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Семантическая сегментация спутниковых
снимков MODIS для определения ледового
покрова в заливе Петра Великого



```
In [83]: import numpy as np
...: import matplotlib.pyplot as plt
...: from torchvision import transforms
...: from torchvision.models.segmentation import DeepLabV3_ResNet50_Weights
...: import imageio.v3 as iio
...:
...: model = torchvision.models.segmentation.deeplabv3_resnet50(weights=DeepLabV3_ResNet50_Weights.DEFAULT)
...: model.eval()
...:
...: img = iio.imread('ITES/P7223786r.JPG', index=None)
...:
...: preprocess = transforms.Compose([
...:     transforms.ToTensor(),
...:     transforms.Normalize(mean=[0.485, 0.456, 0.406], std=[0.229, 0.224, 0.225]),
...: ])
...:
...: batch = preprocess(img).unsqueeze(0)
...:
...: with torch.no_grad():
...:     res = model(batch)['out'][0]
...: res_predict = res.argmax(0)
...: res_msk = (res_predict.numpy()==3)
```

```
In [84]: sum(p.numel() for p in model.parameters() if p.requires_grad)
Out[84]: 42004074
```



```
In [86]: thr_mask=img[:, :, 2]<100
```

Алгоритмы семантической сегментации

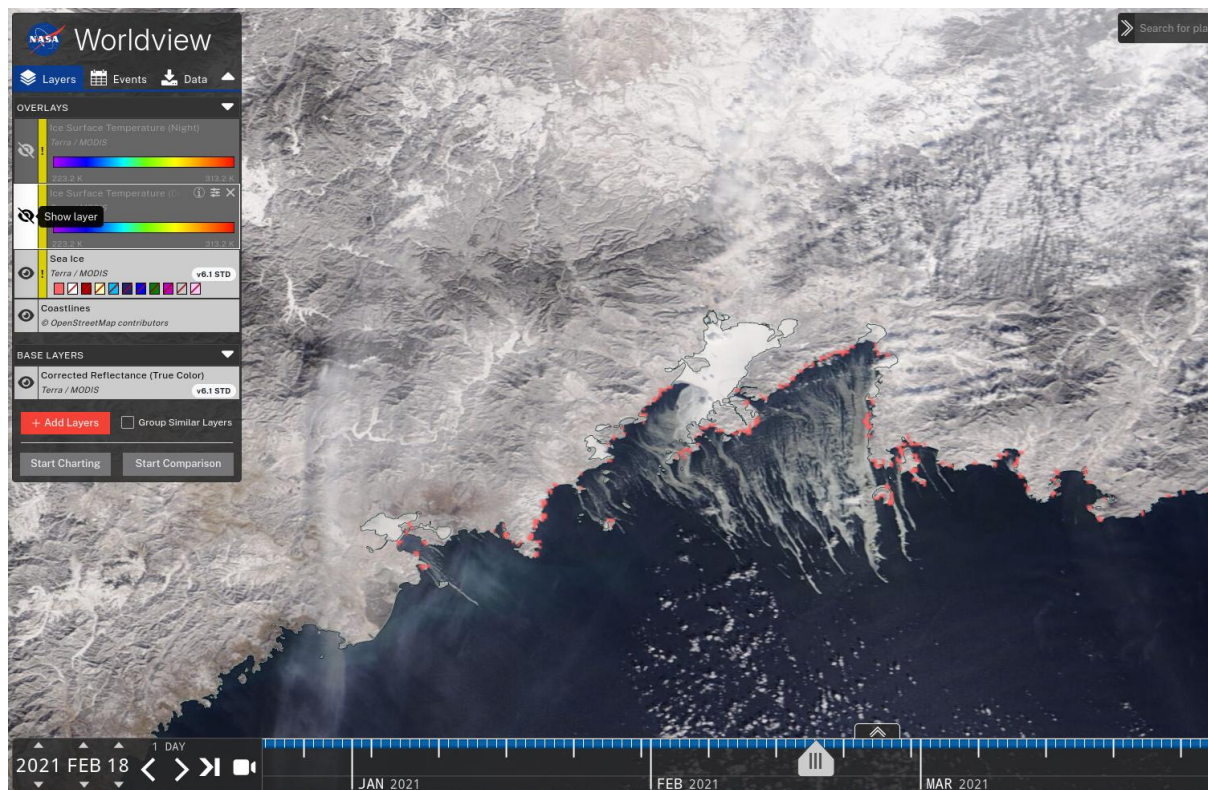
- Пороги, комбинация каналов и порогов (NDSI,...)
- Линейные алгоритмы, SVM
- Region-based segmentation (Watershed, ...)
- Алгоритмы кластеризации (Kmeans, Spectral clustering, Random forest,)
-
- Deep neural networks (CNN, Transformers, различные комбинации)

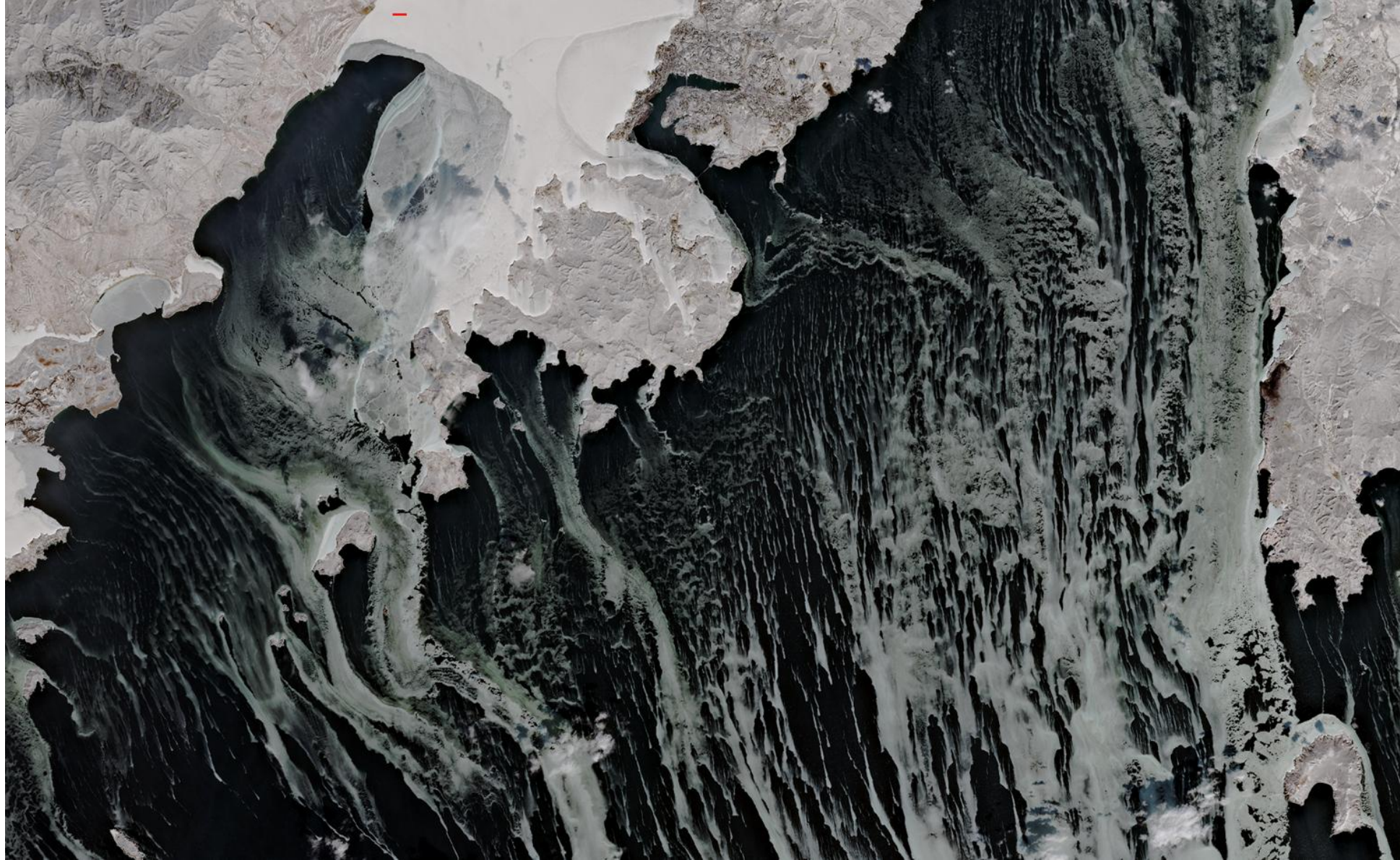
Ледовый покров залива Петра Великого по данным MOD/MYD02HKM

