Marine Microbial Biodiversity, Bioinformatics & Biotechnology

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Acronym: Micro B3

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Deliverable3.4 updated (D3.44)

Selection and definition of geographical pilot areas for Micro B3 cases

Version: 2.0

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Summary

The Micro B3 project aims for a better understanding of the complexity of marine microbial communities and their role in climate change. This requires that the data sets and information on marine organisms and genes are complemented with their environmental context. WP5 is charged with building the Micro B3 Information System (MB3-IS) to provide the bioinformatics capacity for marine biodiversity data processing, analysis and biotechnological exploitation. The MB3-IS analyses are intended to be based on a number of Case Studies (scientific questions we wish to answer using the Micro B3 data integration pipeline) representative of current activities related to exploration of marine microbial ecosystems (and which have specific needs in terms of bioinformatics developments). This requires data input from both the genomic data infrastructure (EMBL-EBI) and the ocean environmental data infrastructure. Oceanographic and marine environmental data will be provided to Micro B3 through the overarching infrastructures, SeaDataNet and EurOBIS, that also are well involved in the EMODNet development. These oversee and give access to extensive volumes and types of data sets from existing ocean and marine data collection activities from multiple sources. Moreover data will be collected in the framework of Micro B3 via the **Ocean Sampling Day** (**OSD**) and derived from the **Tara Oceans** expedition and **Malaspina cruise**. These data will enable to test the bioinformatic and environmental MB3-IS in practice. The portal and the services which will gather and deliver environmental data in the MB3-IS structure (i.e the interfacing between SeaDataNet-EMODNet CDI service and the MB3-IS) are planned to be shown to work for specific geographical sites. This Deliverable defines those locations, which were selected as Micro B3 genomic and oceanographic data matching areas relevant for the Micro B3 Use Cases. The first version of this Deliverable was released in February 2013. Thereafter further requirements have come forward which have resulted in an expansion of the list of defined geographic sites in this updated version.

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Context of the deliverable

One of the major challenges in Micro B3 is to organize cooperation and interoperability between the oceanographic research community and the genomics research community.

Particularly, WP3 aims at establishing interoperability between the Micro B3 Information System and the Oceanographic Environmental data management systems (see the Deliverable 3.1 for further details).

As a model, relevant services from the environmental data infrastructures will be bundled via a portal, from which the bioinformatics analysis system will be able to harvest data and information in an automated way. The dedicated portal and service will be demonstrated for gathering and making available data sets and data products for a number of geographical pilot areas suitable for the Micro B3 Use Cases.

Those specific sites are defined in the present deliverable and were determined together with WP2 and WP6.

Approach

The pilot locations were chosen to be of relevance for datasets resulting from research activities that are planned to take place in Micro B3, namely the samples analyses and studies from the Ocean Sampling Day-OSD- (WP2), from the long-term monitoring and study sites, and from the Tara Oceans and Malaspina past cruises (WP6).

The data coverages of these data sources and of the oceanographic environmental data management systems (SeaDataNet-EMODNet, including ICES and PANGAEA, and EurOBIS) were crossed to select the most suitable sites for the portal and services working demonstration in the Micro B3 Use Cases context.

The actual gathering and delivery of data sets through the oceanographic services for Micro B3 cases will be reported in the Deliverable 3.6 (expected June 2015).

The Micro B3 Use Cases

WP4 will deliver standards for data acquisition and handling that will support interoperability between ocean sampling processes and effective sharing of marine microbial data derived from the sampling. Those concepts development will be fed into by several streams of information, of which the prototype Use Cases are relevant for this Deliverable. The Micro B3 Use Cases are scientific questions/hypotheses in biological or environmental sciences that will be asked of the sampled marine microbial systems. Four biological and two environmental prototype Use Cases were identified by WP4 and the assistance of the Micro B3 Consortium partners. The biological Use Cases focus on diatom biology and the environmental Use Cases on the marine prokaryotic biodiversity (see the Deliverable 4.1 and The Use Case Document for further details and a summary of the prototype Use Cases).

The Use Cases were transformed into a set of scientific and legal parameters -called collectively the Micro B3 Candidate Checklist- that are needed to answer the questions postulated in the Use Cases.

Overview of Micro B3 sampling sites provided by participants

Appropriate samples are crucial for the research activities to be conducted in Micro B3. The following samples providers will bring a rich set of sequence and environmental data, on both temporal and spatial scales, for in depth bioinformatics analysis in the Use Cases context.

Ocean Sampling Day

The Ocean Sampling Day (OSD) is a massive sampling event that took place (for the first time) on summer solstice (June 21st) in the year 2014. This project provides insights into fundamental rules describing microbial diversity and function. Indeed, these cumulative samples, related in time, space and environmental parameters, contribute to determine a baseline of marine biodiversity and functions on the molecular level. In preparation of OSD, WP2 -which coordinates this project- has organized sampling at each solstice from June 2012 until the main event in 2014. Best practices (uniform sampling protocols) and a list of suitable sampling sites have been produced in order to ensure maximum usefulness of the samples and chances of success. All of the information in the sampling sites registry and any sequence data generated from the OSD samples will be put into the public domain. This will be through the Micro B3 Catalogue and the Micro B3 Information System (WP5).

The OSD project is also engaging the public through the „OSD Citizen Science campaign“ (MyOSD). By collecting important environmental data like latitude, longitude, temperature, wind speed and others people will help the scientist to get a better understanding of the world’s oceans.

The full list of OSD and MyOSD sampling sites is presented in section 6.0 of this Deliverable.

Long term sampling sites

Temporal monitoring programmes include L4 (Plymouth), Blanes Bay (Barcelona), Naples, Heraklion, Iceland (MATIS) and Mediterranean deep-sea hypersaline anoxic lakes (DHALs) long term sampling sites. Those sites offer good conditions for plankton biology and ecology studies to which genomics studies can be related. They were regularly sampled for the past 10 (or even more) years and the resulting samples are available at the partners institutes. For details about the sites please refer to Annex 1 of the Micro B3 DoW.

Tara Oceans expedition (spatial monitoring)

The Tara Oceans project was launched in September 2009 for a 3-year study of the global ocean ecosystem aboard the ship Tara. A unique sampling programme encompassing optical and genomic methods to describe viruses, bacteria, archaea, protists and metazoans in their

physico-chemical environment has been implemented. The goal is to generate open access datasets to be used in probing the morphological and molecular makeup, diversity, evolution, ecology and global impacts of plankton on the Earth system. The sampling strategy, sample/data analysis and data management have been carefully tailored and integrated toward this overarching goal.

