Roles of TAO/TRITON and Argo in tropical Pacific observing system: An OSSE study for multiple time scale variability

Jieshun Zhu[1,2], Stylianos Flampouris[3*], Guillaume Vernieres[4], Arun Kumar[1], Avichal Mehra[5], Meghan Cronin[6], Dongxiao Zhang[7], Samantha Wills[7], Travis Sluka[4], Jiande Wang[3], Wanqiu Wang[1]

[1]NOAA/NWS/NCEP/CPC; [2]ESSIC/UMCP; [3]IMSG at NOAA/NWS/NCEP/EMC; [4]JCSDA; [5]NOAA/NWS/NCEP/EMC; [6]NOAA/PMEL; [7]CICOES/UW

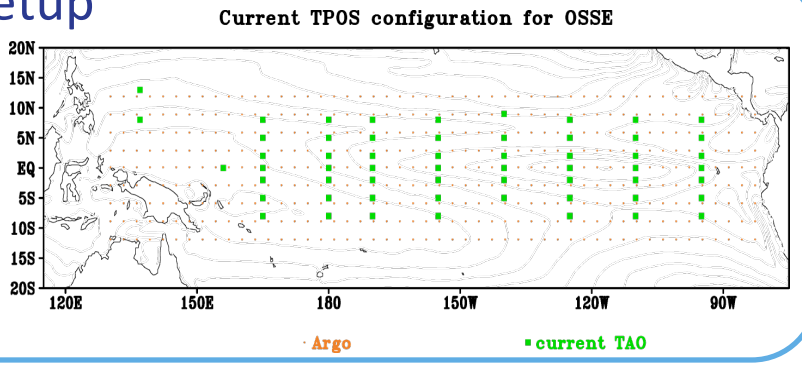
Motivation: Oceanic OSSEs in support of the TPOS 2020 Project

- **Current Configuration** of *in situ* TPOS observations
  - TAO/TRITON
  - Argo
- **Proposed configuration** recommended by the TPOS 2020 Project:
  - New TAO configurations (e.g., new sites; more salinity observations,…)
  - "Doubled" Argo deployments

Support from CVP/CPO is acknowledged for the work

Experimental setup

- **DA system:** 1° MOM6Solo + JEDI-based 3DVar
- **Nature Run:** A free run with a modified CFSv2
- **Atmospheric forcing:** daily from Nature Run
- **Synthetic Obs. sampling:**
  TAO/Argo with current configurations from Nature Run
  - *TAO is sampled every 24 hours (vs. 10min in reality)*
  - *Argo is sampled every 3x3 box every 10 days within TP*



List of Experiments

Experiments	Assimilated data	Correlation Scale	Obs. error	Exp. length
noDA	none	700km	0.1 degree for T and 0.03 psu for S	5 years
crtTAO	T profiles (and a few S) every day with current TAO configurations			
Argo	T/S profiles every 3x3 box and every 10 days			
crtTAO+Argo	Both TAO and Argo profiles			

Assimilations conducted once per day @12z, after a 13-year model spin-up

Analysis Method

- **Mean bias:** 5-year mean state ($\overline{V}$)
- **Variability (V'):**
  multiple time scales ($V^{LF}+V^{IS}+V^{HF}$)

