Detection of marine heatwaves in a fjord-like environment: Chiloé Inner Sea

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Taller del Observatorio Marino Reloncavi – 15/12/2023

WHAT ARE MARINES HEATWAVES (MHWs) ?

Anomalously warm water events

Formed due to processes

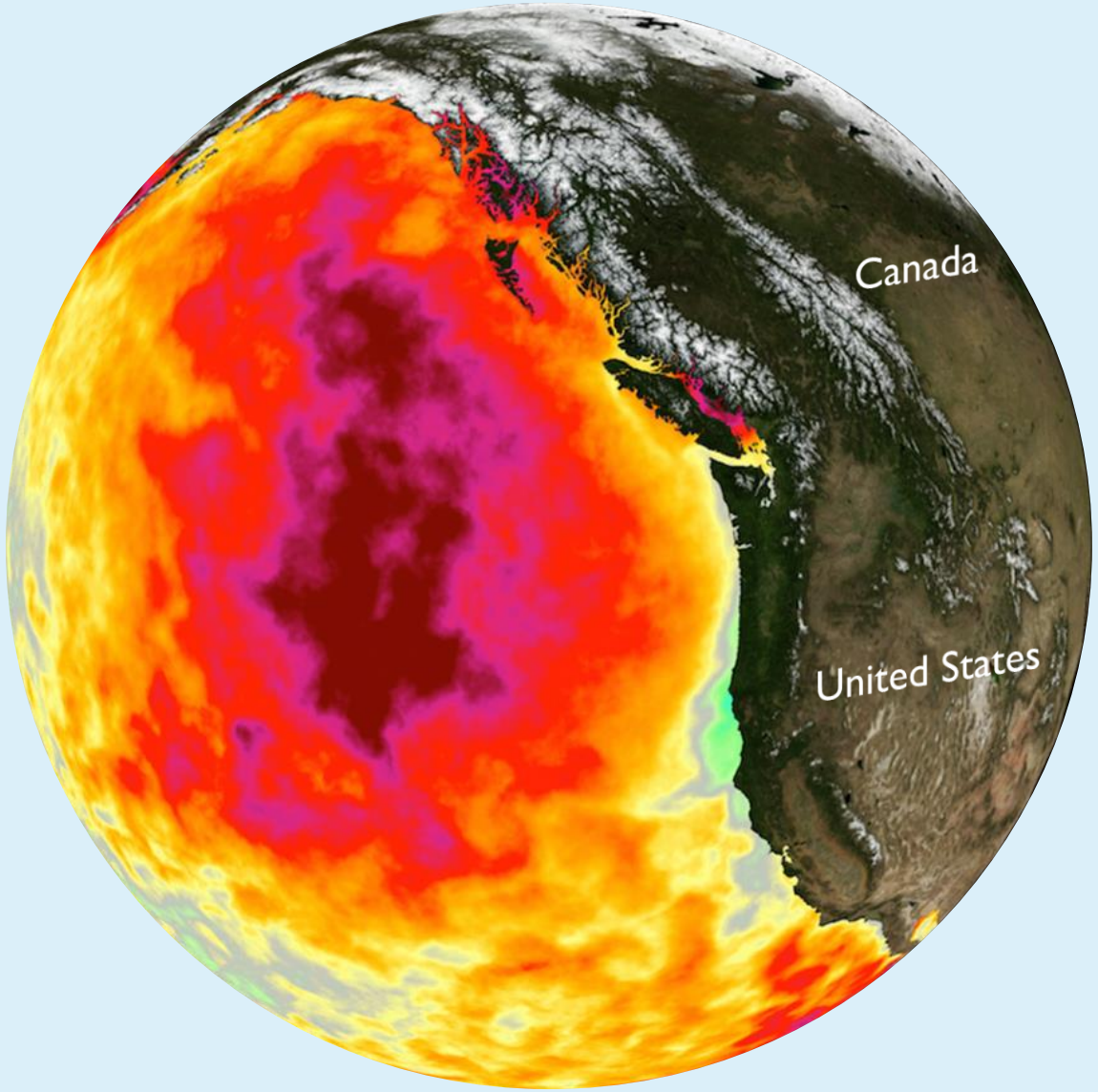
- Atomspheric
- Oceanic

Recently studied phenomenon

↓

Amplification due to global warming

MHW in the North East Pacific Ocean known as « The Blob ».



Temperature anomaly of the ocean in May 2015.

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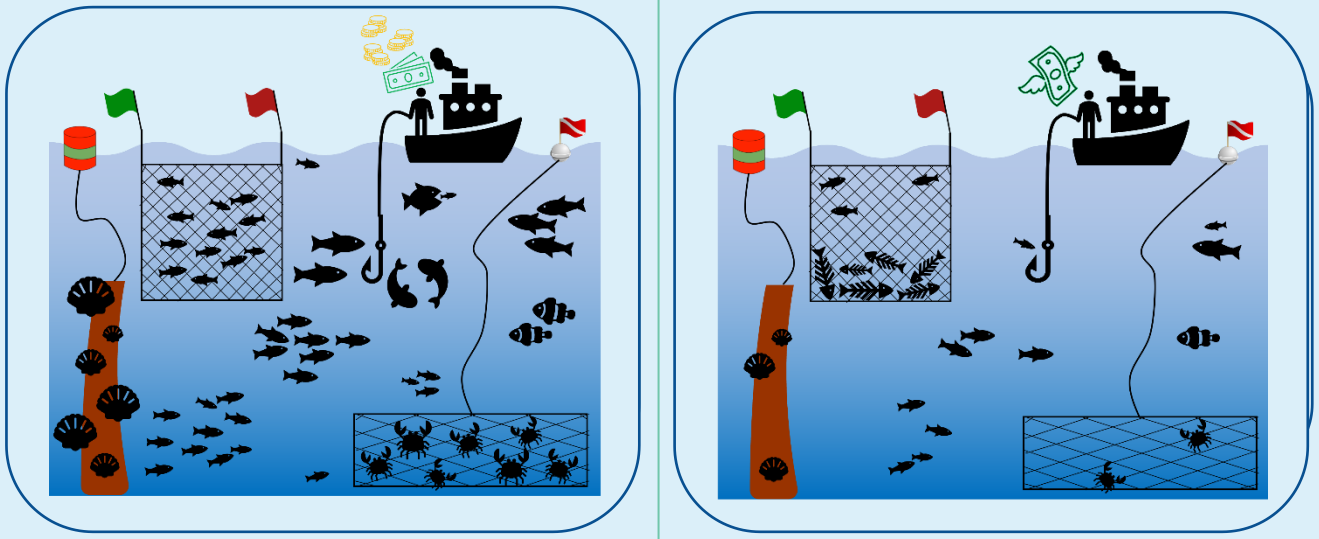
Devastating consequences

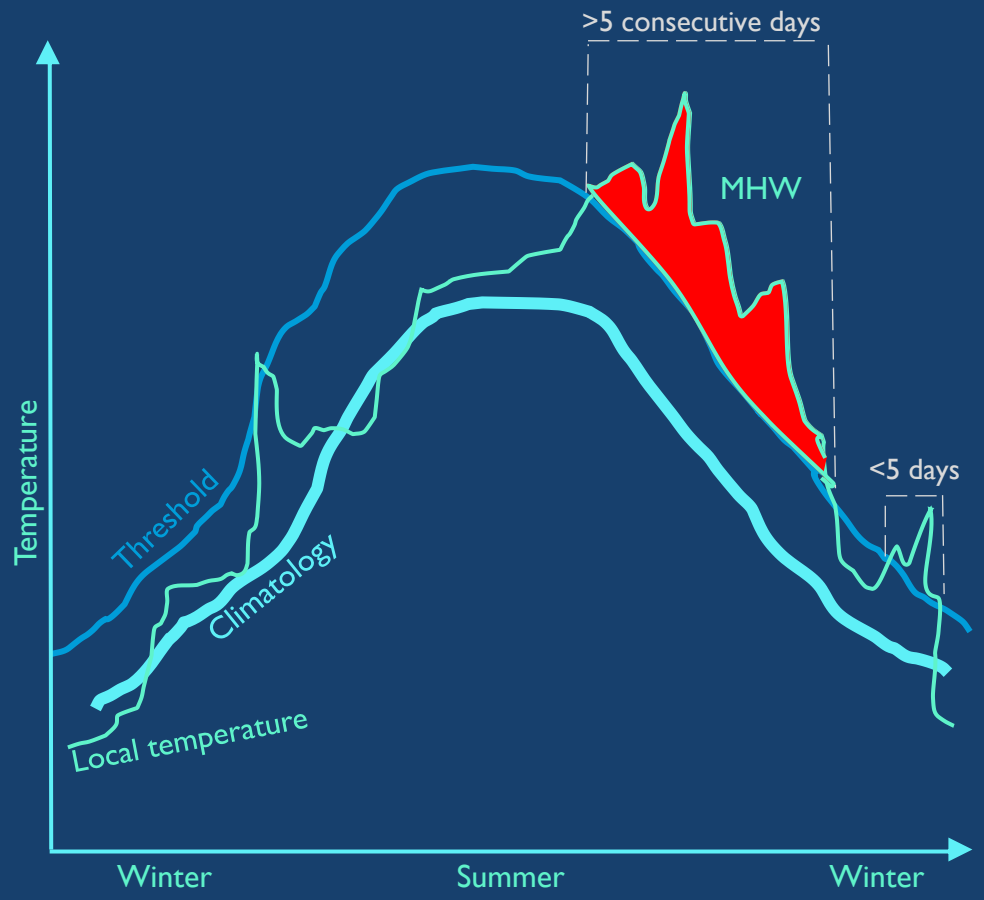
Before a MHW

During a MHW



Human activities

HOW TO DETECT MHWS ?



Detection

Long term climatology vs **Local temperature**

90th percentile

Threshold exceeded ?

if yes

MHW

THESIS OBJECTIVES

Few studies

Study MHWs in a complex coastal area

Influence from the continent

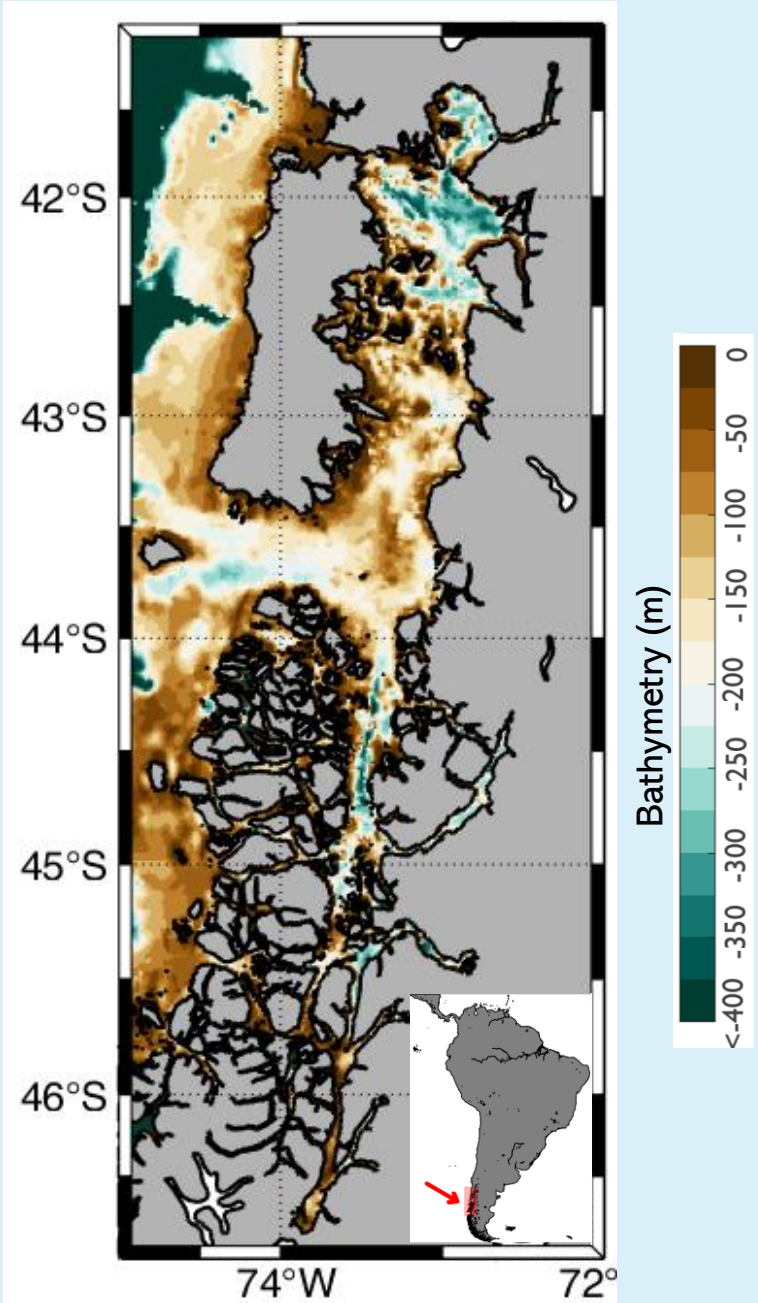
Limited circulation of water masses

Case study of the Sea of Chiloé in South Chile

Semi-enclosed sea

Fjords and channels

River inputs



Study area. Bathymetry indicated in meters by the colorbar.

