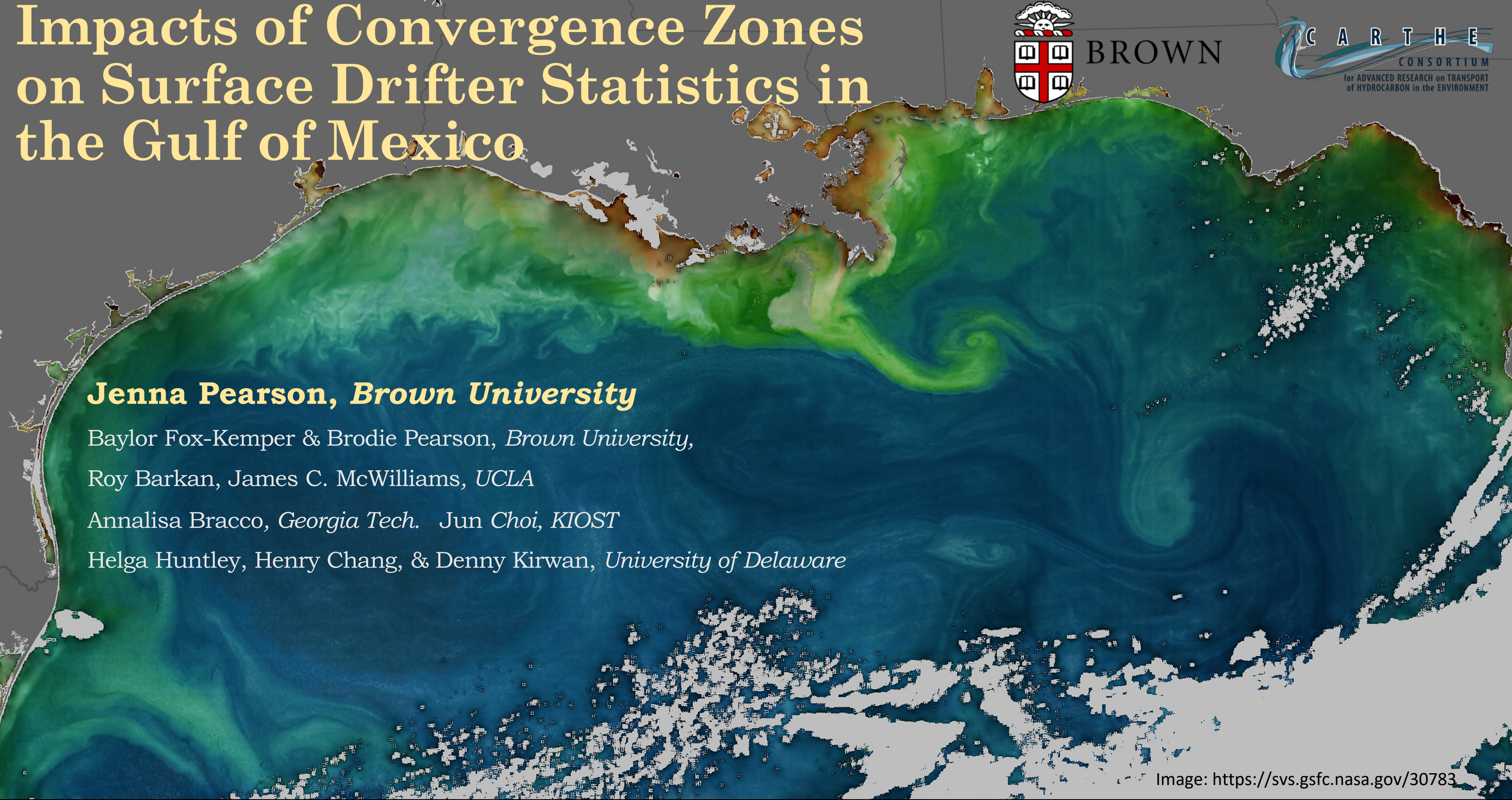

Image: https://svs.gsfc.nasa.gov/30783

Impacts of Convergence Zones on Surface Drifter Statistics in the Gulf of Mexico

BROWN

CARTHE CONSORTIUM for ADVANCED RESEARCH on TRANSPORT of HYDROCARBON in the ENVIRONMENT

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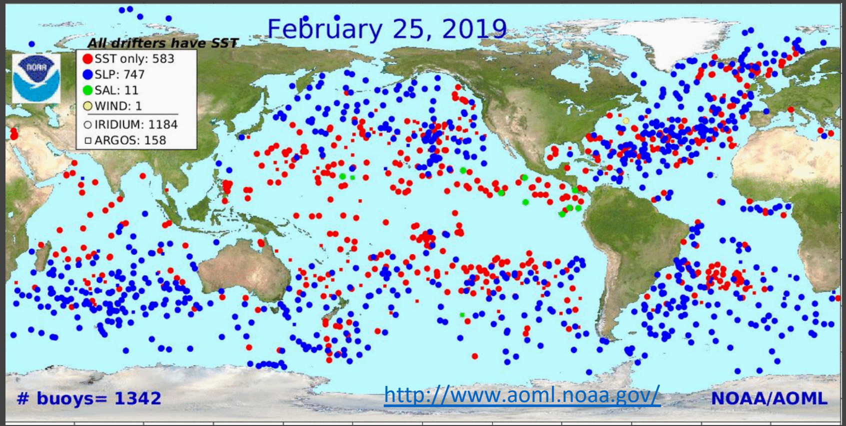
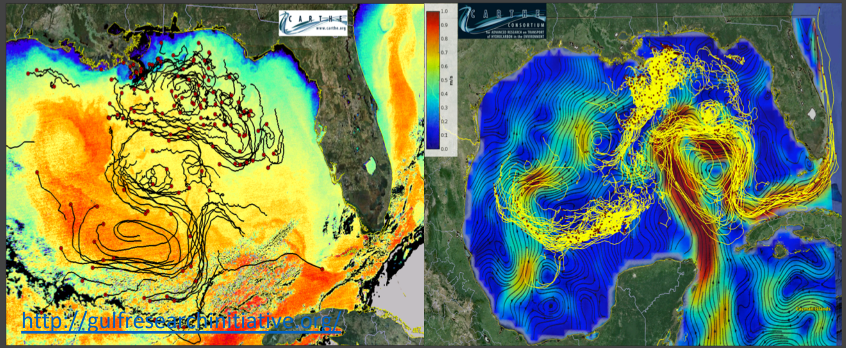
Introduction

