NEODAAS data delivery

Project Details

Principal Investigator:	Lea-Anne Henry
Data recipient (if different):	Lea-Anne Henry
NEODAAS Project Code:	20_01_henry_iatlantic
Date:	September 3, 2020

1 Introduction

This file has been generated specifically for your NERC Earth Observation Data Acquisition and Analysis Node (NEODAAS) project and includes important information about your data. Please make sure you read it fully before trying to use your data.

2 Delivery Contents

The following directories are contained in your delivery:

Directory name	Description
docs	Directory containing documentation
data	Directory containing requested data
data/OC-CCI	Directory containing CCI Ocean Colour derived products
data/SST-CCI	Directory containing CCI Sea Surface Temperature derived products

The filename convention is '<sensor>_<product>[_<algorithm>]_<level>_<area>_<period>_<date>[_<time>][_<end-date>][_<palette>].<file_extension>'
Items in square brackets may not appear depending on the data you have received. These items are:

- <sensor> is the sensor name (for example MODIS, SeaWiFS, MERIS, AVHRR)
- <product> is the product contained in the file (for example chlor)
- <algorithm> is the algorithm used to generate the product (for example OC3, OC5)
- <level> is the processing level identifier (usually L3, may occasionally be L1 or some other descriptor)
- <area> is the code for the area covered by this file (see section 3)
- <period> is a specifier for the time period covered by this file (eg. 0d (0-day, or single-pass), 1d (daily composite), 7d (7-day composite), 1m (monthly composite))
- <date> is the date on which the data in this file were recorded. If the file covers a number of days, this is the start date.
- <time> is the time at which the data in this file were recorded. This will appear only if the file is from a specific sensor pass.
- <end_date> will appear only if the file covers a range of dates, and is the last date for which the file contains data.
- <palette> is the palette used for your data, where this is applicable (eg. rsg-grey, nasa-col)
- <file_extension> is a short string denoting the file format (for example 'nc' for netCDF data)

So an example filename might be:

MODIS_chlor-a_oc3_L3_uk_0d_20140618_1353_rsg-grey.png

This would represent a greyscale MODIS OC3 chlorophyll PNG file at level 3 for the uk area, recorded at 1353 on 18th June 2014.

3 Areas

These files have been mapped and restricted to your area(s) of interest, please note that in some cases the supplied data may cover an area larger than your requested area - if this causes a problem please contact NEODAAS.

For netCDF files the latitude and longitude of each pixel are stored in separate arrays within the netCDF file named 'latitude' and 'longitude'. Many programs will automatically recognise these as containing the pixel locations.
The supplied areas are:

Code	Latitude range	Longitude range	Projection	Reference resolution
iatlantic	50-75N	46W-3E	Geographic	9km

4 Data processing details

4.1 Processing levels

Various processing ‘levels’ have been defined by NASA to describe the states in which remote sensing data may be found. These levels have been adopted by NEODAAS (among others) to describe our data. Data are typically delivered at level 3, but other levels may be delivered if requested by the user. Your delivery contains the following processing levels:

Level 3

Level 3 data are satellite data that have been geocorrected for satellite position and view angle and then projected into a mapped image. Level 3 data will be the only data of use to most users.

4.2 File format

NEODAAS will endeavour to deliver data in your preferred file format. In the event that your preferred format is felt by us to be inappropriate for the data you have requested, we will have discussed this with you in advance. A short description of the file formats present in this delivery follows, we will be happy to provide advice on the use of these if this would be helpful to you - please contact us if you would like this.

These data are delivered in the following formats:

netCDF

NetCDF (Network Common Data Format) is a self-describing container format designed for scientific data. This means that a single file can contain multiple datasets and the metadata that allows these to be usefully interpreted. It is a standard file format for environmental data and is the preferred delivery format for NEODAAS data where the data are to be read into a computer program or analysis package.
The metadata within the netCDF file will contain information about the map projection used (if any). Packages opening the netCDF file for viewing or data manipulation should interpret this and project the data correctly.

