



Drifters for Special Applications

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IR0000032 – ITINERIS, Italian Integrated Environmental Research Infrastructures System
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Mission 4 “Education and Research” - Component 2: “From research to business” - Investment
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THE RIVER DRIFTER



Scripps Institution of Oceanography's

**LAGRANGIAN DRIFTER
LABORATORY**

MARINE DEBRIS TRACKERS



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Impacts of the GDP: Discovery of New Pelagic Marine Communities

COMMENT

<https://doi.org/10.1038/s41467-021-27188-6>

OPEN



Emergence of a neopelagic community through the establishment of coastal species on the high seas

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Discoveries of persistent coastal species in the open ocean shattering longstanding of biogeographic barriers. Floating plastic debris from the Subtropical Gyre supports a novel sea surface community composed of coastal species at sea that might portend significant ecological shifts in the environment.

nature ecology & evolution



Article

<https://doi.org/10.1038/s41559-023-01997-y>

Extent and reproduction of coastal species on plastic debris in the North Pacific Subtropical Gyre

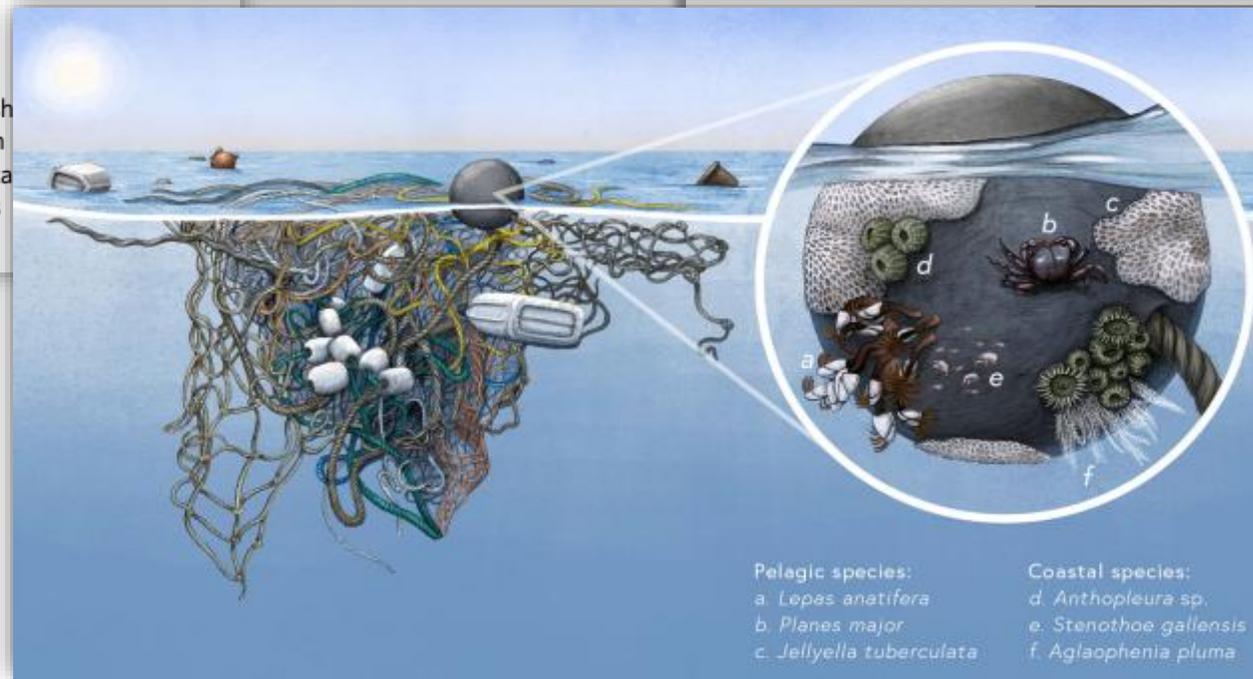
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Pelagic species:

- a. *Lepes anatifera*
- b. *Planes major*
- c. *Jellyella tuberculata*

Coastal species:

- d. *Anthopleura* sp.
- e. *Stenothoe gallensis*
- f. *Aglaophenia pluma*

colonized by a diverse array of coastal species that reproduce in the open ocean, contributing to community composition. Analysis of rafting plastic debris in the Subtropical Gyre revealed 37 coastal species of eastern Pacific origin, exceeding pelagic taxa diversity. 70.5% of debris items supported coastal taxa, including diverse taxonomic groups. Most coastal taxa reproduced on 70.5% of debris items. Most coastal taxa reproduced on rafts. Our results suggest that the Subtropical Gyre limited the colonization of the open

