Working with OLCI Level-2 data

Contents

1 Introduction

OLCI (https://sentinel.esa.int/web/sentinel/missions/sentinel-3/instrument-payload/olci) is ESA's advanced ocean and land color sensor on the Sentinel-3A satellite launched in 2016 and on Sentel-3B launched in 2018. OLCI has WRR (Water Reduced Resolution) data products at ~1000 m spatial resolution and WFR (Water Full Resolution) data products at ~300 m resolution. WFR data are especially useful in coastal zones but their disadvantage seems to be their higher uncertainty.

2 OLCI Level-2 data structure

While OLCI data are in netCDF like NASA OBPG data, ESA has adopted a different structure for OLCI data. In contrast with NASA's OBPG data where many products are packed into a single netCDF file, the OLCI Level-2 files have a single product and the names show only the name of the product (e.g. **chl_oc4me.nc**) while all the other information is in the long directory name, e.g. S3A_OL_2_WRR____20170217T175858_20170217T184245_20170218T230720_2626_014_255 _____MAR_O_NT_002.SEN3. Each file has the data product and the corresponding error product, e.g. **CHL_OC4ME** (chlorophyll concentration of the OC4-Meris algorithm) and CHL_OC4ME_err. The latitude and longitude arrays (LLA) are in a separate file **geo_coordinates.nc** in the same directory with many product files. WIM can read OLCI Level-2 data files with the corresponding LLA files (geo_coordinates.nc) starting with version 10.x.

