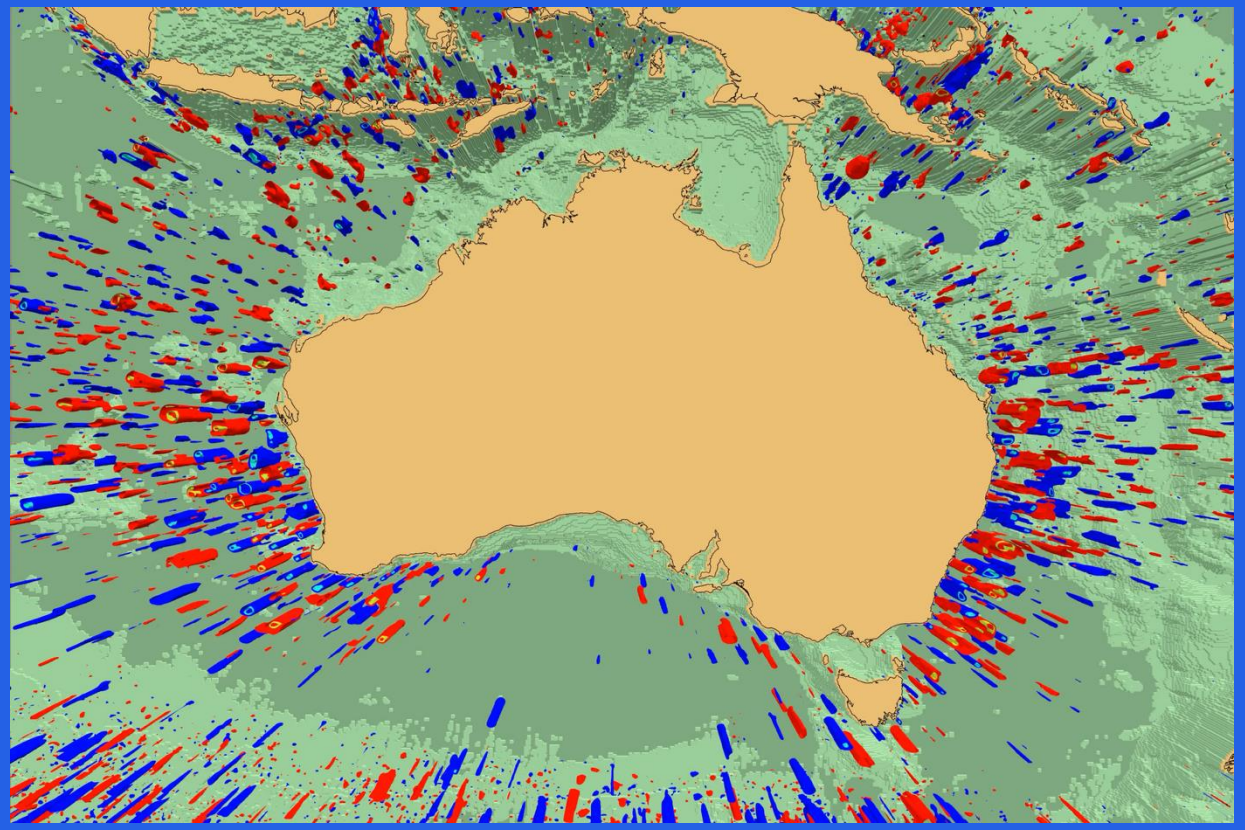
The Bureau of Meteorology

OceanMAPSv4.1i



Prasanth Divakaran

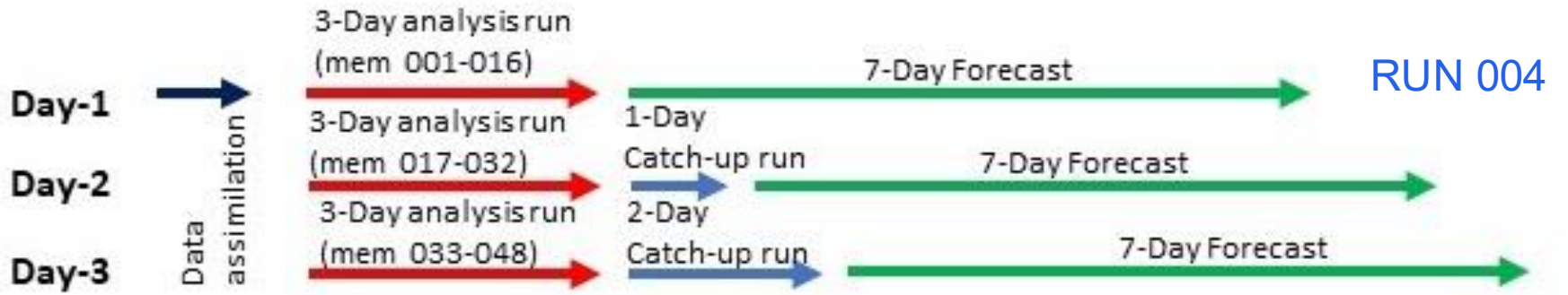
Gary Brasssington, Pavel Sakov, Saima Aijaz, Mirko Velic, Chris Bladwell, Matt Chamberlain, Xinmei Huang, Roy Thompson, Mikhail Entel, Ahmad Khan

Bluelink Ocean Forecasting

Ocean Model Analysis and Prediction System

- Short-range ocean prediction capability of the bureau.
- Based on MOM5.
- Use hybrid ENKF (with 48 dynamic ens members) for data assimilation
- 1/10 horizonal resolution, Latitudinal extend 75S-75N, 51 vertical levels
- Run with APS3/4 Bulk-flux

OMAPSv4p0i

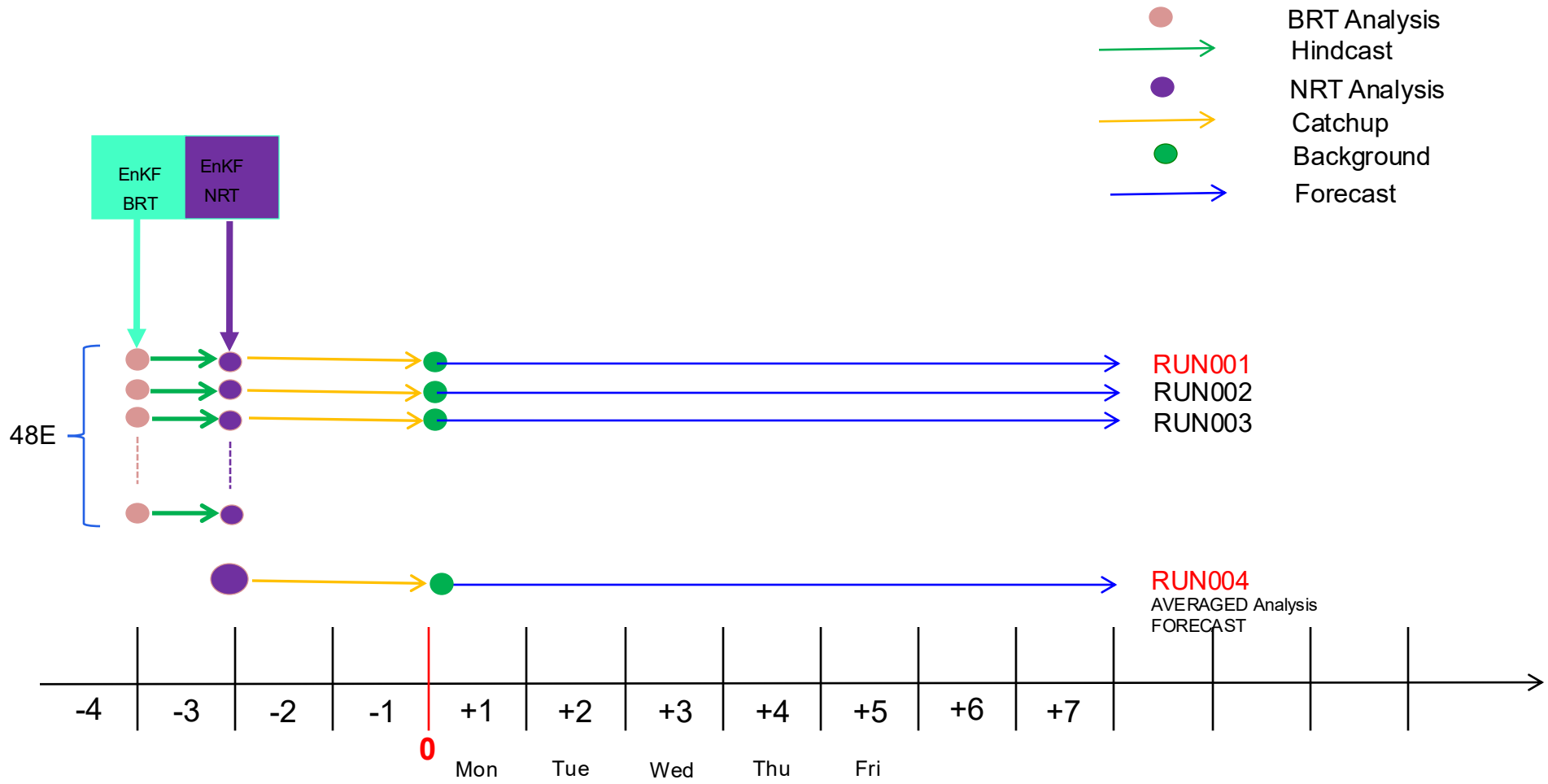


Analysis every 3 days with 3-day observation window
Analysis at 3 days behind real-time

