

<https://www.moanaproject.org/>



Assimilating innovative subsurface observations into an ocean forecast system: How fishers made the forecast better.

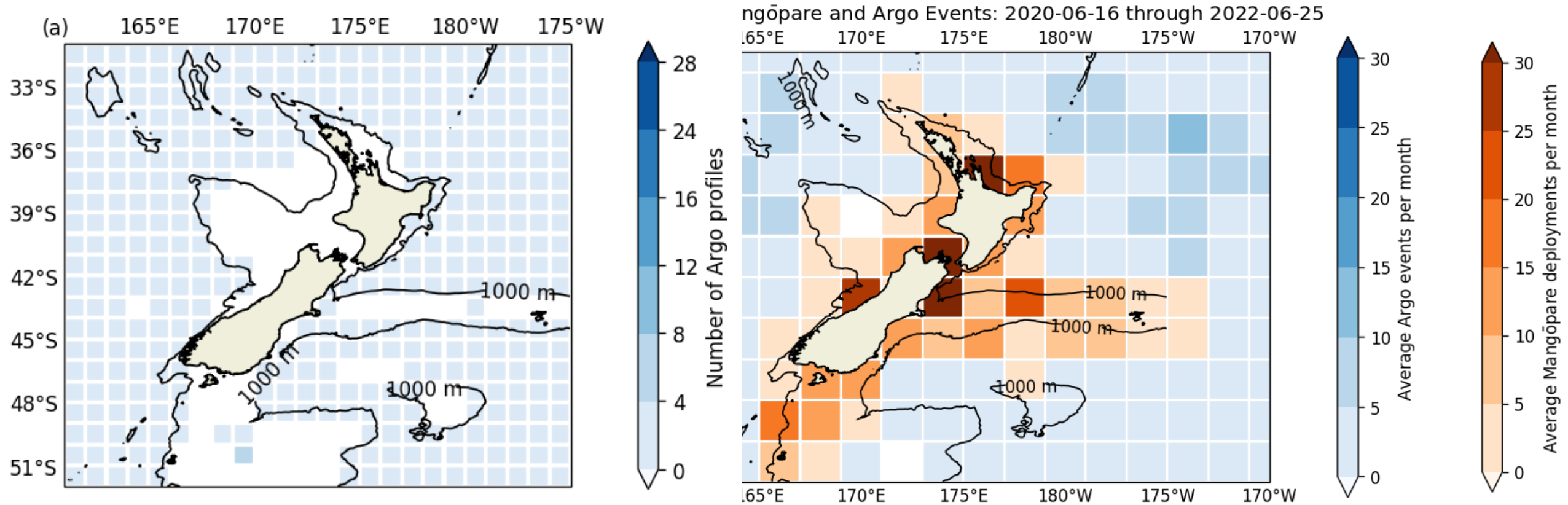
Ocean Predict DA-TT Meeting, 09-11 May 2023

Dr Joao M. A. C. Souza (presenter), Dr. Colette Kerry, and Dr. Julie Jakoboski
On behalf of all the researchers participating in the Moana Project

Moana Project Science Leader
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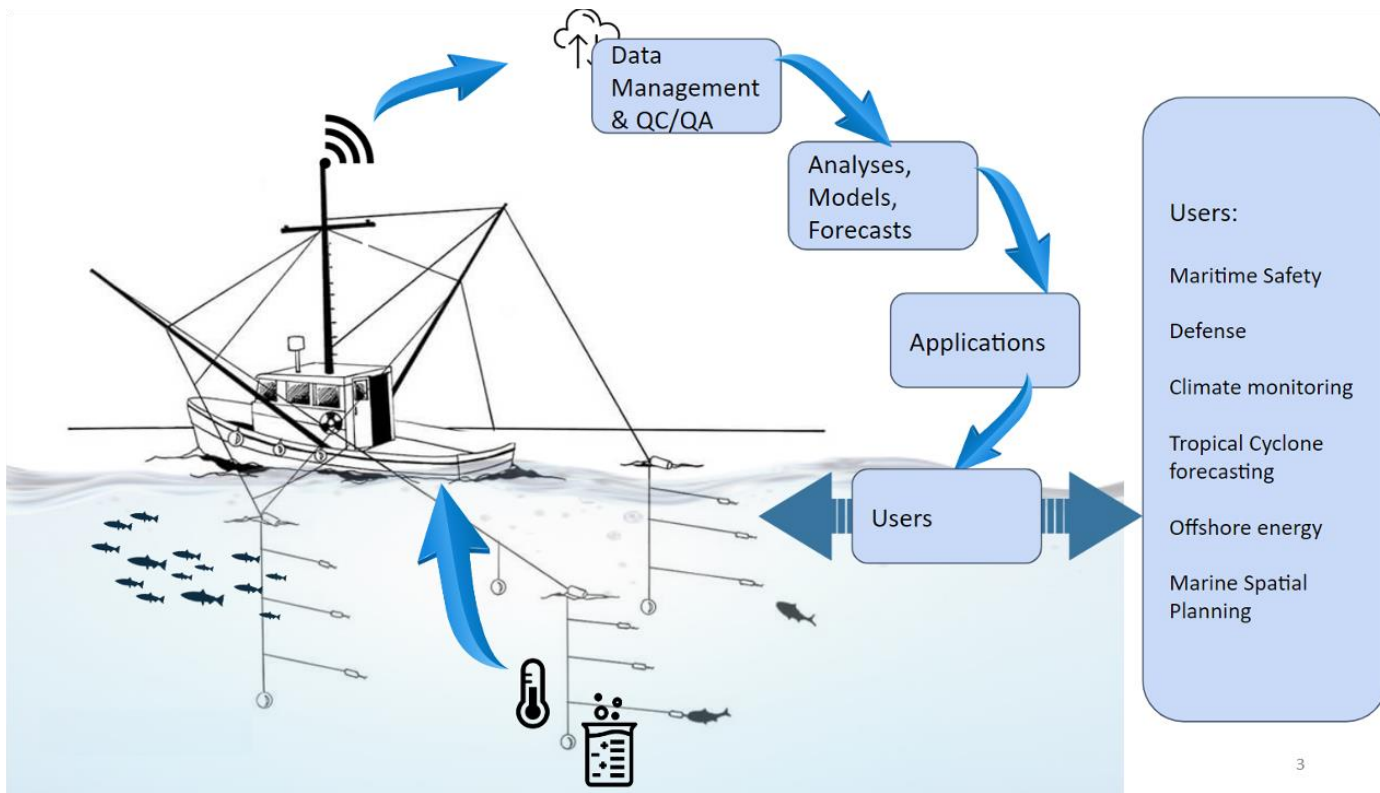


