https://www.moanaproject.org/

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

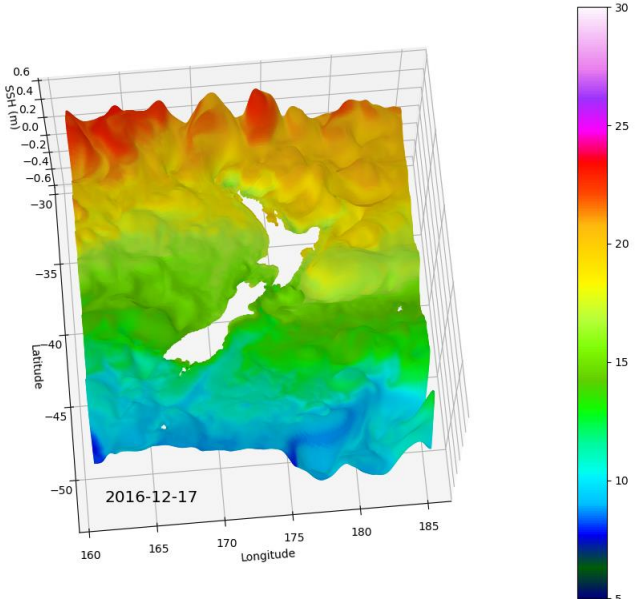
Dr Joao Souza[1] (presenter) - j.souza@metocean.co.nz
In behalf of all the researchers participating in the Moana Project and the members of the MetOcean Research and Development team.

[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***.

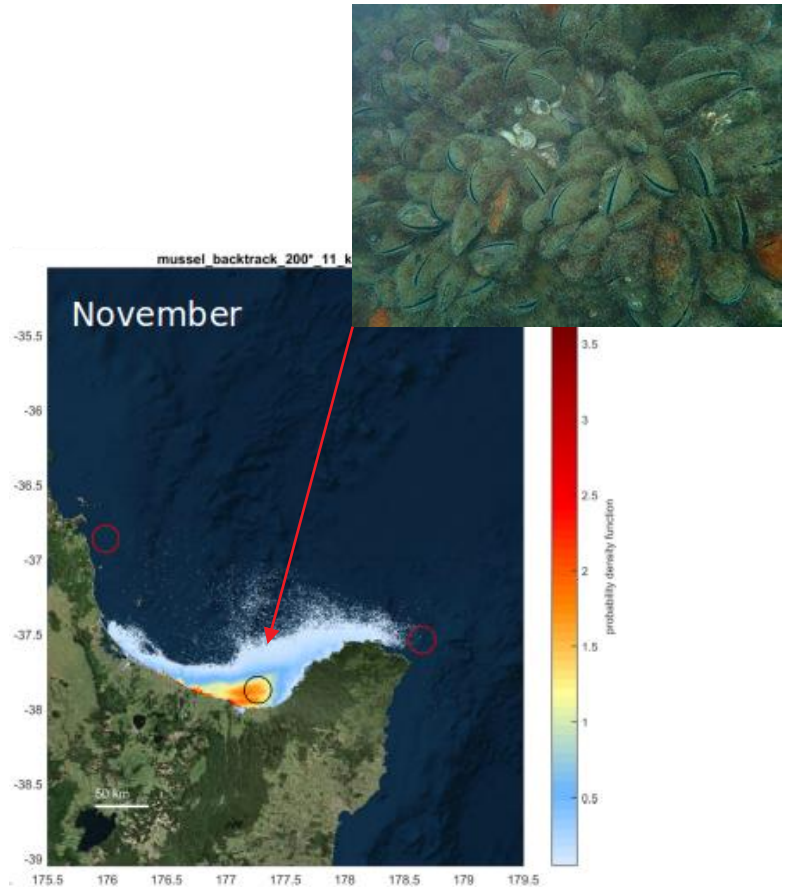
He Papa Moana

Te Tiro Moana



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

Ngā Ripo o Te Moana



He Hono Moana

Whai Hua – Impacts and Benefit

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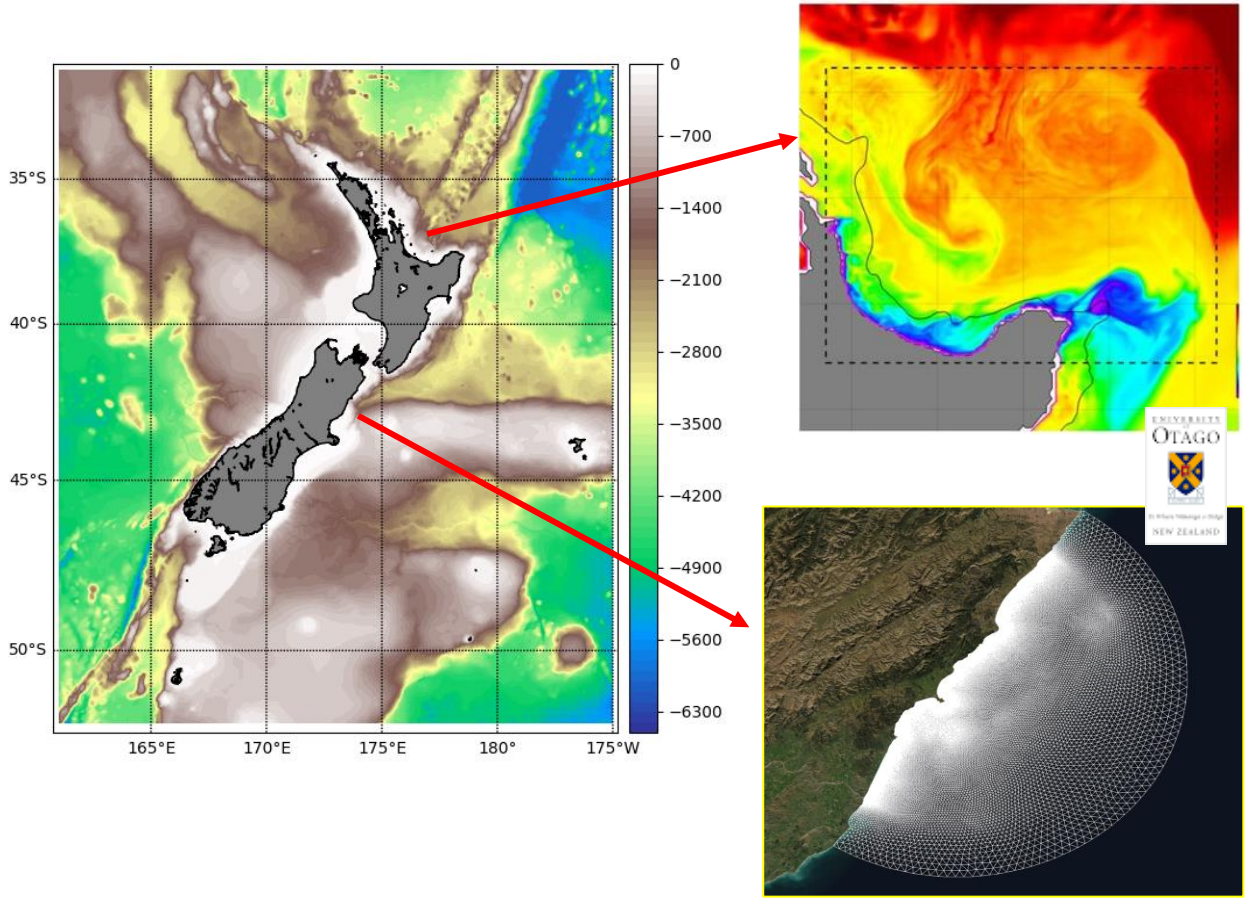
OCEAN MODELS



