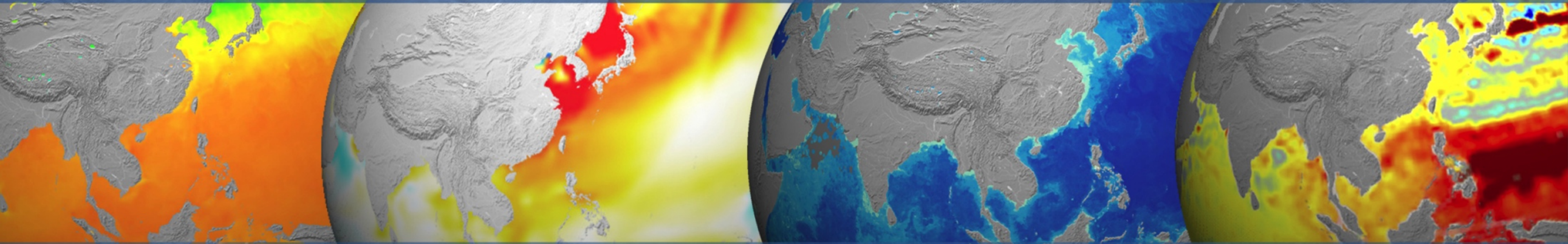
ESA–MOST China Dragon 4 Cooperation

→ ADVANCED TRAINING COURSE IN OCEAN AND COASTAL REMOTE SENSING



12 to 17 November 2018 | Shenzhen University | P.R. China

Sea Surface Temperature Retrievals SNAP & S3 SLSTR Data

- Francesco Nencioli, Plymouth Marine Laboratory

Hosted by

Outline and Info

In this practical session you will use the SNAP GUI to:

1) Explore and visualise SST data.
2) Subset and save a region of interest.
3) Apply bias corrections and masks to SST data.
4) Filter cloud pixels with user-defined flags.

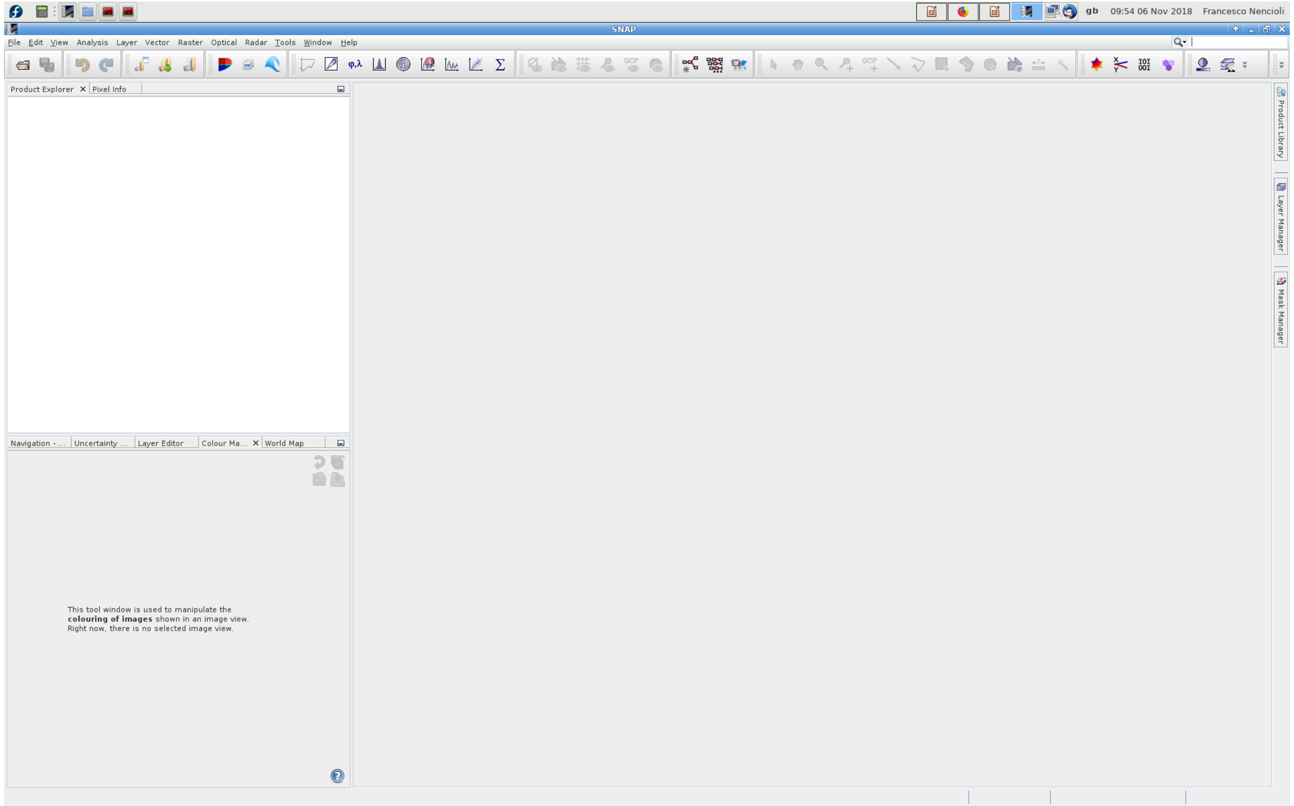
IMPORTANT NOTE:
This lesson requires **Sentinels Application Platform (SNAP) software** and **Sentinel Toolboxes** which can be downloaded at :
http://step.esa.int/main/download/
This should already be available on your machines.

Exercise 1: Explore and visualize SST data

- Start the SNAP program

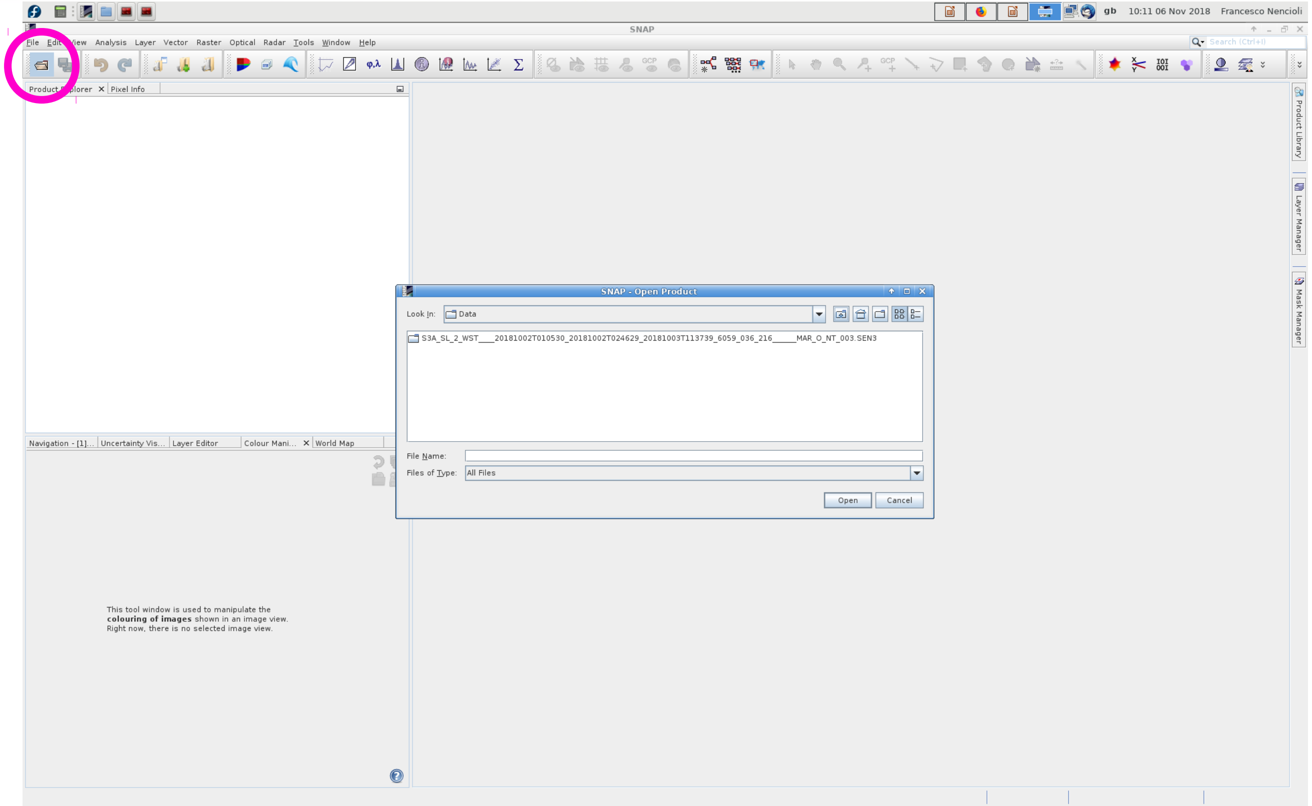
(You can simply type snap and hit enter from the command line)

This should provide an interface that looks like this



Exercise 1: Explore and visualize SST data

- Click the open file icon
- Navigate to the Data folder



As for the OC practical we will work with observations from October 2 2018

Exercise 1: Explore and visualize SST data

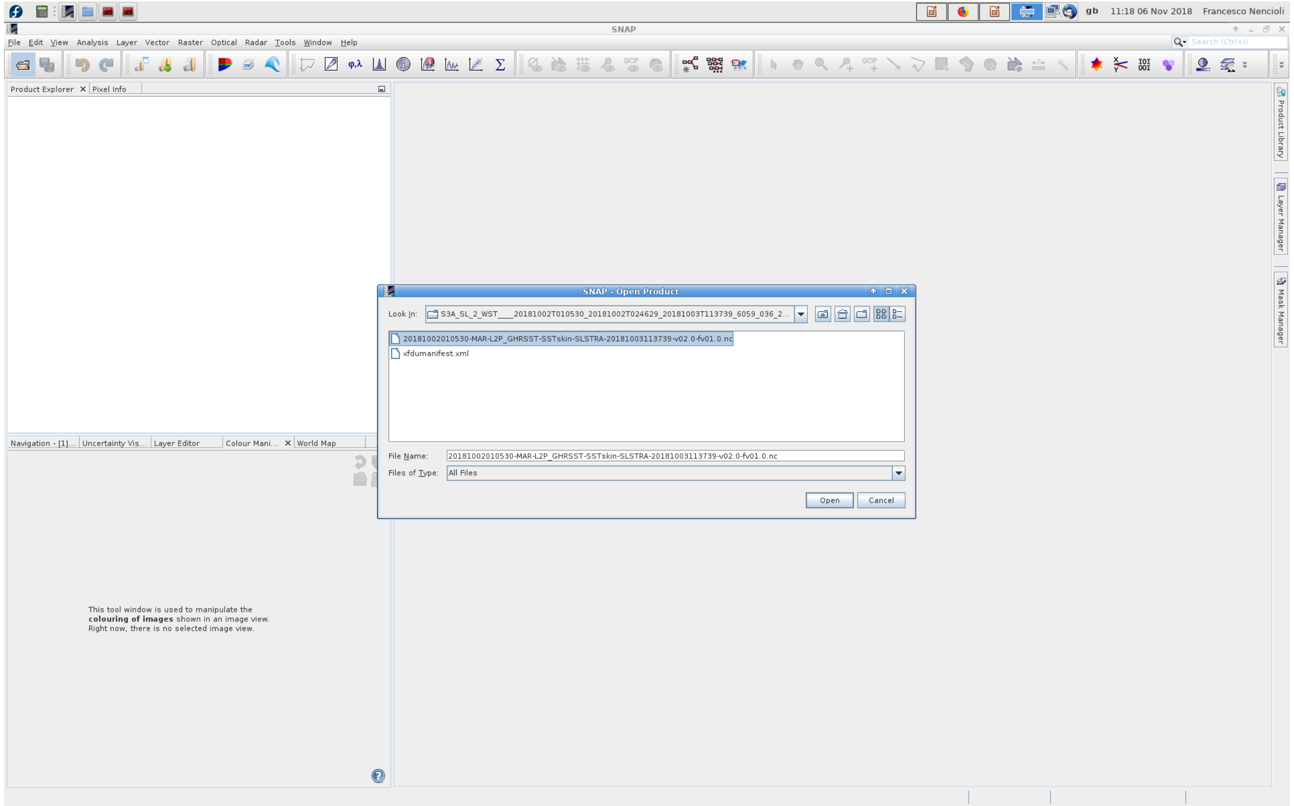
- S3 folder naming convention already provides useful information for the user.

MMM_SL_L_TTTTTT_date1_date2_date3_[instanceID]_GGG_[classID].SEN3

1. ***MMM***: mission id (***S3A***)
2. ***SL***: Data source (***SL***=SLSTR)
3. ***L***: processing level (***2*** = Level 2)
4. ***TTTTTT***: data type ID (***WST___*** = L2P sea surface temperature)
5. ***date1***: sensing start time (***20181002T010530***; format *yyyymmddThhmmss*)
6. ***date2***: sensing end time (***20181002T024629***)
7. ***date3***: product creation date (***20181003T113739***)
8. ***[instance id]***: duration_cycle number_relative orbit (***6059_036_216___***)
9. ***GGG***: id of centre generating the files (***MAR***)
10. ***[classID]***: Platform_timeliness_baseline (***O_NT_003***: operational, non-time critical)
11. ***SEN3***: filename extension

Exercise 1: Explore and visualize SST data

- Enter the folder for the October 2 2018 file
- Click and open the netcdf
- It will take few minutes to load

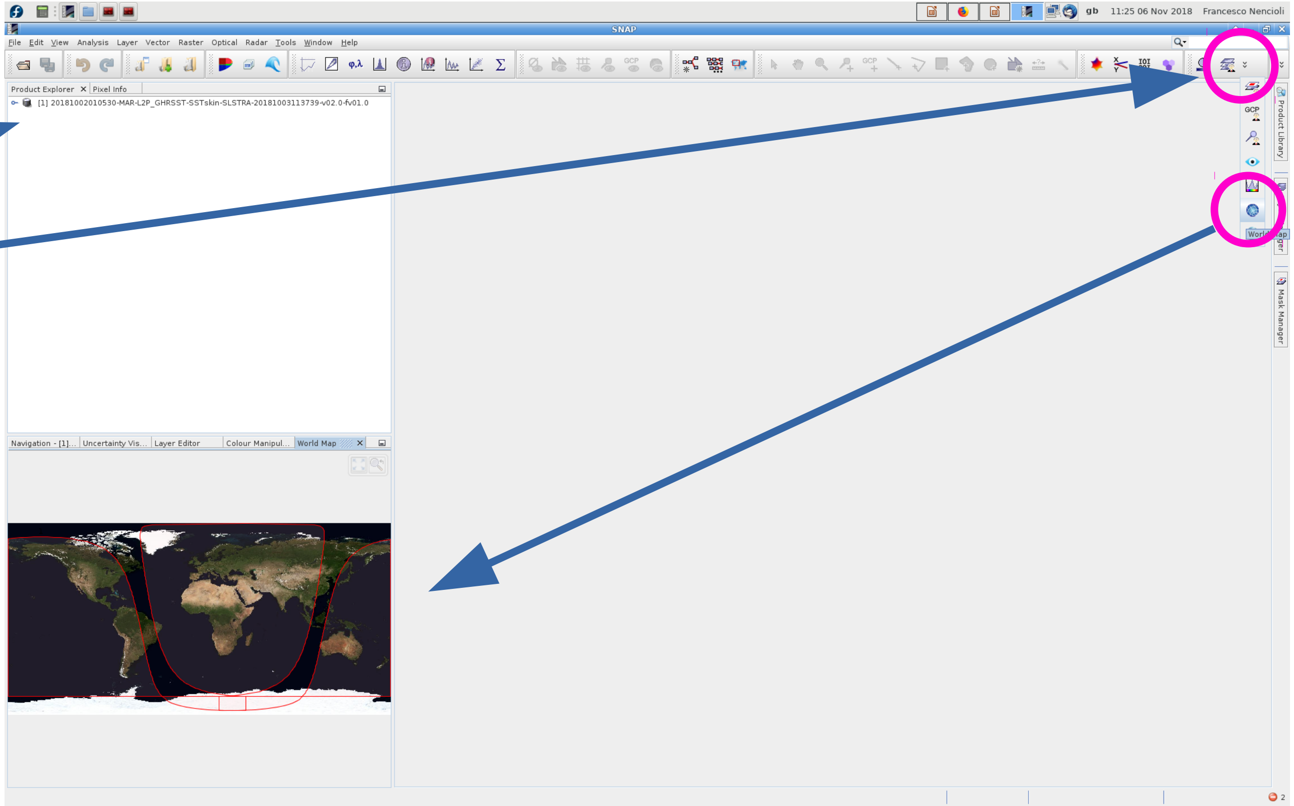


(As opposed to OC files, all SST variables are contained within a single netcdf file;

No need to used the .xml file)

Exercise 1: Explore and visualize SST data

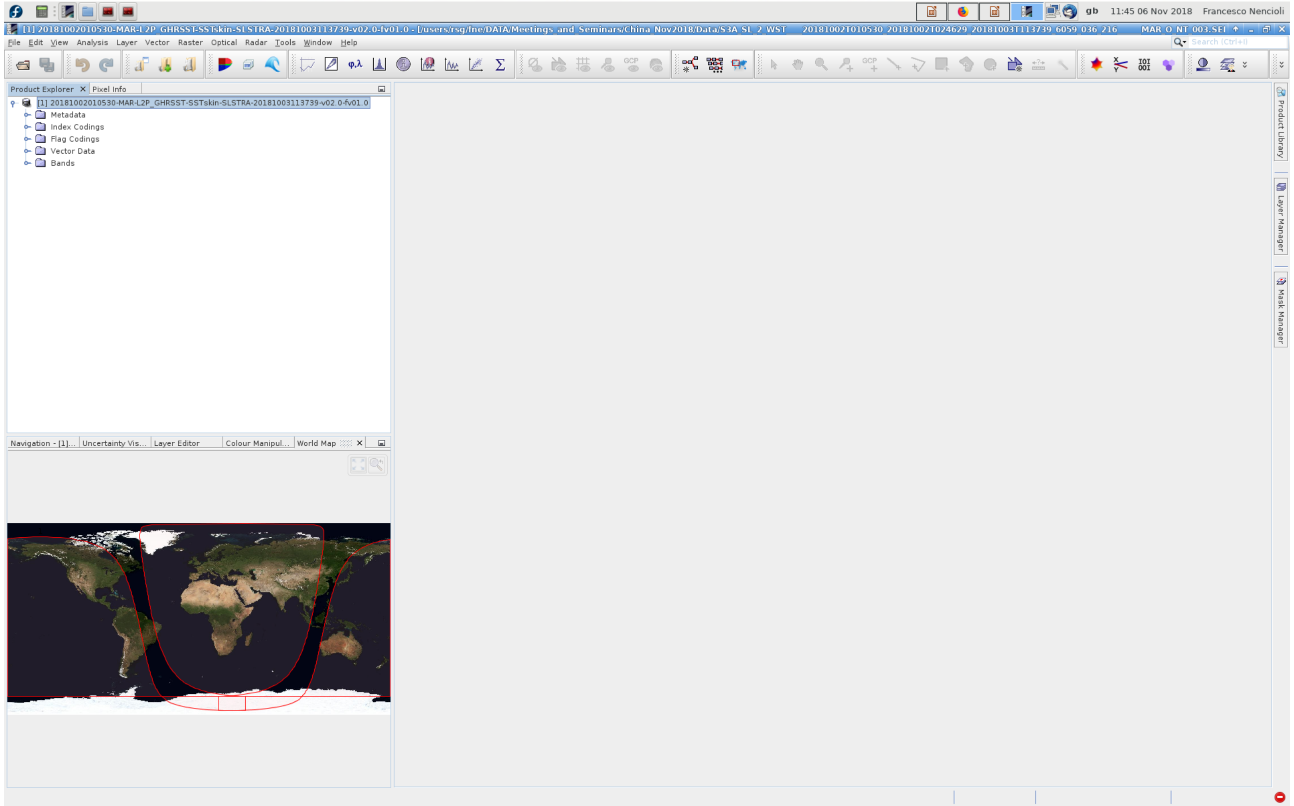
- The Data are now available for browsing in the “Product Explorer” tab
- If you click on the World Map button from the top-down menu in the right you will be able to visualize where the data are located



Exercise 1: Explore and visualize SST data

- Data within the file are organized in:

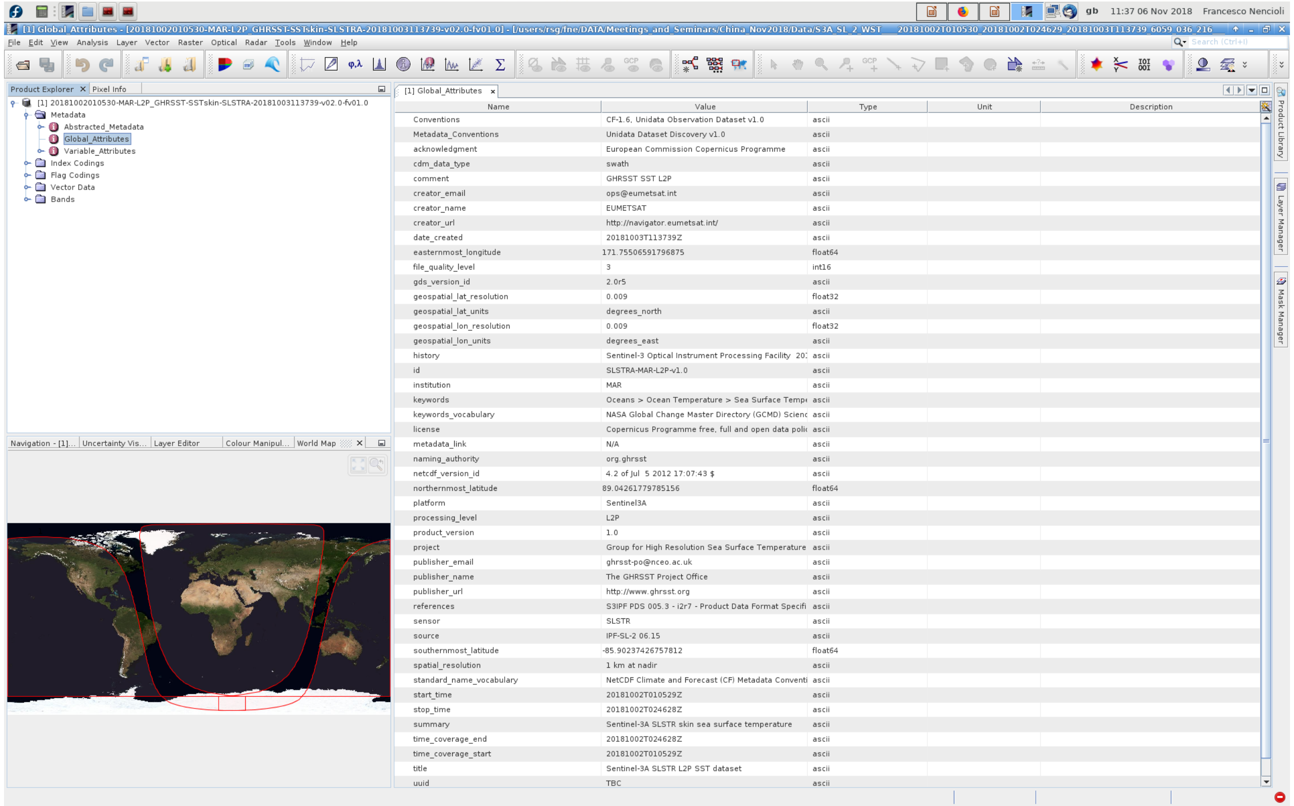
1. *Metadata* (info on file and variables)
2. *Index and Flag codings* (specific flag values)
3. *Vector data* (empty)
4. *Bands* (data matrices)



Exercise 1: Explore and visualize SST data

- **<u>First</u>** (as for OC data) take your time to check the **Metadata**!!! Lots of information there:

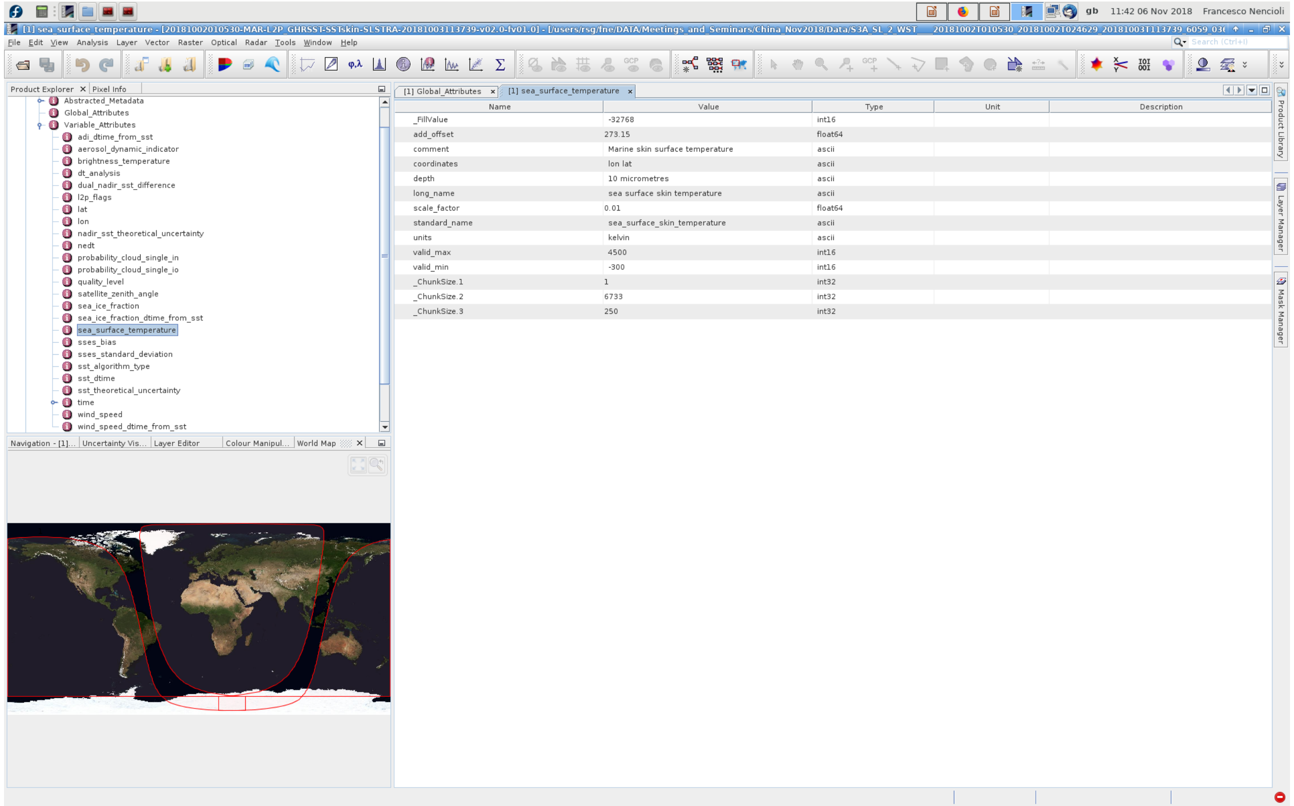
1. General info for the whole file is on the global attributes



Exercise 1: Explore and visualize SST data

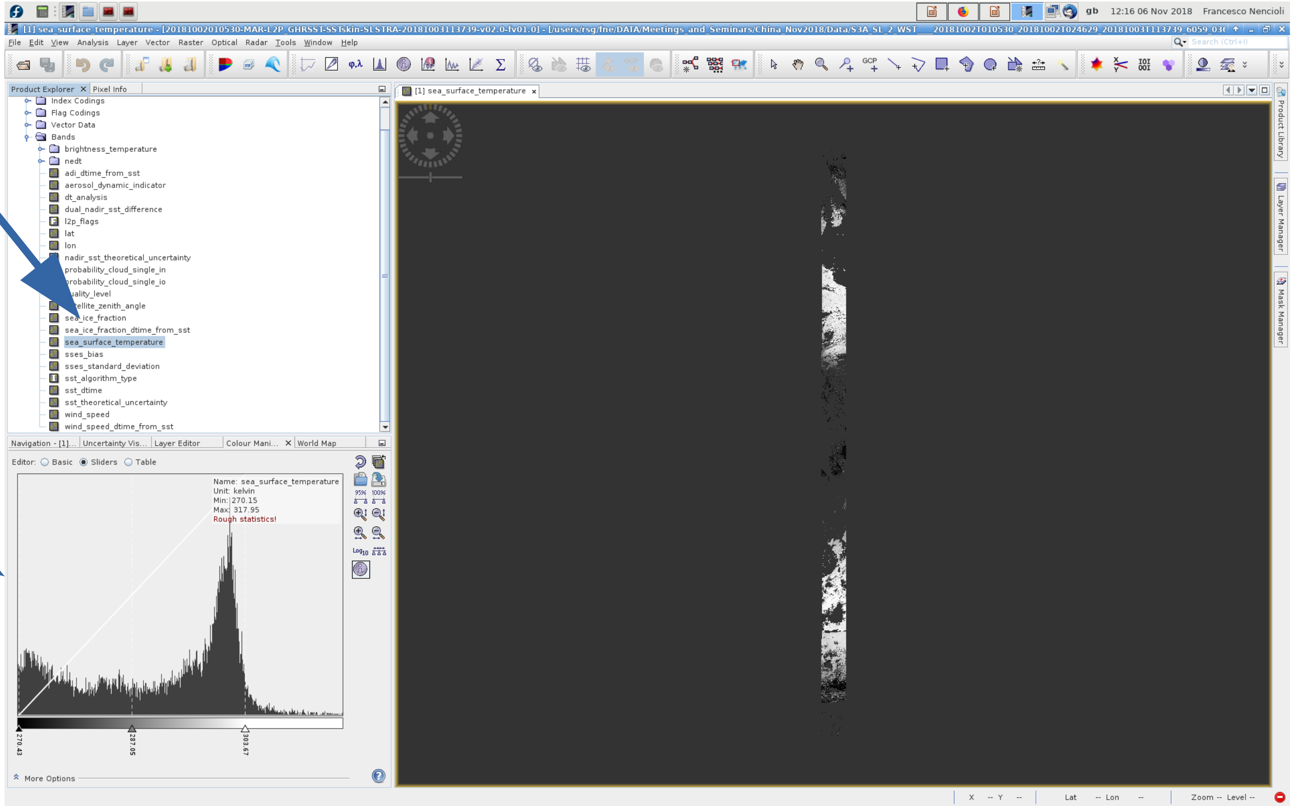
- **First** (as for OC data) take your time to check the **Metadata**!!! Lots of information there:

1. General info for the whole file is on the global attributes
2. Specific info for every given variable is on the variable attributes (e.g. **sea surface temperature**)



Exercise 1: Explore and visualize SST data

- Now within the **Bands** products select the **sea_surface_temperature** variable
- You can also switch the bottom panel to the **Colour Manipulation** tab

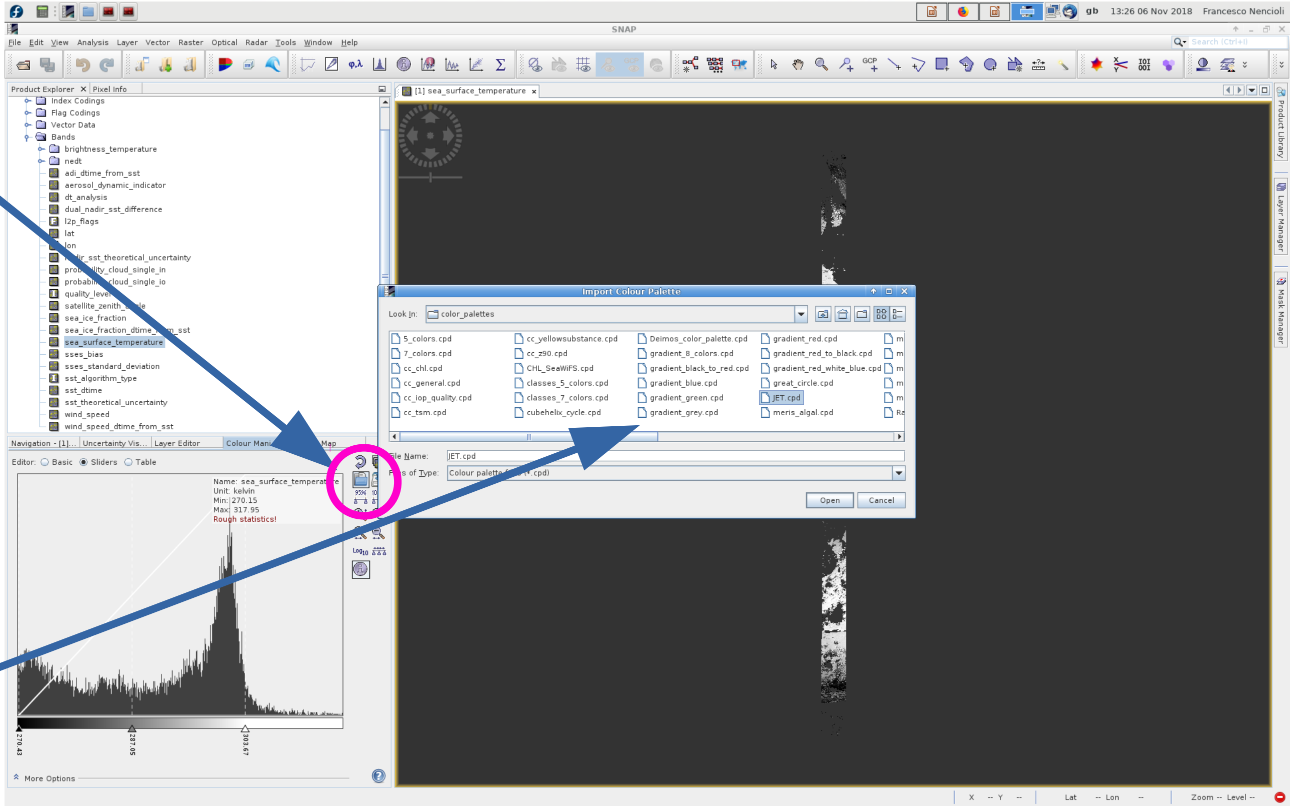


(Your window should look something like this)

Exercise 1: Explore and visualize SST data

To better visualize the data you can change the colour palette from the "**Colour Manipulation**" tab

- Click on the "**Import coulour palette from text file**" button
- Select one of the palettes from the list
- You can test with different ones but I recommend to use the **JET** one for the rest of the practical

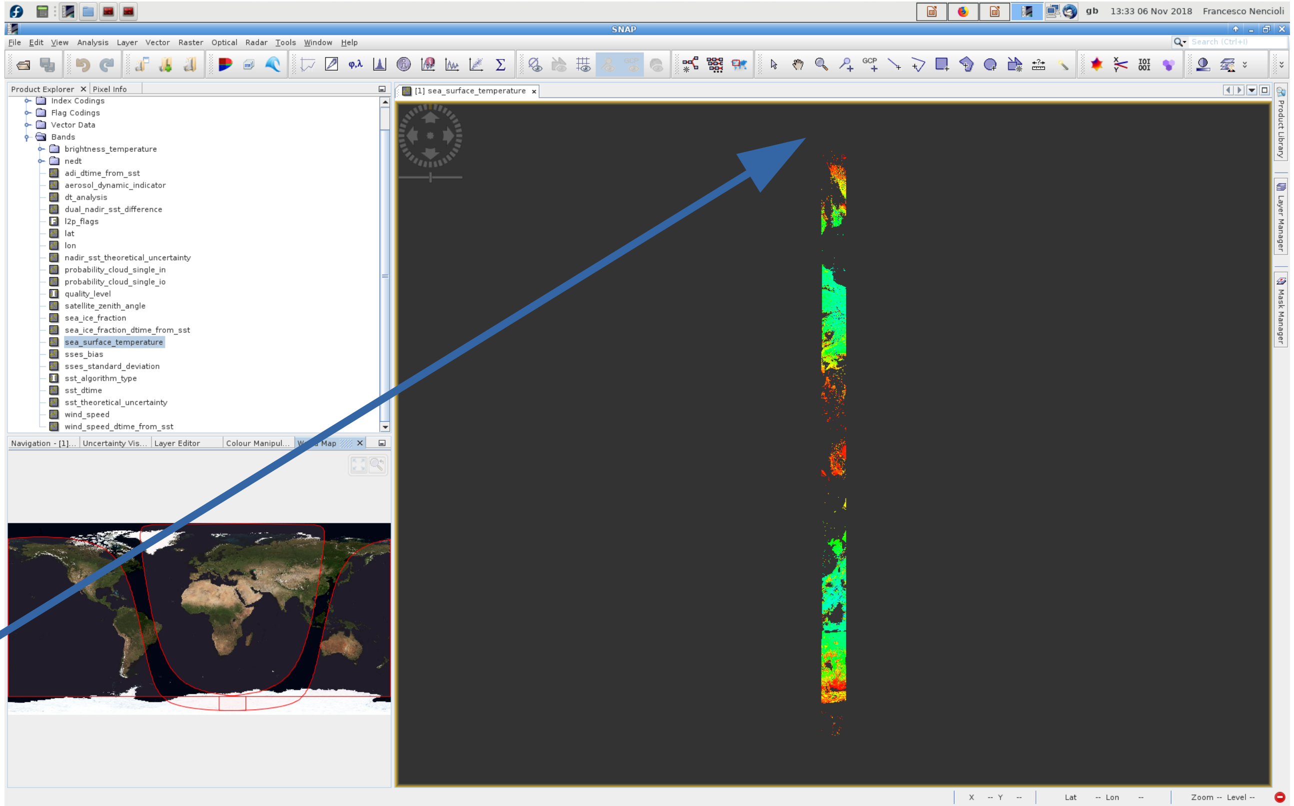


Exercise 1: Explore and visualize SST data

You should obtain something like this

As SST files are smaller in size than the OC ones, they are provided as granules as well as **full swath/orbit cycle** (like in this example; See also the “**World Map**” tab)

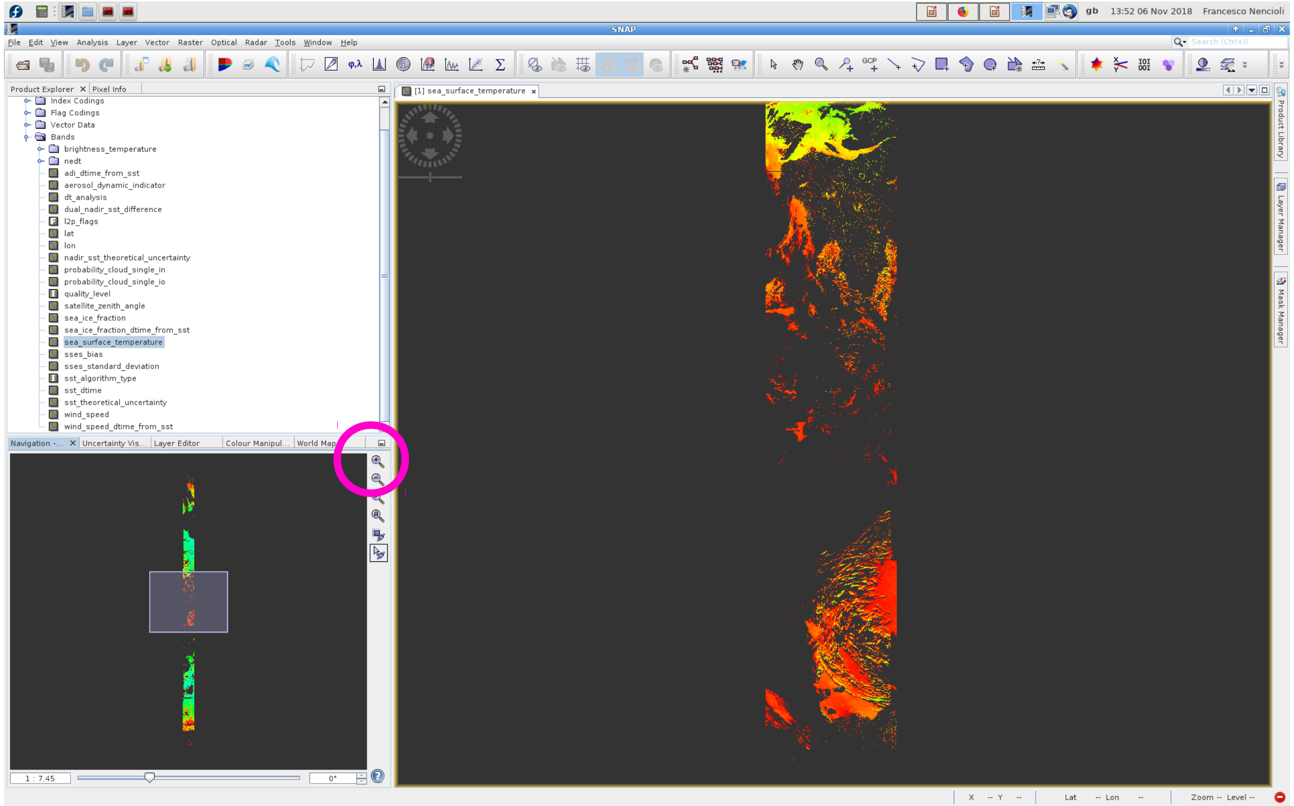
The swath starts at the south pole (top of the graph)



Exercise 1: Explore and visualize SST data

Let's check the direction of the swath:

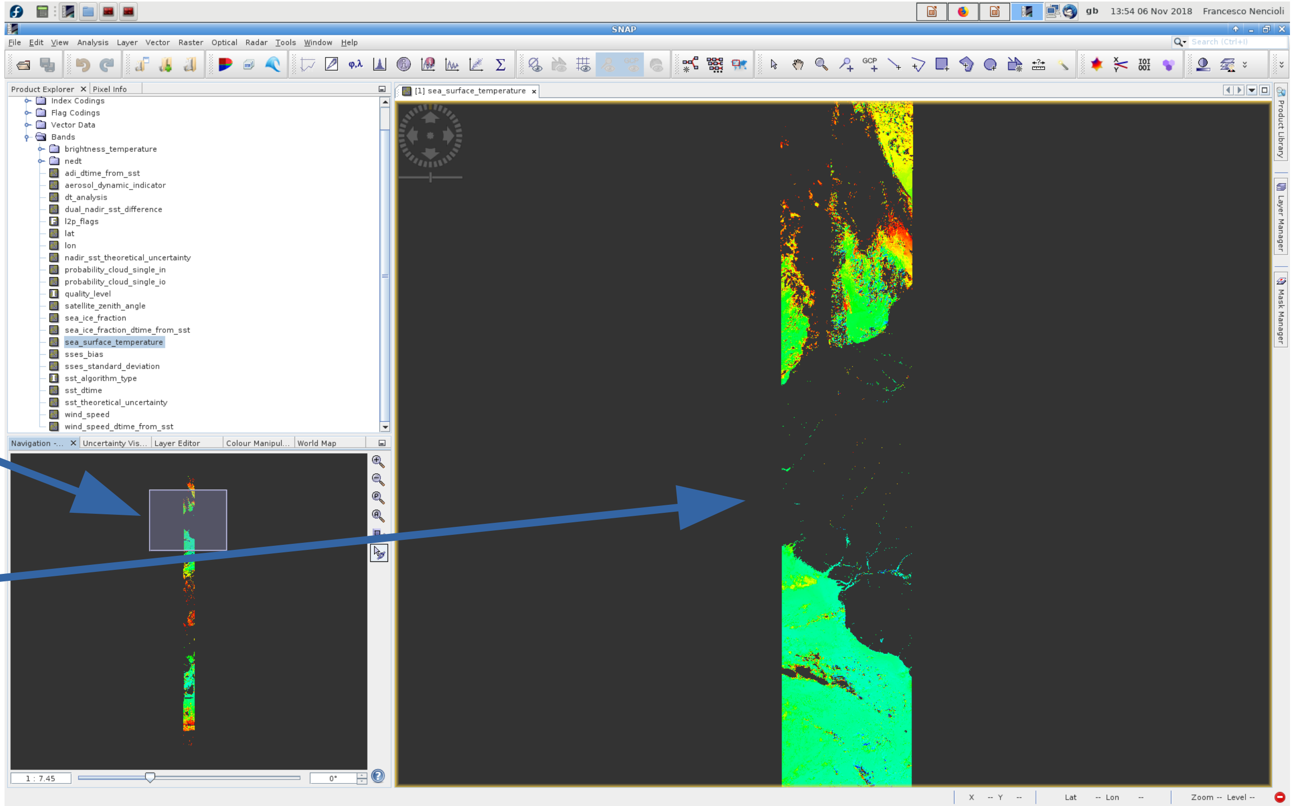
- In the "**Navigation**" tab click in the "**zoom in**" button to focus on a smaller region of the swath.



