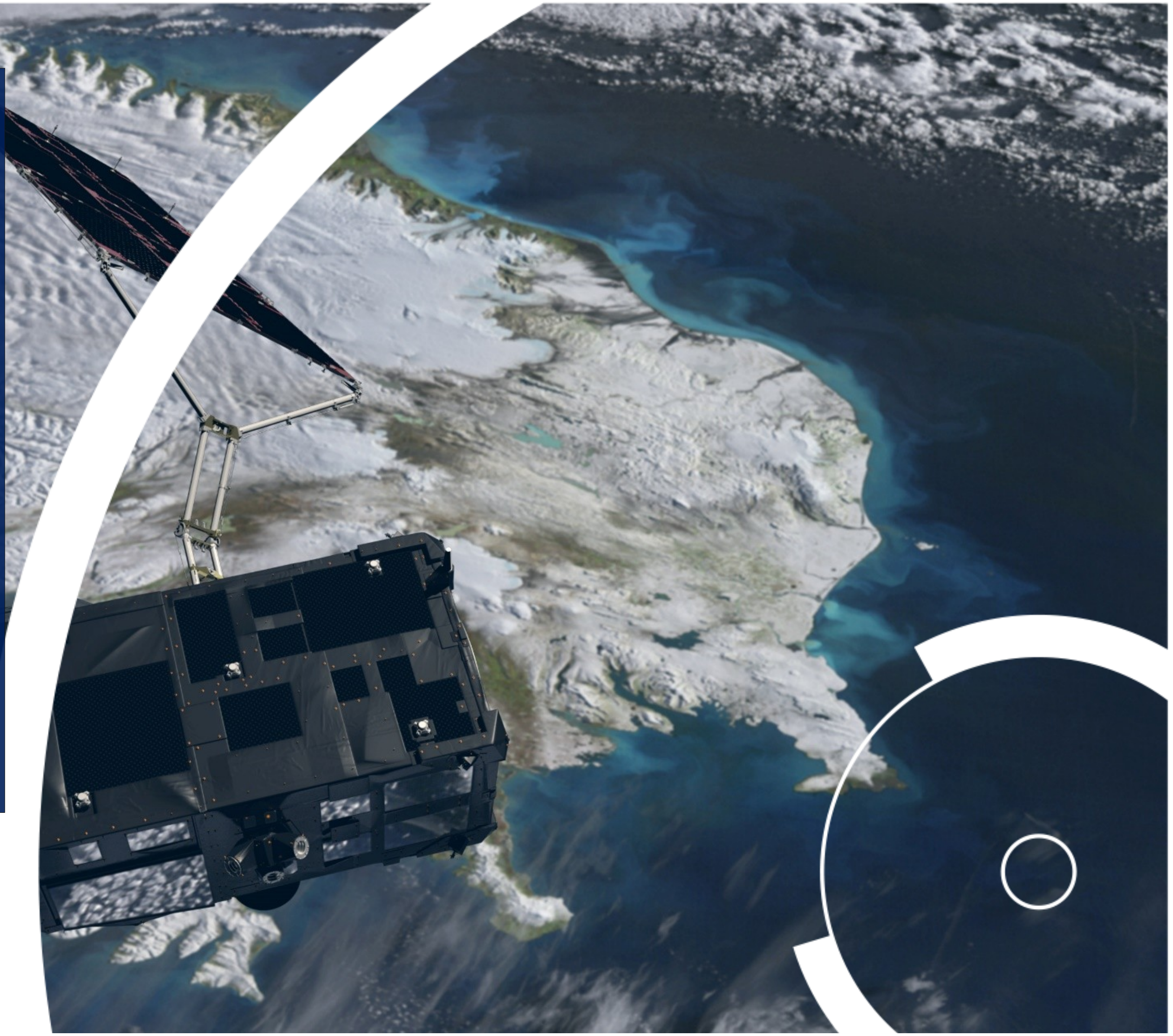
Response of the sea surface temperature to heatwaves during the France 2022 meteorological summer

Thibault Guinaldo[1], Aurore Voldoire[2], Robin Waldman[2], Stéphane Saux Picart[2] & Hervé Roquet[3]

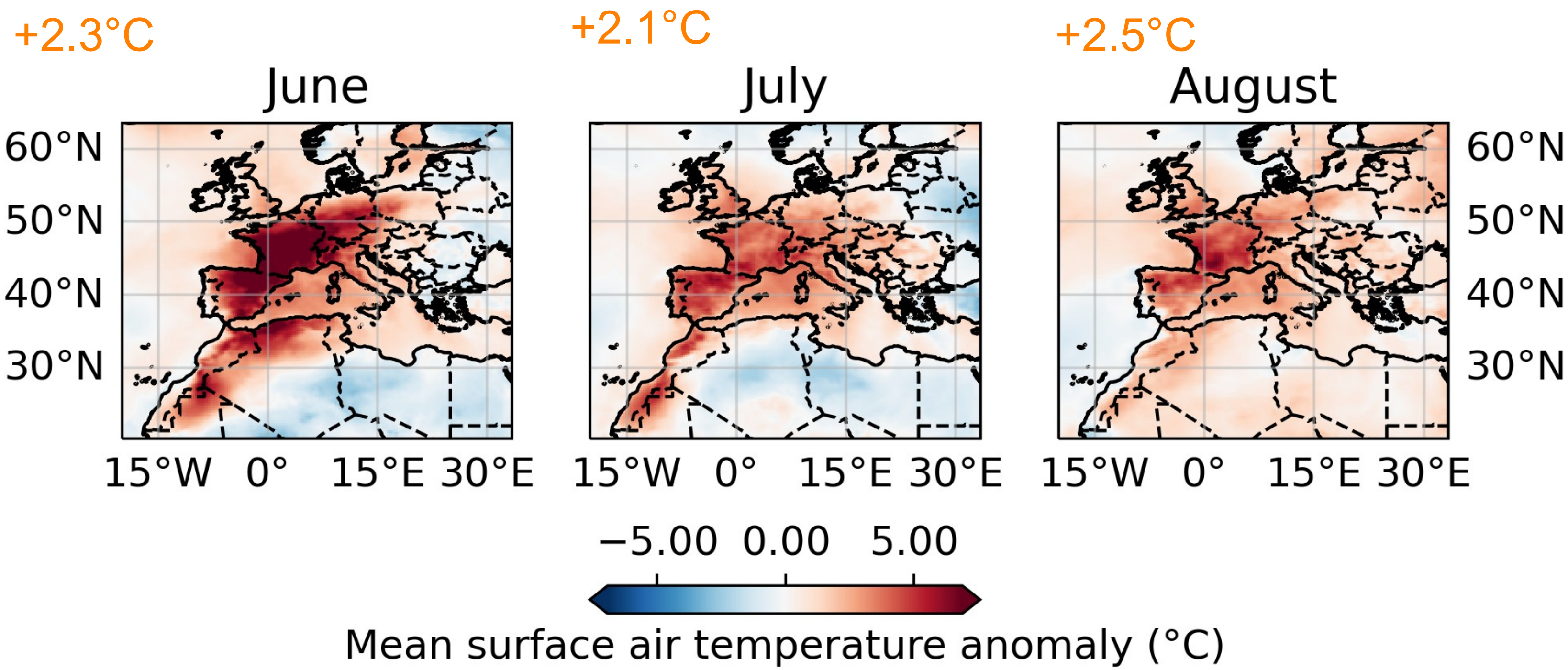
[1] CNRM, Université de Toulouse, Météo-France, CNRS, Lannion, France
[2] CNRM, Université de Toulouse, Météo-France, CNRS,Toulouse, France
[3] DESR, Météo-France, Saint-Mandé, France

