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Comparison of SST diurnal variation models over the Tropical Warm Pool

Haifeng Zhang[1, 2, 7], Helen Beggs[3], Xiao Hua Wang[1, 2], José Rodríguez[4], Livia Thorpe[4], Michael Brunke[5], Leon Majewski[3], Andrew E. Kiss[1, 2, 7] and Chelle Gentemann[6]

[1]The Sino-Australian Research Centre for Coastal Management, The University of New South Wales, Canberra, Australia
[2]School of Physical, Environmental and Mathematical Sciences, The University of New South Wales, Canberra, Australia
[3]Bureau of Meteorology, Melbourne, Australia
[4]Met Office, Exeter, UK
[5]Department of Hydrology and Atmospheric Sciences, The University of Arizona, Tucson, Arizona, USA
[6]Earth and Space Research, Seattle, Washington, USA
[7]ARC Centre of Excellence for Climate System Science

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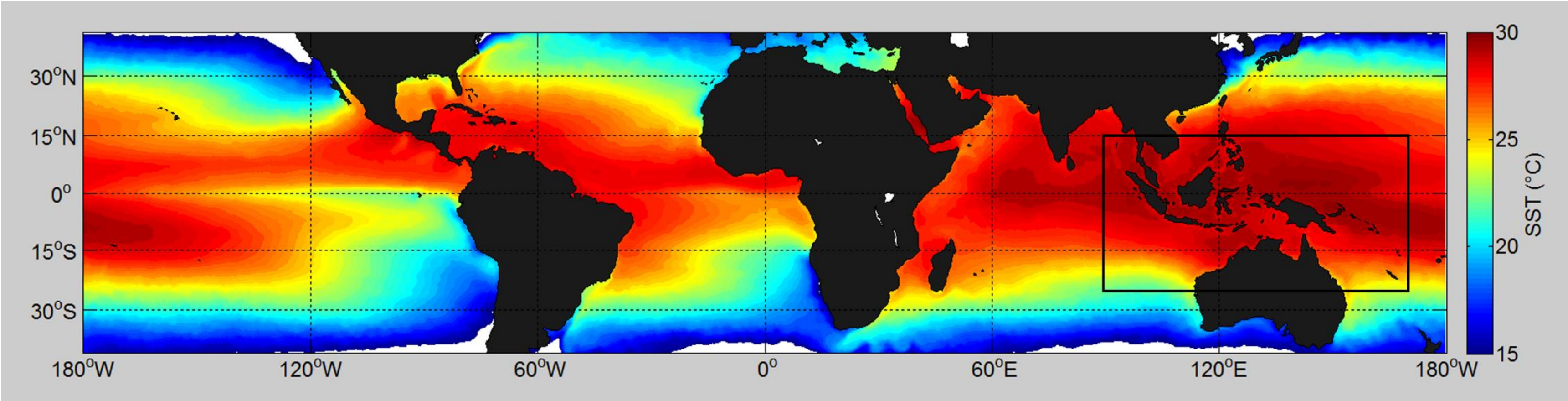
❑ Why compare the SST Diurnal Variation (DV) models over the TWP region?

- An inter-comparison between different DV models could potentially provide useful information to NWP/climate modellers and producers of skin SST analyses/forecasts.
- The TWP region is chosen for its: a) globally highest annual average SST over a large domain; b) relatively calm winds and high cloud-free values of solar shortwave insolation (SSI); and c) frequent large-amplitude DV events.
- This study uses data and DV model outputs from the GHRSST Tropical Warm Pool DV ("TWP+") Data Set, collated by the Bureau of Meteorology.