2.1   Evaluating OLCI Level-2 data with WIM

Find one of the directories with OLCI Level-2data, e.g. S3A_OL_2_WRR____20170217T175858_20170217T184245_20170218T230720_2626_014_255 _____MAR_O_NT_002.SEN3. Click or double-click on **chl_oc4me.nc** and then load **CHL_OC4ME** (chlorophyll concentration of the OC4-Meris algorithm).WIM will prompt for a file with coordinates – select the **geo_coordinates.nc** in the same directory.
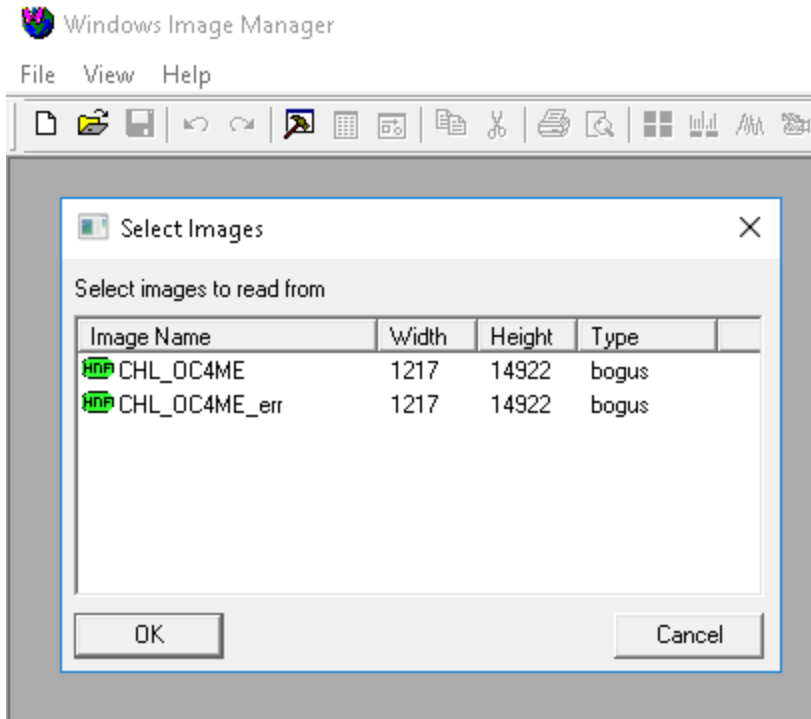
You can scroll down and find an interesting area, e.g. with the Gulf of California. You can check that the geo-coordinates are good by creating and overlaying coastlines. Use *Geo-Get Map Overlay-coast_full.b* and use background pixel value 0 and foreground pixel value 1 (black).