- Surface drifters are a growing global and regional platform
  - Low cost
  - Autonomous
  - Long lifetimes



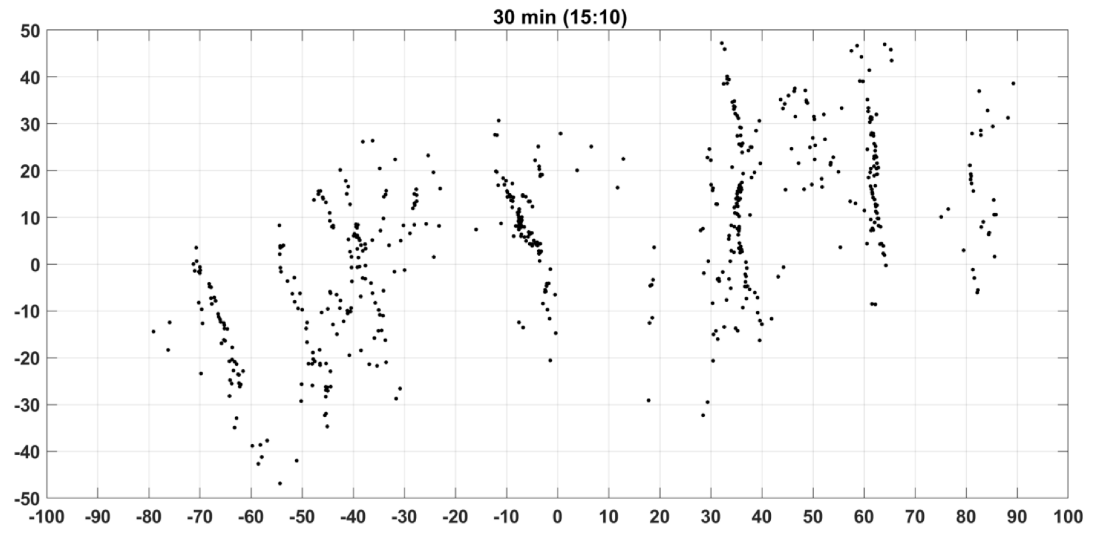
- They provide synoptic measurements of surface currents

- Capable of sampling mesoscale and submesoscale processes



Motivation

Chang et al 2019, Submitting to JPO



Drifters get trapped in fronts, zipper structures, and long lived eddies

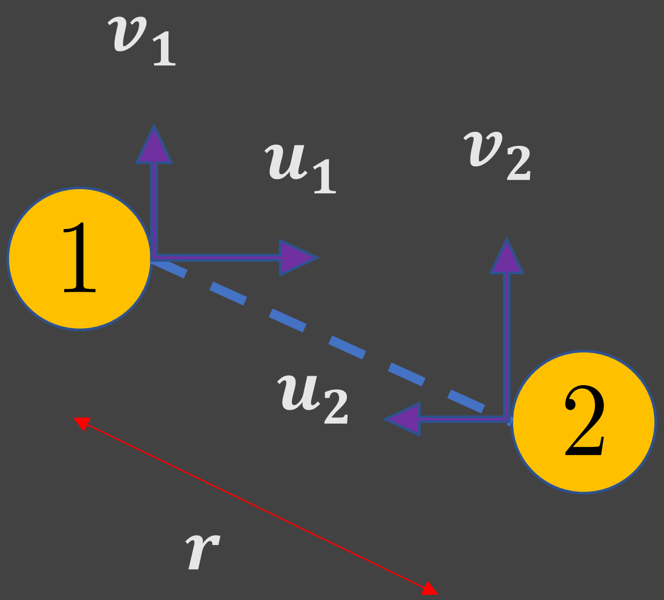
If the tendency to remain in the feature is stronger than the wind slippage's ability to remove it from that feature or other dynamics to break it up

→ sampling bias

Structure Functions

$$D^n_{L,T}(r) = \langle [u_{L,T}(\boldsymbol{x}+\boldsymbol{r}) - u_{L,T}(\boldsymbol{x})]^n \rangle$$

- Moments of the velocity increments
- Relative coordinate system
  - Longitudinal
  - Transverse
- Focus on second and third order