A Method to Estimate the Energy Transfer Across Scales from In-Situ Drifter Observations: Swarms of Drifters

- Ocean currents span across large planetary scales ($\sim 10^3$ - 10^4 m, at which Earth's rotation and stratification constrain the flow) to small scales ($< 10^{-2}$ and less, down to molecular scales at which Earth rotation and stratification effects are negligible) where energy dissipation by friction occurs.
- In a classic turbulence theory, energy fluxes go from large scale to small dissipation scales, and this is called the **forward energy cascade**
- For Geophysical flows however, the situation is more complicated than the scenario depicted above because of rotation and stratification effects. The direction of the energy flux is **scale dependent** and can be sometimes reversed. In other words an **inverse energy cascade, from small scales to larger scale, may occur**

- If for a moment we assume that the forcing of the ocean occurs at a planetary spatial scales ($\sim 10^3$ - 10^4 m, at which Earth's rotation and stratification constrain the flow) energy dissipation by friction at small scales ($< 10^{-2}$, at which Earth rotation and stratification effects are negligible) is required to maintain equilibrium, otherwise the ocean system would keep accelerating and momentum would keep increasing indefinitely
- Basin-wide gyres sustain a rich, energetic mesoscale eddy field which is well described by the quasi-geostrophic turbulence theory that is, however, characterized by energy fluxes from the injection/extraction scales towards larger scales
- **Our problem consists in measuring the direction of the energy cascade to determine which processes are responsible for maintaining equilibrium**

Kolmogorov 4/5th law of turbulence states that:

$$\langle \Delta u_l^3(r) \rangle = -\frac{4}{5} \varepsilon r, \quad \begin{array}{l} \varepsilon > 0 \Rightarrow \text{forward cascade} \\ \varepsilon < 0 \Rightarrow \text{inverse cascade} \end{array}$$

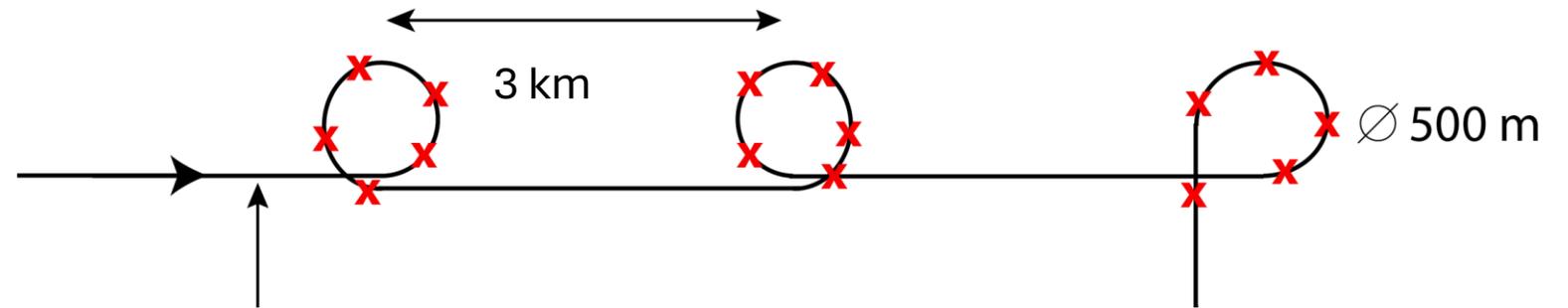
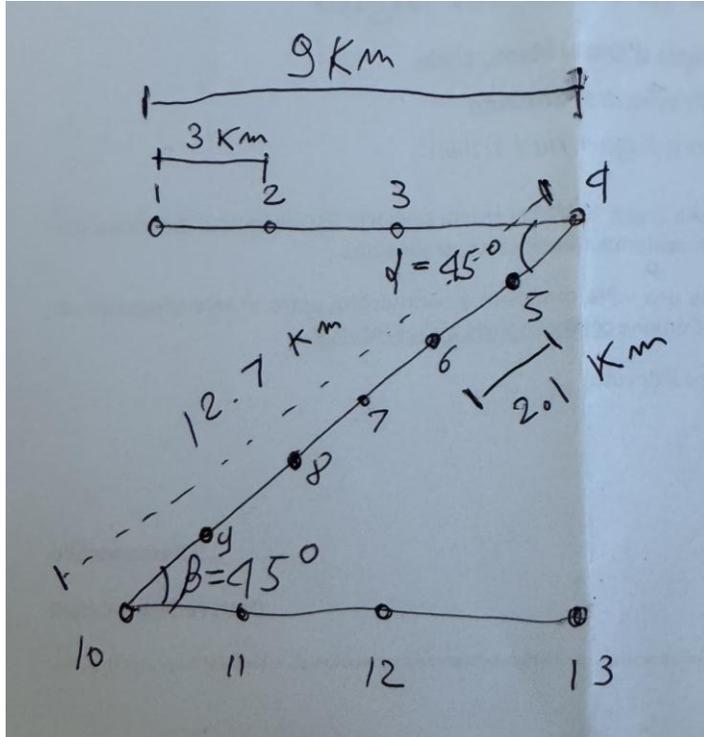
Where ε is the rate of dissipation of energy, r is the spatial scales

