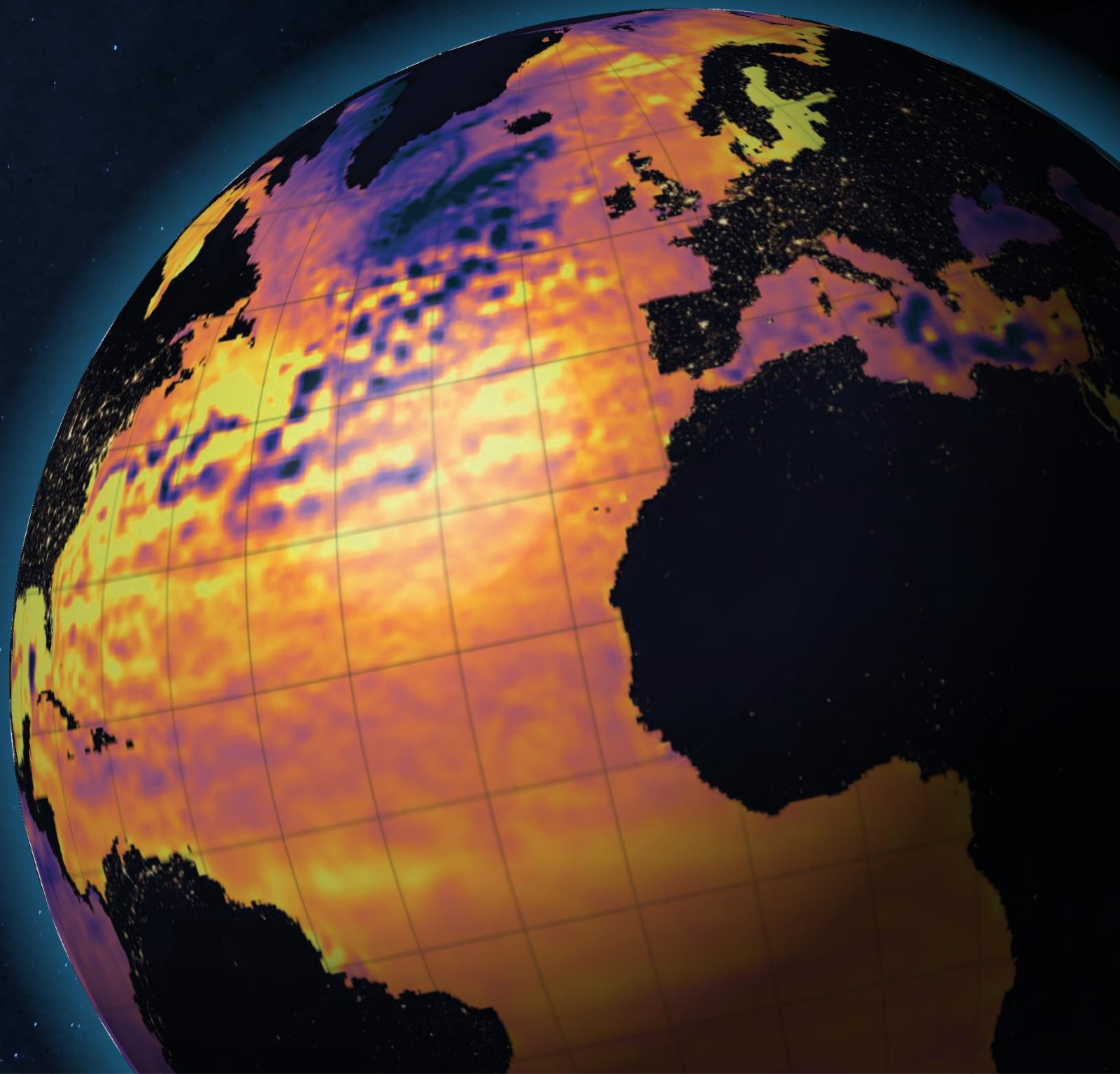
Preliminary results of SynObs Flagship OSEs -Assessments on impact of satellite altimetry versus Argo profiles-

