UN Ocean Decade Project SynObs Activity Report

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Co-chair of OceanPredict OS-Eval TT

Co-chair of UN Ocean Decade Project “SynObs”

Synergistic Observing Network for Ocean Prediction

SynObs

UN Ocean Decade Project

Ocean Prediction Capacity of the Future

ForeSea

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

- **Objective**

  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.

- **Strategy**

  SynObs aims to identify the optimal combination of different ocean observation platforms through observing system design/evaluation, and to develop assimilation methods with which we can draw synergistic effects.

SynObs Contact

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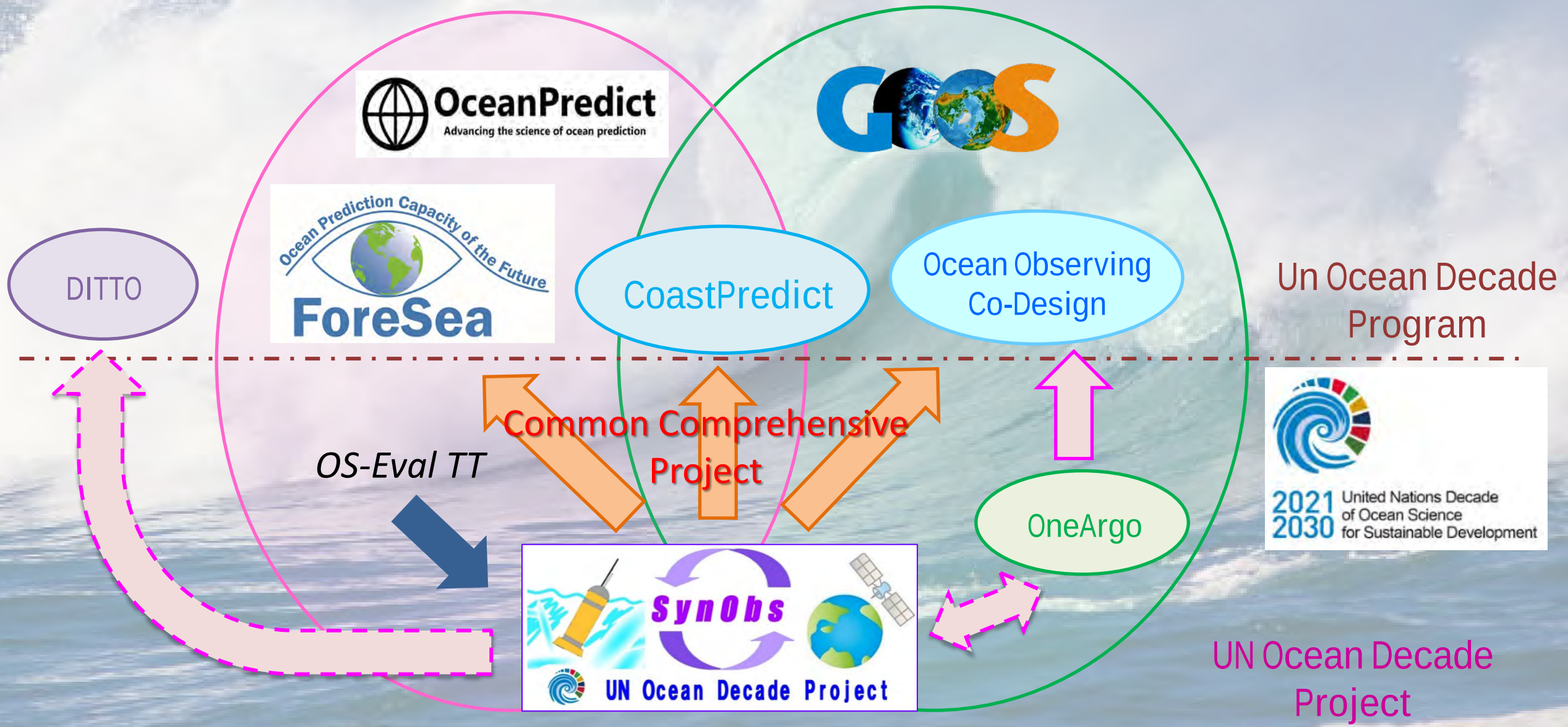
https://https://oceanpredict.org/un-decade-of-ocean-science/synobs-2

Mailing List

SynObsML@googlegroups.com

Please mail to synobs@mri-jma.go.jp for joining

SynObs and other UN Ocean Decade activities



☆ Outline of SynObs Activity Plan

1. Collaboration for evaluation and design

- Collaboration on a Multi-System OSE and OSSE (SynObs flagship OSEs/OSSEs)
- Establish a best practice based on the collaboration above.

