ARR2016 Temporal Patterns for Urban Drainage and Flood-Modelling. Do We Need To Run Them All?

Glenn Ottrey

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ARR 2016 Ensemble Approach

- 10 Temporal Patterns for each duration
  - 20% AEP – 1 to 10
  - 10% and 5% AEP – 11 to 20
  - 2% and 1% AEP – 21 to 30
- Aim by running 10 patterns is to better understand the uncertainty associated with the temporal pattern
- How much variation is there between the patterns and resulting flood depths?
- Chose the average result – median (rank 5 of 10) has been used

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Why is this a challenge?

- 10x increase in run times for hydraulic models
- Complicates results processing – significantly for some results
- If you could choose to do nine sensitivity runs, would you really do them all on temporal pattern?
- Can the median pattern be predicted?
  - Potential to reduce total model runtime
  - Assist in processing results if a single representative pattern for each duration can be chosen

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Data available for this presentation

- 6 models for 1% AEP, all temporal patterns up to at least 3 hour
- 4 models also run for more frequent return periods
- Models spread around Melbourne (Southern Slopes Mainland), three in the north, one in the east and two in the south east.

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How much variation is there between the 10 patterns?

- Overall?
- What about retarding basins?
- Can we predict the median pattern based on the hyetograph shape?
- Could the same set of patterns selected patterns approximate the median result in multiple catchments?

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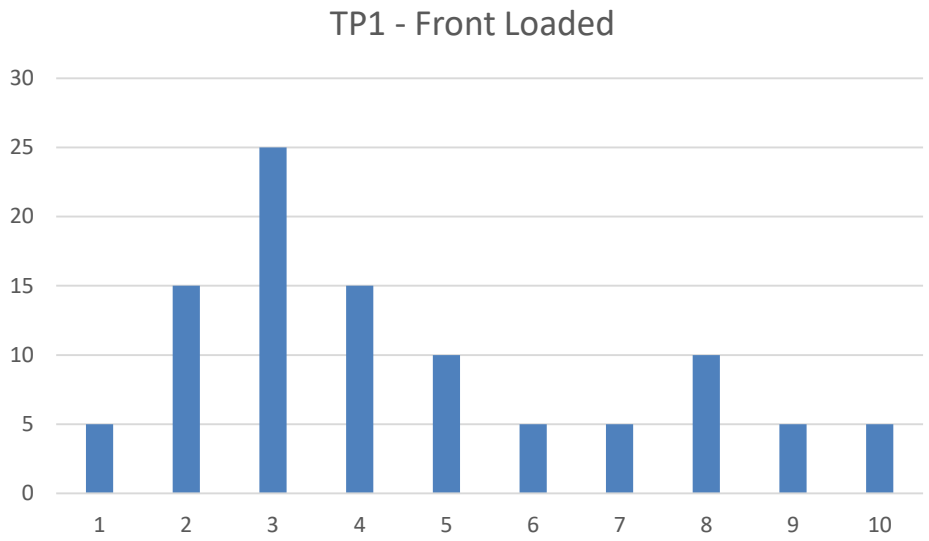
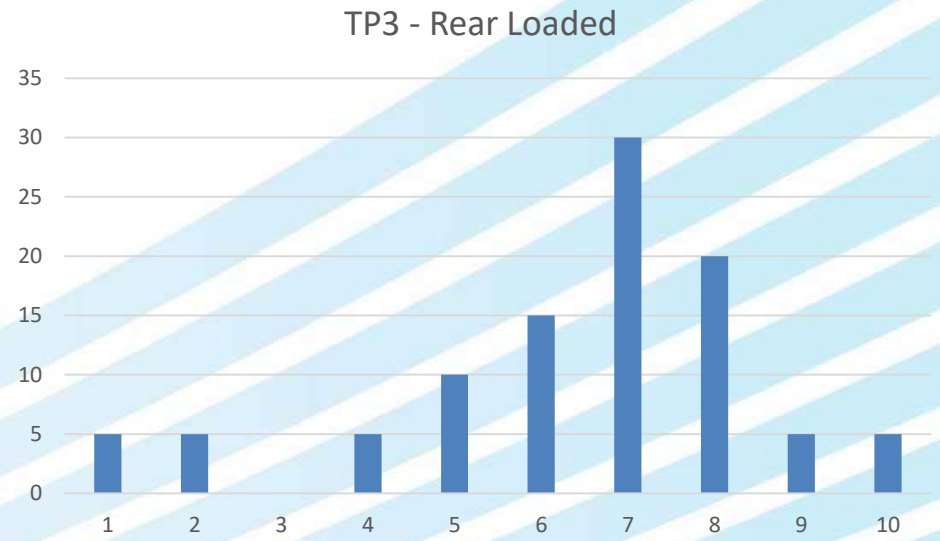
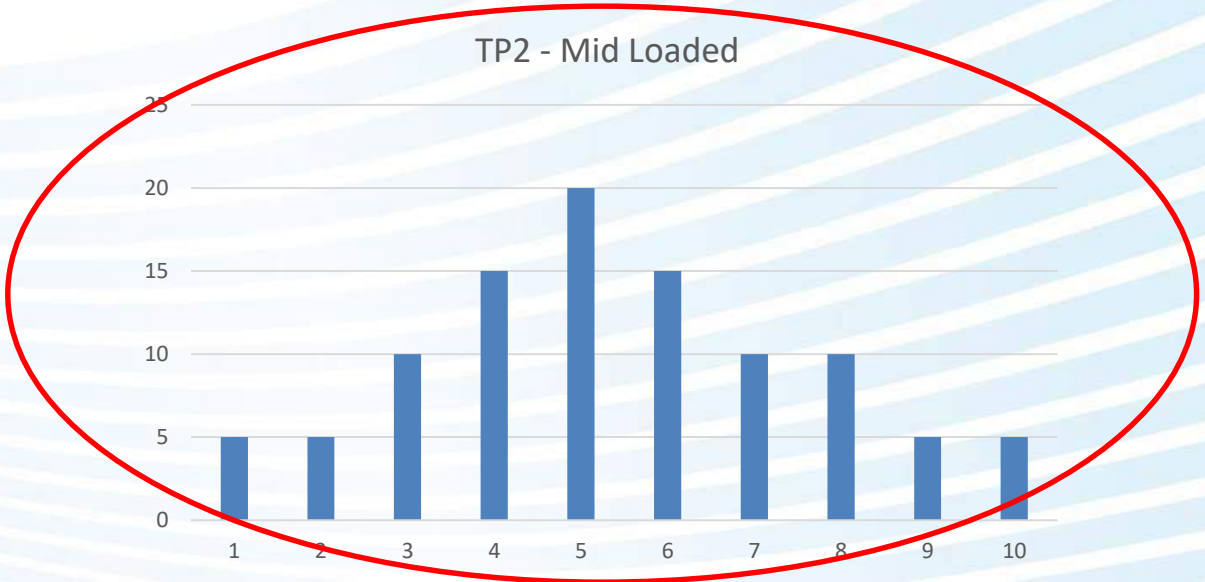
How would we choose the median temporal pattern?







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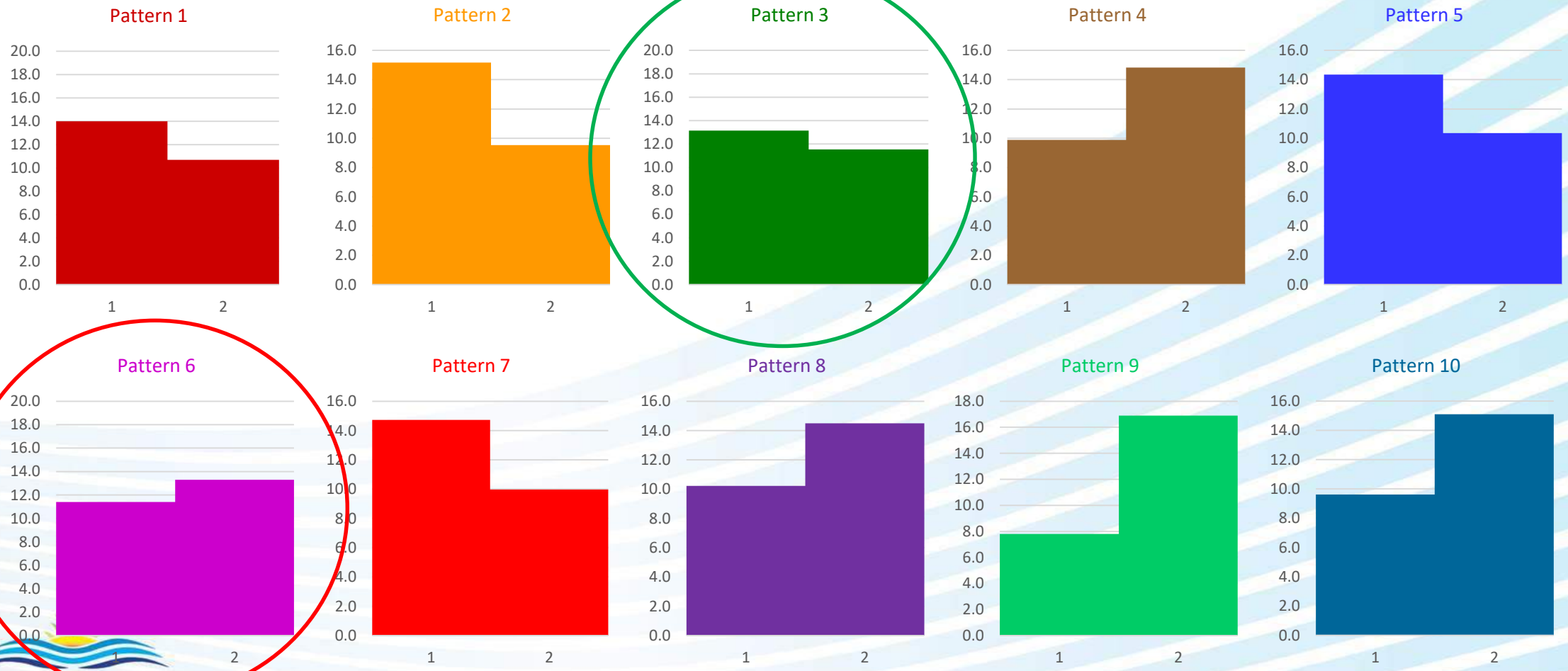
10 minute 1% AEP



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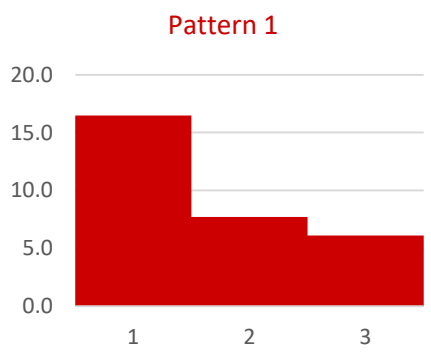
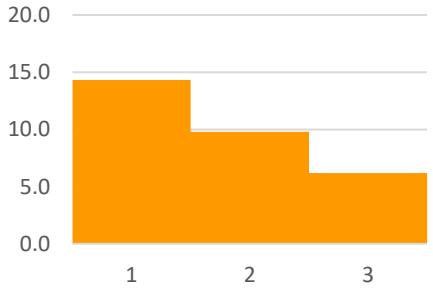
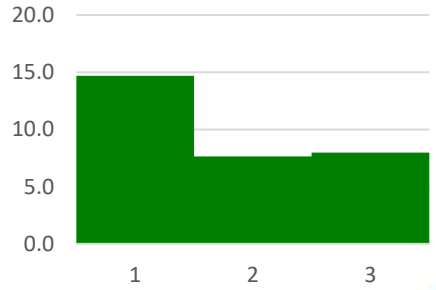
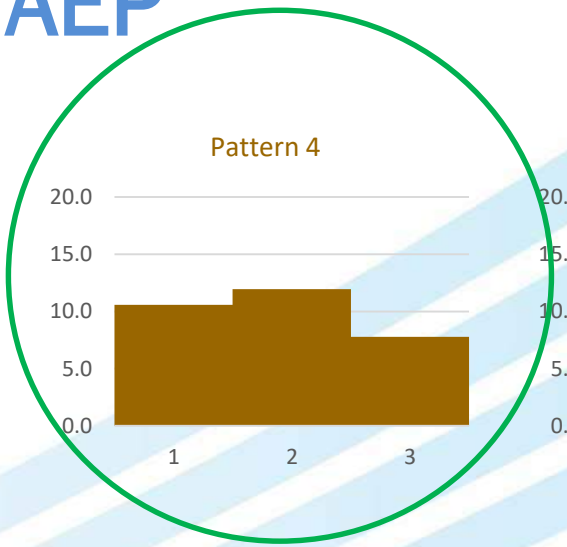
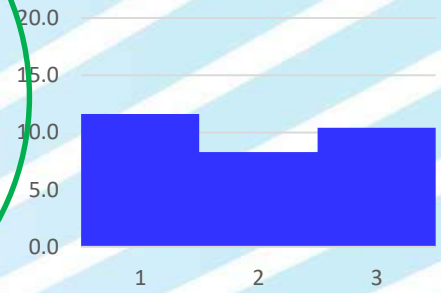
15 minute 1% AEP

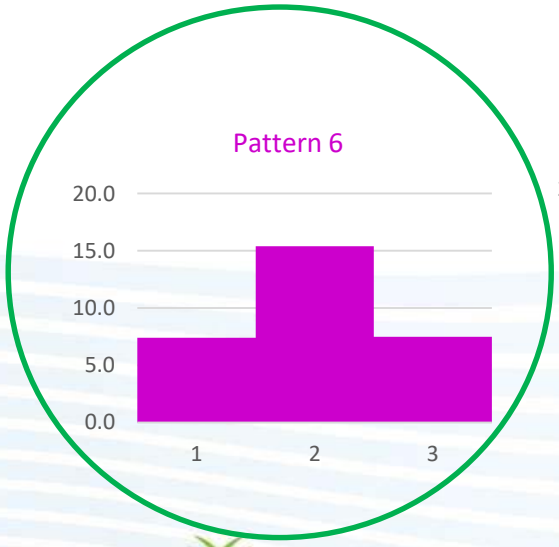


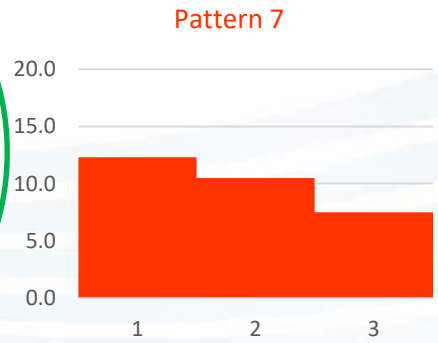


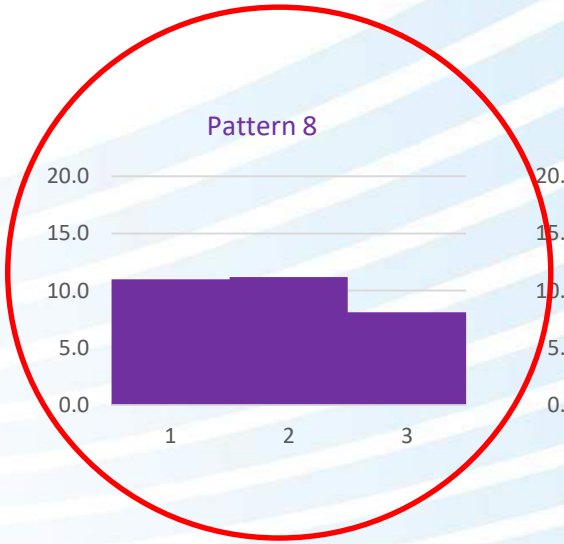


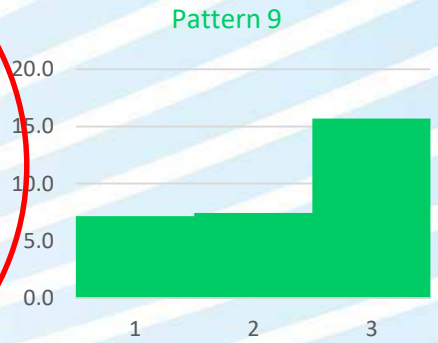


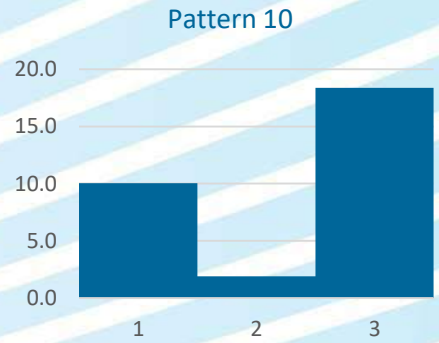












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30 minute 1% AEP

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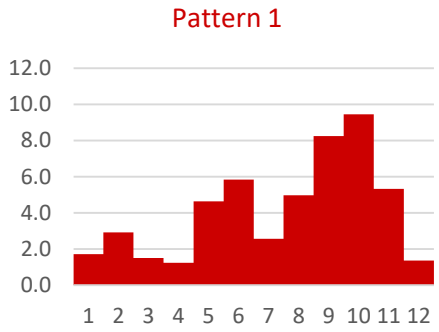
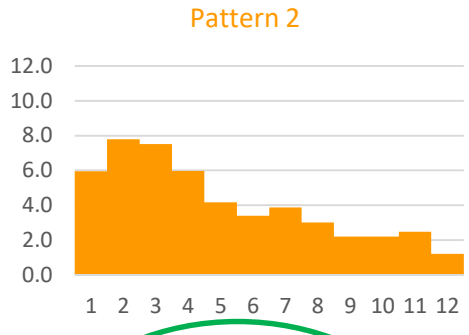
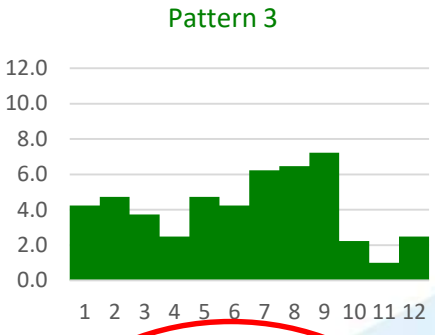
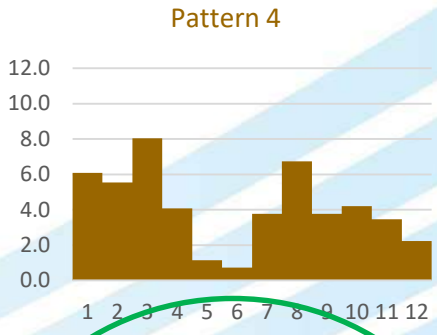
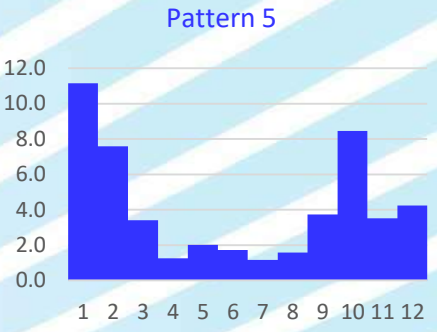
60 minute 1% AEP

