Earth Observation and Data Analysis

Homework 1

Submitted by:

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1. Checking channel image quality:

- Emissive channels EV:

    Good: 20, 22, 23, 25, 31, 32, 33
    Noisy: 21, 24, 27, 28, 29, 30, 34, 35, 36

- Reflective channels:

    Good: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 17, 18, 19, 26
    Noisy: 11, 12, 13lo, 13hi, 14lo, 14hi, 15, 16

2. Data analysis by spectrum, histogram and profile tools

Three different locations were pinned in the map in given locations as follows.

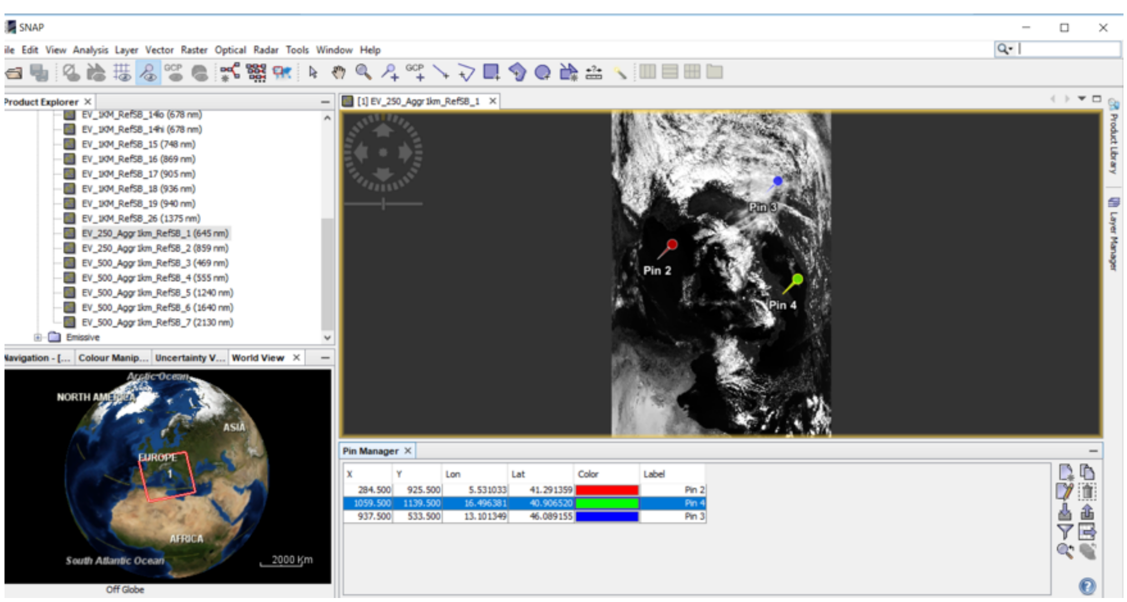

Fig 2.1. Pins created over band images

Pin 2 : at the sea
Pin 3 : Province of Udine, North-east Italy (Land with Clouds)
Pin 4 : Province of Potenza, Southern Italy (Land)

2.1 Spectrum

Here we analyze the spectrum for the pinned locations.

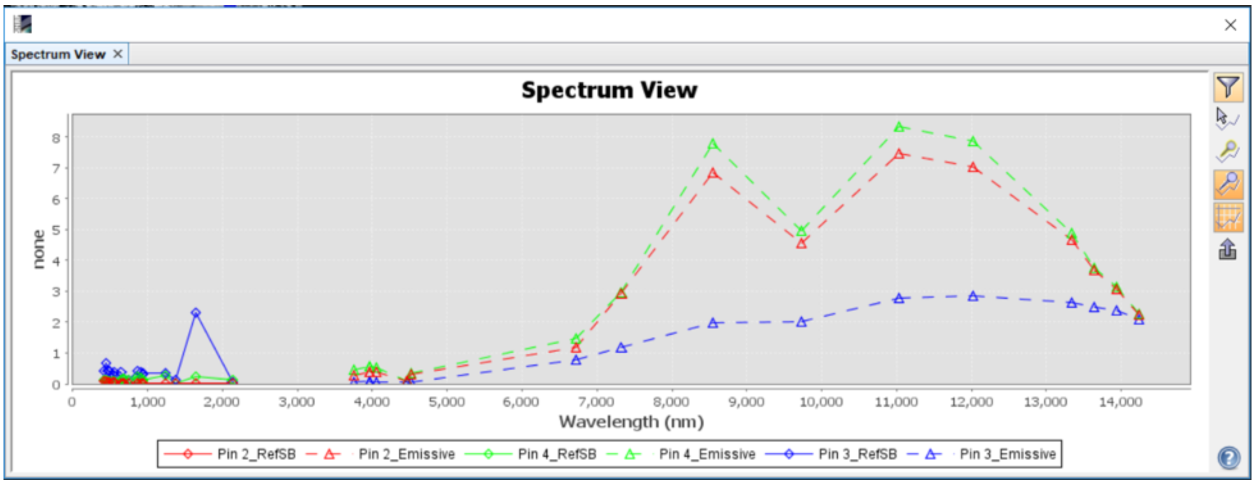

Fig 2.2 Spectrum plot for

Results:

Pin 3 has relatively higher amplitude of electro-magnetic waves in reflective band due to presence of clouds, and Pin 4 has the highest amplitude in emissive bands due to presence of clear land mass.

