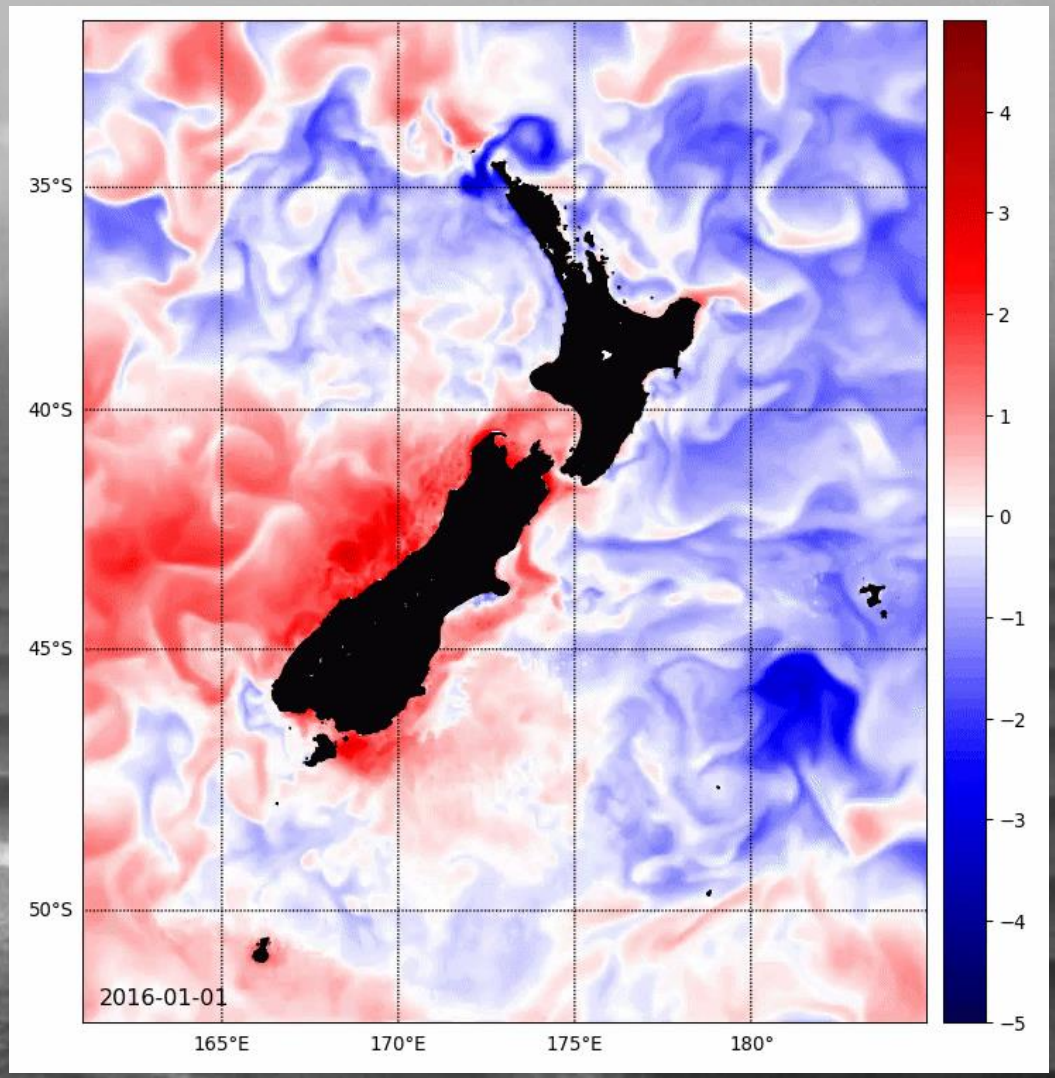
https://www.moanaproject.org/

# Assimilation of fishing vessel derived observations into an operational ocean forecast system

Dr Joao Souza[1] (presenter) - j.souza@metocean.co.nz
In the name of all the researchers participating in the Moana Project and the members of the MetOcean Research and Development team.

[1] MetOcean Solutions, part of the Meteorological Service of New Zealand

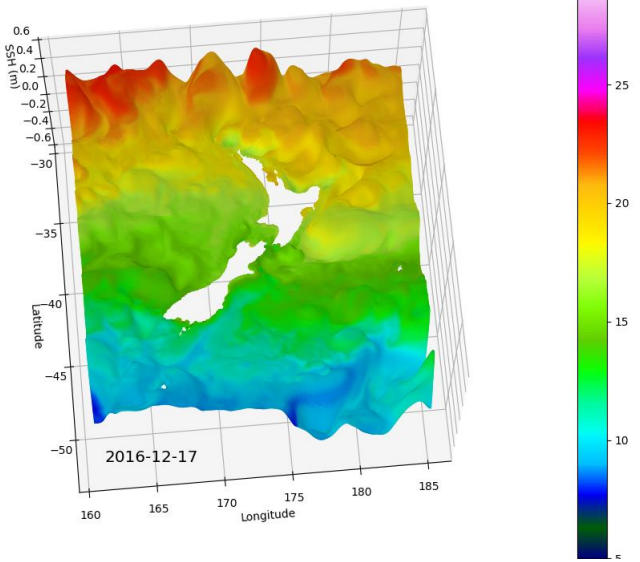
**Goal:** Revolutionize Ocean Observing and Modelling in New Zealand to support the Blue Economy by providing accurate ocean **observations**, ***models*** and ***data products***.



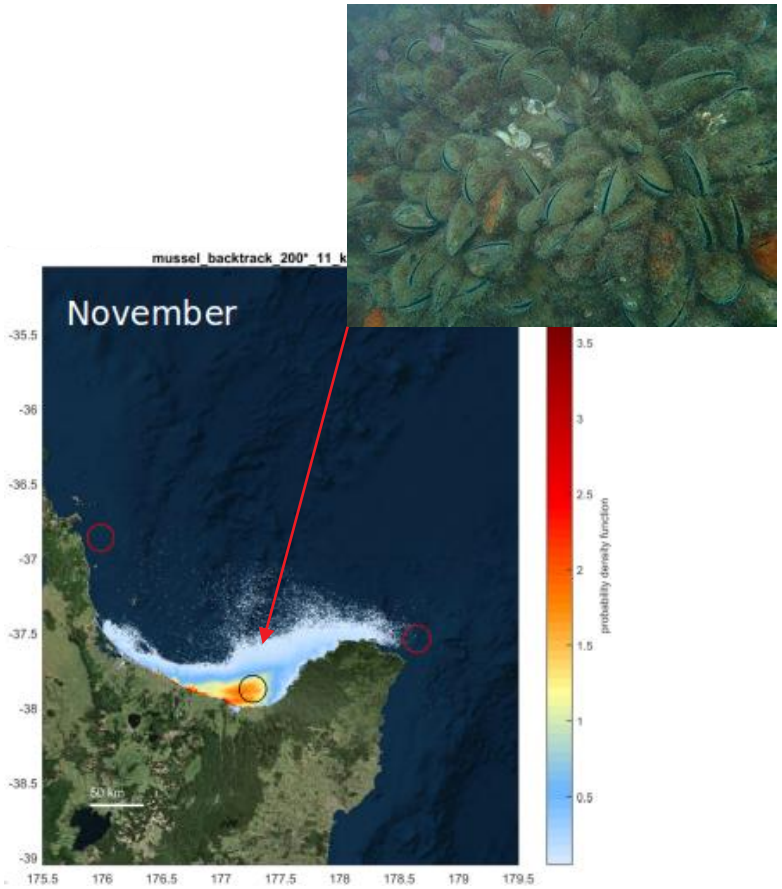

Difference between daily Sea Surface Temperature and the expected climatological value.

