MSc Earth Observation Challenge

Team Members -

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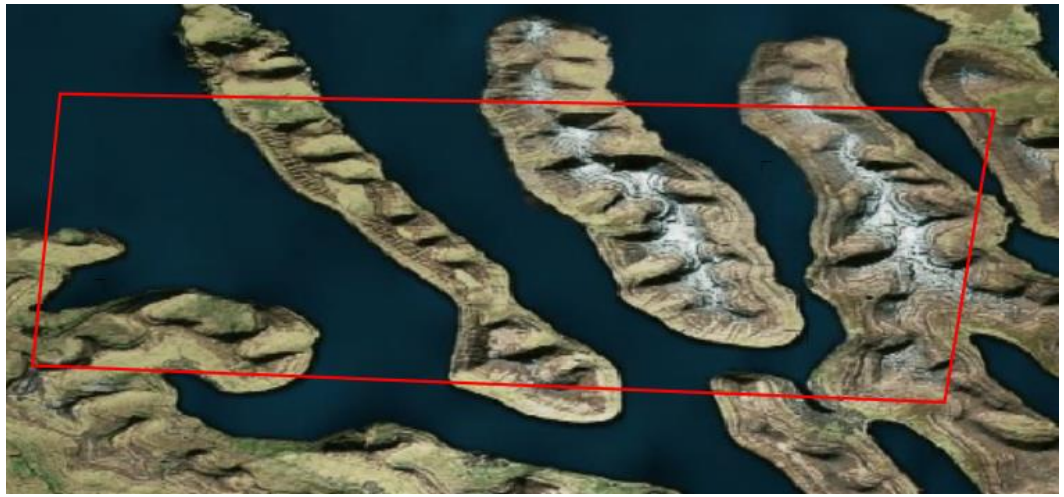
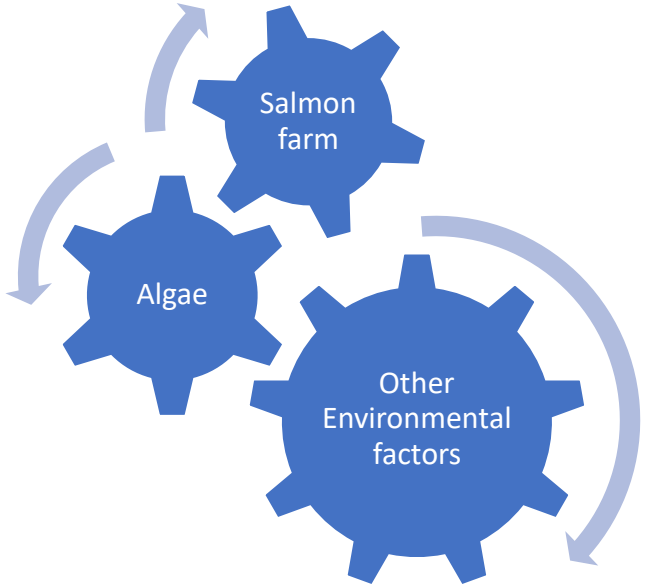
Farai Island – Point of interest



Stake Holders – Salmon Fish Farm

Football match analogy to Remote sensing



- **Cause**
  - Environment
  - Effect
- **Technology**
  - ML, AI
  - Physics constrain
- **Generality**
  - Different client
  - Data Source

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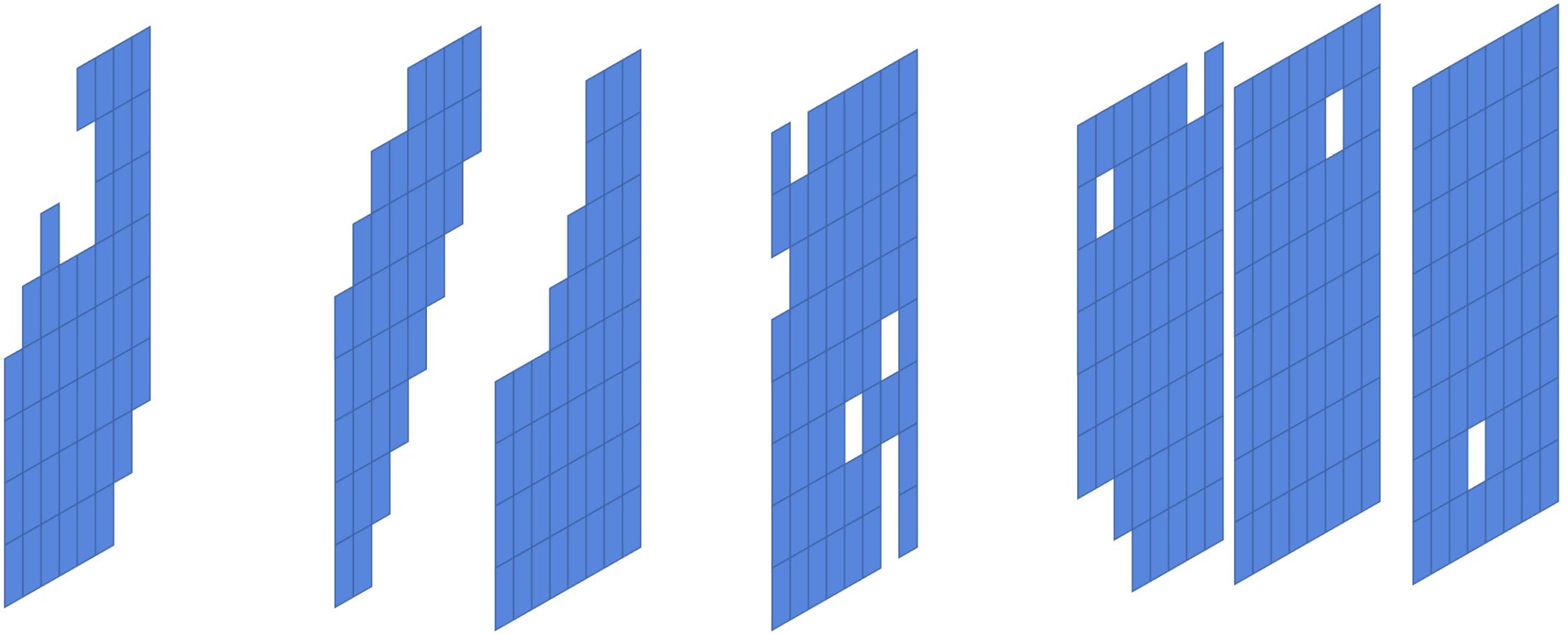

Satellite data depiction of Study Area

Each slide is a picture at different time

(Not to scale)

