C-RISe – Application of satellite data as a tool for managing coastal risk and sustainable development in the South-West Indian Ocean

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www.c-rise.info

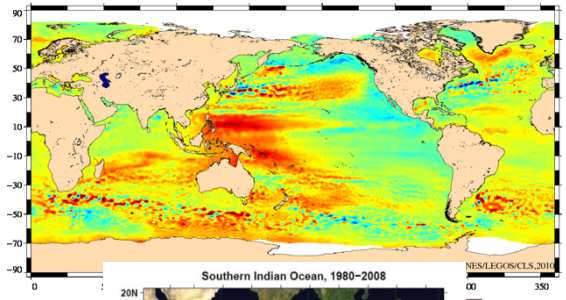
C-RISe
COASTAL RISK
INFORMATION SERVICE

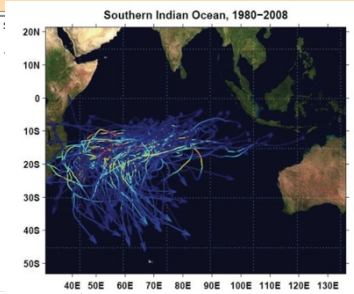
C-RISe Overview: Objectives

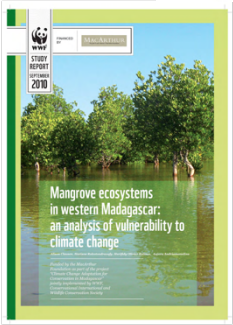
- **C-RISe:** A 3 year project to develop, deliver and evaluate a Coastal Risk Information Service to South Africa, Mozambique, Madagascar and Mauritius
- Funded by the UK Space Agency: International Partnership Programme
- Project Objectives:
  - Deliver a **Coastal Risk Information Service**, providing satellite-derived information about sea level, wind, waves and surface currents to support coastal vulnerability assessment and hazard management efforts.
  - Apply and evaluate the C-RISe service through a set of **Use Cases**, applying the C-RISe products to end use applications that address local priorities.
  - Build **local capacity** to use satellite data to provide **scientific decision support** for strategy development, governance and management of coastal areas to increase resilience to coastal hazards

C-RISe - What is the Problem?

- Global sea level is increasing, and large-scale weather patterns are changing.
- C-RISe partner countries in the South West Indian Ocean (Mozambique, Madagascar, Mauritius, South Africa) have significant coastal populations highly vulnerable to the consequences of climate variability and change.
- With access to improved regional information on coastal risk factors (sea level, wave and wind extremes) plans to protect coastal communities and safeguard economic activity can be improved.
- Will also contribute to improving industrial and commercial competitiveness in the maritime sector, heavily dependent on access to accurate relevant oceanographic information.





