Components for the research to operational transition in Southern Africa – the Oceans and Coastal Information Management System

Stewart Bernard, April 2019
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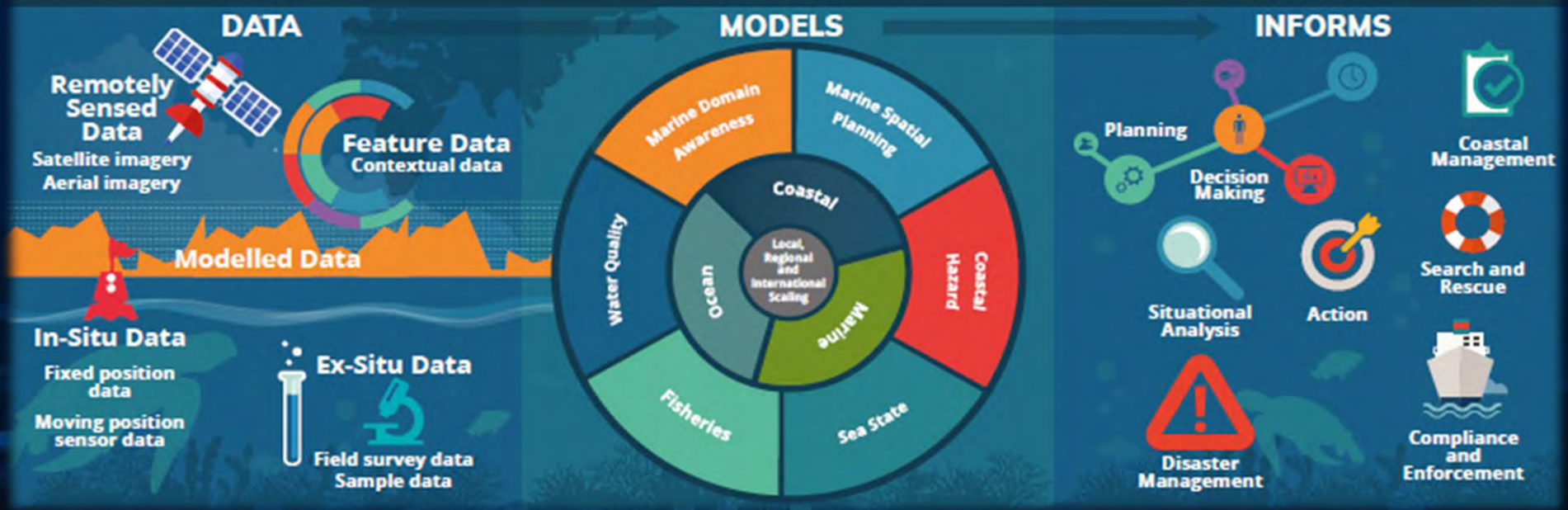

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Spiral Development: components for the research to operational transition

A quick example of the components used in the development of the Oceans and Coastal Information Management System (OCIMS), and the MarCoSouth regional GMES-Africa marine services…with a focus on earth observation and the Copernicus Sentinel constellations... and a slight bias towards Harmful Algal Bloom services...

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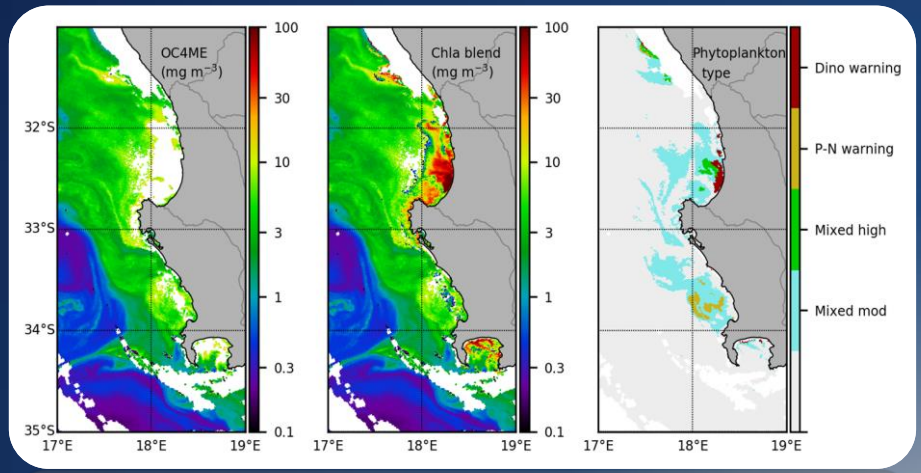
1. Get some regionally relevant science going…

1. Mature regional ocean colour science base: signal understanding through radiative transfer and empirical bio-optics; a strong MERIS heritage; regionally optimised and validated algorithms and products; and sufficient understanding of the regional bio-optical variability, oceanography and ecology.



Example OLCI products of OC4ME Chl-a (l); Chl-a from the Smith et al (2018) regional switching algorithm (c); and dinoflagellate / Pseudo-Nitzschia bloom identification map (r) (Marie Smith)

Need for regionally appropriate multi-sensor products…

MERIS/OLCI

Simple switching algorithm chosen over other available. E.g. optical water type classification, semi-anlytical, as simple and robust…

An optimized Chlorophyll a switching algorithm for MERIS and OLCI in phytoplankton-dominated waters, ME Smith, LR Lain, S Bernard, Remote sensing of environment 215, 217-227

