Evaluation of sea surface temperatures derived from the HY-1C and HY-1D satellites

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Introduction of HY-1C and HY-1D satellites

The Chinese Haiyang-1C (HY-1C) and Haiyang-1D (HY-1D) satellites, the follow-on mission to the HY-1A and HY-1B satellites, was launched in September 2018 and June 2020, respectively. This satellites are both equipped with the COCTS and a coastal zone imager (CZI), as well as an ultraviolet imager (UVI), a satellite calibration spectrometer (SCS) and a satellite-based automatic identification system (AIS) receiver. The orbit altitude and tilting angle are 782 km and 98.5 degrees, respectively. The overpass times are10:30 AM±30 min local time at the descending node for HY-1C and are 1:30 PM±30 min local time at the ascending node for HY-1D, respectively. The joint observations of HY-1C and HY-1D increase the observation time and improve the global coverage. The COCTS instruments on the two satellites can detect the global ocean and land four times every day and provide daily ocean color and daytime and nighttime SST data.

The COCTS is a moderate-resolution imaging scanner with a nadir spatial resolution of 1.1 km and a viewing swath width of more than 2900 km. The satellite measures signals in 8 visible and near-infrared (VNIR) bands and 2 thermal infrared (TIR) bands (10.3~11.3μm，11.5~12.5μm).

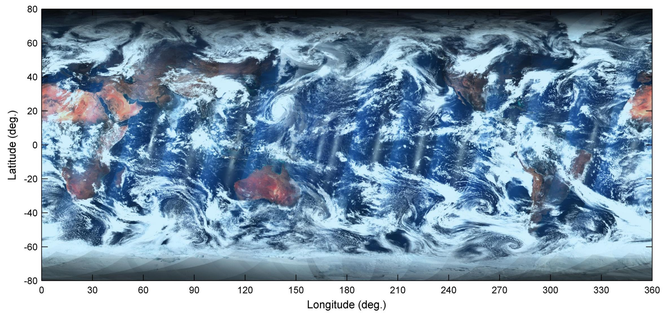

Fig.1 Global quasi true-color image from COCTS on HY-1C (acquired on October 8, 2019)

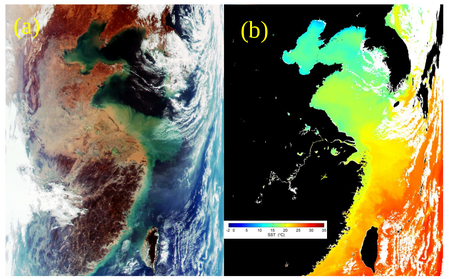

Fig.2 COCTS/HY-1C data covering China's east coastal region acquired at 02:53 UTC on November 11, 2019 for (a) the true color image and (b) its SST retrieval results

Methodology and Products

A nonlinear SST algorithm (NLSST) is applied to derive SSTs from the brightness temperatures (BTs) of the two COCTS thermal infrared bands at 10.8 and 12.0 μm. The SST retrieval results from the multichannel SST algorithm (MCSST) are used as the first guess for the input of the NLSST algorithm. The coefficients of both the MCSST and NLSST algorithms are regressed from the matchup datasets of the COCTS BT observations and the measurements from the in situ Quality Monitor system (iQuam). The algorithm coefficients of HY-1C and HY-1D can be found in Ye *et al* (2021) and Ye *et al* (2022).

Acknowledgements

The authors would like to thank the NASA Goddard Space Flight Center, Ocean Ecology Laboratory, and Ocean Biology Processing Group (OBPG) for providing access to the MODIS and VIIRS SST data, as well as the Center for STAR and NOAA National Environmental Satellite, Data, and Information Service (NESDIS) for providing access to the in situ iQuam data for validation in our study.

References

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[2] X. Ye, J. Liu, M. Lin, J. Ding, B. Zou and Q. Song, "Sea Surface Temperatures Derived From COCTS Onboard the HY-1C Satellite," in IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, vol. 14, pp. 1038-1047, 2021, DOI: 10.1109/JSTARS.2020.3033317.

