Evaluation of Suomi NPP VIIRS Sea Surface Temperature Using Shipboard Measurements in the Northwest Pacific

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✦ Shipboard measurements of the skin SST

✦ Evaluation of VIIRS SST

✦ Summary

ISAR-5C
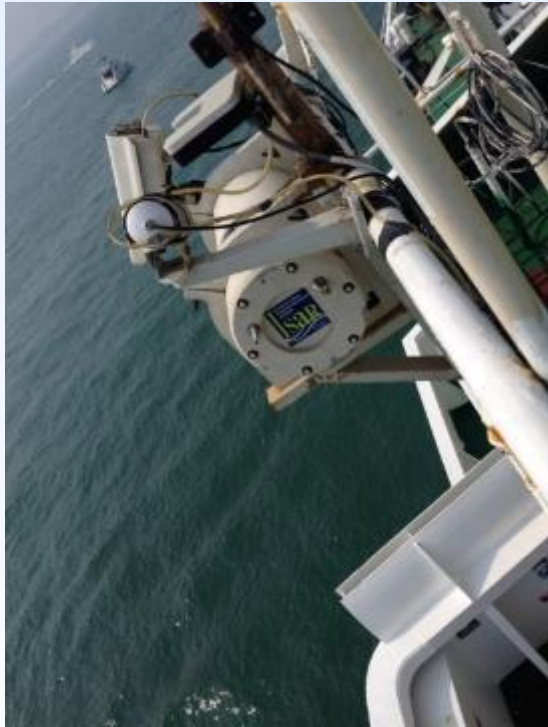made by University of Southampton

Oct, 2007, Qingdao

Dong Fang Hong II (DFH II) is a research vessel of Ocean University of China (OUC).This vessel is 96 m long and 15 m wide, with a draught of 5.5 m

ISAR on the compass deck

Data logging system in the lab

Parameter	Sensor
Shortwave radiation	Kipp & Zonen CMP 21
Longwave radiation	Kipp & Zonen CGR 4
Net radiation	Kipp & Zonen CNR 4
SST_{2m}	SBE 48
SST_{5m}	SBE 37 / SBE39

Ancillary data collections

Specification table:

Spectral Range	500 to 5000 cm^{-1}
Effective Emissivity	>0.9998
Temperature Range	-40C° to +65C°
Radiance uncertainty	<±0.005 K
Temperature Display Resolution	(as per controller BC-231)
Temperature Stability	0.03C° over 120 sec.
Temperature Gradient	<0.35C
Temperature Setting Resolution	0.001C°
Temperature knowledge	± 0.01°C Absolute
Aperture diameter	2,75 inch
Voltage	110/230Vac, 50 or 60 Hz
Power consumption (1 source)	30W

BB-ASSIST II
        LR TECH INC

BB Controller
        LR TECH INC

Date and time retention
Duration: *One month if powered at least 30 min.*

Temperature probe inputs
Probe type: *NTC thermistor*
                        10kOhms at 25°C
Maximum impedance of any probe: *50kOhms*
Maximum total impedance: *125kOhms*
Calibration: *Automatic*
Range of measure: *10°C to 65°C*
Resolution of measure: *0.001°C*

Regulation
Setpoint: *15°C to 60°C*
Resolution of setpoint: *0.001°C*
Maximum stability at setpoint: *±0.005°C*

*Absolute precision of measure: *better than* 0.005°C *(controller)*
* Absolute precision of measure excludes intrinsic error of the probe, but includes a maximum ambient temperature variation of ±20°C.
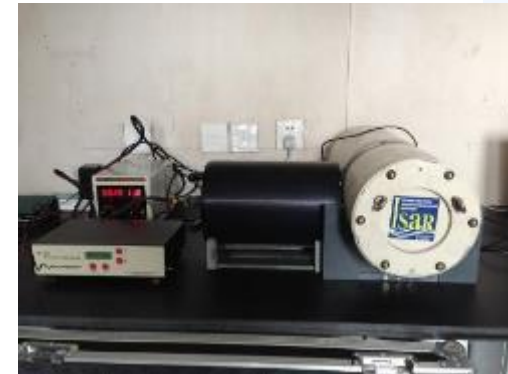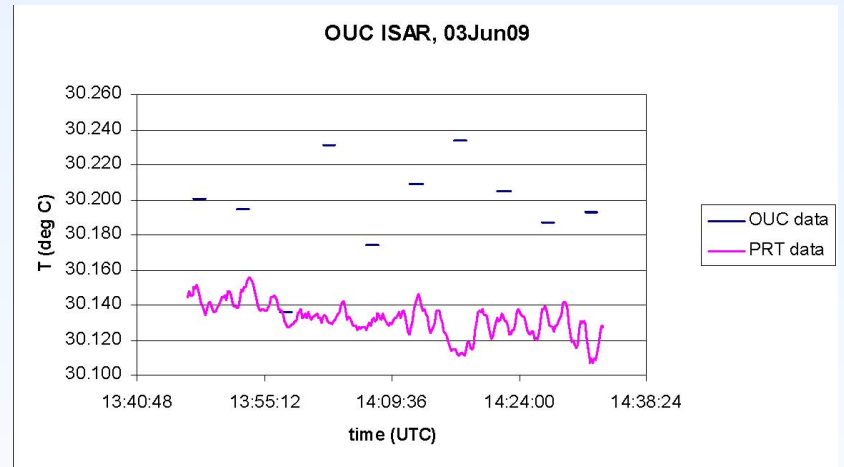
CEOS comparison of Infrared radiometry in support of satellite calibration and validation for measuring SST for studies of climate change, Jun 2009
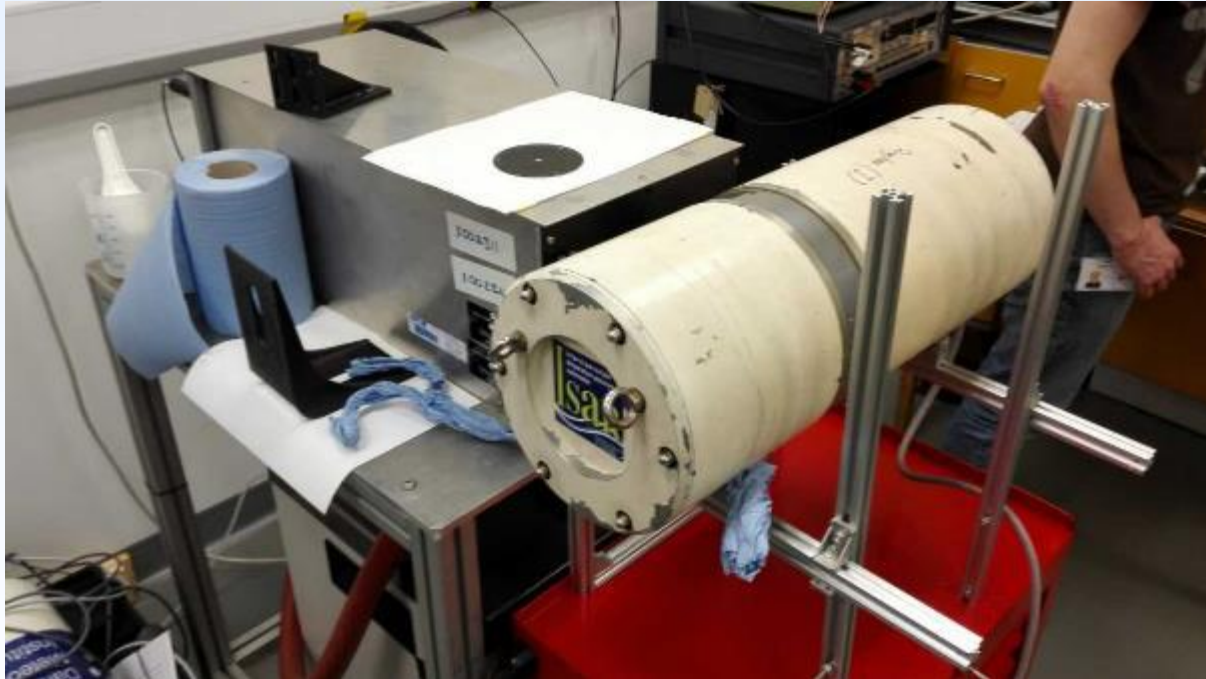
OUC ISAR, 03Jun09
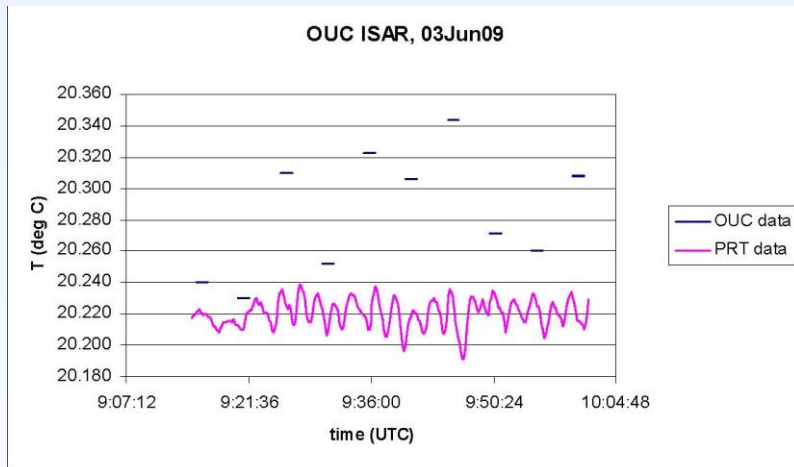
<ISAR – BB> =0.064 K

