Inter-comparison of High-Resolution SST Climatologies over the Australian region

Yuwei Hu[1], Helen Beggs[2] and Xiao Hua Wang[1]

1. *The Sino-Australian Research Consortium for Coastal Management, School of Science, UNSW Canberra, Canberra, ACT, Australia*
2. *Bureau of Meteorology, Melbourne, Australia*

Questions

Uncertainty of using different SST climatology datasets?

Spatial and temporal features?

Optimal climatology dataset for extreme event studies?

Products and Method

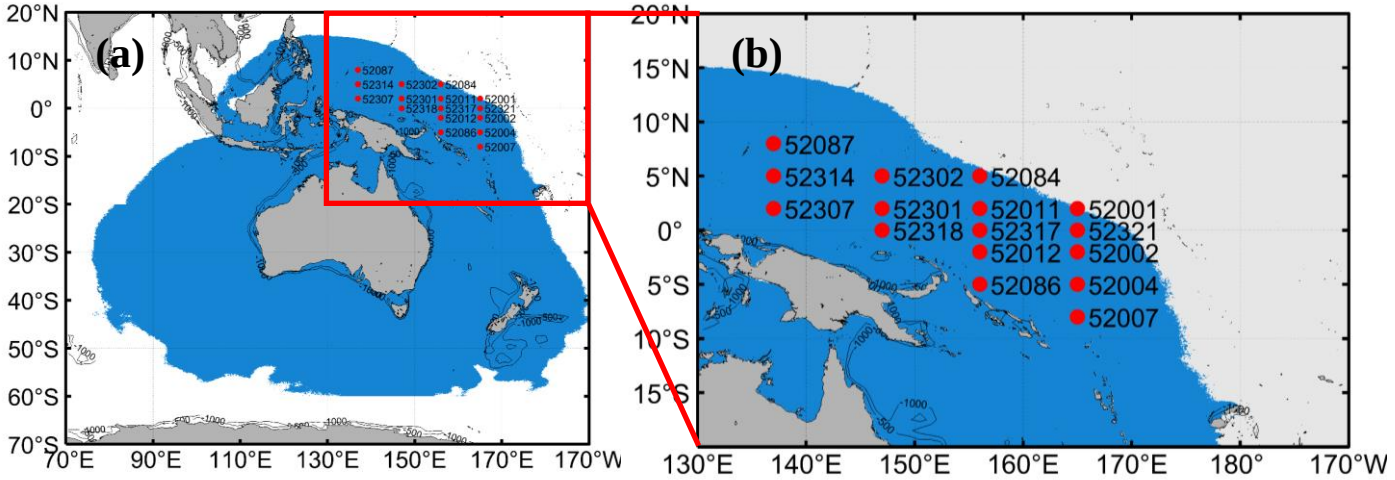
Climatology Datasets	Attributes				
	Spatial Resolution	Temporal Resolution	Reference Period	Data Source	Calculation Algorithm
CCI **CCI_1985** **CCI_1992** **CCI_1994**	0.05° (~5 km)	Daily Monthly Daily Daily	1981-2016 (36 years) 1985-2012 (28 years, Re-centered to 1988 + 2/7 date) 1992-2016 (25 years) 1994-2016 (23 years)	Climate Change Initiative (CCI) SST version 2.0 L4 analyses (daily SST0.2m)	Daily and Monthly averaging
AVHRR_OI	0.25°(~25km) to 0.05° (~5 km)	Daily	1981-2016 (36 years)	NCEI 0.25° daily AVHRR-Only optimum interpolation SST L4 analysis (OISST v2.0)	Daily averaging
CRW	0.05° (~5 km)	Monthly	1985-2012 (28 years, Re-centered to 1988 + 2/7 date)	OSTIA SST L4 Reanalysis (1985 - 2002) NOAA Geo-Polar Blended SST L4 reanalysis (2002 – 2012) (daily night-time SST0.2m)	Monthly averaging
SSTAARS	0.02° (~2 km) to 0.05° (~5 km)	Daily	1992-2016 (25 years)	IMOS AVHRR L3S composite (daily night-time SST0.2m)	Parametric model fitting
BRAN	0.1° (~10 km) to 0.05° (~5 km)	Daily	1994-2016 (23 years)	BRAN_2016 ocean model reanalysis (daily SST2.5m)	Daily averaging

Main attributes of the climatology datasets

Products and Method

Comparison Pairs	Control Factors				
	Day and Night time	Reference Period	Central Year	Calculation Algorithm	SST depth
(a) AVHRR_OI – CCI	√	√	√	√	√
(b) CRW – CCI_1985	×	√	√	√	√
(c) SSTAARS – CCI_1992	×	√	√	×	√
(d) BRAN – CCI_1994	√	√	√	√	×

