EO4OG Deliverable D1 – Offshore Geo-Information Requirements

Report
P-14-043-1133

Prepared for:
European Space Agency

Revision 1.1
September, 2014

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Prepared for:

European Space Agency

Prepared by:

C-CORE

C-CORE Proposal Number:

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Smart Solutions for Challenging Environments

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REVISION HISTORY

VERSION	SVN	NAME	COMPANY	DATE OF CHANGES	COMMENTS
1.0	n/a	Thomas Puestow	C-CORE	08/11/2014	Submitted to Client
1.1	n/a	Thomas Puestow	C-CORE	09/14/2014	Completion of Revised Version

DISTRIBUTION LIST

COMPANY	NAME	NUMBER OF COPIES
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1 INTRODUCTION

This document summarizes the geo-information requirements collected under Task 1 of the European Space Agency (ESA) and International Oil and Gas Producers Association (OGP) Earth Observation for Oil and Gas (EO4OG) initiative. Focusing on met-ocean and environmental information needs in support of offshore oil and gas activities, the following geographic areas of interest were considered:

- Myanmar
- Eastern Mediterranean
- West of Ireland
- Offshore Morocco
- South China Sea
- Falkland Islands

In collecting requirements, special attention was paid to the following life cycle stages of typical oil and gas developments:

- Pre-license acquisition
- Exploration
- Development
- Production
- Decommissioning

1.1 APPROACH

In collaboration with the other three EO4OG project consortia (CLS, Hatfield Consultants, and OTM), a template was designed to collect information requirements consisting of the following principal elements:

- Description of data/products currently being used
- Description of limitations and work-around solutions
- Importance of requirement in each life cycle stage
- Geographic context applicable to the requirement
- Principle activities impacted/concerned
- Urgency of technology solution
- Update frequency
- Temporal resolution
- Spatial resolution
- Data quality
- Data coverage and extent
- Data formats

- Timeliness
- Existing standards

The initial data gathering was completed based on existing knowledge and experience within the project team (C-CORE, StormGeo, Stantec, and Hatfield Consultants), together with a review of applicable literature and regulatory information. The initial requirements were subsequently revised based on feedback from the oil and gas industry during August 2014.

1.2 Preliminary Assessment of EO Capabilities

The identified geo-information requirements were subjected to a first analysis with the objective to identify candidate EO-based products and services. To this end, each requirement was assigned to one of the following categories:

- Category 1: mature EO-based services and products exist to address the parameter at least partially in a meaningful way within acceptable bounds of error
- Category 2: extracting the parameter of interest at least partially may be possible
- Category 3: EO is unlikely to contribute in a meaningful way to the parameter

A summary of geo-information requirements, applicable geographic regions and potential for EO-based extraction (Category 1 = green; Category 2 = yellow; Category 3 = red) is presented in Table 1.

Table 1: Offshore Geo-Information Requirements and EO

Challenge ID	Title	Region
OFF1.1	Historic records for winds	All
OFF1.2	Historic records for waves	All
OFF1.3	Historic records for surface currents	All
OFF1.4	Historic records for currents at depth	All
OFF1.5	Wind observations	All
OFF1.6	Wave observations	All
OFF1.7	Surface current observations	All
OFF1.8	Observations of current at depth	All
OFF1.9	Historical Tropical Storm/Tropical Cyclone probability and tracks	South China Sea, West of Ireland, Myanmar
OFF1.10	Tropical Storm/Tropical Cyclone Observations	South China Sea, West of Ireland, Myanmar
OFF1.11	Sea level	All
OFF1.12	Visibility	All
OFF1.13	Squalls	All
OFF1.14	Ice accretion	Eastern Med, Falklands, West of Ireland

Challenge ID	Title	Region
OFF1.15	Sea surface temperatures	All
OFF1.16	Funnel Clouds and Waterspouts	All
OFF1.17	Convective downbursts	All
OFF1.18	Lightning	All
OFF1.19	Hail	All
OFF2.1	Monitoring of landfall site recovery and coastal vegetation	West of Ireland
OFF2.2	Submarine landslides and seabed stability	West of Ireland, Eastern Med, Morocco/Western Sahara
OFF2.3	Shipwrecks and other archaeological value areas	West of Ireland, Eastern Med
OFF2.4	Detection and monitoring of pollutant discharges	All
OFF2.5	Distribution and abundance of marine mammals	West of Ireland, Falklands
OFF2.6	Distribution and abundance of seabirds	West of Ireland, Falklands, Morocco/Western Sahara
OFF2.7	Information on presence and abundance of deep water fauna	Eastern Med
OFF2.8	Scientific independence in environmental monitoring of pollution	Eastern Med
OFF2.9	Security and safety	Eastern Med
OFF2.10	Monitoring of chlorophyll-a	Falklands, South China Sea, Myanmar, Morocco/Western Sahara
OFF2.11	Monitoring of waste management practices	All
OFF2.12	Information on the intertidal and shallow marine environment	Falklands
OFF2.13	Coastal resource mapping of mangroves, coral reefs, wetlands, and sandbanks	South China Sea, Falklands, Myanmar
OFF2.14	Coastal sediment dynamics, estuarine fronts, and land–ocean interactions.	South China Sea
OFF2.15	Coastal upwelling	South China Sea, Morocco/Western Sahara
OFF2.16	Fish and fish habitat	All
OFF2.17	Commercial shipping	All
OFF2.18	Natural and other existing oil seeps	All
OFF2.19	Commercial and recreational fisheries	All

2 MET-OCEAN REQUIREMENTS

Challenge ID	OFF1.1
Title	**Historic records for winds**
Challenge originator: interviewed company	
General Description	
What data/products do you use?	Historical wind speeds are available in the form of surface-based observations, as reported from ships and buoys, via UCAR (ICOADS), and NOAA (NDBC and NCDC). ICOADS: http://rda.ucar.edu/datasets/ds540.0/ NDBC: http://www.ndbc.noaa.gov/ NCDC: http://www.ncdc.noaa.gov/oa/rsad/air-sea/seawinds.html Historical remotely-sensed satellite observations of 10m wind speeds are available via DEOS-RADS, as well as other agencies such as IFREMER (NAIAD). DEOS-RADS: http://rads.tudelft.nl/rads/rads.shtml IFREMER (NAIAD): http://naiad.ifremer.fr/ Historical hindcasts of reanalyzed 10m wind speeds are available via ECMWF (ERA-Interim) and NOAA (WAVEWATCH III). ERA-Interim: http://apps.ecmwf.int/datasets/data/interim_full_daily/ WaveWatch III: ftp://polar.ncep.noaa.gov/pub/history/waves/ Historical 0-hour global and/or regional model analyses of 10m wind speeds are available via many global agencies such as NOAA, ECMWF, CMC, JMA, UKMET, and others.
When do you use this kind of dataset?	Historical wind data are used to great extent by the O&G industry for all phases of the O&G cycle, except strictly operational tasks.

	The data set is used to assist in qualifying and quantifying the means and extremes of winds in the area of interest, but also to identify frequency of occurrence of wind speeds and weather window (where operational thresholds apply). During the early stages, field assessment/seismics etc. the data are mostly used to assess the operability of the area during different seasons and to assess financial risk and first draft of development costs. During planning of new fields and operations data are used to assess the climatic limitations local/regional weather would have on safety in order to reduce risk for operations, personnel and environment. Finally wind data are important to design of structures that can withstand the local conditions and take into account the risk of the extreme situations of the area.
What are your actual limitations and do you have a work around?	For more superficial analysis, first looks etc. an estimate is often sufficient and the quality of the data set is not as critical as for design studies. The latter requires long time series (for instance preferably more than 1/4 of the extreme calculated – i.e. 25 yrs for 100 year extreme) and high resolution in time and space in order to catch vigorous short-lived and small scale local phenomena. Data of sufficient quality can be hard to come by in coastal and remote/less developed areas and rougher modeled data/estimates/approximations will be used. Sometimes calibration of modeled data to shorter observed time series has to be made. **In addition:** *The heights of many historical wind speed observations that are available via ICOADS are unknown, although a portion of the observations include the height of the observation. Similarly, the averaging period of wind observations is a variable that must be reconciled across all record sets prior to effective analyses. *There are also important spatial and temporal limitations of historical surface-based and remotely-sensed 10m wind observations that make the analyses of extreme values very challenging (e.g., most extremes at sea were probably not observed or otherwise sampled). **Exemplified by the data sources in this study:** *Update frequency:*

	Too slow in some cases, some data sources do not extend to real time (1 month or more lag), and "patching" with any available observations is necessary. *Temporal resolution:* 3 and 6 hours is too infrequent and does not catch short-lived extremes, and approximations have to be made. *Spatial resolution:* *Too large outside well known areas (and large even there). Does not catch small scale and local (topography induced) phenomena. Should be 4 km minimum. **NOTE. High resolution and high update resolution does not equal quality, hence documentation of verification is equally important!!**
Needs and expectations on EO data	EO is used for this today, but resolution, update frequency, length of data series and quality is not sufficient for instance design studies. It is used as input in regional reanalysis and hindcast. Need: Long (10 years +) **observed** time series of high quality (ground truthed) and with high spatial resolution, especially for coastal areas and emerging O&G areas where demand for such data has been small or non-existent. Or - EO data that can improve modeled reanalyses. Example: Long time series of 10m wind speeds with 1-min, 10-min, 1-hour, and 3-second averaging periods).
Challenge classification	
Pre license	3
Exp.	3
Dev.	4
Prod.	4
Decom.	4
Geographic context/ restrictions	Applies to all six C-CORE areas, except for the cautionary notes about tropical cyclones, which only applies to South China Sea, West of Ireland, and Myanmar. Seasonality: Applies to all seasons.

Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	
Technology Urgency	Short term (2-5 years)
Information requirements	
Update frequency	Daily or weekly, since O&G users often need historical data to assess recent events. For some parameters and data sets, monthly is still sufficient. Available today: For the historical reanalyses and archived observations, monthly; however, recent observations are available generally without delay.
Temporal resolution	Data should be at least 1-3 hourly resolution depending on area and phenomena needed to be resolved. Available today: ERA-Interim: 6-hourly WaveWatch III: 3 hourly Surface-bases observation: sub-hourly to less frequently Remotely-sensed satellite observation: sub-daily to less frequently
Spatial resolution	Around 4 km Available: ERA-Interim: 0.75° WaveWatch III: 4 arc-mins, 10 arc-mins, and/or 30 arc-mins, depending on area Surface-bases observation: varies based on the locations of the ship/buoy observations Remotely-sensed satellite observation: varies based on platform scanning swath size and other parameters
Data quality	The sources in this document are selected because they are known to have sufficient quality (after some work arounds and adaptations). In general separate indepth verification studies has to be made for each source planned to be used for analysis, and the analysis has to be repeated for each geographical area (since sources might be of sufficient quality in one area but not

	another). In general, ground observations and modelled sourced are perceived to be of better quality than EO for historical wind data.
Data Coverage and extent	Regional.
Example format	ERA-Interim: grib and netCDF WaveWatch III: grib and/or grib2 Surface-bases observation: text, CSV and/or netCDF Remotely-sensed satellite observation: text
Timeliness	The O&G user normally needs this urgently, possibly before assessing, planning, or exploring a new field. Hence the data source used for analysis needs to be frequently updated to avoid unnecessary waiting for the O&G user. Daily, weekly or monthly updates of data sets are sufficient, depending on the analysis required.
Existing standards	Multiple paragraphs in DNV-RP-C205, OTO 2001/010, ISO-19001-1, NORSOK-N-003e2, NORSOK-N-006u1, and DNV-OS-J001 contain extensive references to the standard measures of the means and extremes of winds, including the recommended approximations and calculations of return periods and probabilities of exceedance. The DNV series acknowledges that the procedures may not be applicable beyond the area of interest that it was tailored for. In addition, DNV-RP-C205, ISO-19001-1, and DNV-OS-J001 contain cautionary notes regarding the treatment of winds in areas that experience tropical cyclones, such as South China Sea, West of Ireland, and Myanmar.

Challenge ID	OFF1.2
Title	**Historic records for waves**
Challenge originator: interviewed company	
General Description	
What data/products do you use?	Historical wind wave heights, swell wave heights, and significant wave heights are available in the form of surface-based observations, as reported from ships and buoys, via ICOADS and NOAA (NDBC). ICOADS: http://rda.ucar.edu/datasets/ds540.0/ NOAA (NDBC): http://www.ndbc.noaa.gov/ Historical remotely-sensed satellite observations of significant wave heights are available via DEOS-RADS, as well as other agencies such as IFREMER (NAIAD). DEOS-RADS: http://rads.tudelft.nl/rads/rads.shtml IFREMER (NAIAD): http://naiad.ifremer.fr/ Historical hindcasts of reanalyzed significant wave heights are available via ECMWF (ERA-Interim) and NOAA (WAVEWATCH III). ECMWF (ERA-Interim): http://apps.ecmwf.int/datasets/data/interim_full_daily/ NOAA (WaveWatch III): ftp://polar.ncep.noaa.gov/pub/history/waves/ Historical 0-hour global and regional model analyses of significant wave heights are available via many global agencies such as NOAA, ECMWF, CMC, JMA, UKMET, and others.
When do you use this kind of dataset?	Historical wavedata (Hs, Tp, Tz etc.) are used to great extent by the O&G industry for all phases throughout the O&G cycle, except strictly operational tasks. The data set is used to assist in qualifying and quantifying the qualifying and quantifying the means and extremes of waves in the area of interest, but also to identify frequency of occurrence

	of wave heights/periods and weather window (where operational thresholds apply). During the early stages, field assessment/seismics etc. the data are mostly used to assess the operability of the area during different seasons and to assess financial risk and first draft of development costs. During planning of new fields and operations data are used to assess the climatic limitations local/regional weather would have on safety in order to reduce risk for operations, personnel and environment. Finally wave data are important to design of structures that can withstand the local conditions and take into account the risk of the extreme situations of the area.
What are your actual limitations and do you have a work around?	For more superficial analysis, first looks etc. an estimate is often sufficient and the quality of the data set is not as critical as for design studies. The latter requires long time series (for instance preferably more than 1/4 of the extreme calculated - i.e. 25 yrs for 100 year extreme) and high resolution in time and space in order to catch vigorous short-lived and small scale local phenomena. Data of sufficient quality can be hard to come by in coastal and remote/less developed areas and rougher modeled data/estimates/approximations will be used. Sometimes calibration of modeled data to shorter observed time series has to be made. **In addition:** There are important spatial and temporal limitations of historical surface-based and remotely-sensed wave height observations that make the analyses of extreme values very challenging (e.g., most extremes at sea were probably not observed or otherwise sampled). **Exemplified by the data sources in this study:** **Update frequency:** To slow in some cases, some data sources do not extend to near real time (1 month or more lag), and "patching" with any available observations is necessary. **Temporal resolution:** 3 and 6 hours are too infrequent and do not catch short lived extremes, and approximations have to be made. **Spatial resolution:** *Too large outside well know areas (and large even there). Does not catch small scale and local (bathymetry induced)

	phenomena. Should be 4 km minimum. **NOTE. High resolution and high update resolution does not equal quality, hence documentation of verification is equally important!!**
Needs and expectations on EO data	EO is used for this today, but resolution, update frequency, length of data series and quality is not sufficient for instance design studies. It is used as input in regional reanalysis and hindcast. Long (10 years +) observed time series of high quality (ground truthed) and with high spatial resolution, especially for coastal areas and emerging O&G areas where demand for such data has been small or non-existent. Or - EO data that can improve modeled reanalyses. Example: Long time series of significant wave heights and all other wave spectra data.
Challenge classification	
Pre license	3
Exp.	4
Dev.	4
Prod.	3
Decom.	3
Geographic context/ restrictions	Applies to all six C-CORE areas, except for the cautionary notes about tropical cyclones, which only applies to South China Sea, West of Ireland, and Myanmar. Seasonality: Applies to all seasons.
Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	
Technology Urgency	Short term (2-5 years)
Information requirements	
Update frequency	Daily or weekly, since O&G users often need historical data to assess recent events. For some parameters and data sets, monthly is still sufficient.

