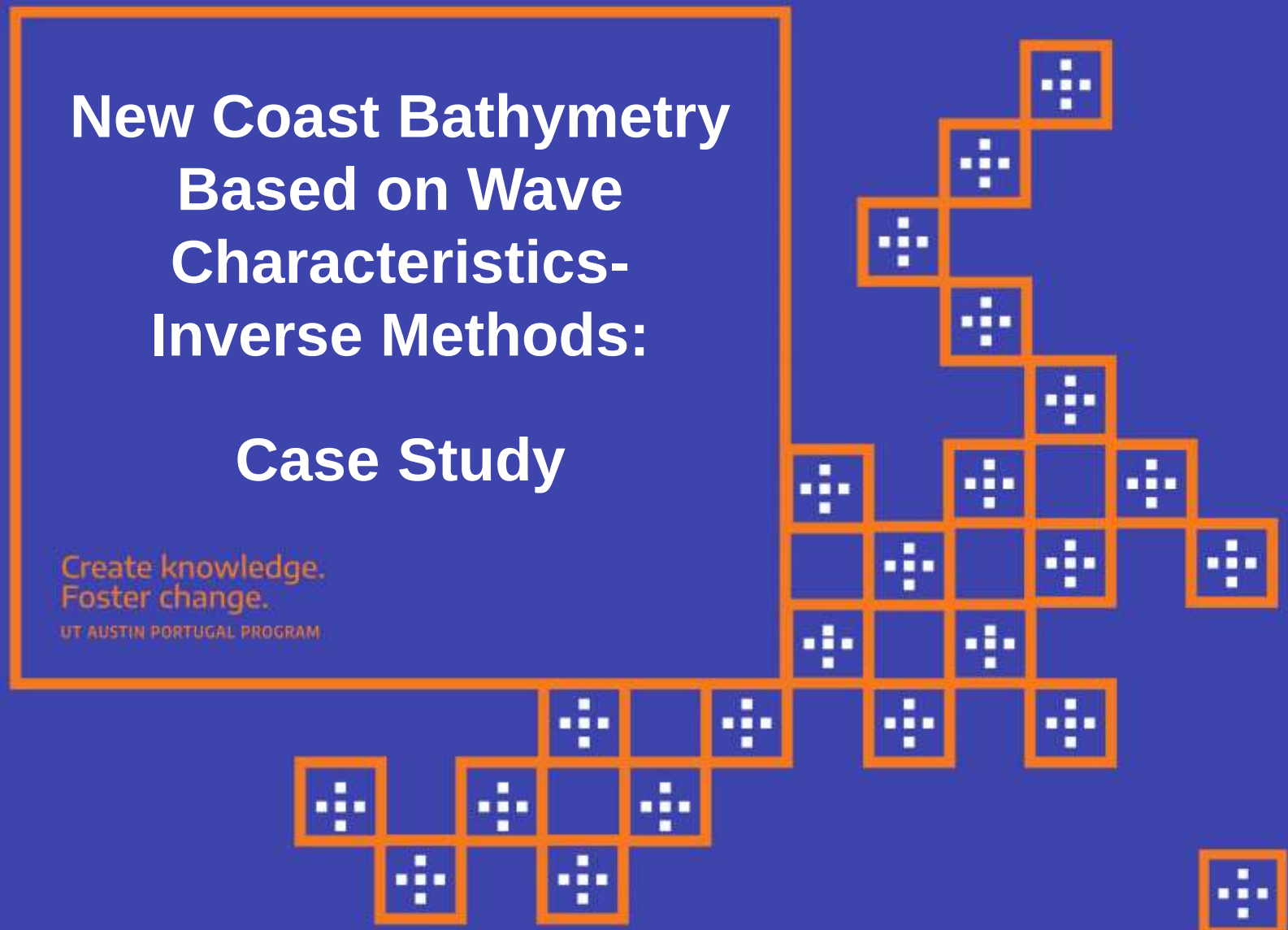
New Coast Bathymetry Based on Wave Characteristics- Inverse Methods:

Case Study

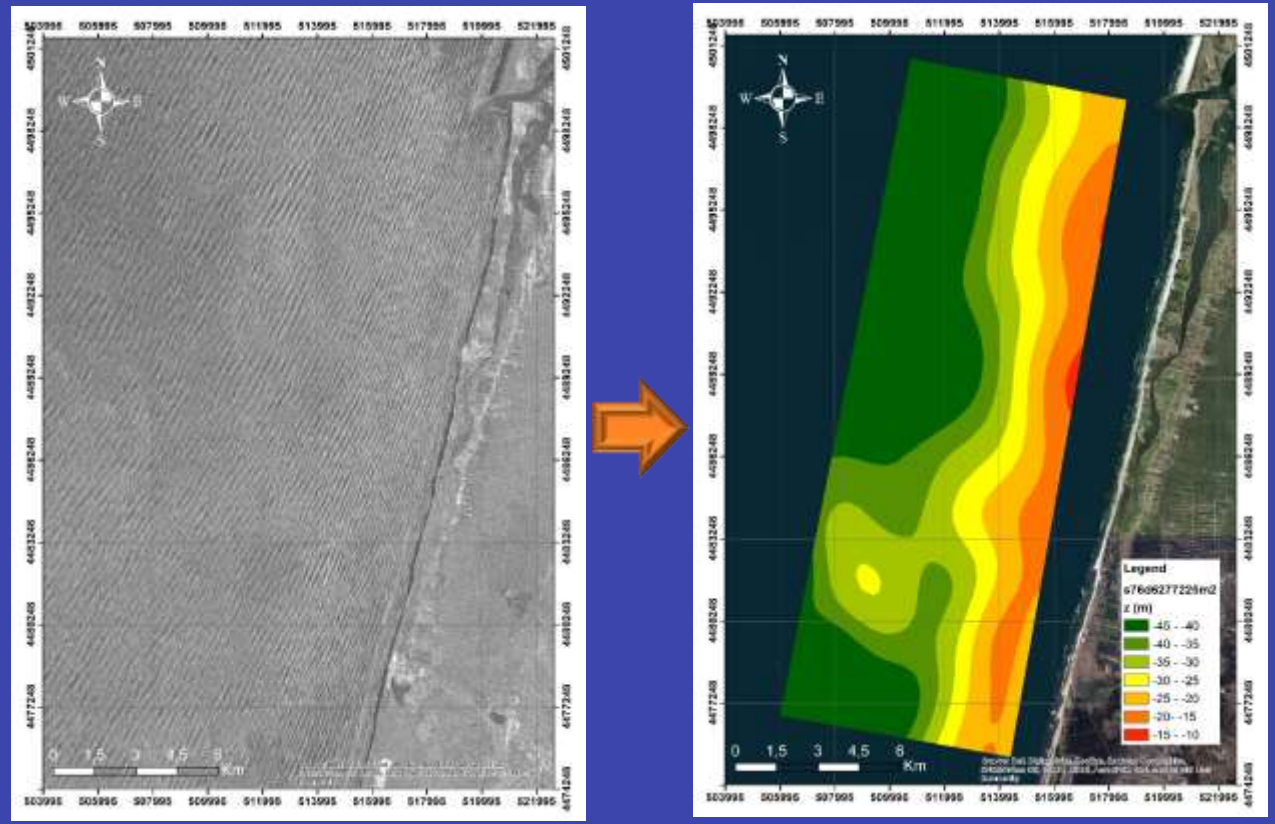
Create knowledge.
Foster change.
UT AUSTIN PORTUGAL PROGRAM



UTAustin Portugal

New Coast Bathymetry Based on Wave Characteristics - Inverse Methods:

Case Study



Sandra Fernández-Fernández

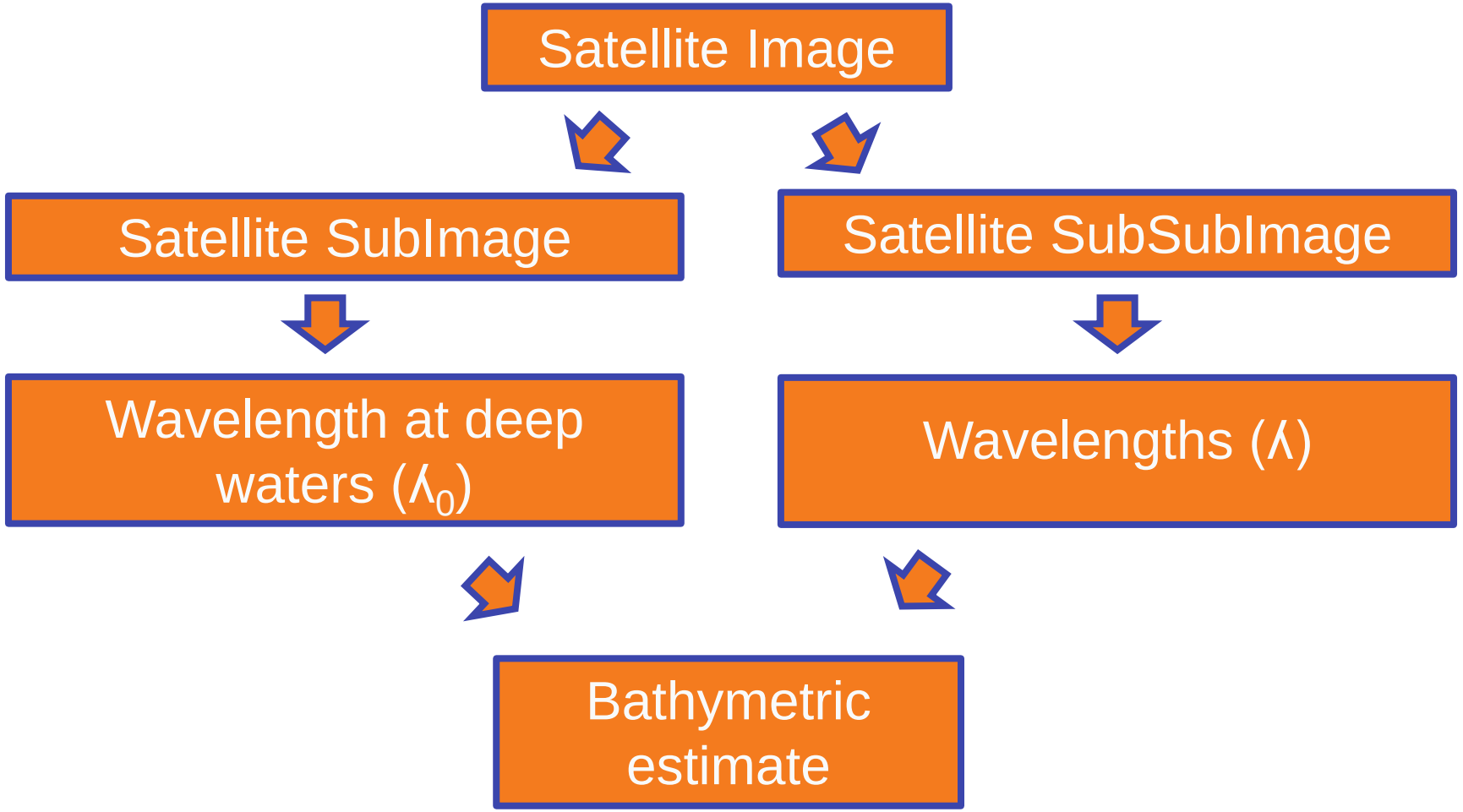
Porto (Portugal)

12/11/2019

universidade de aveiro cesam centre for environmental and marine studies

- How do we obtain the data?
- How do we obtain the subimage?
- How do we estimate the wavelength at deep waters?
- How do we estimate the depth?
- How do we know if the result is realistic?

Methodology approach



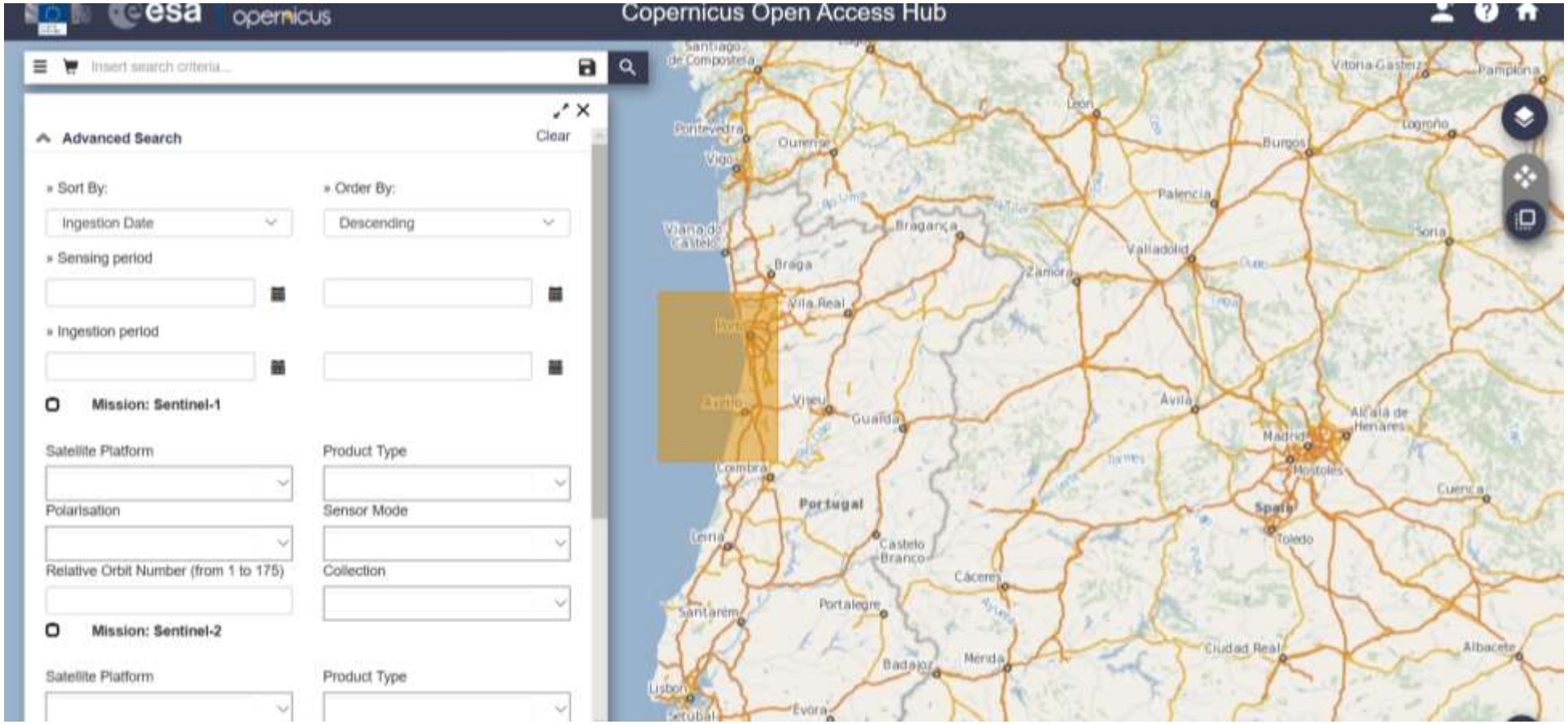
How do we obtain the data?