$$\Delta u_l^3(r)$$

Is the velocity gradient along the direction defined by the pair of points at which the velocity is measured and $\langle \rangle$ is the average operator carried over a meaningful time-scale.

The problem is to create a dataset of velocity pair observations to perform this calculation

Approach



A large array of drifters that measure surface velocity, if deployed quickly (5-6 hours) allows the computation of the direction of the energy transfer across scales for a variety of values of r (recall that r is the radial distance between pairs of velocity observations)

From the Ocean to Lakes and Rivers: the μ -SVP™ Drifter

LAGRANGIAN DRIFTER LABORATORY MICRO SVP DRIFTER

Sea surface temperature, waves and 2 to 5 m depth currents

Main specs

- Scaled down version of the proven mini-SVP concept to enhance its Lagrangian properties
- Eco-friendly: available in bio-plastic and with cotton canvas drogue, ROHS
- can be drogued between 2 and 5 m depth, configurable with Iridium telemetry
- Same sensor suite as the mini-SVP(SST, SLP, wind, etc)
- lightweight

Spherical, 8 inches diameter



Features

- (1) Easy deployment allows repeated and concurrent array realizations
- (2) Designed for operational deployment: no skilled operator is required
- (3) can be deployed at once from self-deploying box, approximating a buoyant point source tracer. Each box may contain up to 50 μ -SVPs



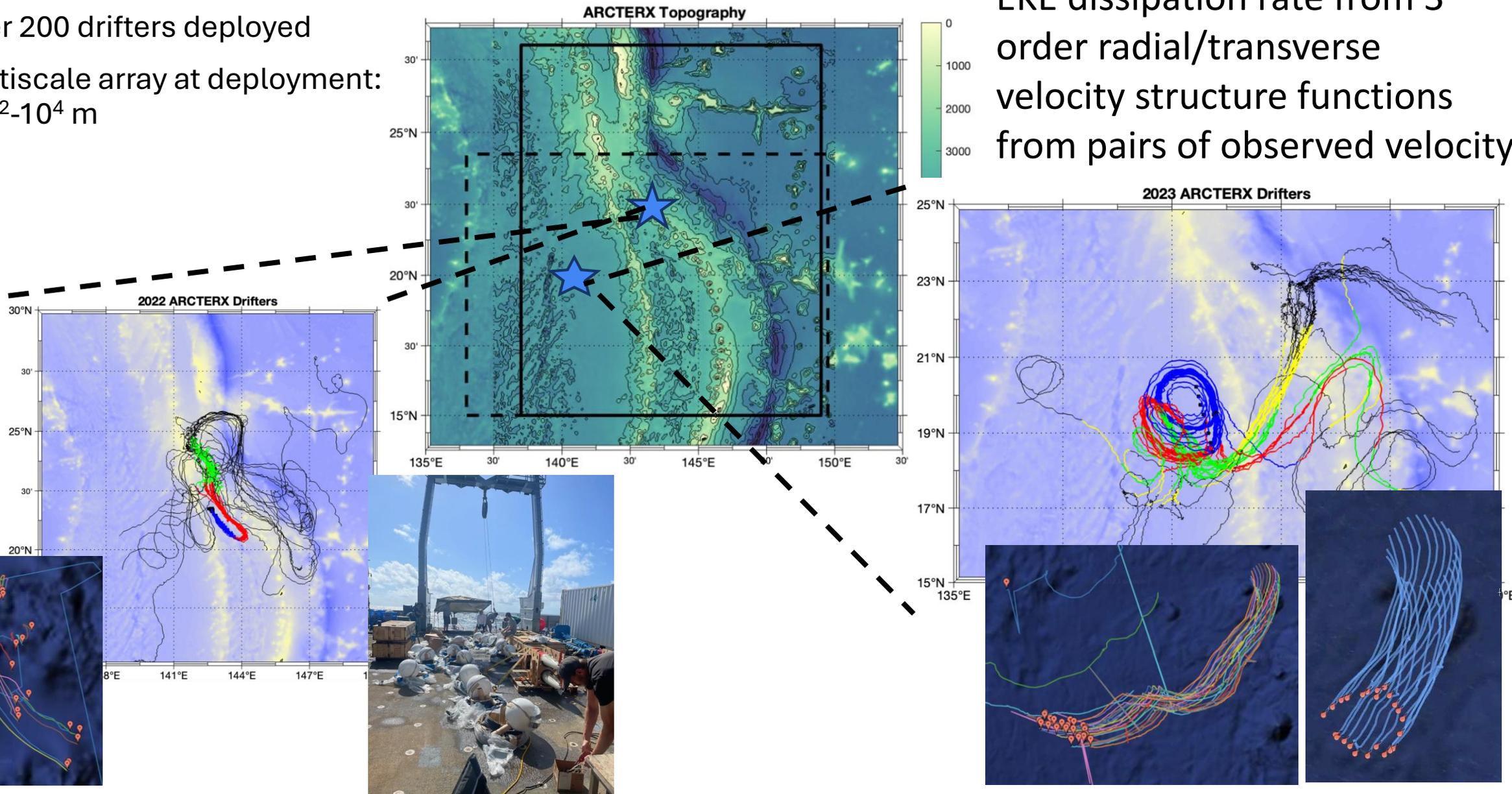
Measuring the Energy Transfer Across Scales In the NW Pacific

