DAYLIGHT SIGNATURE

Qualitative analysis of urban settings in respect to
sunlight and daylight availability

MOTIVATION

- Most existing guidance is based on the concept of worst case scenario, the lowest acceptable threshold above design failure.
- One can check whether minimum requirement is achieved but cannot use this conclusion to analyse the quality of a proposal.
- Guidance is meant to ensure that all receptors achieve the minimum threshold but does not provide statistical indication of overall conditions.
- A district includes several thousand single cases, some form of statistical analysis is needed.

AMBITION

- We propose a methodology that allows to compare daylight and sunlight availability at any urban scale, geographical location, weather, massing density, etc.

- Daylight signature uses machine learning and large datasets to derive typical daylight and sunlight scenarios which represent similar conditions

- One can use the method to identify an existing scenario which closely matches a proposed design

or

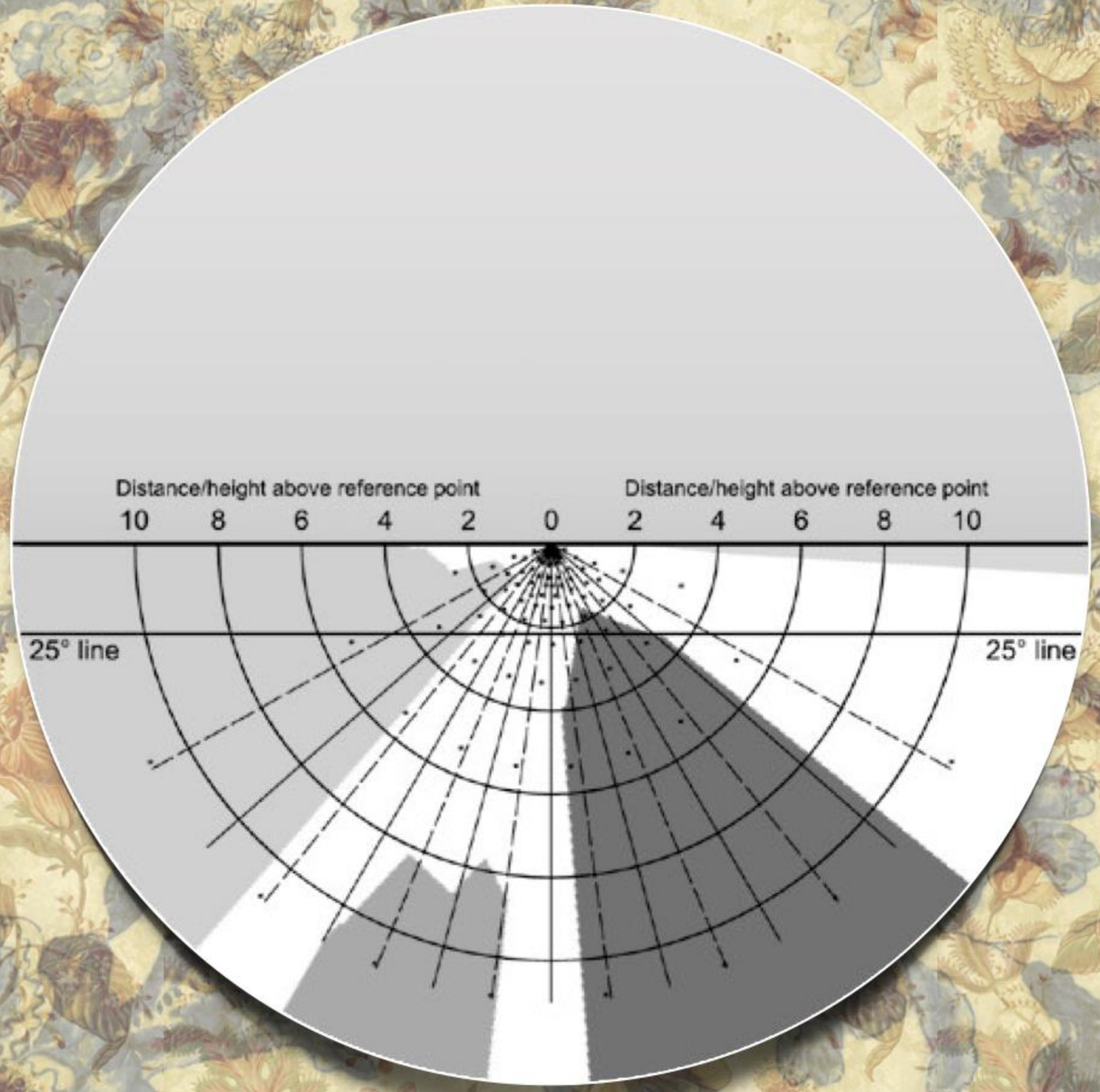
- Inform a design to closely match an existing scenario


COMMUNE NAUFRAGIUM
OMNIBUS SOLACIUM


SITE LAYOUT PLANNING FOR DAYLIGHT AND SUNLIGHT
A guide to good practice
SECOND EDITION
Paul Littlefair

25°


27%


Distance/height above reference point
10 8 6 4 2 0
Distance/height above reference point
2 4 6 8 10
25° line
25° line

APPENDIX F

SETTING ALTERNATIVE TARGET VALUES FOR SKYLIGHT AND SUNLIGHT ACCESS

F1 Sections 2.1, 2.2 and 2.3 give numerical target values in assessing how much light from the sky is blocked by obstructing buildings. These values are purely advisory and different targets may be used based on the special requirements of the proposed development or its location. Such alternative targets may be generated from the layout dimensions of existing development, or they may be derived from

F4 For example, in a mews in a historic city centre, a typical obstruction angle from ground floor window level might be close to 40° (Figure F1). This would correspond to a VSC of 18%, which could be used as a target value for development in that street if new development is to match the existing layout.

F5 A similar approach may be adopted in cases

Towards Generalised Guidance (i.e. threshold can be lowered)

If there is **enough light** when the sky is dark, then there is enough light the rest of the time

Worst case scenario logic.

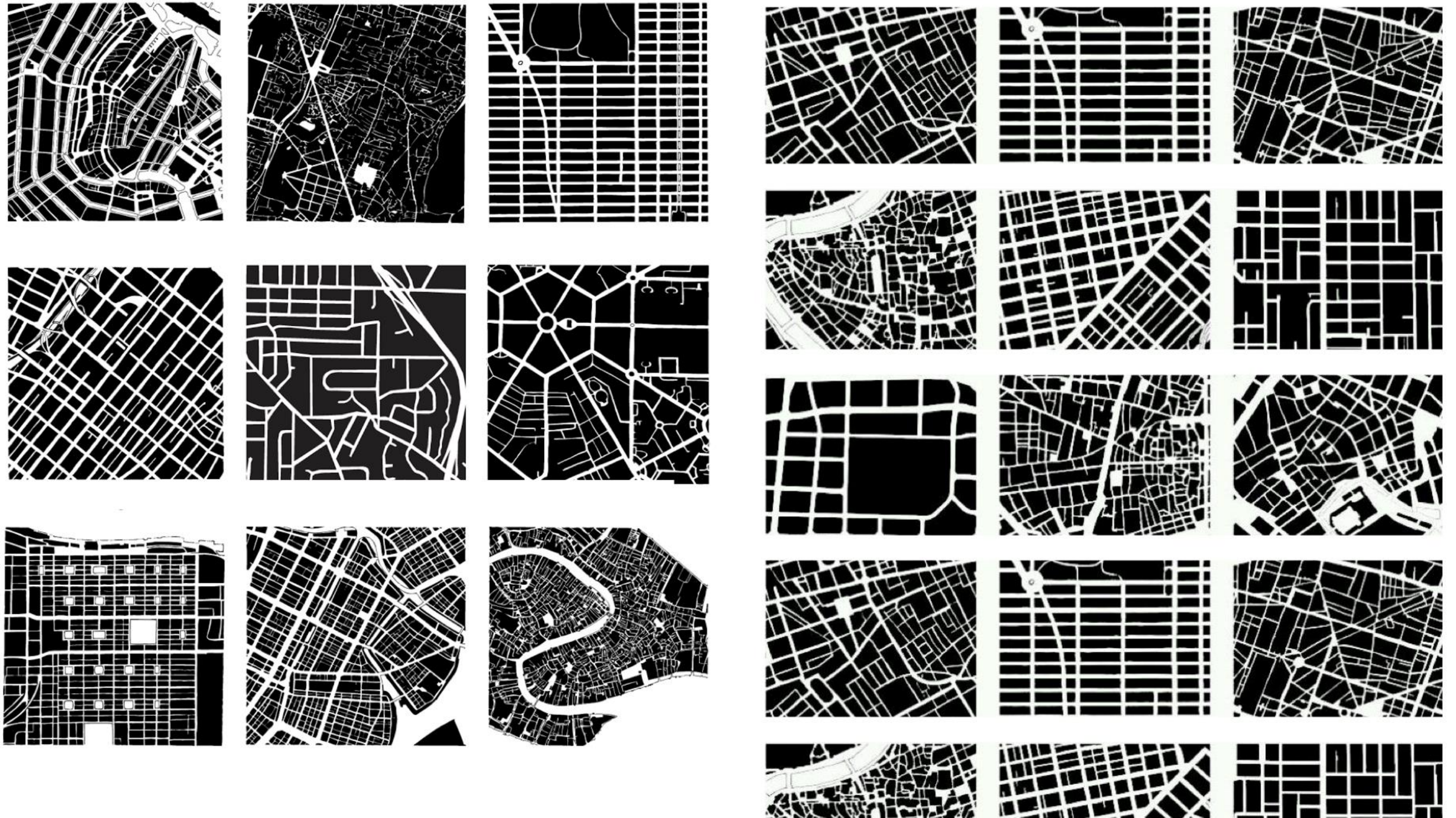
THE FUNDAMENTAL QUESTIONS

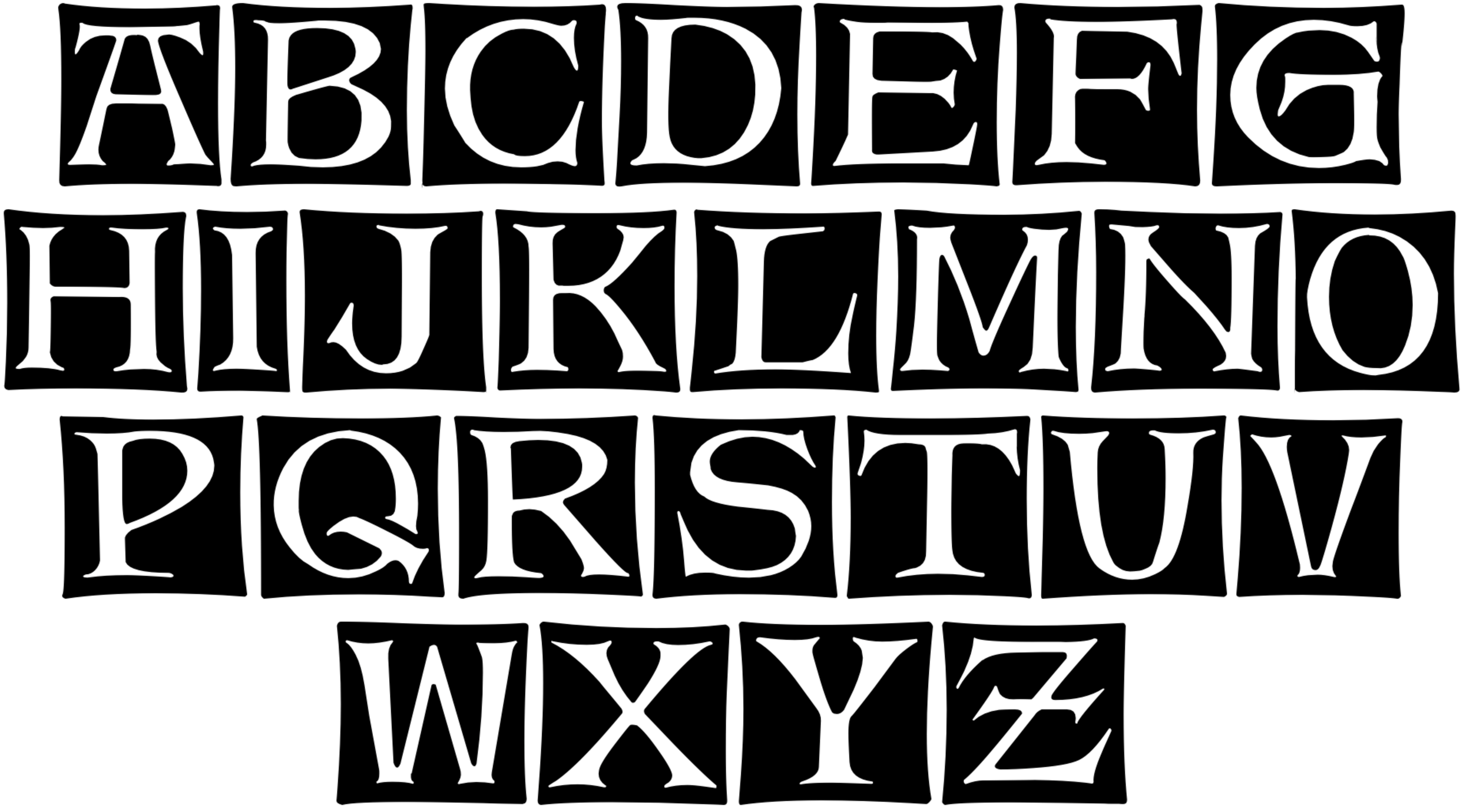
Is compliance sufficient?

Can one decode good daylight?

Can one encode quality?

