



中国海洋大学

OCEAN UNIVERSITY OF CHINA | Sanya Oceanographic Institution

三亚海洋研究院

ISAR in Ocean University of China (OUC) Measurements and Applications

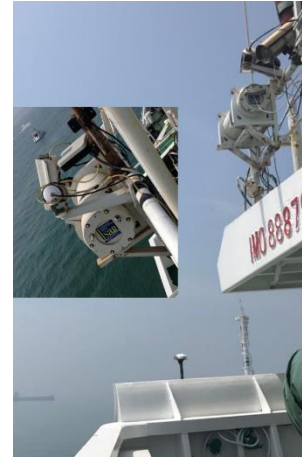
Minglun Yang, Lei Guan, Liqin Qu and Kailin Zhang
Ocean University of China, Sanya Oceanographic Institution

ISFRN Workshop, 21-22 April 2024

- OUC ISAR Measurements
- Validations of satellite SST
- Cool skin and diurnal warming study
- Summary

ISAR5C_005

- RV Dong Fang Hong II
- 2009 – 2019, 70 voyages



RV Dong Fang Hong II

- RV Dong Fang Hong III
- 2019 – now, 14 voyages

- New ISAR is coming this week in Sanya



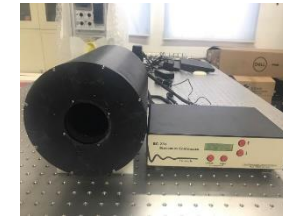
RV Dong Fang Hong III

Pre and post blackbody calibration

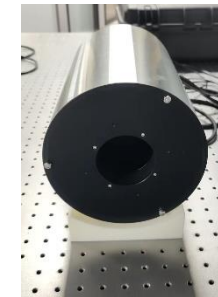
- Blackbody ASSIST II by LR TECH INC
- 2 blackbodies in Qingdao and Sanya
- Calibration since voyage No.24, 2012

International comparison

- CEOS comparison of Infrared radiometry in support of satellite calibration and validation for measuring SST for studies of climate change, 2009
- Fiducial Reference Measurements for Surface Temperatures derived by Satellite (FRM4STS), 2016



