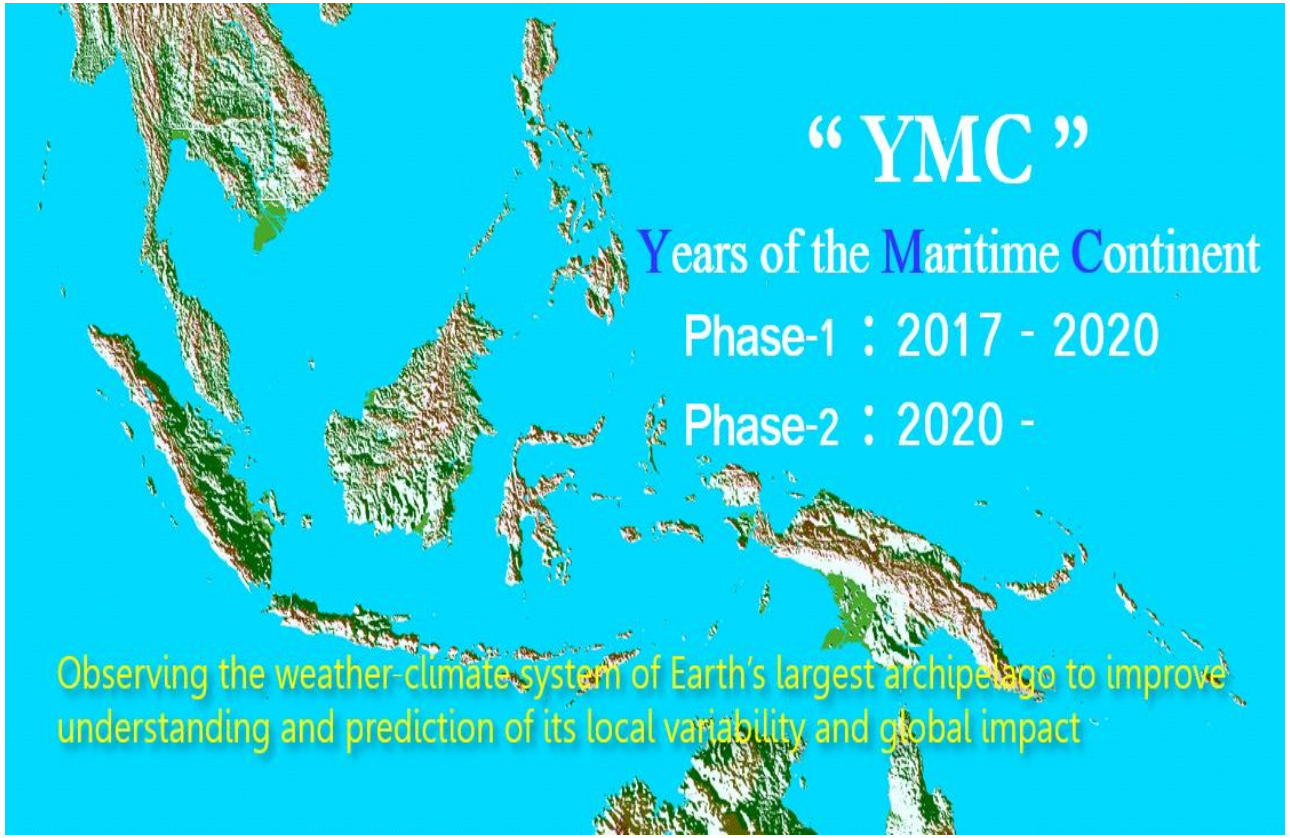
A brief review of JAMSTEC YMC activities for future monsoon studies

(An attempt using autonomous surface vehicles for air-sea interaction studies)

Kunio Yoneyama (JAMSTEC)



< Outline >

1) What is the YMC (Years of the Maritime Continent) ?
2) A new tool for air-sea interaction study (Capability of ASV)
3) Concluding remarks

IWM-7, 22-26 March 2022

Years of the Maritime Continent (YMC)

Purpose

To improve our understanding and prediction skill of local multi-scale variability of the MC weather-climate systems and its global impact.

Participants

Over 70 institutes/universities from
Australia, China, France, FSM, Germany, Indonesia, Japan, Malaysia, Palau, Philippines, Singapore, Taiwan, UK, US, Vietnam, and more.

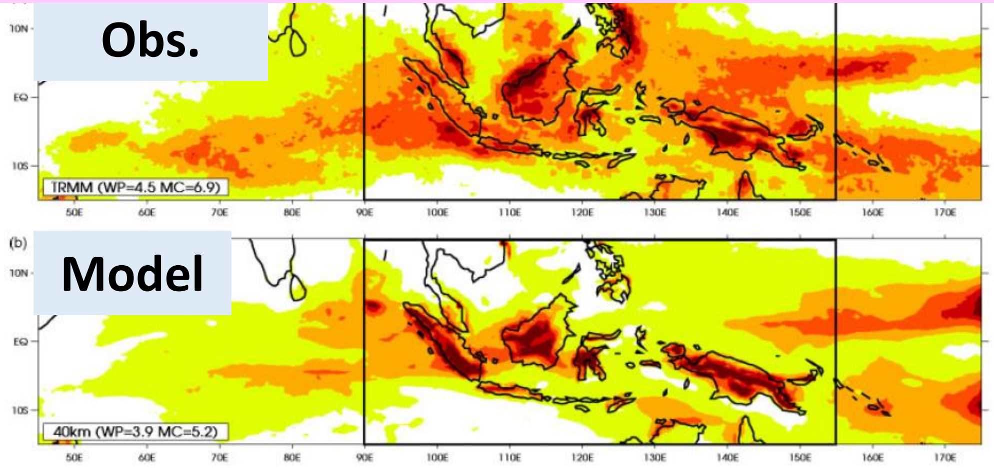
Period

Phase-1 July 2017 - Feb 2020 (IOPs)
Phase-2 Mar 2020 - 2023 (Feedback + IOPs)

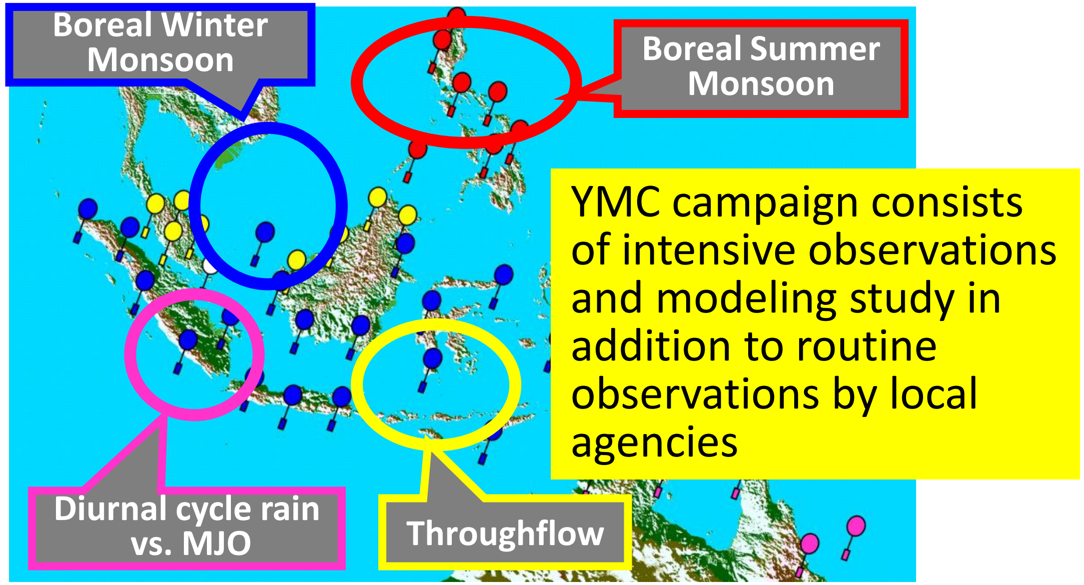
Main Activities

1) Data sharing
2) Field campaign
3) Modeling
4) Prediction and applications
5) Outreaching and capacity building

State-of-the-art numerical models suffer from systematic errors of rainfall estimation



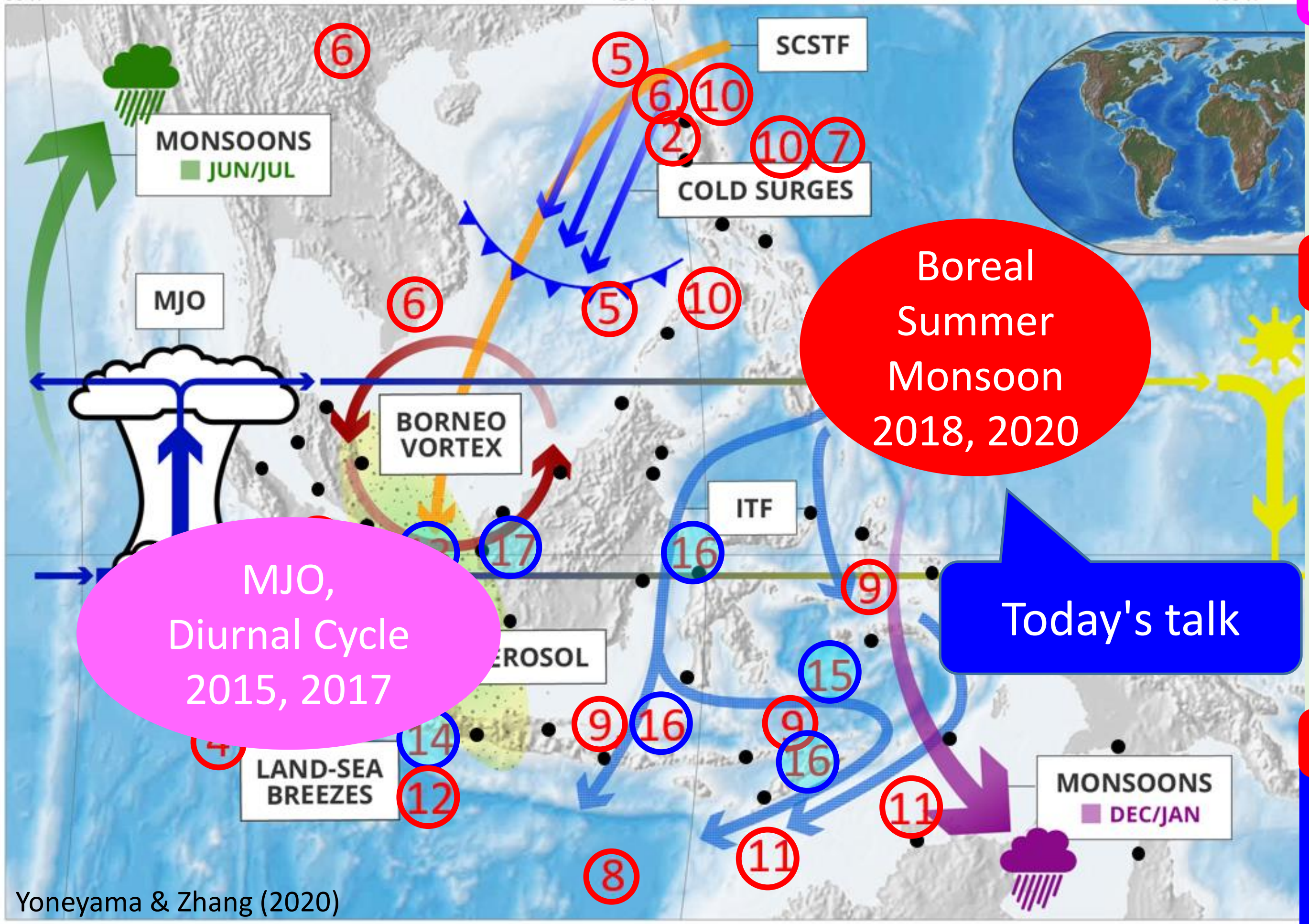
Comparison of rainfall averaged Oct 2008 - Mar 2009. Love et al. (2011)



Routine sounding sites ( ) & Intensive observation areas ( )

Intensive Observations (including relevant projects)

YMC field campaign consists of intensive observations and long-term measurements.



Number Conducted or Planned Intensive Observation Areas

● Radiosonde sounding stations

2015.10-12	1	Pre-YMC in Sumatra (MJO, DC)	
2017.08	2	RSVP (air-sea)	
2017.11-01	3	Sumatra (MJO, DC)	
2017.11-02	4	EIOURI (Upwelling)	
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2020.12-02	12	ELO (ocean)	**Postponed to 2022/23 due to COVID-19**
2021.12-02	14	TerraMaris (DC, MJO)	
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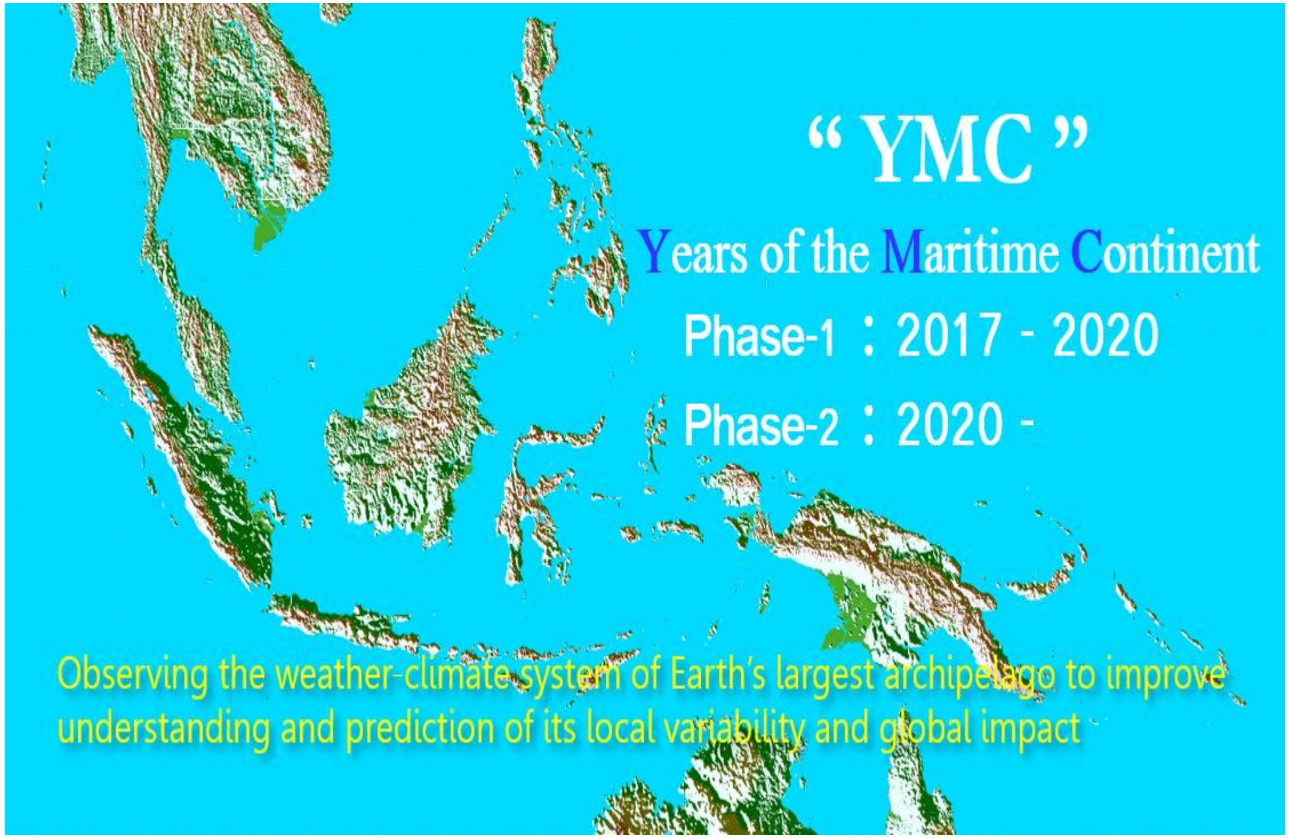