2. Supporting DA scheme development

- Share the information on the development of DA schemes
- Planning of observation campaigns for DA scheme development

3. Providing information from ocean prediction systems in real time

- Explore the methods to evaluate observing system status in real-time

4. OS-Eval showcase and reporting

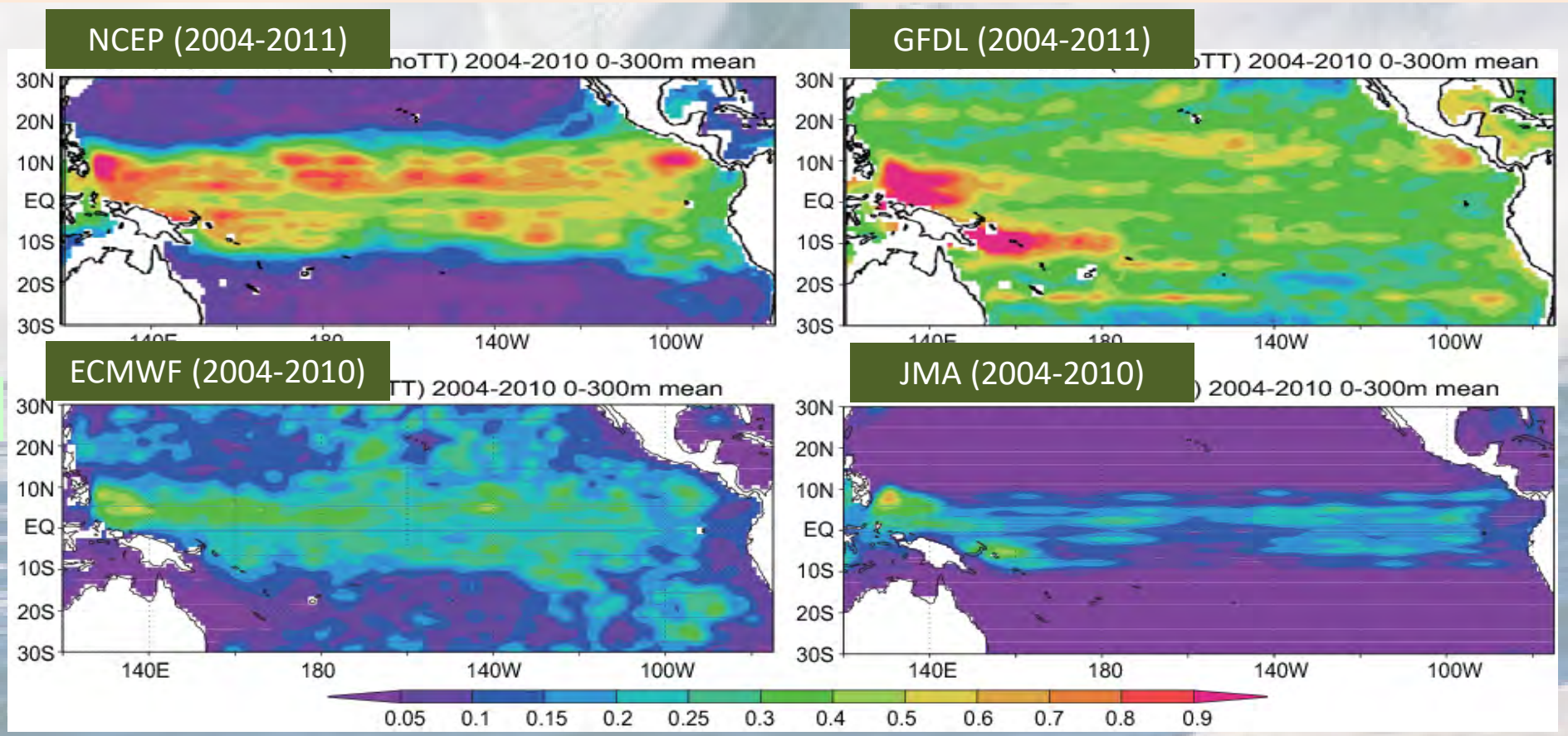
- Frontiers in Marine Science Special Issue (More than 15 papers are planed to be submitted.)
- Contributing to WMO Observation Impacts workshop and Rolling Review of Requirement (RRR)
- OceanPredict Symposium (November 2024)

☆ System Dependency of Observation Impacts

- ◆ Evaluation results inevitably depends on the prediction system.
  - ✓ Systematic errors often hide impacts of ocean observation data.
  - ✓ The dependency cannot be ignored in ocean predictions, and it is further significant in the S2S predictions with coupled model.
- ◆ Therefore, multi-system efforts are indispensable to remove the system dependency and to make a robust and reliable evaluation

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

From Fujii et al., 2015 QJRMS



☆ SynObs Flagship OSEs/OSSEs

- SynObs plans to implement OSEs/OSSEs using various ocean prediction systems with a common setting in order to provide robust evaluation without system-dependency.

