Joint European Research Infrastructure network for Coastal Observatories

Report on the current status of fixed platforms in Europe D3.3.1

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24 Countries
SMHI
Marine Institute
Helmholtz-Zentrum Geesthacht
Zentrum für Material- und Küstenforschung
euskalmet
euskal meteorologia agentzia
afbi
Ifremer
METEOGALICIA
cnrs
INSU
OGS
BUNDESAMT FÜR SEESCHIFFFAHRT UND HYDROGRAPHIE
AMGI
NORWEGIAN MAPPING AUTHORITY
hidrográfico
IBW PAN
45 Institutions
NOOS
METEO FRANCE
FCOO
Forsvarets Center for Operativ Oceanografi
hcmr
ΕΛΚΕΘΕ
IMGW
ISMAR
Cefas
Puertos del Estado
UPMC
SORBONNE UNIVERSITÉS
MUZEUL NATIONAL DE ISTORIE NATURALĂ GRIGORE ANTIPA
PML
Plymouth Marine Laboratory
Met Office
cetmef
marinescotland
80 Systems
916 Stations
Sensors

Document description

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Contents

Executive Summary

This JERICO report describes the current status of fixed platform observing systems in the seas around Europe. Fixed platform or eulerian observatories are fixed with respect to their position on or above the seafloor - they may be part of a coastal feature such as a pier or jetty, or they may be located offshore. These platforms host different types of sensors for making measurements of the water, marine life or contaminants. The location of sensors on the seabed or throughout the water column provides an important capability to sense large parts of the ocean which are not detectable from the surface. This report is intended as a guide to promote sharing of information and best practices, and it can also be used as a mapping tool to identify gaps in the existing data collection system. Metadata about fixed platforms to populate the report was collated from existing portals such EDIOS, SEPRISE (now no longer active), and EMODnet-Physics as well as from national centres and individual scientists. Records were quality-controlled and organised into a relational database before analysis using GIS and database queries.

The results show that close to 2000 marine measuring instruments are currently in place on fixed platforms around Europe; these instruments are collecting data on physical, chemical and biological parameters. The greatest number of measurements is for physical oceanography, with sea level being the commonest instrument type. 463 sea level measuring stations, 446 sea temperature stations and 237 wave measuring stations were recorded in this survey. In contrast, there are comparatively few instruments measuring biogeochemical or biological variables. For example, only 8 stations were found to be measuring pH and a further 11 were measuring nutrients.

Over 900 different fixed platform measuring sites were mapped by region (using the NOOS, BOOS, IBI-ROOS and MOON regions), and by country. A very wide variety of instruments and platform types are in use at these sites. This report does not attempt to describe each station or instrument in detail, but clusters a collection of similar measurements (often made by the same institute) as a distinct system to allow a point of contact and web address for each to be identified.

According to this classification, Europe has 80 identifiable marine observing systems. Systems have on average 11 nodes or measuring stations. The observing systems are predominantly located in the shallow coastal zone where the seabed is less than 50 m deep. The largest system is that of the Danish sea level measuring system with 82 individual measurement points, but more than half of the systems were comprised of less than 5 measuring stations. 33 of the 80 systems belong to organisations who are partners in the JERICO project; JERICO partners are therefore responsible for 39% of Europes fixed platform stations.

A number of stations were recorded as holding multiple sensors, and there are even examples of stations which simultaneously record biological, chemical and physical parameters. If observations at these stations could be sustained, then they will make a very important contribution to the global marine observing network.

Fixed platform measurements are usually made at a temporal resolution much higher than that of the process being studied. The resolution of processes at time scales from seconds to years gives fixed platforms a unique role in the global ocean observing network, providing an unparalleled ability to detect processes which research vessel cruises and daily satellite observations may miss. The availability of high quality time series data of essential variables at key marine sites is important for the validation of model outputs, and in some cases assimilation of in situ data may be used in order to produce better forecasts of ocean state.

One of the aims of JERICO is to improve communication between the different operators of fixed platforms, gliders and Ferrybox systems. The goal of work package 3 is to compare the designs of different observing systems, and to look for examples of best practice in operational procedures which can be shared with the community. Together with the other WP3 reports on Ferrybox and gliders, this report will make an important first step towards the ultimate aims of the project.

Keywords

Observing systems, fixed platform, marine monitoring, coastal.

Introduction

Observations of the physical processes and the biological properties of the coastal seas of Europe are essential to guide good management practices and to advance our understanding of important issues such as pollution and fishing, as well as guiding the sustainable use of resources. The vast 89,000km of coastline around our seas (EC, 2013), and complex range of hydrodynamic types and habitats suggest that many different types of observation will be needed to provide the necessary information. Since the early part of the 20th century a fleet of research vessels has been tasked with this purpose, and has provided data on oceanographic conditions and changes in biological communities. Information on certain features of the ocean surface can also be detected in a quasi-synoptic manner from earth-observing satellites, with ocean colour providing an important evidence of change in processes such as primary production (Jennings et al 2008). There is a considerable international effort at the European level to harmonise both research vessels (e.g. EUROFLEETS), and remote sensing and ocean modelling (GMES). Several other types of ocean observing system are also in use in addition to ships and satellites. The JERICO project is concerned with developments in three types of observing system in particular: FerryBox systems on ships-of-opportunity (see report WP3.1), gliders (WP3 report in prep) and fixed platforms (this report).

Figure 1: Types of fixed platform observing systems in use in Europe (left panel) surface mooring at SmartBay site, Galway, Ireland (upper mid) Observation tower in the COSYNA network, German Bight, Germany (upper right) underwater node of COYNA, Helgoland, Germany (lower) Wave rider buoy, Cefas Wavenet, UK.

Fixed platform or eulerian observatories are fixed with respect to their position on or above the seafloor - they may be part of a coastal feature such as a pier or jetty, or they may be located offshore, such as a moored buoy. These platforms host different types of sensors for making measurements of the water, marine life or contaminants (Figure 1).

The location of sensors on the seabed or throughout the water column provides an important capability to sense large parts of the ocean which are not detectable from space (Larkin et al 2006). Regardless of position in the water, fixed platform measurements are usually made at a temporal resolution much higher than that of the process being studied (Larkin et al 2006). The resolution of processes at time scales from seconds to years gives fixed platforms a unique role in the global ocean observing network, providing an unparalleled ability to detect processes which research vessel cruises and daily satellite observations may miss (Lampitt et al 2008). Extreme weather, short-lived algal blooms and periods of oxygen depletion are examples of the types of events which are highly suited to detection by fixed platforms. Hence, the strongest asset of fixed platform observing systems is their ability to generate high quality time series data which can be used for many purposes, including climate change assessments (Figure 2). The availability of high quality time series data of essential variables at key marine sites is also important for the validation of model outputs, and in some cases assimilation of in situ data may be used in order to produce better forecasts of ocean state, e.g. in the OSTIA daily sea surface temperature analysis available via the MyOcean portal (Martin et al 2012).

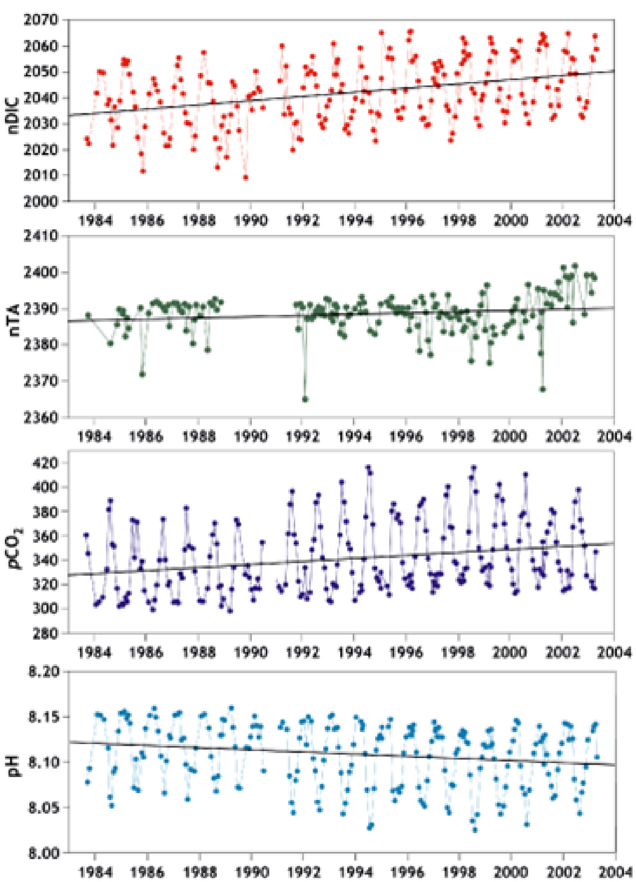

Figure 2: Time series of essential ocean variables from the Bermuda Atlantic Time-series Study, since 1984, charts showing with total dissolved inorganic carbon (DIC, mmol/kg), TA (Total Alkalinity), CO2 concentration (ppmv) and pH.

Moored and fixed systems are usually unmanned, and compared to drifting platforms such as Argo floats or gliders, can carry a greater range of sensors. Power to the platform can be derived from renewable sources such as solar panels, or from large battery packs. Newly developed cabled observatories such as SmartBay in Galway Bay (Marine Institute, 2010) will have additional capability to transmit high volumes of data in real time, as well as the ability to support more powerful instruments.

The fixed platforms considered here are those which are automated, i.e. parameters are sensed or water samples collected automatically, though these samples may be later analysed in a laboratory.

Aims

The aim of this part of JERICO work package 3 is to produce an overview of the current status of European fixed platform observing systems. Specifically, the task is to collate all available data from meta-data sources such as EDIOS, and the regional observatories, in order to produce a database which can be easily updated in the future, and which can supply information for mapping and comparative studies and direct users to data sources for a range of parameters. The database will indicate which platforms belong to JERICO members to enable a project-specific list of infrastructure to be made. This report had the following objectives:

- Verify positions (and convert to standard geographical format) and depths of fixed platforms, identify clusters of platforms belonging to the same system, standardise codes and vocabularies for instruments.
- Construct a database to identify key performance indicators such as: system downtime, platform manufacturers, sensor manufacturers, impact of the platform on data quality.
- Create maps and describe the European fixed platform infrastructure.

Main Report

Database construction

The deliverable of work package 3.3 consists of this report and a relational database containing metadata on the known European fixed platform observing systems. At the onset of the work Patrick Gorringe (EUROGOOS) and Wilhelm Petersen (HZG) produced a table of the known locations and details of existing fixed platforms around Europe. This list was partly derived from details held by the European Directory of the Ocean Observing Systems (EDIOS), an initiative of EuroGOOS originally set up between 2001 and 2004. EDIOS holds around 10,000 records of observing systems of all types, including many fixed platforms. EDIOS uses a harmonised SEADATANET vocabulary to describe its metadata entries, with details at seadatanet.org

The original WP3 listing of fixed platforms was subsequently analysed and quality-controlled at Cefas by Kate Collingridge. Stations were added on a country-by-country basis by adding new metadata from EDIOS and national data collections (e.g. UKDMOS for the UK). The original JERICO table (550 stations) was expanded to 916 stations, with new stations mostly distributed around the UK and the North Sea. This process also reduced considerably the amount of duplication. The format of the original spreadsheet was then converted to that of a Microsoft Access relational database in order to facilitate systematic querying of the records.

Description of JERICO WP3 fixed platform database

The database consists of a series of linked tables as shown in Figure 4. The database distinguishes between two basic sets of metadata: *stations* and *systems*. At the *station* level are the discrete nodes of the observing system defined by a *Jerico ID*. At present there is no internationally recognised identification system for ocean observing platforms or systems, so this represents a new development to be discussed within JERICO. Any existing ID for a node (e.g. from SeaDataNet) was retained as the fields *Station name* and *Station number*. A *Jerico ID* was given to all 916 platforms in the database regardless of whether the node 'belongs' to a member of the JERICO consortium. Attributes used at the *station* level are:

- Jerico ID
- Latitude and Longitude to at least 2 d.p.
- Station name
- Station number
- Minimum measurement depth
- Maximum measurement depth
- Maximum water depth
- Start date

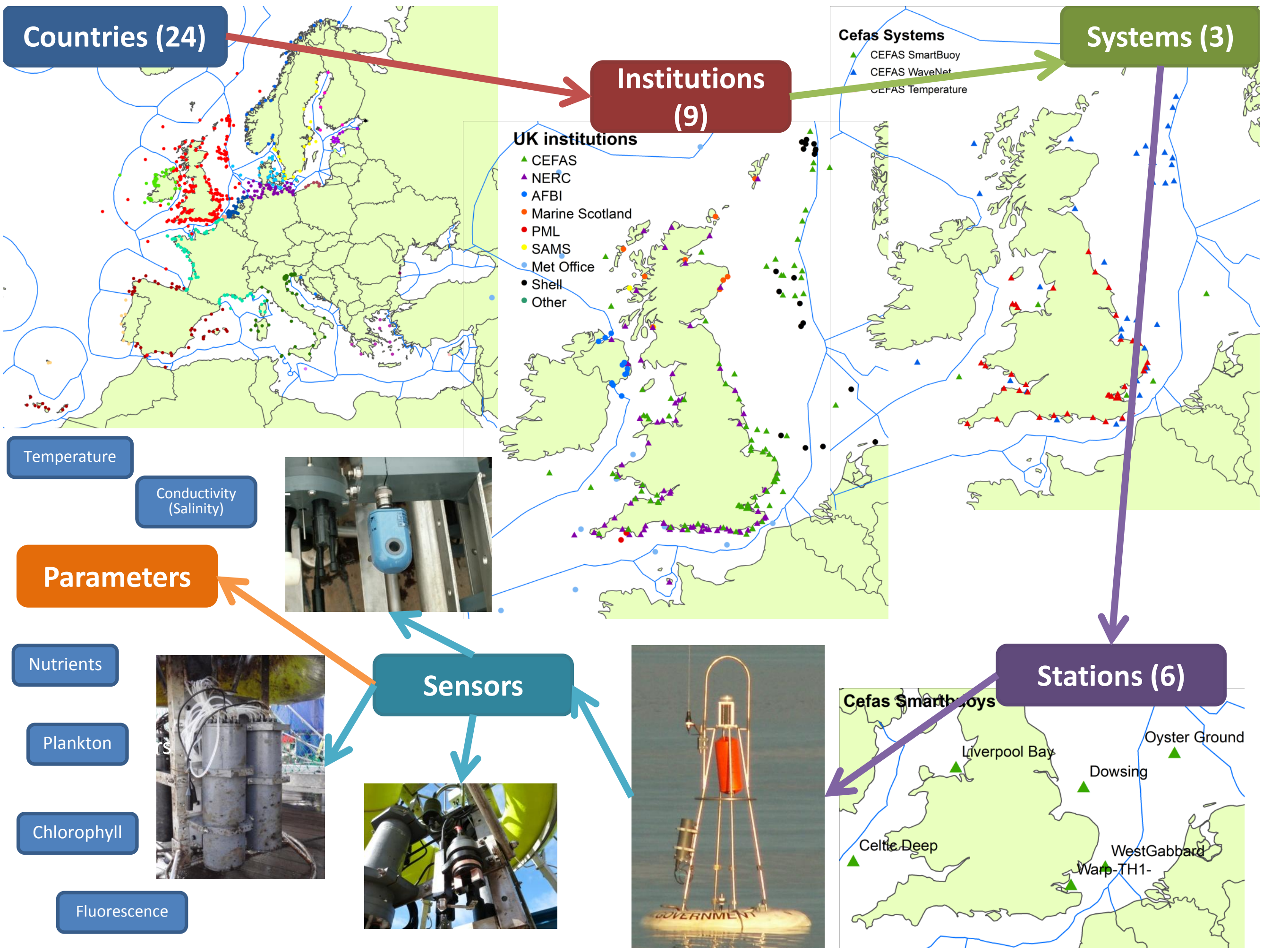

Figure 3: Infographic showing the database structure using the Cefas Smartbuoy system as an example

- End date
- Parameters measured, grouped into 3 broad categories (biological, chemical, physical), and 15 more specific categories (air, chlorophyll, currents, dissolved gases, light/PSM, nutrients, pH, plankton, precipitation, salinity/conductivity, sea level/depth, sea pressure/density, waves, winds: see Appendix 2 for details on parameters in these groupings).

Stations are then grouped into *Systems* based on the country and organisation responsible for them, the platform type, and the types of parameters measured. For example, in the UK all of the Cefas SmartBuoys are grouped into the *Cefas Smartbuoy* system (Figure 3), all of the UK Met Office weather buoys are grouped into the *UKMO buoy system*, and the tide gauges into the *NTSLF system*. These systems are defined by a unique *System ID*, and each *Jerico ID* is assigned to a system.

Attributes used at the *System* level are grouped into 2 tables. The first is *tb System* containing:

- System ID
- System name
- Country
- Institution
- Jerico partner
- Platform types (via a link to tb_platform_types)
- System purpose
- Number of stations in the system
- Start date
- URL
- Responsible person
- Email of responsible person

The second is *tb System management* containing:

- Frequency of measurement
- Maintenance operations
- Frequency of maintenance
- Data processing
- Data storage

- SeaDataNet compliance
- Data access restrictions
- Data access method
- Quality control operations
- Name of responsible data manager
- Email of data manager
- URL for quality-control document if applicable

Figure 4 shows the fields in these tables and the relationships between them. Each field has a description attached to it.

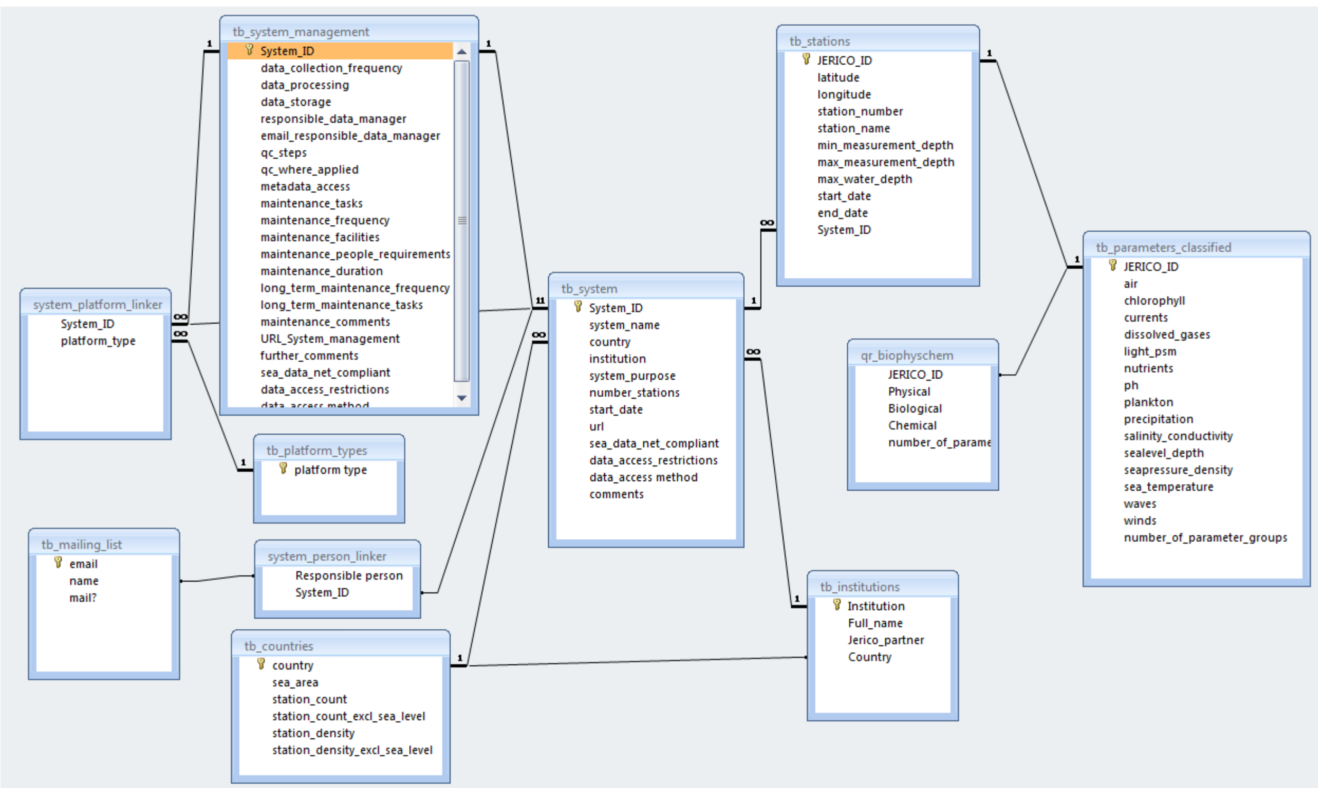

Figure 4: Linked tables comprising the JERICO WP3 fixed platform database.

Updating the database

Updating the database is possible via *forms*. These exist in two types, one for adding new *stations* or *systems* and one for adding or updating metadata for existing *stations* or *systems*. These *forms* can be sent via email to any HTML-enabled email client, and returned with the new information, which will checked before being added to the database. This is an important feature of the database as it will enable the addition of missing system and station metadata, as well as new stations and systems which are absent from the database at present.

Completeness of the database

The vast majority of station entries in the database contain at least the most basic metadata, i.e. station name or number, location, institution and variables measured. There are some exceptions to be completed, for example many Danish tide gauges are missing locations, and many Italian stations are missing variables. Many stations also have the frequency and start date of data collection.

At the system level the database is much less complete. Although all systems have a name, institution, purpose, and platform type, only 40 (of 80) have details for the person responsible for the station, 56 have URLs (although many are not specific to the system, only the institution or data platform homepage), and 31 have start dates. The System management metadata is even more sparse - although most systems have entries for data access and data collection frequency, very few have complete metadata, especially for maintenance and quality control. Filling in these gaps will greatly increase the utility of the database.

In additions to incomplete fields in existing entries, there are likely to be stations missing from the database altogether, especially in smaller countries with no JERICO partner. By circulating the maps produced with this report widely, along with email forms for adding new entries, it will be possible to identify missing stations and add them to the database.

Errors

Some errors found during quality control were:

- Duplicated stations
- Broken URLs
- Incorrect locations (e.g. longitude positive when it should be negative)
- Columns not lined up (e.g. sorted by institution without expanding the selection)
- Formulae referring to incorrect cells
- One entry copied down a column, overwriting other entries
- Spelling errors
- Inconsistent entries (due to misunderstanding in meaning of column header, or using different variable code systems)

Whilst every effort has been made to correct these errors, it is possible that some remain, not least due to the fact that the initial version was compiled as a large spreadsheet. Through the use of forms to update entries it is possible for those responsible for the systems to contact the lead author of this report and update their entries to correct any remaining errors.

European overview and statistics

The database contains 916 records of fixed platforms in Europe. These are shown in Figure 5, colour coded by the country owning the station.

As can be seen from figure 5, the greatest density of platforms is in the NOOS region*, and the lowest in the Black Sea, which is severely undersampled, with only 2 stations recorded here.

*This could in part be due to 'oversampling' of this area due to knowledge of the authors and language barriers; other regions are likely to have more stations missing.

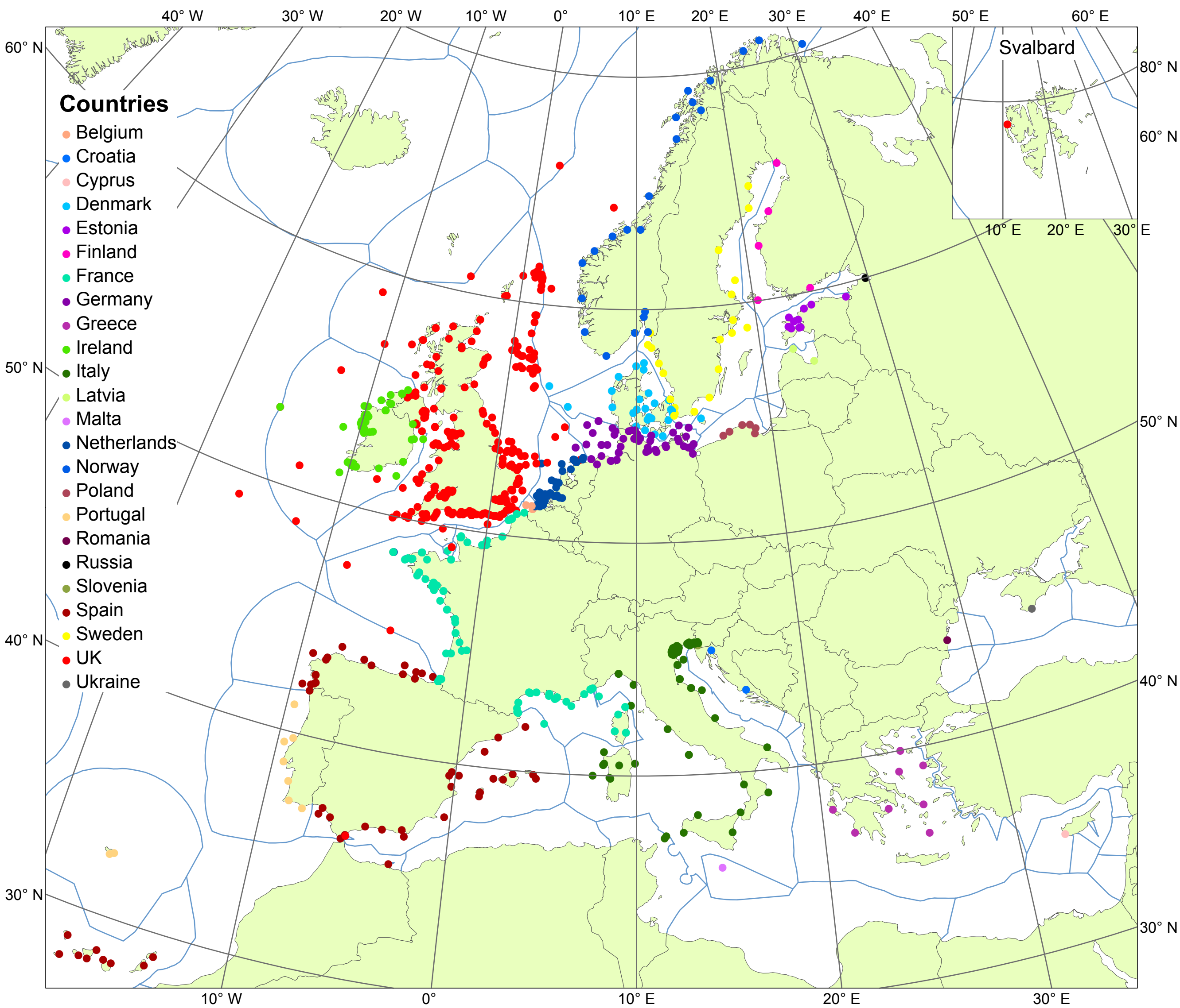

Figure 5: Map showing the location of fixed platforms in Europe, colour coded by the country owning them.

Systems

The fixed platforms are categorised into 80 systems, of which 33 are owned by JERICO partner organisations. There are an average of 3.3 systems per country, with an average of 11.5 stations per system. Of the systems where a start date is included (36/80) the age of the system ranges from 2 to 107 years, with an average age of 64 years . The older systems are mostly networks of tide gauges which started recording in the late 19th or early 20th century.

Stations

The number of stations per country ranges from 1 to 265, with an average of 38. Figure 6 shows the ranked number of stations per country: the UK has by far the most stations, followed by Italy, and there are 14 countries with less than 10 stations. The differences in numbers of stations can be explained in part by the length of coastline and sea area belonging to the country. However, this is not the complete picture: figure 7 shows the number of stations per 100,000 km2 of exclusive economic sone (EEZ), and although the differences between countries are somewhat reduced when the sea area is accounted for, they are still present. When scaled in this way the UK falls from first to 6th position, and it is actually Slovenia which comes out on top, due to its tiny sea area (with only one tide gauge). When stations measuring only sea level are excluded the top 5 countries in order are Belgium, Germany, Denmark, the Netherlands and France (Figure 8). For some countries this may be due to a focus on observation types other than fixed platforms, for example research ship-based (e.g. Norway, Spain) or HF radars (e.g. Spain), but for others there is a lack of ocean observations in general (e.g. Portugal) . The differences between countries are explored in further detail in the subsequent country descriptions, and are also in part due to differing completeness of the database across regions and countries.

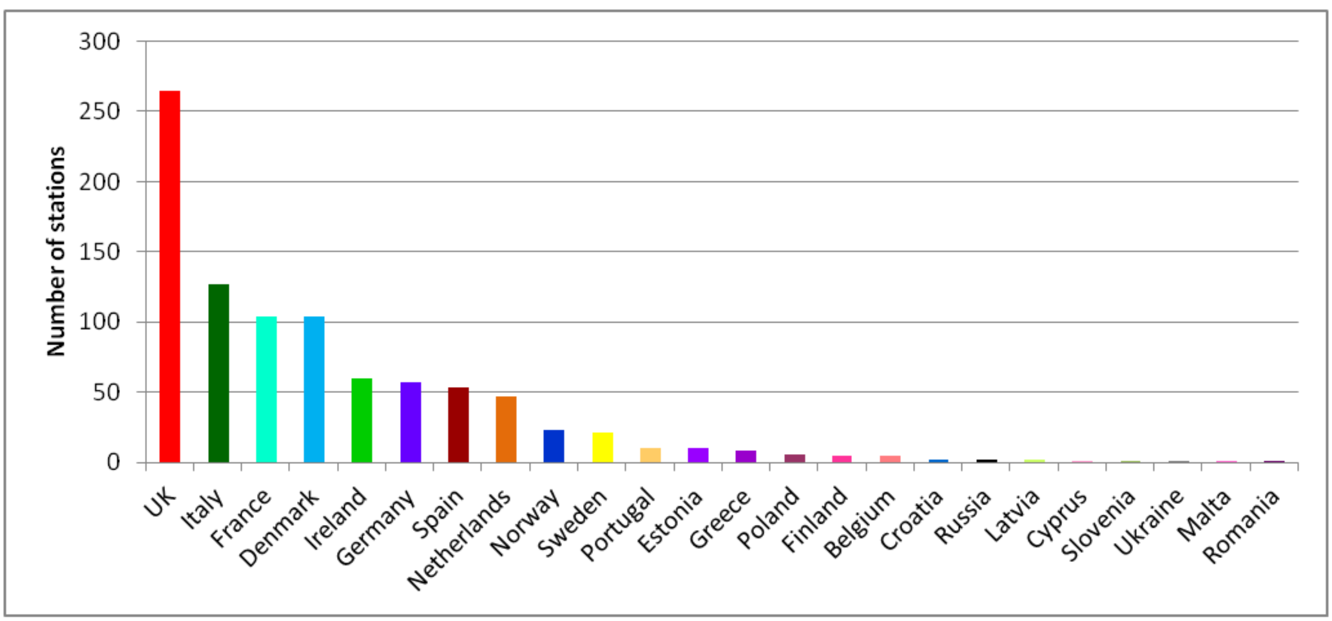

Figure 6: Ranked frequency distribution of the number of fixed platforms per country.

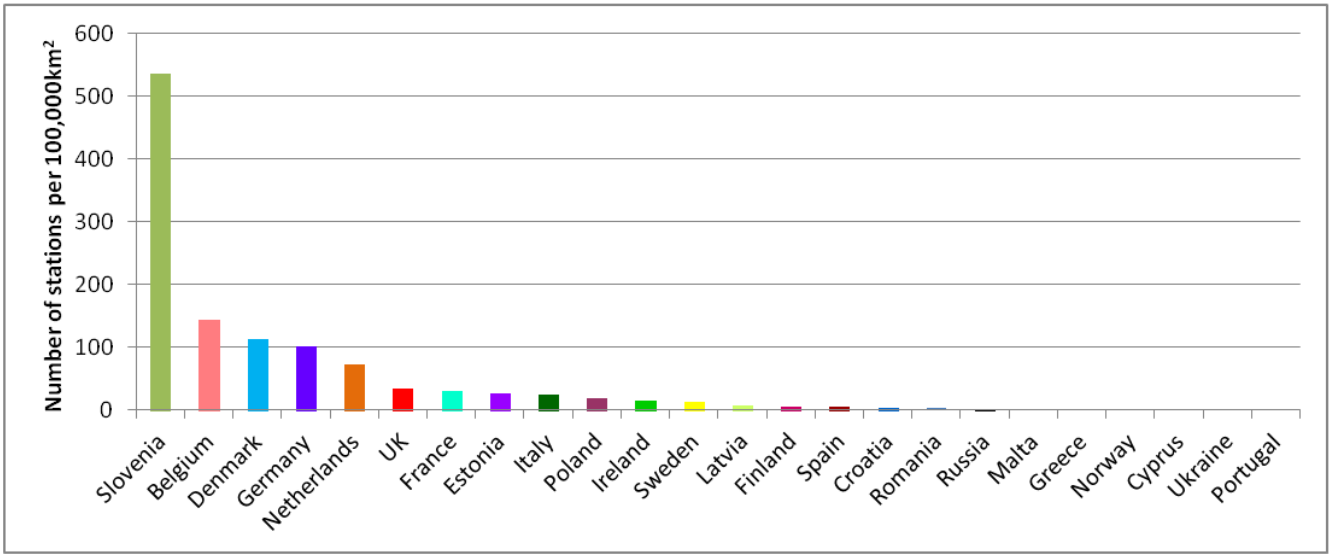

Figure 7: Ranked frequency distribution of the number of fixed platforms per 100,000km2 by country.

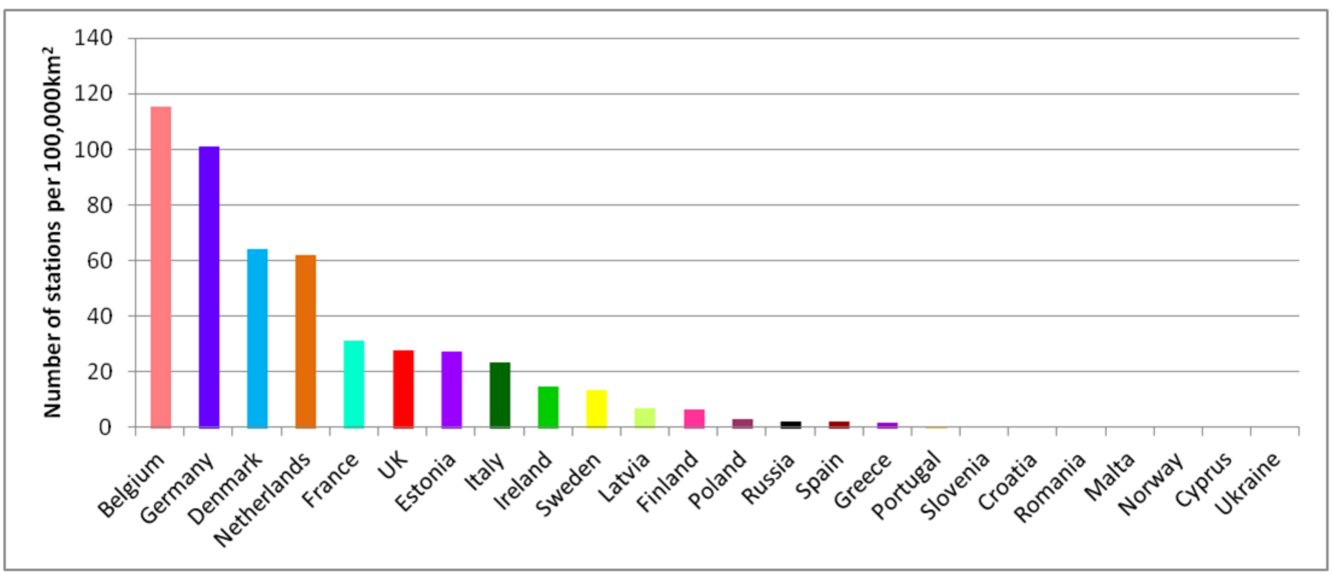

Figure 8: Ranked frequency distribution of the number of fixed platforms per 100,000km2 by country, excluding stations which only measure sea level.