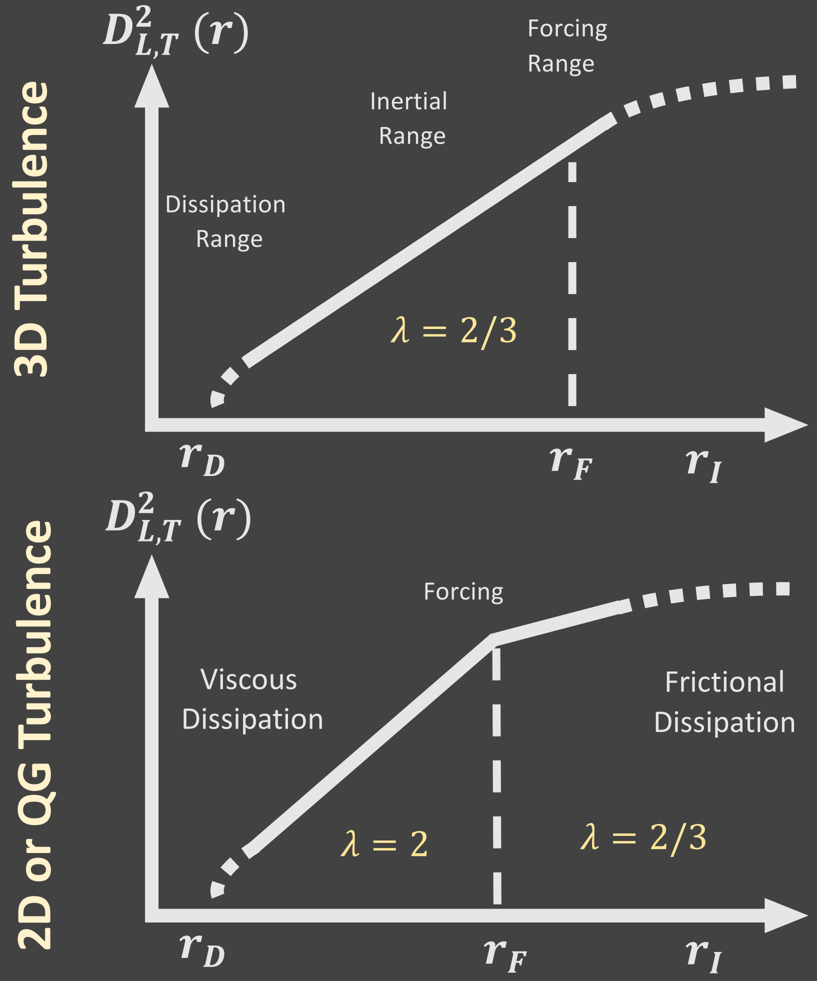
Second Order

$$D^2_{L,T}(r) = \langle \Delta u^2 \rangle$$

- Smoothed version of isotropic and homogenous kinetic energy spectrum with slope β

$$D^2_{L,T}(r) \propto r^{\lambda}, \qquad \lambda = -\beta - 1$$

- Different turbulent regimes have different spectral slopes

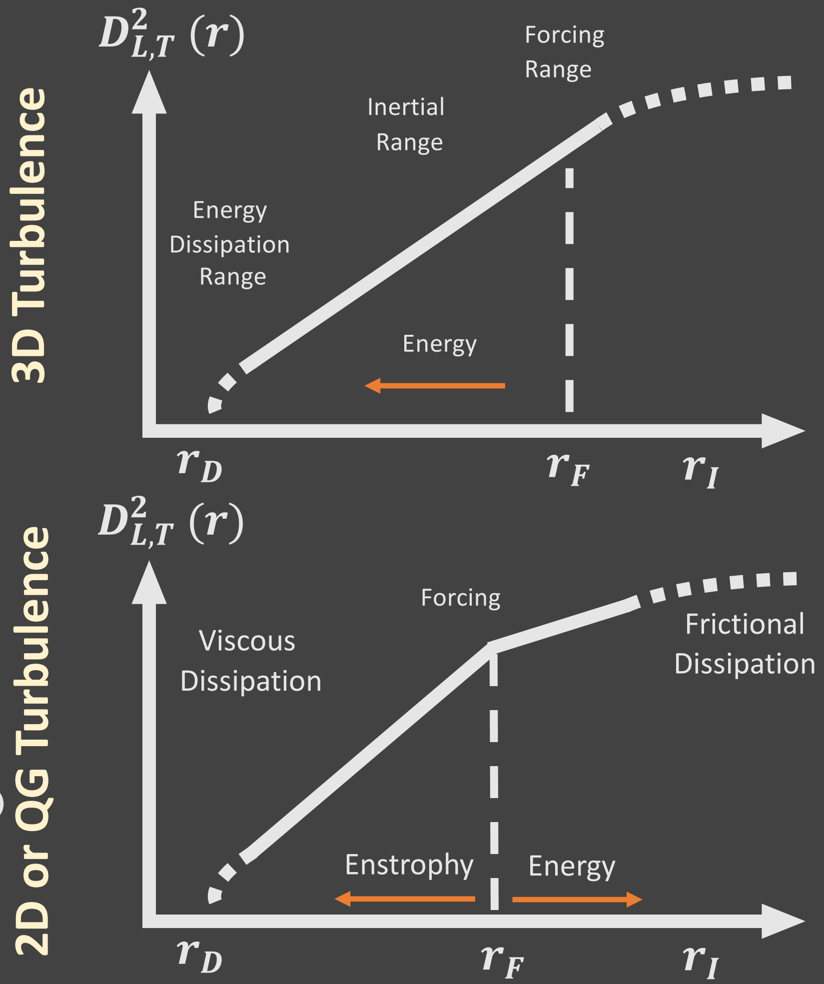


Third Order

$$D_L^3 = \langle \Delta u^3 \rangle$$

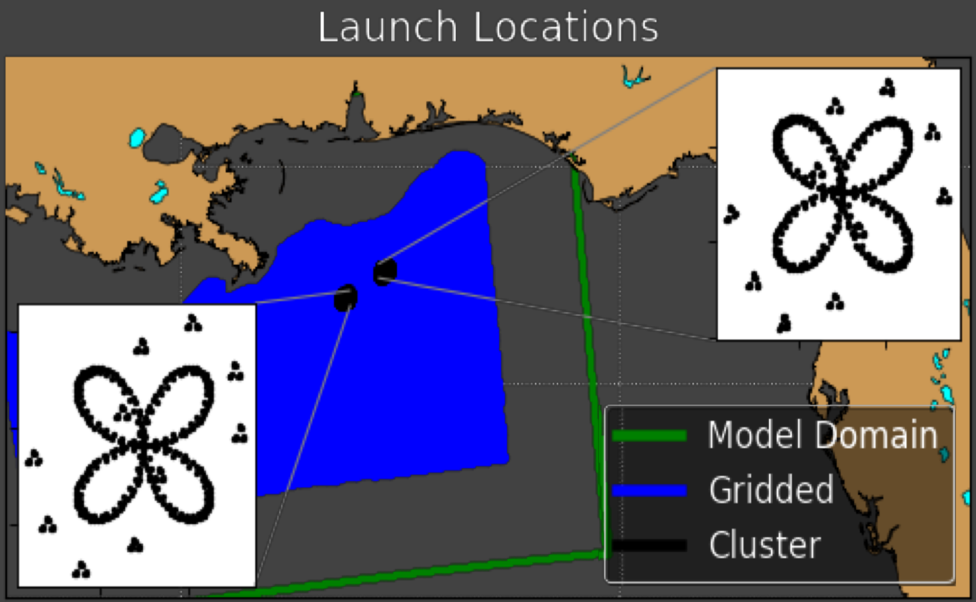
- Gives information about direction of spectral fluxes of energy or enstrophy

$$D_L^3(r) \propto \begin{cases} -\frac{4}{5}|\varepsilon| r & \text{downscale energy cascade } (\varepsilon < 0) \\ \frac{3}{2}|\varepsilon| r & \text{upscale energy cascade } (\varepsilon > 0) \\ \frac{1}{8}|\varepsilon_Z| r^3 & \text{downscale enstrophy cascade } (\varepsilon_Z > 0) \end{cases}$$

