TP1: Download and calibration of Sentinel-2 (S2) and Sentinel-1 (S1) images

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Objective:

The goal of this work session learning how to download and calibrate Sentinel-2 (optical) et Sentinel-1 (radar) images.

This TP Addresses:

- Download of S2 images at level L1C from the ESA website (European space agency). Data at the level L1C are the image of the reflectance from "TOP of Atmosphere"
- Calibration of S2 images at the L1C level to the L2A level. The L2A level is an L1C image that has been radiometrically calibrate to get the reflectance of the surface « Top of Canopy »
- Download S1 images from ESA's website
- Calibration of S1 images to obtain retro-diffusion coefficient σ^0

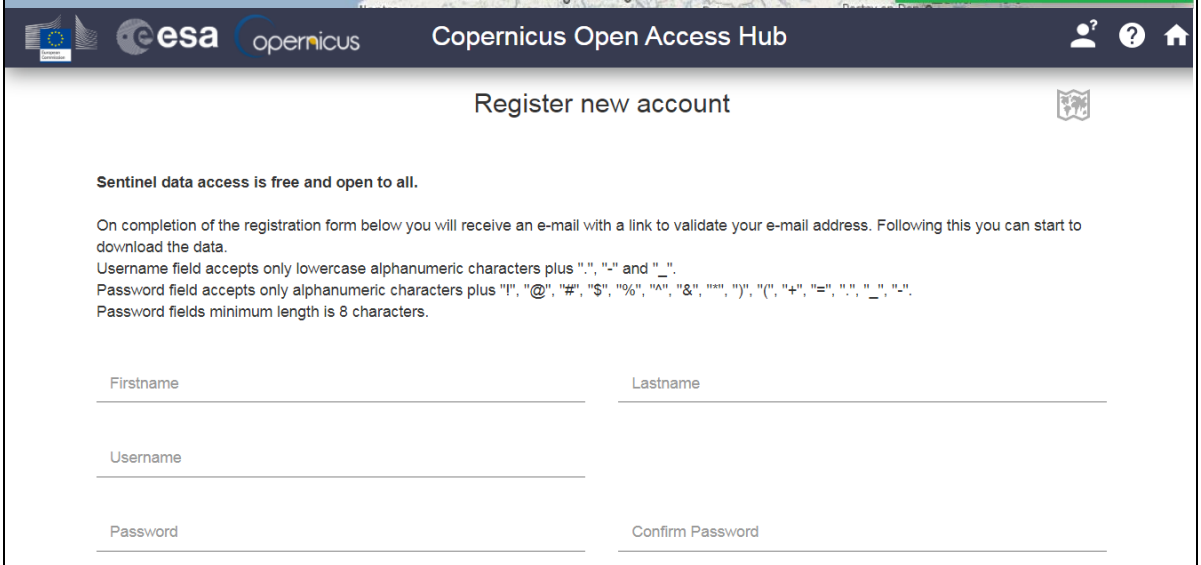
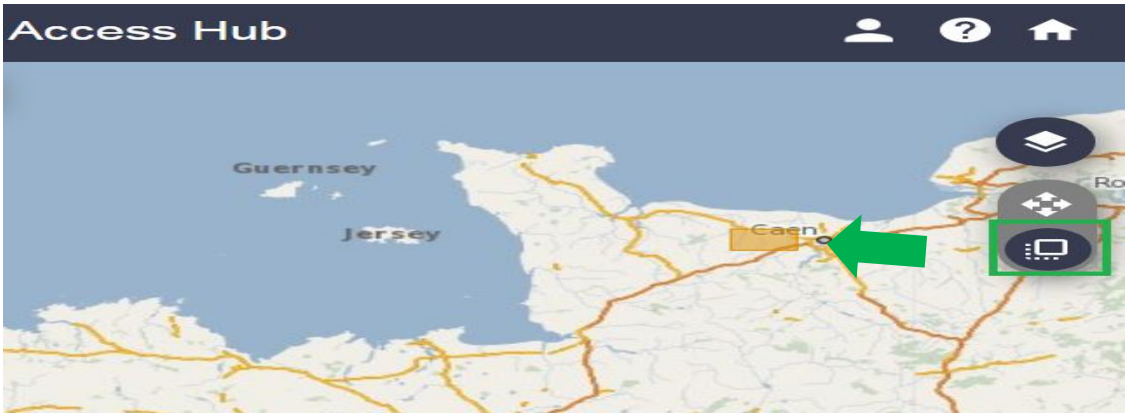
Prerequisite TP:

1. Create an ESA account (https://scihub.copernicus.eu/dhus/#/home)
2. Install the Sen2Cor tool (https://step.esa.int/main/snap-supported-plugins/sen2cor/sen2cor-v2-9) for S2 calibration
3. Install the SNAP program (Sentinel Application Platform https://step.esa.int/main/download/snap-download/)