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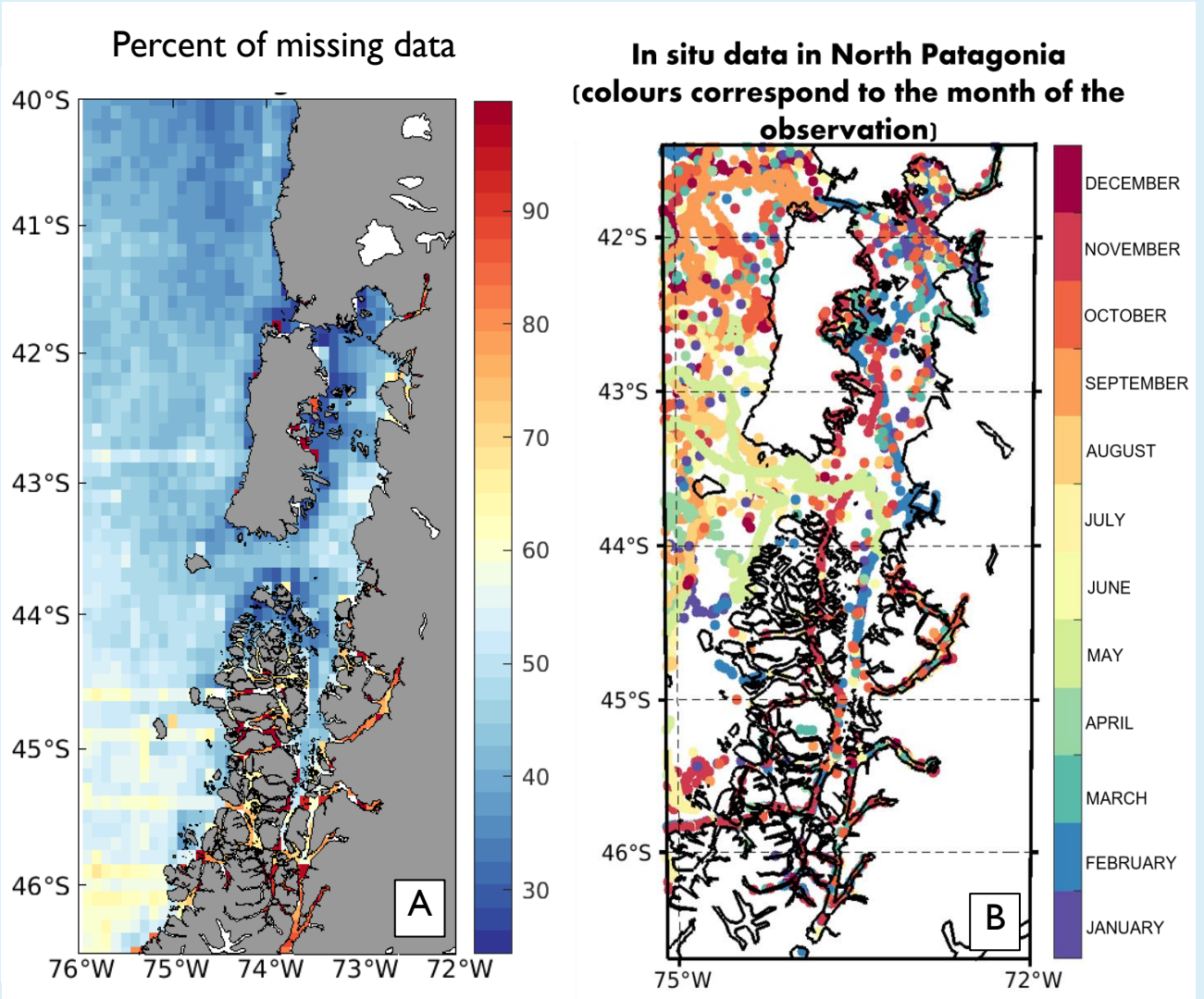
Not well resolved with satellite data



(A) Missing satellite data of SST(CMEMS) and (B) in situ data available.

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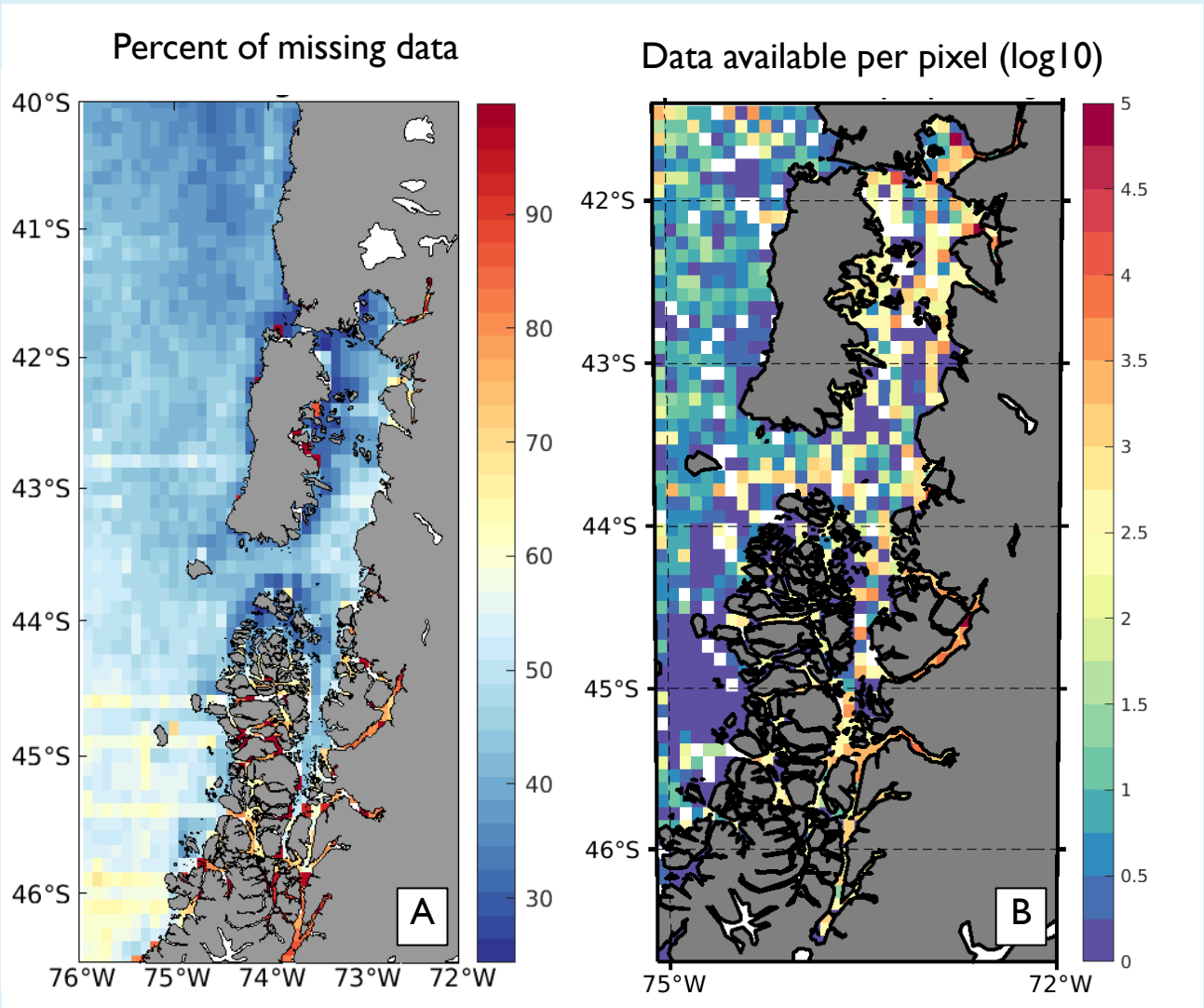

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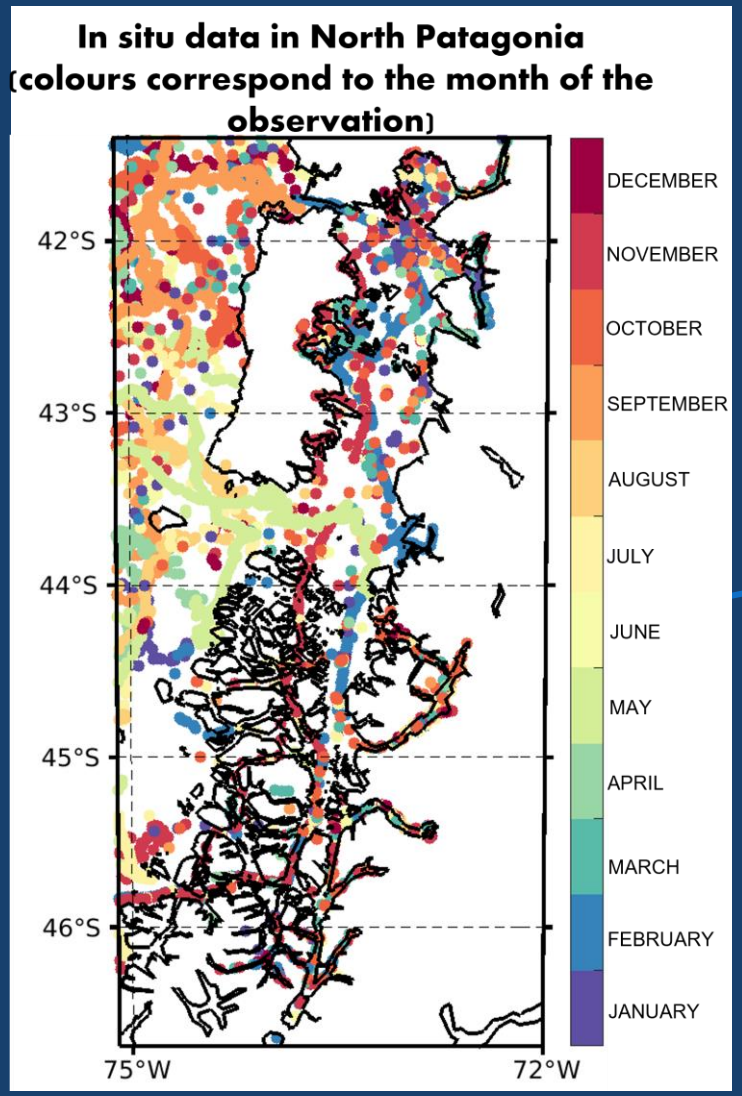
CONSTRUCTION CLIMATOLOGY



Data-Interpolating Variational Analysis

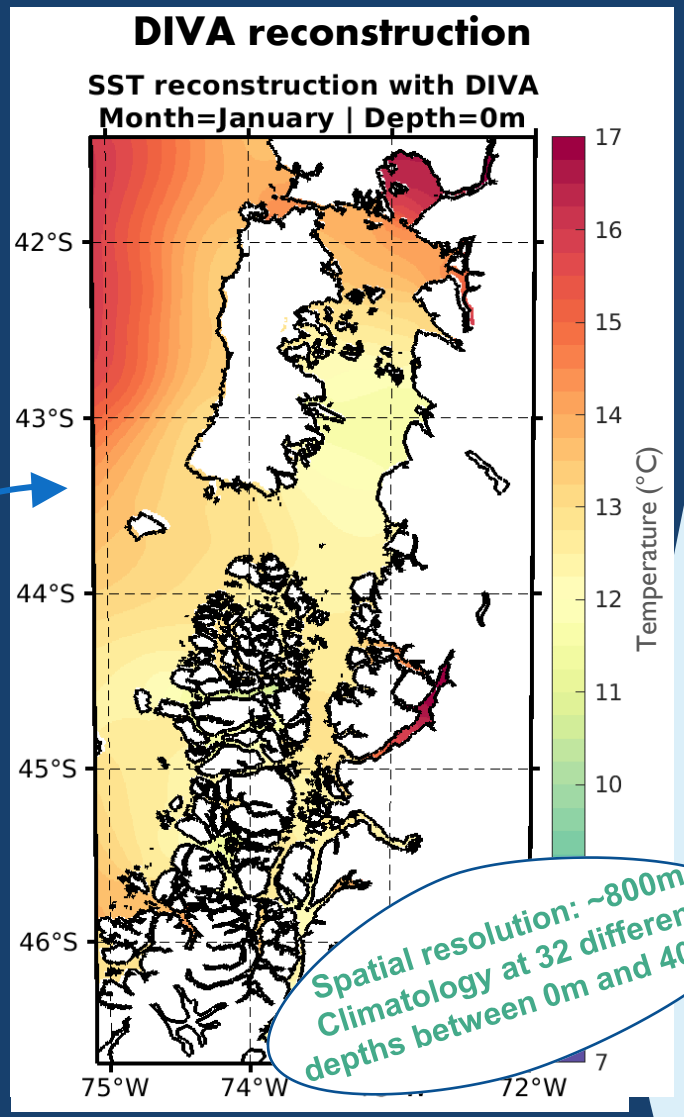
(Troupin et al., 2014)