Parameters

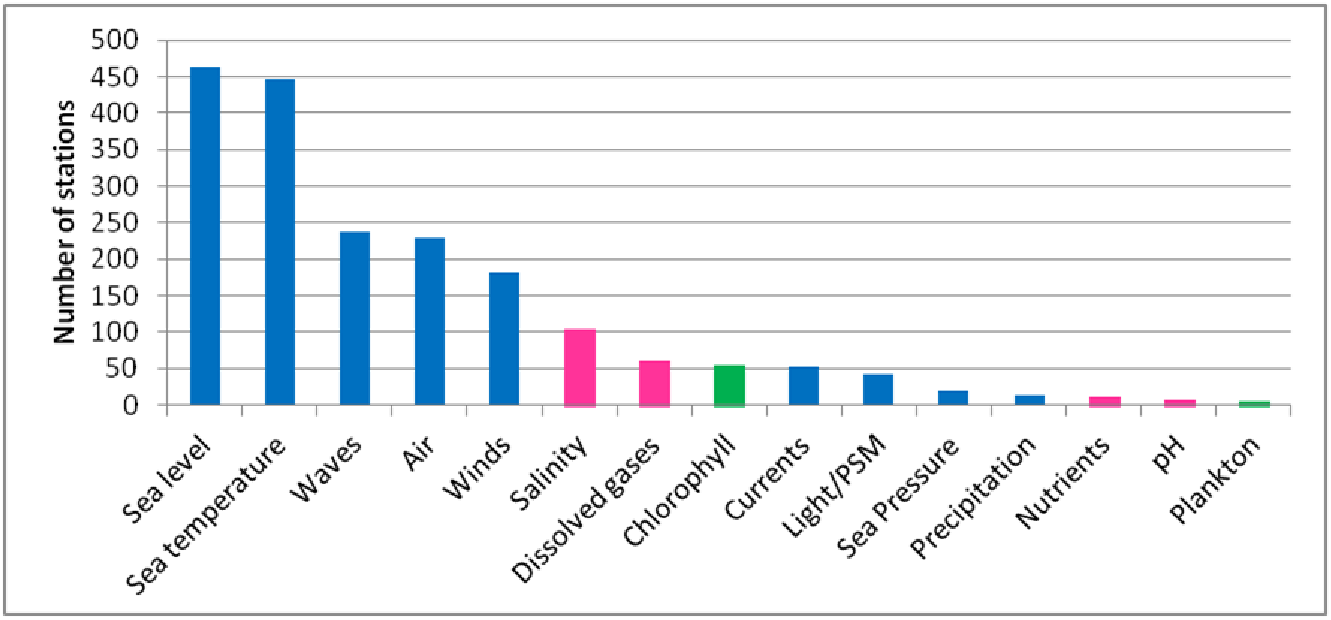

Figure 9: Ranked frequency distribution of the number of fixed platforms measuring each parameter. Physical parameters are coloured blue, chemical pink and biological blue. See Table 2 in Appendix 2 for definitions of the parameter classifications.

Just over 50% of all stations are tide gauges, and of these 38% measure only sea level. Many of the smaller countries only have sea level systems. The next most common parameter is sea temperature (Figure 9), which is measured at nearly 48.7% of stations. While physical parameters (with the exception of currents) are well sampled (measured in almost all stations), biological and chemical parameters (measured at 6% and 12% of stations respectively) are sampled at few stations. Nutrients in particular are only sampled in the UK and the Netherlands, while chlorophyll, light and dissolved gases are also restricted (see Appendix 2). Appendix 2 countains European level maps for each of the 15 parameter groups.

Country descriptions

For each country a series of maps were produced:

- Systems maps (left panel in subsequent figures) show the systems present in the country, with JERICO partners displayed by triangles and non-partners displayed by circles.
- Parameter group maps (right panel in subsequent figures) show the parameter groups (classified as biological, physical and chemical) measured at a station as mini pie charts. The mini pie charts are displayed as non-overlapping, such that they are close to the station location, but where several stations are in close proximity they are not in the exact location.

Additionally, maps showing parameters grouped into 15 more specific categories (listed above) as mini pie charts were produced (Appendix 1).

NOOS

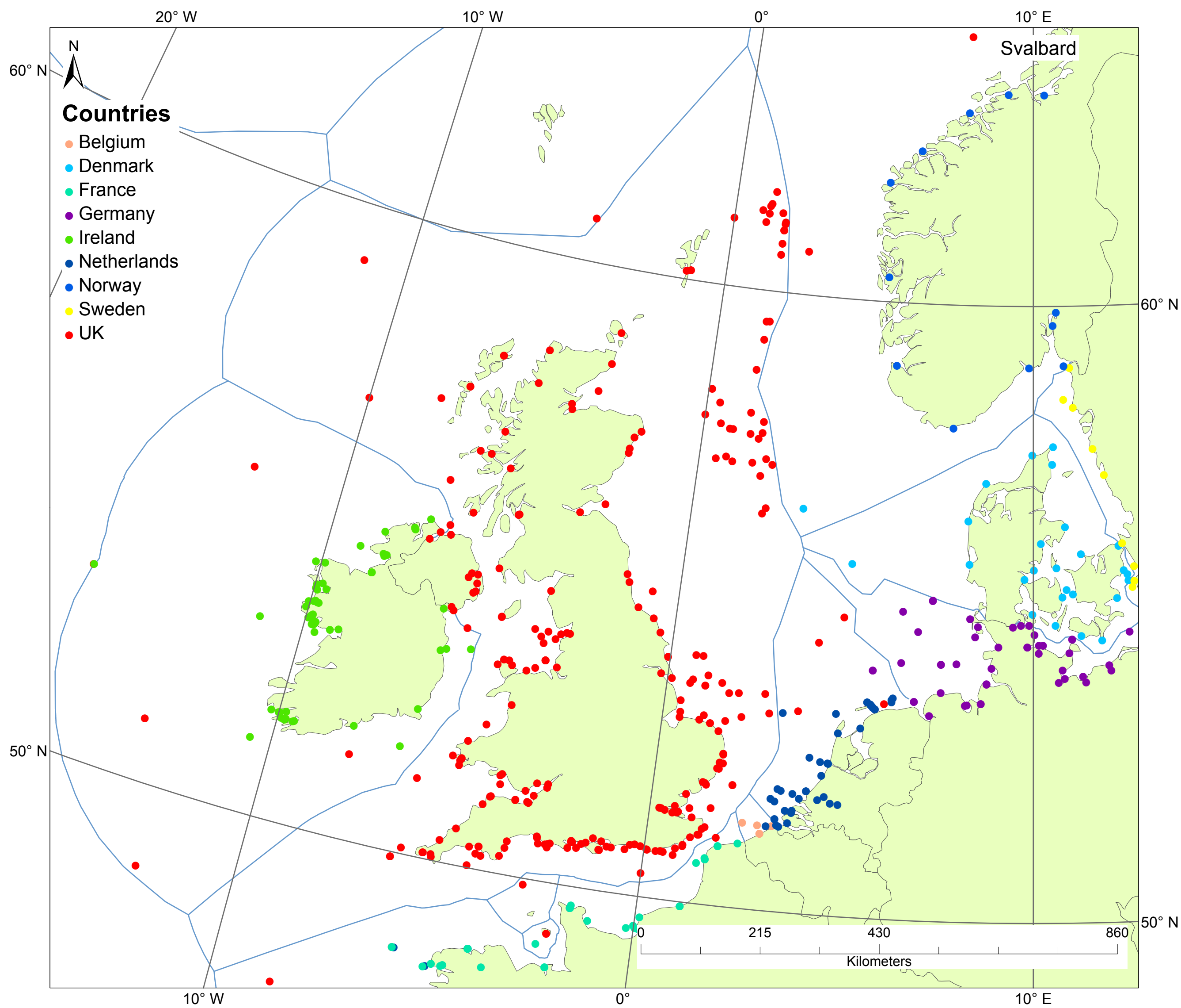

Figure 10: Map showing the location of fixed platforms in the NOOS region, colour coded by the country owning them.

UK

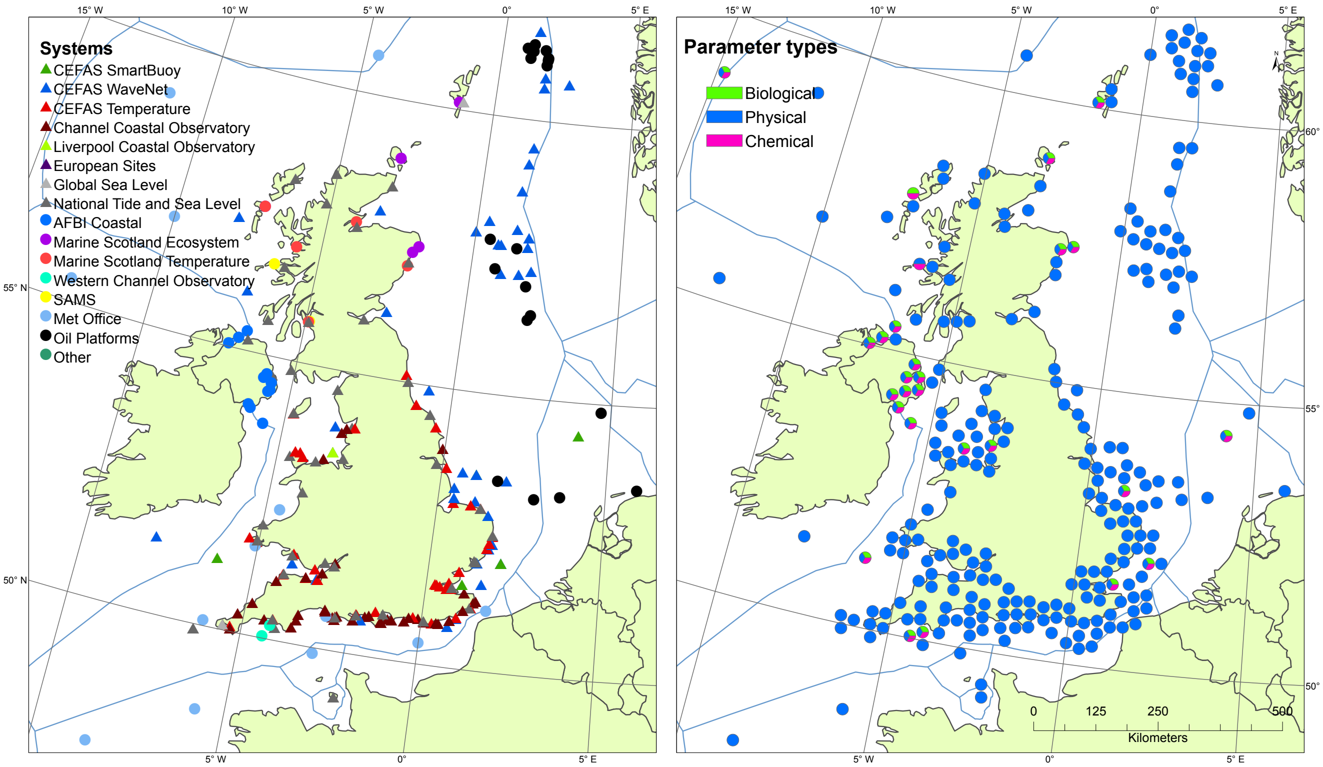

Figure 11: Fixed platforms in the UK.

With a long coastline and a history of oceanographic research the UK has a one of the largest and most diverse networks of in situ fixed platform observing systems. The two largest operators of present-day observing systems are members of JERICO: the National Oceanography Centre (NOC) and CEFAS. The other public sector operators of fixed platforms in the UK are Marine Scotland, Agri-Food and Biosciences Institute of Northern Ireland (AFBI), Plymouth Marine Laboratory, Scottish Association for Marine Sciences (SAMS) and the Meteorological Office (MetOffice). These organisations are not JERICO partners. There are additional fixed platforms operated by the oil and gas industry. The information on the above stations was obtained from EMODNET-PHYSICS, EDIOS and national initiatives. Fixed platforms not yet included in the JERICO database belong to the Scottish Environmental Protection Agency (SEPA), operating 6 coastal moorings, and the Environment Agency whose activities are not known.

NOC operates five different types of observing system, the largest of which is the National Tidal and Sea Level Facility with 49 stations measuring sea level. An additional sea level network is formed of 4 additional stations contributing to the Global Sea Level Observing System (GLOSS). NOC also hosts the Channel Coastal Observatory which has 39 coastal nodes measuring waves, sea-level and metereological conditions. Two smaller observing systems hosted by NOC are the Liverpool Bay observatory with coastal radar and wave buoys and the EuroSites benthic-pelagic oceanic mooring at the Porcupine Abyssal Plain measuring a range of physical, chemical and biological data. Since 1989, the site has become a major focus for international and interdisciplinary scientific research and monitoring including water column biogeochemistry, physics and benthic biology). The PAP mooring carries a many different sensors and ranks as the highest number of parameters measured (13 parameter groups) per station in this survey. The site is the only oceanic site measuring dissolved gases and nutrients. A collaboration between NERC and UK Met Office has led to the first atmospheric measurements at the site beginning in 2010. NOC follow Oceansites best practise.

Figure 12: Surface superstructure of the PAP mooring

Cefas operate three fixed platform observing systems. The Cefas Inshore Temperature Network has been operational since 1903 using citizen science operatives to collect surface temperature measurements at regular intervals. The network of volunteers is has recently been augmented by the installation of temperature-depth loggers. Cefas WaveNet is a fully operational wave and temperature measuring system with 40 nodes which provides data in real-time for storm surge and flood forecasting as well as the needs of offshore industries. Cefas SmartBuoy is a system of ecosystem observatories designed initially for the assessment of eutrophication, but also providing data for other purposes such as remote sensing validation and biogeochemical studies. The SmartBuoy system is well documented with more than 16 recent publications describing different uses of the data (e.g. []).

Best practice in the use of the SmartBuoy network was presented at the JERICO workshop on Crete in October 2012. An operational team is dedicated to the maintenance, servicing, calibration and quality control of the buoy network. Most servicing and repairs are done on land to reduce vessels costs. The construction and deployment of buoys is a routine process in which careful controls are made of parts inventories and instruments. Dedicated workshop and storage areas are used to construct moorings and prepare them for deployment at sea.

The SmartBuoy system uses databases to record both data and changes in instrument performance. A sequence of events is logged before, during and after each deployment: Pre-deployment:

- Logger set up on database - checks on service history of sensors, looks at deployment length, battery life etc.
- Serviced instruments ready to deploy (i.e. two complete sets per site).
- The same sensors are used on rotation - this helps a lot with calibration

Post deployment:

- All sensors photographed - helps when assessing fouling.
- Jet wash
- Dismantle and wash and clean everything in fresh water, pack into transit cases.

- Upload data to database overnight
- Service all instruments

A SmartBuoy data management system is used for conversion of raw instrument responses into quality-controlled data which is then made available on a web portal.

Germany

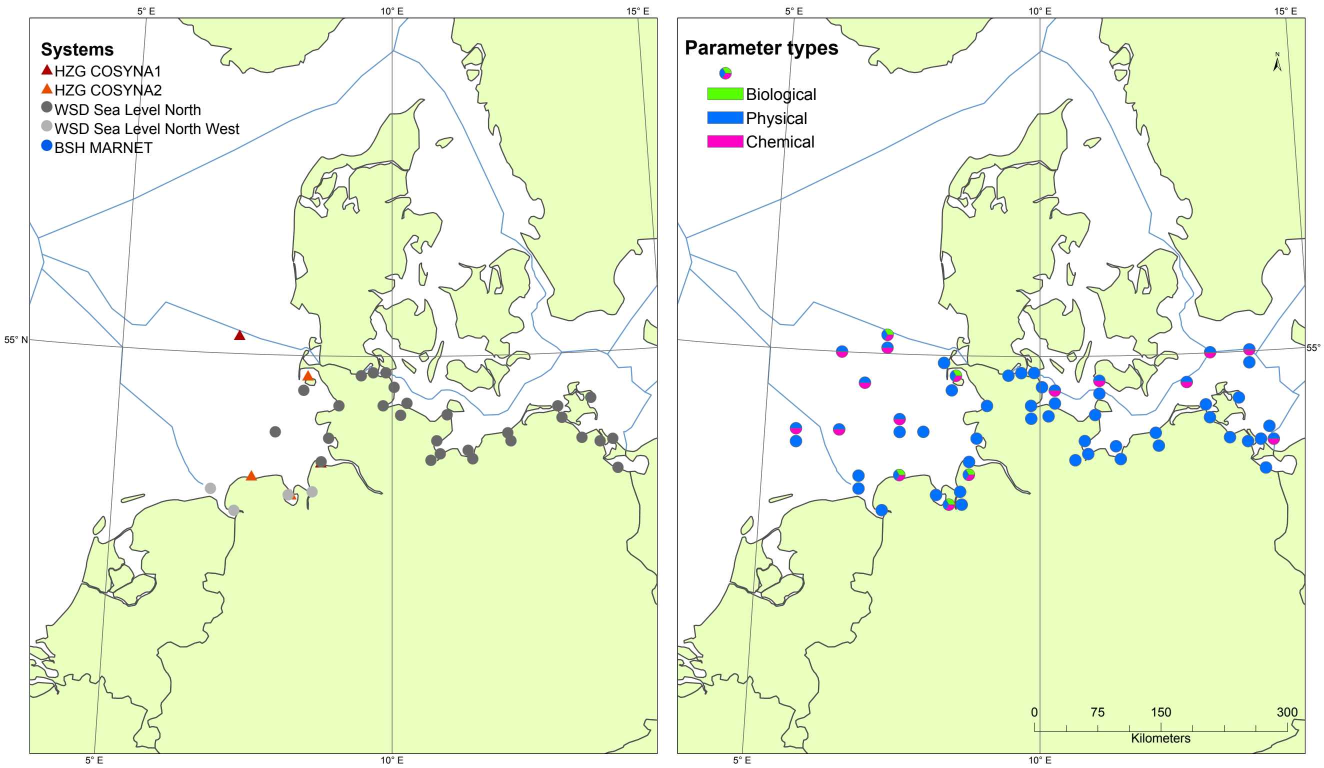

Figure 13: Fixed platforms in Germany.

Figure 14: The Darsser Schwelle moveable platform in the Baltic Sea

The coastal waters of the Baltic Sea and North Sea belonging to Germany are monitored by three different systems. The largest set of measurements is a tide gauge network belonging to the Wasser- und Schifffahrtsverwaltung des Bundes. 31 sea-level measuring stations are recorded here, and many more stations are present inland along Germany's larger rivers. The measurements can be viewed in real-time at (pegelonline). Germany's next most important observing system is MARNET of the Bundesamt fuer Schiffart (BSH). BSH (an associate JERICO partner) sent a representative, Detlev Machoczek, to the WP3 best practice meeting in Heraklion, Crete in 2012. Elements of the BSH presentation about MARNET are used here. There are 21 nodes or individual stations in MARNET. The most advanced in terms of numbers of sensors per station is the FINO tower in the North Sea which measures 8 variables.

It is more difficult to construct fixed platforms in the Baltic Sea due to the presence of drifting ice during the winter months. An ingenious solution used by BSH is to lower their observing tower to the seabed by means of a hinge during late Autumn. The following Spring, the tower is raised to the surface at the end of winter by injecting compressed air into the hull.

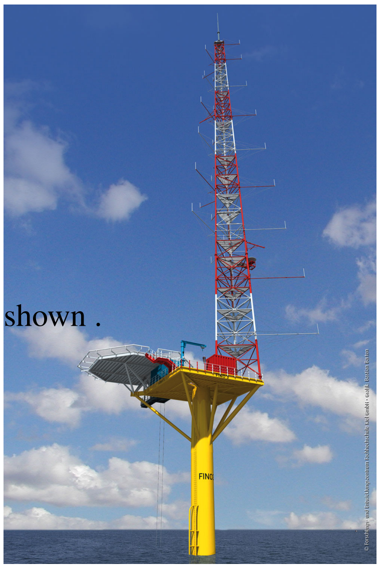

Figure 15: The FINO 3 station in the German Bight is possibly the largest fixed platform in Europe.

Best practice

BSH demonstrated several aspects of their operational system to JERICO users during the best practice workshop. The number of maintenance visits to each station in MARNET was shown. This varied between 6 visits per year up to 11 per year, with a mean of 8 visits. A move towards an automated analysis of chemical and nutrients was shown .

Denmark

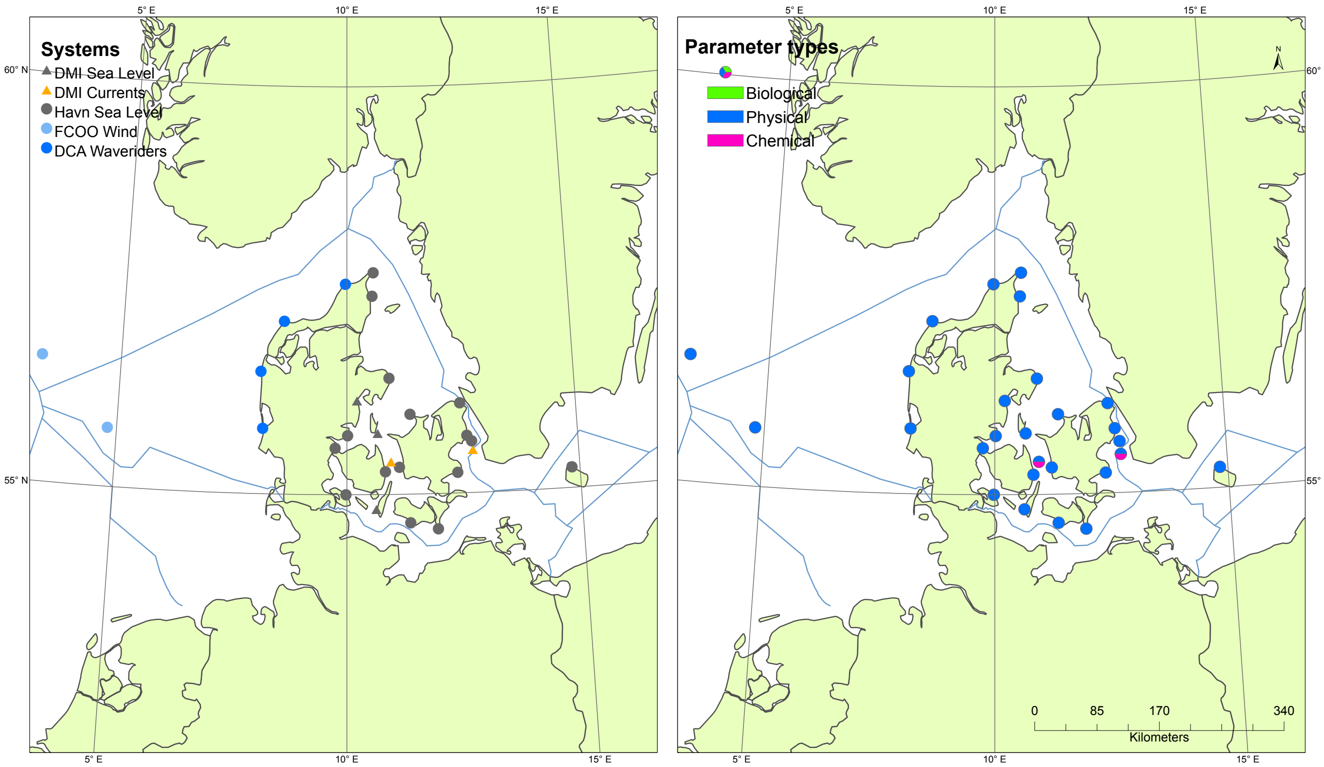

Figure 16: Fixed platforms in Denmark.

The coastline and inshore sea area of Denmark has an extensive network of fixed platform systems which are primarily used for observations of the physical environment. In total, there are 102* stations in Danish waters, making this the fourth largest of the European marine networks. The number of stations recorded for Denmark here is higher than that in EMODmet, which has 33. The main difference is that the JERICO database includes all sea level gauges belonging to the Havn Sea Level system. It is noteworthy that the stations belonging to the Danish Meterological Institute (DMI) are incorrectly classed in EMODnet-Physics as belonging to the Deutsche Marine Institute! DMI operates a system for measuring sea level with 11 stations, and has a 5-node system for current velocity with two stations in the Kattegat (W26 and Drogden) also measuring temperature and salinity. DMI observations can be found on the website of FCOO (Forsvarets Centre for Operativ Oceanografi), and FCOO is also listed as the owner of a wind measuring system with two nodes.

Besides the DMI and FCOO, a wave observing system with 4 stations is operated by the Danish Coastal Authority. The remaining 82 Danish observations belong to a sea level system operated by individual Havne. These observations can be found in the in-situ TAC of MyOcean.

The Danish network includes measurements of sea level, waves, currents, temperature and salinity, but no biological parameters.

There are no details at present for best practices used on the Danish systems.

*a small number of duplicate stations may still be present in the database.

Belgium

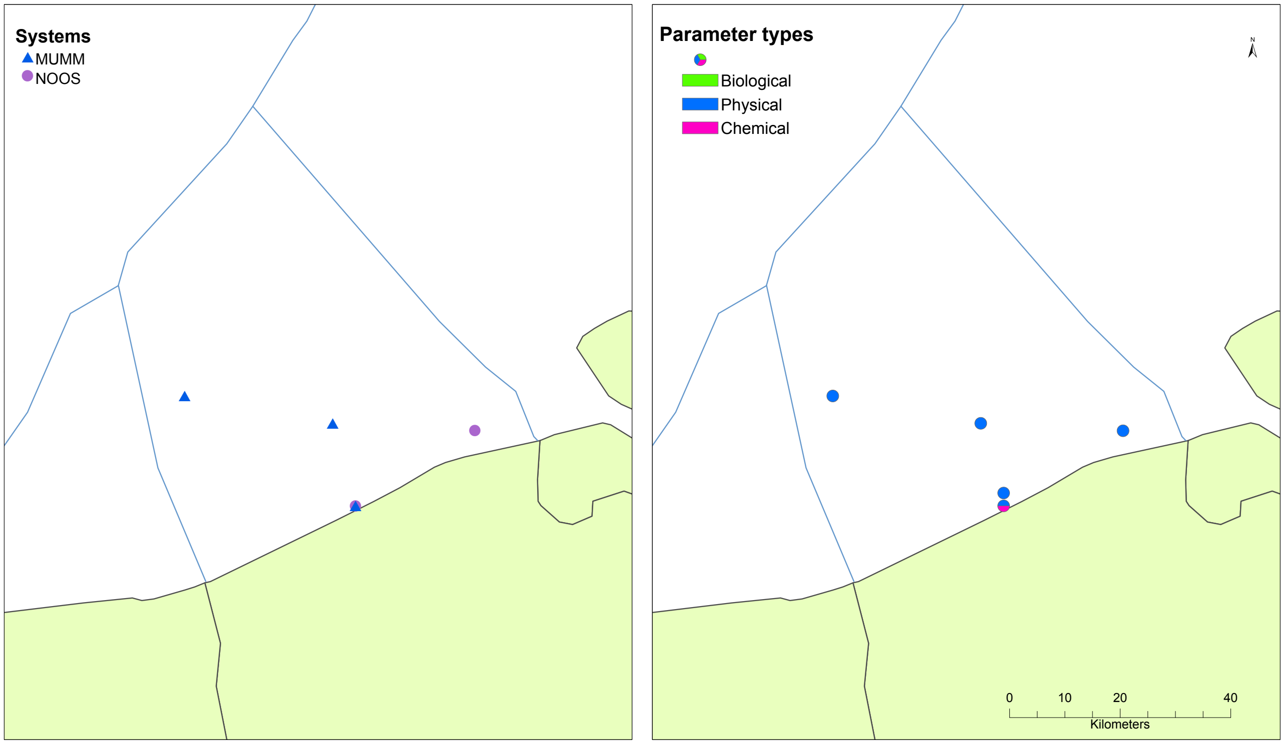

Figure 17: Fixed platforms in Belgium.

There is a small network of autonomous fixed monitoring stations in Belgian waters. MUMM is the main provider of oceanographic data with stations at Ostend measuring temperature, salinity and sea level, and wave and current measurements at Westhinder and stations with waves alone at Akkaert. Real-time values are reported on the MUMM website (and on EMODnet-Physics for Westhinder). The Ostend sea level station can be found on the NOOS and EMODnet-Physics websites and is linked to AWZ (Administratie Waterwegen en Zeewezen).

There are no details at present of best practice for these observing systems.

France

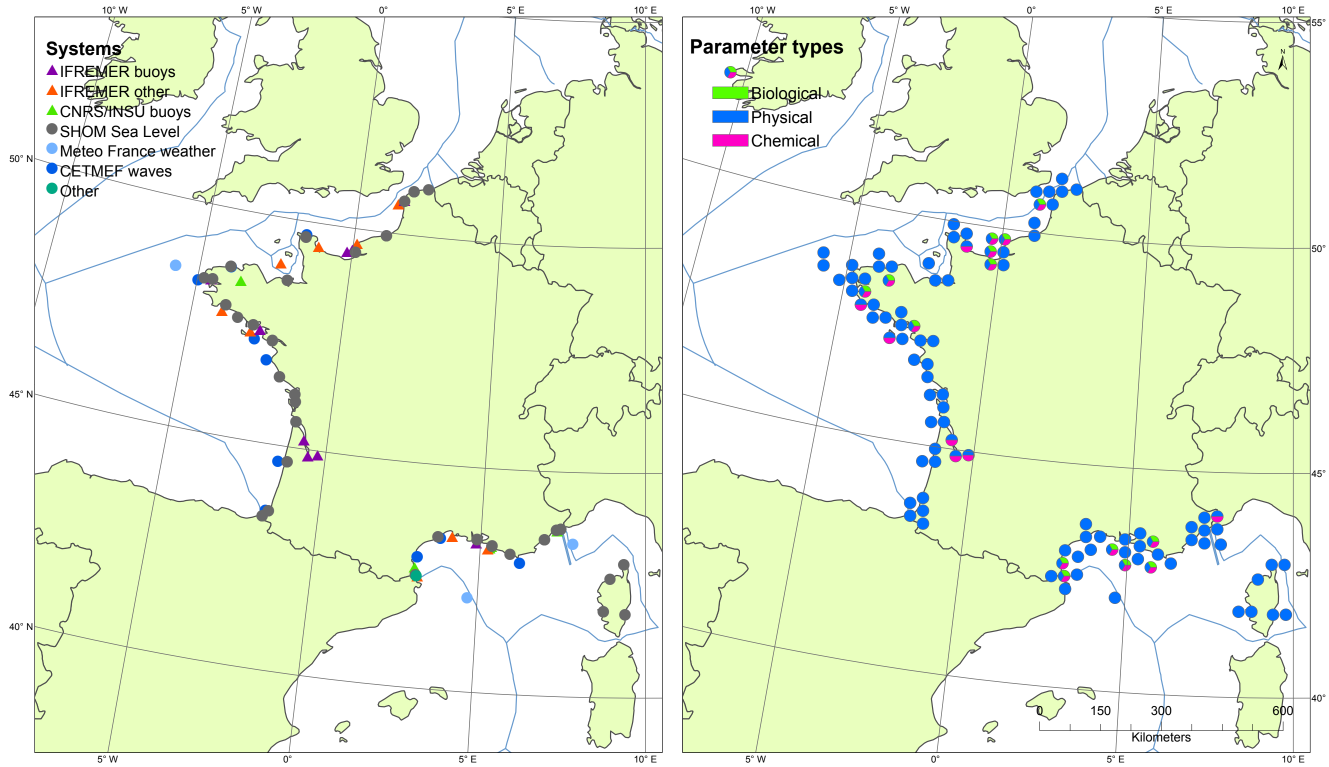

Figure 18: Fixed platforms in France.

Figure 19: Ifremer fixed platforms showing different designs and methods of power supply (top left) cabled platform at Brest (b) solar powered mooring off the Seine estuary (c) wind powered MOLIT mooring off the Vilaine estuary. (Photos of L. Delauney (IFREMER RTD)).

The coastal waters of mainland France and the island of Corsica are monitored by a large array of fixed platforms, operated by six major suppliers. A diverse set of parameters are measured, including ecosystem/biological variables. The largest French observing system is the tide gauge network operated by the hydrographic agency SHOM. This has 61 nodes spaced relatively evenly around the coastline. SHOM sea level measurements are available through the CORIOLIS portal and also in MyOCEAN and EMODNnet-Physics. The second largest system is that for wave measurements operated by CETMET on the French Atlantic and Mediterranean coasts. Some of the wave buoys also measure wind and sea temperature and the observations are available in real-time from CORIOLIS and EMODnet-Physics.

The oceanographic agency IFREMER is the next largest operator and has a very diverse system of physical, chemical and biological sensors deployed on its buoy and other fixed platform systems. High frequency measurements have been established at key sites for 15 years. Rather than using standardised equipment, each design of fixed platform is optimised for a particular location and measuring requirement (Figure 19).

IFREMER is one of the few European system operators which has fixed platforms capable of measuring multiple parameters. For example, the Mediterranean station 61284 measures waves, wind, sea temperature, salinity, currents, light attenuation, and sea level. IFREMER have begun using new sensors for measurement of dissolved gases and pH, although installation is limited to two stations at present. The observations from IFREMER can be found in dedicated web portals such as (previmer). IFREMER data are delivered through to the European portals of MyOcean and EMODnet-Physics. Meteo-France is another national provider of wave, wind and surface temperature data with 4 nodes reported here.

Figure 20: Inshore SOLA station in 27 m water depth, forming part of the Banyuls ocean observatory.

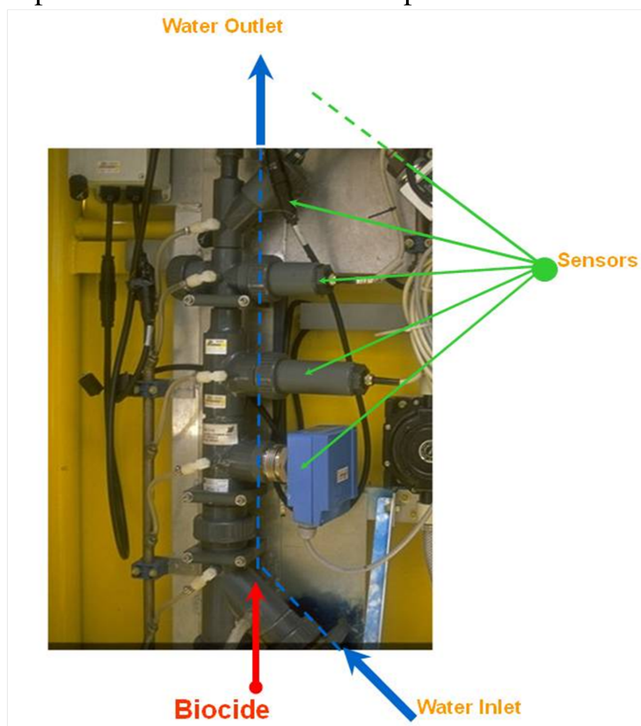

Figure 21: A pumped system allows the use of chlorination or other biocides to prevent biofouling and gives protection against the harsh environment. The use of active biofouling protection is used with the aim of reaching a target time of 3 months between maintenance visits. Further details can be found in the presentation of L. Delauney (Ifremer).

Several marine biological institutes have their own observing programmes, often with long time series of fisheries, benthic and biological data. Instrumented platforms in these programmes have been included collectively under the 6 nodes of the CNRS/INSU system. These buoys include profiler buoys and coastal buoys for monitoring riverine input and floods. The EOL profiler buoy has a set of standard sensors but is also able to be equipped with extra sensors, such as ph and pC02 sensors and even a cytometer, and the Mesurho coastal buoy measures 12 different parameter groups, making it one of the most comprehensive stations in the database. The two moorings of the Banyuls ocean observatory are similar to the CNRS/INSU network. The closest inshore of the Banyuls stations, SOLA, is shown in the photograph above. These observations are multi-disciplinary and include biological (chlorophyll), chemical (salinity) and physical (underwater light) variables, with up to 6 sensors per station. The CNRS/INSU data may be available on local web portals, but do not yet appear in any of the supra-national data portals.

Best practice

The French coastline is a harsh environment for continuous robotic monitoring systems with a high level of energy (waves and tidal current), and biofouling and mineral deposits on sensors present a continuous problem. Mechanical fatigue and stress levels on instruments and structures are also a danger. The intensive industrial and recreational use of the coast brings other hazards such as damage from towed fishing gear, anchoring, and vandalism.

IFREMER presented their approach to solving these problems at the JERICO workshop in Crete during 2012. The quality of measurements and durability of their systems are guaranteed by innovative use of technology. The supply of energy is of huge concern for autonomous systems and the description above shows that this has been solved in different ways. IFREMER stations most frequently use a flow through measuring system rather than exposing sensors directly to the sea.