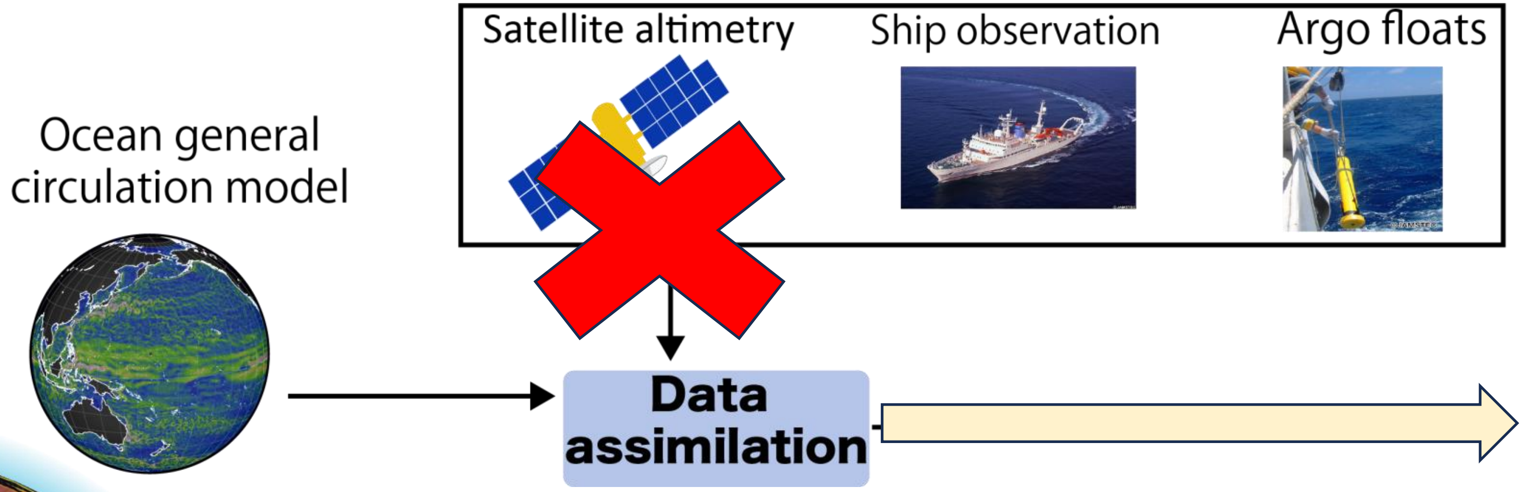
Shoichiro Kido (JAMSTEC Application Lab)

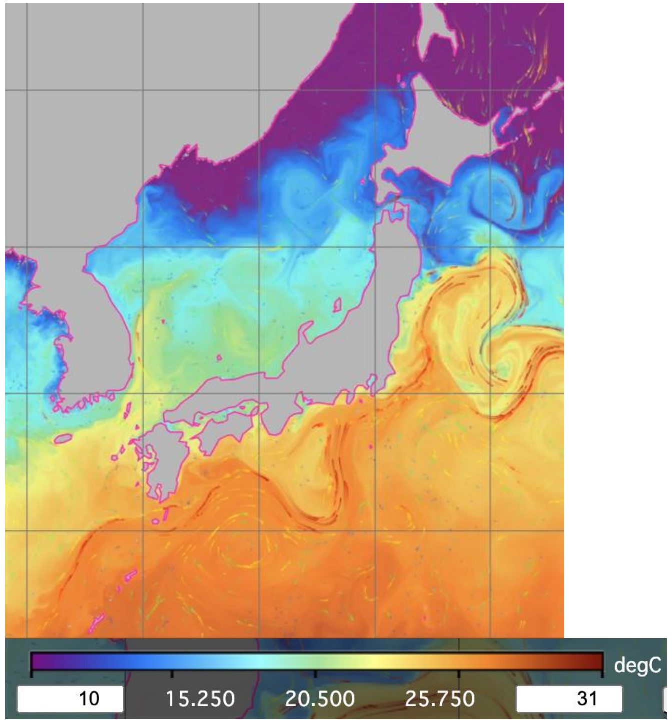
with Y. Fujii, I. Ishikawa, E. Remy, D. Peterson, J. Water, and SynObs members



Ocean Forecast and Observing System Experiments (OSEs)

- **Data from various observational platform are used to obtain ocean state estimates by constraining numerical models**
- **Impact of the target observational data can be estimated by observing system experiments (OSEs)**