Experiment pairs and main control factors



(a) SSTAARS domain
(b) TAO/TRITON Platform Code and location

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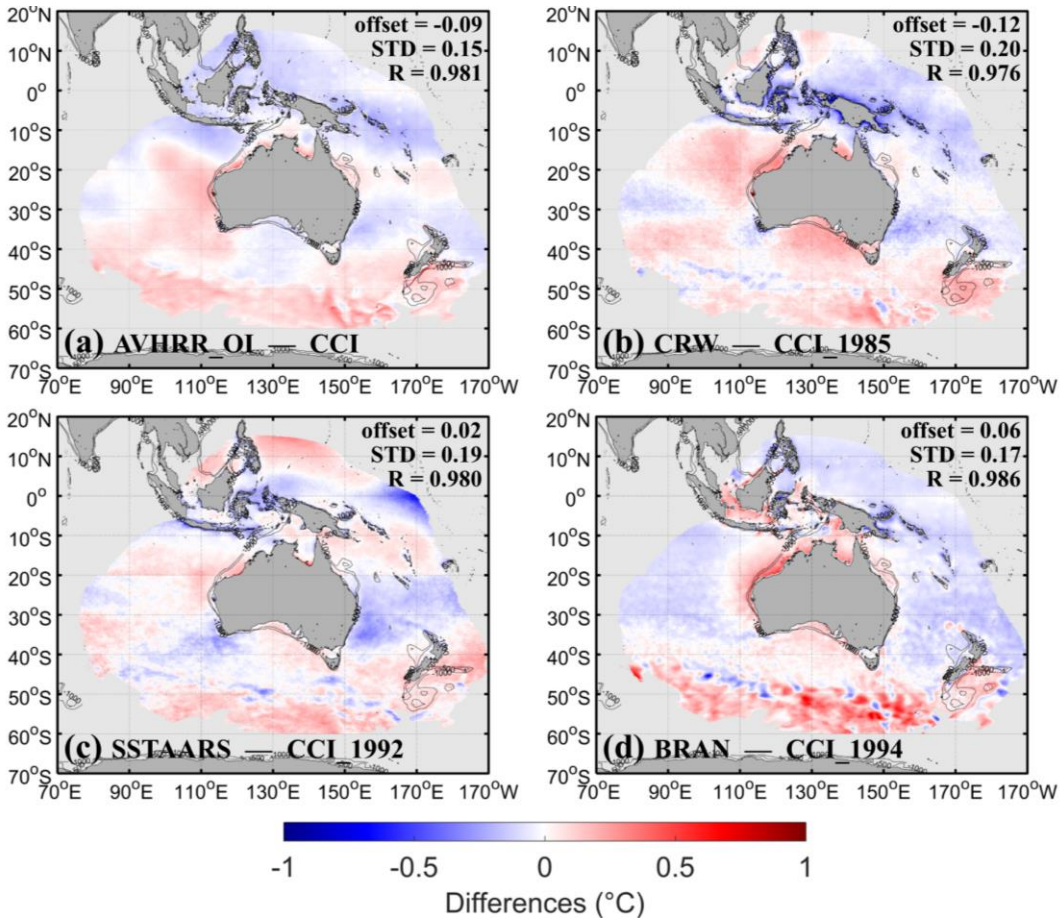
Relative Mean Difference

- STD ≤ 0.20˚C
- R > 0.97
- Colder: AVHRR_OI/CRW
- Warmer: SSTAARS/BRAN

Comparison Pairs	Results		
	Mean Bias (˚C)	Mean STD (˚C)	Mean R (correlation coefficient)
(a) AVHRR_OI – CCI	-0.09	0.15	0.981
(b) CRW – CCI_1985	-0.12	0.20	0.976
(c) SSTAARS – CCI_1992	0.02	0.19	0.980
(d) BRAN – CCI_1994	0.06	0.17	0.986



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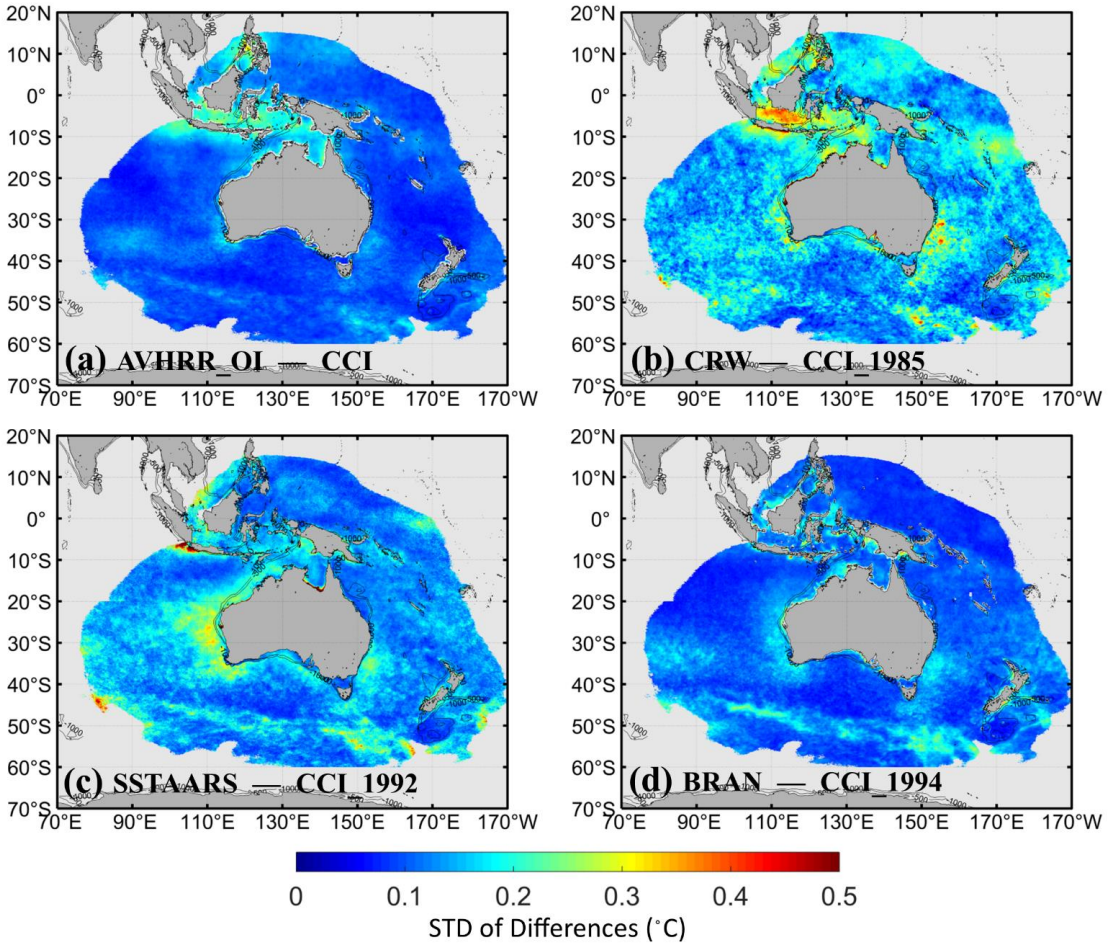
STD