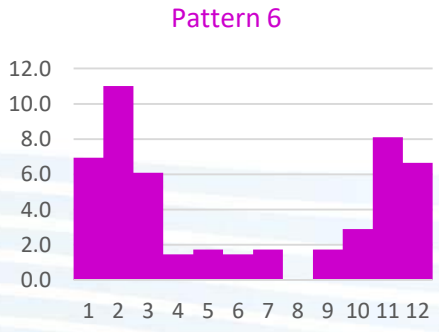


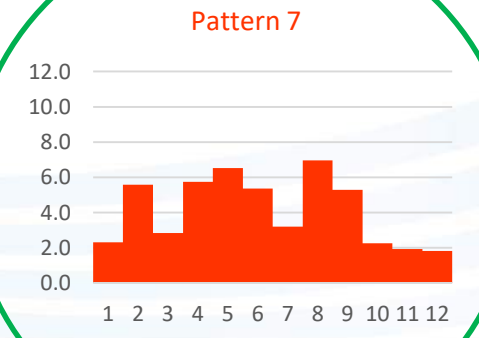


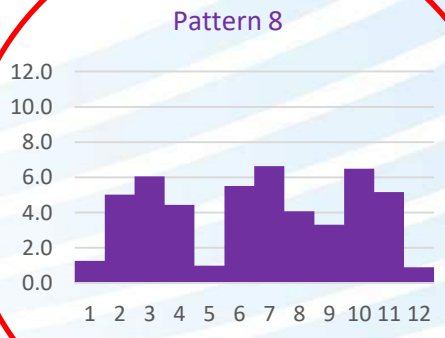


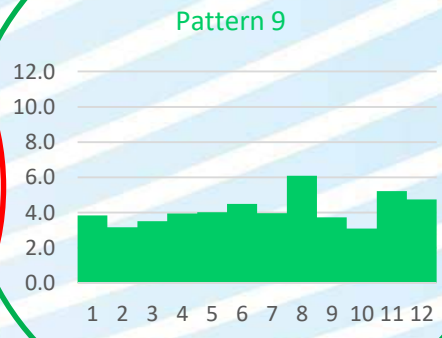


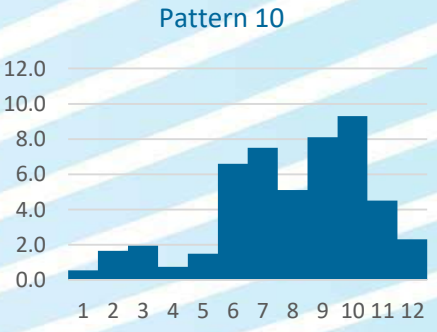












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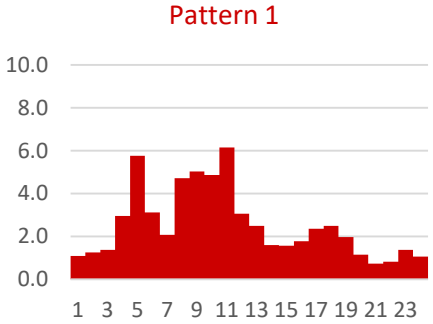
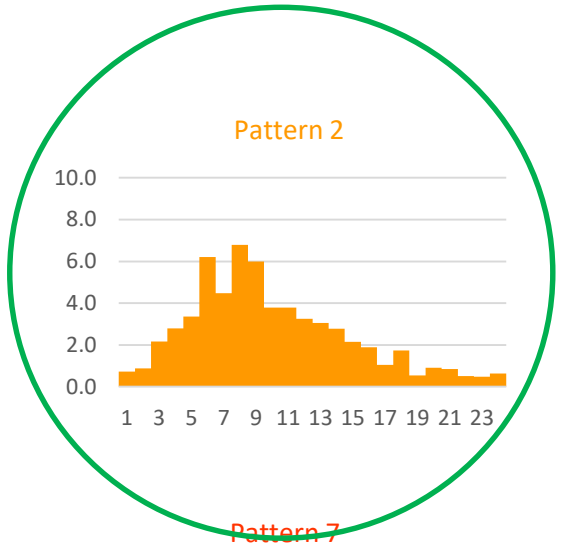
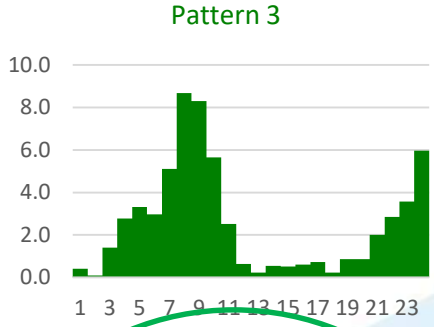
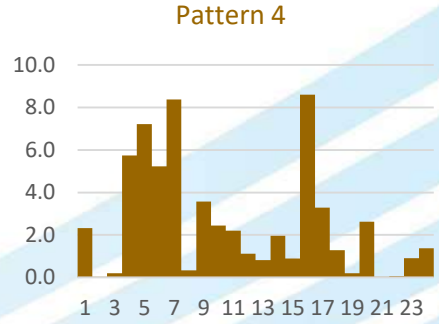
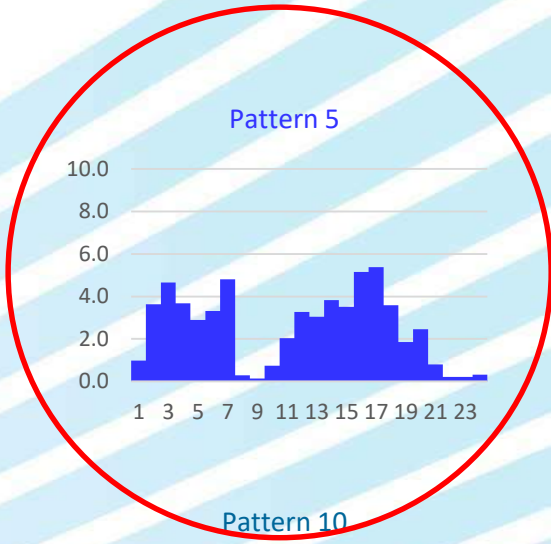
120 minute 1% AEP

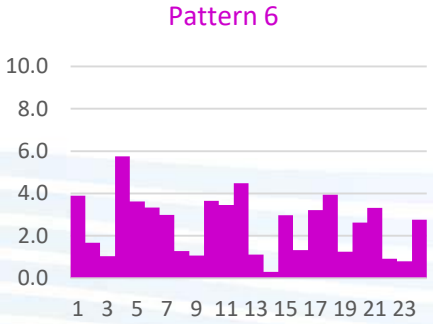


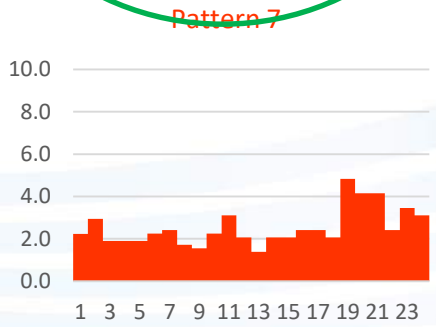


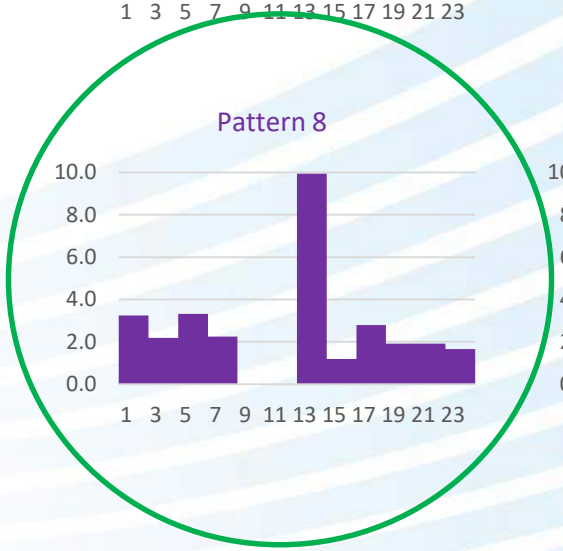


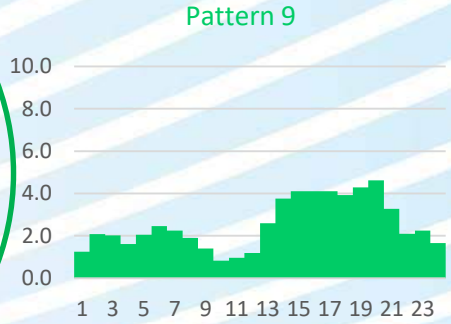


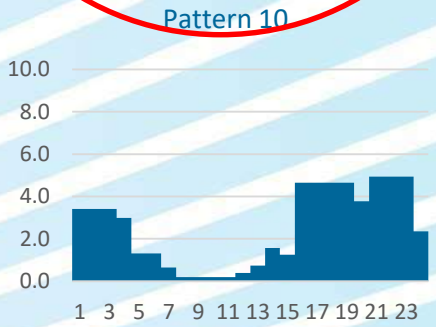












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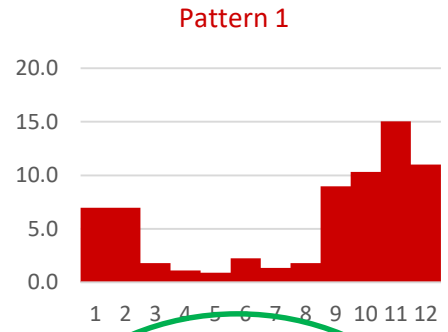
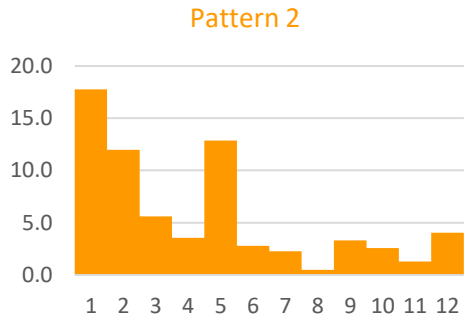
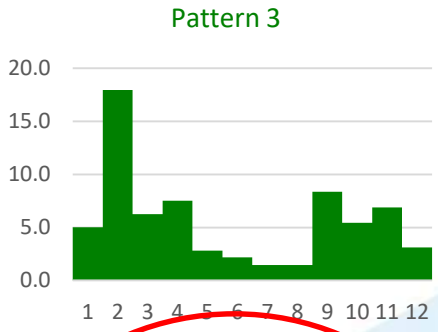
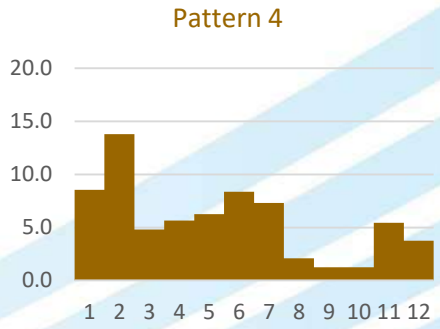
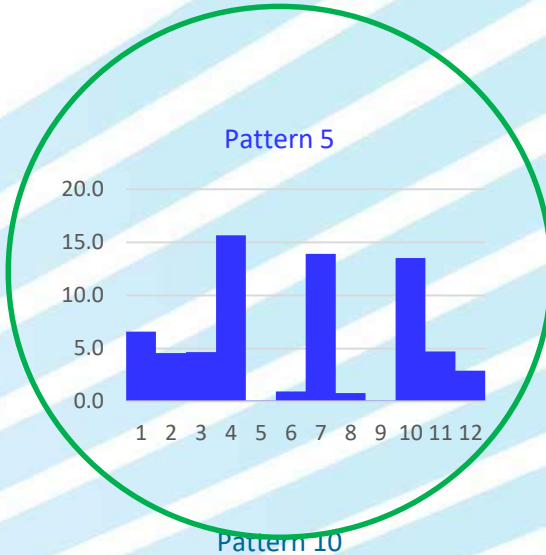
180 minute 1% AEP

