

ESA Remote sensing of the Cryosphere Training Course

Longyearbyen, 12th June 2018

Ice Surface Velocity using Optical Sentinel-2 Data

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Software:

CIAS image tracking tool - to produce velocity maps

QGIS - view results and compare datasets

Data:

Sentinel-2: Two tiles from early April 2017

Tile: 35XMJ

Relative orbit: R138

Dates:

02/04/2017, 12/04/2017

Aim of practical:

Use CIAS to produce displacement maps between two optical images in an image pair.

Convert the raw displacement into velocity and visualise the data in QGIS.

If there is time compare these velocity maps with those produces from SAR.

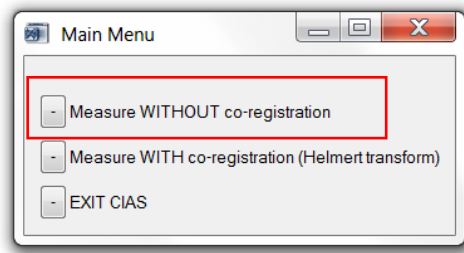
Running CIAS on the IDL VM

For additional information about using CIAS, open the CIAS info webpage

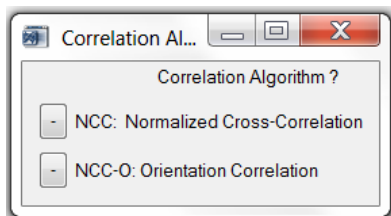
<http://www.mn.uio.no/geo/english/research/projects/icemass/cias/>

- Once the IDL VM is installed, open CIAS and find the CIAS.sav file. Double click on it and CIAS will open automatically.
- The CIAS dialogue box shall open and if you are ready to continue to the tracking then accept and start CIAS
- You will be asked immediately to choose the first image you wish to choose in the image pair for tracking. Note that an information pop up window will also appear giving some information about CIAS.
- A second pop-up window will appear asking to select the second image in the image pair to be used in tracking. Note to select the images in ascending time order with the older of the two images in the pair being selected first.

- Next you will be asked if you want to co-register the image pairs. As we are using images from the same satellite sensor and the same scenes from the same orbit, only separated by time, we will proceed without co-registration as they should have exactly the same viewing geometry.

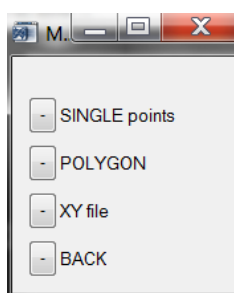


- After this a pop-up will ask which tracking algorithm you wish to use. Whilst there are numerous algorithms out there for optical template matching/feature tracking, CIAS has two tried and tested algorithms you can choose from, NCC and NCC-O.

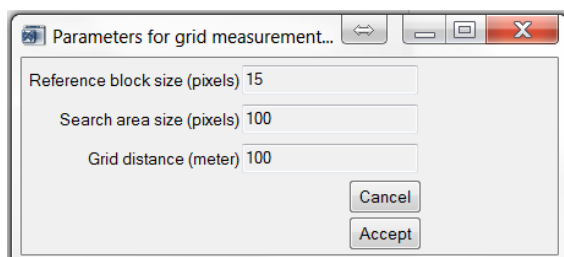


TIPS and QUESTIONS: Try to produce velocity estimates with both NCC and NCC-O and try to see which algorithm performs better overall. Does one algorithm work better than the other? If so are there any patterns or areas on the glacier where one outperforms the other? Can you think of any reasons why this might be?

- Once you have decided on your choice of algorithm, a pop-up asking for the area over which you wish to run your algorithm. At this stage choose the POLYGON option.



- A pop-up will ask you to choose the parameters of the tracking. The default settings are shown below. See the hints and questions section below for more details on these settings.