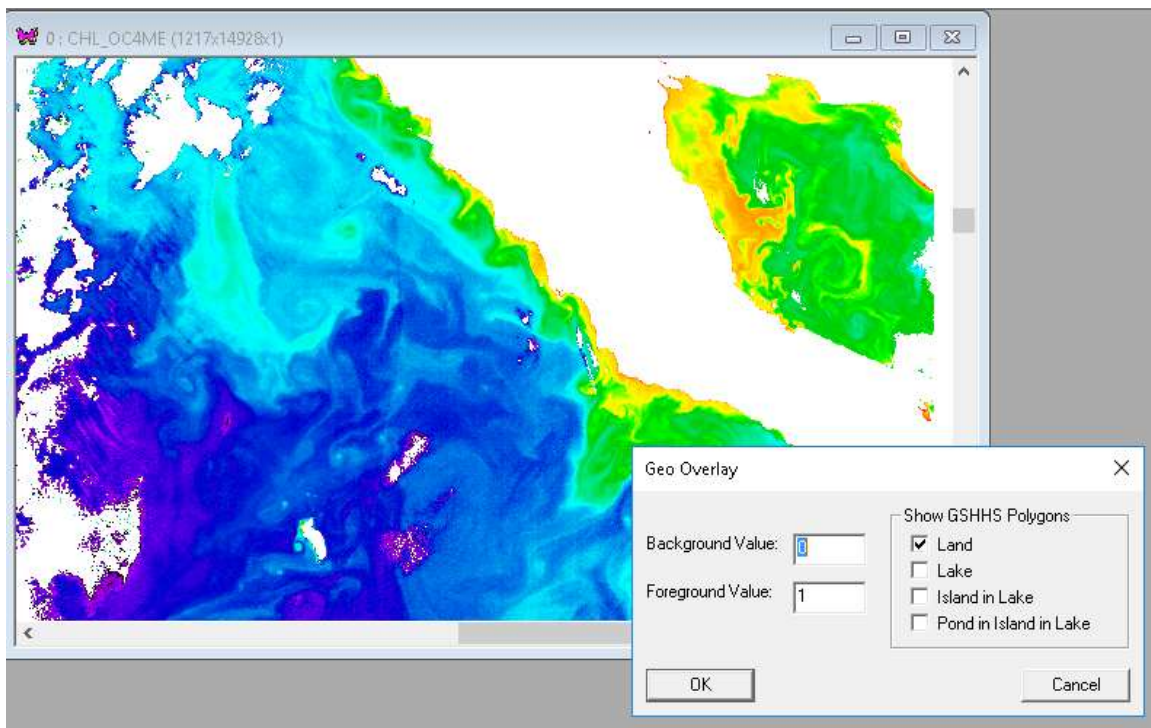
Now overlay the coastlines image on the Chla image. The coastlines should match very well with the image. Now load the level-2 flags image from **wqsf.nc** (you have to select **geo_coordinates.nc** again in the same directory. Select the Hammer (Settings) icon on the Toolbar and set value scaling to Bitmask for the flags image.
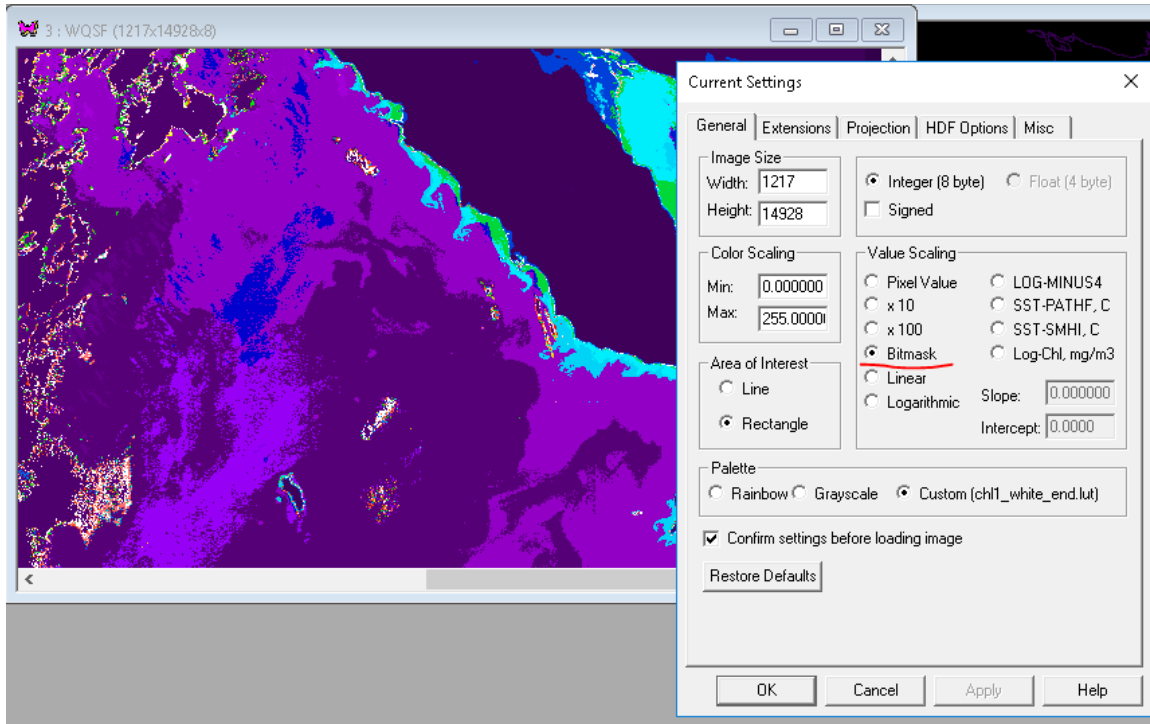
When you right-click and move your mouse pointer around, you can see the various flags that are set for the selected pixels. For example, LAND flag is always set for land pixels.

