# Lagrangian tracer transport in surface ocean turbulence with ageostrophic dynamics

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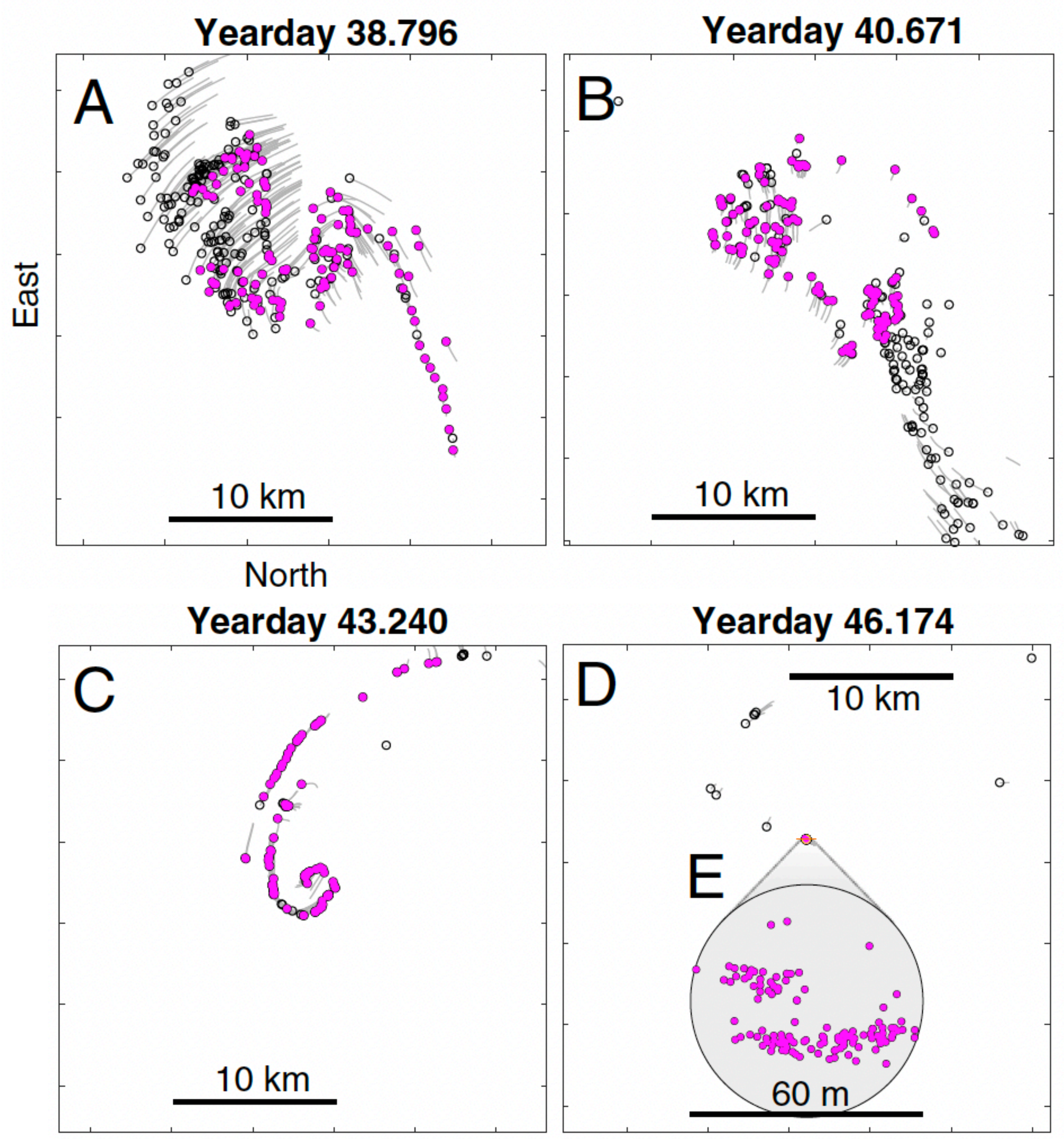
## What are we trying to understand?

