



Forum for Operational  
Oceanography

# FOO 2021

- First virtual FOO
- Three themed sessions
- Maintaining engagement
- Identifying themes
- Capturing feedback





# Waves and Currents

- End-user applications of models
  - Search and rescue; oil spills
  - High risk – need for accuracy
- Environmental applications by industry – coastal processes/sediment transport
- Provision of pollution control tools, marine asset risk tools, route planning optimisation for fuel efficiency, etc.
- Port operations: data and information needed in a changing shipping environment
- Bureau's operational space and delivering to end-users and decision support.
- Bluelink and TIDE updates



# Climate, marine heatwaves, & temperature

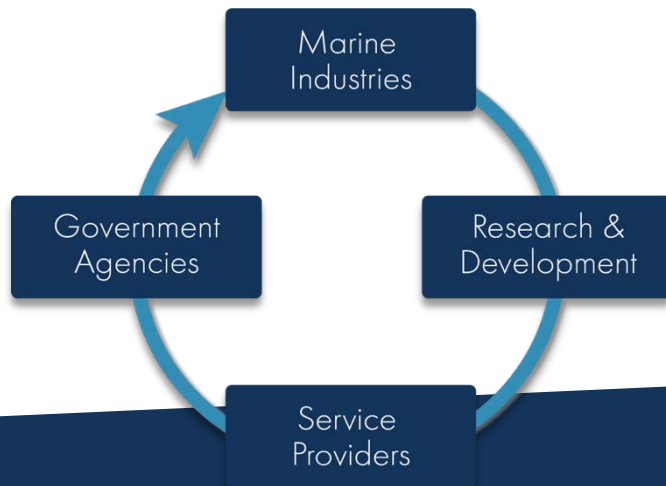
- Priority areas to help industry deal with climate extremes
- Risk management and advanced warning mechanisms
- Seeking greater interdisciplinary engagement to deal with fisheries management
- Seasonal fluctuations and operational impacts
- Engagement across the FOO pillars





# Megafauna interactions with industry

- Tracking of threatened and migratory species
- Working with management and industry for continental-scale tracking
- Acoustic telemetry on oil and gas infrastructure research
- Collection of oceanographic data by megafauna for the benefit of... megafauna.

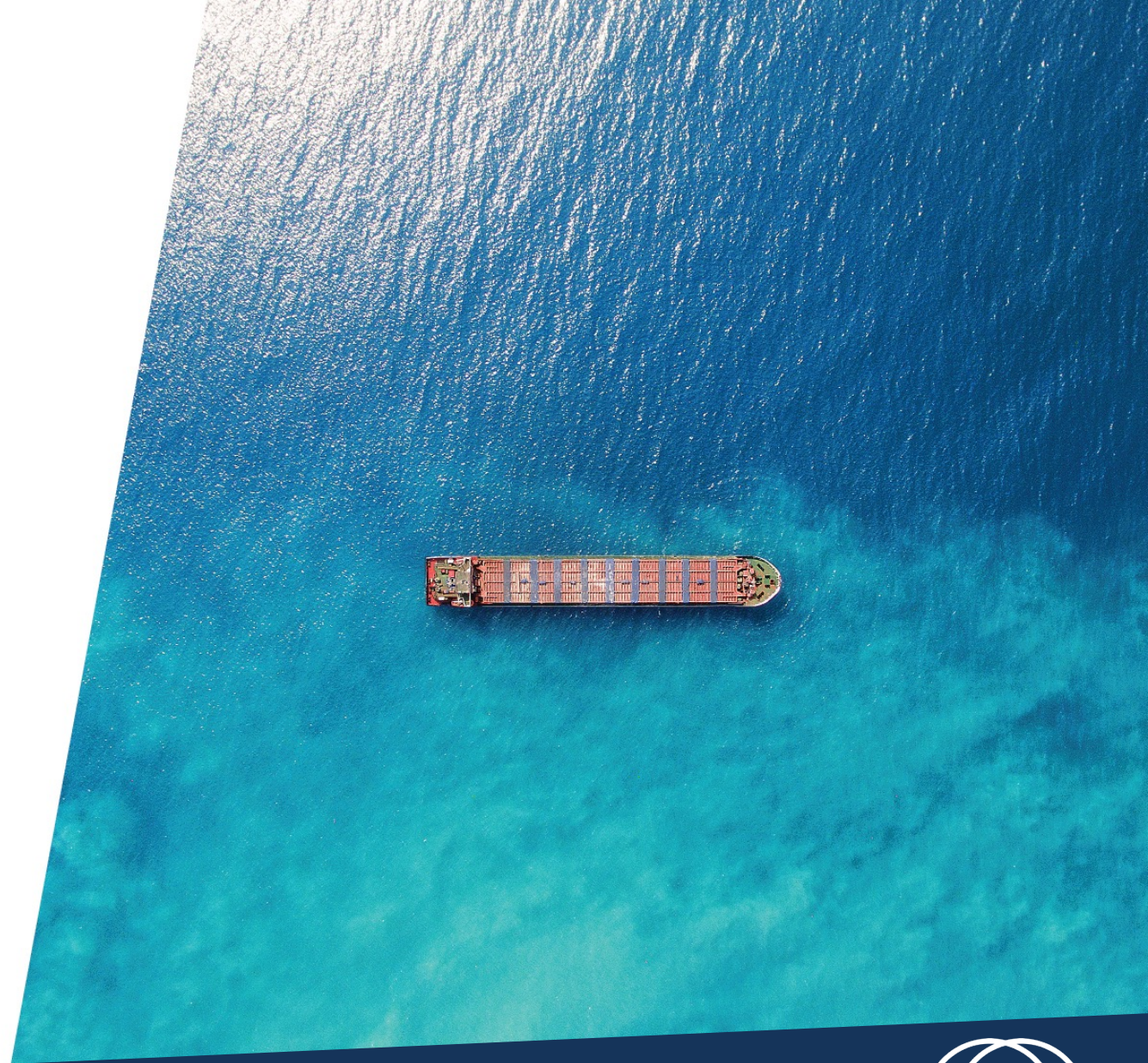




# FOO Spotlights

- Wanted to maximise the engagement opportunity of FOO 2021, and invited people to submit mini-posters to:
  - inspire future collaborations;
  - update the community on some new or ongoing research;
  - pitch a problem for the FOO community;
  - promote a fabulous idea for operational oceanography.

