Wildfire Greece 2018

Second exercise: burned area mapping with Sentinel-2

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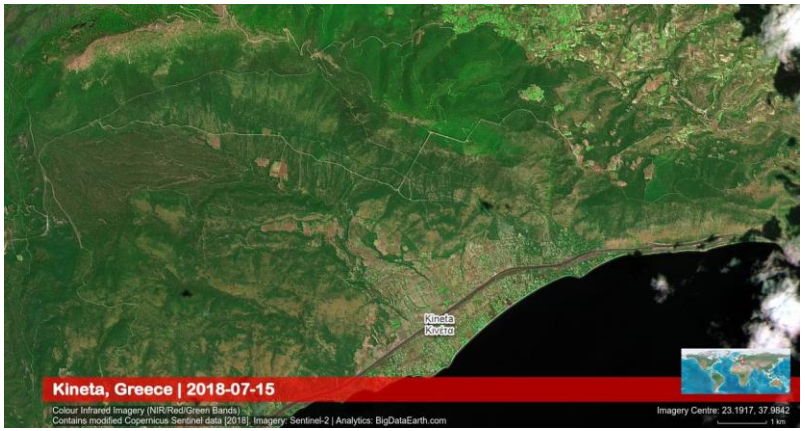
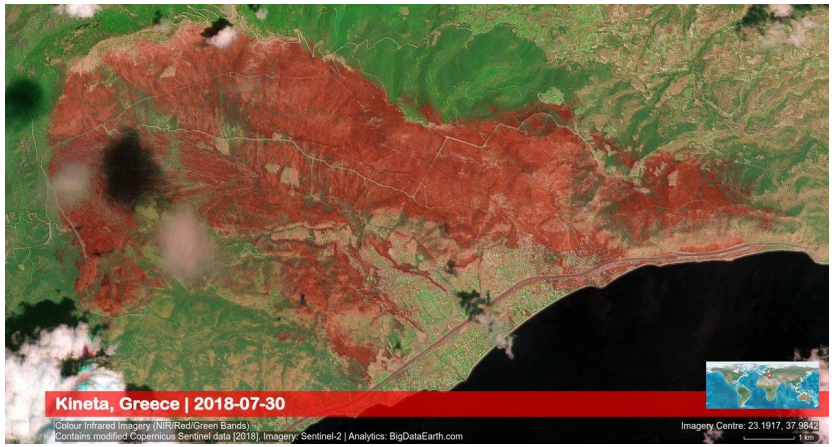
How to quantify the impact of the Kineta wildfire?

Before



After

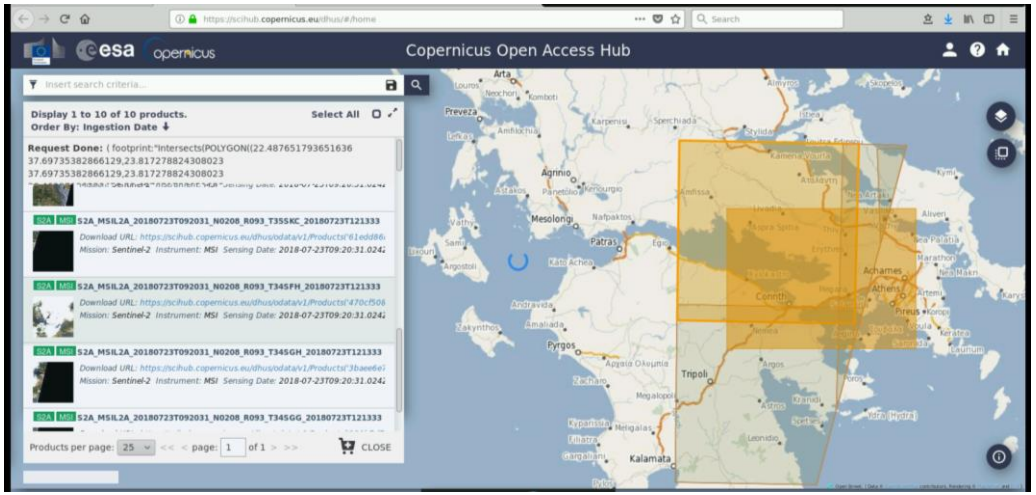


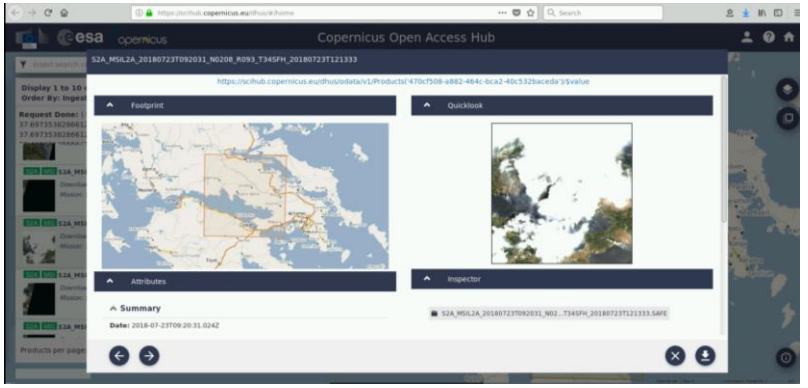
In this exercise we will learn:

- Detection of burned areas and quantification of burn severity.
- Developing a graph for automated processing: Batch processing

Getting S2 data

- Copenicus Open Access Hub:





<u>Before fire:</u>
S2A_MSIL2A_20180703T092031_N0208_R093_T34SFH_20180703T121025.SAFE

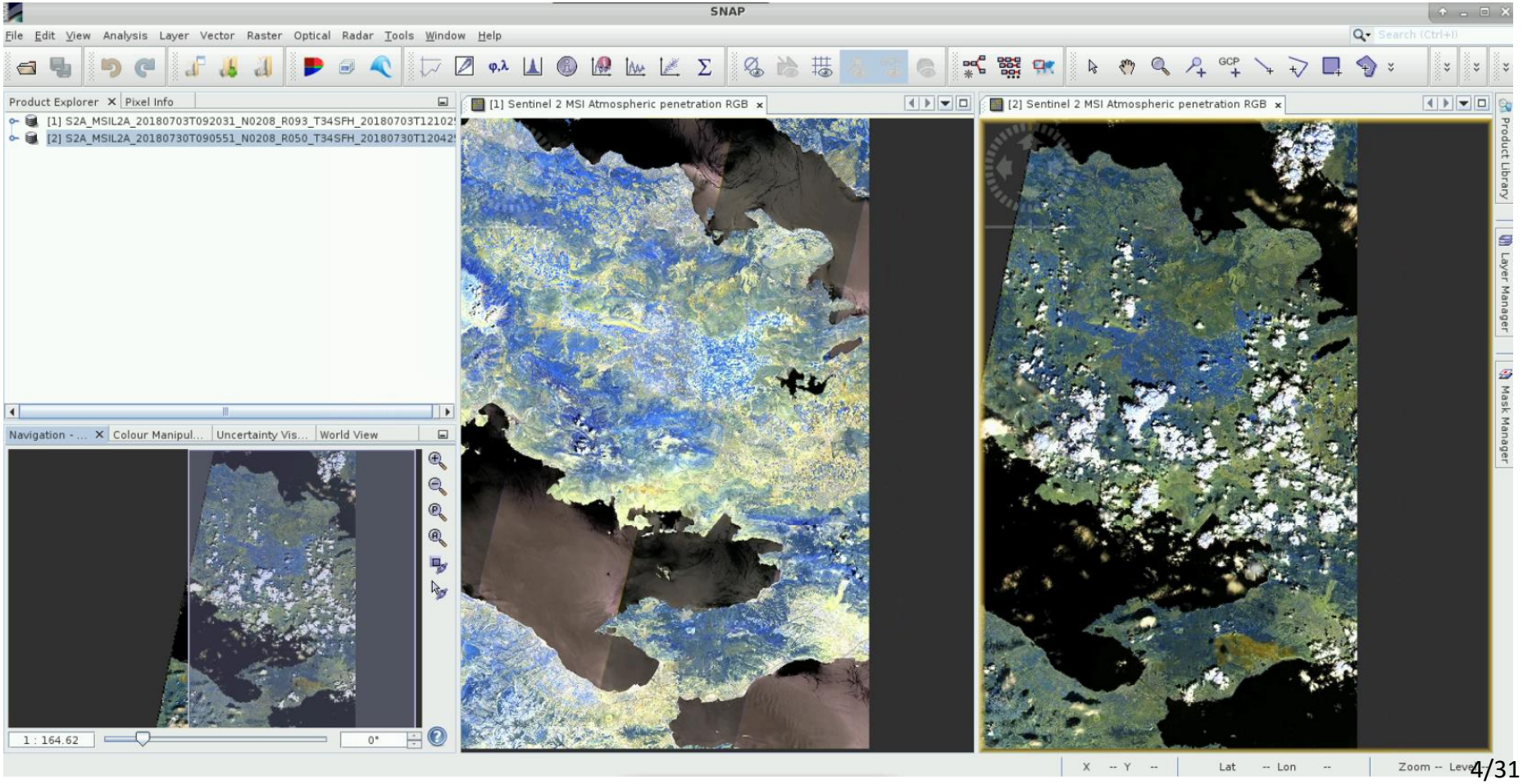
<u>After fire:</u>

S2A_MSIL2A_20180730T090551_N0208_R050_T34SFH_20180730T120425.SAFE

S2 data also available in folder:
PECS_Slovakia/Fires/S2_L2A_images

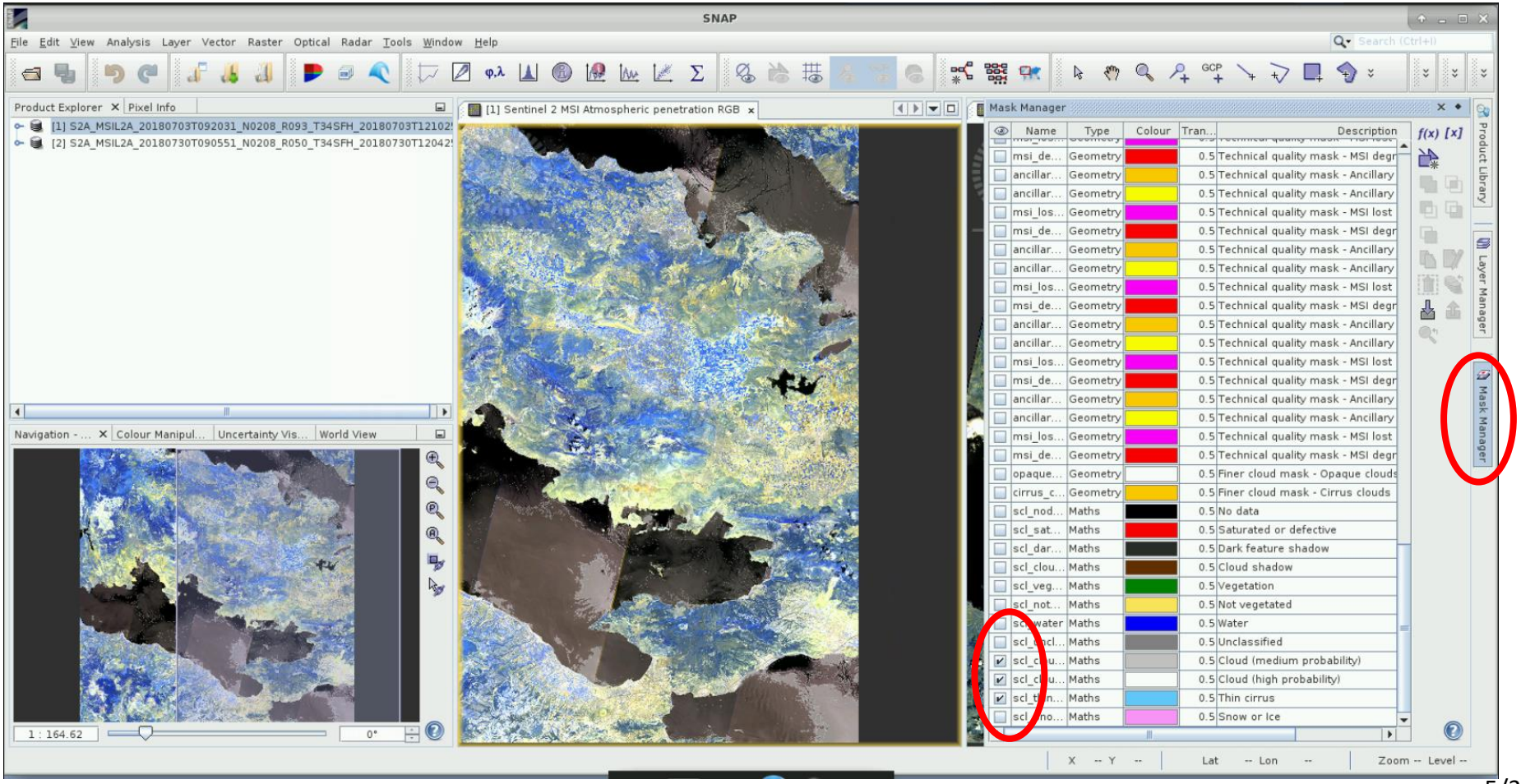
Let’s have look to the before & after images

- Open **RGB Image Window**:
- Select: **MSI Atmospheric penetration**
- **Window-> Tile horizontally, zoom in**



