





TRAINING KIT – OCEA08

SARGASSUM MAPPING WITH SENITNEL-3

Case Study: Caribbean Sea, June 2018









Research and User Support for Sentinel Core Products

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Authors would be glad to receive your feedback or suggestions and to know how this material was used. Please contact us at <u>simon.b@rus-copernicus.eu</u>

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1 Introduction to RUS

The **R**esearch and **U**ser **S**upport for Sentinel core products (RUS) service provides free and open scalable platforms in a powerful computing environment, hosting a suite of open source toolboxes preinstalled on virtual machines, to handle and process data acquired by the Copernicus Sentinel satellites constellation.

In this tutorial, we will map Sargassum rafts in the Caribbean Sea on June 20th 2018 based on Sentinel-3 OLCI products. We will carry out this study in the SNAP software on RUS virtual machines.

2 Sargassum Mapping - Background



Pelagic Sargassum seaweed is a large brown alga floating at the ocean surface thanks to its gas-filled bladders. When present in reasonable amounts, it provides a safe habitat to many marine species such as the threatened loggerhead sea turtle. A large panel of fish species like mahi-mahi, jacks and amberjacks also use this floating vegetation as a nursery.

In the North Atlantic, pelagic Sargassum floats and grows at the

sea surface during its entire lifetime, aggregating and forming mats carried by winds, waves and currents over very long distances. Since 2011, Sargassum algae have been aggregating in rafts several kilometres wide. Massive stranding episodes have increased in periodicity and intensity in the Caribbean Sea, summer 2018 being the historical record so far. Once on the beaches, the rafts rot and decompose, leading to dramatic consequences on the environment, the tourism economy and human health.

It has hence become of prime importance to monitor these disastrous events, but their irregularity makes their forecasting complex. Moreover, the mechanisms at stake in the apparition and arrival of the rafts on shores still need more studies. In situ observations from drones or boats constitute key tools to quantify the algae amount available for stranding, but their coverage in space and time remains limited.

With their high spatial and temporal resolution and coverage, ocean colour satellites can help to fill in the gaps. For example, the satellite-based Sargassum Watch System (SaWS) provides monthly reports on the Sargassum situation based on MODIS, VIIRS and Landsat 8 images. It has not incorporated data from OLCI so far. This case study demonstrates a simple and powerful way of detecting Sargassum rafts with the Sentinel-3 OLCI instrument on June 20th 2018. The methodology presented here is inspired from Ody et. al (2019).

3 Training

The approximate duration of this training session is **one** hour.

The Training Code for this tutorial is OCEA08. If you wish to practice the exercise described below within the RUS Virtual Environment, register on the <u>RUS portal</u> to request a Virtual Machine. Go to Your RUS Service \rightarrow Your training activities and *Request a Webinar Training*.

3.1 Data used

1 Sentinel-3A and 1 Sentinel-3B images acquired on June 20th 2018 [downloadable @ <u>https://scihub.copernicus.eu/]</u>

S3A_OL_1_EFR____20180620T135849_20180620T140149_20180621T175740_0179_032_281_2700_LN1_O_NT_002.zip S3B_OL_1_EFR____20180620T135828_20180620T140128_20200114T081656_0179_009_281_2700_MR1_R_NT_002.zip

3.2 Software in RUS environment

Internet browser, SNAP+Sentinel-3 Toolbox+IdePix Plugin, QGIS

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 (<u>www.rus-copernicus.eu</u>) and click on *Login/Register* in the upper right corner.



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*.

Login / Register		542
Registered RUS users, as well as persons who already own a Copernicus SSO account, can directly access our service.	Copernicus Users' Single Sign On Regist	ration
Login Newcomers shall first create an account on the Copernicus Single Sign-On (SSO) authentication server used to support registration to the RUS service. Create my Copernicus SSO account	Tim always reportend U	
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. Close	The the instructions	

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

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

Login / Register	Credentials			1
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.	CDS-SSO ID Password			0
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.	Max Idle Time	half a day		0
REGISTER COPERNICUS SSO account Users who already have a COPERNICUS SSO account can login here:	Max Session Time	Login	Reset	
Login		Forgot your password?		

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



5 Request a RUS Copernicus Virtual Machine to repeat a Webinar

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** \rightarrow **Your training activities**.