Область: Lon [130.6, 133.25]
Lat [42.25, 43.35]

Бинарная классификация пикселей акватории лёд/нет по снимкам с разрешением 500м/пиксель. 7 каналов:

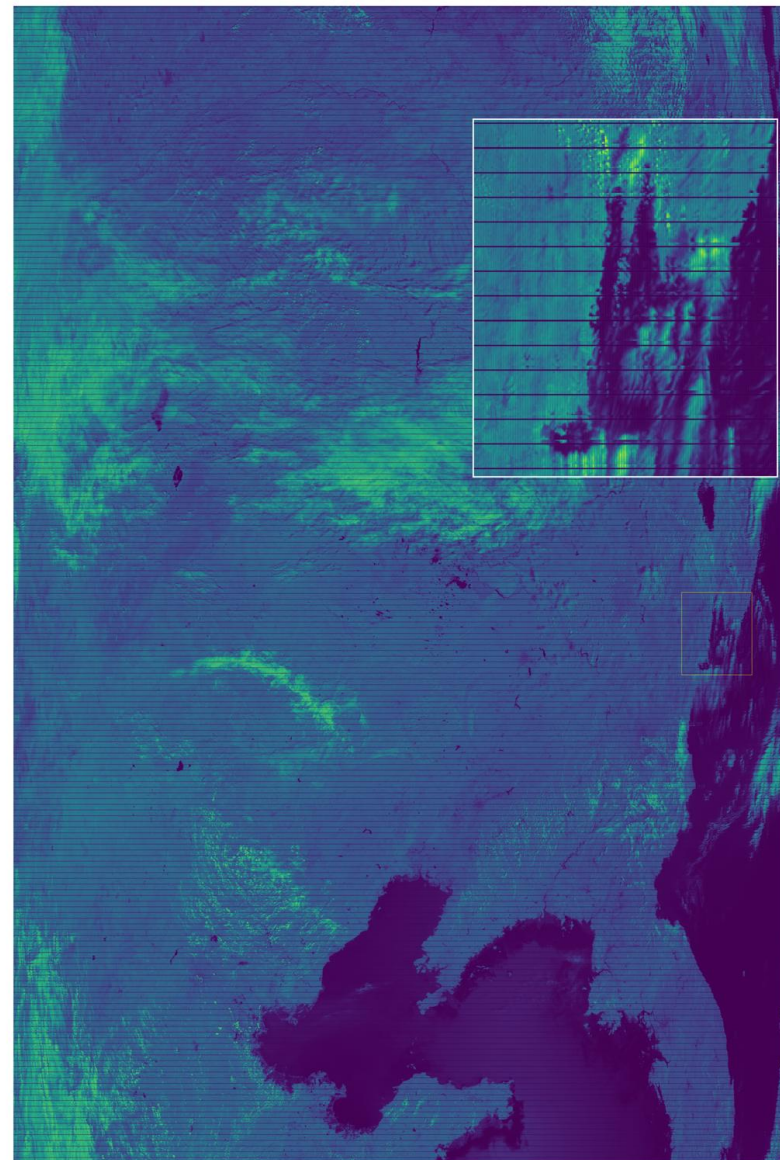
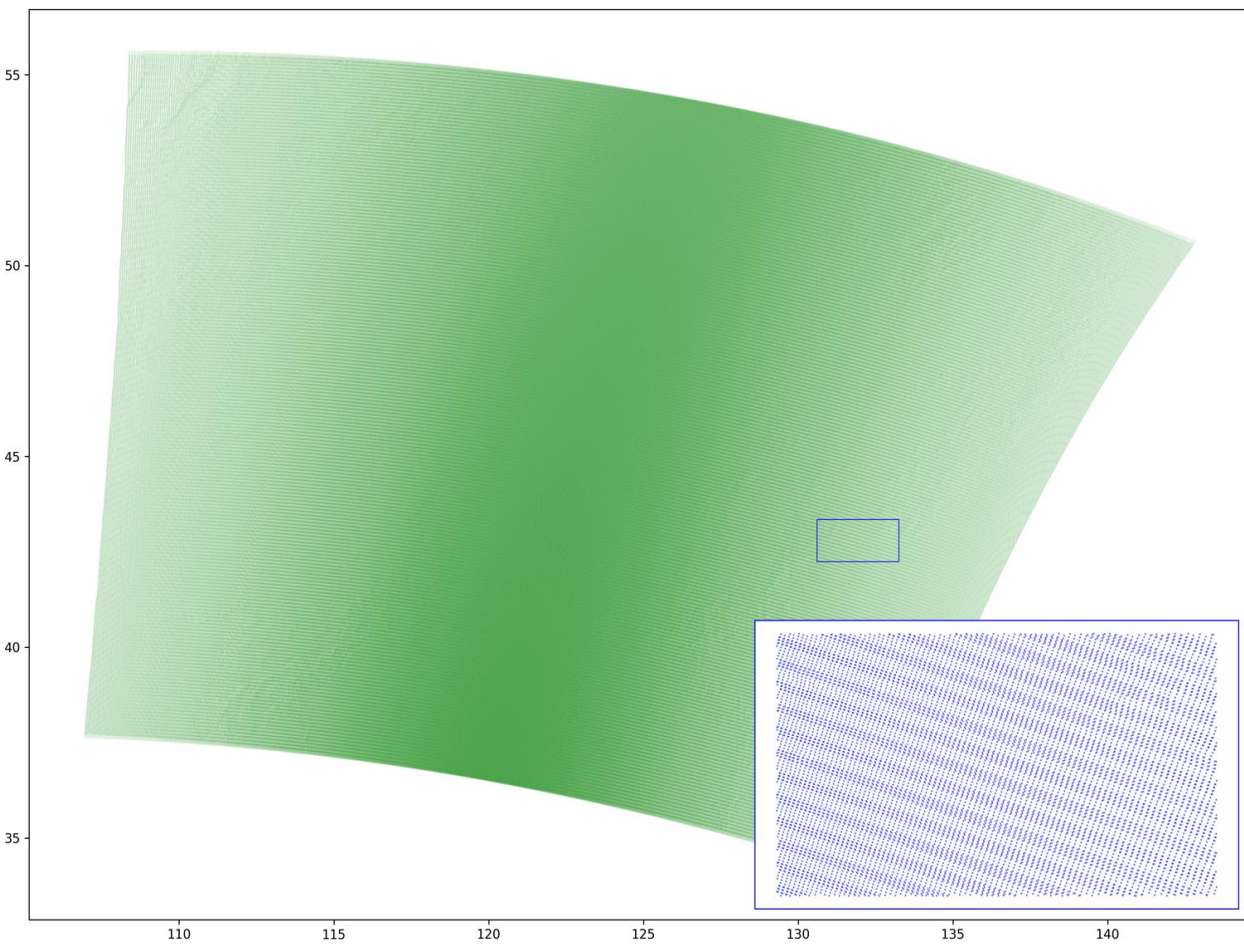
1. 0.620–0.670мкм (красный)
2. 0.841–0.876мкм (NIR)
3. 0.459–0.479мкм (синий)
4. 0.545–0.565мкм (зелёный)
5. 1.230–1.250мкм (NIR)
6. 1.628–1.652мкм (SWIR)
7. 2.105–2.155мкм (SWIR)