A NOVEL APPROACH




ABCDEFG
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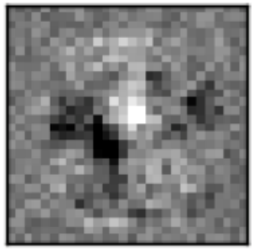
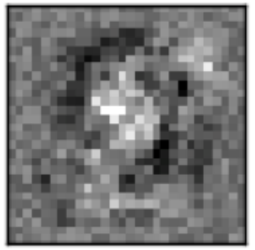
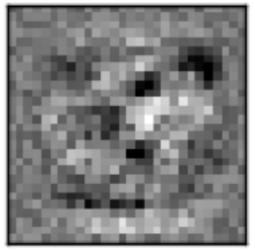
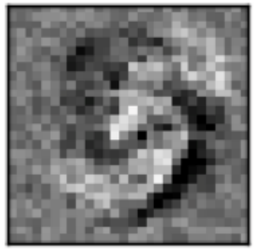
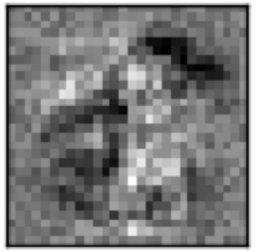
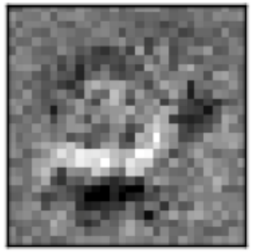
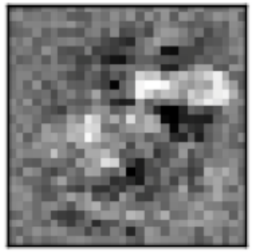
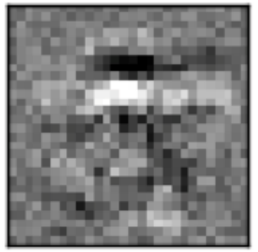
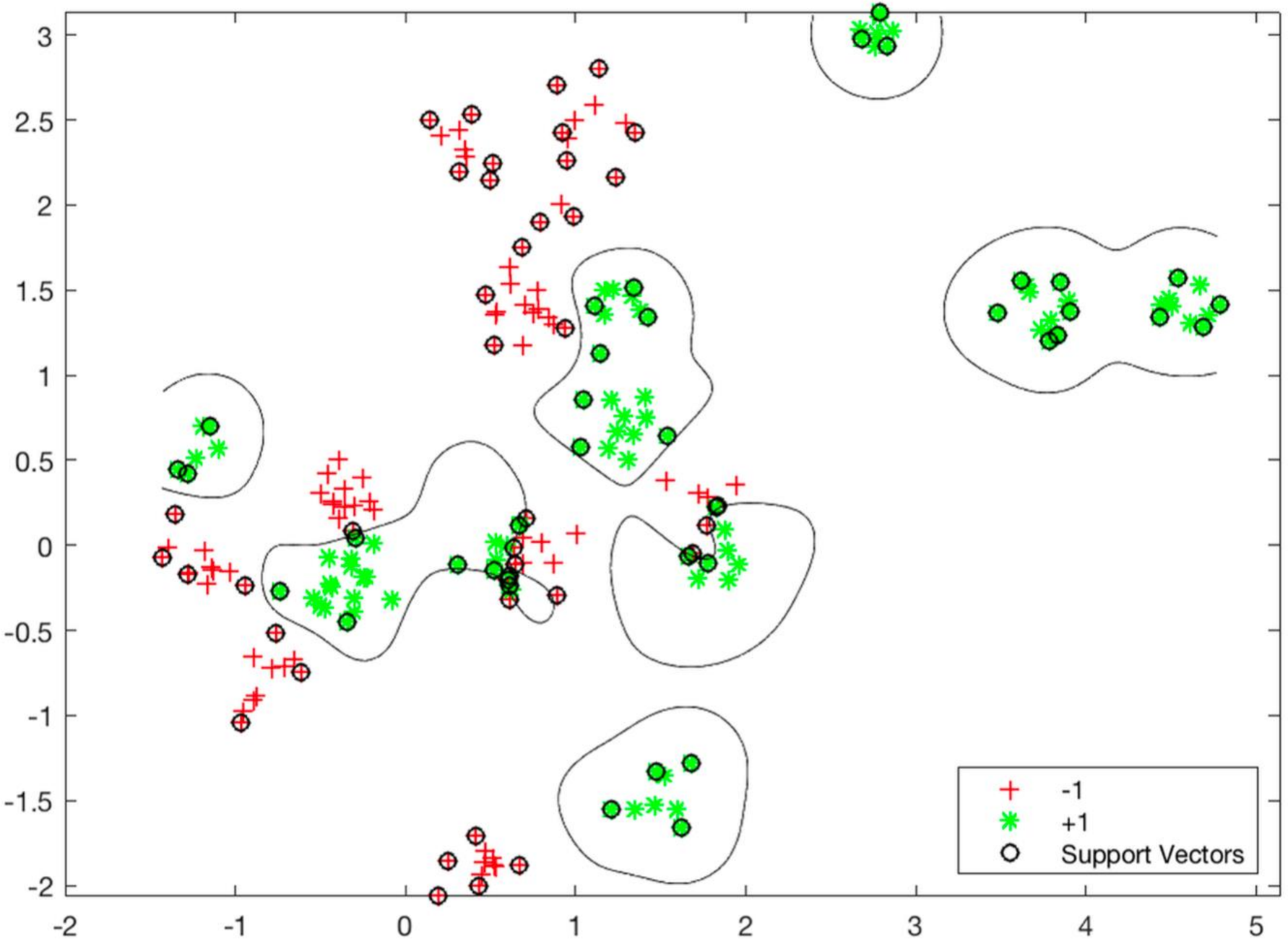
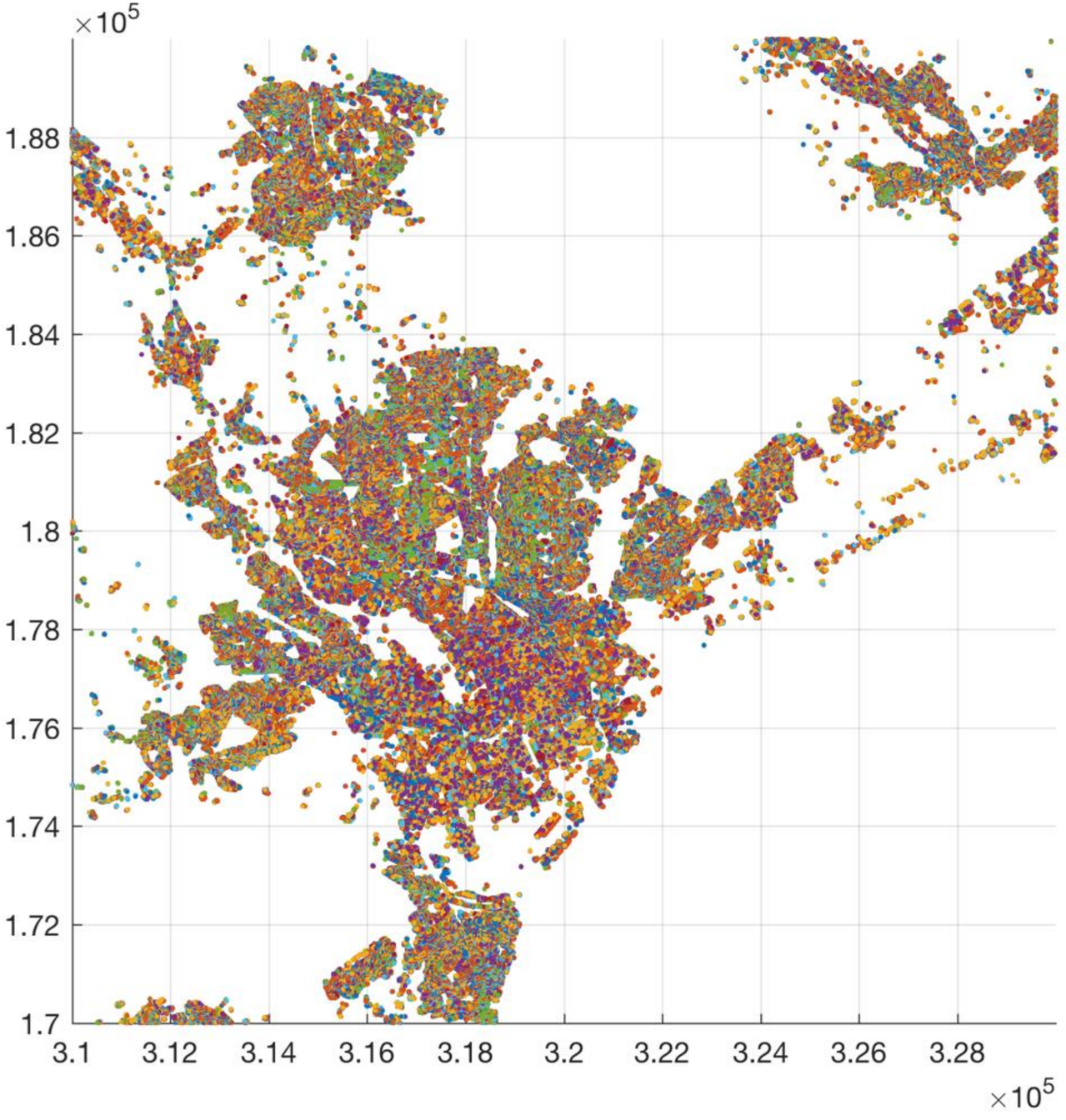
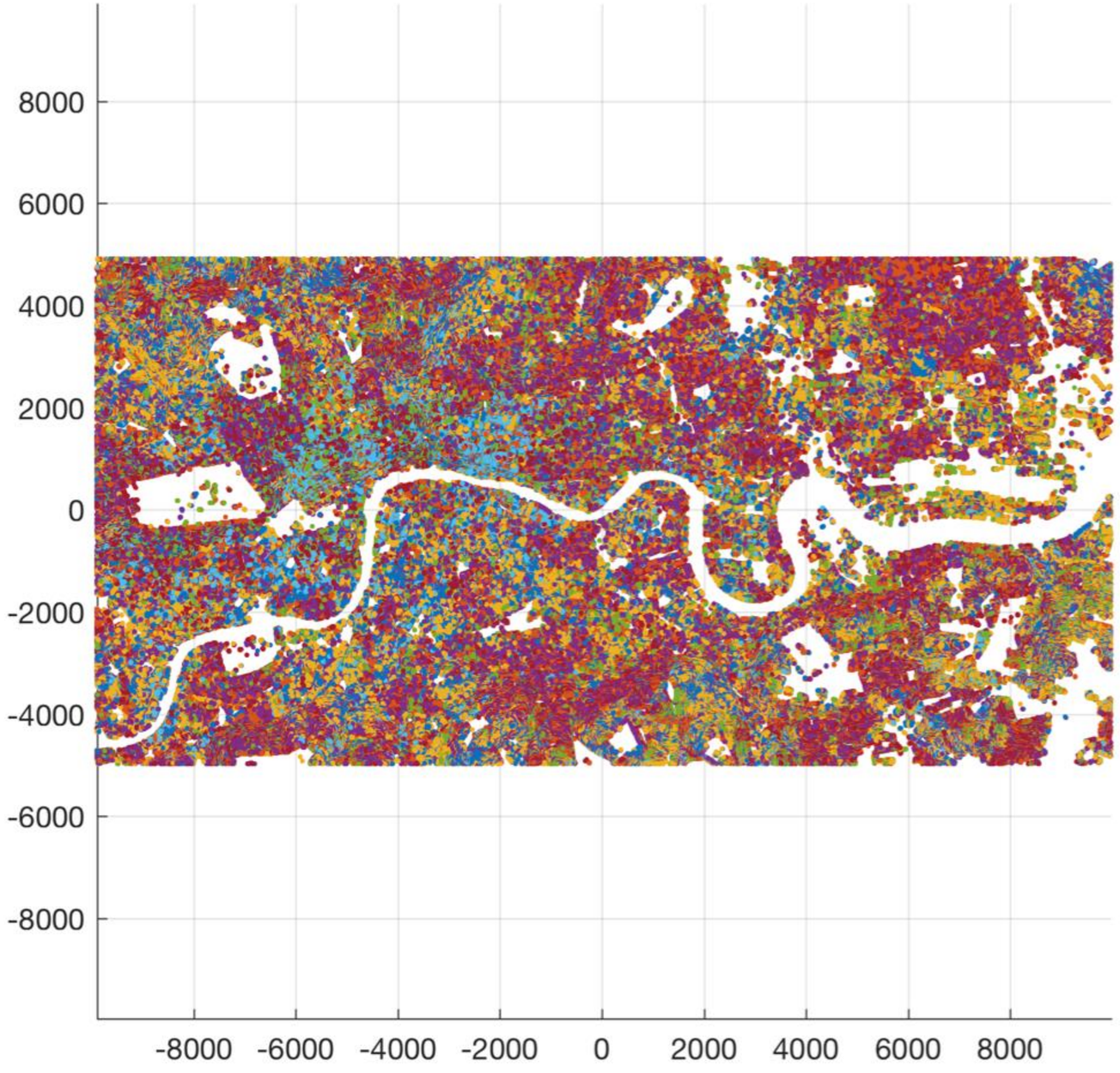









