

A Mesoscale Events Classifier for Sea Surface Temperature Data

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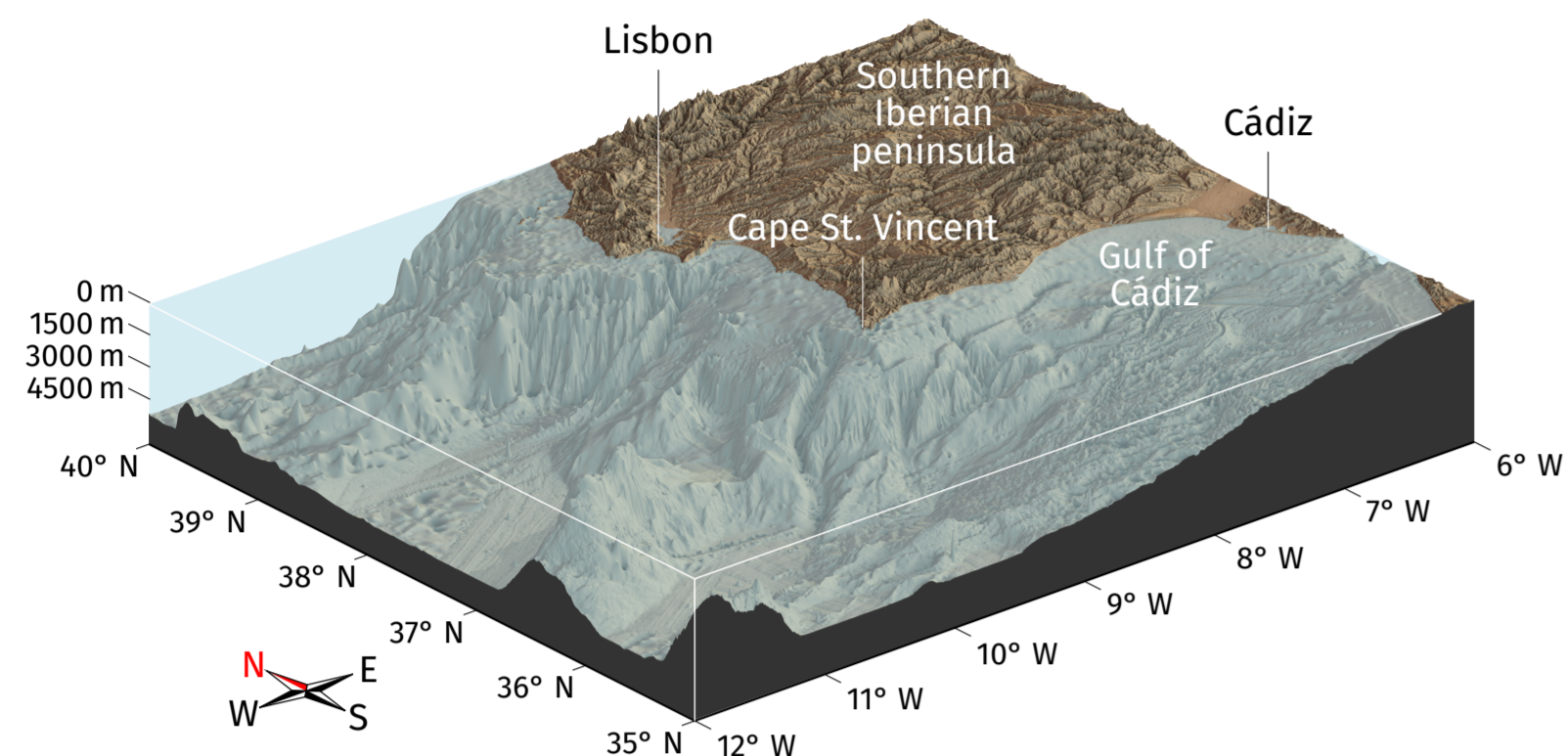