	Available today: For the historical reanalyses and archived observations, monthly; however, recent observations are available generally without delay.
Temporal resolution	Data should be at least 1-3 hourly depending on area and phenomena needed to be resolved. Available today: ERA-Interim: 6-hourly WaveWatch III: 3 hourly Surface-bases observation: sub-hourly to less frequently Remotely-sensed satellite observation: sub-daily to less frequently
Spatial resolution	Around 4 km, maybe less in coastal areas. Available: ERA-Interim: 0.75° WaveWatch III: 4 arc-mins, 10 arc-mins, and/or 30 arc-mins, depending on area Surface-bases observation: varies based on the locations of the ship/buoy observations Remotely-sensed satellite observation: varies based on platform scanning swath size and other parameters
Data quality	The selected sources in this document are selected because they are known to have sufficient quality (after some work arounds and adaptations). In general separate indepth verification studies has to be made for each source planned to be used for analysis, and the analysis has to be repeated for each geographical area (since sources might be of sufficient quality in one area but not another). In general, ground observations and modelled sourced are perceived to be of better quality than EO for historical wave data.
Data Coverage and extent	Regional.
Example format	ERA-Interim: grib and netCDF WaveWatch III: grib and/or grib2 Surface-bases observation: text, CSV and/or netCDF Remotely-sensed satellite observation: text
Timeliness	The O&G user normally needs this urgently possible before

	assessing, planning or exploring a new field. Hence the data source used for analysis needs to be frequently updated to avoid unnecessary waiting for the O&G user. Daily, weekly or monthly updates of data sets are sufficient, depending on the analysis required.
Existing standards	Multiple paragraphs in DNV-RP-C205, OTO 2001/010, ISO-19001-1, NORSOK-N-003e2, NORSOK-N-006u1, and DNV-OS-J001 contain extensive references to the standard measures of the means and extremes of waves, including the recommended approximations and calculations of return periods and probabilities of exceedance. The DNV series acknowledges that the procedures may not be applicable beyond the area of interest that it was tailored for.

Challenge ID	OFF1.3
Title	**Historic records for surface currents**
Challenge originator: interviewed company	
General Description	
What data/products do you use?	Historical ocean surface currents data are available via different agencies. They are either based on reanalysis, hindcast model data or derived from satellite observations. Data from Global models: HYCOM+NCODA model system: : http://hycom.org/dataserver Three Global reanalysis from MERCATOR, University of Reading and CMCC via MyOcean: http://www.myocean.eu/ Data from regional models: Mediterranean Sea: MEDSEA (MyOcean): http://www.myocean.eu/ Iberian, Biscay and Irish Seas: IBI MFC model: http://www.myocean.eu/, limited in time. European NW Shelf: FOAM: http://www.myocean.eu/ Currents derived from satellite: Global geostrophic currents analysis from MyOcean derived from satellite observations: http://www.myocean.eu/ Global geosptrophic currents from NOAA: derived from sea surface height, wind speed and sea surface temperature satellite observations: OSCAR: http://www.oscar.noaa.gov/.
When do you use this kind of dataset?	Historical ocean surface current data are used to great extent by the O&G industry for all phases throughout the O&G cycle, except strictly operational tasks. The data set is used to assist in qualifying and quantifying the means and extremes of ocean currents in the area of interest. In addition ocean data are important for environmental impact studies, oil spill trajectory modeling, modeling of drilling cuttings etc. During the early stages, field assessment/seismics etc. the data are mostly used to assess the operability of the area during different seasons and to assess financial risk and first draft of

	development costs. During planning of new fields and operations data are used to assess the climatic limitations local/regional weather would have on safety in order to reduce risk for operations, personnel and environment. Finally surface current data are important to design of structures that can withstand the local conditions and take into account the risk of the extreme situations of the area.
What are your actual limitations and do you have a work around?	Same as for wind and wave, only that data of sufficient quality is rare. Most of this is due to the limited access to observations, and if accessible available update frequency, quality and resolution is normally poor. Little data is available to sufficiently ground truth EO data. In addition data of sufficient quality can be hard to come by in coastal and remote/less developed areas. Modelled data has low quality for on shorter time scales, while climatology is of sufficient quality. These data rarely catch short lived and small scale extremes. **In addition:** There are important spatial and temporal limitations of historical surface-based and remotely-sensed ocean current observations that make the analyses of extreme values very challenging (e.g., most extremes at sea were probably not observed or sampled). **Exemplified by the data sources in this study:** *Update frequency:* Generally to slow, and not extended to real-time. And observations for "patching" often not available. *Temporal resolution:* Not by far sufficient, often daily snapshots, and averages, does not catch important events. *Spatial resolution:* Not by far sufficient, should have at least 4 km resolution to resolve small scale features and coastal areas. **NOTE. High resolution and high update resolution does not equal quality, hence documentation of verification is equally important!***!*
Needs and expectations on EO data	EO is used for this today, but resolution, update frequency, length of data series and quality is not sufficient for instance design studies. It is used as input in regional reanalysis and hindcast.

	Long (10 years +) observed time series of high quality (ground truthed) and with high spatial resolution, especially for coastal areas and emerging O&G areas where demand for such data has been small or non-existent. Or - EO data that can improve modeled reanalyses. Specific need: Long time series of ocean current data.
Challenge classification	
Pre license	3
Exp.	4
Dev.	4
Prod.	3
Decom.	3
Geographic context/ restrictions	Applies to all six C-CORE areas, except for the cautionary notes about tropical cyclones, which only applies to South China Sea, West of Ireland, and Myanmar. Seasonality: Applies to all seasons.
Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	
Technology Urgency	Short term (2-5 years)
Information requirements	
Update frequency	Daily or weekly, since O&G users often need historical data to assess recent events. For some parameters and data sets, monthly is still sufficient. Available today: For the historical reanalyses and archived observations, monthly; however, recent observations are available generally without delay.
Temporal resolution	Data should be at least 1-3 hourly resolution depending on area and phenomena needed to be resolved. Available today: OSCAR: 5-day moving mean.

	HYCOM+NCODA system: Daily snapshot at 00Z MyOcean global reanalysis: Monthly (all), weekly (MERCATOR) , daily (CMCC) from 1993 Regional models: Mediterranean Sea: MEDSEA (MyOcean): Monthly, daily from 1987 Iberian, Biscay and Irish Seas: IBI MFC model: Daily means (and hourly means) from 20110401 European NW Shelf: FOAM: Daily means from 1985 Currents, temperature and SST derived from satellite: Global geostrophic currents and SST analysis based on satellite observations: Weekly and monthly means
Spatial resolution	Around 4 km, maybe less in coastal areas. Available: OSCAR: 1/3° HYCOM+NCODA system: 1/12° MyOcean global reanalysis: 0.25° Regional models: Mediterranean Sea: MEDSEA (MyOcean) :6-7 km Iberian, Biscay and Irish Seas: IBI MFC model: ~2km European NW Shelf: FOAM: 7 km Currents, temperature and SST derived from satellite: Global geostrophic currents and SST analysis based on satellite observations: 1/4°
Data quality	The selected sources in this document are selected because they are known to have sufficient quality (after some work arounds and adaptations). In general separate indepth verification studies has to be made for each source planned to be used for analysis, and the analysis has to be repeated for each geographical area (since sources might be of sufficient quality in one area but not another). In general, ground observations and modelled sourced are perceived to be of better quality than EO for historical current data.
Data Coverage and extent	Regional

Example format	CSV and/or netCDF
Timeliness	The O&G user normally needs this urgently possible before assessing, planning, or exploring a new field. Hence the data source used for analysis needs to be frequently updated to avoid unnecessary waiting for the O&G user. Daily, weekly or monthly updates of data sets are sufficient, depending on the analysis required.
Existing standards	

Challenge ID	OFF1.4
Title	**Historic records for currents at depth**
Challenge originator: interviewed company	
General Description	
What data/products do you use?	Historical ocean currents data for currents at depth are available via different agencies. They are either based on reanalysis, hindcast model data or derived from satellite observations. Quality is lower than for the surface currents due to fewer observations. Data from Global models: HYCOM+NCODA model system: : http://hycom.org/dataserver Three Global reanalysis from MERCATOR, University of Reading and CMCC via MyOcean: http://www.myocean.eu/ Data from regional models: Mediterranean Sea: MEDSEA (MyOcean): http://www.myocean.eu/ Iberian, Biscay and Irish Seas: IBI MFC model: http://www.myocean.eu/, limited in time. European NW Shelf: FOAM: http://www.myocean.eu/ Currents derived from satellite: Global geostrophic currents analysis from MyOcean derived from satellite observations: http://www.myocean.eu/ Global geosptrophic currents from NOAA: derived from sea surface height, wind speed and sea surface temperature satellite observations: OSCAR: http://www.oscar.noaa.gov/.
When do you use this kind of dataset?	Historical ocean current data at depth are used to great extent by the O&G industry for all phases of the O&G cycle, except strictly operational tasks. The data set is used to assist in qualifying and quantifying the means and extremes of ocean currents in the area of interest. In addition ocean data are important for environmental impact studies, oil spill trajectory modeling, modeling of drilling cuttings etc. During the early stages, field assessment/seismics etc. the data

	are mostly used to assess the operability of the area during different seasons and to assess financial risk and first draft of development costs. During planning of new fields and operations data are used to assess the climatic limitations local/regional weather would have on safety in order to reduce risk for operations, personnel and environment. Finally surface current data are important to design of structures that can withstand the local conditions and take into account the risk of the extreme situations of the area.
What are your actual limitations and do you have a work around?	Same as for wind and wave, only that data of sufficient quality is very rare. Most of this is due to the limited access to observations of currents at dept. Most current observations are made at the surface. In addition data of sufficient quality can be even harder to come by in coastal and remote/less developed areas. Modelled data has low quality for on shorter time scales, while climatology is of sufficient quality. These data rarely catch short lived and small scale extremes. There are important spatial and temporal limitations of historical surface-based and remotely-sensed ocean current observations that make the analyses of extreme values very challenging (e.g., most extremes at sea were probably not observed or sampled). Exemplified by the data sources in this study: Vertical resolution, often to large, does not catch variations in shallow coastal areas. Bottom dynamics not well described. Update frequency: Generally to slow, and not extended to real-time. And observations for "patching" often not available. Temporal resolution: Not by far sufficient, often daily snapshots, and averages, does not catch important events. Spatial resolution: Not by far sufficient, should have at least 4 km resolution to resolve small scale features and coastal areas. NOTE. High resolution and high update resolution does not equal quality, hence documentation of verification is equally important!! Time consuming to work with these data series, makes accurate

	analyses expensive.
Needs and expectations on EO data	EO cannot be used for this today. Long (10 years +) observed time series of high quality from gliders, ADCPs etc., in all areas. Specific need: Long time series of ocean current data.
Challenge classification	
Pre license	3
Exp.	4
Dev.	4
Prod.	3
Decom.	3
Geographic context/ restrictions	Applies to all six C-CORE areas, except for the cautionary notes about tropical cyclones, which only applies to South China Sea, West of Ireland, and Myanmar. Seasonality: Applies to all seasons.
Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	
Technology Urgency	Short term (2-5 years)
Information requirements	
Update frequency	Available today:
Temporal resolution	Data should be at least 1-3 hourly resolution depending on area and phenomena needed to be resolved. Available today: OSCAR: 5-day moving mean. HYCOM+NCODA system: Daily snapshot at 00Z MyOcean global reanalysis: Monthly (all), weekly (MERCATOR) , daily (CMCC) from 1993

	Regional models: Mediterranean Sea: MEDSEA (MyOcean): Monthly, daily from 1987 Iberian, Biscay and Irish Seas: IBI MFC model: Daily means (and hourly means) from 20110401 European NW Shelf: FOAM: Daily means from 1985 Currents, temperature and SST derived from satellite: Global geostrophic currents and SST analysis based on satellite observations: Weekly and monthly means
Spatial resolution	Around 4 km, maybe less in coastal areas. Available: OSCAR: 1/3° HYCOM+NCODA system: 1/12° MyOcean global reanalysis: 0.25° Regional models: Mediterranean Sea: MEDSEA (MyOcean) :6-7 km Iberian, Biscay and Irish Seas: IBI MFC model: ~2km European NW Shelf: FOAM: 7 km Currents, temperature and SST derived from satellite: Global geostrophic currents and SST analysis based on satellite observations: 1/4°
Data quality	The selected sources in this document are selected because they are known to have sufficient quality (after some work arounds and adaptations). In general separate indepth verification studies has to be made for each source planned to be used for analysis, and the analysis has to be repeated for each geographical area (since sources might be of sufficient quality in one area but not another).
Data Coverage and extent	Regional.
Example format	CSV and/or netCDF
Timeliness	The O&G user normally needs this urgently possible before assessing, planning, or exploring a new field. Hence the data source used for analysis needs to be frequently updated to avoid unnecessary waiting for the O&G user. Daily, weekly or monthly updates of data sets are sufficient, depending on the analysis required.

Existing standards	In addition, DNV-RP-C205, ISO-19001-1, and DNV-OS-J001 contain cautionary notes regarding the treatment of waves in areas that experience tropical cyclones, such as South China Sea, West of Ireland, and Myanmar.