2.2 Histogram

Reflective Band 1 (645 nm):

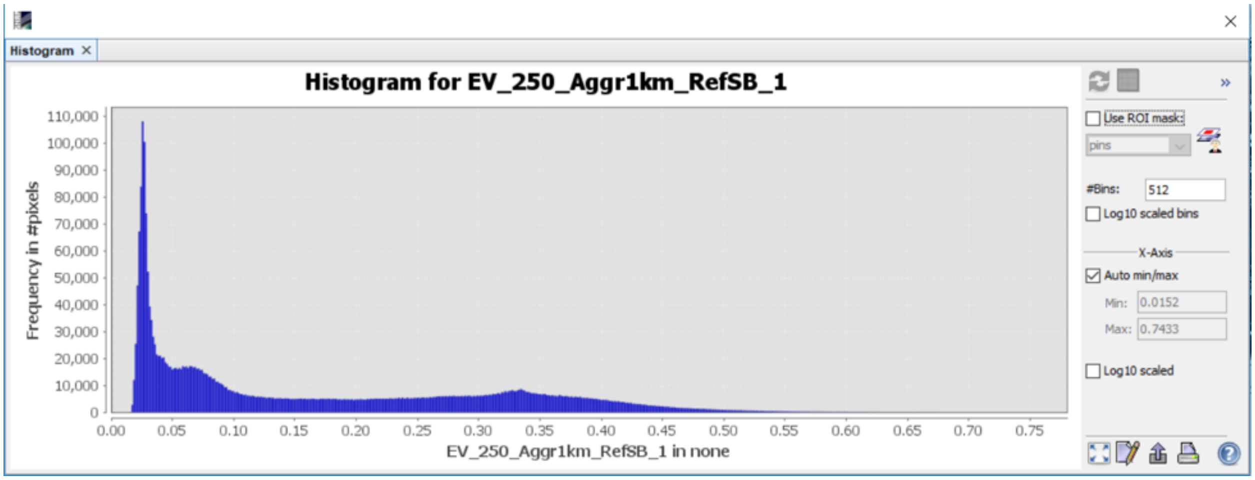

Fig 2.2. Histogram plot of Band 1

The highest frequency observation is at around 0.025 and no observations were recorded for values greater than 0.60.

Reflective Band 31 (11030 nm):

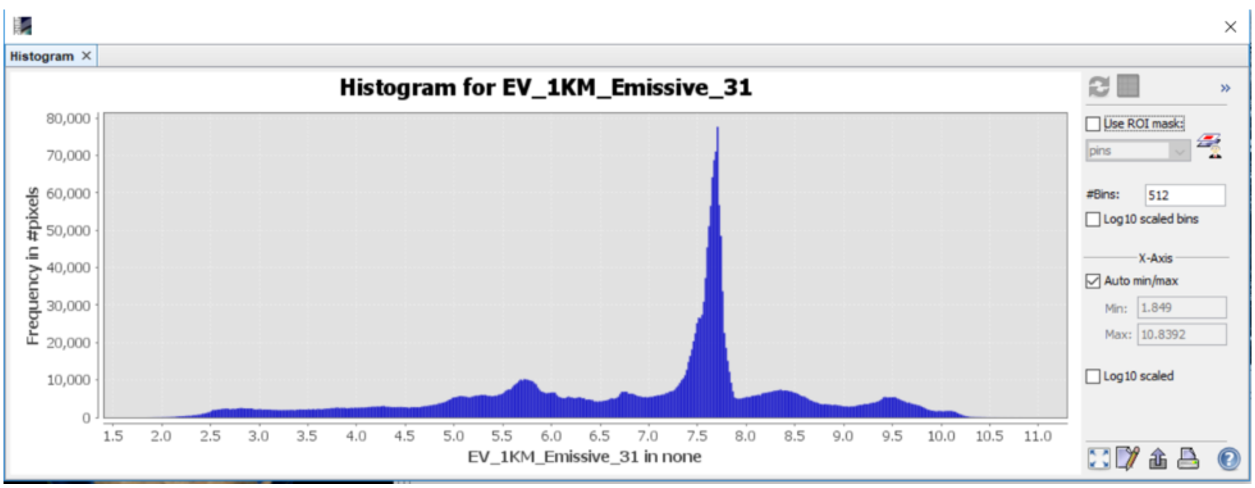

Fig 2.3. Histogram plot of Band 31

The highest frequency observation is at around 7.75 and no observations were recorded for values greater than 10.5.

2.3 Profile

Following is the profile plot between pins 2 and 3.

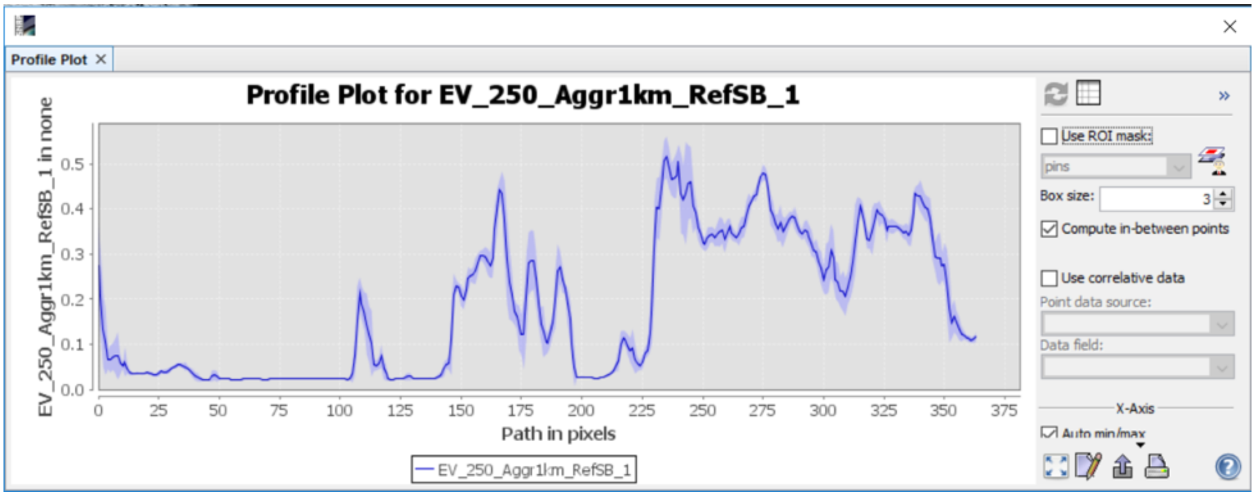

Fig 2.4 Profile plot between pin 2 and 3

3. Channel data correlation by whole image

We plotted a scatter plot for channel data correlation for bands Ref 1 and Em 31.