See these on each session's webpage (scroll to the bottom)





# FOO Spotlights: Waves and Currents

Rafael Santana and the team

NIWA and the University of Otago

Data assimilation sensitivity experiments in the East Auckland Current region

<http://bit.ly/FOOWaves>



## Data assimilation sensitivity experiments in the East Auckland Current region

Rafael Santana<sup>1,2</sup>; Helen Macdonald<sup>1</sup>; Joanne O'Callaghan<sup>1</sup>; Sutara Suanda<sup>2,3</sup>; and Sarah Wakes<sup>2</sup>  
<sup>1</sup>National Institute of Water and Atmospheric Research (NIWA); <sup>2</sup>University of Otago; <sup>3</sup>University of North Carolina Wilmington  
 rafael.santana@niwa.co.nz



### Introduction

Analysis of in-situ and remote sensing observations document strong mesoscale variability in the East Auckland Current (EAC) region (Santana et al. 2021).

**Goal:** Assess the impact of surface and subsurface data assimilation (DA) into a model of the EAC (Fig. 1a).

### Methods

ROMS has 2 km of horizontal resolution and 30 sigma levels. The model was forced on the surface by JRA55do and at the lateral boundaries by HYCOM-NCODA.

4D-Var was used to assimilate AVISO SSH, AVHRR SST, subsurface temperature, salinity, and velocities from moorings M3, M4 and M5 (Fig. 1b).

3 experiments starting on 1<sup>st</sup> of May 2015 (same initial condition) were performed to evaluate the observations impacts:

- No DA (Free run);
- Assimilation surface fields (ASF);
- Assimilation surface and mooring data (ASFUVTS).

Model results were compared to daily averaged observations.

### Results

Fig. 1:

- Free run shows similar mean results for SSH and temperature field. A small cold bias (0.5°C) was simulated in the upper water column.

Fig. 2:

- Assimilation of surface fields was responsible for reduction of SSH rmsd by improving the representation of the mesoscale field.
- Assimilation of subsurface data reduced SSH rmsd near the moorings but slightly increased errors in the southern region.

Fig. 3:

- Free run had small temperature difference in comparison to observations.
- ASF increased cold bias from mid-Oct 2015 onwards. Strong uplift of the 10°C and 6°C isotherms was observed in mid-Feb and mid-Apr, respectively.
- Assimilation of in situ data prevents the growth of cold bias.

Fig. 4:

- ASF run increased temperature rmsd in comparison to the Free run but improved velocity complex correlation by at least 3 fold.
- Assimilation of in situ data (ASFUVTS) was important to correct temperature errors generated by the assimilation of surface fields only.
- ASFUVTS doubled complex correlation with velocities.

### Summary

- Free run well represented mean SSH and temperature fields but misplace mesoscale eddies on a daily basis.
- ASF reduced SSH rmsd relative to Free run as surface assimilation improved representation of the mesoscale field.
- Assimilation of mooring data reduced temperature errors by half and increased velocity representation by 2 fold.

For more: [rafacsantana.github.io](https://github.com/rafacsantana)

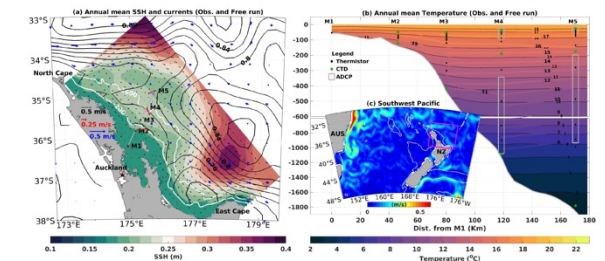


Fig. 1: (a) 1-year mean SSH and currents from AVISO (black contour and blue arrows). Free run (green-purple shade and black arrows), and mooring (coloured arrows). (b) 1-year mean temperature from Free run (shades) and moorings (coloured lines). (c) Study area relative to Southwestern Pacific Ocean

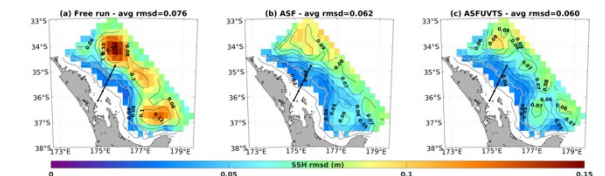


Fig. 2: Maps of SSH rmsd between model and AVISO from (a) Free run (b) ASF, and (c) ASFUVTS.

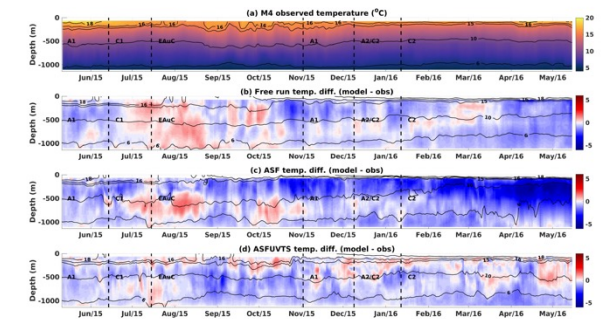


Fig. 3: Time series of temperature profile at M4 from observations (a) and temperature difference between model and observations from (b) Free run, (c) ASF run, and (d) ASFUVTS run, and their corresponding temperature timeseries as black contours. The dashed black lines represent 6 mesoscale events identified in Santana et al. (2021)

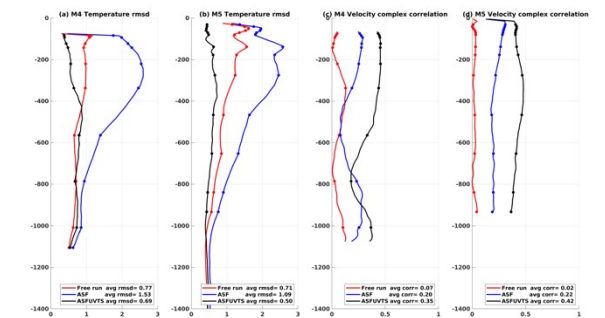


Fig. 4: Profiles of temperature rmsd at M4 (a) and M5 (b), and velocity complex correlation at M4 (c) and M5 (d) from Free run (red), ASF run (blue), and ASFUVTS (black). The dots represent median depth of temperature sensors.



