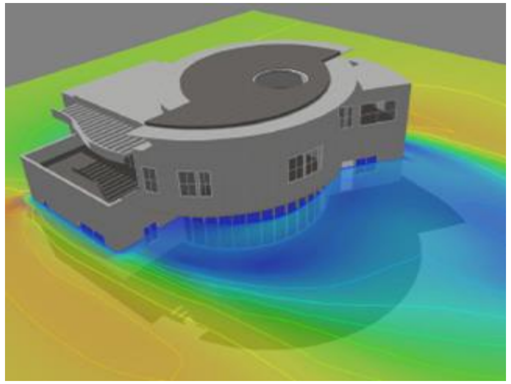
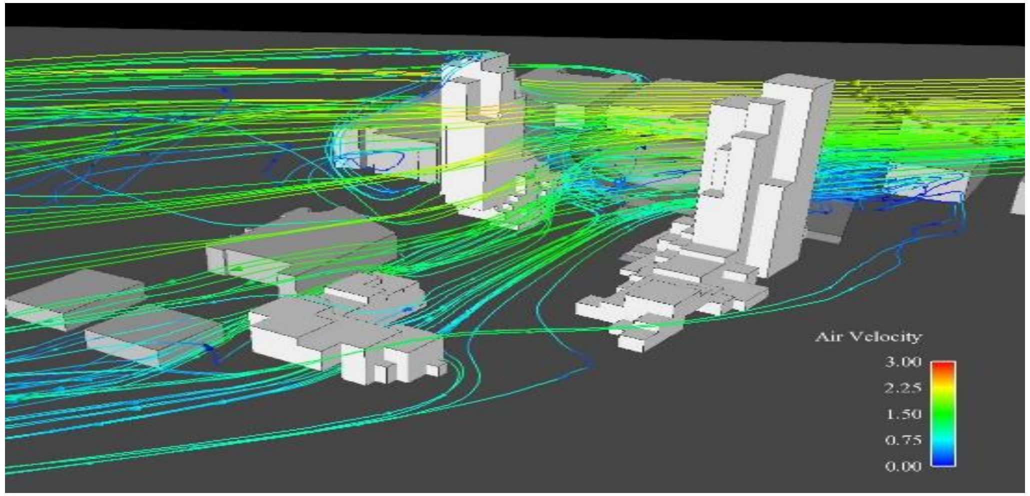
Wind Microclimate Assessment Emerging Findings

CFD Modelling For Smart Designs



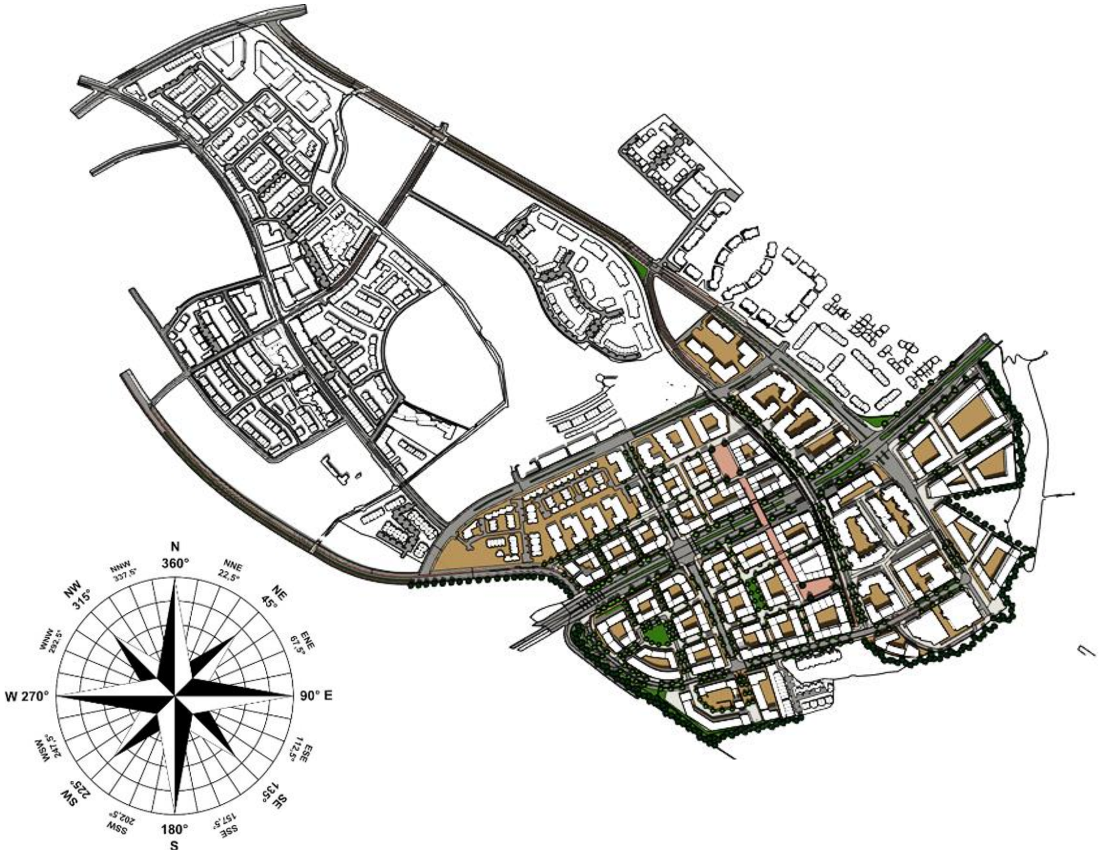


B-Fluid
Buildings Fluid Dynamics

03 -10 - 2024

OBJECTIVE

The objective of this preliminary wind microclimate assessment is to provide a high-level summary of the prospective impact of the 3D built form on wind conditions in the surrounding environment



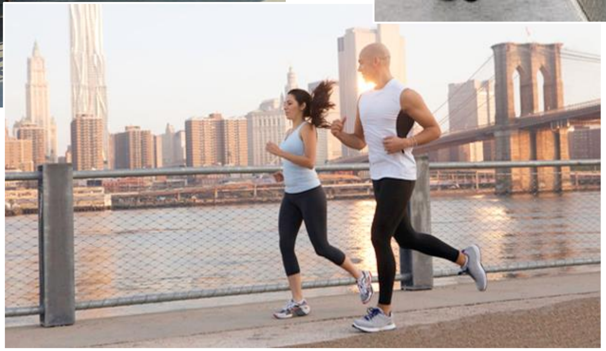
Specifically, the assessment aims to:

- Identify zones of high wind activity that may affect pedestrian comfort and safety.
- Identify designed features with potential to enhance wind comfort and create more favorable microclimates.
- Provide recommendations for mitigating wind hazards around critical zones, ensuring a safe and comfortable urban environment.

The following slides provide an overview of Emerging findings:

Pedestrian Comfort?

Pedestrian Wind Comfort is measured as a function of the frequency of wind speed threshold exceeded based on the pedestrian activity.



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The Lawson Criteria

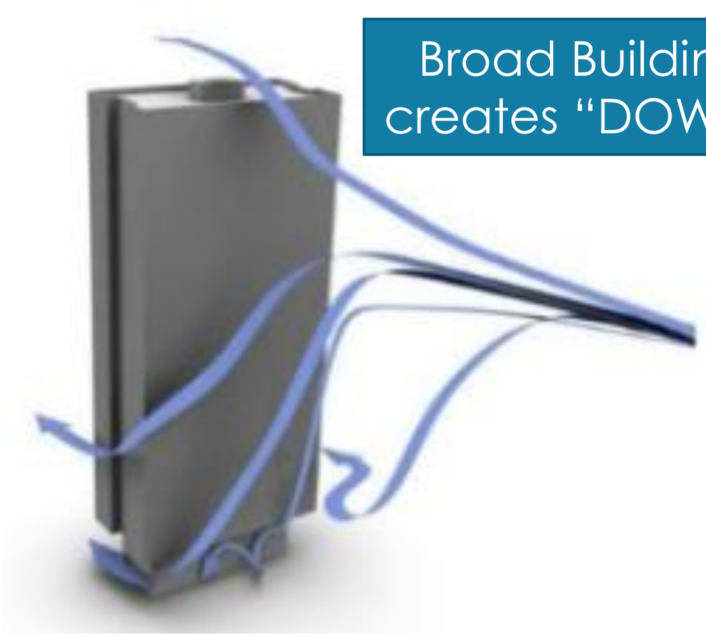
The criteria set out six pedestrian activities and reflect the fact that calm activity requires calm wind conditions

Beaufort Scale	Wind Type	Mean Hourly Wind Speed (m/s)		Acceptance Level Based on Activity–Lawson Criteria			
				Sitting	Standing/ Entrances	Leisure Walking	Business Walking
0-1	Light Air	0 – 1.55	COMFORT				
2	Light Breeze	1.55 - 3.35					
3	Gentle Breeze	3.35 - 5.45					
4	Moderate	5.45 - 7.95					
5	Fresh Breeze	7.95 - 10.75					
6	Strong Breeze	10.75 - 13.85					
7	Near Gale	13.85 - 17.15					
8	Gale	17.15 - 20.75	DISTRESS				
9	Strong Gale	20.75 - 24.45					
Legend	Acceptable / Tolerable	Not acceptable / Dangerous					