- (a) smallest STD
- (b) noise pattern (geostationary satellite)
- (c) larger bias (L3S composite data)
- (d) similar to (c) but smaller



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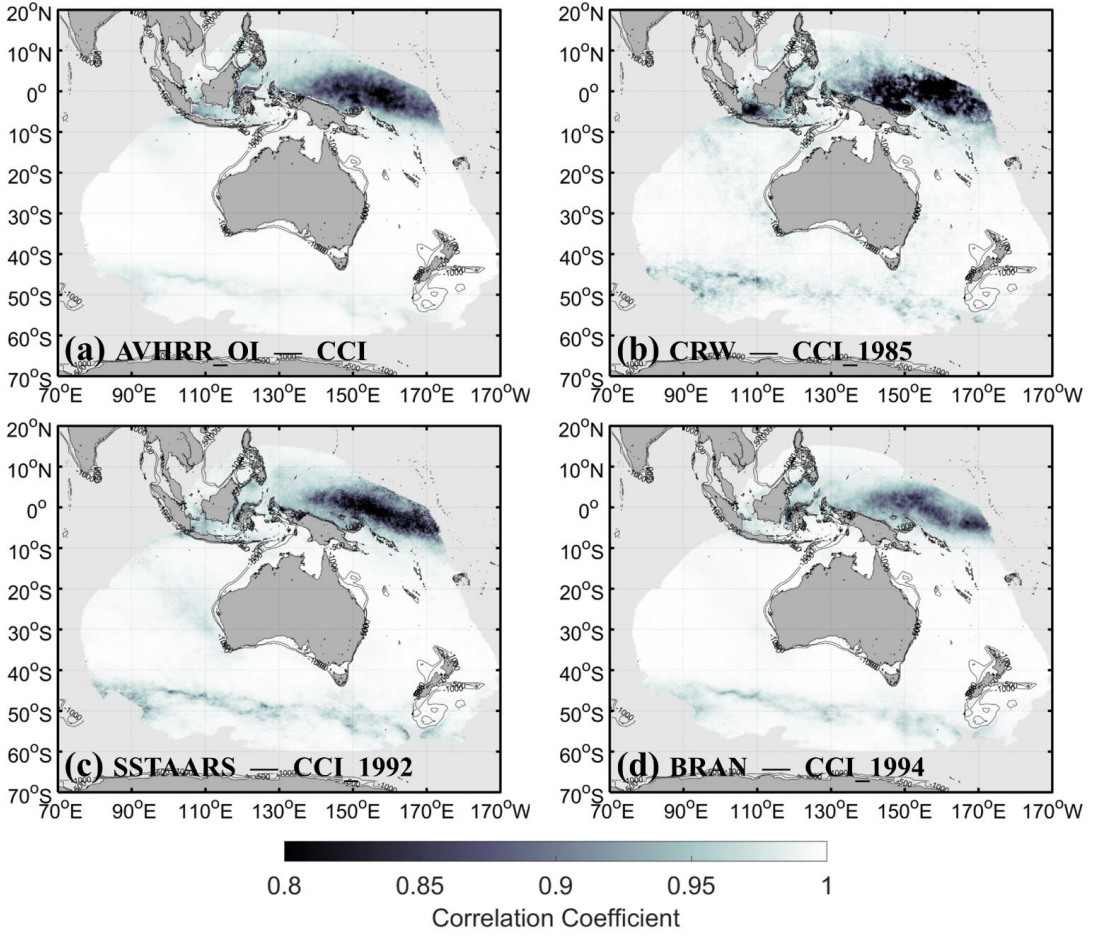
R

- Similar distributions
- 90% > 0.95
- Smaller amplitudes of seasonal cycle



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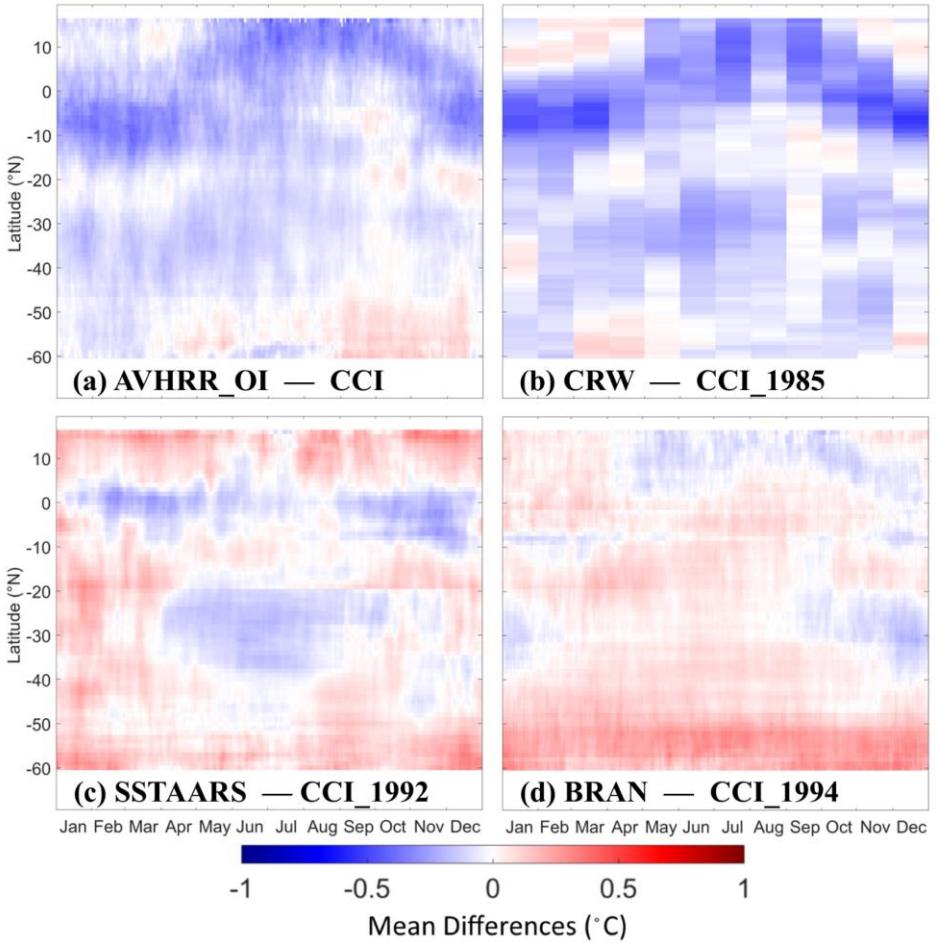
Temporal distribution along latitudes