# FOO Spotlights: Waves and Currents

Joshua Sixsmith and the team  
AusSeaBed

Create your own bathymetry  
compilations with GMRT-AusSeabed

<https://www.foo.org.au/forum/foo-2021/wavescurrents/>



## GMRT-AusSeabed

Create your own seamless seabed maps

A platform for users to create their own seamless seabed maps using AusSeabed datasets.

Access data

Standardise CRS/datums

Customise resolution

Assess data quality

The project will deliver a prototype platform in June 2022 that will focus on bathymetry data.

Do you use gridded seabed data?

Contact [ausseabed@ga.gov.au](mailto:ausseabed@ga.gov.au) to get involved in the testing phase and training workshops

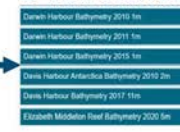
### What can you expect from the prototype?

A user story resulting from key end-user engagements ([Survey](#), [Workshop 1](#) and [Workshop 2](#))

#### 1. Select an area



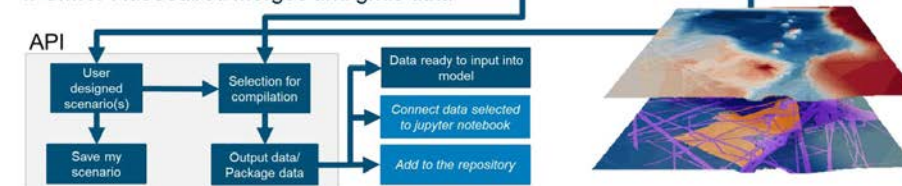
#### 2. View available data



#### 3. Customise your compilation



#### 4. GMRT-AusSeabed merges and grids data



To find out more visit [ausseabed.gov.au/gmrt](https://ausseabed.gov.au/gmrt) and [watch our short video](#)



The GMRT-AusSeabed project (DOI: 10.4230/1.10) is a collaborative, co-investment by Geoscience Australia, Bureau of Meteorology, Deakin University, James Cook University, Lamont-Doherty Earth Observatory, CSIRO, the Australian Antarctic Division and the NCRIS-funded Australian Research Data Commons (ARDC).



# FOO Spotlights: Climate, Marine Heatwaves and Temperature

Pallavi Govekar and the team

BOM and University of Reading

Himawari-8 and Multi-sensor sea surface temperature products and their applications

<http://bit.ly/FOOClimate>

### Introduction

Sea surface temperature (SST) products within a few kilometres of coasts that can resolve fine-scale features, such as ocean upwelling, are increasingly in demand. The Australian Bureau of Meteorology (Bureau) currently produces operational, real-time SST from the Himawari-8 geostationary satellite every 10 minutes at ~2 km spatial resolution. These native resolution SST data have been composited to experimental hourly, 4-hourly and daily SST products and projected onto the rectangular Integrated Marine Observing System (IMOS) grid at 0.02° x 0.02° degrees. In response to user requirements for gap-free, highest spatial resolution and highest accuracy SST data, the Bureau is experimenting with compositing geostationary Himawari-8 data with data from the Visible Infrared Imaging Radiometer Suite (VIIRS) and Advanced Very High-Resolution Radiometer (AVHRR) satellite sensors installed on polar-orbiting satellites to construct new "Multi-sensor L3S" products. The compositing reduces data gaps due to clouds and provides easy-to-use, more gap-free SST data.

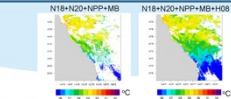


Fig. 1. Addition of Himawari-8 data to NPP/VIIRS L3S SST significantly improves data coverage over Great Barrier Reef region for 15th March 2020.

### IMOS Himawari-8 SST Products

**Himawari-8 L2P:**

- The Radiative Transfer Model (RTTOV12.3) and Bayesian cloud clearing method based on the ESA CCI SST code developed at the University of Reading is used to retrieve Himawari-8 L2P SST
- Sensor Specific Error Statistics (SSES) model developed at the Bureau is then applied to those L2P files<sup>1</sup>
- The quality level is reassessed using SSES<sup>2</sup>
- Native grid, full disk

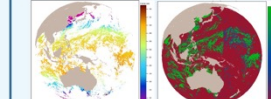


Fig. 2. (a) SST (b) Probability of pixel being clear as estimated by Bayesian cloud detection from Himawari-8 L2P file for 15th March 2020.

**Himawari-8 L3C:**

- Data sourced from Himawari L2P SSTs
- Hourly, 4-hourly and daily night-time L3C products
- IMOS 0.02° x 0.02° grid

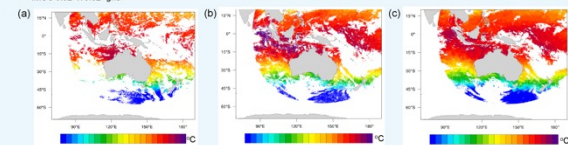


Fig. 3. SST with quality level >=3 from Himawari-8 L3C file for (a) 1-hour (b) 4-hours and (c) night 15th March 2020.

### IMOS new Multi-sensor products

**Data sources**

- IMOS H08-AHI L2P files for Himawari-8
- The ACSPO VIIRS L3U files for Suomi NPP and NOAA-20
- OSISAF FRAC AVHRR L2P files for MetOpB
- IMOS AVHRR-18 L2P files for NOAA-18

In order to merge data from different satellite sensors, the quality level (QL) of each dataset to be merged is redefined as the minimum of the original QL provided by the data provider and QL calculated using Sensor Specific Error Statistics (SSES). The latter is calculated using SSES bias ( $\mu$ ) and SSES standard deviation ( $\sigma$ ) estimates.

$$q_{\text{min}} = \frac{1}{\sqrt{2}} \sqrt{\max\left(\left(\frac{\mu_{\text{min}}}{\sigma_{\text{min}}}\right)^2 + \left(\frac{\mu_{\text{max}} - \mu_{\text{min}}}{\sigma_{\text{max}} - \mu_{\text{min}}}\right)^2 - 1, 0\right)}$$

$$q_{\text{c}} = \lfloor 5 \exp^{-\eta |x|} \rfloor$$

Different data sources can then be combined using  $q_{\text{c}}$  provided that  $\eta \sigma_{\text{c}} = \text{constant}$ , where  $\eta$  is a scaling parameter and the half square brackets in the  $q_{\text{c}}$  equation represent the "nearest integer" function.