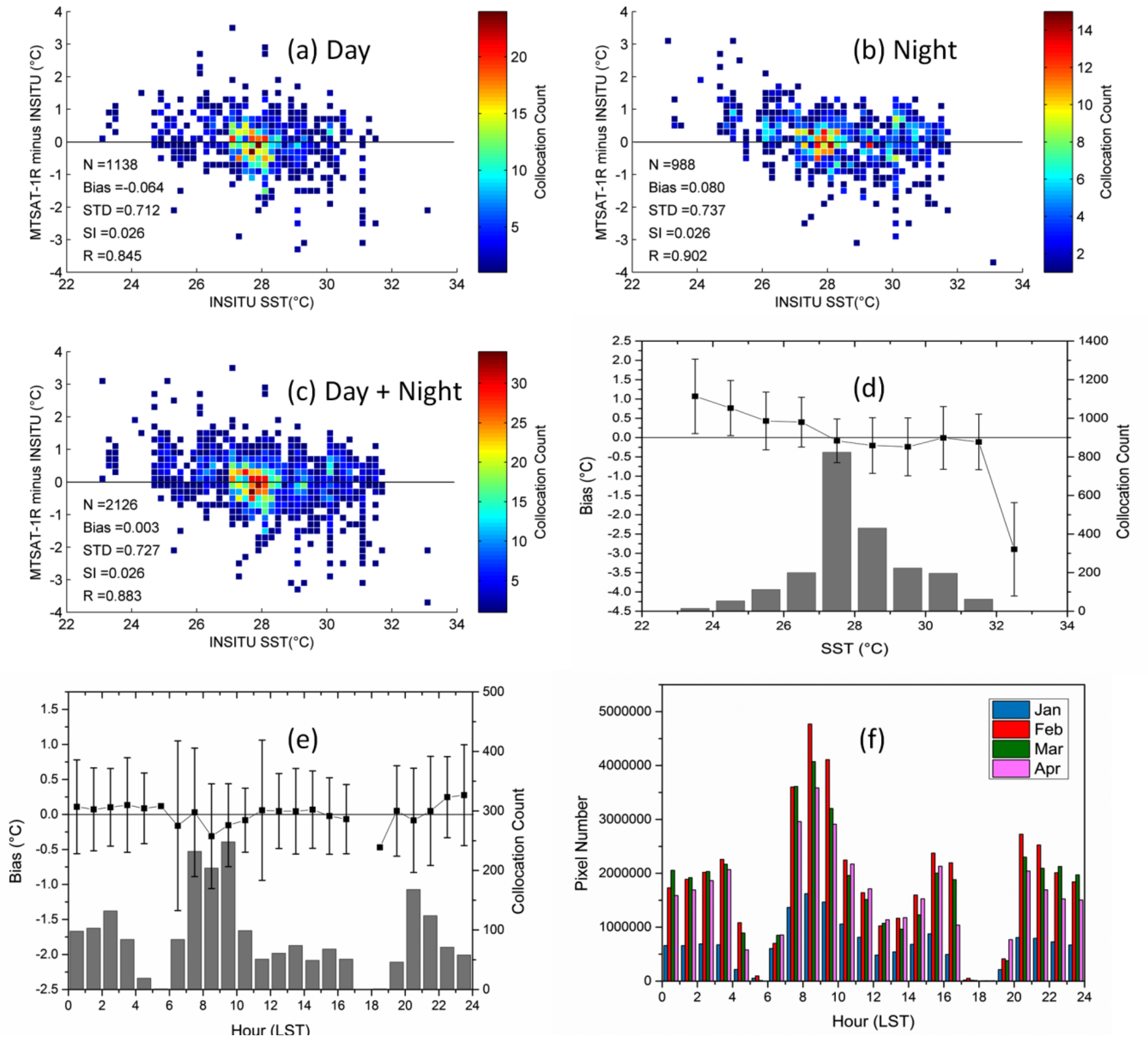
2 DV Models and Data Sets

Four DV models + MTSAT-1R reference data

	Type	Meteorological Inputs	SSTfnd Source	Produce SSTskin DV?
CG03 [Gentemann et al., 2003]	Empirical	NWP model (ACCESS-R)	RAMSSA (to generate SSTsubskin)	NO
ZB05 [Zeng and Beljaars, 2005]	Physical	NWP model (ACCESS-R)	RAMSSA	YES
ZB+T [Takaya et al., 2010]	Physical	NWP model (ACCESS-R)	RAMSSA	YES
UMGC2 [Williams et al., 2015]	Air-Sea Coupled Model + ZB05 warm layer + Artale cool skin	Within the model	$SST_{3.86m}$ within the ocean sub-model	YES

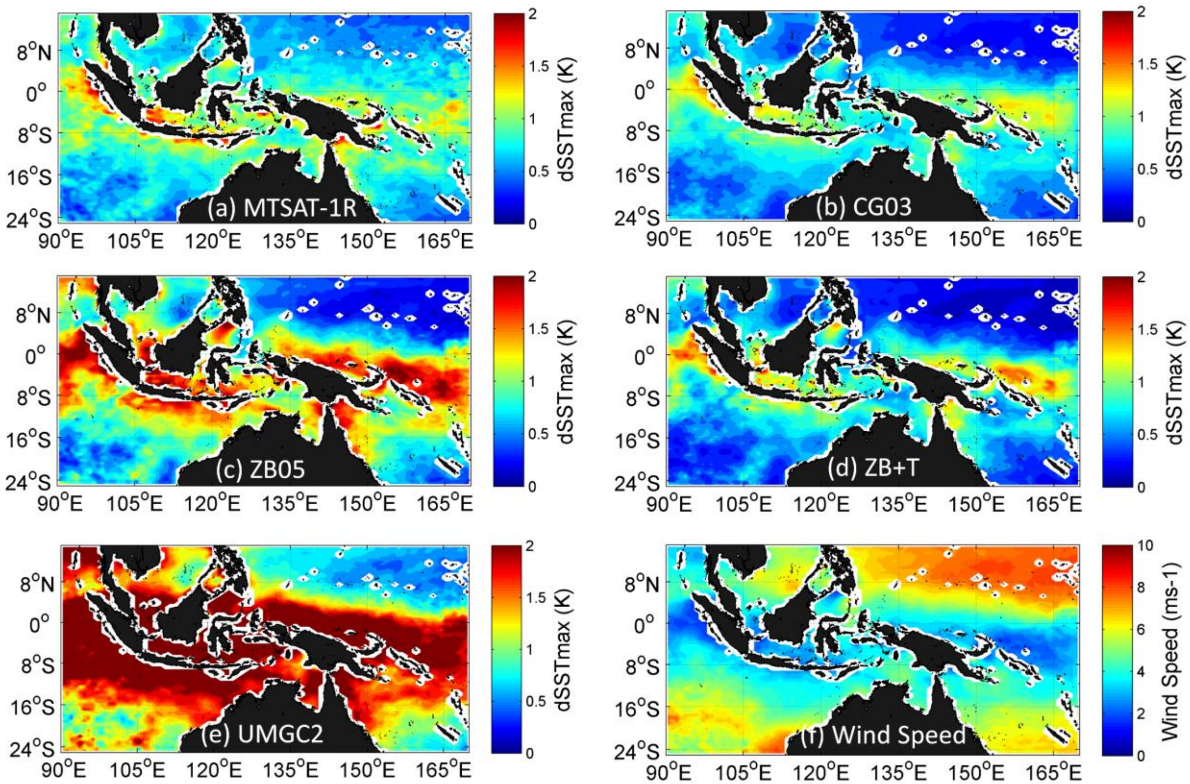
- Reference data set: hourly, 0.05º, V3 MTSAT-1R SST produced by BoM (1st Jan – 30th Apr 2010)
- SSTsubskin DV from all models are investigated as both CG03 and MTSAT-1R can only produce SSTsubskin DV.
- SSTfnd = 0:30 LST – 5:30 LST SSTsubskin from MTSAT-1R and DV models
- Data selected where at least 15 valid MTSAT-1R SST values are within the local day at that grid cell

- TWP+ V3 MTSAT-1R SST Validation (Zhang et al., 2016, *Rem. Sens. Env.*)