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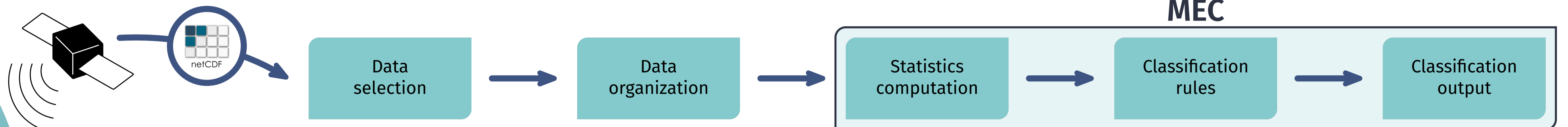
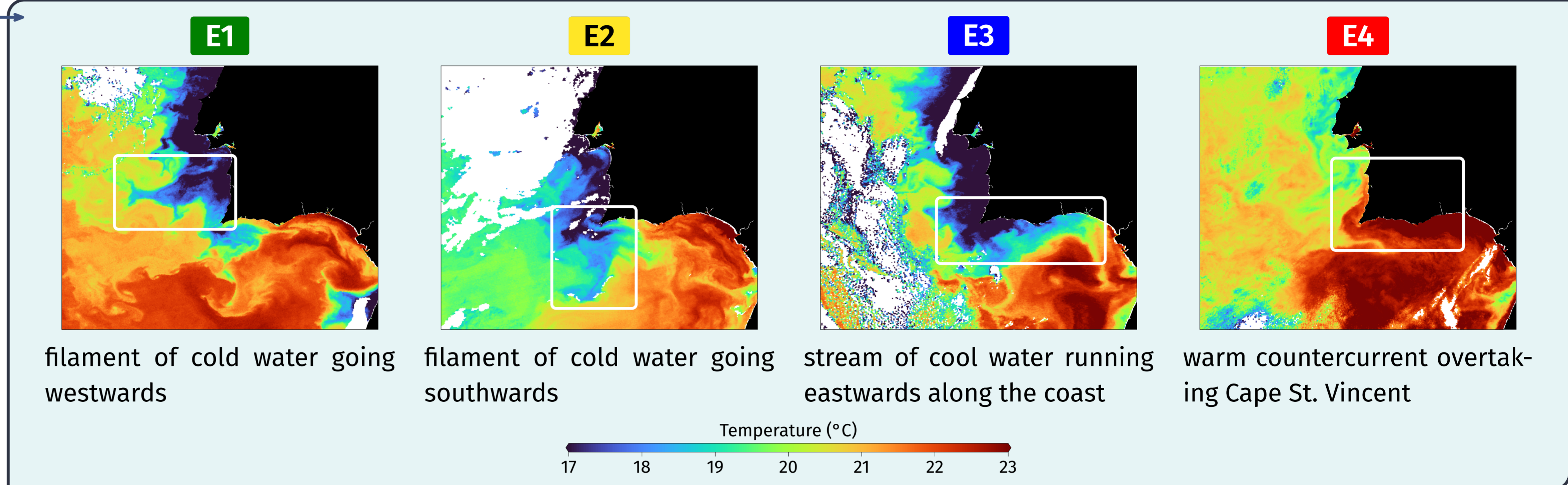
Objective