Data from NOAA-18, Suomi NPP, NOAA-20, MetOp-B and Himawari-8 L3C files are composited using an equal weighted averaging method to construct the new experimental Multi-sensor L3S product<sup>3</sup>.

**Different versions of Multi-sensor L3S SST products:**

- fv01-Operational data (NOAA-18+N20+NPP+MetOpB)
- fv02-Reprocessed data in delayed mode/NOAA-15-20+NPP+MetOpA+MetOpB
- fv03-Experimental data (Himawari-8+NOAA18+N20+NPP+MetOpB)

Adding Himawari-8 SST data to existing data streams for operational Multi-sensor L3S (NOAA-18 and Suomi NPP, NOAA-20 and MetOpB, Fig 3a and Fig 4a), shows significant improvement in spatial coverage (Fig 4b and Fig 5b), specifically for quality level=4.

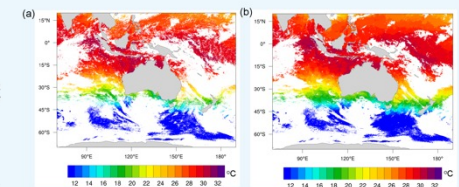


Fig. 4. SST with quality level >=3 from L3S 1-day night file from (a) operational fv01 Multi-sensor (b) Experimental fv03 Multi-sensor for 15th March 2020.

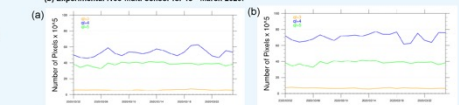


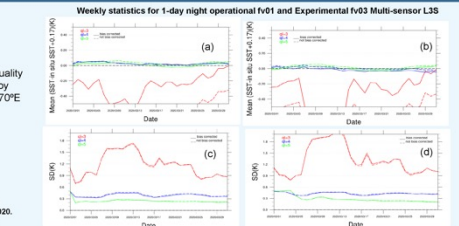
Fig. 5. Number of pixels in L3S 1-day night file from (a) operational fv01 Multi-sensor (b) Experimental fv03 Multi-sensor for March 2020 for QL = 3 (brown line), QL = 4 (blue line) and QL = 5 (green line).

### Validation

As an initial validation of the Experimental fv03 Multi-sensor L3S products, we compared quality level (QL)  $\geq 3$  SST (0.2 m) values from IMOS L3S files with drifting and tropical moored buoy SSTs (0.2m) for the period from 1st Mar 2020 – 31st May 2020 over the Australian domain (70°E – 190°E, 70°S – 20°N). It was found that:

- Experimental fv03 Multi-sensor night L3S had more QL  $\geq 3$  matchups than operational fv01 Multi-sensor night L3S (Fig 4).
- Experimental Multi-sensor L3S shows similar bias and standard deviation values as operational fv01 Multi-sensor L3S SSTs for the night scenario (Fig 5).

Fig. 6. Validation statistics of the 1-day night operational Multi-sensor L3S (a) mean bias (c) standard deviation and experimental Multi-sensor L3S (b) mean bias (d) standard deviation SSTs over a 7-day moving window for March 2020. Note: Mean bias = SST<sub>in situ</sub> SST - 0.17 (in Kelvin). Match-ups thresholds: < 10 km distance and < 6 hours time.



### Applications

Given the improved data coverage with addition of Himawari-8 data, experimental fv03 Multi-sensor L3S can be used for:

- Refeeding NexGen to get information on coral bleaching risk for the Great Barrier Reef region
- IMOS OceanCurrent to monitor marine heat waves
- Identifying and studying coastal upwelling events in the Australian region
- Studying diurnal warming
- Coastal model verification

### Future Plans

Over the coming 12 months, we look forward to:

- Validating fv03 Multi-sensor L3S files more extensively
- Reprocessing Multi-sensor L3S files with Himawari-8 data back to 1st January 2015
- Produce 4-hourly Multi-sensor L3S product
- Work towards making the new processing system operational.

### Acknowledgements

We acknowledge the provision of raw AVHRR data from ground-stations operated by the Bureau of Meteorology, Australian Institute of Marine Science, Western Australian Satellite Technology Applications Consortium, Geosciences Australia, Commonwealth Scientific and Industrial Research Organisation and Japan Meteorological Society. We acknowledge the provision of Suomi NPP and NOAA-20 VIIRS SST retrievals from the National Oceanic and Atmospheric Administration (NOAA) and MetOp-B FRAC AVHRR SST retrievals from EUMETSAT, OSISAF and Ifremer. We also acknowledge provision of software from University of Reading for Himawari-8 SST data processing. GHRSST SST products are produced at the Bureau of Meteorology as a contribution to IMOS.

### Further Information

Email: [pallavi.govekar@bom.gov.au](mailto:pallavi.govekar@bom.gov.au)  
 Web site: <http://imos.org.au/austproducts.html>

### References

1. Satellite-based time-series of sea-surface temperature since 1981 for climate applications. C. M. Deser, G. Danabasoglu, C. E. Deser, T. Bank, S. C. Cockett, E. Fedor, S. W. Woodruff, R. Wilson and C. Deser, 2015. *Nature Scientific Data*, 4:223. <https://doi.org/10.1038/sdata04223>
2. Griffin, C. H., Beggs, H. and Mittaz, J. (2017). GHRSST compliant AVHRR SST products over the Australian region - Version 1. Technical Report, Bureau of Meteorology Melbourne, Australia, 15pp. [https://www.bom.gov.au/fileadmin/user\\_upload/ghrsst/ghrsst\\_sst\\_products/1.000-Case1-1.01.pdf](https://www.bom.gov.au/fileadmin/user_upload/ghrsst/ghrsst_sst_products/1.000-Case1-1.01.pdf)