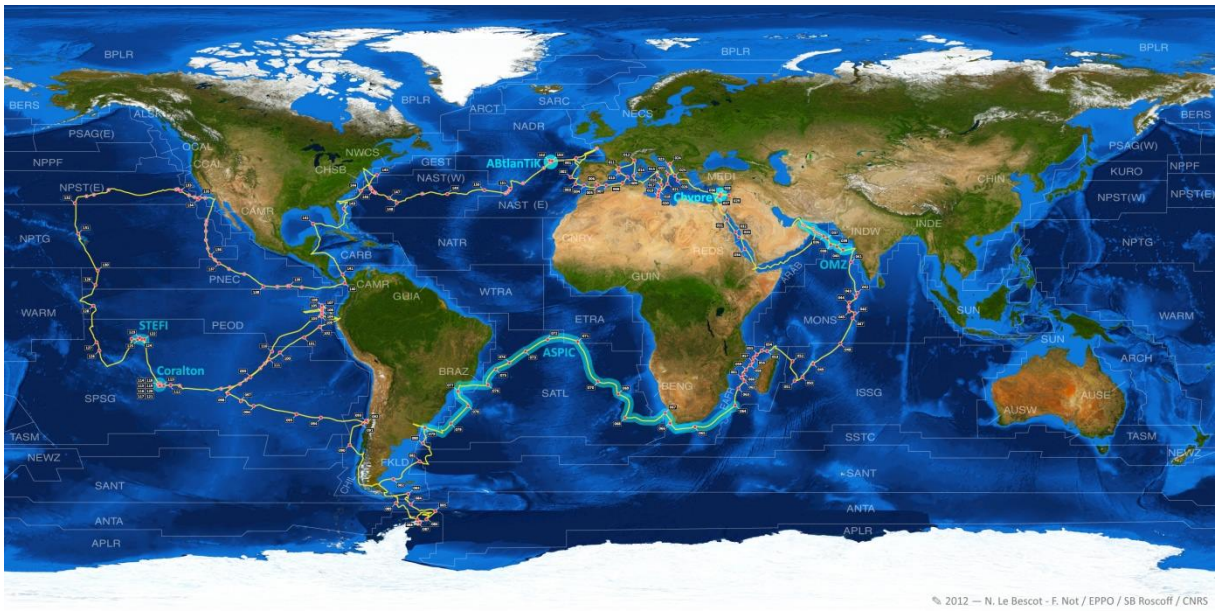

Figure 1: TaraOceans cruise track indicating the sampling stations (154 in total) and highlighting the topical experiments (light blue) carried out during the expedition. A representative of Longhurst's biogeographical provinces has been represented as a background (map credits to Noan Le bescot & Fabrice Not/EPPO/SB Roscoff/CNRS).

The different groups of organisms targeted by Tara Oceans were separated based on their size, using various meshes on the sampling instruments or on filtration units onboard (Figure 2). Tara Oceans has given a particular focus on planktonic protists, including samples for total DNA and RNA, various ways of preserving the communities for laboratory morphological or morpho-genetic analyses (HTM, SEM, TEM, OM, FISH, SAGs), and onboard high-throughput automated imaging (FlowCam, FlowCytometry). Importantly, data and samples were collected from 4 independent size-fractions covering the entire range of protistan biodiversity.

Details of the sampling procedures and sample treatments onboard will be published in a Methods paper (Not *et al.*, in prep).

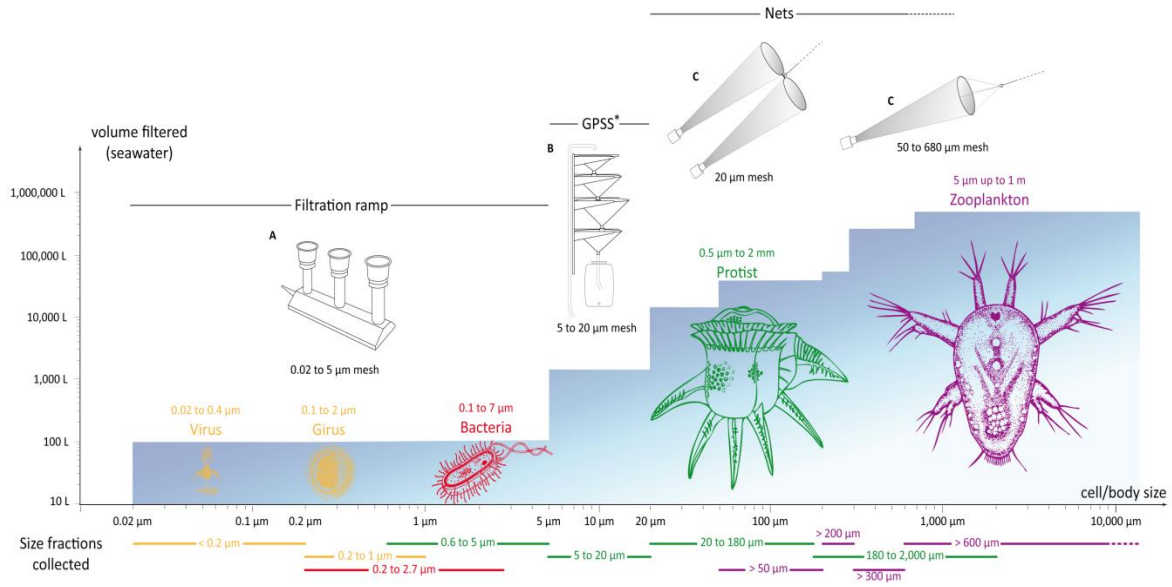

Figure 2: A partial summary of sampling instruments and targeted organisms (Karsenti *et al.* 2011).

Environmental conditions at each sampling location were determined onboard using sensors deployed on the meteorology station (i.e. continuous time series), rosette system (i.e. vertical profiles from 0-1000 m), large volume pumping system (i.e. time series at discrete sampling depths), underway system (i.e. continuous time series at 5 m), and occasionally on surface drifters and gliders. Additionally, the oceanographic context at each station is characterized using remote sensing products such as ocean colour, SST and SSH to determine meso- to large-scale features and variability in key parameters such as surface temperature, salinity, chlorophyll a, currents and mixed layer depth.

Sampling Strategy

Each station was planned a few days or a week in advance by a team of physical and biological oceanographers, together with the chief scientist on board. This short term planning was chosen to take advantage of the latest oceanographic information available based on processed and analyzed satellite data (Chl, SST and altimetry). Near real-time updates of the satellite images were sent to the chief scientist on board. Furthermore, continuous surface measurements (Temperature, Salinity, Fluorescence) were used to fine tune the sampling locations across fronts or filaments for example. When needed, a preliminary CTD transect was performed to characterize station at meso-scale. Finally, on board analysis of sensor readings from the rosette (e.g. CTD, Oxygen, Nutrients, UVP) was used to identify and target features of special interest in water column, such as DCMs, Oxygen Minimum layers, mesopelagic features, etc. In addition to the general sampling strategy outlined above, some topical studies addressed specific scientific questions and required additional sampling approaches and instruments (i. e. state of the art oceanographic instruments such as gliders, biogeochemical autonomous floats, ARGO floats

with drogues and LADCPs) were deployed to improve the success of the survey of the oceanographic feature.

