



## ARGO ONLINE SCHOOL

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Accepted by	<b>Claire Gourcuff</b>

## Document History

Version	Issue Date	Author	Comments
1.0	13 <sup>th</sup> Dec 2021	All lead authors	First version
1.1	21 <sup>th</sup> Dec 2021	All lead authors	Final version with inputs from partners



## EXECUTIVE SUMMARY

This deliverable is related to Task 7.2 of the WP7 of the Euro-Argo RISE and its aim is the creation of an Argo Online School (AOS) to teach the basic foundations to use and understand the Argo program. The need for an online tool for Argo, with similar structure than the now popular Massive Online Open Courses, is due to the complexity and volumen of the technical documentation associated with the Argo data. Given the amount of data gathered by the Argo network of floats, the associated documentation has grown considerably and can be overwhelming. In that sense, the AOS does not attempt to describe and teach all the details of the Argo program and its data, since the Argo documentation is available for a deeper learning, and the AOS does not pretend to be a library or Application Programming Interface to ease Argo data access.

The AOS is a set of videos, animations and hands-on python driven jupyter notebooks designed to make the Argo program accessible for high school or graduate students in any discipline, with no prerequisites. The AOS is organised into three main sections: 1. The Argo Program, that describes the basic concepts of the program, 2. The Argo Data that describes how the data is organised and 3. Using the Argo data, that uses the knowledge of the previous sections and python driven jupyter notebooks to teach how to use the data. Finally, a quiz section is included for auto evaluation.

The AOS has been designed to have the possibility to be expanded following the implementation of new features in the Argo program.



## TABLE OF CONTENT

<b>1</b>	<b>Introduction</b>	<b>7</b>
	What is the Argo Online School and why do we need the Argo Online School?	7
	Objectives	7
<b>2</b>	<b>AOS Factsheet</b>	<b>8</b>
	Version	8
	Content	8
	Level	8
	Language	9
	Subscription	9
	Platform selection and web hosting	9
<b>3</b>	<b>Design</b>	<b>9</b>
	Strategy	9
	Structure and interface style	11
	Programming	12
<b>4</b>	<b>Conclusion and perspectives</b>	<b>15</b>
	Perspectives	15

## 1 Introduction

### What is the Argo Online School and why do we need the Argo Online School?

Access to open education is a fundamental requirement to share knowledge and contribute to keeping everybody educated. In the early 1990s, several schools were offering online-only courses, taking full advantage of the Internet and providing education to people who previously would not have been able to access education for various reasons. Technological advances also helped educational establishments to reduce the costs of distance learning, savings that would also be passed on to students, helping to bring education to a wider audience. Today's "online learning" or "e-learning" platforms constitute a powerful learning tool so that everybody can enrich their lives through expanded knowledge.

The Argo community has always been aware of the difficulties of users to manage the complex and large datasets from the Argo network. While extensive information on Argo's data management was always provided through user manuals, the complexity of the documentation left some room for enhancing the knowledge transfer. The main uncertainties for users were mainly focused on obtaining the Argo data, its processing and the generation of products to interpret the information contained in the datasets. Once this need was identified, Euro-Argo wanted to take advantage of the potential of e-learning platforms to offer all kinds of resources to users and thus promote - improve access and use of Argo data. In this way, the Argo Online School (AOS) is defined as an e-learning tool based on an interactive environment similar to other popular Massive Online Open Courses, as the one offered by private platforms such as Udacity or FutureLearn.

### Objectives

The Argo online School (AOS) aims to teach the basic foundations for understanding and using Argo data. The AOS does not attempt to show everything about the Argo program, since the Argo documentation is available for deeper learning. The AOS does not pretend to be a library or Application Programming Interface to ease Argo data access, since with that purpose has been designed Argopy (A python library for Argo data beginners and experts, <https://github.com/euroargodev/argopy>) or ArgoVis (Argovis: A Web Application for Fast Delivery, Visualization, and Analysis of Argo Data, <https://argovis.colorado.edu/>), among others.