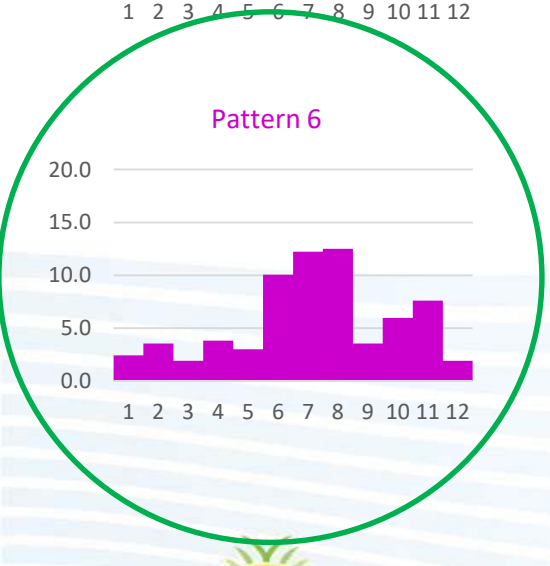


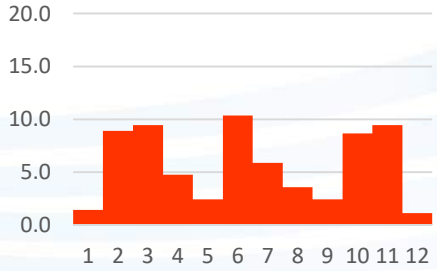


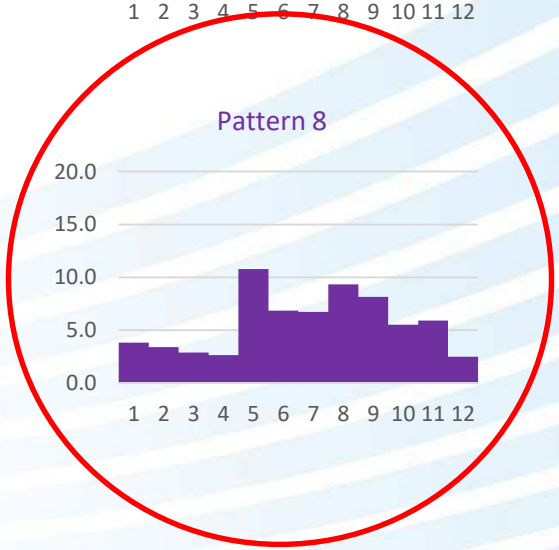


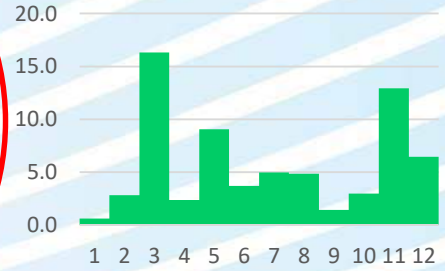


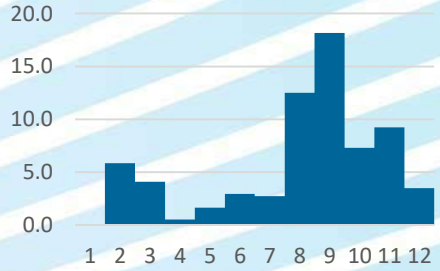












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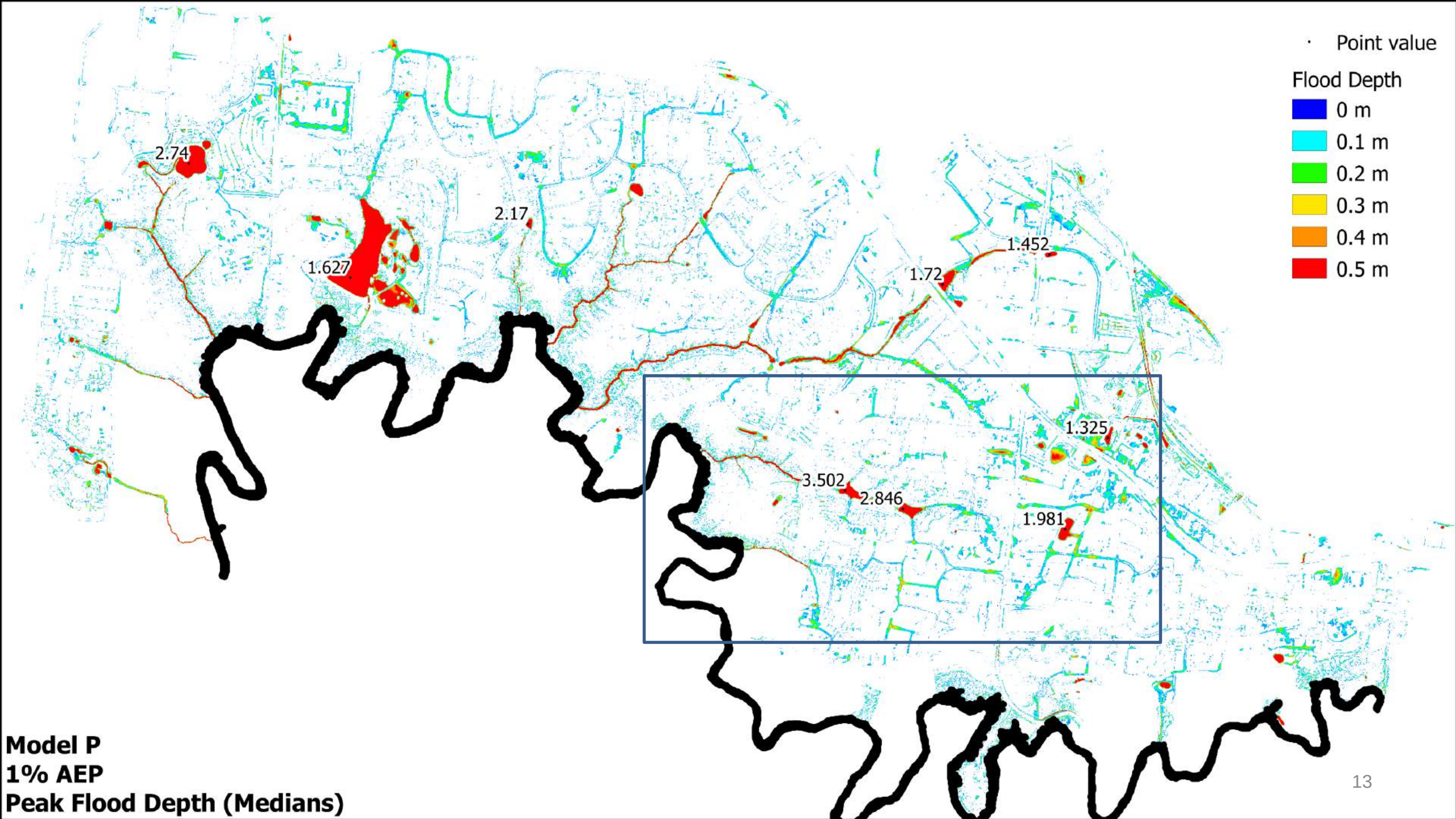
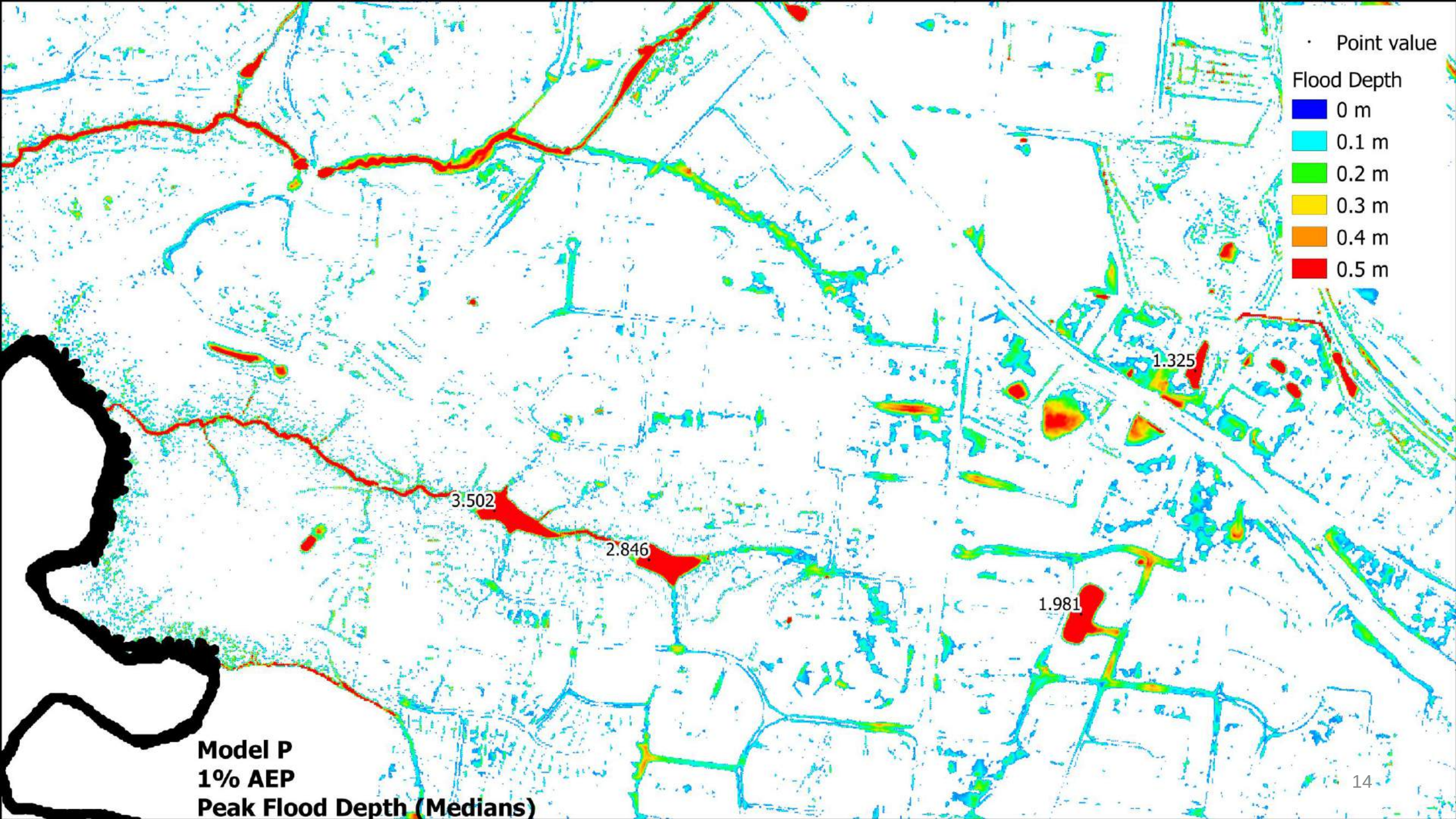
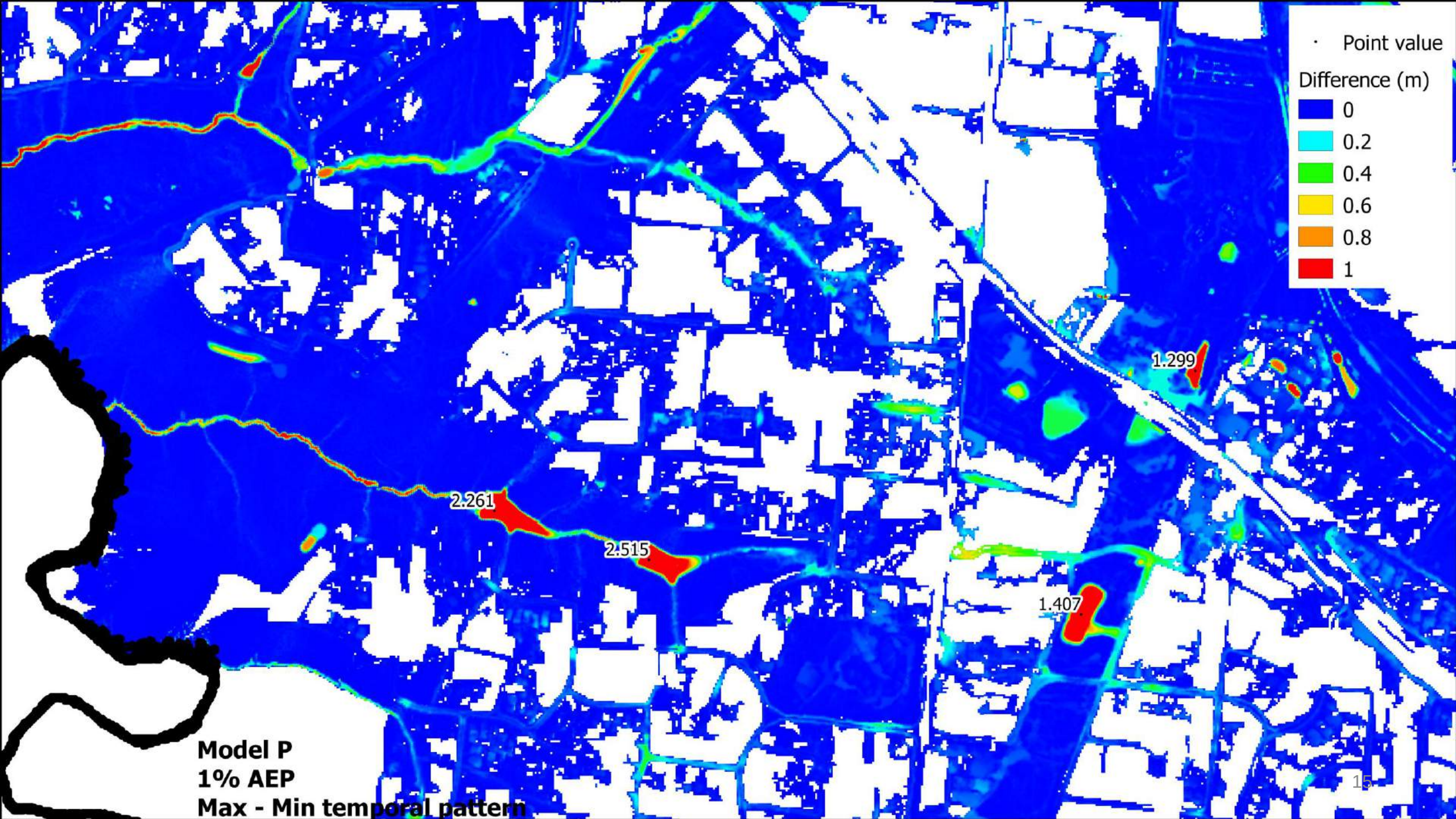
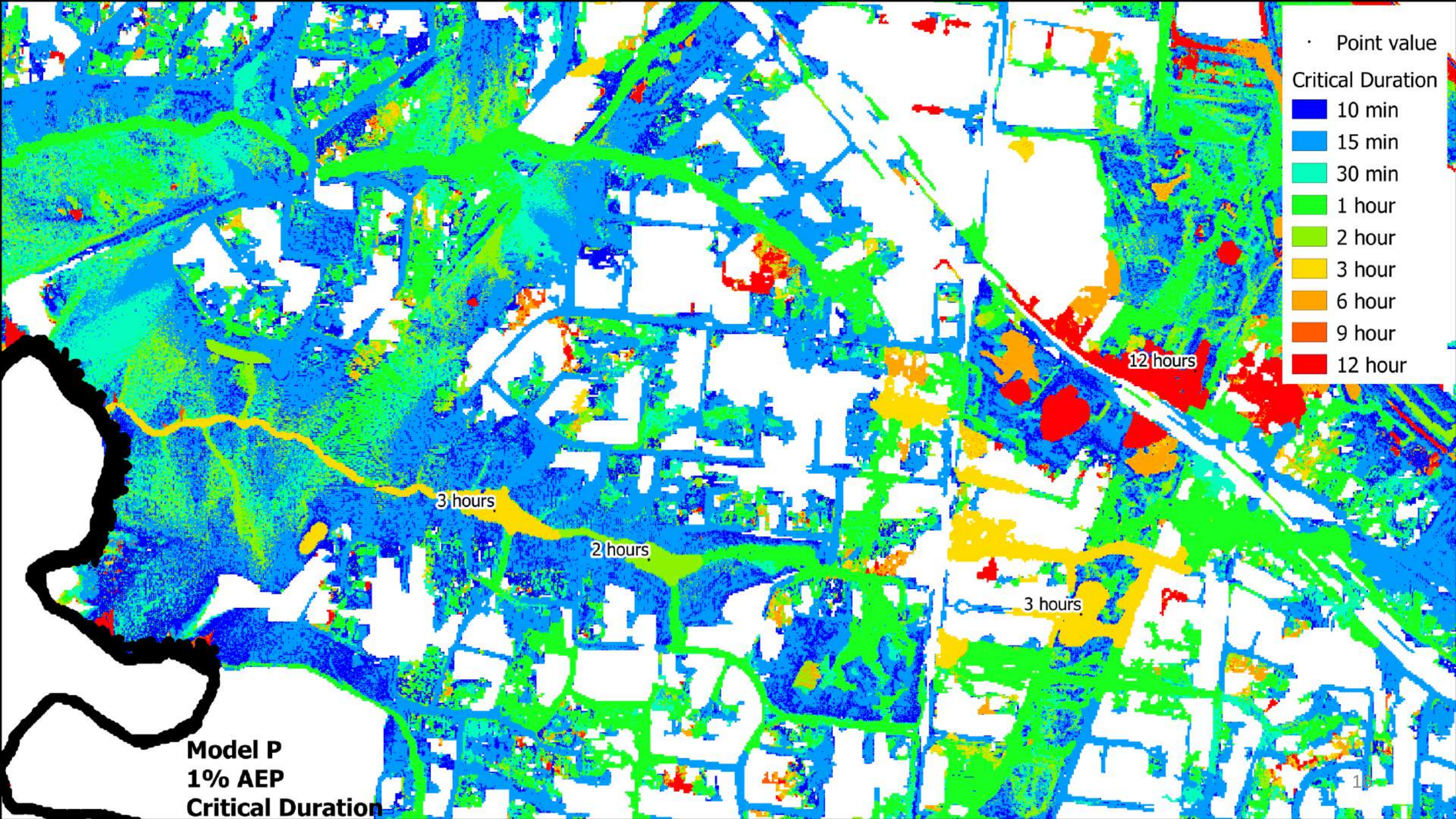
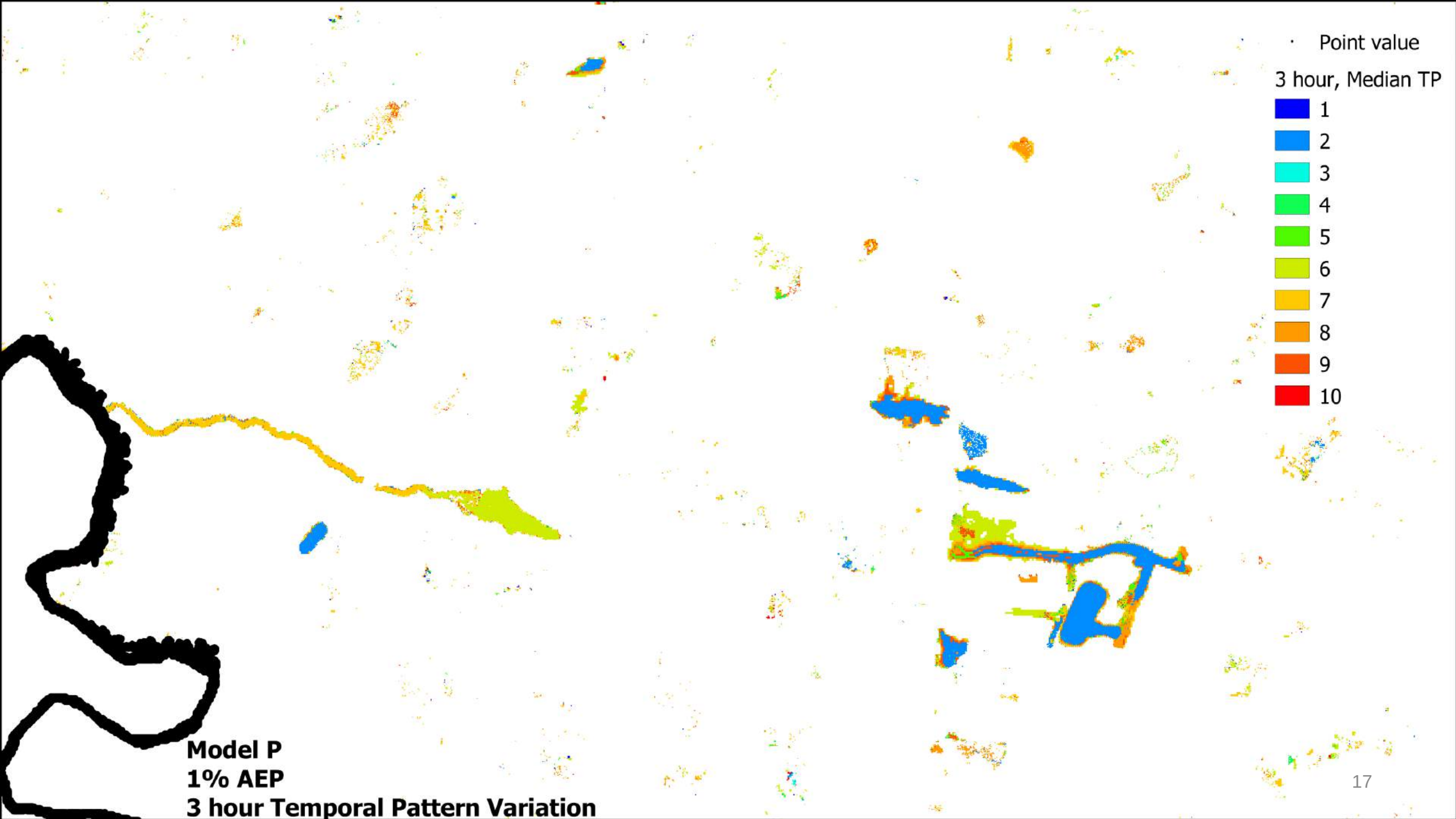


Model P
1% AEP
Peak Flood Depth (Medians)


Point value
Flood Depth
0 m
0.1 m
0.2 m
0.3 m
0.4 m
0.5 m
1.325
3.502
2.846
1.981
Model P
1% AEP
Peak Flood Depth (Medians)