CORRUS Research and User Support	NI 🌾 🌾 🛄 @esa Helio, Georgia 🕯			
The RUS Service 🔹 The RUS Offer 🔹 The RUS Library 🔹 The RUS Community 🔹 👷 Your RUS se	You are there: Home = Your RUS servic			
Your RUS service This services This services	Second P			
Your profile: displays your personal information linked to your FSA SSO and RUS accounts	News from RUS			
 Your dashboard: allows you to access your private dashboard, Your training activities allows you to request one or several webinars you are interested in or to register to a training session you have been invited to attend. 	The evolution of RUS viewed by EARSC RUS Training Session (online) – 5 Nov. 2020 RUS Training Session (online) – 29 Oct. 2020 RUS Webinar – Lebanon damage assessment using Sentinel-1 and Sentinel-2 – 27 Oct. 2020 RUS Webinar – Copernicus Data Access – 29 September 2020			
	RUS Webinar – Processing Copernicus data in Python using snappy – 23 June 2020			

Select OCEA08 – Sargassum Mapping in the Caribbean Sea with Sentinel-3, check the field "I have read and agree to the Terms and conditions of RUS Service" and then click on **Request Webinar** Training to request your RUS Virtual Machine.

CORRUS Research and User Support	Helio, Simon
The RUS Service * The RUS Offer * The RUS Library * The RUS Community * 🕵 Your RUS service *	
Your training activities Webinar Training Request You wish to practice a tutorial exercise shown in a RUS webinar? Please select your choice Select one or more items:	u are here: Home > Your RUS service > Your training activities
CRY003 - Snow Cover Mapping with Sentinel-2 CRY004 - Sea Ice Monitoring with Sentinel-12 CRY004 - Sea Ice Monitoring with Sentinel-5P ATM002 - Monitoring Pollution with Sentinel-5P ATM003 - Volcanic Emissions with Sentinel-5P OCEA08 - Sargassum Mapping in the Caribbean Sea with Sentinel-3 OCEA08 - Sargassum Mapping in the Caribbean Sea with Sentinel-3 I have read and agree to the Terms and conditions of RUS Service. Request Webinar Train	ing

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** \rightarrow **Your Dashboard** and click on **Access my Virtual Machine**.

NOTE: If the "*Access my Virtual Machine*" is greyed out, please access your VM from the direct link you have received at the email informing you about the creation of your VM.

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

RUS Desktop
Usernarbei
Pawword
Login
WELCOME TO RUS' DESKTOP

This is the remote desktop of your Virtual Machine.



6 Step by step

6.1 Data download – ESA SciHUB

In this step, we will download the Sentinel-3 scenes used for the exercise, from the Copernicus Open Access Hub using the online interface.

Go to Applications \rightarrow Network \rightarrow Firefox Web Browser or click the link below.

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

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.

Welcome to the Cope	rnicus Open Access Hub			Reports & Stats
The Copernicus Open Access I Sentinel-1, Sentinel-2, Sentine Sentinel Data are also availab	Data updated ho			
Please visit create script and asynchro For further details or requests	our User Guide for getting starto s for automatic search and down onous access to historic data via s of support please send an e-ma	ed with the Data Hub Interface. Disc load of Sentinels' data, with synchri the API and GUI. iil to eosupport@copernicus.esa.int	cover how to use the APIs and onous access to the latest data	prod. published in the last 24h
			õ	Reports
Open Hub	API Hub	S-5P Pre-Ops	POD Hub	DHUS Open Source Portal
Latest News		Search the news	all the news ()	Opernicus Copernicus Portal

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.

Copernicus O	pen Access Hub		20 🕈
Register n	ew account	團	1
Sentirel 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 valid Username field accepts only aburcase aplicationment characters plus $T_1 = 2^{-1} a^2 a^2 a^2_1 = 2^{-1} a^2_2 a^2_2 = 2^{-1} a^2_2 = 2^{-1} a^2_2 a^2_2 = 2^{-1} a$	ite your e-mail address. Following this you can start to download the data or γ_{c} or $c = 1, \dots, \infty$		•
Firstoame	Lastoame		
Usemane			
Password	Continn Pasawora		
E-mail	Cortlinm E-mail		
Select Domain			
Select Usage			
Select your country		_	
By registering in this website you are deemed	to have accepted the T&C for Sentinel data use.	REGISTER	

You will receive a confirmation email at 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 – LOGIN.



In this guide, we describe the procedure to download the Sentinel-3 images for June 20th 2018. Drag the map to the Caribbean Sea and define the study area using the source button (approximate area – orange rectangle). Then, open the search menu by clicking on the left part of the search bar (\equiv) and specify the parameters below. Press the search button (\bigcirc) after that.