$$\langle \Delta u_l^3(r) \rangle = -\frac{4}{5} \varepsilon r,$$

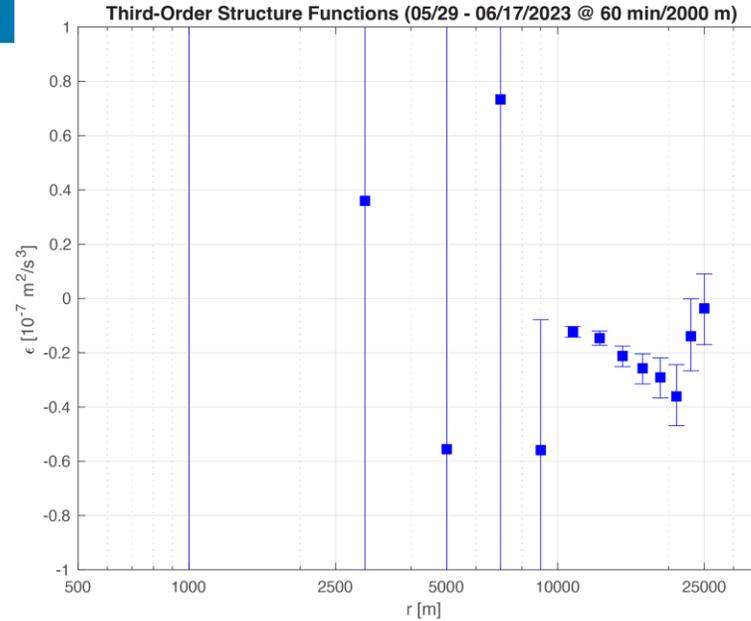
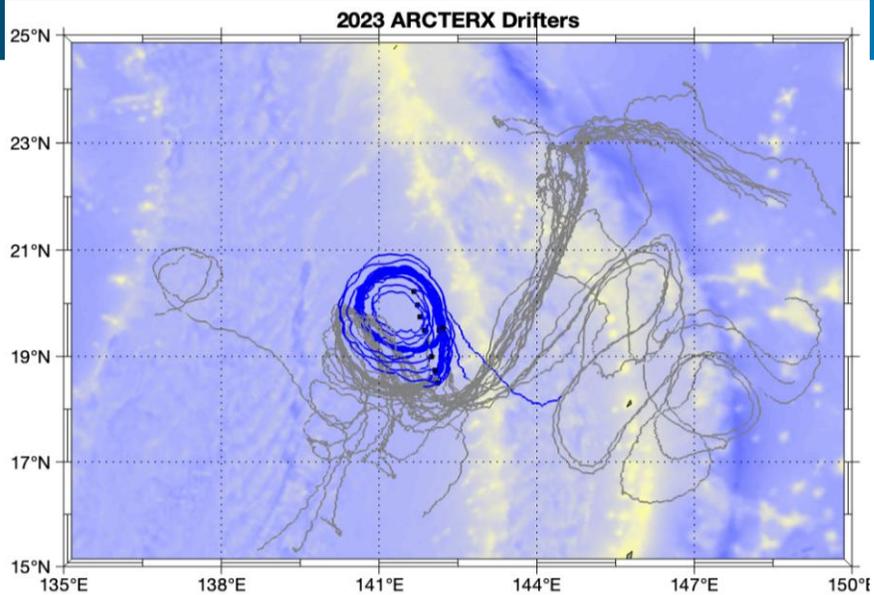
March 2022 and February 2025