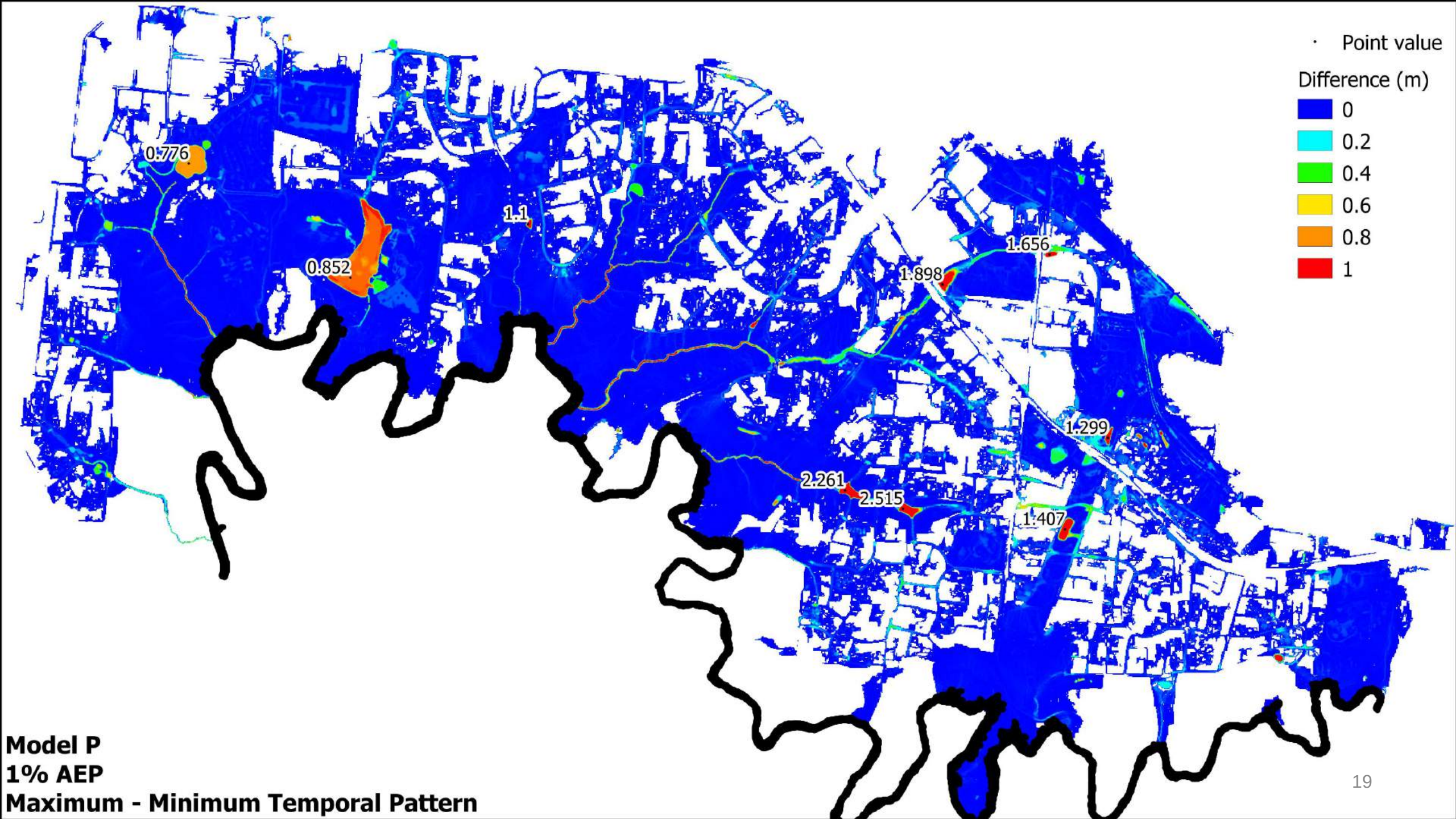

Point value
Difference (m)
0
0.2
0.4
0.6
0.8
1
1.299
2.261
2.515
1.407
Model P
1% AEP
Max - Min temporal pattern


Point value
Critical Duration
10 min
15 min
30 min
1 hour
2 hour
3 hour
6 hour
9 hour
12 hour
12 hours
3 hours
2 hours
3 hours
Model P
1% AEP
Critical Duration

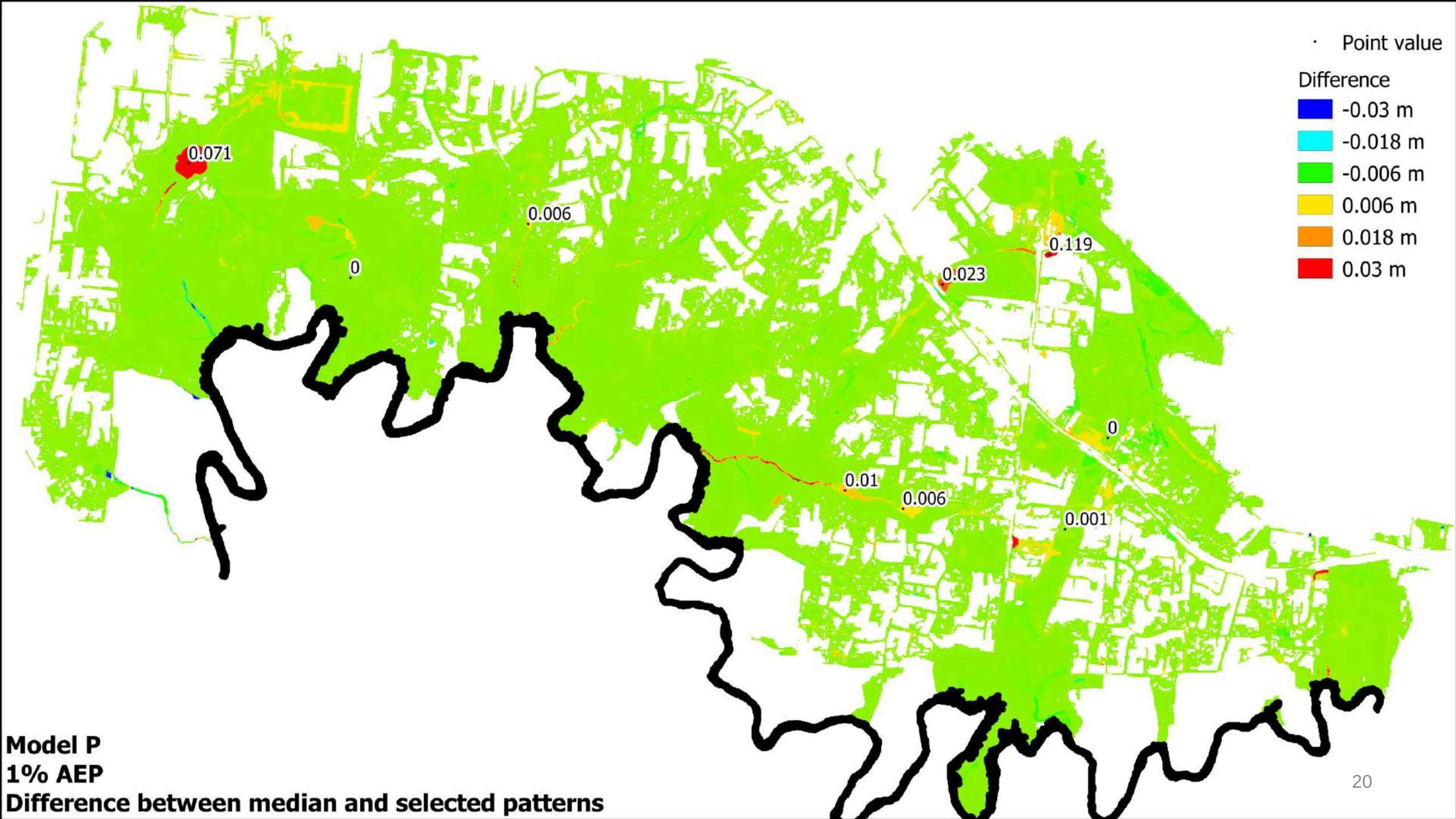


Model P
1% AEP
3 hour Temporal Pattern Variation


Point value
Difference
-0.03 m
-0.018 m
-0.006 m
0.006 m
0.018 m
0.03 m
0
0.01
0.006
0.001
Model P
1% AEP
Difference between median and selected patterns

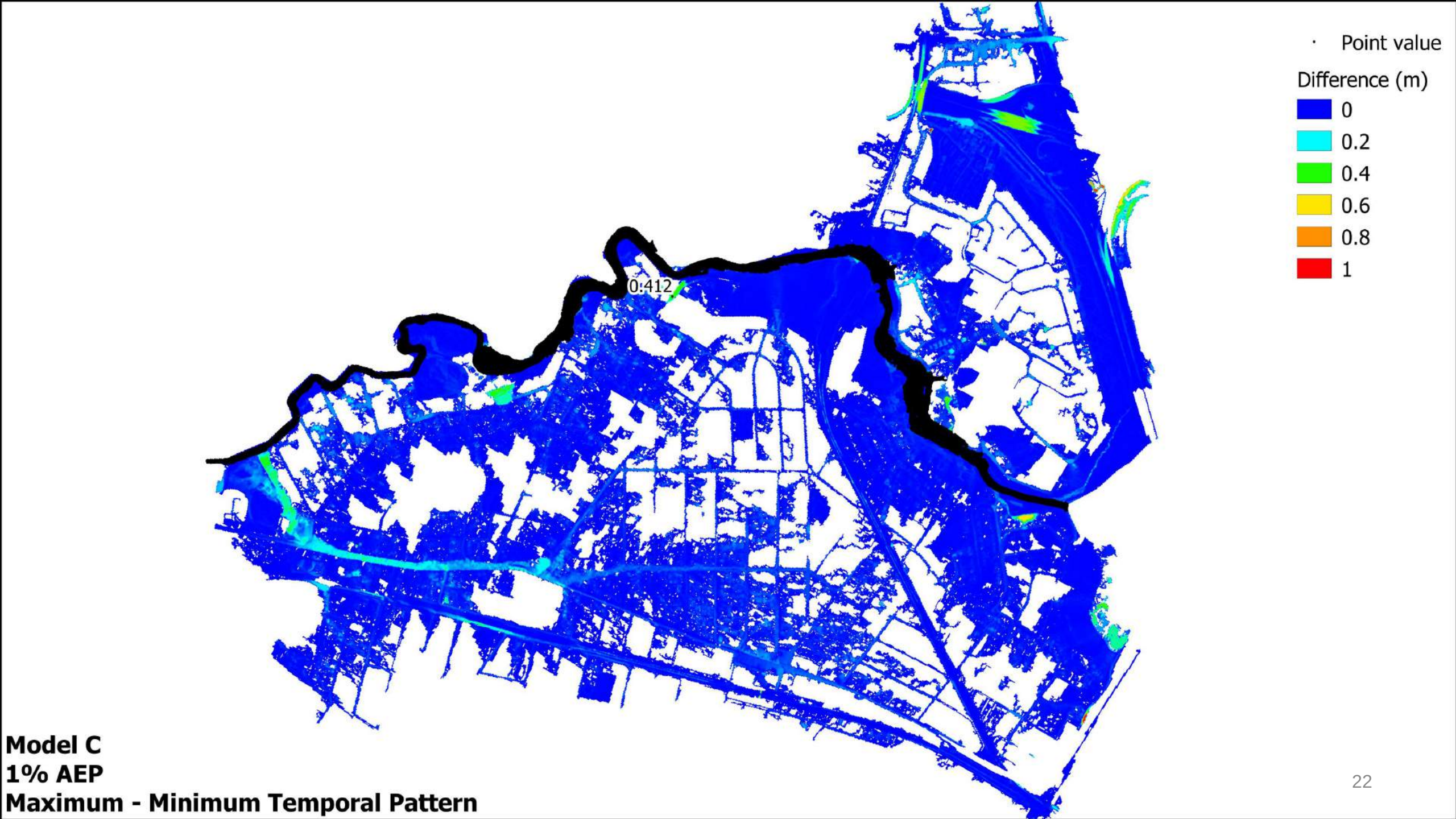


Model P
1% AEP
Maximum - Minimum Temporal Pattern

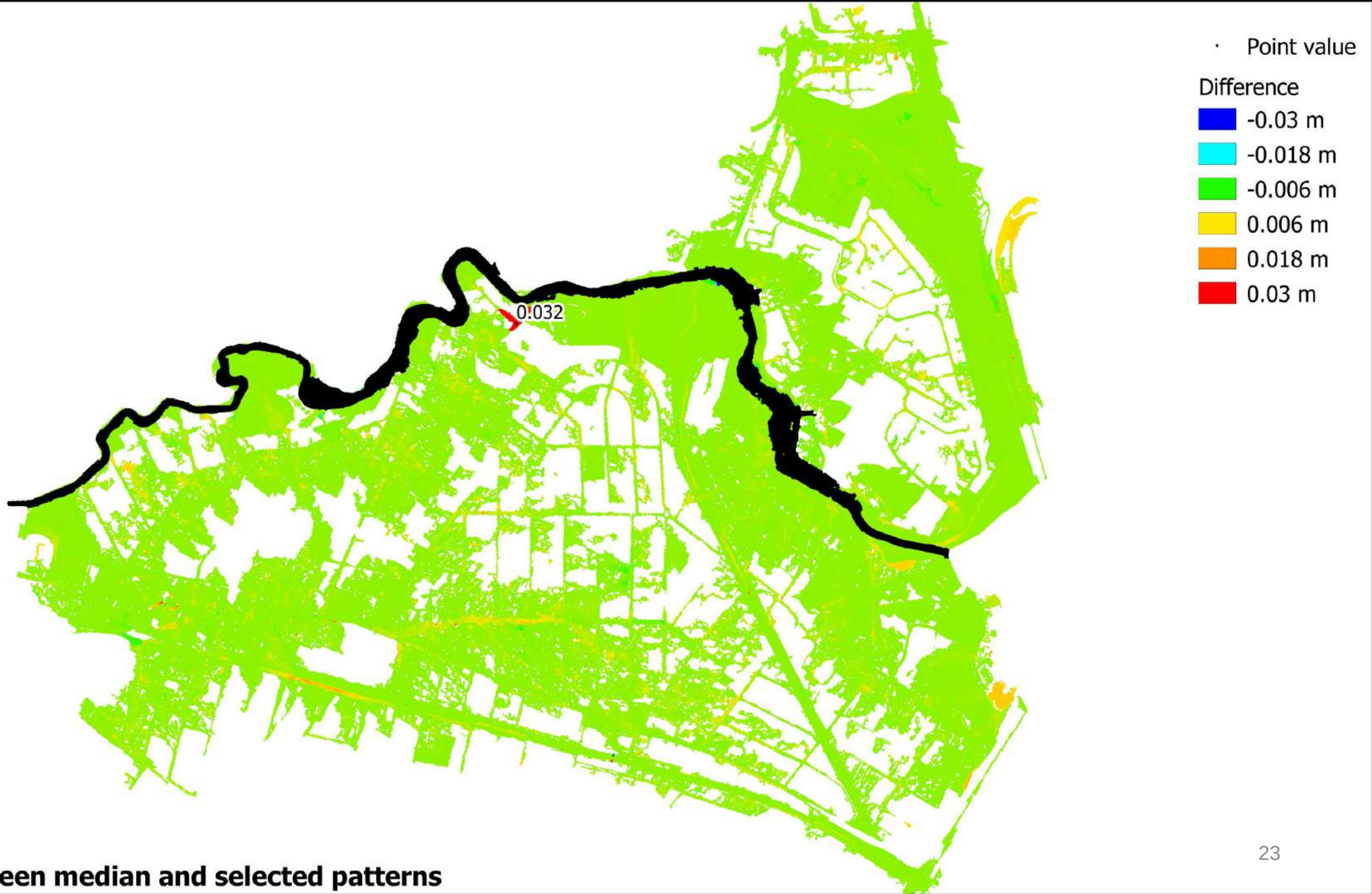


Model P
1% AEP
Difference between median and selected patterns

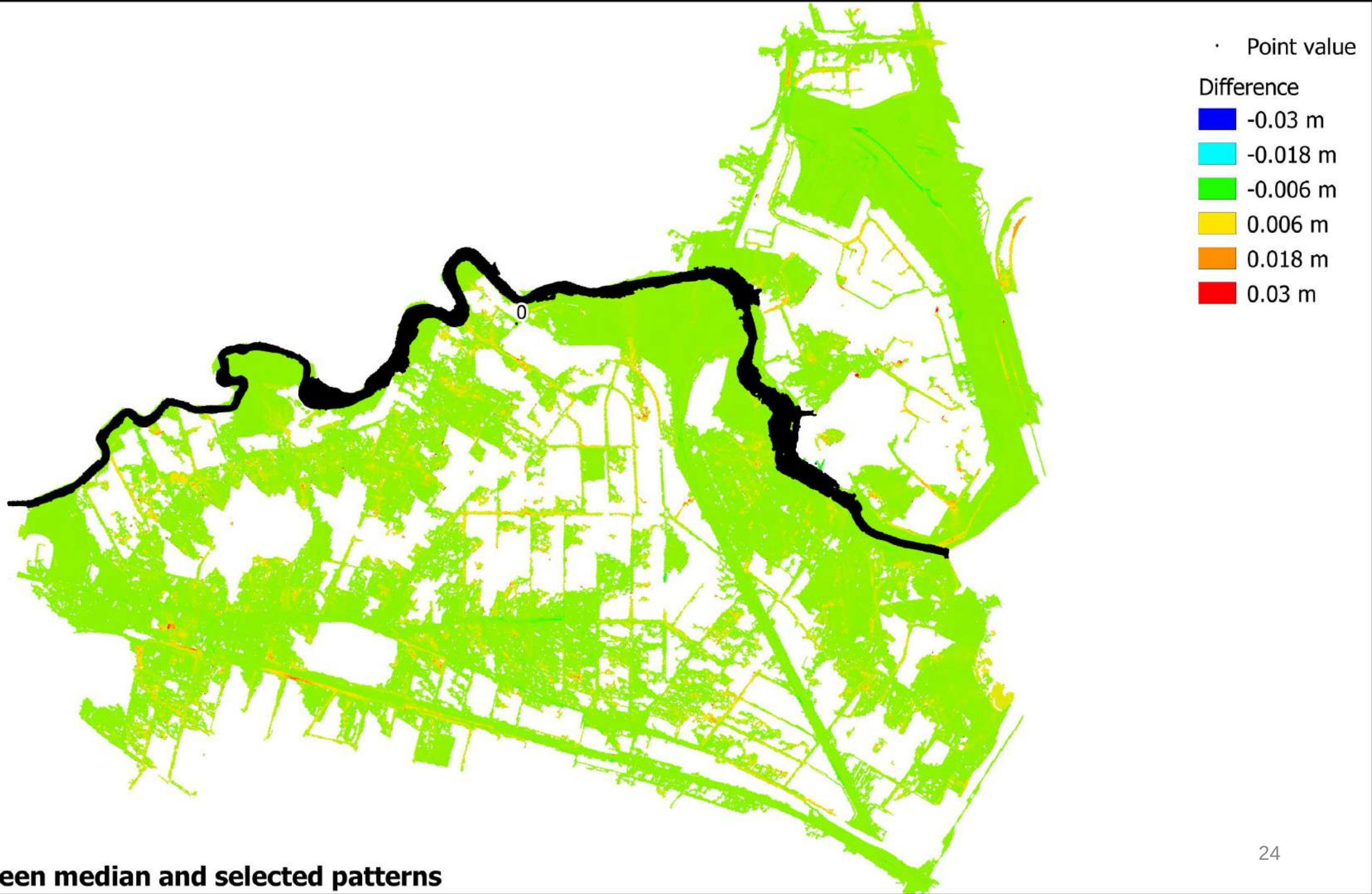
Model C
1% AEP
Peak Flood Depths (Medians)