New observations in collaboration with the fishing fleet - *Mangōpare sensor*

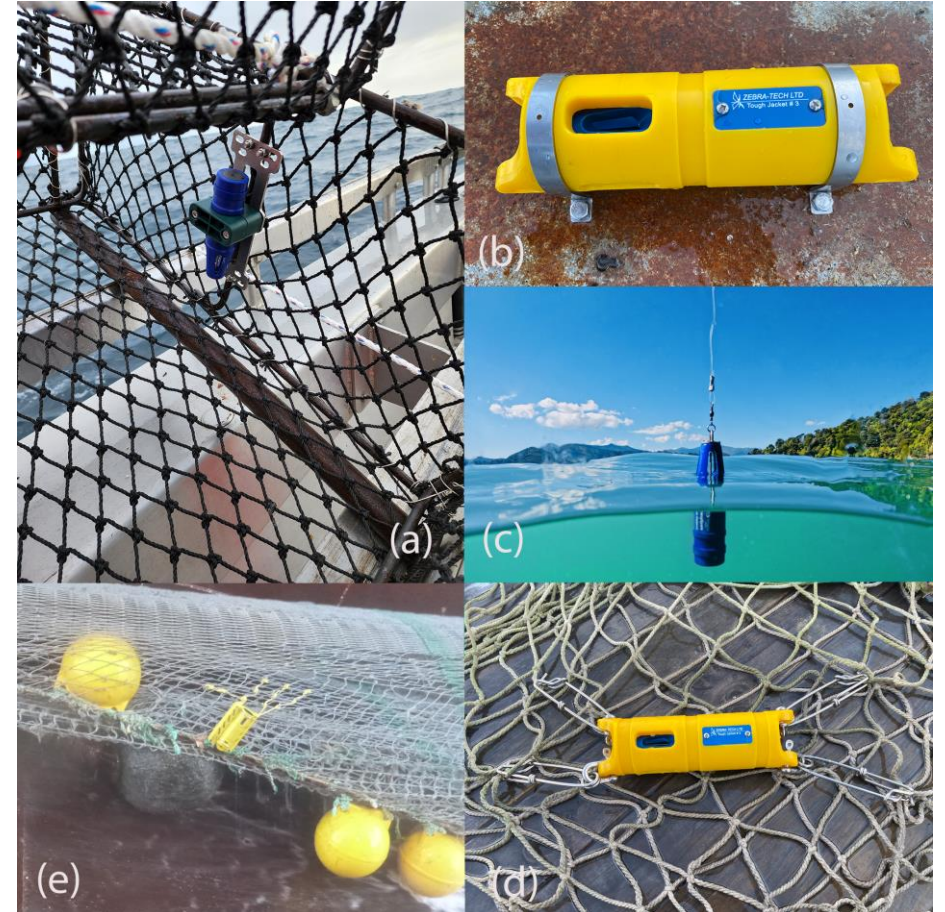


The Te Tiro Moana team is lead by Dr. Julie Jakoboski.

Ocean Observations New Zealand-wide

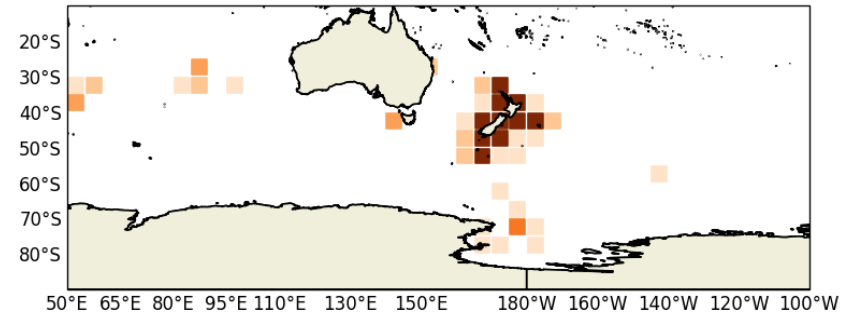


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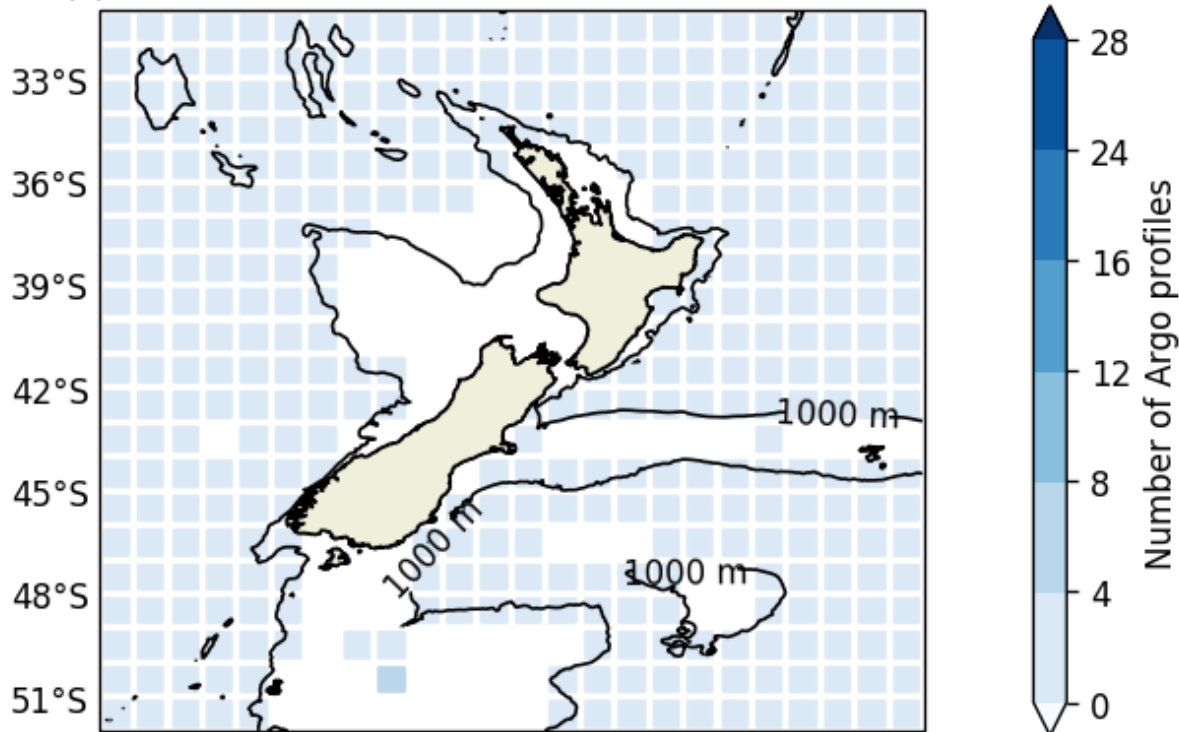