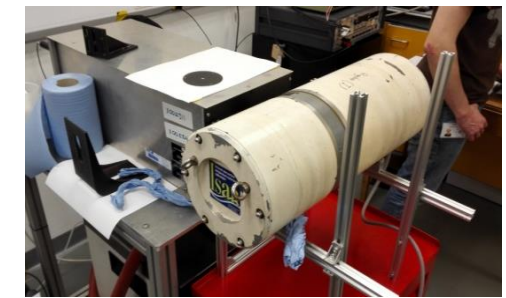
Qingdao



Sanya



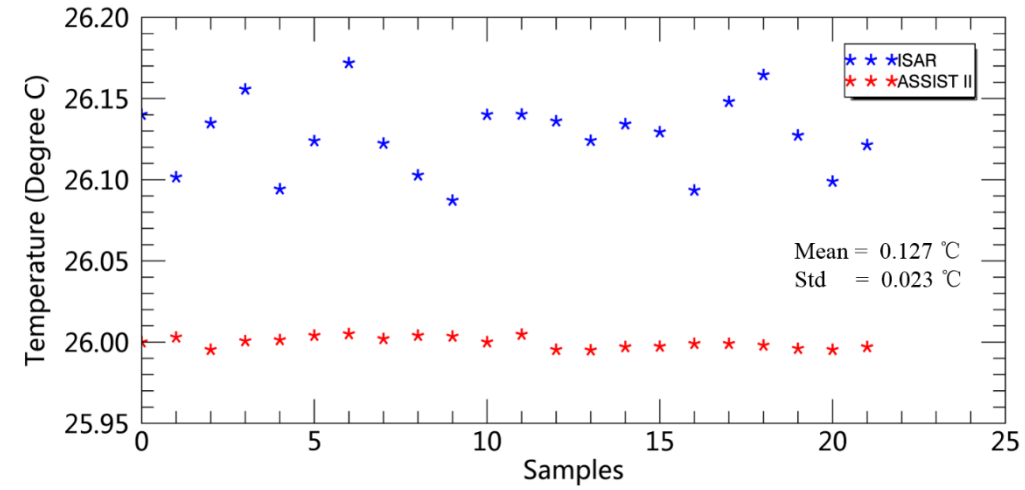
2009



FRM4STS, 2016

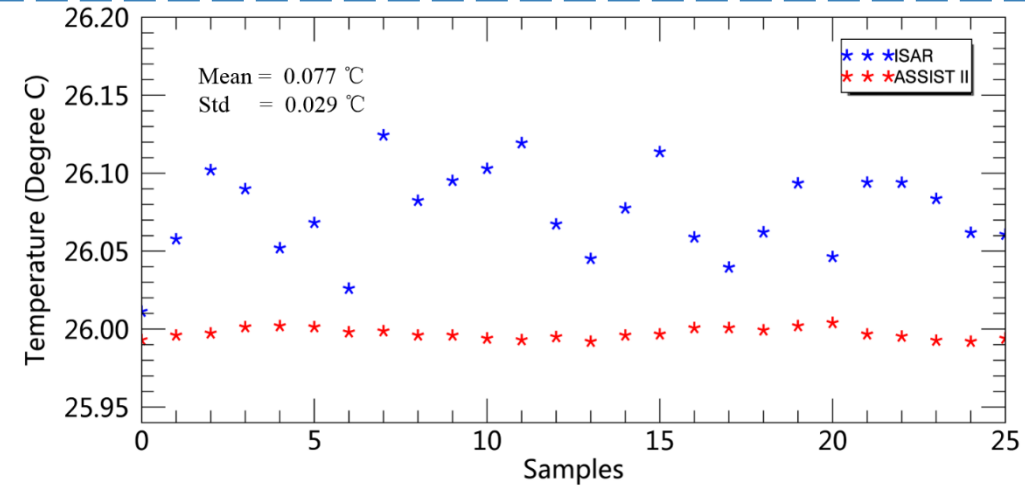
Pre and post blackbody calibration

Mean = 0.127 °C
STD = 0.023 °C



Post calibration of voyage 2016_10, before mirror changing

Mean = 0.077 °C
STD = 0.029 °C



Pre calibration of voyage 2016_12, after mirror changing

Auxiliary measurements

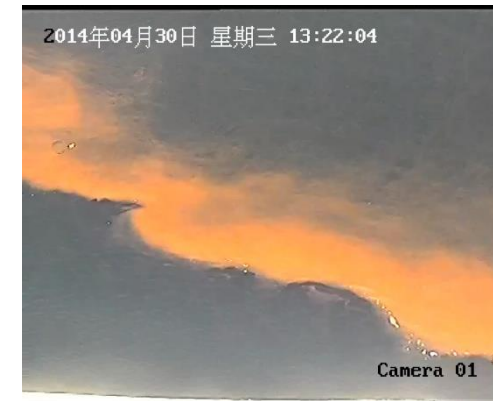
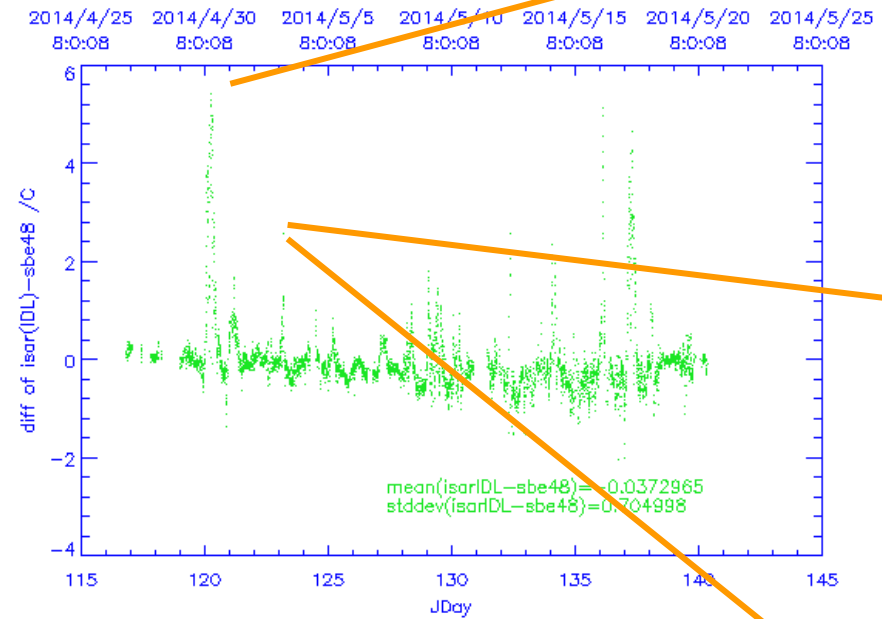


- Shortwave radiation by Kipp & Zonen CMP 21
- Longwave radiation by Kipp & Zonen CGR 4
- Meteorological observations: wind speed and direction, air temperature, air pressure, relative humidity...



- SBE 48 : SST at depth around 4m

Video record



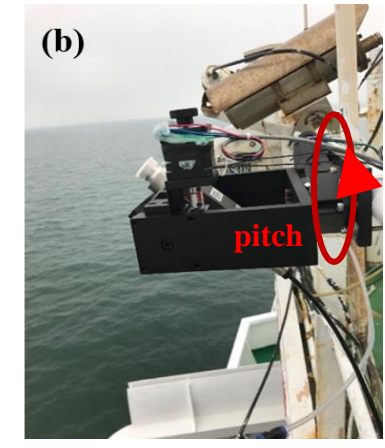
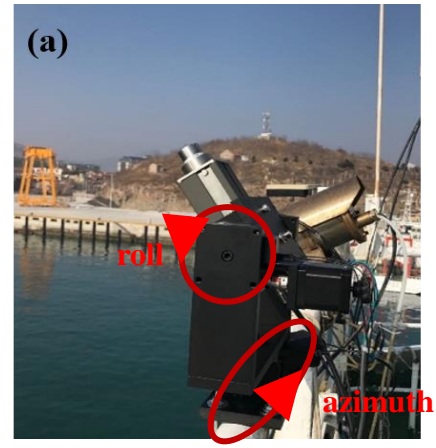
- Data quality reference

Multi-angle sky radiation measurements

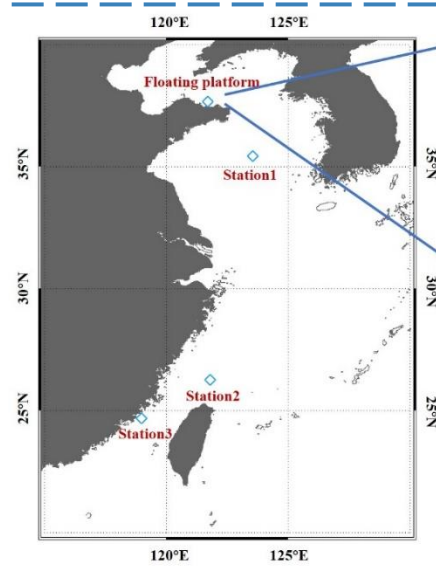
- Discussion during GHRSSST 2017
- Donlon and Nightingale 2000
- Wimmer and Robinson 2016



Two-dimensional rotating platform integrated with an independent infrared radiometer KT15.85



