



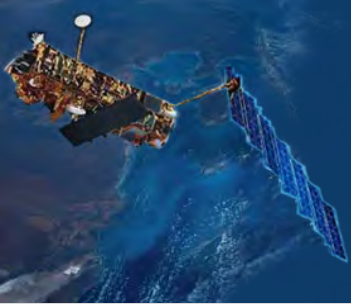
**Introducing LearnEO!**  
**and resources available from**  
**[www.learn-eo.org](http://www.learn-eo.org)**

Valborg Byfield

National Oceanography Centre, Southampton, U.K.

with

Pierre-Philippe Mathieu, Malcolm Dobson, Vinca Rosmorduc, Fabio  
Del Frate, Chris Banks and Matteo Picchiani



# LearnEO!



## A new initiative in Earth observation education

### Aims

- Develop new peer-reviewed on-line learning resources for Earth observation education
  - ❖ Data sets, lessons, software tools, background information
- Stimulate and support participation from the Earth sciences and education communities to develop and share new education resources.

Deepwater Horizon oil spill, Gulf of Mexico  
EnviSat ASAR Wide Swath data acquired 25-05-2010.  
Compressed file size: 35.6 MB.  
The data are used in LearnEO lesson 2.  
Larger image, more information and data download.

Monthly ERS Active Compress  
The data are  
Larger image

January 19 multi ERS-2 Compress  
The data are  
Larger image

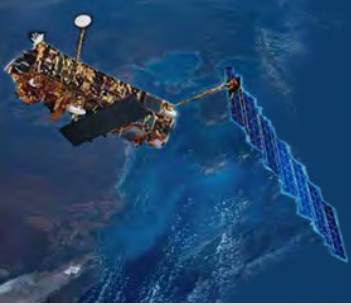
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Larger image,

Chris Banks and Valborg Byfield  
National Oceanography Centre, UK  
Observing the Amazon River Plume  
National Oceanography Centre, UK  
of largest river in the world (after the Nile) and by far the largest when it accounts for approximately one fifth of all the fresh water flowing into the ocean. The Amazon river plume is clearly visible in satellite images.

Flow of fresh water from the Amazon into the Atlantic. The main focus is on satellite data from the ESA Soil Moisture and Ocean Salinity (SMOS) is complemented with ocean colour data from the Medium-Resolution Imaging Spectroradiometer (MERIS) satellite.





# LearnEO!

## Target audience

### Students in formal education

- University level
  - ❖ Undergraduate to post graduate
- High school (16-18)
  - ❖ Data and short case studies

### Continuous professional development

- Short training courses (1-3 weeks)
- Self study

### Non-EO environmental scientists

- Occasional users of EO data
  - ❖ Some understanding of remote sensing, but not EO specialists

### Teachers, lecturers, course organisers

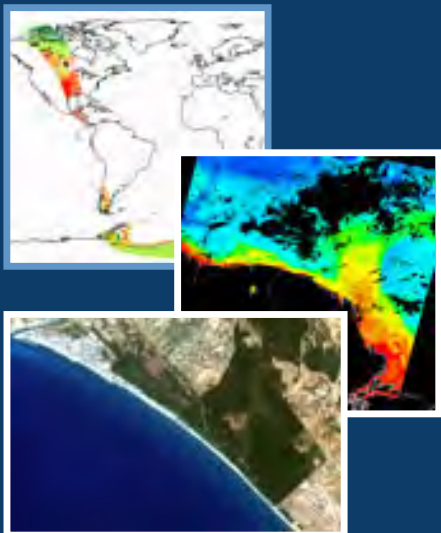




# LearnEO!



## Overview of resources at [www.learn-eo.org](http://www.learn-eo.org)



### LearnEO!

Learn Earth Observation with ESA

[Home](#)
[Competition](#)
[About](#)
[Data sets](#)
[Lessons](#)
[Software](#)
[Resource library](#)
[Information for authors](#)
[Schools](#)
[Register](#)

**Interactive electronic books**

- Earth's Development from Space
- Monitoring Marine Oil Pollution
- Ice and beyond
- Earth's Gravitally from Space

**A holistic framework for EO education**

- Lessons on different EO applications.
- Over 200 data sets with description.
- New powerful version of the UNESCO Bilko software.
- Resource library with extra information and tools.
- Support for lesson writers and lesson users.

