SynObs Kickoff WS
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Tsukuba

Evaluation of Argo array impacts in the global and regional ocean data assimilation systems in JMA/MRI and the international collaboration through SynObs

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☆ Outline

- OSE collaboration for evaluating Abrupt Salinity Drift (ASD) of Argo floats
  - ASD: About 15% of Argo floats deployed after 2015 have experienced abrupt large salinity drifts due to break down of the instrument.
  - In order to support the Argo community, OSE-val TT decided to conduct a OSE collaboration and evaluate the impact of ASD and the QC activities in the Argo GDAC on the operational and research-based data assimilation systems.

- Proposal of the flagship multisystem OSE of SynObs

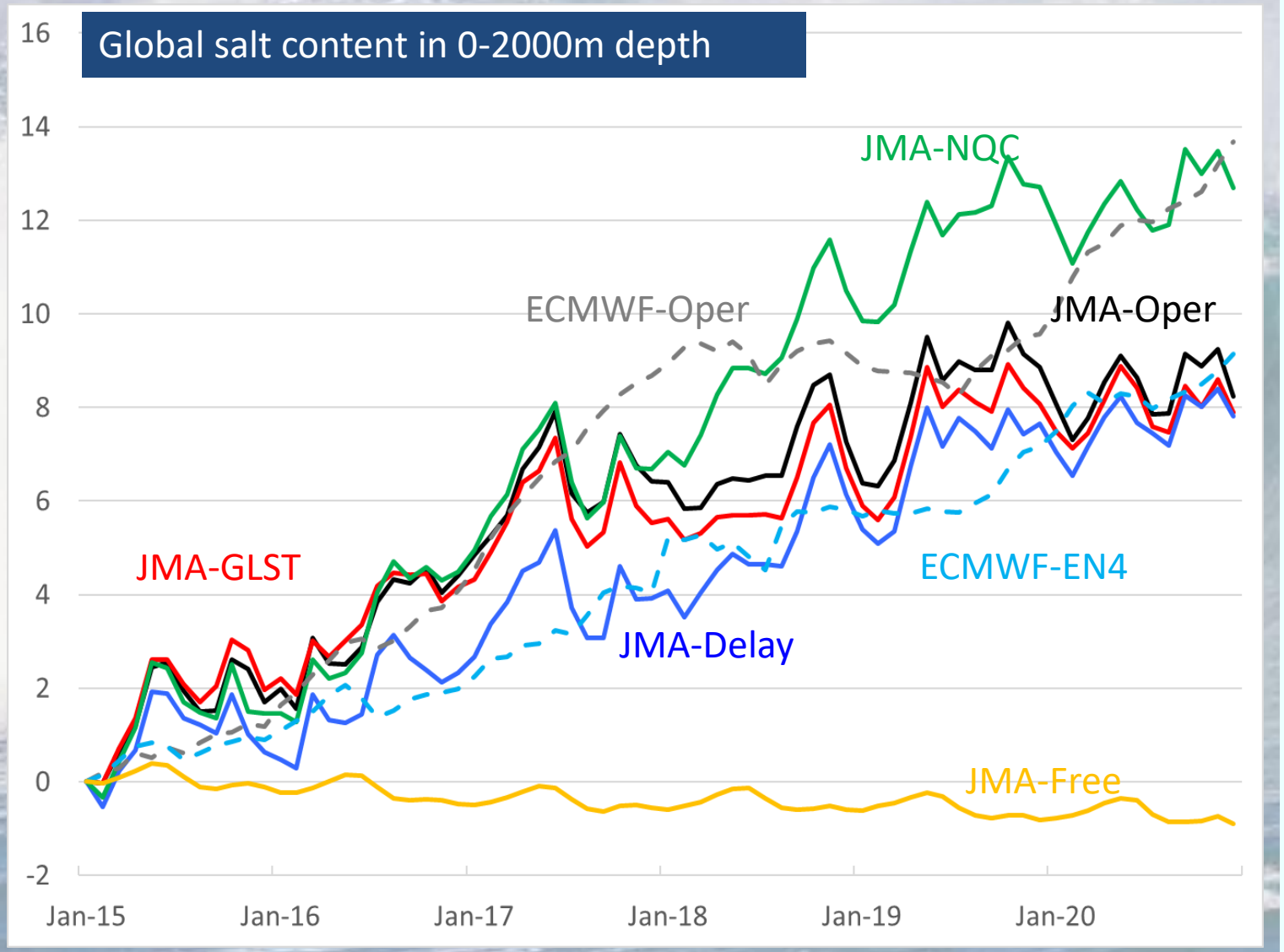

OSE for ASD

☆ OSEs for evaluating the impact of the Abrupt Salinity Drifts (ASD)