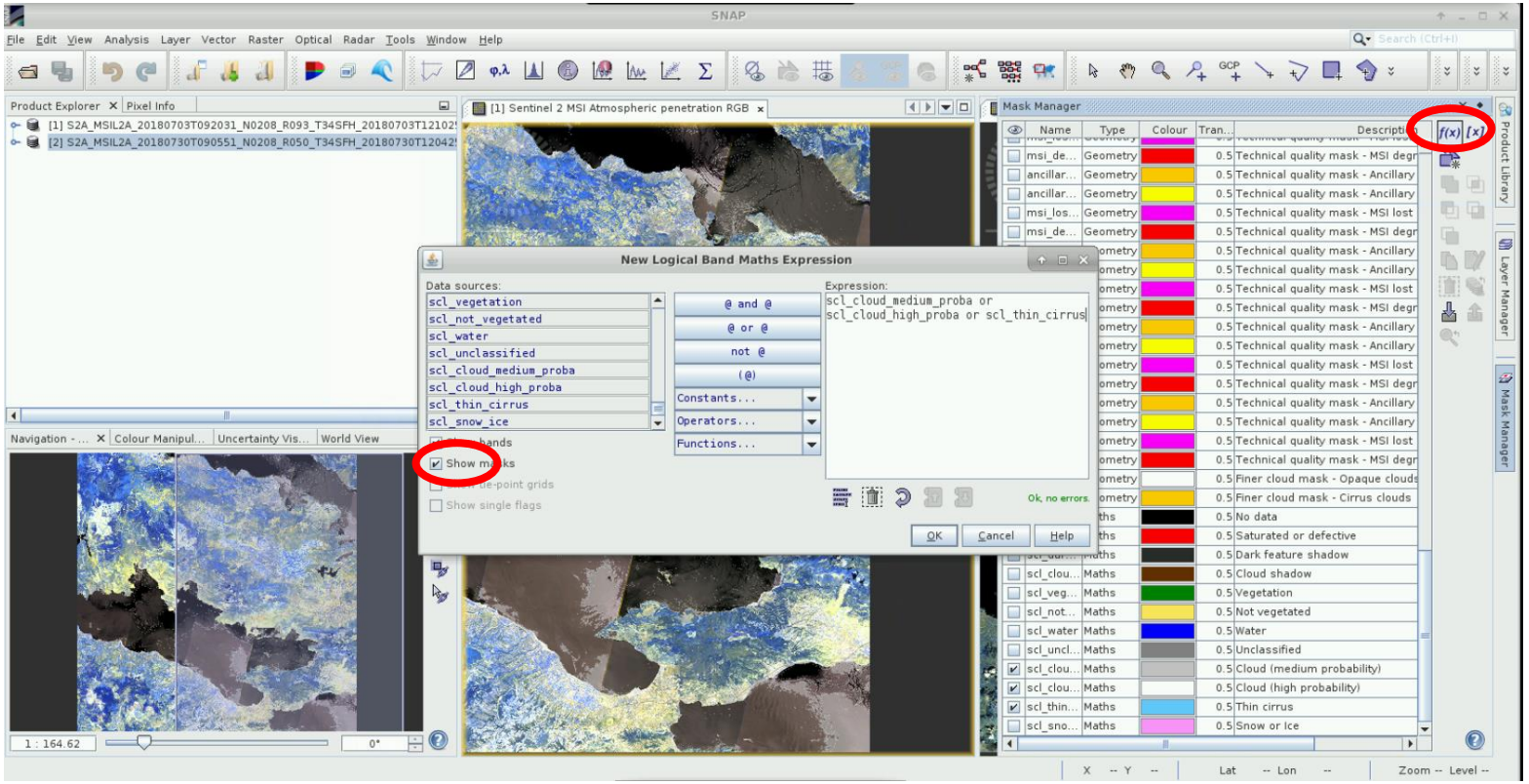
Let’s create a cloud mask

- Go to Mask Manager, and scroll down to the Maths masks
- Select: **cloud medium & cloud high probability & Thin cirrus**
- To visualize them better, lower the transparency (e.g. 0.1)



We make a cloud band based on the selected mask

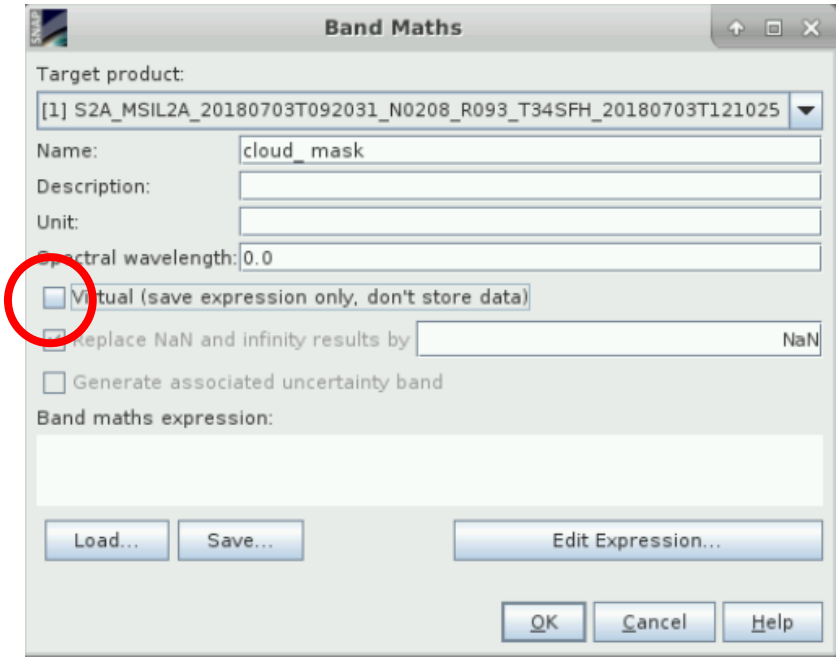
- Band math expression

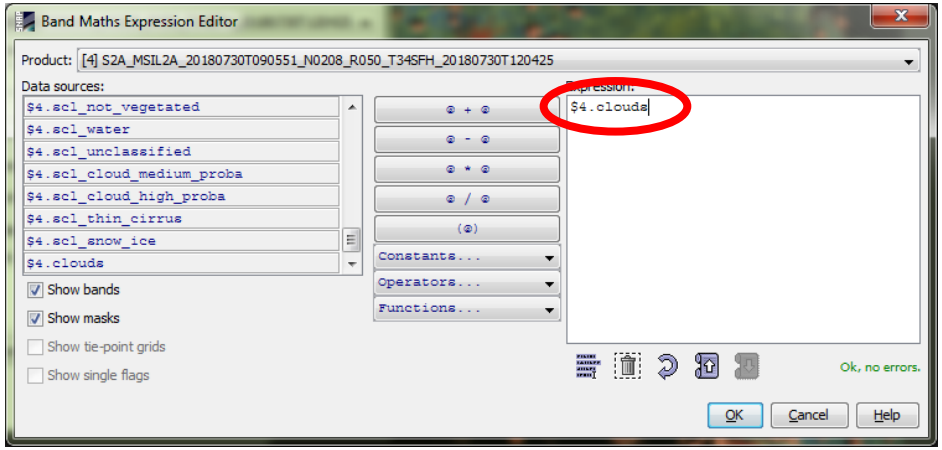


- Name the new mask: ***clouds***

Adding the cloud mask as a band

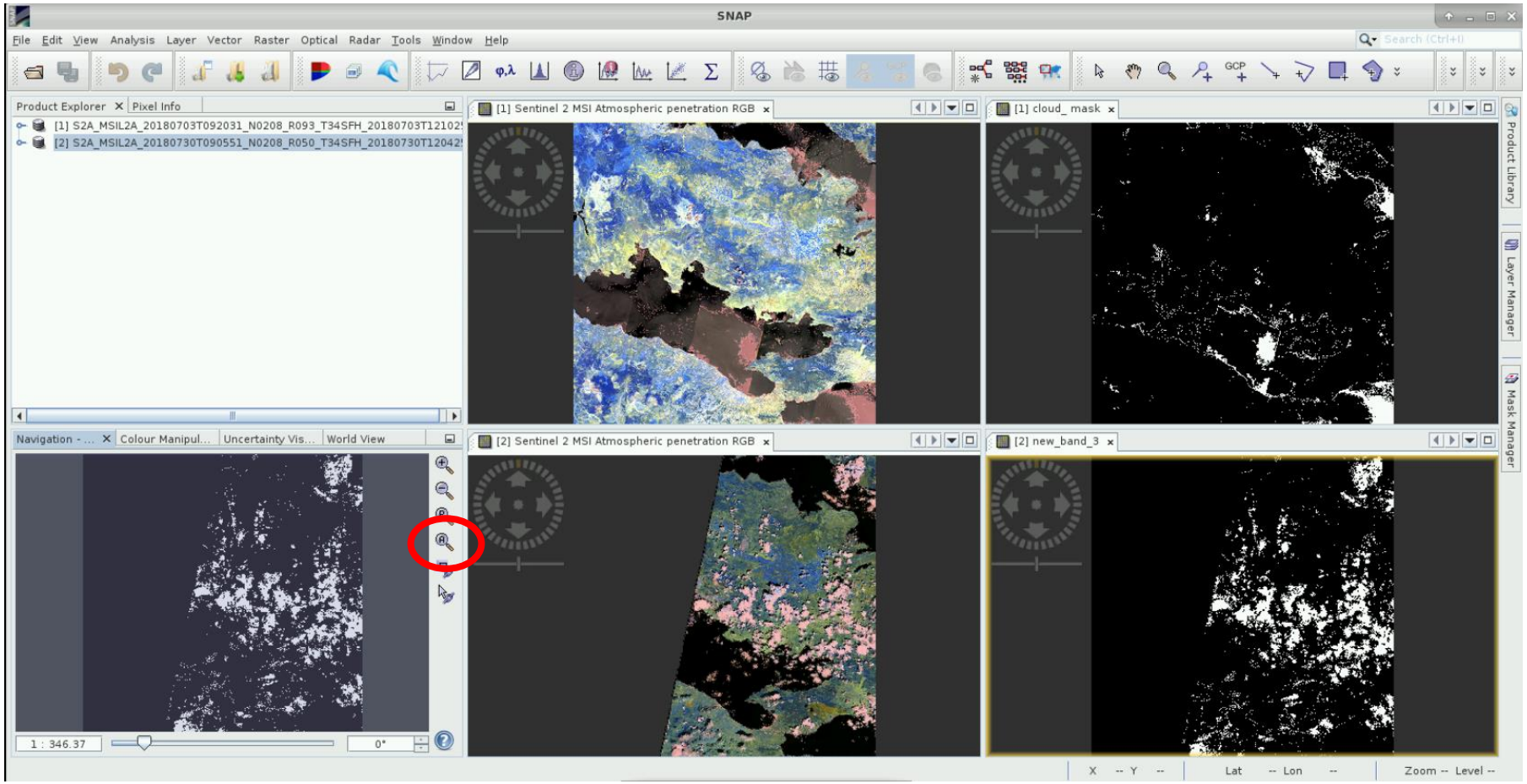
- On the image, right click-> **Band Maths**
- Make sure to deactivate “Virtual”. We want to store the data!
- Go to “**Edit Expression**”
- Select **Clouds**