From the **Moana Backbone** 25 years simulation

- **Cross-cultural ocean knowledge platform**
- **Nation-wide ocean observing capability**
- **Nation-wide, open-access, ocean modelling system**
- **Predicting the source, transport and settlement of marine taonga species**


Sea Surface Height (SSH) and Sea Surface Temperature (SST – colors) from the Moana Backbone model.




**He Papa Moana**

**Te Tiro Moana**

**Ngā Ripo o Te Moana**

**He Hono Moana**

**Whai Hua – Impacts and Benefit**

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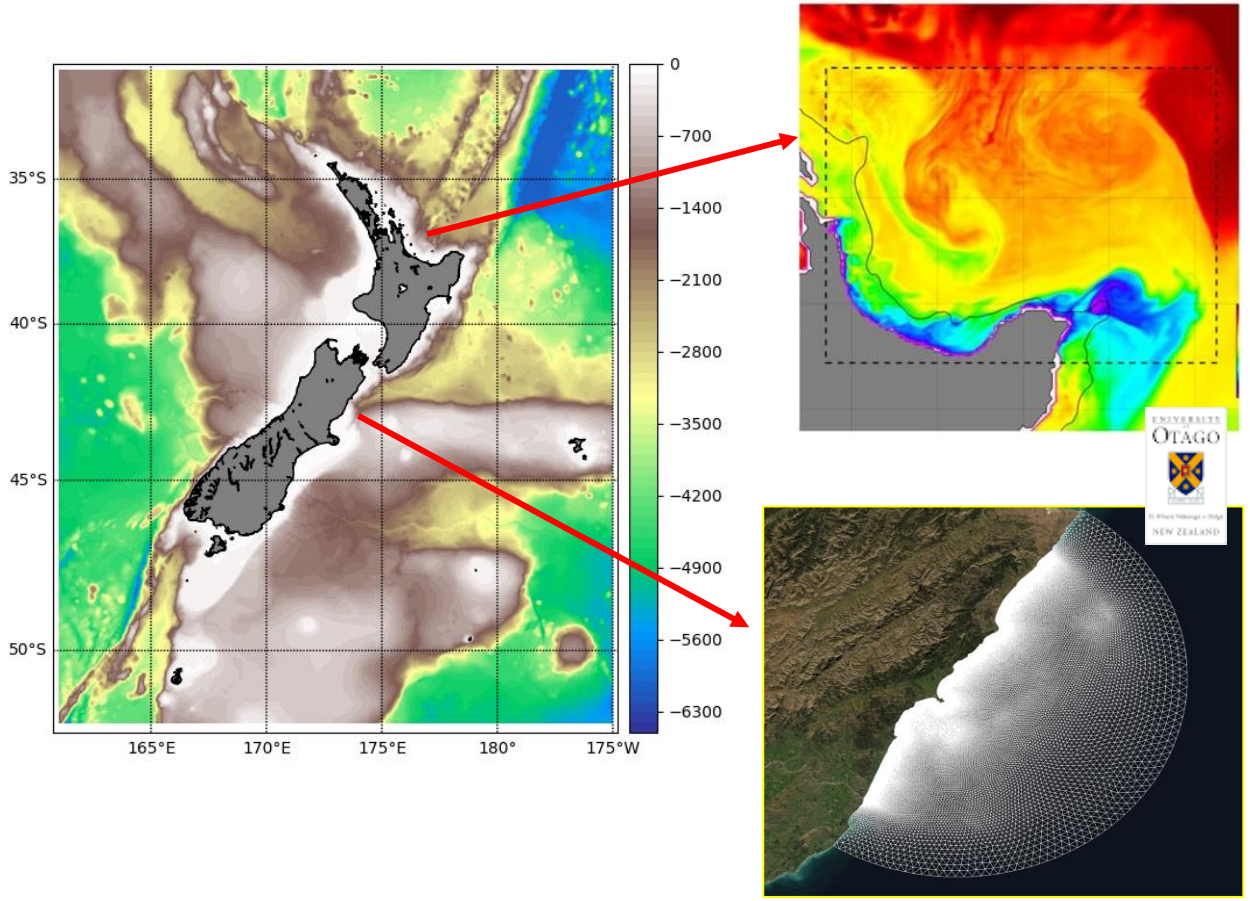
# OCEAN MODELS




"25+" years Hindcast + Reanalysis + Forecast

Data Assimilation

**https://www.moanaproject.org/hindcast**

# DERIVED PRODUCTS

7-day forecast & nowcast

Marine 25-year historical data

**Marine heatwave hindcast & forecast**

Hydrodynamic models:
- NZ EEZ
- Bay of Plenty
- Kaikoura

Ocean particle trajectory tracking tool:
- Plastics
- Larvae
- Bio-invasive
- Oil spill
- Search & Rescue
- Contaminants

**HE HONO MOANA**

**NGĀ RIPO O TE MOANA**

**HE PAPA MOANA**

**TE TIRO MOANA**

Temperature profile data from thousands of fishing trips available to the fishers who collect them

NZ ocean observation data liberated, quality checked and stored in open-access catalogue (NZ-ODN)