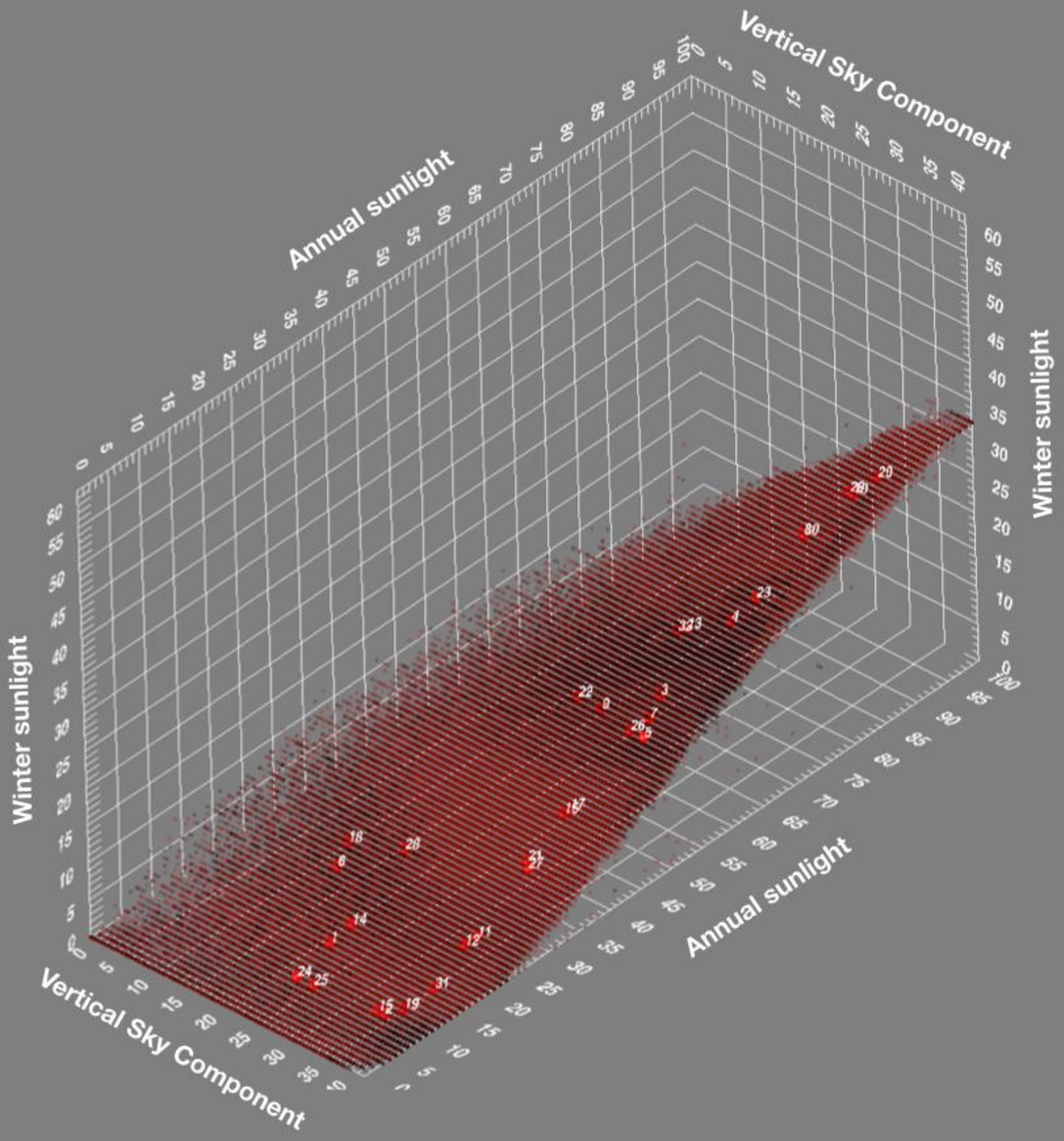

3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2
-1
0
1
2
3
4
5
-1
+1
Support Vectors

THE DATASET

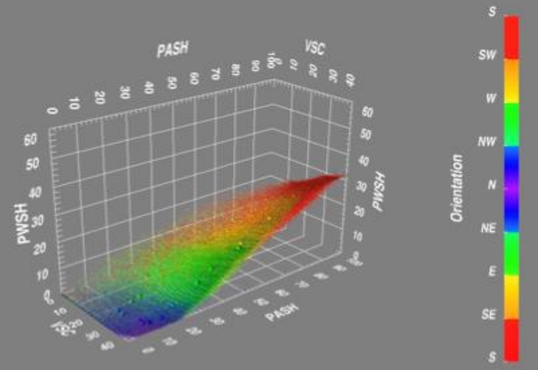

×10^5
1.88
1.86
1.84
1.82
1.8
1.78
1.76
1.74
1.72
1.7
3.1
3.12
3.14
3.16
3.18
3.2
3.22
3.24
3.26
3.28
×10^5


8000
6000
4000
2000
0
-2000
-4000
-6000
-8000
-8000 -6000 -4000 -2000 0 2000 4000 6000 8000

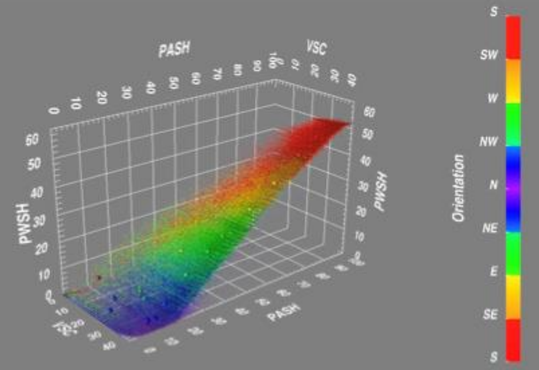
THE SUNLIGHT DAYLIGHT WEDGE



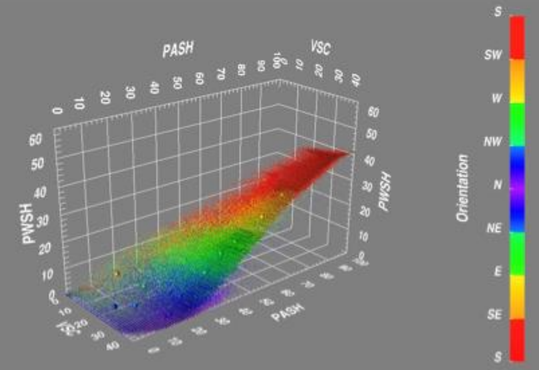
EFFECTS OF WEATHER AND LATITUDE



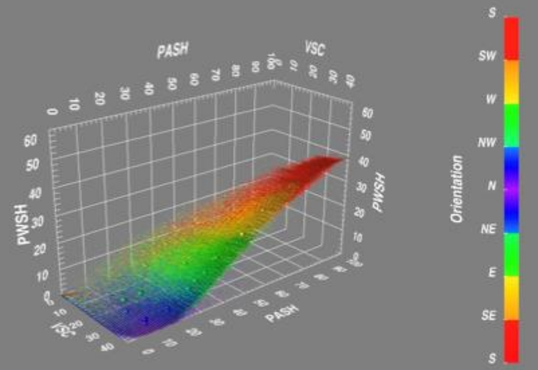
BERLIN, 52.47,13.40



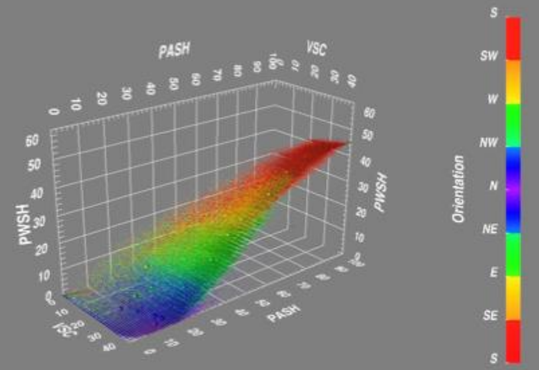
KATHMANDU_INTL_ARPT,27.70,85.37



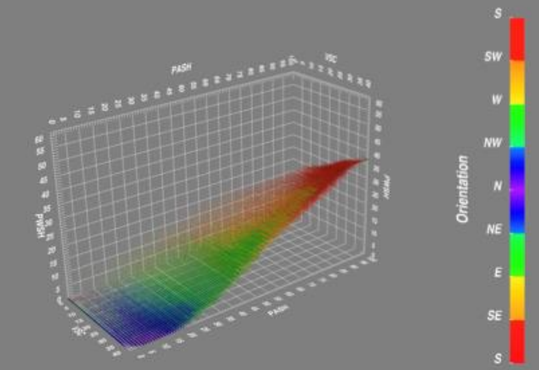
TAIPEI,25.07,121.55



Tabriz,38.05,46.17



Yazd,31.88,54.28



LONDON/GATWICK,51.15,-0.18

Same city geometry / using different weather files

6 weather files:
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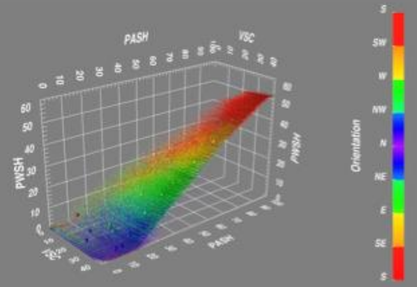
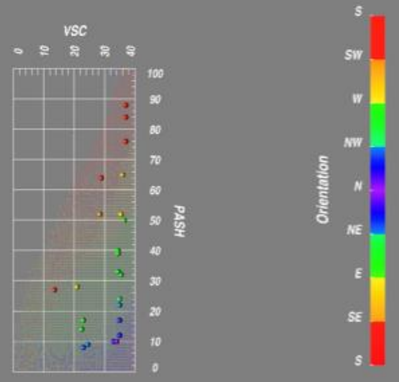
LOCATION,KATHMANDU_INTL_ARPT,-,NPL,SWERA,444540,27.70,85.37,5.75,1337.0
LOCATION,TAIPEI,-,TWN,IWEC Data,466960,25.07,121.55,8.0,6.0
LOCATION,Tabriz,-,IRN,ITMY,407060,38.05,46.17,3.0,1361.0
LOCATION,Yazd,-,IRN,ITMY,408210,31.88,54.28,3.0,1237.0
LOCATION,LONDON/GATWICK,-,GBR,IWEC Data,037760,51.15,-0.18,0.0,62.0

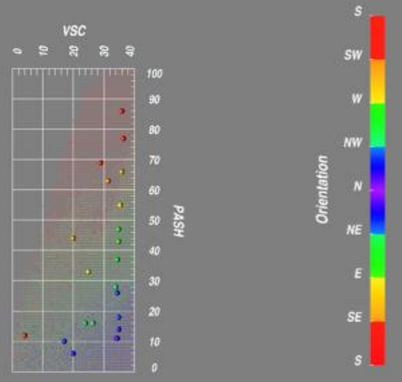


ARUP

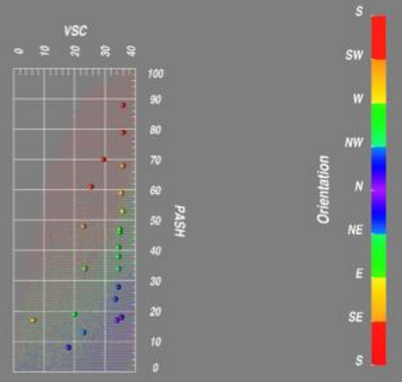
EFFECTS OF WEATHER AND LATITUDE



BERLIN, 52.47,13.40



KATHMANDU_INTL_ARPT,27.70,85.37



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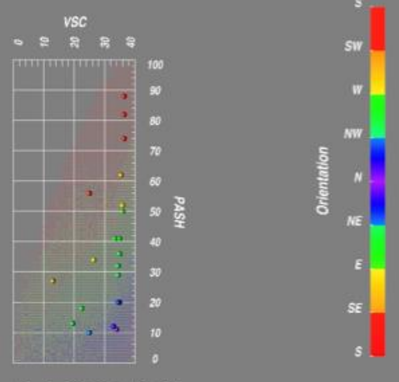

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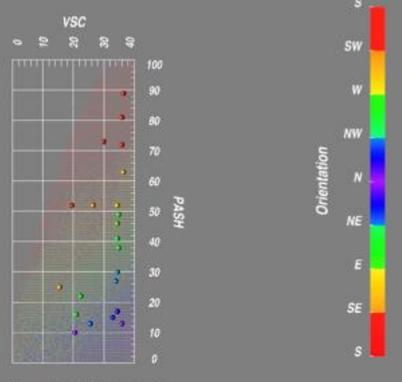

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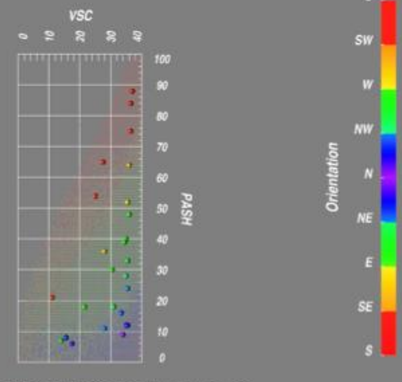
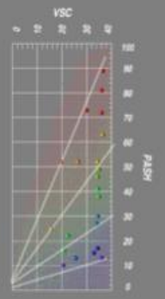
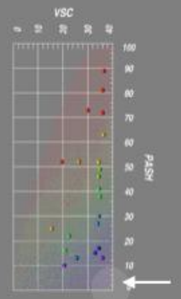


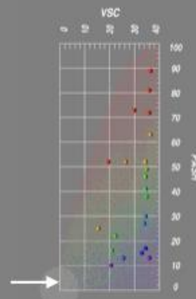
LONDON/GATWICK,51.15,-0.18



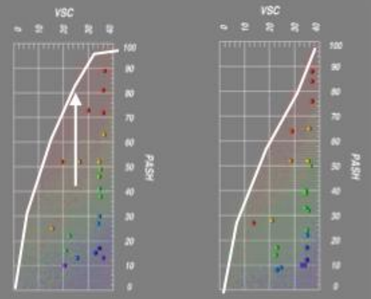
Orientation



Not obstructed
(Pure North)



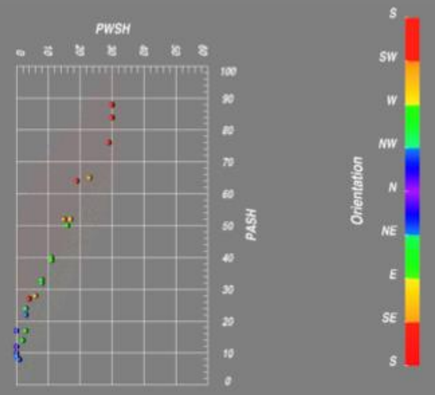
obstructed
(can be any orientation)