This study of the world oceans microorganisms biodiversity combined classical analysis methods and genomics and is then particularly relevant for the Micro B3 project.

The environmental data and the registry of samples collected during the Tara Oceans expedition are archived and managed centrally at PANGAEA. As the data management for the Tara Oceans cruise has been supported by the Micro B3 project (see Deliverable 3.2 and D3.7), oceanographic services from PANGAEA have been connected to the overarching oceanographic data infrastructures in Micro B3 (SeaDataNet, EurOBIS). For the Tara Oceans expedition, the PANGAEA samples registry will be the key to link samples, data archived in a distributed network of databases and metadata about sampling and analysis methodology.

Malaspina expedition (spatial monitoring)

Like the Tara expedition, the Malaspina expedition (2010-2011) produced worldwide samples from marine microbial ecosystems, explored on both temporal and spatial scales. Those biological and (meta)genomic samples, correlated with their oceanographic environmental context, will be exploited in Micro B3 to develop an understanding of the ecosystems biology by relating biodiversity with the functional structure of the ecosystem.

The Malaspina global expedition cruise started on Dec 14th 2010, and was completed on July 15th, 2011. The cruise was divided into 7 legs (Cádiz-Rio de Janeiro, Río-Cape Town, Cape Town-Perth, Perth-Sidney, Auckland-Honolulu, Honolulu-Cartagena de Indias, and Cartagena de Indias-Cartagena), crossing the North Atlantic (Legs 1 and 7), the South Atlantic (Leg 2), the South Indian Ocean (Leg 3), and the South (leg 5) and North Pacific (leg 6). The cruise also sampled Southern ocean waters, south of Australia (Leg 4).

The cruise research activities were divided into several blocks, among them the "Microbial activity and diversity" block is relevant for Micro B3.

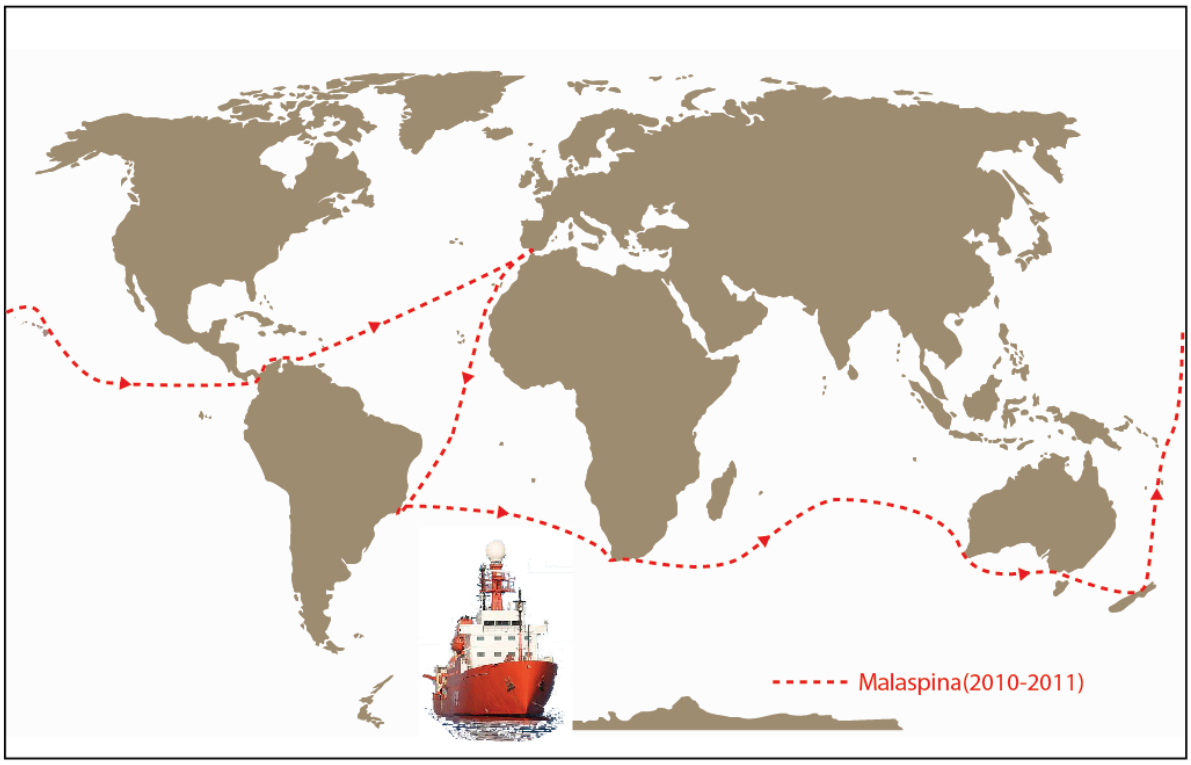

Figure 3: Malaspina cruise track.

Sampling was structured with 1 station a day, with 2-3 CTDs. The stations were classified as "Full profile" or as "Dedicated". The "Dedicated" stations were divided into three types:

- stations dedicated to MICROBIOLOGISTS (metagenomes, metatranscriptomes, metaproteomes),
- stations dedicated to BIOGEOCHEMISTRY (Organic matter fingerprinting),
- stations dedicated to both.

The following is a list of all the variables analyzed by the Microbial Block (not all were taken from all samples):

- Bacterial and picoalgal abundance (by flow cytometry)
- Bacterial physiological status (NADS, CTC)
- Bacterial size (sequential filtration and flow cytometry)
- Virus abundances (flow cytometry)
- Viral morphological diversity (Transmission electron microscopy)
- Protist abundances (flow cytometry)
- Protist abundances (DAPI-epifluorescence)

- Deep Bacterial Respiration (O2 consumption)
- Bacterial activity/production (surface: leucine incorporation)
- Bacterial/Archaeal activity/production (deep samples: leucine
- incorporation and use of archaeal inhibitors)
- DNA sampling with 0.22 µm, 0.8 µm and 3 µm filter sizes
- RNA sampling with 0.22 µm, 0.8 µm and 3 µm filter sizes
- Viruses sampling by precipitation of 0.22 µm filtrate (Sullivan's method)
- Bromo-diuridine-incubated samples. Collection of DNA for BUMP-analyses
- Metaproteome samples
- Samples for SAGs (Single-cell amplified genomes)
- Exoenzymatic activities
- ECO-Biologs for bacterial metabolic diversity profiles
- Transparent exopolymeric particles (TEPS)
- FISH samples for prokaryotes
- FISH samples for eukaryotes
- Samples for Bacteriochlorophyll a determination
- Samples for AAP determination (special filters + DAPI)

Additionally, several sets of experiments were performed at selected stations. These were:

- Grazing by protists
- Viral mortality
- TEP formation and degradation
- Size distribution of organisms and particles
- Inorganic C incorporation by prokaryotes
- 14CO2 and 3H-leucine incorporation by archaea and bacteria
- Nutrient limitation experiments
- Heterotrophic light-use experiments

Concerning Malaspina data, they are firstly stored in Malaspina Digital, a dedicated site (www://metamalaspina.imedea.uib-csic.es/geonetwork/srv/es/main.home). Then they will be sent either to PANGAEA or to the IEO Spanish Data Center (decision to be taken in spring 2013) and will that way become available in the Micro B3 project context.