INDIVIDUAL MEMBER FORECASTS
RUN 001
RUN 002
RUN 003

Forecast cycle – Deterministic forecasts

BRT Analysis + 1-Day Hindcast + NRT Analysis + 2 DAY Catchup + Forecast

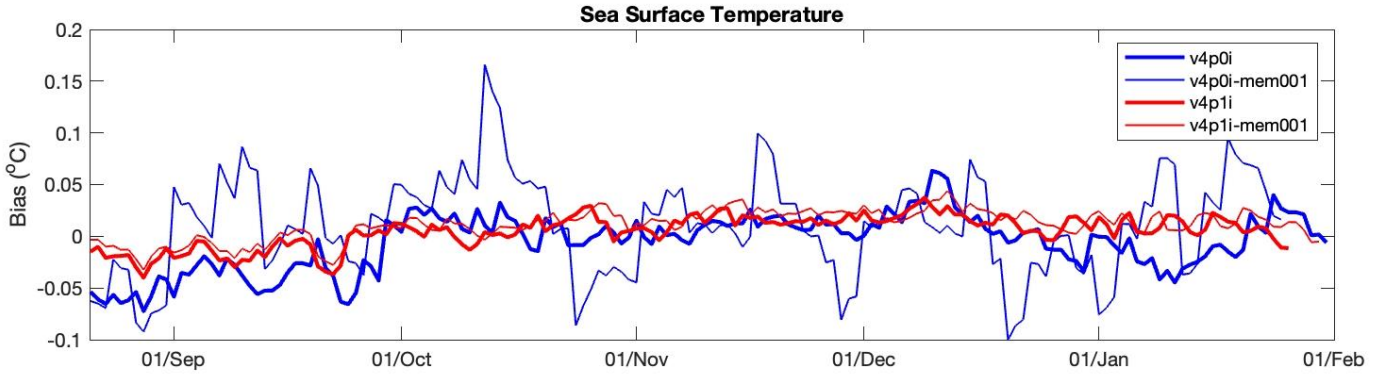


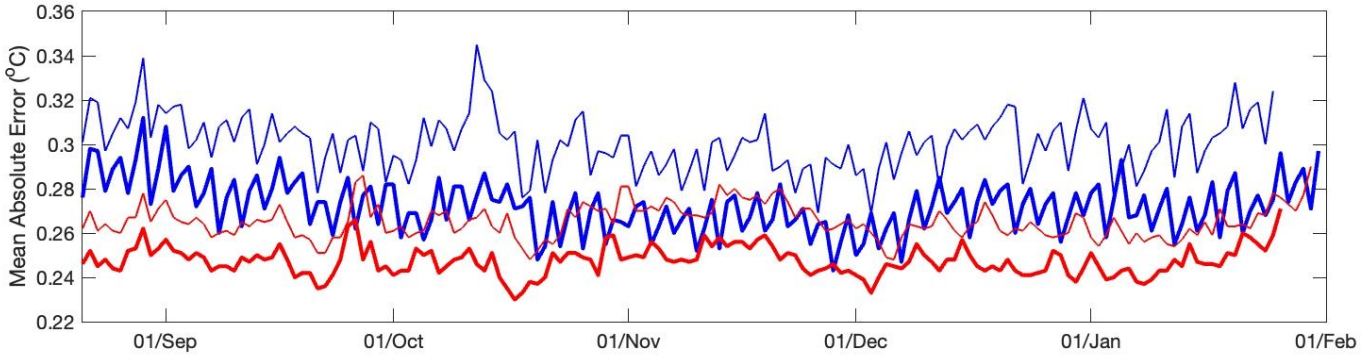
OMAPSv4p1i

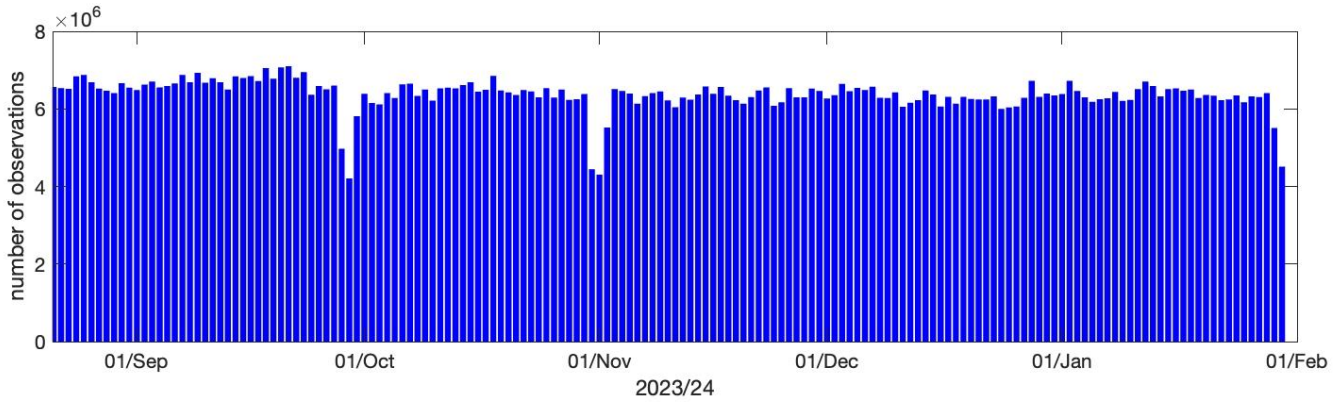
SST 24 hr - Forecast error

Global Domain

60N-60S
180E-180W



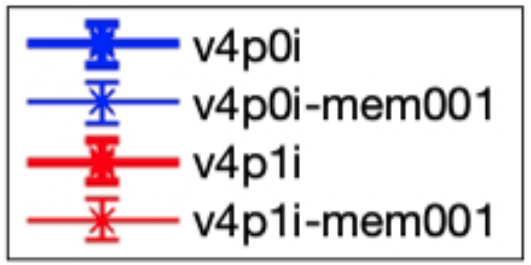


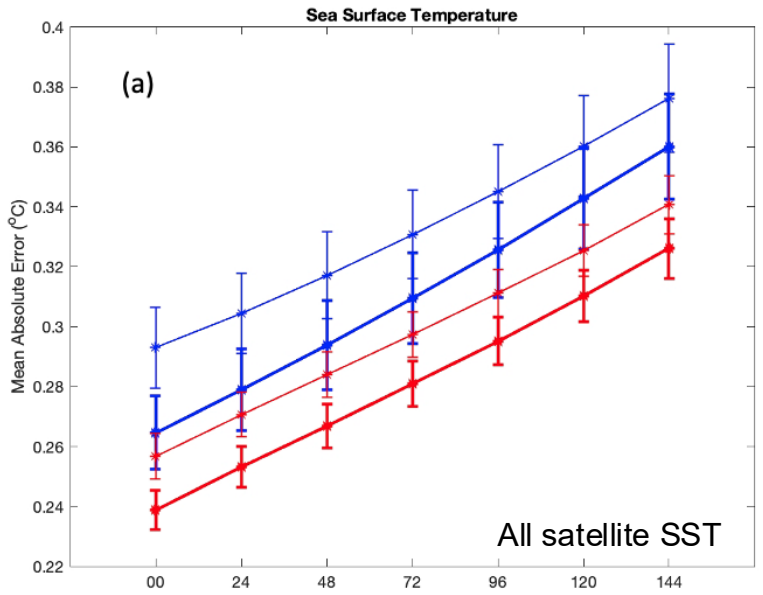


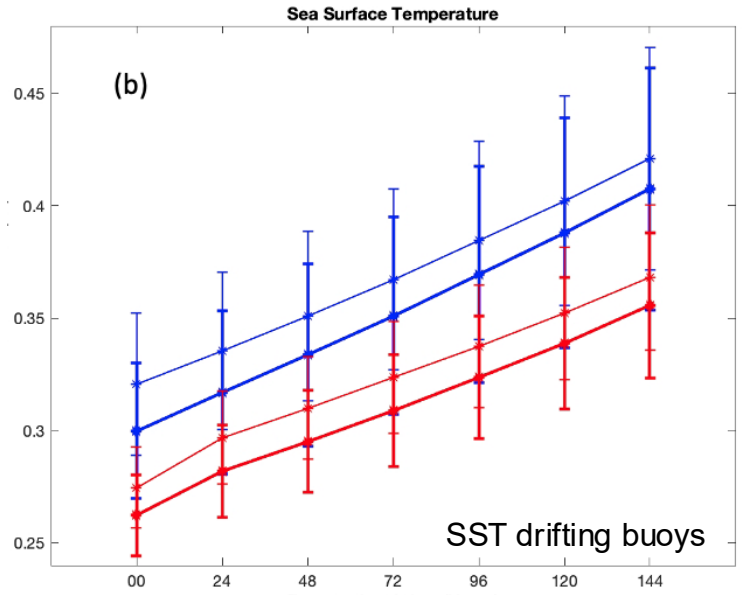
Mean Absolute Error vs forecast lead time

