# Assignment 1

Attempt ALL the questions totalling 22 marks. Write your answers with sufficient reasoning, justification, and description. Your answers should be submitted in the Turnitin link in Assessment 1 folder located below Lecture 6 folder as **a single PDF** by **15 November 2021**. The marks obtained in this assignment weighs 50% of the final marks in the course.

Please note that this is an individual piece of work. Make sure that you **do not copy** your answers from anywhere including other reports as it will be highlighted in the similarity report, and this will reflect on your marks.

## Part I. Theoretical Questions

1. Describe the basic properties of remote sensing with radar in terms of measurements of the distance and speed. [2]

2. What are the main principles of real aperture radar and synthetic aperture radar? State and explain the key advantages of synthetic aperture radar over real aperture radar for radar imaging from space. [2]

3. Give an account on the formation of structure of the ionosphere and its impact on the remote sensing and communications using electromagnetic waves between satellites in orbits and the Earth's surface. [2]

4. Describe the main mechanisms of the atmospheric absorption, scattering, and transmission of the solar radiation and its reflection by the ground objects. Discuss their effects on the natural phenomena as perceived by human eyes and on passive remote sensing in the optical spectrum of the EM waves. [2]

5. Characterise the key parameters and behaviours of the following types of orbits around the Earth with a simple illustrative sketch of their geometries, orientations, and relative orbiting altitudes. For each of the orbital type, explain why it is particularly suited for what type of space missions for sensing, observation, and/or communications. [2]

    i. Low Earth orbit (LEO)
    ii. Medium Earth orbit (MEO)
    iii. Geostationary orbit (GEO)
    iv. Polar orbit
    v. Sun-synchronous orbit

6. Describe the main principles of the Red-Green-Blue (RGB) additive colour system and provide a brief justification of this colour system in relation to the human vision system. [2]

## Part II. Image Enhancements

The following problems involve imaging La Palma Island and the lava flows caused by the Cumbre Vieja eruption starting on 19 September 2021. You are required to create three maps with all essential elements as explained in the GIS practical.

Please download the satellite map data from the USGS EarthExplorer website https://earthexplorer.usgs.gov/, by following these steps:

 i. Search Criteria:
  Add Coordinate – Latitude: 28.6038, Longitude: -17.8308
  Date range (mm/dd/yyyy) – from 09/01/2021 to 10/01/2021.
 ii. Data Sets:
  Landsat > Landsat Collection 1 > Landsat Collection 1 Level-1 > Landsat 8 OLITIRS C1 Level-1.
 iii. Additional Criteria:
  None.
 iv. Search Results:
  Select ID: LC08_L1TP_208040_20210926_20211001_01_T1 (Acquisition Date: 2021-09-26).
  Click the download button and choose Level-1 GeoTIFF Data Product.

(a) **Pseudo Colour**. Launch the ArcMap software and drag the raster image for band 11 into the map window of ArcMap and zoom in the image suitably, then you should see a window like:
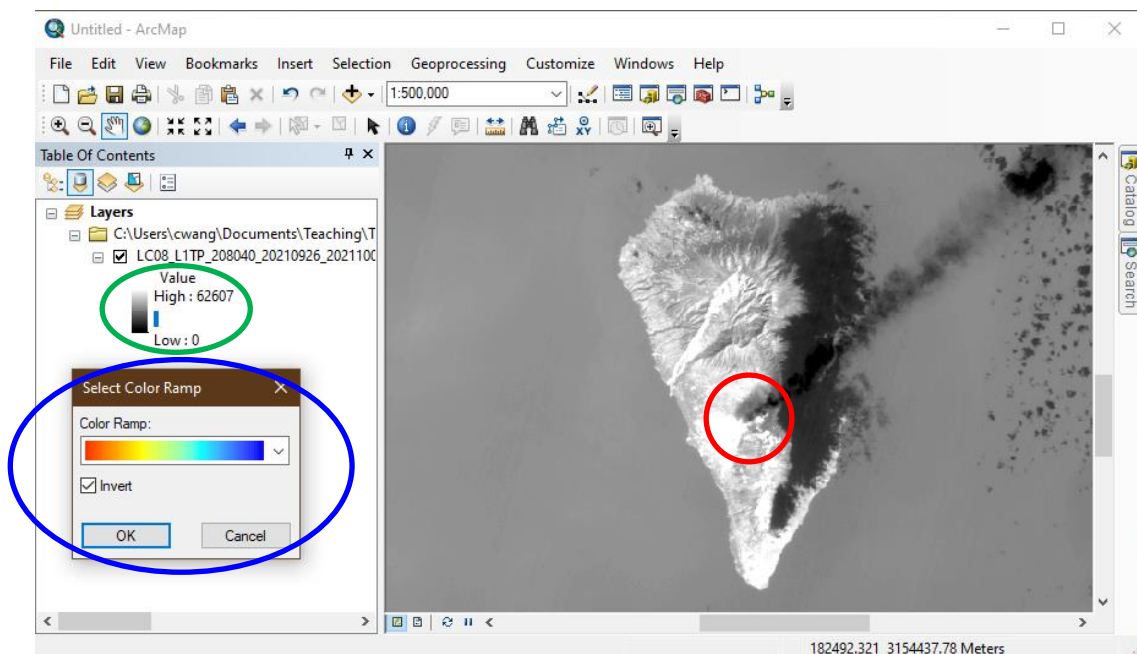