The Mesoscale Events Classifier (MEC) is a tool that has been developed to detect and classify patterns of mesoscale events in an upwelling ecosystem by analysing Sea Surface Temperature (SST) maps coming from satellite data.

As a case study, we focused on the Iberian/Canary Current System in the southwestern part of the Iberian peninsula.



Upwelling – Upward vertical transport of cold and nutrient-rich waters by a combined effect of winds and the Earth rotation.

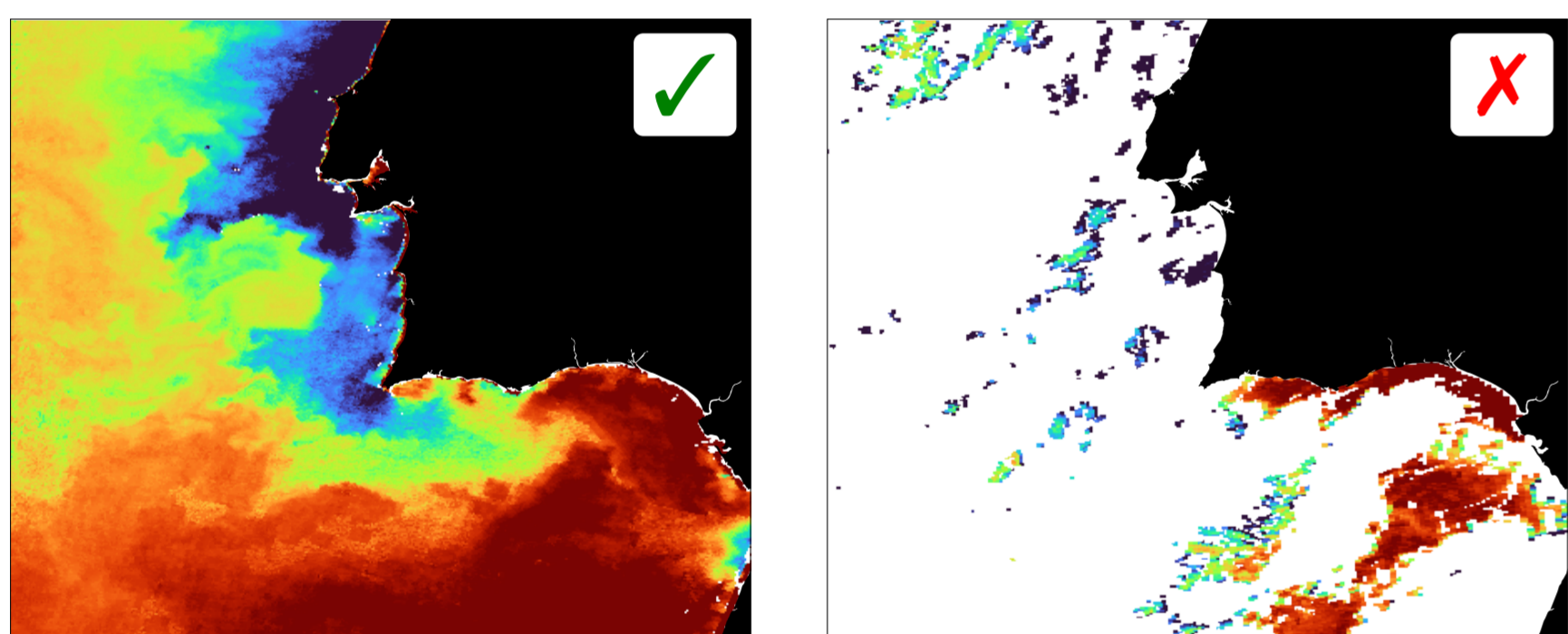


1. Data selection

Institution	Satellite	Sensor	Product DOI
EUMETSAT	Metop-A/B	AVHRR	10.15770/EUM_SAF_OSI_NRT_2013
NASA	Aqua	MODIS	10.5067/GHMDA-2PJ19

A custom script automatically discards files that contain bad quality data.

The images were tagged manually by experts with a single label E1–E4 depending on the recognised pattern. No label was assigned to an image if a pattern could not be seen clearly.