EUMETSAT series of short courses: Warming oceans: using satellites to monitor sea surface temperature, ocean heat content and marine heatwaves; 07.2023



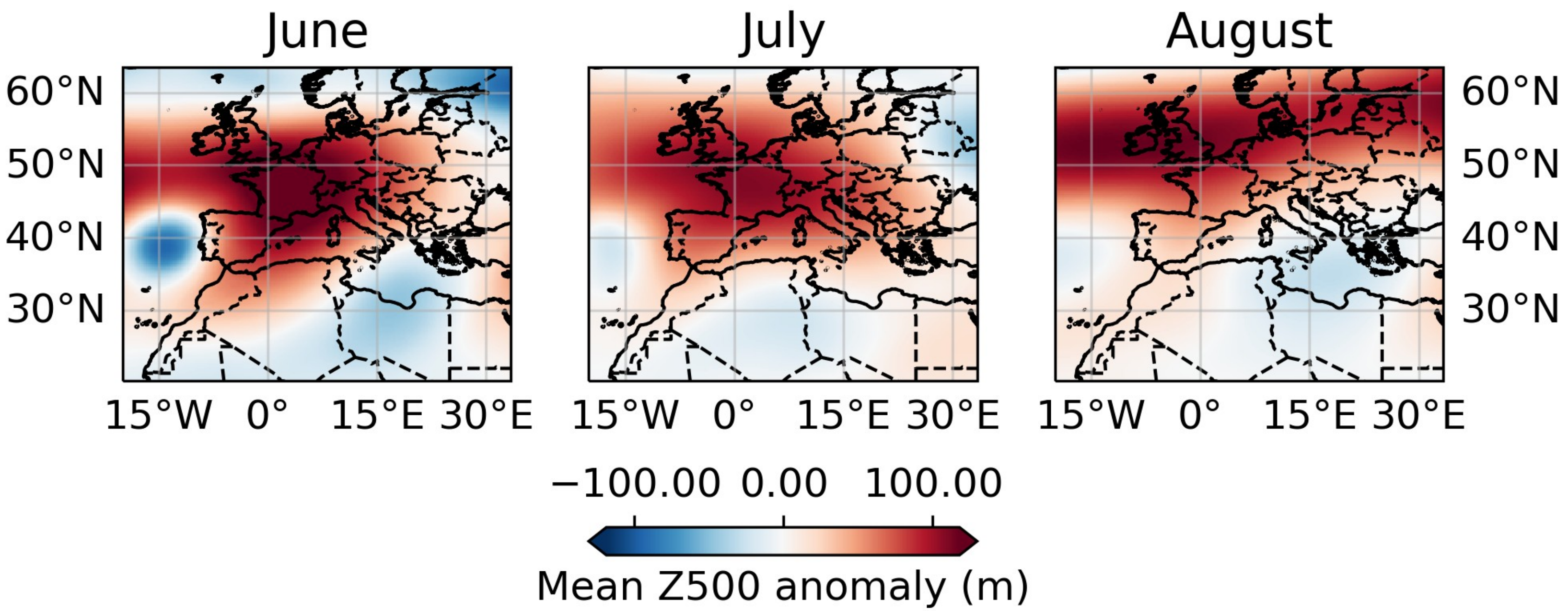
Context of the summer 2022

copernicus.eumetsat.int



- **2nd hottest summer** in France since 1900 (seasonal surface air T°C : 22.7°C)
- 3 atmospheric heatwaves : June 15th-19th, July 11th-25th and July 31th- August 13th
- Record of **earliness** and **duration** (33 days under heatwaves)

Context of the summer 2022

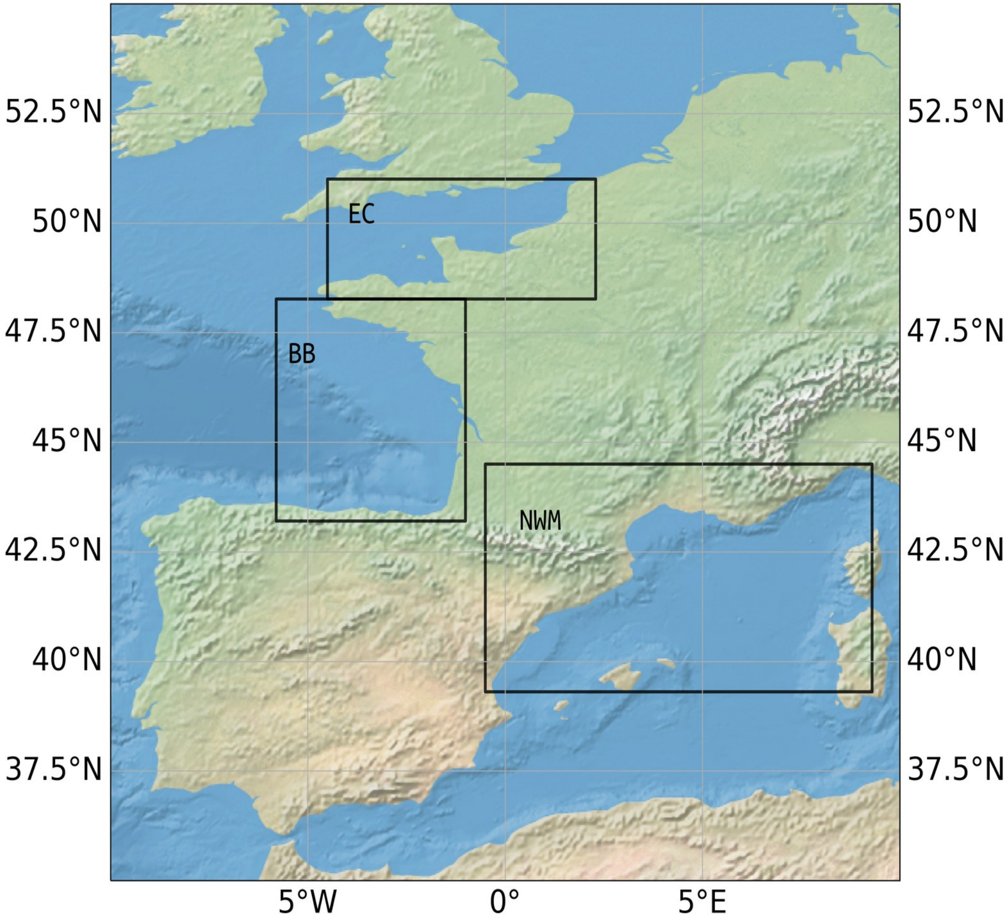


- Joint atmospheric effect :
    - Shifts from a **zonal regime to a summer blocking**
    - **Cut-off low** over the Iberian Peninsula
- Observed increase in the occurrence of such weather regime (*Faranda et al, PNAS, 2023*)

