The Rolling Review of Requirements applied to Marine Heatwaves

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WMO Rolling Review of Requirements

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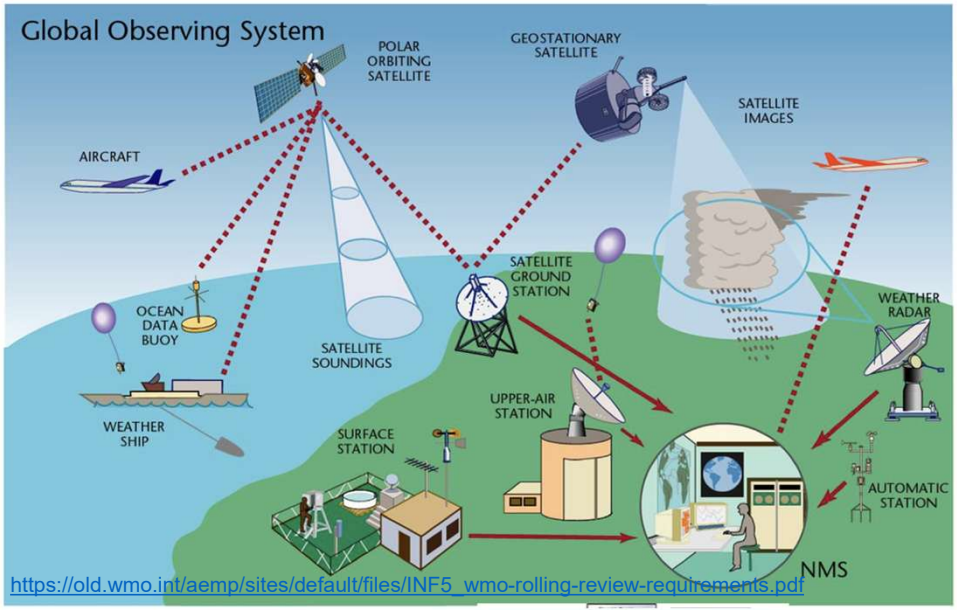
- Support the high-level **design and evolution** of WMO Integrated Global Observing System (WIGOS).
- Compiles information about technology-free **requirements** for observations and observing system **capabilities.**
- Draws on experts and impact studies -> identify **priorities for addressing the gaps between requirements and capabilities.**



OSCAR — Observing Systems Capability Analysis and Review Tool

*Our **objective** is to **apply** the **RRR** framework to new climate sub-application areas, including **marine heatwaves***

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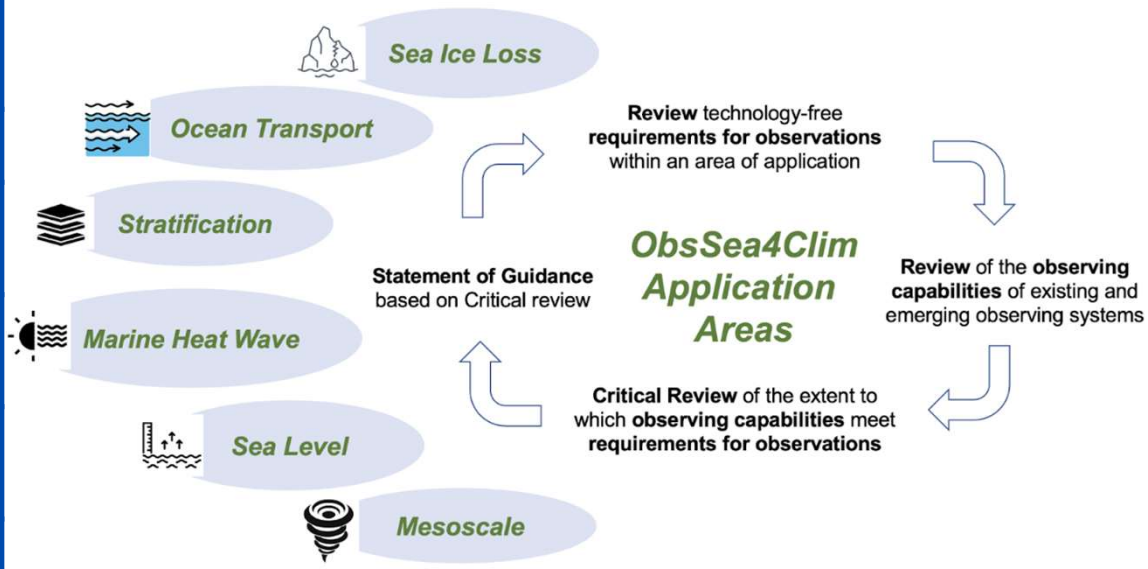
RRR: proposed sub-application areas