wam_remap_lladir is a WAM command line tool for processing OLCI level-2 data. Open command window one level up from the directory with OLCI level-2 data and type the name of the command (*wam_remap_lladir*) to seeall the options. Now type (copy and paste):

wam_remap_lladir S3A_OL_2_WRR____20170221* chl_oc4me.nc   flags=no

(we have added spaces in the above command line to make it better readable).

As you can see, we have shortened the directory name and use * after the date. We load data from file **chl_oc4me.nc** and use the option **flags=no**, i.e. not using flags. The output is the same Chla image saved in P2017052175445.L2_WRR_MAR_O_NT_002.SEN3_chl_oc4me.x.hdf.

Load the CHL_OC4ME image and confirm that it is the same (e.g. by *Multi-Difference*). Rename the just saved ***chl_oc4me.x.hdf** file to ***chl_oc4me.x_noflags.hdf**, i.e. noting that we did not use flags when creating this file. Now try the same command **without** the flags=no option:

wam_remap_lladir S3A_OL_2_WRR____20170221* chl_oc4me.nc

…and compare both images.
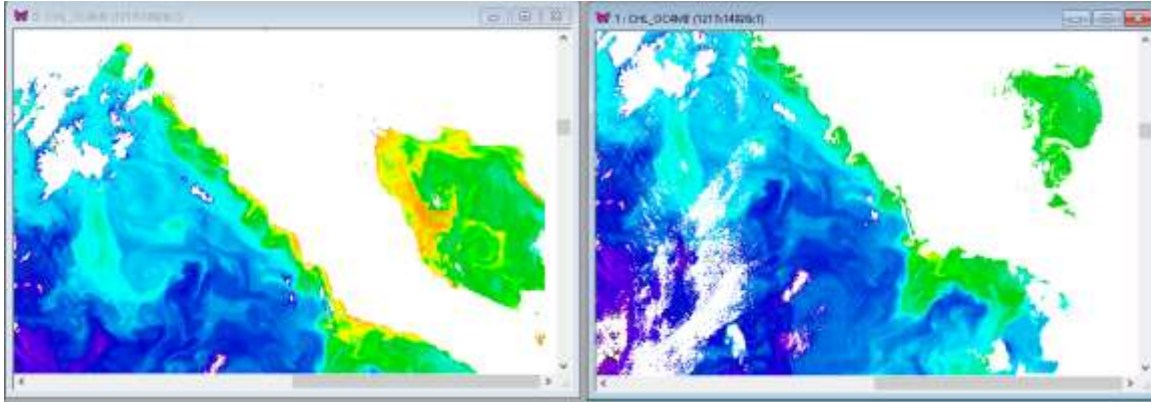
As you can see, the image processed with **flags=no** option (above left) has much more data compared to the image processed with the default flags (above right). Many pixels in the above right image have been set to the invalid value (255, white). In this case the flagging may seem excessive as the flagged data look pretty good. However, when you scroll down and right in the unflagged image (below left) you see obviously bad areas (black) that have been correctly flagged image in the flagged image (below right). So, what is going on in these flagged areas?
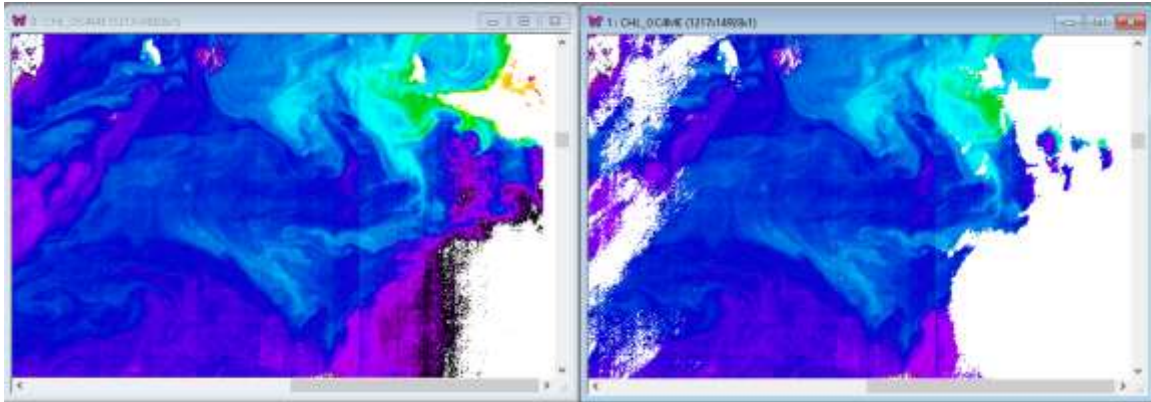
Load the flags image from **wqsf.nc**.
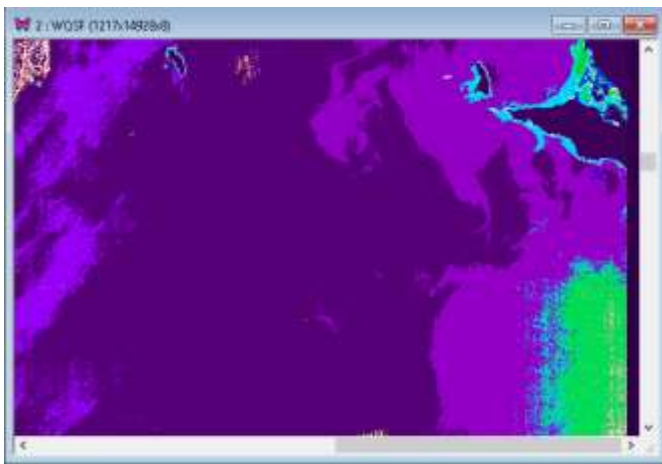
Set value scaling to bitmap and right-click on the questionable areas. You can see that many flags are set in the flagged areas (e.g. the green area in the image to the left) but most importantly HIGHGLINT. Therefore, it seems that the flagged area is primarily due to high sun glint that prevents correctly deriving in-water properties.

You can check the Attributes (icon on the Toolbar)) to see the flag names under *flag_meanings*:

INVALID WATER LAND CLOUD CLOUD_AMBIGUOUS CLOUD_MARGIN SNOW_ICE
INLAND_WATER TIDAL COSMETIC SUSPECT HISOLZEN SATURATED MEGLINT HIGHGLINT
WHITECAPS ADJAC WV_FAIL PAR_FAIL AC_FAIL OC4ME_FAIL OCNN_FAIL KDM_FAIL BPAC_ON
WHITE_SCATT LOWRW HIGHRW ANNOT_ANGSTROM ANNOT_AERO_B ANNOT_ABSO_D
ANNOT_ACLIM ANNOT_ABSOA ANNOT_MIXR1 ANNOT_DROUT ANNOT_TAU06 RWNEG_O1
RWNEG_O2 RWNEG_O3 RWNEG_O4 RWNEG_O5 RWNEG_O6 RWNEG_O7 RWNEG_O8
RWNEG_O9 RWNEG_O10 RWNEG_O11 RWNEG_O12 RWNEG_O16 RWNEG_O17 RWNEG_O18
RWNEG_O21

These are the 51 flags (originally there were 49 and since R004 processing CLOUD_AMBIGUOUS and CLOUD_MARGIN were added).