**Oil spill monitoring**

**Competition Winners**

1st: Monitoring phytoplankton seasonality

2nd: Detecting harmful algal blooms in coastal waters

3rd: Observing the Eyjafjallajökull Volcanic Plume

Winning lessons available on-line  
See our [competition page](#) to learn more

**The Amazon river plume**

**Platforms and missions**

**Land cover mapping**

LearnEO! Lesson 2  
[www.learn-eo.org/2](http://www.learn-eo.org/2)

**Monitoring Marine Oil Pollution**  
Using optical and SAR data to detect and track surface oil

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LearnEO! Lesson 4  
[www.learn-eo.org/4](http://www.learn-eo.org/4)

**Monitoring Atlantic Storms**  
Background Information

1. Measuring wave height with radar altimetry

The principle of a radar is sending an electromagnetic wave and measuring the wave returned after reflection by the surface. Several wavelengths can be used and different configurations (different beams with different angles, for example) allowing radars to measure 5.12 GHz (Ku), 5.3 GHz (C) or 3.7 GHz (X) as components, and in the future 20 GHz (Ka) frequencies, and point mode (i.e. straight down from the satellite). This leads to a rather specific kind of coverage known as along track data.

1.1 "Along-track" data: ground tracks, repetitivity and orbit

Advancing measurements of the surface of the Earth took the Remote Sounding ("ground track") SeaWiFS ocean tracks, there are no measurements when a full cycle of data is completed the measurements look like a track covering the Earth's surface.

When the measurement "track" is completed "along the track" the image the represents the satellite track along the sea surface's orbit, and then on the ground track's surface area (Bilko, 2013)

An alternate satellite that goes over a same point only every 10 days for "Space" (Ocean Color) and 2-30 days for "Sea" (or "Ocean" etc.) is a "sat" orbit, with the same point in exact again makes a "year", and the number of days in the orbit repeat time. For observation earth as ocean, the number is important. Storms move and change at time scales that are much to shorter than the orbital and repeat time. As a result you need many measurements (covering a single orbit of orbit, and repeat exactly at the same place. That makes it difficult to build "years" but the more observations in the "year" results especially because you cannot merge several weeks of data that would have no relation to each other because they exclude both stormy and calm conditions.

### Data collection

### LearnEO! Home

### New lessons

### Bilko software / tutorial

```

bilko 3.3 formula for use with Smith and Sandwell bathymetry
# Creates a new image where land and the continental shelf
# and all ocean pixels with values lower than
# Note 1: Set output image to 8-bit
# and make sure Special Handling for N
# Note 2: This formula creates a new
# Constant Declarations
const bathy = @1;
const threshold = +200;
# Statement creating the new black and
if (bathy >= threshold ) 255 else 0;
    
```

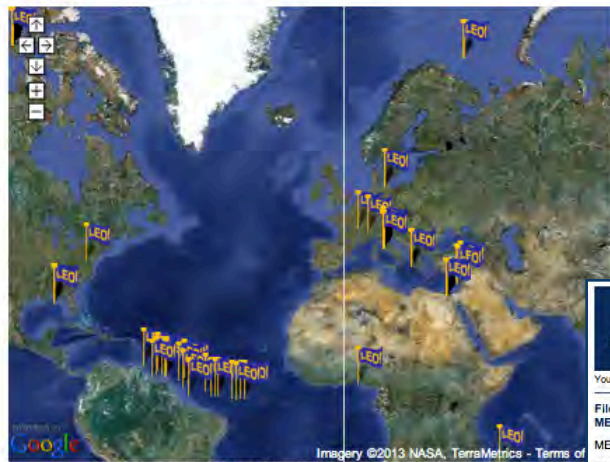
### Resource library

### LearnEO!

#### Explore the Data Collection

Partner log in Home About Data sets Lessons Software Resource library News Authors Register