Ocean Observations New Zealand-wide

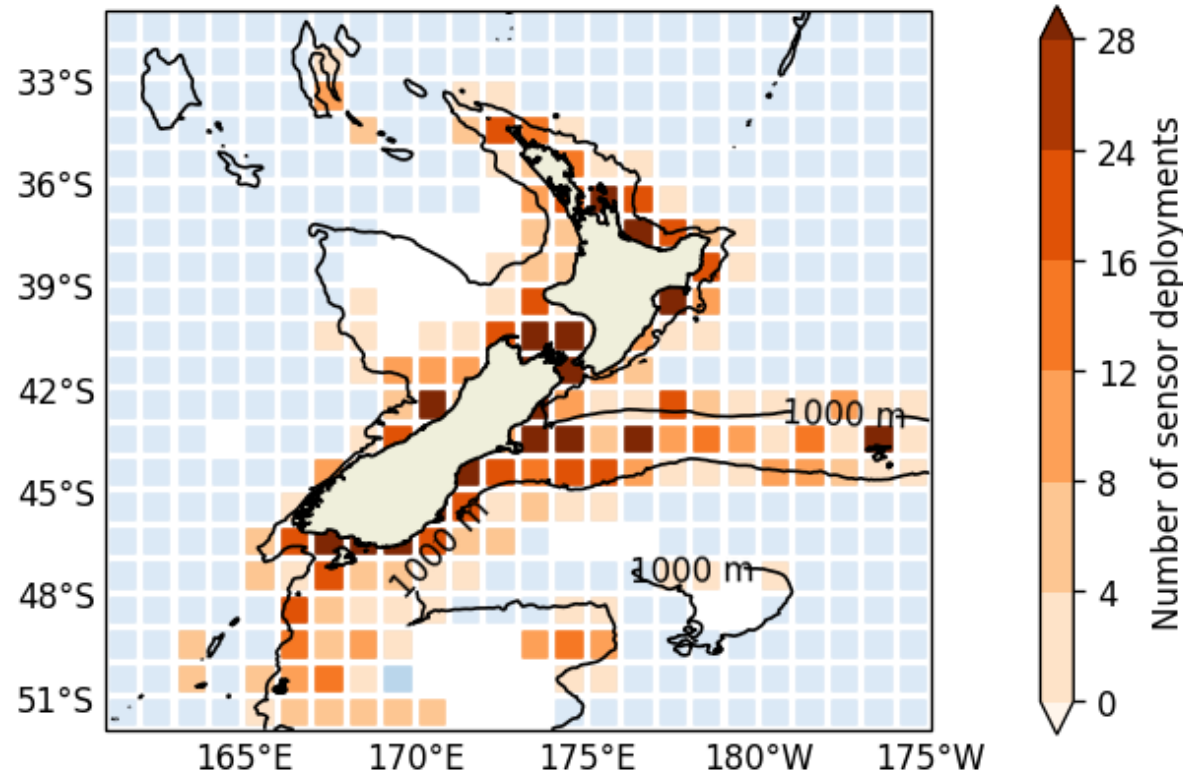
Average Mangōpare Deployments: 2020-06-16 through 2023-03-30
50°E 65°E 80°E 95°E 110°E 125°E 145°E 180°W 160°W 140°W 120°W 100°W



(a) 165°E 170°E 175°E 180°W 175°W

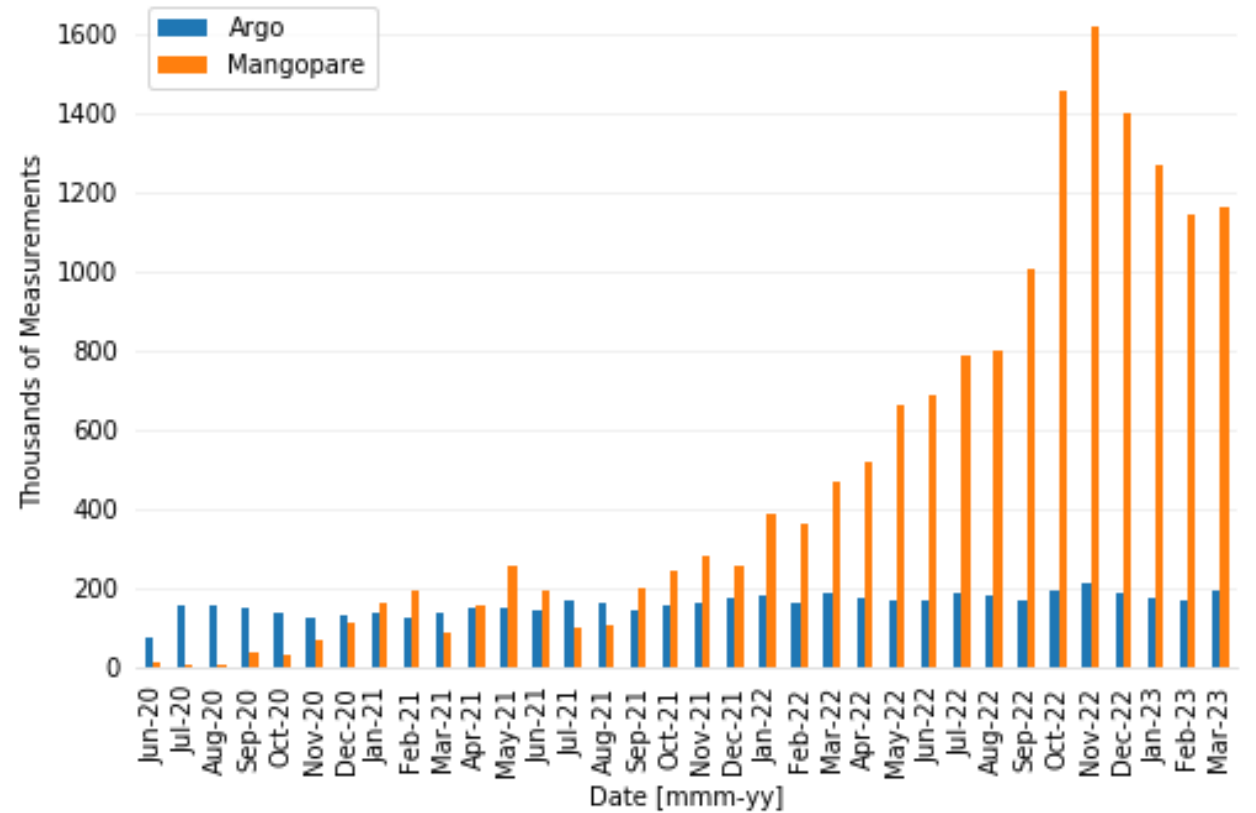


(b)

