European Commission

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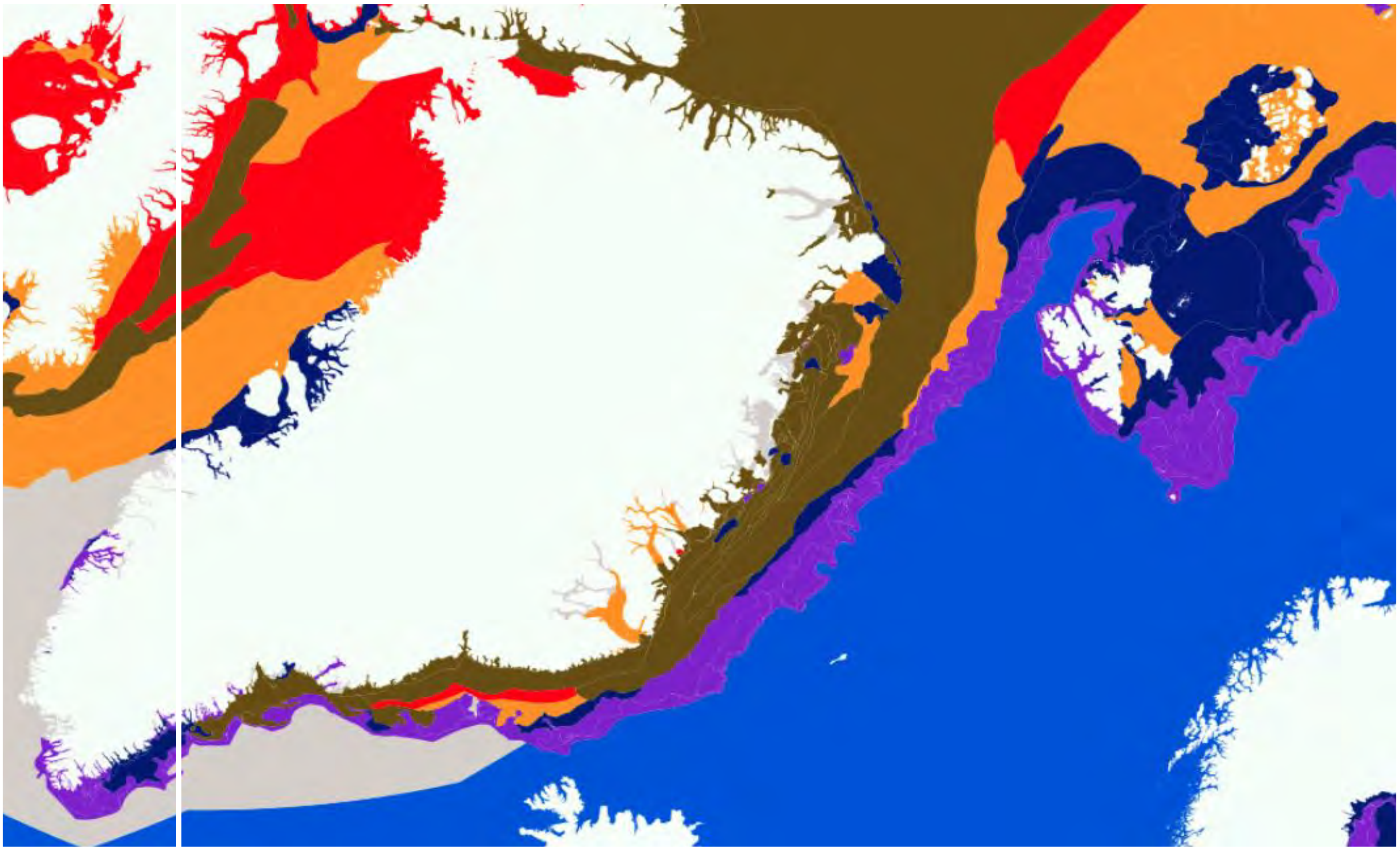
RUS

Copernicus



TRAINING KIT – CRYO04

SEA ICE MONITORING WITH SENTINEL-1

with Python and snappy and Jupyter Notebooks

CS serco NOVELTIS ALONG-TRACK CS ROMANIA

Research and User Support for Sentinel Core Products

The RUS Service is funded by the European Commission, managed by the European Space Agency and operated by CSSI and its partners.

Authors would be glad to receive your feedback or suggestions and to know how this material was used. Please, contact us on training@rus-copernicus.eu

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Table of Contents

1 Introduction to RUS

The Research and User Support for Sentinel core products (RUS) service provides a free and open scalable platform in a powerful computing environment, hosting a suite of open source toolboxes pre-installed on virtual machines, to handle and process data derived from the Copernicus Sentinel satellites constellation.

In this tutorial we will concentrate on the retrieval of sea ice type using texture analysis in the form of Gray-Level Co-occurrence Matrices (GLCMs) and supervised classification trained with existing ice chart data with Python, Jupyter Notebooks and SNAP.

2 Introduction

The US Coast Guard Cutter Maple being escorted by Canadian Coast Guard Ship Terry Fox. - Credits: ESA.int

Sea ice covers about 7% of the Earth's surface and it has a significant influence on the local, regional and global climate environment and local communities and ecosystems. There is clear evidence showing that sea ice extent in the Arctic is decreasing as a result of climatic change. Accurate ice information is crucial to understand and monitor the changes in the Arctic environment and global climate change. Moreover, the decline in ice extent is creating possibilities for new sea routes and the exploration of natural resources in the Arctic. The Arctic region is estimated to have 22% of the world's oil and natural gas reserves, and a large portion of the natural resources in the Arctic are offshore and unexplored. As a result, more industrial activities are expected in this region in the future and supporting information for safe navigation is necessary.

The Sentinel-1 SAR provides invaluable information both in bad weather conditions and during polar nights. Typically, SAR images were/are analyzed by ice analysts in operational centers for manual classification of ice types and drawing of ice charts. This procedure, of course requires a significant effort and human power; therefore, a number of automated and semi-automated algorithms have been developed for dual-polarization C-band SAR image segmentation and ice/water classification; for retrieval of ice concentration; for classification of several ice types.

3 Training

Approximate duration of this training session is **2** hours.

The Training Code for this tutorial is CRYO04. If you wish to practice the exercise described below within the RUS Virtual Environment, register on the RUS portal and open a User Service request from Your RUS service → Your dashboard.

3.1 Data used

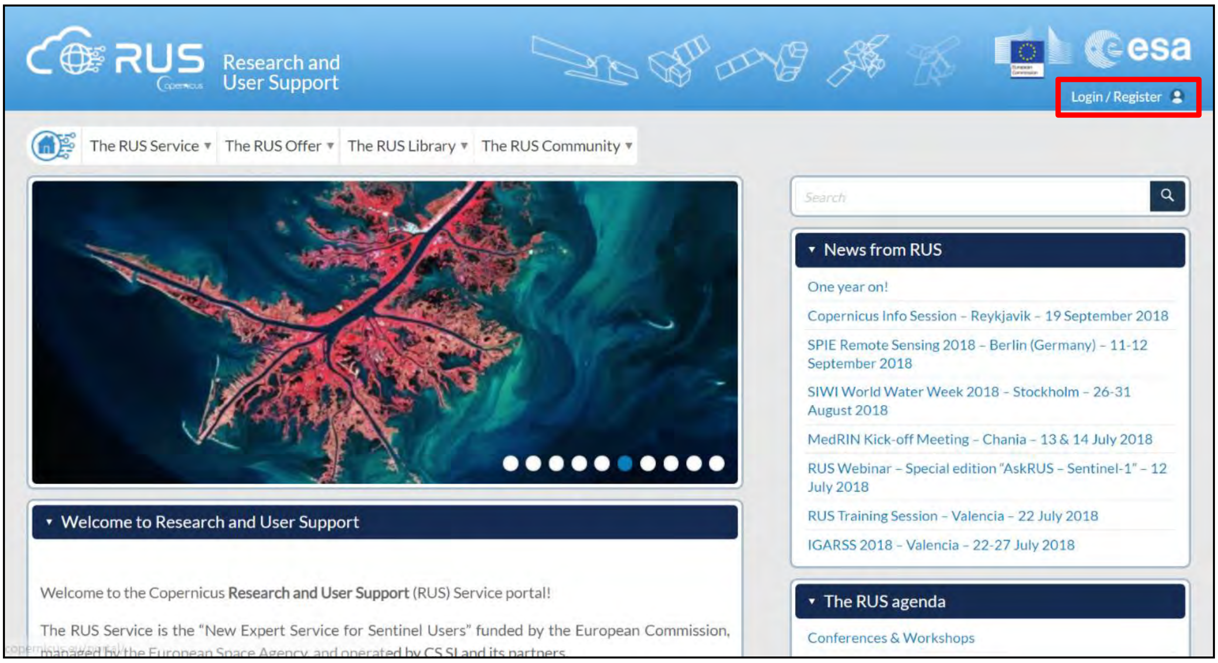
- 29 Sentinel-1 images acquired between 5 October 2021 and 22 March 2021
- Pre-processed data stored locally *@/shared/Training/CRYO04_SeaIce_Classification/AuxData/*

3.2 Software in RUS environment

Internet browser, Jupyter Notebook, Python, Anaconda, *snappy, sentinel1denoised*

4 Register to RUS Copernicus

To repeat the exercise using a RUS Copernicus Virtual Machine (VM), you will first have to register as a RUS user. For that, go to the RUS Copernicus website (www.rus-copernicus.eu) and click on ***Login/Register*** in the upper right corner.



▾ News from RUS

One year on!

Copernicus Info Session – Reykjavik – 19 September 2018

SPIE Remote Sensing 2018 – Berlin (Germany) – 11-12 September 2018

SIWI World Water Week 2018 – Stockholm – 26-31 August 2018

MedRIN Kick-off Meeting – Chania – 13 & 14 July 2018

RUS Webinar – Special edition "AskRUS – Sentinel-1" – 12 July 2018

RUS Training Session – Valencia – 22 July 2018

IGARSS 2018 – Valencia – 22-27 July 2018

▾ The RUS agenda

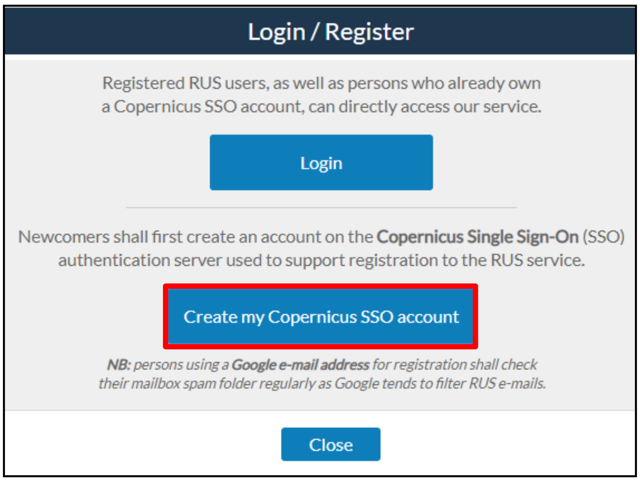
Conferences & Workshops

▾ Welcome to Research and User Support

Welcome to the Copernicus **Research and User Support** (RUS) Service portal!

The RUS Service is the "New Expert Service for Sentinel Users" funded by the European Commission, managed by the European Space Agency, and operated by CS SI and its partners.

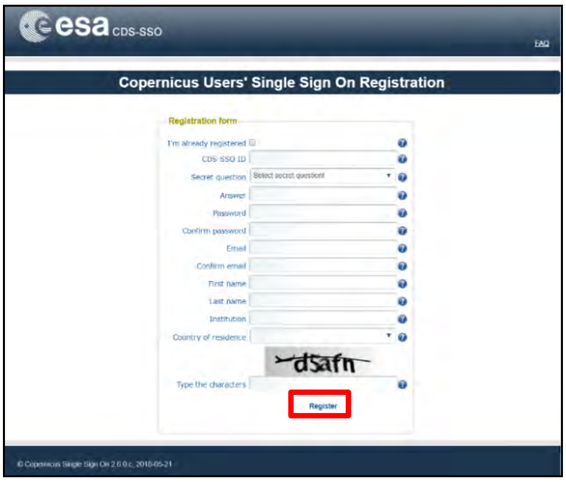
Select the option ***Create my Copernicus SSO account*** and then fill in ALL the fields on the **Copernicus Users' Single Sign On Registration**. Click ***Register***.



Registered RUS users, as well as persons who already own a Copernicus SSO account, can directly access our service.

Newcomers shall first create an account on the **Copernicus Single Sign-On** (SSO) authentication server used to support registration to the RUS service.

