

# South Africa's Operational Ocean Forecasting Developments

Jennifer Veitch, Giles Fearon, Nkululeko Memela, Zach Smith



science & innovation

Department:  
Science and Innovation  
REPUBLIC OF SOUTH AFRICA



**SAEON**  
South African Environmental  
Observation Network



Find us:  
Department of Forestry,  
Fisheries & the Environment



Follow us:  
@EnvironmentZA



Follow us:  
EnvironmentZA



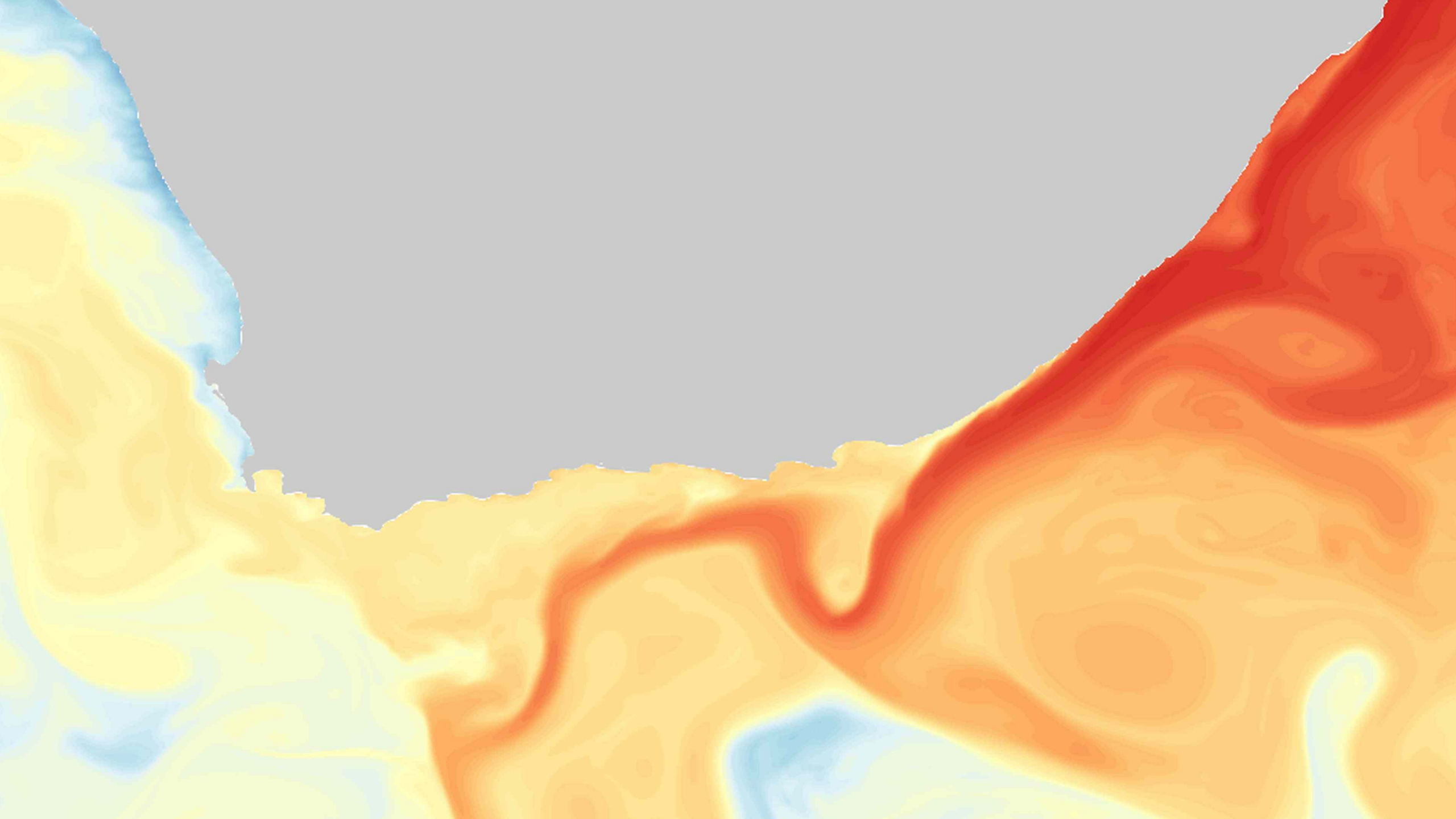
Follow us:  
@Department of Environmental Affairs

Call centre: +27 86 111 2468 [www.dffe.gov.za](http://www.dffe.gov.za)



Forestry, Fisheries and the Environment  
Science and Innovation

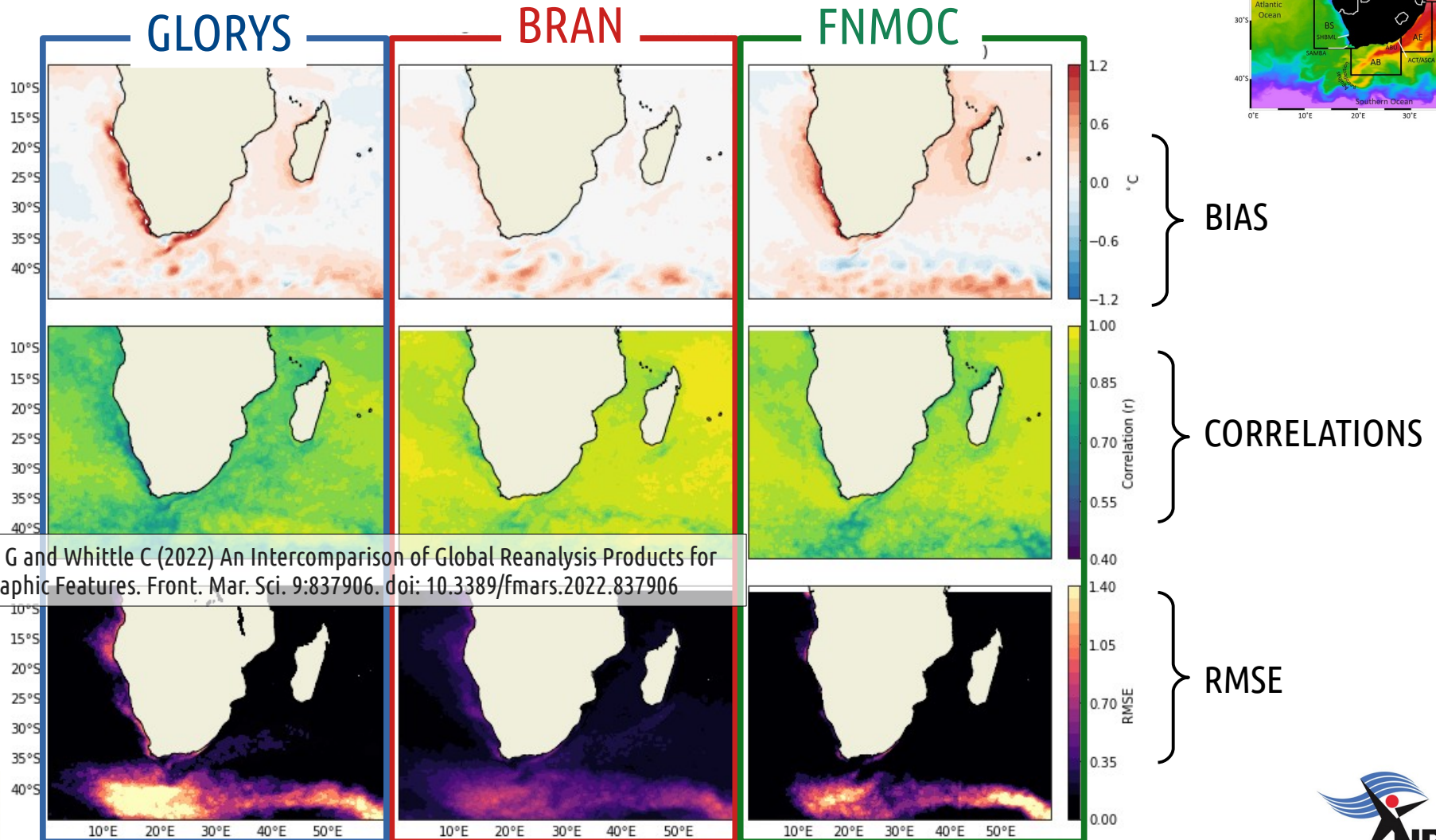
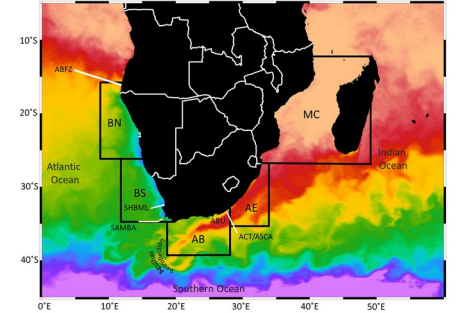




# Southern African Oceans in Global Models

All models struggle to accurately capture regions of intense frontal activity.