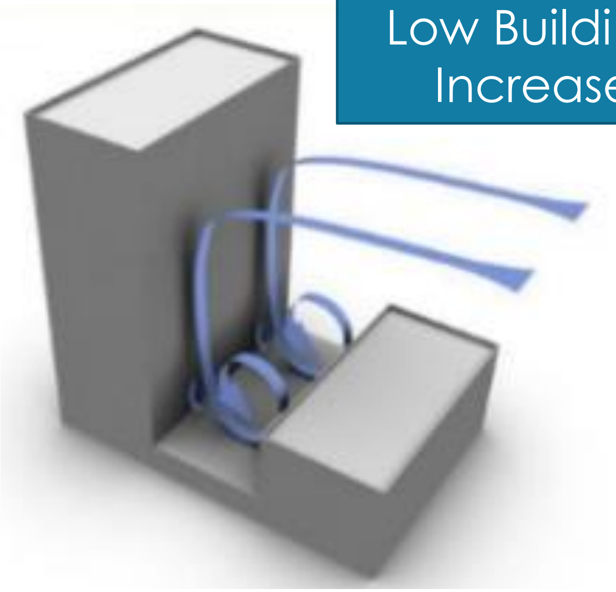
- Lawson scale assesses pedestrian wind comfort in absolute terms and defines the reaction of an average person to the wind
- It is composed by 12 point scale which represent equal increments of pedestrian annoyance to the wind.
- It defines the reaction of an average person to the wind.
- If the predicted wind conditions exceed the threshold then condition are unacceptable for the type of pedestrian activity and mitigation measure should be implemented into the design.

Expected Wind Phenomena at Built Site

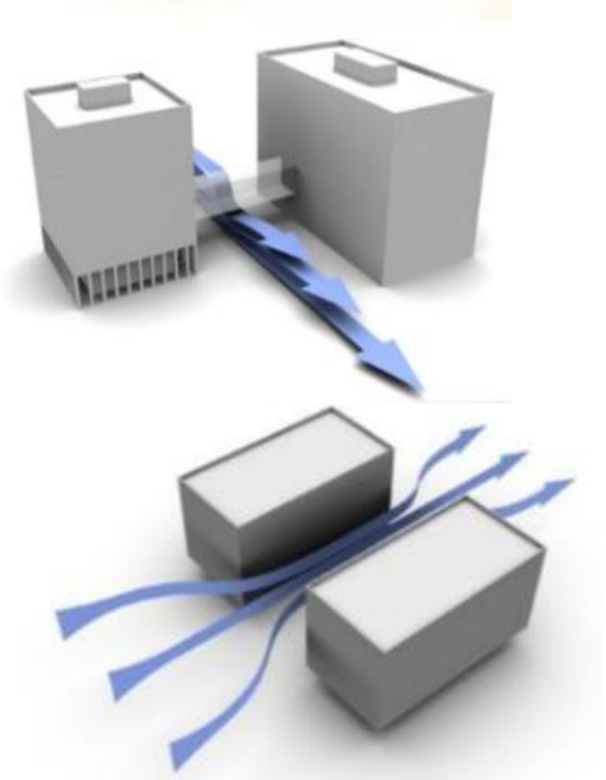
- The following wind effects could be expected on site.



Broad Building Face creates "DOWNWASH"



Low Building Upwind Increases Effect.

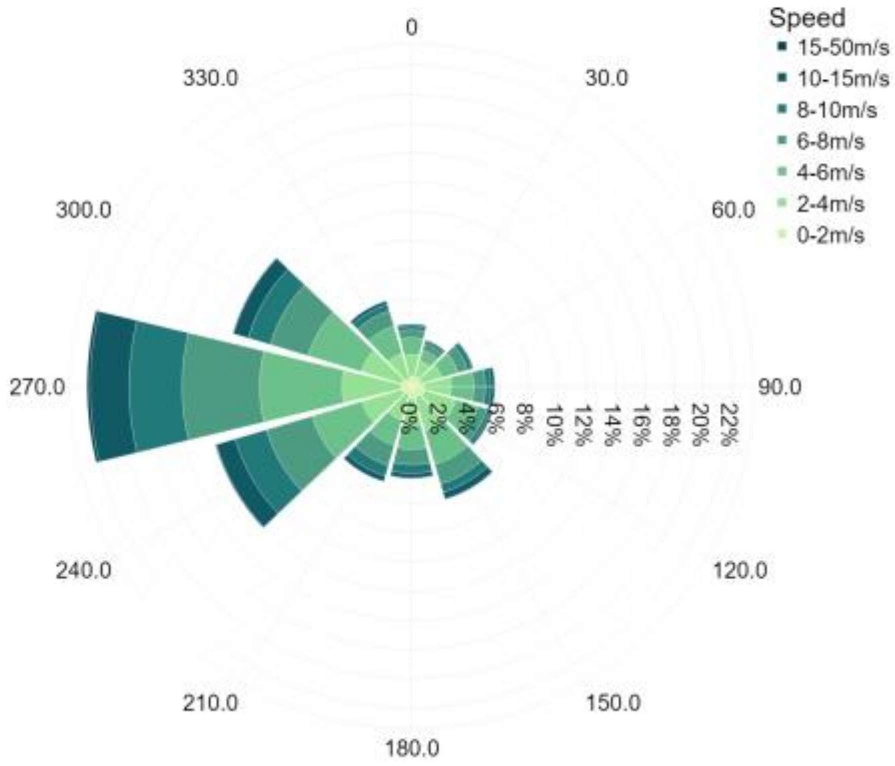


"FUNNELING EFFECT" Gaps Between Buildings Increases Wind Velocity

Wind Flow Conditions at the Site

Local Data Statistical Analysis

- The wind data statistical analysis, used for the wind preliminary assessment, is based on the annual average of meteorology data collected at **Dublin Airport Weather Station.**
- The Local Data Statistical analysis highlights the predominant wind directions and magnitude which will occur on the development.
- Due to the location of the doors being directly in the flow path of wind approaching from the North-West direction, the wind direction angle 315 degrees was selected for the simulation with wind speeds of 10m/s, 6m/s and 3m/s (based on probability of occurrence).



Dublin airport Wind Rose

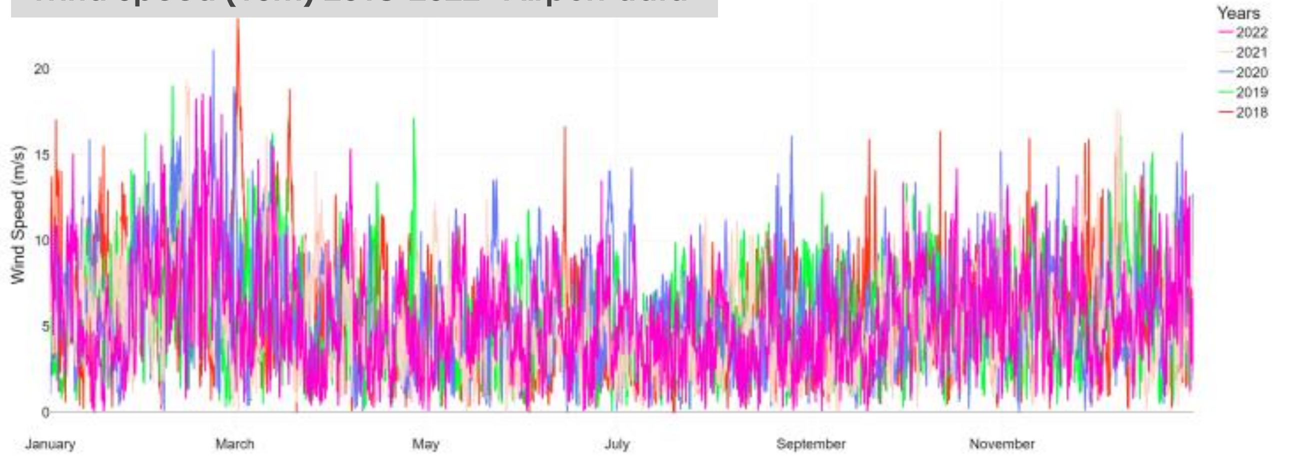
Wind Flow Conditions at the Site

Local Data Statistical Analysis

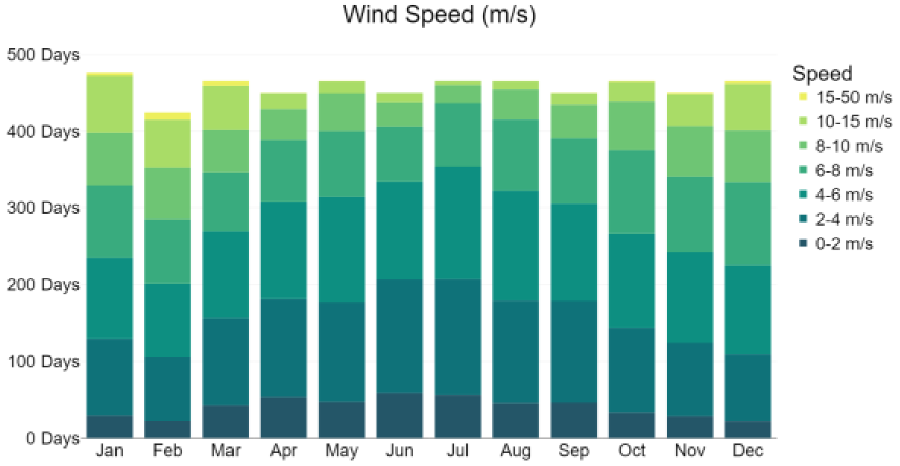
Different datasets are analysed for this assessment as follows:

- The meteorological data associated with the maximum daily wind speeds recorded over a 15 year period between 2008 and 2023 at a weather station at the airport, which is located 10m above ground.
- The mean hourly wind speeds recorded over a 10 years period between 2010 and 2020. The data is recorded at a weather station at the airport, which is located 10m above ground or 71mOD.

