FixO^3

Fixed point Open Ocean Observatories Network

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Work Package 4

Data Management and Harmonisation

Deliverable 4.5

Progress assessment toward sustainable processing streams from each FixO^3 observatory

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Contents

EXECUTIVE SUMMARY

The FixO^3 Observatory network included 22 sites. This report summarises the current state of data delivery for each of these observatories, for both delayed mode and near real time data streams. The report assesses the level to which best practise, with regard to data management, has been adopted for each of the observatories, and the areas where improvement can still be made. This addresses a key component of the data management task of FixO^3, to improve standardisation, interoperability and compliance with major international initiatives. This includes harmonising data management and standardisation efforts with other European and international marine data and observatory infrastructures.

All the currently operational sites provide some data through the FixO^3 data portal. The raw data accessed for the data portal come from a range of data sources, but all are compliant with the core data format standard requirements of the FixO^3 Data Policy, in either OceanSITES (NetCDF) or ascii standard format. The core quality control standards, regarding delivery of data quality information alongside data, are being met by the observatories.

The increased use of standardized services, in particular the development of Sensor Web Enablement services, provides a highly sustainable and standardised method of data sharing. International initiatives are able to interrogate the data centre holdings and either harvest metadata or data, as appropriate for their needs, without the requirement of additional resource at the data centre.

1 INTRODUCTION

1.1 Background and objectives

This deliverable provides an assessment of the status of integration of FixO3 data and data products with related marine infrastructures and initiatives as well as with the carbon observation community. Hence it provides an assessment of the effectiveness of activities carried out under WP4, and specifically under task 4.3. There are wider links to the activities of WP7, specifically through the implementation of the data policy and the harmonisation of best practise and with WP2 and WP9, in particular for technical metadata harmonisation aspects and synthesising data policies.

The main objective of WP4 (Data Management and Harmonisation) is to improve access to marine observatory data by harmonising data management standards and workflows covering the complete life cycle of data from real time data and delayed mode data acquisition, quality control and delivery, through to long-term archiving.

Another primary goal of the work package is to improve standardisation, interoperability and compliance with major international initiatives. This includes harmonising data management and standardisation efforts with other European and international marine data and observatory infrastructures.

These goals both aim towards ensuring that the data from the observatories within FixO^3 can be integrated into sustained international infrastructure activities, providing a sustainable route for data discovery and dissemination. Specifically task 4.3. (Integration with existing marine infrastructures) aims to integrate FixO^3 data and data products with related marine infrastructures and initiatives as well as with the carbon observation community.

The integration of the data provision is underpinned by work carried out under tasks 4.1 (Coordination of data access and archiving policies) and 4.2 (Definition of common standards); in particular, the data policy [1]. This provides the common basis for open and free data exchange and safeguards the continued contribution of FixO^3 observatories to OceanSITES and other international initiatives.

This deliverable is also supported by activities under task 4.4 (the Data Assembly Centre (DAC)), through demonstration of processing data streams for the FixO^3 Observatories and distribution of best practice and skills to ensure that the processing streams continue beyond FixO^3. The DAC also has a responsibility to monitor and document data management activities by providing a joint FixO^3 data catalogue and registry of FixO^3 standards and data processing and transformation services, that has provided a source for much of the information in this deliverable.

1.2 Organisation of this report

The next section of this report aims to provide a summary of the sources of FixO^3 platform data and their delivery routes. This includes the international initiatives that provide

integration services for data discovery and delivery, through which FixO^3 Observatories are providing data.

The third part of the report outlines the current practises regarding the use of data quality handbooks and progress toward update of common data management, dissemination and utilization strategies.

The final section provides a summary of the sustainability of the data services from FixO^3, given the status of the current data streams.

2 CURRENT OBSERVATORY DATA MANAGEMENT PROCESSING STREAMS

The FixO^3 network consists of 22 Fixed Point Observatories, with data being the responsibility of 16 partners, as summarised in Table 1. In the table sites currently providing near real time data are marked as 'active' in the real time operation column. For sites that have a capability that is temporarily unable, the site is marked as 'inactive'. Sites without near real time capability are marked as 'No' in this column.