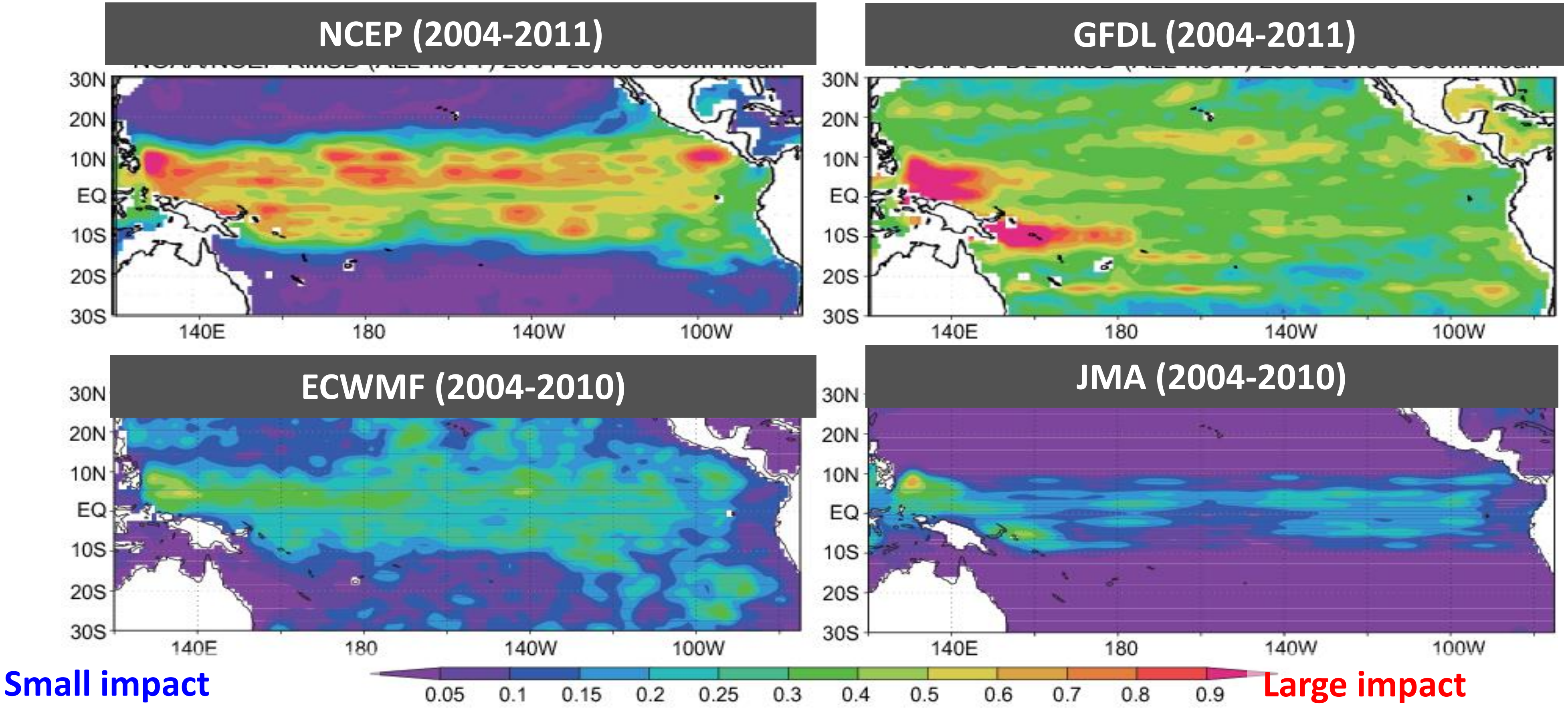




Importance of using multiple systems in assessing impacts of ocean observation

0-300m averaged RMSD of temperature (˚C) between the regular ODA runs and OSE without assimilating tropical mooring buoys

Fujii et al., 2015 QJRMS



Multi-system efforts are indispensable to remove the system dependency and to make a robust and reliable evaluation

Overview of Synergistic Observing Network for Ocean Prediction (SynObs)

SynObs
UN Ocean Decade Project

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

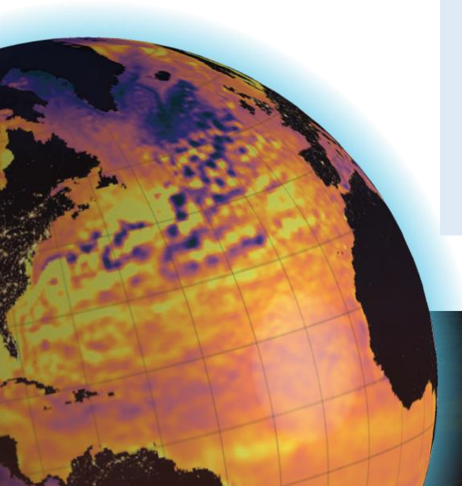
Ocean Prediction Capacity of the Future
ForeSea

Endorsed by United Nation Ocean Decade project

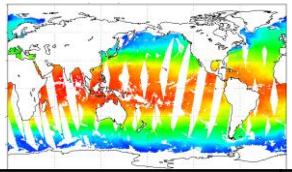
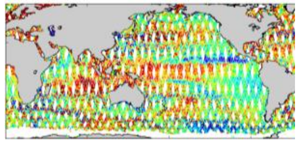
Lead by Dr. Yosuke Fujii at Meteorological Research Institue

←Official website

- **Purpose**： **SynObs** will seek the way to extract maximum benefits from the combination among various observation platforms, typically between satellite and in situ observation data, in ocean predictions.
- **Period**： July of 2022～June of 2026
- **Main activity**： Conduct a series of coordinated OSEs using multiple operational systems