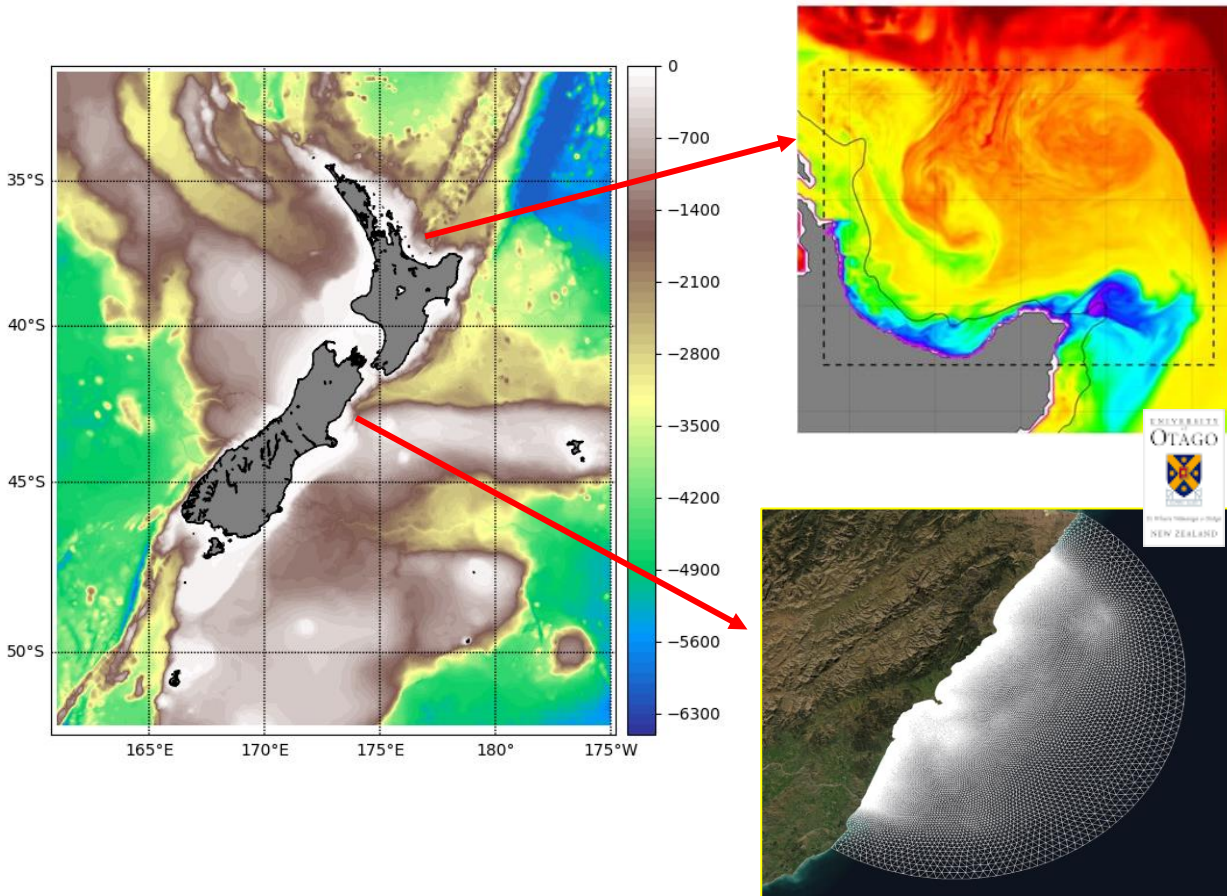


Ocean Observations New Zealand-wide

Number of Participating Vessels by Vessel Type



OCEAN MODELS



"25+" years Hindcast + Reanalysis + **Forecast**

RBL4DVar 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
- Hauraki Gulf

Ocean particle trajectory tracking tool:

- Plastics
- Larvae
- Bio-invasive
- Oil spill
- Search & Rescue
- Contaminants

HE HONO MOANA

HE PAPA MOANA

NGĀ RIPO O TE 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)