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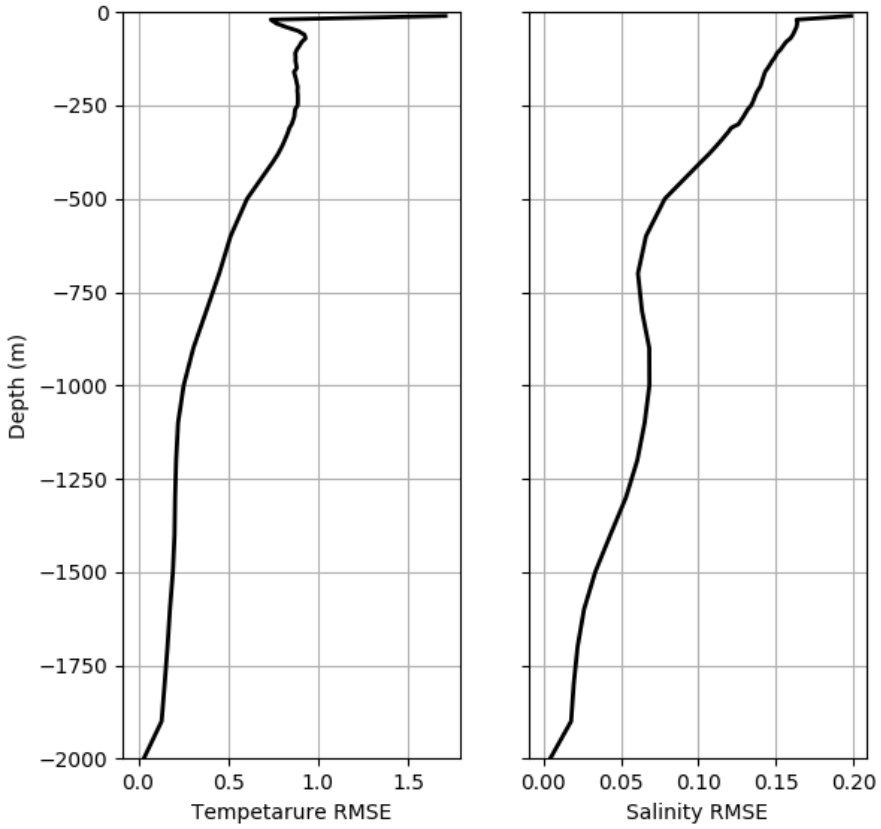
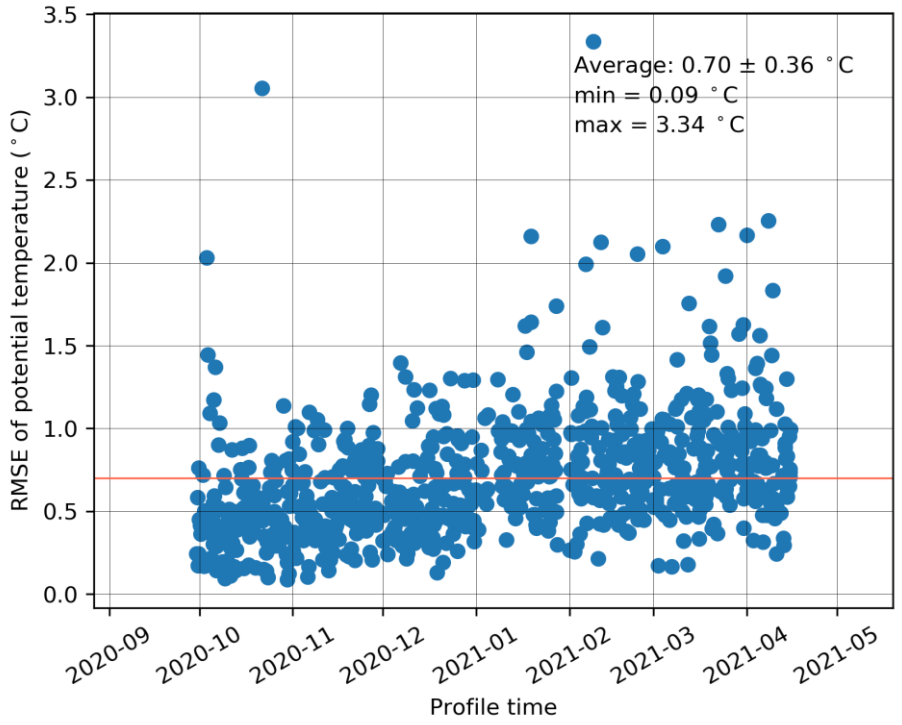
Model evaluation – Argo profiles CORA5.2 / Argo – Root mean square error