$$V' = V^{LF} + V^{IS} + V^{HF},$$

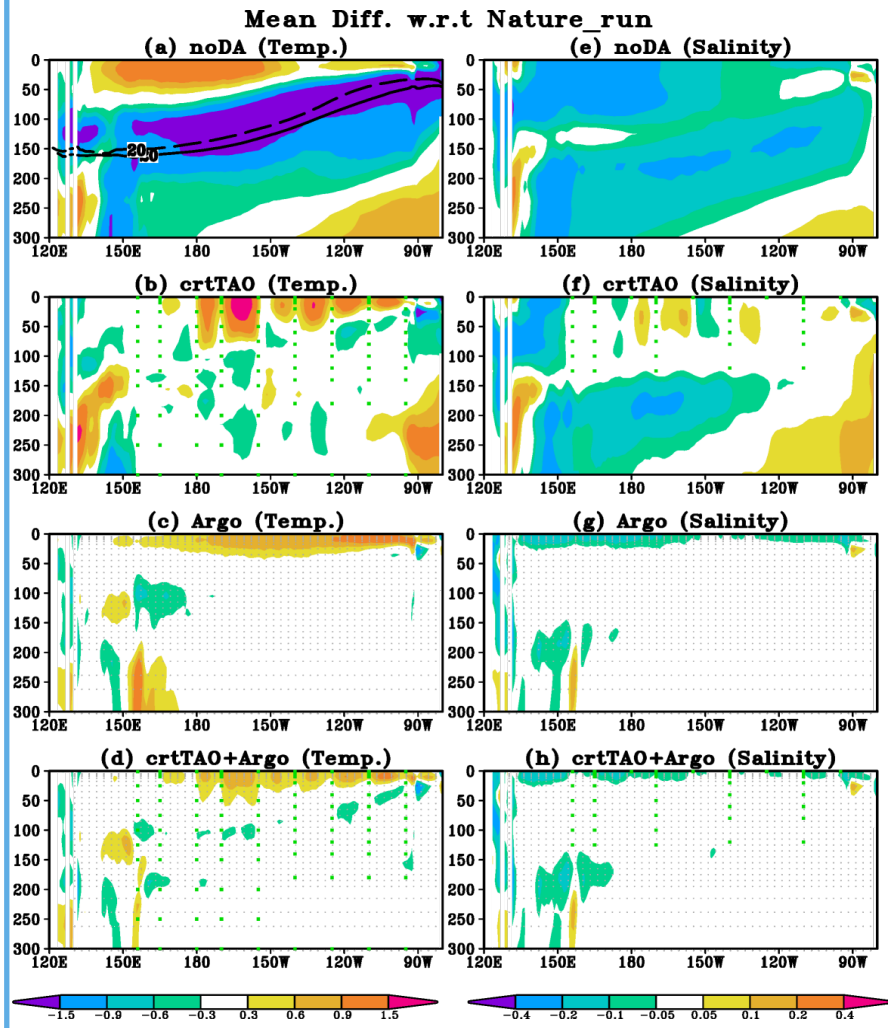
where $V^{LF} = \frac{1}{91}\sum_{k=-45day}^{45day} V'$,

$V^{IS} = \frac{1}{21}\sum_{k=-10day}^{10day} V' - \frac{1}{91}\sum_{k=-45day}^{45day} V'$, and

$V^{HF} = V' - \frac{1}{21}\sum_{k=-10day}^{10day} V'$.

Results

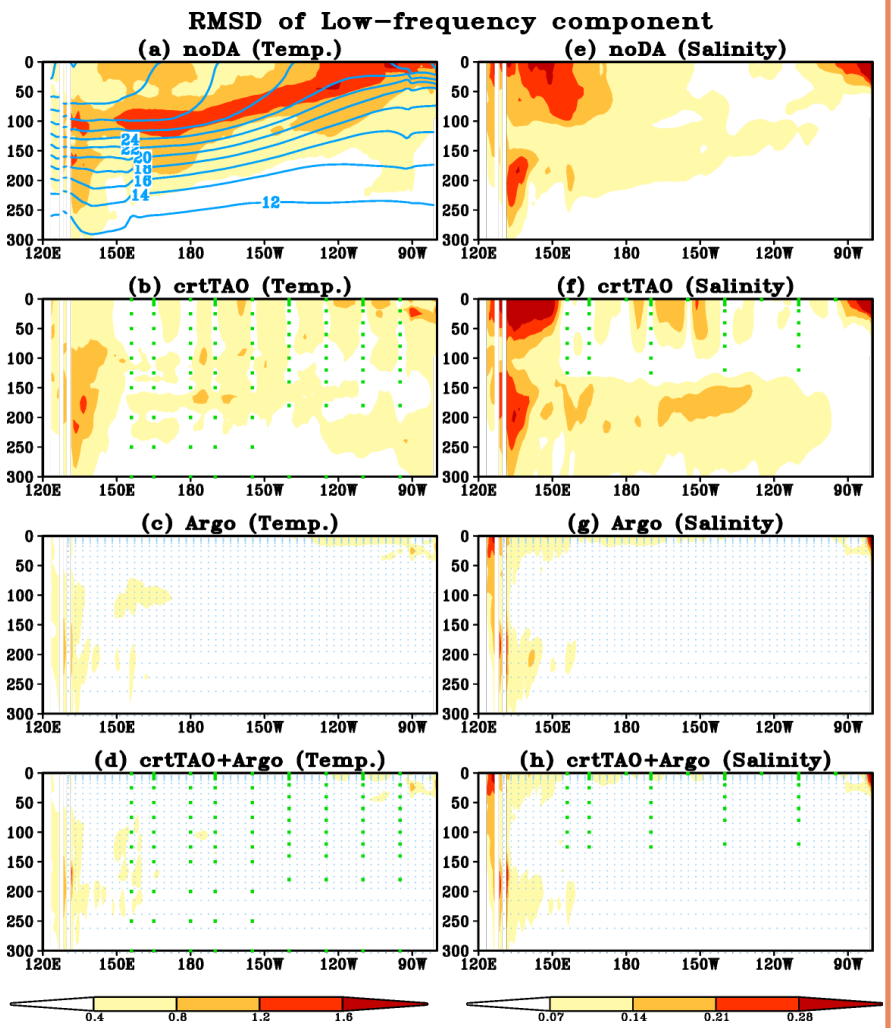
(1) Mean biases ($\overline{V}$)