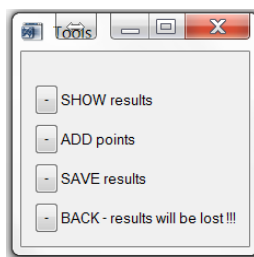
TIPS and QUESTIONS: As well as trying different algorithms as mentioned above, more importantly choosing different parameters for the tracking algorithm is the first thing you should try to establish. Refer back to the lecture this morning to see what changing the reference block size (also known as template size or reference chip) does to the results. Similarly look at this for the search area size too. The search area size is less important for the result, however the search area size must always be larger than the reference block size (see lecture).

A useful tip for the grid distance (also known as the grid spacing) is that when you are testing different options use a larger grid spacing as it will go faster!

Try different settings for the reference block size and see what effect this has.

Are the settings the same for different areas on the glacier? Do some parameters work best in some areas over others? Is there a setting which works best for both slow and fast moving areas?

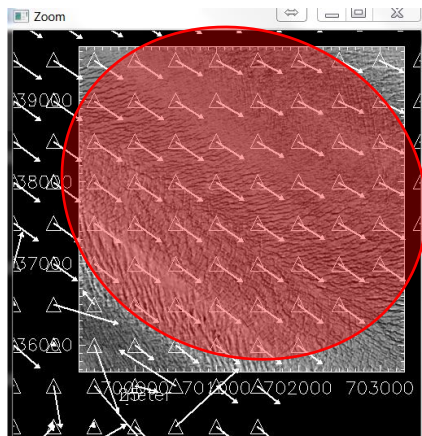
- Once you have decided upon your parameters all pop-up windows will close. You can then draw a rough polygon using the mouse in the window named "*image of time 1*" by left clicking. Once you have an area you are happy with, right click to complete the polygon.
- Next you will be presented with the options of NORMAL and FAST tracking. Choose FAST as it is computationally more efficient during testing
- Once you have chosen FAST, the tracking will start automatically. This stage may take some time (a few minutes or so). The amount of time this will take depends on the parameters you chose. The denser the grid, the longer the time it will take.
- Once the tracking is finished, the polygon will fill with white points (and you can see progress in the information window). As it is relatively hard to see the results effectively in CIAS, it is advised to save the results and import them into QGIS as follows. To do so, click the "SAVE results" option and save them to your workspace. **TIP: when saving the results, it is advisable to keep vital information about the tracking in the filename. E.G the algorithm used, reference block size used, grid distance, and, image pair information, such as acquisition date and sensor. Save the results with the .txt extension.**



- Should you want to do a quick check of the results in CIAS you can do so as follows. **Make sure you have saved the results first before checking the results in CIAS as you risk losing the data if you accidentally close any windows or choose the wrong selection.** Choose the option "*Show results*", then choose "*Show results (400X400 pixel section)*". Then use the mouse to click on an area of the output (area with white dots within your defined polygon). Accept the magnification and a pop-up of the results will appear similar to the one below.

Note that the vector size and the direction are the two main things to look for when assessing the quality of your results at this stage within CIAS. The area outlined in red shows good tracking, where the vectors flow in the same direction (also flowing towards the glacier terminus) and they are of similar length to their neighbour. You can do this for multiple areas so it is up to you to do some trial and error.

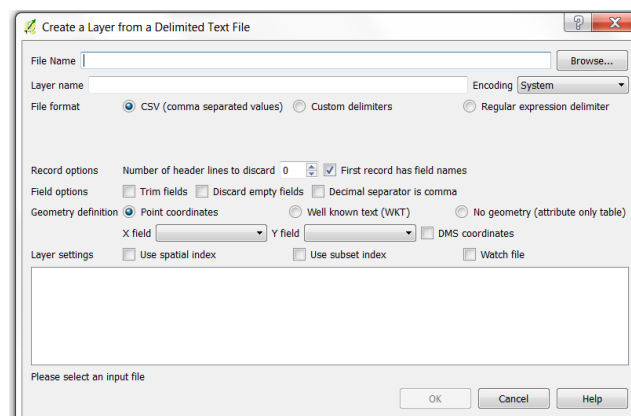
TIP: When checking the results in CIAS, it is best to choose an area where there are many features (e.g. crevasses). This is generally an indication of fast flow and therefore an area that you expect good tracking compared to comparatively featureless, slow-flowing areas.