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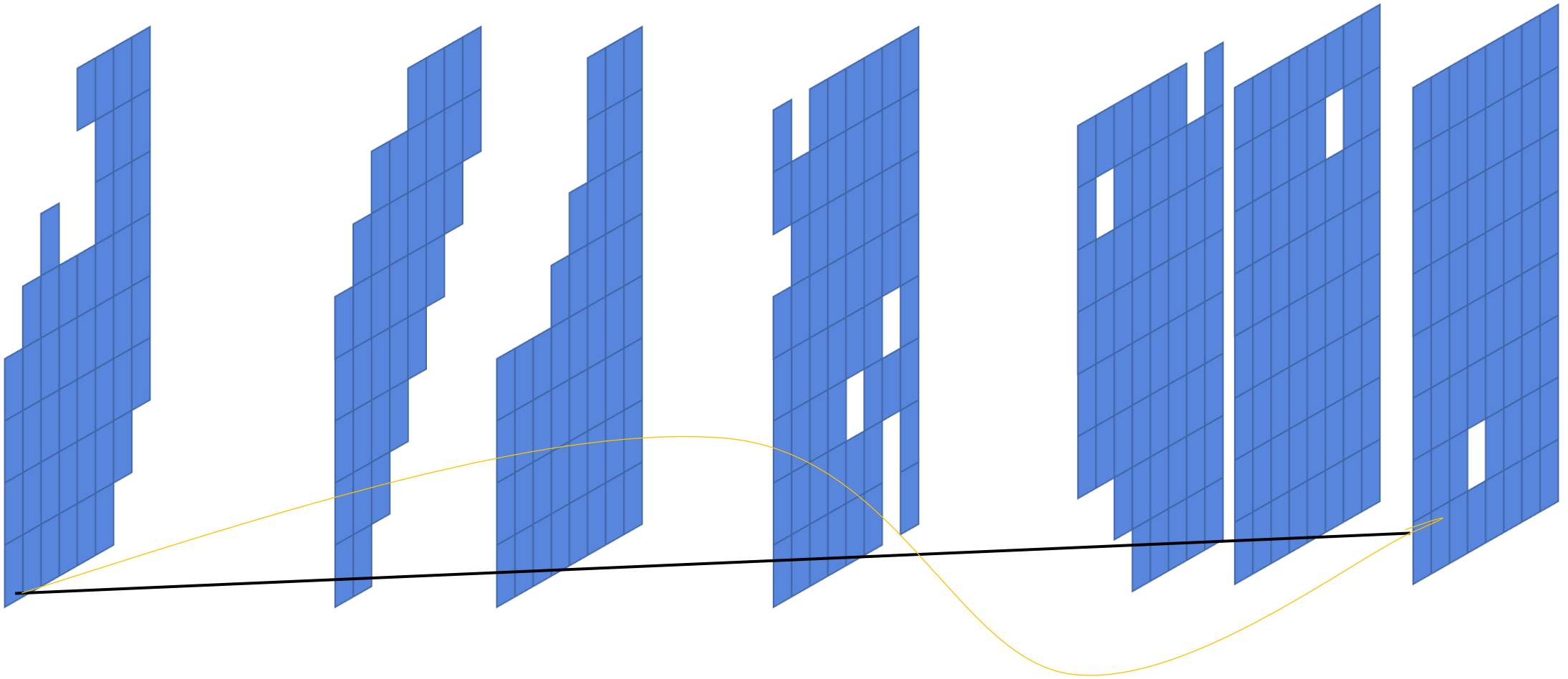
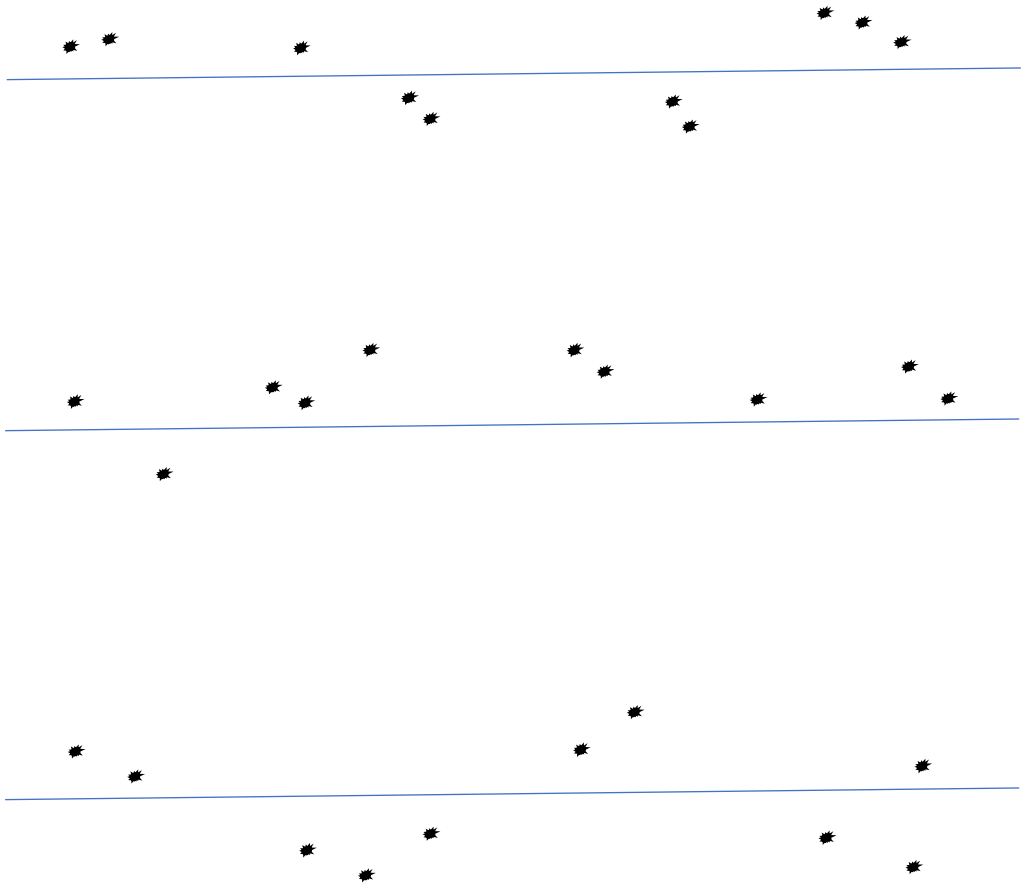


Pixel level Interpolation

Using Gaussian process regression for interpolation



```
In [12]:
x_values = np.array([0, 0.3, 1, 3.1, 4.7,9.1])

y_values = np.array([1, 0, 1.4, 0, -1.2,1.7])
```

```
In [13]:
model = GPR(x_values, y_values)
```

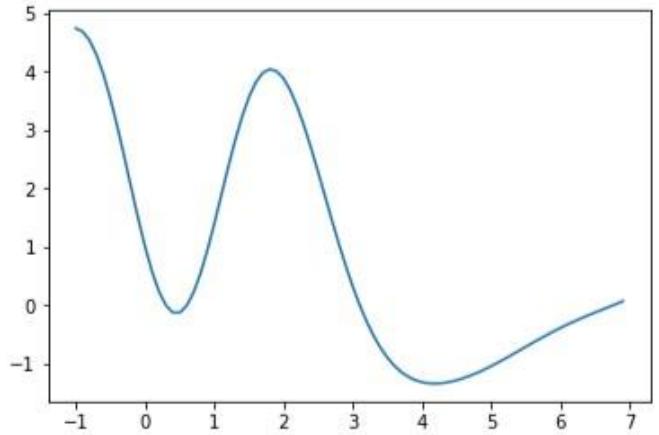
```
In [14]:
x = np.arange(-1,7,0.1)
```

```
In [15]:
mean = model.predict(x)
```

```
In [17]:
import matplotlib.pyplot as plt
```

```
In [18]:
plt.plot(x,mean)
```

```
Out[18]: [<matplotlib.lines.Line2D at 0x1f1f07bd1c8>]
```



- Respect physics as opposed to any cheap interpolation

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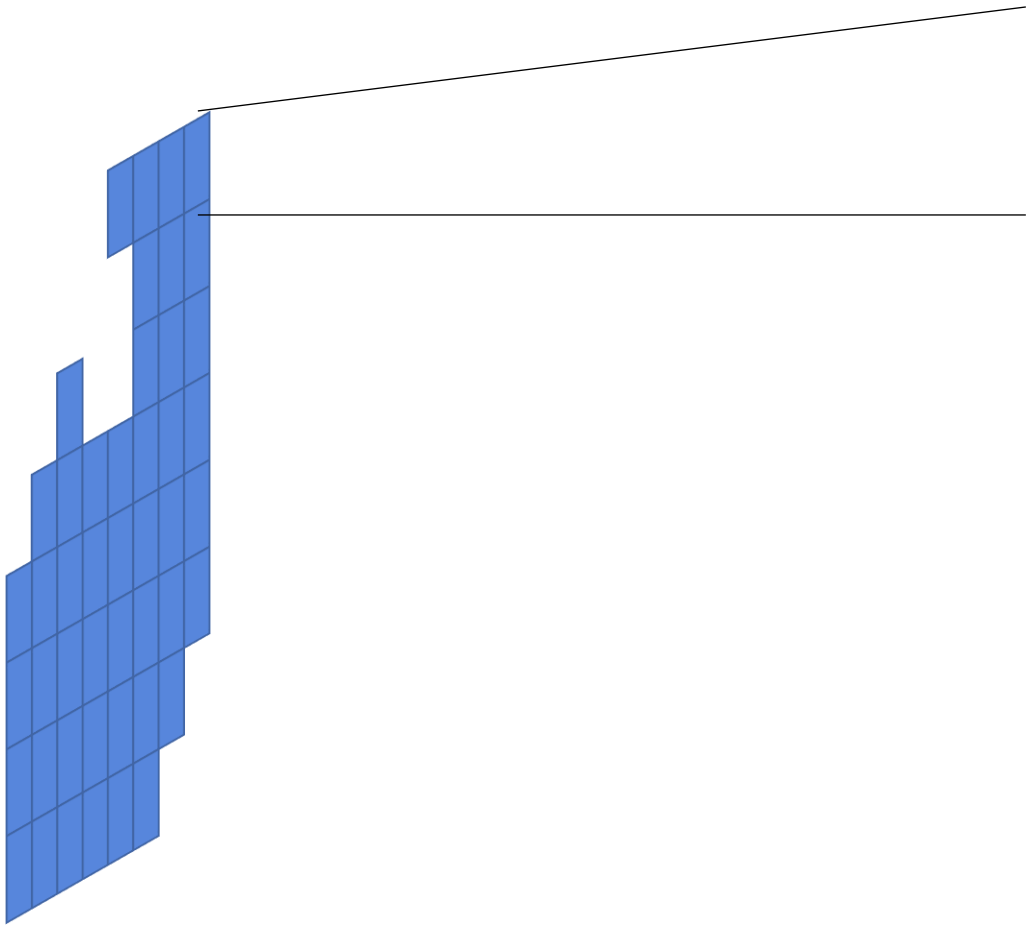
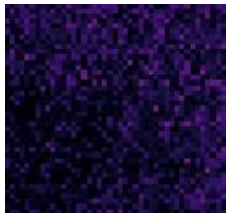
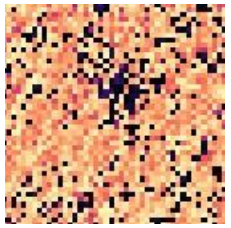
Regression on global pixel level to avoid noise at smaller Resolutions