*NB: persons using a **Google e-mail address** for registration shall check their mailbox spam folder regularly as Google tends to filter RUS e-mails.*



Copernicus Users' Single Sign On Registration

Registration form

I'm already registered □

CDS-SSO ID

Secret question: Select secret question

Answer

Password

Confirm password

Email

Confirm email

First name

Last name

Institution

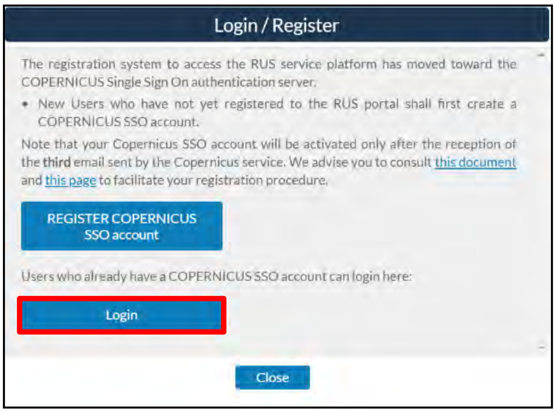
Country of residence

Type the characters

© Copernicus Single Sign On 2.6.0.c, 2018-05-21

Within a few minutes you will receive an e-mail with activation link. Follow the instructions in the e-mail to activate your account.

You can now return to https://rus-copernicus.eu/, click on ***Login/Register***, choose ***Login*** and enter your chosen credentials.



Login / Register

The registration system to access the RUS service platform has moved toward the COPERNICUS Single Sign On authentication server.

- New Users who have not yet registered to the RUS portal shall first create a COPERNICUS SSO account.

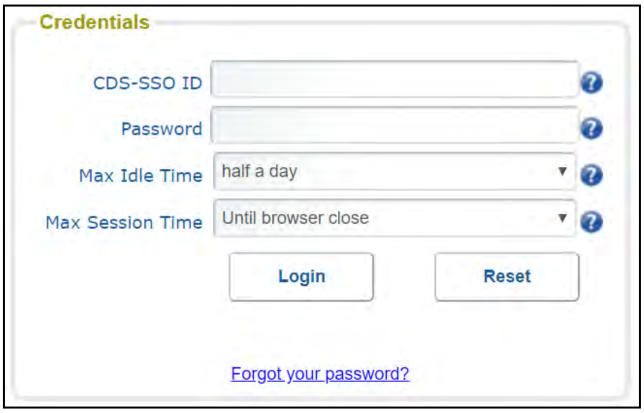
Note that your Copernicus SSO account will be activated only after the reception of the **third** email sent by the Copernicus service. We advise you to consult this document and this page to facilitate your registration procedure.

REGISTER COPERNICUS SSO account

Users who already have a COPERNICUS SSO account can login here:

Login

Close



Credentials

CDS-SSO ID

Password

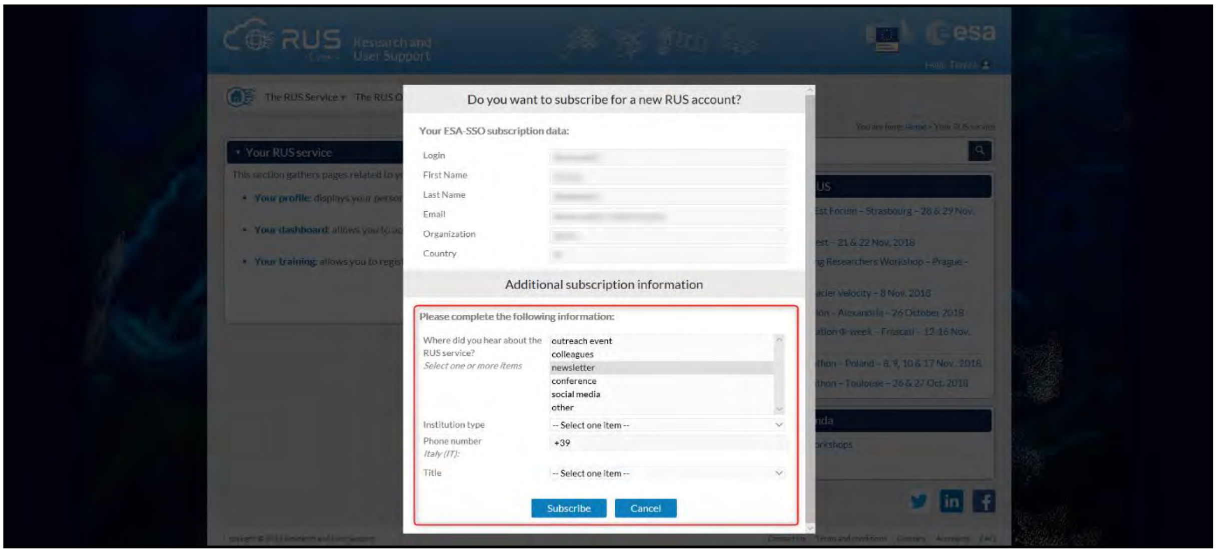
Max Idle Time: half a day

Max Session Time: Until browser close

Login | Reset

Forgot your password?

Upon your first login you will need to enter some details. You must fill all the fields.



Do you want to subscribe for a new RUS account?

Your ESA-SSO subscription data:

Login [redacted]

First Name [redacted]

Last Name [redacted]

Email [redacted]

Organization [redacted]

Country [redacted]

Additional subscription information

Please complete the following information:

Where did you hear about the RUS service? *Select one or more items*: outreach event, colleagues, newsletter, conference, social media, other

Institution type: -- Select one item --

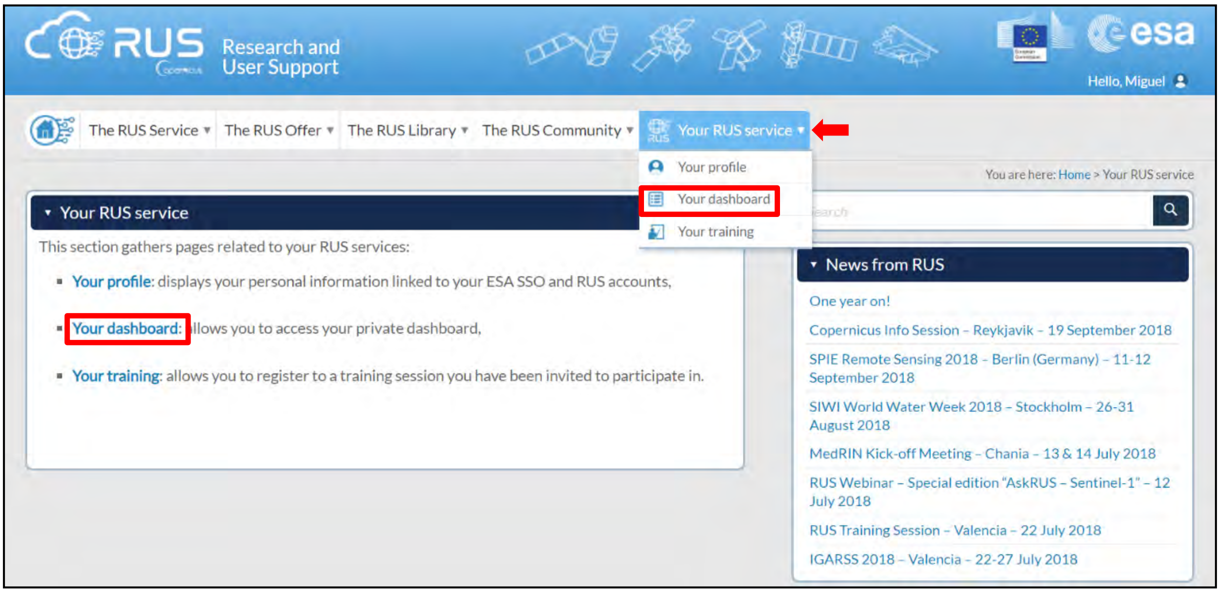
Phone number *Italy (IT):* +39

Title: -- Select one item --

Subscribe | Cancel

5 Request a RUS Copernicus Virtual Machine

Once you are registered as a RUS user, you can request a RUS Virtual Machine to repeat this exercise or work on your own projects using Copernicus data. For that, log in and click on ***Your RUS Service*** → ***Your Dashboard***.



You are here: Home > Your RUS service

Your RUS service

This section gathers pages related to your RUS services:

- Your profile: displays your personal information linked to your ESA SSO and RUS accounts,
- Your dashboard: allows you to access your private dashboard,
- Your training: allows you to register to a training session you have been invited to participate in.

News from RUS

One year on!

Copernicus Info Session – Reykjavik – 19 September 2018

SPIE Remote Sensing 2018 – Berlin (Germany) – 11-12 September 2018

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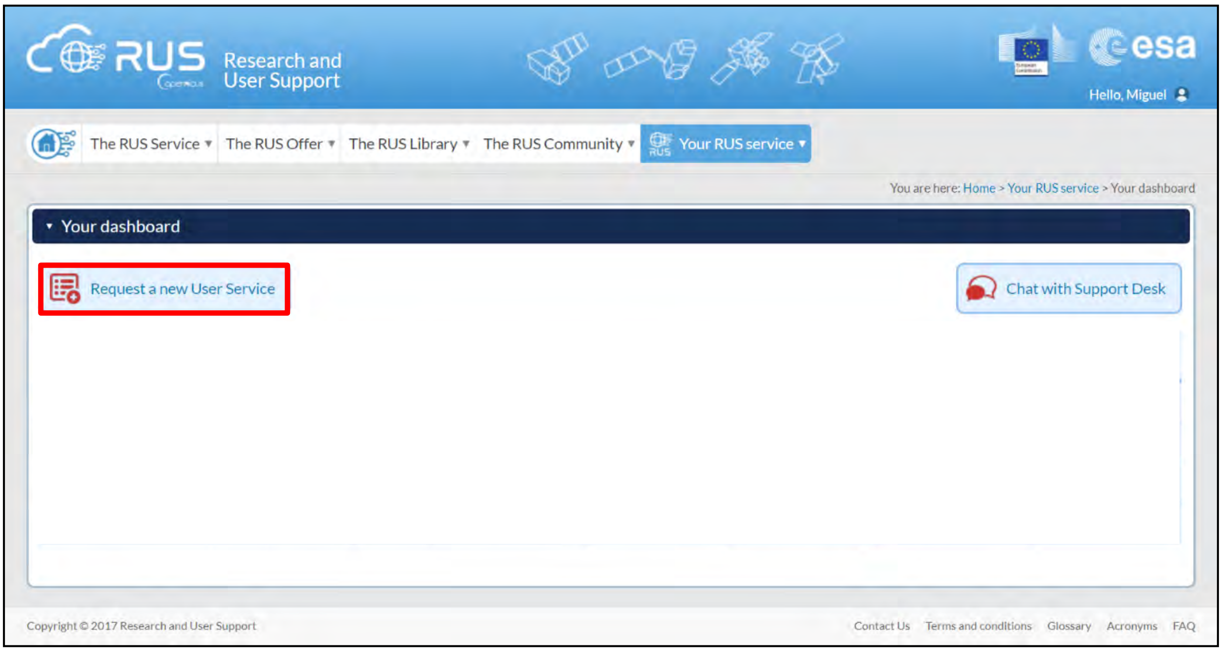
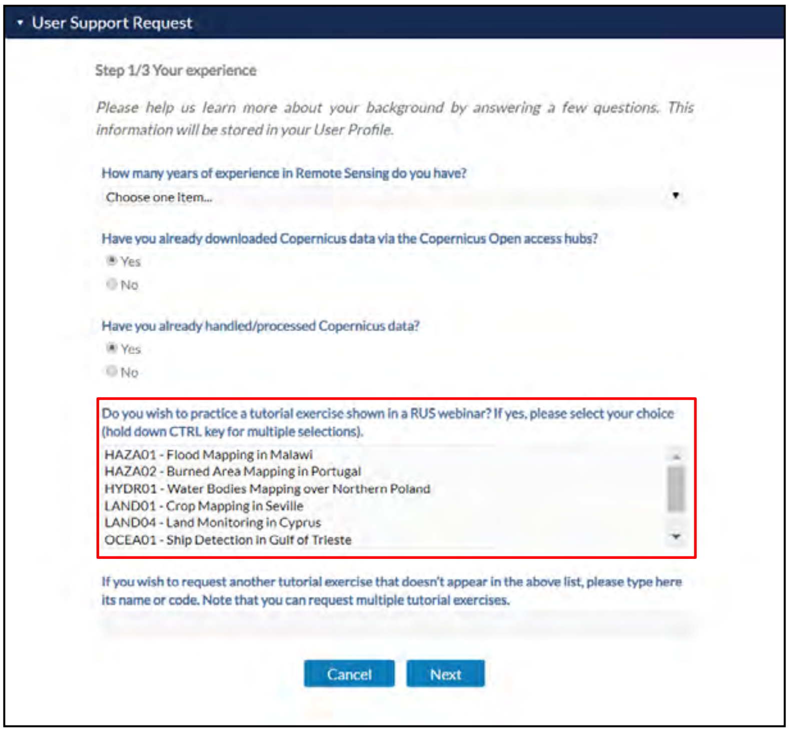
RUS Training Session – Valencia – 22 July 2018

IGARSS 2018 – Valencia – 22-27 July 2018

Click on ***Request a new User Service*** to request your RUS Virtual Machine. Complete the form so that the appropriate cloud environment can be assigned according to your needs.



