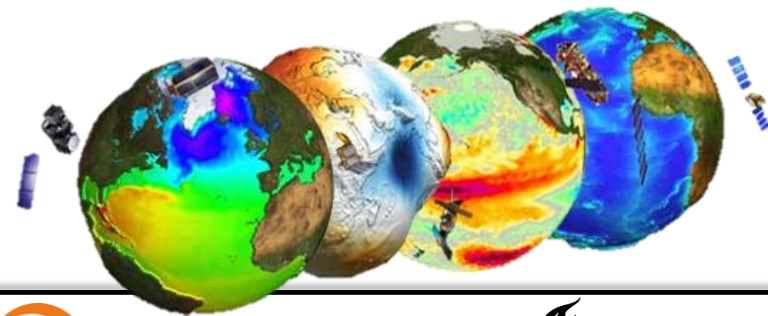
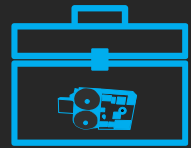


Broadview Radar Altimetry Toolbox Albert Garcia-Mondéjar (isardSAT)





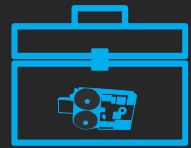
Contents



1. BRAT project
2. Along-track data
3. Gridded data
4. Wind and waves
5. Waveforms



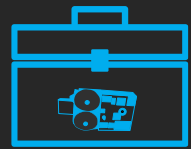
Contents



- 1. BRAT project**
2. Along-track data
3. Gridded data
4. Wind and waves
5. Waveforms



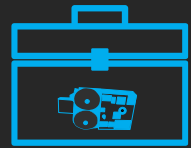
1. S-3 Altimeter Toolbox



- Evolution of the Basic Radar Altimetry Toolbox (BRAT)
 - New datasets
 - New functionalities
 - New GUI
- Update and create new tutorial material
- Support both novice and expert users of the Altimetry Scientific Community.
- Collect feedback from the Altimetry Community on the new concept and gather suggestions for further improvements.



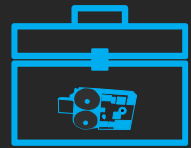
Contents



1. BRAT project
- 2. Along-track data**
3. Gridded data
4. Wind and waves
5. Waveforms



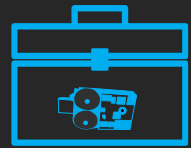
Contents



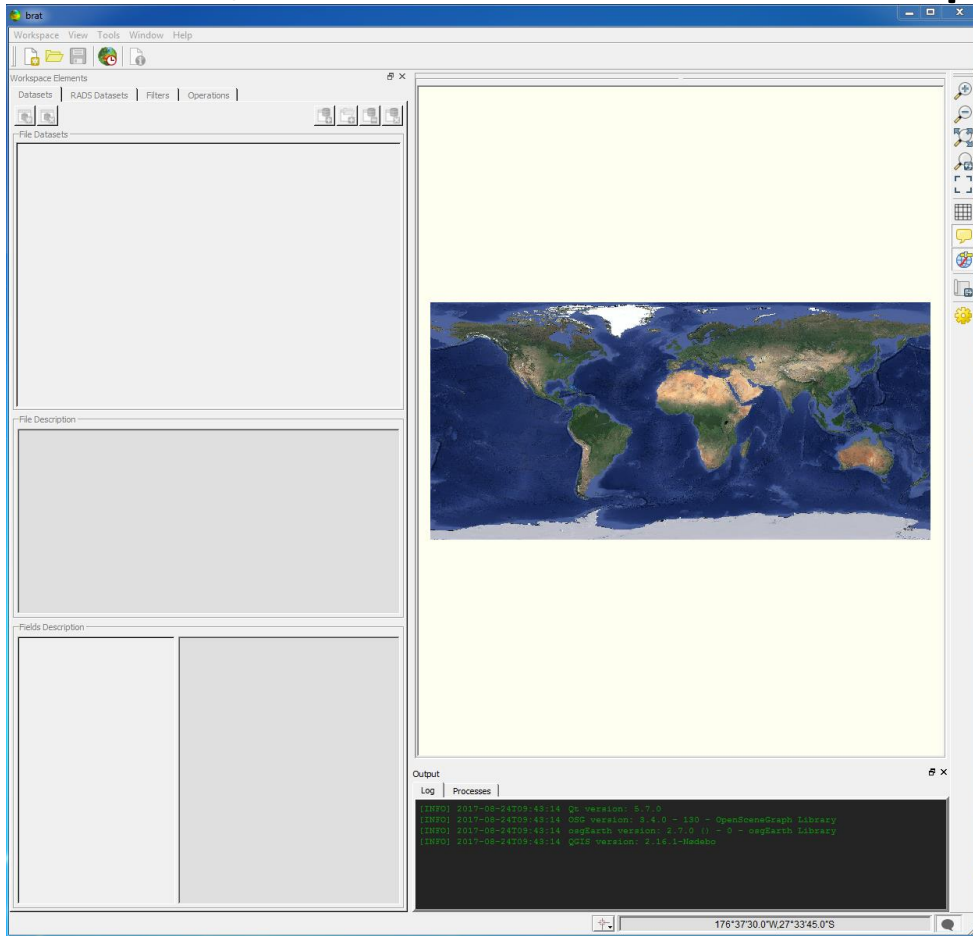
1. BRAT project
- 2. Along-track data**
 - 2.1 Basic functioning**
 - 2.2 Advanced features
3. Gridded data
4. Wind and waves
5. Waveforms



2.1 Basic functioning

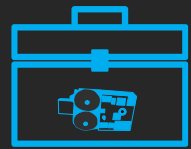


- First, create a new workspace:

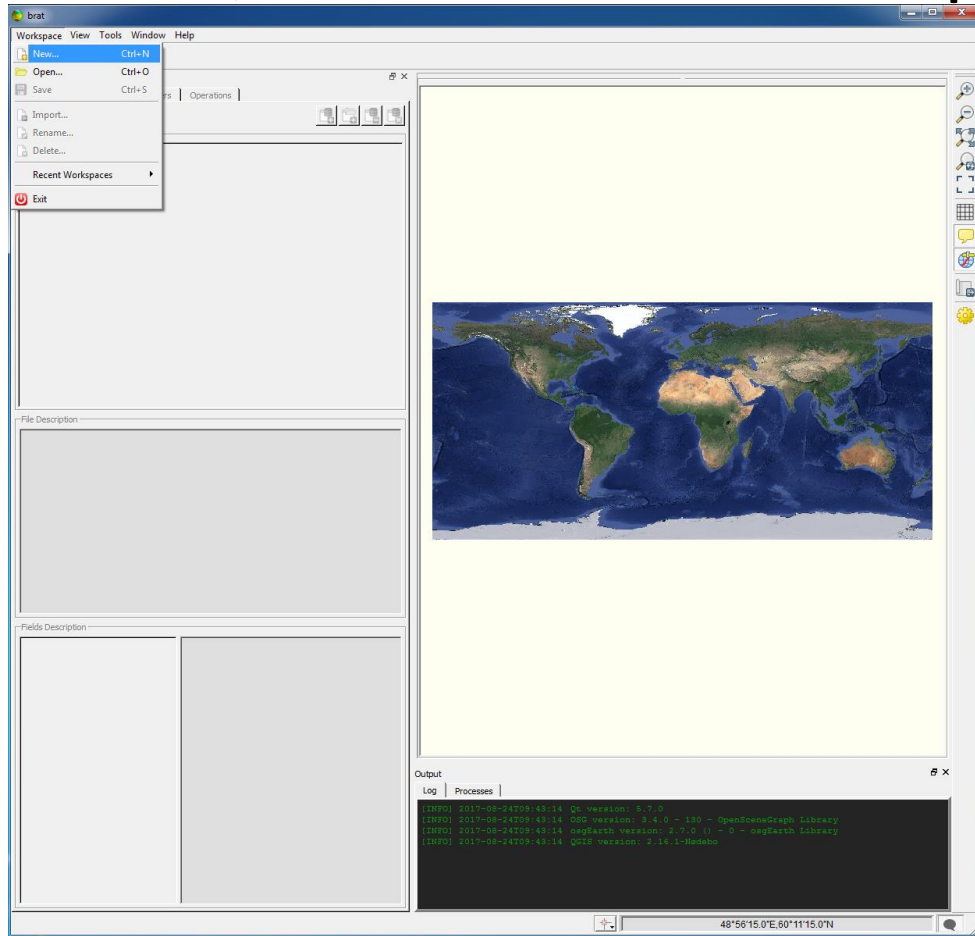




2.1 Basic functioning

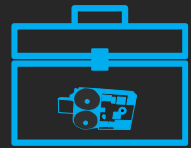


- First, create a new workspace:

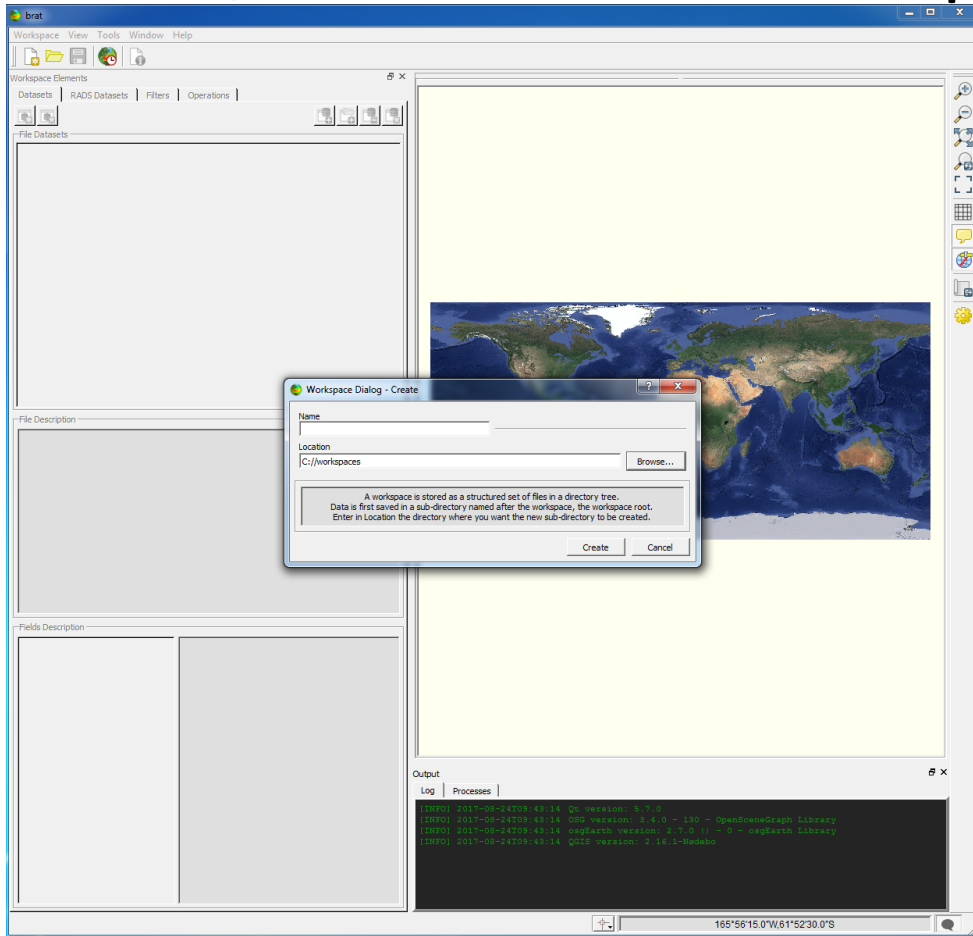




2.1 Basic functioning



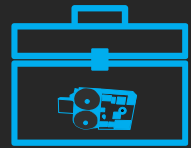
- First, create a new workspace:



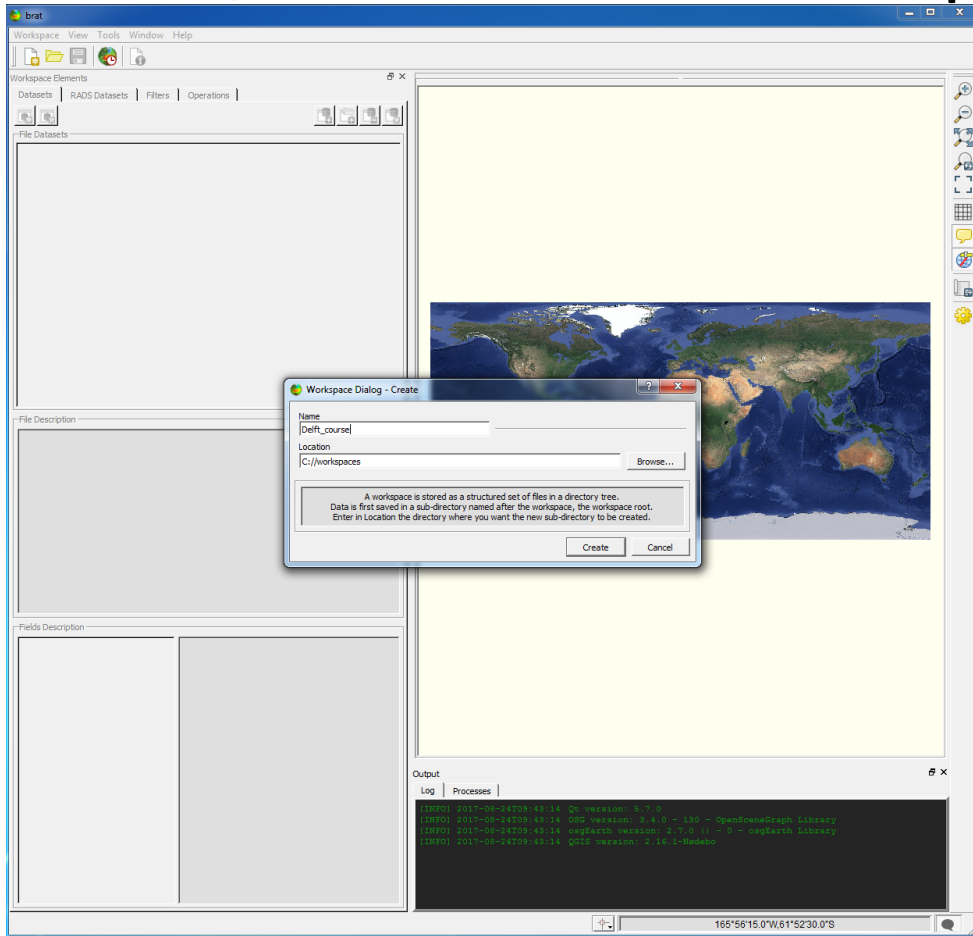
1. Choose the folder where you want to save all your progress.



2.1 Basic functioning



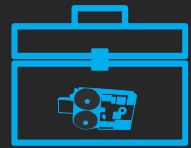
- First, create a new workspace:



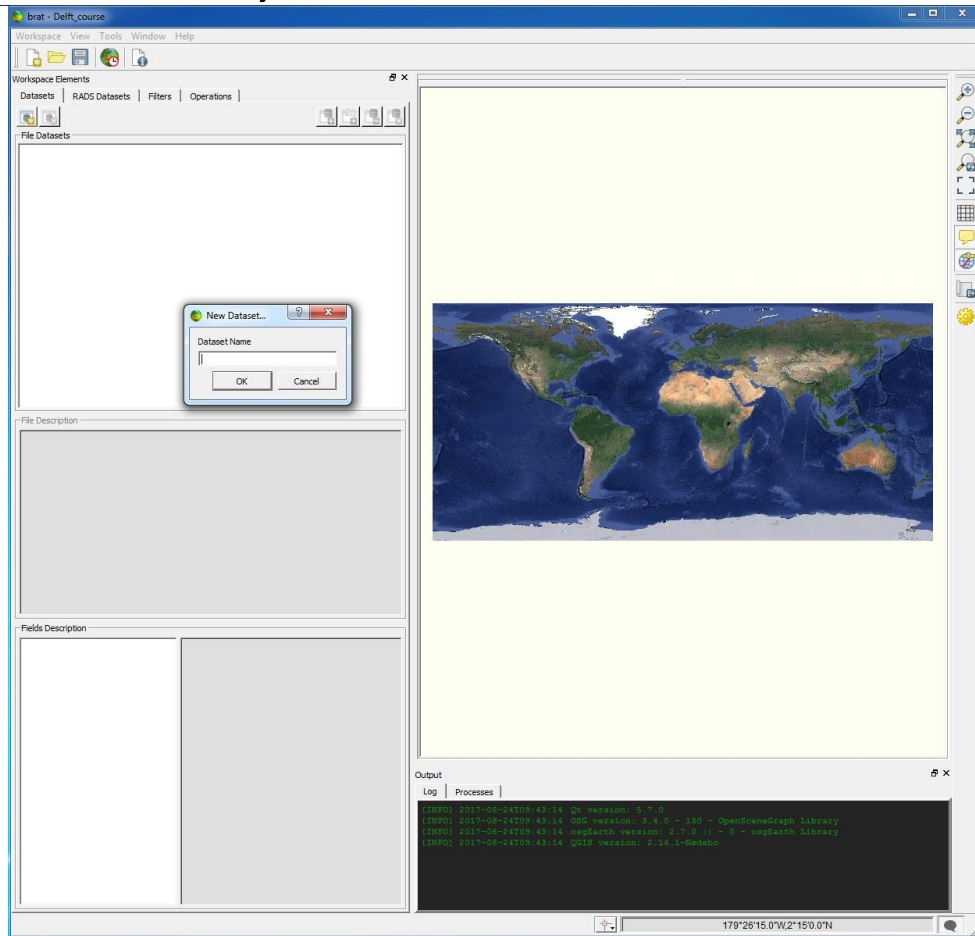
1. Choose the folder where you want to save all your progress.
2. Call the workspace 'Delft_course'.