A series of other organisational and technical measures are used by IFREMER to improve their delivery of data. As with Cefas, the organisation of the observing systems includes a dedicated operational team, which was said to be vital for success. The system is closely supervised at all times so that preventive measures can be taken if a fault is detected. Maintenance and repairs can then be done on site, or in the workshop. The latter is preferable as it reduces expensive ship costs. The IFREMER operational team have developed databases to keep track of spare sensors and devices and to record changes in instrument performance over time. There is also a strong partnership with key suppliers of oceanographic equipment which is beneficial to both customer and supplier. Quality assurance at IFREMER has four levels of data checking. The raw data is controlled using automatic procedures and visual checking by the operations team. This will form the real-time data feed which may be delivered externally e.g. to CORIOLIS and MyOCEAN. After a delay of 3 months the data is controlled further and calibrations are applied. At this point different data flags can be attached to each data point, using an internationally agreed 6-level scale of:

1 Not qualified (raw data)
2 Good
3 Out of stat
4 Unreliable
5 False
6 Missing

Netherlands

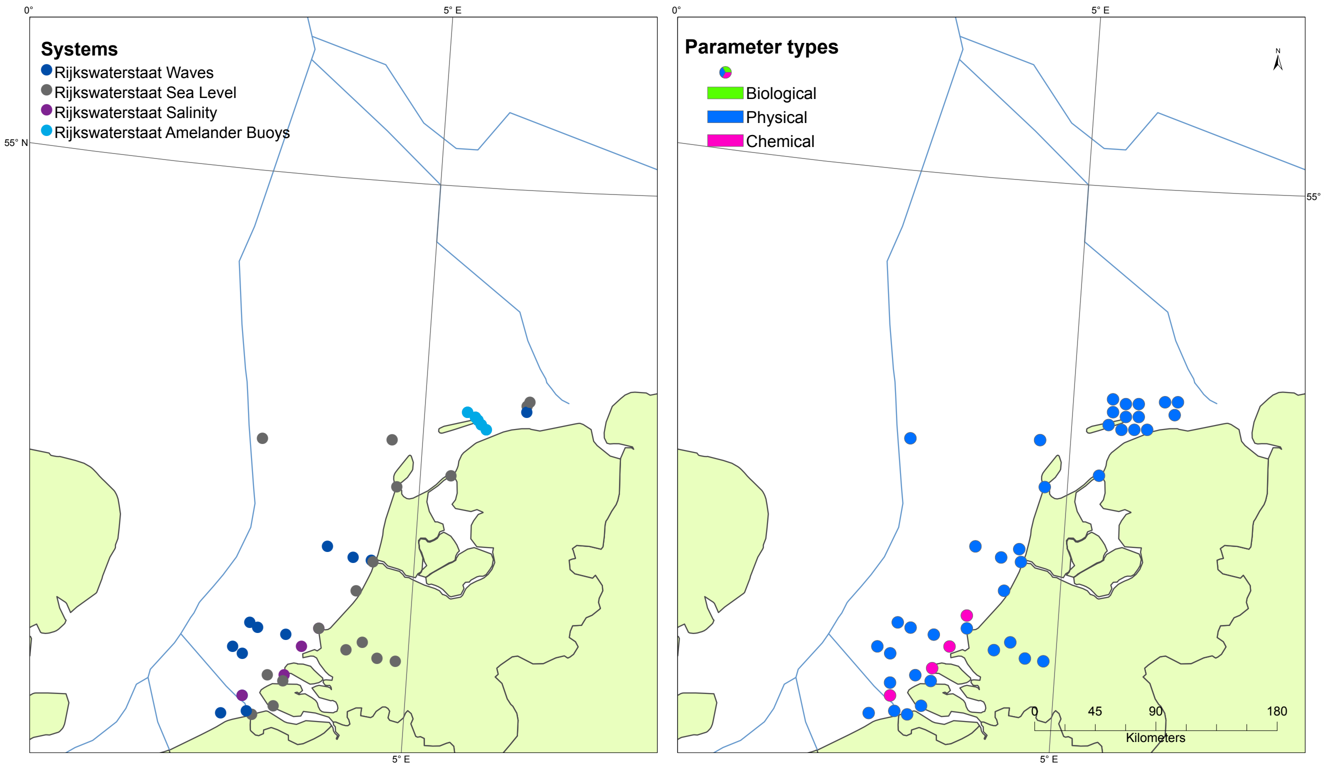

Figure 22: Fixed platforms in Netherlands.

Rijkswaterstaat is the sole provider of fixed platform in situ data for the Netherlands. This agency is not a member of JERICO and its observing systems are not listed in SeaDataNet, but it does provide data feeds to EMODnet-Physics. There are discrepancies however between the stations reporting to EMODnet and those visible from Rikswaterstaats own in situ data page. There are many measuring stations located in the estuaries of the eastern and western Schelde which are not included in EMODnet. The example below shows stations measuring salinity. The four stations located in the North Sea proper are the only ones included in EMODnet (and here).

The Rijkswaterstaat system reported here has been divided into different components for waves, sea level and salinity, with 22, 21 and 4 nodes respectively. A very long time series of sea level is available, starting from 1872, and this network is extensive, with many inland tide gauges not included here. Sea temperature is not recorded as a parameter here or in EMODnet, but some stations are reporting temperature (and also metereological data) on Rijkswaterstaats own website. There is no information on best practice for The Netherlands.

Norway

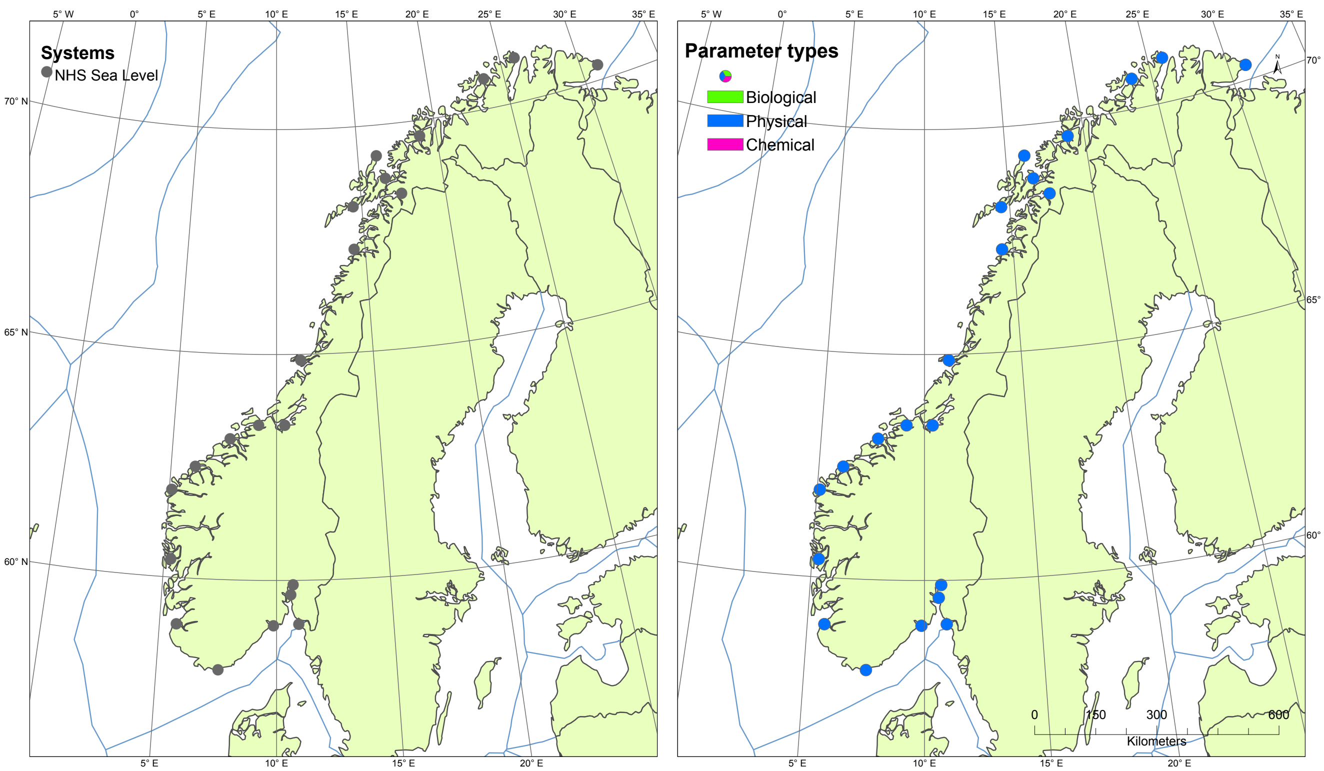

Figure 23: Fixed platforms in Norway.

There is only one operational oceanographic system in Norway at present. According to SEPRISE, the Norwegian Hydrographic Service operates a sea level observing network with gauges at 23 sites. Nine stations in the system report to EMODnet-Physics, which records three different system owners: NMA - Norwegian Mapping Authority - Norway NHS - Norwegian Hydrographic Service - Norway MetNo - Norwegian Meteorological Institute Norway

There are two JERICO partner in Norway, NIVA and IMR, but no records could be found of fixed platforms for these.

BOOS

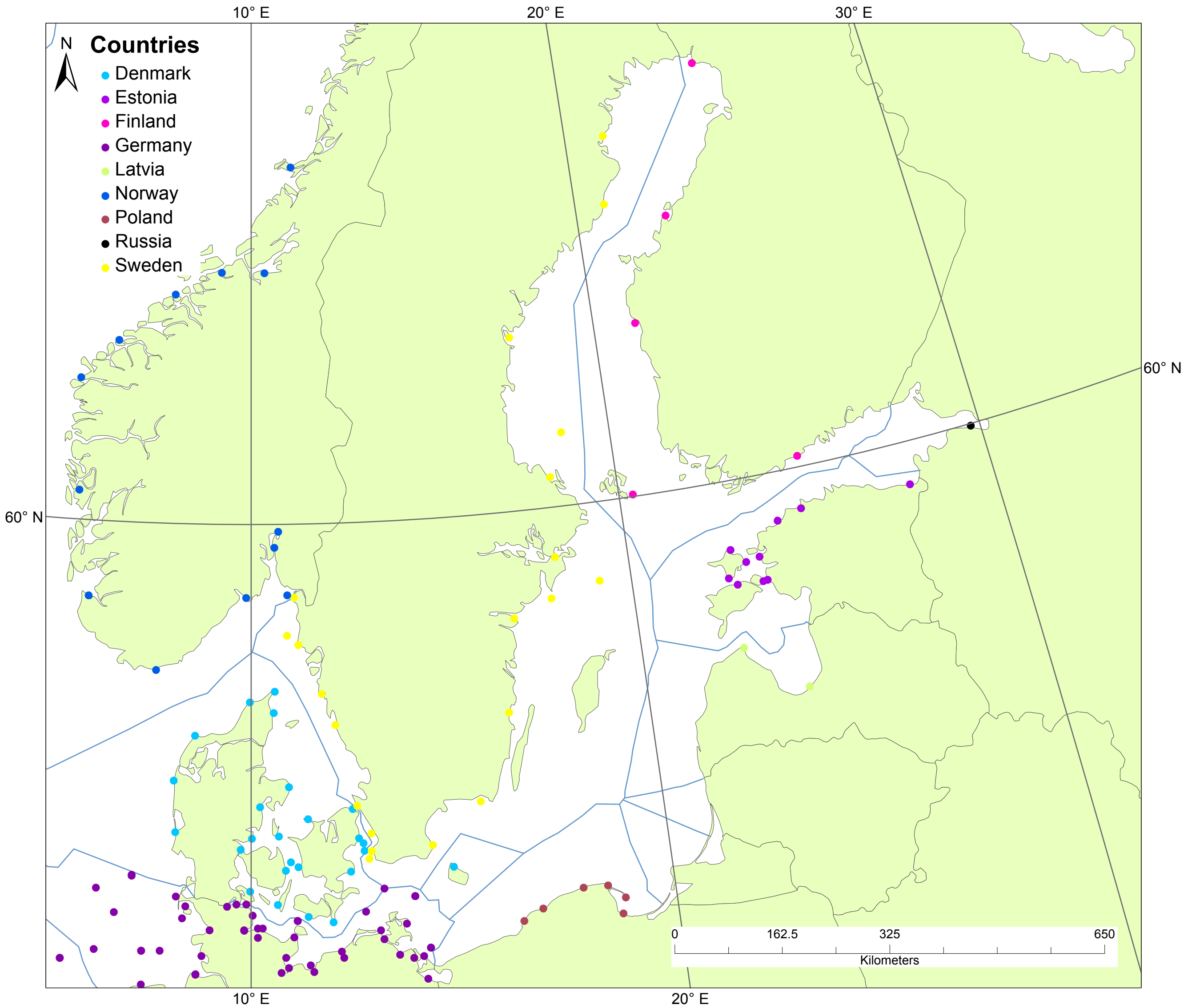

Figure 24: Map showing the location of fixed platforms in the BOOS region, colour coded by the country owning them.

BOOS countries not already described in NOOS: Sweden, Finland, Russia, Estonia, Latvia, Lithuania, Poland.

Sweden

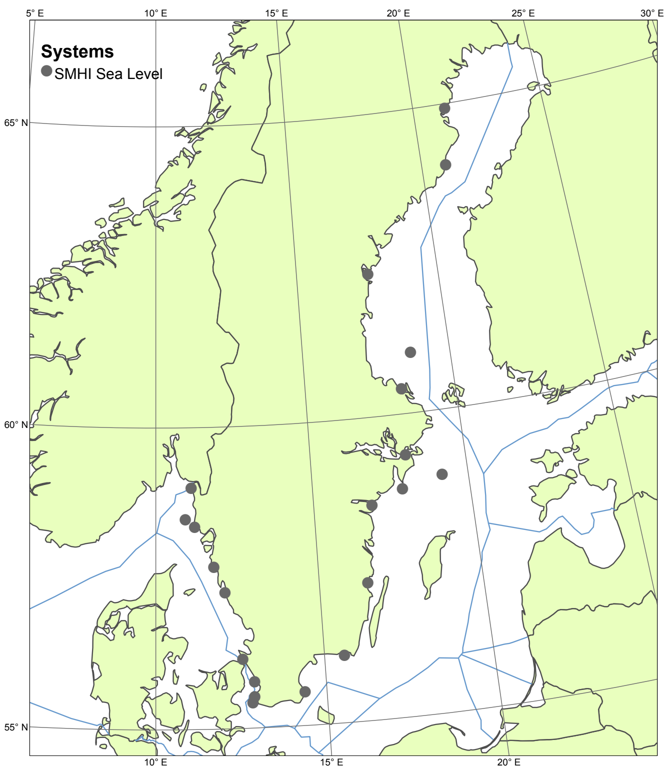

Figure 25: Fixed platforms in Sweden.

Figure 26: The ocean buoy of SMHI.

Sweden has a sea level recording system with good spatial coverage around its coastline, and a smaller number of stations recording waves and temperature. The Swedish Metereological and Hydrological Institute (SMHI) is the sole provider of in situ fixed platform data. The JERICO database has records for 21 swedish stations of which 18 are measuring sea level and temperature. All stations report to BOOS and EMODnet-Physics, when operational. The most advanced SMHI station is the Huvudskr Ost ocean buoy (Figure 26) which measures salinity, temperature, currents, waves and metereological parameters since 2001.

SMHI are a JERICO partner but descriptions of best practices for the fixed platform systems have not yet been obtained.

Finland

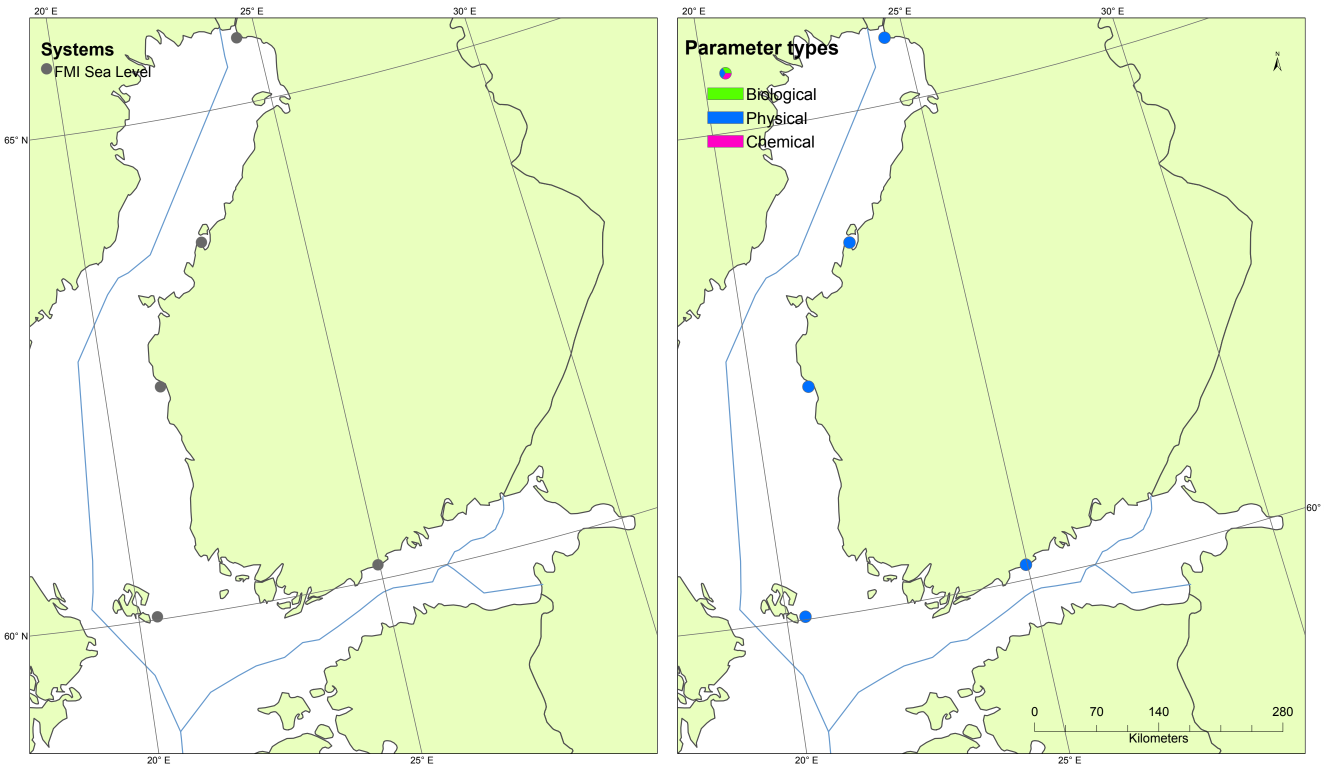

Figure 27: Fixed platforms in Finland.

The only fixed platform system in Finland is a small sea-level observing system operated by the Finnish Meteorological Institute. The five stations reported here are the ones for which real-time data can be found in EMODnet-Physics. All of the stations also measure sea temperature.

Estonia and Russia

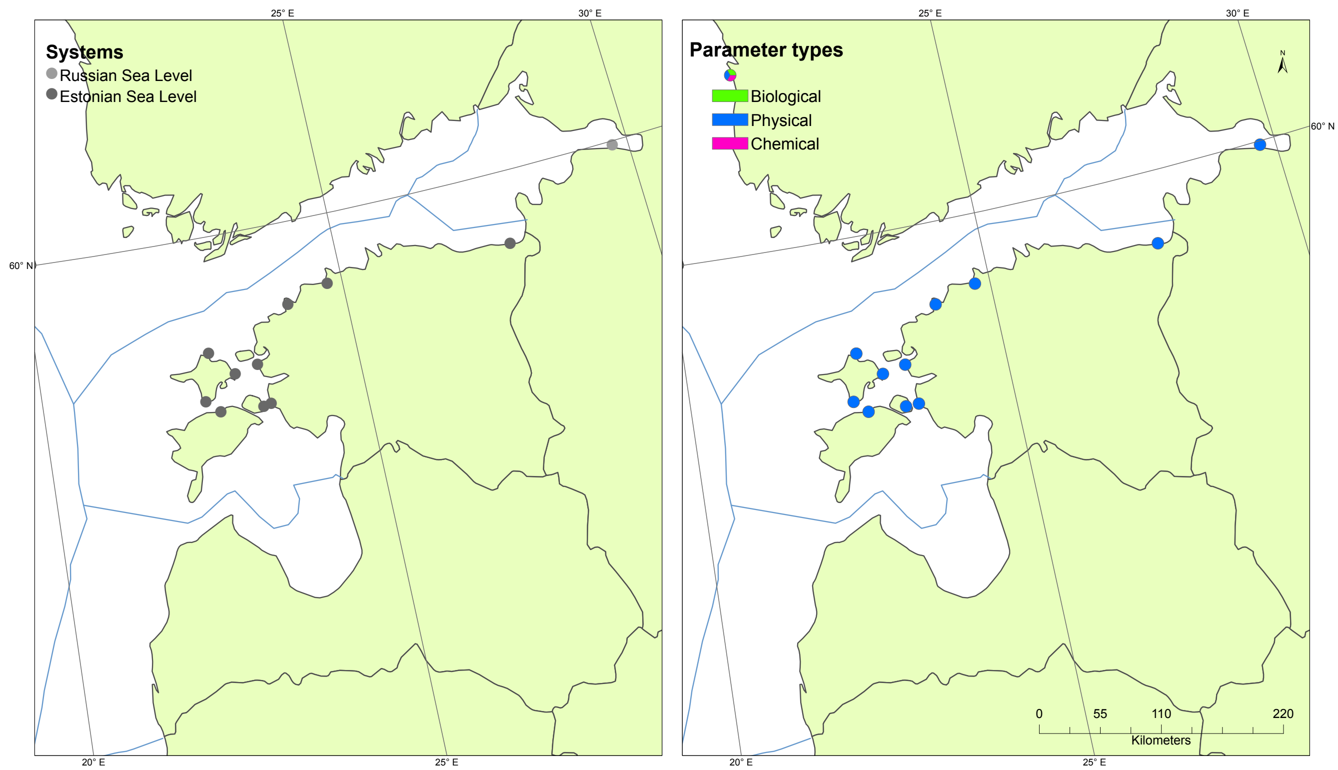

Figure 28: Fixed platforms in Estonia and Russia.

Russia

Two sea-level stations at St. Petersburg and Kronstadt represent the Russian contribution to fixed platform observations in the BOOS region. The operator of the stations is the North-West Regional Administration for Hydrometeorology and Environmental Monitoring (NWAHEM). Real-time data are reported to EMODnet-Physics, where sea temperature measurements from the Kronstadt station can also be found.

Estonia

On the southern shore of the Gulf of Finland, JERICO is represented by the Marine Systems Institute of Tallinn University of Technology, Estonia. MSI operates a coastal observing system using operational models, remote sensing and state-of-the-art in-situ oceanographic measurement systems. An array of measurement devices is used: horizontal distributions of physical and biochemical parameters across the Gulf are recorded by a Ferrybox system, vertical distributions by CTD-profilers with auxiliary sensors and ADCPs, and high-resolution vertical sections by a towed undulating vehicle. A sea-level system with 10 stations represents the fixed platform element to this programme. Sea temperature and sea level are reported to EMODnet-Physics from the Estonian stations.

Latvia, Lithuania and Poland

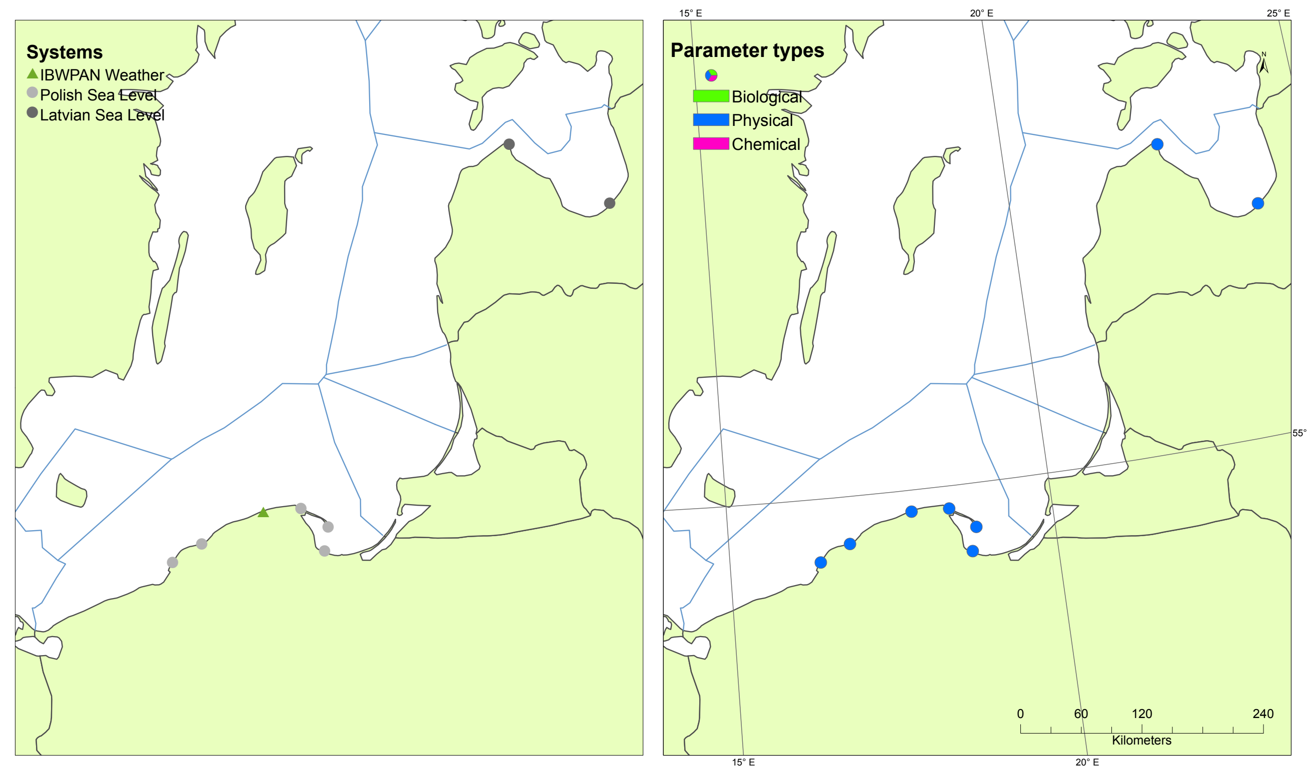

Figure 29: Fixed platforms in Latvia and Poland.

Three of the smaller members of BOOS operate a series of sea-level stations along the southern coast of the Baltic proper. The Environmental Protection Agency of Lithuania and the Latvian Environment, Geology and Meteorology Agency host respectively two and one sea level stations which also measure temperature. In Poland, the S. Hueckel Coastal Research Station at Lubiatowo, belonging to the Institute of HydroEngineering of the Polish Academy of Sciences (IBW PAN) is a JERICO partner and has a station measuring air and sea temperature, wind, and waves. There are an additional five Polish sea level gauges operated by the Institute of Meteorology and Water Management (IMWM). The Latvian and Lithuanian measurements can be found on EMODNET-PHYSICS but the Polish observations are not reported in this way.

IBI-ROOS

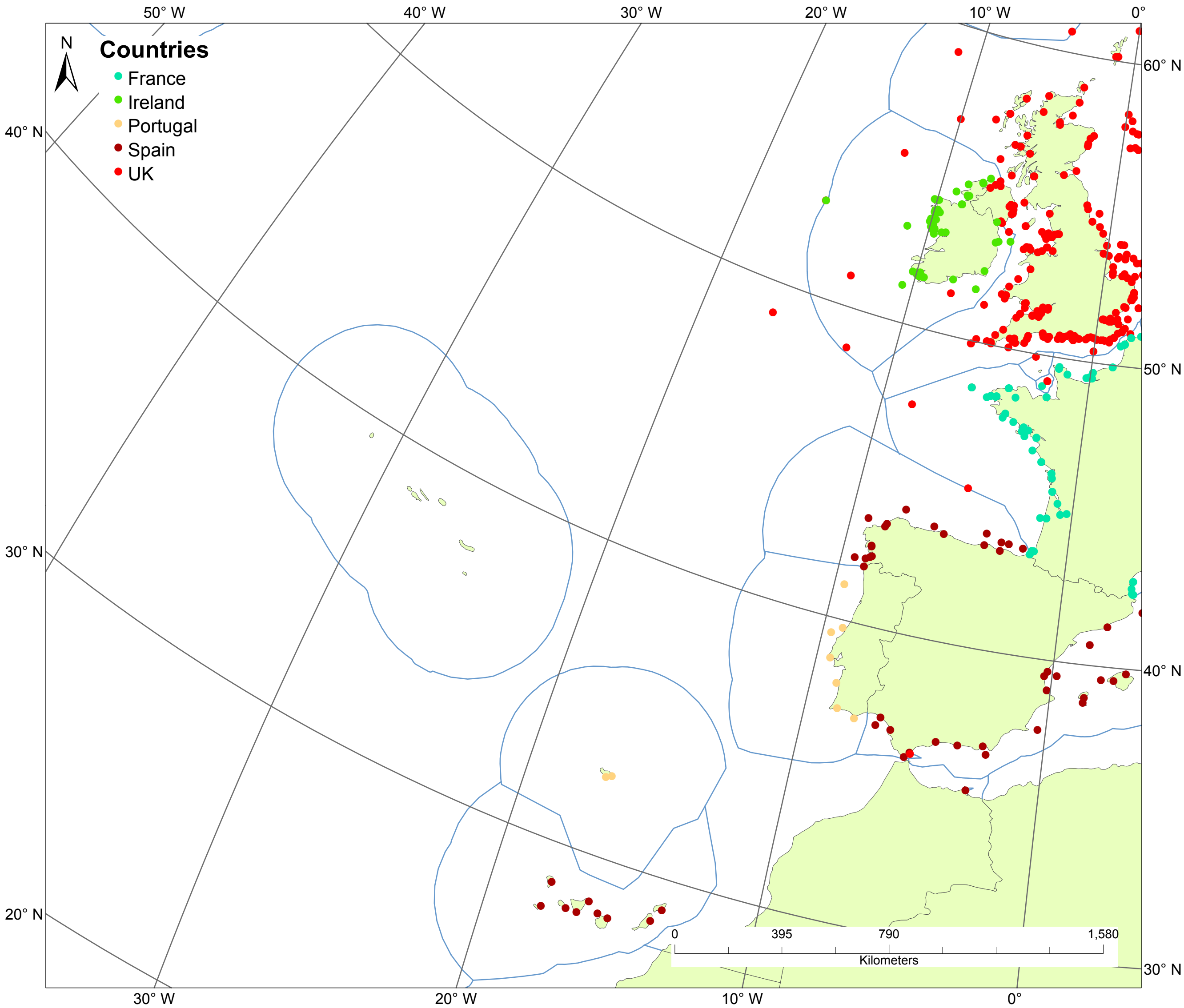

Figure 30: Map showing the location of fixed platforms in the IBI-ROOS region, colour coded by the country owning them.

Ireland

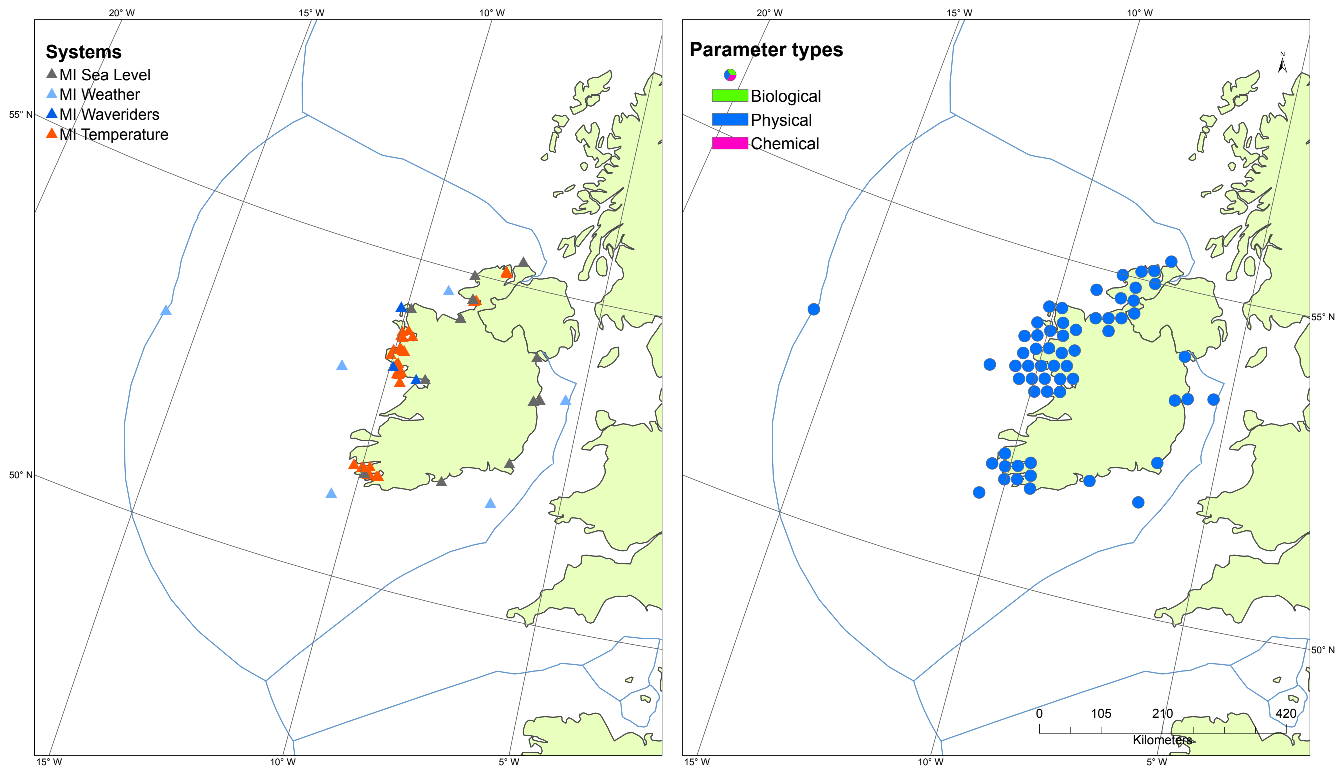

Figure 31: Fixed platforms in Ireland.

The Marine Institute is the sole operator of Ireland's observing system. With 56 stations close to the coast and a further four offshore, there is a very good spatial coverage. The measurements made are all physical, consisting of sea level, temperature (sea and air) and waves. The number of sensors per station is typically two, but five weather buoys each carry four sensors. The Marine Institute observations can be viewed on local websites e.g. the weather buoys at www.marine.ie, as well as via EMODNET-PHYSICS.

There are no details on best practice for the Irish systems.

Spain and Portugal

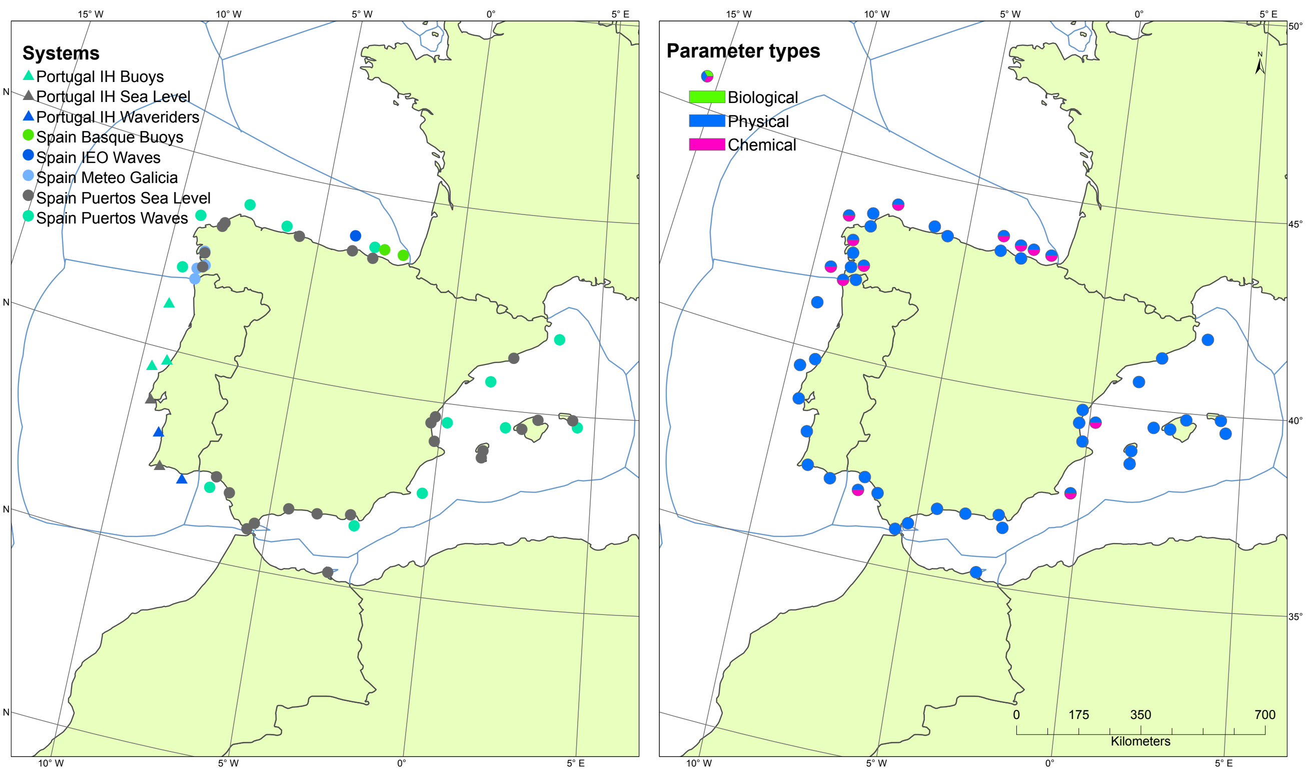

Figure 32: Fixed platforms in Spain and Portugal.