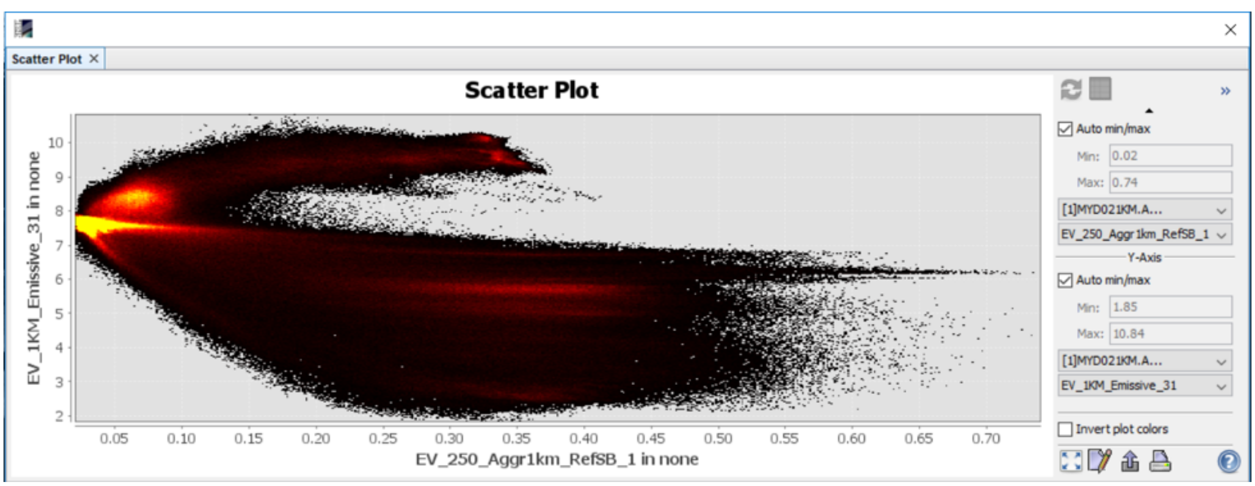

Fig 3.1 Scatter plot for Band 1 and 31

4. Channel data correlation of ROI (region of interest)

We also plotted a scatter plot for channel data correlation for bands Ref 1 and Em 31 within a region of interest.

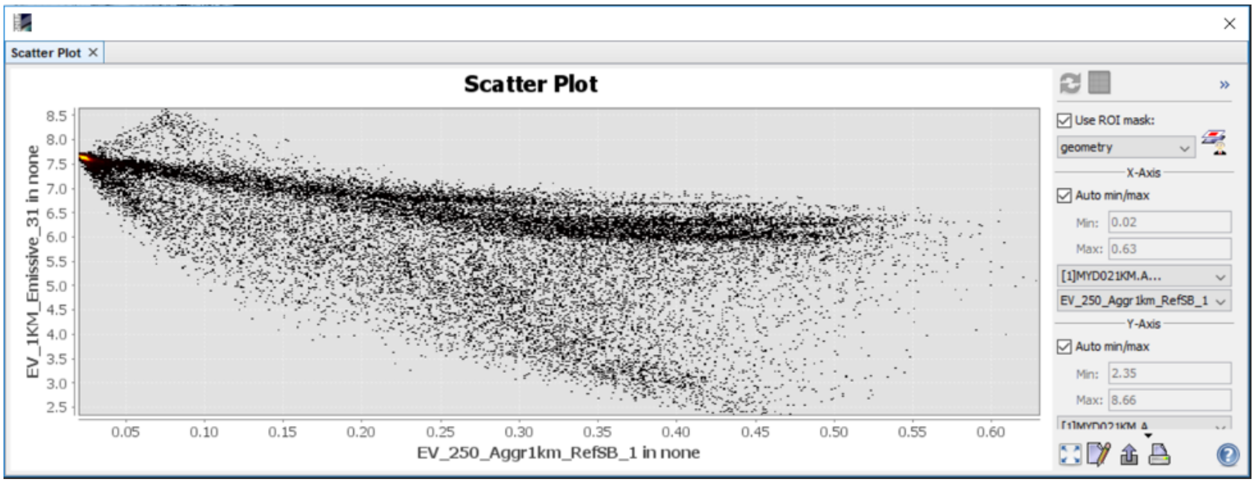

Fig 4.1 Scatter plot for Band 1 and 31 (Region of Interest)

5. Principal component analysis

Principal component analysis was performed for first 7 bands using the SNAP toolbox.