The AOS is a set of videos and hands-on python driven jupyter notebooks, designed to be accessible for high school or graduate students in any discipline, with no prerequisites. Specifically it offers:

- An overview of the Argo program and an assessment of the need for Argo.
- A description of how the Argo data is organised.
- A description of how to access the Argo data.
- A description of the main characteristics of the Argo data format: the netCDF.
- A review of the main characteristics of the quality controls used: Real-Time and Delayed-Mode.

- Step-by-step instructions on data access, processing, and product generation, through the execution of commands based on a programming language.

## 2 AOS Factsheet

<b>Title</b>	Argo Online School (AOS)
<b>Version</b>	1.0 - December 2021
<b>Content</b>	3 Lessons > 25 sections
<b>Level</b>	High school or graduate students
<b>Language</b>	English
<b>Subscription</b>	Free
<b>Platform selection &amp; web hosting</b>	Euro Argo web page: <a href="https://www.euro-argo.eu/argo-online-school">https://www.euro-argo.eu/argo-online-school</a> GitHub: <a href="https://github.com/euroargodev/argoonlineschool">https://github.com/euroargodev/argoonlineschool</a>

### Version

This deliverable is the first version (v1.0) of the AOS, however, in the way that it has been designed, as long as the Argo program continues to grow, the AOS could be updated.

### Content

The AOS offers dynamic and engaging content that would attract users' attention. Several formats have been carefully chosen to facilitate the learning process of users: texts, images, animations, videos and quizzes.

All content is divided into 3 lessons. Lessons 1 and 2 are aimed at users with minimal or no knowledge of the Argo network, therefore no prerequisites are needed. Lesson 3 is intended for advanced users, as it requires basic programming skills in python. However, lesson 3 is duly explained step by step, to facilitate the transition of users coming from lessons 1 and 2. To date, the three lessons contain a total of 25 sections. All the sections have been carefully designed to be connected with the rest of the lessons.

### Level

The target audience of the AOS are high school or early graduate students. The programming content included in Lesson 3 provides an ideal opportunity to support students in technical or science schools



## Language

Since English is the main language for science communication, all the content of the AOS has been developed in English. However, the files containing the English subtitles of the videos will be delivered to the rest of the Argo community partners who are interested in creating translated versions into different languages.

## Subscription

As a product of the Argo community, the AOS follows the same philosophy in terms of data access. To guarantee barrier-free learning, the information and data provided in the AOS is available in open access to the public free of charge, therefore no subscription is required. The AOS is accessible through the web page of Euro-Argo (<https://www.euro-argo.eu/argo-online-school>), but all the content that builds up the web page is hosted in the github repository of Euro-Argo: <https://github.com/euroargodev/argoonlineschool>.

## Platform selection and web hosting

During the design of the AOS, an inventory of private companies that offer e-learning platforms was carried out. Several companies were contacted to host the Argo Online School, including OpenUpEd, OpenEdx, Edx, EduOpen, FutureLearn, Udacity, Imoox and Coursera. As they were private companies, they all required compensation in return, either in the form of an annual fee of up to € 5,000 or requirements such as continuous content creation. In some cases, in addition, the hosting, maintenance and support of the AOS had to be done separately. Ultimately, two of the companies declined to offer the AOS as a free e-learning course. Unfortunately The Ocean Teacher Academy is not designed to include the hand-ons component of the AO, and therefore the only alternatives that met the requirements for the AOS was to host it at the Euro-Argo web site.