DIVA

Uses scattered in situ points to generate a continuous field

4D Monthly climatology

Horizontal correlation length: 50km
Lower weight attributed to data clusters



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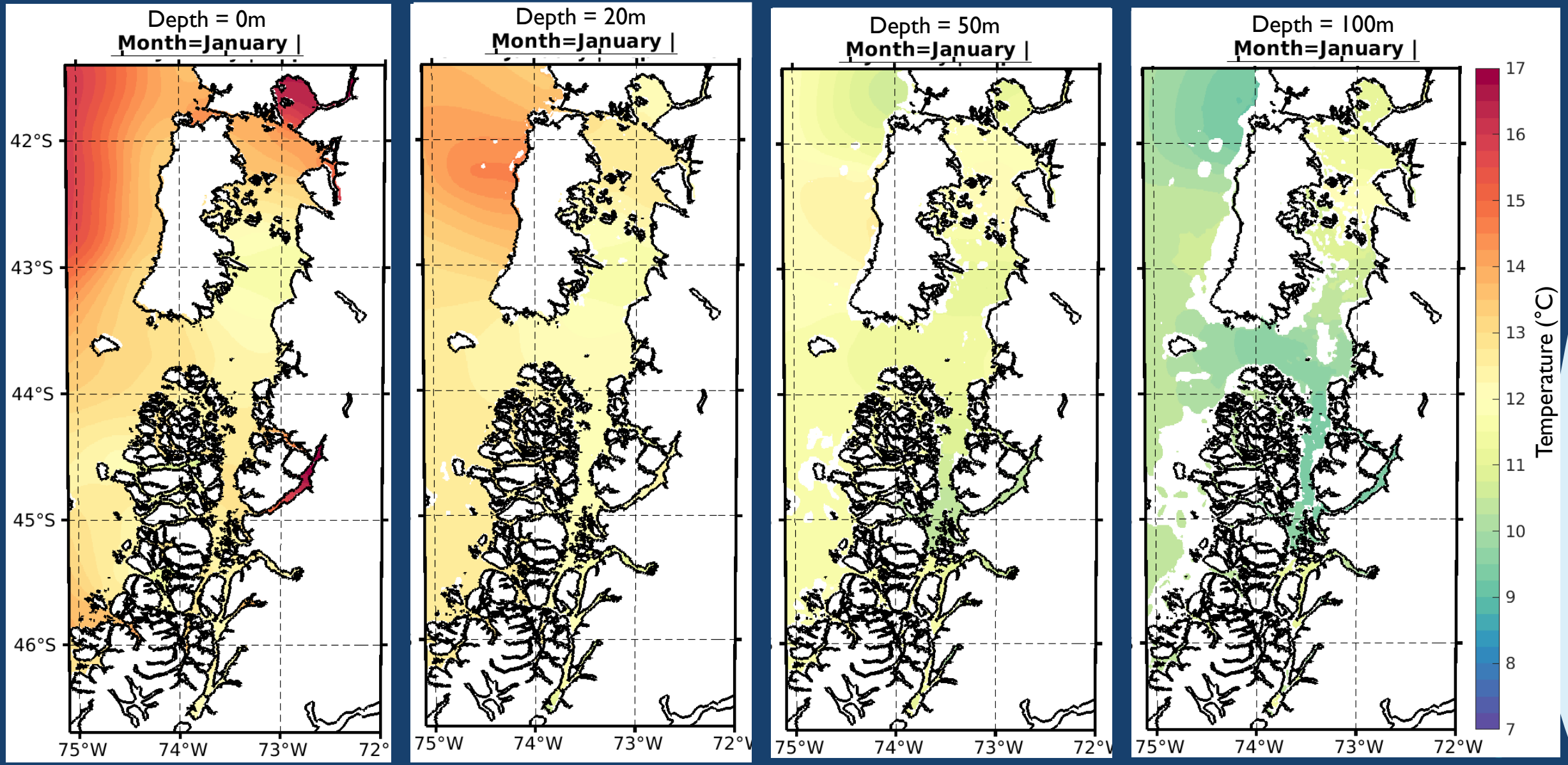

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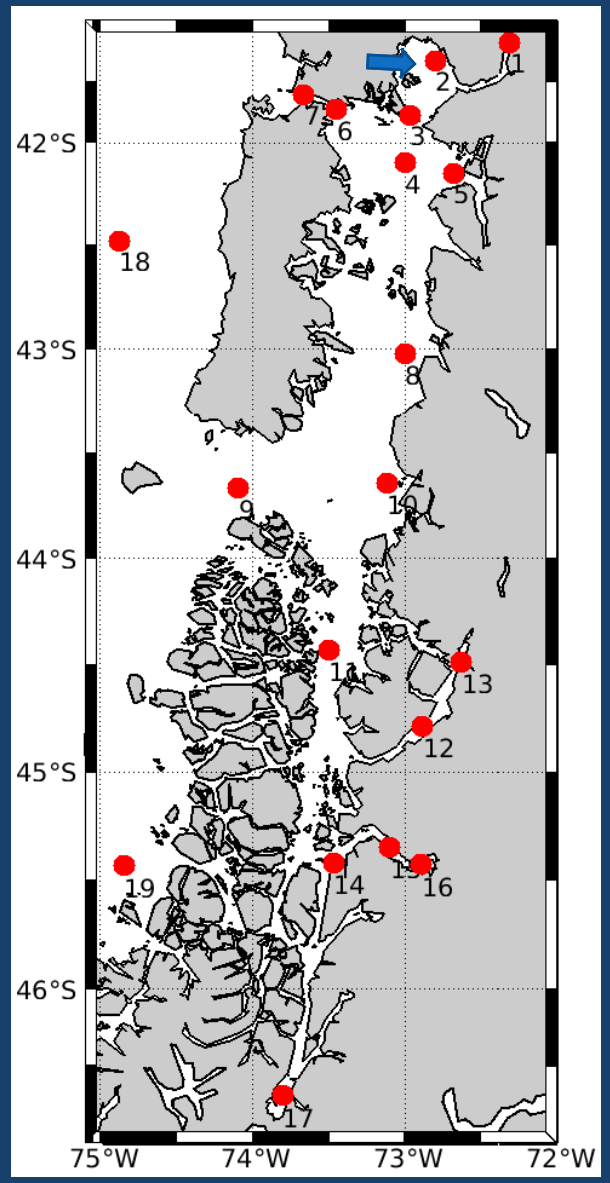

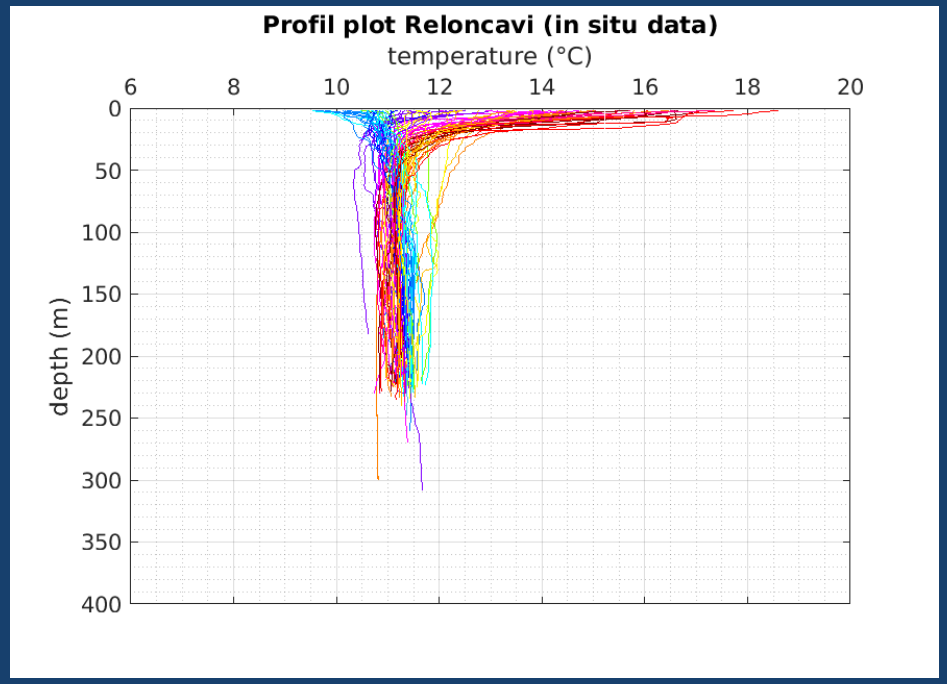

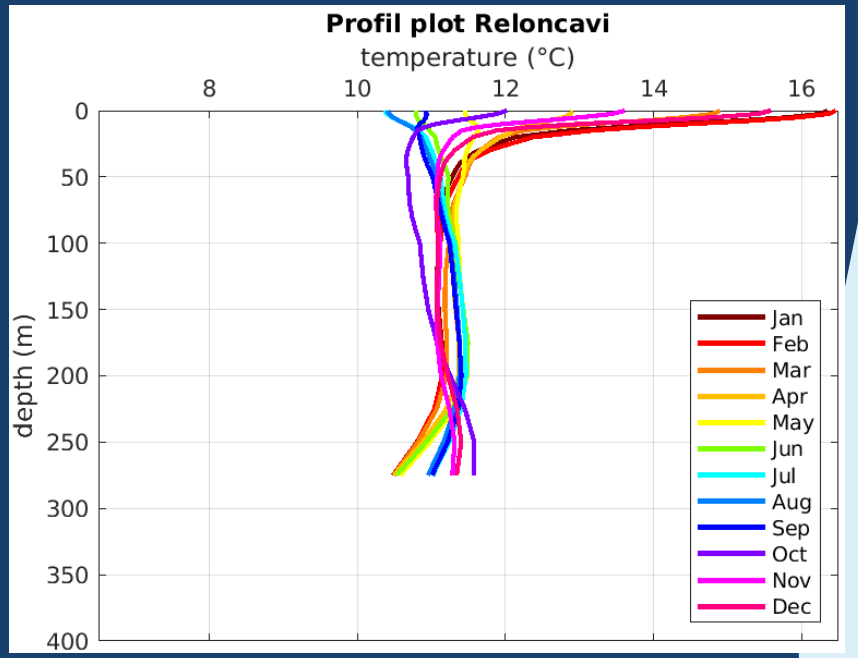

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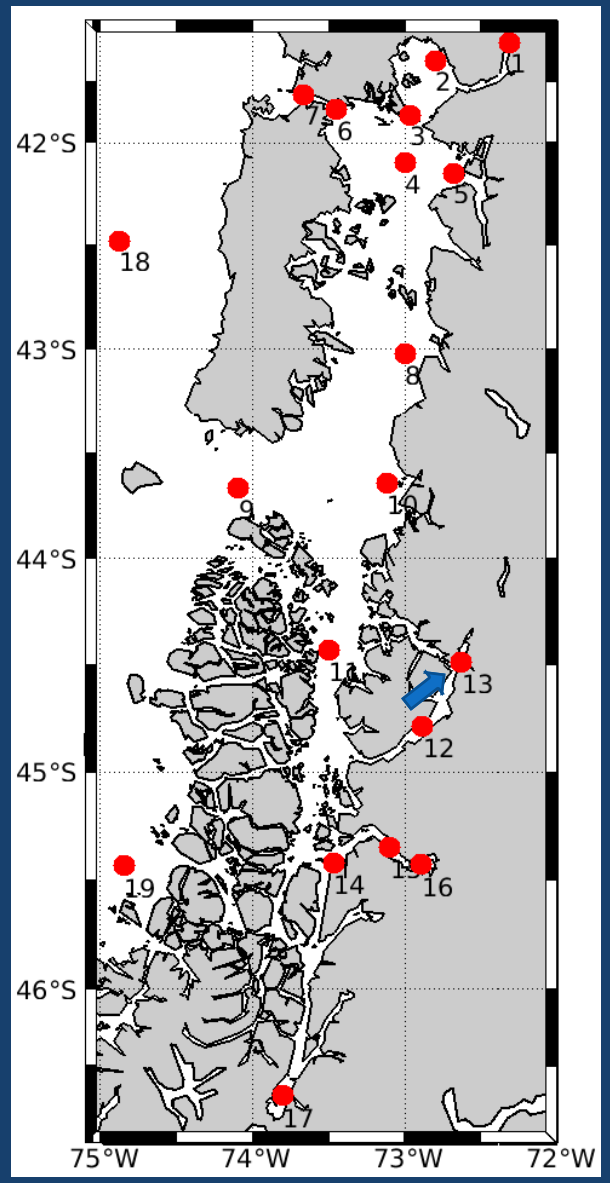