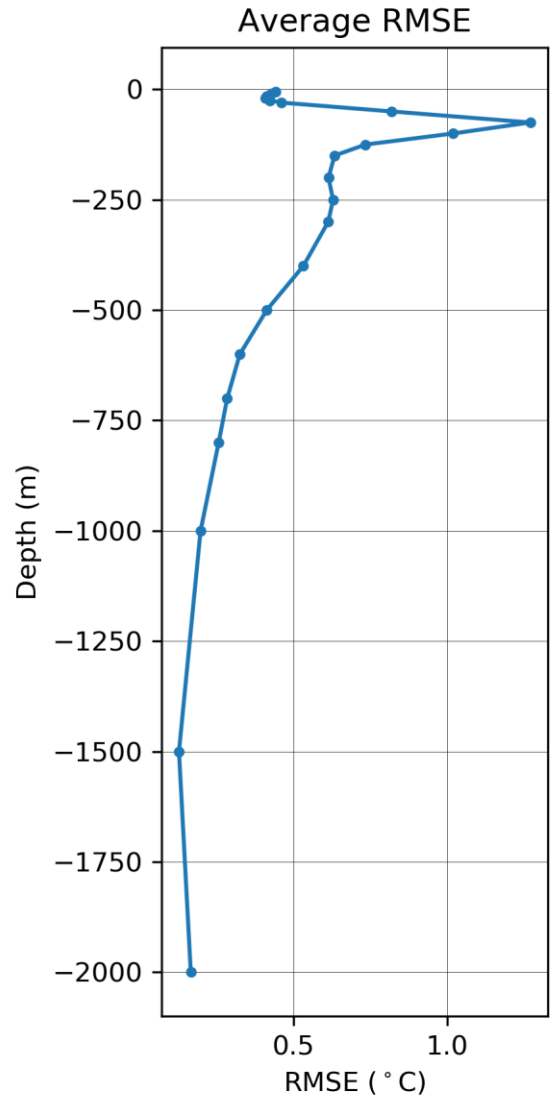
Souza et al: **Moana Ocean Hindcast – a 25+ years simulation for New Zealand Waters using the ROMS v3.9 model**, EGUsphere [preprint], https://doi.org/10.5194/egusphere-2022-41, 2022.



HINDCAST

Jan 1993 – Dec 2020





FORECAST

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

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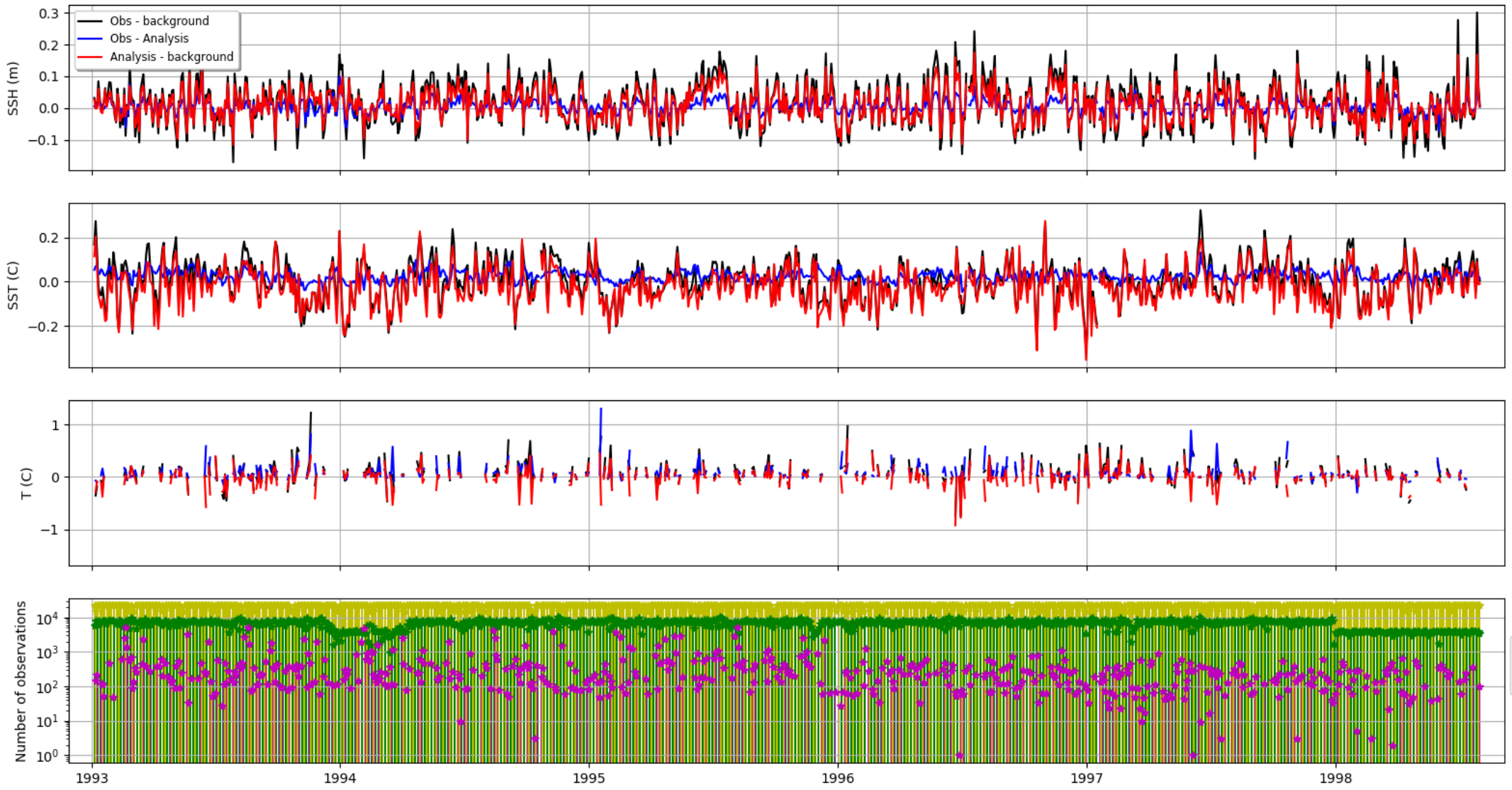
Model evaluation – Reanalysis