Table 1 FixO3 Network Observatories

No.	Observatory	Name	Position Lat	Lon	Real Time Operation	Responsible Partner
1	FRAM	Frontiers in Arctic Marine Monitoring ocean observing system	77-80˚N	-10-10˚E	No	AWI
3	STATION M	Station M	66˚N	2˚E	Active	UiB
4	CIS	Central Irminger Sea	59.4˚N	-39.4˚E	No	GEOMAR
5	PAP	Porcupine Abyssal Plain Observatory	49˚N	-16.5˚E	Inactive	NERC
6	Biscay AGL	Biscay Augusto González de Linares buoy	43.83˚N	-3.78˚E	Active	IEO
7	W1-M3A	Fixed-Point Open Ocean Observatory in the Ligurian Sea	43.79˚N	9.16˚E	Active	CNR
8	DYFAMED	Dynamique des Flux Atmospheriques en MEDiterranee	43.25˚N	7.52˚E	Active	CNRS
9	ANTARES	Astronomy with a Neutrino Telescope and Abyss environmental RESearch	42.8˚N	6.17˚E	Active	CNRS
10	LION	Gulf of Lion Observatory	42˚N	5˚E	Active	CNRS

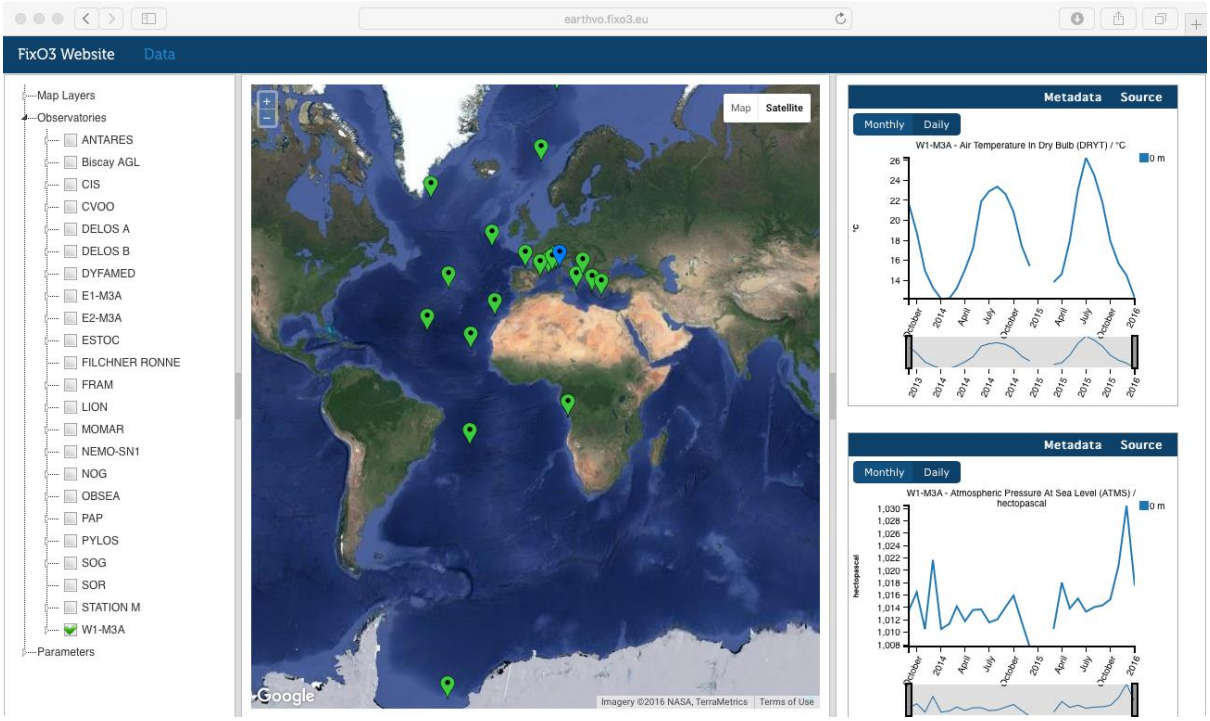
No.	Observatory	Name	Position Lat	Lon	Real Time Operation	Responsible Partner
11	E2-M3A	Southern Adriatic Interdisciplinary Laboratory for Ocean Research	41.54˚N	18.02˚E	Active	OGS
12	OBSEA	Expandable Seafloor Observatory	41.18˚N	1.75˚E	Active	UPC
13	NEMO-SN1	NEutrino Mediterranean Observatory-Submarine Network 1	37.55˚N	15.40˚E	Active	INGV
14	MOMAR	MoMAR (Monitoring the Mid-Atlantic Ridge)	37.5˚N	-33˚E	No	IFREMER / CNRS
15	PYLOS	Pylos Southern Ionian Sea water column and seabed observatory	36.8˚N	21.6˚E	No	HCMR
16	E1-M3A	POSEIDON E1-M3A Multidisciplinary observatory	35.66˚N	24.99˚E	No	HCMR
17	ESTOC	European Station for Time-series in the Ocean, Canary islands	29.04˚N	-15.15˚E	No	PLOCAN / CSIC
18	NOG	Northern Oligotrophic Gyre	23.77˚N	-41.1˚E	No	NERC
19	TENATSO / CVOO	Tropical Eastern North Atlantic Time-Series Observatory (now Cape Verde Ocean Observatory)	17.4˚N	-24.5˚E	No	INDP
20	DELOS A	Deep-ocean Environmental Long-term Observatory System A	-7.9˚N	12.14˚E	No	UNIABDN
21	DELOS B	Deep-ocean Environmental Long-term Observatory System B	-7.95˚N	12.28˚E	No	UNIABDN
22	SOG	Southern Oligotrophic Gyre	-18.53˚N	-25.1˚E	No	NERC
23	FILCHNER-RONNE	S2	-74.65˚N	-33.55˚E	No	UNIRes