OP (Ocean Prediction) OSEs

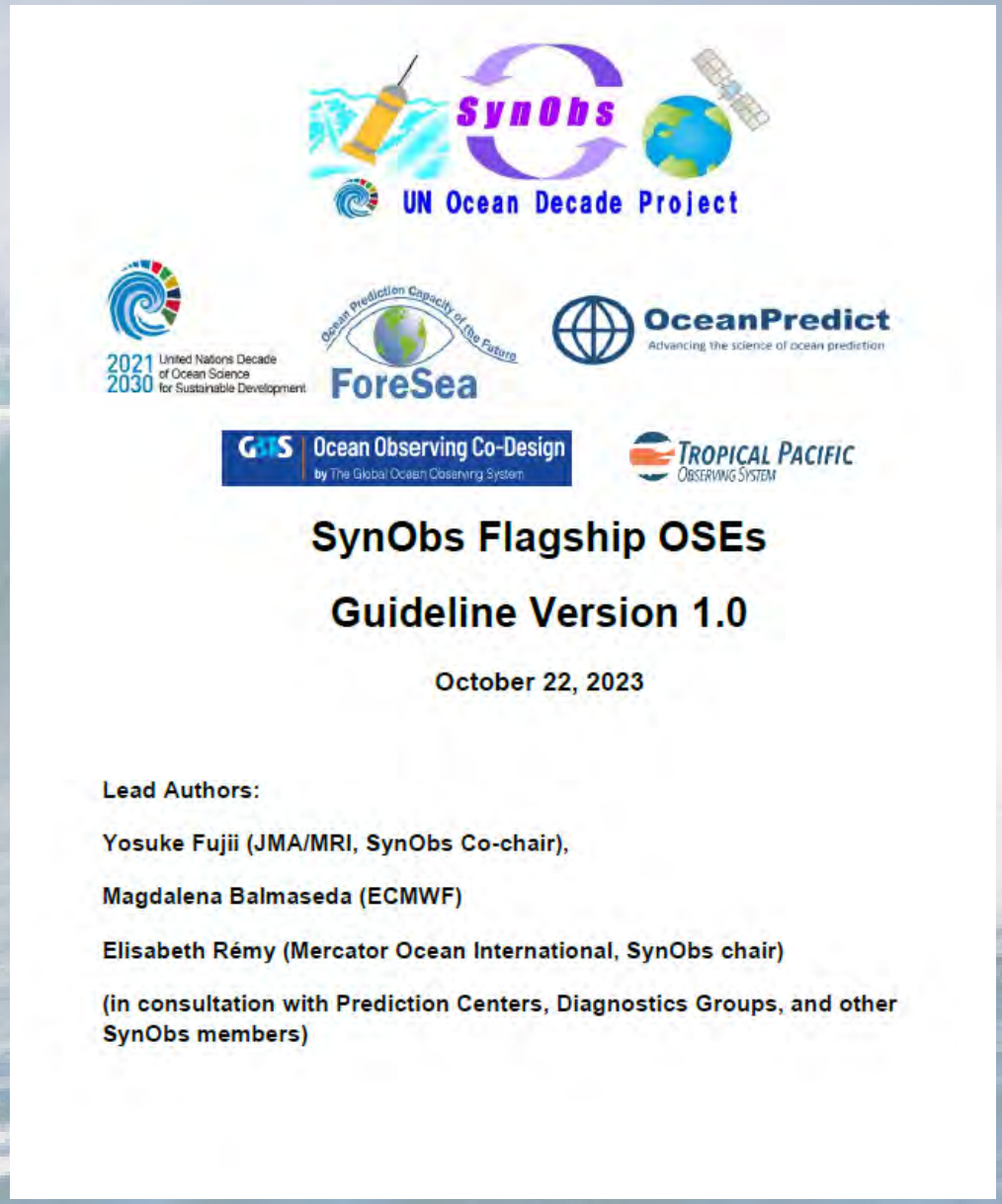
- Use higher-resolution ocean DA and prediction systems.
- Assimilation run for 2020 (2020-2022 if possible)
- 10-day predictions: Started from every pentad

S2S OSEs

- Use coupled prediction systems including lower-resolution ocean DA for initialization
- Reanalysis run for 2003-2022
- Subseasonal (1-month) predictions: Once a month
- Seasonal (4-month) predictions: from May and Nov.