2.1 Basic functioning



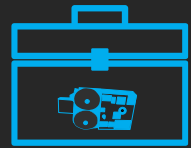
- Then, add a dataset:



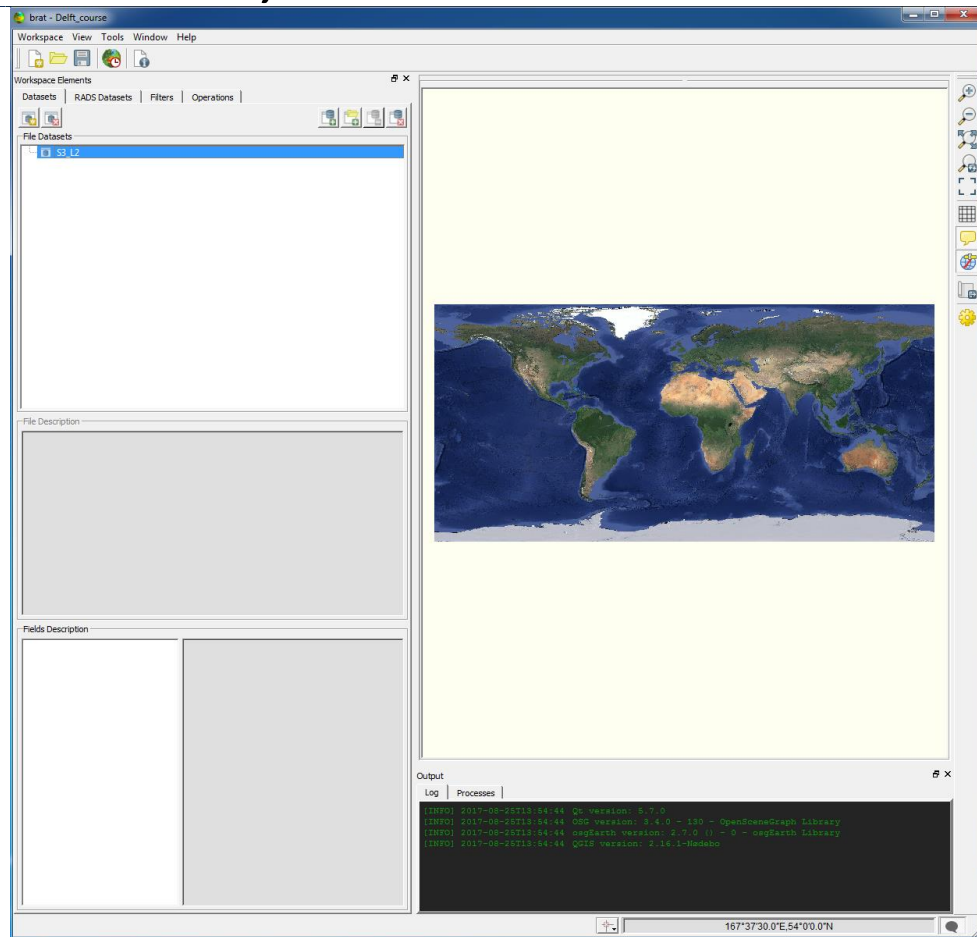
1. Click on *New*.



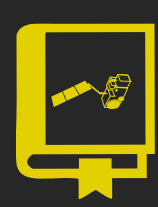
2.1 Basic functioning



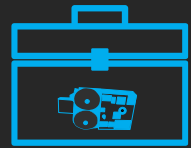
- Then, add a dataset:



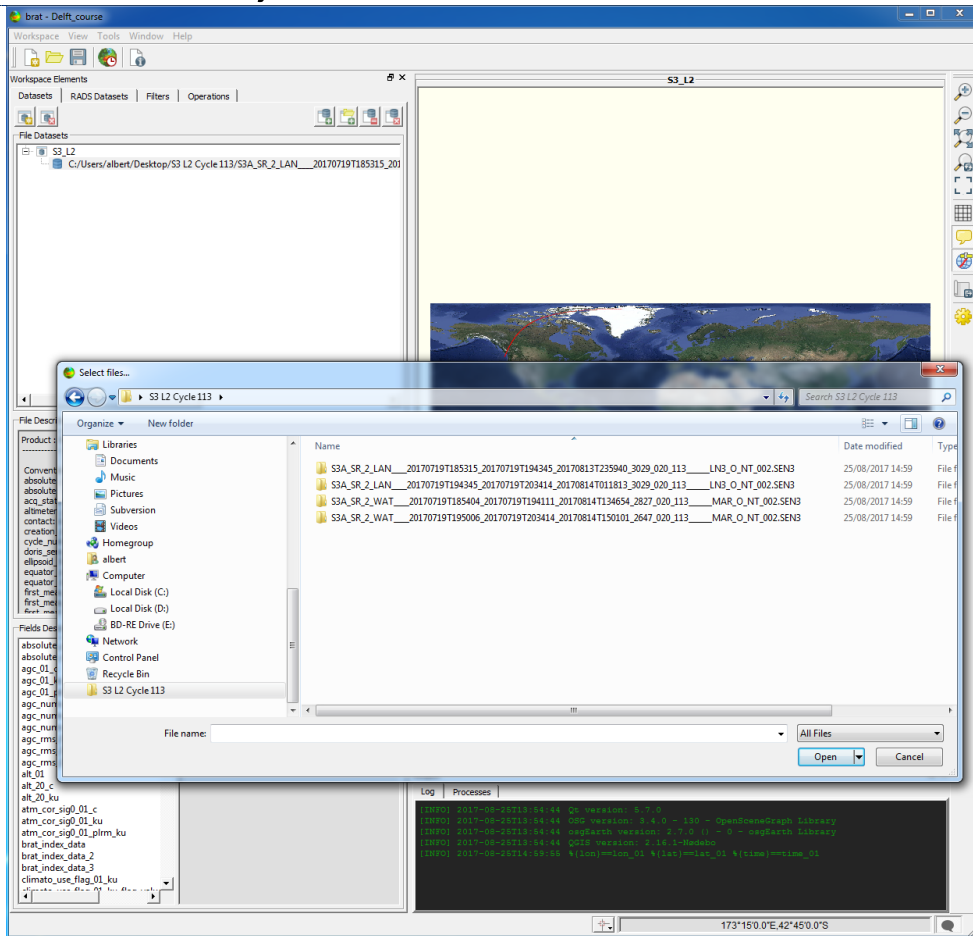
1. Click on *New*.
2. Call it “S3_L2” (Sentinel 3 Level 2 products).



2.1 Basic functioning



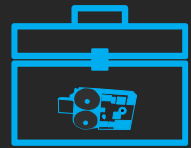
- Then, add a dataset:



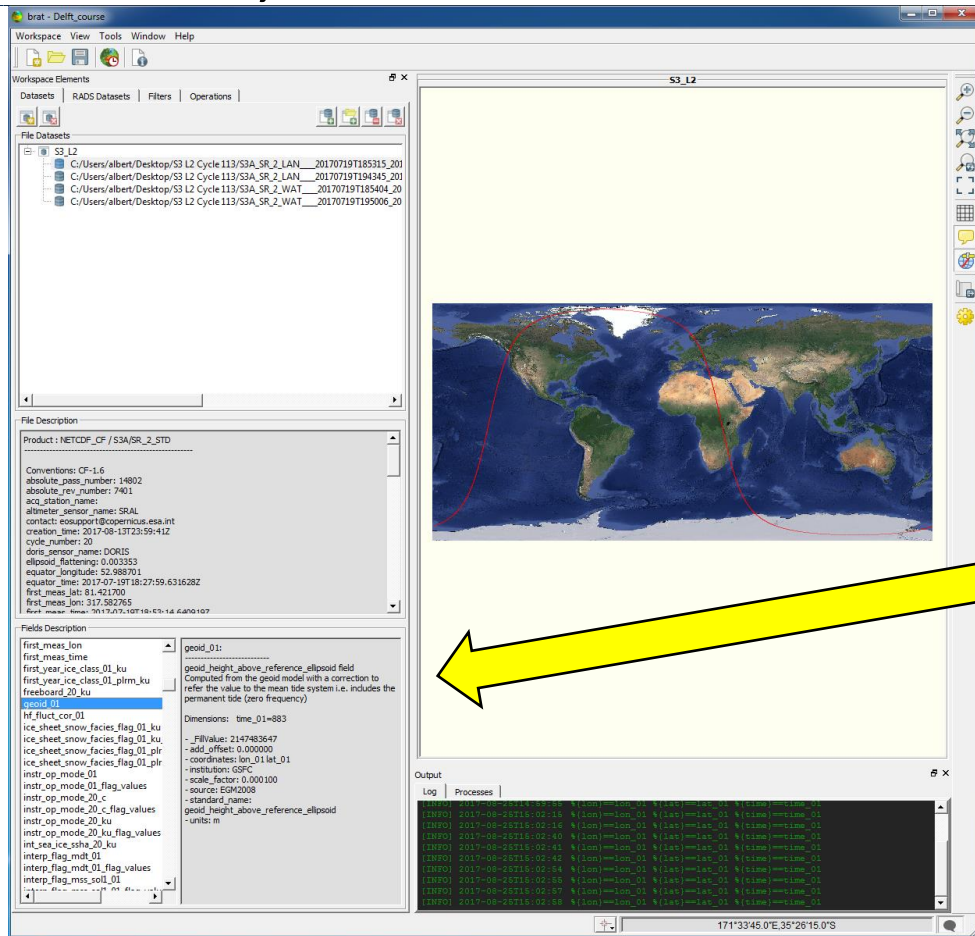
1. Click on *New*.
2. Call it “S3_L2” (Sentinel 3 Level 2 products).
3. Click on *Add File...* and choose the files inside “S3 L2 Cycle 113” in the *Datasets* folder.



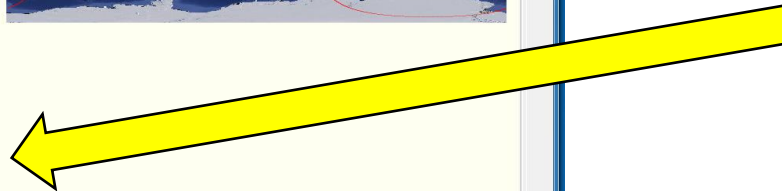
2.1 Basic functioning



- Then, add a dataset:

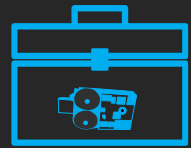


- Now you can inspect all the fields that are contained in the product.
- In the bottom right left, you can find information about the selected field.

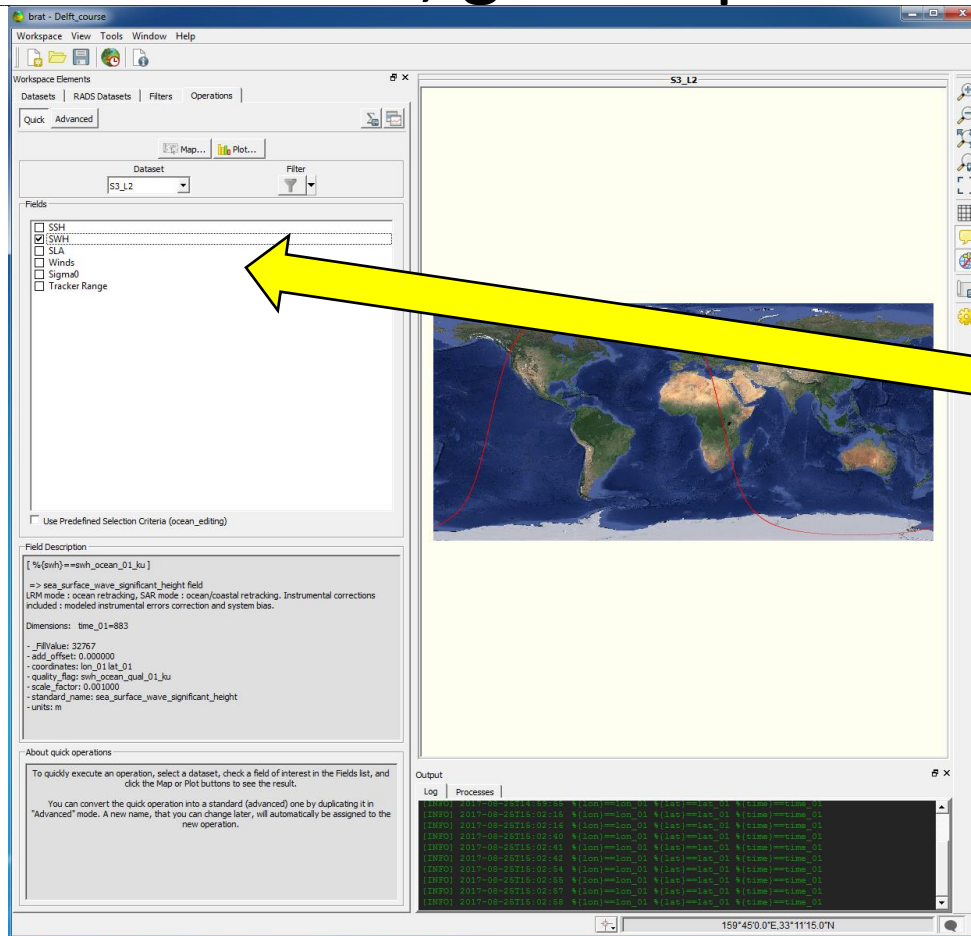




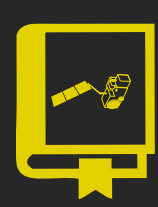
2.1 Basic functioning



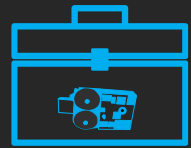
- After that, go to Operations tab:



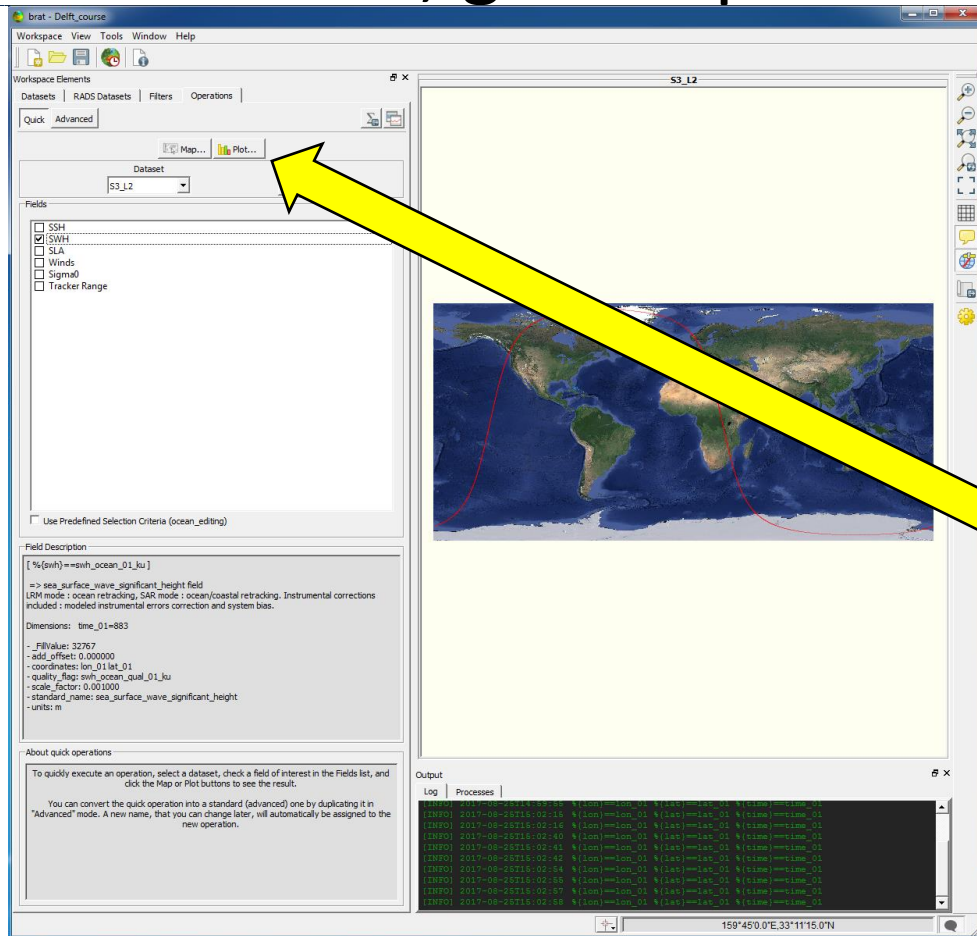
- Here is where you choose between Quick and Advanced operations.
- The Quick ones are SSH, SWH, SLA, Winds, Sigma0 and Tracker Range.



2.1 Basic functioning



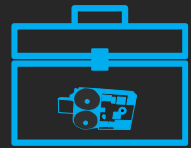
- After that, go to Operations tab:



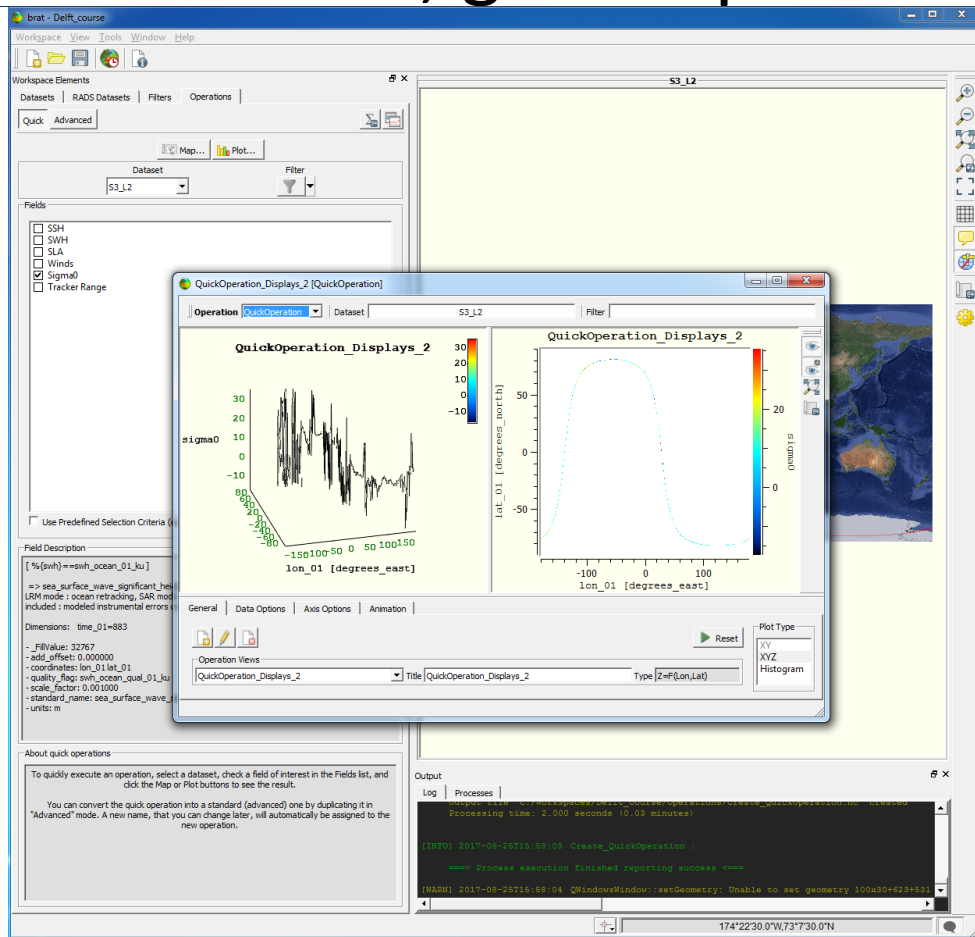
- Here is where you choose between Quick and Advanced operations.
- The Quick ones are SSH, SWH, SLA, Winds, Sigma0 and Tracker Range.
- Select Sigma 0 and “Plot”.