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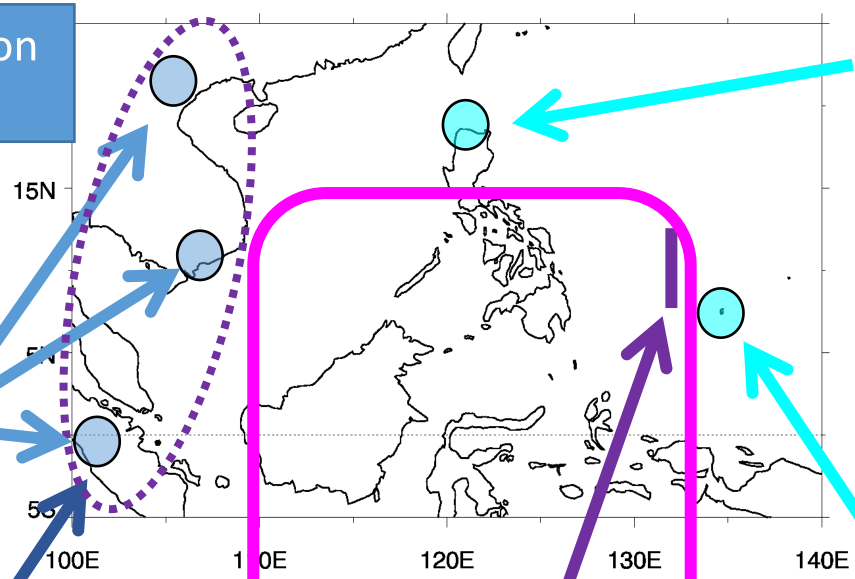
YMC - Boreal Summer Monsoon Study in 2018

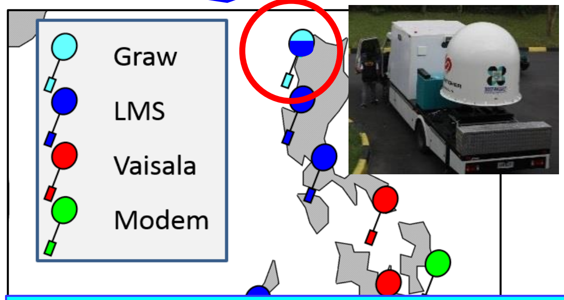
Main targets :	Boreal Summer Monsoon focusing on Northward Propagating Intraseasonal Variability
Period:	July 1 – August 31, 2018
Participants:	Japan (JAMSTEC, Kyoto Univ), Philippines (PAGASA, U Philippines), Indonesia (LAPAN), Viet Nam (NHMS), Palau (Koror Weather Service)

Study of large-scale meridional circulation associated with Asian monsoon

Simultaneous Ozone-sonde (10 times / 3 wk) at Hanoi, Ho Chi Ming, & Kototabang

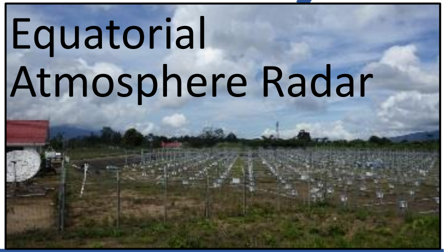


Study of diurnal cycle of rain associated with BSISO



Radiosonde (4/day), AWS, & X-band MP Radar at Laoag

Radiosonde (4/day), Lidar & AWS at Palau.

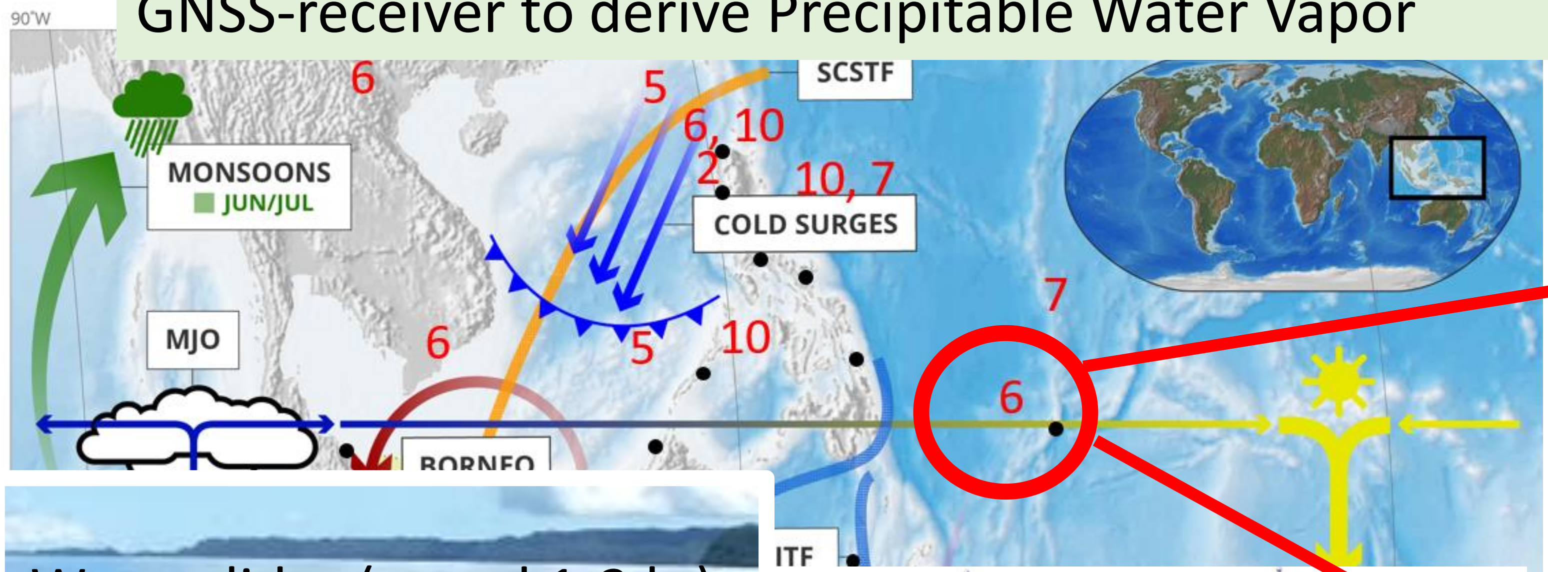


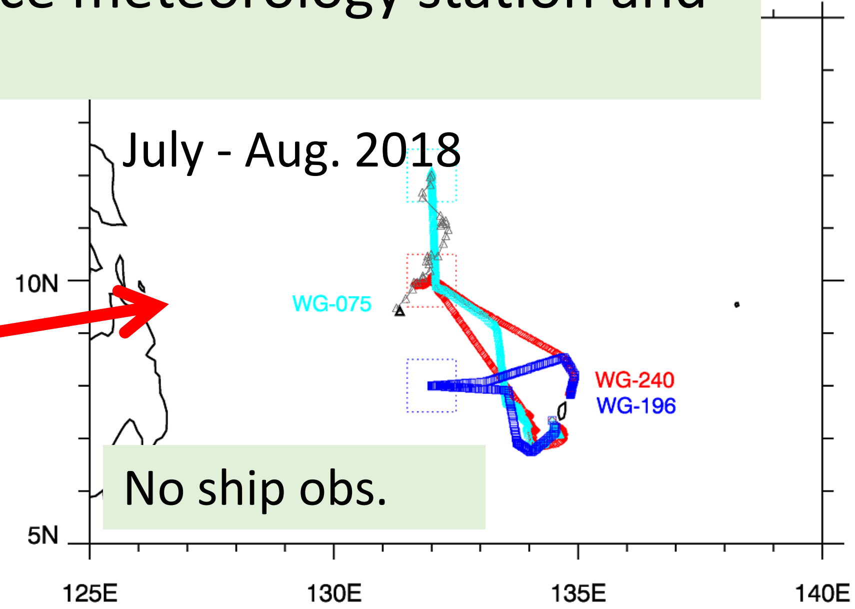
CFH-sonde (5-7 times / 3 wk) & EAR operation at Kototabang

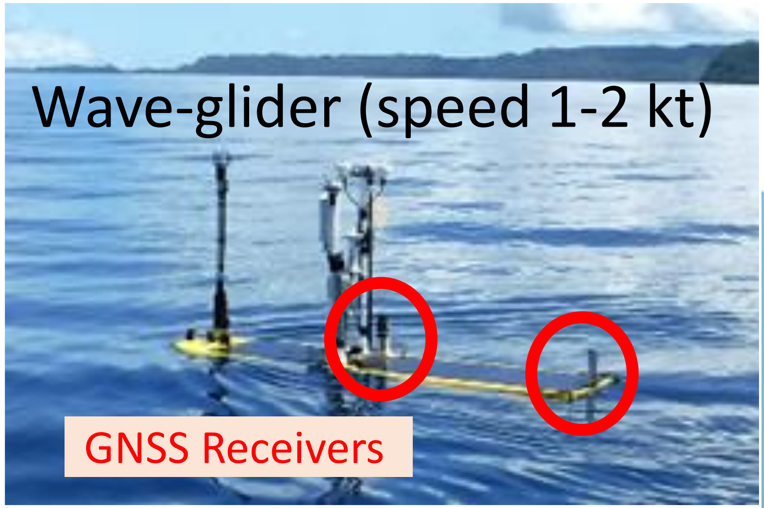
Wave-glider along 132E at 8/10/12N

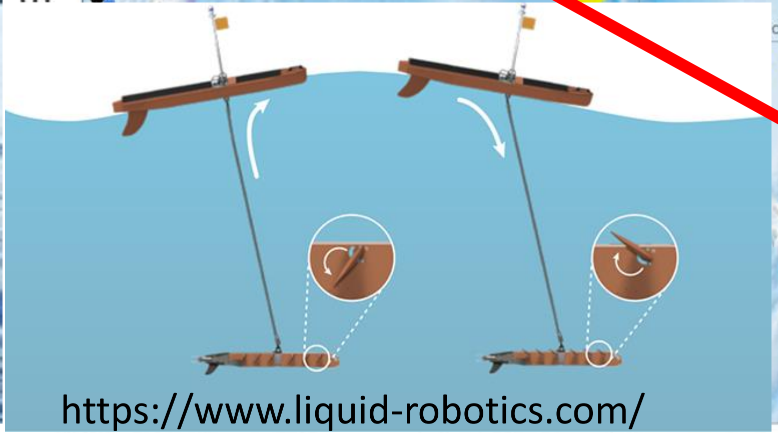
ASV Operation during Boreal Summer Monsoon Study in 2018 & 2020

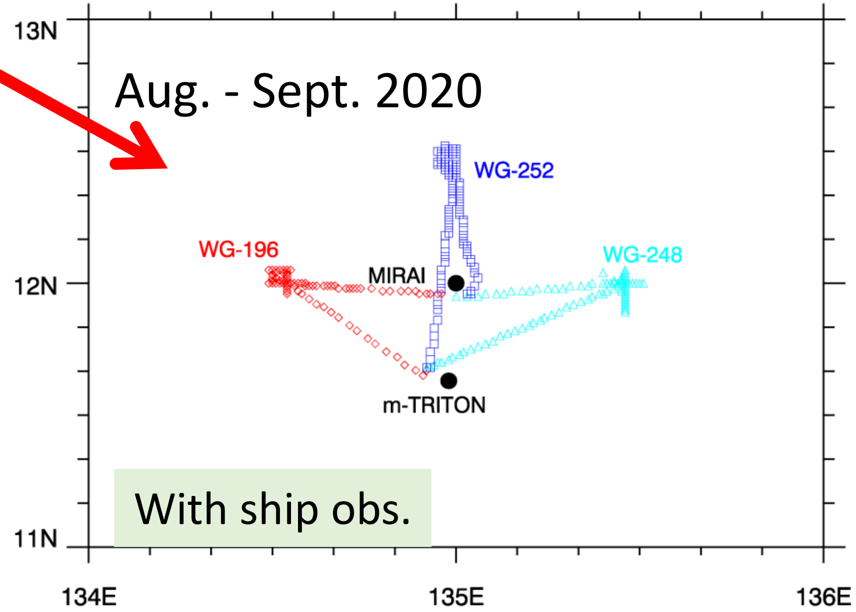
We deployed ASVs (Wave-gliders) equipped with Surface meteorology station and GNSS-receiver to derive Precipitable Water Vapor











Standard Parameters:

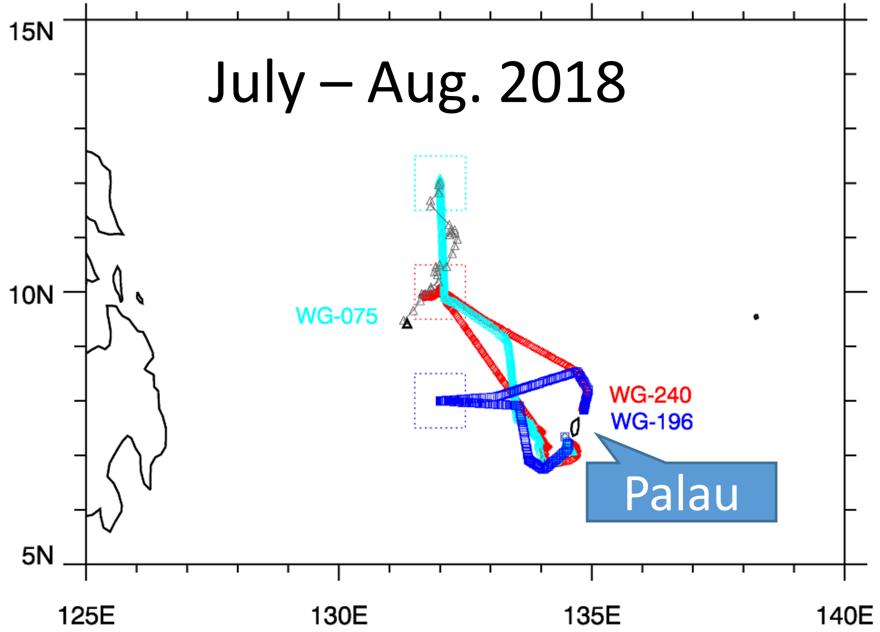
Surface Meteorology (P, T, RH, Rain, Wind, SW/LW), SST, & Salinity

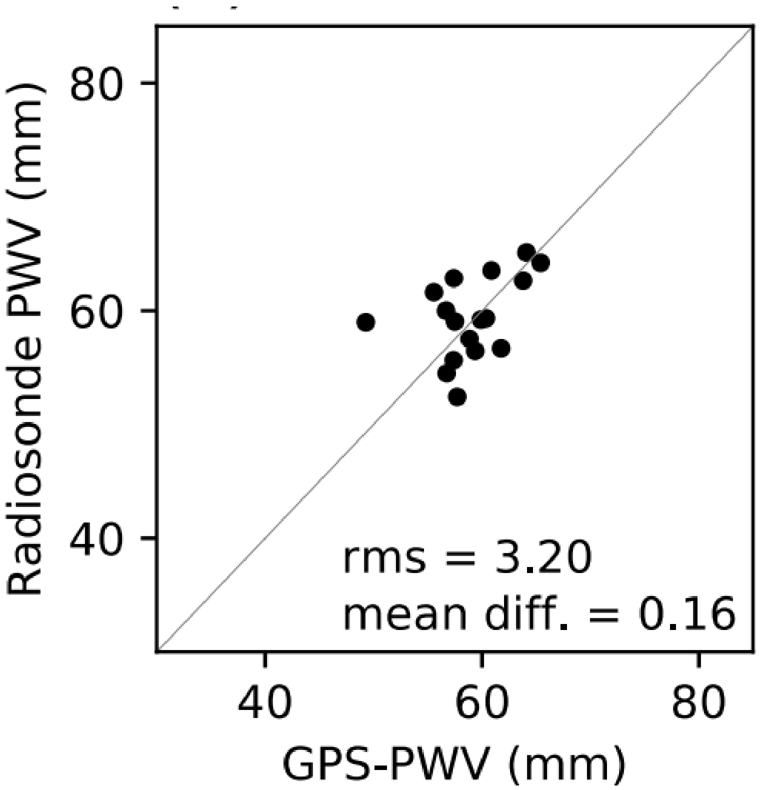
Additional Parameter:

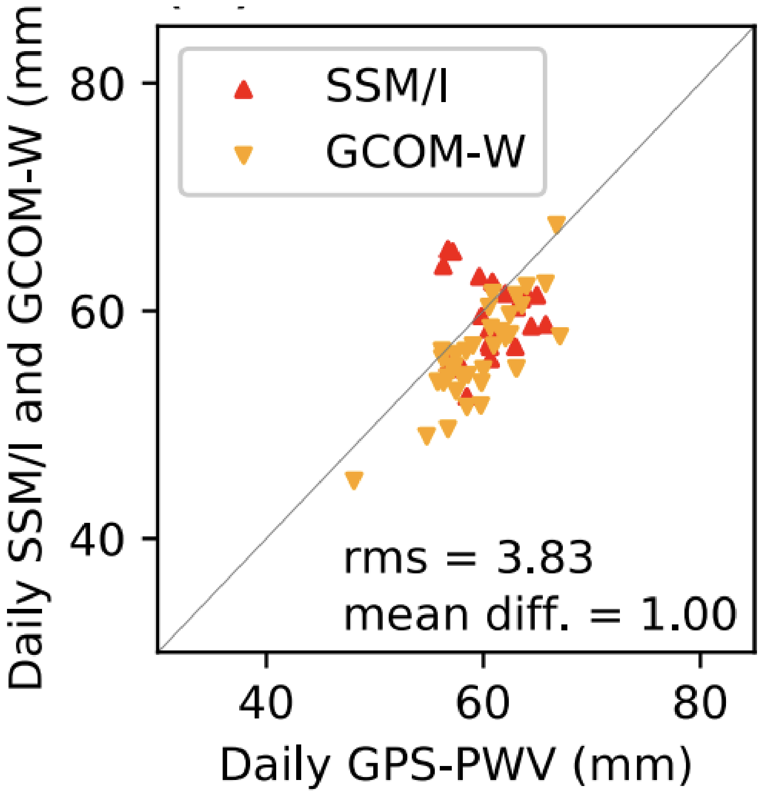
GNSS-derived Precipitable Water Vapor

GNSS-derived Precipitable Water Vapor during BSM 2018

Comparison of PWV between GNSS-derived and (a) Radiosonde within 50 km from Palau
(b) Microwave-based satellite data (daily)

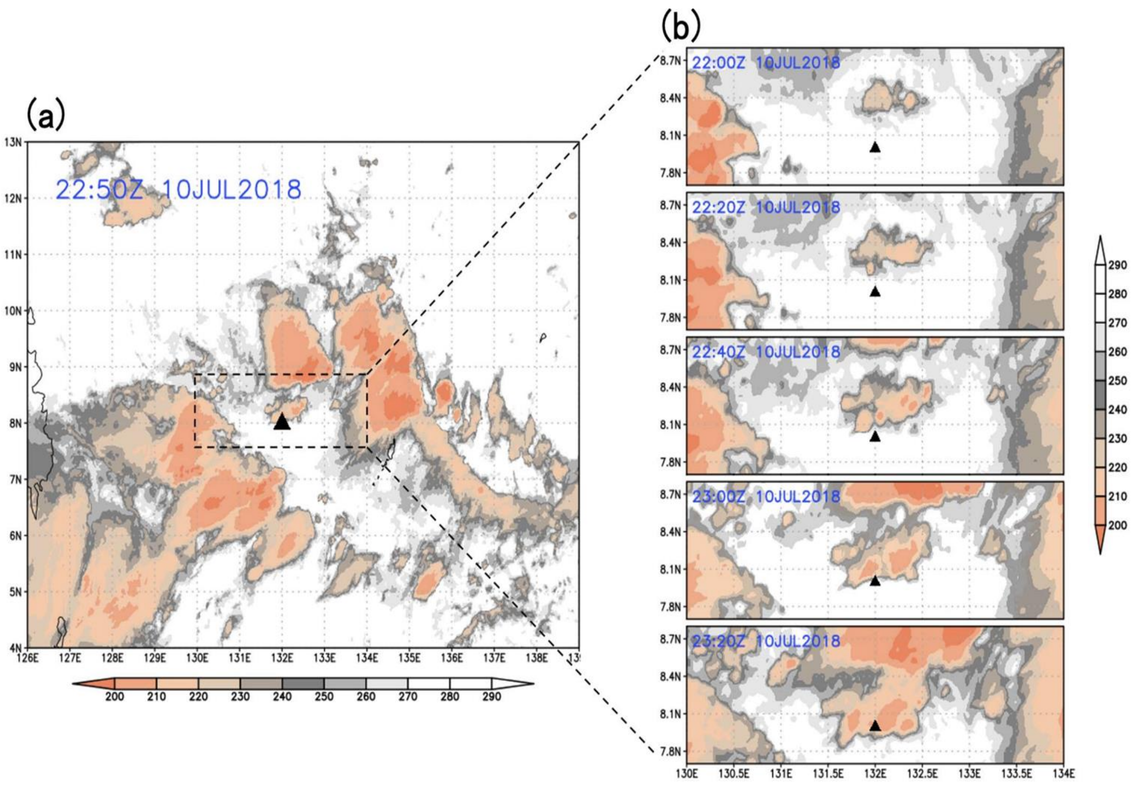




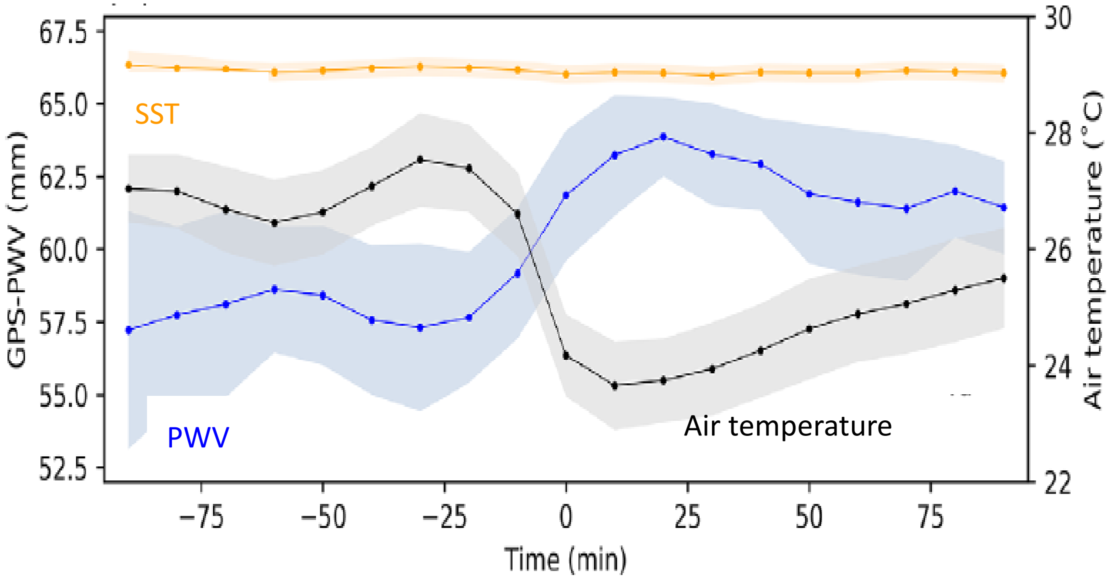


Fujita et al. (2020, SOLA)

GNSS-derived PWV can capture cold pool event features



Example of cold pool event, which was observed at 07:50 LST on July 10, 2018.

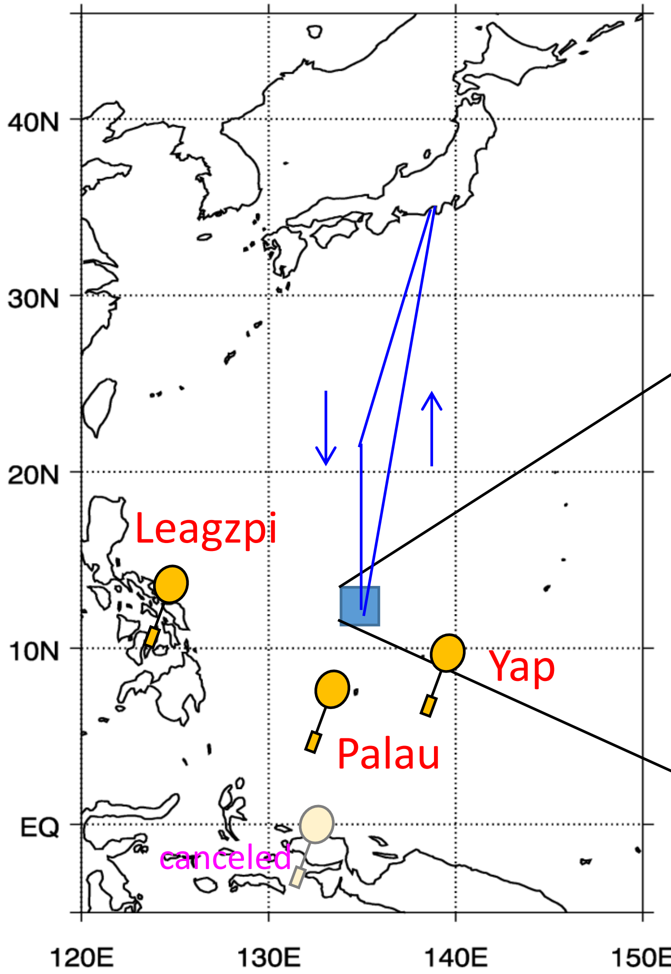


Composite of PWV, Air Temperature, and SST variations during cold event passage. Shading indicates standard deviation.

Fujita et al. (2020, SOLA)

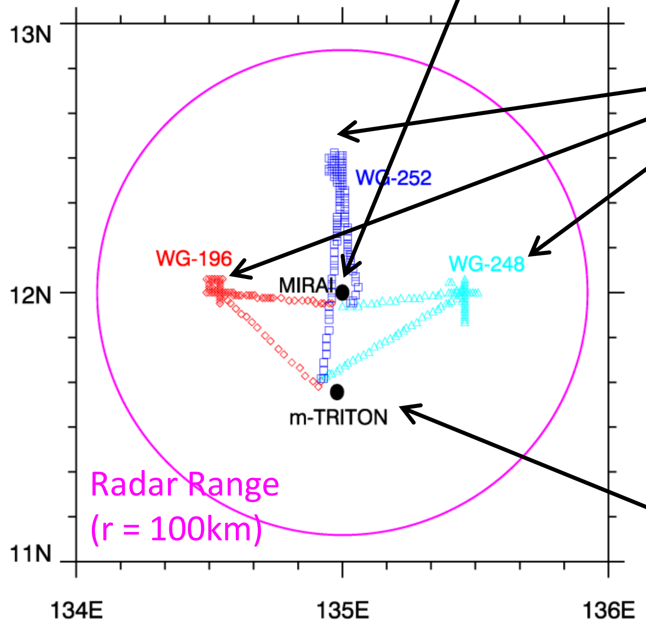
YMC - Boreal Summer Monsoon Study in 2020

Period: Aug. 1 - Sept. 14, 2020
IOP: Aug. 8 - Sept. 3, 2020

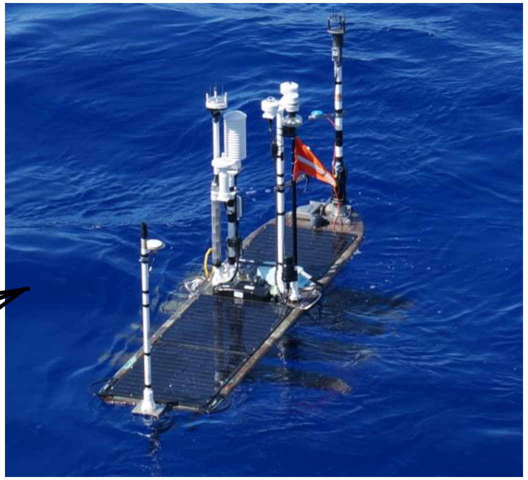


Radiosonde enhanced (4 times/day) land-based sites

R/V Mirai



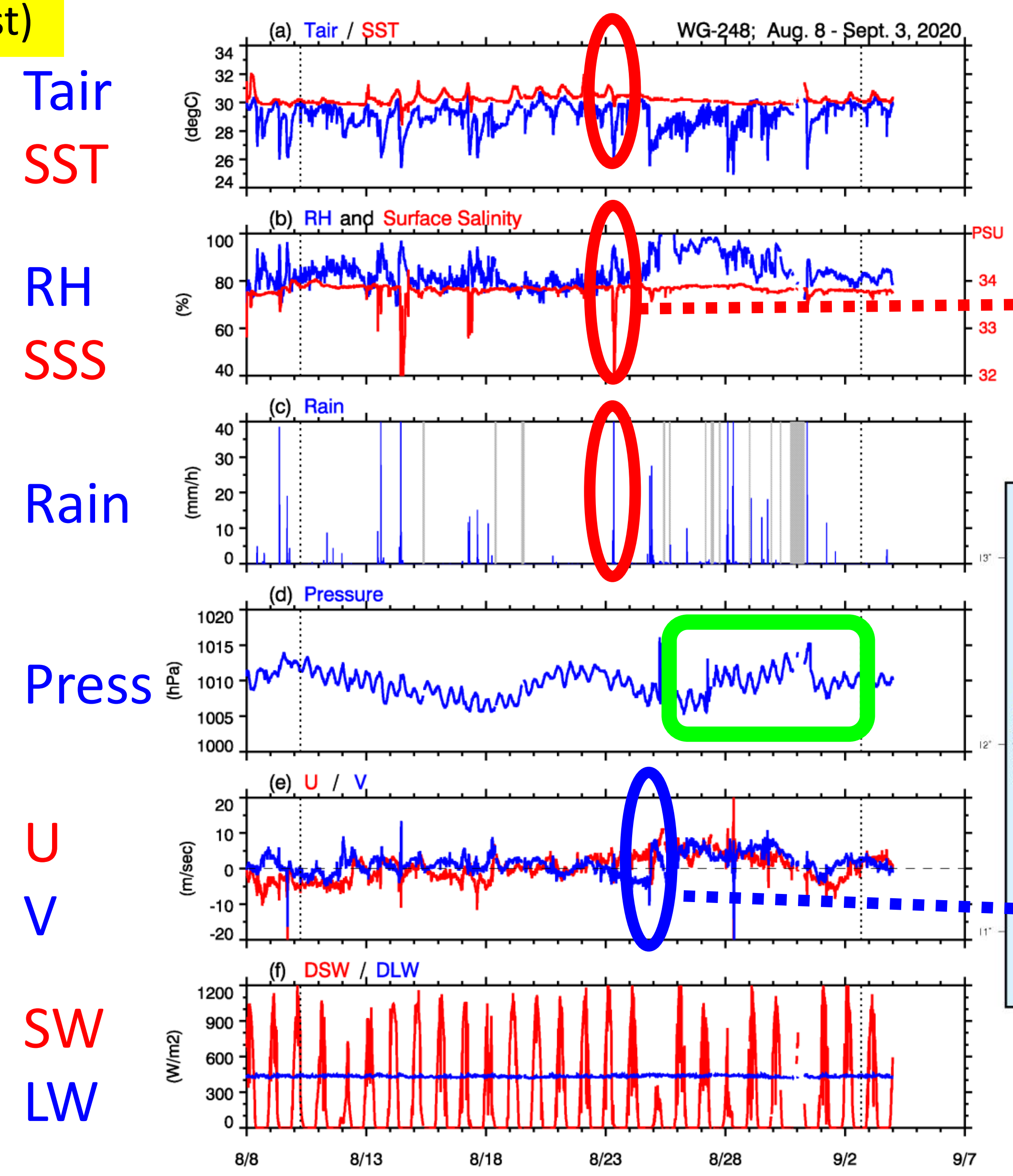
ASV (Wave-glider)