Objectives of the study

- **Characterize the response of the SSTs during the summer of 2022** (presented here)

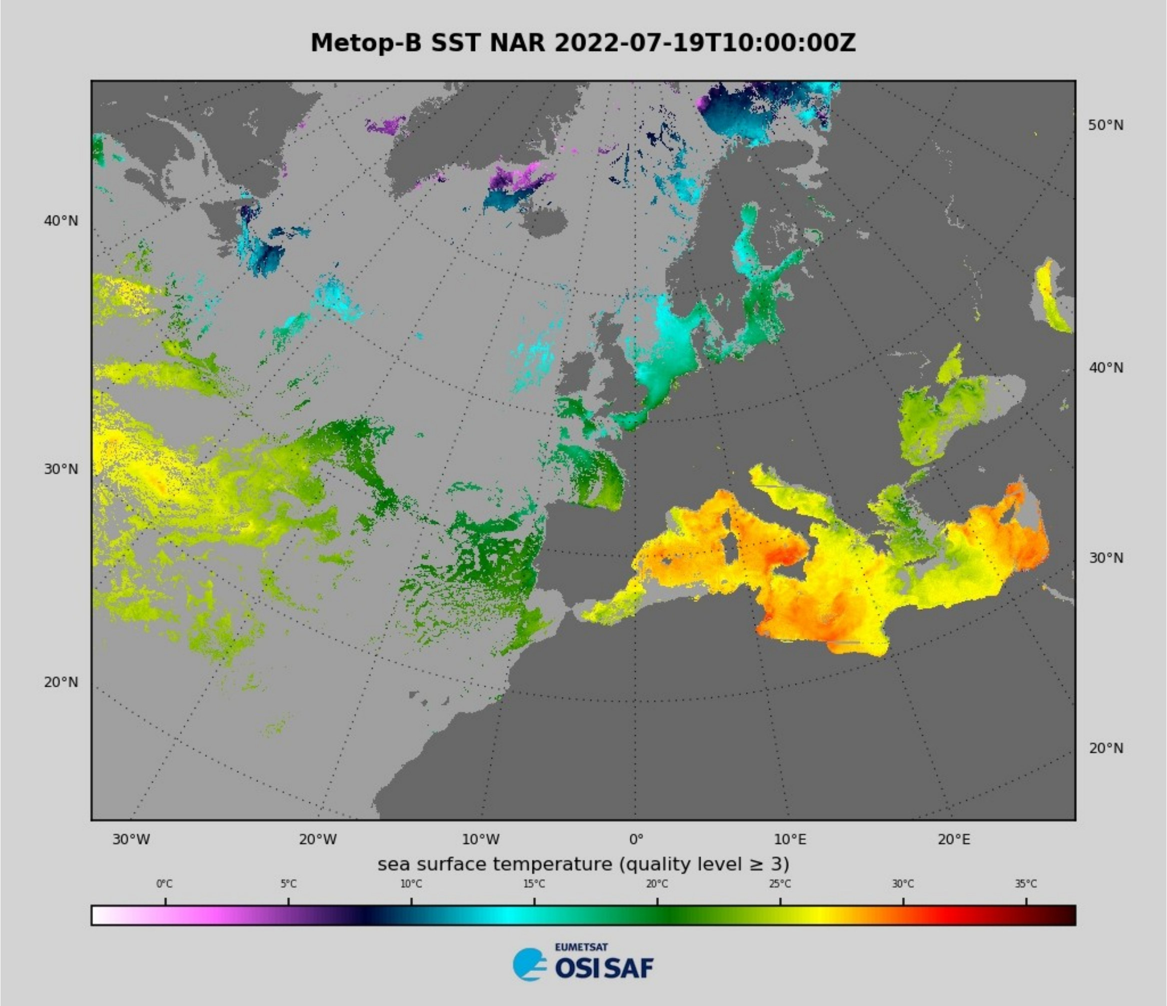
- Attribute this response to the atmospheric conditions by assessing the contribution of atmospheric variables



Methods

copernicus.eumetsat.int

- OSI SAF SSTs 0.05° → Metop-B/AVHRR
- Data filtered :
  - Quality level > 2
  - Solar zenith angle > 95° (nighttime data)
  - Covered area > 50 % of the basin
- Climatology : SST ESA-CCI/C3S 1982-2011 (*Merchant et al., 2019*)



Where do you find the data?

copernicus.eumetsat.int

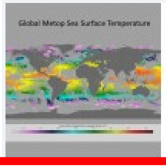
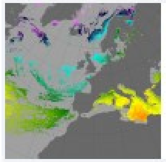
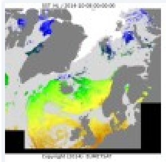
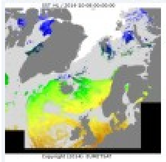
Wind | Sea surface temperature | Sea ice

EUMETSAT OSI SAF OCEAN AND SEA ICE

Products | Documentation | Community | About

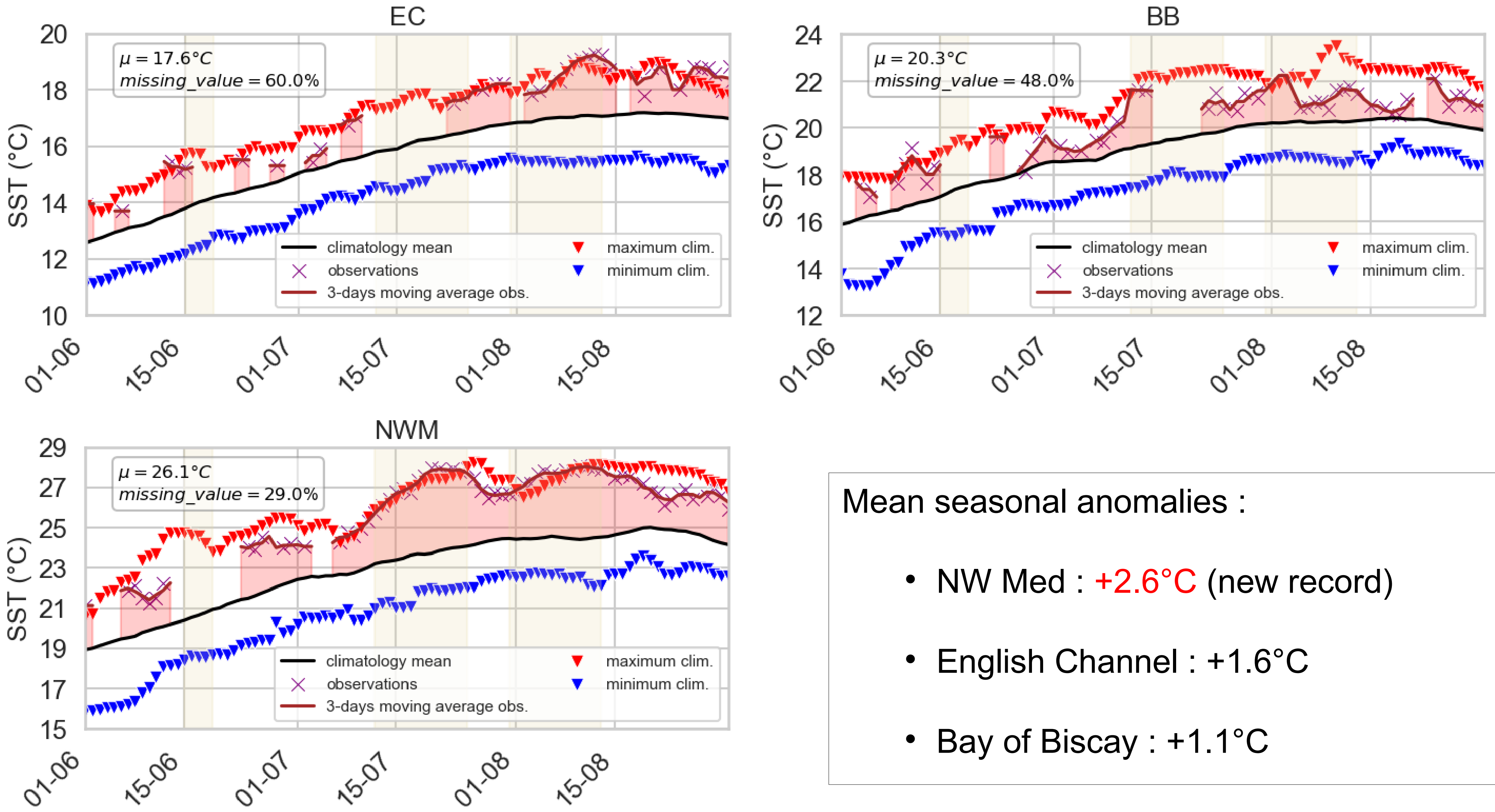
Home / Products / Sea Surface Temperature products