Гранула

MOD02HKM.A2018213.0250



MOD02HKM.A2023023.0230.061.npy 0.454, 0.454, 0.454



MYD02HKM.A2021049.0405.061.npy 0.984, 0.984, 0.984



MYD02HKM.A2018061.0340.061.npy 0.515, 0.515, 0.515



MYD02HKM.A2005347.0505.061.npy 0.267, 0.267, 0.267



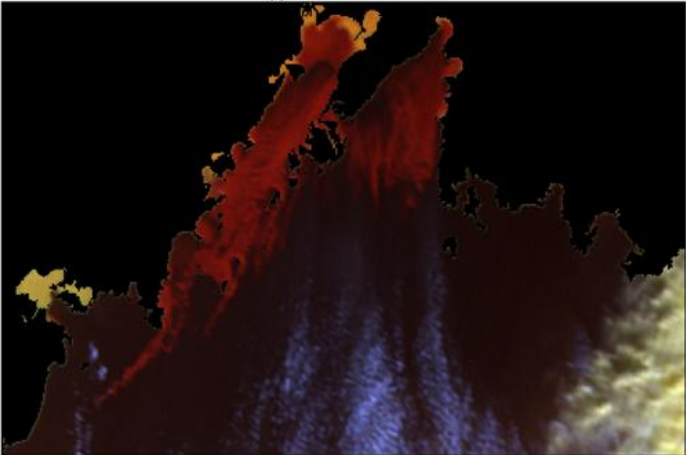
MOD02HKM.A2021049.0225.061.npy 0.905, 0.905, 0.905



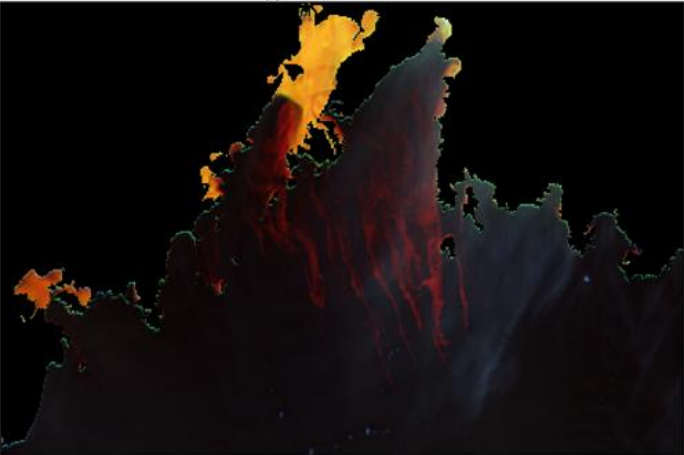
MOD02HKM.A2015034.0130.061.npy 0.392, 0.392, 0.392



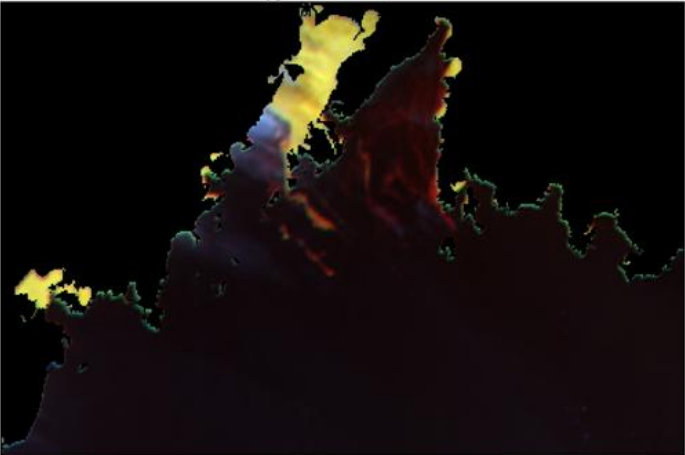
MOD02HKM.A2023023.0230.061.npy 0.454, 0.431, 0.454



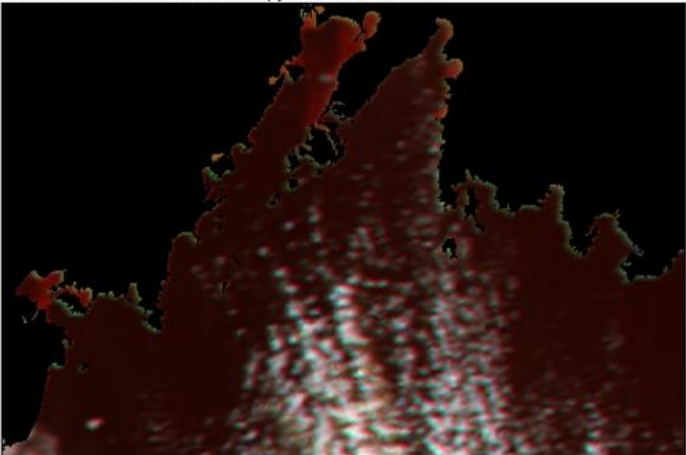
MYD02HKM.A2021049.0405.061.npy 0.984, 0.935, 0.984



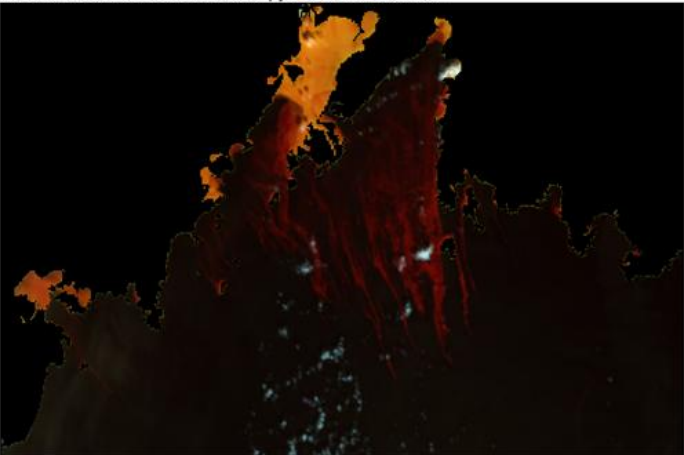
MYD02HKM.A2018061.0340.061.npy 0.515, 0.489, 0.515