Exercise 1: Explore and visualize SST data

Let’s check the direction of the swath:

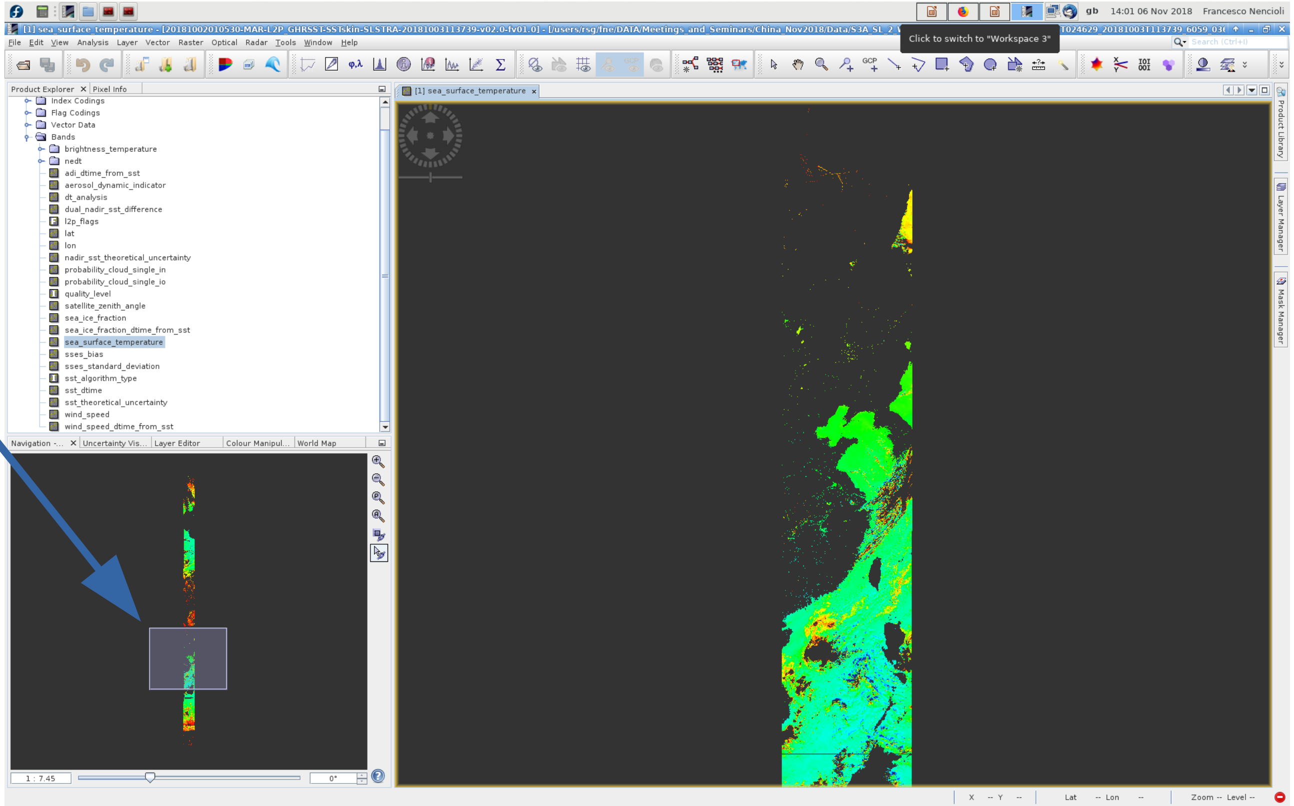
- In the “**Navigation**” tab click in the “**zoom in**” button to focus on a smaller region of the swath.
- Moving the box up in the “**Navigation**” tab you should be able to recognize Brazil!
- The orbit goes from the south pole over the Americas to the north pole.



Exercise 1: Explore and visualize SST data

From the North pole it goes back south over Asia

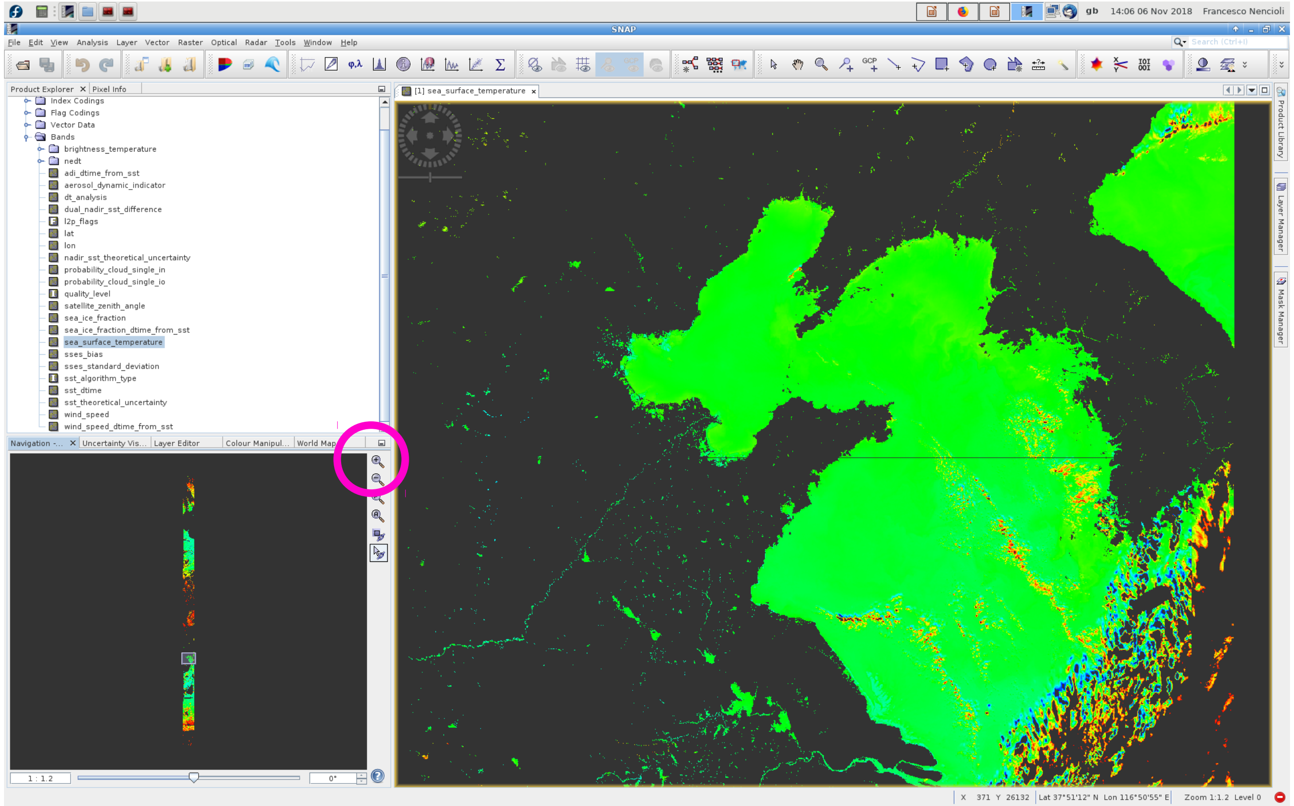
- Moving the box in the "**Navigation**" tab down you should be able to identify the region of the Yellow and East China sea



Exercise 1: Explore and visualize SST data

From the North pole it goes back south over Asia

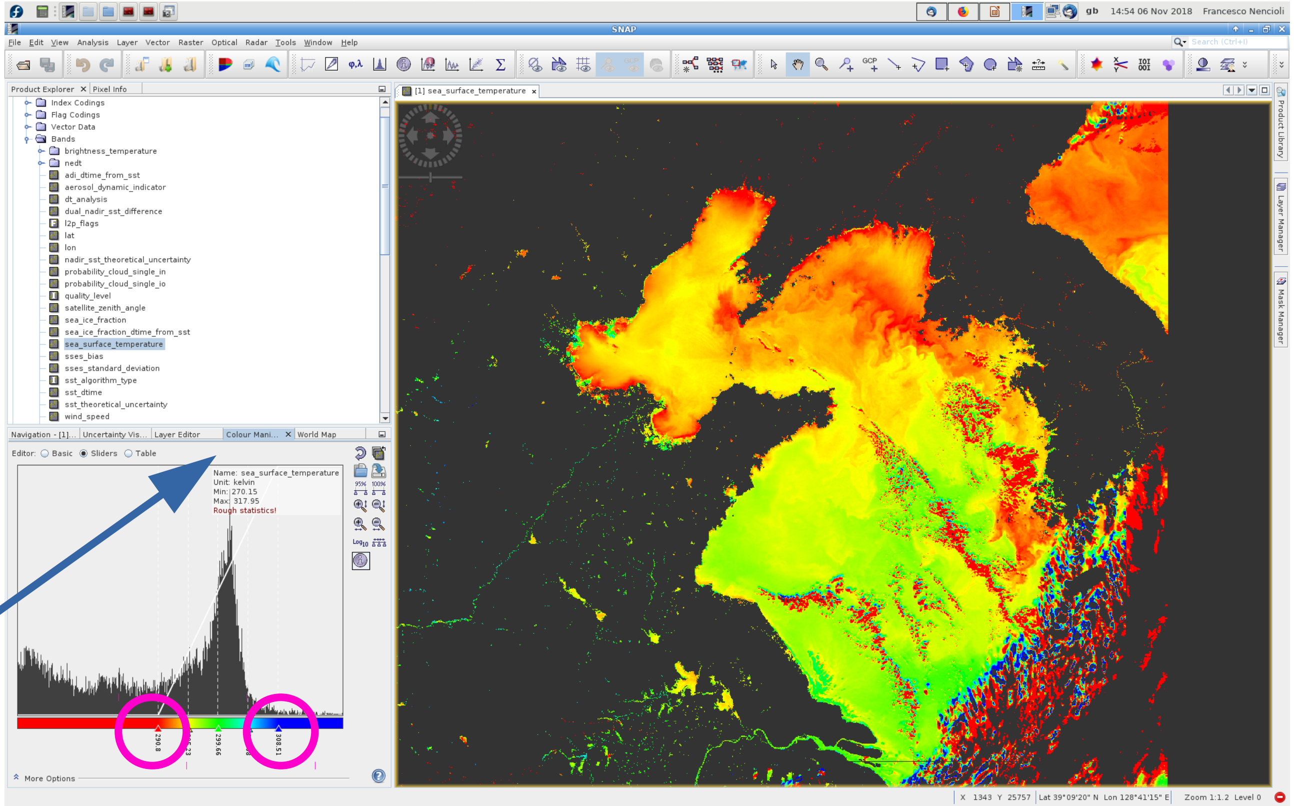
- Moving the box in the "**Navigation**" tab down you should be able to identify the region of the Yellow and East China sea
- You can further zoom in with the "**zoom in**" button



Exercise 1: Explore and visualize SST data

From the North pole it goes back south over Asia

- Moving the box in the "**Navigation**" tab down you should be able to identify the region of the Yellow and East China sea
- You can further zoom in with the "**zoom in**" button
- You can adjust the colours via the "**Colour Manipulation**" tab

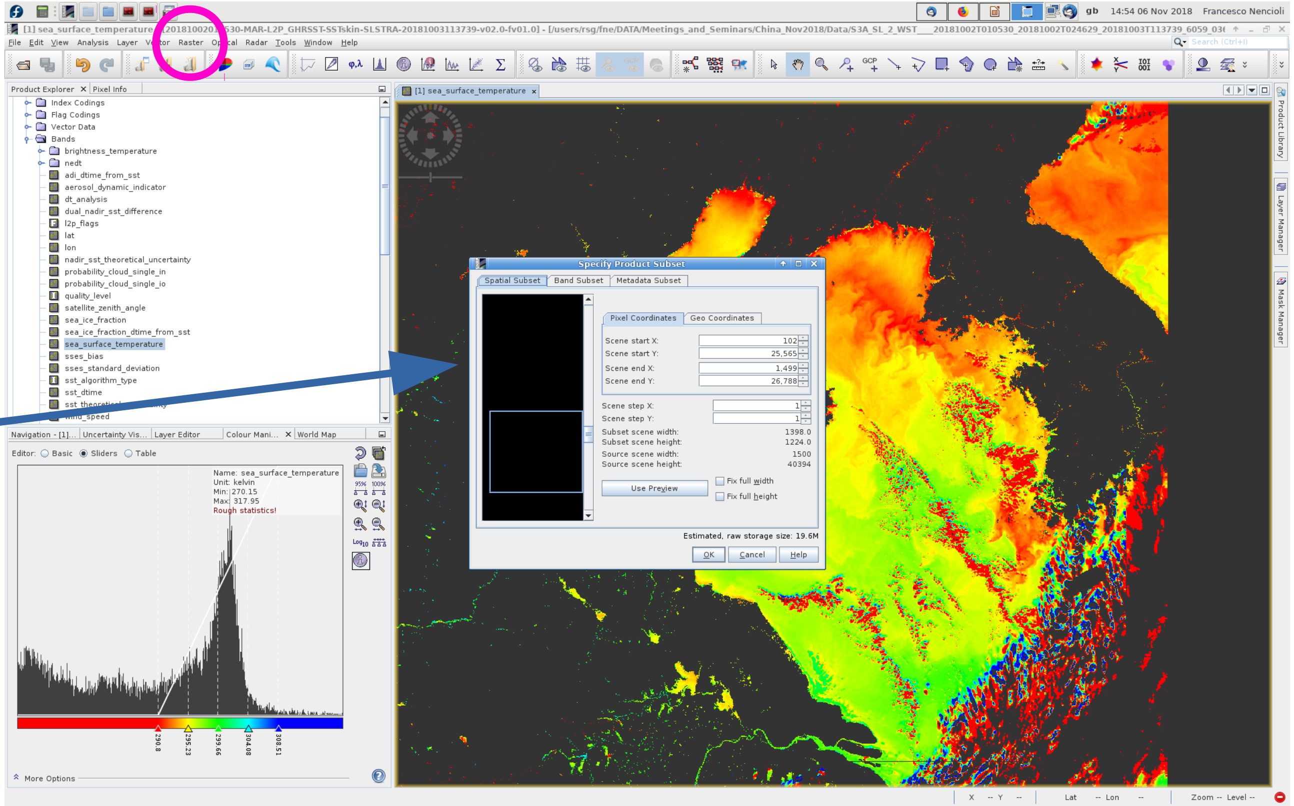


Exercise 2: Subset region of interest

SNAP gives the possibility to subset a given dataset

- From the “**Raster**” button select the “**Subset**” option

This should open a dialogue window like this one



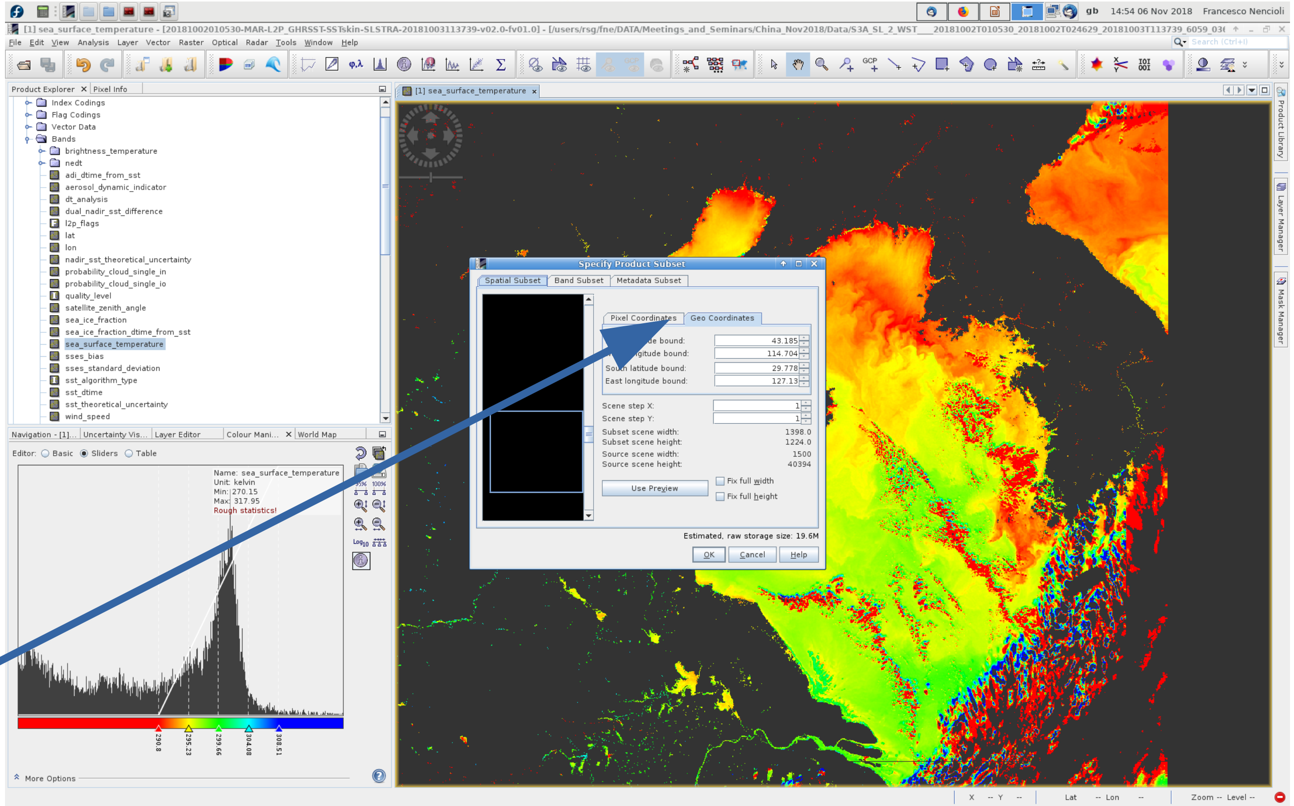
Exercise 2: Subset region of interest

SNAP gives the possibility to subset a given dataset

- From the "**Raster**" button select the "**Subset**" option

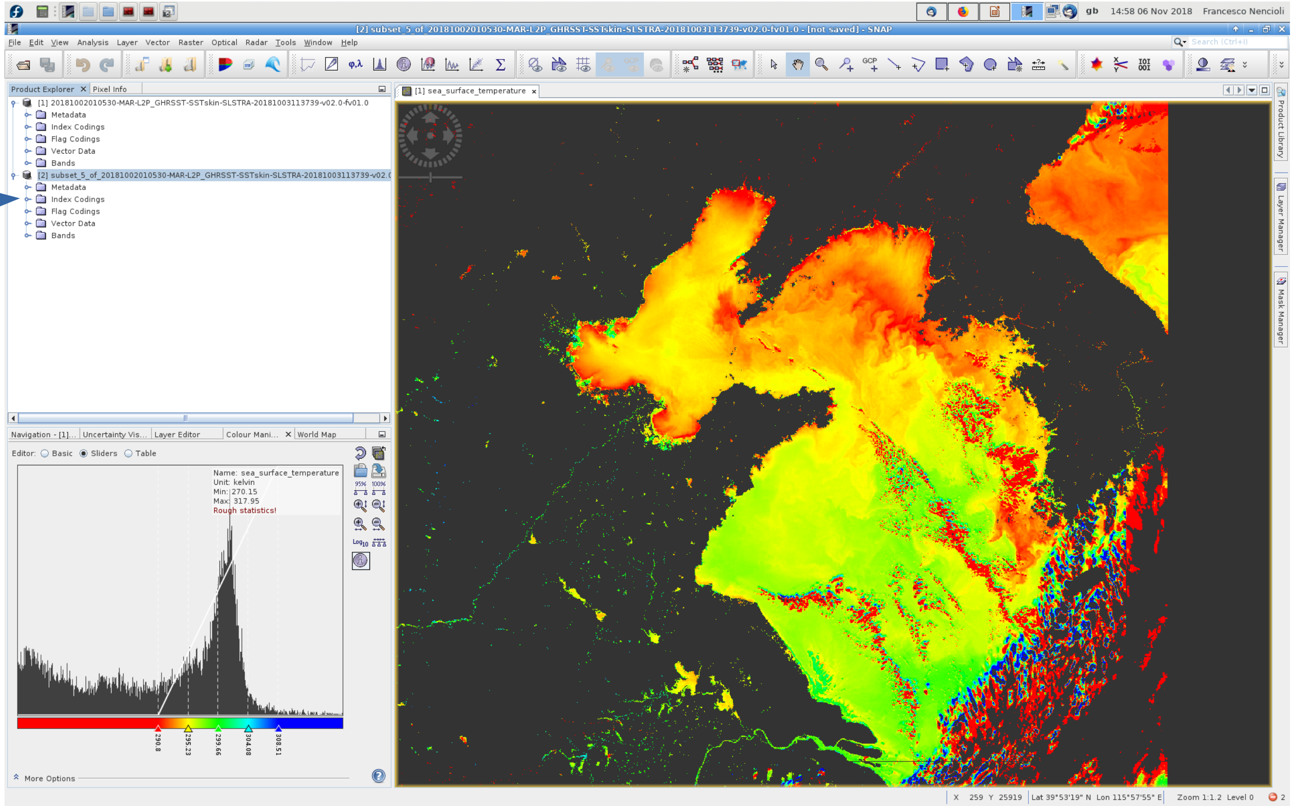
This should open a dialogue window like this one