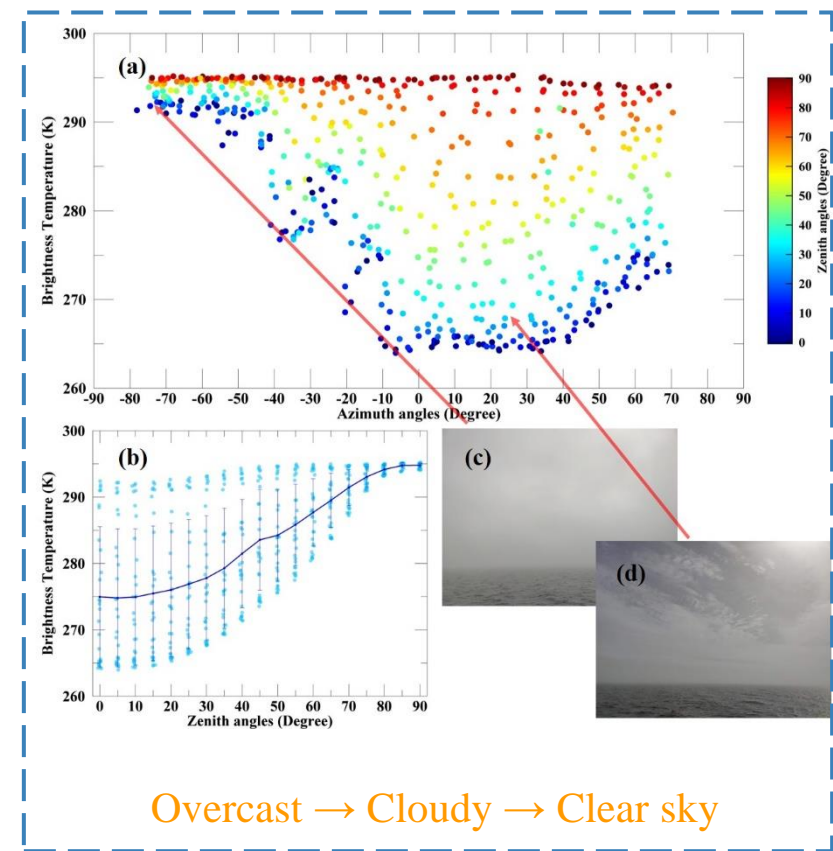
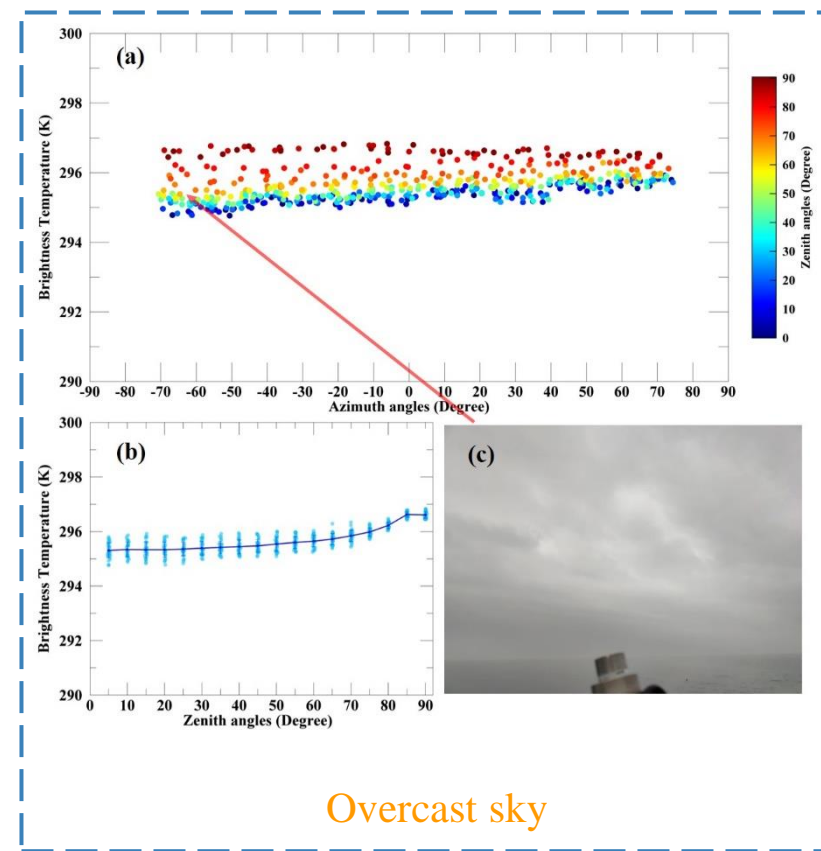
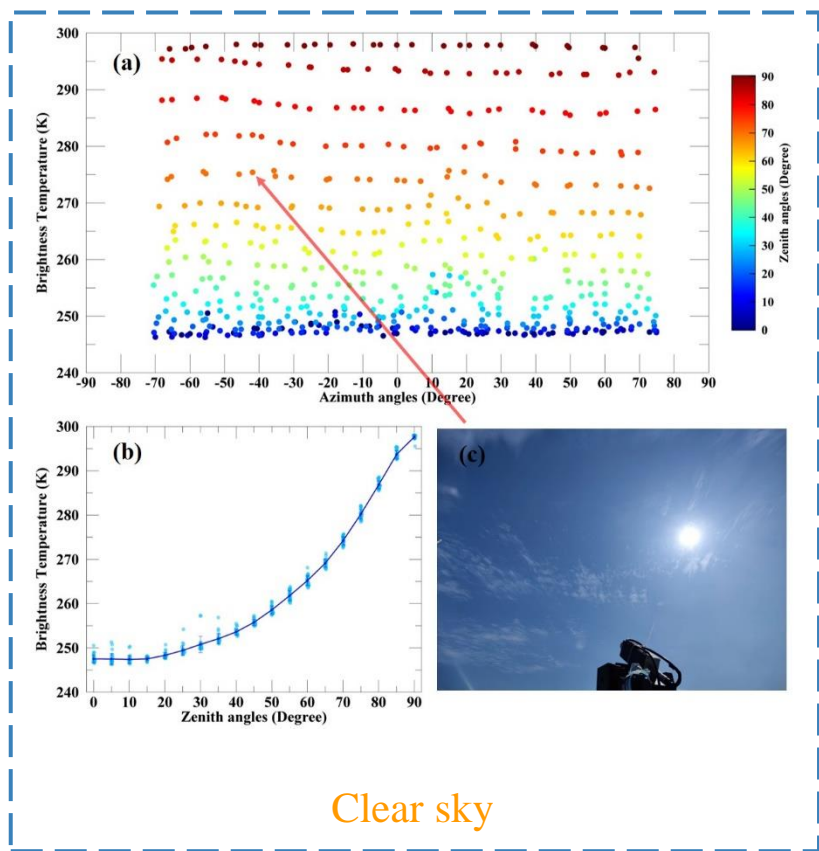
Ship movement simulation



Voyage station measurements, 2018
Floating platform measurements, 2022

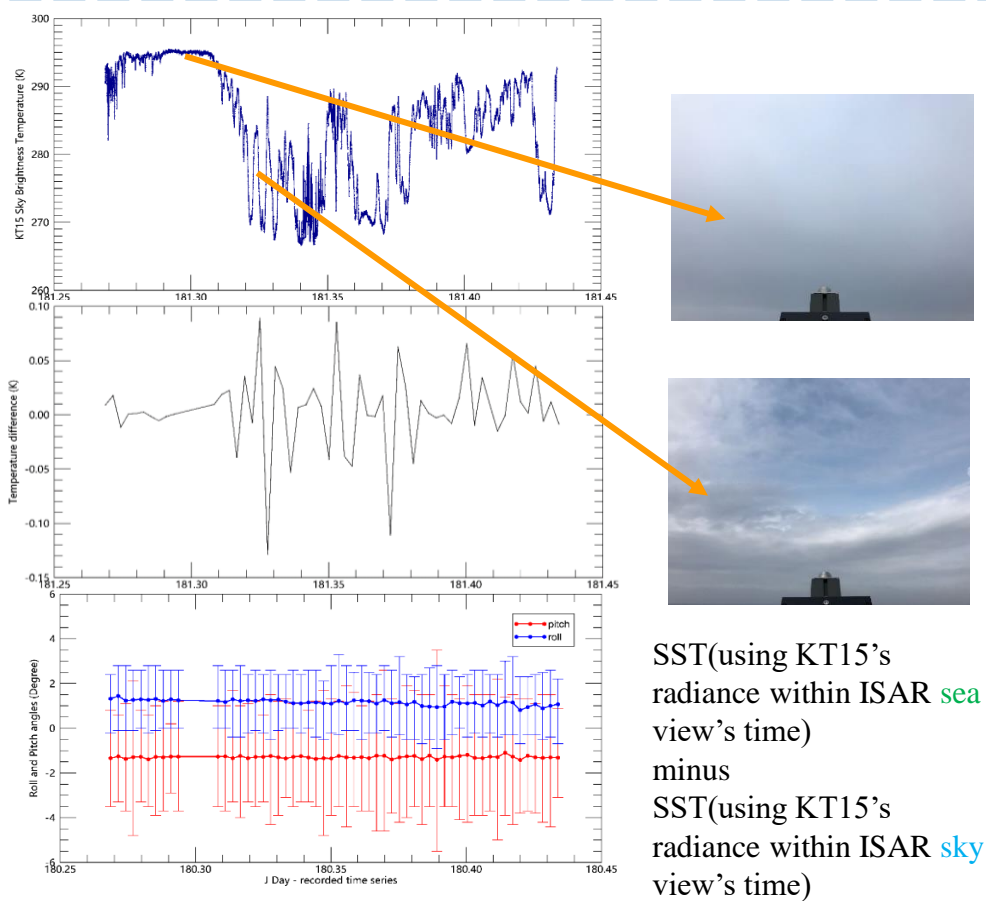
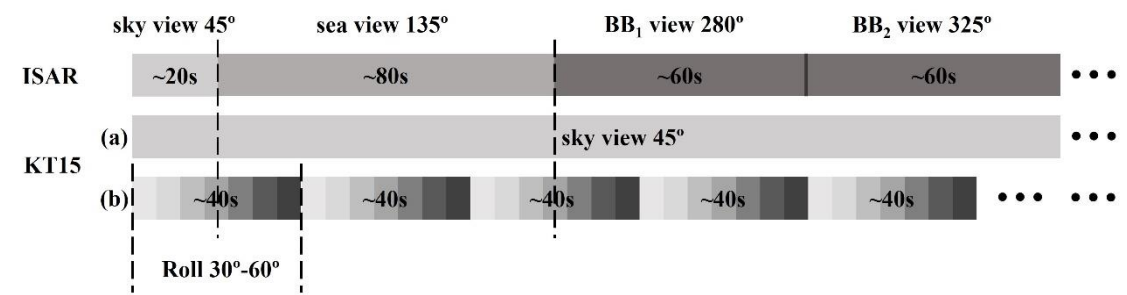
Multi-angle sky radiation measurements

