Environment and Climate Change Canada | Environnement et Changement climatique Canada

ASSESSING DRIFT UNCERTAINTY

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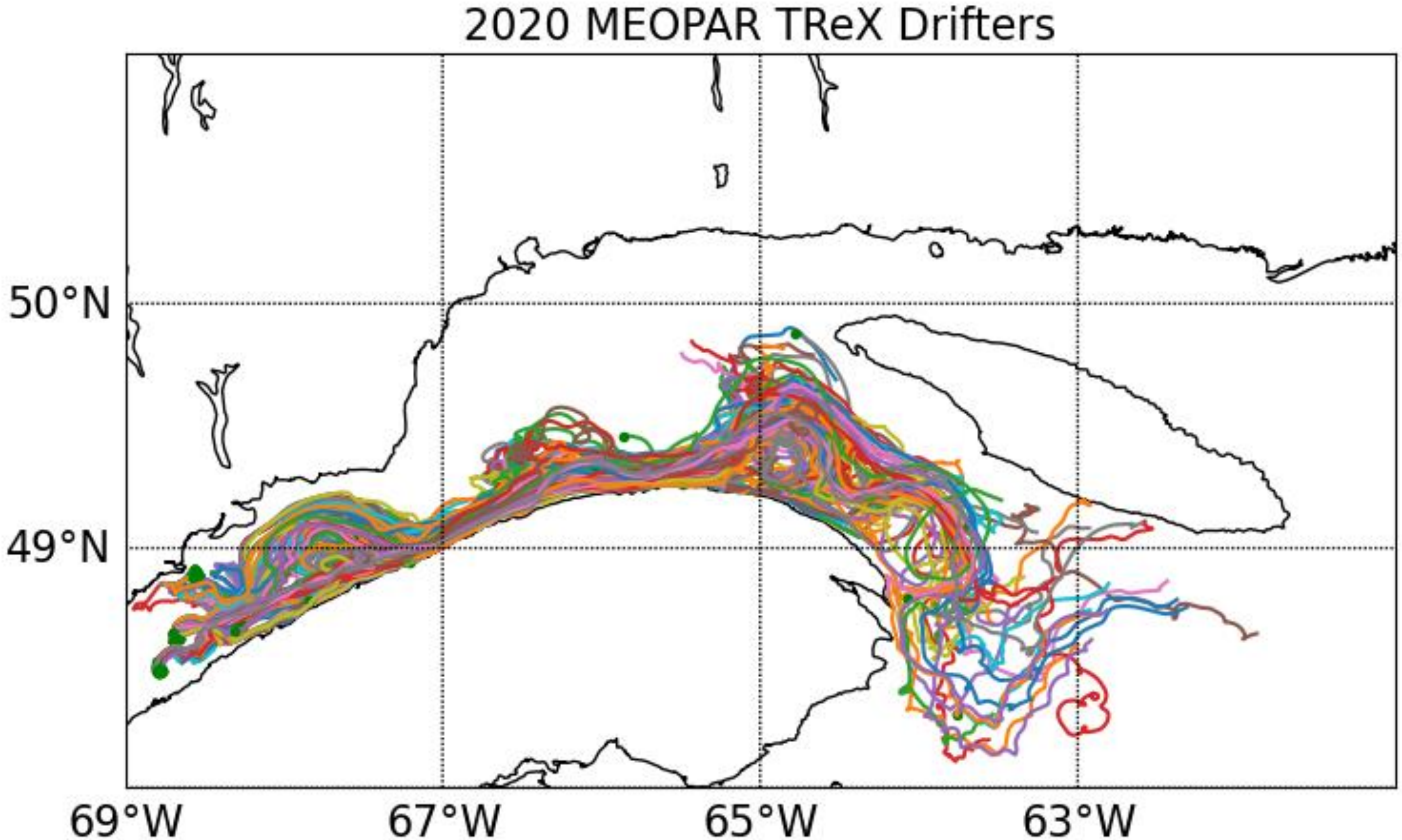
Environment and Climate Change Canada's 50th anniversary
50e anniversaire d'Environnement et Changement climatique Canada
Meteorological Service of Canada's 150th anniversary
150e anniversaire du Service météorologique du Canada

Canada

INTRODUCTION

- The uncertainty of surface currents is important to know for many marine operations
- Most abundant source of surface current data is in the form of Lagrangian drifters
- Look at 232 drifters deployed in the St. Lawrence Estuary as part of a tracer release experiment
- Will create synthetic Lagrangian trajectories using currents from two ocean models and compare dispersion estimates