You have a now a TIR raster image in grey scale where the temperature goes up with the brightness. The location of the volcano can be clearly seen (circled in red) sending volcanic ash and smoke into the sky. You are asked to turn this image into a pseudo colour image using spectral colours so that the increasing temperature variations with black to white are mapped to blue to red. As a hint, you can start by clicking the grey scale bar (circled in green) to the left of the map window to select a suitable pseudo colour scheme (circled in blue) as indicated. Here the invert box is checked so that the colour ramp starts from blue in stead of red. After pressing OK, you then get the following ArcMap window.
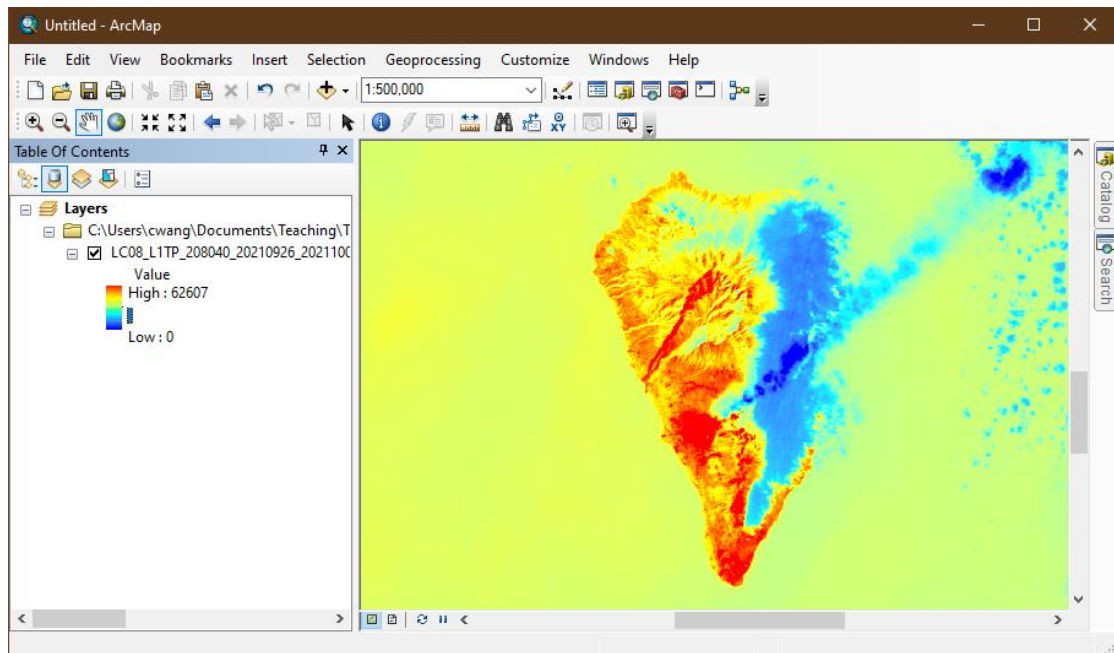
However, where are the lava flows? You must enhance this image with histogram operations to make the lava stands out. As a further hint, you can adjust the contrast stetches with the Image Analysis function accessed from the Windows menu as shown below (circled in red).
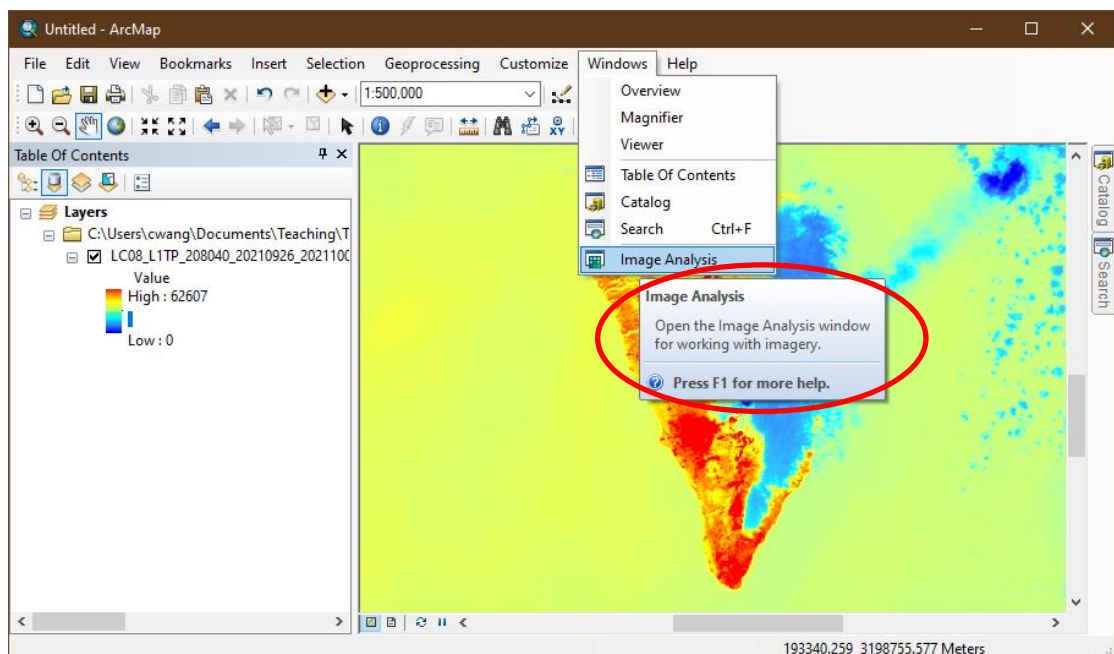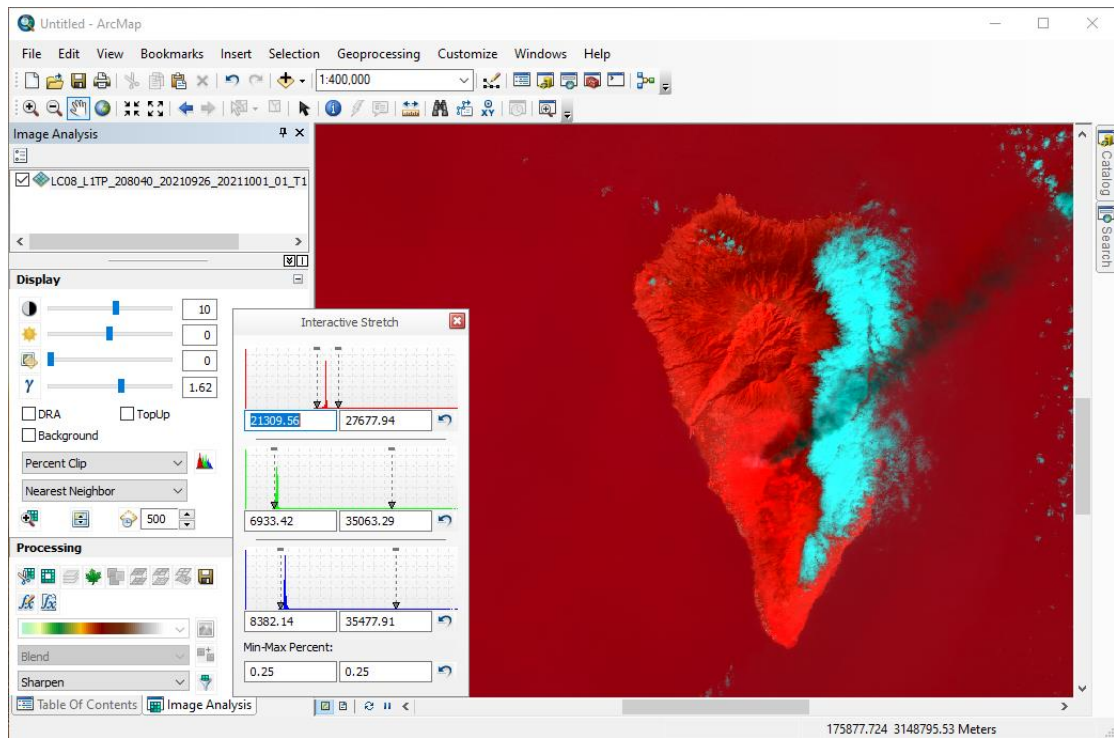