0.005±0.02 m

0.02±0.02 °C

0.09±0.14 °C

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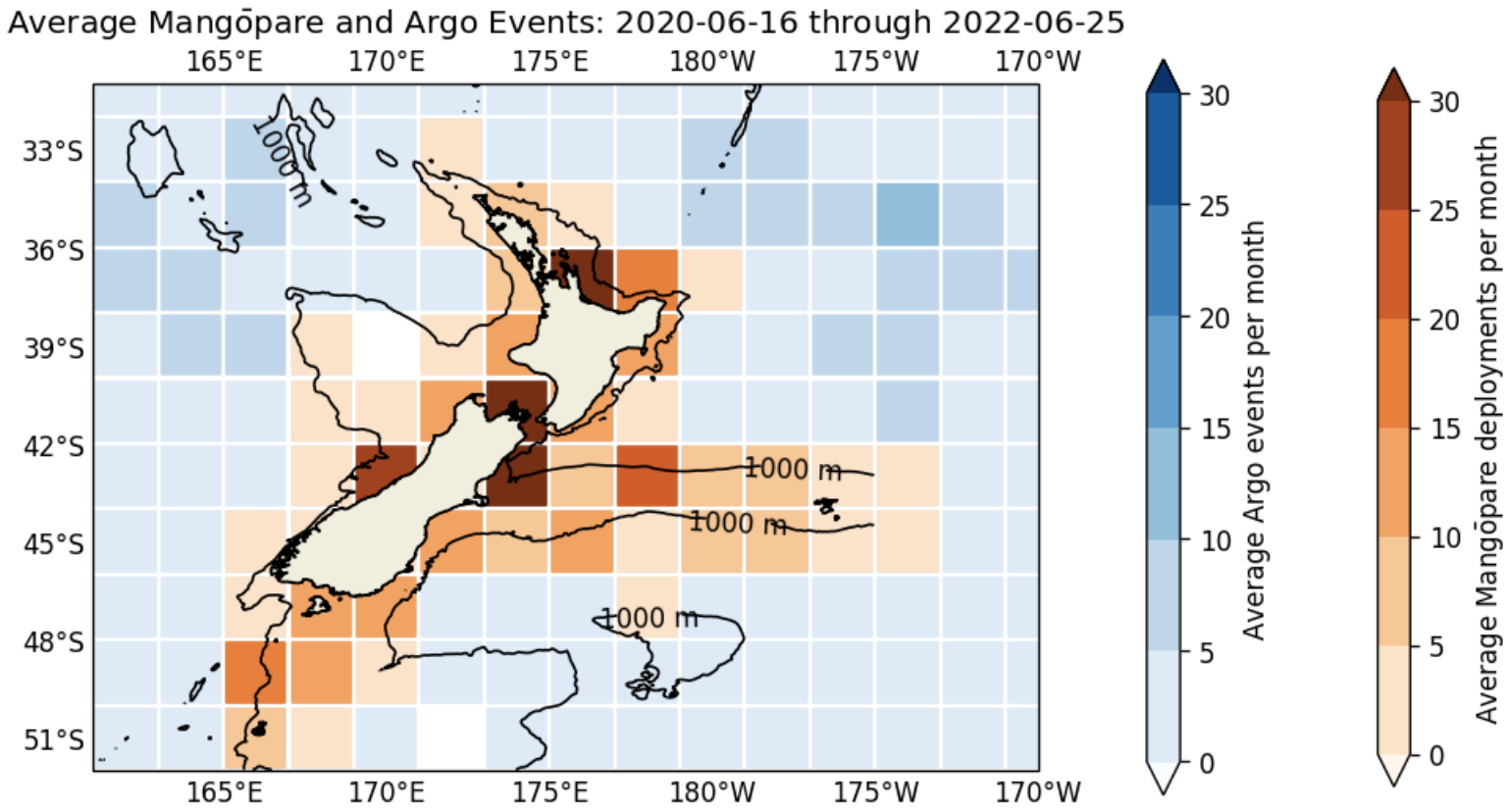
New observations in collaboration with the fishing fleet - *Mangōpare sensor*

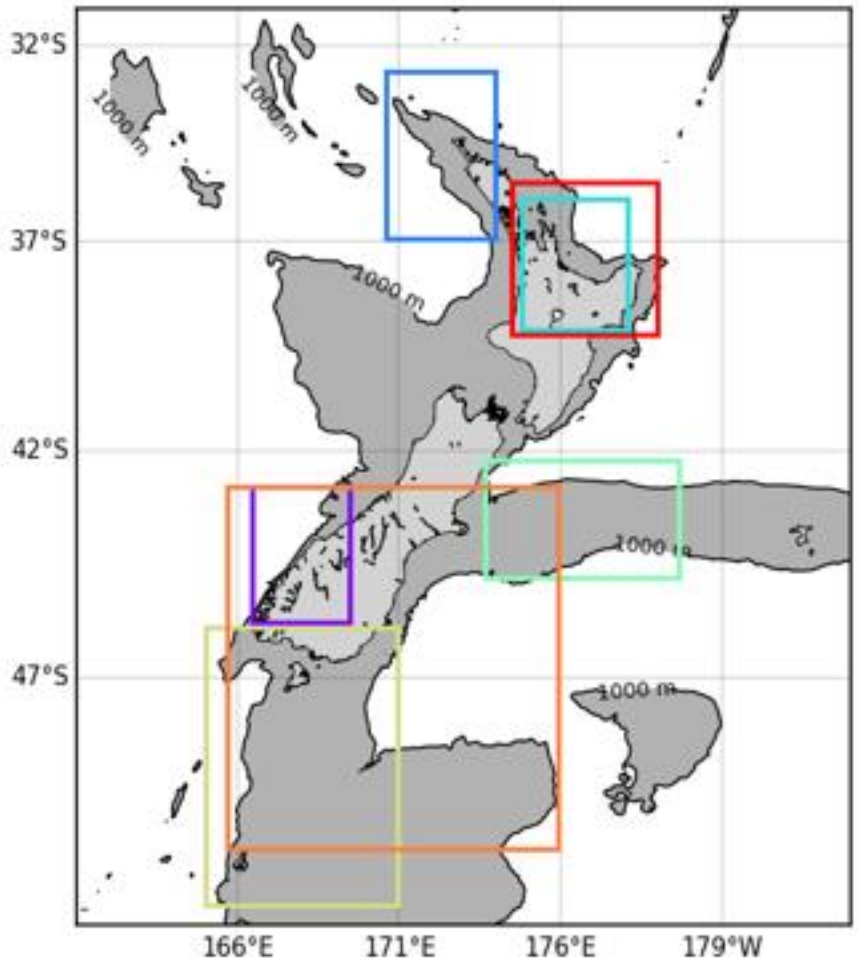


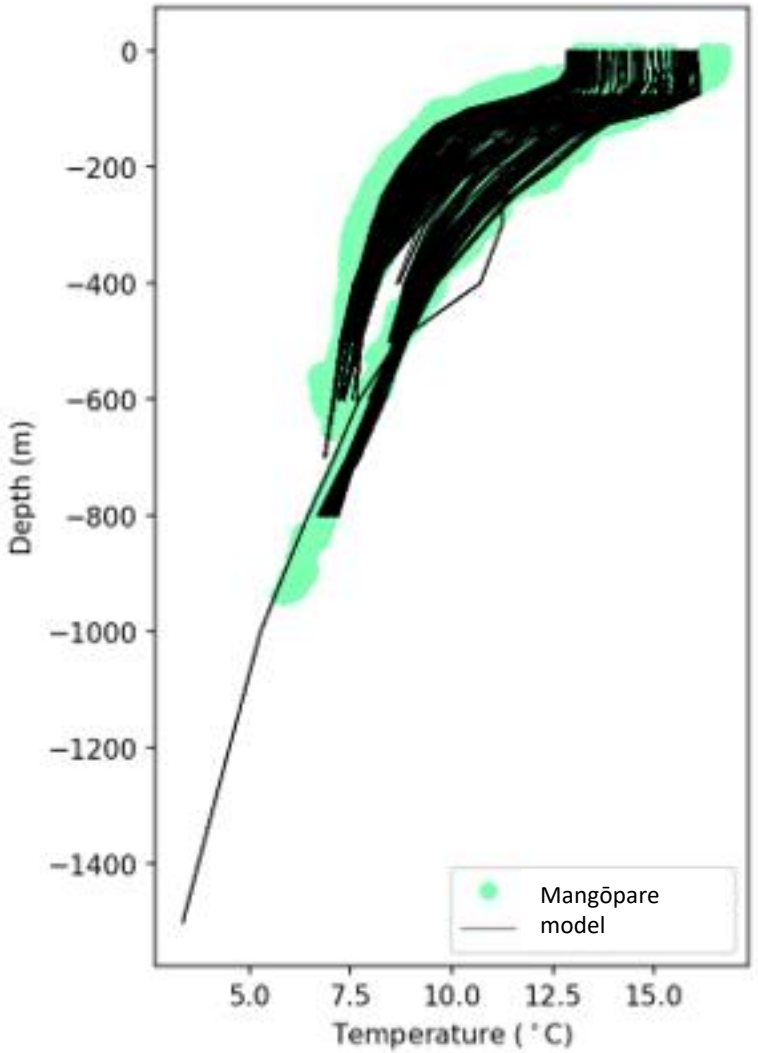
As presented by Julie Jakoboski...