Challenge ID	OFF1.5
Title	**Wind observations**
Challenge originator: interviewed company	
General Description	
What data/products do you use?	Realtime and near-realtime surface-based observations of 10m wind speeds from ships and buoys are available from many sources including NOAA (NWSTG), NOAA (MADIS), NOAA (NDBC), UCAR, and numerous other data distribution centers. NWSTG: ftp://tgftp.nws.noaa.gov/data/observations/ MADIS: ftp://pftp.madis-data.noaa.gov/ NDBC: http://www.ndbc.noaa.gov/ UCAR: http://thredds.ucar.edu/thredds/idd/newPointObs.html Operational 0-hour global and/or regional model analyses of 10m wind speeds are available via many global agencies such as NOAA, ECMWF, CMC, JMA, UKMET, and others.
When do you use this kind of dataset?	These data are used to monitor all day-to-day operations when drilling, surveying etc. To assess current conditions, nowcasting, assess the quality forecast models and plan ahead. Find windows of operability where thresholds apply etc. The aim is to manage risks related to winds, safeguarding lives, protecting assets, and conducting operations. Wind data are particularly important for work at height, during helicopter operations etc.
What are your actual limitations and do you have a work around?	There are spatial and temporal limitations of realtime and near-realtime surface-based and remotely-sensed 10m wind observations. The observation heights and averaging periods of wind observations are variables that must be reconciled across all record sets prior to analyses. Which means: Data are often not on location. Sensors are too high, shielded, measurements averaged, in wrong formats etc. EO observations are have low resolution in time and space, are difficult to access and read, in difficult formats. Quality is often an issue and data are mostly used to get an overview more than treated as an accurate source of observations. Hence ground

	measurements are used instead. Updates at least hourly, spatial resolution min. 4 km, formats standardised, quality improved and documented.
Needs and expectations on EO data	EO is used for this today, but resolution, update frequency and quality is not always sufficient. Mostly used as assimilation into models. More severe situations (se hurricanes, squalls etc.) can be detected using these data real time, however the use for point forecasting is limited. Need: Observed time series of high quality (ground truthed) and with high spatial resolution, especially for coastal areas and emerging O&G areas where demand for such data has been small or non-existent. Specific need: Additional surface-based and remotely sensed observations of 10m wind speeds (with 1-min, 10-min, 1-hour, and 3-second averaging periods).
Challenge classification	
Pre license	2
Exp.	4
Dev.	3
Prod.	4
Decom.	3
Geographic context/ restrictions	Applies to all six C-CORE areas, except for the cautionary notes about tropical cyclones, which only applies to South China Sea, West of Ireland, and Myanmar. Seasonality: Applies to all seasons.
Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	
Technology Urgency	Short term (2-5 years)
Information requirements	
Update frequency	Realtime and near-realtime. Hourly or 10 min.

	Available today: Depends on source, some sources only 6 or 12 hr, most 3 hourly, few less than 1 hr.
Temporal resolution	Realtime and near-realtime. Hourly or 10 min. Available: Surface-based observation: sub-hourly to less frequently Remotely-sensed satellite observation: sub-daily to less frequently
Spatial resolution	Observation on location or around 4 km Available: Surface-based observation: varies based on the locations of the ship/buoy observations Remotely-sensed satellite observation: varies based on platform scanning swath size and other parameters
Data quality	The selected sources in this document are selected because they are known to have sufficient quality (after some work arounds and adaptations). In general separate indepth verification studies has to be made for each source planned to be used for analysis, and the analysis has to be repeated for each geographical area (since sources might be of sufficient quality in one area but not another). In general, ground observations and modelled sourced are perceived to be of better quality/higher accuracy than EO.
Data Coverage and extent	Regional and as localised as possible.
Example format	Surface-bases observation: text, CSV and/or netCDF Remotely-sensed satellite observation: text
Timeliness	Real-time or near-real-time. Forecasts are normally issued 2 to 4 times per day, but O&G users and forecasters are monitoring conditions continuously.
Existing standards	Multiple paragraphs in DNV-RP-C205, OTO 2001/010, ISO-19001-1, NORSOK-N-003e2, and NORSOK-N-006u1 contain extensive references to the standard measures of the means of winds.

Challenge ID	OFF1.6
Title	**Waves observations**
Challenge originator: interviewed company	
General Description	
What data/products do you use?	Realtime and near-realtime surface-based observations of wind wave heights, swell wave heights, and significant wave heights from ships and buoys are available from many sources including NOAA (NWSTG), NOAA (MADIS), NOAA (NDBC), UCAR, and numerous other data distribution centers. NWSTG: ftp://tgftp.nws.noaa.gov/data/observations/ MADIS: ftp://pftp.madis-data.noaa.gov/ NDBC: http://www.ndbc.noaa.gov/ UCAR: http://thredds.ucar.edu/thredds/idd/newPointObs.html Operational 0-hour global and/or regional model analyses of significant wave heights are available via many global agencies such as NOAA, ECMWF, CMC, JMA, UKMET, and others.
When do you use this kind of dataset?	These data are used to monitor all day-to-day operations when drilling, surveying etc. To assess current conditions, nowcasting, assess the quality forecast models and plan ahead. Find windows of operability where thresholds apply etc. The aim is to manage risks related to waves, safeguarding lives, protecting assets, and conducting operations. Waves and wave periods are particularly important when moving jack-ups, heavy lifts etc. etc.
What are your actual limitations and do you have a work around?	There are spatial and temporal limitations of realtime and near-realtime surface-based and remotely-sensed wave observations. Which means: Data are often not on location. Sensors of different formats, give different parameters, could be shielded, measurements averaged, in "wrong formats'" etc. EO observations are have low resolution in time and space, are difficult to access and read, in difficult formats. Quality is often an issue and data are mostly used to get an overview more than treated as an accurate source of observations. Hence ground measurements are used instead.

	Updates at least hourly, spatial resolution min. 4 km, formats Standardised, quality improved and documented.
Needs and expectations on EO data	EO is used for this today, but resolution, update frequency and quality is not always sufficient. Mostly used as assimilation into models. More severe situations (for instance swells) can be detected using these data real time, however the use for point forecasting is limited. Need: Observed time series of high quality (ground truthed) and with high spatial resolution, especially for coastal areas and emerging O&G areas where demand for such data has been small or non-existent. Both wind waves and swells are important. Specific need: Additional surface-based and remotely sensed observations of wave spectra data (e.g., heights, directions, and periods of wind waves and swell waves).
Challenge classification	
Pre license	2
Exp.	4
Dev.	3
Prod.	4
Decom.	3
Geographic context/ restrictions	Applies to all six C-CORE areas, except for the cautionary notes about tropical cyclones, which only applies to South China Sea, West of Ireland, and Myanmar. Seasonality: Applies to all seasons.
Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	
Technology Urgency	Short term (2-5 years)
Information requirements	
Update frequency	Realtime and near-realtime. Hourly or 10 min.

	Available today: Depends on source, some sources only 6 or 12 hr, most 3 hourly, few less than 1 hr.
Temporal resolution	Realtime and near-realtime. Hourly or 10 min. Available: Surface-based observation: sub-hourly to less frequently Remotely-sensed satellite observation: sub-daily to less frequently
Spatial resolution	Observation on location or around 4 km Available: Surface-based observation: varies based on the locations of the ship/buoy observations Remotely-sensed satellite observation: varies based on platform scanning swath size and other parameters
Data quality	The selected sources in this document are selected because they are known to have sufficient quality (after some work arounds and adaptations). In general separate indepth verification studies has to be made for each source planned to be used for analysis, and the analysis has to be repeated for each geographical area (since sources might be of sufficient quality in one area but not another). In general, ground observations and modelled sourced are perceived to be of better quality/higher accuracy than EO.
Data Coverage and extent	Regional and as localised as possible.
Example format	Surface-bases observation: text, CSV and/or netCDF Remotely-sensed satellite observation: text
Timeliness	Real-time or near-real-time. Forecasts are normally issued 2 to 4 times per day, but O&G users and forecasters are monitoring conditions continuously.
Existing standards	Multiple paragraphs in DNV-RP-C205, OTO 2001/010, ISO-19001-1, NORSOK-N-003e2, and NORSOK-N-006u1 contain extensive references to the standard measures of the means of waves.

Challenge ID	OFF1.7
Title	**Surface current observations**
Challenge originator: interviewed company	
General Description	
What data/products do you use?	Near realtime ocean surface current data are available via NOAA (NDBC): http://www.ndbc.noaa.gov/. Surface currents derived from satellite: Global geostrophic currents and SST analysis based on satellite observations: OSCAR: http://www.oscar.noaa.gov/ Global forecast system available on two websites: RTOFS: http://polar.ncep.noaa.gov/global/data_access.shtml? HYCOM+NCODA system: http://www.myocean.eu/ Regional forecast models: Mediterranean Sea: MEDSEA (MyOcean): http://www.myocean.eu/ Iberian, Biscay and Irish Seas: IBI MFC model: http://www.myocean.eu/ European NW Shelf: FOAM: http://www.myocean.eu/
When do you use this kind of dataset?	These data are used to monitor all day-to-day operations when drilling, surveying etc. To assess the current conditions, nowcasting, assess the quality forecast models and plan ahead. Find windows of operability etc. The aim is to manage risks related to surface currents, safeguarding lives, protecting assets, and conducting operations. Knowledge of currents is especially important to access the risks during an oil spill.
What are your actual limitations and do you have a work around?	Data availability is the major issue. Few measurements of sufficient quality exist. Data quality is another issue. There are spatial and temporal limitations of realtime and near-realtime surface-based and remotely-sensed ocean current observations. Also update frequency, quality and usability of EO data.

	EO observations are have low resolution in time and space, are difficult to access and read, in difficult formats. Quality is often an issue and data are mostly used to get an overview more than treated as an accurate source of observations. Updates at least hourly, spatial resolution min. 4 km, formats Standardised, quality improved and documented. Ground observations are more trusted, but are few, and also have issues with quality.
Needs and expectations on EO data	EO is used for this today, but resolution, update frequency and quality is not sufficient. Increasingly used as assimilation into models. More severe situations (for instance eddies/loop current) can be detected using these data real time, however the use for point forecasting is limited. Specific need: Additional surface-based observations of ocean current profiles.
Challenge classification	
Pre license	2
Exp.	4
Dev.	3
Prod.	4
Decom.	3
Geographic context/ restrictions	Applies to all six C-CORE areas, except for the cautionary notes about tropical cyclones, which only applies to South China Sea, West of Ireland, and Myanmar. Seasonality: Applies to all seasons.
Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	
Technology Urgency	Short term (2-5 years)
Information requirements	
Update frequency	Realtime and near-realtime. Hourly, or 10 minutes averaged over 1 hour (because of noise).

	Available today: Depends on source, some sources only daily, most 6-3 hrs, few real time
Temporal resolution	Surface-based observation: sub-hourly to less frequently RTOFS (HYCOM+NCODA): 3 hr HYCOM+NCODA system: Daily snapshot at 00Z Regional models: Mediterranean Sea: MEDSEA (MyOcean): Daily Iberian, Biscay and Irish Seas: IBI MFC model: Daily means or hourly means European NW Shelf: FOAM: Daily means or hourly means Currents, temperature and SST derived from satellite: Global geostrophic currents and SST analysis based on satellite observations: Weekly and monthly means
Spatial resolution	Observation on location or around 4 km (maybe less in coastal areas). Available: Surface-based observation: varies based on the locations of the ship/buoy observations Remotely-sensed satellite observation: varies based on platform scanning swath size and other parameters HYCOM+NCODA system: 1/12° Regional models: Mediterranean Sea: MEDSEA (MyOcean) :6-7 km Iberian, Biscay and Irish Seas: IBI MFC model: ~2km European NW Shelf: FOAM: 7 km Currents, temperature and SST derived from satellite: Global geostrophic currents analysis based on satellite observations: 1/4°
Data quality	The selected sources in this document are selected because they are known to have sufficient quality (after some work arounds and adaptations). In general separate indepth verification studies has to be made for each source planned to be used for analysis, and the analysis has to be repeated for

	each geographical area (since sources might be of sufficient quality in one area but not another).
Data Coverage and extent	Regional and as localised as possible.
Example format	netCDF and/or CSV
Timeliness	Real-time or near-real-time. Forecasts are normally issued 2 to 4 times per day, but O&G users and forecasters are monitoring conditions continuously.
Existing standards	

Challenge ID	OFF1.8
Title	**Current at depth observations**
Challenge originator: interviewed company	
General Description	
What data/products do you use?	Near realtime ocean current data at depth (few) are available via NOAA (NDBC) : http://www.ndbc.noaa.gov/, but very little information on currents at depth. Global forecast system available on two websites: RTOFS: http://polar.ncep.noaa.gov/global/data_access.shtml? HYCOM+NCODA system: http://www.myocean.eu/ Regional forecast models: Mediterranean Sea: MEDSEA (MyOcean): http://www.myocean.eu/ Iberian, Biscay and Irish Seas: IBI MFC model: http://www.myocean.eu/ European NW Shelf: FOAM: http://www.myocean.eu/
When do you use this kind of dataset?	These data are used to monitor all day-to-day operations when drilling, surveying etc. To assess current conditions, nowcasting, plan ahead. Find windows of operability etc. To assist in managing risks related to ocean surface currents, safeguarding lives, protecting assets, and conducting operations. Important during subsea oil spills, running risers in deep water and strong currents, using divers and ROVs etc.
What are your actual limitations and do you have a work around?	Data availability is the major issue. Few measurements of sufficient quality exist. There are spatial and temporal limitations of realtime and near-realtime surface-based and remotely-sensed ocean current observations. EO observations do not exist.
Needs and expectations on EO	EO is not used for this today.

data	Specific need: Additional surface-based observations of ocean current profiles.
Challenge classification	
Pre license	2
Exp.	4
Dev.	3
Prod.	4
Decom.	3
Geographic context/ restrictions	Applies to all six C-CORE areas, except for the cautionary notes about tropical cyclones, which only applies to South China Sea, West of Ireland, and Myanmar. Seasonality: Applies to all seasons.
Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	
Technology Urgency	Short term (2-5 years)
Information requirements	
Update frequency	Realtime and near-realtime. Hourly, or 10 minutes averaged over 1 hour (because of noise). Available today: Depends on source, some sources only daily, most 6-3 hrs, few real time
Temporal resolution	Realtime and near-realtime. Hourly or 10 min. Available: Surface-based observation: observation: sub-hourly to less frequently RTOFS (HYCOM+NCODA): 3 hr HYCOM+NCODA system: Daily snapshot at 00Z Regional models: Mediterranean Sea: MEDSEA (MyOcean): Daily