A further planned partner Observatory (No. 2: SOR) has been withdrawn from the network.

2.1 FixO^3 Observatory Data Delivery

All the Observatories, apart from the Filchner-Ronne and NEMO-SN1 sites, make at least some of their data available through the FixO^3 data portal at earthvo.FixO3.eu (see Figure 1). The NEMO-SN1 site experiences technical difficulties delaying data delivery and as yet there is no timeframe for operations to continue at the site.

Figure 1 Summary of Observatories from the FixO^3 data portal



The data processing and delivery route for each observatory is dependent on the internal systems for the operating institute. For those observatories with a near real time capability, the routes for near real time and delayed data may be separate, with the former being more often the responsibility of a specialist data facility using automated, or semi-automated, systems, whilst the latter are more frequently in the domain of the principal investigator for processing, with only the data formatting, archive and dissemination being the responsibility of the associated data facility.

The data delivery routes identified for the FixO^3 observatories delayed mode data are summarised in Table 2. The delivery routes include local (operator based) delivery, data centre access and delivery via a variety of portals. In some cases, the data may be available through a variety of different routes, in which case on the primary archive and delivery route will be identified.

Table 2 Delayed mode data delivery for FixO^3 Observatories

No	Observatory	Delayed mode delivery
1	FRAM	PANGAEA REST interface / OceanSites
3	STATION M	PANGAEA / OceanSITES (legacy data)
4	CIS	IBI-ROOS / OceanSITES (legacy data)
5	PAP	BODC / OceanSites
6	Biscay AGL	IEO (ftp://arcas.puertos.es/INSITU_IBI_NRT_OBSERVATIONS_013_033/monthly/)
7	W1-M3A	CNR (http://www.odas.ge.issia.cnr.it/OI1/modules/site_pages/historical_database.php)
8	DYFAMED	OceanSITES
9	ANTARES	OceanSITES
10	LION	OceanSITES
11	E2-M3A	OceanSITES
12	OBSEA	SeaDataNet / request from www.obsea.com
13	NEMO-SN1	MOIST (http://www.moist.it/sites/western_ionian_sea/2)
14	MOMAR	COPERNICUS (http://campagnes.flotteoceanographique.fr/series/130/)
15	PYLOS	MONGOOS (legacy available)
16	E1-M3A	MONGOOS / OceanSites
17	ESTOC	PLOCAN / CSIC (http://data.plocan.eu/thredds/catalog/aggregate/public/ESTOCInSitu/catalog.html)
18	NOG	BODC
19	TENATSO / CVOO	Data provided on request (http://cvoo.geomar.de)
20	DELOS A	PANGAEA
21	DELOS B	PANGAEA
22	SOG	BODC

The delivery for the near real time data, for each site with near real time operation, is summarised in

Table 3.