Portugal

The contribution of Portugal to the IBI-ROOS fixed platforms is via three systems belonging to the Instituto Hidrografico (IH; www.hidrografico.pt). There are two sea level stations to the north of Lisbon which report data in real-time to EMODnet-Physics. In addition, IH operates three wave buoys on the northern Portuguese coast. Each measures air and sea temperature, waves and wind. A separate set of 5 wave-only buoys (two of which are on Madeira (Figure 33) forms another system. No stations are recorded in the database for the Azores.

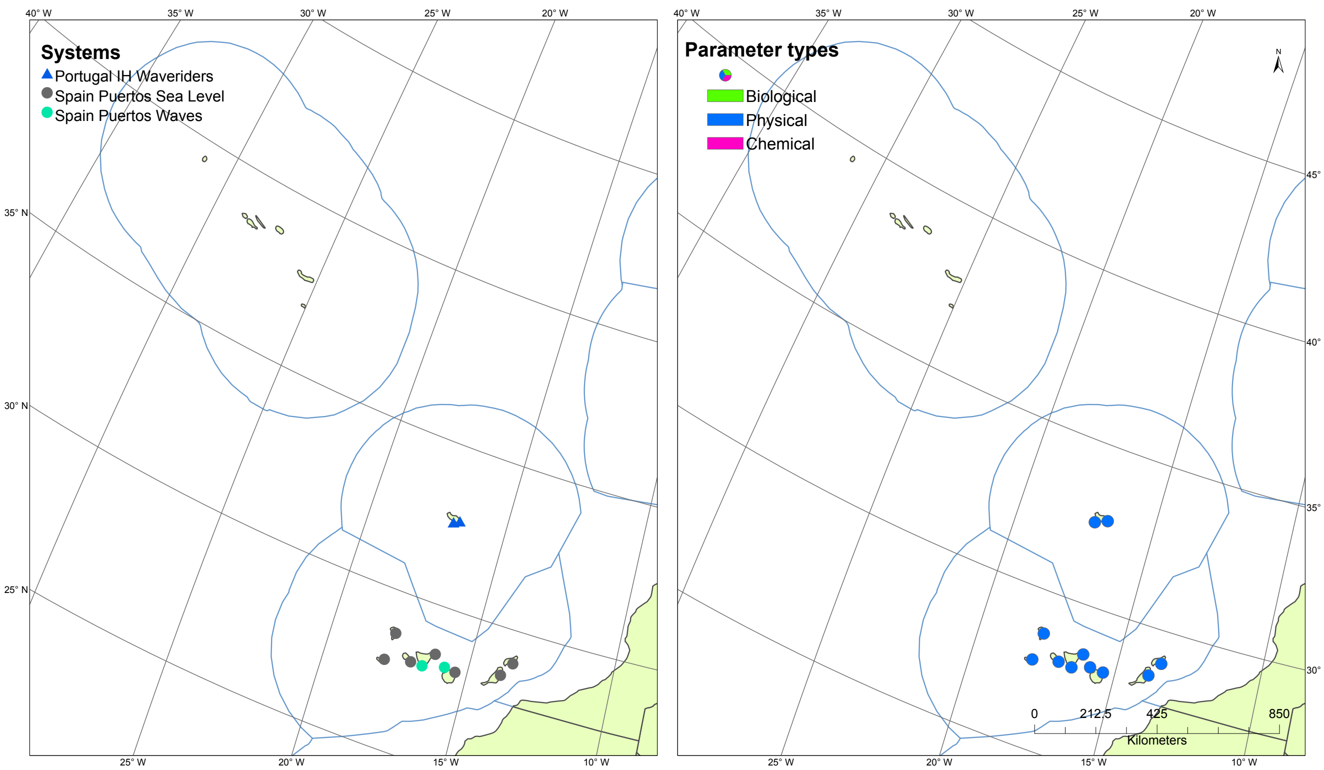

Figure 33: Fixed platforms in the Azores, Canaries and Madeira.

Spain

A total of 53 measuring stations are located along the Spanish Atlantic and Mediterranean coastlines. Puertos del Estado operates two systems for sea level and wave measurements containing 31 and 15 stations respectively, some of which are in the Canary Islands (Figure 33). In addition to waves, the wave stations all record air temperature and the majority also record sea temperature and salinity. Ten of the wave stations additionally measure currents. Meteo Galicia operate an additional wave measurement system on the northwest coast, with stations measuring up to three additional parameters (air and sea temperature, salinity). There are three stations on the Biscay coast of Spain. Two multifunctional buoys are operated by the Basque Metereological Agency, measurements are made of waves and currents as well as temperature and salinity. A single offshore buoy in the Bay of Biscay is operated by the Spanish Institute

Figure 34: Cleaning biofouling from a Euskalmet/AZTI buoy.

of Oceanography (IEO), and measures waves, currents temperature and salinity.

Best Practice

Best practice in the maintenance of the Euskalmet buoys by AZTI was presented at the JERICO workshop on Crete in October 2012. Maintenance is done on land as much as possible and one spare buoy is kept on land to test sensors. Buoys are deployed every 6 months using opportunity vessels.

Pre-deployment activities (carried out one week prior to deployment) include:

- Attaching new ropes
- Protecting sensors and cabling
- System assembly and testing
- Disassembly, elements preparation to go on board
- Filling buoy with N_2

While sailing:

- System assembly
- Connection to PC

Post deployment - on board:

- Visual inspection and photographing
- Hard biofouling removal
- Disassembly

Post deployment - on land:

- Visual inspection
- Mechanical and chemical cleaning
- Data download
- Updating logs - one notebook per buoy with the whole history
- Listing elements to be replaced
- Antifouling paint
- Disassembly and storage

MOON

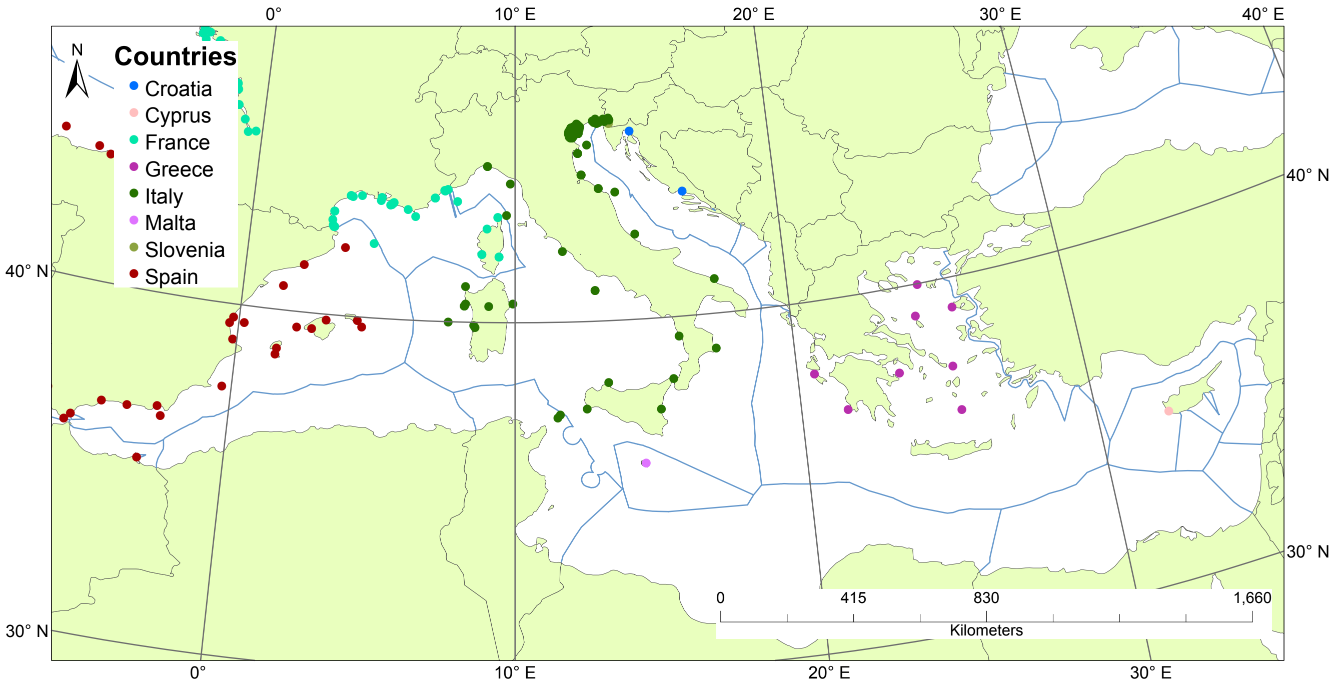

Figure 35: Map showing the location of fixed platforms in the MOON region, colour coded by the country owning them.

Missing countries: Israel, Turkey, Egypt, Montenegro, Morroco. But most not in Europe.

Cyprus

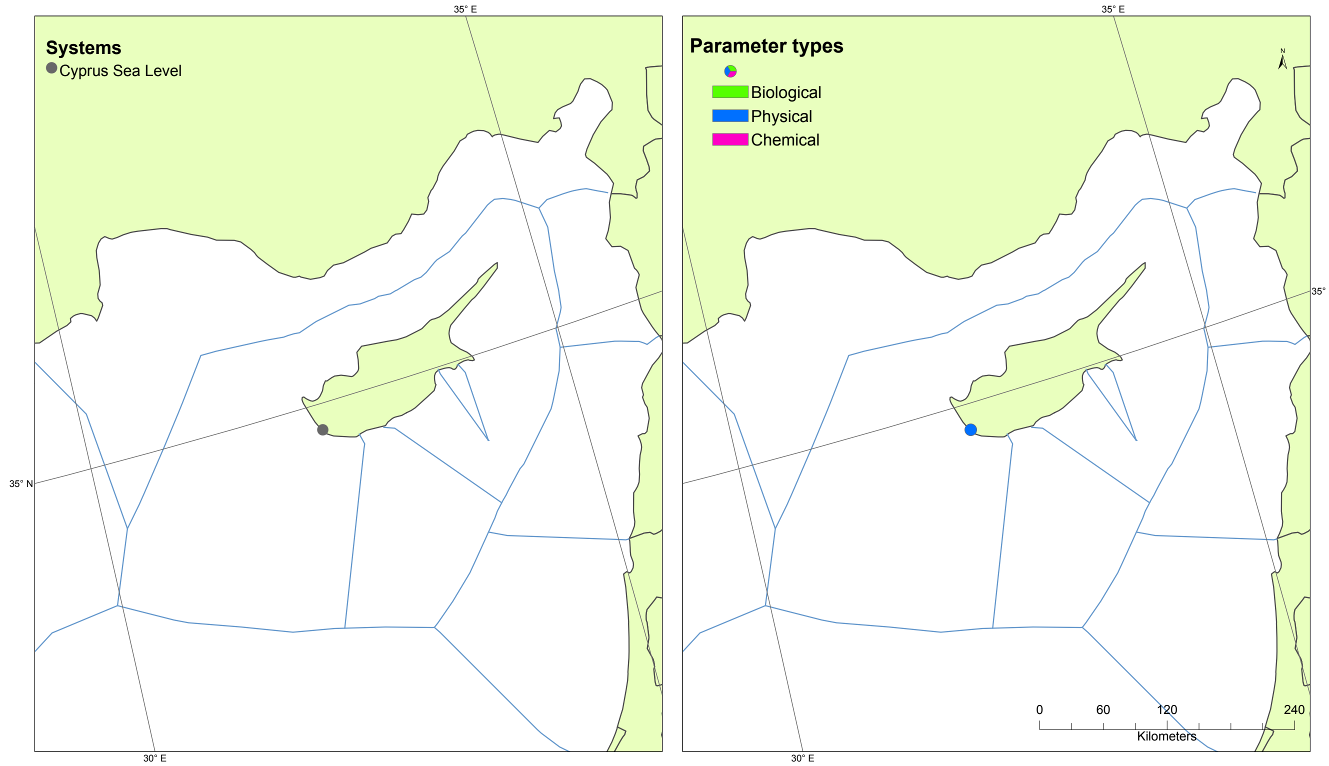

Figure 36: Fixed platforms in Cyprus.

Cyprus has one sea level measuring instrument at station 'Paphos'. No additional parameters are measured other than sea level.

Greece

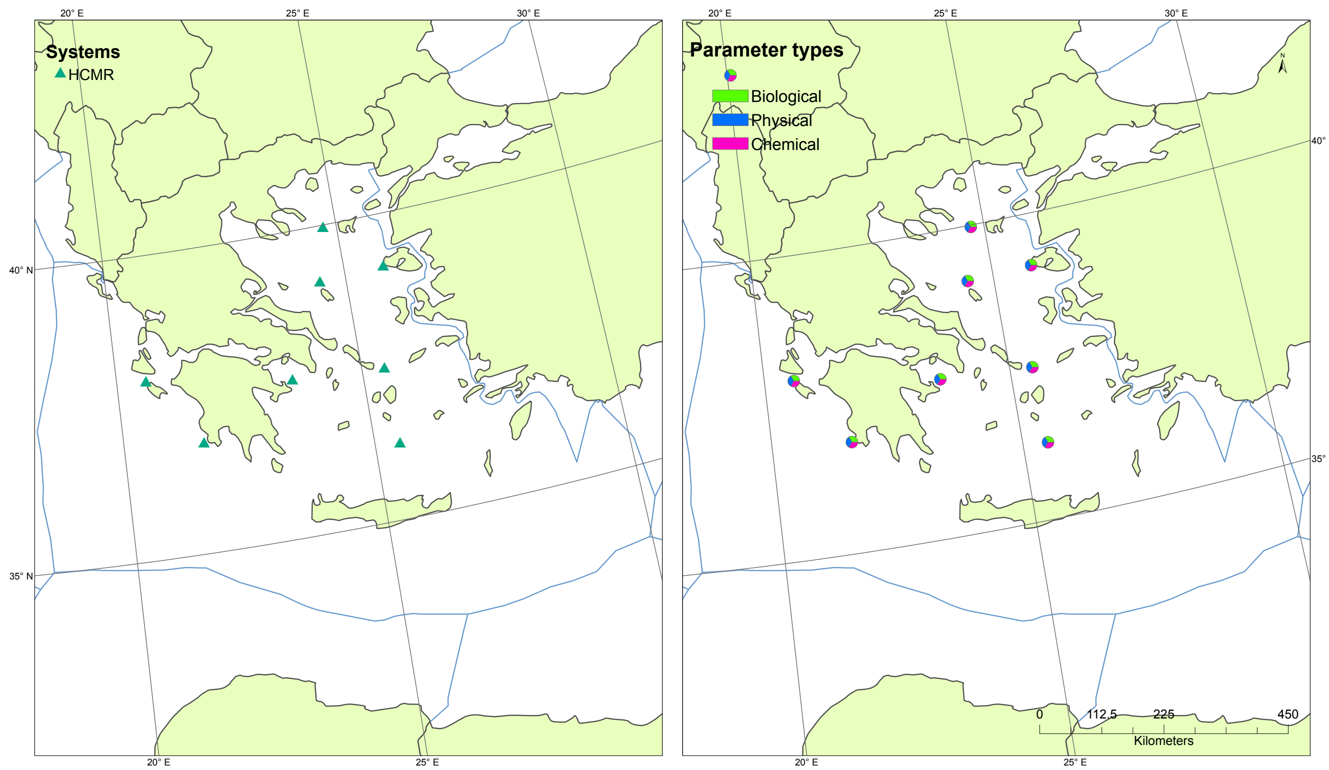

Figure 37: Fixed platforms in Greece.

Figure 38: A Seawatch wavescan buoy of the POSEIDON system.

The Hellenic Centre for Marine Research (HCMR) is a JERICO partner organisation with responsibility for monitoring and making operational forecasts for more than 16000 km of coastline. HCMR has developed a very advanced fixed platform system called POSEIDON (http://poseidon.hcmr.gr/) consisting of:

- a network of observation buoys
- a data transmission telecommunications systems
- an operational centre with forecasting numerical models

Poseidon records continuously the physical, biological and chemical parameters of the Greek seas from 8 stations. Each station has sensor pods at different depths, and each pod can house multiple instruments. The data (Table M1) are then transmitted to the operational centre where they are sorted and fed into forecasting models. There is a forward feed to the main MOON/MedGOOS data centre and from there to MyOcean and EMODnet-Physics.

Table 1: An example of real-time data from the station 'Athos'

Date	2012-12-26
Time (UTC)	21:00:00
Air Pressure (mbars)	1020.43
Air Temp. (deg.C)	16.58
Wind Speed (m/s)	0.94
Wind Gust (m/s)	1.88
Wind Dir. (deg.)	236.25
Significant Wave Height (m)	0.47
Max. Wave Height (m)	0.78
Wave Dir. (deg.)	139.22
Water Temp. 1m (deg.C)	15.33
Current Speed 1m (cm/sec)	10.25
Current Dir. 1m (deg.)	51.33

Each Poseidon station measures air pressure and temperature, wind speed and direction, wave height, period and direction, sea surface salinity and temperature, surface current speed and direction (Figure 38). Deep water measurements are made at two of the sites (Figure 39) for salinity and temperature at depths 20-1000 m, chlorophyll and light attenuation at 20-100 m, dissolved oxygen at 20-100 m, current speed and direction at 20-50 m, radioactivity, underwater light.

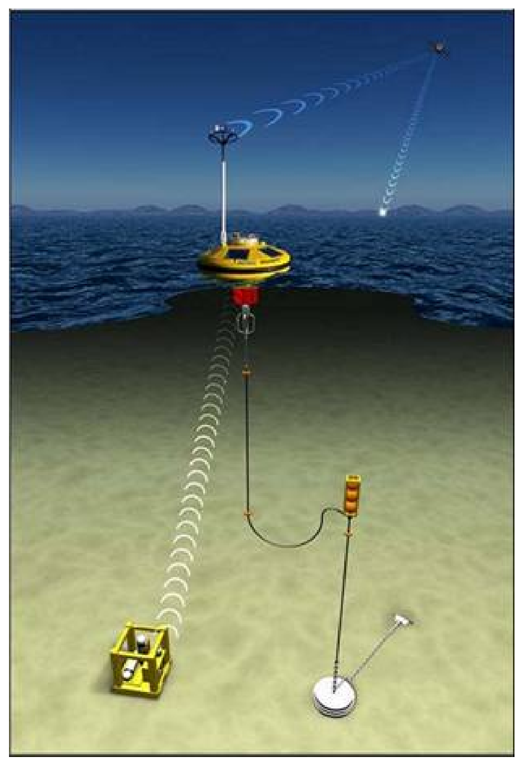

Figure 39: Schematic of a seabed observatory with acoustic telemetry to the main POSEIDON node..

Best practice on POSEIDON

HCMR use several methods to maintain the operational status of their system. Surface moorings are serviced by visits from small boats in case of emergency, with a research vessel, RV Aegeao, used for scheduled buoy and sensor replacement, and validations. SCUBA divers and remote underwater vehicles are used for servicing the benthic observatories. The deployment procedure follows a set protocol: check and test everything (buoy, sensors, mooring line components, releaser) on ship, then perform a successful data transmission on board before deployment. On recovery, basic maintenance is done on board. All the equipment is cleaned with fresh water, data downloaded, conductivity cells and optical sensors are immersed in deionized water and Sea-bird elec-

trochemical sensors are sealed with tubes. Further sensor
maintenance is done in the workshop: deep cleaning of the conductivity cells and the rest of the sensors, replacing batteries and spare parts and testing of instrument functions. HCMR technicians use the sensor manuals to cover all this procedure. It was noted that some companies provide even more such as Sea-bird electronics (SBE) maintenance video tutorials at the SBE webpage.

The calibration procedure for POSEIDON sensors was described as follows: first the acceptable residual thresholds are defined in order to change any calibration coefficients and then the calibration is performed as described in the calibration manuals. It was noted that the JERICO webpage hosts some calibration manuals, but more are needed. HCMR try where possible to use the same sets of sensors on each station and calibrate them according to the local climatology. Calibration is done in the workshop in tanks of fresh seawater, and in the field using CTD casts to sample the water column. The final product is a calibration report containing:

- Sensor serial number and date
- Previous calibration coefficients
- New coefficients
- Table with measurement of calibration steps
- Graph and table with previous and new residuals
- Graph and table with validation test with new residuals

HCMR has a schedule of regular monthly sampling visits to their sites during which a CTD cast is made, zooplankton are sampled, and sensor behaviour is monitored. This enables malfunctions to be spotted early, to allow for data to be corrected. HCMR reported that they are using three different types of data transmission: INMARSAT-C satellite, GPRS, or Iridium. An automated quality control procedure comes into action upon receipt of data (Figure 40).

During their presentation at the JERICO workshop on best practices, HCMR raised the issue of the cost of different types of mooring anchor. Welded steel plates were the preferred option as these are three times denser than concrete, but steel is much more expensive.

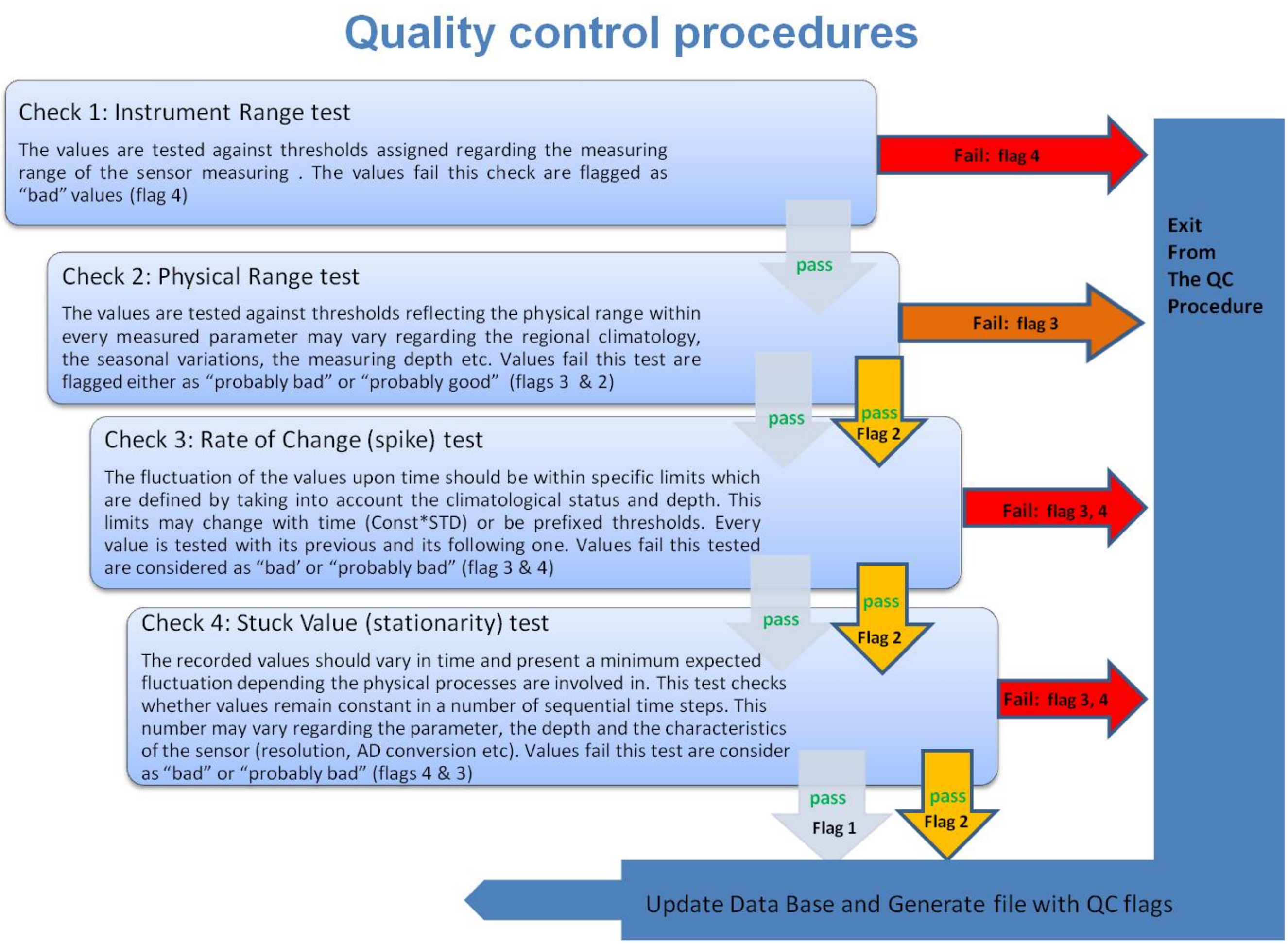

Figure 40: The quality control pathway used at HCMR for POSEIDON

Italy and Malta

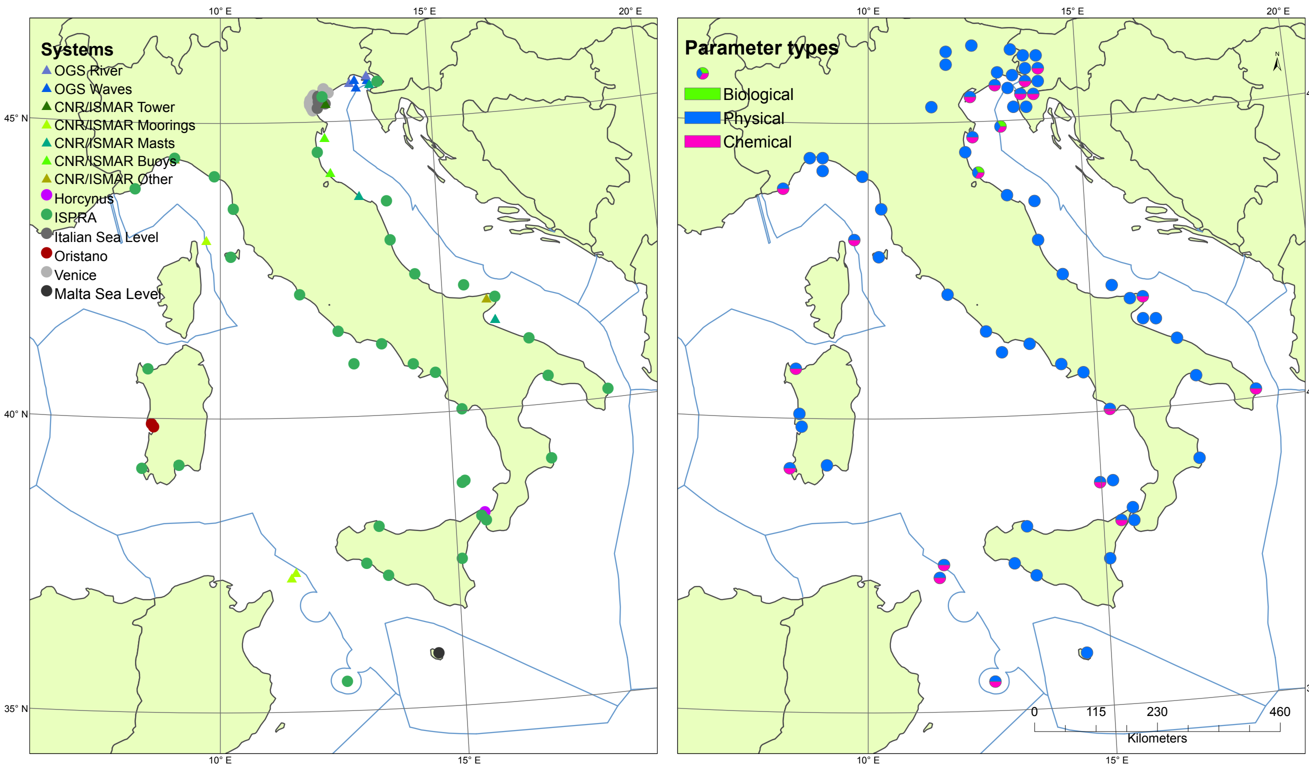

Figure 41: Fixed platforms in Italy and Malta.

Most of the stations registered in the JERICO WP3 fixed platform database are operated by CNR (the National Research Council of Italy) and OGS (the Istituto Nazionale di Oceanografia e Geofisica Sperimentale), both members of the JERICO Consortium, and by ISPRA (the Institute for Environmental Protection and Research). CNR and OGS systems have been reported during the first JERICO workshop on fixed platforms in Rome, 29 February 1 March, 2012 (ref, Minutes from the JERICO Fixed Platforms Workshop, CNR, Rome, 3 May 2012).

CNR operates several multi-parametric coastal observing systems placed along the Italian coasts, both in harbours and offshore, including moorings, buoys, floating platforms, sea bed platforms and shore/harbour stations (see CNR-ISMAR website for details), most of which transmit data in real time. Efforts are ongoing to also develop near real time data transmission from underwater moorings, as well as to improve automated biogeochemical measurements at selected stations. Data are stored on local servers, and through JERICO WP7 some stations are being linked to the MyOcean portal. Maintenance is performed every six months for underwater moorings and from one to six months for buoys and other platforms, depending on site and season. Common problems include ship strikes, biofouling and corrosion.

OGS operates the North Adriatic Coastal Observatory, a real-time observing system in the Friuli-Venezia Giulia region of north-east Italy, made up of the Friuli-Venezia Giulia Regional Coastal Marine Monitoring System (3 profiling data buoys equipped with meteorological sensors, 3 wave measuring buoys and 2 ADCPs, one in each of the two main rivers of the area) and one profiling data buoy (MAMBO) providing hydrological and meteorological measurements moored at the edge of the Miramare Marine Protected Area in the Gulf of Trieste. All data visualization and management is centralized. Currently, the system is supplying data to the local civil protection authority, and to MyOcean and SeaDataNet within the framework of the JERICO project. Problems include damage to instrumentation, biofouling, corrosion, mechanical wear and tear, collision, vandalism, and storm damage.

ISPRA operates an observational network made by the Italian Tide Gauge Network and by the Italian Buoy Network. The Italian Tide Gauge Network is comprised of 36 stations uniformly distributed along the coast and predominantly located inside harbors, equipped to measure sea levels, tides ranges, seiches and meteorological parameters (wind speed and direction at 10m, air pressure, air temperature and humidity). A subset of 9 stations is also equipped for the detection, characterization and propagation of early tidal waves (tsunami) and storm tides, and another one, made by 10 stations placed in open harbors, are provided with a multiparametric probe for water quality monitoring (sea surface temperature, pH, conductivity and redox). The Italian Buoy Network encompasses 15 buoys scattered across the Italian shores and deployed at fixed locations at a depth of 100 m. Each buoy is provided with a very high precision solid-state directional wavemeter, a complete meteorological station and a sea surface temperature thermometer. Some buoys are equipped with a surface water conductivity sensor. Data are distributed via RMN and RON. platform to the land station.

To observe and study so many processes in their wide spectrum of time scales, a traditional experimental approach is not sufficient: systematic, long-term routine measurements of the basic meteo-oceanographic variables, are needed. In 1998, the OGS developed a meteo-oceanographic buoy, named MAMBO, equipped with a profiling multipara- metric probe flanked by a sea-bottom ADCP-300kHz, and deployed it at a site 1 km distant from the coast. The buoy data are sampled every 3 hours. From March 2001 wave motion data are being collected by a Datawell Directional Waverider (DWR) just outside the gulf. From June 2001, an ADCP-600kHz remotely controlled by means of an original device is flanking the MAMBO buoy. The configuration of the ADCP can be remotely changed to resolve the effects of the stratification on the vertical structure of the tidal and the wind induced currents or, occasionally, to record shoaling wave data that can be compared with the DWR ones. The systematic monitoring provides a better understating of the transport and of the vertical mixing in the coastal bound- ary layer within the gulf. Both the MAMBO data and the ADCP data are transmitted to land in near-real-time and disseminated on the Internet

Croatia and Slovenia

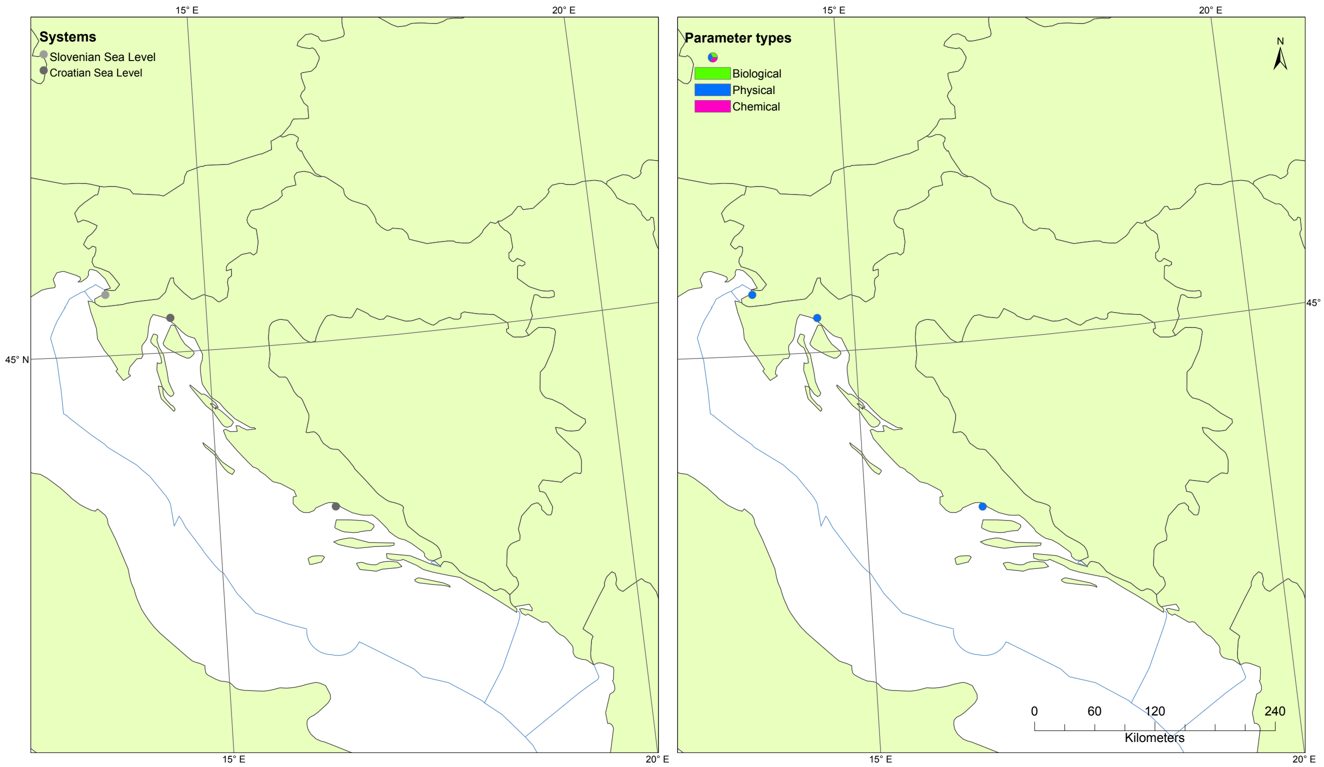

Figure 42: Fixed platforms in Croatia and Slovenia.

Two sea level stations at Bakar and at Split are the components of the only Croatian operational system for fixed platforms.

Slovenia has one tide gauge in its tiny sea area, making it the country with the highest density of fixed platforms!