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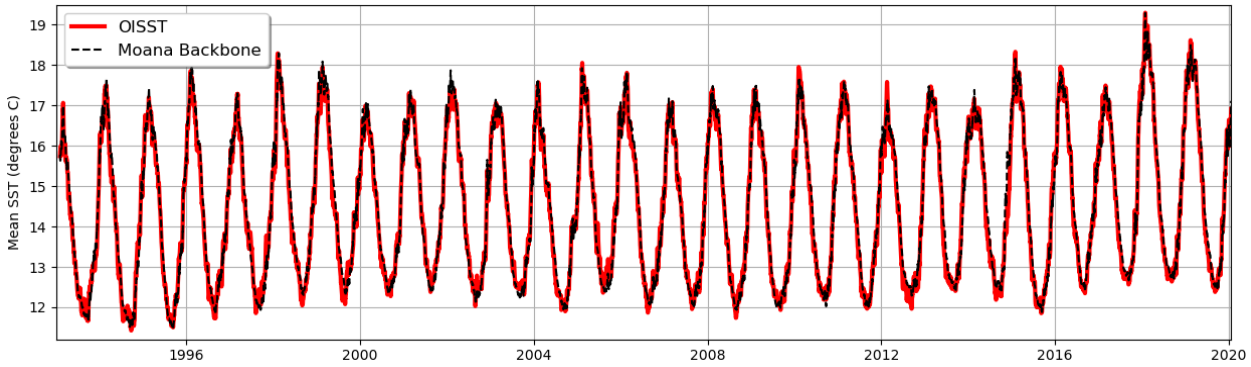
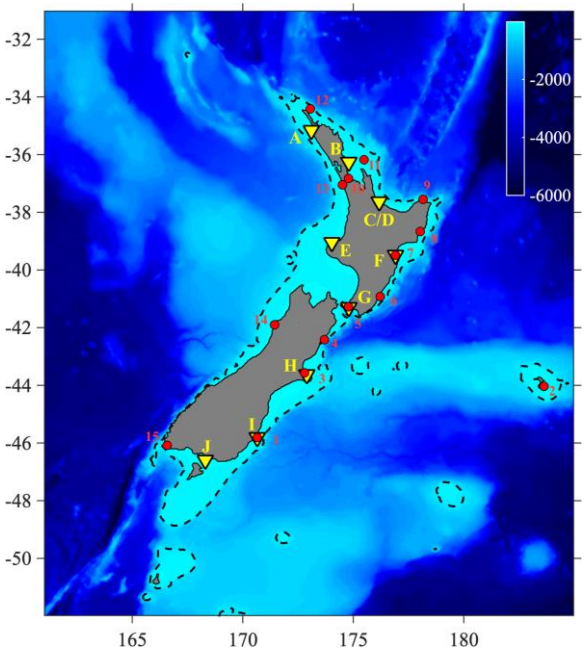
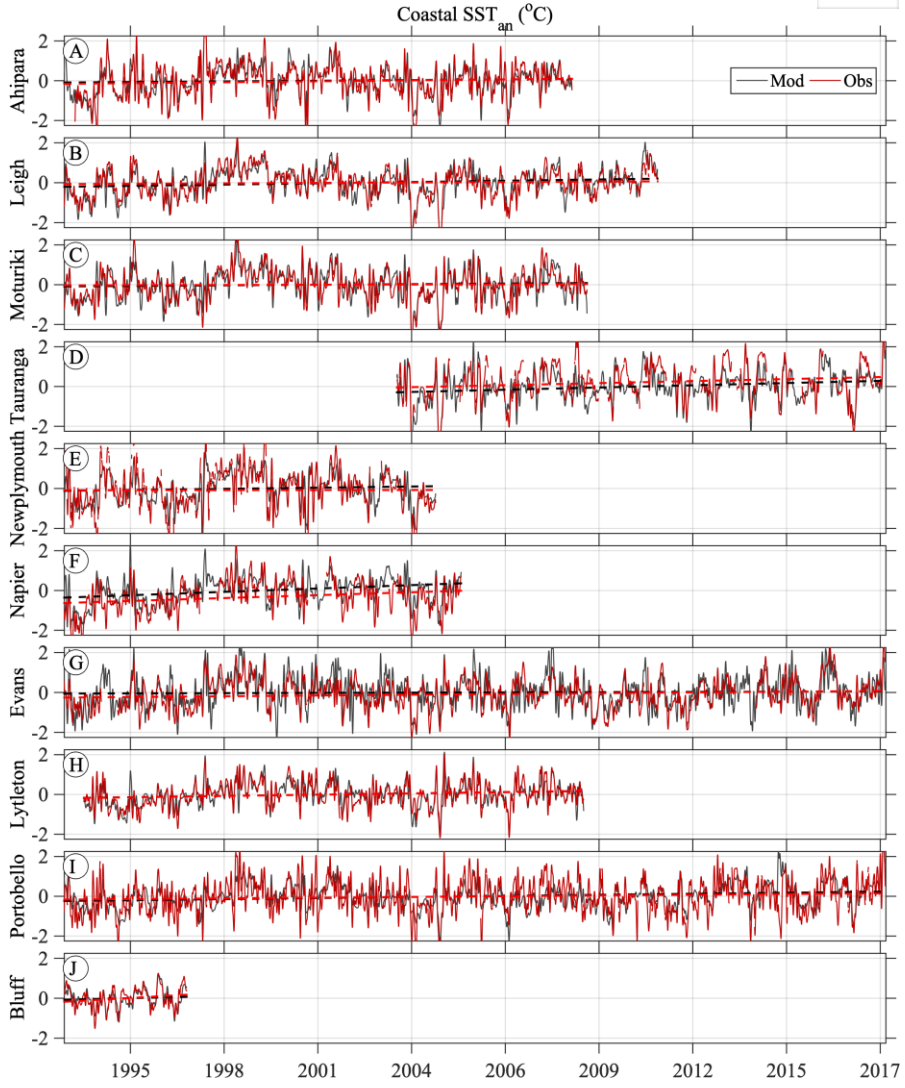
# Model evaluation - SST




| Variable | RMSE | MAE | MaxAE |
|---|---|---|---|
| SSH (m) | 0.11 | -0.04 | 0.25 |
| SST (°C) | 0.23 | 0.18 | 1.53 |