The following flags are recommended to make a pixel invalid in validation exercises:

INVALID, LAND, CLOUD, CLOUD_AMBIGUOUS, CLOUD_MARGIN, SNOW_ICE, SUSPECT,
HISOLZEN, SATURATED, HIGHGLINT, WHITECAPS, AC_FAIL, OC4ME_FAIL, ANNOT_TAU06,
RWNEG_O2, RWNEG_O3, RWNEG_O4, RWNEG_O5, RWNEG_O6, RWNEG_O7, RWNEG_O8

You can see the effect of flags filtering below: the left image has no pixels eliminated and the right image has eliminated all pixels according to the recommended flags. The left image has better coverage, especially in coastal areas but also erroneously low values along cloud edges.
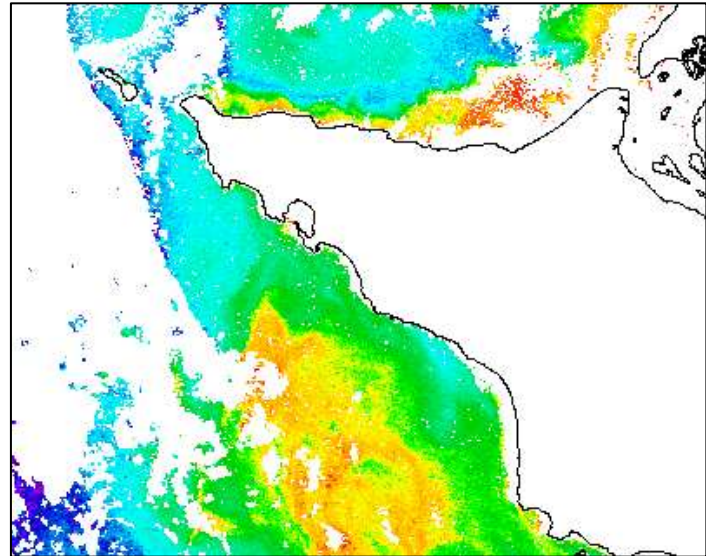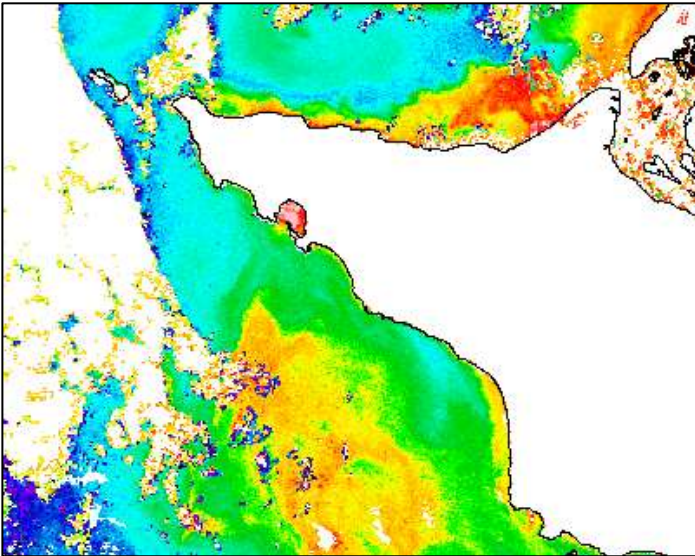
2.2   Remapping with wam_remap_lladir

As you may have realized, the L2 images are not mapped (i.e. they are in satellite-view). That's why they need the LLA (latitude-longitude arrays) for each set of images. With *wam_remap_lladir* you can not only extract images of your interest from the OLCI directories and save them with LLA in HDF4 files but also remap to your standard map projection. LLA wastes disk space and therefore it is better to map datasets to a common map. For example, like that:

wam_remap_lladir S3A_OL_2_WRR* chl_oc4me.nc map= ..\Mymap.hdf

You can add more options to the command:

wam_remap_lladir S3A_OL_2_WRR_____20170221* chl_oc4me.nc map=
California\cal_aco_3840.hdf flags=no colorMin=44 colorMax=210 overlay=Yes

The above command extracts the Chla image, remaps to a map specified with map=XXX in the command line and saved as a mapped HDF4 image. It also stretches the colors from 44 to 210 and overlays the map image on top of the ChlMe image. This way you can add coastlines, color bar, etc. Annotations are added if their position is specified, e.g. with options xPos=XX and yPos=YY where XX is the x-coordinate from left and yPos is the y-coordinate from top. Below is a subset of an unflagged Chla image, mapped to a standard Albers Conic Equal Area map (the image has been reduced by 4x). You can stretch the colors manually (see below right) or add them to the command line (with colorMin and colorMax).