	Iberian, Biscay and Irish Seas: IBI MFC model: Daily means or hourly means European NW Shelf: FOAM: Daily means or hourly means Currents, temperature and SST derived from satellite: Global geostrophic currents and SST analysis based on satellite observations: Weekly and monthly means
Spatial resolution	Observations on location or around 4 km (maybe less in coastal areas). Surface-based observation: varies based on the locations of the ship/buoy observations Remotely-sensed satellite observation: varies based on platform scanning swath size and other parameters HYCOM+NCODA system: 1/12° Regional models: Mediterranean Sea: MEDSEA (MyOcean) :6-7 km Iberian, Biscay and Irish Seas: IBI MFC model: ~2km European NW Shelf: FOAM: 7 km Currents, temperature and SST derived from satellite: Global geostrophic currents analysis based on satellite observations: 1/4°
Data quality	The selected sources in this document are selected because they are known to have sufficient quality (after some work arounds and adaptations). In general separate indepth verification studies has to be made for each source planned to be used for analysis, and the analysis has to be repeated for each geographical area (since sources might be of sufficient quality in one area but not another).
Data Coverage and extent	Regional and as localised as possible.
Example format	netCDF and/or CSV
Timeliness	Real-time or near-real-time. Forecasts are normally issued 2 to 4 times per day, but O&G users and forecasters are monitoring conditions continuously.
Existing standards	

Challenge ID	OFF1.9
Title	Historical Tropical Storm/Tropical Cyclone probability and tracks
Challenge originator: interviewed company	
General Description	
What data/products do you use?	Historical observations of tropical cyclone positions, intensities, sizes and other quantitative measures are readily available in six hour intervals (and sometimes more frequently) from multiple global agencies via the best track archives that comprise IBTrACS. IBTrACS: http://www.ncdc.noaa.gov/ibtracs/
When do you use this kind of dataset?	Historical observations of tropical cyclones data are used to great extent by the O&G industry in tropical storm prone areas for all phases throughout the O&G cycle, except strictly operational tasks. These data are extremely important to assess risk of operations in these areas, frequency of occurrence, most likely track etc. Also, many other data sources do not catch the extremes in the area without these data added to the time series for the point of interest, since data often are averaged and conditions often are mostly benign. The data set is used to assist in qualifying and quantifying the means and extremes of tropical cyclone in the area of interest. The data set is used to assess operability in the area, to reduce risk when designing structures and operations, to design strategies to avoid severe conditions.
What are your actual limitations and do you have a work around?	The averaging periods of the reported maximum wind speeds in tropical cyclones varies among global agencies and must be reconciled across all record sets prior to analyses.
Needs and expectations on EO data	EO is used for this today in combination with modeled data. Need to know the exact position, strength and accurate extent of the storms and wind speeds is important to assess impact of these storms and assess the future risks. Long time series of 10m wind speeds and directions, wave spectra data (e.g., heights, directions, and periods of wind

	waves and swell waves) and ocean current profiles.
Challenge classification	
Pre license	2
Exp.	4
Dev.	3
Prod.	4
Decom.	3
Geographic context/ restrictions	Applies to South China Sea, West of Ireland, and Myanmar. Seasonality: South China Sea -- Applies to all seasons. West of Ireland -- Applies primarily to September. Myanmar. Bimodal. Applies primarily to April/May and October/November.
Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	
Technology Urgency	Short term (2-5 years)
Information requirements	
Update frequency	annually
Temporal resolution	1-3 hourly Available: Generally 6-hourly, but sometimes more or less frequently
Spatial resolution	10-4 km Available: Generally 0.1° for tropical cyclone center locations
Data quality	The selected sources in this document are selected because they are known to have sufficient quality (after some work arounds and adaptations). In general separate indepth verification studies has to be made for each source planned to be used for analysis, and the analysis has to be repeated for each geographical area (since sources might be of sufficient quality in one area but not another).
Data Coverage and extent	Regional or along track.

Example format	netCDF and CSV
Timeliness	The O&G user normally needs this urgently possible before assessing, planning or exploring a new field. Hence the data source used for analysis needs to be frequently updated to avoid unnecessary waiting for the O&G user. Daily, weekly or monthly updates of data sets are sufficient, depending on the analysis required.
Existing standards	DNV-RP-C205, ISO-19001-1, and DNV-OS-J001 contain cautionary notes regarding the treatment of winds and waves in areas that experience tropical cyclones, such as South China Sea, West of Ireland, and Myanmar.

Challenge ID	OFF1.10
Title	**Tropical Storm/Tropical Cyclone Observations**
Challenge originator: interviewed company	
General Description	
What data/products do you use?	Near-realtime warnings, that include the latest tropical cyclone positions, intensities, sizes and other quantitative measures, are readily available every six hours from multiple global agencies, including RSMC Tokyo (for South China Sea), RSMC Miami (for West of Ireland), and RSMC New Delhi (for Myanmar). Tropical cyclone satellite-derived positions and intensities are available more frequently. RSMC Tokyo: http://www.jma.go.jp/en/typh/index.html RSMC Miami: http://www.nhc.noaa.gov/ RSMC New Delhi: http://www.imd.gov.in/section/nhac/dynamic/cyclone.htm
When do you use this kind of dataset?	Real-time observations of tropical cyclones are used to help O&G users to assess the risk of impact of tropical storms in the area of interest. The data are used to assess the position, likely path and impact on the operations. Warnings are issued when thresholds are passed and procedures for safeguarding lives, equipment, assessed area put in place. Equally important is the possibility to conduct operations if the path is likely to stay away from the area of interest.
What are your actual limitations and do you have a work around?	The averaging periods of the reported maximum wind speeds in tropical cyclones varies among global agencies and must be reconciled across all record sets prior to analyses.
Needs and expectations on EO data	EO is used for this today in combination with modeled data. Need to know the exact position, strength and accurate extent of the storms and wind speeds is important to assess impact of these storms and assess the near future risks. Ground observations in the hardest hit areas are likely to be destroyed or miss the highest peaks, better knowledge of speeds and extents area important. Long time series of 10m wind speeds and directions, wave spectra data (e.g., heights, directions, and periods of wind waves and swell waves) and ocean current profiles in the

	offshore environment.
Challenge classification	
Pre license	2
Exp.	4
Dev.	3
Prod.	4
Decom.	3
Geographic context/ restrictions	Applies to South China Sea, West of Ireland, and Myanmar. Seasonality: South China Sea -- Applies to all seasons. West of Ireland -- Applies primarily to September. Myanmar. Bimodal. Applies primarily to April/May and October/November.
Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	
Technology Urgency	Short term (2-5 years)
Information requirements	
Update frequency	Generally six times daily, and often more frequently. Position and intensity data may be available hourly in some cases.
Temporal resolution	Hourly. Available: Advisories/warnings: generally 6-hourly, but sometimes more or less frequently Center fixes/posits/intensity estimates: sometimes hourly
Spatial resolution	10-4 km Available: generally 0.1° for tropical cyclone center locations
Data quality	The selected sources in this document are selected because they are known to have sufficient quality (after some work arounds and adaptations). In general separate indepth verification studies has to be made for each source planned to be used for analysis, and the analysis has to be repeated for

	each geographical area (since sources might be of sufficient quality in one area but not another).
Data Coverage and extent	Regional or along track.
Example format	text
Timeliness	Hourly or more frequent. Forecasts are normally issued 2 to 4 times per day, warnings when thresholds are passed. But O&G users and forecasters are monitoring conditions continuously.
Existing standards	DNV-RP-C205, ISO-19001-1, and DNV-OS-J001 contain cautionary notes regarding the treatment of winds and waves in areas that experience tropical cyclones, such as South China Sea, West of Ireland, and Myanmar.

Challenge ID	OFF1.11
Title	**Sea level**
Challenge originator: interviewed company	
General Description	
What data/products do you use?	Historical sea level heights are available in the form of remotely-sensed satellite observations via DEOS-RADS. DEOS-RADS: http://rads.tudelft.nl/rads/rads.shtml Near-realtime sea level heights are also available in the form of remotely-sensed satellite observations of sea heights from NOAA (STAR) and DEOS-RADS. DEOS-RADS: http://rads.tudelft.nl/rads/rads.shtml STAR: http://www.star.nesdis.noaa.gov/sod/lsa/NearRealTime/ Global Sea Level mean based on satellite observations: http://www.myocean.eu/
When do you use this kind of dataset?	Sea levels data sets area used to assess the most likely interval of the sea surface in the area of interest. The data is crucial where there are chances of strong storm surges, large variations of tidal height, but also where wave heights are likely to add to the sea level. The data are used to qualify and quantify the means and extremes of sea heights. Air gap analysis for jack-up rigs and fixed platforms, seismic survey (to calibrate data), mooring analysis are some uses.
What are your actual limitations and do you have a work around?	The primary limitation of historical and near-realtime sea level heights is that the remotely-sensed satellite observations are not continuous. Modelled data of tidal level and pressure effects are used instead, but wind induced effects are not well represented. Hence these are estimated based on wind data, but are not as accurate as measurements. (Also, improved measurements of sea level heights - high frequency, high resolution - will improve modelling of currents.)
Needs and expectations on EO data	EO is used for this today and probably the best source offshore. However resolution could be better.

	Specific need: Hourly time series of observed sea heights, ideally ≥ 19 years.
Challenge classification	
Pre license	1
Exp.	3
Dev.	4
Prod.	4
Decom.	3
Geographic context/ restrictions	Applies to all six C-CORE areas. Seasonality: Applies to all seasons.
Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	
Technology Urgency	Short term (2-5 years)
Information requirements	
Update frequency	Multiple times per day from polar-orbiting satellites. Sufficient.
Temporal resolution	At least daily. Available: Remotely-sensed satellite observation: sub-daily to less frequently
Spatial resolution	50-10 km. Available: Remotely-sensed satellite observation: varies based on platform scanning swath size and other parameters
Data quality	The selected sources in this document are selected because they are known to have sufficient quality (after some work arounds and adaptations). In general separate indepth verification studies has to be made for each source planned to be used for analysis, and the analysis has to be repeated for each geographical area (since sources might be of sufficient quality in one area but not another).
Data Coverage and extent	Regional
Example format	text
Timeliness	Daily, weekly or monthly is sufficient.

Existing standards	Paragraph 11.1 of HSE OTR 2001/010 states: Metocean parameters are required describing wave or sea state heights, wave lengths, periods and direction, current speed and directions, sea level and (if they are likely to cause significant stress ranges) wind speeds. Paragraph 3.15 of ISO 19901-1:2005(E) states: The Mean Sea Level (MSL) is the arithmetic mean of all sea levels measured at hourly intervals over a long period, ideally 19 years. Paragraph 6.7 of NORSOK-N-003e2 states: Characteristic values of individual environmental actions are defined by annual exceedance probabilities. (Note: The sea level thresholds are shown in Table 4 beneath Paragraph 6.7.)

Challenge ID	OFF1.12
Title	**Visibility**
Challenge originator: interviewed company	
General Description	
What data/products do you use?	Visibility data are largely limited to surface-based observations from ships and buoys. The historical records of observed visibilities are available via UCAR (ICOADS) and NOAA (NDBC). ICOADS: http://rda.ucar.edu/datasets/ds540.0/ NDBC: http://www.ndbc.noaa.gov/ Realtime and near realtime observations of visibility data are available from many sources including NOAA (NWSTG), NOAA (MADIS), NOAA (NDBC), UCAR, and numerous other data distribution centers.
When do you use this kind of dataset?	Visibility data are important in areas prone to frequent reduced visibility. Reduced visibility might slow down operations, tows, stop helicopter operations and other operations that require a certain visibility. Data are used to qualify and quantify the means and extremes of visibilities, and (b) managing risks related to visibility, safeguarding lives, protecting assets, and conducting operations.
What are your actual limitations and do you have a work around?	The temporal and spatial resolutions of surface-based observations significantly limits the availability of visibility data. Unless ships or buoys observe and report visibility data, visibilities are not readily available for analysis over vast areas of the ocean. Hard to use for other purposes than real-time observations, historical data are mostly ground observations, often manual and not very accurate. And when automatic, the cause of low visibility is not easily available (precipitation or fog?). Estimates have to be made. Better resolution, more frequent observations (hourly, 15 mins), better algorithms to separate fog from cloud.
Needs and expectations on EO	EO is used for this today and probably the best source to assess the geographical extent of for instance fog. However the

data	resolution and frequency of observations in some regions needs improvement. Also, tools to distinguish for instance fog from other clouds needs to be improved. Specific need: Time-series of surface-based visibility data. Better algorithms to distinguish fog from cloud etc.
Challenge classification	
Pre license	1
Exp.	3
Dev.	3
Prod.	4
Decom.	2
Geographic context/ restrictions	Applies to all six C-CORE areas. Seasonality: Applies to all seasons.
Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	
Technology Urgency	Short term (2-5 years)
Information requirements	
Update frequency	Hourly or 15 hourly. Available: Geostationary: Realtime or near-realtime observations are available sub-hourly. Polar orbiting rarer. Historical observations are generally updated once per month, for the previous month.
Temporal resolution	Sub-hourly and less frequently.
Spatial resolution	4 km Available: Observations are available based on the location of the ship/buoy observation, therefore the spatial resolution varies greatly.
Data quality	The selected sources in this document are selected because they are known to have sufficient quality (after some work arounds and adaptations). In general separate indepth verification studies has to be made for each source planned to be used for analysis, and the analysis has to be repeated for

	each geographical area (since sources might be of sufficient quality in one area but not another).
Data Coverage and extent	Regional
Example format	Surface-bases observation: text, CSV and/or netCDF
Timeliness	Hourly/15 mins.
Existing standards	Paragraph C.6.11.3 of ISO 19901-1:2005(E) indicates that visibility below 1 km affects flying (e.g., helicopter operations in support of missions).