OP OSSEs

- Use GEOS/NASA coupled simulation as the Nature Run
- 1-year assimilation run and 10-day predictions from every pentad



https://oceanpredict.org/docs/Documents/SynObs/SynObs_FlagshipOSE_Guideline_Ver1.pdf

☆ SynObs flagship OSEs (OSE settings and the schedule)

OSE Settings for OP and S2S OSEs

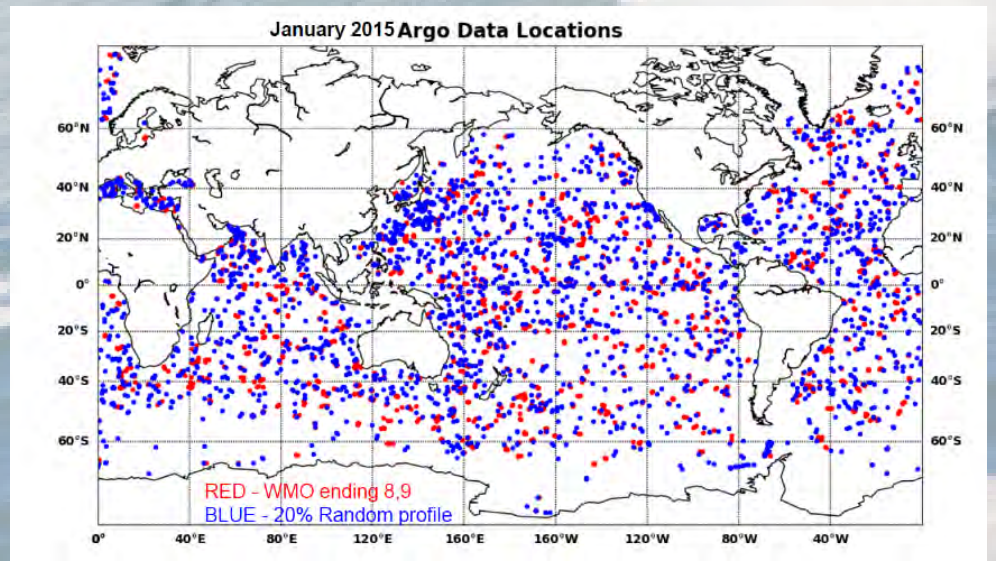
- Control Run (CNTL)
  - Basically, regular observation data are assimilated
  - 20% of Argo data are withhold and used as reference.
  - Participants can choose whether or not to assimilate satellite altimetry data
- OSEs
  - Data of a targeted observation type are excluded (e.g., NoArgo, NoMoor, NoSST etc.)

OP OSSE setting will be discussed at SynObs web MT.

- SWOT, Satellite surface current obs, shallow sea profiles by gliders and other sources will be evaluated.

Suggested OSE Settings

1	CNTL	Ocean Model		SST	Argo 80%	Mooring	Other TS	Alt. (optional)
2	NoAlt	Ocean Model		SST	Argo 80%	Mooring	Other TS	
3	NoArgo	Ocean Model		SST		Mooring	Other TS	Alt. (optional)
4	NoMoor	Ocean Model		SST	Argo 80%		Other TS	Alt. (optional)
5	NoSST	Ocean Model			Argo 80%	Mooring	Other TS	Alt. (optional)
6	NoInsitu	Ocean Model		SST				Alt. (optional)
7	SSTonly	Ocean Model		SST				
8	Free	Ocean Model						
9	HalfArgo	Ocean Model		SST	Argo 40%	Mooring	Other TS	Alt. (optional)
10	Oper	Ocean Model	Oper. Setting	SST	Argo 100%	Mooring	Other TS	Nadir Altimeter



Distributions of Argo floats whose last digits of WMO number is 8 or 9 (red) and 20% random profiles (blue). Example for January 2015 (Thanks to Li Ren, NASA/GMAO.)

★ Database of the SynObs flagship OSE/OOSE output data

- The SynObs flagship OSE/OSSE results are planned to be stored as netCDF files in the common database on a JAMSTEC-APL server and shared with the people who will collaborate for diagnosing the OSE/OSSE results, as well as prediction centers.
- Details of the output data is written in the guideline.
- The database will be constructed as a part of the digital twin ocean in JAMSTEC and contribute to the UN Decade Program DITTO.