Environmental data management systems data coverage

For a detailed description of each data management system cited here under, see Deliverable 3.1.

SeaDataNet-EMODNet

SeaDataNet has developed an efficient distributed Marine Data Management Infrastructure for the management of large and diverse sets of data deriving from in situ and remote observation of the seas and oceans. Professional data centres, active in data collection, constitute a Pan-European network providing on-line integrated databases of standardized quality. SeaDataNet infrastructure and standards were adopted as basis for the implementation of the EMODNet project. This system will ensure interoperability and harmonization between the six EMODNet lots (hydrography, chemistry, physics, biology, geology, habitats).

In Micro B3, SeaDataNet will be a major source of ocean and marine environmental data to complement datasets and information on organisms and genes.

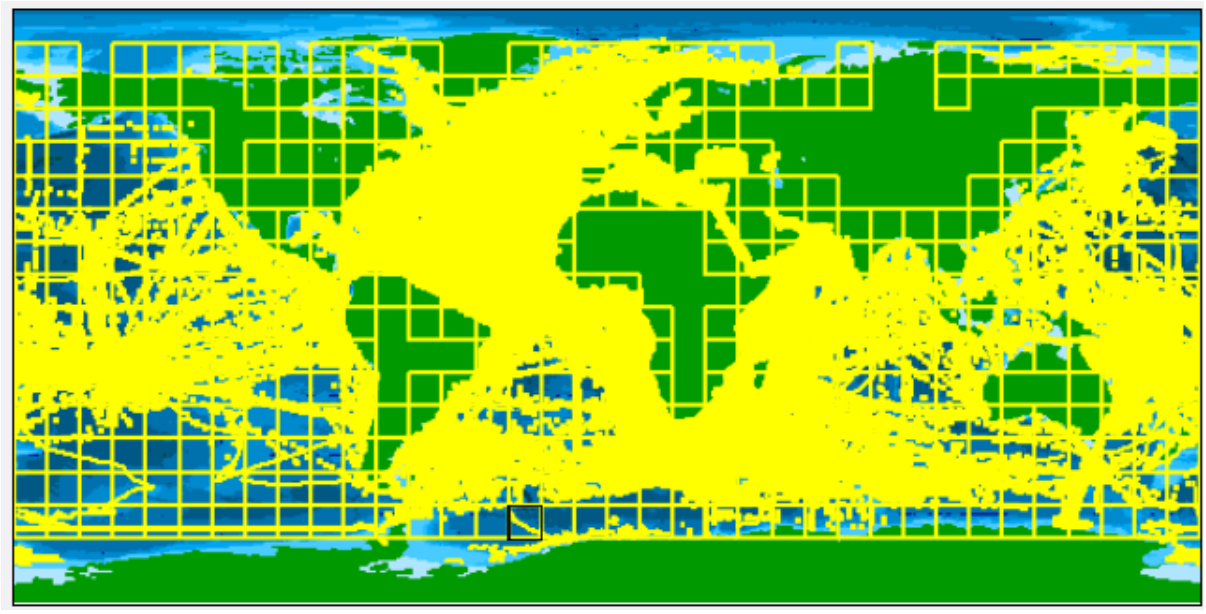

Figure 4: SeaDataNet data coverage (points, tracks and areas) for the timescale 1950-2012.

EurOBIS and the WoRMS

EurOBIS acts as the European node of OBIS. It is a distributed information system giving access to biogeographic data on marine species collected by European institutions. EurOBIS refers to the WoRMS (the World Register of Marine Species) taxonomy, which will also be the standard for Micro B3 species data.

EurOBIS will provide the biodiversity information corresponding to Micro B3 specific data.

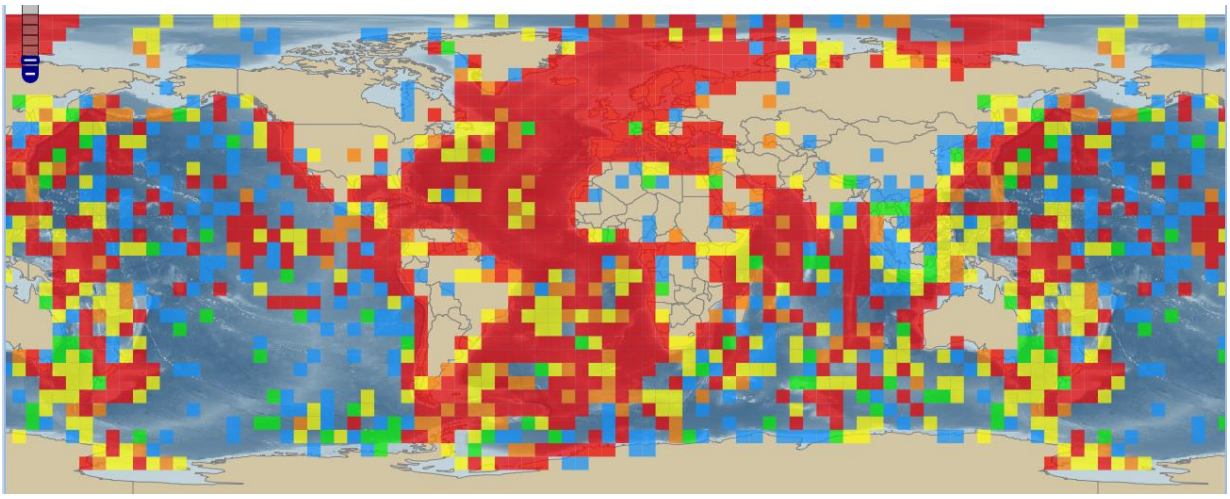

Figure 5: EurOBIS data coverage (years between 1748 and 2009) – extract from OBIS.

ICES

ICES manages marine environmental data covering NE Atlantic, Baltic Sea, Greenland Sea and Norwegian Sea and spanning the years 1877-2012. Those data are organized around specific thematic data portals: oceanographic, contaminants, biological effects and biological community, fish trawl survey, fish predation and historical plankton data.

This paper analyses ICES data coverage separately from the other marine environmental information systems ones. ICES is however expected to be connected to SeaDataNet in a near future and would provide environmental context data to Micro B3 through the SeaDataNet services. ICES biogeographic data are and will be made available through EurOBIS.