MEOPAR TREX SEPT 2020



232 drifters released in St. Lawrence Estuary

- Surface: Osker, iSphere, ISMER
- Intermediate: SCT, UBC
- Drogued: CARTHE, CODE, iSVP

Calculate FSLE using two ocean/atmosphere modelling systems

- 1/36 deg CIOPSE + 2.5 km HRDPS
- 500m GSL + 2.5 km HRDPS

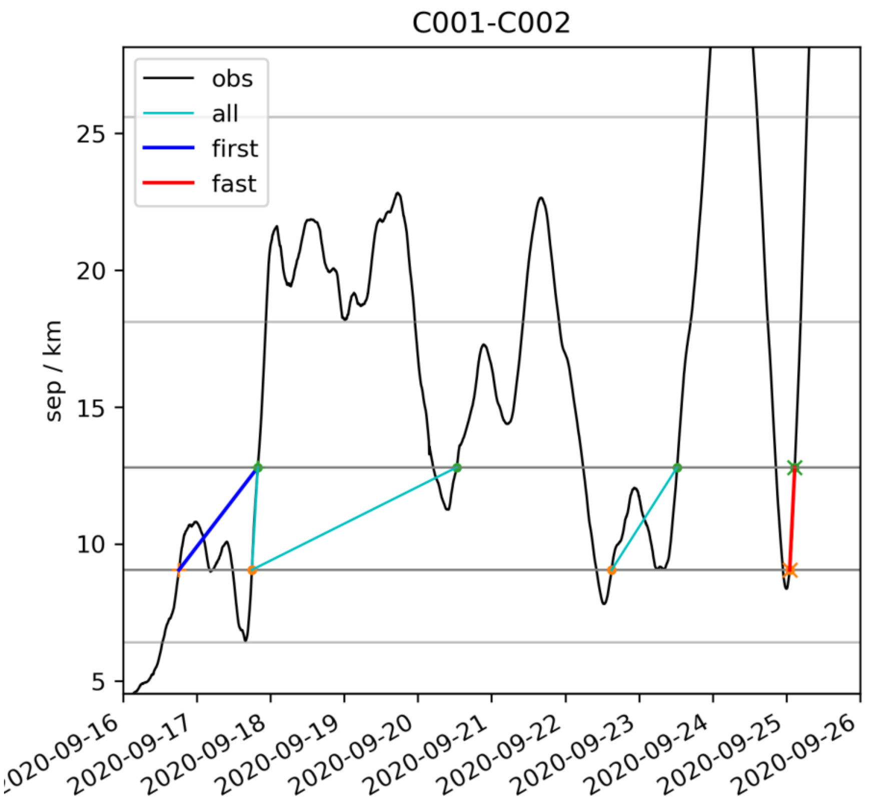
https://meopar.ca/research/tracer-release-experiment/

FINITE SCALE LYAPUNOV EXPONENT (FSLE)

- Will use the Finite Scale Lyapunov Exponent to estimate dispersion from the Lagrangian trajectories
- This method uses the separation distance as the independent variable and looks at the mean time for drifters to increase their separation distance
- Less sensitive to outliers and initial conditions then time based metrics
- Choose distances that increase multiplicatively:
- $\delta_n = r\delta_{n-1} = r^n\delta_0$
- Assuming exponential increase between bins:
- $\delta_n = \delta_{n-1}e^{\lambda_n t} \rightarrow \lambda_n = \frac{\ln(r)}{<T_n>}$, where $\lambda_n$is the Lyapunov exponent associated with the nth separation distance

HOW TO DETERMINE MEAN SEPARATION TIME

- Not trivial to calculate mean travel time when separation distance is not monotonically increasing
- Tested a few methods that are used in the literature
- We use the “fastest” crossing method as FSLE describes the largest separation rates
- When averaging over all drifter pairs the difference in mean travel times between methods is a constant multiplier