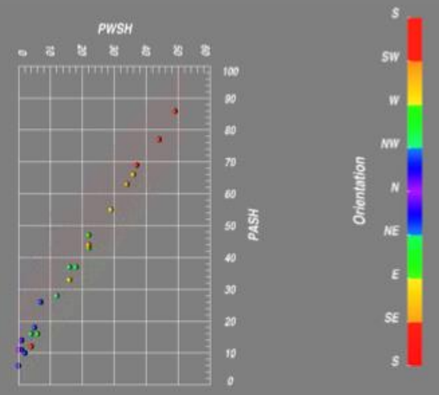
Effect of weather

This line shows the maximum possible sun hours for a given VSC

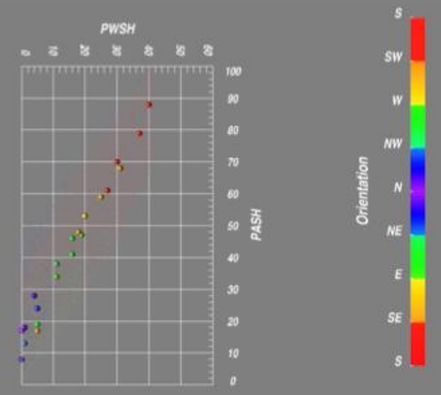
EFFECTS OF WEATHER AND LATITUDE



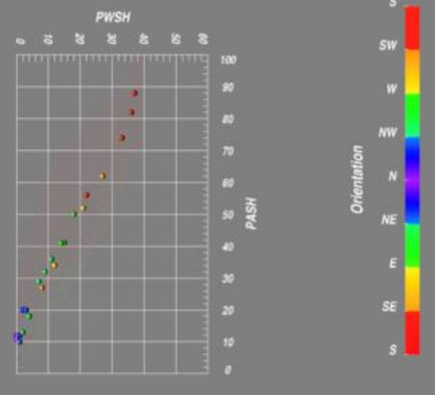
BERLIN, 52.47,13.40



KATHMANDU_INTL_ARPT,27.70,85.37



TAIPEI,25.07,121.55



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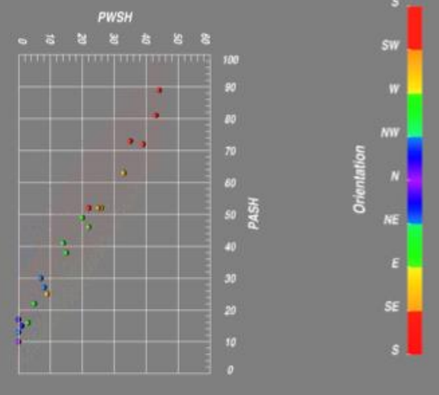
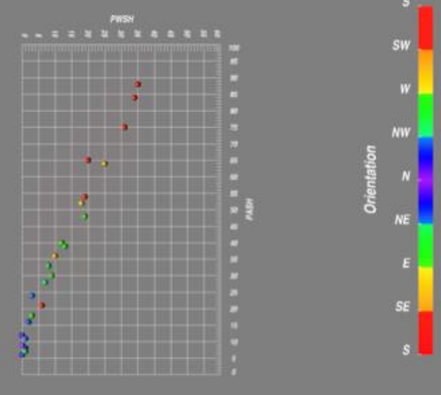
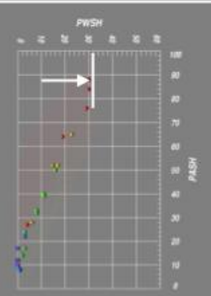


Yazd,31.88,54.28



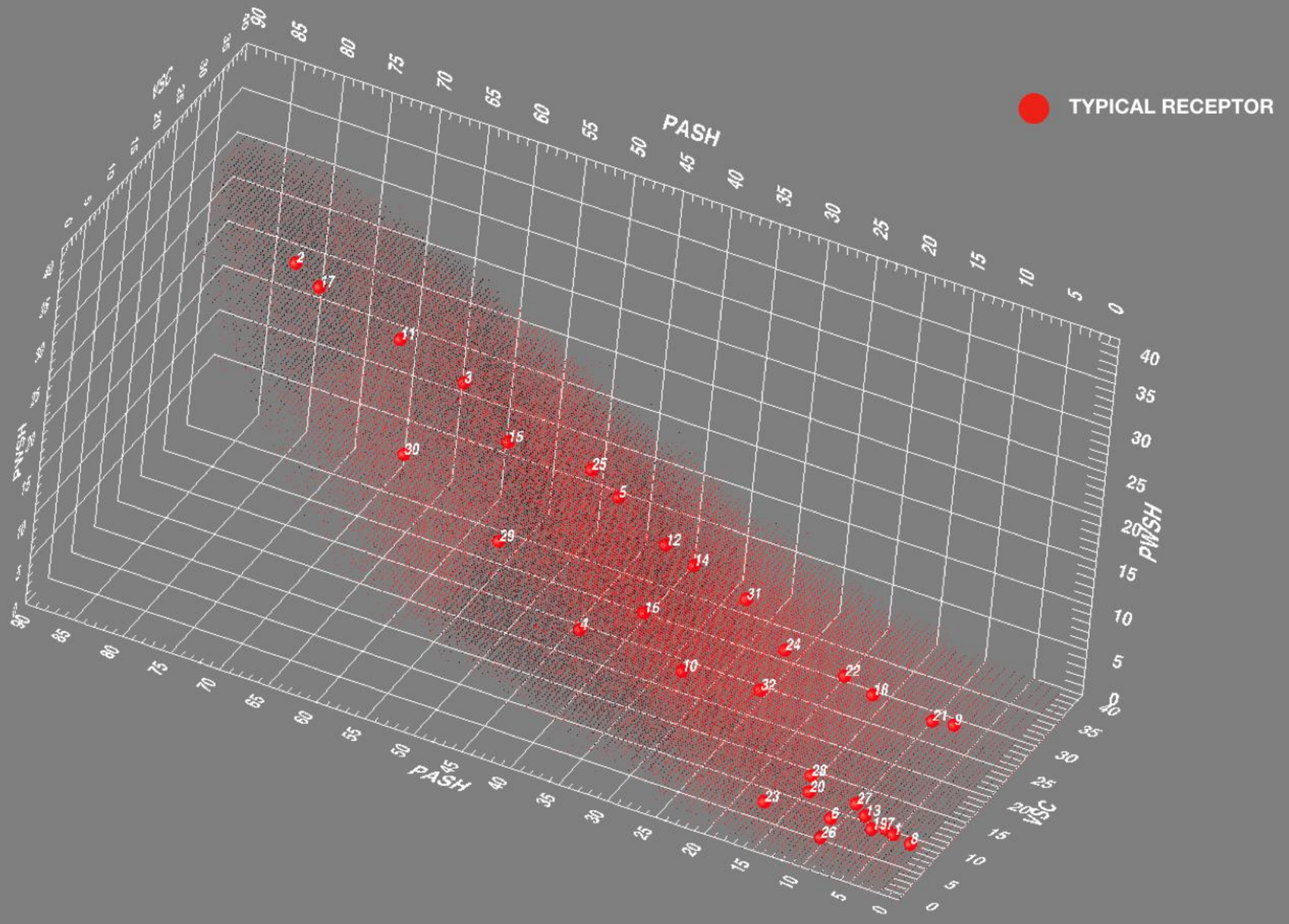
LONDON/GATWICK,51.15,-0.18

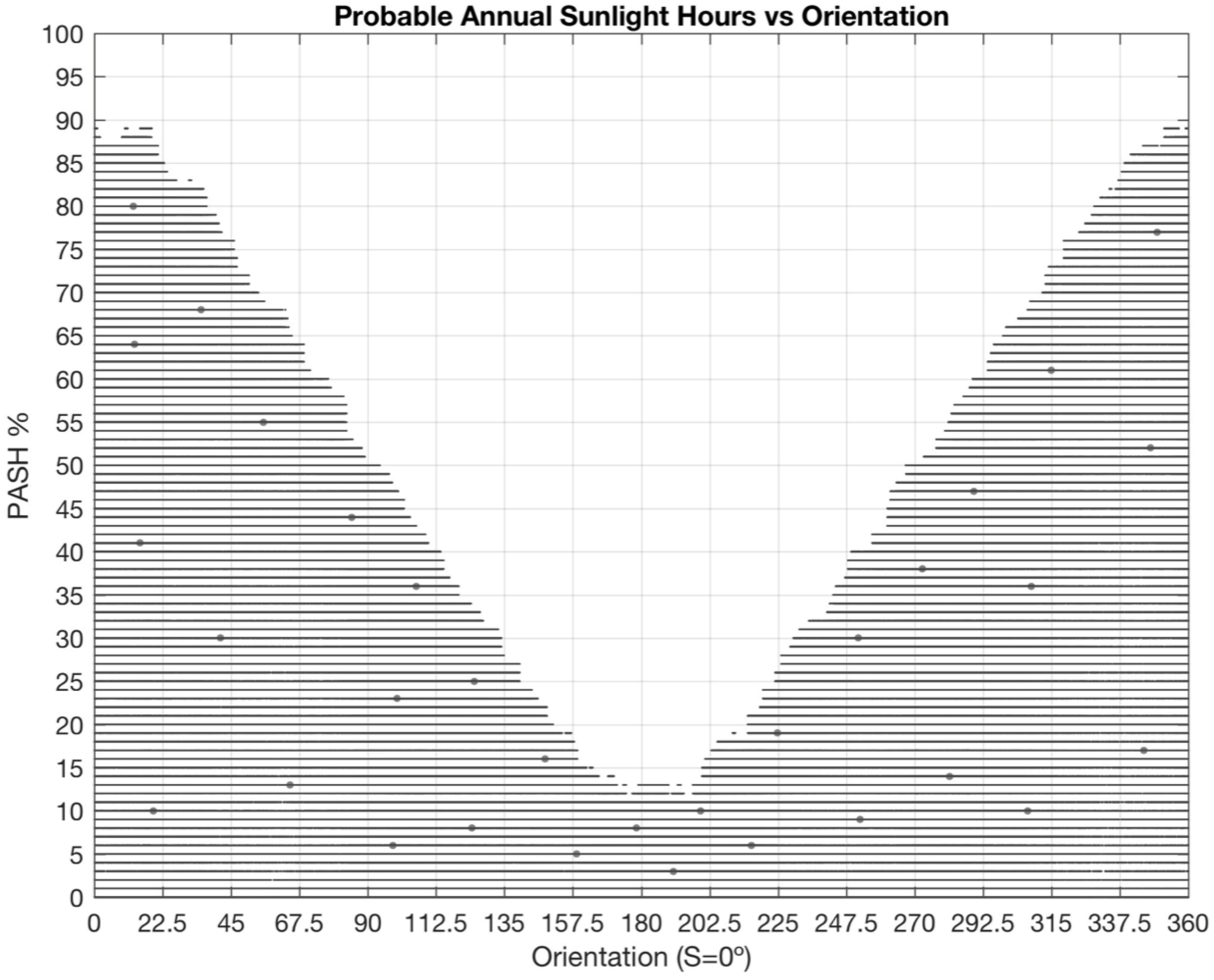


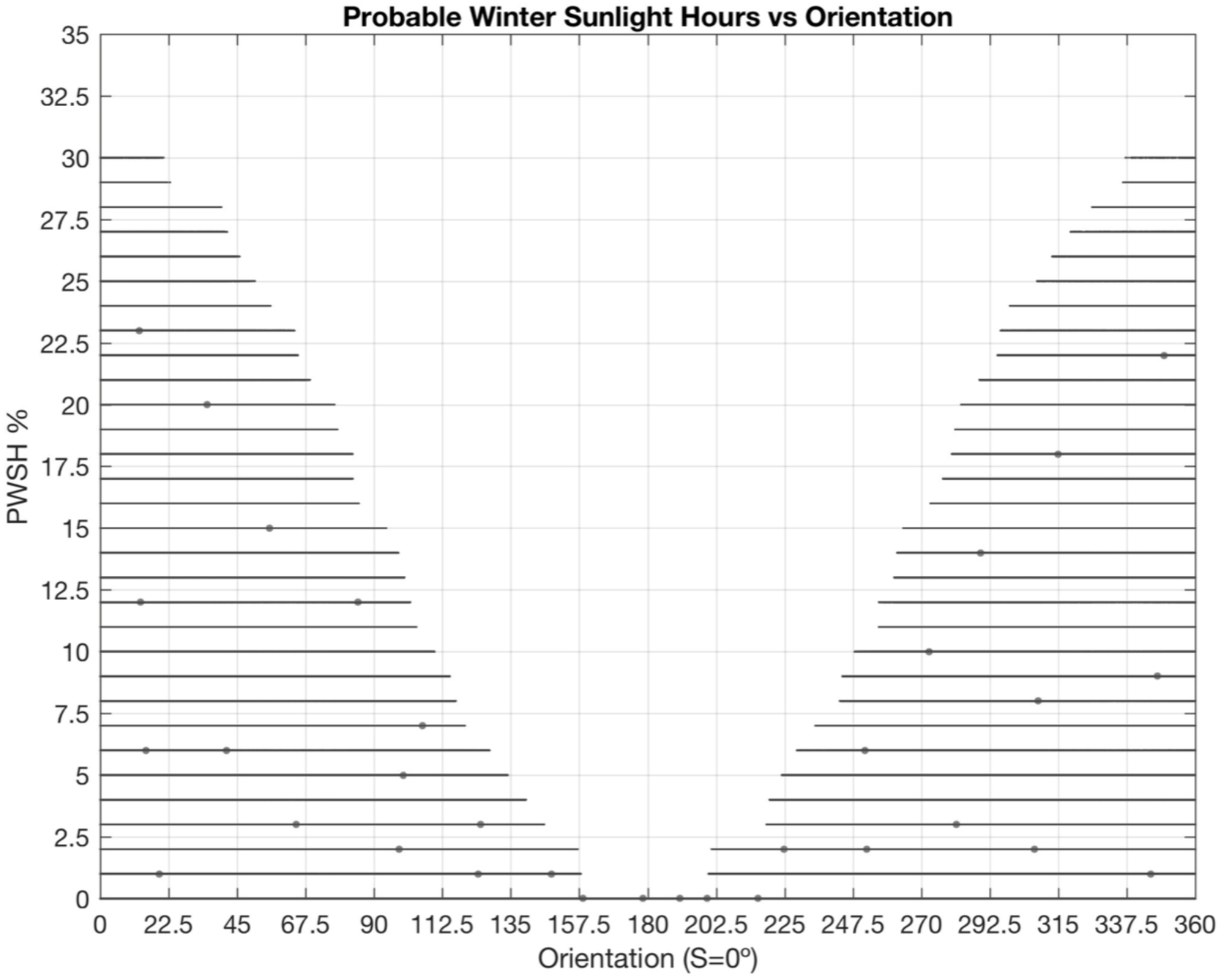
Latitude (and cloud cover)