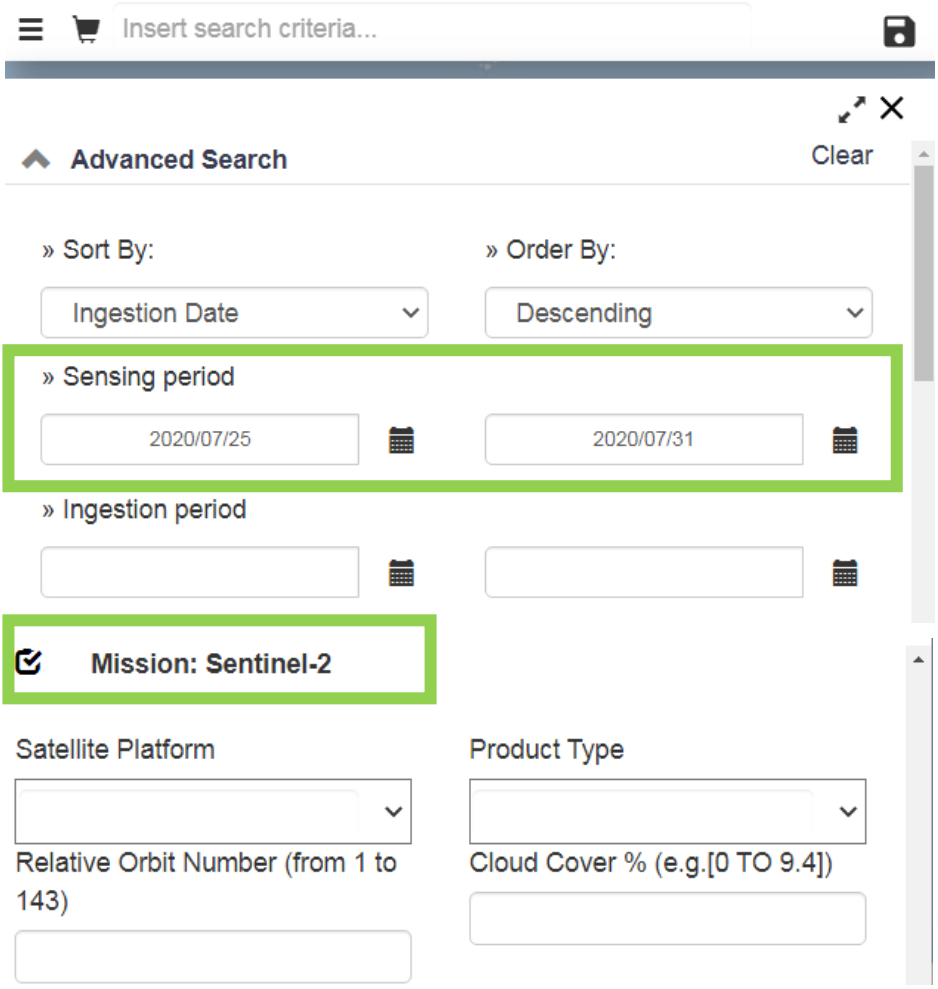
1. Download S2 images

1.1 Download via ESA's website

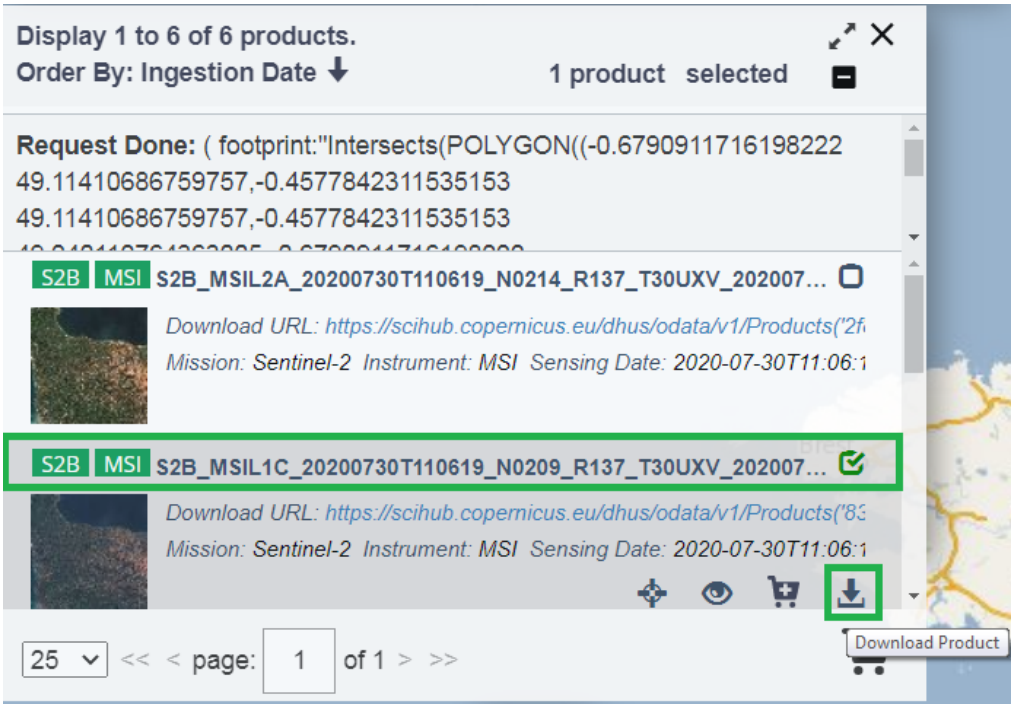
The ESA is the only source of Sentinel products, including optical products Sentinel-2. The images are available either at the L1C level (TOA), or L2A (TOC) depending on the region. In this TP, we will download L1C level data. Supplementary processing will be necessary to turn L1C images into L2A image.

1- Open the ESA website and create an account	➢ Open: https://scihub.copernicus.eu/dhus/#/home In the right corner click on➔ Sign Up ➔  fill the form with the required information to complete your registration  
2- Select and download an image	➢ On the right side, click on the drawing tool  zoom into the map heading towards Caen then draw a small rectangle to define your search zone. 