Data extraction

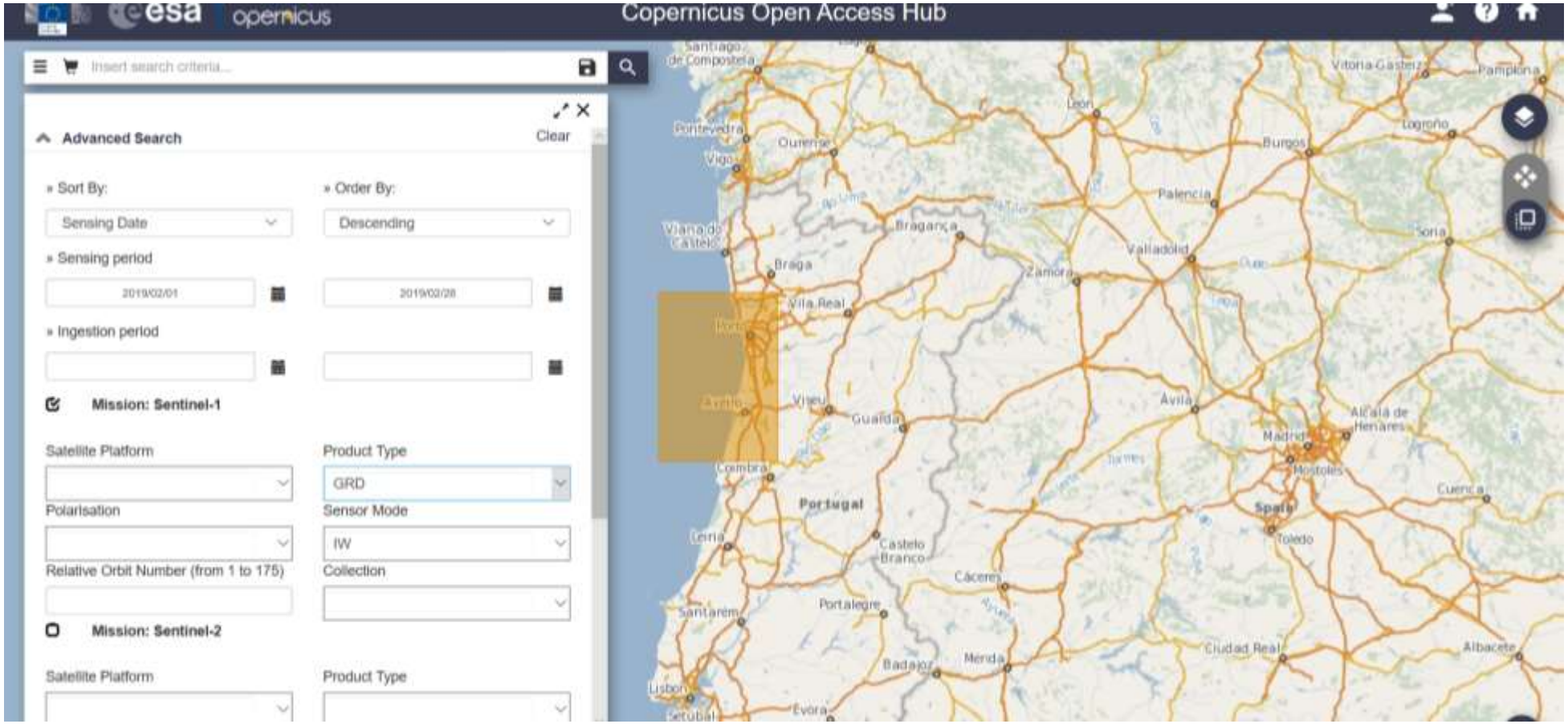
https://scihub.copernicus.eu/dhus/#/home