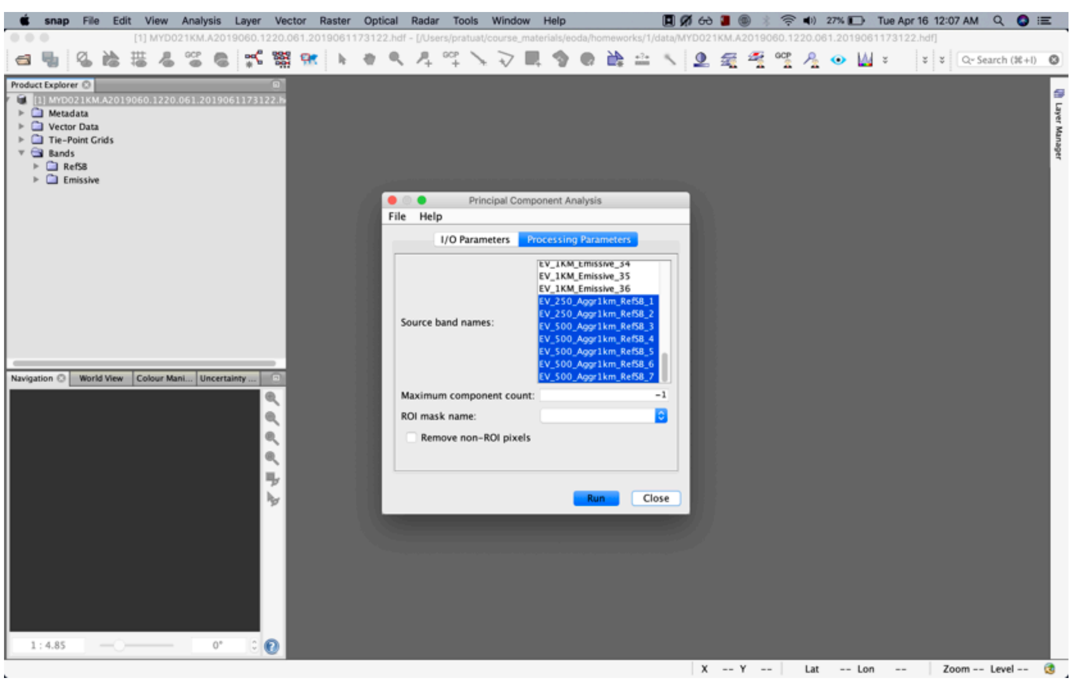

Fig 5.1 SNAP PCA tool options

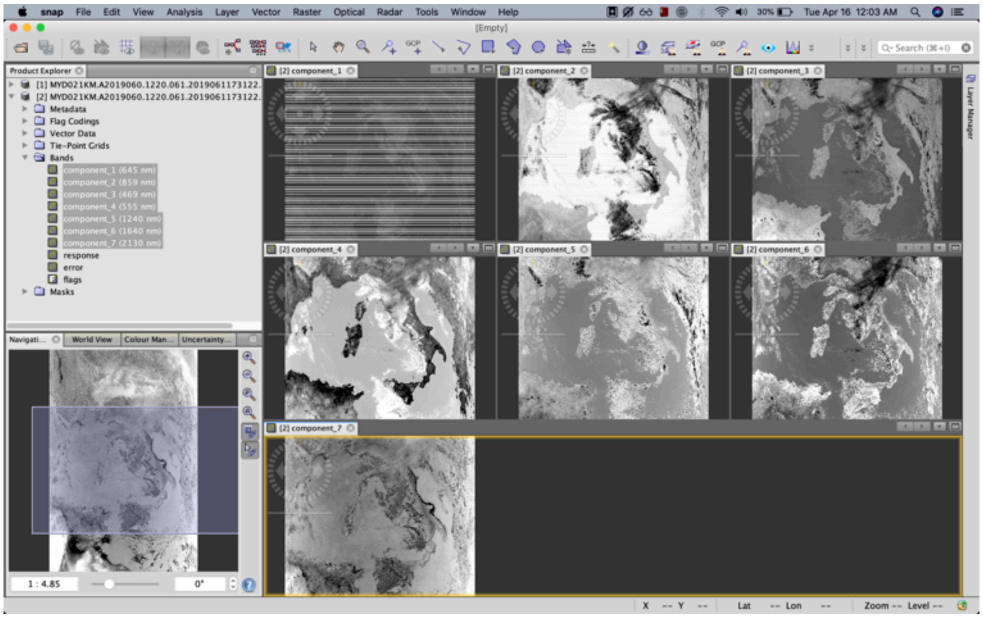

Fig 5.2 SNAP PCA tool results for 7 bands

Results:

- Band 3 and 4: comprise of most information
- Band 1 and 2: presence of noise

6. Unsupervised classification with 3 classes (sea, land and cloud)

An unsupervised K-means cluster analysis was performed with number of cluster set to 3. Multiple trails were conducted with random selection of bands as feature sets but no commendable results were obtained. On performing the clustering operation on smaller region of interest with fewer band parameters, we obtained very good results that correctly classified desired land, sea, and cloud features.

Results:

Bands used: 1, 4, 8, 19, 23, 26

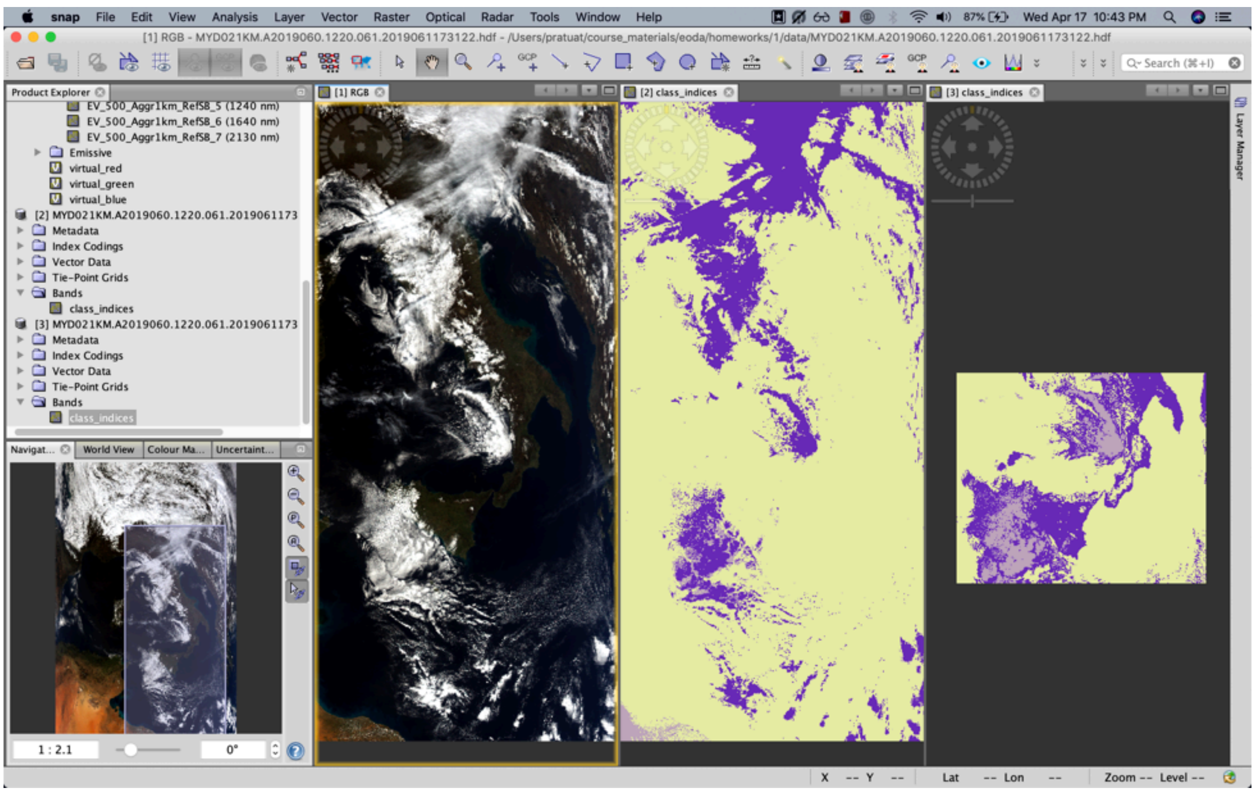

Fig 6.1 Result for unsupervised classification using SNAP toolbox

The process tool appropriately classified sea (yellow), land (violet) and cloud (grey) section into different clusters as we can visibly examine the correctness of the result.

7. Supervised classification with 3 classes (sea, land and cloud)

Firstly we created a RBG visible composite images using three bands.

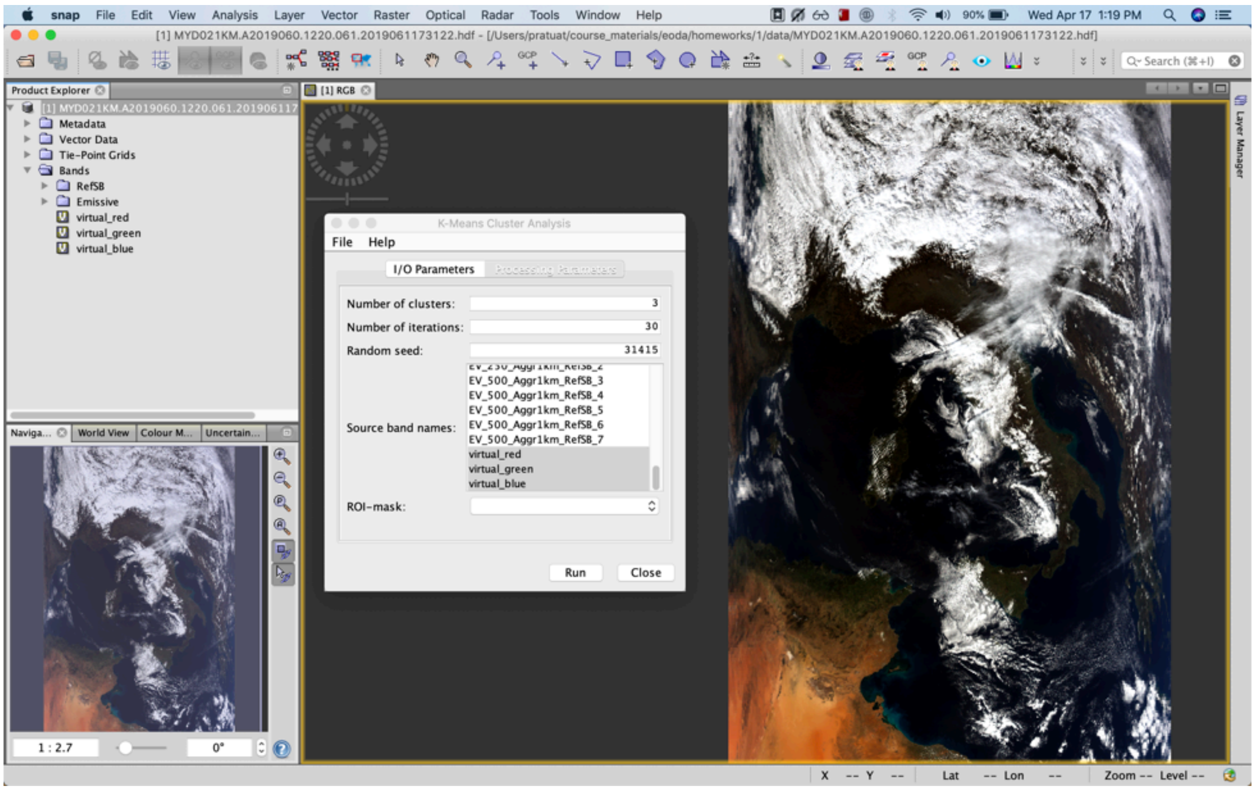

Fig 7.1 RGB visual composite

Then on we created three vector data layers of three classes sea, land and clouds. We used drawing tools to sample sections for all three classes from the visible composite image. Then-on supervised classification was performed using Maximum Likelihood Classifier across the whole area.