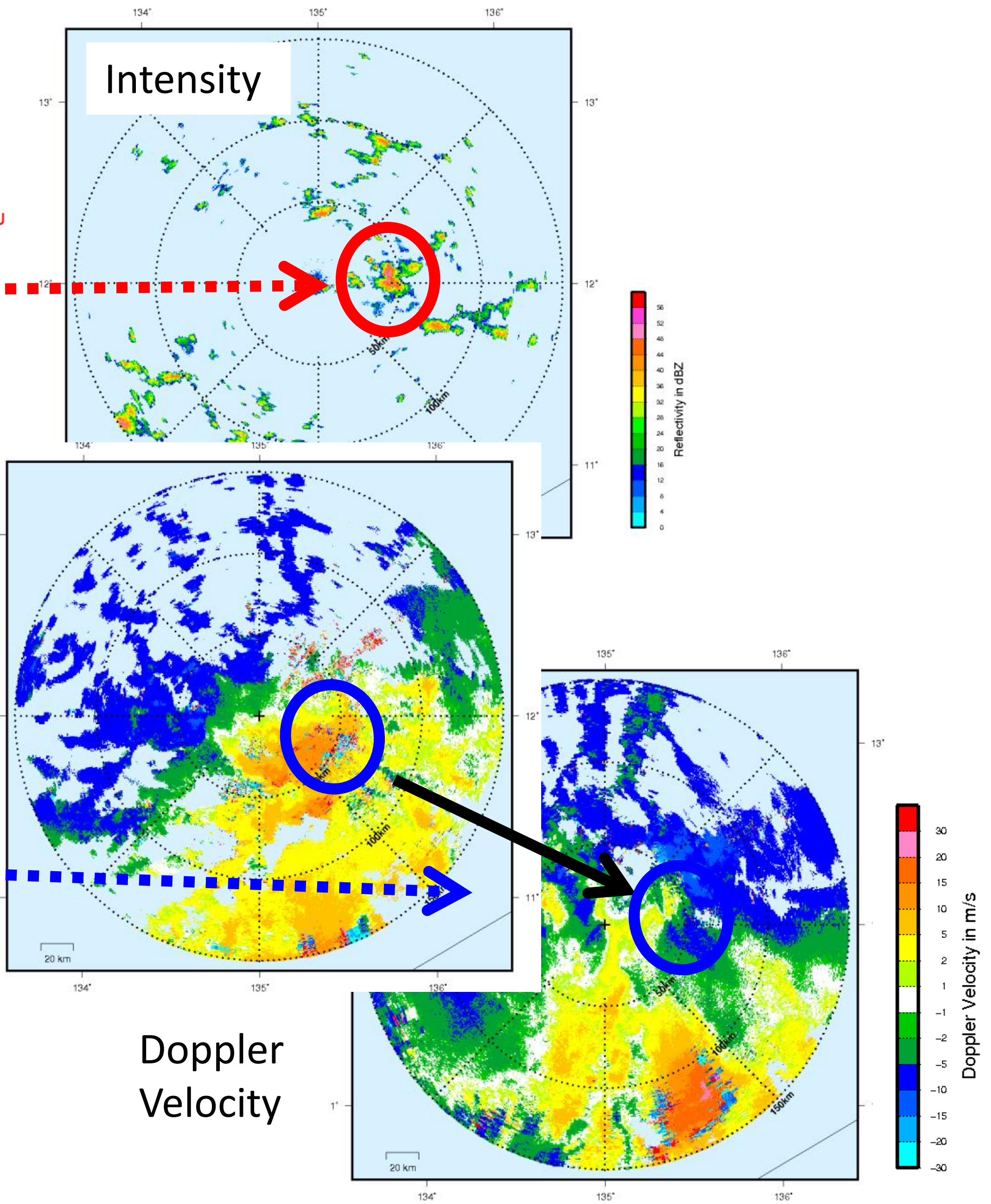


m-TRITON buoy

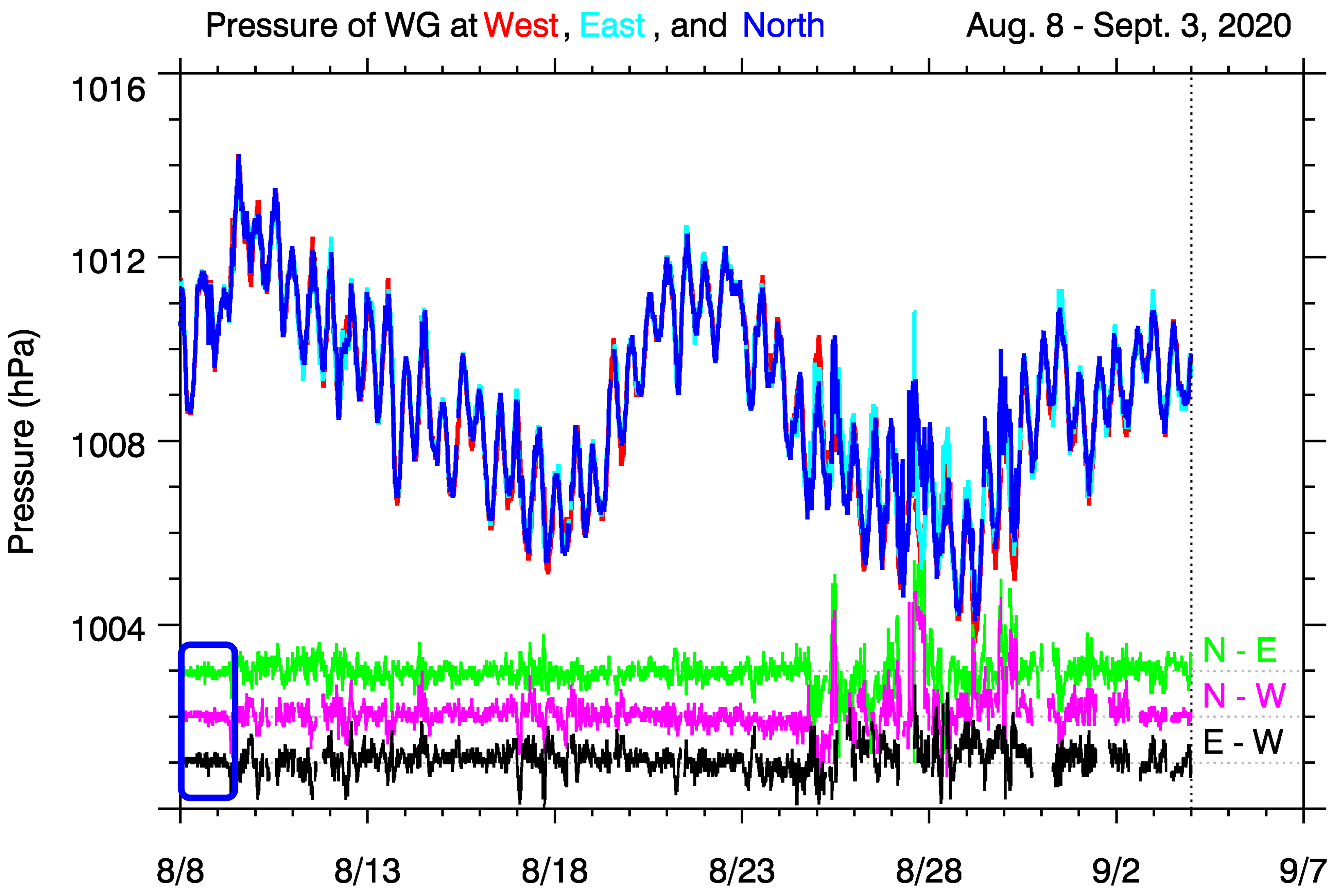
Surface Meteorology

WG (East)





Example of Quality control of WG surface meteorological data



Example of Quality control of WG surface meteorological data

WG (West)