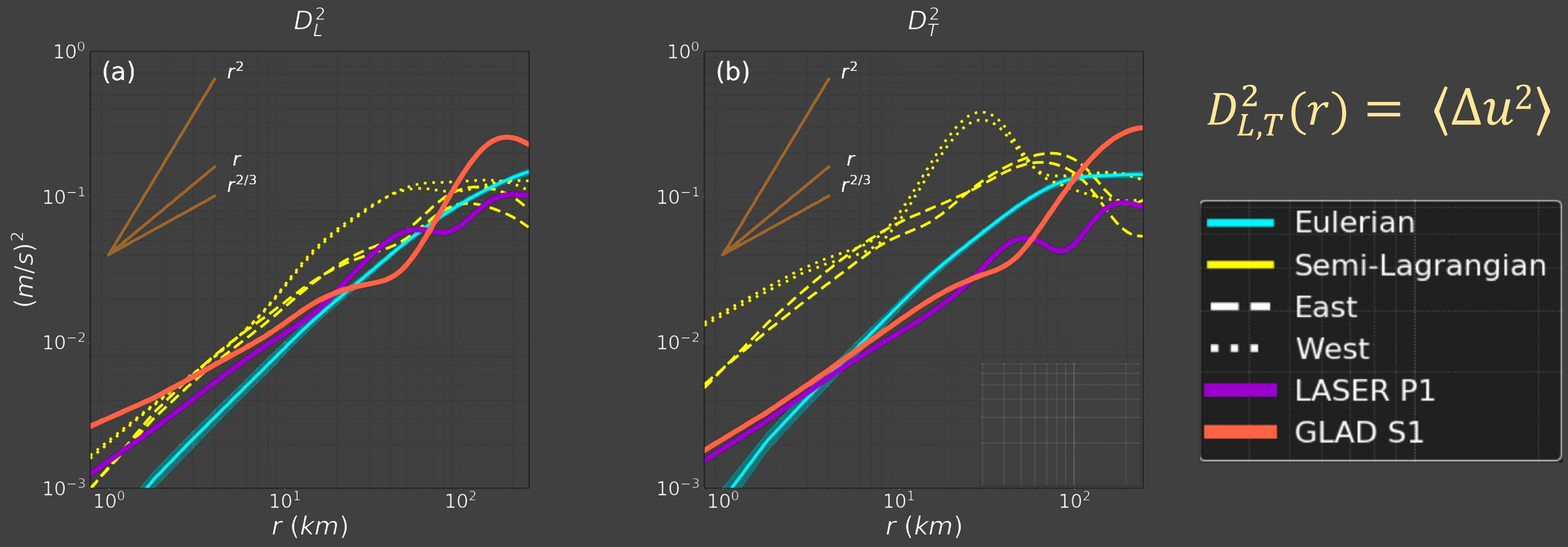


Drifter Deployments

- 2 GLAD-like 90 particle cluster releases (S-shape)
- 2 LASER-like 300 particle cluster releases (clover)
- One of each type launched in LASER location (West)
- One of each type launched in GLAD location (East)
- One large particle gridded release of drifters (blue)