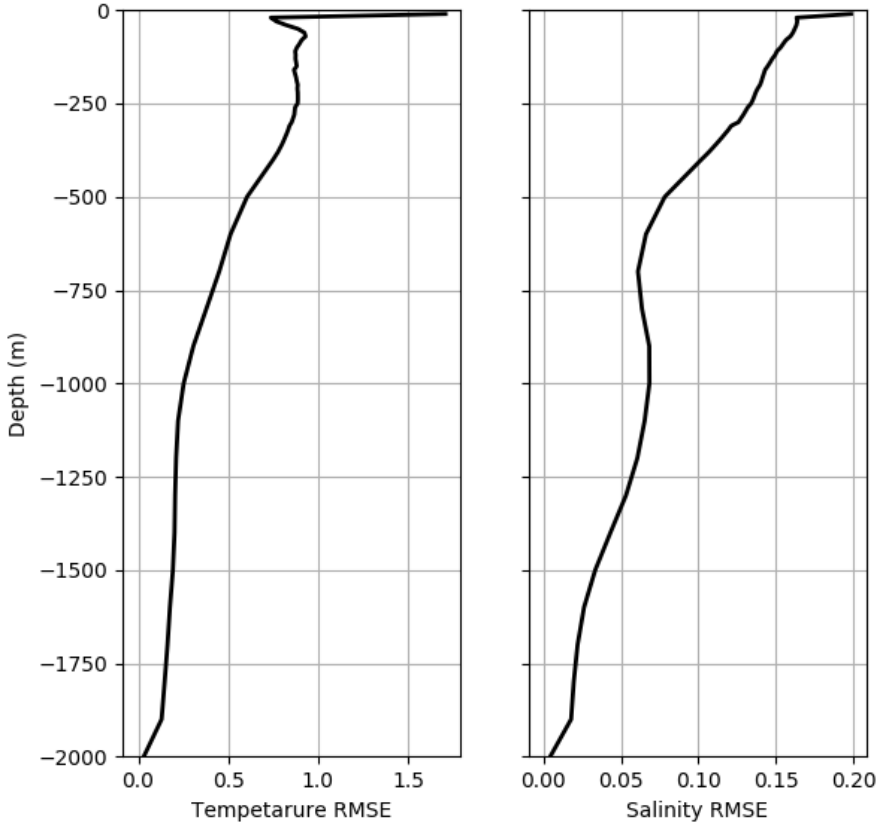


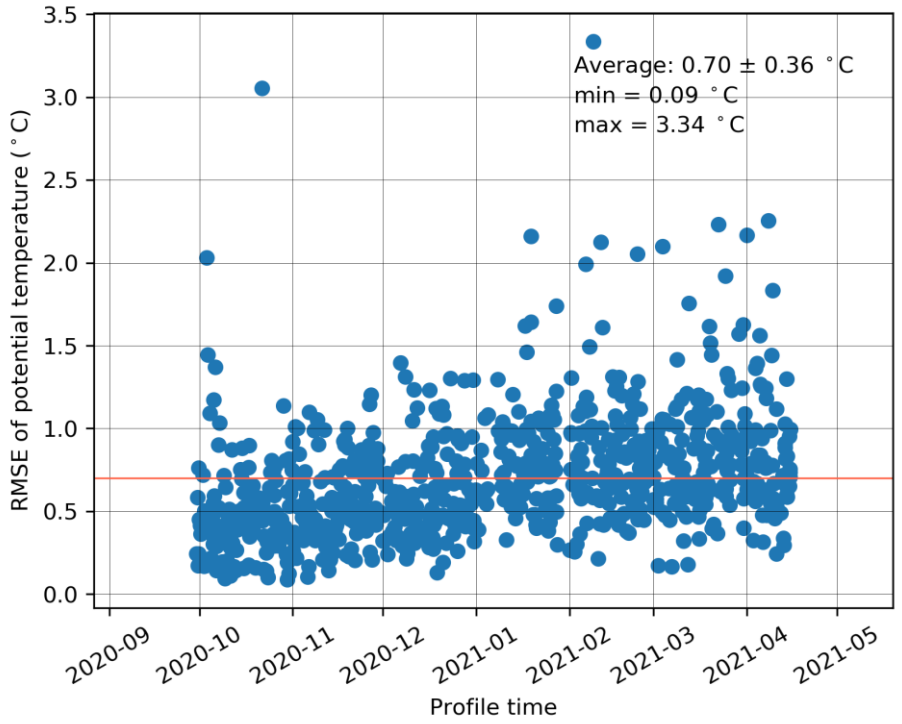

| Wilmott Skill |
|---|
| 0.85 |
| 0.87 |
| 0.87 |
| 0.86 |
| 0.83 |
| 0.77 |
| 0.76 |
| 0.86 |
| 0.70 |
| 0.88 |

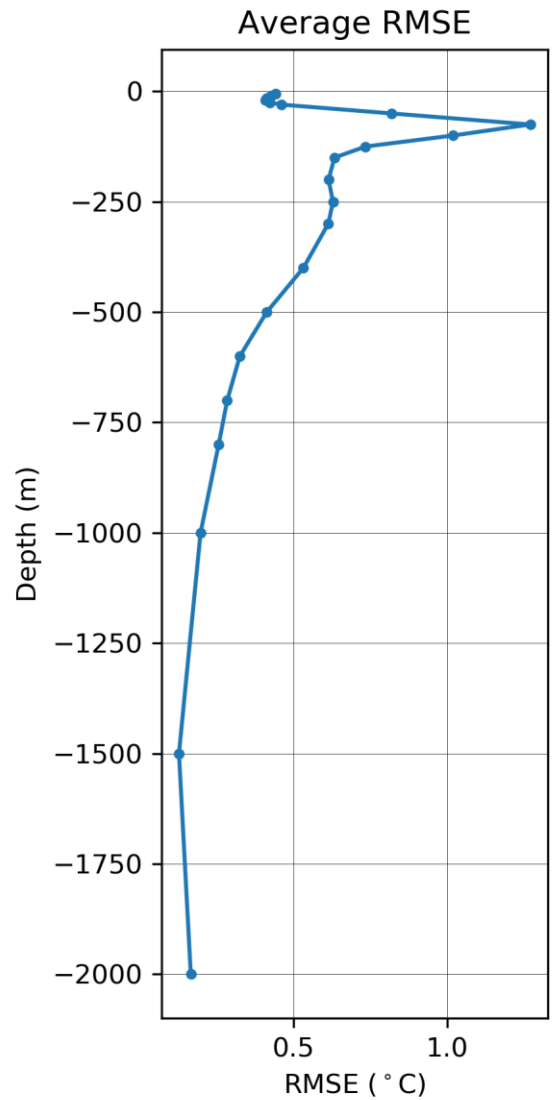

Azevedo Correia de **Souza**, J. M., Suanda, S. H., Couto, P. P., Smith, R. O., Kerry, C., and Roughan, M.: **Moana Ocean Hindcast – a 25+ years simulation for New Zealand Waters using the ROMS v3.9 model**, EGUsphere [preprint], https://doi.org/10.5194/egusphere-2022-41, 2022.

# Model evaluation – Argo profiles CORA5.2 / Argo – Root mean square error

**Souza** et al: **Moana Ocean Hindcast – a 25+ years simulation for New Zealand Waters using the ROMS v3.9 model**, EGUsphere [preprint], https://doi.org/10.5194/egusphere-2022-41, 2022.




**HINDCAST**

Jan 1993 – Dec 2020

**FORECAST**

**Suanda et al.** in preparation for submission to *Geoscientific Model Development*

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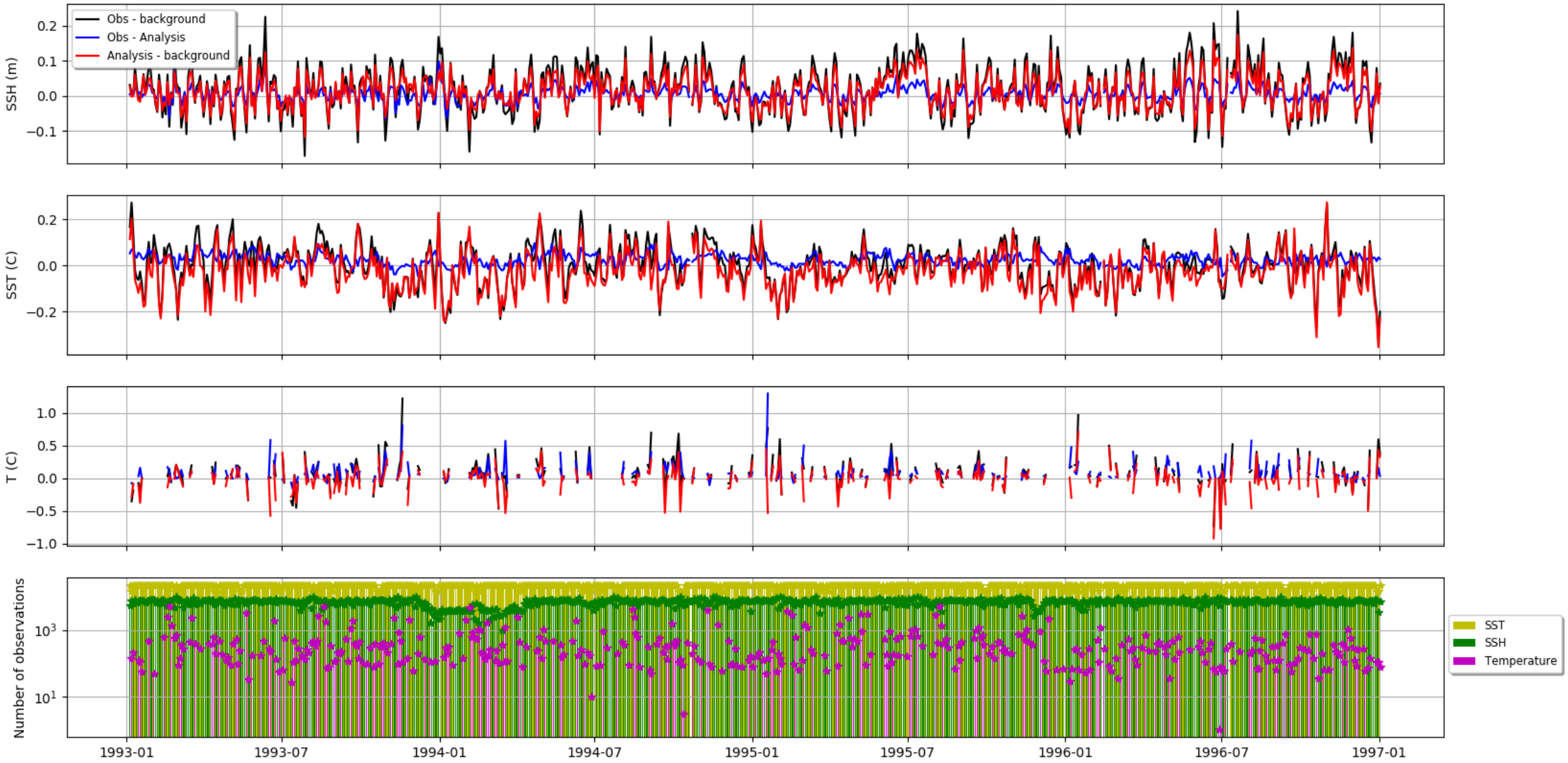
# Model evaluation – Reanalysis