- **OSEs shown here** (Period: 2015-2020)
  - JMA-Oper: JMA's operational run (Argo data on GTS are used).
  - JMA-GLST: Same as JMA-Oper but the data of Argo floats in the gray list is excluded.
  - JMA-Delay: Same as JMA-GLST but the operational Argo data are replaced by delayed mode data at the Argo GDAC if the delayed-mode data are avairable.
  - JMA-NQC: Same as JMA-Oper but the operational Argo data are replaced by the real-time Argo data in the Argo GDAC
  - JMA-Free: Free run of the JMA's system without model field modification
  - ECMWF-Oper: ECMWF's operational run
  - ECMWF-EN4: ECMWF's run with EN4 (delayed-mode) observation data

  - **JMA's system:** MOVE-G3A 3DVAR Version (1-0.5 degree resolution)
  - ECMWF's system: ORAS5 System (0.25 degree resolution)
  - Other centers also plan to join (e.g., NERSC)

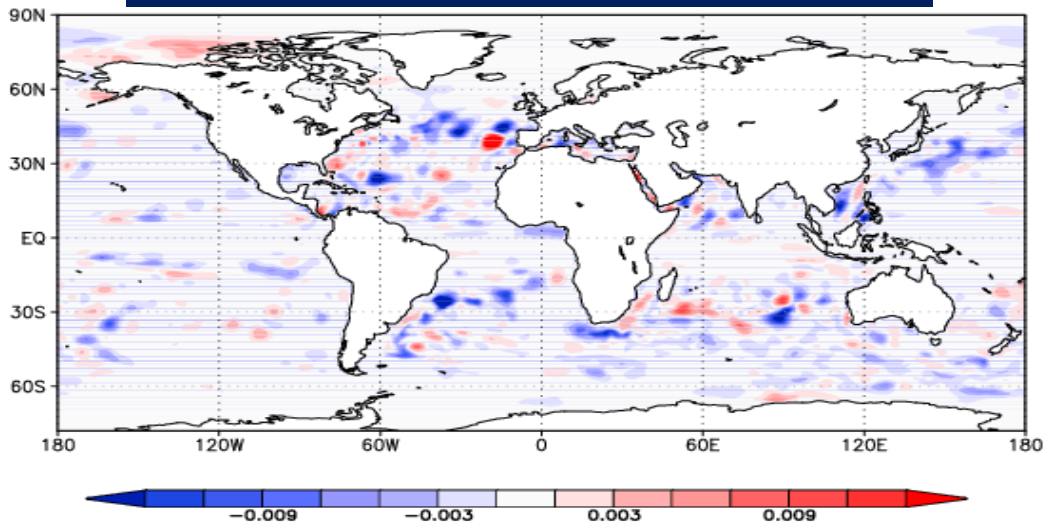
☆ Global Salt content time series.