Model evaluation - Reanalysis



0.005 ± 0.02 m

0.02 ± 0.02 °C

0.09 ± 0.14 °C

Assimilating the Mangōpare observations

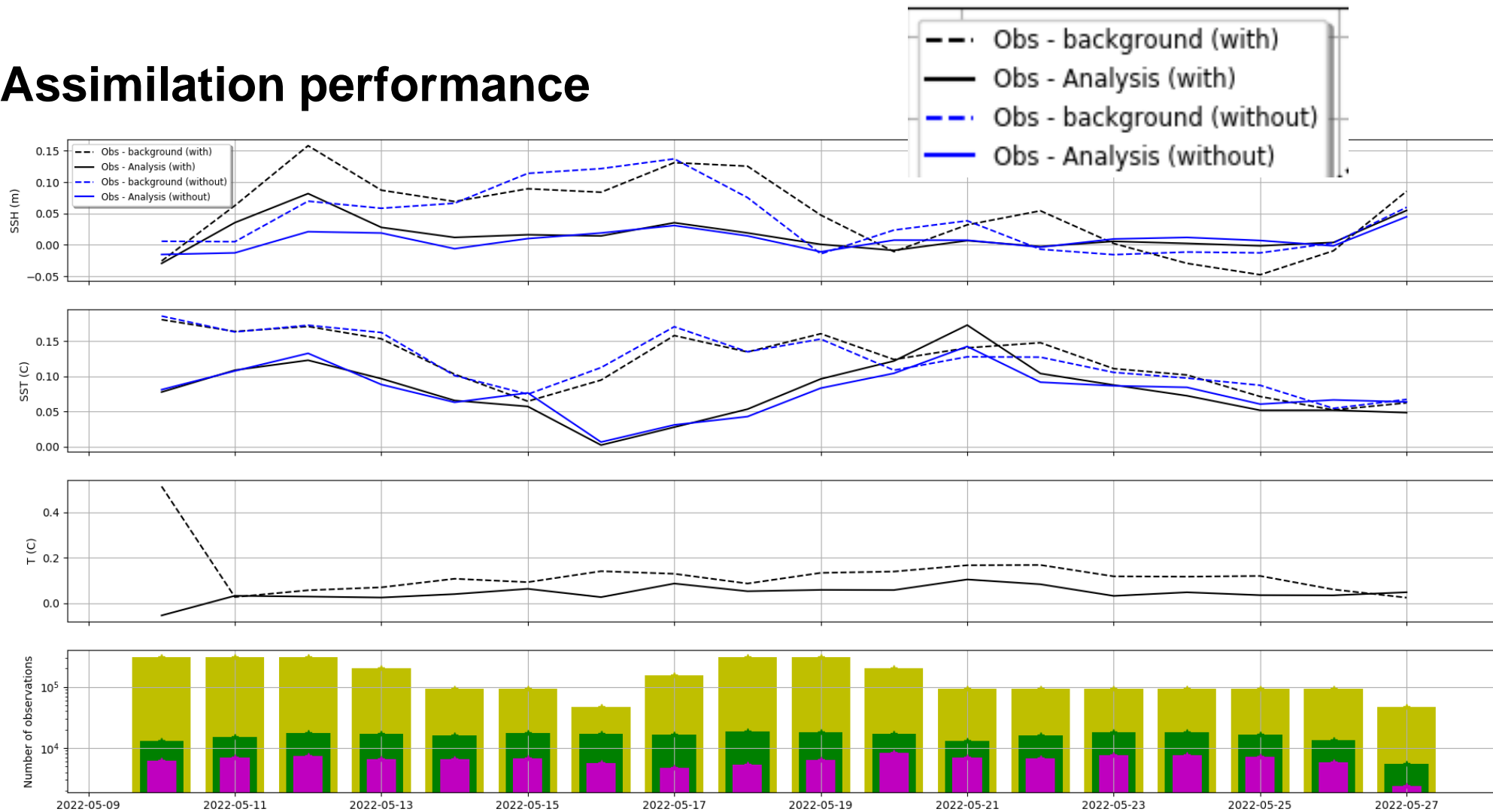
Experiments:

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 – changed to Copernicus daily L3 SST product for operational forecasts.
- 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 (6 inner cycles in the operational implementation)
- Correcting initial state, boundary conditions, and forcing
- **3 days** assimilation window, run daily
- Comparison experiment dates: **10/05/2022** to **27/05/2022**

Assimilation performance



Mean misfits with Mangōpare

0.014 ± 0.02 m

0.084 ± 0.04 °C

0.045 ± 0.03 °C

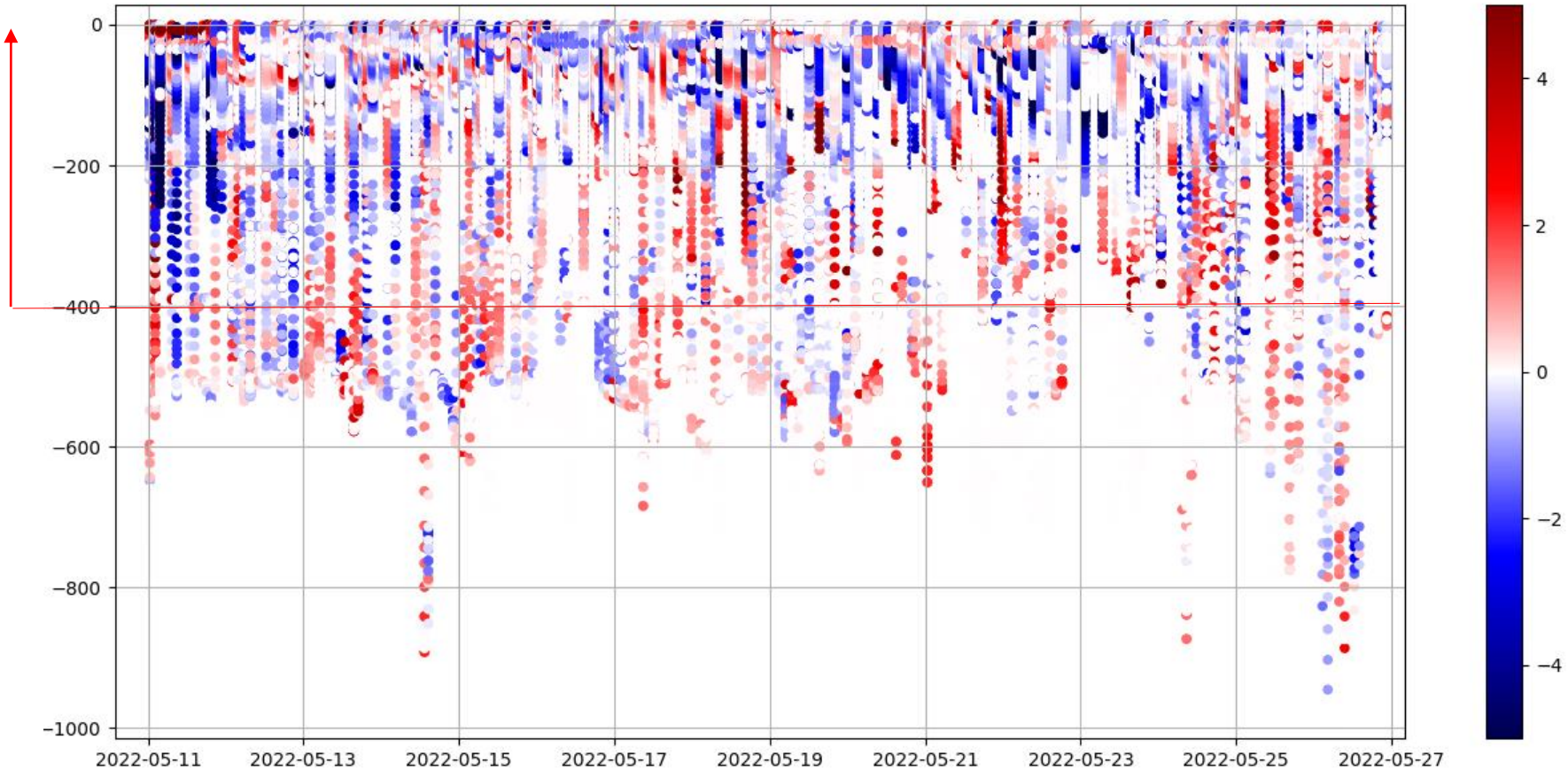
0.09 ± 0.14 °C



Assimilation performance

Mangōpare obs. – Analysis (°C)

