

Nomenclature

Greek letters

α_ℓ, β_ℓ	Angles defining the center slope of the frequency wedge (curvelets)	12
γ_k	Array of parameters stored in the conditional array map (CAM)	71
ϵ	Local dissipation	45
ϵ_{ijk}	Levi-Civita symbol	45
$\bar{\eta}$	Average Kolmogorov length scale	30
ϑ	Eigenvalues of A_{ij}	63
κ_1	Maximum curvature	15
κ_2	Minimum curvature	15
κ_n	Normal curvature	16
Λ	Curvedness	15
λ	Stretching parameter	19
μ	Characteristic length scale of a closed surface	18
μ_c	Mean passive scalar gradient magnitude in x_1 direction	6
ν	Kinematic viscosity	44
ξ, ζ	Local properties mapped onto a surface	72
ρ	Density	63
ϱ	Radial polar coordinate in the plane of principal curvatures	16
σ_l	Local scaling parameter	22
Υ	Shape index	15

ϕ	Azimuthal polar coordinate in the plane of principal curvatures	16
$\varphi_{j,\ell,k}^D$	Curvelets in physical space	11
$\hat{\varphi}_{j,\ell,k}^D$	Curvelets in Fourier space	11
Ω_{ij}	Rotation-rate tensor	45
ω	Wavenumber (Fourier domain)	11
ω_i	Vorticity field ($i = 1, 2, 3$)	45
$\omega_i \omega_i$	Local enstrophy	45

Roman letters

\hat{A}	Locally scaled affinity matrix	22
A	Area of a surface	18
\mathbf{a}	Vector contained on the tangent plane at a point P of a surface	16
a_i	Average distance from an element to other elements of its same cluster (in the clustering algorithm)	26
a_i	Element i of the set \mathcal{A} (in the structure interaction analysis)	71
A_{ij}	Symmetric second-order tensor $S_{ik}\Omega_{kj} + S_{jk}\Omega_{ki}$	3
$[A_{ij}]_+$	Largest remaining eigenvalue of A_{ij} after removing $[A_{ij}]_\omega$	63
$[A_{ij}]_-$	Smallest remaining eigenvalue of A_{ij} after removing $[A_{ij}]_\omega$	63
$[A_{ij}]_\omega$	Eigenvalue of A_{ij} associated with the eigenvector most aligned with the vorticity field, ω_i	63
b_i	Average distance from an element to the elements in the closest cluster	26
C	Dimensionless curvedness	18
\hat{C}	Feature dimensionless curvedness center	24
c	Passive scalar	6
c'	Passive scalar fluctuation	6
c_j	Element j of the set \mathcal{C} (in the structure interaction analysis)	71

$c^D(j, l, k)$	Curvelet coefficients	11
\mathbf{D}	Diagonalizing matrix	22
D	Diffusivity	6
d	Distance	72
D_{a_i}	Non-dimensionalizing length scale of the structure a_i	72
d_{ij}	Distance matrix	21
d_l	Lower distance of a probability density function	24
d_u	Upper distance of a probability density function	24
E	Set of elements, e_i , to cluster, $i = 1, \dots, N$	21
$E(k)$	Energy spectrum of original field (containing all scales)	33
$E_i(k)$	Energy spectrum associated with component field at scale number i	33
F	Distance function in the space of parameters	22
f_k	Cumulative marginal probability density function of proximity for group indices g from 1 to k	78
g	Group index	72
G_g	Groups contained in set \mathcal{B}	72
j	Scale number (curvelets)	11
j_0	Minimum scale number (curvelets)	11
j_e	Maximum scale number (curvelets)	11
k	Spatial location index, $\{k_i, i = 1, 2, 3\}$ (curvelets)	11
k_{\max}	Largest dynamically significant wavenumber	30
\mathbf{L}	Normalized locally scaled affinity matrix	22
ℓ	Orientation index (curvelets)	11
L_i, L'_i	Integral length scales of component field at scale number i	33
\mathbf{N}	Normal vector to the tangent plane at a point P of a surface	16
N	Number of elements to cluster	21
n	Grid size of side cubic domain	11

N_g	Number of G_g groups contained in set \mathcal{B}	72
N_P	Number of parameters defining the feature space	21
p	Pressure field (in the equations of fluid mechanics)	63
p	Proximity (in the structure interaction analysis)	72
\mathcal{P}	Area-based joint probability density function	19
\mathcal{P}_C	Area-based (marginal) probability density function of C	19
\mathcal{P}_S	Area-based (marginal) probability density function of S	19
$\vec{\mathcal{P}}\mathcal{I}(\xi, \zeta; p)$	Area-based joint probability density function in terms of the local properties (ξ, ζ) with averaged intensity component in terms of the local property p	73
$p[k]$	Parameters of feature space	21
R	Radius of curvature	16
r	Number of closest neighbors for local scaling (in the clustering algorithm)	22
Re	Reynolds number	42
Re_λ	Taylor Reynolds number	30
S	Absolute value of the shape index	16
\hat{S}	Feature absolute value of the shape index center	24
SC	Silhouette coefficient	26
Sc	Schmidt number	30
S_{ij}	Strain-rate tensor	45
$S_{ij}S_{ij}$	Local dissipation renormalized by $(2\nu)^{-1}$	45
t	Characteristic thickness of a sheet-like structure	76
t	Time variable (in the equations of fluid mechanics)	6
\mathbf{u}	Velocity vector field (with components $u_j, j = 1, 2, 3$)	6
$\overline{u^2}$	Characteristic squared integral velocity of original field	33

$\overline{u_i^2}$	Characteristic squared integral velocity of component field at scale number i	33
$\tilde{U}_{j,\ell}$	Frequency window (curvelets)	11
V	Volume inside a closed surface	18
$\tilde{V}_{j,\ell}$	Angular frequency window (curvelets)	11
\tilde{W}_j	Radial frequency window (curvelets)	11
\mathbf{X}	Matrix of eigenvectors	22
\mathbf{x}	Position vector (spatial coordinates $x_j, j = 1, 2, 3$)	6
$\mathcal{X}(\alpha)$	Set of extracted structures from a three-dimensional scalar field α	75
\mathbf{Y}	Renormalized matrix of eigenvectors	23

Acronyms

BIC	Bayesian information criterion	26
CAM	Conditional array map	71
DNS	Direct numerical simulation(s)	1
HSB	Hue-saturation-brilliance color space	76
jpgf	Joint probability density function	19
jpgf+i	Joint probability density function with intensity component	73
LES	Large eddy simulation(s)	2
MDM	Minimum distance map	71
pdf	Probability density function	13