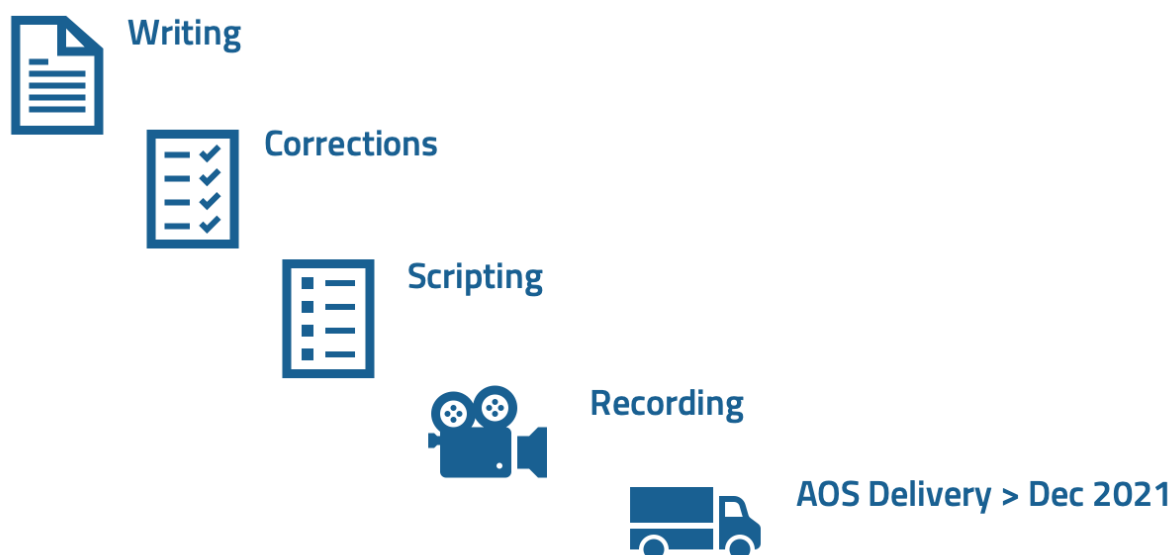
The AOS has been developed using Jupyter-Notebooks and Jupyter-Book, two open source projects that allow editing control in a clear and easy way, and also permits web-based interactive development environments that contain code, visualisations, and texts. It is widely used for data science, statistical modelling, machine learning, .... The hosting is provided by Euro-Argo, and the raw code that builds up the AOS is hosted in the official Euro-Argo account on GitHub.

## 3 Design

### Strategy

The creation of the AOS was done by phases. The first one consisted of writing the content based on all the information about Argo, both in the different official websites and in the technical documents. The second consisted of a correction phase in which the WP7 partners actively participated. In addition, a proofreading service supported IEO to ensure the consistency of the AOS content. In the third phase, the entire programming part of the AOS was developed. The fourth phase consisted of recording the AOS content in video format. Under the direct guidance of IEO, a professional with experience in the audiovisual field took care of the set-up, the recordings and the editions, both of the

videos themselves and of the animations. Government and health restrictions caused by COVID-19 significantly affected this phase of development of the AOS, having to postpone deadlines on several occasions. Finally all the content was organized.



The AOS interface (Fig. 1) is accessed through <https://www.euro-argo.eu/argo-online-school> and is comfortable, intuitive, clear and compatible through a smartphone

At the top of the interface there are three icons (1): the first one makes it possible to work with full-screen mode. The second one allows access to the repository on GitHub, where all the elements used in the development of the AOS are located, and finally, the third icon offers the option of downloading all the content displayed on the screen as .pdf documents.

On the left side of the screen, there is a vertical banner (2) where all the content of the AOS is organised. Through drop-down buttons (4), the lessons will show the different sections contained in them after a simple click. The AOS offers the possibility of taking a total of 2 quizzes on lessons 1 and 2, which are the most descriptive lessons. In this way, the user has the opportunity to self-evaluate the learning process carried out during their course in the AOS. Lastly, Jupyter Notebooks offers a fast keyword finder by default. In this way, any keyword that the user enters the box (3) will be related to the content of the AOS.

## Structure and interface style

Argo Online School

Search this book...

3

The Argo Online School

LESSON 1  
The Argo Program

LESSON 2  
The Argo Data

2 LESSON 3  
Using Argo Data  
Accessing Argo data by float  
Accessing Argo data by date  
Real-Time and Delayed mode data

4

QUIZZES  
Quiz - Lesson 1  
Quiz - Lesson 2

Powered by Jupyter Book

Argo online School  
An introduction to the Argo data

### The Argo Online School

Argo is an international program that collects information from inside the ocean using a fleet of floats that drift with the ocean currents. The floats move up and down between the surface and a mid-water level measuring ocean variables but spend almost all their life below the surface. Argo has been collecting more than 100,000 profiles per year since 2012, and nowadays Argo is the major component of the Global Ocean Observing System.