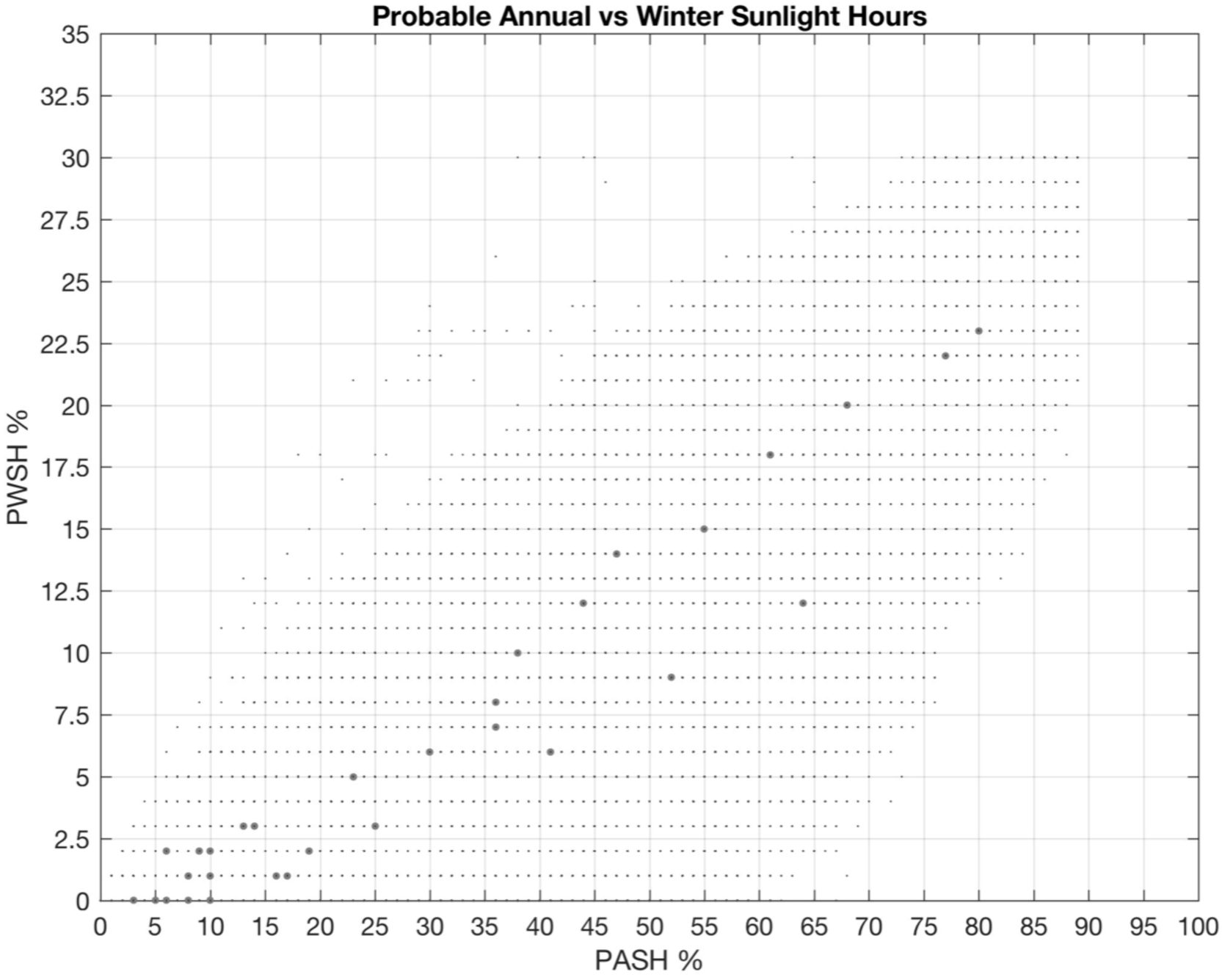
TYPICAL RECEPTORS

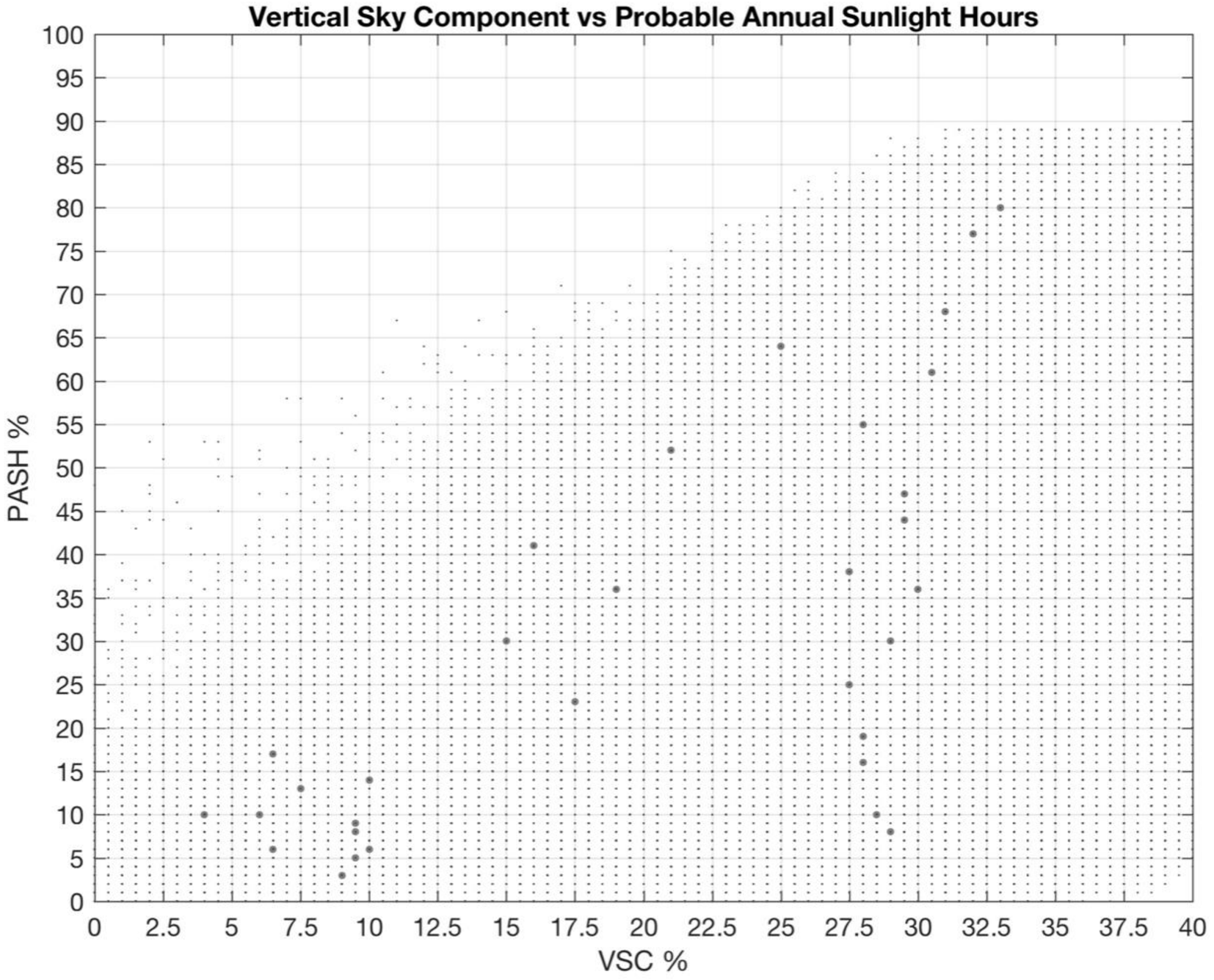
K-MEDOIDS CLUSTERING



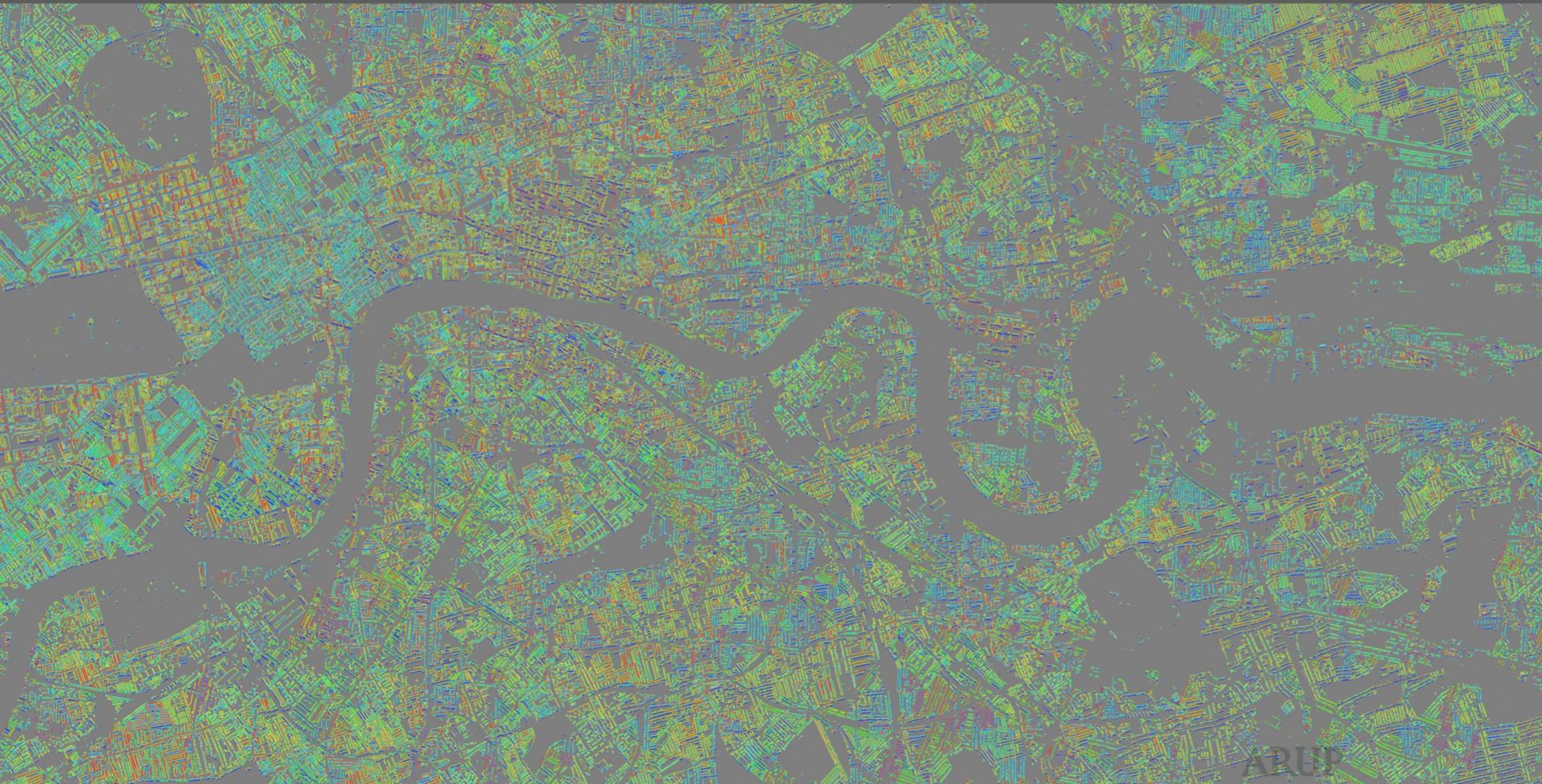

Probable Annual Sunlight Hours vs Orientation
PASH %
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
0
22.5
45
67.5
90
112.5
135
157.5
180
202.5
225
247.5
270
292.5
315
337.5
360
Orientation (S=0º)


Probable Winter Sunlight Hours vs Orientation
PWSH %
35
32.5
30
27.5
25
22.5
20
17.5
15
12.5
10
7.5
5
2.5
0
0
22.5
45
67.5
90
112.5
135
157.5
180
202.5
225
247.5
270
292.5
315
337.5
360
Orientation (S=0º)