Data extraction

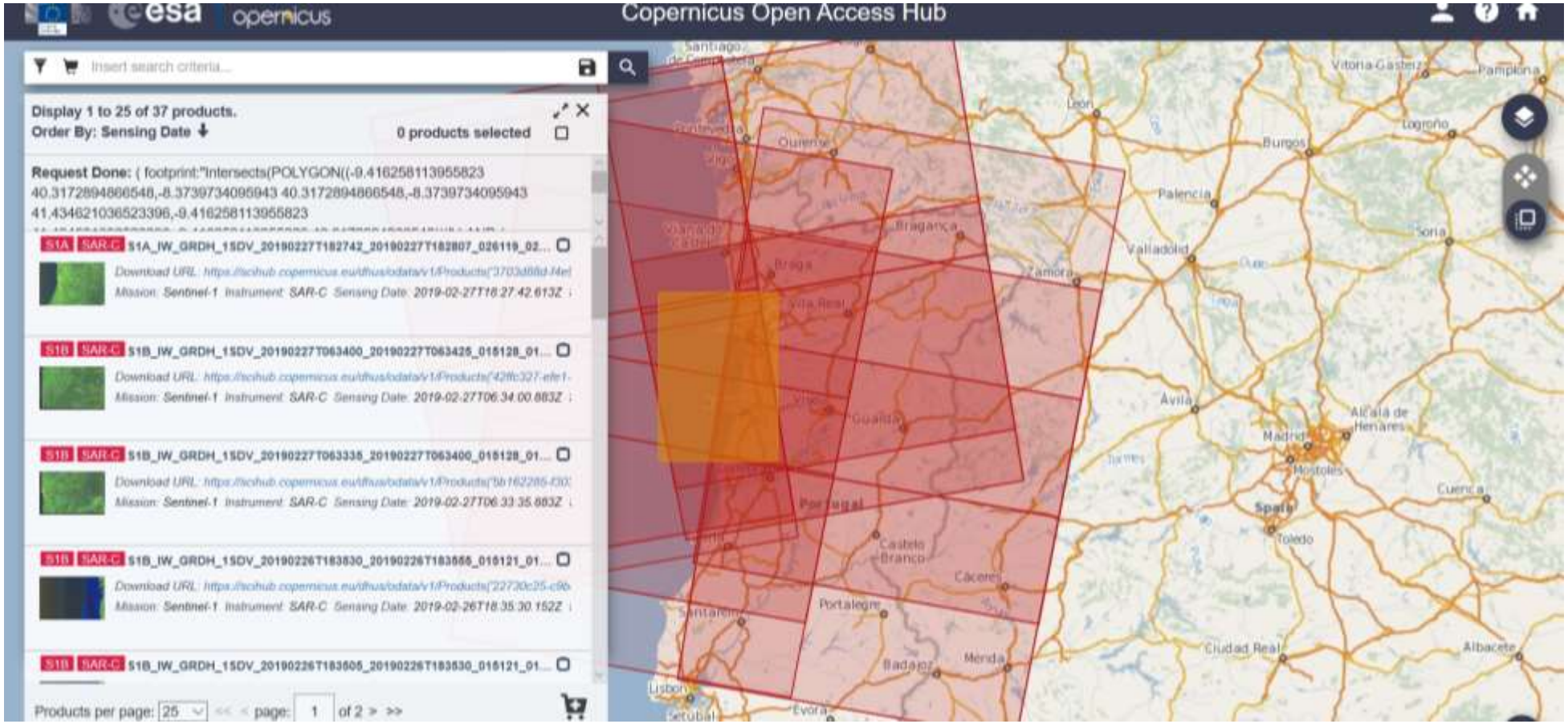
Data extraction



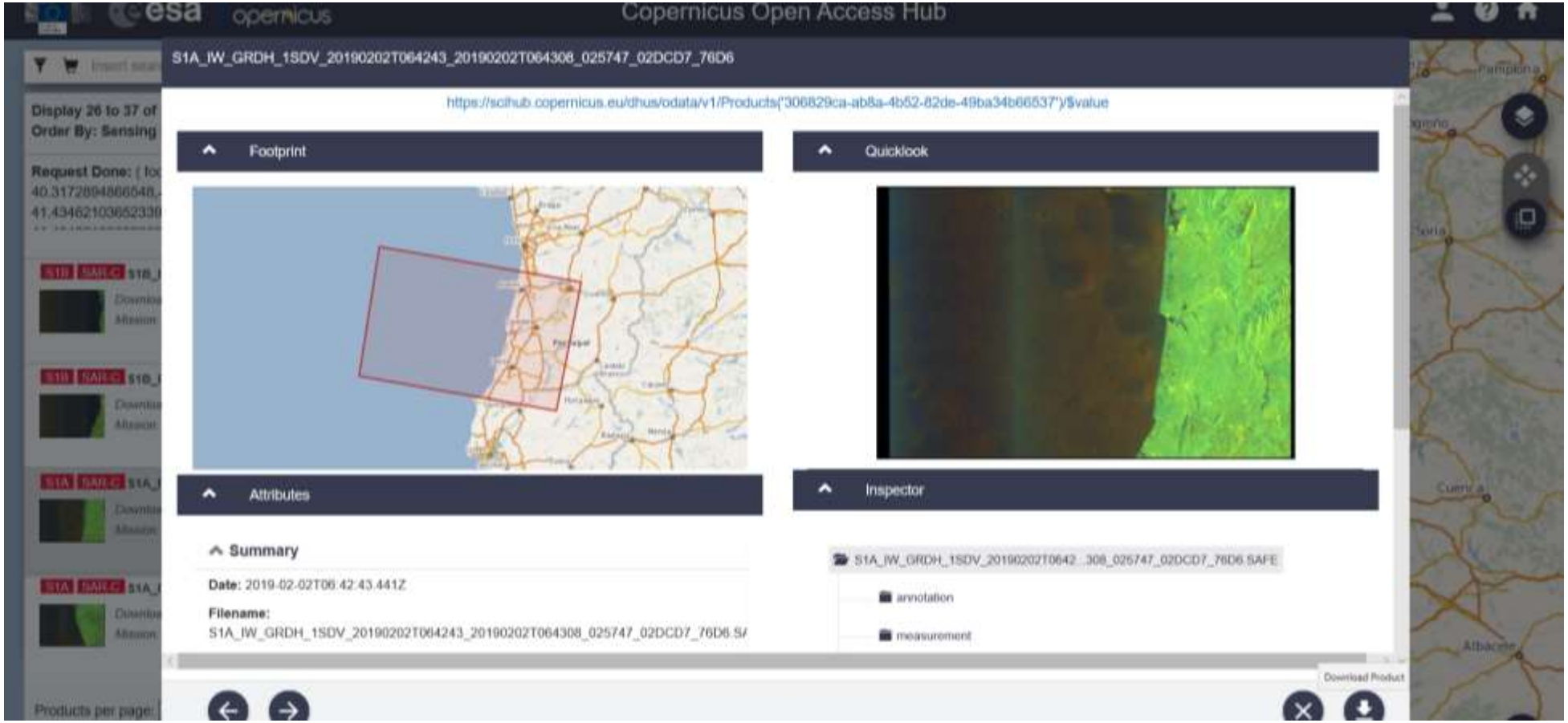
Data extraction



Data extraction



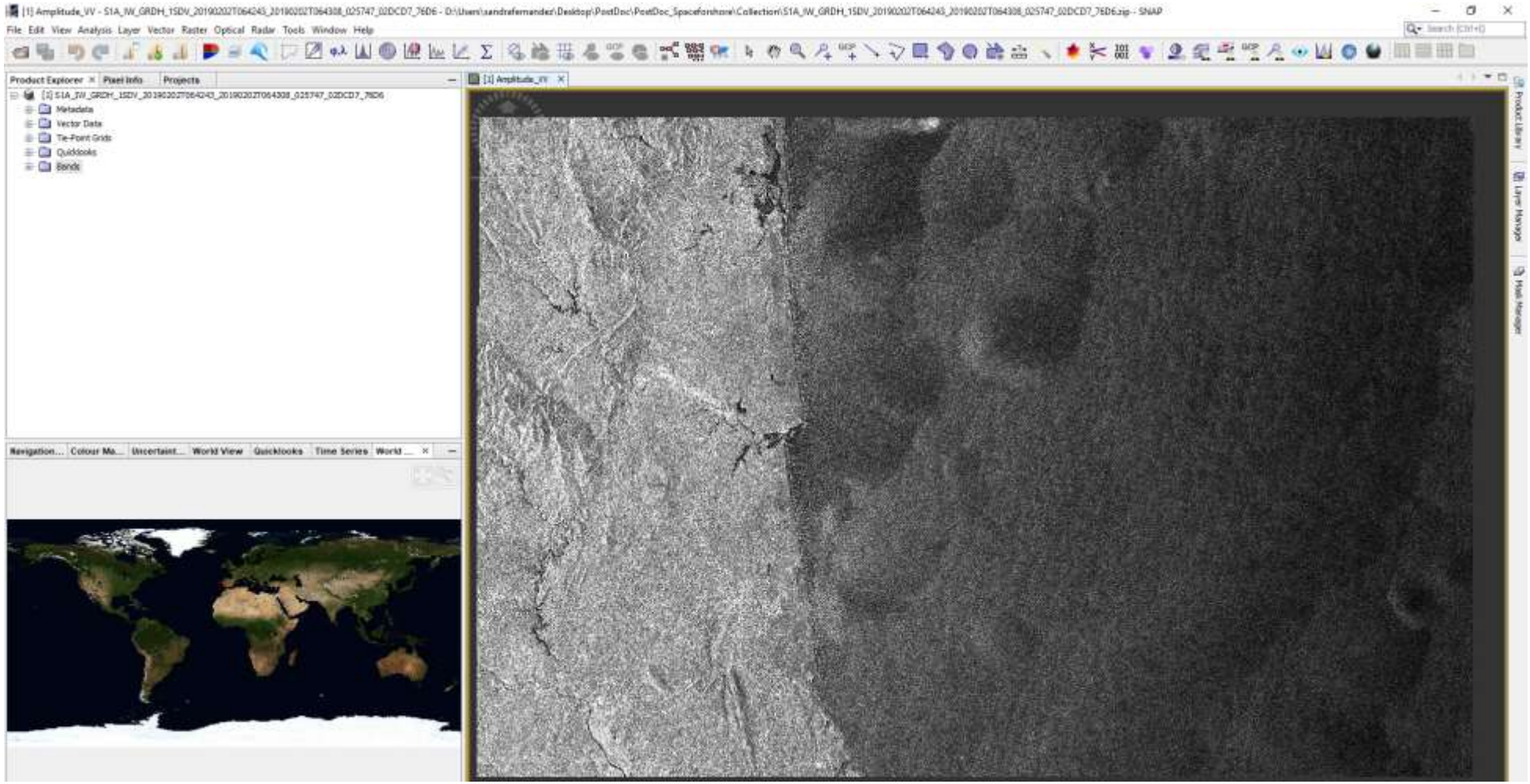
Data extraction



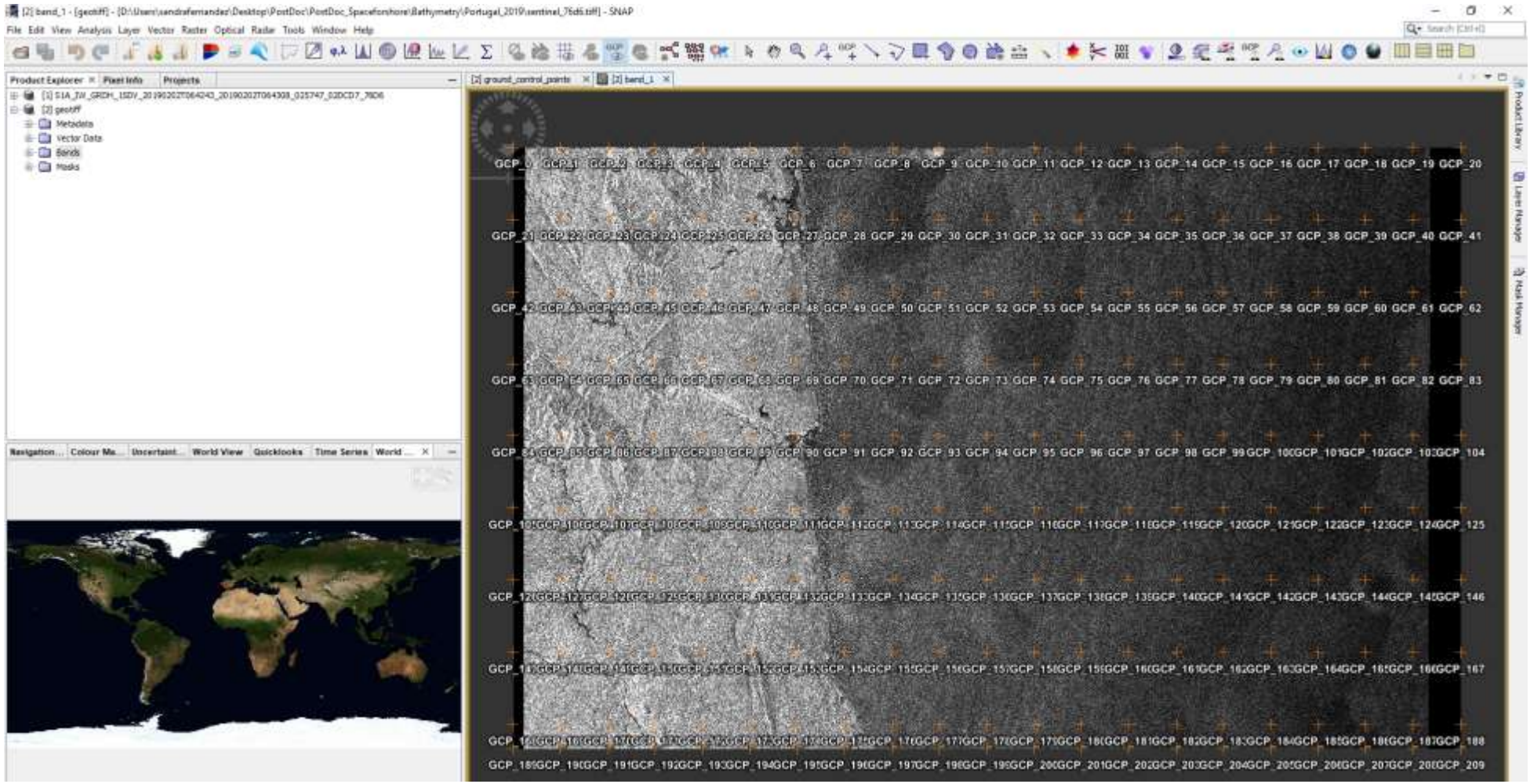
Data extraction

http://step.esa.int/main/download/snap-download/

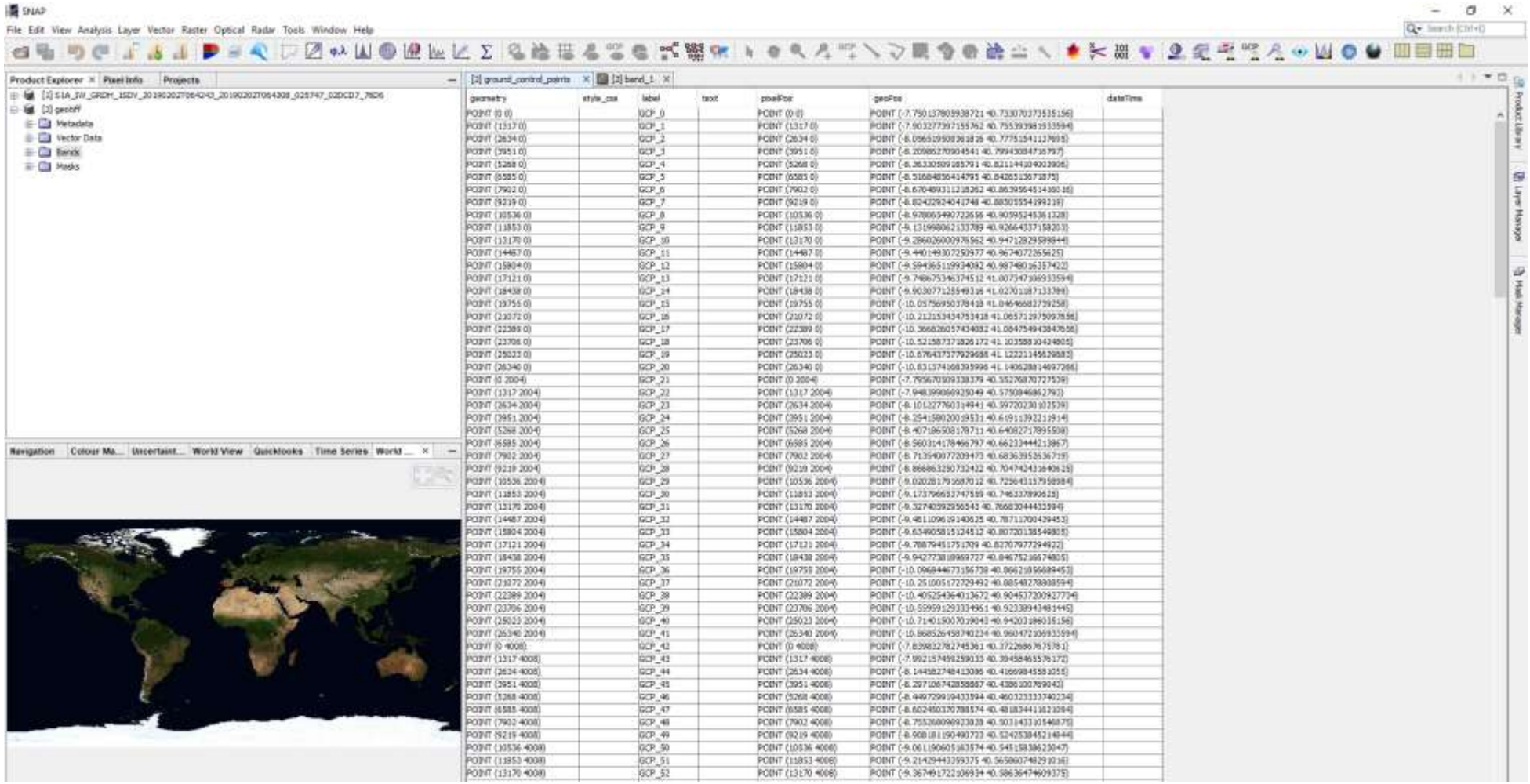
Data extraction



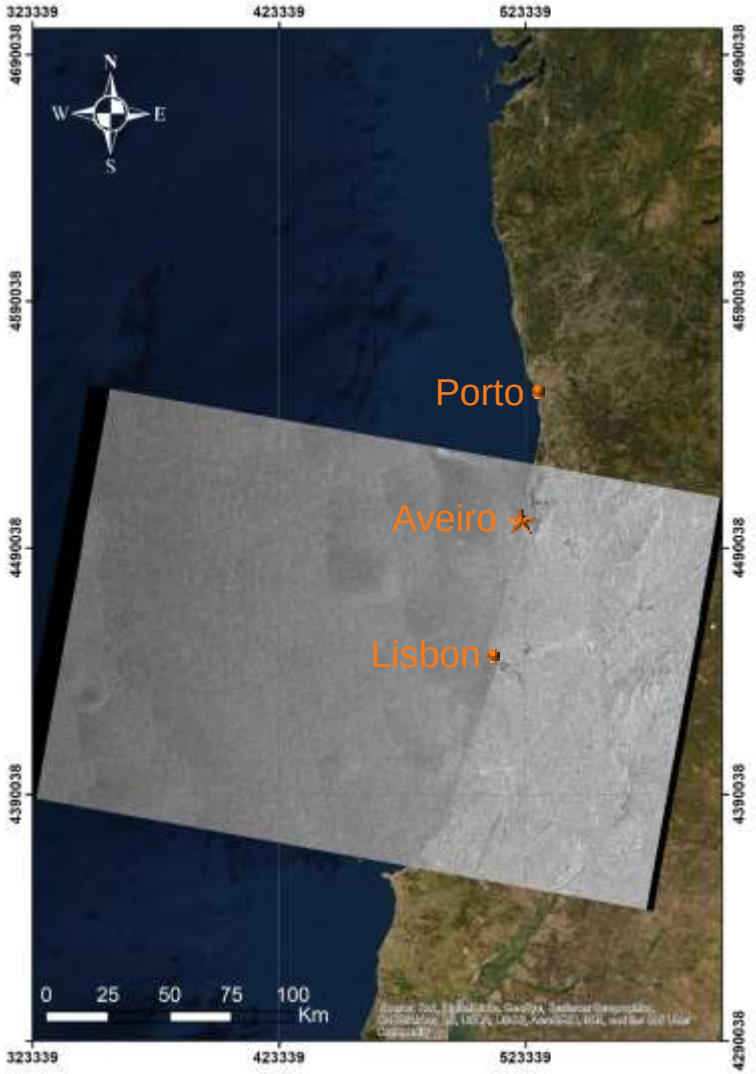
Data extraction



Data extraction

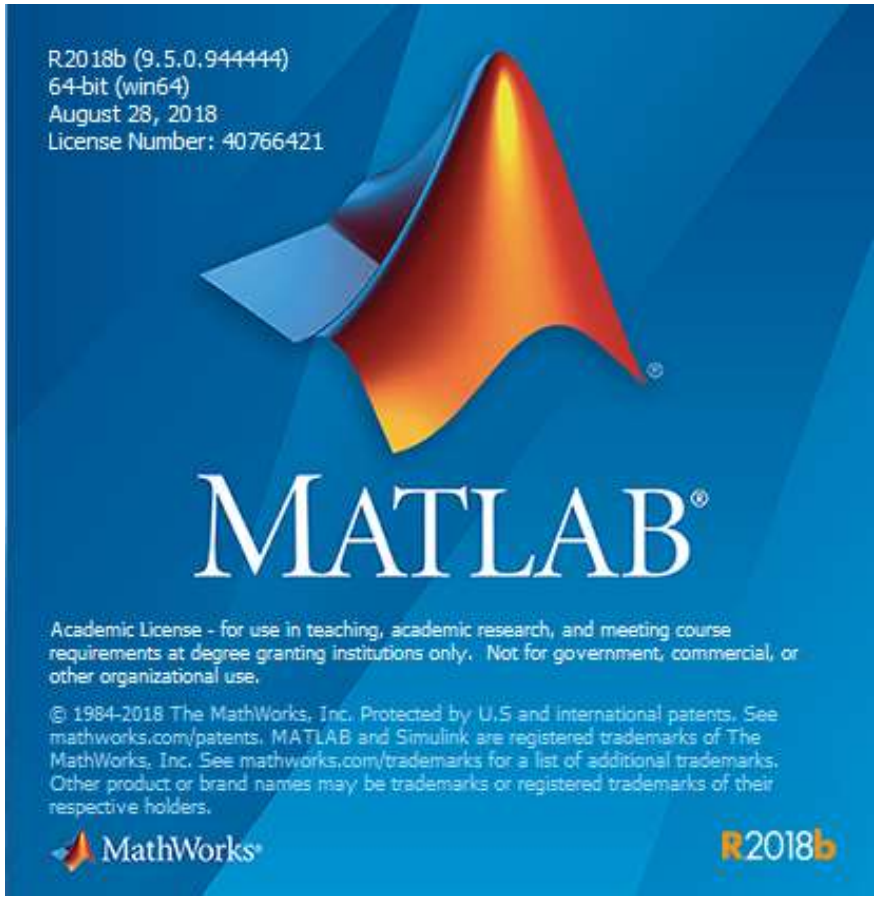


Data extraction



How do we obtain the subimages?

GetSubImages.m



GetSubImages.m

Input arguments:

- **ImageFilename**

```
ImageFilename='sentinel_76d6.tiff';
```

- **GridFilename**

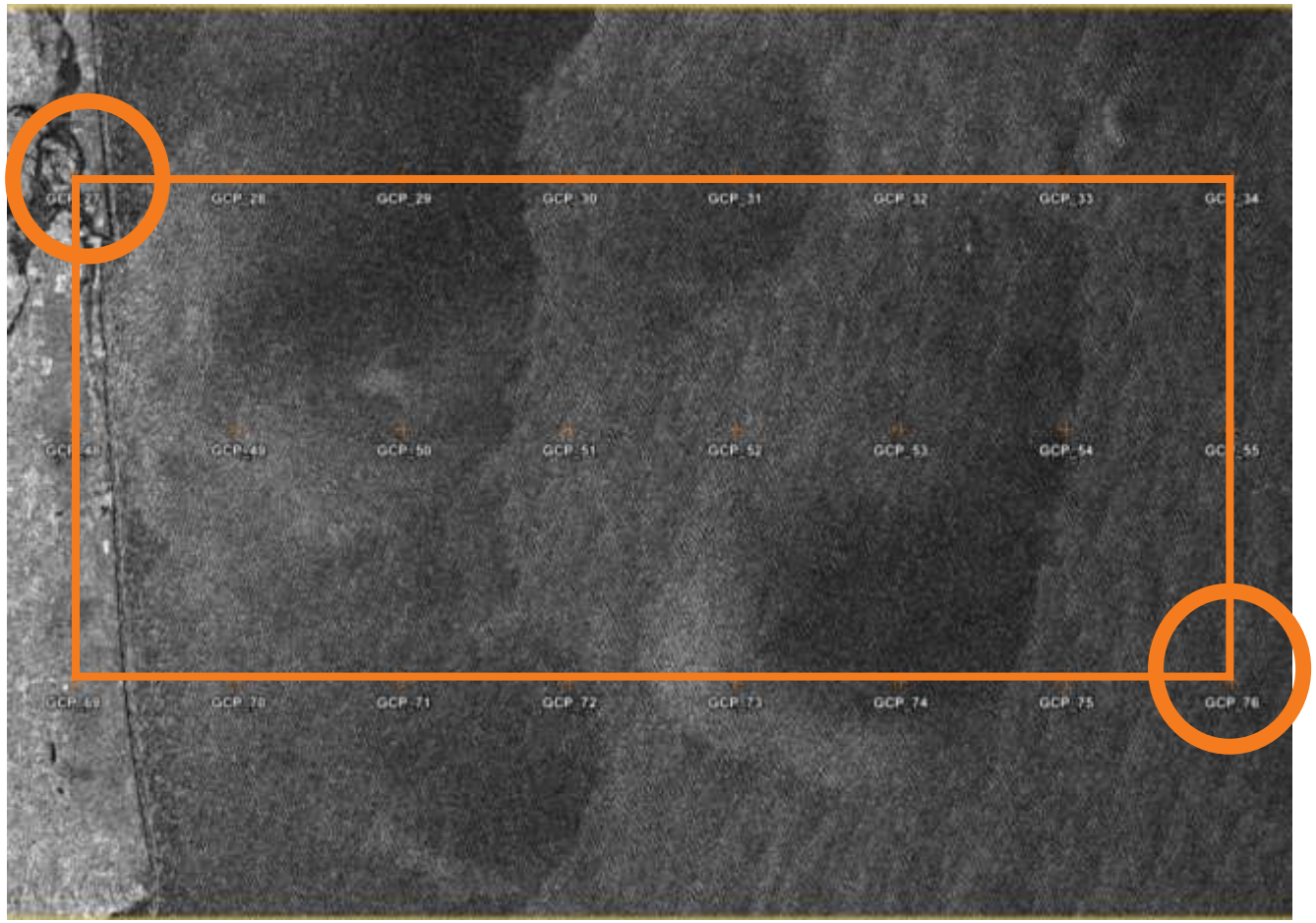
```
load('gcp_76d6.txt');
XA=gcp_76d6(:,1);
YA=gcp_76d6(:,2);
LON=gcp_76d6(:,3);
LAT=gcp_76d6(:,4);
```

GetSubImages.m

Input arguments:

- **Coordinates of the selected SubImage**

```
lat1=40.6836;
long1=-8.7135;
```

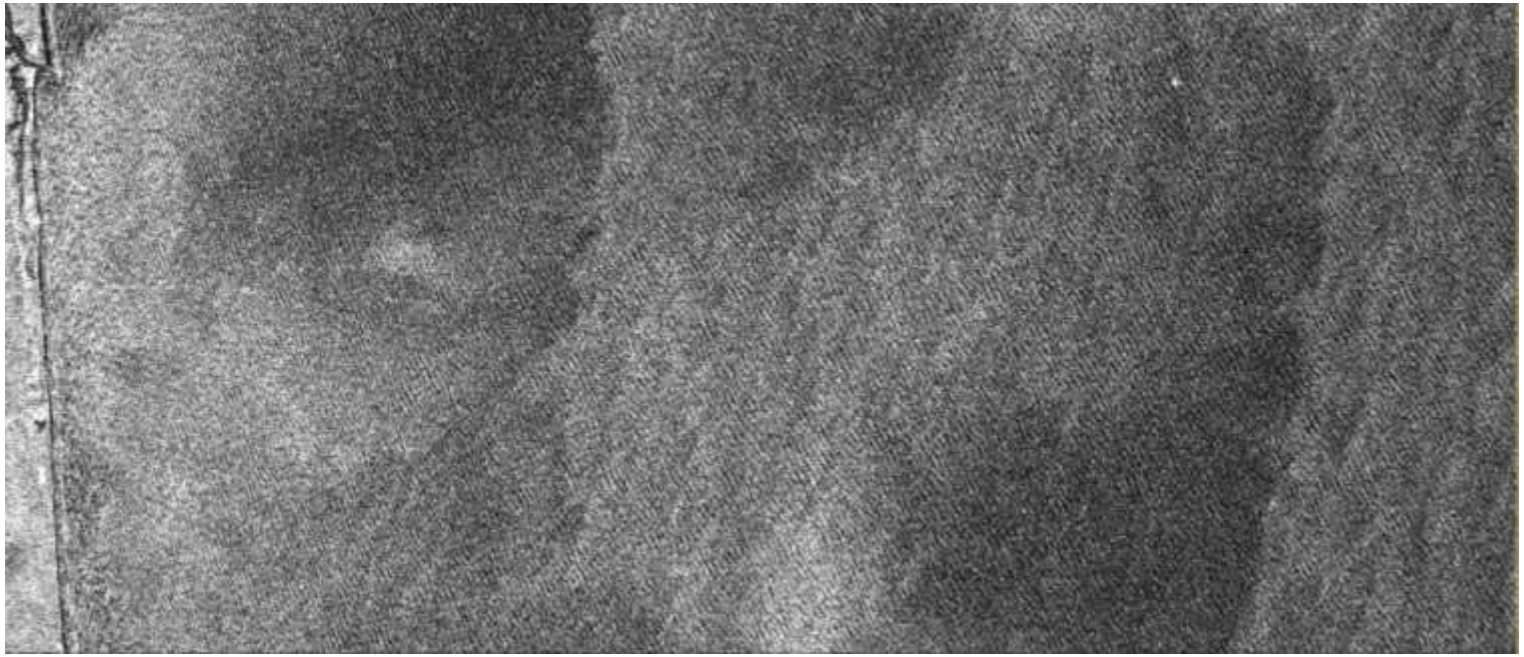



```
lat2=40.4664;
long2=-9.868;
```

GetSubImages.m

Output arguments:

- **SubImage – tiff file**



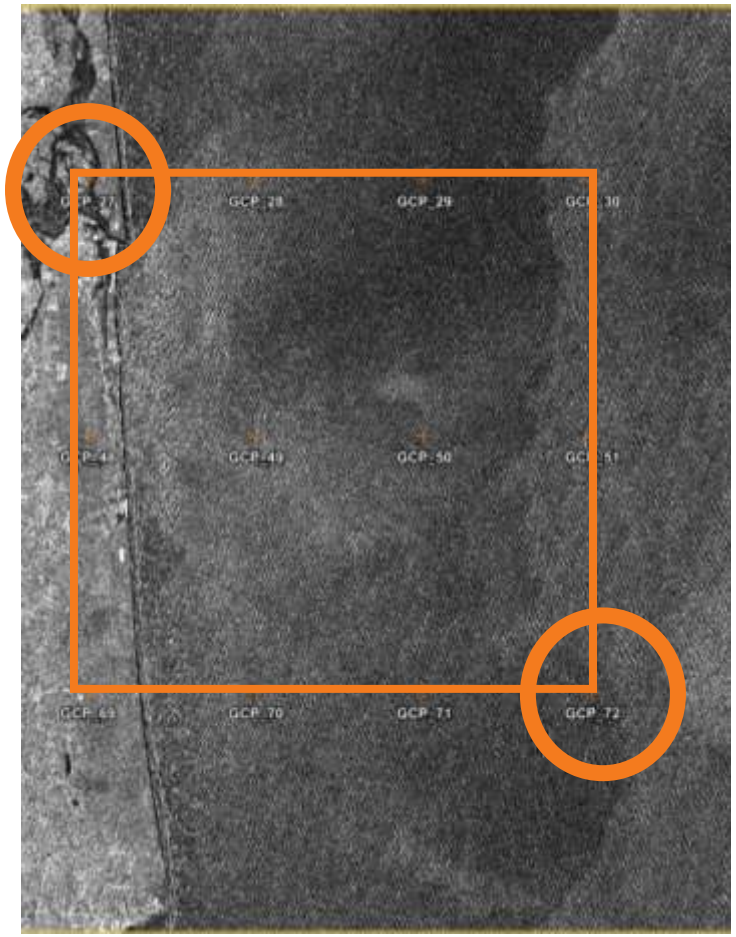
- **SubImage – txt file**

GetSubImages.m

Input arguments:

- **Coordinates of the selected SubSubImage**

```
lat1=40.6836;
long1=-8.7135;
```

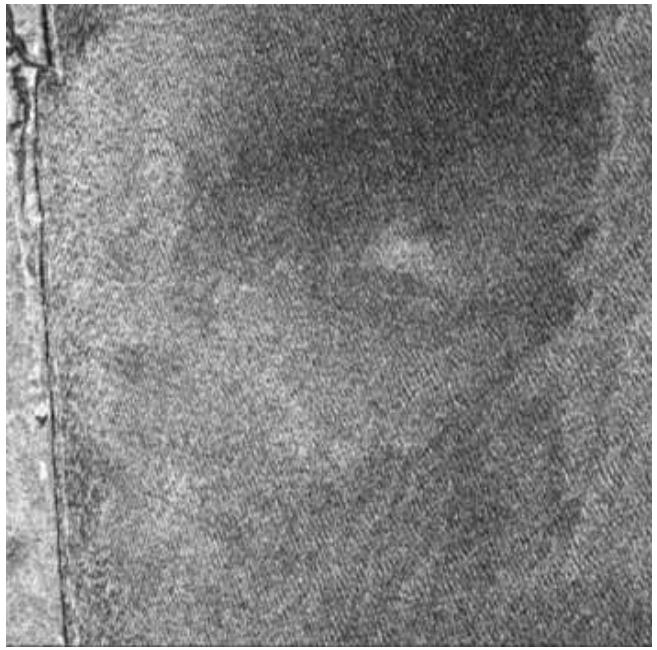



```
lat2=40.3857;
long2=-9.257;
```

GetSubImages.m

Output arguments:

- **SubSubImage – tiff file**

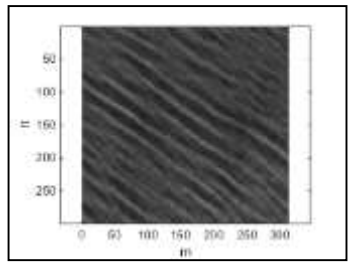


- **SubSubImage – txt file**

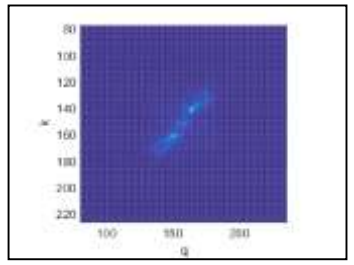
How do we estimate the wavelength at deep waters?

CalcWavelengthGrid.m

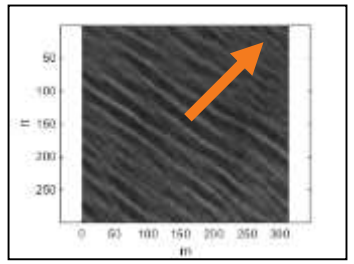
1st Detection of the wave front



2nd Directional spectrum FFT



3rd Wavelength and wave direction



CalcWavelengthGrid.m

Input arguments:

- **ImageFilename** - string with the filename of the image file to be analyzed.
- **MetersPerPixel** - scalar indicating the size, in meters, of one image pixel.
- **CellSize** - length, in meters, of the side of each squared section that will be considered in dividing the image.
- **GridSpacing** - spacing, in meters, between two consecutive squared sections in which the image is divided.

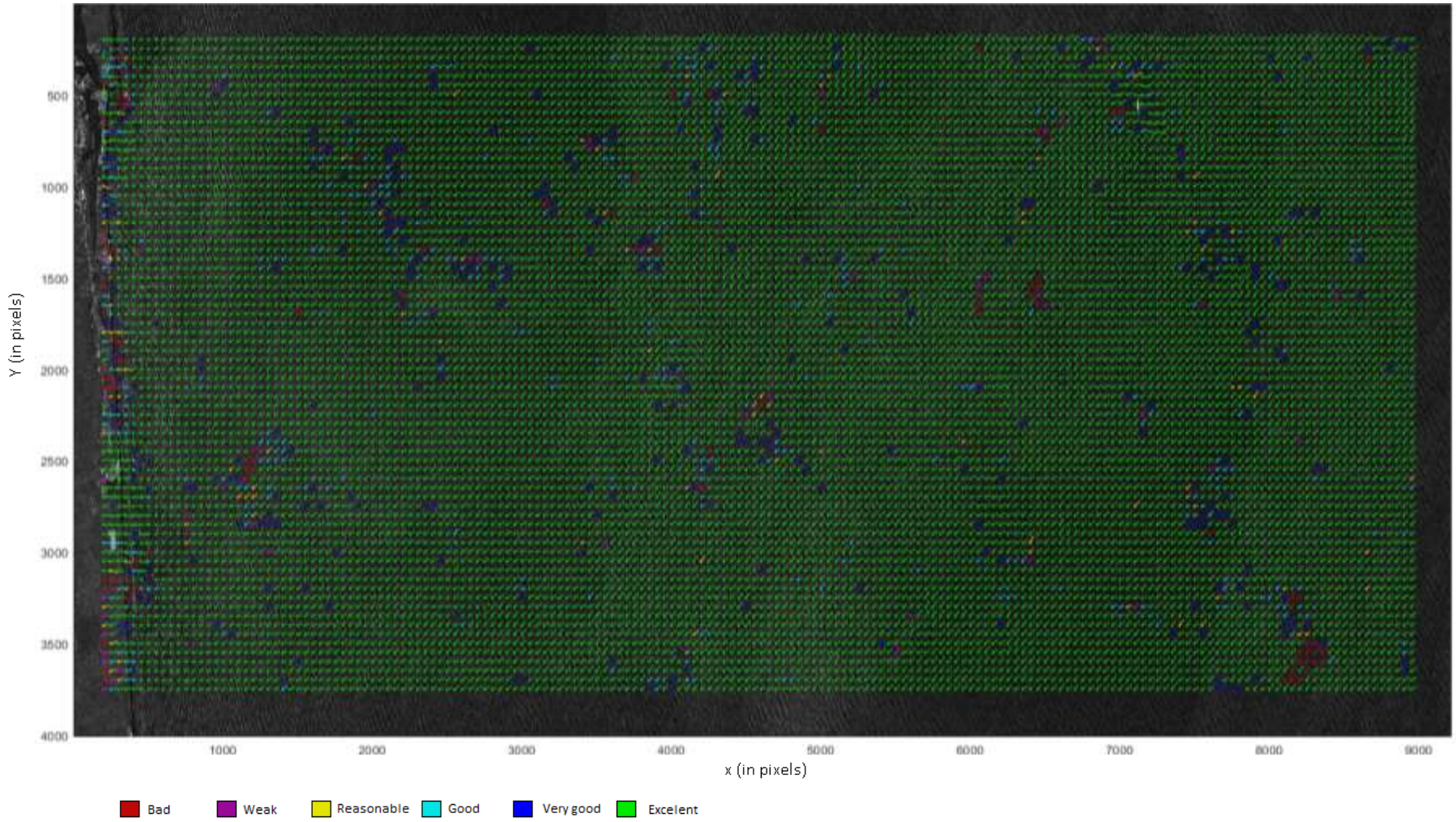
```
[X,Y,Lambda0,Alpha,Quality]=CalcWavelengthGrid('SubImage001.tiff',10,4000,500);
```

CalcWavelengthGrid.m

Ouput arguments:

- **X** - matrix (RxC) with the horizontal position, in meters, of the centers of the image sections that were considered for processing.
- **Y** - same as X, but for the vertical coordinate.
- **Lambda0** - matrix (RxC) with the determined wavelengths of the sea waves for each image section (wavelength given in meters).
- **Alpha** - matrix (RxC) with the wave direction for each section, in degrees.
- **Quality** - matrix (RxC) with a value indicating the quality of the obtained solution for each section, according to the sharpness of the FFT results.

CalcWavelengthGrid.m



CalcWavelengthGrid.m

```
Quality0_5=Quality;
Quality0_5(Quality <5)=NaN;

Lambda0_5=Lambda0;
Lambda0_5(Quality <5)=NaN;


Lambda05=[reshape(Lambda0_5,m*n,1)];
```

PixelToGroundCoordinates.m

Input arguments:

- **xp** - matrix (Nx2) with the image coordinates of N selected pixels,in the format:[n m] where
  - n is the horizontal coordinate (in pixels)
  - m is the vertical coordinate (in pixels)

- **GridFilename**

```
p=10;
X=X./p;
Y=Y./p;

Grid_point_initial_X=7902;
Grid_point_initial_Y=2004;
[m n]=size (X);

xp=[reshape(X+Grid_point_initial_X,m*n,1)reshape(Y+Grid_point_initial_Y,m*n,1)];

[xg]=PixelToGroundCoords(xp,'gcp_subimagem_76d6.txt');
```