The following Figures 6, 7, 8, 9 are the station maps of data in the ICES oceanographic databases (http://ocean.ices.dk/data/maps/maps.htm):

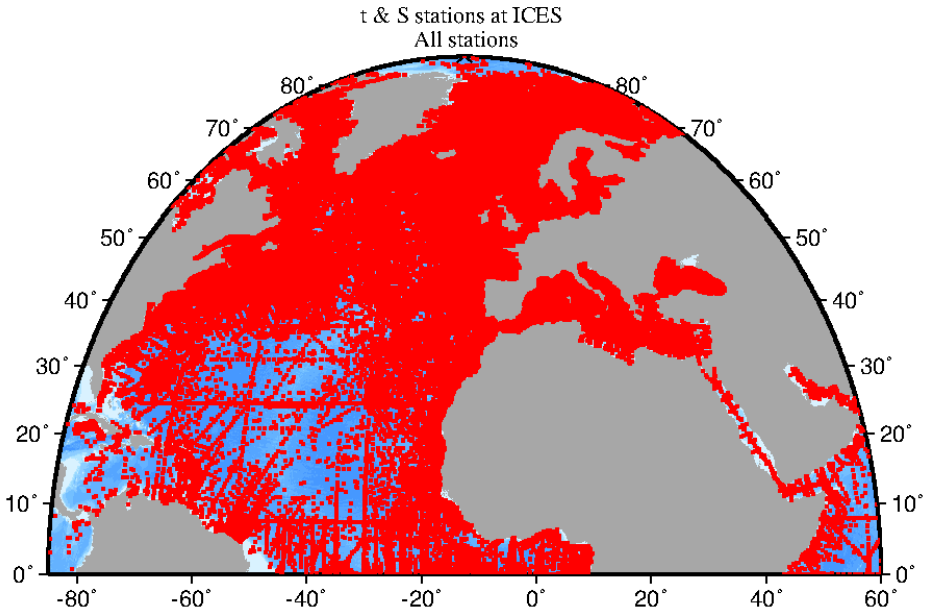

Figure 6: T & S stations at ICES, All stations (http://ocean.ices.dk/data/maps/All_ts.png).

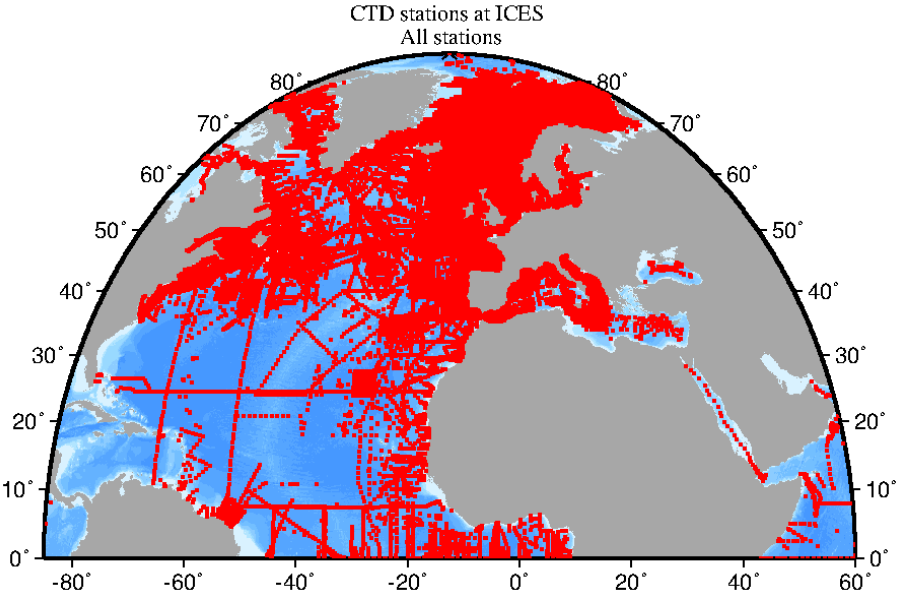

Figure 7: Nutrient stations at ICES, All stations

(http://ocean.ices.dk/data/maps/All_Nut.png).

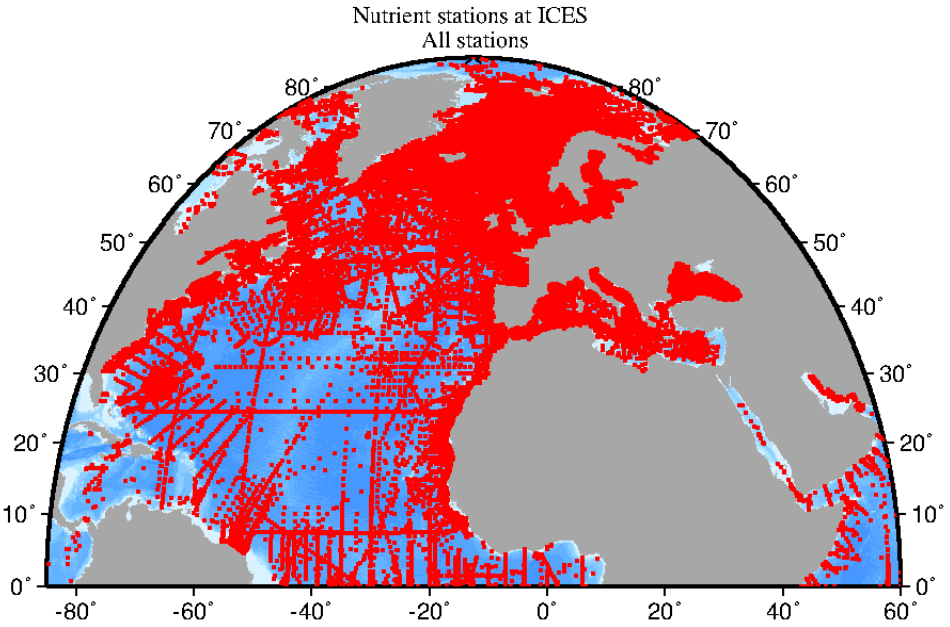

Figure 8: CTD stations at ICES, All stations (http://ocean.ices.dk/data/maps/All_CTD.png).

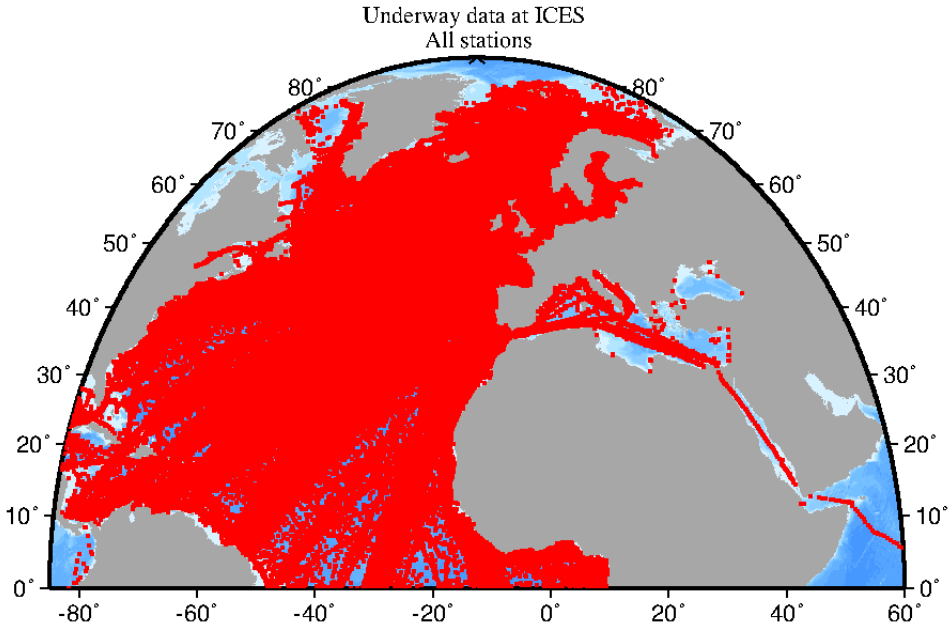

Figure 9: Underway data at ICES, All stations (http://ocean.ices.dk/data/maps/All_UW.png).

