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Quantifying the effects of observational time resolution on marine heatwave detection

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Abstract. Marine heatwaves (MHWs) are increasingly recognized for their significant impacts on coastal marine ecosystems. Following a proposal by Hobday et al. (2016) MHW are often defined as an event when the sea surface temperature (SST) is larger than the 90th percentile of the local climatology, during at least 5 consecutive days. The definition of MHWs presents a methodological challenge: at high temporal resolution, short-term excursions below the 90th percentile threshold can interrupt the continuity of an event and thus invalidate it as a MHW. In contrast, when the data are averaged over longer timescales (e.g., 10 hours), such fluctuations are smoothed out, potentially allowing the same event to meet the MHW criteria. A relaxed version (allowing 2-day gap) of the definition consists in discarding short-time interruptions. We tested the influence of temporal resolution by calculating the number of marine heatwaves detected in 6 coastal stations situated along the French coast, across different temporal aggregations, from raw (e.g., 20-minute) resolution to daily averages. Because short-timescale variability generates numerous brief threshold exceedances, finer resolutions yield more frequent but shorter events, whereas coarser resolutions reduce frequency, maximum intensity and inflate duration. Using these coastal stations, we show that marine heatwave (MHW) metrics are systematically sensitive to changes in temporal resolution and event-detection criteria, with strict and relaxed definitions converging—and in some cases crossing—as data are aggregated to coarser timescales. Overall, the resolution-dependence of MHW metrics is systematic across sites, underscoring the need to consider the time scale when estimating and comparing MHWs.

1 Introduction

Marine environments display pronounced thermal variability over a broad range of spatial and temporal scales. Beyond the seasonal cycle, episodic extreme warming events can occur and persist for days to months. These events, referred to as marine heatwaves (MHWs), have attracted growing scientific attention because of their significant ecological and biogeochemical impacts. Episodes of warming that deviate significantly from the seasonal average have been documented in several regions, such as the 2002 Great Barrier Reef event (Berkelmans et al., 2004) or the 2003 Mediterranean event (Garrabou et al., 2009). Anomalous warming can lead to dramatic impacts on marine ecosystems (e.g., coral bleaching in Great Barrier Reef; Huang et al., 2024). Such warming can also contribute to seawater deoxygenation and reduce the extent of viable ocean habitat (Mongwe et al., 2024). Marine heatwaves have become an increasingly prominent topic in both the scientific literature and public discourse, reflecting their accelerating frequency (Fernández-Álvarez et al., 2025; Mohamed et al., 2025; Oliver et al., 2018), severity (Oliver et al., 2019), and ecological impacts (Jacox et al., 2020; Smale et al., 2019). The rapid growth of MHW research over the past decade has been accompanied by widespread media coverage, driven by high-profile events such as the Northeast Pacific "Blob" and recurrent extreme warming episodes in the Mediterranean and Australian waters (Oliver et al., 2021).

While the term "marine heatwave" may appear self-explanatory, a rigorous definition is necessary for its objective detection. A definition introduced approximately a decade ago is now widely used, as it incorporates both local climatological conditions and the persistence of the warming event (Hobday et al., 2016). Specifically, according to this definition, a MHW is defined as a warm event when temperatures exceed the local seasonally varying 90th percentile for at least five consecutive days, using a 30-year climatology as the baseline. Detecting MHWs requires observations, particularly local in situ measurements, corresponding to Eulerian sampling (Pearce and Feng, 2013). It needs also observations at a daily or sub-daily time scale. The question of time resolution is indeed crucial, since moored buoys around the world collect data at a wide range of sampling intervals, and at higher temporal resolution a methodological challenge arises since short-term excursions below the 90th percentile threshold can interrupt the continuity of an event and invalidate it as MHW (Hobday et al., 2016). This can affect estimates of MHW frequency, intensity, and duration. This implies that MHW detection may be sensitive to the temporal resolution of the data, thereby complicating comparisons among studies based on different sampling frequencies. To investigate this issue, we examine here how temporal resolution affects MHW metrics using several high-frequency temperature datasets collected from the three coastal regions of mainland France. Two detection approaches are considered. The first is a strict approach, in which any excursion below the 90th percentile threshold interrupts the event and invalidates its detection as a continuous MHW. The second is a more permissive approach, proposed in the original reference (Hobday et al., 2016), whereby excursions below the threshold lasting less than two days do not terminate the event.

The next section describes the datasets used in this study. We then present the methodology, including both MHW detection approaches. The results are subsequently presented and discussed, followed by concluding remarks.