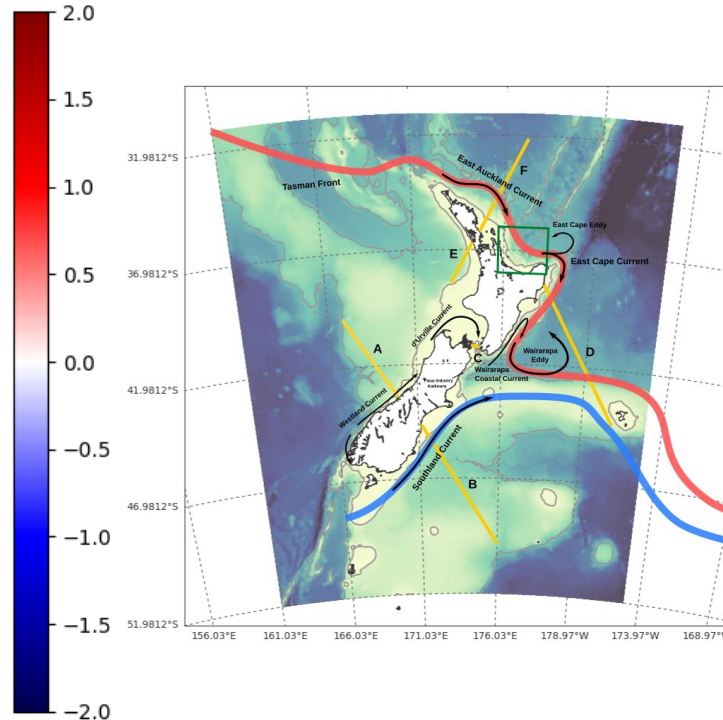
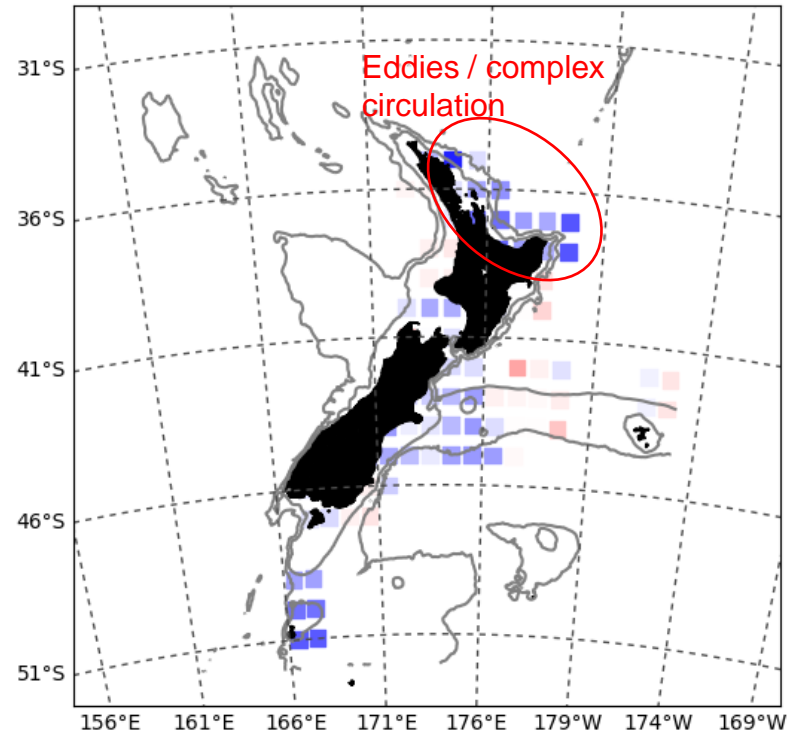
Most obs. are in the top 400m.



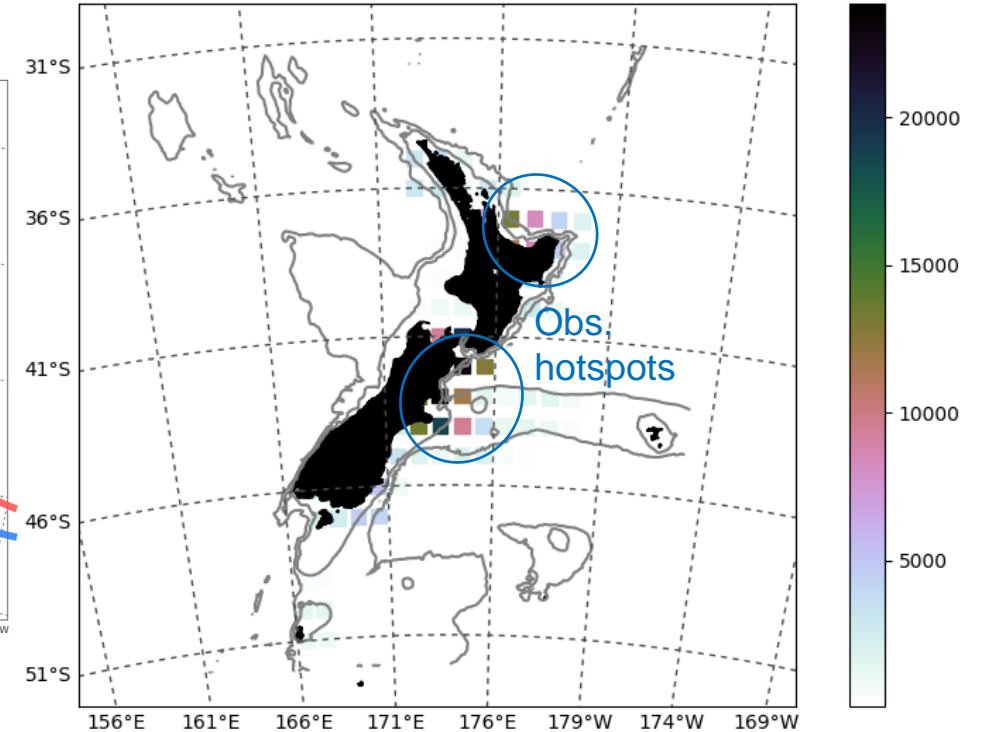
Model performance is heterogeneous in both time and space. Number of available obs seem to be important, but the error follows "dynamical" patterns.

Assimilation performance (0 to 400m)

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".

OSSEs

Experiments are performed from 23 Sept 2017 to 28 Dec 2017 (16 6-day cycles).

This captures a period where temperatures in the Tasman Sea are close to climatology, and then the rapid onset of the extreme MHW of summer 2017-2018, which began mid-November 2017.

