Possible next steps of the YMC - What we learned and obtained

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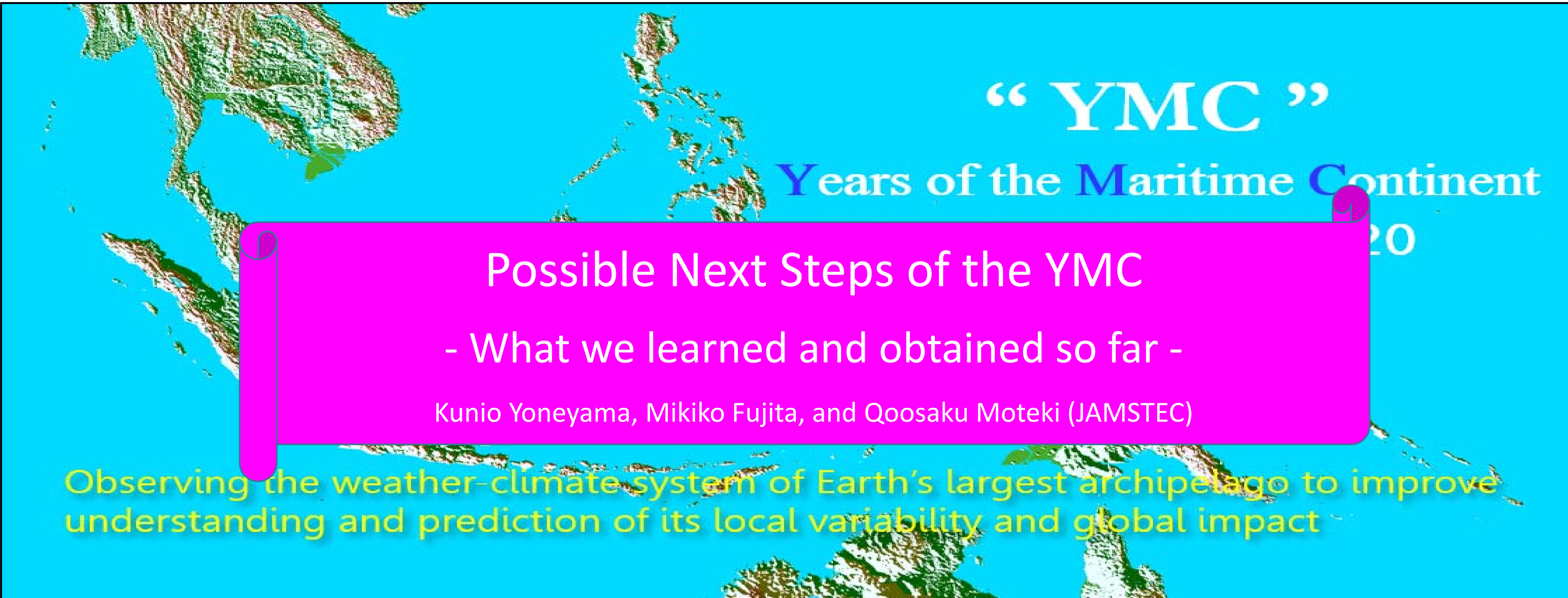
November 22, 2022

Abstract

Years of the Maritime Continent or YMC was designed to improve our knowledge of the weather-climate systems over the MC and their numerical simulation and prediction skill. Since its first field campaign in November 2017, many intensive observations have been carried out under the coordination with the MC countries. Although currently some observations have been postponed due to COVID-19 pandemic, field campaigns are expected to continue beyond 2021. Up to now, some key information could be obtained, which suggest future approaches. In particular, diurnal cycle of rain near the coast is one of major targets, as they are dominant component of precipitation in this region. Some studies suggest the important role of temperature contrast between land and ocean, and inaccurate initial sea surface temperature conditions might cause a delay of offshore propagation of rainfall region. This fact provides a clue to improve simulation of precipitation behavior over the MC. In addition, during the campaign, several new observation tools have been introduced. For example, autonomous surface vehicle (ASV) had been deployed and measured surface meteorology as well as sea surface condition. Besides, GNSS-derived water vapor measurement was successfully carried out. Those results suggest that such ASVs equipped with new tools can be used to monitor accurate sea surface condition without significant cost and time. However, usually those instruments are not allowed to operate freely in the MC. Thus, based on collaboration with the MC countries, researchers in the MC are highly expected to take this role as regional representative. In this presentation, we will also show other results which provide tips for future direction.



Possible Next Steps of the YMC

- What we learned and obtained so far -

Kunio Yoneyama, Mikiko Fujita, and Qoosaku Moteki (JAMSTEC)

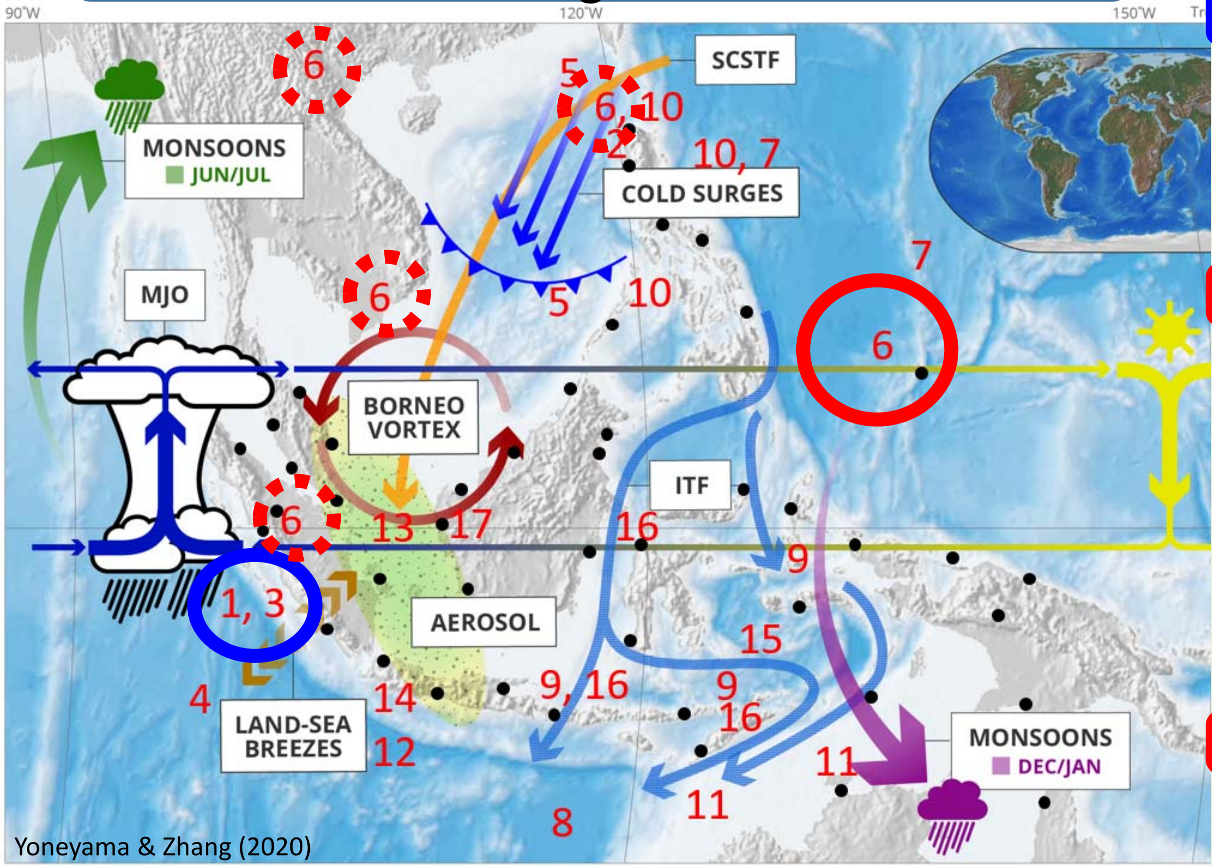
< Outline >

1) Introduction of Intensive Observations that JAMSTEC were directly involved
2) Point 1 : Importance of Ocean Surface Observations
3) Point 2 : Importance of Data Quality Control
4) Concluding Remarks … Suggestions for future plan