**The effect of ageostrophic motions on particle transport (e.g., convergence of Lagrangian tracers).**




Evolution of a drifter array. (A-D) drifter positions at selected times. (E, inset) detail of a 60-m-wide cluster of 127 drifters, coloured magenta, at it's smallest.
**(D'Asaro et al, 2018)**

## Why?

**Ageostrophic motions play a role in determining ocean submesoscale dynamics, consequently impacting climate change and marine ecology.**

## How?

**Using a model that accounts for ageostrophic dynamics, known as $SQG^{+1}$ (small but finite $Ro$).**

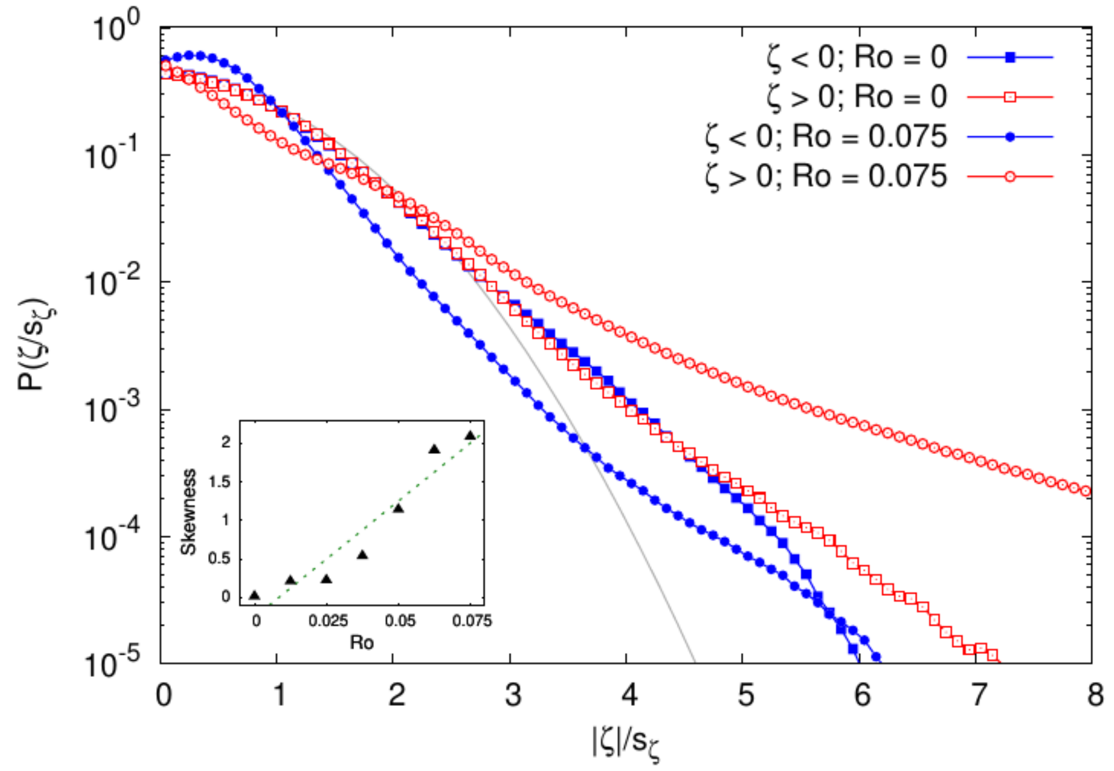
$$\frac{\partial \theta}{\partial t} + \boldsymbol{u} \,.\, \nabla \theta = forcing + dissipation$$

ageostrophic flow components

$$\boldsymbol{u} = (u, v) = (u_g + \boxed{u_{ag}\, Ro},\; v_g + \boxed{v_{ag}\, Ro})$$