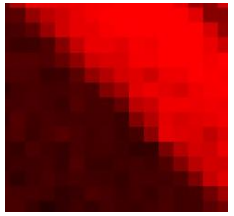
UPSCALE FUNCTION



Average

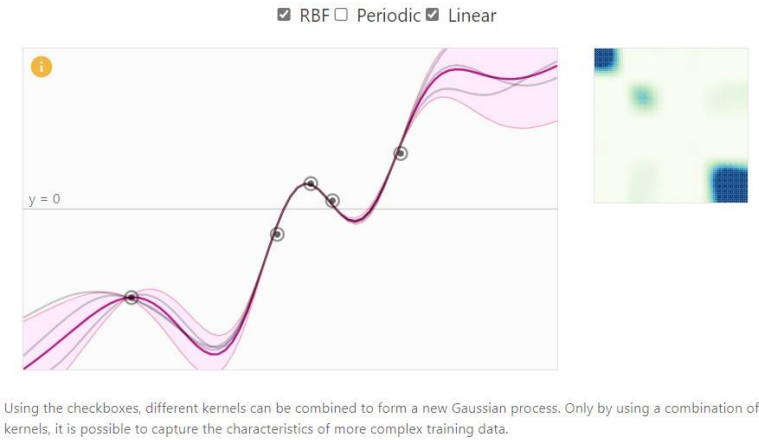


Entropy



Edge Length

INTERPRETATION OF GPR RESULTS



Noise variance Off

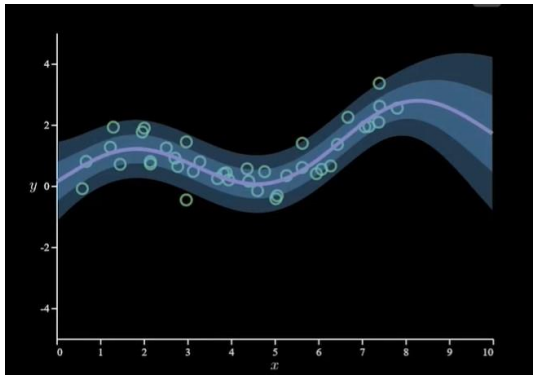
$$\begin{bmatrix} f \\ f_* \end{bmatrix} \sim N(\mu, \Sigma) = N\left(0, \begin{bmatrix} K(x,x) & K(x,x_*) \\ K(x_*,x) & K(x_*,x_*) \end{bmatrix}\right)$$

Gives confidence level on predicted frames

$$\begin{bmatrix} f \\ f_* \end{bmatrix} \sim N(\mu, \Sigma) = N\left(0, \begin{bmatrix} K(x,x) + \sigma_n^2 I & K(x,x_*) \\ K(x_*,x) & K(x_*,x_*) \end{bmatrix}\right)$$

Deals with Noise in data observed quite well

Noise variance on



- It is called gaussian process because it associate gaussian distribution at each time resolution.
- Kernel of the interpolation algorithm can be trained and validated on any similar geographic area.

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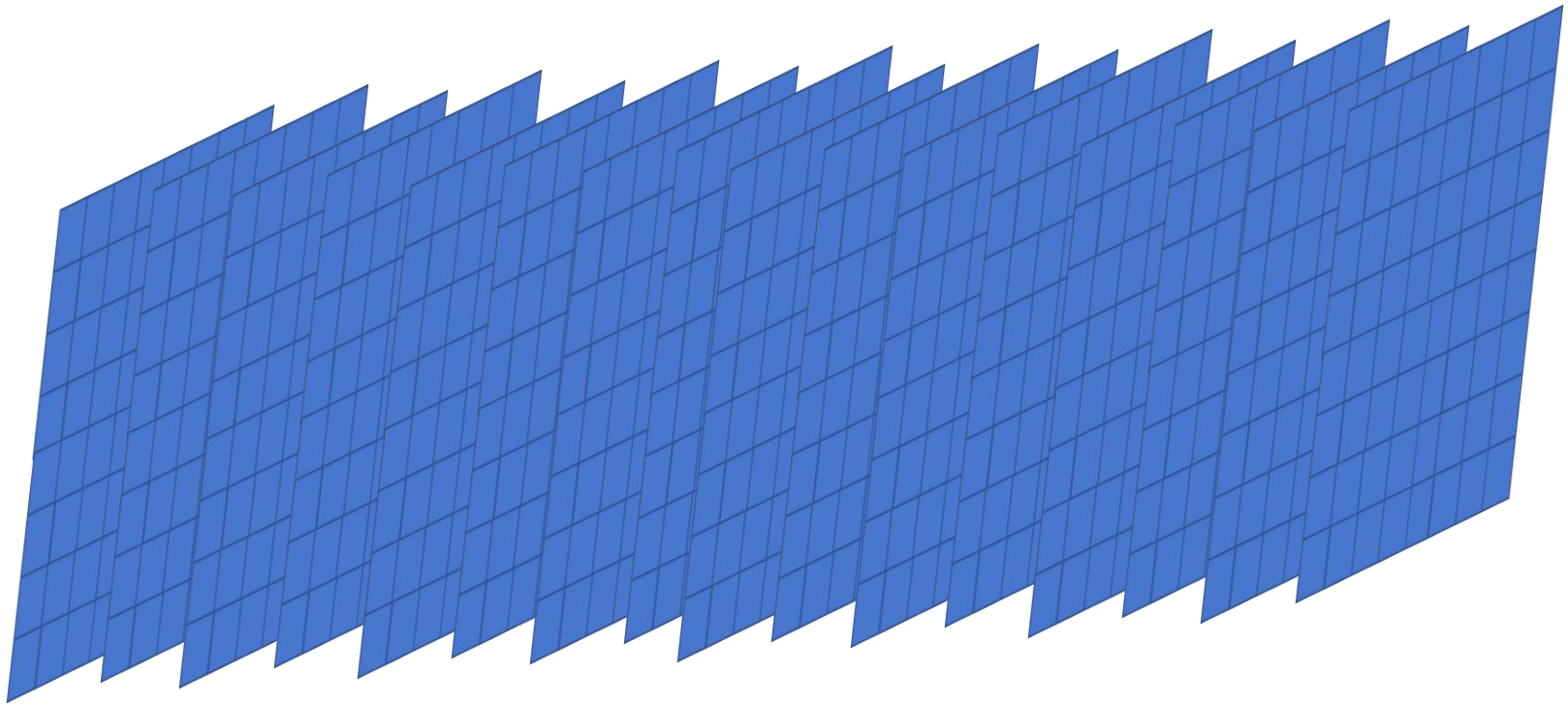
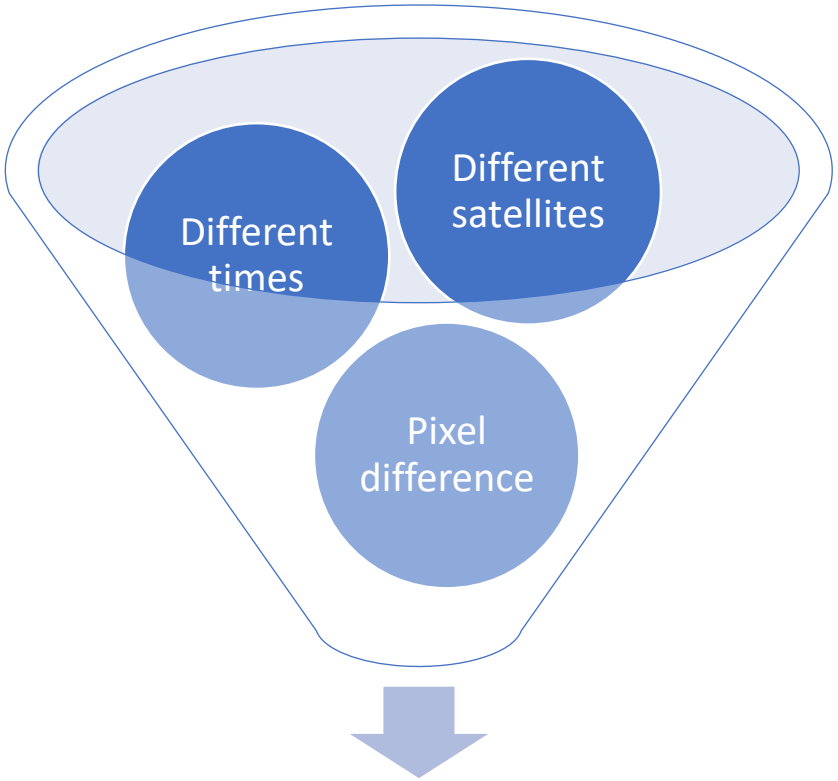
Final result will have High temporal resolution but lower special resolution, yet complete frames