2 Data

Subsurface temperature observations were obtained from the French national coastal monitoring network COAST-HF (https://coast-hf.fr/), which provides high-frequency measurements of temperature, salinity, fluorescence, turbidity at sub-hourly time scale, on 14 fixed positions buoys located on the French coast. Depending on the position, these systems provide measurements over a duration of 7 to 22 years. They

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are therefore suitable for constructing climatologies and characterizing MHW properties (Simon et al., 2023). In this study, we used data from six COAST-HF buoys distributed across three major oceanographic regions: CARNOT and SMILE in the eastern English Channel, Iroise and MOLIT along the eastern Atlantic coast, and EOL and MesuRho in the northern Mediterranean Sea (Fig. 1). These stations are exposed to a wide range of meteorological and oceanographic forcing, including extratropical storms, flash-flood events, mistral winds, droughts, and atmospheric heatwaves, all of which contribute to strong short-term variability in coastal waters. Each buoy is equipped with high-performance sensors and real-time data transmission systems, enabling the acquisition of high-frequency measurements of seawater properties. The collected datasets are all freely available online. We briefly present below each sampling station.

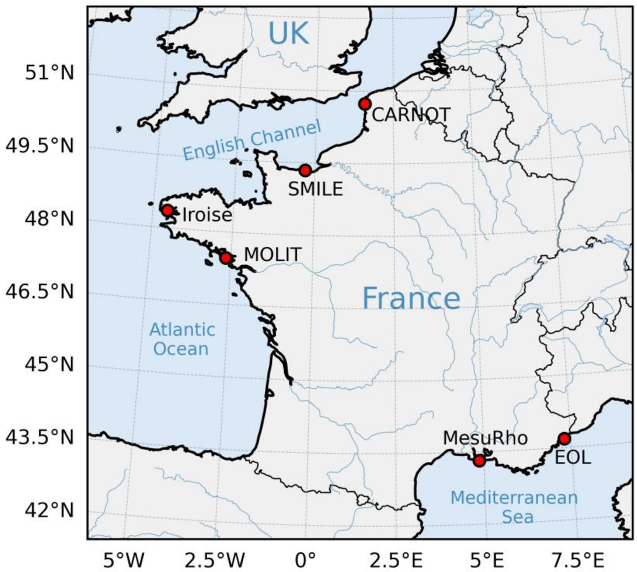

Figure 1. Location of the six stations considered here: two on the English Channel (CARNOT and SMILE), two in the Atlantic coast (Iroise and MOLIT) and two in the Mediterranean Sea (MesuRho and EOL).

In 2004, the MAREL (Mesures Automatisées en Réseau pour l'Environnement Littoral) Carnot monitoring station was installed in the French part (0.7405° N, 1.5677° E) of the eastern English Channel (Halawi Ghosn et al., 2023) (Fig. 1), near the exit of the port of Boulogne-sur-Mer (France). The eastern English Channel is a shallow coastal sea where water depths generally remain below 50 m, averaging about 45 m between Calais and Dover. The area experiences macro- to mega-tidal conditions, with tidal ranges frequently exceeding 8 m. It also receives significant nutrient inputs from several estuaries along the Picardy and Opale coasts, particularly the Seine, Somme, Authie, Canche, Liane, Wimereux, and Slack rivers. The MAREL system records environmental variables at a high-frequency resolution of 20 min. Measurements are taken at 1.5 m below the surface. From 2004 to 2014, measurements were made using a Pt100 sensor, and from 2014 onward they have been obtained using an NKE MP6 sensor. The dataset for the period 2004–2025 is available online (MAREL Carnot, 2026).

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The SMILE (System of Measurement Integrated for Littoral and Environment) buoy has been operating in the Bay of Seine since 2016 as part of the COAST-HF network (Fig. 1). It is a moored platform located in the Bay of Seine (49.3538° N, 0.3281° W) and is equipped with physio-chemical and biological sensors operating continuously and autonomously. Environmental data were measured using a multiparameter NKE probe (MP7, NKE Instrumentation®). Temperature and other environmental variables are recorded at a depth of 3 m. The system is positioned 2 nautical miles north of Luc-sur-Mer (Basse-Normandie, central English Channel) and is influenced by both marine coastal waters and freshwater inputs. The dataset is available online over the period 2016 to 2026 (Claquin et al., 2018).

The MAREL Iroise station is an automated moored buoy located at 48.357° N, 4.582° W in the Bay of Brest (Fig. 1), positioned at the interface between the Bay of Brest and the Atlantic Ocean (Iroise Sea), where fresh and marine waters mix. Subsurface temperature measurements are taken at a depth of 3 m at 20 minutes resolution. The depth of the mooring site ranges from 5 to 12 m, depending on the tide (Blain et al., 2004). The dataset is available online for the period 2000–2021, with a sampling frequency of 20 minutes (Rimmelin-Maury et al., 2025).