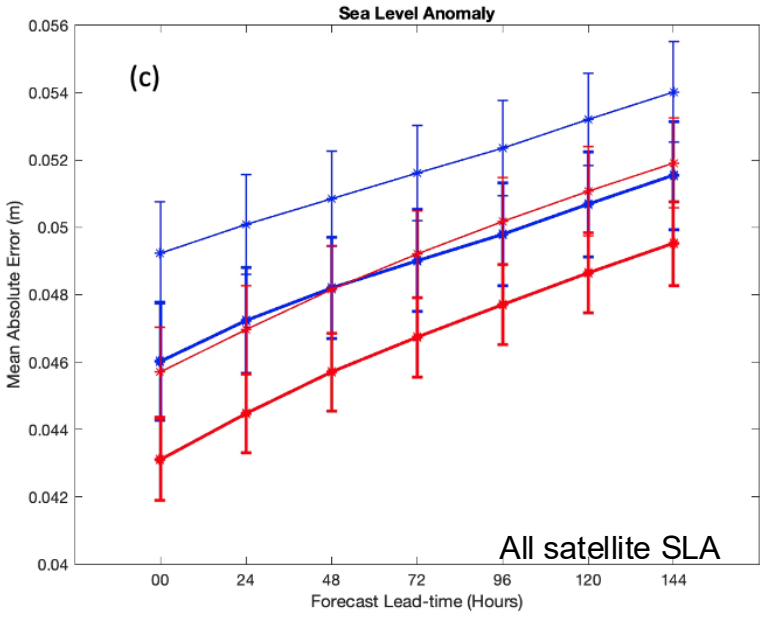
Sea surface temperature

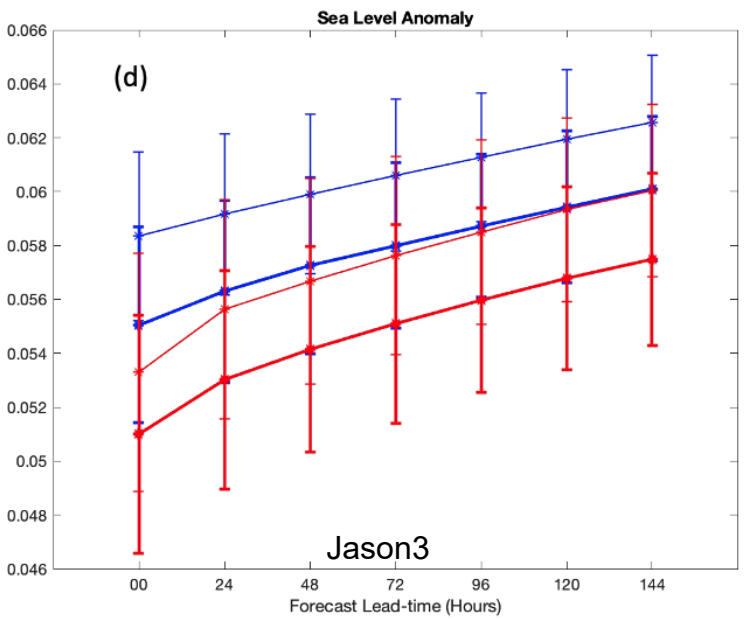
Sea Level Anomaly

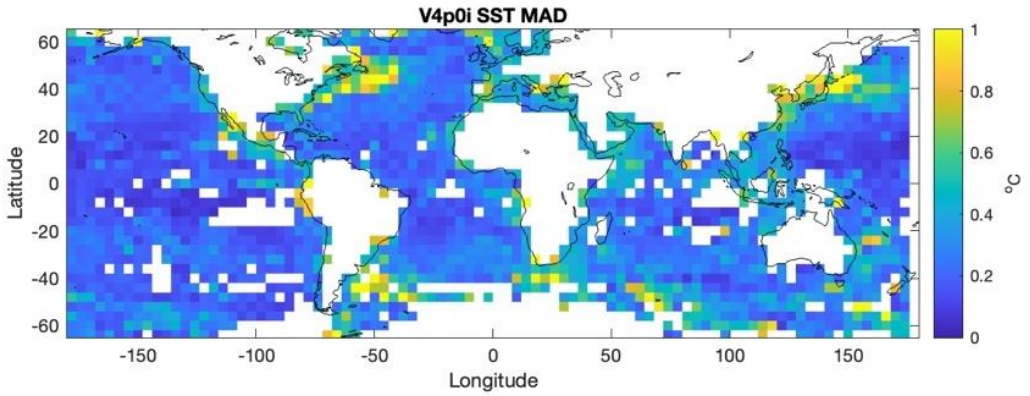


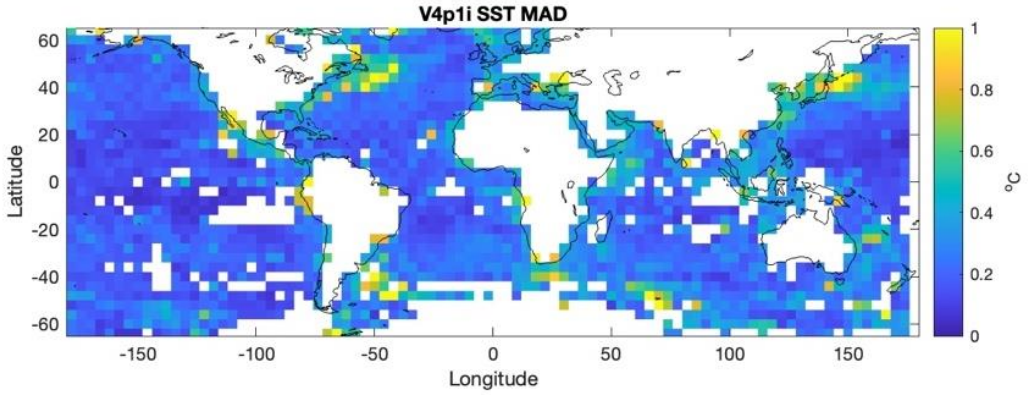


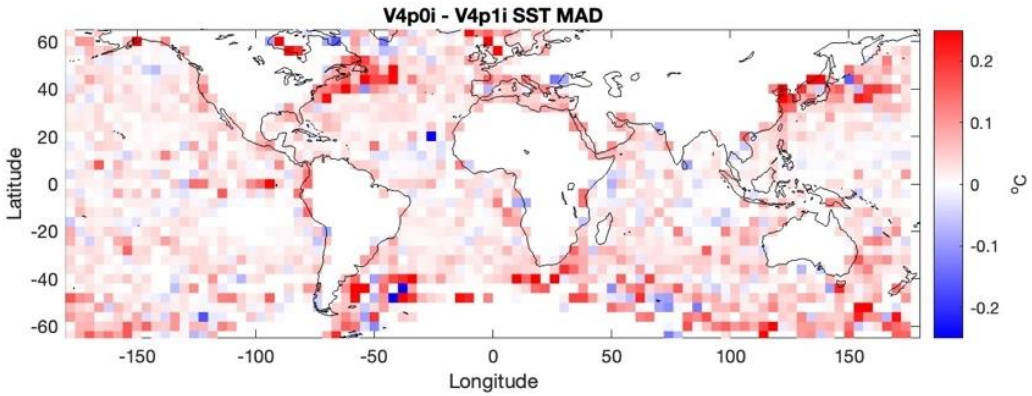






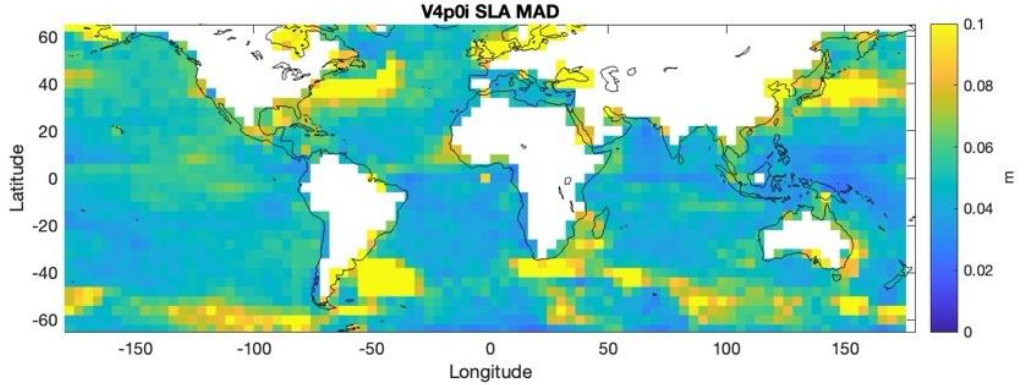


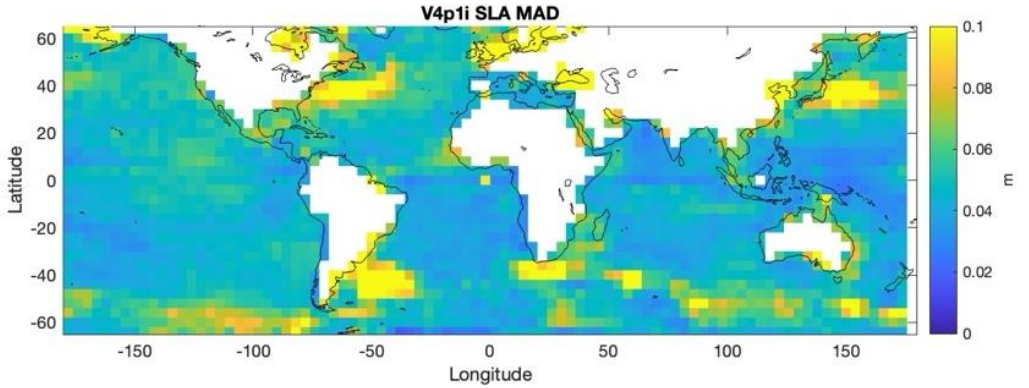




Red
=
reduced error

Figure 6 SST Mean absolute error in 4° spatial bin for v4p0i(top), v4p1i(middle) and difference in MAD between v4p0i and v4p1i(bottom), based on SST drifter observations and averaged restart products from each system.





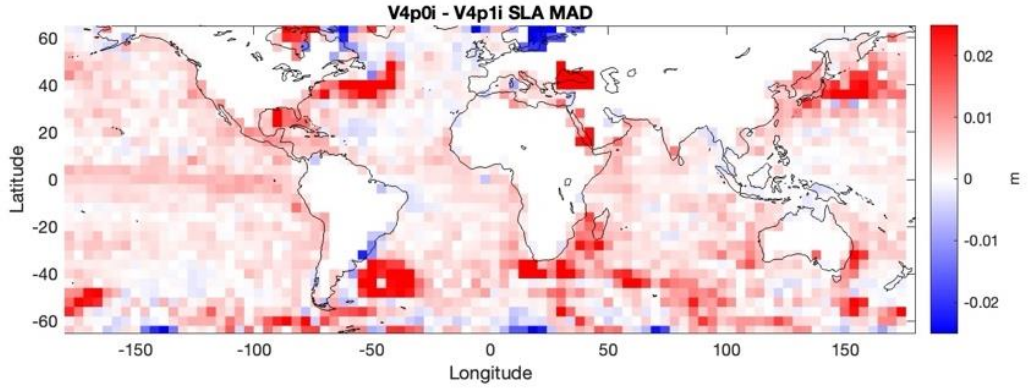


Figure 7 SLA Mean absolute error in 4° spatial bin for v4p0i(top), v4p1i(middle) and difference in MAD between v4p0i and v4p1i(bottom), based on SLA Jason-3 observations and averaged restart products from each system.

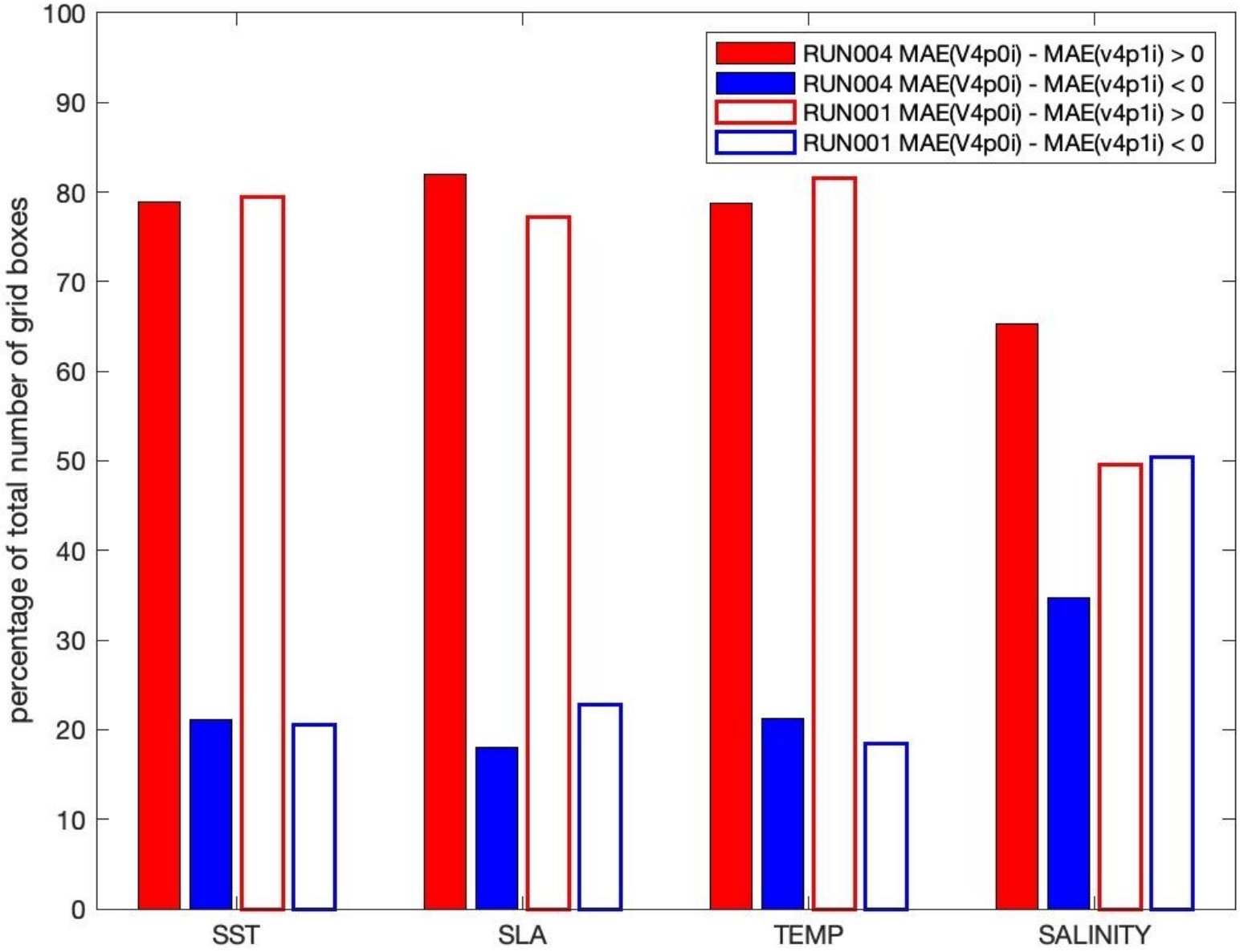
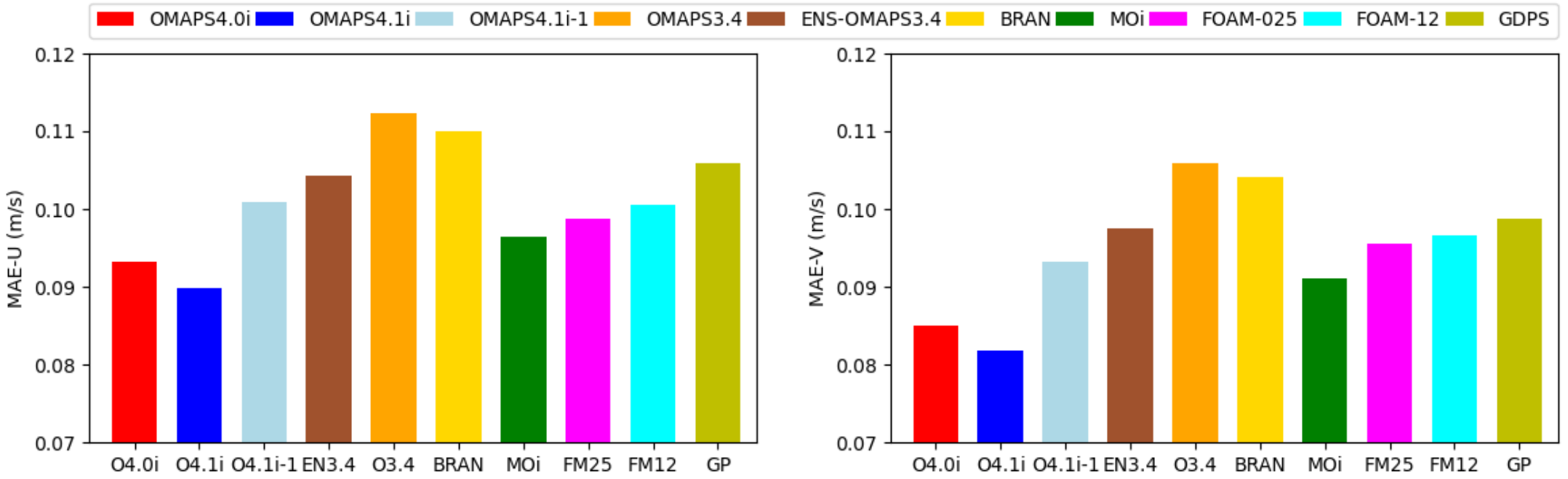


Figure 10 Percentage of positive and negative bins from the global MAE difference binned maps for all four variables.