2.1 Basic functioning



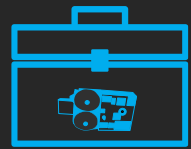
- After that, go to Operations tab:



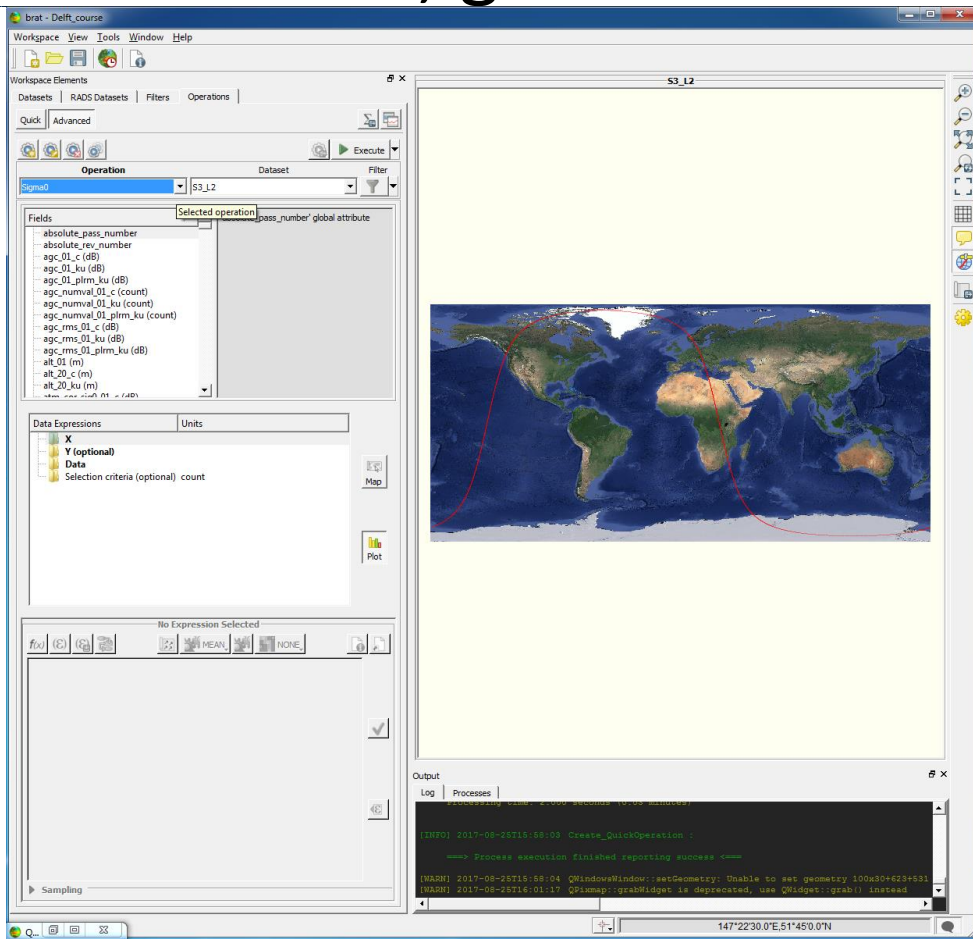
- Here is where you choose between Quick and Advanced operations.
- The Quick ones are SSH, SWH, SLA, Winds, Sigma0 and Tracker Range.
- Select Sigma 0 and “Plot”.



2.1 Basic functioning



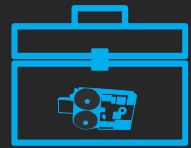
- After that, go to Advanced Operations tab:



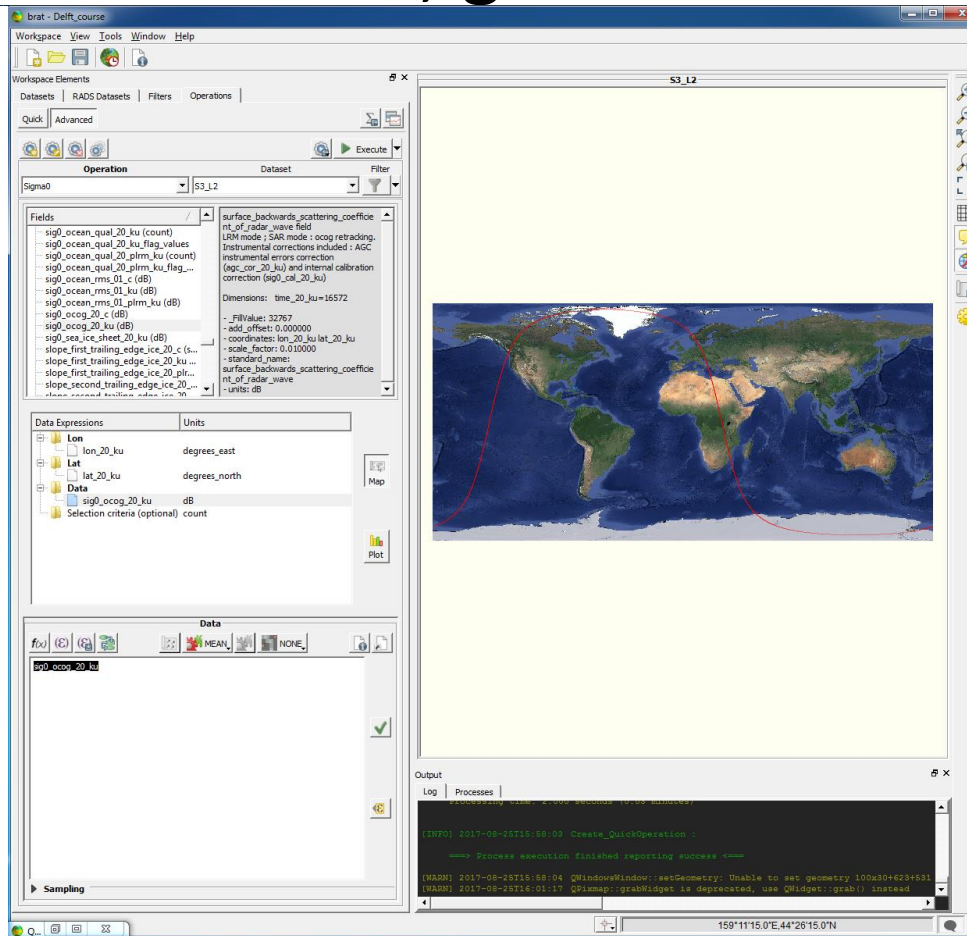
- Click to create a new operation and name it Sigma0
- Notice there are 4 items in the *Data expressions* box:
 - X
 - Y
 - Data
 - Selection criteria (optional)
- These are the fields that have to be filled with meaningful information in order to execute a useful operation.



2.1 Basic functioning



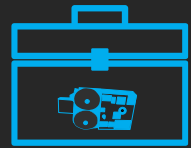
- After that, go to Advanced Operations tab:



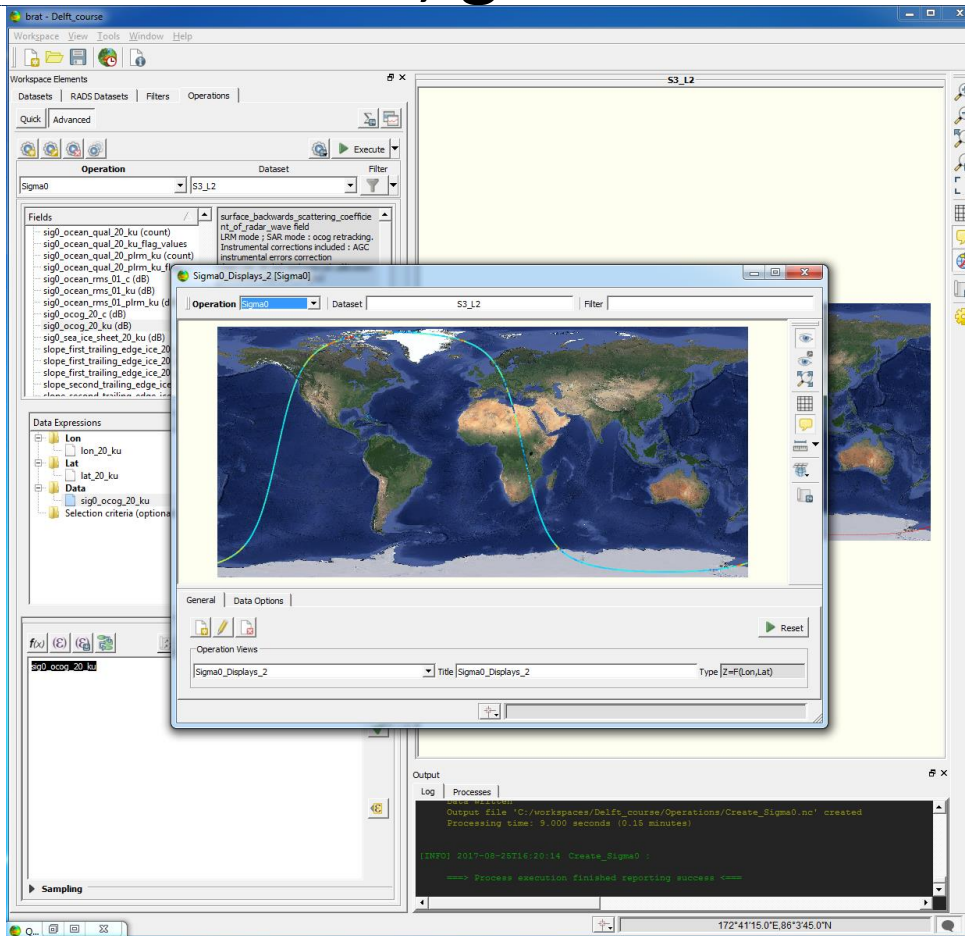
- Selection “Map” type and the X and Y data expressions change to Lon and Lat.
- Add the “lon_20_ku” and “lat_20_ku” fields and the “sig0_ocog_20_ku”
- Click “Execute” to see the plot for this variable.



2.1 Basic functioning



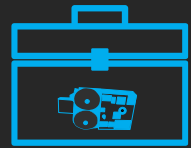
- After that, go to Advanced Operations tab:



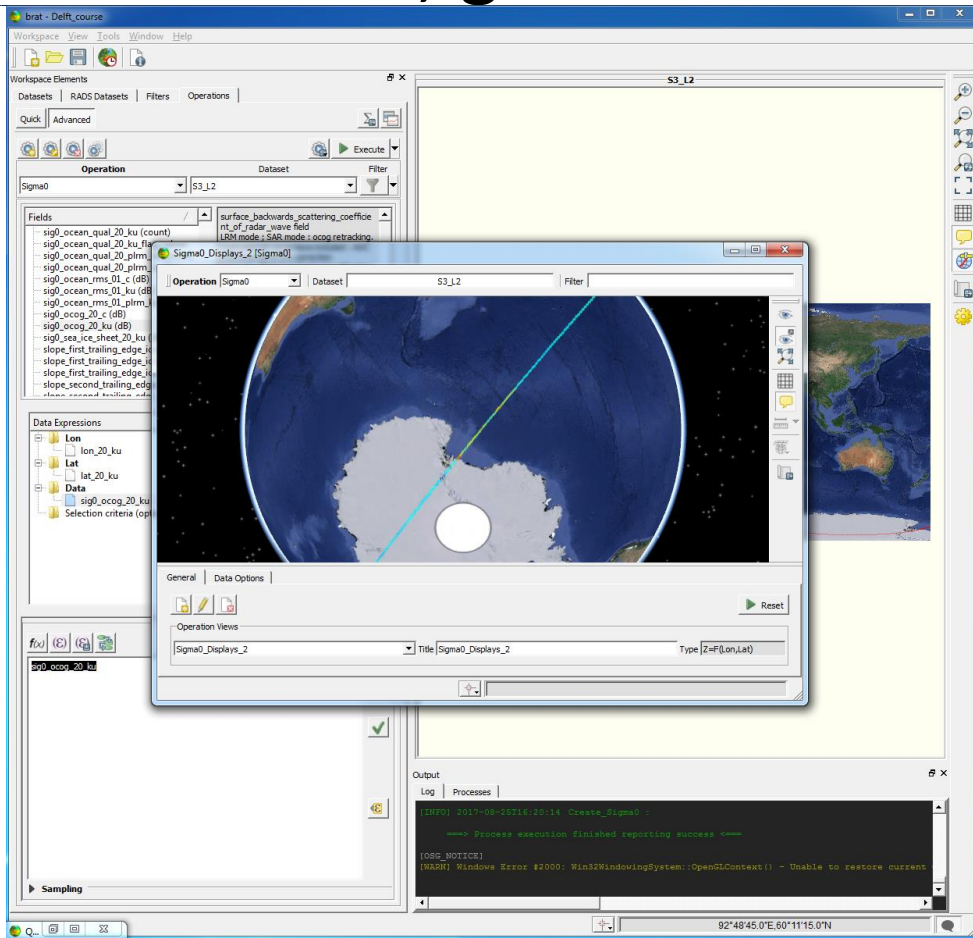
- Selection “Map” type and the X and Y data expressions change to Lon and Lat.
- Add the “lon_20_ku” and “lat_20_ku” fields and the “sig0_ocog_20_ku”
- Click “Execute” to see the plot for this variable.



2.1 Basic functioning



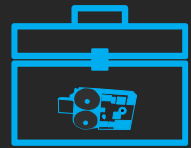
- After that, go to Advanced Operations tab:



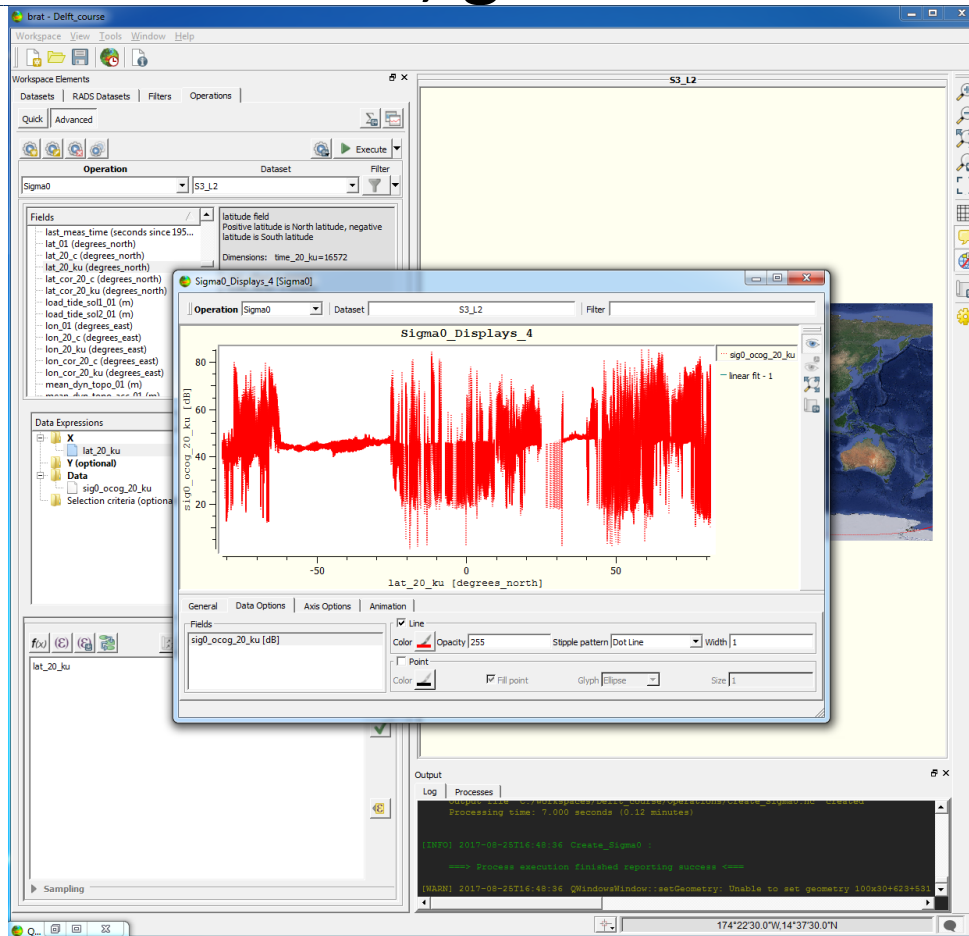
- You can check that the backscatter is higher in the Antarctic ocean due to the presence of sea ice.



2.1 Basic functioning



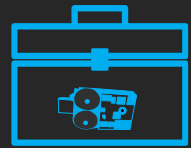
- After that, go to Advanced Operations tab:



- We can now see the same field only against latitude if we do a plot putting the “lat_20_ku” in the X Data Expression



2.1 Basic functioning



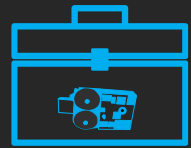
- After that, go to Advanced Operations tab:

The screenshot displays the 'brat - Delft_course' application window. The 'Advanced Operations' tab is active, showing an operation named 'Tracker_elevation' applied to the 'S3_L12' dataset. The 'Fields' panel lists various data fields, including 'lon_20_ku' (degrees_east) and 'lon_20_c' (degrees_north). The 'Data Expressions' panel shows 'lon_20_ku' with units 'degrees_east'. A context menu is open over 'lon_20_ku', offering options like 'Insert empty expression' and 'Insert \'lon_20_ku\' field as a new expression'. The main map area shows a satellite track over the Atlantic Ocean. The 'Output' window at the bottom shows a successful execution log for 'Create_Sigma0'.

- Create a new operation and name it Ocog_elevation.
- We are going to compute the elevation of the OCOG retracker using two fields combined.



2.1 Basic functioning



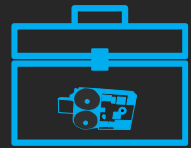
- After that, go to Advanced Operations tab:

The screenshot shows the brat software interface. The 'Operation' dropdown is set to 'Ocoog_elevation'. The 'Fields' list includes 'range_ocean_qual_20_ku' and 'range_oceg_20_ku'. The 'Data Expressions' table shows 'OCOG_elevation' with a 'count' unit. The 'Data' field contains the expression 'alt_20_ku - range_oceg_20_ku'. The main window displays a world map with a red line indicating the OCOG retracker path. The 'Output' window shows a successful execution log.

