Denoising EBSD Data

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MTEX Workshop 2016

Noise in EBSD Data

```
ebsd = loadEBSD('someData.txt')
```

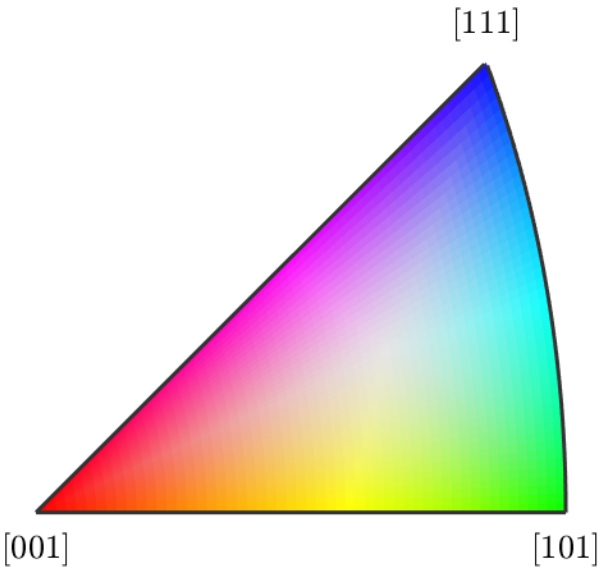
```
ebsd = EBSD (show methods, plot)

 Phase   Orientations   Mineral   Symmetry
     0          30200        Al       m-3m

 Properties: ci, fit, iq, sem, x, y
 Scan unit : um
```

```
grains = calcGrains(ebsd)
plot(grains.boundary)
```

```
plot(ebsd,ebsd.mis2mean.angle)
```

```
plot(ebsd,ebsd.mis2mean)
```

```
oM = ipdfHSVOrientationMapping(...
      ebsd('indexed').mis2mean)
oM.maxAngle = 1*degree
plot(ebsd,oM.orientation2color(...
    ebsd.mis2mean))
```



Noise in EBSD Data

```
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```

```
grains = calcGrains(ebsd)
plot(grains.boundary)
```

```
grains = grain2d (show methods, plot)

 Phase   Grains   Pixels   Mineral   Symmetry
Crystal reference frame
     0       25    30200        Al       m-3m

 Properties: GOS, meanRotation
```

```
plot(ebsd,ebsd.mis2mean.angle)
```

```
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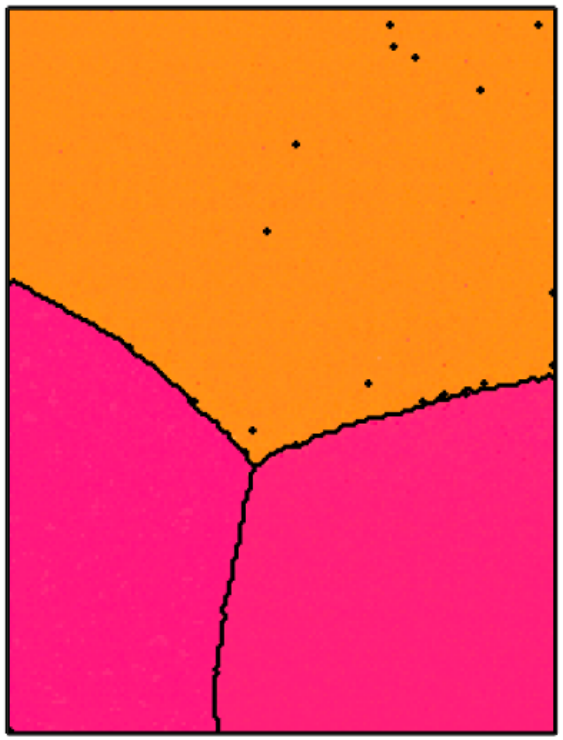

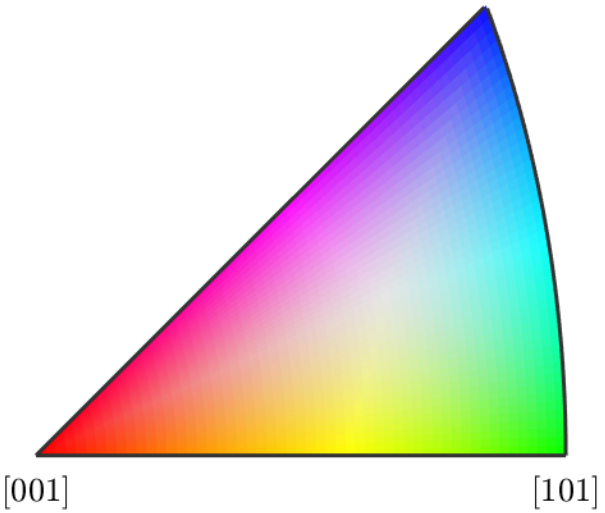

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```
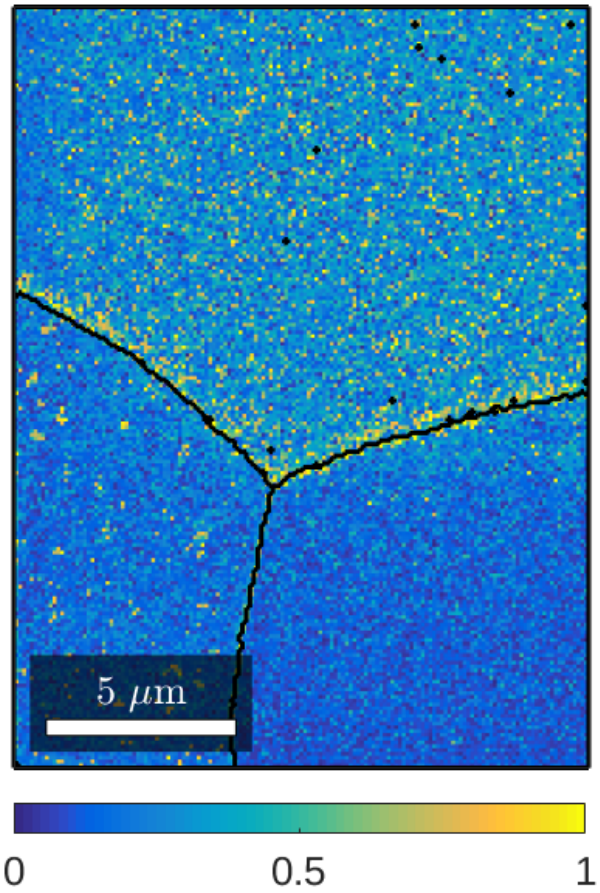

```
ebsd = smooth(ebsd)
plot(ebsd,ebsd.mis2mean)
```



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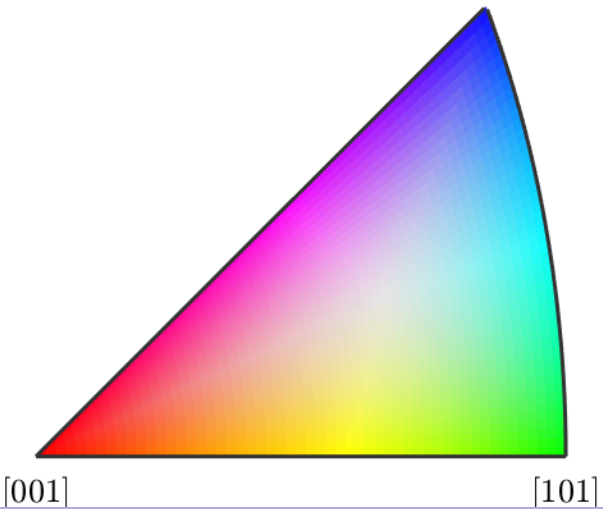

