RETRIEVAL OF SEA SURFACE TEMPERATURE FROM HY-1B/COCTS

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Introduction The Haiyang-1B (HY-1B) satellite was launched in April 2007. The Chinese Ocean Color and Temperature Scanner (COCTS) onboard HY-1B satellite has two thermal infrared channels with the spectrum range of 10.30-11.40μm and 11.40-12.50μm for sea surface temperature (SST) observations. The evaluation of COCTS L2 SST products with buoy SST measurements showed the accuracy of COCTS L2 SST is about 0.74±1.83ºC. To improve COCTS SST accuracy, the Bayesian cloud detection and optimal estimation (OE) SST retrieval of COCTS were carried out.

Bayesian cloud detection of COCTS

In this study, the Bayesian cloud detection algorithm of HY-1B COCTS have been developed, based on the Bayes' theorem and COCTS simulation results. The MODerate resolution atmospheric TRANsmission (MODTRAN) are used for simulation of COCTS brightness temperature (BT). The prior vector, including SST and total column water vapor (TCWV), are obtained from Numerical Weather Prediction (NWP) data. Fig. 1 (a) and (b) are COCTS 11 μm scene BTs on 7 May 2011 before and after cloud detection, respectively.

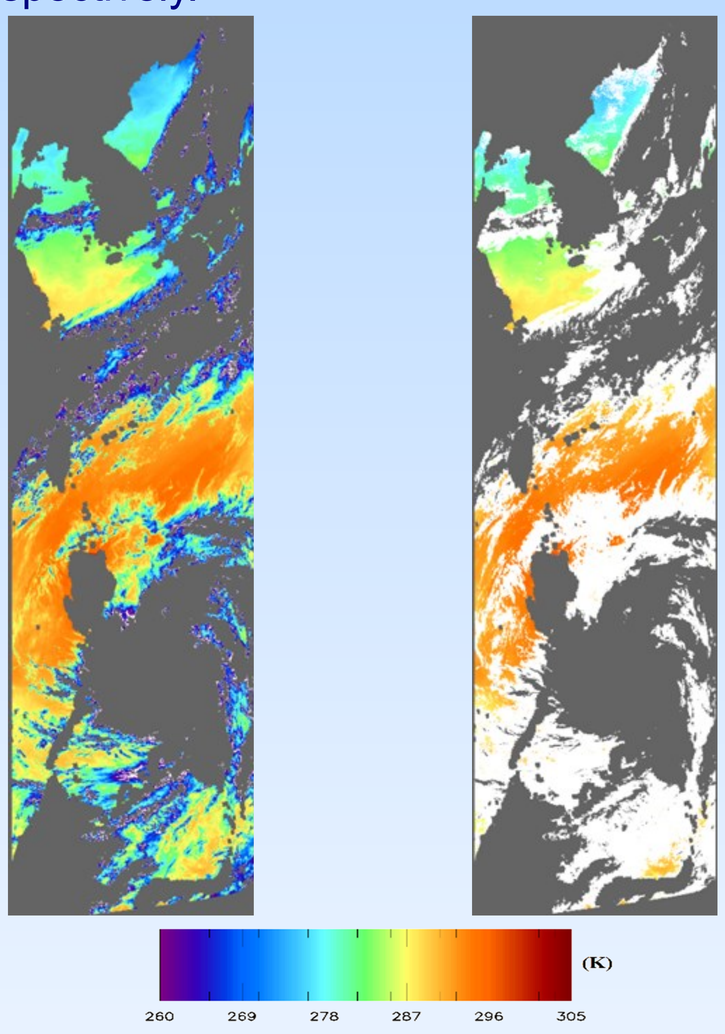

Fig.1. COCTS 11 μm scene BTs on 7 May 2011
(a. before cloud detection; b. after cloud detection)

Optimal estimation SST retrieval of COCTS

The optimal estimation (OE) SST retrieval of COCTS were carried out. The OE SST was estimated using the following equation (Merchant et al, 2008):

$$\hat{x} = x_a + G\left(y_o - F(x_a)\right) = x_a + (K^T S_\varepsilon^{-1} K + S_a^{-1})^{-1} K^T S_\varepsilon^{-1}\left(y_o - F(x_a)\right)$$

where x_a indicates the retrieved vector, including SST and TCWV; K is the matrix of partial derivatives respect to SST and TCWV; Sa and $S\varepsilon$ are combined covariance matrix of prior and satellite observation, respectively. The confidence indicators are important auxiliary information of SST data provided for users. For OE SST, the consistency of satellite observations with simulated BTs is one efficient standard to evaluate the quality of retrieved SST, that is quantified using the following equation (Merchant et al, 2008):