https://osi-saf.eumetsat.int/products/sea-surface-temperature-products

	Product	ID	Status	Sensor	Level		Frequency	Area	Resolution
	NEAR REAL TIME PRODUCT Global Metop Sea Surface Temperature	OSI-201-b	Operational	Metop-B/AVHRR	L3C		2 per day	global	0.05°
	NEAR REAL TIME PRODUCT North Atlantic Regional Sea Surface Temperature	OSI-202-c	Operational	Metop-B/AVHRR and NOAA-20/VIIRS	L3C		4 per day	North Atlantic	2 km
	NEAR REAL TIME PRODUCT Northern High Latitude L3 Sea and Sea Ice Surface Temperature	OSI-203-a	Operational	Metop-B/AVHRR	L3		2 per day	Poleward of 50N	5 km
	NEAR REAL TIME PRODUCT Northern High Latitude L3 Sea and Sea Ice Surface Temperature	OSI-203-b	Operational	NPP/VIIRS	L3		2 per day	Poleward of 50N	5 km

Daily response of the SSTs

copernicus.eumetsat.int

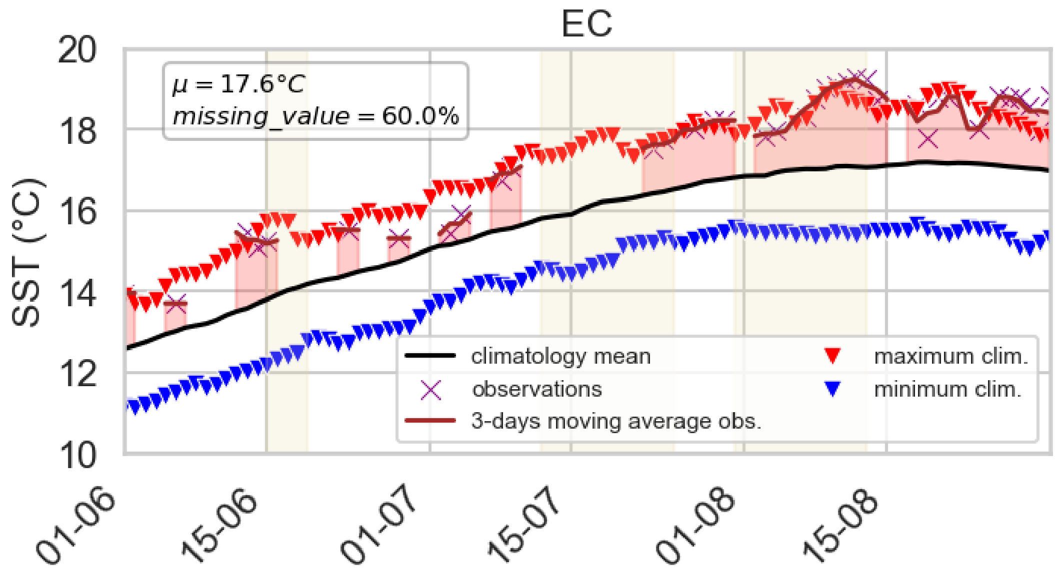


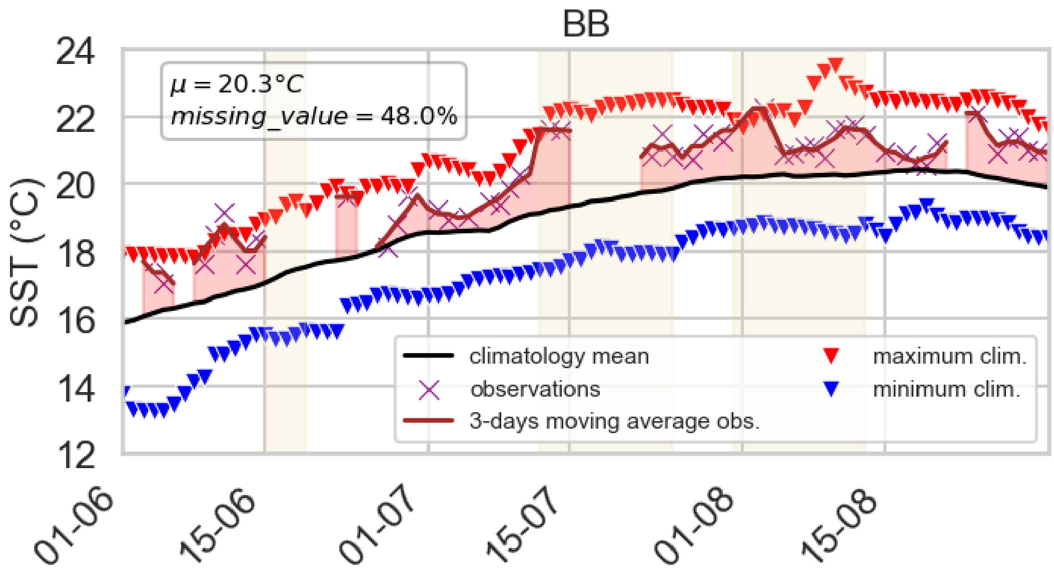
Mean seasonal anomalies :