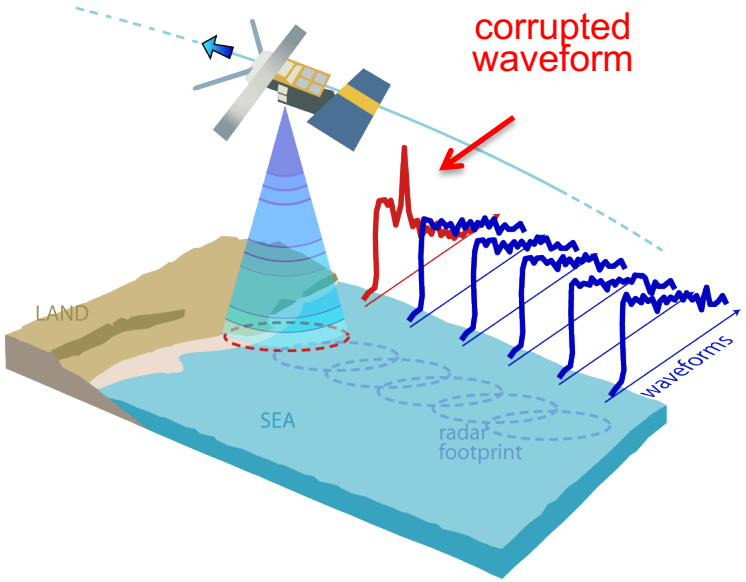


C-RISe: Products and coverage

Parameter	Description	Time Coverage	Satellites
Total Water Level Envelope, significant wave height, surface radar backscatter	Along track data from the NOC coastal processor	2002-2016	Jason-1, Jason-2, Jason-3
Significant Wave Height Climatology	Monthly, 1° x 1° gridded climatology, Globwave	1992-2014	ERS-1, ERS-2, Envisat, Topex, Jason-1, 2,3
Wind Speed and Direction Climatology	Monthly, 0.25° x 0.25°, from copernicus	2007-2017	ASCAT
Total surface current (geostrophic + Eckmann)	Daily, 0.25° x 0.25°, from Globcurrent	1993-2015	Envisat, Jason-1, 2,3
Significant Wave Height, wind speed	Near Real Time along track data	Daily updated	Jason-2, Jason-3, AltiKa, Sentinel-3
Wind speed and wind direction	Near Real Time data across scatterometer swath (25km resolution)	Daily updated	Metop/ ASCAT-A
Total surface current (geostrophic + Eckmann)	Near Real Time data, 0.25° x 0.25°	Weekly updated	Jason-2, Jason-3

Climatology data available through the CSIR data portal at
https://eo.meraka.csir.co.za/crise/

Satellite altimetry at the coast



In the **coastal zone** altimetry encounters specific problems:

- corruption of the radar waveforms (see plot on the left)
- inaccurate corrections for some effects, for instance those due to water vapour and tides

Traditionally, data in this zone are flagged as bad and left unused

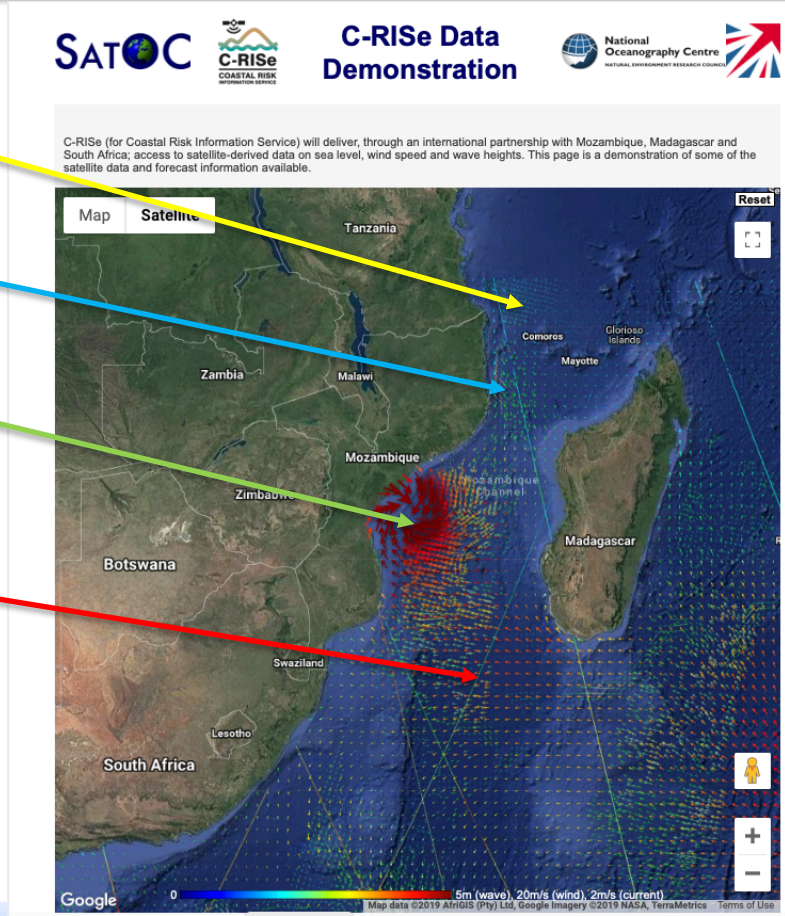
NOC has developed **a new algorithm** (ALES, Passaro et al., 2014) **that improves the estimates of sea level and of significant wave height.**