The MOLIT (Mer Ouverte LITorale) measuring station is a moored buoy equipped with biological and physico-chemical sensors operating in continuous and autonomous conditions, located south of Brittany in the Vilaine Bay (Fig. 1). The station is positioned at 47.434° N, 2.660° W, and the temperature dataset taken at depths of 1 m and 3 m are available for the period 2008–2026, with a sampling frequency of 60 minutes (Retho et al., 2024).

The MesuRho station is a submerged buoy in the delta of the Rhône River (Fig. 1) (43.32° N, 4.87° E; depth: 20 m) which is operational since June 2009. This station is configured to collect physicochemical data in near-real time and at high frequency (30 min) in the freshwater–saltwater transition zone. Temperature and salinity are measured by a multiparameter Smatch NKE probe at a depth of 2.5 m. The data are available online from 2009 to 2021 (Pairaud et al., 2023).

The EOL (Environmental Observation of the Littoral) buoy is located in the Bay of Villefranche-sur-Mer (NW Mediterranean, France, 43.68167° N, 7.31967° E, Fig. 1) over a water depth of approximately 90–100 m. It has been operated since 2013 and records environmental variables at a resolution of 30 minutes, at a depth of 2.5 m. Temperature, oxygen, and salinity are measured using a Sea-Bird CTD (SBE37 SMP-ODO). Data from 2018 to 2024 are available online (Alliouane et al., 2026).

3 Methods

In this section we present the method which is used to detect MHW at different resolutions. First the climatology is determined, using a smoothing. Then two different algorithms for MHW detection are applied, with a change in time resolution from the smallest resolution (20, 30 or 60 minutes depending on the series) to 24 hours.

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3.1 Baseline climatology and thresholds

Marine heatwave (MHW) detection was performed following the algorithm proposed in Hobday et al. (2016), using a seasonally varying baseline derived from long-term temperature records. The time series analysed in this study range from 7 to 22 years in length, shorter than the 30-year climatological baseline proposed by Hobday et al. (2016). Nevertheless, the aim of this work is primarily methodological. Given the duration of the records, the climatologies obtained are expected to closely approximate the corresponding 30-year climatologies (Schlegel et al., 2019), such that the main conclusions regarding the influence of temporal resolution on marine heatwave metrics remain unaffected. For each day of the year, two climatological statistics were computed: the daily mean climatology T_{clim} and the 90th percentile threshold T_{90}. These statistics were calculated from the full historical time series and represent the expected seasonal cycle and the corresponding extreme warm conditions. Temperature observations within the baseline were grouped by day of year (DOY), and for each DOY d, the climatological mean temperature $T_{clim(}$d) and the 90th percentile threshold T_{90}(d) were computed across all baseline years. Because the climatological statistics are computed on a daily basis, a smoothing procedure is applied to obtain a continuous high-frequency climatology and to avoid the step-like artifacts that would otherwise become apparent at shorter timescales. Both T_{clim}(d) and T_{90}(d) were smoothed using a Gaussian kernel, applied as a weighted convolution,

$$X(d) = \sum_{k=-K}^{K} X(d+k)w(k), \quad (1)$$

where X(d) represents either T_{clim}(d) or T_{90}(d), and the Gaussian weights *w(k)* are defined as

$$w(k) = \frac{1}{\sqrt{2\pi}\sigma} exp\left(-\frac{k^2}{2\sigma^2}\right), \quad (2)$$

with σ = 3 days denoting the smoothing bandwidth. The kernel was truncated at *K* = *9* days, thereby retaining more than 99% of the cumulative kernel weight.

3.2 Temperature data and temporal resolutions

High-frequency in situ temperature measurements were obtained from coastal monitoring stations. To assess the sensitivity of MHW detection to sampling frequency, the raw temperature series were resampled to multiple temporal resolutions ranging from the fine resolution (20, 30 or 60 minutes depending on the series) to 24 hours. This allowed a systematic evaluation of how temporal averaging affects the identification of warm anomalies and event structure.

3.3 Definition MHW: Strict MHW detection vs relaxed MHW detection

For each temporal resolution, MHWs were detected by comparing the observed temperature T(time) to the smoothed climatological threshold:

$$T(time) > T_{90}(d), \quad (3)$$

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A period was classified as a marine heatwave when temperatures exceeded the threshold for at least five consecutive days, consistent with the standard MHW definition.

Two versions of the detection algorithm were applied to assess event continuity and sensitivity to data gaps (Fig. 2). In the strict detection approach, no gaps were allowed, and a single measurement below the threshold immediately terminated the event. In contrast, the relaxed detection approach permitted short interruptions of up to two consecutive days below the threshold, thereby reconnecting fragmented warm periods that are likely part of the same physical event. Both strict and relaxed detection methods were applied to temperature series in order to quantify how gap-filling interacts with temporal resolution and influences MHW metrics as defined below.