You are here: LearnEO! » Explore the Data Collection



#### Search the data collection:

Amazon

#### Choose a browse option:

- Browse data used in LearnEO! lessons
- Browse all available data sets
- Browse all EnviSat data
- Browse all CryoSat data
- Browse all SMOS data
- Browse all GOCE data
- Browse other missions

Select ESA Living Planet theme(s)

#### Amazon river plume interaction with tropical Atlantic currents

LearnEO! Home Data sets Lessons Software Resource Library Information for Authors Register

File name:  
MER\_RR\_2PRBCM20100912\_131425\_000003722092\_00482\_4--bz2

MERIS Level 2 RR data obtained by EnviSat at 11:37 on 12 September 2010.

This is one of several MERIS images showing the Amazon river plume mixing with tropical Atlantic water during 2 weeks in September, 2010. Taken together the images shows how the plume moves north along the coast on the landward side of the Brazil Current. At about 5-6° North it splits, the most distinctive part moving eastward across the Atlantic in the Equatorial Counter Current, the remainder continuing northwards, eventually merging with the plumes from other rivers such as the Orinoco.

Data source: [ESA MERCI on-line data archive](#).  
Accessed 21-12-2012.

For information on how to obtain similar data, see  
<https://earth.esa.int/web/guest/data-access/online-archives>

The data is used in [lesson 1](#) and is required for completing the lesson activities.

Download the data (15.6 MB):

Please enter your registered e-mail address:

val.byfield@noc.ac.uk

- Select files to download:
- Download this data set.
  - Download the other files in the collection.
  - Download tools for data analysis

Submit

## Finding data

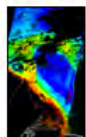
- By keyword search, Google map or selective browse tool

## Individual data information

- Preview image with description
- Sensor, mission, acquisition date
- Where and how to obtain similar data

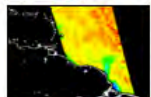
Click on the flags for information about individual data sets

### Selected data sets



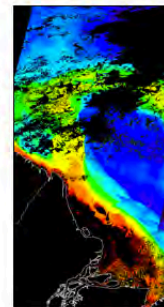
**Amazon river plume interaction with tropical Atlantic currents**  
EnviSat MERIS Level 2 RR data acquired 12-09-2010.

Compressed file size: 15.6 MB.  
The data are used in [LearnEO lesson 1](#).  
[Larger image, more information and data download.](#)



**SMOS sea surface salinity of Amazon river plume 7 S**  
SMOS MIRAS Level 2 data acquired 07-09-2010.

Compressed file size: 7.3 MB.  
The data are used in [LearnEO lesson 1](#).  
[Larger image, more information and data download.](#)



Click on the image for higher resolution

Use the link below to access the data:

#### DOWNLOAD DATA FILE

Use the links below to download the other files in the collection:

- [MER\\_RR\\_2PRBCM20100904\\_122537\\_000003772092\\_00367\\_44509\\_0001.N1.bz2](#) (48.5 MB)
- [MER\\_RR\\_2PRBCM20100904\\_140554\\_000000562092\\_00368\\_44510\\_0002.N1.bz2](#) (5.8 MB)
- [MER\\_RR\\_2PRBCM20100905\\_115427\\_000003492092\\_00381\\_44523\\_0003.N1.bz2](#) (43.7 MB)
- [MER\\_RR\\_2PRBCM20100905\\_133432\\_000003552092\\_00382\\_44524\\_0004.N1.bz2](#) (48.8 MB)
- [MER\\_RR\\_2PRBCM20100906\\_130257\\_000003802092\\_00396\\_44538\\_0005.N1.bz2](#) (51.7 MB)
- [MER\\_RR\\_2PRBCM20100907\\_123119\\_000003802092\\_00410\\_44552\\_0006.N1.bz2](#) (48.5 MB)
- [MER\\_RR\\_2PRBCM20100908\\_120008\\_000003552092\\_00424\\_44566\\_0007.N1.bz2](#) (42.7 MB)
- [MER\\_RR\\_2PRBCM20100909\\_130841\\_000003772092\\_00439\\_44581\\_0010.N1.bz2](#) (52.5 MB)
- [MER\\_RR\\_2PRBCM20100910\\_123703\\_000003802092\\_00453\\_44595\\_0011.N1.bz2](#) (52.4 MB)