3927 Floats  
13-Dec-2021

60°N  
30°N  
0°  
30°S  
60°S

60°E 120°E 180° 120°W 60°W 0°

Given the amount of data gathered by the Argo network of floats, the associated documentation has grown considerably and can be overwhelming. Therefore the goal of the Argo Online school (AOS) is to teach the basic foundations to use and understand the Argo data. The AOS does not attempt to show everything, since

Contents  
Further reading  
Acknowledging Argo data  
License for this book  
Credits

Fig 1. Front page of the Argo Online School (AOS)

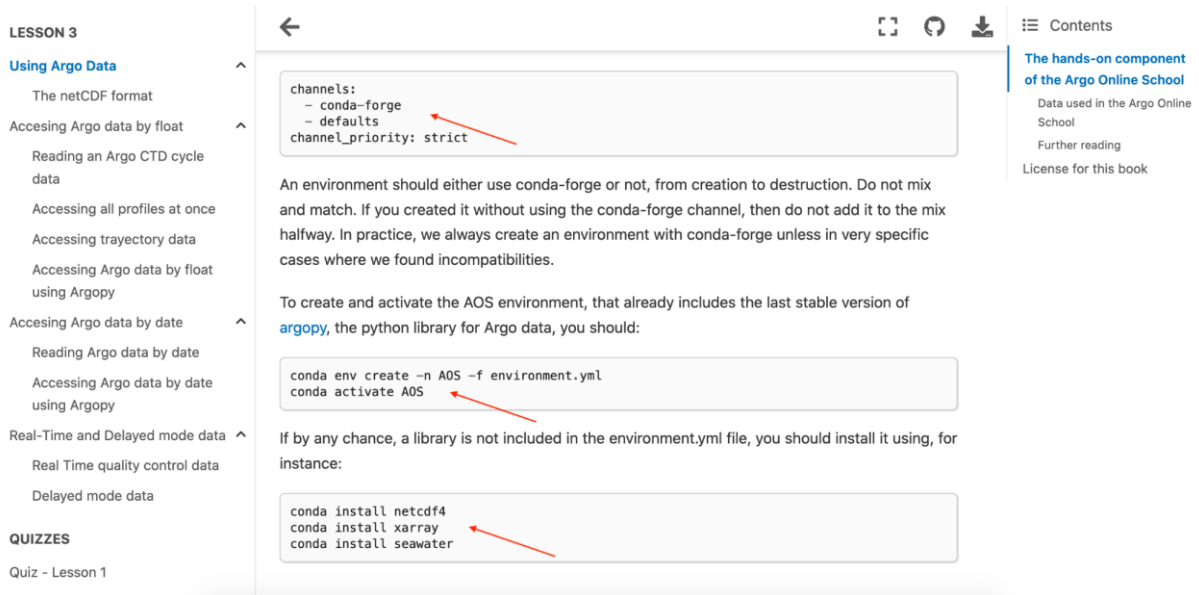
The videos and animations (Fig 2.) can be accessed through the vertical banner (2) drop-down buttons (4) for lessons 1 and 2, with a summary of the text described in the videos, and links to the Argo documentation if the user wants a more in detail explanation.

The screenshot displays the Argo Online School interface. On the left is a sidebar menu with the 'Argo Online School' logo and a search bar. The menu lists 'The Argo Online School', 'LESSON 1' (with sub-items like 'The Argo Program', 'What is the Argo network?', 'Why do we need Argo...', 'How the observations are done?', 'What is an oceanographic profile?', 'Technological innovations', 'Recap Lesson 1'), 'LESSON 2' (with sub-item 'The Argo Data'), and 'LESSON 3' (with sub-items 'Using Argo Data', 'Accessing Argo data by float', 'Accessing Argo data by date'). The main content area features a video player titled 'What is the Argo network?' with two video thumbnails. The first thumbnail shows two men on a boat, and the second shows a man working with equipment on a ship. Each thumbnail has a play button and a 'Click to show' link with a plus icon. At the top right of the video player area are icons for back, full screen, refresh, and download.