- Over 200 drifters deployed
- Multiscale array at deployment: $\sim 10^2$ - 10^4 m

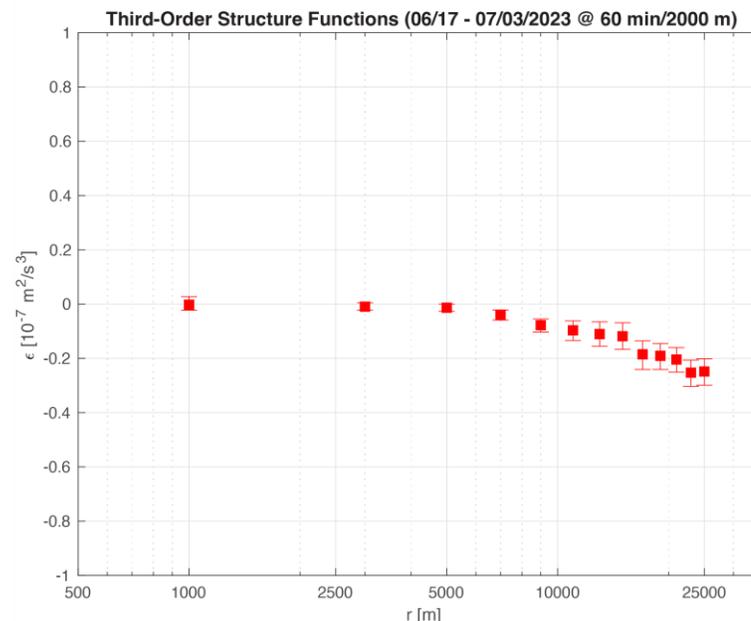
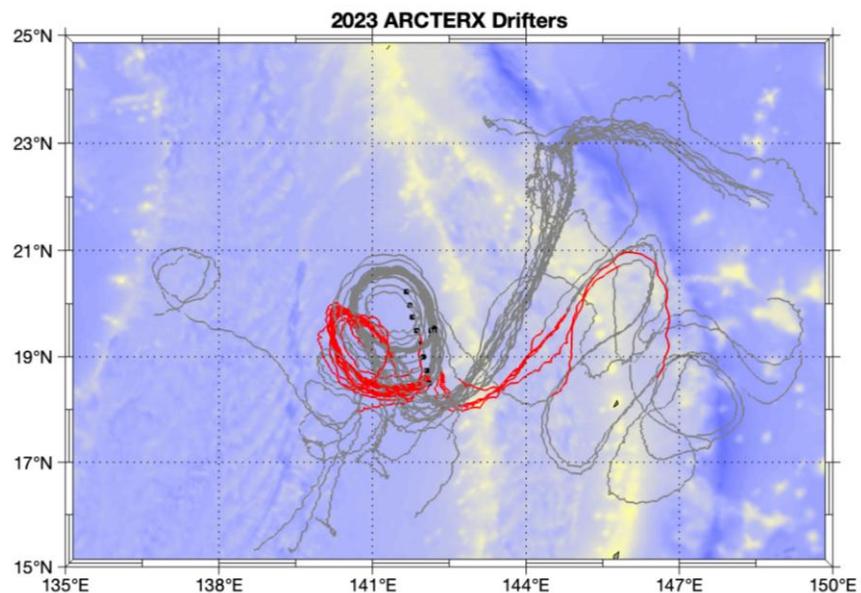
EKE dissipation rate from 3rd order radial/transverse velocity structure functions from pairs of observed velocity



Preliminary results from the 2023 experiment



Eddy (first revolution):
inverse cascade for $L \sim >$
8-10 km, perhaps
shifting to direct
cascade for $L > 20$ Km



Eddy (second
revolution): inverse
cascade for $L \sim >$ 7 km



Drifter Technology in Coastal Polar Areas: Helheim Fjord, Greenland



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THANKS!

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