Currents verification & intercomparison against global drifters (GDP)

Global Analysis



Zonal **Meridional**

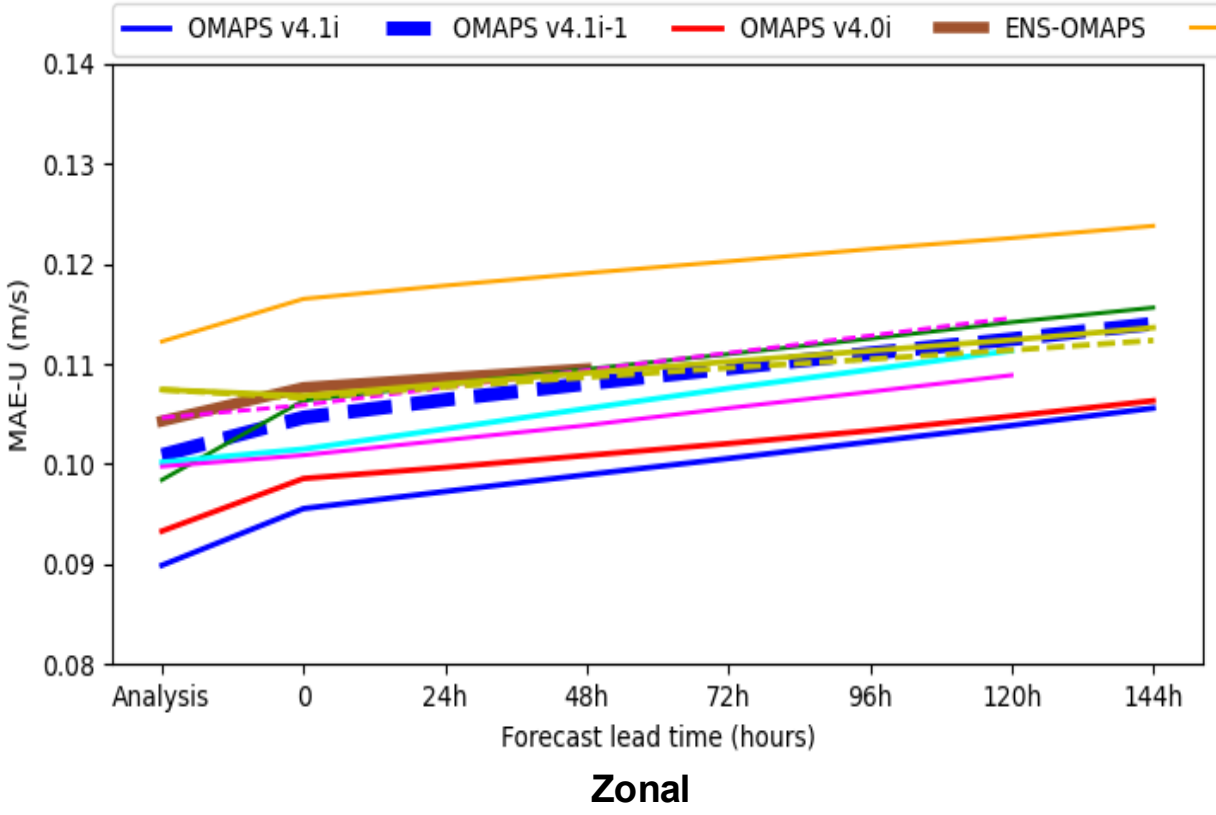
OMAPS 4.0i, 4.1i, 4.1i-MEM1: 1JAN2024 – 30JUN2024 (182 days)
MOi,FOAM-025, FOAM-12, GDPS: 1JAN2022 – 10MAR2023 (432 days)
OMAPS3.4, ENS-OMAPS3.4: 20MAY2021 – 19MAY2022 (364 days)

Australia: OMAPS3.4/4.0i/4.1i, ENS-OMAPS3.4, BRAN2020
France: MOi
UK: FOAM025, FOAM12
Canada: GDPS

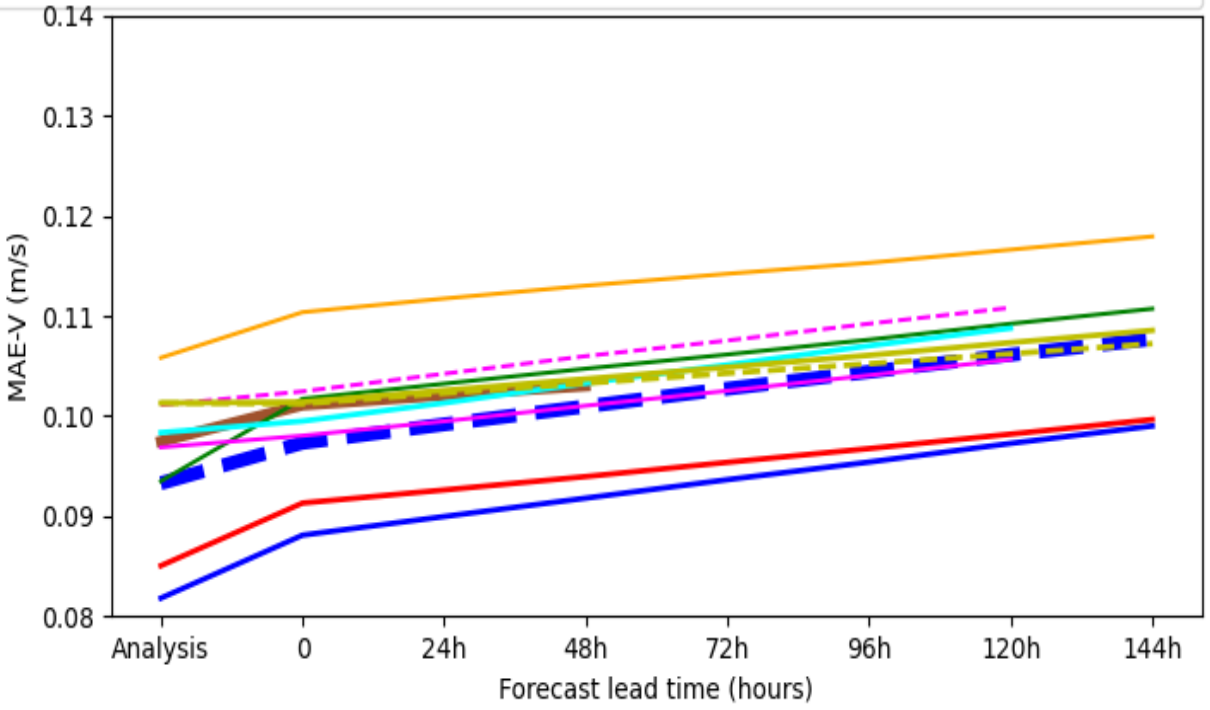
Aijaz et al. (2023), Ocean Modelling

Currents verification & intercomparison against global drifters (GDP)

