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

**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

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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

\[
V^{LF} = \frac{1}{91} \sum_{k=-45}^{45} V',
\]

\[
V^{IS} = \frac{1}{21} \sum_{k=-10}^{10} V' - \frac{1}{91} \sum_{k=-45}^{45} V',
\]

and

\[
V^{HF} = V' - \frac{1}{21} \sum_{k=-10}^{10} V'.
\]
• **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.

\[ V_{LF} = \frac{1}{91} \sum_{k=-45\text{day}}^{45\text{day}} V' \]

• **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 ($V^{IS}$)

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

**RMSD of Intraseasonal component**

- (a) noDA (Temp.)
- (b) crtTAO (Temp.)
- (c) Argo (Temp.)
- (d) crtTAO+Argo (Temp.)
- (e) noDA (Salinity)
- (f) crtTAO (Salinity)
- (g) Argo (Salinity)
- (h) crtTAO+Argo (Salinity)

- **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 ($V^{HF}$)

\[ V^{HF} = V - \frac{1}{21} \sum_{k=-10}^{10} V' \]

**RMSD of High-frequency component**

- (a) noDA (Temp.)
- (b) crtTAO (Temp.)
- (c) Argo (Temp.)
- (d) crtTAO+Argo (Temp.)
- (e) noDA (Salinity)
- (f) crtTAO (Salinity)
- (g) Argo (Salinity)
- (h) crtTAO+Argo (Salinity)

- 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 $\rightarrow$ RAS
2) Near the ocean surface, 10-meter vertical resolution $\rightarrow$ 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

- **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.

Courtesy of S. Flampouris