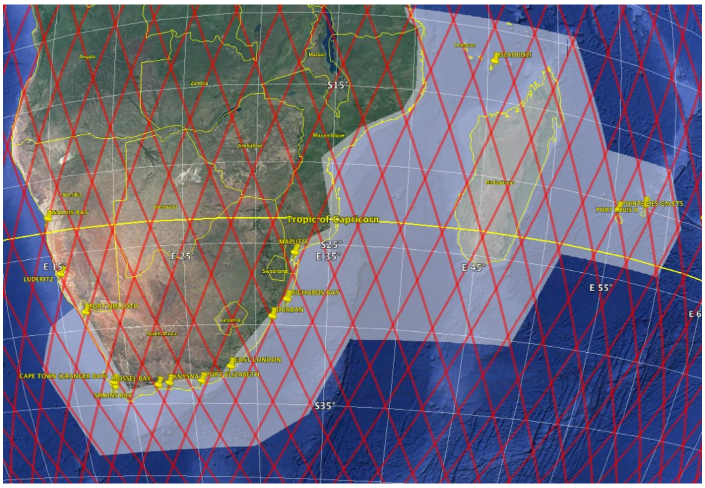
C-RISe –
Coastal Risk Information Service

Satellite Products Specification



	Name	Signature	Date
Written by	David Cotton (SatOC)		23/09/19
Authorised by	David Cotton		

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NMIFC /RMIFC: Cdr John Edmond Randrianantenaina	1	Electronic
UKSA: Rhodri Briddon, Athene Gadsby	1	Electronic

SUMMARY OF MODIFICATIONS

Ed.	Date	Chapter	Modification	Author/s
1.0	27/04/17		Document Issue 1.0	SatOC
1.3	01/08/17	various	Updates	SatOC, NOC
1.4	07/12/17	Ch. 3 Annex A	Added altimeter product specification with examples	NOC
1.5	15/02/19	Ch 4	Correction to details of Wind Speed and Direction Climatology	SatOC (DC)
1.6, 1.7, 1.8	16/07/19, 23/09/19		Include information on data updates	SatOC (DC)

1 Introduction

1.1 C-RISe – Coastal Risk Information Service

C-RISe is a proposal in response to the first call from the UK Space Agency's "International Partnership Programme" Call 1. C-RISe will deliver, through an international partnership with Mozambique, Madagascar, Mauritius and South Africa, access to satellite-derived data on sea level, wind speed and wave heights. The goal is to enable stakeholders to use this information to improve socio-economic resilience to coastal hazards associated with sea level changes such as inundation, floods, storm damage, wetland loss, habitat change, coastal erosion and saltwater intrusion.

1.2 This Document

This document provides the specification of the data products that will be supplied to the C-RISe users.

Further sections are as follows:
Section 2: C-RISe Products: Overview and Coverage
Section 3: Along Track Satellite Altimeter Data - Coastal Processor
Section 4: Ocean Wave and Wind Climatologies
Section 5: Near Real Time Satellite Wind and Wave data
Section 6: Surface Current Climatology from Satellite Data
Section 7: In Situ Data Sets
Section 8: Analyses of Sea Level, Wave and Wind Products

2 C-RISe Products– Overview and Coverage

2.1 Overview

C-RISe products include processed satellite and in-situ data.

The satellite data comprise:

- Along-track satellite data reprocessed with the NOC Coastal Processor. The source data are Jason-1, Jason-2 and Jason-3 data for the period 2002-2018. Parameters include Total Water Sea Level, Sea Level Anomaly and Significant Wave Height
- Sea State (Significant wave height) climatologies for 1° x 1° grid squares, compiled from satellite altimeter data and sourced from the ESA CCI Sea State project. The data cover the period 1992-2018.
- Wind Speed and Direction climatologies for 0.25° grid squares, compiled from satellite scatterometer data, and sourced from the Copernicus Marine Environment Monitoring Service (CMEMS). The data cover the period 2007-2018.
- Long Period Swell Wave Period and Direction climatologies for 2° x 2° grid squares, compiled from satellite Synthetic Aperture Radar data and sourced from the ESA Globwave data base. The data cover the period 2002-2012.
- Near Real Time satellite wind and wave data, from satellite altimeter and scatterometer measurements, overlaid on model forecasts.
- Surface Current climatologies, for 0.25° grid squares, sourced from the ESA Globcurrent project database. The data cover the period 2002-2016

The in-situ data include:

- Tide Gauge data as available from the region: including at least data from South Africa, Mozambique, La Réunion and Mauritius.
- Weather Station data from Madagascar
- Relevant In situ marine observations data as available from regional partners

2.2 Data Coverage

The geographical coverage of the data is shown in
Figure 1.
The shaded area gives the overall coverage of the project, including all satellite data to be provided, and in-situ data where available.
The red lines are the ground tracks for the Jason-series satellites, these are the tracks for which data from the NOC coastal processor will be generated.
Locations of known, currently operating, tide gauges are indicated by yellow markers.

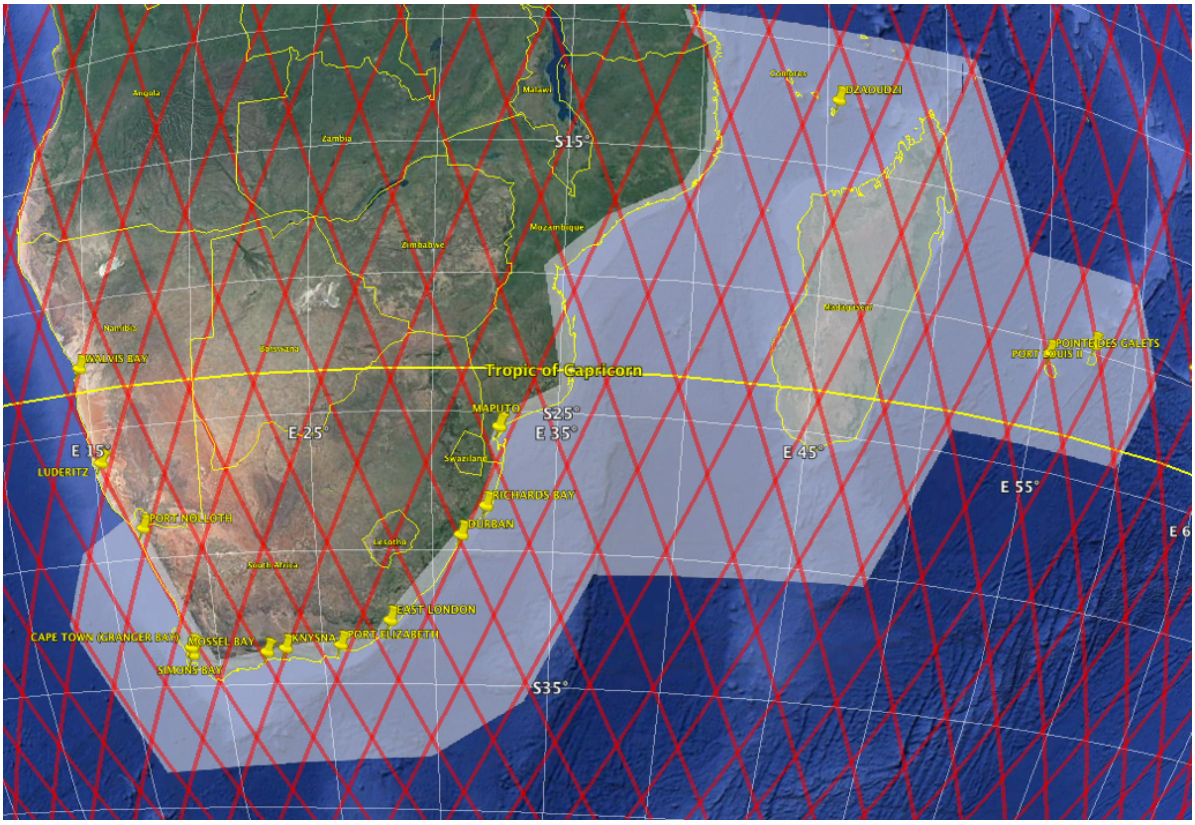

Figure 1: Coverage of C-RISe data products. The shaded area gives the overall coverage of the project. The red lines are the ground tracks for the Jason-series satellites, the tracks for which data from the NOC coastal processor will be generated. Yellow markers indicate the location of known tide gauges.

Further details of the individual products are given in subsequent sections.

3 Along Track Satellite Altimeter Data - Coastal Processor

3.1 Introduction

The NOC coastal processor has been applied to Jason-1, Jason-2 and Jason-3 satellite altimeter data, for data from the period January 2002 – December 2018. The Jason-series satellites are in a 10-day repeat orbit, so there will be a repeat measurement for each along-track location every 10 days (the exact orbit repetition period is 9.92 days).

