Targeted observation analysis of a Northwestern Tropical Pacific Ocean mooring array using an ensemble-based method

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Northwestern Tropical Pacific Ocean (NWTPO) mooring array

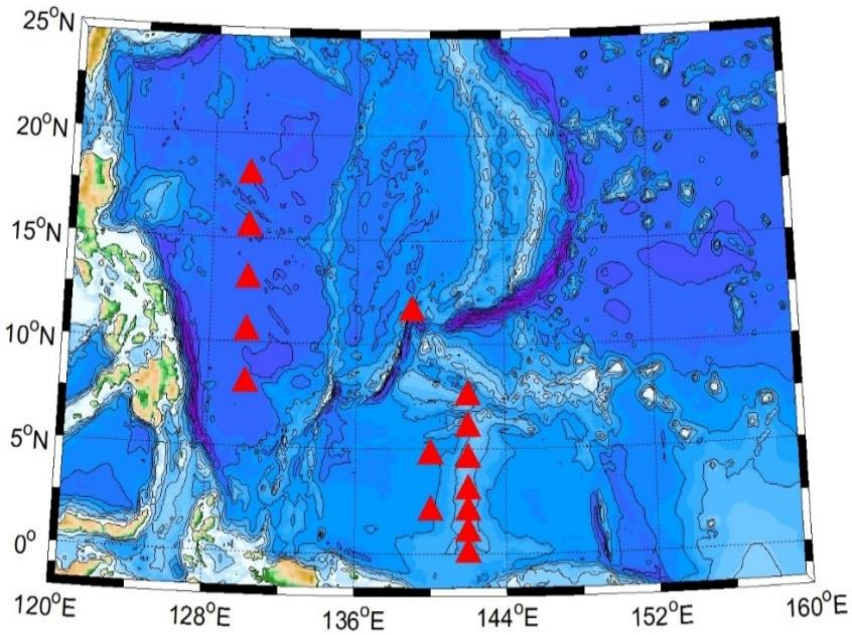


Fig. Mooring locations

Key points :

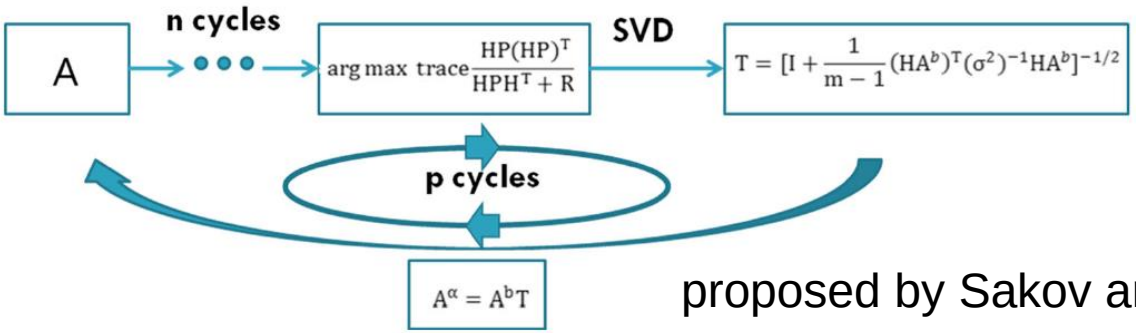
1) Evaluating the performance of present moorings in estimating the circulation state in the NWTPO.

2) Optimal mooring sites for maximizing monitoring efficiency and resolving the most energetic oceanic signals and spatial/temporal propagation of signals

The ensemble–based method

Targeted observation (or optimal observation) is defined as the optimum location **H** to minimize the trace of the background error covariance matrix

$$\mathbf{H}^{\mathrm{opt}} = \arg\min_{\{\mathbf{H}\}} \|\mathbf{P}^{a}\|$$



proposed by Sakov and Oke (2008)

Fig. Schematic diagram depicting the serial calculation of the targeted observation

The ensemble representing
the background error covariance matrix **P** is formed from the output data from a model run (AIPOcean: Yan et al. 2015a,b)
that estimates long duration time-spans.