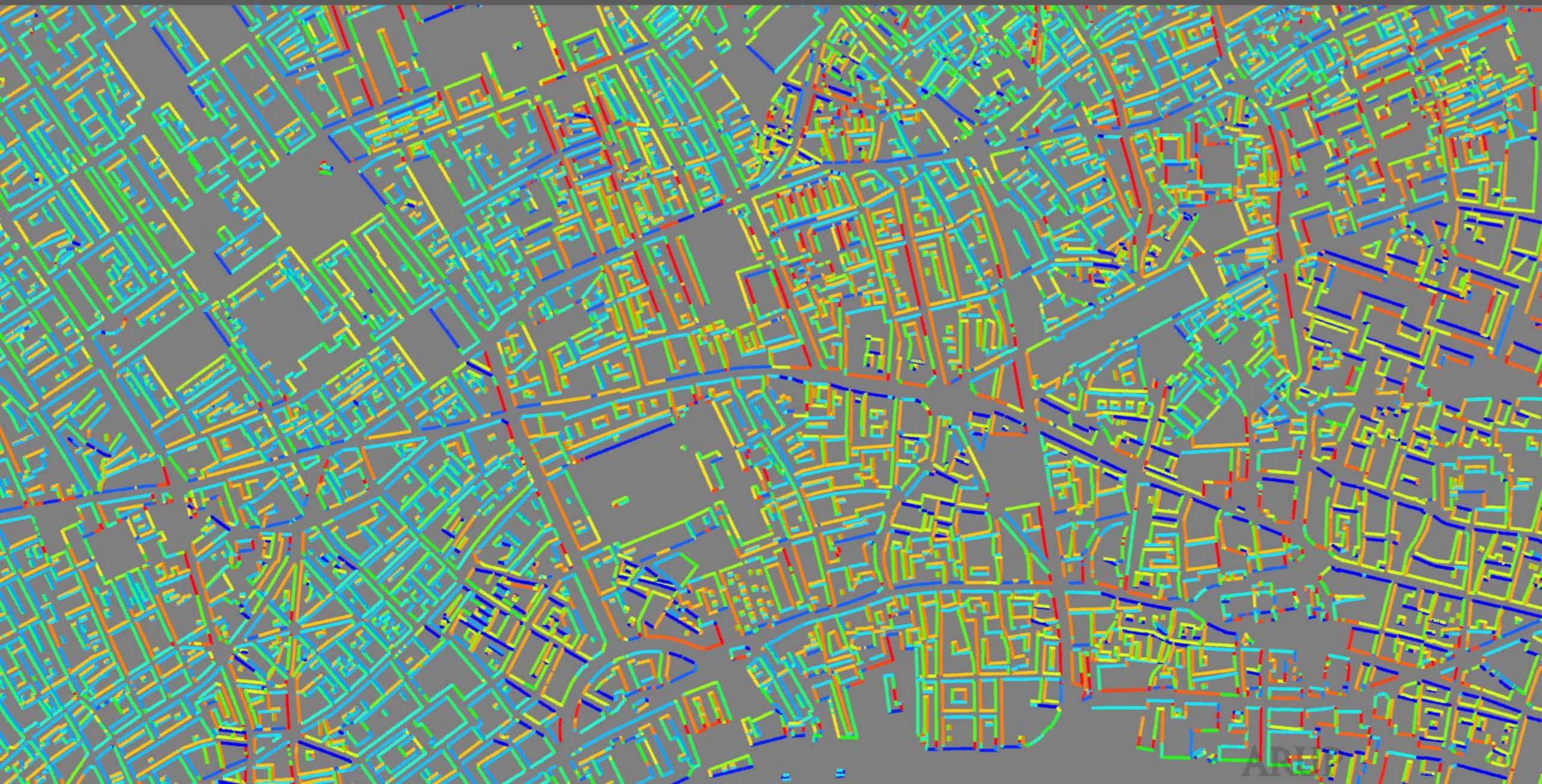

Probable Annual vs Winter Sunlight Hours
PWSH %
PASH %
0
2.5
5
7.5
10
12.5
15
17.5
20
22.5
25
27.5
30
32.5
35
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100


Vertical Sky Component vs Probable Annual Sunlight Hours
PASH %
VSC %
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
0
2.5
5
7.5
10
12.5
15
17.5
20
22.5
25
27.5
30
32.5
35
37.5
40

