D4.5 Operational METOC service
D4.10 Operational Ice Chart service

Project no.	636329
Project acronym:	EfficienSea2
	EFFICIENSEA2 – efficient, safe and sustainable traffic at sea
Funding scheme:	Innovation Action (IA)
Start date of project:	1 May 2015
End date of project:	30 April 2018
Duration:	36 months
Due date of deliverable:	25.04.2017
Actual submission date:	30.04.2017
Organisation in charge of deliverable:	Danish Meteorological Institute

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Document Status

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Document History

Version	Date	Initials	Description
1	30.04.2017	TAR	

Review

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1. The scope of deliverables D4.5 and D4.10

The scope of this document is to describe the two deliverables 4.5 and 4.10. Deliverable D4.5 covers information from ocean, sea ice, waves and atmospheric forecast up to ~5 days. Deliverable D4.10 aims at providing manual and automated interpretations of sea ice and ice berg conditions in near real time.

The aim is to provide all data according to standardized formats as described in for instance S-411, which is relevant for ice charts. If there are no available standard a typical data format has been chosen.

Both deliverables are important for improved situation awareness and defining go/no go zones and in relation to the IMO Polar Code that just recently entered into force. The Polar Code describes when a ship is allowed to enter ice infested waters.

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2. Data

This section will briefly describe the original data and their creation.

2.1. Forecast data

Forecast data are output from numerical models that describe the ocean, sea ice, waves and the atmosphere up to five days ahead in time. Short term forecast are initial value problems (days), thus the value at the beginning of the forecast is important for the quality of the entire forecast. Therefore observations from available resources are used to improve this. An example from a wave forecast in Arctic web is shown in Figure 1.

Figure 1 Wave forecast from Arctic web. The example is from the area between Greenland and Svalbard. Arrows indicate direction of waves and the color of the arrow indicates the magnitude.

The different forecast provides information in four dimensions (time, longitude, latitude and depth). This results in huge amounts of data (Gigabytes). This is not ideal for a user especially in Arctic where bandwidth is an issue.

2.2. Ice charts

Ice charts are manually interpreted satellite images that are grouped to cover for instance the waters of Greenland. First step is to analyse the individual images from the area of interest. See example in

2 of a quick look from Qaanaq, which is located in the Northwestern part of Greenland

2 Quick look based on ice charters initial interpretation of a Sentinel-1 image. Example is from Qaanaq in the Northwestern part of Greenland.

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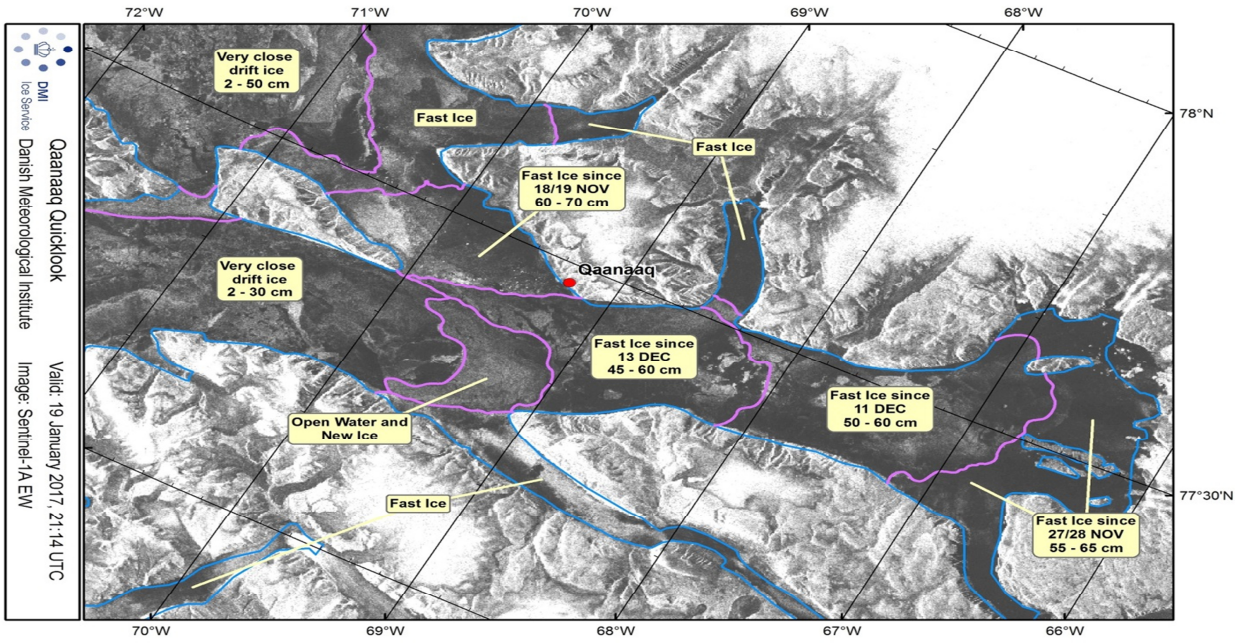

2 Quick look based on ice charters initial interpretation of a Sentinel-1 image. Example is from Qaanaq in the Northwestern part of Greenland.