- Find the search window on the left side, select « **Sensing Period** » between **25/07/2020 and 31/07/2020.** Next select sentinel 2 mission by finding « **Mission: Sentinel-2** » and checking it



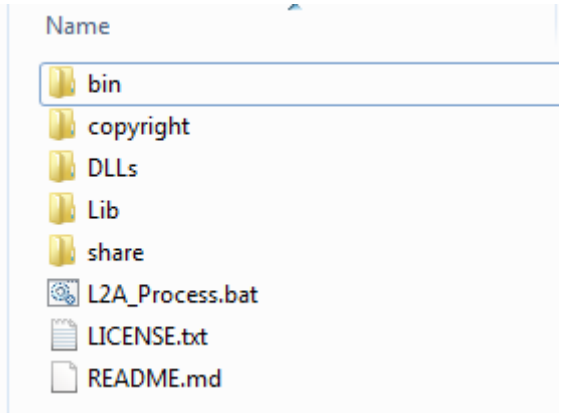
- Click on  to launch the search
- In the resulting window the **« S2B_MSIL1C_20200730T110619_N0209_R137_T30UXV**…» will appear, here's an explanation of the name scheme:
    - S2B : Satellite S2-B (Image from satellite S2B)
    - MSIL1C : Multi spectral level 1C (S2 multi spectral image)
    - 20200730T110619 : Acquisition date 30/07/2020 11h 06m 19s
    - N0209: Reference number of processing unit or Payload Data Ground Segment, PDGS
    - R137 : Relative orbit number of the image «137 »
    - T30UXV : Tile number. The surface is divided into many smaller tiles, each one has its own unique tile code. (each image belongs to a specific tile)

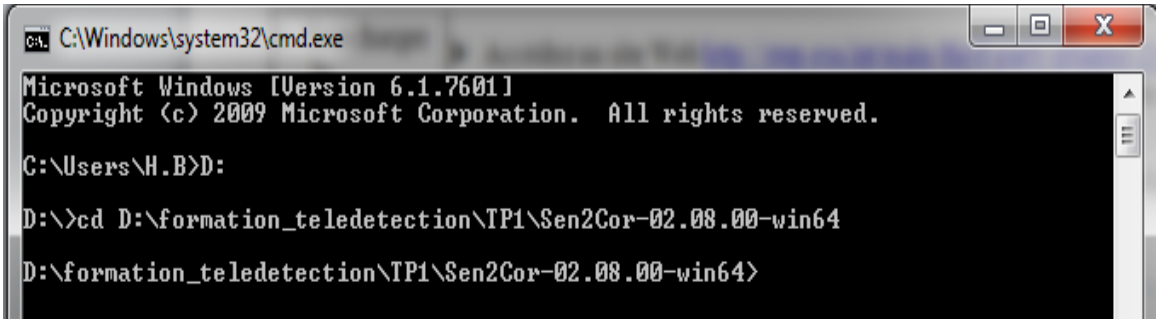


➢ Click on « **Download Product** » to download. Save the image in the folder « S2_L1C »

1.2 Calibration of the S2 image: L1C (TOA) to L2A (TOC)

Calibrating an L1C image to produce a L2A image allows us to have an image of the reflectance of the surface of the Erath instead of a top of atmospheric one like it is the case with L1C. To accomplish this calibration, a tool created by ESA called "Sen2Cor"is available.

1- Download “Sen2Cor”	Visit the website https://step.esa.int/main/snap-supported-plugins/sen2cor/sen2cor-v2-9 ➢ and go to the download page « Sen2Cor-02.09.00-win64.zip » for Windows, Linux or Mac. ➢ Once the download is done extract the file « .zip » to have access to its contents 
2- Launch the application	➢ Create a folder to save the L2A image. Example « S2_L2A » ➢ Extract the content of the « .zip » file of the downloaded image “L1C”. The extraction will result in a « .SAFE » file that contains the image data. ***S2B_MSIL1C_20200730T110619_N0209_R137_T30UXV_20200730T122556.SAFE*** ➢ Open the windows command line and direct to the file containing the download file of « sen2cor ». steps : Type the command : cd « ***your path to download file***/Sen2Cor-02.09.00-win64 » example : **cd D:\formation_teledetection\TP1\Sen2Cor-02.09.00-win64**