- Azimuth angles: -80 ~ 80 degree; Zenith angles: 0 ~ 90 degree
- 10-15 July, 2022

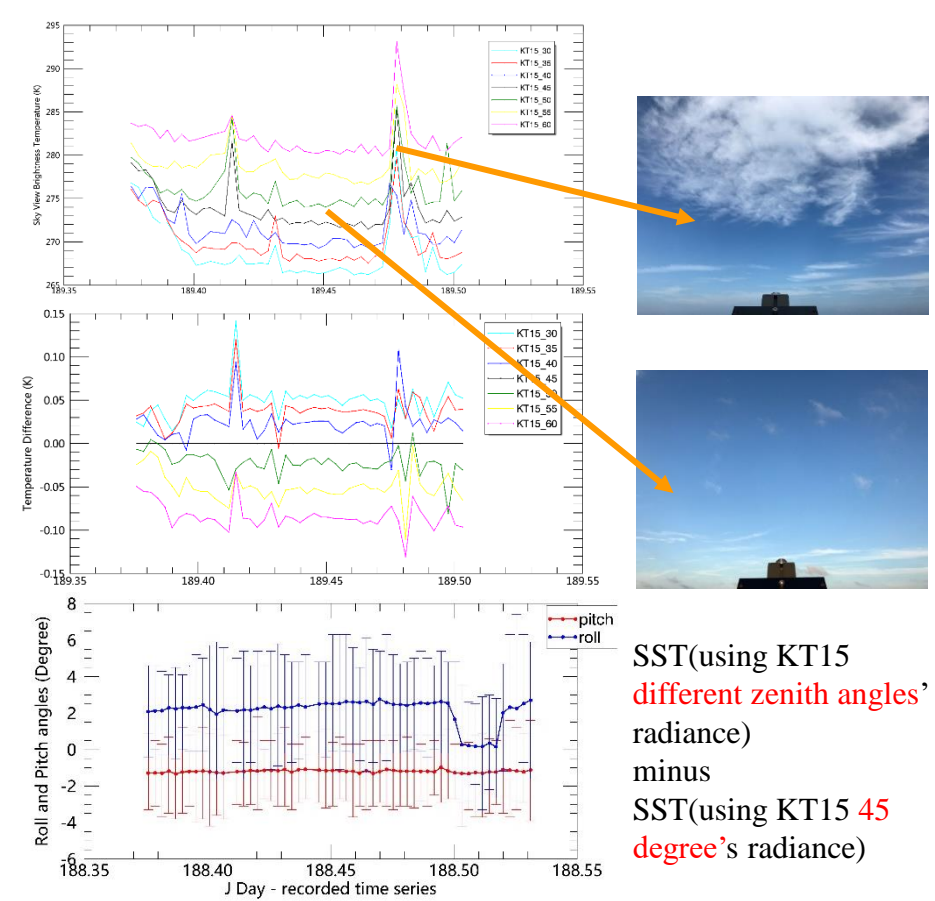


Measuring strategy

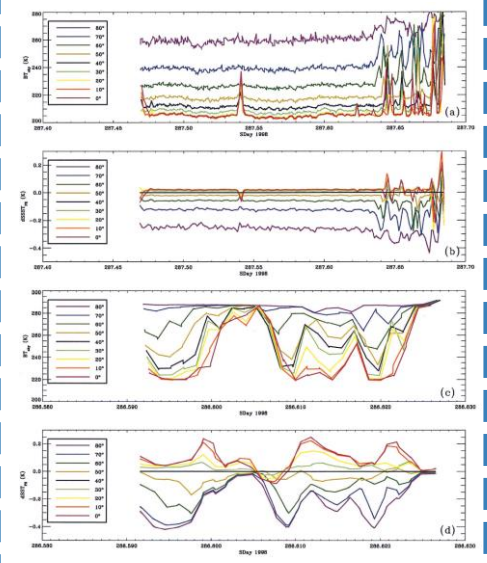
- (a) simulation of sky and sea view time difference
- (b) simulation of ship's roll, $-15^\circ - 15^\circ$ of ISAR sky view angles, 5° interval



SST(using KT15's radiance within ISAR sea view's time) minus SST(using KT15's radiance within ISAR sky view's time)