Moana PROJECT

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

Moana
PROJECT

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 !
- Experiment dates: **10/05/2022** to **27/05/2022**

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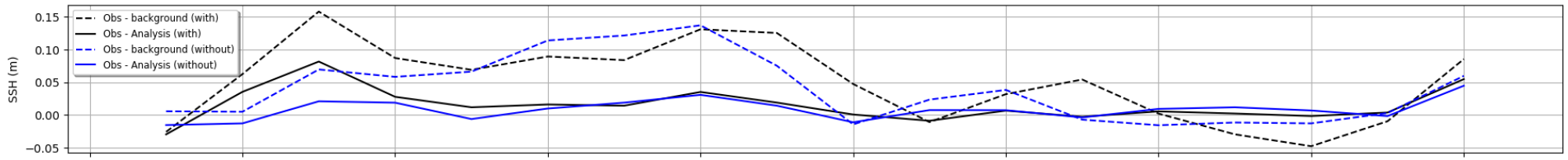
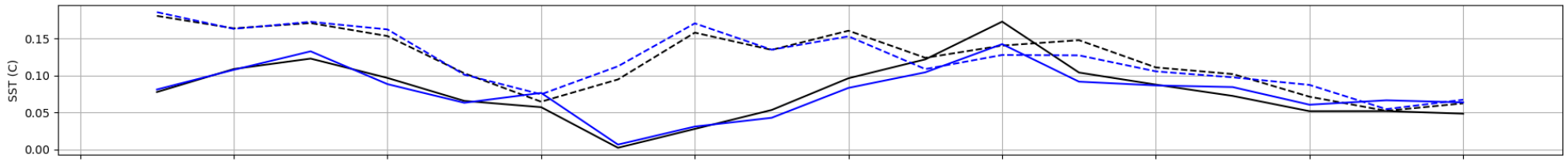
Assimilation performance