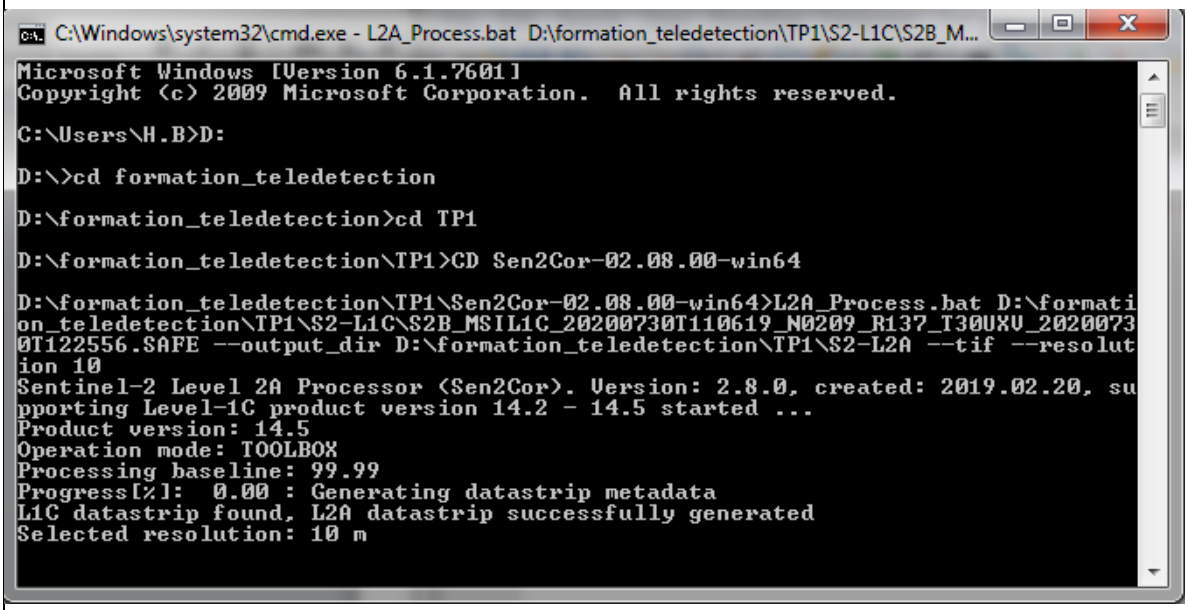
- The L2A_Process.bat is the command that will convert the L1C image to L2A. Make sure you have:
  1. Input image: extracted S2B image « .SAFE »
  2. **Output_dir** : File where to save L2A the image. → Create a folder called « S2_L2A »
  3. Optional setting "**resolution**": allows you to calibrate all the bands in the image to the same resolution (ex: 10 m)
- Type the following command:

L2A_Process.bat**…...\S2B_MSIL1C_20200730T110619_N0209_R137_T30UXV_20200730T122556.SAFE** --output_dir **….\S2-L2A** --tif --resolution 10

Make sure you modify this commands with the right input and output directories « input dir » « output_dir » depending on your directory paths

Example :

L2A_Process.bat **D:\formation_teledetection\TP1\S2-L1C\S2B_MSIL1C_20200730T110619_N0209_R137_T30UXV_20200730T122556.SAFE** --output_dir **D:\formation_teledetection\TP1\S2-L2A** --tif --resolution 10



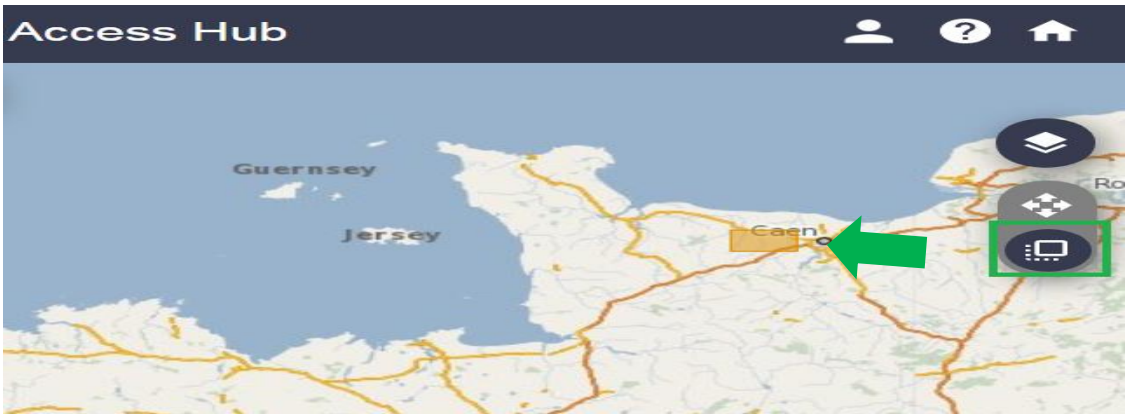
The calibration requires some time and enough memory (RAM) in order to succeed. Once completed, and L2A image will be produced in the directory "S2_L2A". For a computer with 6GB of RAM, the calibration take around 13 min.