Table 3 Near Real Time delivery for FixO^3 Observatories

	Observatory	Location
3	**STATION M**	http://talos.nodc.no:8080/stasjonm/view.html
4	**CIS**	COPERNICUS / ftp://arcas.puertos.es/
5	**PAP**	IBIROOS / http://www.eurosites.info/pap/data.php
6	**Biscay AGL**	IBI-ROOS
7	**W1-M3A**	MONGOOS
8	**DYFAMED**	IBI-ROOS
9	**ANTARES**	IBI-ROOS
10	**LION**	IBI-ROOS
11	**E2-M3A**	MONGOOS / http://reponodc.ogs.trieste.it/rtdata/E2M3A/
12	**OBSEA**	MONGOOS
13	**NEMO-SN1**	MOIST / MONGOOS
16	**E1-M3A**	COPERNICUS / ftp://medinsitu.hcmr.gr

2.2 Integration with existing services

2.2.1 OceanSITES

Through the Data Policy and the data management workshops the adoption of a standard format for data delivery gives a strong foundation for data interoperability. The OceanSITES data format, specifically developed to cover data from fixed observatories, was adopted within FixO^3 as the preferred data delivery format.

All observatories listed in

Table 4 are providing data in this format to the OceanSITES Global Data and Archive Centres.

OceanSITES data can be accessed using either of the GDAC locations, at CORIOLIS (IFREMER) or NDBC (NOAA) using either the thredds catalogues:

http://tds0.ifremer.fr/thredds/catalog/CORIOLIS-OCEANSITES-GDAC-OBS/<site_code>/catalog.html

http://dods.ndbc.noaa.gov/thredds/catalog/oceansites/DATA/<site_code>/catalog.html

or via ftp at

ftp://ftp.ifremer.fr/ifremer/oceansites/DATA/

Data are mirrored between the two locations 6 times daily. The <site_code> for each FixO^3 site is provided in

Table 4, along with the data held in the OceanSITES GDAC at the end of November 2016.

Table 4 Summary of FixO^3 Observatory data held at the OceanSITES GDAC

Number	Observatory	site_code	Data held (DM: delayed Mode, RT: Real Time)
1	FRAM	FRAM	DM (1997-2013)
3	STATION M	STATION-M	DM (1948-2009)
4	CIS	CIS	DM (2002-2009) RT (2010, 2011, 2014)
5	PAP	PAP	DM (2002-2014) RT (2007-2015))
7	W1-M3A	W1M3A	RT (2004-2015)
8	DYFAMED	DYFAMED	DM (1995-2015) RT (2007-2015)
9	ANTARES	ANTARES	DM (2005-2010) RT (2010-2011)
10	LION	LION	DM (2007-2014)
11	E2-M3A	E2M3A	DM (2002-2009) RT (2004)
15	PYLOS	PYLOS	DM (2010-2015)
16	E1-M3A	E1-M3A	RT (2007-2015)
17	ESTOC	ESTOC	DM (1994-2010) RT (2004)
18	NOG	NOG	DM (2012-2014)
19	TENATSO	TENATSO	DM (2006-2008)
22	SOG	SOG	DM (2008)

2.2.2 PANGAEA

The World Data Center PANGAEA (https://pangaea.de) provides an alternative archive and delivery service across European and worldwide networks.

The observatories not providing data to OceanSITES or COPERNICUS (DELOS A & B), as well as FRAM, have data archived at PANGAEA. The data are available in a standard ascii format, as agreed in the data management workshops and stated in the data policy [1].

2.2.3 EMODNET

The European Marine Observation and Data Network (EMODnet) consists of more than 160 organisations assembling marine data, products and metadata, relying on quality-assured,

standardised and harmonised marine data which are interoperable and free of restrictions on use.

As a result of the collaboration between FixO^3 and EMODNET, FixO^3 data are also available in the EMODNET physics portal.

2.2.4 SEADATANET

SeaDataNet is a standardized system for managing the large and diverse data sets collected by oceanographic fleets and automatic observation systems. The SeaDataNet infrastructure networks and enhances the currently existing infrastructure of national oceanographic data centres of 35 countries.

Each contributing data centre has its own responsibility regarding contribution to SEADATANET, requiring creation and uploading of Common Data Index (CDI) metadata records for each data set. The input required additional resource beyond the best practise required of the FixO3 data policy and although encouraged, will be limited by centre resource. The relationship of the SEADATANET records to other data sources (eg OceanSITES) is not simple, with a change in data granularity often occurring.