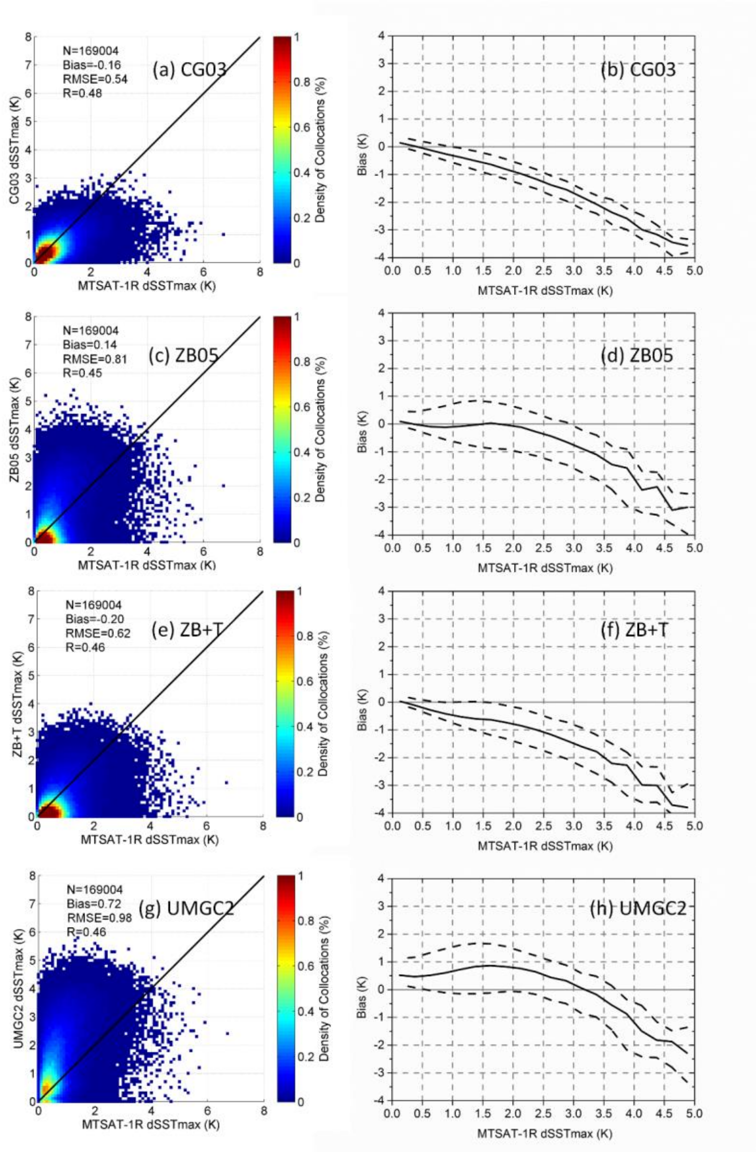
❑ Spatial distributions of average dSSTmax values and the collocated wind speed

- dSST: hourly SST – SSTfnd within a local day
- dSSTmax: maximum dSST within a local day



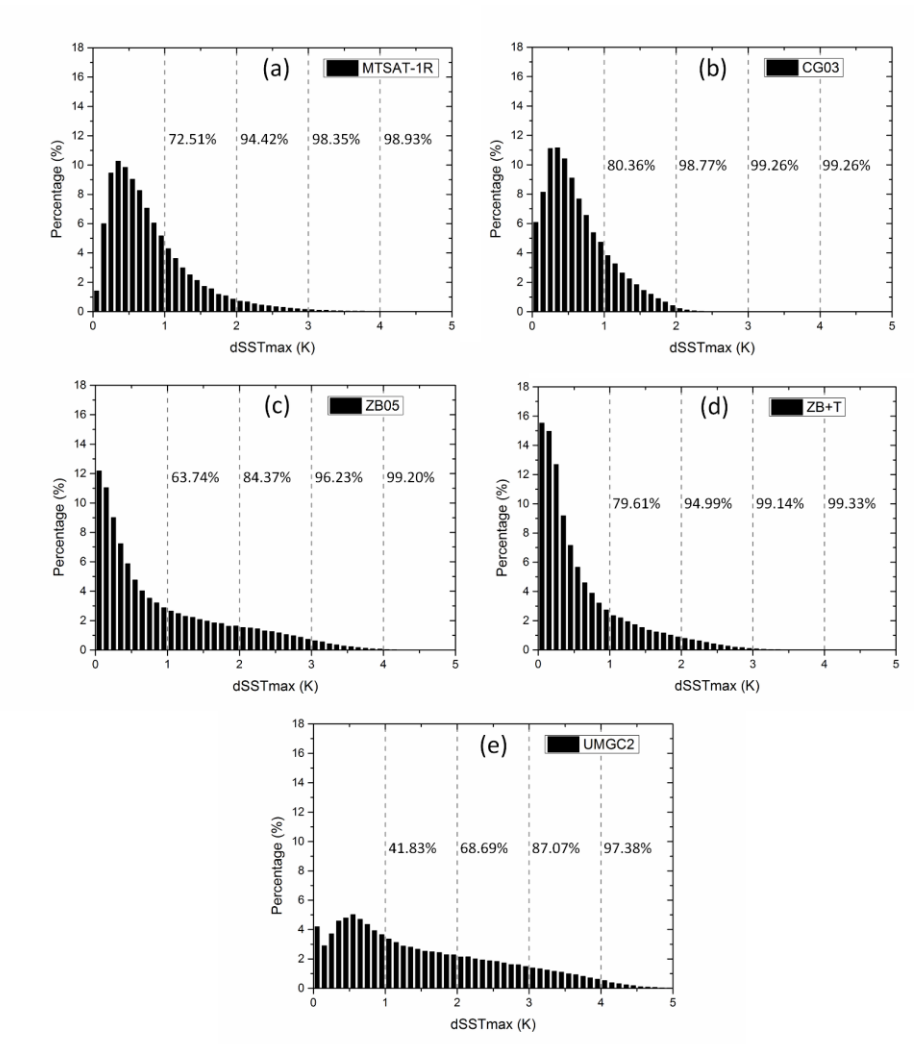
- CG03 and ZB+T:
  - ✓ Reflecting the distribution quite well, both spatially and amplitude-wise
- ZB05:
  - ✓ Good spatial agreement, but with larger amplitudes for most DV events
- UMGC2:
  - ✓ Strong DV overestimation over a much larger region

❑ Validation of modelled dSSTmax against MTSAT-1R dSSTmax



- Overall **moderate** agreement between the models and the observations with correlation coefficients between 0.45-0.48
- For all models, **large DV** leads to increasingly **negative** dSSTmax bias.