If you want to repeat this tutorial (or any previous one) select the one(s) of your interest in the appropriate field.



User Support Request

Step 1/3 Your experience

Please help us learn more about your background by answering a few questions. This information will be stored in your User Profile.

How many years of experience in Remote Sensing do you have?

Choose one Item... ▾

Have you already downloaded Copernicus data via the Copernicus Open access hubs?

● Yes

○ No

Have you already handled/processed Copernicus data?

● Yes

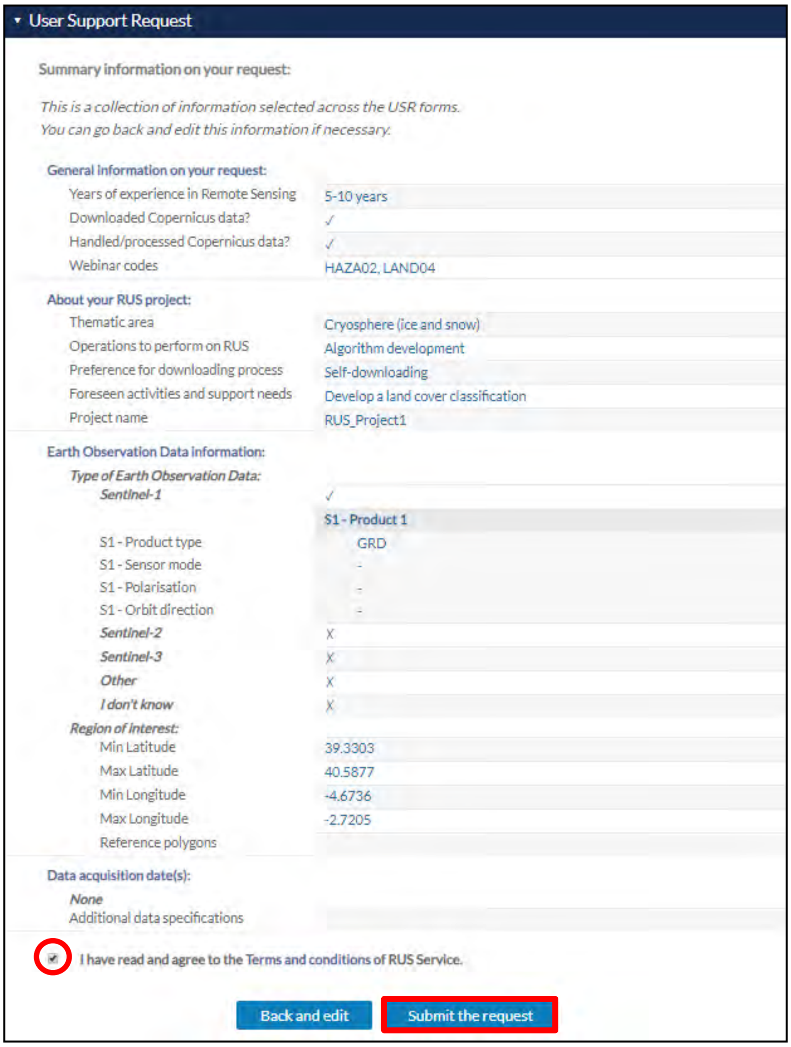
○ No

Do you wish to practice a tutorial exercise shown in a RUS webinar? If yes, please select your choice (hold down CTRL key for multiple selections).

HAZA01 - Flood Mapping in Malawi
HAZA02 - Burned Area Mapping in Portugal
HYDR01 - Water Bodies Mapping over Northern Poland
LAND01 - Crop Mapping in Seville
LAND04 - Land Monitoring in Cyprus
OCEA01 - Ship Detection in Gulf of Trieste

If you wish to request another tutorial exercise that doesn't appear in the above list, please type here its name or code. Note that you can request multiple tutorial exercises.

Complete the remaining steps, check the terms and conditions of the RUS Service and submit your request once you are finished.



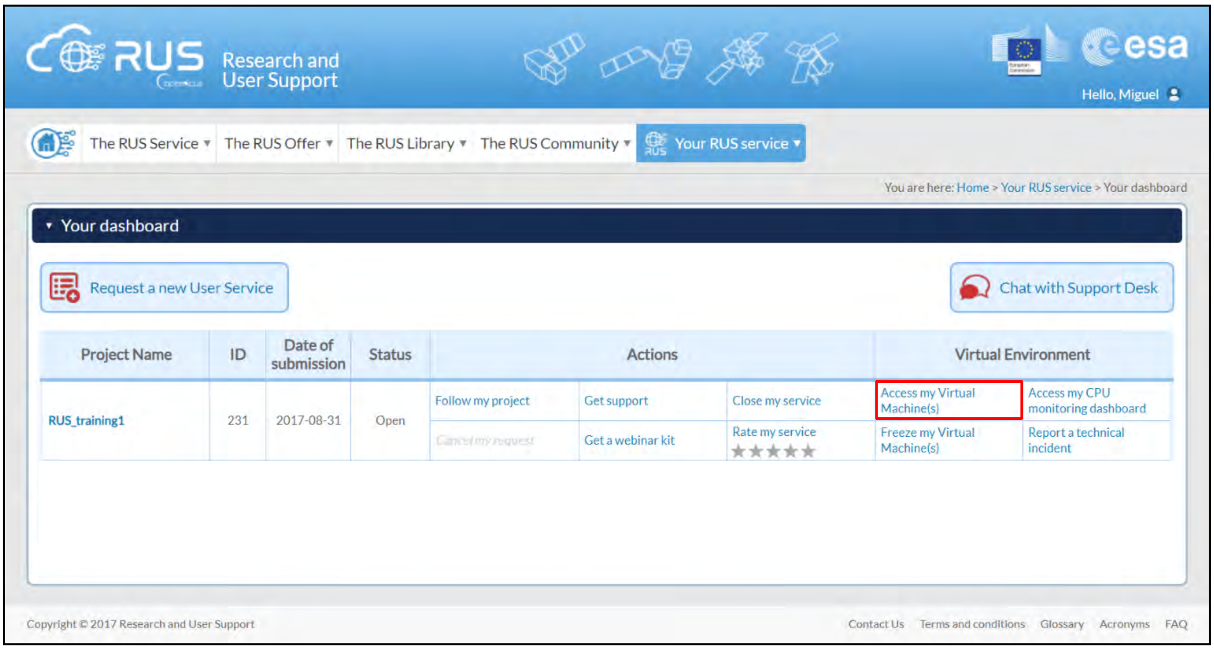
Summary information on your request:

This is a collection of information selected across the USR forms. You can go back and edit this information if necessary.

General information on your request:	
Years of experience in Remote Sensing	5-10 years
Downloaded Copernicus data?	✓
Handled/processed Copernicus data?	✓
Webinar codes	HAZA02, LAND04
About your RUS project:	
Thematic area	Cryosphere (ice and snow)
Operations to perform on RUS	Algorithm development
Preference for downloading process	Self-downloading
Foreseen activities and support needs	Develop a land cover classification
Project name	RUS_Project1
Earth Observation Data information:	
Type of Earth Observation Data:	
Sentinel-1	✓
	S1 - Product 1
S1 - Product type	GRD
S1 - Sensor mode	-
S1 - Polarisation	-
S1 - Orbit direction	-
Sentinel-2	X
Sentinel-3	X
Other	X
I don't know	X
Region of interest:	
Min Latitude	39.3303
Max Latitude	40.5877
Min Longitude	-4.6736
Max Longitude	-2.7205
Reference polygons	
Data acquisition date(s):	
None	
Additional data specifications	

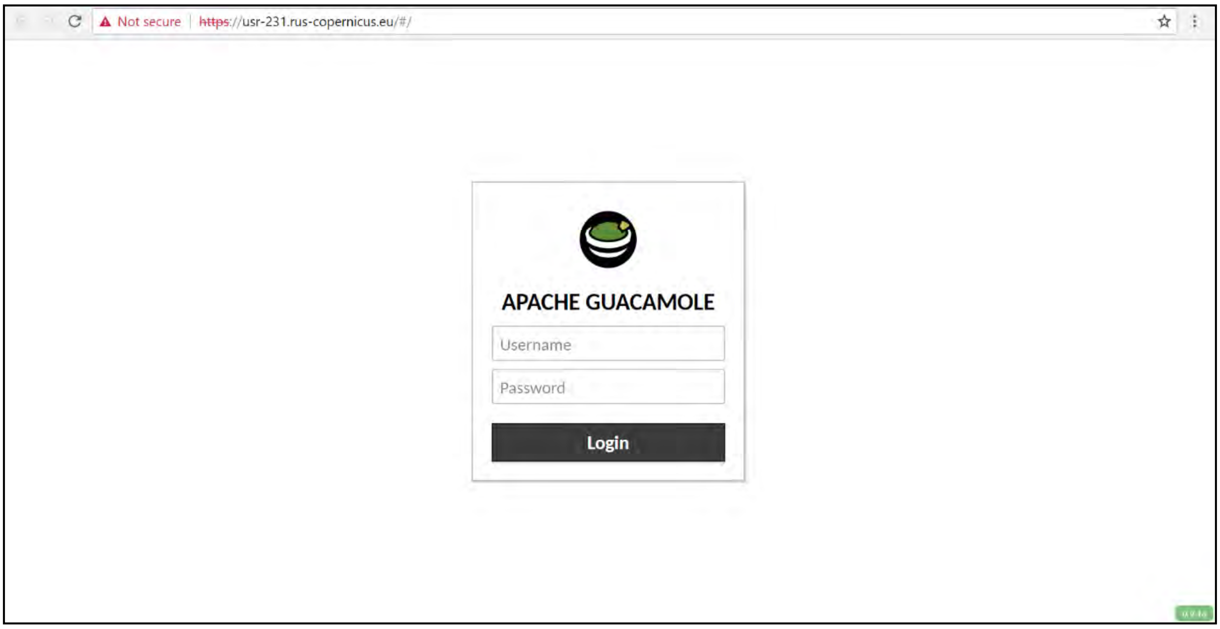
☑ I have read and agree to the Terms and conditions of RUS Service.

Further to the acceptance of your request by the RUS Helpdesk, you will receive a notification email with all the details about your Virtual Machine. To access it, go to ***Your RUS Service → Your Dashboard*** and click on ***Access my Virtual Machine***.

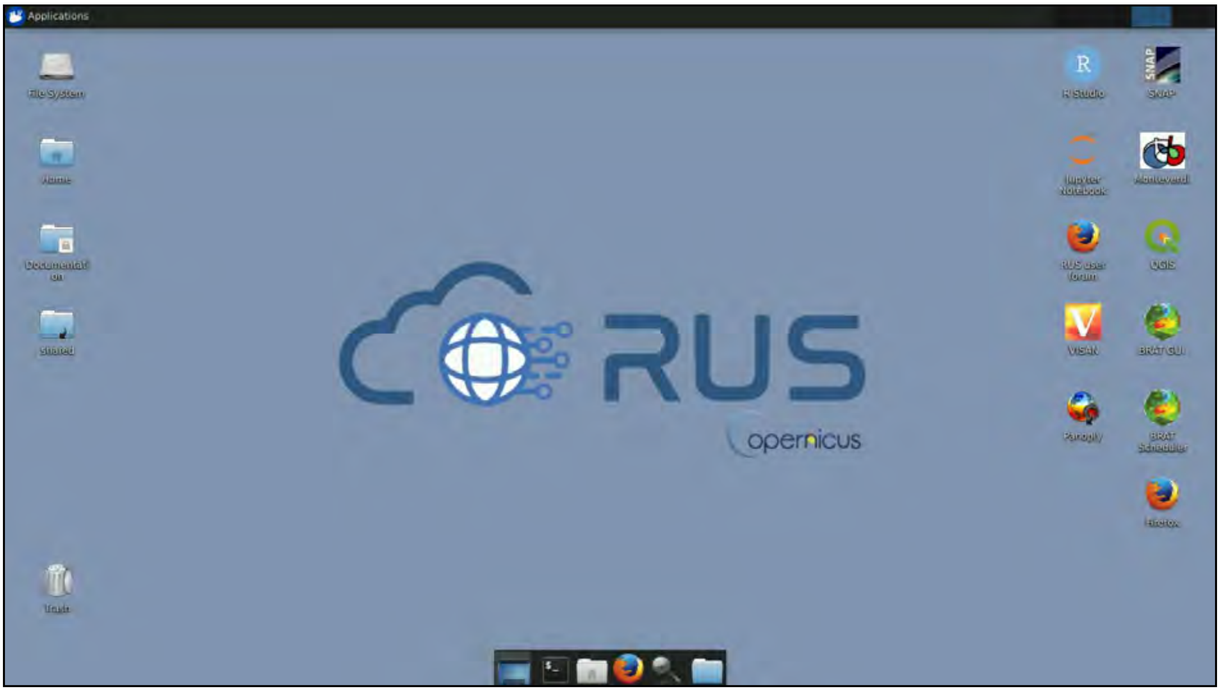


Project Name	ID	Date of submission	Status	Actions			Virtual Environment	
RUS_training1	231	2017-08-31	Open	Follow my project	Get support	Close my service	Access my Virtual Machine(s)	Access my CPU monitoring dashboard
				Cancel my request	Get a webinar kit	Rate my service ★★★★★	Freeze my Virtual Machine(s)	Report a technical incident

Fill in the login credentials that have been provided to you by the RUS Helpdesk via email to access your RUS Copernicus Virtual Machine.