AGU 2020 Fall Meeting by online, 1-17 December 2020

Intensive Observations (including relevant projects)

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



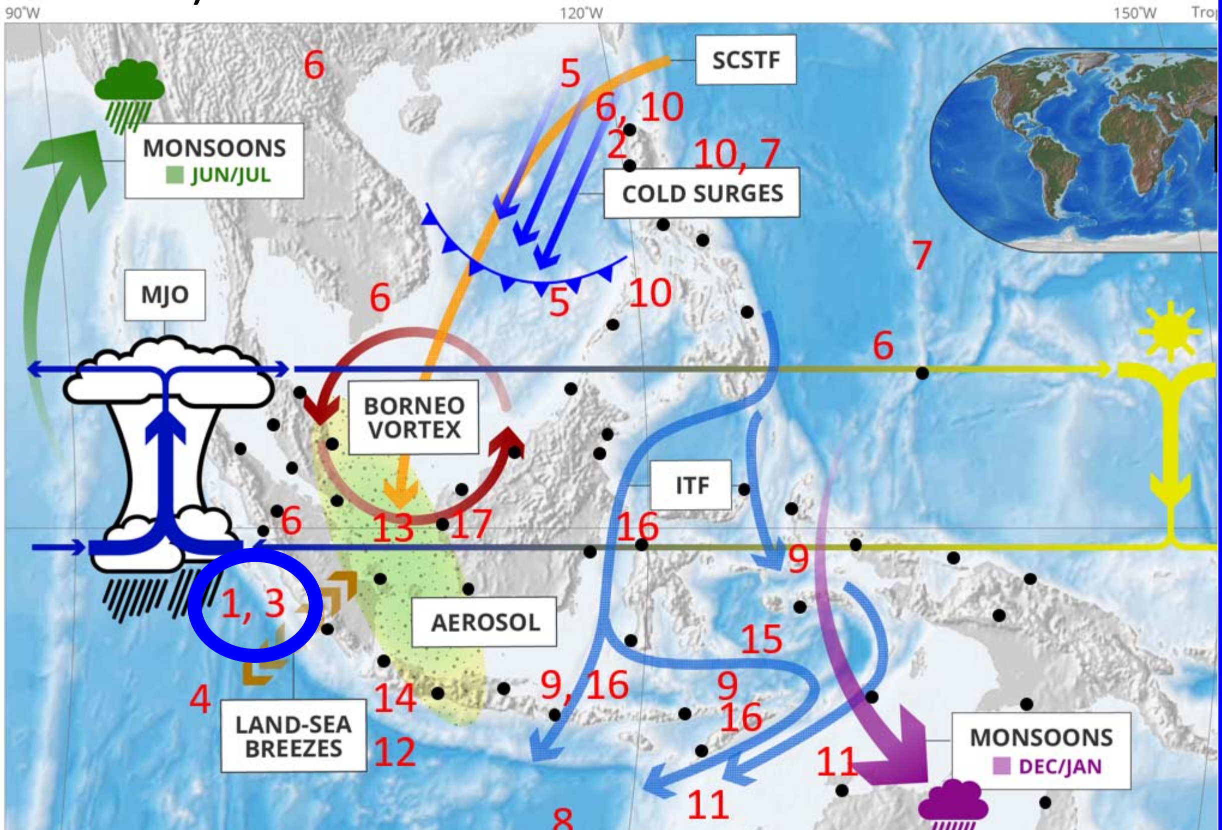
Number Conducted or Planned Intensive Observation Areas

● Radiosonde sounding stations

2015.10-12	1	Pre-YMC in Sumatra
2017.08	2	RSVP (air-sea)
2017.11-01	3	Sumatra (MJO, DC)
2017.11-02	4	EIOURI (Upwelling)
2017.12	5	SCSTIMX (monsoon)
2018.03-04	5	SCSTIMX (monsoon)
2018.05-06	5	SCSTIMX (monsoon)
2018.06-08	6	BSM (monsoon)
2018.08-10	7	PISTON (DC, ISV)
2018.11	8	MAMOS/CWPDIP (MJO, Monsoon)
2019.01-04	12	ELO (ocean)
2019.02-03	9	OM/CAT (ITF, tide)
2019.08-10	10	CAMP2Ex (Aerosol)
2019.09	7	PISTON (DC, ISV)
2019.10-12	11	Investigator(MJO, DC)
2020.08-09	6	BSM (monsoon)
2020.12-02	12	ELO (Ocean)
2021.12-02	14	TerraMaris (DC, MJO)
2021.12-02	13	ELO-O (Cold Surge)
2022.01-02	15	Banda Sea (air-sea)
2022.01	16	MINTIE (ITF)

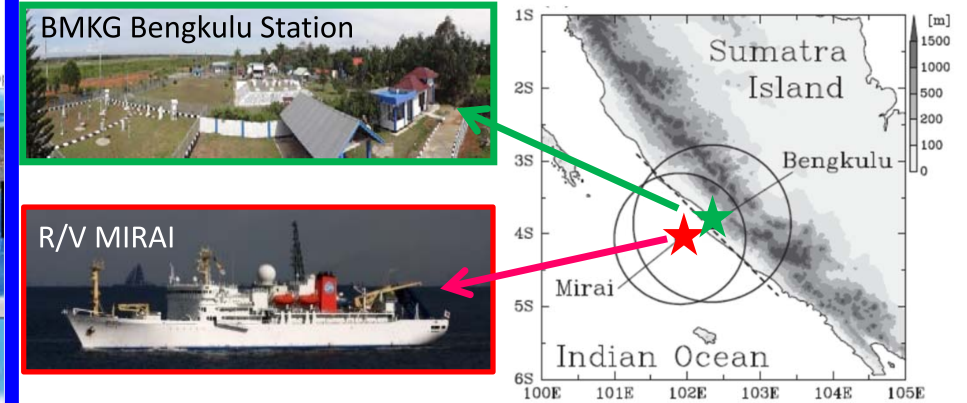
YMC-Sumatra 2015 (Pilot Study) and 2017

1) Nov. 2015 - Dec. 2015
2) Nov. 2017 - Jan. 2018

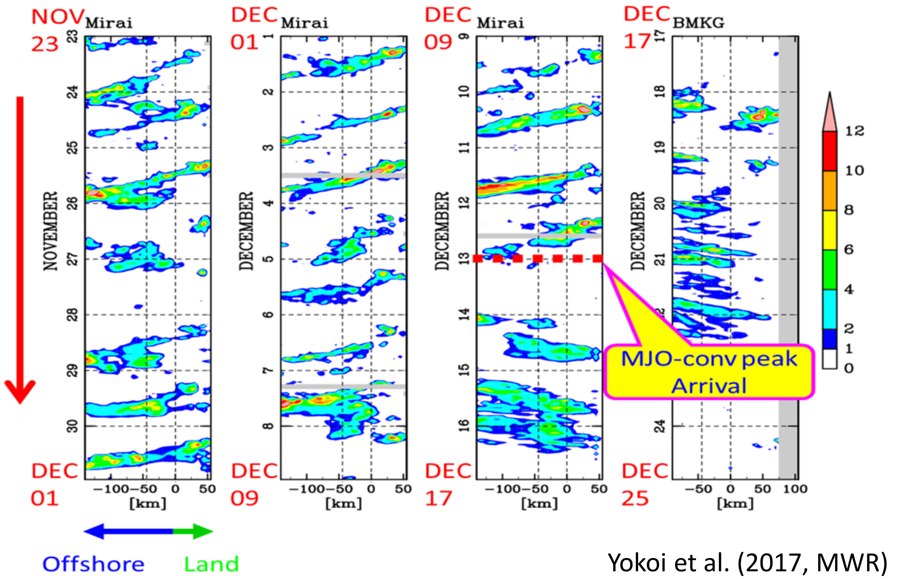


Yoneyama & Zhang (2020)