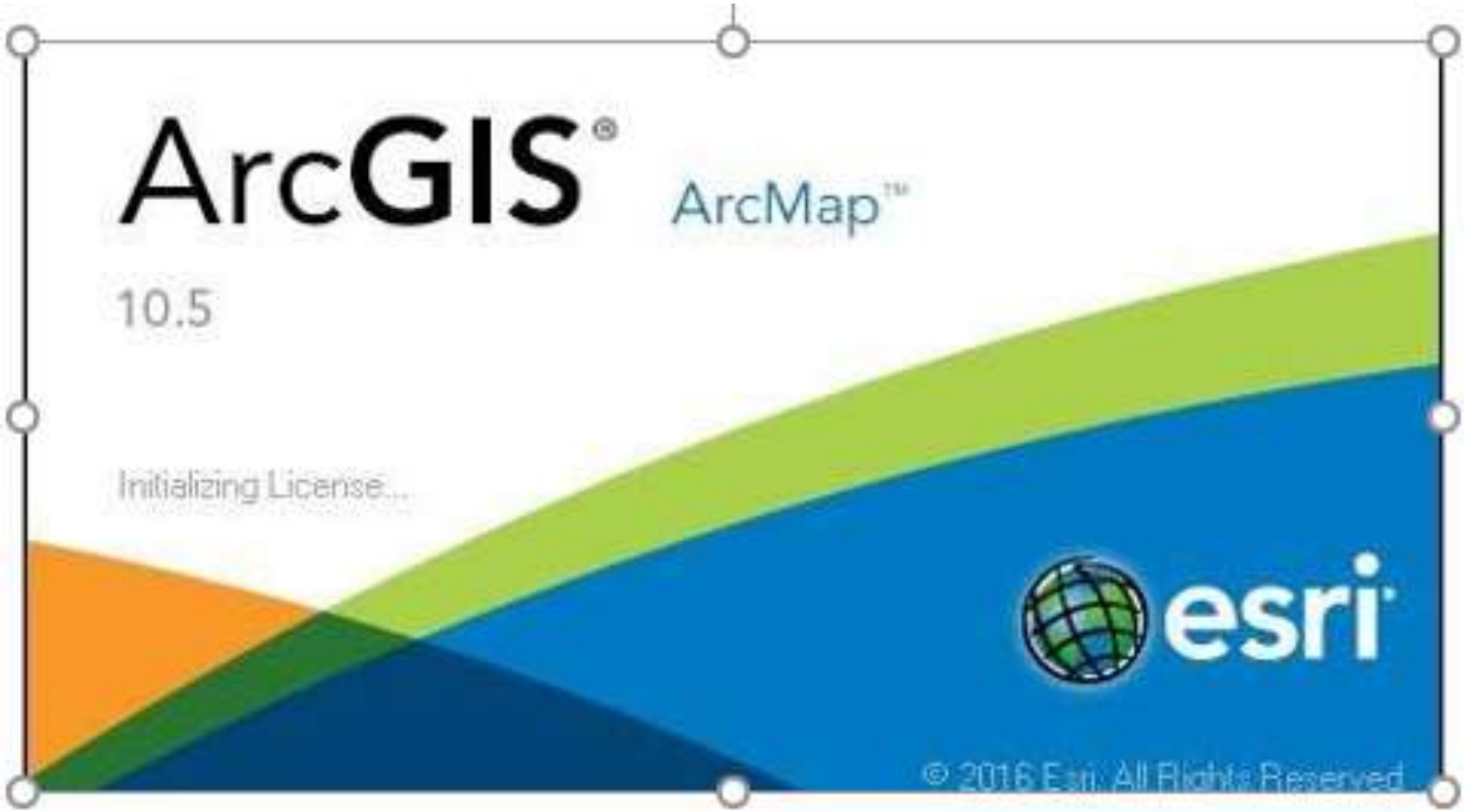
PixelToGroundCoordinates.m

Output argument:

- **xg** - matrix (Nx2) with the calculated ground coordinates corresponding to the respective image pixels of xp (in the same units provided in the grid file).

```
Xg=xg(:,1)%Longitude
Yg=xg(:,2)%Latitude
```

```
Lambda0_5_76d6_GCP27_76_cell4000=[Xg Yg Lambda05];
```


ArcGIS®
ArcMap™
10.5
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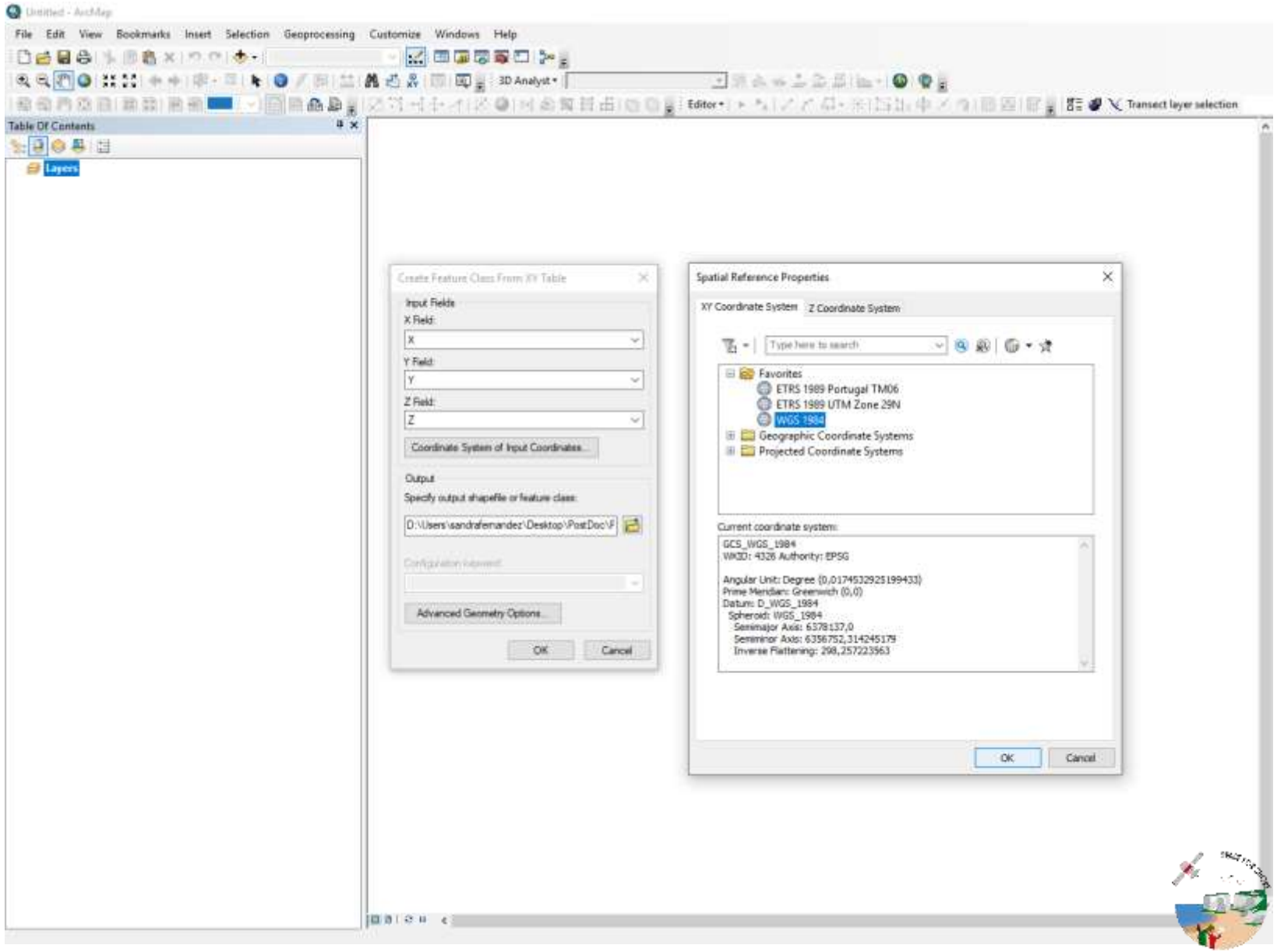
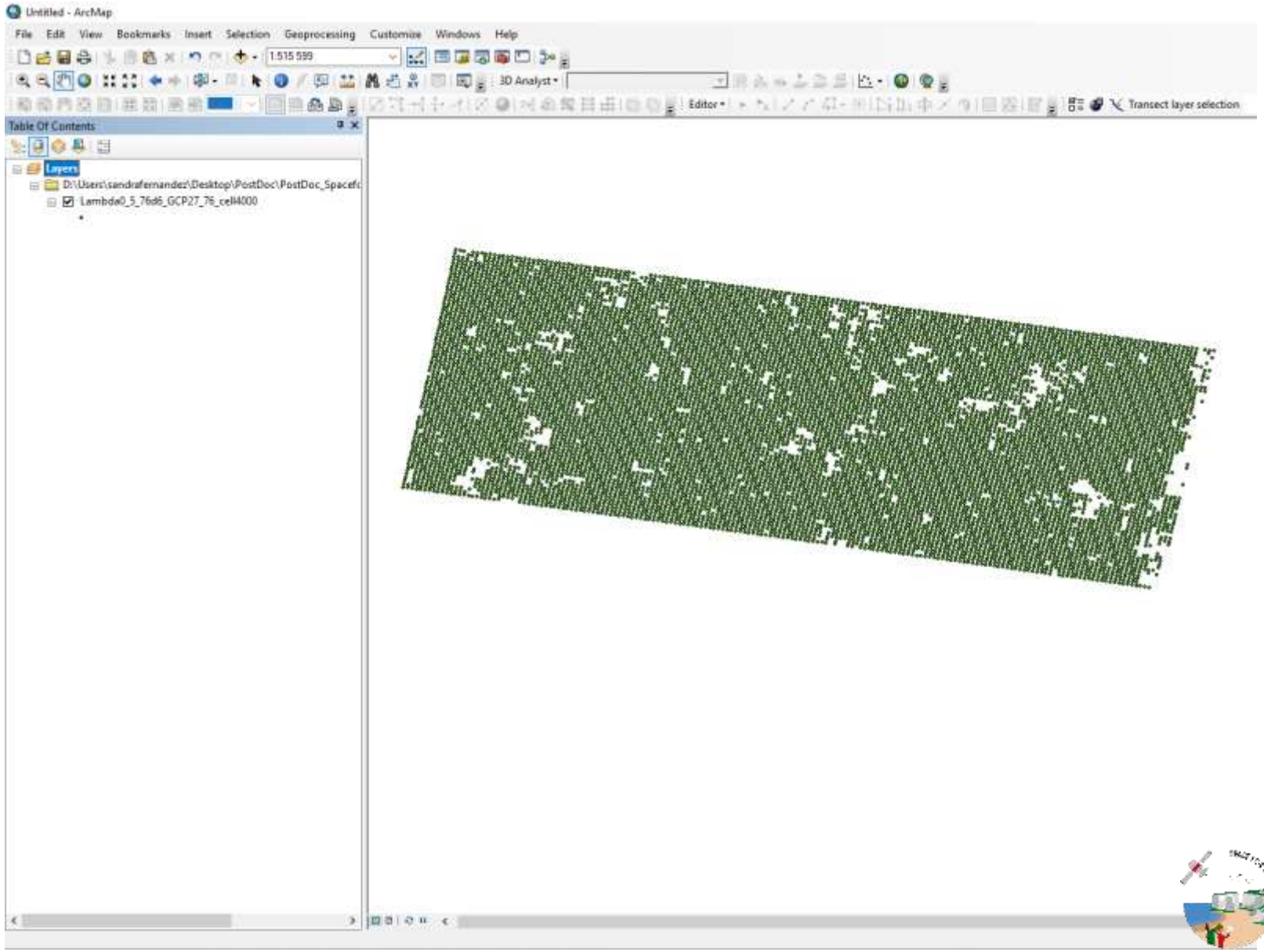
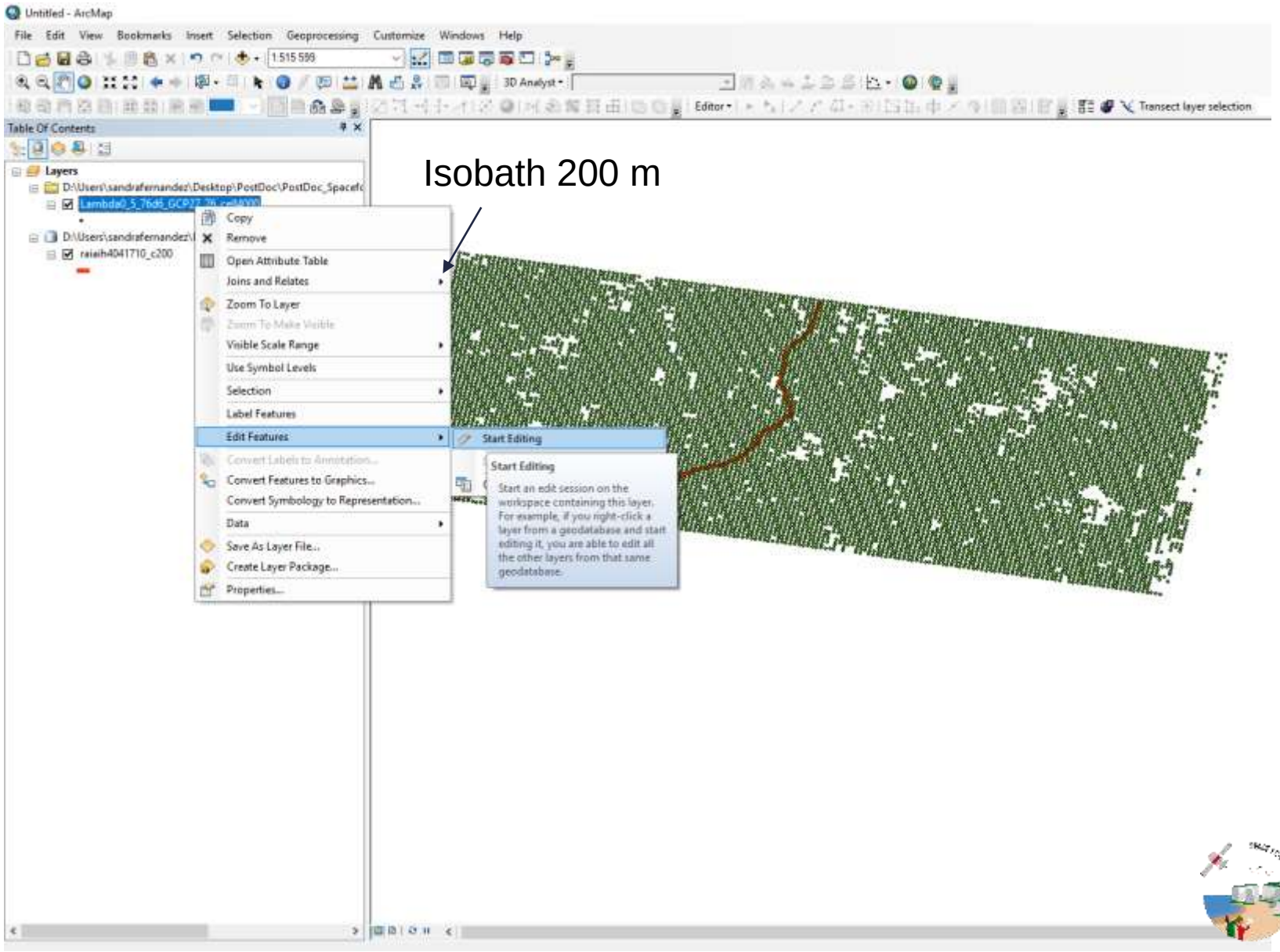
Input file: Lambda0_5_76d6_GCP27_76_cell4000.txt