<ISAR – BB> =0.048 K

(Theocharous et. al., NPL Report OP3, 2010)

FRM4STS：Laboratory comparison of radiation thermometers, Jun 2016

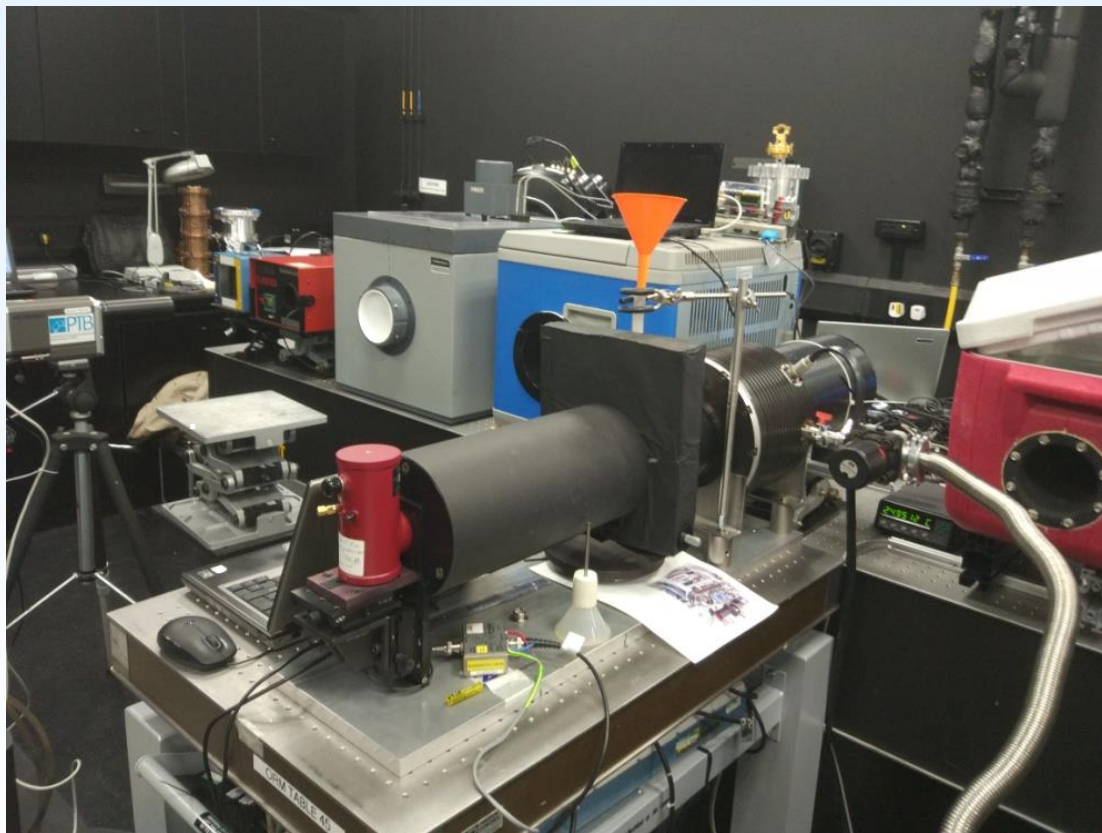FRM4STS：Laboratory comparison of radiation thermometers, Jun 2016

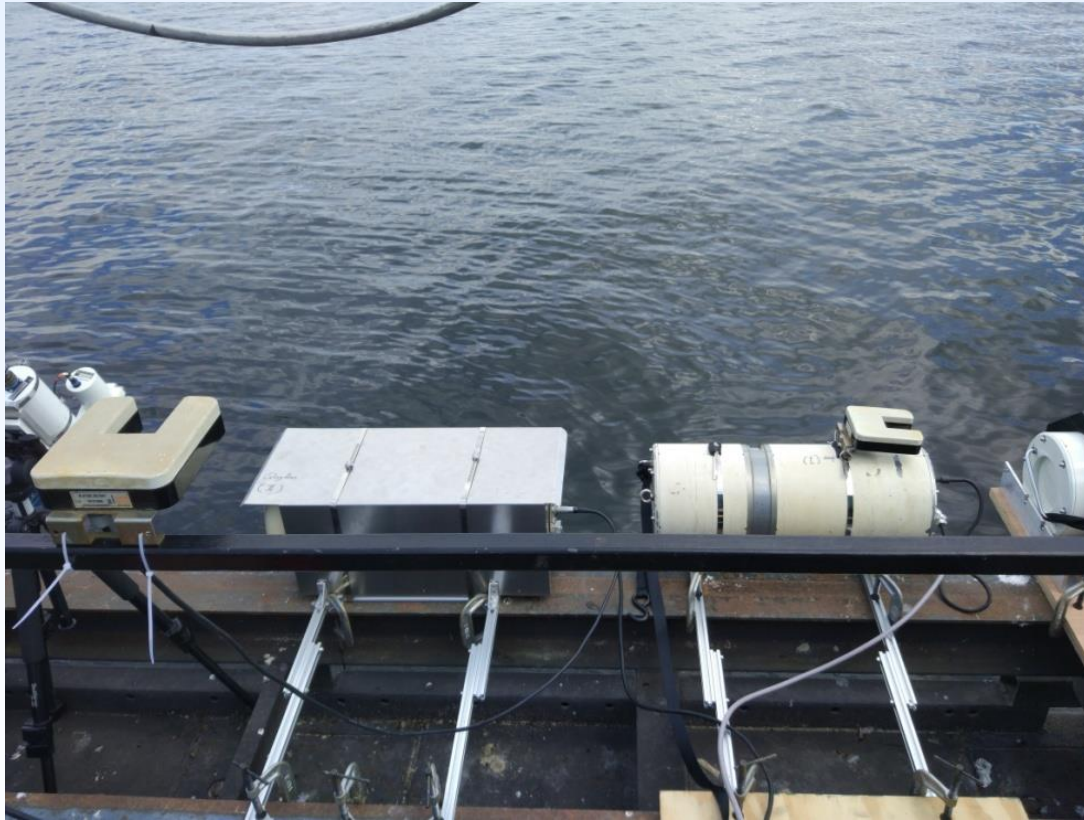|	Set temperature / °C	NPL VTBB / mK
OUC	45	728
ISAR	30	94
	20	71
	10	157
	0	229
	-15	515
	-30	2413
OUC	45	18
FIRST	30	22
	20	27
	10	6
	0	125
	-15	102
	-30	538