3.4 MHW metric estimation

Marine heatwave characteristics were quantified using standard event-level metrics. Duration was defined as the number of consecutive time steps during which SST remained above the MHW threshold. Mean intensity was calculated as the average temperature anomaly above the threshold across all time steps of the event, providing a measure of its typical strength. Maximum intensity corresponded to the highest anomaly reached during the event and represents its peak severity. These metrics were derived directly from the SST time series at each sampling interval to ensure consistency with the temporal resolution of the measurements.

4 Results and discussion

4.1 Example using the MAREL Carnot station

In this study, we used raw data and generated timestamps at multiple temporal resolutions, ranging from the native sampling frequency to daily means, by aggregating the raw time series. Figure 2 a–d presents the results for the MAREL Carnot station for the year 2022, using a 21-year baseline. The choice of temporal resolution (20 min vs. 24 h) influenced the number of MHWs detected, as well as their intensity and category (Fig. 2). Under the strict criteria, the 20-min resolution did not detect MHWs in March, June, or November. Overall, the minimum number of MHWs was detected with the 20-min strict case. At this resolution, event durations were also shorter than those identified in the 24-h strict and relaxed cases. For example, the August heatwave lasted 28.8 days in the 20-min strict case (Fig. 2a), whereas in all other cases the duration exceeded 39 days; in the 20-min relaxed case, the event extended into July and October (Fig. 2c). Mean and maximum intensities were higher in both the 20-min strict and 20-min relaxed cases. This is reflected in the July MHW, which was classified as a strong event at 20-min resolution (Fig. 2a, c), while the same event was categorized as moderate at 24-h resolution (Fig. 2b, d). Additionally, an extra MHW was detected at the end of November in the 20-min relaxed case (Fig. 2c),

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which was absent in all other cases. In next subsection we give the systematic analysis of scale dependence of MHW detection on all sites.

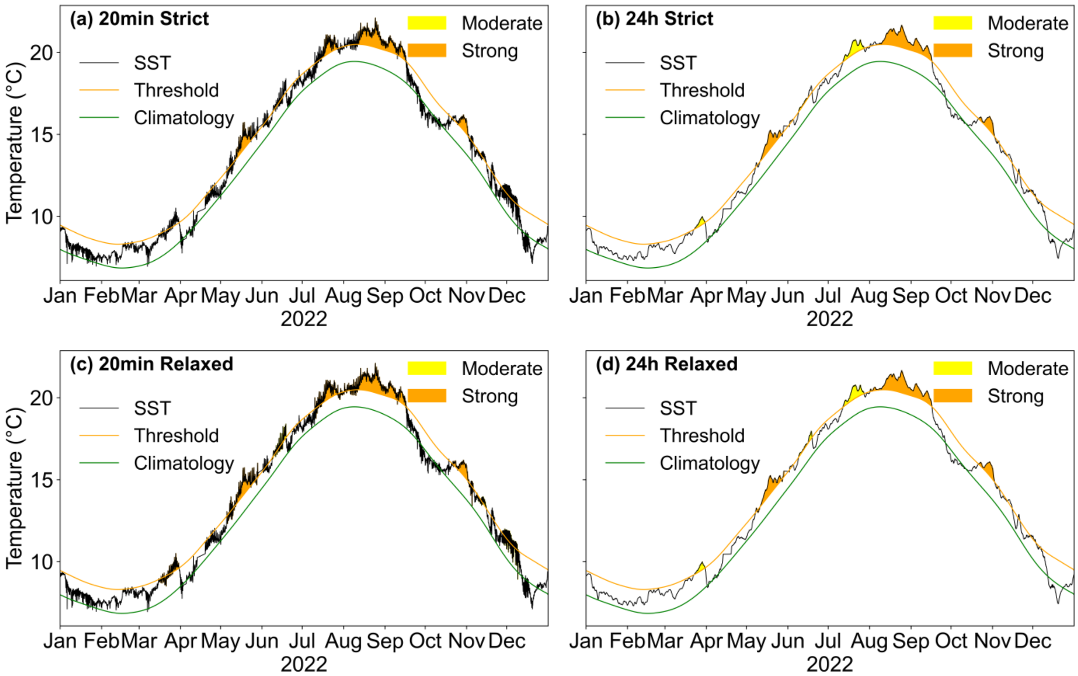

Figure 2. Comparison of marine heatwave (MHW) detection at the COAST-HF station MAREL Carnot in 2022 under different temporal resolutions and continuity criteria. The orange line represents the seasonally varying percentile threshold, and the green line shows the temperature climatology. (a) Detection using 20-min SST data with a strict criterion that does not allow SST to fall below the threshold during an event. (b) Detection using daily-mean SST (24-h resolution) with the same strict criterion. (c) Detection using 20-min SST data with a relaxed criterion allowing SST to drop below the threshold for up to 2 days during an event. (d) Detection using daily-mean SST with the relaxed 2-day continuity allowance. Yellow shading indicates moderate MHW intensity, and orange shading indicates strong MHW intensity.