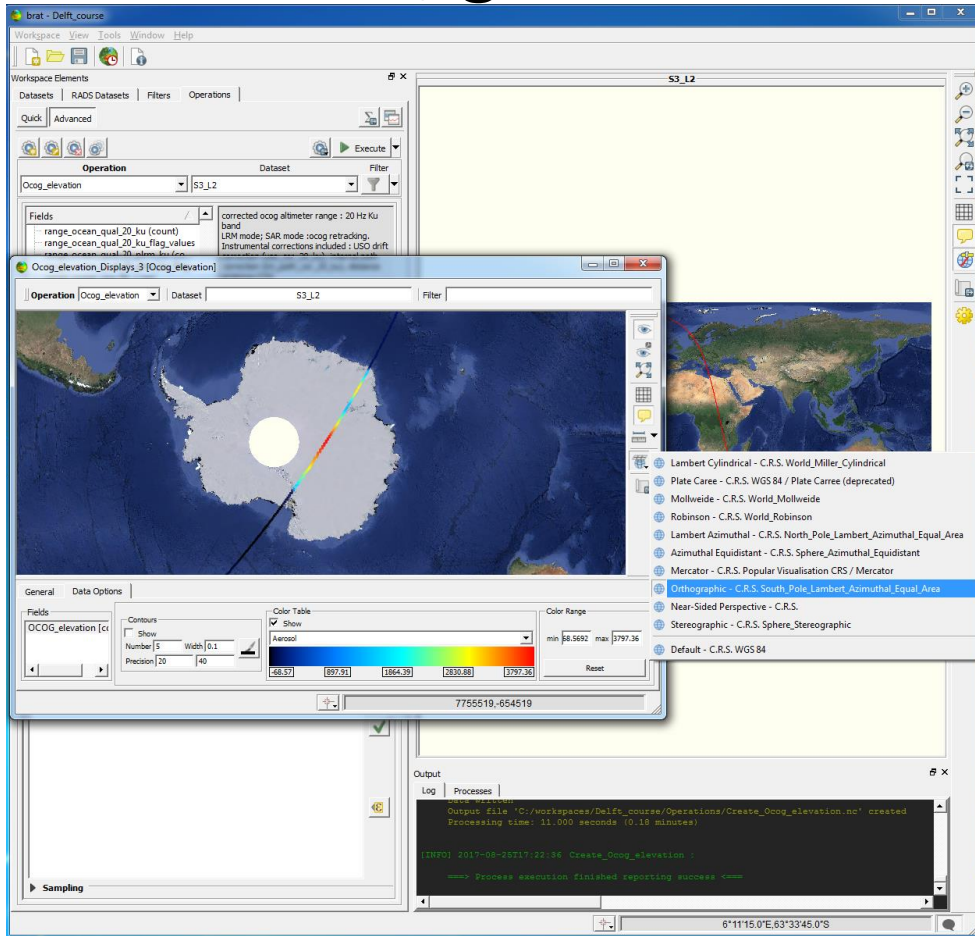
- Create a new operation and name it Ocoog_elevation.
- We are going to compute the elevation of the OCOG retracker using two fields combined.
- Create a new empty expression and name it “OCOG_elevation”
- Write in the bottom “alt_20_ku - range_oceg_20_ku”. You can check the syntax and assign it to the expression



2.1 Basic functioning



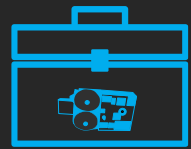
- After that, go to Advanced Operations tab:



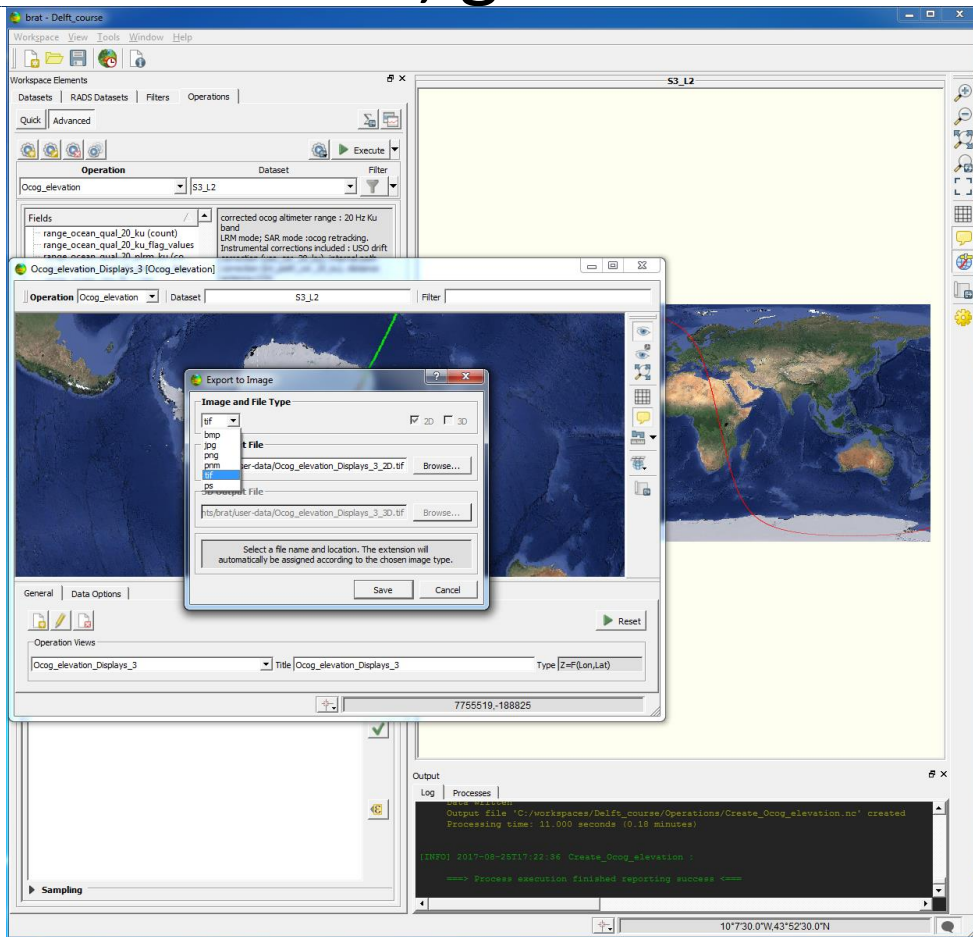
- Press Execute to get the map plot.
- The projection can be changed if needed.



2.1 Basic functioning



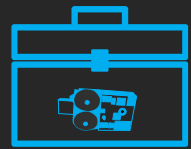
- After that, go to Advanced Operations tab:



- Press Execute to get the map plot.
- The projection can be changed if needed.
- Save the plot as jpg.



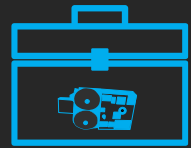
Contents



1. BRAT project
- 2. Along-track data**
 - 2.1 Basic functioning
 - 2.2 Advanced features**
3. Gridded data
4. Wind and waves
5. Waveforms



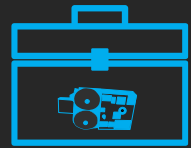
2.2 Advanced features



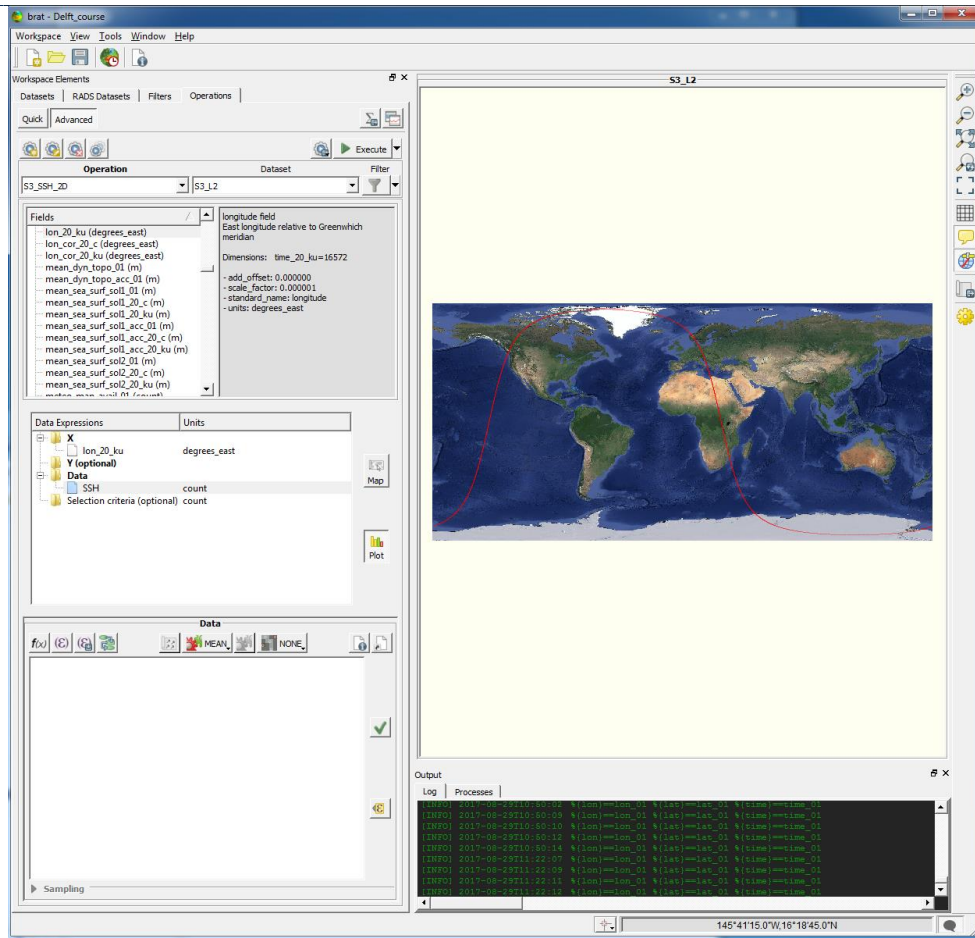
- Add formulas
- Export
- Filter
- Smooth



2.2 Advanced features



• Add formulas

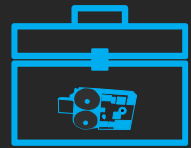


- Apart from dealing with fields included in the input product files, the toolbox allows you to include new expressions and formulas.

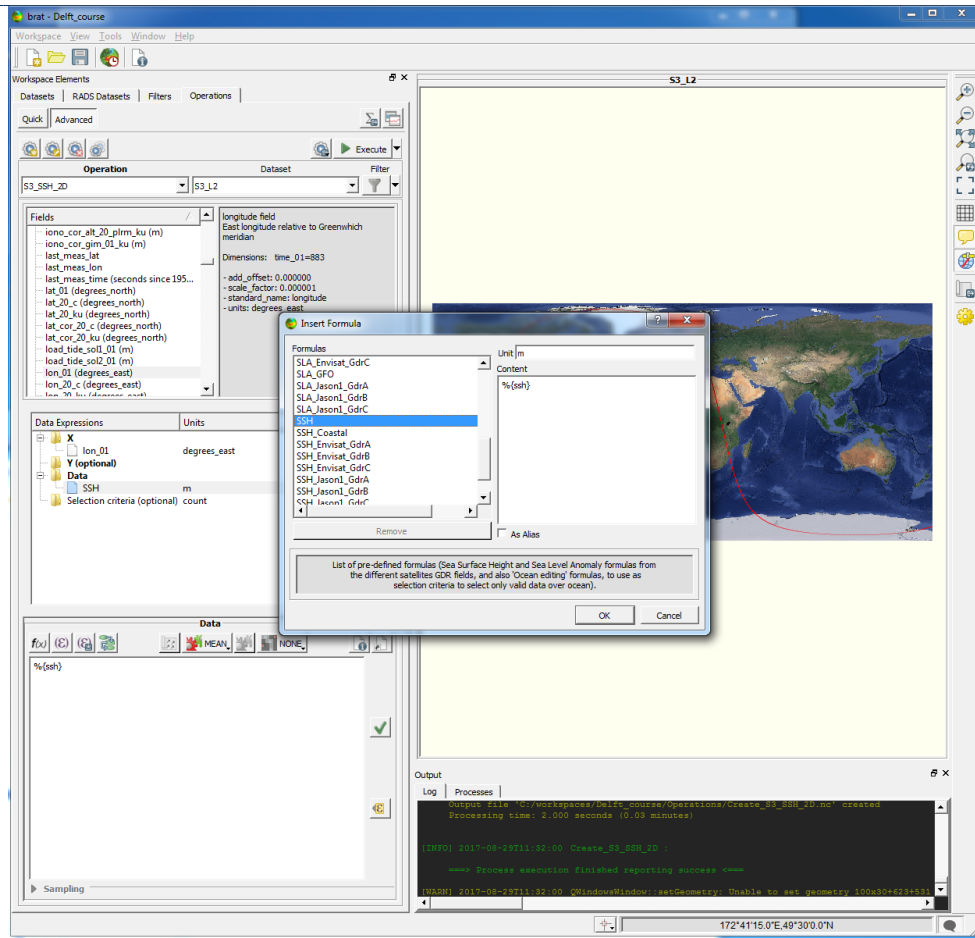
1. Create a new operation ("S3_SSH_2D"). This time, only with longitude ('lon_01') in the X expression.
2. Click on *Data*, then *Insert empty expression* and call it "SSH".



2.2 Advanced features



• Add formulas



3. Then, click on insert formula. A box pops up. Scroll down and select “SSH”.

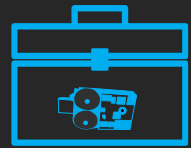
• You can analyse the expression that appears in the Log after pressing execute,

“Expression :”

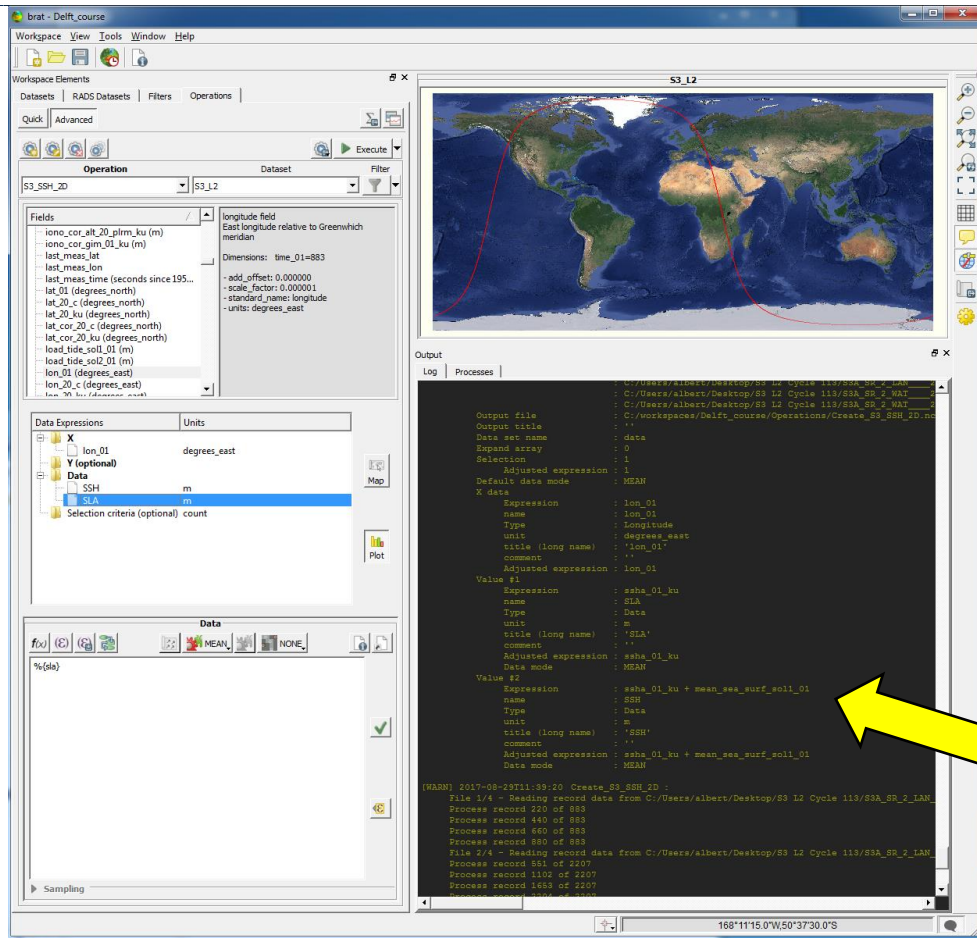
It will vary depending on the mission being inspected.



2.2 Advanced features



• Add formulas



5. Before executing, create another empty expression called “SLA” and insert the “S3_SLA_2D” formula.

Now click on *Execute*.

- You can find the expressions used for these formulas on the Log, or open the

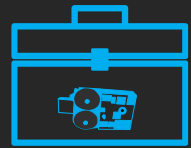
SSH = “ $ssha_01_ku + mean_sea_surf_sol1_01$ ”

- SLA = “ $ssha_01_ku$ ”.

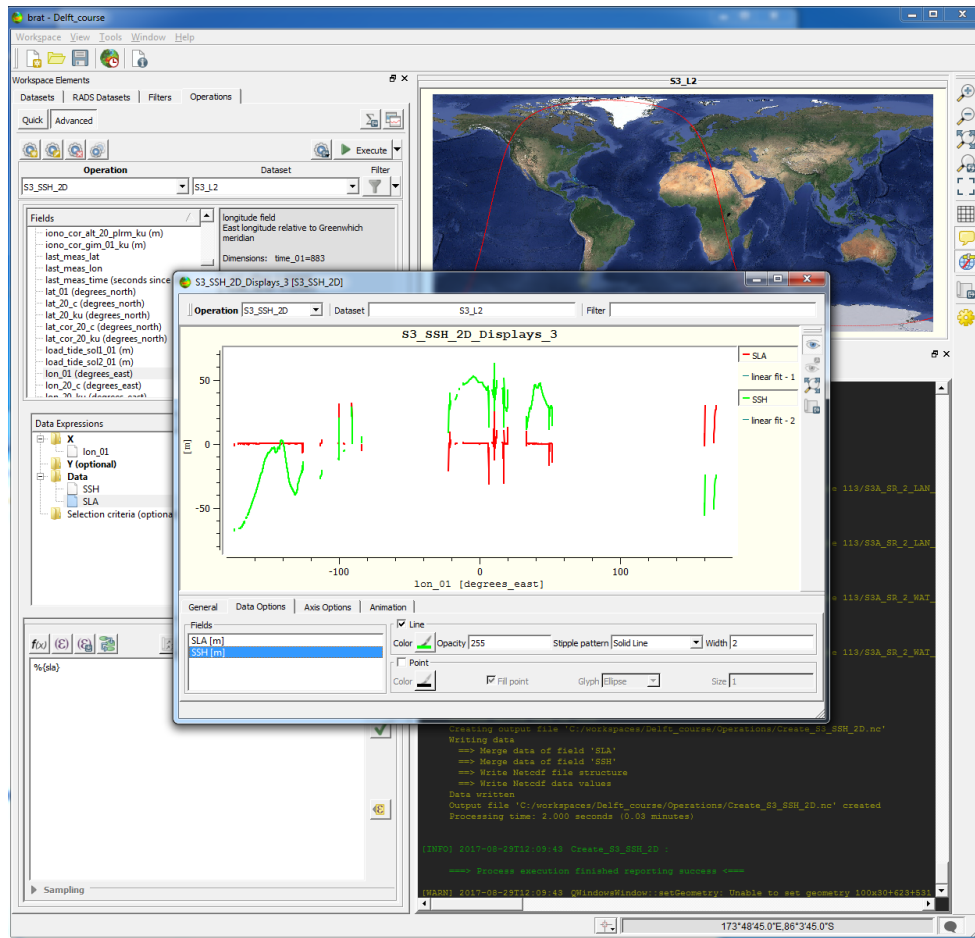




2.2 Advanced features



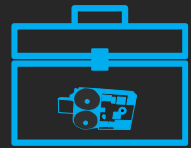
- Add formulas



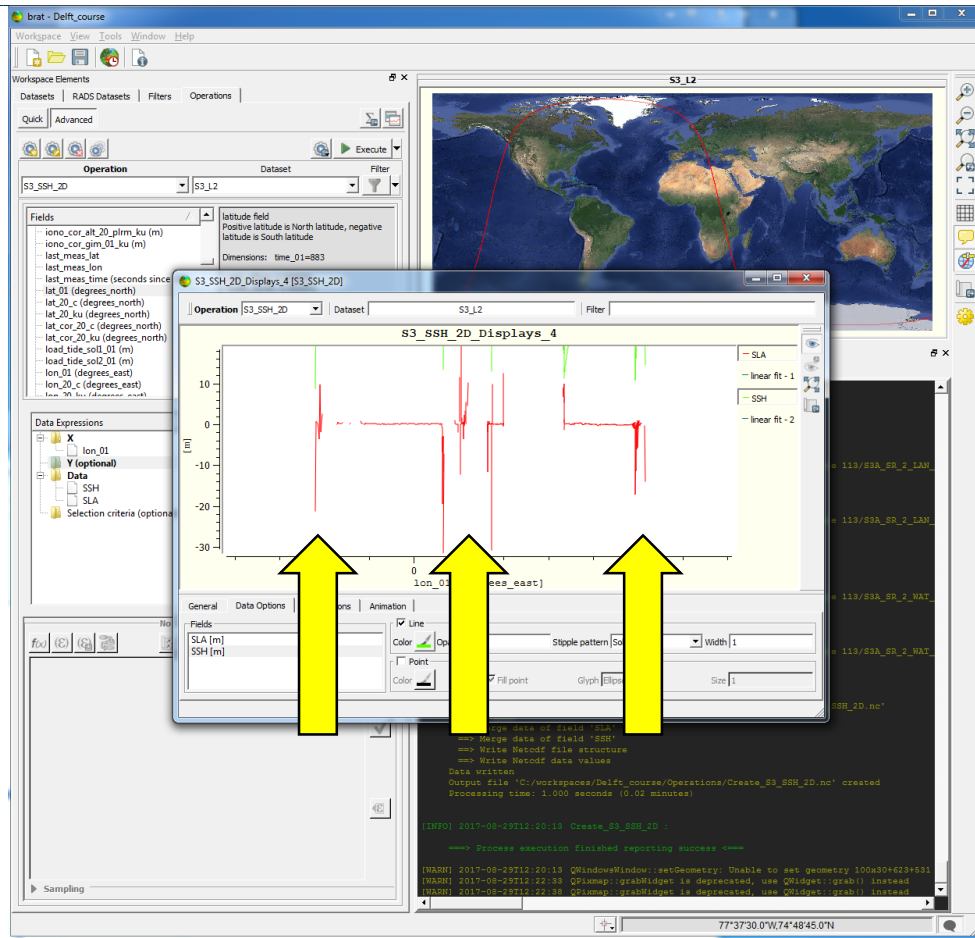
7. Take a look at the plot.
8. SSH is in green and SLA in red. Use the options on the right to thicken the curves, change colour, etc.
9. Observe the strange behaviour with the SLA?
 - What might have caused this?