Challenge ID	OFF1.13
Title	**Squalls**
Challenge originator: interviewed company	
General Description	
What data/products do you use?	The identification of squalls, as a characterization of transient 10m wind speeds, is essentially limited to surface-based observations, as reported from ships and buoys. The historical records of observed squalls are available via ICOADS. In addition, historical observed squall data are also available from a small number of proprietary measured data sets as indicated in paragraph C.3.2 of ISO 19901-1:2005(E). ICOADS: http://rda.ucar.edu/datasets/ds540.0/ Realtime and near realtime observations of squall data, when observed and reported, are available from many sources including NOAA (NWSTG), NOAA (MADIS), NOAA (NDBC), UCAR, and numerous other data distribution centers. NWSTG: ftp://tgftp.nws.noaa.gov/data/observations/ MADIS: ftp://pftp.madis-data.noaa.gov/ NDBC: http://www.ndbc.noaa.gov/ UCAR: http://thredds.ucar.edu/thredds/idd/newPointObs.html
When do you use this kind of dataset?	Observations of squalls are used by the O&G industry in squall prone areas for all phases throughout the O&G cycle, except strictly operational tasks. The onset of these events can be sudden and interrupt all kinds of operations on deck, helicopter activity, heavy lifts etc. Historical data are important to assess risk of operations in these areas, frequency of occurrence, strength of gusts etc. Also, many other data sources do not catch the extremes in the area without these data added to the time series for the point of interest, since data often are averaged and conditions often are mostly benign. The data sets are used to assist in (a) qualifying and quantifying the means and extremes of squalls, and (b) managing risks

	related to squalls, safeguarding lives, protecting assets, and conducting operations. The data set is used to assess operability in the area, to reduce risk when designing structures and operations, to design strategies to avoid severe conditions.
What are your actual limitations and do you have a work around?	Squall lines can often be identified from satellite pictures. But the intensity of the convective cell is hard to assess. The temporal and spatial resolutions of surface-based observations significantly limit the identification of squalls, as a characterization of transient 10-meter wind speeds. Unless ships or buoys measure and report squalls, the phenomena are not readily available for analysis over vast areas of the ocean. Hence warnings are based on modelled data and spotting of convective cells instead, not too accurate and might lead to downtime when it is not needed.
Needs and expectations on EO data	EO is used for this today, to spot convective cells and try to assess they movement. However, it is hard to assess the wind speed of each individual cell based on satellite data. Also, the direction of movement for each individual cell is often hard to predict. This leads to unnecessary downtime because of warnings. Specific need: Continuous time series of 10m wind speed data in the offshore environment.
Challenge classification	
Pre license	1
Exp.	3
Dev.	3
Prod.	4
Decom.	2
Geographic context/ restrictions	Applies to all six C-CORE areas. Seasonality: Applies to all seasons.
Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	
Technology Urgency	Short term (2-5 years)

Information requirements	
Update frequency	Hourly or 15 mins. Available: Realtime or near-realtime observations are available sub-hourly and less frequently. Historical observations are generally updated once per month, for the previous month.
Temporal resolution	At least hourly. Available: Sub-hourly and less frequently.
Spatial resolution	4-2 km Available: Observations are available based on the location of the ship observation, therefore the spatial resolution varies greatly.
Data quality	The selected sources in this document are selected because they are known to have sufficient quality (after some work arounds and adaptations). In general separate indepth verification studies has to be made for each source planned to be used for analysis, and the analysis has to be repeated for each geographical area (since sources might be of sufficient quality in one area but not another).
Data Coverage and extent	Regional
Example format	Surface-bases observation: text, CSV and/or netCDF
Timeliness	Hourly/15 mins. Hourly or more frequent. Forecasts are normally issued 2 to 4 times per day, warnings when thresholds are passed. But O&G users and forecasters are monitoring conditions continuously.
Existing standards	Paragraph 2.4.3.3 of DNV-RP-C205 discusses a possible modeling solution for squalls, based on vertical wind profiles, but it is not necessarily applicable beyond the Norwegian Sea. Paragraph 7.4 of ISO 19901-1:2005(E) states: The concept of a wind spectrum is only applicable to steady wind conditions. As squalls are not steady, the time and spatial variation of the wind speed in a squall cannot be described by a wind spectrum. Analysis of actions and action effects caused by squalls requires the specification of a time series of wind velocity.

Challenge ID	1.14
Title	**Ice Accretion**
Challenge originator: interviewed company	
General Description	
What data/products do you use?	The identification of historical ice accretion events is essentially limited to reports from surface based observations, as reported from ships and buoys. The historical records of events involving weather conditions that potentially resulted in ice accretion are available via ICOADS. Realtime and near-realtime observations of weather conditions that could potentially result in ice accretion are available from many sources including NOAA (NWSTG), NOAA (MADIS), NOAA (NDBC), UCAR, and numerous other data distribution centers. ICOADS: http://rda.ucar.edu/datasets/ds540.0/ NWSTG: ftp://tgftp.nws.noaa.gov/data/observations/ MADIS: ftp://pftp.madis-data.noaa.gov/ NDBC: http://www.ndbc.noaa.gov/ UCAR: http://thredds.ucar.edu/thredds/idd/newPointObs.html
When do you use this kind of dataset?	Ice accretion might affect and slow down operations on deck, as well as alter the load of structures (if heavy icing occurs). Data are used to (a) qualify and quantify the means and extremes of weather conditions that potentially resulted in ice accretion, and (b) manage risks related to weather conditions that could potentially result in ice accretion, safeguarding lives, protecting assets, and conducting operations.
What are your actual limitations and do you have a work around?	Although surface-based observations report weather events that could result in ice accretion, the observations do not always quantify ice accretion events. The temporal and spatial resolutions of surface-based observations significantly limit the identification of ice accretion events. Unless ships or buoys measure and report ice accretion, the parameter is not readily available for analysis over vast areas of the ocean.

Needs and expectations on EO data	Specific need: More surface-based observations that quantify and verify ice accretion.
Challenge classification	
Pre license	2
Exp.	3
Dev.	3
Prod.	4
Decom.	2
Geographic context/ restrictions	Eastern Mediterranean, Falklands, and West of Ireland. Seasonality: Eastern Mediterranean - Applies to Northern Hemisphere's winter Falklands - Applies to Southern Hemisphere's winter West of Ireland - Applies to Northern Hemisphere's winter
Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	
Technology Urgency	Short term (2-5 years)
Information requirements	
Update frequency	Realtime or near-realtime observations are available sub-hourly and less frequently. Historical observations are generally updated once per month, for the previous month.
Temporal resolution	Sufficient. Sub-hourly and less frequently.
Spatial resolution	Observations are available based on the location of the ship observation, therefore the spatial resolution varies greatly.
Data quality	The selected sources in this document are selected because they are known to have sufficient quality (after some work arounds and adaptations). In general separate indepth verification studies has to be made for each source planned to be used for analysis, and the analysis has to be repeated for each geographical area (since sources might be of sufficient quality in one area but not another).
Data Coverage and extent	Local

Example format	Surface-bases observation: text, CSV and/or netCDF
Timeliness	Daily or twice daily.
Existing standards	NA

Challenge ID	1.15
Title	**Sea Surface Temperatures**
Challenge originator: interviewed company	
General Description	
What data/products do you use?	The sea surface temperatures in the offshore environment are identified through a variety of surface-based observations and modeled reanalyses. Historical sea surface temperatures, observed from ships and buoys, are available via ICOADS, whereas modeled historical sea surface temperatures are available from NOAA (ESRL). ICOADS: http://rda.ucar.edu/datasets/ds540.0/ ESRL: http://www.esrl.noaa.gov/psd/data/gridded/data.cobe2.html Near-realtime sea surface temperatures are available from many sources including NOAA (NWSTG), NOAA (MADIS), NOAA (NDBC), UCAR, and numerous other data distribution centers. NWSTG: ftp://tgftp.nws.noaa.gov/data/observations/ MADIS: ftp://pftp.madis-data.noaa.gov/ NDBC: http://www.ndbc.noaa.gov/ UCAR: http://thredds.ucar.edu/thredds/idd/newPointObs.html Global Sea Surface temperature analysis based on observations from NCOF (via MyOcean): OSTIA: http://www.myocean.eu/ Global Sea Surface Temperature analysis based on satellite observations from NOAA: OISST: ftp://eclipse.ncdc.noaa.gov/pub/OI-daily-v2/NetCDF/
When do you use this kind of dataset?	Sea surface temperatures are important to assess corrosion on steel structures, to assess potential ice accretion from sea spray icing etc. It also has an impact on the behaviour of an oil spill. The data assist in (a) qualifying and quantifying the means and extremes of sea surface temperatures, and (b) managing risks related to sea surface temperatures, safeguarding lives, protecting assets, and conducting operations.

What are your actual limitations and do you have a work around?	Remotely-sensed sea-surface temperatures from geostationary and polar-orbiting satellites provide a healthy record set of historical and current sea surface temperatures. There are no significant limitations.
Needs and expectations on EO data	The needs related to sea-surface temperatures are generally met. Deep-water temperatures, however, require more observations for better analysis results.
Challenge classification	
Pre license	1
Exp.	1
Dev.	2
Prod.	2
Decom.	1
Geographic context/ restrictions	Applies to all six C-CORE areas. Seasonality: Applies to all seasons.
Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	
Technology Urgency	Short term (2-5 years)
Information requirements	
Update frequency	Daily
Temporal resolution	At least daily. Available: Daily and less frequently.
Spatial resolution	Surface-based: Observations are available based on the location of the ship/buoy observation, therefore the spatial resolution varies greatly. Remotely-sensed: Dependant on the IR resolution of the scanning platform, which varies. NOAA OI SST product has 0.25 grid cell resolution. OSTIA product has about 6 km grid cell resolution but is effective accuracy is coarser especially close the coast line.
Data quality	The selected sources in this document are selected because they are known to have sufficient quality (after some work

	arounds and adaptations). In general separate indepth verification studies has to be made for each source planned to be used for analysis, and the analysis has to be repeated for each geographical area (since sources might be of sufficient quality in one area but not another).
Data Coverage and extent	Regional
Example format	Surface-bases observation: text, CSV and/or netCDF Remotely-sensed satellite observation: CSV and/or netCDF
Timeliness	Daily
Existing standards	NA

Challenge ID	1.16
Title	**Funnel Clouds and Waterspouts**
Challenge originator: interviewed company	
General Description	
What data/products do you use?	Funnel clouds and waterspouts in the offshore environment are identified through a variety of surface-based observations. Historical funnel clouds and waterspouts, observed from ships, are available via ICOADS. ICOADS: http://rda.ucar.edu/datasets/ds540.0/ Near-realtime observations of funnel clouds and waterspouts are available from many sources including NOAA (NWSTG), NOAA (MADIS), NOAA (NDBC), UCAR, and numerous other data distribution centers. NWSTG: ftp://tgftp.nws.noaa.gov/data/observations/ MADIS: ftp://pftp.madis-data.noaa.gov/ NDBC: http://www.ndbc.noaa.gov/ UCAR: http://thredds.ucar.edu/thredds/idd/newPointObs.html
When do you use this kind of dataset?	Observations of funnels/sprouts are mostly used by the O&G industry in funnel/spout prone areas for all phases during operations. The onset of thee events can be sudden and interrupt all kinds of operations on deck, helicopter activity etc as they pose a large threat to personnel onboard rigs and vessels. Historical data are important to assess risk of operations in these areas, frequency of occurrence, strength of gusts etc., but are mostly used as input to improve operational forecasting. Also, many other data sources do not catch the extremes in the area without these data added to the time series for the point of interest, since data often are averaged and conditions often are mostly benign. The data set is used to assist in (a) qualifying and quantifying the means and extremes of funnel clouds and waterspouts and (b) managing risks related to funnel clouds and waterspouts, safeguarding lives, protecting assets, and conducting

	operations. The data set is used to assess operability in the area, to reduce risk when designing structures and operations, to design strategies to avoid severe conditions.
What are your actual limitations and do you have a work around?	Convective cells can often be identified from satellite pictures. But it is it is difficult (impossible) to assess the likelihood of funnels/sprouts based on satellite alone. The temporal and spatial resolution of surface-based observations significantly limits the identification of funnel clouds and waterspouts in the offshore environment. Unless ships report funnel clouds and waterspouts, the events are not readily available for analysis over vast areas of the ocean. Hence warnings are based on modelled data, and spotting of convective cells in satellite pictures. Not too accurate and might lead to downtime when it is not needed.
Needs and expectations on EO data	Specific need: More surface-based observations that verify the existence of funnel clouds and waterspouts in the offshore environment.
Challenge classification	
Pre license	1
Exp.	3
Dev.	1
Prod.	3
Decom.	2
Geographic context/ restrictions	Applies to all six C-CORE areas. Seasonality: Applies to all seasons.
Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	
Technology Urgency	Short term (2-5 years)
Information requirements	
Update frequency	Realtime or near-realtime observations are available sub-hourly and less frequently. Historical observations are generally updated once per month, for the previous month.
Temporal resolution	At least hourly.

	Available: Sub-hourly and less frequently.
Spatial resolution	4-2 km Available: Observations are available based on the location of the ship observation, therefore the spatial resolution varies greatly.
Data quality	The selected sources in this document are selected because they are known to have sufficient quality (after some work arounds and adaptations). In general separate indepth verification studies has to be made for each source planned to be used for analysis, and the analysis has to be repeated for each geographical area (since sources might be of sufficient quality in one area but not another).
Data Coverage and extent	Regional.
Example format	Surface-bases observation: text, CSV and/or netCDF
Timeliness	Real- time or near-real time
Existing standards	NA

Challenge ID	1.17
Title	**Convective Downbursts**
Challenge originator: interviewed company	
General Description	
What data/products do you use?	Offshore convective downbursts that are beyond the footprints of land-based radar systems are currently not directly identified via products; however, the existence of convective downbursts may be indirectly inferred by using geostationary and polar-orbiting satellite observations, as well as surface-based observations. Most convective downbursts offshore are not qualified and quantified properly, because, typically, the events are not directly observed.
When do you use this kind of dataset?	Observations of convective downbursts are mostly used by the O&G industry in affected areas during operations. The onset of thee events can be sudden and interrupt all kinds of operations on deck, helicopter activity etc as they pose a large threat to personnel onboard rigs and vessels. Historical data are important to assess risk of operations in these areas, frequency of occurrence, strength of gusts etc, but are mostly used as input to improve operational forecasting. Also, many other data sources do not catch the extremes in the area without these data added to the time series for the point of interest, since data often are averaged and conditions often are mostly benign. The data set is used to assist in (a) qualifying and quantifying the means and convective downbursts and (b) managing risks related to these events, safeguarding lives, protecting assets, and conducting operations. The data set is used to assess operability in the area, to reduce risk when designing structures and operations, to design strategies to avoid severe conditions.
What are your actual limitations and do you have a work around?	In the absence of surface-based radar data, in order to qualify and quantify convective downbursts at sea requires (a) vertical wind profile data, (b) satellite imagery and (c) surface wind data, which must be analyzed together. Typically, the spatial and temporal resolution of a and c are inadequate for the identification of historical convective downbursts. Hence warnings are based on modelled data and spotting of

	convective cells in satellite pictures, not too accurate and might lead to downtime when it is not needed.
Needs and expectations on EO data	EO is used for this today, to spot convective cells and try to assess they movement. However, it is hard to assess the wind speed of each individual cell based on satellite data. Also, the direction of movement for each individual cell is often hard to predict. This leads to unnecessary downtime because of warnings. Specific need: Continuous time series of 10m wind speed data in the offshore environment. Specific need: Higher temporal and spatial resolution of vertical wind profiles, and surface wind data are needed to verify the occurrences of convective downbursts in the offshore environment.
Challenge classification	
Pre license	1
Exp.	3
Dev.	1
Prod.	3
Decom.	2
Geographic context/ restrictions	Applies to all six C-CORE areas. Seasonality: Applies to all seasons.
Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	
Technology Urgency	Short term (2-5 years)
Information requirements	
Update frequency	The parameter is not directly available in observations.
Temporal resolution	The parameter is not directly available in observations.
Spatial resolution	The parameter is not directly available in observations.
Data quality	The selected sources in this document are selected because they are known to have sufficient quality (after some work arounds and adaptations). In general separate indepth

	verification studies has to be made for each source planned to be used for analysis, and the analysis has to be repeated for each geographical area (since sources might be of sufficient quality in one area but not another).
Data Coverage and extent	Regional
Example format	The parameter is not directly available in observations.
Timeliness	Real- time or near-real time
Existing standards	NA