The data observatories that currently upload CDI records to SEADATANET are: DYFAMED, E2M3A, E1M3A, MOMAR and PYLOS. Other data centres are working to deliver their data to SEADATANET as part of wider commitments to the SEADATANET project.

2.2.5 Operational Services

Across Europe, there are a number of initiatives, related to the Global Ocean Observing System (GOOS), designed to allow provision of near real time, and delayed mode, data to the operational marine sector: primarily to ocean modelling and forecasting community, although many other interested.

The COPERNICUS marine environment monitoring service provides regular and systematic reference information on the state of the physical oceans and regional seas. FixO^3 data streams are currently incorporated into the COPERNICUS marine services.

Regional components of GOOS: IBI-ROOS (Ireland-Biscay-Iberia Regional Operational Oceanographic System http://ibidataportal.puertos.es) and MONGOOS (The Mediterranean Operational Network for the Global Ocean Observing System http://www.mongoos.eu) also provide more tailored access to data and services for their regions of interest. These regional GOOS services also feed data through to the COPERNICUS Marine Environment Monitoring Service.

All the data provided through the OceanSITES GDAC, both in Near Real Time and delayed mode are also provided to the COPERNICUS marine service and the GOOS regional components. In addition, some data are provided directly to COPERNICUS (as shown in Table 3).

2.2.6 European Multidisciplinary Seafloor and water-column Observatory (EMSO)

EMSO is a large scale, distributed, marine Research Infrastructure (RI) that consists of ocean observation systems for long-term, high-resolution, (near) real-time monitoring of environmental processes including natural hazards, climate change, and marine ecosystems. EMSO observatory nodes have been deployed at key sites around Europe, from the Arctic to the Atlantic, through the Mediterranean, to the Black Sea.

The developing EMSO system, linking existing infrastructure (nodes), using standardised data interfaces, is seeking to provide a sustainable infrastructure for observatories. The current EMSO node network is illustrated in Figure 2 and is comprised of 11 deep-sea observatories plus four shallow water test nodes, including the FixO^3 Observatories: Balearic Sea (OBSEA), Canary Islands (ESTOC), Hellenic Arc (Pylos and E1-M3A), Ligurian Sea (DYFAMED, ANTARES), Porcupine Abyssal Plain (PAP), Svalbard Islands and Western Ionian (NEMO-SN1).

Figure 2 Current EMSO node locations

2.2.7 MOIST (Multidisciplinary Oceanic Information SysTem)

MOIST is a data provider initiated within the ESONET NoE project and now under development in the frame of ESFRI (European Strategy Forum on Research Infrastructures) and EMSO (European Multidisciplinary Seafloor and water column Observatory). This system actively harvests metadata and data from seafloor observatories. The harvesting mechanism allows the relevant data to be collected from FixO^3 observatories, using their existing data acquisition systems and databases. A number of FixO^3 observatories provide data through the MOIST data portal (see Table 3).

2.3 Carbon Observation Community Interaction

FixO³ aims to foster the cooperation with the marine carbon observation community by disseminating FixO³ data via relevant international infrastructures and data centres such as the Carbon Dioxide Information Analysis Center (CDIAC) and the ICOS Ocean Thematic Centre.

2.3.1 CDIAC

CDIAC is located at the U.S. Department of Energy's (DOE) Oak Ridge National Laboratory (ORNL) and is the primary climate change data and information analysis centre for DOE. The service provides a single portal for estimates of carbon dioxide emissions from fossil-fuel consumption and land-use changes; records of atmospheric concentrations of carbon dioxide and other radiatively active trace gases; carbon cycle and terrestrial carbon management datasets and analyses; and global/regional climate data and time series. Several of the FixO³ observatories provide their carbon data to CDIAC directly, or allow access through the OceanSITES portal to appropriate CO^2 data, as shown in Table 5.

The current provision of CDIAC at ORNL is due to cease on 30th September 2017, and data transition plans are being developed to ensure preservation and availability of the data and service beyond 2017.