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```
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```

```
oM = ipdfHSVOrientationMapping(...
      ebsd('indexed').mis2mean)
oM.maxAngle = 5*degree
plot(ebsd,oM.orientation2color(...
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```

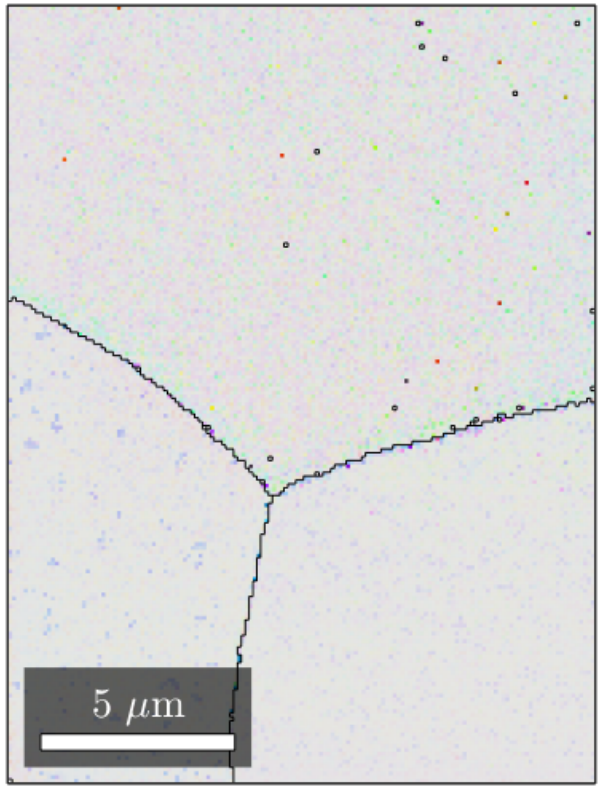


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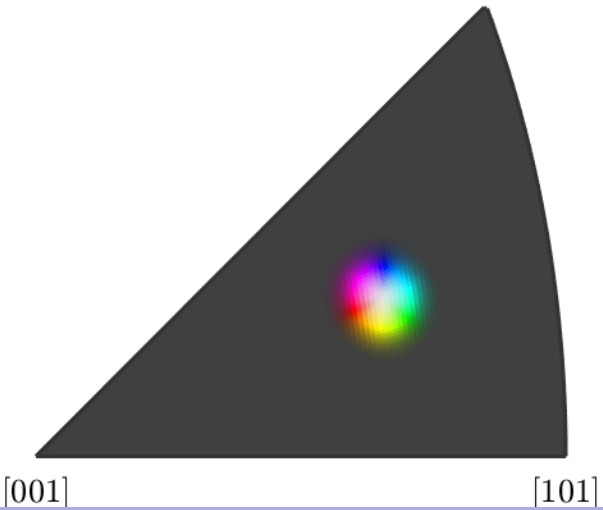

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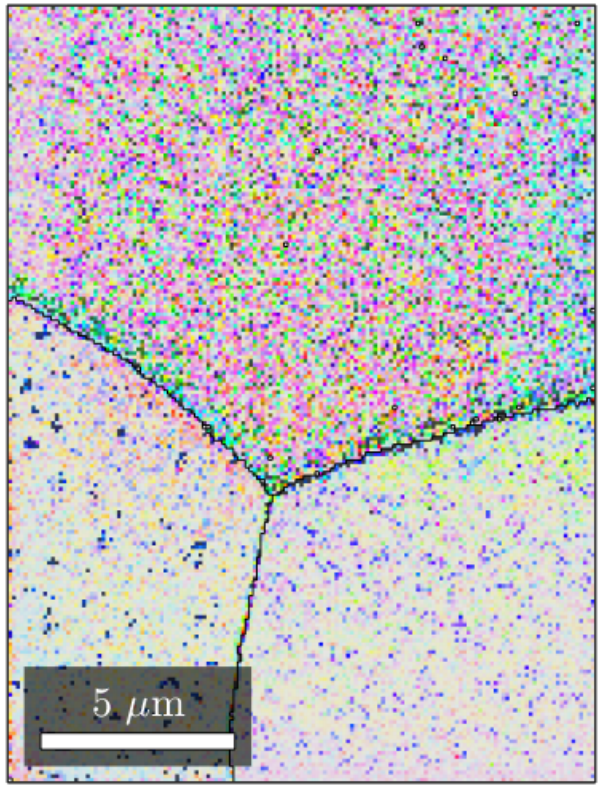

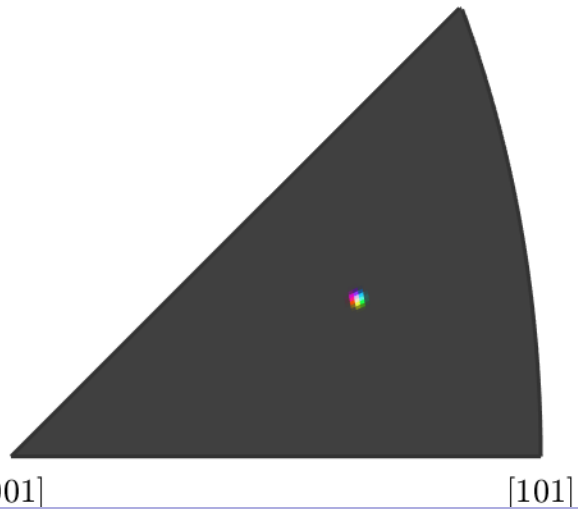

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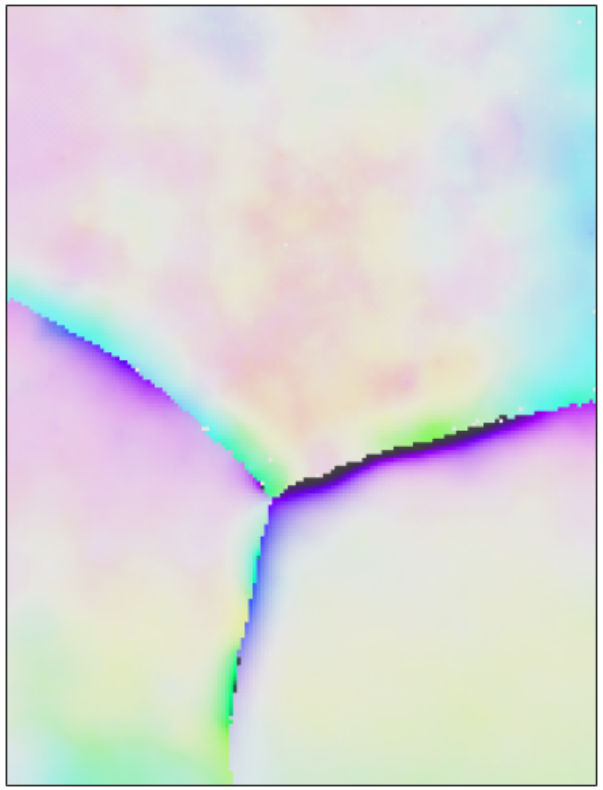