- (a), (b) and (d) relative cold bias band in tropical
- Cloud coverage (monsoon season)
- (c) constant cold bias in tropical
- (c) larger amplitude (~0.3˚C) in midlatitude region



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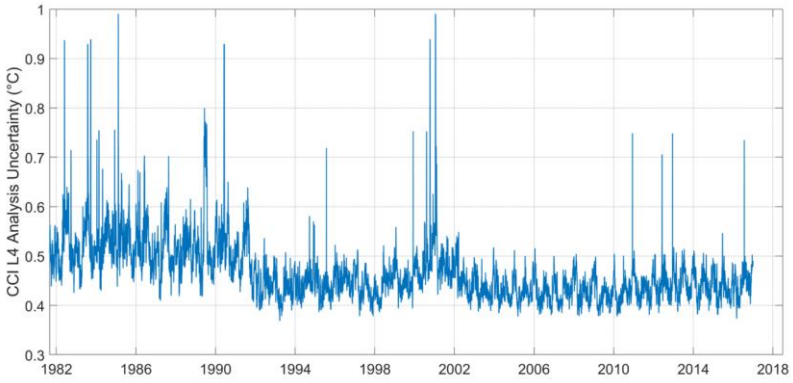
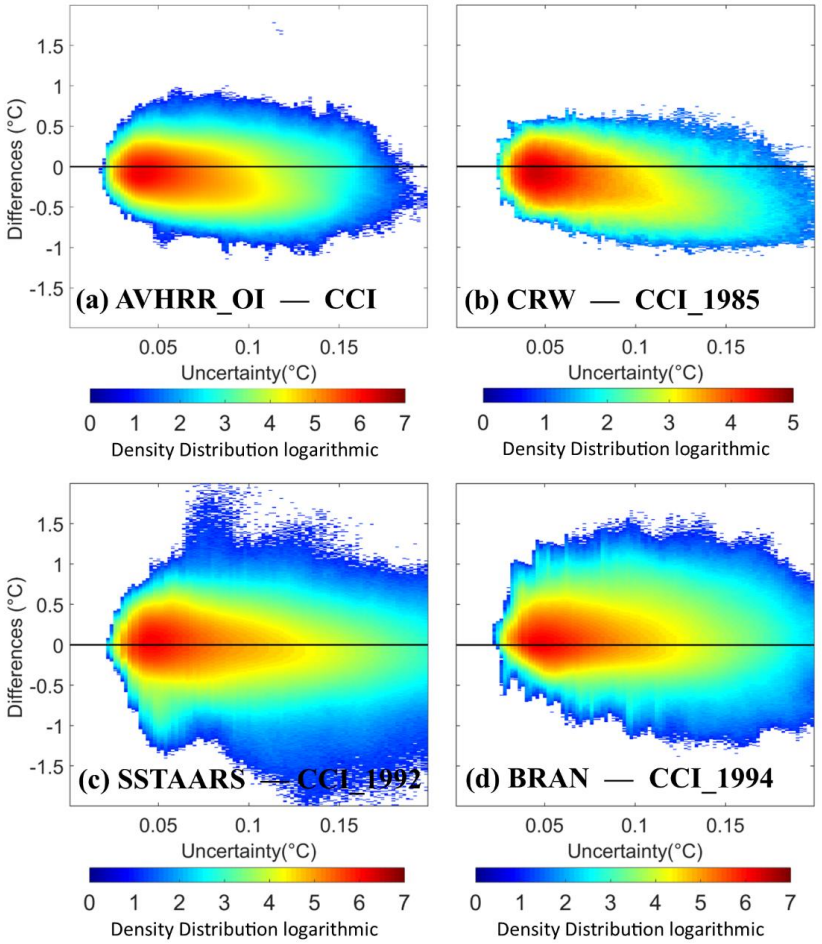
Density distribution along CCI uncertainty

- (a) and (b) larger cold bias tail — larger uncertainty
- (c) evenly distributed — larger scattering areas
- (d) evenly distributed — warm mean bias

CCI uncertainty (Root mean square)