$$\hat{\chi}^2 = \left(K(\hat{x} - x_a)\right)^T (S_\varepsilon (K S_a K^T + S_\varepsilon)^{-1} S_\varepsilon)^{-1} \left(K(\hat{x} - x_a) - \left(y_o - F(x_a)\right)\right)$$

where chi-square value is calculated for every pixel. The matchups of COCTS OE SST with iQuam buoy SST are generated with a spatial window of 0.01ºand a temporal window of 1 hour. Fig. 3 shows the SST difference of COCTS with buoy against chi-square values. The negative biases and standard deviations of SST difference increase with the increasing chi-square values, indicating that chi-square statistic is an efficient indicator of SST quality. Table 1 shows the statistic results of SST difference under different chi-square ranges. We set SSTs with chi-square values lower than 2 as the high quality level data, account for a proportion of 77.02%. The mean difference of COCTS OE SST with high quality minus buoy SST is -0.23º C and the STD is 0.51º C.

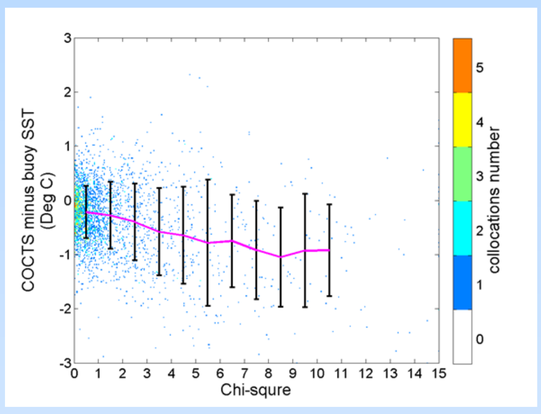

Fig.3. COCTS minus buoy SST difference against chi-squares

Table 1 The statistic results of SST difference under different chi-square ranges

chi-square	COCTS OE SST-buoy SST		
	bias (ºC)	STD(ºC)	proportion(%)
$0<\chi^2<1$	-0.22	0.48	60.62
$1<\chi^2<2$	-0.28	0.61	16.40
$2<\chi^2<5$	-0.50	0.78	16.05
$\chi^2>5$	-0.86	1.02	6.93

Validation of COCTS OE SST

Based on the matchups of COCTS OE SST with buoy SST, we analyzed the dependence of SST difference on SST and TCWV. Fig. 4 and fig. 5 are variations of SST difference against SST and TCWV, respectively. Most matchups are located in warm water with SST higher than 10º C. And there are not significant dependences on SST and TCWV shown, although the STDs are relatively larger under lower TCWV conditions. There are two main reasons about the mean difference of –0.23º C between COCTS OE SST and buoy SST. One is the difference of COCTS observed BTs with simulated BTs. The other one is the SST difference due to the inconsistency of measured depth between satellite and buoy. 116 scenes of COCTS SST are compared with CCI AATSR SST. The total number of matchups between COCTS and AATSR is 7264012, with the mean difference of –0.09º C and the STD of 0.49º C. Compared with COCTS L2 SST products, the accuracy of COCTS SST has improved a lot, that is also benefit for the development of SST retrieval for HY-1C/D satellites in the future.

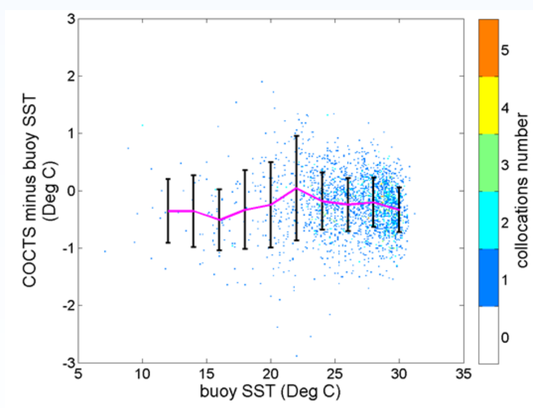

Fig.4. COCTS minus buoy SST difference against buoy SST

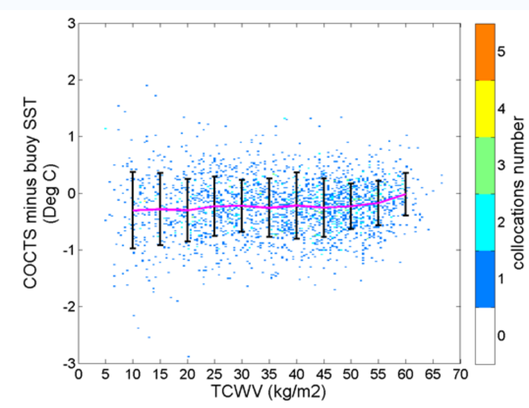

Fig.5. COCTS minus buoy SST Difference against TCWV

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