Pilot study area in 2015



Time-distance from the coastline plot of rainfall intensity observed by radar onboard the Mirai and land-based

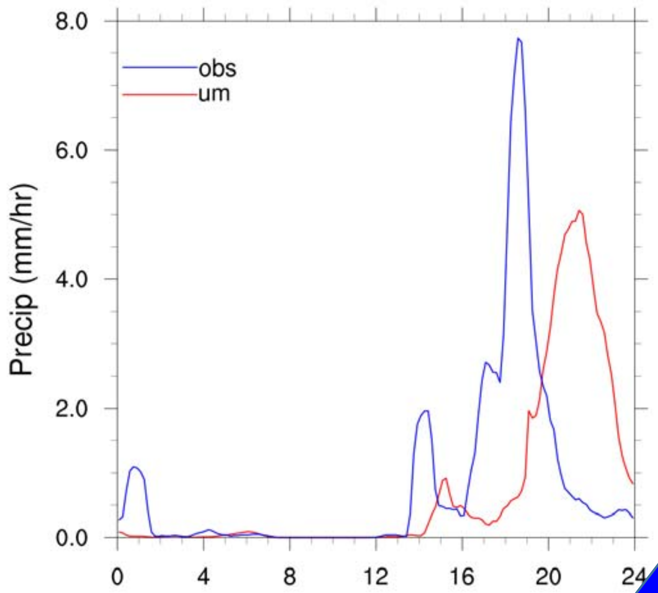


Yokoi et al. (2017, MWR)

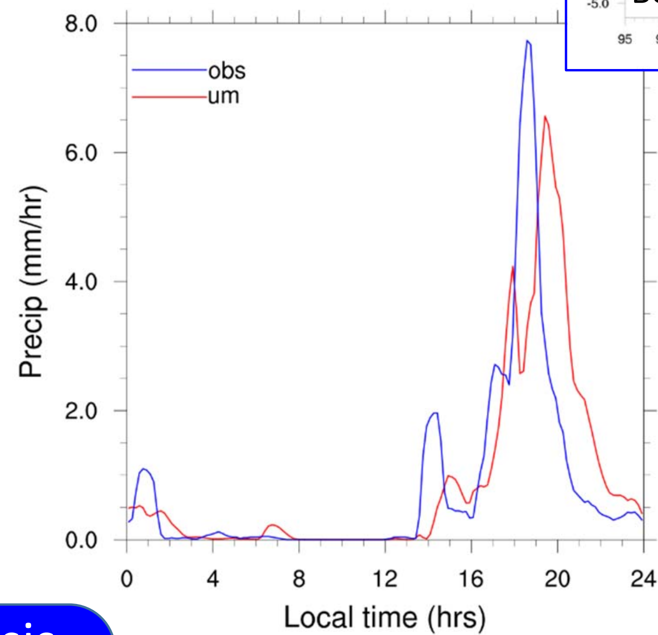
Improvement of Numerical Model Skill

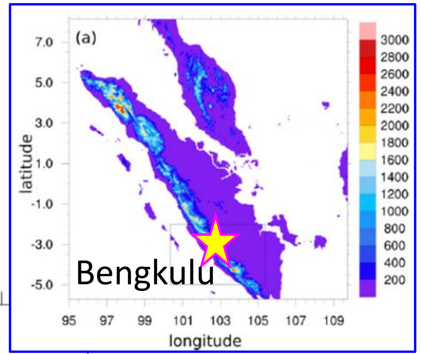
Meteorological Service Singapore has already used YMC in-situ data, and confirmed their modeling skill of diurnal cycle of rain can be improved .

Mean Diurnal Cycle of Rain at Bengkulu



$SST_{control}$ + 2K





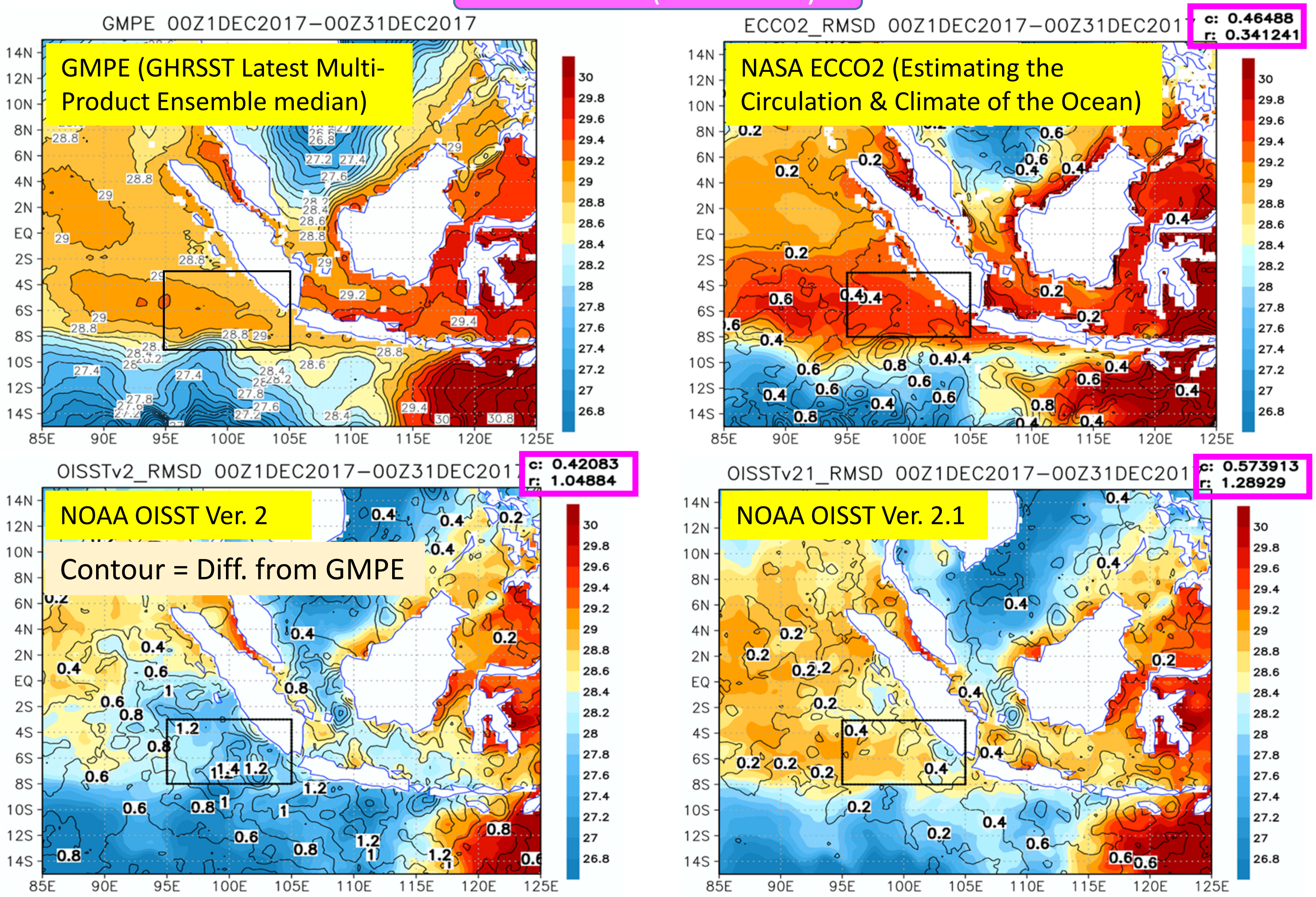
When they changed initial condition data from analysis product to in-situ, modeled result showed one similar with observation. This suggests a low-SST bias in initial condition caused a delay of simulated rain over land.