Global forecast error growth



Zonal

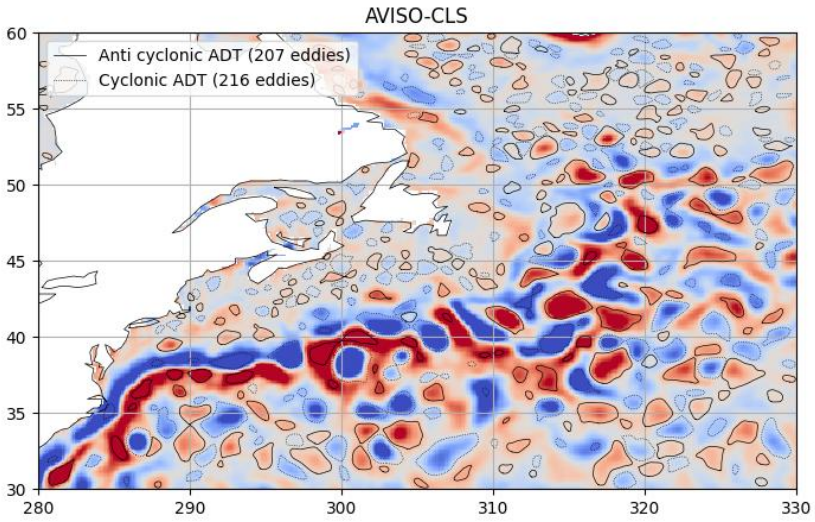


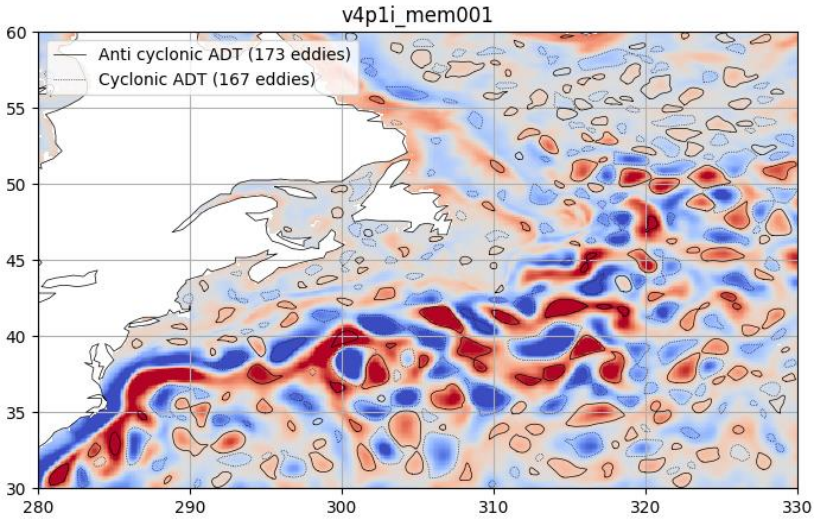
Meridional

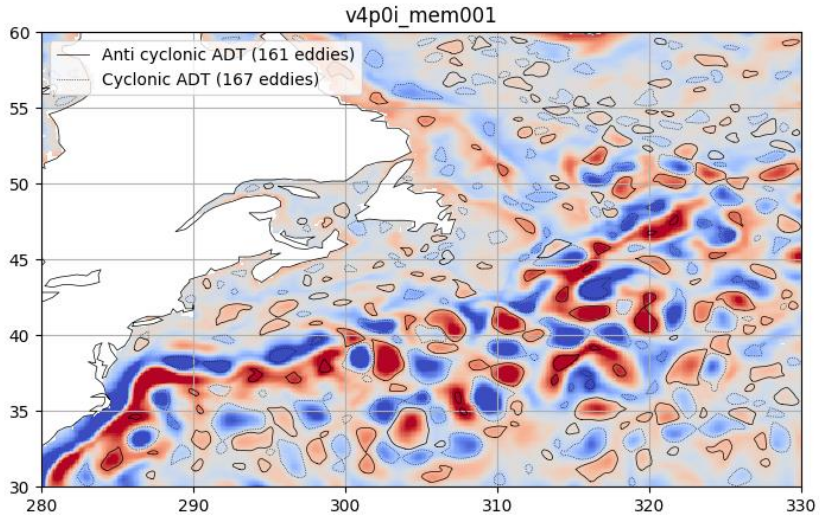
Aijaz et al. (2023), Ocean Modelling

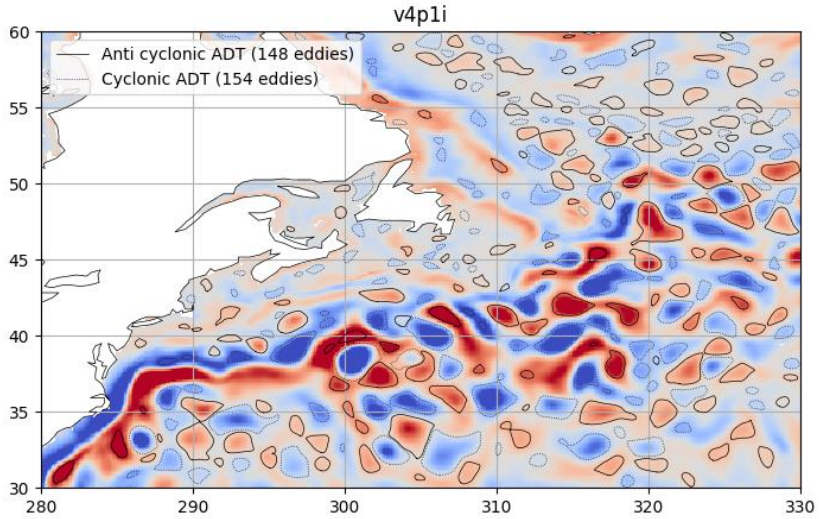
Mesoscale Eddies

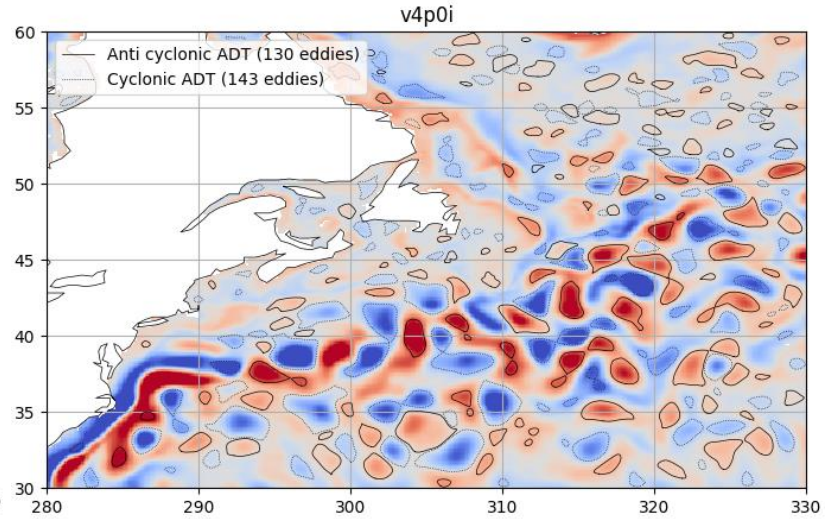
2023 08 26





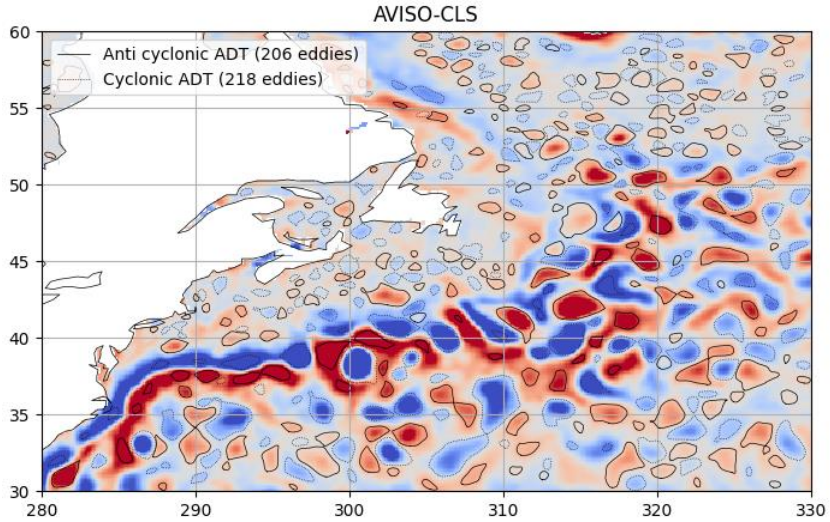


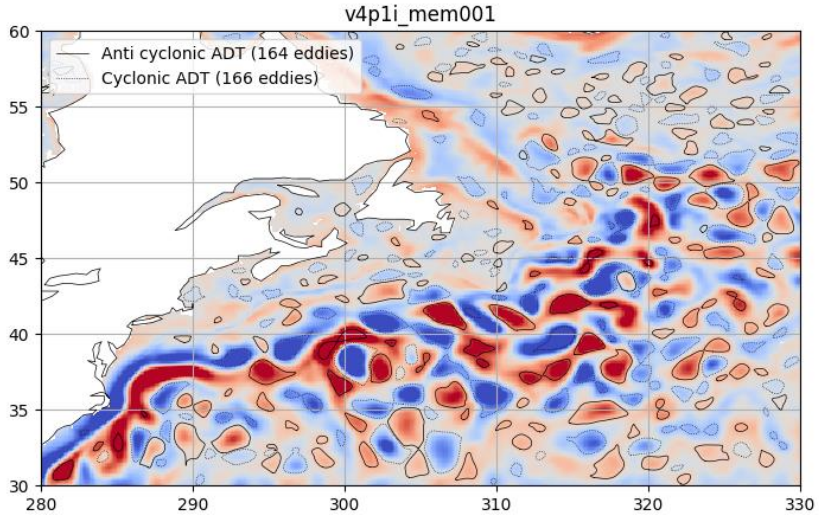


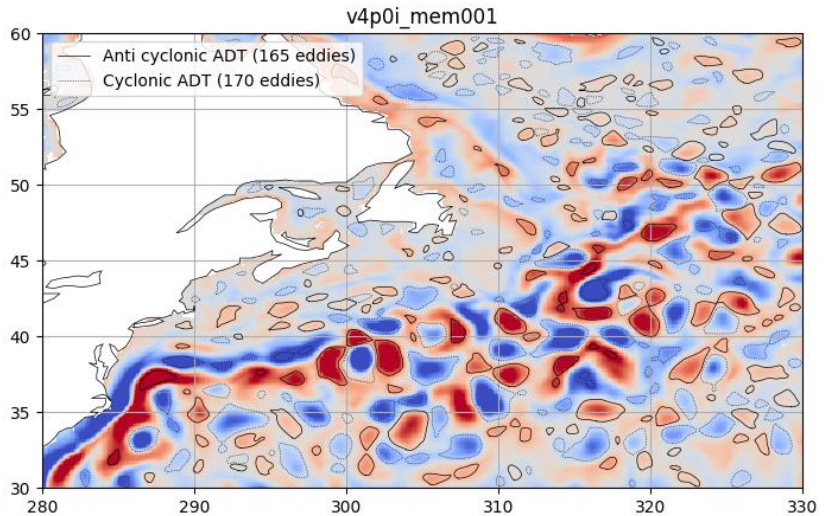


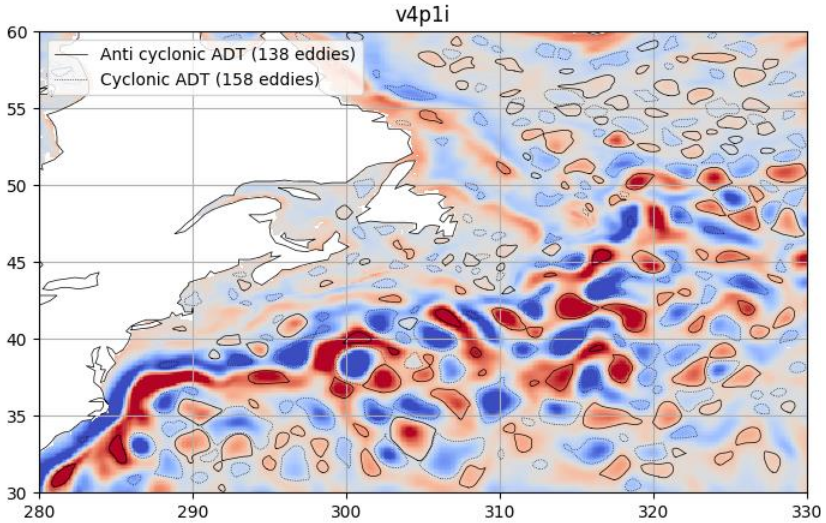
Mesoscale Eddies