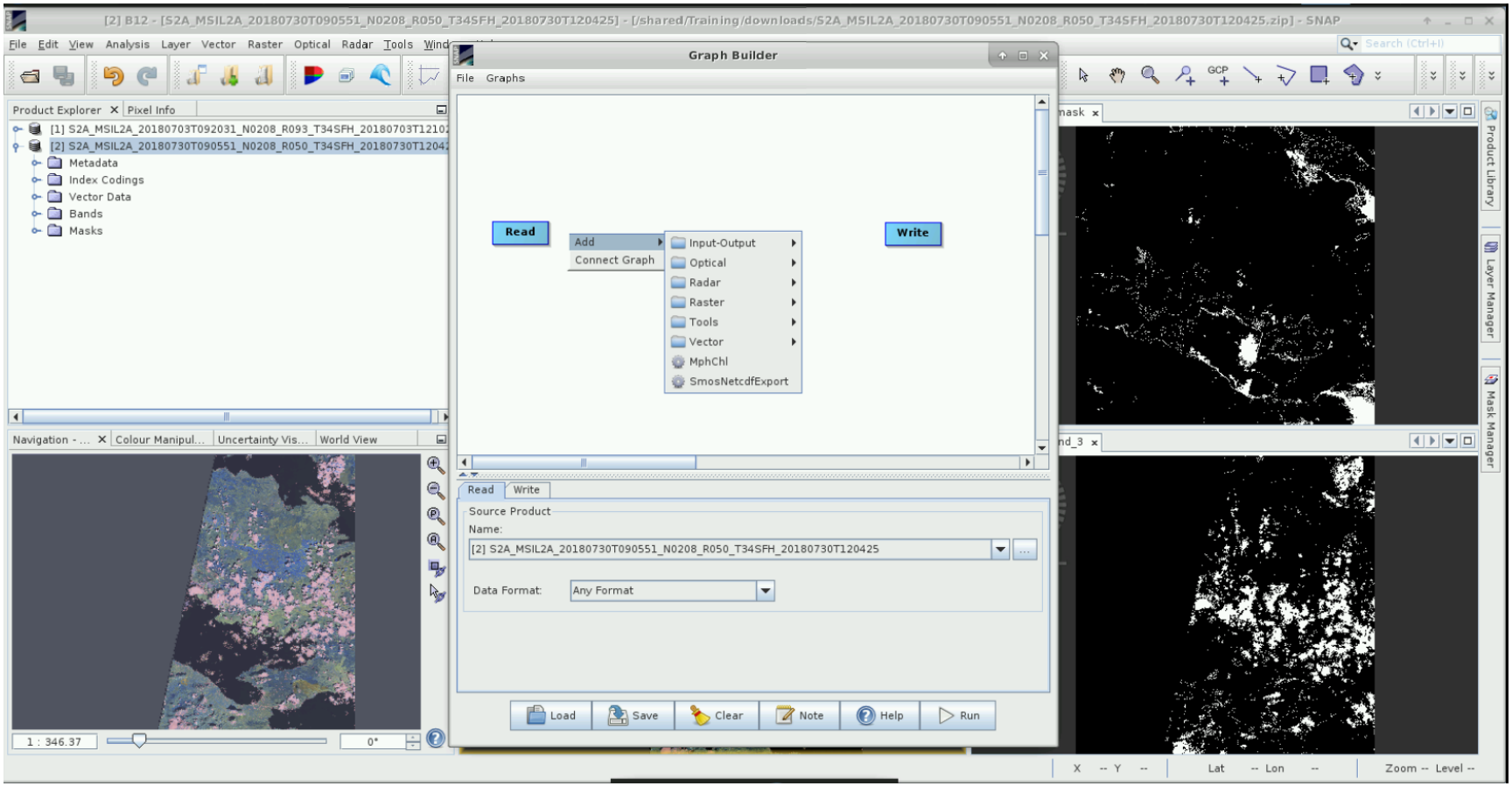


Vizualize all products

- Windows: **Tile evenly**
- Navigation: zoom all

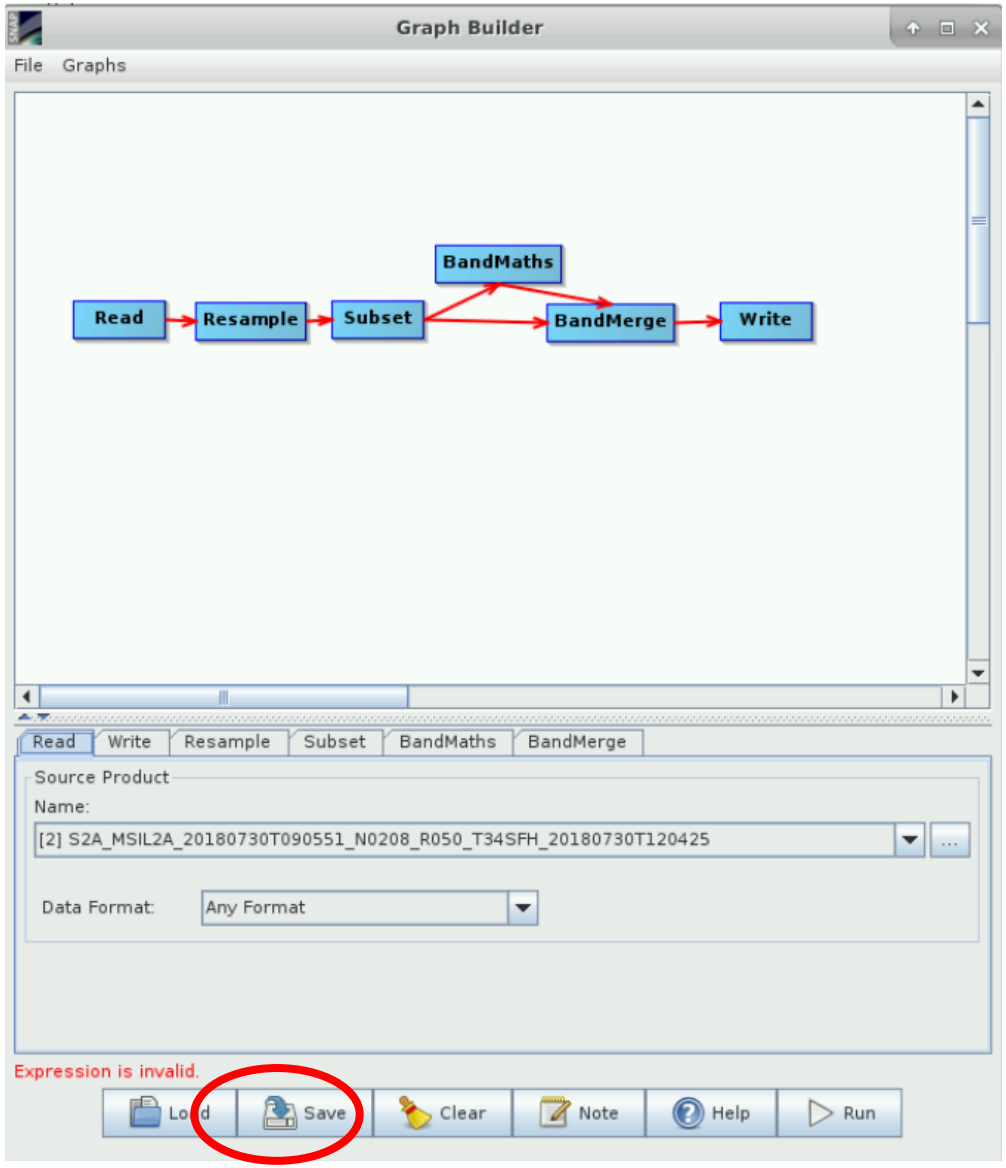


Batch processing: Graph building



- Add->Raster->Geometric->**Resample**
- Add->Raster->Geometric->**Subset**
- Add->Raster->**BandMaths**
- Add->Raster->**BandMerge**

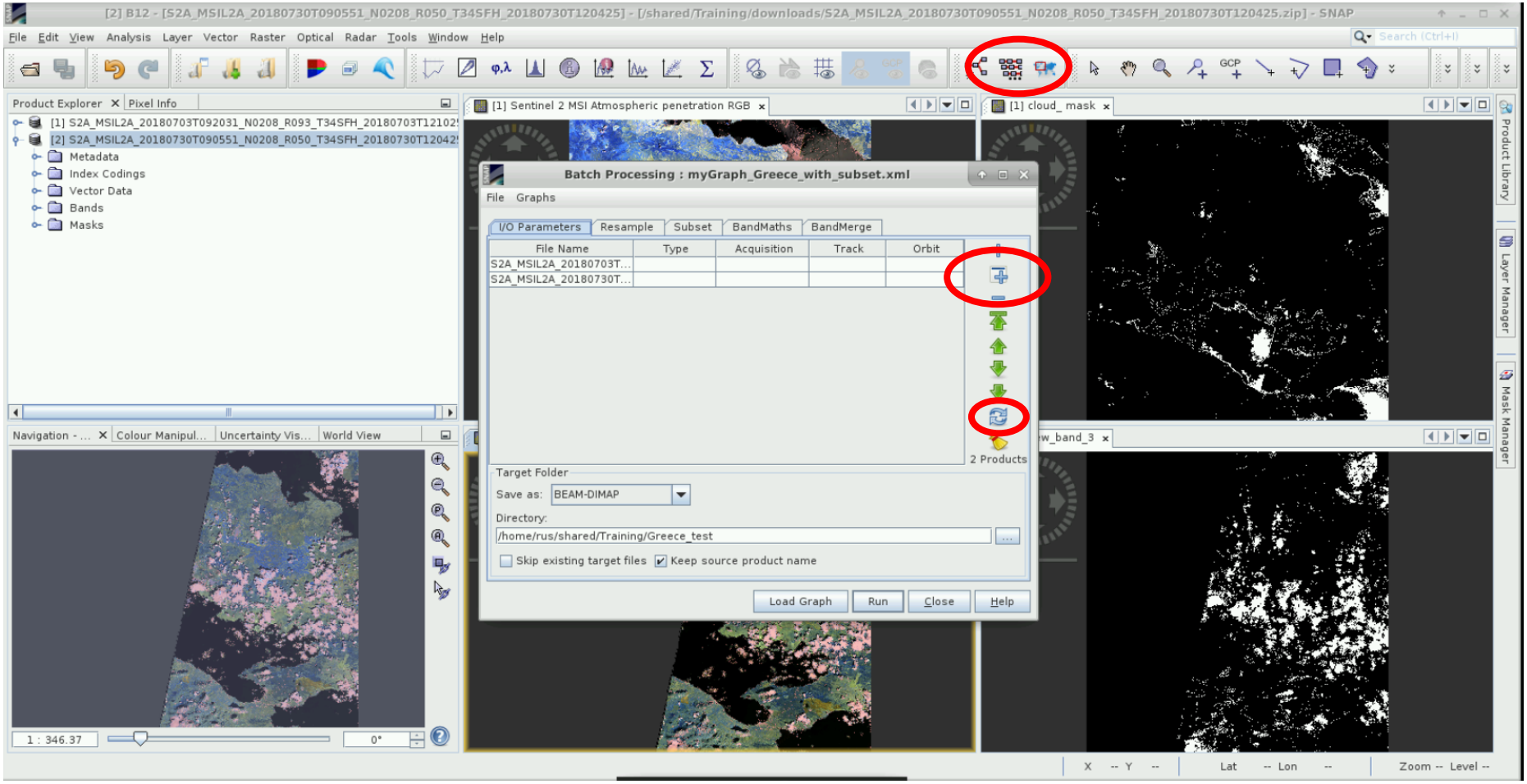
Save the graph



Batch processing

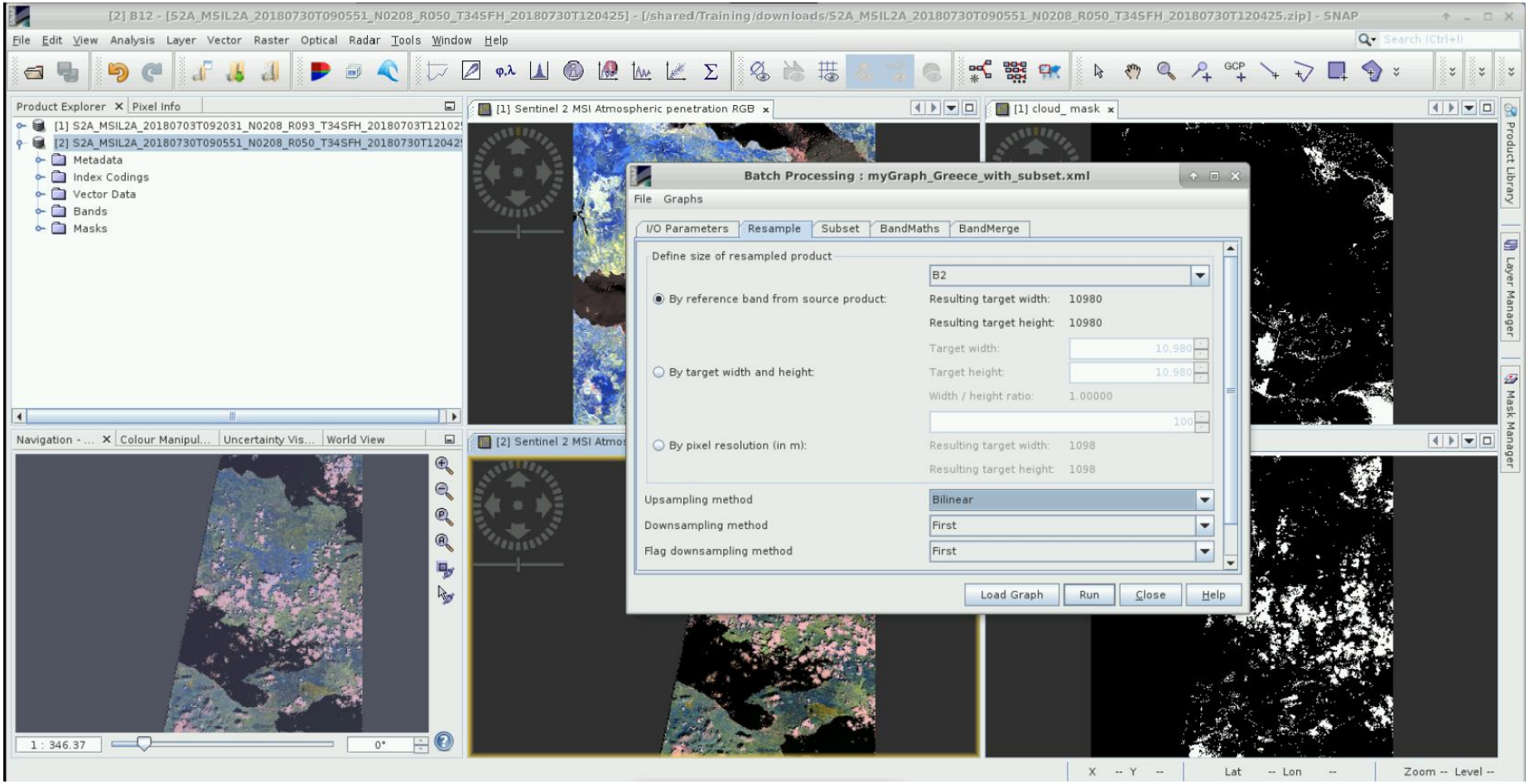
This allows to process both images at the same time.