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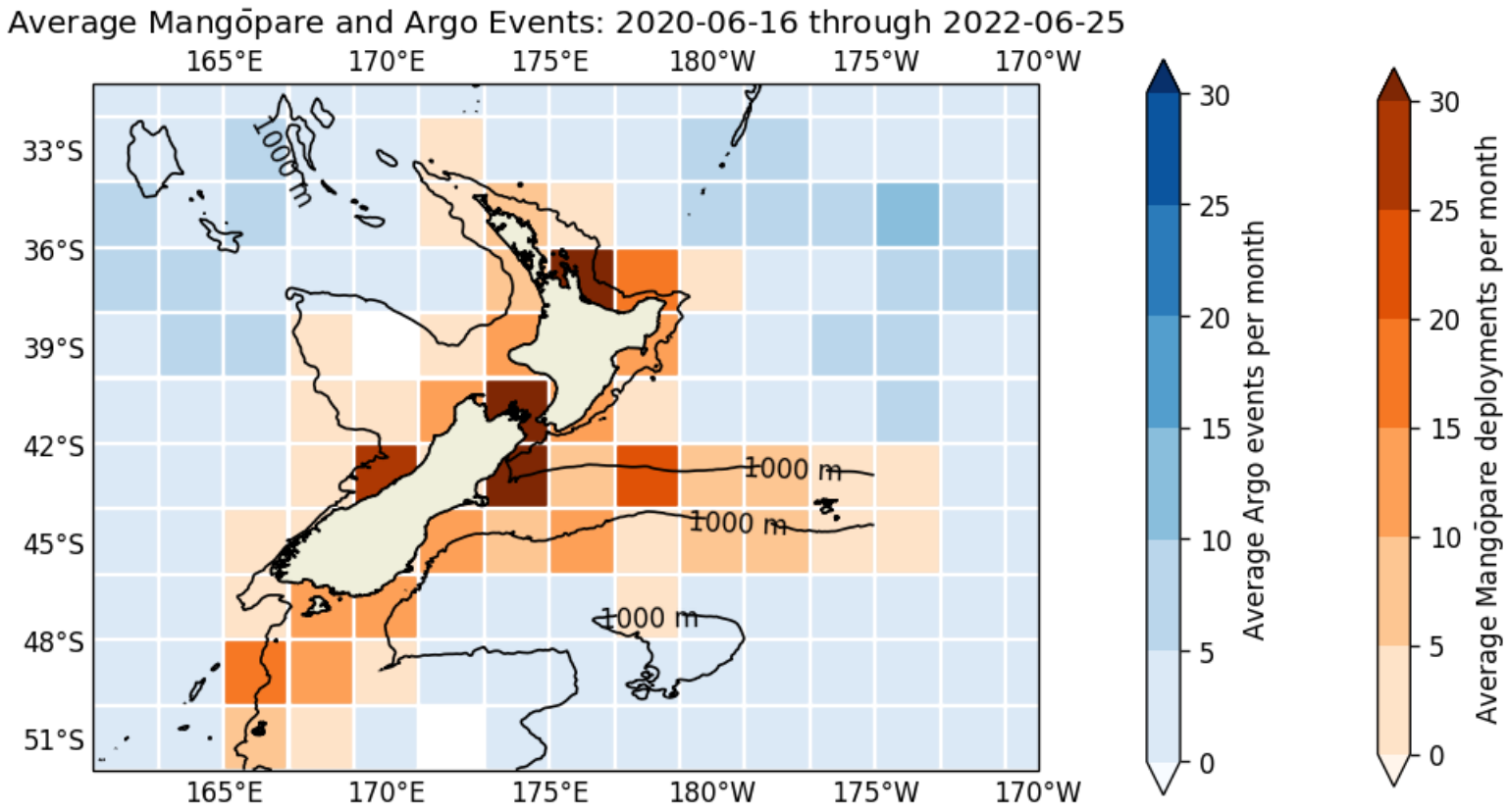
# New observations in collaboration with the fishing fleet - *Mangōpare sensor*