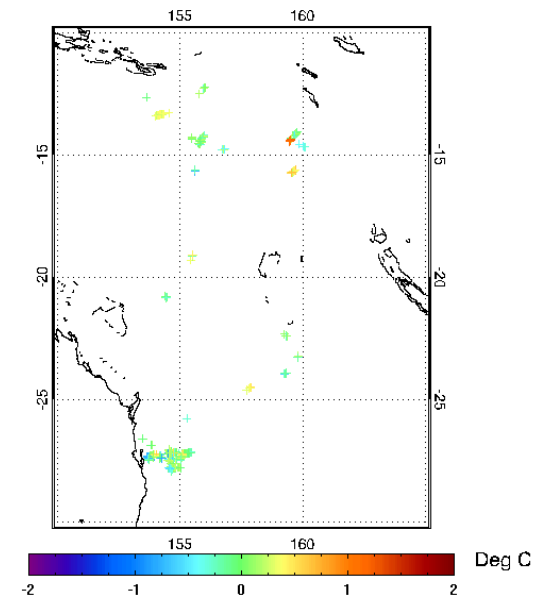
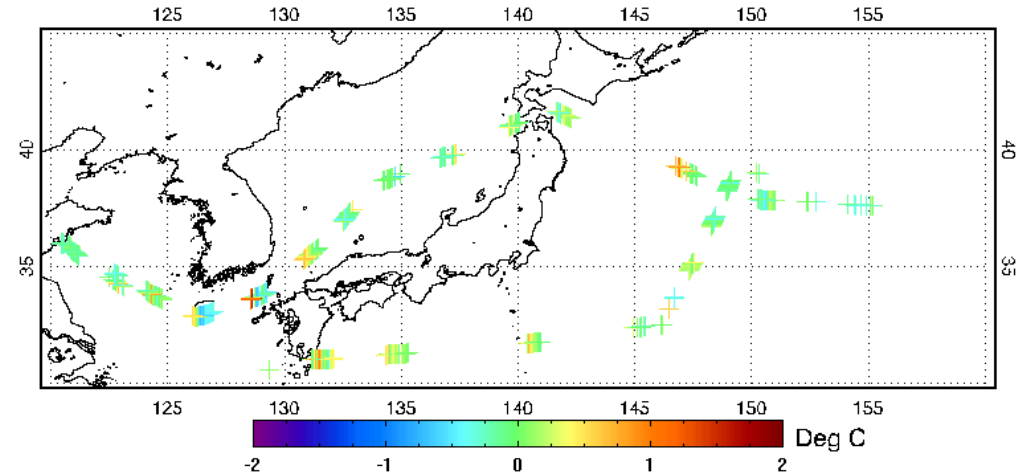
SST(using KT15 different zenith angles' radiance) minus SST(using KT15 45 degree's radiance)



Donlon and Nightingale 2000

HY-1C COCTS OE SST validation

- OUC ISAR and CSIRO ISAR
- Temporal window: 2 h
- Spatial window: 1 km



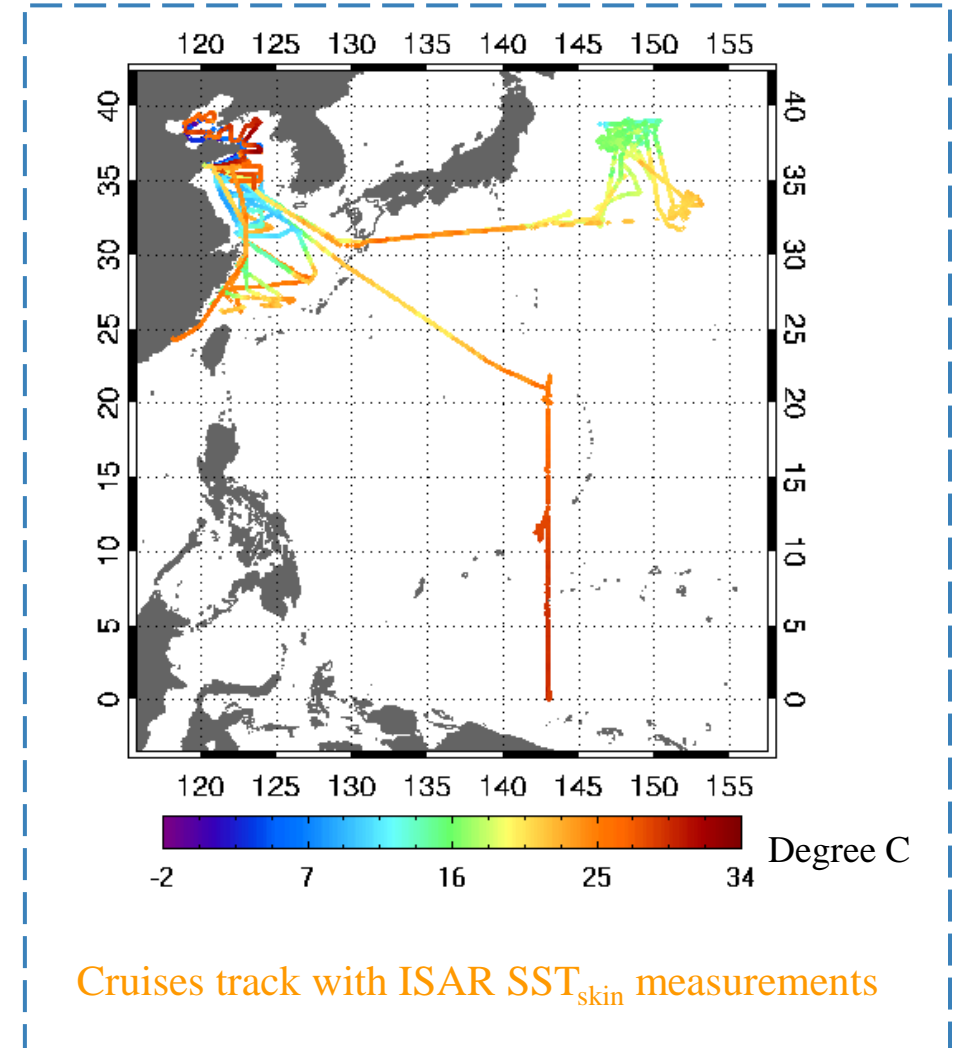
	Bias (°C)	STD (°C)	MED (°C)	RSD (°C)	No.
all	0.06	0.35	0.06	0.30	905
day	0.07	0.37	0.09	0.31	419
night	0.06	0.34	0.04	0.29	486

Cool skin effect

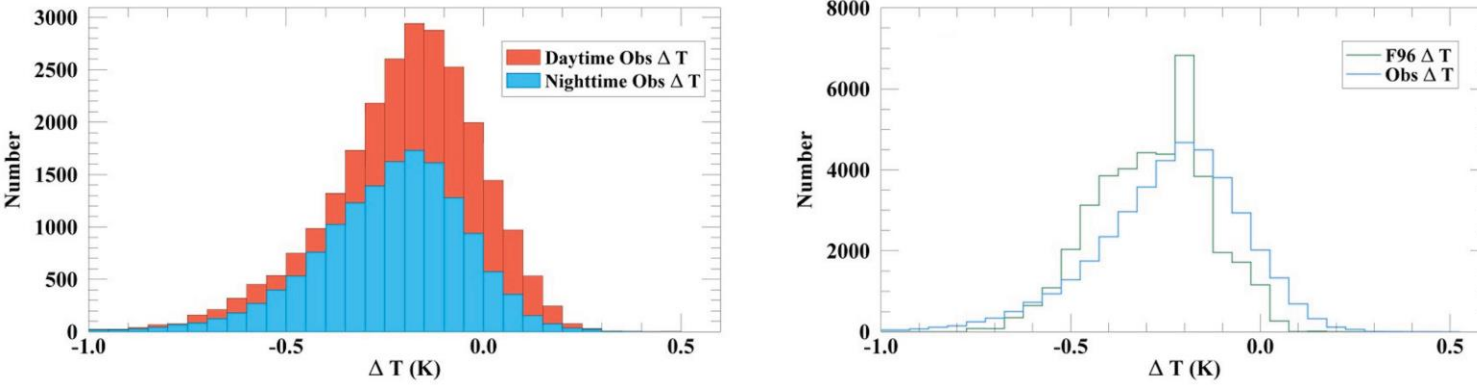
- 11 voyages measurements from August 2015 to October 2018
- SST_{skin} range: 271 K – 307 K
- SST_{depth} : SBE48 at 4m
- U_{10} , RH_{10} , $AirT_{10}$...