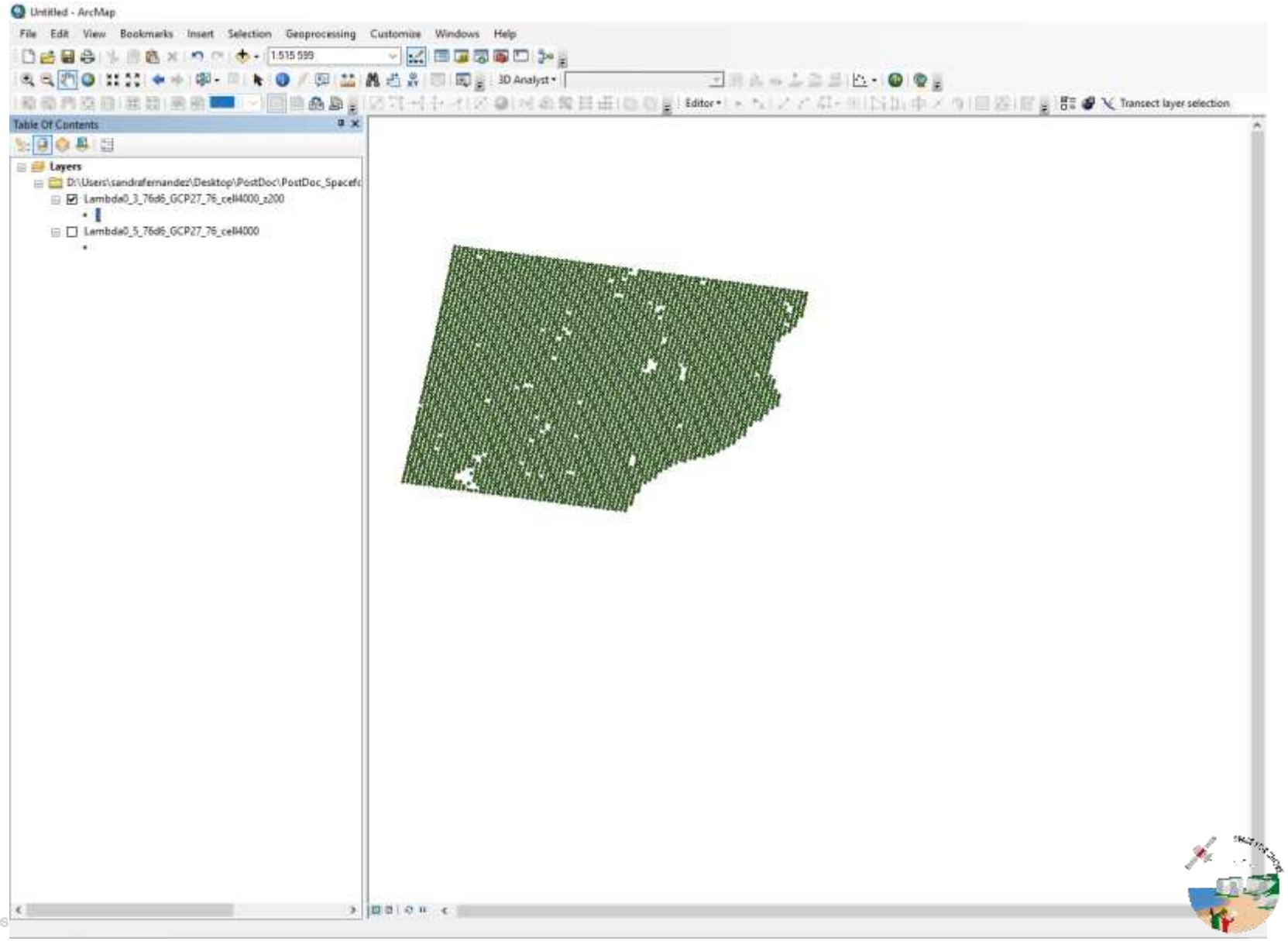
Output file: Lambda0_5_76d6_GCP27_76_cell4000.shp



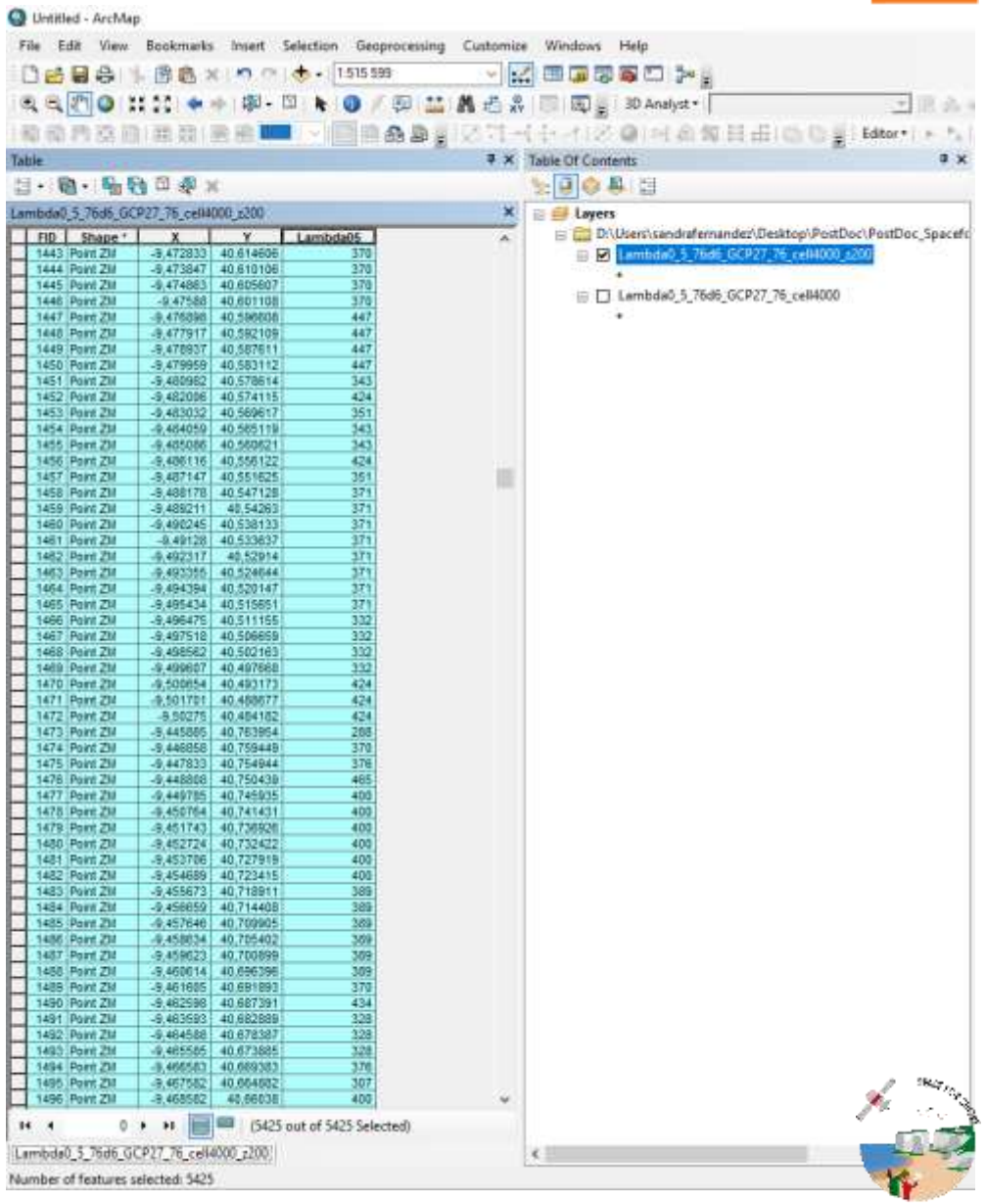
Input/Output file: **Lambda0_5_76d6_GCP27_76_cell4000_z200.shp**

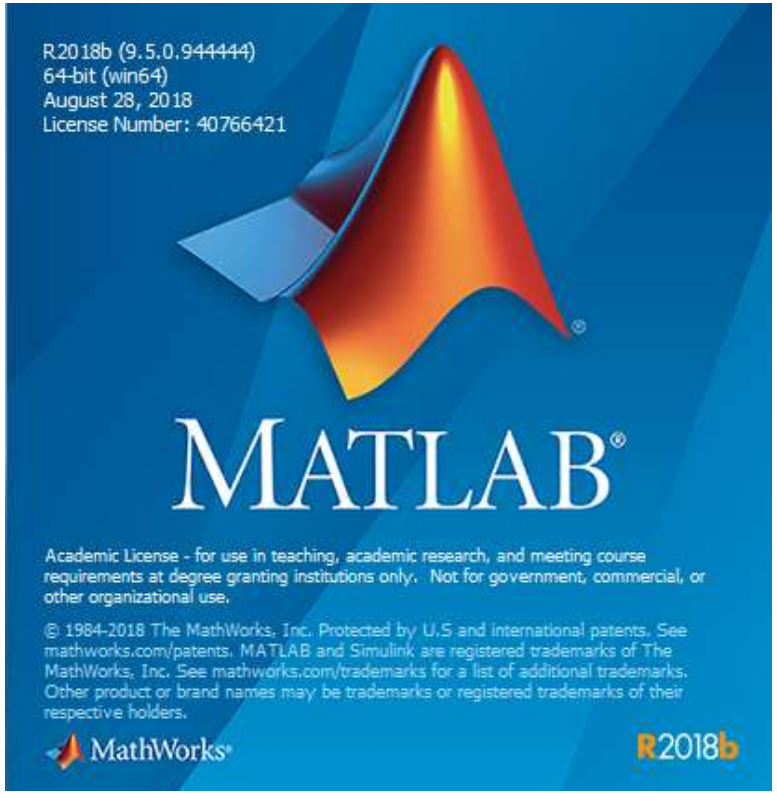


Output file: Lambda0_5_76d6_GCP27_76_cell4000_z200.shp



Output file: Lambda0_5_76d6_GCP27_76_cell4000 z200.txt




R2018b (9.5.0.944444)
64-bit (win64)
August 28, 2018
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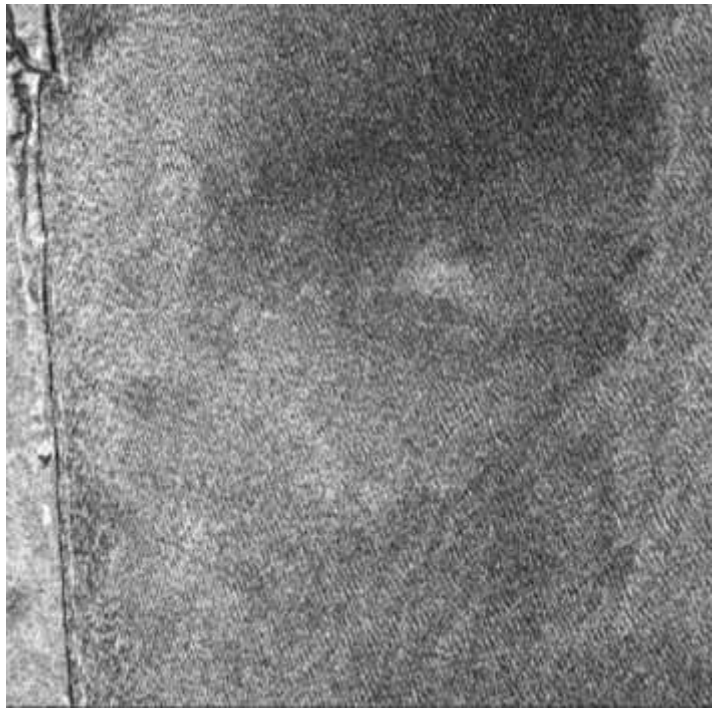
R2018b

```
F=load('Lambda0_5_76d6_GCP27_76_cell4000_z200.txt');

Lambda0_5_z200=F(:,5);

Lambda0=nanmean(Lambda0_5_z200);
```

How do we estimate the depth?

CalcWavelengthGrid.m



```
[X,Y,Lambda,Alpha,Quality]=CalcWavelengthGrid('SubSubImage.tiff',10,2500,500);
```

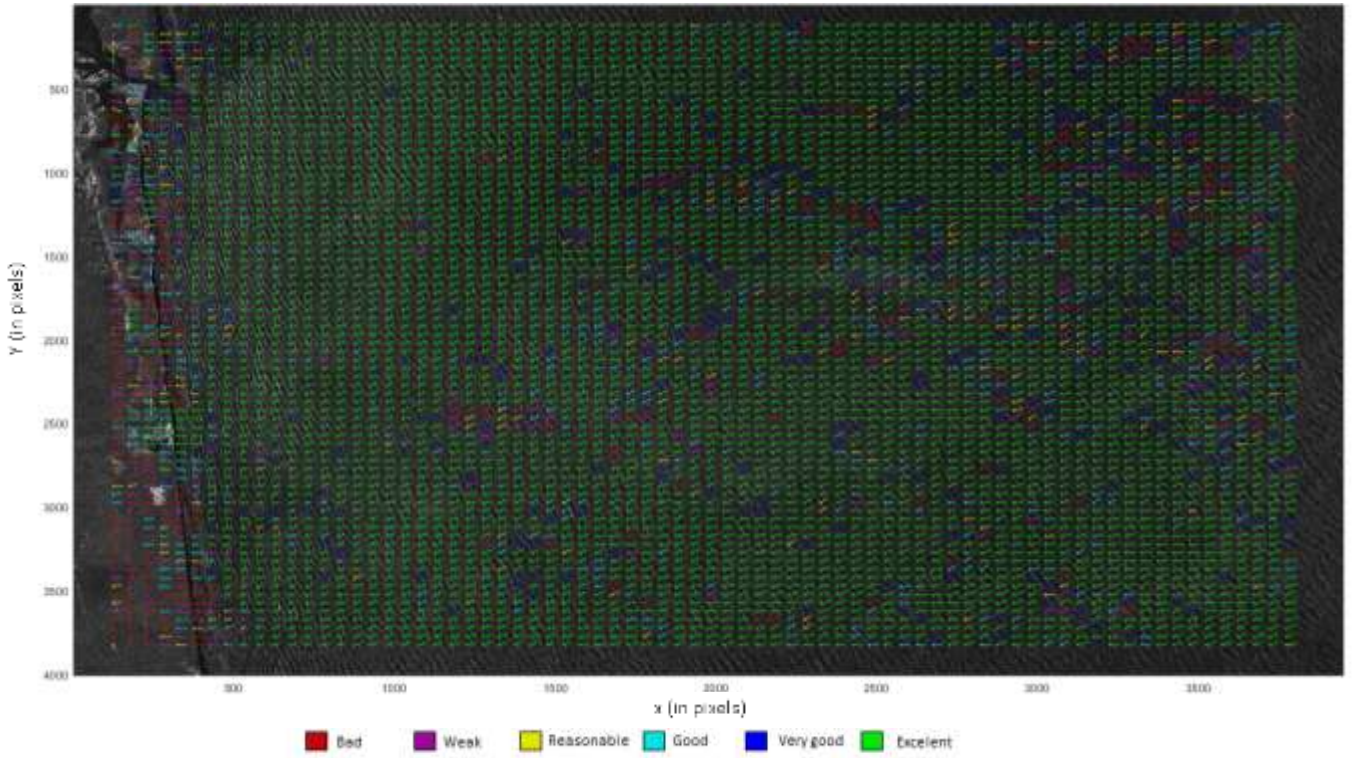
PixelToGroundCoordinates.m

```
p=10;
X=X./p;
Y=Y./p;

Grid_point_initial_X=7902;
Grid_point_initial_Y=2004;
[m n]=size (X);

xp=[reshape(X+Grid_point_initial_X,m*n,1)reshape(Y+Grid_point_initial_Y,m*n,1)];

[xg]=PixelToGroundCoords(xp,'gcp_subimagem_76d6.txt');
```

Bathymetry.m

- **1st Selecting wavelengths with Quality>3**

```
Lambda_3=Lambda;
Lambda_3(Quality <3)=NaN;
```