Wind Speed (10m) 2018-2022- Airport data



Wind Speed Diagram



- The wind speed diagram for Dublin, illustrates the number of days per month when the wind attains specific speeds. It is evident from this figure that strong winds are more prevalent during the winter season (December, January, and February) and the start of spring season (March) compared to other seasons.

Emerging Findings

Downwash Effects Localisation

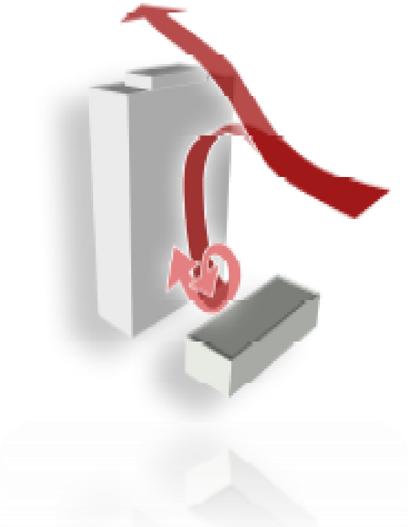
Potential Downwash Effects to Mitigate

- When the height ratio between a proposed tall building and its surrounding is increased significantly, it will be likely to occur a **Downwash** effect. The tall building tends to deflect the wind downwards, causing accelerated wind speeds at pedestrian level and around the windward corners of the building.

Emerging Findings

Downdraft Effects Localisation

- The building heights varies across the site, this can create phenomena of **downdraft** in areas as indicated in the image. This can be seen when the leeward face of a low building faces the windward face of a tall building, it causes an increase in the downward flow of wind on the windward face of the tall building.



Emerging Findings

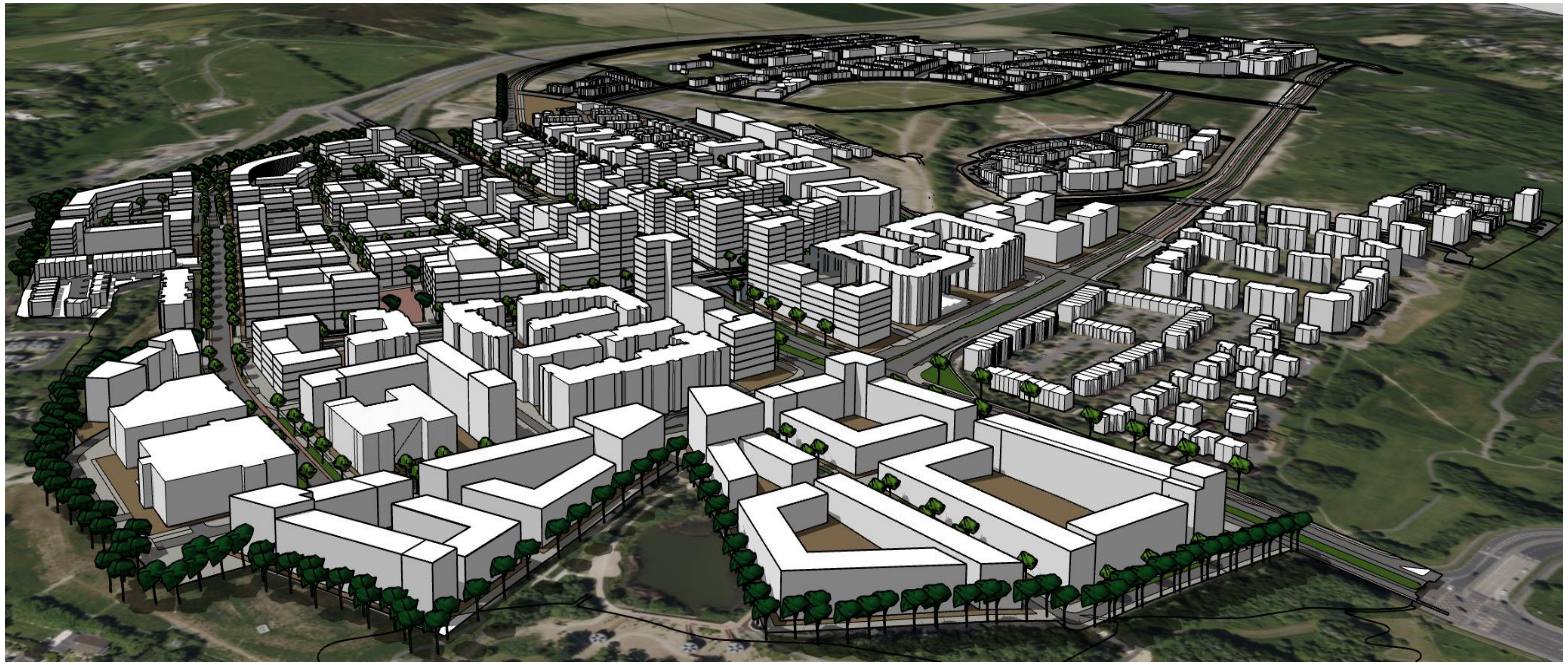
Potential Funneling Effects to Mitigate

Funneling Effects Localisation

The distribution of building clusters around the site is likely to create phenomena of **funneling/wind canyon** causing acceleration of wind speeds. The intensity of this acceleration is influenced by the building heights, size of the facades, building separation distance and building orientation. However, the built form does well to feature equally adjacent spaces between the rows of blocks to help dissipate build up of wind funnels where they have been formed.

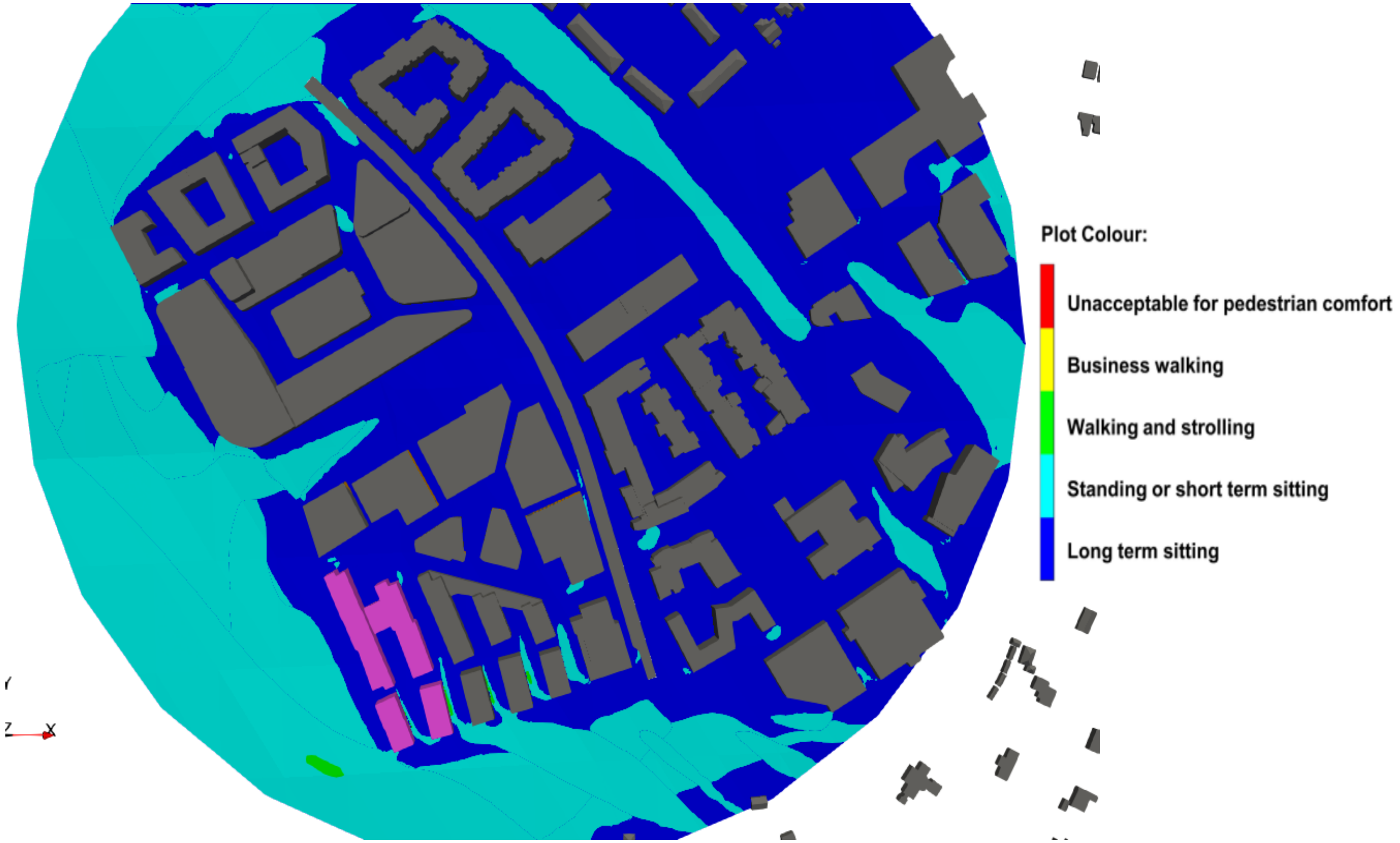
Mitigation

Current Possible Mitigation in proposed built-form Design



- Most of the buildings seem to have been designed to feature a terraced roof style which may help to reduce wind downwash and downdraft.
- Trees planted across most open streets and at edges of buildings may help to reduce funnelling and corner effects.
- However, a CFD wind microclimate study would provide more insight into the types and impact of wind flow on pedestrian activity.