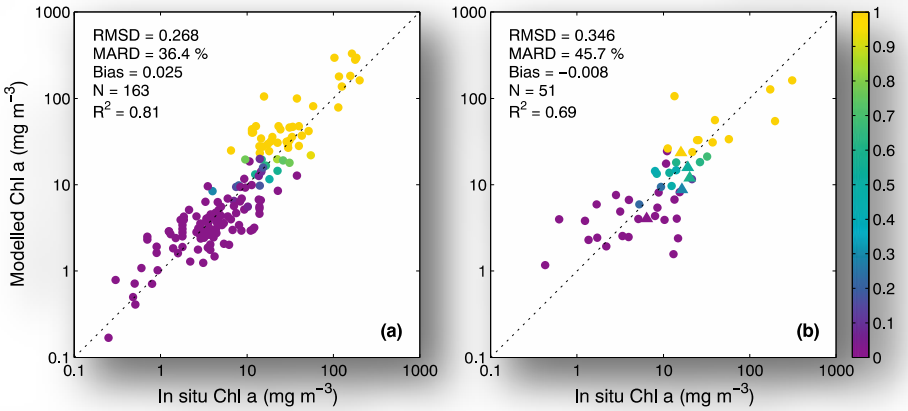
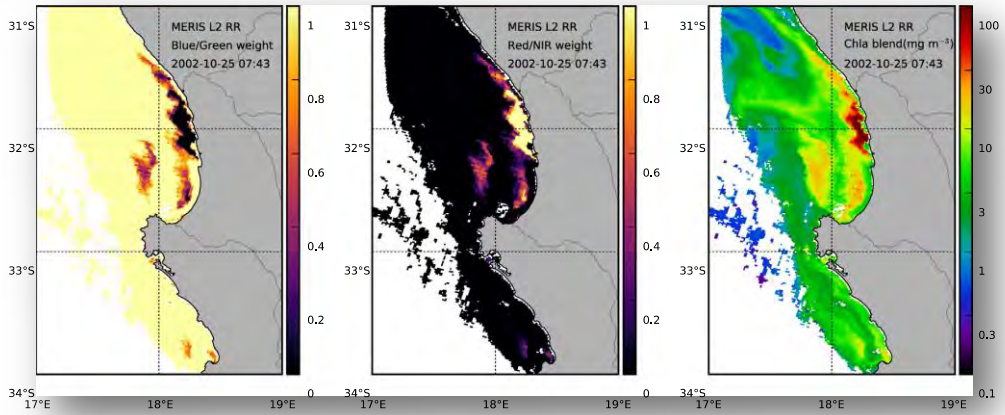


Fig. 3. Scatterplot showing the relationship between *in situ* Chl *a* and the modeled Chl *a* obtained by application of the switching and blending method to (a) *in situ* and (b) satellite-derived reflectance from MERIS (N = 46, circles) and OLCI (N = 5, triangles). The colour bar indicates the weighting of the G2B algorithm (i.e. a weighting of zero means that only OCI was applied). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)



(c) Sentinel3A OLCI - *Ceratium sp.*

Fig. 4. Examples of algorithm blending application for reduced resolution MERIS reflectance on the 25th of October 2002 (a) and the 30th of March 2005 (b), as well as for OLCI on the 10th of May 2017 (c). Panels on the left and centre show the weighting used to blend the OCI and G2B algorithms respectively, with the final blended Chl *a* product on the right.

Need for regionally appropriate multi-sensor products…

MERIS/OLCI

Also some regionally specific PFT indication based on red/NIR classification – distinguishes between dinoflagellate- and diatom-dominated blooms at high biomass

Satellite ocean colour based Harmful Algal Bloom identification for improved risk assessment and mitigation, M Smith, S Bernard, Earth and Space Science Open Archive, 2019

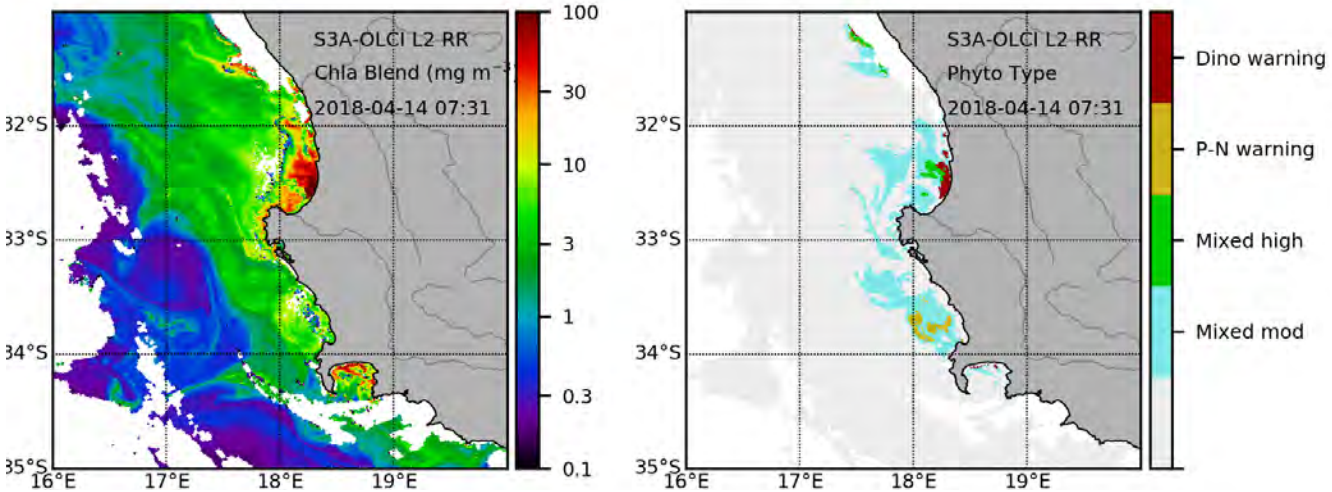
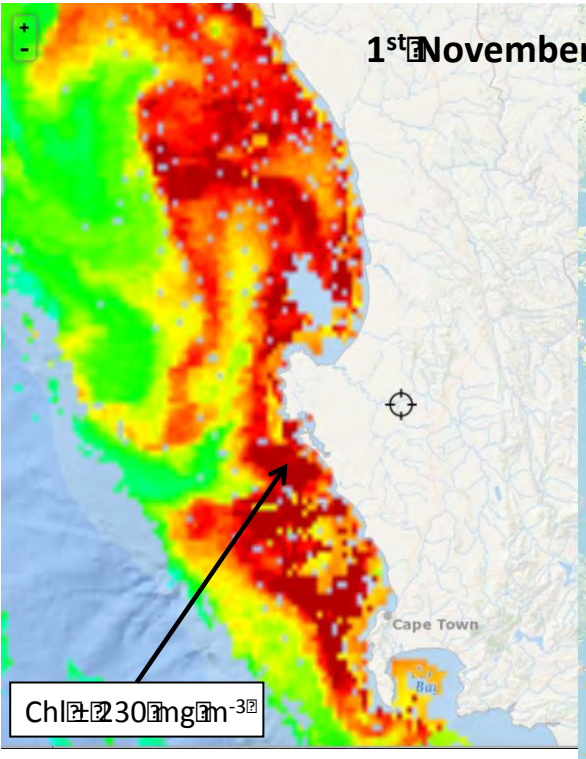