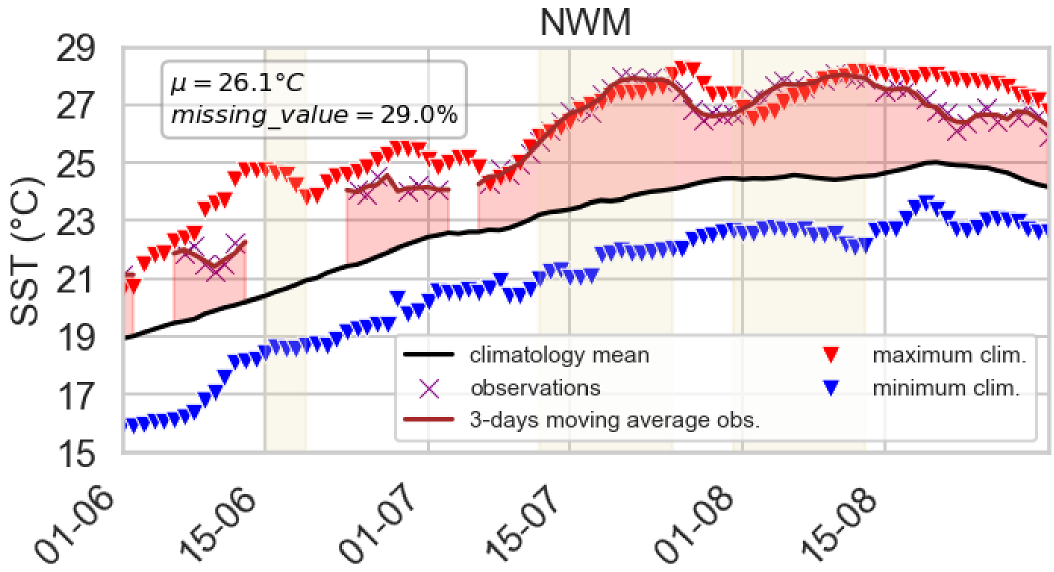
- NW Med : +2.6°C (new record)
- English Channel : +1.6°C
- Bay of Biscay : +1.1°C

Daily response of the SSTs

copernicus.eumetsat.int



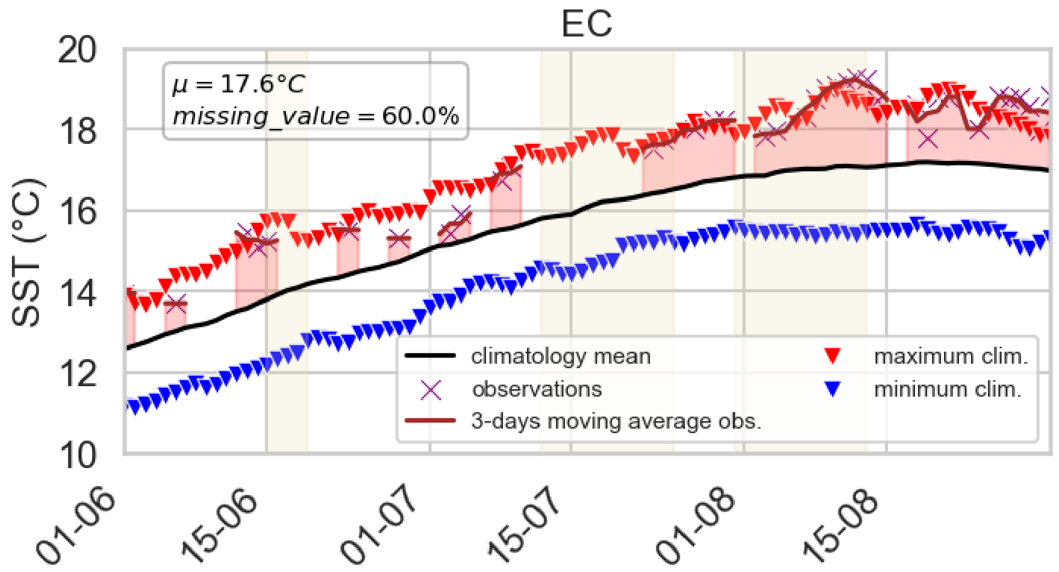


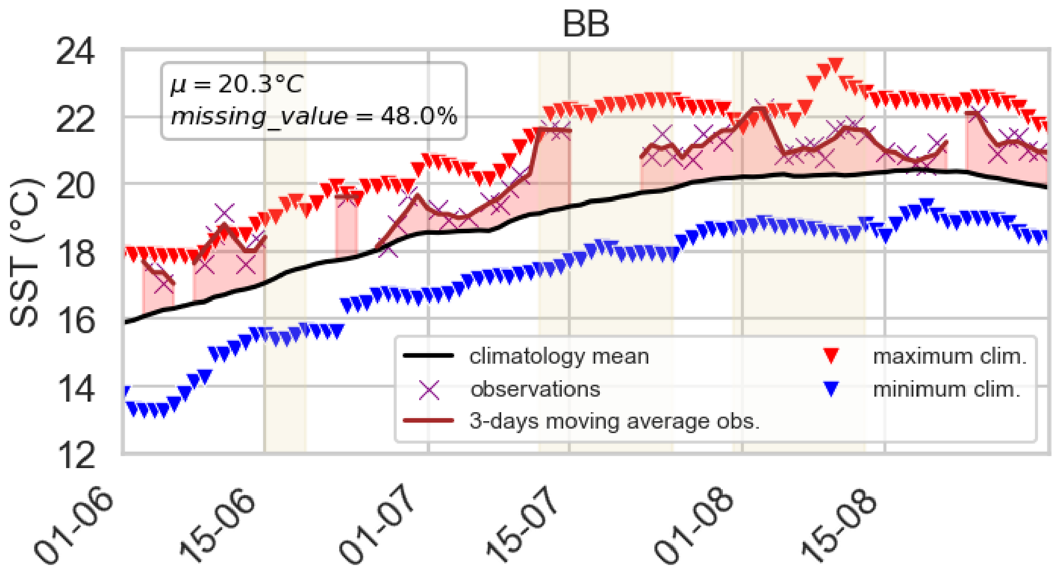


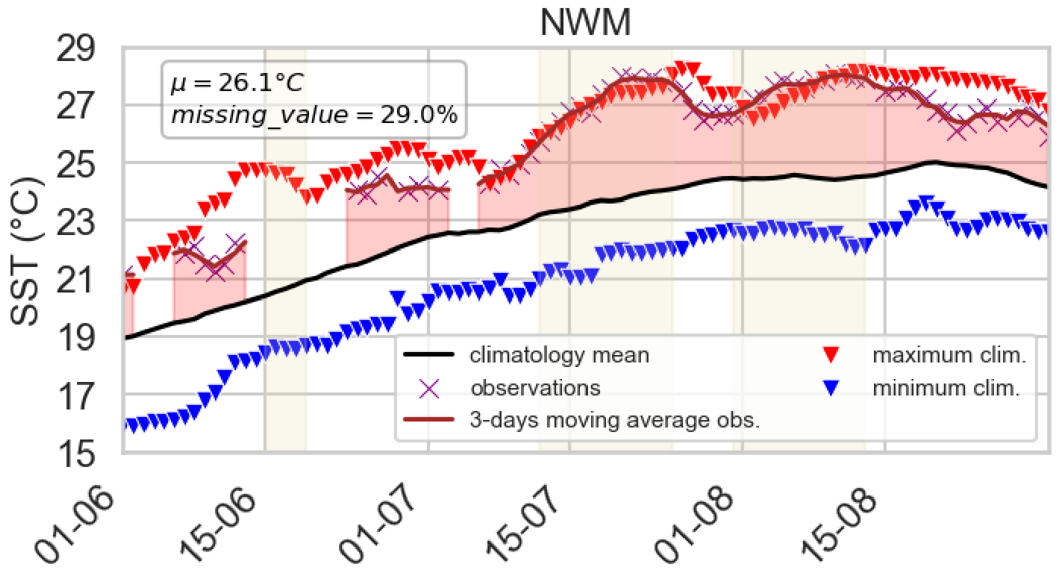
Number of days > clim. max :