Satellite SST: OSTIA L4 1/20°



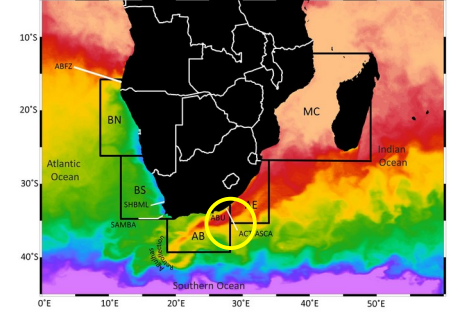
Russo CS, Veitch J, Carr M, Fearon G and Whittle C (2022) An Intercomparison of Global Reanalysis Products for Southern Africa's Major Oceanographic Features. *Front. Mar. Sci.* 9:837906. doi: 10.3389/fmars.2022.837906



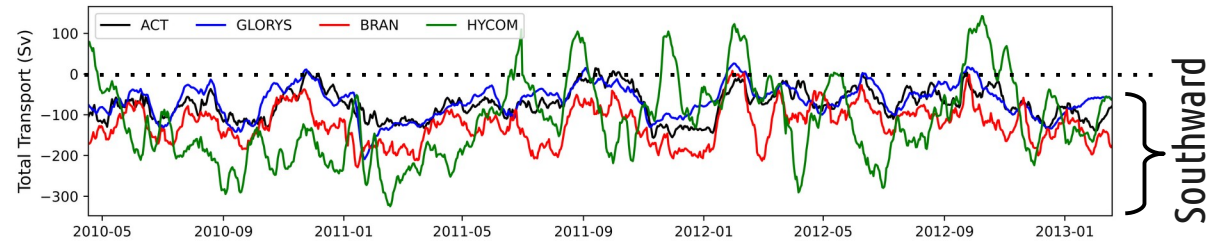
# Agulhas Current Transport in Global Models

Global models highly variable in capturing Agulhas transport

In Situ Data: ACT/ASCA array

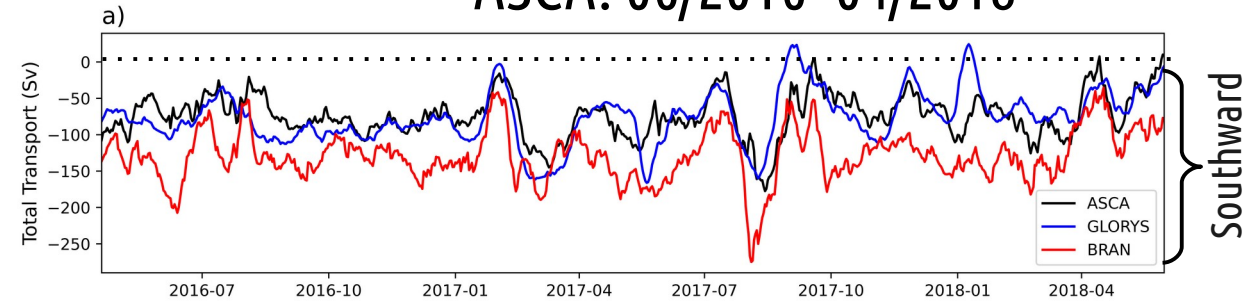


ACT: 05/2010- 01/2013



Mean transport	r-value
ACT Data: 74.5 ± 1.5 Sv	
GLORYS: 65.8 ± 1.2 Sv	0.75
BRAN: 123.7 ± 1.4 Sv	0.72
FNMOG: 116.3 ± 2.7 Sv	not significant

ASCA: 06/2016- 04/2018

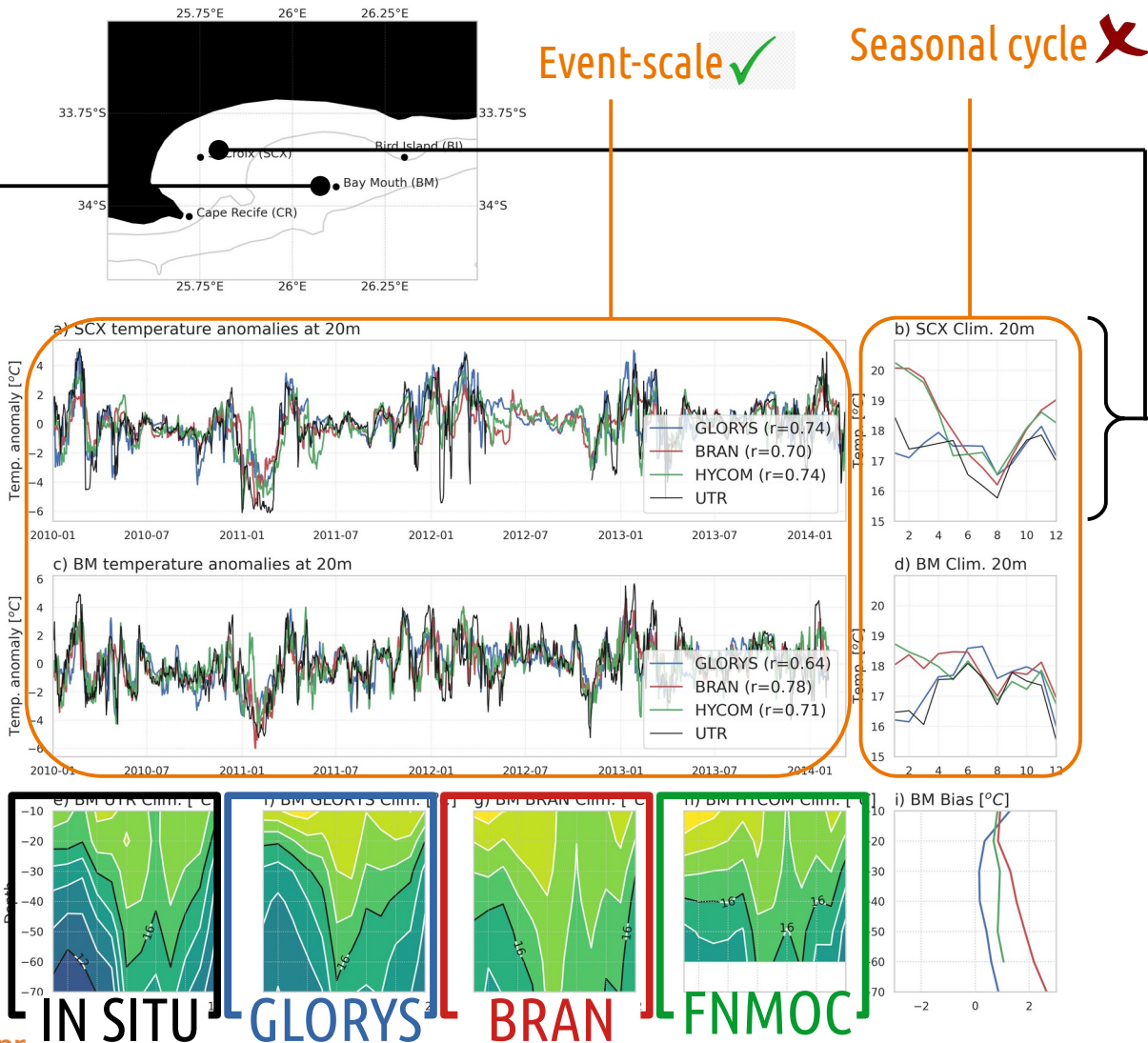
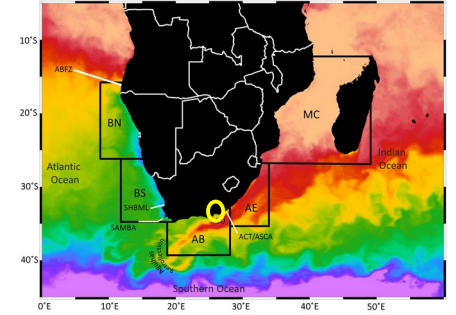


Mean transport	r-value
ACT Data: 73.2 ± 1.1 Sv	
GLORYS: 75.6 ± 1.3 Sv	0.61
BRAN: 128.6 ± 1.3 Sv	0.72



# Coastal Temperatures in Global Models

## In Situ Data: Algoa Bay UTRs



All models capture the event-scale subsurface temperature anomalies well, but all struggle to accurately capture the seasonal cycle.

# Operations Phakisa and the Oceans Economy



An initiative to 'fast-track' the implementation of solutions highlighted as issues in the National Development Plan 2030

## Six work streams:

1. Marine Transport and Manufacturing
2. Offshore Oil and Gas Exploration
3. Aquaculture
4. Marine Protection Services and Ocean Governance
5. Small Harbours
6. Coastal and Marine Tourism

**OPERATION PHAKISA | OCEANS ECONOMY**

**What is Operation Phakisa?**

**Why Oceans Economy matters:**

analysis; priority setting; intervention planning; and delivery.

**Why the Oceans Economy matters:**

South Africa has a coastline of 3 900 km including the sub-antarctic islands. We also have an Exclusive Economic Zone (EEZ) of 1.5 million square kilometres. The Oceans Economy will greatly benefit the country. It will create at least 1 million jobs. It will also create opportunities for economic growth.