**See Julie Jakoboski talk for more details!**

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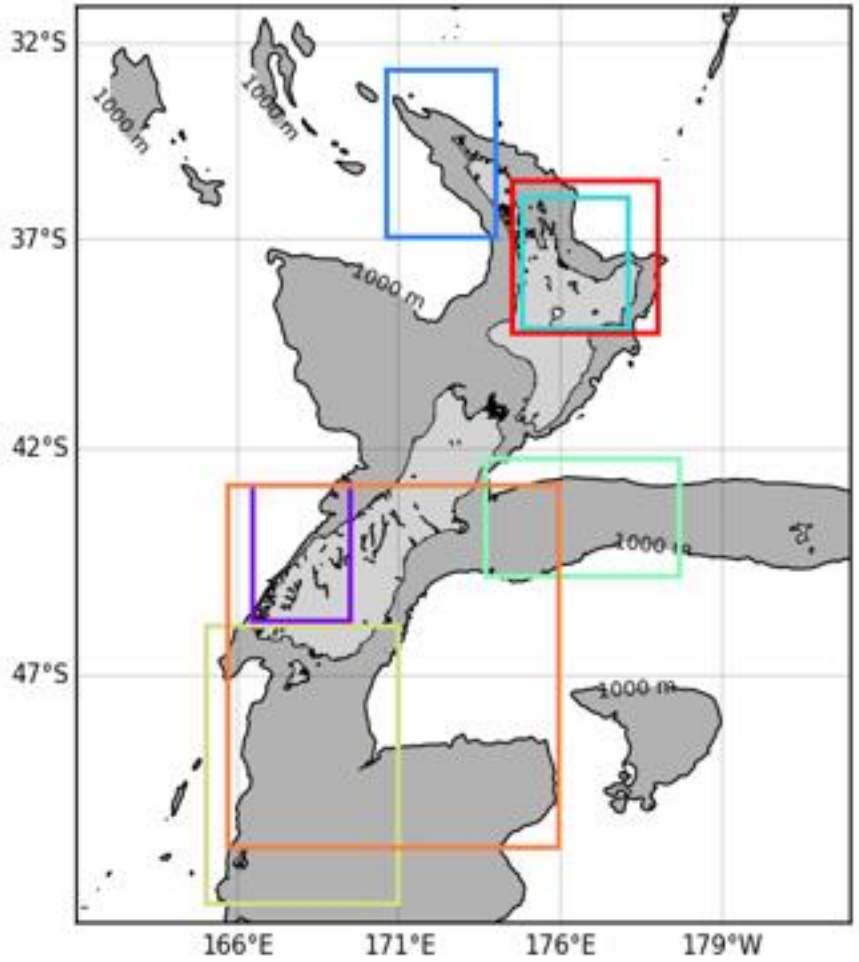
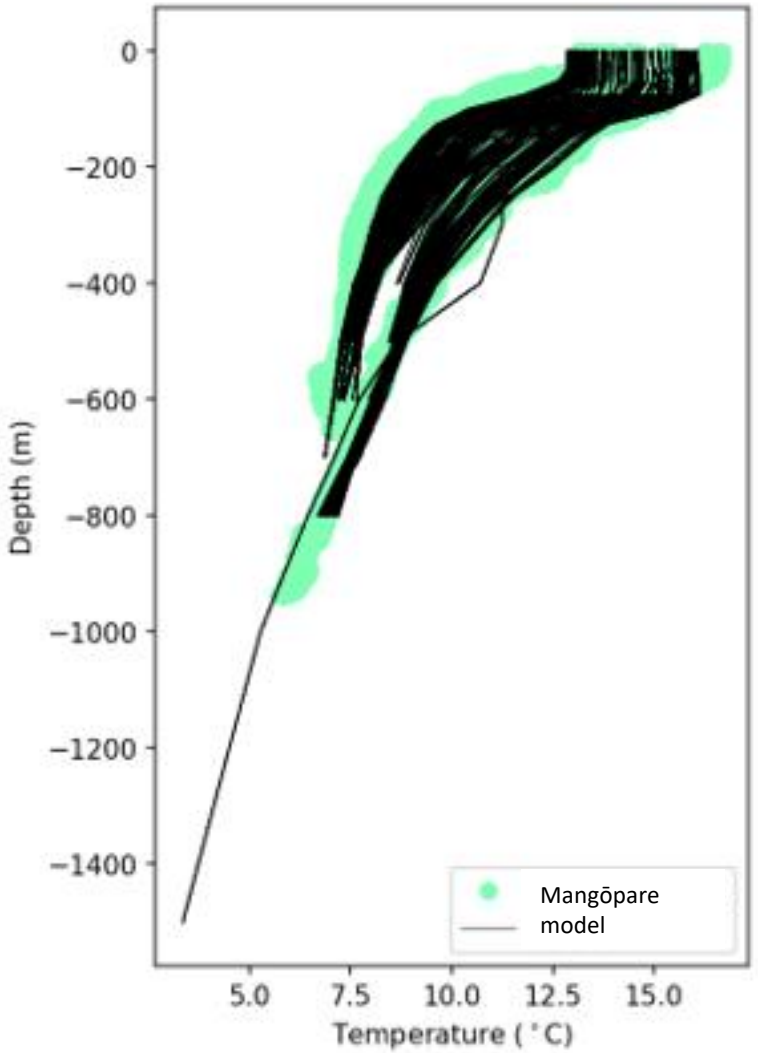
# How accurate is the Moana Project forecast? Temperature profiles - Mangōpare

Regions of Mangōpare Sensor Data
2021-April 20 to 2021-April-27




Mangōpare observations
courtesy of Talleys Group Ltd

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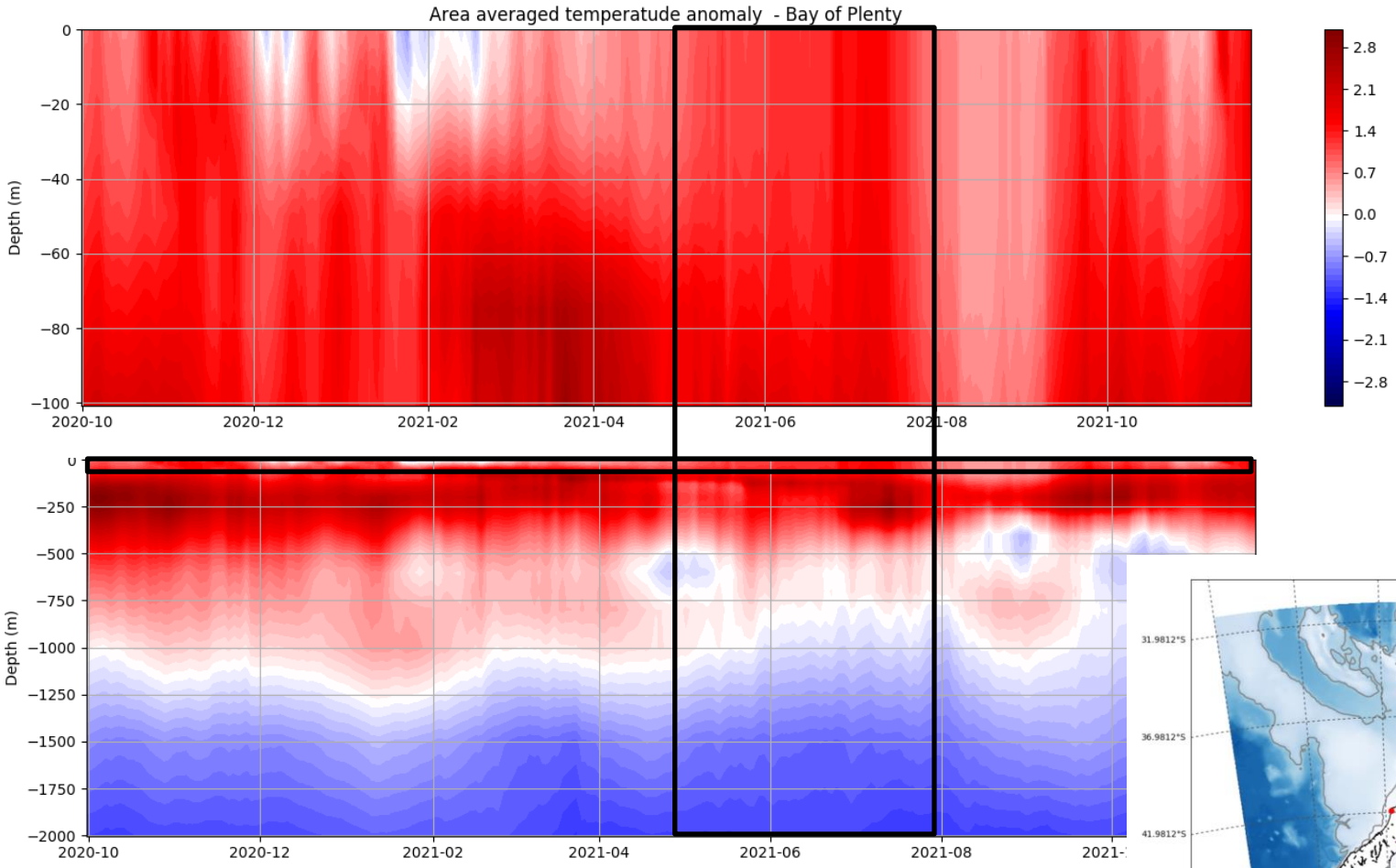
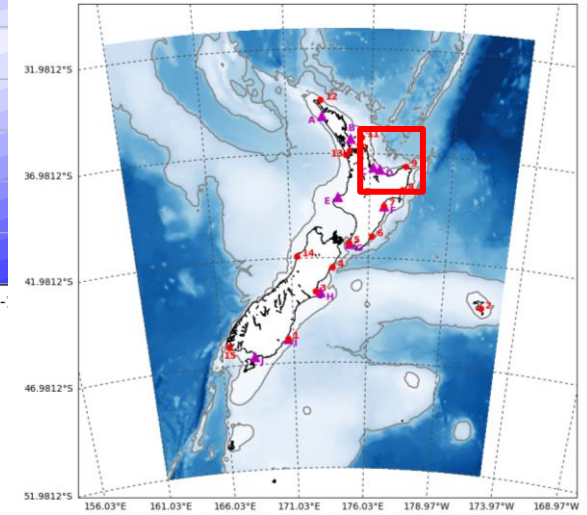
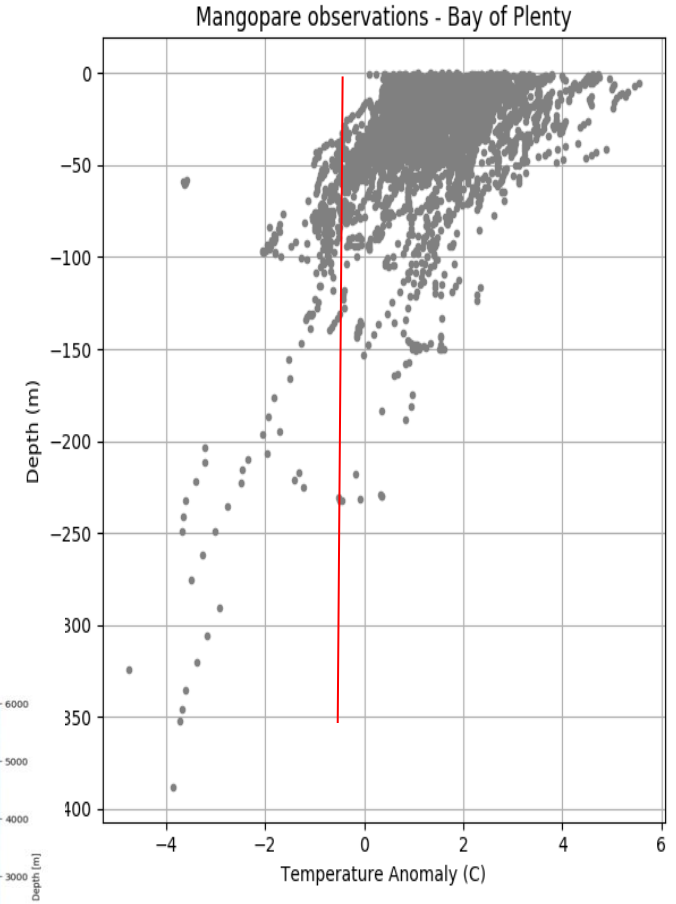
# Product: marine heatwave "forecast" - Looking at last winter