Tair
SST

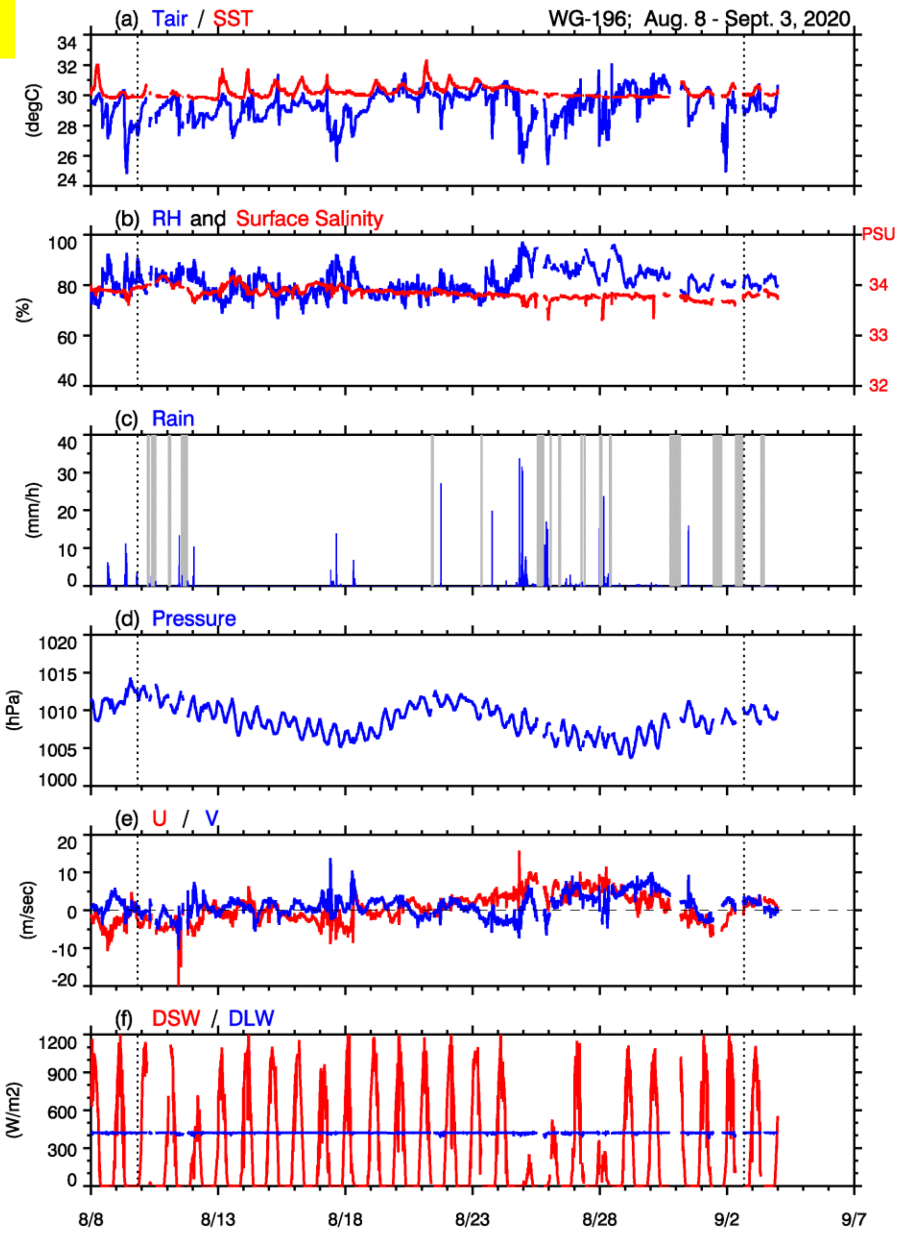
RH
SSS

Rain

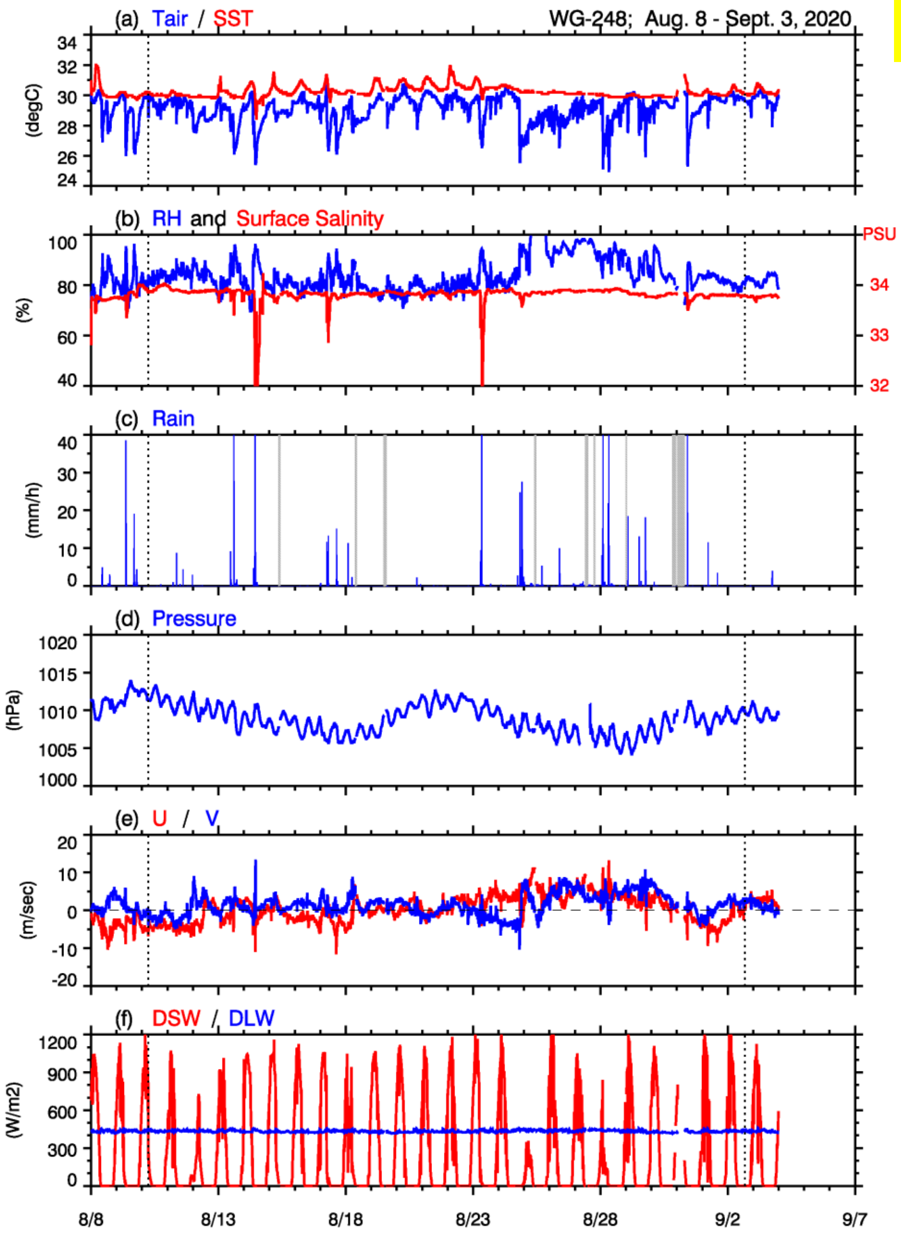
Press

U
V

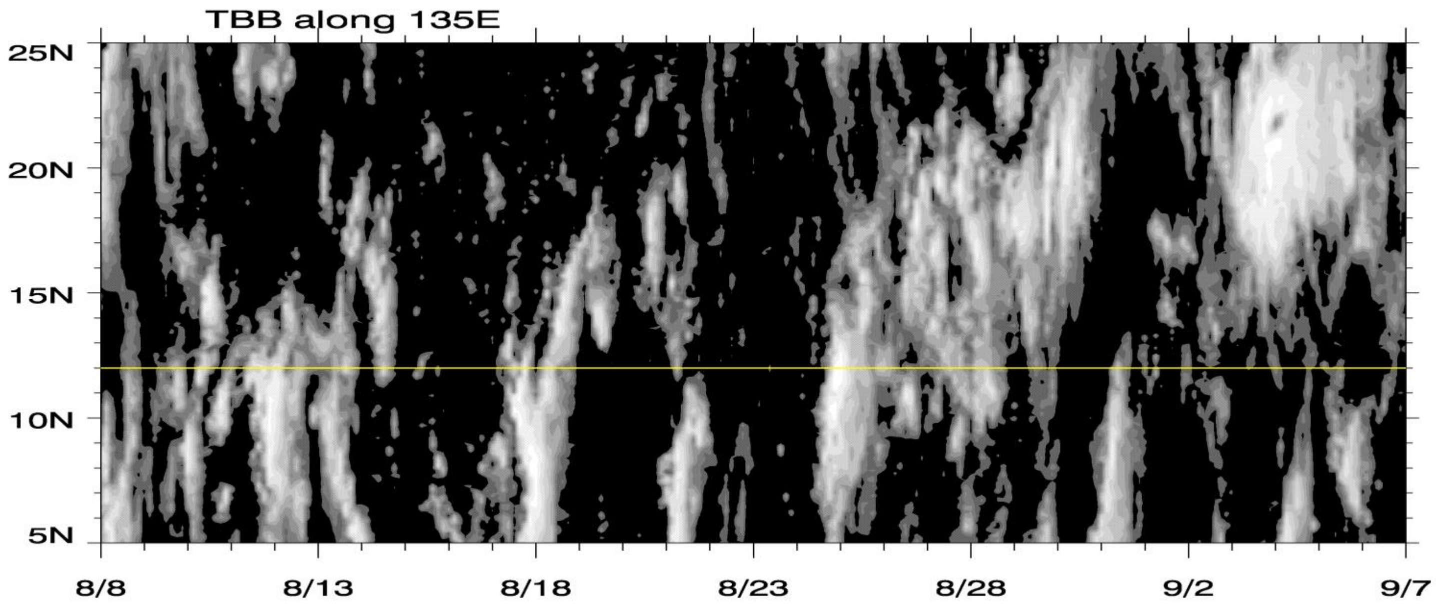
SW
LW



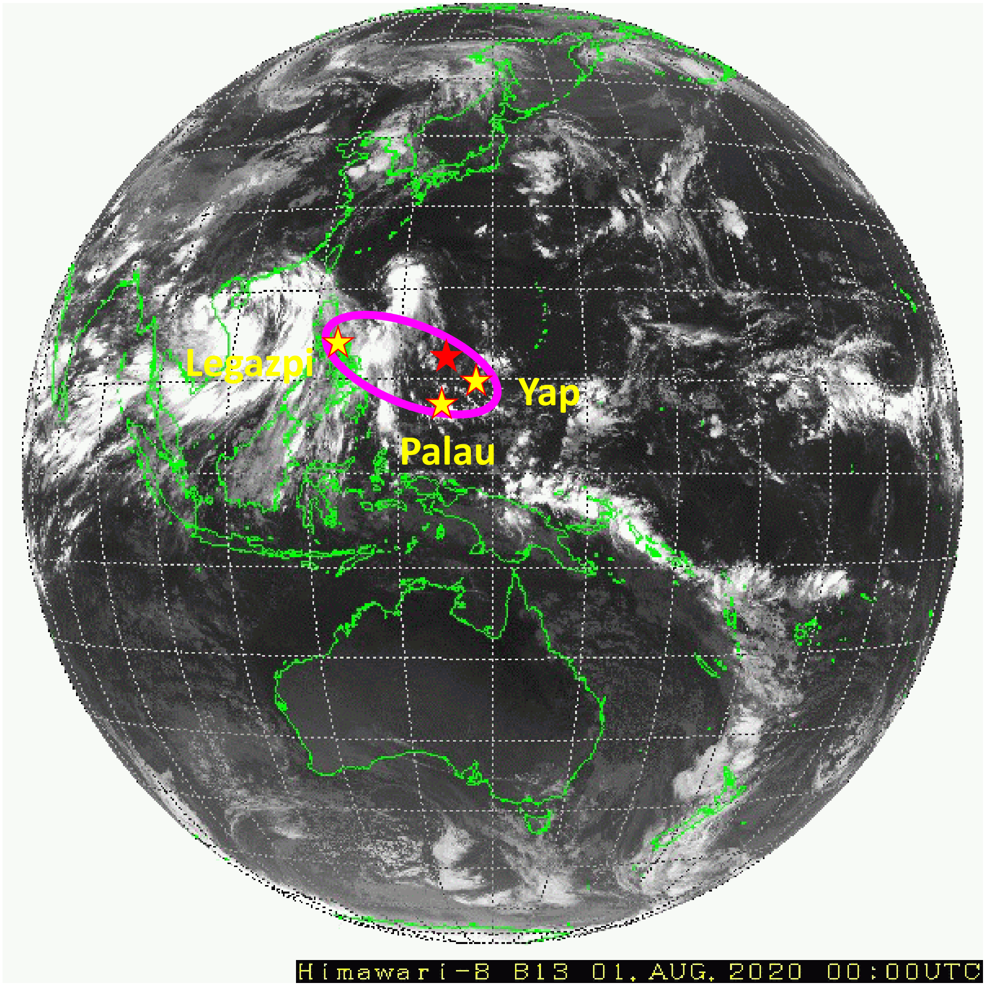
WG (East)

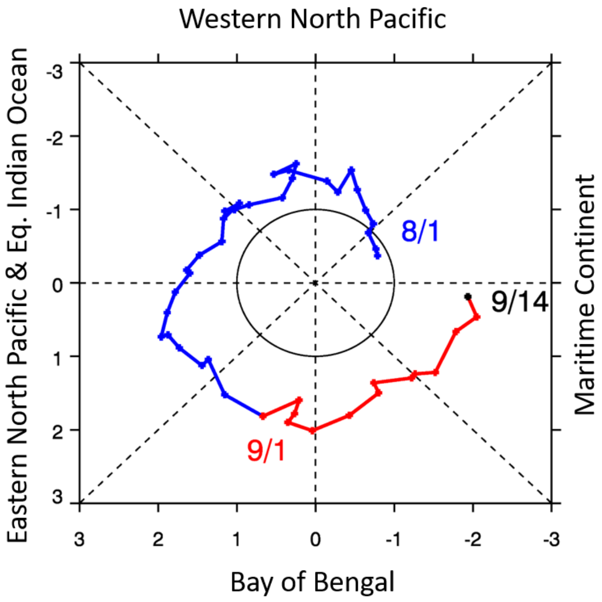


IR + BSISO Phase during YMC-BSM 2020



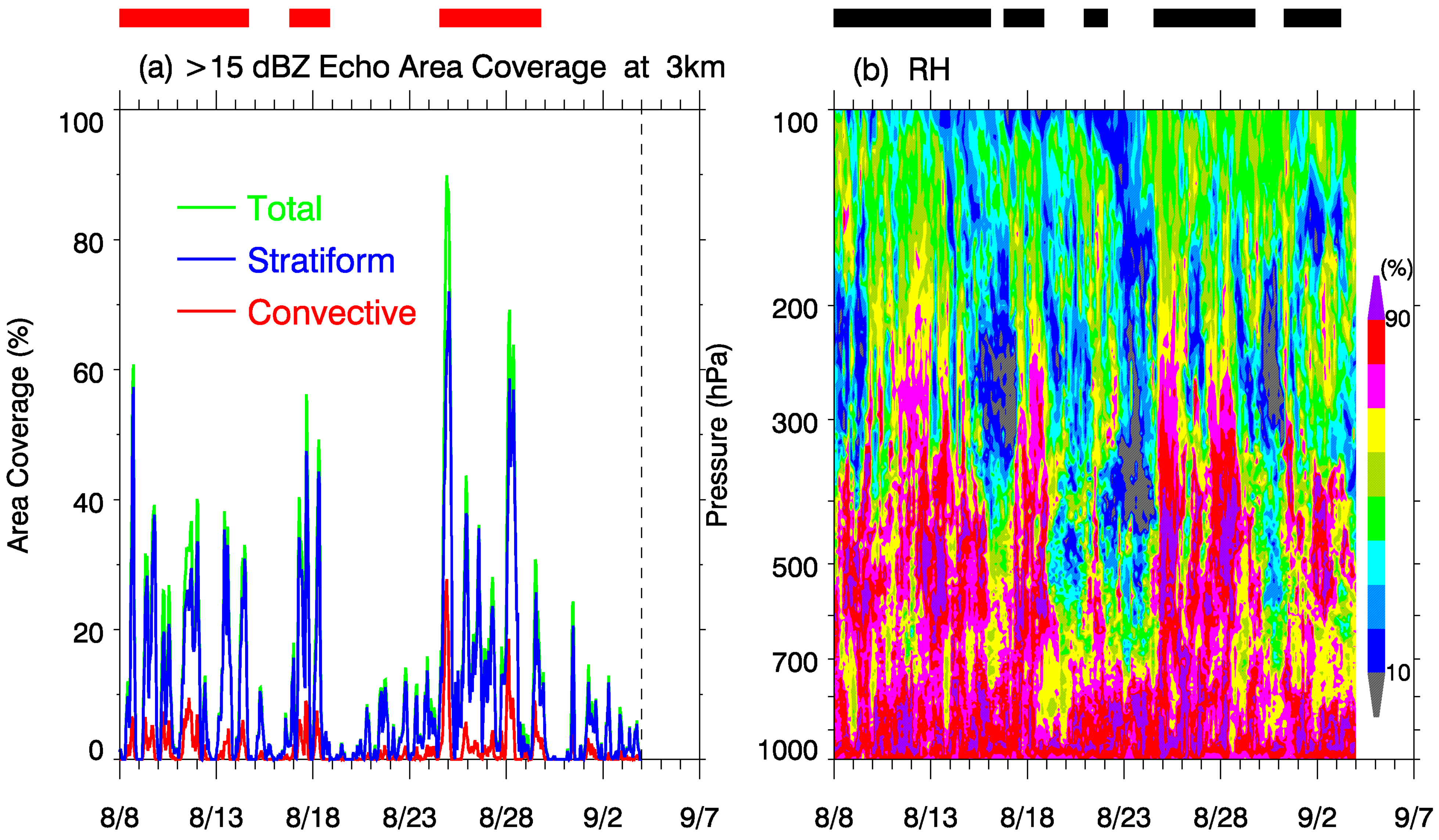
Himawari IR (8/1 - 9/7)



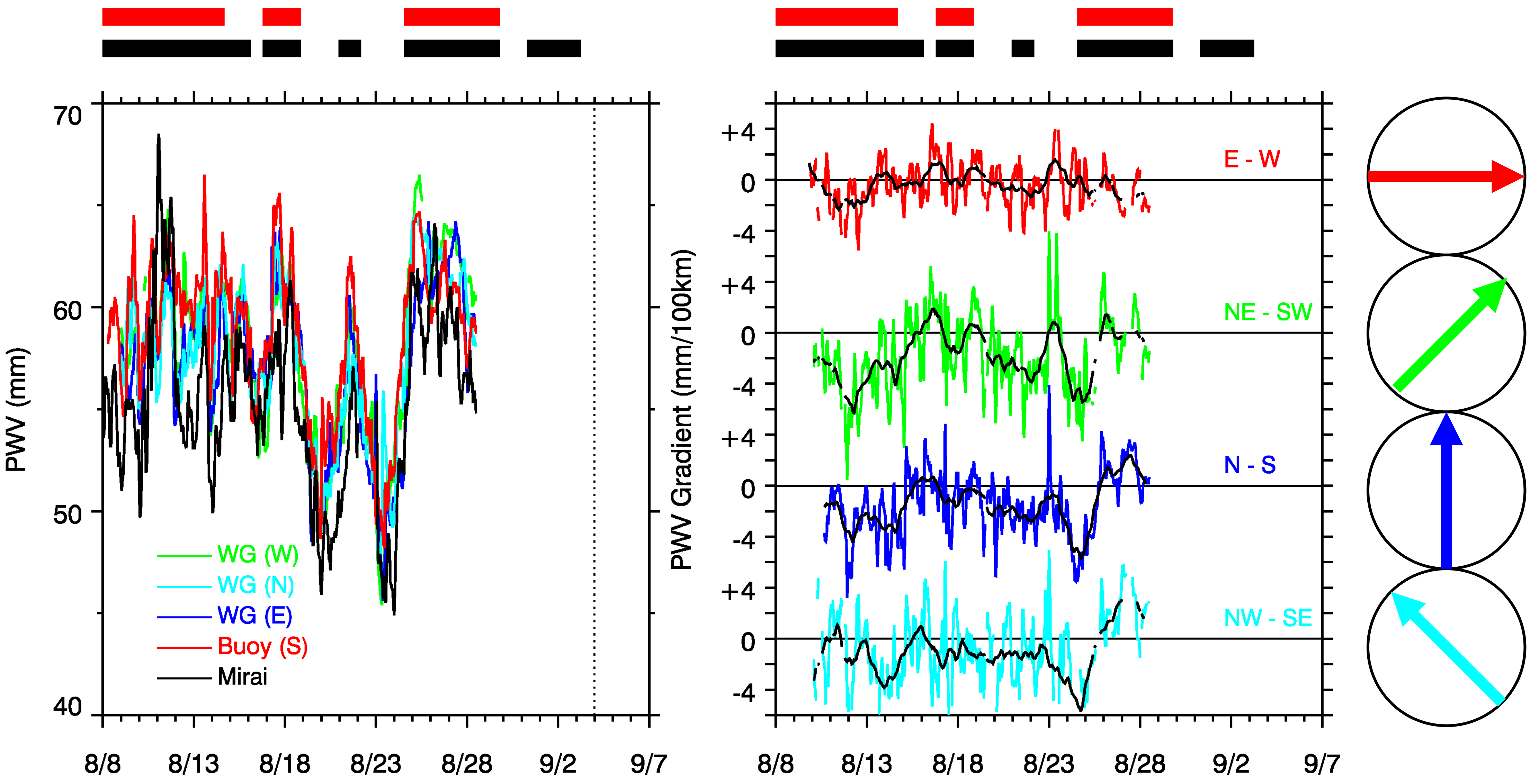


BSISO Index
(cf. Kikuchi et al. 2012)