Earth System Application Category
1. Space Weather
2. Atmospheric
3. Oceanic
4. Hydrological and Terrestrial
5. Cryospheric
6. Integrated Earth System

Application Areas
3.1 Ocean Forecasting and Real-Time Monitoring
3.2 Coastal Forecasting
3.3 Oceanic Climate Monitoring and Services
3.4 Tsunami Monitoring and Detection
3.5 Marine Environmental Emergency Response
3.6 Maritime Safety (ports to open ocean)



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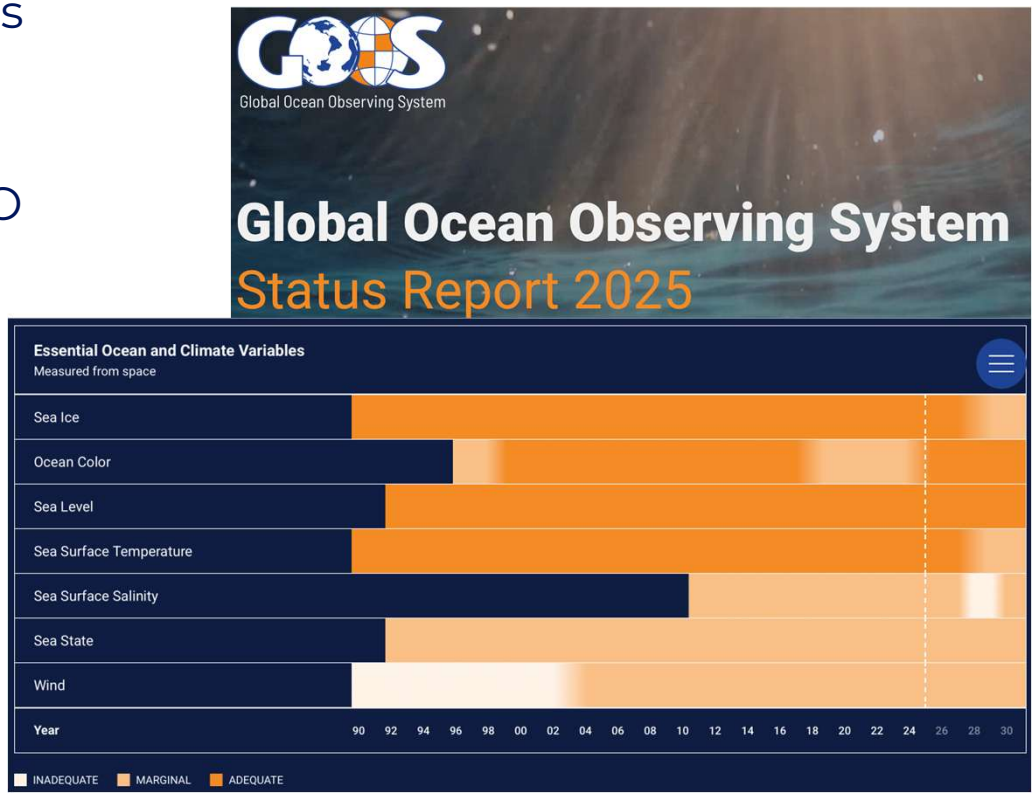
Role of the RRR

- Perform a gap analysis: recommendations on how to address the gaps, and observations impact studies.
- Provide resource materials useful to WMO Members for dialogue with the agents responsible of implementing observing systems.