# FOO Spotlights: Climate, Marine Heatwaves and Temperature

Pete Strutton and the team  
UTAS and CSIRO

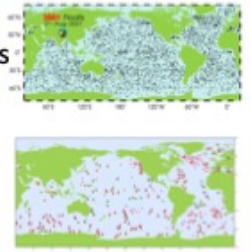
Autonomous floats and high resolution  
modelling: potential applications

<http://bit.ly/FOOClimate>

## Autonomous floats and high resolution modelling: potential applications

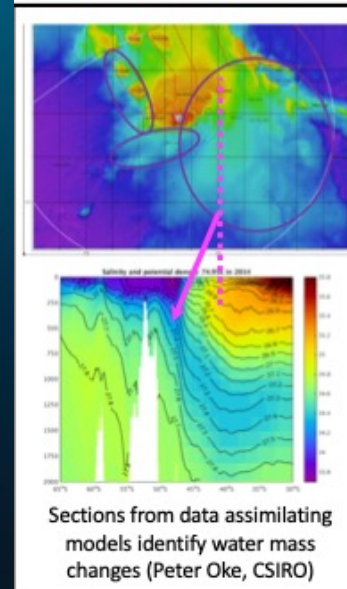
The UTas and CSIRO Argo and modelling groups (pete.strutton@utas.edu.au)

- The global Argo array has been tracking ocean heat uptake and sea level rise for 2 decades: >3,000 floats
- Great progress is being made towards a 1,000 float global biogeochemical (BGC) Argo array: T&S + nutrients, biomass, O<sub>2</sub>, pH, light
- At the same time, models can assimilate these data for hindcasts and future projections

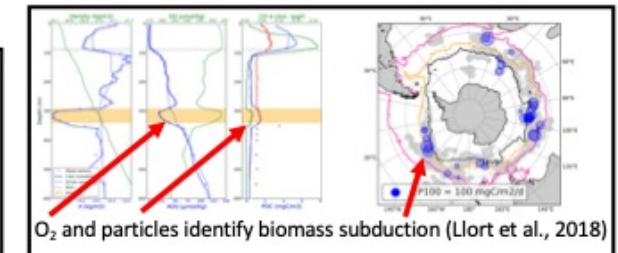


### Where are the potential future uses? Fisheries, surveillance...

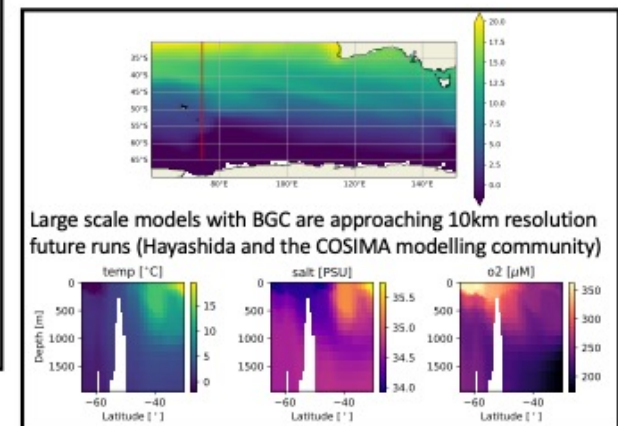
- Floats provide several different measures of water masses, ocean chemistry and productivity...
- ...at a range of spatial and temporal scales, suitable for pelagic and demersal applications
- Data assimilating hindcasts show change that has already occurred
- Future projections of varying lengths and spatial resolution are possible
- Consultation with potential end users is an important next step to understand needs



Sections from data assimilating models identify water mass changes (Peter Oke, CSIRO)



O<sub>2</sub> and particles identify biomass subduction (Llort et al., 2018)



Large scale models with BGC are approaching 10km resolution future runs (Hayashida and the COSIMA modelling community)



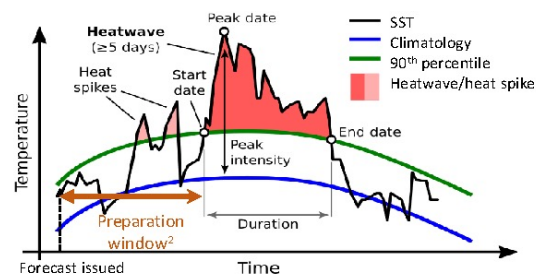
# FOO Spotlights: Climate, Marine Heatwaves and Temperature

Claire Spillman and the team  
BOM and CSIRO  
Marine Heatwave Prediction  
<http://bit.ly/FOOClimate>

## MARINE HEATWAVE PREDICTION

Claire Spillman (BoM), Grant Smith (BoM), Alistair Hobday (CSIRO) and Jason Hartog (CSIRO)

### What is a marine heatwave?

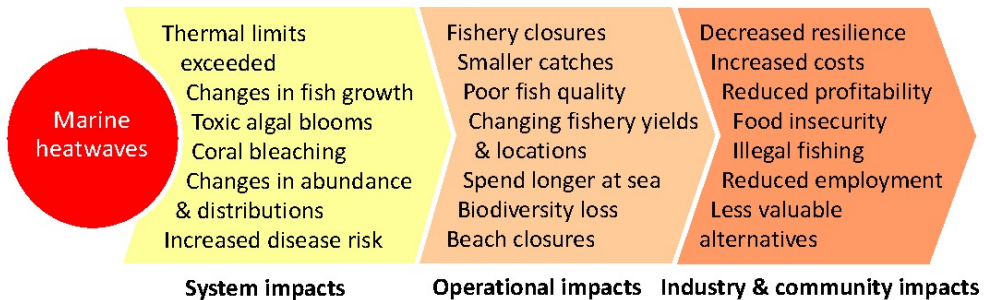


A marine heatwave is defined as when sea surface temperatures (SST) exceed the 90<sup>th</sup> percentile for 5 or more consecutive days.<sup>1</sup>

Marine heatwaves can occur year round, though usually have the greatest impacts in summer. Severity of impacts depend on event duration, intensity, extent and timing.

### What's the big deal?

Marine heatwaves can have devastating impacts on marine systems and industries.