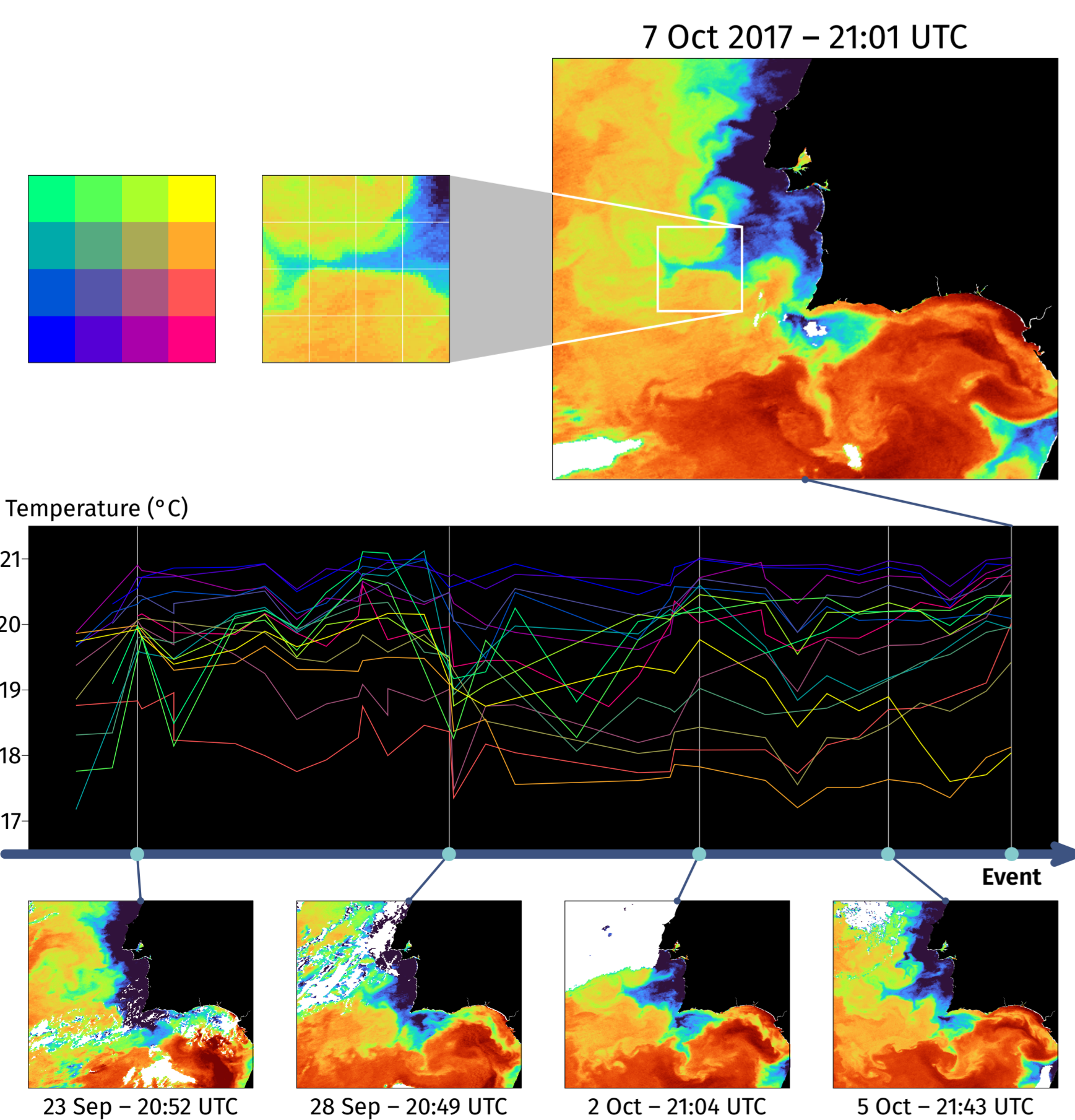


2. Data organization

1. The area of interest is divided into a grid.
2. For each timestamp t_i and each square s , let SST_i be the spatial average of the SST in s at time t_i .
3. For each square s , a time series for the SST is obtained:

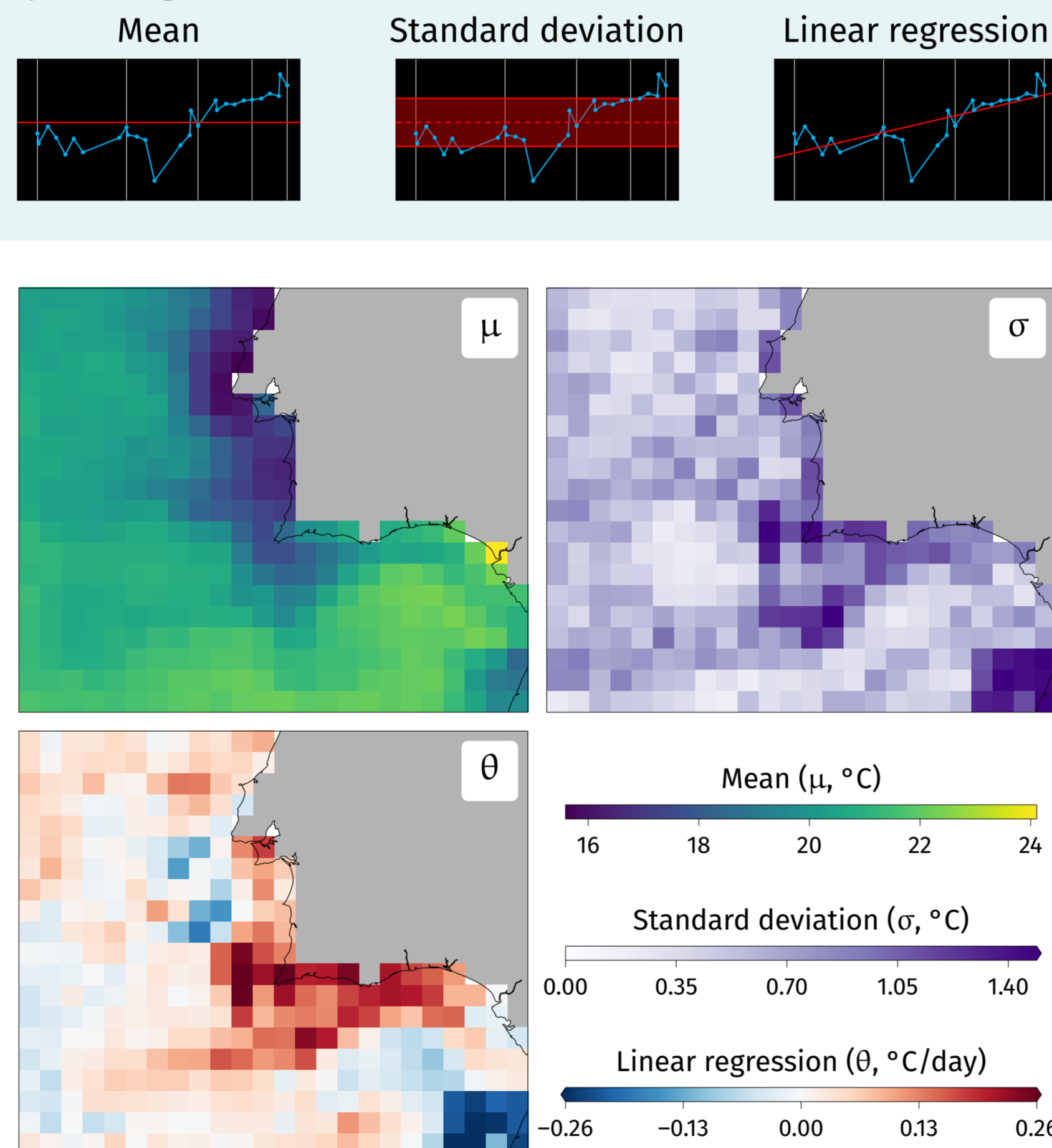
$$p(s) = \{(t_1, SST_1), \dots, (t_n, SST_n)\}.$$

Notice that the number n of pairs in $p(s)$ also depends on the square s .