Black Sea GOOS

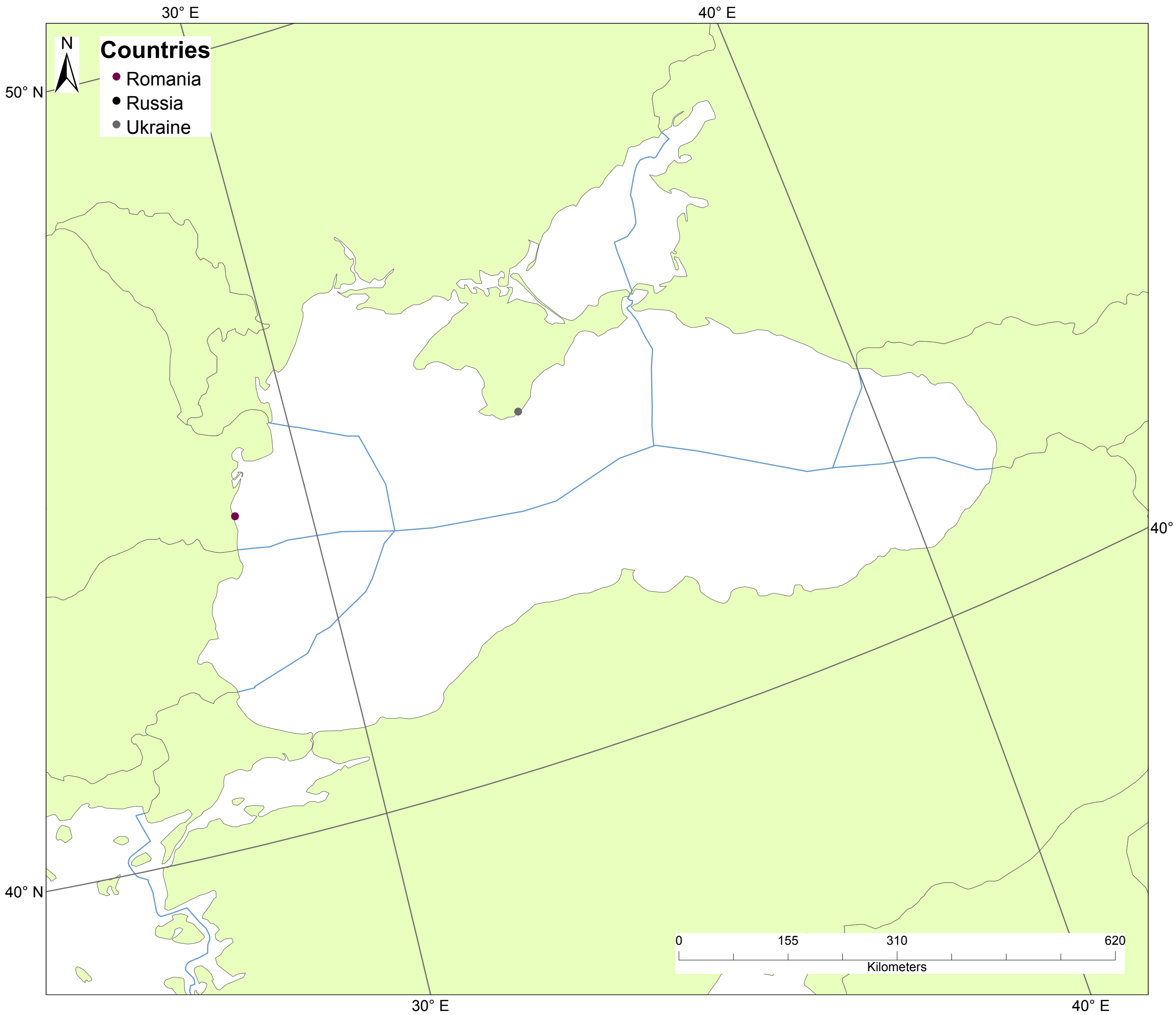

Figure 43: Map showing the location of fixed platforms in the Black Sea GOOS region, colour coded by the country owning them.

Missing countries: Bulgaria, Georgia, Russia, Turkey.

Romania and Ukraine

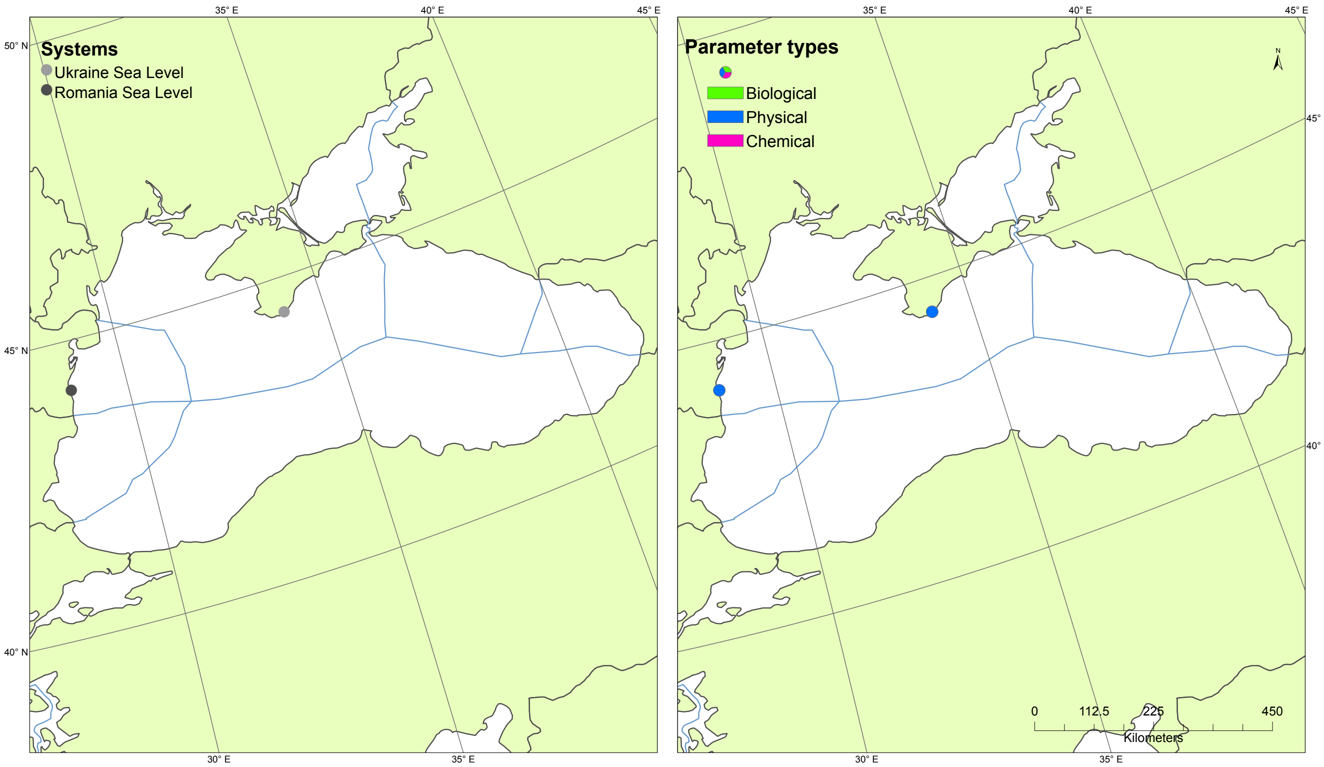

Figure 44: Fixed platforms in Romania and Ukraine.

Romania and Ukraine each have one sea level recording station.

Discussion

This report along with the accompanying maps and database provide a means for data users and providers to obtain an overview of where fixed platform oceanographic data is or has been measured in Europe, along with the parameters measured. The /emphSystem table provides a contact person for each observation system as well as information on data access restrictions, enabling potential users to obtain the data they need. This will promote the adoption of the principle of collecting data once and using it many times. It will also avoid duplication of effort as it is possible to see in one place all of the fixed platforms in operation. For example, rather than setting up a new platform, it may be possible to locate an existing platform to which a new sensor could be added, or to obtain data from another organisation, thus saving costs.

This work will be valuable to others outside of the project for setting priorities in funding for marine observations. For example, the knowledge accumulated here can be used together with the parallel studies of mobile platforms (gliders and FerryBox) for analysing gaps in the observing network or for guiding the placement of new observing systems. There is little coordination, for example, between the choice of sites for biodiversity monitoring (BIOMARE sites - Figure 45) and sites recording physical parameters or water chemistry.

For many of the stations recorded here the main purpose is for monitoring sea level or temperature, or for weather forecasting. Systems whose purpose is monitoring of nutrients or ecosystems, such as the Cefas Smartbuoy program and the HCMR Poseidon program, are rare. The addition of more chemical and biological parameters, such as nutrients and chlorophyll would greatly increase the utility of fixed platforms in Europe. There is great demand for these types of parameters both for research and, as modelling expands from physical to biogeochemical modelling, for in situ data to validate these models. Much as many of the weather stations exist to provide input to weather forecasting models, new stations could be put in place with the primary purpose to provide data for asimilation into or validation of biogeochemical models such as ERSEM (European Regional Seas Ecosystem Model) [].

Further work

The previously discussed benefits of the Jerico WP3 database rely on it containing records of all fixed platforms in Europe. Currently there are likely to be a number of platforms missing, especially in regions other than NOOS. It will be important to continue adding platforms through the use of forms*, in order to make this database the best representation of the current status of fixed platforms.

One of the goals of work package 3 is to share best practice. Some details on best practice in fixed platforms have been reported here as a result of the 2012 workshop in Crete. However, the system management table in the database is still incomplete and filling in system management details here will facilitate the sharing of best practice. The current database contains metadata at the country, system and platform level. The next level would be that of individual sensors, and the database is designed to allow additional information such as this to be added at a later date with minimal additional effort, further enabling sharing of best practice.

The database of fixed platforms will provide opportunities for collaboration within the JERICO project, and improving best practices among the community. It will facilitate a move away from smaller systems often focussed on one site and associated with one individual, to a more efficient net-centric,

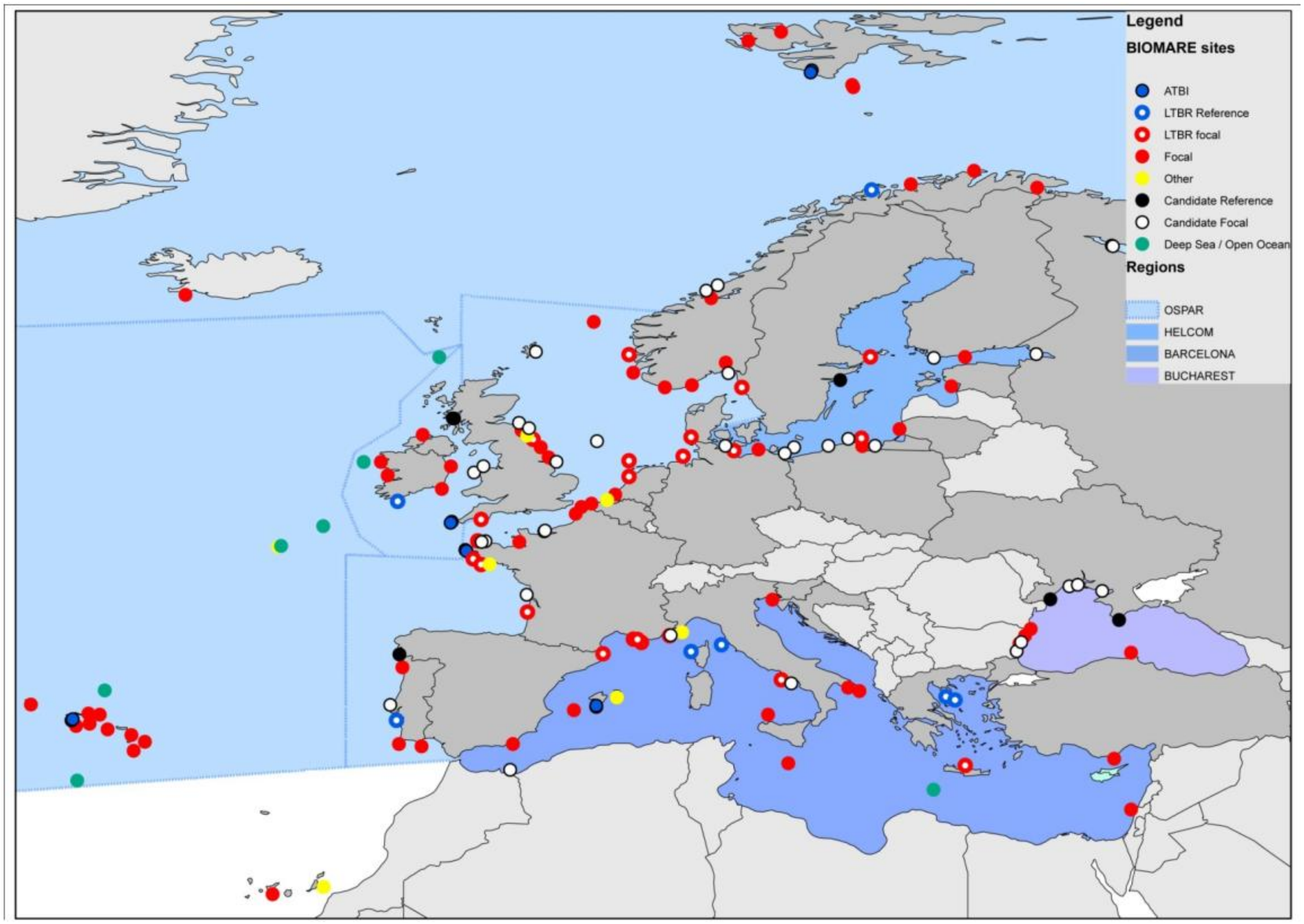

Figure 45: BIOMARE marine sites. Image by Pim van Avesaath.

distributed system which eliminates duplication and allows common tasks to be shared among many partners.

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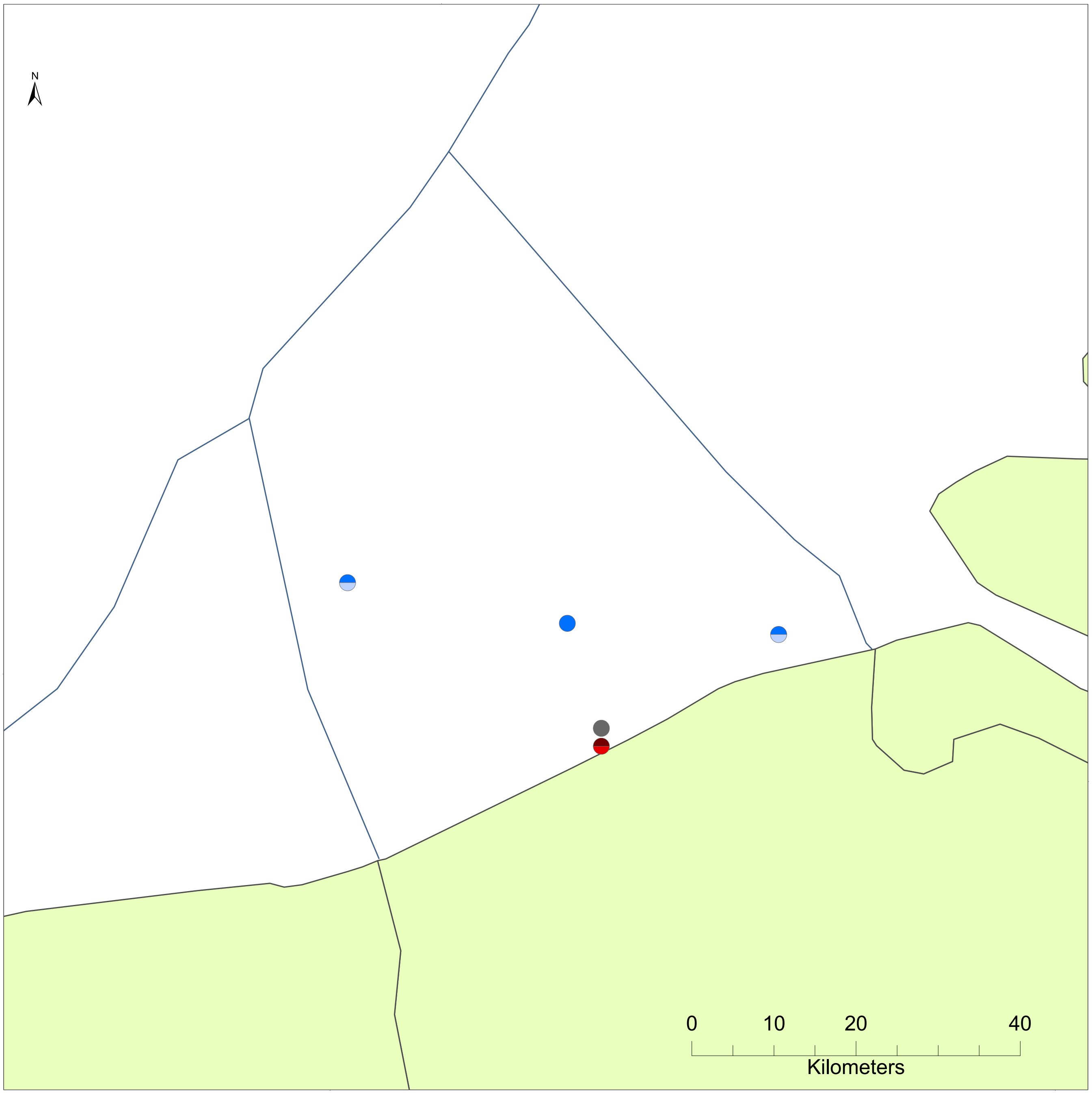
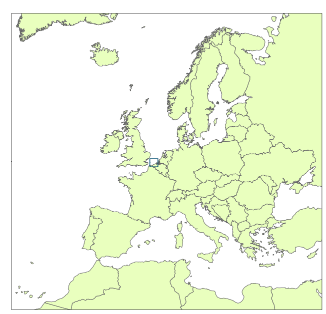
Appendix 1

This appendix contains maps for all countries showing all parameter groups measured at each station.

Jerico Fixed Platforms
Belgium

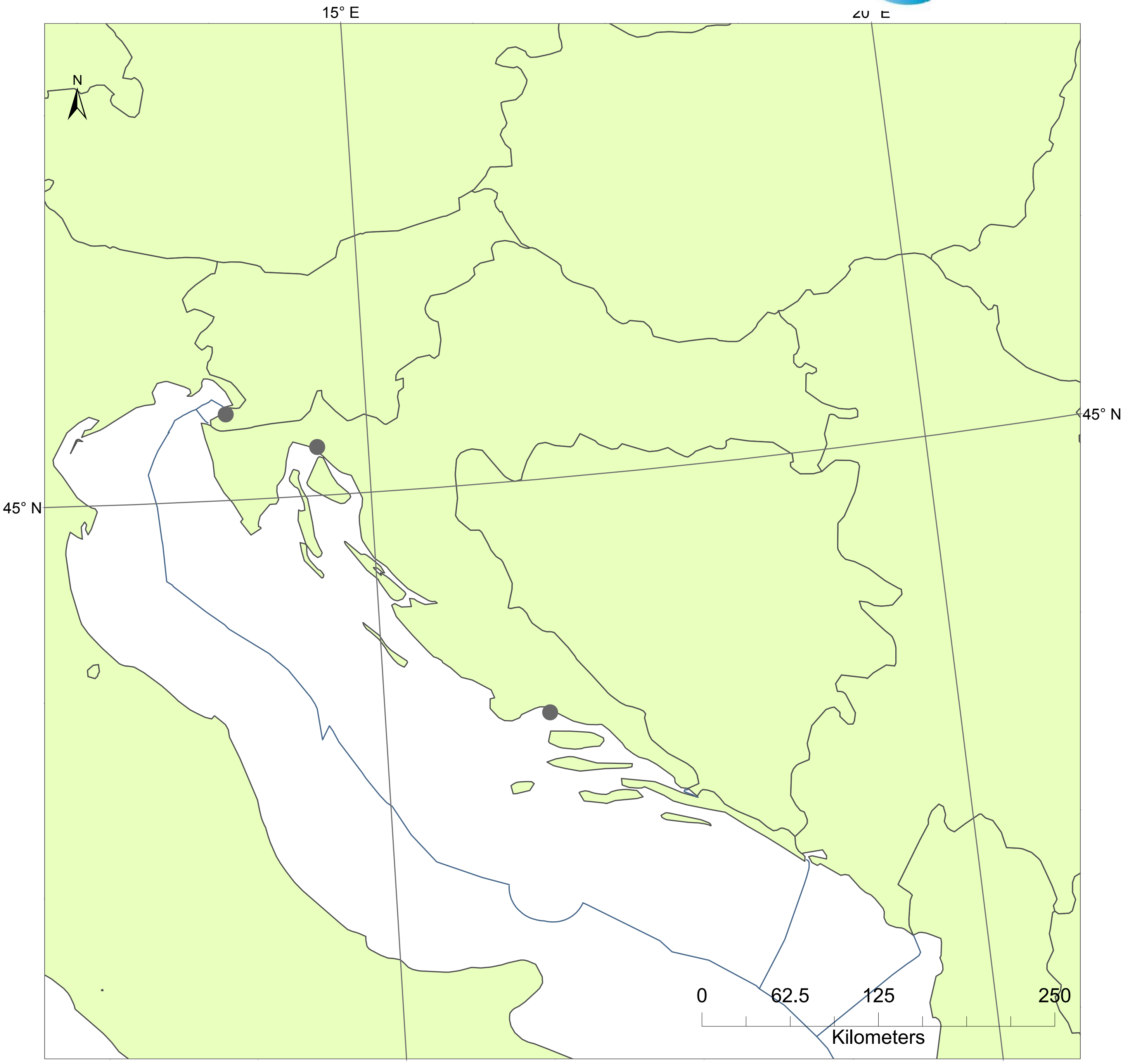


Sea Level	Nutrients	Air
Sea Pressure	pH	Chlorophyll
Sea Temperature	Plankton	Currents
Waves	Precipitation	Dissolved gases
Winds	Salinity	Light/PSM

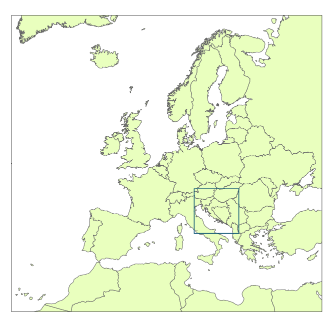


This map was produced as part of JERICO WP3, using metadata from the JERICO WP3 fixed platforms database.

Jerico Fixed Platforms
Croatia and Slovenia



Sea Level
Sea Pressure
Sea Temperature
Waves
Winds
Nutrients
pH
Plankton
Precipitation
Salinity
Air
Chlorophyll
Currents
Dissolved gases
Light/PSM



This map was produced as part of JERICO WP3, using metadata from the JERICO WP3 fixed platforms database.

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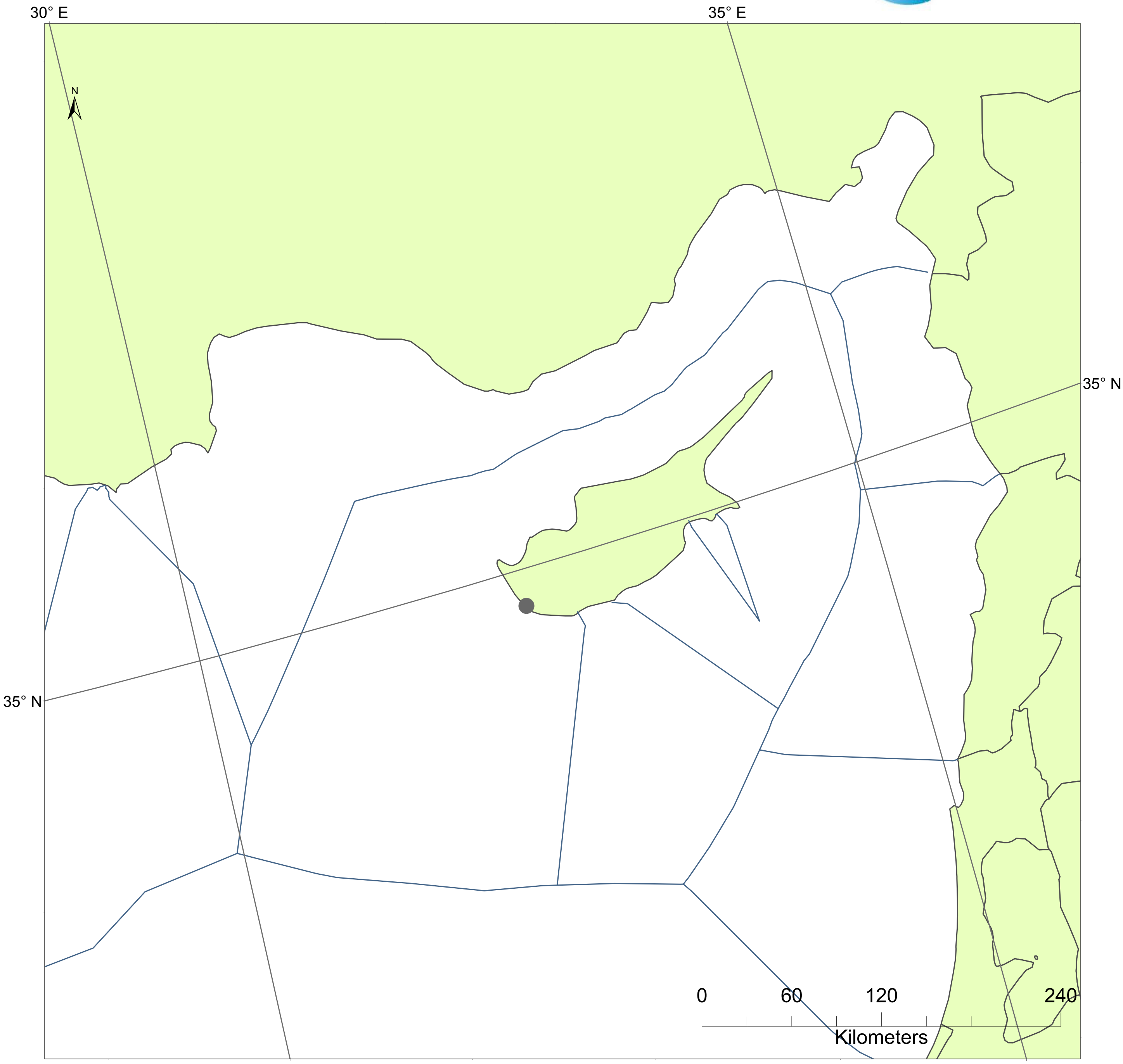
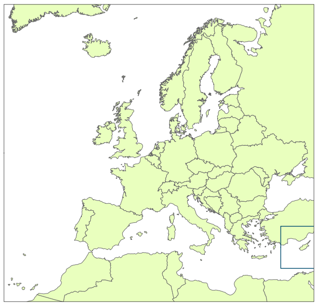
Jerico Fixed Platforms
Cyprus





	Sea Level		Nutrients		Air
	Sea Pressure		pH		Chlorophyll
	Sea Temperature		Plankton		Currents
	Waves		Precipitation		Dissolved gases
	Winds		Salinity		Light/PSM

This map was produced as part of JERICO WP3, using metadata from the JERICO WP3 fixed platforms database.

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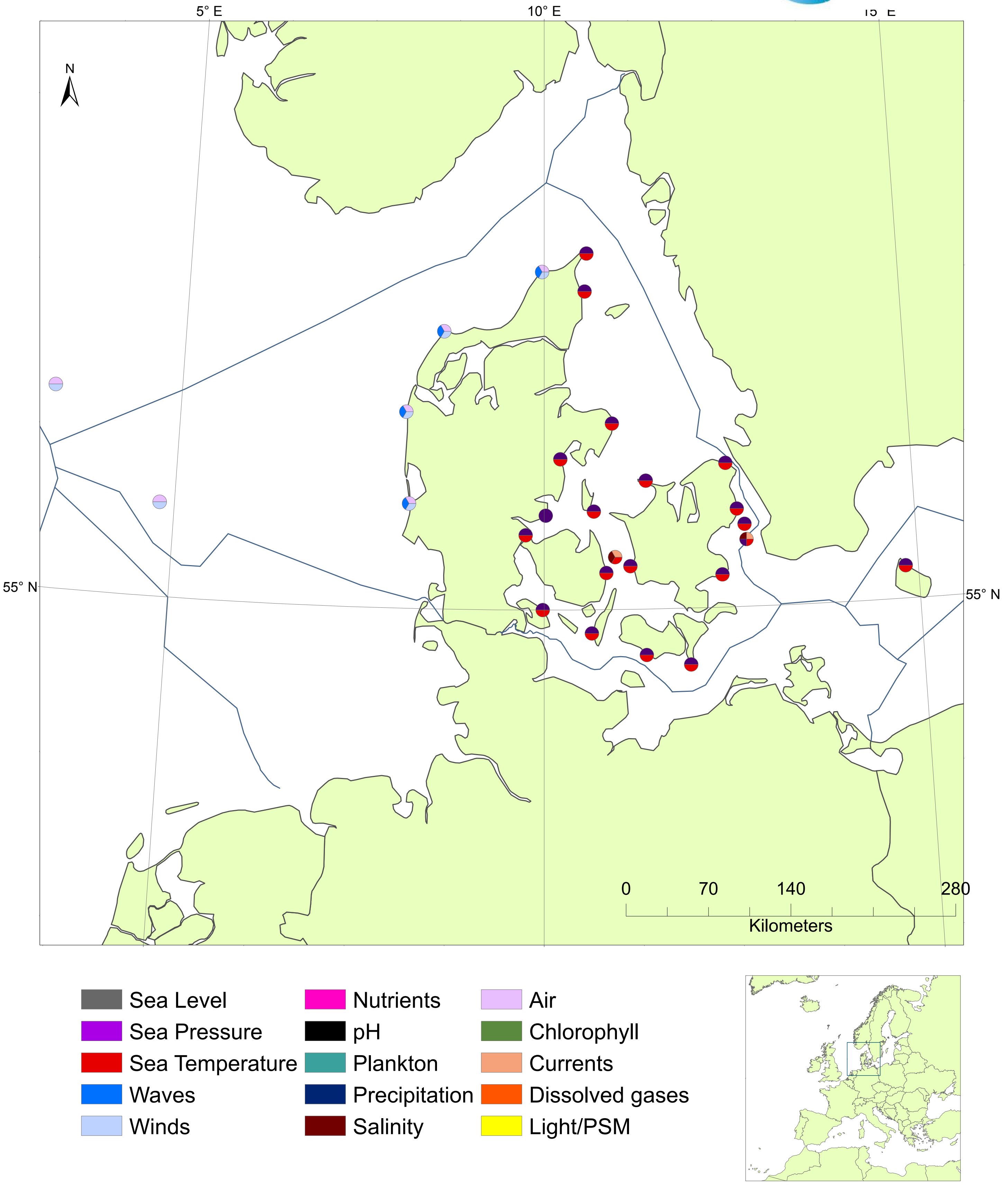
Jerico Fixed Platforms
Denmark



This map was produced as part of JERICO WP3, using metadata from the JERICO WP3 fixed platforms database.

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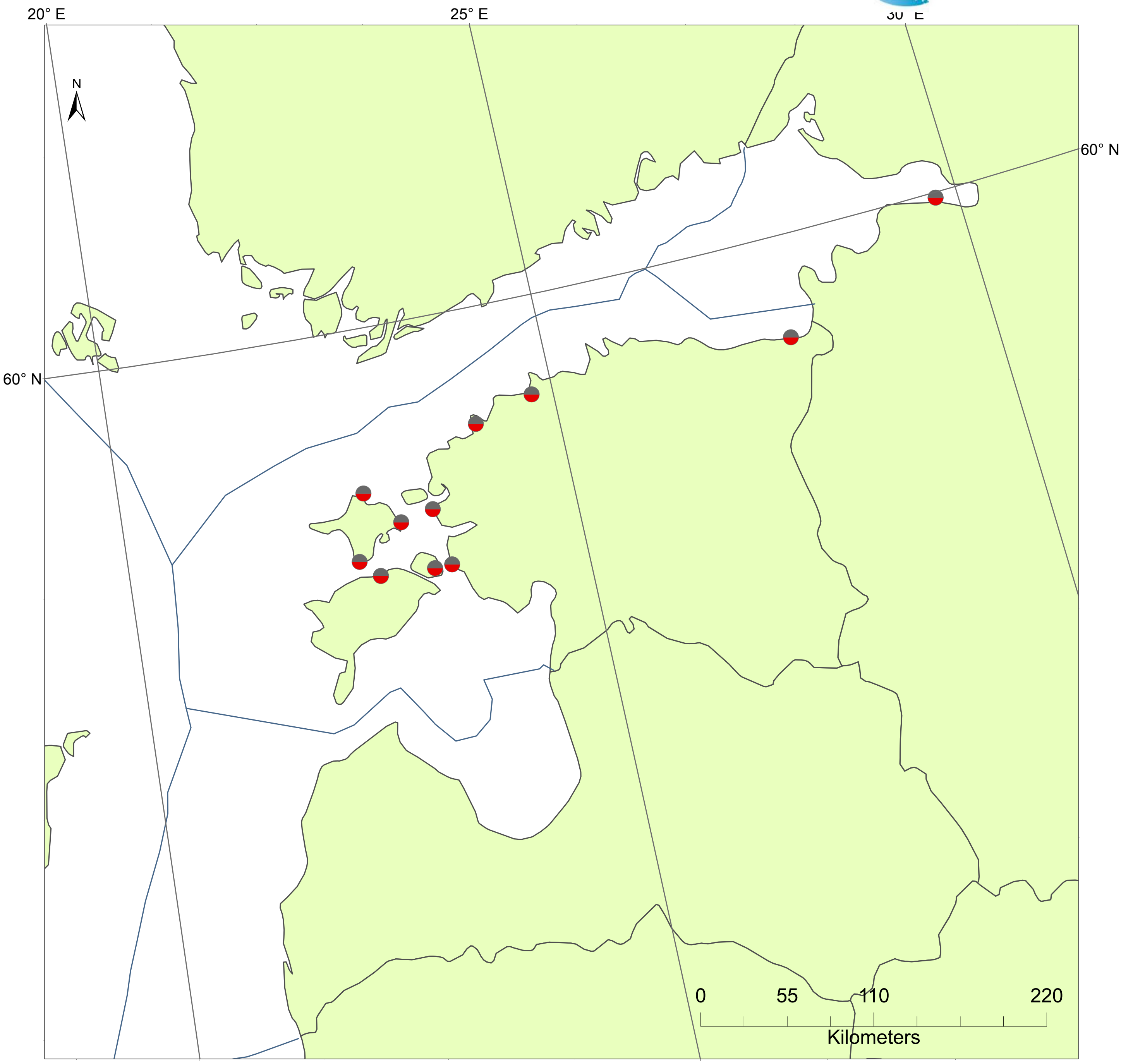
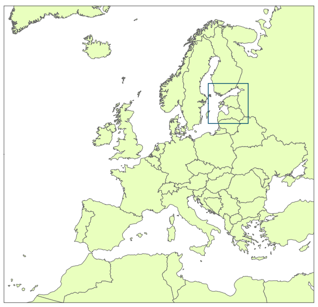
Jerico Fixed Platforms
Estonia and Russia



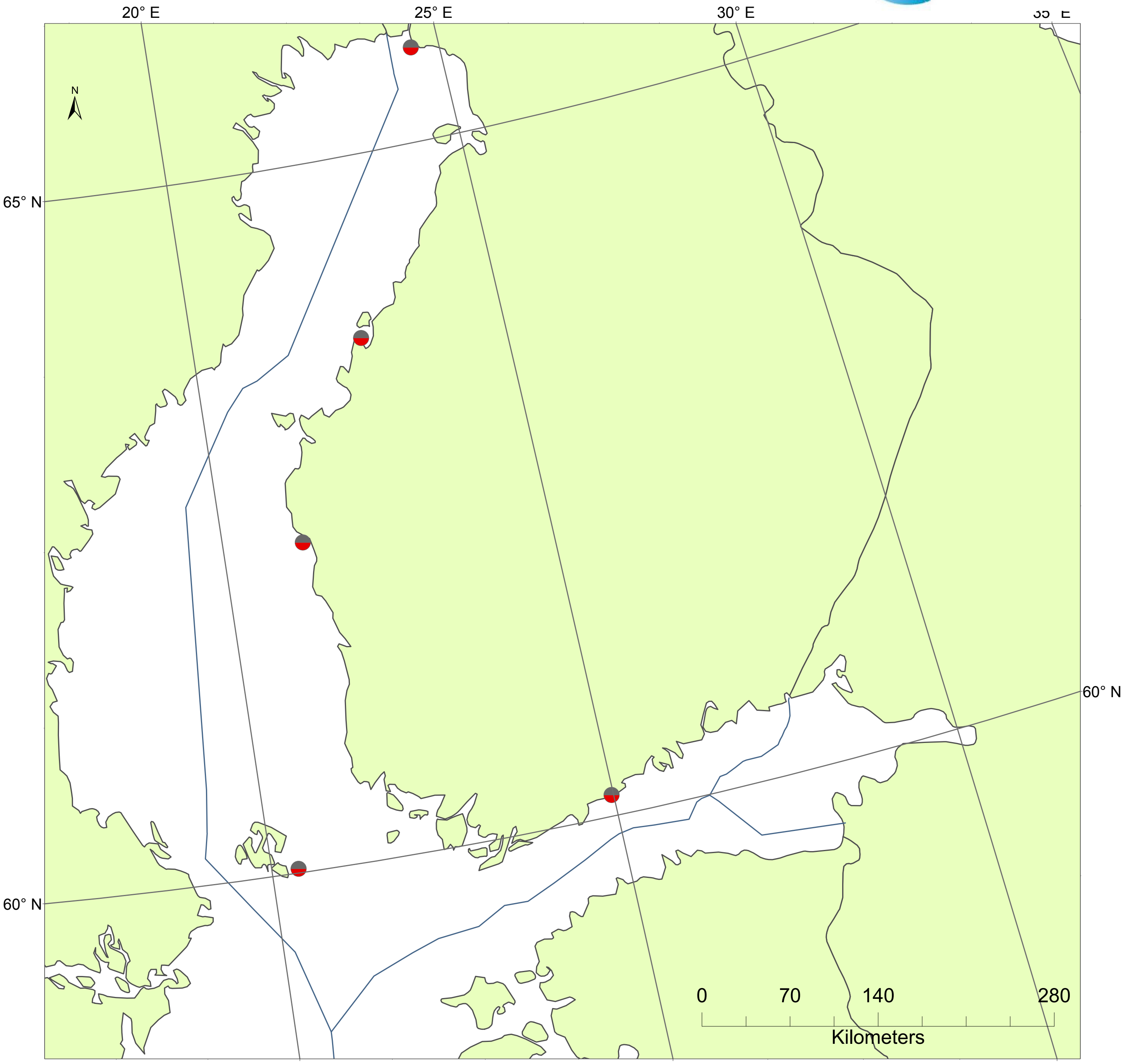
Sea Level	Nutrients	Air
Sea Pressure	pH	Chlorophyll
Sea Temperature	Plankton	Currents
Waves	Precipitation	Dissolved gases
Winds	Salinity	Light/PSM

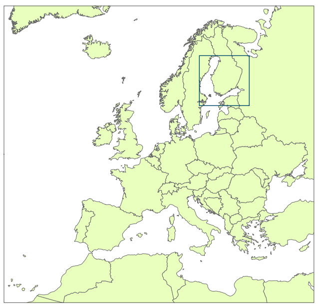


This map was produced as part of JERICO WP3, using metadata from the JERICO WP3 fixed platforms database.