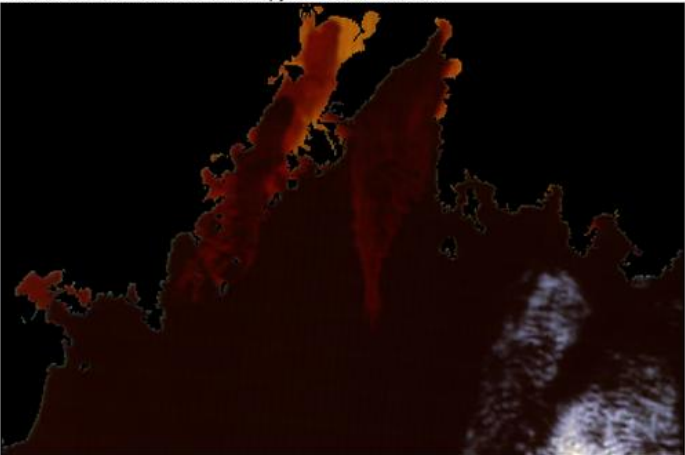
MYD02HKM.A2005347.0505.061.npy 0.267, 0.253, 0.267



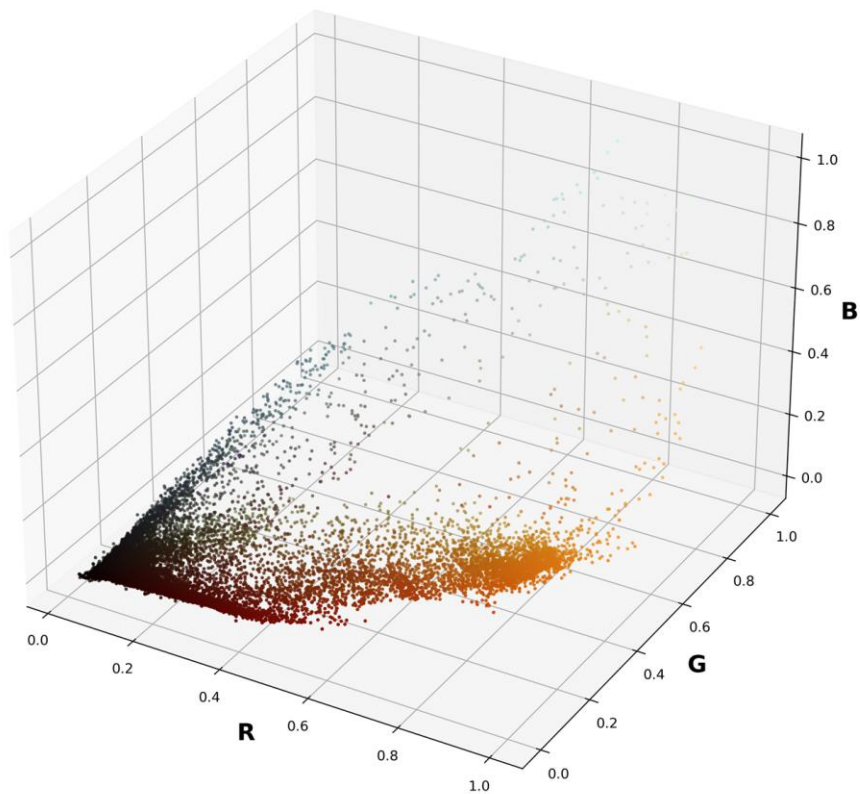
MOD02HKM.A2021049.0225.061.npy 0.905, 0.860, 0.905



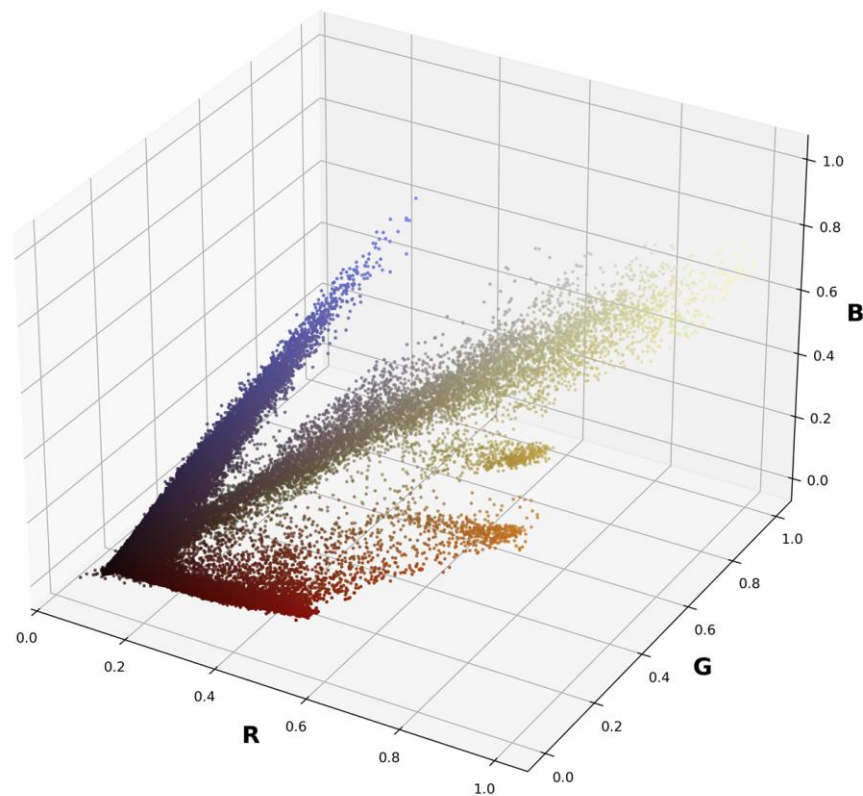
MOD02HKM.A2015034.0130.061.npy 0.392, 0.373, 0.391