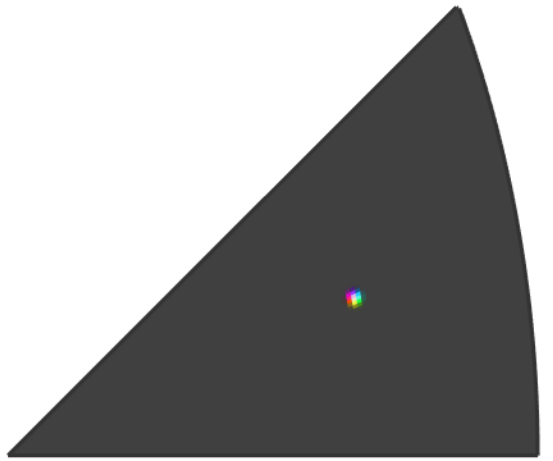


[111]



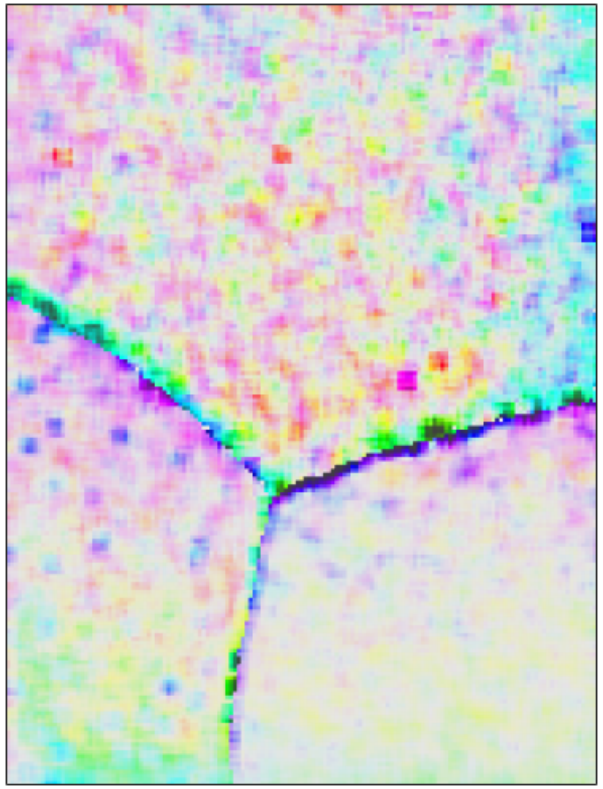
Some Smoothing Techniques

1. Mean Filter: new orientation is mean orientation of neighbors
2. Median Filter: new orientation is neighboring orientation with minimum distance to all other neighboring orientations
3. Smoothing Splines: Given orientation map O_{ij}, determine smoothed map $\tilde{O}_{ij}$ as solution of the minimization problem

$$\sum_{i,j} \omega(O_{ij}, \tilde{O}_{ij})^2 + \alpha(\triangle \tilde{O}_{ij})^2 \to \min$$

4. Half Quadratic Optimization: Solve

