SynObs: a UN Decade project on Synergistic Observing Network for Ocean Prediction

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Partner Institutions:
JMA/MRI (contact point, Japan), Mercator Ocean International (France)
Met Office (UK), NOAA Quantative Observing System Assessment Program
(USA) ECMWF, CNR ISMAT (Italy), NERSC (Norway), Ocean Data Network
(Denmark) CNRS (France), UFBA (Brazil)

Synergistic Observing Network for Ocean Prediction (**SynObs**)

UN Ocean Decade Project Under ForeSea

(Led by OceanPredict OS-Eval TT)

Officially Endorsed on June 8th 2022

◆ 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/coastal predictions.

◆ Strategy

SynObs aims to identify the optimal combination of different ocean observation platforms through observing system design/evaluation, and to develop assimilation methods for maximum synergy among different observations.

◆ Scope

Targets of **SynObs** include open-ocean (global, tropical, mid-latitude, polar areas), coastal, and biogeochemical (BGC) observing systems

SynObs: A common comprehensive project
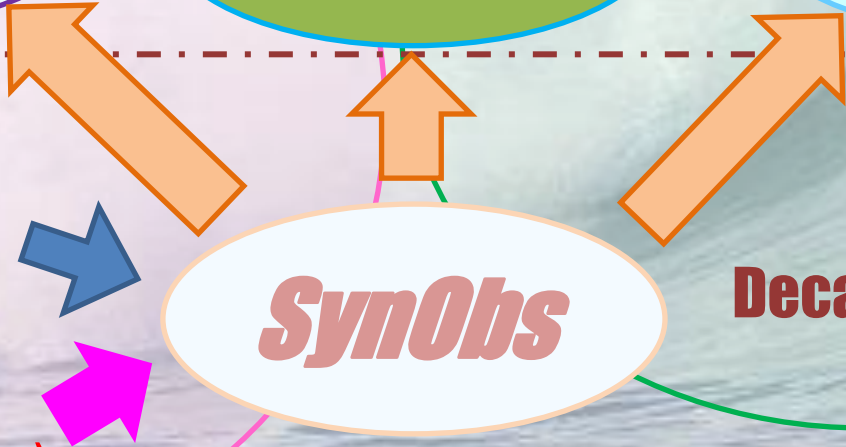

ForeSea

CoastPredict

Ocean Observing Co-Design

Decade Programmes

COSS-TT, DA-TT
MEAP-TT, CP-TT
IV-TT

OS-Eval TT
(Lead Institution)

SynObs

Decade Project

Partner Institutions (Officially confirmed):
JMA/MRI (contact point, Japan), Mercator Ocean International (France)
Met Office (UK), NOAA Quantative Observing System Assessment Program
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★ Expected Activities in SynObs

1. OS-Eval showcase and reporting

- ➢ Collect OS-Eval examples and discuss them (Showcase)
- ➢ Generate a report on observation requirements and design

2. Collaboration for evaluation and design

- ➢ Flagship multi-system OSEs
- ➢ Extensions of the flagship OSE to S2S OSEs and OSSEs
- ➢ Facilitating communication for OS-Eval collaborations

3. Providing information from ocean prediction systems on regular basis

- ➢ Regular reporting on information of QC, innovations, increments, etc.
- ➢ Explore the methods to evaluate observing system status in real-time operation

4. Supporting DA scheme development

- ➢ Support DA-TT seminar series
- ➢ Discussion on required development of DA technology and models
- ➢ Observation campaigns for the development

★ OSEs for the flagship multi-system OSEs

Operation	Ocean Model	Oper. Setting	SST	Argo	Moor	Other TS	Nadir Alti.	
InsituAlti	Ocean Model		SST	Argo	Moor	Other TS	Nadir Alti.	
NoArgo	Ocean Model		SST		Moor	Other TS	Nadir Alti.	
NoMoor	Ocean Model		SST	Argo		Other TS	Nadir Alti.	
Insitu	Ocean Model		SST	Argo	Moor	Other TS		
SatOnly	Ocean Model		SST				Nadir Alti.	
SSTOnly	Ocean Model		SST					
Free	Ocean Model							
SWOT	Ocean Model		SST	Argo	Moor	Other TS		SWOT
FullAlti	Ocean Model		SST	Argo	Moor	Other TS	Nadir Alti.	SWOT

Only for the 2nd phase (2023-2024)

Some specific setting used in operation (e.g., bias correction, etc.) can be removed in OSEs other than "Operation".

