

# Cloud detection based on deep neural network for HY-1C COCTS

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## INTRODUCTION

Cloud detection is one of the key pre-processing steps of SST retrieval. We use the deep learning model U-Net to identify the cloud over the ocean in HY-1C COCTS images. The HY-1C COCTS cloud detection dataset is composed of HY-1C COCTS L1B global area coverage data in July and August 2019. We choose 14 features from COCTS as inputs of the dataset. The ground truth of dataset using to train the U-Net model is constructed by Bayesian cloud detection method and manual mask. In order to estimate the results of cloud detection, the SST retrieval based on Optimal Estimation (OE) algorithm for clear pixels detected by U-Net is conducted. The COCTS OE SST is compared with iQuam SST.

## METHOD

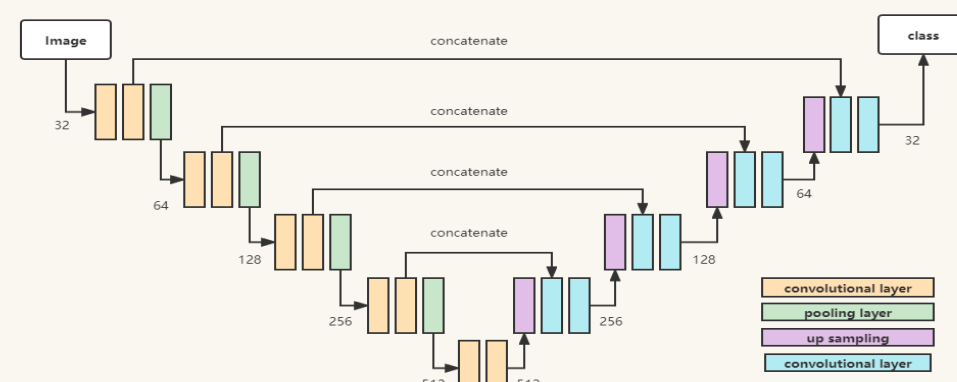


Figure 1. The U-Net architecture. The U-Net is a neural network model consisting of an encoder and an decoder. The encoder's inputs are the image pixel values and the decoder outputs the cloudy/clear labels for each pixel.

## CONCLUSION

- ◆ The ratio of matchups with SST difference lower than -1.67 K is 1.26%, indicating that the missed cloud detection is not obvious.
- ◆ In addition, the brightness temperature images after cloud detection show that the performance of cloud detection over the ocean front works well.
- ◆ In general, the cloud detection based on deep learning algorithm performs well for HY-1C COCTS.

## RESULTS

Table 1. Evaluation results of test set. The test set is obtained from the data taken every four days in HY-1C COCTS cloud detection dataset.

	Accuracy	Cloud over error	Cloud missed error
In Daytime	95.20%	2.32%	2.48%
In Nighttime	96.17%	1.59%	2.24%

▲ The results of evaluation and test for the U-Net model.

▼ The COCTS OE SST is retrieved and compared with iQuam SST. And we compare the SST differences from U-Net cloud detection method and Bayesian cloud detection algorithm.

Table 2. The statistics of SST differences between COCTS OE SST retrieved from clear pixels detected by U-Net or Bayesian minus iQuam SST.

Status	Index	U-Net	Bayesian
ALL	Bias (°C)	-0.18	-0.20
	STD (°C)	0.52	0.55
	Median(°C)	-0.15	-0.15
	RSD(°C)	0.33	0.33
	Number	11321	11556
	Cloud missed number	143	178
	Cloud missed ratio	1.26%	1.54%
Daytime	Bias (°C)	-0.11	-0.13
	STD (°C)	0.51	0.53
	Median(°C)	-0.09	-0.09
	RSD(°C)	0.31	0.32
	Number	6014	6091
	Cloud missed number	57	80
	Cloud missed ratio	0.95%	1.31%
Nighttime	Bias (°C)	-0.27	-0.27
	STD (°C)	0.53	0.56
	Median(°C)	-0.22	-0.22
	RSD(°C)	0.32	0.33
	Number	5307	5465
	Cloud missed number	86	98
	Cloud missed ratio	1.62%	1.79%