4.2 Effect of the temporal resolution on the number of MHW events and on their intensity

We first considered here the relaxed criteria to detect MHW. In Fig. 3a, the number of MHW detected is normalized by the number of years to obtain a mean frequency of MHW per year. This figure shows that for all the six sites considered, this frequency is scale-dependent and decreases with the time resolution of the measurements.

Normalized counts, when the frequencies depicted in Fig. 3b are divided by the frequency at a time resolution of 24 hours, quantify methodological sensitivity, highlighting how many additional short-lived detections are introduced by high-frequency sampling (Fig. 3b). For example, the MOLIT, MesuRho, and SMILE stations show a steep decline, indicating strong sensitivity to temporal aggregation (Fig. 3b). Overall, higher temporal resolution leads to a marked increase in the number of detected events: compared with a 24-hour resolution, the use of 20-minute data results in 40% to 120% more events, depending on the monitoring station, corresponding to an increase by a factor of 1.4 to 2.2.

On the other hand, the mean intensity is moderately increasing with the time resolution, suggesting that inclusion of the small events might have raised the mean intensity (Fig. 3c). Maximum MHW intensities

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tend to decrease slightly as the time resolution increases from 20 minutes to daily scales (Fig. 3d). This change is of smaller proportion and systematic, visible on all stations. This behavior arises because temporal smoothing dampens short-lived, high-amplitude SST spikes, thereby reducing instantaneous maxima (Fig. 3d), while persistent warm anomalies that largely determine mean intensity are less affected by moderate averaging (Fig. 3c). Although station-specific responses reflect these dynamics, stations characterized by frequent short-lived spikes at high temporal resolution (Fig. 3d; e.g. MOLIT and MesuRho) exhibit larger reductions in maximum intensity with decreasing time scale, whereas stations dominated by more persistent anomalies show comparatively smaller changes. At MOLIT, the mean and maximum intensities ranged from 1.58 to 1.96 °C and from 2.55 to 3.55 °C, respectively (Figs. 3c–d). Similarly, at MesuRho, the mean and maximum intensities ranged from 2.56 to 2.86 °C and from 3.40 to 3.7 °C, respectively (Figs. 3c–d). Changes in temporal resolution can influence event classification, particularly for marginal cases where events may shift from stronger to more moderate categories as the resolution becomes coarser.