This is the remote desktop of your Virtual Machine.

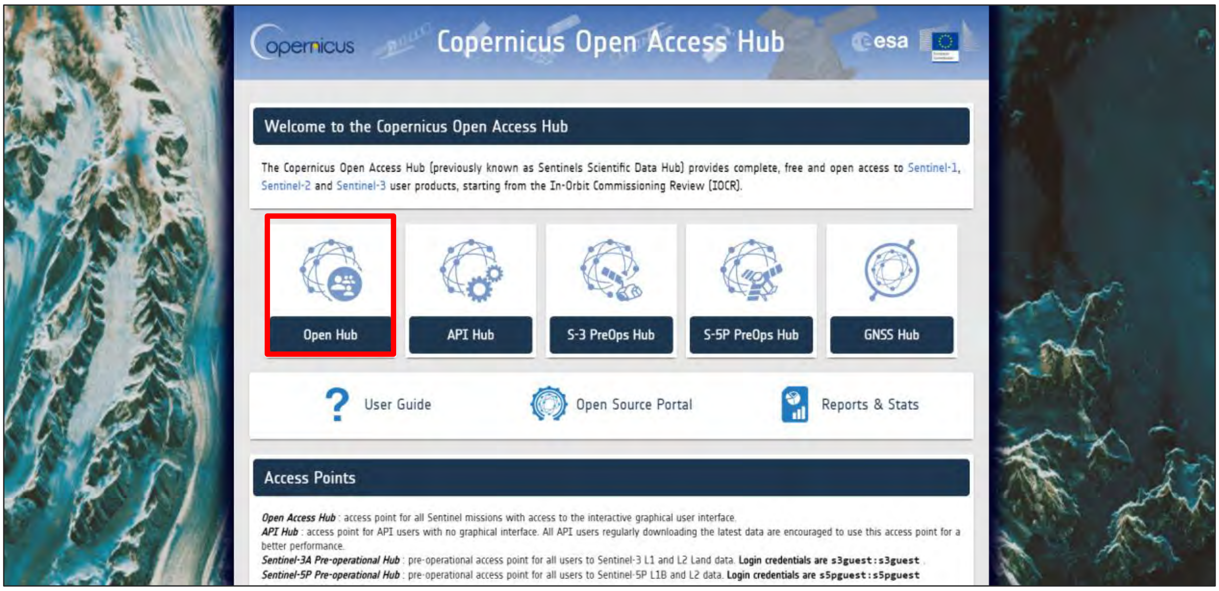


6 Step by step

6.1 Data download – ESA SciHUB

Before starting the exercise, make sure you are registered in the Copernicus Open Access Hub so that you can access the free data provided by the Sentinel satellites.

Go to https://scihub.copernicus.eu/



Copernicus Open Access Hub

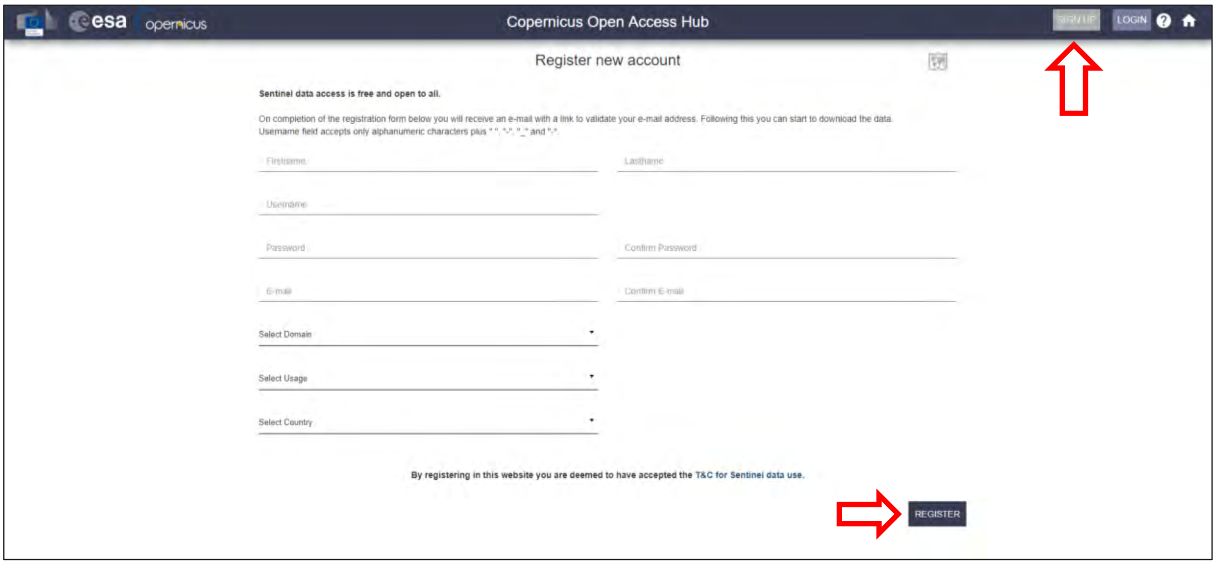
Welcome to the Copernicus Open Access Hub

The Copernicus Open Access Hub (previously known as Sentinels Scientific Data Hub) provides complete, free and open access to Sentinel-1, Sentinel-2 and Sentinel-3 user products, starting from the In-Orbit Commissioning Review (IOCR).

Access Points

Open Access Hub : access point for all Sentinel missions with access to the interactive graphical user interface.
API Hub : access point for API users with no graphical interface. All API users regularly downloading the latest data are encouraged to use this access point for a better performance.
Sentinel-3A Pre-operational Hub : pre-operational access point for all users to Sentinel-3 L1 and L2 Land data. **Login credentials are s3guest:s3guest** .
Sentinel-5P Pre-operational Hub : pre-operational access point for all users to Sentinel-5P L1B and L2 data. **Login credentials are s5pguest:s5pguest**

Go to *Open Hub*. If you do not have an account, sign up in the upper right corner, fill in the details and click register.



Register new account

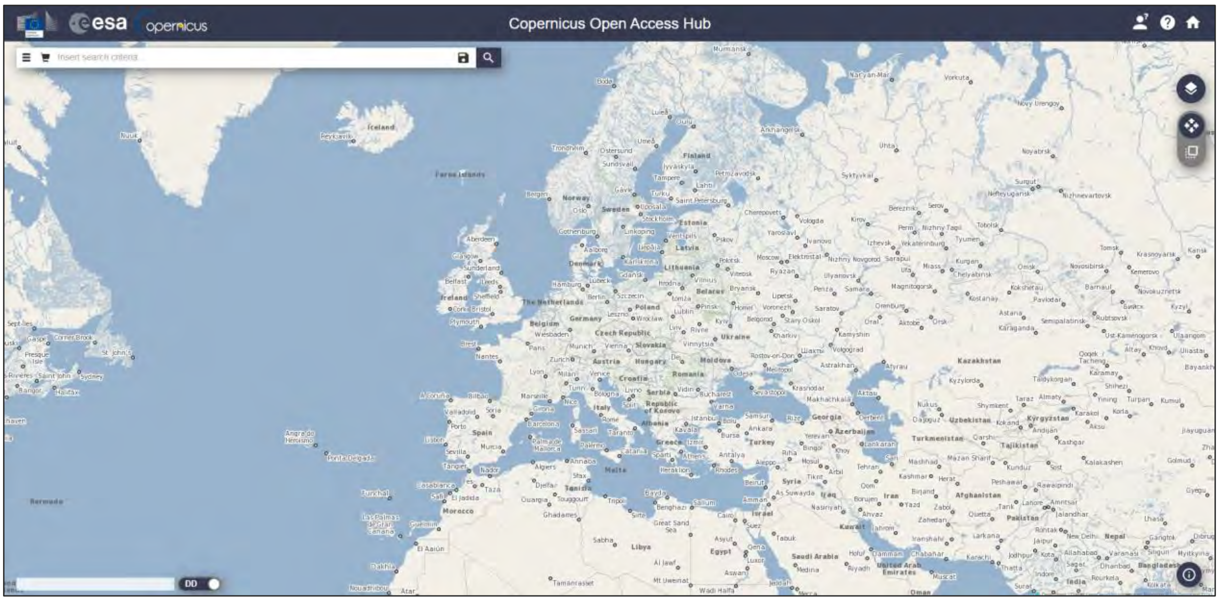
Sentinel data access is free and open to all.

On completion of the registration form below you will receive an e-mail with a link to validate your e-mail address. Following this you can start to download the data.
Username field accepts only alphanumeric characters plus "", "-", "_" and ".".

By registering in this website you are deemed to have accepted the T&C for Sentinel data use.

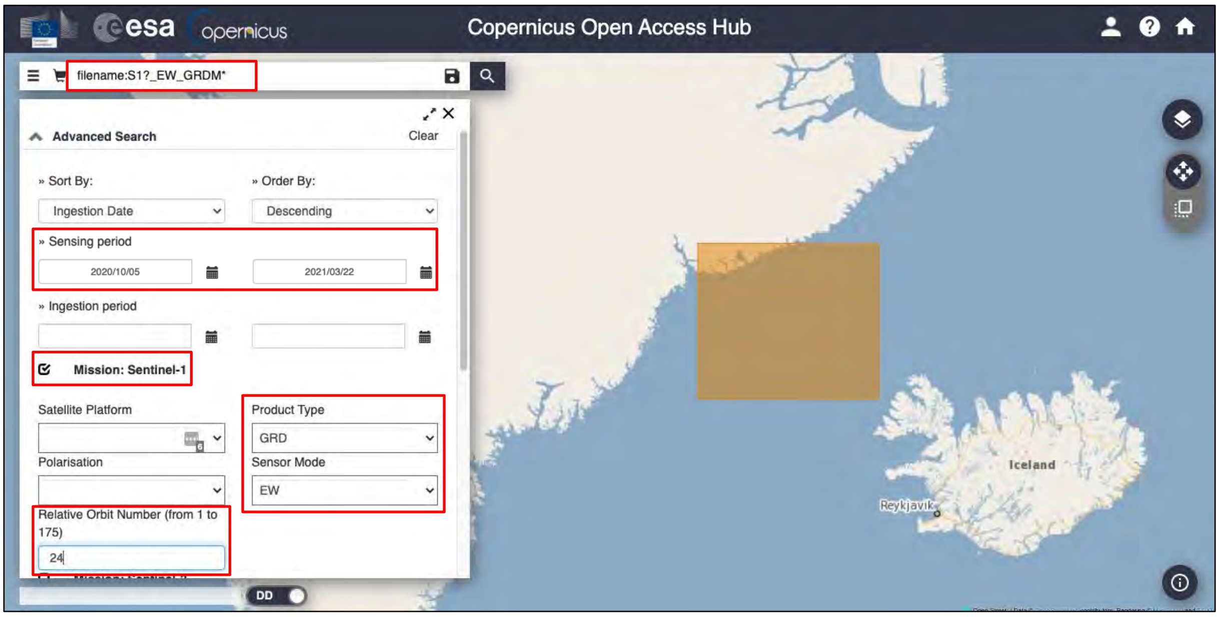
You will receive a confirmation email on the e-mail address you have specified: open the email and click on the link to finalize the registration.

Once your account is activated – or if you already have an account – log in.



In this guide, we describe the procedure to download the Sentinel-1 images. Define the study area over the Straight of Denmark between Greenland and Iceland. Then, open the search menu by clicking to the left part of the search bar (≡, and specify the parameters below. Press the search button (🔍) after that.