- Drift of target can be calculated by divergence of scalar field in time.
- Resulting frames can be verified by usual train test split comparing metric “MSE”

ALGORITHM

1. CHOOSE THE INDEX
2. GIVE GLOBAL PIXEL
3. CHOOSE UPSCALE FUNCTION
4. EXECUTE GAUSSIAN PROCESS REGRESSION
5. OPTIMIZE KERNEL
6. RECOVER HIGH-RES TIME RESULTS



One Algorithm

INDEX WE FOUND HELPFUL

$$MCI = \frac{\left(\left(\frac{B4}{B3}\right) - 1\right)}{\left(\left(\frac{B4}{B3}\right) + 1.4\right)}$$

$$NEW = \frac{\left(\frac{B3 - B1}{B3 + B1}\right)}{\left(\frac{B3 - B2}{B3 + B2}\right)}$$

$$SSC = \left(\frac{B4}{B8}\right)^2$$

$$TI = \frac{(B3 - B4)}{(B3 + B4)}$$

$$SSD = \left[\frac{2.5}{\ln\left(\frac{B2 + B3}{2}\right) - \ln B1}\right] * \left[\frac{B1}{(B2 + B3)}\right]$$

$$SWIR = \frac{(B12 - B8A)}{(B12 + B8A)}$$

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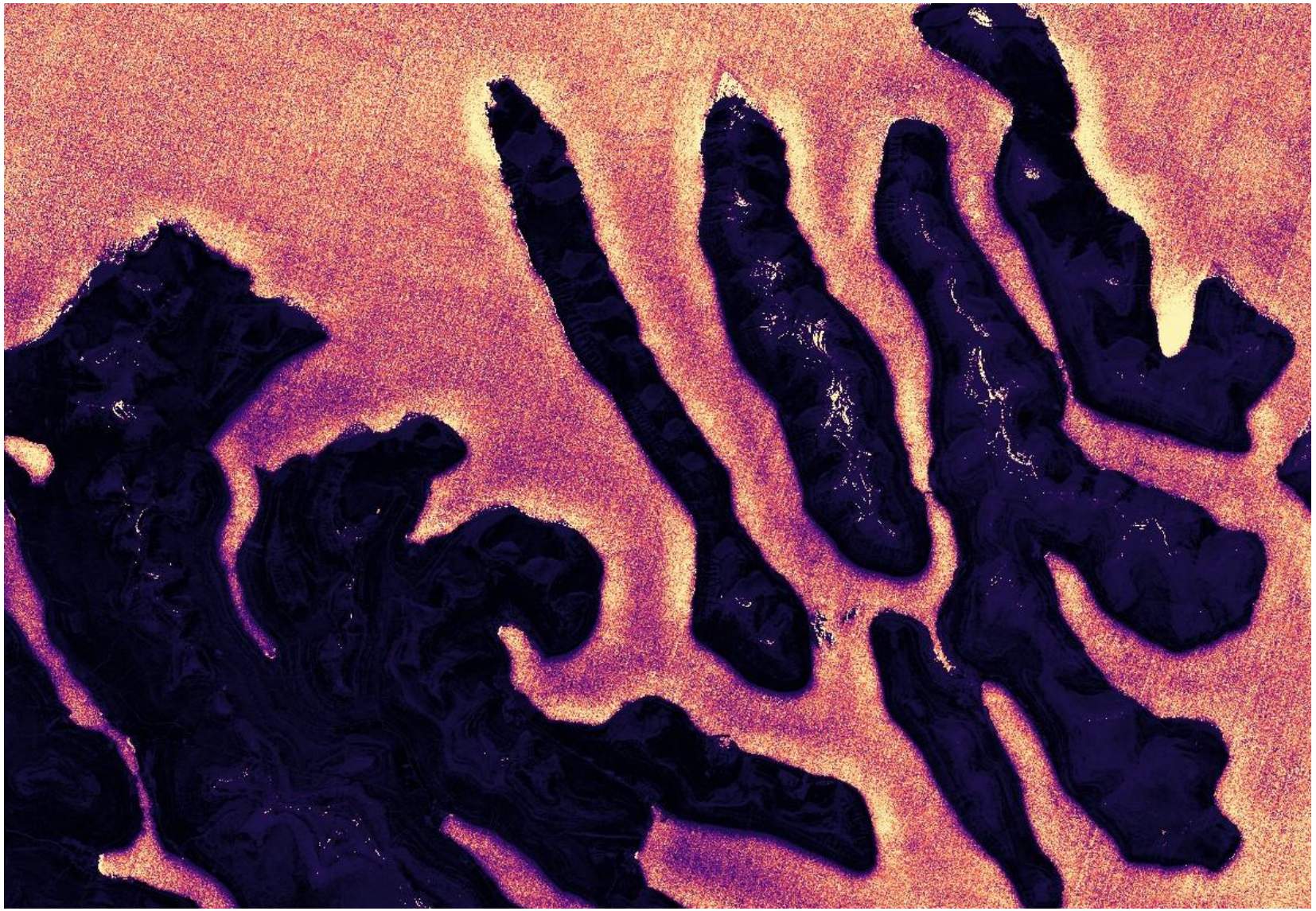
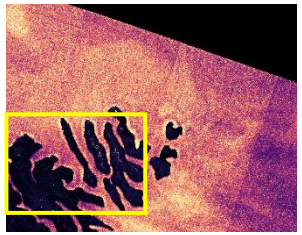


Sedimentation Index

- Significantly dull near salmon farms
- Higher near cost
- Even higher near concave Cost