Dipankar et al. (2019, MWR)

Model: SINGV Tropical Ver. of UK Met Office Unified Model (UM) (res =1.5km)

SST Bias in Analysis Products ?

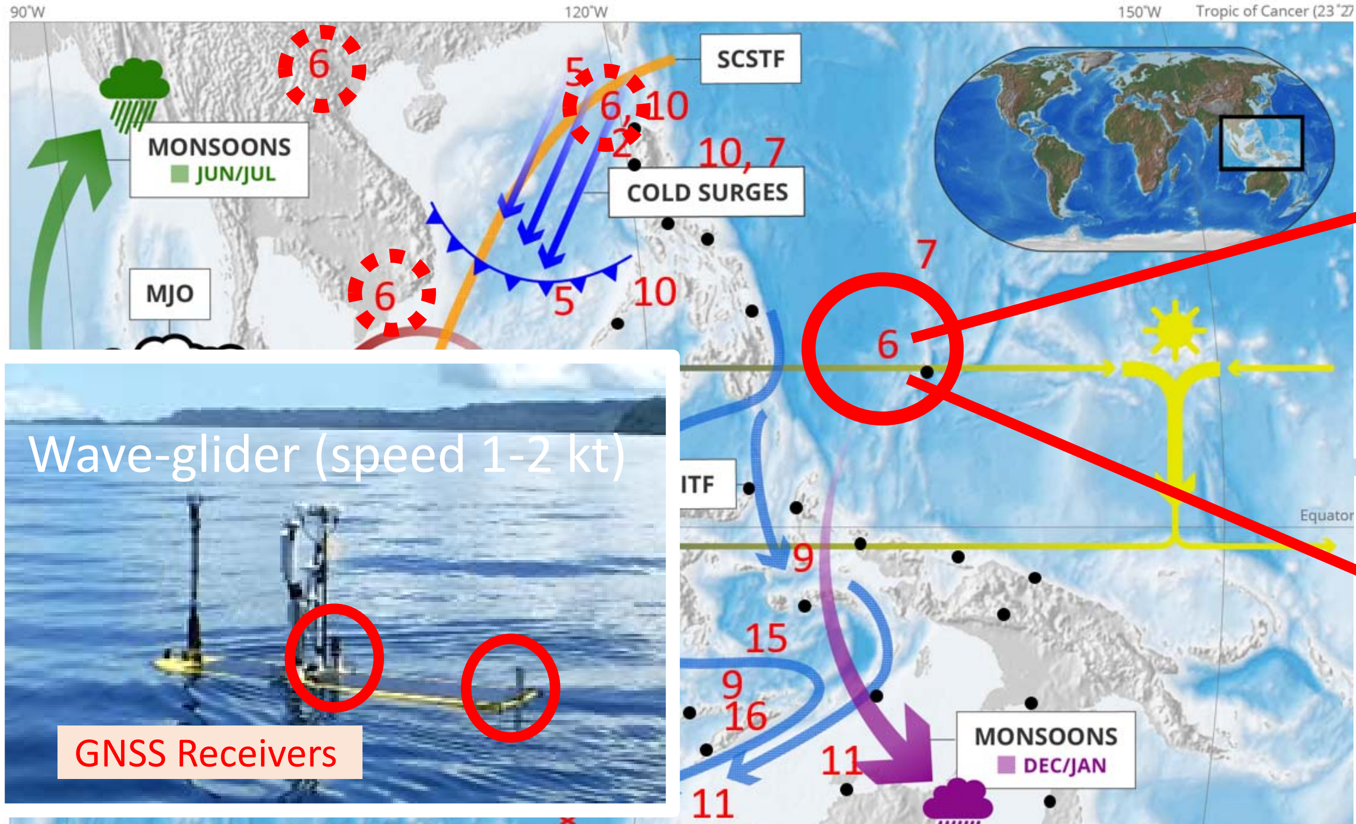
Mean SST (Dec. 2017)

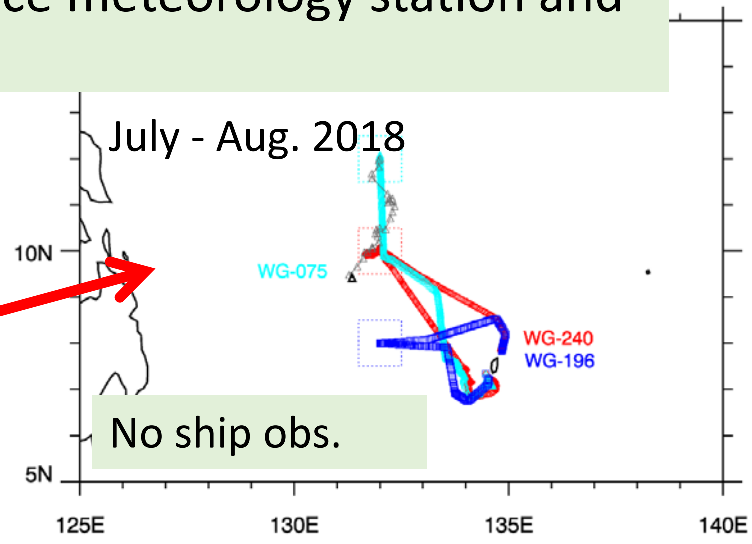


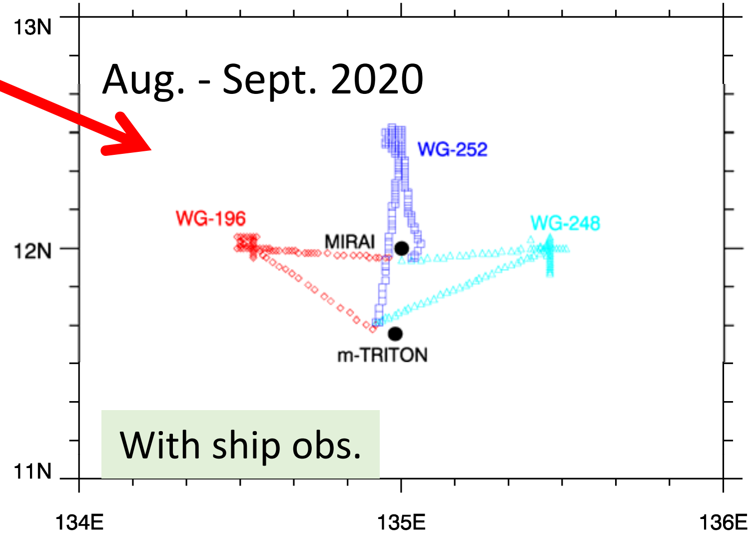
Moteki (2020, SOLA, in revision)