BAMS Article

Effects of the Pandemic on Observing the Global Ocean

Tim Boyer, Huai-Min Zhang, Kevin O'Brien, James Reagan, Stephen Diggs, Eric Freeman, Hernan Garcia, Emma Heslop, Patrick Hogan, Boyin Huang, Li-Qing Jiang, Alex Kozyr, Chunying Liu, Ricardo Locarnini, Alexey V. Mishonov, Christopher Paver, Zhankun Wang, Melissa Zweng, Simone Alin, Leticia Barbero, John A. Barth, Mathieu Belbeoch, Just Cebrian, Kenneth J. Connell, Rebecca Cowley, Dmitry Dukhovskoy, Nancy R. Galbraith, Gustavo Goni, Fred Katz, Martin Kramp, Arun Kumar, David M. Legler, Rick Lumpkin, Clive R. McMahon, Denis Pierrot, Albert J. Plueddemann, Emily A. Smith, Adrienne Sutton, Victor Turpin, Long Jiang, V. Suneel, Rik Wanninkhof, Robert A. Weller, and Annie P. S. Wong



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Marine Heatwaves

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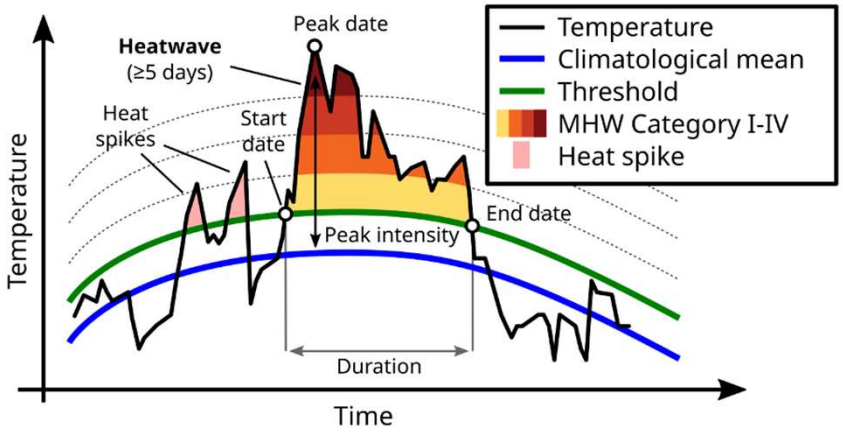
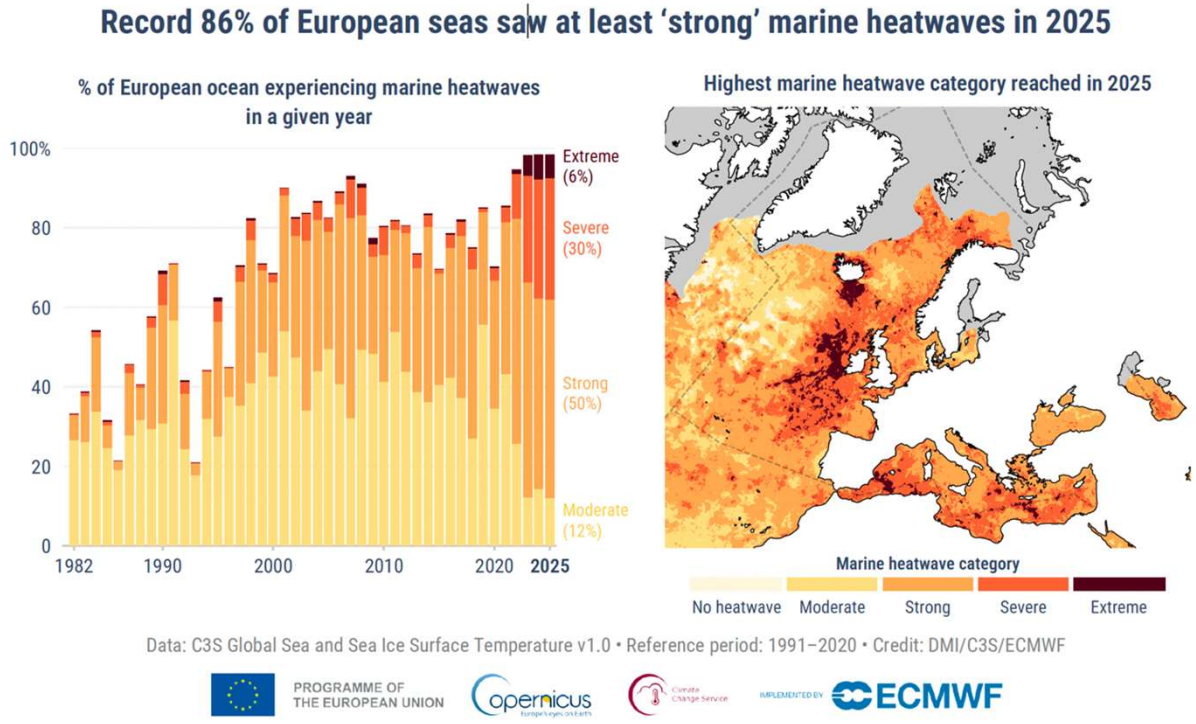