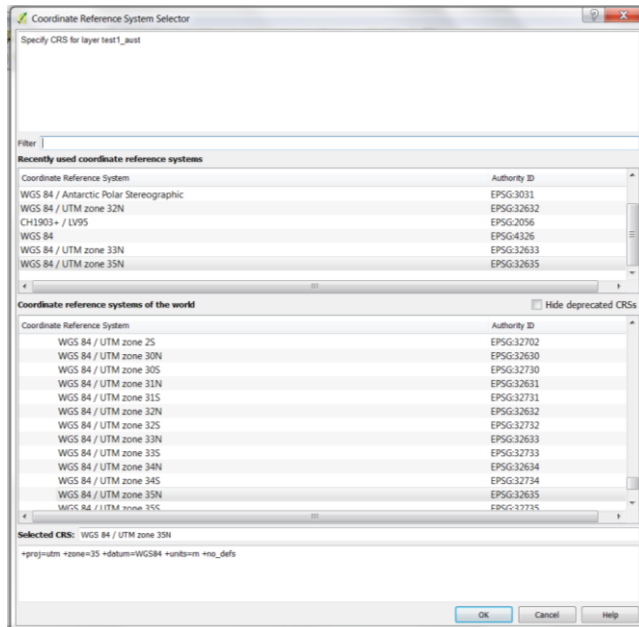
- **Before importing this data into QGIS, run CIAS a couple more times using different parameters and correlation algorithms and save the data as instructed. You will therefore be able to compare your results in the next stage rather than having to go back and run CIAS.**

Importing and viewing results in QGIS

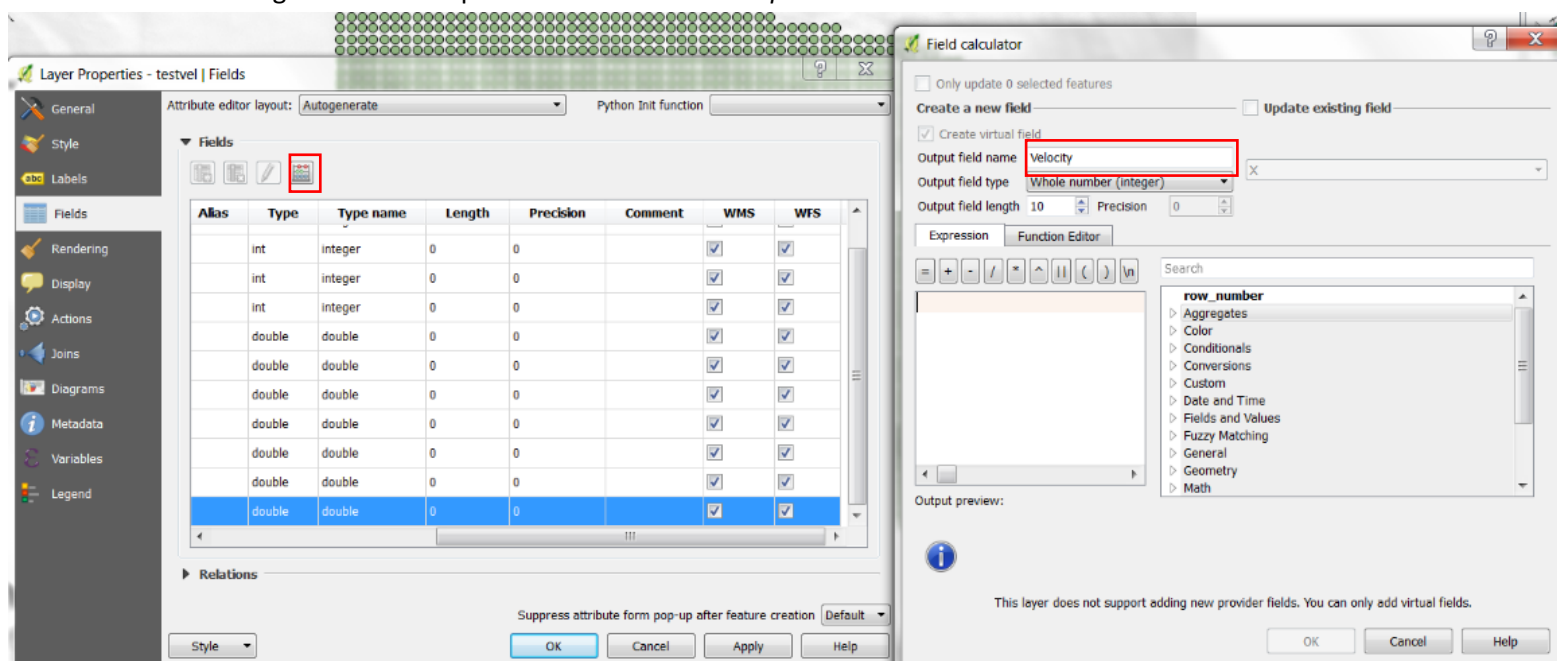
- Open QGIS
Import the .txt output data from CIAS using the dropdown menu option “Layer” >> Add Layer”>>“Add Delimited Text Layer”