SSC

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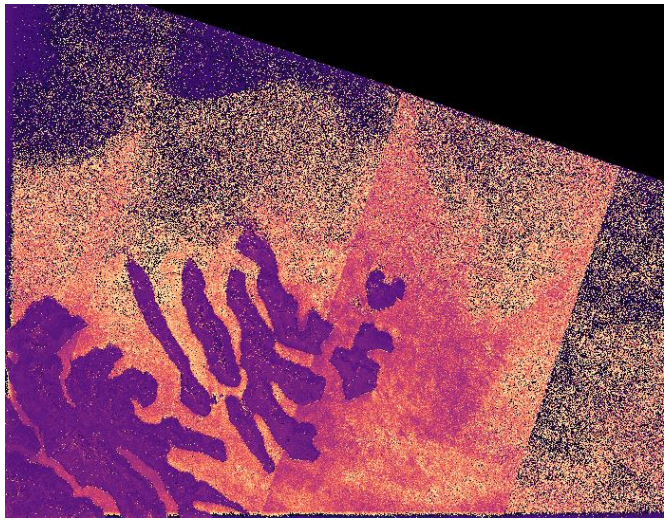
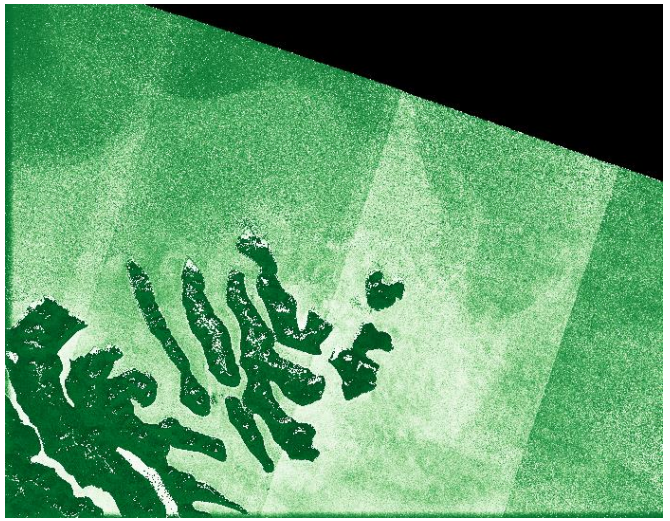
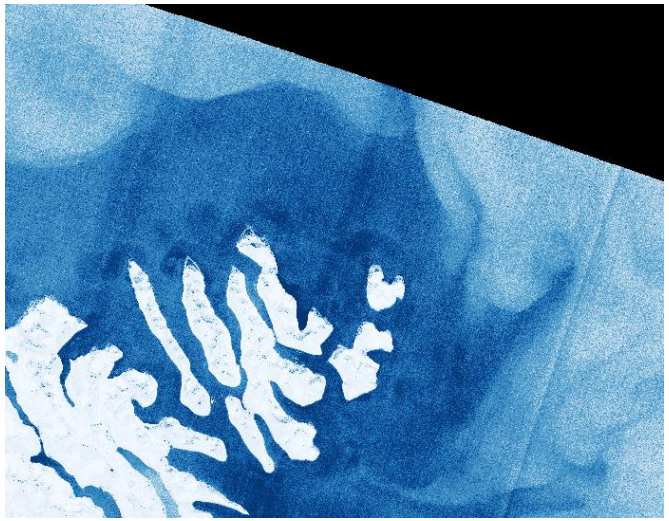
Images rendered on QGIS, using 52 categorical colour's classification



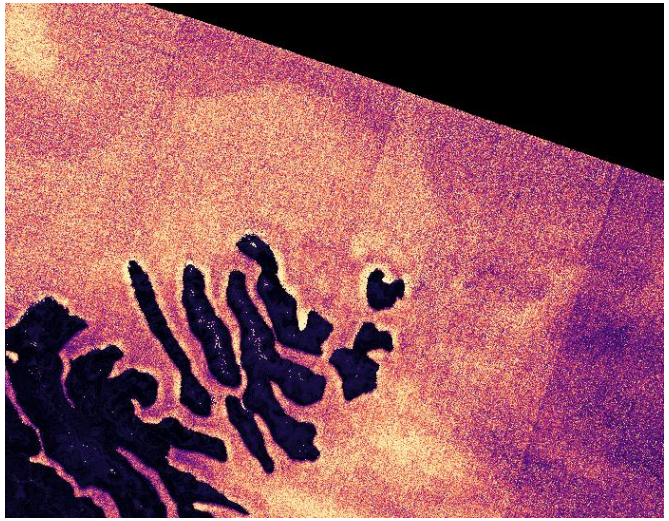
SWIR



NEW



TI



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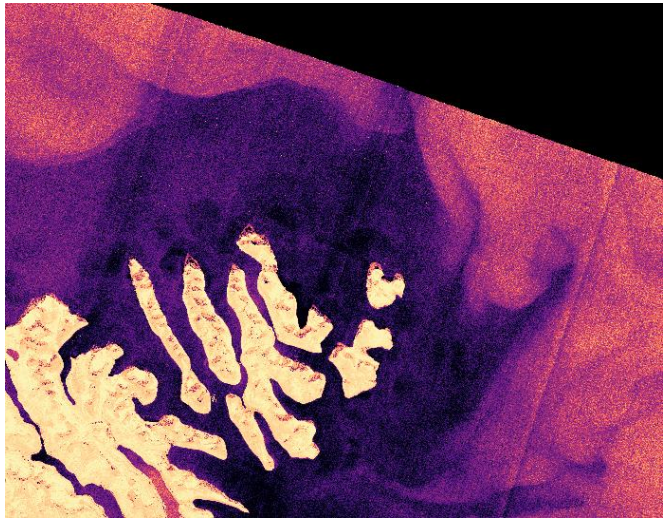
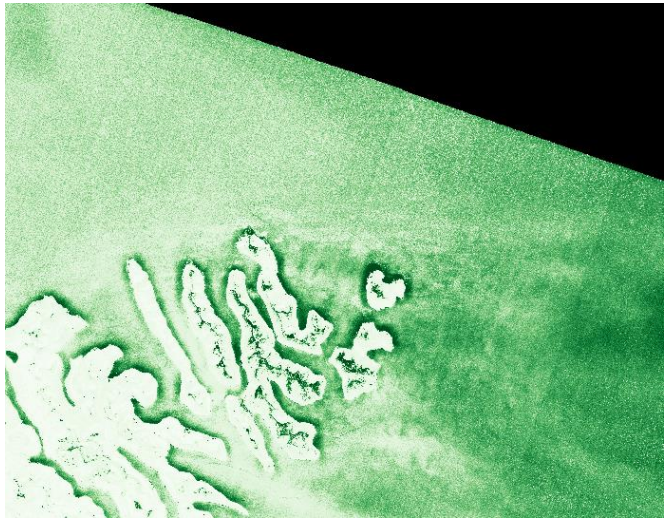


MCI



SSD

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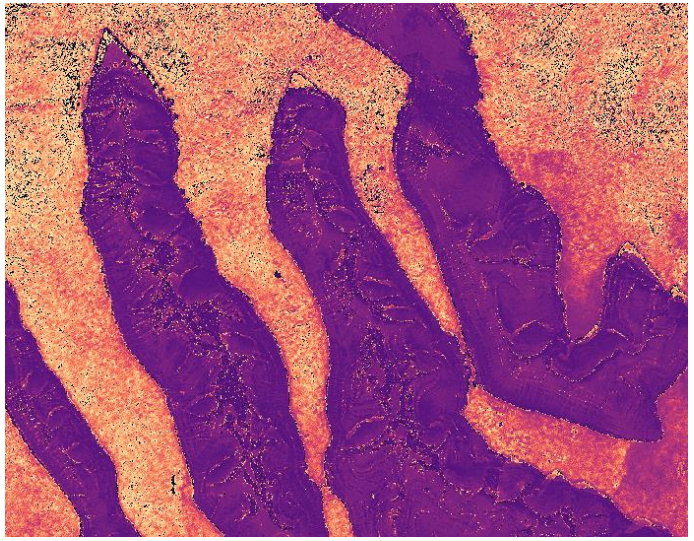

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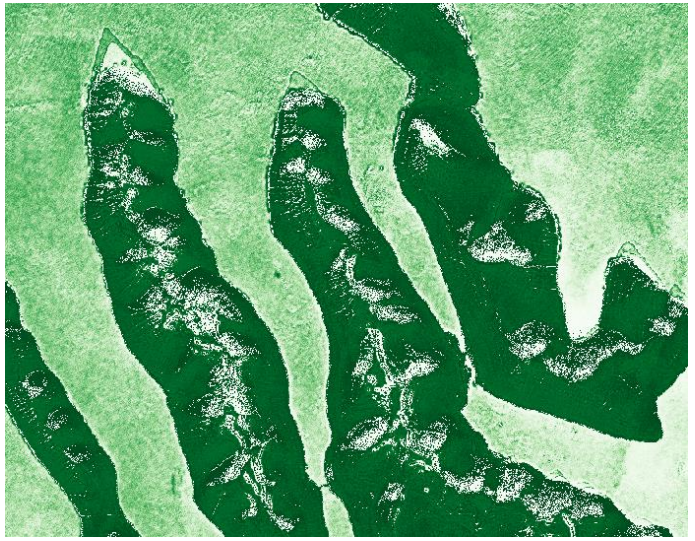

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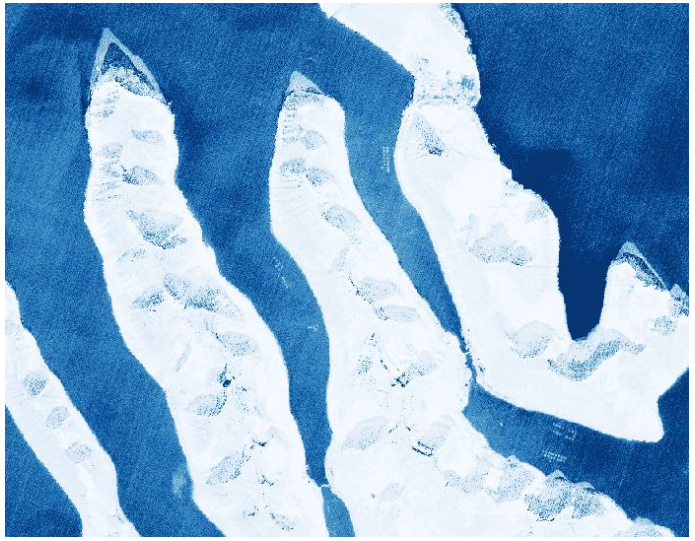

