

# Working with OLCI Level-2 data

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## 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. Another OLCI on Sentinel-3B is planned to be 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 the disadvantage is their higher uncertainty.

## 2 OLCI Level-2 data structure

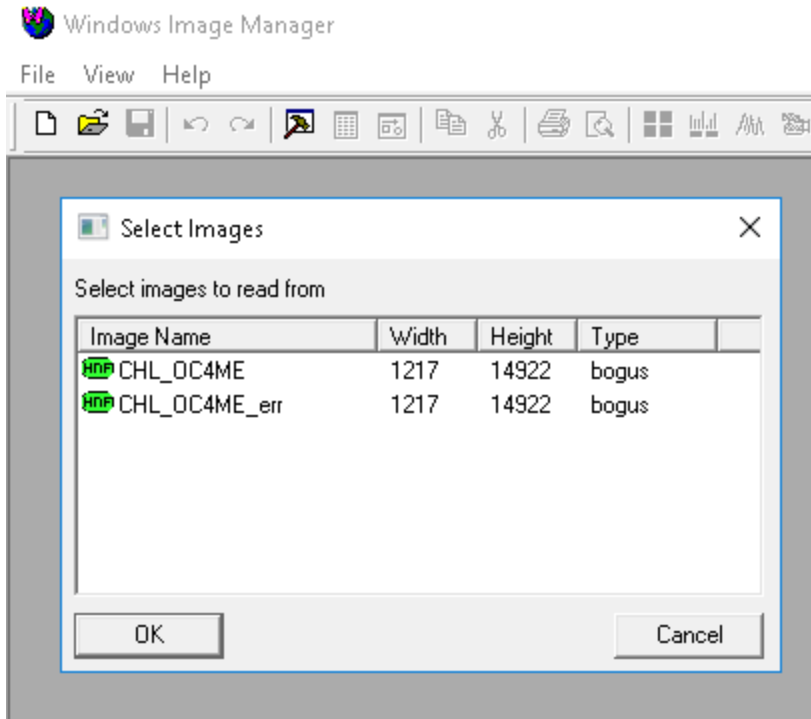
While OLCI data are in netCDF like NASA OBPG data, ESA has adopted a very different structure for OLCI data. In contrast with NASA's OBPG data where many products are packaged into a single netCDF file, the Level-2 files have a single product and the names show only the name of the product (e.g. **chl\_oc4me.nc**) 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 itself 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 as well as many other files. Starting from version 10.x WIM can read OLCI Level-2 data files with the corresponding LLA files (**geo\_coordinates.nc**). More tools for working with OLCI data will be added.

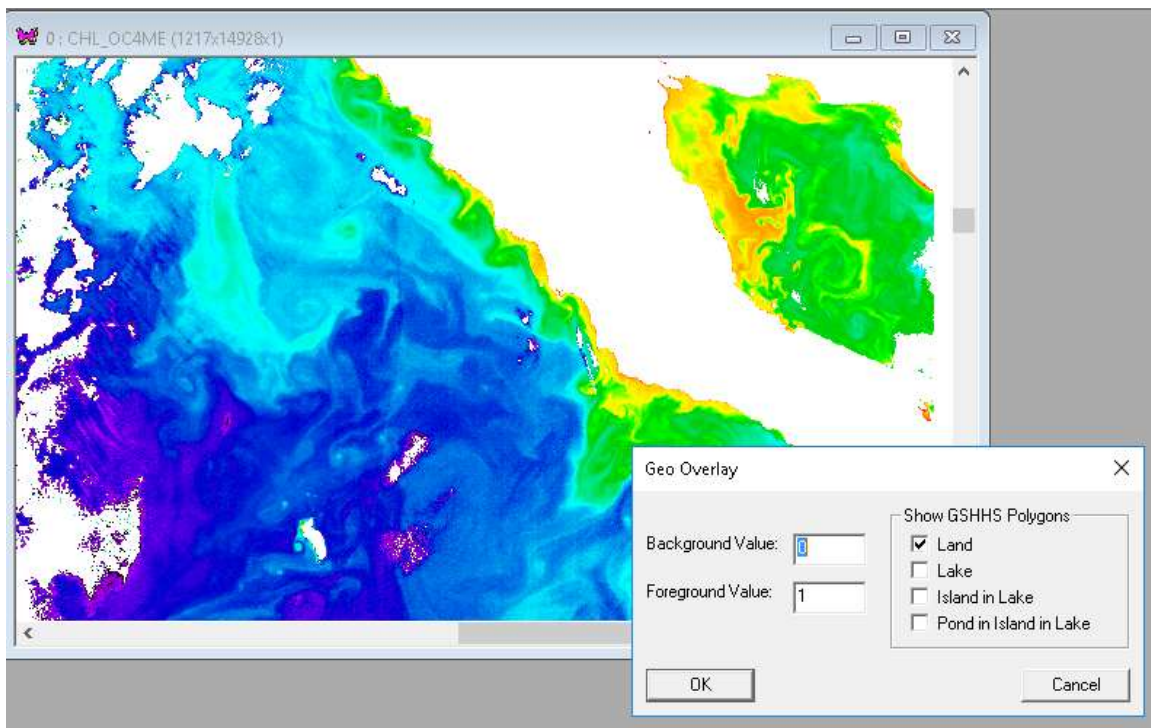
### 2.1 Evaluating OLCI Level-2 data with WIM