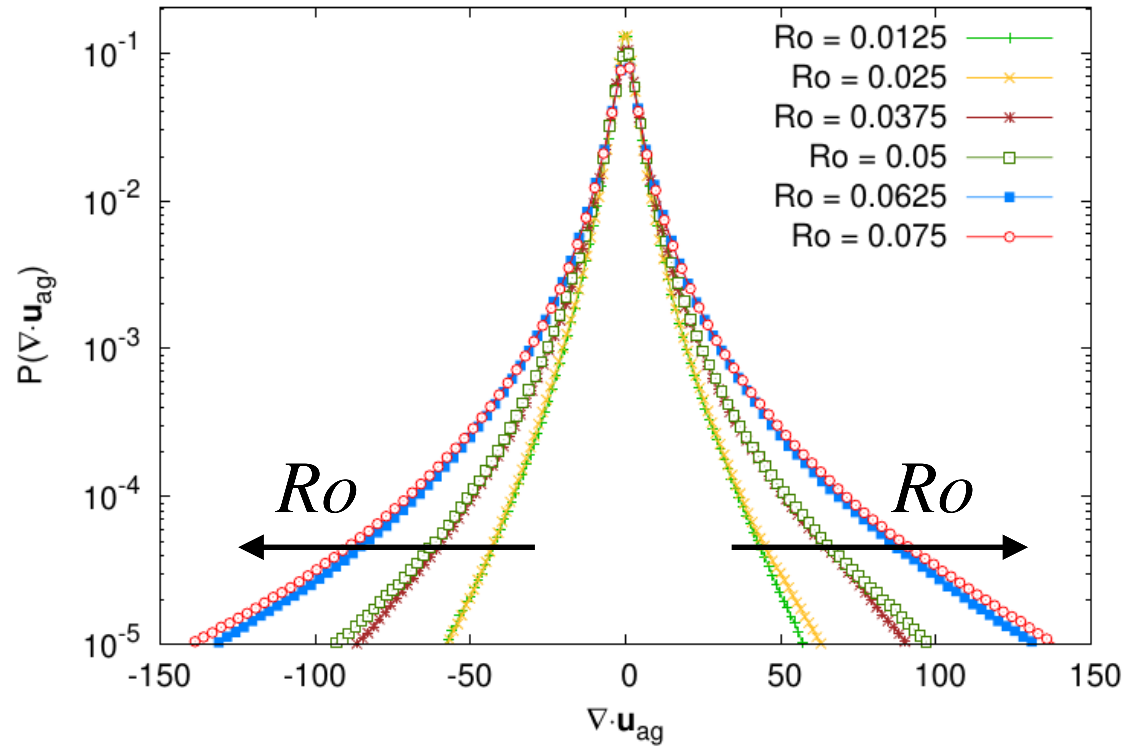
## Flow features from observations unaccounted for by $QG$ theory ($Ro \rightarrow 0$):