**2020-12-10 to 2021-11-15**

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# Assimilating the Mangōpare observations

*Experiments:*

*1- Assimilates along-track SLA, and OSTIA SST*

*2- Assimilates along-track SLA, OSTIA SST, and **Mangōpare** T profiles.*

- Add mean SSH from free-run to the satellite SLA, tides, and dynamical atmospheric correction to account for IB effect.
- Use OSTIA mapping error and free-run variance to estimate SST representation error.
- **Mangōpare** error set to 0.1C (sensor accuracy) or std of observations inside each grid cell.
- We use the ROMS (Regional Ocean Model System) Strong Constraint, Dual Formulation, Restricted B-preconditioned Lanczos 4D-Var (RBL4D-Var)
- 1 outer cycle, and 18 inner cycles
- Correcting initial state, boundary conditions, and forcing
- 3 days assimilation window, run daily
- Pre-operational state (needs human intervention) - fully automated version coming soon !

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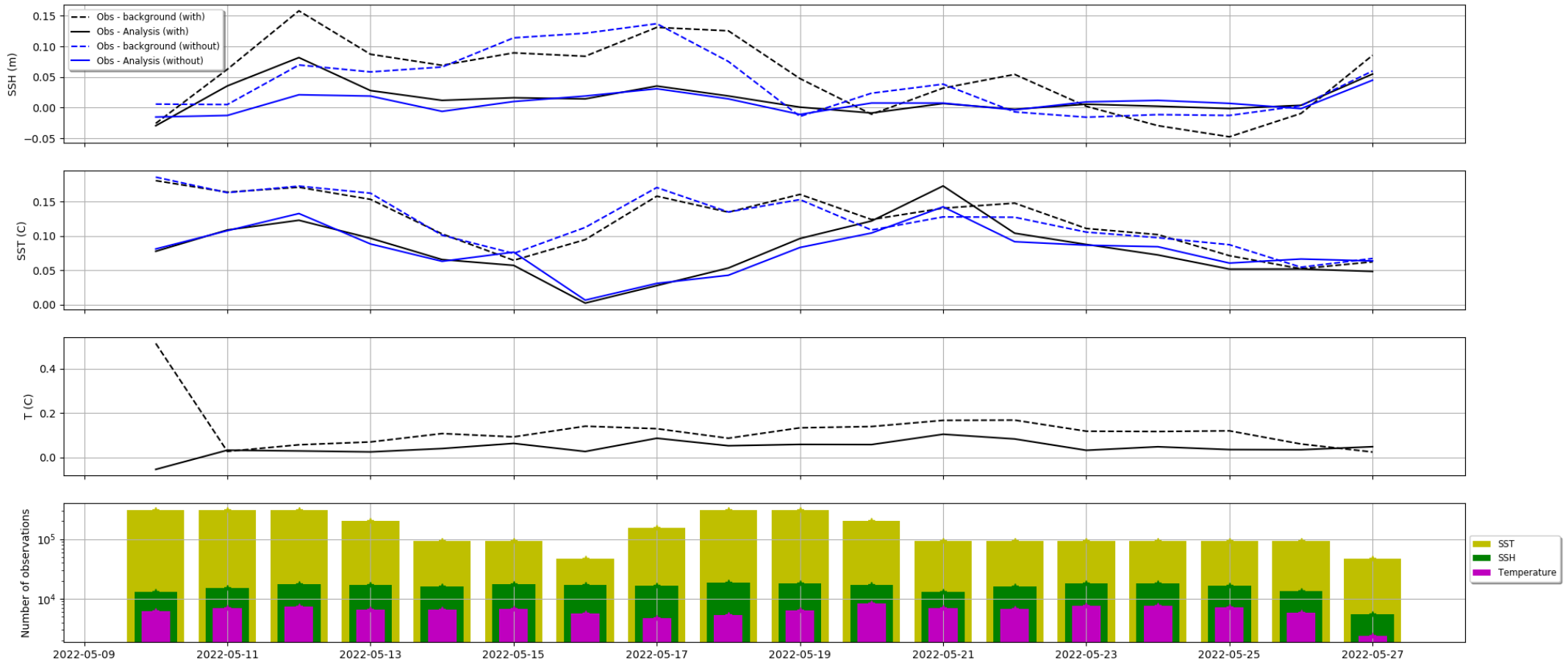
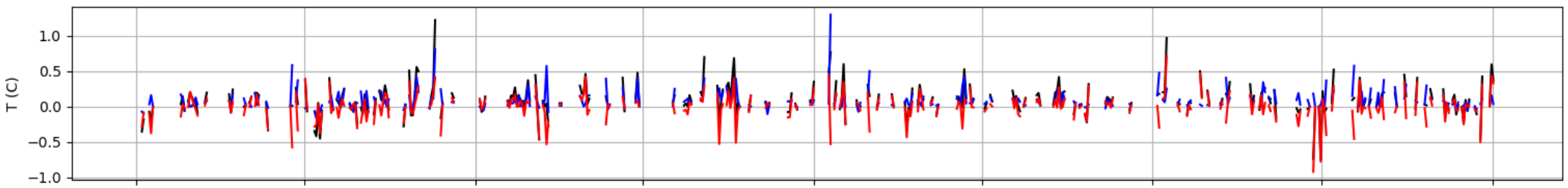
# Assimilation performance