- You can inspect the geographical limits in the "**Geo Coordinates**" tab



Exercise 2: Subset region of interest

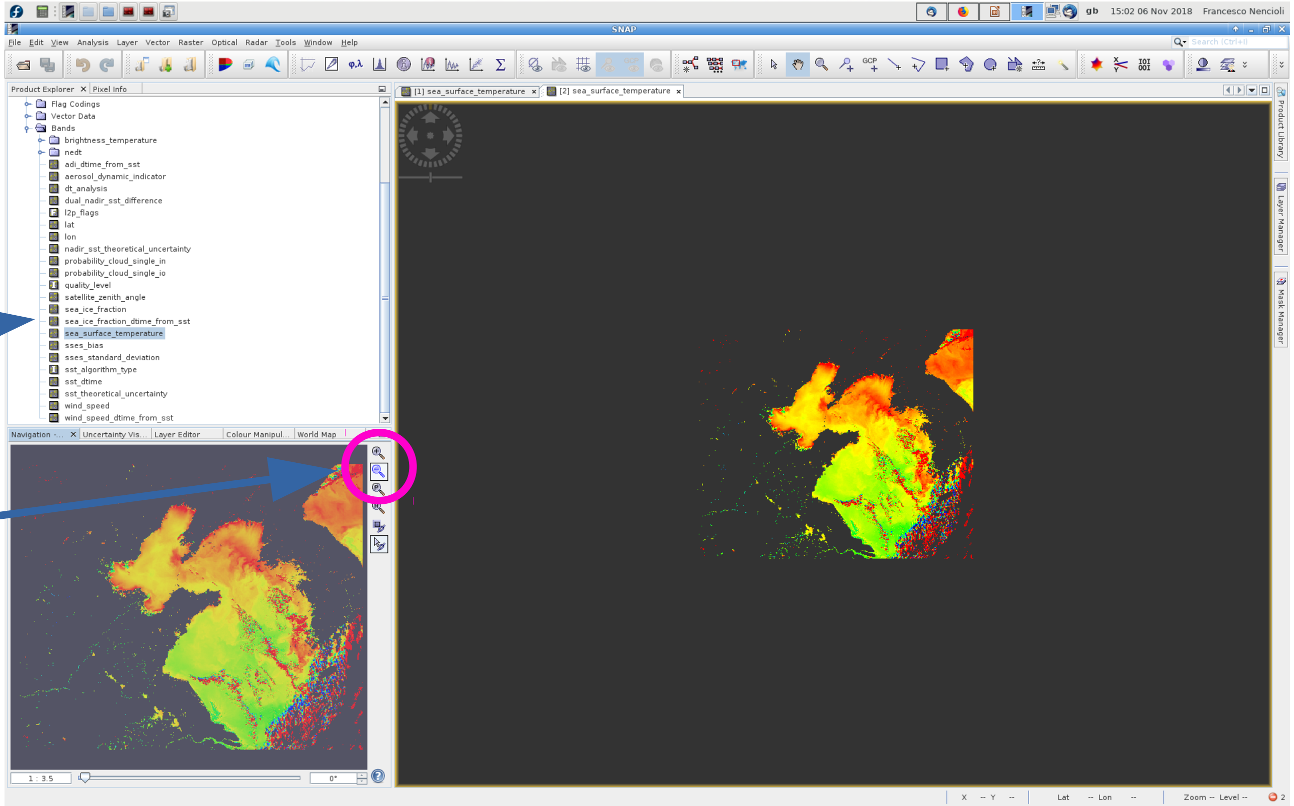
- If you press “**Ok**”, you should see a new product appearing in the “**Product explorer**” tab



Exercise 2: Subset region of interest

- If you press “**Ok**”, you should see a new product appearing in the “**Product explorer**” tab
- Open the product to display “**Sea Surface Temperature**”
- “**Zoom out**” from the “**Navigation**” tab

The product contains the same variables as the original one, but spans only the desired area

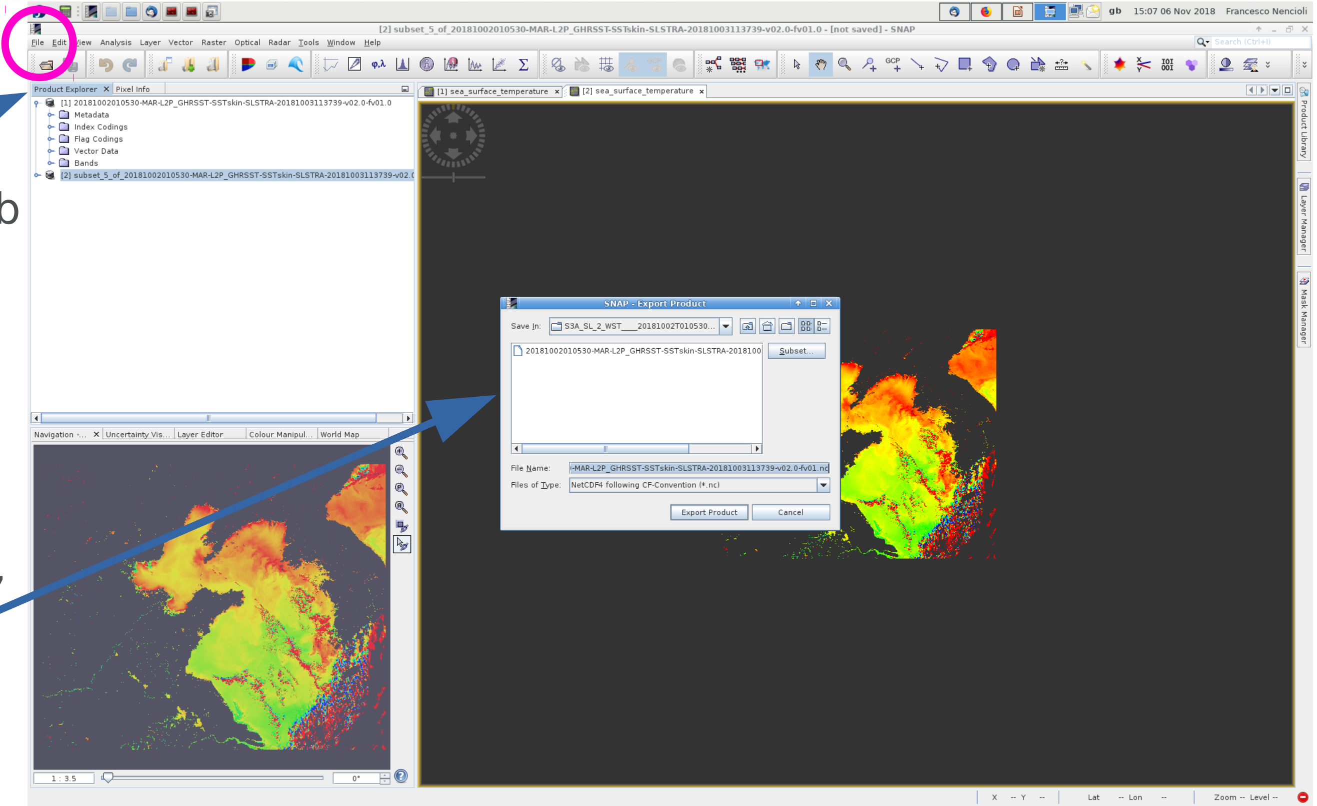


Exercise 2: Subset region of interest

You can now save the product

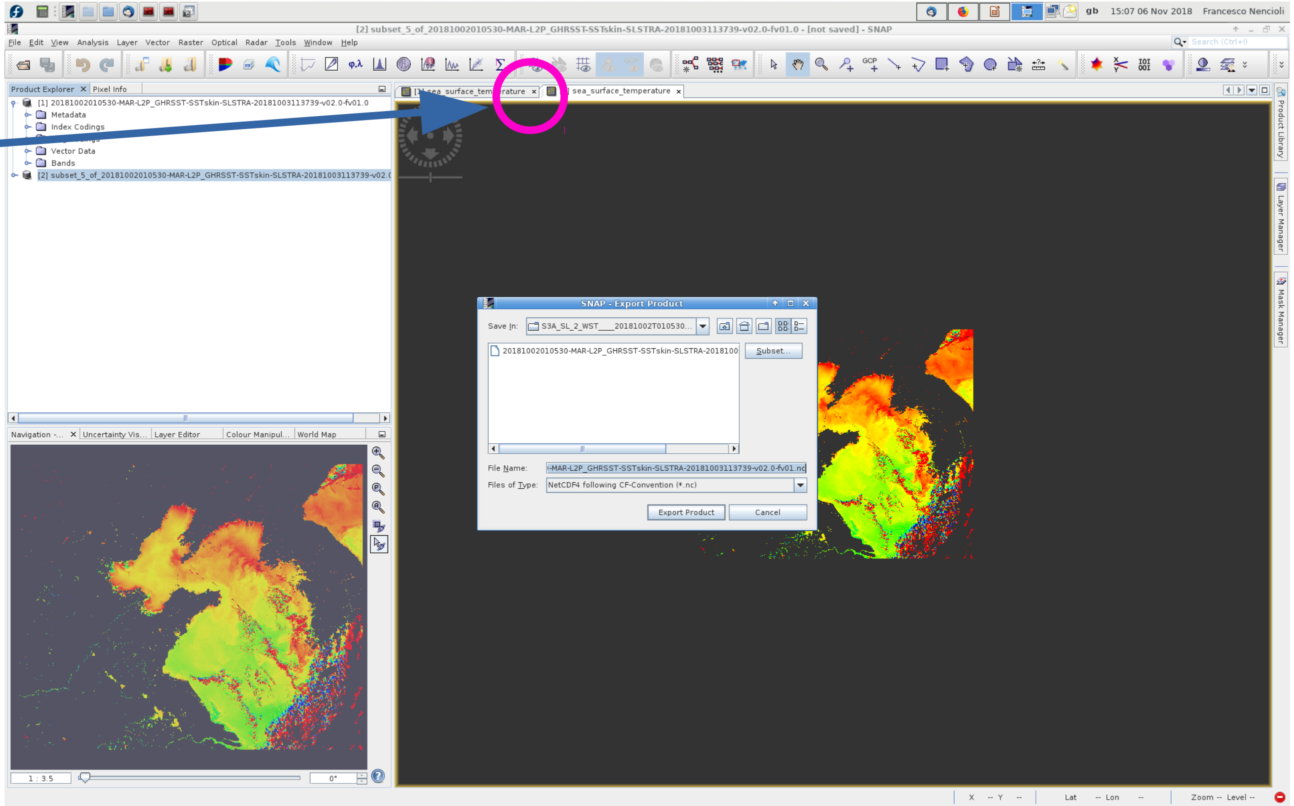
- Select it from the "**Product explorer**" tab
- Click on the "**File**" button
- Select the "**Export**"/"**NETCDF4-CF**" options on the menu
- Click "**Export product**" to save to disc

(This subset product will be used with OC in the synergy Practical)



Exercise 2: Subset region of interest

- You can now close the window from the full swath product



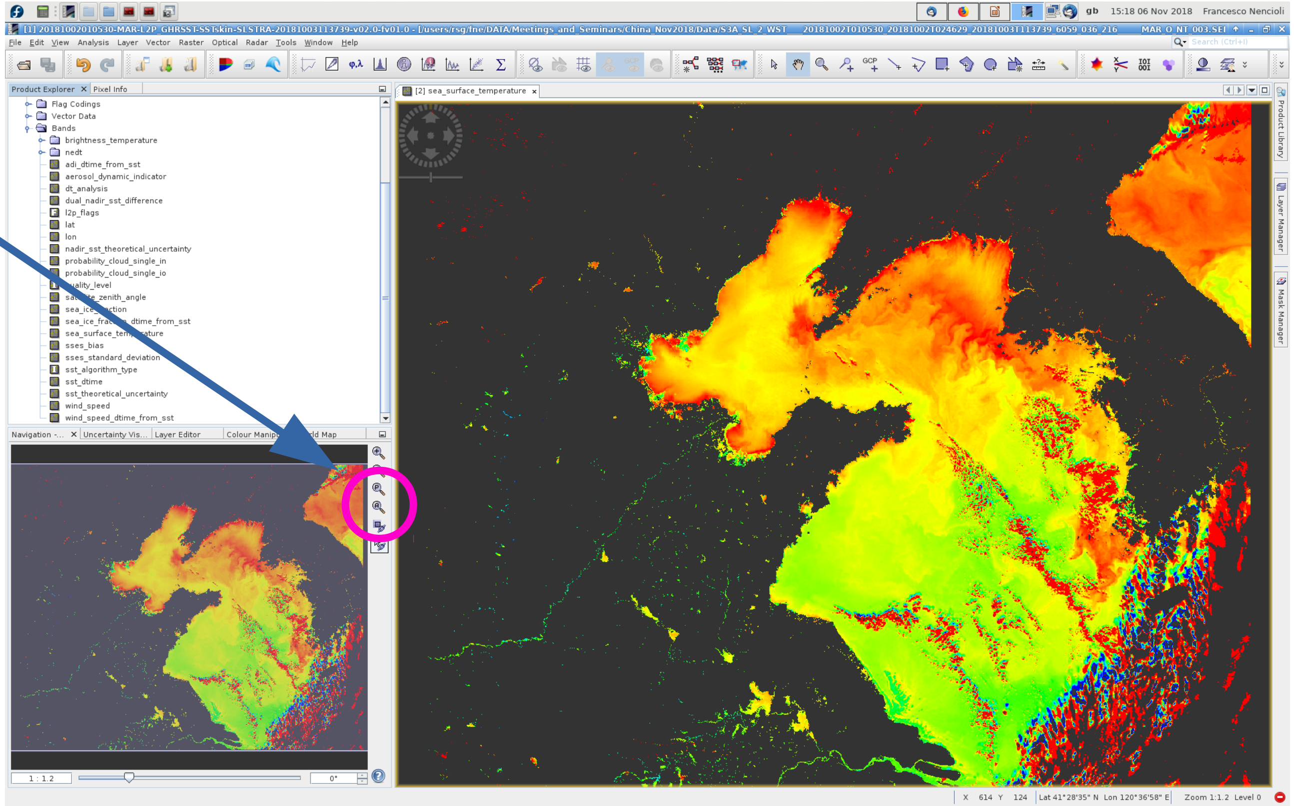
Exercise 3: Bias correction and masks

- Go back to full view by using the “**Zoom all**” button in the “**Navigation**” tab

What is displayed here is **raw SST**.

Before we can use it, we have to:

1. Correct it by its bias
2. Mask undesired pixels



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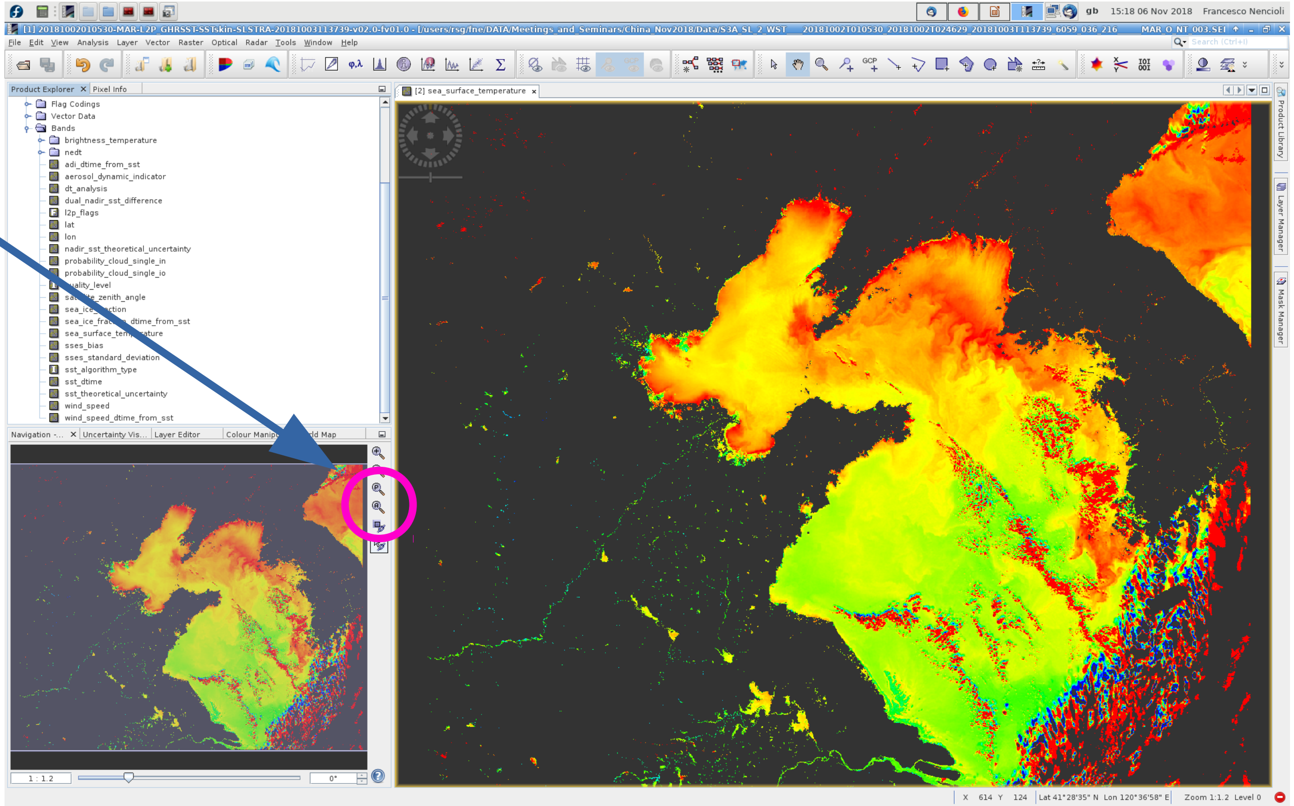
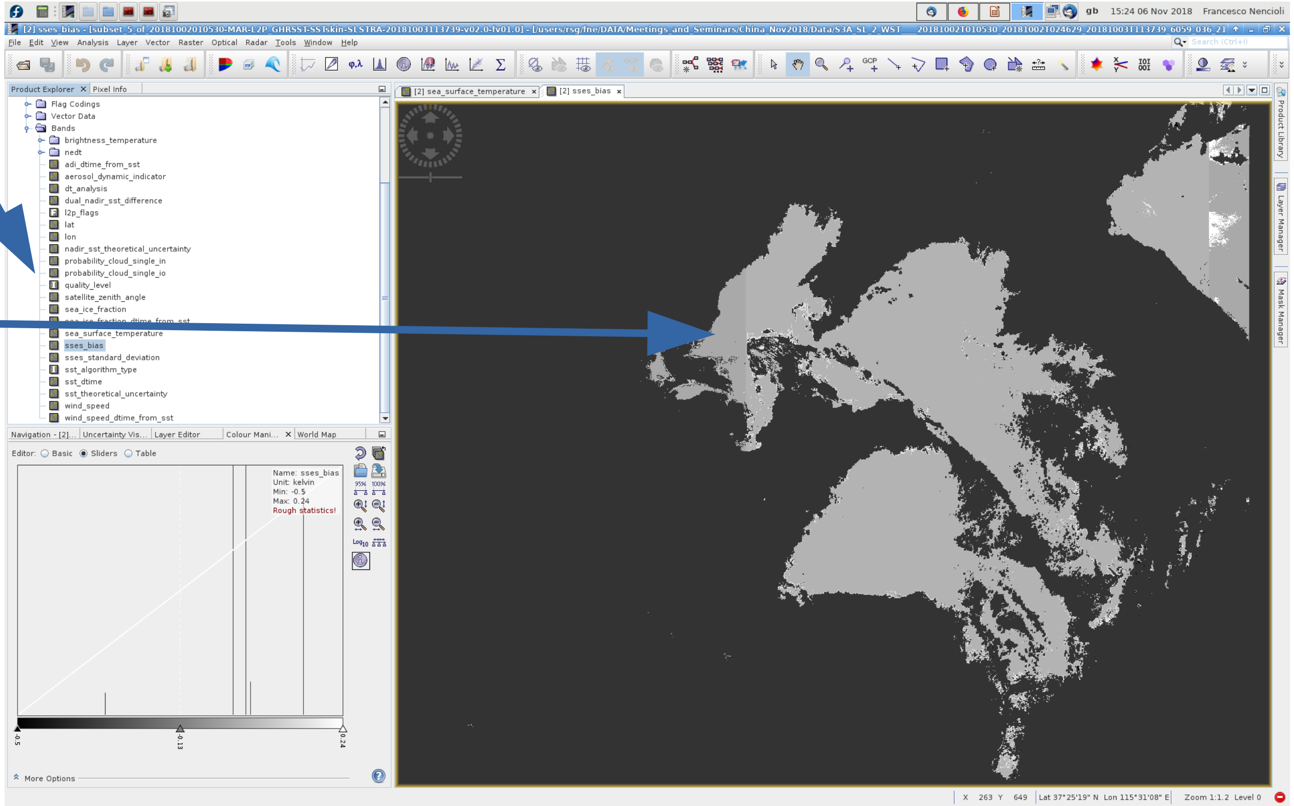