Persistent and extreme temperature conditions



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Our Framework

1. Ocean Climate Sub-Application Area description and relevance for society
2. Observing Approaches
   - Remote Sensing, In-situ & Reanalysis
3. Nations Interest in observing Marine Heatwaves
   - Case Studies - Observing Capabilities & Requirements
4. Communality and Best Practices

Tools for implementing RRR: Requirements Questionnaire (see talk by A. Onida, ENS)

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Key Applications & Services

Application Area	Key Applications & Services
3.3 Oceanic Climate Monitoring and Services	• Detection, modelling and assessment of climate change and its impact • Supporting adaptation to climate change • Monitoring the effectiveness of policies for mitigating climate change • Development of climate change information services
Marine Heatwaves	• Aquaculture & Fisheries • Marine Ecosystem Management • Carbon Uptake • Understanding climate variability • Tourism • Human Health

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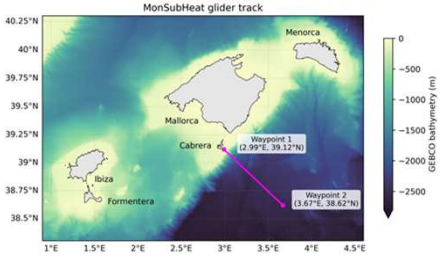
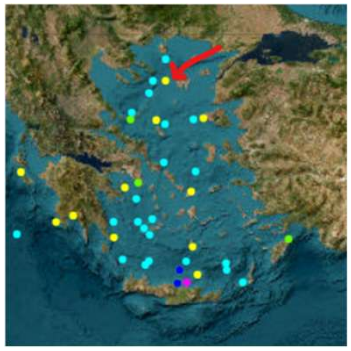
Relevant Observing Approaches

- Remote Sensing: widely-available and widely-used; focus on surface events until recent years; diversity of products (OISST, OSTIA, regional products etc)
- In-situ: Direct role and In-direct role (through reanalysis). Moorings for long-term climatology, fixed location and several depths. Gliders deployed given prior warning of event. ARGO for subsurface but difficult to use directly for short-term extremes.
- Reanalysis: widely relied upon for subsurface and bottom MHWs. Studying drivers (eddies, currents). Essential tool, quality dependent on data availability





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Observational Requirements

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Requirements for 3.3 Ocean Climate and Monitoring Services

This tables shows all related requirements. For more operations/filtering, please consult the full list of Requirements
Note: In reading the values, goal is marked blue, breakthrough green, threshold orange
Application-dependent Technical Priority (ATP) Magenta and Relative priority of the attributes Red

Id	Variable	Layer	App Area	ATP	Uncertainty	Layer/s Quality	Coverage Quality	Stability / decade	Hor Res	Ver Res	Obs Cyc	Timeliness	Coverage	Conf Level	Val Date	Source	General Comment
1023	Sea surface temperature	Sea surface Bulk	3.3 Oceanic Climate Monitoring and Services	0.5	0.05 K 0.3 K			0.01 K 0.1 K	5 km 100 km			3 h 24 h	Global	reasonable	2023-08-17	GCOS-245: The 2022 ECVs	Requirements for uncertainty are specified at
1025	Ocean temperature	Upper oc	3.3 Oceanic Climate Monitoring and Services	0.5	0.01 K 0.1 K				10 km 300 km	1 m 2 m 10 m 0.5	2 3						
1026	Ocean temperature	Deep oc	3.3 Oceanic Climate Monitoring and Services	0.5	0.001 K 0.01 K				100 km 250 km 500 km 0.5	1 m 2 m 10 m 0.5	2 3						

How would this differ for Marine Heatwaves?