Table 5 Summary of FixO³ Observatory data recorded in CDIAC

Observatory	CDIAC Information URL	Data Availability
CIS	http://cdiac.ornl.gov/oceans/Moorings/CIS.html	no data, link to EuroSites
TENATSO	http://cdiac.ornl.gov/oceans/Moorings/TENATSO.html	no data, link to EuroSites
PAP	http://cdiac.ornl.gov/oceans/Coastal/PAP.html	no data, link to EuroSites
ESTOC	http://cdiac.ornl.gov/oceans/Coastal/ESTOC.html	time series data available / mooring data n/a (link to EuroSites)
STATION M	http://cdiac.ornl.gov/oceans/Moorings/Station_M.html	limited data available (2001-2007, some data from 2011)
DYFAMED	http://cdiac.ornl.gov/oceans/Coastal/DYFAMED.html	data available
W1-M3A	Listed on http://cdiac.ornl.gov/oceans/Moorings/Atlantic.html	No data
E2-M3A	Listed on http://cdiac.ornl.gov/oceans/Moorings/Atlantic.html	No data
E1M3A	Listed on http://cdiac.ornl.gov/oceans/Moorings/Atlantic.html	No data

2.3.2 ICOS

ICOS (Integrated Carbon Observing System) is a pan-European research infrastructure for quantifying and understanding the greenhouse gas balance of the Europe and its neighbouring regions. Near real time data streams for carbon dioxide are handled thought the ICOS Ocean Thematic Centre. It will receive data from a number of platforms, including instruments deployed on voluntary observing ships (VOS lines), fixed buoys, and repeat sections carried out at extended intervals. There are currently 18 VOS lines or fixed buoys measuring surface CO2 registered to participate in the ICOS project.

The ICOS Carbon Portal is part of the ICOS ERIC (European Research Infrastructure Consortium) and offers access to research data concerning greenhouse gases and carbon cycling in oceans, ecosystems and atmosphere throughout Europe. The basic design principle of the Carbon Portal is to use linked open data, semantic web ontology, scalable and containerized services, all based on open source software.

The ICOS Station table (https://www.icos-cp.eu/node/83) includes E2M3A, W1M3A and PAP observatories. However, the (prototype) portal at Data portal prototype (https://data.icos-cp.eu/portal/#search) that provides a map interface to the expected data sources for ICOS, does not yet contain data for these observatories.

3 FixO^3 STANDARDS AND BEST PRACTISE

3.1 Data format and Quality Control Standards

The primary sources of best practise in data management for the FixO^3 observatories are:

- the OceanSITES data format handbook (http://www.oceansites.org/docs/oceansites_data_format_reference_manual.pdf)
- The FixO^3 Handbook of best practises

The FixO^3 handbook is governed by the OceanSITES reference information in regard to quality control of data and hence the OceanSITES reference manual provides the definitive reference for FixO^3 quality control best practise.

For quality control (QC) flagging the OceanSITES Data management team recommends the use of flags for standard meaning [Table 6].

Table 6 OceanSITES quality flags meaning

Code	Meaning	Comment
0	Unknown	No QC was performed
1	Good data	All QC tests passed.
2	Probably good data	
3	Potentially correctable bad data	These data are not to be used without scientific correction or re-calibration.
4	Bad data	Data have failed one or more tests.
5	-	Not used
6	-	Not used.
7	Nominal value	Data were not observed but reported. (e.g. instrument target depth.)
8	Interpolated value	Missing data may be interpolated from neighbouring data in space or time.
9	Missing value	This is a fill value

Based on the OceanSITES User's Manual the quality control and other processing procedures applied to all the measurement of a variable must also be set and protocolled as a value in the data structure. String values (in the 'Meaning' column of Table 7) are used as an overall indicator (i.e. one summarizing all measurements) and also in the attributes of each variable in the processing level attribute.

Table 7 OceanSITES Processing level codes

Code	Meaning
0	No QC performed
1	Ranges applied, bad data flagged
2	Data interpolated
3	Not used
4	Not used
5	Data manually reviewed
6	Data verified against model or other contextual information
7	Other QC process applied

The current implementation of quality control in the FixO^3 near real time data flows is summarised in

Table 8. As defined in the standards documentation, the application of QC is desirable for both near real time and delayed mode data. However, the primary responsibility of the data providers is to ensure that the status of the QC is recorded in the data files, both in terms of the overall file content, and for each for the parameters recorded within the file.

The expectation for near real time systems, that operate in automated, or semi-automated mode, will be that either no QC is applied, or that the QC will involve readily automated activates, including checks on valid (i.e. possible) data values.