Three sets of products are provided, as detailed below:

3.2 Along-Track Coastal Geophysical Data Records (CGDR)

The output "CGDR" (Coastal Geophysical Data Record) products are supplied as netCDF files, the primary output geophysical parameters include:

- Time
- Location (latitude, longitude)
- Total Water Level Envelope (TWLE): The TWLE including tides and atmospheric forcing – useful as a reference and because it displays extreme events (surges).
- Sea Surface Height Anomaly (SSHA): The anomaly with respect to the mean sea surface, with tides and atmospheric effects removed. Sea level rates of change are calculated from this value.
- Significant Wave Height (SWH)
- Radar backscatter coefficient (sigma0), from which an estimate of surface wind can be obtained

The products also include a range of supplementary parameters including relevant auxiliary geophysical corrections. Note that, because satellite orbits are typically maintained within ±1km in the longitudinal direction from the 'nominal' orbit, every overpass over a given 'nominal' ground track of the satellite will sample slightly different (lon, lat) locations.

3.3 Along-Track Co-located Time Series

From these CGDR data, further processing has been carried out to provide a time series, at each nominal along-track location, of the following parameters:

- TWLE
- SSHA
- SWH
- Sigma0

Derived from the accumulation of all the overpasses over that location over the period January 2002 – December 2018).

In practice, the processing consists of 'co-locating' the measurements that had been taken at slightly different locations during each overpass (for the reasons explained above). "Co-locating" means that we translate the measurements onto the same set of nominal (lon, lat) pairs (accounting for any variation expected during this sight translation), so that in each of the nominal locations there is a time series. We do the co-location on a 20-Hz nominal track, i.e. the ground points are spaced by about 300 m along-track. The co-located variables are in the form of 2-D matrices, where one dimension is along-track (so it can be plotted as lon, lat or along-track distance) and the other is orbital cycle, i.e. time. An example of these data for pass 0044 of the Jason-1/2 altimeters is in Figure 2.

3.4 Trends and Variability

Single values for each nominal along-track location, of the following parameters:

- Long-term sea level trend in mm/yr (for the period 2002-2018). This is computed both with Ordinary Least Squares and with Robust Regression, and is accompanied by standard error estimates and Newey-West error estimates.
- Annual sea level cycle (amplitude and time of maximum).
- Inter-annual variability (characterised by the standard deviation and maxima of the annual sea level values).

These trends and other statistics are saved as separate 1-D variables in the same netCDF files containing the along-track time series described above. An example of the trends for pass 0044 is in Figure 3.

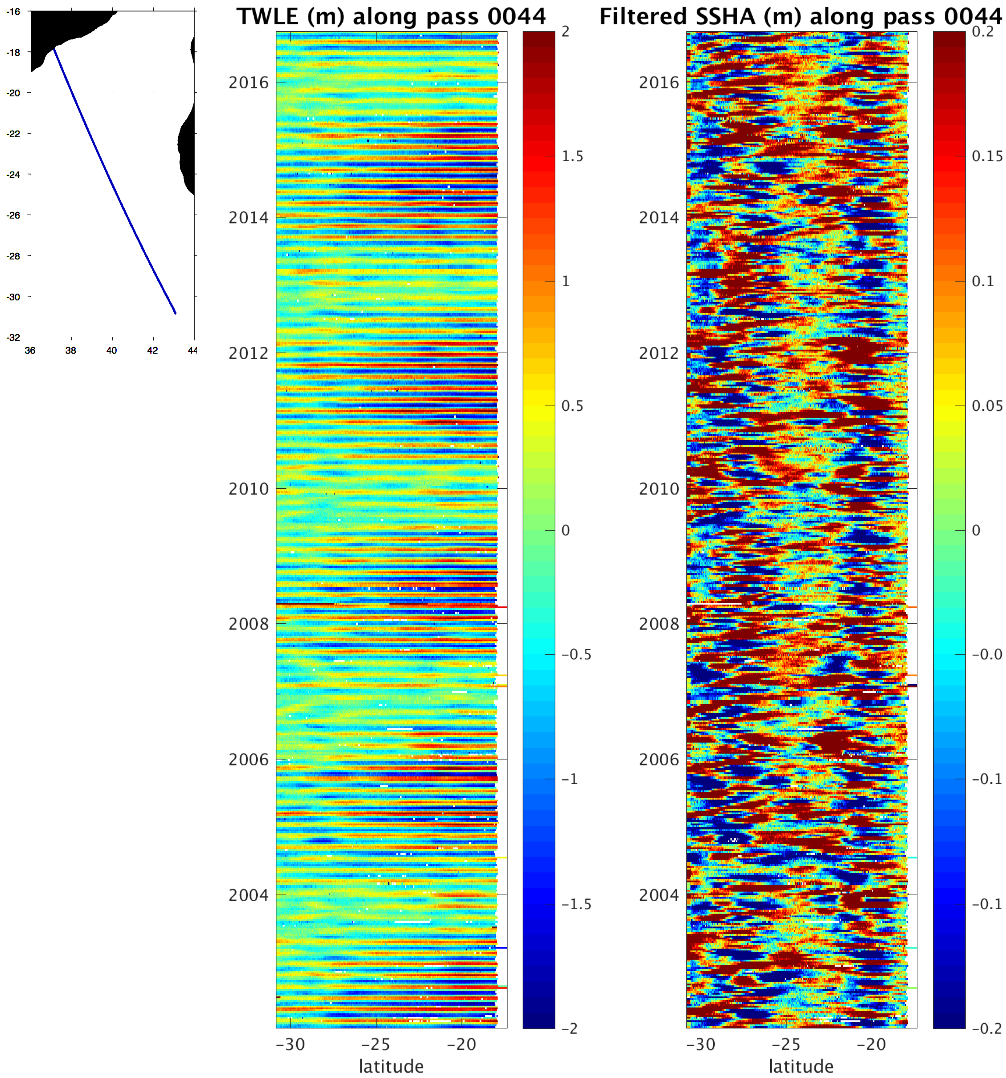

Figure 2: Example of 2-D variables in the C-RISe netCDF output for Jason-1 and Jason-2 pass 0044 (shown in the inset map on the top left), plotted as function of along-track latitude and time. Left panel: Total Water Level Envelope (variable 'twle'); Right panel: filtered Sea Surface Height Anomaly (variable 'ssha_filt').

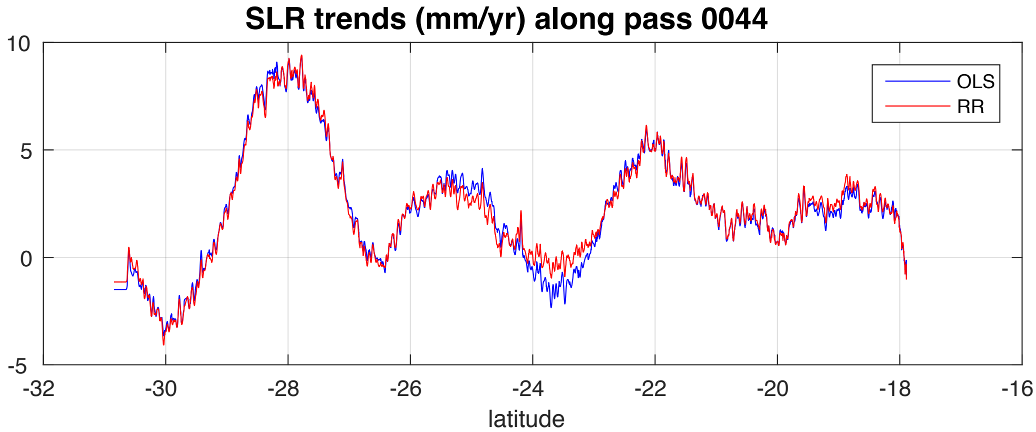

Figure 3: Example of sea level trends (mm/yr) in the C-RISe netCDF output for Jason-1 and Jason-2 pass 0044, derived from Ordinary Least Squares ('OLS', blue curve, variable 'ssha_trend') and Robust Regression ('RR', red curve, variable 'ssha_trend_RR'))

4 Ocean Wave and Wind Climatologies

4.1 Introduction

C-RISe is providing access to the following ocean wave and wind climatologies:

- Sea State (Significant Wave Height) climatologies for 1° x 1° grid squares, compiled from satellite altimeter data and sourced from the ESA CCI Sea State project. The data cover the period 1992-2018.
- Long Period Swell Wave Period and Direction climatologies for 2° x 2° grid squares, compiled from satellite Synthetic Aperture Radar data and sourced from the ESA Globwave data base. The data cover the period 2002-2012.
- Wind Speed and Direction climatologies for 0.25° grid squares, compiled from satellite scatterometer data, and sourced from the Copernicus Marine Environment Monitoring Service (CMEMS). The data cover the period 2007-2018.