- **Do we need sub-daily data?**
- **Higher resolution for local impacts compared to climate assessment?**

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Case Studies from the Mediterranean Sea

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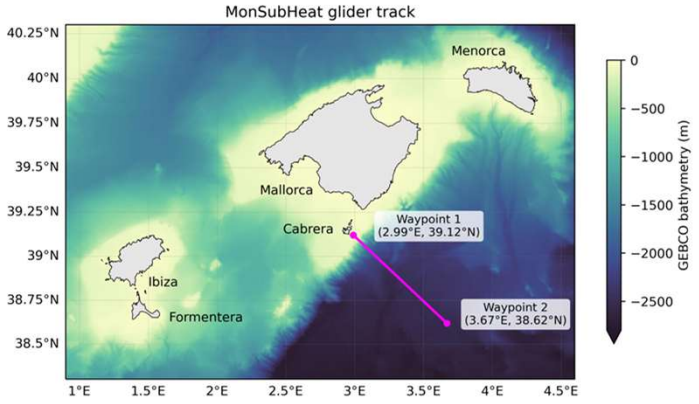
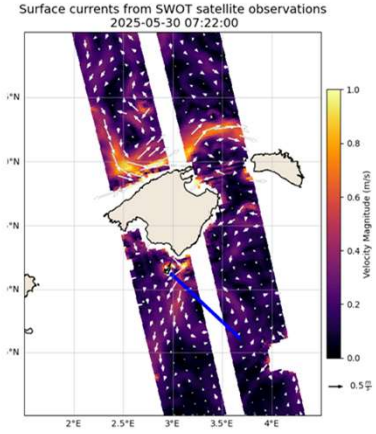
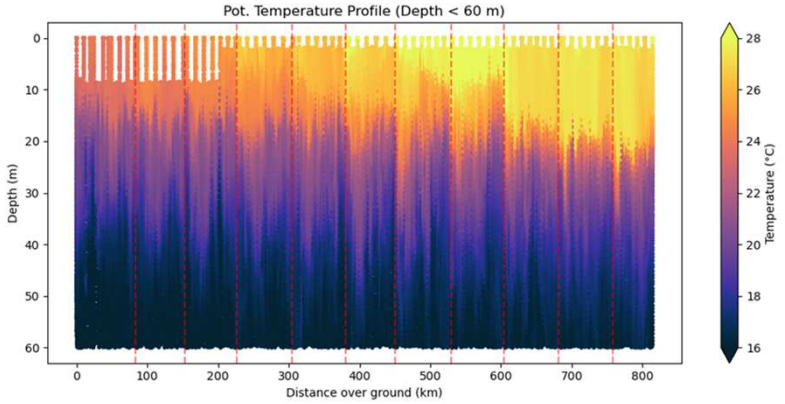
Balearic Islands, Spain
IMEDEA-UIB CSIC (Combes, V., Fernandez, B. , Barceló-Llull, B.)

- Gliders:
  + Ideal for cross-shelf measurements, easy to deploy, detailed view of upper-ocean MHW structure
  - Provide only snapshots of events, used with surface monitoring or forecasts
- In this project: studying open-ocean to coastal transition of MHWs







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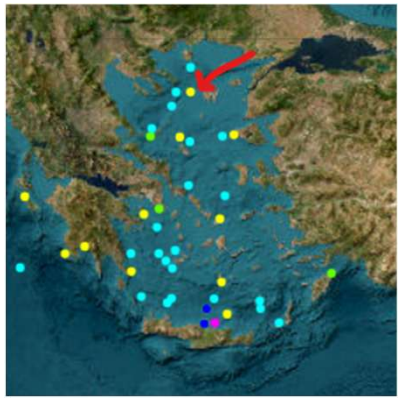
Case Studies from the Mediterranean Sea

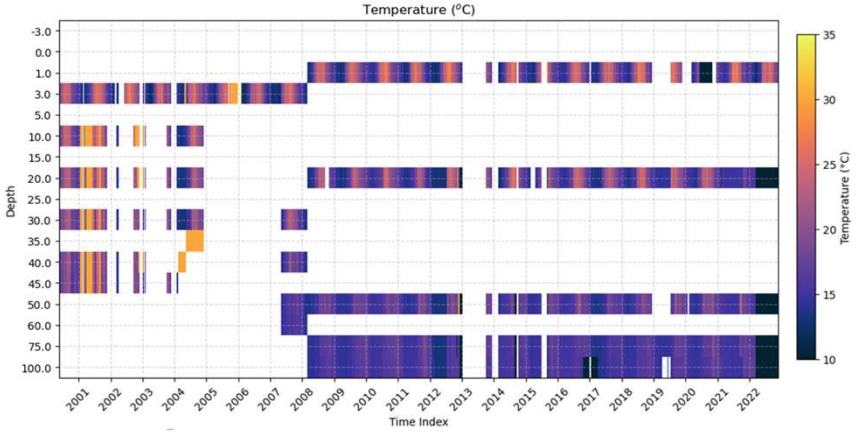
Aegean Sea, Greece (HCMR, Denaxa, D.; CMCC, McAdam, R.)