$$\sum_{i,j} \omega(O_{ij}, \tilde{O}_{ij})^2 + \alpha\varphi(\nabla \tilde{O}_{ij}) \to \min$$



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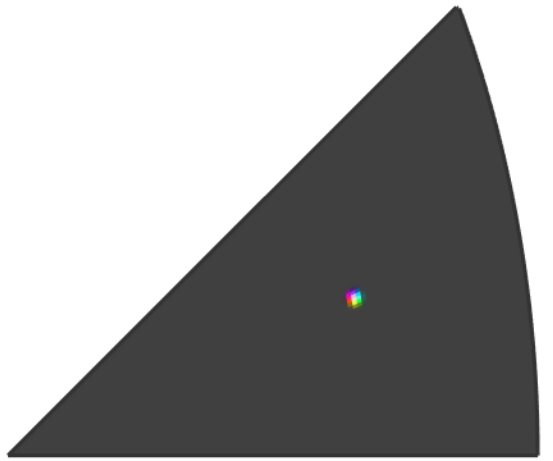

[001] [101]

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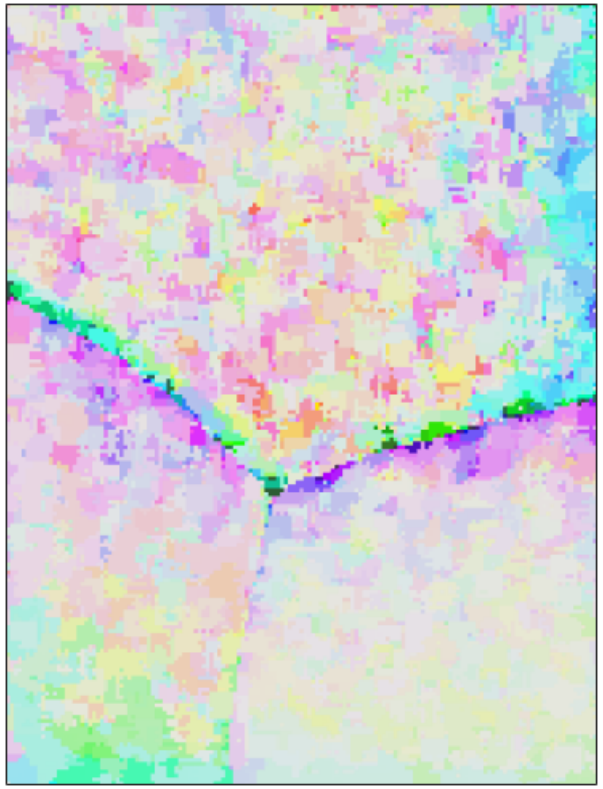

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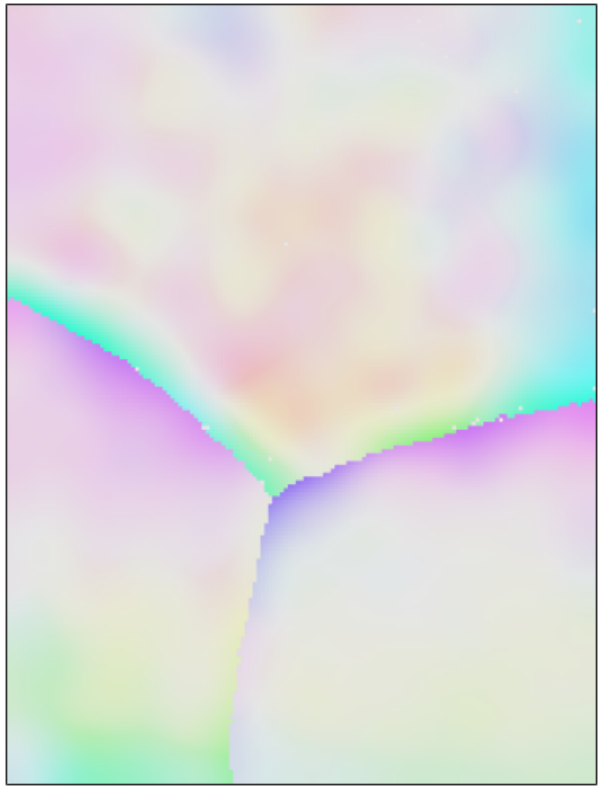

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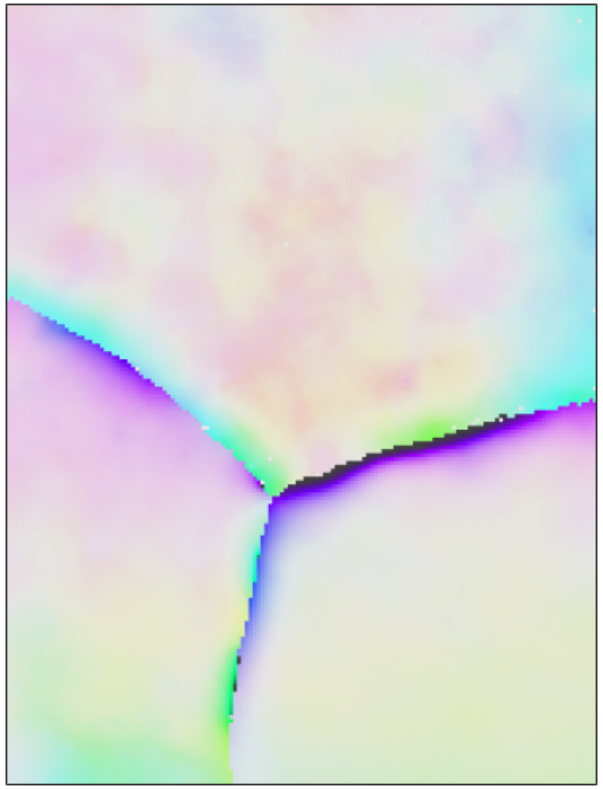
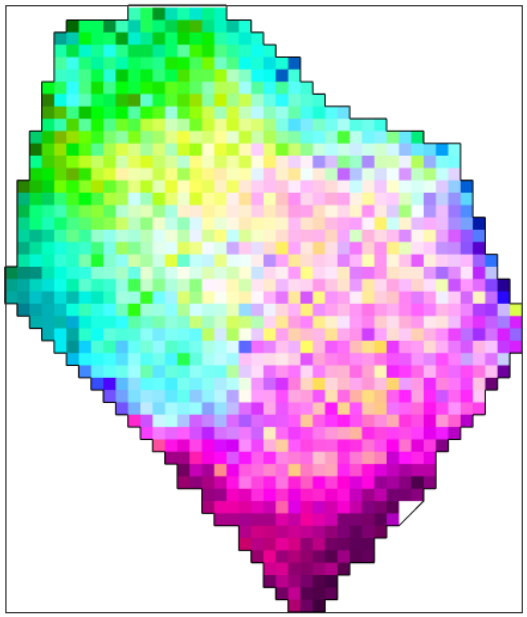


A deformed grain



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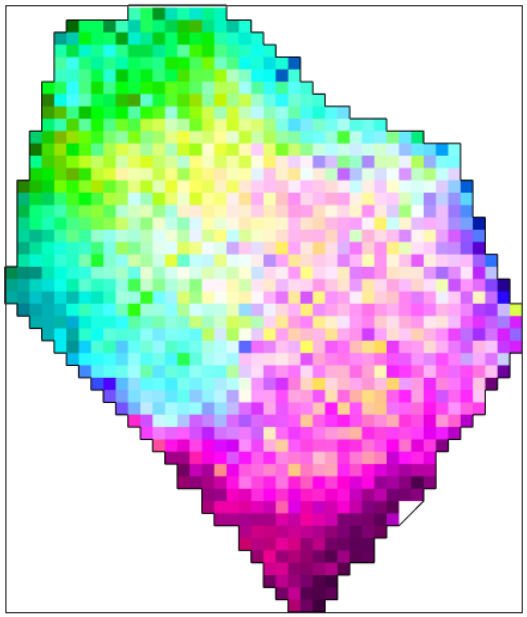