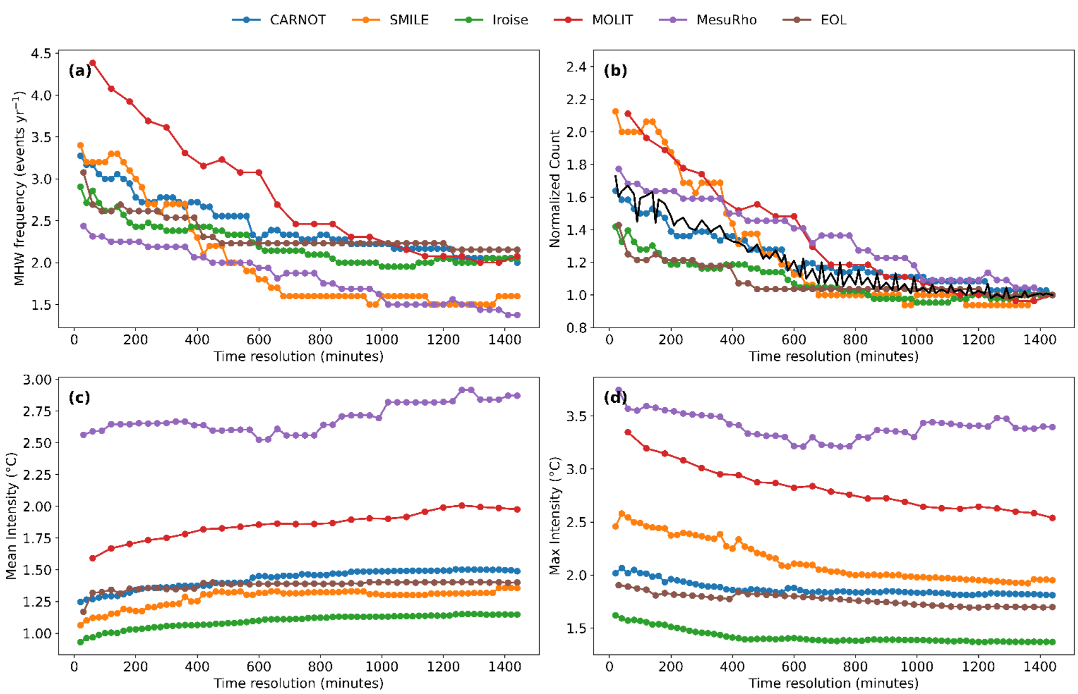

Figure 3. Marine heatwave (MHW) metrics derived from relaxed detections across six stations (CARNOT, SMILE, Iroise, MOLIT, MesuRho and EOL) as a function of the time resolution (in minutes) used to compute SST. (a) Normalised MHW frequency (events per year), based on total events scaled by baseline length. (b) Normalized total MHW counts relative to the event count obtained at the lowest time resolution (24 h). (c) Mean event intensity across time resolutions. (d) Maximum event intensity across time resolutions.

In contrast, applying the strict criterion leads to the opposite behaviour: the number of detected MHWs also strongly depends on scale resolution, and systematically increases as the temporal resolution increases (Fig. 4a). Stations with long, continuous records (CARNOT and Iroise) exhibit higher absolute

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frequencies, whereas stations with shorter records or substantial gaps (SMILE, MOLIT, MesuRho) show lower frequencies except EOL (Fig. 4a). After normalization by the daily-resolution value, the curves exhibit a broadly similar pattern across stations, except for EOL and MOLIT (Fig. 4b). Relative to daily data, the use of 20-minute observations reduces the number of detected MHWs by 30% to 60%, with an average reduction of about 41%, effectively halving the number of events.

Concerning the MHW intensity, mean and maximum intensities decrease with increasing resolution time scale (Figs. 4c–d). Mean intensities are less sensitive to the change in time scale, because persistent anomalies remain after averaging (Fig. 4c), whereas maximum intensities are more strongly affected since they are driven by instantaneous peaks (Fig. 4d). However, changes in mean intensities exhibited an opposite pattern to changes in MHW frequency. Under the relaxed criteria, MHW frequency decreased as the temporal resolution became coarser (Figs. 3a, 3c), while mean intensity increased (Figs. 4a, 4c). In contrast, under the strict criteria, MHW frequency increased with finer temporal resolution, whereas mean intensity decreased. For example, at station MOLIT under the strict criteria, the highest mean intensity was 2.58 °C at 60-minute resolution and decreased to 2.06 °C at daily resolution. Under the relaxed criteria, the mean intensity increased from 1.59 °C at 60-minute resolution to 1.98 °C at daily resolution. These results suggest that the mean intensity tends to converge toward a common value at coarser temporal resolutions.

Stations dominated by short-lived spikes, such as MesuRho and MOLIT, exhibit larger reductions in maximum intensity when smoothed. At MOLIT, the mean and maximum intensities ranged from 2.07 to 2.62 °C and from 2.55 to 4.18 °C, respectively (Figs. 4c–d). Station MOLIT is in very shallow waters (0–15 m) and due to shallow water column depth allowing a faster surface warming (Juza et al., 2022) and influenced by the Vilaine River (Poppeschi et al., 2022), leading to high mean and maximum intensity anomalies (Figs. 3c–d, 4c–d). Similarly, at MesuRho, the mean and maximum intensities ranged from 3.44 to 5.20 °C and from 3.91 to 6.22 °C, respectively (Figs. 4c–d). Station MesuRho is located within the upwelling region of the northern Mediterranean Sea, where strong atmospheric heat fluxes into the ocean (Hamdeno and Alvera-Azcaráte, 2023), together with southerly winds, can induce downwelling and promote the spread of warm water into the Gulf of Lion (Estournel et al., 2025) causing most intense anomalies (Figs. 3c–d, 4c–d).