Sensing period: From 2018/06/20 to 2018/06/20

Check mission: Sentinel-3

Product type: OL_1_EFR



In this case, the search returns 2 results (**blue** tiles). There is one S3A_OL_1_EFR product and one S3B_OL_1_EFR product, almost entirely overlapping.



As you can see, both products appear Offline. Hitting the download icon will trigger the offline product retrieval:



This will automatically add the product to the "**Cart**" \mathbf{r} . In case an error message appears, try again a bit later – you can request for one offline product per account per hour. (See \mathbf{r} NOTE 1 and \mathbf{r} NOTE 2). The product will be online within a few hours. Once online, the product will remain available for download for at least 3 days before it is moved back offline.

- NOTE 1: Please keep in mind that you cannot download more than 2 products at the same time, per account from SciHub.
- NOTE 2: You can find more information about the retrieval of offline/long term archive products here: <u>https://scihub.copernicus.eu/userguide/DataRestoration</u>. Most Sentinel products remain online for a month after they are published. They are then moved offline and need to be requested back online as previously shown. In a more general way, the <u>scihub user guide</u> is a very useful resource to check.

You need to repeat the same process for both images. The products will be downloaded to **/home/rus/** as zip archive. Move them to the below path and unzip the archives: **Right-click on the product** \rightarrow **Extract Here**.

Path: /shared/Training/OCEA08_SargassumMapping_Caribbean/Original/

6.2 SNAP – Open and Explore data

Once you have extracted the archives, open the SNAP software from the icon in located on the desktop. Hit the **Open Product** icon is browse to the *Original/* folder and open both Sentinel-3 products by selecting the **xfdunmanifest.xml** file of each product. You can also navigate to the product folder from a product browser and drag and drop the **xfdunmanifest.xml** file in the **Product Explorer Tab**.

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This tool endow is used to manpulate colouring of images shown in an im Right now, there is no selected image	the oge view. dew							1	

The products are now open in the **Product Explorer Tab** of the SNAP software. Feel free to expand the product trees by hitting the key button located left of each open product. Unfold the product content and appreciate how SNAP conveniently gathers the data into several folders.

The main data of interest (top of atmosphere radiances in the 21 spectral bands of OLCI) is stored in the **Bands** \rightarrow **Oa*_radiance** folder. The other folders contain data that give additional information on the context of the measurements. For example, the **Mask** folder encloses very useful information on the quality of the retrieval. **MetaData** contains static information about the product such as the timestamp, the platform name, the observation mode, etc...



If you want to check the properties of a band, right-click on the band and hit Properties.

* •	0a*_radi 0 a01 0 a02 0 a03 0 a04 0 a05 0 a05 0 a07 0 a08 0 a07 0 a08 0 a07 0 a08 0 a01 0 a12 0 a13 0 a14 0 a15 0 a16 0 a17 0 a18	ance radiance (400 n radiance (412.5 radiance (42.5 radiance (430 n radiance (500 n radiance (500 n radiance (500 n Add Elevation B Band Maths Convert Band Filtered Band Linear to/from c Engert Transect Open Image Wir Add Land Cover Cut	m) nmi nmi m) mi m) mi m) mi and de: Friets	Anne Description Modified PRASter Band Properties Unit Data Type Raster size Valid-Pixel Expression ta Value Used ata Value ral Wavelength ral Bandwidth ary Variables ary Relations		Oa08_radia TOA radian mW.m-2.sr- uint16 a865 * 6091 65535.0 665.0 10.0	nce re for OLCI acquisition 1.nm-1		
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6.2.1 Create RGB Image – Natural Colours Oa08, Oa06, Oa04

Right click on the S3A product and select **Open RGB Image Window**. Select **Oa08 for Red**, **Oa06 for Green** and **Oa04 for Blue**. Hit **OK** and the RGB view will open in the **View Window**

Product Explorer × P	ixel Infa	Mask Manager	07140149 20180		Select RGB-Image Ch	annels		• *
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			Green: \$1.0 Blue: \$1.0	a06_radiance		-		
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	Propertie	s						

🐐 TIP 1: \$1 Refers to the index number of the product in the **Product Explorer Tab**

Repeat the operation for the S3B product. Then go to **Window** \rightarrow **Tile Horizontally** to have a simultaneous view of both RGB images.



