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On identification of appropriate sites in the South China Sea for ocean color SVC with time-series data analysis

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BACKGROUND

The prerequisite for ocean color is to retrieve required quantities (i.e., water-leaving radiance) within a predefined uncertainty level, and to assure data consistency among different missions in decadal or even a longer scale. To achieve this goal, the **System Vicarious Calibration (SVC)** technique is the best practice to assure ocean color sensors meeting those uncertainty requirement (Eplee et al., 2001; Franz et al., 2007; Werdell et al., 2007; Bailey et al., 2008; Mélin and Zibordi, 2010), especially to characterize uncertainties in the sensor calibration and the atmospheric-correction algorithm on mission-long scale. Besides the operational SVC sites are the Marine Optical Buoy (MOBY), operated by NOAA and the BOUSSOLE, operated by LOV, France, Zibordi and Mélin (2017) systematically evaluated existing and potential new SVC sites on a global level. They outlined general requirements for SVC sites.

The **South China Sea (SCS)** is the largest semi-enclosed marginal sea in the tropical-subtropical area in northwest Pacific. The SCS covers an area of $3.5*10^6$ km^2, and is characterized with mean depth of 1, 350m and maximum depth of over 5,000m (Huang et al, 1994; Chen et al., 2001) (see Fig.1). Because of its large area and basin-scale gyres' isolating interior water from the influence of land-runoff (Wong et al., 2007), SCS is characterized by oligotrophic properties even though terrestrial inputs from several rivers (Gong et al., 1992). According to the SVC requirements, whether or not the SCS is suitable for establishing a permanent and operational SVC site is still an open question.

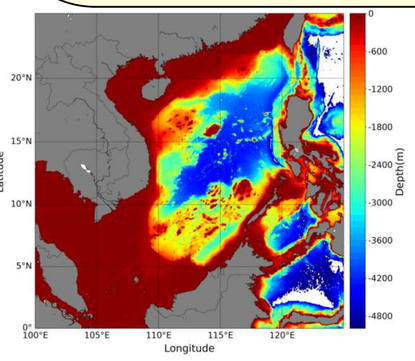

Figure 1. The South China Sea region in this study, i.e., 100–125° E and 0–25° N. The color shade shows the topography (https://topex.ucsd.edu) in this area. Water deeper than 5, 000 meters is shown in white.

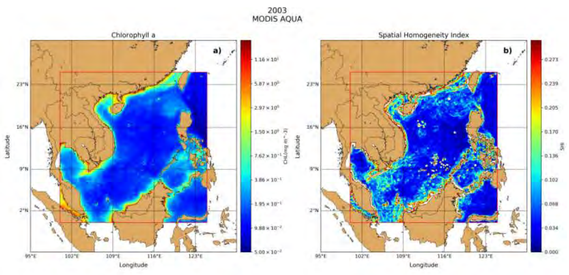

Figure 2. Maps of a) chlorophyll a concentration and b) spatial homogeneity index (SHI) of level-3 MODIS AQUA data provided by NASA DAAC. Here shows an example of annual data in 2003. The upper limit of SHI is set to 0.3, beyond which it is shown in white. Also, it is shown in white when SHI is not available.

OBJECTIVE

Here, we attempted to identify sub-regions with low coefficient of variation with respective to key ocean color and meteorological environment parameters. According to the SVC requirements, several potential sites are determined for SVC in the SCS considering geographic and logistics issues.

DATA & METHOD

Data:

- MODIS AQUA Level-2 data, 2003-2017
- MODIS AQUA Level-3 data (annual, month), 2003-2017
- ECMWF CERA-SAT reanalysis, 2008-2016
- SM HY-2A Level-2 data, 2012-2018
- Chla, Rrs, AOT, angstrom, SST, wind, cloud

Method:

- **Spatial Homogeneity Index (SHI)**

----Coefficient of variation (CV), i.e., the ratio of its standard deviation σ to the mean μ.
----Pre-defined region or box, 5 by 5 pixels of EDR data.
----For gridded data, SHI is calculated with a moving box and valid if at least two pixels available in this box.
----Figure 2 as an example.

