Ergodicity Defect

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ED in 3 dimensions + time – Numerical Algorithm

For a trajectory with initial conditions $\vec{x}_0, t_0$

$$d(s;\vec{x}_0,t_0)=\sum_{j=1}^{s^{-3}}\left(\frac{N_j(s)}{N}-s^3\right)^2$$

(*N* is the total number of sample points, and $N_j(s)$ is the number of points in jth cube of volume s^3)

“Ergodic” (most complex) trajectory: $d=0$

Stationary (least complex) trajectory:

$$d=1-s^3\rightarrow 1 \quad \text{as} \;\; s\rightarrow 0$$

Summary

Ergodicity Defect (ED) captures trajectory/flow complexity for identifying Lagrangian Coherent Structures

- Understanding barriers to transport
- Understanding/Determining transport of material/flow properties by coherent structures

Advantages of ED

- Distribution of trajectory can be non-uniform/sparse
- Works in both 2 and 3 dimensions

Other aspects of ED

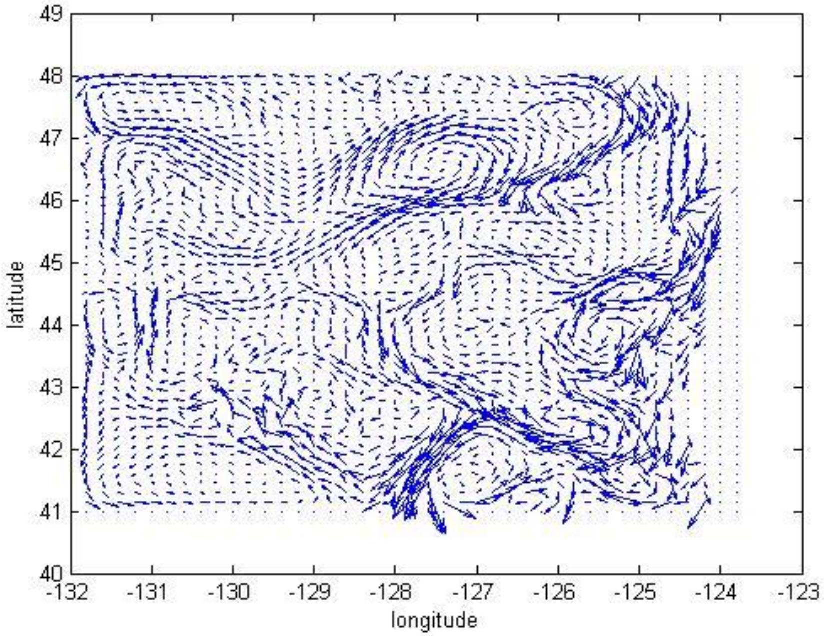
Use Ergodicity Defect (ED) to distinguish optimal trajectories/initial conditions

for assimilating data ?

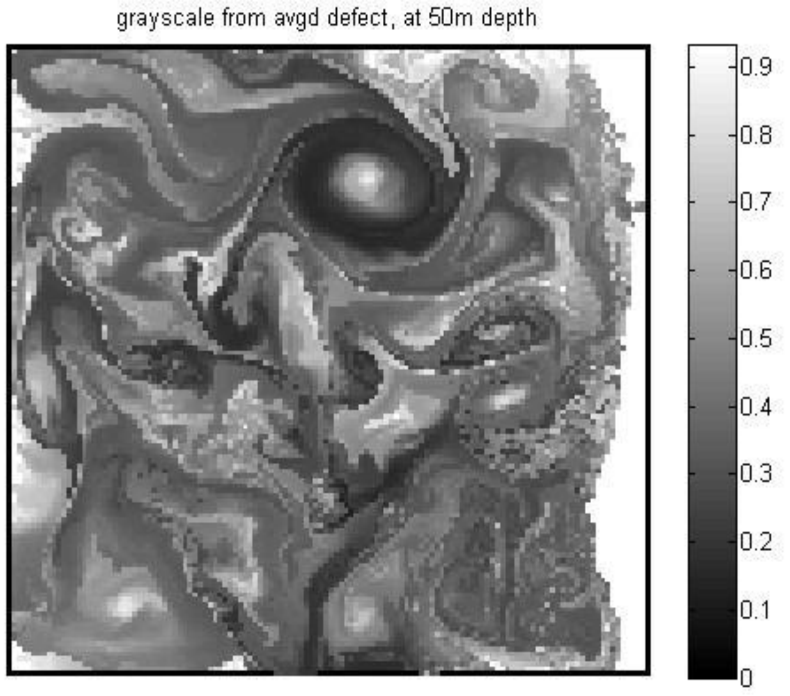
for deployment strategy?

for estimating fluid flow properties?

ED & an Upwelling flow (3D + time example)



2D snapshot of flow



Each point is colored according to its averaged defect value