The netCDF format is maintained by Unidata, tools and documentation are available from
http://www.unidata.ucar.edu/software/netcdf/

PNG

PNG is a lossless raster image file format in widespread use. It is NEODAAS’ preferred file format for transferring of image files for human viewing (in which case we will typically supply coloured images with coastlines and a lat/lon graticule marked, as well as a scale bar), but may sometimes also be used for transferring actual data (in which case the files will be supplied as greyscale and without annotation). NetCDF is recommended as a more appropriate file format for transferring data.
PNG files do not of themselves contain georeferencing information. Where this is needed, NEODAAS will supply a world (.wld) file with each PNG, which will contain the information needed to understand the map projection used. If the world file is kept in the same directory as the associated PNG file then GIS packages should interpret this and project the data correctly.
http://en.wikipedia.org/wiki/Portable_Network_Graphics
http://en.wikipedia.org/wiki/World_file

5 Sensors and data products

This section gives details of the data products included in your delivery and the sensors used to collect the raw data used.

5.1 OC-CCI Chlorophyll

Data products generated by the Ocean Colour component of the European Space Agency Climate Change Initiative project. These files are daily composites of merged sensor (MERIS, MODIS Aqua, SeaWiFS LAC and GAC, VIIRS) products. MODIS Aqua and MERIS were band-shifted and bias-corrected to SeaWiFS bands and values using a temporally and spatially varying scheme based on the overlap years of 2003–2007. VIIRS was band-shifted and bias-corrected in a second stage against the MODIS Rrs that had already been corrected to SeaWiFS levels, for the overlap period 2012–2013. VIIRS and SeaWiFS Rrs were derived from standard NASA L2 products; MERIS and MODIS from a combination of NASA's l2gen (for basic sensor geometry corrections, etc) and HYGEOS Polymer v3.5 (for atmospheric correction). The Rrs were binned to a sinusoidal 4km level-3 grid, and later to 4km geographic projection, by Brockmann Consult's BEAM. Derived products were generally computed with the standard SeaDAS algorithms. QAA IOPs were derived using the standard SeaDAS algorithm but with a modified backscattering table to match that used in the bandshifting. The final chlorophyll is a combination of OC4, Hu's CI and OC5, depending on the water class memberships. Uncertainty estimates were added using the fuzzy water classifier and uncertainty estimation algorithm of Tim Moore as documented in Jackson et al (2017).

Your data were processed by NEODAAS from ESA Ocean Colour CCI L3 data.

- Jackson, T., Sathyendranath, S., Mélin, F. (2017), "An improved optical classification scheme for the Ocean Colour Essential Climate Variable and its applications", Remote Sensing of Environment, 203, 152-161, https://doi.org/10.1016/j.rse.2017.03.036

OC-CCI Primary Production

A wavelength-dependent and non-uniform biomass treatment of marine photosynthesis model (Platt et al. 2017; Platt and Sathyendranath, 1988; Longhurst et al., 1995; Platt et al., 1995; Sathyendranath et al., 1995) was used for the computation. The angular distribution of the irradiance is included (Sathyendranath and Platt 1988; Sathyendranath and Platt, 1989), the light field being separated into its direct and diffuse components. Information derived from ship-based in situ measurements on phytoplankton physiology and vertical biomass profile parameters were organised according to season and ecological province, as in Longhurst et al. (1995). Photophysiological parameter (P_{m^B} and α_B) values for defined biogeochemical provinces were taken from the work of Mélin and Hoepffner (2004). The vertical structure of the phytoplankton biomass profile was described by three parameters: the depth of maximum chlorophyll concentration (Z_m), the thickness of the subsurface peak in chlorophyll concentration (σ) and the ratio of the peak chlorophyll concentration to the background chlorophyll concentration (ρ), also provided on a provincial basis following Mélin and Hoepffner (2011). To provide a smooth transition of parameter estimates across province boundaries, a smoothing filter was applied to the province values of Mélin and Hoepffner (2004) where values at a given pixel were averaged from a 30-30 pixel box, with individual pixel size of 9 km, centred on the pixel of interest. Phytoplankton absorption was computed following the formulation of Sathyendranath (2001) with parameterisation updated using a global database of phytoplankton absorption measurements.
The chlorophyll profile parameters and photosynthesis parameters (Kulk et al. 2020) were used in conjunction with the remotely-sensed chlorophyll data from the OC-CCI v4.2 products (Sathyendranath et al., 2016), to create chlorophyll profiles for each 9 km pixel. Average sea-surface irradiance (Photosynthetically-Active Radiation) for each month was taken from the NASA MODIS and SeaWiFS PAR products (OBPG, 2014).