The calculated optimal observation was a profile

State vector: $x^{n\times 1} = (U_{0-200}, U_{200-400}, V_{0-200}, V_{200-400})$

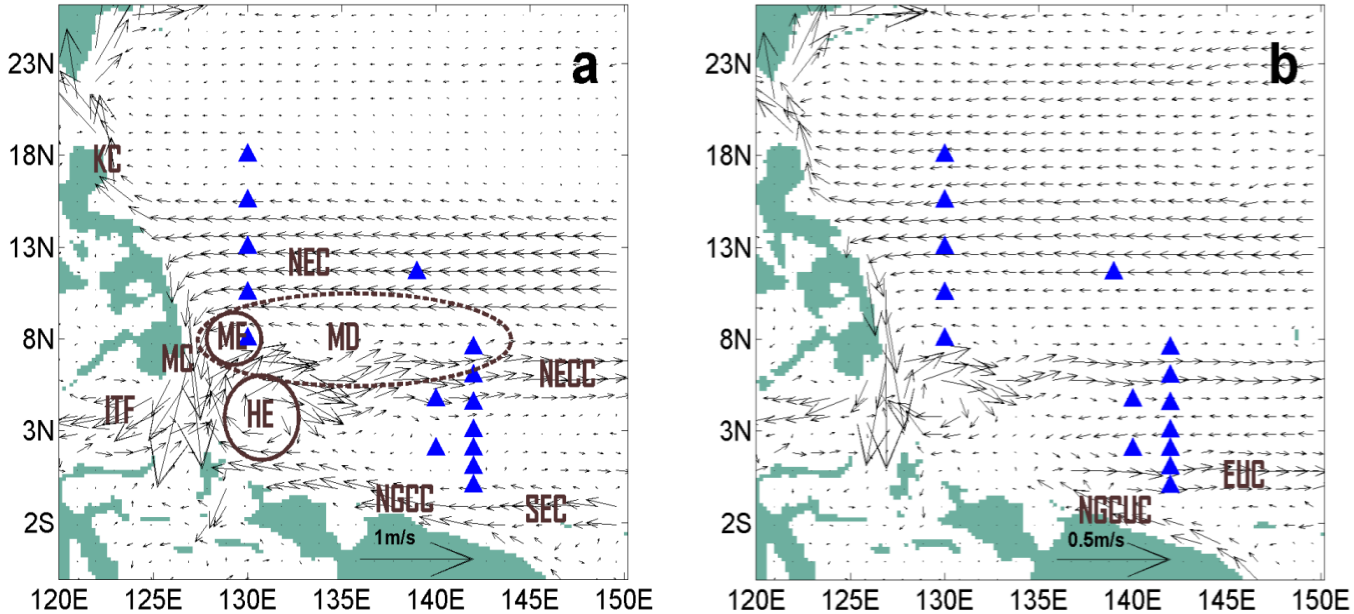


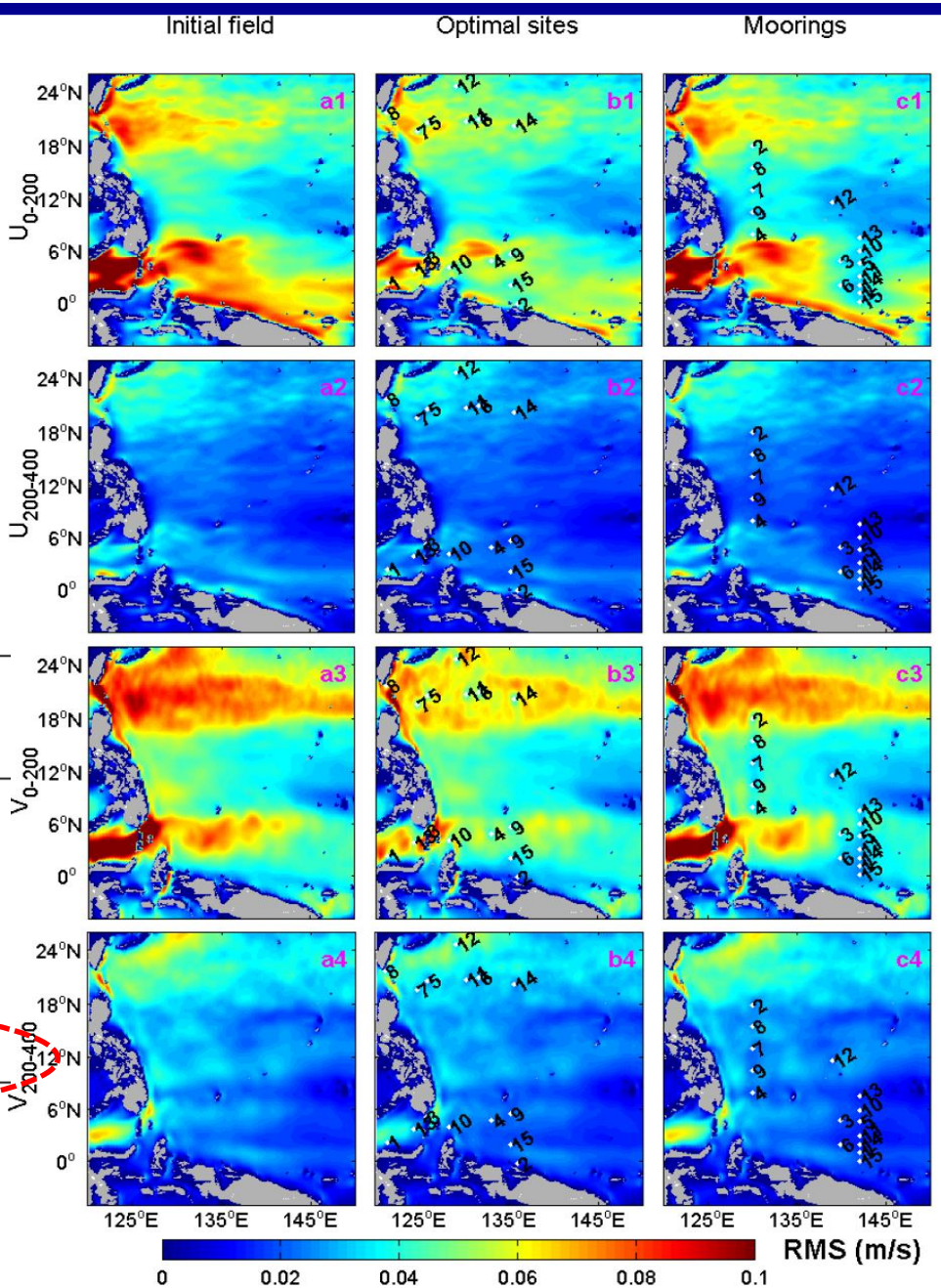
Fig. The vertical-averaged circulation at the depth of from 0 m to 200 m (a) and from 200 m to 400 m (b). Blue triangles denote the locations of the NWTPO moorings.

Objective assessment on the intra-seasonal timescale

Key regions ：
the equator, Indonesian throughflow (ITF), headstream of the North Equatorial Countercurrent (NECC), and Subtropical Countercurrent (STCC)

	Initial field	Optimal sites	Exsiting moorings
$U_{0\text{-}200}$	4.96	4.25(14.46%)	4.55(8.28%)
$U_{200\text{-}400}$	2.34	2.08(11.29%)	2.18(6.9%)
$V_{0\text{-}200}$	5.07	4.42(12.68%)	4.7(7.17%)
$V_{200\text{-}400}$	2.68	2.48(11.23%)	2.50(6.52%)
mean	3.84	3.31(12.42%)	3.48(7.22%)