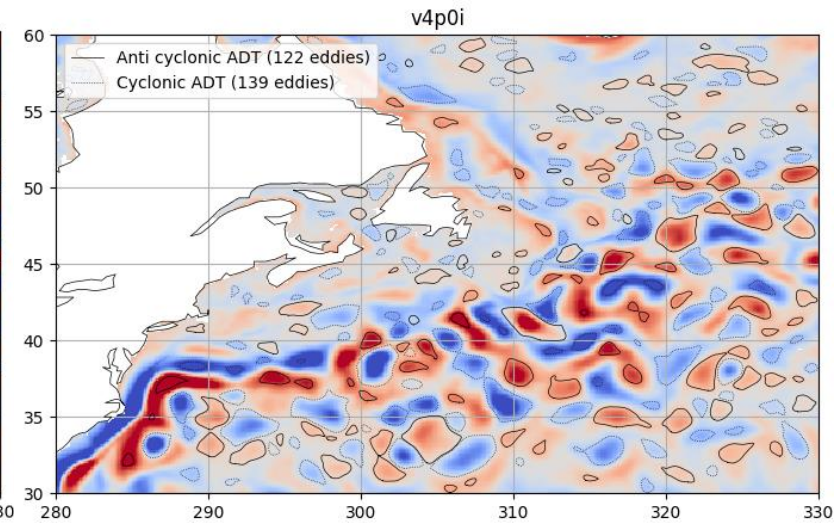
2023 08 27



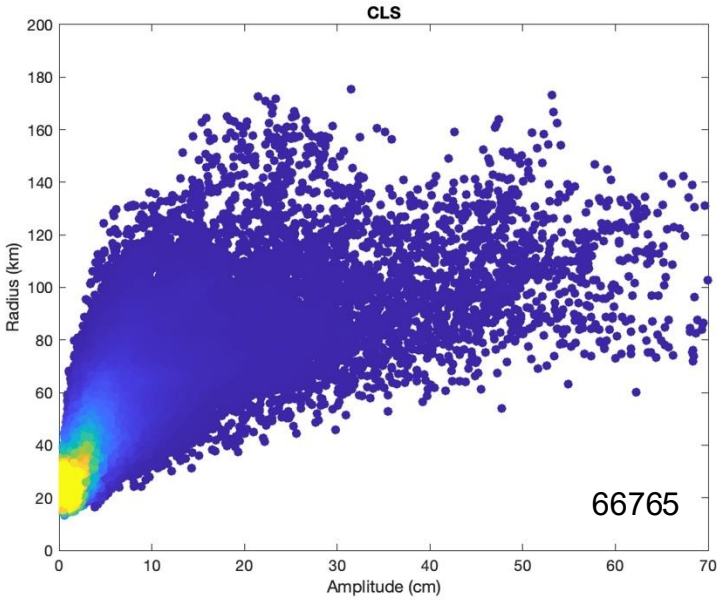


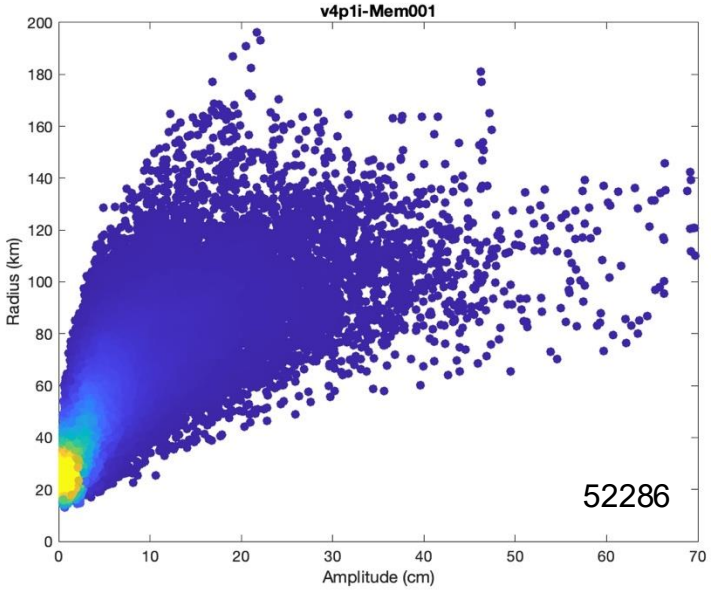


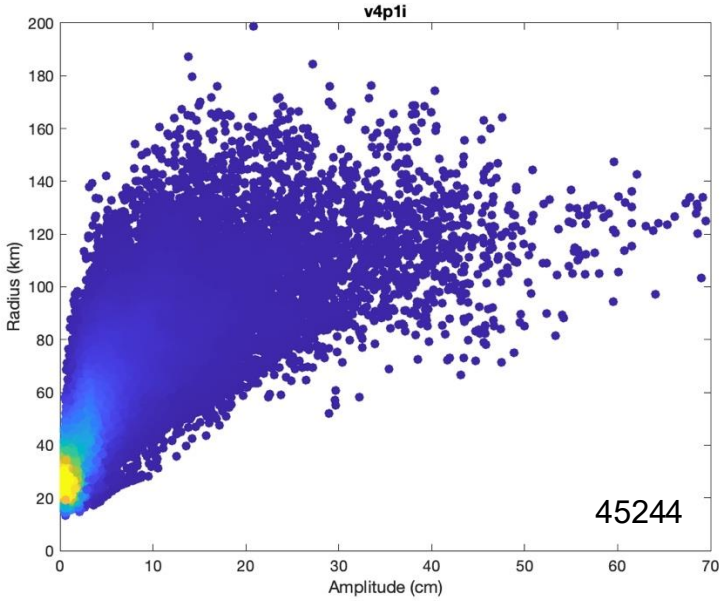


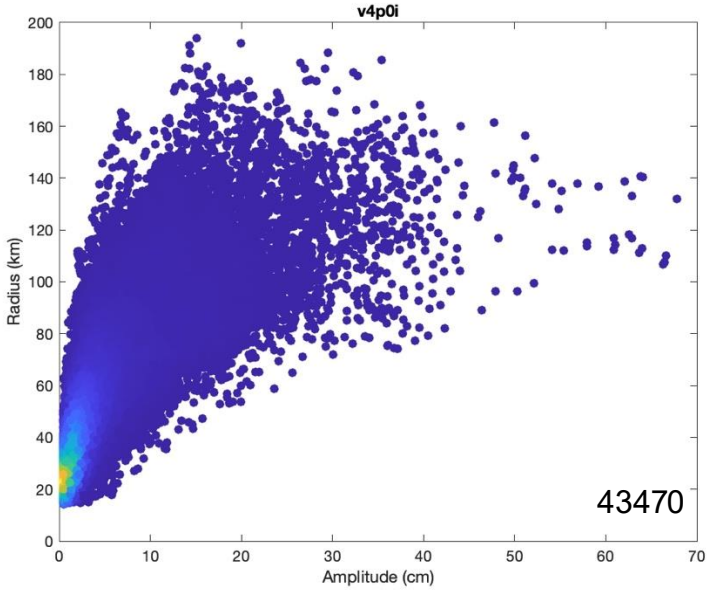


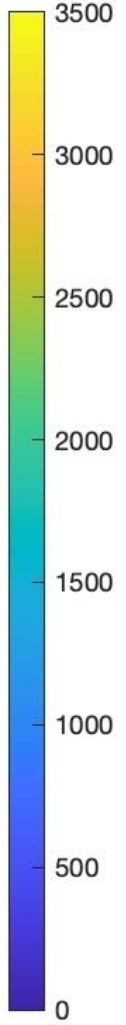
Eddy characteristics





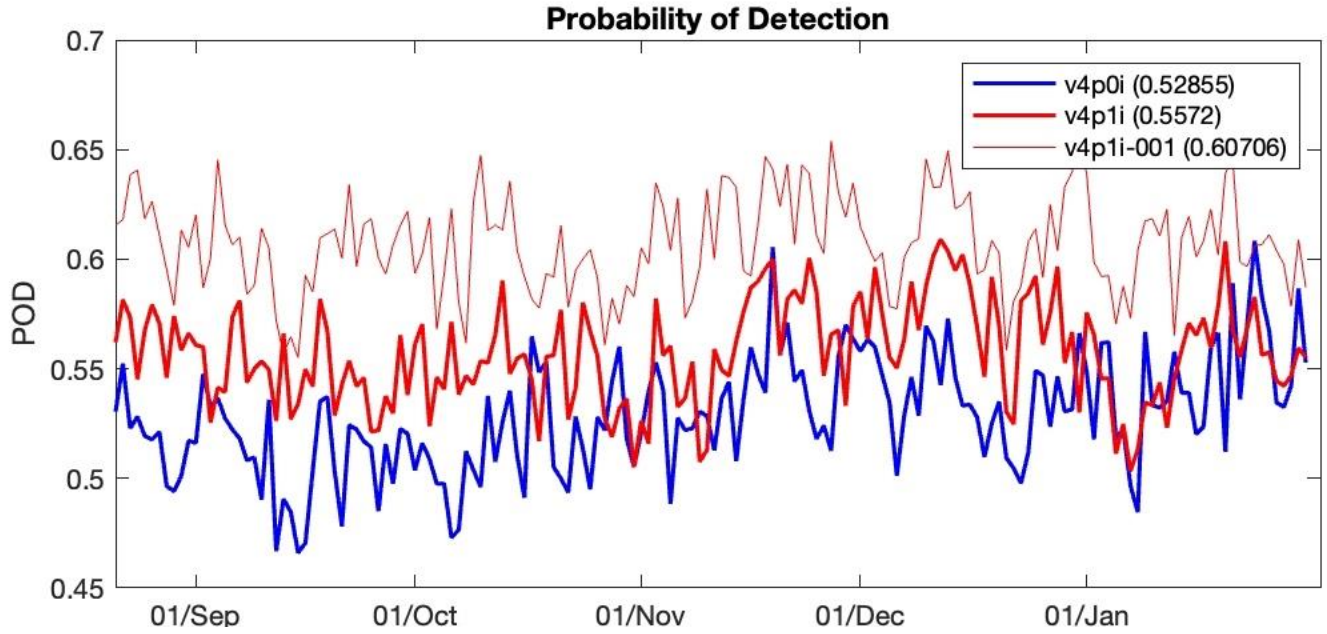






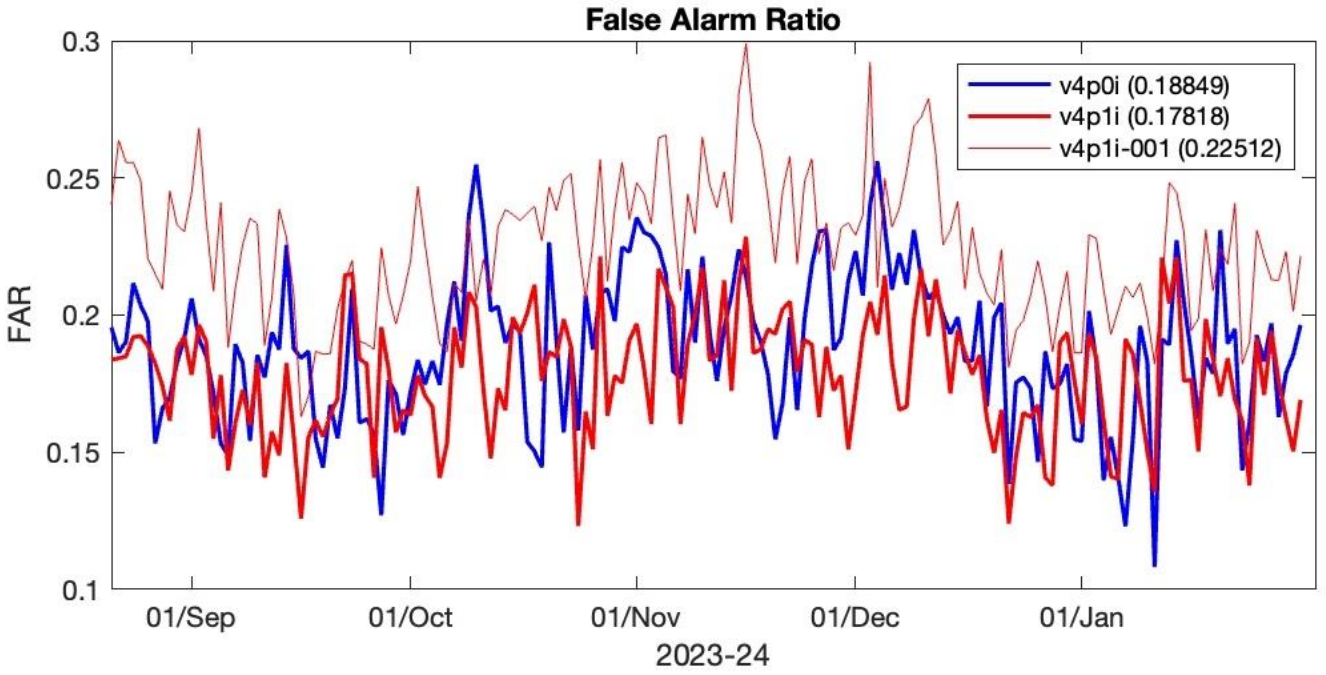
Probability of Detection (POD)

$$POD = \frac{hits}{hits+misses}$$

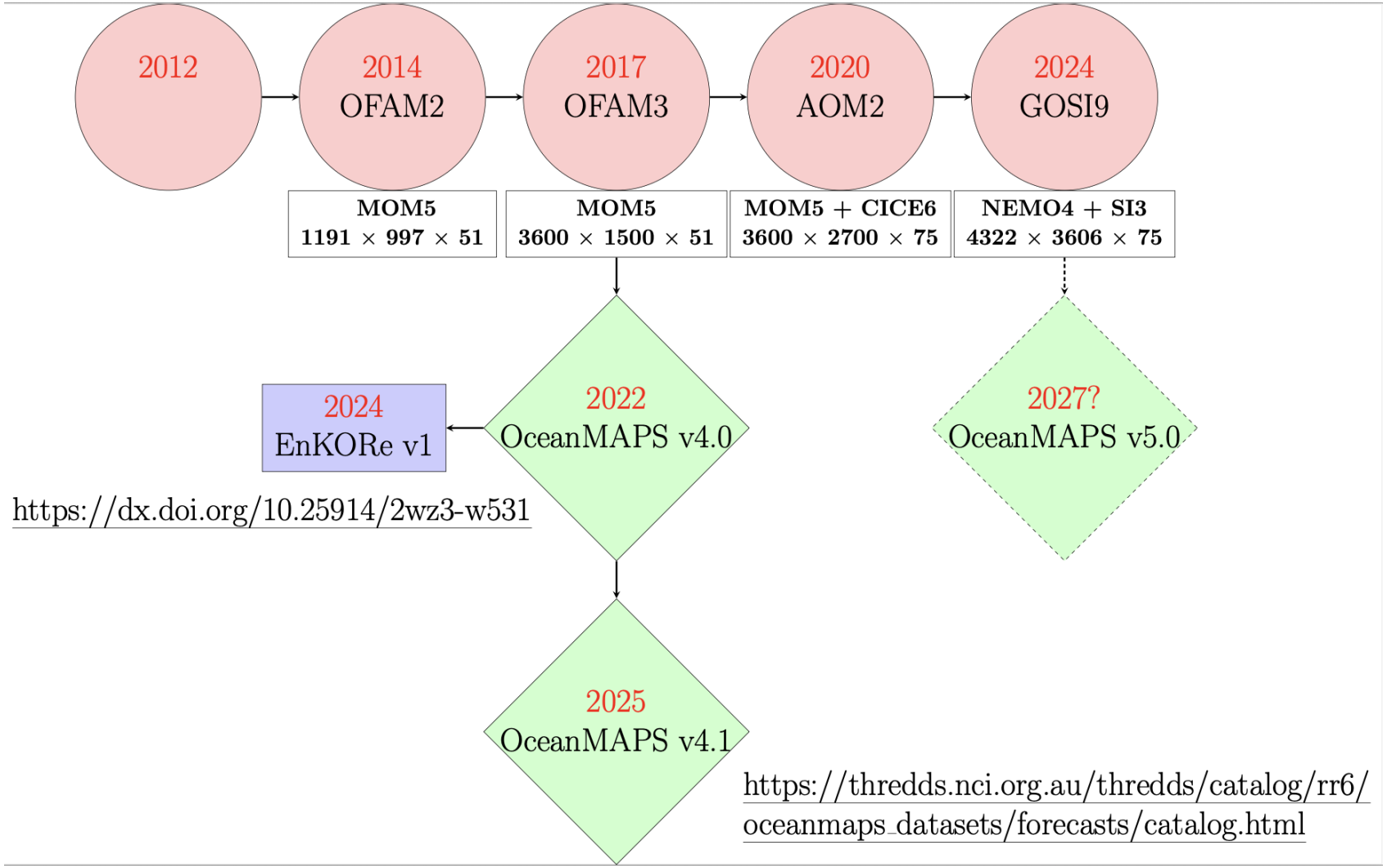


False Alarm Ratio (FAR)