Fig 2. Easy access to video content (by clicking in the video, a preview is provided)

## Programming

While lessons 1 and 2 are fully descriptive with video and animations, lesson 3 provides a more hands-on environment (Fig 3). The aim of the AOS is not only to teach about the Argo program, but to improve their use of the data also, through programming with recommendations and exercises. In this way, it helps the user to face future science programming scenarios in a complete way. Access to data, its processing and obtaining information through the interpretation of graphs, are the most common demands of users who want to handle Argo data.



**LESSON 3**

**Using Argo Data**

- The netCDF format
- Accessing Argo data by float
- Reading an Argo CTD cycle data
- Accessing all profiles at once
- Accessing trajectory data
- Accessing Argo data by float using Argopy
- Accessing Argo data by date
- Reading Argo data by date
- Accessing Argo data by date using Argopy
- Real-Time and Delayed mode data
- Real Time quality control data
- Delayed mode data

**QUIZZES**

Quiz - Lesson 1

---

```
channels:
- conda-forge
- defaults
channel_priority: strict
```

An environment should either use conda-forge or not, from creation to destruction. Do not mix and match. If you created it without using the conda-forge channel, then do not add it to the mix halfway. In practice, we always create an environment with conda-forge unless in very specific cases where we found incompatibilities.

To create and activate the AOS environment, that already includes the last stable version of **argopy**, the python library for Argo data, you should:

```
conda env create -n AOS -f environment.yml
conda activate AOS
```

If by any chance, a library is not included in the environment.yml file, you should install it using, for instance:

```
conda install netcdf4
conda install xarray
conda install seawater
```

**Contents**

- The hands-on component of the Argo Online School
- Data used in the Argo Online School
- Further reading
- License for this book

Fig 3. AOS set up for the hand-ons component in lesson 3.

The basic recommendations and instructions for configuring the hand-on section of the AOS are also provided (Fig 3.), whether the user wants to work online or if they want to work on their local computer. Specific libraries and packages are recommended to guarantee the correct functioning of the AOS. A complete section is dedicated to explaining the main characteristics of the format chosen by the Argo community, the netCDF format (Fig 4.). Through the execution of a few simple commands, the user will easily understand the netCDF format to handle Argo data efficiently.

After these preliminary considerations, in the following sections in lesson 3, the user is guided to learn how to access Argo data through FTP and HTTP sites, in addition to processing them to obtain information (Fig. 5). Two full sections are devoted to the possible ways to access Argo data, by date and by float. Given its importance, an entire section is also devoted to quality control of Argo data, both in Real-Time and in Delayed-Mode (Fig 6.). In this way, the user will know how to correctly interpret the different quality flags assigned to the Argo data and thus choose the data according to their convenience.

Additionally to the data access using FTP and HTTP, there are sections where the access to the data is done using the argopy library (<https://argopy.readthedocs.io/>) developed also in the framework of EA-RISE.

**LESSON 3**

**Using Argo Data**

**The netCDF format**

Accessing Argo data by float

Reading an Argo CTD cycle data

Accessing all profiles at once

Accessing trajectory data

Accessing Argo data by float using Argopy

Accessing Argo data by date

Reading Argo data by date

Accessing Argo data by date using Argopy

Real-Time and Delayed mode data

Real Time quality control data

Delayed mode data

**QUIZZES**

Quiz - Lesson 1

Quiz - Lesson 2

← [Icons] Contents

Let's import the libraries.

```
import netCDF4
import numpy as np
```

fileExampleNC='../Data/sst.day.mean.2019.nc'

### Open the netCDF file

We will create **SST**, a **Dataset** object, representing an open netCDF file. The data actually is not read yet (just have a reference to the variable object with metadata).

```
ncDS = netCDF4.Dataset(fileExampleNC)
type(ncDS)
```

netCDF4.\_netCDF4.Dataset

And here it comes the **Self-Describing** property of the netCDF format, with all information about the data it contains. The information provides depends on the particular data set, as we will see for Argo data.