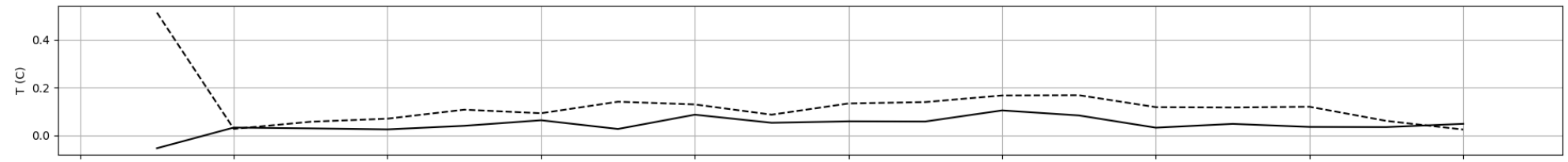
"Errors" with **Mangōpare**



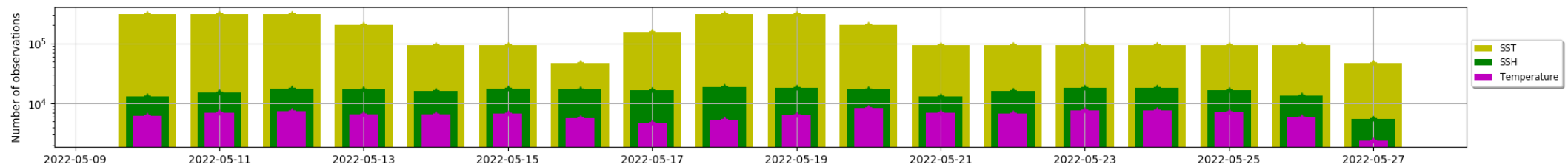
0.014±0.02 m

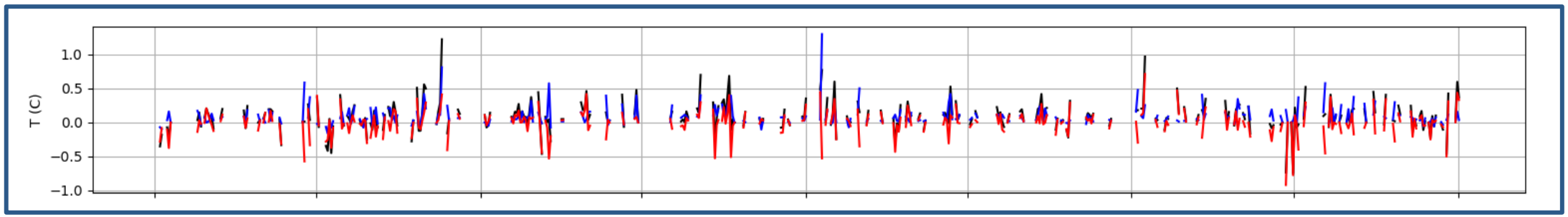


0.084±0.04 °C



0.045±0.03 °C





0.09±0.14 C

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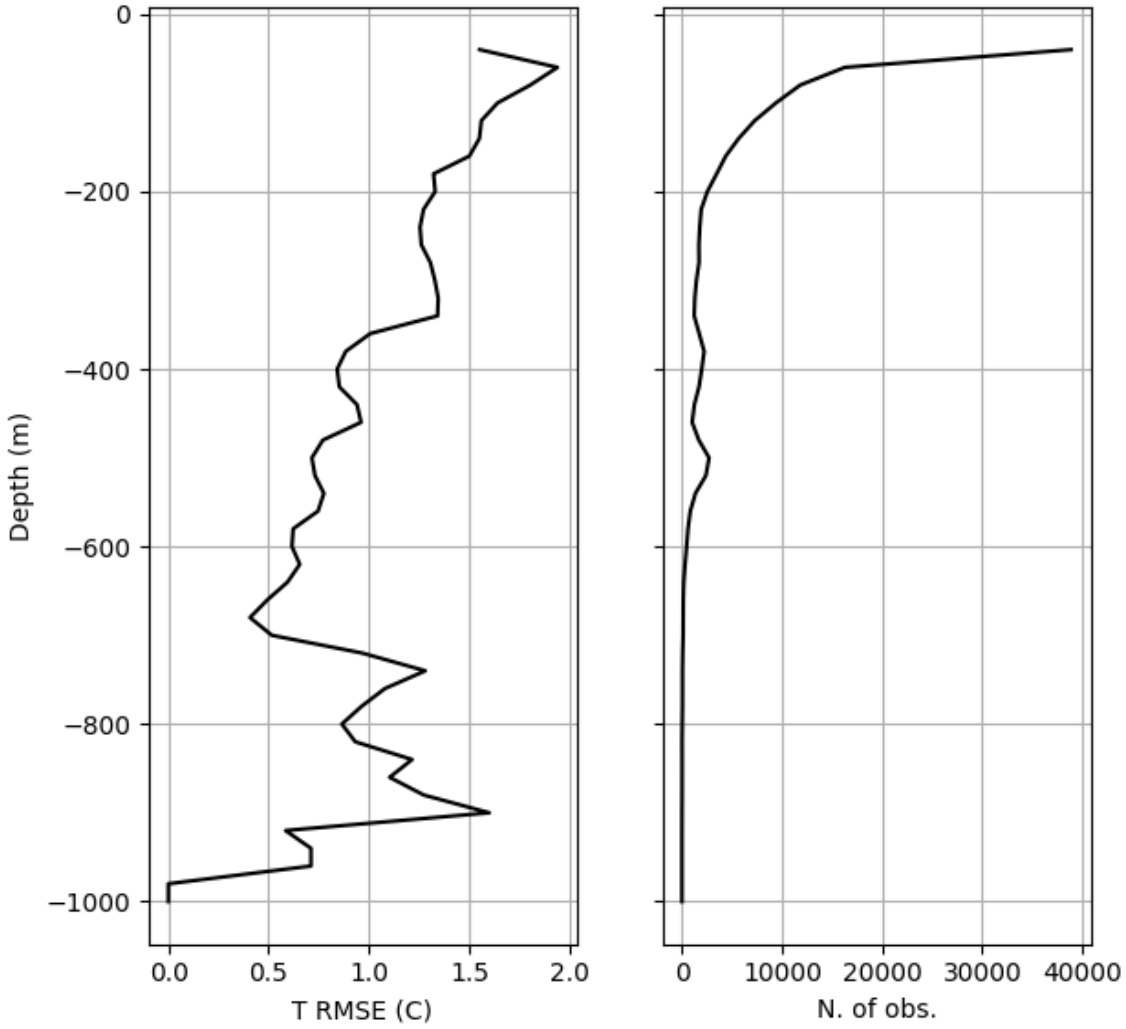
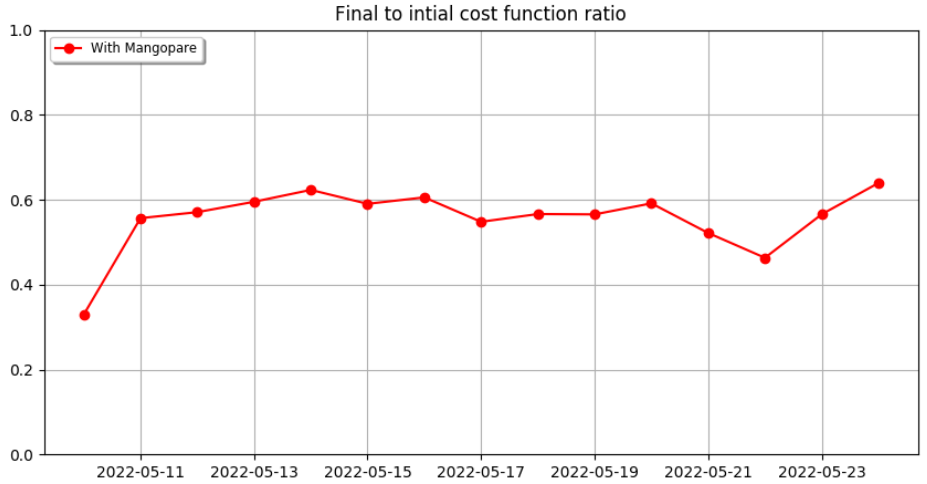
Assimilation performance





DA seems to be working properly, with good minimization of the cost function.

Observations are concentrated near the surface.