When on each view, select the Hand with the drag the view to your area of interest. Simply use the centre wheel of your mouse to zoom in and out. You can go to the **World View** tab and zoom in to see the location of the opened product(s) on the globe.

4	JI.		•
Navigatio	n - [Colour Manip	Uncertainty V World	d View 🛛 🗙 🖃
		12)	
	T		1000 Km



In the Navigation tab, click on the two icons shown within the **blue rectangle** below, to synchronize the views and the cursor position across the views.

You probably noticed that the images are a bit dark and not much is visible on them. We are going to improve the visualisation. For this go to the **Colour Manipulation** panel and for each **Red**, **Green** and **Blue** component, drag the sliders to the below values. You need to repeat the operation for both images

Name Ga08 radiance	Name: Ga06_radiance	Name. Daðá radiance
Unit mW.m-Z.st-1 mm-1	Unit_mW.m.2.sr-1.nm-1	Unif miV m-2 sr-3 nm-1
Min: 9,653	Min_19.643	Min 55 343
Max 547 1.62	Max_583.509	Max. 634.754
Rough statistics	Bough statistics	Rough statisticsi
~54	22 TA 22 ~72	103

You can also hit a slider value to change its defined value.



Once the views are clearer, we now distinguish different elements on our images.



First, we notice that both OLCI-A and OLCI-B sensors show very similar patterns. This is normal as the products were acquired 20 seconds apart and roughly cover roughly the same area. The S3A product name indicates that the measurements were collected between 13:58:49 and 14:01:49 UTC on June 20th 2018 whereas S3B measurements were collected between 13:58:28 and 14:01:28 UTC on June 20th 2018. On both views, we find the following elements:

- Wide areas covered in clouds at the upper left and lower right corners
- Sun glint on the right of the images (see 📒 NOTE 3).
- Caribbean Islands at the centre
- NOTE 3: Sun glint occurs when sunlight reflects off the surface of the ocean at the same angle that a sensor is viewing the surface

From these RGB views, it is very hard to distinguish where the potential Sargassum rafts are located. Zooming in on **particular areas** gives us a hint. As shown on the image below, **subtle dark green patterns** appear but they are not easy to spot with a bare eye on the RGB views.



6.2.2 The ocean colour spectrum

Another useful tool in SNAP is the **Optical** \rightarrow **Spectrum View** that allows you to check the spectrum of the ocean colour signal per pixel.



When hovering over the image, you will see how the ocean colour signal evolves from a pixel to another. Holding the shift key will automatically adapt the scale of the spectrum view. For example, on a dark blue pixel the spectrum will have a strong component in the blue part (short wavelengths) and a weaker component in the red and infrared parts.



When the cursor is located over a dark green pixel, the ocean colour spectrum has a much stronger component in the Near Infrared (NIR) and Infrared part of the spectrum compared to a 'clear water' pixel:



To better assess the spectrum differences between our pixels, it would be nice to plot both spectra on the same view. Good news: SNAP also has a functionality for this. We first need to place pins on

our images. Select the **Pin Placing tool button** A and add one pin (Pin 1) over a dark blue water pixel and one pin (Pin 2) over a dark green water pixel. In your **Spectrum View** graph, select the

Show spectra for all pin button Right clicking anywhere on the graph will display a selection of choices for:

- Setting your graph properties (Title, axes, labels etc)
- Export your graph as a PNG file (Save as...). It is also possible to export the spectra as a csv file with the button at the bottom right of the spectrum window.



To manage your pin colour and name or to delete a pin, go to **View→Tool Windows→Pin manager**. There you will be able to control your pin options. Changing a pin colour/name will also change the colour/name of its curve in the **Spectrum view**!



Analysing the ocean colour spectrum collected by OLCI can tell us a great deal about the ocean optical constituents content. We just saw that the spectrum collected by OLCI in the various bands varies a lot from one pixel to another.

It is this shift in the ocean colour spectrum that the Maximum Chlorophyll Index (MCI) exploits to highlight the areas where the probability of presence of Sargassum rafts is maximized (see 1 NOTE 4).

NOTE 4: The Maximum Chlorophyll Index (MCI) is an algae index based on the red-edge effect of floating vegetation. As highlighted before, there is an increase of the Sargassum radiometric signal in the NIR part of the spectrum (650-1200nm).