CLUSTER DISTRIBUTION

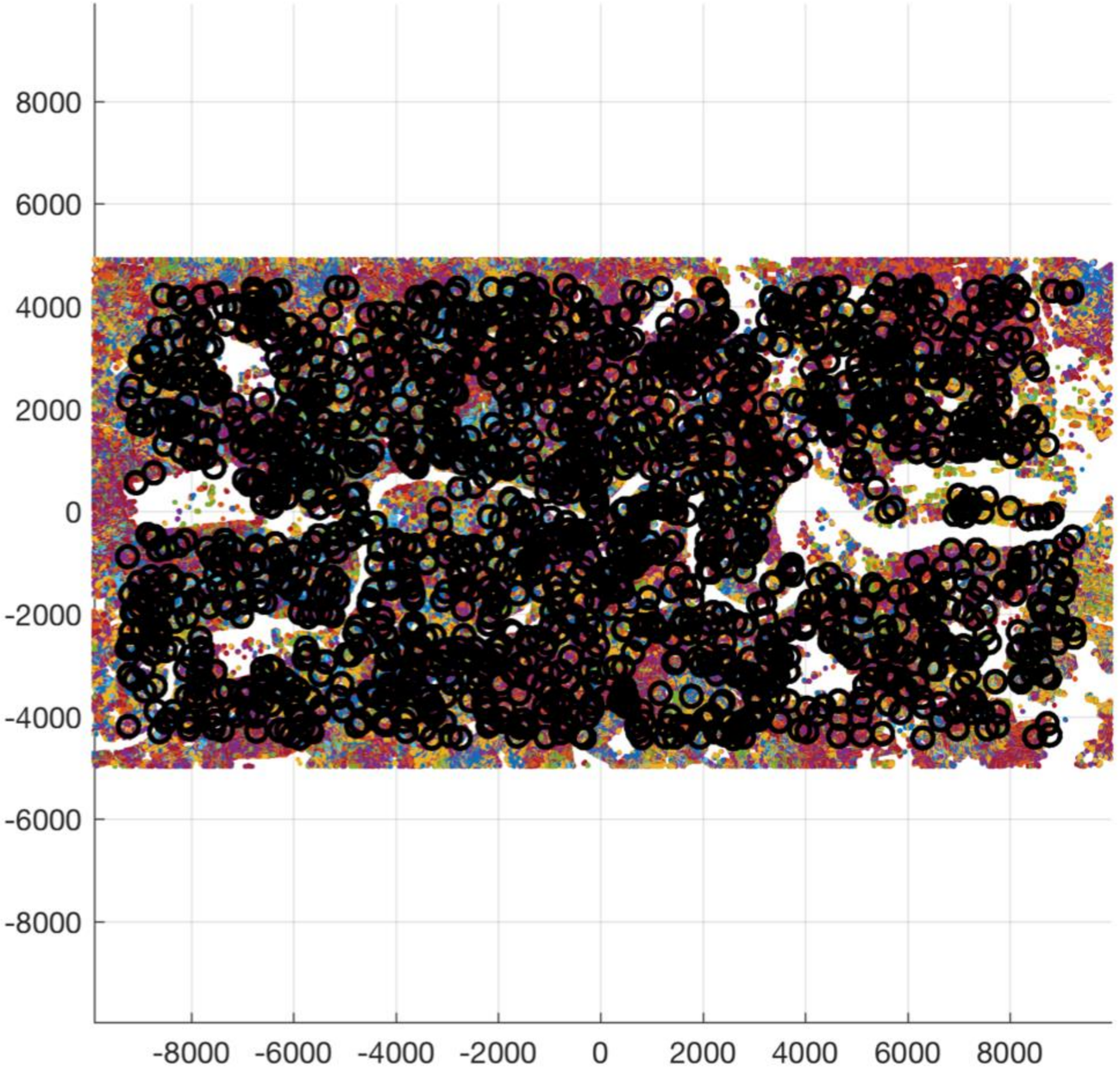


CLUSTER DISTRIBUTION

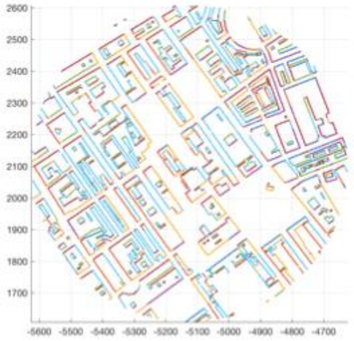


TYPICAL AREAS / DAYLIGHT SIGNATURE

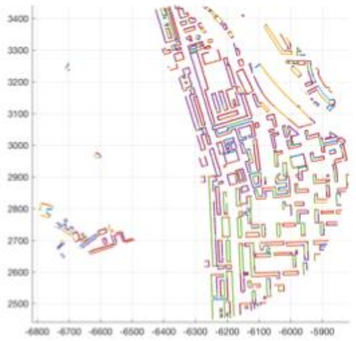
RANDOM GENERATION OF AREAS



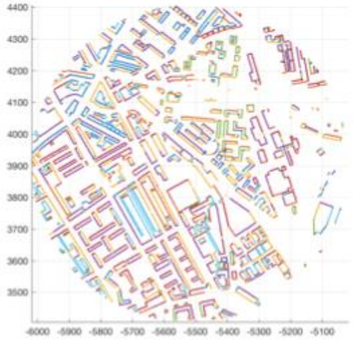
AREA ANALYSIS



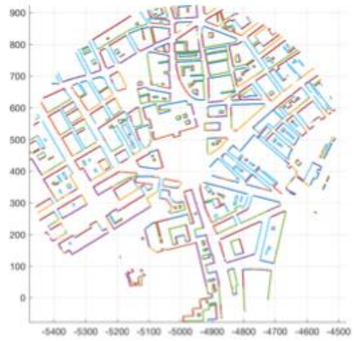
Fitzrovia



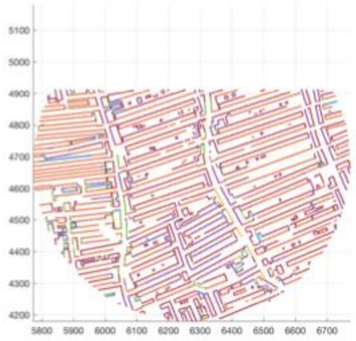
Regent's Park



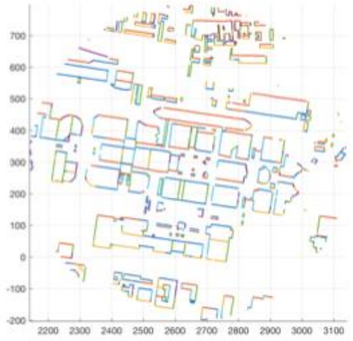
Camden



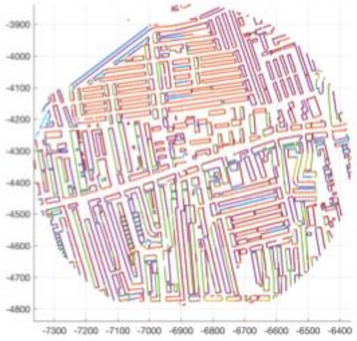
Trafalgar



North East

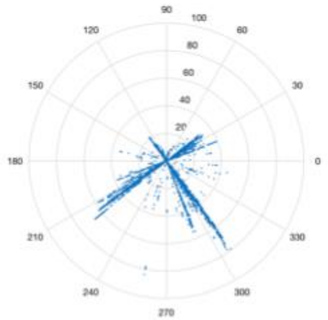


Canary Warf

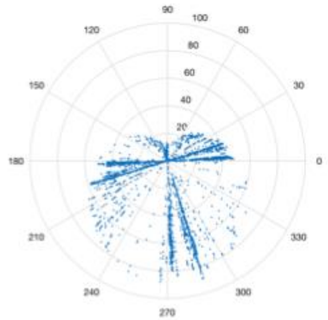


South of Battersea

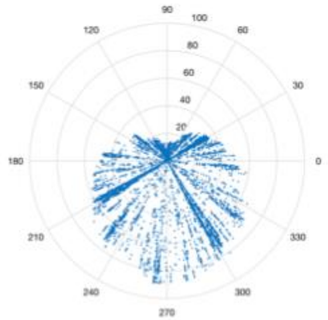
ANNUAL SUNLIGHT



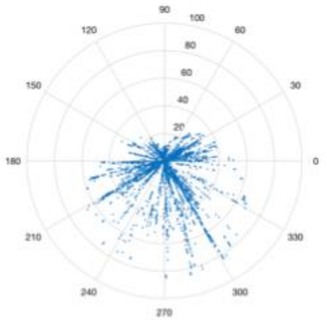
Fitzrovia



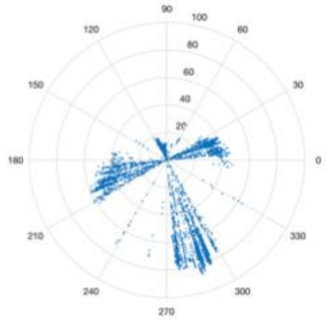
Regent's Park



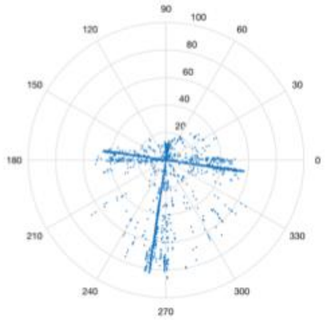
Camden



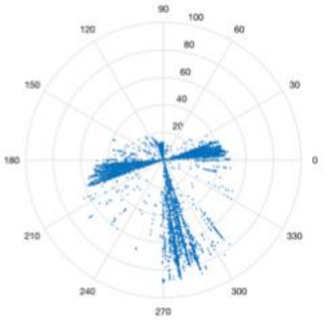
Trafalgar



North East

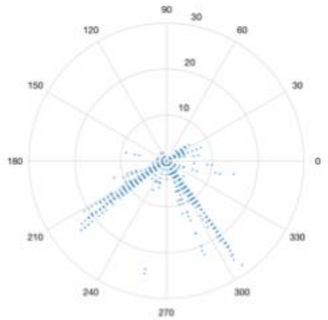


Canary Warf

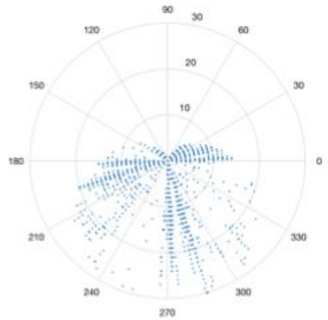


South of Battersea

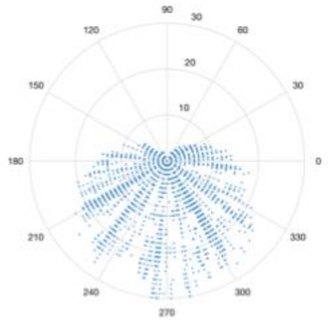
WINTER SUNLIGHT



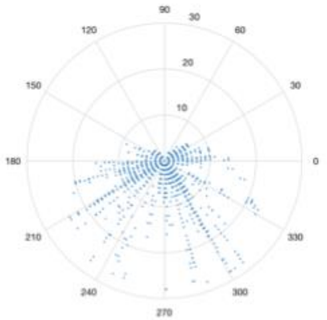
Fitzrovia



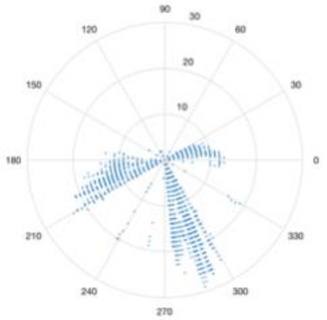
Regent's Park



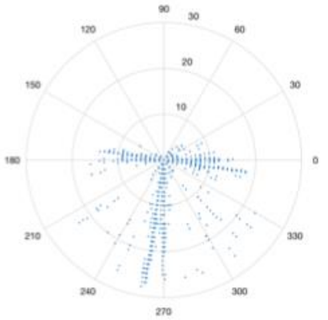
Camden



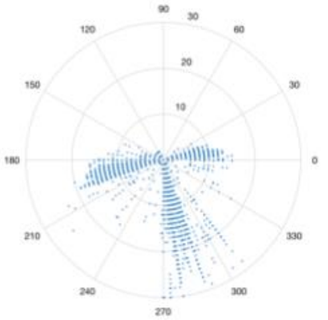
Trafalgar



North East

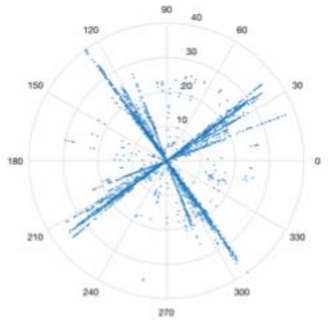


Canary Warf

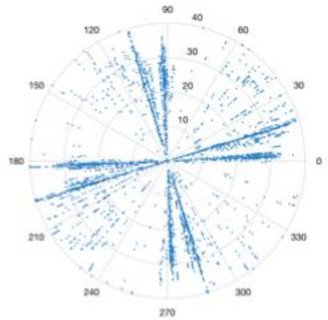


South of Battersea

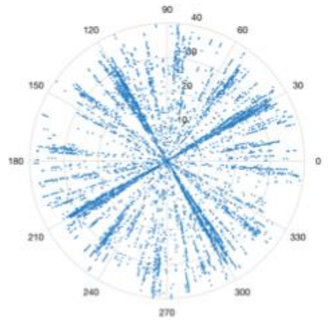
VERTICAL SKY COMPONENT



Fitzrovia



Regent's Park



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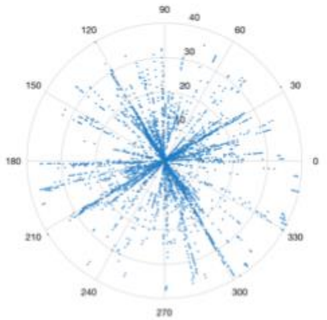
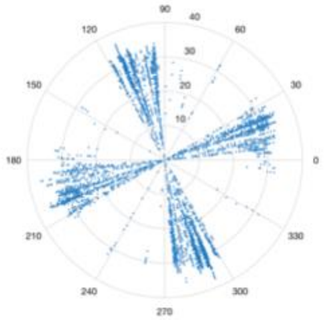
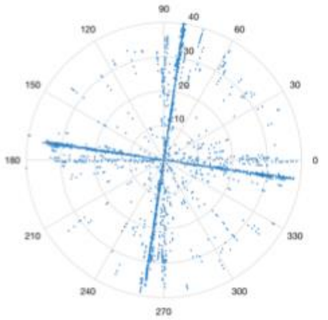


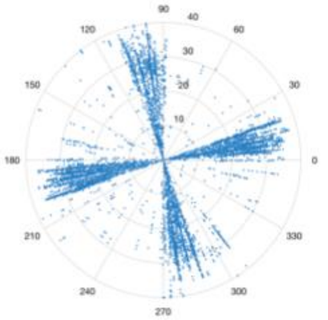
Trafalgar



North East



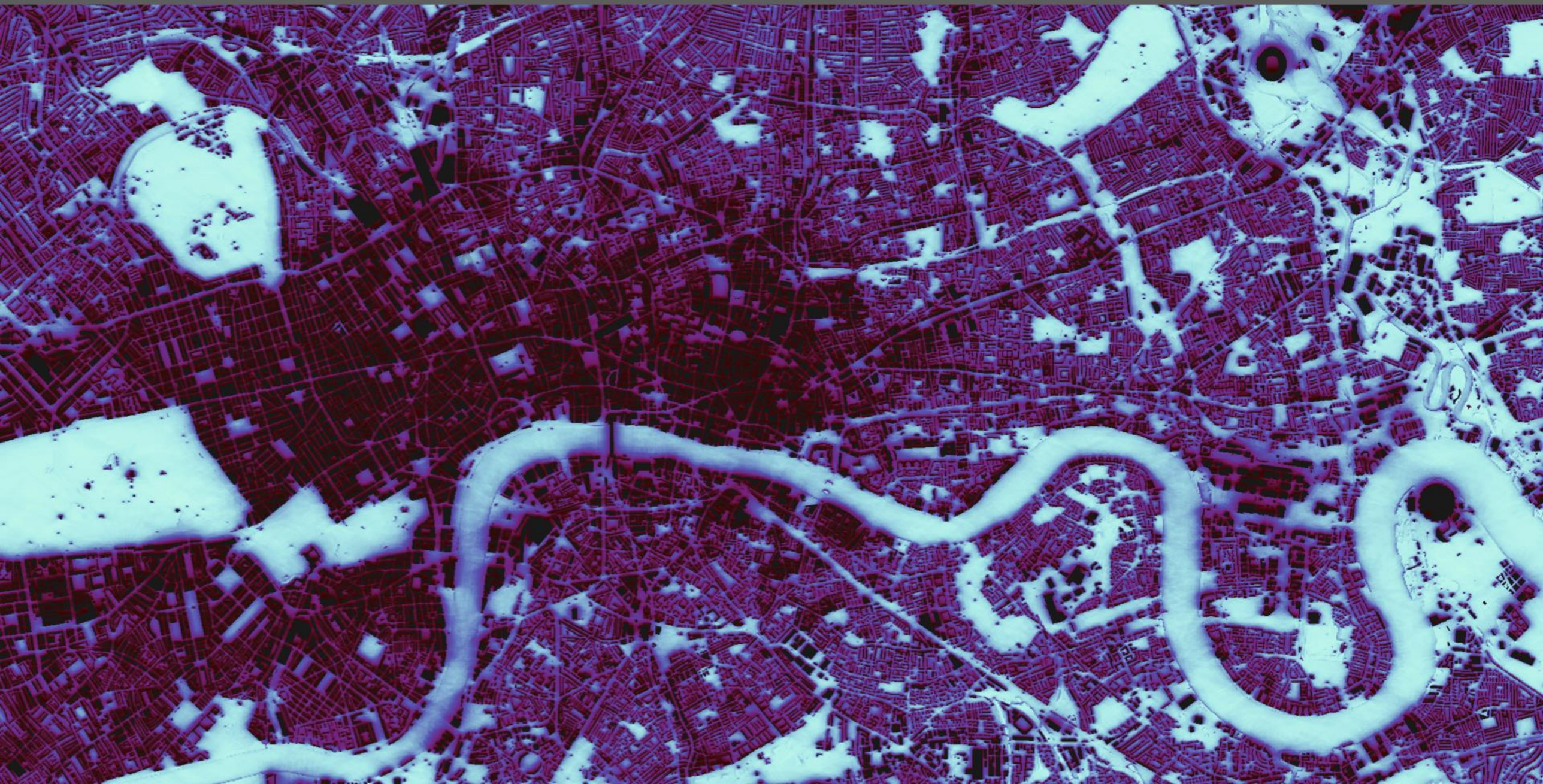
Canary Warf



South of Battersea

DENSITY

SUNLIGHT ON THE GROUND

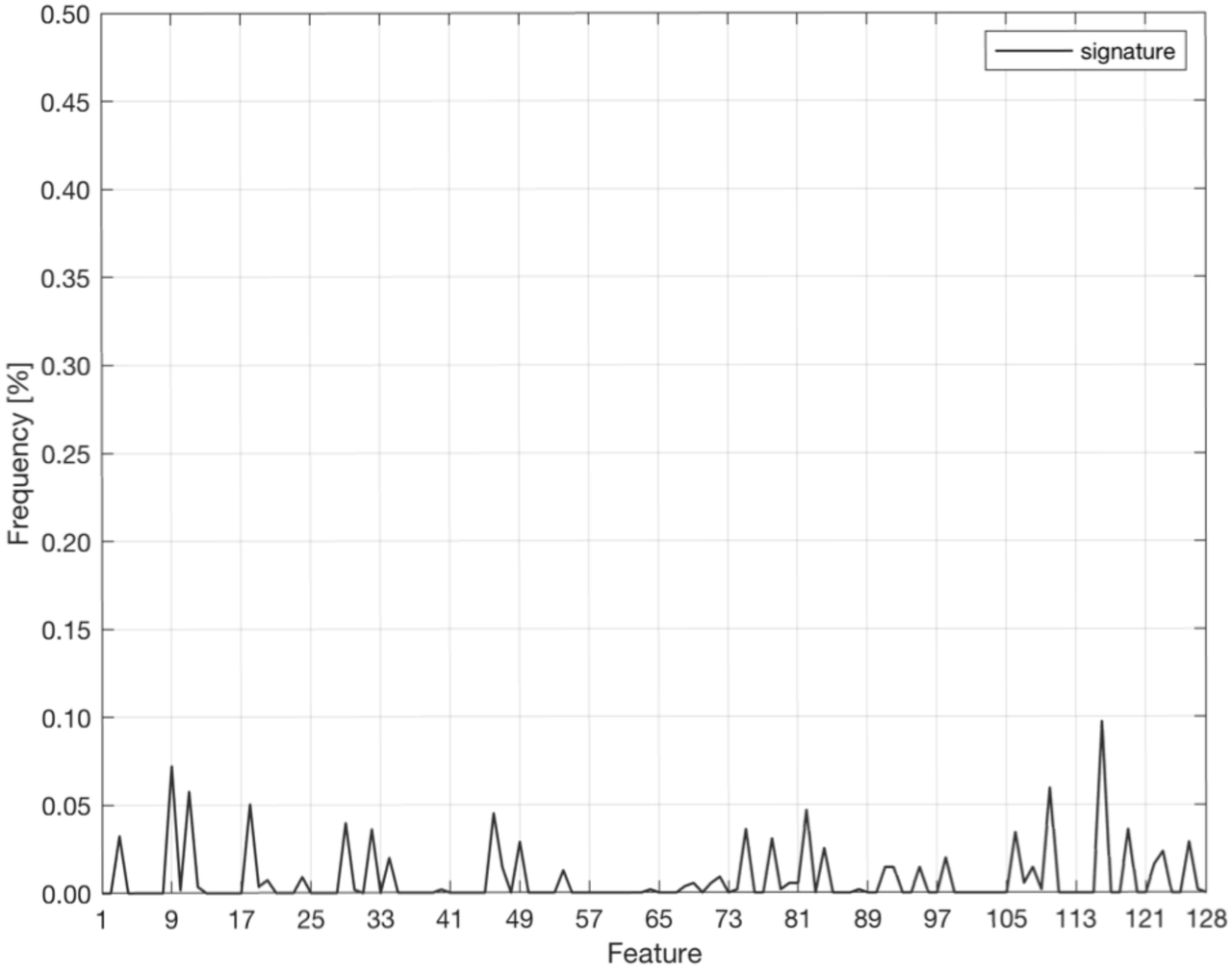


EXAMPLE OF AREA HISTOGRAM

Sunlight/Daylight/ Orientation/Obstruction [number of typical receptors]

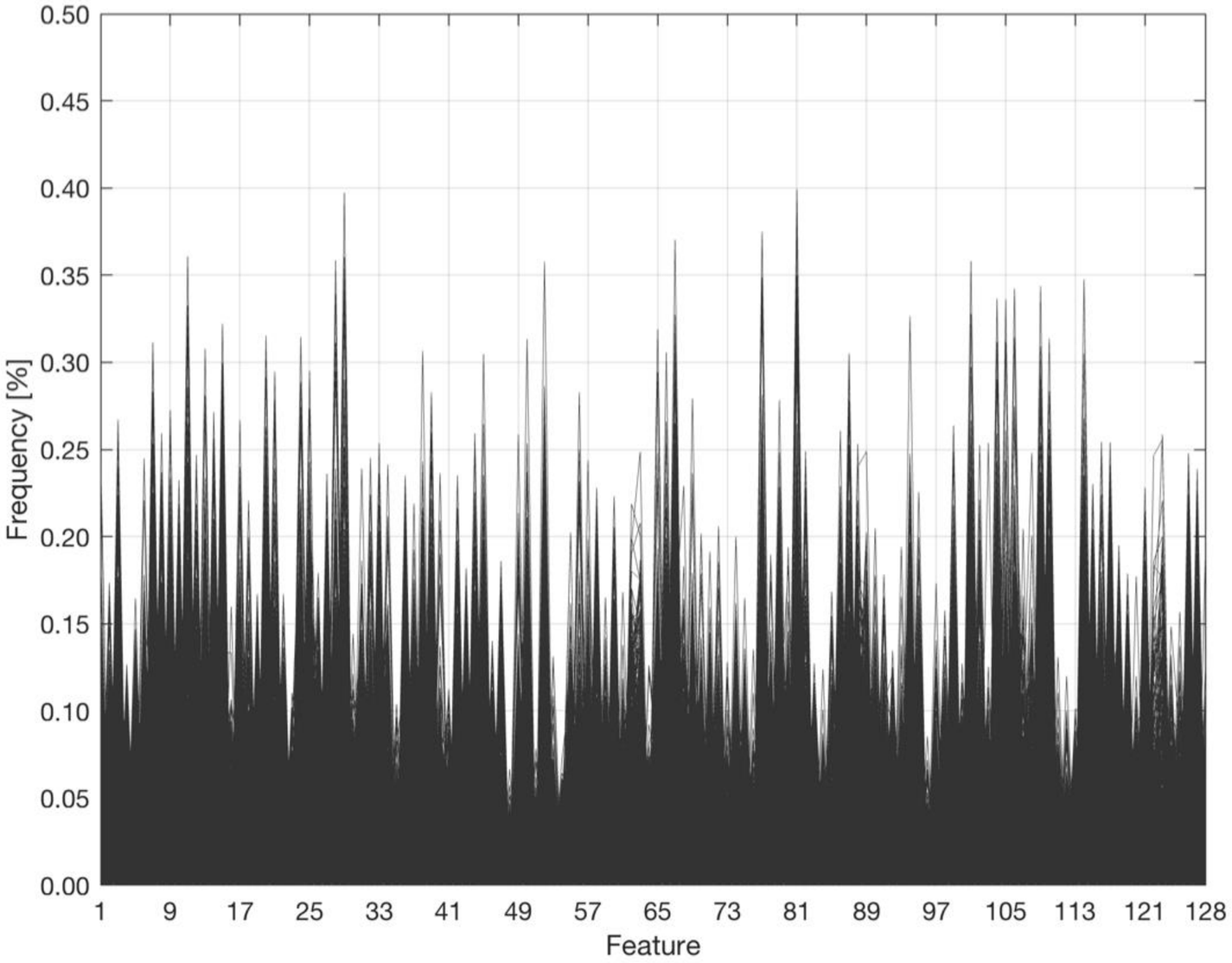
Density [average height over ground]