- **cyclone/anti-cyclone asymmetry**,



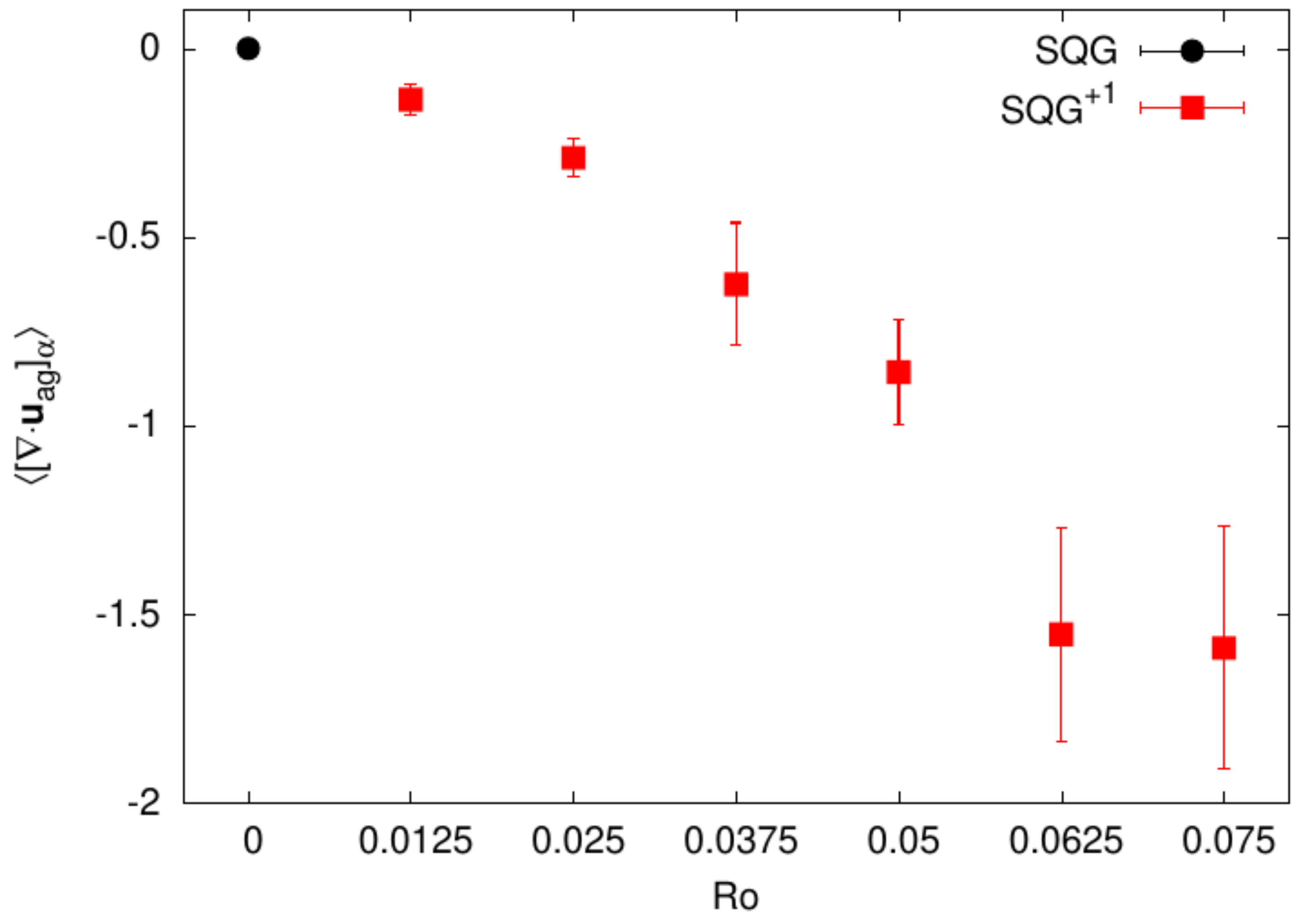

Time averaged PDF of the vorticity rescaled by its standard deviation. Inset showing the skewness of the vorticity vs $Ro$.

- **divergent horizontal flow**.