You can run the same operation for many directories with a SINGLE command. For example, wam_remap_lladir S3A_OL_2_WRR* chl_oc4me.nc

will go through all directories matching **S3A_OL_2_WRR*** and look for files like chl_oc4me.nc. It will read the 0-th dataset (CHL_OC4ME) from each file and the latitude-longitude arrays (LLA) from *geo_coordinates.nc* in each directory and save as HDF-LLA, i.e. with the latitude and longitude arrays in each file. Don't forget to add other options to the command line! The saved files will be given names like P2017052175445.L2_WRR_chl_oc4me.x.hdf where "P" is a letter identifying OLCI data on Sentinel A and R is the identifier for OLCI data on Sentinel 3B. Note that identifier S was taken by SeaWiFS, O by OCTS), 2017 is the year, 052 is the day of the year (February-21), 175445 is the time (17:54:45), L2 shows the processing level, WRR is the product and resolution (RR = reduced resolution), chl_oc4me is the product name.
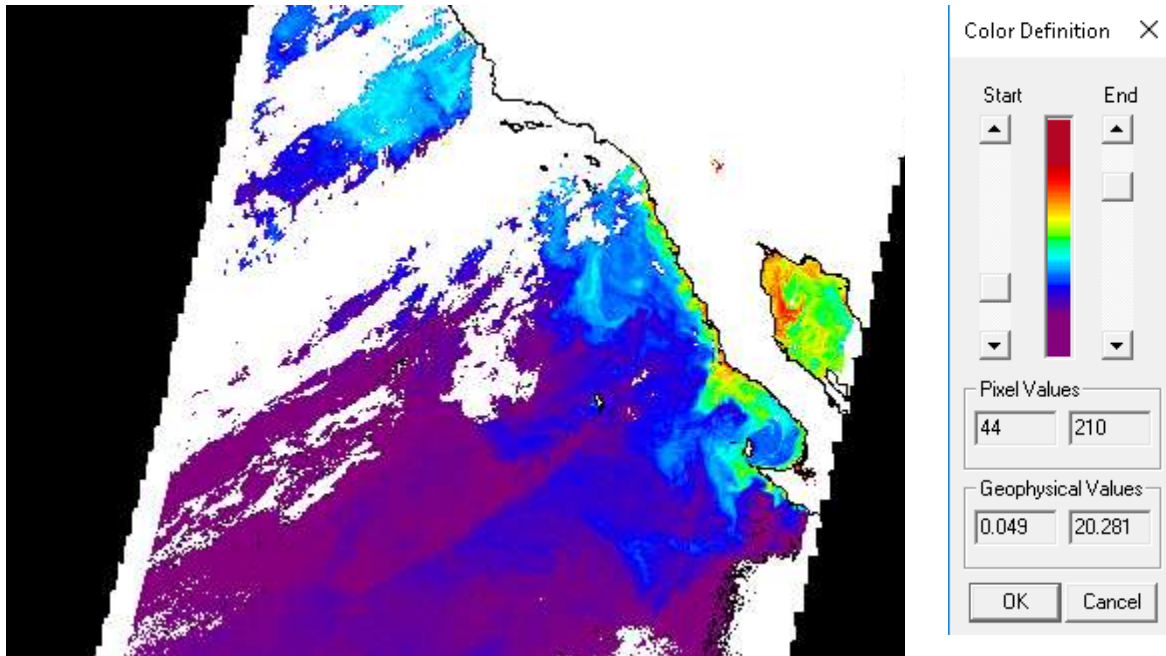
For remapping we need a WIM file with a projection, e.g. ..\Mymap.hdf. The naming of the output file is similar with the ending of ".mapped.hdf" instead of just ".hdf". The mapped file is typically an order of magnitude smaller than the unmapped (HDF-LLA) file.
Similar commands can be applied for other product types, e.g. PAR and reflectance.

wam_remap_lladir S3A_OL_2_WRR* par.nc map= ..\Mymap.hdf

The command above will extract PAR, map to the specified projection and save as HDF4.
wam_remap_lladir S3A_OL_2_WRR* *reflectance.nc map= ..\Mymap.hdf
The command above will extract all *reflectance.nc files, map to the specified projection and save as HDF4. Note that while there was just one chl_oc4me.nc   and one par.nc file in each directory, there are multiple *reflectance.nc files and therefore all matching reflectance datasets will be mapped and saved.

We can also set the color range manually or in the command line. For example, color range from pixel value 44 to 210 that corresponds to Chla range approximately 0.05 to 20 mg m^{-3} (see above right). The same can be set in command line with options colorMin=44 and colorMax=210.

Note that when data from both OLCI sensors (on Sentinel 3A and 3B) will be available, you can merge data files (P*.hdf from OLCI-3A and R*.hdf from OLCI-3B) from these sensors.