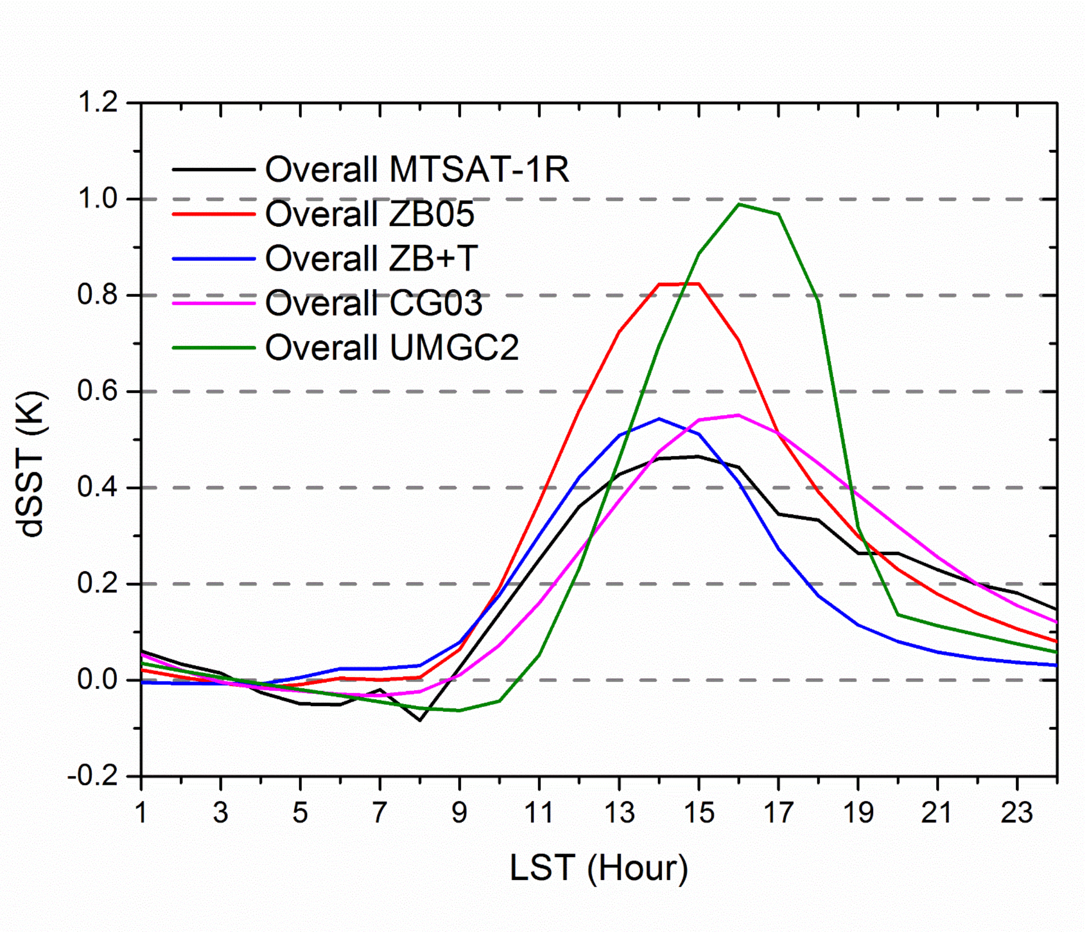
Distribution of MTSAT-1R and modelled dSSTmax values



Compared with MTSAT-1R,

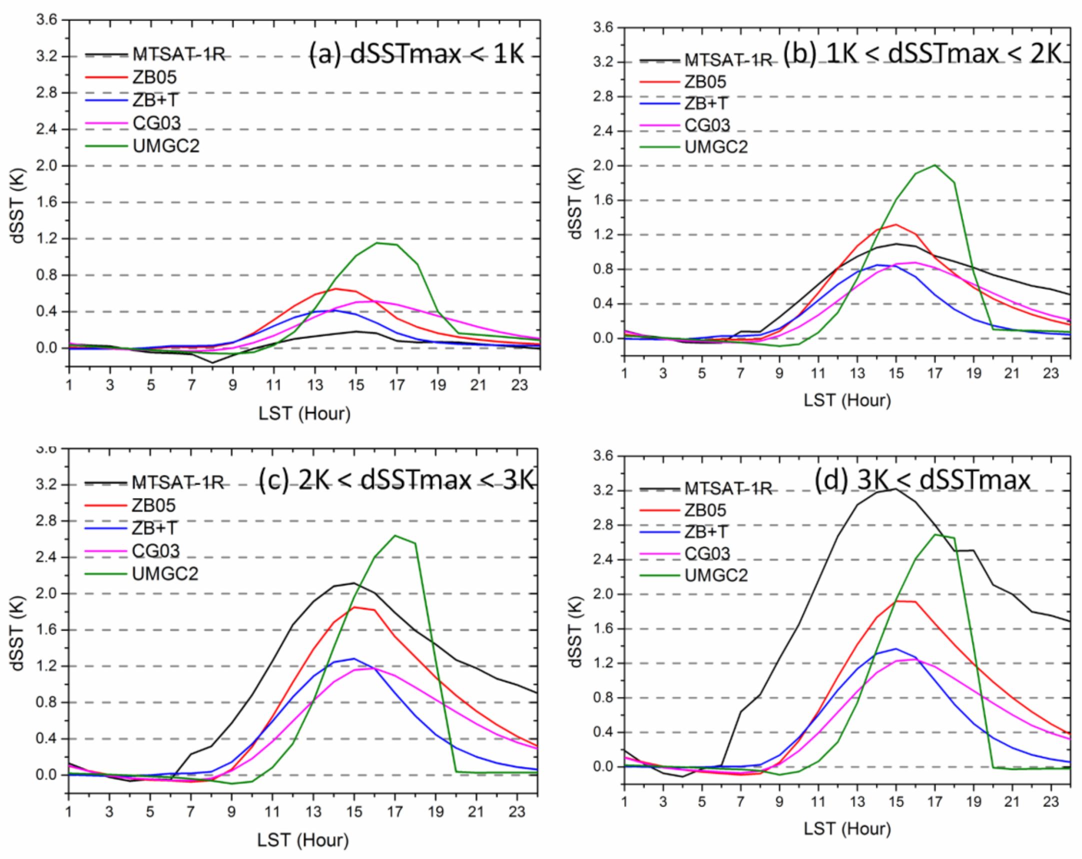
- CG03:
  - ✓ Best captures the MTSAT-1R shape, especially for dSSTmax < 1 K
  - ✓ Too many (few) 0-0.1 K(> 3 K) events
- ZB05:
  - ✓ 8.8% fewer dSSTmax values < 1 K and 7.8% more between 2-3 K.
- ZB+T:
  - ✓ Significantly more dSSTmax < 0.3 K
  - ✓ Close to MTSAT-1R shape for dSSTmax > 0.5 K
- UMGC2:
  - ✓ Too many dSSTmax > 2 K and > 3 K