Mitigation



Lawson Map of area in a previous CFD Wind Microclimate

Suggested Mitigation Strategies

- A CFD wind microclimate study would provide more insight into the types and impact of wind flow on pedestrian activity. The following are some key points to consider regarding wind conditions around the 3D built form.

- Based on Historical wind data, South-west winds can be expected to be more prevalent in the area and more likely to pose a threat to pedestrian comfort. Activity planning for amenity areas should take this wind direction into account in determining.

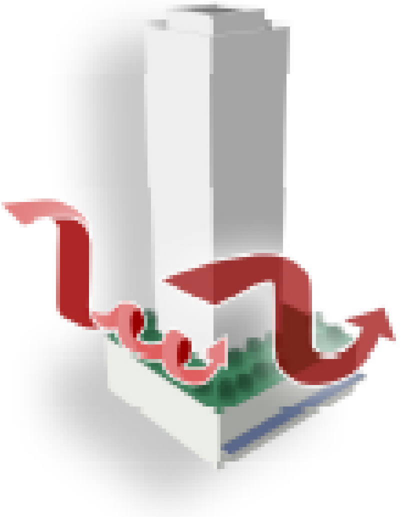
- Strategic Tree Placements may help reduce the effects of Wind on pedestrian comfort in essentially wind prone areas.

- Balconies and associated railings or Cascaded Facades on particularly Tall Buildings could help reduce downwash effects.

Mitigation

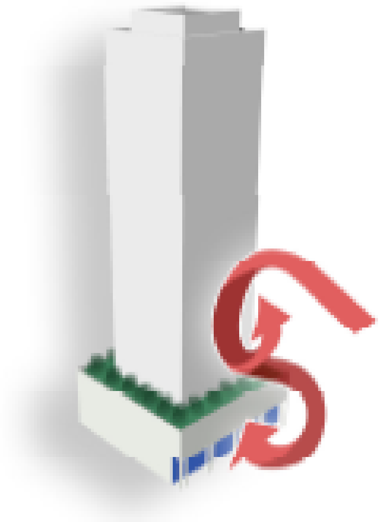
Suggested Mitigation Strategies

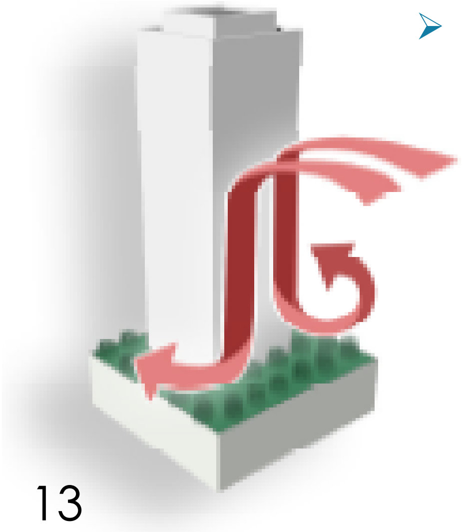
- A horizontal canopy on the windward face of a base building can improve pedestrian level wind conditions. Parapet walls around a canopy can make the canopy more effective.
- Sloped canopies only provide partial deflection of downward wind flow.



- Landscaping the base building roof and tower step back, wind speeds at grade can be further reduced, and wind conditions on the base building roof can improve

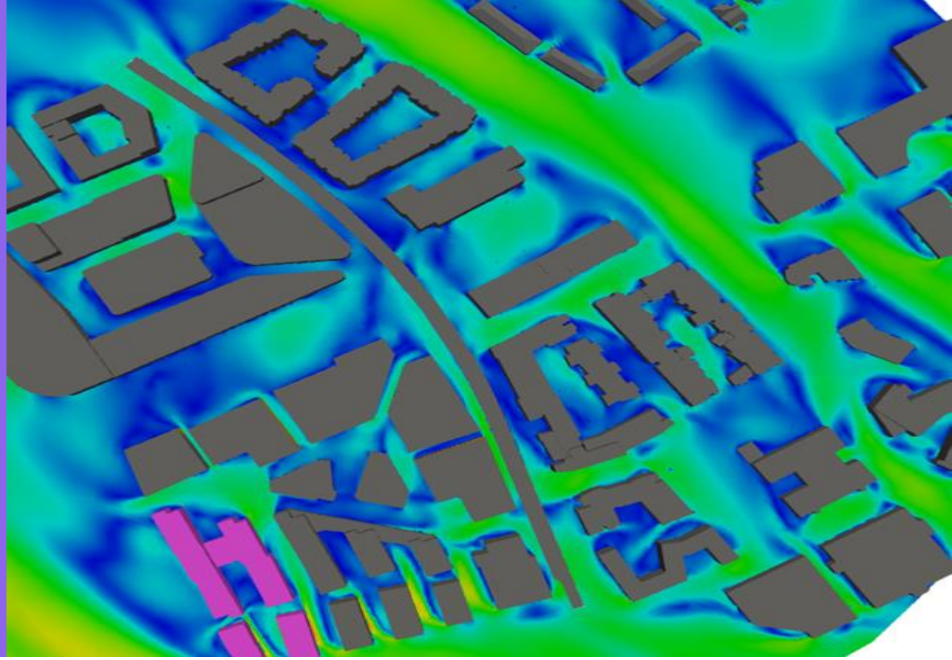
- A colonnade on the windward face of the base building provides the pedestrian with a calm area where to walk while being protected or a breeze walking space outside the colonnade zone





- To mitigate unwanted wind effects it is recommended to introduce a base building or podium with a step back, and setting back a tower relative to the base building, the downward wind flow can be deflected, resulting in reduced wind speed at pedestrian level.

Preliminary Assessment of the subject Area



Wind Microclimate Model of the Site

B-Fluid
Buildings Fluid Dynamics

Wind Simulation S-W Direction

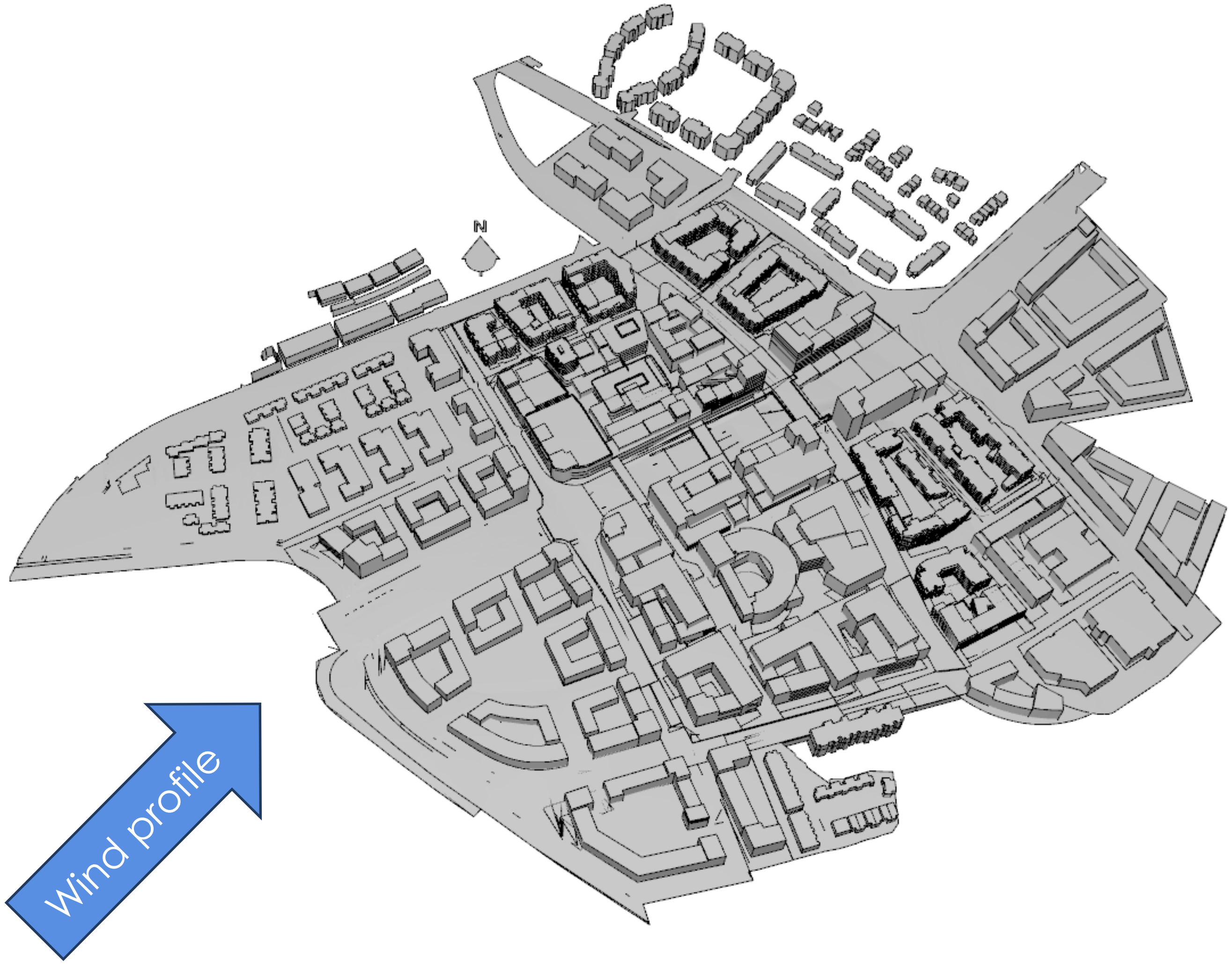
- A CFD simulation is shown in the following images.A wind profile based on the historical weather data of the site has been applied on the South West direction (the prevailing one).