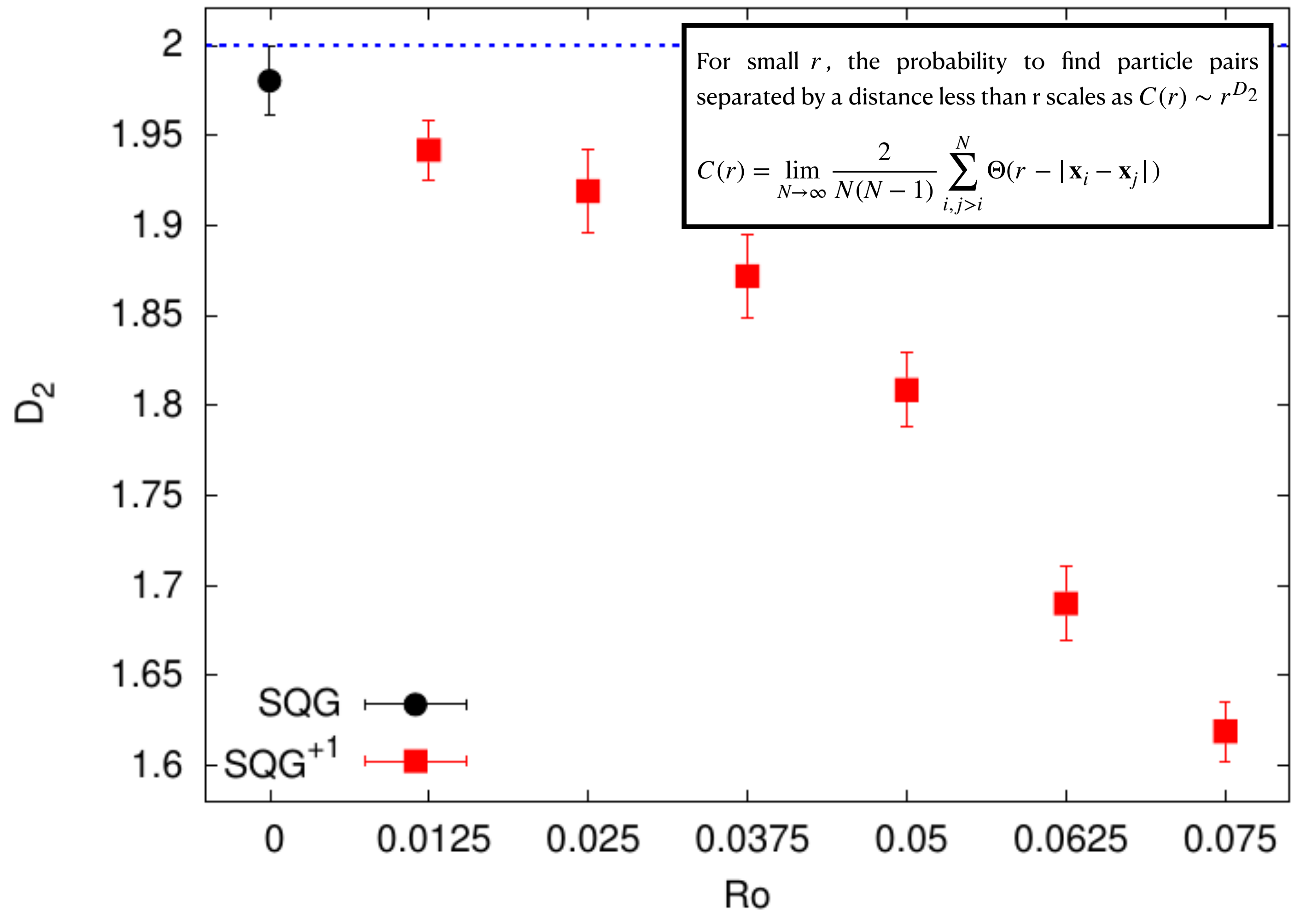

Time averaged PDF of the divergence of the ageostrophic flow components.

# Particle Clustering




Time averaged, ensemble average divergence sampled by particles in the flow.