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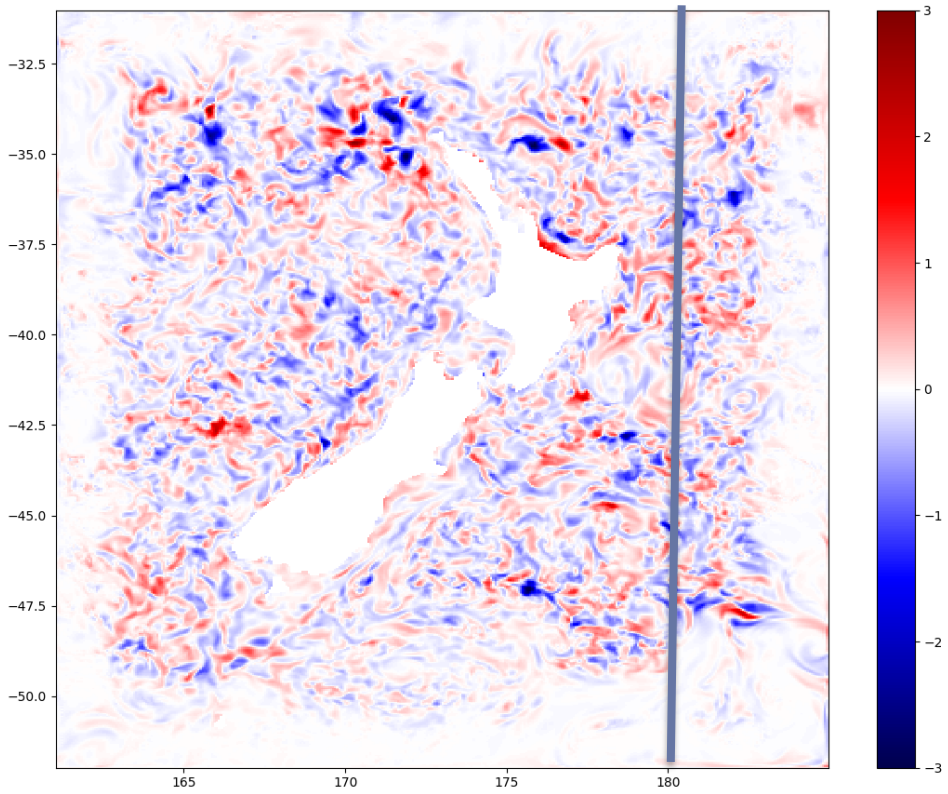
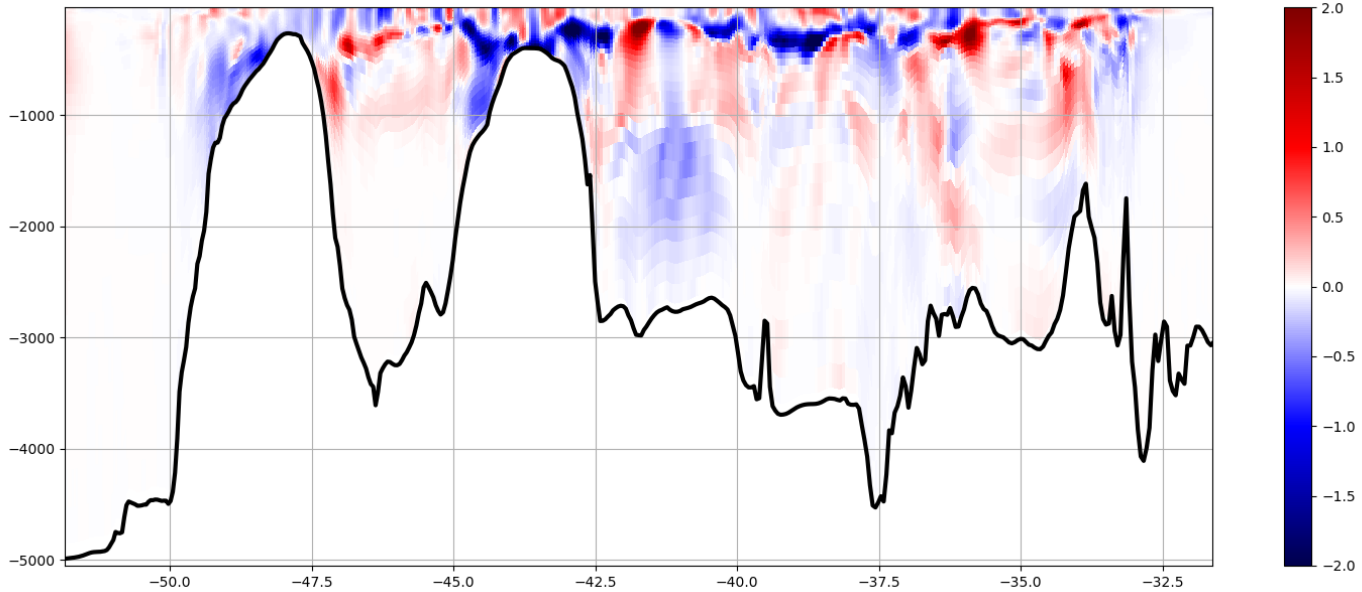
# Differences between experiments

Temp. (with – without) for the cycle 25/05/2022




Next steps:

Evaluate the impact of **Mangōpare** on heat content.

Compare experiments to independent observations (Argo)

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# Take away points

- The **Mangōpare** sensors provide reliable operational observations for data assimilation and forecast provision in a cost-effective way.
- Promising results show an improvement in the representation of the water column thermal structure when assimilating **Mangōpare** observations.
- For that, the large increase in the number of observations in the regions critical for the forecast is key.
- *More analysis are still needed to quantify the forecast improvement in relation to the "spin-up" approach.*

Pre-processing and analysis python code available at https://github.com/metocean/seapy

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# Thank you

Joao Souza – j.souza@metocean.co.nz

**www.moanaproject.org**

## Project Partners