C-RISe Service: Near Real Time

- Wind speed and direction from satellite scatterometer (ASCAT)
- Daily average surface currents from ESA Globcurrent project
- Forecast winds and waves from US NOAA model
- Along track wind speed and wave height data from satellite altimeter, most recent passes (Jason-2, Jason-3, AltiKa, Sentinel-3)

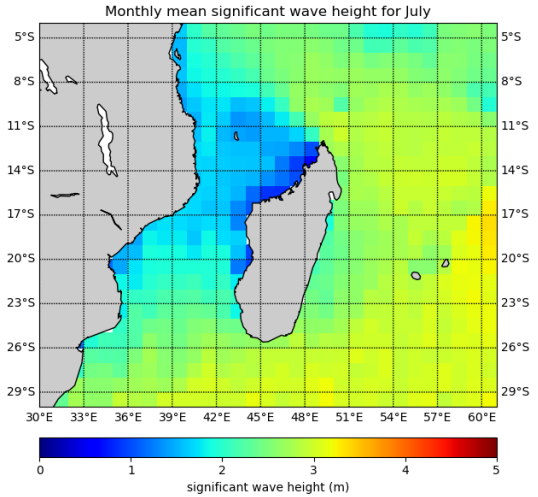
http://www.satoc.eu/projects/c-rise/demo.html