The Aquaculture sector has the potential to grow sector revenue to R3 billion and produce 15 000 jobs by 2019. These are real opportunities for economic growth.

**Potential to contribute up to R177 billion to SAs GDP by 2033 and to create over a million jobs**

South Africa has a coastline of 3 900 km including the sub-antarctic islands. We also have 60 trillion cubic feet of gas which is equivalent to 375 years of gas consumption.

A coordinated oceans economy skills development and capacity building plan will equip potential entrants into the priority sectors of Marine Transport and Manufacturing, Aquaculture, Offshore Oil and Gas and Marine Protection and Governance.

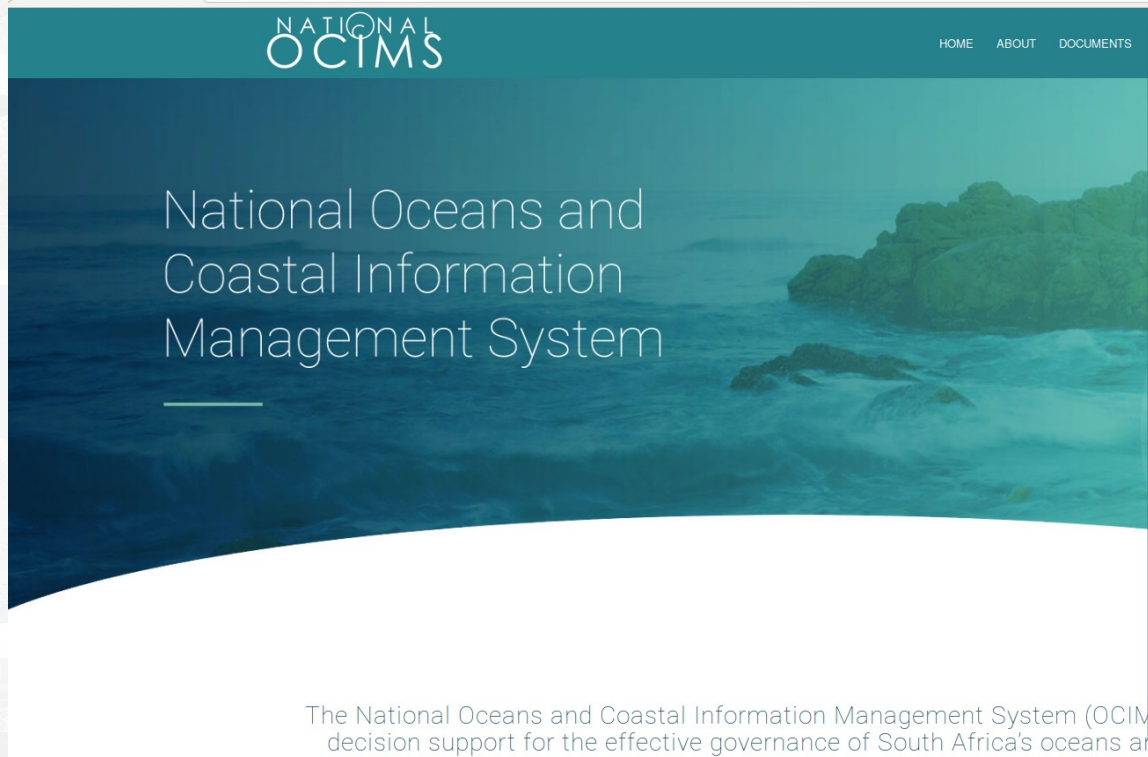
**Together moving South Africa's Oceans Economy Forward**

Tel: +27 (0)12 312 0000 Website: [www.operationphakisa.gov.za](http://www.operationphakisa.gov.za) or [www.environment.gov.za](http://www.environment.gov.za) Email us: [oceansphakisa@environment.gov.za](mailto:oceansphakisa@environment.gov.za)



# OCIMS

## The Oceans and Coastal Information Management System

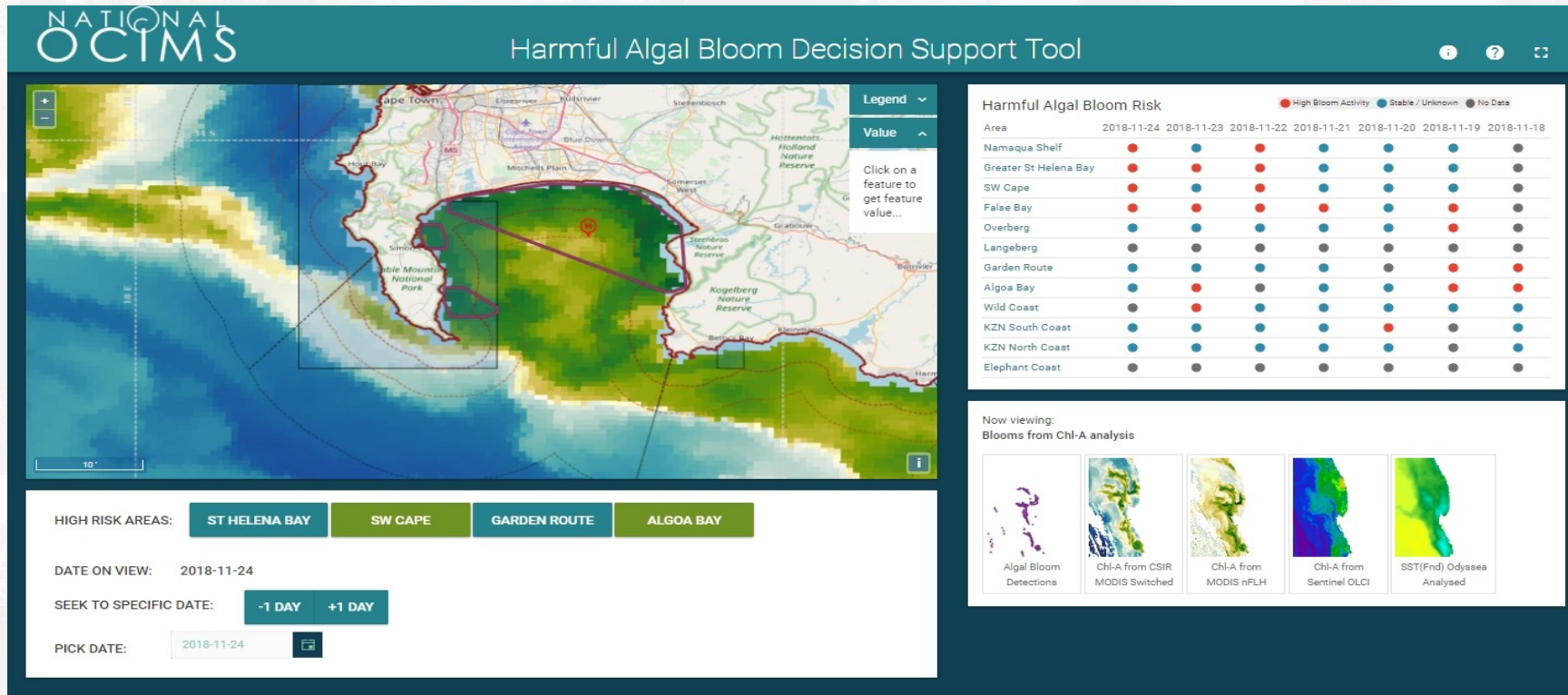


-  Harmful Algal Bloom
-  Ops at Sea
-  Coastal Flood Hazard
-  Integrated Vessel Tracking
-  Coastal Viewer
-  Marine Spatial Planning
-  Water quality
-  Oil spill / Bilge Detection
-  Fisheries Support



# OCIMS HAB Decision Support Tool

2016: HAB event costs the aquaculture industry R70m



# SOMISANA

## The Sustainable Ocean Modelling Initiative: a South AfricaN Approach

### VISION

A sustained and transformed **critical mass** of internationally recognized South African numerical ocean modelling experts who provide **accurate information** about the changing state of the ocean for **enhanced impact**.

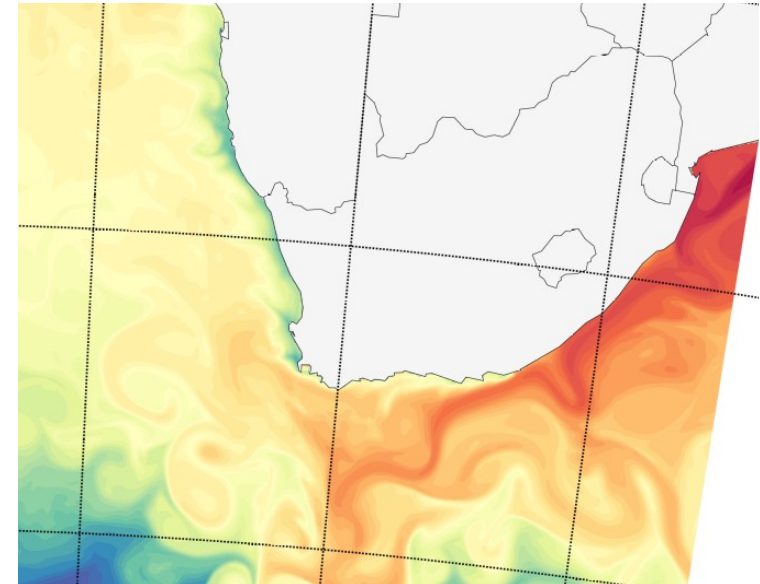
### MISSION

An ocean modelling hub and platform that promotes the **inclusive development of local expertise** and that produces and provides **state-of-the-art ocean information**, tools and research that is **visible and accessible to all**.