- Physical model: Coupled Ocean–Atmosphere Response Experiment (COARE) V3.6

- Empirical parameterization: Donlon et al. 2002



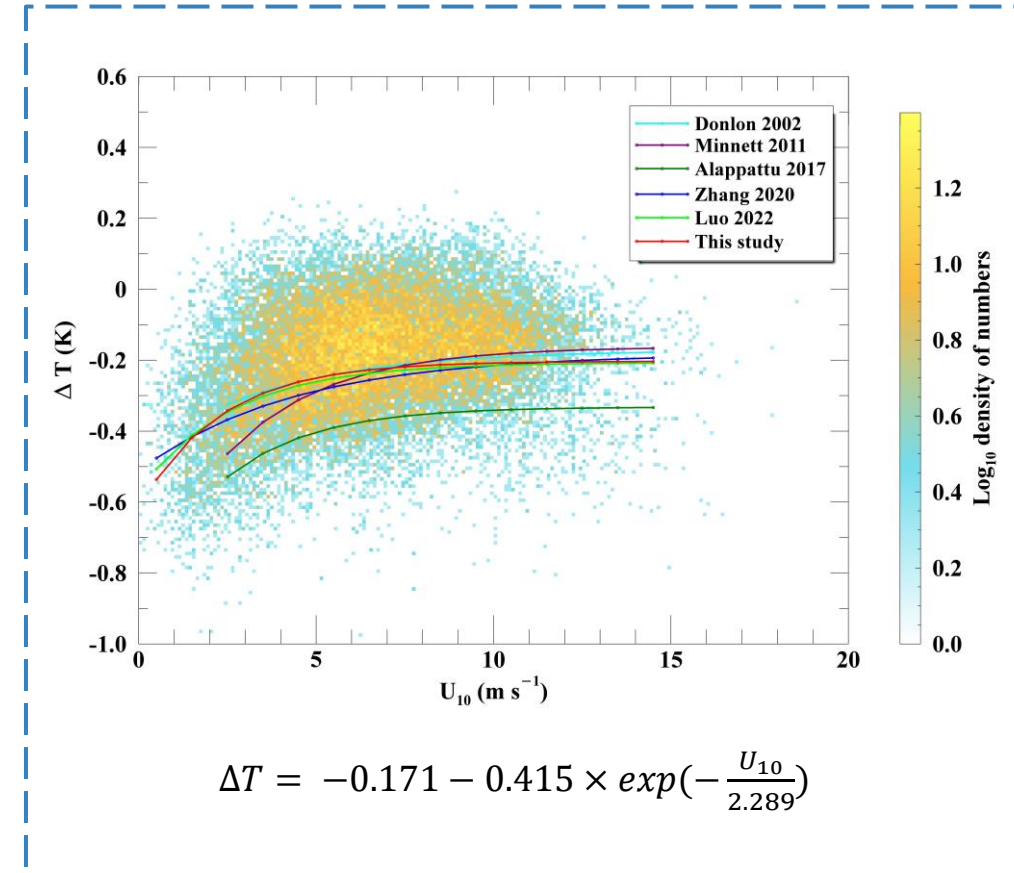
Cool skin and diurnal warming study



Left: histograms of nighttime (blue) and daytime (orange) ΔT . Right: distribution of F96 modeled ΔT (green) and observations (blue). The interval of bars is 0.05 K.

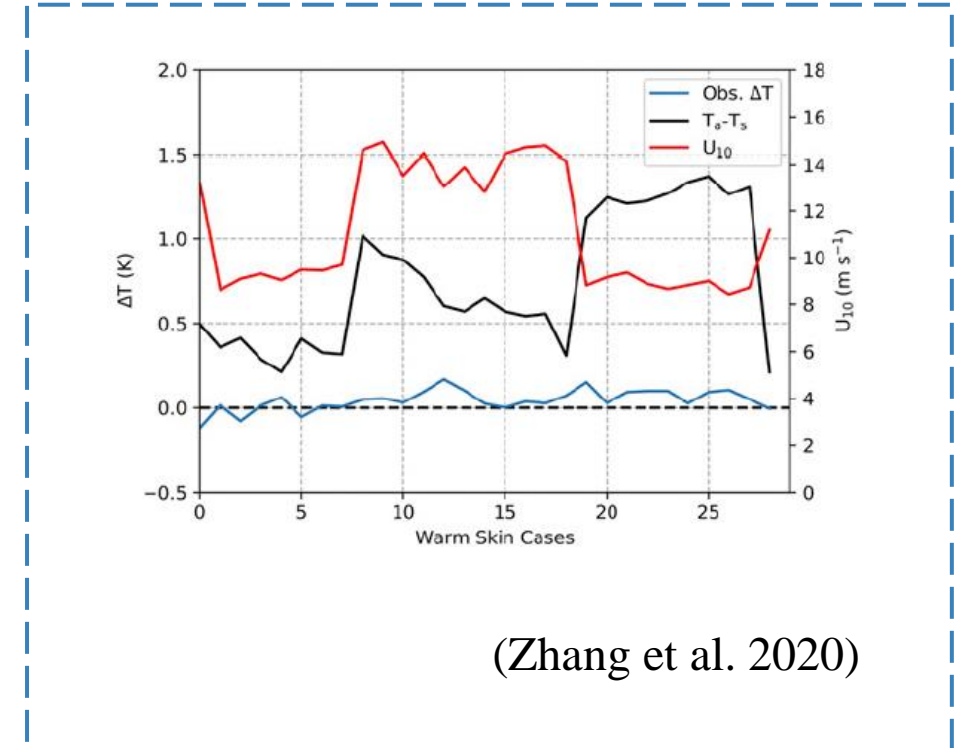
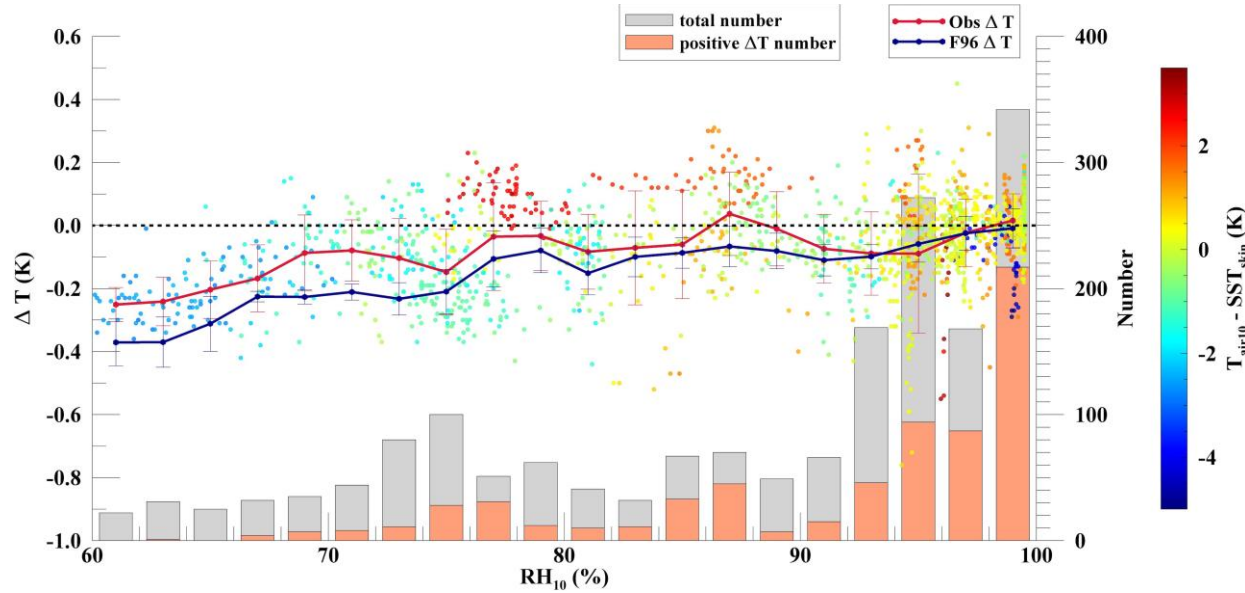
Statistics of F96 modeled ΔT and observations