(Barker-Snook et. al., NPL Report, 2016)

FRM4STS：Blackbody Laboratory comparison, Jun 2016
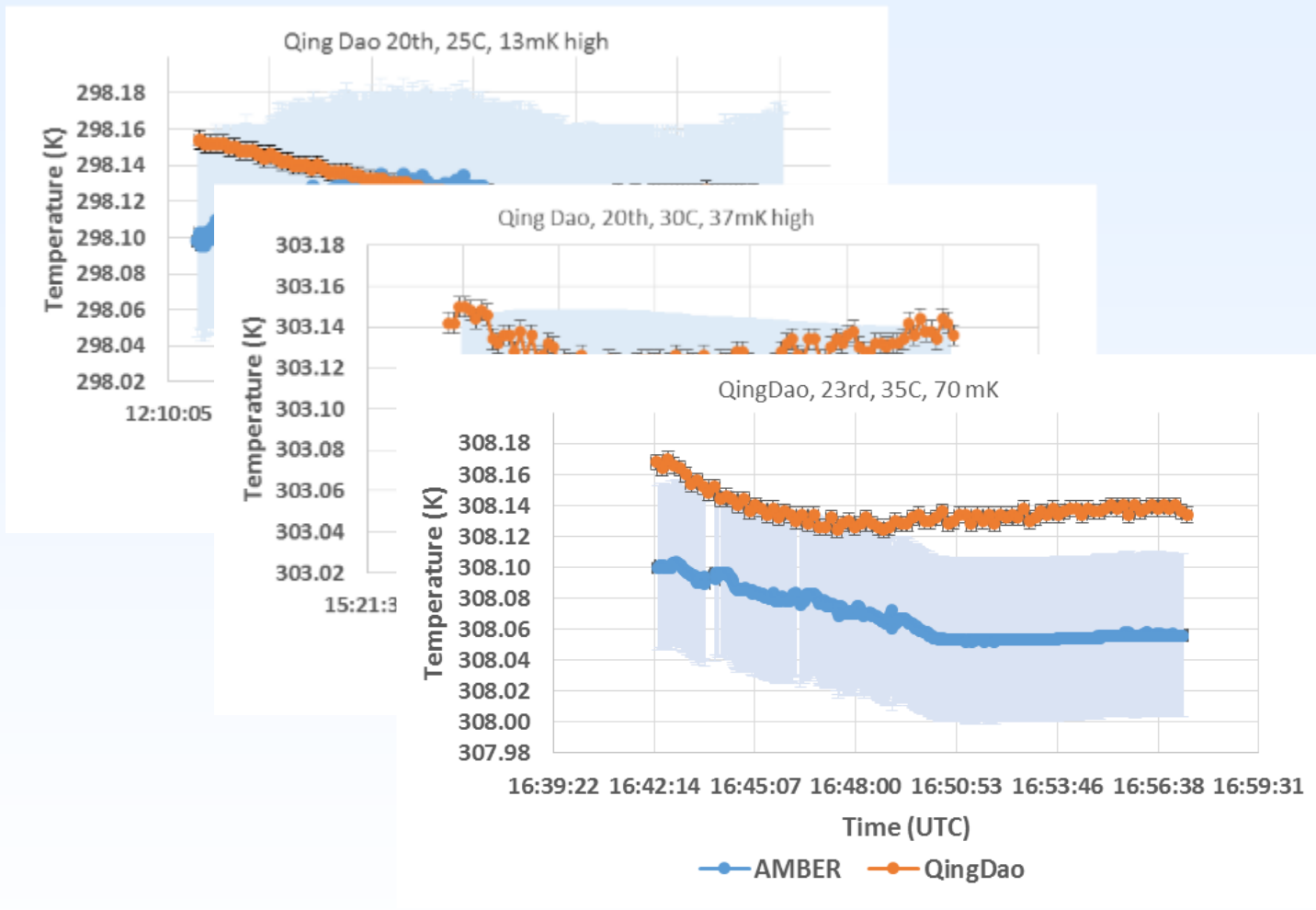
(Theocharous et. al., NPL Report, 2016)

FRM4STS： Water surface temperature comparison of radiation thermometers.
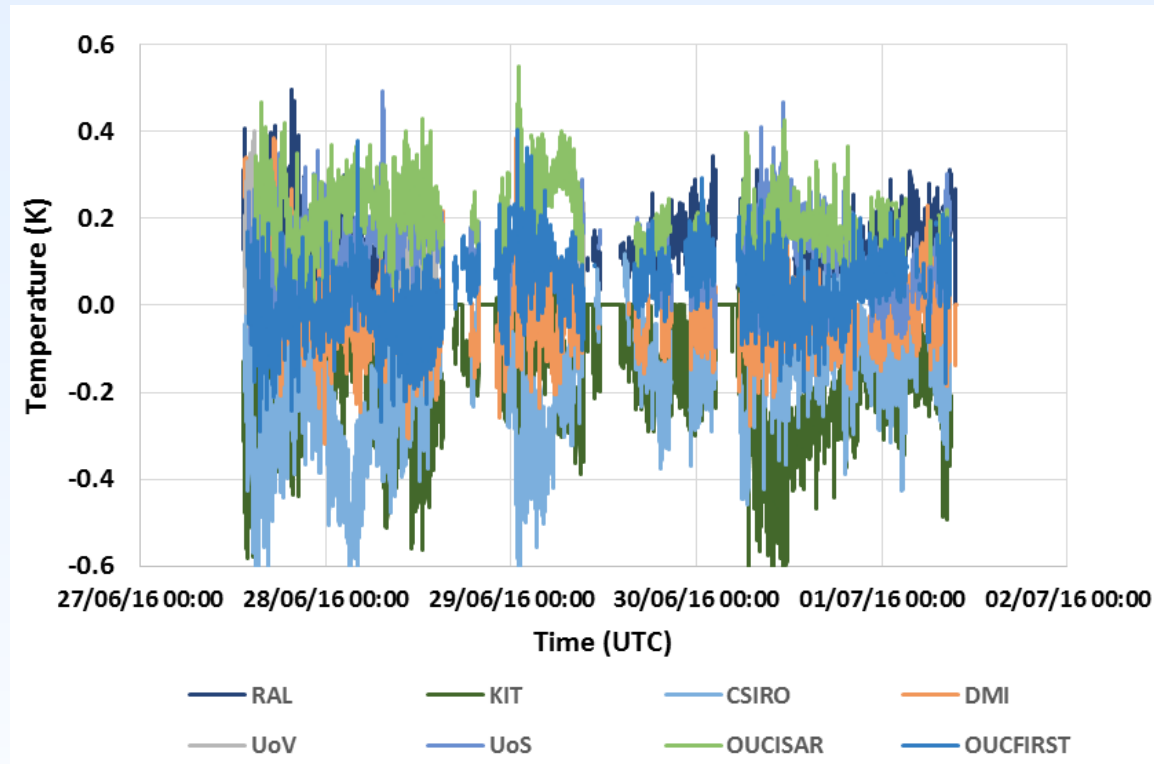
Figure 4.4: Plot of the difference of the WST measurements of the various participants from their arithmetic mean, excluding JPL and GOTA, over the five-day comparison period.