Results:

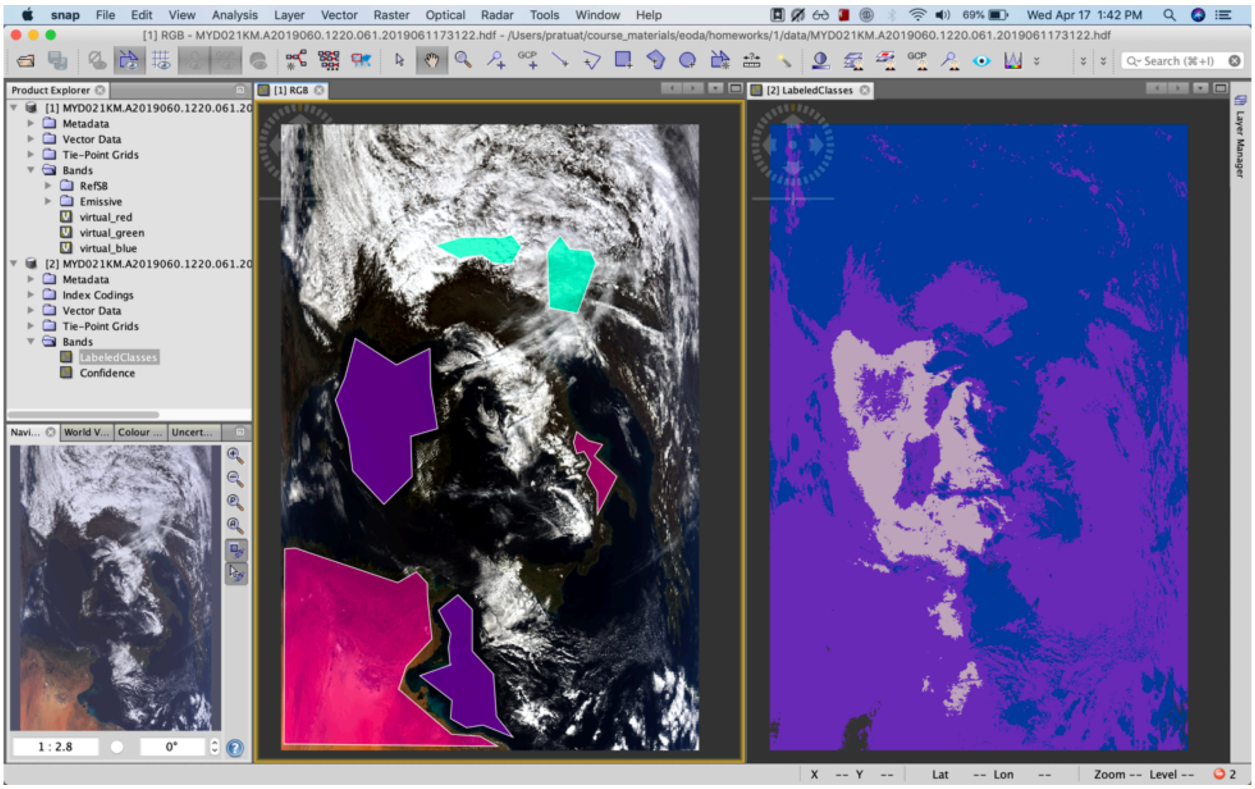

Fig 7.2 Class labelled vector geometries and corresponding results using Supervised Learning

The classifier seem to have accurately classified sea (grey), land (purple) and cloud (blue) section. Supervised classification yielded better results compared to unsupervised classification for whole image.

8. Vegetation Index using SNAP processing tools

8.1. Normalized Difference Vegetation Index (NDVI)

NDVI is one of the simplest indicator used to analyze remote sensing measurements for live green vegetation in the observed land mass. Normalized Difference Vegetation Index (NDVI) quantifies vegetation by measuring the difference between near-infrared (which vegetation strongly reflects) and red light (which vegetation absorbs).

$$NDVI = \frac{NIR - Red}{NIR + Red}$$

8.2. Soil-adjusted vegetation index (SAVI)

SAVI is an improvement over NDVI in terms that it accounts for the differential red and near-infrared extinction through the vegetation canopy. SAVI minimizes soil brightness influences from spectral vegetation indices involving red and near-infrared (NIR) wavelengths.

$$SAVI = \frac{(1 + L)(NIR - Red)}{NIR + Red + L}$$

Here, **L** is a canopy background adjustment factor. An **L** value of 0.5 in reflectance space was found to minimize soil brightness variations and eliminate the need for additional calibration for different soils. The transformation was found to nearly eliminate soil-induced variations in vegetation indices

8.3. Ratio Vegetation Index (RVI)

RVI is the simplest vegetation index with the assumption that ratio of **Red** to **NIR** is proportional to healthy vegetation.

$$RVI = \frac{Red}{NIR}$$

Following is our observation for NDVI, SAVI and RVI obtained using SNAP's inbuilt processing tools to distinguish vegetation.

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Results:

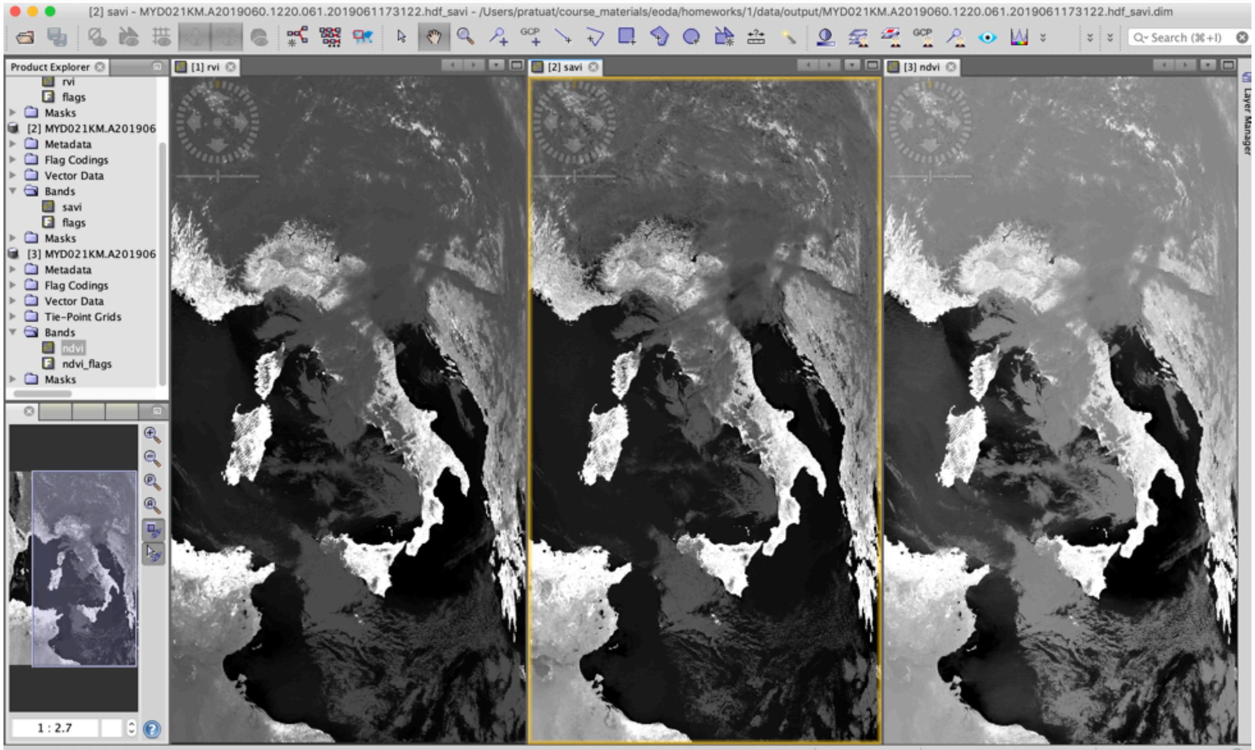

Fig 8.1 Visual comparison of RVI, SAVI and NDVI vegetation index results

In comparison against SVI and NDVI, RVI projects high degree of contrast between vegetations with darker segments representing clouds and barren desert against much brighter vegetation segments in the Tunisian shorelines and mainland Italy.

9. Unsupervised classification using VI index

We performed unsupervised classification over the RVI band and observed far better results compared to classification using RGB visible bands.

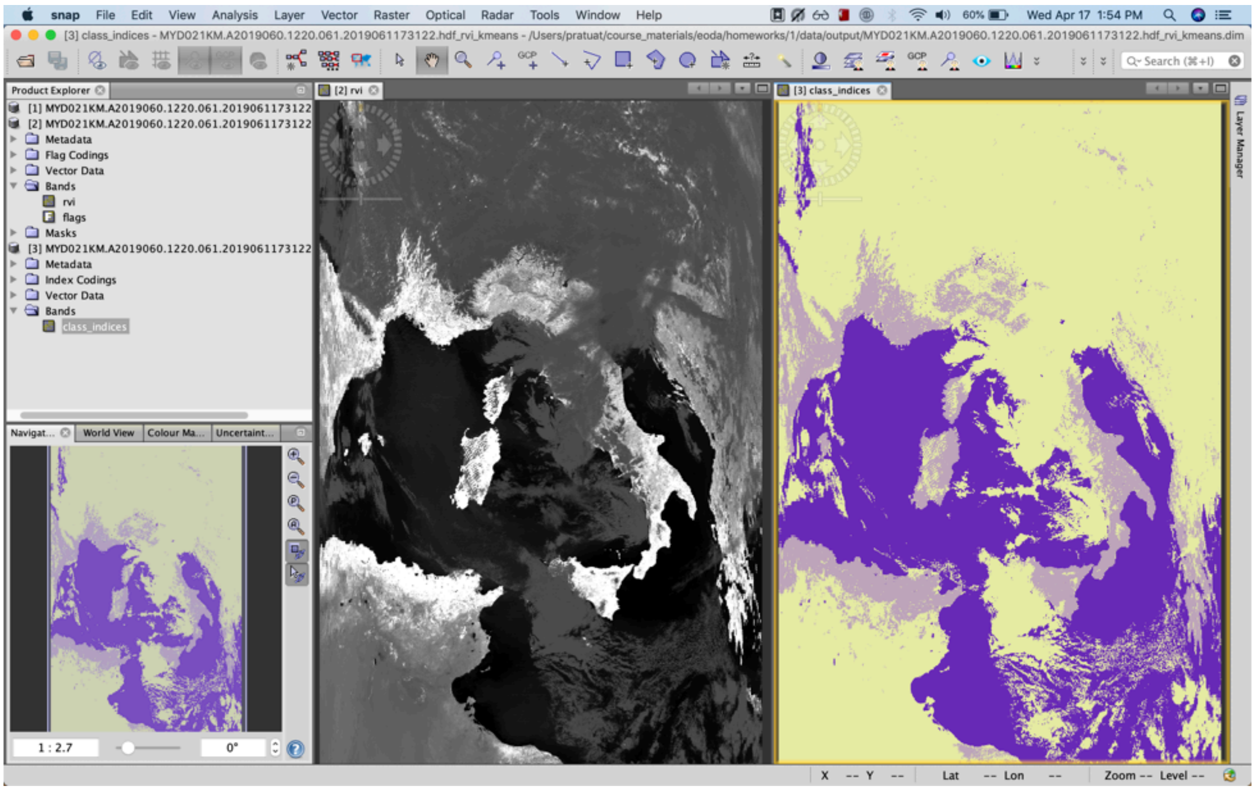

Fig 9.1 Unsupervised classification of using RVI index band

The classifier accurately distinguished the land (grey), sea (purple) and clouds(yellow) for whole dataset.

10. Qualitative analysis of VI index over interested area in winter

We used SAVI algorithm to detect vegetation over Tunisia for two datasets assimilated one in summer (March 2019) and another in winter (December 2018). We set common visualization scale for the both VI bands.

