Australia's National Science Agency

Regional And Coastal Oceanography Experiences From Talisman Sabre 2023

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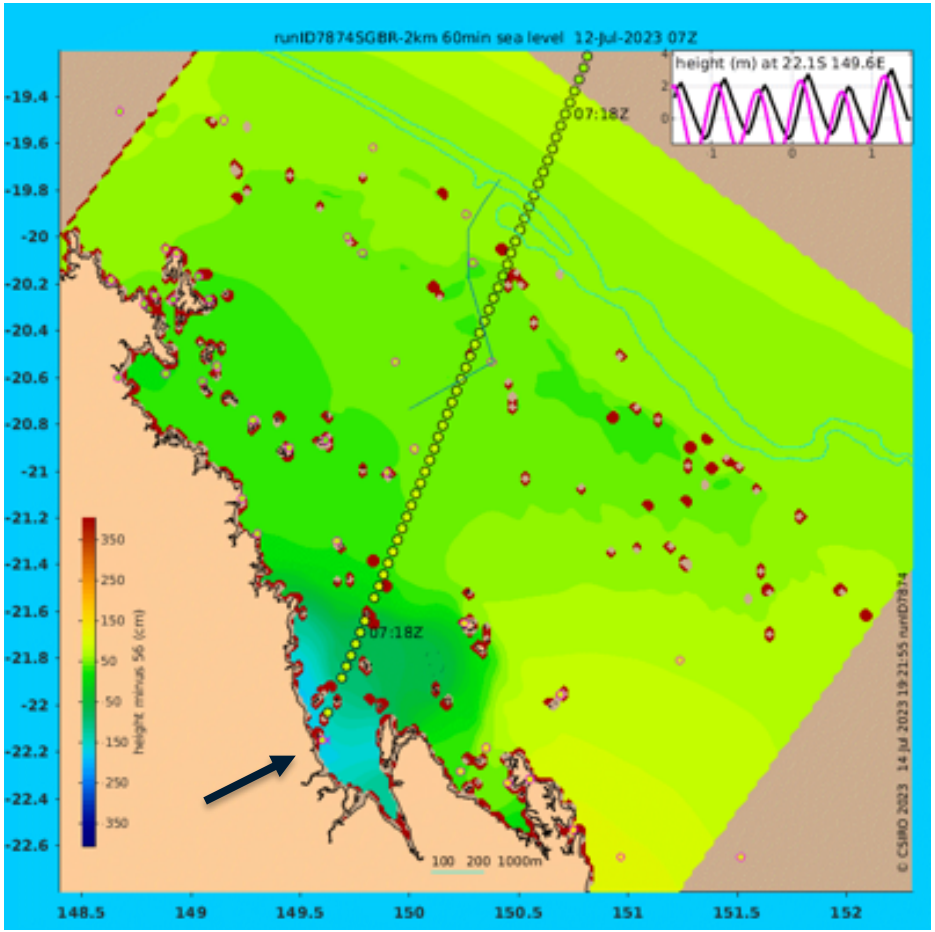
Talisman Sabre 2023

The Bluelink team established a range of bespoke prediction domains during the Talisman Sabre 2023 Defence exercise in July/August 2023. Here we highlight three areas of effort:

1. Importance of **accurate bathymetric** information for correctly predicting tide heights, currents and their timing in coastal regions
2. High-resolution forecast domains were established to deliver particle tracking predictions to support **search and rescue and recovery activities**
3. Developments in providing predictions of water levels, currents and waves for **nearshore and littoral decision making** were tested in a forecast “dev” environment, enabling feedback from end users to guide future modifications

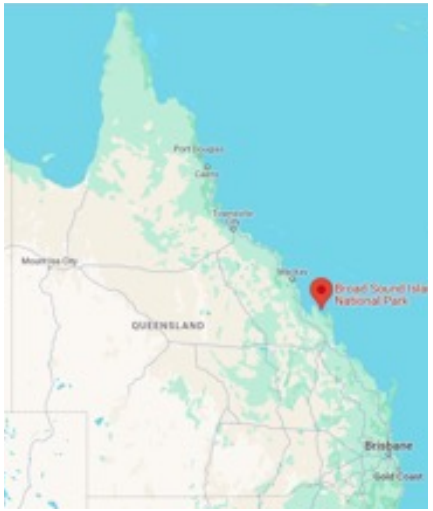
ROAM-Ocean



Tidal height (3 days):

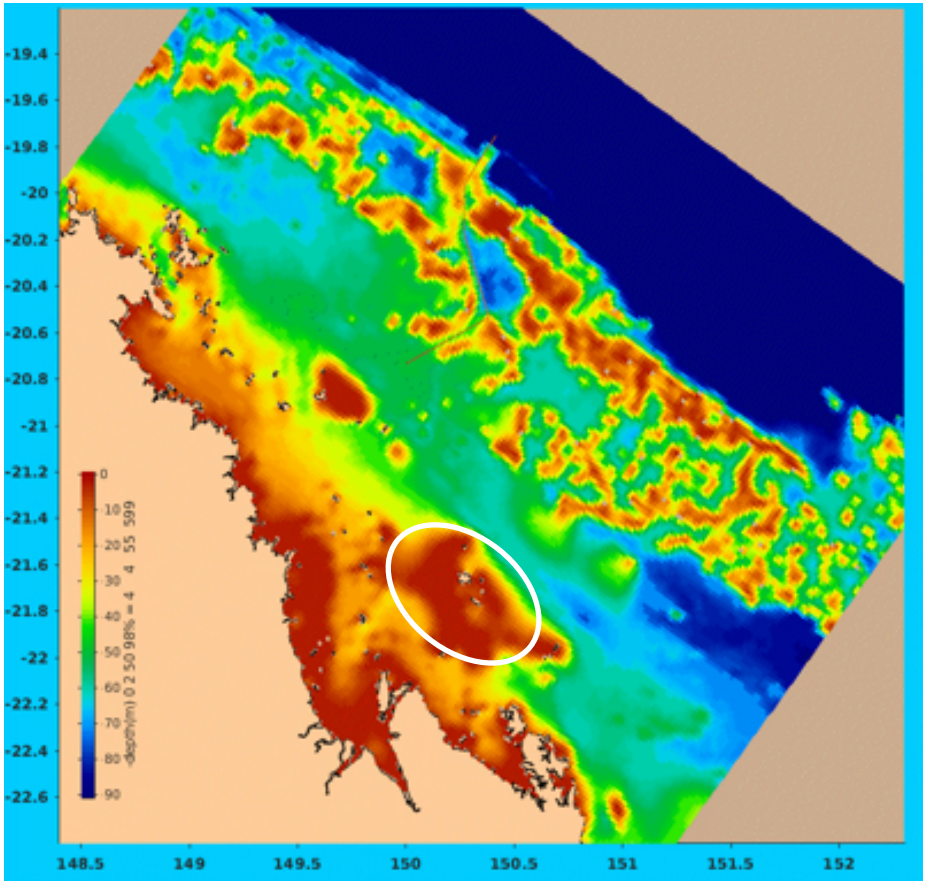
ROAM

Tidegauge



David Griffin, CSIRO

Original regional bathymetry



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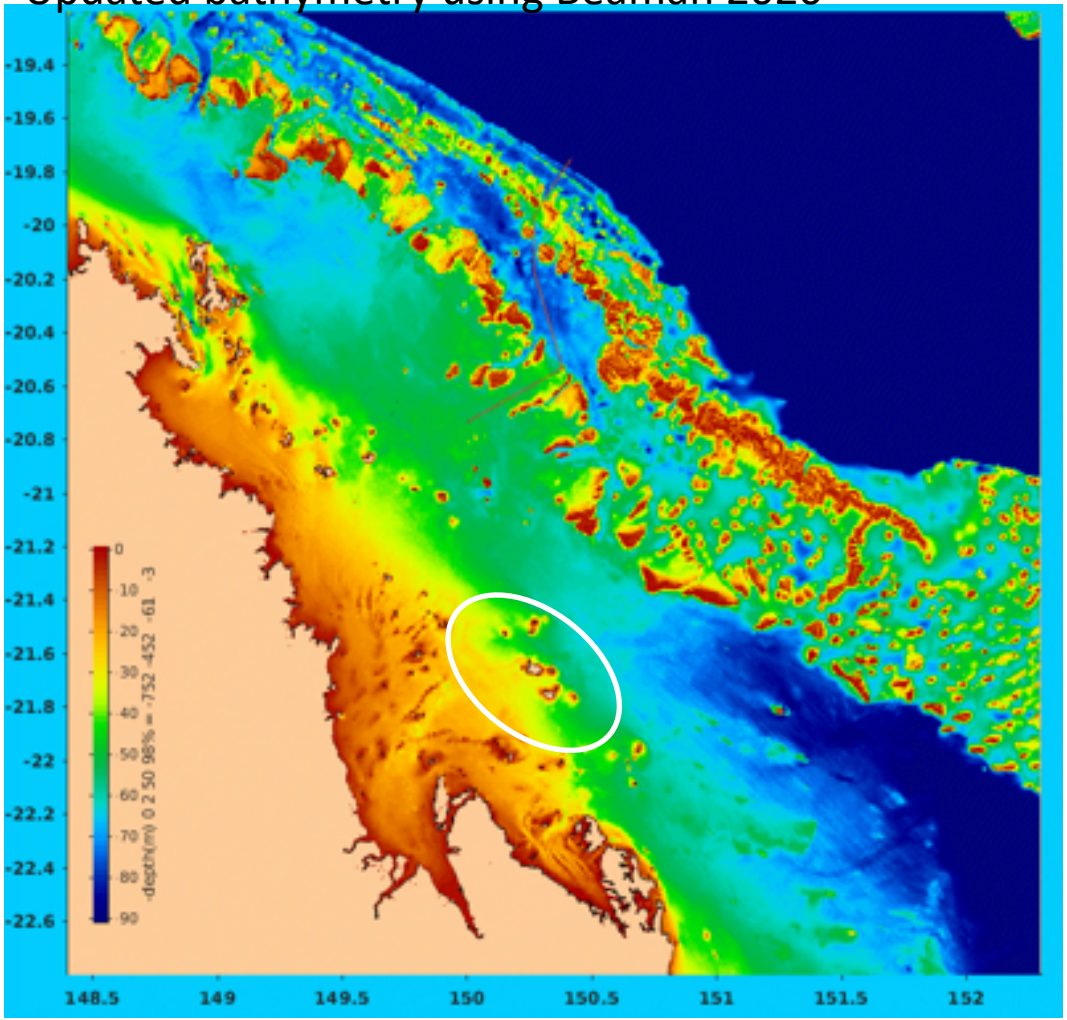
Updated bathymetry using Beaman 2020