- Longhurst, A. R., Sathyendranath, S., Platt, T., and Caverhill, C. M. (1995). An estimate of global primary production in the ocean from satellite radiometer data. J. Plankton Res. 17, 1245–1271. doi:10.1093/plankt/17.6.1245
- Mélin, F., and Hoepffner, N. (2004). Global Marine Primary Production: A Satellite View. Ispra: Institute for Environment and Sustainability

- Mélin, F., and Hoepffner, N. (2011). Monitoring Phytoplankton Productivity from Satellite, Chap. 6. Dartmouth, NS: EU PRESPO and IOCCG.
- OBPG (2014). Moderate-resolution Imaging Spectroradiometer (MODIS) Aqua Photosynthetically Available Radiation Data; 2014 Reprocessing. NASA OB.DAAC. Greenbelt, MD: NASA Goddard Space Flight Center, Ocean Ecology Laboratory, Ocean Biology Processing Group. doi:10.5067/AQUA/MODIS/L3B/PAR/2014
- Platt, T, Sathyendranath, S (1988) Oceanic primary production: Estimation by remote sensing at local and regional scales. Science 241: 1613–1620.
- Platt, T, Sathyendranath, S, Longhurst, A (1995) Remote sensing of primary production in the ocean: Promise and fulfilment. Phil. Trans. R. Soc. Lond. B 348: 191–202.
- Platt, T, Sathyendranath, S, White III, GN, Jackson, T, Saux-Picart, S, Bouman H (2017) Phytoplankton production as archived data: sensitivity to surface irradiance. Frontiers in Marine Science. 4:387. doi:10.3389/fmars.2017.00387
- Sathyendranath, S, Platt, T (1988) The spectral irradiance field at the surface and in the interior of the ocean: A model for applications in oceanography and remote sensing. J. Geophys. Res. 93: 9270-9280.
- Sathyendranath, S, Platt, T (1989) Computation of aquatic primary production: Extended formalism to include effect of angular and spectral distribution of light. Limnol. Oceanogr. 34: 188–198.
- Sathyendranath, S, Longhurst, A, Caverhill, CM, Platt, T (1995) Regionally and seasonally differentiated primary production in the North Atlantic. Deep-Sea Res. I 42: 1773–1802.
- Sathyendranath, S., G. Cota, V. Stuart, H. Maass, and T. Platt (2001), Remote sensing of phytoplankton pigments: A comparison of empirical and theoretical approaches, Int. J. Remote Sens., 22, 249–273.
- Kulk, G, Platt, T, Dingle, J, Jackson, T, Jönsson, BF, Bouman, HA, Babin, M, Brewin, RJW, Doblin, M, Estrada, M, Figueiras, FG, Furuya, K, González-Benítez, N, Gudfinnsson, HG, Gudmundsson, K, Huang, B, Isada, T, Kovač, Ž, Lutz, VA, Marañón, E, Raman, M, Richardson, K, Rozema, PD, van de Poll, W H, Segura, V, Tilstone, GH, Uitz, J, van Dongen-Vogels, V, Yoshikawa, T, Sathyendranath, S, (2020) Primary Production, an Index of Climate Change in the Ocean: Satellite-Based Estimates over Two Decades, Remote Sens., 2020, 12, 826
- Sathyendranath, S, Jackson, T, Brockmann, C, Brotas, V, Calton, B, Chuprin, A, Clements, O, Cipollini, P, Danne, O, Dingle, J, Donlon, C, Grant, M, Groom, S, Krasemann, H, Lavender, S, Mazeran, C, Mélin, F, Moore, TS, Müller, D, Regner, P, Steinmetz, F, Steele, C, Swinton, J, Valente, A, Zühlke, M, Feldman, G, Franz, B, Frouin, R, Werdell, J, Platt, T (2020) ESA Ocean Colour Climate Change Initiative (Ocean_Colour_cci): Global chlorophyll-a data products gridded on a geographic projection, Version 4.2. Centre for Environmental Data Analysis, 1 July 2020. https://catalogue.ceda.ac.uk/uuid/5400de38636d43de9808bfc0b500e863