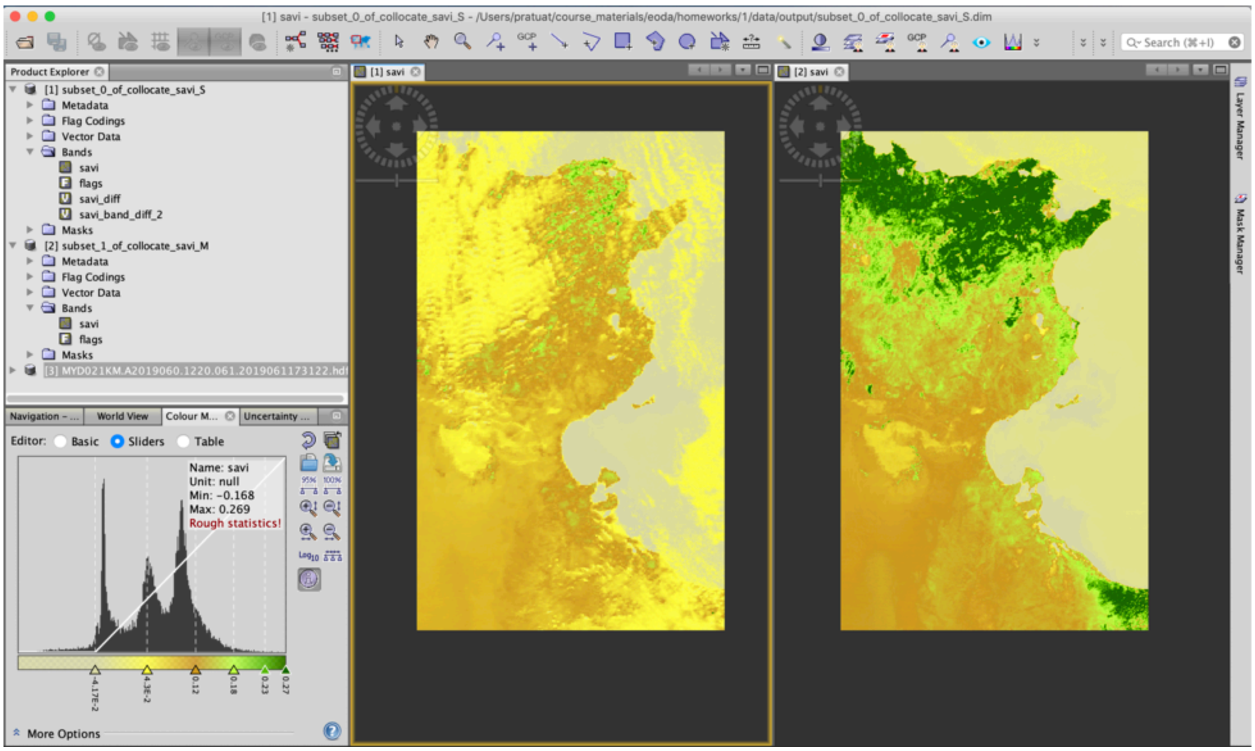

Fig 10.1 Qualitative comparison of vegetation index in summer and winter using SAVI index

It was clearly observed that the vegetation is widespread across norther mediterranean shore line in summer but barely existing in winter. However we see no change in vegetation in souther region which is occupied by Saharan desert.

11. Quantitative change detection of vegetation coverage in summer and winter

In this section we used band-math tool to compute the difference between SAVI index to quantitatively check the difference in vegetation index for two seasons and the results obtained corroborated our qualitative analysis in previous section summarizing the difference of vegetation in the northern shoreline.

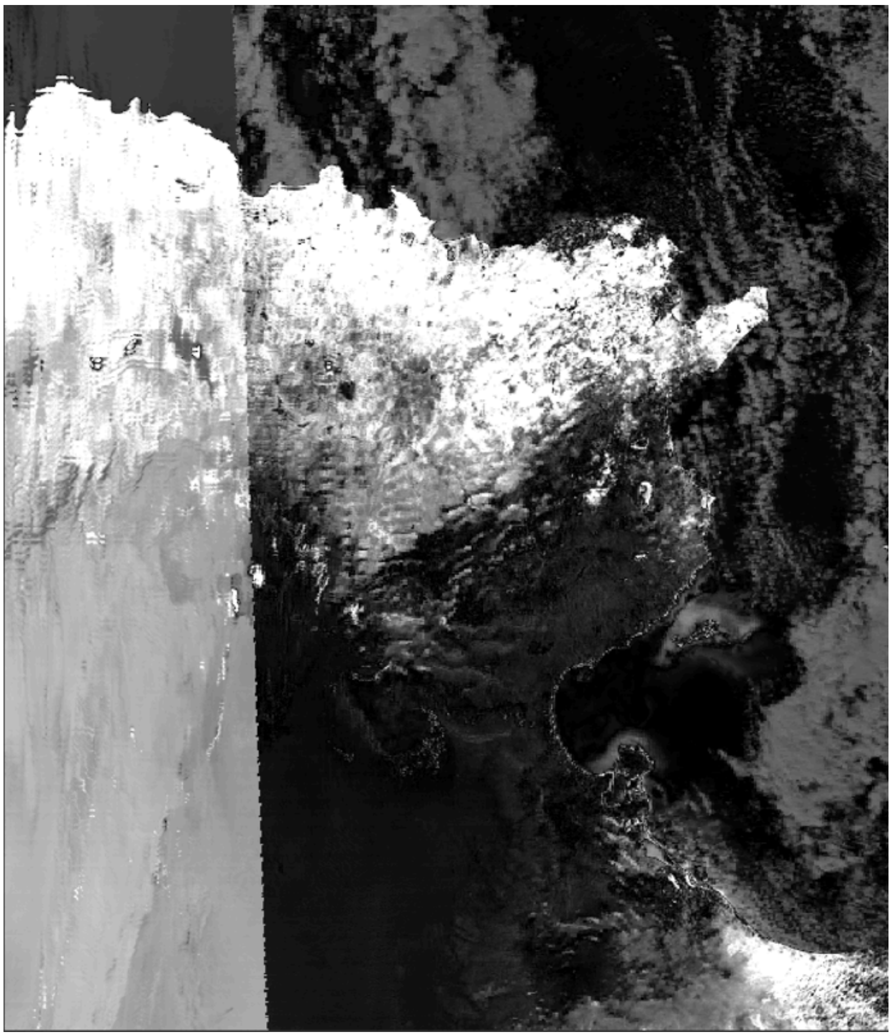

Fig 11.1 Qualitative analysis of change in vegetation