Secondly the ice charter gathers information from the all images in the area of interest and creates a map of the ice conditions.

2.3. Icebergs

Iceberg detections are automatically retrieved from Sentinel 1 images by an algorithm (CFAR), which utilizes a statistical method to derive locations of icebergs. This method is limited in the sense that it do not detect the small icebergs (less than ~15m) and it may detect ships as ice bergs. An example of detections from Disco bay can be seen in Figure 3.

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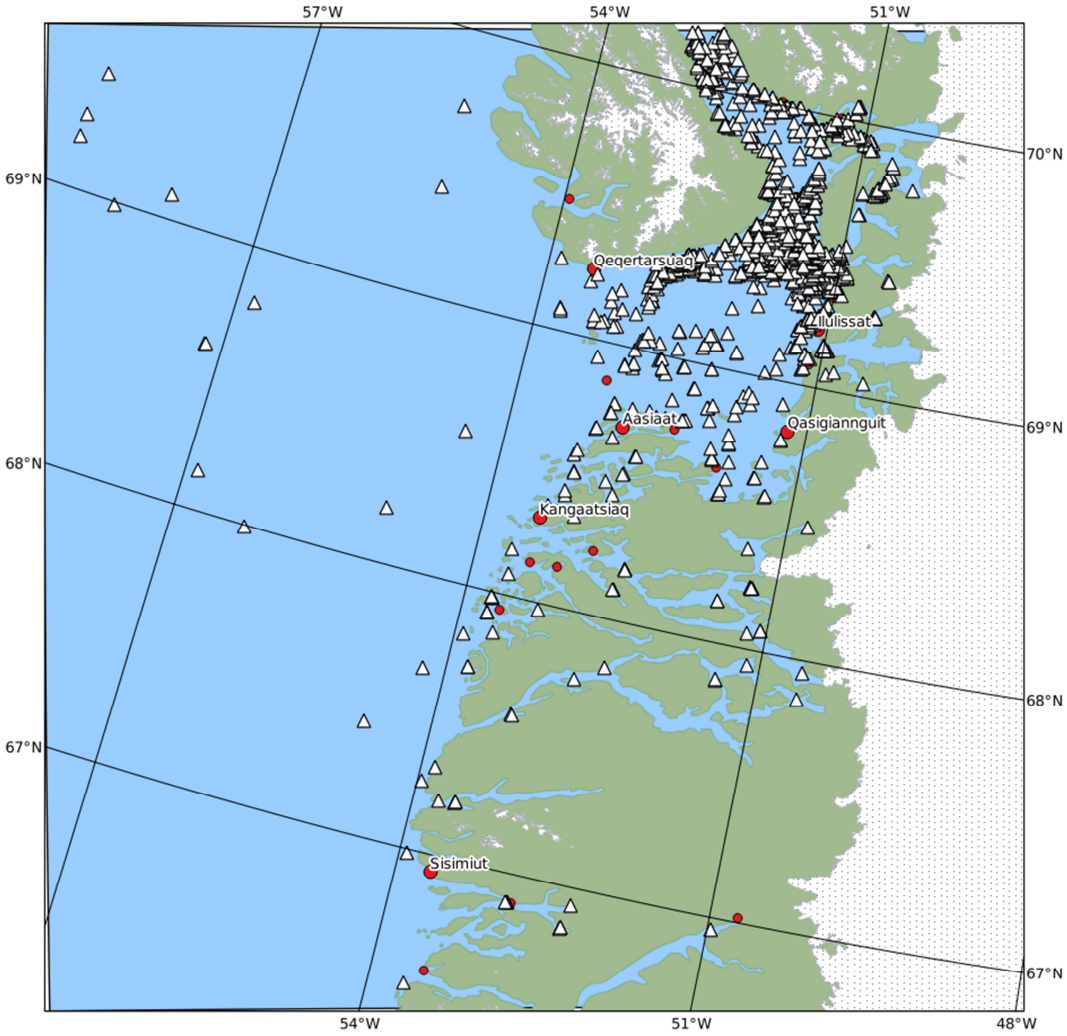

Figure 3 Iceberg detections are marked with white triangles. Example from the 10th of October 2016.