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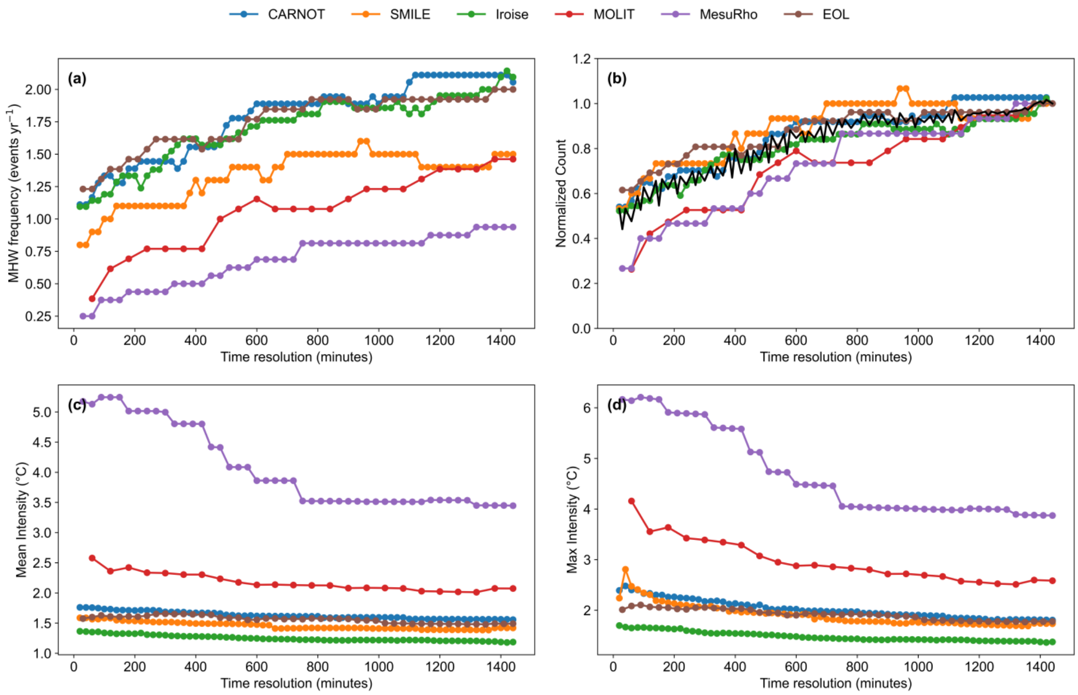

Figure 4. Marine heatwave (MHW) metrics derived from strict detections across six stations (CARNOT, SMILE, Iroise, MOLIT, MesuRho and EOL) as a function of the time resolution used to compute SST anomalies. (a) Normalised MHW frequency (events per year), based on total events scaled by baseline length. (b) Normalized total MHW counts relative to the event count obtained at the lowest time resolution (24 h). (c) Mean event intensity across time resolutions. (d) Maximum event intensity across time resolutions.

4.3 Comparison of total durations between both methods

Finally, we examine the cumulative duration of MHWs, expressed as the total number of MHW days per year, and compare the results obtained using the strict and relaxed detection methods (Fig. 5 a–d). For all stations, this metric depends on the temporal resolution of the data. Under the strict criterion, the total duration increases as the temporal resolution increases, whereas the opposite trend is observed with the relaxed criterion. At a daily resolution, however, the estimates produced by the two methods converge and yield relatively similar values.

Overall, when averaged across the six stations, the annual cumulative duration of MHWs derived from the strict criterion is 2.34 times smaller at the fine resolution (20, 30 or 60 minutes) than at daily resolution. In contrast, the relaxed criterion produces an annual cumulative duration that is 1.98 times larger at the fine resolution than at daily resolution. These findings highlight the strong dependence of MHW duration estimates on temporal resolution, irrespective of the detection method used.

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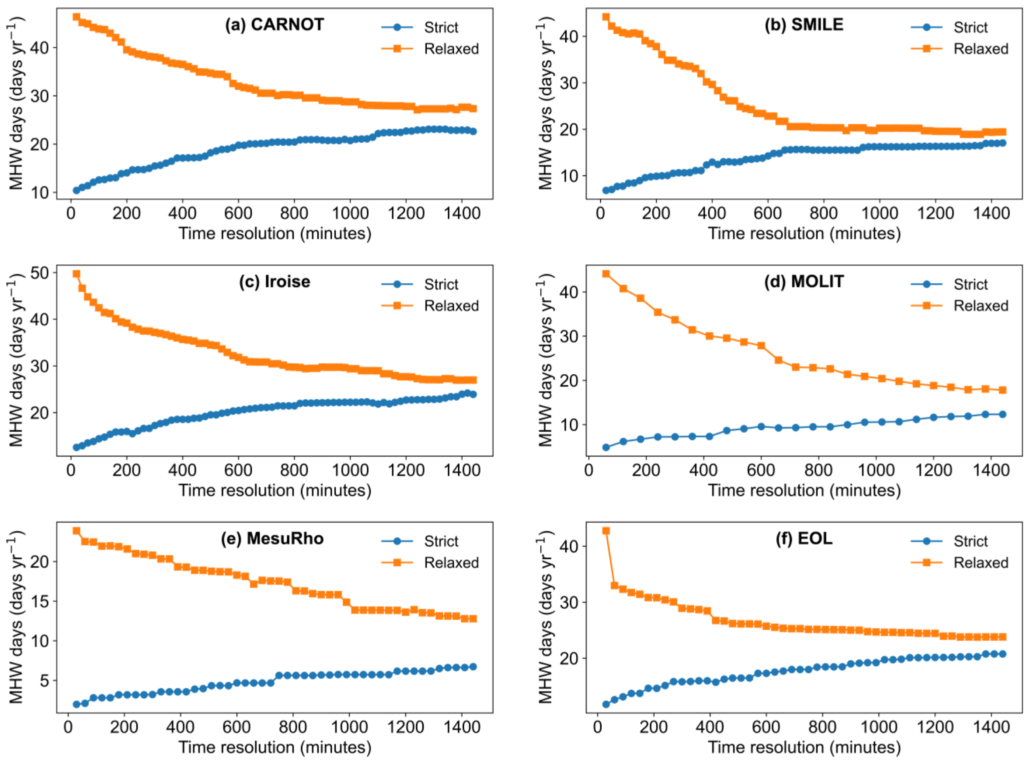