Cefas 2013

Jerico Fixed Platforms
Finland

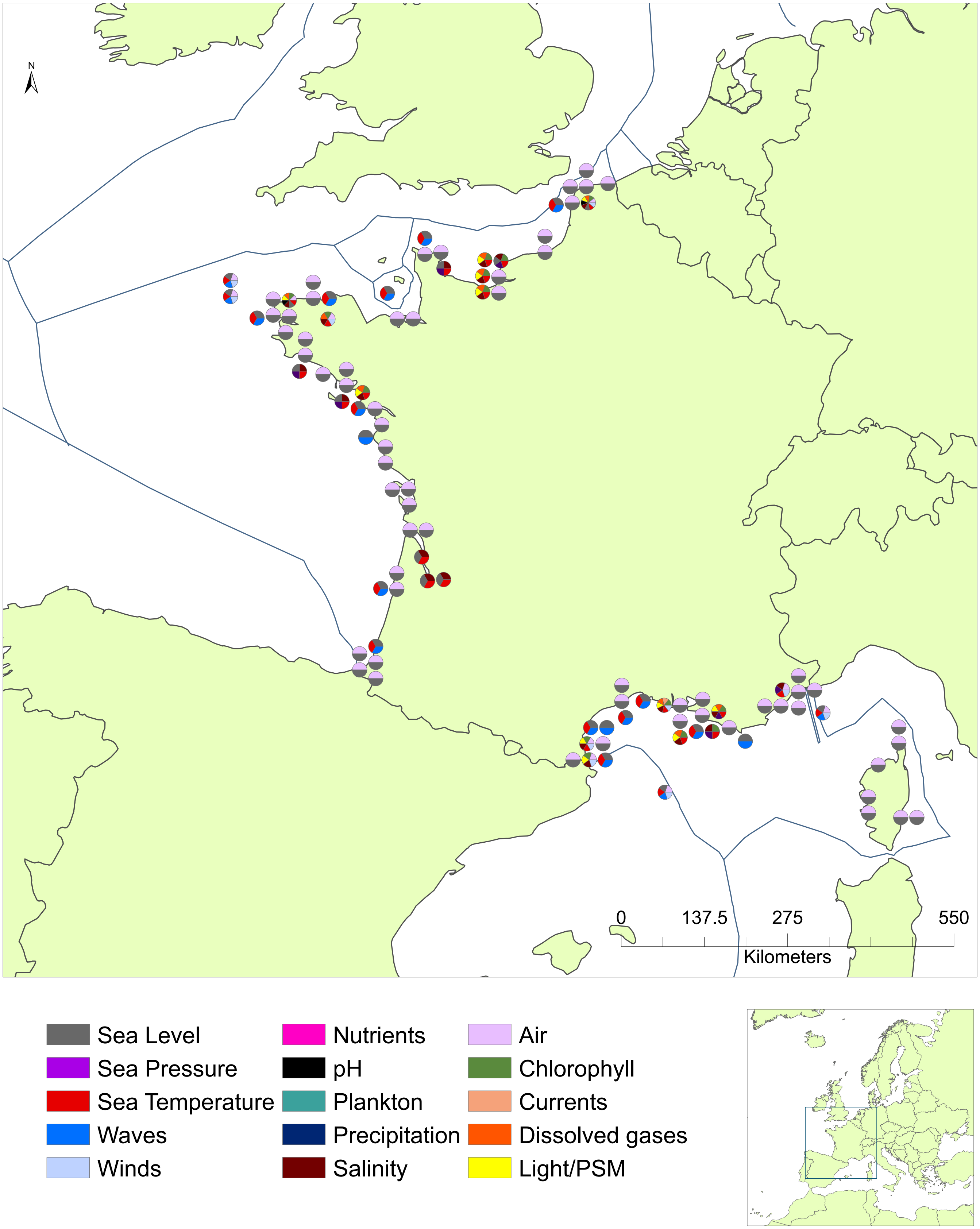




This map was produced as part of JERICO WP3, using metadata from the JERICO WP3 fixed platforms database.

Cefas 2013

Jerico Fixed Platforms
France



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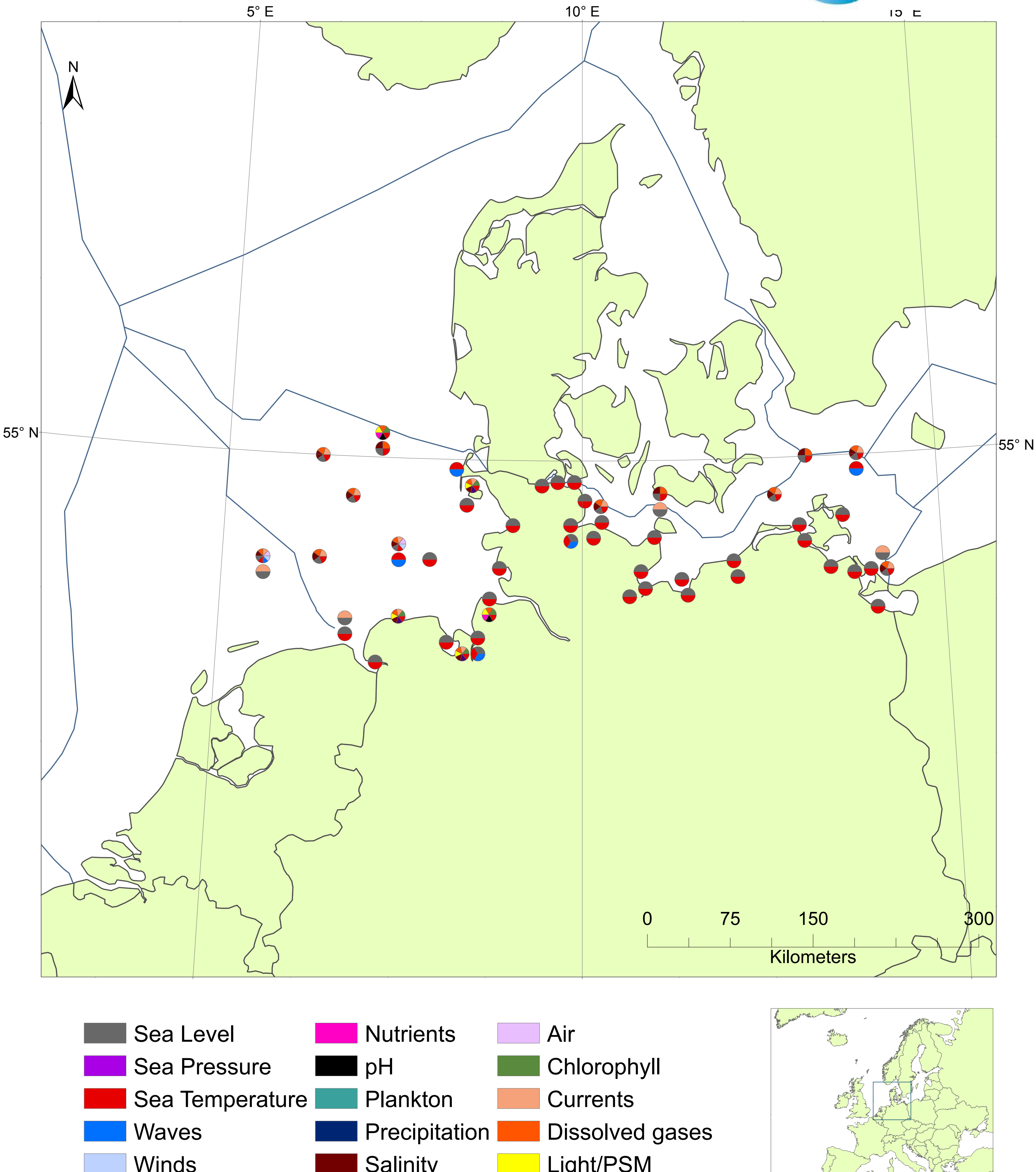
Jerico Fixed Platforms
Germany



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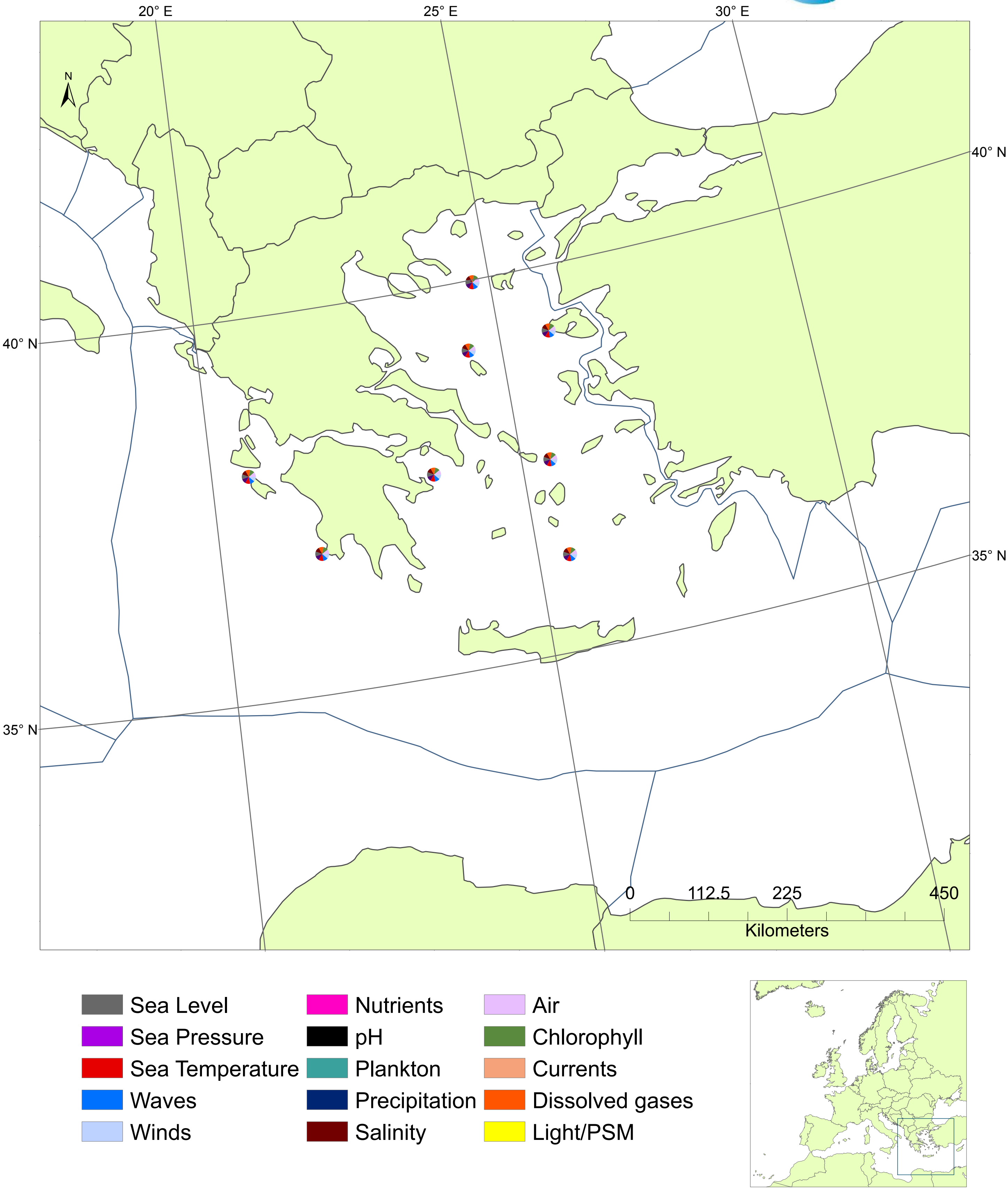
Jerico Fixed Platforms
Greece



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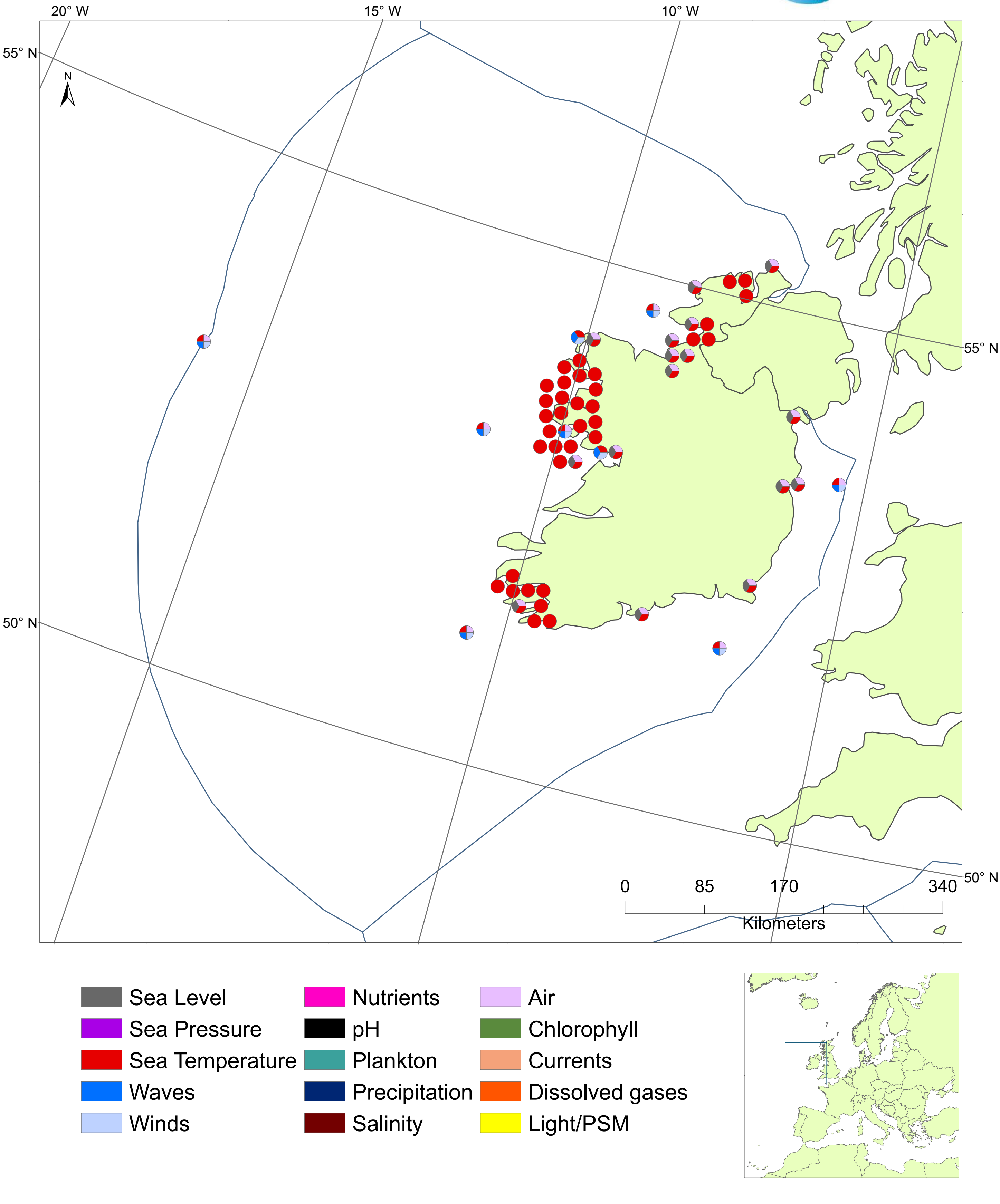
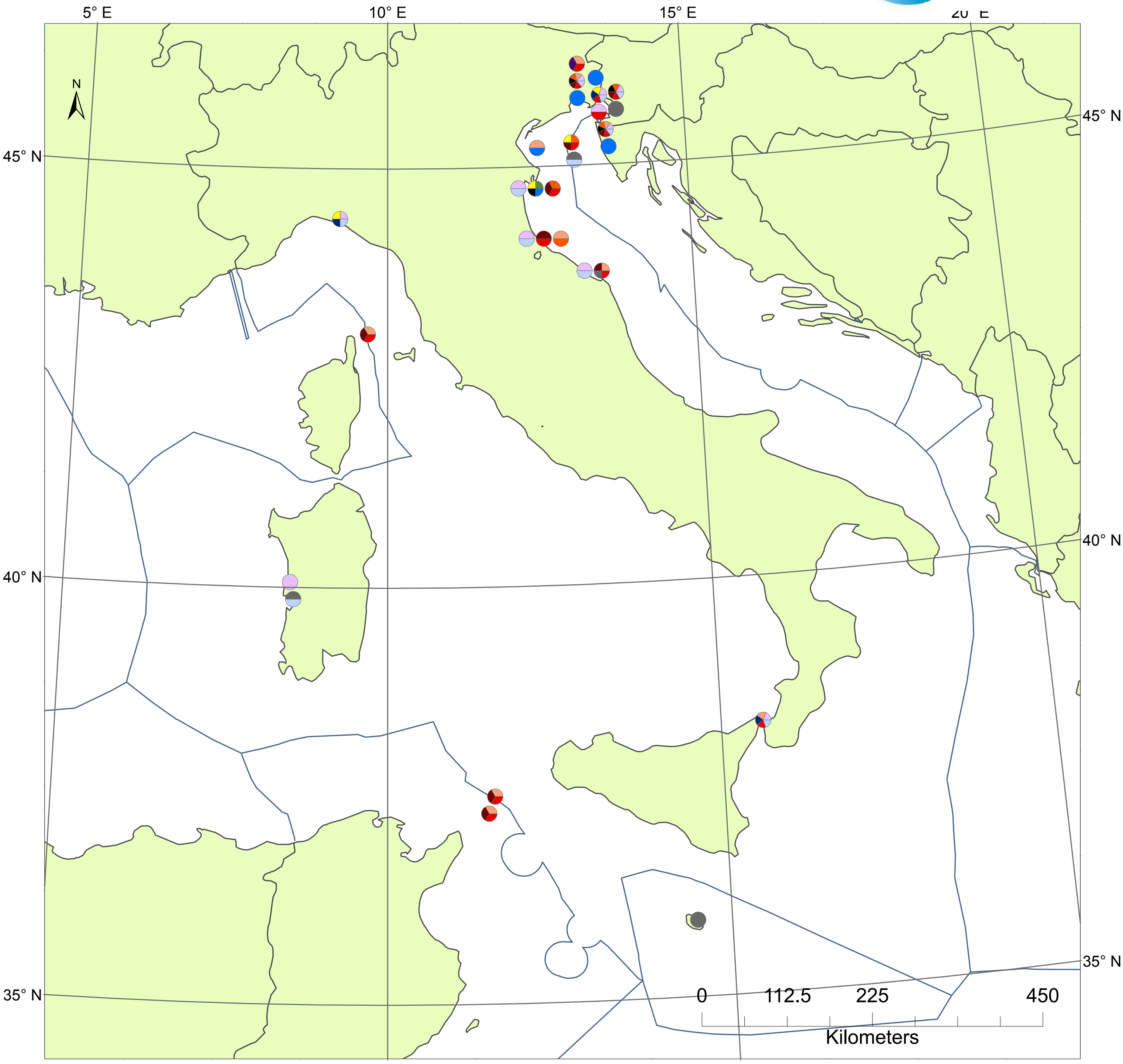
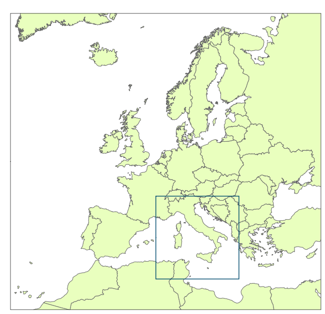
Jerico Fixed Platforms
Ireland



This map was produced as part of JERICO WP3, using metadata from the JERICO WP3 fixed platforms database.

Jerico Fixed Platforms
Italy and Malta





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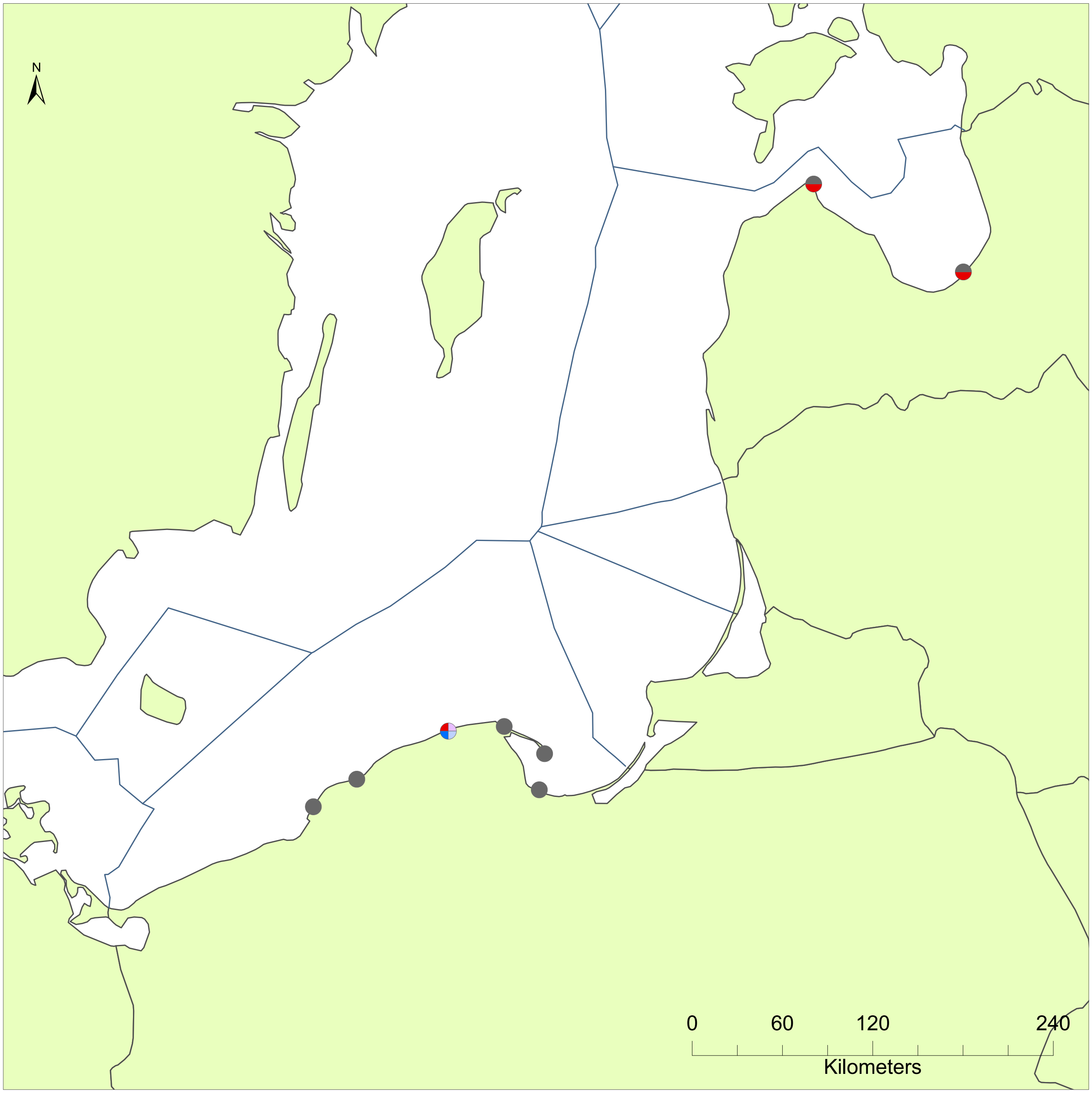
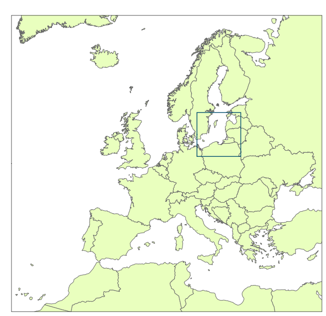
Jerico Fixed Platforms
Latvia and Poland



Sea Level
Sea Pressure
Sea Temperature
Waves
Winds
Nutrients
pH
Plankton
Precipitation
Salinity
Air
Chlorophyll
Currents
Dissolved gases
Light/PSM



This map was produced as part of JERICO WP3, using metadata from the JERICO WP3 fixed platforms database.

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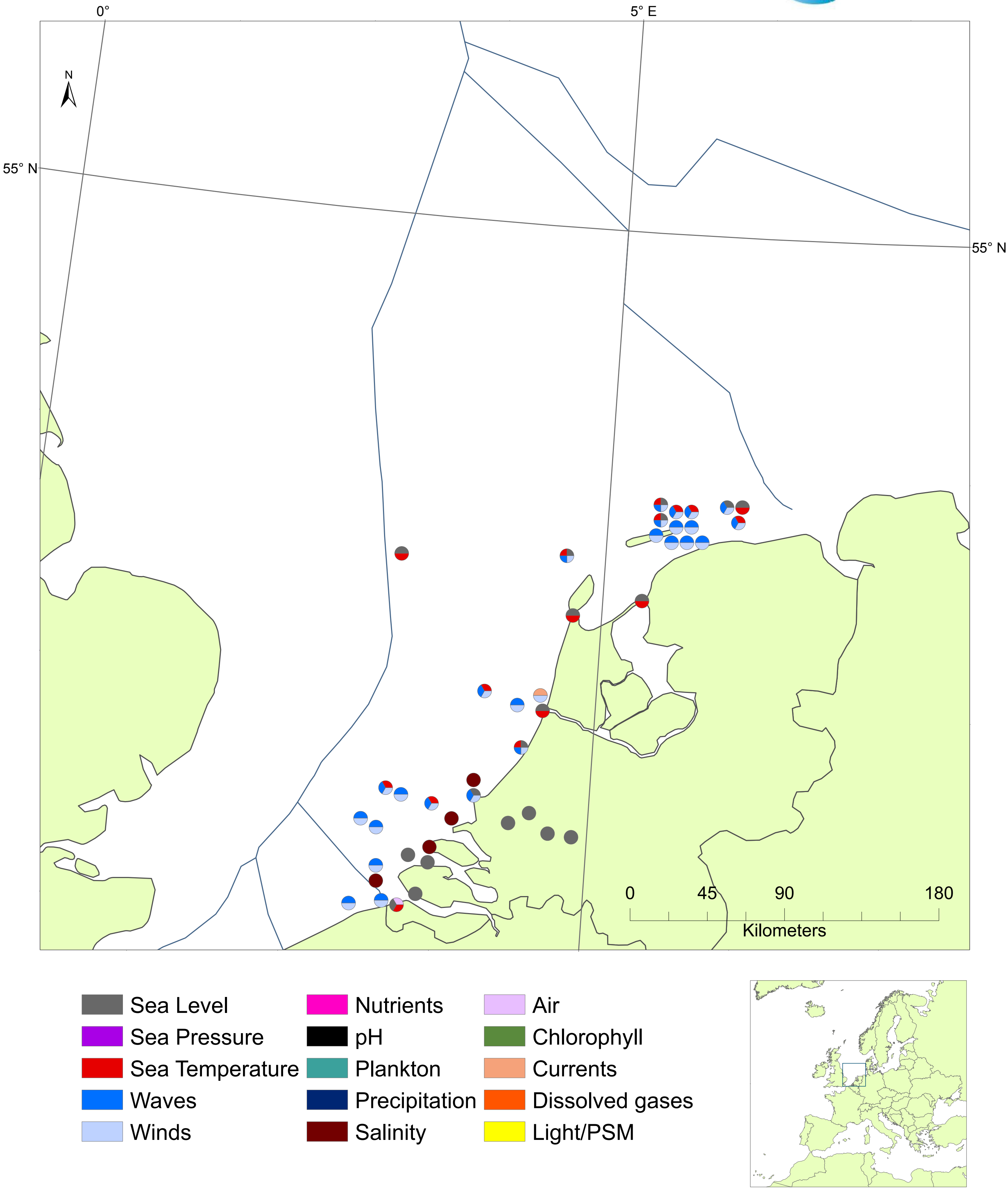
Jerico Fixed Platforms
Netherlands



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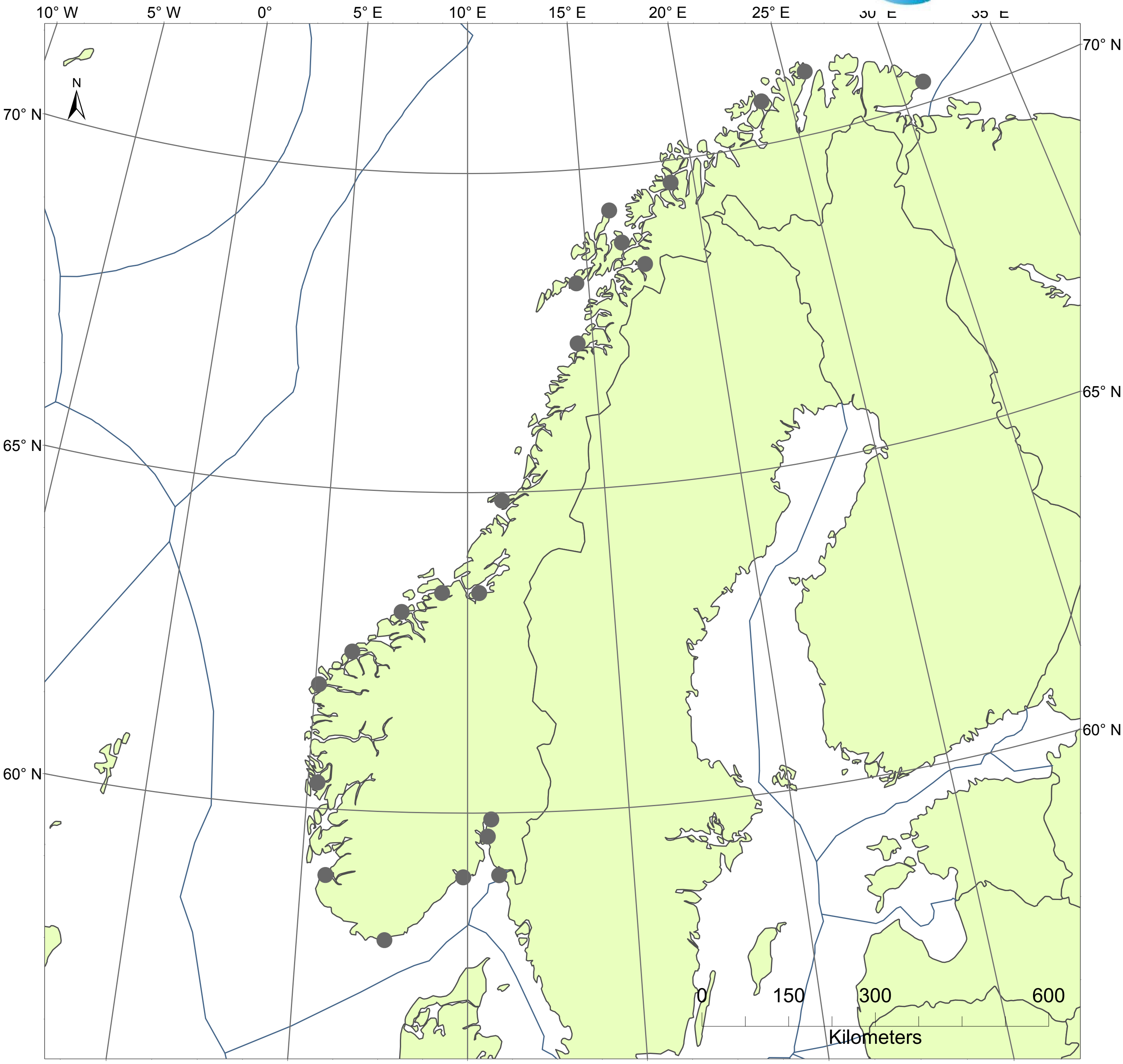
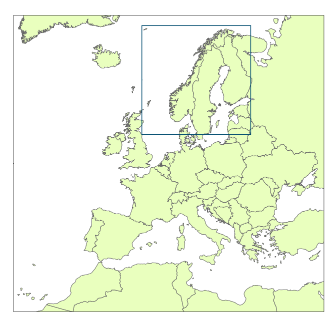
Jerico Fixed Platforms Norway





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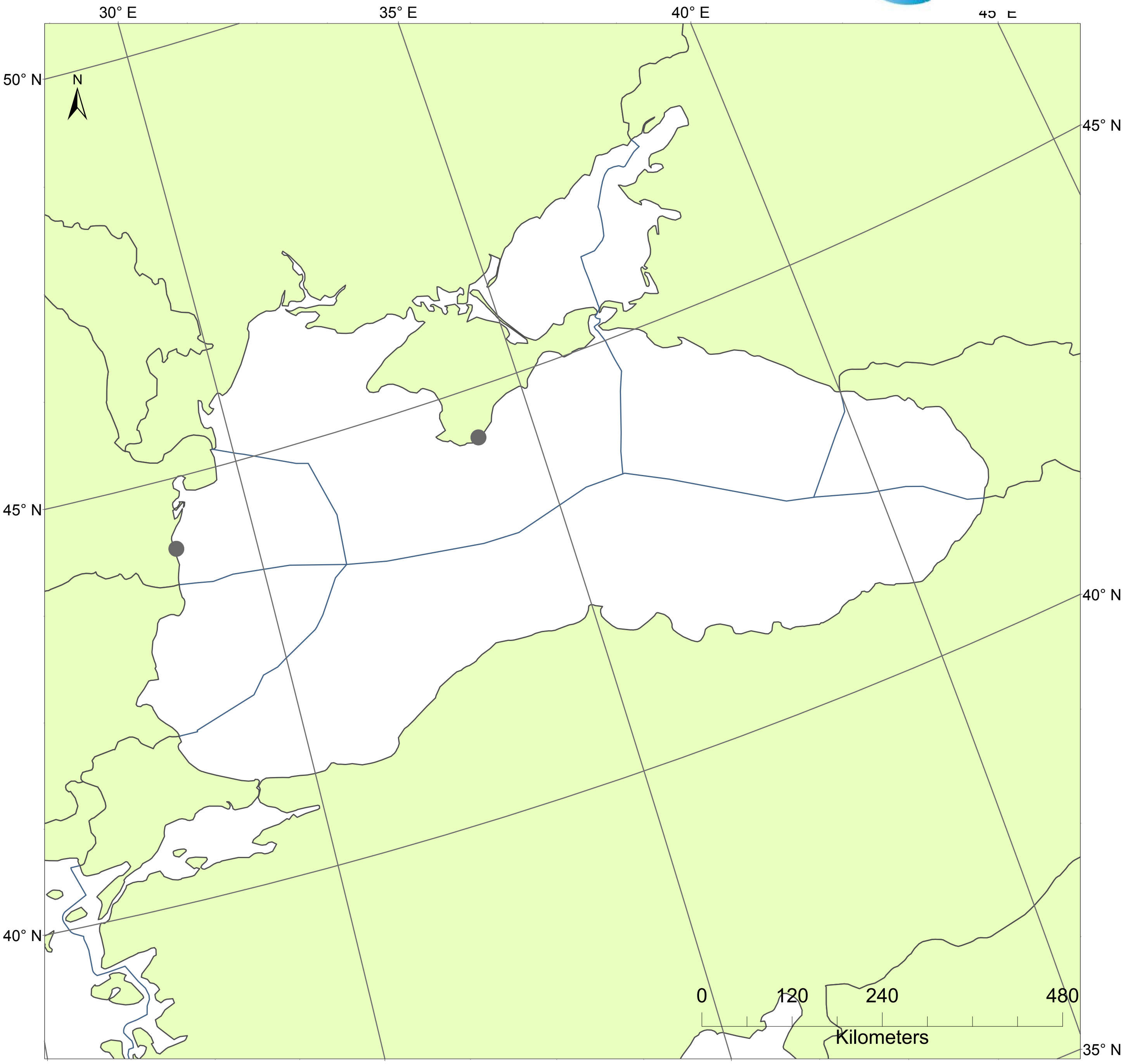
Jerico Fixed Platforms
Romania and Ukraine



- Sea Level
- Sea Pressure
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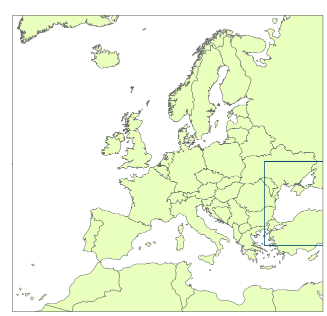
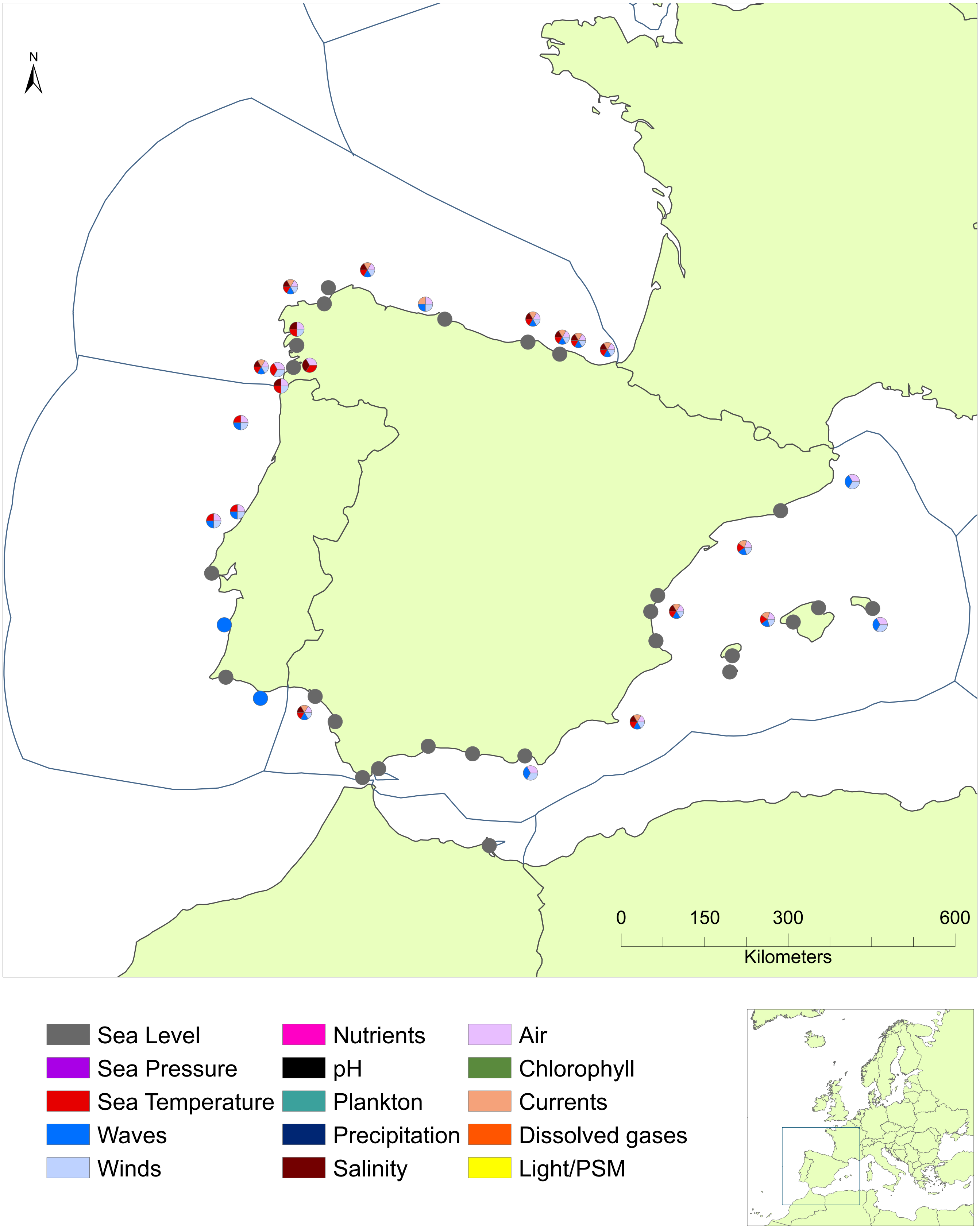
- Waves
- Winds
- Nutrients
- pH
- Plankton
- Precipitation
- Salinity
- Air
- Chlorophyll
- Currents
- Dissolved gases
- Light/PSM



This map was produced as part of JERICO WP3, using metadata from the JERICO WP3 fixed platforms database.