Search bar: *filename:S1?_EW_GRDH**
Sensing period: From 2020/10/05 to 2021/03/22
Check Mission: Sentinel-1
Product type: GRD
Relative Orbit Number: 24



filename:S1?_EW_GRDM*

Advanced Search

» Sort By: Ingestion Date

» Order By: Descending

» Sensing period: 2020/10/05 – 2021/03/22

» Ingestion period

☑ Mission: Sentinel-1

Satellite Platform

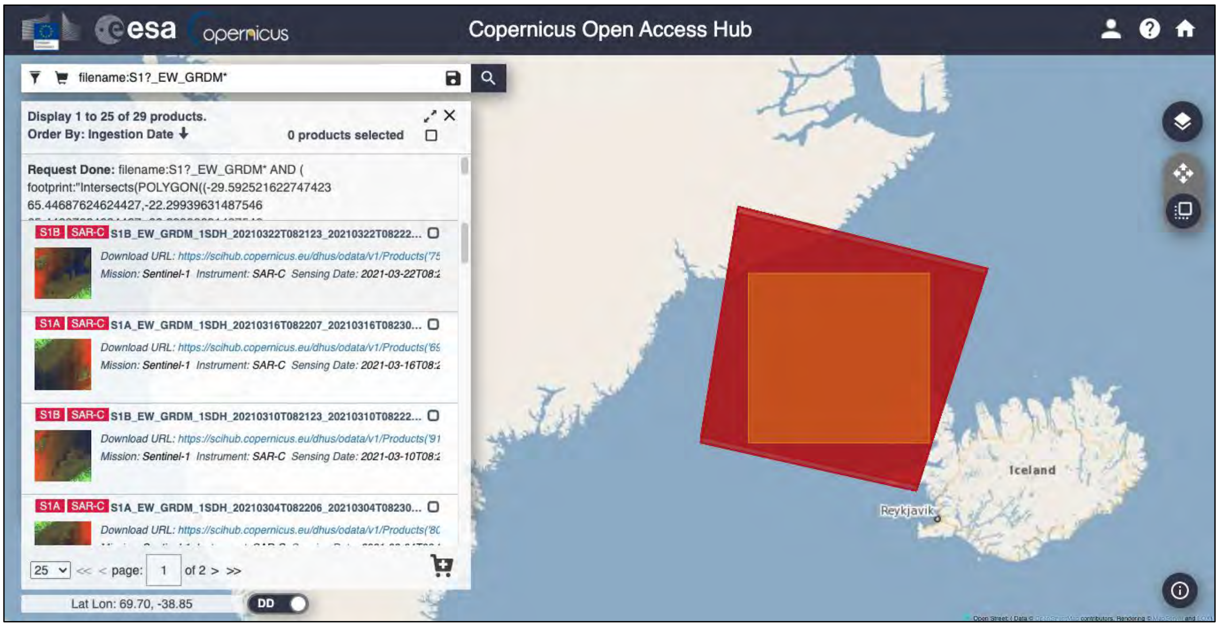
Product Type: GRD

Polarisation

Sensor Mode: EW

Relative Orbit Number (from 1 to 175): 24

In this case the search returns 29 results. Download the products (it will be saved in ***/home/rus/)*** and move it to: ***/shared/Training/CRYO04_SeaIce_Classification/Original/***



filename:S1?_EW_GRDM*

Display 1 to 25 of 29 products.
Order By: Ingestion Date ↓ 0 products selected □

Request Done: filename:S1?_EW_GRDM* AND (footprint:"Intersects(POLYGON((-29.592521622747423 65.44687624624427,-22.29939631487546

S1B SAR-C S1B_EW_GRDM_1SDH_20210322T082123_20210322T08222... □
Download URL: https://scihub.copernicus.eu/dhus/odata/v1/Products('75
Mission: Sentinel-1 *Instrument:* SAR-C *Sensing Date:* 2021-03-22T08:

S1A SAR-C S1A_EW_GRDM_1SDH_20210316T082207_20210316T08230... □
Download URL: https://scihub.copernicus.eu/dhus/odata/v1/Products('6
Mission: Sentinel-1 *Instrument:* SAR-C *Sensing Date:* 2021-03-16T08:

S1B SAR-C S1B_EW_GRDM_1SDH_20210310T082123_20210310T08222... □
Download URL: https://scihub.copernicus.eu/dhus/odata/v1/Products('91
Mission: Sentinel-1 *Instrument:* SAR-C *Sensing Date:* 2021-03-10T08:

S1A SAR-C S1A_EW_GRDM_1SDH_20210304T082206_20210304T08230... □
Download URL: https://scihub.copernicus.eu/dhus/odata/v1/Products('80

25 << < page: 1 of 2 > >>

Lat Lon: 69.70, -38.85

6.2 Anaconda environment installation

In this exercise we will use *snappy*, *sentinel1denoise* and *python* code in *Jupyter Notebook* to process the Sentinel-1 products we have previously downloaded. However, before starting the analysis, we need to set up both the Anaconda environment and the *snappy* module to work (see NOTE 1 and NOTE 2).

NOTE 1: Project Jupyter is a non-profit, open-source project, born out of the IPython Project in 2014 as it evolved to support interactive data science and scientific computing across all programming languages. Notebook documents (or "notebooks", all lower case) are documents produced by the Jupyter Notebook App, which contain both computer code (e.g. python) and rich text elements (paragraph, equations, figures, links, etc…). Notebook documents are both human-readable documents containing the analysis description and the results (figures, tables, etc..) as well as executable

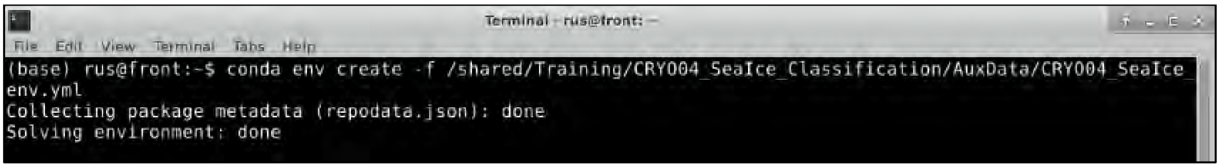
NOTE 2: Python is an interpreted, high-level, general-purpose programming language. Created by Guido van Rossum and first released in 1991, Python's design philosophy emphasizes code readability through use of significant whitespace. Its language constructs and object-oriented approach aim to help programmers write clear, logical code for small and large-scale projects. Python is dynamically typed and garbage-collected. It supports multiple programming paradigms, including procedural, object-oriented, and functional programming. Python is often described as a "batteries included" language due to its comprehensive standard library. More info at: www.python.org

Anaconda is a free and open-source distribution of the Python and R programming languages for scientific computing (data science, machine learning applications, large-scale data processing, predictive analytics, etc.), that aims to simplify package management and deployment. Package versions are managed by the package management system *conda*. More info at:

To create the same conda environment as the one used for the creation of this training material open Terminal in your RUS Virtual Machine and copy-paste the following command. Then, press *Enter* to run it (this step may take several minutes, do not interrupt it). The conda environment will be called *CRYO04_SeaIce_env*.

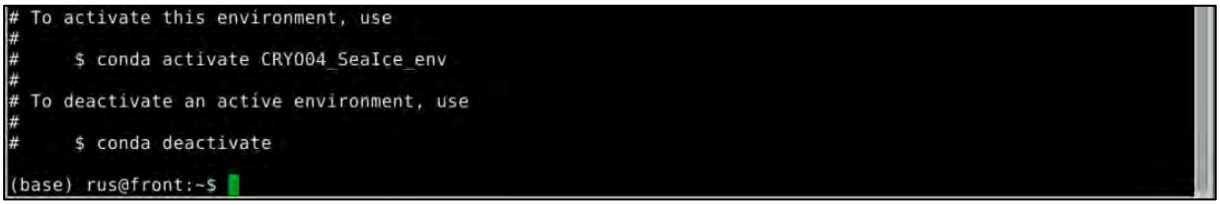
TIP: All following commands can also be copied from *setup_environment.txt* saved in the */shared/Training/CRYO04_SeaIce_Classification/AuxData/* folder.

```
conda env create -f
/shared/Training/CRYO04_SeaIce_Classification/AuxData/CRYO04_SeaIce_env.yml
```



```
(base) rus@front:~$ conda env create -f /shared/Training/CRYO04_SeaIce_Classification/AuxData/CRYO04_SeaIce_env.yml
Collecting package metadata (repodata.json): done
Solving environment: done
```

...

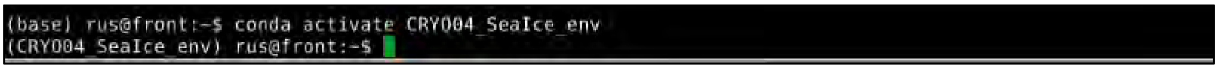


```
# To activate this environment, use
#
#     $ conda activate CRYO04_SeaIce_env
#
# To deactivate an active environment, use
#
#     $ conda deactivate

(base) rus@front:~$
```

Then we need to activate the environment. In the same terminal window run the following command:

```
conda activate CRYO04_SeaIce_env
```



```
(base) rus@front:~$ conda activate CRYO04_SeaIce_env
(CRYO04_SeaIce_env) rus@front:~$
```

When the environment activated you will see that the (*base*) at the beginning of the line has changed to (*CRYO04_SeaIce_env*).

6.3 Install snappy and sentinel1 denoised

The .yml file contains all the packages needed for this training except for snappy and sentinel1denoise. These two packages must be installed separately.

6.3.1 Snappy

SNAP provides the Python module *snappy* which allows you to access the SNAP Java API from Python. *Snappy* requires either a SNAP installation or a SNAP build. The following instructions will guide you through the installation process to have *snappy* working in the anaconda environment we have created in the previous step. Generic instructions on how to install *snappy* can be found in the following website:

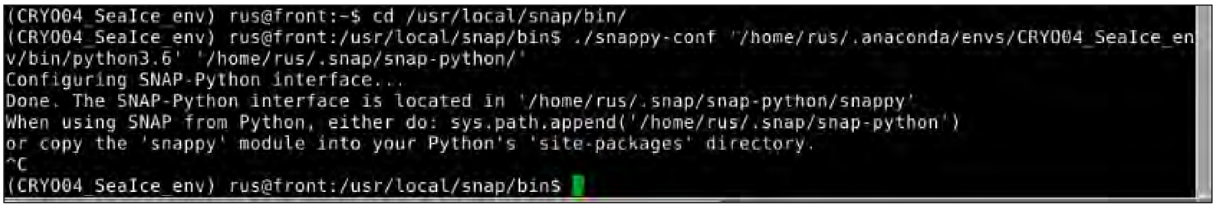
https://senbox.atlassian.net/wiki/spaces/SNAP/pages/24051781/Using+SNAP+in+your+Python+programs

To start, in the same Terminal window where we have created and activated the environment, change the directory to the snap installation directory:

```
cd /usr/local/snap/bin/
```

Next, we will generate the Python module *snappy* configured for the current SNAP installation and the Python interpreter of choice set in the <*python-exe*> parameter. Following the previous command in Terminal, copy-paste the next one and press *Enter*.

```
./snappy-conf '/home/rus/.anaconda/envs/CRYO04_SeaIce_env/bin/python3.6'
'/home/rus/.snap/snap-python/'
```



```
(CRY004_SeaIce_env) rus@front:~$ cd /usr/local/snap/bin/
(CRY004_SeaIce_env) rus@front:/usr/local/snap/bin$ ./snappy-conf '/home/rus/.anaconda/envs/CRY004_SeaIce_en
v/bin/python3.6' '/home/rus/.snap/snap-python/'
Configuring SNAP-Python interface...
Done. The SNAP-Python interface is located in '/home/rus/.snap/snap-python/snappy'
When using SNAP from Python, either do: sys.path.append('/home/rus/.snap/snap-python')
or copy the 'snappy' module into your Python's 'site-packages' directory.
^C
(CRY004_SeaIce_env) rus@front:/usr/local/snap/bin$
```

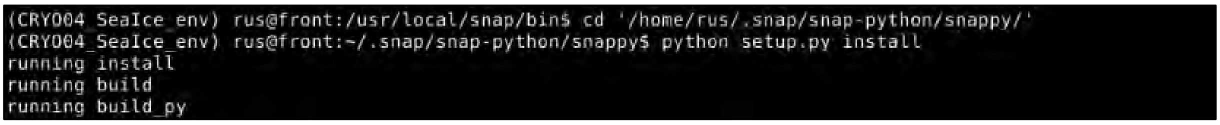
When the message starting with “Done” appears, but the code does not seem to finish, press CTRL+C.

Then change the directory to the directory where we have just generated the snappy python module:

```
cd '/home/rus/.snap/snap-python/snappy/'
```

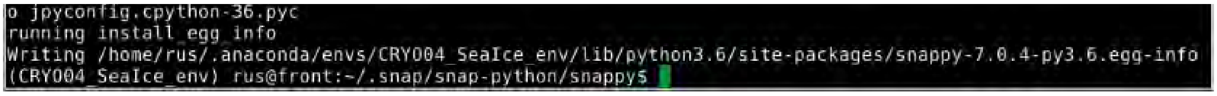
And finally, we use install the generated module by running the following command:

```
python setup.py install
```



```
(CRY004_SeaIce_env) rus@front:/usr/local/snap/bin$ cd '/home/rus/.snap/snap-python/snappy/'
(CRY004_SeaIce_env) rus@front:~/.snap/snap-python/snappy$ python setup.py install
running install
running build
running build_py
```

...



```
o jpyconfig.cpython-36.pyc
running install_egg_info
Writing /home/rus/.anaconda/envs/CRY004_SeaIce_env/lib/python3.6/site-packages/snappy-7.0.4-py3.6.egg-info
(CRY004_SeaIce_env) rus@front:~/.snap/snap-python/snappy$
```

Do not close the terminal window.