Whether nadir altimeter data are assimilated can be chosen.

Basically the same as the S2S OSEs

➢ Ocean data assimilation and prediction runs are conducted.

1st Phase → 2003-2022
    Analysis is conducted in 2023

2nd phase → 2003 (2023) – 2024
    Analysis is conducted in 2025

★ Collaborative OSE activities in SynObs

Flagship (Core) multi-system OSEs

System: Reanalysis and
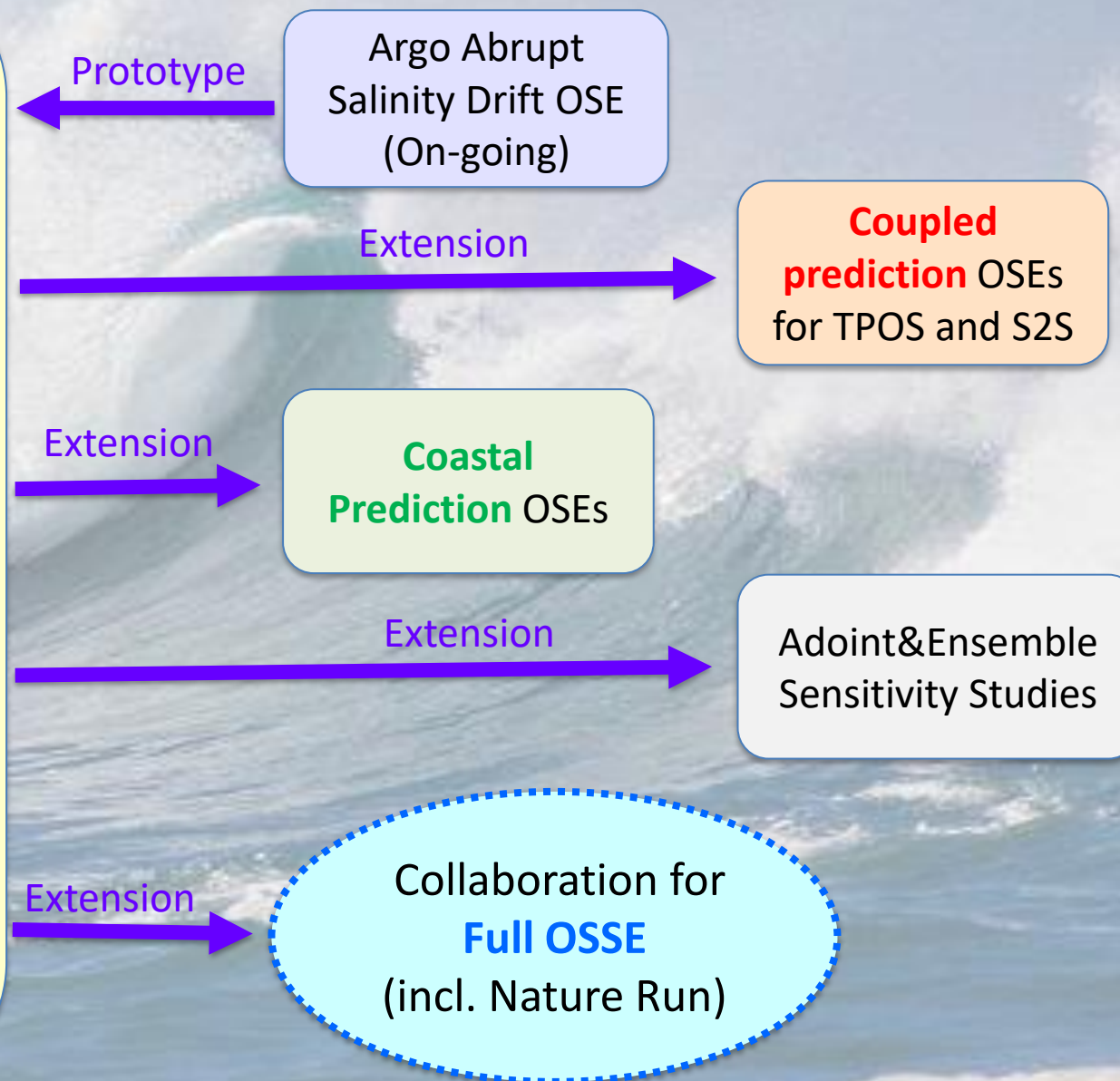
       Ocean Prediction Systems

Targeted Observations:
- ✓ SSH (Nadir+SWOT)
- ✓ In-situ (Argo, Trop. Buoys, etc.)
- ✓ consider their Synergy

Prediction Targets:
- ✓ 0-100m Temp. (MHWs)
- ✓ Near-surface currents (WBCs)
- ✓ Etc.