Printing the object gives you summary information.

```
print(ncDS)
```

What is NetCDF?

How is the netCDF format?

**Exploring a netCDF File**

Open the netCDF file

Exploring a netCDF File with xarray

Open the netCDF file with xarray

Accessing a netCDF data variable

Using the data

Remote data access via openDAP

Closing your netCDF file

Fig.4. How to handle the netCDF format

**LESSON 1**

The Argo Program

**LESSON 2**

The Argo Data

**LESSON 3**

Using Argo Data

The netCDF format

**Accessing Argo data by float**

Reading an Argo CTD cycle data

**Accessing all profiles at once**

Accessing trajectory data

Accessing Argo data by float using Argopy

Accessing Argo data by date

Reading Argo data by date

Accessing Argo data by date using Argopy

Real-Time and Delayed mode data

Real Time quality control data

Delayed mode data

**QUIZZES**

Quiz - Lesson 1

Quiz - Lesson 2

Powered by Jupyter Book

← [Icons] Contents Metadata

```
fig, ax = plt.subplots(figsize=(15,10))
cs=ax.contourf(juld,prei,psali.transpose(),40,cmap="RdBu_r")
cs2=ax.contour(juld,prei,psali.transpose(),colors='k',levels=cs.levels[:4])
ax.invert_yaxis()
ax.clabel(cs2,fmt="%2.1f",colors='w',fontSize=10)
ax.set_title("Vertical Salinity section for float {prof.PLATFORM_NUMBER[0].astype(str).values}")
ax.set_xlabel("{prof.JULD.standard_name}")
ax.set_ylabel("{prof.PRES.long_name}")
cbar=fig.colorbar(cs,ax=ax)
```

Fig.5. Argo data collection and processing.

QCflag	Meaning	Real time description	Adjusted description
0	No QC performed	No QC performed	XX
1	Good data	All real time QC tests passed	XX
2	Probably good data	Probably good	XX
3	Bad data that are potentially correctable	Test 15 or Test 16 or Test 17 failed and all other real-time QC tests passed. These data are not to be used without scientific correction. A flag '3' may be assigned by an operator during additional visual QC for bad	data that may be corrected in delayed mode.
4	Bad data	Data have failed one or more of the real-time QC tests, excluding Test 16. A flag '4' may be assigned by an operator during additional visual QC for bad data that are not correctable.	XX
5	Value changed	Value changed	XX
6	Not currently used	Not currently used	XX
7	Not currently used	Not currently used	XX

Fig.6. Quality control flags in Real-Time and Delayed-Mode

## 4 Conclusion and perspectives

The Argo Online School addresses an existing need for the Argo community to better communicate on the Argo programme and how its invaluable dataset can be used for various applications. The School was presented at the **2nd Ocean Observers Workshop** on November 29th 2021 <https://bit.ly/3pUChmJ> and at the **22nd Argo Data Management Team** meeting <https://bit.ly/3e39rLL> on December 10th 2021, with a very good reception from the attendees. This new tool will be advertised by Euro-Argo but also within the international Argo community and should help to grow the community of Argo data users. Moreover, it will also promote other tools developed within Euro-Argo RISE e.g. the Euro-Argo Data Selection tool (see D7.14) or the *argopy* library (developed within WP2).

### Perspectives

This first version of the AOS contains the basic content to understand and use the actual Argo observing system, however, in the way it has been designed, it is possible to update it to show the newest aspects of the Argo network. For instance, in the future it may be easily updated to include the new management of data from biogeochemical floats, or the description of the algorithms that allow Argo floats to operate under ice; or the way to access the different configurations of the Argo floats that operate in energetic regions such as the boundary currents; or update to show the latest advances in terms of sensors such as the incorporation of the new RBR sensors in the standard Argo floats.