- **Temp.**: Over most regions, both TAO and Argo correct the subsurface temperature mean biases efficiently
- **Salinity:** Argo corrects most subsurface salinity mean biases, TAO presents some corrections over upper ocean close to TAO sites with salinity obs.

(2) Low-frequency component (V^{LF})

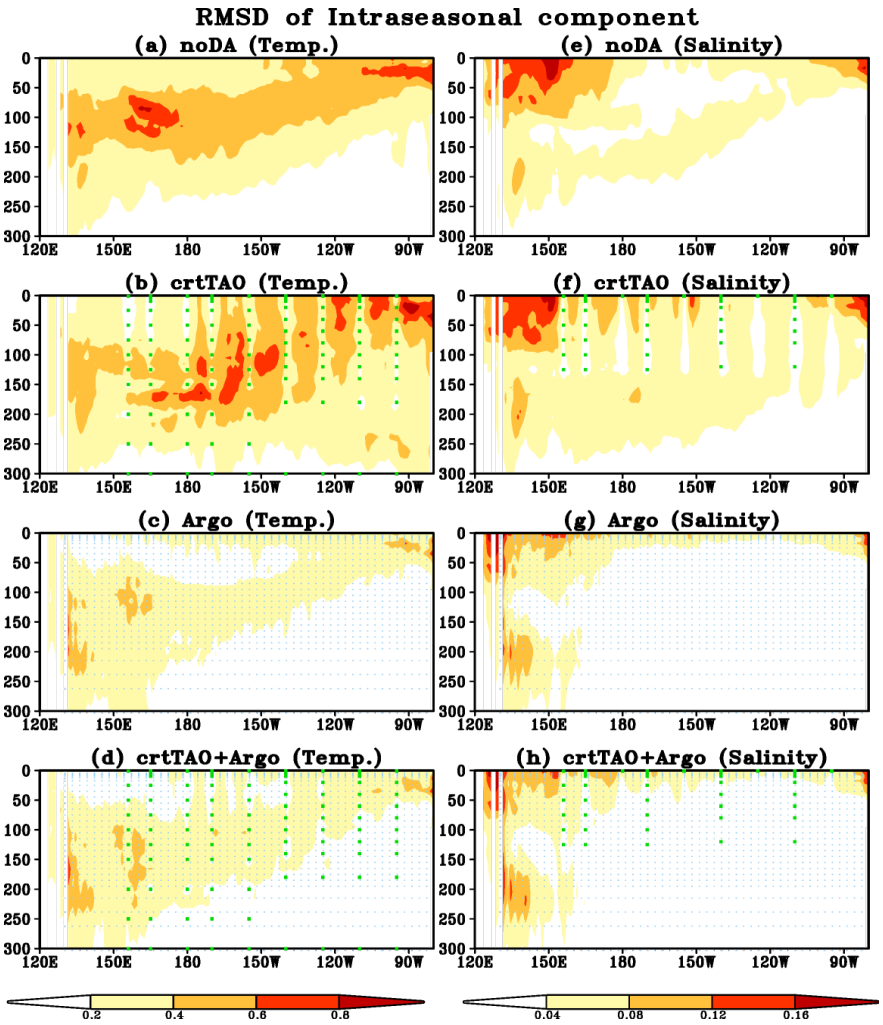
$$V^{LF} = \frac{1}{91}\sum_{k=-45day}^{45day} V'$$