Average DV cycles for all four months



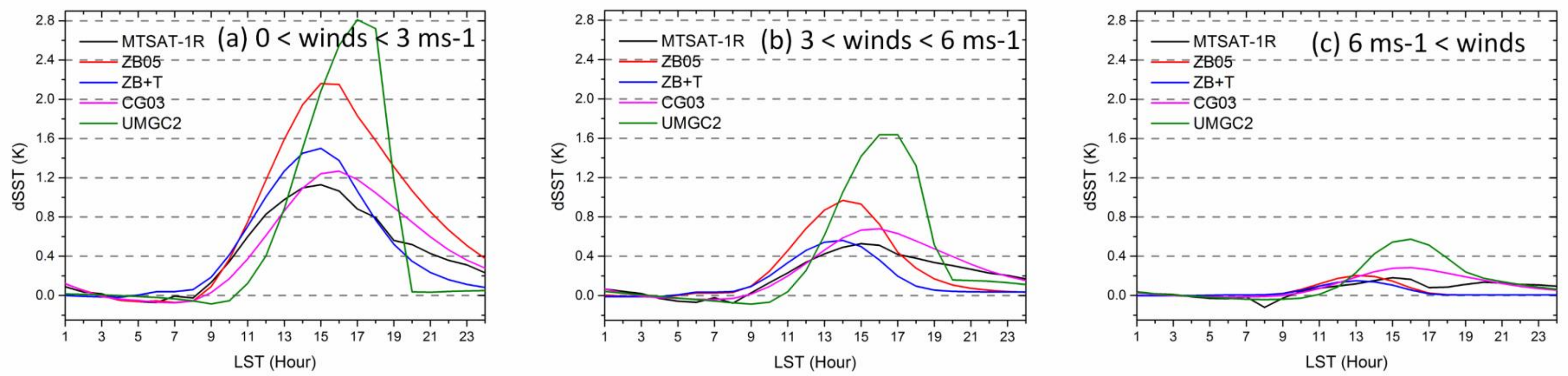
- Good agreement for CG03 and ZB+T
- Positive bias in ZB05
- UMGC2:
  - ✓ Largest positive bias
  - ✓ Warming starts (~10 LST) and peaks (16-17 LST) 1-2 hr later than MTSAT-1R

Average DV cycles for different MTSAT-1R dSSTmax conditions



- 1 K < dSSTmax < 2 K:
  - ✓ Best agreement between MTSAT-1R and CG03, ZB05, and ZB+T
- dSSTmax > 3 K:
  - ✓ All models underestimate the DV.

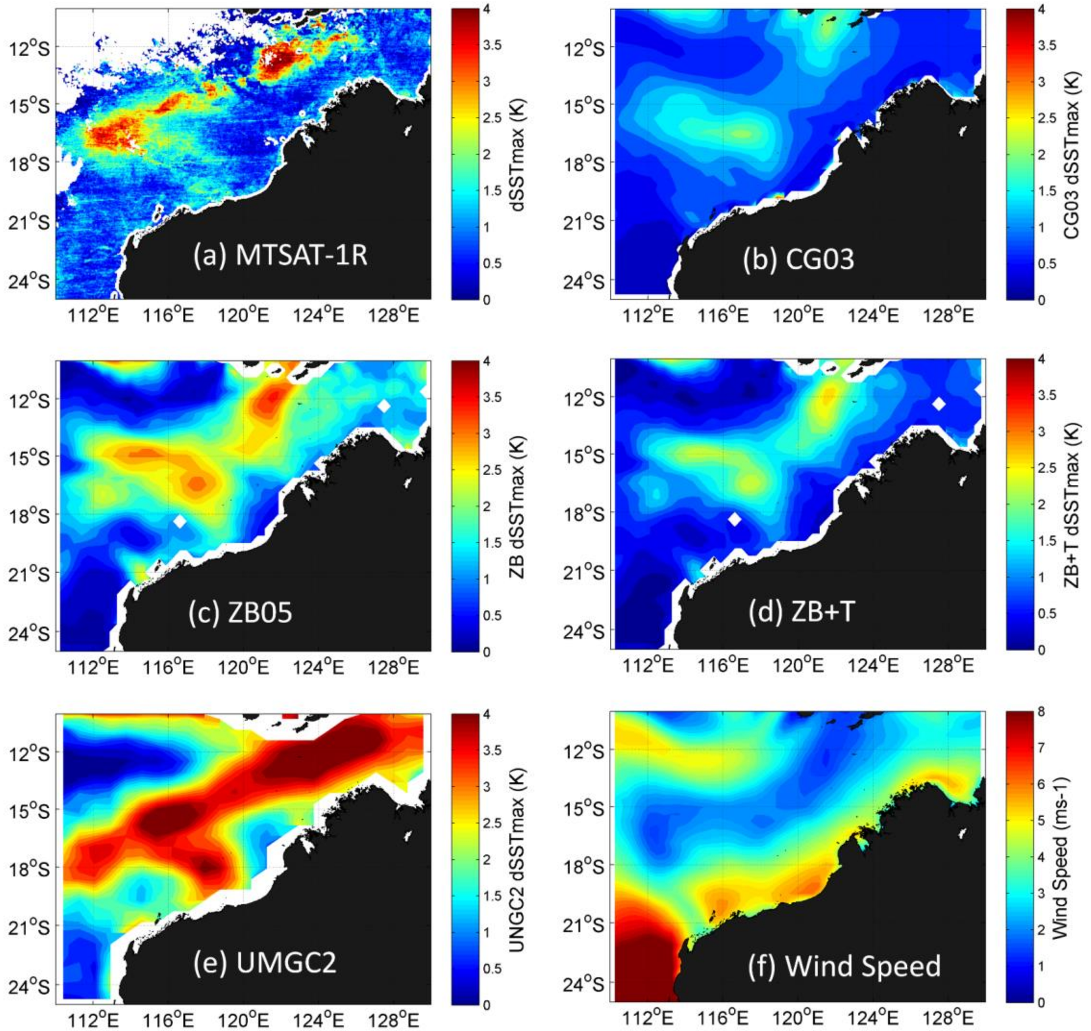
Average DV cycles for different wind conditions



- Low wind speed conditions:
  - ✓ All models tend to overestimate the observed dSSTmax values.
- High wind speed conditions:
  - ✓ Noticeable overestimation found in UMGC2

A case study on 6th March 2010

06/03/2010



- ZB05 best captures this large DV event observed in MTSAT-1R in this case study.

4 Conclusions

- In general, all models are able to resolve the DV patterns under most conditions. However, statistically, they all underestimate very large DV events (with dSSTmax > 2-3 K).
- Specifically,
  - CG03 agrees well with MTSAT-1R data for small to moderate DV events (dSSTmax < 2 K) but predicts few dSSTmax values > 3 K.
  - ZB05 tends to overestimate small to moderate DV events, but can potentially predict large DV cases more accurately.
  - As an updated version of ZB05, the skill of ZB+T is improved, showing better estimation in most DV ranges and in terms of the spatial distribution and amplitude.
  - UMGC2 has a clear tendency to highly overestimate DV events. 1-2 hr lags in warming start and peak times in UMGC2 are also found.