The MCI is computed from the difference between the Top of Atmosphere (TOA) radiances in the central waveband λ_2 , where the red-edge effect of the floating algae signal is at a maximum, and a linear baseline drawn between the two surrounding bands λ_1 and λ_3 :

$$MCI = r(\lambda_2) - [r(\lambda_1) + (r(\lambda_3) - r(\lambda_1)) * \frac{\lambda_2 - \lambda_1}{\lambda_2 - \lambda_1}]$$

Where $r(\lambda_x)$ are the OLCI L1 EFR TOA radiances for bands:

- $\lambda_1 = 681 \ nm \rightarrow \text{Oal0}$
- $\lambda_2 = 709 \ nm \rightarrow 0a11$
- $\lambda_3 = 754 \ nm \rightarrow \text{Oal2}$

For more details on MCI for OLCI, see Ody et al. (2019).



6.2.3 The quality flags

Alongside the TOA radiances in the 21 spectral bands, the OLCI L1 products contain a set of flags that give contextual elements around the measures. To display the different masks, as for the **Pin Manager**, go to **View→Tool Windows→Mask manager**. From there, you can **activate/deactivate a particular mask by ticking/unticking the boxes**, **change the colour of a mask** or set its **transparency**.



For this study, we would like to ignore land pixels (quality_flags_land) and cloudy pixels. However, there is no cloud flag in the OLCI L1 product. We will hence need to compute our own cloud mask using the SNAP **Idepix for OLCI Processor**.

6.3 SNAP – Idepix Processor

The Idepix processor for OLCI retrieves a set of pixel classification attributes such as clear/cloudy, land/water, snow/ice, etc. The implementation of the features calculation is instrument specific meaning there is an Idepix processor per supported instrument (including but not limited to: MSI on board Sentinel-2, OLCI on board Sentinel-3, MERIS on board ENVISAT, OLI on board Landsat 8, etc.). For cloud detection, the following features are used: brightness, whiteness, height, temperature, spatial pattern, temporal consistency, Neural Network probability.

If this is your first use of the Idepix processor, the plugin needs to be downloaded and installed in SNAP beforehand. Go to **Tools**->**Plugins** and select **IdepPix OLCI** & **IdePix Core** and hit **Install**. Then hit **Next** and agree to the terms and conditions. After the installation, hit **Finish** and SNAP will restart. You will need to import the OLCI products again following the beginning of section 6.2.

5		8	Plugins	
Ele Edit View Analysis Layer Vector Raster Optical Radar Tools Product Explorer Pixel Info Mask Manager X Name Type Colour Transpare. Description Product Pixel	Window Help etadata	Cupatra 111 Available Billigans 153 1	Disentionalitier Instantier (18) Settings Staff Staff Caracita Staff Staff Staff Caracita Staff Staff Staff Staff Staff	Smorth hated Pfugin s more classification of plants class, alon, i.e., sum classification of plants class, alon, i.e., sum classification of plants classification sum classification of plants classification along the sum of the sum of the sum of the sum of the sum of classification of the sum of the sum of the sum of the sum of classification of the sum of the sum of the sum of the sum of the sum of the sum of the sum of th
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6.4 SNAP – Sentinel-3 Processing

We are going to apply several processing steps to both products:

- Cloud identification with IdePix
- Spatial subset to crop the products to our area of interest
- MCI Computation in a new Band (BandMath)
- Addition of the new MCI band to the output product (BandMerge)
- Reprojection of the product to define a Coordinate Reference System (CRS)

Repeating these steps for every image one by one would be very time consuming. For this reason, we can create a graph containing all the steps of our methodology and use the batch processing option of SNAP to run bulk processing.

6.4.1 Graph Builder

We will use the **GraphBuilder** tool, to create a chain with the processing steps we want to apply and at the end, only the final product will be physically saved (this way we will also save disk space since the products of the intermediate steps will not be stored). To create an empty graph, go to **Tools** \rightarrow **GraphBuilder**. At the creation, the graph only has two operators: *Read* (to read the input) and *Write* (to write the output). To avoid any confusion, **right click on the** *Write* **operator and delete it**.

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In the Graphbuilder, we will not define any parameters in the tabs (they will be defined in the Batch Processing step where we will apply this processing for both of the images we have downloaded, at once). We will only create and save the graph.

First, we compute the cloud mask out of the OLCI bands. To add the IdePix operator (be sure the plugin is installed first, see section 6.3), right click and go to Add->Optical->Pre-Processing->IdePix.Olci.