4.2 Climatology Data Set

4.2.1 Significant Wave Height Climatology

The significant wave height climatology product is provided on a global 1° x 1° grid.
The data are a new data ser provided in 2019 by the ESA CCI Sea State project (http://cci.esa.int/seastate), and cover the period 1992-2018, and are provided in monthly files, in annual folders.
For access to these data register at https://forms.ifremer.fr/lops-siam/access-to-esa-cci-sea-state-data/

The base parameter is Significant Wave Height, as measured by satellite altimeters, cross calibrated across all missions to ensure a consistent data set. The panel below gives the parameters available for each month (based on median values of satellite passes through a grid square):

Product	Monthly Gridded Sea State (altimeter)
Description	Significant wave height (swh) statistics based on median values of satellite altimeter passes on a 1-degree grid. A powerful summary dataset for rapid wave climate assessment.

Format	NetCDF
Parameters	• Number of median values • Sum of swh, swh squared • Sum of log(swh), log(swh) squared • Number of medians greater than 12 thresholds
Spatial coverage	C-RISe Region (See Figure 1), 1° x 1° resolution
Time period	1992-2018

4.2.2 Ocean Surface Wind Speed and Direction Climatology

The ocean surface wind speed and direction climatology product is provided on a 0.25° x 0.25° global grid from the global Copernicus data base (http://marine.copernicus.eu), as measured by the MetOP ASCAT scatterometer satellites. Ref Bentamy and Croize Fillon, 2012, International Journal of Remote Sensing, vol 33 issue 6, p1729-1754

The data cover the period 2007-2018, and there is one file per month, in annual folders.
The base parameters are ocean wind speed and direction, cross calibrated across all missions to ensure a consistent data set. The panel below gives the parameters available for each month, based on > 25 daily passes per grid square:

Product	Monthly gridded ocean wind speed and direction (scatterometer)
Description	Ocean wind speed and directions, monthly mean
Format	NetCDF
Parameters	• Monthly mean wind speed • Monthly mean zonal (eastward) wind • Monthly mean meridional (northward) wind • Root mean squared values • Wind stresses
Spatial coverage	C-RISe Region (See Figure 1), 0.25° x 0.25° resolution
Time period	2007-2018

4.2.3 Ocean Swell Climatology

The ocean swell climatology product is provided on a 2° x 2° grid, extracted from the global data base for the region covered by the C-RISe project (within 38°S – 9°S, 12°E – 62°E).
The data cover the period 2002-2012), and will be provided as a single file.

The base parameters are swell significant wave height, swell wavelength and swell direction, as measured by satellite Synthetic Aperture Radar (Wave Mode), cross calibrated across all missions to ensure a consistent data set. The panel below gives the parameters available for each month (based on median values of satellite passes through a grid square):

Product	Monthly Gridded Sea State (SAR)
Description	Swell wave statistics based on satellite SAR passes on a 2-degree grid. A powerful summary dataset for rapid swell-wave climate assessment.
Format	NetCDF
Parameters	• Number of observations • Percentage occurrence of detected swell • Sum of swh (+ squared) • Sum of dominant wavelength (+ squared) • Sum of dominant direction (+ squared) • Cross swell occurrence
Spatial coverage	C-RISe Region (See figure 1), 2° x 2° resolution
Time period	2002-2012

5 Near Real Time Satellite Wind and Wave data

5.1 Introduction

SatOC retrieves all available wind and wave measurements from scatterometer and altimeter satellites and ingests data into a global database within 3 hours of measurement. Coverage is global, twice daily for the wind velocity at 25km resolution, but unfortunately quite sparse for the wave height measurements. Although generally of excellent reliability, satellite data are potentially subject to interruption for maintenance activity, and individual missions are designed for fixed-term operation (typical 5 years) after which availability cannot be guaranteed.

These data are produced by a Fast Delivery Processing chain, which may contain data gaps due to anomalies in data transmission or processing. "Offline" data products may provide better coverage, but with several days delay.

Figure 4 gives an example of these data for the 1st August 2017

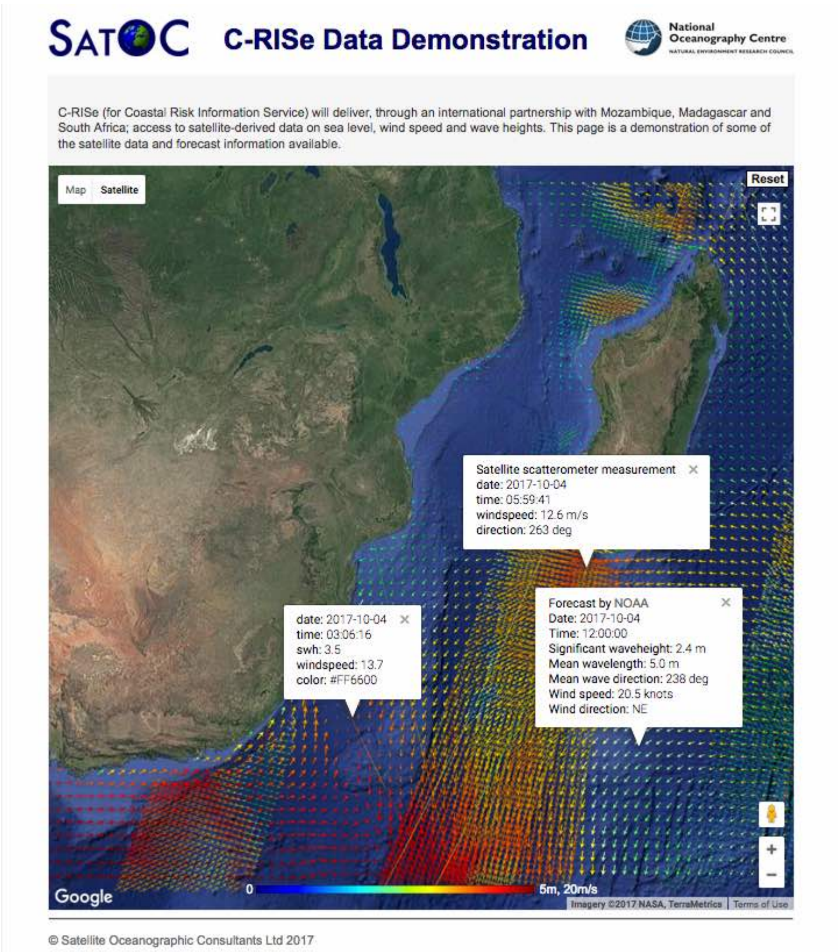

Figure 4: Screen shot of C-RISe Demonstration Data Page, showing Near Real Time satellite wind and wave data, and NOAA model forecast for the same period.

5.2 Satellite Data Set

5.2.1 Altimeter Significant Wave Height and Wind Speed data

Satellite altimeter measurements are made along-track, at 7km intervals, on a ground track directly beneath the orbit of the satellite. Measurements are available from up to 4 satellite altimeters: AltiKa / SARAL, Jason-2 and Jason-3, and Sentinel-3

Product	Satellite altimeter waves
Description	Significant wave heights from up to 4 satellite altimeters provided as received within 3 hours of measurement.
Format	Fusion table, NetCDF
Parameters	• Significant wave height • Surface wind speed
Spatial coverage	7km along-track, sparse daily tracks
Frequency / delay	Daily, within 3 hours of measurement.
URL	https://tinyurl.com/ky9jodp

5.2.2 Scatterometer Ocean Wind Speed and Direction data

The scatterometer ocean wind speed and direction measurements that will be provided are derived from measurements by ASCAT instruments on the MetOp-A and Metop-B satellites, operated by EUMETSAT. These instruments make measurements in two 550km swaths either side of the satellite track, and are provided in the near real time data stream on a 25 km resolution grid within these swaths:

Product	Satellite scatterometer winds
Description	Wind vectors from 2 satellite scatterometers provided as received within 3 hours of measurement.
Format	Fusion table, NetCDF
Parameters	• Surface wind speed • Surface wind direction
Spatial coverage	25km resolution (non regular grid)
Frequency / delay	Up to twice daily, within 3 hours of measurement.
URL	https://tinyurl.com/kpyahu8

5.3 Model Outputs

The National Oceanographic and Atmospheric Administration (NOAA) provides global wave forecasts from the WaveWatch III model. This is available at 0.5 degree resolution in the C-RISe study area and will be re-packaged by SatOC for convenient visualisation in Google Maps.