An overview of SynObs Flagship OSEs

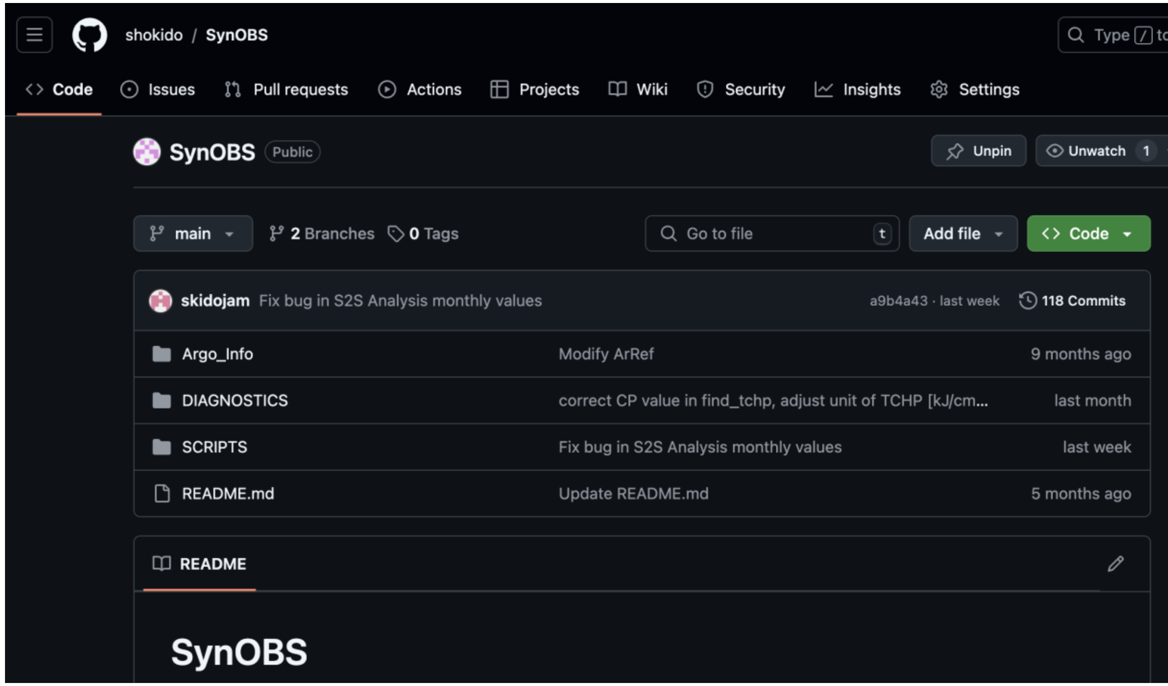




	Argo profiles	Satellite SST	Nadir altimeter	Ship observation	Mooring
Control （CNTL)	✓	✓	✓	✓	✓
Without nadir altimetry(NoALT)	✓	✓	×	✓	✓
Without Argo data (NoArgo)	×	✓	✓	✓	✓
Without Mooring(NoMoor)	✓	✓	✓	✓	×
Without satellite SST (NoSST)	✓	×	✓	✓	✓
Satellite only (NoInsitu)	×	✓	✓	×	×
Satellite SST only (SSTOnly)	×	✓	×	×	×
Half Argo (HalfArgo)	50%	✓	✓	✓	✓
Model only(Free)	×	×	×	×	×

An overview of SynObs Flagship OSEs

Name of systems	Resolution
FOAM (UK MetOffice GB)	Global, 9km
GIOPS (ECCC CA)	Global, 25km
MOVE-G3F (MRIJP)	Global, 25km
JCOPE-FGO (JAMSTECJP)	Semi-global, 10km
ORAS5/6 (ECMWF EU)	Global, 25km
RTOFS-DA (NOAA/NCEP US)	Global, 8km
GLORe (NOAA/NCEP US)	Global, 100km
GEO-S2S V3 (NASA/GMAOUS)	Global, 25km

Outputs of OSEs are stored in common netCDF format for facilitate analysis



	FOAM (9km)	JCOPE-FGO (10km)	GIOPS (25km)	MOVE-G3 (25km)

Control (CNTL)

Withoul satellite altimetry (NoALT)

Without Argo profiles (NoArgo)