Boreal Summer Monsoon Study in 2018 & 2020

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





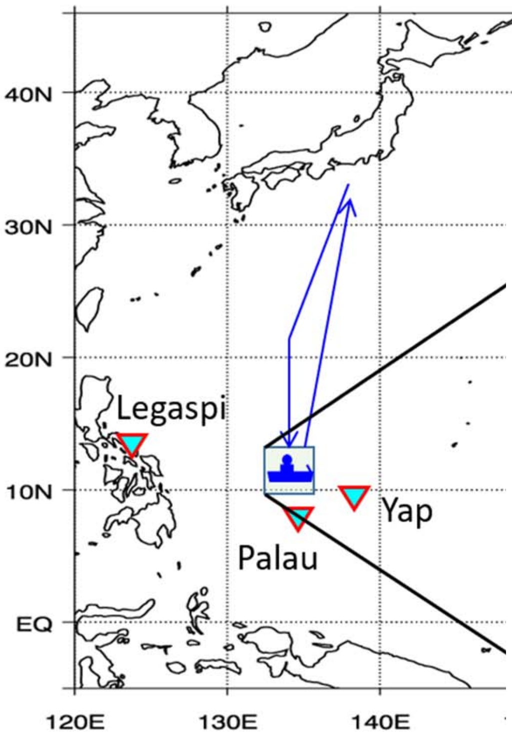


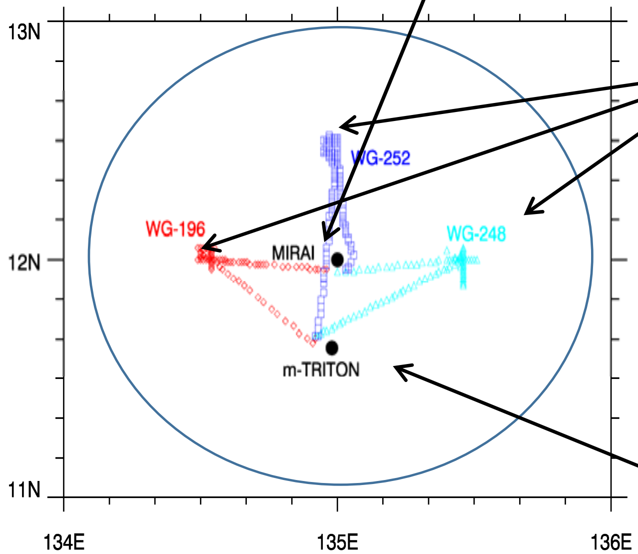
Standard Parameters:
Surface Meteorology (P, T, RH, Rain, Wind, SW/LW), SST, & Salinity
Additional Parameter:
GNSS-derived Precipitable Water Vapor