		N	Mean	Median	STD	RSD	Max	Min
Nighttime	F96	14693	-0.27	-0.26	0.14	0.14	0.27	-0.74
	Obs		-0.24	-0.22	0.20	0.18	0.66	-1.54
Daytime	F96	25216	-0.25	-0.23	0.15	0.15	0.50	-0.76
	Obs		-0.20	-0.18	0.20	0.18	0.30	-1.86
Total	F96	39909	-0.26	-0.25	0.15	0.15	0.50	-0.76
	Obs		-0.22	-0.19	0.20	0.18	0.66	-1.86



(Yang et al. 2023)

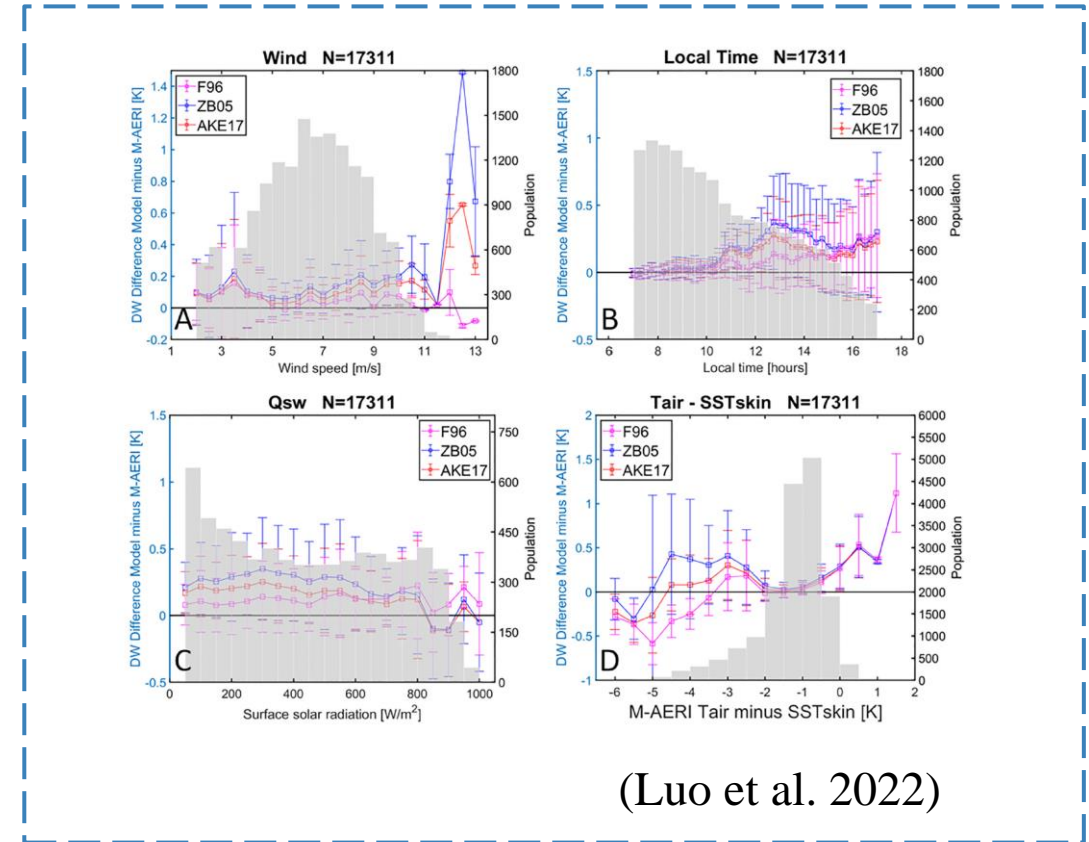
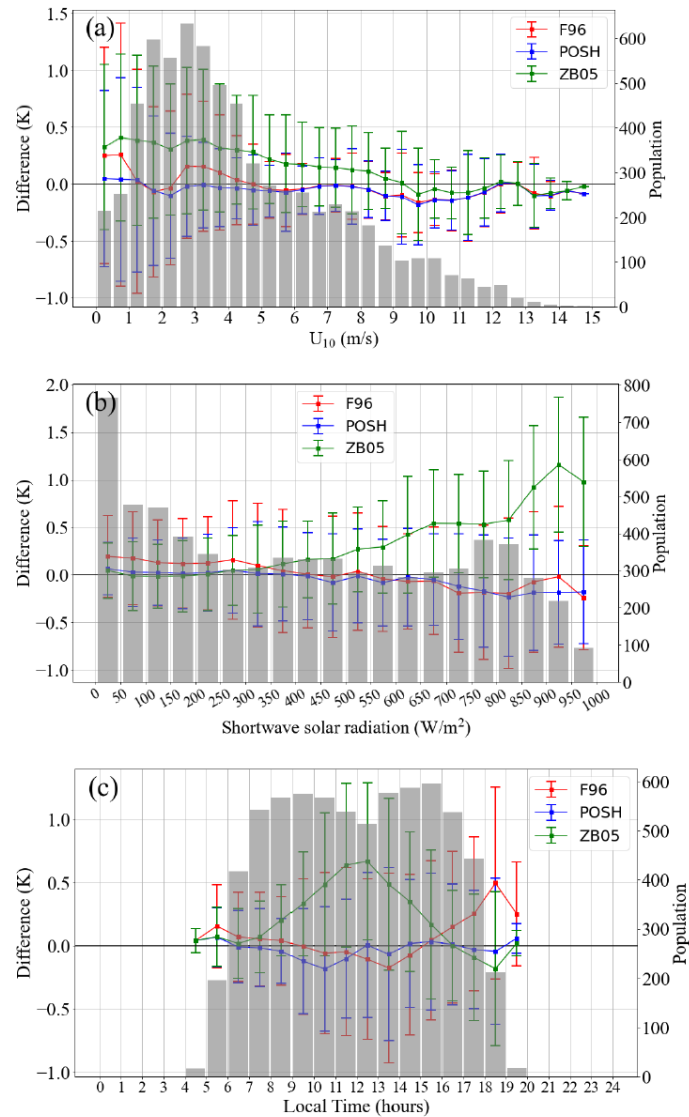
Warm skin phenomenon