S2B_MSIL2A_20200730T110619_N9999_R137_T30UXV_20201115T143441.SAFE

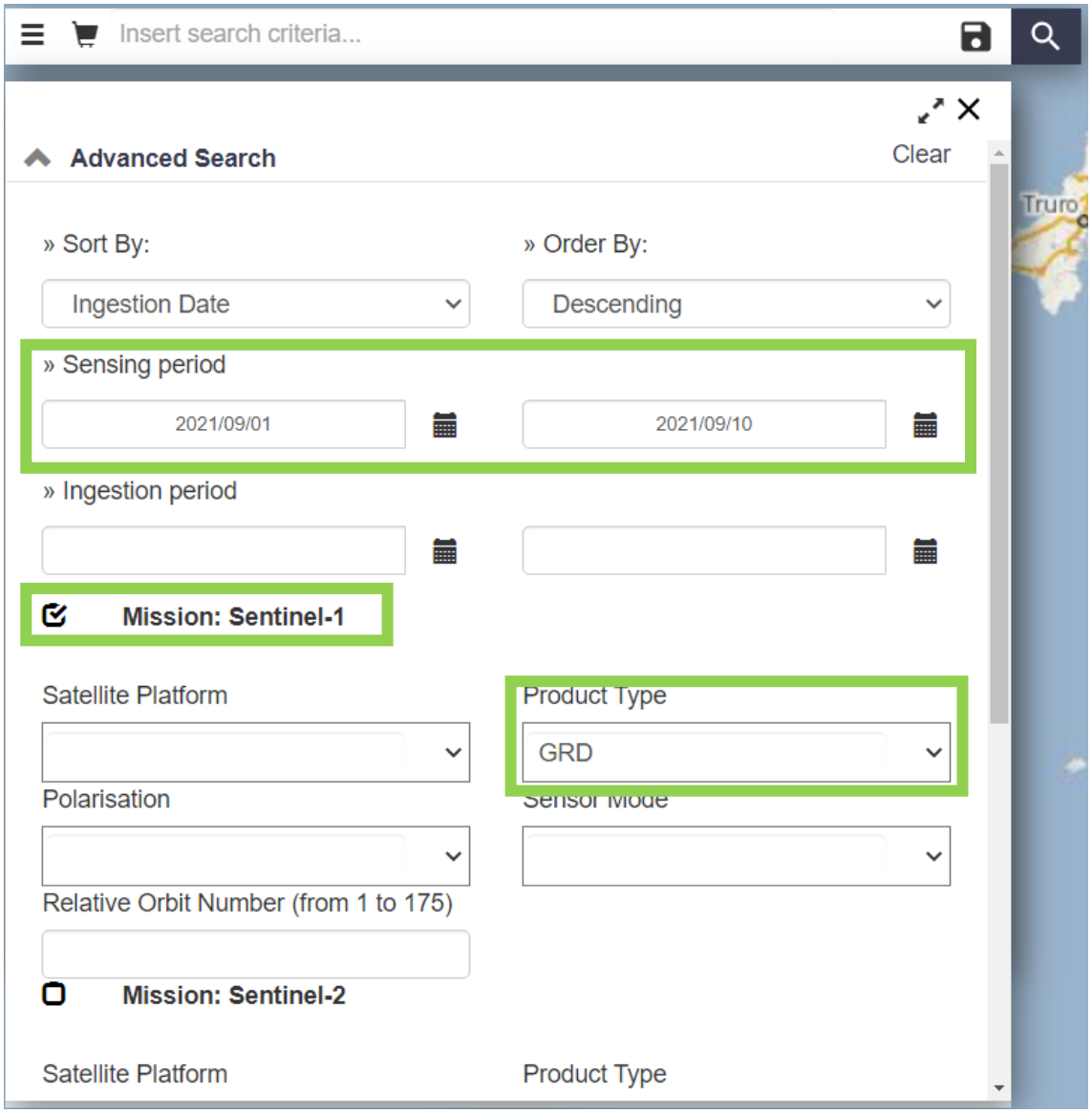
2. Download of S1 images

2.1 Download via ESA's website

ESA is the only source of Sentinel products, including radar data (Sentinel-1). In this TP, we will download an image at level S1 and calibrate it to obtain the retro-diffusion coefficient σ^0.

<table>
<tr>
<td>1- Open the ESA website and create an account</td>
<td>2- Open: https://scihub.copernicus.eu/dhus/#/home
In the right corner click on➔ Sign Up ➔  fill the form with the required information to complete your registration
 
</td>
</tr>
<tr>
<td>3- Select and download an image</td>
<td>4- On the right side, click on the drawing tool  zoom into the map heading towards Caen then draw a small rectangle to define your search zone.
 

5- Find the search window on the left side, select « Sensing Period » between 01/09/2021 and 10/09/2021. In the same window, scroll down and select the sentinel 1 mission by checking « Mission: Sentinel-1 ». In « Product Type » Select « GRD »</td>
</tr>
</table>



6- Click on  The launch the search

7- When the result of the search appears find the image « **S1A_IW_GRDH_1SDV_20210907T174912_20210907T174937_039579_04ADB0_BE50**»

8- **S1A :** Satellite S1-A (Image from satellite S1A)

9- **IW :** Acquisition mode: Interferometric Wide-swath

10- **GRDH** : Product type = Ground Range Detected High resolution

11- **1SDV** : 1 = Processing level, SDV = product class is “standard”