Screenshot from 14 March 2019: Tropical Cyclone Idai



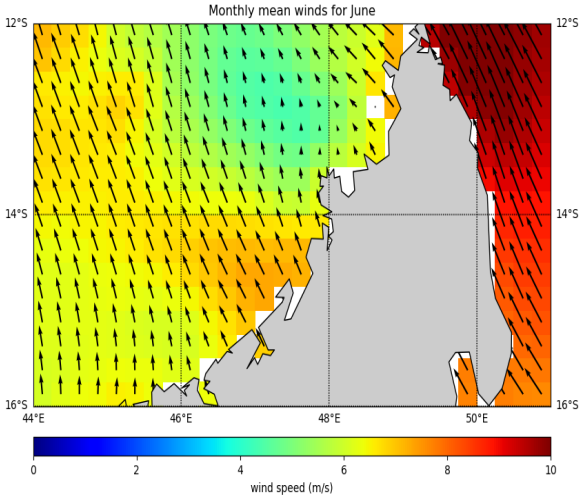
C-RISe Service: Climatological Product

Waves



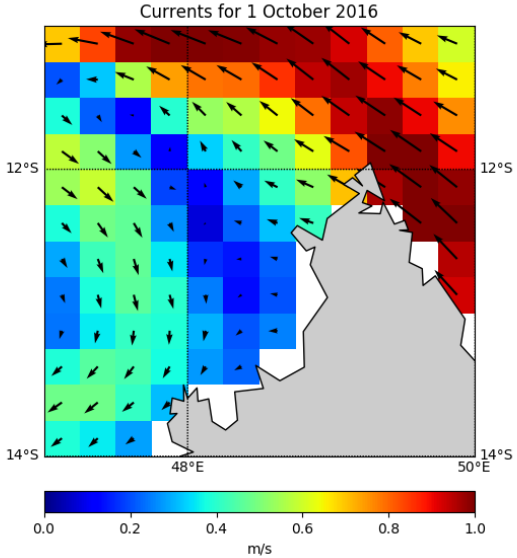
July mean SWH

Winds



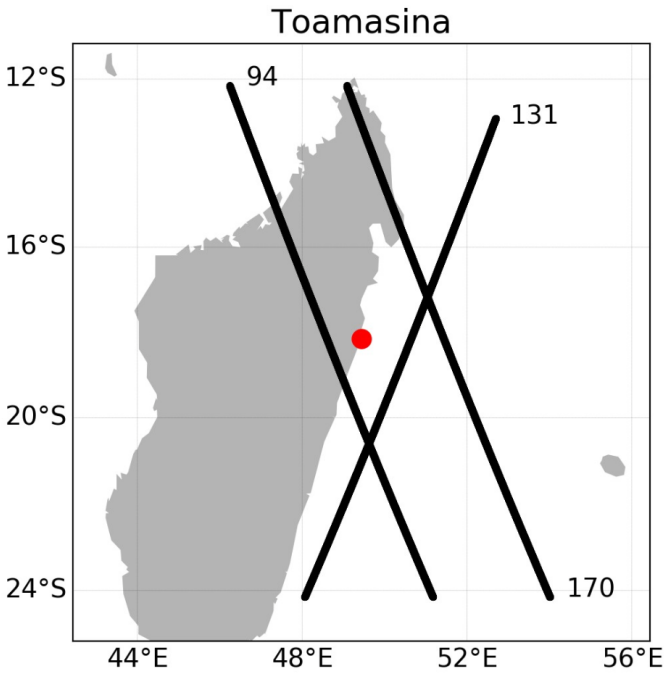
June mean wind speed and direction

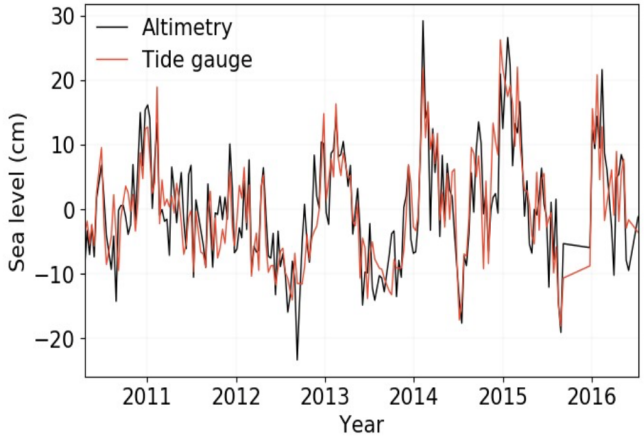
Surface Currents



Mean surface current 01/10/16

Validation of altimeter sea level against tide gauge



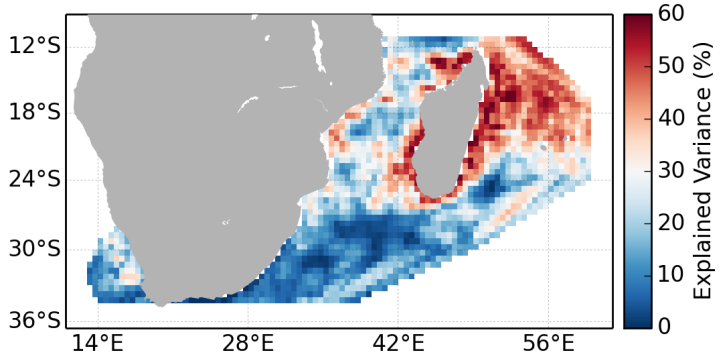


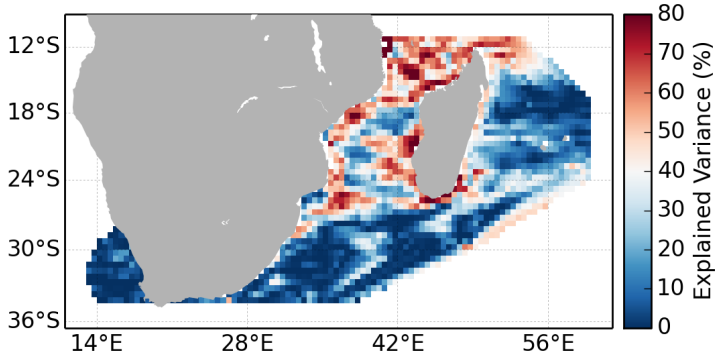
Track 94
Correlation: 0.83
RMS diff: 5.02 cm
Distance from coast: 6.6 km