Figure 3: Satellite products derived from S3A-OLCI for the 14th of April 2018. The left panel shows [Chl-a], whilst the right panel shows the derived phytoplankton type classification; classes include dinoflagellate (red) and *Pseudo-nitzschia* (yellow) dominated waters, as well as high (green) and moderate (blue) biomass mixed assemblages.

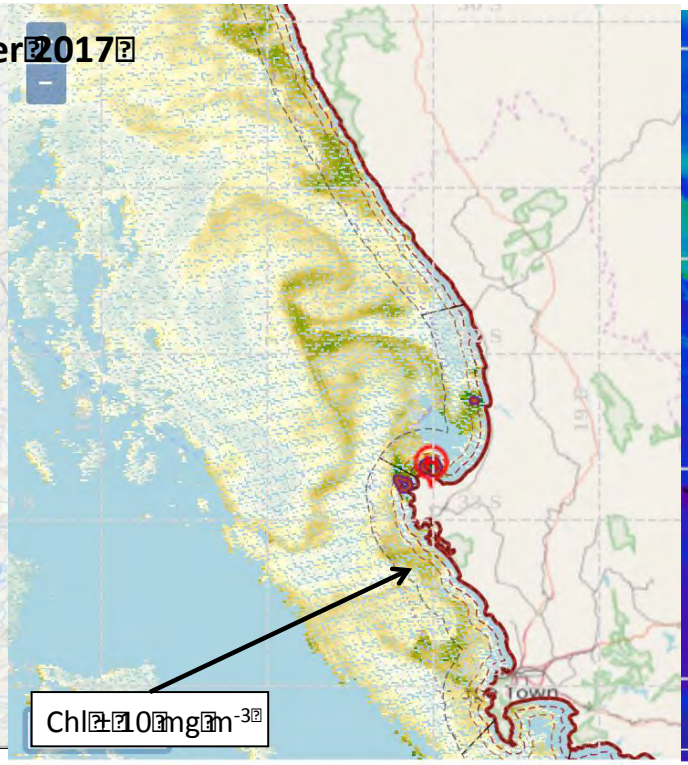
Need for regionally appropriate multi-sensor products…