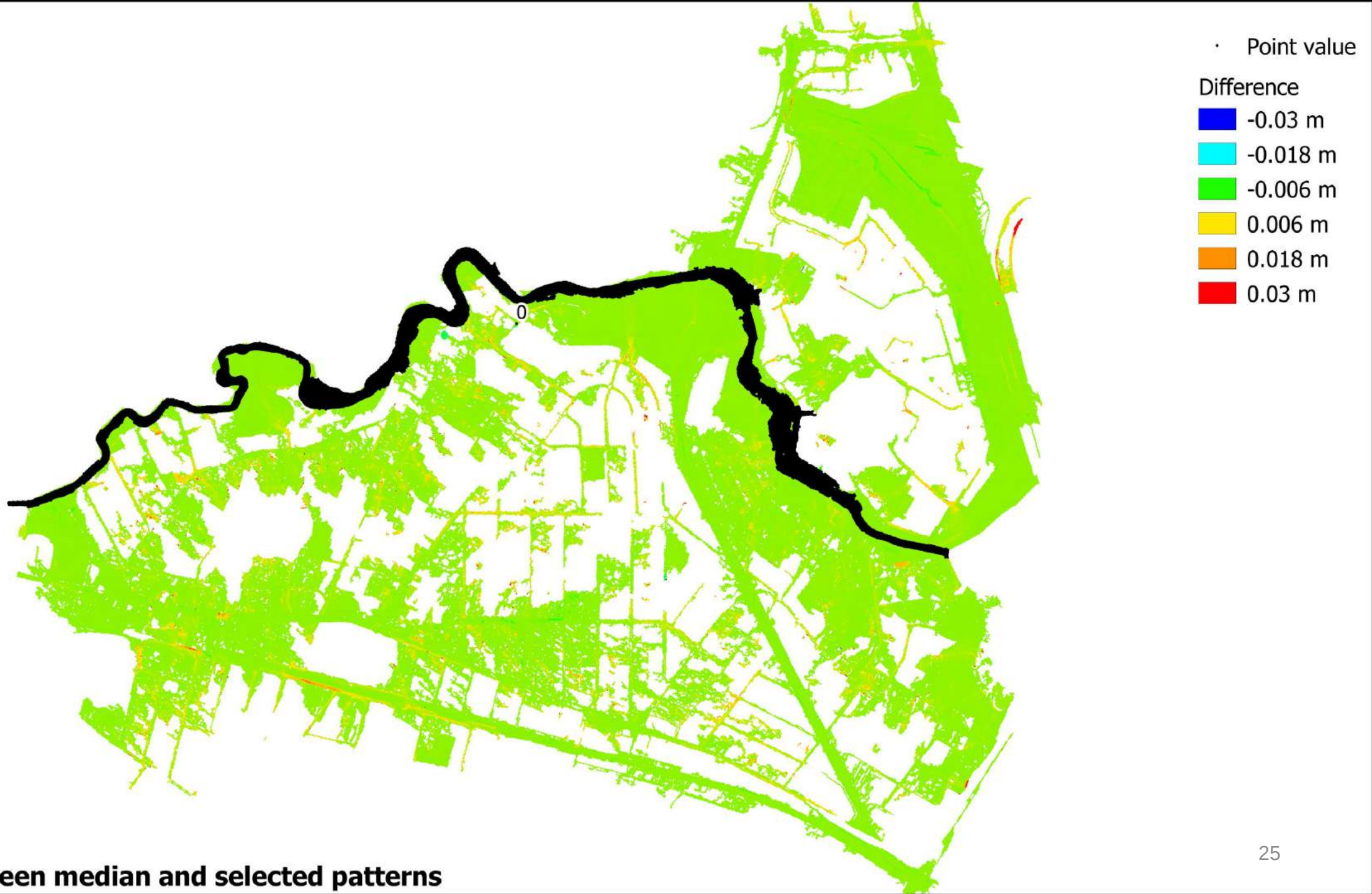
Model C
1% AEP
Maximum - Minimum Temporal Pattern



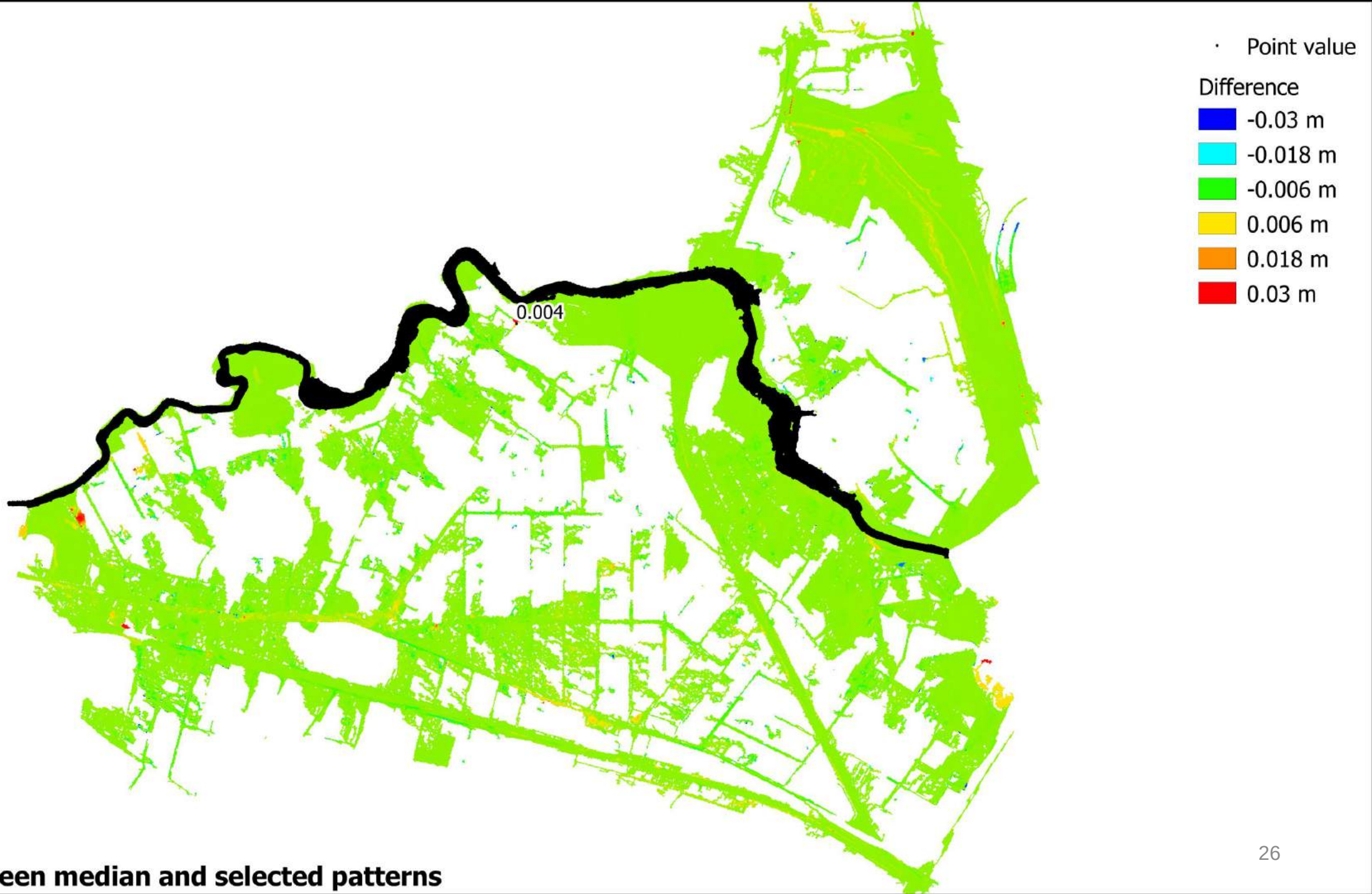
Model C
1% AEP
Difference between median and selected patterns



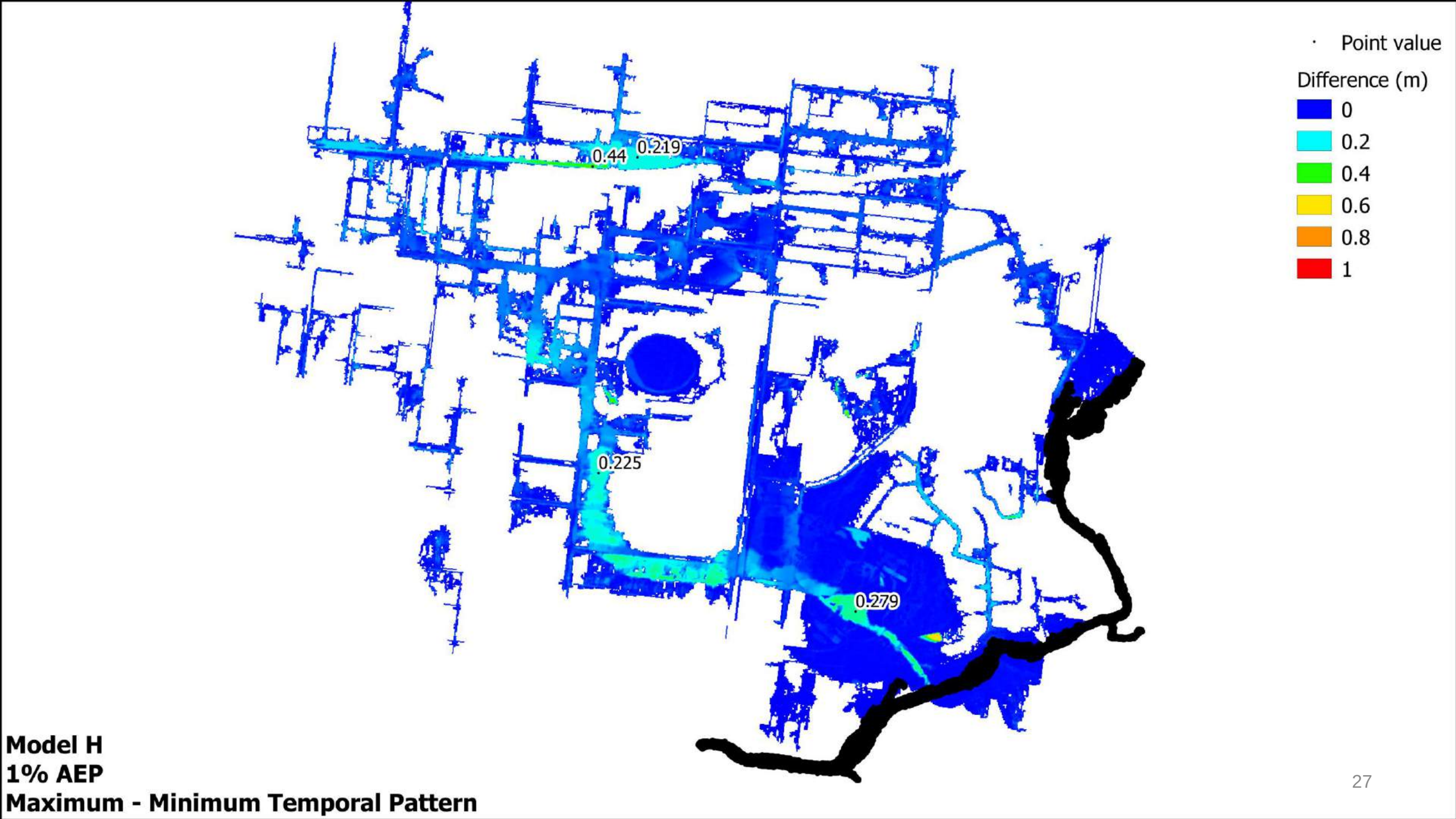
Model C
5% AEP
Difference between median and selected patterns



Model C
10% AEP
Difference between median and selected patterns



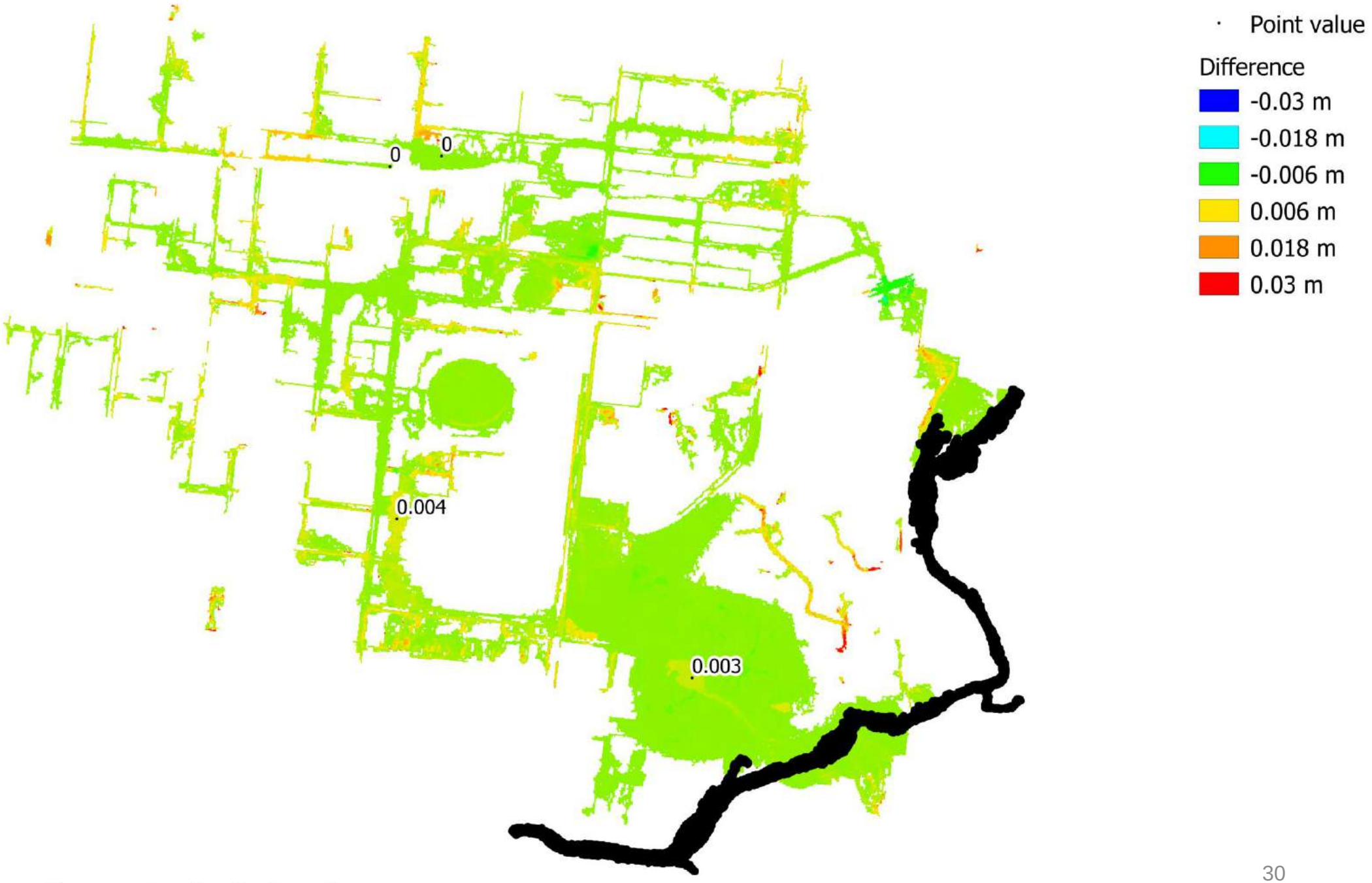
Model C
20% AEP
Difference between median and selected patterns