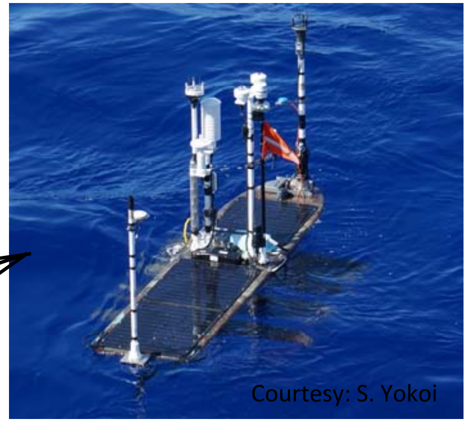
Boreal Summer Monsoon Study in 2020

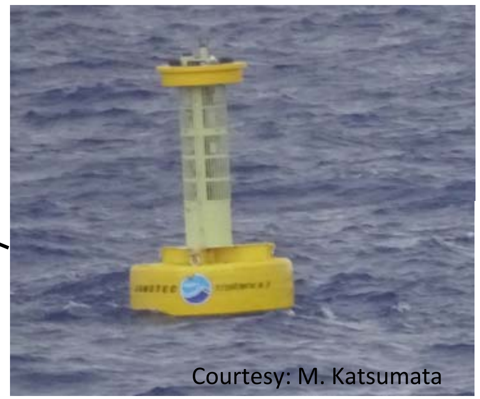
Period: Aug. 1 - Sept. 14, 2020

IOP: Aug. 8 - Sept. 4, 2020

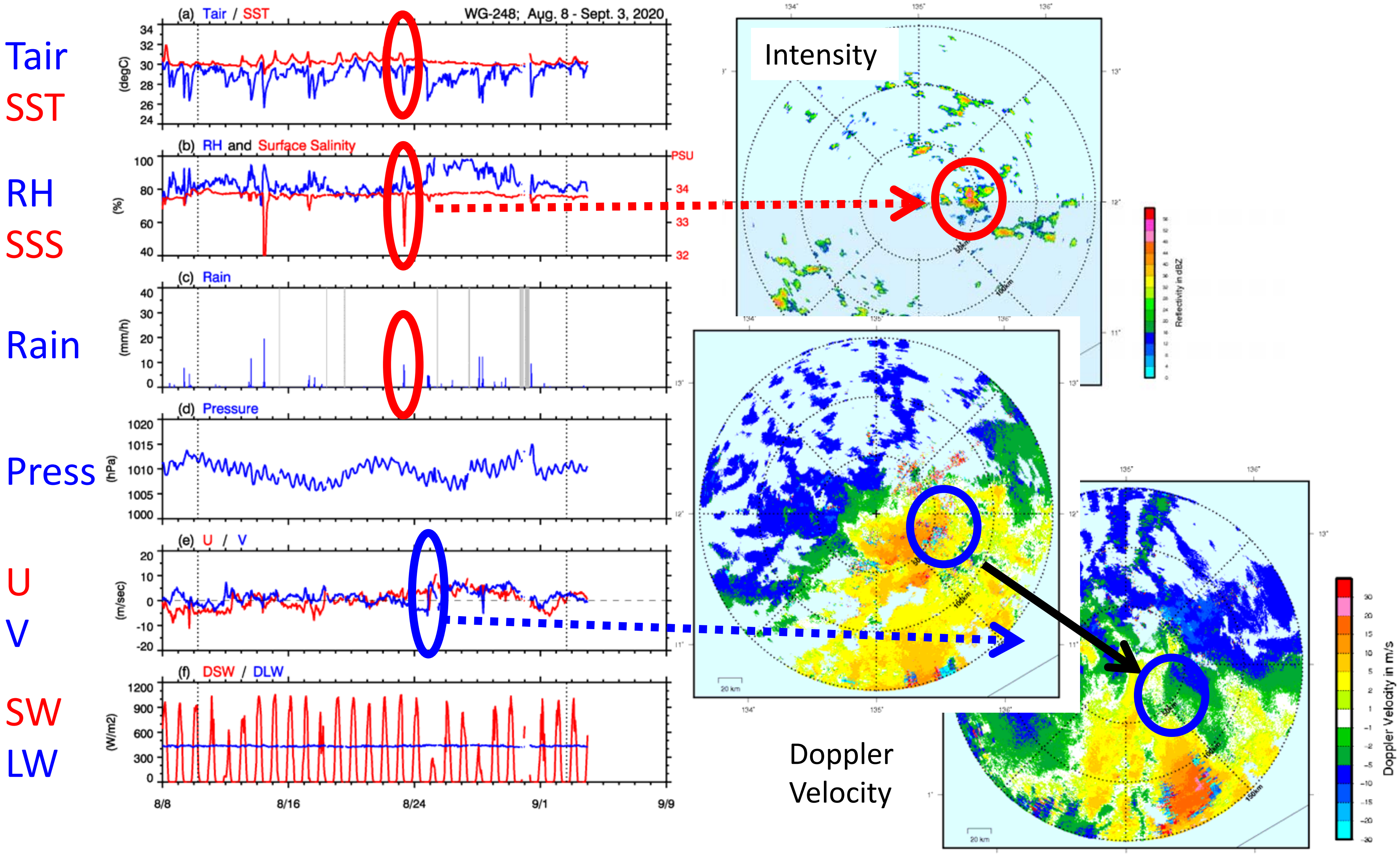






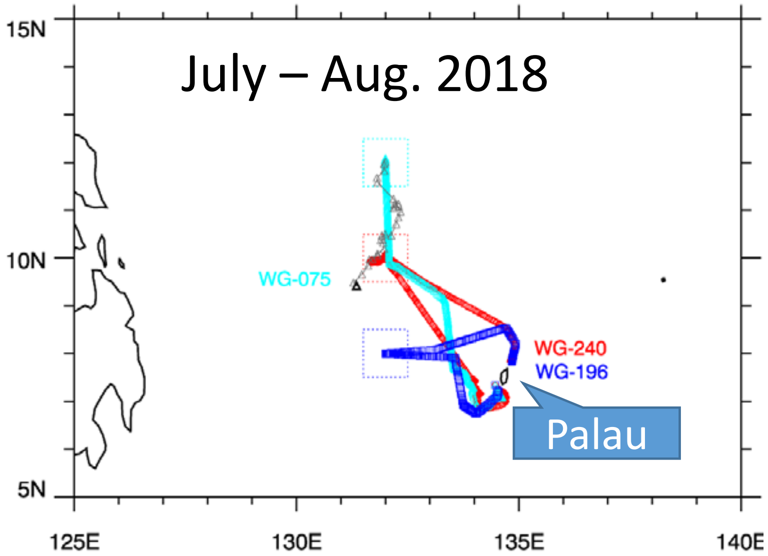


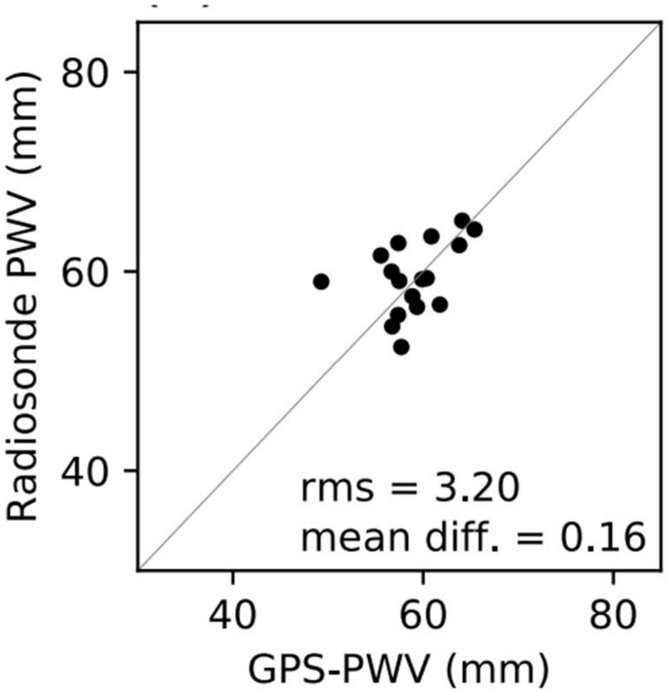
Surface Meteorology

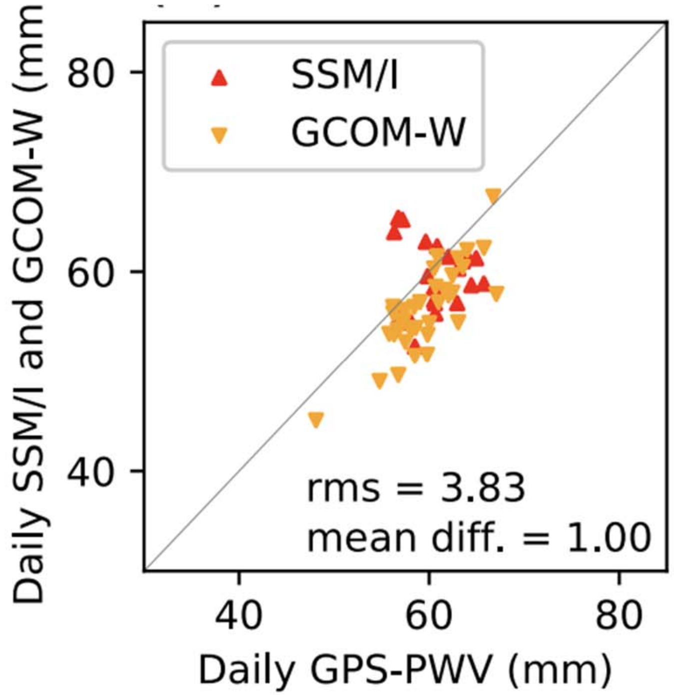


GNSS-derived Precipitable Water Vapor during BSM 2018

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

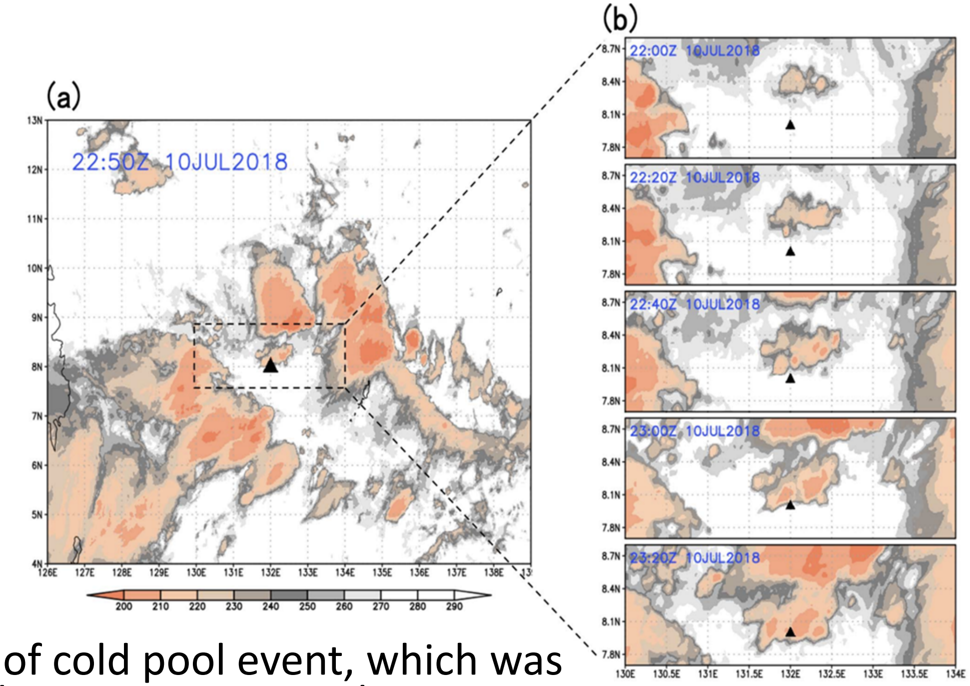




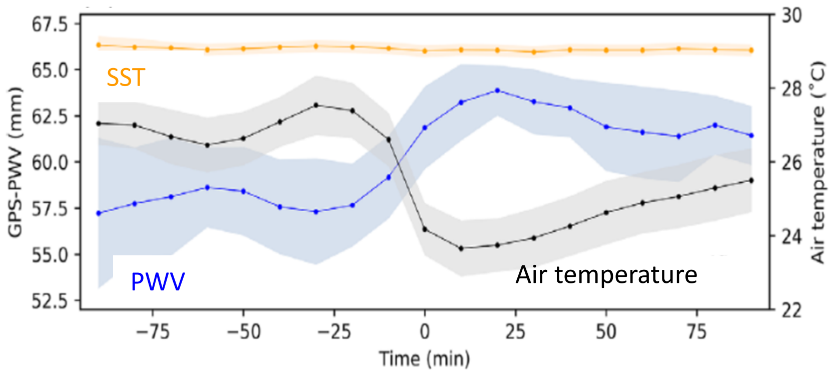


Fujita et al. (2020, SOLA)

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.