SST-CCI Sea Surface Temperature

Data produced as part of the European Space Agency (ESA) Climate Change Initiative (CCI) Sea Surface Temperature project. The data from SST-CCI accurately map the surface temperature of the global oceans over the period 1981 to 2016 using observations from many satellites. The data provide independently quantified SSTs to a quality suitable for climate research.

This v2.1 SST-CCI Level 4 Analysis Climate Data Record (CDR) provides a globally-complete daily analysis of sea surface temperature (SST) on a 0.05 degree regular latitude - longitude grid. It combines data from both the Advanced Very High Resolution Radiometer (AVHRR) and Along Track Scanning Radiometer (ATSR) SST-CCI Climate Data Records, using a data assimilation method to provide SSTs where there were no measurements.

Your data were processed by NEODAAS from SST-CCI L4 data.

- Merchant, C. J., Embury, O., Bulgin, C. E., Block T., Corlett, G. K., Fiedler, E., Good, S. A., Mittaz, J., Rayner, N. A., Berry, D., Eastwood, S., Taylor, M., Tsushima, Y., Waterfall, A., Wilson, R., Donlon, C. (2019), “Satellite-based time-series of sea-surface temperature since 1981 for climate applications”, Scientific Data 6:223. doi: 10.1038/s41597-019-0236-x

Thermal front maps

The algorithm for automatic detection of ocean thermal fronts was developed by Peter Miller at PML. The composite front map technique combines the location, gradient, persistence and proximity of all fronts observed over a given period into a single map. This often achieves a synoptic view from a sequence of partially cloud covered scenes without blurring dynamic fronts, an inherent problem with conventional time-averaging methods. It is important to emphasise that: (a) front detection is based on local window statistics specific to frontal structures (homogenous regions of distinctly different temperature), and not simply on horizontal gradients; and (b) fronts are detected on individual scenes rather than on composite maps, to reveal the detailed structure without averaging artefacts.

The standard period covered by each composite front map is 7 days, though other periods may be used. We will normally produce thermal front maps from Advanced Very High Resolution Radiometer (AVHRR) Sea Surface Temperature (SST) data, though we may produce front maps from other SST products in some cases. You should assume we have produced your front maps to these standards unless an alternative has been discussed with you.

Please contact Peter Miller <pim@pml.ac.uk> for information about advanced front metrics suitable for relating to oceanographic or marine animal sightings/tracking datasets.

Your data were processed by NEODAAS from SST-CCI L4 data

- Miller, P. (2009), Composite front maps for improved visibility of dynamic sea-surface features on cloudy SeaWiFS and AVHRR data, Journal of Marine Systems, 78(3), 327-336. doi: 10.1016/j.jmarsys.2008.11.019

5.2 Masking

Some data pixels may have been masked out during processing because some aspect of their input data was of poor quality. If no sections appear here then no such masking has been done on your data.