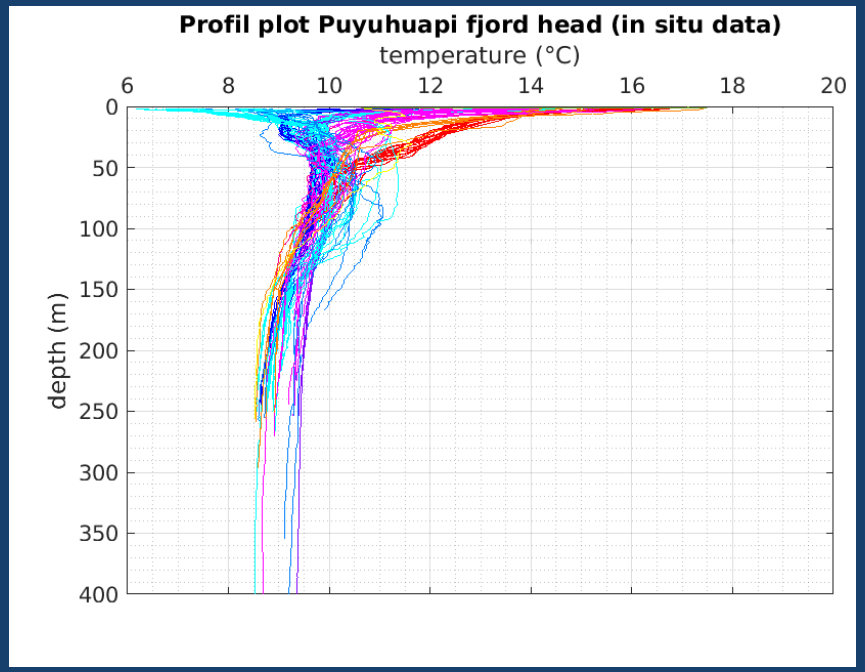

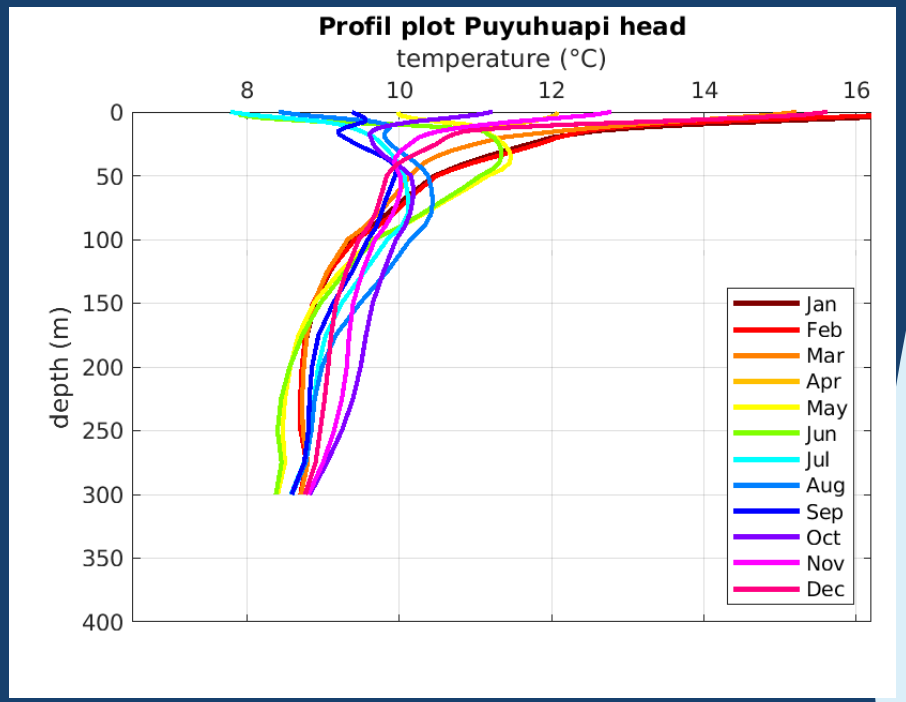

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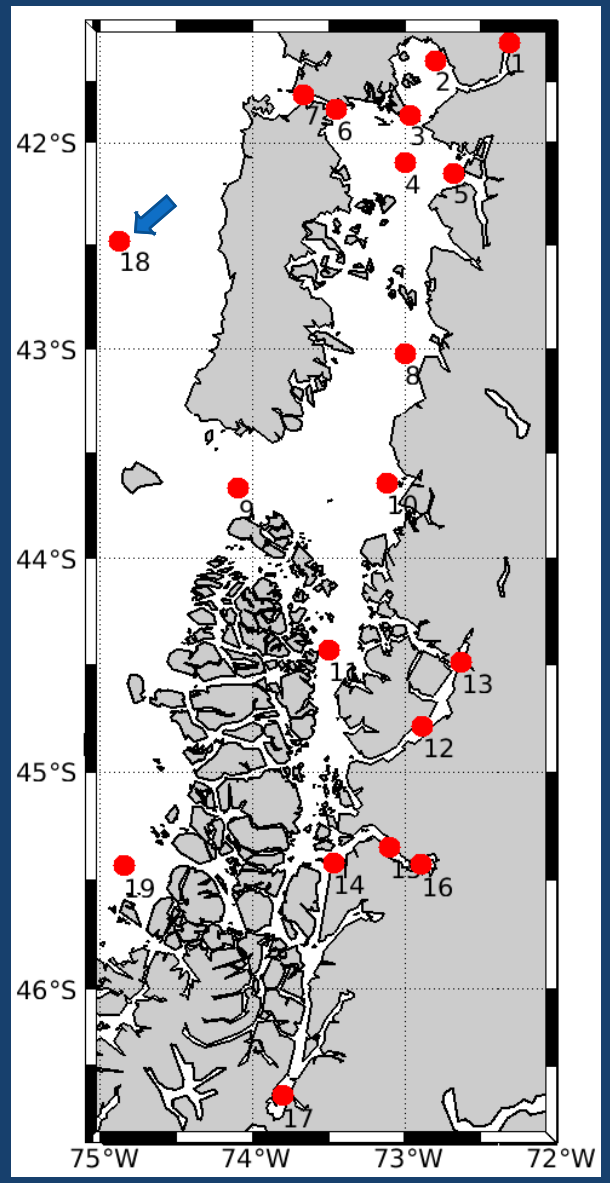
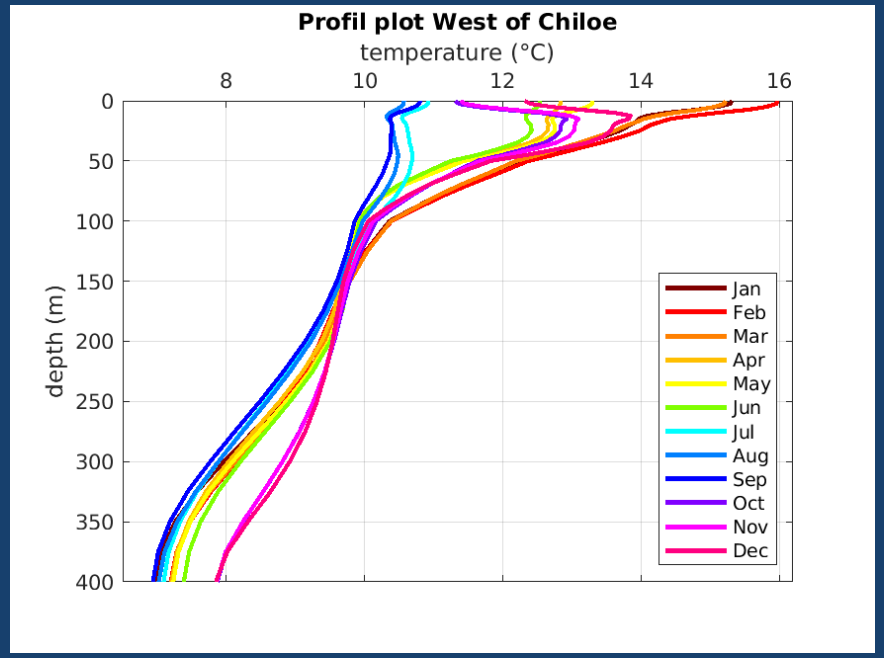
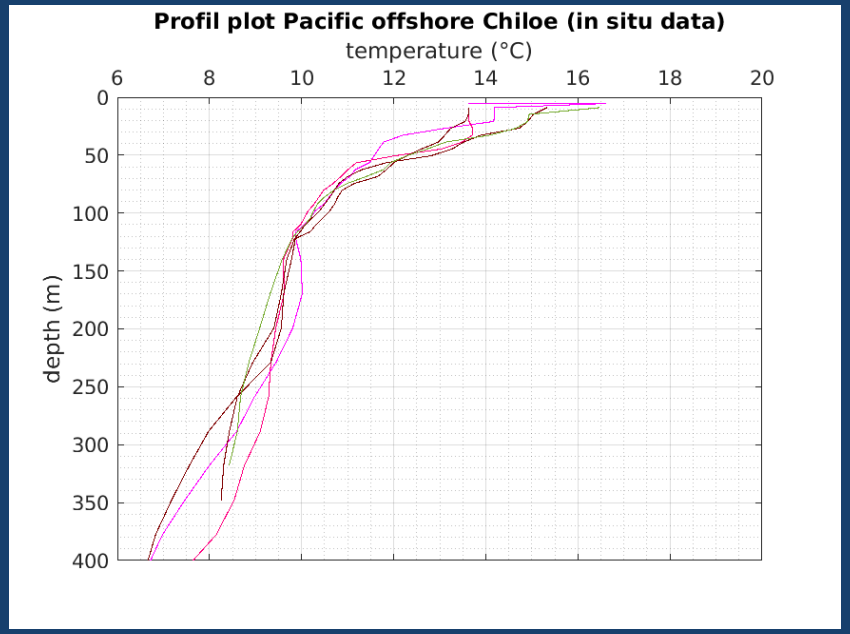
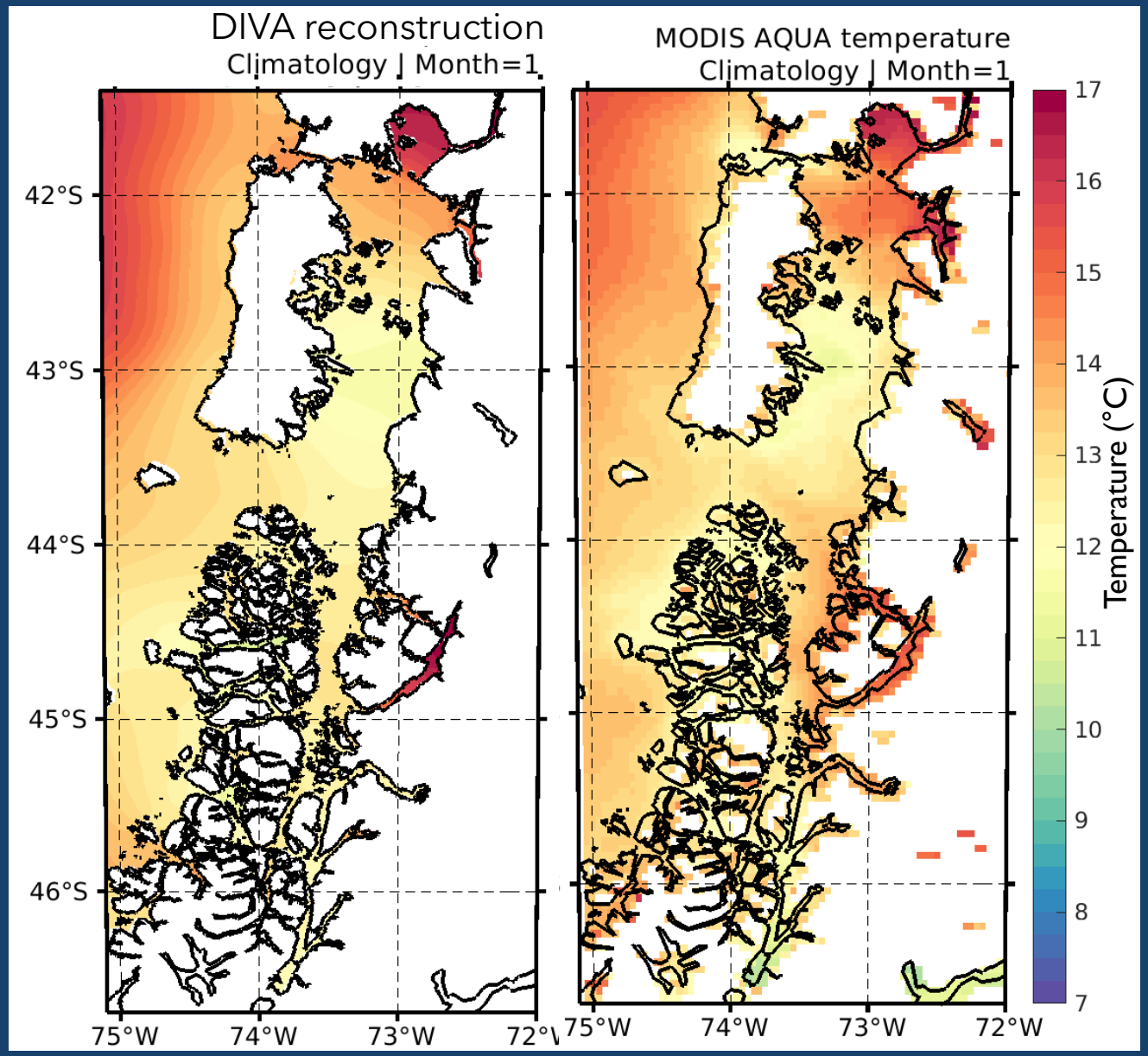
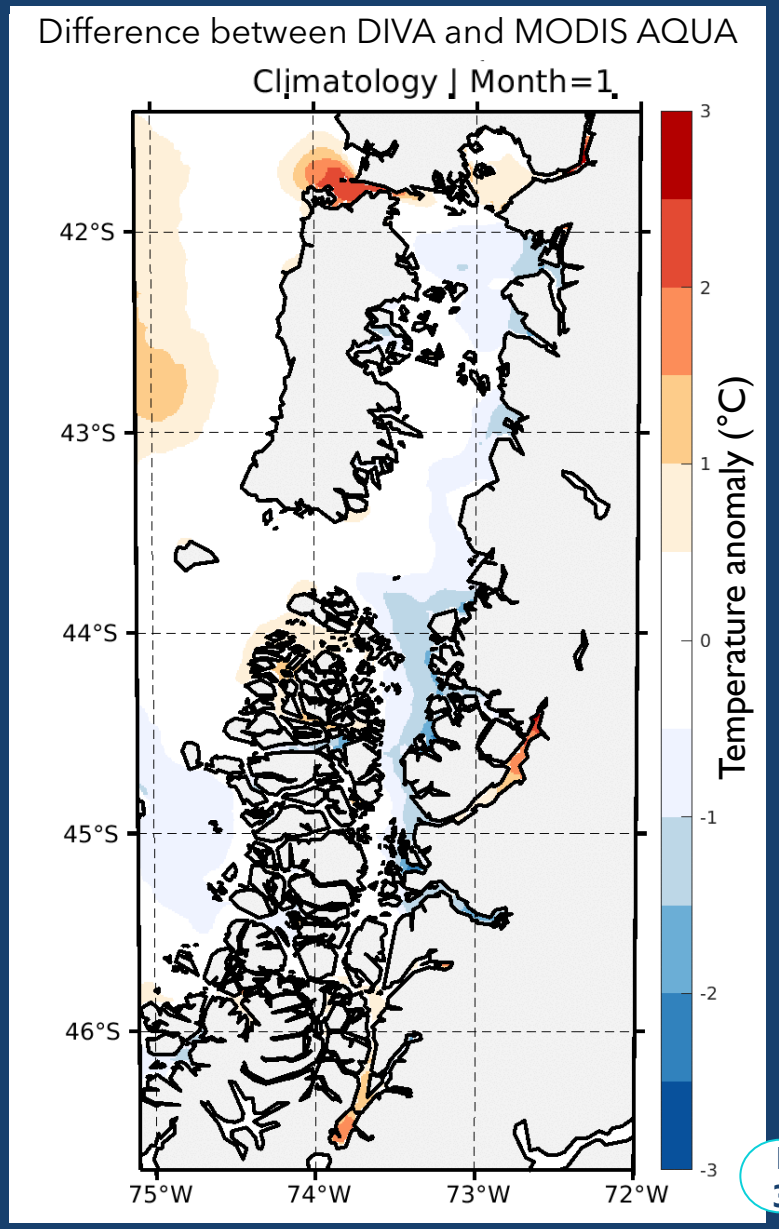