Jerico Fixed Platforms
Portugal and Spain



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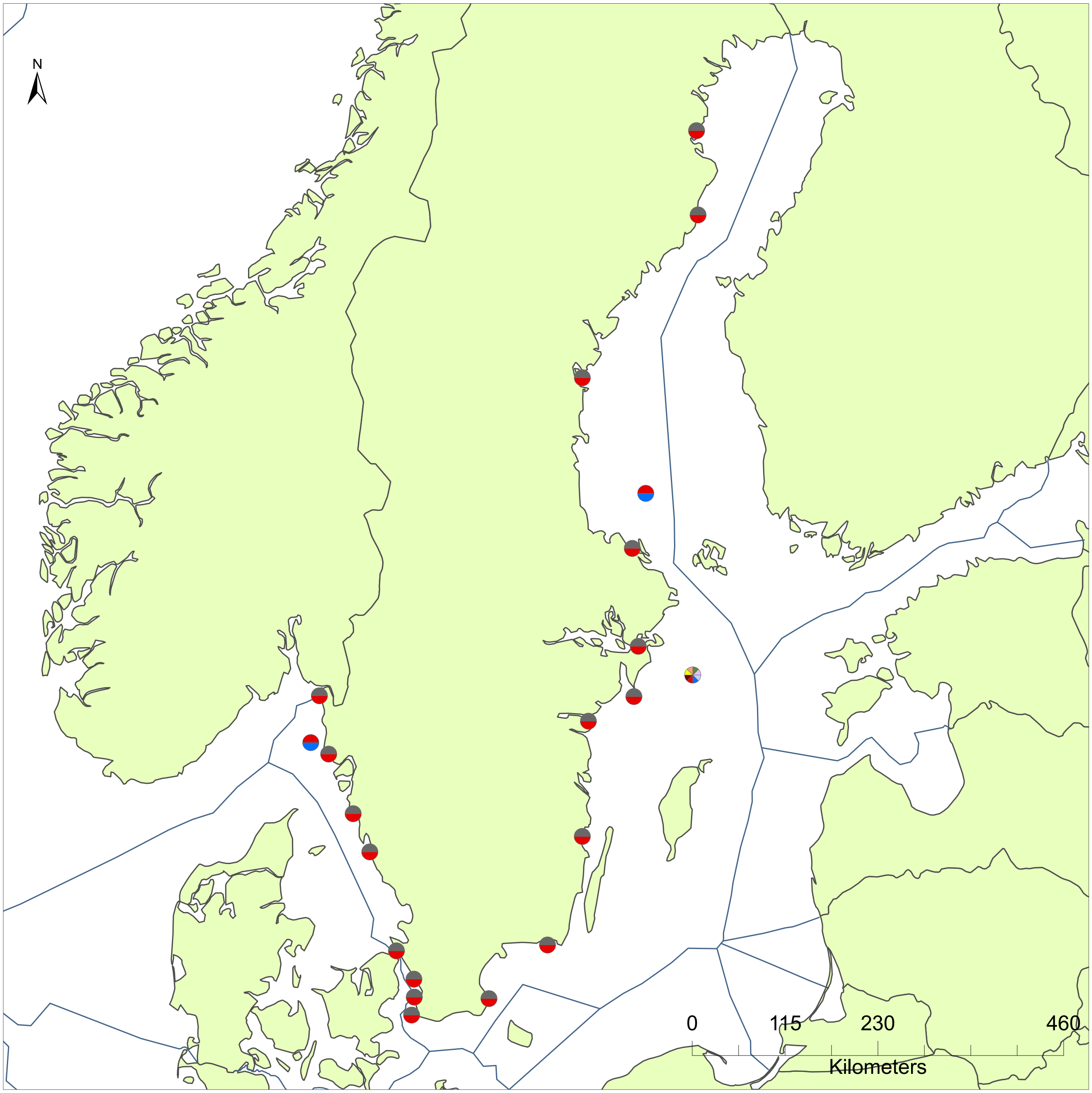
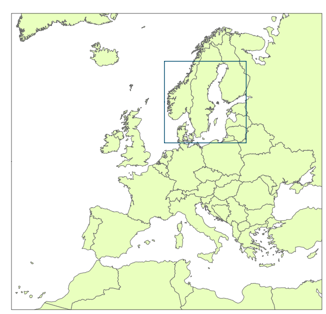
Jerico Fixed Platforms
Sweden



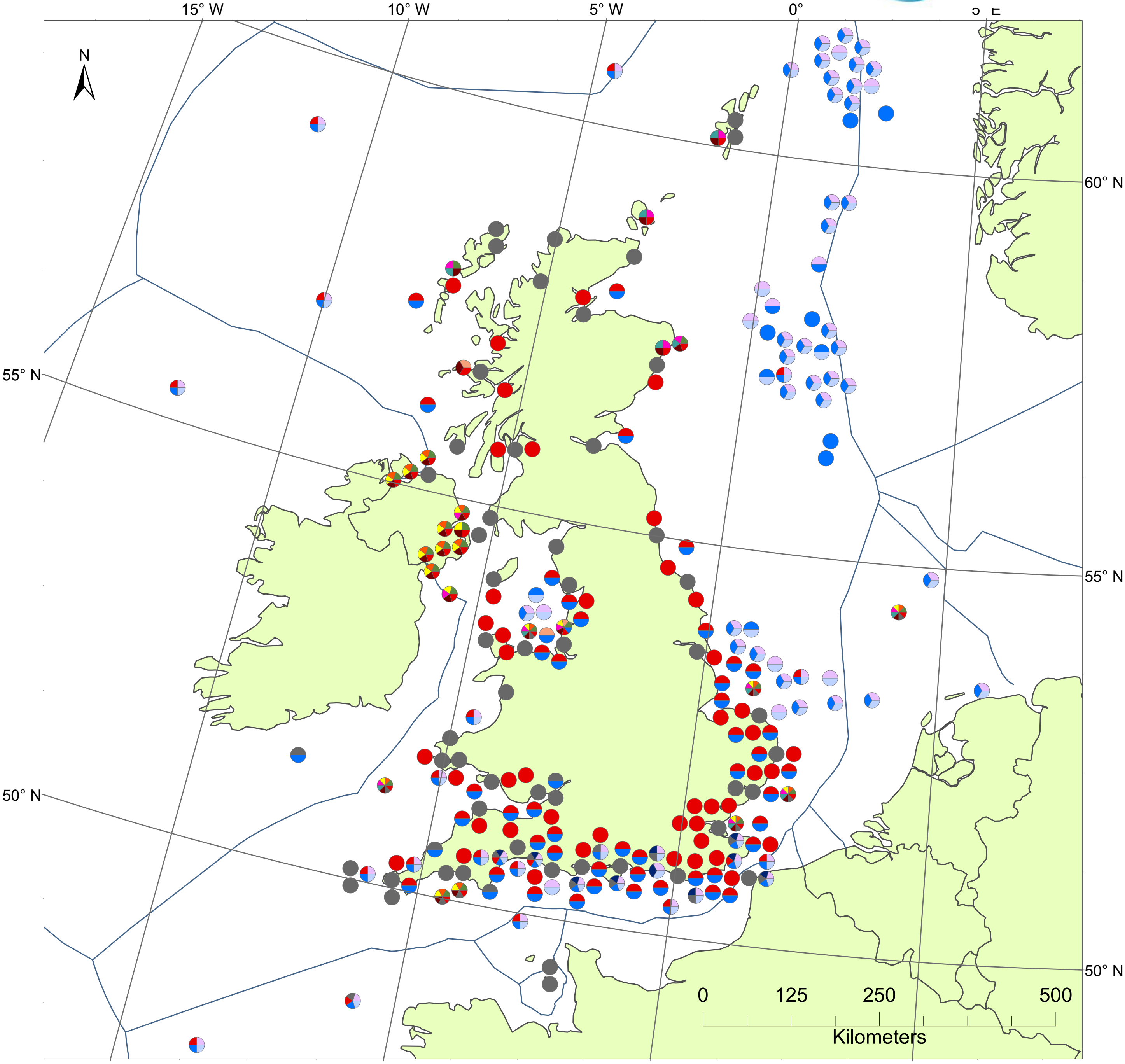
- Sea Level
- Sea Pressure
- Sea Temperature
- Waves
- Winds
- Nutrients
- pH
- Plankton
- Precipitation
- Salinity
- Air
- Chlorophyll
- Currents
- Dissolved gases
- Light/PSM

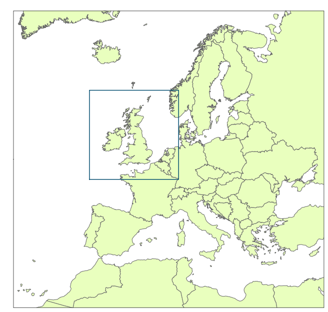


This map was produced as part of JERICO WP3, using metadata from the JERICO WP3 fixed platforms database.

Cefas 2013

Jerico Fixed Platforms
UK





This map was produced as part of JERICO WP3, using metadata from the JERICO WP3 fixed platforms database.

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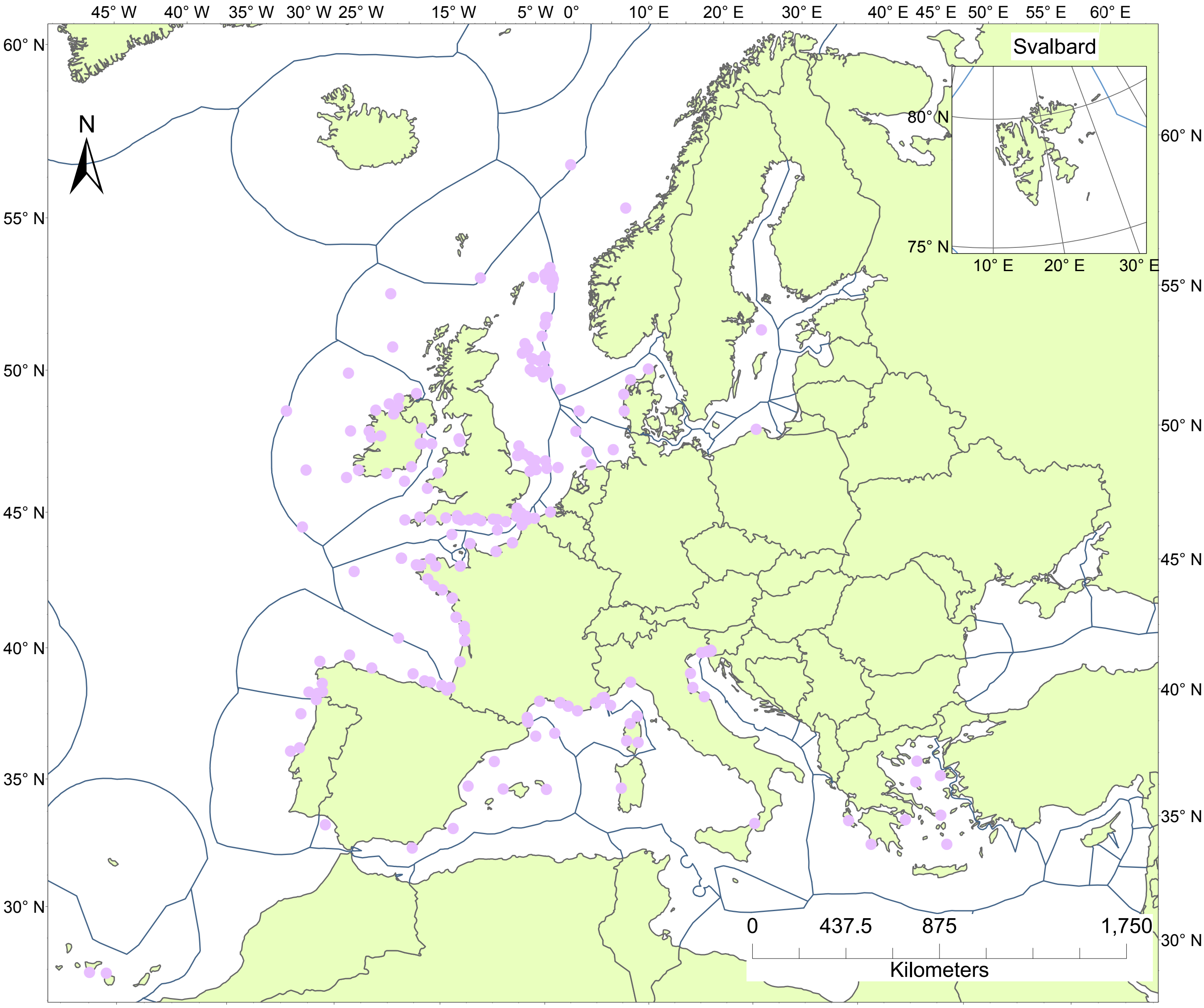
Appendix 2

This appendix countains individual European Scale maps for each parameter, showing only the stations measuring that parameter.

Air	Chlorophyll	Currents	Dissolved Gases	Light/PSM	Nutrients	pH	Plankton	Precipitation	Salinity	Sea Level	Sea Pressure	Sea Temperature	Waves	Wind
Air temperature	Chlorophyll a	Current direction	Dissolved oxygen	Light irradiance (surface and immerged)	Ammonium	pH	Mesozooplankton weight	Rainfall	Conductivity	Observed sea level	Sea pressure	Sea temperature	Wave direction	Wind direction
Atmospheric pressure	Fluorescence	Current speed	Dissolved carbon dioxide	Light scattering	Nitrate		Phytoplankton abundance		Practical salinity	Residual sea level	Sea density		Wave period	Wind speed
Dew point temperature		River flow rate	Fugacity carbon dioxide	Light attenuation	Nitrite					Sea depth			Wave energy	Wind chill
Relative humidity			Partial pressure carbon dioxide	Turbidity	Phosphate								Wave height	Gust wind direction
Visibility (air)				Suspended matter	Silicate								Wave spreading direction	Gust wind speed
					Silicate								Significant wave height	
													Significant wave period	
													Swell direction	
													Swell period	

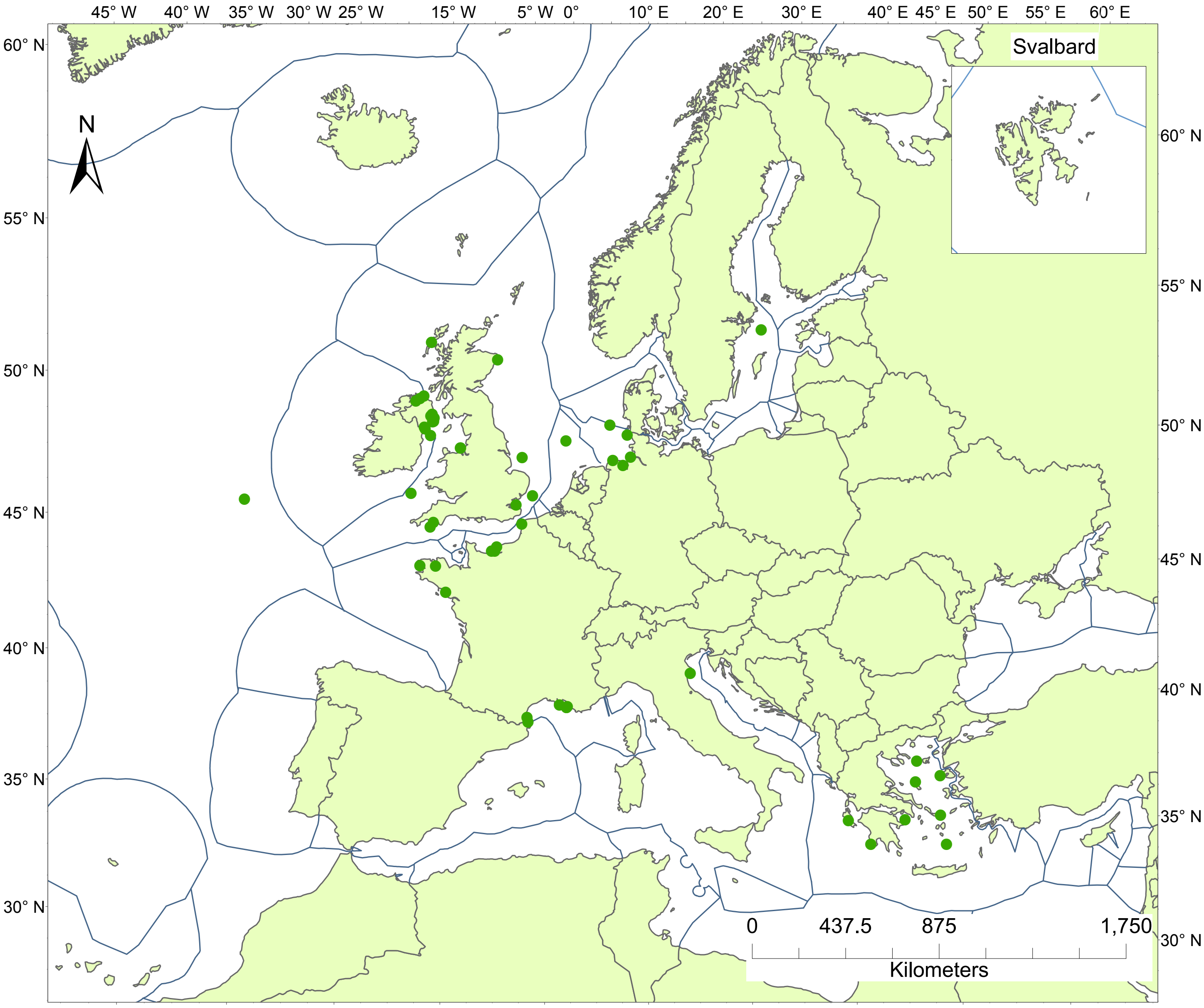
Table 2: Parameter classification.

Jerico Fixed Platforms
Air



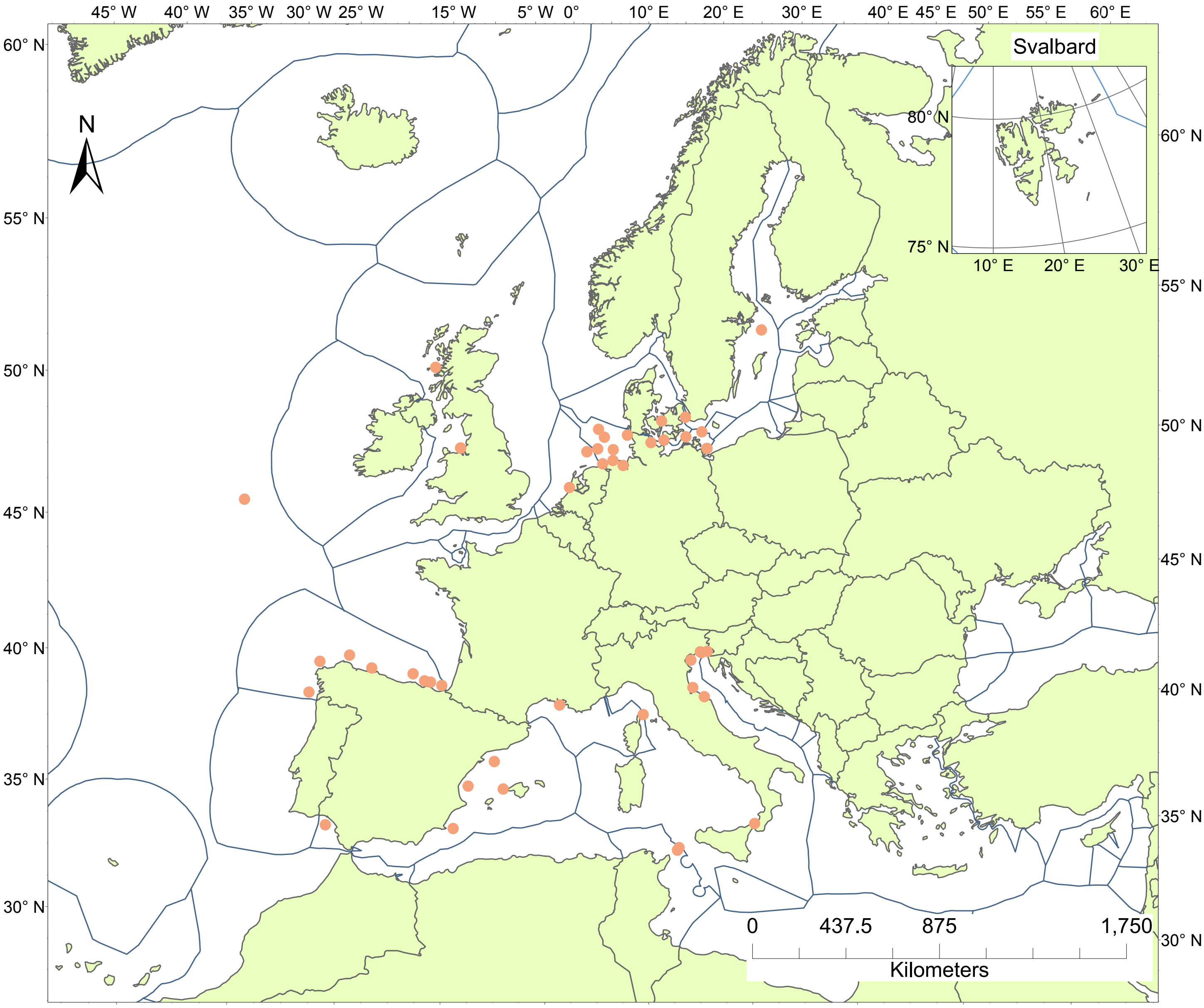
This map was produced as part of JERICO WP3, using metadata from the JERICO WP3 fixed platforms database.

Jerico Fixed Platforms
Chlorophyll



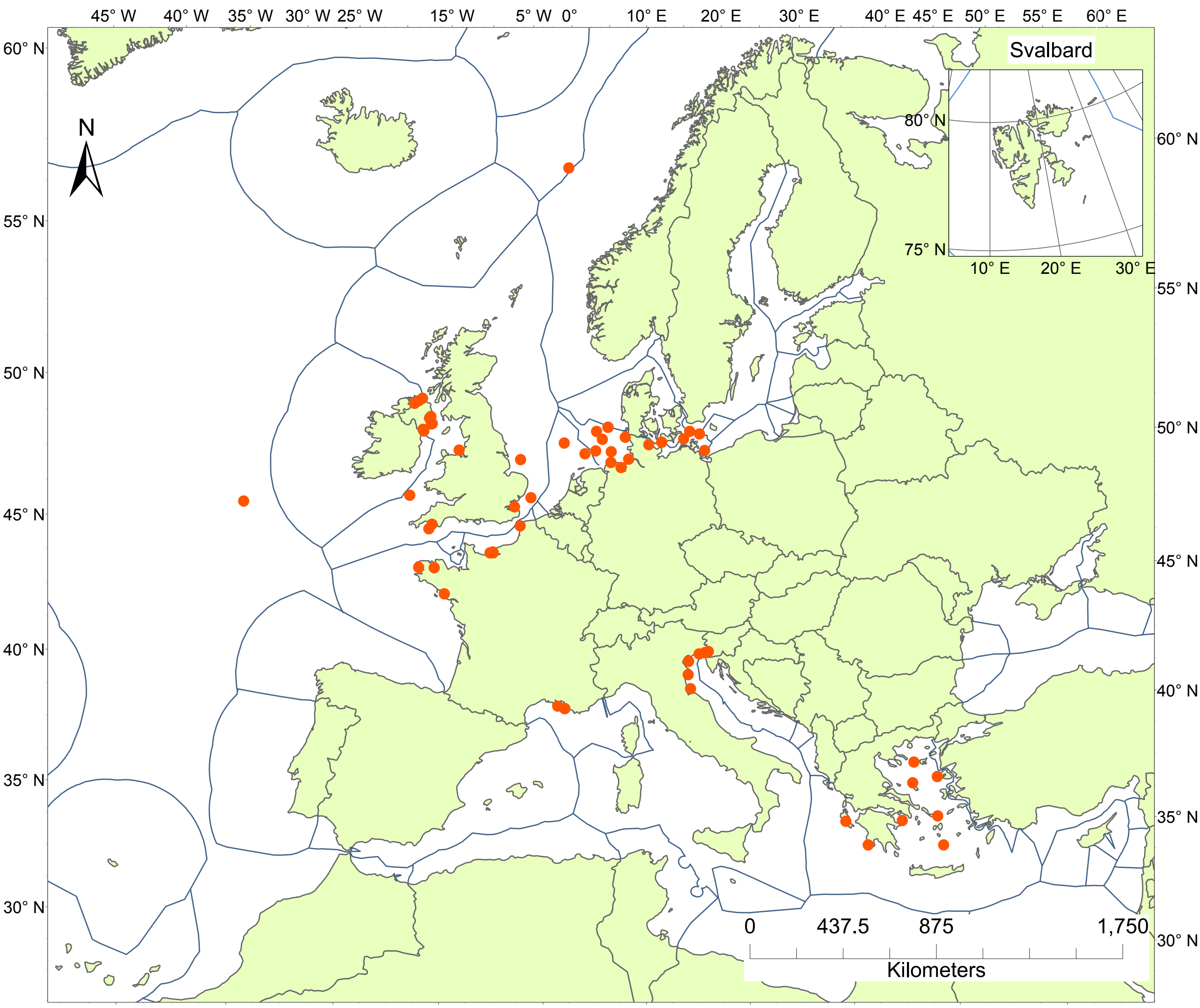
This map was produced as part of JERICO WP3, using metadata from the JERICO WP3 fixed platforms database.

Jerico Fixed Platforms
Currents



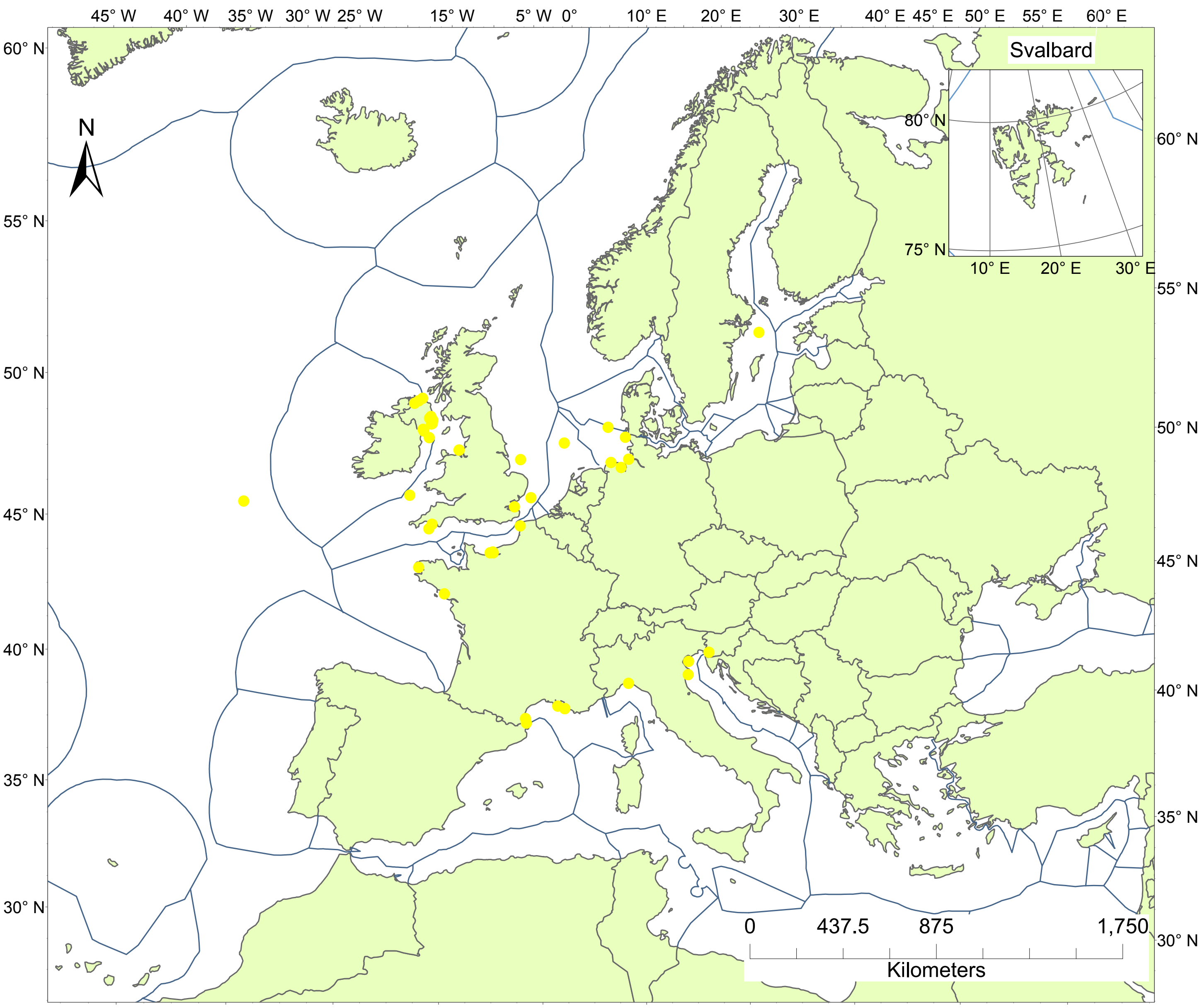
This map was produced as part of JERICO WP3, using metadata from the JERICO WP3 fixed platforms database.

Jerico Fixed Platforms
Dissolved gases



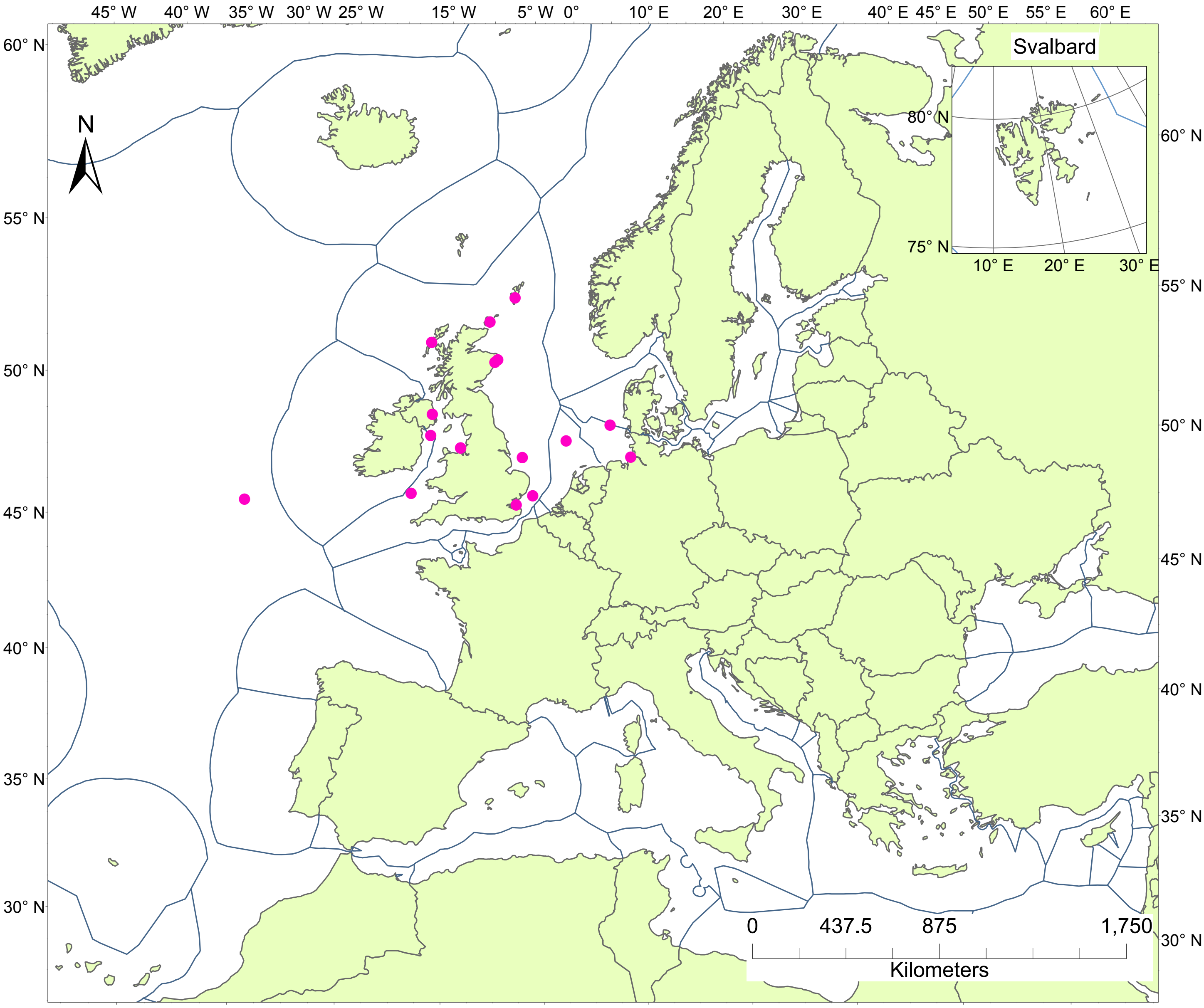
This map was produced as part of JERICO WP3, using metadata from the JERICO WP3 fixed platforms database.