A typical set of automated QC tests might include:

1. Platform Identification
2. Date validation
3. Global Range Check
4. Drifting mooring
5. Range checks based on regional climatology
6. Rate of Change, or Spike test
7. Unchanging results, in either a temporal and depth sense.

In the following table (

Table 8) the column entitled ‘QC routines Applied’ references which of these 7 basic QC types are applied, and also provides information on any additional QC routines used for the near real time observatories. The QC applied in many of the data streams is also compliant with additional protocols, as indicated in the table.

Table 8 Current Near Real Time Quality Control Procedures implemented within FixO^3

Observatory	QC Routines Applied	Comments
STATION M	ad hoc /in house routines Additional routines for the carbon measurements	
CIS	no real-time QC	
PAP	1, 2, 3	
BISCAY AGL	1, 2, 3, 6, 7	
W1-M3A	1-7 Different quality tests are applied to different parameters (i.e., meteo or ocean variables)	Based on [3], [4], [5] & [6]
DYFAMED	no real-time QC	
ANTARES	no real-time QC	
LION	no real-time QC	
E2-M3A	1, 2, 3, 6 Pressure increasing	
OBSEA	1, 2, 3, 6, 7	Based on [7] & [8]
NEMO-SN1	(not currently active)	
PYLOS	1-7	Based on [7]
E1-M3A	1-7	Based on [7]
ESTOC	1-7	Based on [7] & [9]
FILCHNER RONNE	ad hoc self defined QC routines	

For Delayed Mode data, the data typically undergo a higher level of processing and QC, normally the responsibility of the scientists responsible for the observatory, rather than the data centres. In almost all cases, the QC involves manual review of the data in addition to the automated, or semi-automated, screening carried out on the near real time data.

The major additional factor for the delayed mode data is the calibration of the data streams, using additional data sources, most often sample data, collected during deployment and / or retrieval of the instrumentation, according to the protocols for data corrections provided in the Best Practise Handbook [2].

3.2 Near-Real-Time Carbon data QC

Within the ICOS project, there are more specific quality control protocols for the Carbon data. Principal investigators will submit Level 0 (raw) data from their observatories to the ICOS Ocean Thematic Centre for automatic processing and quality control using QuinCe, a web-based tool being developed for the purpose. This will ensure that all data submitted to the OTC is processed using identical methodologies, and reduce the workload of the PIs in preparing their data for publication.

QuinCe will perform data reduction to calculate surface fCO2 from the Level 0 sensor data according to the methods in [10]. Once data reduction is complete, automated quality control routines will analyse the data and attempt to identify problems in the data, such as Global Positioning System errors, range checking, spike detection etc. These routines will be based on those used in the Surface Ocean CO2 Atlas (SOCAT) project [11] to maintain consistency across the global surface ocean carbon community.

The output of this processing will constitute Level 1 data, which will be used to produce near-real-time output from the OTC. NRT data will be published as visualisations, but without the underlying data set itself being available (since it is not yet officially published).

3.3 Sensor Web Enablement

A developing set of standards for FixO^3 data management are regarding the use of standards for data services, as opposed to standards for the data themselves. A core initiative within FixO^3 is to support the development of Sensor Web Enablement (SWE). SWE is a suite of standards developed and maintained by the Open Geospatial Consortium. SWE standards enable developers to make all types of sensors, transducers and sensor data repositories discoverable, accessible and usable via the Web.

Sensor Observation Service (SOS) is a part of the SWE suite of standards, that enables definition of a web service to query characteristics of observations and instrumentation, as well as features. Provision of SOS services allows observations to be linked and searched using external portals, without additional overhead for the data provider. Currently, data from six FixO3 observatories are available via SOS. The development of these services allows the interaction of the observatory data collections with a range of international initiatives, without data duplication and in a standardised manner

Provision of SWE metadata, as defined within the Handbook of Best Practice [2] is being developed by several of the data providers.

As part of the development of SWE profiles, several partner organisations (for E2-M3A, OBSEA, W1M3A, PLOCAN) are operating SOS, with a viewer for these services available through FixO^3 (http://sensorweb.demo.52north.org/fixo3-client/#/map). Data from the ANTARES, LION and DYFAMED observatories will be made available via SOS during the coming months.