Immediately after adding the operator, make sure to **UNTICK the Compute cloud Shadow** option in the IdePix.Olci Tab as this option makes the SNAP software crash. Then, connect the Read operator to the IdePix Processor. To connect two blocks, start from the right of the block to create a red arrow and drag it to the following block

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We then need to create a **Subset** of the image, since we want to focus only over a defined area and we do not need the whole extent of the products. To add the **Subset** operator, go to **Add→Raster→Geometric→ Subset**. Connect the IdePix.Olci operator to it.



The next processing step will be to derive the MCI for the pixels that are not flagged as cloudy by the IdePix processor (*IDEPIX_CLOUD* flag) and that are not land pixels (*quality_flags_land*). For this task, we will use **Band Math**. To add the Band Math operator, right-click and go to Add->Raster->BandMath. Connect the operators as shown below.



In batch processing mode, the output of the BandMaths operator is the computed band (MCI) only. In our output product, we would like to save some additional data such as reflectances and product flags. To merge the MCI band with the subsetted product bands we will use the Add->Raster->BandMerge operator.



Then let's set a CRS to our product. We will use **Add→Raster→Geometric→ Reproject.**

Read Idepix.Olci Subset BandMerge Reproject	e
BandMaths	

Finally, we just need to properly save the output. Right click and navigate to Add→Input-Output→Write. Your final graph should be similar to the one shown below:

Read Hepix.Olci Subset BandMerge Reproject	Write
BondMaths	

Finally, click on Save in the lower part of the panel and save the graph in the following path as '*MCI_Graph.xml*' without setting any parameter.

Path: /shared/Training/OCEA08_SargassumMapping_Caribbean/AuxData/

TIP 2: If you did not succeed to create the processing graph, you will find a backup version in /shared/Training/OCEA08_SargassumMapping_Caribbean/AuxData/Backup

6.4.2 Batch Processing

If the same processing scheme is applied to multiple images, the **Batch Processing** tool is what you are looking for. To use the **Batch Processing** tool go to **Tools→Batch Processing**. First, you need to **Load the Graph** you want to run. Hit **Load Graph**, browse to /shared/Training/OCEA08_SargassumMapping_Caribbean/AuxData/ and load MCI_graph.xml. New tabs corresponding to our operators appear at the top of the window.

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In the **I/O Parameters tab**, unselect the "**Keep source product name**" option. In the same tab, we will add all opened products from the Product Explorer window by clicking **Add Opened button** at the right and then hit **Refresh**. In our case, we have loaded the S3A and S3B images from June 20th 2018.

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6.4.2.1 IdePix Olci Processor

In the IdePix.Olci tab, select the Oa10, Oa11 and Oa12_radiance bands (needed to compute the MCI). Select also the Oa04, Oa06 and Oa08 reflectance bands (to generate a RGB view later if you wish to) as shown below (see NOTE 5). To select multiple bands, hold the *Ctrl* key. Keep the Compute cloud buffer ticked and leave the default value of 2 for the width of cloud buffer. This option dilates the IdePix cloud mask with a 2-pixel buffer to deal with cloud edges and cloud shadows.

NOTE 5: Radiance is the variable directly measured by remote sensing instruments. It is the amount of light seen by instrument from a surface of an object. In the OLCI products, it is given as 10-3 W.m-2.sr-1.µm-1

Reflectance is the ratio (percentage) of the amount of light leaving a target to the amount of light arriving at the target. It has no units. It is the property of the observed object/material.

I/O Parameters Idepix Olci Subset BandMat	hs BandMerge Reproject N	Nrite
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Select TDA reflectances to write to the target product	Oa01_reflectance Oa02_reflectance Oa03_reflectance Oa04_reflectance Oa05_reflectance Oa05_reflectance Oa07_reflectance Oa08_reflectance	
Write NN value to the target product		
Compute cloud shadow		
Path to alternative NN for CTP retrieval	[
if cloud shadow is computed, write CTP value to t	the target product	
Compute a cloud buffer		
Width of cloud buffer (# of pixels):		
Use SRTM Land/Water mask		-

6.4.2.2 Subset

In the **Subset** tab, first select all **Source Bands**. Then select **Geographic Coordinates**, copy and paste the following Well-Known Text (WKT) in the box beneath the map, hit **Update** to define the area and then hit the button in the top righthand corner of the map to zoom-in.