$$FAR = \frac{False\ alarms}{hits+False\ alarms}$$

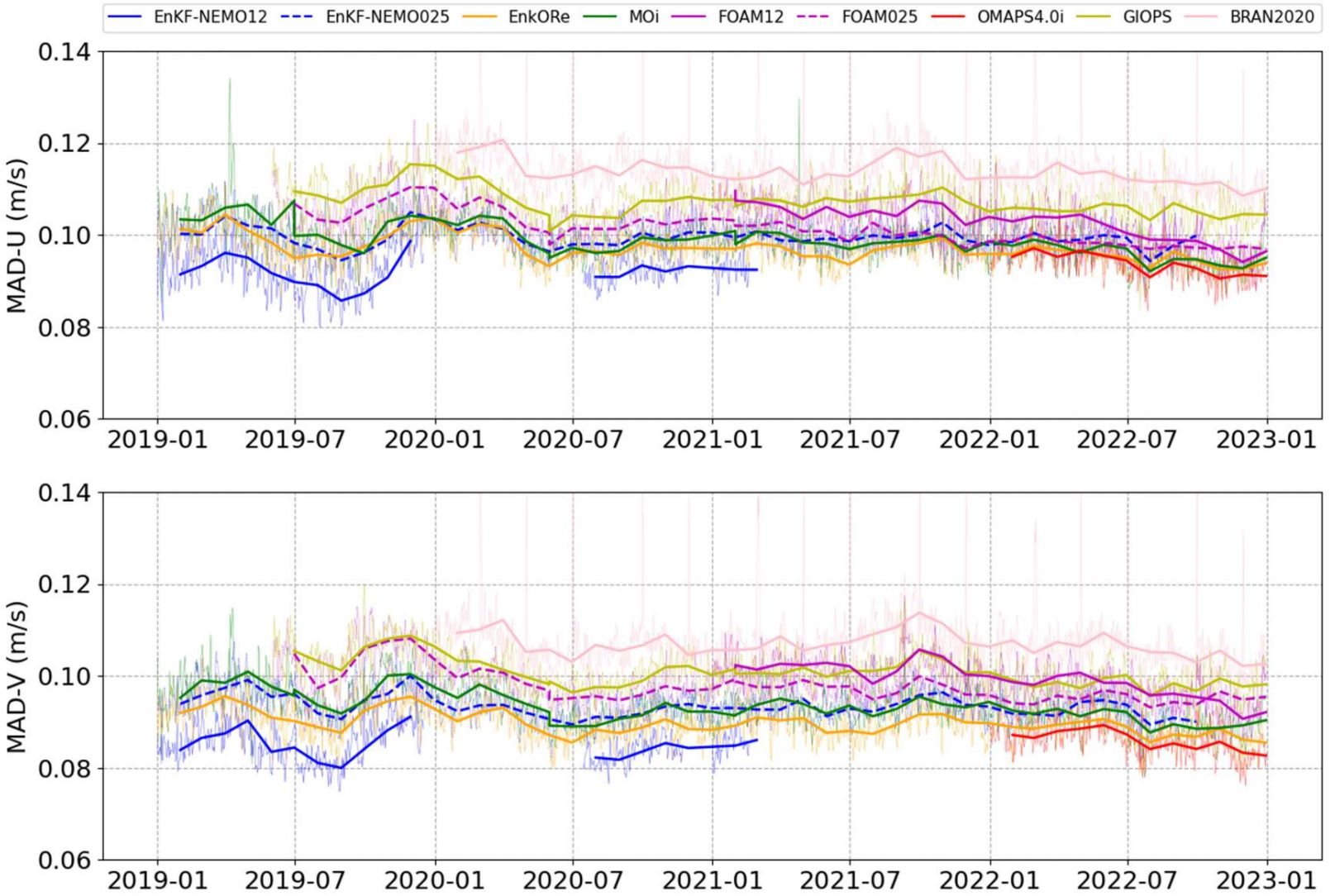


Evolution of EnKF OceanMAPS



Credit:PavelSakov

Current verification and Intercomparison against drifters



Summary

Operationalisation of OceanMAPSv4.1i (1-day cycle) successfully completed

Broad range of positive impacts

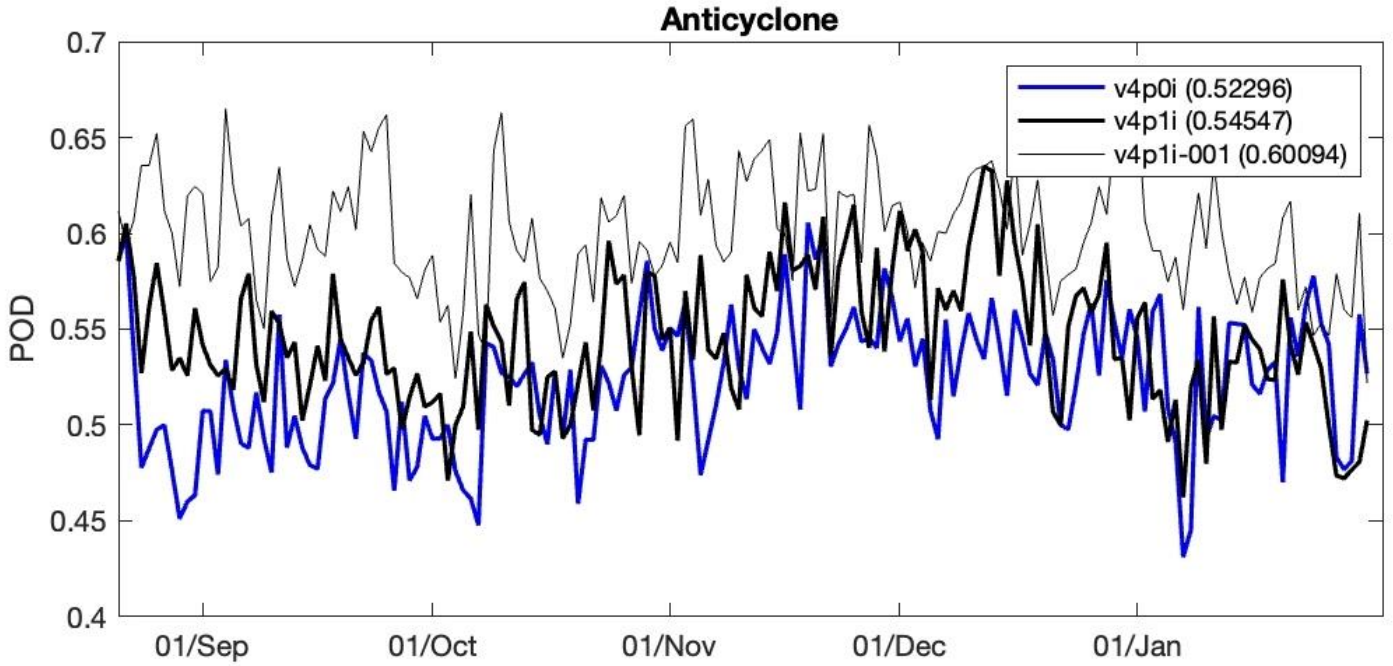
- Improved accuracy of state variables and ocean currents
- Shown to have less errors spatial errors compared to OceanMAPSv4p0i.
- Better continuity of eddy propagation
- Constraining low signal to noise eddies