Time Series of Radar Echo Area & Time-height Section of RH

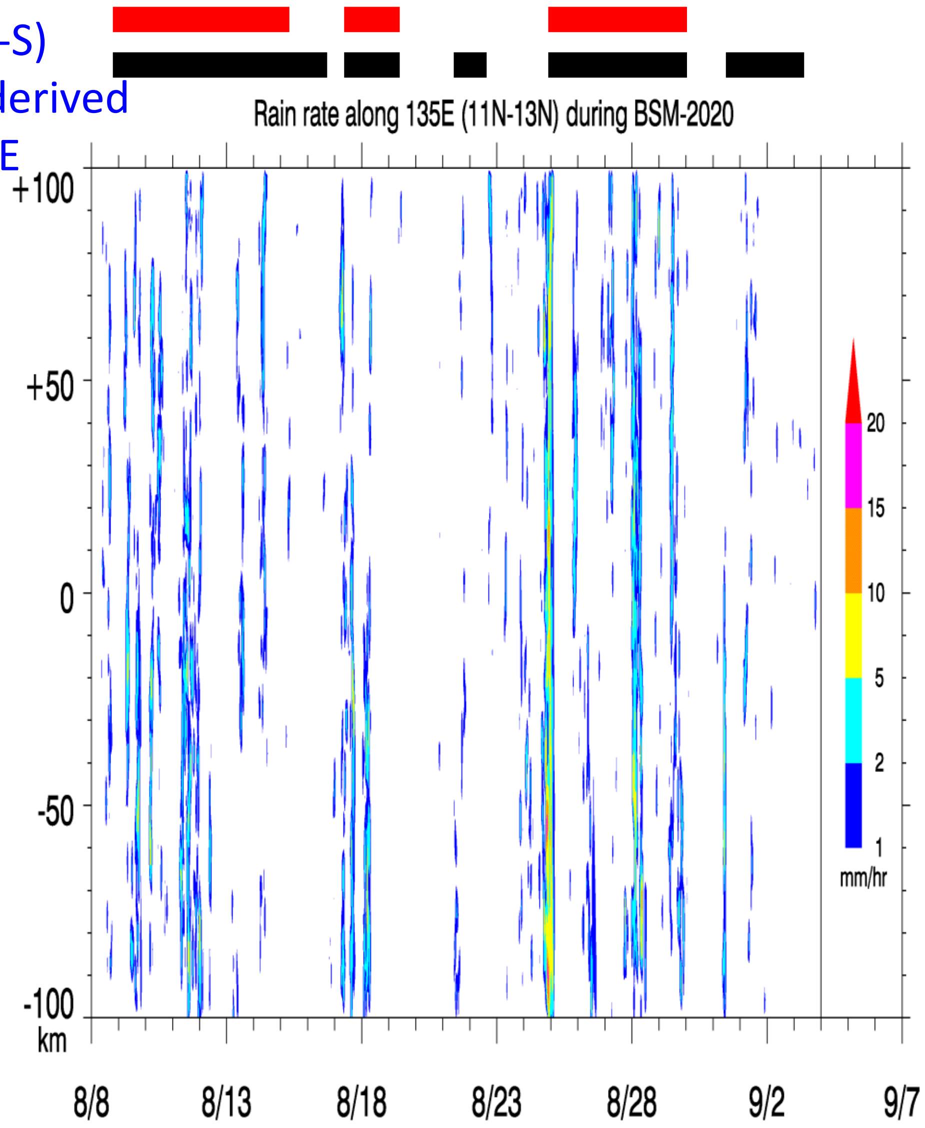


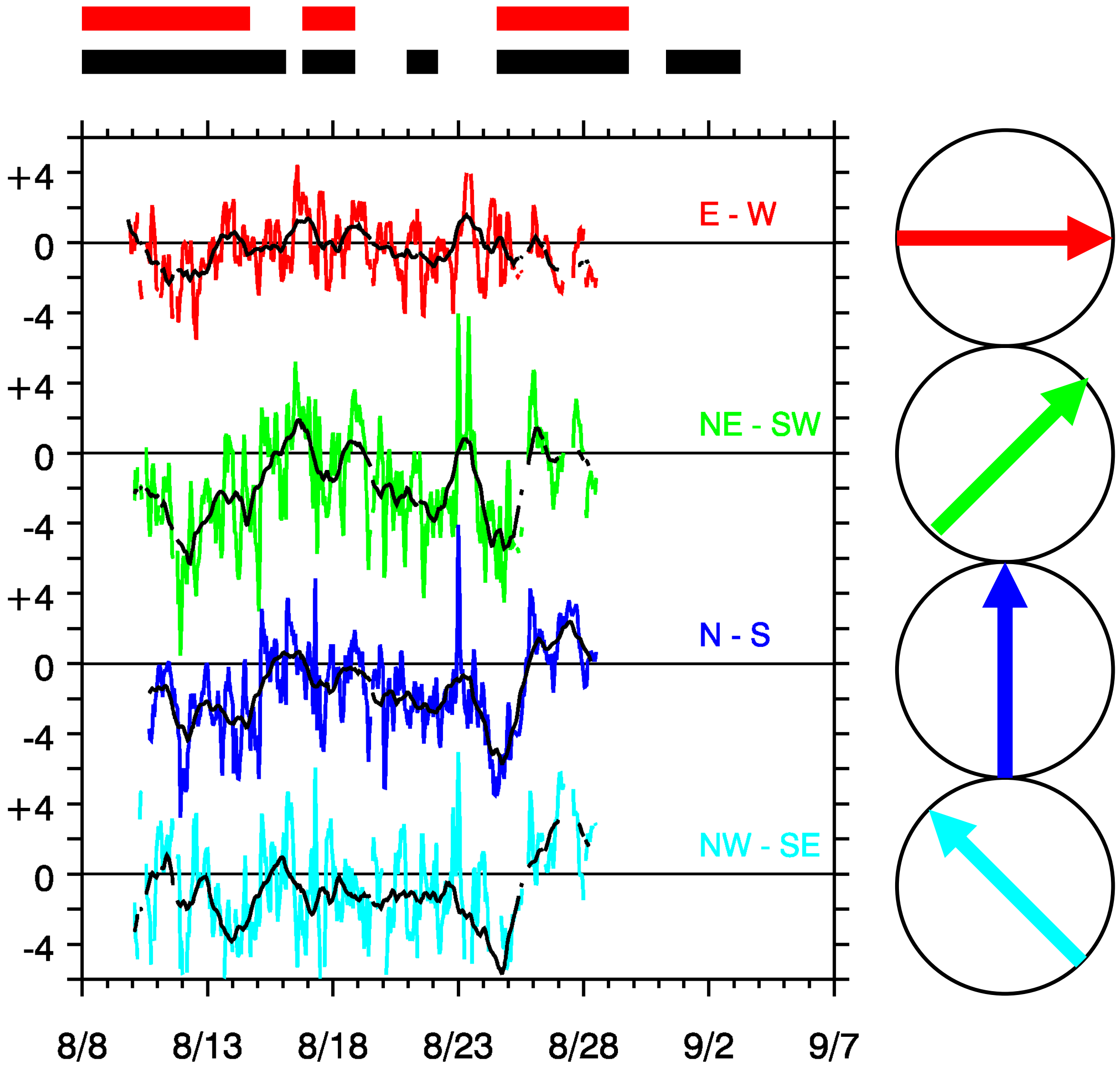
GNSS-derived Precipitable Water Vapor



GNSS-derived Precipitable Water Vapor

Time-Distance (N-S) section of radar-derived rainfall along 135E





Relationship between Convection Onset and SST Distribution

Li and Carbone (2012, JAS)

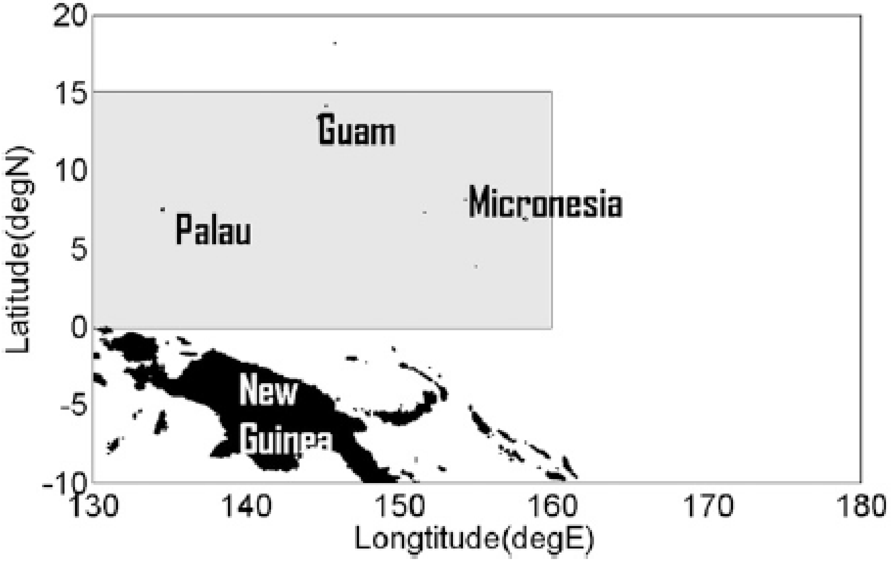
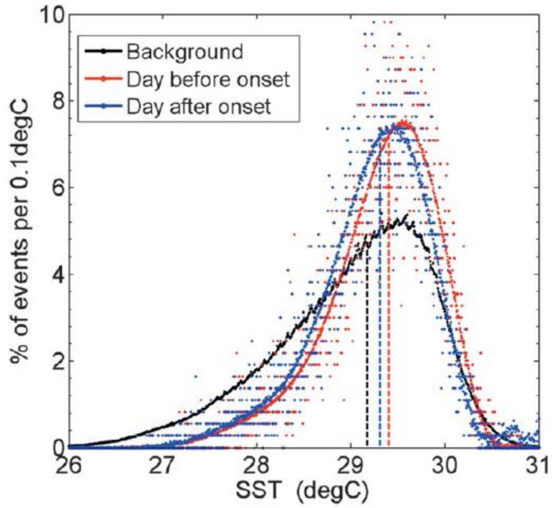
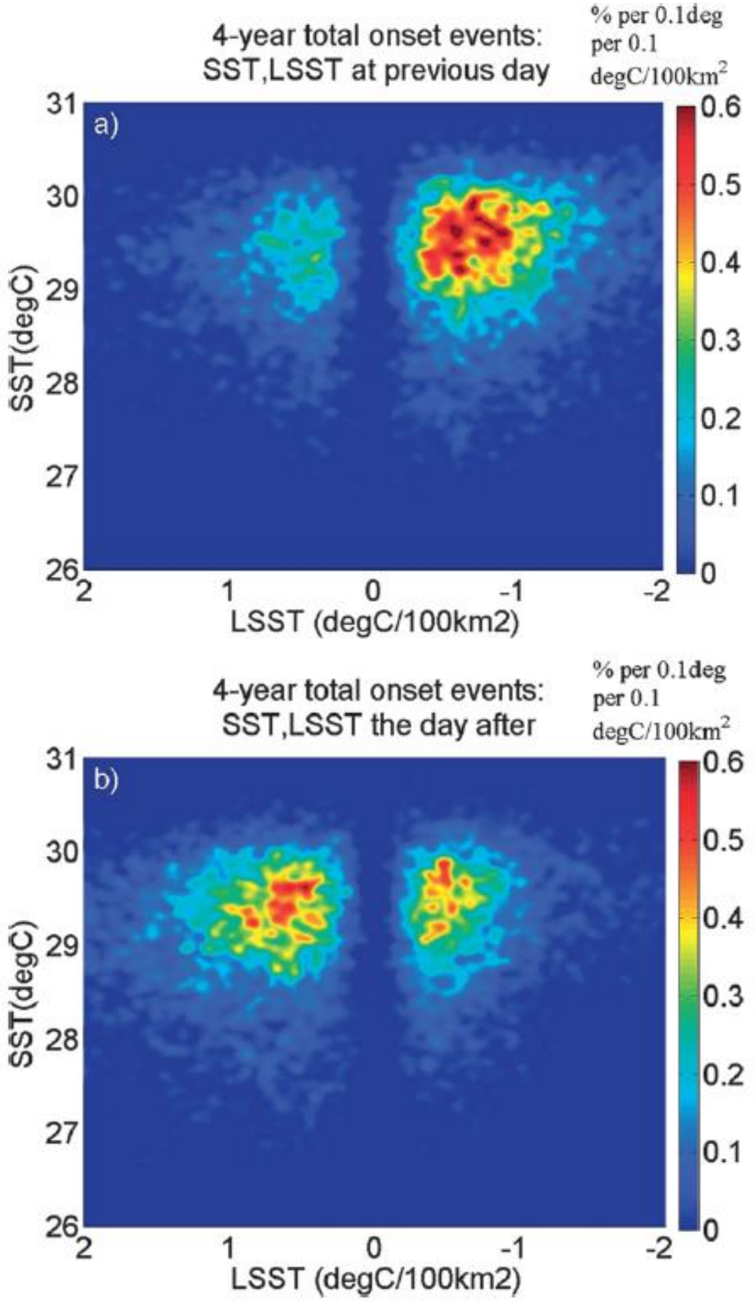


FIG. 1. Computational domain (shaded).



Distribution of rainfall onset SST.

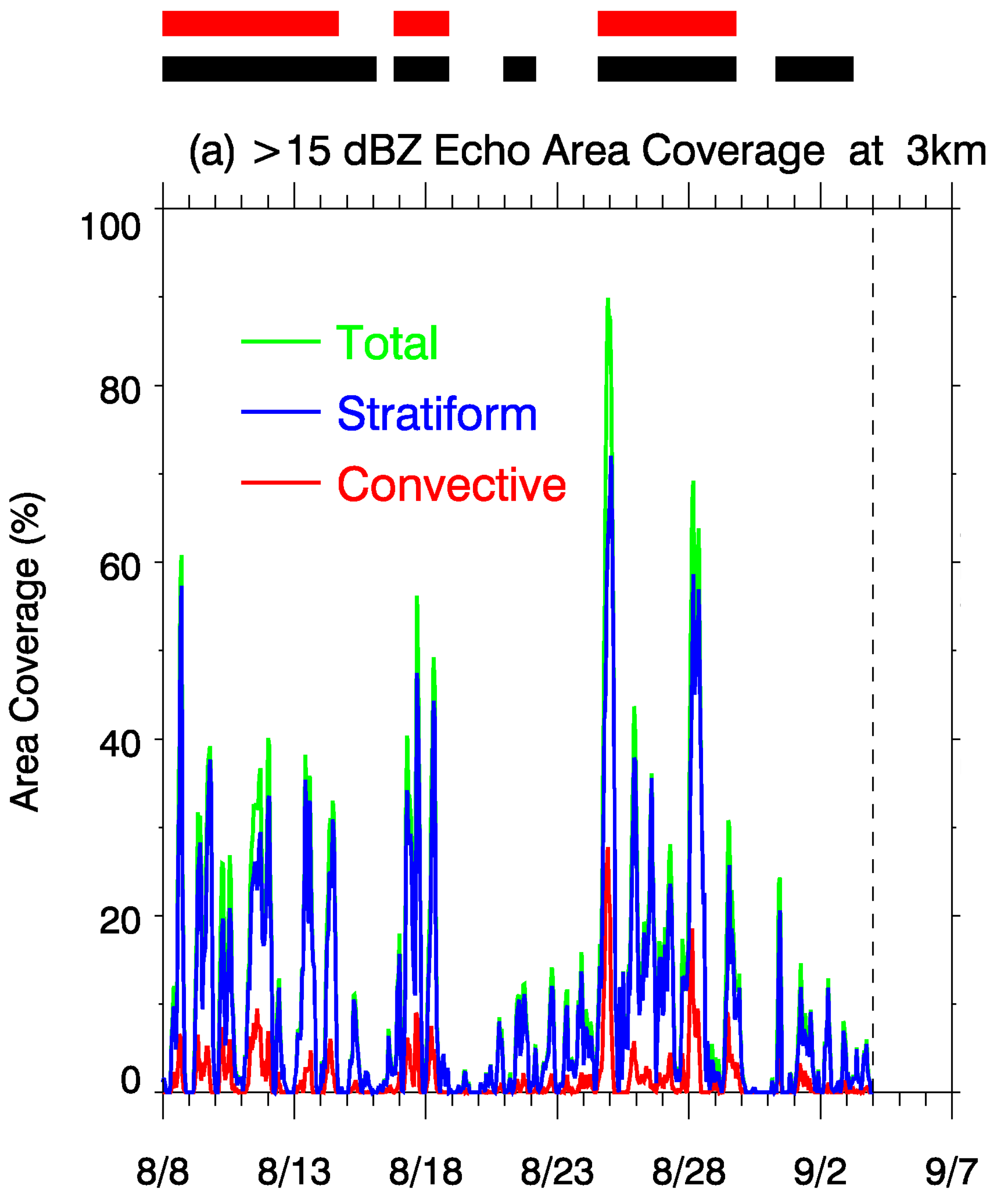


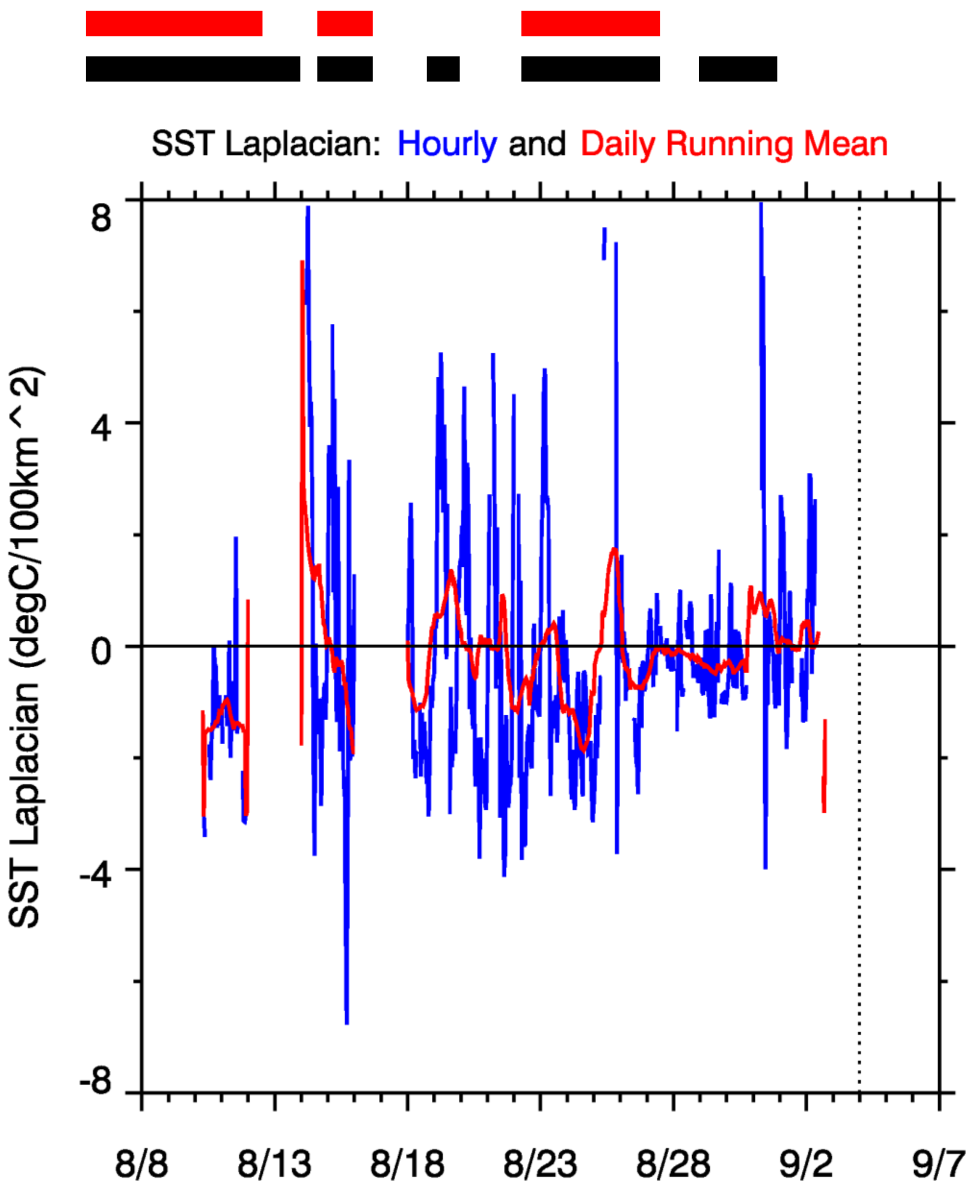
Li and Carbone (2012) demonstrated based on satellite-derived (SST & Rain) data that rainfall onset events occurred at locations with enhanced horizontal convergence, which is inferred by the Laplacian of SST (O(100km)).

Frequency of convection onset as a function of SST and SST Laplacian. (a) previous day, (b) following day.