- Select the file that you exported from CIAS and press OK. The output data with the correct headers should appear in the window above.
- In this case using Sentinel-2 data 35XMJ set the coordinate reference system to WGS84 Zone 35N. Note that this may not always be the case depending on where your data is from and what coordinate reference system the original GeoTif imagery is in.



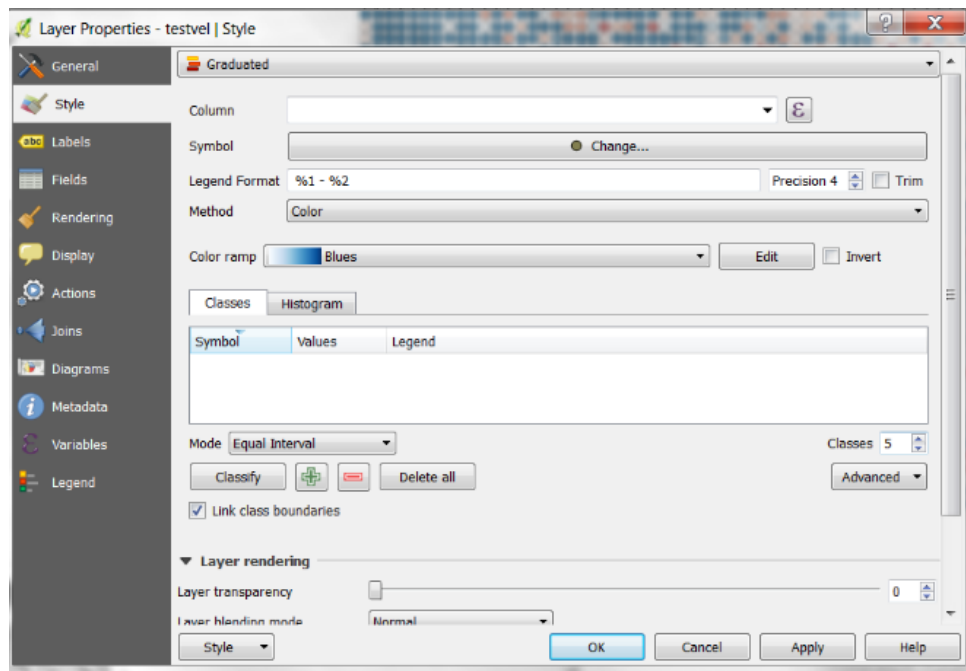
- You should now see your points in the QGIS workspace. The easiest way to check their locations is to load in one of the image pairs into QGIS. You can do this simply by importing the raster via the drop down menu options “Layer” >> “Add Layer” >> “Add raster layer”. This will allow you to overlay your results onto the satellite image (make sure the layers are ordered correctly).
- Once loaded, you will need to make a new attribute called “velocity”. To do so, you need to right click on the point data and select “Properties”.



