

AIPOcean reanalysis

1. Introduction

The joint region of Asia, the Indian Ocean, and the western Pacific Ocean (AIPOcean) is one of the key areas influencing short-term (seasonal to interannual) climate variability over China. Air-sea interaction in this region, namely the exchanges of energy, momentum and mass across the air-sea interface, serves as one of the critical factors modulating large-scale climate variations in China. Therefore, we construct a long-term AIPOcean reanalysis by an ocean data assimilation system combining various types of observations with an ocean model, which may provide an important dataset for improving the understanding of the ocean and air-sea interactions in this area.

2. Ocean assimilation system

2.1 Model

The Hybrid Coordinate Ocean Model (HYCOM), which was developed from the Miami Isopycnic Coordinate Ocean Model (Bleck et al., 1992), is used. It is a primitive equation model with a hybrid vertical coordinate that is isopycnic in the open, stratified ocean, and smoothly transfers to a z-coordinate or terrain-following sigma coordinate in the weakly stratified or shallow waters. The K-Profile Parameterization vertical mixing scheme is used in HYCOM. The model domain spans the AIPOcean, which is one-way nested in an external model domain of (50°S–62°N, 27°–290°E). The model resolution is about 1/5°, while the outer domain resolution is about 1/3°. There are 28 vertical hybrid layers. The 6-hourly fields from the ERA5 dataset including temperature, dew point temperature, mean sea level pressure and wind are used to force the model. The precipitation data are taken from the climatology of Legates and Willmott (1990).

2.2 Observations

This reanalysis assimilates observations from satellite sea level anomaly (SLA), satellite sea surface temperature (SST), and in situ temperature (T) and salinity (S)

profiles. The SLA observations assimilated are sourced from the global gridded product with a horizontal resolution of $1/4^\circ$ and a temporal resolution of 1 day delivered by the Sea Level TAC (Thematic Assembly Centre) of the Copernicus Marine Environment Monitoring Service (CMEMS) project. The SST observations assimilated come from the NOAA high-resolution daily analysis product OISST at a spatial resolution of $1/4^\circ$ and a temporal resolution of 1 day with global coverage. All in situ temperature and salinity profile observations are sourced from the ENSEMBLES EN4.2.2 dataset.

2.3 Assimilation Schemes

The ocean data assimilation schemes used in this reanalysis are based on the ensemble optimal interpolation (EnOI) method. The assimilation schemes corresponding to different types of observations are employed. A scheme with bias correction suitable for isopycnic coordinates is adopted to assimilate temperature and salinity profiles (Xie and Zhu, 2010; Yan and Zhu, 2023). A vertical localization technique, which confines the influence of SST observations to the mixed layer, is employed to assimilate SST (Yan et al., 2018). For SLA assimilation, a new mean dynamic topography is used (Yan et al., 2015). These schemes are combined to assimilate multi-source observations.

3. AIPOcean Reanalysis dataset

The AIPOcean reanalysis dataset is generated by the above assimilation system, and will be updated when a new assimilation scheme or a new type of observations is available. In practice, the AIPOcean was originally constructed in 2015. It was continuously updated with the development of new assimilation techniques. The AIPOcean reanalysis includes five variables: two-dimensional sea level anomaly, three-dimensional temperature, salinity, meridional current and zonal current. The original data are defined on isopycnic coordinates and have been interpolated onto standard vertical 33 z levels (see tables below for details), and are stored in NETCDF format.

Table 1. Variables in the AIPOcean reanalysis

Variable name	Variables abbr.	unit
temperature	t	°C
salinity	s	psu
Zonal current	u	m/s
Meridional current	v	m/s
Sea level anomaly	sla	m

Table 2. Vertical levels in the AIPOcean reanalysis

Level number	Depths(m)	Level number	Depths (m)	Level number	Depths (m)	Level number	Depths (m)
1	5	10	200	19	1000	28	3000
2	10	11	250	20	1100	29	3500
3	20	12	300	21	1200	30	4000
4	30	13	400	22	1300	31	4500
5	50	14	500	23	1400	32	5000
6	75	15	600	24	1500	33	5500
7	100	16	700	25	1750		
8	125	17	800	26	2000		
9	150	18	900	27	2500		

We compare AIPOcean with other reanalysis datasets such as SODA and ECCO. Figure 1 shows sea level anomaly (SLA) variability. Mesoscale eddies exert a substantial influence on SLA variability. The higher-resolution AIPOcean and SODA datasets better represent SLA variability than the lower-resolution GODAS dataset which is mainly used to describe large-scale climate variations. The AIPOcean performs best in the strong variability signals. The linear trend of SLA in the AIPOcean also agrees with the observations, in comparison with SODA and ECCO (Fig. 2).