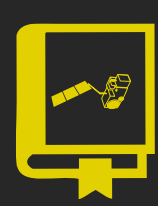
2.2 Advanced features



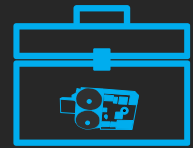
- Add formulas



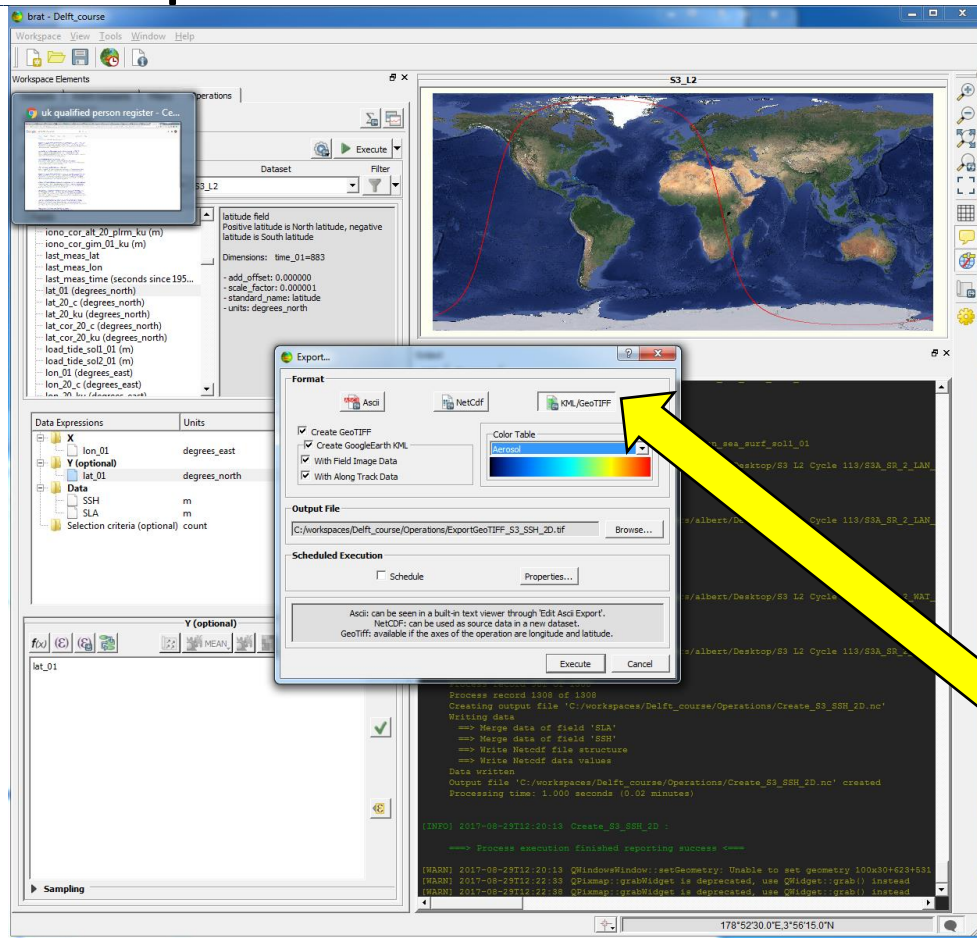
7. Take a look at the plot.
8. SSH is in green and SLA in red. Use the options on the right to thicken the curves, change colour, etc.
9. Observe the strange behaviour with the SLA?
 - What might have caused this?



2.2 Advanced features



• Export



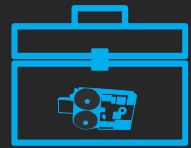
- Usually, this is land contamination. But an ocean mask was already applied.
- You can do 2 things:

1. Plot S3 on Google Earth ("S3A_ground_track.kml")
2. Export data into a KML file and visualise it in Google Earth as well.

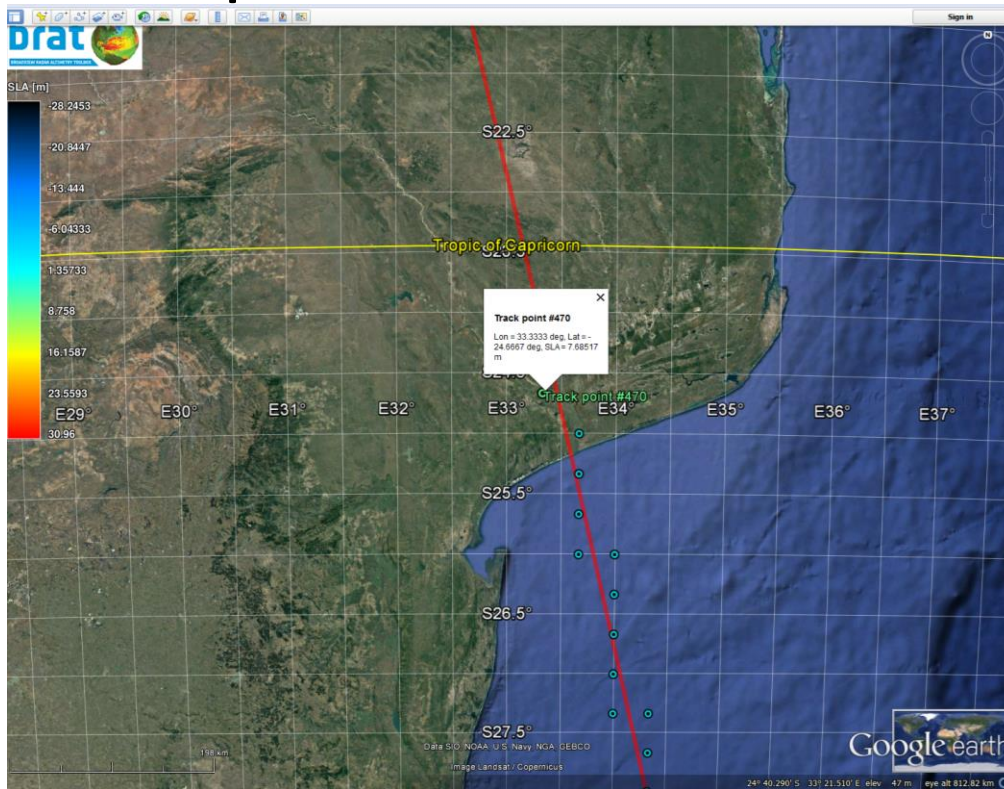
For this, go to Operations tab and go to the export button (the KML option will need to have lat and lon in the data expressions to be enabled).



2.2 Advanced features



- Export

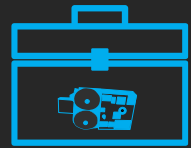


1. Go to your workspace folder and visualise in Google Earth the generated KML file:

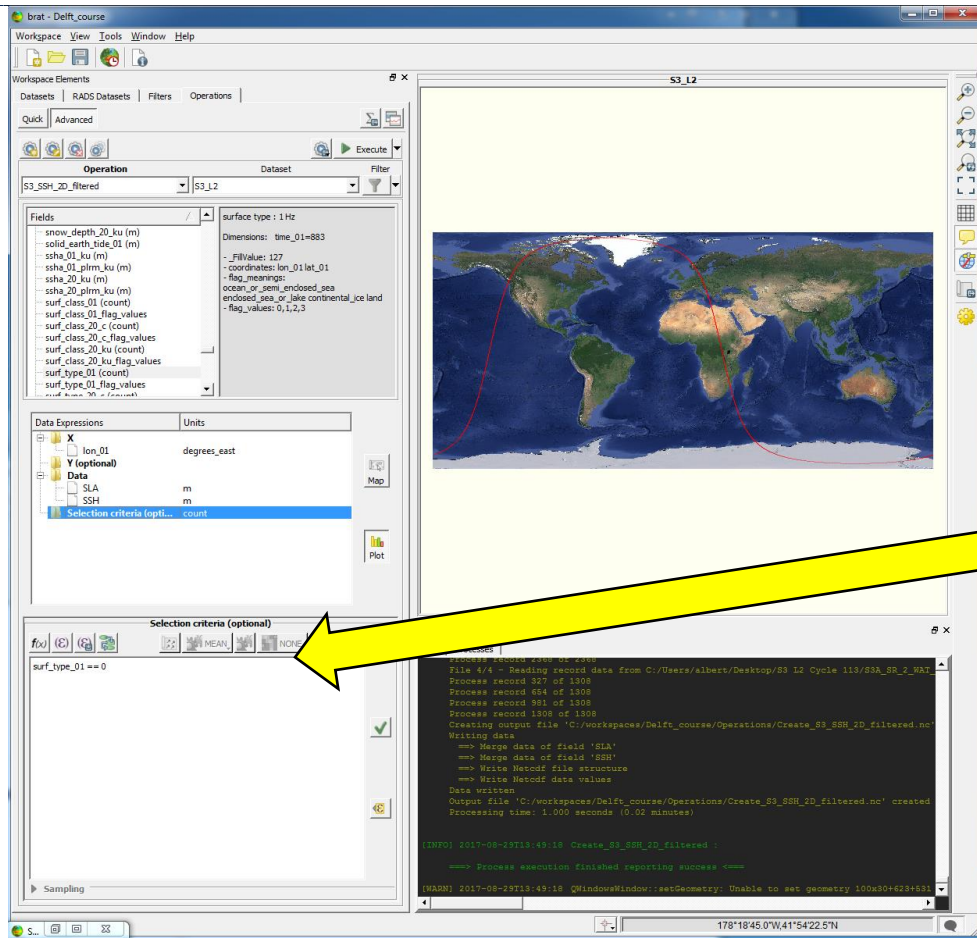
```
../Operations/ExportGeoTIFF_S3_SSH_2D
```
2. Observe that all the measurements over water bodies or ice sheets are related with the jumps in SLA.



2.2 Advanced features



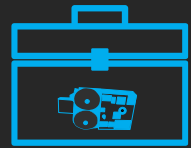
• Filter



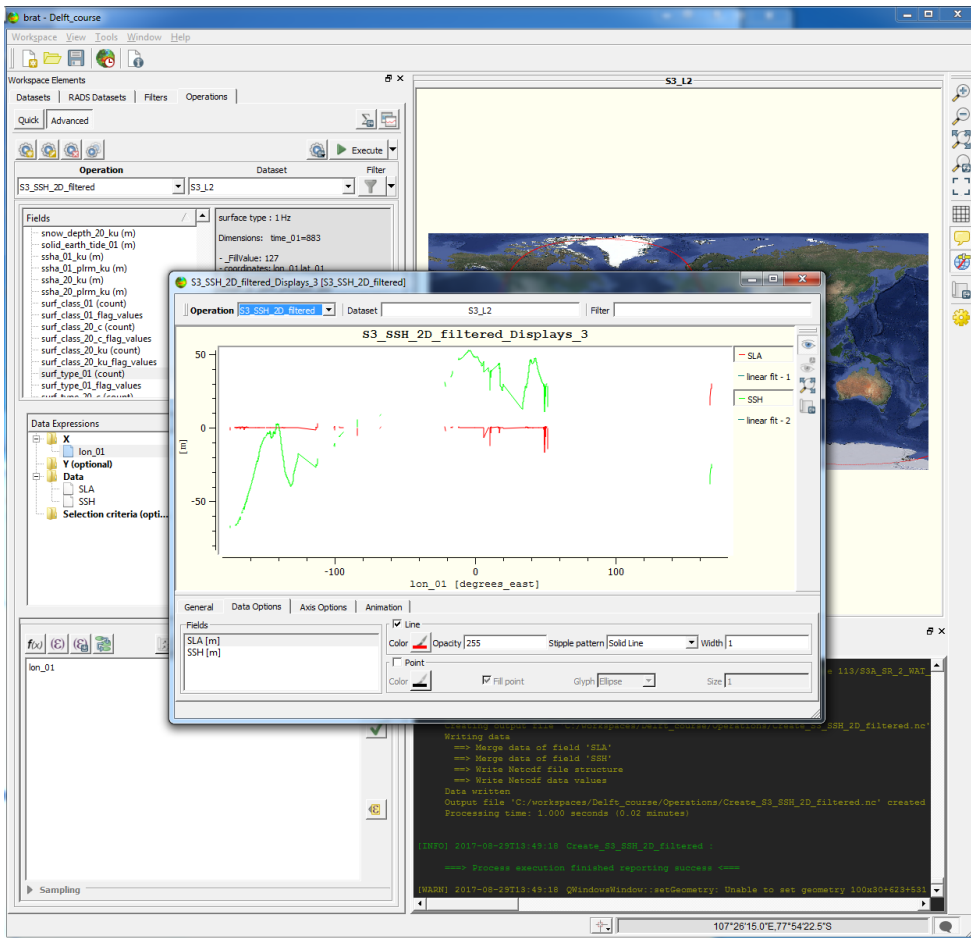
- However, this can be solved by editing the *Selection criteria*.
1. Duplicate “S3_SSH_2D” and add “_filtered” at the end.
 2. Drag ‘surface_type’ into the *Selection criteria* box. Find the information inside the variable to know the its value for ocean surfaces. Then type ‘==[the_value]’.



2.2 Advanced features



- Filter

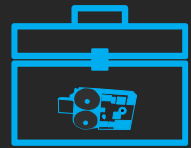


- Also, there is a predefined, more complete formula for this filtering that could be used as well.

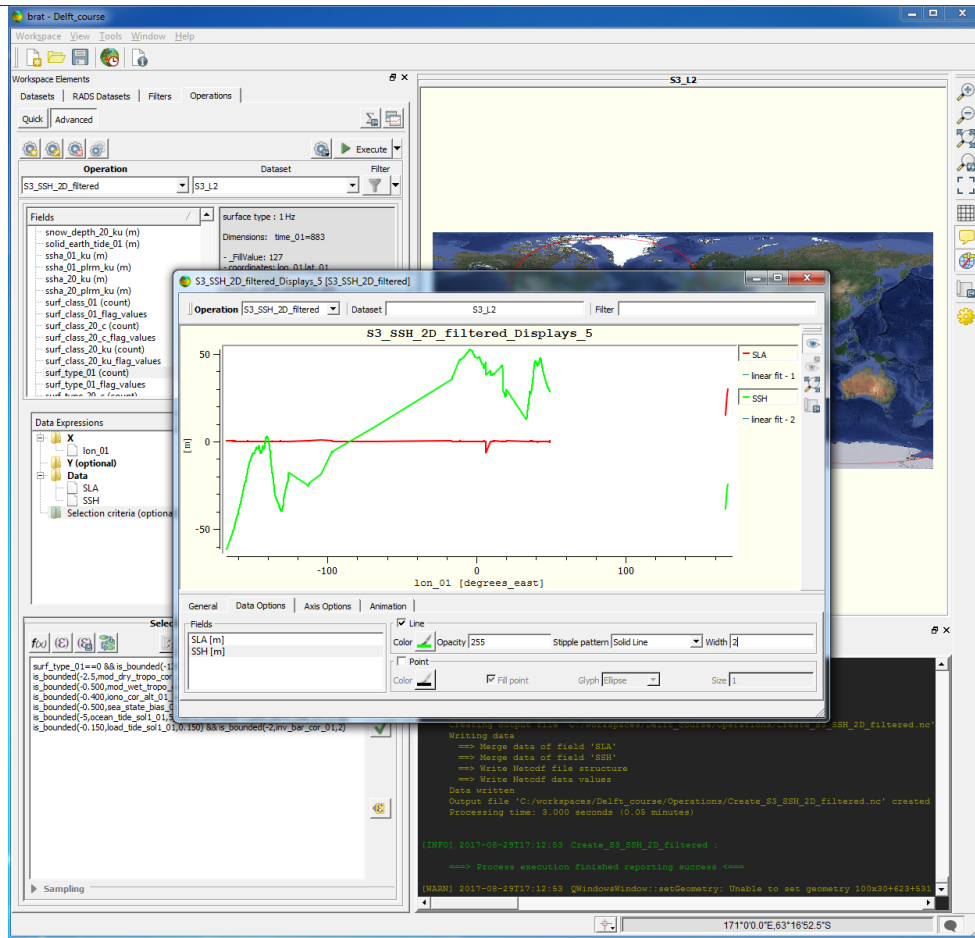
3. Press *Execute* and generate a new view with both the original SLA values and the edited ones.