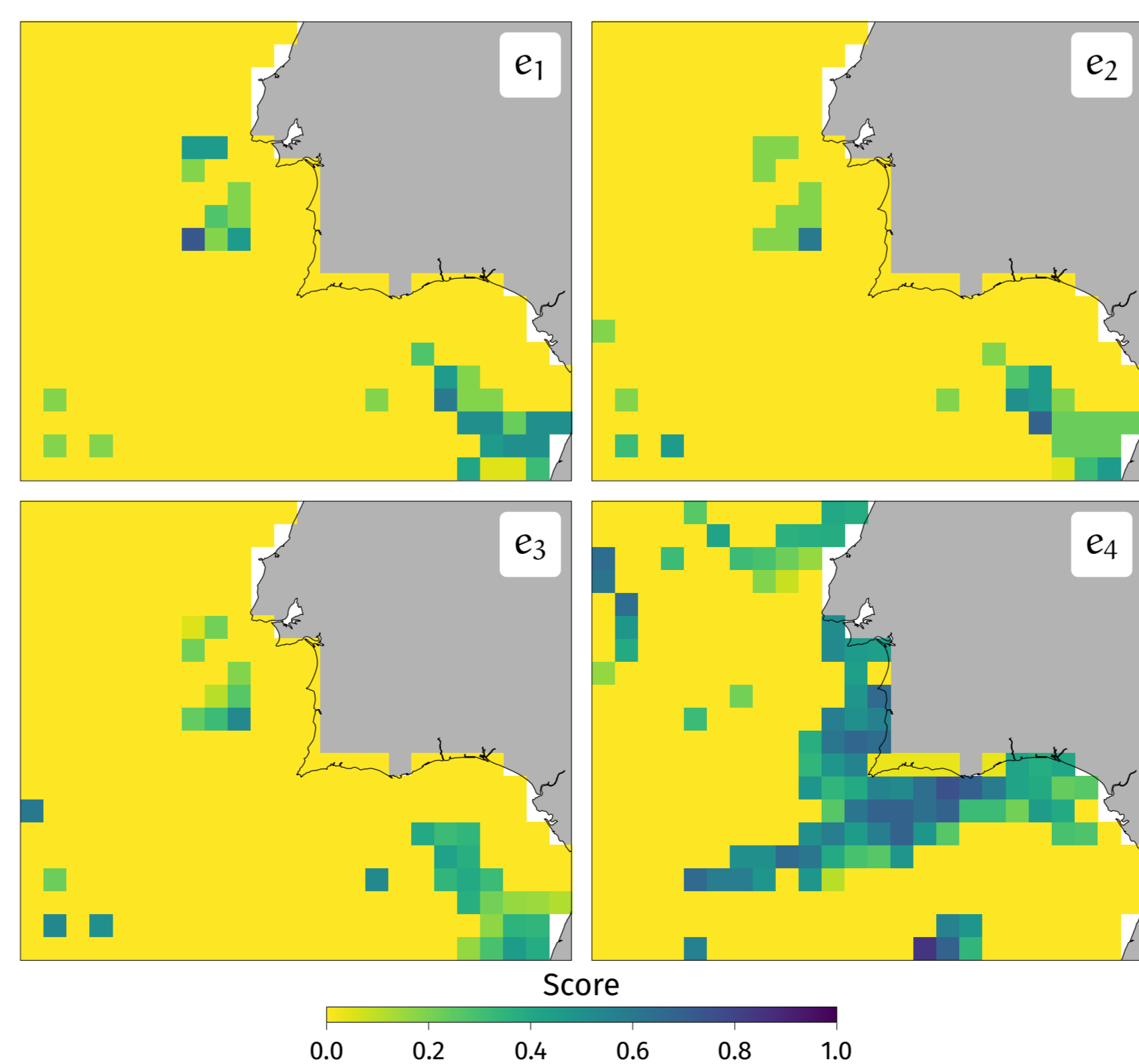
3. Statistics computation

For each square, three statistics are computed from the corresponding time series:



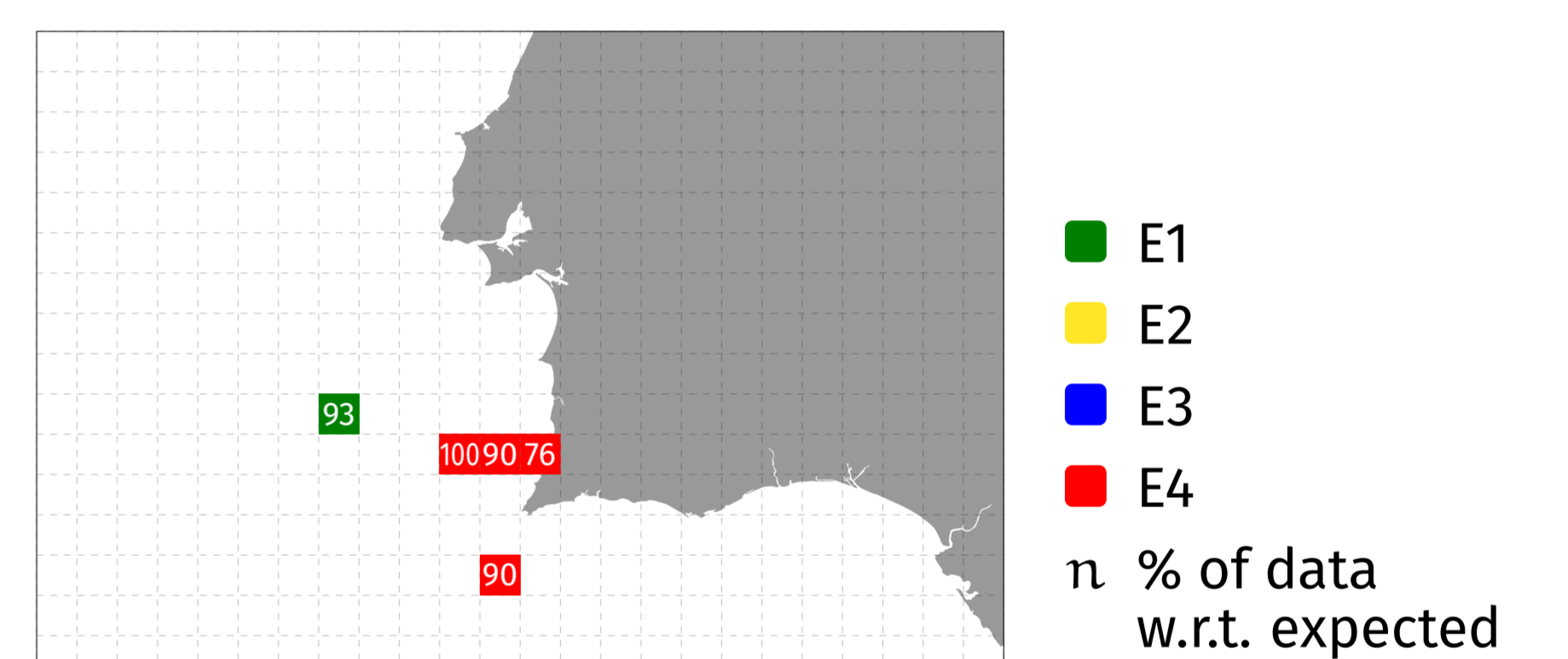
4. Classification rules

Using a set of handcrafted conditional rules, four scores are assigned to each square depending on the values of the statistics both for it and for its neighbours. The score e_i represents a confidence level for an event of type E_i to have occurred in the square.



5. Classification output

For each square, the maximal score $e_m = \max\{e_1, e_2, e_3, e_4\}$ is considered and an event label "Em" is assigned to the square if e_m is greater than a fixed threshold. A geographical mask is then applied to filter out unrealistic labels.



Performances

MEC obtains satisfactory scores when evaluated taking its peculiarities into account.

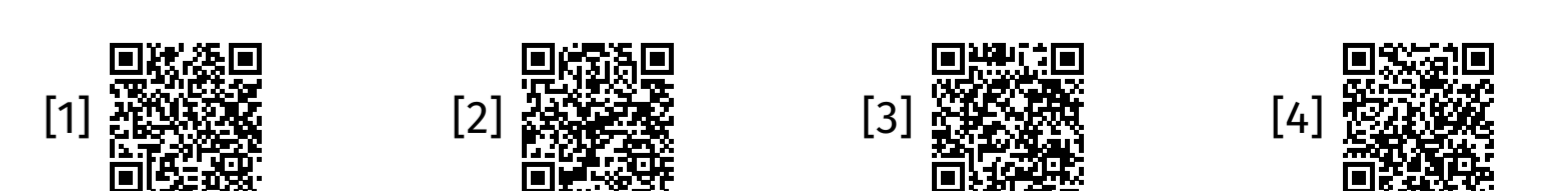
	Precision	Recall	F-score	Accuracy
E1	0.849	0.534	0.655	0.584
E2	0.474	0.291	0.360	0.505
E3	0.856	0.474	0.610	0.511
E4	0.730	0.606	0.663	0.718
Aggregate	0.753	0.481	0.587	0.579

Conclusion

This poster presents MEC, an algorithm for the detection and classification of upwelling patterns in SST maps. In a situation where a frame-by-frame template-matching approach cannot be successfully applied, MEC represents an innovative method that considers both the spatial distribution and the evolution over time of the SST within an area of interest.

References

- [1] Gabriele Pieri, João Janeiro, Flávio Martins, Oscar Papini and Marco Reggiannini. "MEC: A Mesoscale Events Classifier for Oceanographic Imagery". In: *Applied Sciences* 13.3, 1565 (2023). doi: 10.3390/app13031565
- [2] Marco Reggiannini, Oscar Papini and Gabriele Pieri. "Evaluation of a Mesoscale Event Classifier". In: *2023 IEEE International Conference on Acoustics, Speech, and Signal Processing Workshops (ICASSPW)*. 2023. doi: 10.1109/ICASSPW59220.2023.10193234
- [3] Oscar Papini. *Mesoscale Events Classifier: An algorithm for the detection and classification of upwelling events using Sea Surface Temperature satellite data*. ISTI Technical Reports 2023/011. ISTI-CNR, 2023. doi: 10.32079/ISTI-TR-2023/011
- [4] "MEC: Mesoscale Events Classifier" on GitHub. <https://github.com/ospapini/nautilus-T8.5-sst>



This work is part of a project that has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101000825 (NAUTILOS).