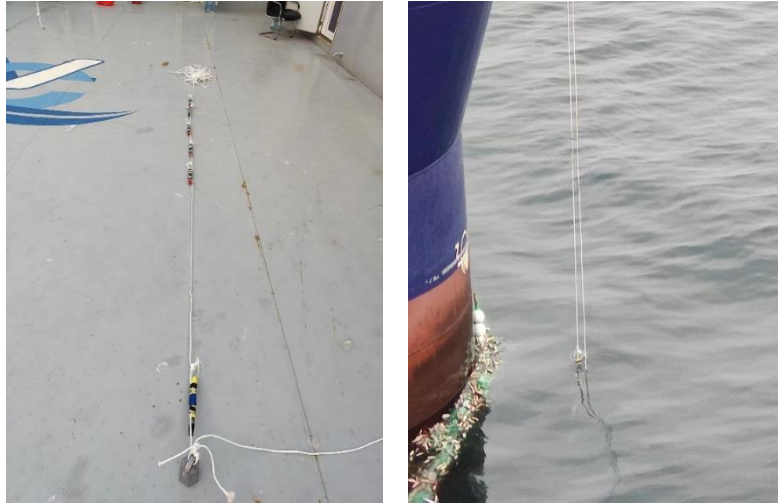
(Zhang et al. 2020)

- $RH_{10} > 94\%$, $T_{air_{10}} \text{ minus } SST_{skin} > 0 \text{ K}$
- $T_{air_{10}} \text{ minus } SST_{skin} \sim 3 \text{ K}$
- Magnitude of warm cases up to 0.3 K

Diurnal warming effect

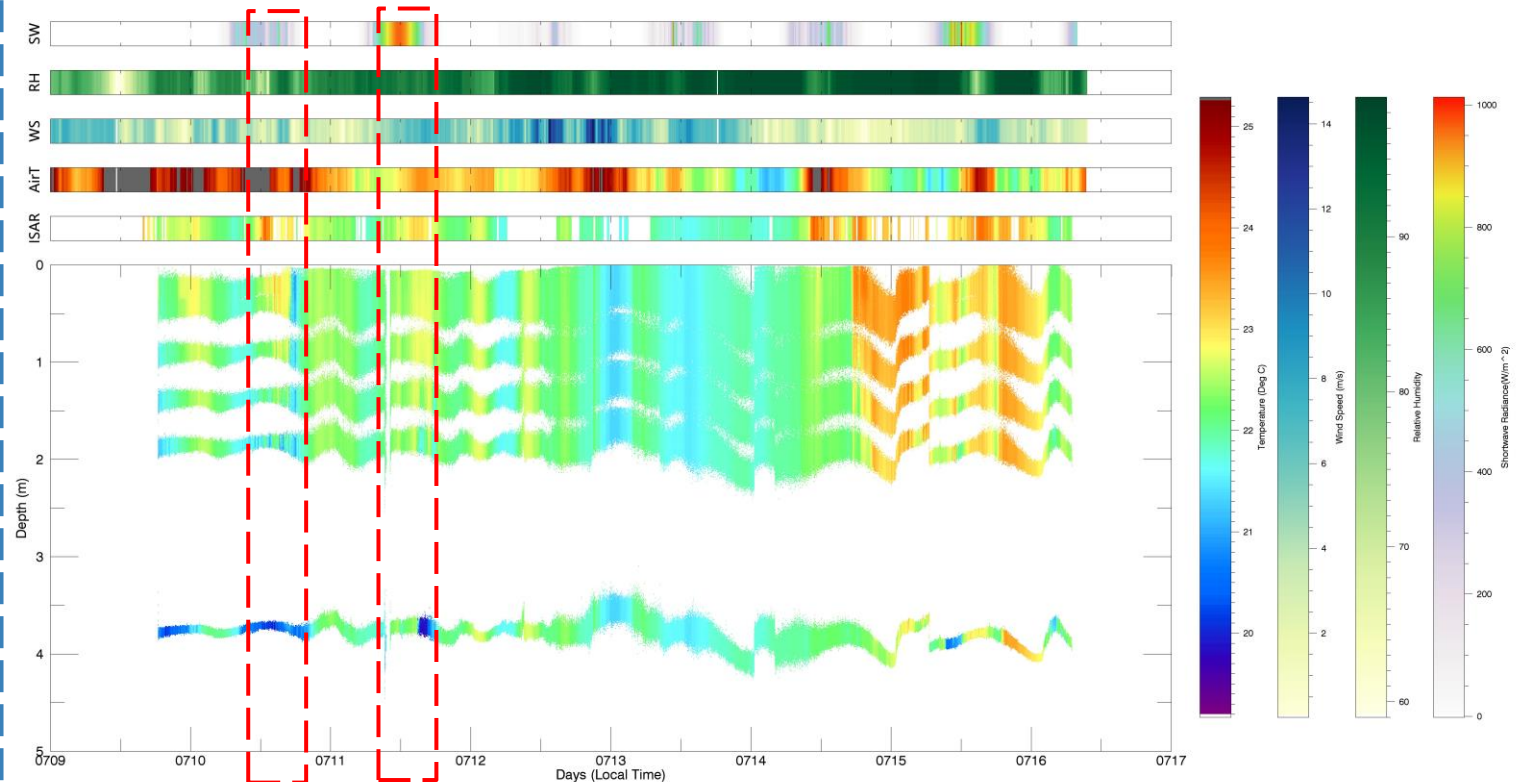


SST profile measurements



- 3 RBR solo T and 3 RBR T.D.
- At depth around 0.2m, 0.5m, 1m, 1.5m, 2m, 4m

- 5min-1cm averaged profile



- Captured diurnal warming events

To do:

- Intercomparison with new ISAR and M-AERI
- Reprocess history ISAR SST using newly python code
- Build relationship between SST error with changing sky signal using All-Sky Imager and sea surface emissivity
- Continuous SST profile measurements and analysis



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A wide-angle photograph of a sunset over the ocean. The sky is a mix of blue, orange, and yellow, with scattered clouds. The sea is dark blue with white-capped waves. In the distance, there are silhouettes of ships and structures on the horizon.

Thanks for listening!

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