TI

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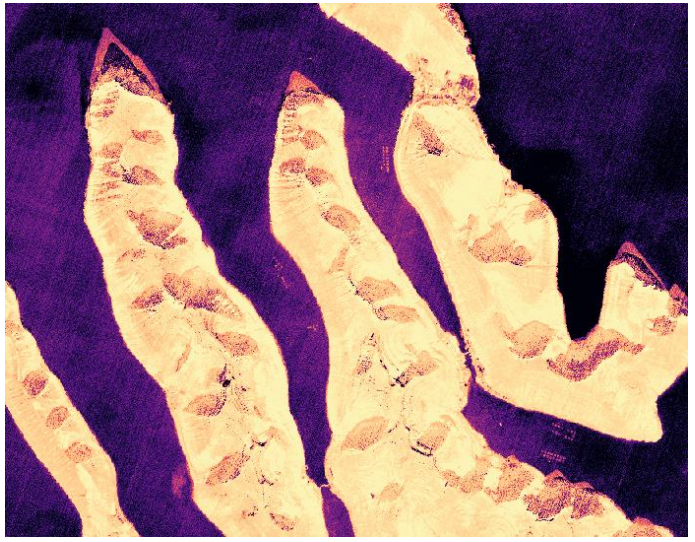

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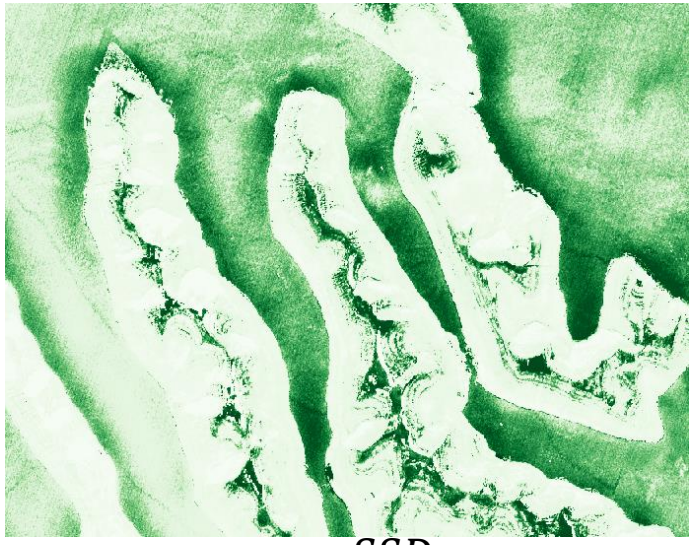

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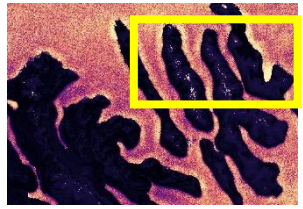
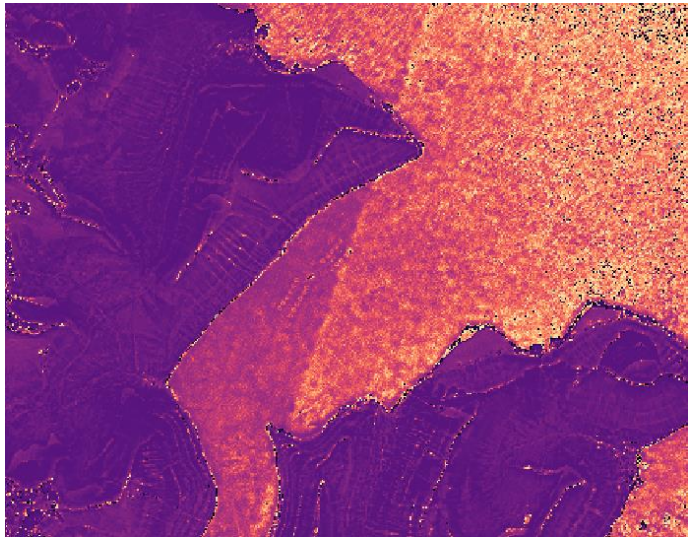
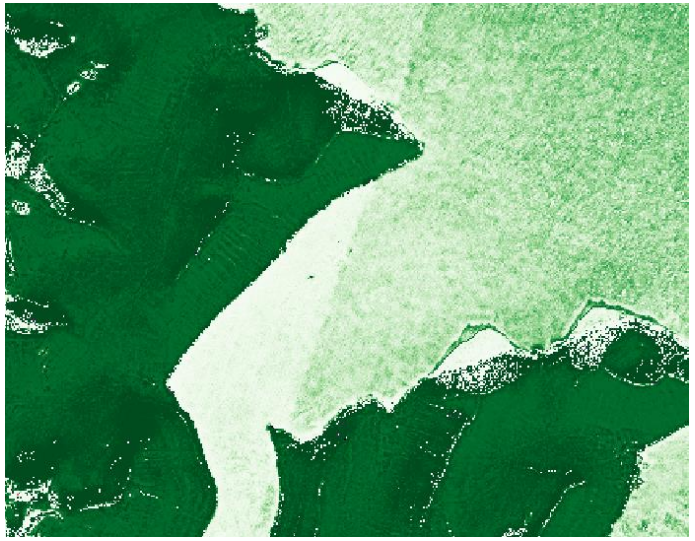




SWIR



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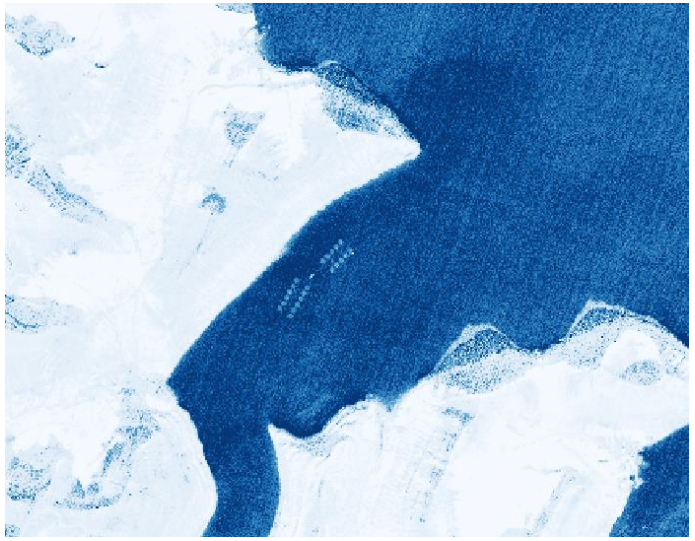
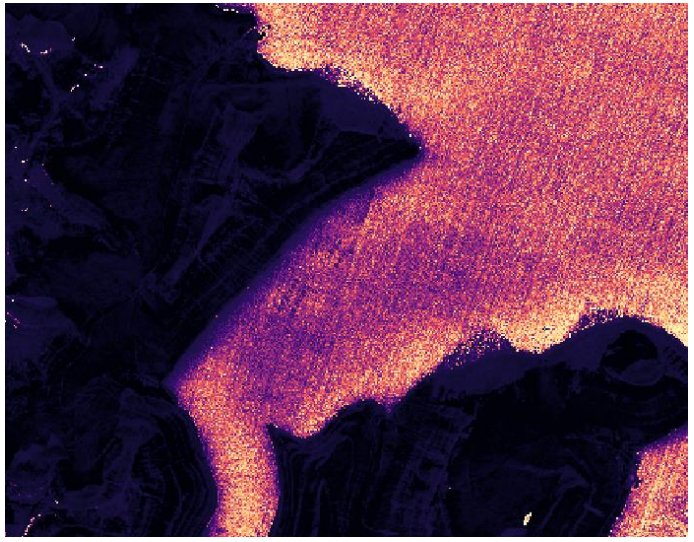


