ModelFLOWs APP

MODAL DECOMPOSITION

Pattern detection	Reconstruction	Prediction
HOSVD	Data Repairing	HODMD
HODMD	Superresolution	

DEEP LEARNING

Pattern detection	Reconstruction	Prediction
Autoencoders	Superresolution	Full DL
		Hybrid

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Motivation

HODMD

Physics of Fluids LETTER scitation.org/journal/phf

On the generation and destruction mechanisms of arch vortices in urban fluid flows

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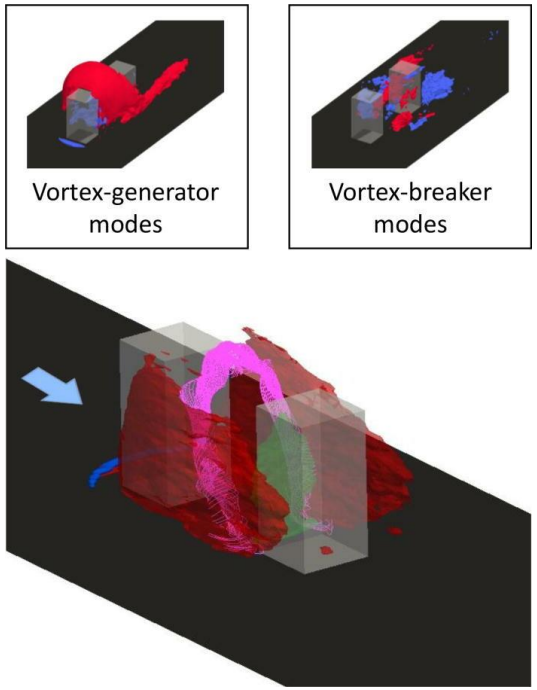
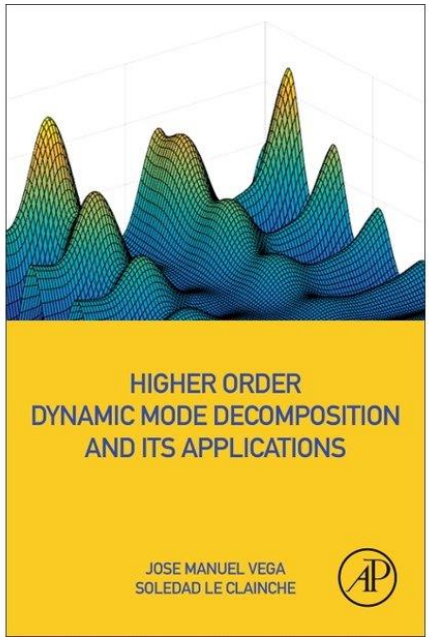


Pattern analysis in turbulent complex flows in urban environments.

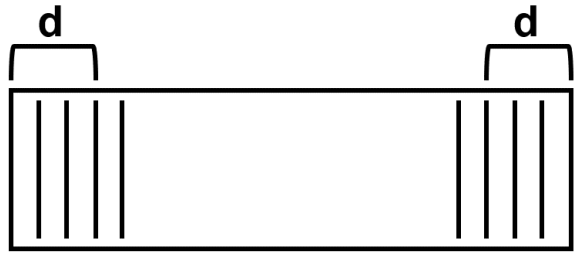
Methodology

HODMD



Vega, J. M., & Le Clainche, S. (2020). *Higher order dynamic mode decomposition and its applications*. Academic Press.

$$\boldsymbol{V}_{d+1}^{K} \cong R_1 \boldsymbol{V}_1^{K-d} + R_2 \boldsymbol{V}_2^{K-(d-1)} + \cdots + R_d \boldsymbol{V}_d^{K-1}$$



$$\boldsymbol{M}(t) \simeq \sum_{m=1}^{M} a_m \boldsymbol{u}_m e^{(\delta_m + i\omega_m)t} \quad for\ t_1 \le t \le t_1 + T$$