2.2 Advanced features



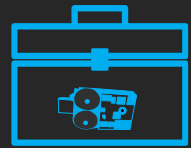
- Filter



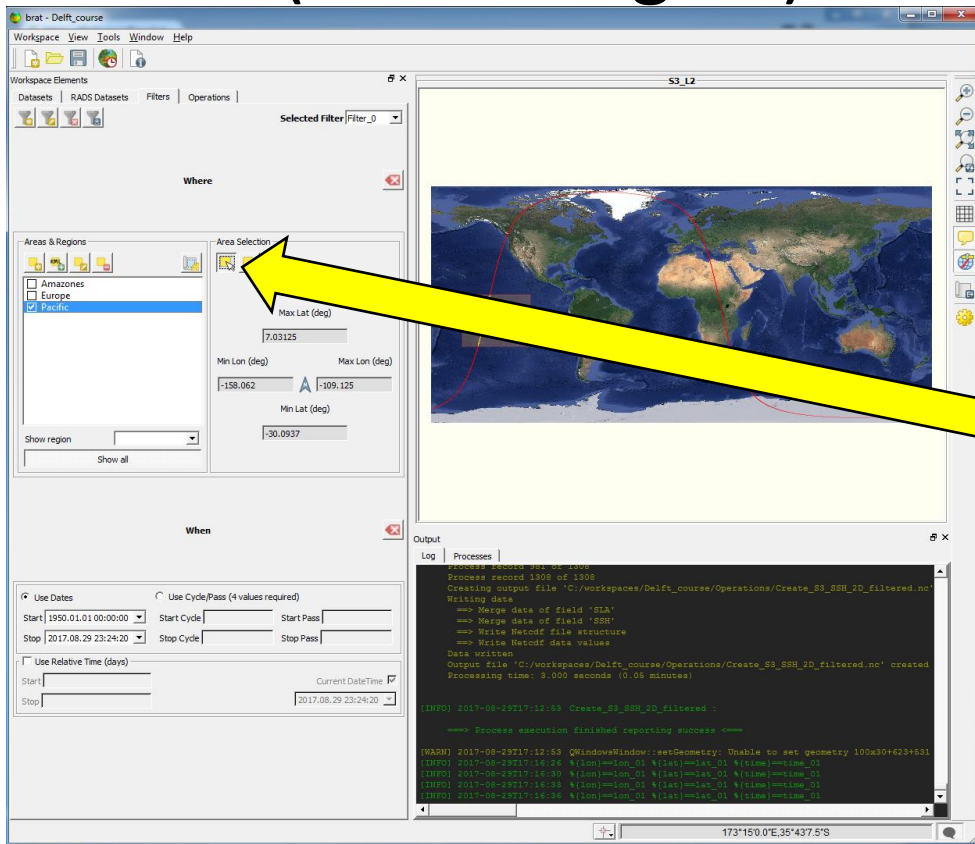
- Also, there is a predefined, more complete formula for this filtering that could be used as well (“Ocean data editing Sentinel3”).
- 3. Press *Execute* and generate a new view with both the original SLA values and the edited ones.
- Results improve a lot, even though a marginal error remains.



2.2 Advanced features



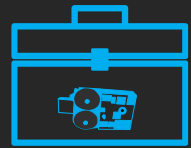
- Filter (draw a region)



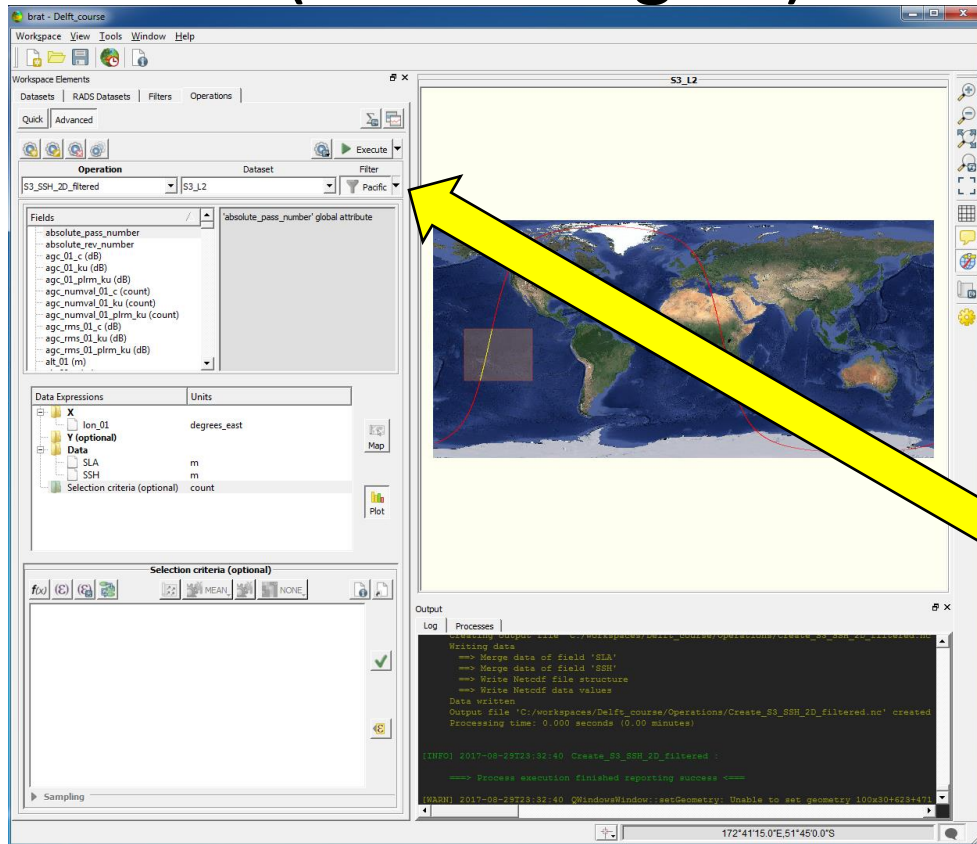
- On the Filters tab, a geographical mask can be defined to select only regions from a region of interest
- 3. Create a new Filter and add it to the list.



2.2 Advanced features



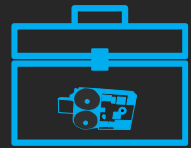
- Filter (draw a region)



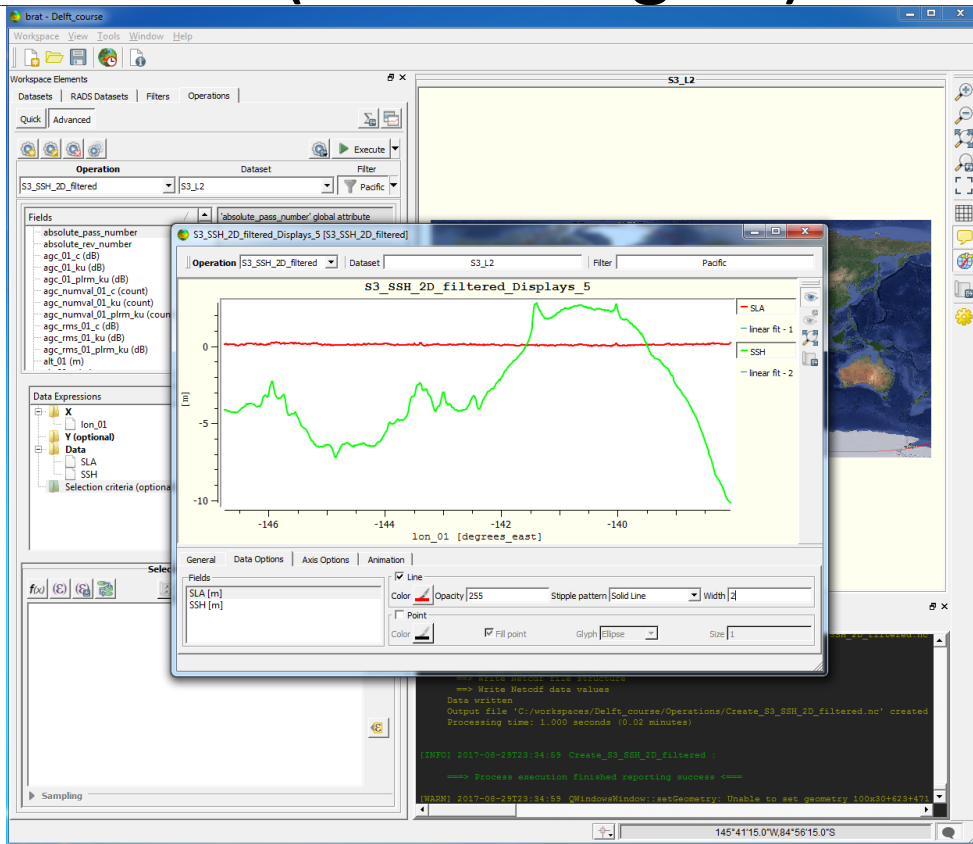
- On the Filters tap, a geographical mask can be defined to select only regions from a region of interest
- 3. Create a new Filter and add it to the list.
- 4. Activate the filters on the filter list and execute.



2.2 Advanced features



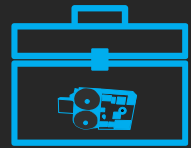
- Filter (draw a region)



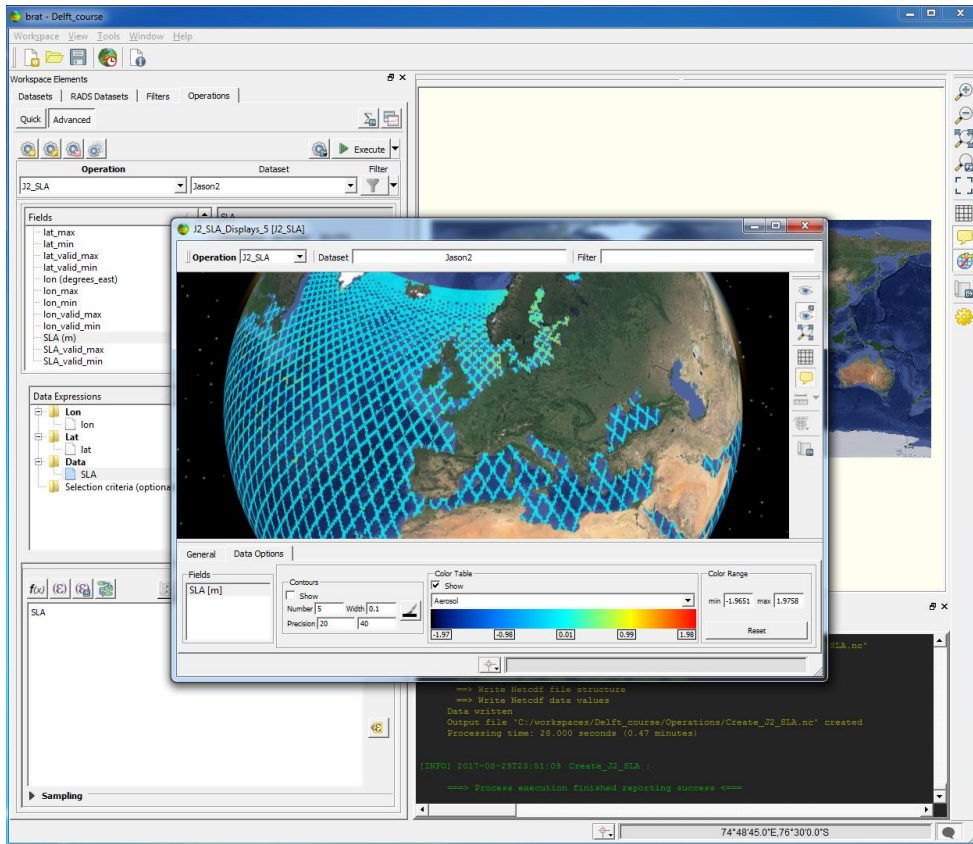
- On the Filters tap, a geographical mask can be defined to select only regions from a region of interest
- 3. Create a new Filter and add it to the list.
- 4. Activate the filters on the filter list and execute.



2.2 Advanced features



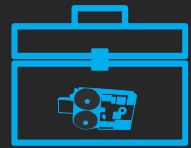
- Smooth



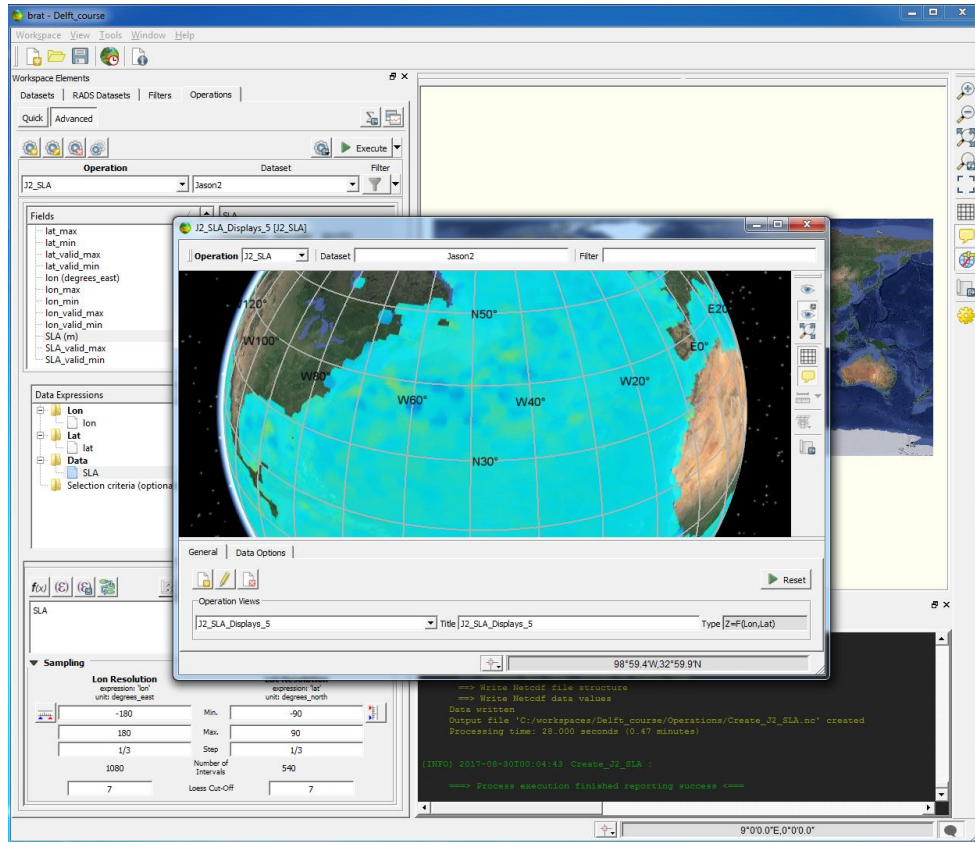
1. Create a new dataset with a whole cycle (“J2_240_edit.nc”)
2. Create a new operation with longitude / latitude and the SLA.
3. Play with the map zooming and change from 2D to 3D on the right in order to visualise smaller changes in SLA. Find the areas with lower/higher variability.



2.2 Advanced features



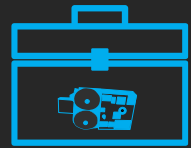
- Smooth



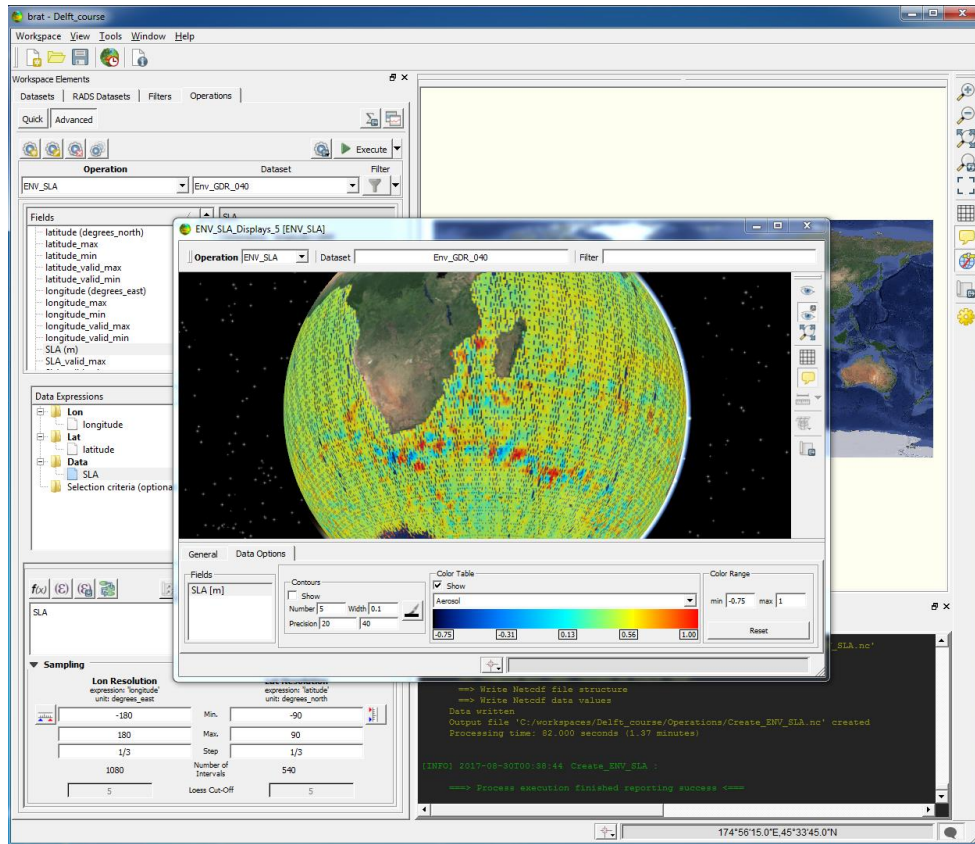
3. You can also obtain a full-coloured map (not just tracks) applying the Loess filter before executing the operation.
4. However, Jason-2 tracks are not close enough to get a good result and you will get a low resolution map with too much interpolated data.
5. Try other filter options.



2.2 Advanced features



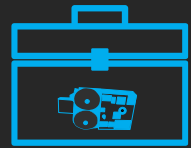
- Smooth



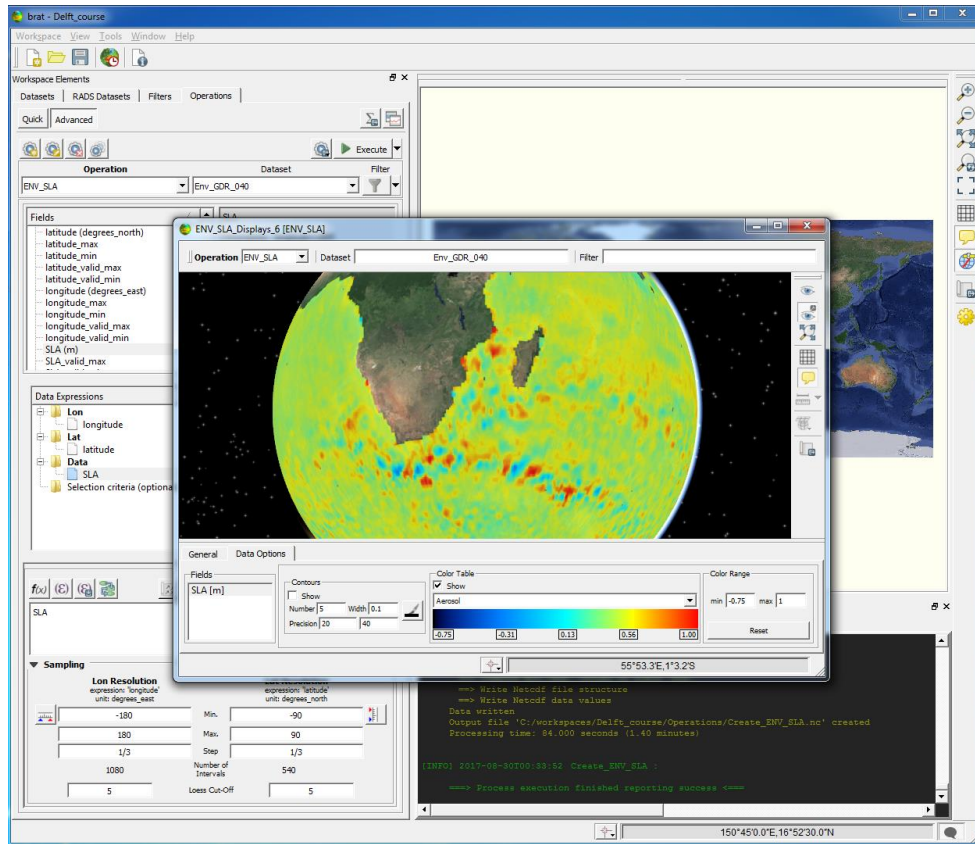
6. Now create a new dataset and load the following file: "Env_GDR_040". This is an example available in the BRAT website. Visualise it.