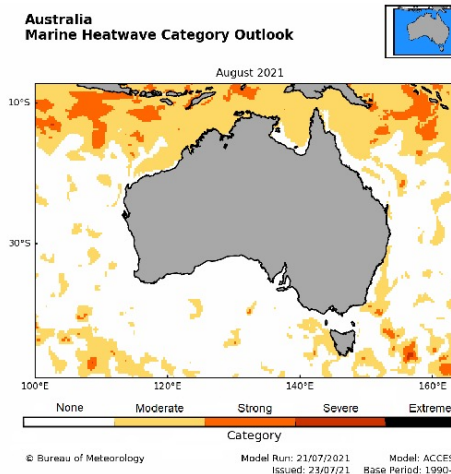


### Predicting marine heatwaves

The Bureau of Meteorology and CSIRO have a [3 year project](#) to research and develop prototype [ACCESS-S](#) seasonal marine heatwave forecast tools.

These cutting edge decision support tools will predict marine heatwave likelihood, intensity and location in the coming months.

Advance warning of these extreme events provides a [preparation window<sup>2</sup>](#) for marine users. This allows for proactive management responses to mitigate impacts, increasing system and industry resilience in a warming climate.



Prototype marine heatwave forecast for August 2021

1. [Hobday et al 2016](#) 2. Spillman et al in review

Contact: [claire.spillman@bom.gov.au](mailto:claire.spillman@bom.gov.au)



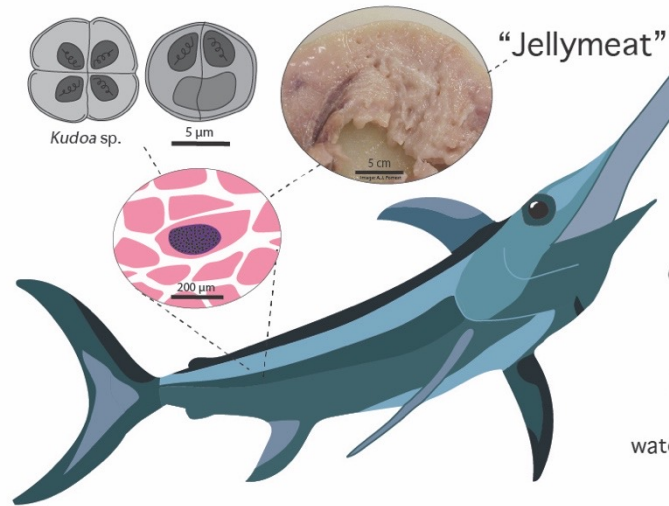
# FOO Spotlights: Climate, Marine Heatwaves and Temperature

Jessica Bolin  
University of the Sunshine Coast  
Forecasting swordfish quality: a tool for  
dynamic industry adaptation

<http://bit.ly/FOOClimate>

## Forecasting swordfish quality

A tool for dynamic industry adaptation



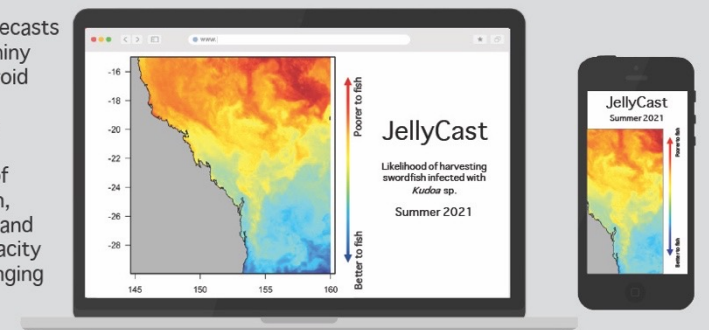
① Infection by *Kudoa* sp. can cause “jellymeat” (post-mortem myoliquefaction) in swordfish. Fishers and seafood processors operating within Australia’s Eastern Tuna and Billfish Fishery (ETBF) have reported observing “jellymeat” more often in summer, or when waters fished are warmer than usual

② Model relationships between the prevalence/intensity of *Kudoa* sp. infection and ocean state throughout the ETBF



③ Create “jellymeat” forecasts for industry via an RShiny app, to help fishers avoid harvesting infected swordfish. This could:

- (i) reduce potential for unnecessary wastage of poor-quality swordfish,
- (ii) maintain profitability, and
- (iii) improve adaptive capacity of the industry to changing ocean conditions





# FOO Spotlights: Megafauna Interactions

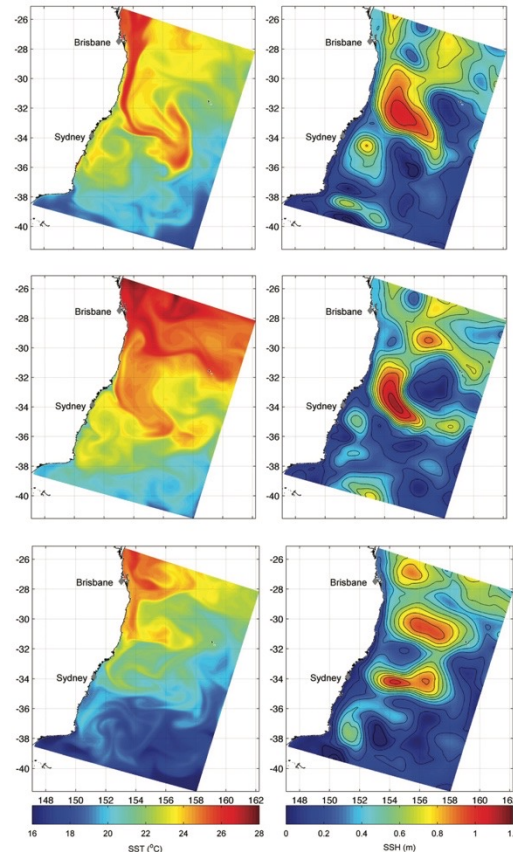
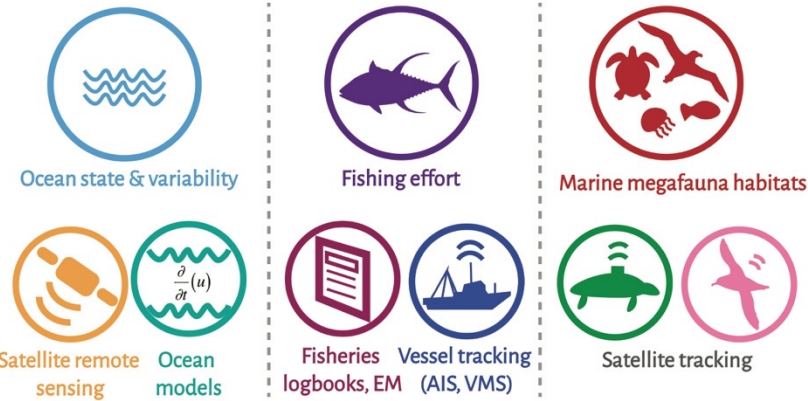
Kylie Scales – University of the Sunshine Coast  
Can we predict fisheries-wildlife interactions in dynamic seascapes?