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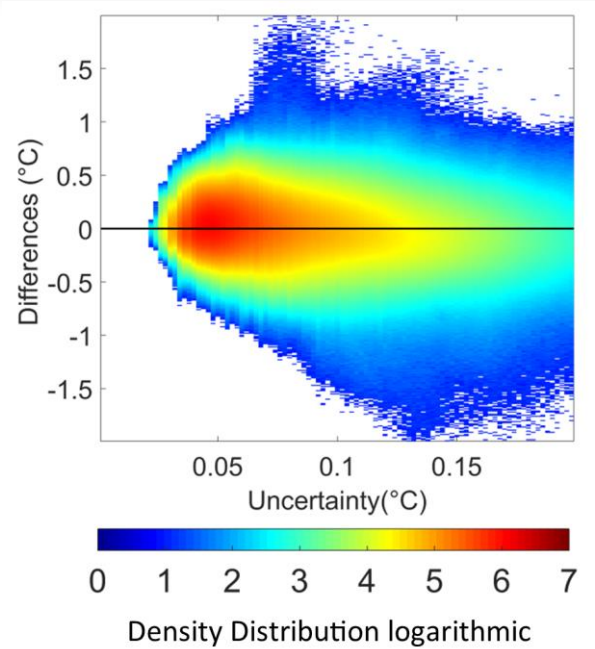
TAO/TRITON mooring validation



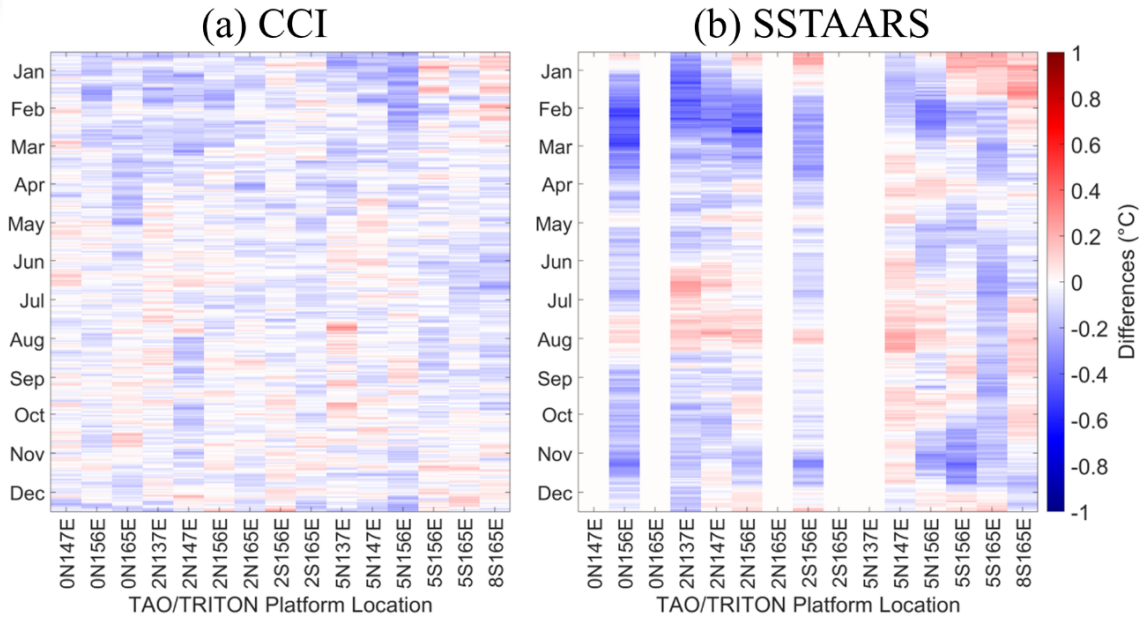
- Removed data in east tropical

Platform Code	Latitude (°N)	Longitude (°E)	CCI			SSTAARS			
			Bias	STD	R	Bias	STD	R	Error
52318	0	147	-0.01	0.06	0.94				
52317	0	156	-0.06	0.07	0.93	-0.16	0.14	0.76	0.07
52321	0	165	-0.05	0.08	0.92				
52307	2	137	-0.03	0.08	0.95	-0.12	0.16	0.84	0.06
52301	2	147	-0.07	0.08	0.89	-0.08	0.13	0.78	0.06
52011	2	156	-0.03	0.07	0.94	-0.06	0.14	0.83	0.07
52001	2	165	-0.05	0.06	0.97				
52012	-2	156	-0.02	0.06	0.94	-0.08	0.12	0.81	0.06
52002	-2	165	-0.05	0.07	0.93				
52314	5	137	-0.03	0.10	0.97				
52302	5	147	-0.03	0.08	0.97	0.02	0.10	0.95	0.07
52084	5	156	-0.08	0.10	0.94	-0.07	0.13	0.84	0.08
52086	-5	156	-0.03	0.08	0.98	-0.05	0.13	0.90	0.06
52004	-5	165	-0.03	0.07	0.93	-0.11	0.12	0.84	0.07
52007	-8	165	-0.03	0.09	0.98	0.02	0.11	0.95	0.06
Mean			-0.04	0.08	0.97	-0.07	0.14	0.86	0.07

- Unmatched location and period
- Low input data density of SSTAARS
- Red mark: $R_{CCI} < 0.9$ $R_{SSTAARS} < 0.8$
- Unmatched seasonal cycle