Find one of the directories with OLCI Level-2 data, e.g.

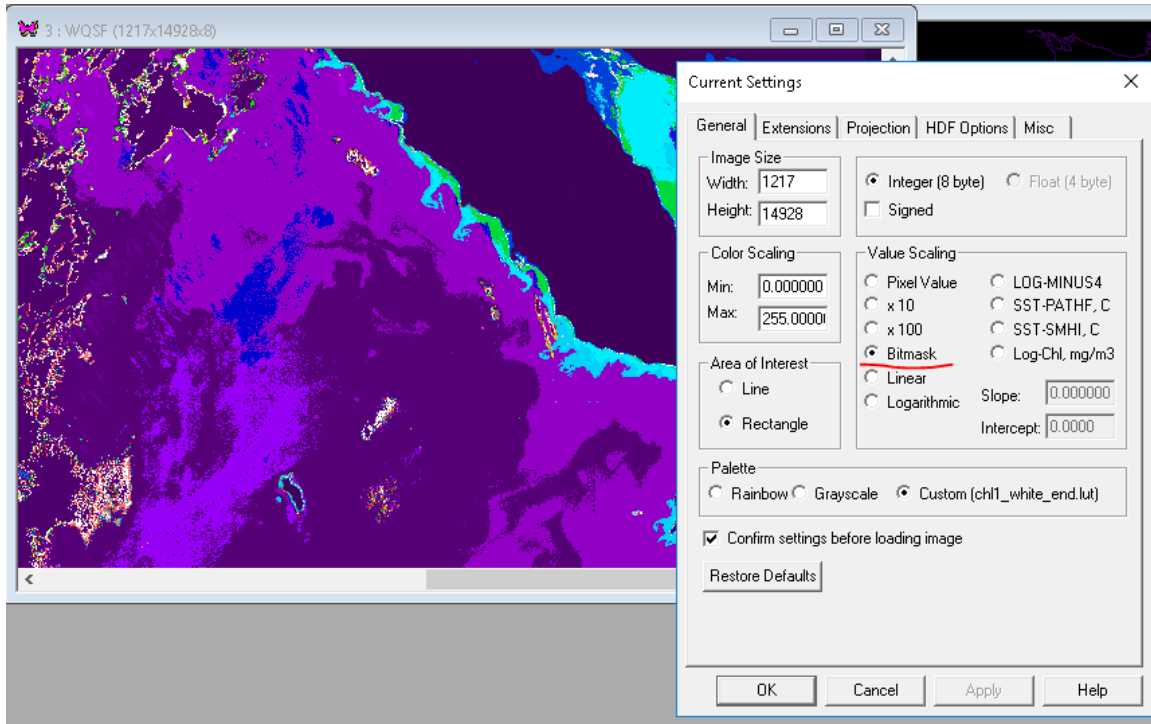
S3A\_OL\_2\_WRR\_\_\_\_20170217T175858\_20170217T184245\_20170218T230720\_2626\_014\_255\_\_\_\_MAR\_O\_NT\_002.SEN3. Click or double-click on **chl\_oc4me.nc** and then load **CHL\_OC4ME** (chlorophyll concentration of the OC4-Meris algorithm). WIM will prompt for a file with coordinates – select the **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 or copy and paste the name of the command (**wam\_remap\_lladir**). That shows you all the options. Now type:

```
wam_remap_lladir S3A_OL_2_WRR____20170221* chl_oc4me.nc flags=no
```