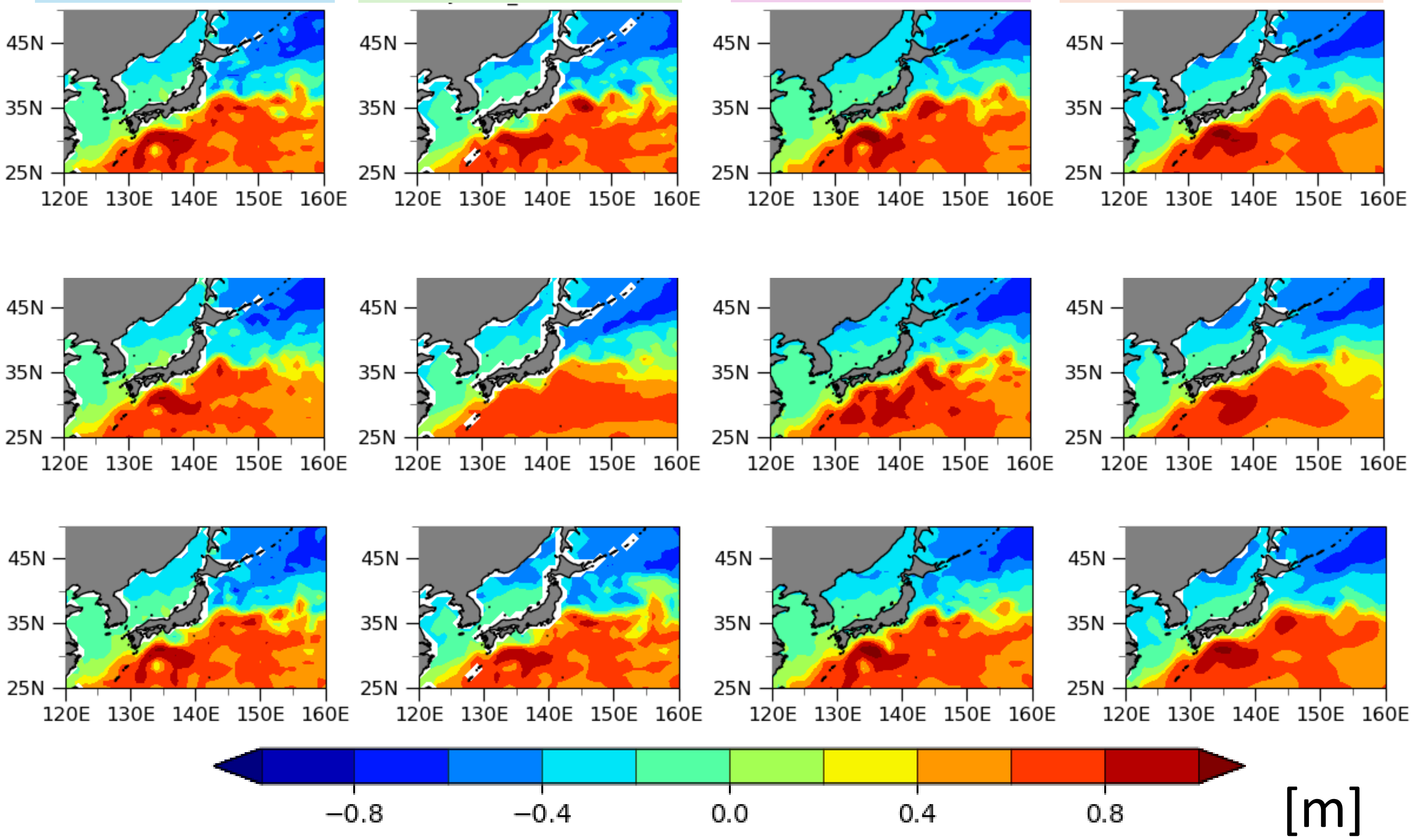
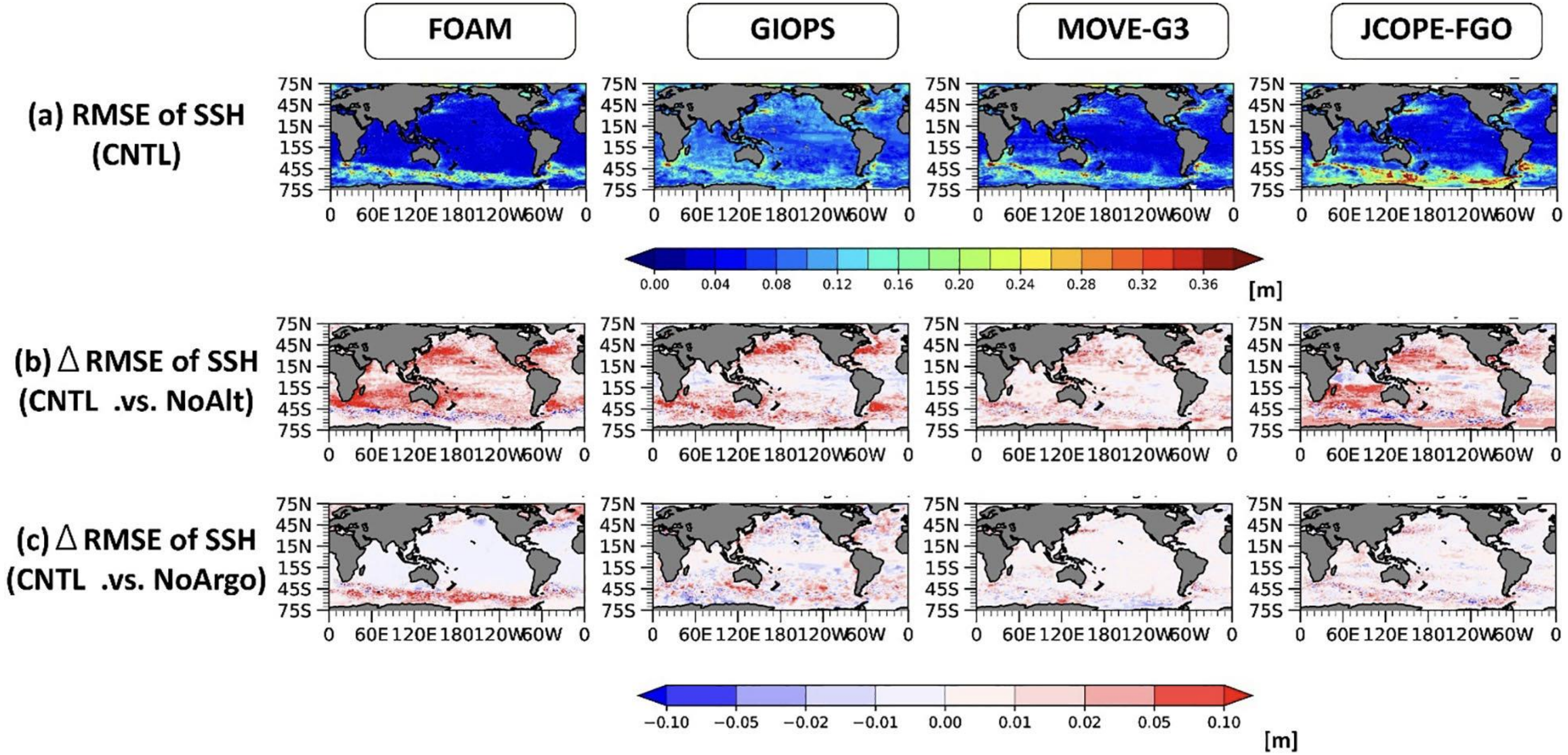