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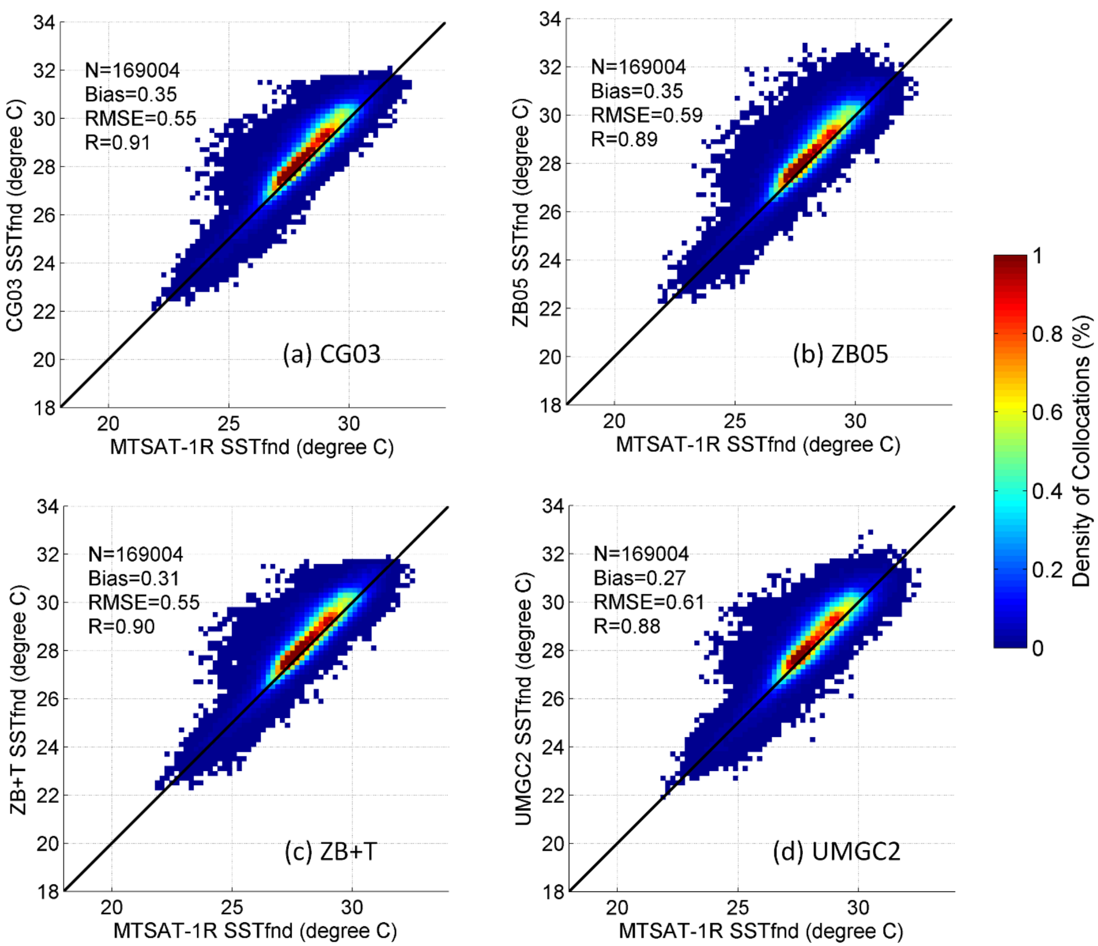
THANK YOU!

Questions?

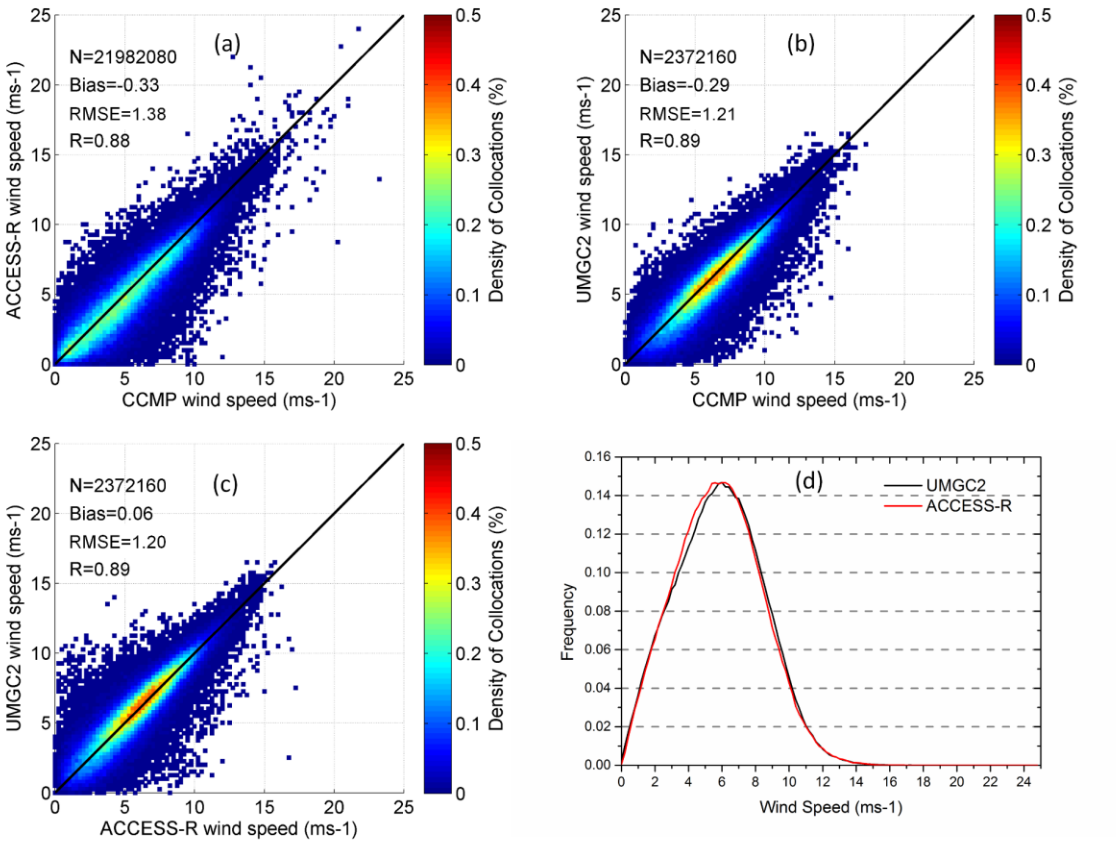
Extra Slides for Discussion

Comparison of modelled SSTfnd with MTSAT-1R SSTfnd



- SSTfnd data are compared to examine:
  - ✓ the performance of modelled SSTsubskin without DV
  - ✓ the effectiveness of our SSTfnd construction method
- Similar performance for all four models are observed:
  - ✓ UMGC2 uses SST3.86m in FOAM, rather than RAMSSA as used in other three models