Moreover, the AIPOcean surface ocean current shows better correlation with the observations than both SODA and ECCO (Fig.3).

References

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4. Data citation

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5. Contact

Dr. Changxiang Yan

Institute of Atmospheric Physics, Chinese Academy of Sciences

Beijing, China

Email: ycxlsg@mail.iap.ac.cn

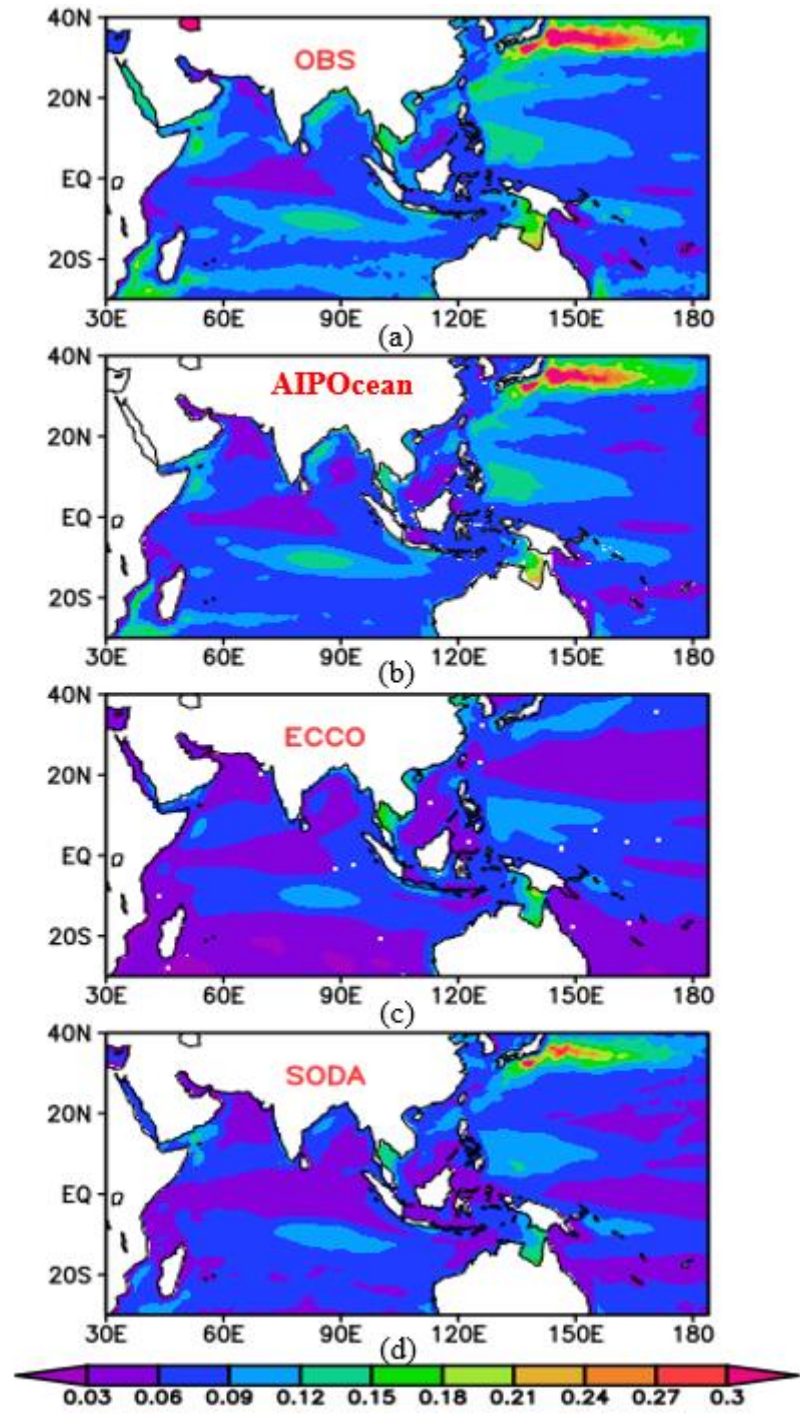


Figure 1. SLA variability from different datasets. (a) observations, (b) AIPOcean, (c) ECCO, (d) SODA.