### GOAL

1. Modelling developments:
  - Limited domain regional OFSs
  - Optimized hindcasts
2. Capacity development:
  - student supervision, workshops etc ..

} **OCIMS**

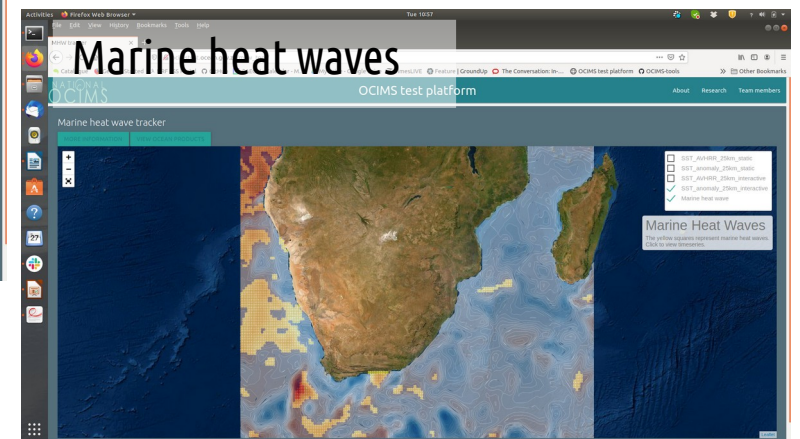
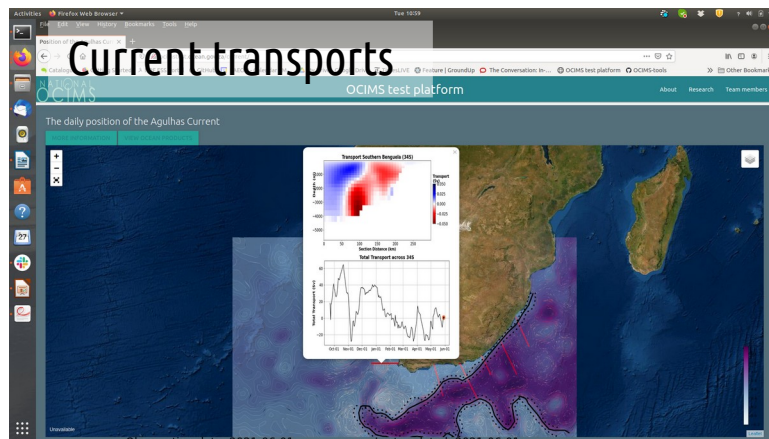
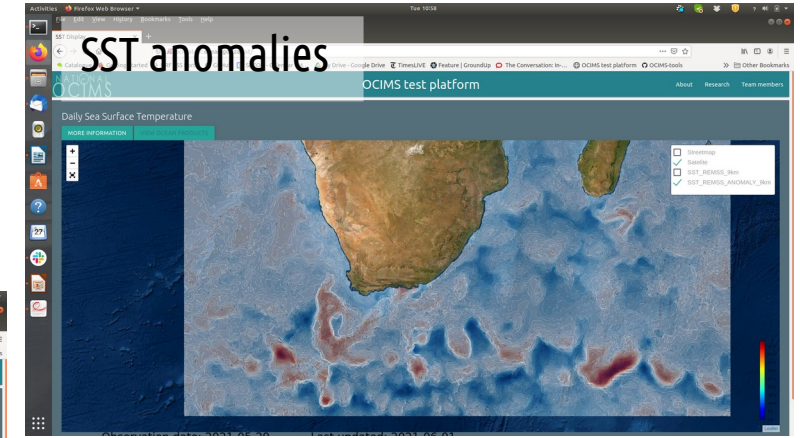
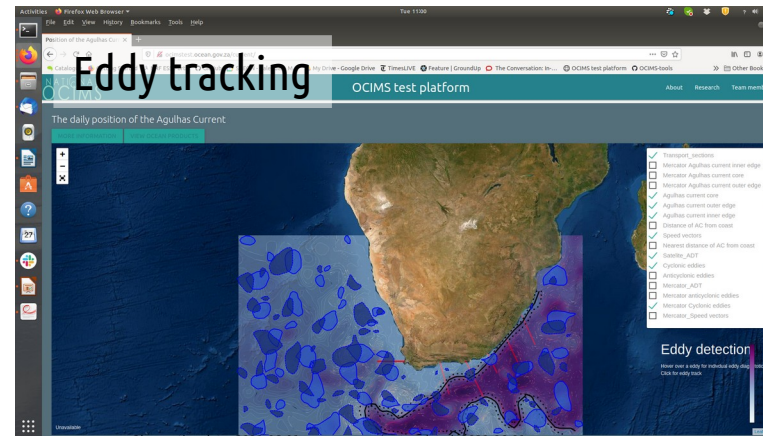
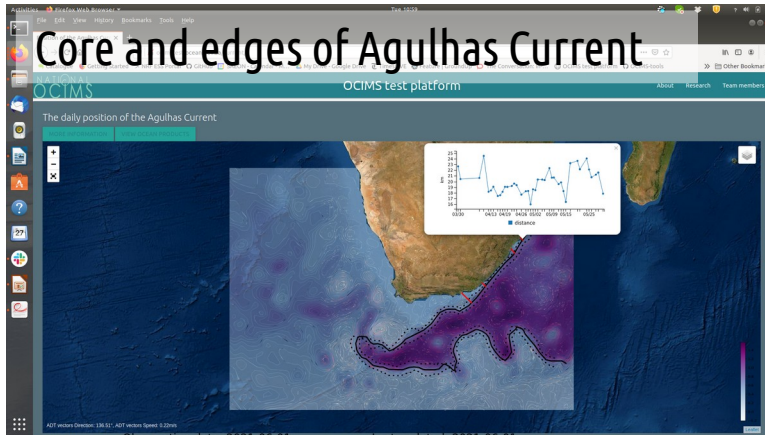




# SOMISANA

## GOAL: Contributions to OCIMS

### 1. Adding value to CMEMS operational satellite and model products

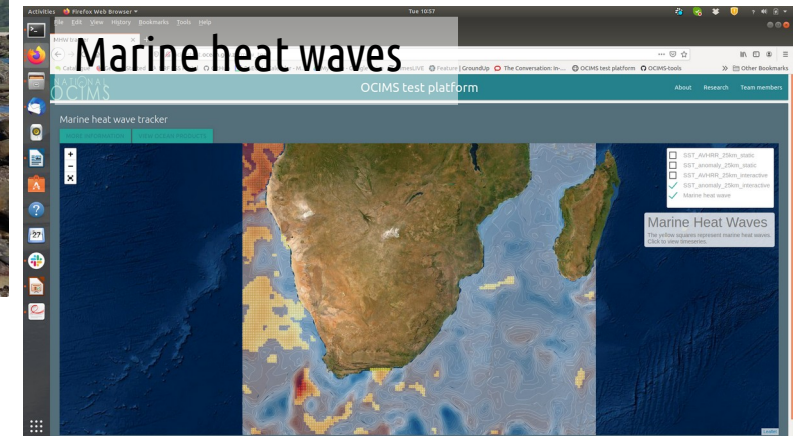
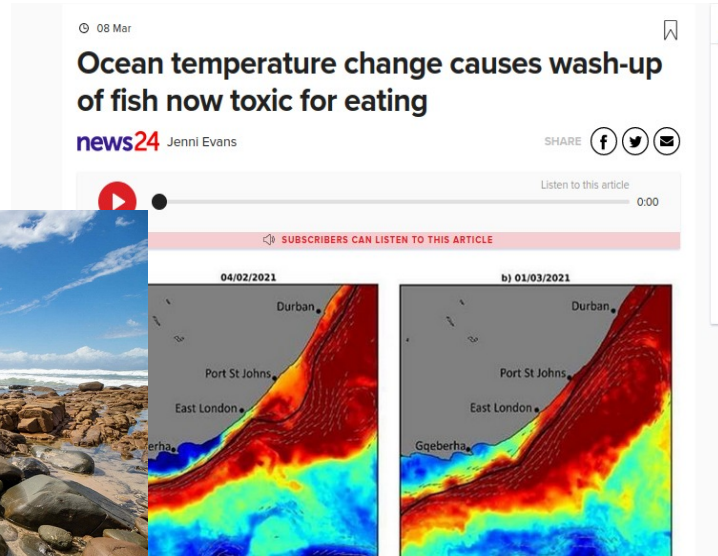
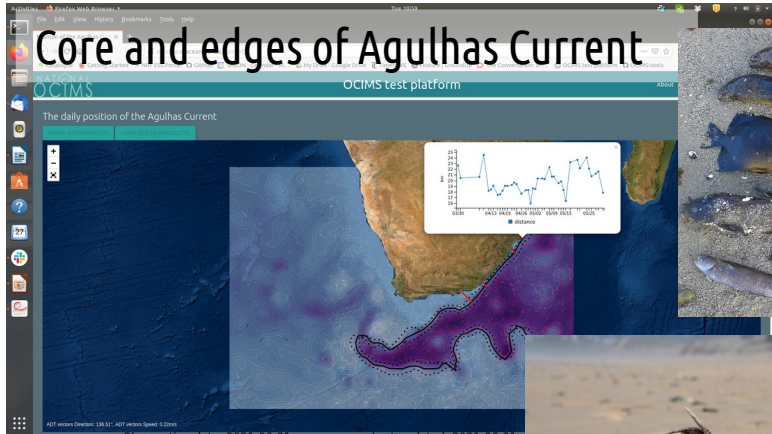