- NW Med : 22 days
- English Channel : 19 days
- Bay of Biscay : 4 days

Daily response of the SSTs



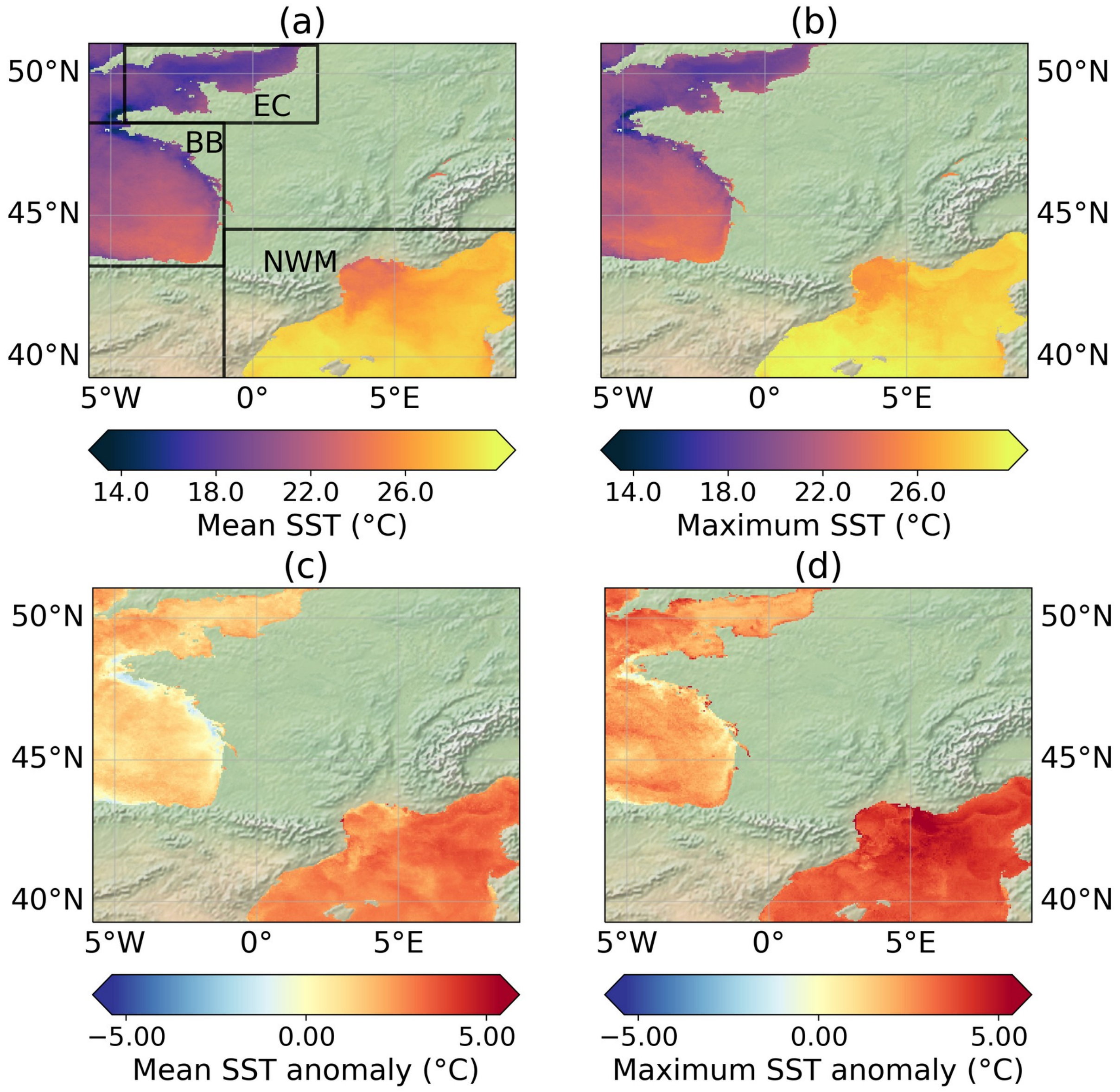




Ano. 31/07-13/08 (variation over 1 week) :

- NW Med : +3.1°C (+0.4°C)
- English Channel : +1.5°C (+0.7°C)
- Bay of Biscay : +1.2°C (+0.2°C)

Zoom on the 31/07-13/08 heatwaves



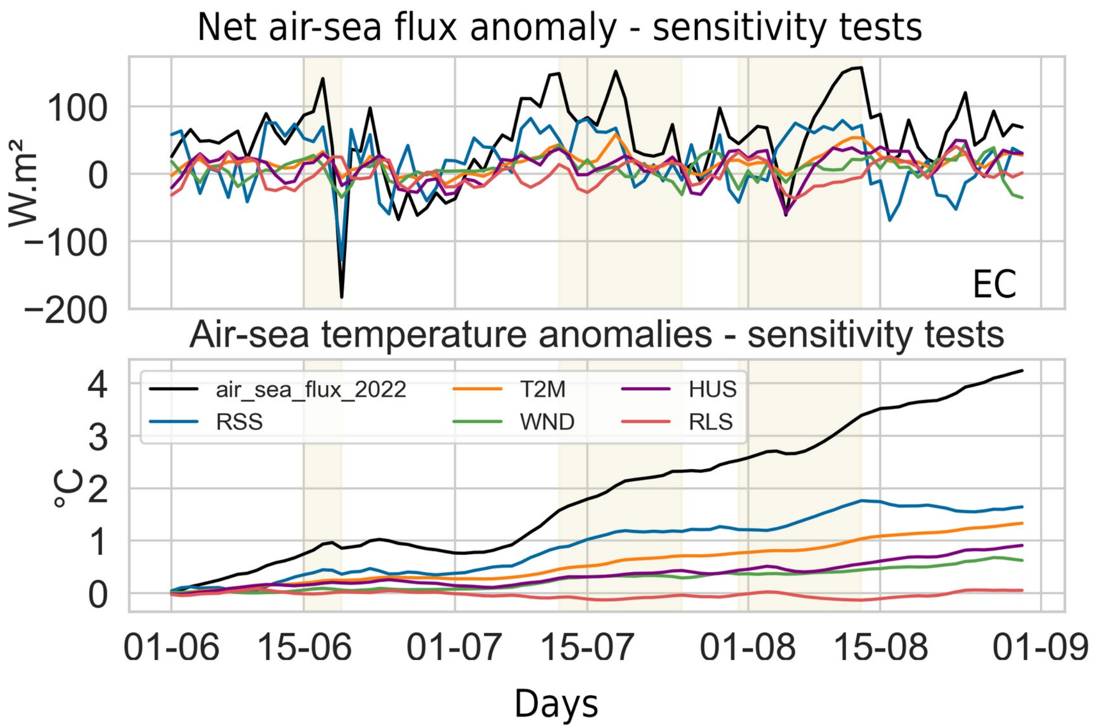
Get further insights into the local response