Period: 2020 up to 2023 for OP OSEs;
       2003 – 2022 for S2S-OSEs
- ➢ A protocol is defined for OSE production

Prototype ⟵ Argo Abrupt Salinity Drift OSE (On-going)

Extension ⟶ **Coupled prediction** OSEs for TPOS and S2S

Extension ⟶ **Coastal Prediction** OSEs

Extension ⟶ Adoint&Ensemble Sensitivity Studies

Extension ⟶ Collaboration for **Full OSSE** (incl. Nature Run)

★ Collaborative Analysis of the flagship OSEs

◆ **"ORA-IP like organization":**

Definition of targeted processes and regions to focus the analysis are identified: Marine Heatwaves, current fields, tropical cyclone, North Atlantic, North Pacific, etc.

➢ Volunteer people are assigned to each target

➢ Each OSEs data producer provides the required data to the person in charge of the diagnostic

➢ Volunteer people analyze the data based on their own idea and generate figures.

➢ Papers on the results will be submitted preferably to the Frontiers special issue, other journal, etc.

◆ Regional and global systems are encouraged to participate to the flagship OSEs

◆ Collaboration on exemplars from the Ocean Observing Co-Design for the analysis

◆ Discussion with the OceanPredict Intercomparison and Validation Task Team are ongoing for comparison to pre-defined sets of observations (Class4 metrics)

☐ **A public data archive center will be established in JAMSTEC to store the OSE data and make them accessible to participants.**

★ Collaborative Analysis of the flagship OSE

Global scale analysis

- Impact of Argo on Heat budget and surface flux imbalances for OP OSE: Greg Smith, ECCC, Canada

- Representation of mesoscale Eddies in the SSH fields: Greg Smith, ECCC, Canada

- Impact of Argo on Sound Speed Profiles (Shallow water ducts/local minimums, depth of deep sound channel/absolute sound speed minimum): Andrew Peterson, ECCC, Canada

- TC-related quantities of interest (0-50mT, Z20, Z26, TCHP, MLD): Matthieu Le Henaff, UM/CIMAS - NOAA/AOML, and TC ObsCoDe Exemplar

- Innovation statistics, class 4 assessment for OP OSEs: Jennifer Water/G. Smith in collaboration with OceanPredict IV-TT

- Lagrangian drift comparisons to drifters: Jennifer Water, Met Office, UK

- Ocean heat budget analysis and marine heatwaves: Eric de Boissen, ECMWF, UK

- Statistics of the Difference for S2S OSE: Yosuke Fujii, JMA/MRI, Japan?)

- Verification and intercomparison of near-surface ocean currents: Saima Aijaz, BoM, Australia

★ Collaborative Analysis of the flagship OSE

Regional scale analysis

- Tropical Regions

- Eastern Equatorial and South Pacific: Boris Dewitte, CEZA, Chile

- Western Equatorial and South Atlantic: Clemente Tanajura, UFBA-REMO, Brazil

- Western South Indian Ocean: Tamaryn Morris, South African Water Service, South Africa

- Western North Pacific: Yosuke Fujii, JMA/MRI, Japan?

- Arctic and subarctic regions: Dimitry Dukhovskoy, NOAA NWS EMC, USA

- North Atlantic ?

- Western South Pacific (around New Zealand)?

Volunteers to analyze the observation impacts from the flagship OSE results are welcome!