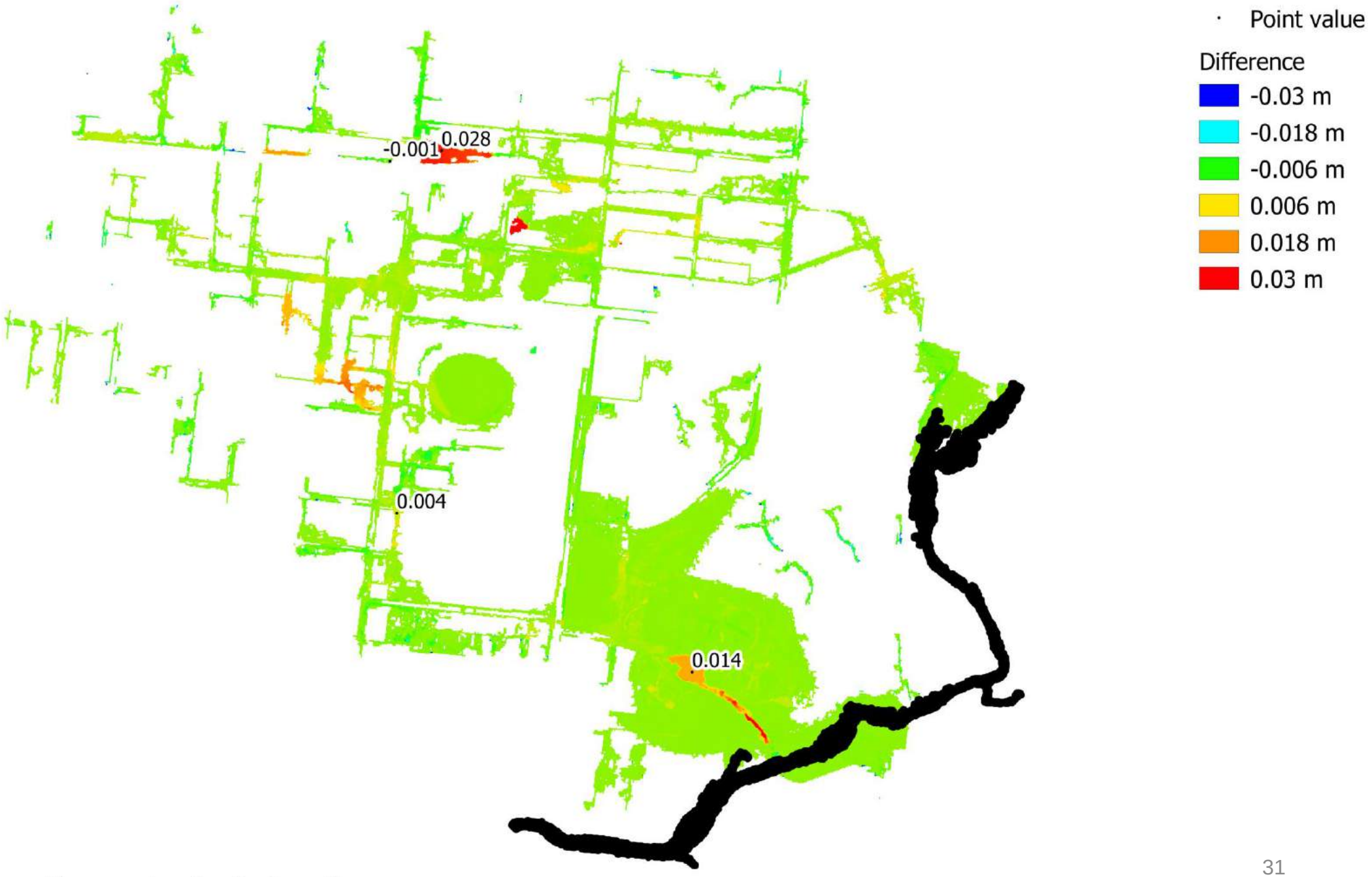
Model H
1% AEP
Maximum - Minimum Temporal Pattern

Model H
1% AEP
Difference between median and selected patterns

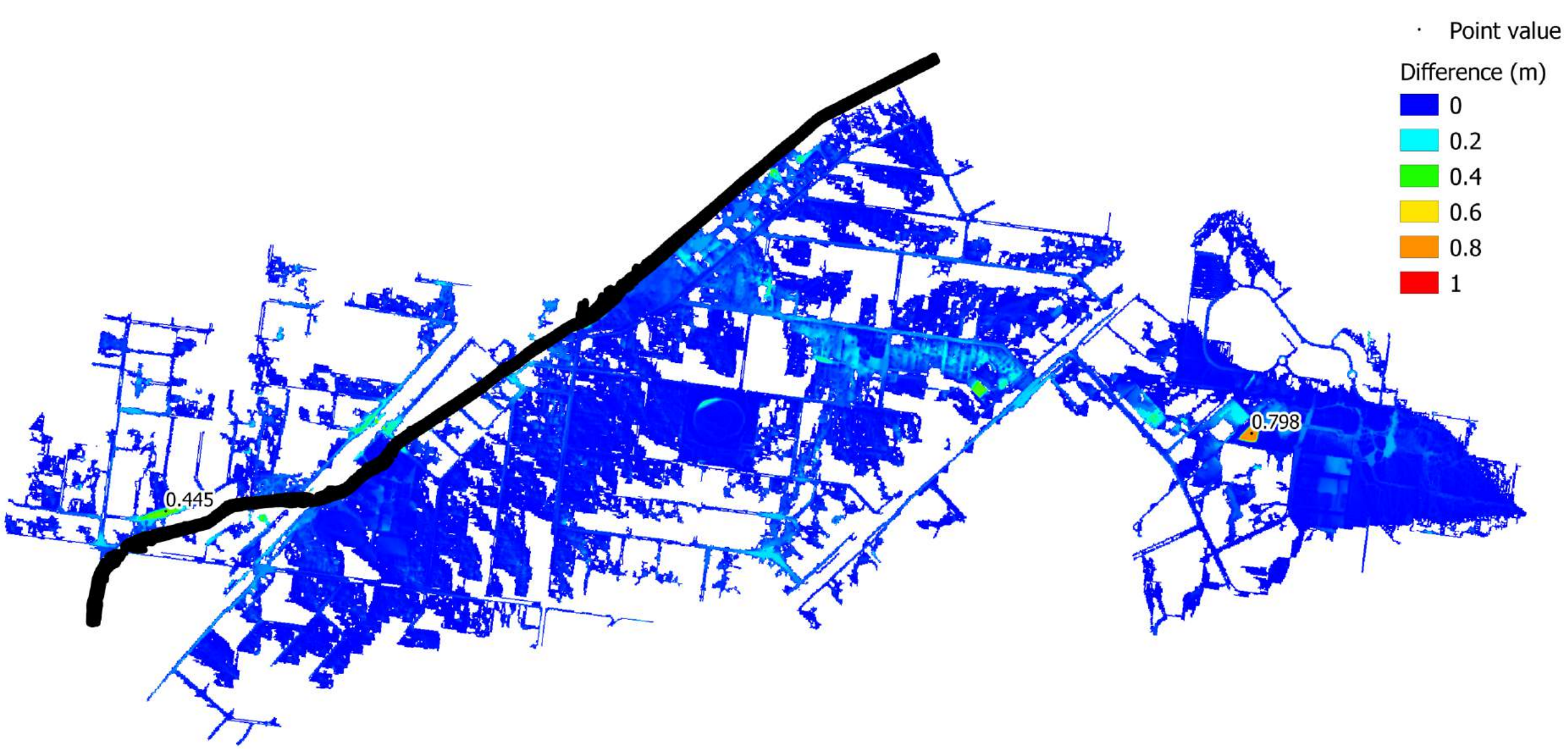
Model H
5% AEP
Difference between median and selected patterns



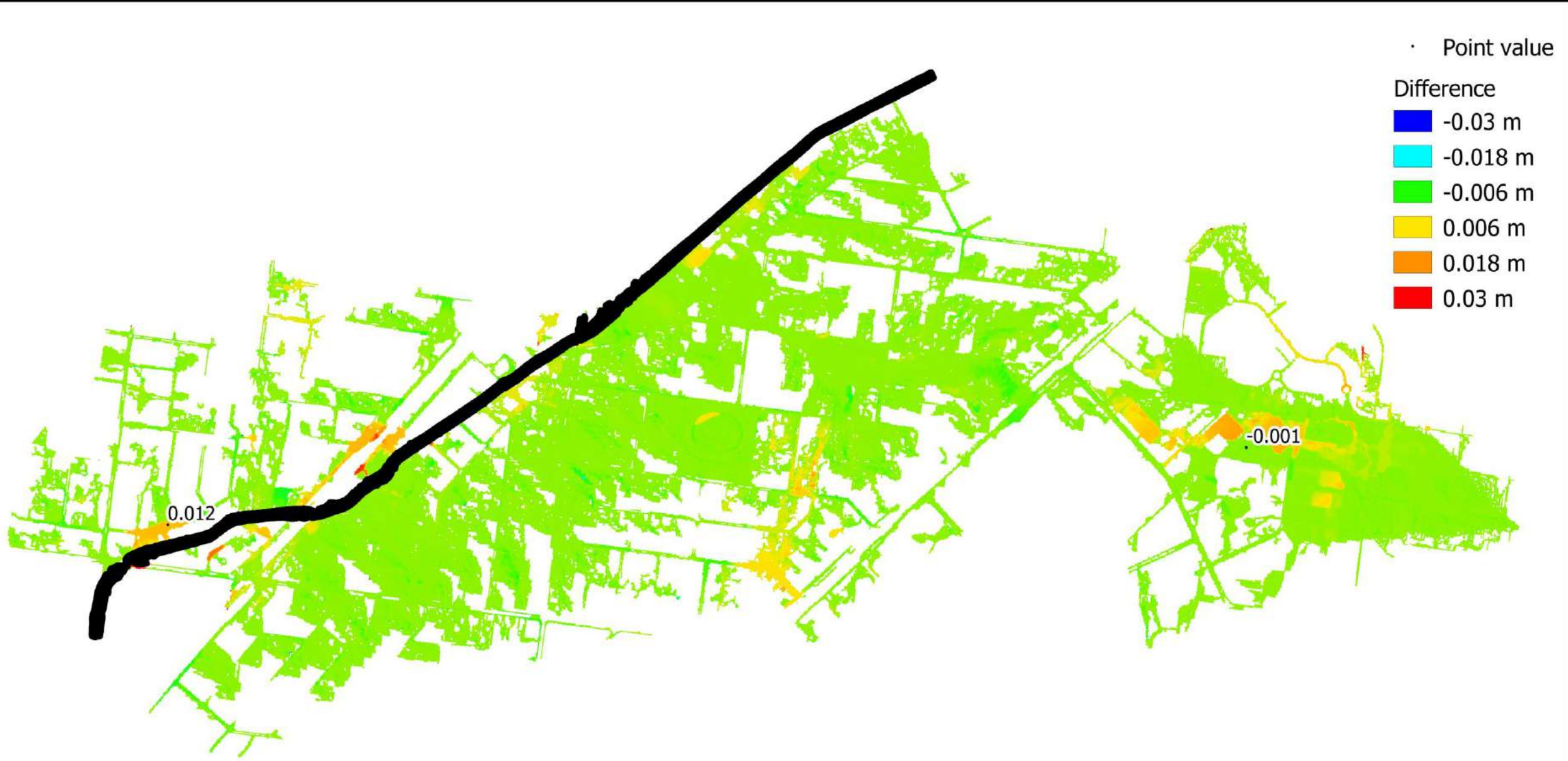
Model H
10% AEP
Difference between median and selected patterns



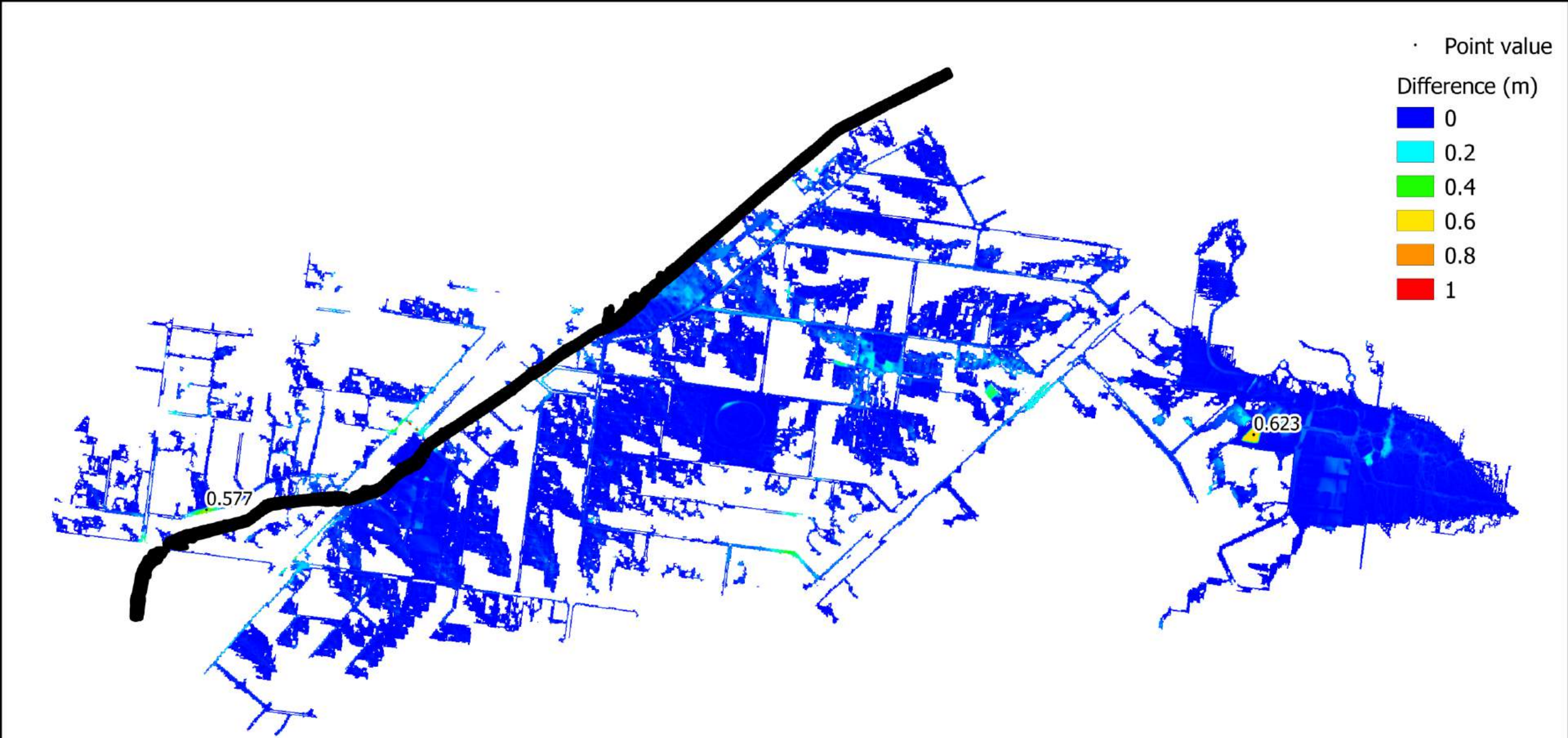
Model H
20% AEP
Difference between median and selected patterns



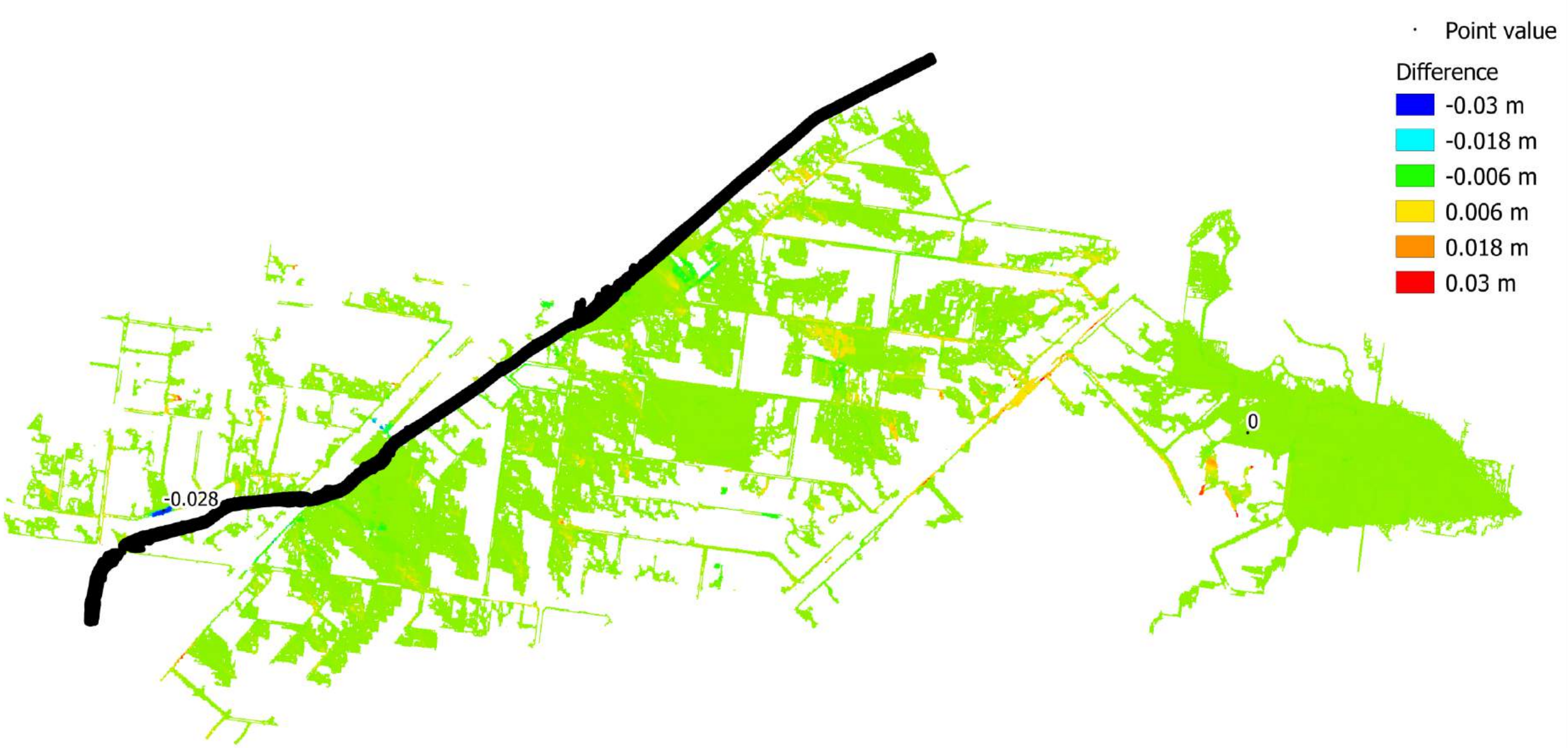
Model D
1% AEP
Maximum - Minimum Temporal Pattern