Table 1: Summary of the variables, resolution, frequency of output from each OSEs

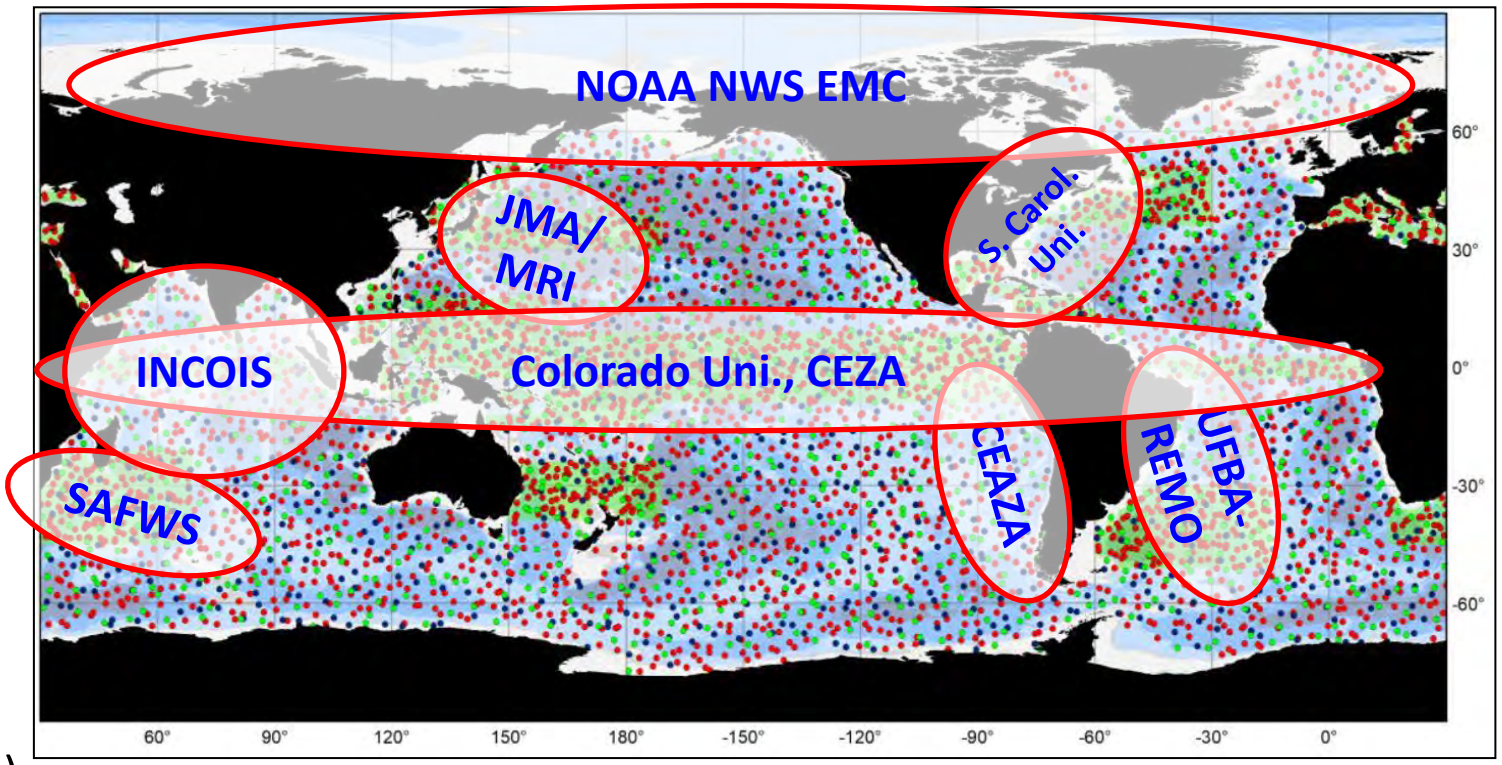
	Daily	Pentad/Weekly	Monthly	Point Location
OP-OSE Analysis (OP-AN)	**OPA-D (OPA-DH)** Variables: OP-2 Resolution: 0.25°, 0.1° Frequency: Daily	**OPA-P** Variables: OP-1 Resolution: 0.25° Frequency: Pentad		**OPA-PL** • Argo (Daily) • Mooring (Hourly)
OP-OSE Forecast (OP-FC)	**OPF-D (OPF-DH)** Variables: OP-2 Resolution: 0.25°, 0.1° Lead Times: D1, D3, D7	**OPF-P** Variables: OP-1 Resolutions: 0.25° Lead Times: P1, P2		**OPF-PL** • Argo (Daily, D1-D10) • Mooring (Hourly, H1-H240)
S2S-OSE Analysis (S2S-AN)	**S2SA-D** Variables: S2S-2 Oc Resolution: 1° Frequency: Daily		**S2SA-M** Variables: S2S-1 Oc Resolution: 1° Frequency: Monthly	**S2SA-PL** • Argo (Daily) • Mooring (Daily)
S2S-OSE Forecast (S2S-FC)	**S2SF-D** Variables: S2S-3 Oc+Atm Resolution: 1° Lead Times: D1-D35	**S2SF-W** Variables: S2S-1 Oc+Atm Resolution: 1° Lead Times: W1-W18	**S2SF-M** Variables: S2S-1 Oc+Atm Res: 1° Lead Times: M1-M4	**S2SF-PL** • Argo (Daily, D1-D126) • Mooring (Daily, D1-D126)