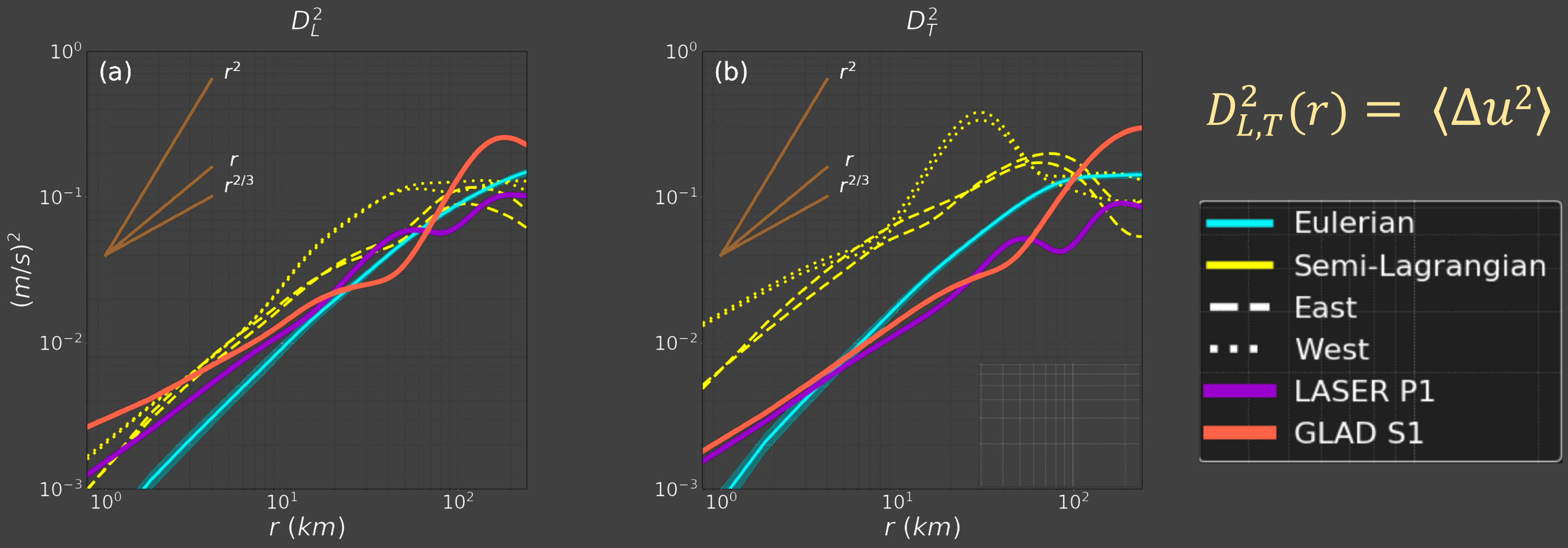
Cluster Second Order Results



$$D^2_{L,T}(r) = \langle \Delta u^2 \rangle$$

Overall shallower slopes and larger magnitude

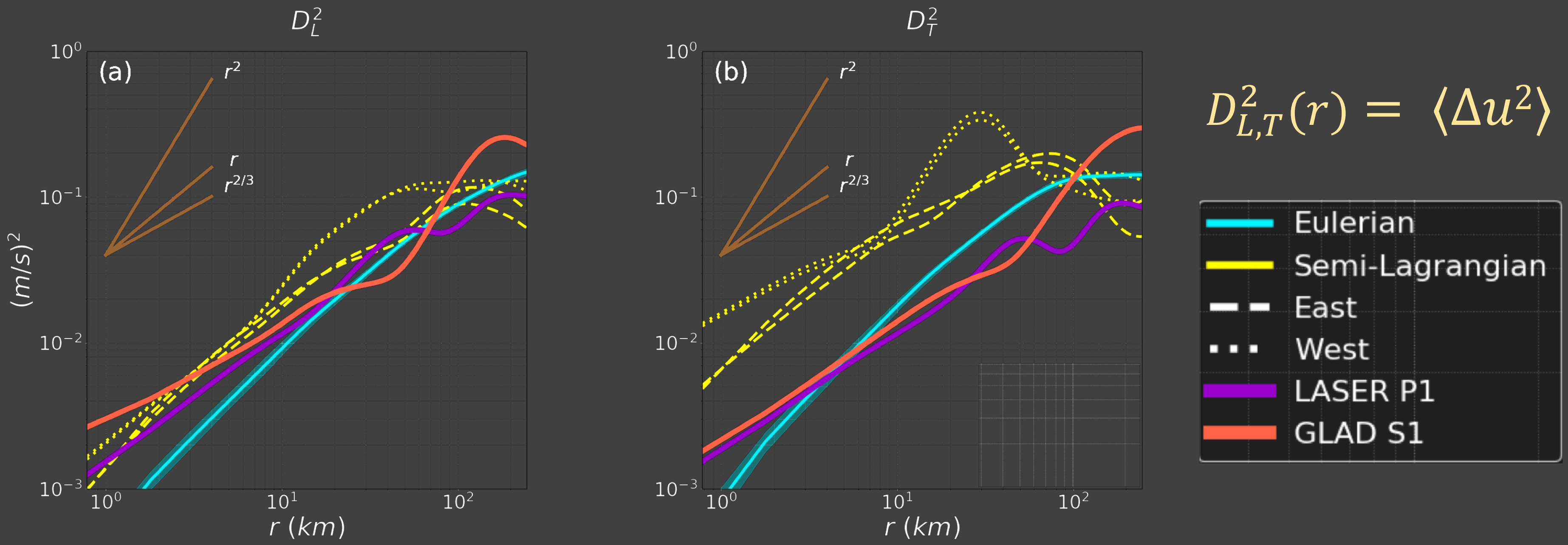
Launch Location



$$D_{L,T}^2(r) = \langle \Delta u^2 \rangle$$

Accounts for the largest differences

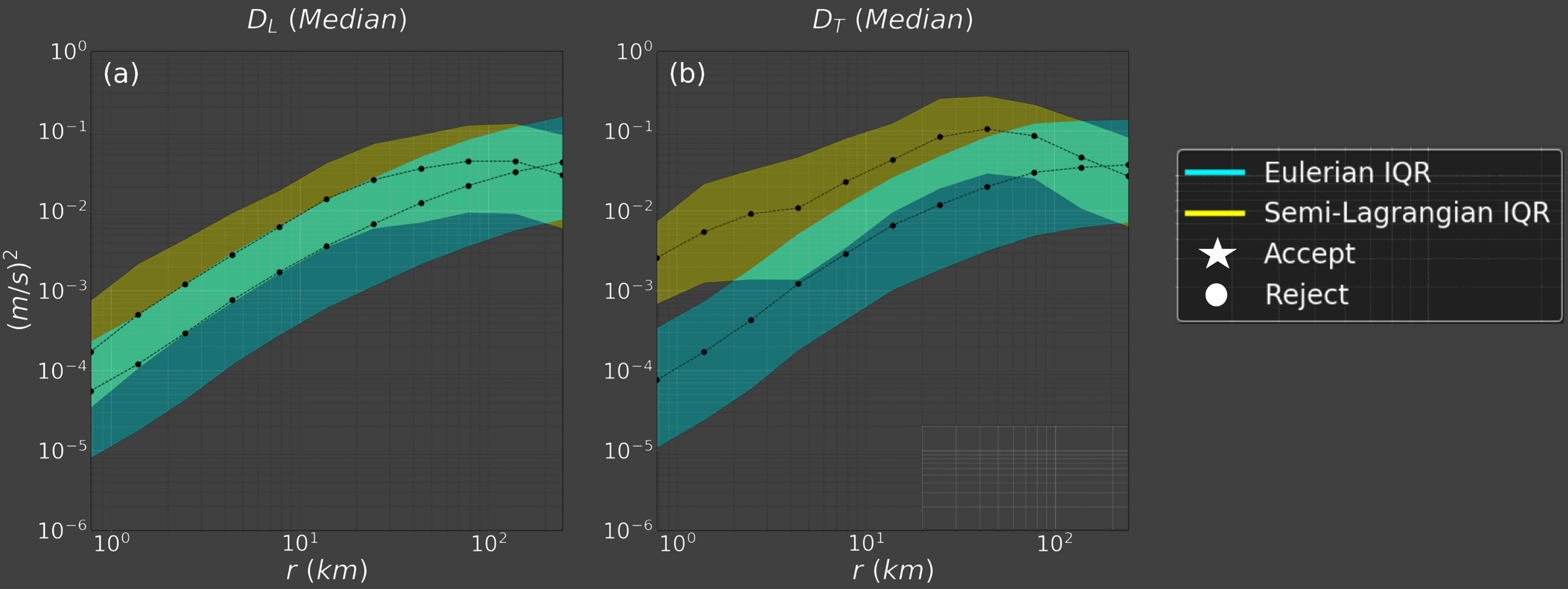
Launch Pattern



$$D_{L,T}^2(r) = \langle \Delta u^2 \rangle$$

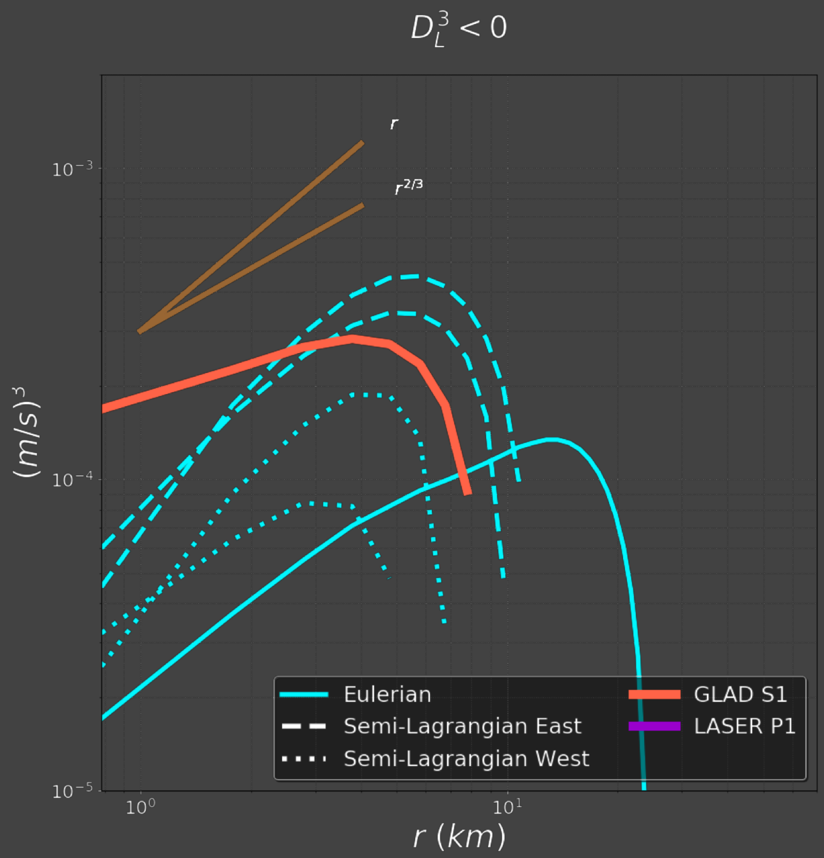