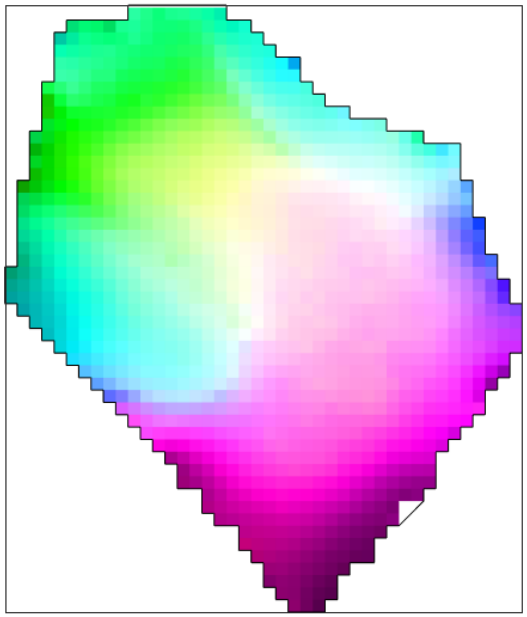

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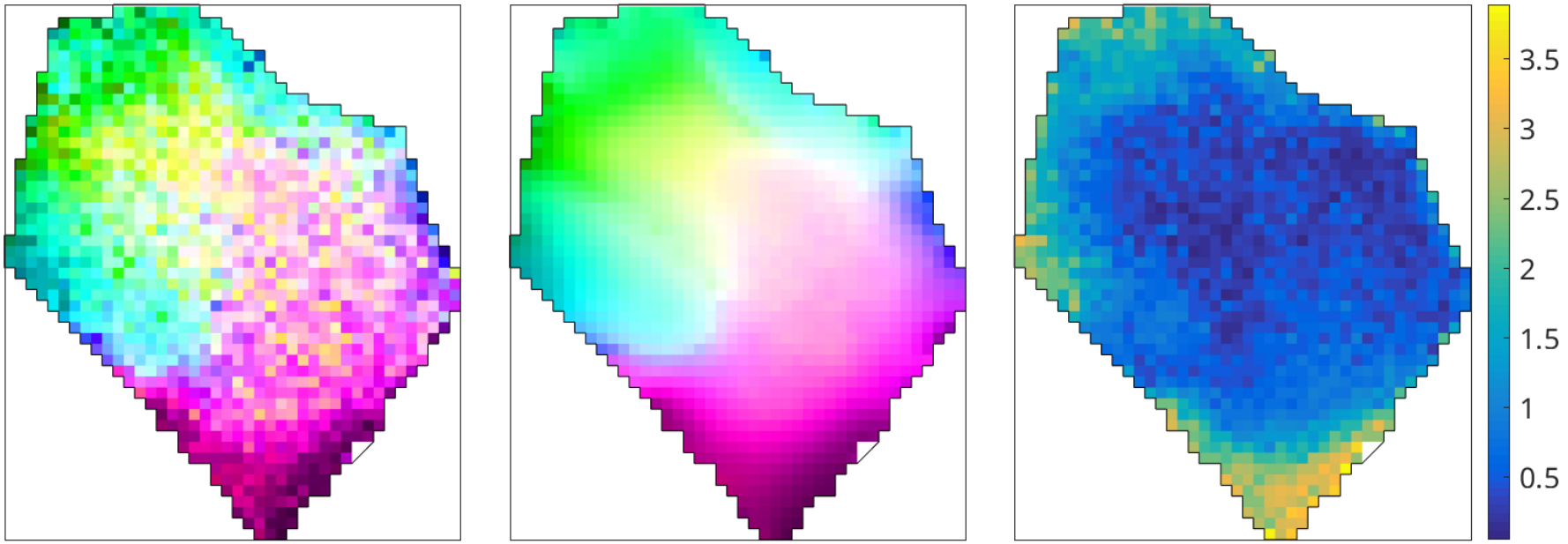

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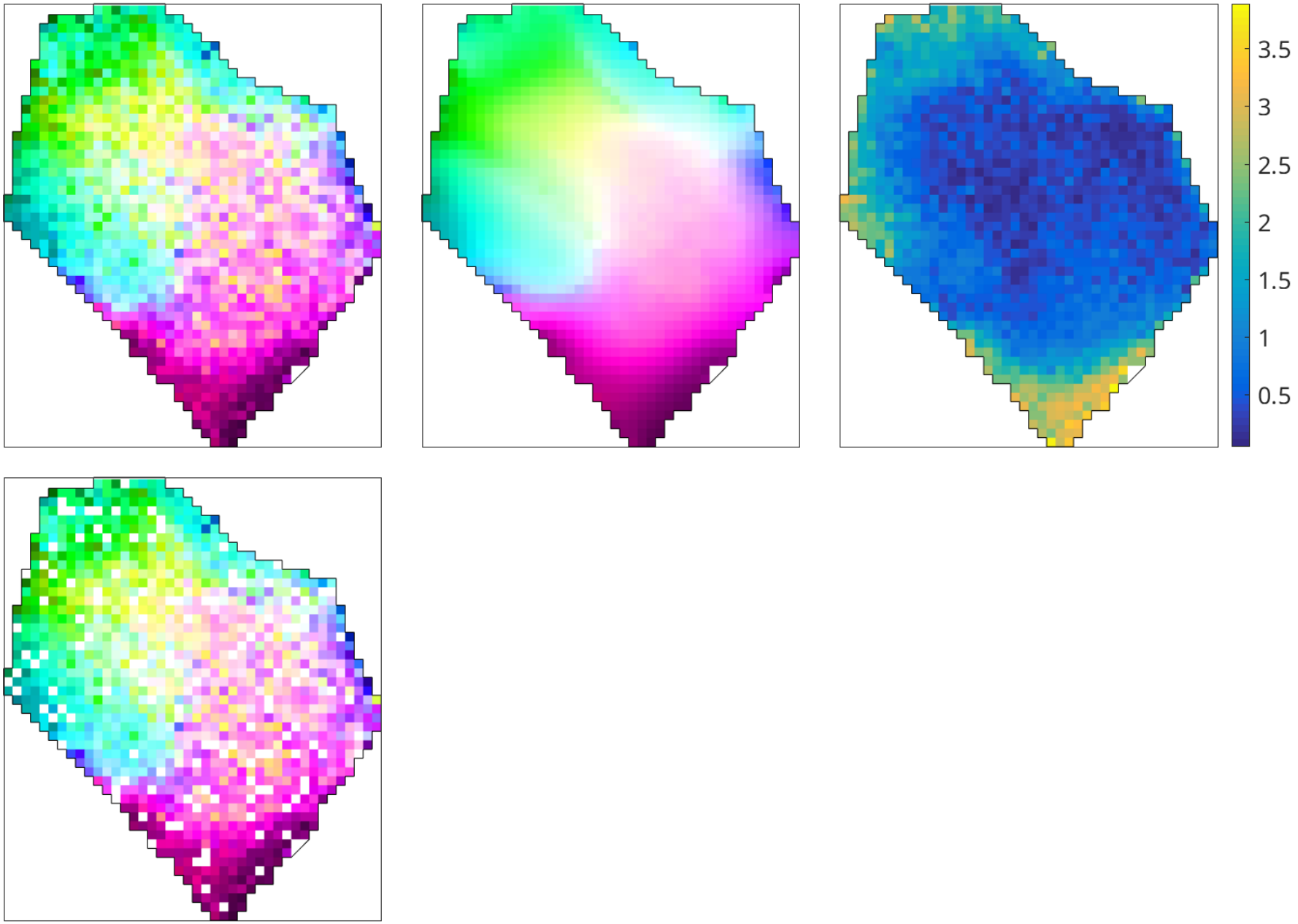

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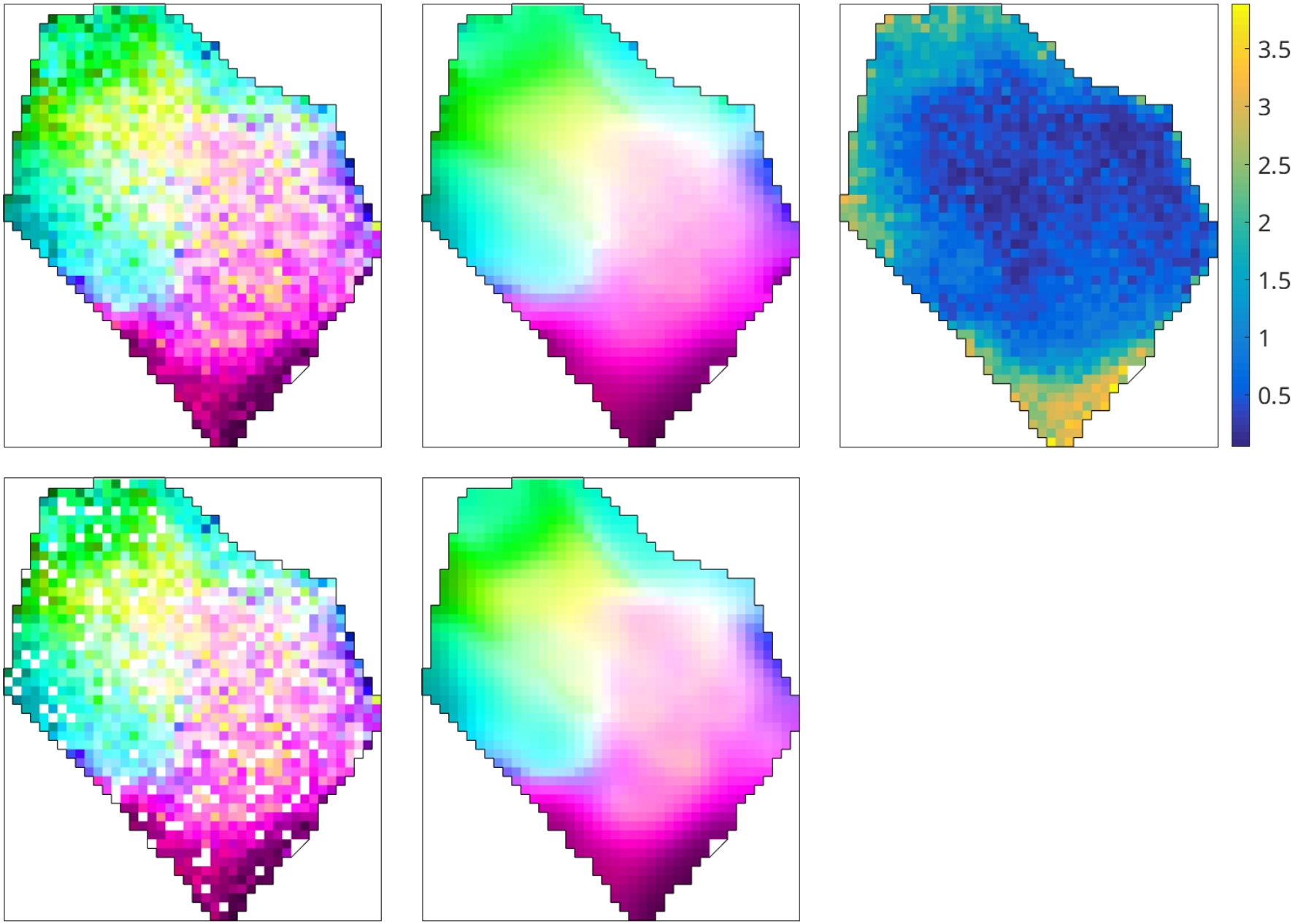

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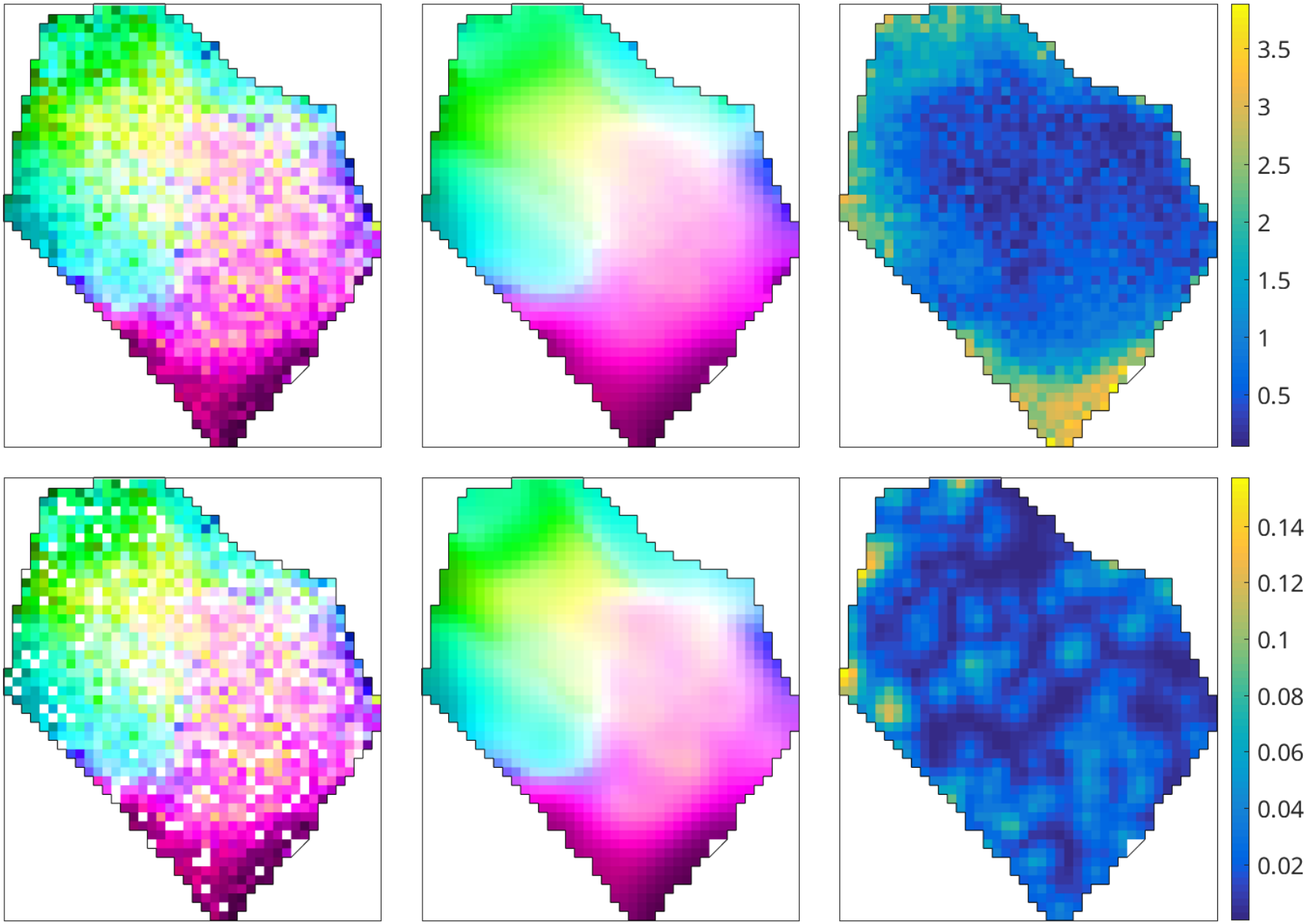
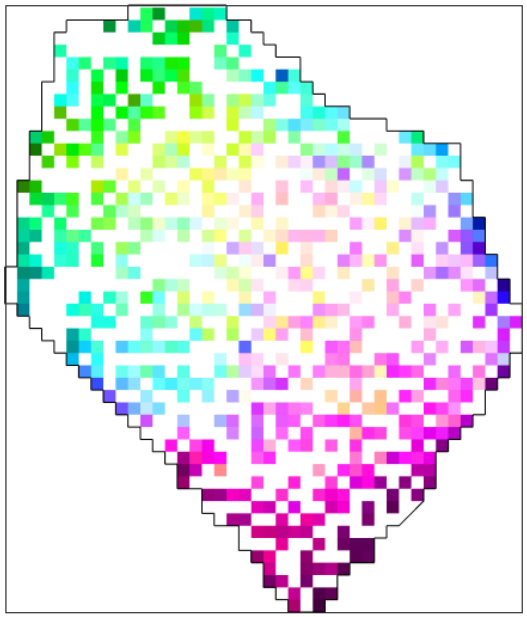


Not Indexed Data



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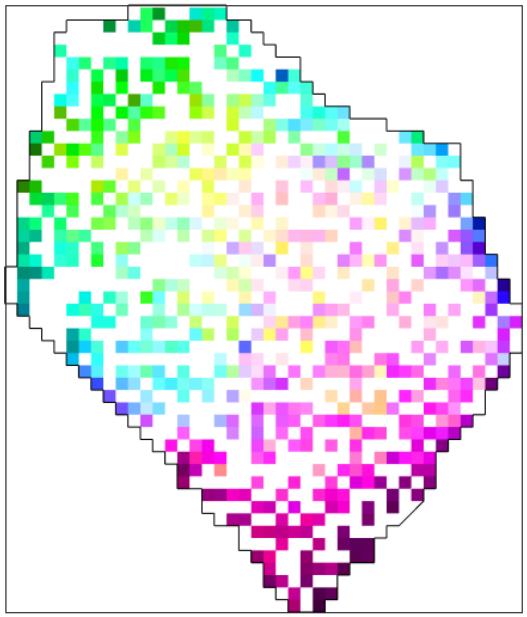

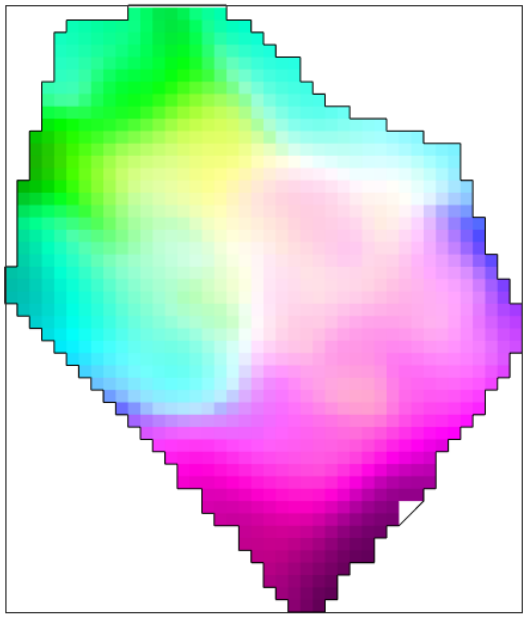