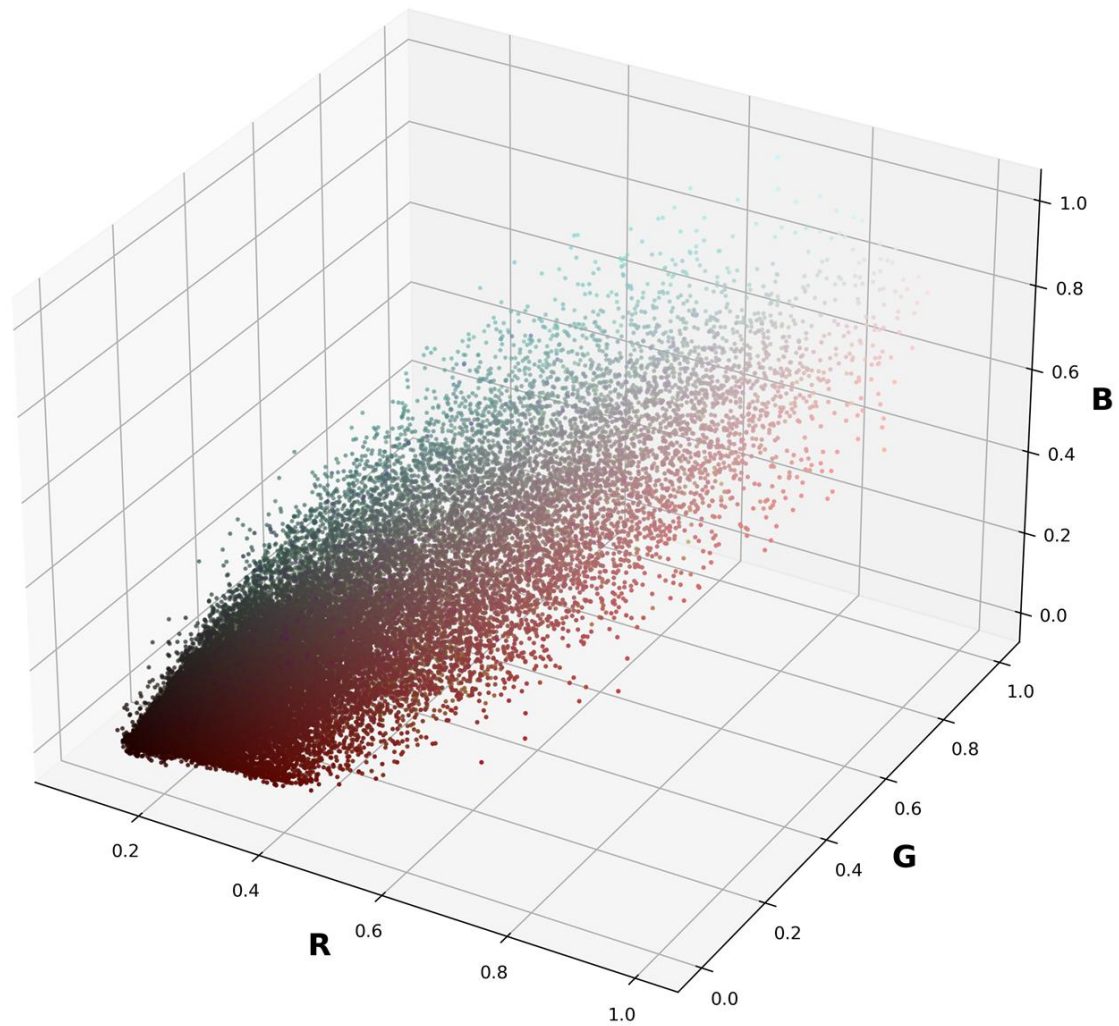
MOD02HKM.A2021049.0225.061.npy



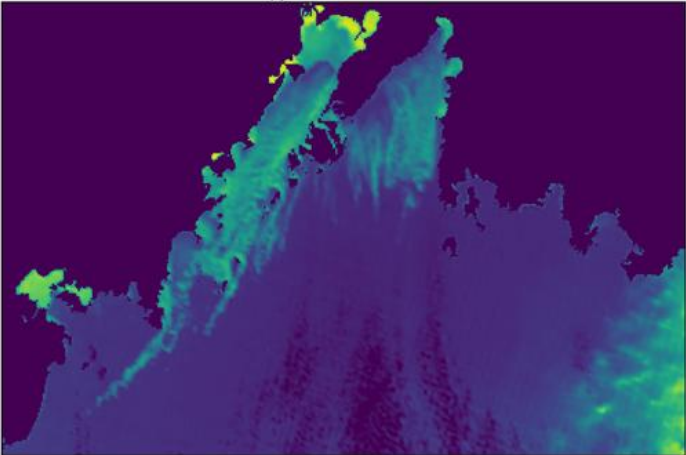
MOD02HKM.A2023023.0230.061.npy



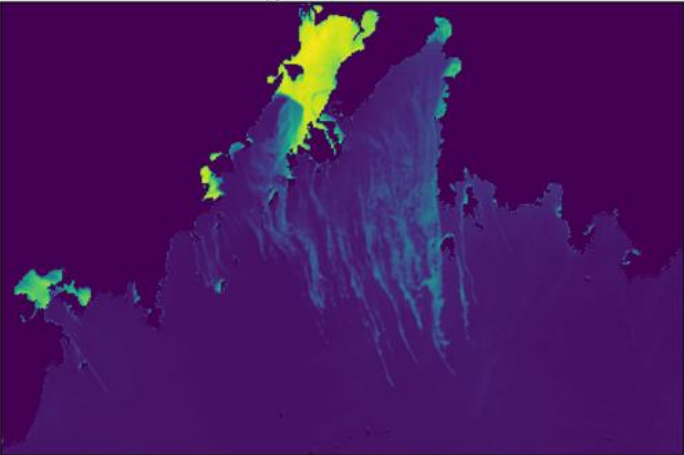
MYD02HKM.A2005347.0505.061.npy



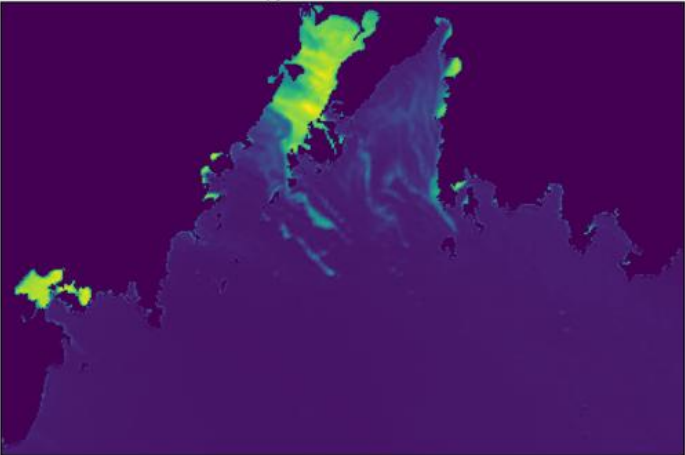
MOD02HKM.A2023023.0230.061.npy 0.454, 0.454



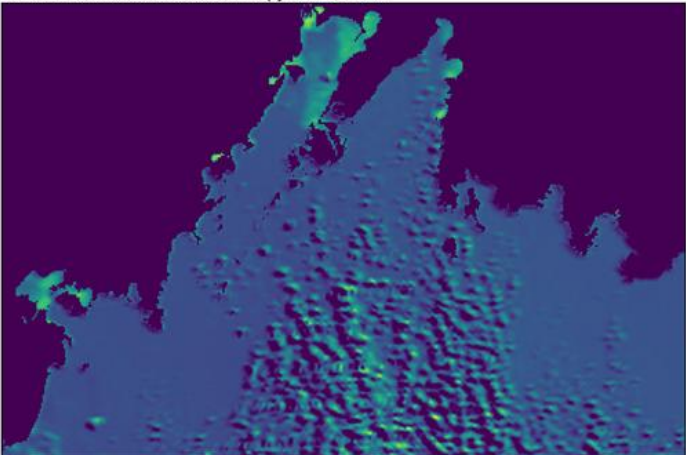
MYD02HKM.A2021049.0405.061.npy 0.984, 0.984



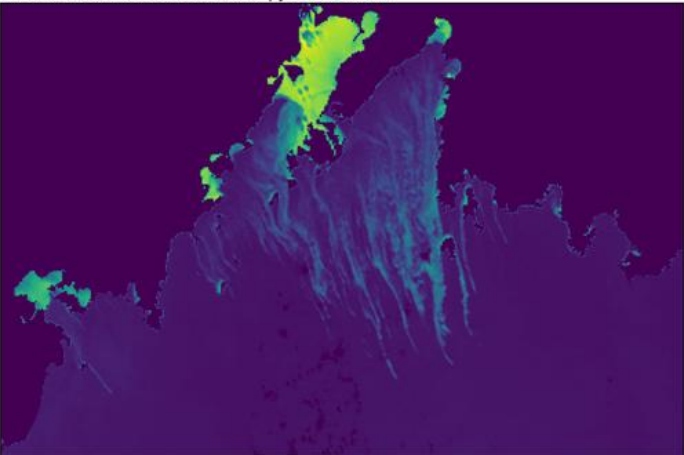
MYD02HKM.A2018061.0340.061.npy 0.515, 0.515