★ Extension to OSSEs

SSTOnly	Ocean Model	SST				
SatOnly	Ocean Model	SST				Nadir Alti.
Insitu	Ocean Model	SST	Argo	Moor	Other TS	
InsituAlti	Ocean Model	SST	Argo	Moor	Other TS	Nadir Alti.
SWOT	Ocean Model	SST	Argo	Moor	Other TS	SWOT
FullAlti	Ocean Model	SST	Argo	Moor	Other TS	Nadir Alti. / SWOT
OldTPOS	Ocean Model	SST	Argo	Old TPOS	Other TS	Nadir Alti.
NewTPOS	Ocean Model	SST	Argo	New TPOS	Other TS	Nadir Alti.
NoArgo	Ocean Model	SST		Moor	Other TS	Nadir Alti.

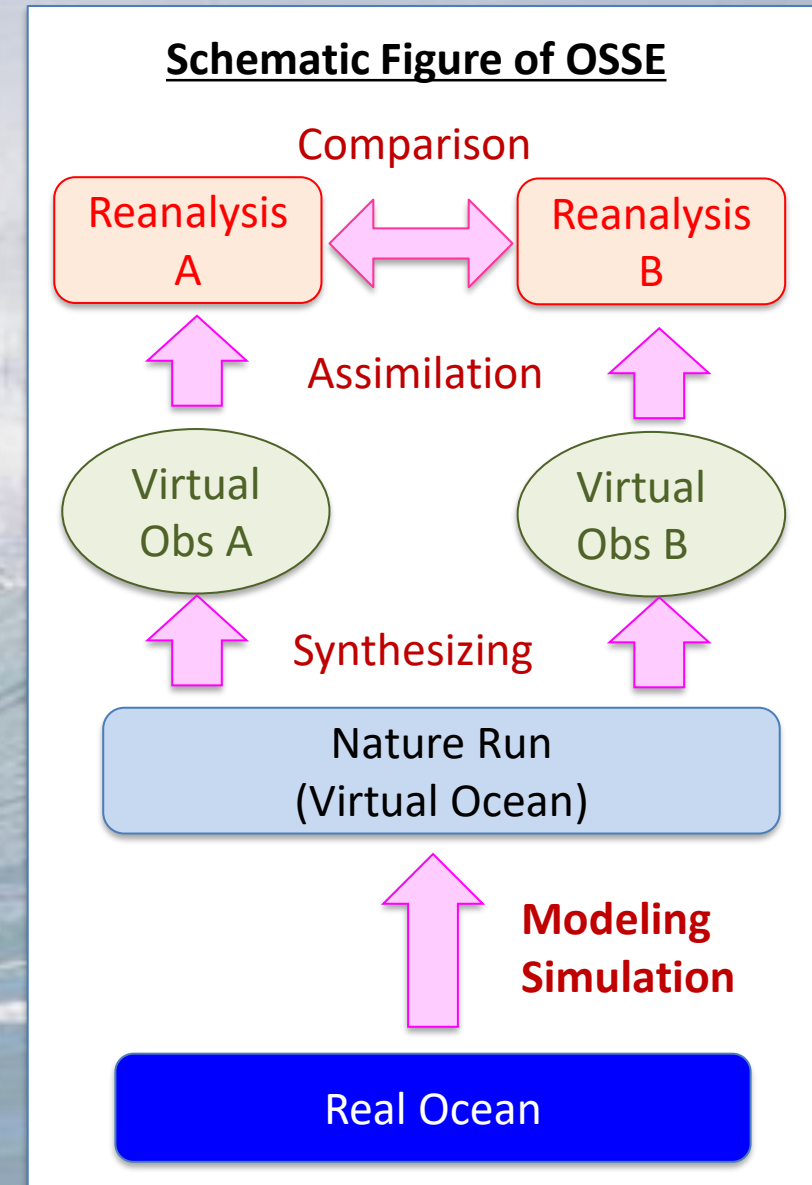> Synthesis observations are generated from the coupled ocean-atmosphere CEOS/MITgcm Nature Run at 1/48°.

Open Questions:
1. Atmospheric forcing: It may be possible to use the atmospheric output of the coupled run but the gap of atmospheric forcings may induce shocks.
2. How to spin up the ocean fields.
3. Who generates synthesis observations (We can use SWOT generator etc. But it needs some efforts to generate data for in-situ observations.)
4. Calibration?

⭐ Possible collaboration for Nature Runs and multi-system OSSEs

◆ A high-quality Nature Runs is essential to make reliable observing system evaluation as done with OSSE.