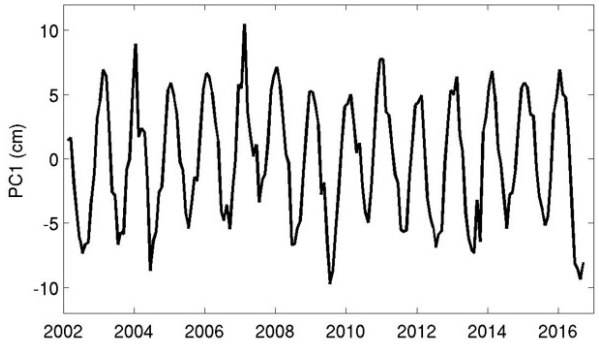
	Altimetry	Tide gauge
Annual amplitude (cm)	6.8 ± 1.0	7.0 ± 1.0
Annual phase (days)	32 ± 9	37 ± 8
Semi-annual amplitude (cm)	1.4 ± 0.7	1.8 ± 0.8
Semi-annual phase (days)	22 ± 37	25 ± 21
Max anomaly (cm)	14.4	NaN
Min anomaly (cm)	-12.0	NaN

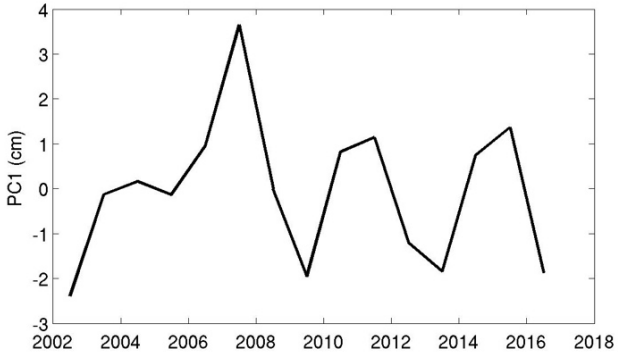
Analysis by R. Rajaonarivony (DGM) using C-RISe analysis software