- Click on **Add all**
- Make sure to **refresh**



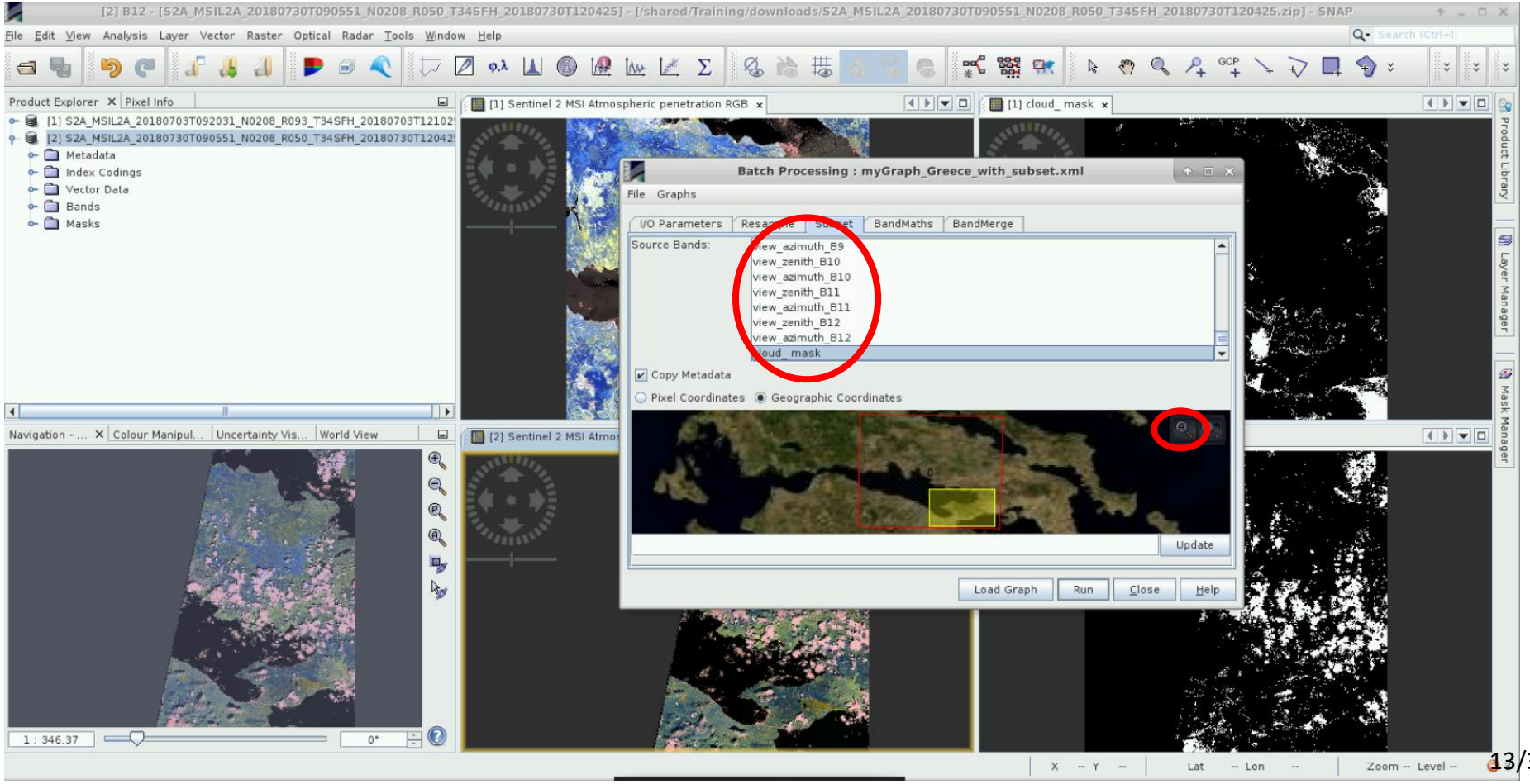
Resample

- Select a reference band: **B2** at 10 m.
- Resampling method: **Bilinear**



Subset

- Select bands: **B3, B8, B12, Cloud_mask**
- Select **Geographic coordination**
- Click on A, zoom in to the area of interest
- Select a **yellow box** within the red square



Band Math

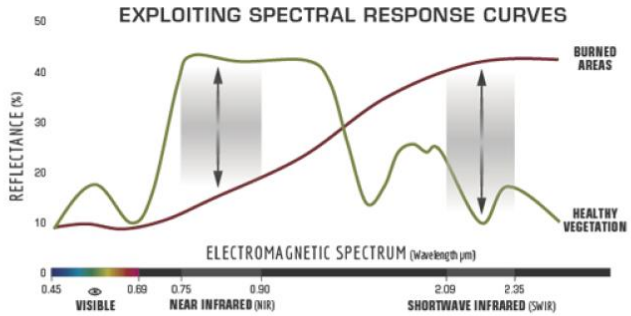
- Go to "**Edit Expression**"
- **NBR: Normalized Burn Ratio:**

  (B8-B12)/(B8+B12)

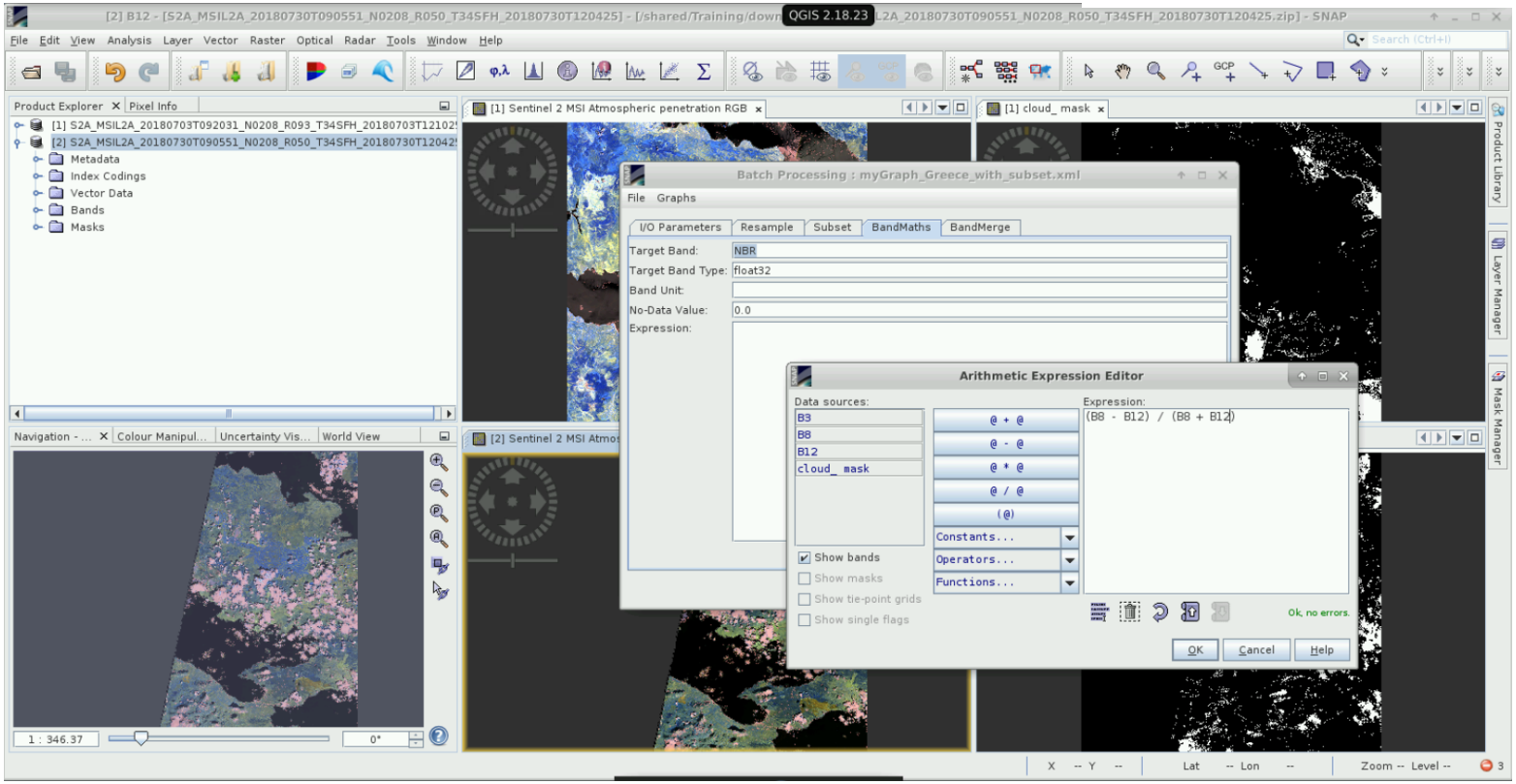
NOTE 2: The most commonly used metrics for burned area and burn severity mapping, derived from satellite data, is the normalized burn ratio (NBR).

$$NBR = \frac{NIR - SWIR}{NIR + SWIR}$$

Healthy vegetation has very high near-infrared reflectance and low reflectance in the shortwave infrared portion of the spectrum. Burned areas on the other hand have relatively low reflectance in the near-infrared and high reflectance in the shortwave infrared band. A high NBR value generally indicates healthy vegetation while a low value indicates bare ground and recently burned areas.