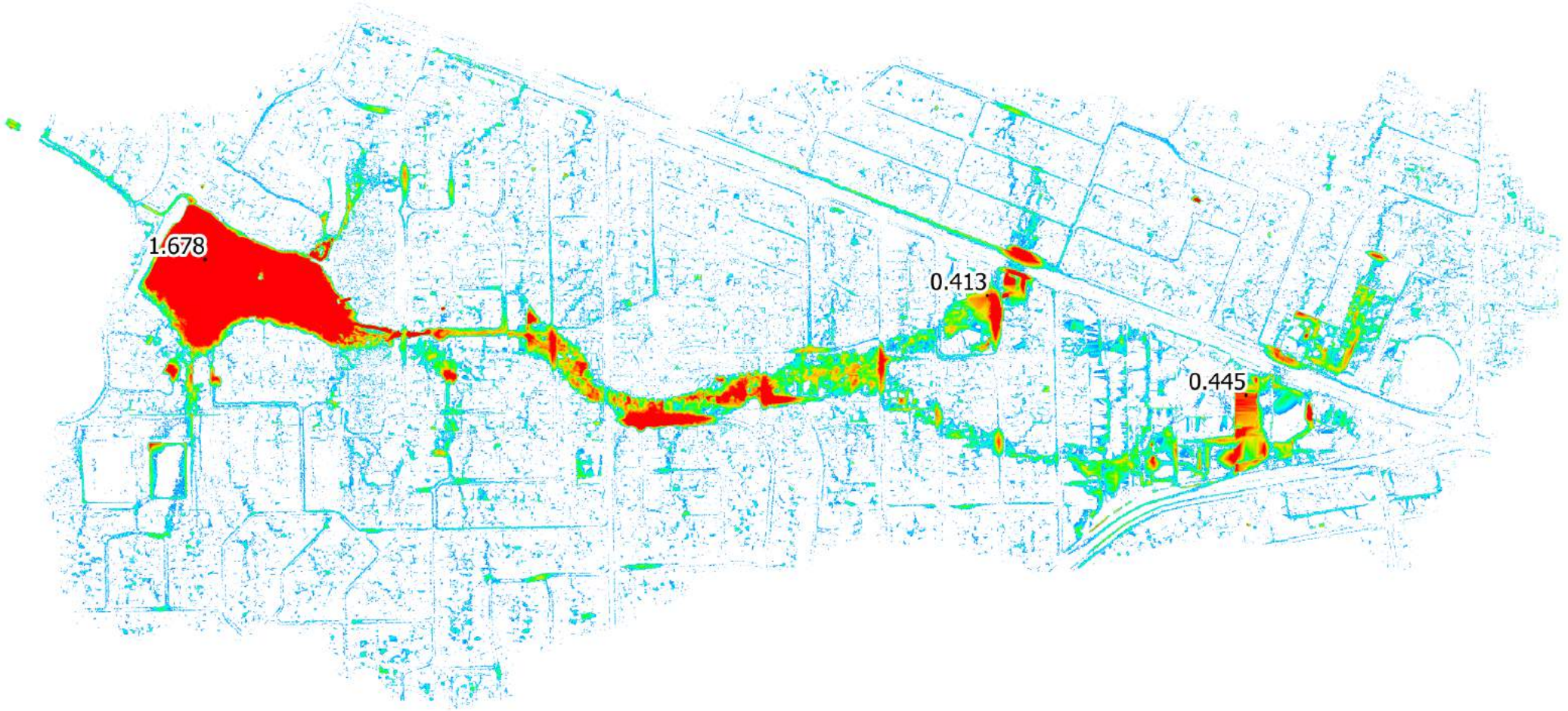
Model D
1% AEP
Difference between median and selected patterns



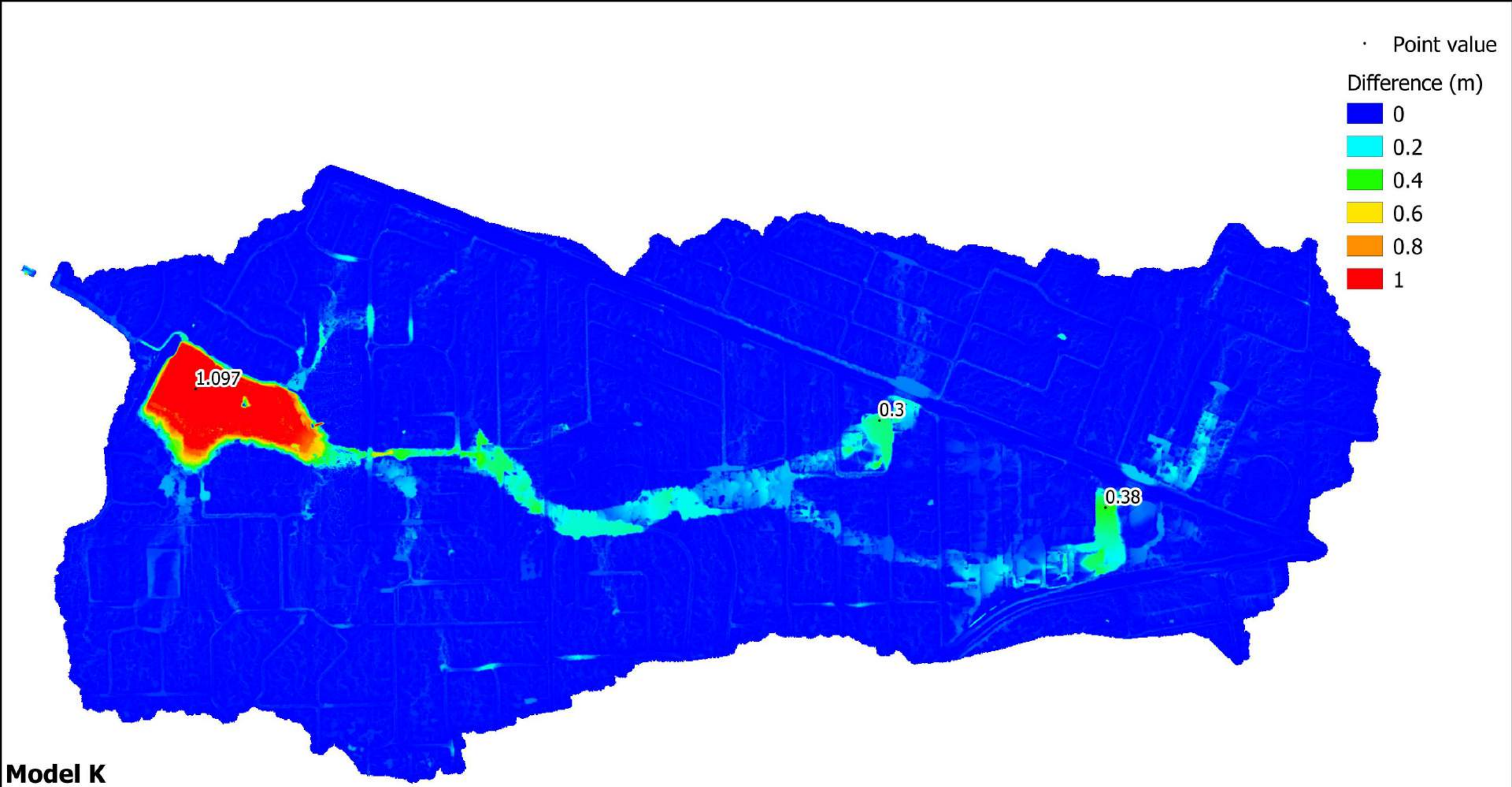
Model D
10% AEP
Maximum - Minimum Temporal Pattern



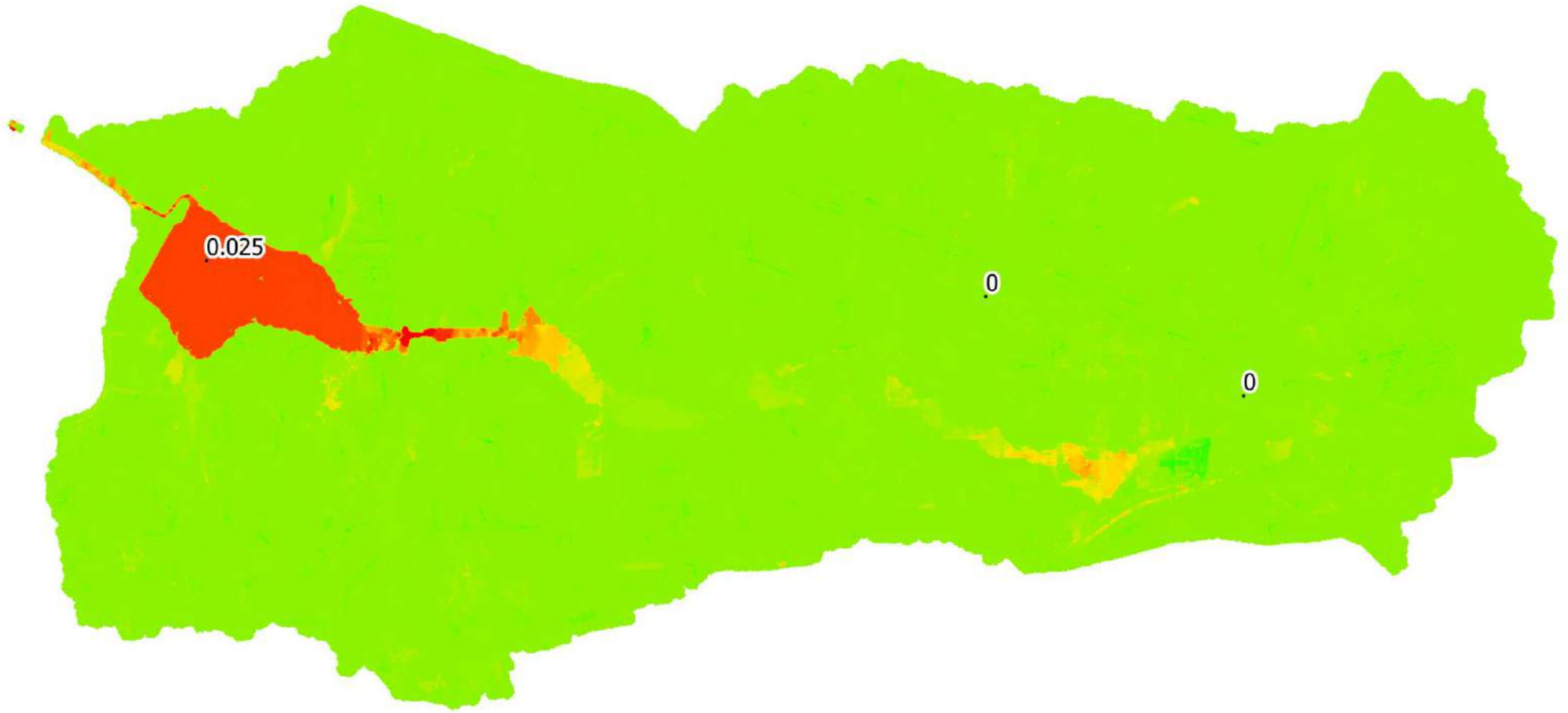
Model D
10% AEP
Difference between median and selected patterns



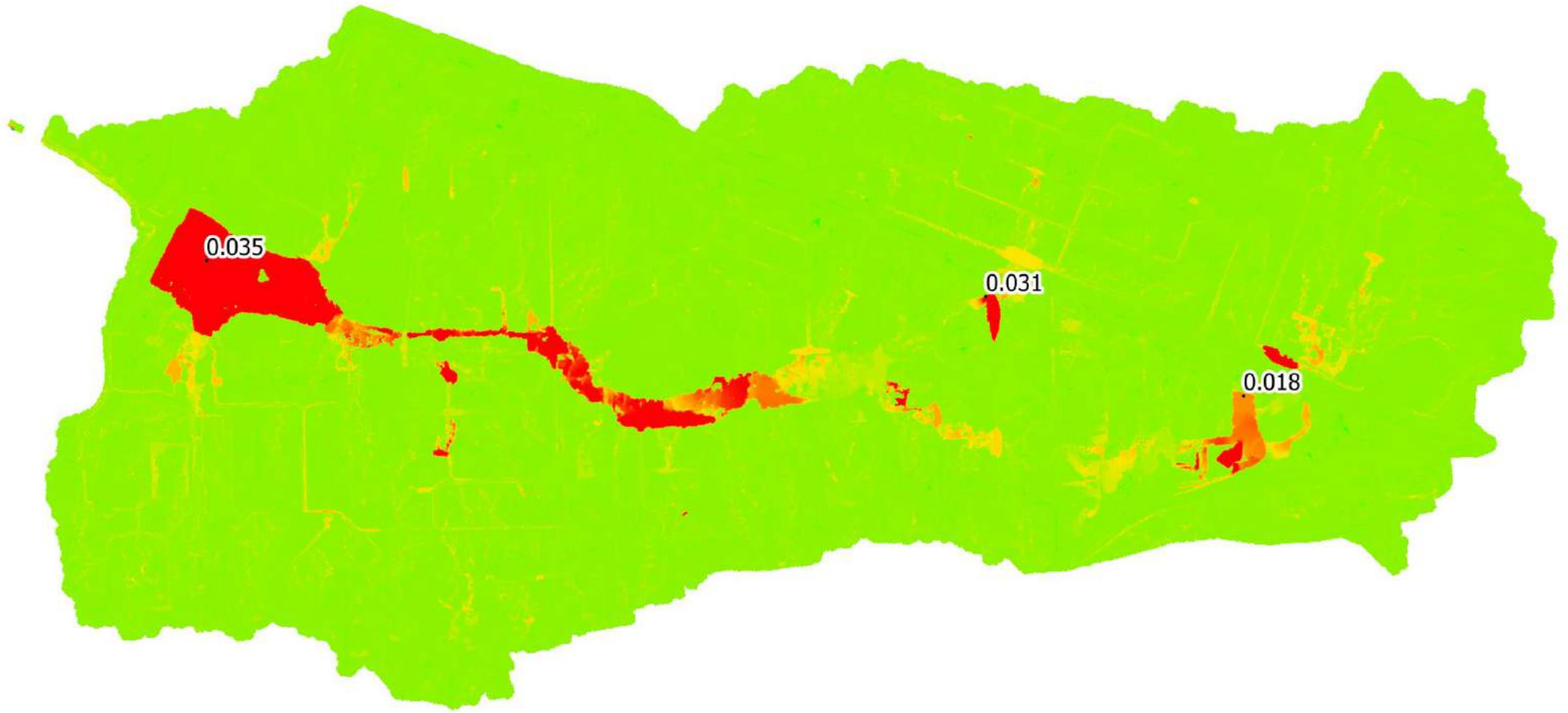
Model K
1% AEP
Peak Flood Depths (Medians)



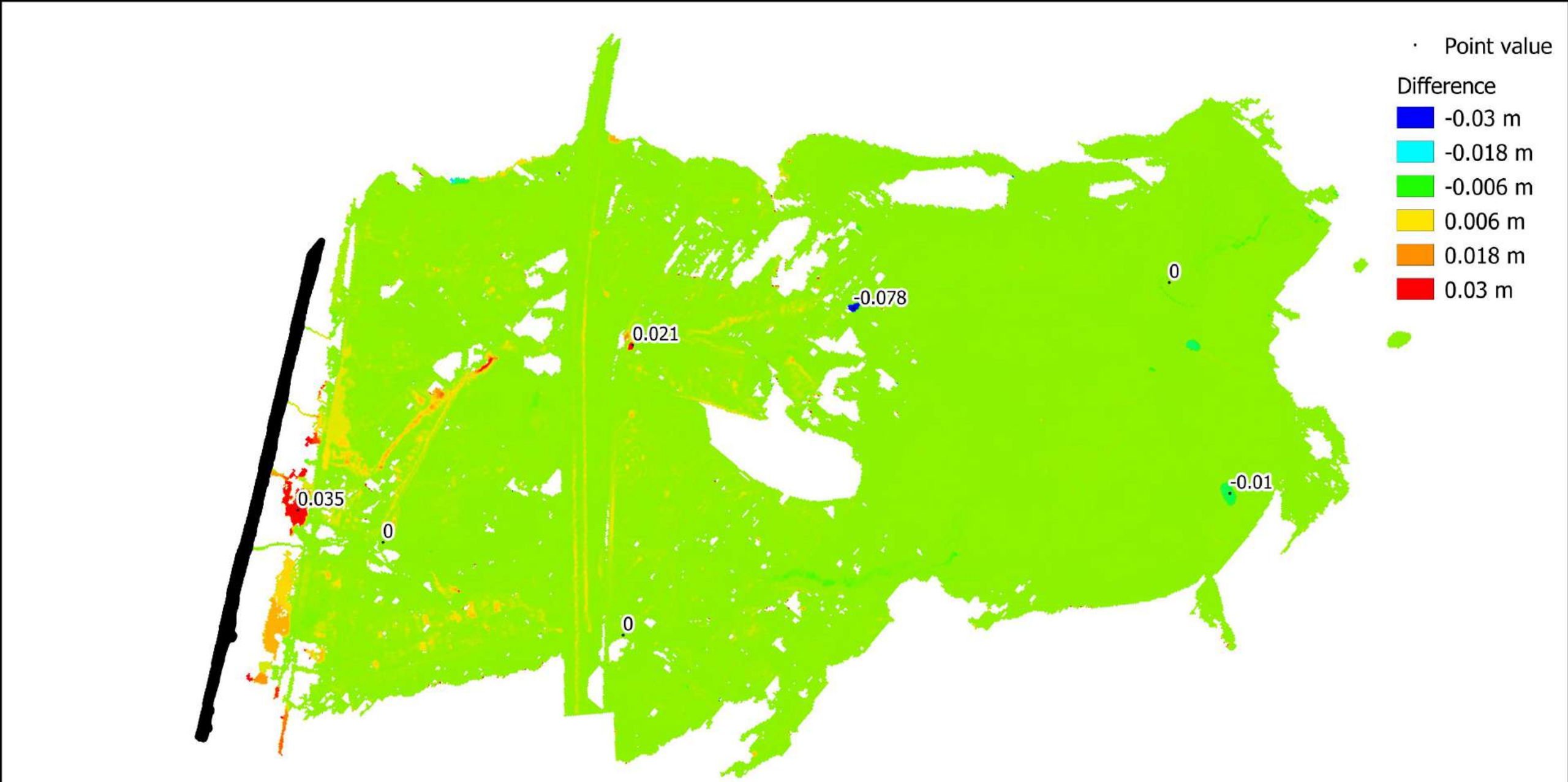
Model K
1% AEP
Maximum - Minimum Temporal Pattern