2.2 Advanced features



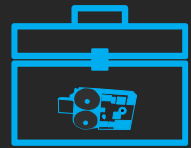
- Smooth



6. Now create a new dataset and load the following file: "Env_GDR_040". This is an example available in the BRAT website. Visualise it.
7. Now do the same and add the Loess cut-off filter with values set to 5. Reduce SLA range to [-0.75, 1] and you should get a map like the one shown here.



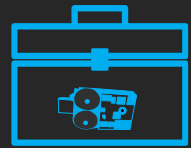
Contents



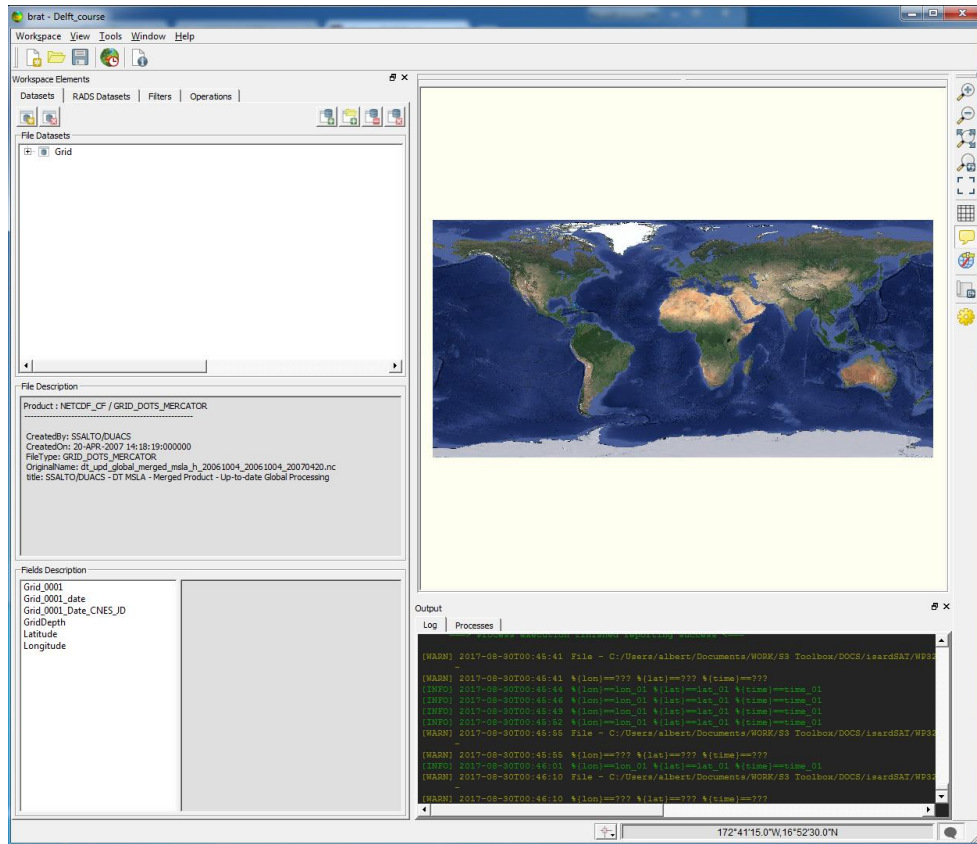
1. BRAT project
2. Along-track data
- 3. Gridded data**
4. Wind and waves
5. Waveforms



3. Gridded data



- Mean and standard deviation

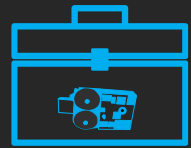


- Gridded data are the result of converting altimeter measurements (individual tracks), that can come from different missions, into a regular grid of calculated, hypothetical values.

1. Create a new dataset by clicking on *Add Dir...* and choose “/Grid/”. These data is also available in the BRAT website.

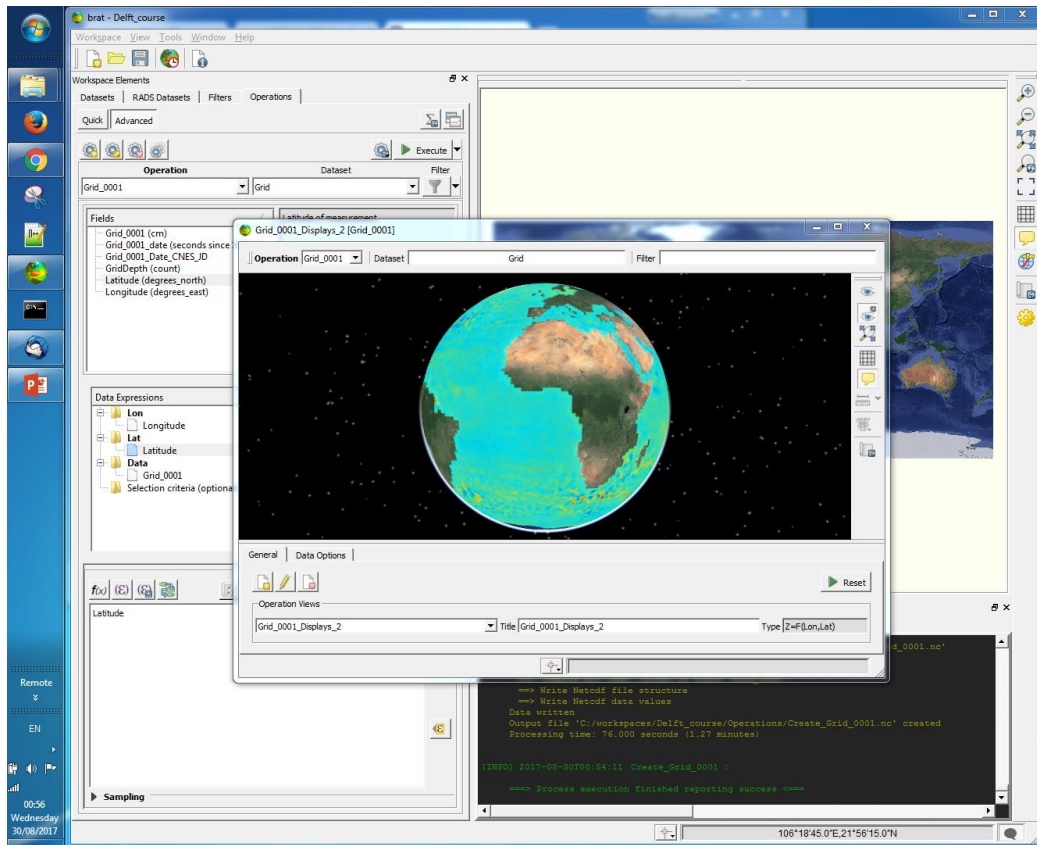


3. Gridded data



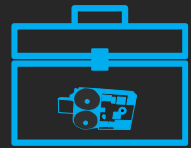
- Mean and standard deviation

- These 4 files that contain pre-computed SLA over a year.
- 2. Create a 3D operation with longitude, latitude and 'Grid_0001(cm)' and visualise it.

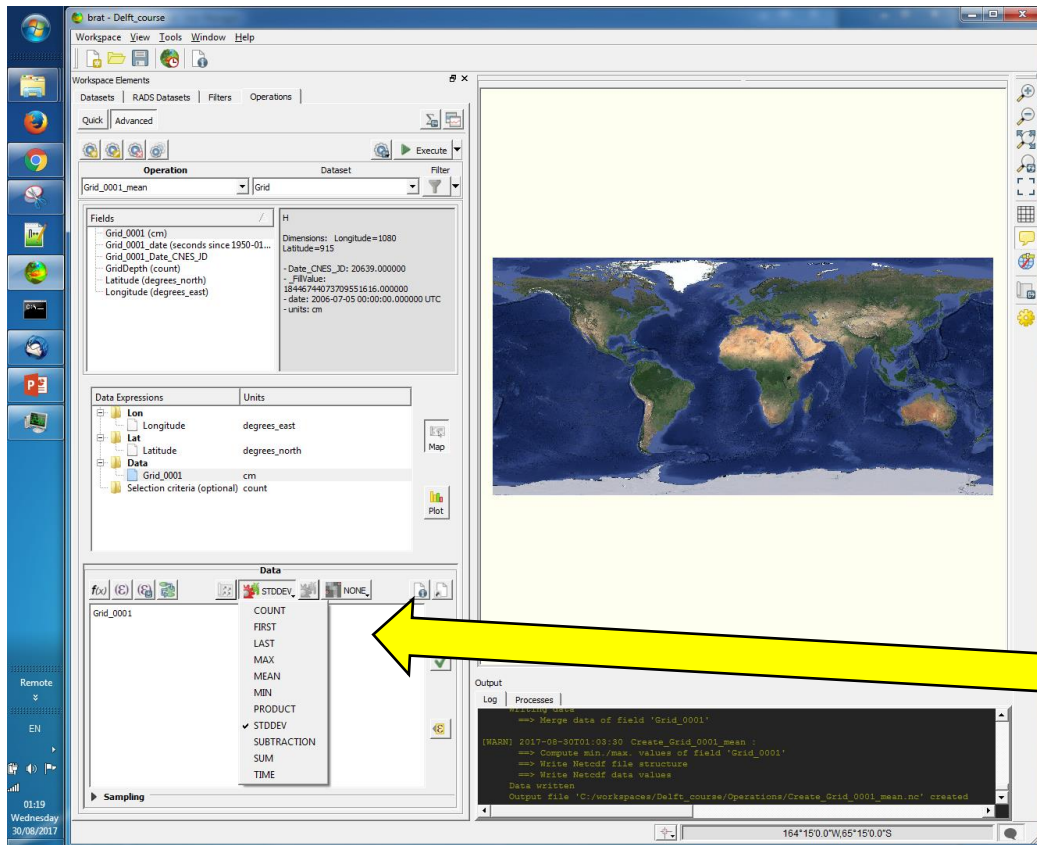




3. Gridded data



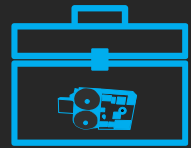
- Mean and standard deviation



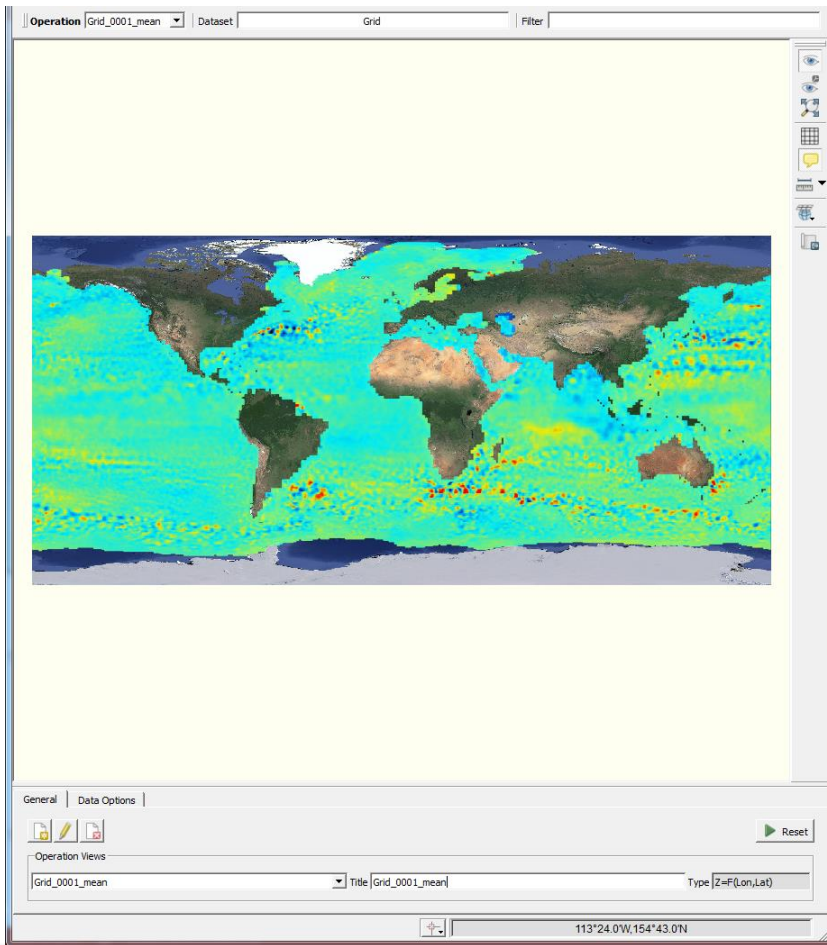
- These 4 files that contain pre-computed SLA over a year.
- 2. Create a 3D operation with longitude, latitude and 'Grid_0001(cm)' and visualise it.
- 3. After that, go back to the Operations tab and select STDDEV instead of MEAN. This will create the standard deviation of the input files. Visualise it too.



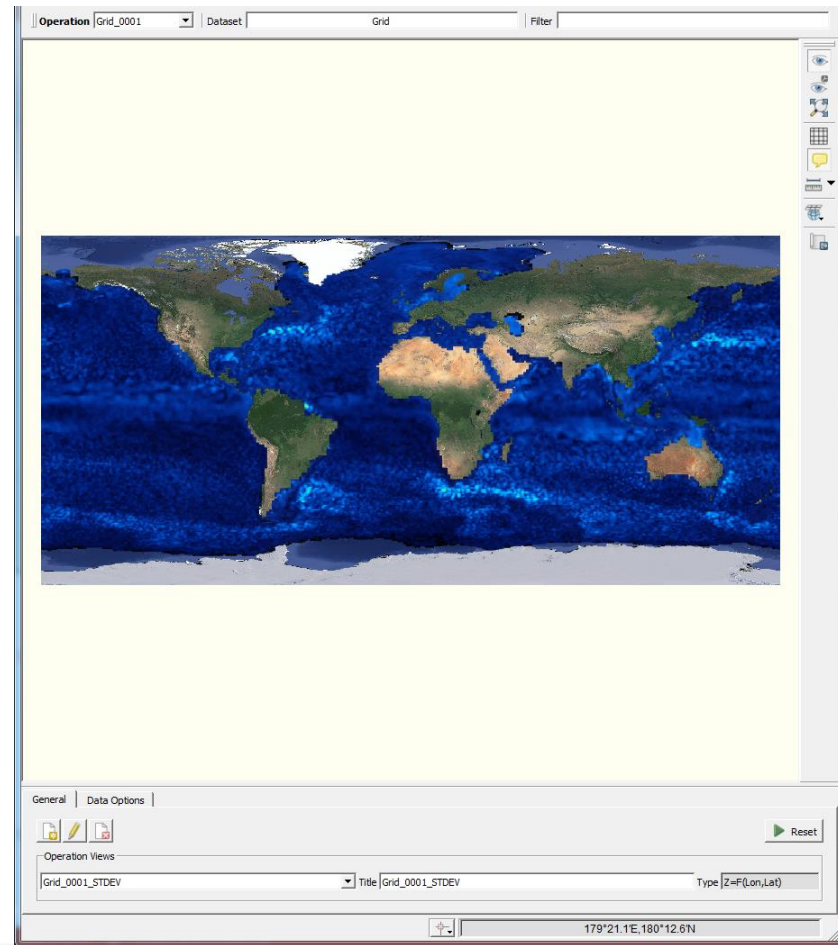
3. Gridded data



Mean

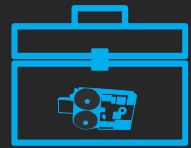


Standard deviation





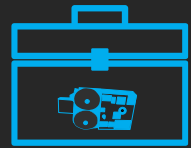
Contents



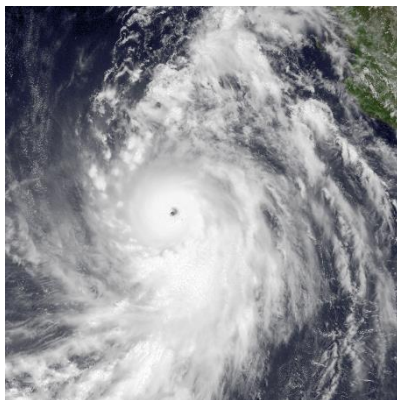
1. BRAT project
2. Along-track data
3. Gridded data
- 4. Wind and waves**
5. Waveforms



4. Wind and waves



- Hurricane Marie



Saffir-Simpson hurricane wind scale

Category	Wind speeds
Five	≥ 70 m/s, ≥ 137 knots ≥ 157 mph, ≥ 252 km/h
Four	58–70 m/s, 113–136 knots 130–156 mph, 209–251 km/h
Three	50–58 m/s, 96–112 knots 111–129 mph, 178–208 km/h
Two	43–49 m/s, 83–95 knots 96–110 mph, 154–177 km/h
One	33–42 m/s, 64–82 knots 74–95 mph, 119–153 km/h

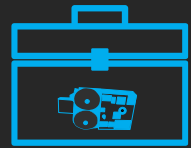


- In August 24-28 2014, Hurricane Marie hit the west coast of California and Mexico.
- It was classified as a Category 5 hurricane, since it reached peak sustained winds of 260 km/h.
- Bottom picture shows its track during this maximum-intensity 5 days.
- This hurricane was also observed with altimetry.