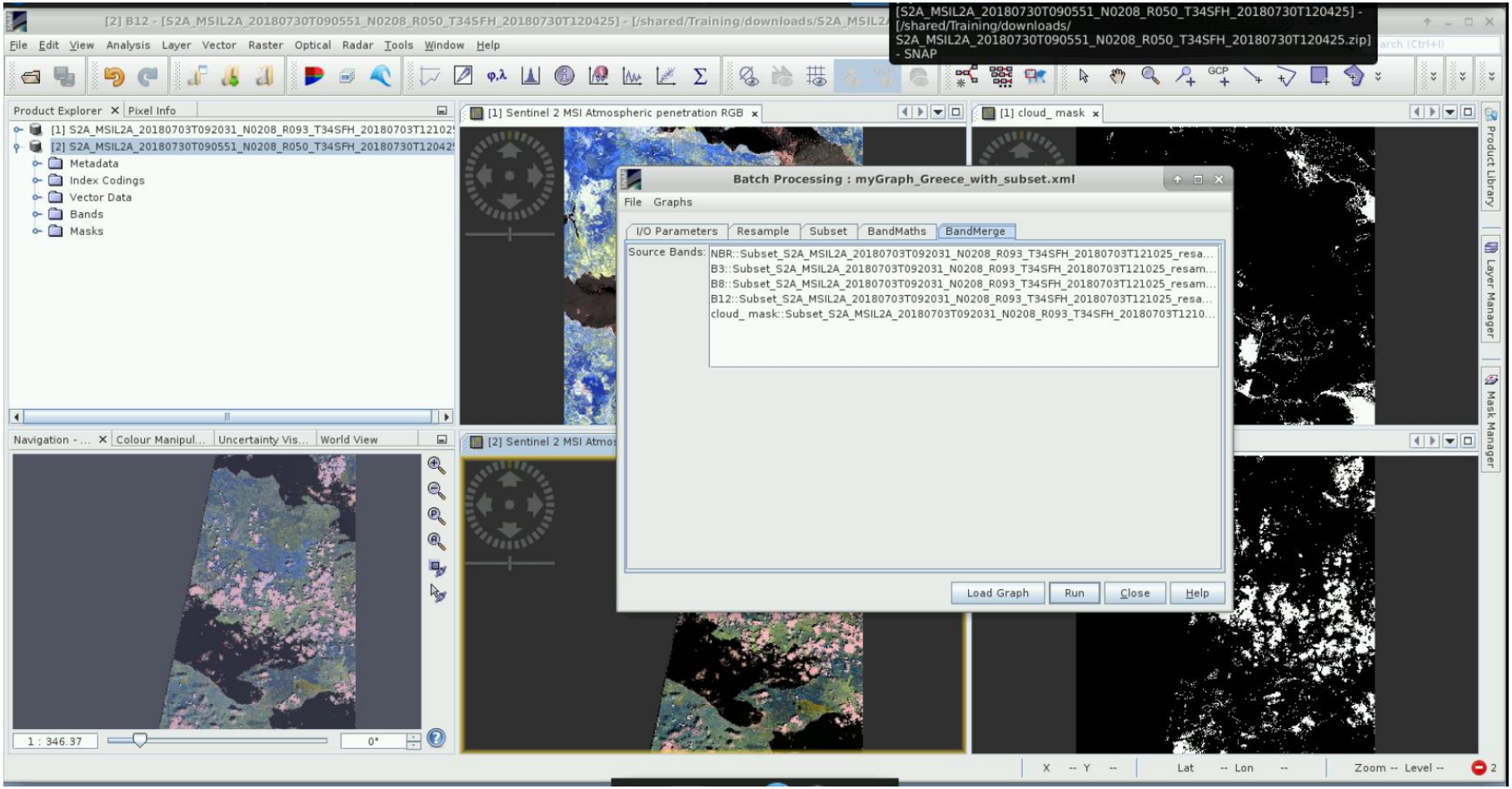


Credits: U.S. Forest service

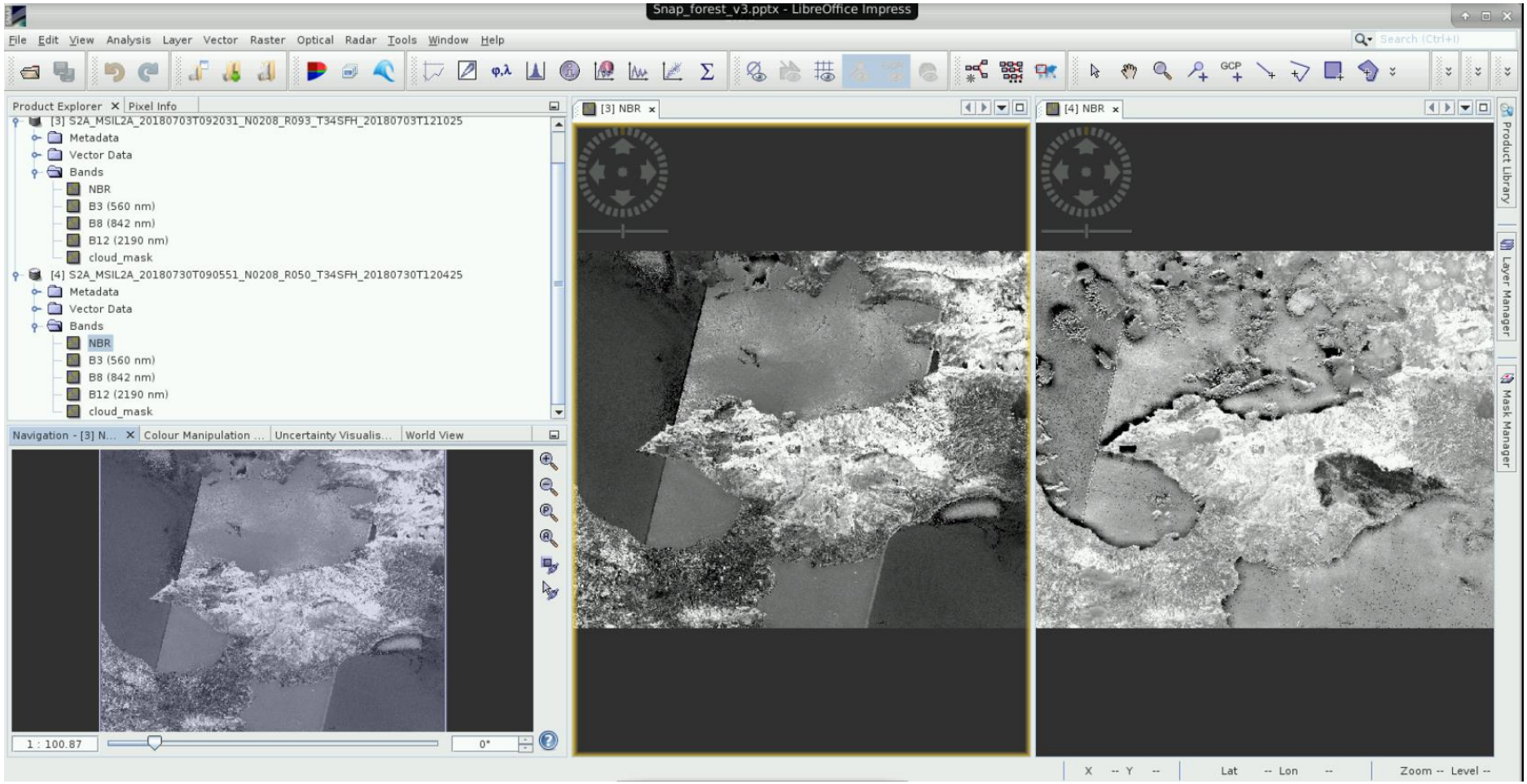


Band Merge

- Keep the source bands: **NBR, B3, B8, B12, cloud_mask**



Running and visualizing the NBR band



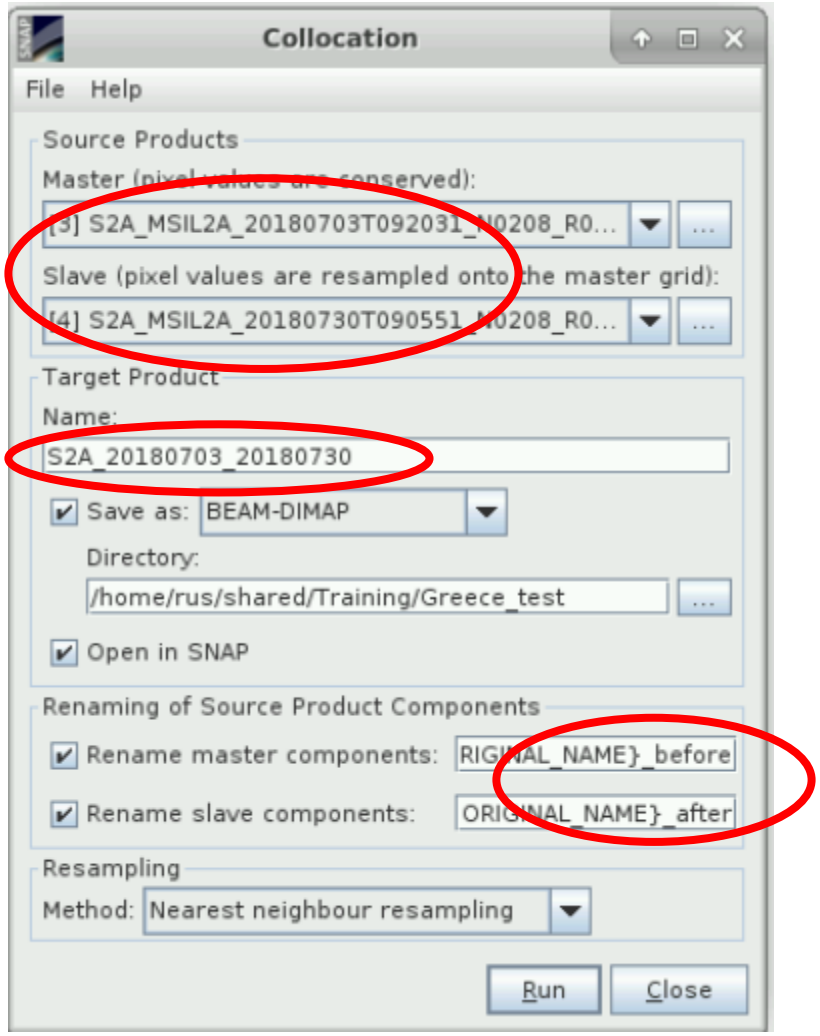
Try a color table:

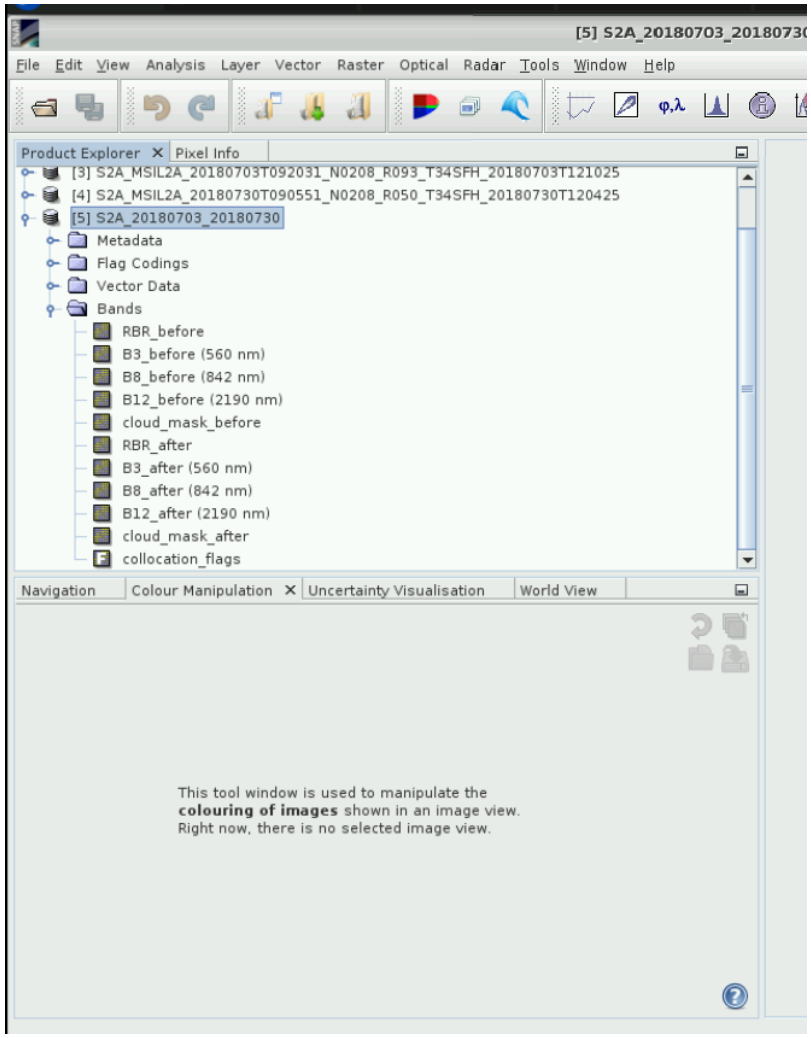
- Colour manipulation: **Open color table,** choose a color gradient

Collocation

Raster->Geometric Operations -> Collocation

- **Select the two new images, give a name, rename source product**

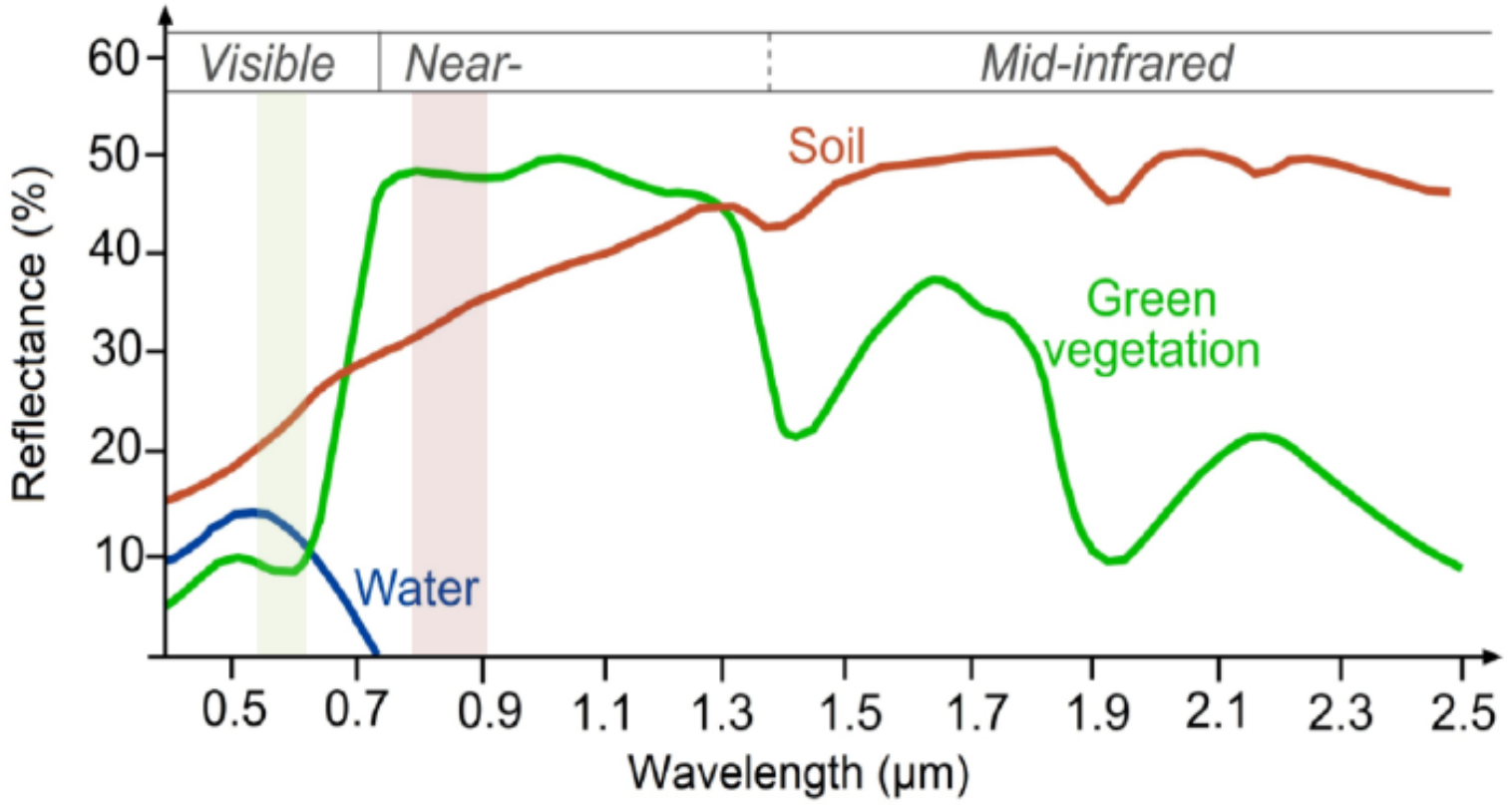




Create a water and cloud mask (1/2)

NOTE 3: The Normalized Difference Water Index (NDWI) proposed by McFeeters[2] is designed to: maximize the reflectance of the water body in the green band; minimize the reflectance of water body in the NIR band. McFeeters's NDWI is calculated as:

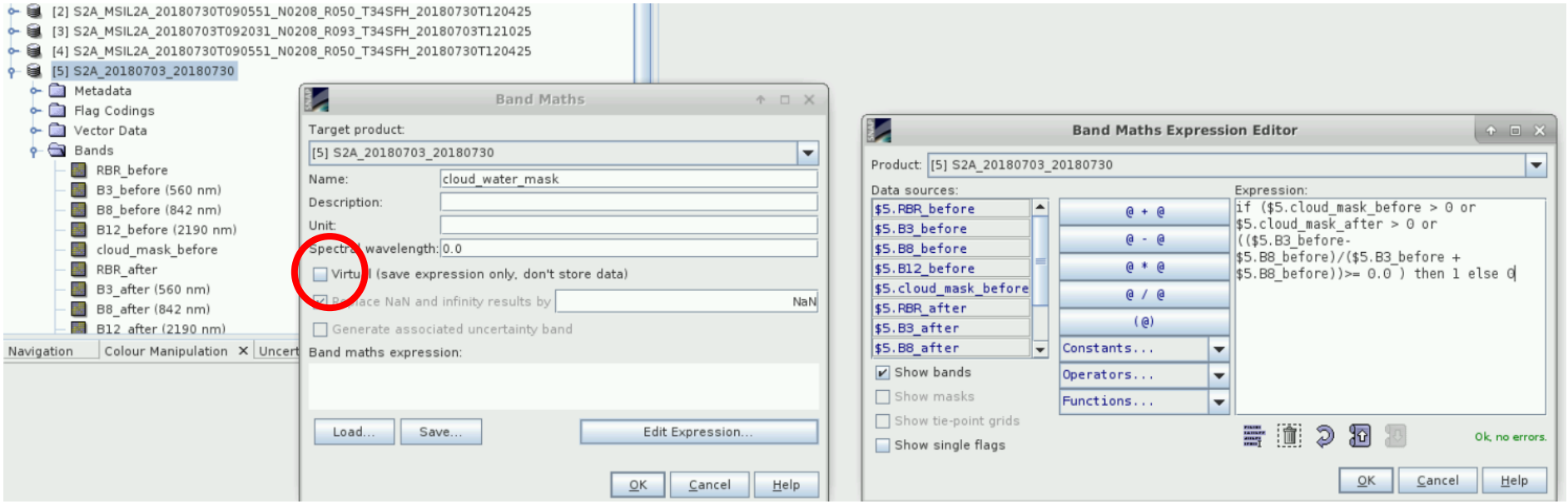
$$NDWI = \frac{Green - NIR}{Green + NIR} = \frac{B3 - B8}{B3 + B8}$$



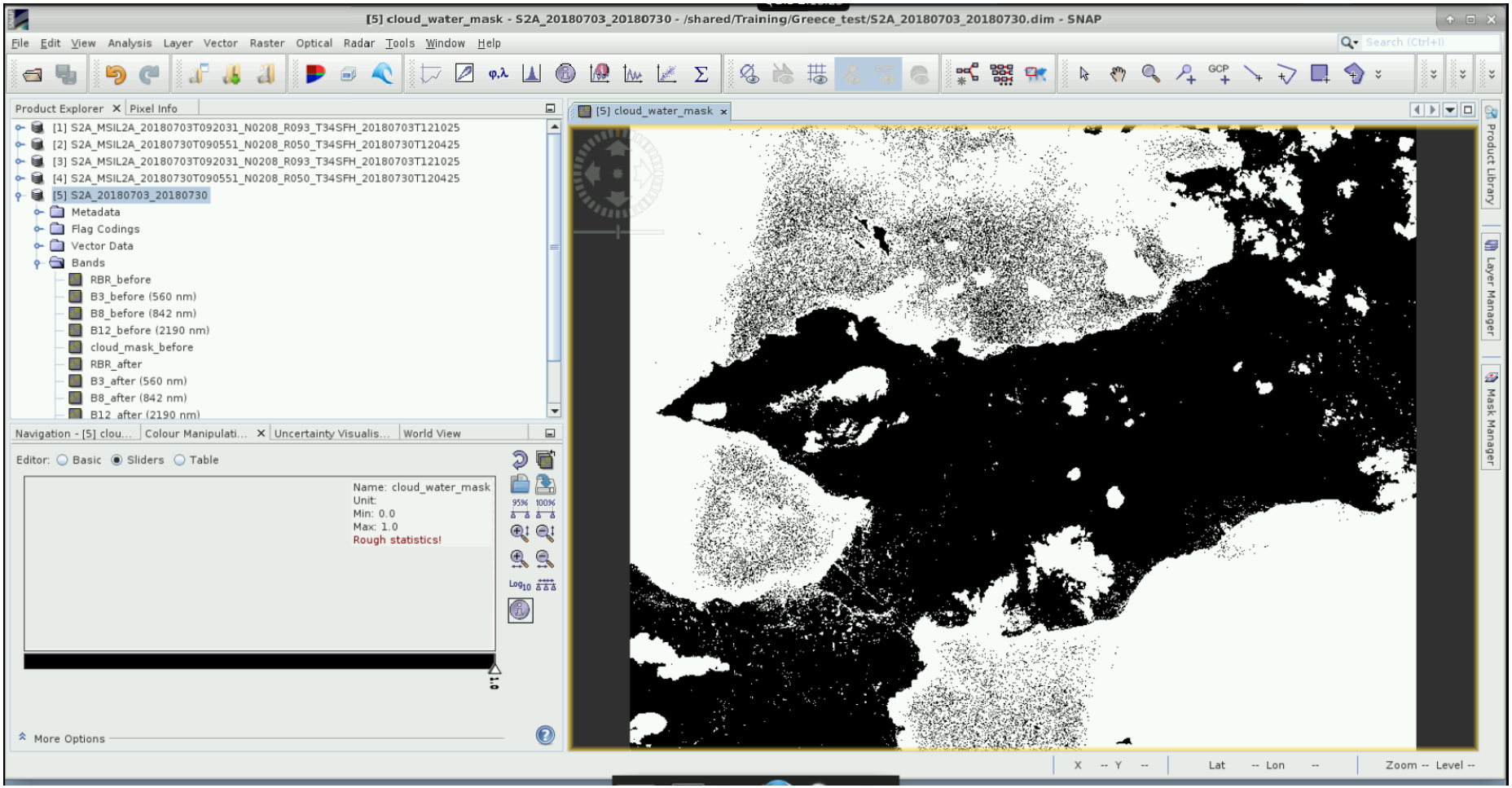
Create a water and cloud mask (2/2)

- Click on the newly created stacked product [5], select **BandMaths**
- **Cloud_water_mask**
- Make sure to deactivate “Virtual”. We want to store the data!

Expression:
```
if (cloud_mask_June > 0 or cloud_mask_July > 0 or ((B3_June - B8_June)/ (B3_June + B8_June))>= 0.0) then 1 else 0
```



The masked map



Mapping burned areas and burn severity

To identify recently burned areas and differentiate them from bare soil and other non-vegetated areas the difference between pre-fire and post-fire NBR, the delta Normalized Burn Ratio (dNBR) is frequently used.

$$dNBR = NBR_{pre-fire} - NBR_{post-fire}$$

However, the dNBR is an absolute difference which can present problems in areas with low pre-fire vegetation cover, where the absolute change between pre-fire and post-fire NBR will be small. In such cases the relativized version of burn severity is advantageous. In this tutorial we will use the Relativized Burn Ratio (RBR)[3].

$$RBR = \left(\frac{dNBR}{(NBR_{pre-fire} + 1.001)}\right) = \left(\frac{NBR_{pre-fire} - NBR_{post-fire}}{(NBR_{pre-fire} + 1.001)}\right)$$

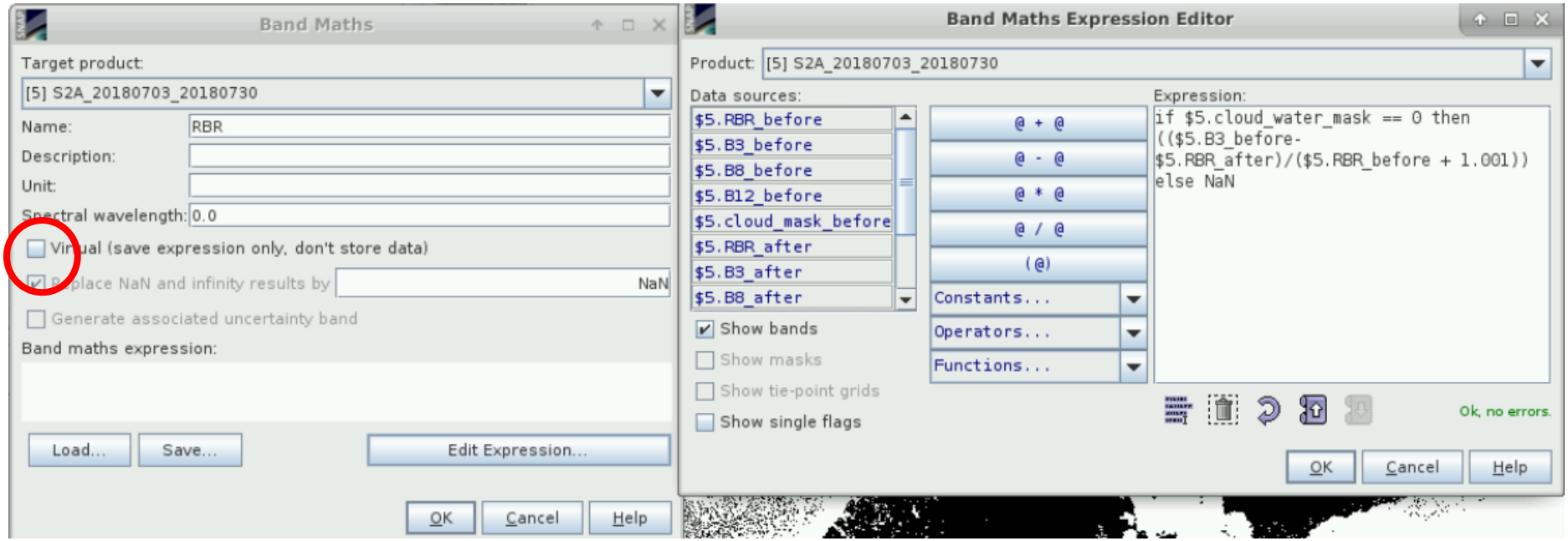
Target band: RBR

Expression: `if cloud_water_mask == 0 then ((NBR_June - NBR_July)/(NBR_June + 1.001)) else NaN`

Relative Burn Ratio: RBR

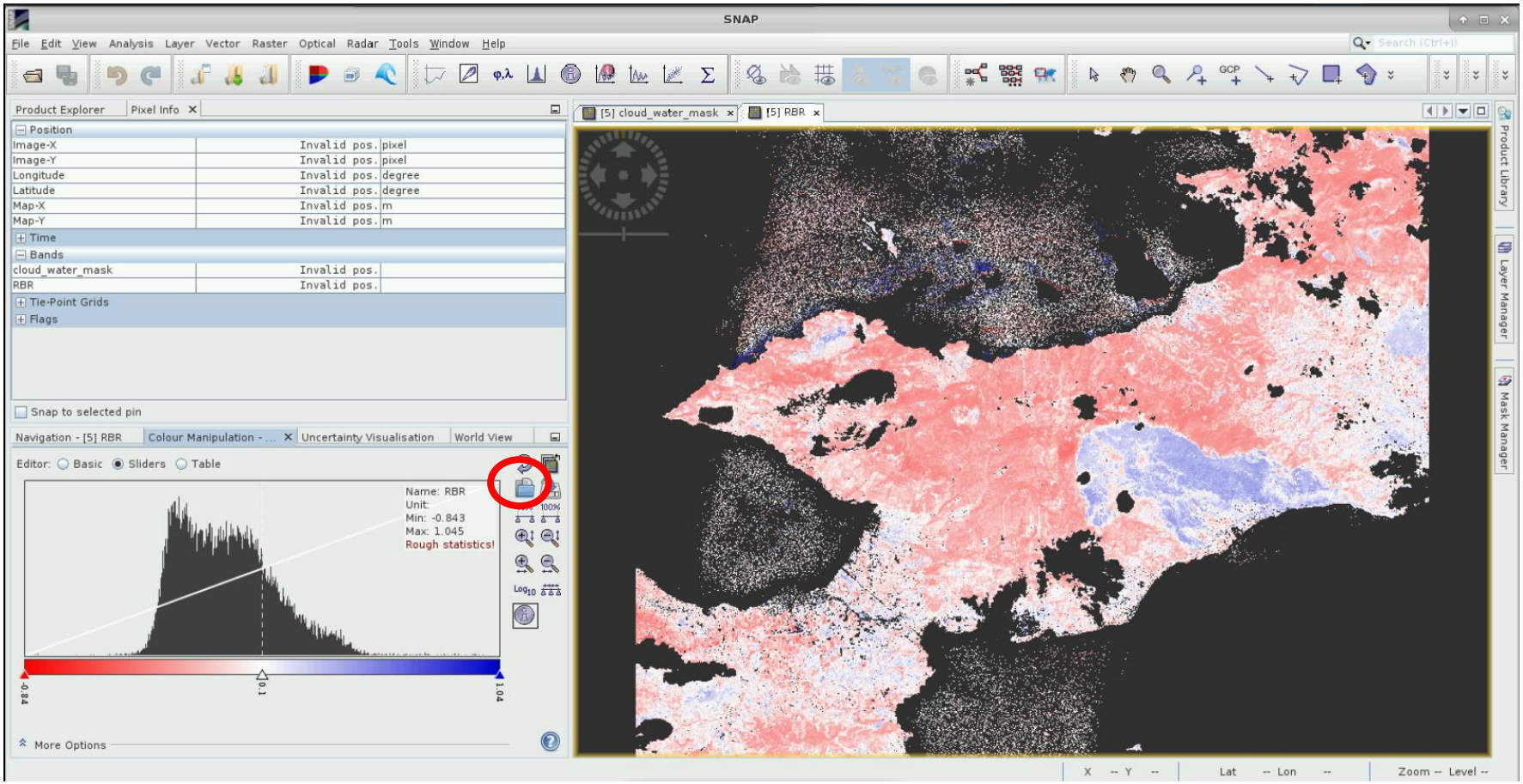
- Click on the newly created stacked product [5], select **BandMaths**
- **RBR**
- **Apply the expression in case no cloud & water:**
- Make sure to deactivate “Virtual”. We want to store the data!