- **Temp.**: Both TAO and Argo improve the estimate of its LF component
- **Salinity:** Argo presents the same improvement as in Temp., but TAO presents some improvement only over the upper ocean

(3) Intraseasonal component (V^{IS})

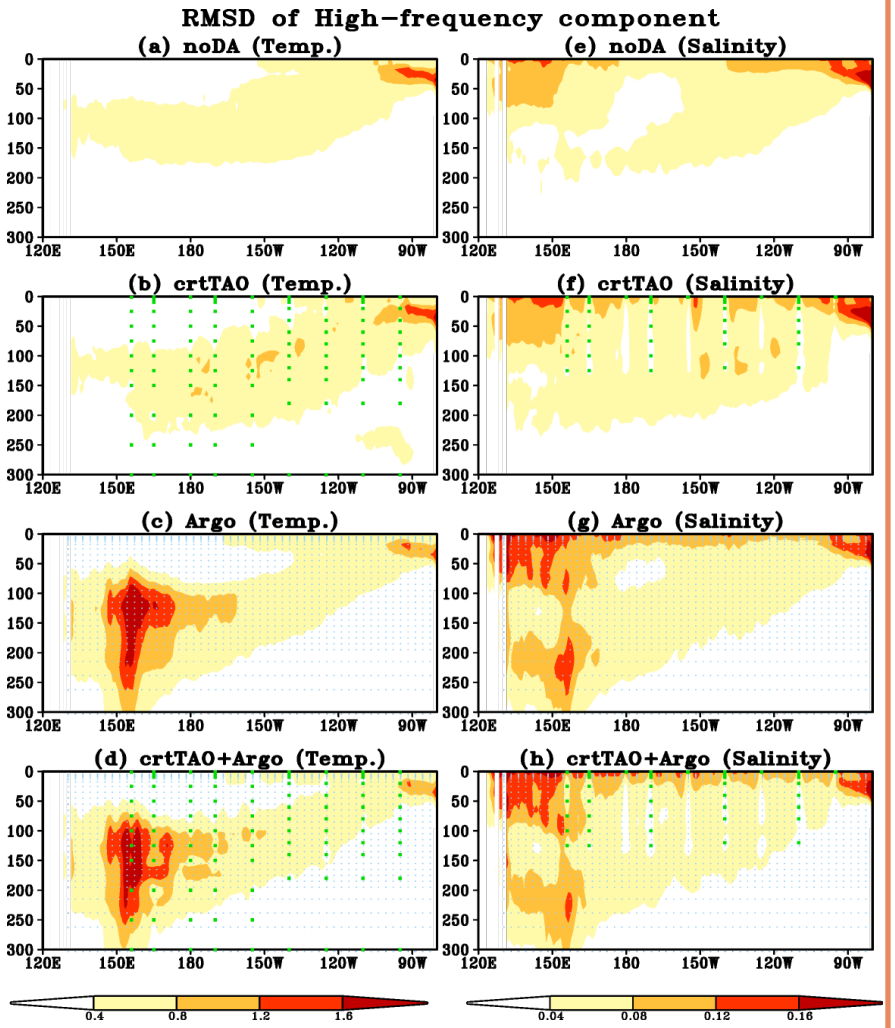
$$V^{IS} = \frac{1}{21}\sum_{k=-10day}^{10day} V' - \frac{1}{91}\sum_{k=-45day}^{45day} V'$$



- **Temp.**: Argo improves the estimate of its IS component, and TAO presents some improvement only close to TAO sites;
- **Salinity:** Argo presents the same improvement as in Temp., but TAO presents limited improvements close to TAO sites

(4) High-frequency component (V^{HF})

$$V^{HF} = V' - \frac{1}{21}\sum_{k=-10day}^{10day} V'$$



- Both TAO and Argo have little capability in improving the estimate of the **HF** variability.