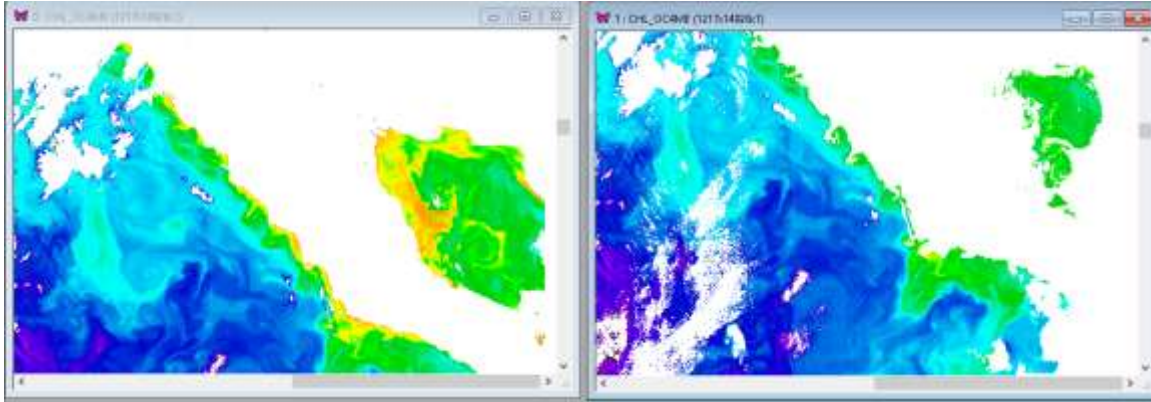
(we have added spaces in the above command line to make it better readable).

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.

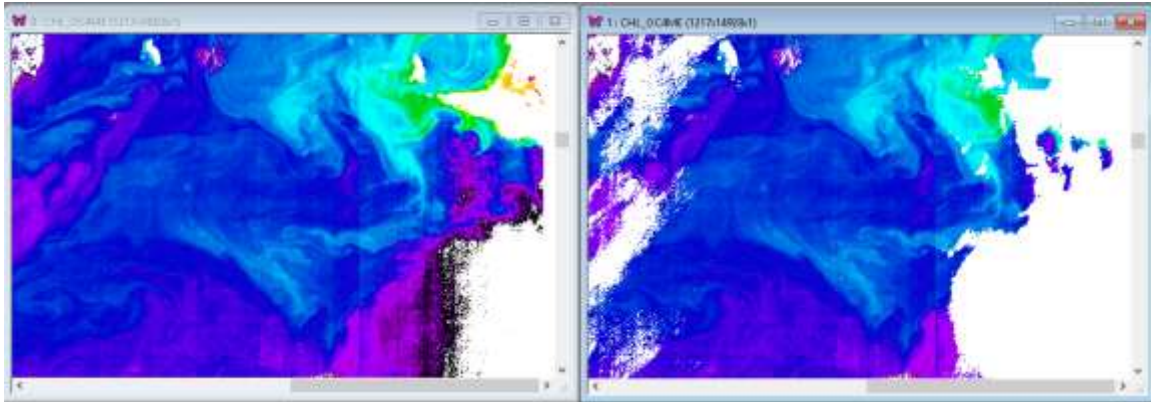
Load the CHL\_OC4ME image and confirm that it is the same (e.g. by *Multi-Difference*). Rename the just saved **\*chl\_oc4me.x.hdf** file to **\*chl\_oc4me.x\_noflags.hdf**, i.e. noting that we did not use flags when creating this file (image). Now try the same command **without** the flags=no option:

```
wam_remap_lladir S3A_OL_2_WRR____20170221* chl_oc4me.nc
```