Note: your resulting velocity attributes should be in **m day⁻¹**. You will need to calculate the time interval between the two images in your image pair. You should be able to find the dates in the imager file name.

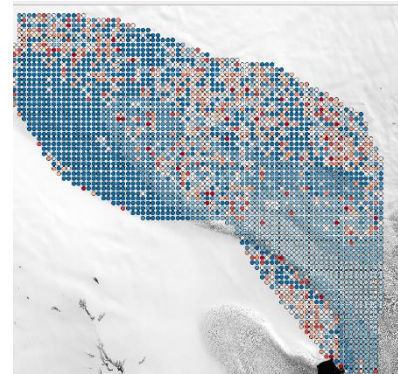
Hint: Pythagoras' Theorem may come in handy here.

- Once you have made all the attributes you wish to make, save the data (up until now, the new attributes that you have created are only in virtual form and will be lost if you close the program). Do so by right clicking on the point data and “save as”. Save as a .csv file. In addition to this, save the QGIS project in your work folder using the dropdown menu options “Project” >> “Save”, and re-import the updated point data using the “Layer” >> “Add Layer” >> “Add Delimited Text Layer”.
- Once you have calculated the velocity you will need to display your data by changing the “style” information. Again you navigate to the “Properties” menu of the point data.

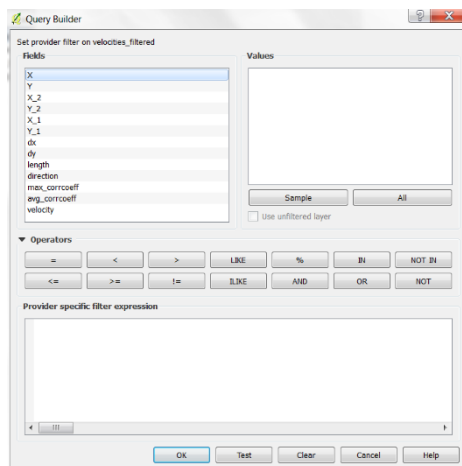


- Select the “graduated” symbol type. Select the “Column” you wish to display, for example the “velocity” attribute you just created. Select your “colour ramp” and the number of “classes” you wish to bin your data into, and click “classify”. You can test if your setting are reasonable by using the “apply” button. Once you are happy and want to explore your data click OK.

- Your results should look something like this. They will vary depending on the polygon you chose and the settings you selected for the tracking and the display. Here you can see I have overlain the CIAS output over one of the satellite images in the pair I used for tracking.



- As you can see in the example, there are many outliers. You need to filter the data in order to better visualise your results. This can be done in a number of ways.
- To filter the results you need to open the “filter” option by right clicking on your data.
- Filter the velocities using the range of conditions in the pop-up window. This allows you to select and visualise values based on expressions you decide. **The option to filter your velocity results will not show here if you have not saved and re-imported your point data.**



- To save the filtered data the same way as earlier with a unique name and reload the filtered data into the project. Make sure you periodically save the project to ensure no data is lost.

HINTS and QUESTIONS: It is up to you how you filter your results and there is no one method for doing so. The most obvious attributes to begin filtering are the “*max_corrcoeff*” and “*direction*” attributes. It is also possible to make new attributes like Signal to Noise Ratios in the same way you created the “*velocity*” attribute in order to assist in the filtering of data. Play around with trying different filters in the calculation field. Which filters and thresholds are most effective at removing most outliers? Why not try a combination of filters.

- If you get to this stage you can also try and interpolate your saved filtered data. QGIS has a handy interpolation tool “*Raster*” >> “*Interpolation*” >> “*Interpolation*”. Note that the interpolated result will only be as good as the filtered data and it will not work very well where there are large data gaps or a large number of outliers. If there is time at the end you can use this to compare to the SAR data from the other part of the practical.