(Barker-Snook et. al., NPL Report, 2016)

Radiometer	Mean difference from the mean (°C)
STFC RAL	0.123
KIT	-0.159
CSIRO	-0.189
DMI	-0.020
UoV	0.117
UoS	0.125
OUCFIRST	0.033
OUC-ISAR	0.206
GOTA	0.593
JPL	-0.109

(Barker-Snook et. al., NPL Report, 2016)

Measurements of the skin SST by ISAR

- ✧ 1st cruise, 21 Sept. 2009

- ✧ 63rd cruise, 27 Sept. 2017
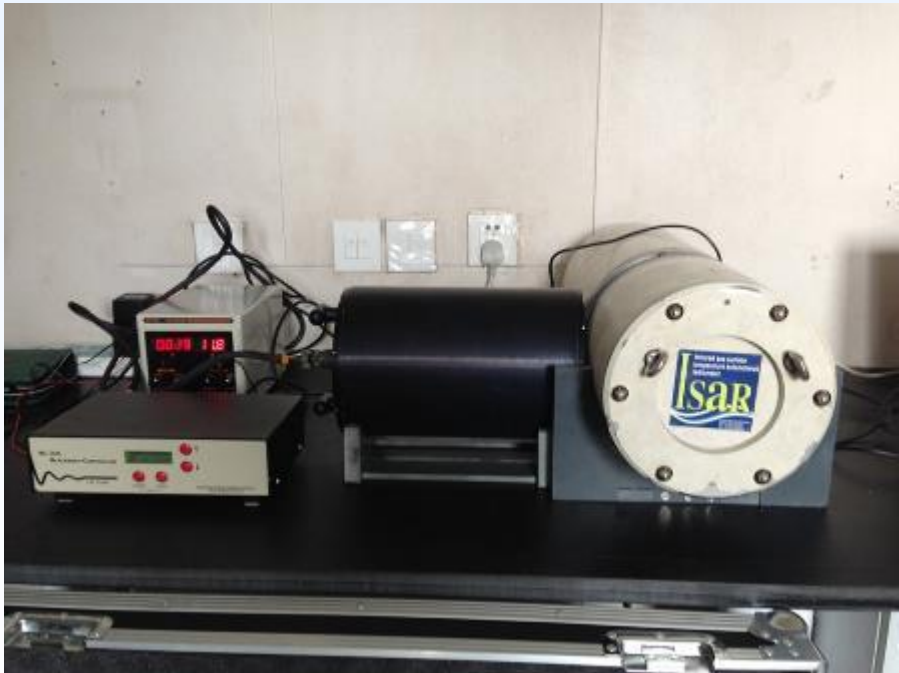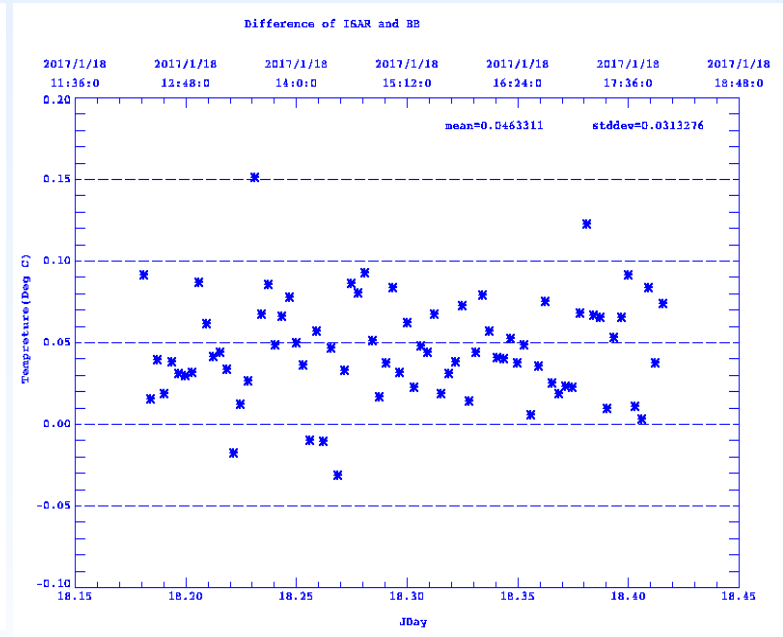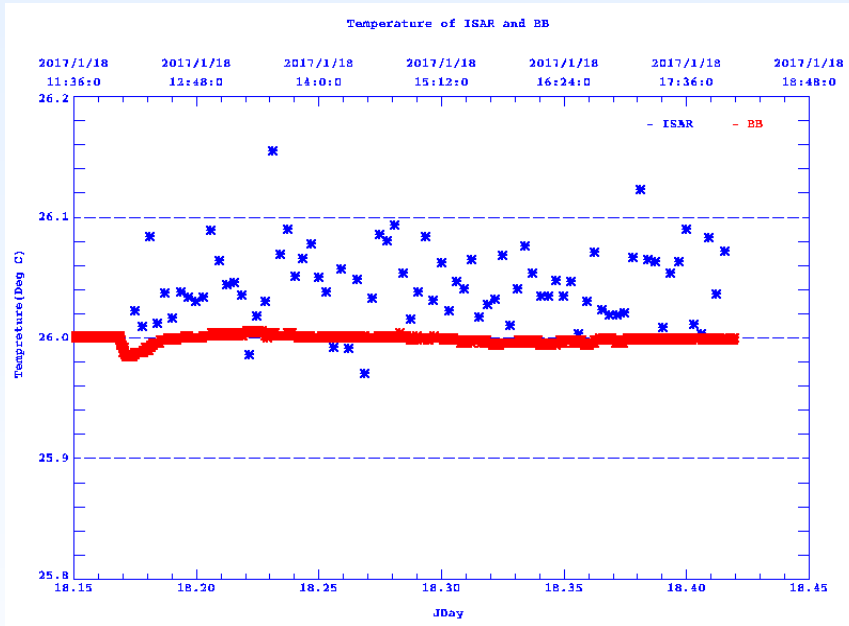
Calibration after 57th cruise（12/27/2016 – 0117/2017）

Bias: 0.046 K   Std Dev: 0.03 K
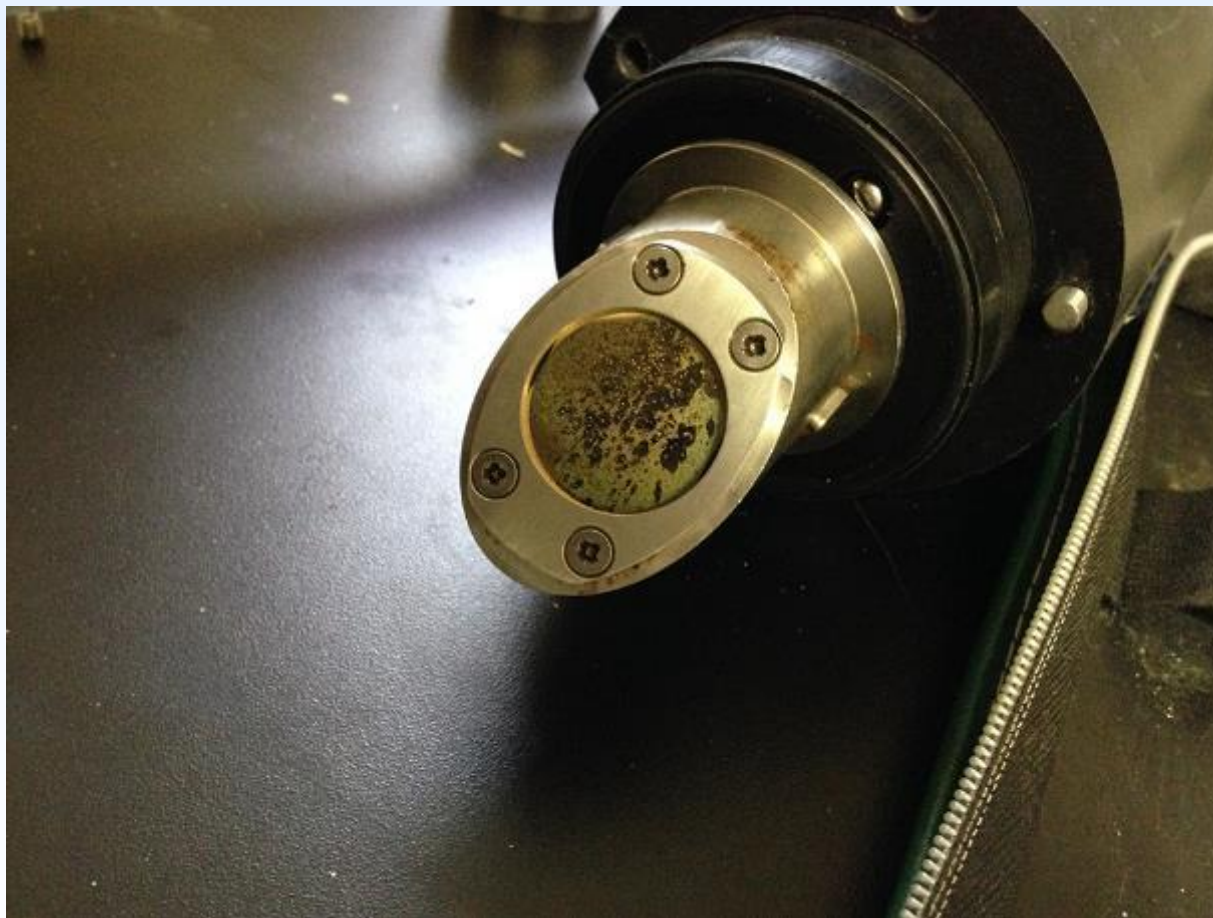
- ✧ Shipboard measurements of the skin SST