TAO/TRITON mooring validation

- Day and night time data
- Diurnal warming
- Receiving station distance



Daily difference

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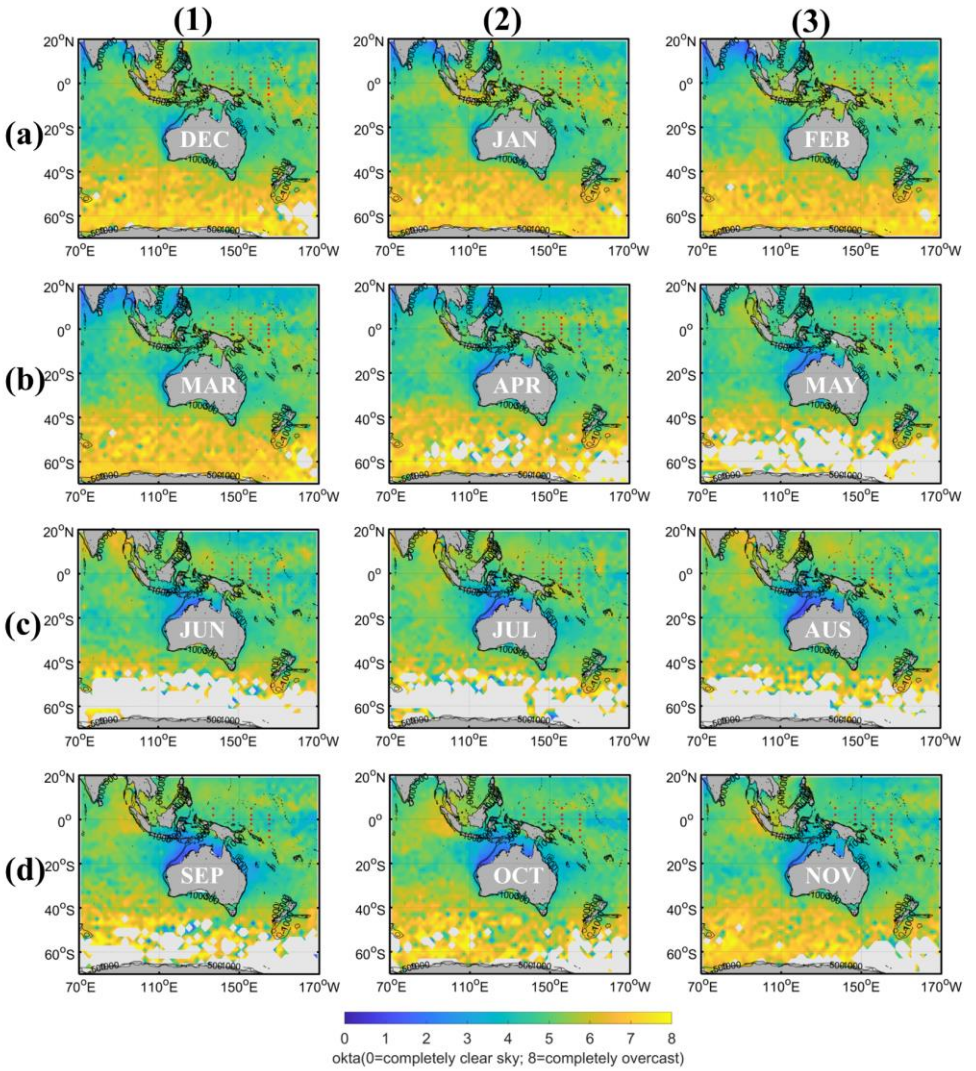
Cloudiness

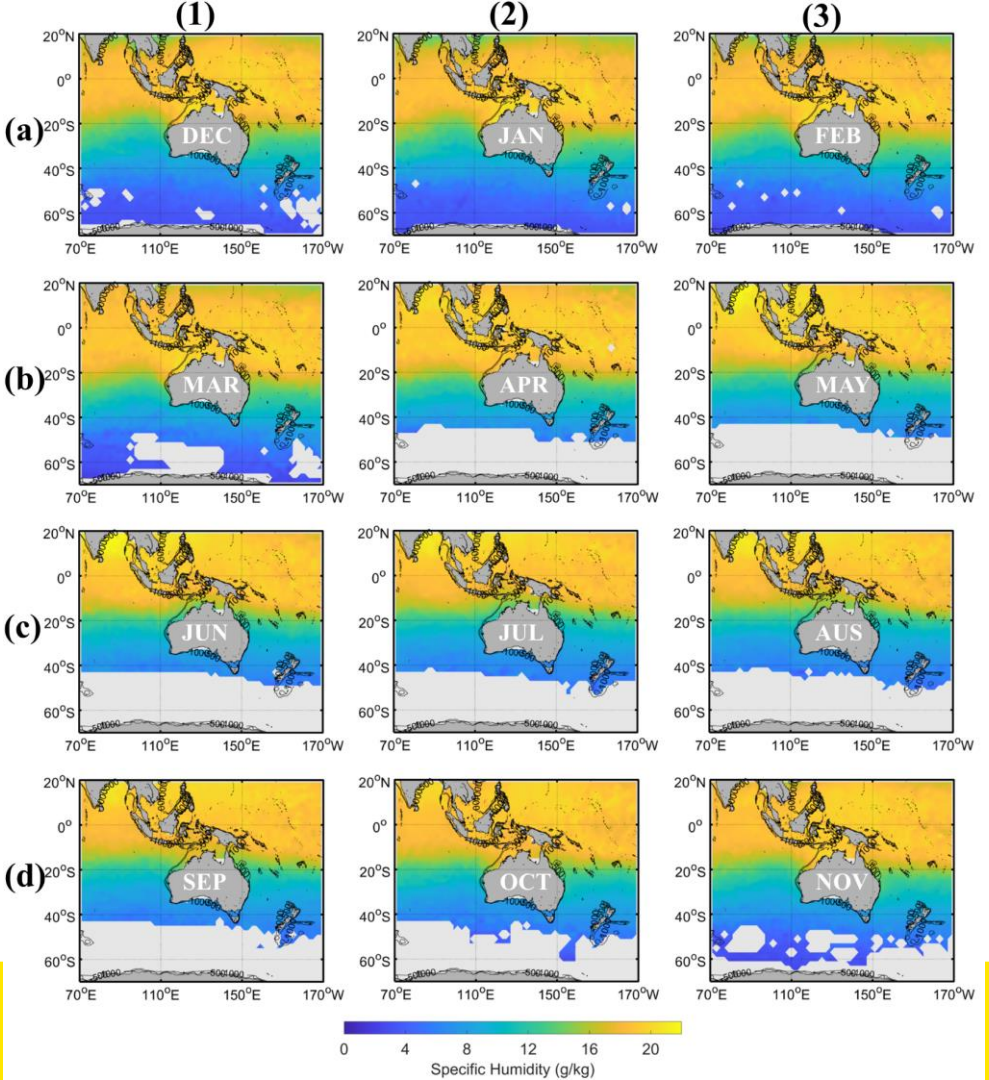
- The International Comprehensive Ocean-Atmosphere Data Set (ICOADS)
- 2 degree
- Monthly climatology (1981-2010)