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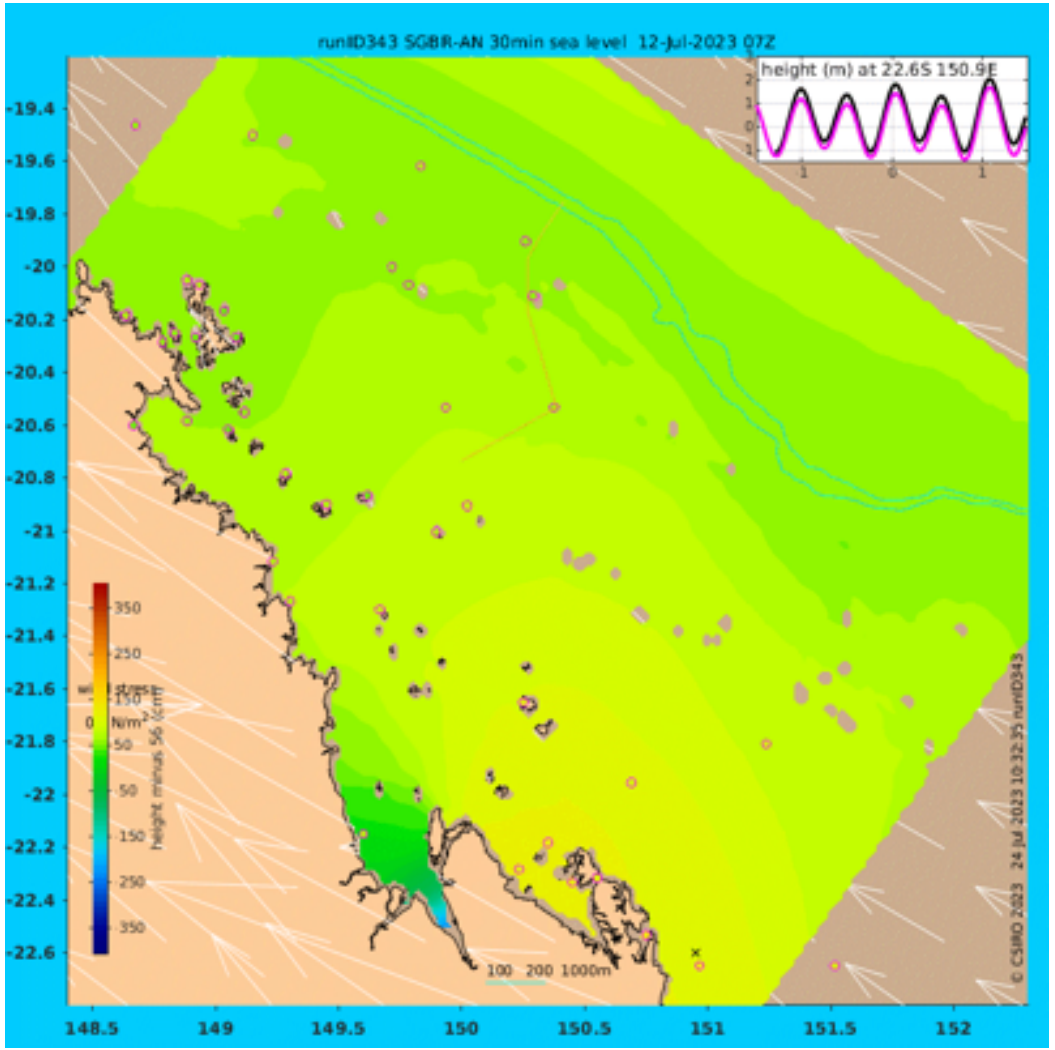

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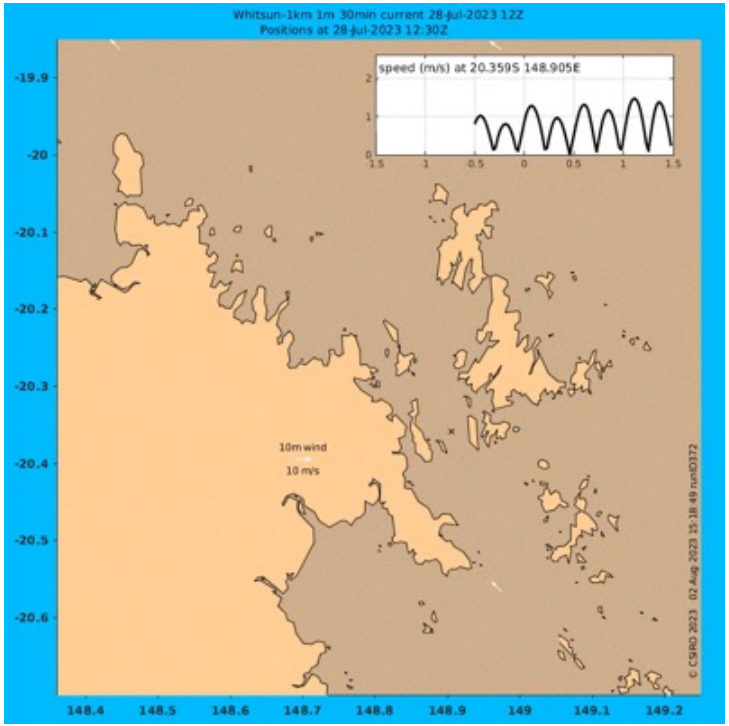
Unplanned application in support of MRH-90 search

High-res forecast domains to deliver particle tracking predictions to support search & rescue and recovery



1) surface drift of debris (ROAM sfc vel + 1% wind)

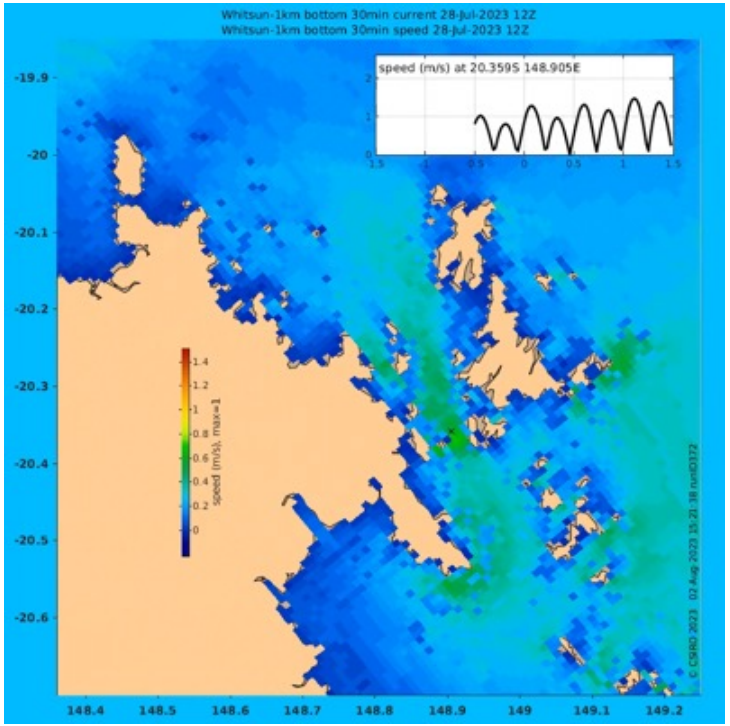
NW drift trajectory from point of impact

David Griffin, CSIRO

Unplanned application in support of MRH-90 search

Predictions of sea floor currents to enable safe recovery activities

Time of slack tide often needed by end users e.g., divers, ROV operators



2) epi-benthic drift (bottom-most ROAM velocity)

Map and time series to identify time of slack tide

Wave and Littoral (WAL) Team Participation Goals:


U.S. Navy hovercraft, Stanage Bay, Aug. 2, 2023

1. Develop/test/improve nearshore littoral modelling:
   a. **Littoral-scale**: first deployment of wave-flow unstructured mesh model in automated forecast "dev" environment

   b. **Surf zone**: first nesting within littoral scale/automating triggering of runs via ROAM API and delivering output to multiple decision makers

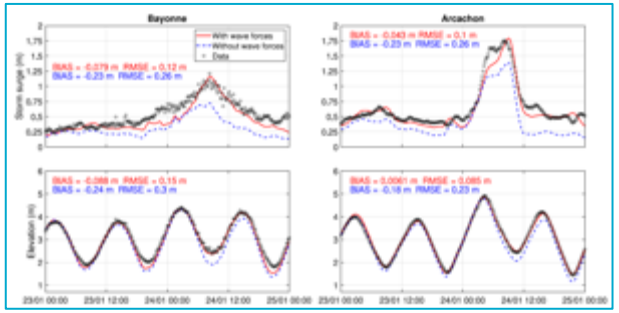
2. Seek feedback from larger end user community both of the above

Wave-flow coupling

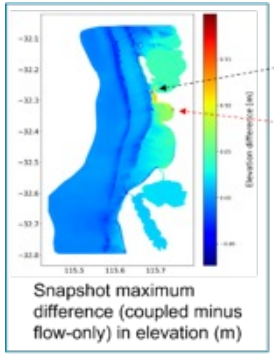
Nonlinear interaction of ocean waves and currents is very important for wide range of nearshore applications

Waves can provide a strong contribution to water levels and littoral processes (e.g., contribute to storm surge & extreme water levels; improve storm surge simulations)

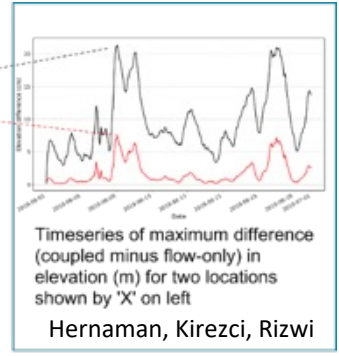
Currents influence the wave field (e.g., counter-currents can cause wave shoaling/steepening; strong currents + shallow water depth -> wave dissipation by whitecapping)



Lavaud et al. 2020



Snapshot maximum difference (coupled minus flow-only) in elevation (m)

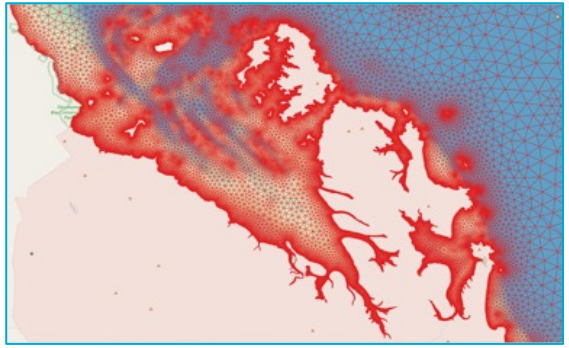


Timeseries of maximum difference (coupled minus flow-only) in elevation (m) for two locations shown by 'X' on left

Hernaman, Kirezci, Rizwi

Unstructured mesh

- Many nearshore features require a **higher resolution in specific and often discontinuous areas** to be fully resolved
- **Unstructured models can**:
  - Represent complex coastlines and channels very easily
  - Precisely define areas of high resolution for specific features
  - Allow seamless resolution transition without the need for nesting



Focal areas

Tide gauges

Permanent wave buoys

Three Spotter wave buoys were also deployed to support validation

Mesh:

Requirement: balance of resolution vs runtime (target of <30 mins runtime) for coupled hydrodynamics-wave
305,131 elements (faces); 162,298 nodes
Mesh resolution:

- 3 focal areas: 100 m nearshore extending to 2 km at edge
- GBR: ~800 m over reefs extending to 2 km at edge
- Broad Sound: ~250 m nearshore extending to 2 km

Bathymetry:

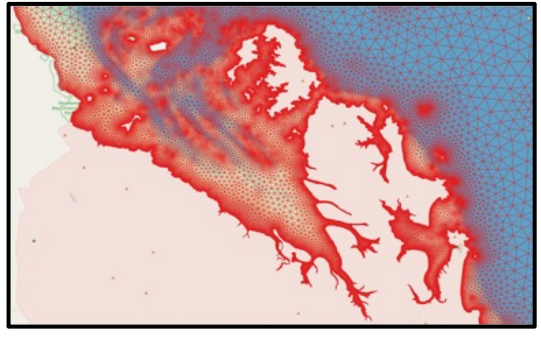
GA 30m tiles (https://pid.geoscience.gov.au/dataset/ga/115066)

Forcing:

Waves: AUSWAVE
Winds & MSLP: ACCESS-G
Tidal elev & velocities: TPXO
Non-tidal elev: OceanMAPS

MPI Compute:

Petrichor (CSIRO HPC)
256 CPUs
240GB mem
~27 min wall time



Simulations:

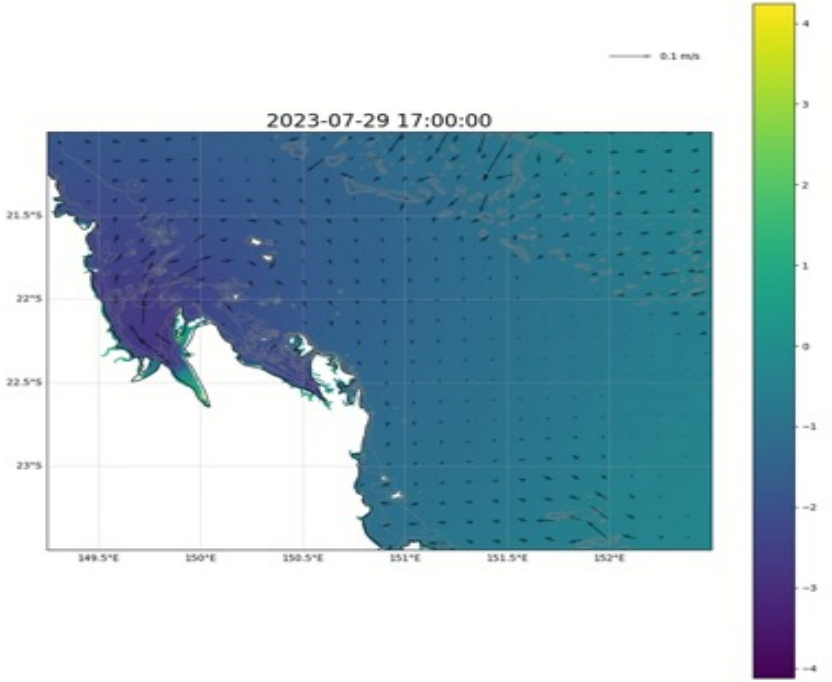
24-hr spin-up
72-hr forecast
Run twice daily

Validation:

Tide gauges
Wave buoys
Satellite altimeter (tuning runs)

Water Levels

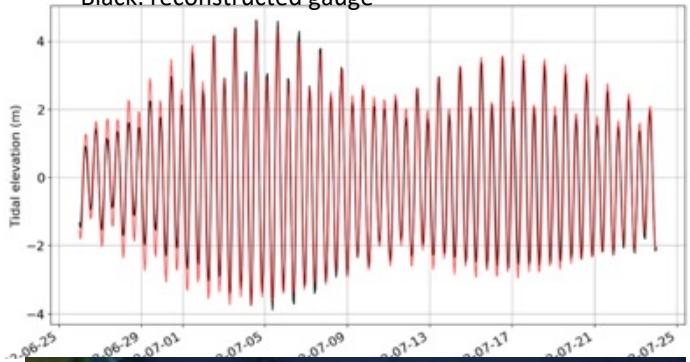
Good performance even in the complex regions such as Broad Sound.