- [MER\\_RR\\_2PRBCM20100911\\_120547\\_000003602092\\_00467\\_44609\\_0012.N1.bz2](#) (43.2 MB)
- [MER\\_RR\\_2PRBCM20100911\\_134604\\_000003442092\\_00468\\_44610\\_0013.N1.bz2](#) (51.3 MB)
- [MER\\_RR\\_2PRBCM20100913\\_124247\\_000003802092\\_00496\\_44638\\_0016.N1.bz2](#) (49.1 MB)
- [MER\\_RR\\_2PRBCM20100914\\_121126\\_000003662093\\_00009\\_44652\\_0017.N1.bz2](#) (46.4 MB)
- [MER\\_RR\\_2PRBCM20100914\\_135148\\_000002962093\\_00010\\_44653\\_0018.N1.bz2](#) (40.3 MB)
- [MER\\_RR\\_2PRBCM20100915\\_132010\\_000003662093\\_00024\\_44667\\_0020.N1.bz2](#) (49.9 MB)

Resources for data analysis:

- [Tools for analysis of MERIS Level 2 data](#)



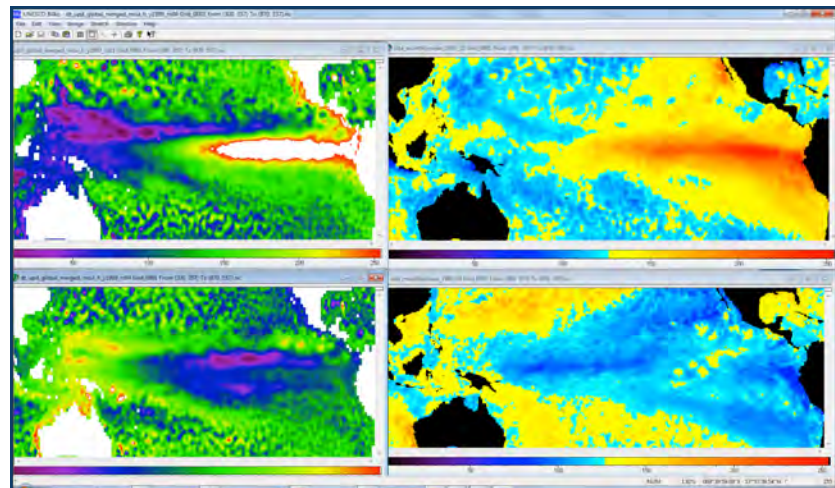
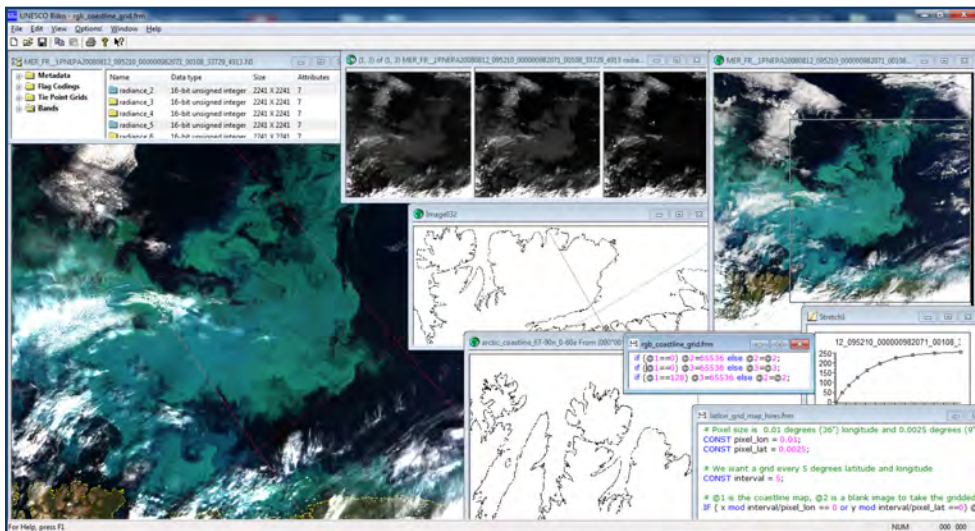
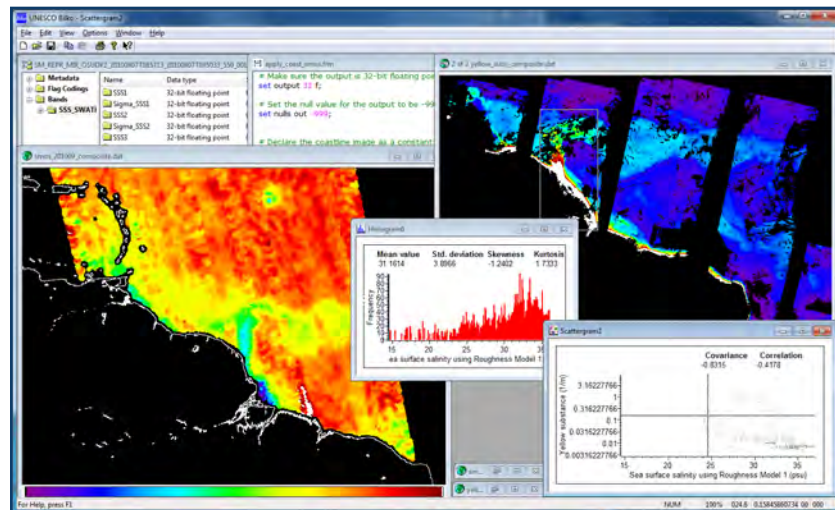
# LearnEO!