- Eastern tropical areas in summer
- Lower data density
- Low R-values



Specific humidity

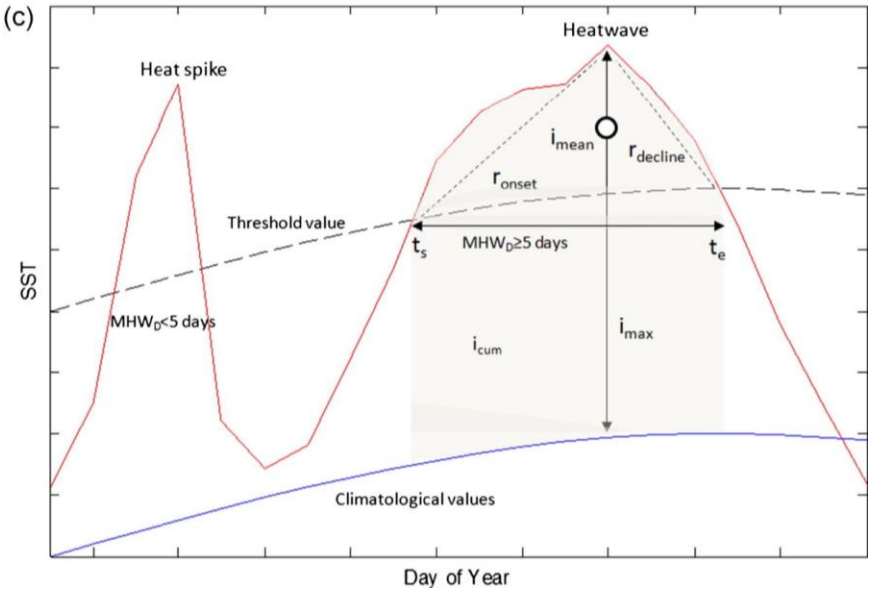
- Transition around 20˚S
- Sharp decrease in surface water vapor
- Different cloud detection method
- Abruption of bias at 20˚S in pair (c) SSTAARS – CCI_1992



Marine Heatwave (MHW)

MHW

- anomalous warm events
- days to months
- hundreds to thousands kilometres
- surface to subsurface



- Temperature over threshold
- Longer than five consecutive days (after Hobday et al., 2016)

(Credit: Hobday et al., 2016)

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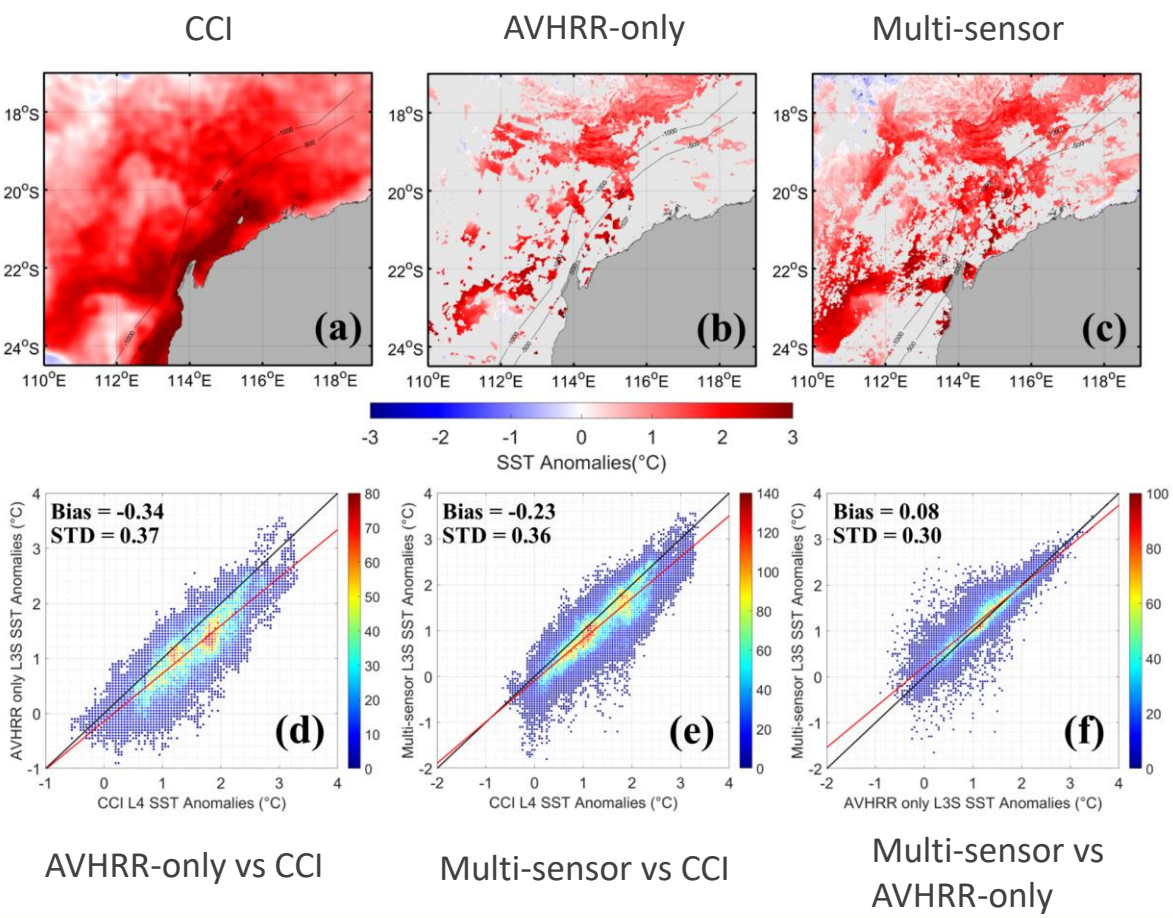
MHW case study