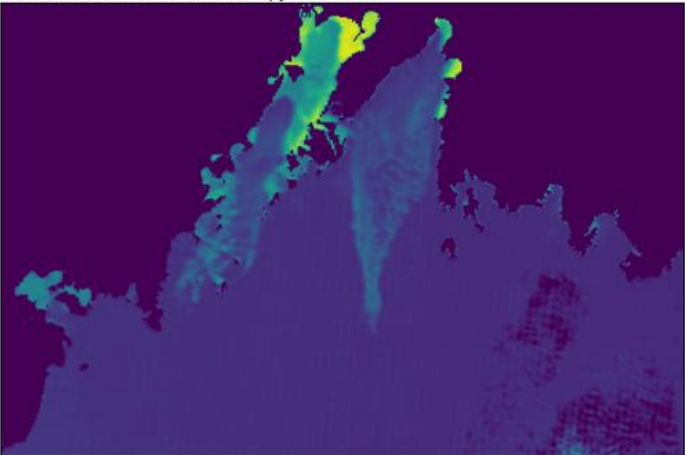
MYD02HKM.A2005347.0505.061.npy 0.267, 0.267



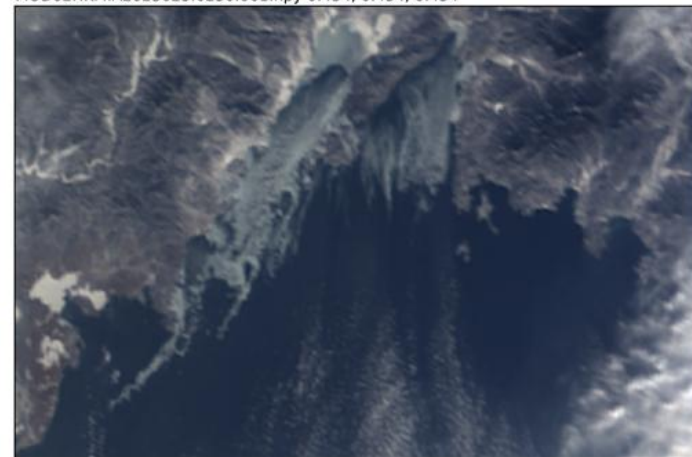
MOD02HKM.A2021049.0225.061.npy 0.905, 0.905



MOD02HKM.A2015034.0130.061.npy 0.392, 0.391



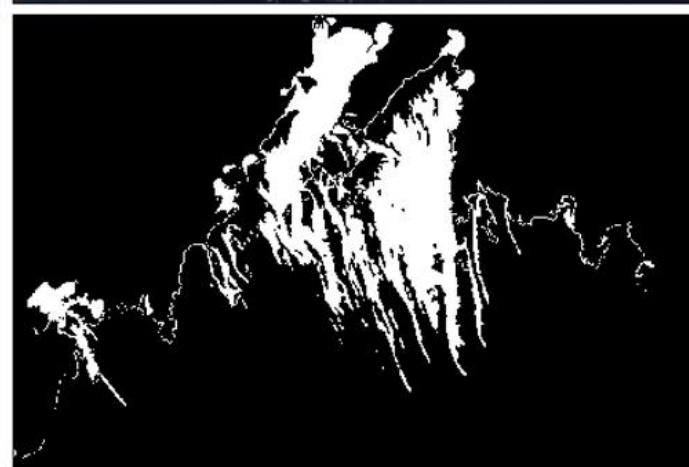
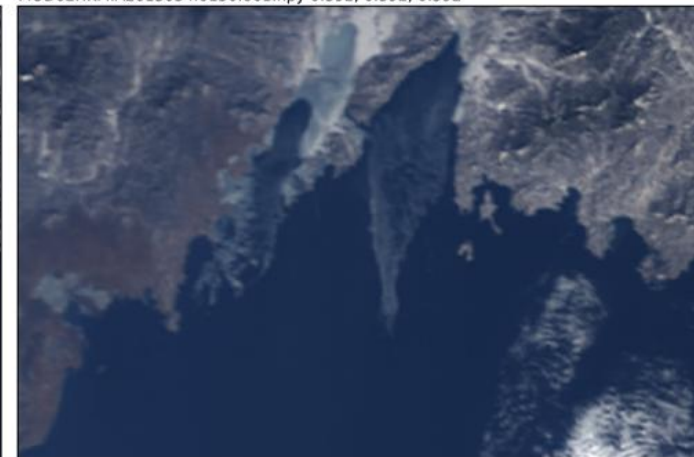
MOD02HKM.A2023023.0230.061.npy 0.454, 0.454, 0.454