6.3.2 sentinel1denoised

The first steps we apply in the pre-processing are: thermal noise subtraction, scalloping correction and angular correction. We will use the Sentinel1Denoised software developed by the Nansen Environmental and Remote Sensing Center, Bergen, Norway.

For more information see:

Park, Jeong-Won; Korosov, Anton; Babiker, Mohamed; Sandven, Stein; and Won, Joong-Sun (2018): *Efficient noise removal of Sentinel-1 TOPSAR cross-polarization channel*, IEEE Transactions on Geoscience and Remote Sensing, 56(3), 1555-1565, doi:10.1109/TGRS.2017.2765248

Park, Jeong-Won; Won, Joong-Sun; Korosov, Anton A.; Babiker, Mohamed; and Miranda, Nuno (2019): *Textural Noise Correction for Sentinel-1 TOPSAR Cross-Polarization Channel Images*, IEEE Transactions on Geoscience and Remote Sensing, 57(6), 4040-4049, doi:10.1109/TGRS.2018.2889381

To install this package, we first need to download it from:
https://github.com/nansencenter/sentinel1denoised

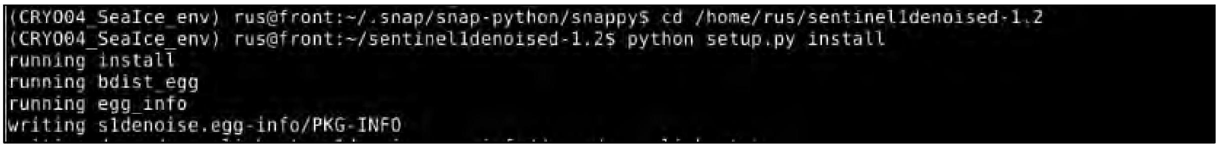
Download the zipped archive containing the SW. On RUS VM it will be saved to ***/home/rus/***. In file explorer, go to this folder, right-click the downloaded archive and select ***Extract Here***.

Go back to the terminal and change the directory to the downloaded extracted folder by running the following command:

```
cd /home/rus/sentinel1denoised-1.2
```

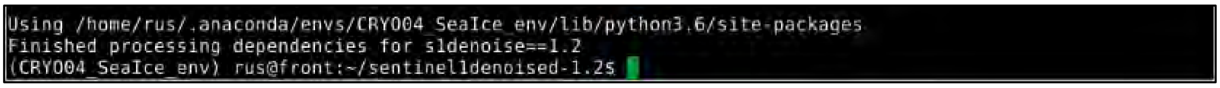
Then install the package by running the install script:

```
python setup.py install
```



```
(CRY004_SeaIce_env) rus@front:~/.snap/snap-python/snappy$ cd /home/rus/sentinel1denoised-1.2
(CRY004_SeaIce_env) rus@front:~/sentinel1denoised-1.2$ python setup.py install
running install
running bdist_egg
running egg_info
writing s1denoise.egg-info/PKG-INFO
```

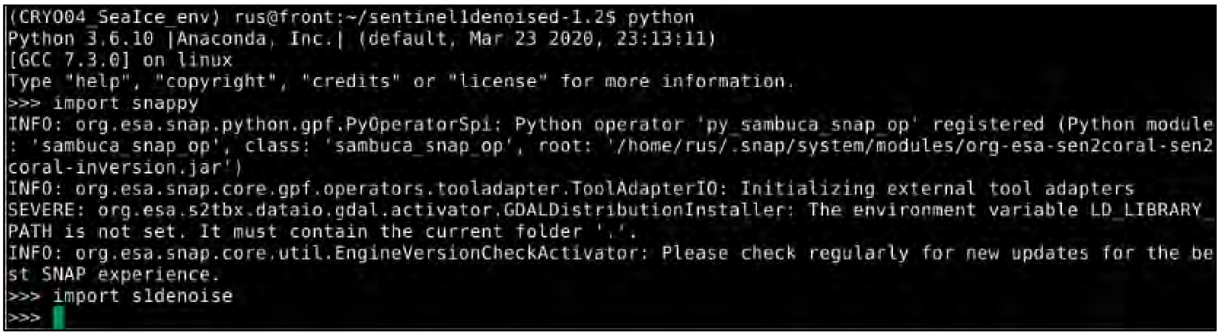
...



```
Using /home/rus/.anaconda/envs/CRY004_SeaIce_env/lib/python3.6/site-packages
Finished processing dependencies for s1denoise==1.2
(CRY004_SeaIce_env) rus@front:~/sentinel1denoised-1.2$
```

Once the installation is completed, we can check whether snappy and sentinel1denoised were installed successfully. In the same terminal window launch python and import the packages:

```
python
import snappy
import s1denoise
```



```
(CRY004_SeaIce_env) rus@front:~/sentinel1denoised-1.2$ python
Python 3.6.10 |Anaconda, Inc.| (default, Mar 23 2020, 23:13:11)
[GCC 7.3.0] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> import snappy
INFO: org.esa.snap.python.gpf.PyOperatorSpi: Python operator 'py_sambuca_snap_op' registered (Python module
: 'sambuca_snap_op', class: 'sambuca_snap_op', root: '/home/rus/.snap/system/modules/org-esa-sen2coral-sen2
coral-inversion.jar')
INFO: org.esa.snap.core.gpf.operators.tooladapter.ToolAdapterIO: Initializing external tool adapters
SEVERE: org.esa.s2tbx.dataio.gdal.activator.GDALDistributionInstaller: The environment variable LD_LIBRARY_
PATH is not set. It must contain the current folder '.'.
INFO: org.esa.snap.core.util.EngineVersionCheckActivator: Please check regularly for new updates for the be
st SNAP experience.
>>> import s1denoise
>>>
```

To close python type:

```
exit()
```

Now we are ready to start our Jupyter notebook.

6.4 Launch the Jupyter notebook

You can continue in the same terminal window or close it and open a new terminal. If you open new terminal window you need to activate the environment again:

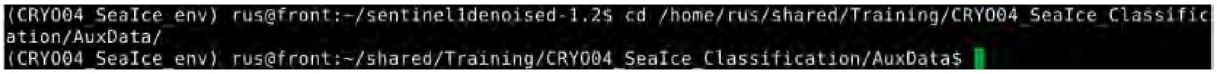
```
conda activate CRY004_SeaIce_env
```

Next, we change the directory to the location where our jupyter notebook is saved. Run the following command:

```
cd /home/rus/shared/Training/CRY004_SeaIce_Classification/AuxData/
```

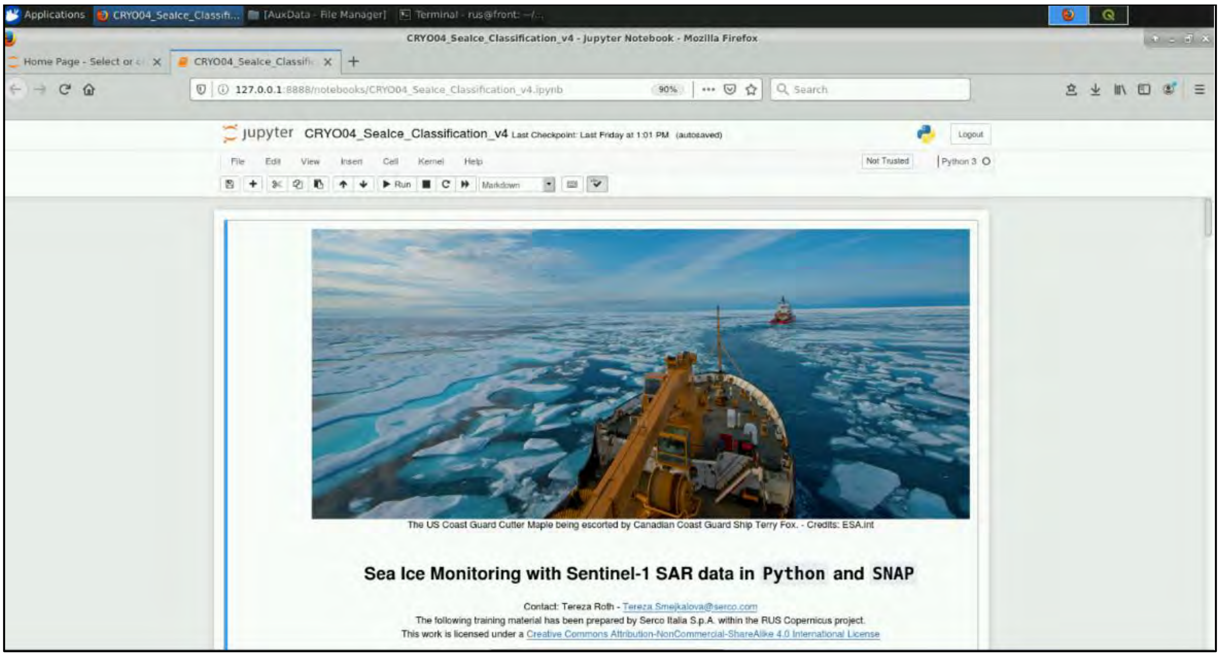
Finally, lets launch the jupyter notebooks. Type "jupyter-notebook" and press enter to launch the application. The application will be launched in the browser window.

```
jupyter-notebook
```



```
(CRY004_SeaIce_env) rus@front:~/sentinel1denoised-1.2$ cd /home/rus/shared/Training/CRY004_SeaIce_Classific
ation/AuxData/
(CRY004_SeaIce_env) rus@front:~/shared/Training/CRY004_SeaIce_Classification/AuxData$
```

Once the interface is open, double click on the notebook *CRYO04_SeaIce_Classification_v4.ipynb* to open it in the next tab. The next steps of the exercise are described in detail in the notebook.


Applications
CRYO04_SeaIce_Classifi...
[AuxData - File Manager]
Terminal - rus@front: ~/...
CRYO04_SeaIce_Classification_v4 - Jupyter Notebook - Mozilla Firefox
Home Page - Select or c
CRYO04_SeaIce_Classifi
127.0.0.1:8888/notebooks/CRYO04_SeaIce_Classification_v4.ipynb
90%
Search
jupyter
CRYO04_SeaIce_Classification_v4 Last Checkpoint: Last Friday at 1:01 PM (autosaved)
Logout
File
Edit
View
Insert
Cell
Kernel
Help
Not Trusted
Python 3
Run
Markdown

The US Coast Guard Cutter Maple being escorted by Canadian Coast Guard Ship Terry Fox. - Credits: ESA.int

Sea Ice Monitoring with Sentinel-1 SAR data in `Python` and `SNAP`

Contact: Tereza Roth - Tereza.Smejkalova@serco.com

The following training material has been prepared by Serco Italia S.p.A. within the RUS Copernicus project.

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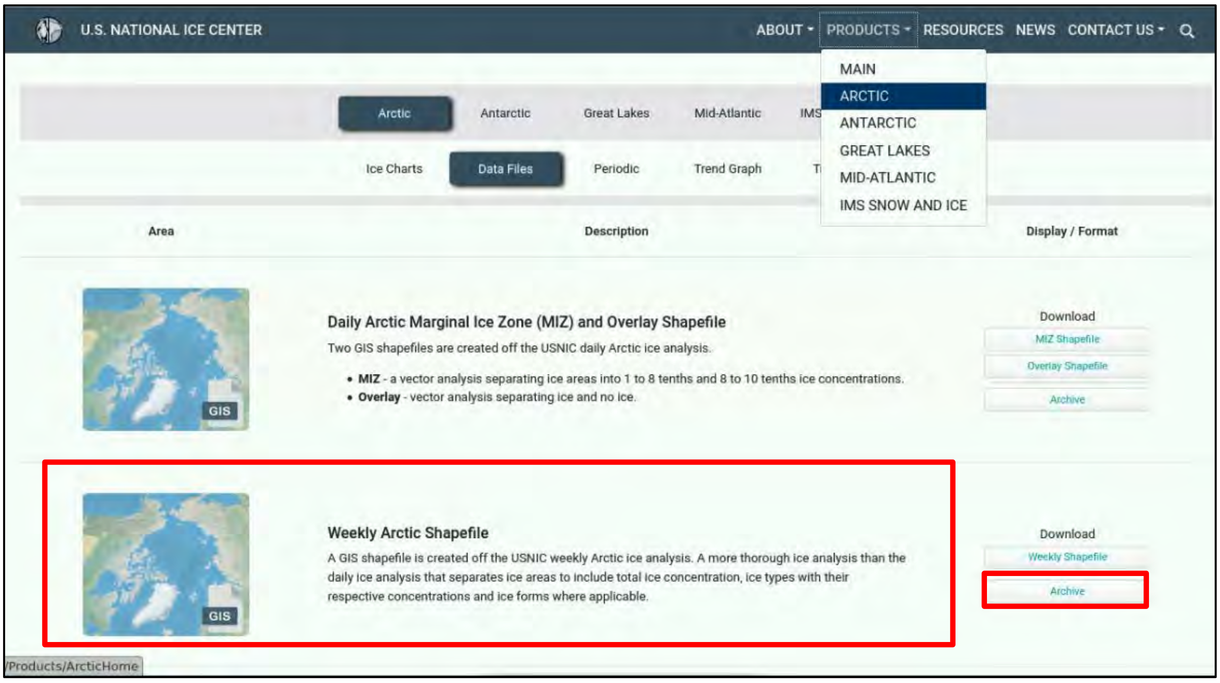
Follow the instructions in the JupyterLab Notebook to continue the exercise.