- ✧ Evaluation of VIIRS SST

- ✧ Summary
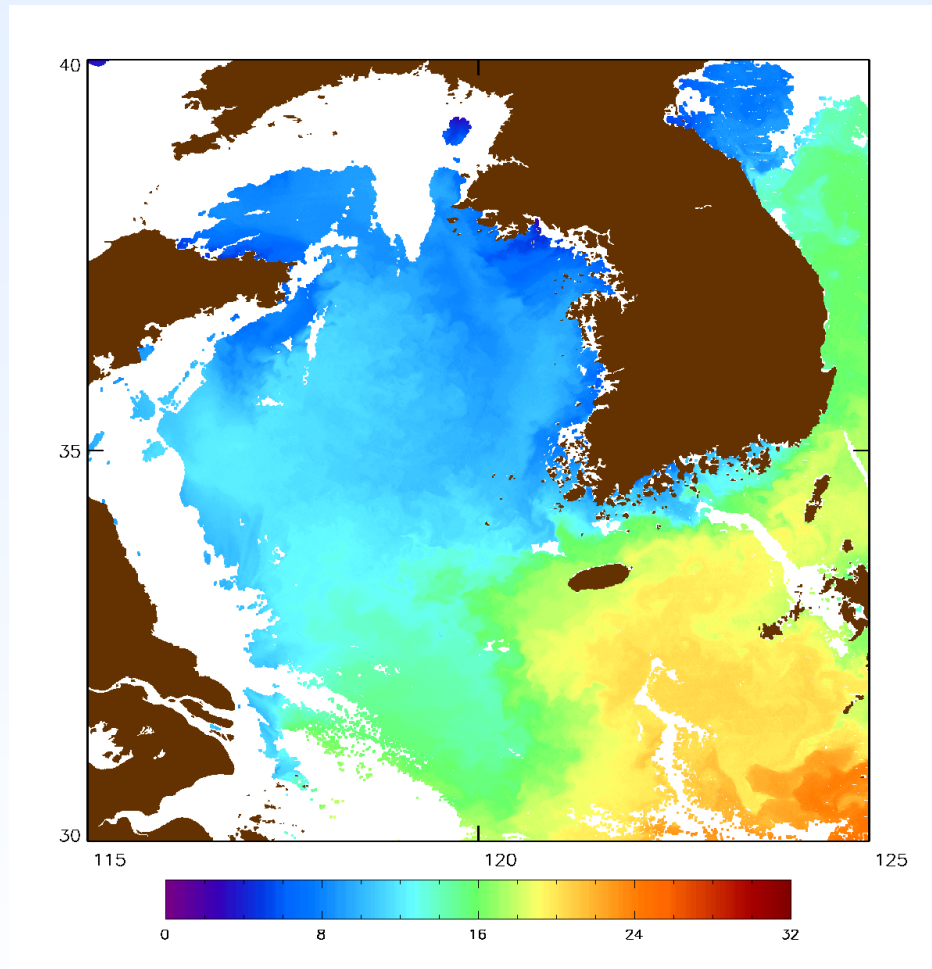
VIIRS SST

20170103051000-OSPO-L2P_GHRSST-SSTskin-VIIRS_NPP-ACSPO_V2.40
ftp://ftp.nodc.noaa.gov/pub/data.nodc/ghrsst/GDS2/L2P/VIIRS_NPP/OSPO/v2.4

20150816-20150907
20151019-20151104
20160114-20160201
20160320-20160426
20161227-20170117
20170131-20170315
20170322-20170415
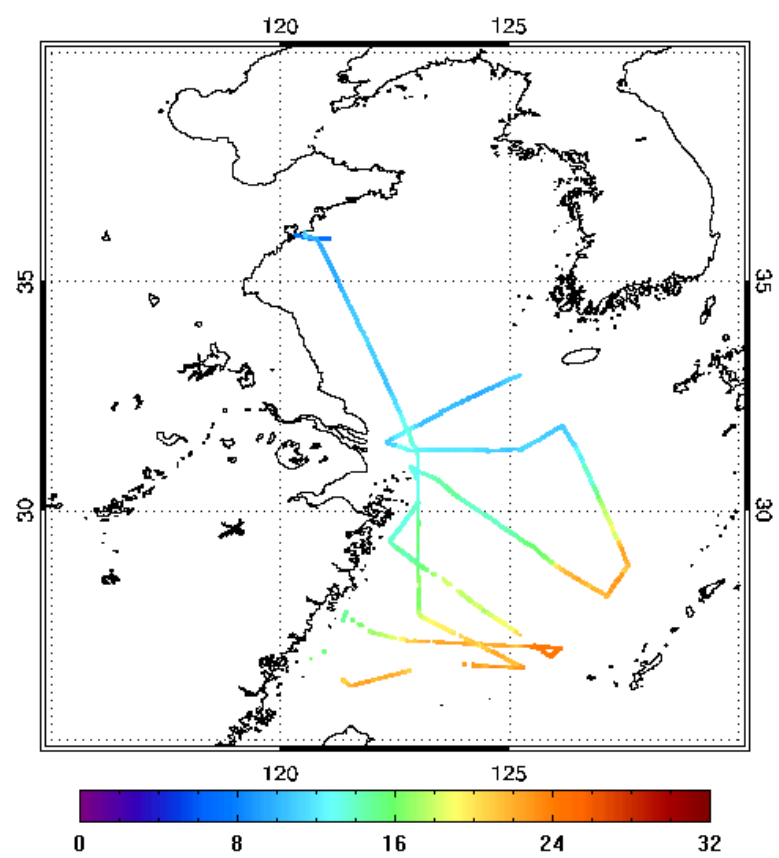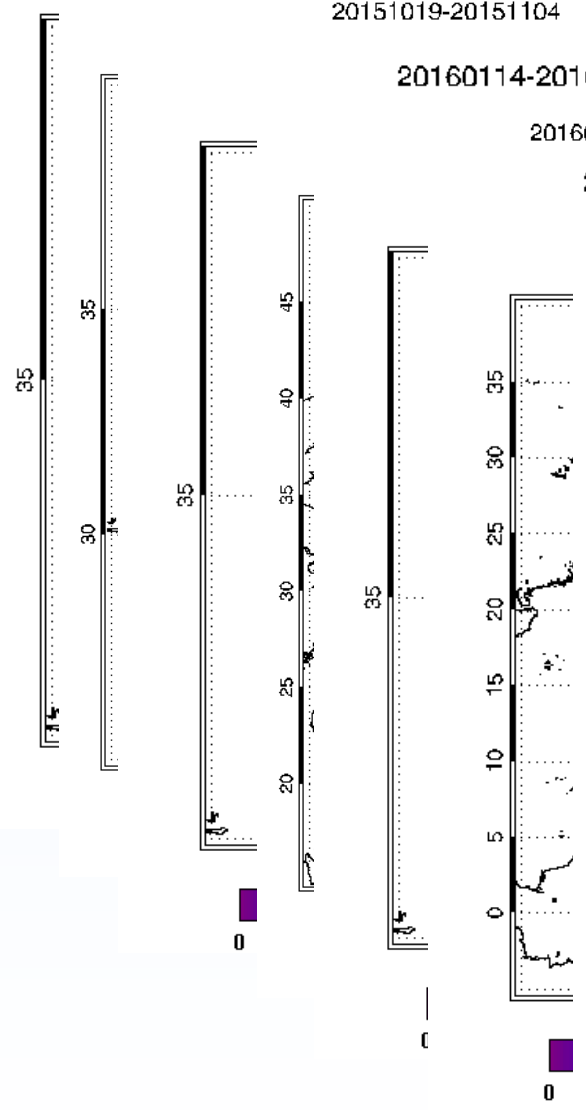
Cruise		ISAR	
		mean(K)	std(K)
2015_08	pre	0.09	0.02
	post	0.08	0.03
2015_10	pre	0.08	0.03
	post	0.16	0.03
2016_01	pre	0.06	0.03
	post	0.06	0.03
2016_03	pre	0.06	0.03
	post	-0.02	0.04
2016_12	pre	0.06	0.03
	post	0.05	0.03
2017_01	pre	0.05	0.02
	post	0.09	0.03
2017_03	pre	0.08	0.03
	post	0.08	0.03