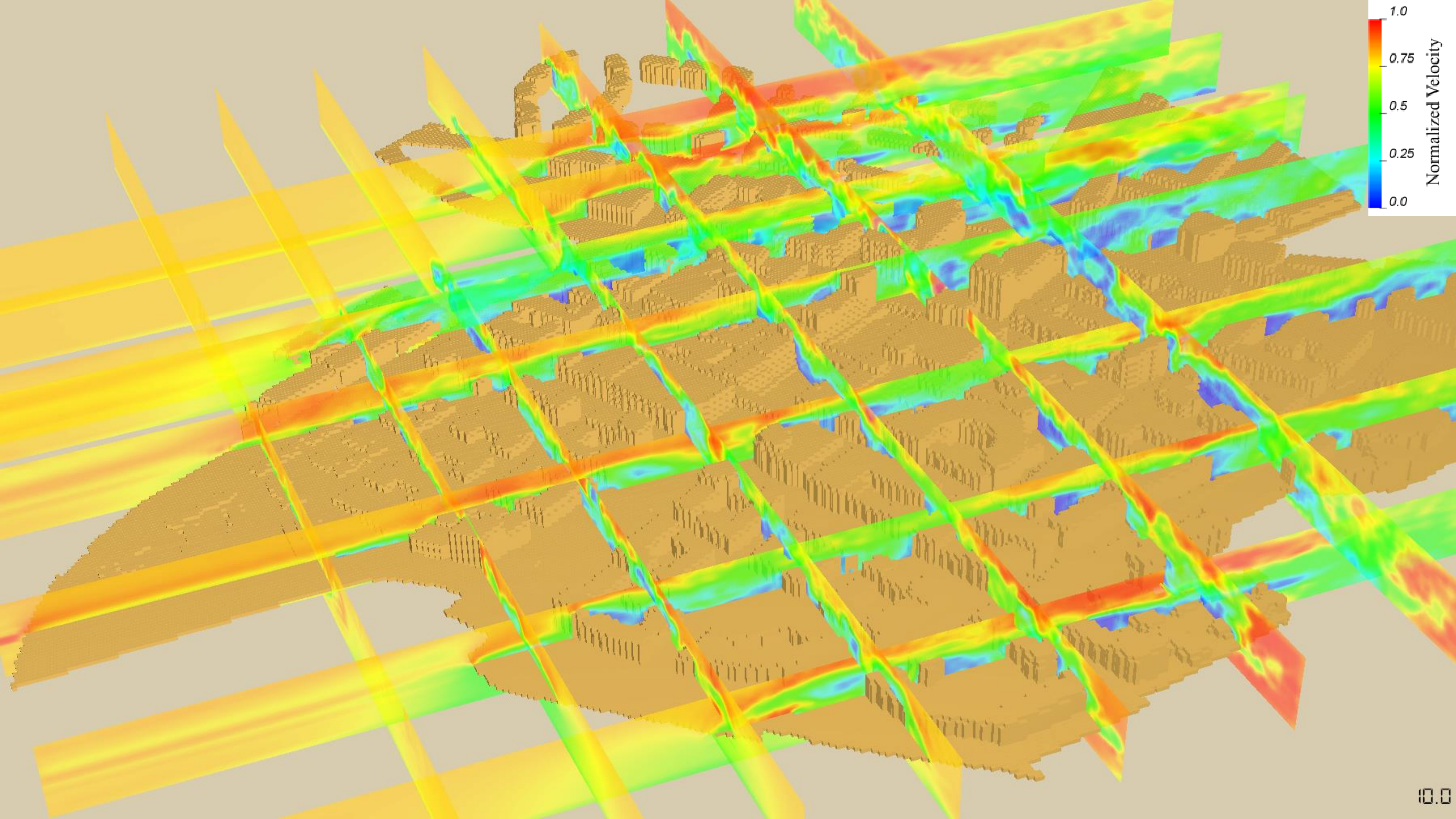
- The analysis is accounting all the proposed construction and the terrain, however no trees or landscaping is implemented here as part of this model, which make it conservative.

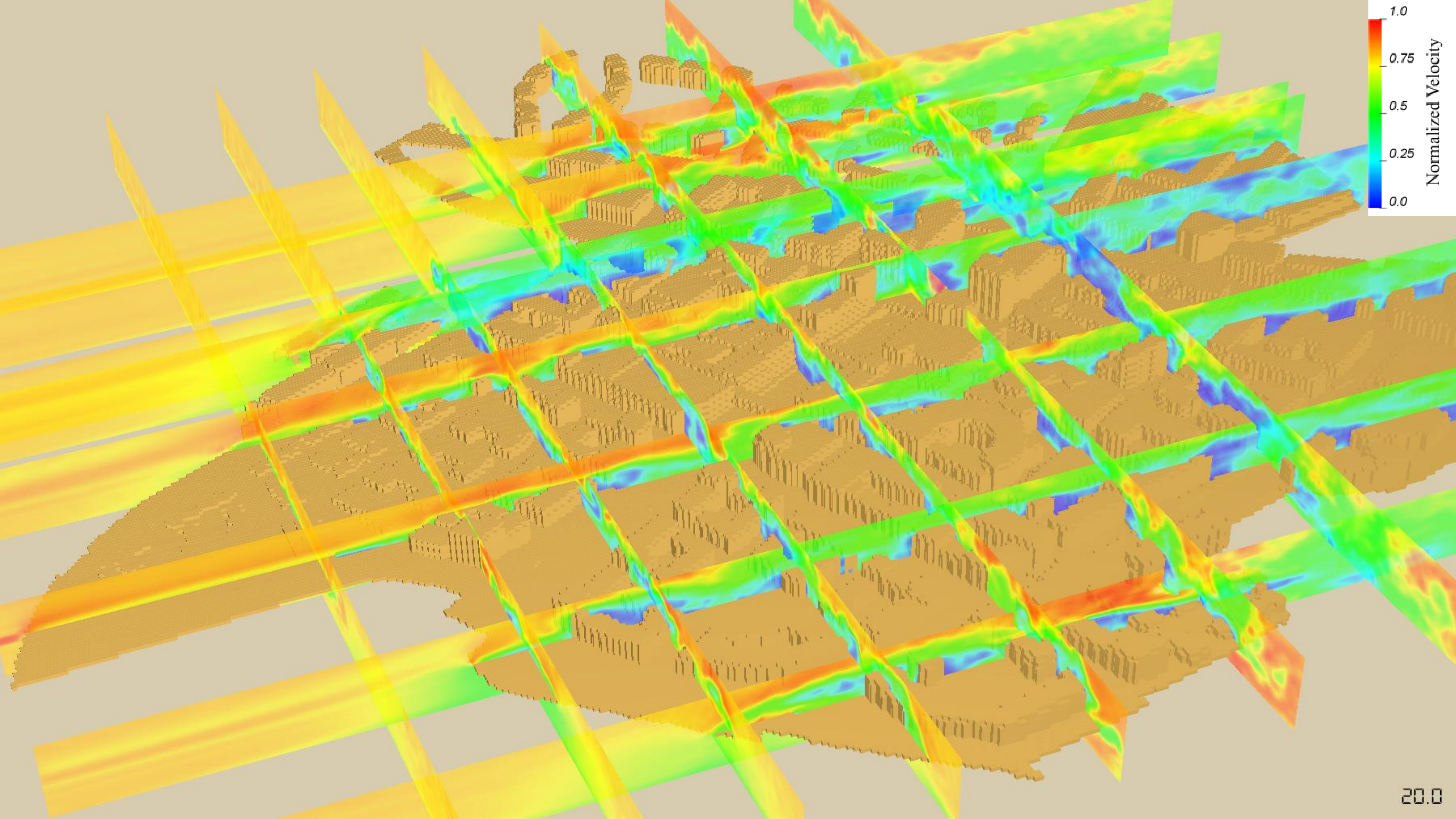
- Velocity is reported at different location across the entire model and velocity is normalized to the incoming wind , in this way any red color is capturing the acceleration of wind above the incoming value.