TI



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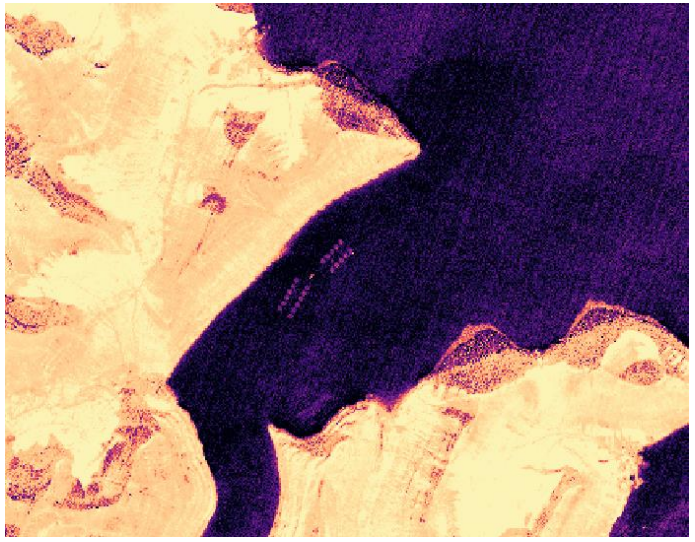
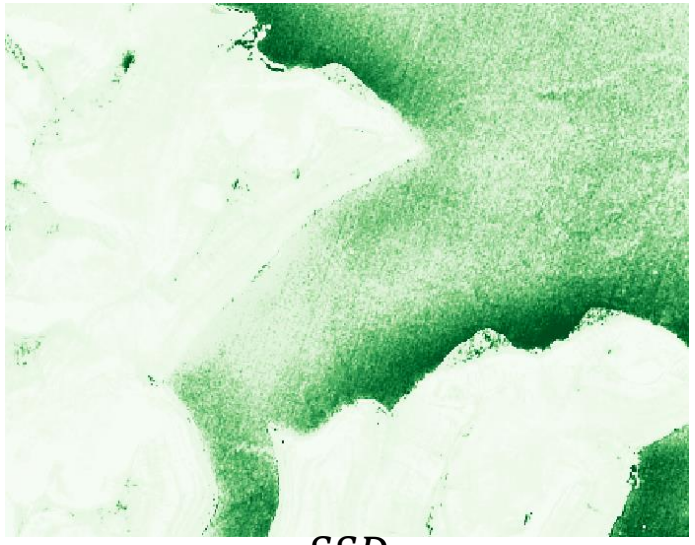


MCI



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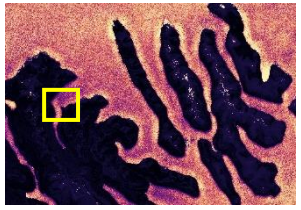

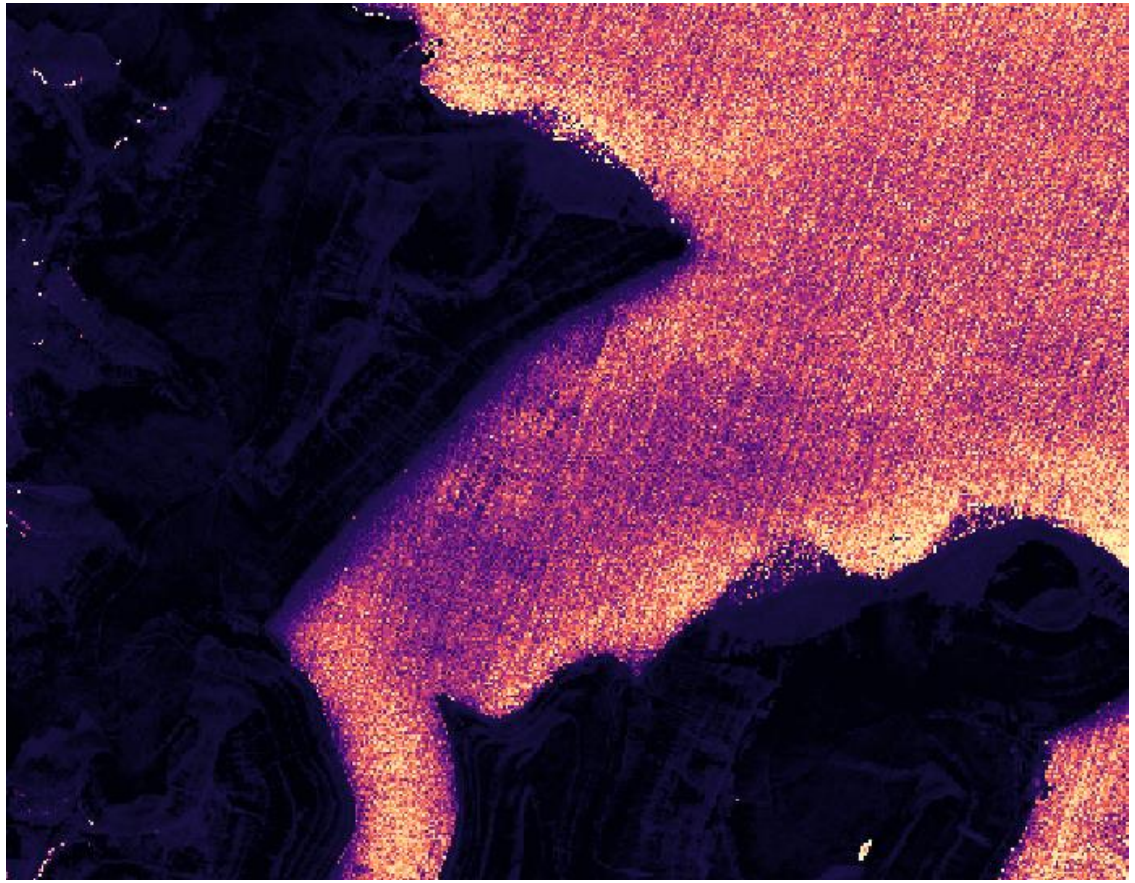

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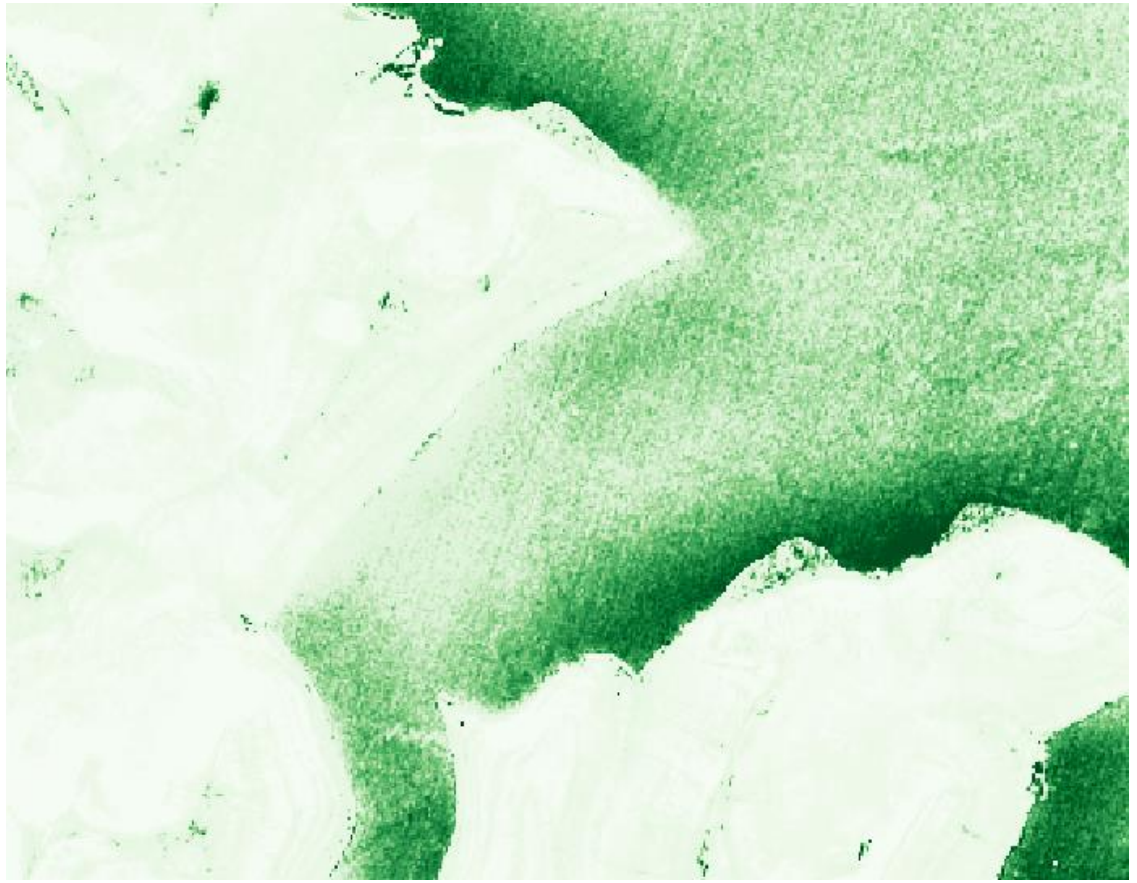

SSD

SSD gives similar results, SSD is formed from higher index, so can penetrate shallow clouds.