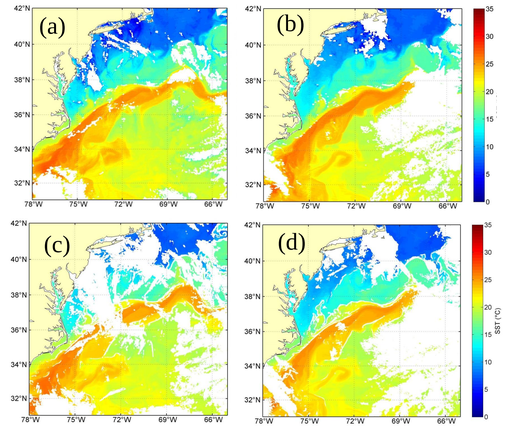

Fig.3 SSTs derived from COCTS on the HY-1D satellite covering Gulf Stream waters acquired at (a) 17:35 UTC and (b) 06:20 UTC on April 27, 2021, and SST from VIIRS on the S-NPP satellite acquired at (c) 18:12 UTC and (d) 06:48 UTC on April 27, 2021.

Global SST have been detecting by the COCTS instruments since September 2018. The BTs (Level-1 data) and SST products (Level-2 and Level-3 data) of SST can be distributed to public for free. Examples of data products are shown in Fig.1 to Fig.4. Level-3 SST data are the gridded products with a grid resolution of 4 km and 9 km(see Fig.4).

Validation Results

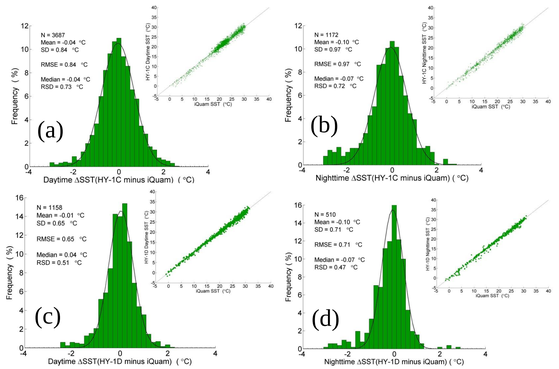

Fig5. Validation results of SST from COCTS against in situ measurements from iQuam during (a) daytime and (b) nighttime in the period from Jan. 1, 2019 to Mar. 31, 2020 for HY-1C, and (c) daytime and (d) nighttime in the period from April 26 to August 31, 2021 for HY-1D,

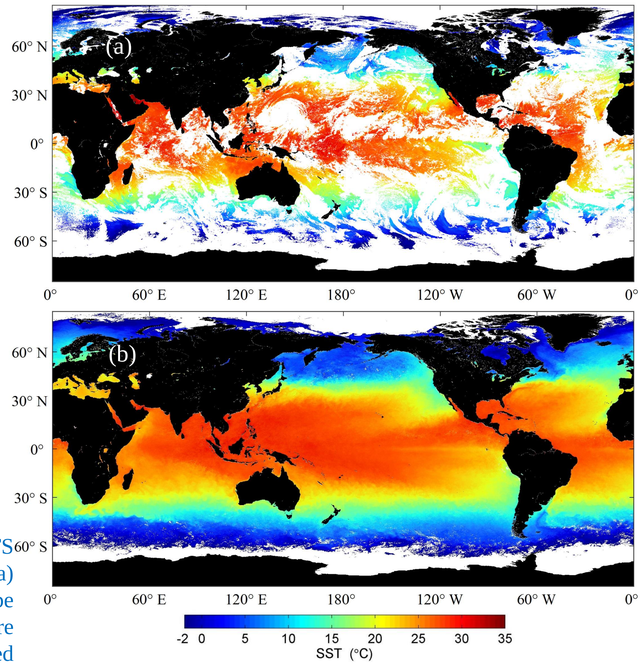

Fig.4 (a) Daily gridded nighttime SST of HY-1C satellite on October 8, 2019 and (b) Monthly gridded daytime SST of HY-1D satellite in June 2021.

The retrieved SSTs from Jan. 1, 2019 to Mar. 31, 2020 were evaluated by the *in situ* measurements from iQuam with root mean square errors (RMSEs) of 0.84 ° C for daytime and 0.97 ° C for nighttime and robust standard deviations (RSDs) of 0.73 ° C for daytime and 0.72 ° C for nighttime, respectively. RMSEs of 0.65 ° C and 0.71 ° C and RSDs of 0.51 ° C and 0.47 ° C were obtained for the daytime and nighttime SSTs of the COCTS/HY-1D recorded from April 26 to August 31, 2021, using a spatiotemporal matching window of 4 hours and 2.5 km. Daily gridded retrieval SSTs from COCTS on both HY-1C and HY-1D were compared with SSTs from the moderate-resolution imaging spectroradiometer (MODIS) on Terra satellite and the visible infrared imaging radiometer (VIIRS) on the Suomi National Polar-orbiting Partnership (S-NPP) satellite. Both daytime and nighttime SSTs from COCTS are consistent with those from MODIS and VIIRS(Ye et al, 2021; 2022).