- Time-series data analysis

RESULTS

(1) Spatial homogeneity of bio-optical environment in the SCS

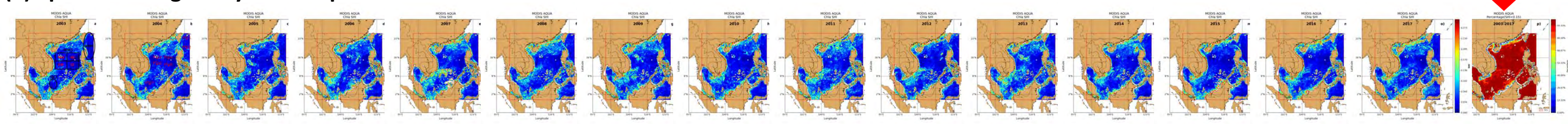

Figure 3. Maps of a)-p) SHI of annual level-3 chlorophyll a data in the SCS and b) cumulative percentage of SHI when it's below the pre-defined threshold (0.15). Black circles and rectangle in a) indicates three regions characterized with permanent spatial homogeneity, while red dots are those chosen for later analysis.

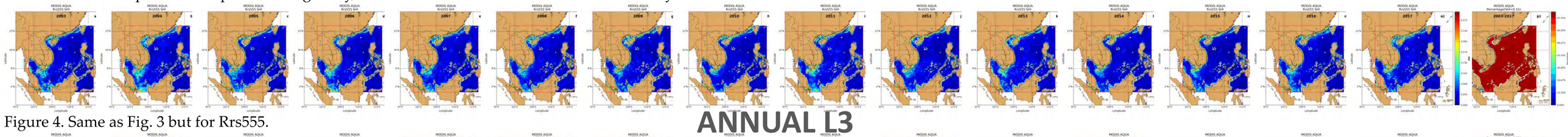

Figure 4. Same as Fig. 3 but for Rrs555.

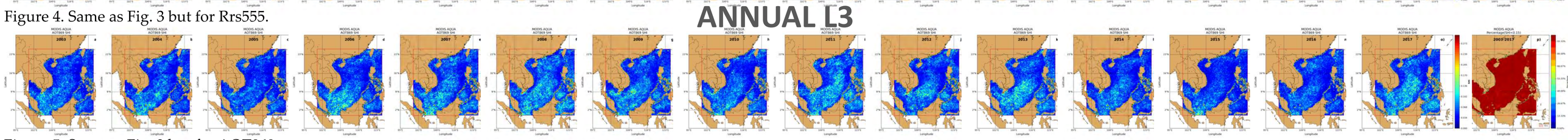

Figure 5. Same as Fig. 3 but for AOT869.

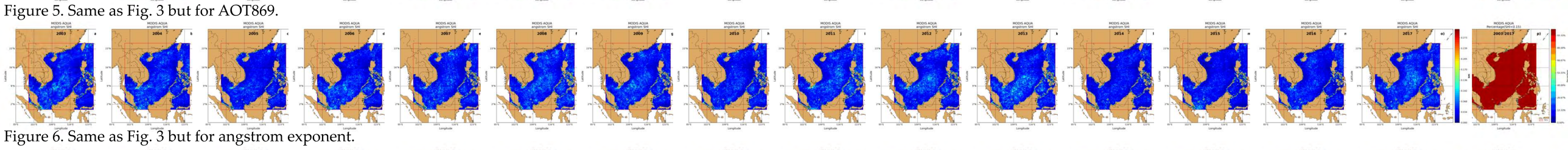

Figure 6. Same as Fig. 3 but for angstrom exponent.