Small differences between drifter SFs – resolution?

Wilcoxon Rank Sum Test



Grouped cluster releases and Eulerian statistics are significantly different across all scales

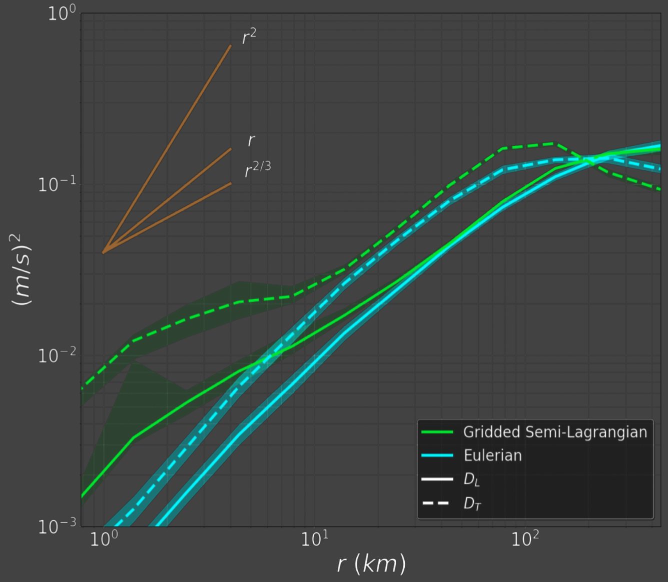
Cluster Third Order Results



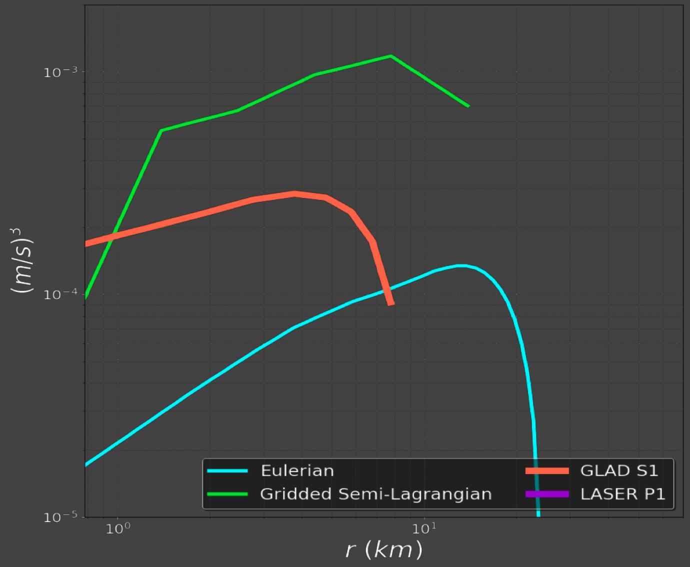
- Model structure functions depend linearly on r
- Drifters overestimate energy dissipation by factor of 2 to 8
- Cluster releases underestimate scale of sign change by 2-20km