PANGAEA

PANGAEA manages and can provide to the Micro B3 project environmental and biological data, including an extensive range of parameters describing the life history and vital rates of marine plankton (viruses, bacteria, autotrophic and heterotrophic protists, crustaceans and jellyfish) and microbenthos from contemporary to paleobiogeographic records.

Furthermore PANGAEA will be the receptacle for the Tara Oceans metadata and data and will allow to make them available to the Micro B3 data management system.

As it is the case for ICES, PANGAEA has been connected to the SeaDataNet infrastructure for giving overview and access to its data sets via the SeaDataNet CDI Data Discovery and Access service. Furthermore, PANGAEA biogeographic data are being made available through EurOBIS.

Selection of pilot geographical and temporal sites/areas

Pilot „temporal“ locations: OSD sites

It was decided to consider all the unique stations sampled during the first OSD event (on June 21st, 2014) because they are all significant and relevant for the MicroB3 Use Cases.

Name	Start Latitude	Start Longitude	Stop Latitude	Stop Longitude	Description
C1	45.70092	13.71003	45.70092	13.71003	Adriatic Sea
CONISMA	43.570	13.595	43.570	13.595	Adriatic Sea
Croatia	45.08	13.61	45.08	13.61	Adriatic Sea
Foglia	43.9475	12.935	43.9475	12.935	Adriatic Sea
Lido	45.4142	12.4378	45.4142	12.4378	Adriatic Sea
Marghera	45.4568	12.2605	45.4568	12.2605	Adriatic Sea
Metauro	43.8514	13.0731	43.8514	13.0731	Adriatic Sea
Venice Acqua Alta	45.314350	12.508317	45.314350	12.508317	Adriatic Sea
Venice Gulf	45.4125	12.5265	45.4125	12.5265	Adriatic Sea
Venice Lagoon	45.502	12.4176	45.502	12.4176	Adriatic Sea
Vida	45.325568	13.33189	45.325568	13.33189	Adriatic Sea
Villefranche - SOMLIT	43.6861111	7.31567	43.6861111	7.31567	Adriatic Sea
Crete	35.661	24.99	35.661	24.99	Aegean Sea
Crete - GOS	35.35	25.29	35.35	25.29	Aegean Sea
IMST_izmir	38.41333	27.03421	38.41333	27.03421	Aegean Sea
Marchica	35.1927	-2.88005	35.1927	-2.88005	Alboran Sea
Saidia Marina/Rocher	35.086353	-2.214658	35.086353	-2.214658	Alboran Sea
Blanes	41.6666	2.8	41.6666	2.8	Balearic Sea
Belize	16.802575	88.08165	16.802575	88.08165	Bay of Bengal
Rajarata	8.5216	81.0521	8.5216	81.0521	Bay of Bengal
Arcachon-SOMLIT	44.66666	-1.16666	44.66666	-1.16666	Bay of Biscay
Pasaia	43.333333	-1.925	43.333333	-1.925	Bay of Biscay
Odessa	46.44155	30.77595	46.44155	30.77595	Black Sea
Varna Bay	43.175843	27.908643	43.175843	27.908643	Black Sea
Zlatna ribka	42.244907	27.400804	42.252939	27.415647	Black Sea
Bocas del Toro	9.3485	-82.2660	9.3485	-82.2660	Caribbean Sea
Brest-SOMLIT	48.359	-4.552	48.359	-4.552	Celtic Sea

Name	Start Latitude	Start Longitude	Stop Latitude	Stop Longitude	Description
Lough Hyne	51.7423	-8.3112	51.7423	-8.3112	Celtic Sea
North Stradbroke	-27.342	153.5622	-27.2000	153.3373	Coral Sea
Yongala	-19.3050	147.6220	-19.3050	147.6220	Coral Sea
L4	50.151	-4.13	50.151	-4.13	English Channel
Roscoff - SOMLIT	48.7778	-3.9375	48.7778	-3.9375	English Channel
Kangaroo Island	-35.8372	136.4413	-35.8372	136.4413	Great Australian Bight
Eyafjordur_1	66.00691	-18.19653	66.00659	-18.19753	Greenland Sea
Eyafjordur_2	66.00776	-18.19531	66.00696	-18.19041	Greenland Sea
Eyafjordur_3	65.4886	-18.06080	65.4877	-18.06032	Greenland Sea
Eyafjordur_4	65.817186	-18.101835	65.48868	-18.06080	Greenland Sea
Eyafjordur_5	66.1316	-18.7902	66.1316	-18.7902	Greenland Sea
Eyafjordur_6	65.7064	-18.1181	65.7064	-18.1181	Greenland Sea
Fram Strait	78.453333	-2.829667	78.453333	-2.829667	Greenland Sea
Young Sound	74.3100	-20.3043	74.3100	-20.3043	Greenland Sea
Station A Gulf Of Eilat	29.4667	34.9291	29.4667	34.9291	Gulf of Aqaba
TvÃ¤rminne	59.8822	23.2538	59.8822	23.2538	Gulf of Finland
Celestun	20.8841	-90.4967	20.8841	-90.4967	Gulf of Mexico
Dzilam	21.4934	-88.8468	21.4934	-88.8468	Gulf of Mexico
Horn Island	30.24840	-88.74825	30.24840	-88.74825	Gulf of Mexico
Progreso	21.3142	-89.6712	21.3621	-89.6602	Gulf of Mexico
Tampa Bay	27.61578	-82.72587	27.61578	-82.72587	Gulf of Mexico
Rottnest Island	-32.0000	115.4167	-32.0000	115.4167	Indian Ocean
Loch Ewe	57.8498	-5.6495	57.8498	-5.6495	Inner Seas off the West Coast of Scotland
Etoliko Lagoon	38.48435	21.31689	38.48435	21.31689	Ionian Sea
Manai Straits	53.225417	-4.159028	53.225417	-4.159028	Irish Sea and St. George's Channel
Osaka Bay	34.32444	135.12083	34.32444	135.12083	Japan Sea
Boknis Eck	54.8333	10	54.8333	10	Kattegat
Jyllinge Harbour	55.7449	12.0974	55.7449	12.0974	Kattegat
Alexandria	31.21667	29.96667	31.21667	29.96667	Mediterranean Sea - Eastern Basin