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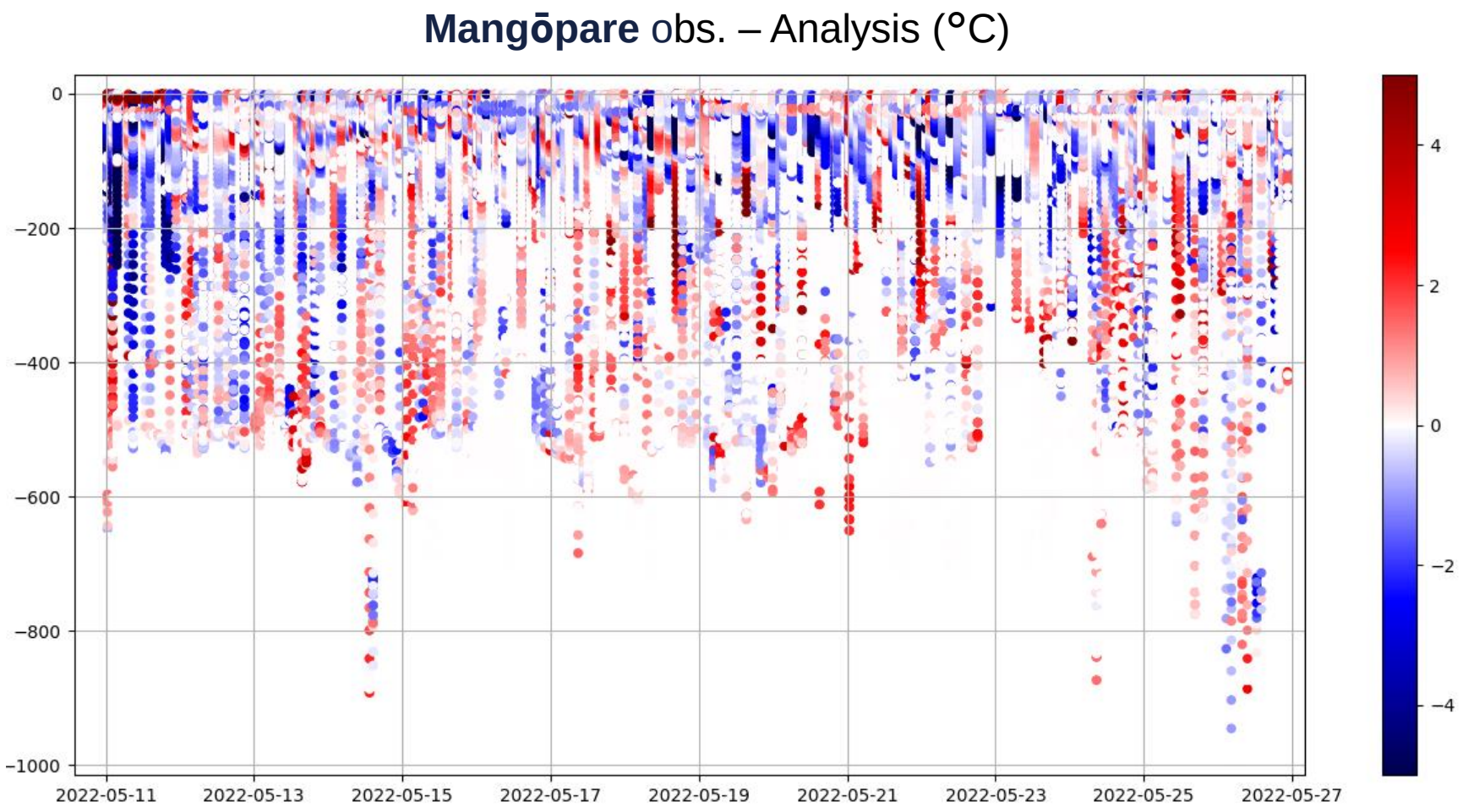
Assimilation performance



Model performance is heterogeneous in both time and space. Number of available obs seem to be important, but the error follows "dynamical" patterns.

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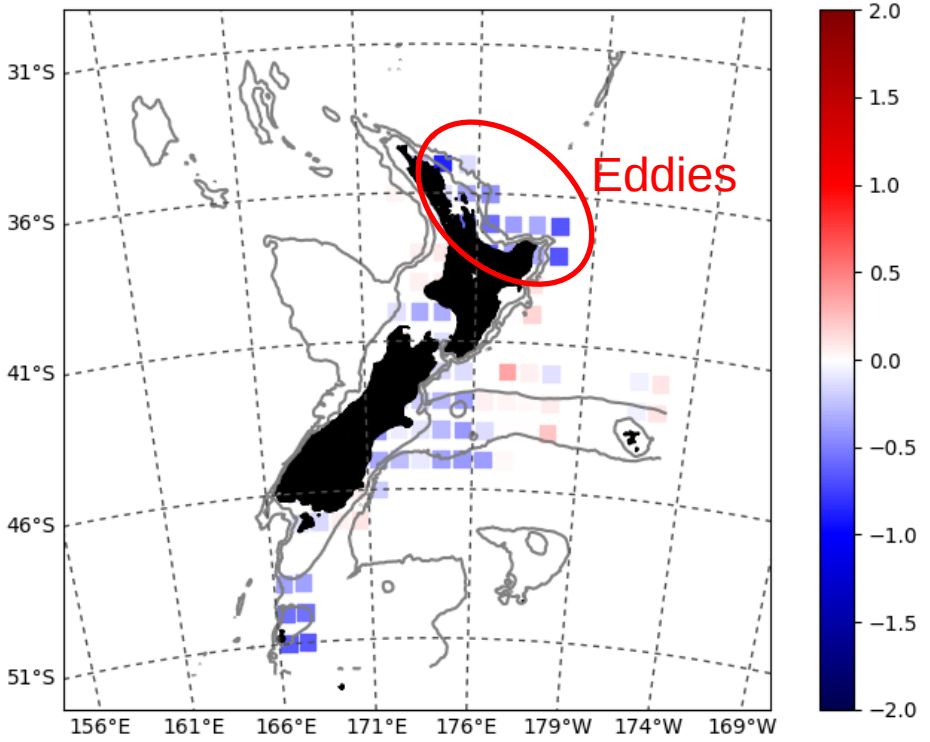
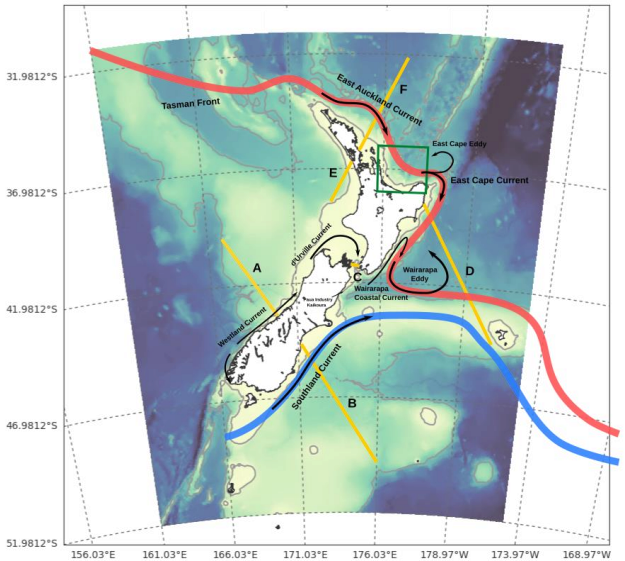
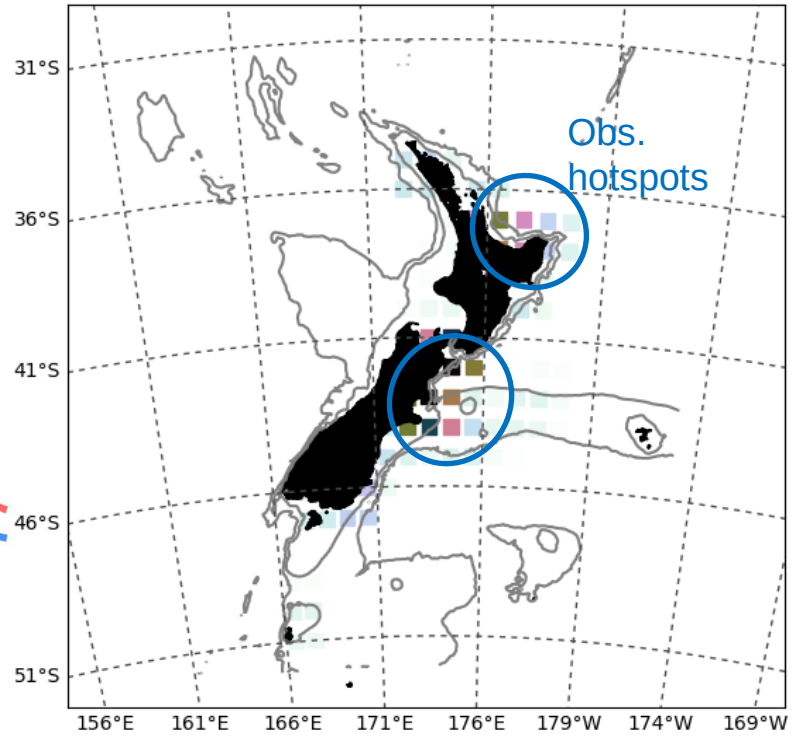
Assimilation performance