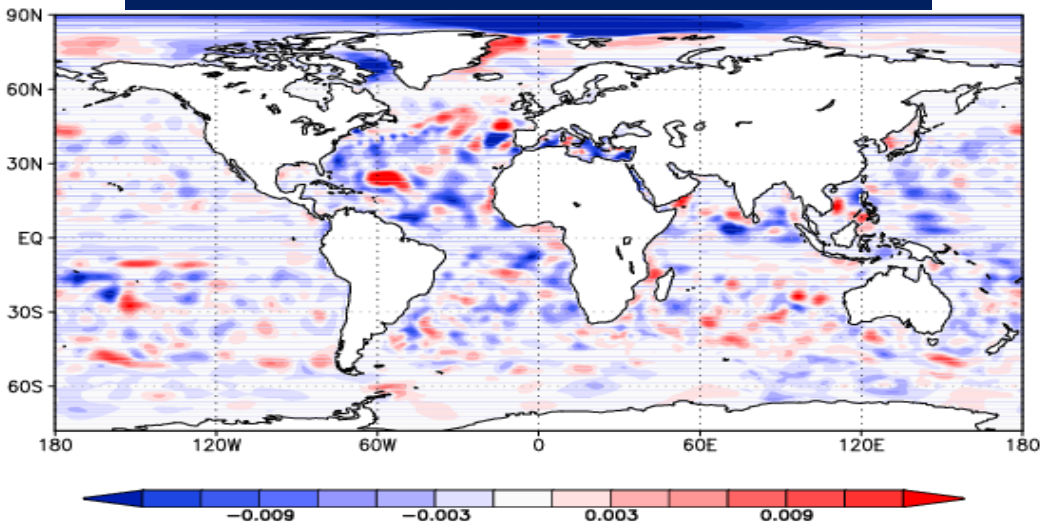
- Global salinity content is almost conserved in JMA-Free
- But it has increasing trend in other 4 OSEs in JMA and 2 OSEs in ECMWF.
- Objective analyses also has the trend.
- Results are consistent between JMA and ECMWF
- Real Time QC by the Argo GDAC effectively mitigate the trend in JMA.
- The gray list and delayed mode QC and using EN4 in ECMWF also contribute to reduce the trend.
- We can infer that the trend is mainly induced by ASD.
- The difference between JMA-GLST and JMA-Delay becomes small in 2020 because the ratio that the delayed mode data are available is decreasing.
- The QC activity by the Argo GDAC contributes to reliable ocean reanalysis.

☆ Horizontal Distribution of impacts on the vertically averaged salinity (2018-2019)