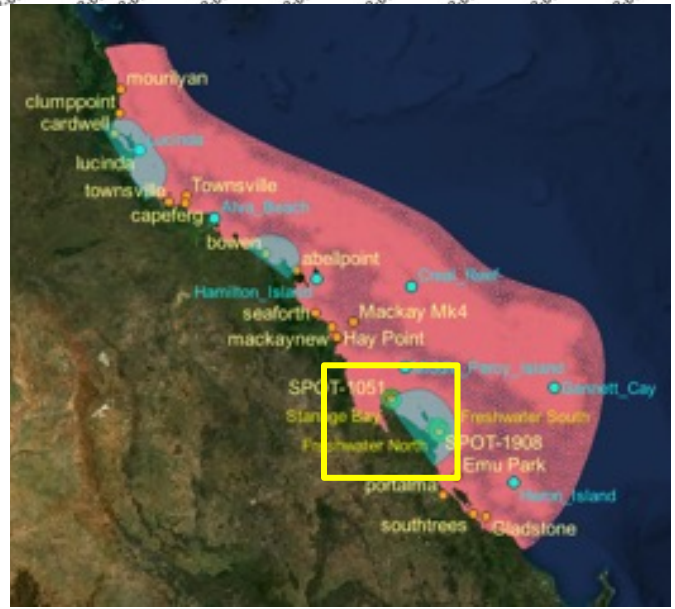


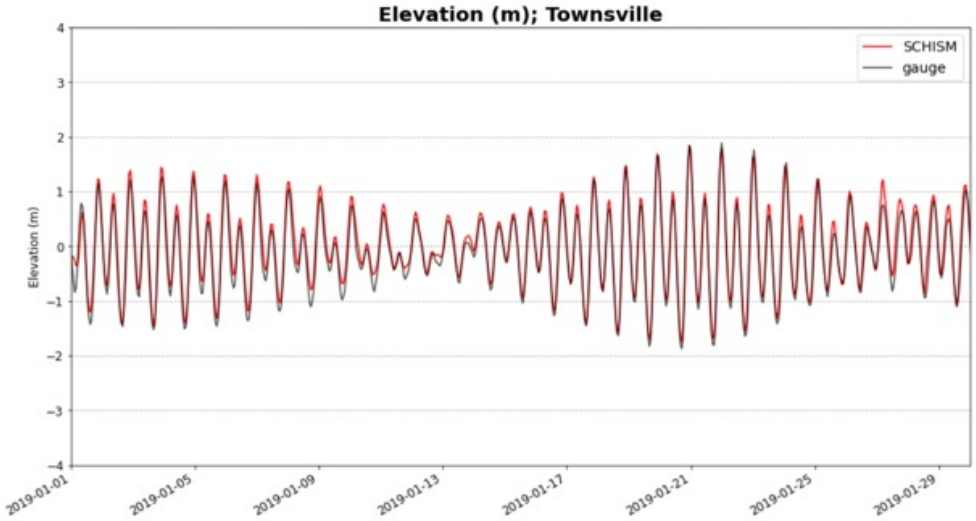
McEwen Islet

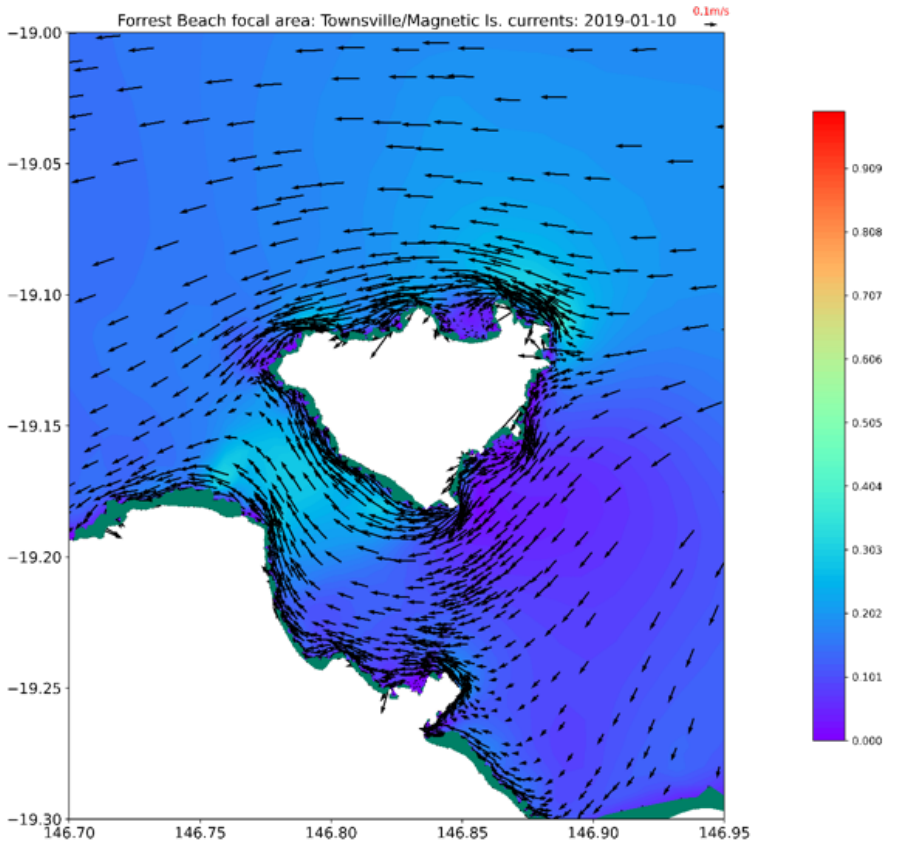
Red: SCHISM-WWMIII

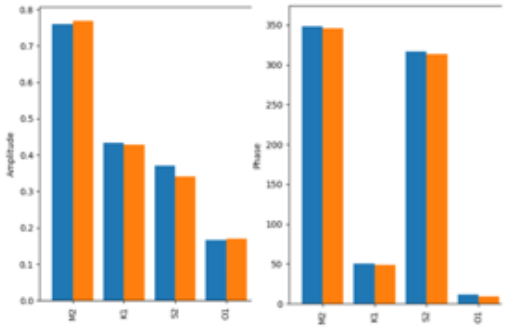
Black: reconstructed gauge







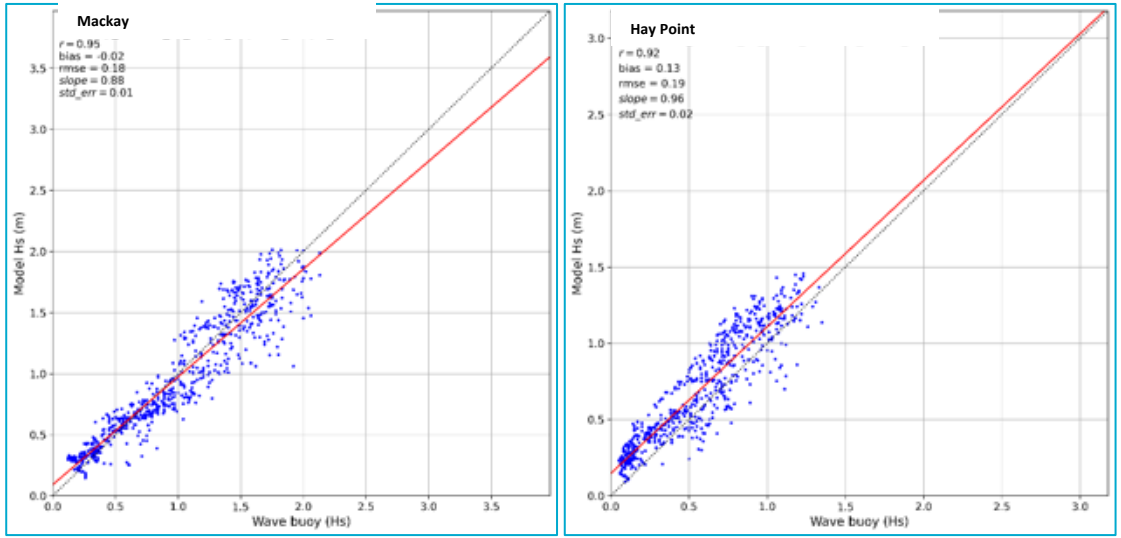


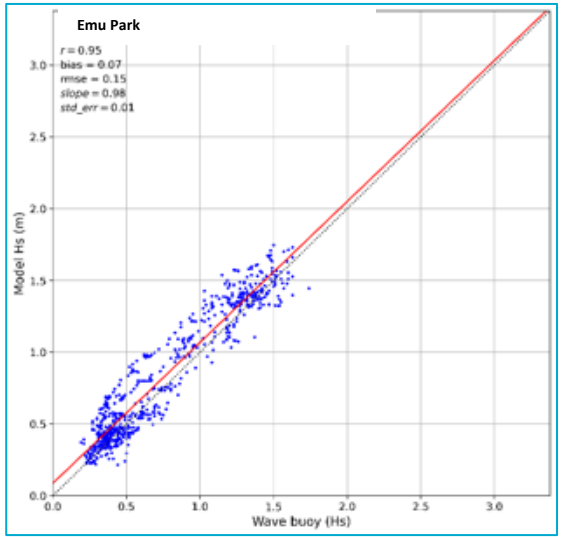


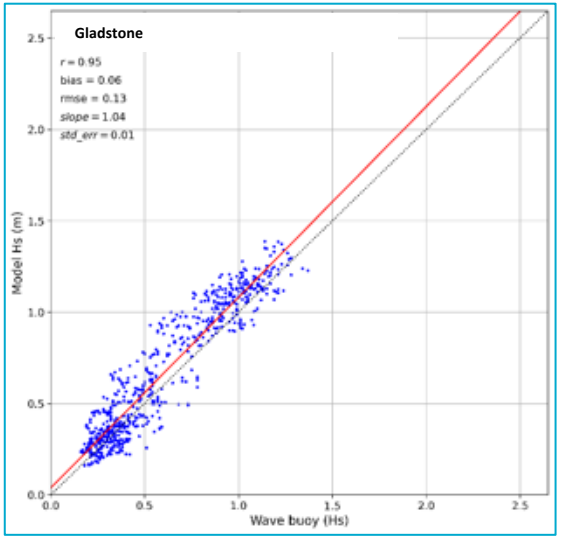
Tidal analysis

Blue: gauge
Orange: model

Wave validation: Significant wave height (Hs)