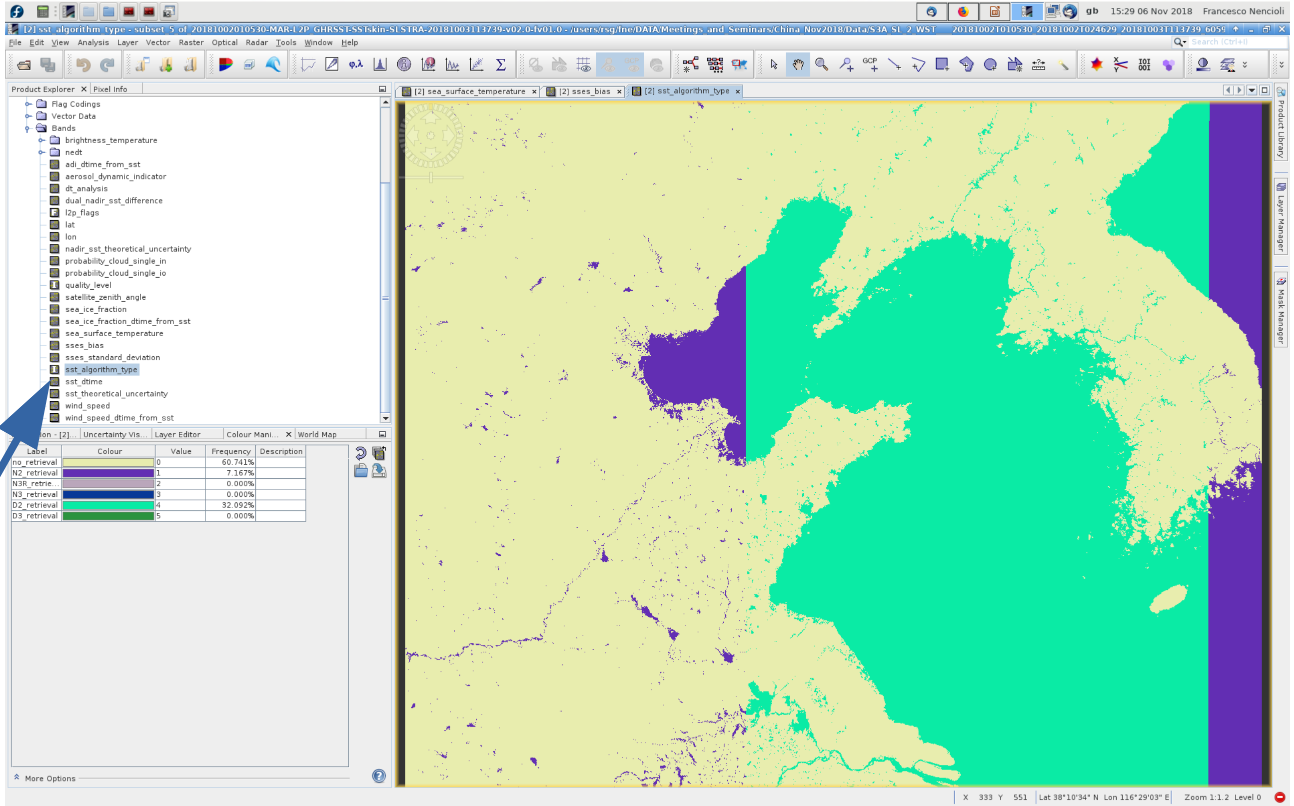
Exercise 3: Bias correction and masks

- The bias is provided within the dataset as the variable "**sses_bias**"
- The "sses_bias" field is characterized by "stripe" patterns



Exercise 3: Bias correction and masks

- The bias is provided within the dataset as the variable “**sses_bias**”
- The “sses_bias” field is characterized by “stripe” patterns
- These are directly related to the type of algorithm used to derive the SST observations (based on Nadir view or dual view)
- You can see it by visualizing “**sst_algorithm_type**”

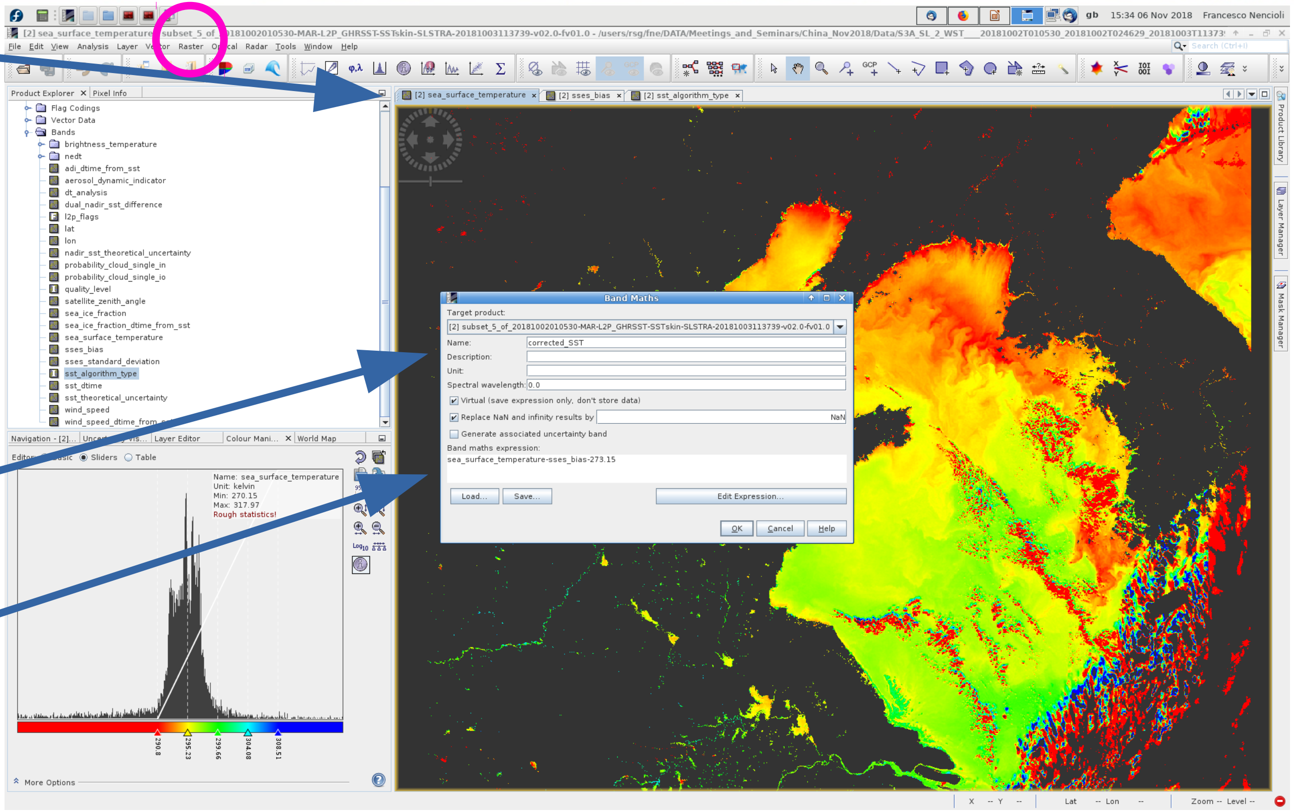


Exercise 3: Bias correction and masks

- Back to the SST field

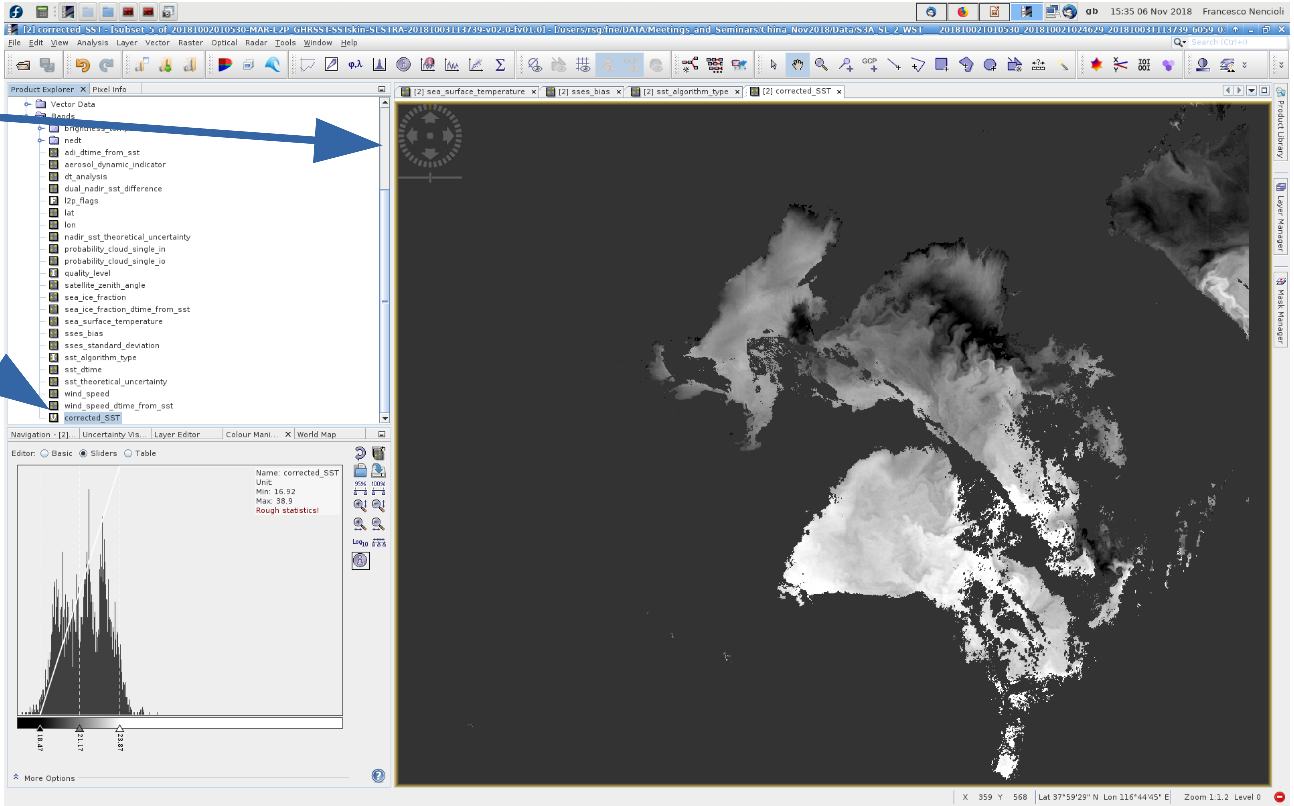
To apply the bias correction:

1. Click on “**Raster**”
2. Select “**Band Maths**”
3. In the dialogue window change the **Name** field to “**Corrected_sst**”
4. In the **Band maths expression** subtract the bias from the sst (by variable name)
5. Also, convert from degree Klevin to Celsius by subtracting 273.15



Exercise 3: Bias correction and masks

- You should obtain a plot like this
- You should see the new variable appearing in the “**Product Explorer**” tab



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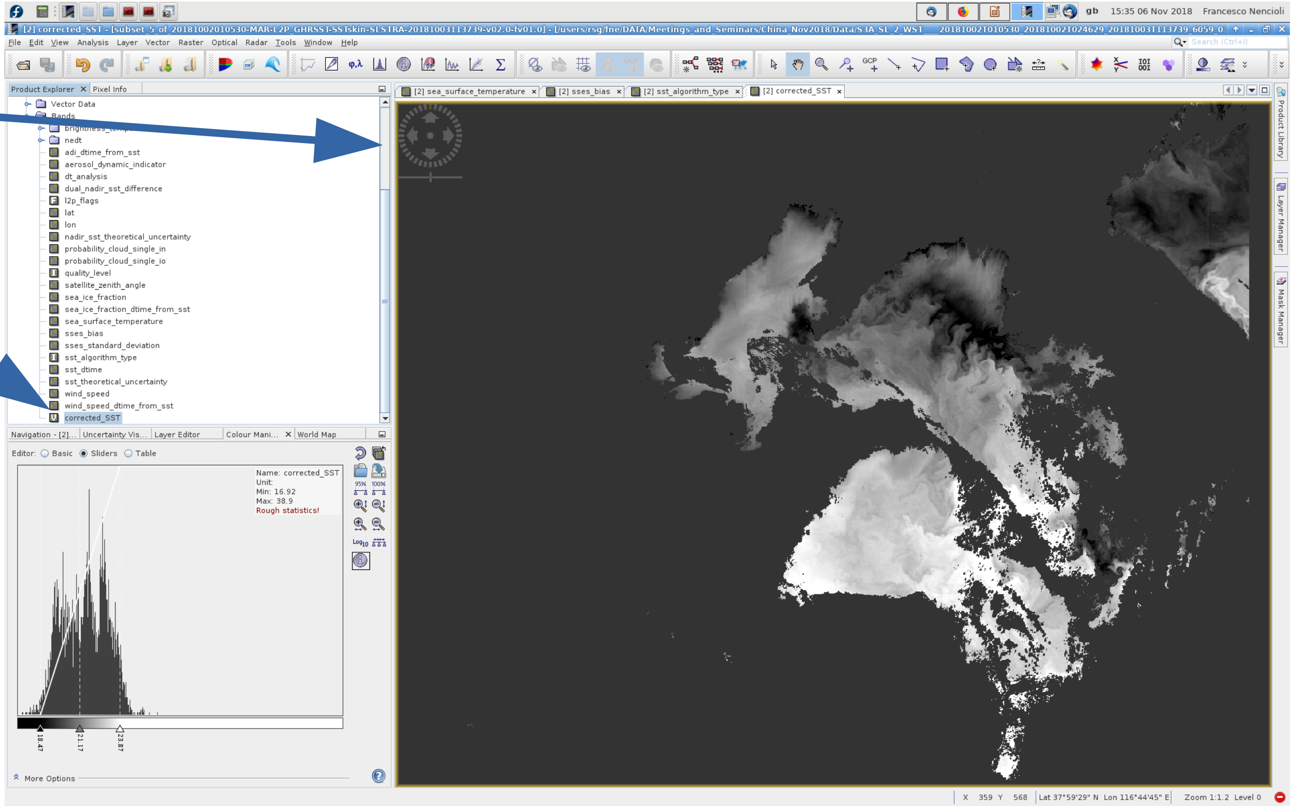
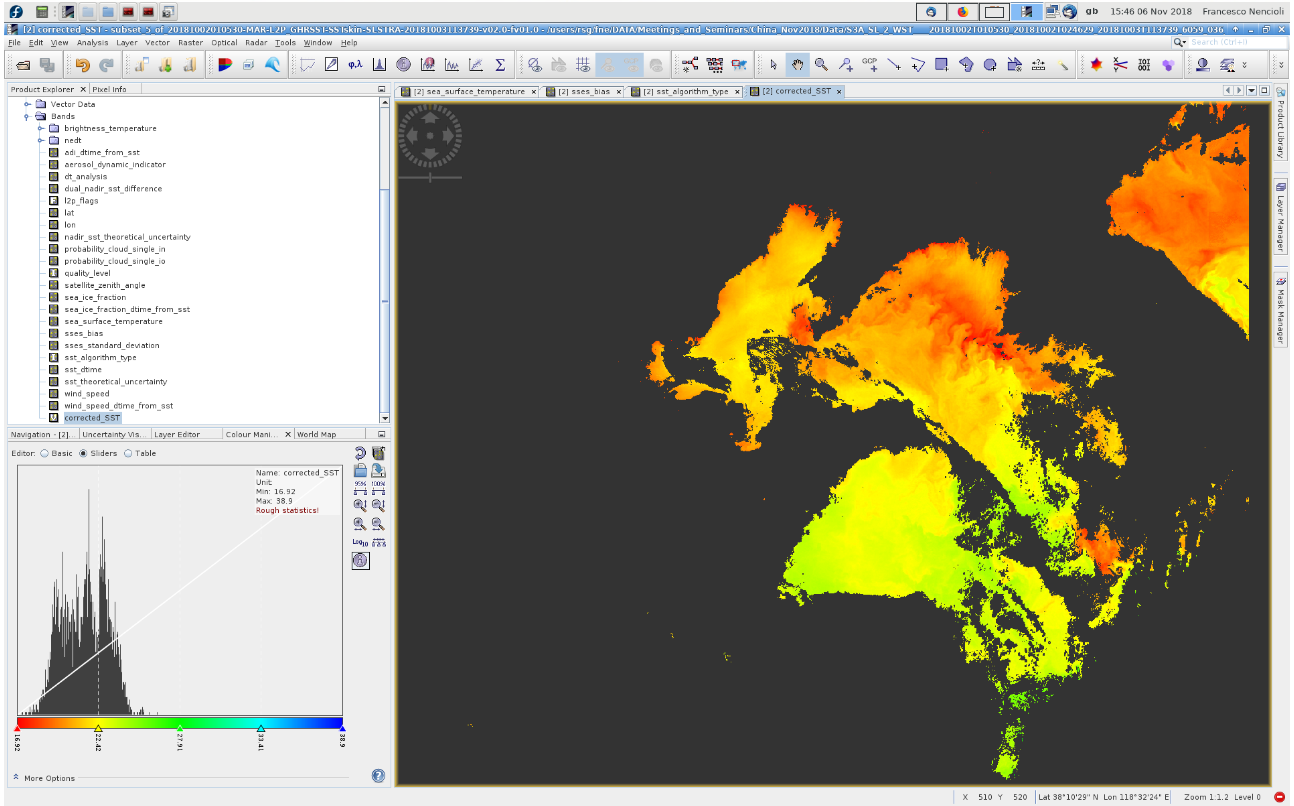


Exercise 3: Bias correction and masks

- You should obtain a plot like this
- You should see the new variable appearing in the "**Product Explorer**" tab
- Select again the JET colour palette from the "**Colour Management**" tab