Comparison of UMGC2/ACCESS-R winds against CCMP winds



- Both wind data sets perform similarly well against Cross-Calibrated Multi-Platform (CCMP) winds.
- The large positive error in UMGC2 must come from other factors within the coupled model.

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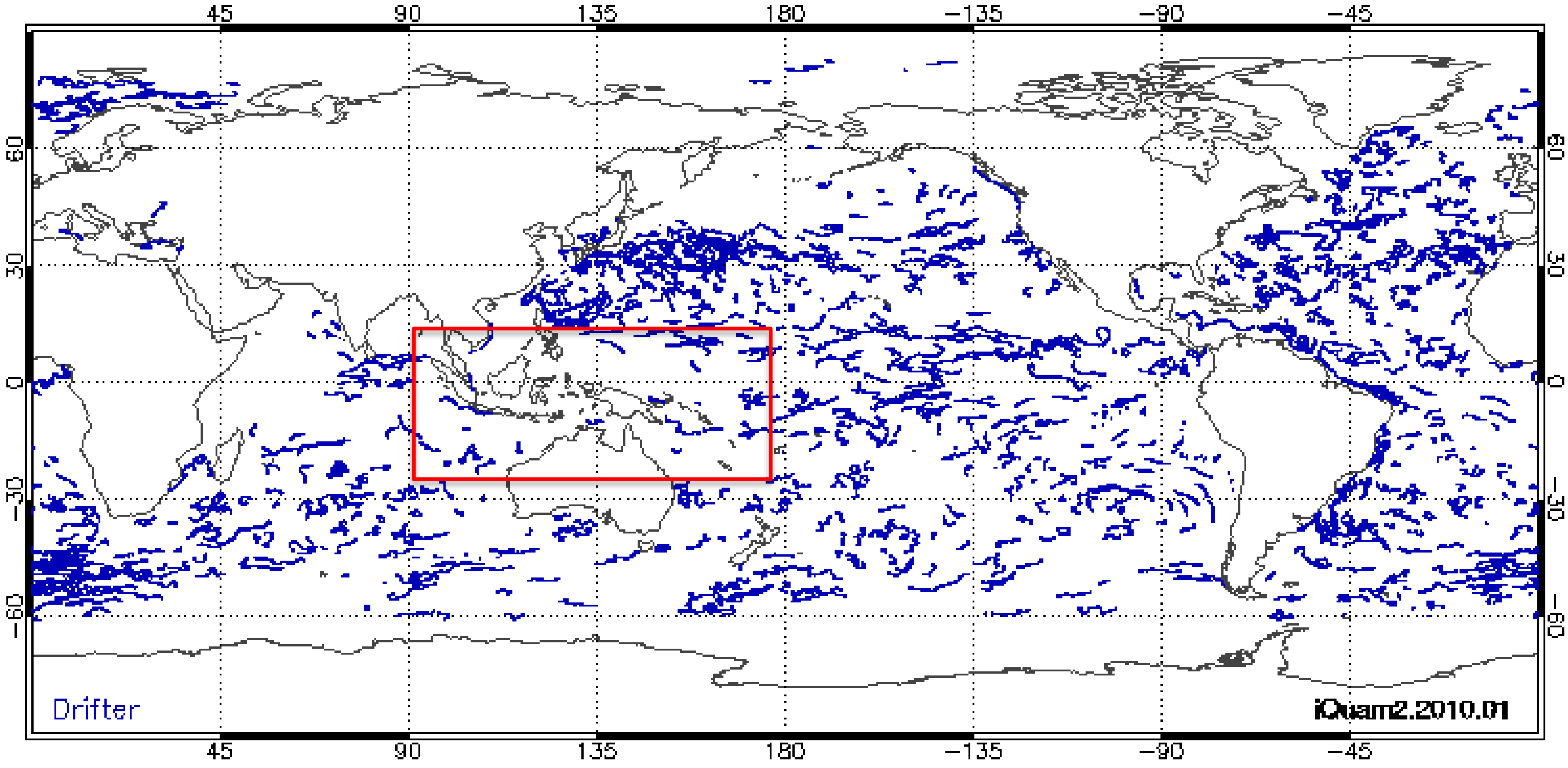
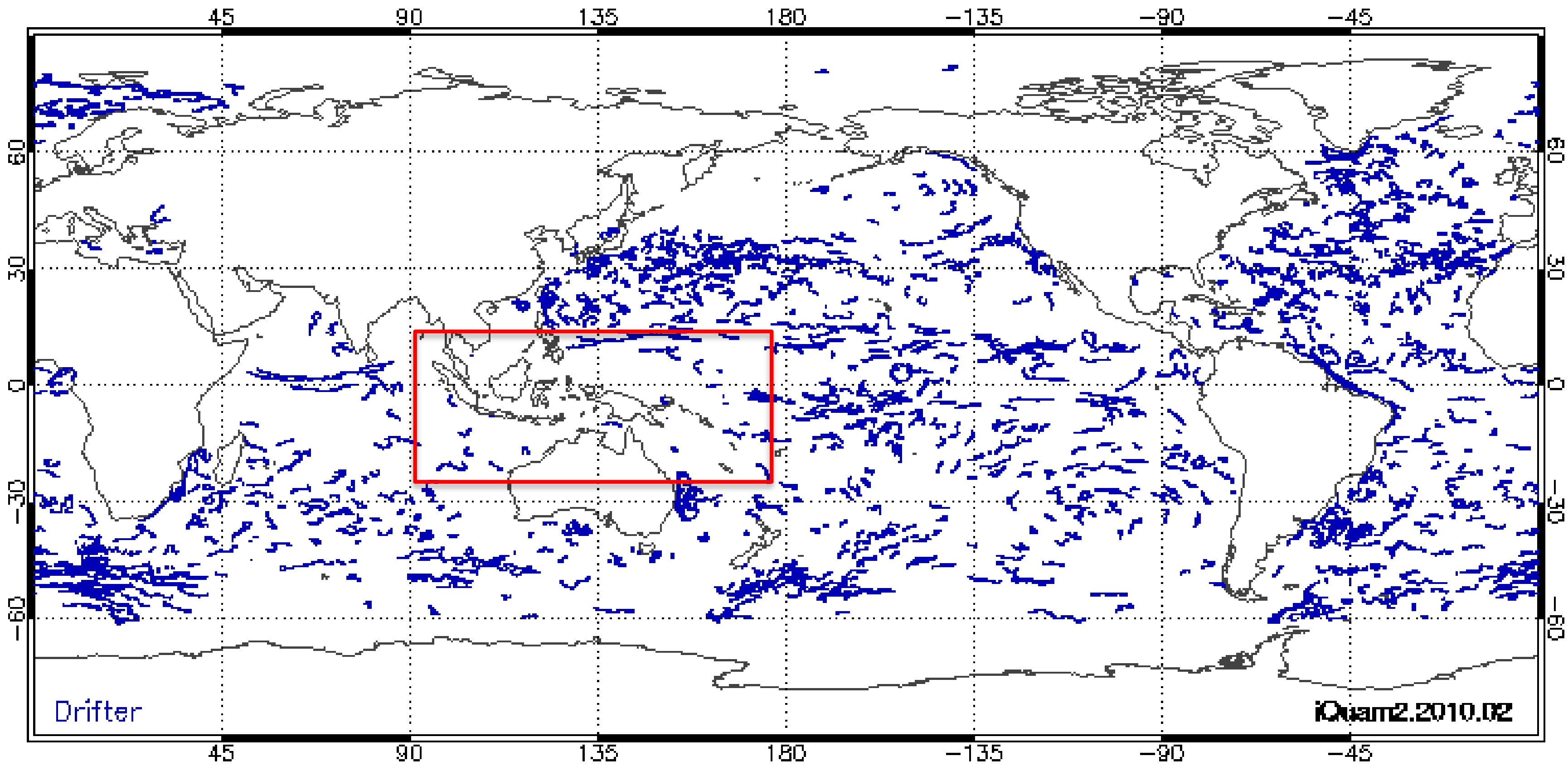
Never Stand Still