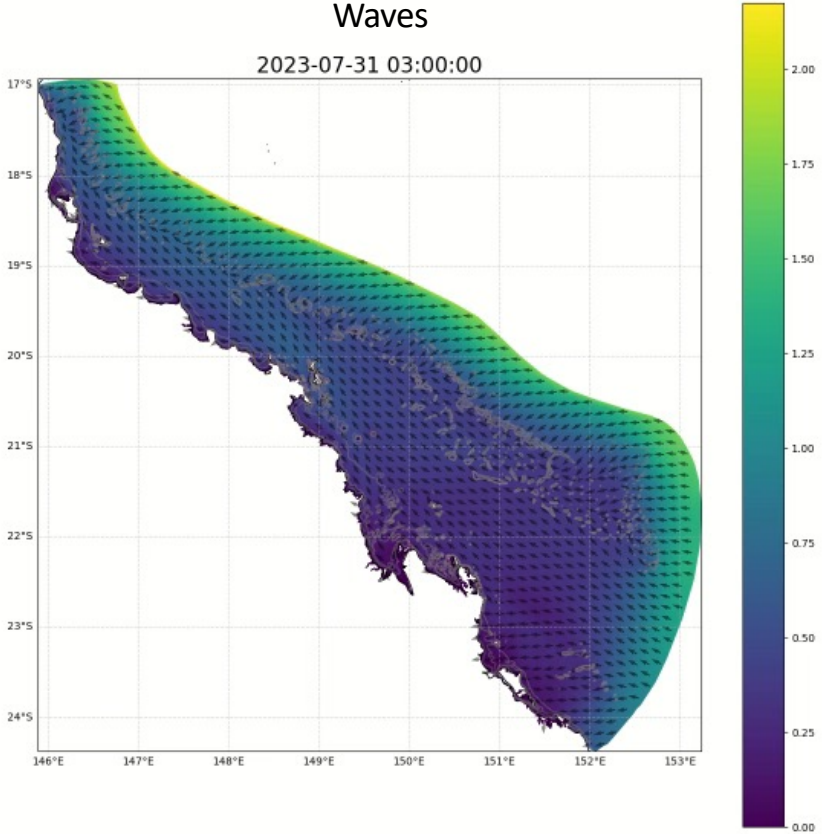




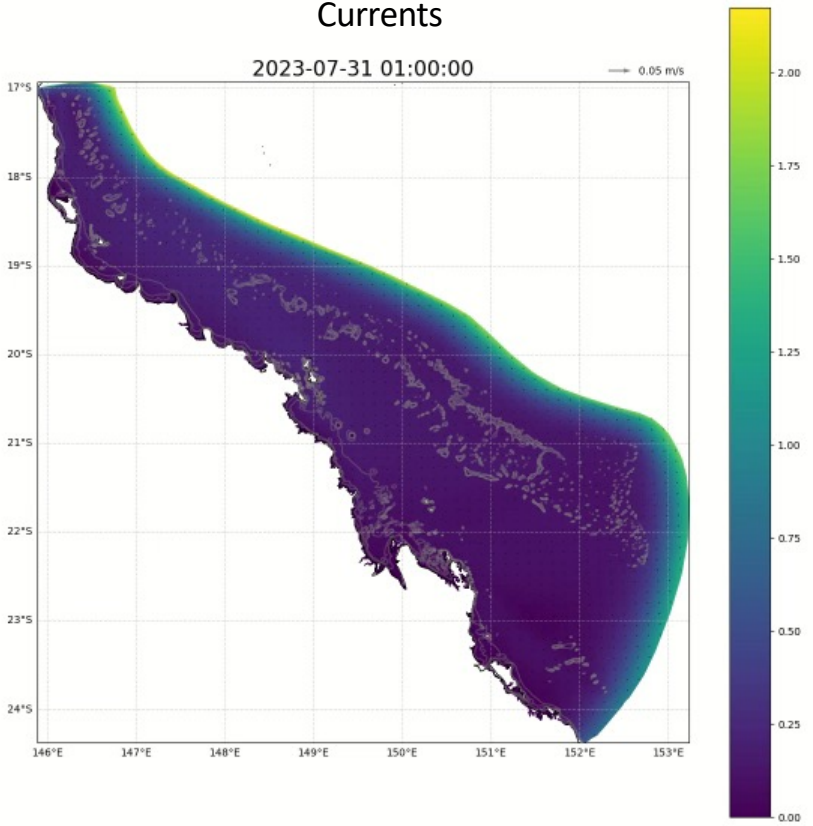
Bias generally 2-7 cm except at Hay Point