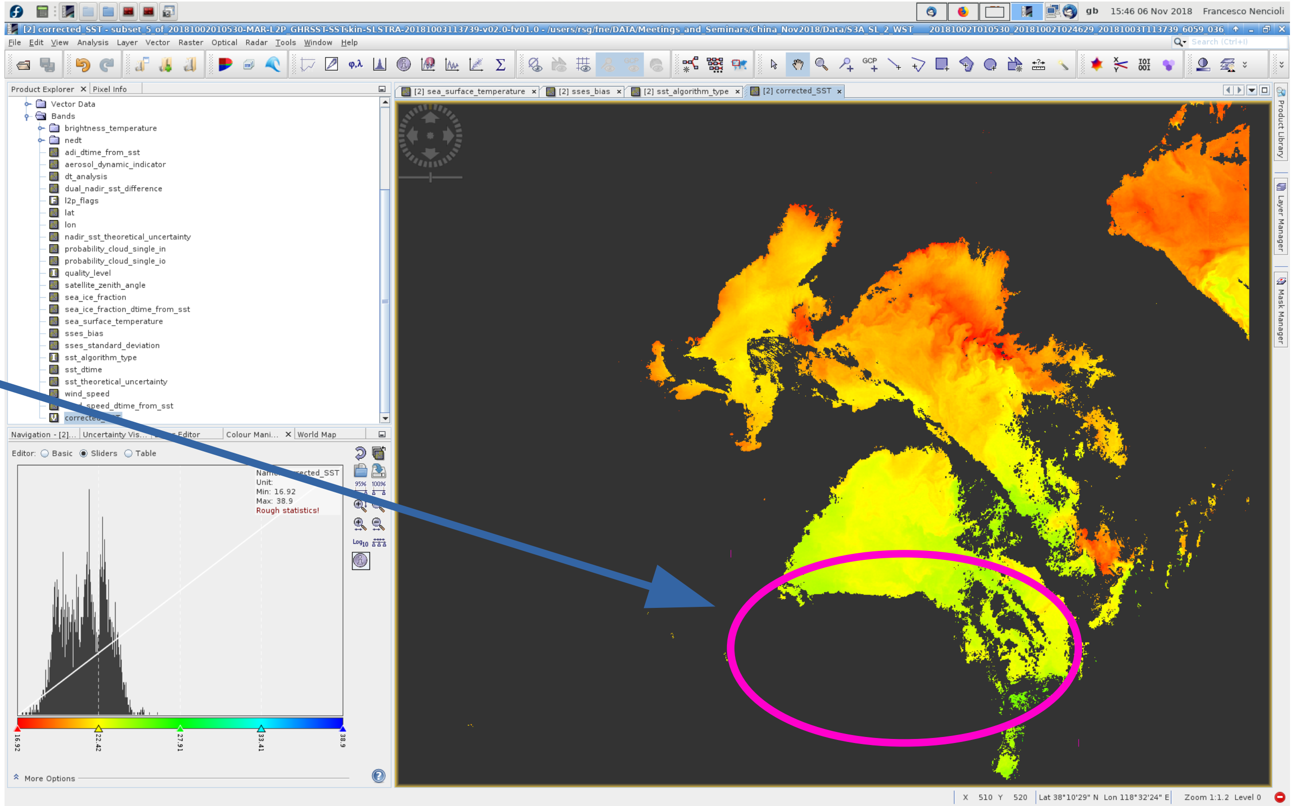
(You should obtain something like this)

Exercise 3: Bias correction and masks

Compared to raw SST this image has lots of areas masked (e.g. the area north of the Yangtze river mouth)

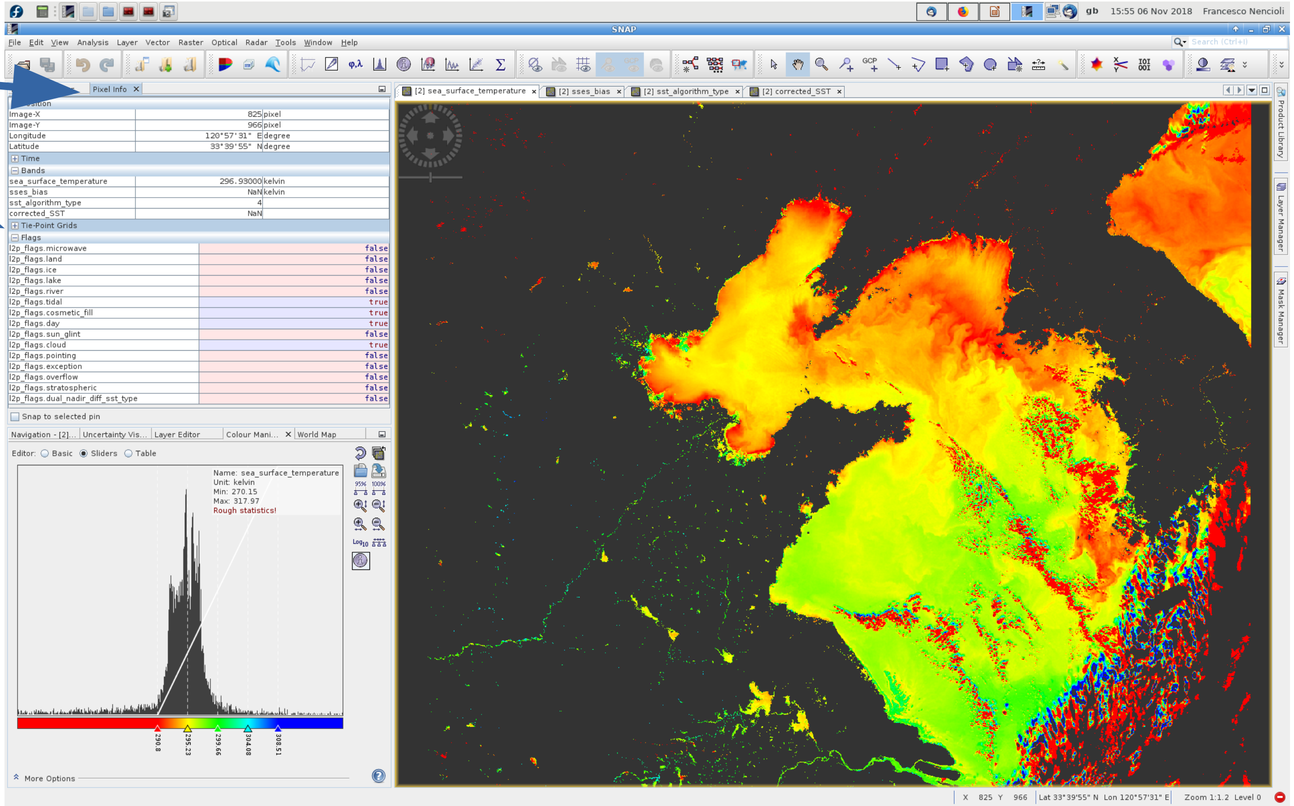
Why that?

Let's explore the pixels in the sea_surface_temperature tab



Exercise 3: Bias correction and masks

- Click on the “**Pixel info**” tab
- Open the “**Flags**” menu
- Hovering over the map you will see the info changing depending on the pixel
- The ones north of the Yangtze river mouth are all flagged as clouds

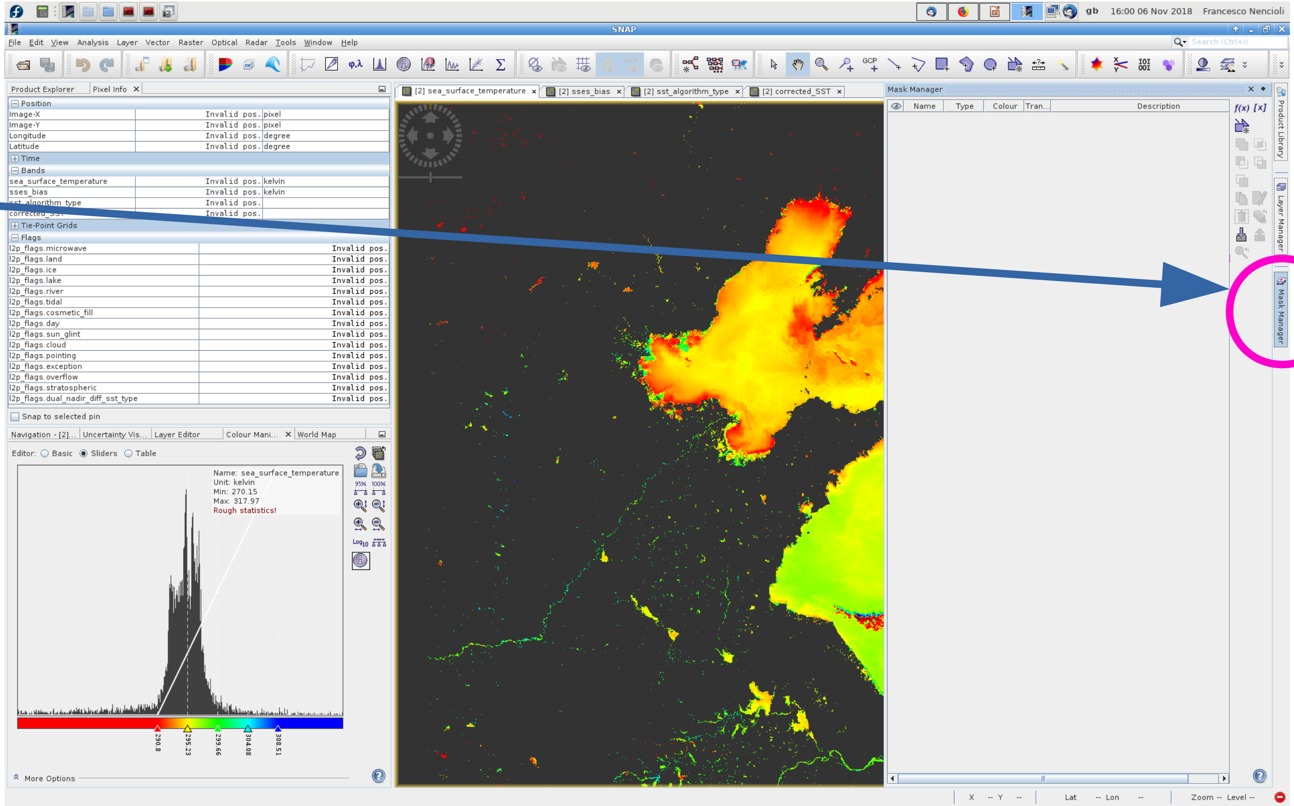


Exercise 3: Bias correction and masks

To better visualize this we can display the cloud mask

- Click on the "**Mask manager**" button

Unlike OC data, there are no masks readily available for SST



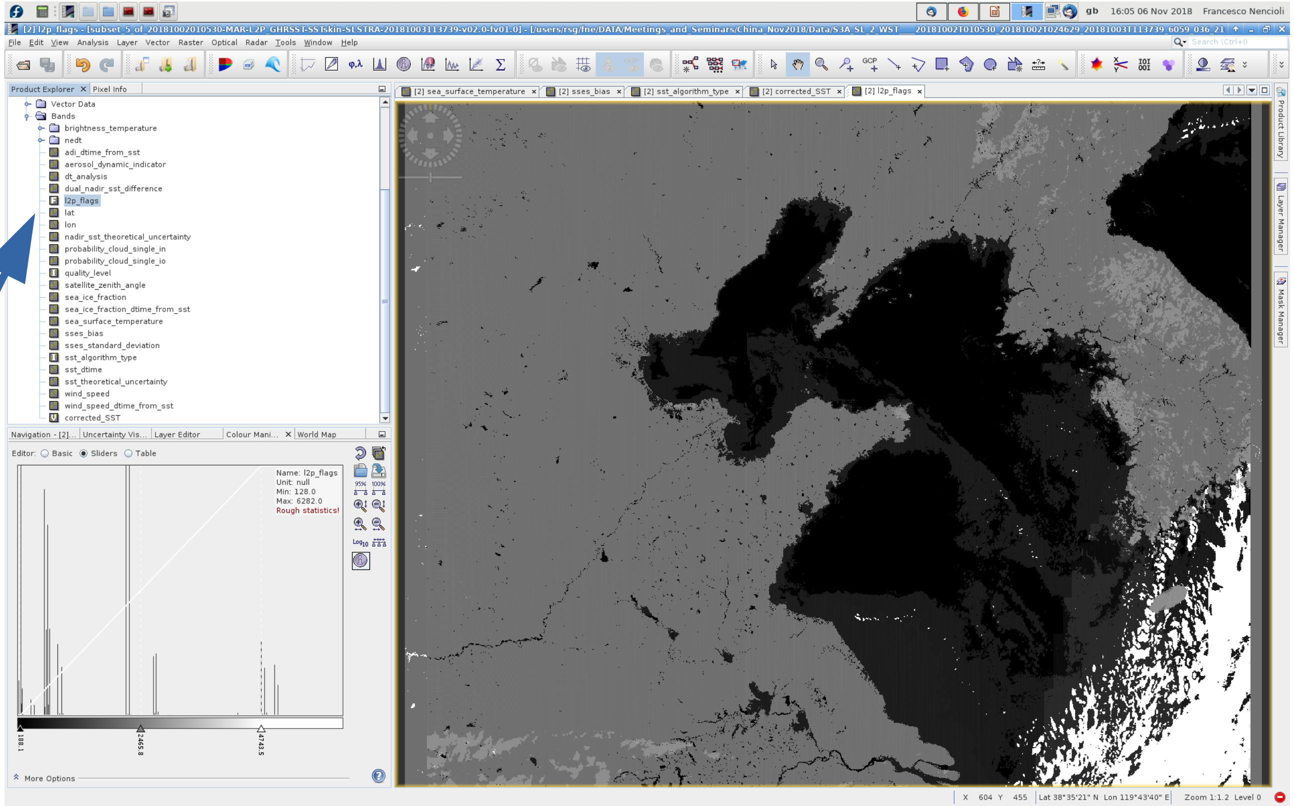
Exercise 3: Bias correction and masks

To better visualize this we can display the cloud mask

- Click on the "**Mask manager**" button

Unlike OC data, there are no masks readily available for SST

That's because all masks are grouped together in the "**l2p_flag**" variable as **bitwise flags**



Exercise 3: Bias correction and masks

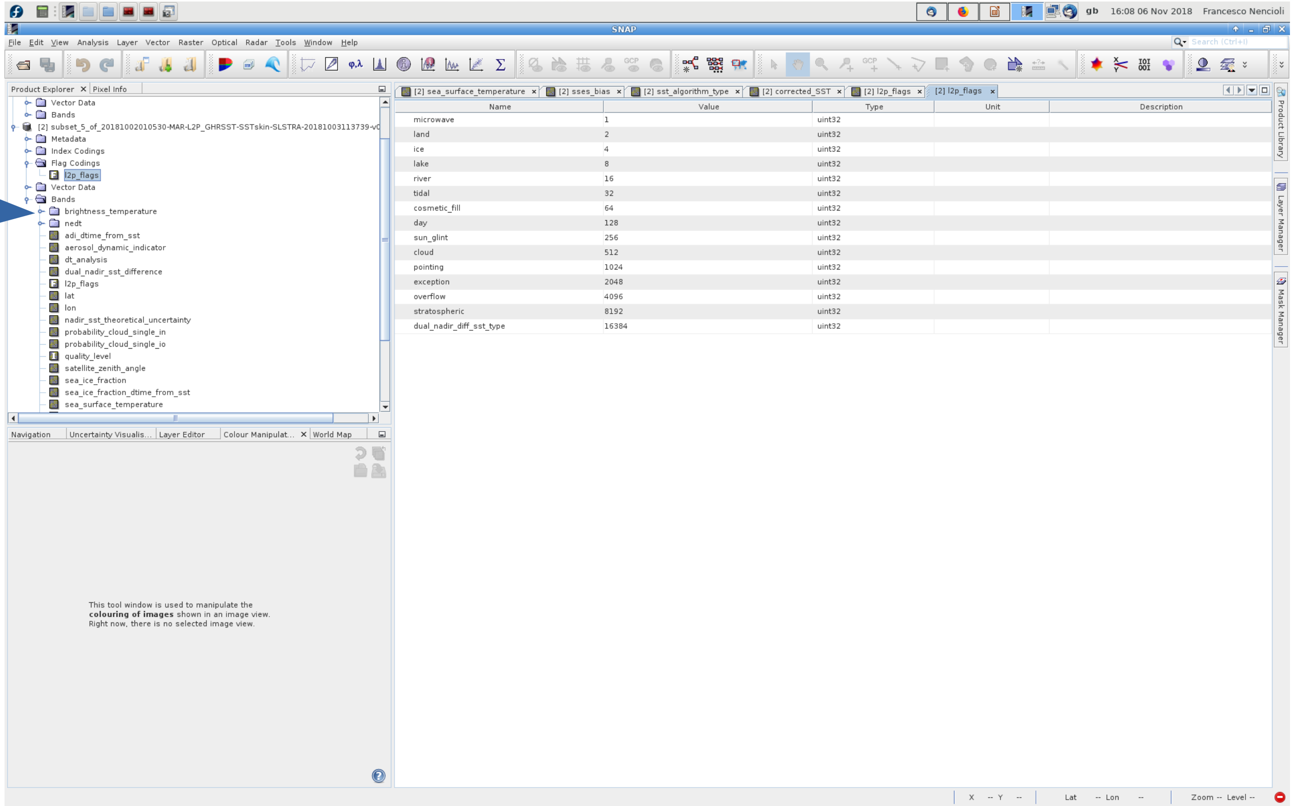
Values for the individual flags are given in the **Flag_coding/l2p_flags** variable

These are combined together bitwise into 16 digits integers (one binary digit per flag).

Example: a point that is both a land point and and ice point have a flag:

0110000000000000

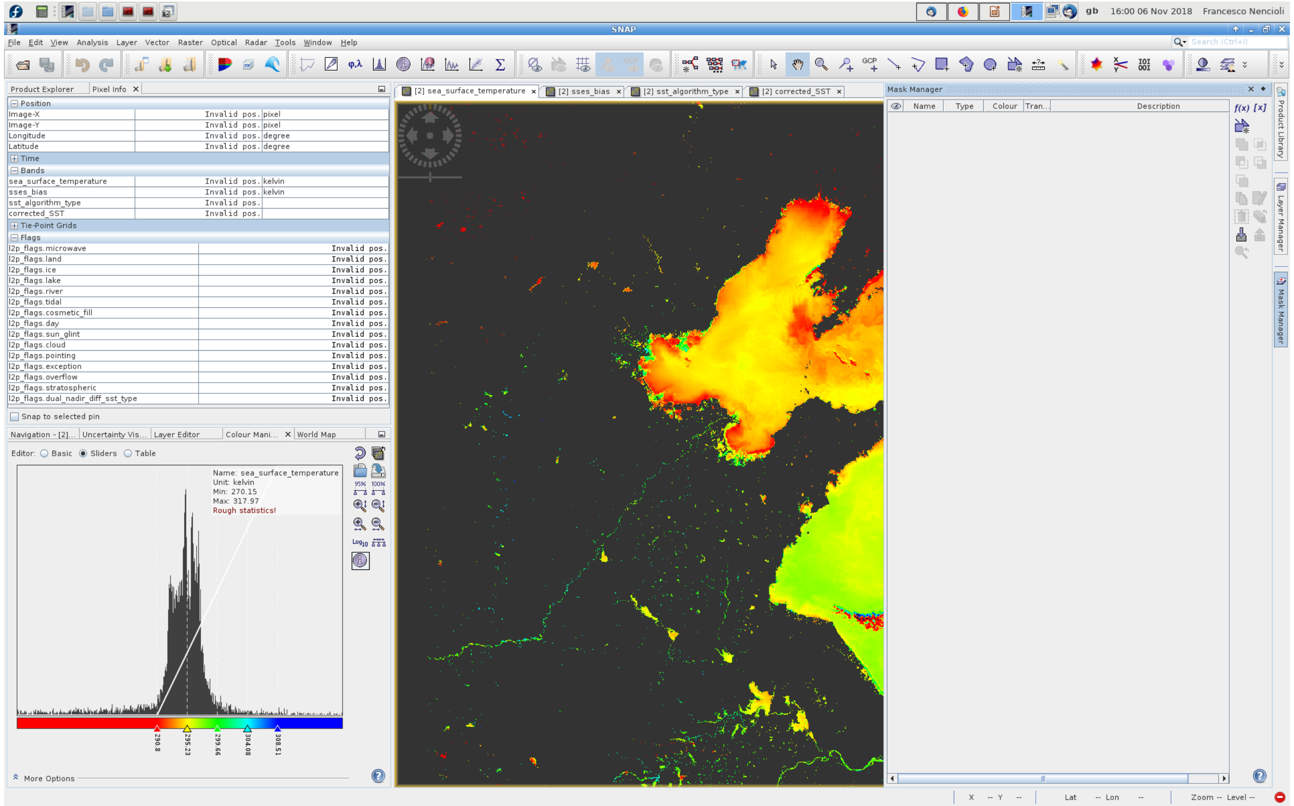
This corresponds to a value of 6.