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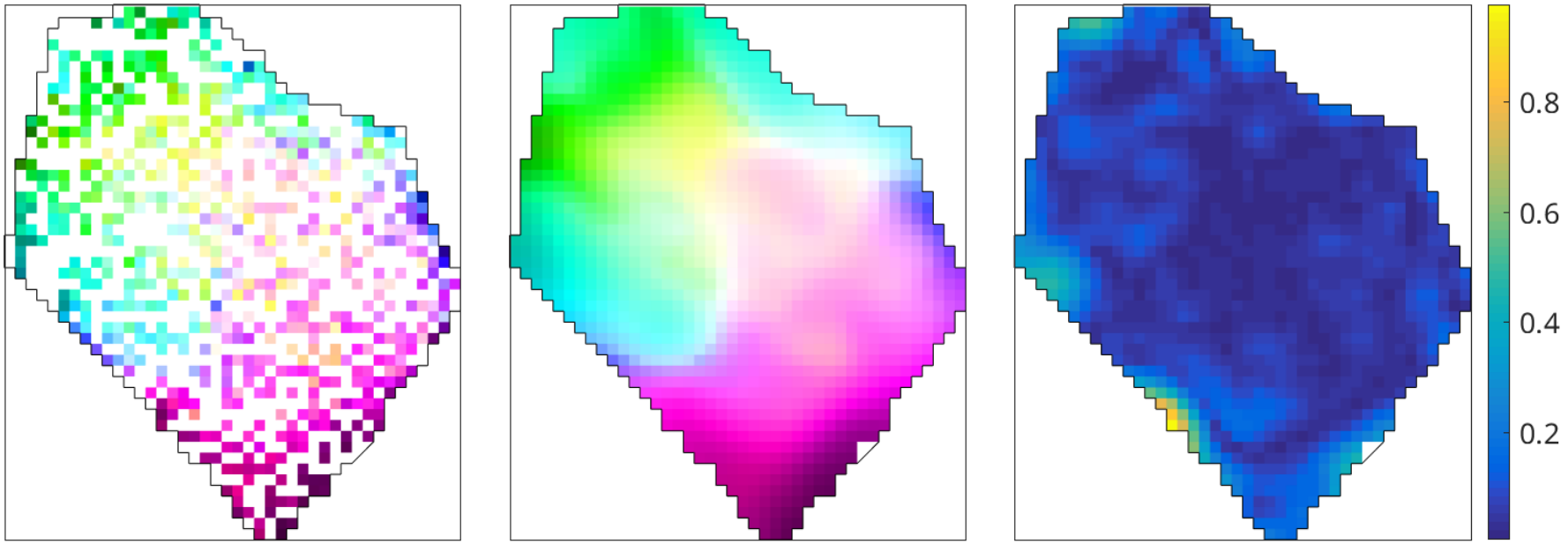

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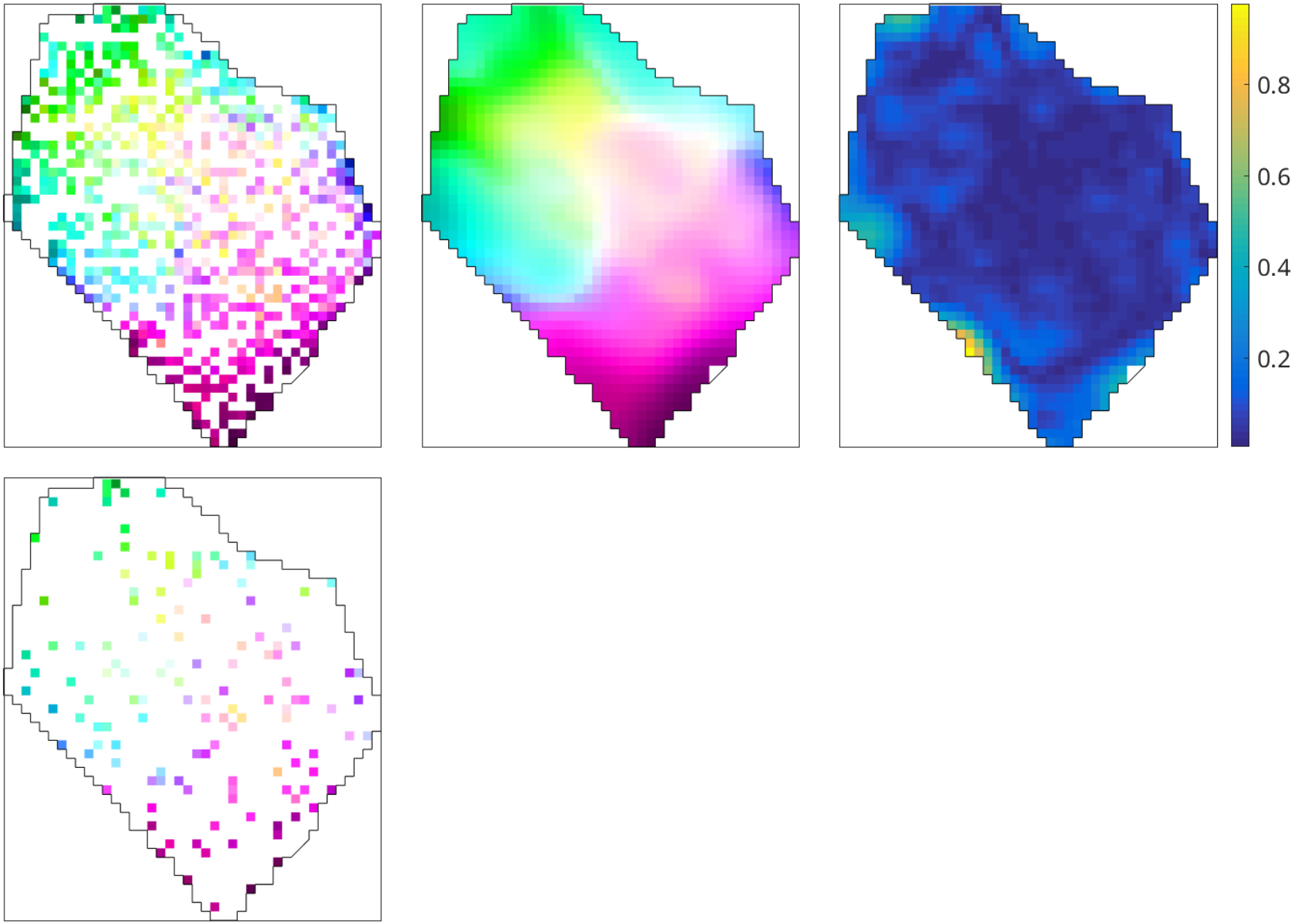

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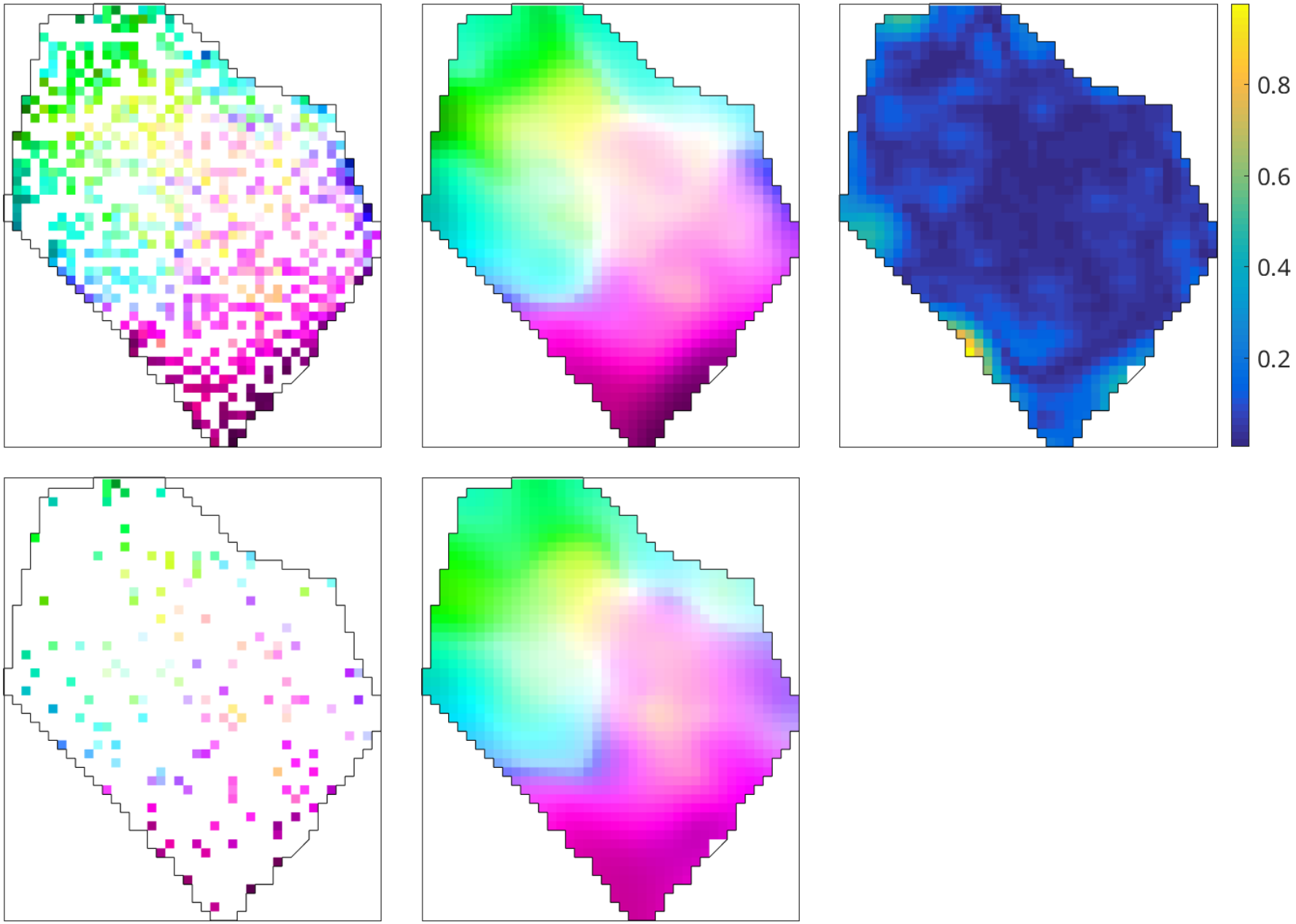

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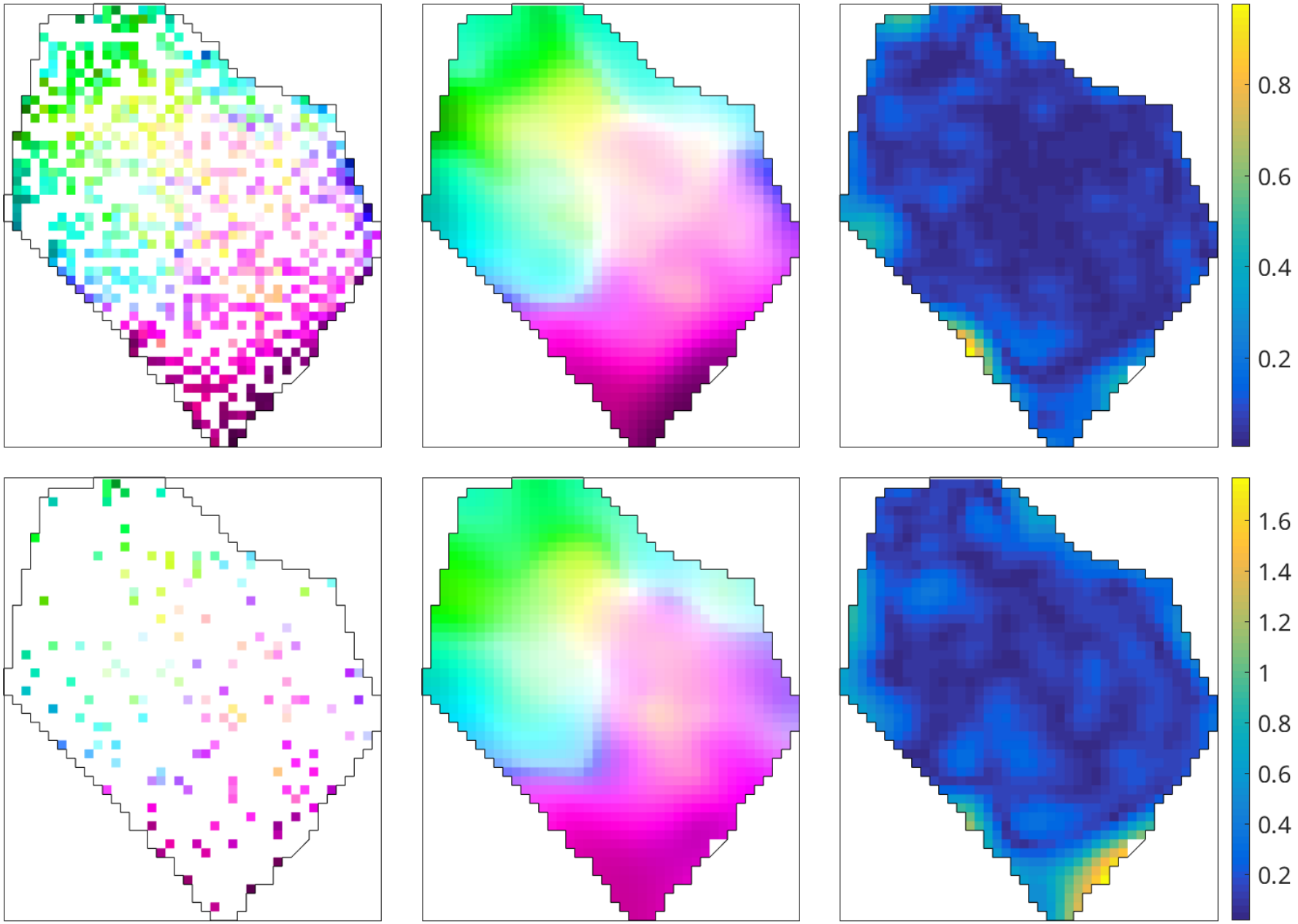
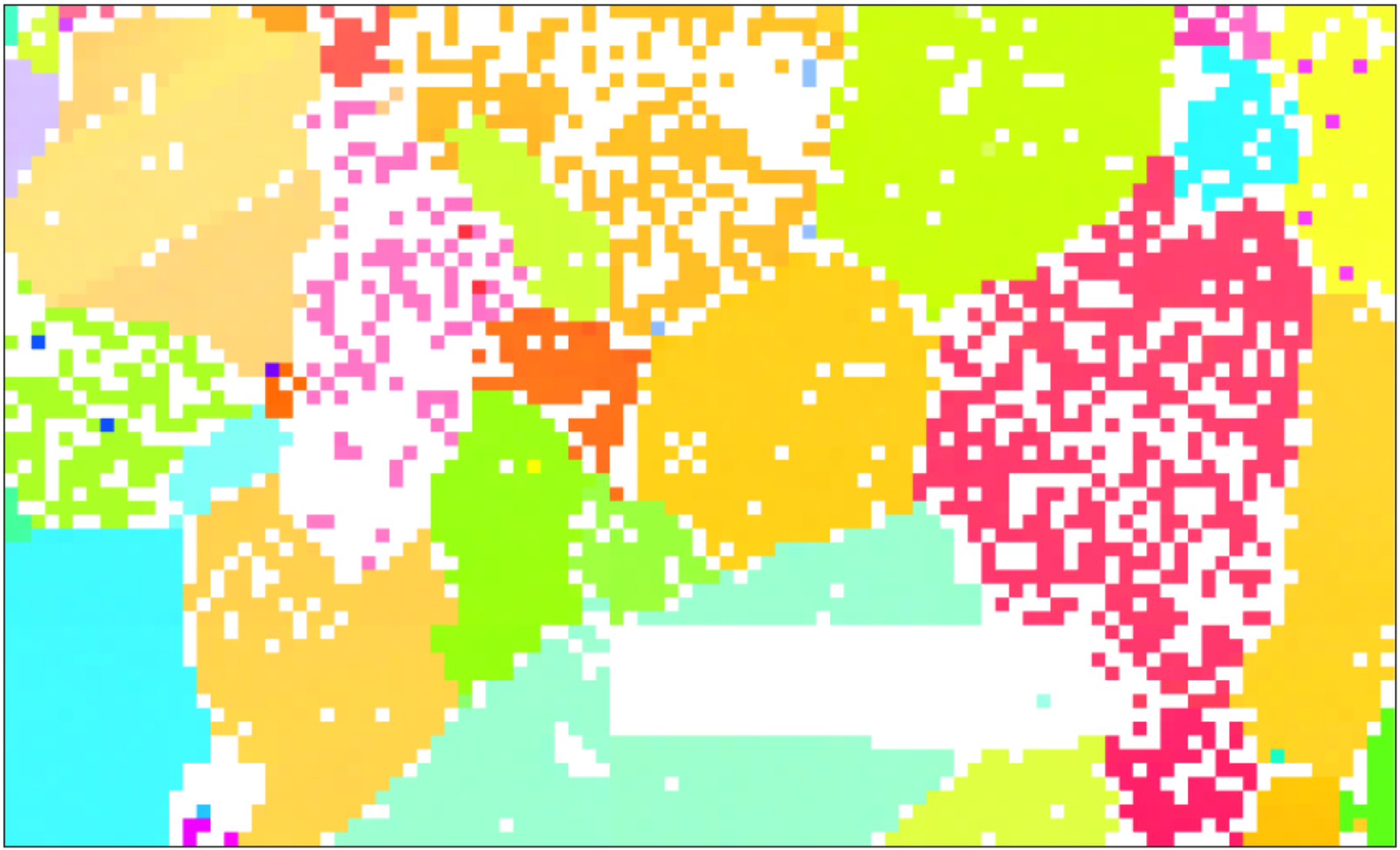


Grains from partly not indexed data



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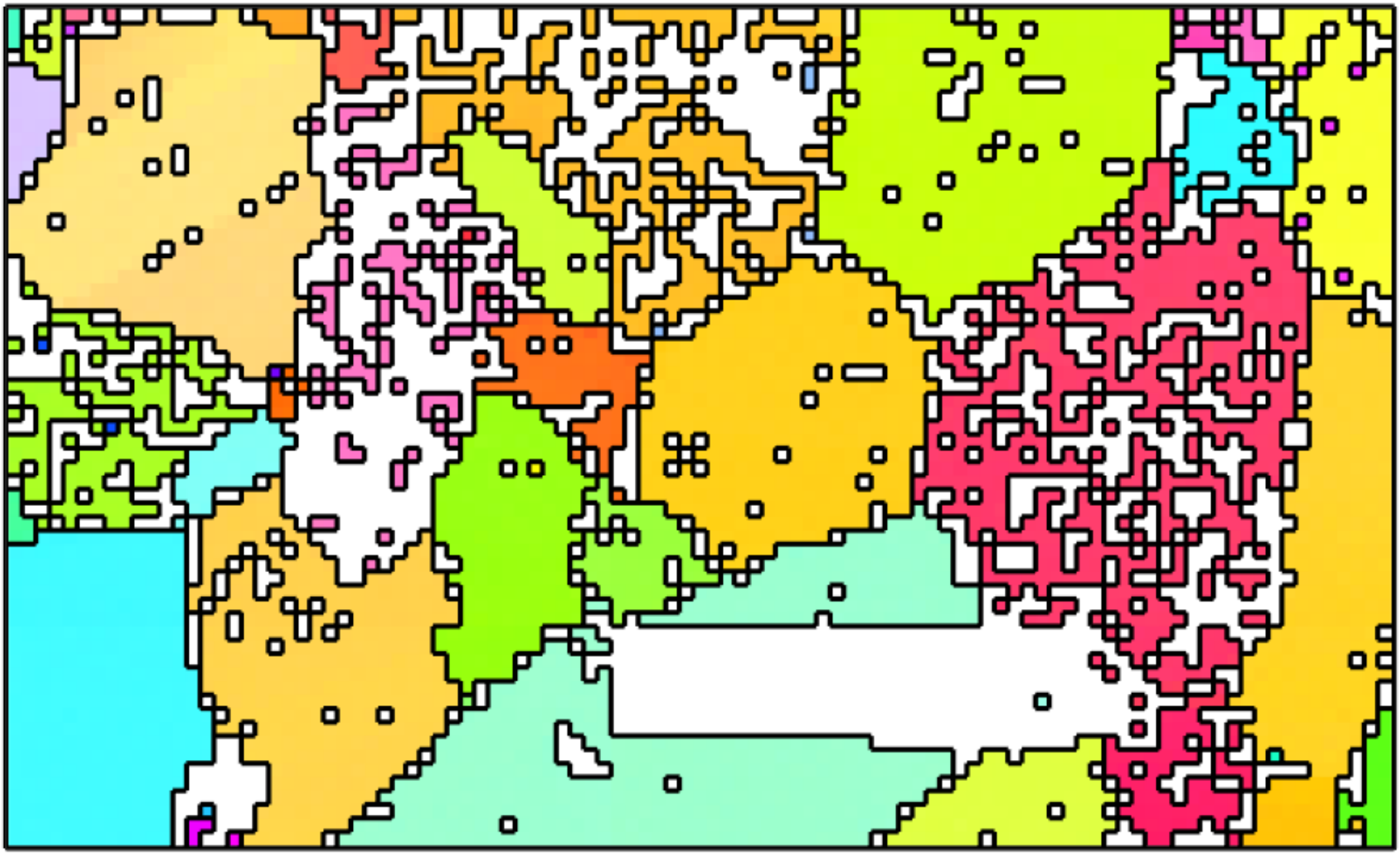

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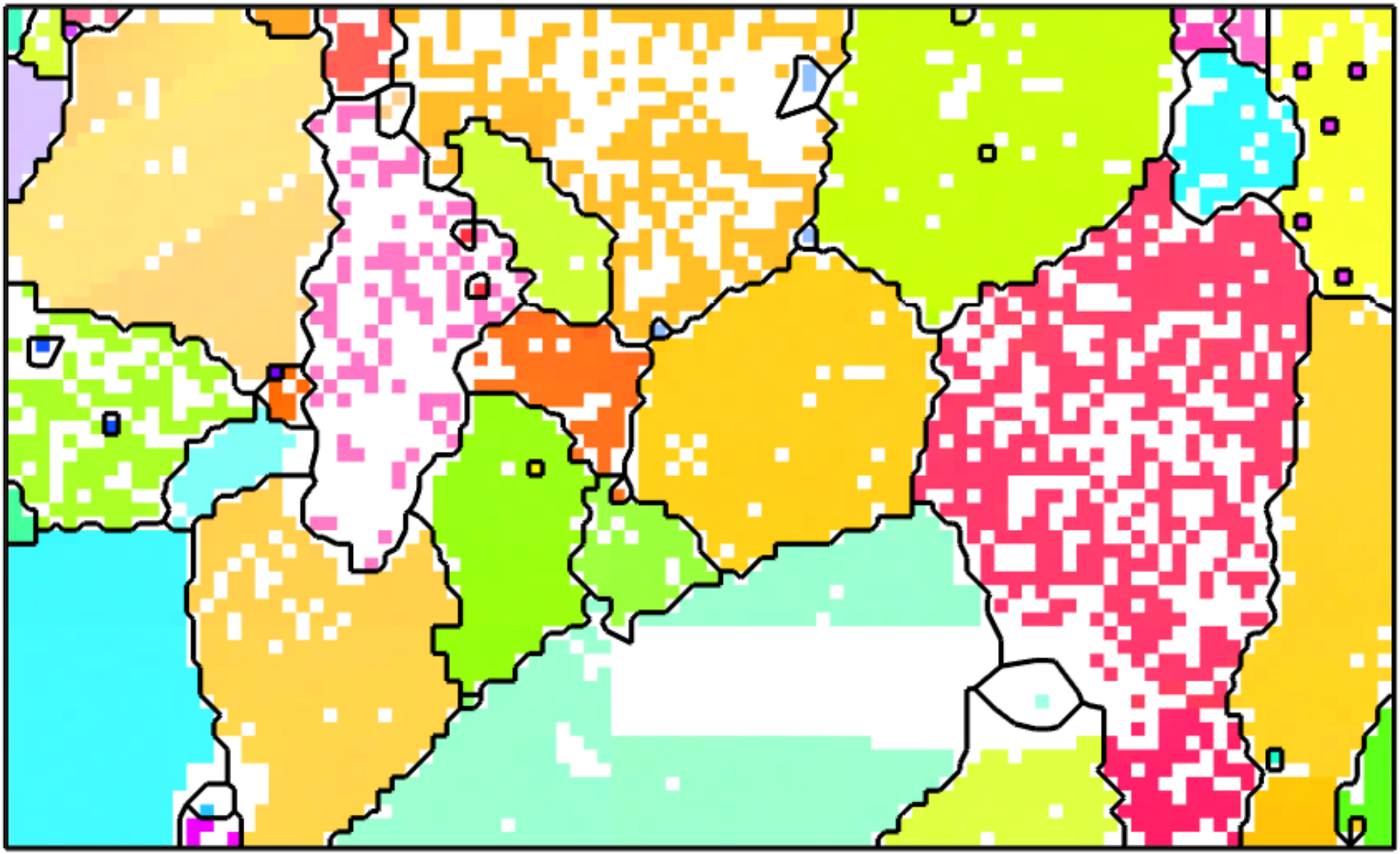