6.5 Additional clarifications

6.5.1 Download Ice Chart data

For this exercise the Ice chart data have already been downloaded and prepared for you. They have been downloaded from the U.S. National Ice Center. On the webpage you can find them in **Products → Arctic → Data Files**.

We will use the Weekly Arctic Shapefiles. You can search and download all the data in our study period (05/10/2021 to 22/03/2021) in the Archive.



Daily Arctic Marginal Ice Zone (MIZ) and Overlay Shapefile

Two GIS shapefiles are created off the USNIC daily Arctic ice analysis.

- **MIZ** - a vector analysis separating ice areas into 1 to 8 tenths and 8 to 10 tenths ice concentrations.
- **Overlay** - vector analysis separating ice and no ice.

Weekly Arctic Shapefile

A GIS shapefile is created off the USNIC weekly Arctic ice analysis. A more thorough ice analysis than the daily ice analysis that separates ice areas to include total ice concentration, ice types with their respective concentrations and ice forms where applicable.

Move the downloaded files to:

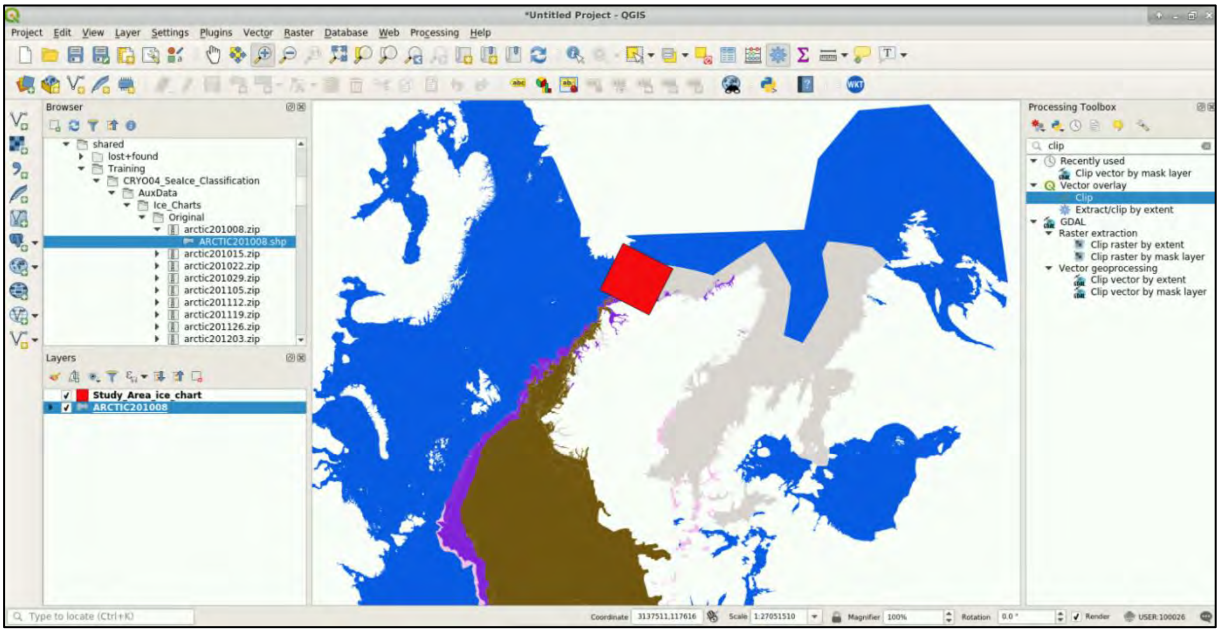
/home/rus/shared/Training/CRYO04_SeaIce_Classification/AuxData/Ice_Charts/Original/

Once we have the zipped archives downloaded, we can pre-process them in QGIS. Open QGIS and in the Browser tab on the left, navigate to the AuxData folder. Open the two following files:

/shared/Training/CRYO04_SeaIce_Classification/AuxData/Ice_Charts/Original/arctic201008.zip
/shared/Training/CRYO04_SeaIce_Classification/AuxData/Shapefile/Study_Area_ice_chart.shp

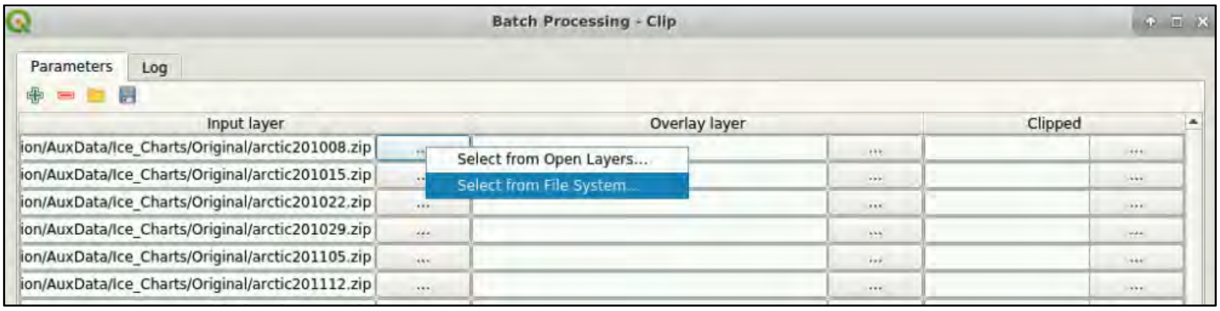
We can also enhance the visualization for the loaded ice chart right-clicking on it in the **Layers** tab and go to **Properties**. Then click **Style** at the bottom of the **Properties** window and go to **Load Style**, in the new window navigate to ***/shared/Training/CRYO04_SeaIce_Classification/AuxData/Shapefile*** and open the ***QGIS_oldClasses.qml.***

Click OK in all the menus to apply the style to the layer.



Then go to the **Processing Toolbox** on the right side and search for "***Clip***", open the clip operator menu and in the bottom click **Run as Batch Process…**

Now we have to load all our ice charts. To do this click the … next to the **Input Layer** field and select "***Select from File System***". Then select all the downloaded zipped charts and load them. You should now have one line for each chart.



Input layer	Overlay layer	Clipped
ion/AuxData/Ice_Charts/Original/arctic201008.zip		
ion/AuxData/Ice_Charts/Original/arctic201015.zip		
ion/AuxData/Ice_Charts/Original/arctic201022.zip		
ion/AuxData/Ice_Charts/Original/arctic201029.zip		
ion/AuxData/Ice_Charts/Original/arctic201105.zip		
ion/AuxData/Ice_Charts/Original/arctic201112.zip		

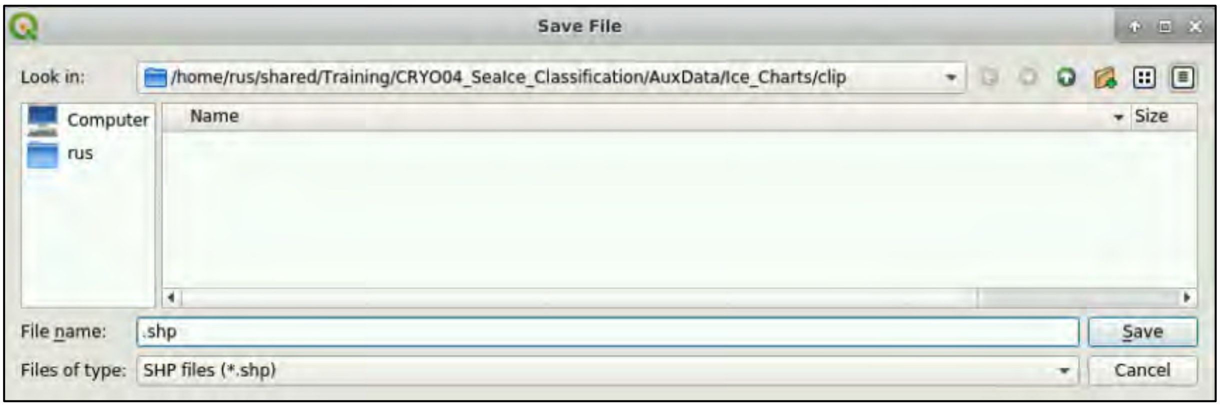
For the overlay layer we choose **Select from Open Layers** and choose the ***Study_Area_ice_chart.*** You can copy paste the name to each line.

Then we need to define the output layer names. Click on the … next to the first line of the "Clipped" column and navigate to the IceCharts folder:

/shared/Training/CRYO04_SeaIce_Classification/AuxData/Ice_Charts/

Right-click and create a new folder called “***clip***” then set:

File name: *“.shp”*
Files of type: *SHP files (*.shp)*



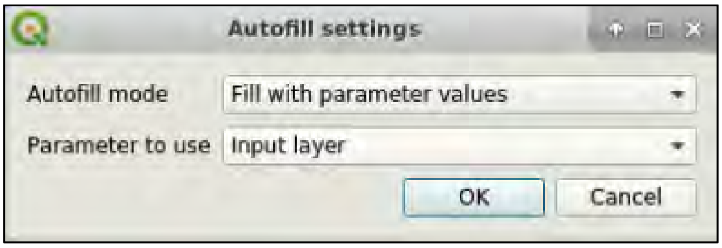
Look in: /home/rus/shared/Training/CRYO04_SeaIce_Classification/AuxData/Ice_Charts/clip

File name: .shp

Files of type: SHP files (*.shp)

Then click **Save**. A new menu will appear called **Autofill settings**. Set the following:

Autofill mode: *Fill with parameter values*
Parameter to use: *Input layer*

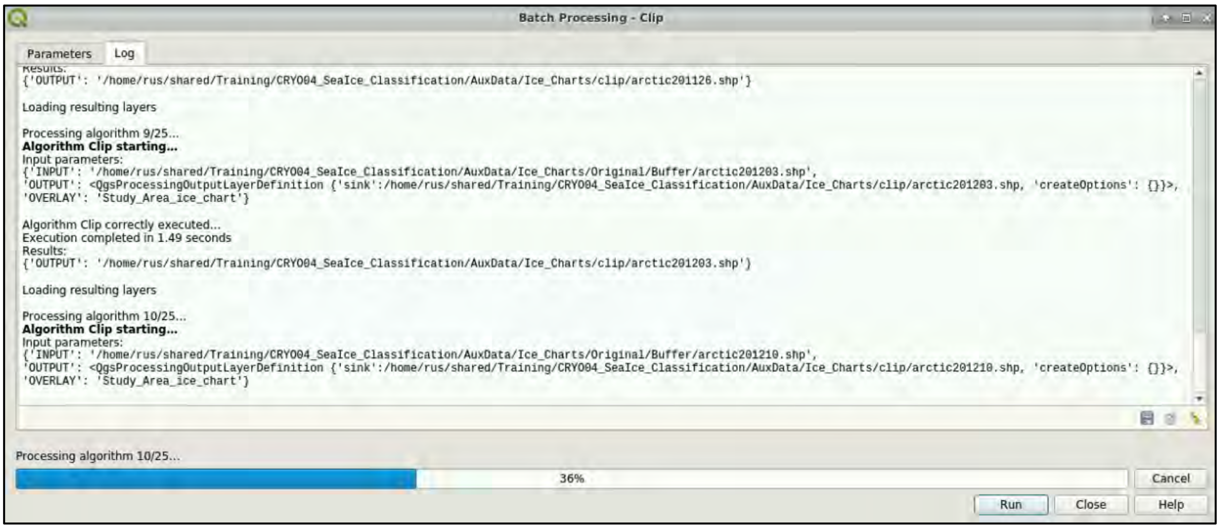


Autofill mode: Fill with parameter values

Parameter to use: Input layer

Then click **OK**. All the rows should now be filled with the path to the output product. The names of the output should be the same as of the input but saved in the ***“clip”*** folder.