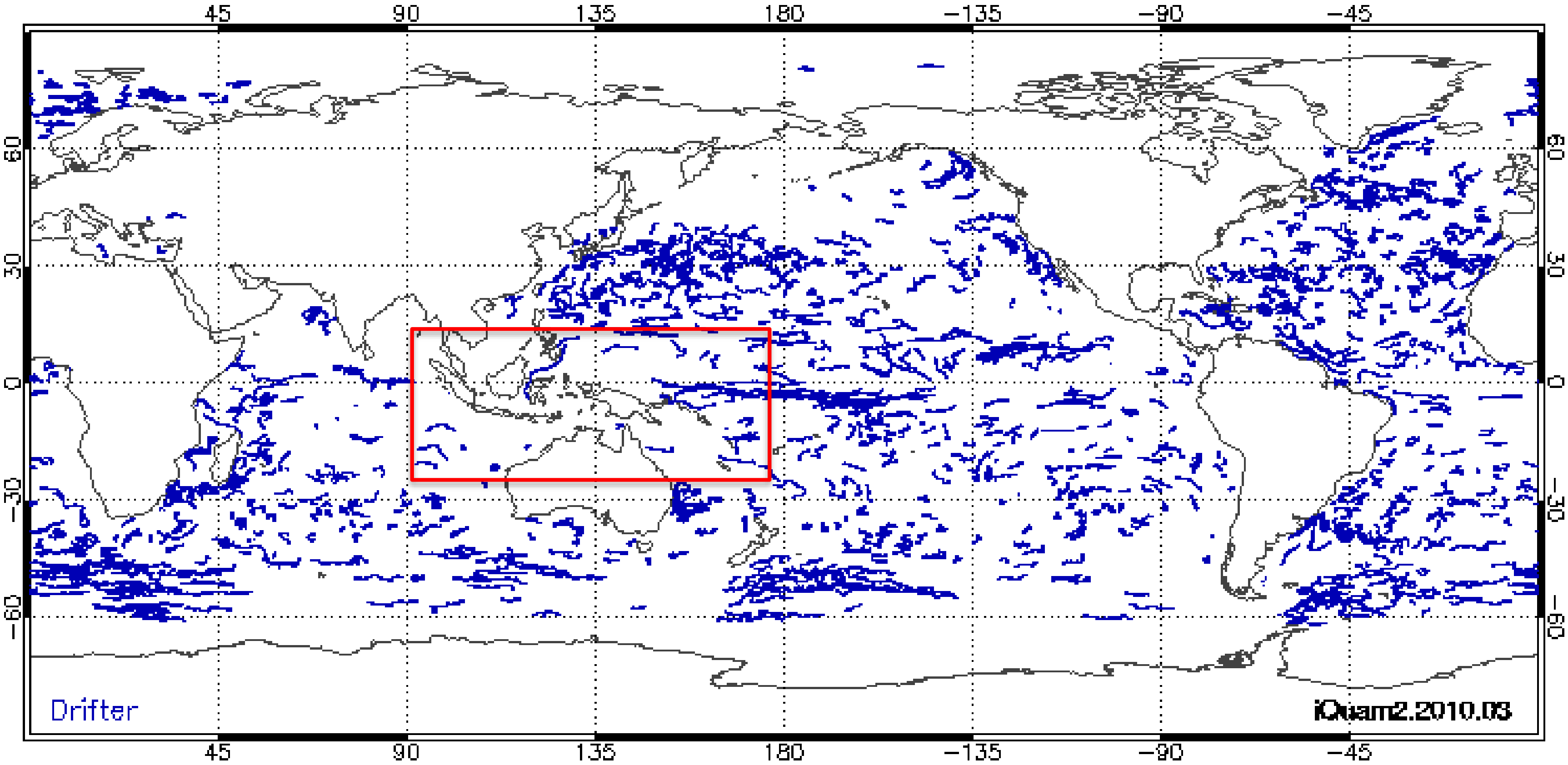
Available drifting buoy data for Jan 2010



Available drifting buoy data for Feb 2010



Available drifting buoy data for Mar 2010



Available drifting buoy data for Apr 2010