Comparison with example commercial product…

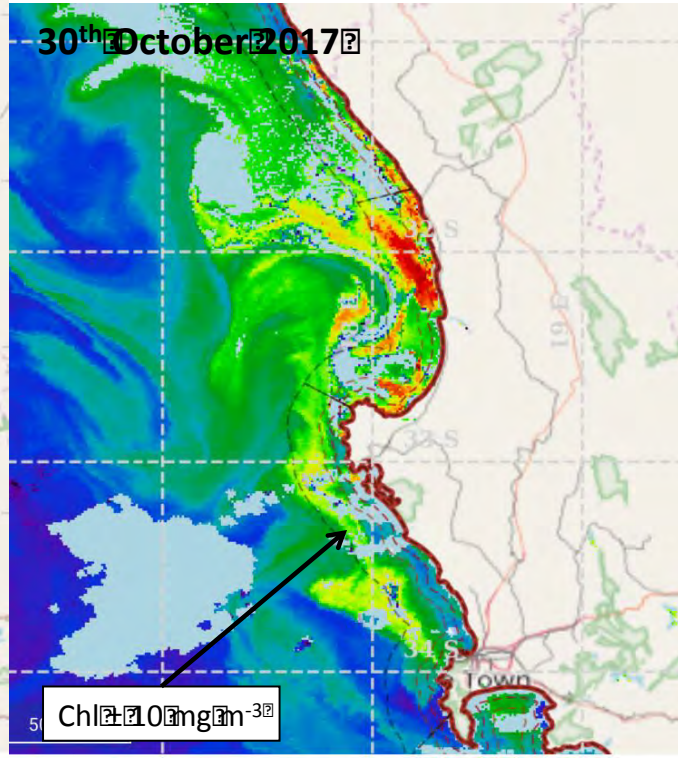
Fishtrack.com MODIS Aqua



HAB DeST MODIS Aqua

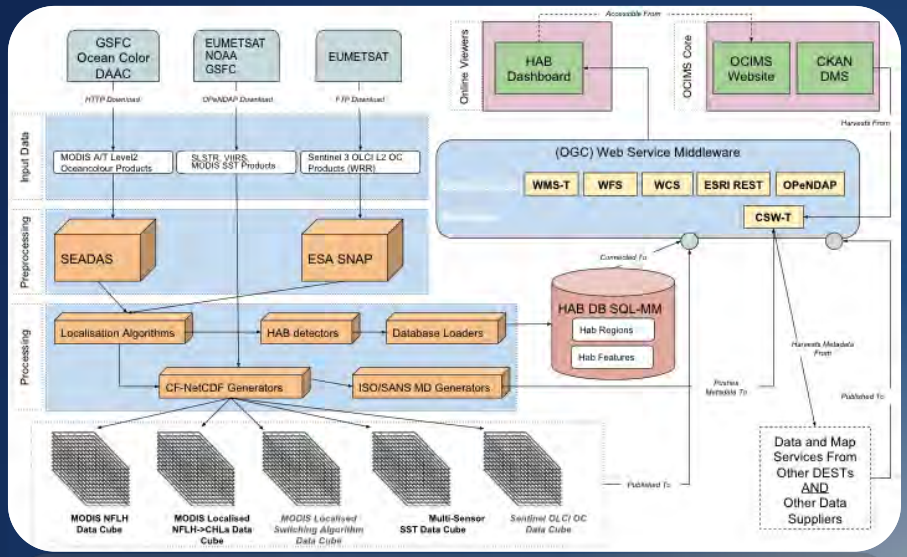


HAB DeST OLCI



2. Develop/buy/borrow a decent IT capability…

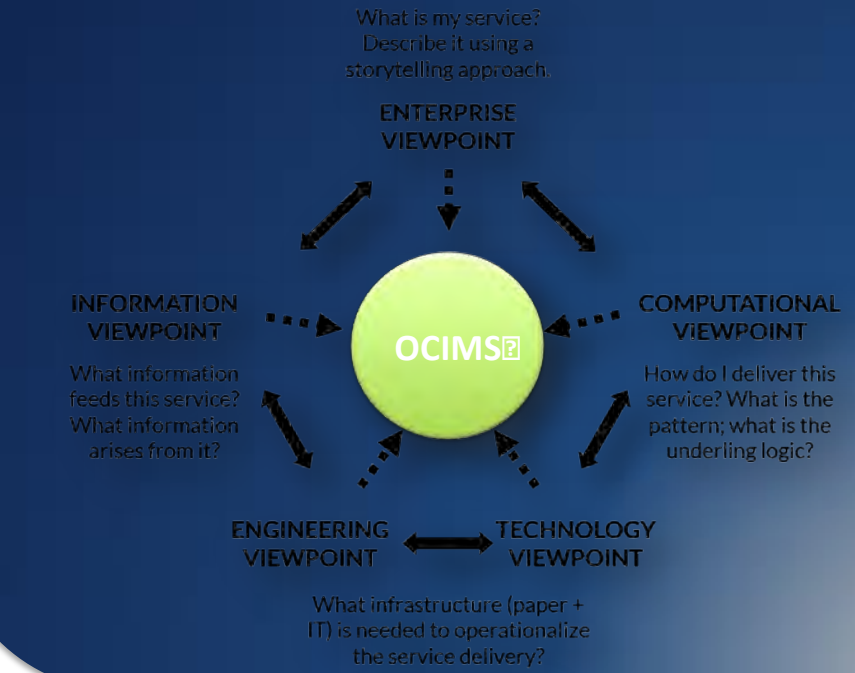
2. Appropriate multi-sensor IT architecture for acquisition, regional processing and cataloguing for science products; analytics application and data management for value add; and middleware, front ends for product serving.



An example of the multi-sensor processing architecture underlying the HAB & Aquaculture Decision Support Tool)

3. Design services around quantified user needs..

3. Quantitative user engagement & co-design mechanisms allowing development of complex operational systems from multiple view and architecture considerations. OCIMS uses the Reference Model for Open Distributed Processing (RM-ODP), providing a set of viewpoints for partitioning the design of a distributed system.



User needs are highly specific & sensitive….

Aquaculture & HABs

Community

- Very open, interactive & developing community that have suffered severe HAB losses recently and welcome any improved HAB observations

User Archetypes: farm/facility managers; government monitoring & regulatory departments; desalination plant engineers & managers ; disaster management….

Emerging Approach

- 100% public service model for 1st phase
- Open technical advisory group
- Farms provide daily phytoplankton counts
- Sharing of all NRT and historical EO & in situ data
- WhatsApp groups (user preferred system) provides information sharing & consensus risk evaluation…

Fisheries Support

Community

- Actually many different industry communities from artisanal through small/large pelagic to agri-business demersal hake etc – all with different competitiveness, investments in"business intelligence" etc . Regulators & industry associations

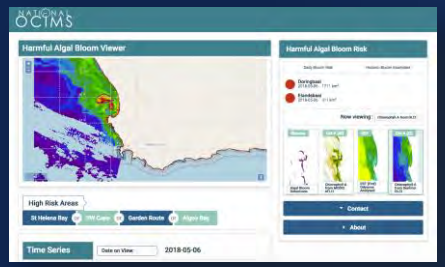
User Archetypes: artisanal; pelagic; demersal; associations; fisheries regulators…

Emerging Approach

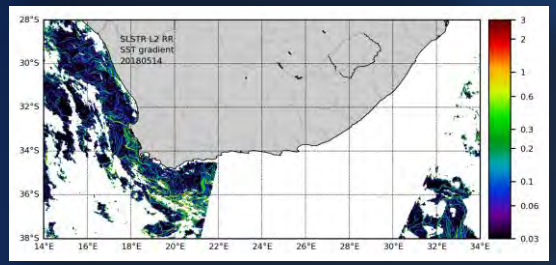
- 100% public service model inappropriate – requires mixed sectors-specific approach
- Open technical advisory group but some industry users prefer closed one-one
- Primary engagement with fisheries ministries as regulators and sector guides
- Marine stewardship certification increasingly valuable as collaborative engagement…

4. Build products & systems that users find rewarding..

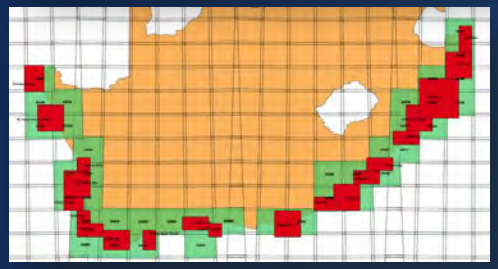
4. Developing user co-designed decision support tools, intended to provide highly synthesised, robust information through simple, intuitive web-based interfaces.



The Harmful Algal Bloom Decision Support tool, providing bloom analytics and alerting from Sentinel 3/OLCI and MODIS Aqua regionally optimised biomass and bloom identifier products.