Expression: `if cloud_water_mask == 0 then ((NBR_June - NBR_July)/(NBR_June + 1.001)) else NaN`



Show the RBR in a color table

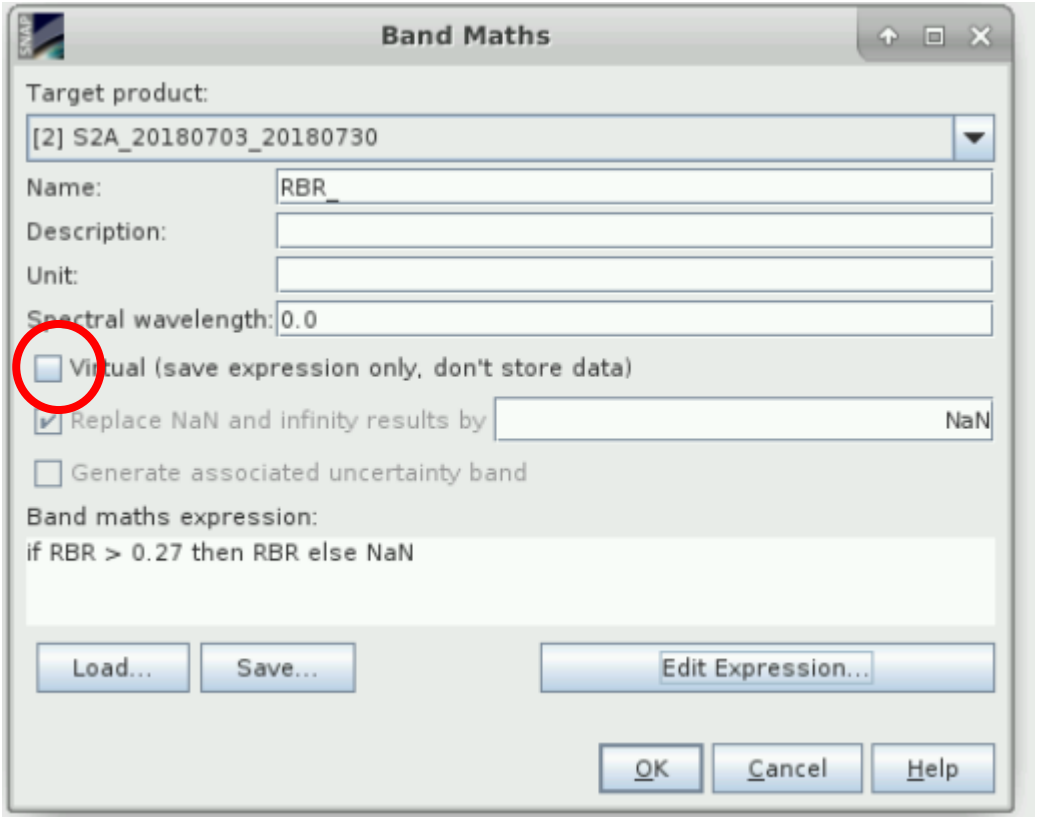
- Open the RBR band
- Lets change the colors: **Color manipulation**
- Open color table**: gradient_red_White_blue**
- Play a bit with the boundaries



Let’s try to restrict to only burned areas

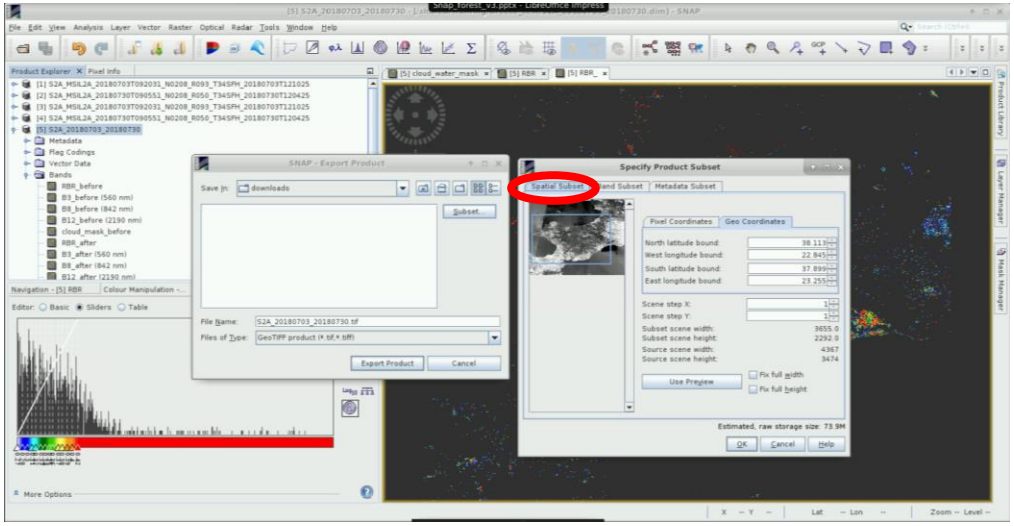
We will create another band that will only contain burned areas. We will set the **threshold** for pixel to be classified as burned to **> 0.27.**

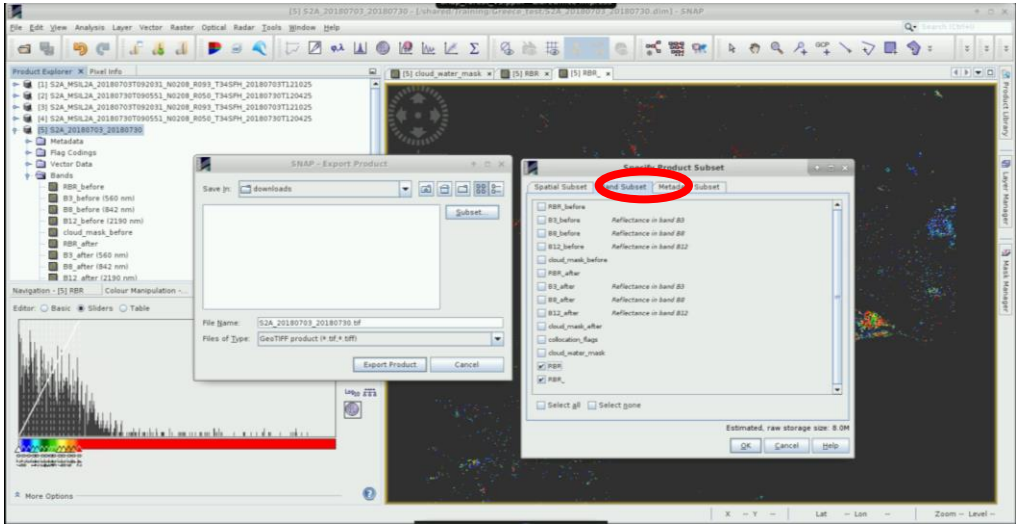
- BandMath: **RBR_**
- No-Data Value: **NaN**
- Expresion: **if RBR > 0.27 then RBR else NaN**
- Make sure to deactivate “Virtual”. We want to store the data!



Export as geoTIFF

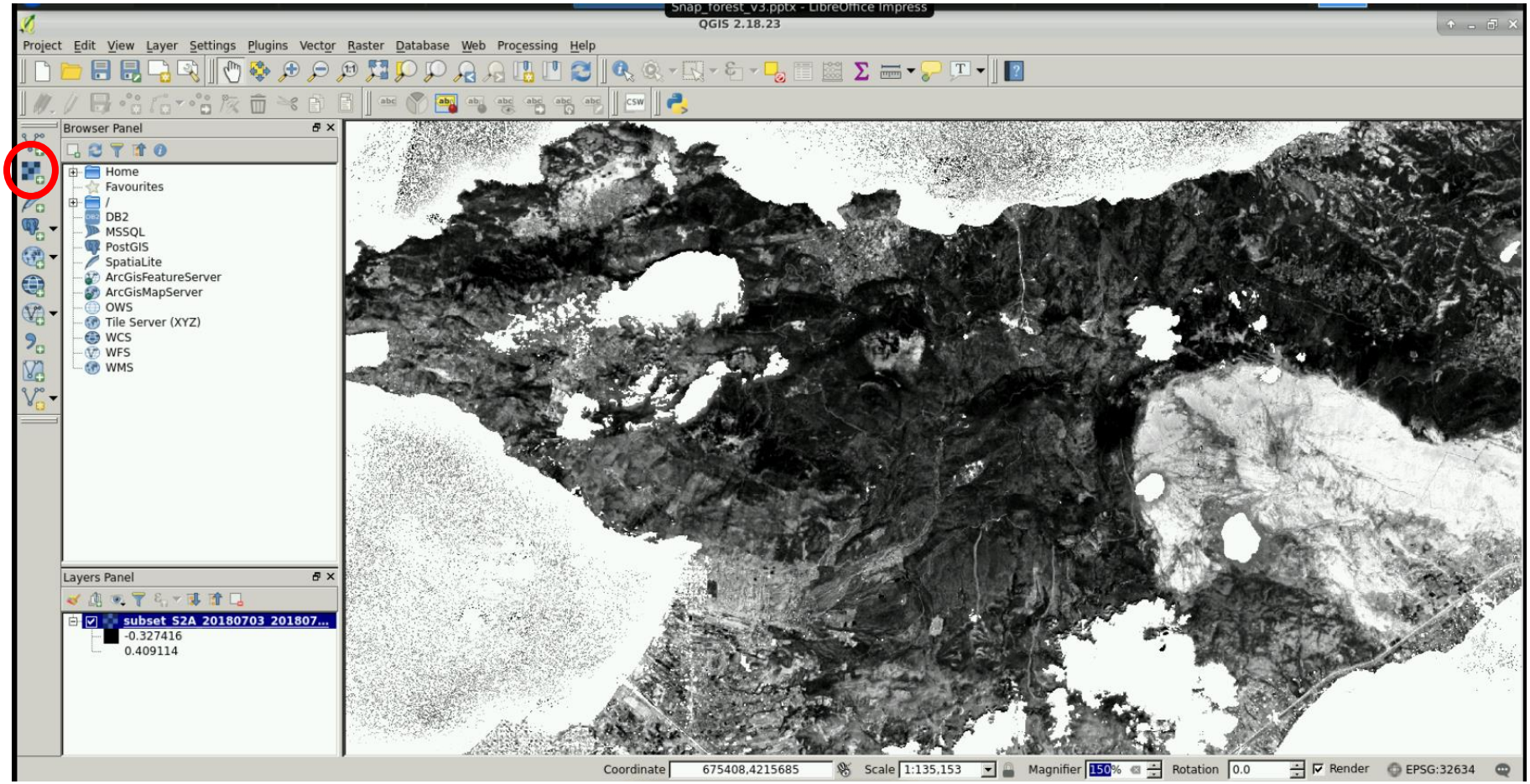
- File -> Export -> GeoTiff
- In Band Subset, select only: RBR, RBR_
- Select No flag dataset





Vizualization in QGIS

- Click on the Add Raster Layer
- In Band Subset, select only: RBR, RBR_



Lets color-scale according to USGS classification table to interpret the burn severity (dNBR)

NOTE 4: The United States Geological Survey (USGS) proposed a classification table to interpret the burn severity (dNBR), which can be seen in the table below[4]. In our data the lowest value is -0.08, demonstrating that there were no values related to detectable regrowth. The large number of ambiguous pixels (yellow) is caused by the one month difference between our pre- and post-fire images. Due to the severe drought the vegetation likely degraded significantly between these two dates producing similar NBR difference as low severity burn.