Particles sample more negative divergence with the increase of $Ro$

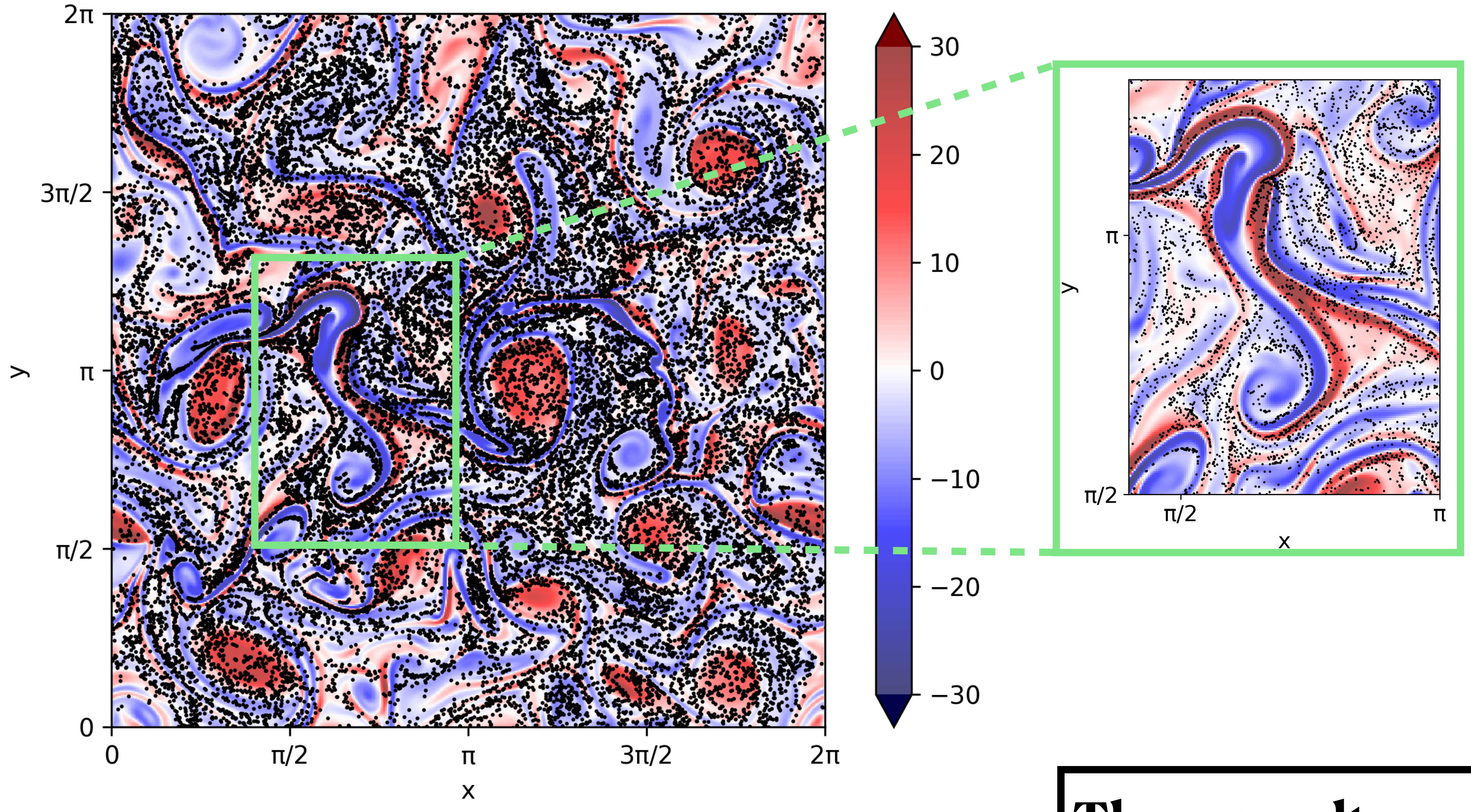



Time averaged, ensemble average correlation dimension.