Product	NOAA Global Wave Forecast
Description	Wind and directional wave forecast
Format	Fusion table, NetCDF

Parameters	• Significant wave height • Mean wave period • Mean wave direction • Surface wind speed and direction
Spatial coverage	0.5 degree global
Frequency / delay	Forecast in 3 hourly time steps for 5 days ahead
URL	http://polar.ncep.noaa.gov/waves

6 Surface Current Climatology from Satellite Data

6.1 Introduction

Although not listed in the proposal C-RISe is also providing access to a surface current climatology, sourced from the ESA Globcurrent project.

6.2 Ocean Surface Current Climatology Data Set

The panel below describes the product:

Product	GlobCurrent historical data
Description	Global total surface current based on satellite altimeter height measurements and model output
Format	NetCDF
Parameters	• Total surface current (geostrophic + Eckmann)
Spatial coverage	90S to 90N subsetted for the C-RISe region, 1/4 degree resolution
Time period	1993-2015
URL	http://globcurrent.ifremer.fr/products-data

7 In situ Data Sets

7.1 Introduction

Regional in-situ data is provided either as the original data or as analysed products, as described below.

7.2 Tide Gauge Data

Regional Sea level data from tide gauges will primarily be sourced from the Permanent Service for Mean Sea Level (PSMSL - http://www.psmsl.org), for monthly / annual means, from the University of Hawaii Sea Level Center (UHSLC - http://uhslc.soest.hawaii.edu) for hourly and daily means and also from IOC (Intergovernmental Oceanographic Commission) High Frequency monitoring data base (http://www.ioc-sealevelmonitoring.org). Table 1 below gives the known coverage for different locations. Where there are gaps, local organisations will be approached to investigate if these data may be available by other means.

The Tide Gauge data will be processed to produce 4 different datasets:

1. Data for deriving trends in mean sea level
   This dataset comprises individual files of PSMSL RLR (datum-controlled) monthly mean sea level data or files of monthly means sea level calculated by Doodson filtering of higher frequency UHSLC or IOC SLMF data. UHSLC and IOC SLMF data will only be used for this purpose where adequate datum information is available. IOC SLMF data will be quality controlled prior to filtering.
   This dataset will potentially cover 26 locations, depending upon data quality.

2. Data for evaluating seasonal and interannual variability
   These data comprises individual files of monthly mean sea level derived from either PSMSL RLR and metric records or by Doodson filtering of UHSLC hourly data and quality-controlled high frequency IOC SLMF observations.
   This dataset will potentially cover 36 locations, depending upon data quality.

3. Data for validation of altimetry
   This dataset comprises total water levels and non-tidal residuals at hourly intervals, derived from UHSLC and quality-controlled IOC SLMF data.
   This dataset will potentially cover 25 locations, depending upon data quality.

4. Data for tidal analysis
   This dataset comprises UHSLC hourly data from Pemba and Inhambane and 1 min data from Toamasina. These data will be sub-sampled and quality-controlled as required. Tidal analysis will be performed and tidal predictions will be produced for each location, together with monthly means of sea level. These data will be output at each stage of the processing method and retained for demonstration purposes during C-RISe training events.

Country	Location	Latitude[1]	Longitude[1]	PSMSL Mthly & ann. means	UHSLC Hrly & daily means	IOC SLMF (High freq. data) start date	Frequency of IOC data
Tanzania	Tanga	-5.067	39.1	1962-1966[3]			
	Zanzibar	-6.15	39.1833	1984-2014	1984-2015	2006	1,3 or 5 min
	Dar Es Salaam	-6.817	39.283	1986-1990[3]			
	Mtwara	-10.267	40.2	1956-1962[3]		2009	1min [2]
Comores	Comores	-11.7035	43.24809444			2010	1min
Mayotte	Dzaoudzi	-12.783	45.2583	2008-2015 1985-2015[3]	2008-2016	2008	1min
Madagascar	Toamasina	-18.1536	49.4281			2010	1min
	Nosy-Be	-13.40	48.283333	1958-1972 1987-1999[3]			
Seychelles	Port La Rue/ Point La Rue	-4.666667	55.533333	1993-2014	1977-2016	2007	1,3 or 6 min
	Port Victoria	-4.617	55.467	1962-1992[3]			
Reunion	Pointe des Gallets/Galets	-20.934924	55.285005	1975-2015 1967-2015[3]	1982-2016	2008	1min
Reunion	Sainte Marie	-20.892778	55.536944			2013	1min
Mauritius	Agalega	-10.34559167	56.58556167			2009	1 or 3 min
	Port Louis	-20.15	57.50	1942-2016[4]	1986-2016	2006	1 or 6 min
	Blue Bay	-20.44413333	57.71095			2009	1 or 3 min
	Rodrigues Island	-19.666667	63.416667	1986-2015	1986-2016	2006	1 or 6 min
Mozambique	Pemba	-12.967	40.55	1971-2009[3]	2007-2013		
	Nacala	-14.467	40.683	1975-1999[3]			
	Mozambique Island	-15.033333	40.733333	1963-1967			
	Beira	-19.817	34.833	1996-2000[3]			
	Inhambe	-23.917	35.5		2007-2014		
	Maputo	-25.966667	32.566667	1961-2001[4]			
S Africa	Saldanha	-33.0	17.93		1973-2016		
	Marlon Island	-46.8667	37.8667		2007-2016	2007	1 min
	Richards Bay	-28.811944	32.078611	1977-2015[4]	1977-2016		
	Durban	-28.874203	31.050761	1971-2015 1926-2015[3]	1970-2016		
	East London	-33.027222	27.931667	1967-2015[4]	1965-2016		
	Port Elizabeth	-33.951111	25.629722	1978-2015 1957-2015[3]	1973-2016		
	Knysna	-34.049444	23.045556	1960-2015	1966-2016		
	Mossel Bay	-34.178611	22.135278	1958-2015	1966-2016		
	Hermanus	-34.433333	19.233333	1958-1964			
	Cape Town (Granger Bay)	-33.905278	18.434722	1967-2015	1967-2016		
	Salamander	-33.066667	18.000000	1979-1994			
	Simons Town	-34.187778	18.440139	1957-2015	1959-2016	2007	1min[2]
	Port Nolloth	-29.256667	18.867778	1956-2015	1958-2016		
	Stompneus Bay	-32.716667	17.983333	1957-1962			

Table 1: Tide Gauge Sea Level data available for C-RISe from PSMSL, UHSLC, and IOC SLMF (See text for abbreviations).

[1] Latitudes and longitudes are shown to the highest precision given on the source web pages, to be verified as part of this project.
[2] Currently non-operational
[3] Metric data only – not to be used for long term trends
[4] Time series contain significant gaps

8 Analyses of Sea Level, Wave and Wind Products

8.1 Introduction

Further analyses have been carried out on the data products described in the previous sections, to derive further information products. These analyses have been made together with the regional C-RISe partners, as part of the Training / Capacity Building activities. Examples of the types of analyses completed are presented below.

8.2 Sea Level Analyses

Sea level measurements from the re-processed satellite coastal altimetry data, as described in Section 3, have been further analysed to derive the following over the period of satellite data coverage (2002-2018):

- Sea Level long-term trend with uncertainty estimates
- Annual cycle amplitude and phase with uncertainty estimates
- Sea Level variability:
    - Inter-annual variability, characterized by means of both the standard deviation and the maxima of annual sea level values
    - Characterisation of the magnitude of the variability and identification of regions of coherent variability by using cross-correlation analysis

8.3 Statistical Parameters from Wave and Wind Climatologies

The wind and wave climatological data can be further analysed to derive relevant statistical indices.
An example of the types of analysis possible are given below.
Figure 5 shows the monthly mean significant wave height for a particular month of the year, here for the global dataset:

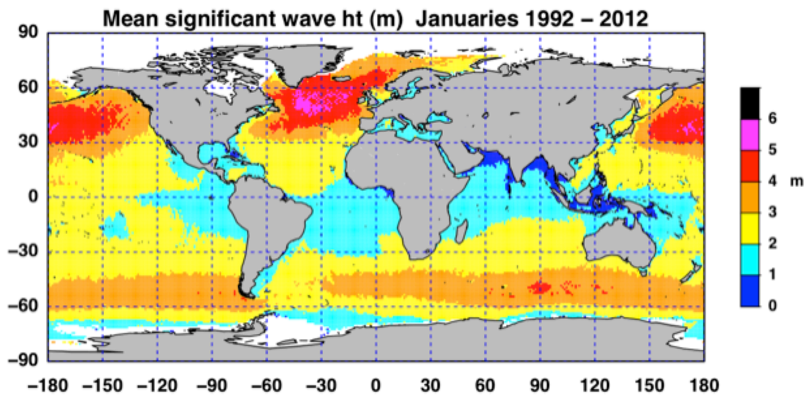

Figure 5: Global mean Significant Wave Height for January (1992-2012) for a single 1° x 1° grid square the wave height distribution is easily estimated:

For a single 1-degree area the wave height distribution is easily estimated, see Figure 6:

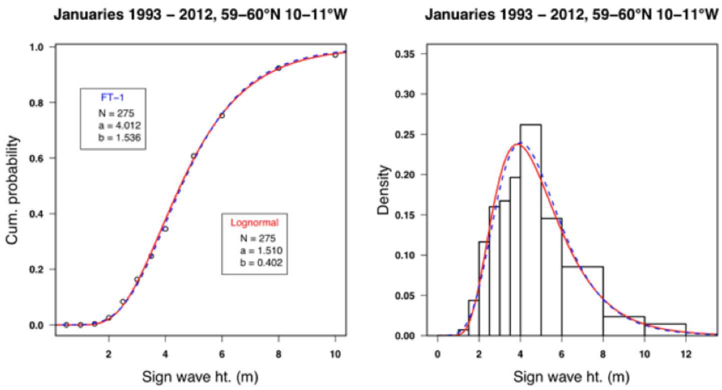

Figure 6: Statistics derived from January Sea State Climatology for a single grid square. (left) Cumulative Probability vs SWH. (right) SWH Probability Distribution.

8.4 Comparisons of satellite and in-situ wind and wave measurements

Where suitable in situ data (or model forecasts) are available, at a location and time close to that of the satellite data, then analyses will be carried out to compare these two data sets, most probably within the training workshops, as part of the capacity building.