Calibration of the ISAR before and after each campaign
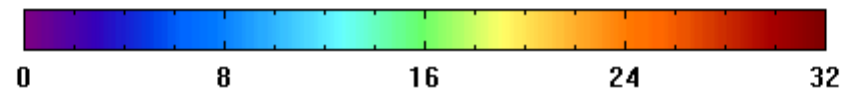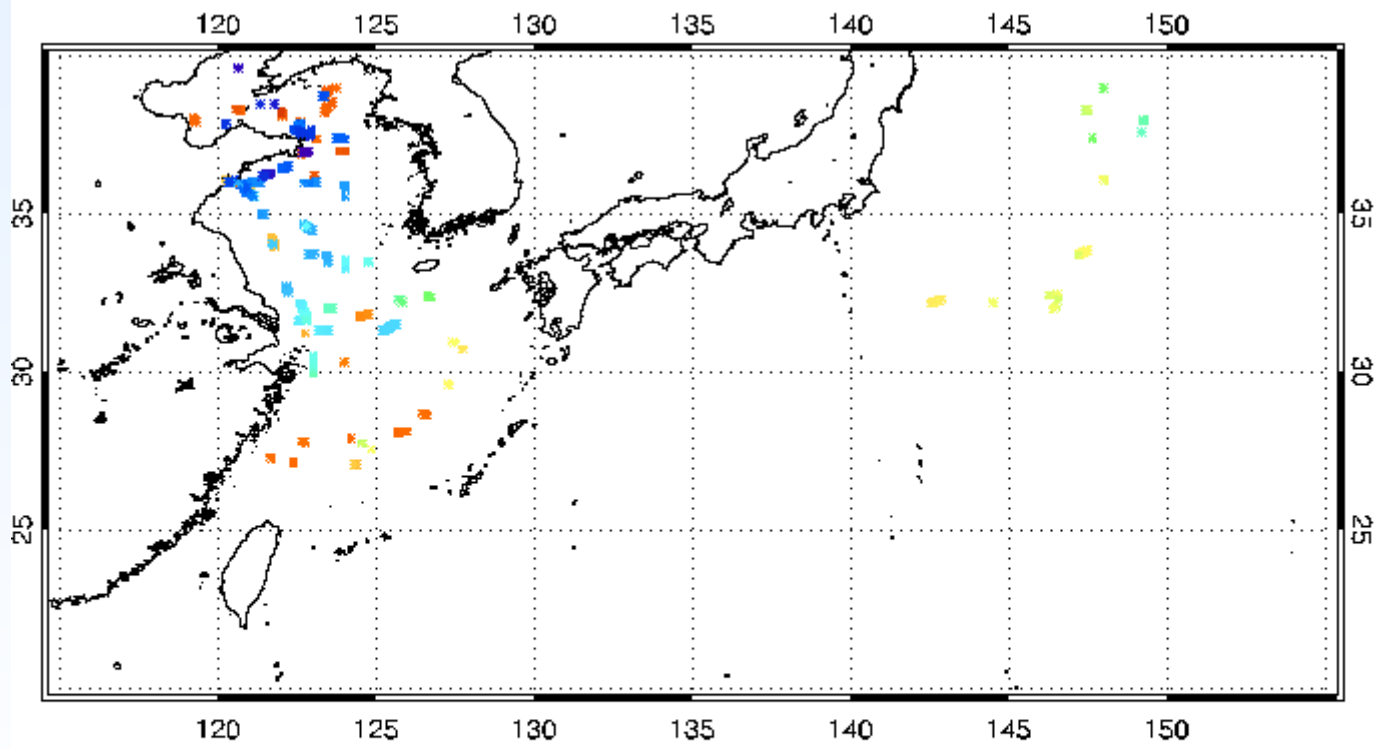
Cruise	mean(K)	median(K)	std(K)	max(K)	min(K)	num	P(0.1)	P(0.2)	P(0.3)	P(0.4)	P(0.5)
2015_08_OUC 8.16-9.7	0.27	0.27	0.29	0.99	-0.92	105	0.19	0.39	0.52	0.73	0.78
2015_10_OUC 10.19-11.4	0.02	0.02	0.26	0.64	-0.68	90	0.31	0.63	0.76	0.86	0.92
2016_01_OUC 1.13-2.1	0.26	0.28	0.27	0.92	-0.48	138	0.20	0.33	0.53	0.70	0.85
2016_03_OUC 3.20-4.26	-0.13	-0.12	0.50	2.01	-2.11	148	0.24	0.55	0.70	0.78	0.84
2016_12_OUC 12.27-1.17	0.21	0.24	0.18	0.59	-1.17	129	0.15	0.36	0.72	0.91	0.98
2017_01_OUC 1.31-3.15	0.15	0.17	0.46	0.97	-1.76	69	0.20	0.46	0.62	0.68	0.74
2017_03_OUC 3.22-4.15	0.15	0.15	0.33	1.29	-0.91	190	0.27	0.47	0.65	0.78	0.85