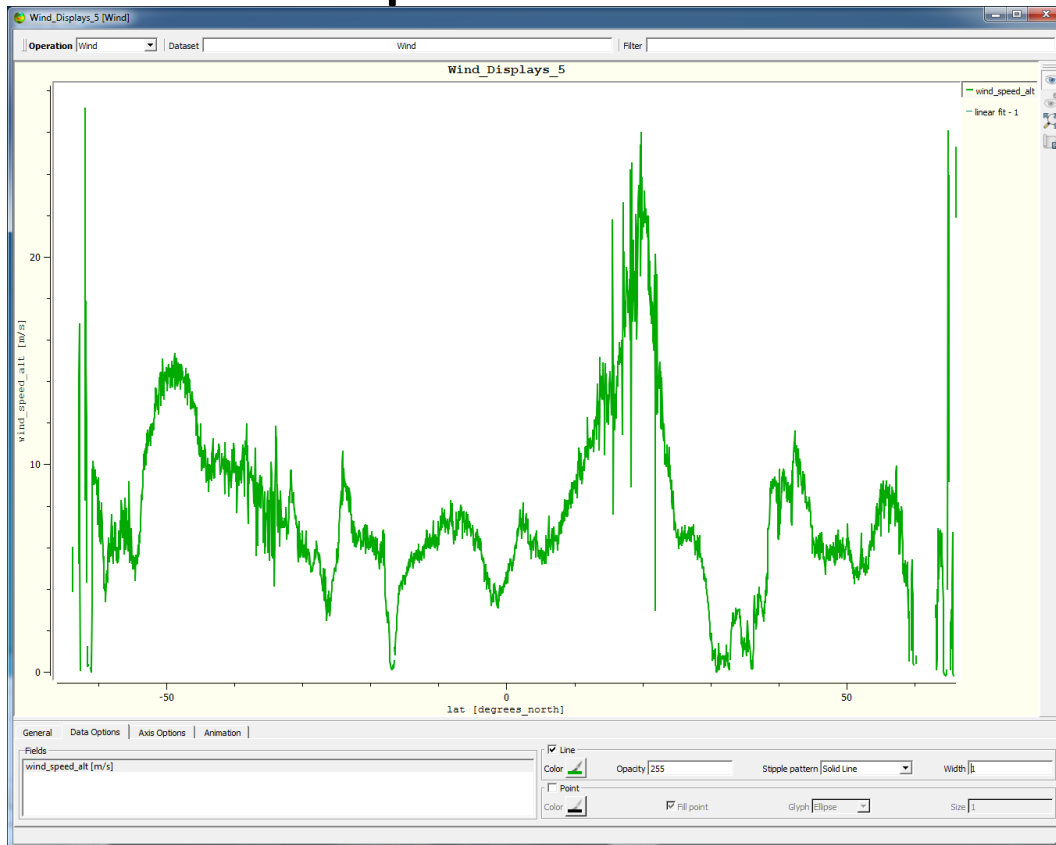
Image Source: Wikipedia



4. Wind and waves



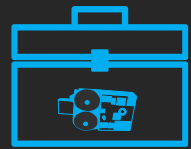
- Wind speed



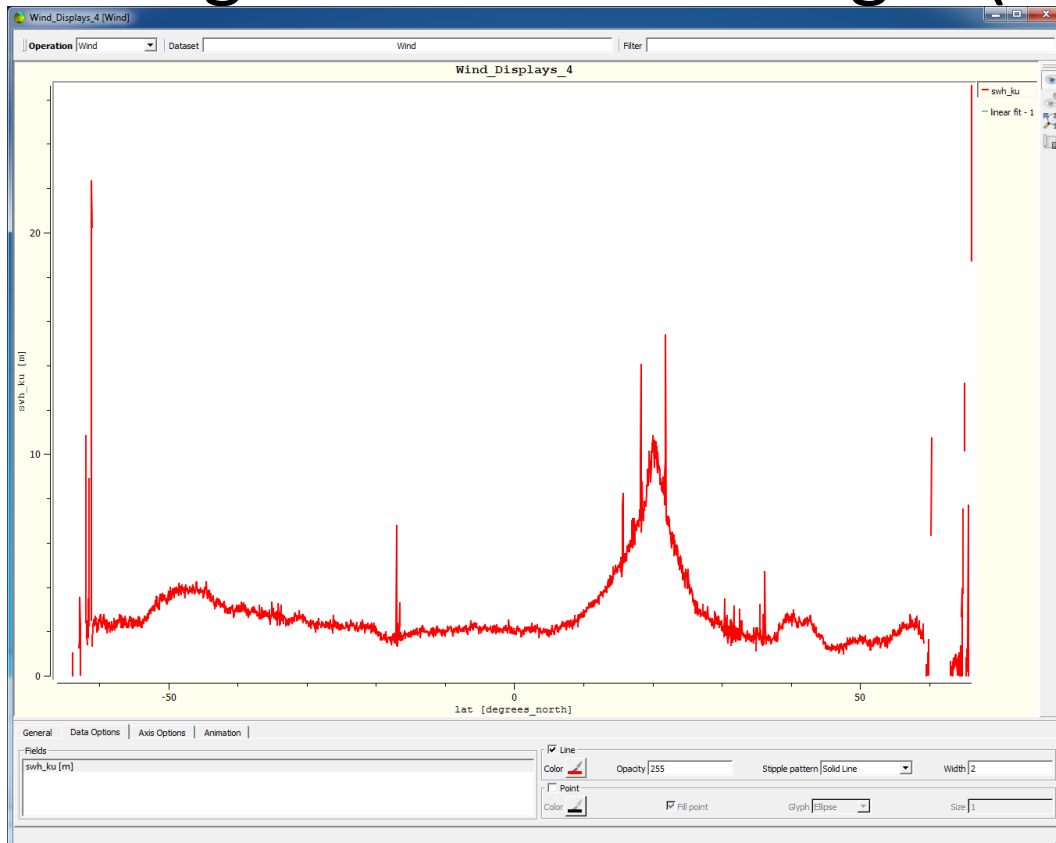
1. Load the file
“JA2_GPR_2PdP226_130_2014
0826_024007_20140826_0336
20.nc”.
2. Visualise the wind speed in a
2D plot. Up to almost 100
km/h were measured by
Jason-2.



4. Wind and waves



- Significant Wave Height (SWH)

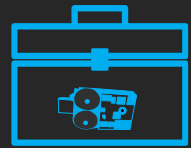


3. Now create another operation and visualise the SWH of the same file.

- The highest peaks could be outliers, but the satellite measured waves of more than 10 m.



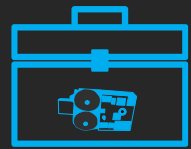
Contents



1. BRAT project
2. Along-track data
3. Gridded data
4. Wind and waves
- 5. Waveforms**



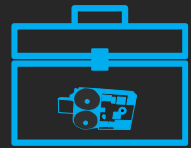
5. Waveforms



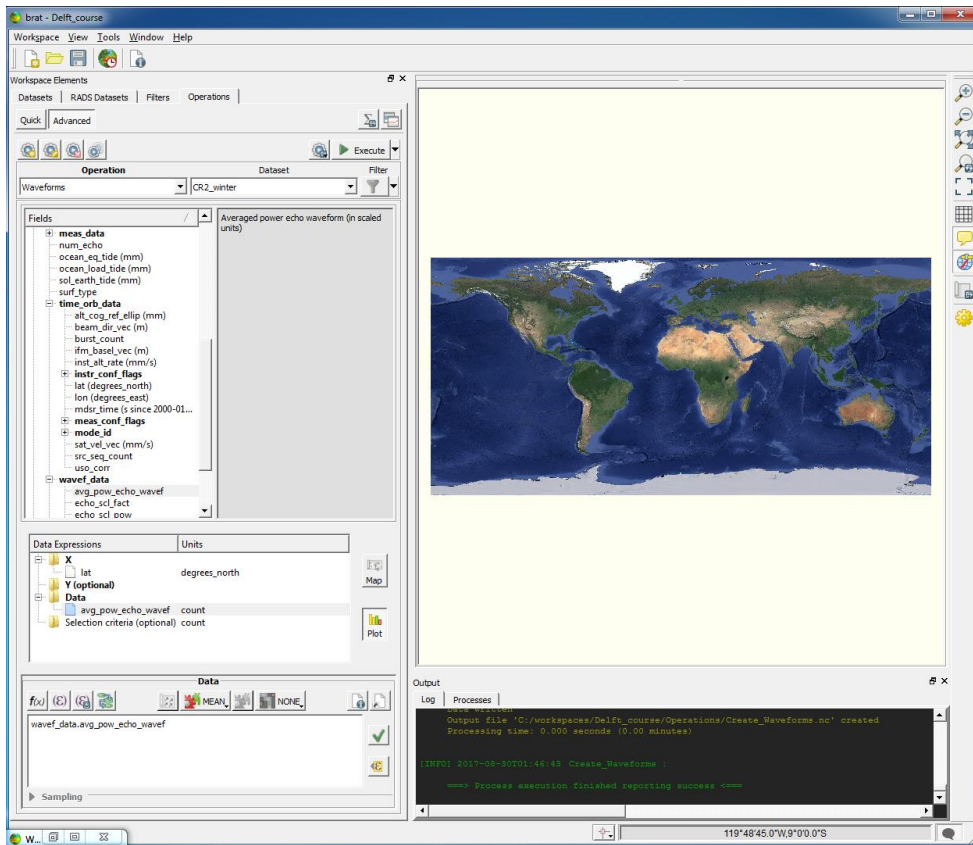
- Introduction
 - The toolbox also allows to go to almost the beginning of the processing of altimetry: waveforms.
 - Waveforms are the echoes that the altimeter receives back from the observed surface.
 - After L1B processing, retrackers are used to retrieve SSH, SWH, etc. from the resulting L1B waveforms.



5. Waveforms



- Winter-Summer variations in Qinghai lake

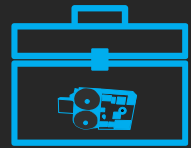


1. Create a new dataset with the CryoSat L1B file from February 2011 over the Qinghai lake, China.
2. Set 'lat' as X and 'avg_pow_echo_wavf' as Data from 'wavef_data' tree.
3. Execute. Change the "operation view" to Z=F(X,Y) on the bottom left.

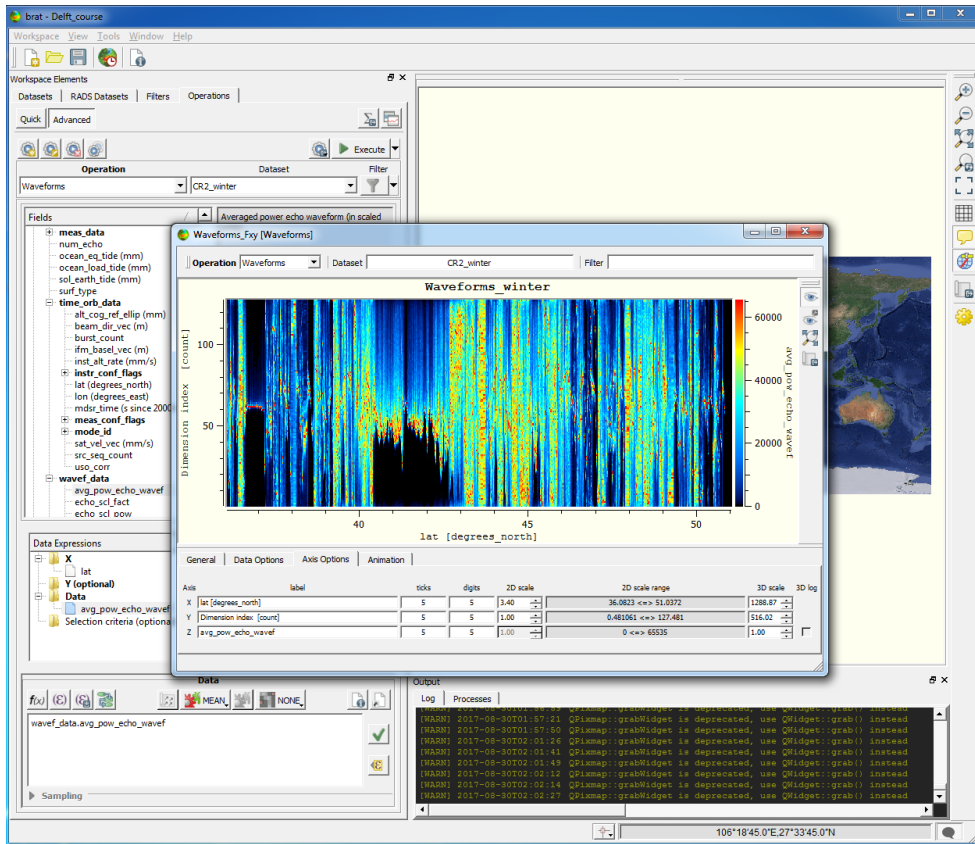
Image Source: USGS-Landsat 8



5. Waveforms



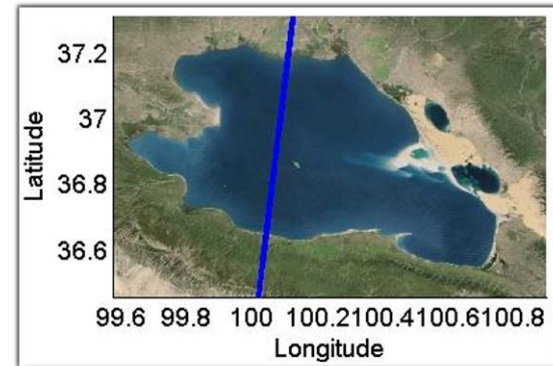
- Winter



1. Z=F(X,Y) view.

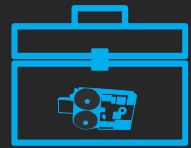
- You will see a lot of noise. This is due to land contamination.

2. Instead of adding a filter, now narrow the latitude range (see figure below).

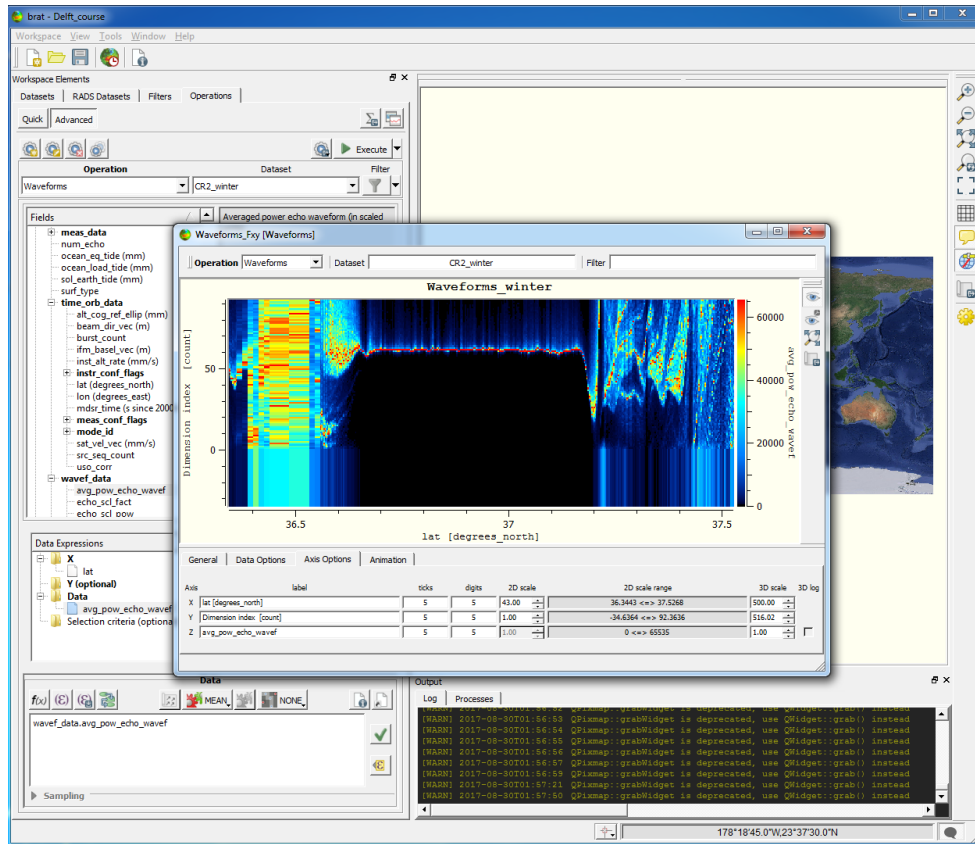




5. Waveforms



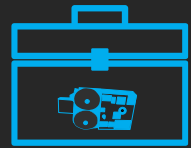
- Winter



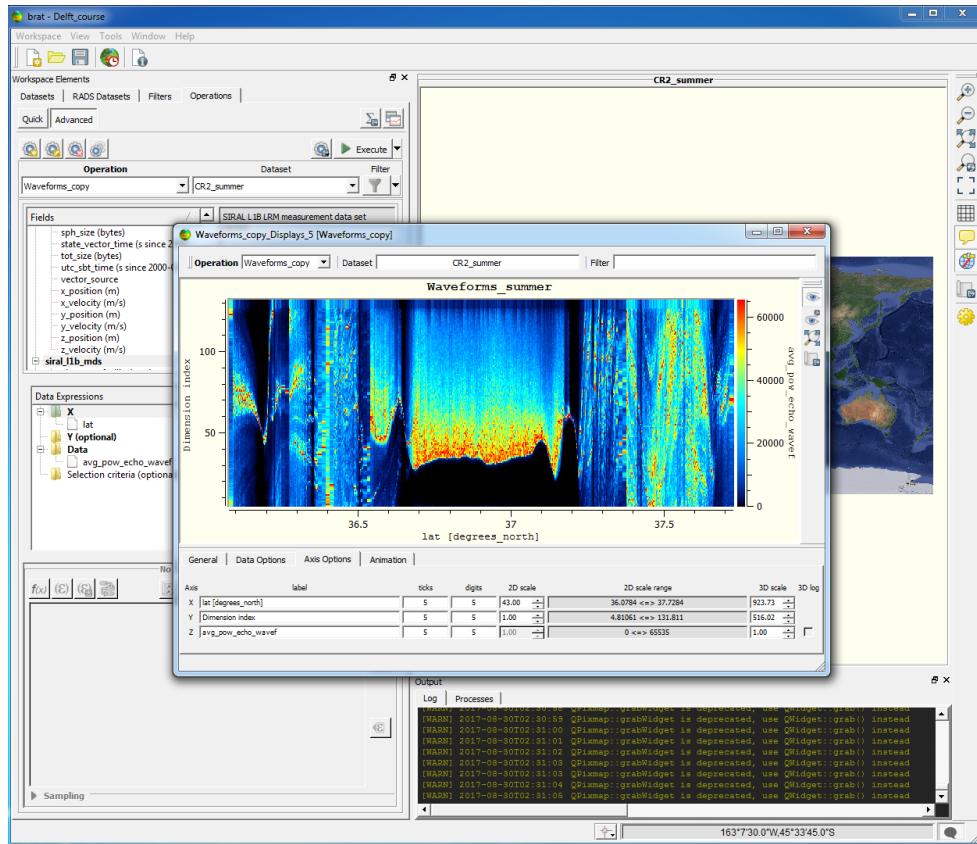
- The plot looks completely different now. Note that the waveforms are only a few samples long.
- This is because it is winter season and the lake is frozen. And frozen water is very specular.



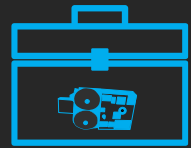
5. Waveforms



- Summer



- Now load the other CryoSat file (July 2011) and compare them.
- Here, it is summer. The lake is not frozen and the waveforms are not so short and have a smooth transition to 0.
- Note that there are only 8 waveforms in this plot. If you try to do the 2D plot, you will see a shape like the following one.



We appreciate your feedback.

Visit altimetry.info and stay
connected with us