Table 2: Variables in each variable group

Group	Included Variables
OP-1	3D-TSUV, SSH, SIC, SIT, SWHF, LWHF, LAHF, SNHF, NetHF, NetWF, Taux, Tauy Optional: TotalHF, TotalWF, Analysis Increment (3D-TSUV, SSH)
OP-2	SST, SSS, SSU, SSV, SSH, 0-50mT, Z20, Z26, TCHP, MLD005, 15mU, 15mV
S2S-1	Ocean: 3D-TSUV, **SSH, 0-300mT, Z20, MLD001, 0-300mS, SIC, SIT,** 0-50mT, Z17, Z26, Z28, TCHP,MLD005, ILD05, SWHF, NetHF Atmosphere: **3D-TZUVQ, T2m, U10m, V10m, Precip, LWHF, SWHF, LAHF, SNHF,** Taux, Tauy, **MSLP, Total Cloud Cover, OLR**
S2S-2	Ocean: **SST ,SSS, SSU, SSV, SSH, 0-300mT, Z20, MLD001, 0-300mS, SIC, SIT,** 0-50mT, Z17, Z26, Z28, TCHP, MLD005, ILD05, SWHF, NetHF Atmosphere: **3D-TZUVQ, T2m, U10m, V10m, Precip, LWHF, SWHF, LAHF, SNHF,** Taux, Tauy, **MSLP, Total Cloud Cover, OLR**
S2S-3	Ocean: **SST, SSH, SIC, MLD001**, ILD05 Atmosphere: **OLR, U200, U850**
Point Location	**Argo:** TS **Mooring:** TSUV, SWHF, NetHF

★ How will we analyze OSE/OSSE results?

- **Assign variables/diagnostics and regions to potential groups and request analysis.**
- Analysis of variables or diagnostics for the global ocean
  - Impact of Argo on heat budget and surface flux (ECCC)
  - Diagnostics related to tropical cyclone (Ocean Observing CoDesign TC Exemplar Team)
  - Comparison b/w forecasted value and Argo observation (OceanPredict IV-TT)
  - Trajectory of Drifters (UKMO)
  - Heat budgets and MHWs（ECMWF）
  - Near-surface ocean current（ABoM）
- **Regional Analysis**
  - MLD in tropics (Colorado Uni)
  - Tropical waves・Peru coast (CEZA)
  - WN Pacific (JMA/MRI)
  - Brazilian Coast (UFBA-REMO)
  - Agulhas Current (SAFWS)
  - Arctic and Antarctic (NOAA NWS EMC)
  - Indian Ocean (INCOIS)
  - Western North Atlantic (S. Caroline Uni.)



☆ SynObs flagship OSEs (OSE settings and the schedule)

Participating Systems

Center	System	Area	Res. (Deg.)	OP-OSE	OP-OSSE	S2S-OSE
UK MetOffice	FOAM	Global	1/12	O		
NOAA/NCEP	RTOFS-DA	Global	0.08	O		
ECMWF	ORAS5/6	Global	1/4	O		O
NASA/GMAO	GEO-S2S V3	Global	1/4	O		O
JMA/MRI	MOVE-G3F	Global	1/4	O	O	O
ECCC	GIOPS	Global	1/4	O	O	O
NOAA/NCEP	GLORe	Global	1	O		O
NOAA/QUOSAP	MOM6	Global	?		O	
JAMSTEC-APL	JCOPE-FGO	Semi-glob.	0.1	O	O	
JMA/MRI	MOVE-NP	N Pac.	1/10x1/11	O	O	
Pukyong Uni.	KOOS-OPEM	N. Pac	1/24	O	O	
REMO-UFBA	HYCOM-RODAS	S. Atl.	1/12	O	?	
MetService, NZ	Moana Forecast	S. Pac.	1/24		O	
Mercator Ocean	GLO12	Global	1/12	△	?	

◆ Schedule

- OSE Analysis Runs (Until Dec. 2024?)
- OSE Forecast Runs (Until Apr. 2024?)
- OSSE (2024-2025?)

- Frontiers in Marine Science 1st SynObs special issue ⇒ Preface Paper (Feb. 2024)
- Introductive paper (BAMS?, Mar. 2024?)
- WMO Obs Impact Sympo (May 2024)
- OceanPredict Symposium (Nov. 2024)

- Detailed results including those by volunteer analysis groups will be presented in the 2nd SynObs special issue (2025-2026?)

- Special Session in Academic Meeting?