VALIDATION CLIMATOLOGY



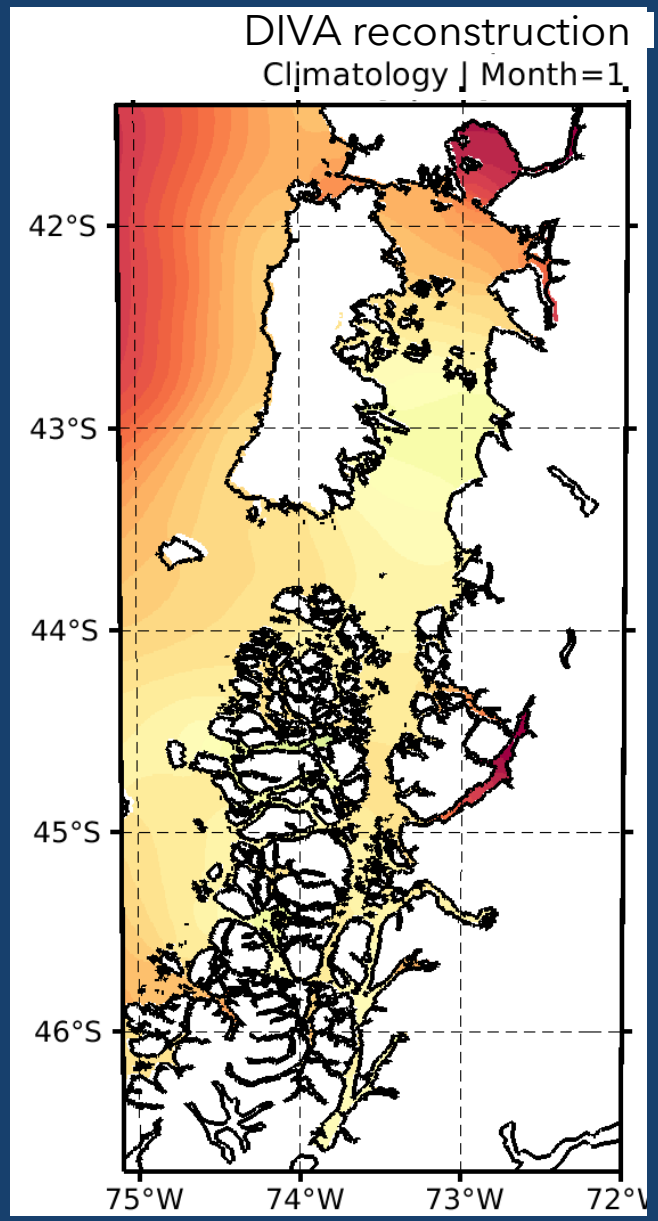


VALIDATION CLIMATOLOGY

5% of the in situ data kept apart for validation

Month	Total data	Whose mooring	Whose not from mooring	Total data kept apart	Data kept appart for validation (whose mooring)	Data kept appart for validation (whose not mooring)
Jan	9128	8693	435	104	99	5
Feb	14369	13685	684	1045	995	50
Mar	14397	13711	686	221	210	11
Apr	8792	8373	419	169	161	8
May	9952	9478	474	633	603	30
Jun	9531	9077	454	349	332	17
Jul	9798	9331	467	519	494	25
Aug	8985	8557	428	488	465	23
Sep	10017	9540	477	786	749	37
Oct	9633	9174	459	509	485	24
Nov	8086	7701	385	1062	1011	51
Dec	9471	9020	451	229	218	11

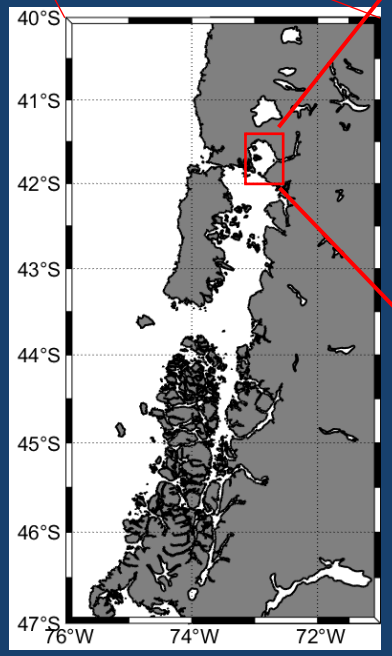
VALIDATION CLIMATOLOGY

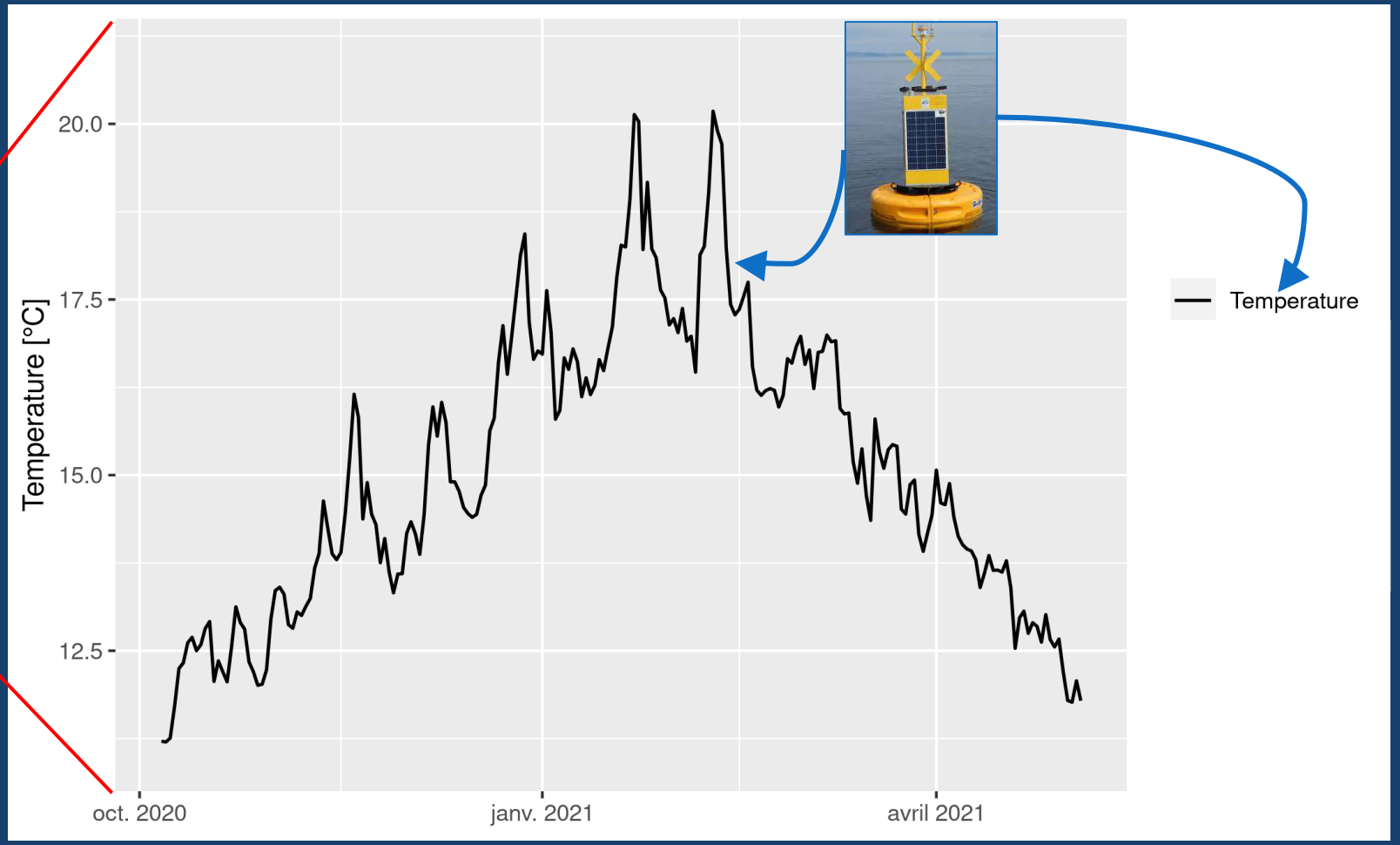


5% of the in situ data kept apart for validation

	Bias between DIVA and in situ (°C)	rms	crms	Standard deviation in situ data
Jan	0,21	1,85	1,83	1,97
Feb	0,04	1,43	1,43	2,05
Mar	0,11	1,14	1,14	1,68
Apr	-0,07	1,01	1,00	0,83
May	-0,08	0,78	0,78	0,77
Jun	-0,08	0,71	0,70	0,46
Jul	0,06	0,87	0,87	0,59
Aug	-0,14	0,71	0,69	0,58
Sep	0,01	0,73	0,73	0,51
Oct	0,20	0,95	0,93	0,82
Nov	0,09	1,23	1,23	1,23
Dec	0,10	1,42	1,42	2,18

RESULTS: MHW DETECTION





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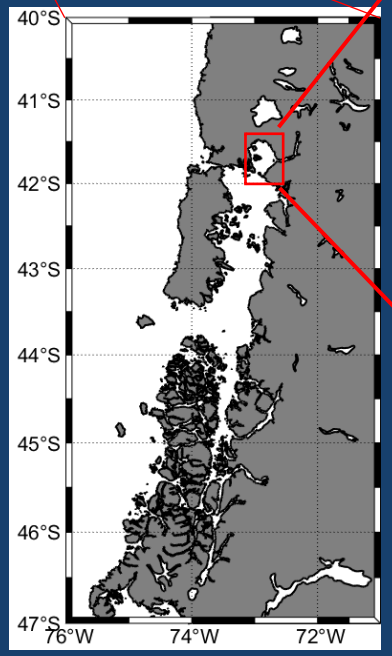