Variability in Sea Surface Height from C-RISe data



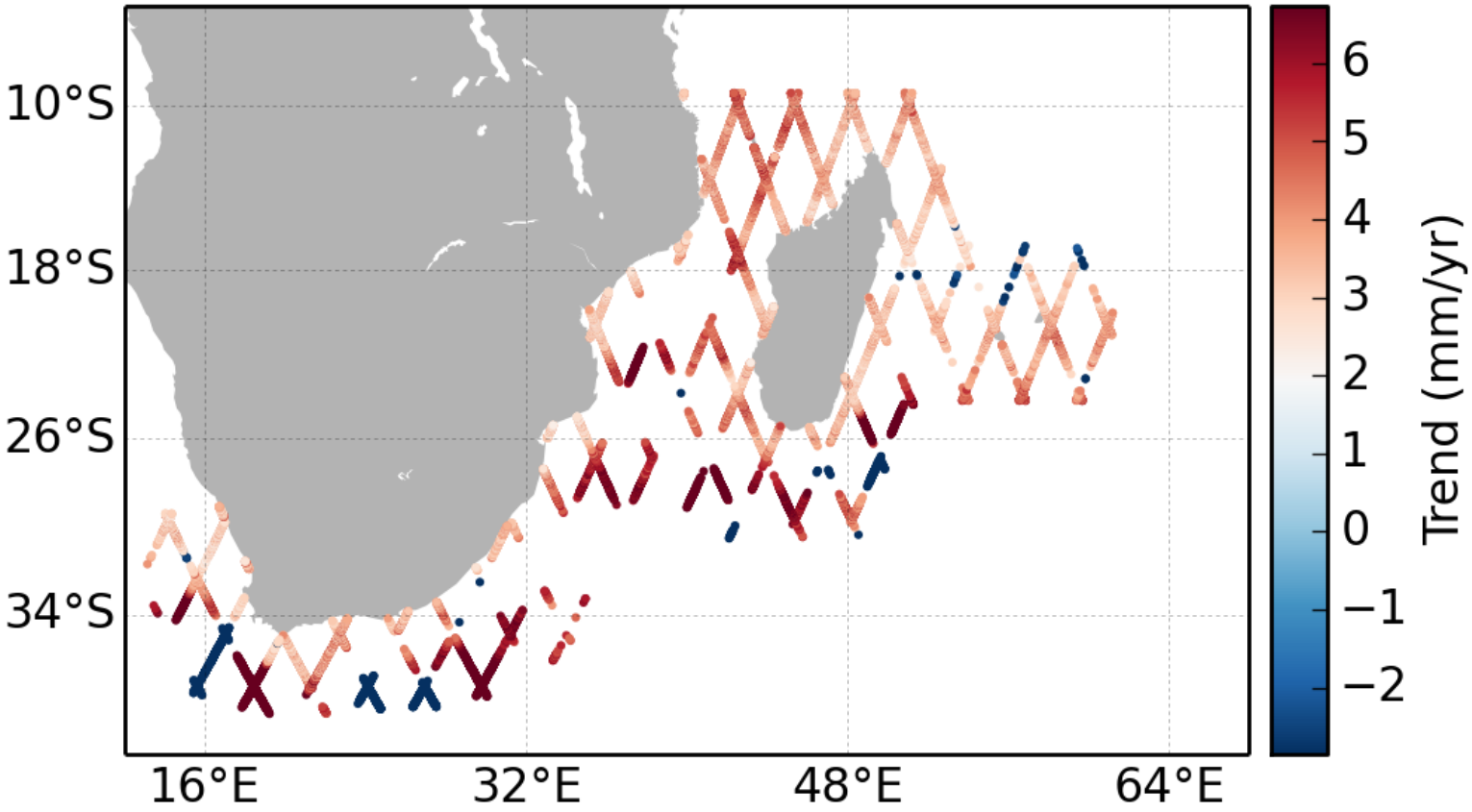




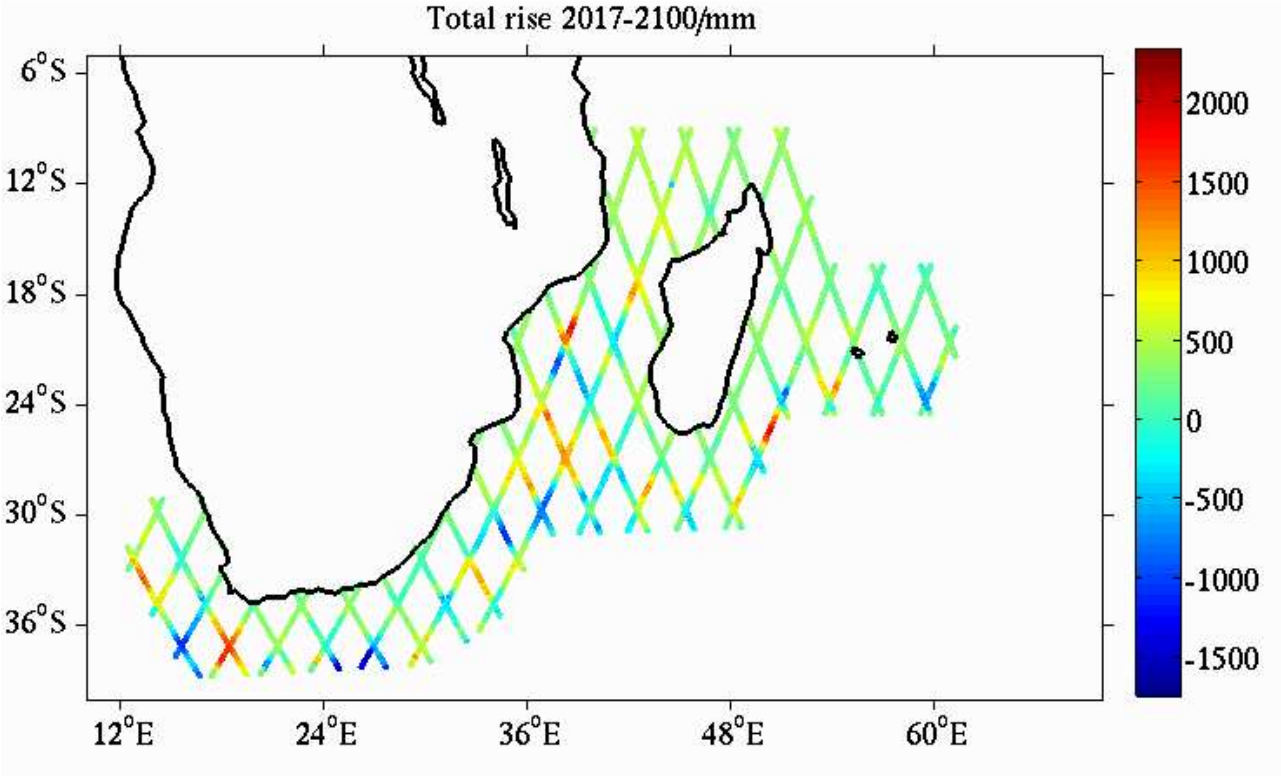


EOF (Empirical Orthogonal Function) analysis of C-RISe sea level, map and time series of detrended (left) monthly means, and right (annual means). The seasonal (annual) cycle dominates the monthly data, the annual data show different behavior in 2005-2008 from the rest of the time series

Sea level trend from C-RISe data 2002-16 (95% sig.)



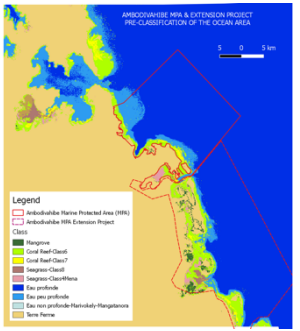
Total projected SLR by 2100



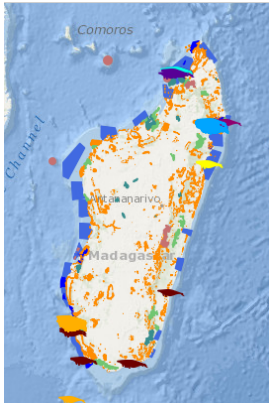
Work in progress to relate the total projected sea level rise by 2100, derived from C-RISe altimetry, to changes in MHW based upon Pickering et al. (2012)

C-RISe Applications: Use Cases

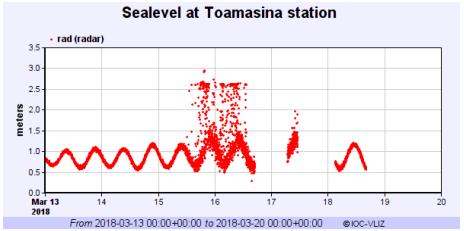
- 27 Use Cases: Practical implementation in local applications to support Monitoring and Evaluation and assess usefulness and benefits.
- Marine Protected Area Management - Information Services
- Near Real Time Sea State Information
  - Maritime safety, search and rescue support
  - Operational Planning: illegal logging, smuggling, pollution
  - Improved tropical storm information
- Sea Level Analyses:
  - Tidal Analyses, extreme events, inter-annual variability
  - Understanding changing coastal risk
- Wave and Wind (and current) climatologies
  - Operational planning
  - Coastal and Marine Atlas
  - Wind and wave energy resource
- Climate change impact on marine ecosystems
  - Mangroves, coral reefs, shrimp fisheries,
  - Algal blooms, sea water quality, pollution, acidification