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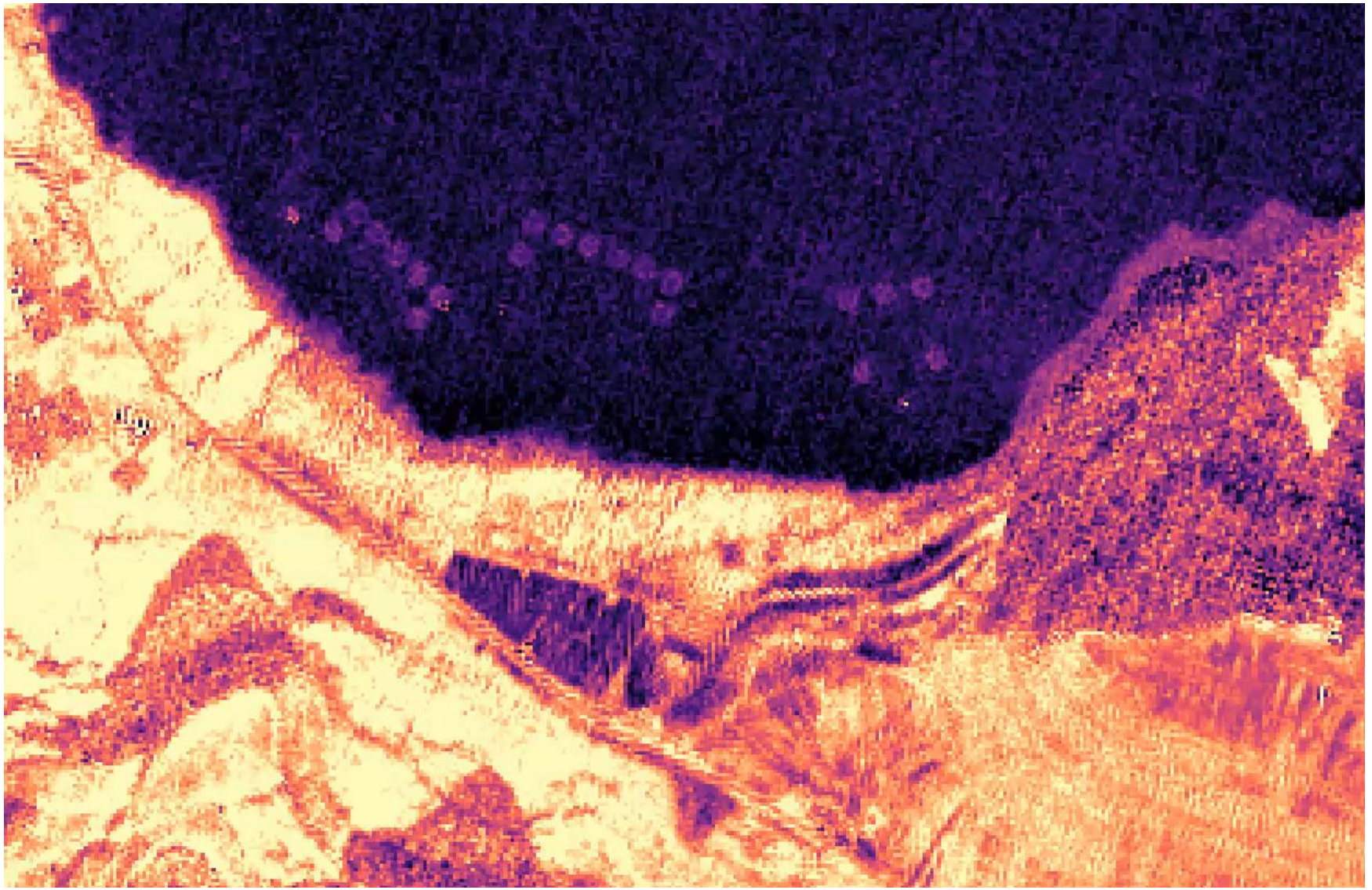
MCI In time Calibration



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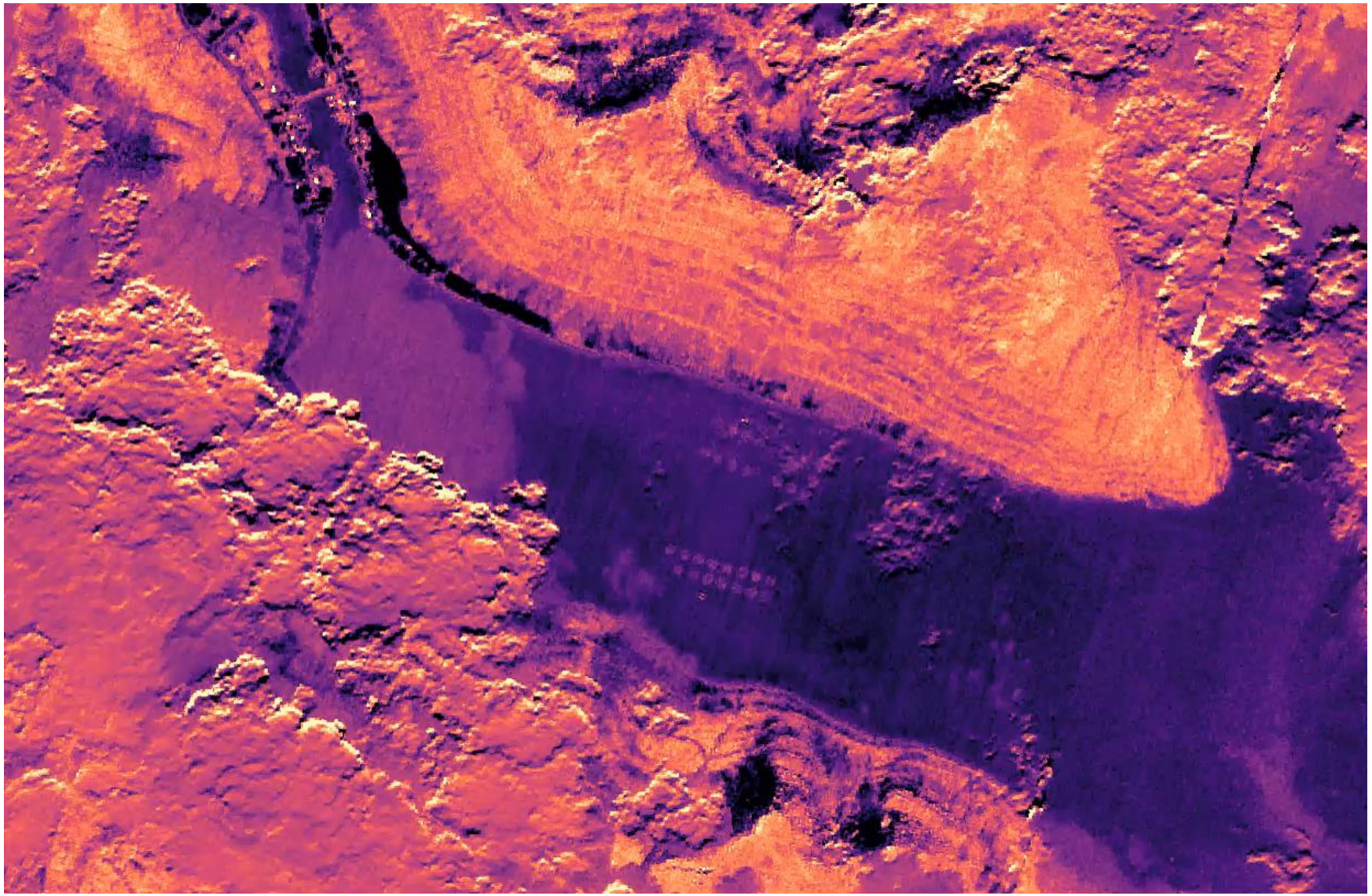

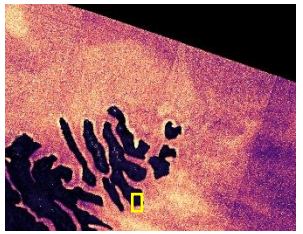

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