Exercise 3: Bias correction and masks

Back to masking:

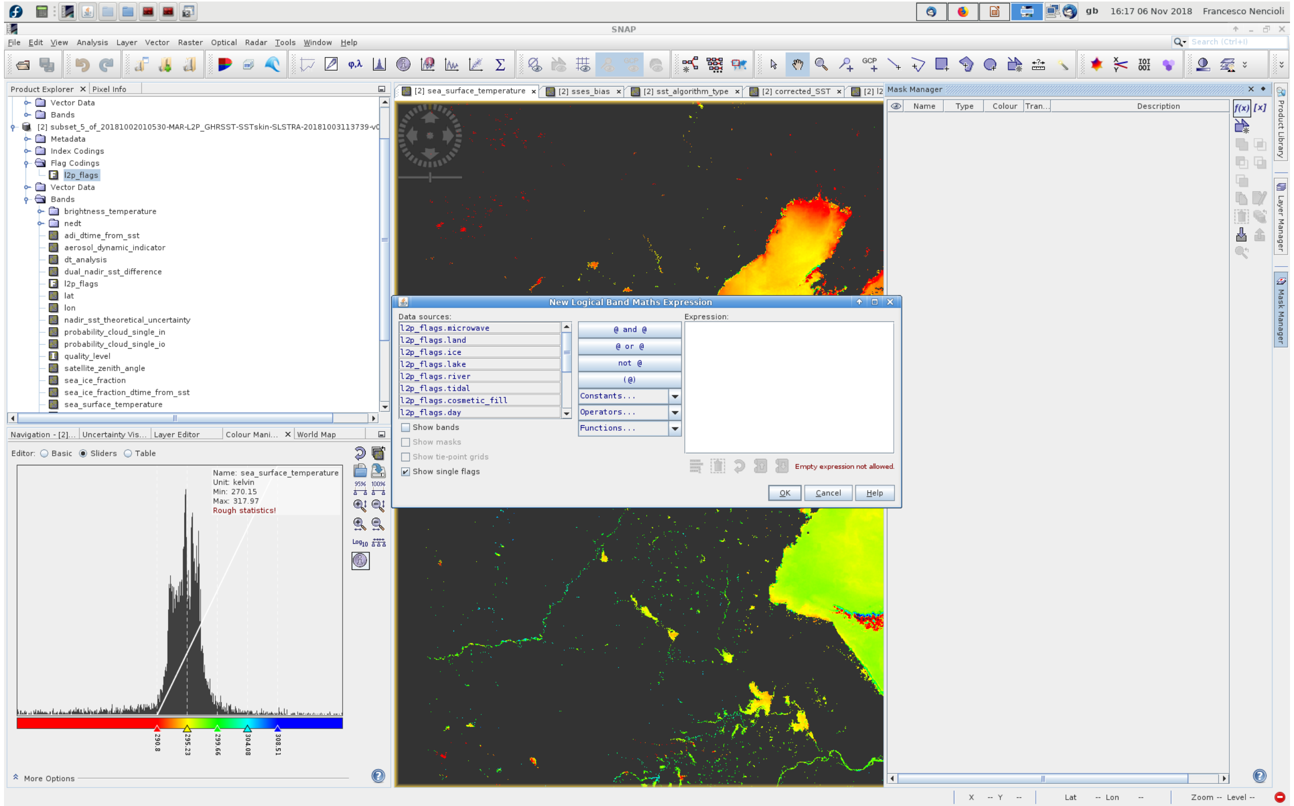
- SNAP cannot interpret SST bitwise flags
- Individual masks must be created by the user



Exercise 3: Bias correction and masks

1. Mask can be created from logical math bands expressions

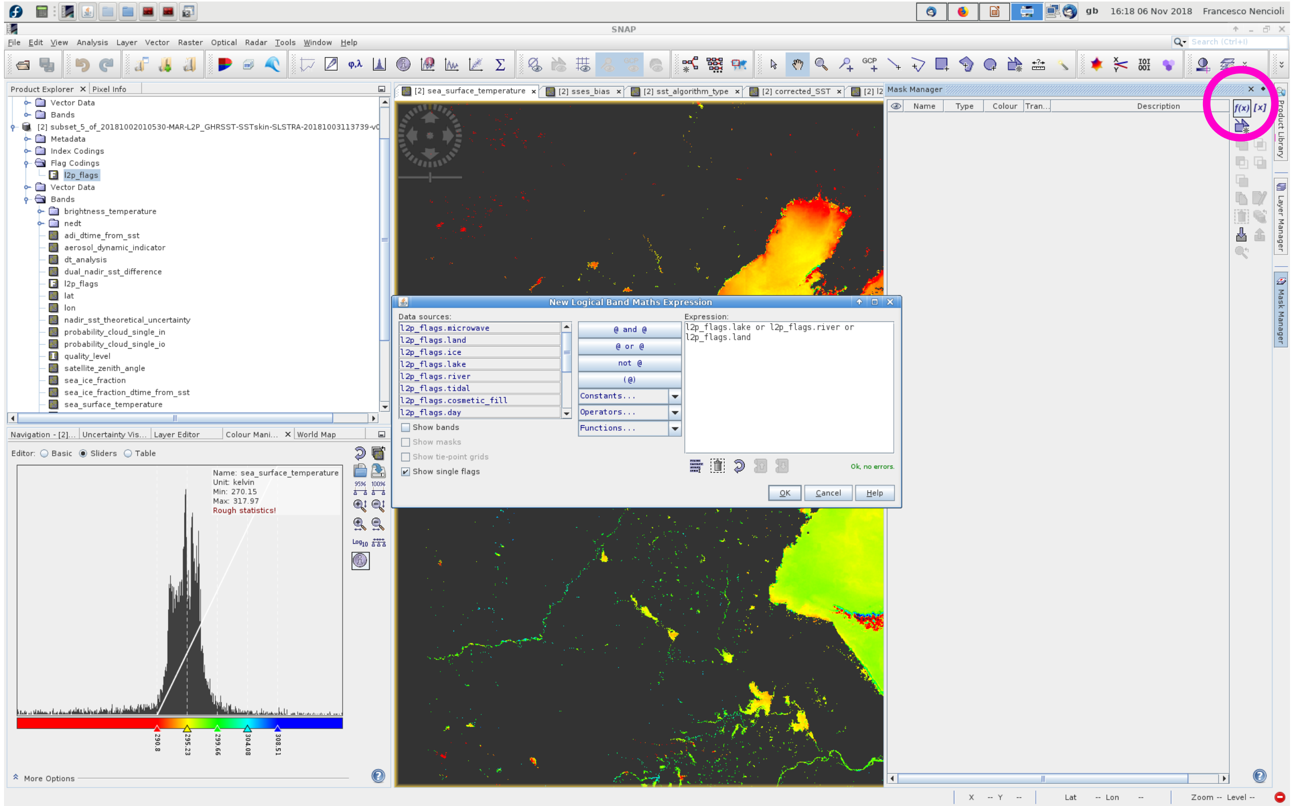
- Click on the **f(x)** button in the **Mask Manager** menu



Exercise 3: Bias correction and masks

1. Mask can be created from logical math bands expressions

- Click on the **f(x)** button in the **Mask Manager** menu
- Define the land mask building the expression **l2p_flags.lake or l2p_flags.land or l2p_flags.river**



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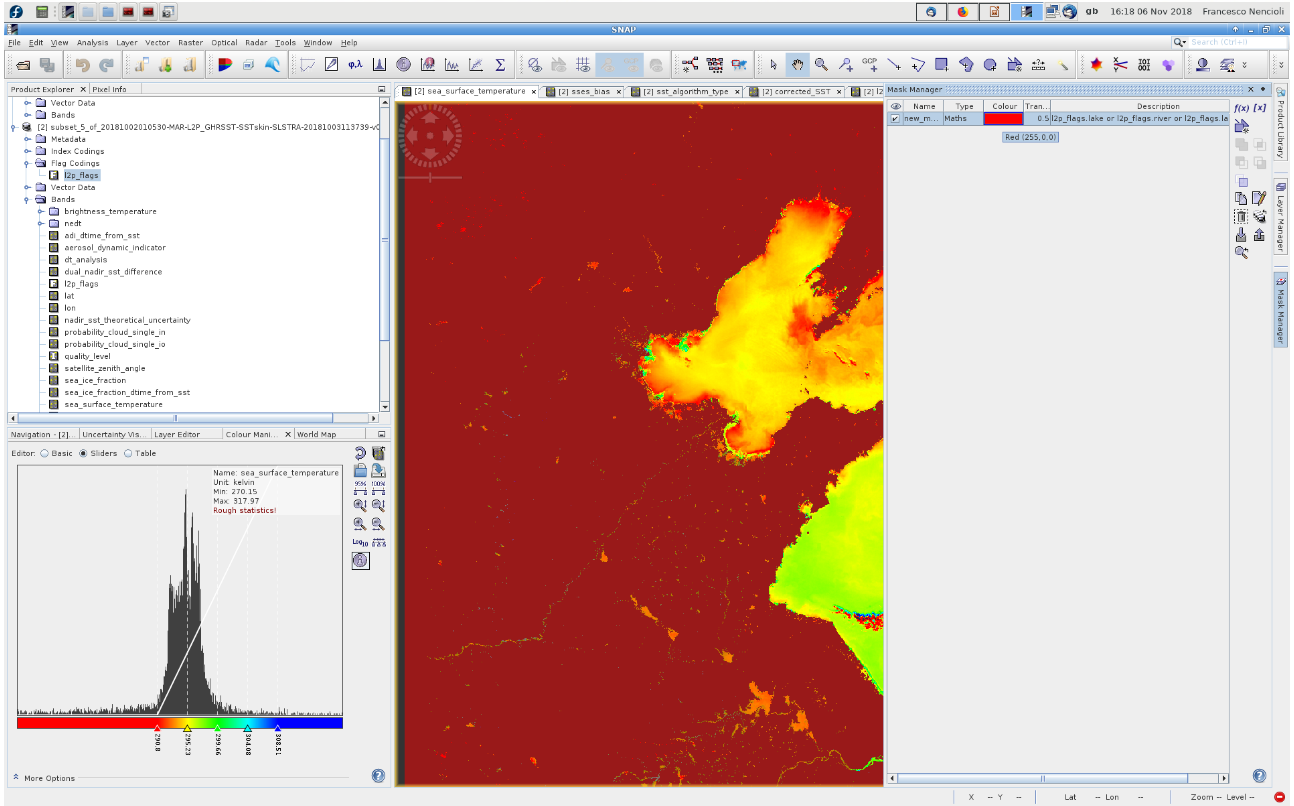
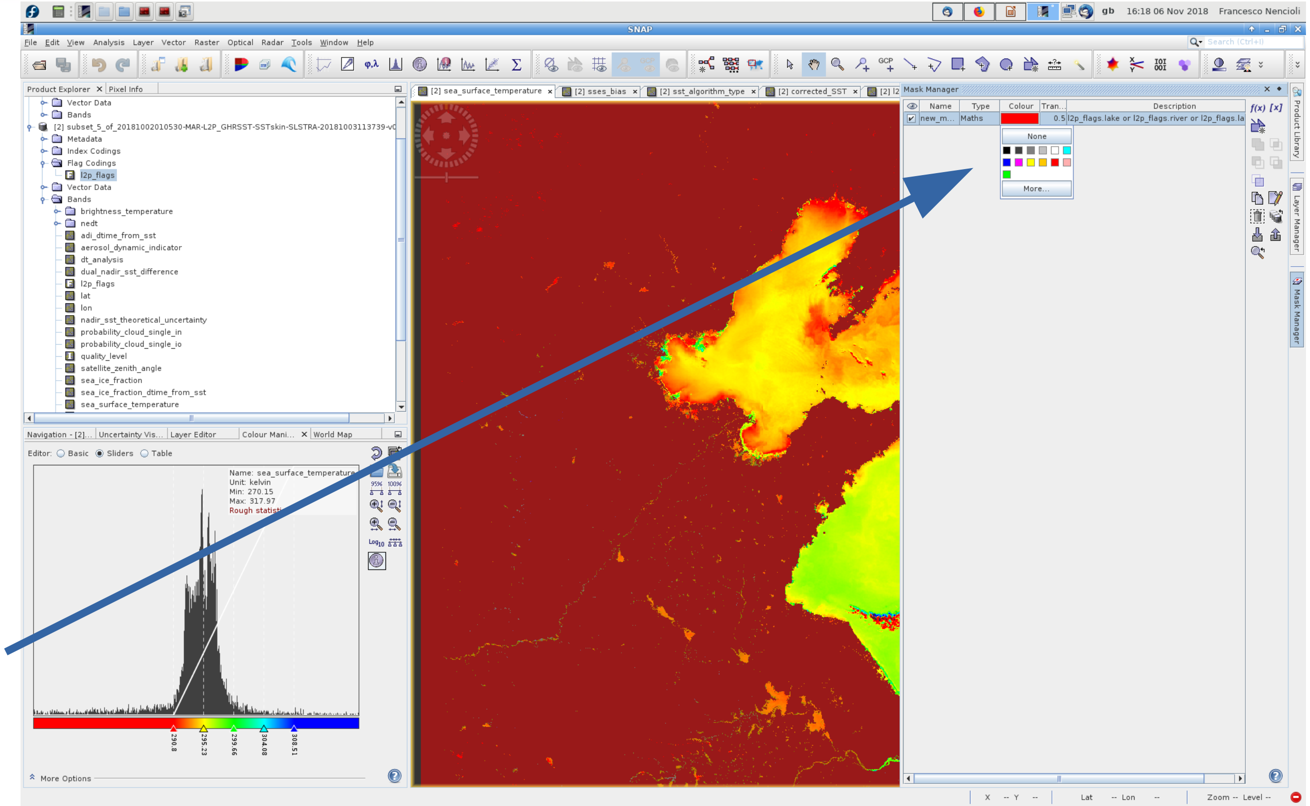


Exercise 3: Bias correction and masks

1. Mask can be created from logical math bands expressions

- Click on the **f(x)** button in the **Mask Manager** menu
- Define the land mask building the expression **l2p_flags.lake or l2p_flags.land or l2p_flags.river**
- Change colour to **black** and set transparency to **0**



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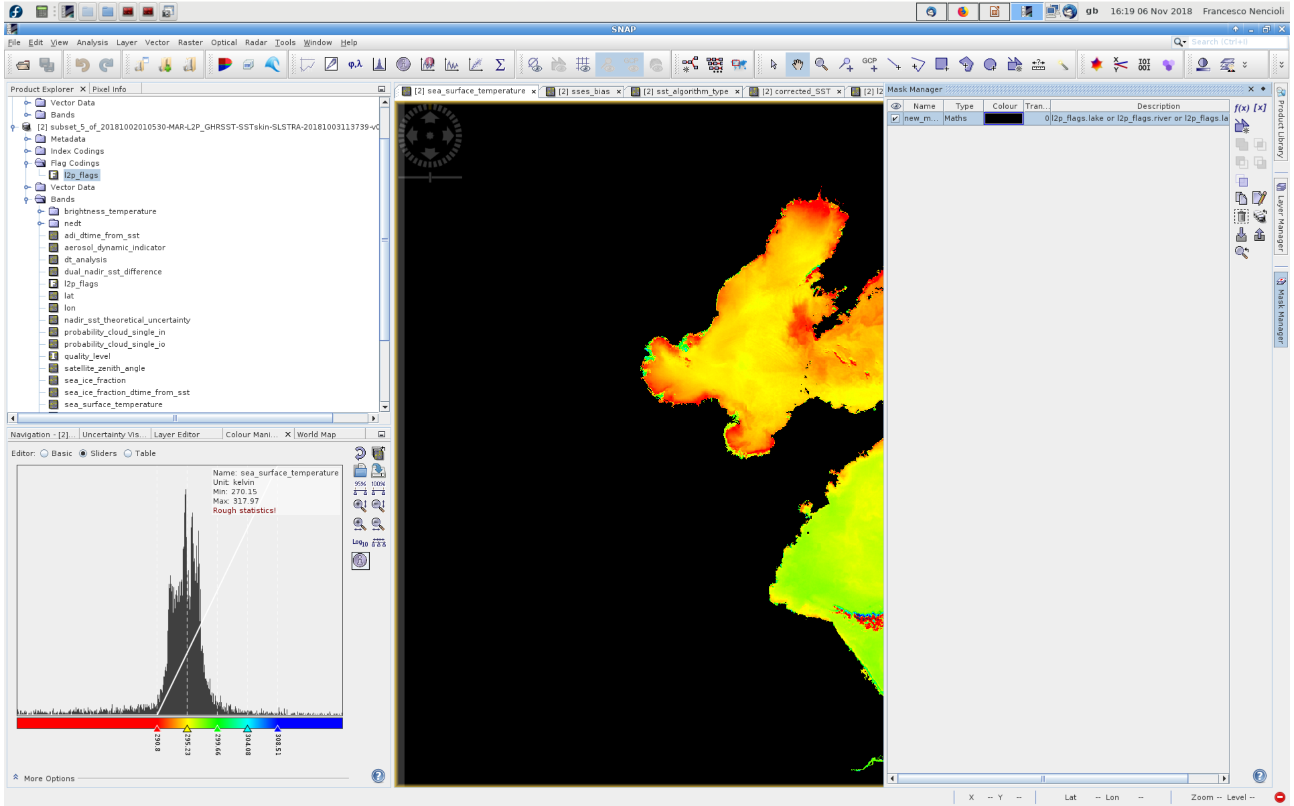
- Define the land mask building the expression **l2p_flags.lake or l2p_flags.land or l2p_flags.river**
- Change colour to **black** and set transparency to **0**

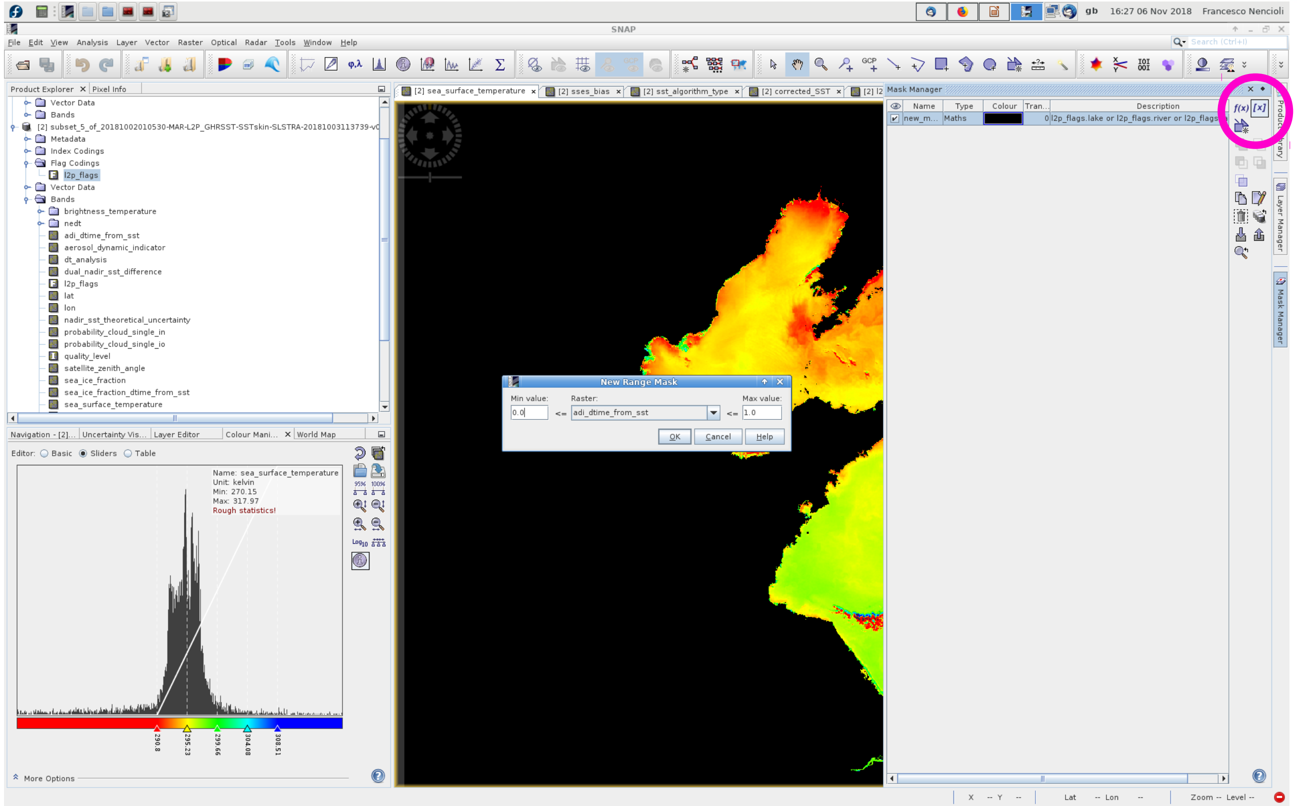
You should obtain this



Exercise 3: Bias correction and masks

2. Mask can be created from value range (we can use this for cloud masking)

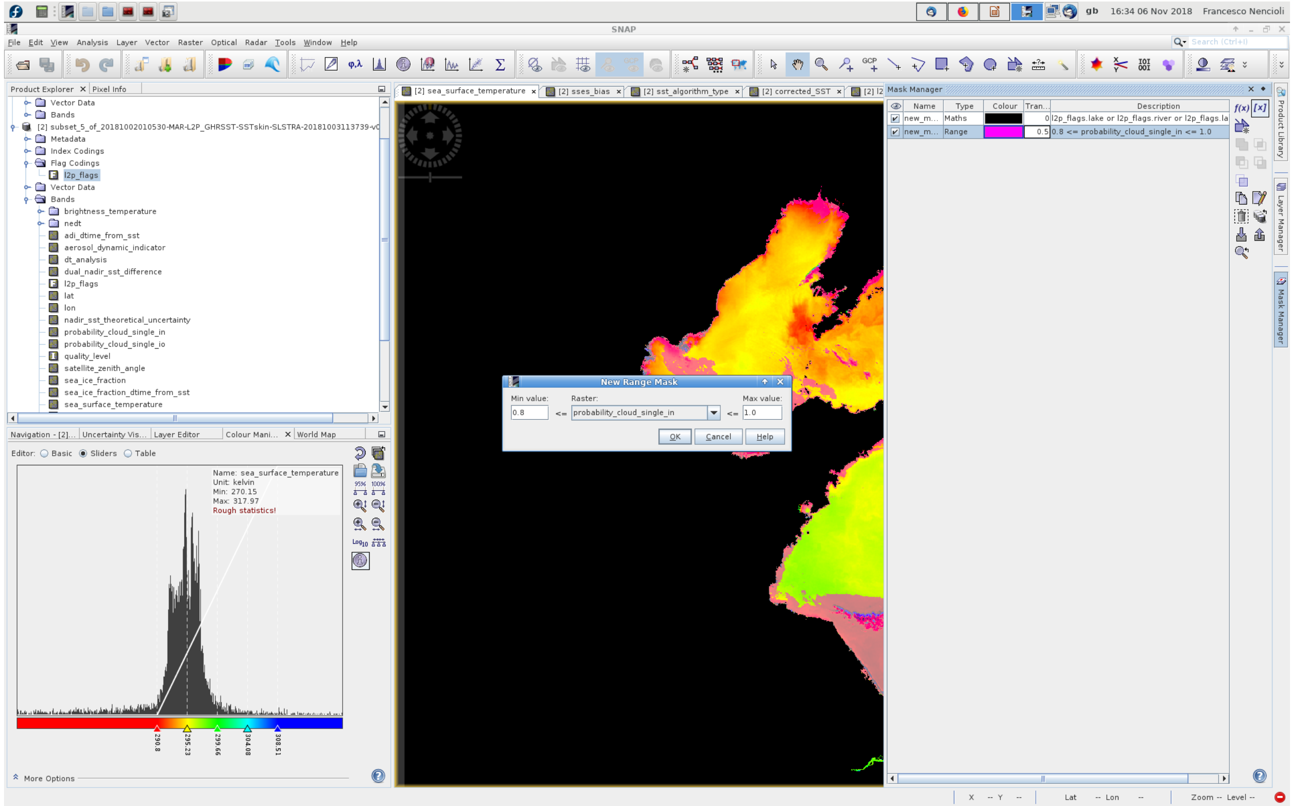
- Click on the **[x]** button in the **Mask Manager** menu