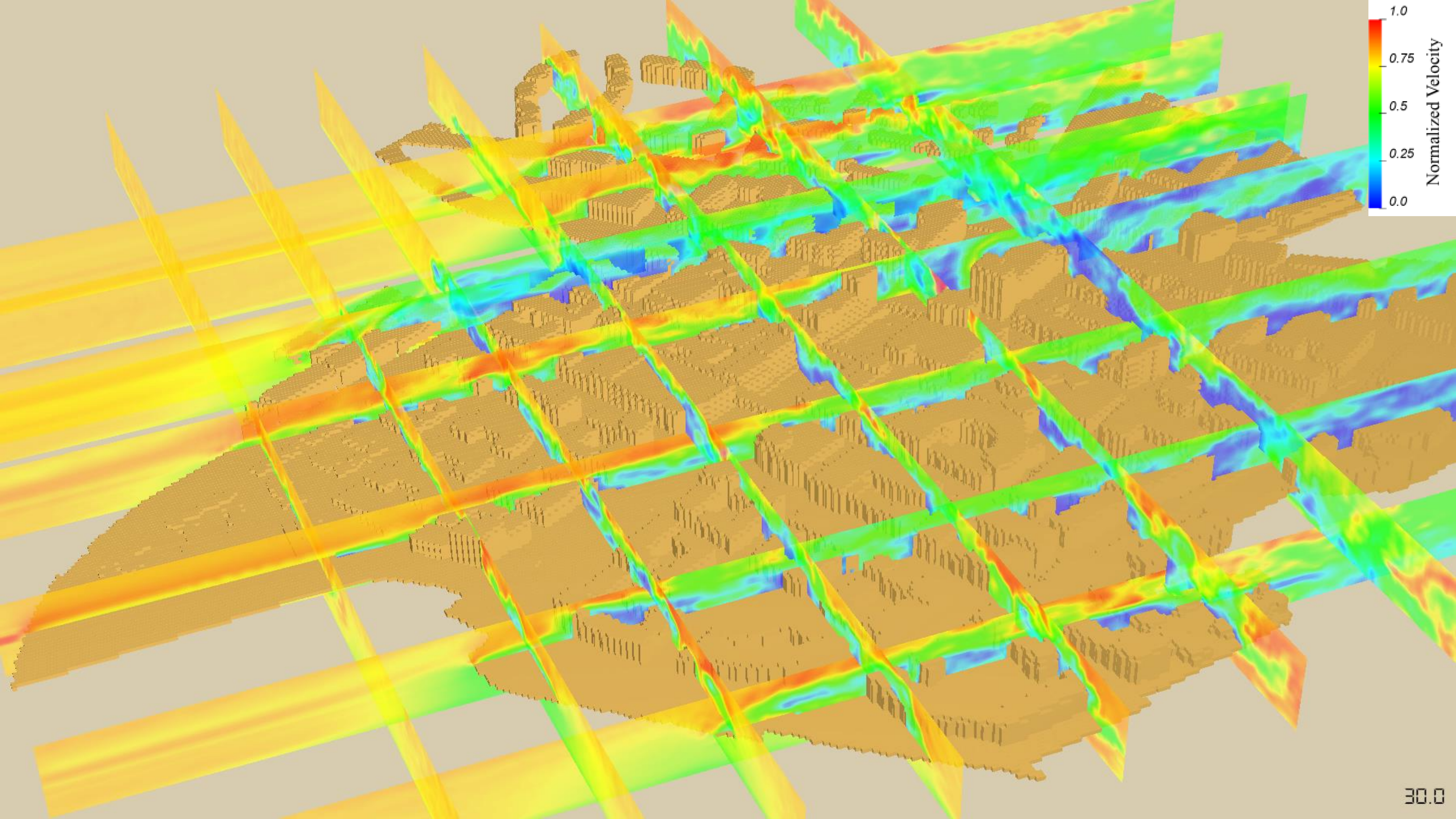
- As it can be seen some area, at high level is shown as accelerating the wind however at lower heights this effect is less notable.

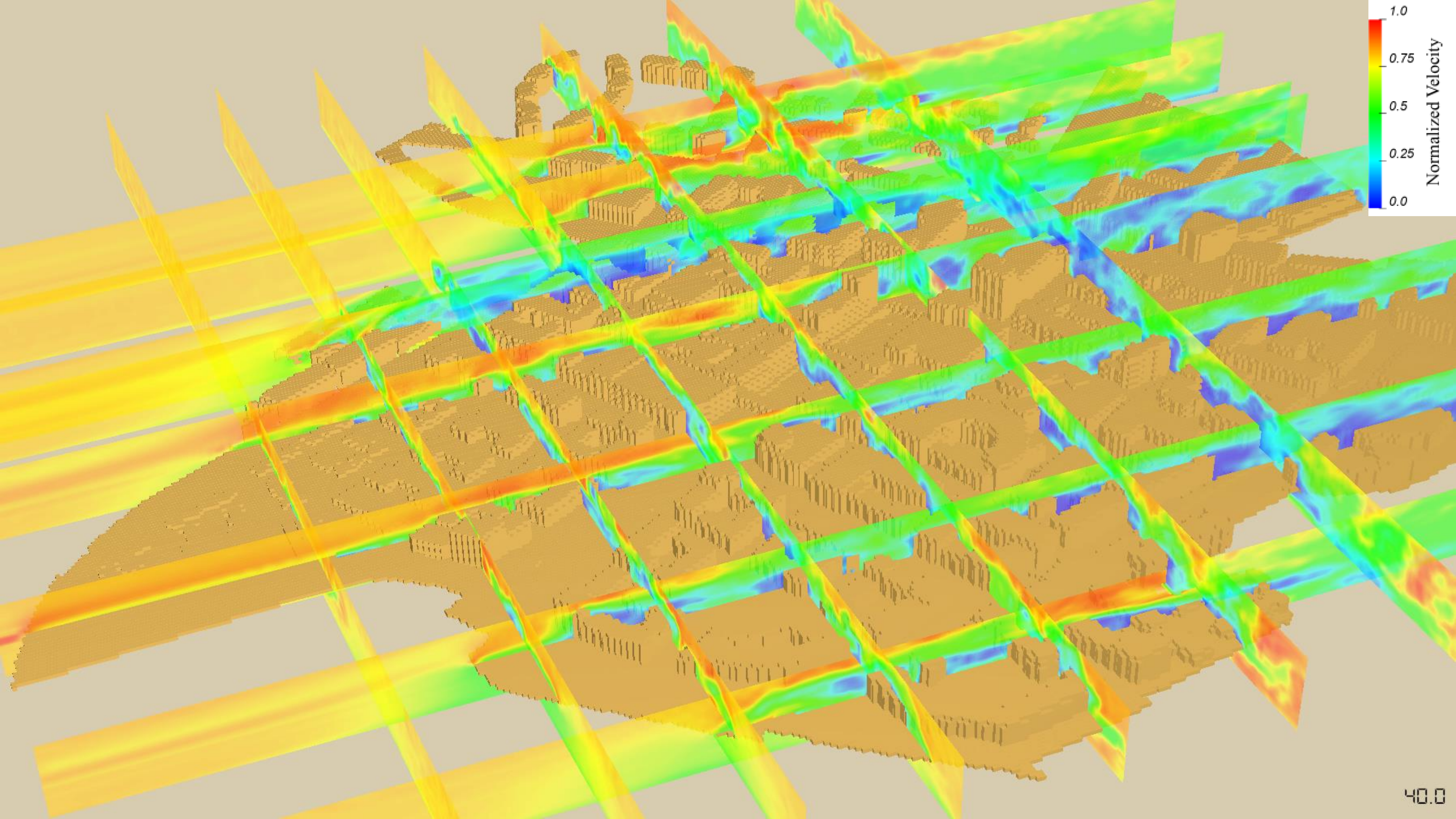
- Further directions should be investigated to assess if the outcomes noted here are similar when the wind occurs from a less frequent direction.