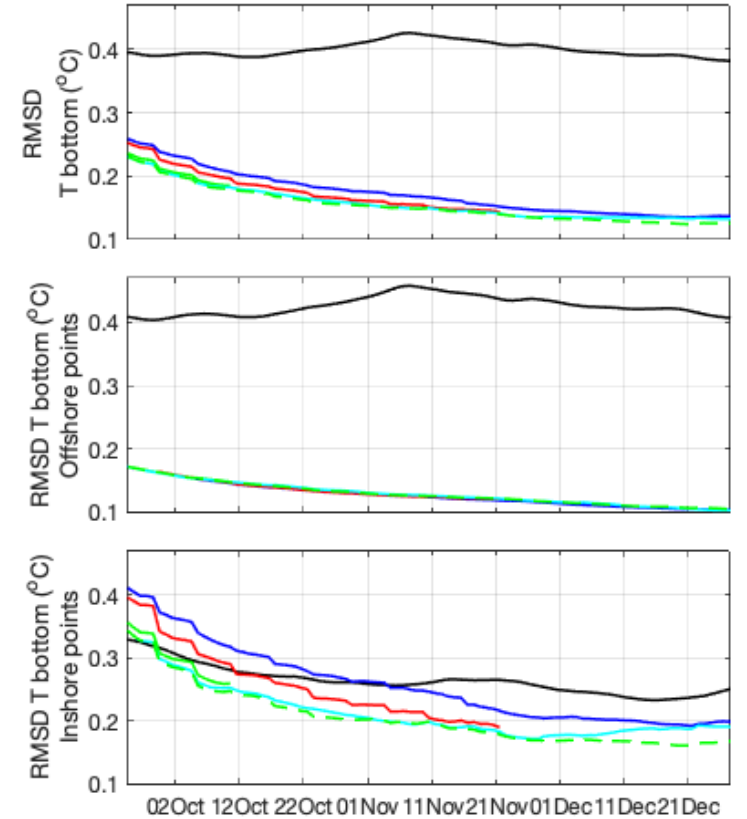
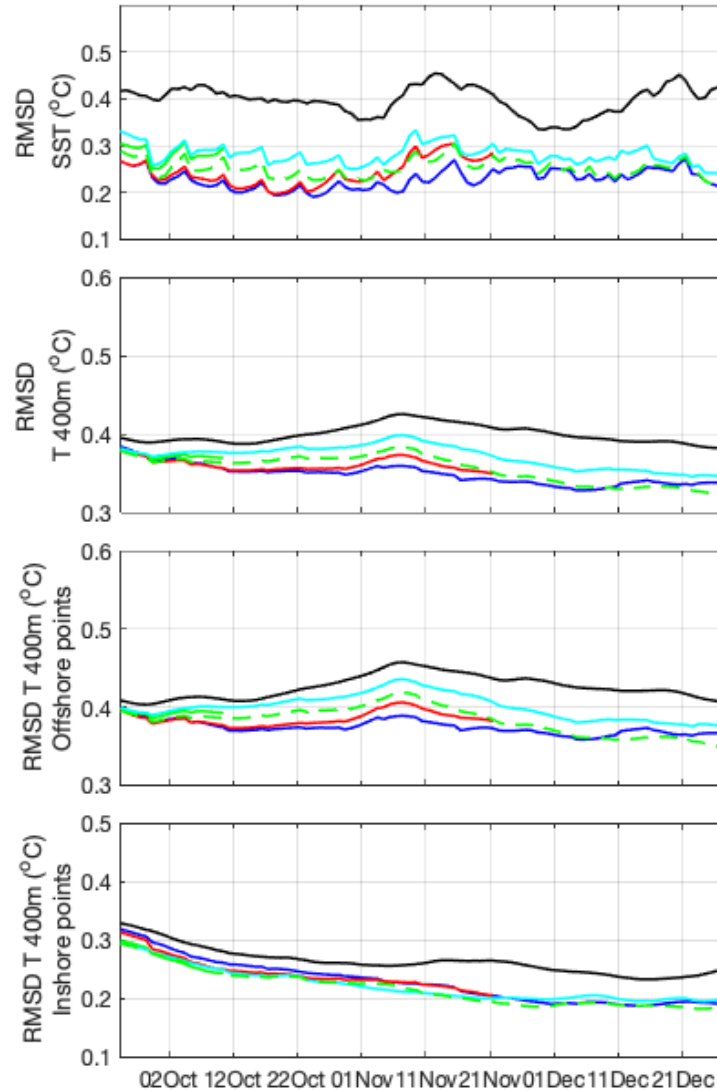
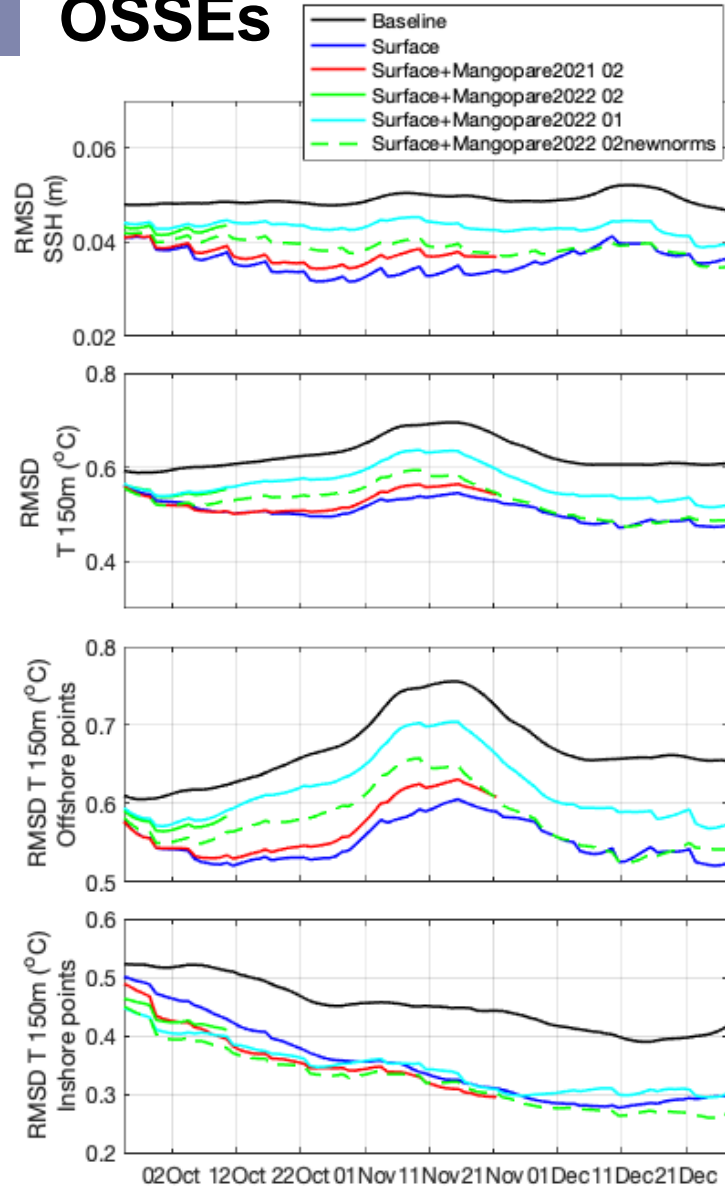
We perturb the initial conditions of the truth simulation by 18 days to generate the base model. Eighteen days was chosen as this is the number of days to 0.5 autocorrelation of UOHC at chosen points in NZ's shelf seas (the time to zero correlation is 30 days).