<http://bit.ly/FOOMegafauna>

## Can we predict fisheries-wildlife interactions in dynamic seascapes?

Marine wild-capture fisheries operate in heterogeneous and dynamic systems. The distributions of both target species and non-target species are driven by multiple interacting processes, which influence the spatio-temporal dynamics of fishing behaviour, and the relative risk of unwanted interactions with threatened, endangered and protected species.

Dynamic predictive modelling of the relative likelihood of occurrence of target and non-target species with respect to physical conditions can inform dynamic management. This project uses high-resolution physical data fields from a data-assimilative Regional Ocean Modelling System (ROMS) for the East Australia Current region (UNSW) to elucidate the drivers underlying fisheries-wildlife interactions in Australia's Eastern Tuna and Billfish Fishery.





# FOO Spotlights: FOO 2021

Stef Stimson  
RBR

## Expansion of the RBRcervello for Multi-Instrument Capability in Real-time

<http://bit.ly/FOObeyond>

# RBR

rbr-global.com

### Expansion of the RBRcervello for Multi-Instrument Capability in Real-time

Stef Stimson, [stef.stimson@rbr-global.com](mailto:stef.stimson@rbr-global.com)

RBR Ltd, Hobart

Since 1973, RBR has been designing and manufacturing oceanographic instruments in its Ottawa, Canada headquarters. From the ocean abyss to the polar ice cap, and on every continent, RBR sensors track water parameters: temperature, depth, salinity, dissolved gases, pH, and many others.

This spotlight article details the evolution of the RBR Mooring Line Modem (MLM) and RBRcervello to allow multi-instrument moorings to report their data in real-time.

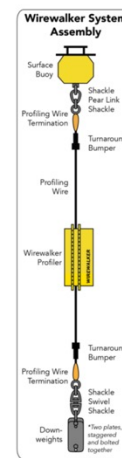


RBR's inductive modem communication system, the MLM-1000, was developed to provide fast communication with deployed instruments over several thousand metres of jacketed wire. It uses an inductive signal to bring data to the surface via the mooring line at speeds up to 4800 baud, where the seawater acts as the return to complete the circuit.



Instruments are connected to a sub-surface modem (SSM), either directly integrated or via a cable, and the jacketed cable feeds through the coupler for data transmission. This allows flexibility in where the instruments are mounted. A head end modem is used at the surface to provide control and connect to the user's data logger / telemetry system.

The DMO Wirewalker is a vertically profiling platform, powered by ocean waves, that uses the RBR mooring line modem as the profiling wire to bring data from instruments in the profiling body to the surface buoy.

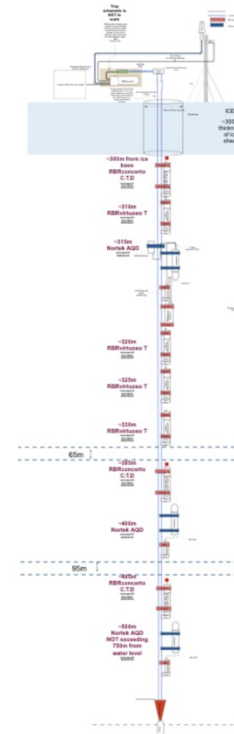


To expand the Wirewalker's capability, RBR then developed the RBRcervello as the "brain" of the system. In addition to controlling the mooring line communications, the RBRcervello also provides data storage and data telemetry (via GSM and Iridium). This allowed the data from the RBR instrumentation in the profiling body to be brought to the surface and be telemetered to the world in real-time. Reconfiguring of the on-board instrumentation via the telemetry is also possible.

In the most recent evolution of the RBRcervello, RBR has worked extensively with two international organisations to develop the RBRcervello's capabilities to allow it to communicate with multiple instruments on a single mooring line and not just the one in a profiling body. This has been specifically valuable for a current project in Antarctica requiring under ice, multi-instrument, multi-year, real-time measurements. The collaboration in this project has included customised transit cases that are then used at site as permanent enclosures, buried in the snow, for insulation.

The systems that have been delivered to date host multiple RBR instruments as well as Nortek Aquadopp's (see right), acquiring data to a depth of ~750m.

Although this collaboration focused specifically on a design evolution with the upper ~300m frozen in the ice and measuring below the ice, this system can equally work from a surface buoy or vessel, reporting in real-time from all sensors, expanding the possibilities for moored, or drifting, ocean column monitoring.





# FOO Spotlights: FOO 2021

# Anna Riddell – Geoscience Australia Height Systems in Australia - Introducing the AVWS and AUSHYDROID <http://bit.ly/FOObeyond>



## Height Systems in Australia

Introducing the Australian Vertical Working Surface and AUSHYDROID

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<sup>1</sup>Geoscience Australia  
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### Which height do I use?

The connection of land and sea datums in Australia remains a challenge considering that we do not currently have a model of the vertical separation between the defined global Earth-centred reference frame and local maritime chart datums.

### Welcome to AVWS

The Australia Vertical Working Surface (AVWS) is a reference surface for heights that works on and offshore and forms part of the Australian Geospatial Reference System (Figure 1). AVWS is a model of gravity that provides the offset between the ellipsoid (common height reference used by Global Navigation Satellite Systems, GNSS in an Earth-centred frame) and the quasigeoid, and does not suffer from the same biases and distortions in the Australian Height Datum (AHD). AVWS heights can be computed directly from GNSS without needing to connect to survey mark infrastructure and has an accuracy of 4-8 cm, which presents an improvement on the accuracy previously available from AUSGeoid models (~8-13 cm).