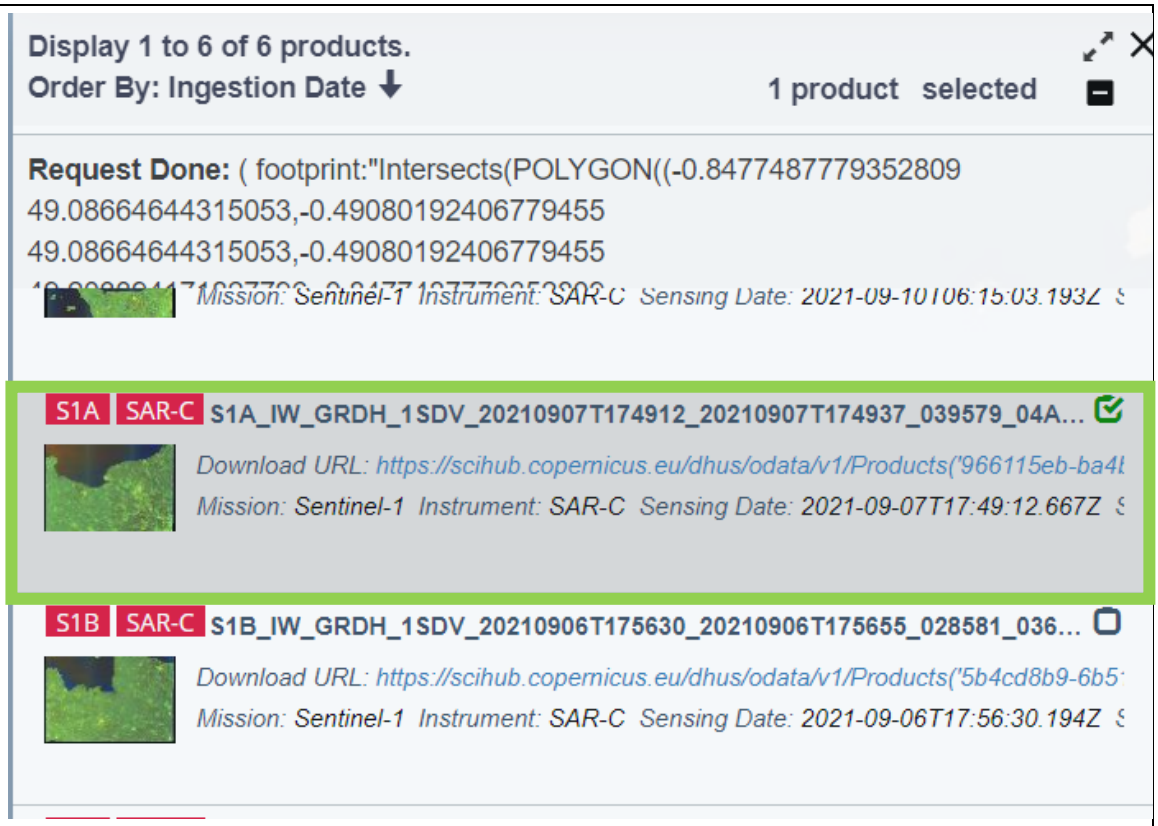
12- **20210907T174912**: Date and time at the beginning of the acquisition