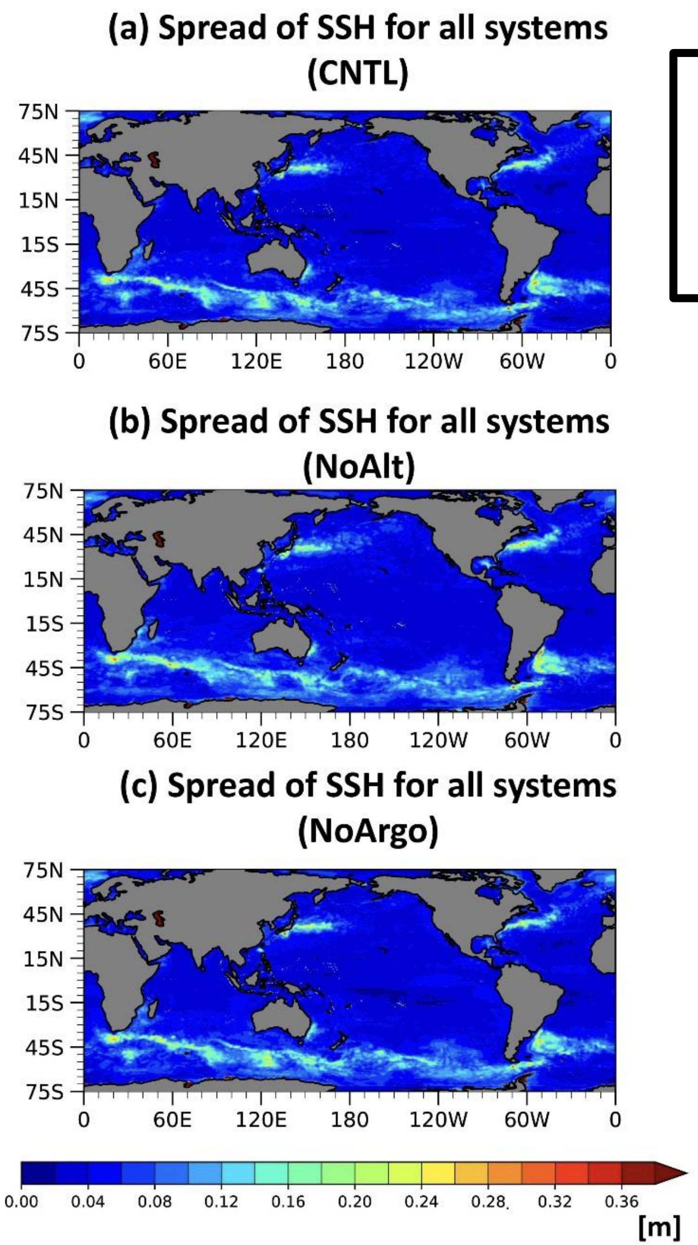
Figure: Snapshot of sea level anomalies on Dec.15, 2020 from satellites and each system