★ Collaborations with other international communities (1)

1. Web Meeting (Every 2 months?) and Steering Team Meeting (Every 6 months?)
2. Introducing the SynObs activity in
   I. COSS-TT annual meeting
   II. WCRP WS on improving climate model using observation
   III. GOOS Observation Coordination Group MT14
   IV. EuroSea&OP Joint WS
   V. Ocean Prediction DCC West Pac. & Marginal Sea RG Meetings
   VI. S2S summit (by M. Balmaseda)
   VII. CLIVAR SSG (By. M. Balmaseda)
3. Joint working group with OOPC and CLIVAR GSOP? (Proposed by P. Oke)
4. WMO S2S project supports the Flagship OSEs (F. Vitart in ECMWF)
5. TPOS also supports the flagship OSEs for evaluating the new TPOS design. (W. Kessler)

★ Collaborations with other international communities

6. Collaboration with Ocean Observing Codesign for diagnosing the flagship OSE results
7. UCSAR plans to apply to the fund of US NSF AccelNet for the collaboration among Ocean Observing Co-design exemplars and SynObs
   - For travel cost for workshops in US, Storage, heiring scientists or research assistant
8. We proposed Ocean Science Meeting 2024 Session but it canceled due to small number of abstracts
9. UN Ocean Decade Symposium (10-12, Apr., 2024).
   - ➢ Support the ocean observing co-design event
   - ➢ Introduction in the event by Ocean Prediction DCC?
10. We also propose EGU 2024 Science Session (led by A. Peterson)
11. WMO Impact workshop (27-40 May 2024, Norrköping, Sweden)

    ⇒ Abstract deadline 15 Dec. 2024

    (Y. Fujii participates in the Science Organizing Committee)
12. OceanPredict Symposium (18-22 Nov 2024)

    (E. Remy participates in the Science Organizing Committee)

★ Remaining Challenge 1: Providing Info for Real-time Evaluation

◆ Information from operational OP systems

- ➢ Usage-of-observation table (possible extension?)
- ➢ QC flags
- ➢ Data misfits
- ➢ Analysis Increments, etc.

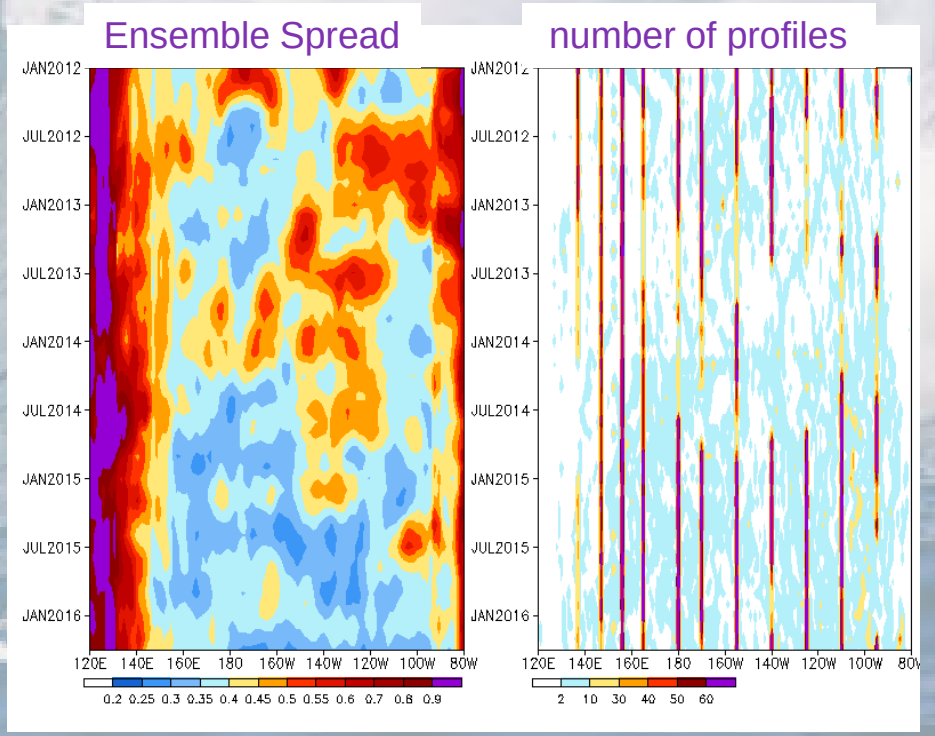
◆ Real Time Evaluation of Ocean Observing Network

- ➢ Monitoring multi-system ensemble spread in the real-time ORA-IP is very effective.
- ➢ Is it possible to extend the real time ORA-IP?
- ➢ Are there other possible way to monitor the status of the ocean observing network?

Strong commitments of OP centers are required.