Sunlight on ground [percentage of area receiving a certain amount of sunlight during morning, midday, afternoon for summer and winter]



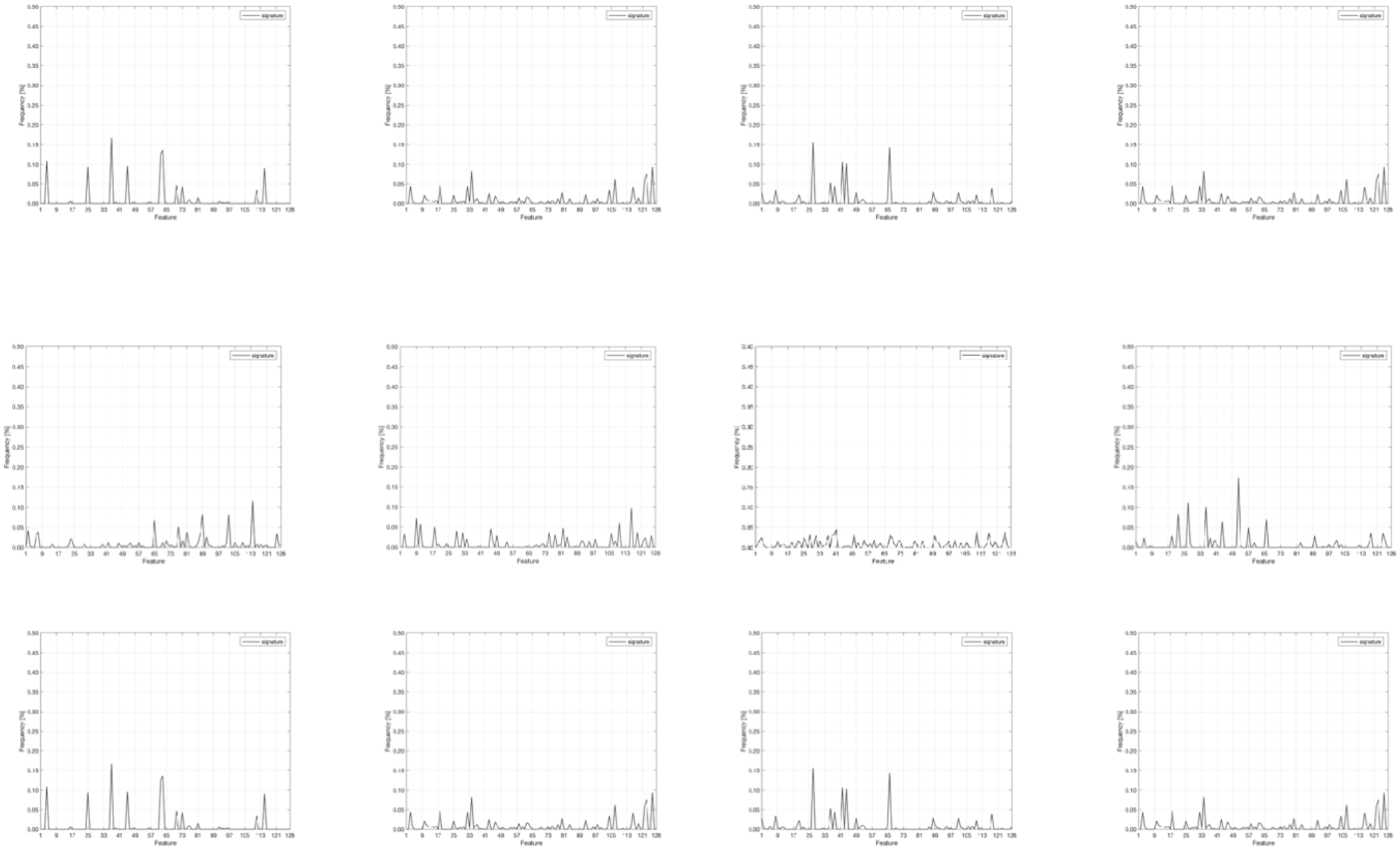
Signature

ALL HISTOGRAMS



All Signatures

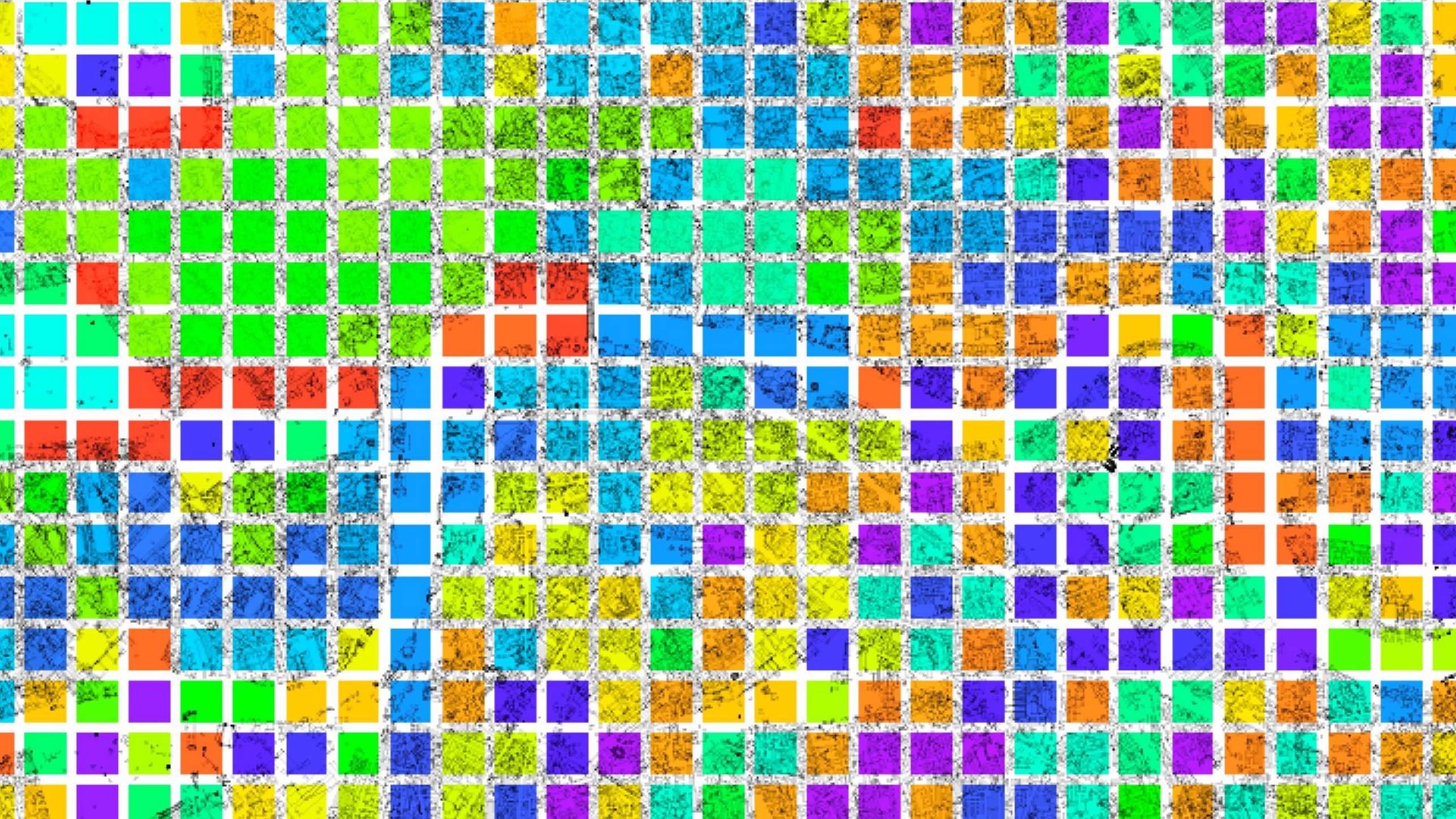
TYPICAL HISTOGRAMS



Typical Signatures (k-medoids)

Visualising Signatures / class colour coding


ARUP



CONCLUSIONS

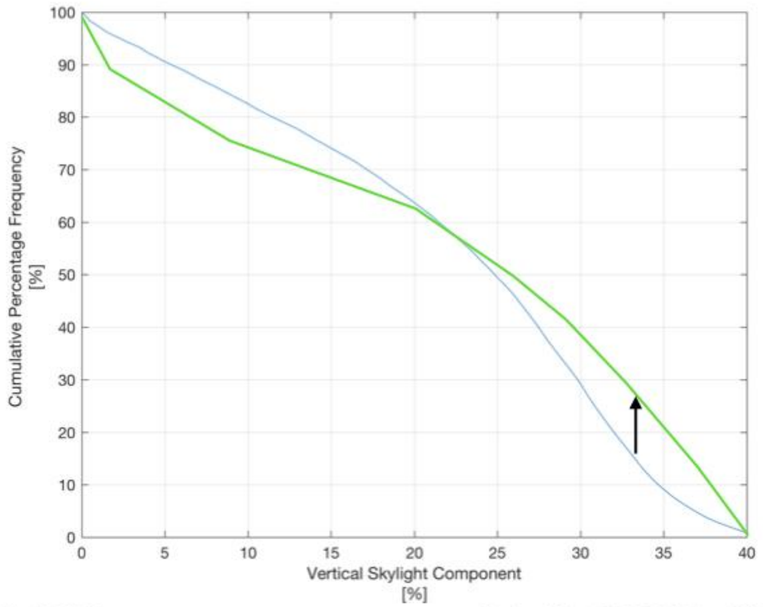
CONCLUSION

- Daylight and sunlight distribution in urban spaces can be classified and compared
- Image recognition can be used to enhance the dataset to include also surface finishes (for example by scraping google street view)
- For planners. High density areas require different “worst case scenario” targets than low density ones; these targets cannot be determined by simple guess (“a vertical sky component of 15% is typical of a city centre”). If a quantitative approach is required we recommend that a histogram approach is used

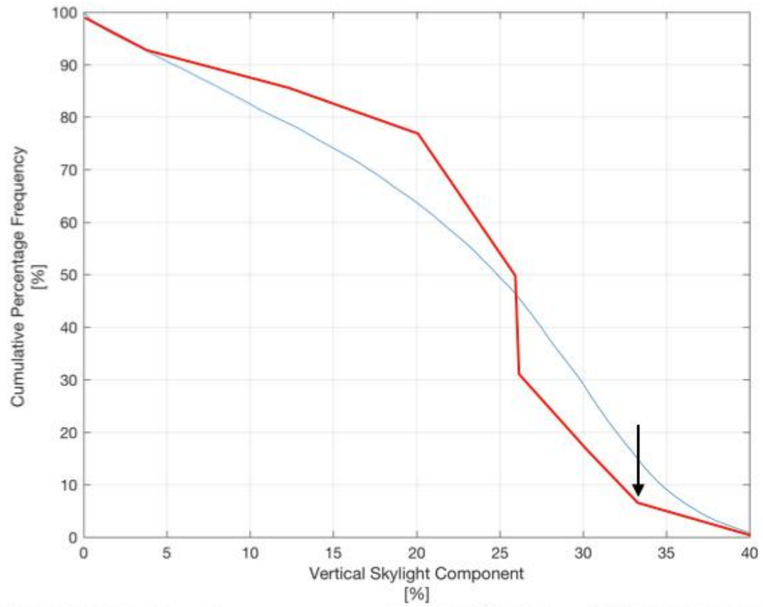
NOTES

- The size of the area considered needs to be consistent with the one used during the clustering
- The number of typical receptors needs to be estimated looking at how well the clusters represent the full dataset. A value of 32 can be used as a starting point
- The number of typical areas also needs to be estimated. It is possible to plot clusters and typical clusters and verify that these are sufficient (i.e. the clusters within the same class are similar enough) and not redundant (two clusters have the same distributions).

SETTING ALTERNATIVE TARGETS #1



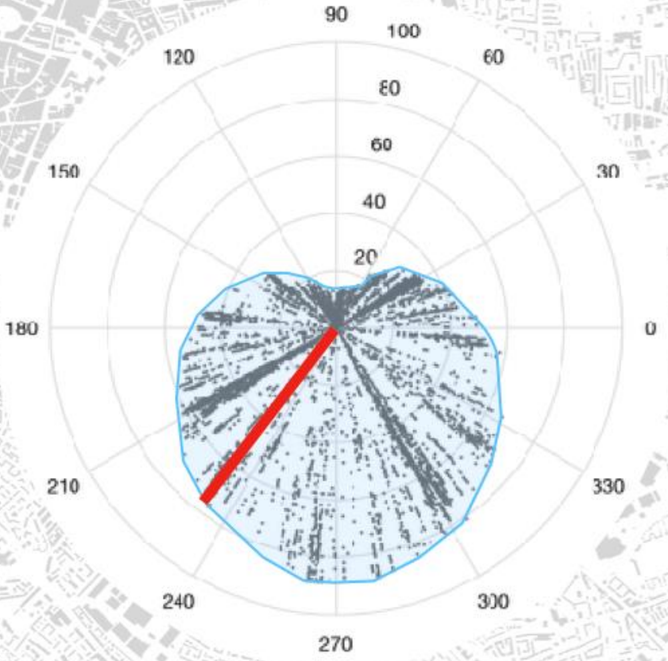
Improvement



Deterioration

SETTING ALTERNATIVE TARGETS #2

- Forget the 25% and 5% from BR 209.
- Include all orientations
- Measure ratio between receptor performance and maximum availability for given orientation (use a flexible target for each orientation)



Maximum sunlight availability for a given orientation