9 ANNEX A – C-RISe Altimeter data product specification

9.1 Along-Track Coastal Geophysical Data Records (CGDR)

The specification and content of the CGDR products in netCDF format is given here, using the netCDF self-describing metadata in the form of name/value attributes, for example data file *cgdr_crise_j1_p0144_c247.nc* which refers to mission Jason-1 (j1), pass 0144 and orbital cycle 247. Note that, as is common practice in along-track altimetry, the data are organized in 1-second 'blocks' of 20 20-Hz samples each, i.e. the variables are 2-D with one dimension being time in steps of 1 second and the other dimension being a 'measurement index' which in practice corresponds to the twenty samples spaced by 1/20 s.
The global attributes of the file (such as history, contact, reference, details of the pass, etc) are at the end of the variable list.

```
netcdf cgdr_crise_j1_p0144_c247 {
dimensions:
        time = 91 ;
        meas_ind = 20 ;
variables:
        double time(time) ;
                time:long_name = "time (sec. since 2000-01-01)" ;
                time:standard_name = "time" ;
                time:calendar = "gregorian" ;
                time:tai_utc_difference = 33. ;
                time:leap_second = "0000-00-00 00:00:00" ;
                time:units = "seconds since 2000-01-01 00:00:00.0" ;
                time:comment = "[tai_utc_difference] is the difference between TAI - UTC (i.e., leap
seconds) for the first measurement of the data set. [leap_second] is the UTC time at which a leap second
occurs in the data set, if any. After this UTC time, the [tai_utc_difference] is increased by 1 second.
time variable is corrected from datation bias. See Jason-1 User handbook." ;
        byte meas_ind(meas_ind) ;
                meas_ind:long_name = "elementary measurement index" ;
                meas_ind:units = "count" ;
                meas_ind:comment = "Set to be compliant with the CF-1.1 convention" ;
        double time_hi(time, meas_ind) ;
                time_hi:_FillValue = 1.84467440737096e+19 ;
                time_hi:long_name = "time 20 Hz (sec. since 2000-01-01)" ;
                time_hi:standard_name = "time" ;
                time_hi:calendar = "gregorian" ;
                time_hi:tai_utc_difference = 33. ;
                time_hi:leap_second = "0000-00-00 00:00:00" ;
                time_hi:units = "seconds since 2000-01-01 00:00:00.0" ;
                time_hi:comment = "[tai_utc_difference] is the difference between TAI - UTC (i.e., leap
seconds) for the first measurement of the data set. [leap_second] is the UTC time at which a leap second
occurs in the data set, if any. After this UTC time, the [tai_utc_difference] is increased by 1 second.
time_20hz variable is corrected from datation bias. See Jason-1 User handbook." ;
        int lat(time) ;
                lat:long_name = "latitude" ;
                lat:standard_name = "latitude" ;
                lat:units = "degrees_north" ;
                lat:quality_flag = "orb_state_flag_rest" ;
                lat:scale_factor = 1.e-06 ;
                lat:comment = "Positive latitude is North latitude, negative latitude is South latitude.
See Jason-1 User Handbook." ;
        int lon(time) ;
                lon:long_name = "longitude" ;
                lon:standard_name = "longitude" ;
                lon:units = "degrees_east" ;
                lon:quality_flag = "orb_state_flag_rest" ;
                lon:scale_factor = 1.e-06 ;
                lon:comment = "East longitude relative to Greenwich meridian. See Jason-1 User Handbook."
;
        int lon_hi(time, meas_ind) ;
                lon_hi:_FillValue = 2147483647 ;
```

```
            lon_hi:long_name = "20 Hz longitude" ;
            lon_hi:standard_name = "longitude" ;
            lon_hi:units = "degrees_east" ;
            lon_hi:scale_factor = 1.e-06 ;
            lon_hi:comment = "East longitude relative to Greenwich meridian. See Jason-1 User
Handbook" ;
        int lat_hi(time, meas_ind) ;
            lat_hi:_FillValue = 2147483647 ;
            lat_hi:long_name = "20 Hz latitude" ;
            lat_hi:standard_name = "latitude" ;
            lat_hi:units = "degrees_north" ;
            lat_hi:scale_factor = 1.e-06 ;
            lat_hi:comment = "Positive latitude is North latitude, negative latitude is South
latitude. See Jason-1 User Handbook" ;
        short swh_hi(time, meas_ind) ;
            swh_hi:_FillValue = 32767s ;
            swh_hi:long_name = "20 Hz Ku band corrected significant waveheight" ;
            swh_hi:standard_name = "sea_surface_wave_significant_height" ;
            swh_hi:units = "m" ;
            swh_hi:scale_factor = 0.001 ;
            swh_hi:coordinates = "lon_20hz lat_20hz" ;
            swh_hi:comment = "All instrumental corrections included, i.e. modeled instrumental errors
correction (modeled_instr_corr_swh_ku) and system bias" ;
        short wind_speed(time) ;
            wind_speed:_FillValue = 32767s ;
            wind_speed:long_name = "altimeter wind speed" ;
            wind_speed:standard_name = "wind_speed" ;
            wind_speed:units = "m/s" ;
            wind_speed:scale_factor = 0.01 ;
            wind_speed:coordinates = "lon lat" ;
            wind_speed:comment = "Should not be used over land. See Jason-1 User Handbook " ;
        short inv_bar_static(time) ;
            inv_bar_static:_FillValue = 32767s ;
            inv_bar_static:long_name = "static inverse barometer correction" ;
            inv_bar_static:standard_name =
"sea_surface_height_correction_due_to_air_pressure_at_low_frequency" ;
            inv_bar_static:source = "ECMWF" ;
            inv_bar_static:units = "m" ;
            inv_bar_static:scale_factor = 0.0001 ;
            inv_bar_static:coordinates = "lon lat" ;
            inv_bar_static:field = 1002s ;
            inv_bar_static:comment = "Effect of the static atmospheric pressure on sea surface,
subtracting global mean" ;
        short inv_bar_mog2d(time) ;
            inv_bar_mog2d:_FillValue = 32767s ;
            inv_bar_mog2d:long_name = "MOG2D dynamic atmospheric correction" ;
            inv_bar_mog2d:source = "MOG2D-G" ;
            inv_bar_mog2d:units = "m" ;
            inv_bar_mog2d:scale_factor = 0.0001 ;
            inv_bar_mog2d:coordinates = "lon lat" ;
            inv_bar_mog2d:field = 1004s ;
            inv_bar_mog2d:comment = "Combined low and high frequency effect of atmospheric pressure
and wind on sea surface height" ;
        short tide_pole(time) ;
            tide_pole:_FillValue = 32767s ;
            tide_pole:long_name = "pole tide" ;
            tide_pole:standard_name = "sea_surface_height_amplitude_due_to_pole_tide" ;
            tide_pole:source = "Wahr [1985]" ;
            tide_pole:units = "m" ;
            tide_pole:scale_factor = 0.0001 ;
            tide_pole:coordinates = "lon lat" ;
            tide_pole:field = 1401s ;
            tide_pole:comment = "Variation of absolute sea level due to polar motion" ;
        short tide_solid(time) ;
            tide_solid:_FillValue = 32767s ;
            tide_solid:long_name = "solid earth tide" ;
            tide_solid:standard_name = "sea_surface_height_amplitude_due_to_earth_tide" ;
            tide_solid:source = "Cartwright, Taylor, Edden" ;
            tide_solid:units = "m" ;
            tide_solid:scale_factor = 0.0001 ;
            tide_solid:coordinates = "lon lat" ;
            tide_solid:field = 1101s ;
```

```
                tide_solid:comment = "Calculated using second and third degree constituents, excluding
permanent tide" ;
        short tide_load_fes04(time) ;
                tide_load_fes04:_FillValue = 32767s ;
                tide_load_fes04:long_name = "FES2004 load tide" ;
                tide_load_fes04:source = "FES2004" ;
                tide_load_fes04:units = "m" ;
                tide_load_fes04:scale_factor = 0.0001 ;
                tide_load_fes04:coordinates = "lon lat" ;
                tide_load_fes04:field = 1313s ;
                tide_load_fes04:comment = "Load tide variation to be added to ocean tide" ;
        int tide_ocean_fes12(time) ;
                tide_ocean_fes12:_FillValue = 2147483647 ;
                tide_ocean_fes12:long_name = "FES2012 ocean tide" ;
                tide_ocean_fes12:source = "FES2012" ;
                tide_ocean_fes12:units = "m" ;
                tide_ocean_fes12:scale_factor = 0.0001 ;
                tide_ocean_fes12:coordinates = "lon lat" ;
                tide_ocean_fes12:field = 1223s ;
                tide_ocean_fes12:comment = "Ocean tide variation including equilibrium and non-
equilibrium tides" ;
        int tide_ocean_got410(time) ;
                tide_ocean_got410:_FillValue = 2147483647 ;
                tide_ocean_got410:long_name = "GOT4.10 ocean tide" ;
                tide_ocean_got410:source = "GOT4.10" ;
                tide_ocean_got410:units = "m" ;
                tide_ocean_got410:scale_factor = 0.0001 ;
                tide_ocean_got410:coordinates = "lon lat" ;
                tide_ocean_got410:field = 1222s ;
                tide_ocean_got410:comment = "Ocean tide variation including equilibrium and non-
equilibrium tides" ;
        short tide_load_got410(time) ;
                tide_load_got410:_FillValue = 32767s ;
                tide_load_got410:long_name = "GOT4.10 load tide" ;
                tide_load_got410:source = "GOT4.10" ;
                tide_load_got410:units = "m" ;
                tide_load_got410:scale_factor = 0.0001 ;
                tide_load_got410:coordinates = "lon lat" ;
                tide_load_got410:field = 1322s ;
                tide_load_got410:comment = "Load tide variation to be added to ocean tide" ;
        int mss_dtu15(time) ;
                mss_dtu15:_FillValue = 2147483647 ;
                mss_dtu15:long_name = "DTU15 mean sea surface height" ;
                mss_dtu15:source = "DTU15" ;
                mss_dtu15:units = "m" ;
                mss_dtu15:scale_factor = 0.0001 ;
                mss_dtu15:coordinates = "lon lat" ;
                mss_dtu15:field = 1618s ;
        int wfm_fit_err_ALES_hi(time, meas_ind) ;
                wfm_fit_err_ALES_hi:_FillValue = 2147483647 ;
                wfm_fit_err_ALES_hi:long_name = "Error of waveform fit (ALES retracking)" ;
                wfm_fit_err_ALES_hi:units = "1" ;
                wfm_fit_err_ALES_hi:scale_factor = 0.0001 ;
                wfm_fit_err_ALES_hi:add_offset = 0. ;
                wfm_fit_err_ALES_hi:coordinates = "lon_hi lat_hi" ;
                wfm_fit_err_ALES_hi:comments = "Error of the waveform fit to the leading edge, not the
complete sub-waveform used in the ALES retracking, in normalised power units" ;
        short swh_ALES_hi(time, meas_ind) ;
                swh_ALES_hi:_FillValue = 32767s ;
                swh_ALES_hi:standard_name = "sea_surface_wave_significant_height" ;
                swh_ALES_hi:units = "m" ;
                swh_ALES_hi:scale_factor = 0.001 ;
                swh_ALES_hi:add_offset = 0. ;
                swh_ALES_hi:coordinates = "lon_hi lat_hi" ;
        short sigma0_ALES_hi(time, meas_ind) ;
                sigma0_ALES_hi:_FillValue = 32767s ;
                sigma0_ALES_hi:long_name = "20 Hz Ku band backscatter coefficient (ALES retracking)" ;
                sigma0_ALES_hi:standard_name = "surface_backwards_scattering_coefficient_of_radar_wave" ;
                sigma0_ALES_hi:units = "dB" ;
                sigma0_ALES_hi:scale_factor = 0.01 ;
                sigma0_ALES_hi:add_offset = 0. ;
                sigma0_ALES_hi:coordinates = "lon_hi lat_hi" ;
```

```
                sigma0_ALES_hi:comments = "Sigma0 corrected using scaling_factor_20hz_ku and
atmos_corr_sig0_ku interpolated at 20 Hz" ;
        short twle_SGDR_hi(time, meas_ind) ;
                twle_SGDR_hi:_FillValue = 32767s ;
                twle_SGDR_hi:long_name = "Total Water Level Envelope (SGDR retracking)" ;
                twle_SGDR_hi:units = "m" ;
                twle_SGDR_hi:scale_factor = 0.0001 ;
                twle_SGDR_hi:add_offset = 0. ;
                twle_SGDR_hi:coordinates = "lon_hi lat_hi" ;
                twle_SGDR_hi:comments = "Total Water Level Envelope calculated using SGDR range" ;
        short ssha_SGDR_hi(time, meas_ind) ;
                ssha_SGDR_hi:_FillValue = 32767s ;
                ssha_SGDR_hi:long_name = "Sea Surface Height Anomaly (SGDR retracking)" ;
                ssha_SGDR_hi:units = "m" ;
                ssha_SGDR_hi:scale_factor = 0.0001 ;
                ssha_SGDR_hi:add_offset = 0. ;
                ssha_SGDR_hi:coordinates = "lon_hi lat_hi" ;
                ssha_SGDR_hi:comments = "Sea Surface Height Anomaly using SGDR range: altitude of
satellite - Ku band corrected altimeter range (range_ku) - altimeter ionospheric correction on Ku band
(iono_corr_alt_ku) - model dry tropospheric correction (model_dry_tropo_corr) - radiometer wet
tropospheric correction (rad_wet_tropo_corr) - sea state bias correction in Ku band (sea_state_bias_ku)
- solid earth tide height (solid_earth_tide) - geocentric ocean tide height solution 1 (ocean_tide_sol1)
-load tide height solution 1 (load_tide_sol1)- geocentric pole tide height (pole_tide) - inverted
barometer height correction (inv_bar_corr) - high frequency fluctuations of the sea surface topography
(hf_fluctuations_corr for I/GDR off line products only) - mean sea surface (mean_sea_surface). Set to
default if the altimeter echo type (alt_echo_type) is set to 1 = non ocean like, the radiometer surface
type (rad_surf_type) set to 2 = land\"" ;
        short twle_ALES_hi(time, meas_ind) ;
                twle_ALES_hi:_FillValue = 32767s ;
                twle_ALES_hi:long_name = "Total Water Level Envelope (ALES retracking)" ;
                twle_ALES_hi:units = "m" ;
                twle_ALES_hi:scale_factor = 0.0001 ;
                twle_ALES_hi:add_offset = 0. ;
                twle_ALES_hi:coordinates = "lon_hi lat_hi" ;
                twle_ALES_hi:comments = "Total Water Level Envelope calculated using ALES retracked
range" ;
        short ssha_ALES_hi(time, meas_ind) ;
                ssha_ALES_hi:_FillValue = 32767s ;
                ssha_ALES_hi:long_name = "Sea Surface Height Anomaly (ALES retracking)" ;
                ssha_ALES_hi:units = "m" ;
                ssha_ALES_hi:scale_factor = 0.0001 ;
                ssha_ALES_hi:add_offset = 0. ;
                ssha_ALES_hi:coordinates = "lon_hi lat_hi" ;
                ssha_ALES_hi:comments = "Sea Surface Height Anomaly calculated using ALES retracked
range" ;

// global attributes:
                :Conventions = "CF-1.1" ;
                :title = "GDR - Expertise dataset" ;
                :institution = "NOC" ;
                :source = "radar altimeter" ;
                :history = "2016-01-14 07:10:54 : Creation. ALES products for C-RISe Project Data subset
to coastal region" ;
                :contact = "CNES aviso@altimetry.fr NASA/JPL podaac@podaac.jpl.nasa.gov. NOC
bodcnocs@bodc.ac.uk" ;
                :references = "CNES Reprocessing Tool 2.0 (Updates to time tags, ranges, models and all
JMR derived parameters updated with dedicated recalibration of JMR in 2015). Processing Version ALES v6"
;
                :processing_center = "NOC" ;
                :reference_document = "[1] Passaro M., Cipollini P., Vignudelli S., Quartly G., Snaith H.
(2014) \"ALES: a multi-mission adaptive sub-waveform retracker for coastal and open ocean altimetry\",
Remote Sensing of Environment, Vol. 145, pp. 173-189 [2] Passaro M., Fenoglio-Marc L., Cipollini P.
(2015) \"Validation of Significant Wave Height From Improved Satellite Altimetry in the German Bight\",
IEEE Transactions on Geoscience and Remote Sensing, Vol. 53, n. 4,  pp. 2146-2156" ;
                :mission_name = "Jason-1" ;
                :altimeter_sensor_name = "POSEIDON-2" ;
                :radiometer_sensor_name = "JMR" ;
                :doris_sensor_name = "2GM" ;
                :gpsr_sensor_name = "TRSR" ;
                :acq_station_name = "CNES/NASA" ;
                :cycle_number = 247 ;
                :absolute_rev_number = 31315 ;
```

```
                :pass_number = 144 ;
                :absolute_pass_number = 62628 ;
                :equator_time = "2008-09-25 01:35:40.893000" ;
                :equator_longitude = 53.16 ;
                :first_meas_time = "2008-09-25 01:41:21" ;
                :last_meas_time = "2008-09-25 01:42:53" ;
                :ellipsoid_axis = 6378136.3 ;
                :ellipsoid_flattening = 0.0033528131778969 ;
}
```