Bathymetry.m

➢ **2nd Estimation of the bathymetry with Linear Wave Theory**

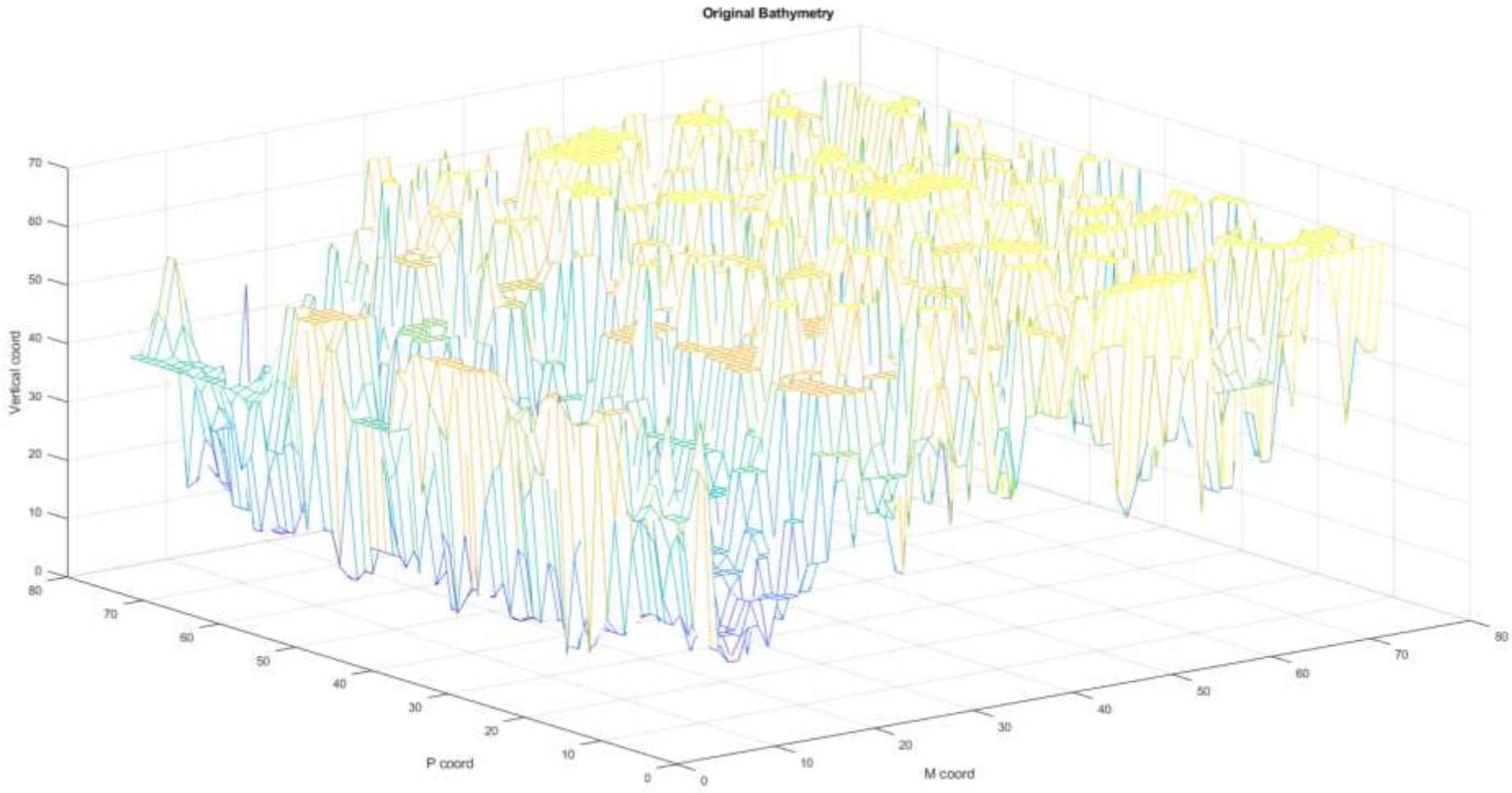
```
h=zeros(size(Lambda_3));

for i=1:size(Lambda_3,1);
    for j=1:size(Lambda_3,2);
        if Lambda_3 (i,j) < Lambda0
        h (i,j)= (Lambda_3 (i,j)./(2*pi)).*atanh(Lambda_3(i,j)./Lambda0);
        else
        h (i,j)=NaN;
        end
    end
end
```


Bathymetry.m

- **3rd Application of tidal correction**

```
load ('pred_ba_2019_2_1.dat');

tide=pred_ba_2019_2_1(308,5);

h_def=-1*(h-tide);
```

Bathymetry.m

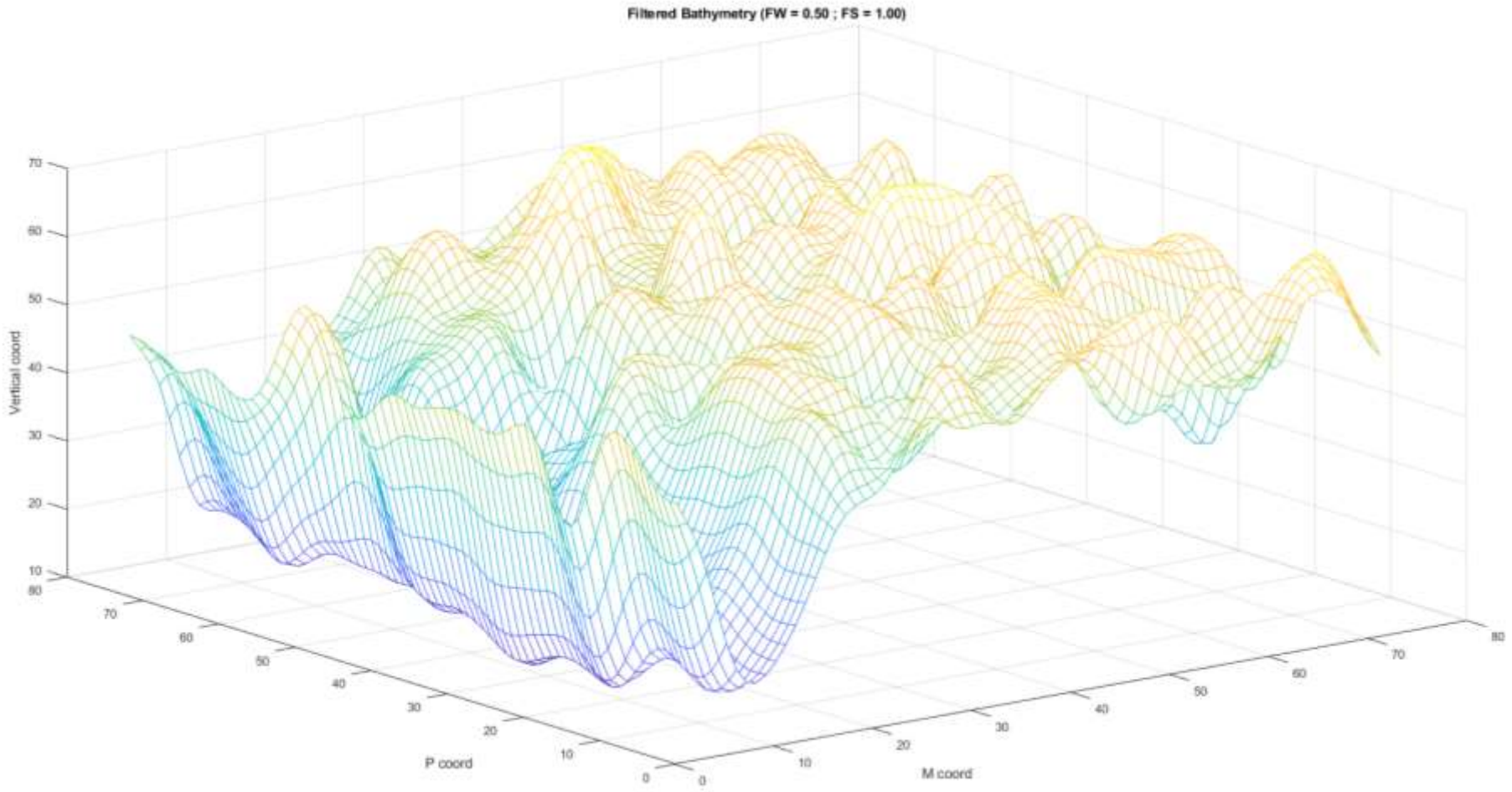


Bathymetry.m

➢ **4th Application of filter to obtain a smooth bathymetry**

```
for q=2:size(h_def,1)-1
    for r=2:size(h_def,2)-1
        if isnan (h_def(q,r))
           h_def(q,r)=nanmean([h_def(q-1,r) h_def(q+1,r) h_def(q,r-1) h_def(q,r+1)]);
        end
    end
end

FilterWidth=0.5;
FilterSharpness=1;

h_defs=FilterBathymetry(h_def(2:end-1,2:end-1),FilterWidth,FilterSharpness);
```

FilterBathymetry.m



Bathymetry.m

```
[mm nn]=size (h_defs);
Z_s=[reshape(h_defs,mm*nn,1)];


Xg2=[reshape(Xg,m,n)];
Xgs= Xg2(2:end-1,2:end-1); Xgs2=[reshape(Xgs,mm*nn,1)];

Yg2=[reshape(Yg,m,n)];
Ygs= Yg2(2:end-1,2:end-1);
Ygs2=[reshape(Ygs,mm*nn,1)];

Bat_s=[Xgs2,Ygs2,Z_s];
```

How do we know if the result is realistic?


ArcGIS®
ArcMap™
10.5
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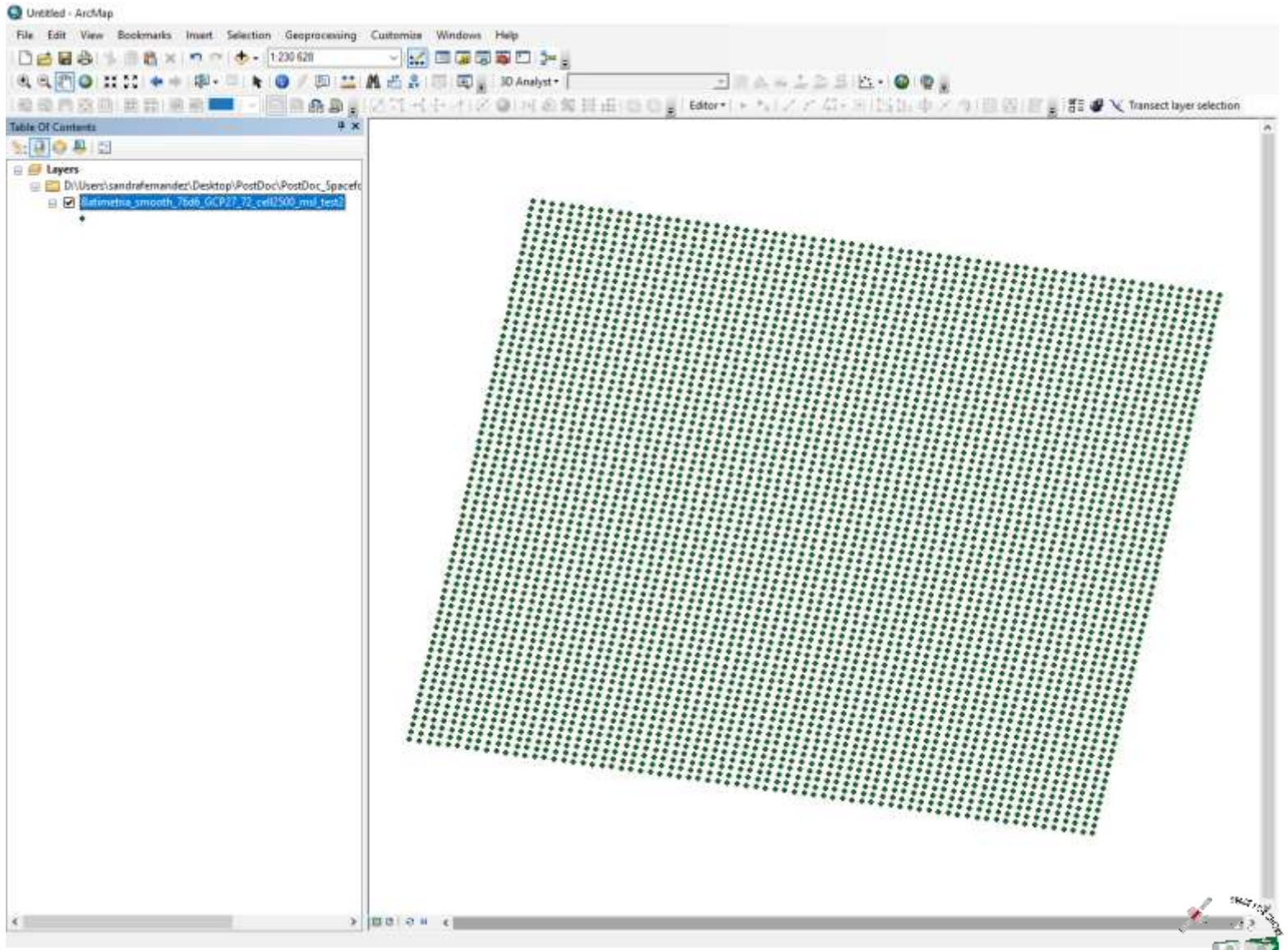
Bathymetry