Name	Start Latitude	Start Longitude	Stop Latitude	Stop Longitude	Description
Famagusta	35	33	35	33	Mediterranean Sea - Eastern Basin
Kyrenia	35.363732	33.289649	35.362826	33.287118	Mediterranean Sea - Eastern Basin
Sdot YAM	32.0694	34.8430	32.0694	34.8430	Mediterranean Sea - Eastern Basin
Shikmona	32.822	32.954	32.822	32.954	Mediterranean Sea - Eastern Basin
Armintza	43.43255	2.89966	43.43287	2.90056	Mediterranean Sea - Western Basin
Banyuls	42.49	3.15	42.49	3.14	Mediterranean Sea - Western Basin
Marseille Solemio SOMLIT	43.22639	5.74583	43.22639	5.74583	Mediterranean Sea - Western Basin
Alcochete	38.757283	-8.966333	38.757283	-8.966333	North Atlantic Ocean
BerlengasWatch	34.41	-9.51	34.41	-9.51	North Atlantic Ocean
Casablanca	33.583917	-7.700639	33.583917	-7.700639	North Atlantic Ocean
CascaisWatch	38.6667	-9.4367	38.6667	-9.4367	North Atlantic Ocean
Cheasapeake Bay	38.6792	-76.1742	38.6792	-76.1742	North Atlantic Ocean
Compass Buoy Station - Bedford Basin	44.6936	-63.6403	44.6936	-63.6403	North Atlantic Ocean
Delaware	39.3322	-75.4699	39.3322	-75.4699	North Atlantic Ocean
Douro Estuary	41.1416	-8.6668	41.1416	-8.6668	North Atlantic Ocean
Eljadida	33.259611	-8.499222	33.259611	-8.499222	North Atlantic Ocean
Faial Azores	38.52970	-28.601778	38.52970	-28.601778	North Atlantic Ocean
Faro Island	36.997655	-7.973119	36.997655	-7.973119	North Atlantic Ocean
Faxafloi	64.208333	-22.015	64.208333	-22.015	North Atlantic Ocean
Figueira da Foz	40.145122	-8.869328	40.145122	-8.869328	North Atlantic Ocean
Florida	27.4694	-80.283366	27.4694	-80.283366	North Atlantic Ocean
Grayâ€™s Reef National Marine Sanctuary	31.383607	-80.866685	31.383607	-80.866685	North Atlantic Ocean
Lagoa de Ã“bidos	39.415067	-9.218828	39.415067	-9.218828	North Atlantic Ocean
Lima Estuary	41.6835	-8.8341	41.6835	-8.8341	North Atlantic Ocean
Lisboa	39.14039	-9.38011	39.14039	-9.38011	North Atlantic Ocean

Name	Start Latitude	Start Longitude	Stop Latitude	Stop Longitude	Description
Long Key	24.74490	-80.78375	24.74490	-80.78375	North Atlantic Ocean
Maine Booth Bay	43.8444	-69.6409	43.8444	-69.6409	North Atlantic Ocean
Maine Damariscotta River	43.8604	-69.5781	43.8604	-69.5781	North Atlantic Ocean
Marina do Funchal	32.64605	-16.910158	32.64605	-16.910158	North Atlantic Ocean
Oualidiya	32.74675	-9.036667	32.74675	-9.036667	North Atlantic Ocean
PICO	34.7181	-76.6707	34.7181	-76.6707	North Atlantic Ocean
Port Everglades	26.10293	-80.09315	26.10293	-80.09315	North Atlantic Ocean
Porto da Cruz	32.7747	-16.828664	32.7747	-16.828664	North Atlantic Ocean
Quinta do Lorde	32.741808	-16.711281	32.741808	-16.711281	North Atlantic Ocean
REYKIS	65.9449	-22.4192	65.9449	-22.4192	North Atlantic Ocean
Ria de Aveiro_1	40.659875	-8.703761	40.659875	-8.703761	North Atlantic Ocean
Ria Formosa Lagoon	37.005053	-7.973119	37.005053	-7.973119	North Atlantic Ocean
RosÃ¡rio	38.676942	-9.012392	38.676942	-9.012392	North Atlantic Ocean
Santa Cruz	39.134347	-9.384778	39.134347	-9.384778	North Atlantic Ocean
Sao Jorge Azores	38.64	-28.13	38.64	-28.13	North Atlantic Ocean
Sao Miguel Azores I	37.4257	-25.3156	37.4257	-25.3156	North Atlantic Ocean
Sao Miguel Azores II	37.4328	-25.19	37.4328	-25.19	North Atlantic Ocean
SERC Rhode River Maryland	38.885507	-76.541600	38.885507	-76.541600	North Atlantic Ocean
Skidaway Institute of Oceanography	31.982820	-81.01667	31.982820	-81.01667	North Atlantic Ocean
South Carolina 2 - North Inlet	33.32306	-79.16763	33.32306	-79.16763	North Atlantic Ocean
Tavira Beach	37.167	-7.504	37.167	-7.504	North Atlantic Ocean
Vineyard Sound	41.524467	-70.672174	41.524467	-70.672174	North Atlantic Ocean
Hawaii Kakaako	21.28880	-156.86362	21.28880	-156.86362	North Pacific Ocean
Hawaii Oahu	21.28656	-157.84351	21.28656	-157.84351	North Pacific Ocean
Maunalua Bay O'ahu	21.26882	-157.72231	21.26882	-157.72231	North Pacific Ocean
SIO Pier	32.86698	-117.25725	32.86698	-117.25725	North Pacific Ocean
SPOTS	33.55	-118.4	33.55	-118.4	North Pacific Ocean
120	51.18575	2.701667	51.185917	2.702133	North Sea
130	51.269517	2.9047	51.2695	2.90465	North Sea