# SOMISANA

## GOAL: Contributions to OCIMS

### 1. Adding value to CMEMS operational satellite and model products



science & innovation

Department:  
Science and Innovation  
REPUBLIC OF SOUTH AFRICA



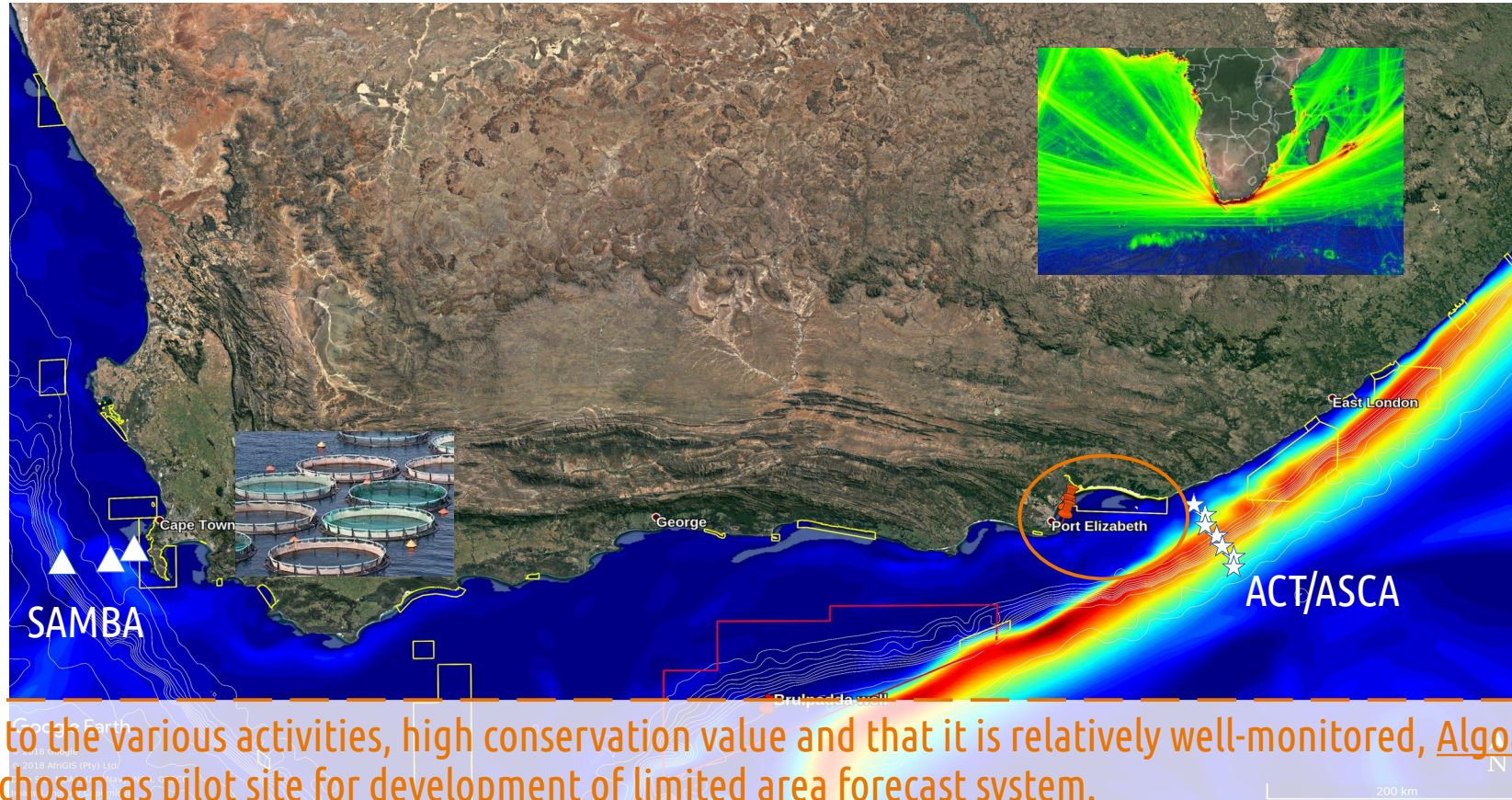
SAEON  
South African Environmental  
Observation Network



# SOMISANA

## GOAL: Contributions to OCIMS

### 2. Downscaling global forecast models, optimized for key coastal regions

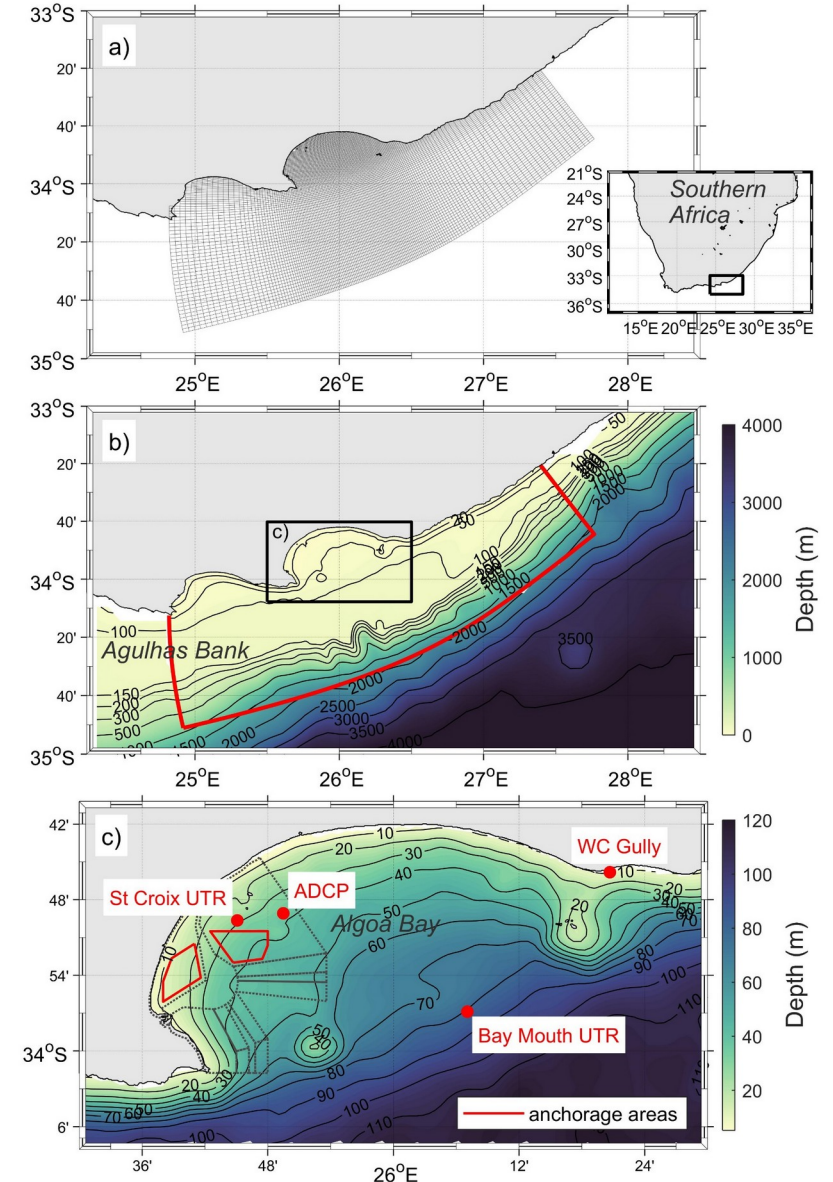


Due to the various activities, high conservation value and that it is relatively well-monitored, Algoa Bay chosen as pilot site for development of limited area forecast system.