DMD modes

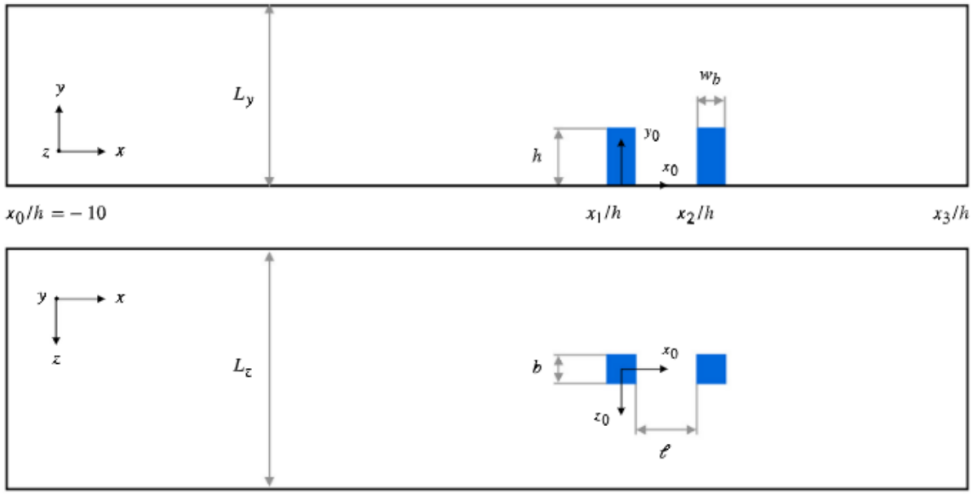
Amplitude

Growth-rate

Frequency

Database & Data preparation

HODMD



Spatial dimensions

Snapshots Tensor = $\{N_v, N_x, N_y, N_z, N_t\}$

Variables

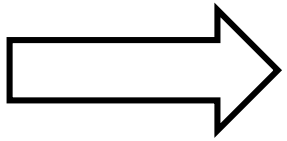
Temporal dimensions

Database & Data preparation

HODMD

Snapshots Tensor = $\{N_v, N_x, N_y, N_z, N_t\}$

- $N_v = 3$
- $N_x = 100$
- $N_y = 125$
- $N_z = 50$
- $N_t = 224$



Spatial dimension = 1875000

Temporal dimension = 224

Calibration

HODMD

Spatial dimension = 1875000

Temporal dimension = 224

Tolerance SVD: How many singular values we retain. In turbulence, different scales.

Values: 1e-2, 1e-3, 1e-4

Tolerance DMD: What minimum amplitude is associated to the modes. Different scales.

Values: 1e-2, 1e-3, 1e-4

Number of windows: Needed for the HODMD windowing process ($\sim 10 - 50\%\ N_t$).

Values: 10, 20, 50, 100

Calibration

HODMD

Tolerance SVD:

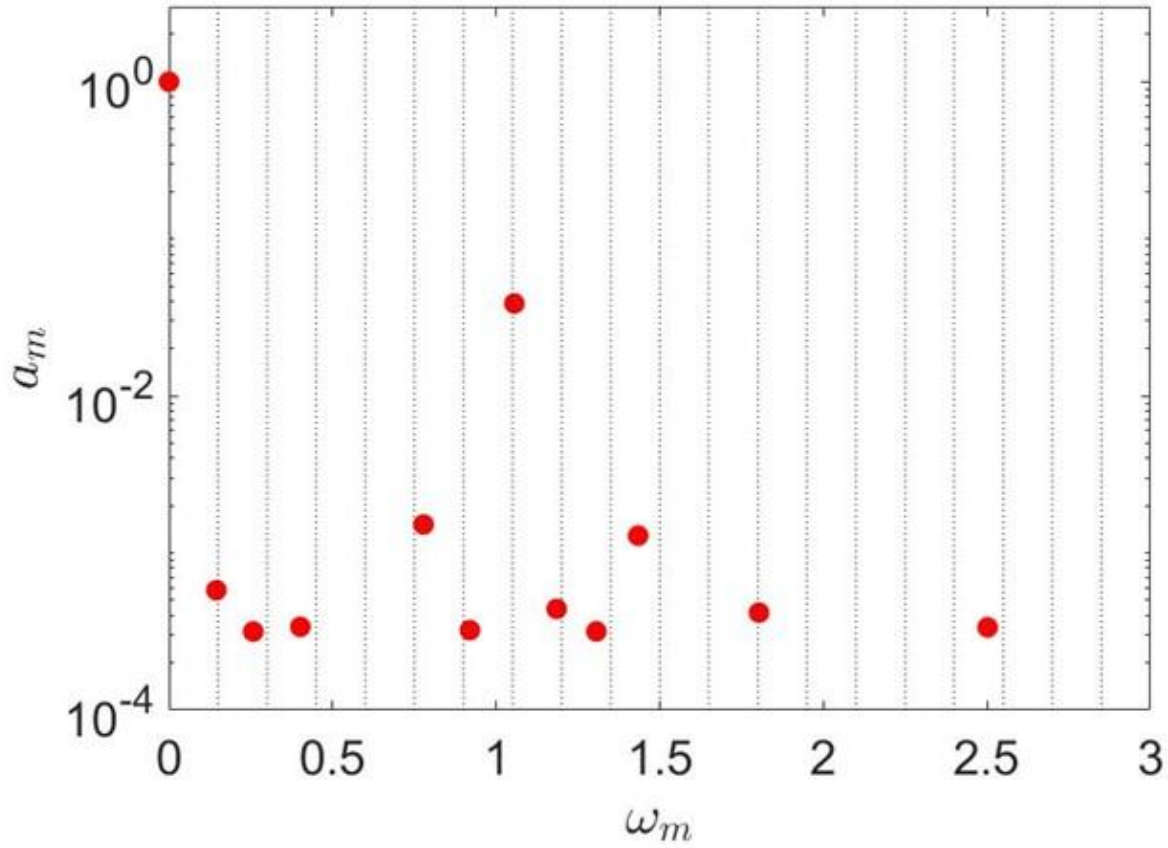
Values: 1e-3

Tolerance DMD:

Values: 1e-3

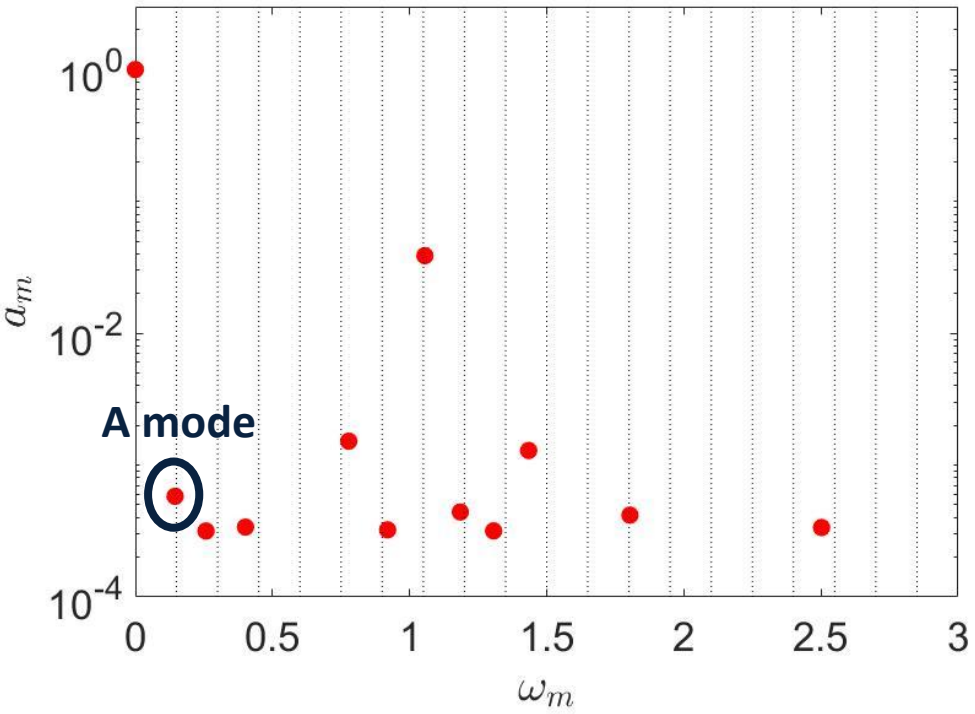
Window size:

Values: 50

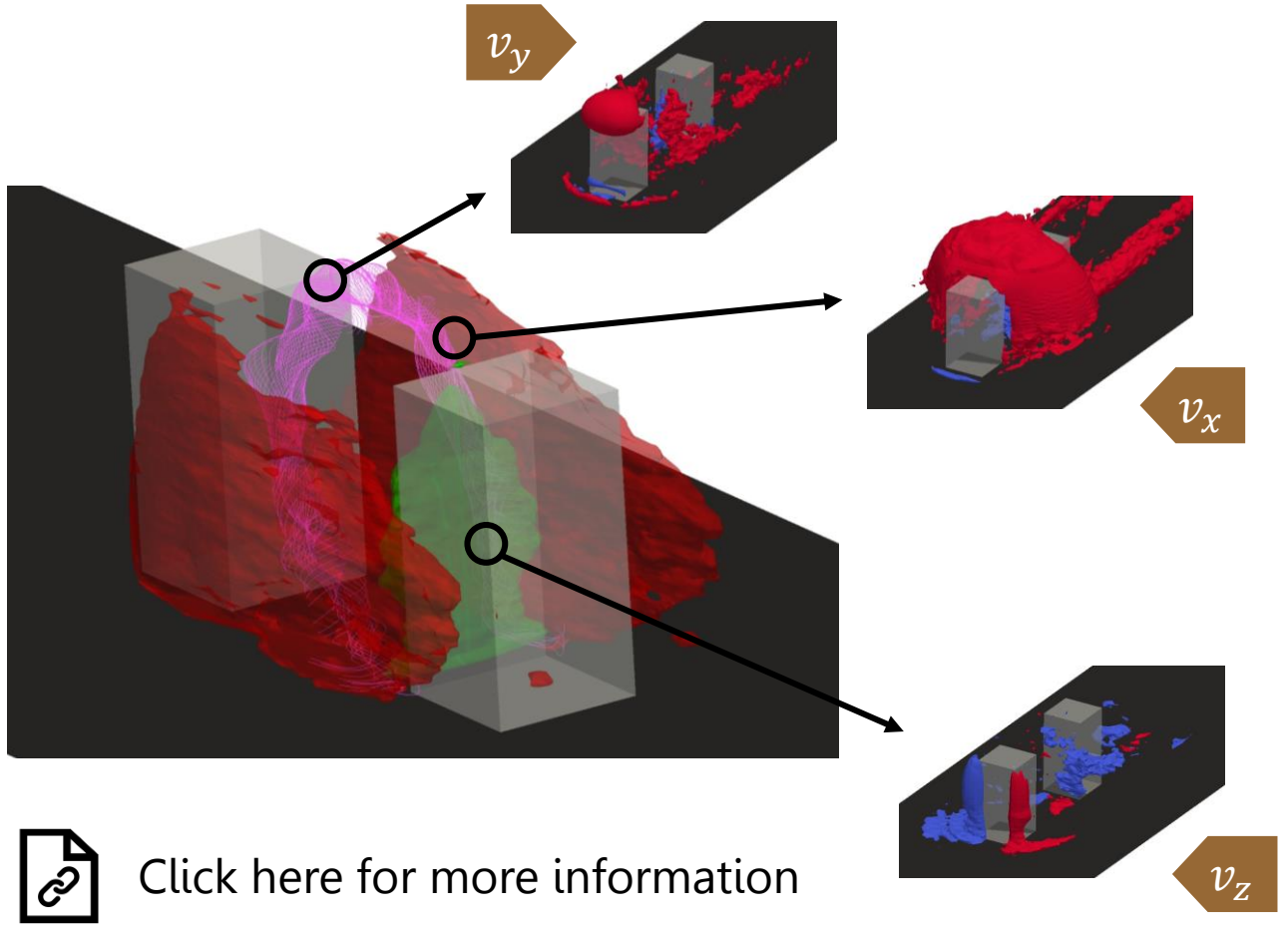


Results

HODMD



Generator modes



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