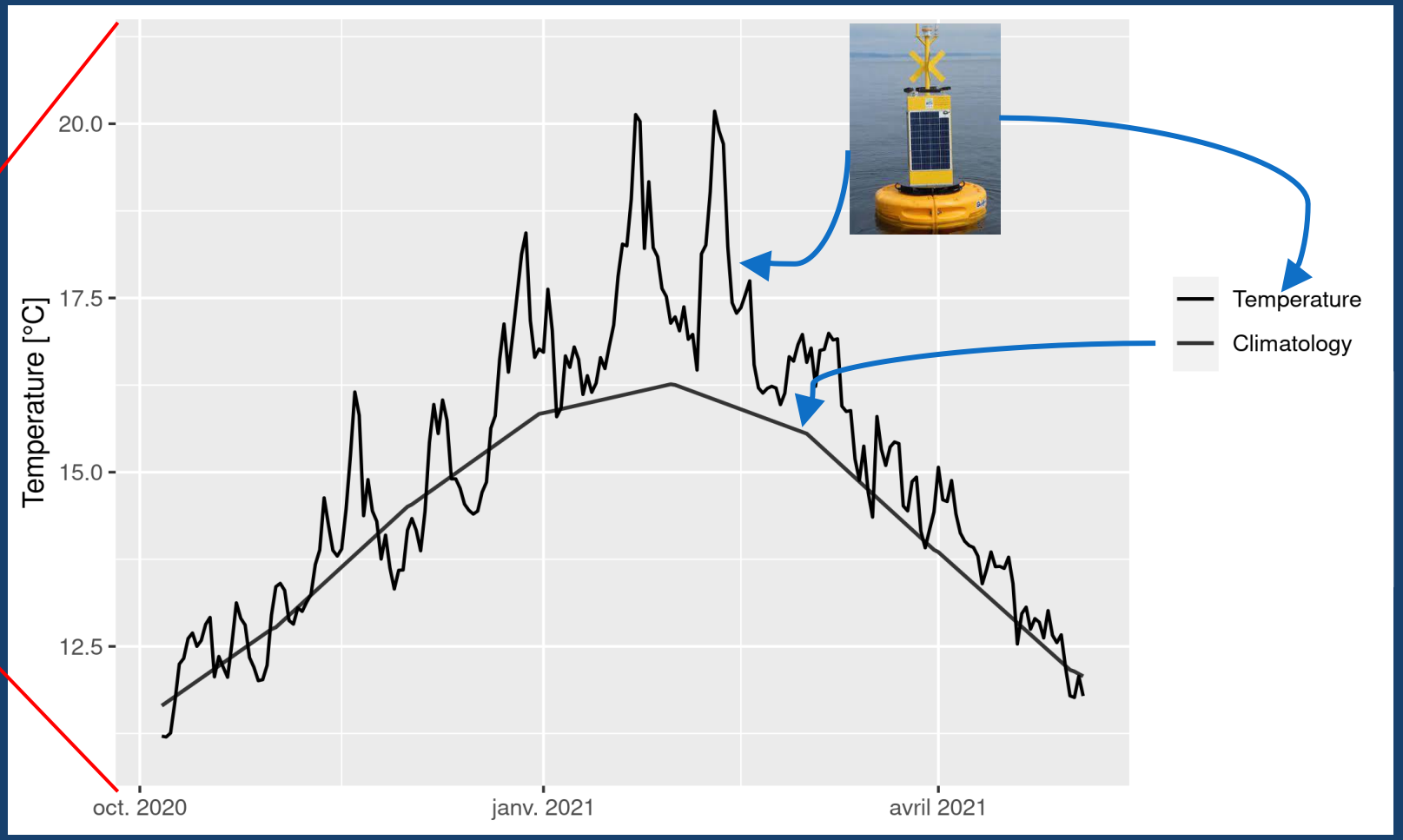

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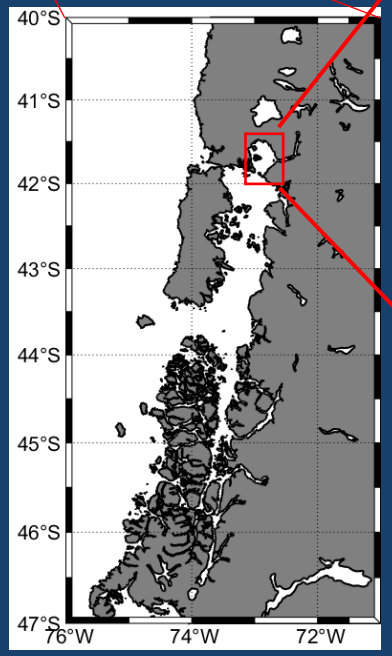

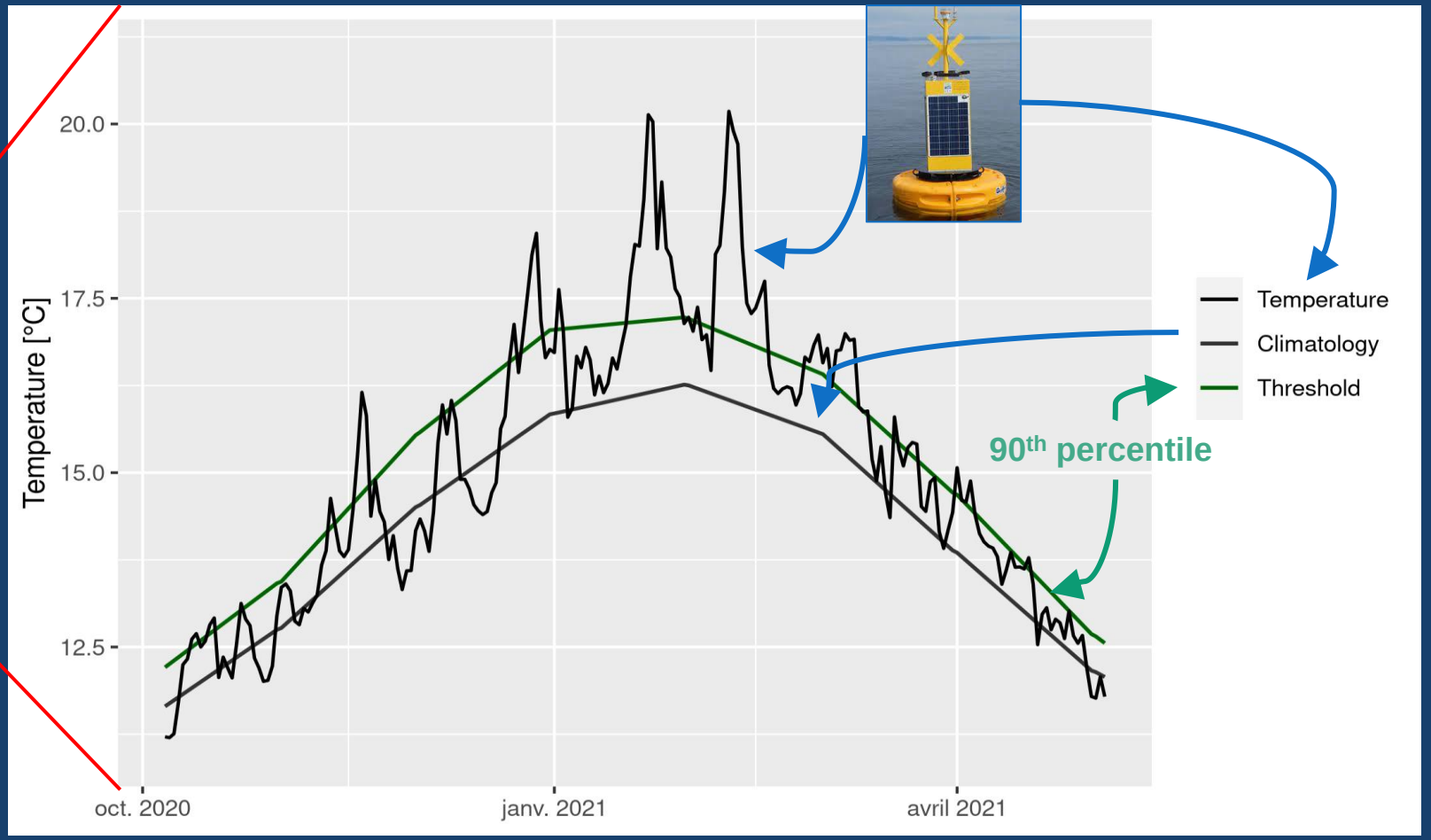

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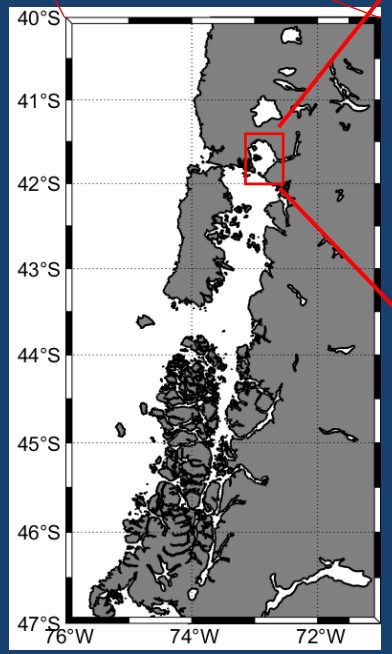

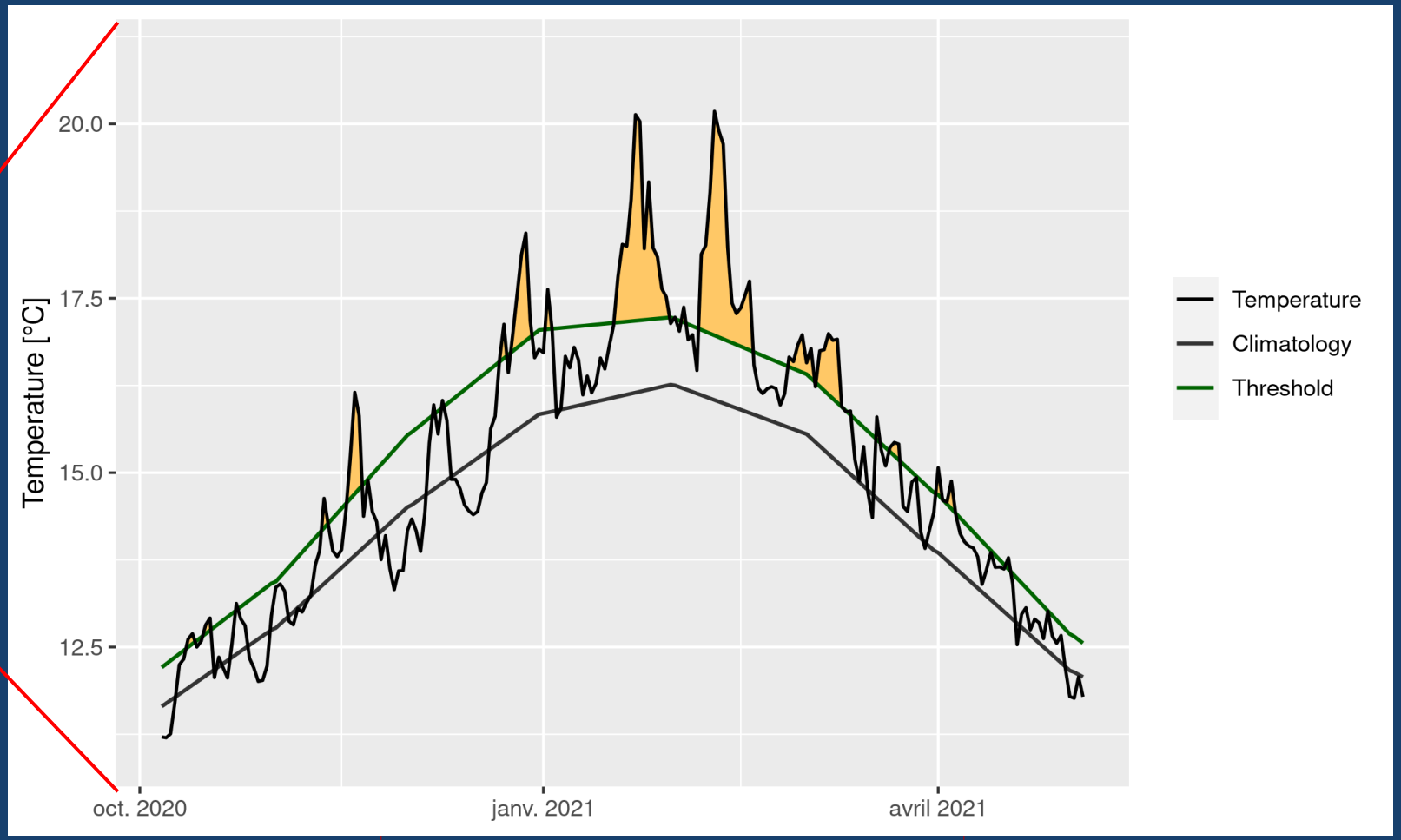

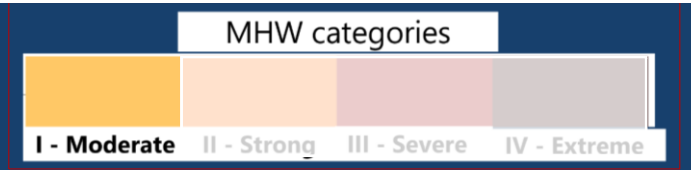

Hobday et al., 2018

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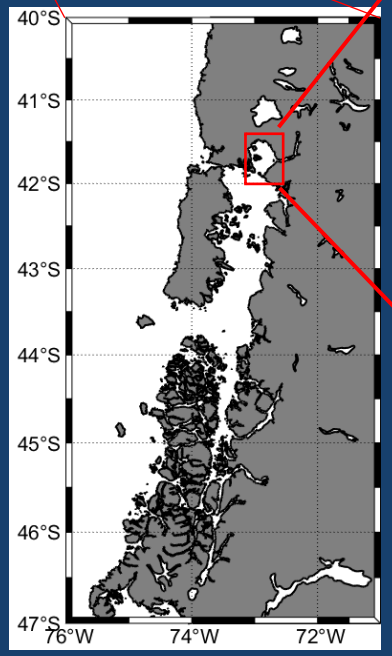