Cruise		mean(K)	median(K)	rsd(K)	max(K)	min(K)	num	p(0.1)	P(0.2)	P(0.3)	P(0.4)	P(0.5)
2015_08_OUC 8.16-9.07	day	0.32	0.29	0.38	0.99	-0.92	51	0.12	0.35	0.49	0.59	0.65
	night	0.22	0.26	0.26	0.98	-0.37	54	0.26	0.43	0.56	0.87	0.91
2015_10_OUC 10.19-11.4	day	0.06	0.11	0.34	0.64	-0.65	57	0.19	0.54	0.68	0.81	0.89
	night	-0.06	-0.04	0.19	0.32	-0.68	33	0.52	0.79	0.88	0.94	0.97
2016_01_OUC 1.13-2.1	day	0.27	0.28	0.12	0.51	0.08	46	0.09	0.20	0.63	0.87	0.98
	night	0.25	0.31	0.41	0.92	-0.48	92	0.26	0.39	0.48	0.61	0.78
2016_03_OUC 3.20-4.26	day	-0.17	-0.25	0.77	2.01	-2.11	56	0.16	0.29	0.41	0.55	0.66
	night	-0.10	-0.10	0.23	0.63	-0.89	92	0.29	0.71	0.87	0.92	0.96
2016_12_OUC 12.27-1.17	day	0.30	0.28	0.11	0.59	0.11	57	0.00	0.11	0.56	0.88	0.98
	night	0.15	0.18	0.19	0.50	-1.17	72	0.26	0.57	0.85	0.94	0.99
2017_01_OUC 1.31-3.15	day	-0.17	0.17	1.08	0.92	-1.76	10	0.00	0.30	0.40	0.50	0.50
	night	0.20	0.16	0.36	0.97	-0.44	59	0.24	0.49	0.66	0.71	0.78
2017_03_OUC 3.22-4.15	day	0.05	0.08	0.33	0.66	-0.91	87	0.33	0.53	0.70	0.83	0.87
	night	0.23	0.21	0.37	1.29	-0.41	103	0.21	0.43	0.60	0.75	0.83
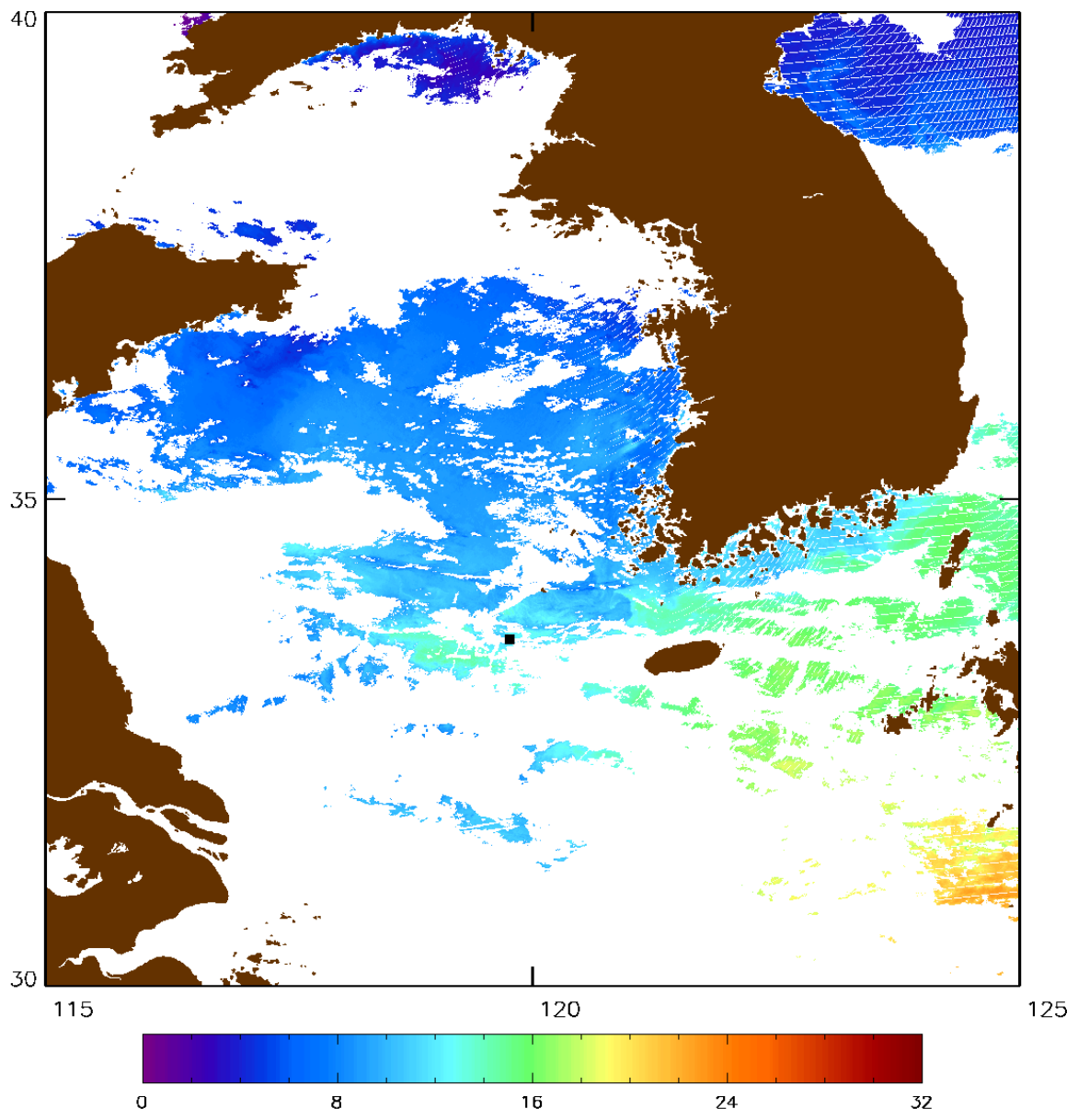
Cruise	mean(K)	median(K)	std(K)	max(K)	min(K)	num	P(0.1)	P(0.2)	P(0.3)	P(0.4)	P(0.5)
2015_08_OUC 8.16-9.7	0.27	0.27	0.25	0.83	-0.37	105-3	0.20	0.40	0.54	0.75	0.80
2015_10_OUC 10.19-11.4	0.02	0.02	0.26	0.64	-0.68	90	0.31	0.63	0.76	0.86	0.92
2016_01_OUC 1.13-2.1	0.25	0.28	0.26	0.80	-0.48	138-3	0.21	0.33	0.54	0.71	0.87
2016_03_OUC 3.20-4.26	-0.12	-0.12	0.33	1.26	-1.51	148-7	0.26	0.57	0.73	0.82	0.89
2016_12_OUC 12.27-1.17	0.22	0.24	0.13	0.50	-0.19	129-2	0.15	0.37	0.73	0.93	1.00
2017_01_OUC 1.31-3.15	0.20	0.17	0.35	0.97	-0.97	69-2	0.21	0.48	0.64	0.70	0.76
2017_03_OUC 3.22-4.15	0.12	0.14	0.29	0.83	-0.91	190-5	0.28	0.49	0.66	0.81	0.88