◆ Providing a list of model simulation data which are available for a Nature Run ⇒ A tentative action

◆ Within OP, we discuss a possibility to collaborate with Digital Twin Ocean (DITTO) for provision of Nature Runs and multi-system OSSEs.

◆ OSSE is actually the most familiar application of the concept of the digital twin ocean, and a good tool for promote the collaboration among ocean modelers, DA scientists, application engineers.

◆ What kind of Nature Runs? Global Ocean? Coastal? BGC? Coupled?

◆ Funding?

Schematic Figure of OSSE

Comparison

Reanalysis A ⟷ Reanalysis B

Assimilation

Virtual Obs A   Virtual Obs B

Synthesizing

Nature Run (Virtual Ocean)

Modeling Simulation

Real Ocean

★ Potential Partners for the flagship OSE/OSSE

1. **Ocean Observing Co-Design UN Decade Program**

   ➢ Marine Heatwave, WBC and TCHP exemplars

2. **Argo Community**

   ➢ UN Decade Project OneArgo is also in Ocean Observing CoDesign.

3. **TPOS community**

   ➢ TPOS requests to evaluate the new TPOS design.

4. **SWOT and OSTST Community**

   ➢ SWOT must have a significant impact on operational oceanography.

   ➢ OSTST is historically collaborating with GODAE-OceanPredict community.

5. **EuroSea community**

   ➢ Share results on OSSE/OSE, for example on synergy between altimetry and in situ observations, impact of gliders in regional systems, …

6. **CoastPredict / PredictOnTime (UN decade programs)**

   ➢ Potential extension of the flagship OSE to coastal areas

7. **Potential collaboration with GSOP/CLIVAR**

★ Other expected activities

1. Providing information from ocean prediction systems on regular basis

➢ Monitoring the use of observations and the impact of observations through OSE/OSSE in other projects such as EuroSea

➢ Extension of the Near Real-time Ocean Reanalysis Intercomparison Project (Presented by Caihong Wen)?

➢ Encourage developments of the methods for near-real-time observing system evaluation (e.g., DFS, FSOI, Array-mode, Multi-system ensemble, etc.)

2. Supporting DA scheme development, satellite Cal/Val

➢ Encourage discussions in DA-TT seminar series, OceanPredict Symposium in 2024, SynObs workshop in 2026.

➢ Encourage regular discussion in Slack or some other web application

➢ Co-located observation of Satellite atmospheric hypers-sounders and Argo floats?

3. Communication

➢ Special issue on Frontiers in Marine Science Research "Demonstrating observation impacts for ocean and coupled prediction" planned for 2024 and at the end of the analysis of the flagship OSEs

➢ Dedicated Science Session at the Ocean Science Meeting 2024

➢ Contribution to WMO observation impact workshop

SynObs - a UN decade project

Webpage for Information on SynObs

https://oceanpredict.org/foresea/synobs/
        with SynObs flagship OSE/OSSE Guideline

Participation to the multi-system OSE/OSSE production AND analysis of the multi-system experiments is welcome !

A Frontiers special issue is planned on «Demonstrating observation impacts for ocean and coupled prediction", submission of final papers at the end of 2023 / beginning of 2024

Contact (OceanPredict OS-Eval TT co-chairs)

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★ Expectations/Requests of OSE/OSSE to SynObs

◆ **SynObs proposal defined 7 targeted combinations**
- Altimetry and satellite surface velocity with Argo
- Tropical buoy array, Argo, and Altimetry
- Satellite SSS and in-situ observations
- Satellite SST/radiometer observations and near surface observations
- Satellite ocean color and BGC Argo
- Sea ice concentration and thickness
- Coastal ocean and Open Ocean Observations

◆ **SWOT:** OSSE and post-launch OSE (launch targeted for November 2022) .

◆ **Ocean Observing Co-Design** expects SynObs to conduct OSE/OSSEs for some of their exemplars (Marine Heatwaves, Boundary Currents, Tropical Cyclones, Storm Surge, Carbon Cycle, Biodiversity).

◆ **TPOS-SAC requested OSE/OSSE for new TPOS**, and ECMWF, NCEP, and JMA started to discuss on a collaborative OSE for S2S forecasts.

◆ **Argo Science Team** aims to enhance the communication with modeling communities.
  ➢ Multi-system OSE for salinity drifts are currently on-going (Suggested by P. Oke.)