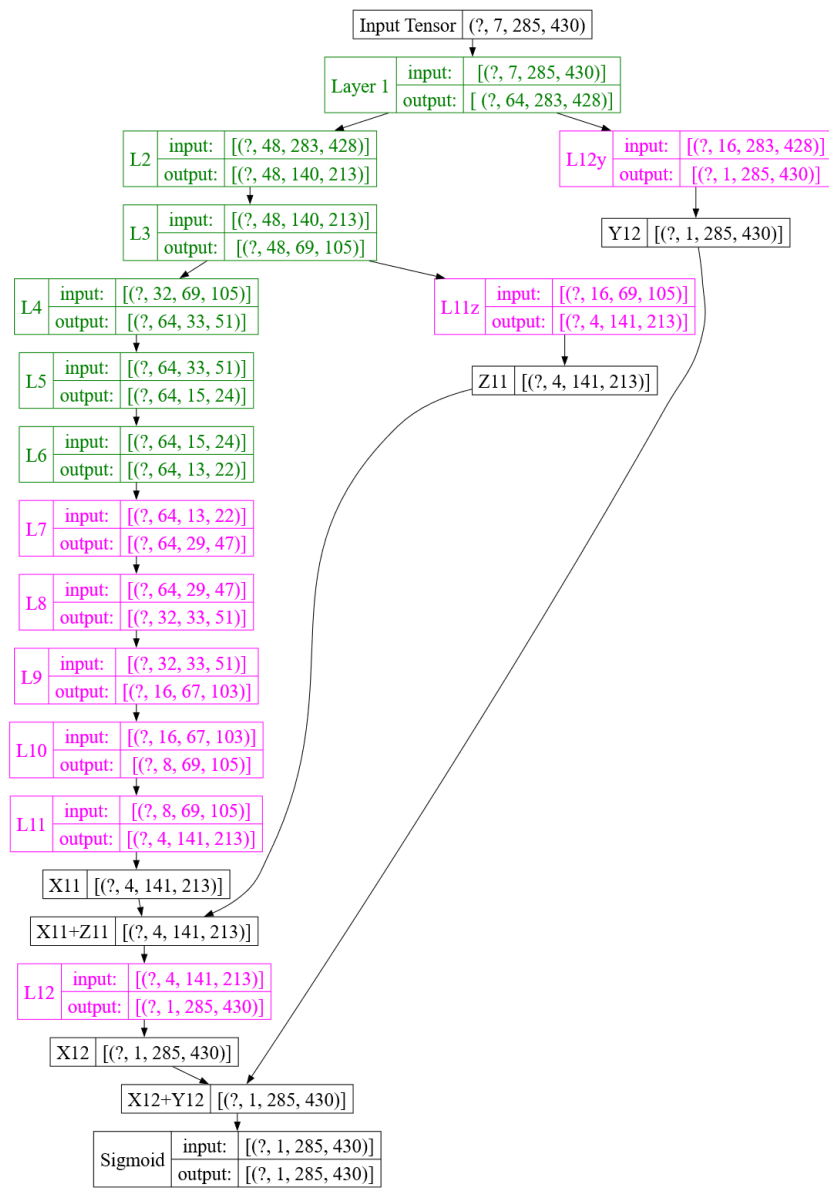


MOD02HKM.A2021049.0225.061.npy 0.905, 0.905, 0.905



MOD02HKM.A2015034.0130.061.npy 0.392, 0.392, 0.392





SSegm M21.1 (301132 параметра)

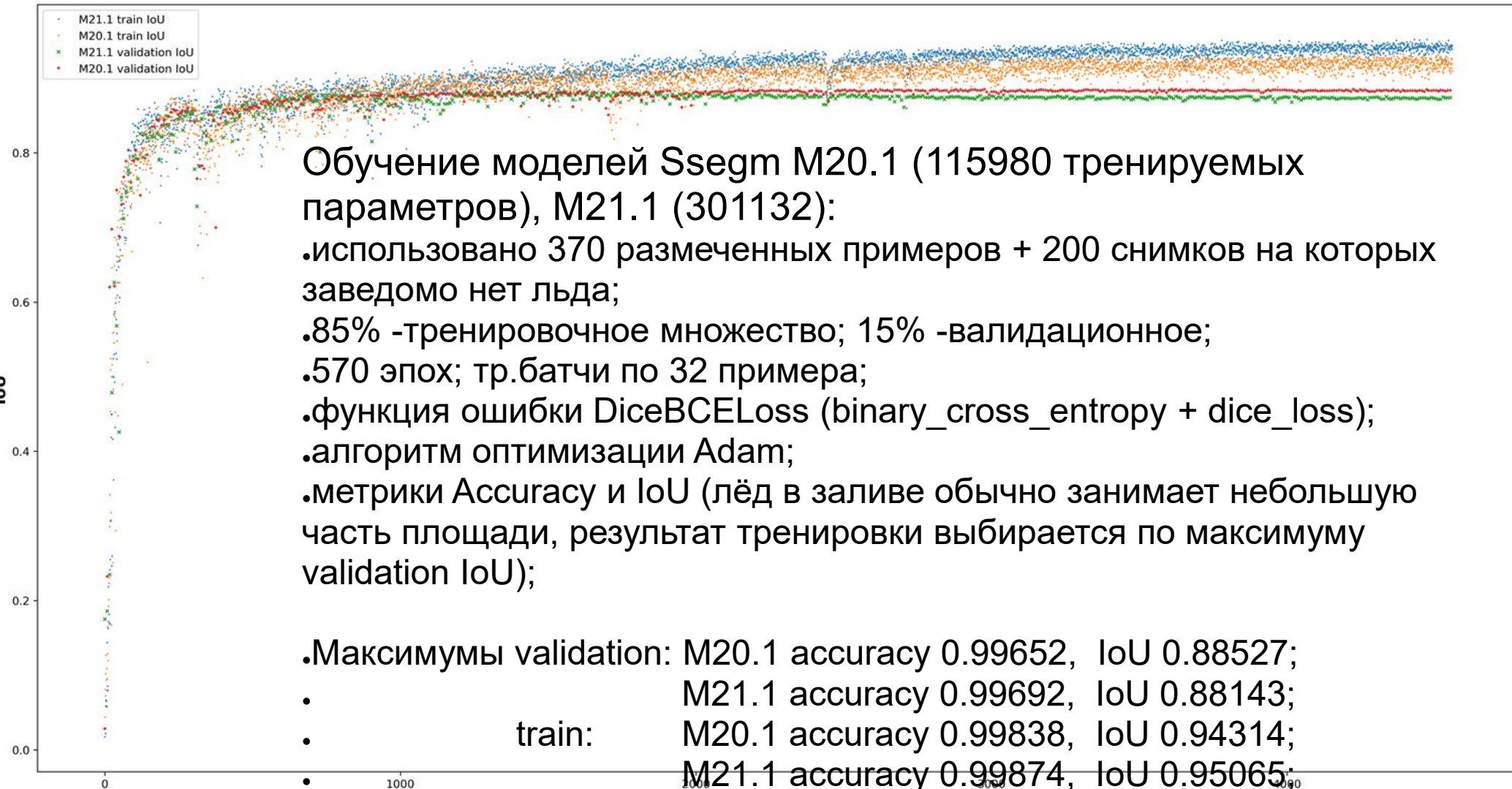
L1,L6: Conv2d(3x3);
BatchNorm2d;
GELU.

L2,L3,L4,L5: Conv2d(3x3);
BatchNorm2d;
MaxPool2d(2x2);
GELU.

L7,L9,L11,L11z: ConvTranspose2d(5x5, stride=2);
BatchNorm2d;
GELU.

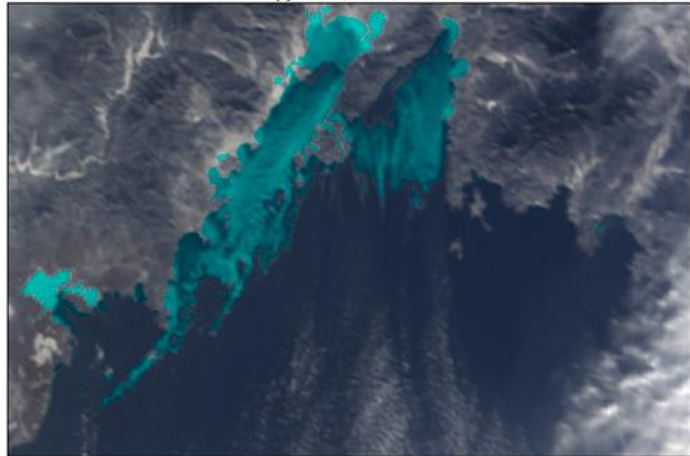
L10,L12y: ConvTranspose2d(3x3);
BatchNorm2d;
GELU.

L12: ConvTranspose2d(5x6).