Ecosystem classification



Madagascar Coastal Atlas



Tropical Storm Analyses

Capacity Building

A key objective of C-RISe is Capacity Building, to ensure a sustained impact:

- Software for sea level validation/ analysis, wind/wave climatology statistical analyses
- Series of Workshops, to develop local capacity to access, analyse and apply oceanographic satellite data sets in applications to increase resilience to coastal hazards.
- 2 sets of workshops delivered in Mozambique and Madagascar, to 68 participants:
  - ***Workshop 1 (Nov, Dec 2017): "Wind, wave and sea level information from satellites"***
  - ***Workshop 2 (Oct 2018): "Tools to apply satellite data to coastal risk."***

Summary

- C-RISe has provided climatological and near real time, sea level, surface current, wind and wave data to partners in the South West Indian Ocean
- These products have been applied in 27 Use Cases over a wide range of applications
- Benefits to local population generally over the longer term – Impacts from development of coastal management strategies will be felt in 5-10 year timescale
- Development of local capability through knowledge transfer and training
    - Training element has been very important and well received.

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Any Questions?

C-RISe is funded by the UK Space Agency under the International Partnership Programme (IPP), a five-year, £152 million programme designed to partner UK space expertise with overseas governments and organisations. It is funded from the Department for Business, Energy and Industrial Strategy's Global Challenges Research Fund (GCRF)