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6.4.2.3 BandMath – MCI

Click now on the **BandMaths** tab, set the target band name to **MCI** set the **No-Data value to NaN**, click on **Edit Expression** and copy and paste the following expression into the box. Click OK afterwards.

if quality_flags_land==False and IDEPIX_CLOUD==False and IDEPIX_CLOUD_BUFFER==False then Oa11_radiance-(Oa10_radiance+(Oa12_radiance- Oa10_radiance)*(709-681)/(754-681)) else NaN

This expression means that the MCI gets computed only over clear-sky water pixels. Over land and/or cloudy pixels, the value will be set to NaN. You will also find the MCI expression in /shared/Training/OCEA08_SargassumMapping_Caribbean/AuxData/MCI.txt

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6.4.2.4 BandMerge

In the BandMerge Tab, select all source bands. You can select all source bands by selecting one band and then using the *Ctrl+A* keyboard shortcut.



6.4.2.5 Reproject

In the **Reproject Tab**, you can choose from a wide variety of CRS, for example the **UTM/ WGS 84** (Automatic) towards the bottom of the list. Unselect the **Reproject tie-point grids** option.

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6.4.2.6 Write

In the Write tab, under Name keep the default name (Projected, Subset and IDEPIX will be added). At the Directory set the path to */shared/Training/OCEA08_SargassumMapping_Caribbean/Processing/*

Finally Hit **Run**! The processing may take up to 15mn on a RUS VM. It might take more time if you are practicing on your own computer. The processed products will automatically open in the **Product Explorer Window** when the processing is completed ((see **NOTE** 6).

NOTE 6: When executing the graph on a RUS VM, it may happen that SNAP suddenly closes without any warning because of a RAM shortage. If this happens, first go to */shared/Training/OCEA08_SargassumMapping_Caribbean/Processing/* and delete the written output(s) as they will only be partial. Then restart SNAP and open both Sentinel-3 products again (section 6.2). Then open the batch processing tool again and repeat all the steps of section 6.4.2.

6.5 Analysis of the processed products

Both products now contain an MCI band. Let's open the MCI band from each product. The first view is black and white. To add a colour ramp, go to Colour manipulation \rightarrow Basic \rightarrow Colour Ramp. There, you will find a set of pre-defined colour bars.

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To correctly visualize the MCI, we are going to use a colour ramp created ahead if this webinar. For

this, hit the **Import colour palette from text file** button and navigate to */shared/Training/OCEA08_SargassumMapping_Caribbean/AuxData/* and select *MCI_OLCI.cpd*. When opening the file, a window will appear, hit No.

ow Hidden Files to	make the .snap / folder appear.
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Zoom In	Ctrl++
Zoom Out	Ctri+
Normal Size	Ctrl+0
View as Icons	Ctrl+1 0
• View as Detailed List	Ctri+2
View as Compact List	Ctrl+3



You need to repeat the operation for the second view.

TIP 4: Once you have defined a convenient style for a view, you can apply this style to other views by hitting the button from the Colour Manipulation tab. Then you just need to select the opened band you wish to apply the colour ramp to.

In the product the light blue areas correspond to the dark water regions. The Sargassum rafts are easily identified by the yellow stripes. The black pixels are the ones that were either flagged as land, or cloud/cloud_buffer by the **IdePix processor** and set to NaN in the **BandMath** operation.

To further enhance the view, you can activate the *IDEPIX_CLOUD* and *IDEPIX_CLOUD_BUFFER* masks by selecting the check box to the left of the name of each mask in the Mask Manager and set their colour to light grey. You can also activate the *quality_flags_land* mask on both images.



If you want to export an interesting view, right-click anywhere on the view and select **Export View as Image**.



You can see how some rafts seem to mark current meanders and eddies borders and centres.



We also observe that most Sargassum rafts present east-west thin filament structures most probably caused by wind.

7 Conclusions

Satellite imagery is widely used to detect and map floating vegetation. Space-borne technologies offer a frequent and global coverage of our oceans. As this exercise highlighted, simple index computations based on the red-edge spectral properties of the Sargassum in the near infrared part of the spectrum allow for a relatively easy detection of large rafts. The Sentinel-3 constellation constitutes a valuable asset to map Sargassum distribution at large scales on a frequent basis. Furthermore, the OLCI products could be combined with other sensors to create multi-sensor products and hence ensure a gap-free coverage of the Caribbean Sea.