**Particle clustering increases with the increase of *Ro* but**

**Where?**

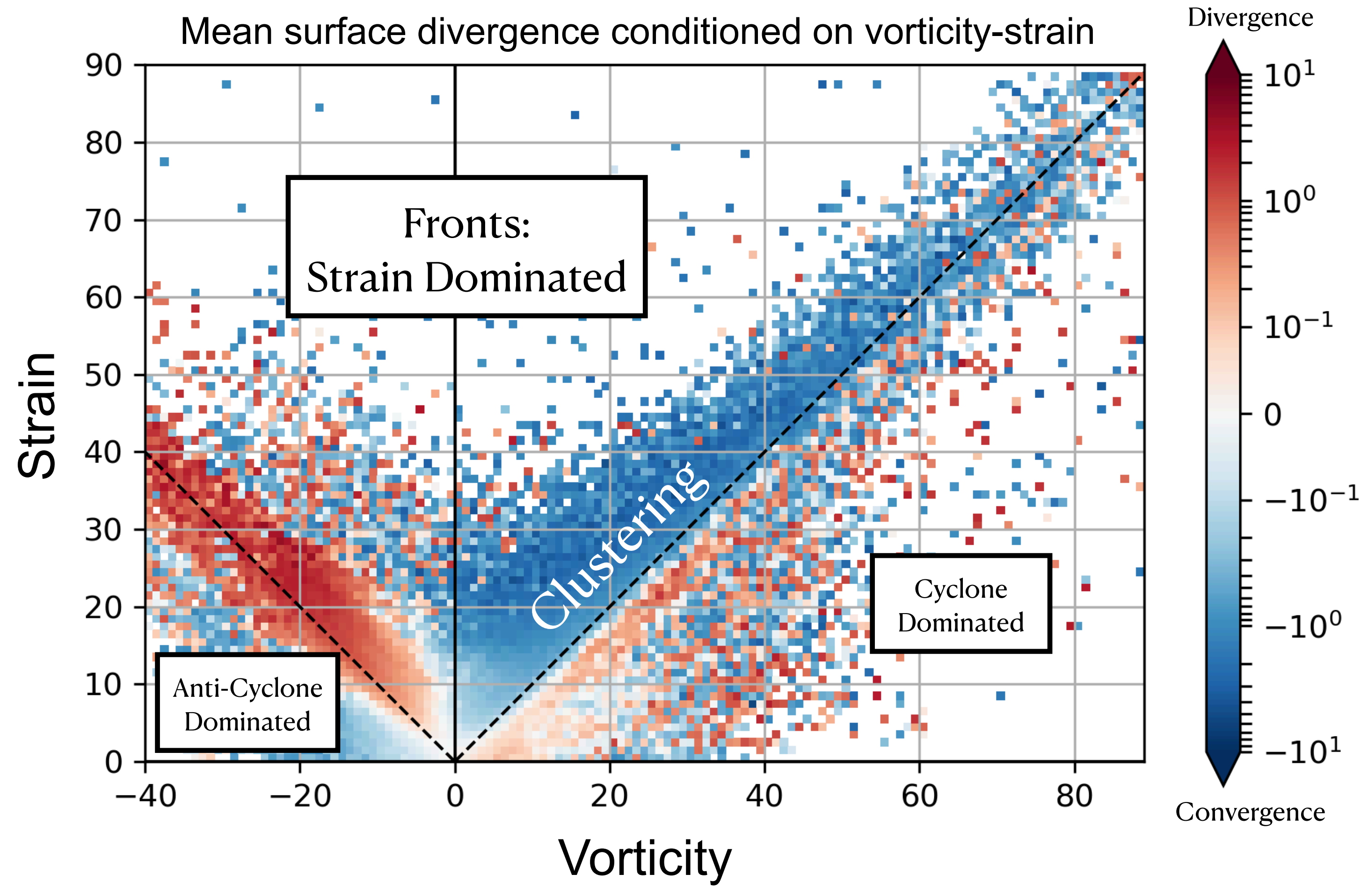
$D_2$ decreases with the increase of $Ro$. $\Longrightarrow$ Particles cluster on fractal sets with smaller dimension with the growth of $Ro$.




Snapshot of the particle distribution at $Ro = 0.075$ superimposed on the vorticity.

Particle distribution and vorticity snapshot

Link with flow structure: preferential concentration in cyclonic frontal regions




Time averaged mean surface divergence conditioned on vorticity-strain for $Ro = 0.075$.

**These results are in good agreement with drifter observations and more realistic ocean models.**

**Therefore, this relatively simple ($SQG^{+1}$) model can help improve our understanding of ocean submesoscale dynamics and their effect on particle transport.**