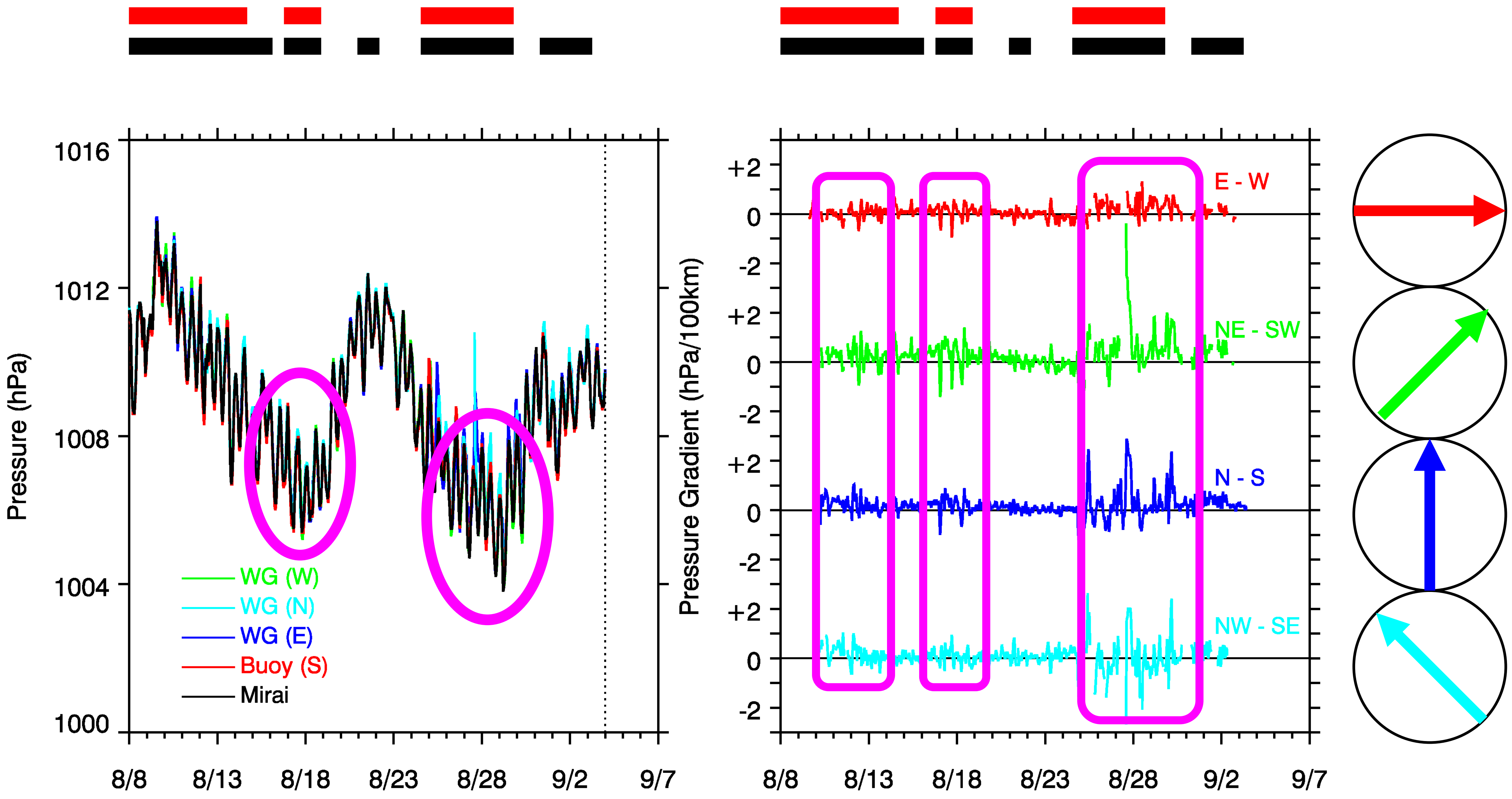
From Li and Carbone (2012, JAS)

Time Series of Radar Echo Area & SST Laplacian

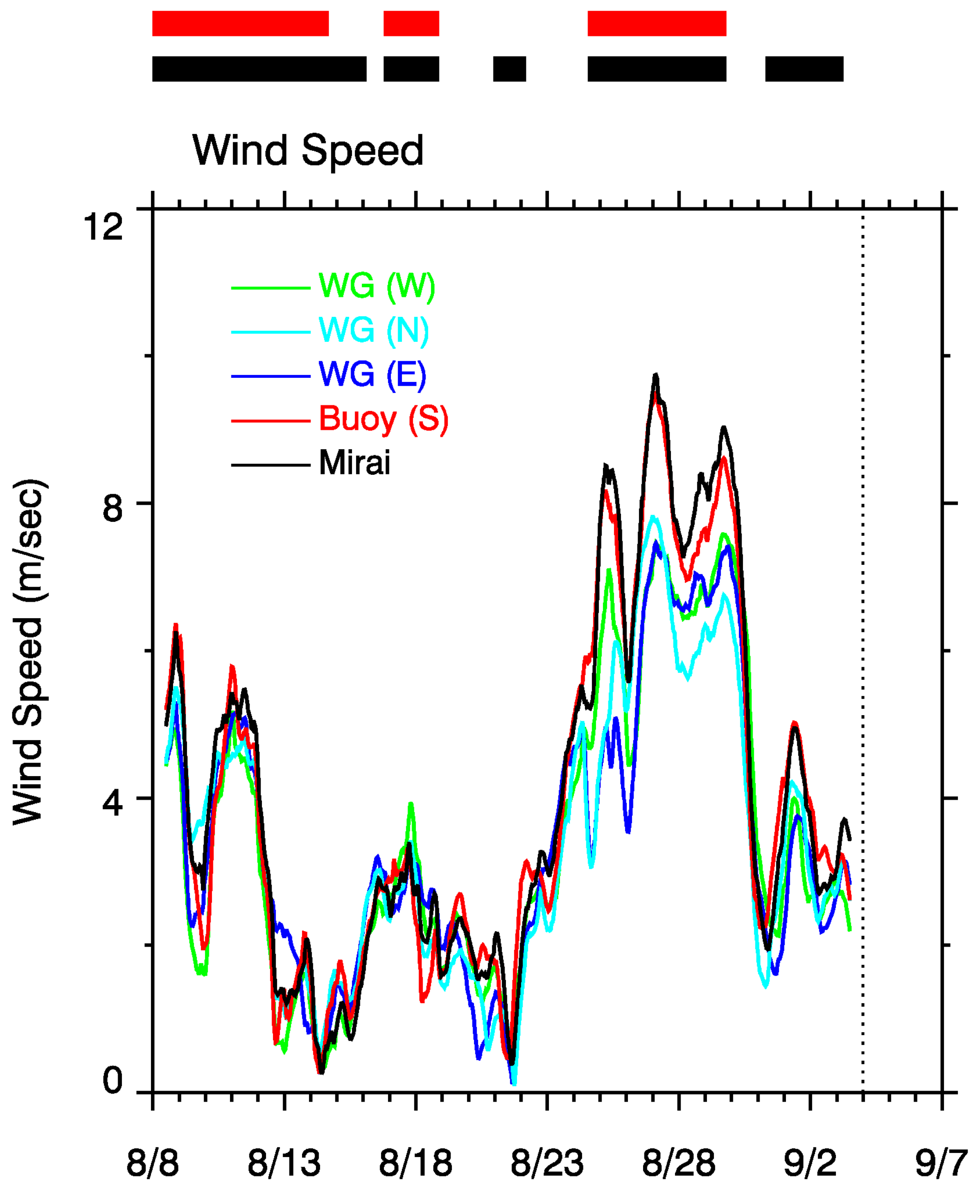


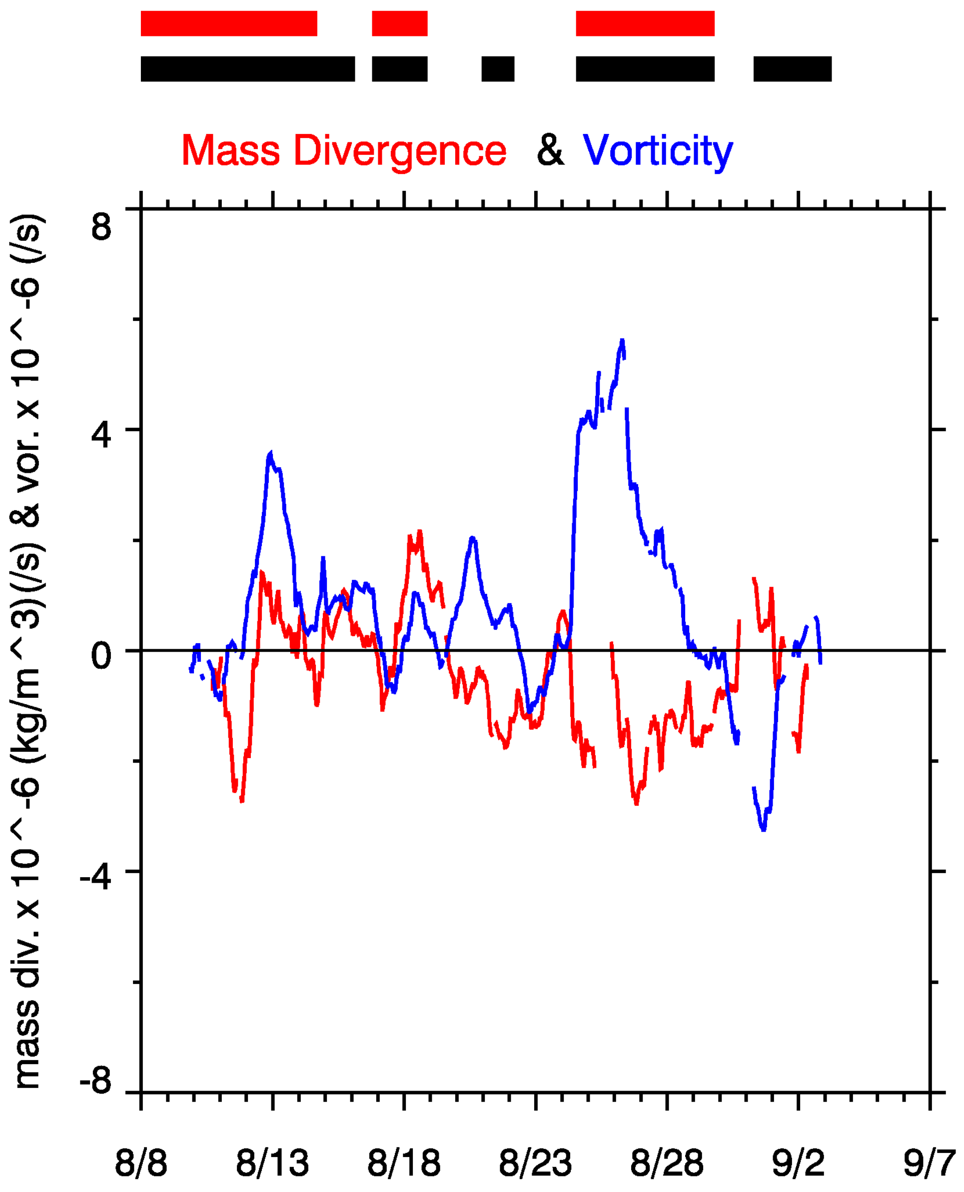


Pressure Field



Mass Divergence and Vorticity





Concluding Remarks

a) Autonomous Surface Vehicle (ASV) is a new useful tool to study air-sea interaction. In addition to their standard measurement system, we confirmed that GNSS-derived precipitable water vapor measurement is also available.

b) While it is desirable to deploy a ship in addition to ASVs in studying air-sea interaction, it is usually difficult due to funding constraints and others. Our trial suggests alternative by deploying several ASVs. Some parameters can be a candidate of index of convective activity and moisture condition. It is possible to deploy ASVs and form an array with land-based sites to study ocean-atmosphere-land interaction.

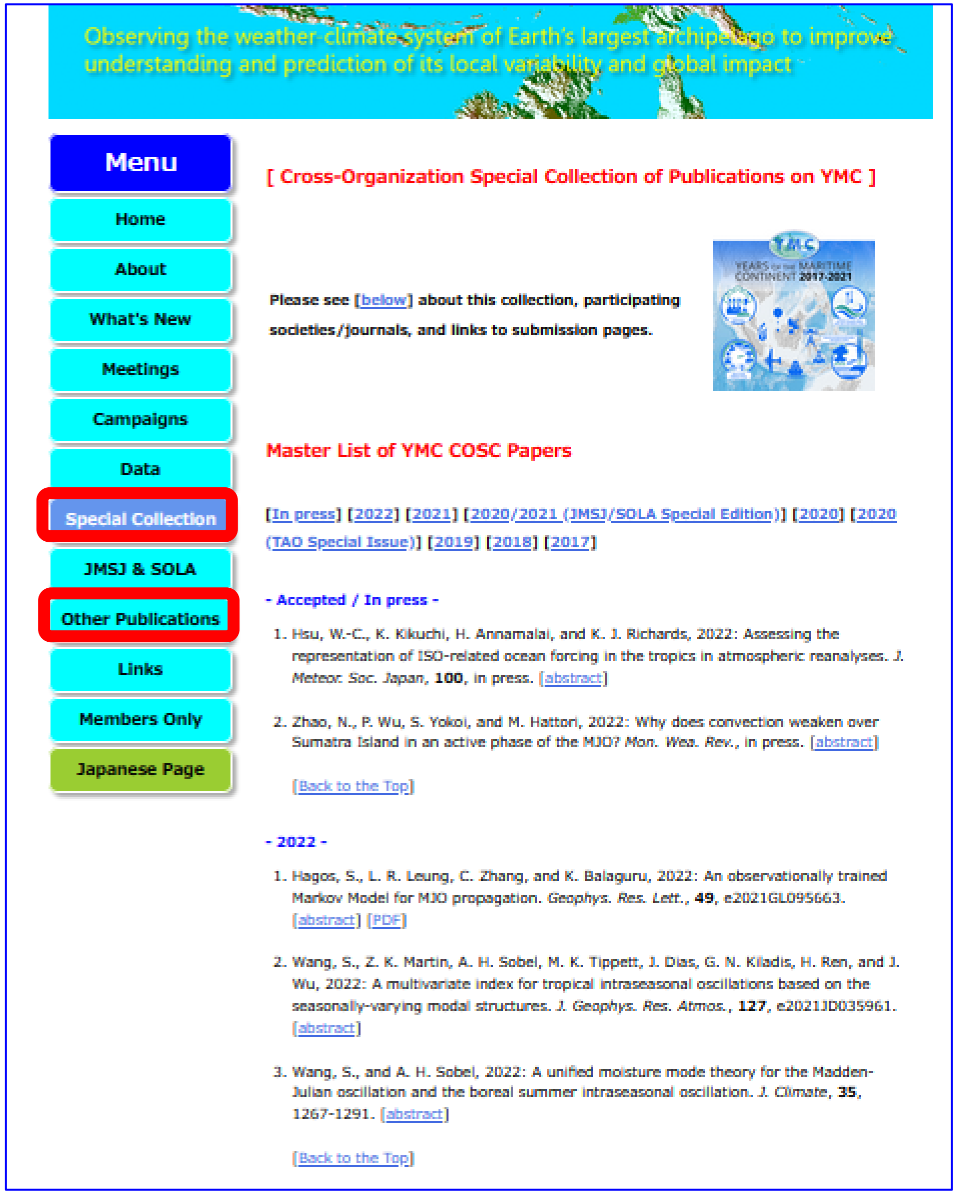
c) Data obtained during YMC-BSM 2018 and 2020 have already been opened to the public from the YMC website. https://www.jamstec.go.jp/ymc/

d) Although nothing was mentioned today, those knowledge as well as data QC techniques have been shared with local agencies following the YMC guidance, which will lead high-quality long-term measurement in future.