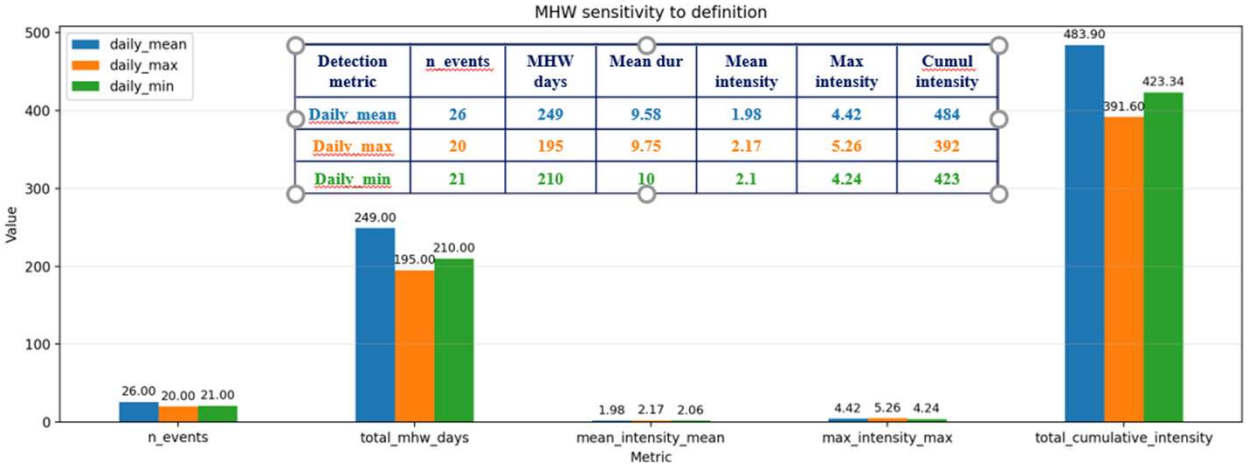
Moorings:

+ Allows definition of baseline and define “extremes”
- Gaps, sparse horizontal coverage

In this project: assess the added-value of diurnal measurements to (1) diagnose daily mean and (2) explore nighttime extremes.







Detection metric	n_events	MHW days	Mean dur	Mean intensity	Max intensity	Cumul intensity
Daily_mean	26	249	9.58	1.98	4.42	484
Daily_max	20	195	9.75	2.17	5.26	392
Daily_min	21	210	10	2.1	4.24	423

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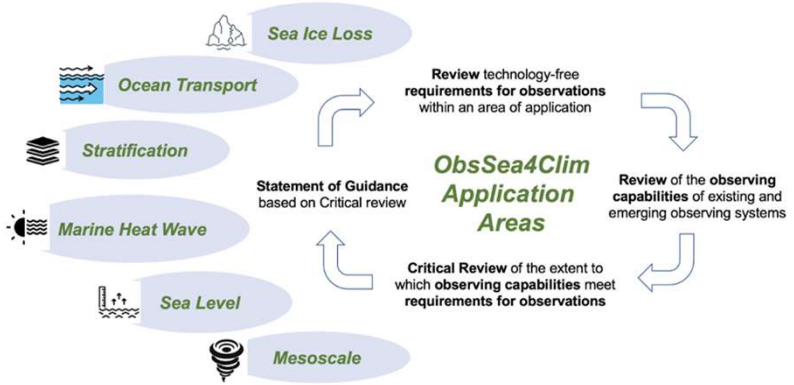
Summary So Far

- We have begun applying the RRR process to Marine Heatwaves, exploring requirements and current capacity of the observing system.
- The maturity of Ocean Application Area is low compared to other AAs e.g. Weather & Forecasting
- The RRR is an ongoing process - relies on continued feedback, and new applications and services.



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Abundance and diversity of products for **surface** MHWs is crucial for identifying the role of (atmospheric) drivers of MHWs and for validating forecasting systems.

Characterisation of subsurface MHWs depends heavily on reanalysis. Suitable in-situ data (e.g. long-term fixed moorings with several depth levels) are rare.

Sub-daily temperature observations are rarely considered but may be relevant; impact studies are necessary.