Waves & Current Animations

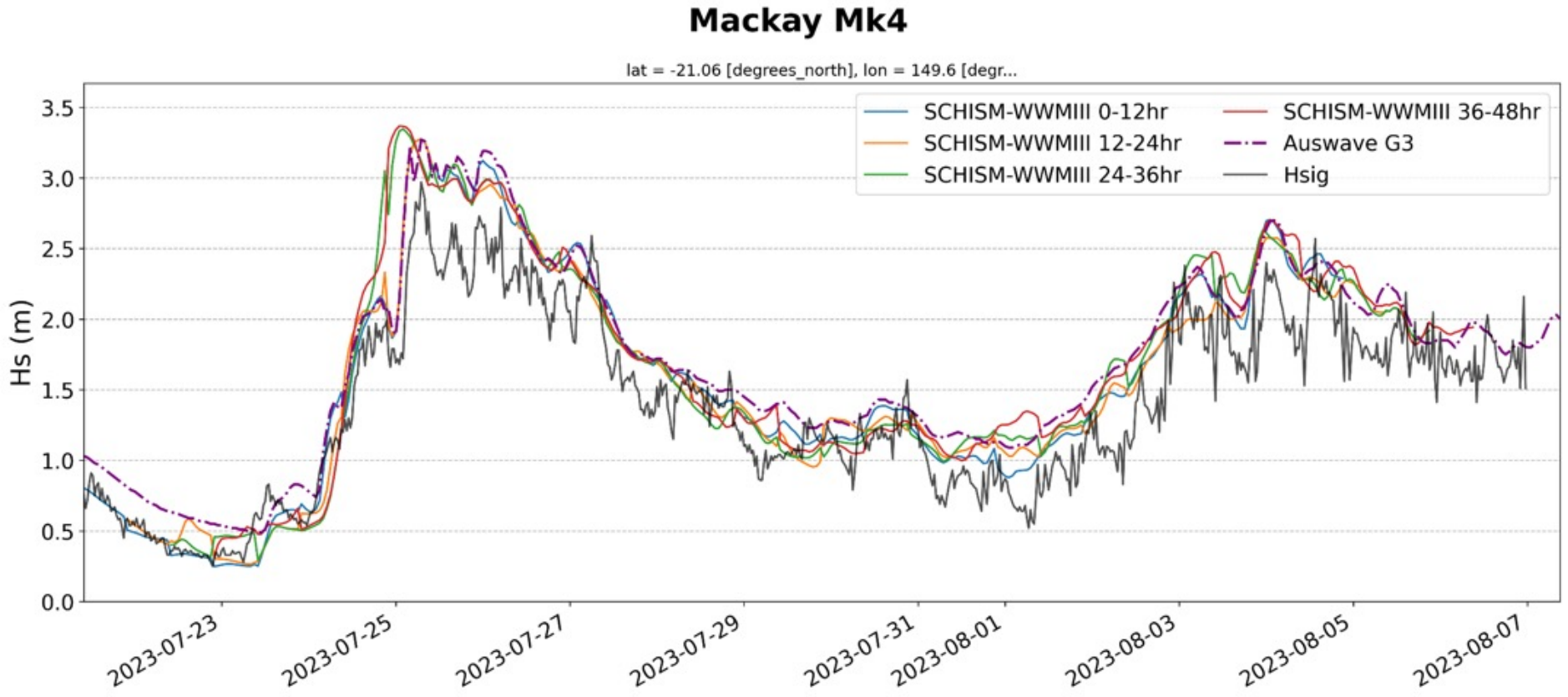
Waves

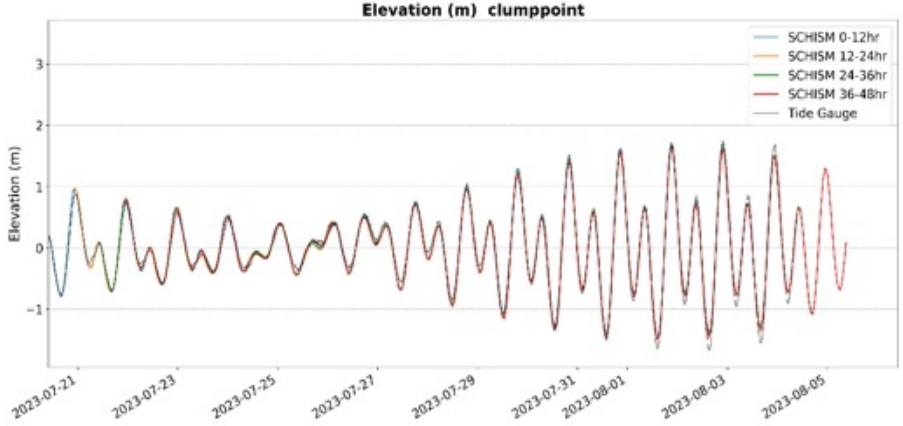


Currents



Forecast skill over time




Elevation (m) clumppoint
SCHISM 0-12hr
SCHISM 12-24hr
SCHISM 24-36hr
SCHISM 36-48hr
Tide Gauge
Elevation (m)
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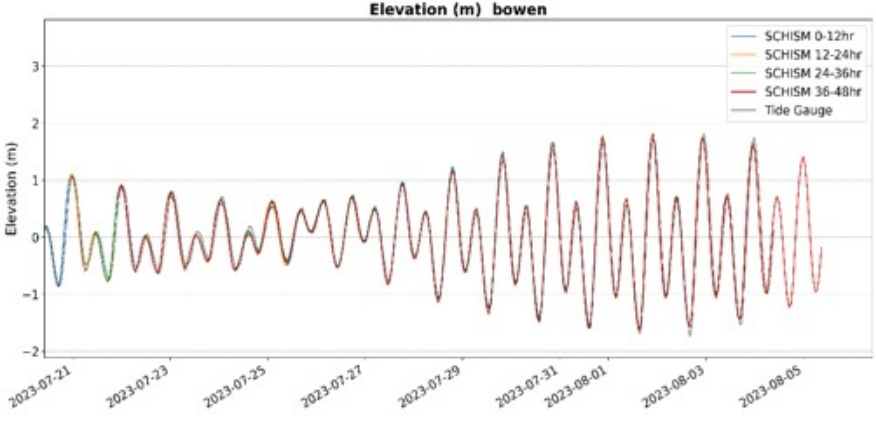
1
0
−1
2023-07-21
2023-07-23
2023-07-25
2023-07-27
2023-07-29
2023-07-31
2023-08-01
2023-08-03
2023-08-05


Elevation (m) bowen
SCHISM 0-12hr
SCHISM 12-24hr
SCHISM 24-36hr
SCHISM 36-48hr
Tide Gauge
Elevation (m)
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2023-07-23
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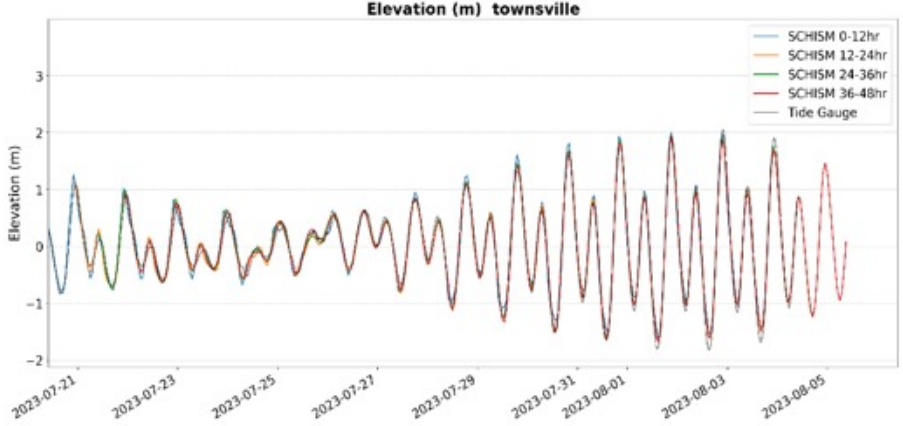
2023-08-05


Elevation (m) townsville
SCHISM 0-12hr
SCHISM 12-24hr
SCHISM 24-36hr
SCHISM 36-48hr
Tide Gauge
Elevation (m)
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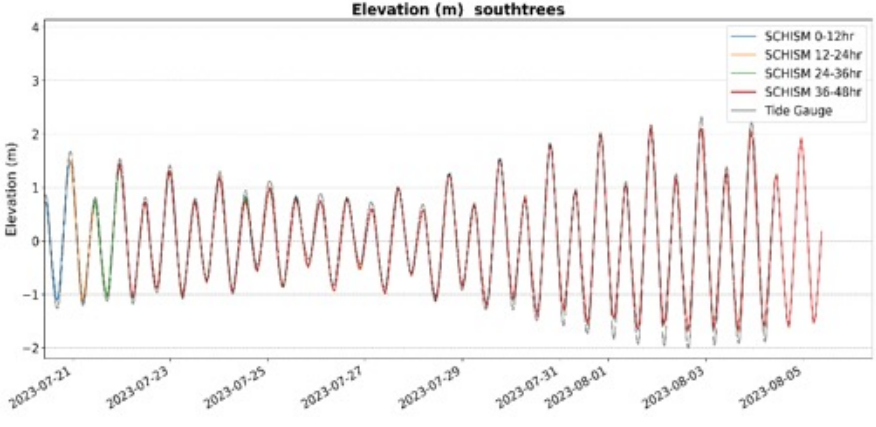
Elevation (m) southtrees
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SCHISM 12-24hr
SCHISM 24-36hr
SCHISM 36-48hr
Tide Gauge
Elevation (m)
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2
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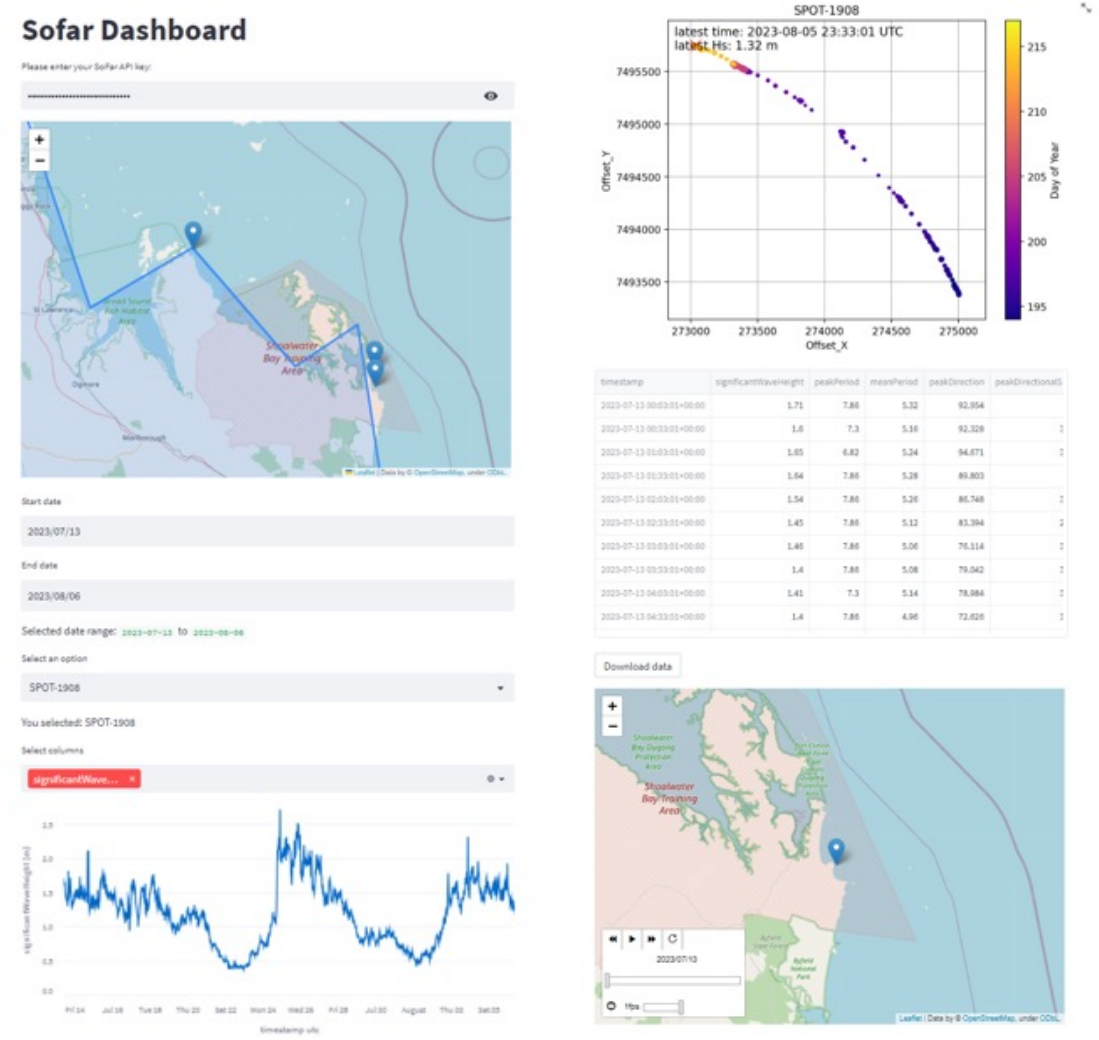
2023-07-21
2023-07-23
2023-07-25
2023-07-27
2023-07-29
2023-07-31
2023-08-01
2023-08-03
2023-08-05