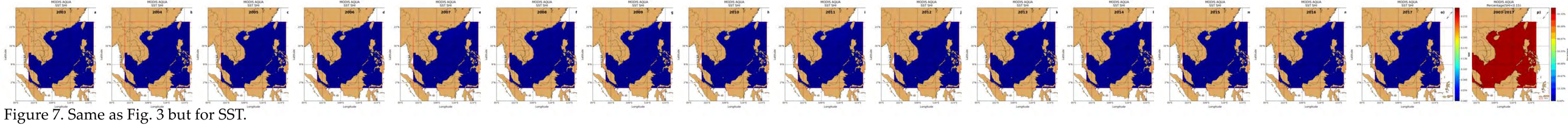

Figure 7. Same as Fig. 3 but for SST.

(2) Cumulative percentage of SHI with monthly level-3 data

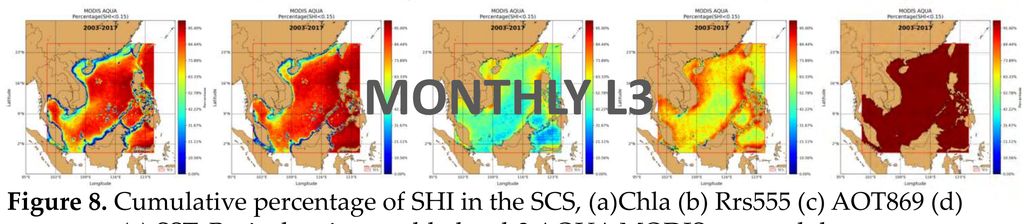

Figure 8. Cumulative percentage of SHI in the SCS, (a)Chla (b) Rrs555 (c) AOT869 (d) angstrom (e) SST. Basic data is monthly level-3 AQUA MODIS mapped data.

Table 1. Seven selected locations in the WPAC, MSCS and SCS, see Fig.2 a) and b)

Location	Longitude (degree north)	Latitude (degree east)	region(sub-region)
PT01	123.8	23.0	WPAC
PT02	123.8	19.5	WPAC
PT03	112.5	15.75	MSCS
PT04	116.8	15.75	MSCS(NW)
PT05	116.8	13.0	MSCS(NE)
PT06	112.5	13.5	MSCS(SE)
PT07	109.5	6.0	SSCS(SW)

(3) Time-series variability

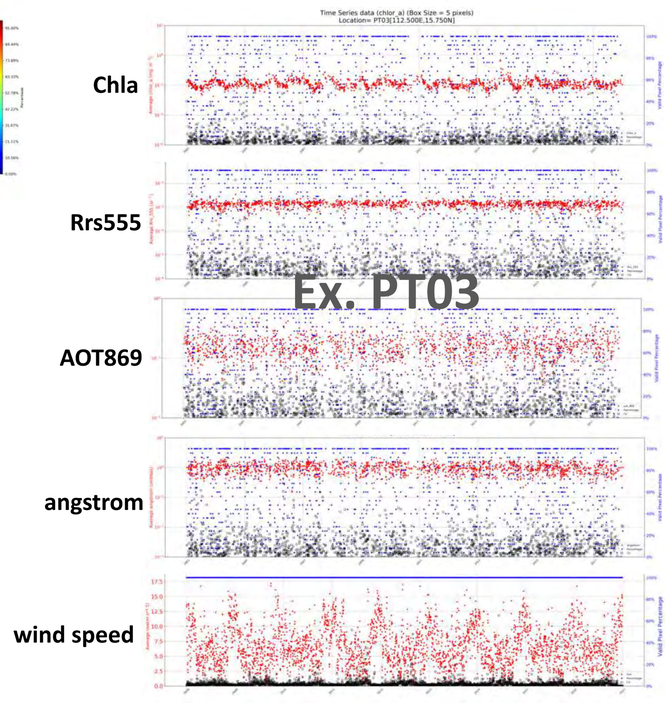

Figure 9. Time-series of ocean color (AQUA MODIS L2 data) and meteorological (ECMWF reanalysis) environmental parameter at PT03(see Fig 2. a)).

CONCLUSION

- Spatial homogeneity prevails in several sub-regions in the SCS, bio-logically and meteorologically
- 7 locations are chosen by SHI analysis
- **Potential SVC sites in the SCS exist**, e.g., near Xisha Islands (left)

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