However, satellite data present some drawbacks and in situ data remain essential to create a reliable Sargassum monitoring system. OLCI spatial resolution (300m) limits the detection of smaller aggregations. The tropical Atlantic Ocean also often experiences Saharan dust plumes that may decrease the Sargassum signature in the near infrared and hence make the MCI computation unreliable. In addition to these dust episodes, sun glint, clouds and haze that are typical to tropical regions create further gaps in the observations. OLCI captures very well the floating algae at the very surface of the ocean but Sargassum located a few centimeters (10-15cm) below the surface are not well detected. It is also very challenging to discriminate Sargassum from other floating vegetation or even from other floating material such as plastic and oil that have a similar spectral signatures in the NIR.

Finally, detecting rafts is not equivalent to accurately quantifying the Sargassum biomass available for strandings on coasts. MCI is not a concentration measure but an indicator to highlight the areas covered by potential Sargassum rafts. A pixel flagged by the MCI may be composed of several sub-pixel sized aggregations which can reach a depth of half a meter.

As a conclusion, the MCI computed out of OLCI products is a very efficient tool for detecting the position of floating material rafts under relatively clear sky conditions, but complementary information is needed to fill in the gaps in satellite ocean colour data and quantify the biomass available for stranding. Moreover, monitoring and forecasting these disastrous aggregations requires that other sea state parameters such as the wind strength and direction, wave height or currents be taken into account. For more explanation, do not forget to read the article from Ody et al. (2019) which inspired this exercise.

8 Extra steps – Export to QGIS

8.3 Export as a GeoTIFF

SNAP allows the user to export the outputs as GeoTIFF for further analysing and processing in a GIS software such as QGIS. To do this, make sure to select the output product in the Product Explorer Tab. Then from File→Export, choose the GeoTIFF option. In the dialog tab that opens, hit Subset.

-	SNAP - Export Product	+ = ×
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At the **Band Subset** (second tab) use the **Select none** button to unselect them all first and then select only the MCI band. Then go to the **Metadata Subset** tab and click **Select none**. Finally, hit **OK** and hit **No** in both dialog tabs that open.

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uality_flags Classification and quality flags	Marifest
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Oall_radiance TDA radiance for OLCI acquisition band Oall	I frame_offeet
Oal2_radiance TOA radiance for OLC/ acquisition band Oal2	arvibda0
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Oa06_reflectance Reflectance converted from radiance	atmospheric_temperature_profile
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Define your export folder thanks to the Save in option and hit Export Product.

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Files of Type:	GeoTIFF product (*.tif,*.tiff)	

8.4 Opening the File in QGIS

Your GeoTIFF is now ready to be opened in QGIS (**See 1** icon from your VM desktop)! First open the software. From the **left panel**, expand the **XYZ Tiles** and drag the **OpenStreetMap** and drop it to the **layer** panel.



Then, from a file browser, drag and drop your generated GeoTIFF in QGIS and zoom in to the Caribbean Sea using the central wheel of your mouse. A black and white view of the MCI has opened.



Double-click on the GeoTIFF layer. This will open the properties of your layer. In the Symbology section, set the **Render Type** as **Singleband pseudocolor**. Then with the button, navigate to /shared/Training/OCEA08_SargassumMapping_Caribbean/AuxData/ and open the MCI_colour_QGIS.txt file which is a pre-defined colour ramp. Then simply hit OK.



Enjoy the result!



THANK YOU FOR FOLLOWING THE EXERCISE!

9 Further reading and resources

Sentinel-3 OLCI User Guide https://sentinel.esa.int/web/sentinel/user-guides/sentinel-3-olci Sentinel-3 OLCI Technical Guide https://sentinel.esa.int/web/sentinel/technical-guides/sentinel-3-olci Sentinel-3 Marine User Handbook https://earth.esa.int/eogateway/documents/20142/1564943/Sentinel-3-OLCI-Marine-User-Handbook.pdf Sargassum Side Event, All Atlantic 2021 workshop https://www.eu4oceanobs.eu/all-atlantic-2021/sargassumsideevent/ Satellite-based Sargassum Watch System (SaWS) https://optics.marine.usf.edu/projects/saws.html High quality Sargassum Mapping in the W-Atlantic with OLCI https://people.mio.osupytheas.fr/doglioli.andrea/Ody_etal_IOCS17_OLCI.pdf

10 References

Ody A, Thibaut T, Berline L, Changeux T, André J-M, Chevalier C, et al. (2019) From *In Situ* to satellite observations of pelagic *Sargassum* distribution and aggregation in the Tropical North Atlantic Ocean. PLoS ONE 14(9): e0222584. <u>https://doi.org/10.1371/journal.pone.0222584</u>

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