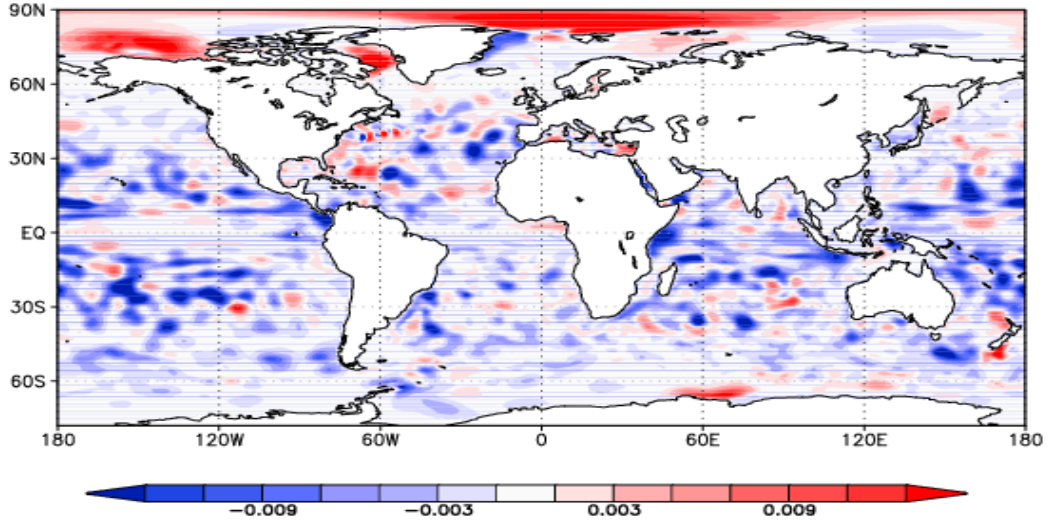
JMA-GLST - JMA-Oper



JMA-Delay - JMA-GLST



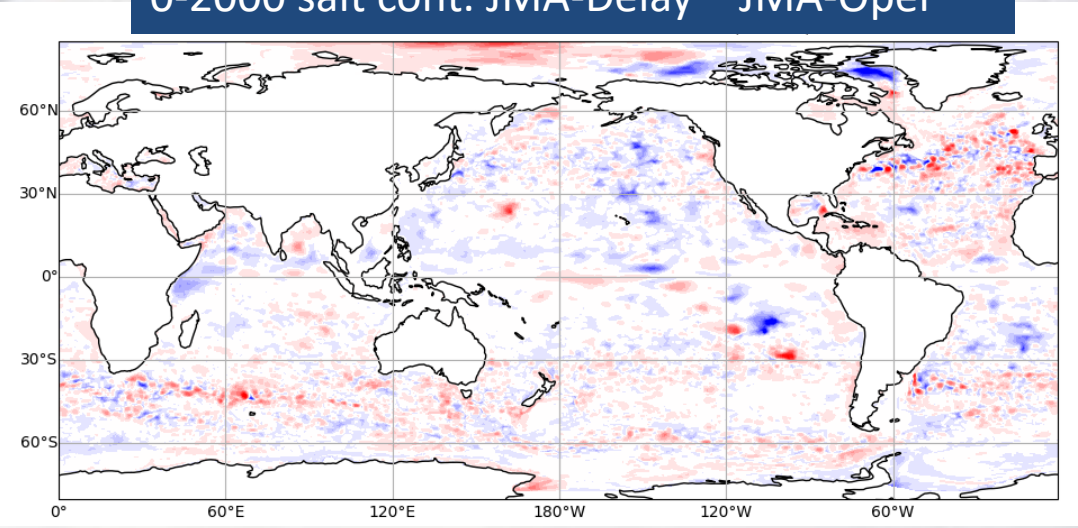
JMA-Oper - JMA-NQC



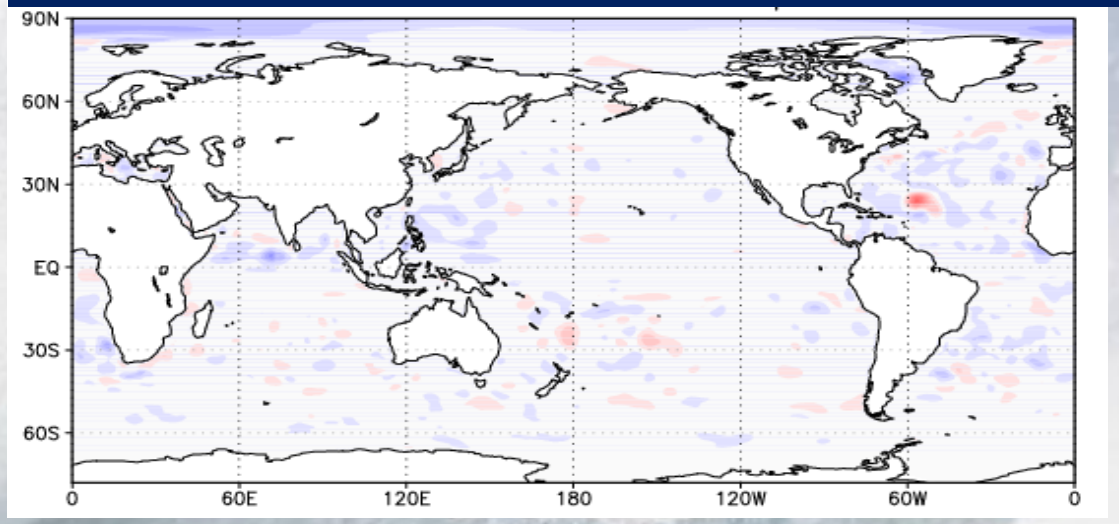
- The impact of the real-time QC is homogeneously distributed.
- The impact of gray list is relatively small.
- The impact of the gray list and impact of the delayed mode QC is relatively large in the Atlantic Ocean and relatively small in the eastern Pacific.

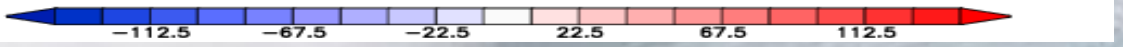
☆ Comparison of the impact between JMA and ECMWF