9.2 Along-Track co-located time series, with trends and variability

The statistics of the sea level (trend, annual cycle and phase) together with SSHA, TWLE, SWH and Sigma0 of ALES-generated quantities are provided over reference tracks in netCDF format. The metadata such as the name/value attribute are self-described in this format. Each file contains statistics and the aforementioned sea surface quantities for a single pass for all the orbital cycles between January 2002 and December 2018 from the concatenation in time of the Jason-1, Jason-2 and Jason-3 missions. For example, the file *j1j2j3_stats_ales_p0044.nc* contains along-track statistics at 20-Hz samples (every 300 m) for pass 0044 from the concatenation of Jason-1 cycles 1 to 259, Jason-2 cycles 1 to 303, and Jason3 cycles 1 to 106.
The global attributes of the file (such as history, contact, reference, details of the pass, etc) are at the end of the variable list.

```
netcdf j1j2j3_stats_ales_p0044 {
dimensions:
        position = 5518 ;
        time = 614 ;
variables:
        double lat(position) ;
                lat:long_name = "latitude" ;
                lat:standard_name = "latitude" ;
                lat:units = "degrees_north" ;
        double lon(position) ;
                lon:long_name = "longitude" ;
                lon:standard_name = "longitude" ;
                lon:units = "degrees_east" ;
        double time(time) ;
                time:long_name = "Time" ;
                time:standard_name = "Time in seconds since 1 Jan 2000" ;
                time:units = "sec. since 1 Jan 2000" ;
                time:comment = "Reference time of overpass (median time of pass segment). Orbital cycle
is 9.92 days" ;
        double time_dy(time) ;
                time_dy:long_name = "Reference Time" ;
                time_dy:standard_name = "reference time in decimal years" ;
                time_dy:units = "year" ;
                time_dy:comment = "Reference time in decimal years" ;
        double twle(position, time) ;
                twle:long_name = "sea surface height" ;
                twle:units = "m" ;
                twle:comment = "Total Water Level Envelope, i.e. height inclusive of ocean tide and
atmospheric effects relative to DTU15 MSS. Computed using range from ALES retracker" ;
        double ssha(position, time) ;
                ssha:long_name = "sea surface height anomaly" ;
                ssha:units = "m" ;
                ssha:comment = "Sea Surface Height anomaly relative to DTU15 MSS. Computed using range
from ALES retracker" ;
        double ssha_filt(position, time) ;
                ssha_filt:long_name = "sea surface height anomaly" ;
                ssha_filt:units = "m" ;
                ssha_filt:comment = "Sea Surface Height anomaly relative to DTU15 MSS - filtered along-
track with 21-point Hamming window. Computed using range from ALES retracker " ;
        double swh(position, time) ;
                swh:long_name = "significant wave height" ;
                swh:units = "m" ;
                swh:comment = "sea surface Significant Wave Height. Output from ALES retracker " ;
```

```
        double swh_filt(position, time) ;
                swh_filt:long_name = "significant wave height" ;
                swh_filt:units = "m" ;
                swh_filt:comment = "sea surface Significant Wave Height - filtered along-track with 21-
point Hamming window. Output from ALES retracker " ;
        double sigma0(position, time) ;
                sigma0:long_name = "surface_backwards_scattering_coefficient_of_radar_wave" ;
                sigma0:units = "dB" ;
                sigma0:comment = "Sigma0 corrected using scaling_factor_20hz_ku and atmos_corr_sig0_ku
interpolated at 20 Hz. Output from ALES retracker  " ;
        double sigma0_filt(position, time) ;
                sigma0_filt:long_name = "surface_backwards_scattering_coefficient_of_radar_wave" ;
                sigma0_filt:units = "dB" ;
                sigma0_filt:comment = "Sigma0 corrected using scaling_factor_20hz_ku and
atmos_corr_sig0_ku interpolated at 20 Hz - filtered along-track with 21-point Hamming window. Output
from ALES retracker " ;
        double OceanTide(position, time) ;
                OceanTide:long_name = "FES2014 Ocean Tide" ;
                OceanTide:units = "m" ;
                OceanTide:comment = "Ocean Tide variation including equilibrium and none-equilibrium
tides" ;
                OceanTide:source = "FES2014 taken from RADS and interpolated to 20Hz" ;
        double DACorr(position, time) ;
                DACorr:long_name = "MOG2D dynamic atmospheric correction" ;
                DACorr:units = "m" ;
                DACorr:comment = "Combined low-and high-frequency effect of atmospheric pressure and wind
on sea surface height" ;
                DACorr:source = "MOG2D-G taken from RADS and interpolated to 20Hz" ;
        double ssha_trend(position) ;
                ssha_trend:long_name = "sea surface height trend" ;
                ssha_trend:units = "mm/yr" ;
                ssha_trend:comment = "Overall trend from Ordinary Least Squares fitting over entire
altimeter record" ;
        double ssha_trend_RR(position) ;
                ssha_trend_RR:long_name = "sea surface height trend" ;
                ssha_trend_RR:units = "mm/yr" ;
                ssha_trend_RR:comment = "Overall trend from Robust Regression over entire record" ;
        double ssha_trend_seols(position) ;
                ssha_trend_seols:long_name = "Standard error for the sea surface height trend" ;
                ssha_trend_seols:units = "mm/yr" ;
                ssha_trend_seols:comment = "Standard error for the overall trend over entire altimeter
record, from Ordinary Least Squares" ;
        double ssha_trend_senw(position) ;
                ssha_trend_senw:long_name = "Newey-West error for the sea surface height trend" ;
                ssha_trend_senw:units = "mm/yr" ;
                ssha_trend_senw:comment = "Standard error for the overall trend over entire record, with
Newey-West technique. This is often preferred to error estimated from OLS, as it accounts for
correlation of time series" ;
        double ssha_amp(position) ;
                ssha_amp:long_name = "sea surface height annual signal amplitude" ;
                ssha_amp:units = "m" ;
                ssha_amp:comment = "Amplitude of the annual cycle in SSHA" ;
        double ssha_amp_error(position) ;
                ssha_amp_error:long_name = "error for sea surface height annual signal amplitude" ;
                ssha_amp_error:units = "m" ;
                ssha_amp_error:comment = "Standard error for Amplitude of the annual cycle in SSHA" ;
        double ssha_amp_RR(position) ;
                ssha_amp_RR:long_name = "sea surface height annual signal amplitude" ;
                ssha_amp_RR:units = "m" ;
                ssha_amp_RR:comment = "Amplitude of the annual cycle in SSHA from Robust Regression" ;
        double ssha_amp_error_RR(position) ;
                ssha_amp_error_RR:long_name = "error for sea surface height annual signal amplitude" ;
                ssha_amp_error_RR:units = "m" ;
                ssha_amp_error_RR:comment = "Standard error for Amplitude of the annual cycle in SSHA
from Robust Regression" ;
        double ssha_phase(position) ;
                ssha_phase:long_name = "sea surface height annual signal phase" ;
                ssha_phase:units = "days" ;
                ssha_phase:comment = "Phase of the annual cycle in SSHA expressed as day-of-year of
maximum" ;
        double ssha_phase_error(position) ;
                ssha_phase_error:long_name = "error for sea surface height annual signal phase" ;
```

```
                ssha_phase_error:units = "days" ;
                ssha_phase_error:comment = "Standard error for Phase of the annual cycle in SSHA
expressed as day-of-year of maximum" ;
        double ssha_phase_RR(position) ;
                ssha_phase_RR:long_name = "sea surface height annual signal phase" ;
                ssha_phase_RR:units = "days" ;
                ssha_phase_RR:comment = "Phase of the annual cycle in SSHA expressed as day-of-year of
maximum from Robust Regression" ;
        double ssha_phase_error_RR(position) ;
                ssha_phase_error_RR:long_name = "error for sea surface height annual signal phase" ;
                ssha_phase_error_RR:units = "days" ;
                ssha_phase_error_RR:comment = "Standard error for Phase of the annual cycle in SSHA
expressed as day-of-year of maximum from Robust Regression" ;
        double ssha_semi_amp(position) ;
                ssha_semi_amp:long_name = "sea surface height semi-annual signal amplitude" ;
                ssha_semi_amp:units = "m" ;
                ssha_semi_amp:comment = "Amplitude of the semi-annual cycle in SSHA" ;
        double ssha_semi_amp_error(position) ;
                ssha_semi_amp_error:long_name = "error for sea surface height semi-annual signal
amplitude" ;
                ssha_semi_amp_error:units = "m" ;
                ssha_semi_amp_error:comment = "Standard error for Amplitude of the semi-annual cycle in
SSHA" ;
        double ssha_semi_amp_RR(position) ;
                ssha_semi_amp_RR:long_name = "sea surface height semi-annual signal amplitude" ;
                ssha_semi_amp_RR:units = "m" ;
                ssha_semi_amp_RR:comment = "Amplitude of the semi-annual cycle in SSHA from Robust
Regression" ;
        double ssha_semi_amp_error_RR(position) ;
                ssha_semi_amp_error_RR:long_name = "error for sea surface height semi-annual signal
amplitude" ;
                ssha_semi_amp_error_RR:units = "m" ;
                ssha_semi_amp_error_RR:comment = "Standard error for Amplitude of the semi-annual cycle
in SSHA from Robust Regression" ;
        double ssha_semi_phase(position) ;
                ssha_semi_phase:long_name = "sea surface height semi-annual signal phase" ;
                ssha_semi_phase:units = "days" ;
                ssha_semi_phase:comment = "Phase of the semi-annual cycle in SSHA expressed as day-of-
year of maximum" ;
        double ssha_semi_phase_error(position) ;
                ssha_semi_phase_error:long_name = "error for sea sea surface height semi-annual signal
phase" ;
                ssha_semi_phase_error:units = "days" ;
                ssha_semi_phase_error:comment = "Standard error for Phase of the semi-annual cycle in
SSHA expressed as day-of-year of maximum" ;
        double ssha_semi_phase_RR(position) ;
                ssha_semi_phase_RR:long_name = "sea surface height semi-annual signal phase" ;
                ssha_semi_phase_RR:units = "days" ;
                ssha_semi_phase_RR:comment = "Phase of the semi-annual cycle in SSHA expressed as day-of-
year of maximum from Robust Regression" ;
        double ssha_semi_phase_error_RR(position) ;
                ssha_semi_phase_error_RR:long_name = "error for sea surface height semi-annual signal
phase" ;
                ssha_semi_phase_error_RR:units = "days" ;
                ssha_semi_phase_error_RR:comment = "Standard error for Phase of the semi-annual cycle in
SSHA expressed as day-of-year of maximum from Robust Regression" ;

// global attributes:
                :Conventions = "CF-1.4" ;
                :institution = "National Oceanography Centre" ;
                :mission = "Jason-1, Jason-2 and Jason-3" ;
                :Pass = "0044" ;
                :start_date = "16-Jan-2002 22:02:14" ;
                :end_date = "16-Dec-2018 08:51:23" ;
}
```