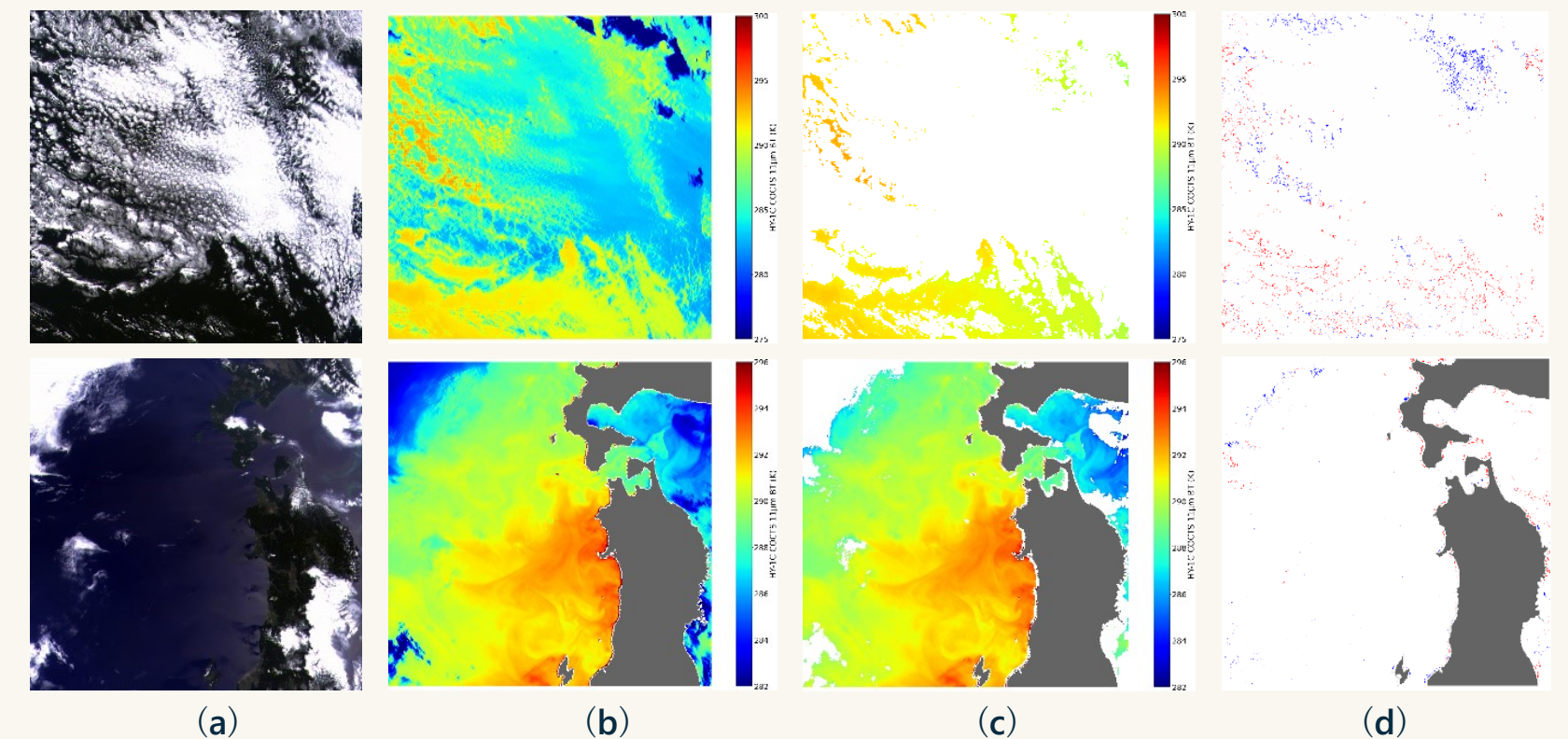


Figure 2. The test samples of HY-1C COCTS images, each line is a sample: (a) HY-1C COCTS RGB image; (b) HY-1C COCTS L1B 11μm channel BT; (c) HY-1C COCTS L1B 11μm channel BT reserving clear pixels detected by U-Net model; (d) The difference between U-Net and the ground truth. Blue represents pixels that the ground truth is cloud while U-Net detects as ocean; Red represents pixels that the ground truth is ocean and U-Net detects as cloud.