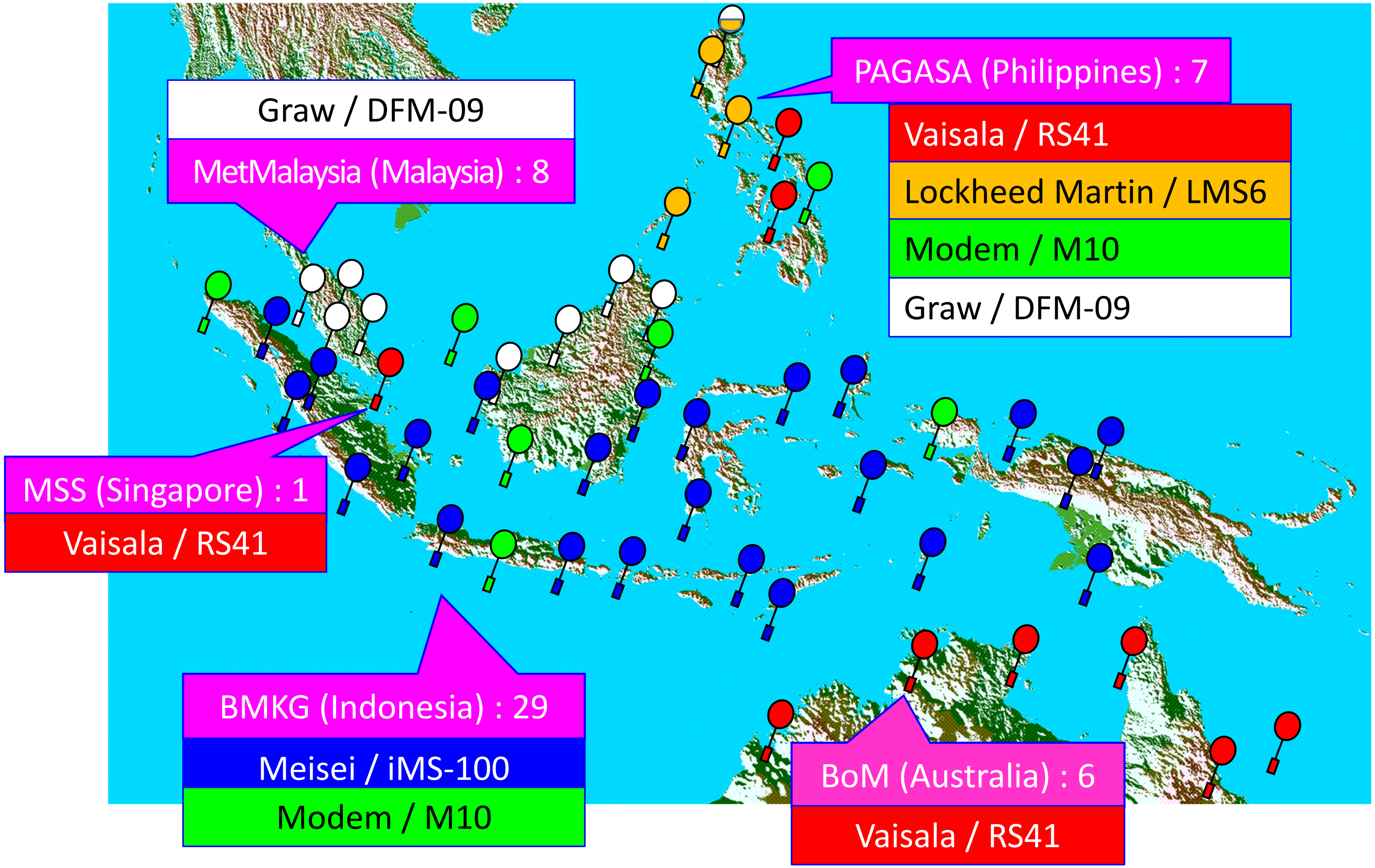
Composite of PWV, Air Temperature, and SST variations during cold event passage. Shading indicates standard deviation.

Fujita et al. (2020, SOLA)

To evaluate capability of GNSS-derived PWV measurement, we checked their behavior, when cold pool events associated with convection were observed. Following de Szoeke et al. (2017) study definition (10-min surface air temperature drop by 2C or more), we identified 23 cold pool events during BSM2018 campaign period. The result (right panel) clearly shows drastic increase of PWV by 5mm or so indicating it can be used to study meso-scale convective cloud systems.

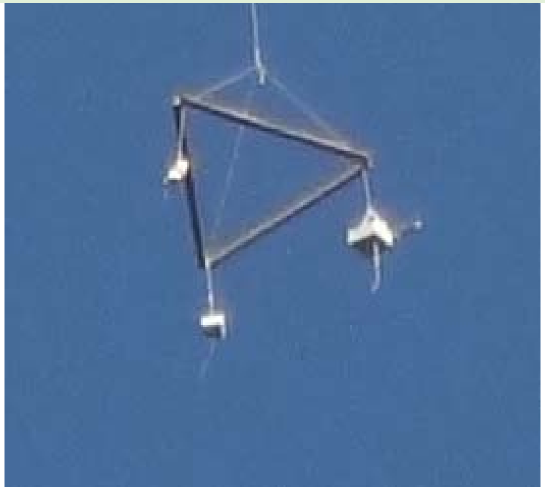
Quality Control of Radiosonde Sounding Data

Operational Radiosonde Observations by the MC Meteorological Agencies

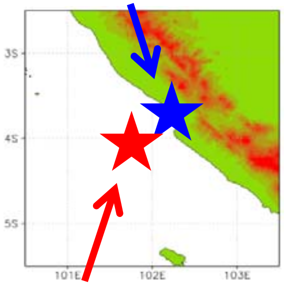


Intercomparison (Meisei vs. Vaisala) at BMKG Bengkulu Station

To confirm possible humidity bias among different radiosondes, intercomparison has been conducted at several sites during IOPs.