6 Quality and issues with data

Un-detected cloud

Various algorithms are applied to data in order to detect clouds. In most cases this detection is successful and cloud will appear in your image as black or zero-value areas (in a similar way to land). Sometimes this automatic detection fails and an area of cloud will be interpreted as valid data. This leads to areas of anomalously low temperature within a higher-temperature region. Such areas should be disregarded.
This problem is more common in night-time Sea Surface Temperature (SST) scenes, because low-level sea mist that is only slightly cooler than the sea may arise (in contrast to normal clouds, which are much colder than the sea and are correspondingly easy to spot).
Examples are shown in figs. 1 and 2

Solar heating

Satellites measuring SST 'see' only the very top few micrometres of the water, sometimes called the 'skin' layer. In sunny and calm conditions, the top few centimetres may become significantly warmer than the bulk SST. For SST composites we try to mask these areas automatically based on the expected temperature range, though this is not completely effective. For this reason it can be better to use night-time SST (though this is more likely to be affected by un-detected clouds, see above) or only the first day-time SST image of the day. However, the trade-off is that this provides lower data coverage.

Adjacency and other coastal effects

Earth observation sensors work by interpreting sunlight that is reflected from their target into the sensor head. Some of this light is scattered by the atmosphere, and therefore light from pixels close to the target (rather than the target itself) can be scattered into the sensor head, causing an error in the detected properties of the target. This is especially true where the target is a dark (eg. ocean) pixel next to an especially bright area such as snow or ice, or a bright pixel such as a coccolithophore bloom next to a particularly dark area such as the open ocean, but is also true where the target is close to the coast.
Additionally, satellite algorithms that rely on detection of ocean colour often have errors introduced where the target water contains many elements affecting the colour of the water, in particular suspended sediment and Coloured Dissolved Organic Matter (CDOM). These are particularly found close to coasts and in river plumes, especially after rain. Note that the effects of plumes from large, sediment-laden rivers can stretch offshore by tens to hundreds of kilometres.
It is therefore the case that satellite measurements close to the coast must be considered to be less accurate than those in the open ocean, in some cases containing very large errors. These can sometimes be mitigated by the use of algorithms designed to cope with this, such as the OC5 chlorophyll algorithm, but they can never be entirely eliminated. In extreme cases, such as in estuaries, the errors will be so large that the use of satellite-derived chlorophyll data may be inappropriate. If your research relies on satellite measurements of coastal areas, it is recommended that you try and obtain in-situ measurements to corroborate the satellite measurements. Where this is not possible, you must consider the possibility of large errors in the satellite measurements.

Winter sun angles

Ocean colour sensors working with visible light cannot obtain data if the angle of the sun is too low at the latitude and time being observed. During the winter months at high latitudes, there may be no data at all as a result of the sun being too low (or even entirely absent) at the time of day the satellite passes overhead. The exact period of the year and latitude at which this effect occurs is different for different satellites, but was worst for SeaWiFS, for which the effect may extend as far south as the English Channel at times, and further north had periods of several months each year during which no observations were possible