RMS of velocity (unit:cm/s)

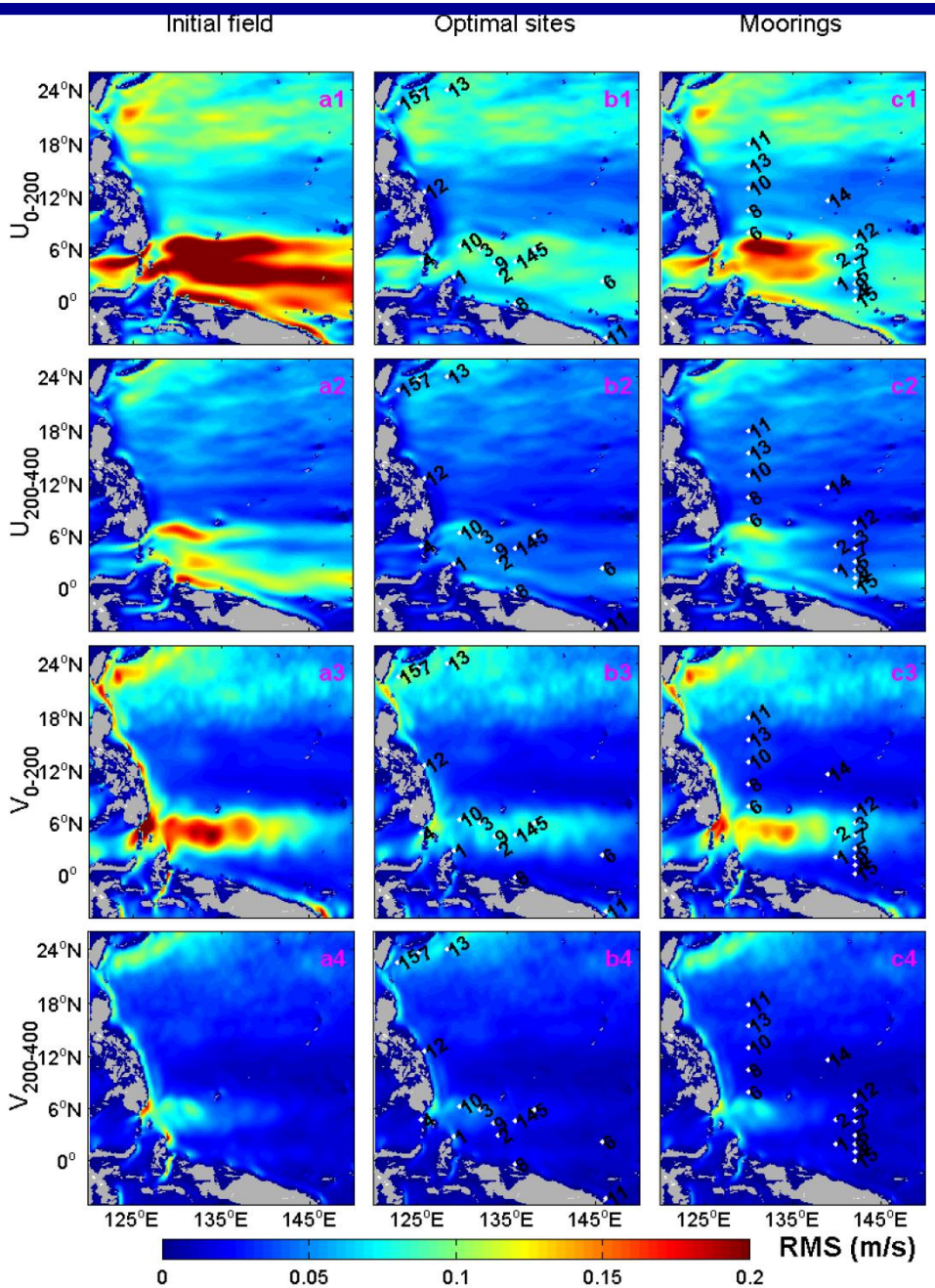


Objective assessment on the low-frequency timescale

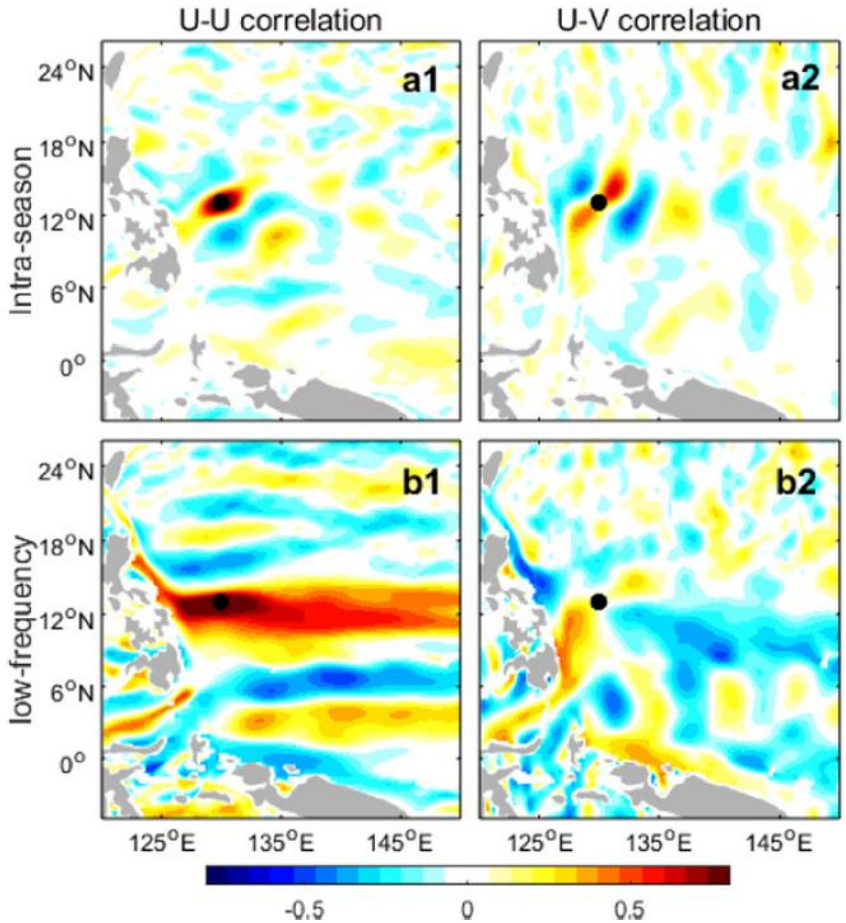
Key regions ：
the Western Boundary Current (WBC), NECC, and the Equatorial Undercurrent (EUC).

	Initial field	Optimal sites	Exsiting moorings
$U_{0\text{-}200}$	9.76	6.25(35.97%)	7.29(25.30%)
$U_{200\text{-}400}$	5.37	3.75(30.15%)	4.26(20.77%)
$V_{0\text{-}200}$	5.69	4.20(26.27%)	4.84(15.01%)
$V_{200\text{-}400}$	3.03	2.44(19.43%)	2.69(11.06%)
mean	5.96	4.16(27.96%)	4.77(18.03%)

RMS of velocity (unit:cm/s)



The ensemble-based correlations



The variability of the currents can be monitored well on the low-frequency timescale but poorly on the intra-seasonal timescale.

1) For monitoring intra-seasonal variability, the range of each mooring is confined to a local scale.
2) For monitoring the low-frequency variability, NWTPO moorings performed relatively well, as indicated by the strong background correlations between each of the currents.

Discussion

- In the future, intra-seasonal current monitoring in the NWTPO will remain a big challenge.
- Future mooring deployments should primarily consider the large residual uncertainty at present.
- The assimilation of the moored current need to be explored.