Challenge ID	1.18
Title	**Lightning**
Challenge originator: interviewed company	
General Description	
What data/products do you use?	Historical surface-based lightning observations are available via ICOADS. Historical remotely-sensed lightning data are available via NASA, as well as proprietary commercial sources WSI (GLN), and Vaisala (GLD360). ICOADS: http://rda.ucar.edu/datasets/ds540.0/ NASA: ftp://ghrc.nsstc.nasa.gov/pub/data/otd/ NASA: ftp://ghrc.nsstc.nasa.gov/pub/data/lis/science/ WSI: http://www.wsi.com/products-lightning-global-lightning-network.htm Vaisala: http://www.vaisala.com/ Near-realtime observations of lightning are available from many sources including NOAA (NWSTG), NOAA (MADIS), UCAR, and numerous other data distribution centers, as well as proprietary commercial sources WSI (GLN), and Vaisala (GLD360). NWSTG: ftp://tgftp.nws.noaa.gov/data/observations/ MADIS: ftp://pftp.madis-data.noaa.gov/ UCAR: http://thredds.ucar.edu/thredds/idd/newPointObs.html WSI: http://www.wsi.com/products-lightning-global-lightning-network.htm Vaisala: http://www.vaisala.com/
When do you use this kind of dataset?	Observations of lightning are mostly used by the O&G industry during operational tasks. The onset of these events can be sudden and interrupt all kinds of operations on deck, helicopter activity etc as they pose a large threat to personnel onboard rigs and vessels. Historical data are important to assess risk of operations in these areas, frequency of occurrence etc., but are mostly used as input to improve operational forecasting. The data set is used to assist in (a) qualifying and quantifying the means and extremes of lightning and (b) managing risks related to lightning, safeguarding lives, protecting assets, and

	conducting operations. The data set is used to assess operability in the area, to reduce risk when designing structures and operations, to design strategies to avoid severe conditions.
What are your actual limitations and do you have a work around?	Surface-based observations, surface-based remote network sensors, and remote sensors in orbit collectively provide a healthy coverage pattern for global lightning, although the lightning strike data based on surface-based network sensors is proprietary and very expense for commercial interests to obtain. Hence warnings are based on modelled data, and spotting of convective cells in satellite pictures, and where available lightning sensors. Not too accurate and might lead to downtime when it is not needed.
Needs and expectations on EO data	EO is used for this today, to spot convective cells and try to assess they movement. However, it is hard to assess the wind speed of each individual cell based on satellite data. Also, the direction of movement for each individual cell is often hard to predict. This leads to unnecessary downtime because of warnings. Specific need: Continuous time series of 10m wind speed data in the offshore environment. Specific need: Less expensive (or free) access to detailed lightning strike data, which is currently proprietary and quite expensive for commercial interests to acquire for commercial research.
Challenge classification	
Pre license	1
Exp.	3
Dev.	1
Prod.	3
Decom.	2
Geographic context/ restrictions	Applies to all six C-CORE areas. Seasonality: Applies to all seasons.
Topographic classification / Offshore classification	Ocean

Activity impacted/concerned	
Technology Urgency	Short term (2-5 years)
Information requirements	
Update frequency	Historical: Daily and less frequently. Near-realtime: Sub-minutely and less frequently.
Temporal resolution	Real time or near real-time, 10 mins. Available: Surface-based observations: Sub-hourly and less frequently. Remotely-sensed surface network observations: Sub-minutely and less frequently. Remotely-sensed satellite observations: Sub-daily and less frequently.
Spatial resolution	Surface-based observations are available based on the location of the ship observation, therefore the spatial resolution varies greatly. Remotely-sensed surface network observations: <1 km and coarser. Remotely-sensed satellite observations: 3 km and coarser.
Data quality	The selected sources in this document are selected because they are known to have sufficient quality (after some work arounds and adaptations). In general separate indepth verification studies has to be made for each source planned to be used for analysis, and the analysis has to be repeated for each geographical area (since sources might be of sufficient quality in one area but not another).
Data Coverage and extent	Regional
Example format	netCDF and CSV
Timeliness	Real- time or near-real time
Existing standards	NA

Challenge ID	1.19
Title	**Hail**
Challenge originator: interviewed company	
General Description	
What data/products do you use?	Historical surface-based hail observations are available via ICOADS. ICOADS: http://rda.ucar.edu/datasets/ds540.0/ Near-realtime observations of hail are available from many sources including NOAA (NWSTG), NOAA (MADIS), UCAR, and numerous other data distribution centers. NWSTG: ftp://tgftp.nws.noaa.gov/data/observations/ MADIS: ftp://pftp.madis-data.noaa.gov/ UCAR: http://thredds.ucar.edu/thredds/idd/newPointObs.html
When do you use this kind of dataset?	Observations of large hail events can be used by the O&G industry to assess the risk of these events happening. Large hail can be disruptive to all operations on deck, damage equipment etc. Historical data are important to assess risk of operations in these areas, frequency of occurrence etc., but are mostly used as input to improve operational forecasting. The data set is used to assist in (a) qualifying and quantifying the means and extremes of hail and (b) managing risks related to hail, safeguarding lives, protecting assets, and conducting operations. The data set is used to assess operability in the area, to reduce risk when designing structures and operations, to design strategies to avoid severe conditions.
What are your actual limitations and do you have a work around?	The temporal and spatial resolutions of surface-based observations significantly limit the identification of hail events in the offshore environment. Unless ships measure and report hail, the parameter is not readily available for analysis over vast areas of the ocean.
Needs and expectations on EO data	EO is used for this today, to spot convective cells and try to assess they movement. However, it is hard to assess the wind speed of each individual cell based on satellite data. Also, the direction of movement for each individual cell is often hard to

	predict. This leads to unnecessary downtime because of warnings. Specific need: Continuous time series of 10m wind speed data in the offshore environment. Specific need: More surface-based observations that verify the existence of hail in the offshore environment.
Challenge classification	
Pre license	1
Exp.	2
Dev.	1
Prod.	2
Decom.	1
Geographic context/ restrictions	Applies to all six C-CORE areas. Seasonality: Applies to all seasons.
Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	
Technology Urgency	Short term (2-5 years)
Information requirements	
Update frequency	Realtime or near-realtime observations are available sub-hourly and less frequently. Historical observations are generally updated once per month, for the previous month.
Temporal resolution	At least hourly. Available: Sub-hourly and less frequently. .
Spatial resolution	4-2 km Available: Surface-based observations are available based on the location of the ship observation, therefore the spatial resolution varies greatly.
Data quality	The selected sources in this document are selected because they are known to have sufficient quality (after some work arounds and adaptations). In general separate indepth verification studies has to be made for each source planned to be used for analysis, and the analysis has to be repeated for

	each geographical area (since sources might be of sufficient quality in one area but not another).
Data Coverage and extent	Regional
Example format	Surface-bases observation: text, CSV and/or netCDF
Timeliness	Real- time or near-real time
Existing standards	NA

3 ENVIRONMENTAL REQUIREMENTS

Challenge ID	OFF2.1

Title	**Monitoring of landfall site recovery and coastal vegetation**
	Includes initial characterization and vulnerability of coastline and nearshore environment
	
	• Coastline vulnerability; change detection
	• Initial impact and recovery time
	• Parameters of interest:
	  ○ Shallow bottom vegetation and substrate
	  ○ Terrestrial and intertidal/subtidal, two parameters
	• Baseline information is most critical
	• Need to interface with oil spill trajectory models
	• Need to cover sufficiently large area
	• General requirement, not specific to Ireland

Challenge originator: interviewed company	Falkland islands Biodiversity Strategy: 2008 – 2018. 2008. Falkland Islands Government: Environmental Planning Department. Available at: http://www.epd.gov.fk/wp-content/uploads/BiodiversityStrategy09.pdf
General Description	
What data/products do you use?	Vegetation data currently collected through shoreline surveys, but satellite imagery has been used to help with broad vegetation classification
When do you use this kind of dataset?	When offshore production transported to shore via pipeline, or operation requires construction of a terminal and has associated shipping with potential of oil spills in nearshore environment
What are your actual limitations and do you have a work around?	EO products have been used in some cases but are expensive. Using EO products for this would still require on-the-ground validation, but if area is extensive, assessment in this way would save time and could easily be repeated on a seasonal basis.
Needs and expectations on EO data	High resolution maps that will allow characterization/ classification of coastal vegetation and coastal substrate
Challenge classification	
Pre license	3
Exp.	1

Dev.	1
Prod.	2
Decom.	1
Geographic context/ restrictions	- Ireland;all areas
Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	Strategic decision enabler
Technology Urgency	Mid-Term (5-10 years)
Information requirements	
Update frequency	One-off, perhaps every few years might be helpful
Temporal resolution	Seasonal
Spatial resolution	1m
Data quality	High
Data Coverage and extent	District area
Example format	High resolution image
Timeliness	Reference data - timeliness not important
Existing standards	

Challenge ID	OFF2.2
Title	**Submarine landslides and seabed stability** Detection, aging of submarine slides Site Surveys for Geohazards • Currently monitored/mapped using side-scan sonar • Geohazards include earthquakes, mass movement, unexploded ordnance etc.
Challenge originator: interviewed company	ERT Scotland. 2008. Third strategic environmental assessment for oil and gas activity in Ireland's offshore Atlantic waters: IOSEA3 Rockall Basin. Prepared for Department of Communications, Energy and Natural Resources Galil B. and Herut B. 2011. *Marine environmental issues of deep-sea exploration and exploitation activities (oil and gas) off the coast of Israel.* IOLR Report H15/2016 Georgiopoulou, A., S. Krastel, D. G. Masson and R. B. Wynn. 2007. *Repeated Instability Of The New African Margin Related To Buried Landslide Scarps.* Pp. 29-36 in *Submarine* Mass Movements and Their Consequences, Advances in Natural and Technological Hazards Research Vol. 27. General requirement
General Description	
What data/products do you use?	Sidescan, multibeam sonar bathymetry maps, sub-surface data if available
When do you use this kind of dataset?	During seismic surveys to determine susceptibility of substrate to seismic activities and gain information on substrate stability During exploration and development to help determine of anchor placement or location of production platform
What are your actual limitations and do you have a work around?	This data is currently not available unless the area has seen recent multibeam mapping. Current data acquisition is vessel based and thus expensive and time consuming
Needs and expectations on EO data	Not sure, EO capabilities can address this as it requires penetration to ocean floor

	Unclear - require sub-sediment penetration into ocean floor
Challenge classification	
Pre license	3
Exp.	4, **4**(2.37)
Dev.	**4**(2.37)
Prod.	
Decom.	1
Geographic context/ restrictions	Western Ireland, Eastern Mediterranean, Morocco / Western Sahara Everywhere(2.37)
Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	Strategic decision enabler Cost reduction, reduction of HSE risk associated with vessel based surveys (2.37)
Technology Urgency	Mid-Term (5-10 years); the cheaper it is the faster we want it (if better than current); large area coverage with satellite would be very useful (high-res altimetry?)
Information requirements	
Update frequency	One-off
Temporal resolution	None
Spatial resolution	10-100m up to 1 m for unexploded ordnance; different resolution for different development stages
Data quality	High
Data Coverage and extent	District area
Example format	High resolution image
Timeliness	Reference data - timeliness not important
Existing standards	

Challenge ID	OFF2.3
Title	**Shipwrecks and other archaeological value areas** Geophysical mapping of the upper sub-surface and detection of man-made features on the seafloor • Unexploded ordnance is a concern • Major issue in the Mediterranean
Challenge originator: interviewed company	Enterprise Energy Ireland Ltd and ERT Scotland. 2008. Third strategic environmental assessment for oil and gas activity in Ireland's offshore Atlantic waters: IOSEA3 Rockall Basin. Prepared for Department of Communications, Energy and Natural Resources Galil B. and Herut B. 2011. *Marine environmental issues of deep-sea exploration and exploitation activities (oil and gas) off the coast of Israel.* IOLR Report H15/2013
General Description	
What data/products do you use?	Historic database showing location of shipwrecks and map of documented archeological sites where available, ROV survey data, multibeam data, sediment grabs
When do you use this kind of dataset?	Impact assessments, seismic surveys
What are your actual limitations and do you have a work around?	Use the aforementioned databases but they are limited to knowledge from areas that have previously been surveyed for other purposes
Needs and expectations on EO data	Not sure, EO capabilities can address this as it requires penetration to ocean floor Maybe in very shallow water?? Not really
Challenge classification	
Pre license	4
Exp.	
Dev.	
Prod.	
Decom.	
Geographic context/ restrictions	Western Ireland, Eastern Mediterranean

Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	Strategic decision enabler
Technology Urgency	Mid-Term (5-10 years) Long Term (10+ years)(Eastern Mediterranean)
Information requirements	
Update frequency	One-off
Temporal resolution	None
Spatial resolution	10-100m
Data quality	High
Data Coverage and extent	District area
Example format	High resolution image
Timeliness	Reference data - timeliness not important
Existing standards	

Challenge ID	OFF2.4
Title	**Detection and monitoring of pollutant discharges** Parameters: Cement, cuttings, mud, oil discharges • Monitor coastal and offshore oil pollution to assess the impact of pollution on the marine environment • Monitoring of pollution arising from oil spillage and gas flaring • Validation of models is tricky • Surface current data will be helpful (cross-reference to metocean) • Operational discharges (at depth/surface) • Accidental discharges (at depth/surface) • Authorized surface discharges can be used for validation • High-resolution imagery can be used to detect pollutant plumes and slicks
Challenge originator: interviewed company	ERT Scotland. 2008. Third strategic environmental assessment for oil and gas activity in Ireland's offshore Atlantic waters: IOSEA3 Rockall Basin. Prepared for Department of Communications, Energy and Natural Resources Galil B. and Herut B. 2011. *Marine environmental issues of deep-sea exploration and exploitation activities (oil and gas) off the coast of Israel.* IOLR Report H15/2012. RPS Energy. 2009. *Environmental Impact Assessment for Offshore Drilling The Falkland Islands.* Report prepared for Rockhopper Exploration PLC. Huang, Weigen, Fu, Bin. 2002. *Remote Sensing for Coastal Area Management.* Laboratory of Ocean Dynamic Processes and Satellite Oceanography Second Institute of Oceanography State Oceanic Administration Hangzhou, People's Republic of China in China. *Coastal Management,* 30:271–276, 2002.; UNEP, 2005. Wilkinson, C., DeVantier, L., Talaue-McManus, L., Lawrence, D. and D. Souter. South China Sea, GIWA Regional assessment 54. University of Kalmar, Kalmar, Sweden. BOBLME (2011) Country report on pollution – Myanmar. BOBLME-2011-Ecology-13; Ramamurthy, V.D. and J. Sreenivasan. 1983. Sources of Oil Pollution along the Indian