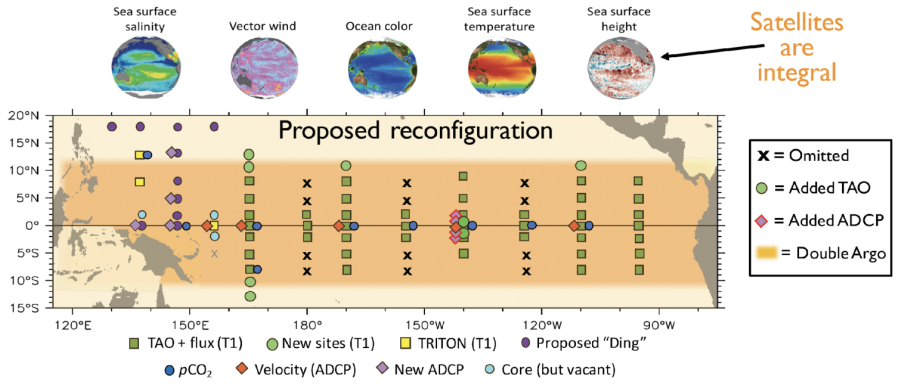
TAO -- spatially too coarse;
Argo -- temporally too coarse

Summary and discussions

- Both TAO and Argo could effectively improve the estimation of mean states and low-frequency variations *(for TAO, temperature only)* ;
- For the intraseasonal variability, Argo presents significant improvements more than TAO *(except for regions close to TAO sites)*;
- For the high-frequency variability, both TAO and Argo have little capability in improving its estimates. *(TAO -- spatially too coarse; Argo -- temporally too coarse)*.

Further work

- Repeat ocean data assimilation experiments with various future configurations of TAO and Argo under consideration by the TPOS 2020 Project.



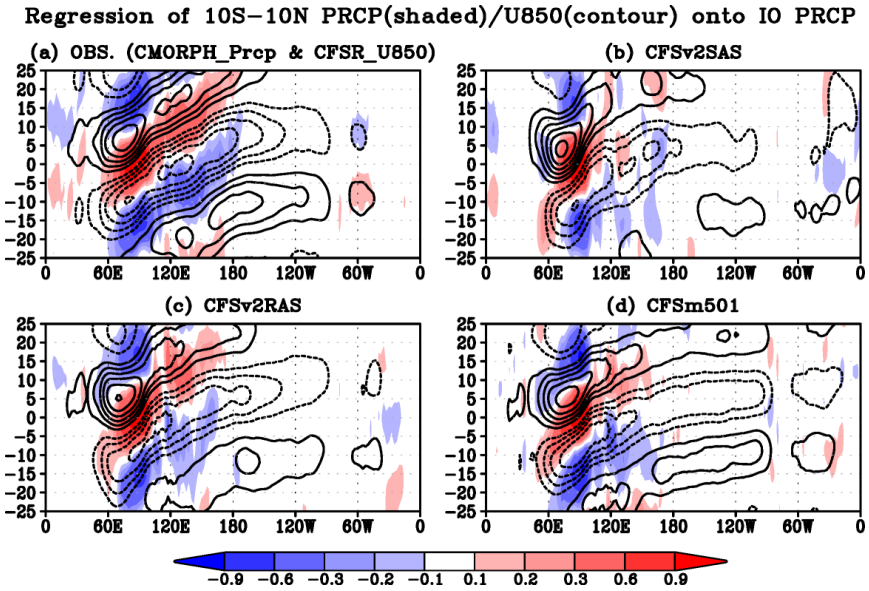
Backup Slides

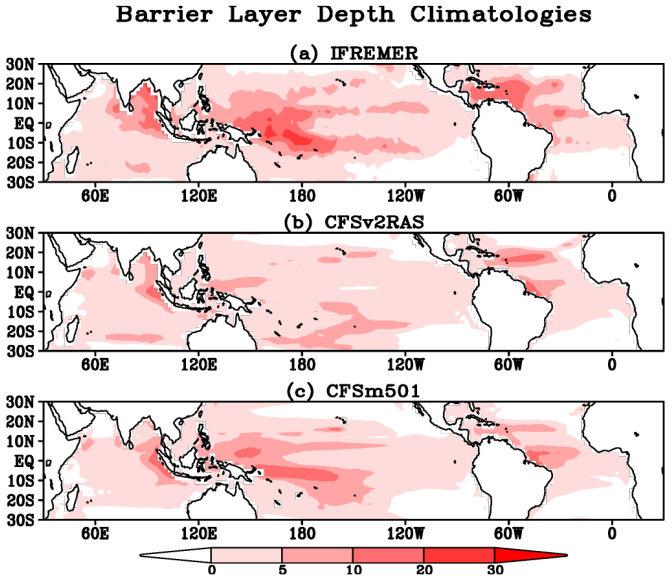
Nature Run:

CFSm501 includes two major modifications in operational CFSv2:

1) The SAS atmospheric convection scheme=>RAS

2) Near the ocean surface, 10-meter vertical resolution=>1-meter

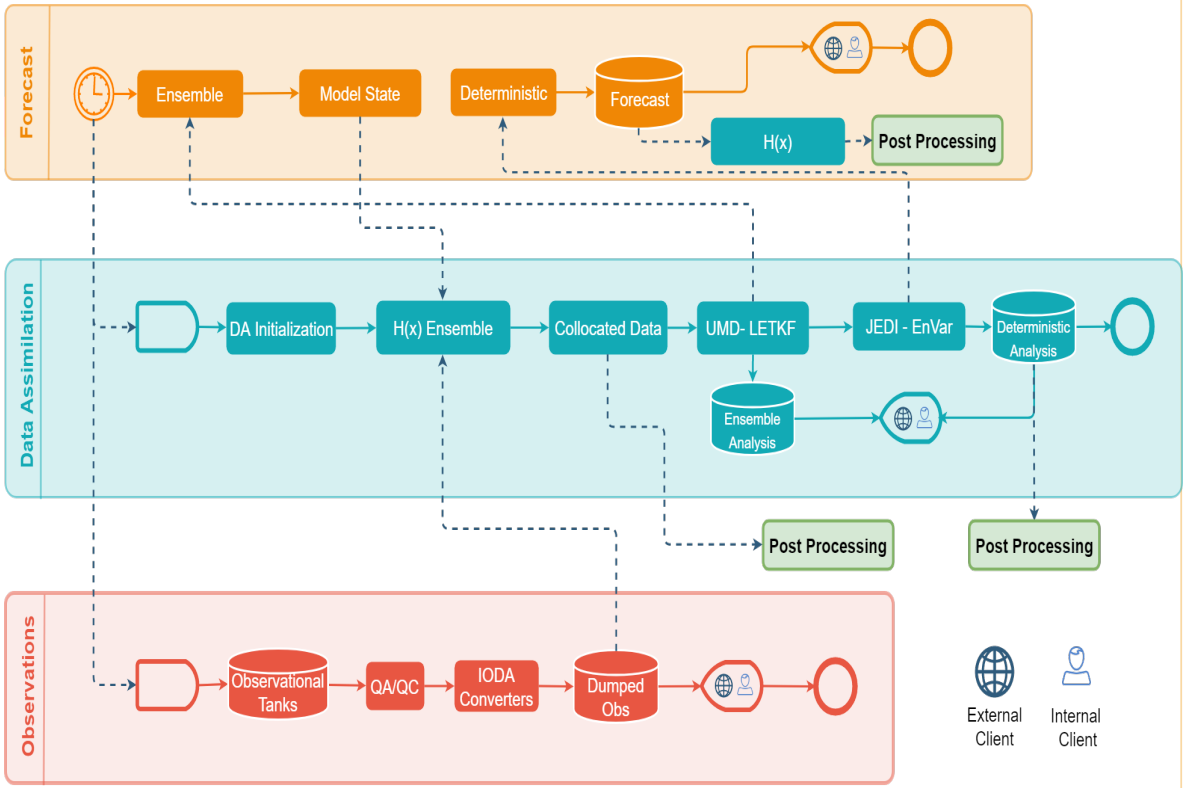




Improved simulations of the MJO, barrier layer distribution/thickness, intraseasonal SST/SSS variance……

A JEDI-based Ocean Data Assimilation System: next generation GODAS

*A **hybrid-EnVar** system being developed at JCSDA and EMC*



Courtesy of *S. Flampouris*

- **Ocean**: MOM6 (0.25° spatial resolution; 75 layer hybrid vertical coordinates)
- **Sea-Ice:** Los Alamos CICE5/6 (same as the ocean)
- **Data assimilation** framework: Joint Effort for Data assimilation Integration- Sea-Ice Couple Data Assimilation (JEDI-SOCA)
- Capability to assimilate **a wide array of observations**: T & S profiles, SST, altimetry, sea ice concentration, etc.