Bat_s text file

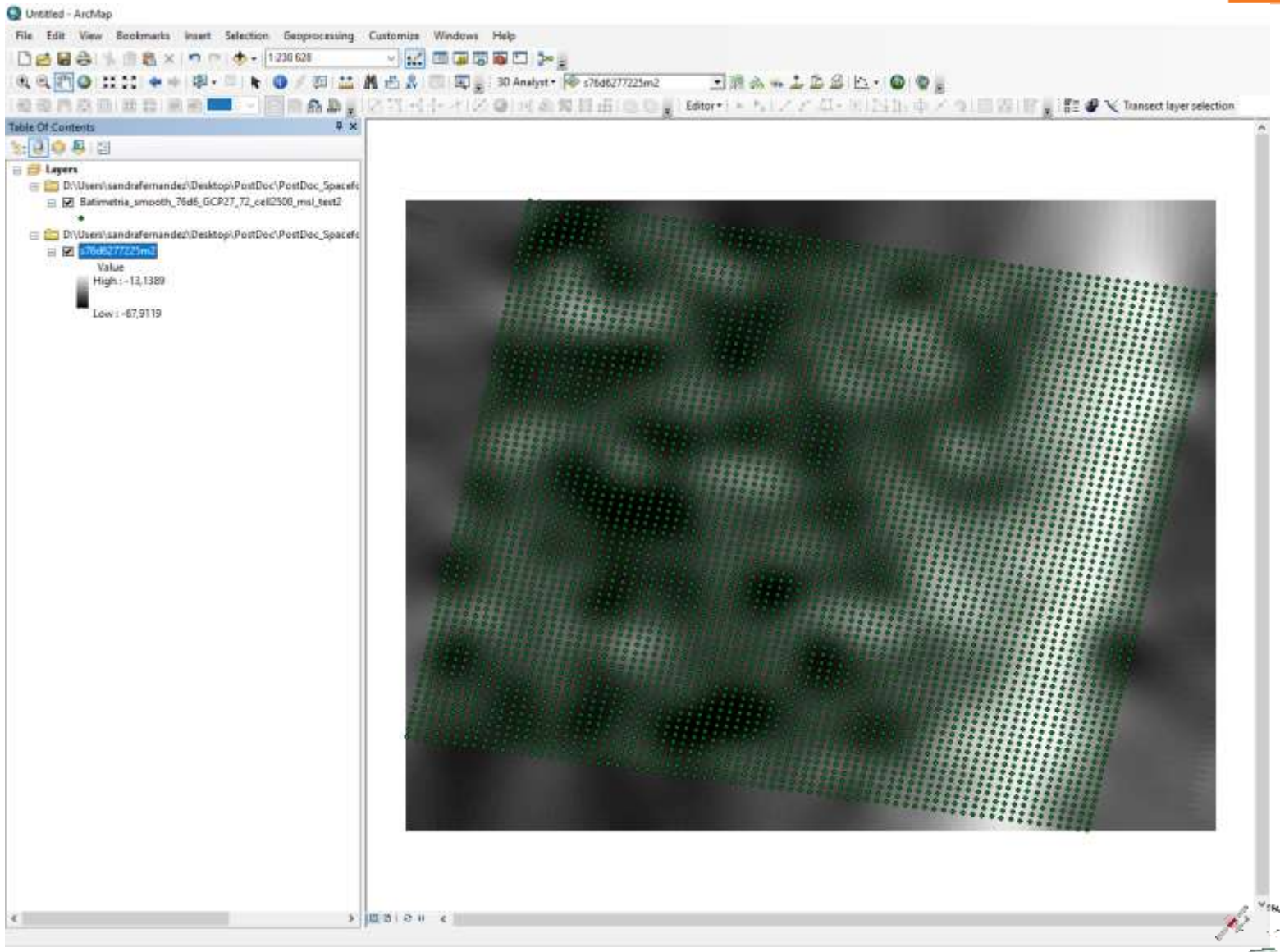
➢ 1st Create a shape



Bathymetry

Bat_s shape file

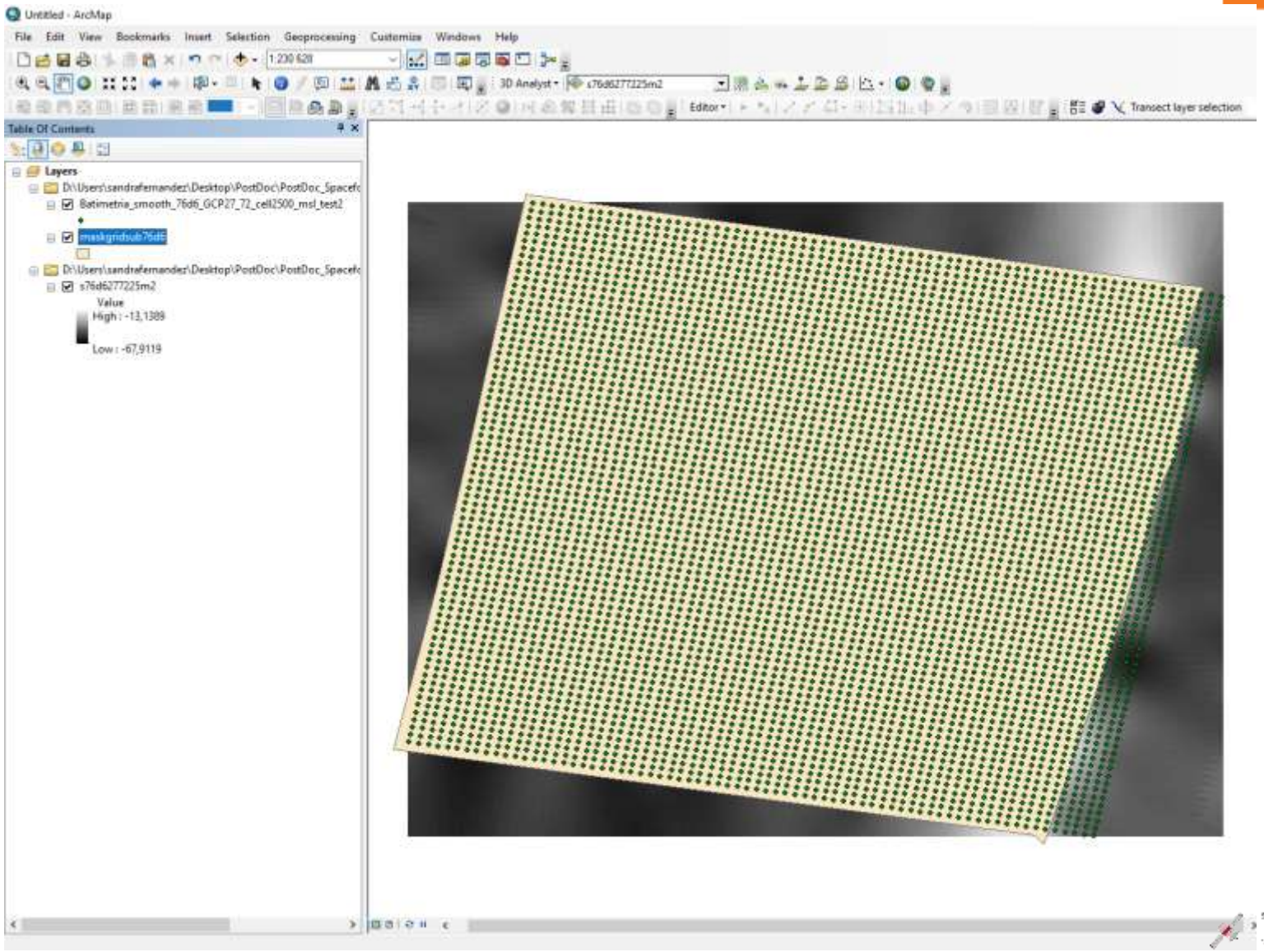
➢ **2nd Interpolate**



Bathymetry

Bat_s raster file

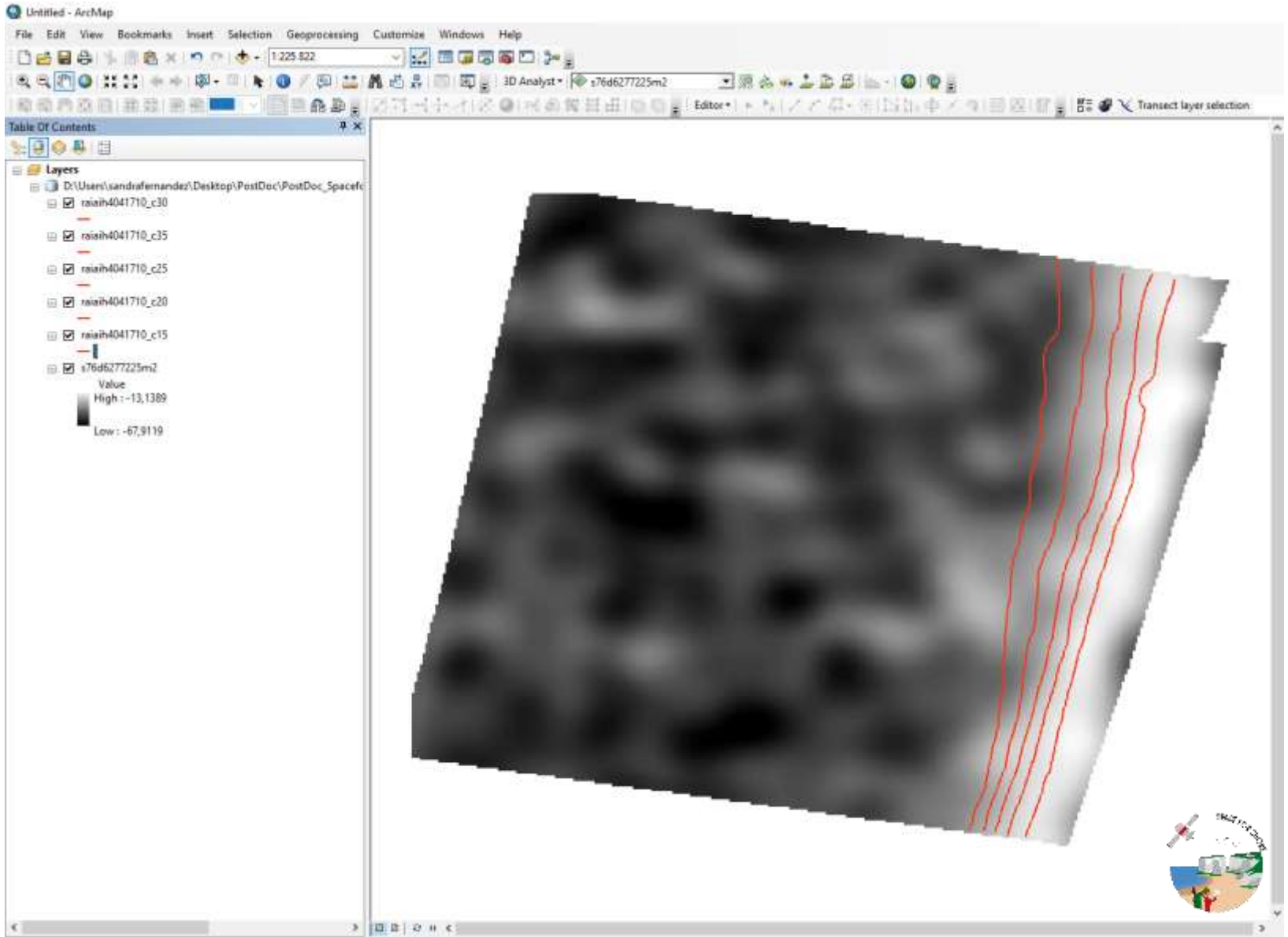
➢ **3rd Extract the area of interest**



Bathymetry

➢ 4th Extract the values of depth along measured isobaths

Bat_s raster file



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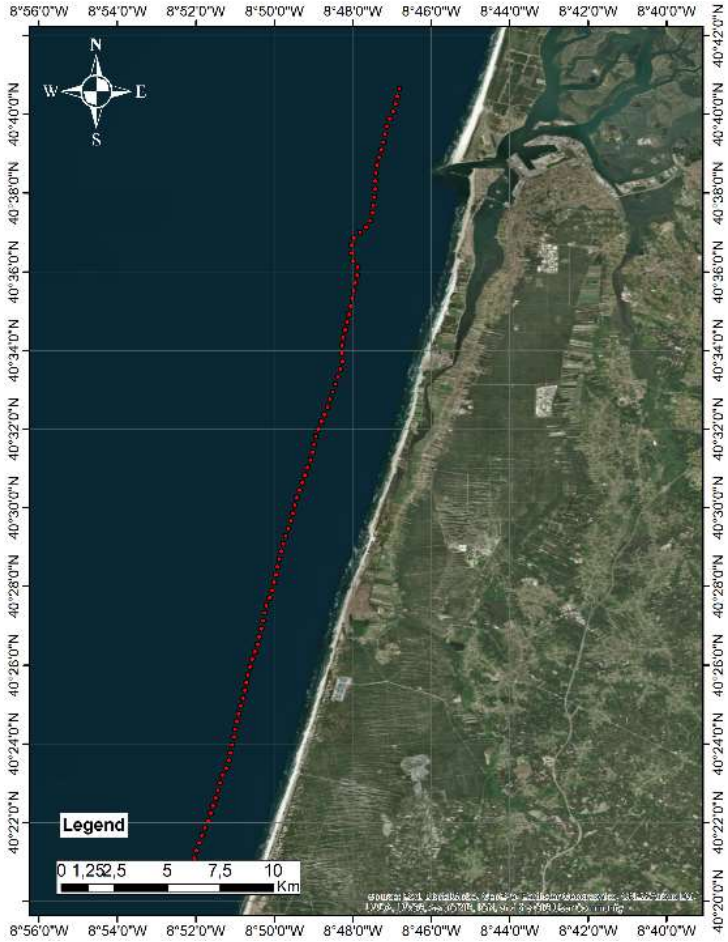
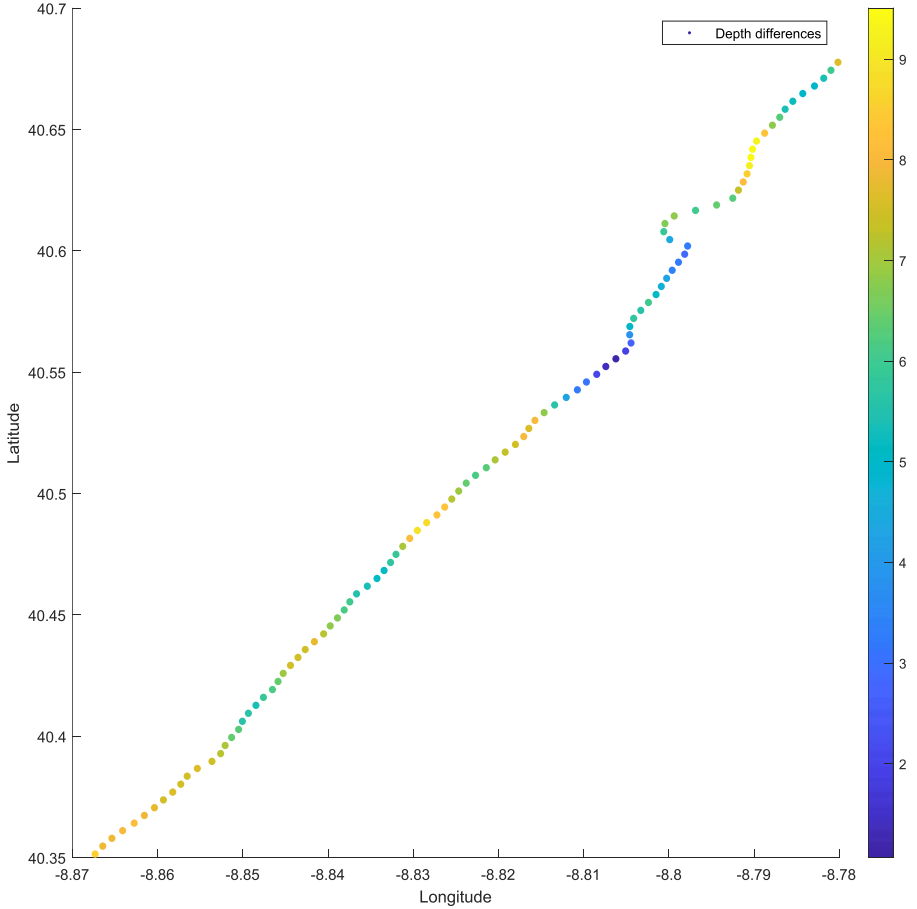
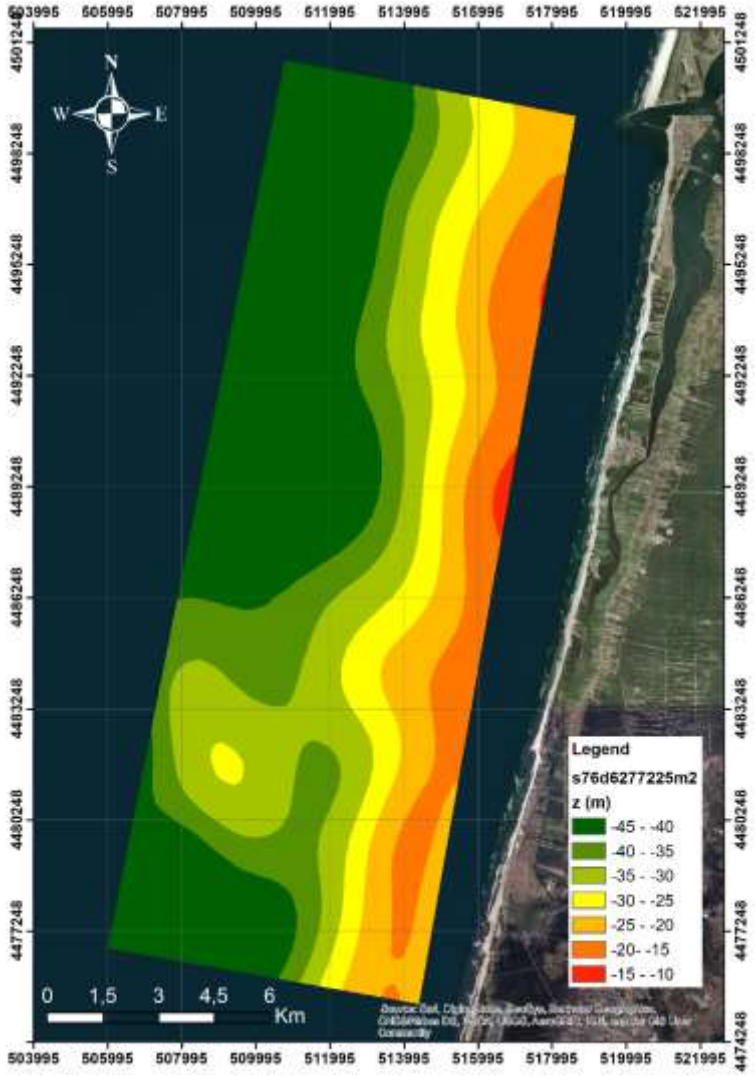
Bathymetry

➢ 5th Estimate the difference between measured and derived satellite depth





Bathymetry


503995
505995
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513995
515995
517995
519995
521995
4501248
4498248
4495248
4492248
4489248
4486248
4483248
4480248
4477248
4474248
N
W
E
S
Legend
s76d6277225m2
z (m)
-45 - -40
-40 - -35
-35 - -30
-30 - -25
-25 - -20
-20- -15
-15 - -10
0 1,5 3 4,5 6
Km

Thank you very much for your attention!

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http://www.marnaraia.org/?page_id=1574

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