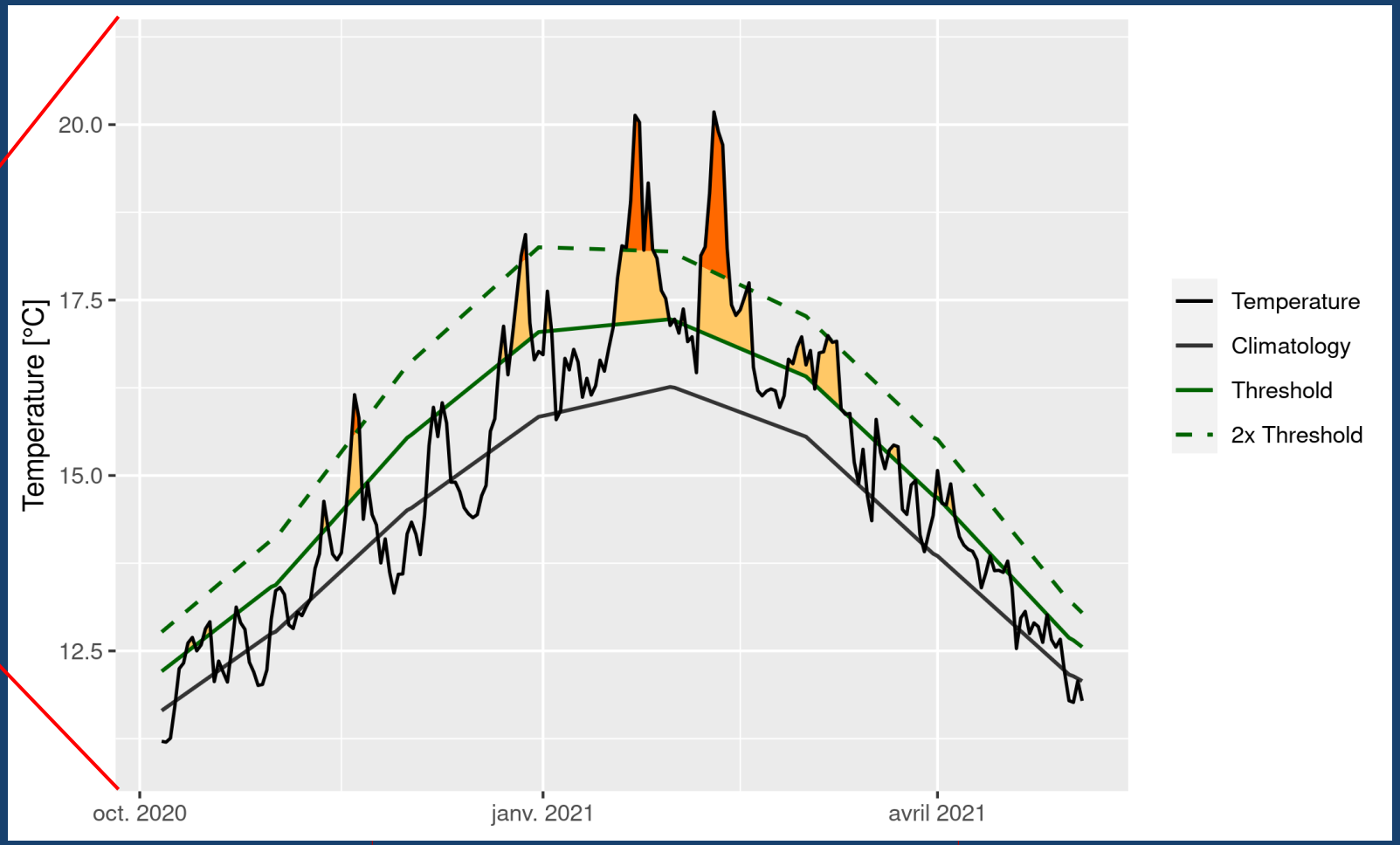

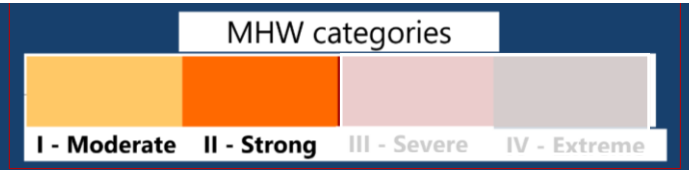

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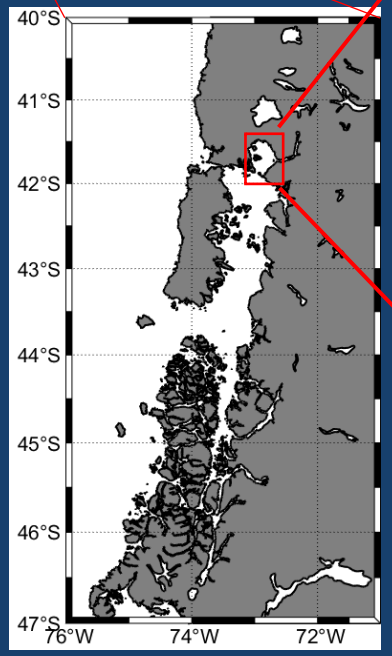

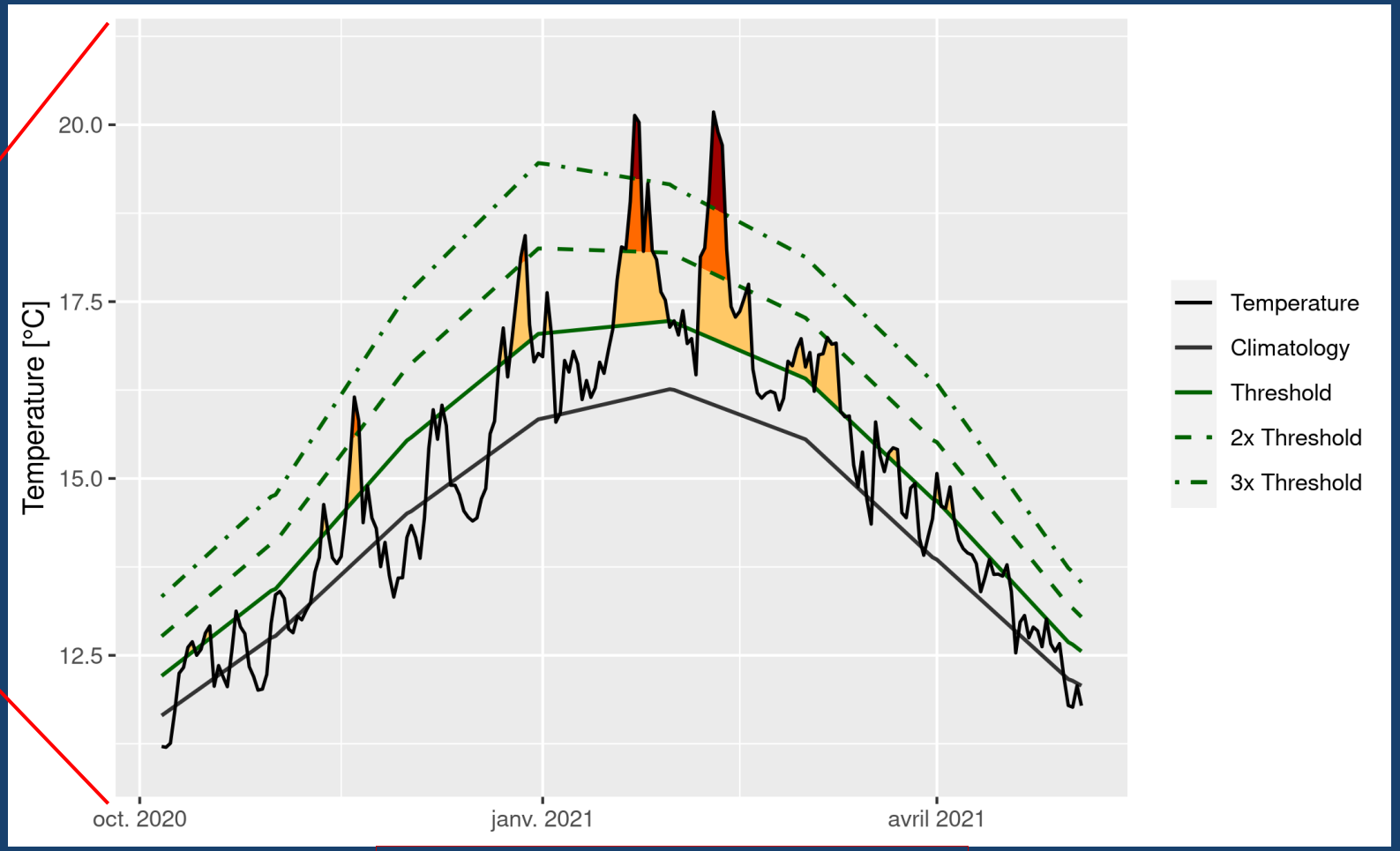

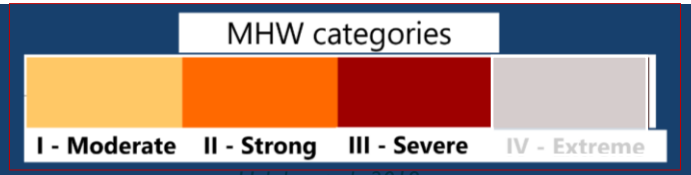

Hobday et al., 2018

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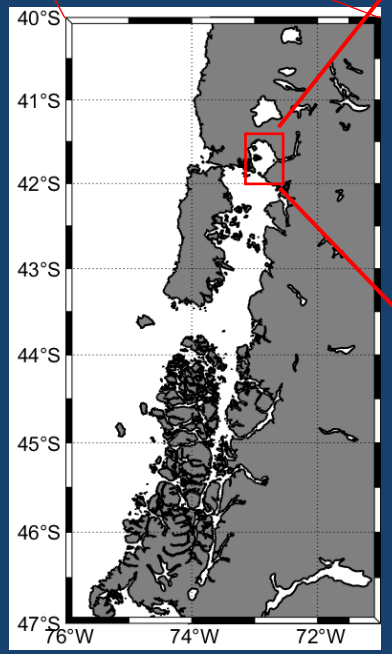