0-2000 salt cont. JMA-Delay – JMA-Oper



0-2000m salt cont. ECMWF-EN4 - ECMWF-Oper





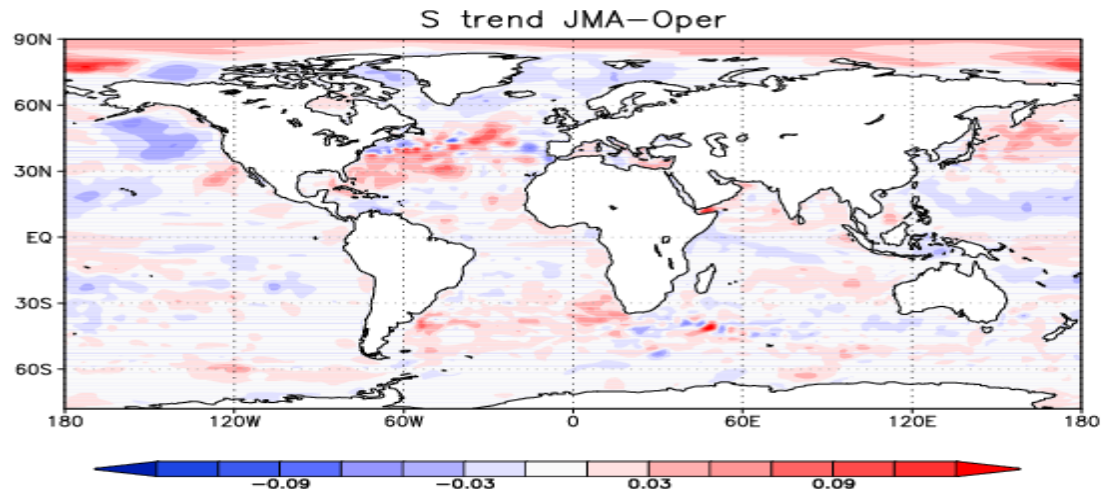
(2019-2020 Mean)

- Generally it looks not so consistent between JMA and ECMWF.
- But we can still find consistent (e.g., south of Japan, Labrador Sea etc)
- The difference can be at least partly attributed to the difference between Delayed-mode data in GDAC and EN4 data.
- It should be examined more in the future.

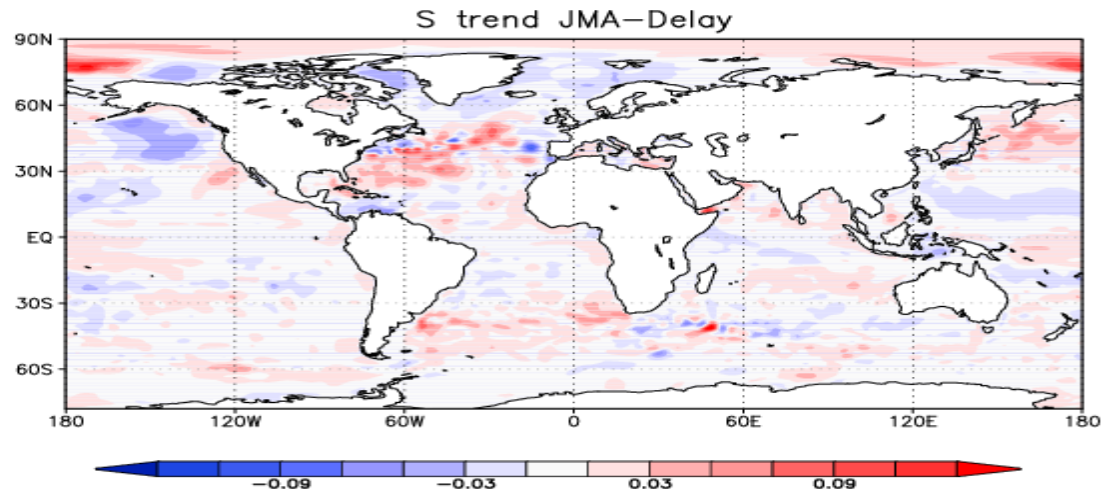
☆ The Salt content trend

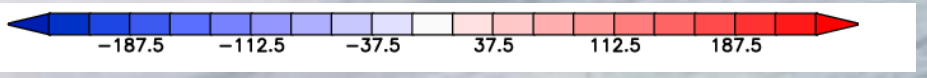
Trend: (2019-2020 Mean) – (2015-2016 Mean)

Salt Content Trend (JMA-Oper)



Salt Content Trend (JMA-Delay)