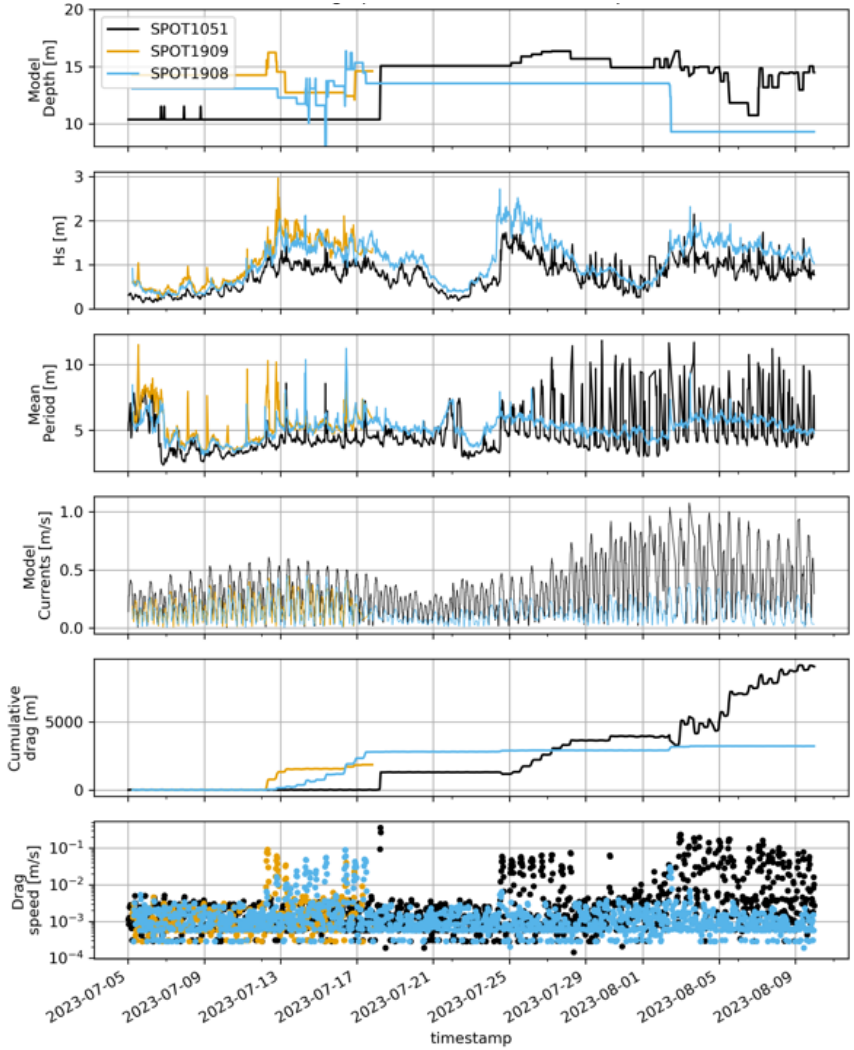
In-situ deployment of wave buoys

Customizable dashboard developed to improve data viewing and local data hosting



Both the operational guidelines and the dashboard were used and evaluated during the activity

Figure on bottom right indicates drag analysis during ~6 week operational deployments

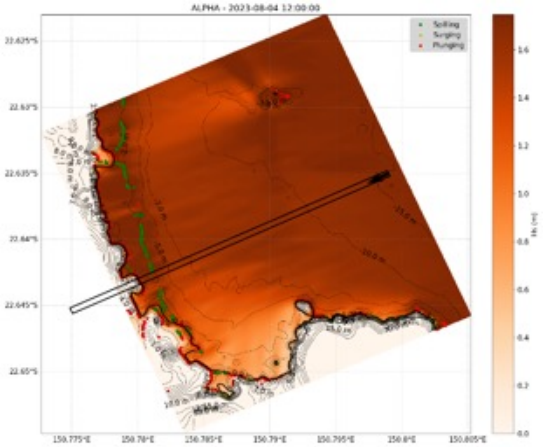


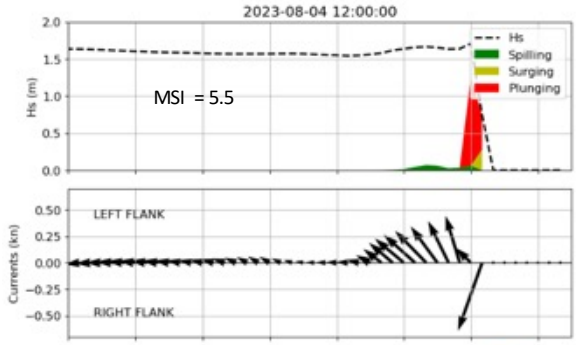
ROAM-Surf

- Wave group resolving hydrodynamics model for beach processes
- Transforms ocean waves up to the beach-face
- Applied for regions up to O(1) km length of coastline with a resolution of O(10) m
- Due to high resolution, global bathymetry datasets insufficient
- User supplied bathymetry is necessary
- Provides predictions of waves, currents and water levels in the nearshore
- **TS2023** - first nesting within littoral scale/automating triggering of runs via ROAM API and delivering output to multiple decision makers