Longitude-time section of the ensemble spread of temperature averaged in 0-300m and the number of profiles

2ºS-2ºN



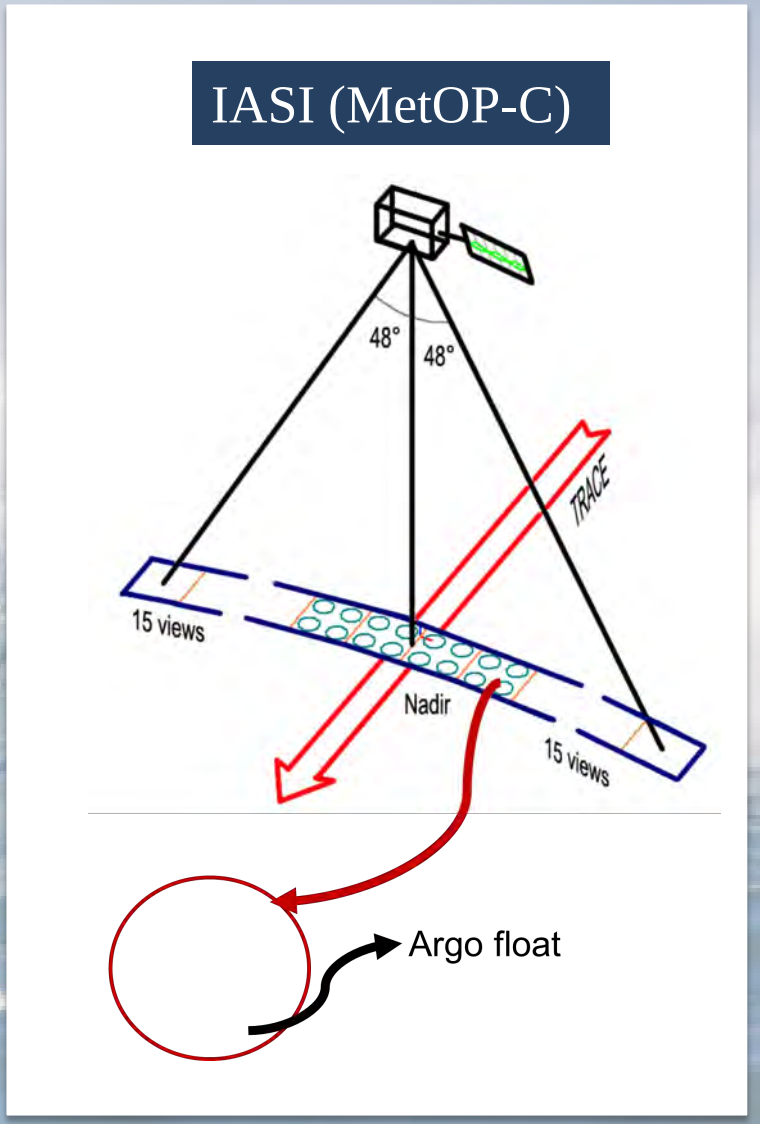
From Xue et al., 2017 Clim. Dyn.

★ Remaining Challenge 2: How can SynObs support DA development?

- One of the SynObs objectives is to support DA development for assimilating new observation data or more effective use of existing observation data

- Sharing Information through technical workshops and academic journal special issues is a way to promote the developments

- We also seek the possibility to propose an observation campaign which contribute to the developments.
  - We used to proposed a collocated observations of Argo and satellite atmospheric hyper-spectral sounder.
  - But the proposal was not got enough attentions.
  - We need to consider what is effective observation campaign we can get collaboration with observational communities.



★ Remaining Challenge 3: Webpage Management

- SynObs webpage is published on the OceanPredict website https://https://oceanpredict.org/un-decade-of-ocean-science/synobs-2

- We are trying to improve the content and timeliness of the webpage under the support of OPPO (Kirsten and Stephanie)

- We also aim to create OS-Eval showcase on the web. But we do not secure the webspace and human and financial resources.

Thank you!!

SynObs Contact

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☆ Methods to evaluate observation impacts

Observing System Experiment (OSE)

- Assimilation (and prediction) run in which a certain observation-type is withheld from, or added to, the regular assimilation data.
- Evaluate the impact of the observation-type by comparing OSEs with the regular (control) run.

Observing System Simulation Experiment (OSSE)

- Same as OSE but it uses virtual observations synthesized from a high-accuracy simulation called the Nature Run.
- Future observations which have not existed yet can be evaluated.

Other methods

- Adjoint-based methods (Sensitivity Analysis, FSOI, etc.)
- Ensemble-based methods (DFS, EFSO, Multi-system ensemble etc.)
- Other methods (e.g., Check the accuracy of the reanalysis data, use the statistics of the natural variability.)