# Downscaling Approach: Algoa Bay

- Developed with the Coastal and Regional Ocean COMMunity model (CROCO)
- High resolution curvilinear grid (~500 m in Algoa Bay)

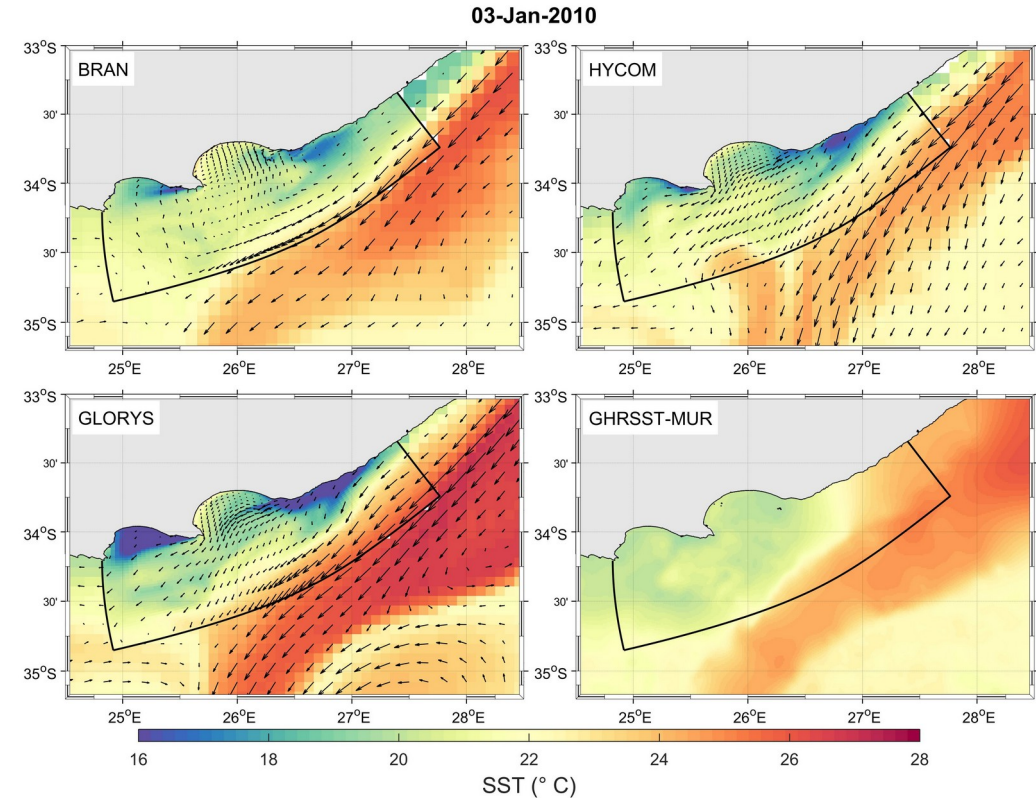
The curvilinear grid was produced using Delft3D tools, allowing for a seamless transition from the coarse boundary forcing to the high resolutions within the bay.





# Downscaling Approach: Algoa Bay

- Developed with the Coastal and Regional Ocean COMMunity model (CROCO)
- High resolution curvilinear grid (~500 m in Algoa Bay)
- Boundary forcing – tested sensitivity to different global ocean reanalysis products:
  - HYCOM
  - GLORYS
  - BRAN\*
- Our model downscales these coarse resolution (1/10° to 1/12°) products to high resolution over Algoa Bay

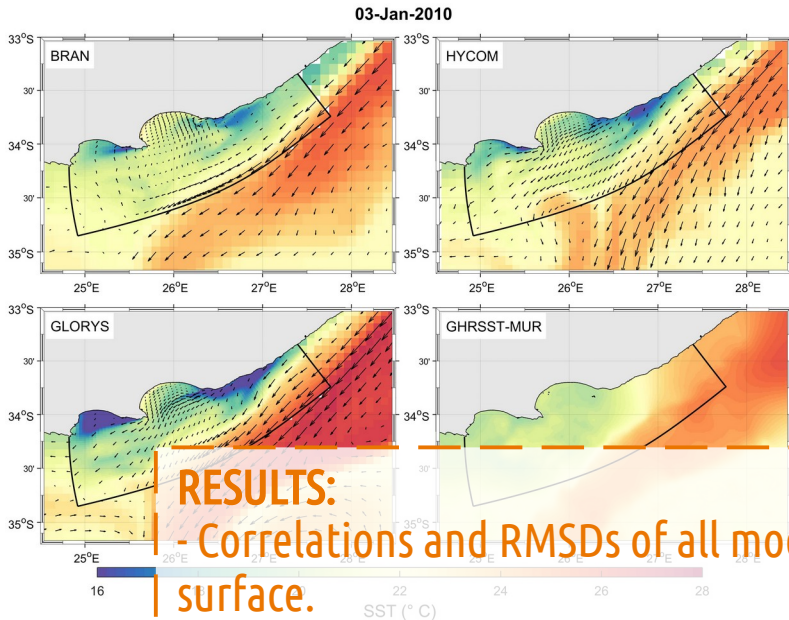


# Downscaling Approach: Algoa Bay

Fixed atmospheric forcing: WRF (~ 3km )

Three different boundary forcings:

1. BRAN
2. HYCOM
3. GLORYS

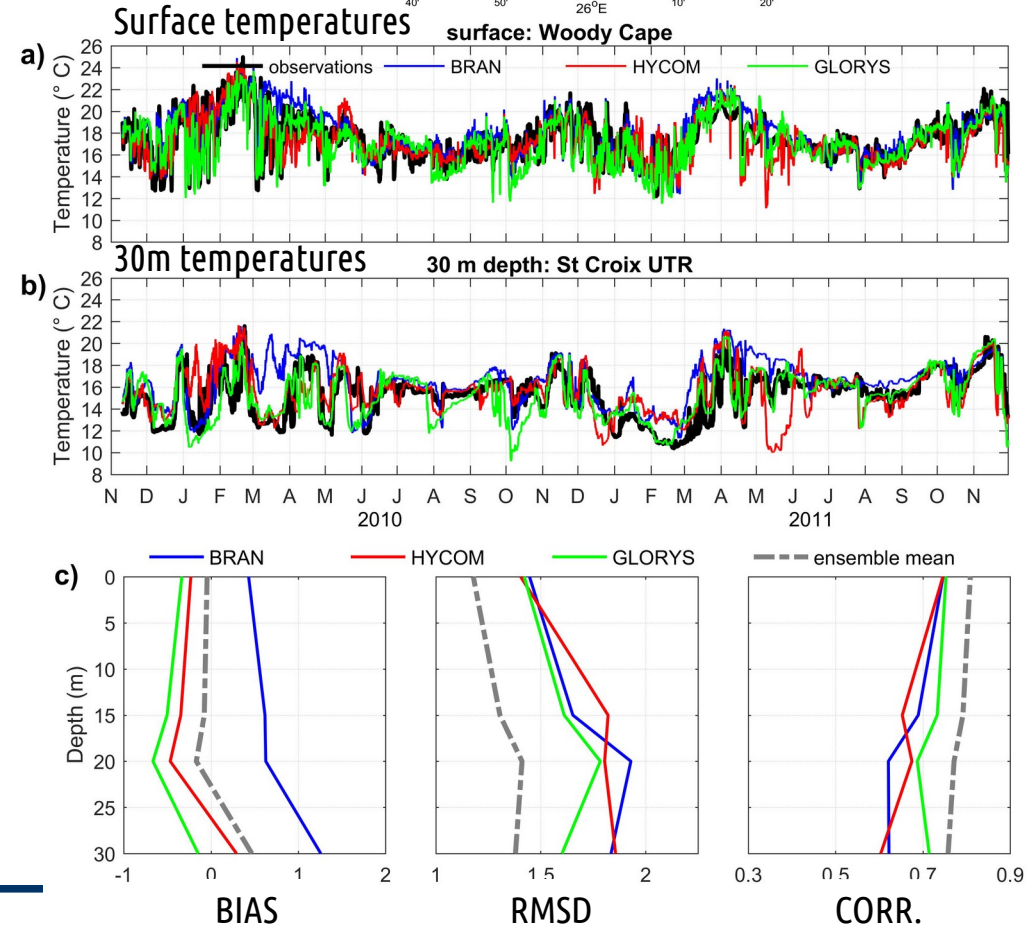
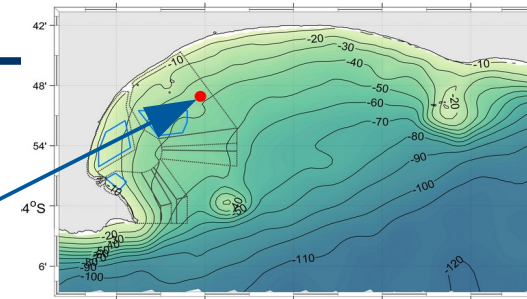


**RESULTS:**

- Correlations and RMSDs of all models converge at the surface.
- Ensemble mean performs best, followed by the model with with GLORYS boundaries