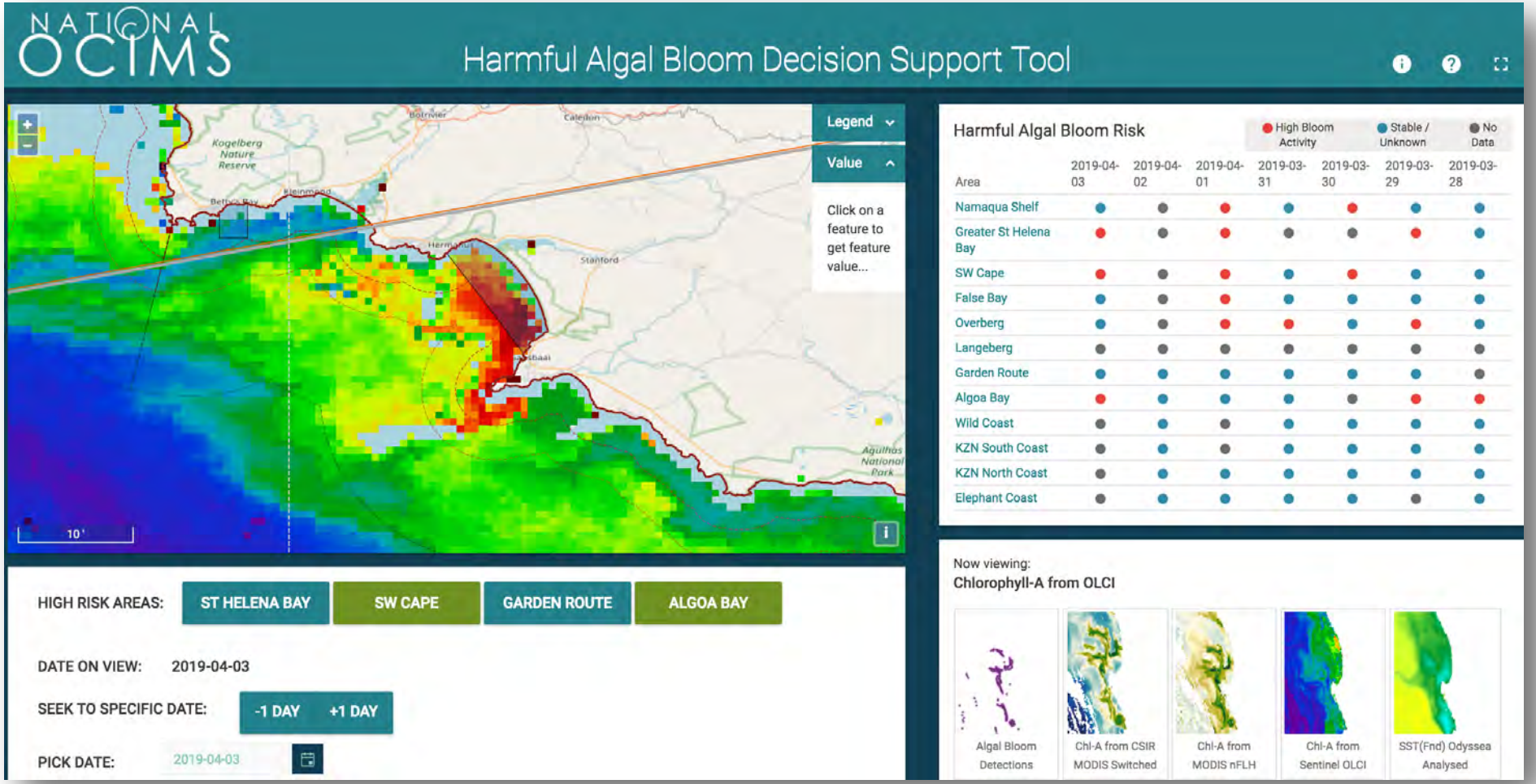


Example thermal front product from SLSTR for the Fisheries Decision Support tool, supporting the artisanal, pelagic and demersal fishing industries; and resource management agencies.



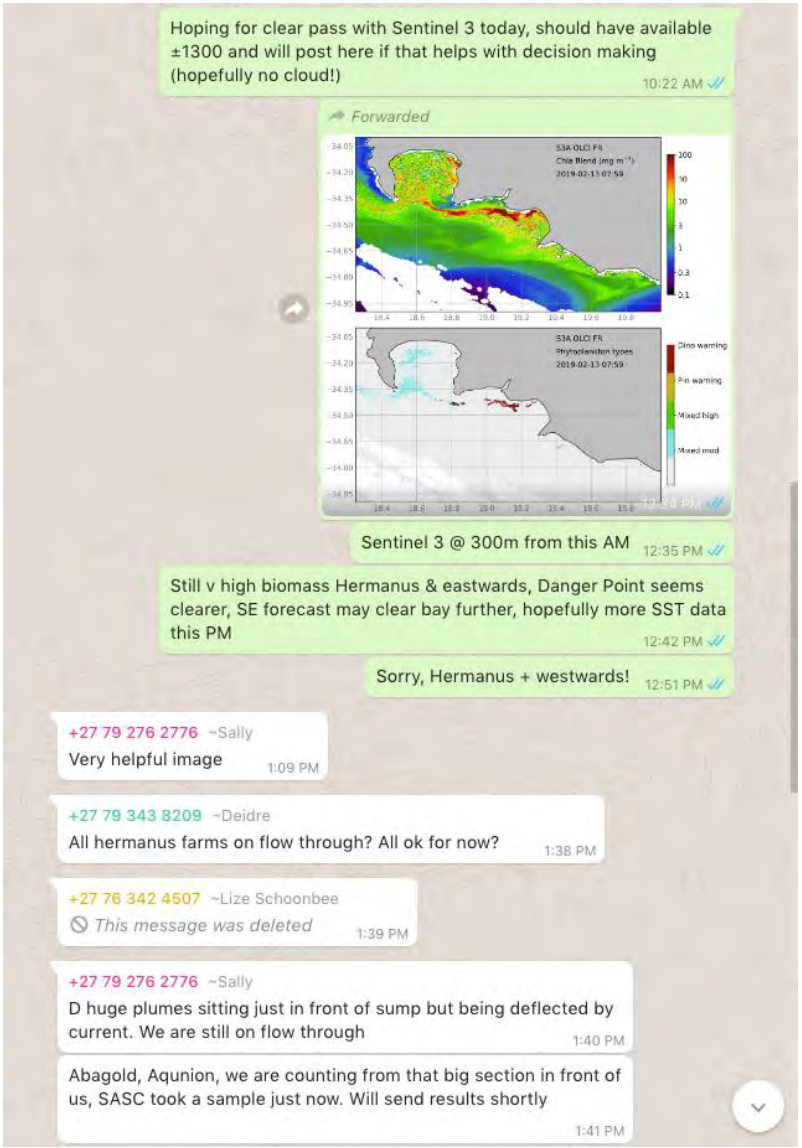
The Water Quality Decision Support Tool will provide a range of <300m resolution products from Sentinels 2 and 3 for regional sites, focusing on eutrophication, turbidity, macrophytes, effluent and reef monitoring.

