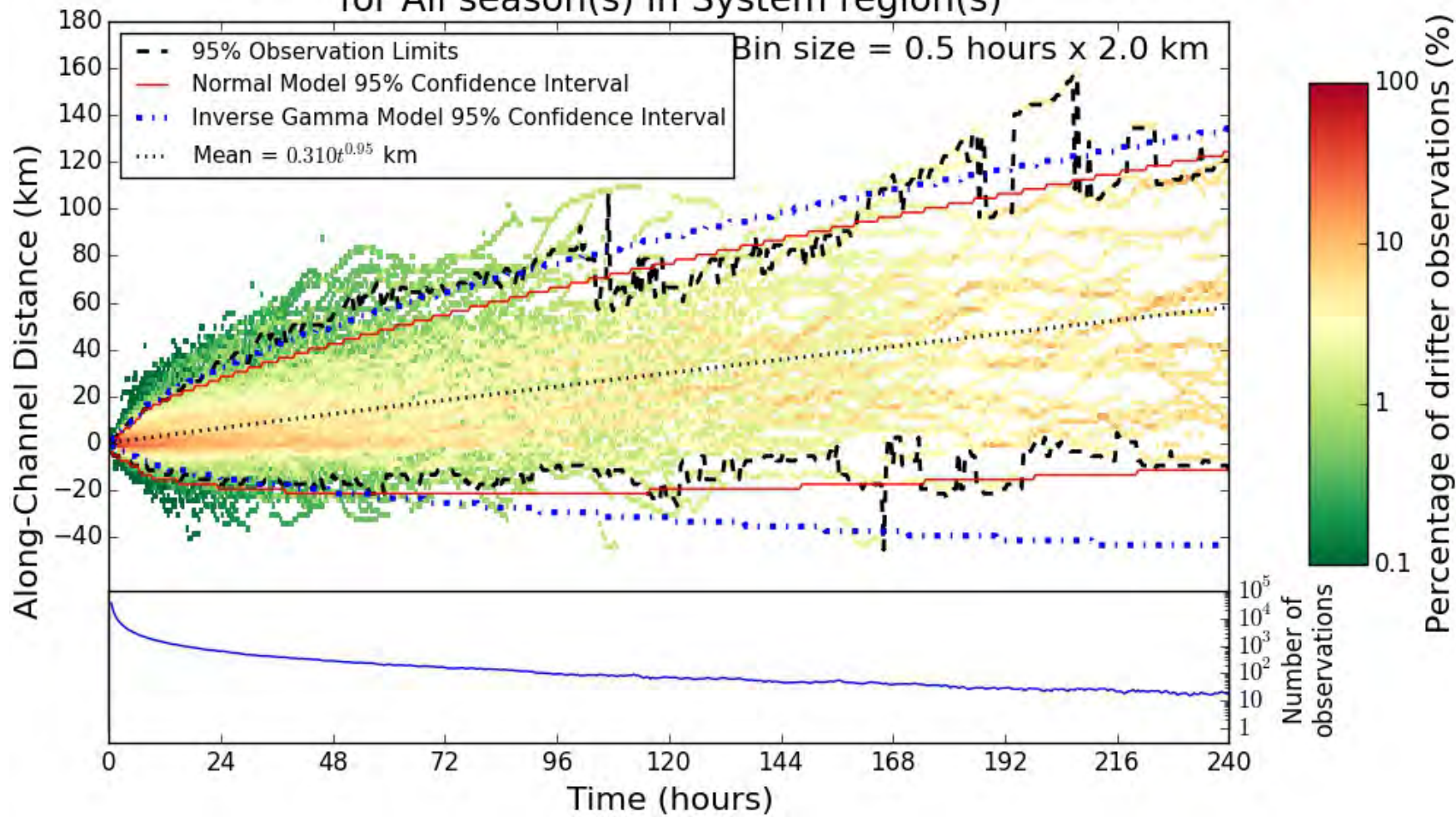$$E(x) = \frac{\beta}{\alpha - 1} \approx 0.31t^{0.95}$$

$$\beta(t) = \frac{(E(x))^3}{Var(x)} + E(x) \approx 0.03t^{1.11} + 0.31t^{0.95} \text{ for } t \leq 6.5 \text{ hours}$$

$$\approx 0.005t^{1.9} + 0.31t^{0.95} \text{ for } t > 6.5 \text{ hours}$$

$$Var(x) = \frac{\beta^2}{(\alpha-1)^2(\alpha-2)} \approx 0.975t^{1.74} \text{ for } t \leq 6.5 \text{ hours}$$

$$\approx 6.19t^{0.95} \text{ for } t > 6.5 \text{ hours}$$

Normalized frequency of along-channel drifter observation distances for All season(s) in System region(s)

Questions?