## Evaluation:

Temperature\*



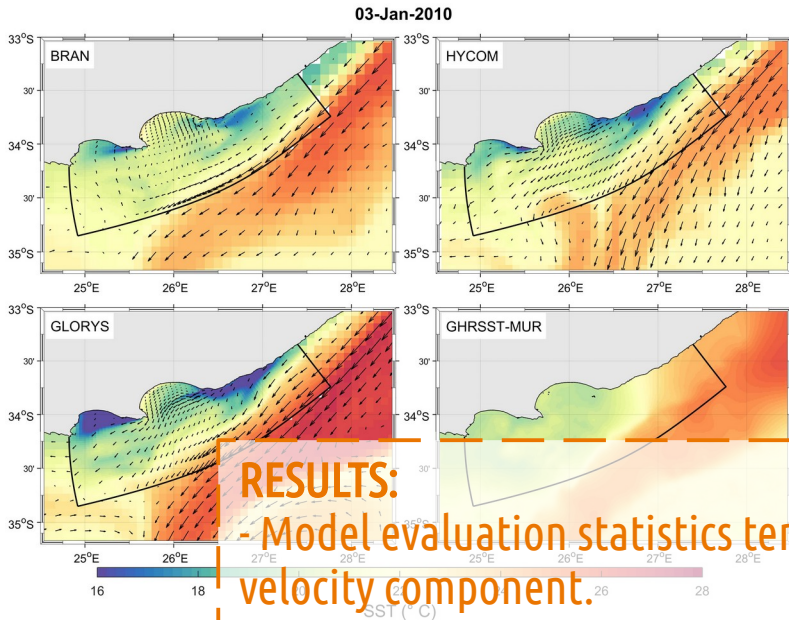
\*UTR data courtesy of SAEON Elwandle node

# Downscaling Approach: Algoa Bay

Fixed atmospheric forcing: WRF (~ 3km )

Three different boundary forcings:

1. BRAN
2. HYCOM
3. GLORYS

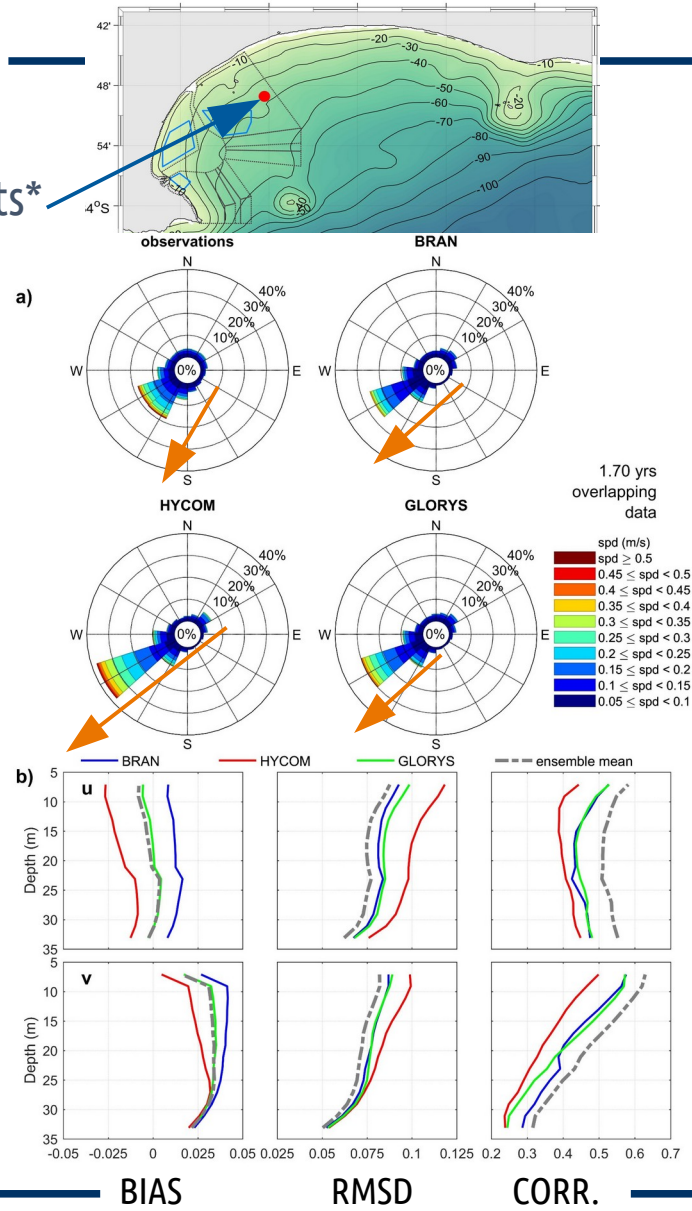


## RESULTS:

- Model evaluation statistics tend to converge with depth for v velocity component.
- The ensemble mean performs best, followed by the model forced with GLORYS boundaries (based on the current roses)

## Evaluation:

Currents\*



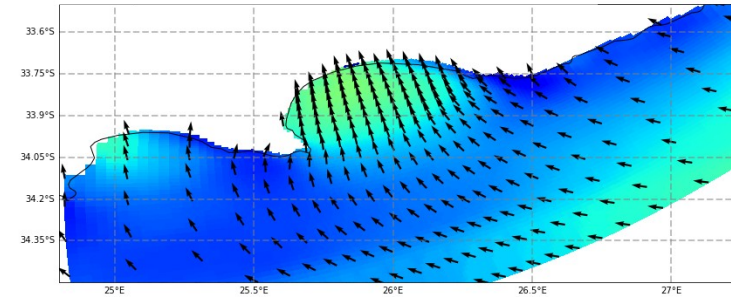
\*ADCP data courtesy of SAEON Elwandle node



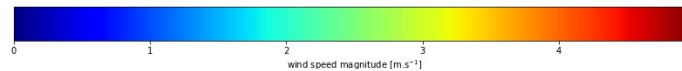
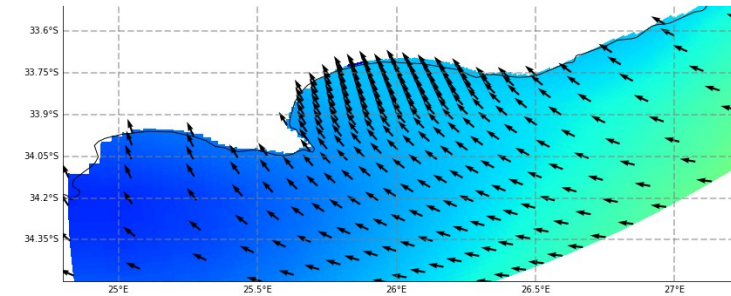
## Downscaling Approach: Algoa Bay

- Developed with the Coastal and Regional Ocean COMMunity model (CROCO)
- High resolution curvilinear grid (~500 m in Algoa Bay)
- Boundary forcing – tested sensitivity to different global ocean reanalysis products:
  - HYCOM
  - GLORYS
  - BRAN\*
- Our model ‘downscales’ these coarse resolution ( $1/10^\circ$  to  $1/12^\circ$ ) products to high resolution over Algoa Bay
- Atmospheric forcing – tested sensitivity to winds of different resolutions:
  - 3 km resolution WRF model from Climate Systems Analysis Group (CSAG)
  - ~30 km reanalysis from CFSR