Aquaculture & HABS: The operational front end...



Aquaculture & HABS: The operational front end...

…of course, what users really want is just a WhatsApp group...



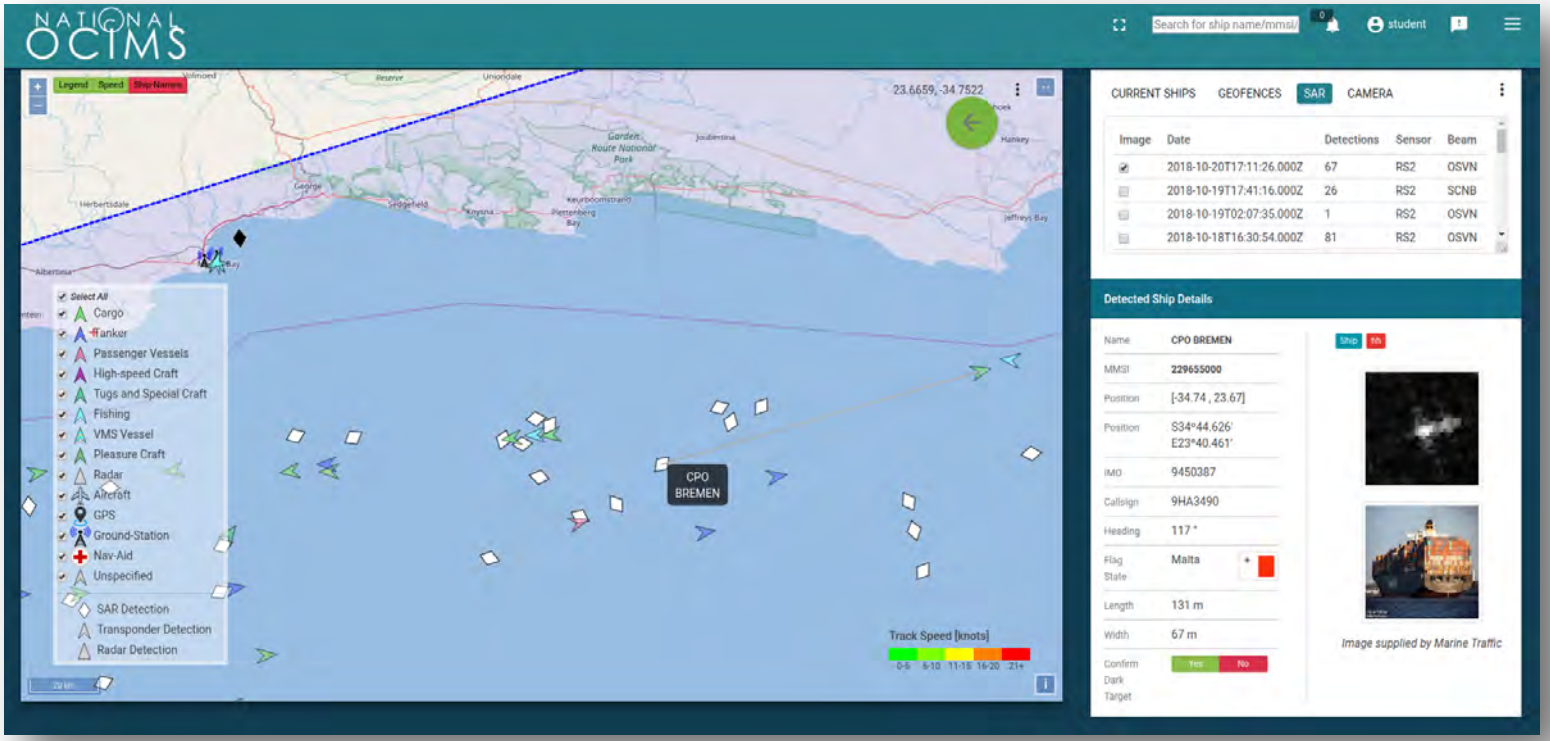
Fisheries Support Tools: IVT as critical forerunner…

Tracking and monitoring of large vessels in the South African Exclusive Economic Zone by combining various data sources that include:

- Automatic Identification System
- Synthetic Aperture Radar
- Vessel Monitoring Service
- Optical cameras

Features include:

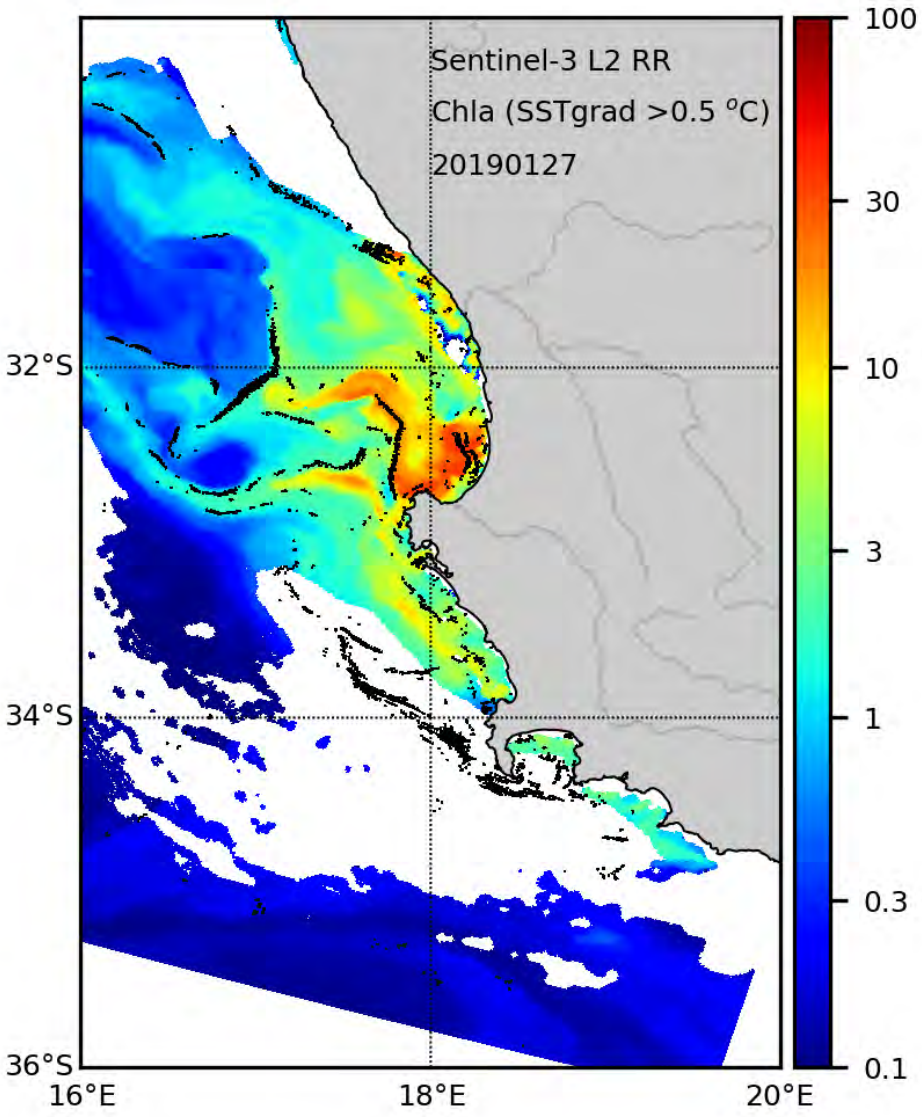
- tracking current and historic ship behaviour
- Identifying dark targets
- Optical cameras
- Geofence entry/exit notifications



Fisheries Support Tools

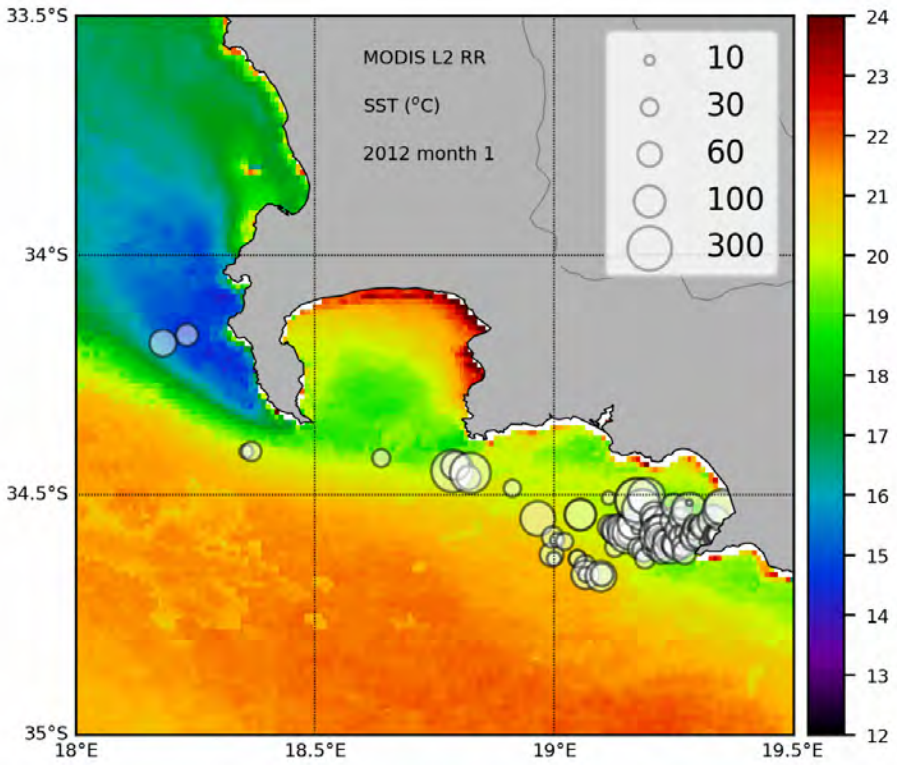
A combination of regionally optimised temperature and ocean colour products, such as ocean fronts, in combination with vessel tracking tools, will provide for holistic fisheries management, industry and community support:

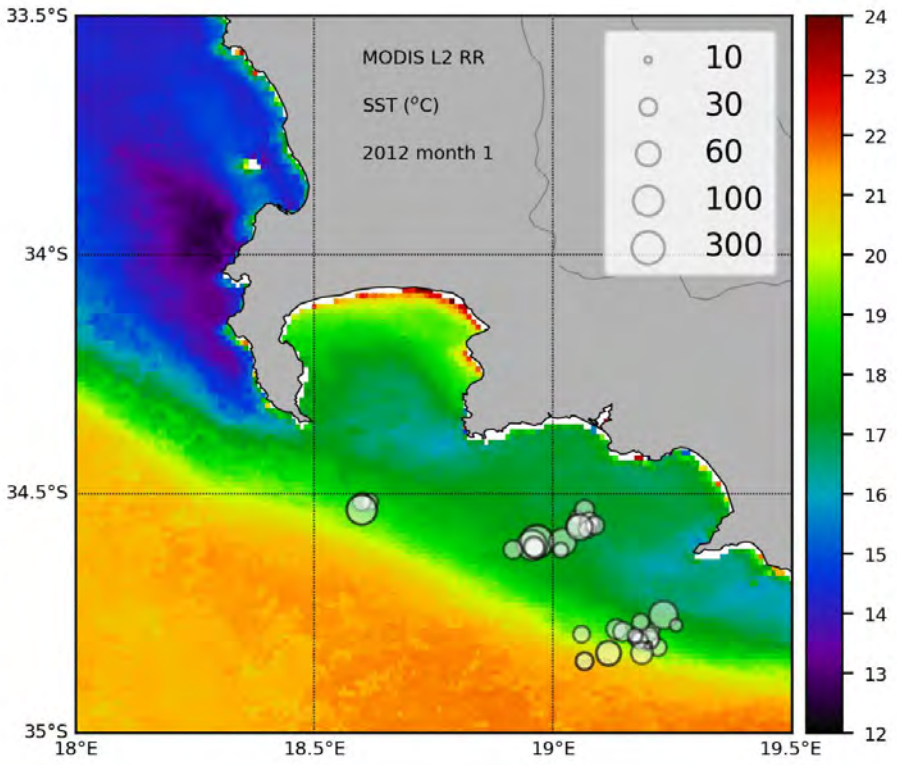
- Tools to understand ecosystem & catch changes over decades to better manage fisheries,
- Tools to provide both industrial and small scale fishers the means to catch allowable quotas more effectively & sustainably,
- Tools to lower risk in going to sea and allowing more effective asset management,
- Tools to assist in fisheries certification programmes, such as the Marine Stewardship Certification, increasing market value and sustainability…



Fisheries Examples: Sardine as key pelagic species

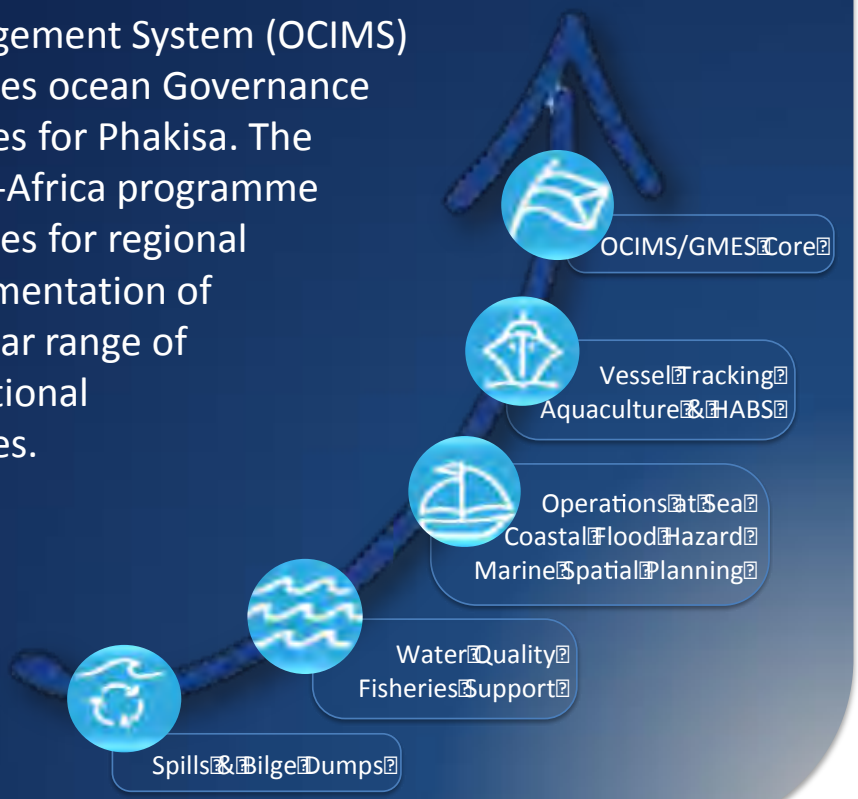
Example first order analysis of sardine catch data vs SST for high/low catch years…





5. All of this will need funding through policy support…

5. Operation Phakisa focuses on unlocking the economic potential of South Africa's oceans, which could contribute up to R177 billion to the GDP by 2033 and between 800 000 and 1 million direct jobs. The Oceans and Coastal Information Management System (OCIMS) provides ocean Governance services for Phakisa. The GMES-Africa programme provides for regional implementation of a similar range of operational services.



6. Demonstrate that your services have high economic value…

6. Establishing the economic value of the services is important to success and sustainability. This is achieved through a value-of-information approach e.g. actionable information is typically worth ±1% of the resource. Ecosystem services are valued at over $20 billion for the Western Indian Ocean. The GMES-Africa project aims to grow the regional blue economy by ± €25M p.a. by 2021....

Recommendations

Science products: robust, regionally relevant, i.e. works for regional water types, and ideally multi-sensor science products are important.

User Models: Quantitative, ongoing user engagement is **critical**. Technical advisory groups & embedded champion users are ways to do this. Most important is understanding the user decision making process - from a quantitative perspective…

Critical Events: These are very important & valuable and should be well documented. They test the validity of the science products, the effectiveness of the user facing products, and allow insight into the user decision making

Agency Recommendations: Multi-water type algorithms addressing wide range of water types (high biomass); low latency products (<3 hours); importance of NIR bands as water leaving products; value of continuity & constellations for investment in service development…

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