Observations mimic along-track SSH data and OSTIA SST, as well as the *Mangōpare* observations.

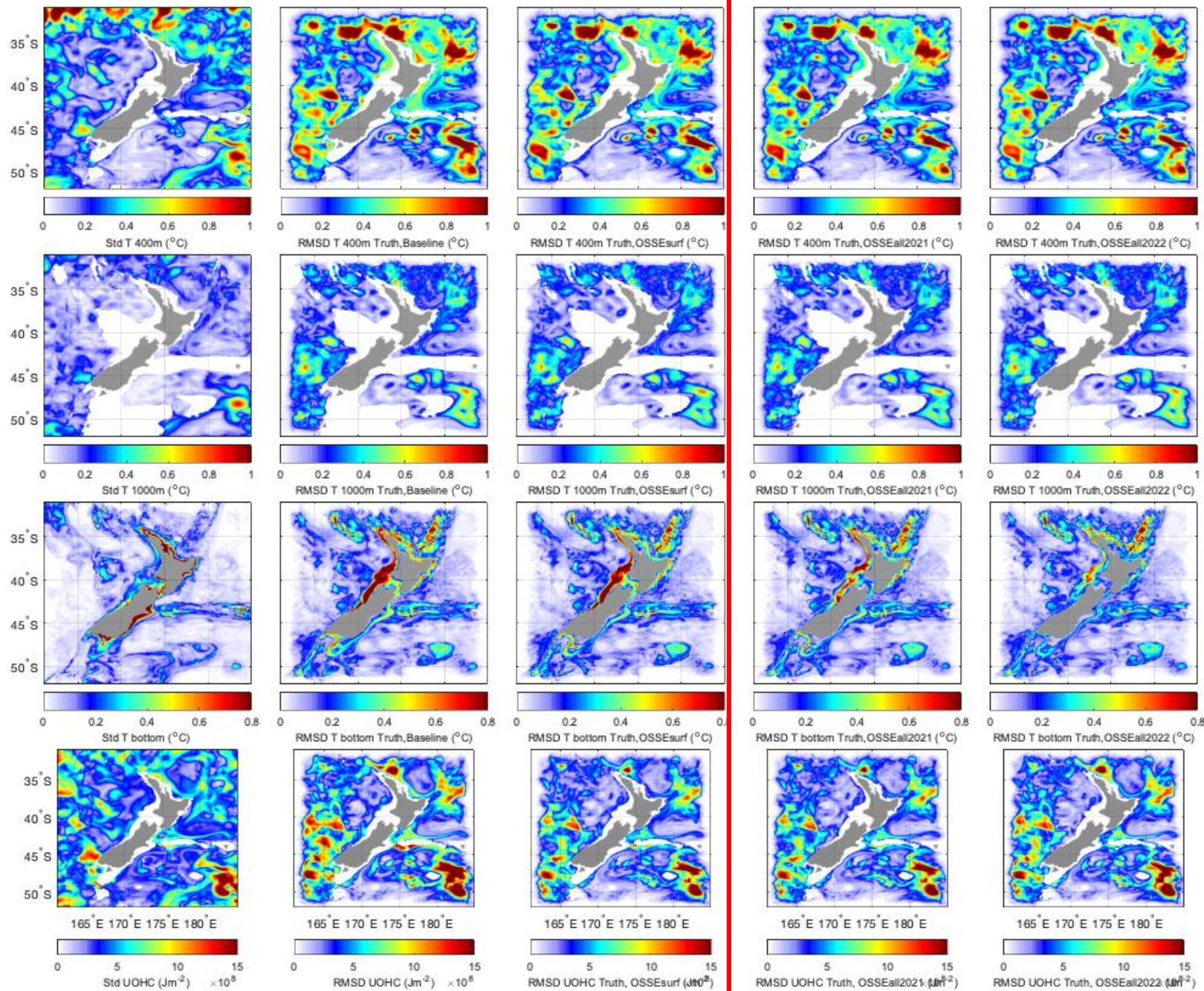
Mangōpare observational network is set to mimic the observations that we available from **23 Sept 2021 to 28 Dec 2021** and from **23 Sept 2022 to 28 Dec 2022**.

The OSSEs runs and analysis were conducted by Dr. Colette Kerry.

OSSEs



OSSEs



Take away points

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- The **Mangōpare** sensors provide reliable operational observations for coastal data assimilation and forecast provision in a **cost-effective** way. *(The whole system costs between 500k and 1M NZD per year)*
 - 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.
 - **The full end-to-end system is implemented and most of the code base is open.**
 - **OSE's experiments including Mangōpare obs are included in the SynOBS project, part of the CoastPredict UN Decade of Ocean Sciences Program. Observations impact analyses are being conducted.**
 - **New observations template has been submitted to the GTS and an experiment dealing with the impact on weather forecasts for New Zealand is planned – to be presented at the 2024 WMO meeting.**
-
- *The system provides fully automated analyses and forecasts daily! These are linked to extreme events alert systems that communicate the model results to the general public on easy-to-understand and timely ways.*

Pre-processing and analysis python code available at

The model results are publicly available.

We are strong supporters of the FAIR and CARE data sharing principles.

What's next???

Ocean observations and operational systems depend on institutional and government support.

The value delivered to society largely overweights the cost of monitoring and forecasting the ocean.
(as registered by benefit mapping through user engagement)

The Moana Project will end at the 30th of September 2023.
The future of the system is uncertain... at least in NZ.