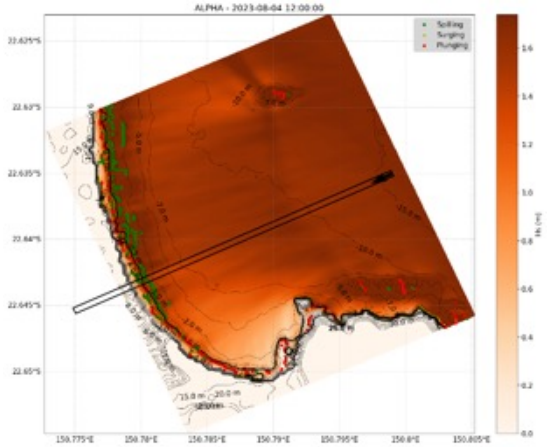
Differences in model runs

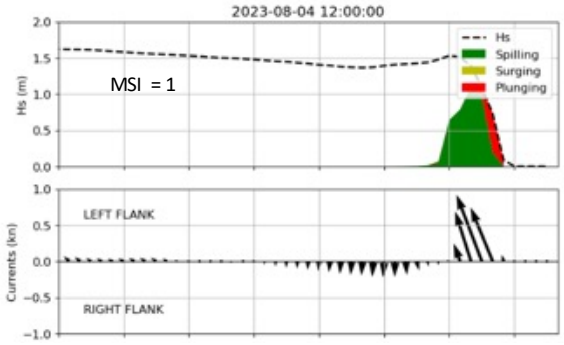
LADS 2001





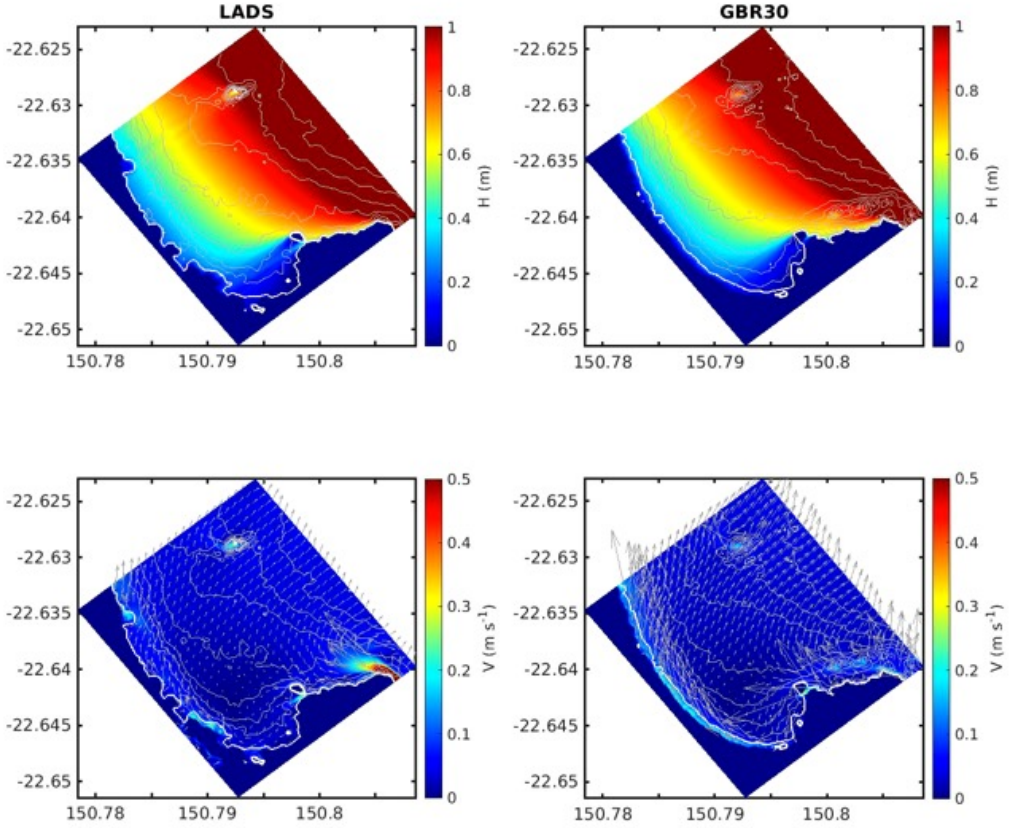
GBR30





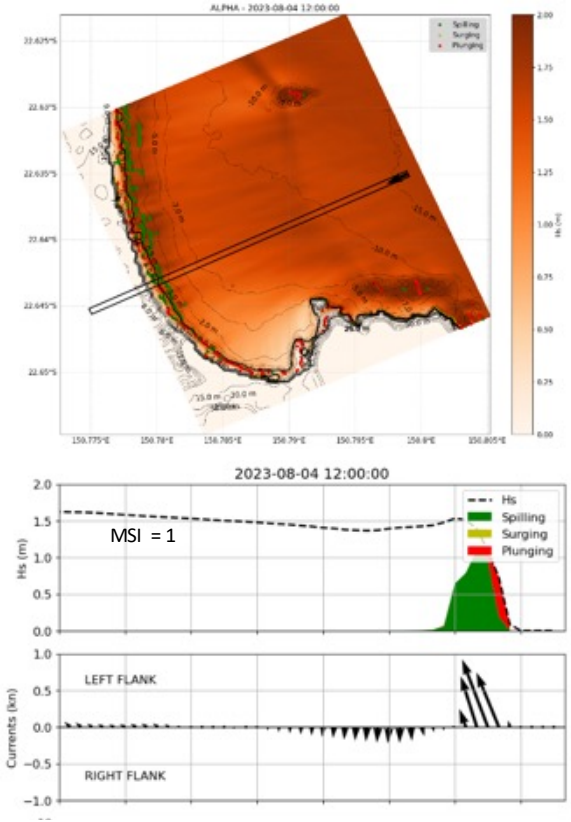
MSI = Modified Surf Index

Differences in model runs

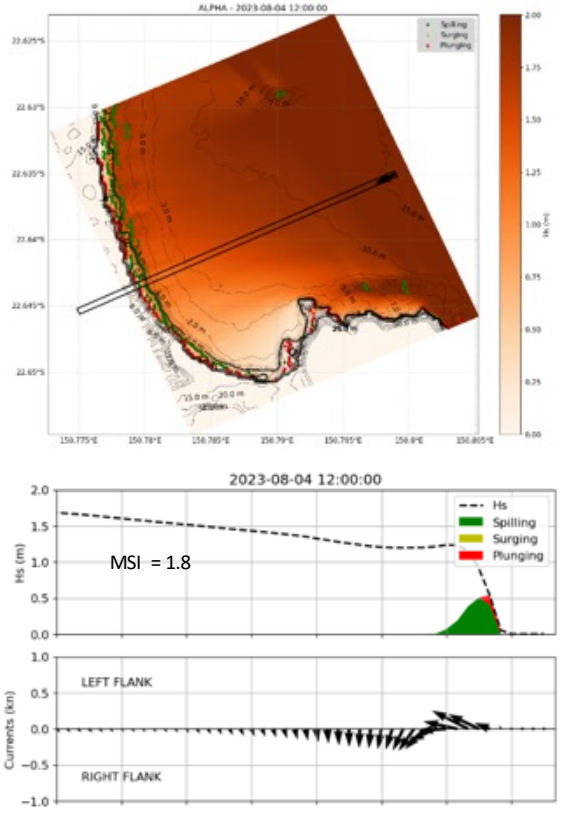


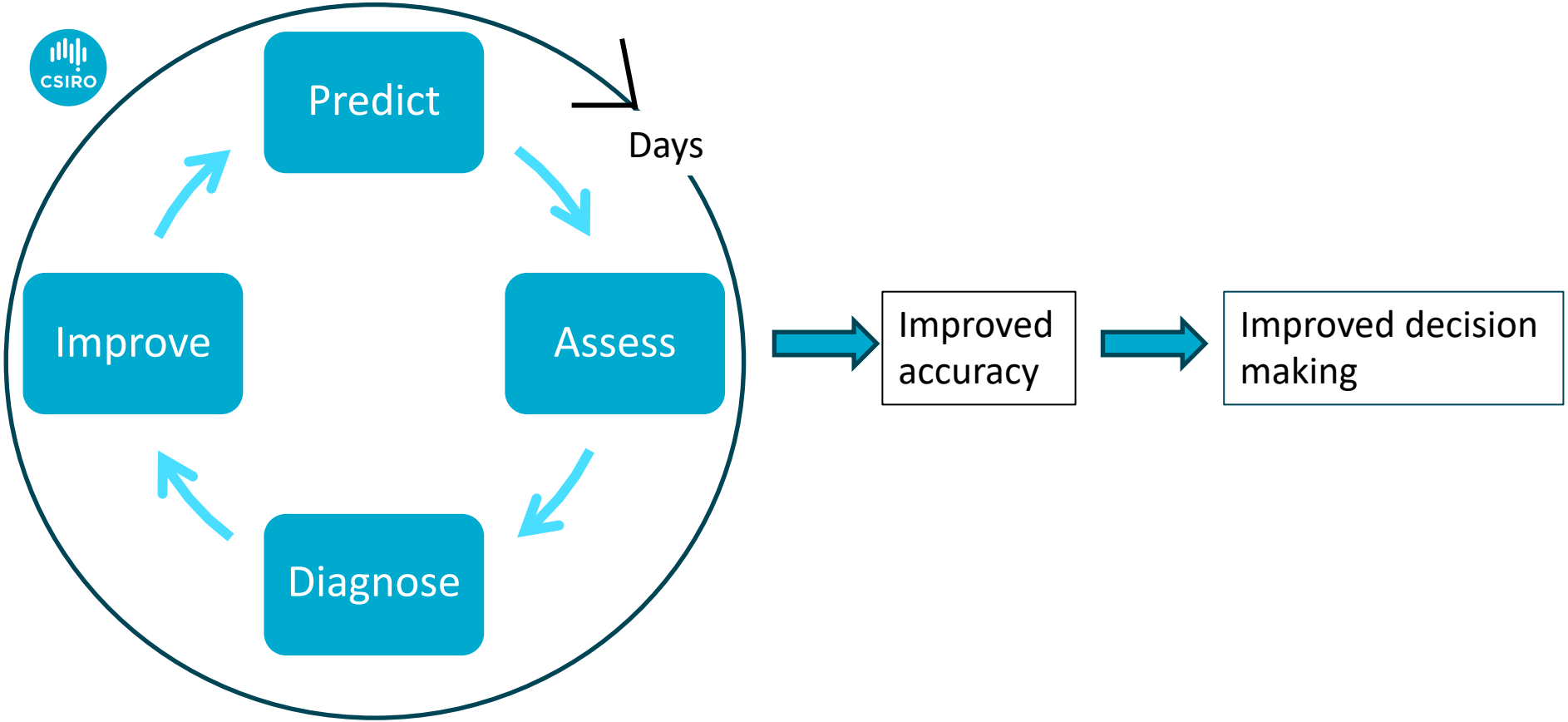
GBR30

forced with SCHISM-WWMIII

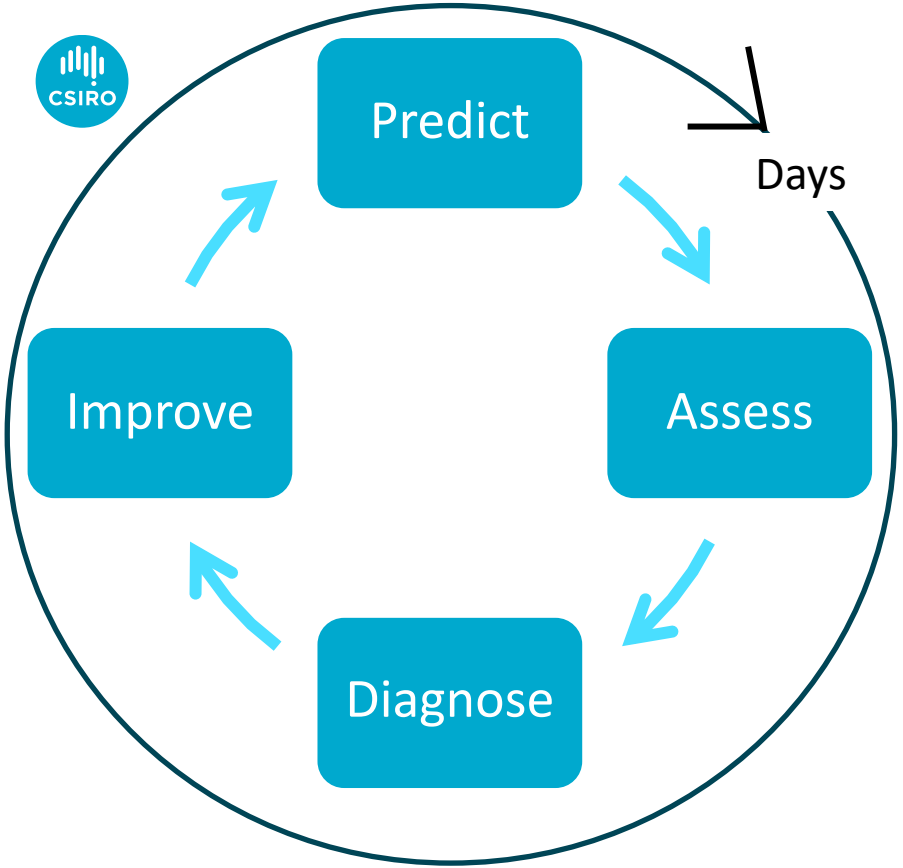


forced with global model data





Iterative cycle had rapid turnaround of days;
demonstrated under pressure during TS2023



Improved accuracy

Improved decision making

Iterative cycle had rapid turnaround of days; demonstrated under pressure during TS2023

Facilitated by close relationship between end user and developers

Rapid pathway to operations

Thank you

Environment
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