```
grains = calcGrains(ebsd('indexed'))
```

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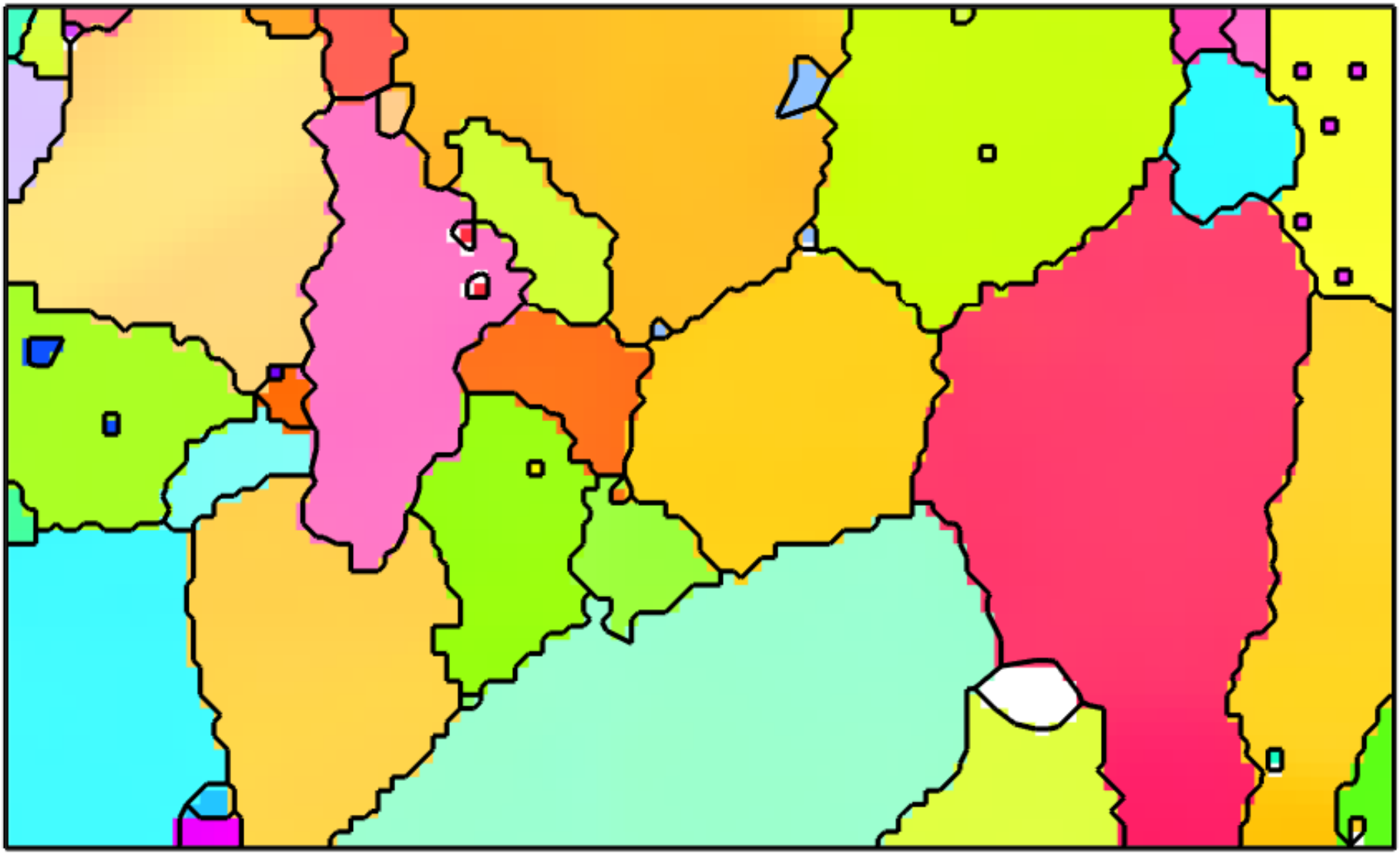

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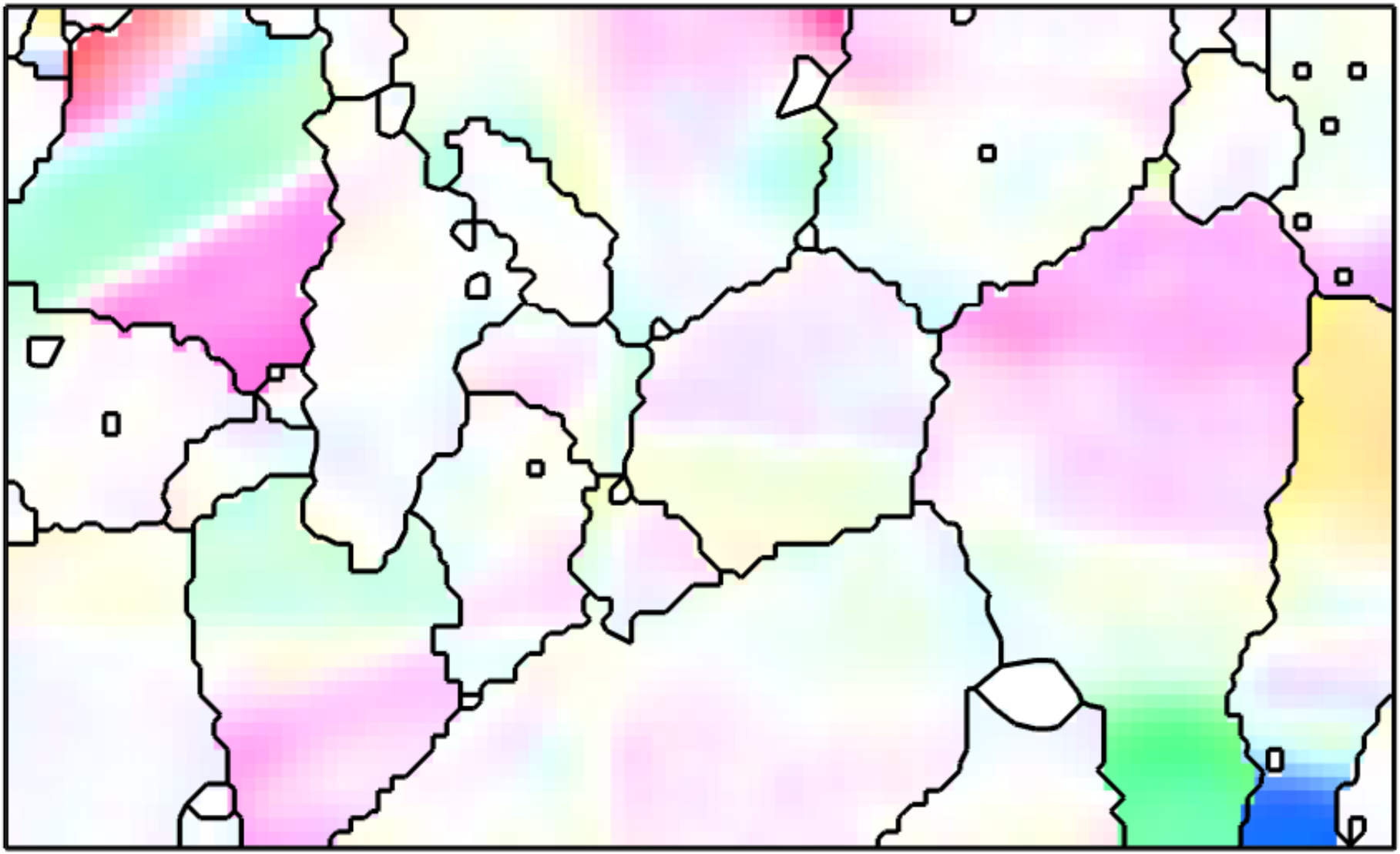
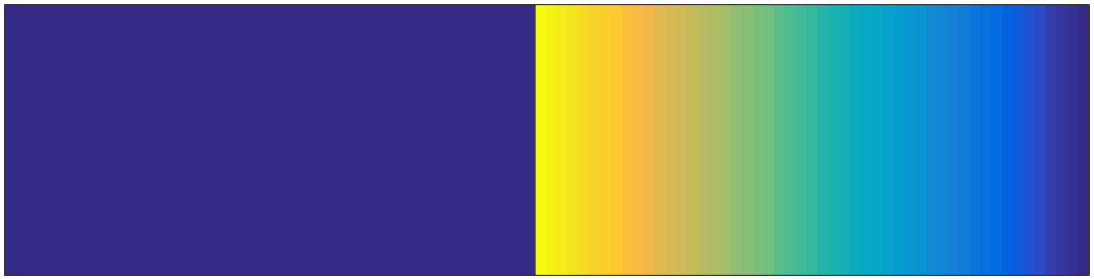


A synthetic example



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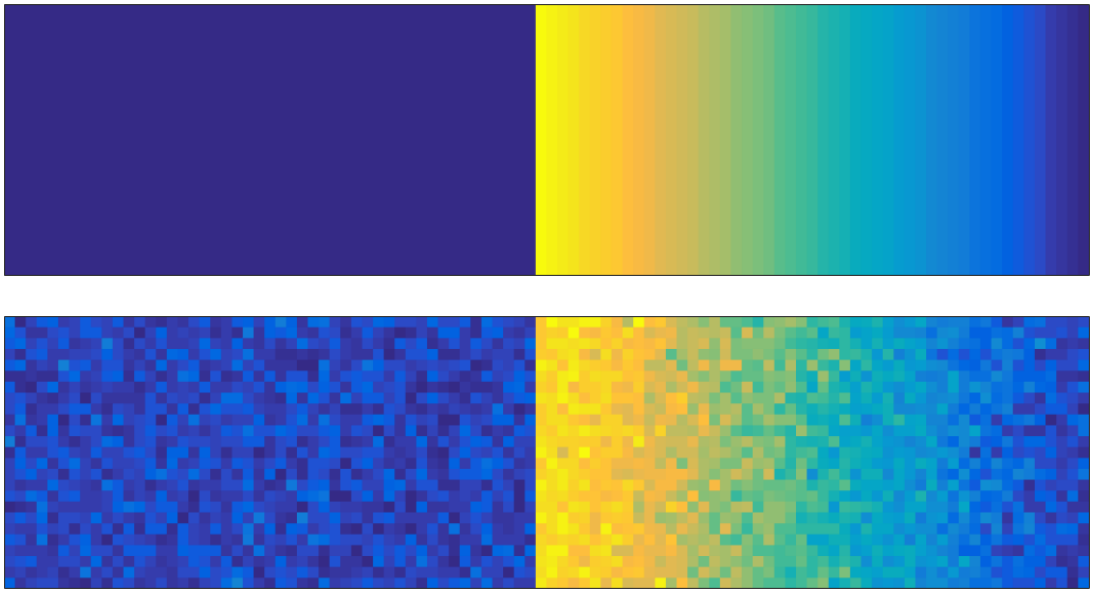

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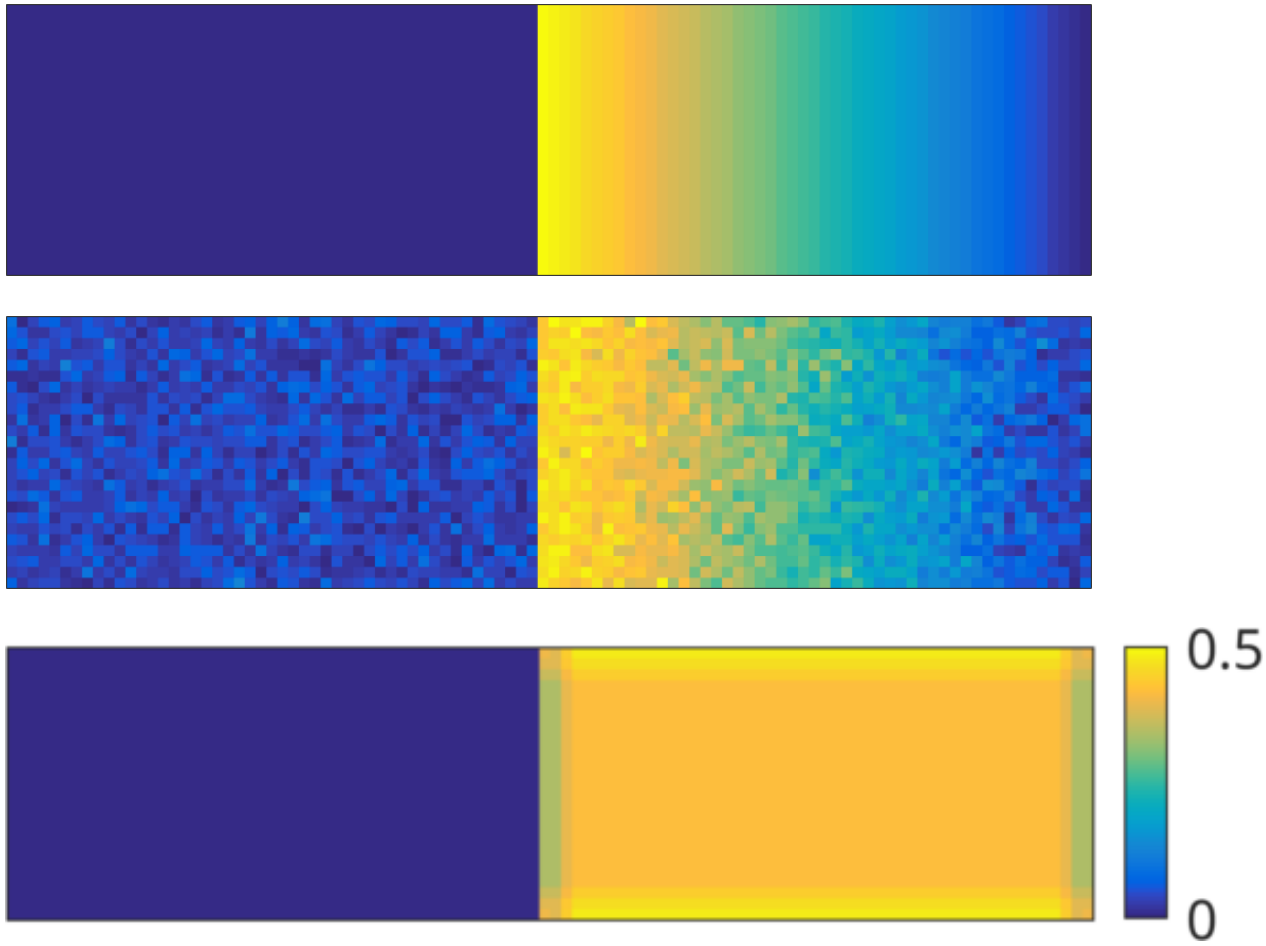

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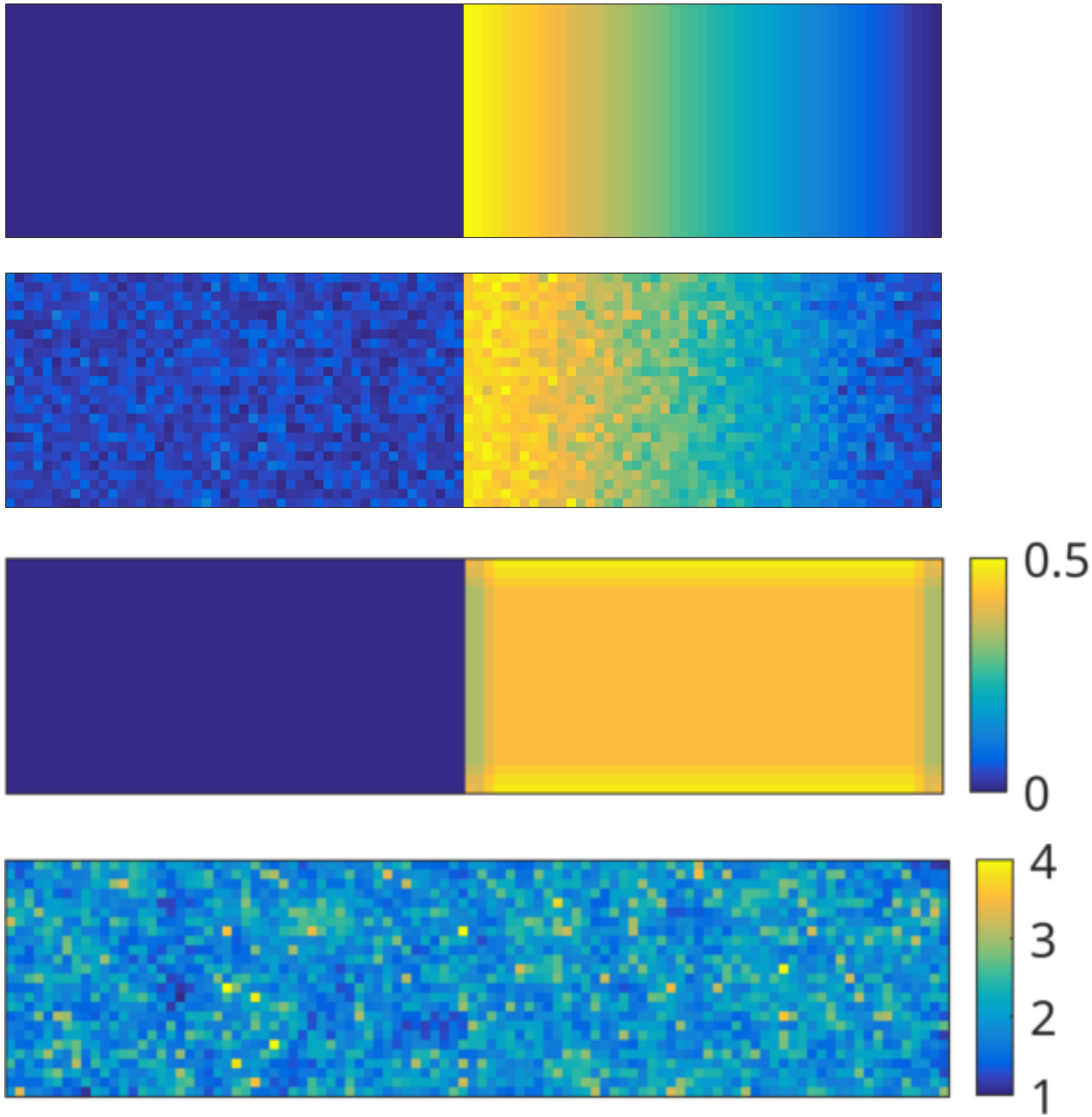
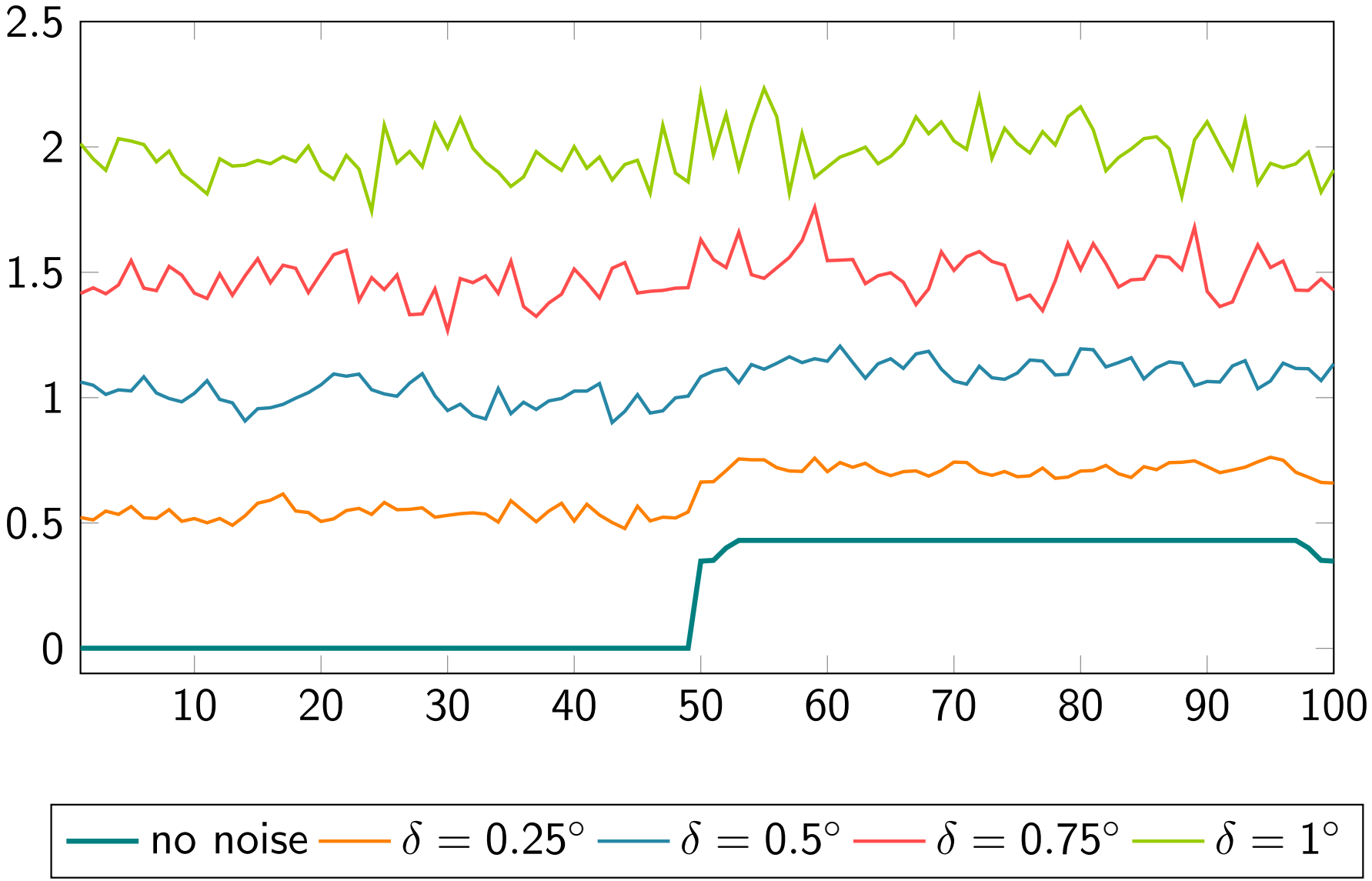
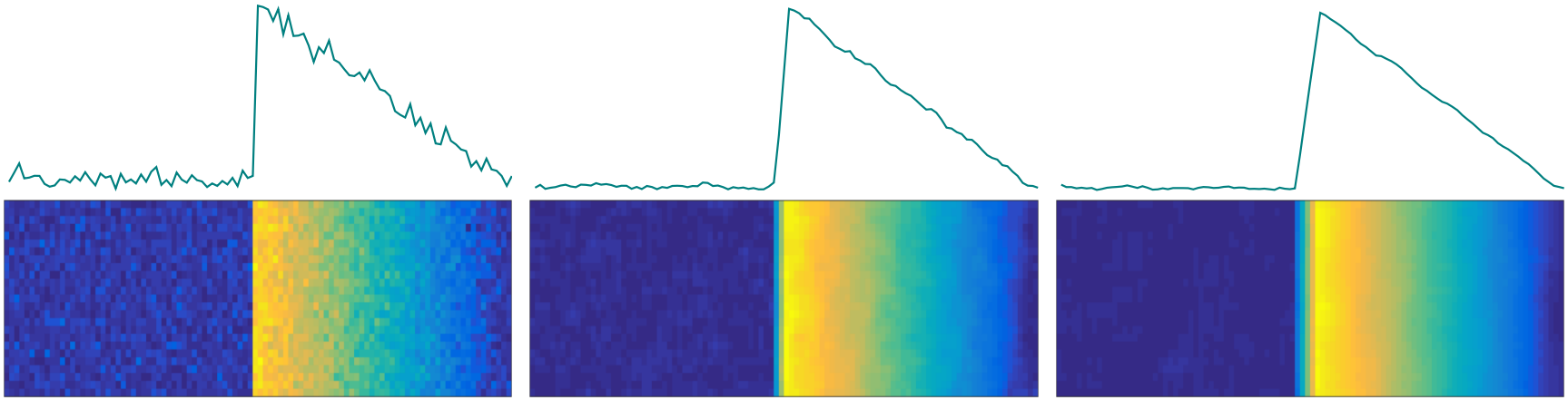


KAM


2.5
2
1.5
1
0.5
0
10
20
30
40
50
60
70
80
90
100
no noise
$\delta = 0.25°$
$\delta = 0.5°$
$\delta = 0.75°$