| Cruise		mean(K)	median(K)	std(K)	max(K)	min(K)	num	p(0.1)	P(0.2)	P(0.3)	P(0.4)	P(0.5)
2015_08_OUC 8.16-9.07	day	0.33	0.29	0.27	0.83	-0.16	49	0.12	0.37	0.51	0.61	0.67
	night	0.21	0.26	0.20	0.64	-0.37	53	0.26	0.43	0.57	0.89	0.92
2015_10_OUC 10.19-11.4	day	0.06	0.11	0.29	0.64	-0.65	57	0.19	0.54	0.68	0.81	0.89
	night	-0.06	-0.04	0.19	0.32	-0.68	33	0.52	0.79	0.88	0.94	0.97
2016_01_OUC 1.13-2.1	day	0.27	0.28	0.10	0.51	0.08	46	0.09	0.20	0.63	0.87	0.98
	night	0.23	0.23	0.31	0.80	-0.48	89	0.27	0.40	0.49	0.63	0.81
2016_03_OUC 3.20-4.26	day	-0.16	-0.25	0.48	1.26	-1.51	49	0.18	0.33	0.47	0.63	0.76
	night	-0.10	-0.10	0.22	0.63	-0.89	92	0.29	0.71	0.87	0.92	0.96
2016_12_OUC 12.27-1.17	day	0.30	0.28	0.08	0.48	0.11	56	0.00	0.11	0.57	0.89	1.00
	night	0.17	0.18	0.14	0.50	-0.19	71	0.27	0.58	0.86	0.96	1.00
2017_01_OUC 1.31-3.15	day	0.18	0.24	0.54	0.92	-0.97	8	0.00	0.38	0.50	0.63	0.63
	night	0.20	0.16	0.32	0.97	-0.44	59	0.24	0.49	0.66	0.71	0.78
2017_03_OUC 3.22-4.15	day	0.05	0.08	0.31	0.66	-0.91	87	0.33	0.53	0.70	0.83	0.87
	night	0.18	0.20	0.26	0.83	-0.41	98	0.22	0.45	0.63	0.79	0.88
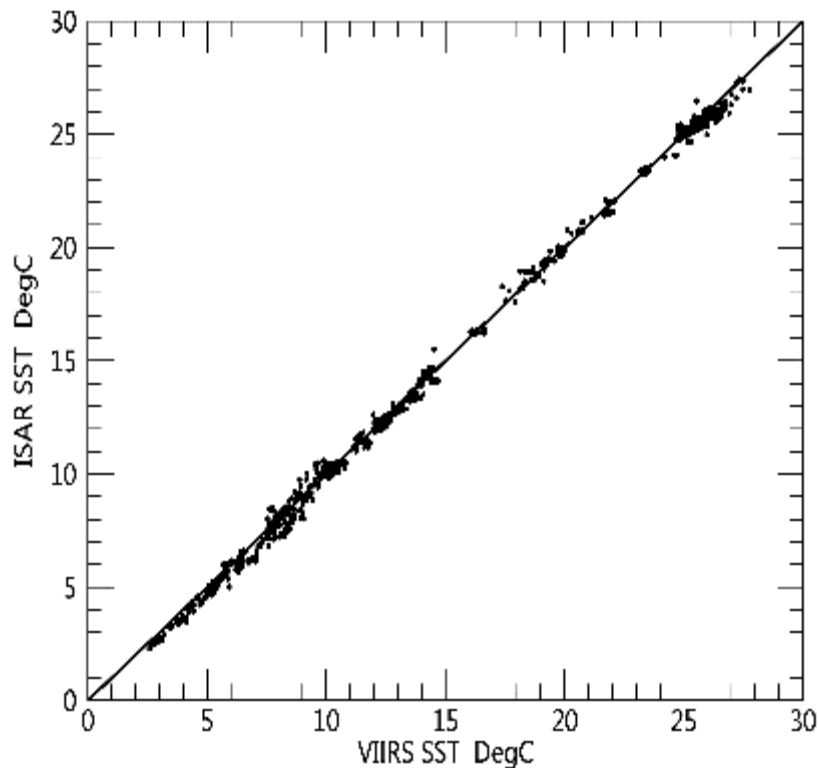
All matchups

Temporal window: 1 hour

Spatial window: 0.01°

No. of Matchup: 853

Bias: 0.14 K, Std. Dev.: 0.30 K
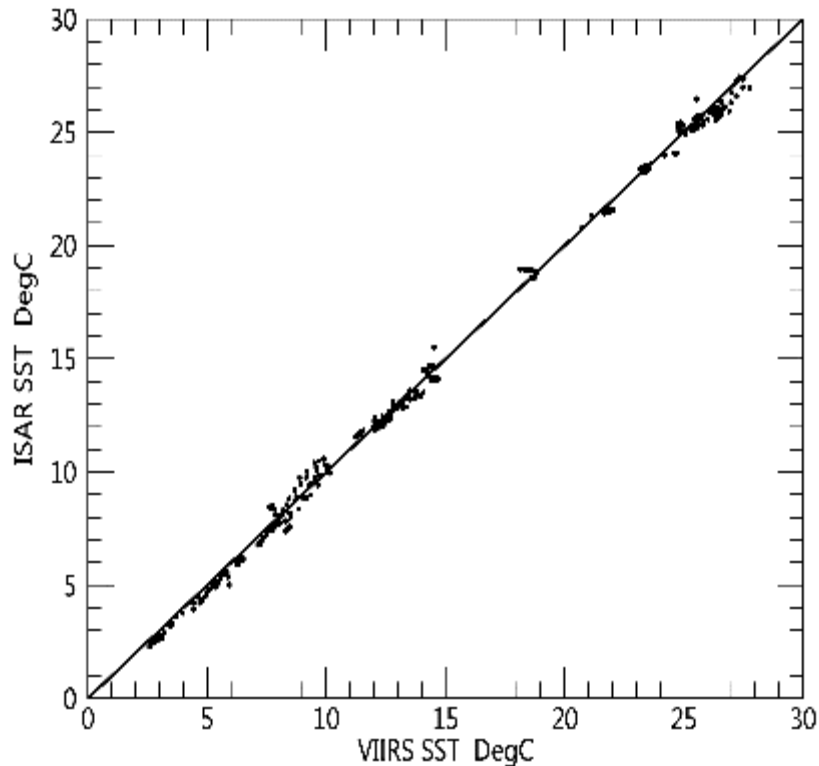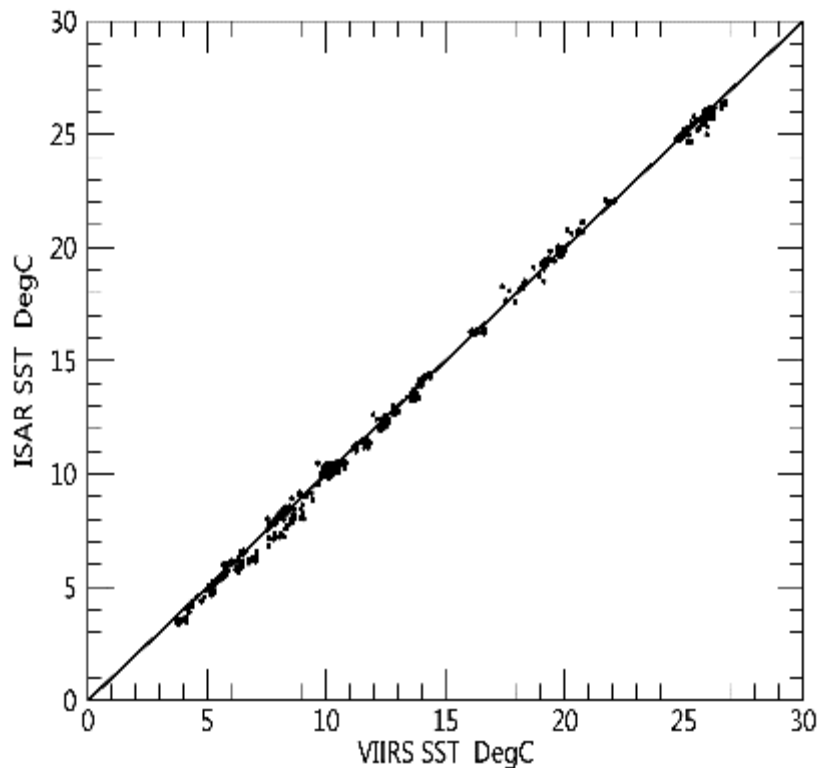
Daytime

Temporal window: 1 hour

Spatial window: 0.01°

No. of Matchup: 353

Bias: 0.14 K, Std. Dev.: 0.33 K

Nighttime

Temporal window: 1 hour

Spatial window: 0.01°

No. of Matchup: 500

Bias: 0.13 K, Std. Dev.: 0.29 K

✧ Shipboard measurements of the skin SST

✧ Evaluation of VIIRS SST

✧ Summary

- ✧ Continue ISAR deployment on RV DFH II

- ✧ Future OUCFIRST deployment on RV HD

- ✧ Future ISAR deployment on RV DFH III

- ✧ Produce multi-sensor SST mathups

Thank you