$$RMSE_{SSH}(x,y,i,j) = \sqrt{\frac{1}{t_n}\sum_{t=1}^{t_n}\{SSH_m(x,y,t,i,j) - SSH_o(x,y,t)\}^2}$$



- Both satellite altimetry and Argo data generally have large impacts on the model SSH accuracy
- Improvement is especially evident in the western boundary current regions and around the Antarctic Circumpolar Current.

Global maps of SSH RMSE in CNTL, (B) SSH RMSE difference between NoAlt and CNTL, and (C) SSH RMSE difference between NoArgo and CNTL



$$Spread_{SSH}(x,y,t,i) = \sqrt{\frac{1}{N_s}\sum_{j=1}^{N_s}\left\{SSH_m(x,y,t,i,j) - \frac{1}{N_s}\sum_{j'=1}^{N_s} SSH_m(x,y,t,i,j')\right\}^2}$$

The multi-system ensemble spread (i.e., uncertainty) of SSH is reduced by assimilating satellite altimetry and Argo profiles

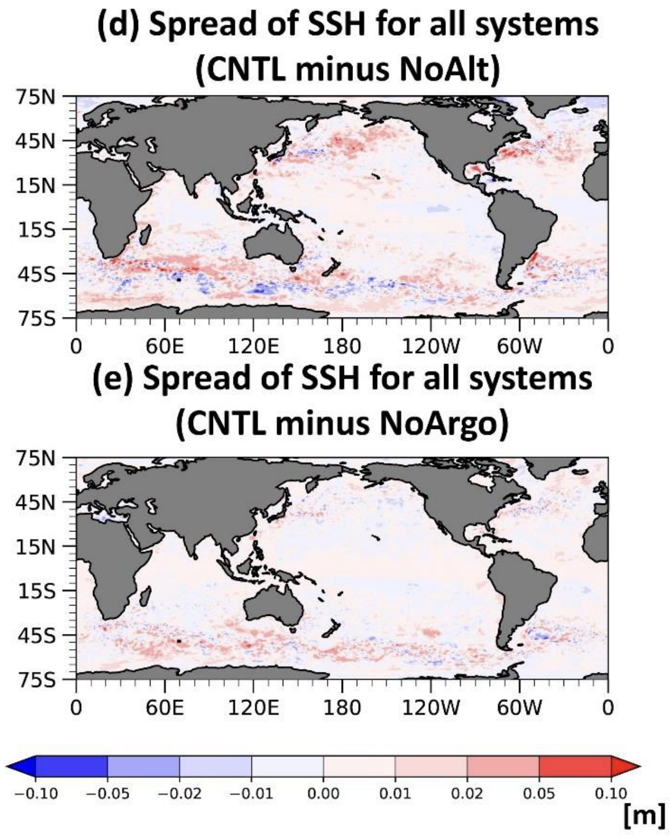


Figure: Global maps of the ensemble spreads of SSH among the four systems for (A) CNTL, (B) NoAlt, and (C) NoArgo, averaged over the whole period of 2020