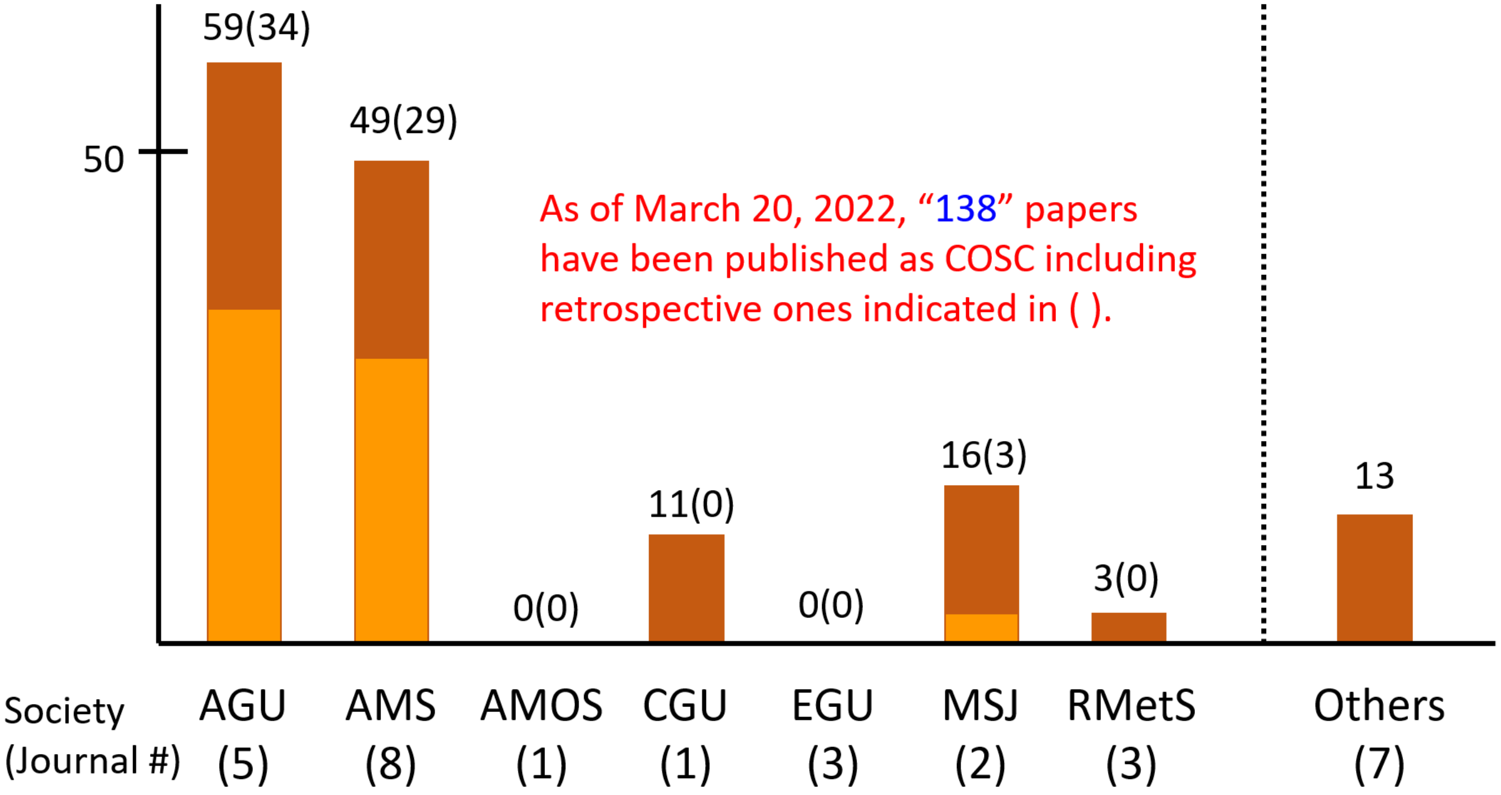
Acknowledgments. Special thanks to PAGASA/Philippines, YWS/FSM, KWS/Palau, and US NOAA for their observation support.

Information

https://www.jamstec.go.jp/ymc/



Cross-Organization Special Collection of the YMC papers (cooperation by 7 societies)
YMC website offers one-stop site seeking those papers easily.



Extra slides

Intensive Observations (including relevant projects)

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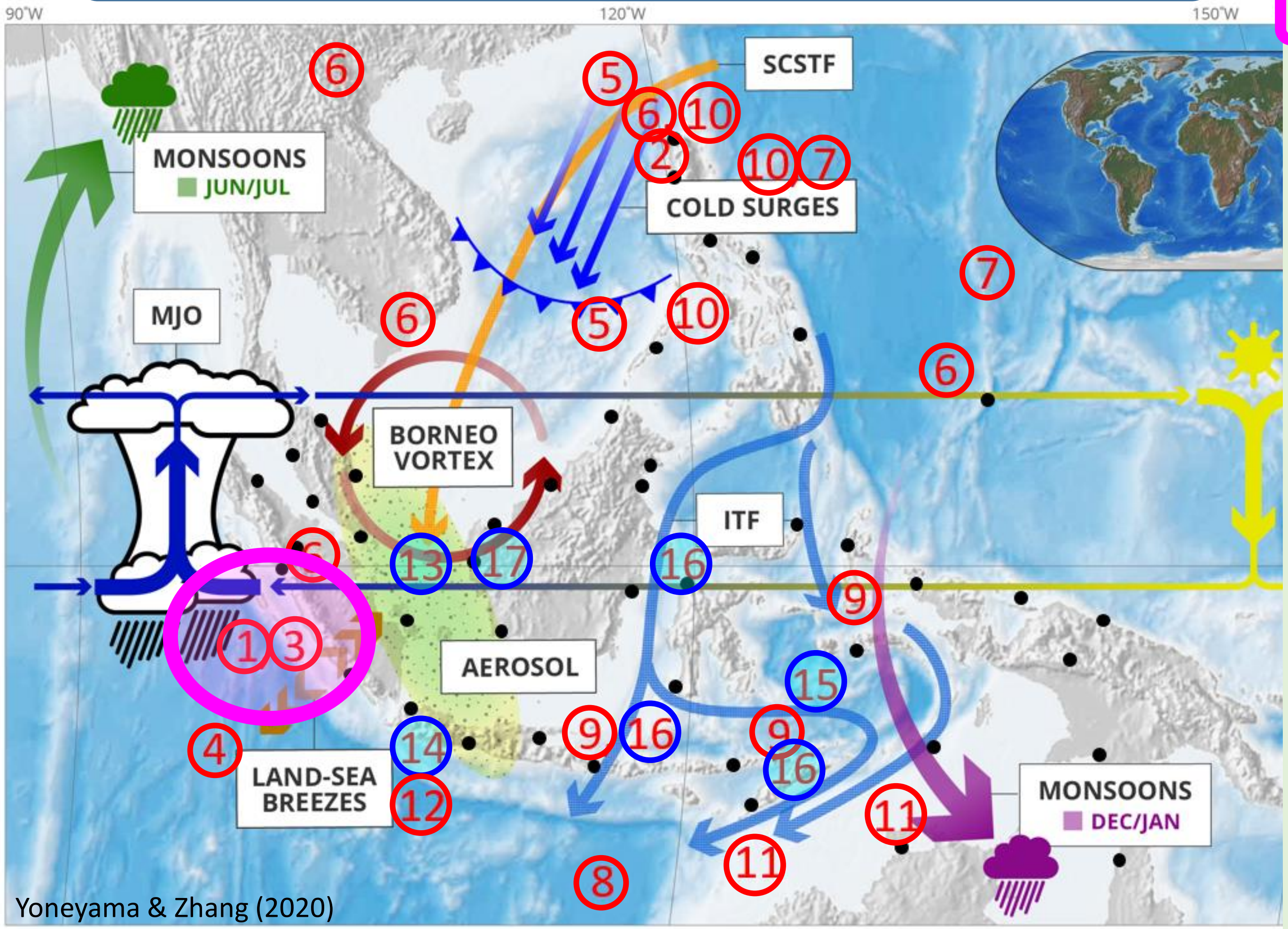

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Postponed to 2022/23 due to COVID-19

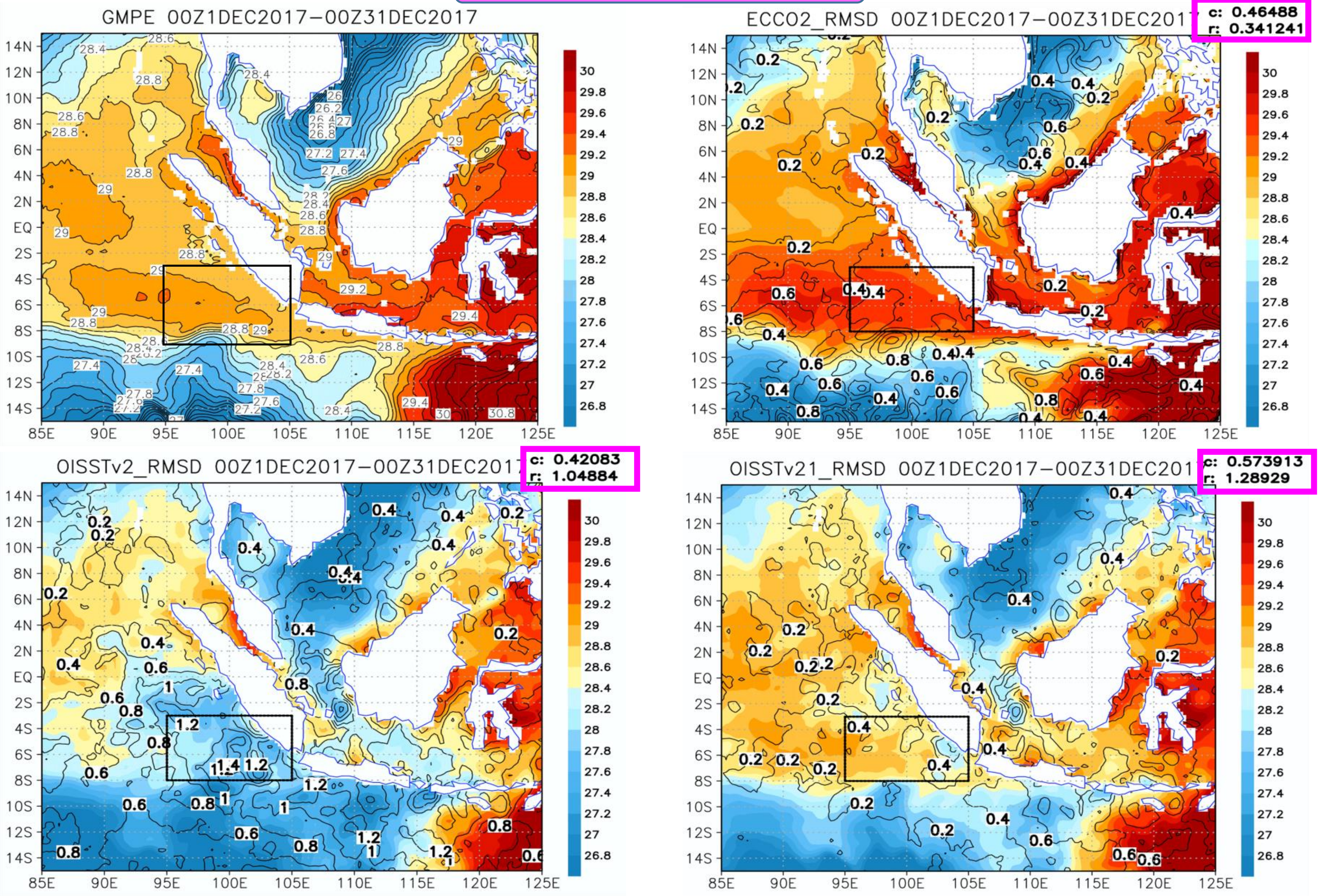
SST Bias in Analysis Products ?

Mean SST (Dec. 2017)

GMPE

GHRSST Latest Multi-Product Ensemble Median

NASA ECCO2



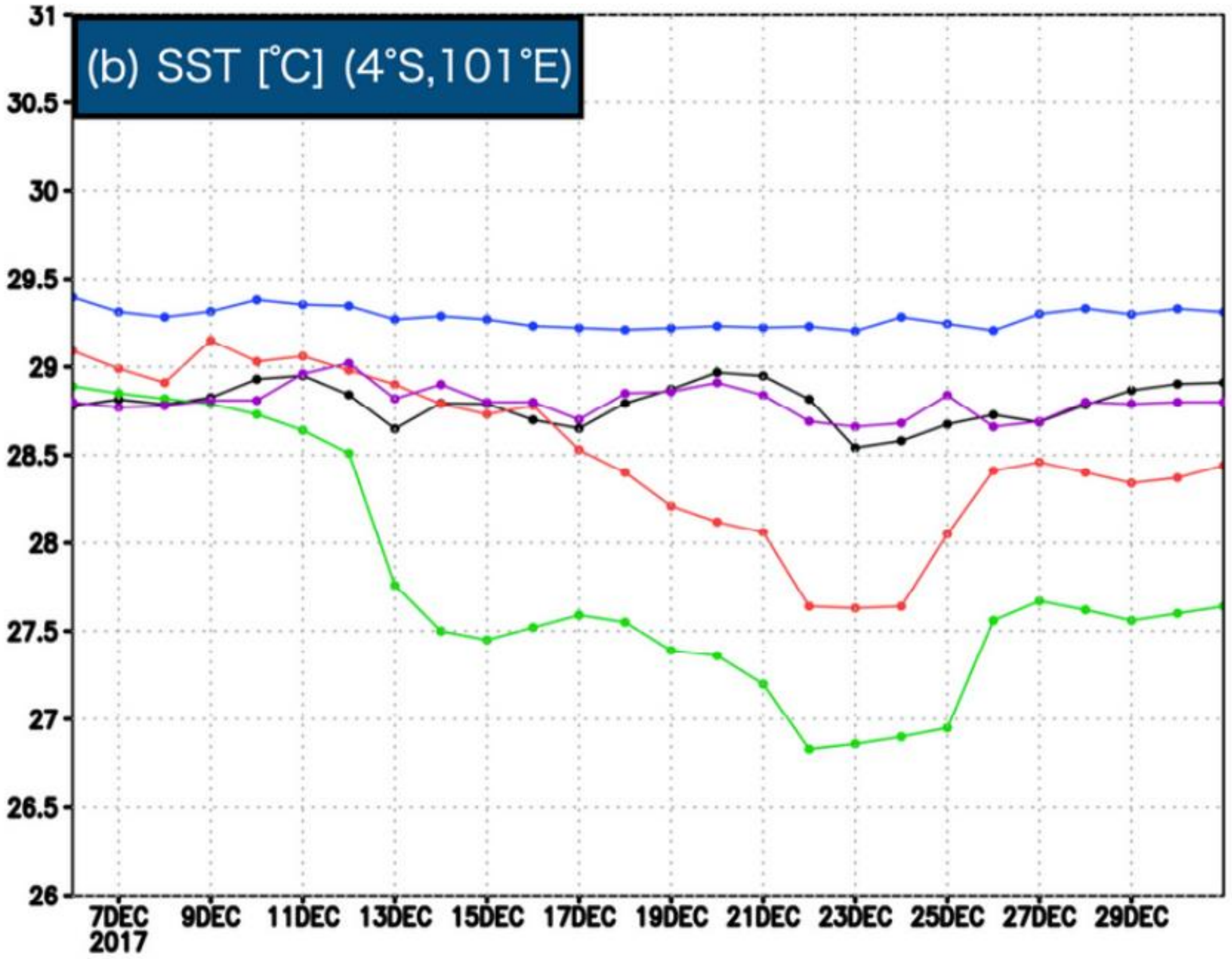
NOAA OISST v.2

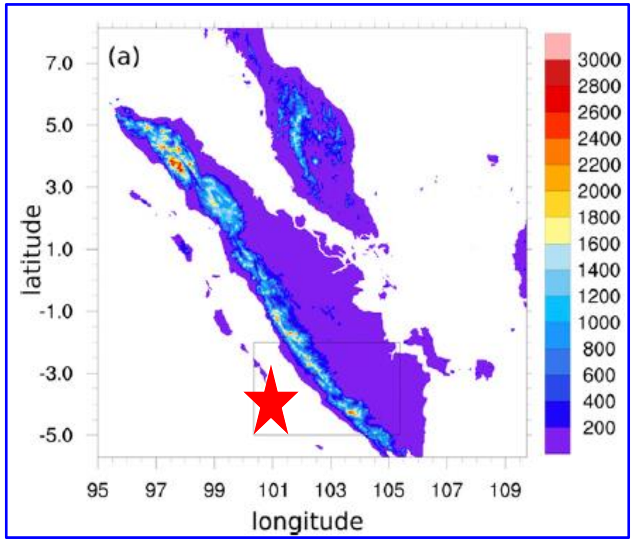
NOAA OISST v.2.1

Note. Contour indicates difference from GMPE

Moteki (2022, Sci. Rep.)

SST Bias in Analysis Products ?





Moteki (2022, Sci. Rep.)

Sea Surface Temperature Gradient