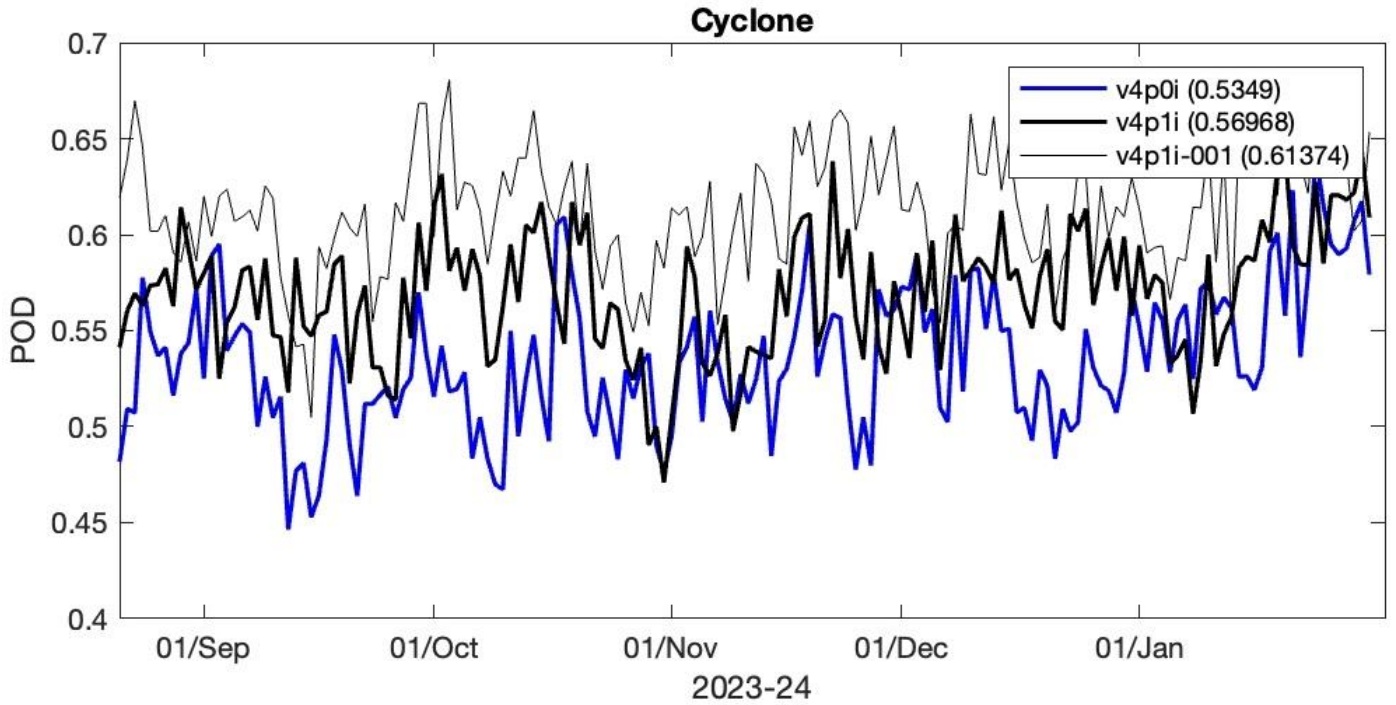
The Bureau of Meteorology

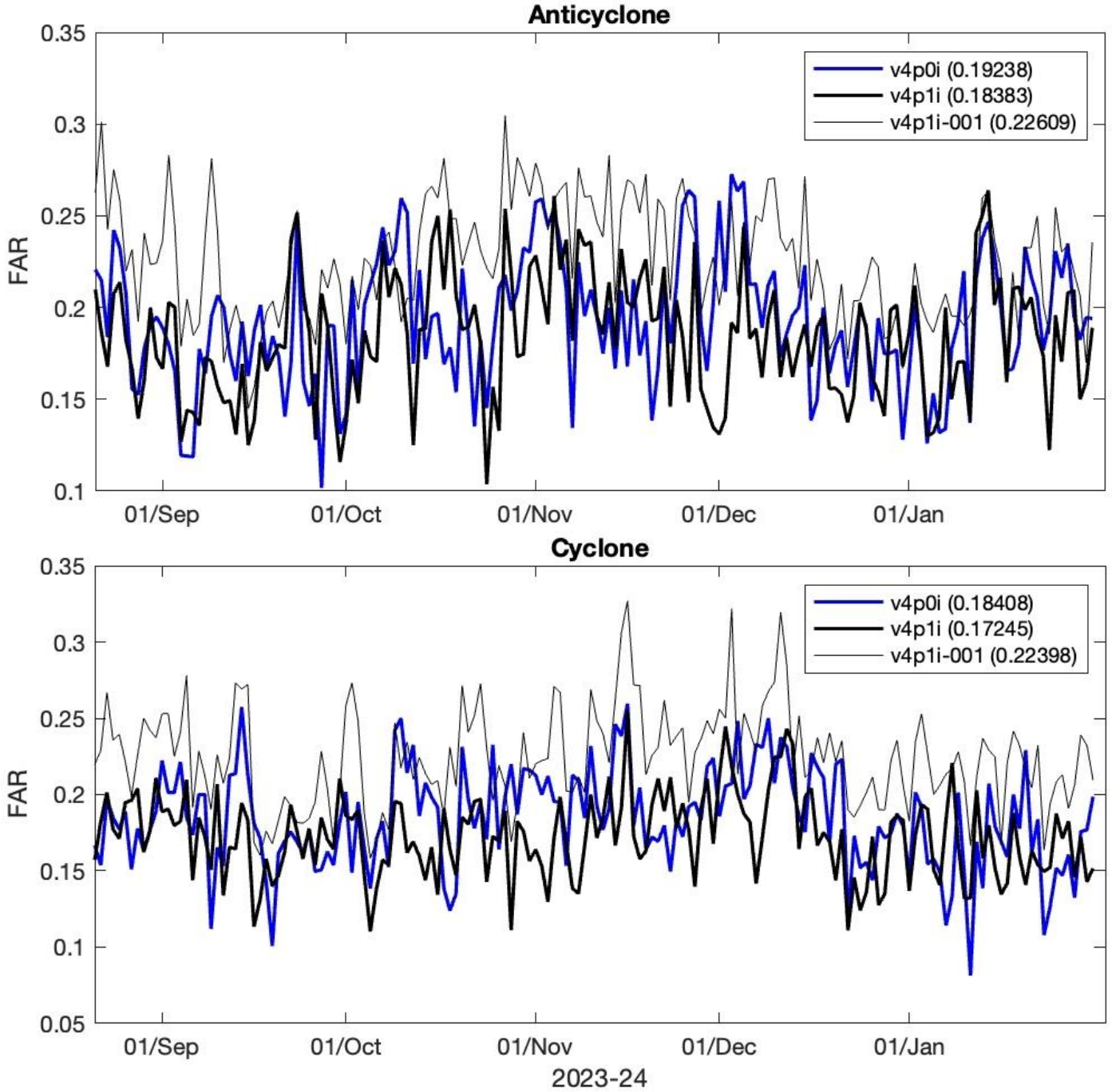
Thank you

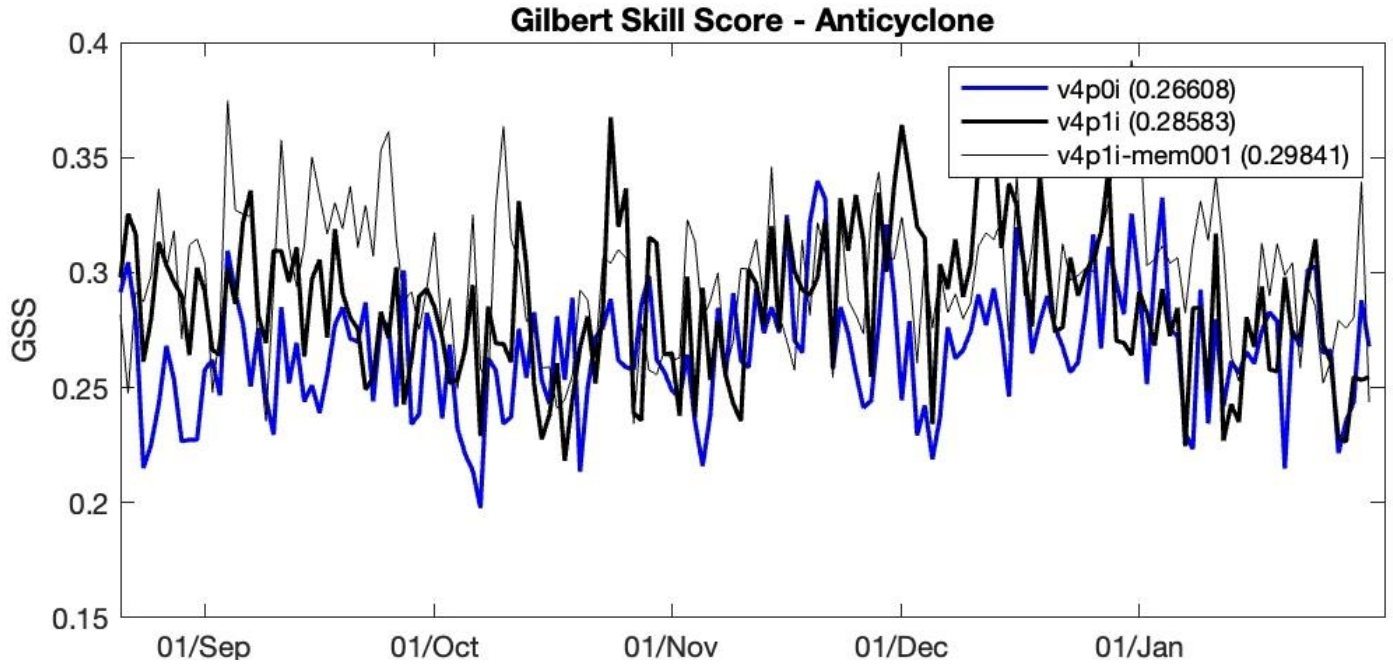
Prasanth Divakaran

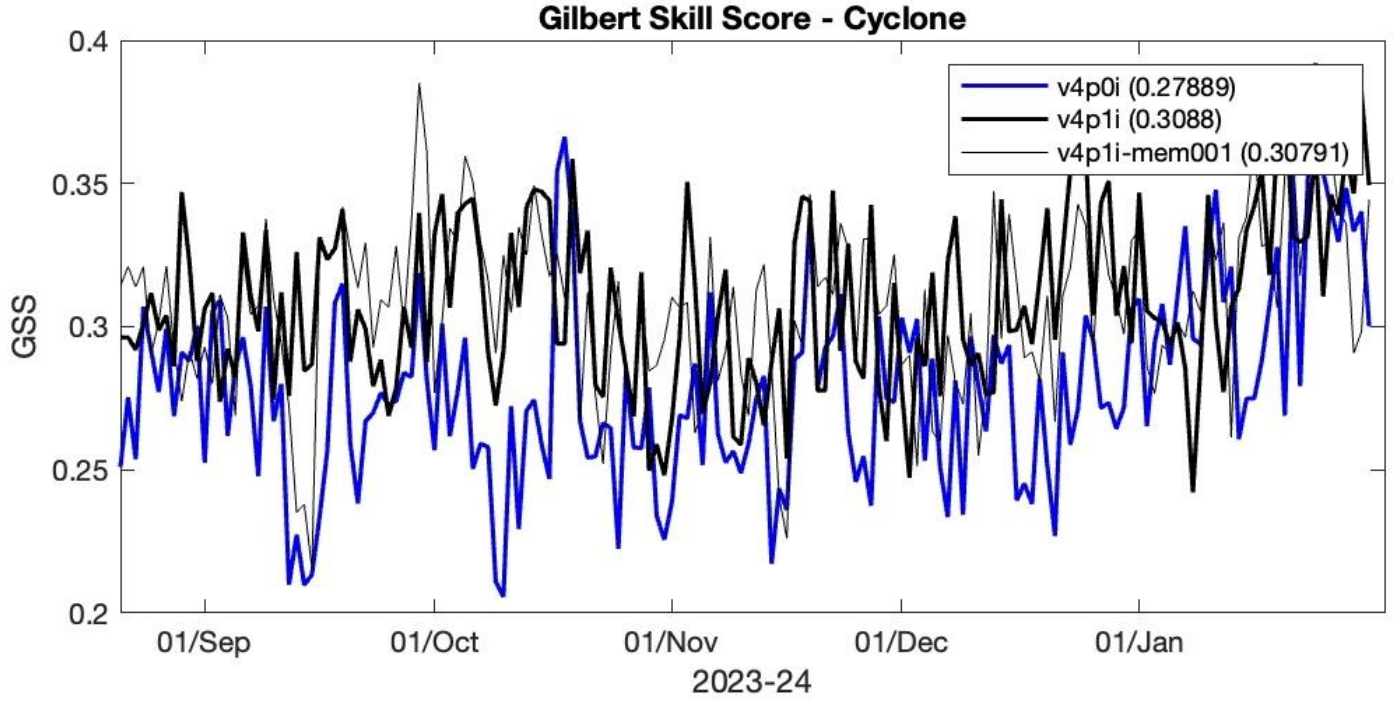
prasanth.divakaran@bom.gov.au


Anticyclone
POD
0.7
0.65
0.6
0.55
0.5
0.45
0.4
01/Sep
01/Oct
01/Nov
01/Dec
01/Jan
v4p0i (0.52296)
v4p1i (0.54547)
v4p1i-001 (0.60094)


Cyclone
POD
0.7
0.65
0.6
0.55
0.5
0.45
0.4
01/Sep
01/Oct
01/Nov
01/Dec
01/Jan
2023-24
v4p0i (0.5349)
v4p1i (0.56968)
v4p1i-001 (0.61374)


Anticyclone
v4p0i (0.19238)
v4p1i (0.18383)
v4p1i-001 (0.22609)
FAR
0.35
0.3
0.25
0.2
0.15
0.1
01/Sep
01/Oct
01/Nov
01/Dec
01/Jan
Cyclone
v4p0i (0.18408)
v4p1i (0.17245)
v4p1i-001 (0.22398)
FAR
0.35
0.3
0.25
0.2
0.15
0.1
0.05
01/Sep
01/Oct
01/Nov
01/Dec
01/Jan
2023-24


Gilbert Skill Score - Anticyclone
GSS
0.4
0.35
0.3
0.25
0.2
0.15
v4p0i (0.26608)
v4p1i (0.28583)
v4p1i-mem001 (0.29841)
01/Sep
01/Oct
01/Nov
01/Dec
01/Jan


Gilbert Skill Score - Cyclone
GSS
0.4
0.35
0.3
0.25
0.2
v4p0i (0.27889)
v4p1i (0.3088)
v4p1i-mem001 (0.30791)
01/Sep
01/Oct
01/Nov
01/Dec
01/Jan
2023-24

Overview

Model configuration

	GOSI9 (eORCA12)	OFAM3 (MOM5)
Model (ocean)	NEMOv4.0.6	MOM5
Model (sea-ice)	SI^3	Nil
Grid type	C-grid	B-grid
Domain	0-360, 85S-90N (4322 x 3606)	0-360, 75S-75N (3600 x 1500)
Grid (horizontal)	Orthogonal curvilinear	Orthogonal curvilinear
Resolution (horizontal)	1/12 Mercator projection Tri-polar	1/10 Uniform
Grid (vertical)	z*	z*
Vertical levels	75	51
Surface/Bottom cell depth	1.1m / 200m	5m / 750m
No. levels top 30m	14	6
Bathymetry	GEBCO_2014	GEBCO_08 / GA
State equation	TEOS-10	UNESCO
Mixed layer	TKE (Gaspar et al., 1990)	GOTM K-epsilon
River discharge	Climatological (Bourdalle-Badie and Treguier, 2006)	Climatological (Dai and Trenberth, 2002)
Time integration	Split-explicit / Leap-frog	Split-explicit / Predictor-corrector

Overview

Computational cost

System costs

OFAM3 based (similar to OceanMAPS4.0/1i)
- 48 dynamic members
- **9kSU** per 3-day cycle

AOM2-01 based (similar to OceanMAPS4.2)
- 48 dynamic members
- **61kSU** per 3-day cycle
- 6.1 times OFAM3 system

GOSI9/eORCA12 based (similar to OceanMAPS5.0)
- 24 dynamic members
- **90kSU** per 3-day cycle
- **10 times** times OFAM3 system
- **1.5 times** times AOM2-01 system

Model sizes

OFAM3 - 1500 x 3600 x 51 - **275,400,000**

AOM2-01 - 3600 x 2700 x 75 - 729,000,000
- 2.6 times OFAM3

GOSI9/eORCA12 - 4322 x 3606 x 75 - **1,168,884,900**
- 4.2 times OFAM3
- 1.6 times AOM2-01

Model timesteps

OFAM3 - **900s**

AOM2-01 - 450s
- Accounts for factor of 2 over OFAM3

GOSI9/eORCA12 – **360-240s**
- Accounts for factor of 2.5 over OFAM3
- Accounts for factor of 1.25 over AOM2-01