SSegm M20.1

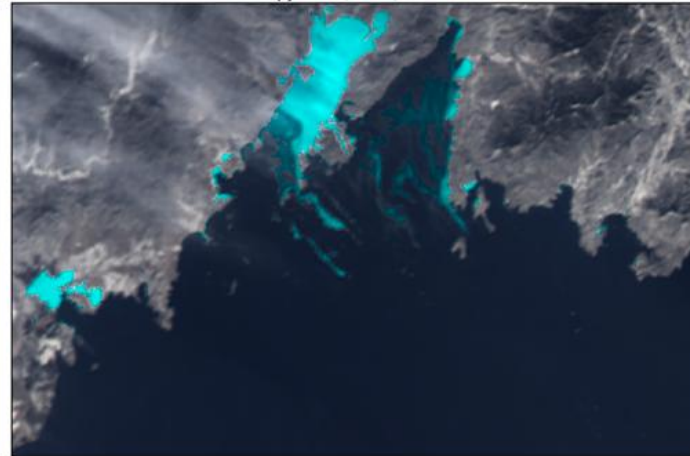
MOD02HKM.A2023023.0230.061.npy 0.454,0.454,0.454



MYD02HKM.A2021049.0405.061.npy 0.984,0.984,0.984



MYD02HKM.A2018061.0340.061.npy 0.515,0.515,0.515



MYD02HKM.A2005347.0505.061.npy 0.267,0.267,0.267



MOD02HKM.A2021049.0225.061.npy 0.905,0.905,0.905



MOD02HKM.A2015034.0130.061.npy 0.392,0.392,0.392



SSegm M20.1

MOD02HKM.A2023023.0230.061.npy



MYD02HKM.A2021049.0405.061.npy



MYD02HKM.A2018061.0340.061.npy



MYD02HKM.A2005347.0505.061.npy



MOD02HKM.A2021049.0225.061.npy



MOD02HKM.A2015034.0130.061.npy

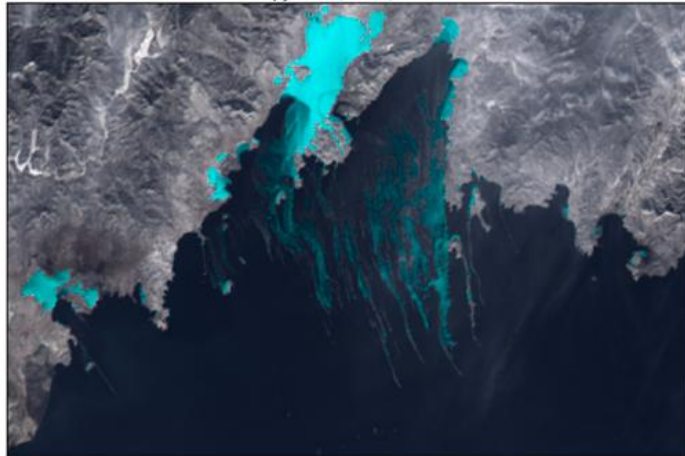


SSegm M21.1

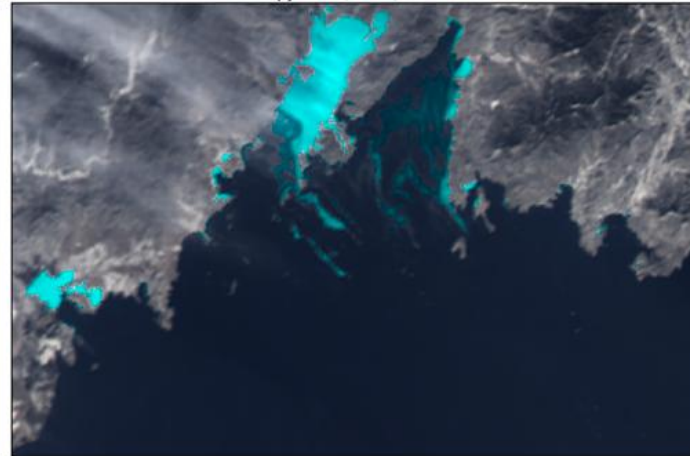
MOD02HKM.A2023023.0230.061.npy 0.454,0.454,0.454



MYD02HKM.A2021049.0405.061.npy 0.984,0.984,0.984



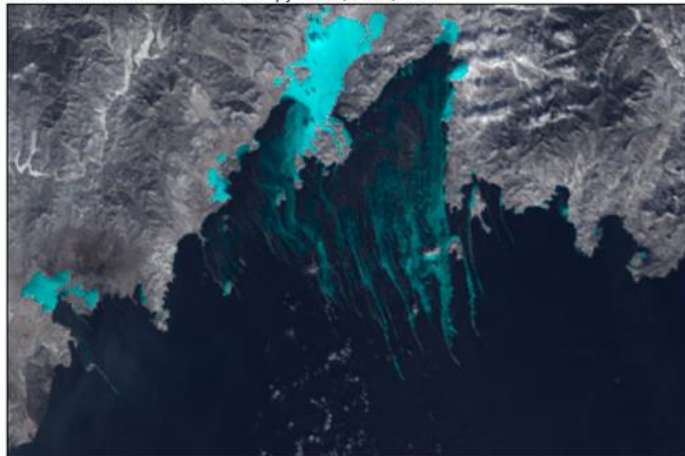
MYD02HKM.A2018061.0340.061.npy 0.515,0.515,0.515



MYD02HKM.A2005347.0505.061.npy 0.267,0.267,0.267



MOD02HKM.A2021049.0225.061.npy 0.905,0.905,0.905

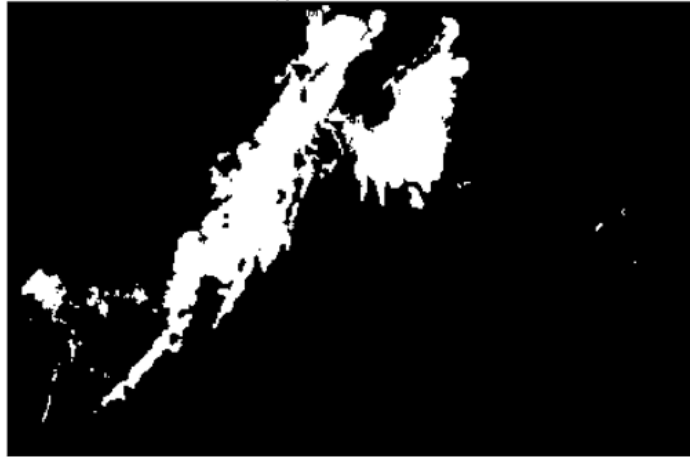


MOD02HKM.A2015034.0130.061.npy 0.392,0.392,0.392



SSegm M21.1

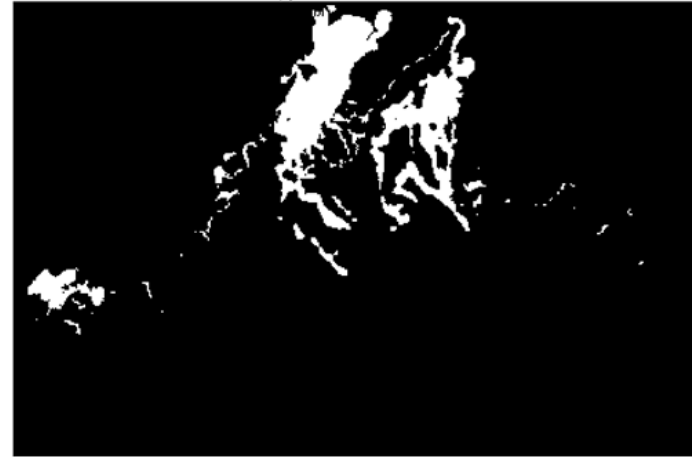
MOD02HKM.A2023023.0230.061.npy



MYD02HKM.A2021049.0405.061.npy



MYD02HKM.A2018061.0340.061.npy



MYD02HKM.A2005347.0505.061.npy



MOD02HKM.A2021049.0225.061.npy



MOD02HKM.A2015034.0130.061.npy