CSAG HR (~3km) winds: Jan 2010



CFSR LR (~30km) winds: Jan 2010

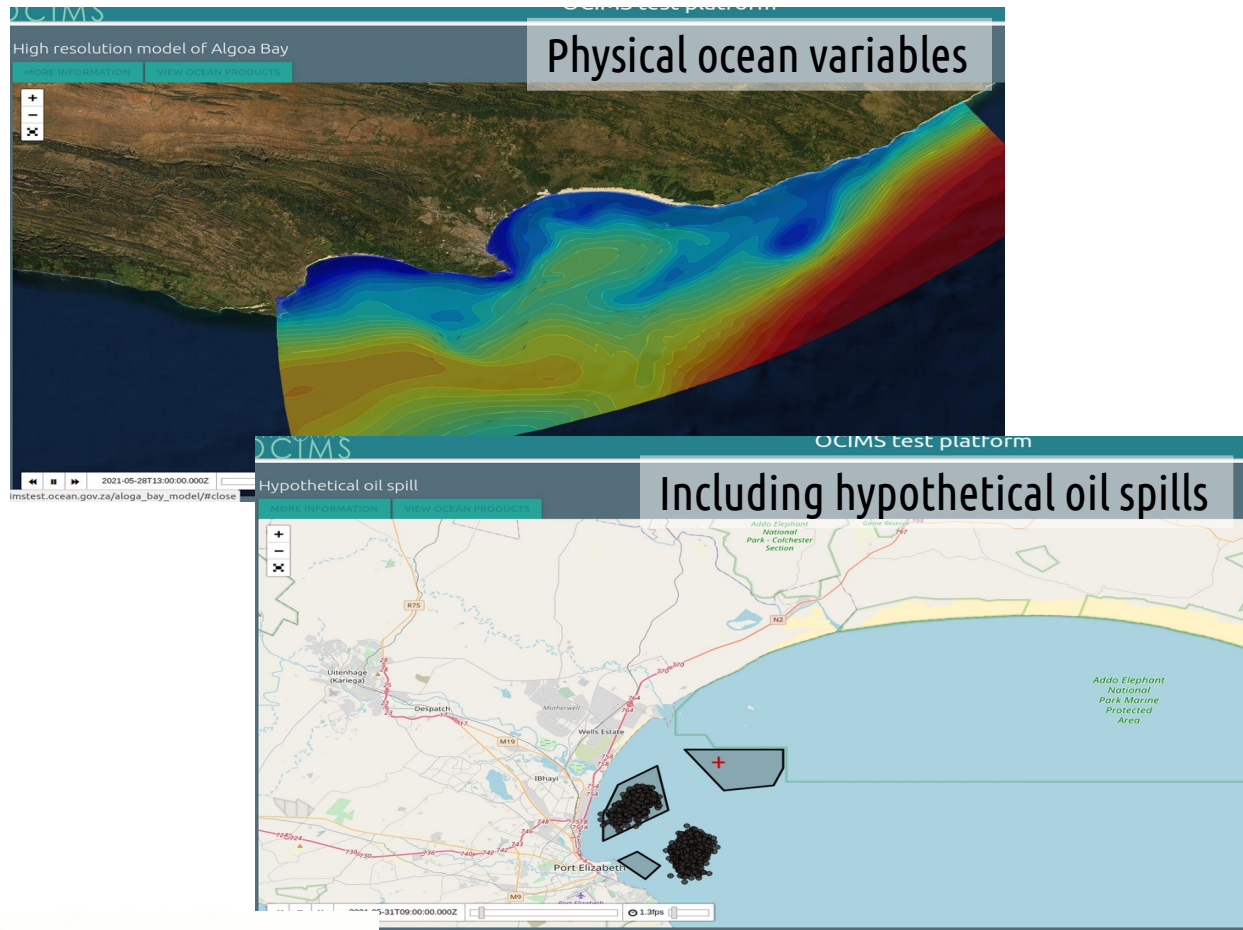


### RESULTS:

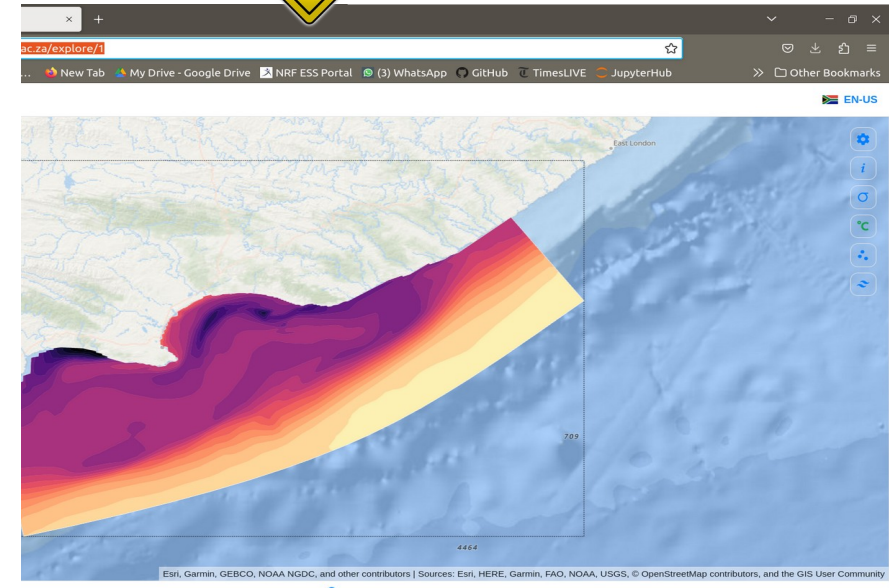
- High res. winds are important for capturing current variability

# Algoa Bay Forecast Model (5 day forecasts)

Atmospheric forcing: GFS (~30 km) ; Boundary forcing: CMEMS forecasts for ease of re-deployment, the model tools have been 'dockerized'.



 <http://somisana.ac.za>



science & innovation

Department:  
Science and Innovation  
REPUBLIC OF SOUTH AFRICA

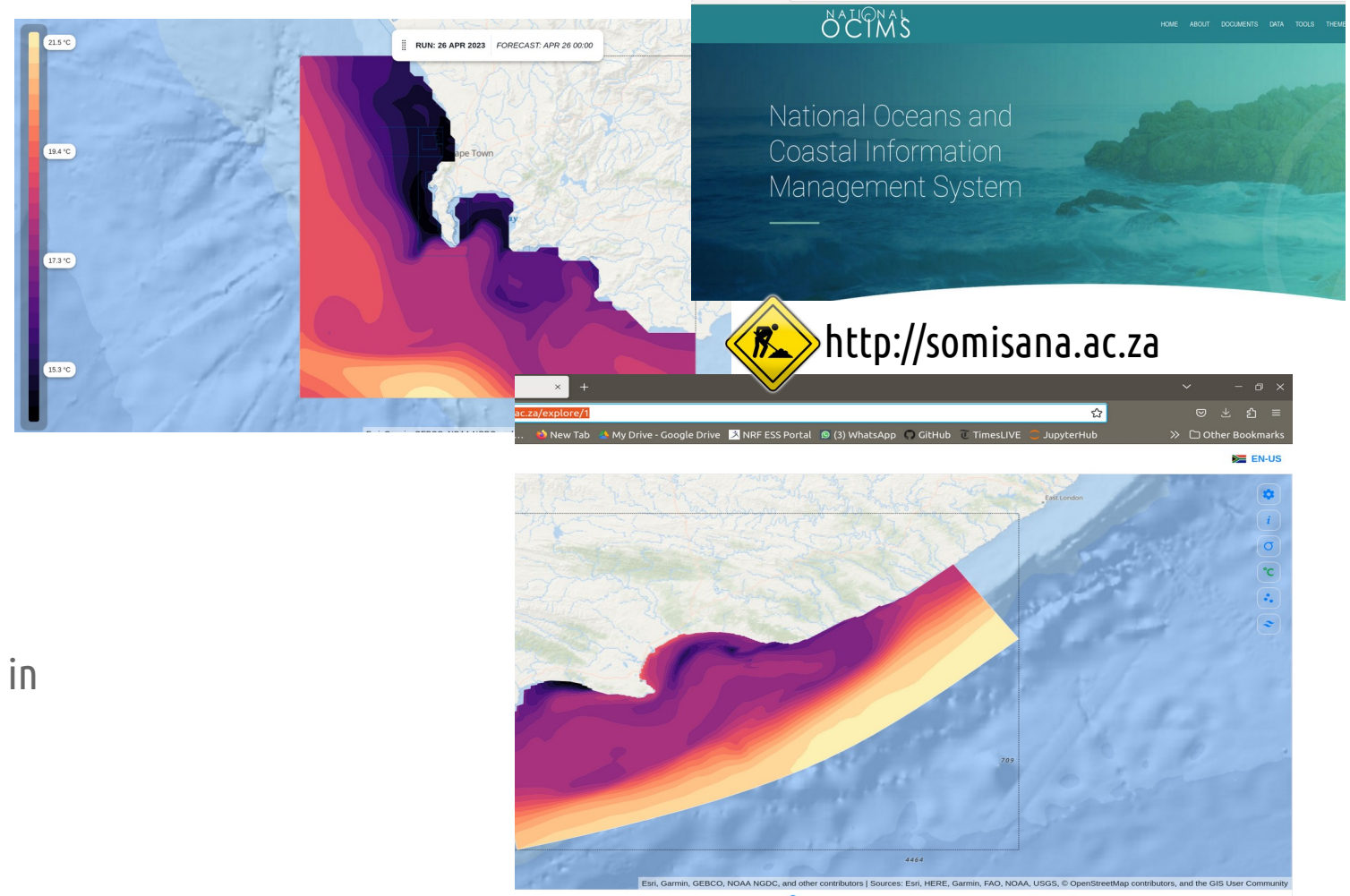


SAEON  
South African Environmental  
Observation Network



# Future Plans

- Improve this forecast system
  - improved atmospheric forcing
  - data assimilation
  - forecast evaluation protocol
  - estuary/harbour downscaling (Deltares colab)
  - improve the oil spill model
  - value-added products (Stakeholder engagements)
  - .....
- Develop new bay-scale forecast systems in other contentious/sensitive regions





A simple system that is **easy to implement** and redeploy and that will facilitate the **contribution of under-resourced** nations to various Ocean Decade programs from forecast to climate-scales.



Find us:  
Department of Forestry,  
Fisheries & the Environment



Follow us:  
@EnvironmentZA



Follow us:  
EnvironmentZA



Follow us:  
@Department of Environmental Affairs

Call centre: +27 86 111 2468 [www.dffe.gov.za](http://www.dffe.gov.za)



Forestry, Fisheries and the Environment  
Science and Innovation



THANK YOU!

Jennifer Veitch: ja.veitch@saeon.nrf.ac.za  
Giles Fearon: g.fearon@saeon.nrf.ac.za



Call centre: +27 86 111 2468 [www.dffe.gov.za](http://www.dffe.gov.za)