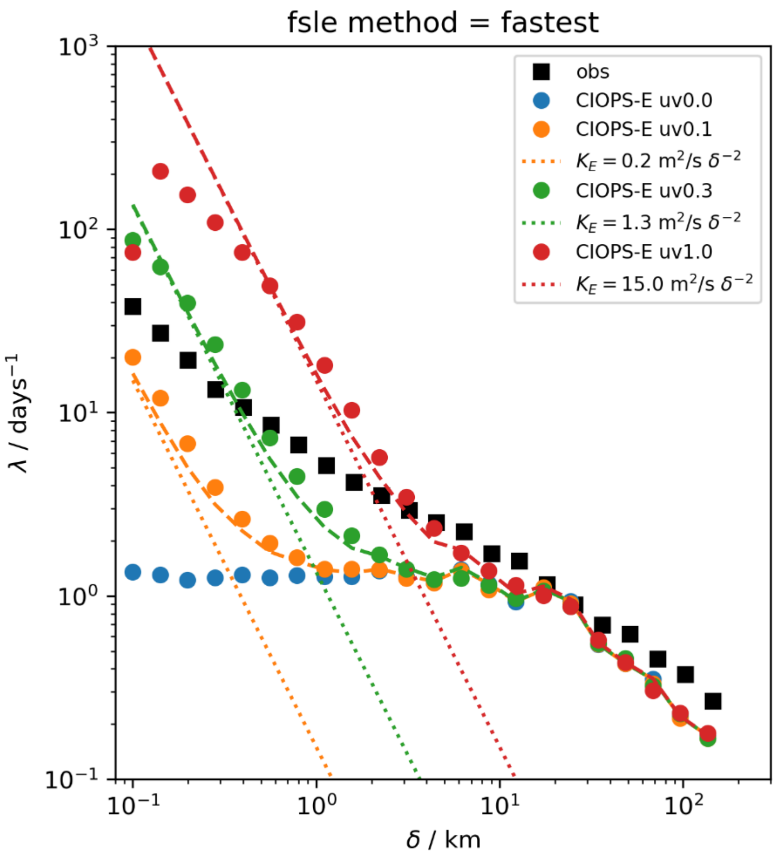


FSLE – GULF OF ST. LAWRENCE

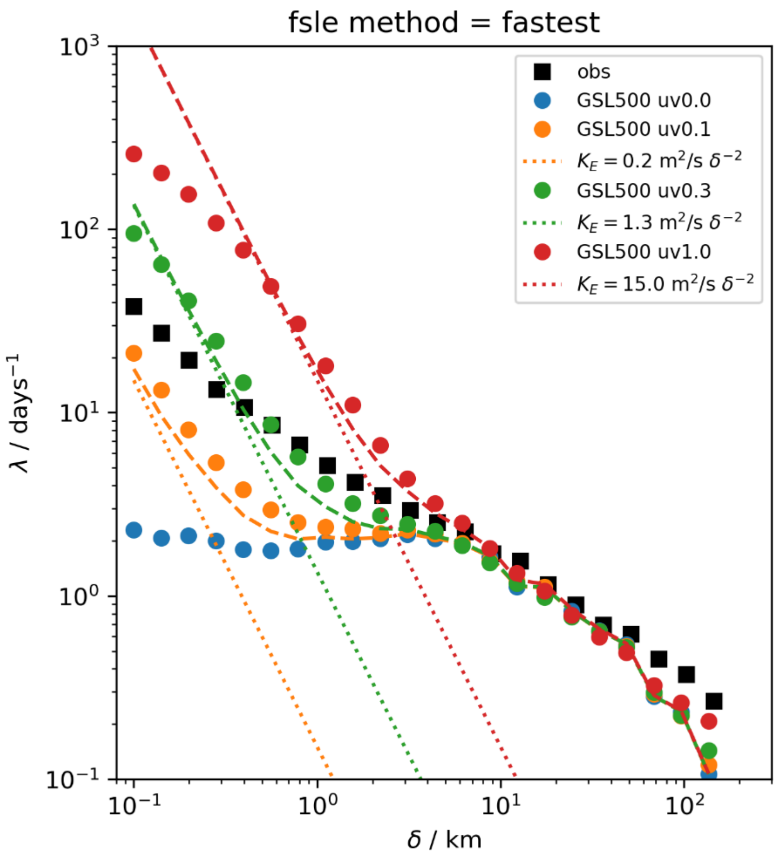
- Calculate FSLE from 232 drifters deployed (26796 unique pairs) in the Gulf of St. Lawrence
- Set $d_0 = 100$ m and $r = \sqrt{2}$
- Calculate FSLE from simulated trajectories (MLDP particle tracking software) using 2 model configurations
    1. CIOPSE + HRDPS
    2. GSL500 + HRDPS

FSLE COMPARISON

CIOPS-E



GSL500



SUMMARY

- Compare FSLE from observations with synthetic trajectories created from two ocean models in the St. Lawrence Estuary
- Dispersion well reproduced for scales greater than about 5 times the grid spacing
- For the estuary, sub-grid dispersion is not well reproduced by random walk