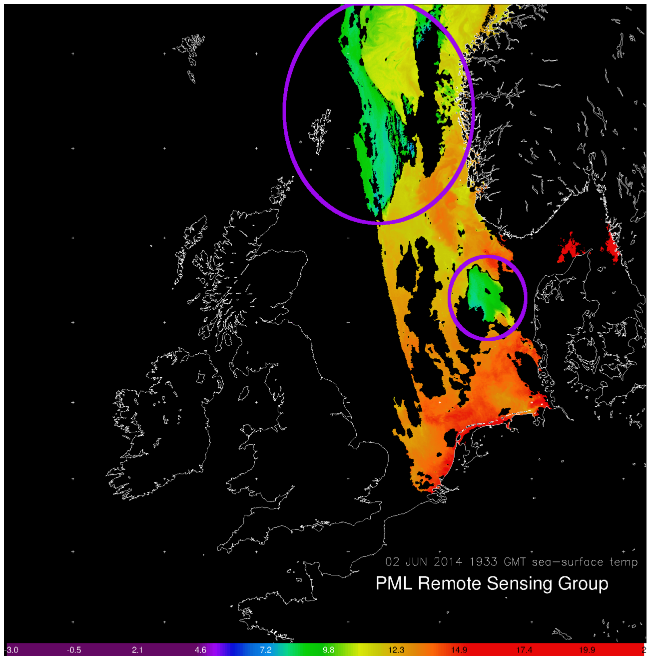

Figure 1: *Image showing un-detected cloud - well-defined cooler areas that fade into areas of cloud*

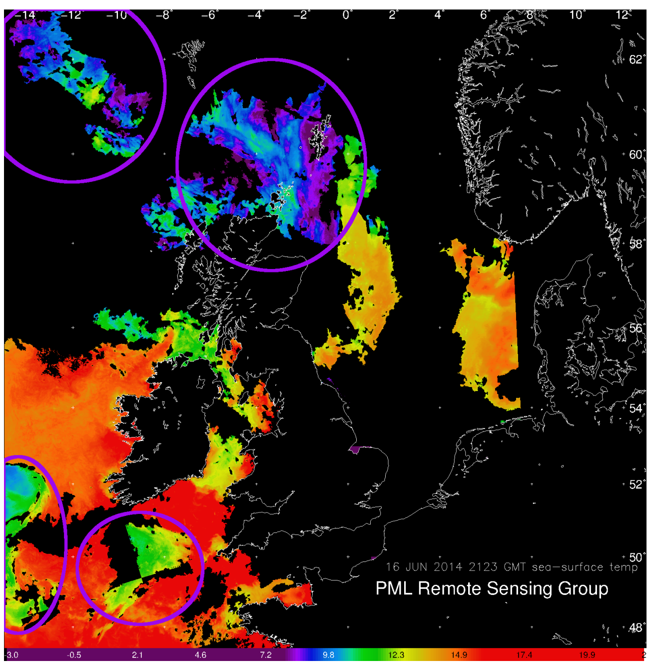

Figure 2: *Image showing un-detected cloud - both north of Scotland (areas significantly cooler than other areas) and south of Ireland (patch of significantly cooler water fading into cloud, without the shape of an eddy). Affected regions are highlighed with purple ellipses.*

7 Acknowledging NEODAAS

A condition of use of NEODAAS data is that NEODAAS is acknowledged in all publications and presentations that either directly use NEODAAS imagery or report on work that benefited from data supplied by NEODAAS. It would be greatly appreciated if you would notify info@neodaas.ac.uk of any such use of our data. Number of publications using our data is a major benchmark by which NEODAAS' success is measured, and as such this directly impacts on our funding.
The appropriate acknowledgement is flexible, we suggest:

- 'Image courtesy of NEODAAS' in the figure caption for a small number of images
- 'The authors thank the NERC Earth Observation Data Acquisition and Analysis Service (NEODAAS) for supplying data for this study' in the acknowledgements section where more use has been made of the data
- Co-authorship where there has been considerable interaction and/or contribution from NEODAAS staff

8 Contacting NEODAAS

Part of the NEODAAS service is to ensure that you get the most use out of your data. If you encounter any problems or if you have any queries relating to the data processing, please contact NEODAAS using the details below. Your feedback is important to us: positive feedback helps us to justify the service while negative feedback helps us to improve.

Email: helpdesk@neodaas.ac.uk
Tel: +44 (0)1752 633100

(Plymouth Marine Laboratory switchboard, ask for NEODAAS helpdesk, Dan Clewley, Peter Miller, Silvia Pardo, Stephen Goult, Nick Selmes, James Dingle, William Jay, Aser Mata, Emma Sullivan or Steve Groom)

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