- CCI L4 – CCI_1992
- IMOS AVHRR-only L3S – SSTAARS
- IMOS Multi-sensor L3S – SSTAARS
- 1st February 2013
- SSTAARS warmer than CCI
- Agreements on SST gradients



AVHRR-only vs CCI

Multi-sensor vs CCI

Multi-sensor vs AVHRR-only

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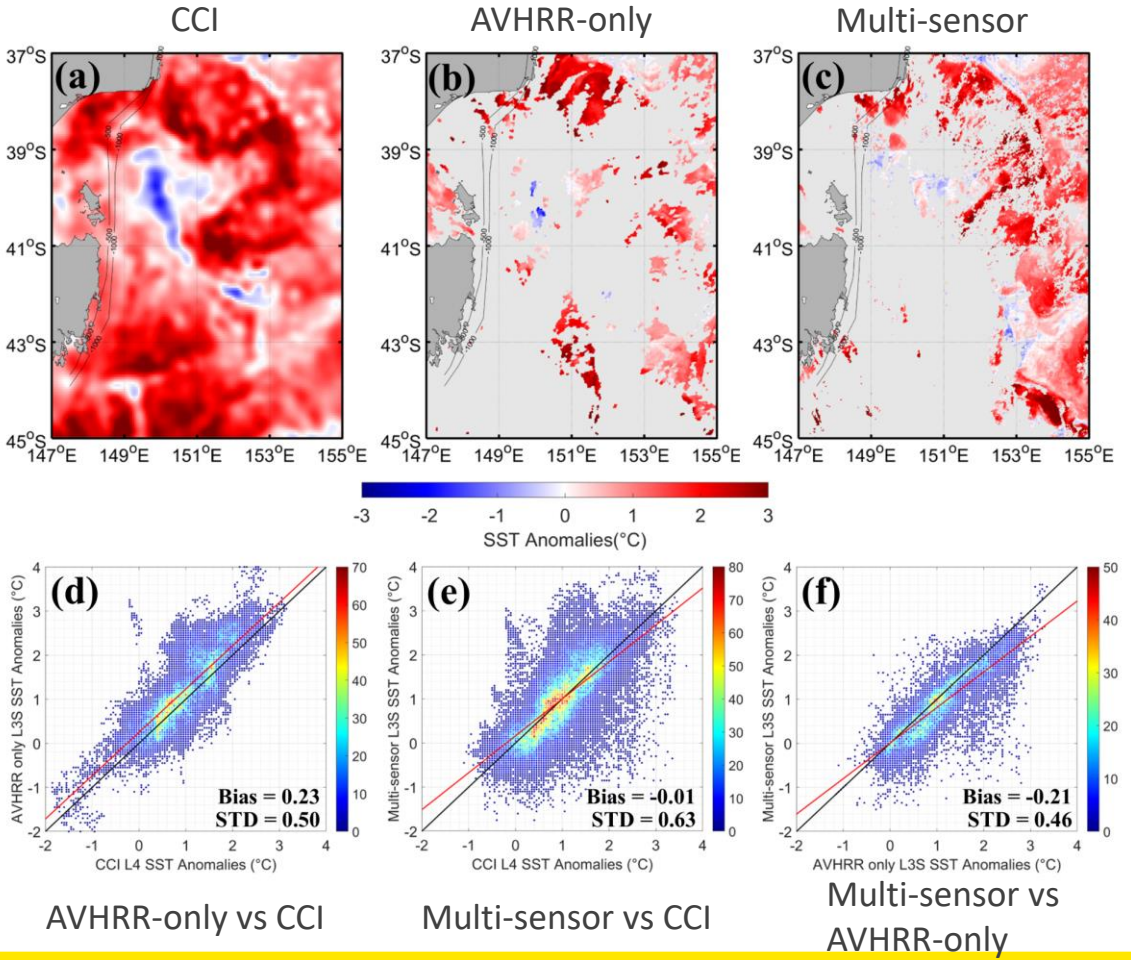
MHW case study

- 1st March 2016
- SSTAARS – CCI_1992: a combination of warm and cold differences
- AVHRR-only warmer than Multi-sensor



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Summary

- SSTAARS has the closest agreement with the CCI.
- BRAN_2016 is warmer than CCI over the west and south, AVHRR_OI and CRW climatology are generally colder.
- Bias in the east tropical region should be considered for SSTAARS.
- CCI; SSTAARS: finer SST gradient features
- Decision-making

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Thanks for your attention!

The full contents are available in this published paper:

Hu, Y., Beggs, H., & Wang, X. H. (2021). Intercomparison of high-resolution SST climatologies over the Australian region. Journal of Geophysical Research: Oceans, 126, https://doi.org/10.1029/2021JC017221