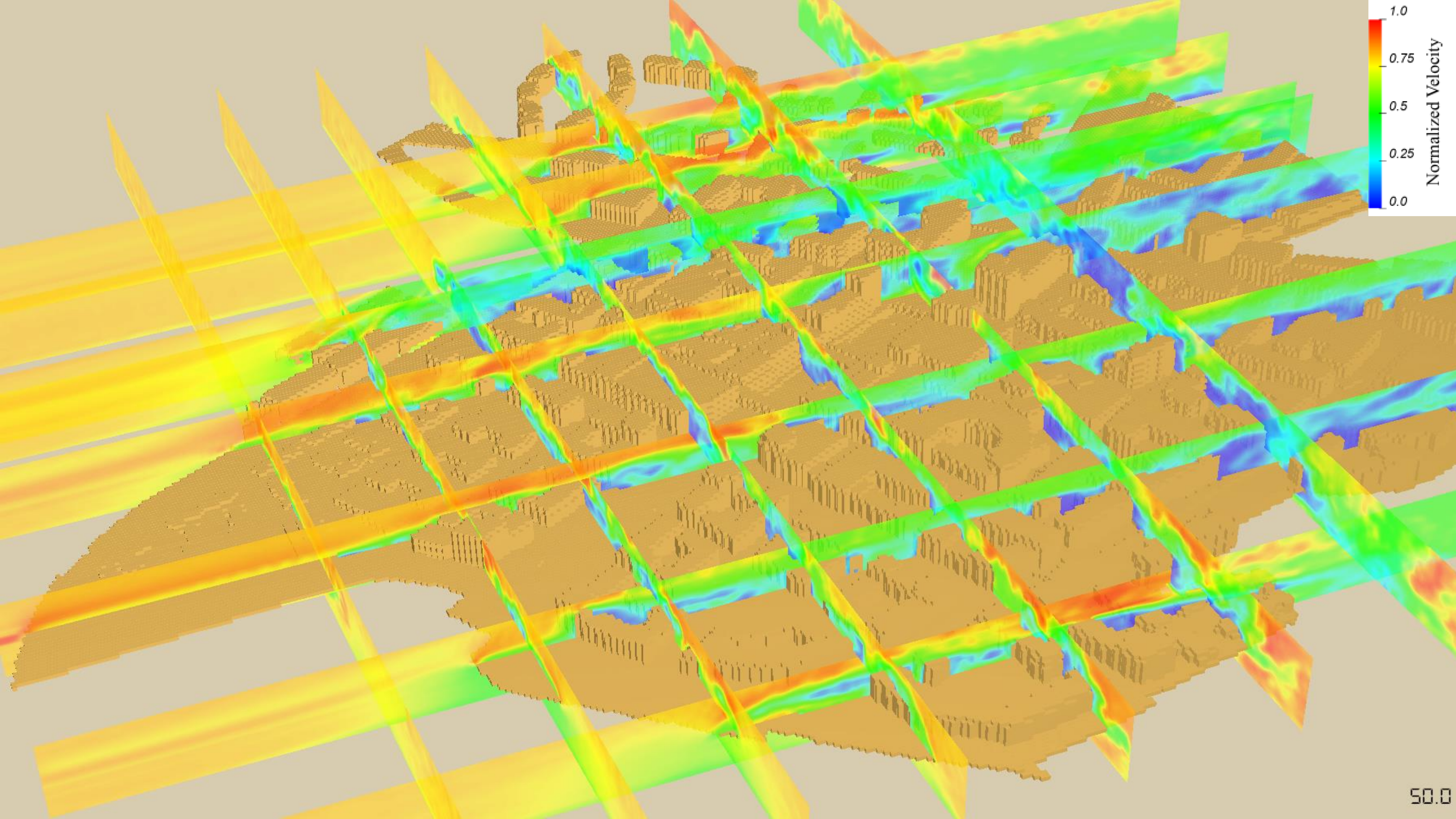



1.0
0.75
0.5
0.25
0.0
Normalized Velocity
10.0

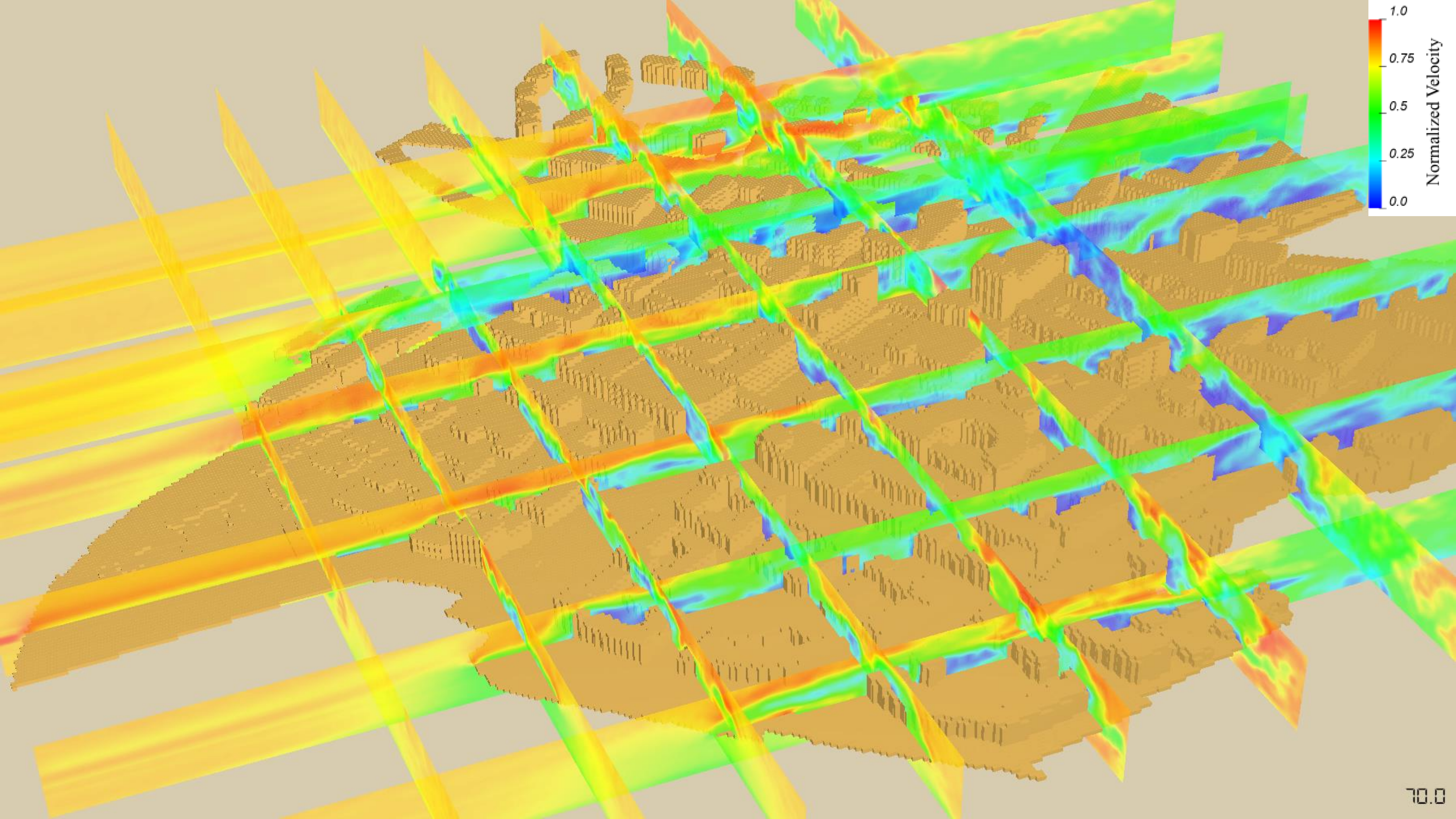

1.0
0.75
0.5
0.25
0.0
Normalized Velocity
20.0


1.0
0.75
0.5
0.25
0.0
Normalized Velocity
30.0

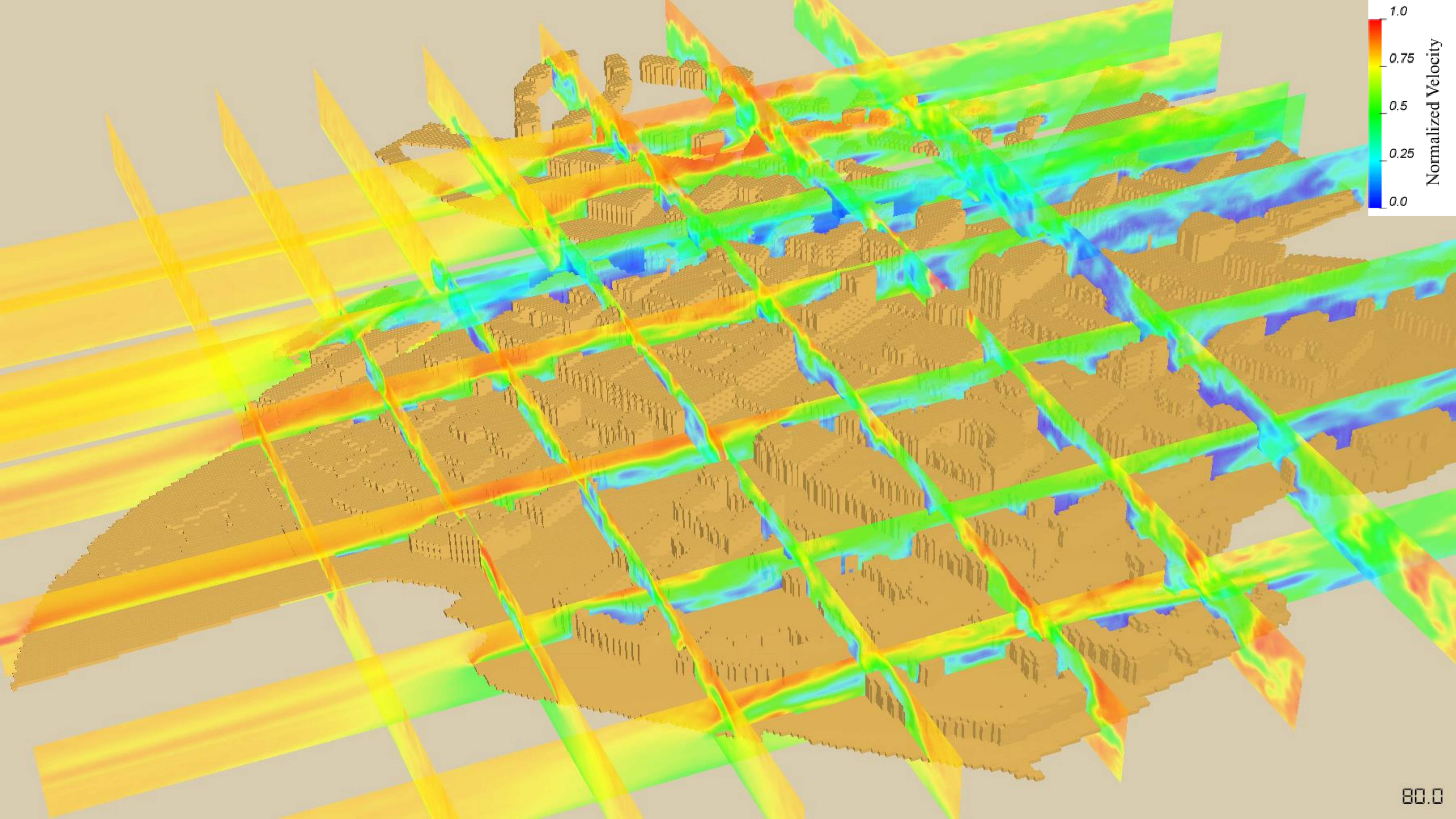

1.0
0.75
0.5
0.25
0.0
Normalized Velocity
40.0