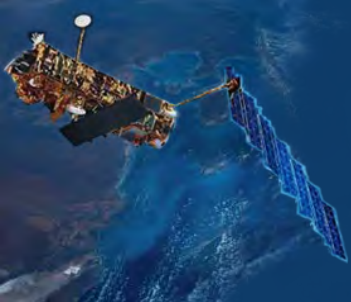


## Bilko software

### UNESCO software – started 1987

- Updated to support a wider range of data
- New and improved image display and analysis tools
- Free – depends on volunteer effort
- **Relies on volunteers for testing!**





# LearnEO!



## Hands-on lessons in different EO applications

### Self contained

- All material required to complete the lesson are provided as downloads

### Lesson content

- Hands on activities
  - ❖ Brief introductory information
  - ❖ Step by step instructions
  - ❖ Questions to guide understanding
- Model answers
  - ❖ Explaining the reasoning behind suggested answers
- Background information
  - ❖ More detail on topics introduced in activities
- Example data, analysis/display tools

The screenshot displays the LearnEO! website interface, which is organized into several sections:

- LearnEO! Lessons in EO applications**: The main header with navigation links like Home, About, Downloads, Lessons, Software, Resources Library, News, Authors, Register.
- Lesson 1: The Amazon river plume**: A large visualization showing a satellite image of the Amazon river mouth with a corresponding color-coded data overlay (likely chlorophyll-a concentration) extending into the ocean.
- Lesson 2: Monitoring sea level rise**: Includes a graph showing sea level rise data and a satellite image of a coastal area.
- Lesson 3: El Niño and the Southern Oscillation (ENSO)**: Features a map of the Pacific Ocean showing sea surface temperature anomalies and a graph of the Southern Oscillation Index (SOI).
- Lesson 4: Monitoring Atlantic storms**: Shows a satellite image of a storm system over the Atlantic Ocean.
- Lesson 5: Observing Earth's gravity: the geoid and sea level**: Includes a map of the Earth's geoid and a graph showing sea level data.
- Lesson 6: Monitoring Arctic sea ice**: Shows a satellite image of the Arctic region with sea ice extent data overlays.
- Lesson 7: Forest monitoring**: Features a satellite image of a forest area with a graph showing forest health indicators.
- Lesson 8: Monitoring urban green**: Shows a satellite image of an urban area with a graph showing green space indicators.
- Lesson 9: Land cover mapping**: Includes a satellite image of a landscape with a legend for different land cover types.
- Lesson 10: Monitoring soil moisture**: Shows a satellite image of a field with a graph showing soil moisture data.
- Lesson 11: Measuring wave height with radar altimetry**: Features a satellite image of the ocean surface with a graph showing wave height data.
- Lesson 12: "Along track" data: ground tracks, repeatability and orbit**: Shows a map of the Earth with satellite ground tracks and a graph showing orbit parameters.

Each lesson page includes a title, a brief description, and various data visualizations such as maps, graphs, and satellite images.

### ← Phenology indices and their importance for coral reef biology →

By Marie-Fanny Racault and Dionysios E. Raitsos

*Plymouth Marine Laboratory, U.K.*

#### 1st Prize in the LearnEO! Lesson Writing Competition 2013/14

Being the base of the marine food-web, phytoplankton provides a source of food for the larvae of many coral reef species, including fish, crustaceans and mollusks. The bloom timing (phenology), along with the intensity of phytoplankton availability is determinant for the larvae survival.

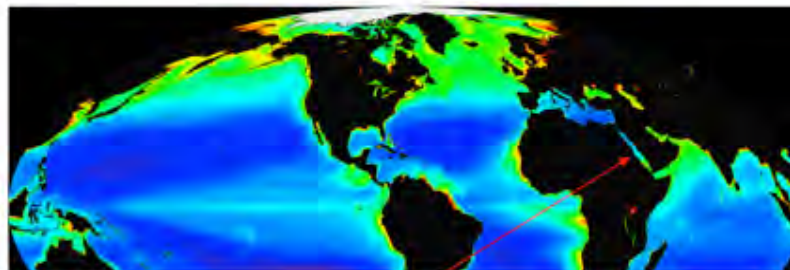
This lesson introduces phenology metrics relevant to monitor the seasonality of phytoplankton using remote sensing ocean colour data from the European Space Agency (ESA) Climate Change Initiative project (OC-CCI). It investigates the phytoplankton dynamics in major coral reefs of the Red Sea, which is one of the most saline and warm seas in the world.

**Suitable for university students or continued professional development training (intermediate level).**

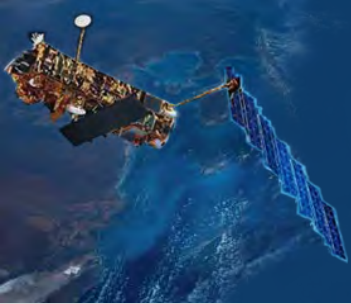
The research that forms the basis of this lesson is published in: Racault, M.-F. et al. (2015): Phytoplankton phenology indices in coral reef ecosystems: Application to ocean-color observations in the Red Sea, Remote Sensing of Environment. <http://dx.doi.org/10.1016/j.rse.2015.01.019>

On this page: [Introduction](#) [Lesson Overview](#) [Data and Tools](#) [Lesson Downloads](#)

**IMPORTANT NOTE:** This lesson requires Bilko 3.4 from February 2013 or later, as earlier versions of the software can not open and display all data as described in the lesson.







# LearnEO!



## Other lessons available from LearnEO!

- Ten lessons developed in LearnEO! for Bilko software
- Three lessons from the winners of the LearnEO! lesson writing competition – also for Bilko
- Ten lessons from the Global Lakes Sentinel Services (GLASS) for either BEAM or SNAP software

Available at

<http://www.learn-eo.org/lessons.php>