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3. Preface of services

The Danish Meteorological Institute derives the metocean and the ice information based on a combination of physical 3D models and retrieval of satellite images. The result is huge amounts of data which are not suitable for transfer to ships in its raw form. Therefore discussions have been ongoing on how to develop the service and how to reduce the amount of data that is required by the ship without losing necessary information. The main points of this are outlined in this section.

3.1 Users and expectations

There are different users of metocean data and they require different definitions and extraction of data. These can be seen in table 1.

Users	Requirements	Data
Ships offshore	Potential low bandwidth and expensive data transfers. Especially ships in high Arctic have limitations on bandwidth	Points along route as described in D4.5
On shore distributers of services. Transas, Furono, SSPA, RocketBrothers and others	Access to data. No limits of bandwidth. Extract subsets themselves.	Areas or full domains as described in D4.10.

Table 1 Users, requirements and service associated

These two types of users motivate creation of two services:

1. Low bandwidth users. These will be served by weather on route service.
2. Extraction of a polygon (rectangle) from the area or the full file. These are implemented for ice charts and ice bergs but they will be implemented for metocean data at a later stage.

3.2 Standards and data formats

Ice charts are described in S-411, see below link to JCOMM for further info on standard:
http://www.jcomm.info/index.php?option=com_oe&task=viewDocumentRecord&docID=14168

The standard requires the use of Geographical Markup Language (GML), which is implemented for the delivery. There are no standards available for forecast models and icebergs.

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4. Service provision

Two services are developed. These are the METOC_WeatherOnRoute and the METOC_Ice services that can be seen in the Arctic web and in BalticWeb:

- ArcticWeb: https://arcticweb-test.e-navigation.net/ (Login: oratank / 1qa2ws3ed)
- Balticweb, see: https://balticweb.e-navigation.net/ . Login for BalticWeb via Maritime Cloud ID registry in the category ProjectTestUsers: with user dmatest@dma.dk and password: safepassword.

4.1DMI service - METOC_WeatherOnRoute

The scope of this service is to provide weather along a route, which includes information from atmosphere, waves, sea ice and ocean. This is important information for planning and choosing routes and for improved situational awareness when executing voyages, for the following reasons:

- Potential go/no go areas based on severe weather or other obstacles that makes it impossible to go through certain areas.
- Fuel emissions. Currents, winds etc. can increase the resistance against ship movement, thus the choice of route can potentially depend on the weather along the route.

This service is named METOC_WeatherOnRoute

The weather on route service will meet deliverable D4.5, where the user defines time of interest, point of interest (lon, lat) and variables as defined in Appendix A and B. An example request can be found in Appendix C. The service is executed using a JSON object request file. Similar a JSON object is returned to standard-out.

4.2DMI services - METOC_Ice

This service fulfils deliverable D4.10 includes ice charts and icebergs. Ice charts are manually retrieved sea ice concentrations from satellite images that are mapped for the area of Baltic and Greenland. These follow the S-411 which is the S-100 standard for ice charts.

Icebergs are delivered as gridded files that cover the area of Greenland. In order to save space all variables within the Geotiff file will be saved as 8-bit integers. The service for ice charts and icebergs is named METOC_Ice.

The aim of this service is to enable users to extract the full area or a subsection of this. As a start this will be enabled for ice charts and ice bergs. With time this will be expanded with areas from forecast that are also utilized for the metocean service.

Data will be delivered according to table 2.

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ObjectData type	Format	Variable	Details
Ice charts	Geographcial Markup Language (GML)	Ice concentration	According to S-411.
Ice bergs	Geotiff. 8 bit integers.	Iceberg density hours since observation	Number of icebergs 0..249, 250+, 251-255 error messages. Delivered as 8 bits files. Projections: Proj4-streng: +proj=lcc +lat_1=66 +lat_2=76 +lat_0=55 +lon_0=-39 +x_0=1500000 +y_0=0 +datum=WGS84 +units=m +no_defs

Table 2 Data types for ice charts and ice bergs

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5 Future development

The services will continue to be developed within the project. Below is listed the foreseen updates within work package 4.

- In the near future (days) the implementation within the Maritime Cloud for both services will be tuned. This means that both can be seen within the Maritime Service registry
- A third service similar to the METOC_Ice service will be developed for the metocean data. This will enable the user to extract subdomains or full domains of the data sets for their own service development.
- Development of the quality of the services will be developed in work package 6. These will be implemented in the operational services that feed the services described in this document.