	Coasts of Arabian Sea, Bay of Bengal Indian Ocean, and its Impact on Commercial Fisheries. Anales Del Instituto de Ciencias del Mar Y Limnología. Akpomuvie, Orhioghene, Benedict. 2011. Tragedy of Commons: Analysis of Oil Spillage, Gas Flaring and Sustainable Development of the Niger Delta of Nigeria. Journal of Sustainable Development. Vol. 4, No. 2. IPIECA publications on oil spill avoidance, preparedness response and best practices (http://www.ipieca.org/topic/oil-spill-preparedness/oil-spill-report-series)
General Description	
What data/products do you use?	Models, aerial surveillance, satellite imagery, drifter buoys, in situ monitoring at platforms
When do you use this kind of dataset?	To aid in trajectory modeling, spill response and protection of important ecological and archeological areas
What are your actual limitations and do you have a work around?	Validations of trajectory models is difficult and in case of a spill in situ monitoring is limited to aerial surveillance, weather limitations of current technology
Needs and expectations on EO data	High resolution imagery capable of detecting and tracking slicks and plumes of discharged materials
Challenge classification	
Pre license	1 modelling happens at this phase
Exp.	3
Dev.	3
Prod.	3
Decom.	3
Geographic context/ restrictions	All Regions
Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	Operational, response capability enhancement

Technology Urgency	Short term (2-5 years)
Information requirements	
Update frequency	1-6 h during time of discharge
Temporal resolution	1-6 h during time of discharge
Spatial resolution	10-100m
Data quality	High
Data Coverage and extent	Regional
Example format	High resolution image
Timeliness	As close to real-time as possible
Existing standards	

Challenge ID	OFF2.5
Title	**Distribution and abundance of marine mammals** • Consistently identified as gap in strategic environmental assessments • Seismic activities, noise and spills affect mammals • Importance is "4" for all life cycle stages • Applicable to all areas • Timeliness: hourly updates required in case of spills or seismic activity
Challenge originator: interviewed company	OSPAR Commission. 2009 document. Assessment. ERT Scotland. 2008. Third strategic environmental assessment for oil and gas activity in Ireland's offshore Atlantic waters: IOSEA3 Rockall Basin. Prepared for Department of Communications, Energy and Natural Resources. RPS Energy. 2009. *Environmental Impact Assessment for Offshore Drilling The Falkland Islands.* Report prepared for Rockhopper Exploration PLC.
General Description	
What data/products do you use?	Abundance and distribution data from ship-based or aerial surveys
When do you use this kind of dataset?	During seismic and drilling activities to determine impacts of noise on marine mammals and during discharges to determine vulnerability and impact; seismic noisy and spills affect mammals
What are your actual limitations and do you have a work around?	Vessel and aerial surveys are time consuming and expensive. Current data products are adequate but need to be updated and repeated on a regular basis due to high natural variability, seasonal data and weather dependant
Needs and expectations on EO data	High resolution imagery that would allow counting and possibly identifying marine mammals when at the surface. Could be visual or IR
Challenge classification	
Pre license	4
Exp.	4
Dev.	4
Prod.	4
Decom.	4

Geographic context/ restrictions	Western Ireland, Falklands; all areas?
Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	Cost reduction, reduction of HSE risk associated with vessel based and aerial surveys, improved project planning
Technology Urgency	Short term (2-5 years)
Information requirements	
Update frequency	Weekly-monthly
Temporal resolution	Weekly-monthly
Spatial resolution	1-10m
Data quality	High
Data Coverage and extent	Regional
Example format	High resolution image
Timeliness	Reference data - timeliness not important except for spill or seismic…hourly needed
Existing standards	

Challenge ID	OFF2.6
Title	**Distribution and abundance of seabirds** • Includes interaction between birds and light, flare and ships • Importance is "3" for all life cycle stages • Coverage is regional and includes shipping route
Challenge originator: interviewed company	OSPAR Commission. 2009 document. Assessment of impacts of offshore oil and gas activities in the North-East Atlantic. Woods, R., R. Ingham, & A. Brown. 2009. Falkland Islands (Malvinas). Pp 205 – 212 in C. Devenish, D. F. Díaz Fernández, R. P. Clay, I. Davidson & I. Yépez Zabala Eds. *Important Bird Areas Americas - Priority sites for biodiversity conservation.* Quito, Ecuador: BirdLife International (BirdLife Conservation Series No. 16). Camphuysen CJ. & J. van der Meer. 2010. *Wintering seabirds in West Africa: foraging hotspots off Western Sahara and Mauritania driven by upwelling and fisheries.* African Journal of Marine Science, Vol. 27(2), pp. 427-437
General Description	
What data/products do you use?	Direct observations of bird-light/flare interactions Direct observations of birds using ship-based and/or aerial surveys
When do you use this kind of dataset?	During exploratory drilling and production when lighted platforms are out there and/or there is flaring During seismic and drilling activities to determine impacts of light on seabirds and during discharges to determine vulnerability and impact
What are your actual limitations and do you have a work around?	Bird mortality due to light and flares is sporadic and dependent on time of year (migration periods) and weather. Assessment is difficult for those reasons, requires constant monitoring, but can affect large numbers of birds (up to 10% of migrating birds in North Sea) Vessel and aerial surveys are time consuming and expensive. Current data products are adequate but need to be updated and repeated on a regular basis due to high natural variability

Needs and expectations on EO data	Unclear - requires high temporal spatial resolution and cloud penetration High resolution imagery that would allow counting and possibly identifying seabirds. Could be visual or IR
Challenge classification	
Pre license	3
Exp.	(Ireland), 3
Dev.	(Ireland), 3
Prod.	(Ireland), 3
Decom.	3(Ireland)
Geographic context/ restrictions	Western Ireland, Falklands, Morocco / Western Sahara
Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	Cost reduction, reduction of HSE risk associated with vessel based surveys
Technology Urgency	Mid to Long Term (5-10, 10+ years(Ireland))
Information requirements	
Update frequency	Weekly-monthly
Temporal resolution	Weekly-monthly
Spatial resolution	<1m
Data quality	High
Data Coverage and extent	regional; include shipping routes (light)
Example format	High resolution image
Timeliness	As close to real-time as possible
Existing standards	

Challenge ID	OFF2.7
Title	**Information on presence and abundance of deep water fauna** Includes deep-water coral and other vulnerable seabed habitat • Parameters of interest include bottom type and topography
Challenge originator: interviewed company	Galil B. and Herut B. 2011. *Marine environmental issues of deep-sea exploration and exploitation activities (oil and gas) off the coast of Israel.* IOLR Report H15/2011
General Description	
What data/products do you use?	ROV surveys and multibeam
When do you use this kind of dataset?	During environmental impact assessments (EIAs), oil spill response, environmental damage assessment
What are your actual limitations and do you have a work around?	ROV and multibeam surveys are expensive and time consuming
Needs and expectations on EO data	Not sure, EO capabilities can address this as it requires penetration to ocean floor and species and/or habitat identification
Challenge classification	
Pre license	4
Exp.	4
Dev.	4
Prod.	4
Decom.	3
Geographic context/ restrictions	- Eastern Mediterranean;
Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	Strategic decision enabler
Technology Urgency	Mid-Term (5-10 years); short term, the sooner the better
Information requirements	
Update frequency	Yearly, for monitoring of change, but hourly during oil spills
Temporal resolution	Seasonal or yearly

Spatial resolution	1-10m
Data quality	High
Data Coverage and extent	; regional
Example format	High resolution image
Timeliness	Reference data - timeliness not important, near real time for spill
Existing standards	

Challenge ID	OFF2.8
Title	**Scientific independence in environmental monitoring of pollution** Accidental spills, drill cuttings, atmospheric emissions, light and noise • Often no independent verification • Due diligence tool • Everybody having the same information would be good as quality check • Geographic context: regional bias, lack of transparency in environmental monitoring and reporting
Challenge originator: interviewed company	Galil B. and Herut B. 2011. *Marine environmental issues of deep-sea exploration and exploitation activities (oil and gas) off the coast of Israel.* IOLR Report H15/2014
General Description	
What data/products do you use?	Aerial surveillance, self-reporting
When do you use this kind of dataset?	Any time once exploratory drilling commences
What are your actual limitations and do you have a work around?	Public confidence in self-reporting is low, aerial surveillance or other types of independent monitoring are few, expensive or non-existent
Needs and expectations on EO data	High resolution imagery capable of detecting and tracking slicks and plumes of discharged materials
Challenge classification	
Pre license	
Exp.	3
Dev.	3
Prod.	3
Decom.	3
Geographic context/ restrictions	- Eastern Mediterranean (lack of transparence in envt. Monitoring, reporting); regional bias
Topographic classification / Offshore classification	Ocean

Activity impacted/concerned	Due diligence tool
Technology Urgency	Immediately (0-2 years)
Information requirements	
Update frequency	Daily
Temporal resolution	Daily
Spatial resolution	10-100m
Data quality	High
Data Coverage and extent	District area
Example format	High resolution image
Timeliness	As close to real-time as possible
Existing standards	

Challenge ID	OFF2.9
Title	**Security and safety** • Operational rather than environmental requirement • Issues include piracy, unauthorized access to installations, encroachment • Geographic context: importance depends on geography and political context
Challenge originator: interviewed company	U.S. Energy Information Administration. Eastern Mediterranean Region. Overview of oil and natural gas in the Eastern Mediterranean region. Last updated August 12, 2013.
General Description	
What data/products do you use?	Aerial surveillance, coast guard, satellite imagery
When do you use this kind of dataset?	Any time once exploratory drilling commences
What are your actual limitations and do you have a work around?	Physical security of offshore operations due to political instability is a concern and could cause environmental damage in the area
Needs and expectations on EO data	High resolution imagery capable of detecting unauthorized shipping and other activity in the vicinity of offshore operations
Challenge classification	
Pre license	
Exp.	3
Dev.	3
Prod.	3
Decom.	3
Geographic context/ restrictions	- Eastern Mediterranean; importance depends on geography/political context
Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	Strategic decision enabler
Technology Urgency	Immediately (0-2 years)
Information requirements	
Update frequency	Hourly to Daily

Temporal resolution	Hourly to Daily
Spatial resolution	10-100m
Data quality	High
Data Coverage and extent	District area
Example format	High resolution image
Timeliness	As close to real-time as possible
Existing standards	

Challenge ID	OFF2.10
Title	**Monitoring of chlorophyll-a** Productivity and harmful algal blooms (HAB) • Broad context is impact of ocean productivity on marine organisms • Satellite imagery is routinely used for ocean colour applications • Data from SEAWIFS (now defunct) has not been widely used by O/G industry • In-situ measurement sets context for timing of primary production; goal is understanding the integrated productivity throughout water column • Possible to correlate wastewater discharge with chlorophyll-a, interface different
Challenge originator: interviewed company	RPS Energy. 2009. *Environmental Impact Assessment for Offshore Drilling The Falkland Islands.* Report prepared for Rockhopper Exploration PLC. DanLing Tang, Hiroshi Kawamura, Tran Van Dien, MingAn Lee. 2004. *Offshore phytoplankton biomass increase and its oceanographic causes in the South China Sea.* Marine Ecology Progress Series. Vol. 268: 31-41. Jing Yu, Dan-Ling Tang, Im-Sang Oh, and Li-Jun Yao. 2007. *Response of Harmful Algal Blooms to Environmental Changes in Daya Bay, China*. Terr. Atmos. Ocean. Sci., Vol. 18, No. 5, 1011-1027.
General Description	
What data/products do you use?	Ship-based sampling (plankton tows), MODIS and SeaWifs ocean colour Ship-based measurements; satellite images
When do you use this kind of dataset?	To determine timing and magnitude of productivity and HABs in the area - would help with assessing change in ocean climate on a regional basis that would be reflected in environmental effects monitoring (EEM) data around the operation without causal linkage

What are your actual limitations and do you have a work around?	EEM data is generally collected around production platforms without a broader spatial or temporal environmental context. If changes in productivity or biota are detected around the site, it may not be clear whether it is a human induced effect or if it reflects an independent regional shift in ocean conditions. Data is sparse and SeaWifs is offline. To collect all these environmental data would require extensive ship surveys which are time consuming and expensive
Needs and expectations on EO data	Ocean colour imagery Satellite imagery to detect features such a productivity (colour), SSH, temperature, winds, waves, fronts, etc.
Challenge classification	
Pre license	3
Exp.	3 4 under spill even
Dev.	3 (4 under spill event)
Prod.	3 4 under spill even
Decom.	3
Geographic context/ restrictions	– Falklands, South China Sea, Myanmar, Morocco / Western Sahara; probably all reas
Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	Possible reduction of environmental liability
Technology Urgency	Immediately (0-2 years)
Information requirements	
Update frequency	Daily-weekly Daily-seasonal (Morocco / Western Sahara)
Temporal resolution	Daily-weekly; during spill event, more frequently, monitor effect of spill or application of dispersant Daily-seasonal (Morocco / Western Sahara)
Spatial resolution	100m (important in some areas, coastal); open ocean 1km 1-100m (Morocco / Western Sahara)
Data quality	Medium to high
Data Coverage and extent	Regional

Example format	Ocean colour imagery
Timeliness	Within a month As close to real-time as possible
Existing standards	

Challenge ID	OFF2.11
Title	**Monitoring of waste management practices**
Challenge originator: interviewed company	RPS Energy. 2009. *Environmental Impact Assessment for Offshore Drilling The Falkland Islands.* Report prepared for Rockhopper Exploration PLC. General requirement • Plumes/slicks due to discharge of regular waste (kitchen waste, grey water, black water, etc.) • All operations have waste management protocol • Waste protocols cover different products in different jurisdictions
General Description	
What data/products do you use?	Self-reporting, ship-based water sampling, aerial surveys, ship to shore waste transfer
When do you use this kind of dataset?	Environmental and compliance monitoring
What are your actual limitations and do you have a work around?	Self-reporting is not trusted, other sampling is infrequent and expensive
Needs and expectations on EO data	High resolution imagery capable of detecting and tracking plumes of discharged materials
Challenge classification	
Pre license	
Exp.	1
Dev.	1
Prod.	1
Decom.	1
Geographic context/ restrictions	All regions
Topographic classification / Offshore classification	Ocean