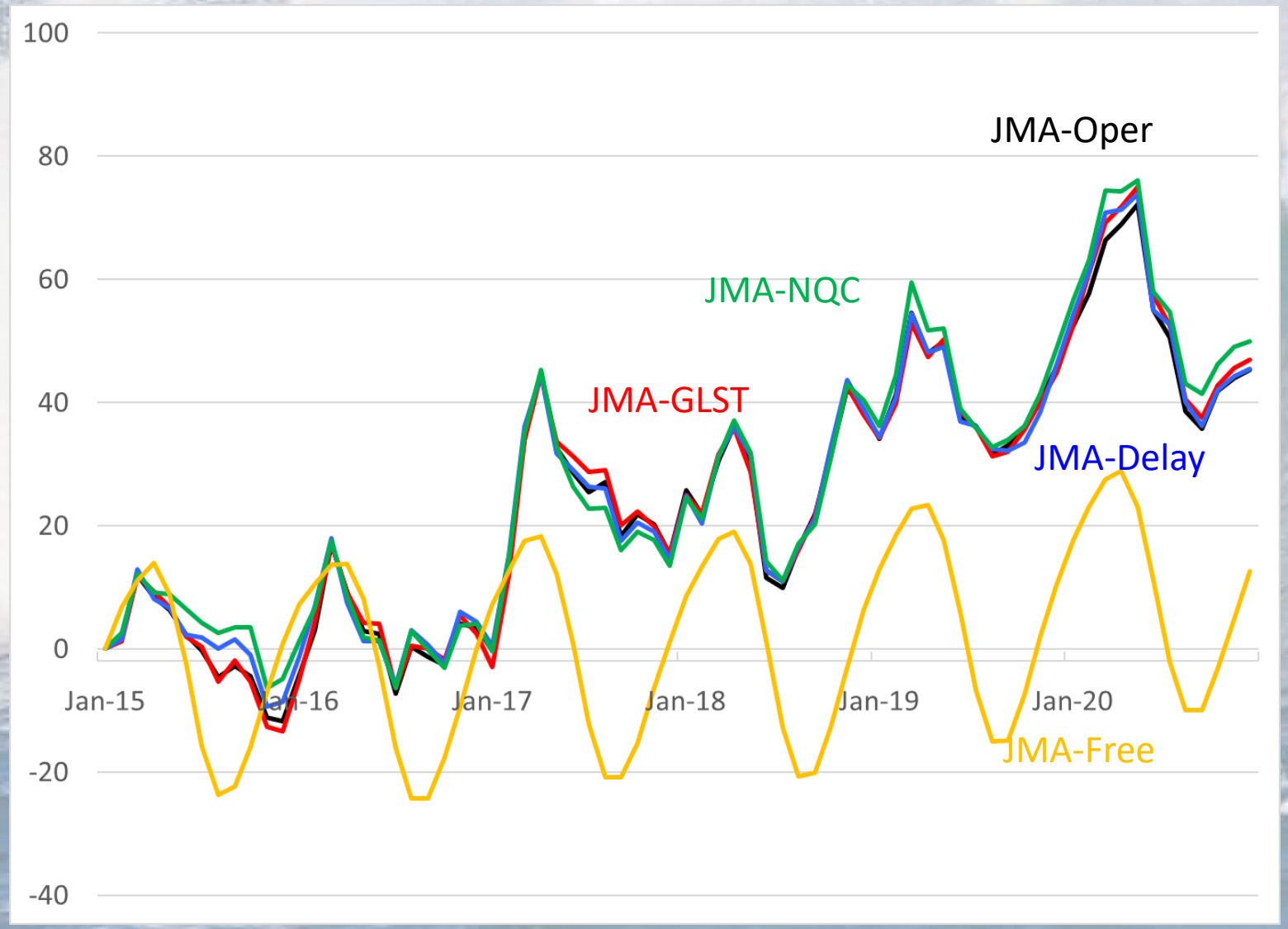




- The impact of the salt content trend due to the QC procedures is not significant. Actually, the order of the error is typically 1-oder smaller.
- The difference of the distribution of the trend between JMA and ECMWF is also very similar.

☆ The OSE Results

Global salinity content in 0-200m depth



- The impact on the heat content is visible but not significant.
- The horizontal distribution of the impact on the heat content is also very similar although we found large impacts at the Labrador Sea.