Name	Start Latitude	Start Longitude	Stop Latitude	Stop Longitude	Description
215	51.2777	2.6135	51.277933	2.613667	North Sea
230	51.307333	2.849333	51.307333	2.849333	North Sea
421	51.481583	2.451483	51.481583	2.451483	North Sea
435	51.580333	2.7897	51.580317	2.7897	North Sea
700	51.37485	3.218333	51.37485	3.218333	North Sea
710	51.441017	3.13995	51.441017	3.13995	North Sea
780	51.471567	3.059167	51.471583	3.0592	North Sea
Brightlingsea Creek, Essex	51.796139	1.012958	51.796139	1.012958	North Sea
Cullercoats Beach	55.03306	-1.43278	55.03306	-1.43278	North Sea
Helgoland	54.18194	7.9	54.18194	7.9	North Sea
North Sea - Blankenberge	51.361369	3.118856	51.361369	3.118856	North Sea
Raunefjorden	60.16121	5.11504	60.16121	5.11504	North Sea
Scapa	58.957	-2.9726	58.957	-2.9726	North Sea
Stonehaven	56.9631	-2.1031	56.9631	-2.1031	North Sea
UK Shelf - North Sea	51.1953	1.3405	51.1953	1.3405	North Sea
VLIZ	51.434733	2.810867	51.434733	2.810867	North Sea
W08	51.458433	2.350467	51.458433	2.350467	North Sea
W09	51.74835	2.698	51.74835	2.698	North Sea
W10	51.682917	2.4152	51.682717	2.414967	North Sea
Wadden Sea	53.580926	8.148636	53.580926	8.148636	North Sea
ZG02	51.334817	2.50215	51.334817	2.50215	North Sea
Cambridge Bay, Nunavut,	69.023323	-105.34339	69.023323	-105.34339	Northwestern Passages
Abu Hashish	27.02527	33.91255	27.02527	33.91253	Red Sea
Ras Disha	27.041533	33.907033	27.041533	33.9082	Red Sea
Singapore Indigo_V	1.2685	103.9168	1.2726	103.9206	Singapore Strait
ELLEIm2	59.6220	10.6282	59.6220	10.6282	Skaggerak
Hvaler Tisler Site	59.89961	10.71999	59.89961	10.71999	Skaggerak
Steilene Oslofjord	59.81618	10.59863	59.81618	10.59863	Skaggerak
Laguna Rocha Norte	-34.37	-54.16	-34.37	-54.16	South Atlantic Ocean
Laguna Rocha Sur	-34.6759	-54.2752	-34.6759	-54.2752	South Atlantic Ocean

Name	Start Latitude	Start Longitude	Stop Latitude	Stop Longitude	Description
Robben Island	-33.897069	18.386825	-33.93572	18.47147	South Atlantic Ocean
South Atlantic Microbial Observatory	-34.42	-54.16	-34.42	-54.16	South Atlantic Ocean
Leigh Marine Laboratory (NZ)	-36.292794	174.818567	-36.292794	174.818567	South Pacific Ocean
Moorea - Tiahura	-17.2894	-149.53985	-17.2894	-149.53985	South Pacific Ocean
Otago	-45.7442	170.7706	-45.7442	170.7706	South Pacific Ocean
Rothera	-67.344	-68.135	-67.344	-68.135	Southern Ocean
Tangier	35.82	-5.75	35.82	-5.75	Strait of Gibraltar
Maria Island	-42.5966	148.2333	-42.5966	148.2333	Tasman Sea
Port Hacking	-34.0833	151.2500	-34.0833	151.2500	Tasman Sea
Sequim Bay Park	48.04051	-123.0257	48.04051	-123.0257	The Coastal Waters of Southeast Alaska and British Columbia
Darwin	-12.3382	130.6952	-12.3382	130.6952	Timor Sea
Faro Lake	38.26861	15.63708	38.26861	15.63708	Tyrrhenian Sea
LTER-MC	40.8080	14.25	40.8080	14.25	Tyrrhenian Sea
Charleston Harbor	32.75240	-79.89954	32.75240	-79.89954	
Guaymas Bay	27.9011	-110.8717	27.9011	-110.8717	
Lake Erie W4	41.839834	-83.18995	41.839834	-83.18995	
Scalloway	60.14333	-1.28250	60.14333	-1.28250	

Pilot „geographical“ locations

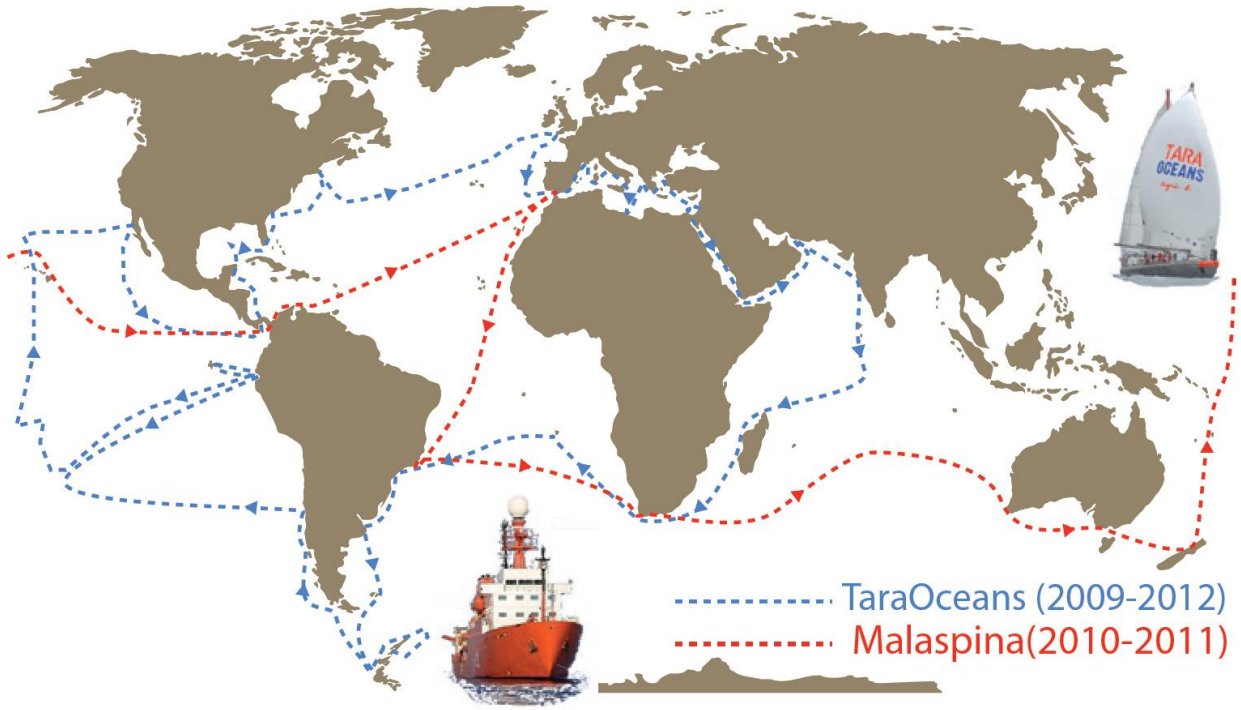

Figure 12: Overview of the Tara Oceans and Malaspina circumnavigation cruises.

When crossing data from the environmental data providers with Tara Oceans and Malaspina expeditions data (see Figures 4-9 and 12), four data „hot spots“ were revealed:

Name	Latitude N	Latitude S	Longitude W	Longitude E
Gibraltar	38	33	-13	-2
South Africa	-30	-40	10	30
Hawai	30	20	-170	-150
Atlantic NE	50	25	-40	-10

Those locations were confirmed by WP2 and WP6 to be of relevance for the MicroB3 Use Cases in light of the samples and variables analyzed through their participants work.

Reference list

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