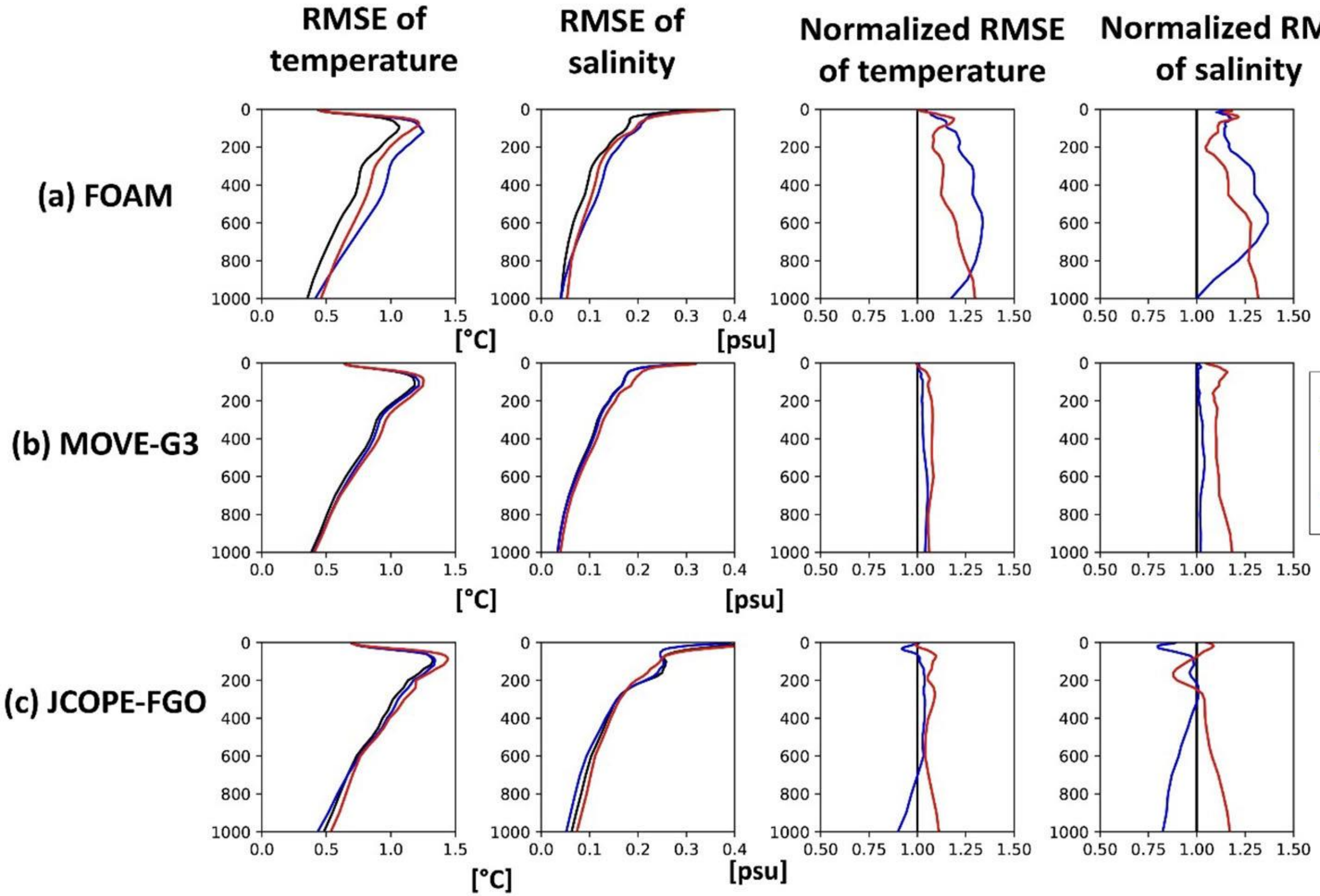
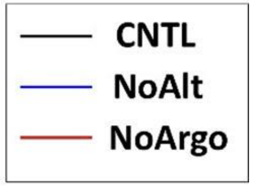


Figure: Vertical profiles of global mean RMSEs of temperature (units in degree C) and salinity (units in PSU) for CNTL, NoAlt, and NoArgo

$$RMSE_T(z) = \sqrt{\frac{1}{N}\sum_{l=1}^{N}\{T_m(z,l) - T_o(z,l)\}^2},$$

$$RMSE_S(z) = \sqrt{\frac{1}{N}\sum_{l=1}^{N}\{S_m(z,l) - S_o(z,l)\}^2},$$



- Assimilating Argo data reduces TS RMSE, with a stronger effect in FOAM
- In MOVE-G3, Argo data has a greater impact on salinity than on temperature
- The impact of altimetry data depends on the system, with minimal effect in JCOPE-FGO

Summary

- SynObs promotes collaboration among various national prediction centers and observation groups to effectively design ocean observation networks.

- SynObs Flagship OSEs aim to comprehensively evaluate the impact of various observation platforms

- Impacts of individual observation platform estimated by OSE were generally consistent across systems, but results showed some dependency on horizontal resolution of models.

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The international multi-system OSEs/OSSEs by the UN Ocean Decade Project SynObs and its early results

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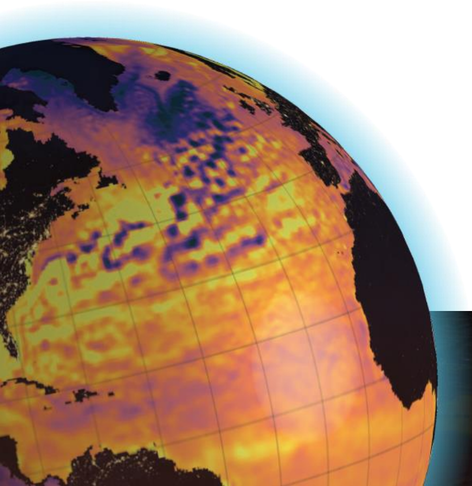

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