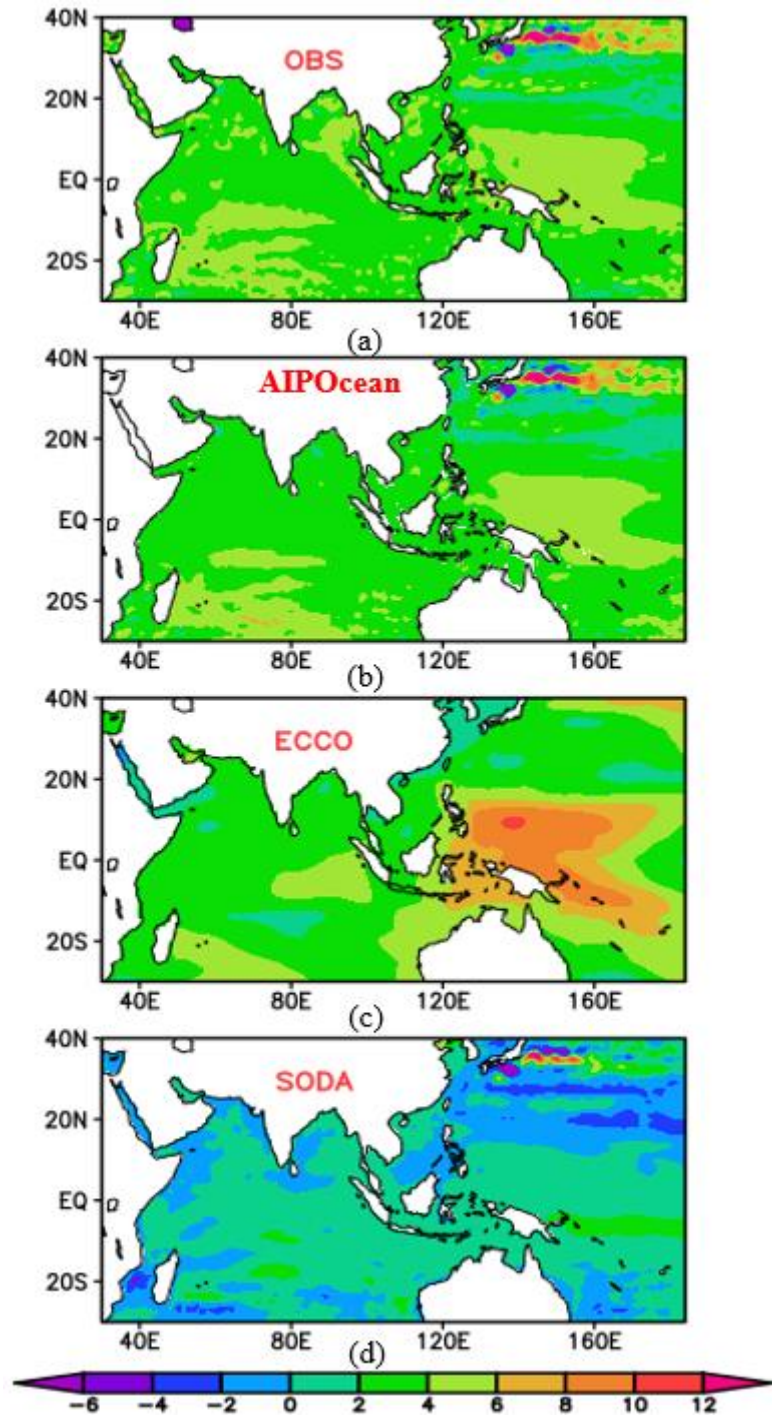


Figure 2. The linear trend of SLA from different datasets. (a) observations, (b)AIPOcean, (c) ECCO, (d) SODA