Gridded Results

$D^2_{L,T}$



$D^2_L < 0$

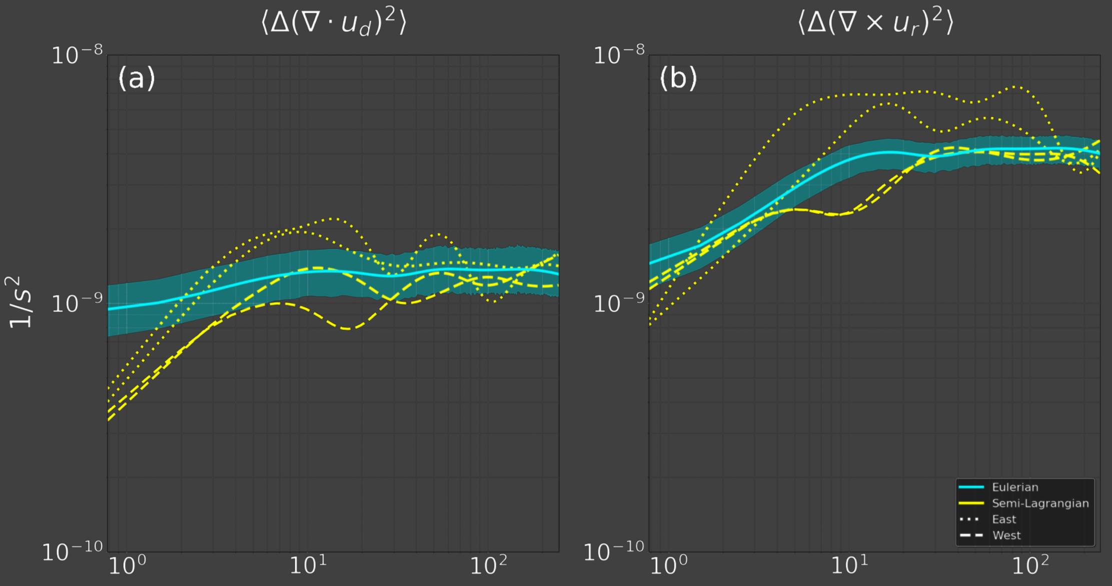


Second order shallower below 10km but agree in mesoscale range

Third order overestimates magnitude

Curl and Divergence Structure Functions

$$D^n_{L,T}(r) = 2\langle u_\gamma(x)\rangle \text{-} 2\langle u_\gamma(x) u_\gamma(x+r)\rangle$$

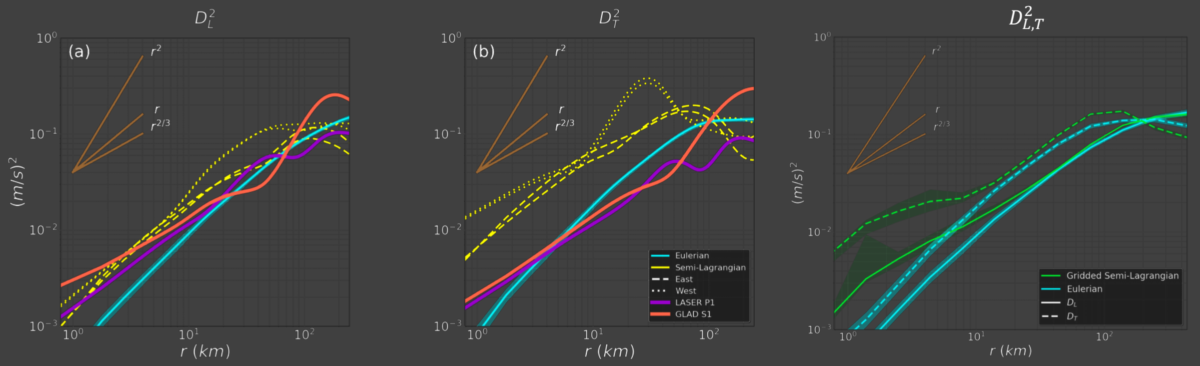


Cluster SFs are steeper below ~ 10km

Summary

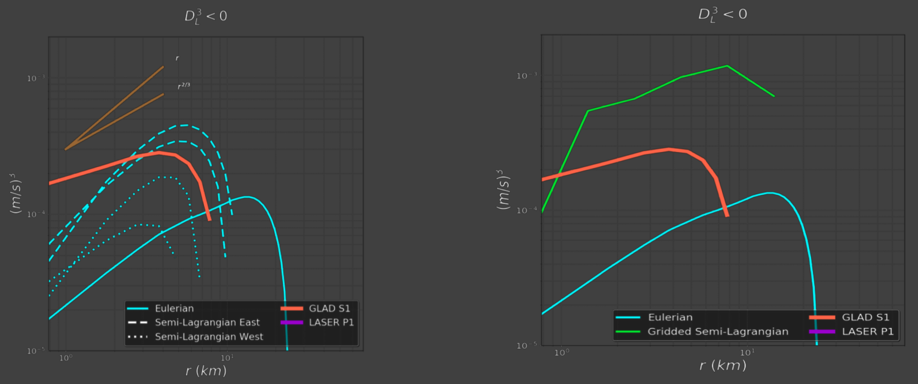
Second order drifter structure functions:

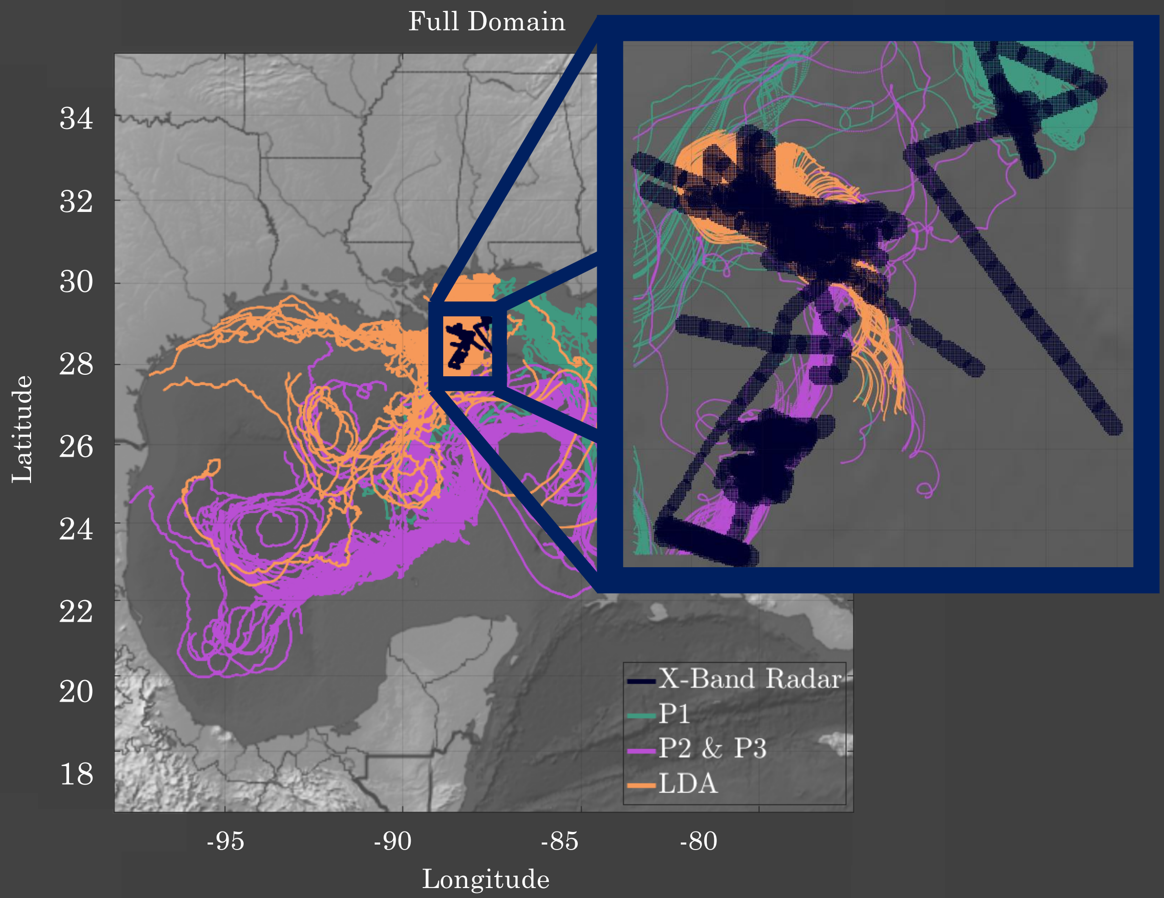
Consistently shallower than Eulerian structure functions below 10km



Third order drifter structure functions:

Will systematically and significantly overestimate the spectral energy flux and underestimate the transition scale to a forward cascade

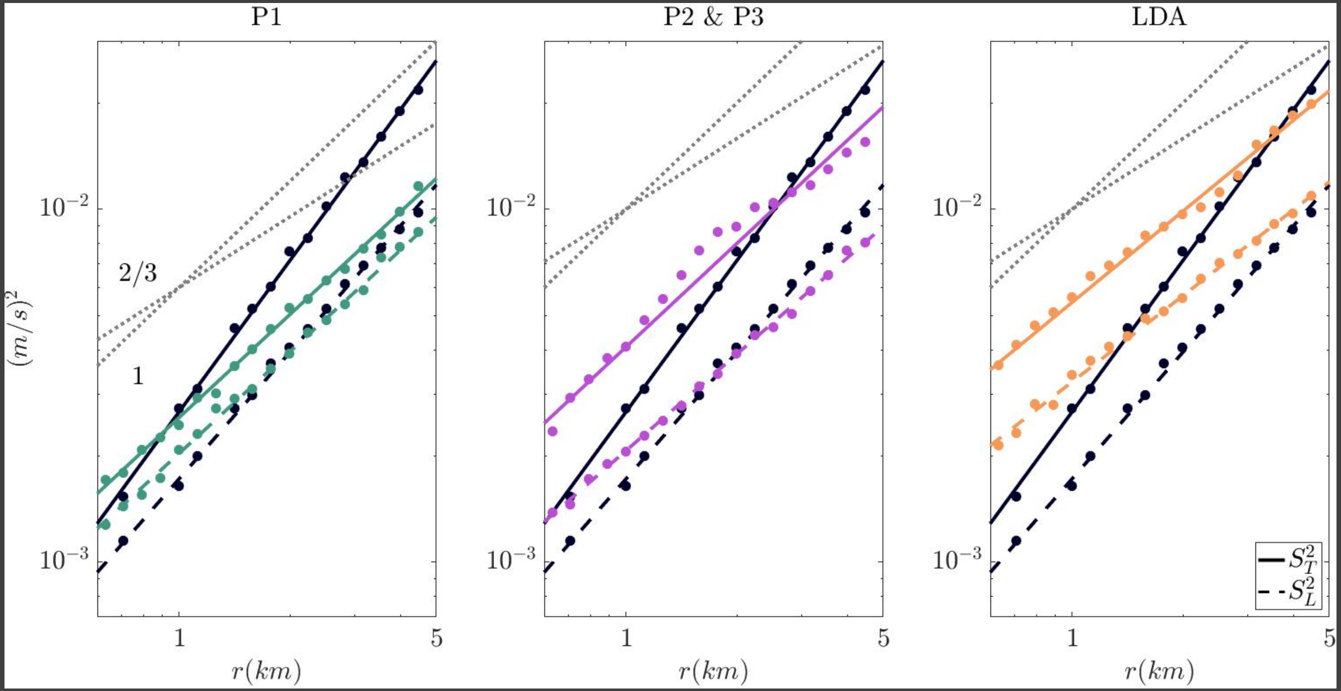




Future Work

- Use LASER drifters pair with X-band radar data
- Currently all results are consistent
- More work to isolate impacts of convergence zones

Second Order Structure Functions



Velocity Difference PDFs