10 ANNEX B – Accessing / Downloading C-RISe Data Sets

10.1 CSIR Data Portal

CSIR has developed a Data Portal for accessing and downloading the C-RISe data sets, and partners are encouraged to use this as a first option.
However, at the time of writing (16 July 2019), the latest data sets are not available through this route.

The URL of the portal is https://eo.meraka.csir.co.za/crise/

The home page provides a free text search. General information about the project and the data is available on the "ABOUT" tab, and a full data set listing through the "DATA" tab.

This section to be updated when the CSIR portal is updated

10.2 FTP access

10.2.1 Coastal Altimeter Products

The NOC process Coastal altimeter products can be downloaded by ftp through anonymous ftp as specified below:

Coastal Altimetry Geophysical Data Records
For Jason-1: ftp://ftp.noc.soton.ac.uk/pub/nayoub/CRISe/J1_ref
For Jason-2: ftp://ftp.noc.soton.ac.uk/pub/nayoub/CRISe/J2_ref
For Jason-3: ftp://ftp.noc.soton.ac.uk/pub/nayoub/CRISe/J3_ref

Co-located altimeter data
ftp://ftp.noc.soton.ac.uk/pub/nayoub/CRISe/collocated_j1j2j3

10.2.2 Wave Climatology

The wave climatology data set is a new data set provided as a pre-release from the ESA CCI Sea State project. These data are not currently freely available from the project, though a public release is expected soon.
For access to these data email d.cotton@satoc.eu

10.2.3 Wind Climatology

The wind climatology data are available through the EU Copernicus Marine Environment Monitoring Service (CMEMS). The front page is http://marine.copernicus.eu
Data sets can be selected through http://marine.copernicus.eu/services-portfolio/access-to-products/
Regional Domain, Parameters and Temporal Coverage can be selected.
Under Parameters select "wind", and a number of possible ocean wind data sets are displayed. For the data set used in C-RISe select "**WIND_GLO_WIND_L4_REP_OBSERVATIONS_012_003**", which is the Level 4 Monthly Mean data set.

10.2.4 Surface Current Climatology

The surface current climatology was produced by the ESA Globcurrent project. Information and ftp access is available at http://globcurrent.ifremer.fr/products-data.

11 ANNEX C –C-RISe Data Sets Structure for Python Software

The C-RISe python software assumes a specific folder structure for the software and data, as specified below:

/Shared
  /Software
  /Data
  /Results
  /Documentation

Under
/Shared/Data
  /C-RISe (for the NOC processed altimeter data)
    /ALES
      /j1 , /j2 , /3
        Under each of j1, j2, j3 further folders for each cycle (e.g. cycle000), and then one file per pass in each cycle (e.g. *cgdr_crise_j3_p0120_c000.nc*)
    /altimetryBy Pass
      one file for each pass. e.g. j1j2j3_stats_ales_p0005.nc

  /Currents (for the surface current climatological data)
    /Currents_L4
      /2002, /2003, … /2016 (one folder per year)
        In each year folder one folder per day, one file for each day
        e.g. *C-RISe_20020104-GLOBCURRENT-L4-CUReul_hs-ALT_SUM-v03.0-fv01.0.nc*

  /WindWave
    /buoy (example buoy data for validation)
      Separate folder for each buoy (e.g. /46006), one file per year e.g.
        46006h1993.txt
    /L4SAR (directional SAR wave mode data – swell only)
      /2002, /2003, … /2016 (one folder per year)
        In each folder one file per month, e.g. *GW_L4_SAR_monthly_200301.nc*
    /waves
      /2002, /2003, … /2018 (one folder per year)
        In each folder one file per month, e.g. *ESACCI-SEASTATE-L4-SWH-MULTI_1M-201701-fv01.nc*
    /winds
      /2007, /2008, … /2018 (one folder per year)
        In each folder one file per month, e.g. *2009011612_1mm-ifremer-L4-EWSB-wind_gridded-GLO-20110902154412NRT-02.0.nc*

  /TideGauge (see Section 7.2 above for details)
    /C-RISe_Seasonal_Variability
      /IOC_SLMF_data, /PSMSL_data
    /C-RISe_TG_validation
      /C-RISe_IOCSLMF, C-RISe_UHSLC

/PSMSL_data_for_trends
/Tidal_analysis