Once you have opened the Image Analysis box, you can apply the linear contrast stretch of the histogram using the Interactive Stretch Tool to make trails of the lava flows with highest temperature in the map clearly identifiable. Please export the resulting pseudo colour image covering mainly the La Palma Island into a common image file, such as the JPEG format, and paste it into your answer sheet with a size like the above figures. Please also describe how you produce it and the features including the highlighted lava flows in it. Please export this map with all essential components. [3]

(b) **True and False Colours**. You have already learned from the lectures how to compose a true colour image from the raster data of the visible band 4 (red), band 3 (green), and band 2 (blue) files. This gives you the following composite colour image using ArcMap:
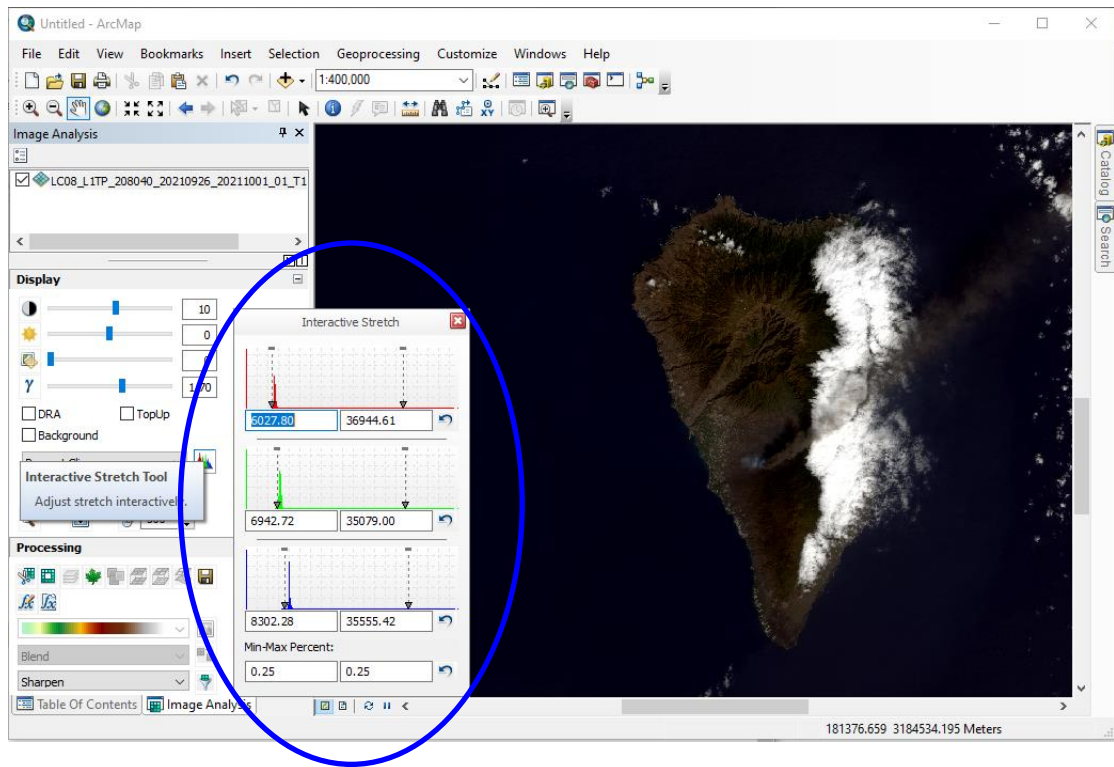


However, the presence of the white cloud patch makes the land and other features in hardly distinguished dark colours. Your task now is to enhance this image by applying linear contrast stretches to the histograms for all the three bands. Again, this can be done through the Image Analysis using the Interactive Stretch Tool as shown in the figure above (circled in blue). Please export the enhanced true colour image covering mainly the La Palma Island into a common image file and paste it into your answer sheet with a similar size as described above, with a description of how you produce it and its more obvious features except the lava flows. Please export this map with all essential components.     [3]

(c) Make a false colour imagery of the La Palma Island that has an appearance close to a true colour imagery of the island as in problem (b), but with the lava flows clearly presented as in problem (a). To this end, please follow the methods used in problem (b) but replace the red visible band 4 raster with the thermal IR band 11 raster. This should initial lead to the ArcMap window shown below, which can be enhanced by following steps in problems (a) and (b). No additional hints should be needed and please also export the enhanced false colour, but true colour looking, image covering mainly the island into a common image file and paste it into your answer sheet with a description as required above. Please export this map with all essential components.     [4]

**The End of Assignment 1**