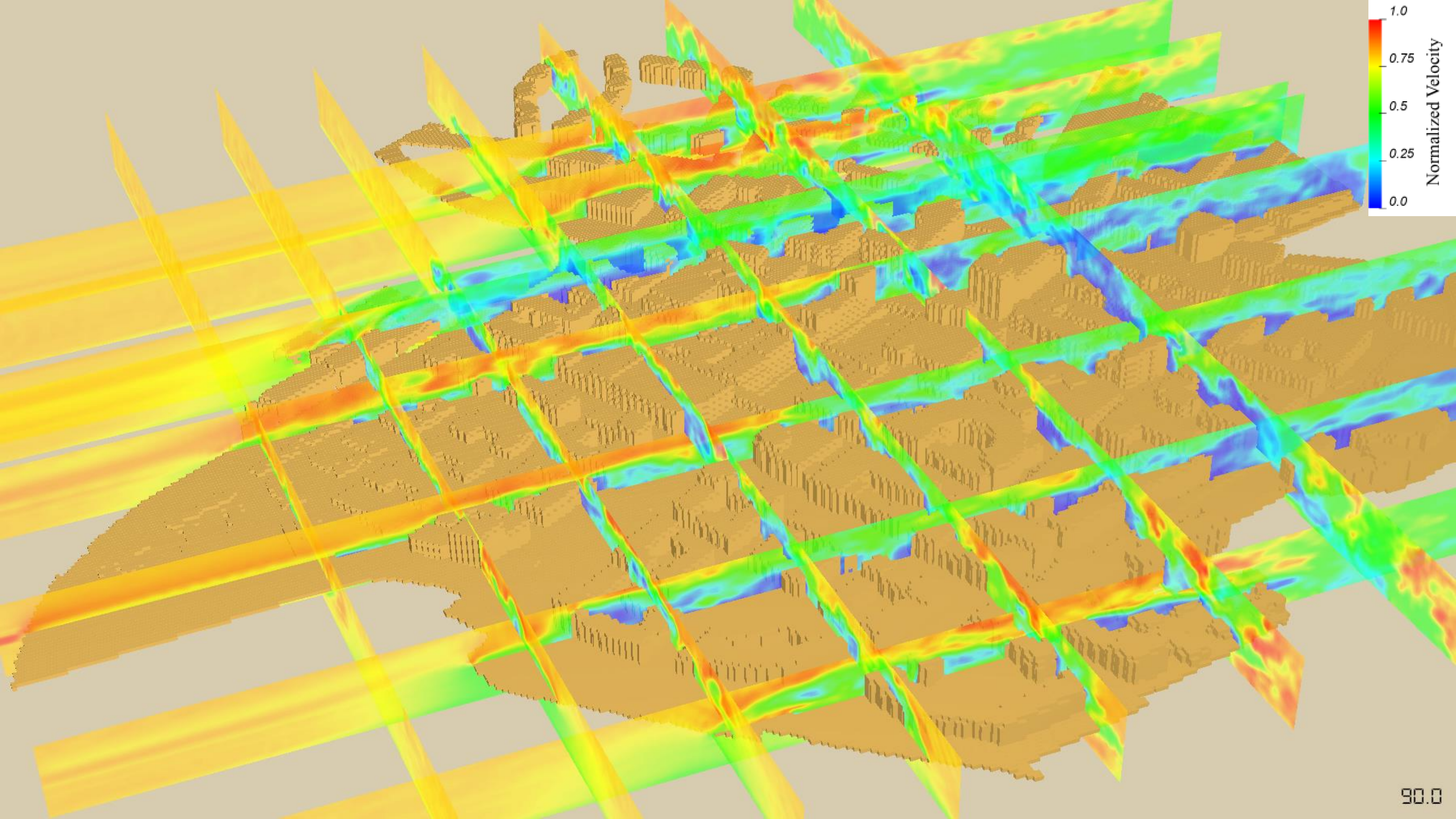
1.0
0.75
0.5
0.25
0.0
Normalized Velocity
50.0



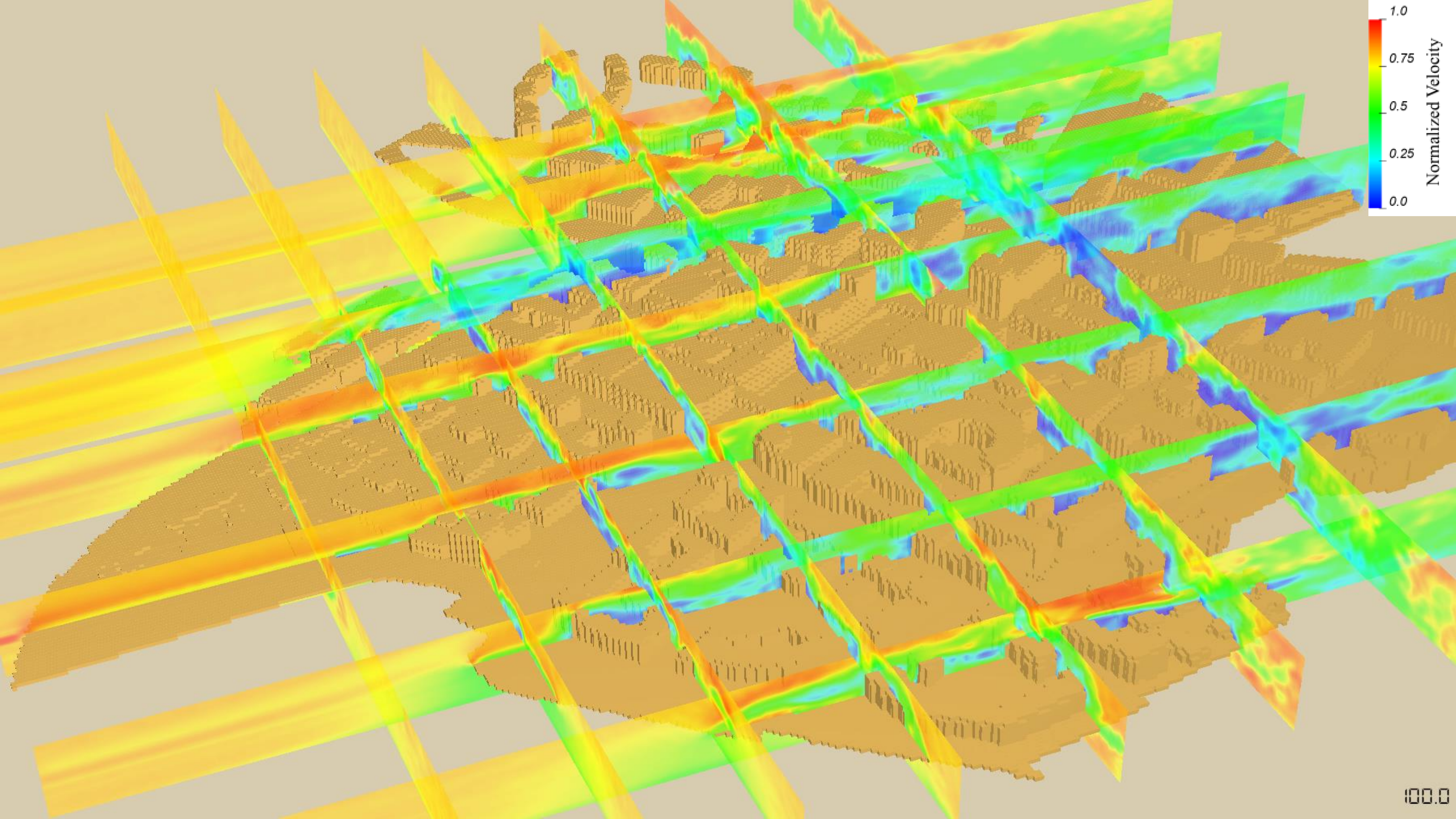
1.0
0.75
0.5
0.25
0.0
Normalized Velocity
70.0



1.0
0.75
0.5
0.25
0.0
Normalized Velocity
80.0



1.0
0.75
0.5
0.25
0.0
Normalized Velocity
90.0



1.0
0.75
0.5
0.25
0.0
Normalized Velocity
100.0