4 HOW WILL DATA STREAMS BE MAINTAINED INTO THE FUTURE

All of the current data providers have indicated that their existing data streams are to continue, subject to the availability of funding for the continuation of their observatories.

Several data centres have invested significant efforts into developing new data streams that can be searched and integrated into a variety of international initiatives. These data stream incorporate the FixO^3 best practise in terms of QC, data formatting and open data access.

One example is the data centre activity at PLOCAN for the ESTOC observatory. By implementing a standards-compliant infrastructure they are able to provide local data services for both near real time and delayed mode data, as well as delivering data through OceanSITES, IRI-ROOS and other integration frameworks.

Similar initiatives at the HCMR provide the framework to deliver data from a number of FixO^3 observatories to OceanSITES, MONGOOS and developing networks such as EMSO. The SOS implementation at HCMR provides the capability to investigate the sensors, observations and instrument deployments at these sites.

Within NERC, there is a planned transition of the existing workflow for the near real time data from the current stand-along service for the PAP observatory, to a core BODC managed service that will provide consistent quality control and data provision across all the NERC observatories (PAP, NOG and SOG) as they become near real time enabled.

The existing data archive centres, including PANGAEA and CORIOLIS are also consistently providing data access through standardised services, allowing alternative data access routes for those observatories that do not operate dedicated data centre activities.

The current FixO^3 data providers are actively engaged with a wide range of international initiatives, including AtlantOS, EMSO, EMODnet and SEADATANET, as well as the operational services, including the regional components of GOOS (IBI-ROOS and MONGOOS) that feed into the COPERNICUS Marine Environment Service. These initiatives continue to provide the infrastructure for data integration, ensuring wider discoverability and dissemination of FixO^3 observatory data.

Support for wider generation of the SWE profiles for marine observations, across the full suite of observatory instrumentation and deployment, will continue to enhance the discoverability of the FixO3 data through new data initiatives.

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6 ACRONYMS

AGL	Augusto González de Linares
ANTARES	Astronomy with a Neutrino Telescope and Abyss environmental RESearch
AWI	Alfred Wegener Institut
CDIA	Carbon Dioxide Information Analysis Center
CIS	Central Irminger Sea
CNR	Consiglio Nazionale delle Richerche
CNRS	Centre National de la Recherche Scientifique
CSIC	Consejo Superior de Investigaciones Científicas
CVOO	Cape Verde Ocean Observatory
DELOS	Deep-ocean Environmental Long-term Observatory System
DYFAMED	Dynamique des Flux Atmospheriques en MEDiterranee
EMSO	European Multidisciplinary Seafloor and water column Observatory
ERIC	European Research Infrastructure Consortium
ESFRI	European Strategy Forum on Research Infrastructures
ESONET	European Seas Observatory NETwork
ESTOC	European Station for Time-series in the Ocean, Canary islands
FixO^3	Fixed point Open Ocean Observatories Network
FRAM	Frontiers in Arctic Marine Monitoring
HCMR	Hellenic Centre for Marine Research
IBI-ROOS	Ireland-Biscay-Iberia Regional Operational Oceanographic System
ICOS	Integrated Carbon Observing System
IEO	Instituto Español de Oceanografía
IFREMER	Institut français de recherché pour l‟exploitation de la mer
INDP	Instituto Nacional de Desenvolvimento das Pescas
INGV	Istituto Nazionale di Geofisica e Vulcanologia
LION	Gulf of Lion Observatory
MOIST	Multidisciplinary Oceanic Information SysTem
MoMAR	Monitoring the Mid-Atlantic Ridge
MONGOOS	Mediterranean Operational Network for the Global Ocean Observing System
NEMO-SN1	NEutrino Mediterranean Observatory-Submarine Network 1
NERC	Natural Environment Research Council
NOG	Northern Oligotrophic Gyre
OBSEA	Expandable Seafloor Observatory
OGS	Istituto Nazionale di Oceanografia e di Geofisica Sperimentale
PAP	Porcupine Abyssal Plain
PLOCAN	La Plataforma Oceánica de Canarias
QC	Quality Control
SOG	Southern Oligotrophic Gyre

TENATSO	Tropical Eastern North Atlantic Time-Series Observatory
UiB	Universitetet I Bergen
UNIABDN	The University Court of the University of Aberdeen
UNIRes	Uni Research
UPC	Universitat Politècnica de Catalunya