Activity impacted/concerned	Public trust, compliance, environmental liability
Technology Urgency	Short term (2-5 years)
Information requirements	
Update frequency	Daily-weekly
Temporal resolution	Daily-weekly
Spatial resolution	100m
Data quality	Medium to high
Data Coverage and extent	District area, vessel route and onshore site
Example format	Mid-high resolution image
Timeliness	As close to real-time as possible
Existing standards	

Challenge ID	OFF2.12
Title	**Coastal resource mapping of mangroves, coral reefs, wetlands, and sandbanks**
Challenge originator: interviewed company	Huang, Weigen, Fu, Bin. 2002. *Remote Sensing for Coastal Area Management.* Laboratory of Ocean Dynamic Processes and Satellite Oceanography Second Institute of Oceanography State Oceanic Administration Hangzhou, People's Republic of China in China. *Coastal Management,* 30:271–276, 2002. UNEP, 2005. Wilkinson, C., DeVantier, L., Talaue-McManus, L., Lawrence, D. and D. Souter. South China Sea, GIWA Regional assessment 54. University of Kalmar, Kalmar, Sweden. BOBLME (2011) Country report on pollution – Myanmar. BOBLME-2011-Ecology-14
General Description	
What data/products do you use?	Data currently collected through shoreline, small boat, and dive surveys but satellite imagery has been used to help with broad classification
When do you use this kind of dataset?	When offshore production transported to shore via pipeline, or operation requires construction of a terminal and has associated shipping with potential of oil spills in nearshore environment
What are your actual limitations and do you have a work around?	EO products have been used in some cases but are expensive. Using EO products for this would still require on-the-ground validation, but if area is extensive, assessment in this way would save time and could easily be repeated on a seasonal basis.
Needs and expectations on EO data	High resolution maps that will allow characterization/ classification of inter and sub-tidal and nearshore environment High resolution maps that will allow characterization/ classification of coral reefs
Challenge classification	
Pre license	1
Exp.	1
Dev.	1
Prod.	1
Decom.	1
Geographic context/ restrictions	- South China Sea, Falklands, Myanmar

Topographic classification / Offshore classification	Shallow Water
Activity impacted/concerned	Strategic decision enabler
Technology Urgency	Mid-Term (5-10 years)
Information requirements	
Update frequency	One-off, perhaps every few years might be helpful One-off for initial assessment and monthly for monitoring purposes
Temporal resolution	Seasonal
Spatial resolution	1m
Data quality	High
Data Coverage and extent	District area, vessel route and onshore site
Example format	High resolution image
Timeliness	Reference data - timeliness not important
Existing standards	

Challenge ID	OFF2.13
Title	**Coastal sediment dynamics, estuarine fronts, and land–ocean interactions.** • More important/necessary if coastal infrastructure is involved: equipment, terminal • Does not include bottom; discharges from land, siltation, coastal erosion (link with water quality/turbidity) • Currently achieved using modelling • Satellite images used to identify fronts, especially off-shore
Challenge originator: interviewed company	Huang, Weigen, Fu, Bin. 2002. *Remote Sensing for Coastal Area Management.* Laboratory of Ocean Dynamic Processes and Satellite Oceanography Second Institute of Oceanography State Oceanic Administration Hangzhou, People's Republic of China in China. *Coastal Management,* 30:271–276, 2002.
General Description	
What data/products do you use?	Models, aerial surveillance, satellite imagery
When do you use this kind of dataset?	To monitor coastal erosion, freshwater run-off and other dynamics that can influence currents and sedimentation in the nearshore environment
What are your actual limitations and do you have a work around?	Acquiring data of this type is difficult and expensive, requires modeling and in-situ data validation
Needs and expectations on EO data	High resolution imagery capable of detecting and tracking plumes and oceanic fronts
Challenge classification	
Pre license	2
Exp.	2
Dev.	2
Prod.	2
Decom.	
Geographic context/ restrictions	- South China Sea
Topographic classification / Offshore classification	Shallow Water

Activity impacted/concerned	Operational, response capability enhancement
Technology Urgency	Short term (2-5 years)
Information requirements	
Update frequency	1-6 h during time of discharge (hourly to daily)
Temporal resolution	1-6 h during time of discharge
Spatial resolution	10-100m
Data quality	High
Data Coverage and extent	Regional
Example format	High resolution image
Timeliness	As close to real-time as possible
Existing standards	

Challenge ID	OFF2.14
Title	**Coastal upwelling** Includes index of seasonal and inter-annual variations of summer upwelling • Indicates high productivity • Provides context • Can be achieved via SSH or SST or ocean colour • EO can provide context, time series, help explain what is observed • EO not really widely used, but if something happens, people would come looking for EO-derived information
Challenge originator: interviewed company	Xie, S.-P., Q. Xie, D. Wang, and W. T. Liu. 2003. *Summer upwelling in the South China Sea and its role in regional climate variations.* J. Geophys. Res., Vol. 108(3261), doi:10.1029/2003JC001867, C8. Pelegrí, J.L. et al. 2005. *Coupling between the open ocean and the coastal upwelling region off northwest Africa: water recirculation and offshore pumping of organic matter*. Journal of Marine Systems, Volume 54, Issues 1–4, February 2005, Pp. 3-37 Available online at: http://www.sciencedirect.com/science/article/pii/S0924796304002027
General Description	
What data/products do you use?	Ship-based measurements; satellite images
When do you use this kind of dataset?	To determine timing and magnitude of productivity in the area - would help with assessing change in ocean climate on a regional basis that would be reflected in environmental effects monitoring (EEM) data around the operation without causal linkage
What are your actual limitations and do you have a work around?	To detect timing and extent of upwelling would require extensive ship surveys which are time consuming and expensive
Needs and expectations on EO data	Satellite imagery to detect upwelling features such a productivity, SSH, temperature
Challenge classification	
Pre license	2

Exp.	1
Dev.	1
Prod.	1
Decom.	1
Geographic context/ restrictions	- South China Sea, Morocco / Western Sahara
Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	Possible reduction of environmental liability
Technology Urgency	Immediately (0-2 years)
Information requirements	
Update frequency	Weekly-seasonal South China Sea Daily-seasonal (Morocco / Western Sahara)
Temporal resolution	Weekly-seasonal South China Sea Daily-seasonal (Morocco / Western Sahara)
Spatial resolution	100m – > 1km
Data quality	Medium to high
Data Coverage and extent	Regional
Example format	Ocean colour imagery
Timeliness	Within a month South China Sea As close to real-time as possible (Morocco / Western Sahara)
Existing standards	

Challenge ID	OFF2.15
Title	**Fish and fish habitat**
Challenge originator: interviewed company	General requirement • Habitat includes bottom type for shallow areas • Need to have reference area(s) to estimate uniqueness/significance • Looking for any change in fish habitat • EO can be used to map bottom type in clear, shallow water (not applicable to deep water) • Seasonal changes of habitat parameters can be important (e.g. temperature) • Importance should be 4 in all life cycle stages
General Description	
What data/products do you use?	Sidescan and multibeam survey data for habitat, stock-assessment and fishing effort data for fish distribution and abundance
When do you use this kind of dataset?	During impact assessment, environmental monitoring, spill response and damage assessment
What are your actual limitations and do you have a work around?	Data is highly seasonal and expensive to collect through dedicated surveys
Needs and expectations on EO data	High resolution imagery capable of detecting fish habitat features
Challenge classification	
Pre license	4
Exp.	4
Dev.	4
Prod.	4
Decom.	4
Geographic context/ restrictions	Everywhere
Topographic classification / Offshore classification	Ocean

Activity impacted/concerned	Strategic decision enabler
Technology Urgency	Short term (2-5 years)
Information requirements	
Update frequency	One-off for initial assessment, seasonal for monitoring, but near real time in case of a spill
Temporal resolution	One-off for initial assessment, seasonal for monitoring, but near real time in case of a spill
Spatial resolution	1-10m
Data quality	high
Data Coverage and extent	District area, vessel route and onshore site
Example format	High resolution image
Timeliness	Reference data - timeliness not important
Existing standards	

Challenge ID	OFF2.16
Title	**Commercial shipping** (not including shipping activity related to offshore oil operations) • Includes container vessels etc. (i.e. does not include O/G-related shipping) • Accurate shipping data is difficult to get • Most useful at pre-licensing stage (e.g. verify if AOI is located on shipping route) • Shipping/transit is a category in environmental impact assessments (EIA) • Knowledge of ship traffic especially relevant for confined areas • In international waters, knowledge of fishing vessel locations is also important (e.g. in case of claim against O/G development, use of regional areas) o Fishing is captured as a separate category in this analysis
Challenge originator: interviewed company	General requirement
General Description	
What data/products do you use?	Aerial surveillance, satellite imagery, AIS, logbook port-inspections
When do you use this kind of dataset?	During initial assessment to determine placement of offshore installation in context of commercial shipping lanes
What are your actual limitations and do you have a work around?	AIS is not available everywhere, other shipping data is hard to get or confidential
Needs and expectations on EO data	High resolution imagery capable of detecting and tracking ship traffic
Challenge classification	
Pre license	2
Exp.	
Dev.	
Prod.	
Decom.	

Geographic context/ restrictions	Everywhere
Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	Data accessibility and logistic feasibility
Technology Urgency	Mid-Term (5-10 years)
Information requirements	
Update frequency	Daily-weekly
Temporal resolution	Daily-weekly
Spatial resolution	10-100m
Data quality	High
Data Coverage and extent	Regional
Example format	High resolution image
Timeliness	Reference data - timeliness not important
Existing standards	

Challenge ID	OFF2.17
Title	**Natural and other existing oil seeps**
Challenge originator: interviewed company	General requirement • Also includes newly appearing seeps • Key issue is differentiating between natural and man-made seeps ○ Seeps from old ship wrecks would be considered "natural" in this context • Being able to visualize water column from bottom to surface is very important
General Description	
What data/products do you use?	Any visual detection of oil seeps from unknown sources (through aerial surveillance, sat imagery, oiled wildlife, ship based reports)
When do you use this kind of dataset?	During initial environmental assessment and during environmental monitoring
What are your actual limitations and do you have a work around?	Observations are by chance, not due to dedicated surveys. Operators may be charged for pollution in cases where they are not the cause
Needs and expectations on EO data	High resolution imagery capable of detecting slicks
Challenge classification	
Pre license	3
Exp.	3
Dev.	3
Prod.	4
Decom.	3
Geographic context/ restrictions	Everywhere
Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	Operational, environmental monitoring, spill response

Technology Urgency	Short term (2-5 years)
Information requirements	
Update frequency	Daily-weekly
Temporal resolution	Daily-weekly
Spatial resolution	10-100m
Data quality	High
Data Coverage and extent	Regional
Example format	High resolution image
Timeliness	Reference data - timeliness not important
Existing standards	

Challenge ID	OFF2.18
Title	**Commercial and recreational fisheries**
Challenge originator: interviewed company	General requirement • Detection and monitoring of fishing vessels to safeguard against liability claims • Identifying small boats is a challenge
General Description	
What data/products do you use?	Data from resource management agency responsible for fisheries
When do you use this kind of dataset?	During initial environmental assessment and during oil spills
What are your actual limitations and do you have a work around?	Exact location of fisheries effort and not always easy to come by and in case of a spill real-time information is needed to determine economic impact
Needs and expectations on EO data	High resolution imagery capable of detecting and tracking fishing activity
Challenge classification	
Pre license	3
Exp.	3
Dev.	2
Prod.	2
Decom.	2
Geographic context/ restrictions	Everywhere
Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	Strategic decision enabler and spill response
Technology Urgency	Short term (2-5 years)
Information requirements	
Update frequency	Weekly
Temporal resolution	Weekly
Spatial resolution	10-100m

Data quality	High
Data Coverage and extent	Regional
Example format	High resolution image
Timeliness	As close to real-time as possible
Existing standards	

Challenge ID	OFF2.19
Title	**Monitoring of Sea Surface Height (SSH)** • Parameter used to assess primary productivity, which affects species abundance • Primary productivity is also assessed using sea surface temperature, chlorophyll concentration • Effects on offshore structures (e.g. vibrations near risers)
Challenge originator: interviewed company	DanLing Tang, Hiroshi Kawamura, Tran Van Dien, MingAn Lee. 2004. *Offshore phytoplankton biomass increase and its oceanographic causes in the South China Sea.* Marine Ecology Progress Series. Vol. 268: 31-41. Patidar, B. 2006. *Application of remote sensing and GIS in the analysis of environment of Bay of Bengal*. MSc., Dissertation, Barkatullah University, Bhopal(MP)- National Institute of Oceanography, Goa, India Pelegrí, J.L. et al. 2005. *Coupling between the open ocean and the coastal upwelling region off northwest Africa: water recirculation and offshore pumping of organic matter*. Journal of Marine Systems, Volume 54, Issues 1–4, February 2005, Pp. 3-37 Available online at: http://www.sciencedirect.com/science/article/pii/S0924796304002027
General Description	
What data/products do you use?	Ship-based measurements; satellite images
When do you use this kind of dataset?	Environmental assessment and effects monitoring, characterizations of currents (eddies) and possible foraging hotspots for birds and mammals
What are your actual limitations and do you have a work around?	Ship-based surveys are expensive and there are always safety concern when putting people in the field. Data is often seasonally limited due to weather conditions
Needs and expectations on EO data	Satellite imagery to monitor eddy activity and impacts on productivity and species distribution
Challenge classification	
Pre license	3

Exp.	3
Dev.	3
Prod.	3
Decom.	3
Geographic context/ restrictions	OFF.REG.12 - South China Sea
Topographic classification / Offshore classification	Ocean
Activity impacted/concerned	Possible reduction of environmental liability, reduction of HSE risks
Technology Urgency	Immediately (0-2 years)
Information requirements	
Update frequency	Daily-weekly
Temporal resolution	Daily-weekly
Spatial resolution	100m
Data quality	Medium to high
Data Coverage and extent	Regional
Example format	High resolution image
Timeliness	Within a month
Existing standards	

Other Parameters of Interest

- Ice is key operational parameter for O/G industry
  - EO4OG precursor activity addresses the generation of ice charting guidelines for the O/G sector
    - Phase 1 has been completed under ESA funding
    - Phase 2 is being considered for funding by OGP
  - Ice edge is information is important from environmental perspective
    - Primary productivity
    - Mammal activity

- Asset integrity
  - Pipeline to shore, annual survey would be helpful to assess stress on near-shore pipelines
  - Pipelines in subtidal areas can be subjected to high current; would be helpful to monitor more than every few years
  - Estimating fouling rates on structures would be heloful (e.g. via growth in girth)

- Bottom type
  - Proportion of organic matter
  - Assessment of benthic health
  - Redox potential

- Methane in sediment
  - Current approaches use box core over sediment, capture water directly above to analyze for methane

- Invasive species
  - Monitor ballast water discharges (e.g. via temperature as main difference to surrounding waters)

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