Figure 5. Normalized marine heatwave (MHW) duration for six stations as a function of time resolution, shown for both strict and relaxed detection criteria. Values represent total MHW duration normalized by the baseline year length, illustrating how temporal scale and detection rules influence accumulated event duration.

Conclusions

High-frequency observations capture small-scale variability in coastal waters (Schmitt et al., 2008; Robache et al., 2025), and such monitoring systems are increasingly being deployed worldwide to characterize coastal environmental variability. Concurrently, marine heatwaves (MHWs) have become more frequent, with sustained increases in sea surface temperature reported in a variety of regions, including the eastern English Channel and North Sea (Mohamed et al., 2025), the Mediterranean Sea (Fernández-Álvarez et al., 2025), and the open ocean (Frölicher et al., 2018). Many of these assessments rely on the detection framework proposed by Hobday et al. (2016), which is also adopted in the present study.

Across all six monitoring sites, our analysis demonstrates that temporal resolution exerts a strong control on the detection and characterization of marine heatwaves. The effect of temporal resolution on event frequency depends critically on the detection criterion employed and operates in opposite directions for the strict and relaxed approaches. Under the relaxed criterion, high-frequency SST variability is preserved at finer temporal resolutions, generating numerous short-lived exceedances of the climatological threshold and resulting in substantially larger event counts. On average, the number of detected MHWs

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is approximately twice as high at 20-minute resolution as at daily resolution. In contrast, the strict criterion yields the opposite behaviour, with roughly half as many events detected at 20-minute resolution compared with daily data.

Mean MHW intensity is also influenced by temporal resolution, although to a lesser extent than event frequency. Here again, the response differs between the two detection criteria: mean intensity increases with temporal resolution under the relaxed criterion, whereas it decreases under the strict criterion. Similarly, the cumulative annual duration of MHWs, expressed as the total number of MHW days per year, exhibits a pronounced dependence on temporal resolution. The relaxed criterion produces cumulative durations that are approximately twice as large at 20-minute resolution as at daily resolution. Conversely, under the strict criterion, cumulative durations are about 2.3 times shorter at 20-minute resolution than at daily resolution.

Our study demonstrates how changes in temporal resolution under both strict and relaxed MHW detection criteria affect MHW metrics, similarly to the changes reported when modifying thresholds (Huang et al., 2025), detrending SST and applying shifting baselines (Fernández-Álvarez et al., 2025; Smith et al., 2025). Overall, our findings demonstrate that the sensitivity of MHW metrics to temporal resolution and evolving SST variability is consistent across sites. The metric differences among stations are largely explained by record length and data completeness, as longer and more continuous records yield higher total event counts and durations (Schlegel et al., 2019).

Together, these results demonstrate that MHW metrics—frequency, duration, mean intensity, and maximum intensity—are inherently sensitive to the sampling interval of the SST record, regardless of whether strict or relaxed criteria are applied. Because temporal smoothing alters the expression of short-timescale variability, the same underlying SST dataset can yield markedly different MHW characteristics solely due to differences in measurement resolution. This creates a fundamental limitation for cross-site or cross-dataset comparisons unless the temporal resolution is explicitly reported and standardised.

Data availability

The temperature data from the MAREL CARNOT (https://doi.org/10.17882/39754, MAREL Carnot, 2026), SMILE (https://doi.org/10.17882/53689, Claquin et al., 2018), MAREL Iroise (https://doi.org/10.17882/74004, Rimmelin-Maury et al., 2025), MOLIT (https://doi.org/10.17882/46529, Retho et al., 2024), MesuRho (https://doi.org/10.17882/100304, Pairaud et al., 2023) and EOL (https://doi.org/10.17882/91965, Alliouane et al., 2026) stations are available through the SEANOE data repository.

Author contributions

This work was conceptualized by FGS, UC, and HC. HC performed the analysis and interpreted the results with input from FGS and UC. HC wrote the first draft with the help of UC and FGS. FGS and UC secured funding and supervised HC.

Competing interests

The contact author has declared that none of the authors has any competing interests.

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