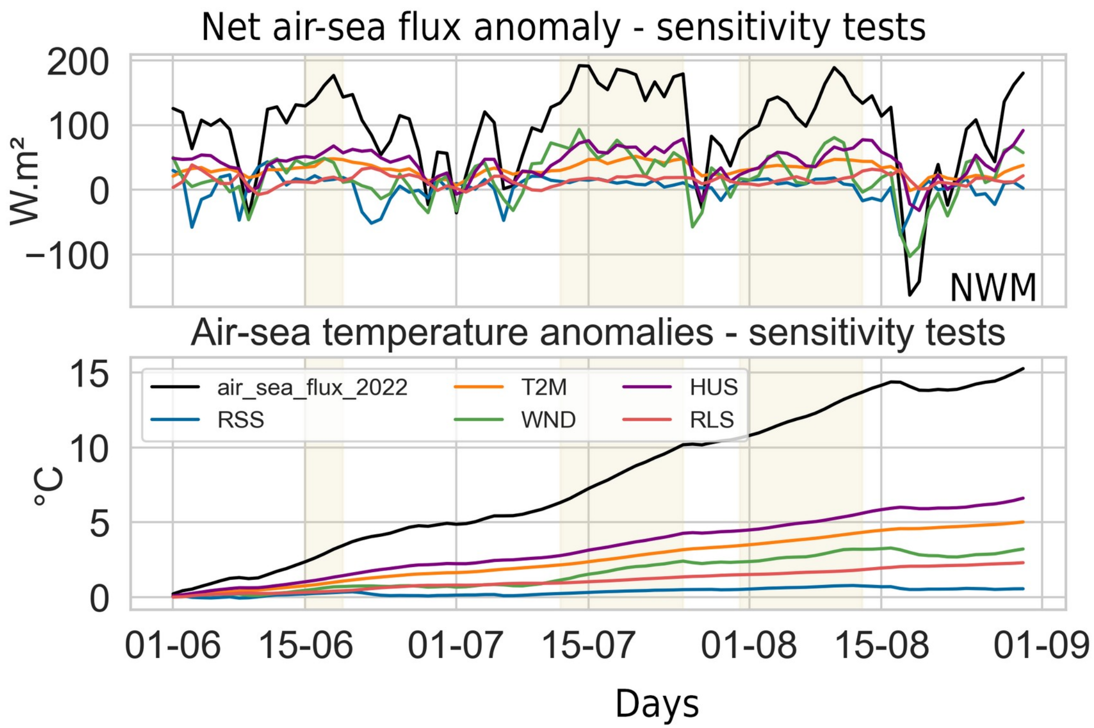
Anomalies reached **+7.9°C** (30.8°C measured) in NW Med

<u>Relative spatial homogeneity</u> :

- East-West gradient in EC
- Colder areas in coastal areas of BB
- Signature of the Rhone plume

Few words about the sensitivity test





Anomalies >0 of the total heat budget during atmospheric heatwaves

Major contribution of the T2m over all basins

Regional variability :
Atlantic/EC : contribution of **SW down** → low cloudiness
Med : contribution of **specific humidity** → humid air masses

Contribution of the wind is low (counter-intuitive) and variable

Take-home messages

Characterisation of the SSTs responses :

Summer of 2022 was record-breaking over all the maritime areas and even more in NW Med : seasonal record over the period (1982-2022)

Large scale anomalies are relatively homogeneous

Research article | Highlight paper | *Ocean Science, EGU*

Response of the sea surface temperature to heatwaves during the France 2022 meteorological summer

Thibault Guinaldo, Aurore Voldoire, Robin Waldman, Stéphane Saux Picart, and Hervé Roquet

Attribution to the atmospheric forcing :

Surface warming driven by air-sea fluxes/ cooling by oceanic processing

Regional variability :

- NW Med : 2-m T°C and Q linked to the advection of hot and humid air masses
- Atlantic/EC : 2-m T°C and SW down linked to a steady heat dome (large scale subsidence & adiabatic compression)
- Low contribution of the wind which modulates regionally the oceanic processes (Med)

Some perspectives

Reduce the dependency to the data availability :

- Combined products using geostationnary and polar-orbiting satellites (MTG, Metop-SG)

Extend and systemize the study framework :

- **Highest cumulative intensity for the 2022 MHW** in NW Med (*Martinez et al. 2023, Frontiers in Marine Science*)

- MHW in the Atlantic in May/June 2023 seems to be driven by similar synoptic conditions

Processus :

- Assess the variability of the oceanic processes

- Moving towards a more **complex modeling framework** : 3D coupling (1/36° simulation using NEMO coupled to AROME regional atmospheric model)

- Quantifying the influence of anthropogenic forcing using **single event attribution methods** (*Robin and Ribes, 2020*).

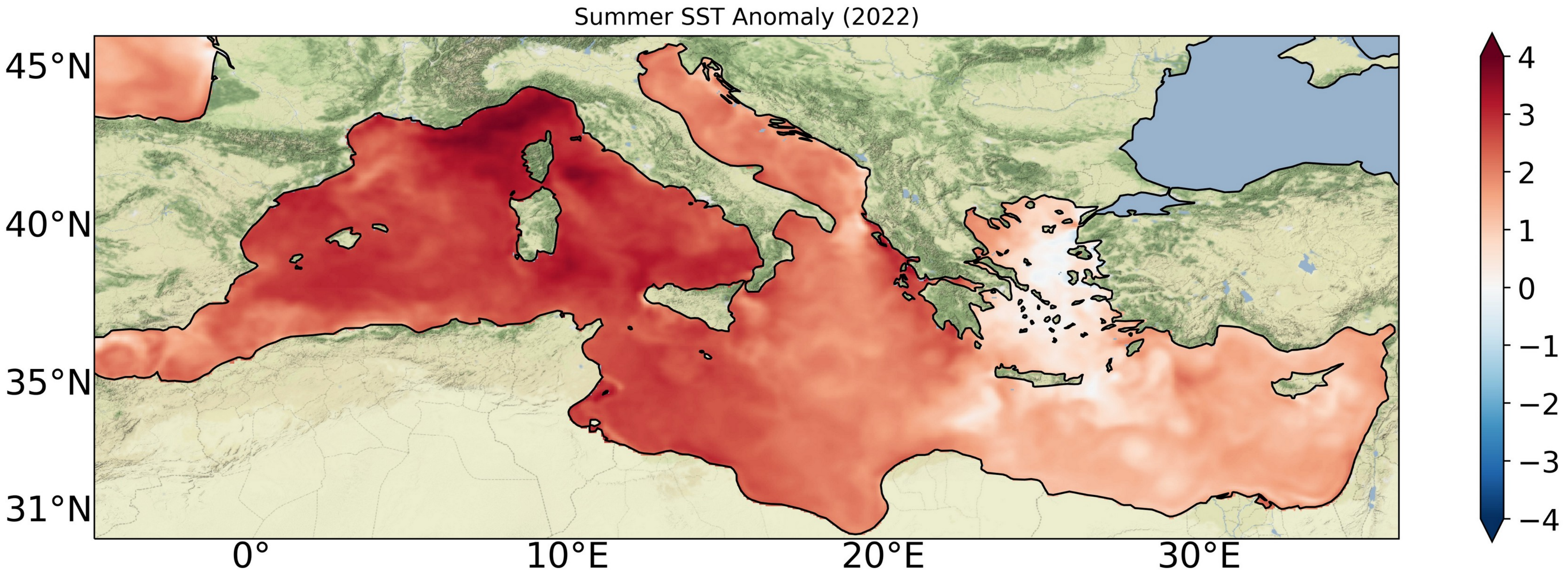
Thank you for your attention

Any questions?