Exercise 3: Bias correction and masks

2. Mask can be created from value range (we can use this for cloud masking)

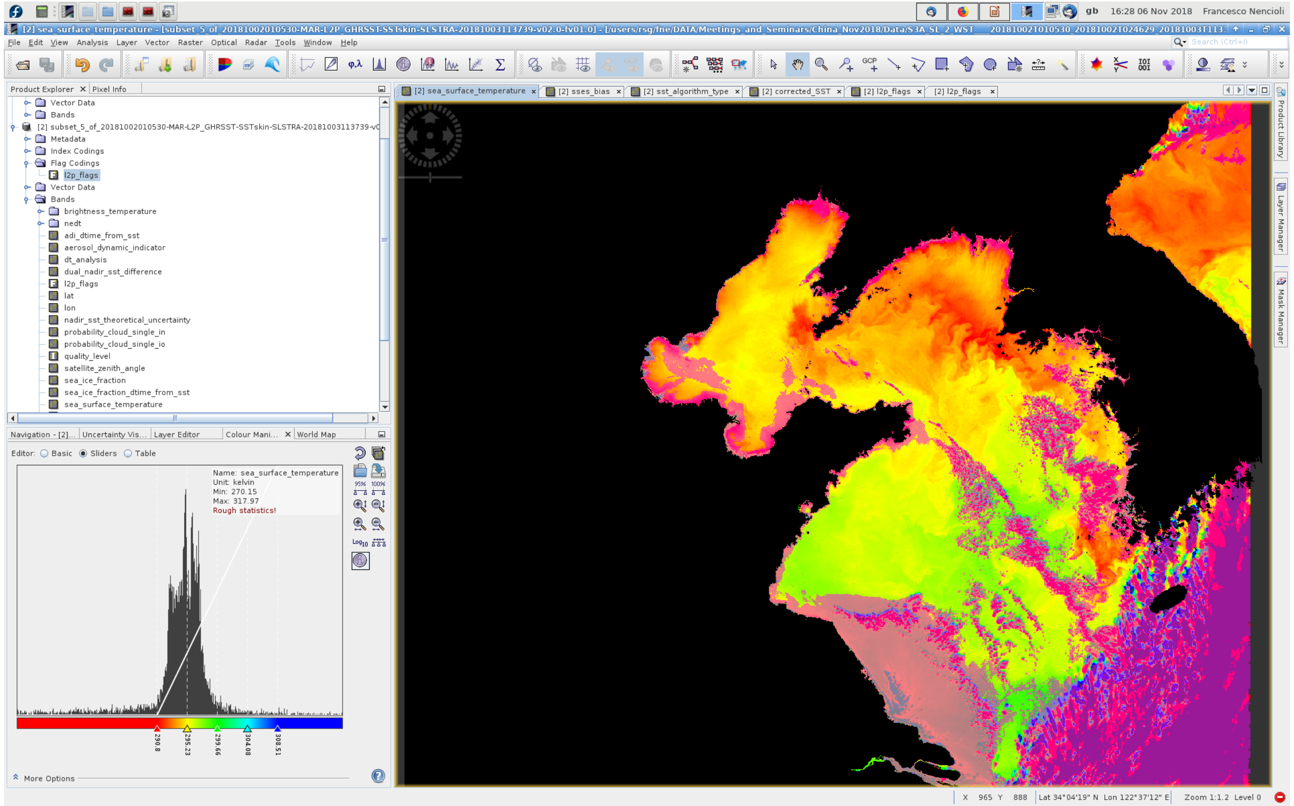
- Click on the **[x]** button in the **Mask Manager** menu
- Select the "**probability_cloud_single_in**" from the dialogue menu
- Set the limits between 0.8 and 1



Exercise 3: Bias correction and masks

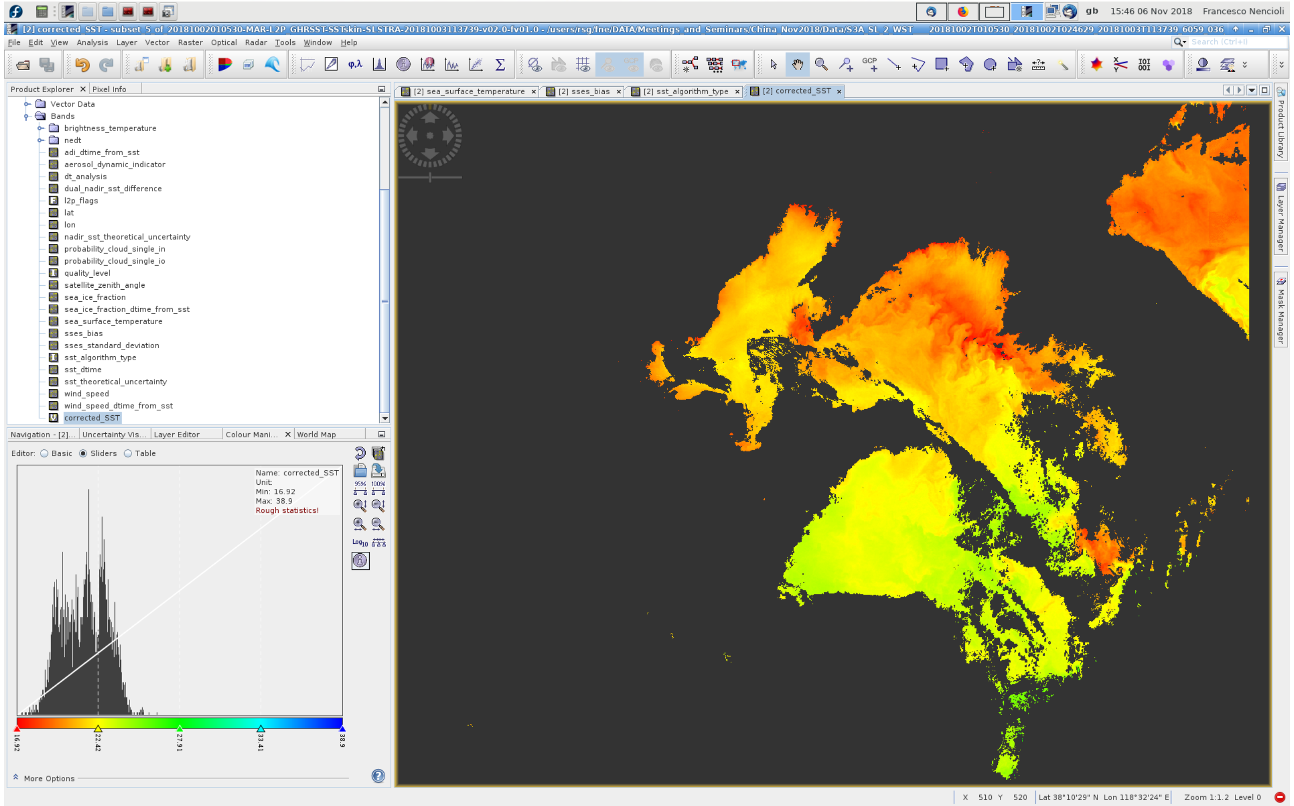
2. Mask can be created from value range (we can use this for cloud masking)

- Click on the **[x]** button in the **Mask Manager** menu
- Select the "**probability_cloud_single_in**" from the dialogue menu
- Set the limits between 0.8 and 1
- Change colour to pink



Exercise 3: Bias correction and masks

The cloud mask matches the masked pattern of the unbiased SST



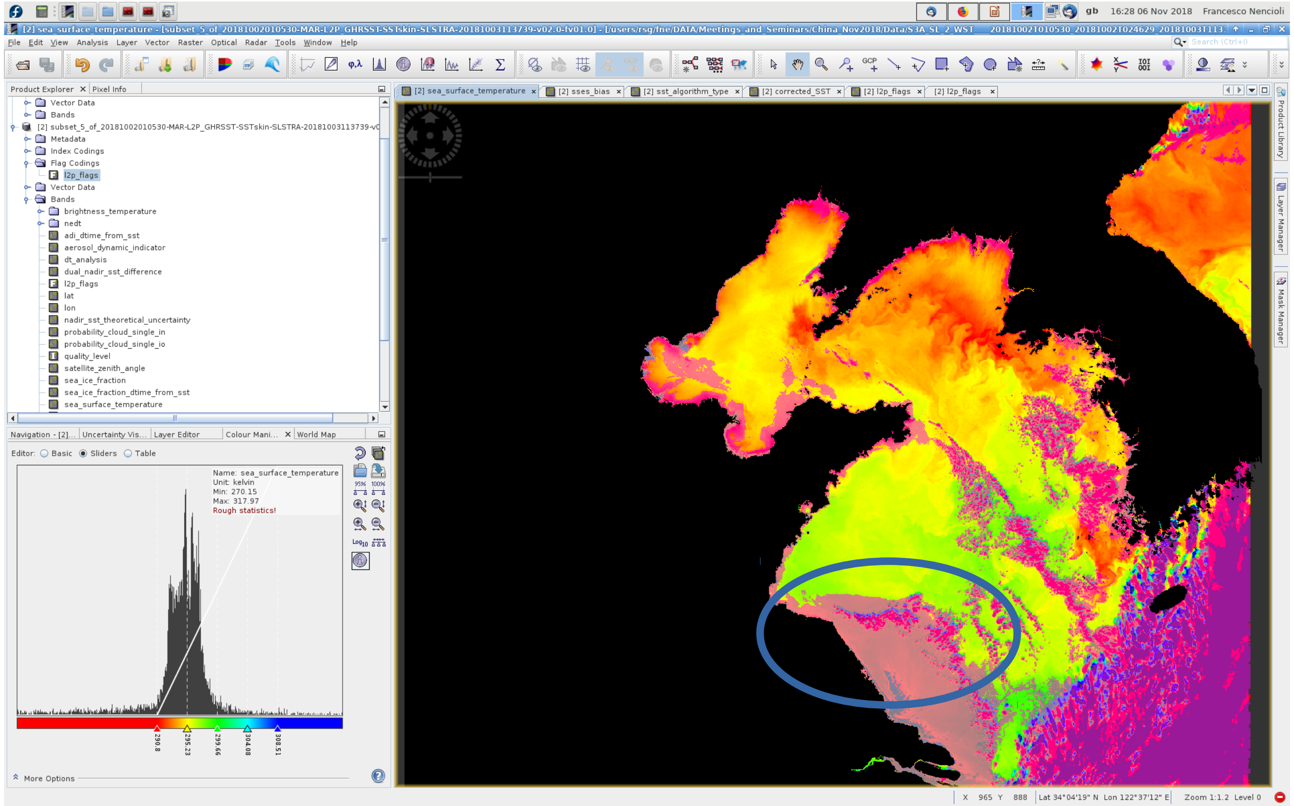
Exercise 3: Bias correction and masks

The cloud mask matches the masked pattern of the unbiased SST

However not all masked pixels seems to be associated with clouds

Cloud mask (derived from bayesian method) not entirely accurate in coastal and turbid regions

Always check your flags!!!



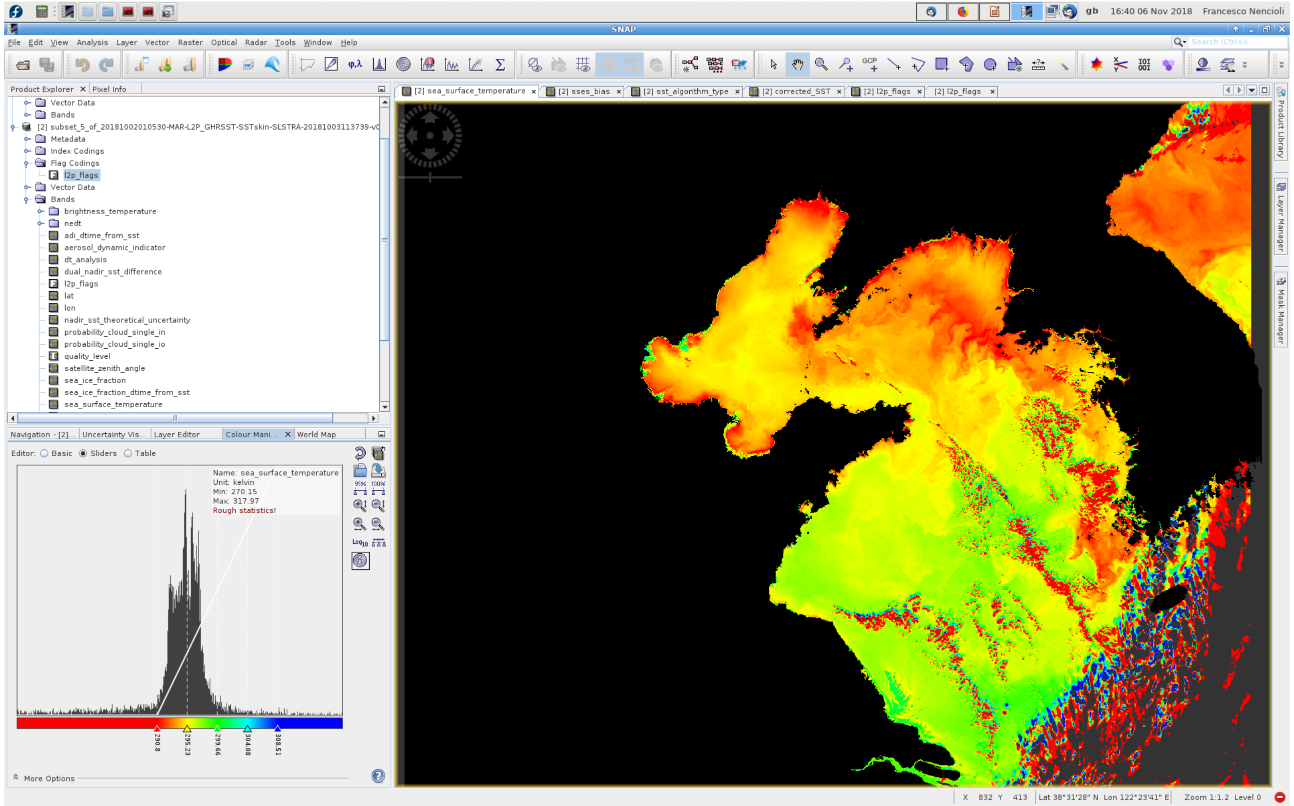
Exercise 4: User-defined cloud masks

Can you define a more accurate **regional** cloud mask using S3 data?

- Untick the cloud mask from the "**Mask Manager**" menu

Note that clouds are usually associated with high and low values of SST

- Define a mask based on SST values from mask manager
- Other variables to use?

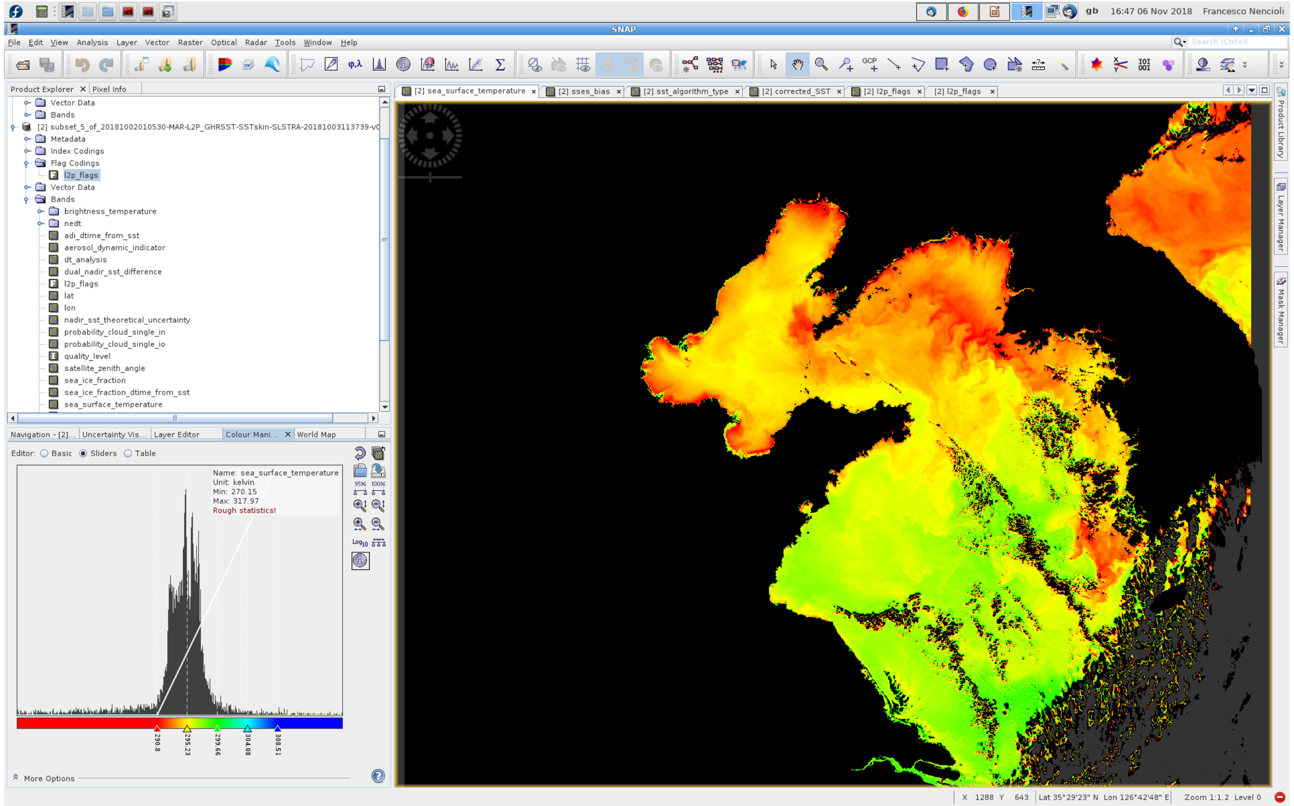


Exercise 4: User-defined cloud masks

To use SST you will need two masks:

1. One for the lower threshold
2. One for the upper one
3. Also, remember that raw SST is still in deg Kelvin

Note: although this will work for this specific area for this specific time, this is not an approach that can be used for the whole dataset!!!



Exercise 4: User-defined cloud masks

To use SST you will need two masks:

1. One for the lower threshold
2. One for the upper one
3. Also, remember that raw SST is still in deg Kelvin

This map was created masking all SST values lower than 290 and higher than 300

More on cloud masking in the Synergy Practical