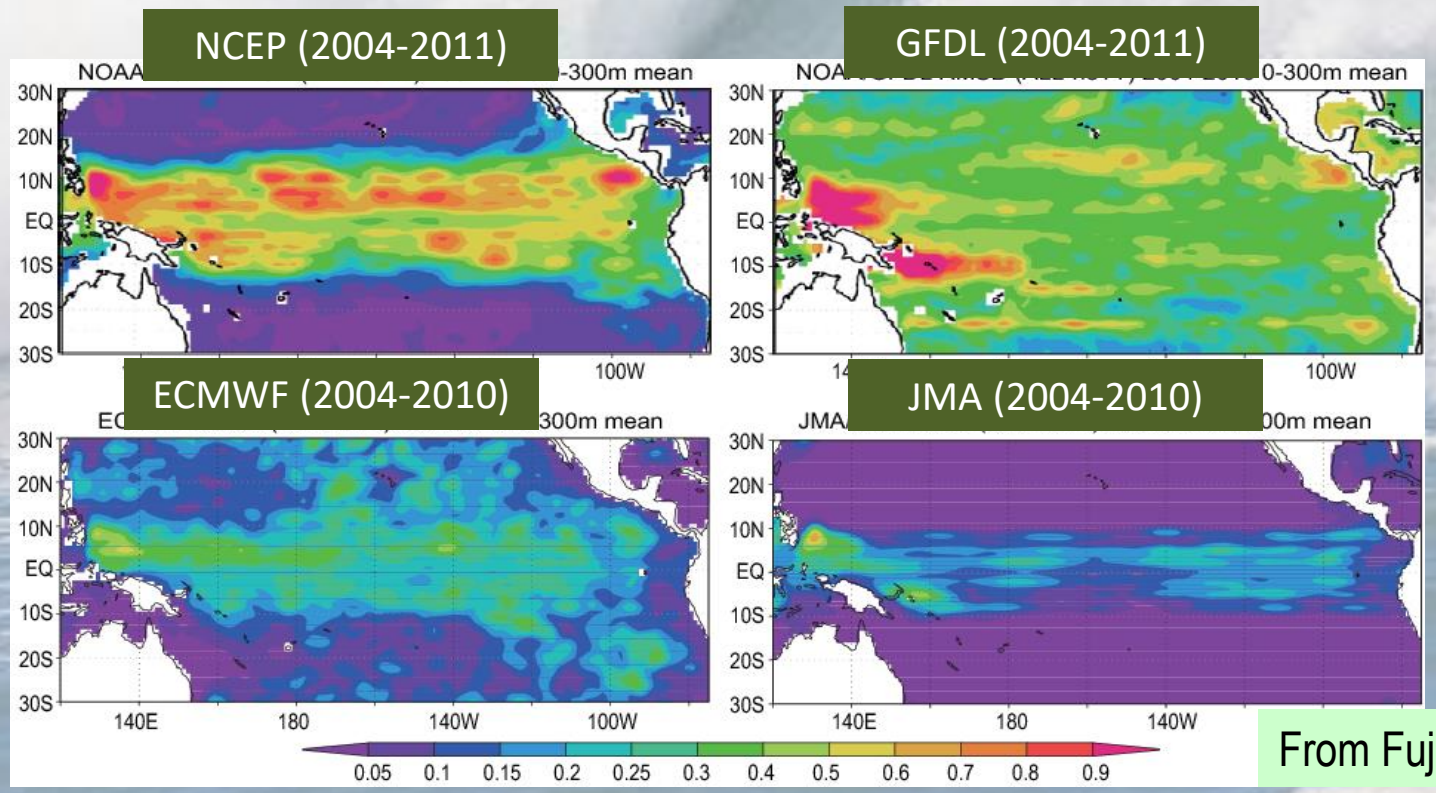
Proposal of SynObs Flagship OSE

☆ Why multi-system OSE/OSSE is necessary?

◆ Evaluation results inevitably depends on the prediction system.