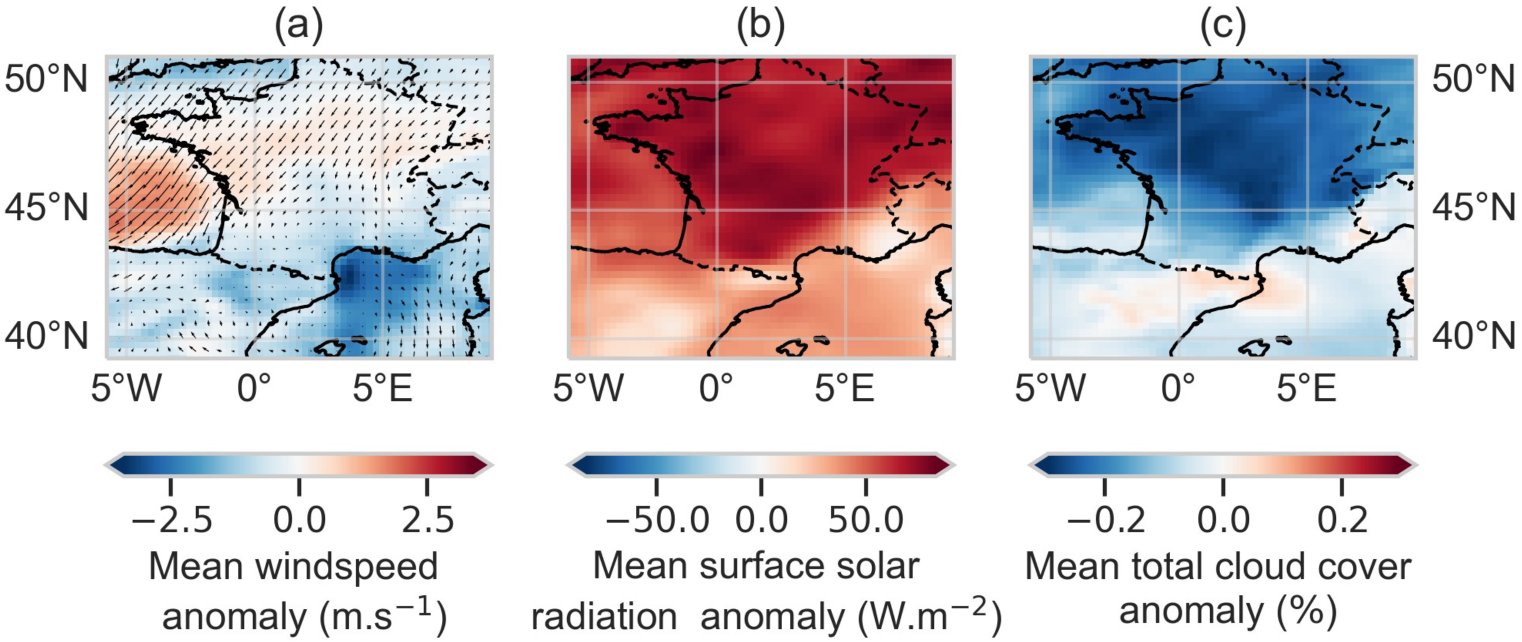
@: thibault.guinaldo@meteo.fr
@TGuinaldo

Seasonal SST OSTIA

copernicus.eumetsat.int



Seasonal SST OSTIA

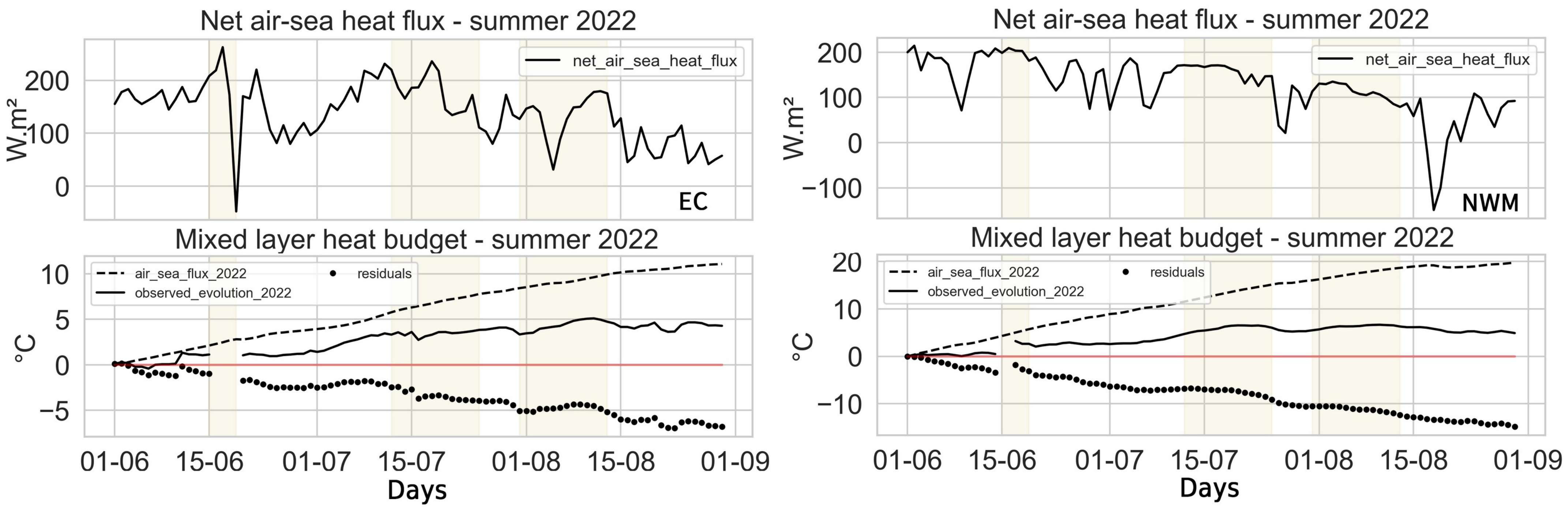


Solar radiation : + 50 $W.m^{-2}$ (+85 $W.m^{-2}$ South Brittany)

10-m mean wind speed :

- Atlantic coast : +0.6 $m.s^{-1}$ (max : +1.9 $m.s^{-1}$)
- NW Mediterranean Sea : -1.5 $m.s^{-1}$ (max : -3.7$m.s^{-1}$)

Seasonal SST OSTIA



Continuous warming throughout summer : +0.2 °C.day^{-1}

During heatwaves : +0.25 C.day^{-1}

Outside of heatwaves : +0.16 C.day^{-1}

Residuals contribute to cooling : mixing and entrainment

Strong signal at the end of the heatwaves