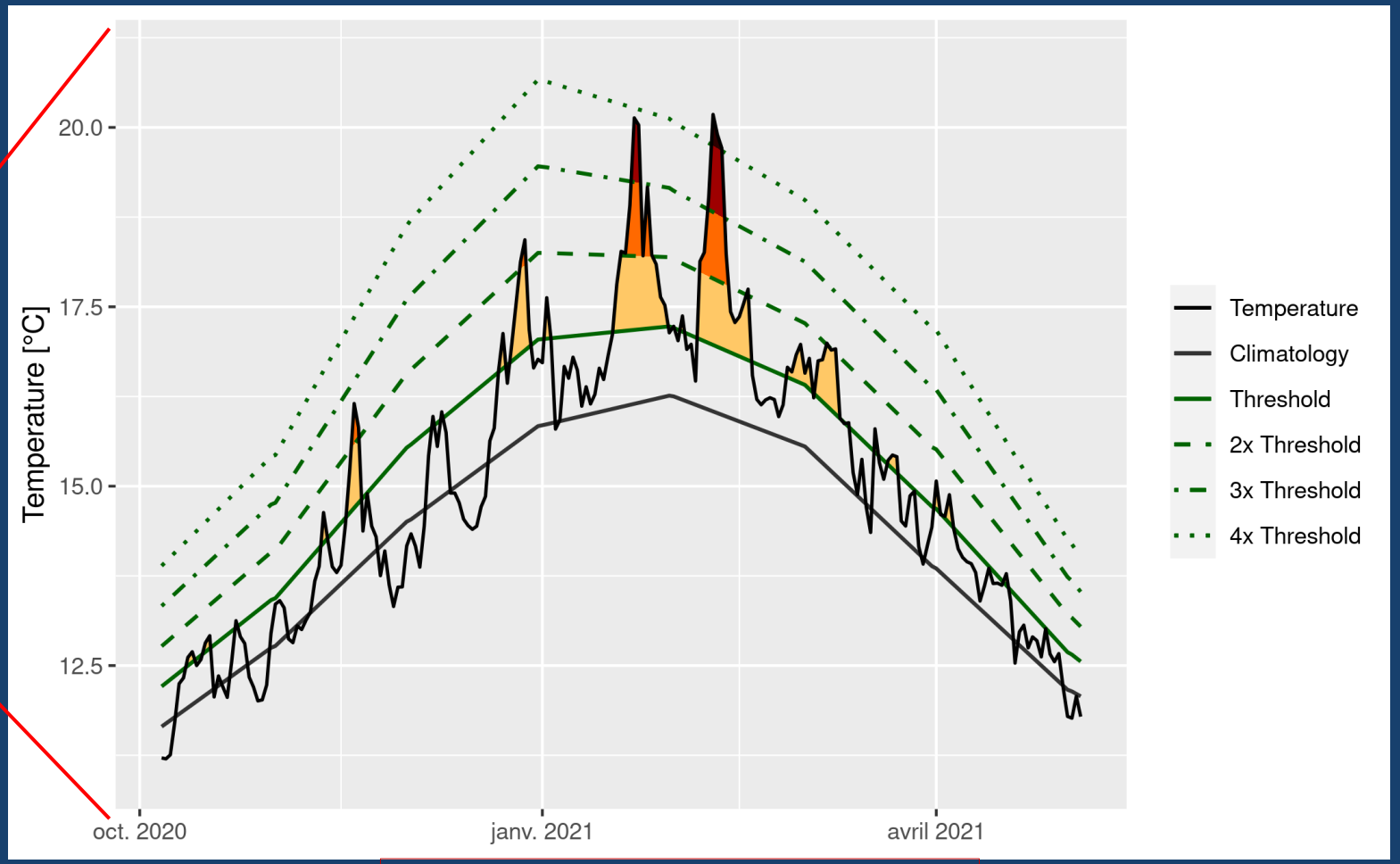

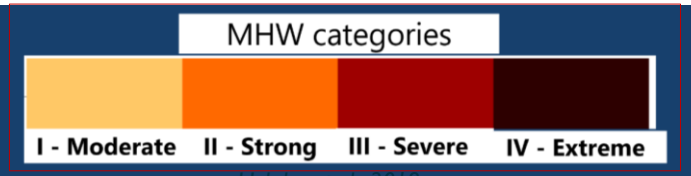

Hobday et al., 2018

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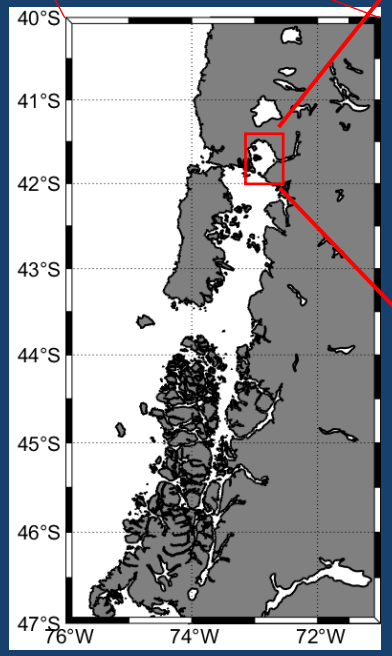
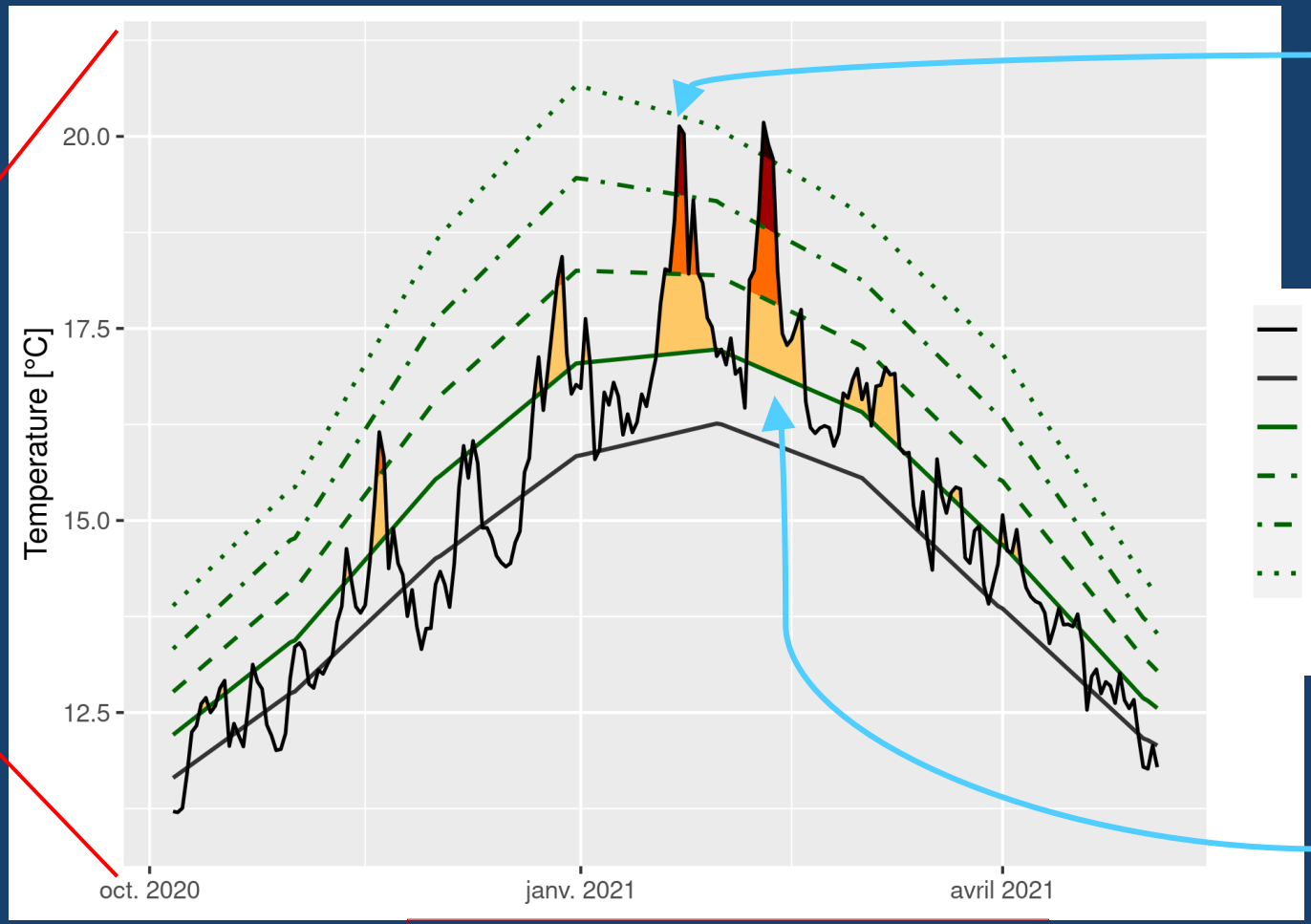
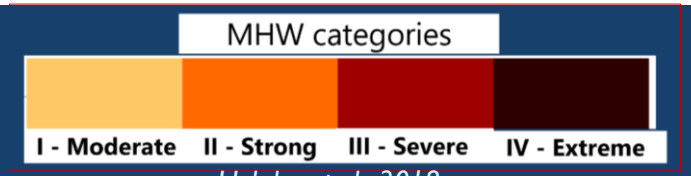




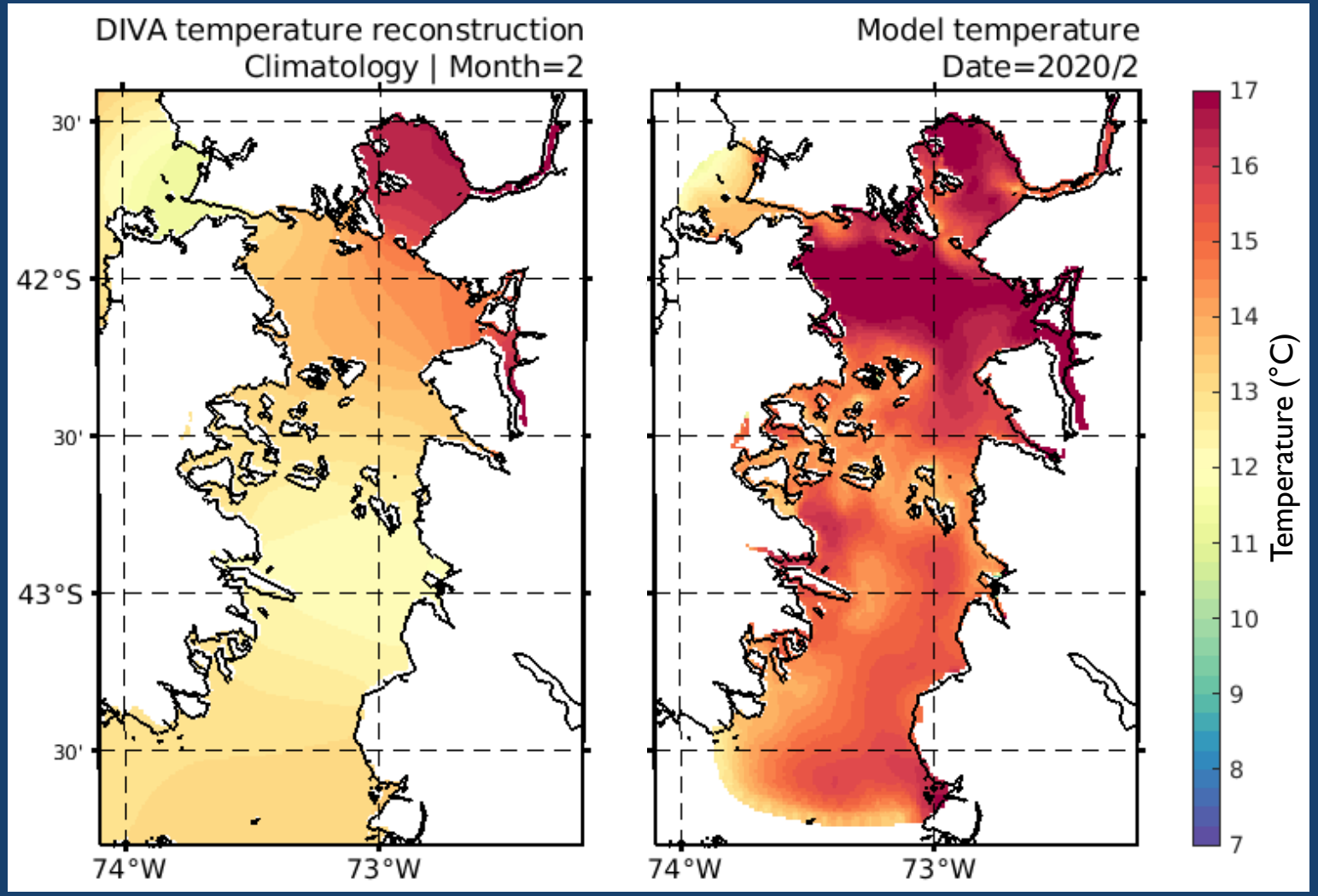
Duration: 12 days
Period: January 2021
Intensity max: 4,0°C
Category III

Duration: 12 days
Period: February 2021
Intensity max : 4,1°C
Category IV



Hobday et al., 2018

RESULTS: SPATIAL MHW DETECTION

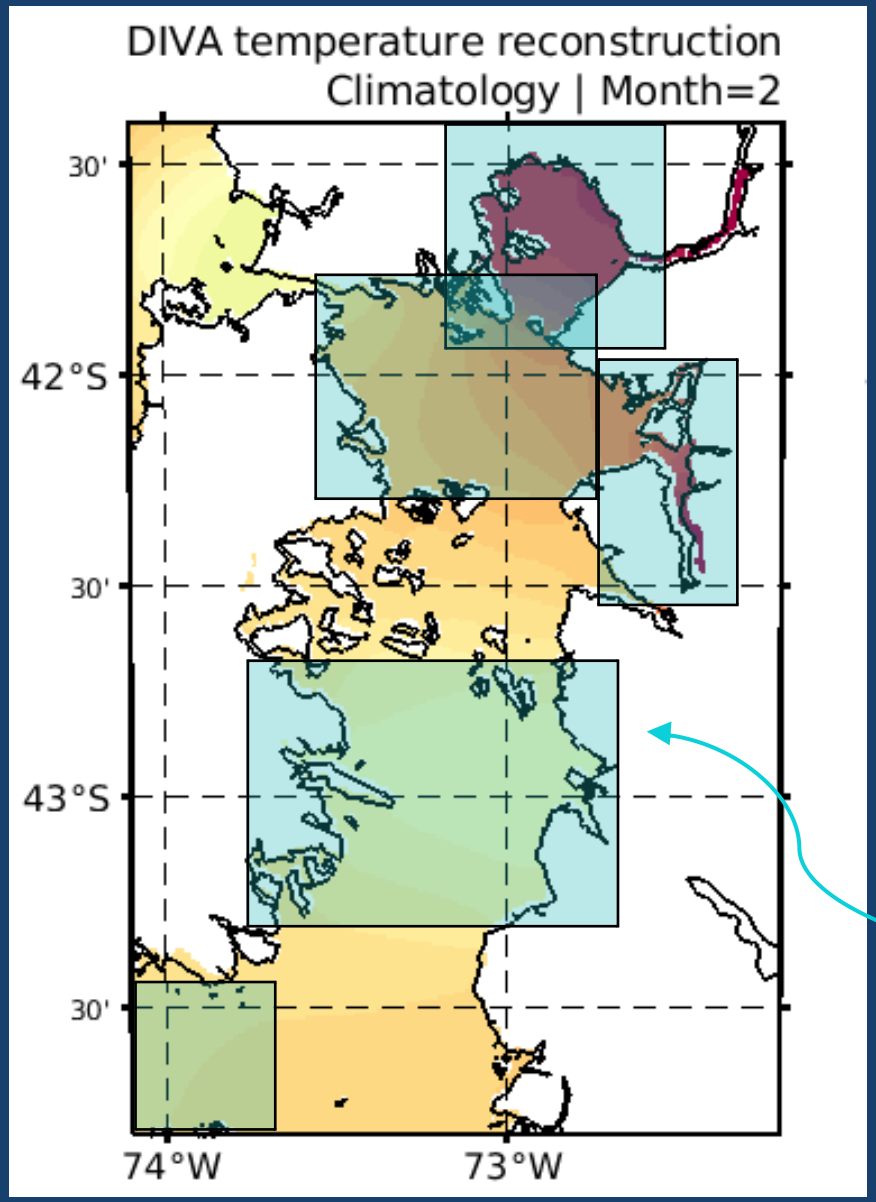


MHW expected !

Problem : how to detect spatially MHWs ?

Need of a threshold

NEED OF A THRESHOLD



Traditionnally : threshold established for every pixel using satellite data

Using in situ data ?

↓

What about places with few data ?

Need to determine areas to increase the number of data available

Using satellite data ?

↓

Need to correct data

Still working…

CONGRESS ON OCEAN EXTREMES IN MAY IN LIÈGE, BELGICA

Ocean Extremes

55th International Liege Colloquium on Ocean Dynamics

27 to 31 May 2024

Given the above terms, the Colloquium will be organized in the following sessions:

- **Drivers and mechanisms** (air-sea interactions, ocean processes, local and remote drivers...)
- **Long-term changes** (paleoclimate, historical reanalyses, future projections, detection and attribution, interactions with climate modes, extremes at high latitudes, long term observations)
- **Compound events** (preconditioned, multivariate events, temporally compounding and spatially compounding, cascading events)
- **Predictions** (novel forecasting approaches, numerical modeling and machine learning, operational systems, applications and technologies, adequacy of observations and monitoring)
- **Impacts and Adaptation** (short-term and long-term, coastal, individual and cumulative impacts on ecosystems, socio-economic impacts, adaptation, governance)