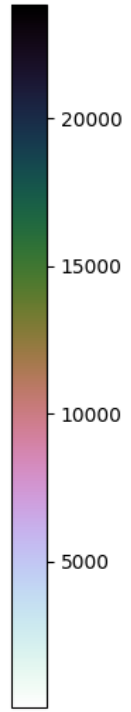
Mangōpare obs. – Analysis (°C)





Number of **Mangōpare** obs.





Model performance is heterogeneous in both time and space. Number of available obs seem to be important, in addition to local "dynamics".

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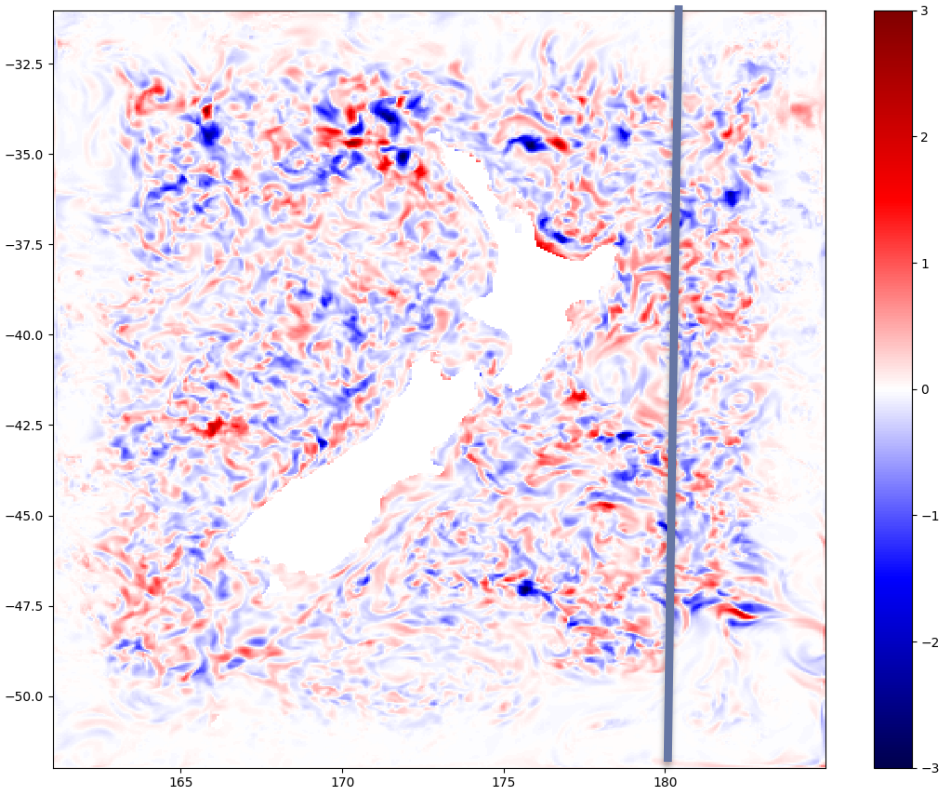
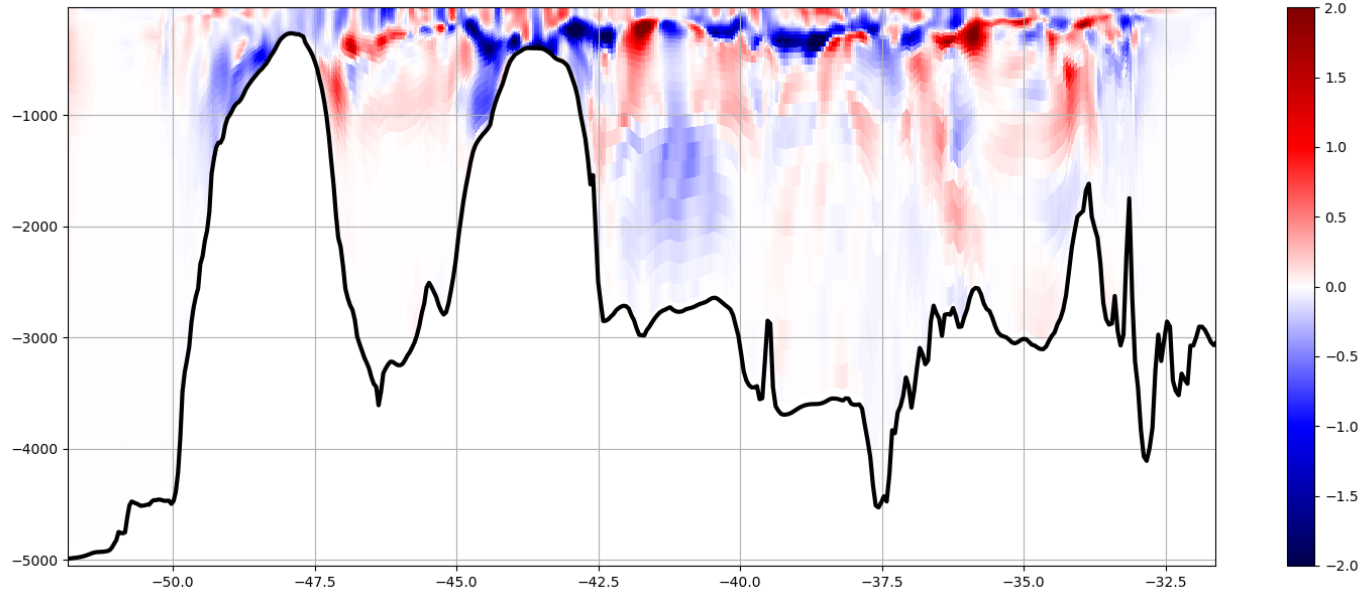
Differences between experiments

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 coastal 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 analyses are still needed – observation impact studies.
- *The system is being implemented to provide fully automated analyses and forecasts.*

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

Joao Souza –

www.moanaproject.org