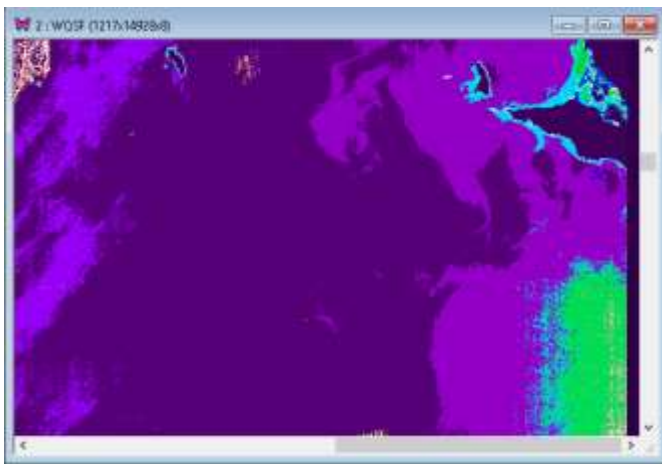
You can now compare both images.




As you can see (above), the image processed with **flags=no** option has much more data as the image processed with the default flags option has many pixels set to the invalid pixel value (255, white). In the image above the flagging may seem excessive as the flagged data looks pretty good. However, when you scroll down and right in the unflagged image (below left) you see dark (black) areas that do not seem correct. On the flagged image these areas are flagged (white). So, what is going on in these flagged areas?



Load the flags image from **wqsf.nc** (if you don't have it in WIM already).



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, 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*:



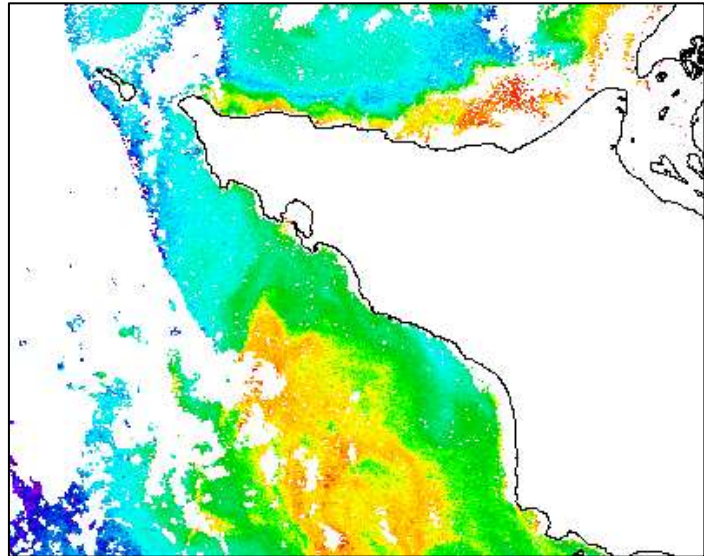
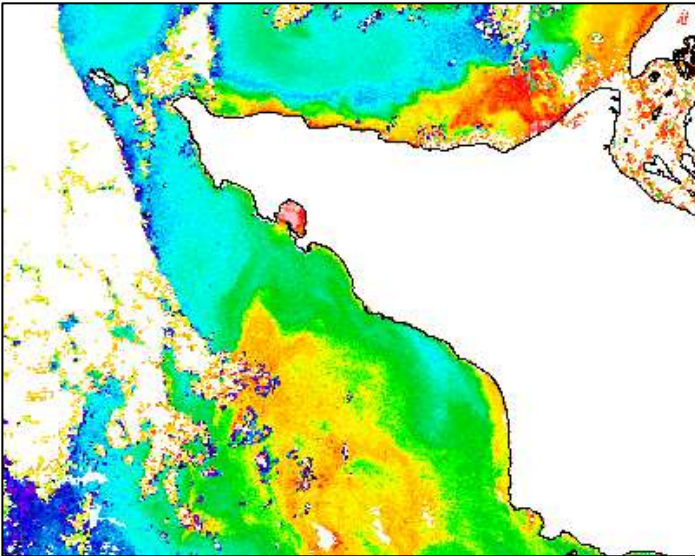
INVALID WATER LAND CLOUD CLOUD\_AMBIGUOUS CLOUD\_MARGIN SNOW\_ICE  
 INLAND\_WATER TIDAL COSMETIC SUSPECT HISOLZEN SATURATED MEGLINT HIGHGLINT  
 WHITECAPS ADJAC WV\_FAIL PAR\_FAIL AC\_FAIL OC4ME\_FAIL OCNF\_FAIL KDM\_FAIL BPAC\_ON  
 WHITE\_SCATT LOWRW HIGHRW ANNOT\_ANGSTROM ANNOT\_AERO\_B ANNOT\_ABSO\_D  
 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 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 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
```

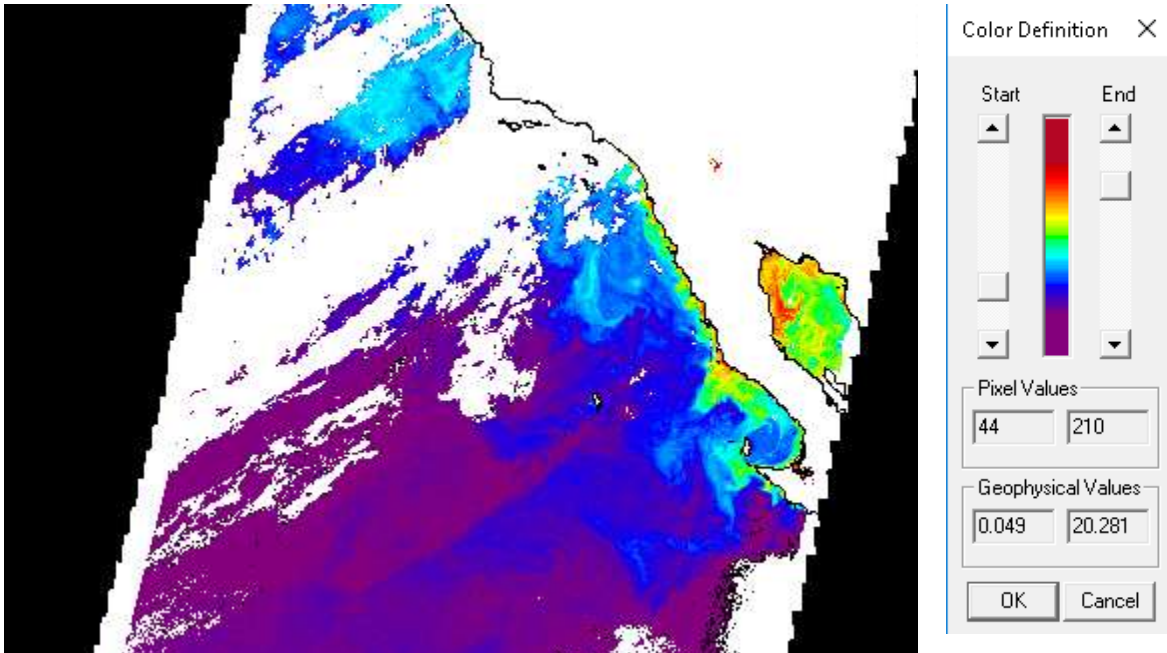
You can add more options to the command:

```
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 just a letter identifying this product (S was taken by SeaWiFS, O was taken 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<sup>-3</sup> (see above right). The same can be set in command line with options `colorMin=44` and `colorMax=210`.