### What is a Quasigeoid?

The Australian Gravimetric Quasigeoid (AGQG) is a model of the gravity field across the Australian region and like the AUSGeoid model which is used to derive AHD heights, the AGQG model can be used to compute AVWS heights. The latest AGQG model (AGQG2017) was determined from ~1.8 million onshore gravity values provided in the Australian National Gravity Database, offshore satellite altimetry derived gravity anomaly values from Sandwell et al. (2014), the global gravity model (EGM2008), and the national digital elevation model DEMH1s. A detailed description of the procedure used to create the model is given in Featherstone et al. (2018).

An online tool is available to transform between ellipsoidal and AVWS heights and also provides uncertainty estimates  
<https://geodesyapps.ga.gov.au/avws/>

Figure 2 shows the different surfaces that heights can be observed to or derived from with respect to an ellipsoid, geoid or quasigeoid surface.

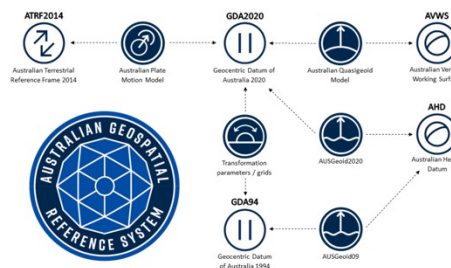


Figure 1: The Australian Geospatial Reference System is the collection of datums, reference frames and working surface used to define the latitude longitude, height, orientation and gravity across Australia.

### AUSHYDROID

One of the complexities of hydrographic surveying is the relationship between chart datum and the reference ellipsoid. To allow for the reduction of this data to chart datum a new separation model is required to augment traditional tidal models. The new AUSHYDROID is intended to be a model of chart datum (lowest astronomical tide) and will be based in-part on AGQG2017, tide gauge data and models of the mean dynamic topography. It will provide a mechanism to reduce ellipsoidal heights from GNSS to chart datum to facilitate high accuracy surveys in the maritime environment.

- AUSHDROID will have a number of benefits that will contribute to Australia's blue economy including:
- Linking bathymetry and land based observations through a common reference frame;
  - Enabling the definition of coastlines and inter-tidal zones on a national scale;
  - Assist in defining maritime baselines, marine cadastres and claims of sovereignty; and
  - Provide a baseline for sea-level rise estimates and climate change strategies for coastal infrastructure.

### Future Work

There are known issues that any model faces and that is no different for the existing models of gravity across Australia, particularly in coastal areas. To ensure the seamless integration of gravity data onshore and offshore, we are filling in the areas of interest with airborne gravity data. A large project to acquire airborne gravity data across Eastern Victoria is underway and a state-wide survey of NSW is being developed. AUSHYDROID is being established to maintain models that to relate land and sea datums in Australia's ocean regions.

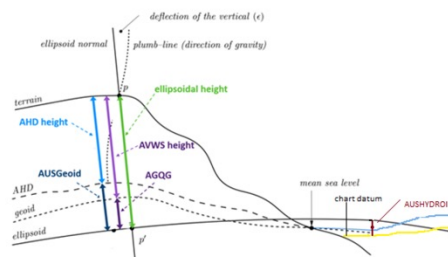


Figure 2: The AGQG model (dark purple) enables users to convert ellipsoidal heights (green) to AVWS heights (light purple). The AUSGeoid model (dark blue) enables users to convert ellipsoidal heights (green) to derived AHD heights (light blue). ICSM, 2021.

### REFERENCES

- Featherstone, J. et al., (2018), The first Australian gravimetric quasigeoid model with location-specific uncertainty estimates, *JoG*, 92(2), 149-168.  
ICSM, (2021), AVWS Technical Implementation Plan, <https://www.icsm.gov.au/publications/australian-vertical-working-surface-technical-implementation-plan-v16>  
Sandwell, D. et al., (2014), New global marine gravity model from CryoSat-2 and Jason-1 reveals buried tectonic structure, *Science*, 346(6205), 65-67.





# Winners: Spotlights

- Joshua Sixsmith et al (Waves and Currents)
- Jessica Bolin (Climate, Marine Heatwaves and Temperature)
- Kylie Scales (Megafauna Interactions with Industry)
- Stef Stimson (FOO 2021)

Congratulations!

Thank you to all participants.

The FOO Secretariat (IMOS Office) will be in touch.





# FOO Report

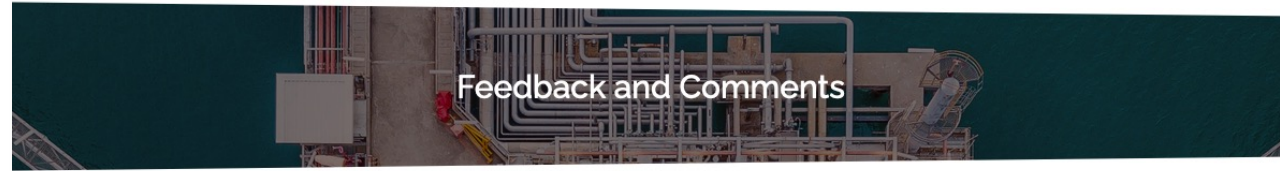
- Produce a report of the FOO 2021 proceedings so we can make sure we stay on track with our objectives
- That will be drafted in the IMOS Office, go to session speakers and leads, then out to the registrants and the website.
- Presentations will be on website - once permissions and access is sorted (only with permission)
- Recordings won't be made public





# Getting in touch

- Today, please use Sli.do (#FOOBeyond) during the Q&A
- Contact the FOO Secretariat (IMOS Office)
- Or feedback form on the website: <https://bit.ly/FOO-21>



## Forum Feedback and Comments

Please use this form to provide feedback on the Australian Forum for Operational Oceanography, as discussed at FOO 2021.

Alternatively, please contact the FOO Secretariat at [indiah.hodgsonjohnston@utas.edu.au](mailto:indiah.hodgsonjohnston@utas.edu.au)

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