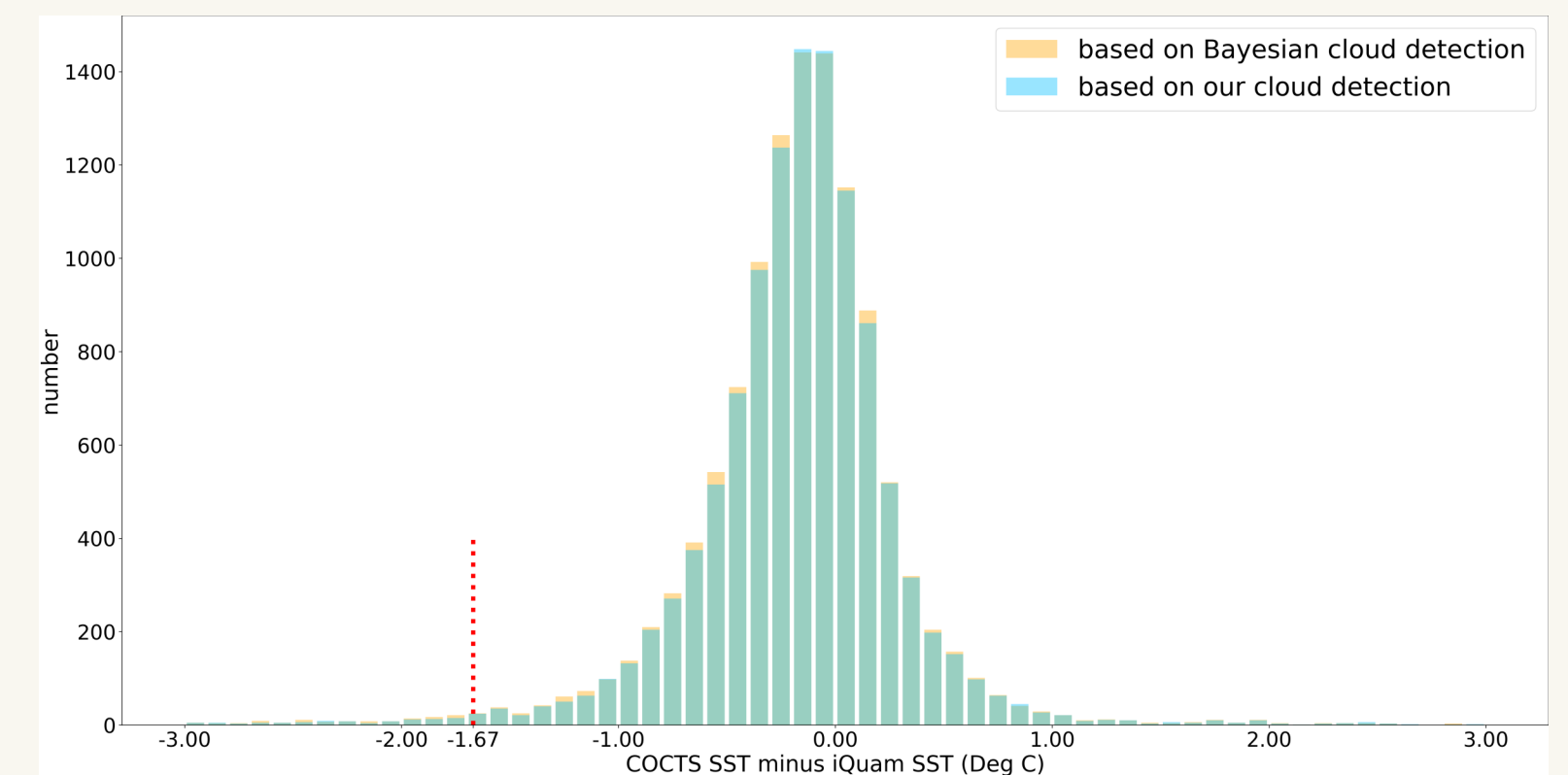


Figure 3. The histogram of SST differences between COCTS OE SST from clear pixels detected by U-NET (blue) or Bayesian (yellow) minus iQuam SST. Blue represents our cloud detection, yellow represents Bayesian cloud detection, and green is the part where the two overlap.