Jerico Fixed Platforms
Light/PSM



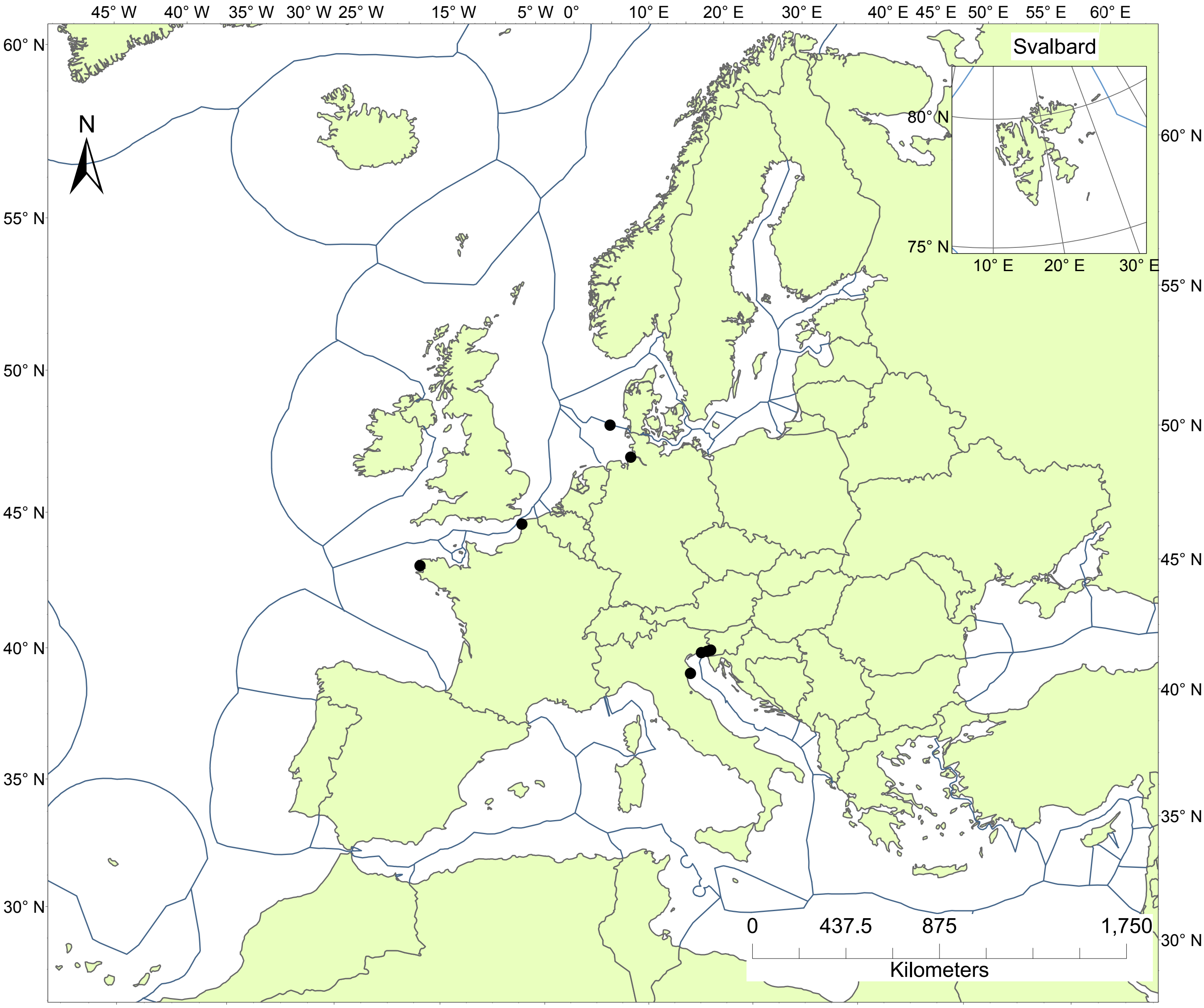
This map was produced as part of JERICO WP3, using metadata from the JERICO WP3 fixed platforms database.

Jerico Fixed Platforms
Nutrients



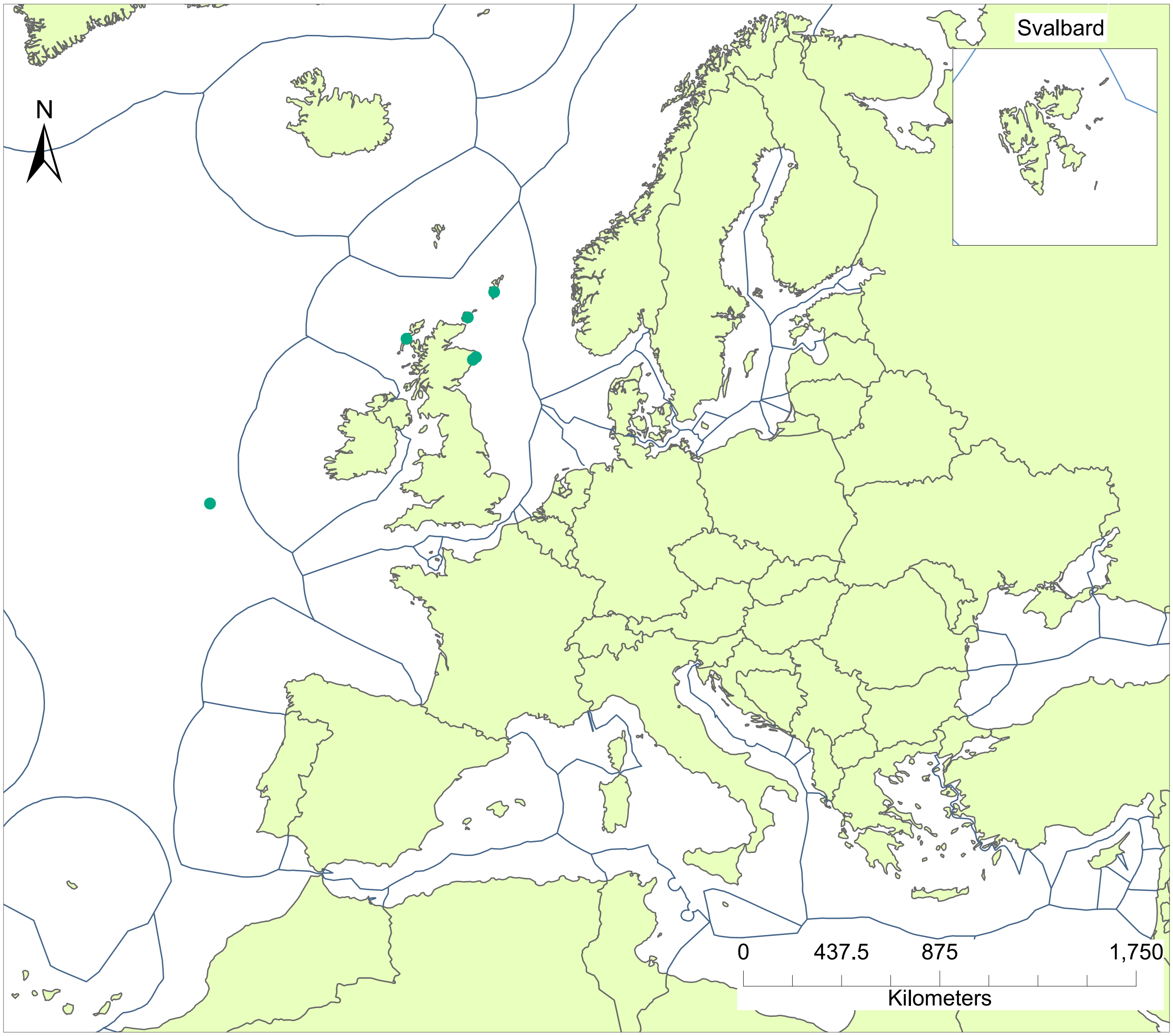
This map was produced as part of JERICO WP3, using metadata from the JERICO WP3 fixed platforms database.

Jerico Fixed Platforms
pH



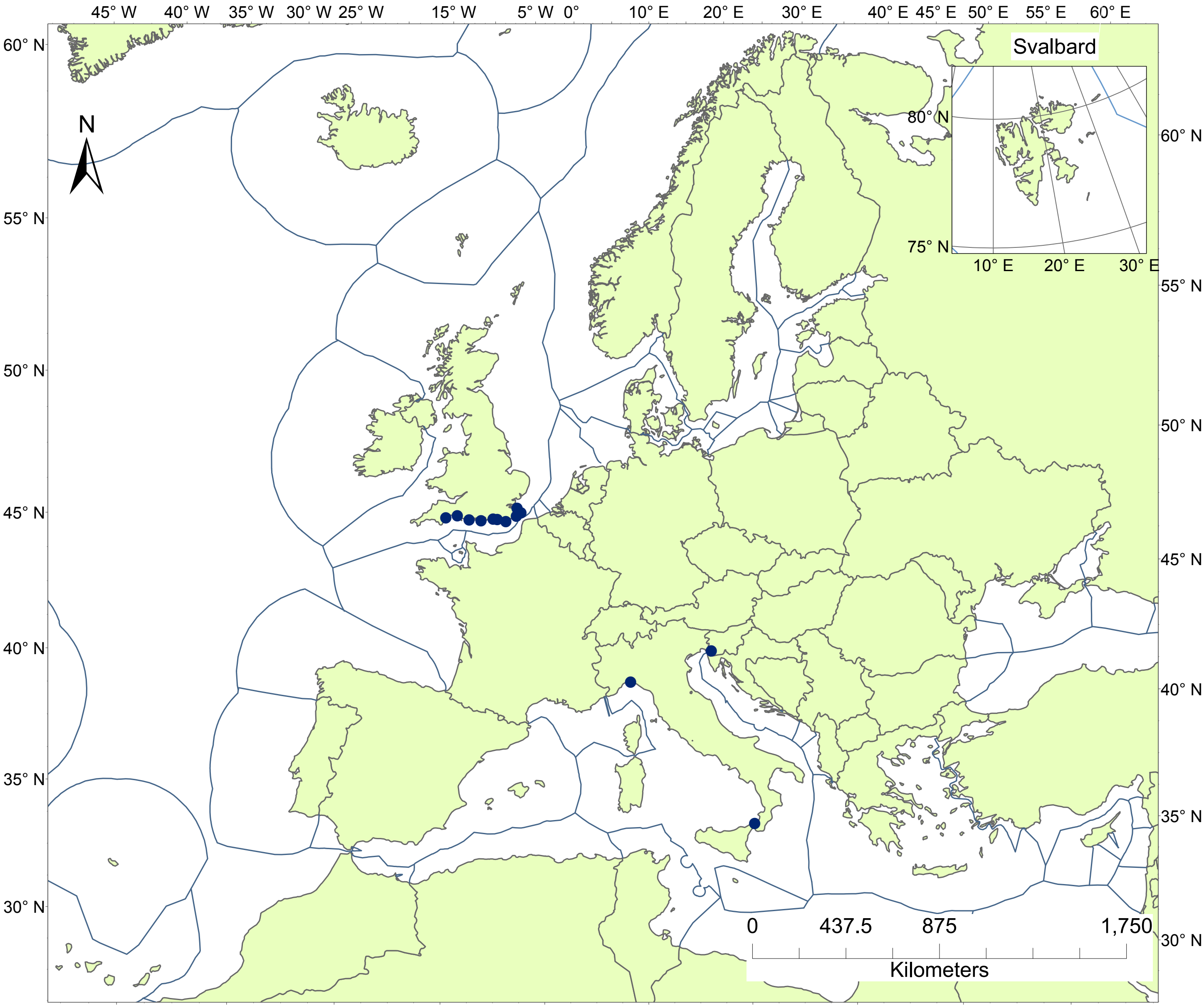
This map was produced as part of JERICO WP3, using metadata from the JERICO WP3 fixed platforms database.

Jerico Fixed Platforms
Plankton



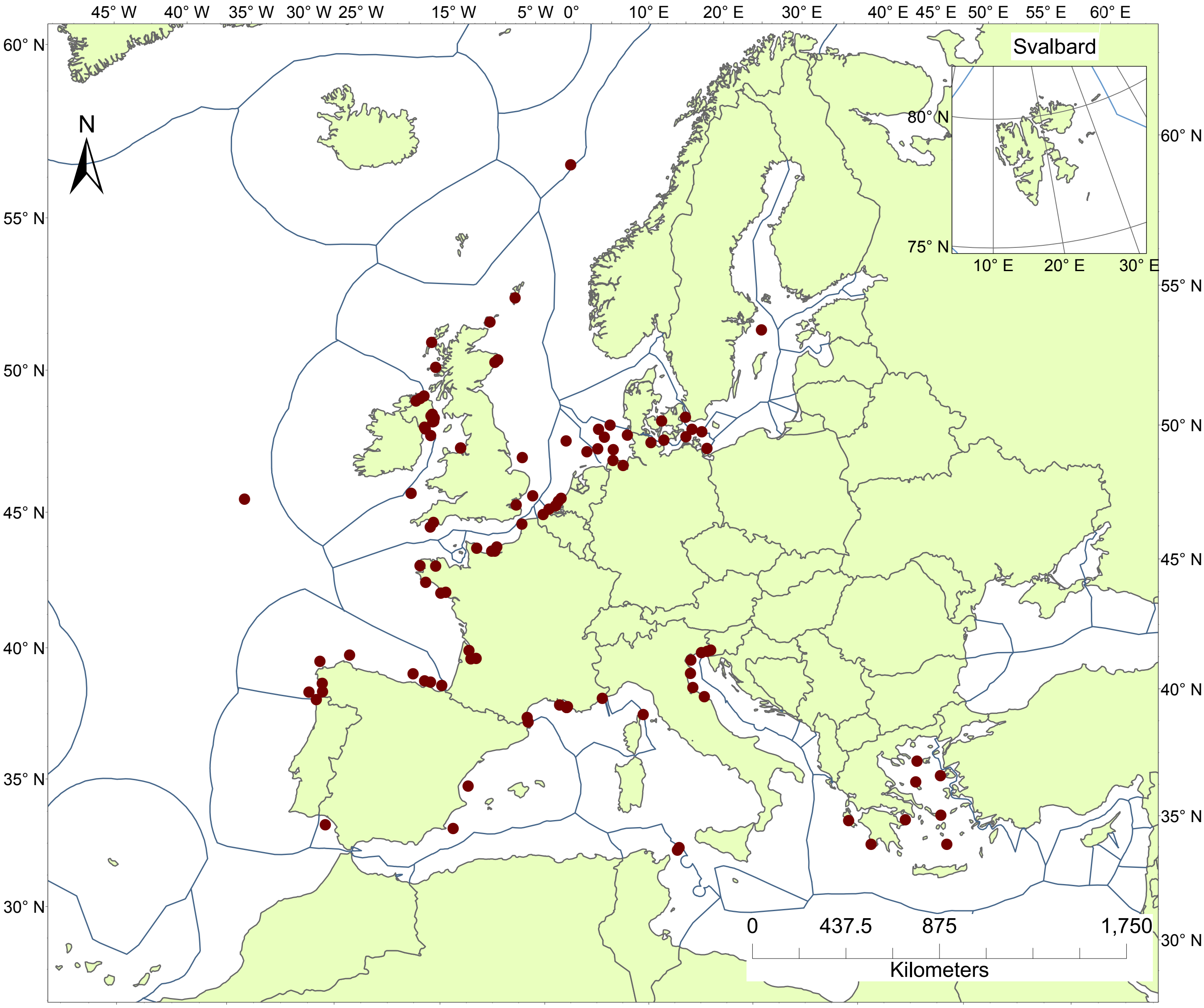
This map was produced as part of JERICO WP3, using metadata from the JERICO WP3 fixed platforms database.

Jerico Fixed Platforms
Precipitation



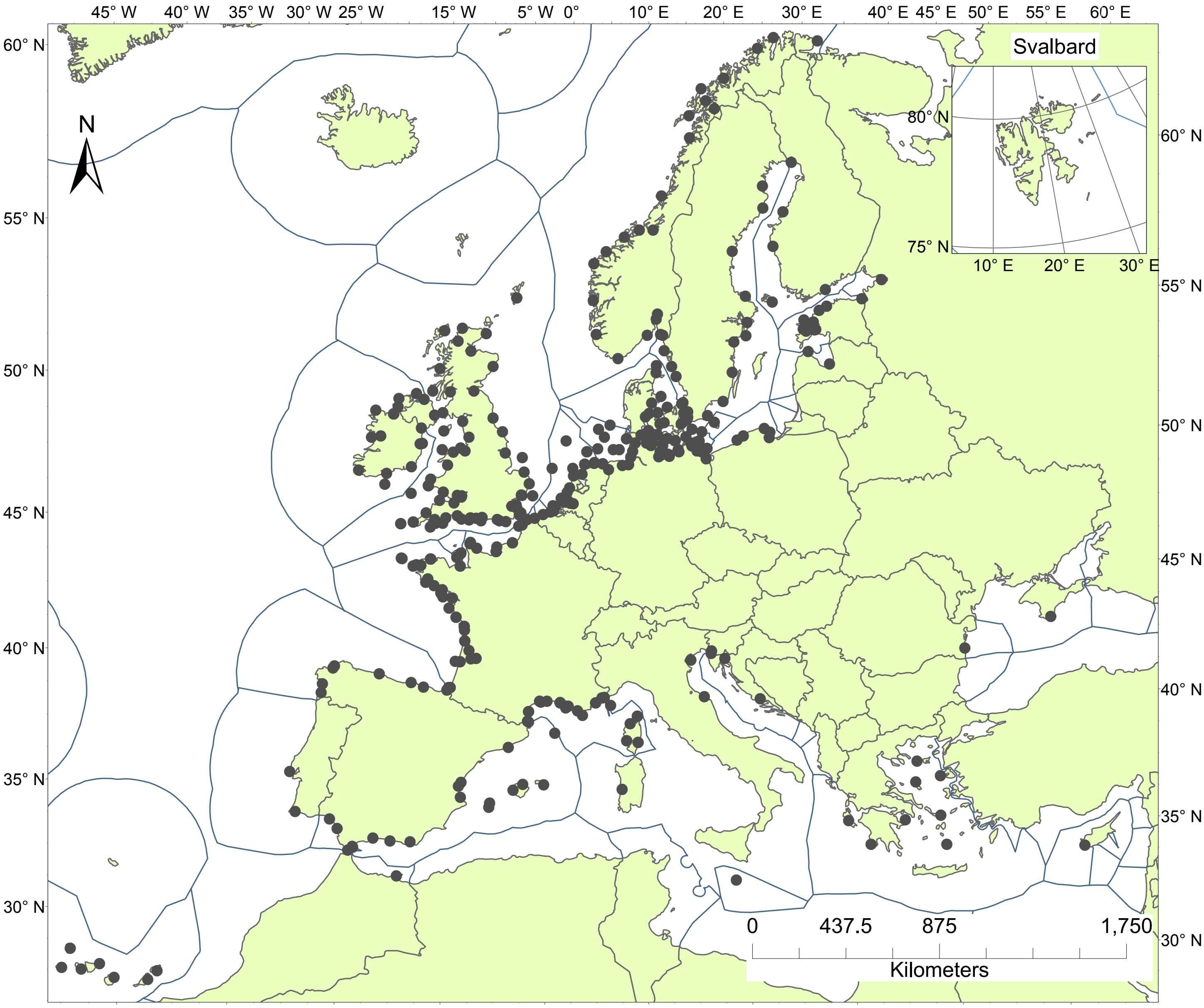
This map was produced as part of JERICO WP3, using metadata from the JERICO WP3 fixed platforms database.

Jerico Fixed Platforms
Salinity



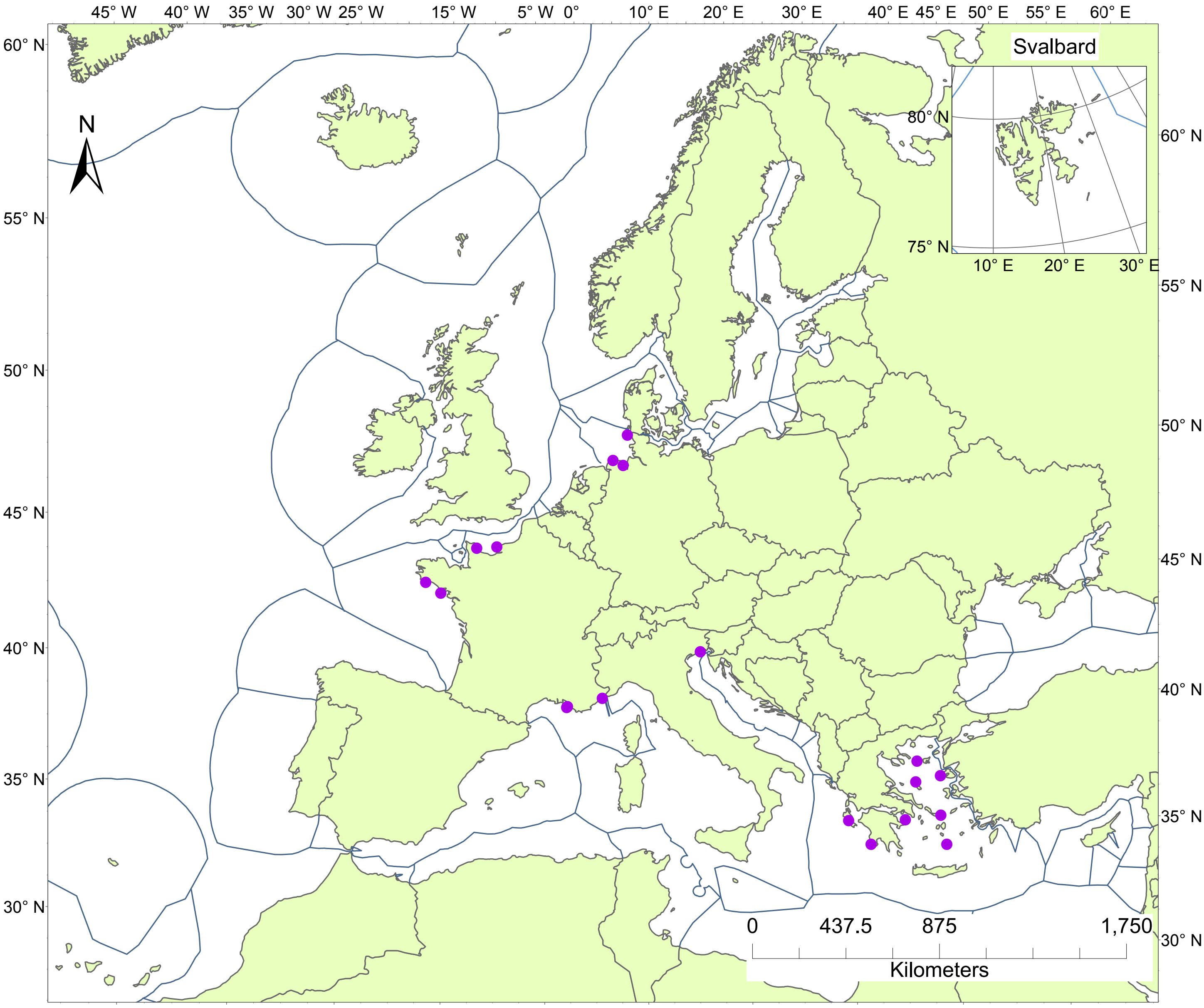
This map was produced as part of JERICO WP3, using metadata from the JERICO WP3 fixed platforms database.

Jerico Fixed Platforms
Sea level



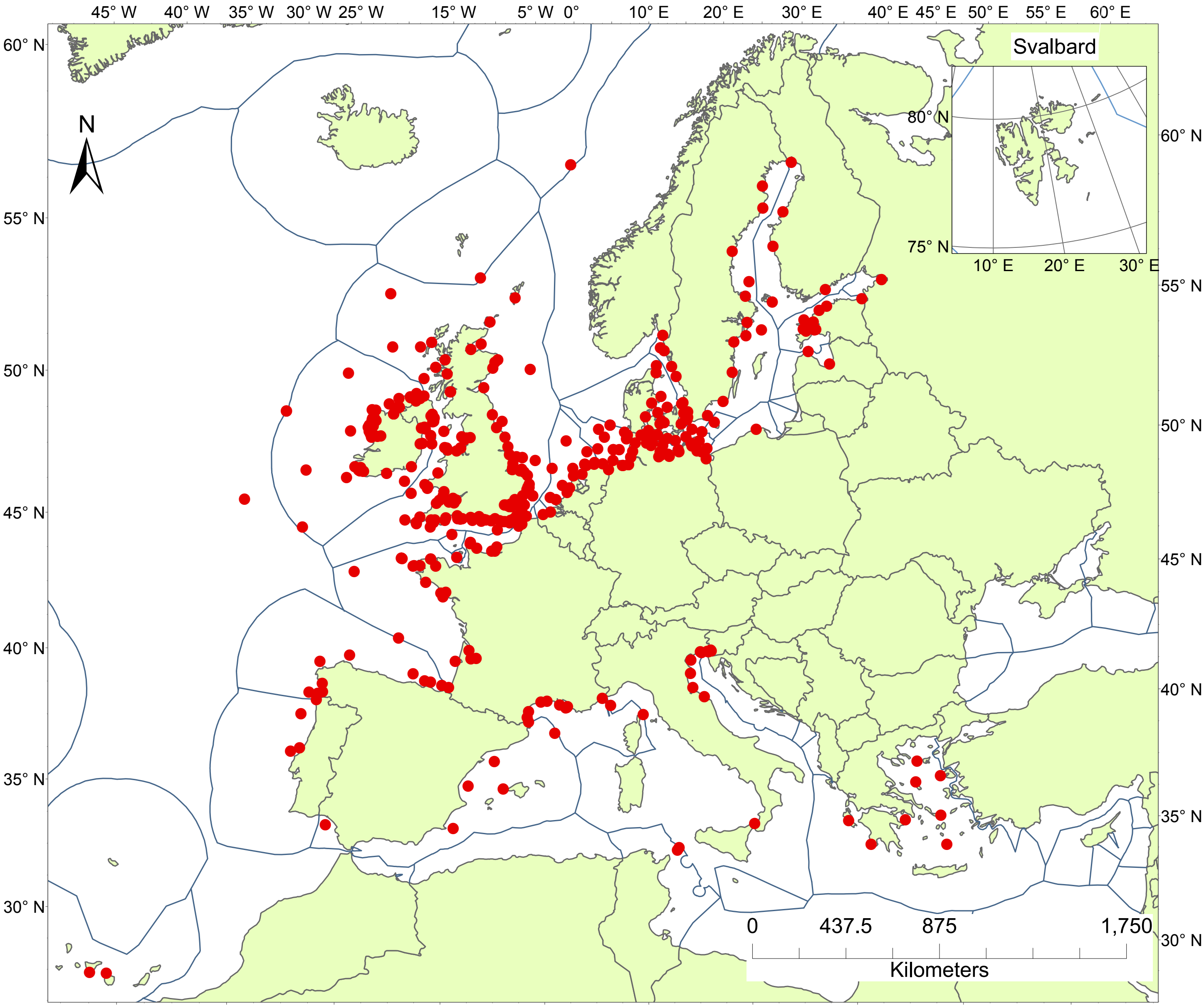
This map was produced as part of JERICO WP3, using metadata from the JERICO WP3 fixed platforms database.

Jerico Fixed Platforms
Sea pressure



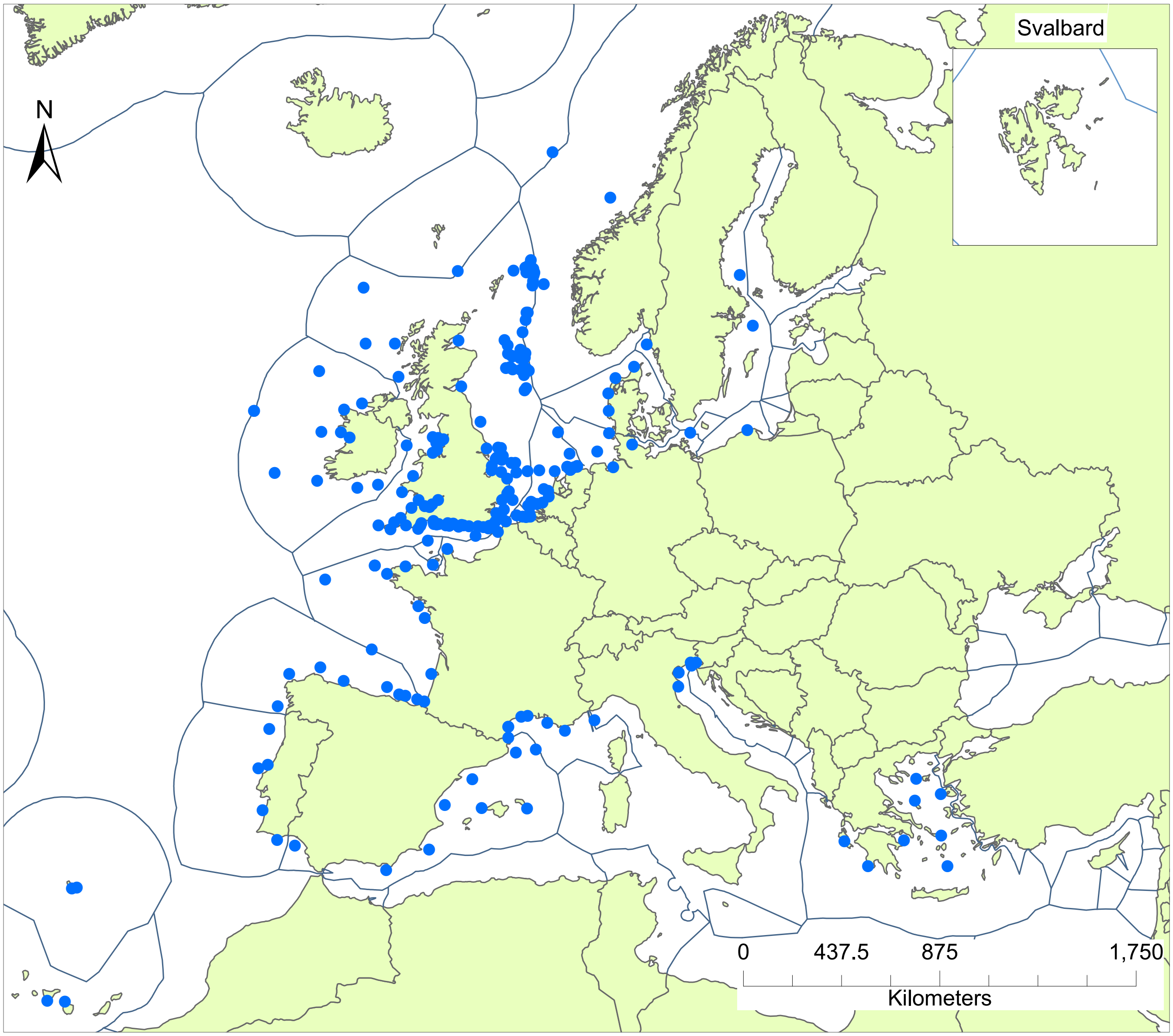
This map was produced as part of JERICO WP3, using metadata from the JERICO WP3 fixed platforms database.

Jerico Fixed Platforms
Sea temperature



This map was produced as part of JERICO WP3, using metadata from the JERICO WP3 fixed platforms database.

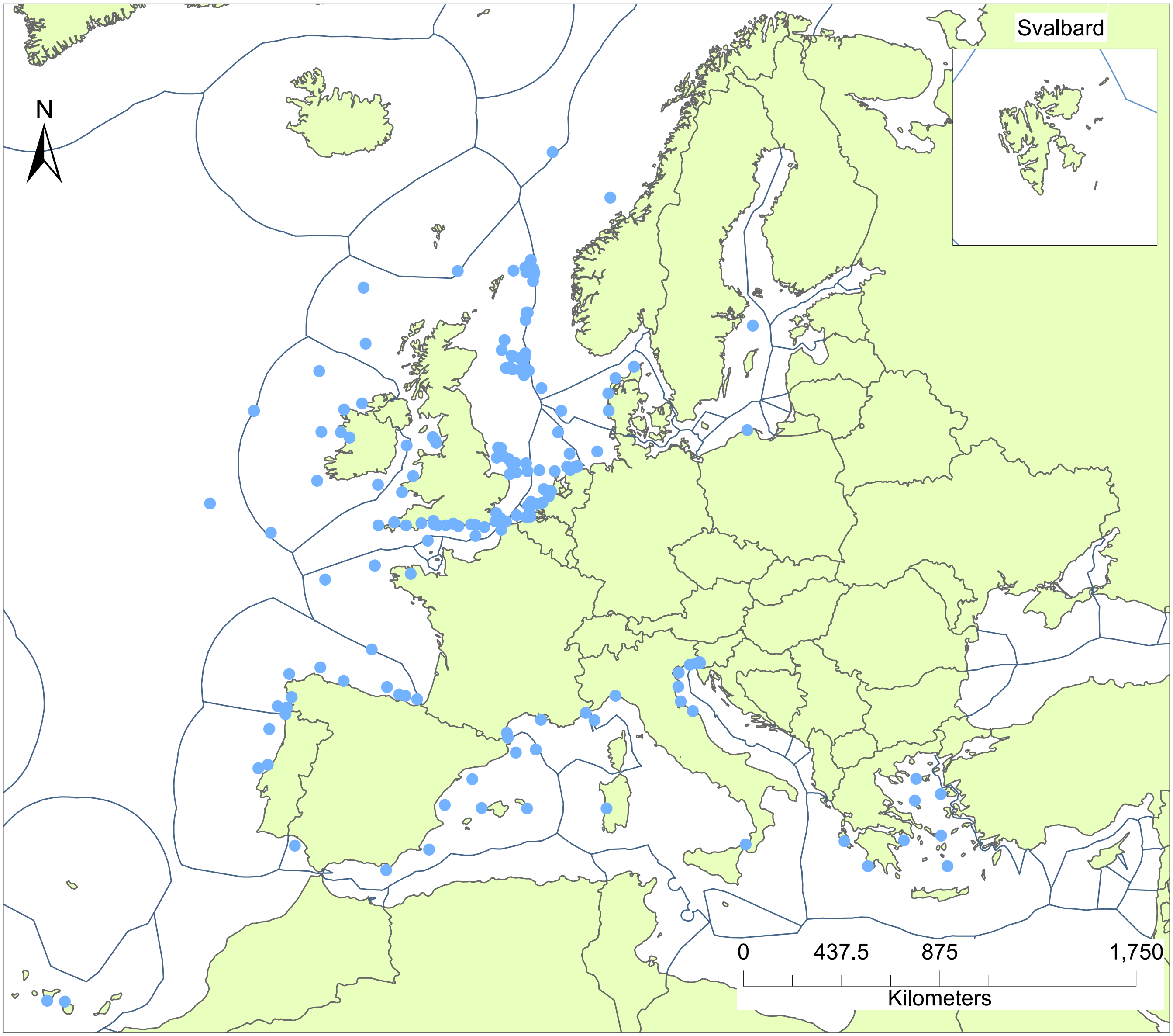
Jerico Fixed Platforms Waves



This map was produced as part of JERICO WP3, using metadata from the JERICO WP3 fixed platforms database.

Cefas 2013

Jerico Fixed Platforms
Wind



This map was produced as part of JERICO WP3, using metadata from the JERICO WP3 fixed platforms database.