13- **20210907T174937** : Date and time at the end of the acquisition

14- **039579**: Absolut orbit number

15- **04ADB0**: mission data ID

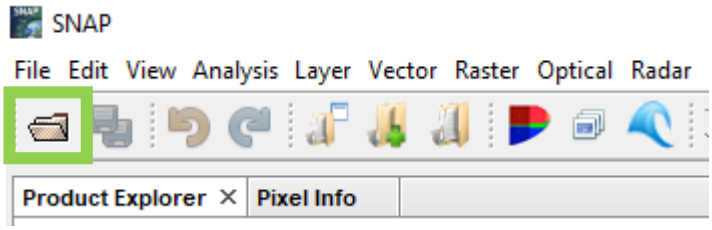
16- **BE50**: unique ID of product

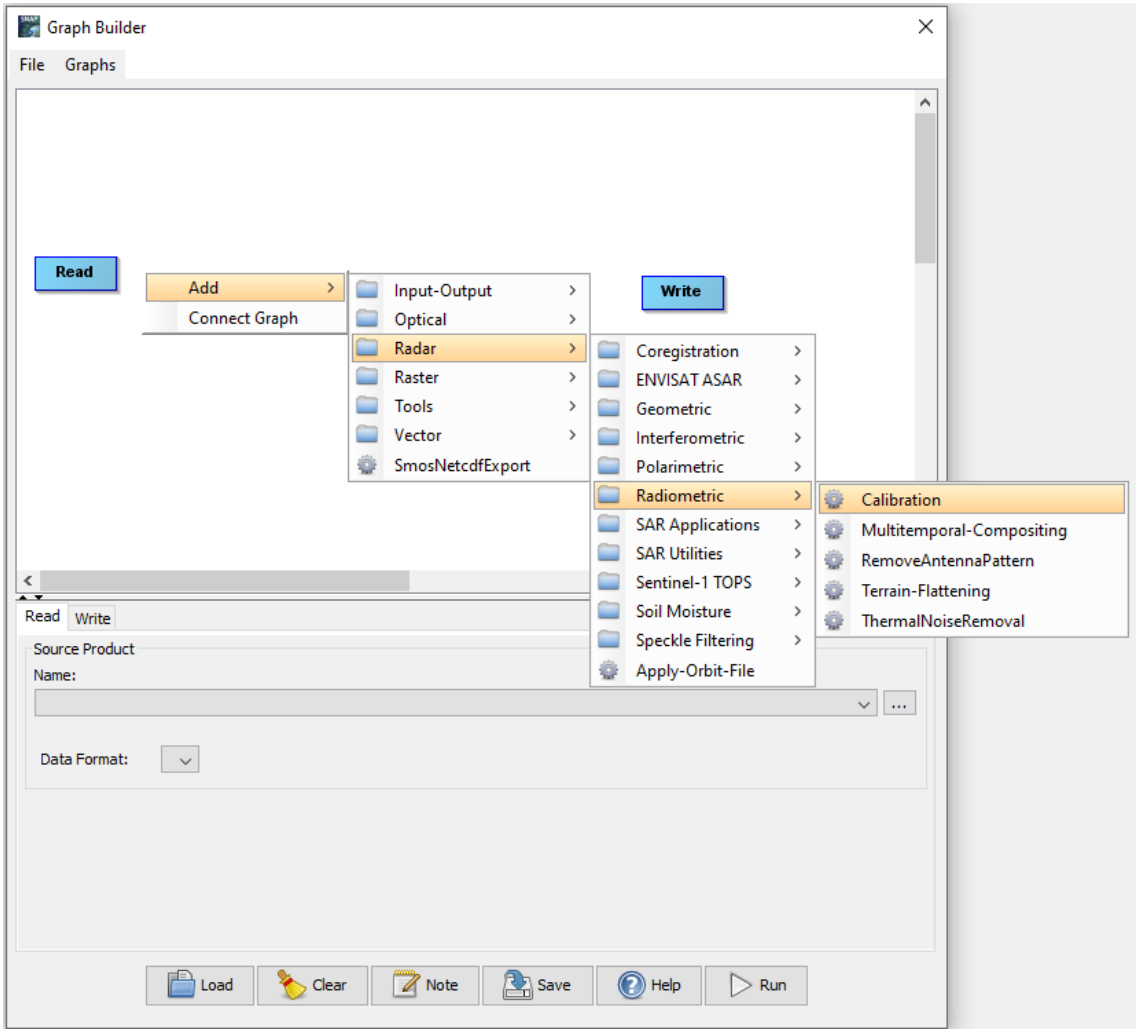


17- Click on « **Download Product** » save it in a file called « S1_GRD »

2.2 Calibration of the S1 image

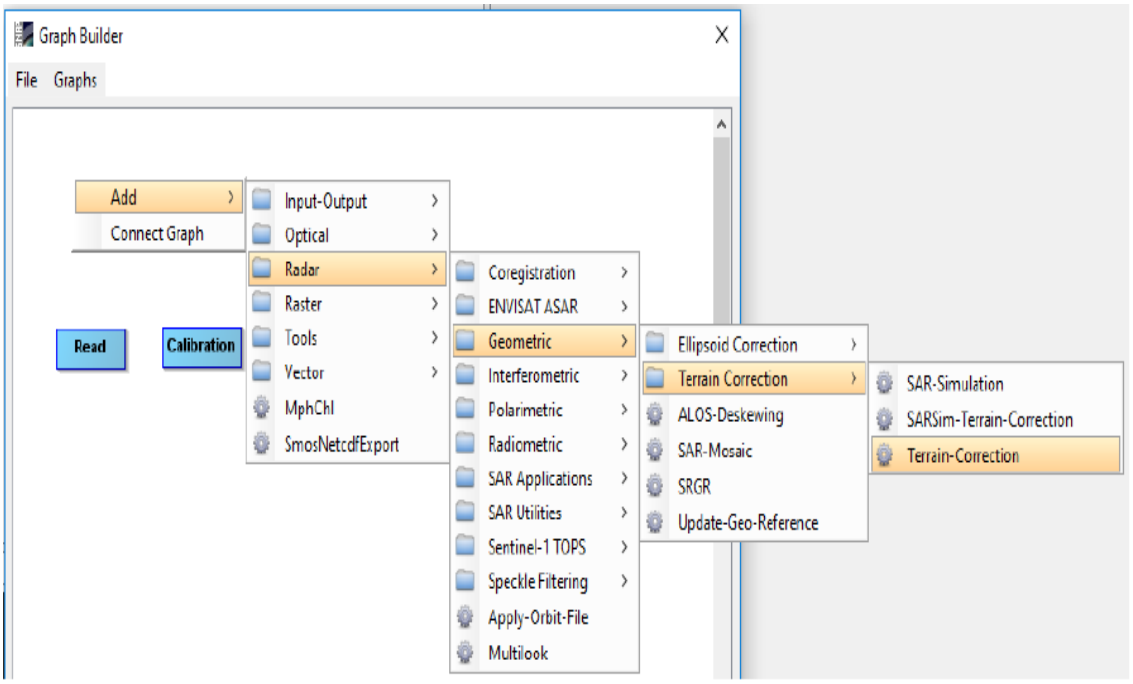
The calibration of the S1 image is a radiometric and geographic calibration that correct for the slope and for other geographic elements on the surface. For this calibration ESA created a program called "SNAP".

3- Launch SNAP	➢ Import the image « .zip » dans SNAP **Menu principal ➔ open product ➔ Select the image S1 (.zip) that we downloaded in a folder called « S1_GRD» (….TP1\S1_GRD)** 
4- Create a processing chain in the grap builder	➢ In the menu, click on  to create a calibration graphic ➢ In this graphic we will add two sections: o Radiometric calibration o Geographical calibration ➢ Add the function of radiometric calibration in the graph generator: ***Clique Droit ➔ Add ➔Radar ➔ Radiometric ➔ Calibration***



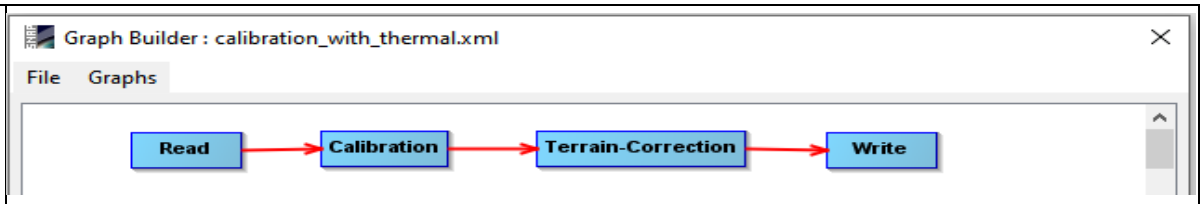
➢ Add the geometric calibration:

Clique Droit ➔ Add ➔ Radar ➔ Geometric ➔ Terrain Correction ➔ Terrain Correction

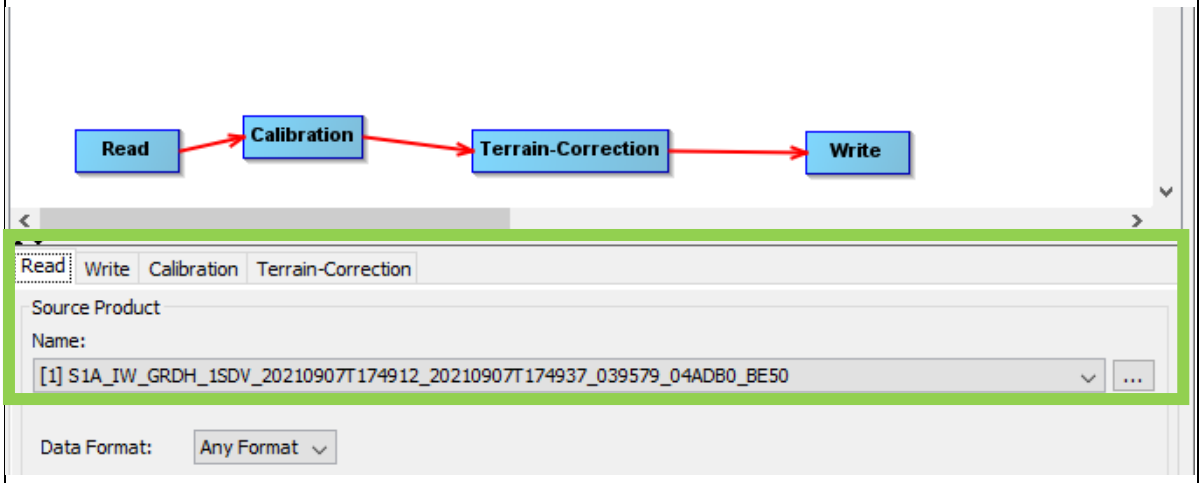


➢ To make the links between the two functions:

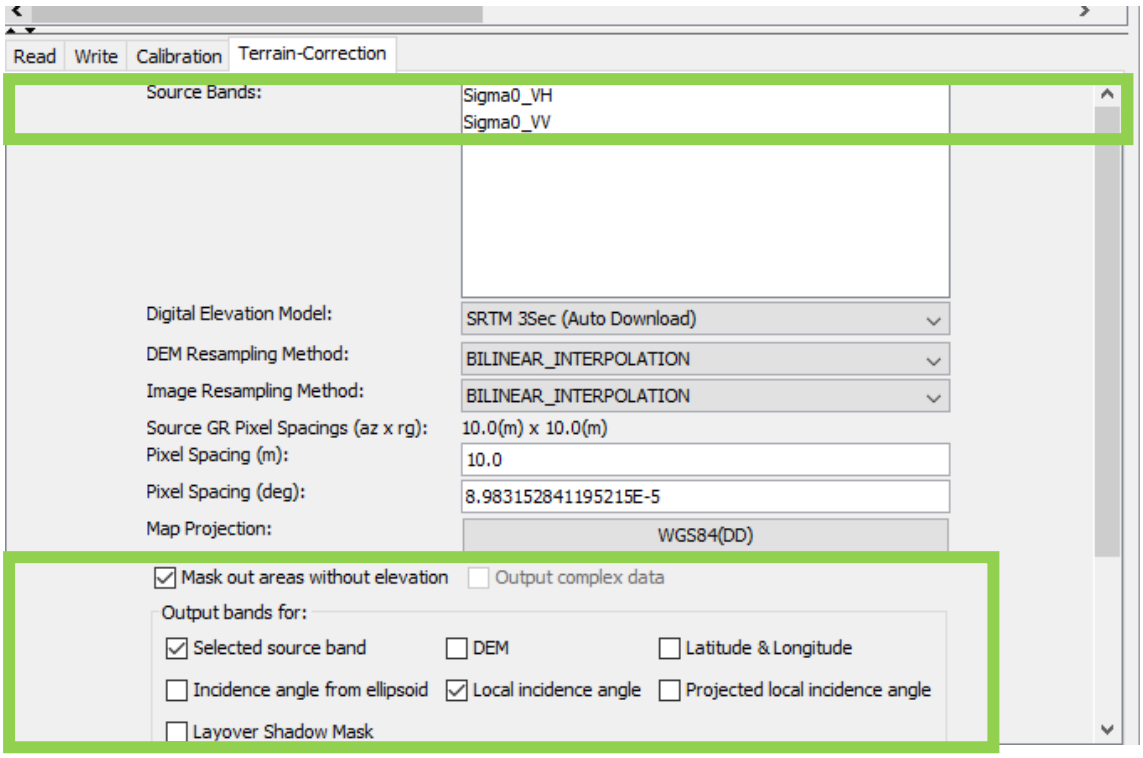
Clique Droit ➔ Connect Graph



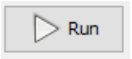
➢ Dans l'onglet « ***Read*** », Select l'image radar « .zip »



➢ Dans le menu « ***Correction du terrain*** », Select « Local Incidence Angle »



➢ In the « ***Write*** »section , name your image

➢ To launch the calibration, Click on 

➢ The final product will be a « .SAFE » file, containing three imaged:

- ***Sigma0_VV.img ➔ Radar image radar in VV polarization***
- ***Sigma0_VH.img ➔Radar image radar in VH polarization***
- ***LocalIncidenceAngle.img ➔ Incidence angle***