- ✓ There is considerable dependency in the seasonal forecasts (mainly due to large systematic biases)
- ✓ Also, there is significant dependency in the ocean reanalysis fields (due to differences of models and data assimilation methods).
- ✓ Impacts also depend on the evaluation method.
- ✓ Multi-system multi-method evaluation are indispensable to get 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

★ Image of collaborative OSE activities in SynObs

Flagship (Core) multi-system OSEs

System: Ocean Data Assimilation and Prediction Systems

Targeted Observations:

- ✓ SSH (Nadir+SWOT)
- ✓ In-situ (Argo, Tropical Moorings, etc.)
- ✓ consider their Synergy

Prediction Targets:

- ✓ 0-50m Temp. (MHWs)
- ✓ Near-surface currents (BCs)
- ✓ Salinity(?)

Period: 2015-2024

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

Extension → **Coupled prediction** OSEs for S2S

Extension → **Coastal Prediction** OSEs

Extension → Adoint&Ensemble Sensitivity Studies

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

★ 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 selected.

Basically the same as the S2S OSEs

➢ Ocean data assimilation and prediction runs are conducted.

1st Phase → 2005-2022
Analysis is conducted in 2023

2nd phase → 2005 (2023) – 2024
Analysis is conducted in 2025

★ Configuration of the flagship OSEs

- Data Assimilation Run
  - Integration should be started at least before 01/01/2000 from the operational reanalysis fields or the fields of a model free run at the initial date.
  - Some special setting for the OSEs is acceptable. (All OSEs other than “Operation” should use the same setting.)
- Prediction Run
  - Initial time: At the beginning of every month (or every pentad?) in 2005-2024
  - Prediction Length: 10 days (Is a longer length possible?)
  - Results of deterministic predictions or ensemble means will be analyzed.
- Analysis and Prediction targets
  - MHWs: SST and 0-40m(?) heat content 5-day-avaraged anomaly
  - Surface (10m?) Current fields (daily?)
  - Tropical Cyclone Heat Potential, Subsurface T, Salinity etc.? (daily?)
  - The fields of the values above with 0.1˚ or 0.25˚ resolutions (enough?) will be analyzed.

★ Method of Collaborative Analysis of the flagship OSE

- How about adopting the method used in ORA-IP?

  ⇒ The best practice example of the collaboration I know.

  - Decide several targets of analyses: (e.g., Marine Heatwaves, current fields, tropical cyclone, North Atlantic, North Pacific, etc.)
  - Assign responsible people for each target
  - Each data provider, who conducted OSEs, provides the required data to the responsible people based on the request.
  - The responsible people analyze the data by their own idea and generate figures.
  - The result will be submitted the special issue, or independently to an academic journal, etc.
  - Some regional models can participates the flagship OSE through some regional targets.
  - It is probably possible to collaborate with exemplars of Ocean Observing Co-Design for the analysis.

- Tentative deadline of data submission for the first phase : 30 Sep. 2023 (too early?)
- We should also consider to establish the data archive center in which the data of collaborative OSEs are stored and distributed to the participants.


Thank you

★ Expected Collaboration with Ocean Observing Co-Design

1. Ocean Observing Co-Design
   - Marine Heatwave (MHW) exemplar: YF, as a member of the planning team, suggested evaluating the global forecast skills of MHW and impacts of existing observation net work on the skills
   - It is also possible to provide information on the prediction of the ocean currents and tropical cyclone heat potential (TCHP) from the flagship OSEs to Boundary Currents and Tropical Cyclone exemplars.
   - The flagship OSE/OSSE does not directly contribute to other exemplars. But SynObs contributes to other exemplars in a couple of ways.
     - OS-Eval Showcase: Various OS-Eval results including TC, BGC, etc.
     - Storm Surge exemplar is lead by CoastPredict FA1 PredictOnTime team, which YF is also participating.

★ Other partners.

2. Argo Community
   - ➢ UN Decade Project OneArgo is also in Ocean Observing Codesign.
3. TPOS community
   - ➢ TPOS requests SF communities (MB) to evaluate the new TPOS design. YF is in the TPOS science team.
4. SWOT and OSTST Community
   - ➢ SWOT must have a significant impact on operational oceanography.
   - ➢ OSTST is historically collaborating with GODAE-OceanPredict community.
   - ➢ The final goal of SynObs is extracting the synergy among in-situ and satellite data.
6. CoastPredict/ PredictOnTime
   - ➢ Extension of the flagship OSE to the coastal areas(?)