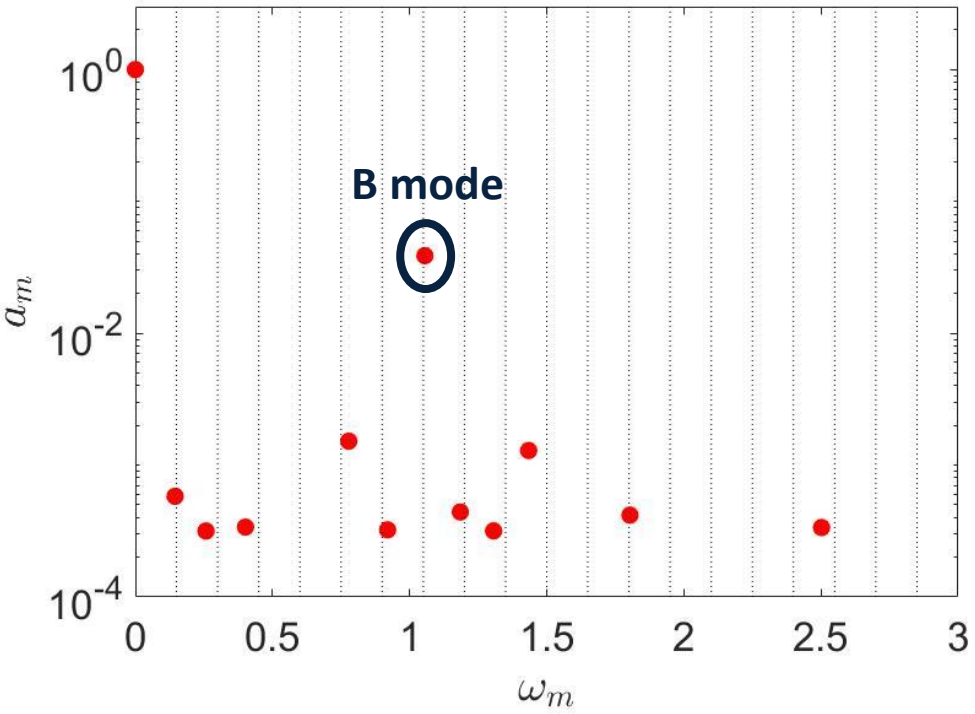
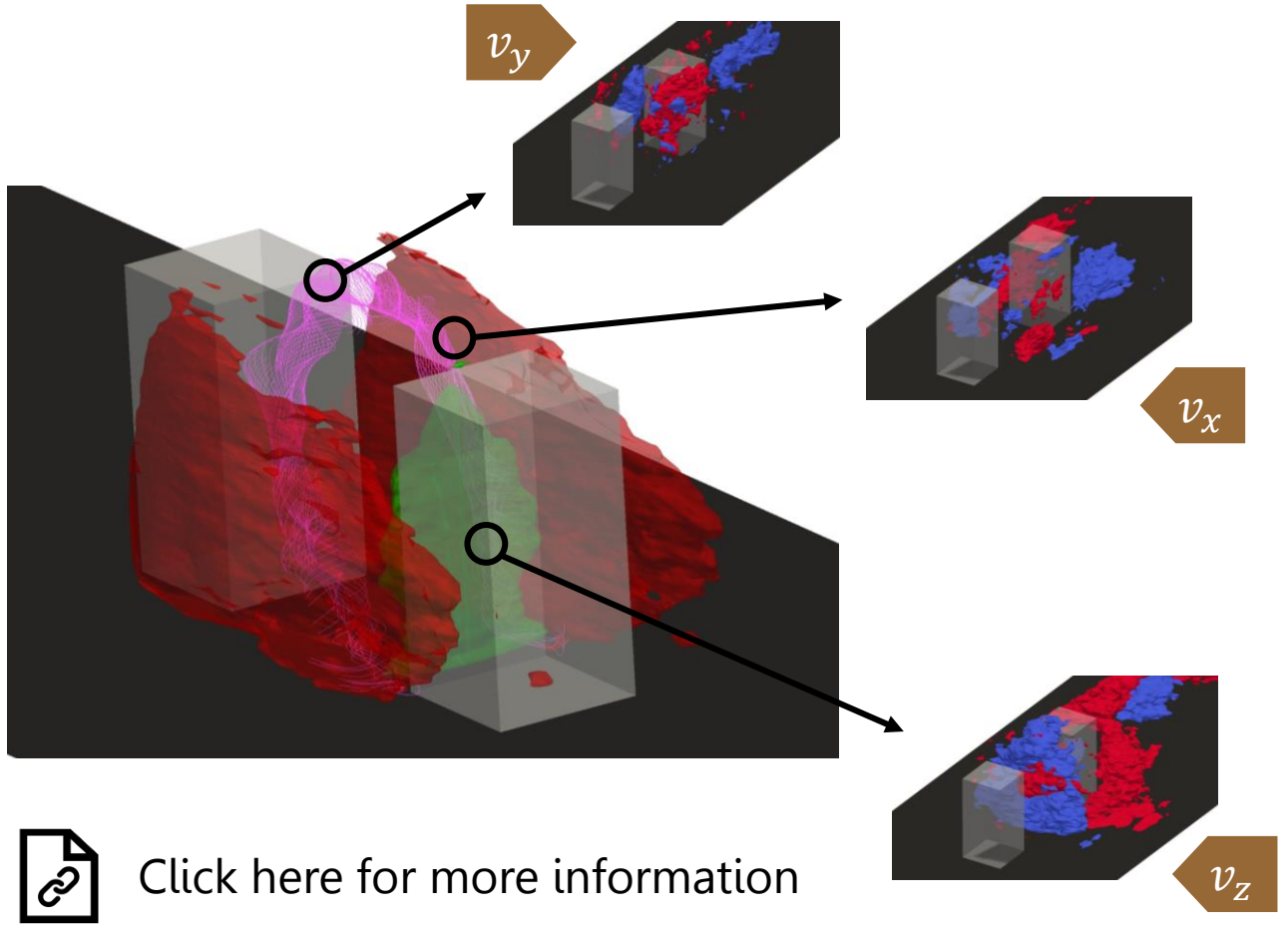
Results

HODMD



Breaker modes



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