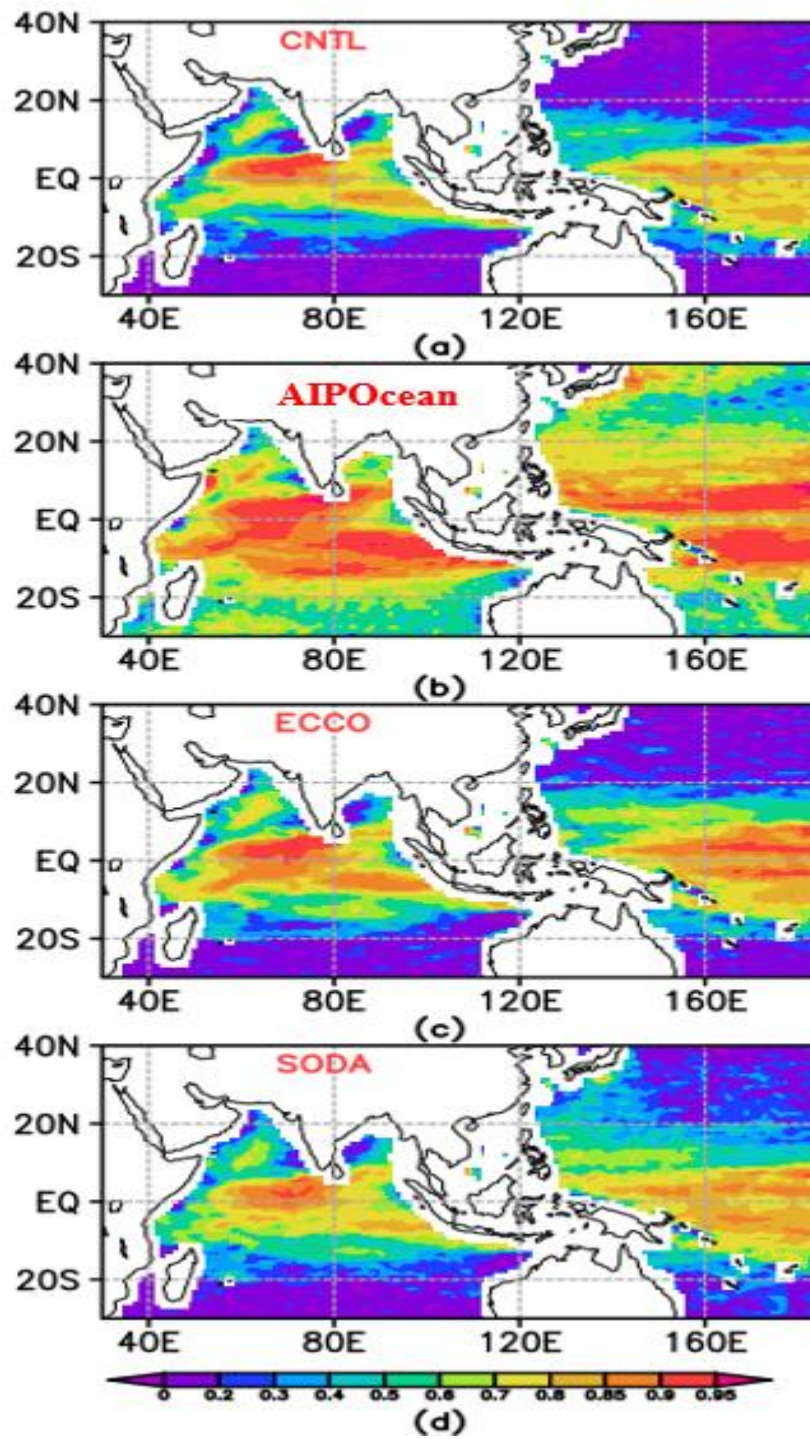


Figure 3. The correlation of surface zonal current with OSCAR observations. (a) The experiment without any assimilation, (b) AIPOcean, (c) ECCO, (d) SODA.