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Appendix A - METOC_WeatherOnRoute Parameter list

Group	Parameter	Long description	Unit
”Waypoints"	"eta"	Datestring ISO 8601	[yyyy-mm-ddTHH:MM:SS.sss+TZD] ; TZD:HHMM
	"heading"	"RL" / "GC" Rumb Line or Great Circle route	
	"lat"	Latitude	signed decimal degrees
	"lon"	Longitude	signed decimal degrees
”datatypes”	"sealevel"	"sealevel"	[m]
	"current"	"current-dir" "current-speed"	[0-360] [m/s]
	"wind"	"wind-dir" "wind-speed"	[0-360] [m/s]
	"wave"	"wave-dir" "wave-height" "wave-period"	[0-360] [m] [s]
	"density"	"ocean-density" (NOT implemented yet)	[kg/m**3]
	"temperature"	"ocean-temperature" (NOT implemented yet)	[degC]
	"salinity"	"ocean-salinity" (NOT implemented yet)	[-]
	"sea-ice"	"ice-dir" "ice-speed" "ice-concentration" "ice-thickness"	[0-360] [m/s] [0-1] [m]
	"airtemperature"	"air-temperature" (NOT implemented yet)	[degC]
"dt"		Time interval between waypoint(s). Large dt => Only values at waypoint times {integer value}	[minutes]
”mssi”		”Maritime Mobile Service Identity” – unique number-id for ships	integer

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Appendix B – METOC_WeatherOnRoute JSON schema

```
{
  "$schema": "http://json-schema.org/draft-04/schema#",
  "id": "http://ocean.dmi.dk/apps/SejlRute/ ",
  "description": "Extract DMI metocean forecast along a given route",
  "type": "object",
  "properties": {
    "mssi": {
      "type": "integer"
    },
    "dt": {
      "type": "integer"
    },
    "datatypes": {
      "type": "array",
      "items": { "type": "string" },
      "minItems": 1,
      "uniqueItems": false
    },
    "waypoints": {
      "type": "array",
      "items": {
        "type": "object",
        "properties": {
          "eta": { "type": "string" },
          "heading": { "type": "string" },
          "lat": { "type": "number" },
          "lon": { "type": "number" }
        }
      },
      "required": ["eta","heading","lat","lon"],
      "minItems": 1,
    }
  },
  "required": ["mssi","dt","datatypes","waypoints"]
}
```


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Appendix C – METOC_WeatherOnRoute JSON object request example


```
{ "mssi": 999999999,
  "datatypes":["sealevel","current","wave","wind"],
  "dt":15,
  "waypoints":[
    {
      "eta":"2017-04-28T20:00:00.000+0100",
      "heading":"RL",
      "lat":58.7,
      "lon":-12.0},
    {
      "eta":"2017-04-28T21:30:00.000+0100",
      "heading":"GC",
      "lat":59.0,
      "lon":-12.0},
    {
      "eta":"2017-04-28T22:15:00.000+0100",
      "heading":"RL",
      "lat":59.0,
      "lon":-12.5}
  ]
}
```


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Appendix D METOC_Ice service parameter list

Group	Parameter	Long description	Unit
”Area"	”lat_11_”	Latitude lower left corner	signed decimal degrees
	"lon_11"	Longitude lower left corner	signed decimal degrees
	"lat_22"	Latitude upper right corner	signed decimal degrees
	"lon_22"	Longitude upper right corner	signed decimal degrees
Datatypes	”icechart”	Ice concentration from ice chart	0..100
	Iceberg	Number of icebergs	8 bit Integer (0..255)

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Appendix E METOC_Ice JSON schema

```
{
  "$schema": "http://json-schema.org/draft-04/schema#",
  "id": "http://ocean.dmi.dk/apps/METOC_Ice/",
  "description": "Extract DMI iceberg or icecharts for a given square",
  "type": "object",
  "properties": {
    "datatypes": {
      "type": "array",
      "items": { "type": "string" },
      "minItems": 1,
      "uniqueItems": false
    },
    "area": {
      "type": "array",
      "items": {
        "type": "object",
        "properties": {
          "lat_11": { "type": "number" },
          "lon_11": { "type": "number" },
          "lat_22": { "type": "number" },
          "lon_22": { "type": "number" }
        }
      },
      "required": ["lat_11","lon_11","lat_22","lon_22"],
      "minItems": 1
    }
  },
  "required": ["mssi","datatypes","waypoints"]
}
```


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Appendix F – METOC_Ice JSON object request example


```
{ "mssi": 999999999,
  "datatypes":["icechart","iceberg"],
  "waypoints":[
    {
      "lat_11":  59.0,
      "lon_11": -50.0,
      "lat_22":  62.0,
      "lon_22": -40.0}
  ]
}
```


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