$\delta = 1°$

Basic Denoising Techniques



noisy data, mean filter: first and second neighbor

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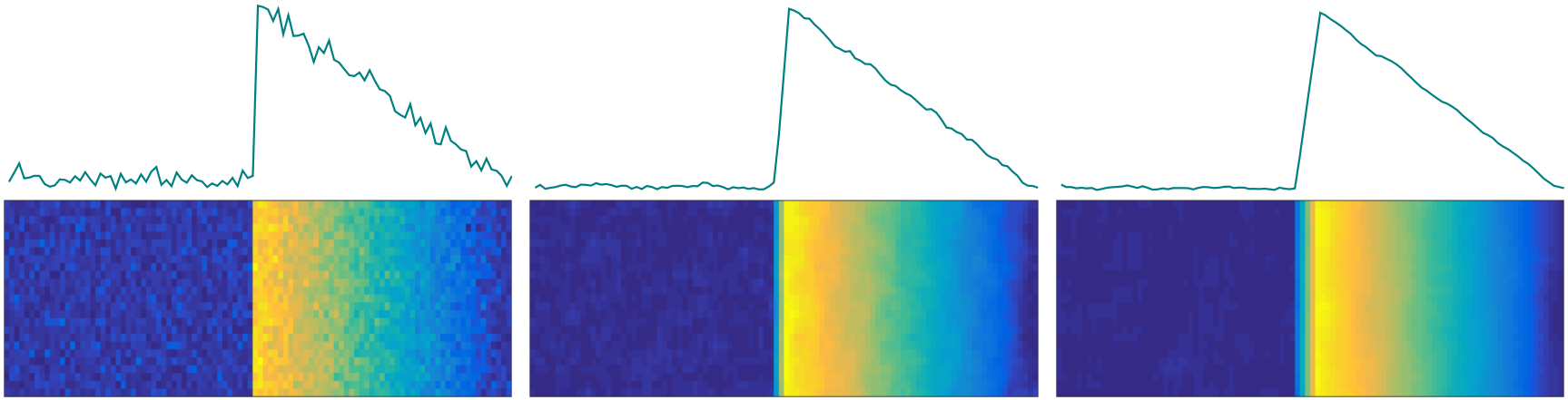

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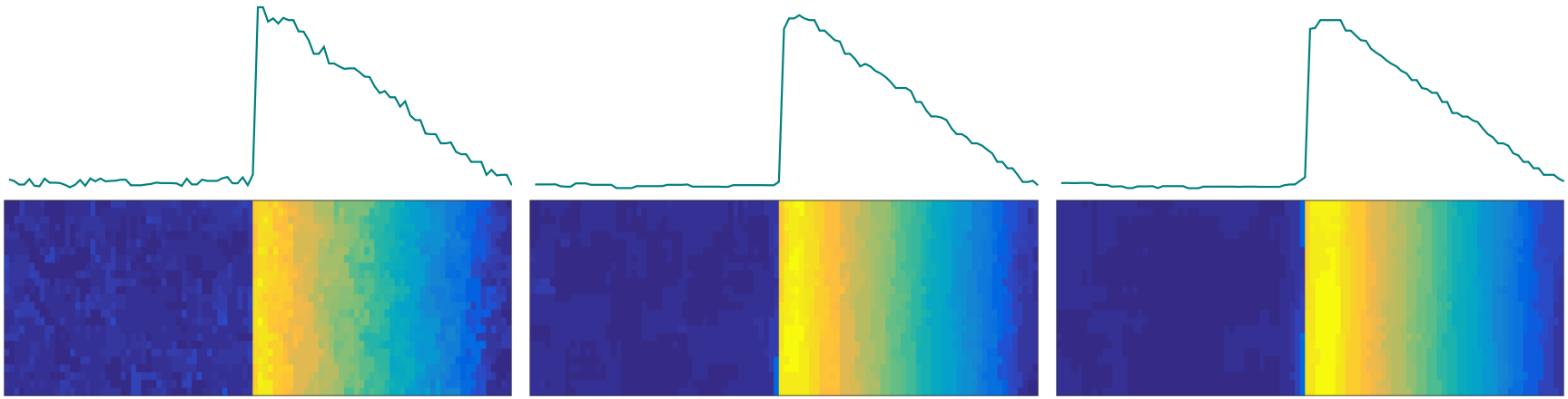
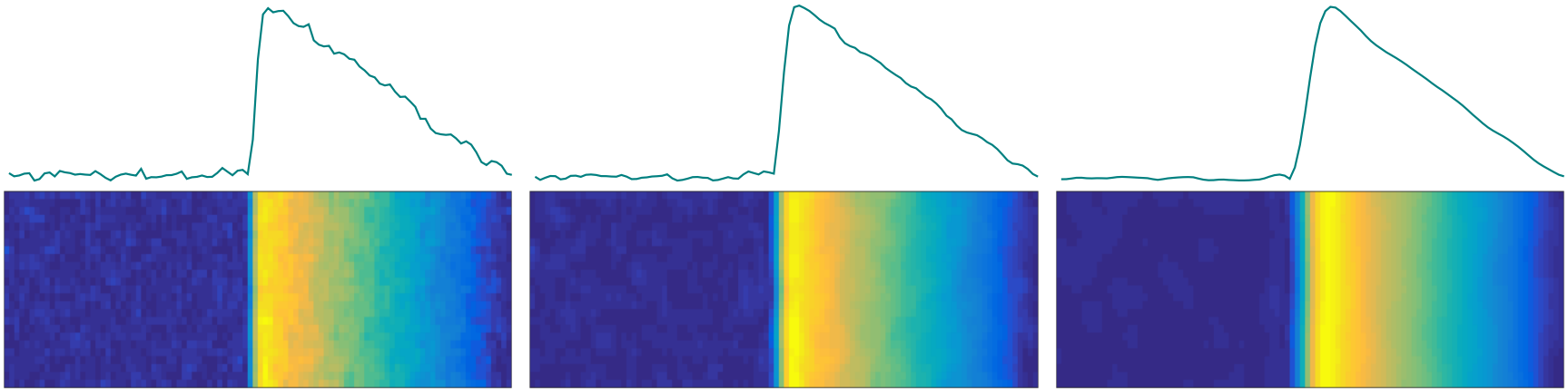


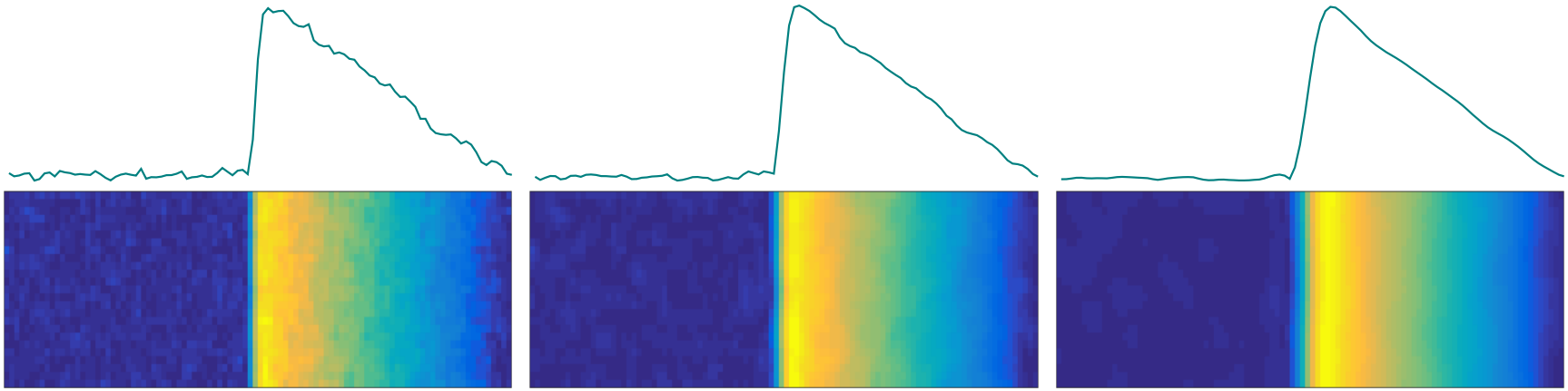
median filter: first, third, and fifth neighbor

Advanced Denoising Techniques

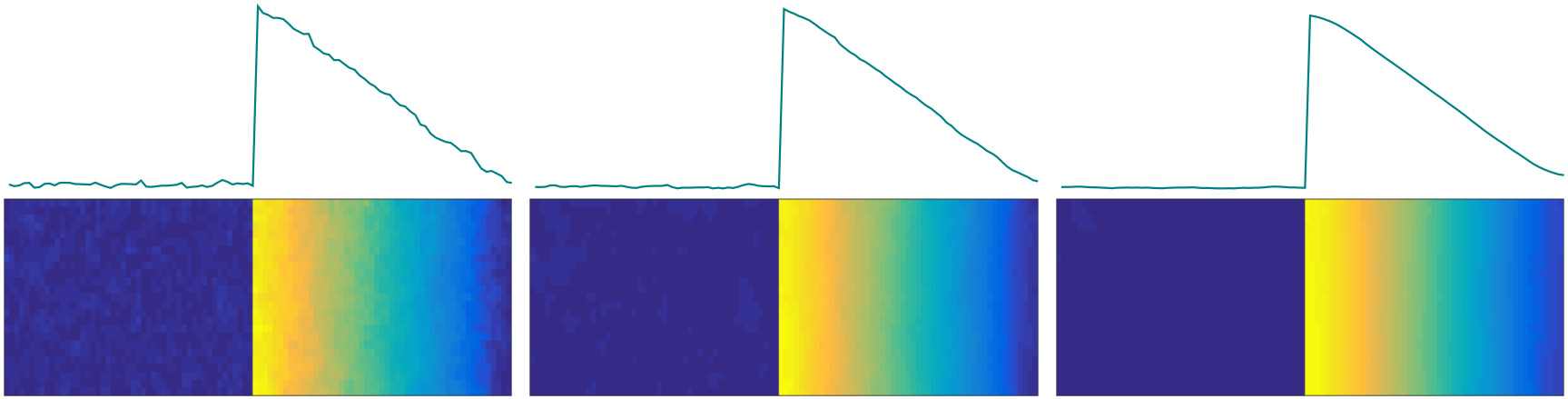


smoothing spline filter with $\alpha = 0.1$, $\alpha = 0.58$, and $\alpha = 5$

Advanced Denoising Techniques



smoothing spline filter with $\alpha = 0.1$, $\alpha = 0.58$, and $\alpha = 5$



half quadratic filter with $\alpha = 0.025$, $\alpha = 0.1$, and $\alpha = 0.5$

KAM of Denoised Data