Finally, we can click **Run**.



```
Results:
{'OUTPUT': '/home/rus/shared/Training/CRY004_SeaIce_Classification/AuxData/Ice_Charts/clip/arctic201126.shp'}

Loading resulting layers

Processing algorithm 9/25...
Algorithm Clip starting...
Input parameters:
{'INPUT': '/home/rus/shared/Training/CRY004_SeaIce_Classification/AuxData/Ice_Charts/Original/Buffer/arctic201203.shp',
'OUTPUT': <QgsProcessingOutputLayerDefinition {'sink':/home/rus/shared/Training/CRY004_SeaIce_Classification/AuxData/Ice_Charts/clip/arctic201203.shp, 'createOptions': {}}>,
'OVERLAY': 'Study_Area_ice_chart'}

Algorithm Clip correctly executed...
Execution completed in 1.49 seconds
Results:
{'OUTPUT': '/home/rus/shared/Training/CRY004_SeaIce_Classification/AuxData/Ice_Charts/clip/arctic201203.shp'}

Loading resulting layers

Processing algorithm 10/25...
Algorithm Clip starting...
Input parameters:
{'INPUT': '/home/rus/shared/Training/CRY004_SeaIce_Classification/AuxData/Ice_Charts/Original/Buffer/arctic201210.shp',
'OUTPUT': <QgsProcessingOutputLayerDefinition {'sink':/home/rus/shared/Training/CRY004_SeaIce_Classification/AuxData/Ice_Charts/clip/arctic201210.shp, 'createOptions': {}}>,
'OVERLAY': 'Study_Area_ice_chart'}
```

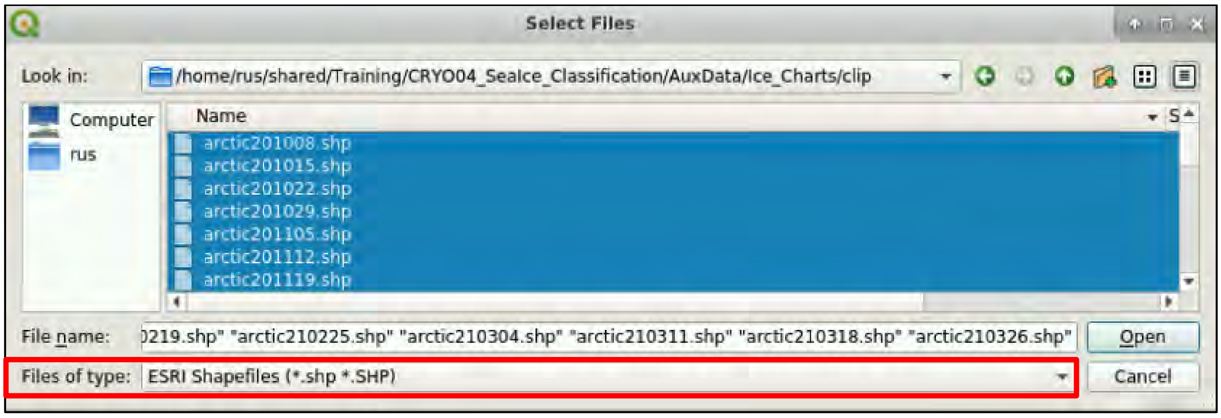
```
Processing algorithm 10/25...
36%
```

TIP: If you receive an error, then another step must be run to fix the bad geometry. In the same way we have now setup the batch processing for the clip, run the Buffer operator on all the files. Set the buffer distance to 0.00. we do not wish to apply a buffer, just to fix the geometry. Save the results into a new directory called buffer and then continue with the clip as described above.

Once our ice charts are clipped, we need to reproject them to the projection of our final image. When we apply the terrain correction in our code, we choose the "EPSG:32626 - WGS 84 / UTM zone 26N" we now need to apply the same for our ice charts.

In the **Processing Toolbox** search for "***Reproject layer***", open the operator menu and in the bottom click **Run as Batch Process…**

Similarly, as for the clip we need to select all our clipped input files. To only select .shp files set **Files of Type:** *ESRI Shapefiles (*.shp *.SHP)*



Look in: /home/rus/shared/Training/CRYO04_SeaIce_Classification/AuxData/Ice_Charts/clip

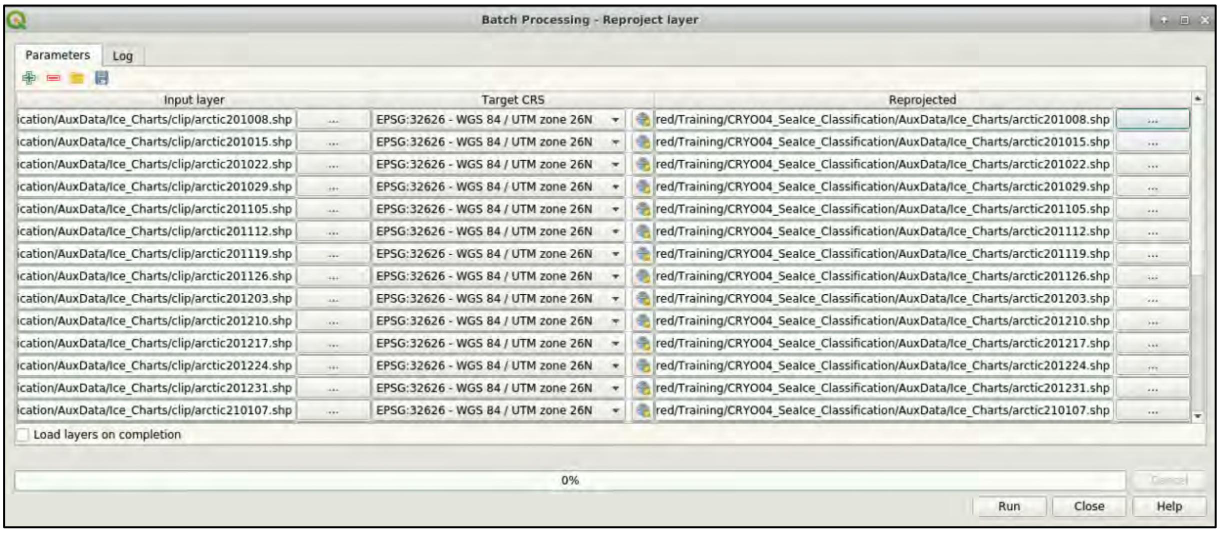
arctic201008.shp
arctic201015.shp
arctic201022.shp
arctic201029.shp
arctic201105.shp
arctic201112.shp
arctic201119.shp

File name: 0219.shp" "arctic210225.shp" "arctic210304.shp" "arctic210311.shp" "arctic210318.shp" "arctic210326.shp"

Files of type: ESRI Shapefiles (*.shp *.SHP)

Then complete the settings with the **Target CRS:** *EPSG:32626 - WGS 84 / UTM zone 26N*

And the Reprojected field filled the same way as for the clipped using the Autofill option. Save the results to ***/shared/Training/CRYO04_SeaIce_Classification/AuxData/Ice_Charts/***



Input layer		Target CRS	Reprojected	
ication/AuxData/Ice_Charts/clip/arctic201008.shp	...	EPSG:32626 - WGS 84 / UTM zone 26N	red/Training/CRYO04_SeaIce_Classification/AuxData/Ice_Charts/arctic201008.shp	...
ication/AuxData/Ice_Charts/clip/arctic201015.shp	...	EPSG:32626 - WGS 84 / UTM zone 26N	red/Training/CRYO04_SeaIce_Classification/AuxData/Ice_Charts/arctic201015.shp	...
ication/AuxData/Ice_Charts/clip/arctic201022.shp	...	EPSG:32626 - WGS 84 / UTM zone 26N	red/Training/CRYO04_SeaIce_Classification/AuxData/Ice_Charts/arctic201022.shp	...
ication/AuxData/Ice_Charts/clip/arctic201029.shp	...	EPSG:32626 - WGS 84 / UTM zone 26N	red/Training/CRYO04_SeaIce_Classification/AuxData/Ice_Charts/arctic201029.shp	...
ication/AuxData/Ice_Charts/clip/arctic201105.shp	...	EPSG:32626 - WGS 84 / UTM zone 26N	red/Training/CRYO04_SeaIce_Classification/AuxData/Ice_Charts/arctic201105.shp	...
ication/AuxData/Ice_Charts/clip/arctic201112.shp	...	EPSG:32626 - WGS 84 / UTM zone 26N	red/Training/CRYO04_SeaIce_Classification/AuxData/Ice_Charts/arctic201112.shp	...
ication/AuxData/Ice_Charts/clip/arctic201119.shp	...	EPSG:32626 - WGS 84 / UTM zone 26N	red/Training/CRYO04_SeaIce_Classification/AuxData/Ice_Charts/arctic201119.shp	...
ication/AuxData/Ice_Charts/clip/arctic201126.shp	...	EPSG:32626 - WGS 84 / UTM zone 26N	red/Training/CRYO04_SeaIce_Classification/AuxData/Ice_Charts/arctic201126.shp	...
ication/AuxData/Ice_Charts/clip/arctic201203.shp	...	EPSG:32626 - WGS 84 / UTM zone 26N	red/Training/CRYO04_SeaIce_Classification/AuxData/Ice_Charts/arctic201203.shp	...
ication/AuxData/Ice_Charts/clip/arctic201210.shp	...	EPSG:32626 - WGS 84 / UTM zone 26N	red/Training/CRYO04_SeaIce_Classification/AuxData/Ice_Charts/arctic201210.shp	...
ication/AuxData/Ice_Charts/clip/arctic201217.shp	...	EPSG:32626 - WGS 84 / UTM zone 26N	red/Training/CRYO04_SeaIce_Classification/AuxData/Ice_Charts/arctic201217.shp	...
ication/AuxData/Ice_Charts/clip/arctic201224.shp	...	EPSG:32626 - WGS 84 / UTM zone 26N	red/Training/CRYO04_SeaIce_Classification/AuxData/Ice_Charts/arctic201224.shp	...
ication/AuxData/Ice_Charts/clip/arctic201231.shp	...	EPSG:32626 - WGS 84 / UTM zone 26N	red/Training/CRYO04_SeaIce_Classification/AuxData/Ice_Charts/arctic201231.shp	...
ication/AuxData/Ice_Charts/clip/arctic210107.shp	...	EPSG:32626 - WGS 84 / UTM zone 26N	red/Training/CRYO04_SeaIce_Classification/AuxData/Ice_Charts/arctic210107.shp	...

□ Load layers on completion

0%

THANK YOU FOR FOLLOWING THE EXERCISE!

7 Further reading and resources

Park, J.-W., Korosov, A. A., Babiker, M., Won, J.-S., Hansen, M. W., & Kim, H.-C. (2020). *Classification of sea ice types in Sentinel-1 synthetic aperture radar images*. The Cryosphere, 14(8), 2629–2645. https://doi.org/10.5194/tc-1

Park, Jeong-Won; Korosov, Anton; Babiker, Mohamed; Sandven, Stein; and Won, Joong-Sun (2018): *Efficient noise removal of Sentinel-1 TOPSAR cross-polarization channel*, IEEE Transactions on Geoscience and Remote Sensing, 56(3), 1555-1565, https://doi.org/10.1109/TGRS.2017.2765248

Park, Jeong-Won; Won, Joong-Sun; Korosov, Anton A.; Babiker, Mohamed; and Miranda, Nuno (2019), *Textural Noise Correction for Sentinel-1 TOPSAR Cross-Polarization Channel Images*, IEEE Transactions on Geoscience and Remote Sensing, 57(6), 4040-4049, https://doi.org/10.1109/TGRS.2018.2889381

Remote Sensing Special Issue - Sea Ice Remote Sensing and Analysis

SIGRID-3 - A vector archive format for sea ice georeferenced information and data

Sentinel-1 User Guide

Sentinel-1 Technical Guide

SNAP GPT Guide

7.1 SW resources

Anaconda – Info and Download

Jupyter Notebook - Info

SNAP and snappy – Info and Download**,** snappy configuration

Sentinel1Denoised – Info and Download

RUS training on processing data with python and snappy (For Anaconda and Jupyter Notebook introduction)

7.2 Auxiliary and other data

Sentinel-1 Orbit files – STEP repository **or** Copernicus Sentinels POD Data Hub - if SNAP does not download automatically then individually zipped orbit files should be placed in the SNAP */auxdata/Orbits/* folder sorted by platform, year and month. (in RUS */home/rus/.snap/auxdata/Orbits/*)

Sentinel-1 Calibration Auxiliary Data - Sentinel-1 Quality Control **-** used by the Sentinel1Denoised algorithm, if not downloaded automatically then un-zipped AUX_CAL files should be placed in the */.s1denoise/*folder sorted by platform, year and month. (in RUS /home/rus/.s1denoise/)

Land polygons - Global Self-consistent, Hierarchical, High-resolution Geography Database (GSHHG) **-** subsetted and reprojected GSHHS_f_L1 layer was used to mask land areas in the exercise.

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