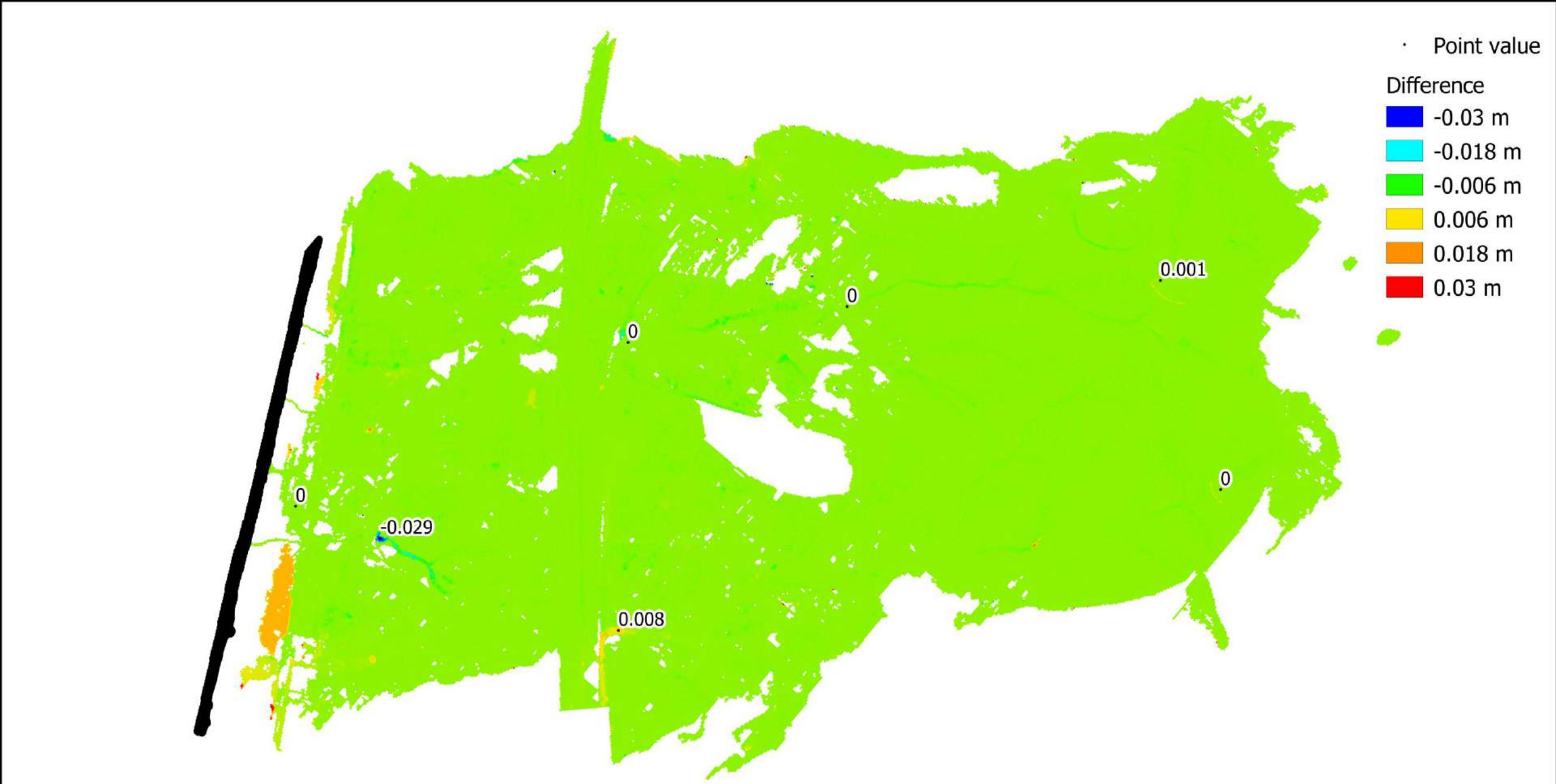
Model K
1% AEP
Difference between median and selected patterns



Model K
20% AEP
Difference between median and selected patterns



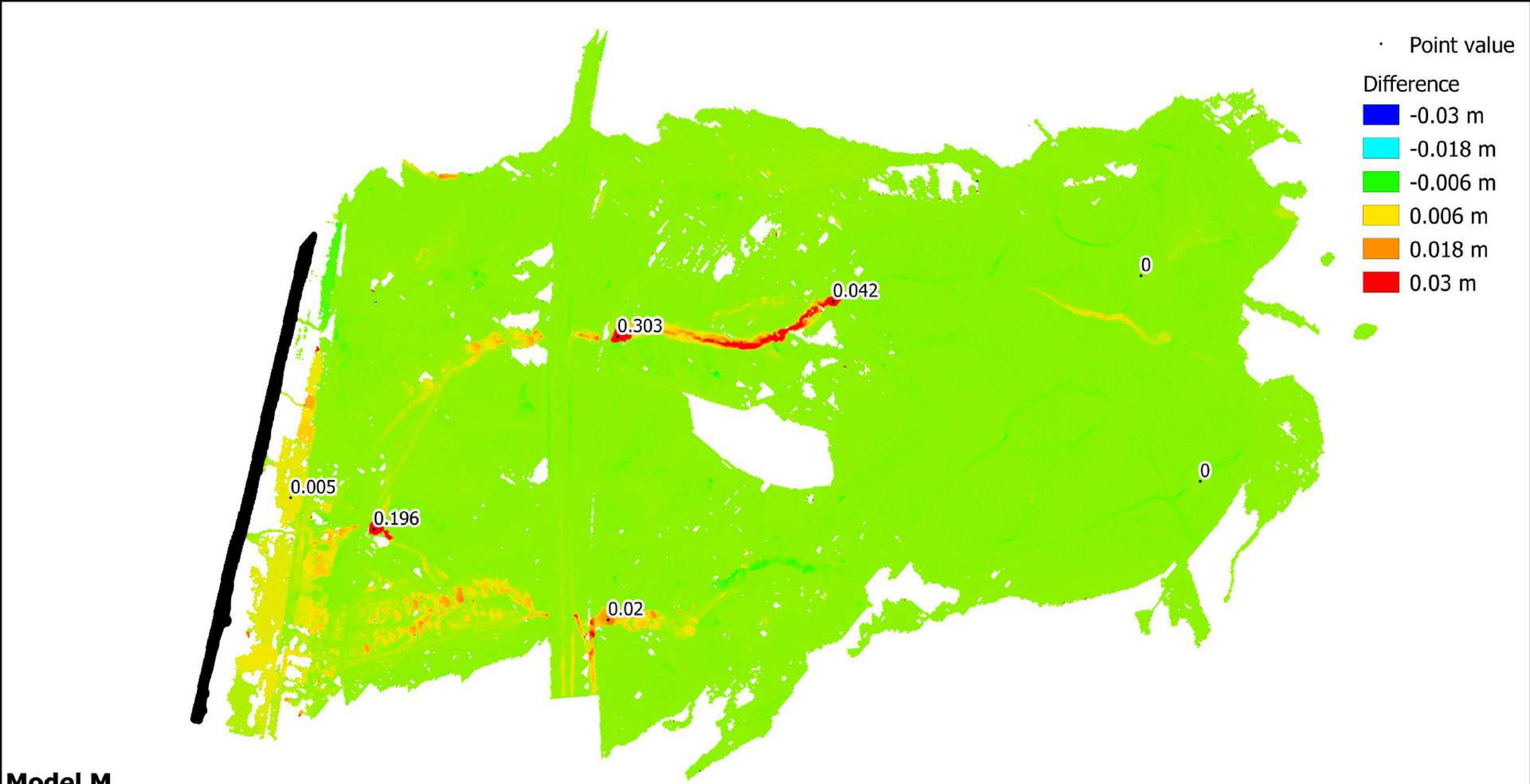
Model M
20% AEP
Difference between median and selected patterns



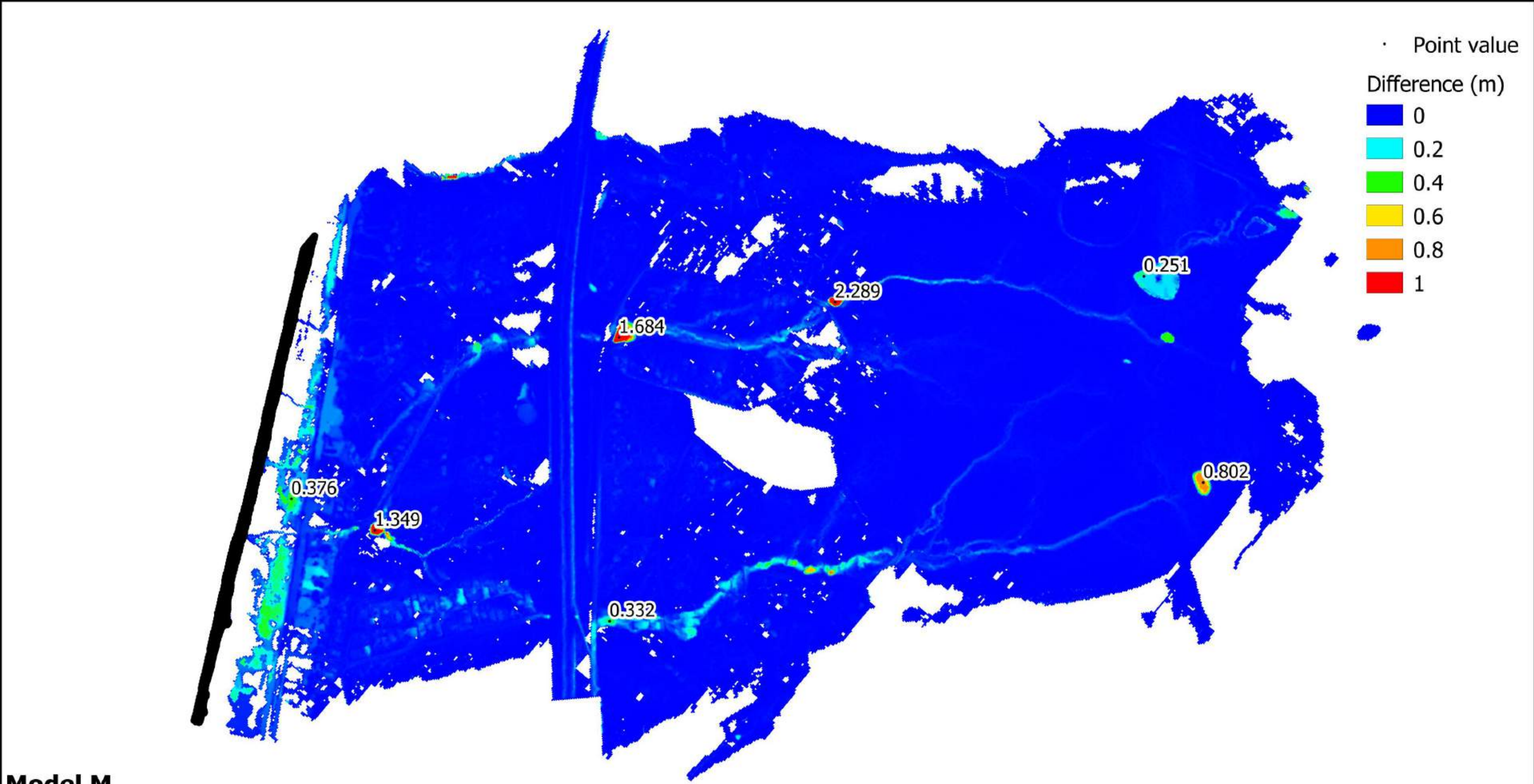
Model M
10% AEP
Difference between median and selected patterns

Model M
5% AEP
Difference between median and selected patterns

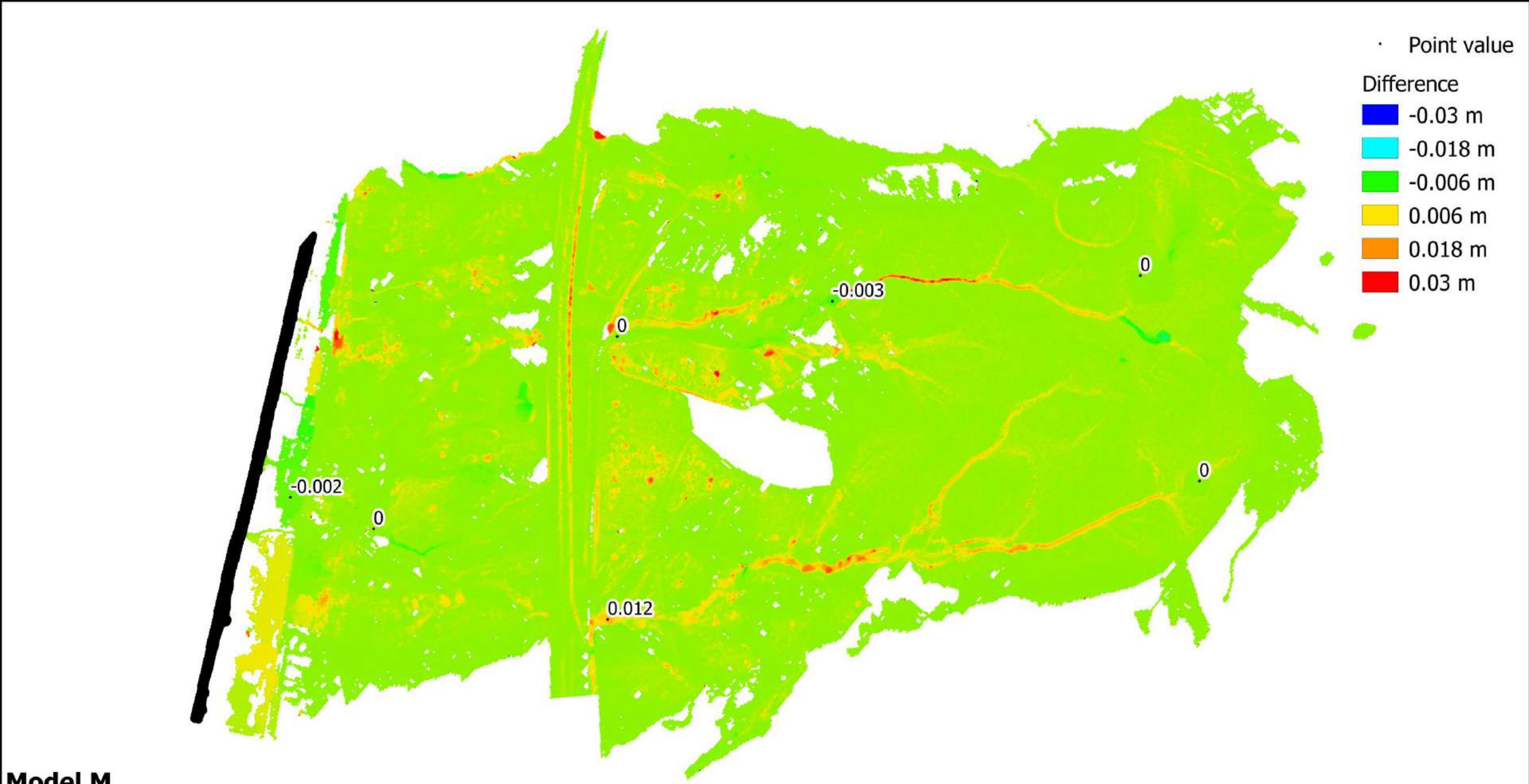
Model M
2% AEP
Difference between median and selected patterns



Model M
1% AEP
Difference between median and selected patterns



Model M
1% AEP
Maximum - Minimum Temporal Pattern



Model M
1% AEP
Difference between median and alternative selected patterns

Statistics 1% AEP

Model	AEP	Mean difference (mm)	Difference - Standard Deviation (mm)	Maximum underestimate (mm)	Maximum overestimate (mm)
H	100y	2.3	3.6	-33	109
C	100y	1.1	3.1	-126	121
M	100y	3.6	18.9	-424	304
K	100y	5.9	10.0	-24	332
D	100y	1.6	4.3	-42	70
P	100y	2.4	12.6	-141	428

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Statistics 10% and 20% AEP

Model	AEP	Mean difference (mm)	Difference - Standard Deviation (mm)	Maximum underestimate (mm)	Maximum overestimate (mm)
C	20%	0.4	4.2	-150	133
H	20%	2.7	7.7	-59	88
K	20%	17.6	16.3	-113	99
M	20%	1.7	6.6	-78	154
C	10%	1.0	3.0	-27	85
D	10%	0.4	4.2	-42	36
H	10%	1.6	3.4	-17	194
M	10%	0.5	3.4	-240	43

Which patterns best match the median results?

Duration	20% AEP	10% and 5% AEP	2%, 1% and 0.5% AEP
10 min	1	16	26
15 min	8	17	28
30 min	6	18	28
60 min	6	18	28
120 min	9	17	25
180 min	4	15	28

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Discussion

- Can chose one TP from each duration to match closely to the median result
- Appears to be fairly set of patterns consistent across 6 catchments tested
- Some areas of outliers in some models
  - have tended to be more on the conservative side (high flood level)
  - can also predict where these areas may be located (RB's and defacto RBs)

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Discussion – Does it make sense?

- Don’t want an extreme, want the middle
- Limited possible variation within a short time period for shorter storms
  - little value variation in storms under 60 minutes
  - Total rainfall depth more important – impact of initial loss
- More variation possible in longer storms, would expect more variation
- Steeper catchments show more variation
  - less attenuation of runoff so flow patterns match temporal patterns more closely

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Can we just run one TP?

- Yes, it is a valid estimate of the AEP flood (we did this for 30 years… all that work is not “wrong”)
- Running more patterns will quantify the uncertainty better
- Consider running a front and back loaded pattern to understand the variability

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Where should we put our effort?

- Initial loss (data hub data is low confidence and highly variable, particularly around Melbourne, between 8 mm and 32 mm west to east sides of the bay)
- Continuing loss (data hub data is low confidence)
- Climate change
- Future development

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Finally

- All modelling is wrong
  - Aim to minimise by how much
  - The median (or mean) of the temporal patterns is not the perfect answer
- Be an Engineer and not a Scientist!
  - We should not be obsessing over millimetre differences between temporal patterns
  - Safety factor (freeboard)
  - Acknowledge or quantify the uncertainty and move on
  - Make a practical call on if the uncertainty is important

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