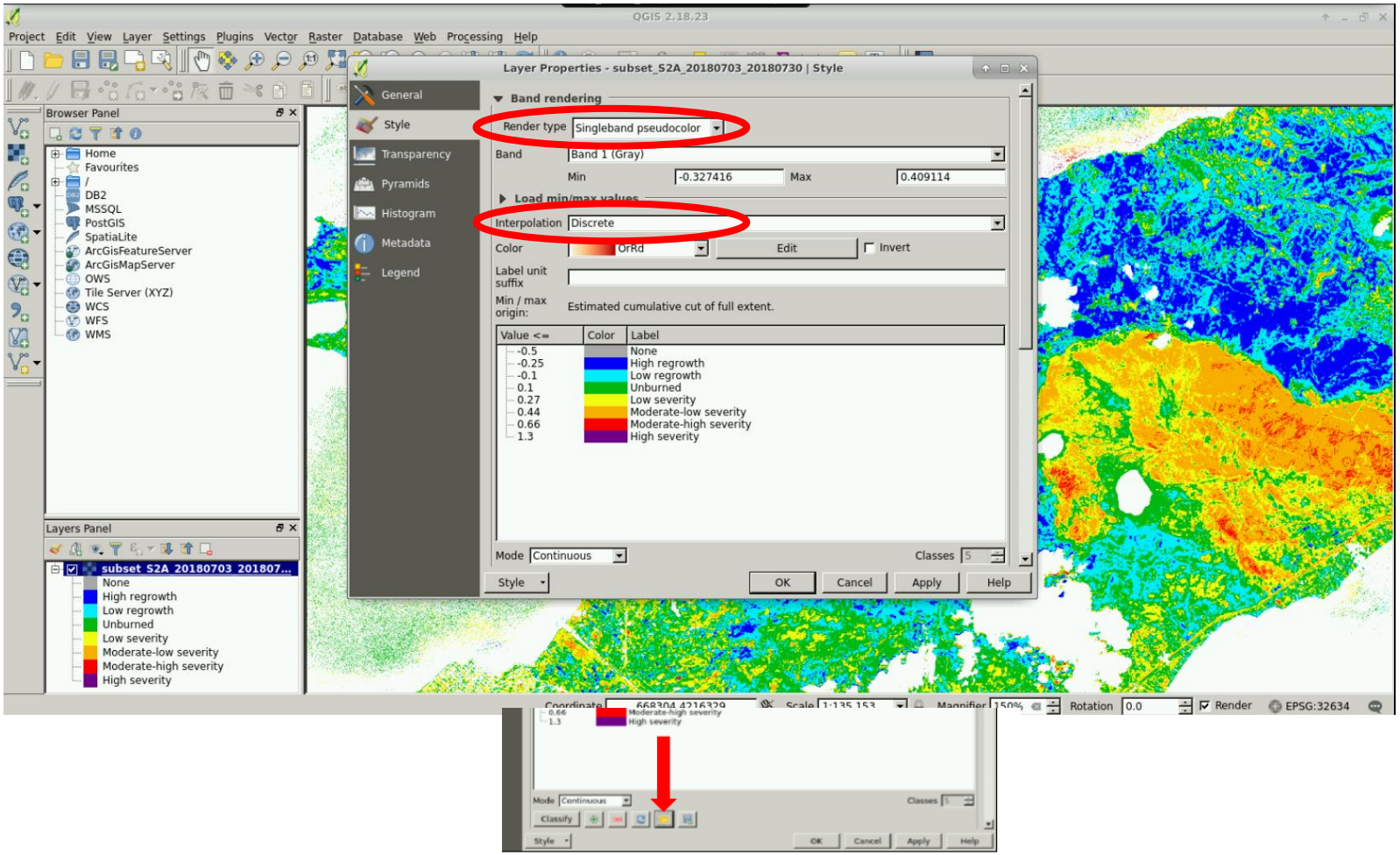
While we are using RBR and not dNBR, we will apply the same classes as defined below for visualization. It is generally difficult to derive the burn severity without ground data to relate the values to.

Severity Level	dNBR range (scaled by 10^3)	dNBR range (not scaled)
Enhanced Regrowth, high (post-fire)	-500 to -251	-0.500 to -0.251
Enhanced Regrowth, low (post-fire)	-250 to -101	-0.250 to -0.101
Unburned	-100 to +99	-0.100 to +0.099
Low Severity	+100 to +269	+0.100 to +0.269
Moderate-low Severity	+270 to +439	+0.270 to +0.439
Moderate-high Severity	+440 to +659	+0.440 to +0.659
High Severity	+660 to +1300	+0.660 to +1.300

Credits: UN-SPYDER Knowledge Portal

Add the color table

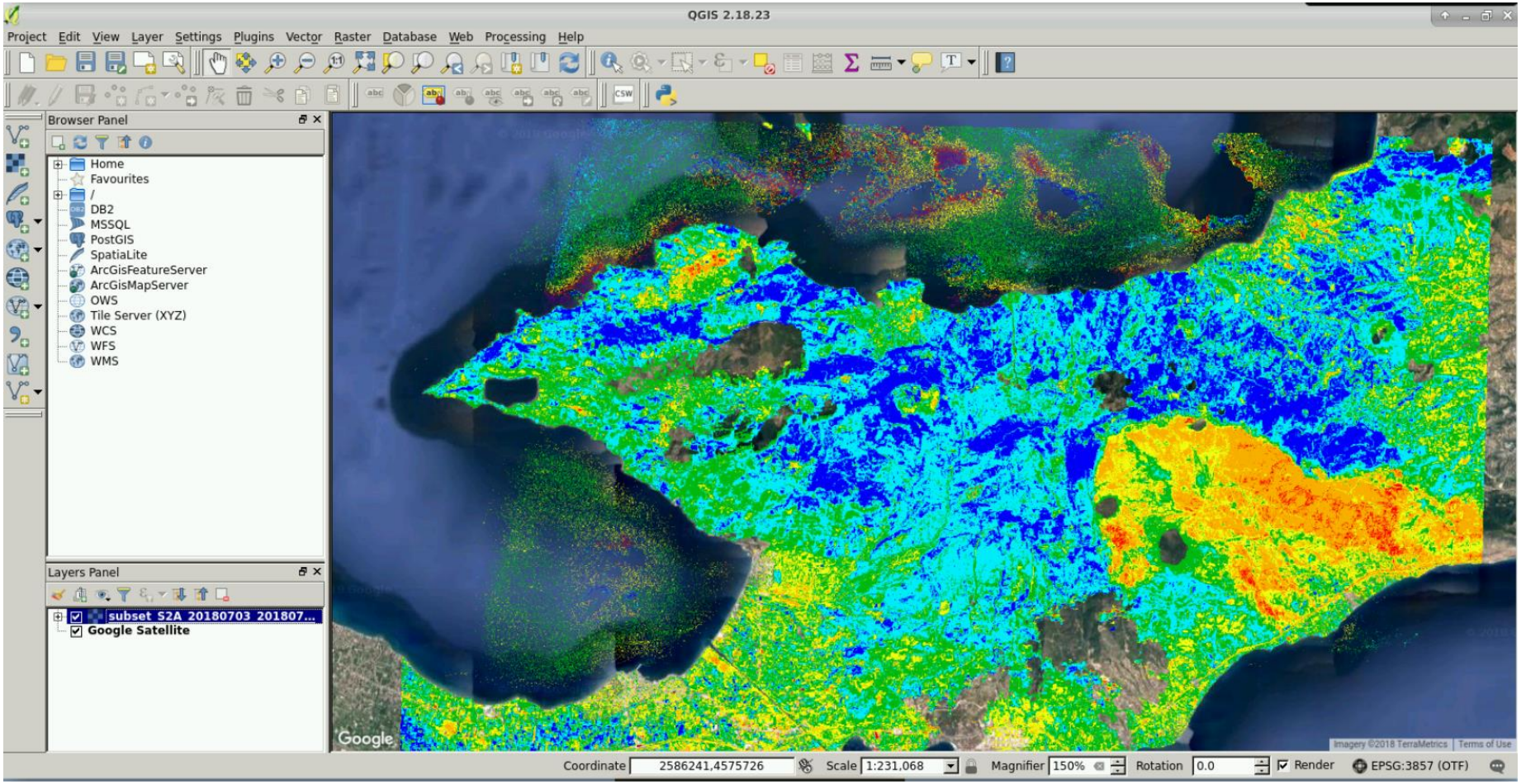
- Right-click the opened raster-layer in the Layers Panel (lower left) -> **Properties**
- In **Style** set**: Singleband pseudocolor, Discrete**
- Click on **Load color map from file.** Navigate too the *Auxdata* folder, open: ***Colour_pallete_RBR.txt***



Final RBR map

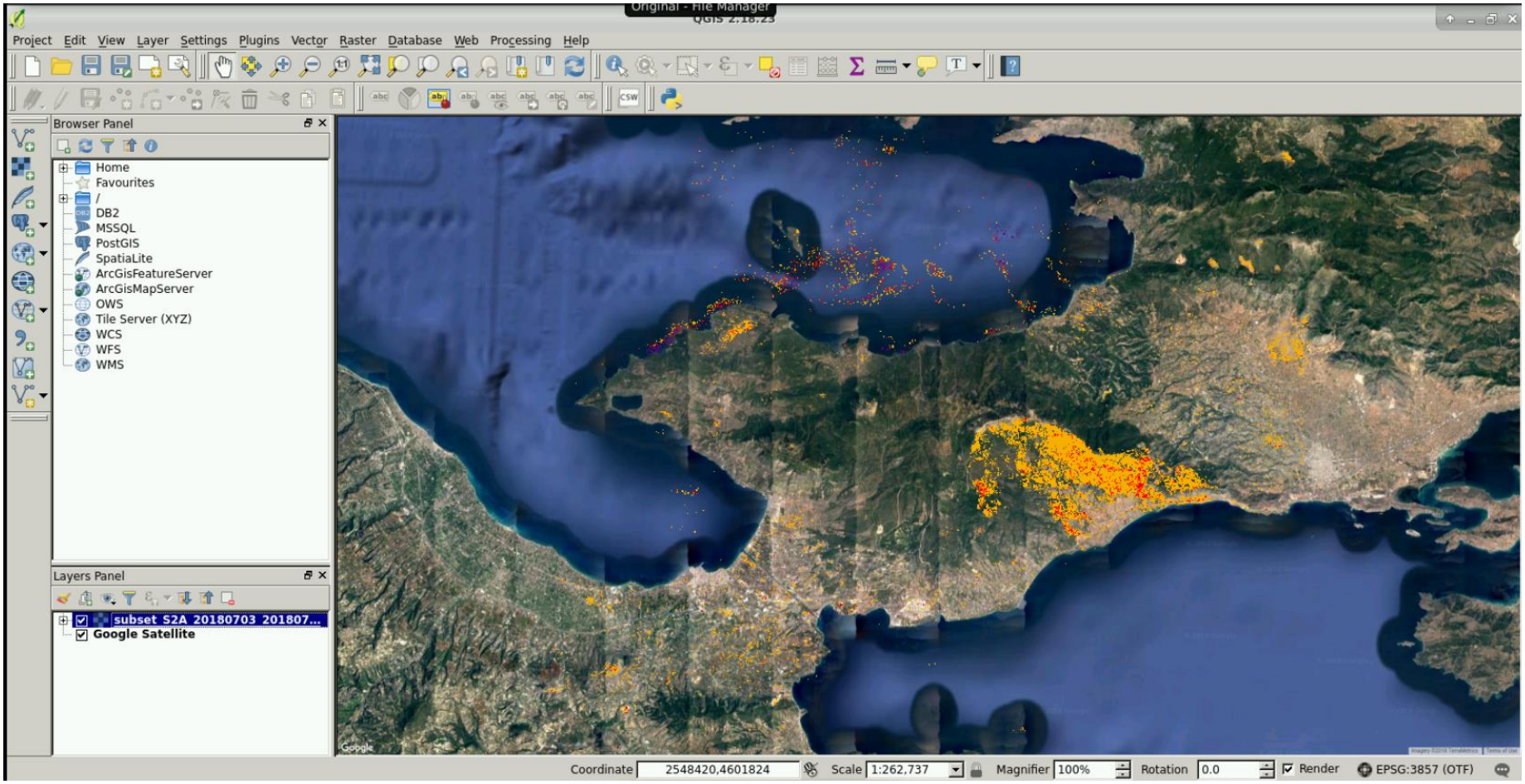
Overlay over Google Sattelite:

Web-> OpenLayers plugin -> Google Maps -> Google Satellite

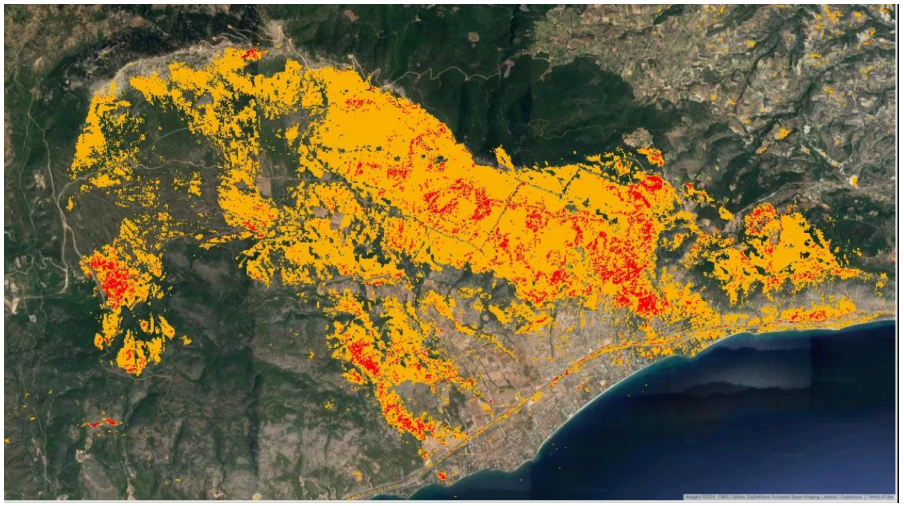


Visualizing only the Moderate to High severity areas

- In the Style tab set band to **Band 2**
- Load the color table



Comparison



- **Burned area correctly detected.**
- **Burn severity quantified**
- **Some spots missed due to clouds and cloud shadowing**