Meisei @ Bengkulu



Vaisala @ Mirai

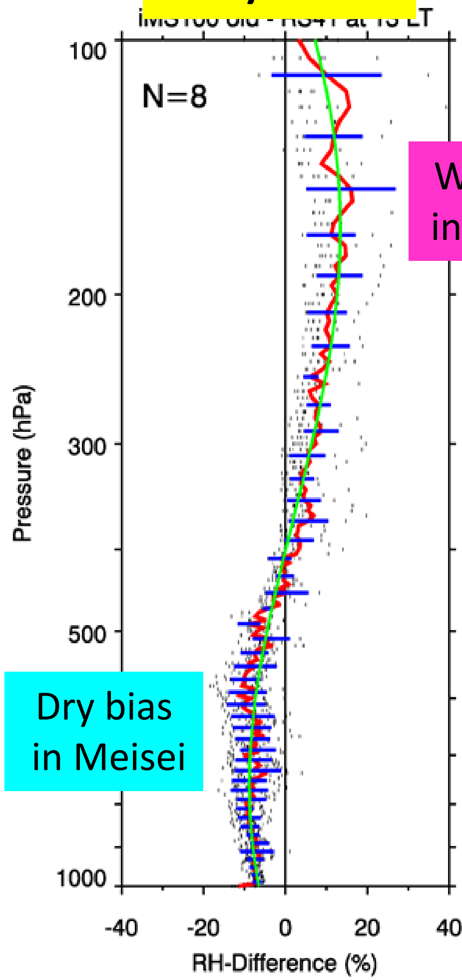
Inter-comparison: 17 times (15 daytime, 2 nights)

1) Meisei (iMS-100) … BMKG Routine observations + IOP
2) Vaisala (RS41-SGDP) … onboard the R/V MIRAI

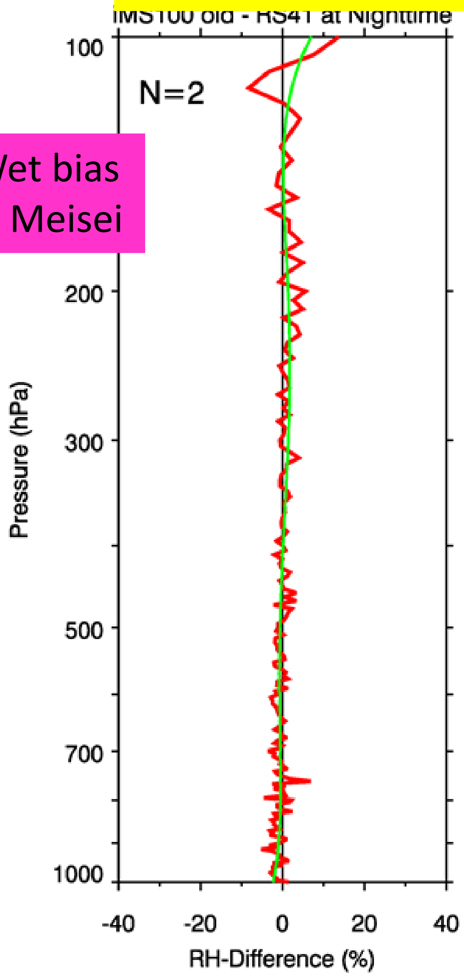
3) CFH (Cryogenic Frost-point Hygrometer) … 7 times
4) GNSS-derived Water Vapor

Intercomparison (Meisei vs. Vaisala) at BMKG Bengkulu Station

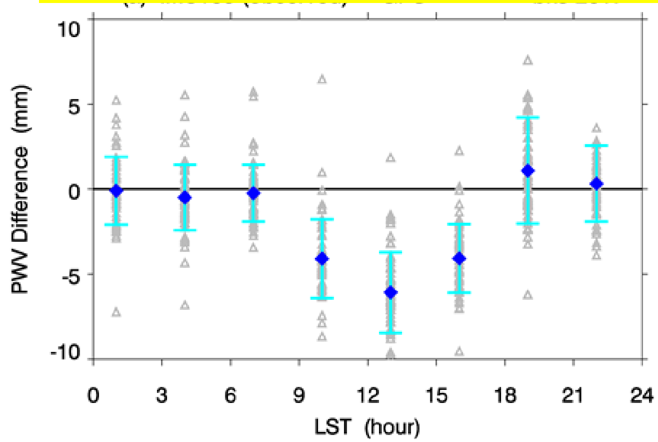
Daytime



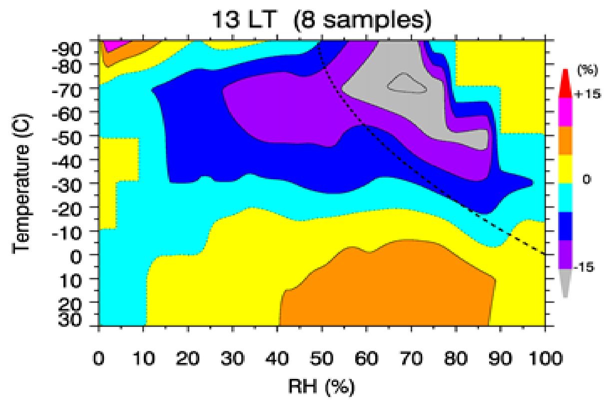
Nighttime



Precipitable Water Vapor Sonde (Meisei) - GNSS

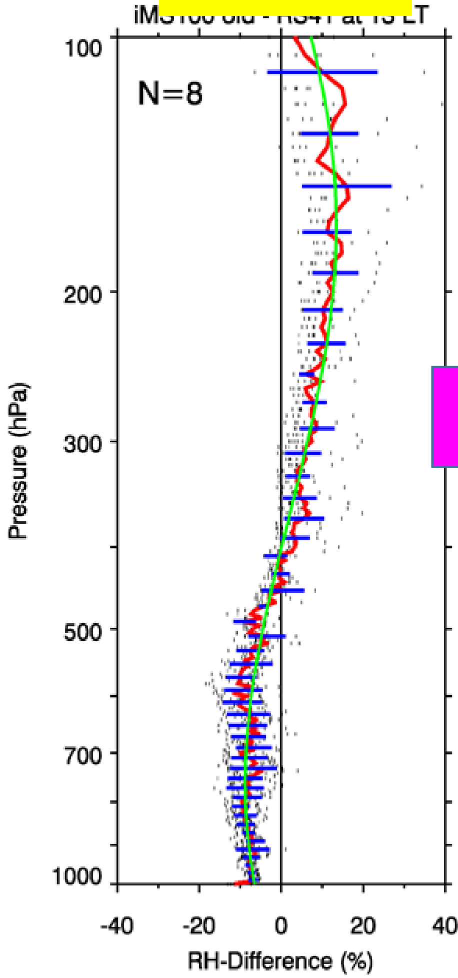


CDF Matching

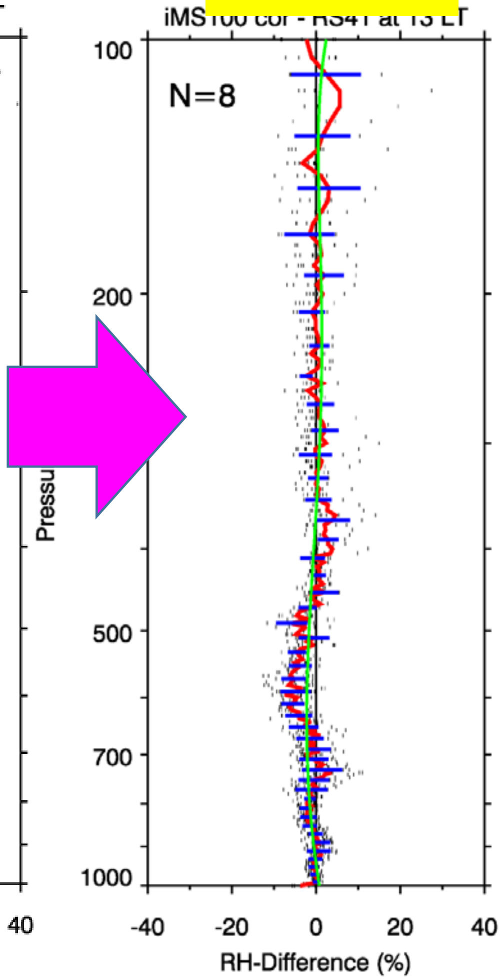


Intercomparison (Meisei vs. Vaisala) at BMKG Bengkulu Station

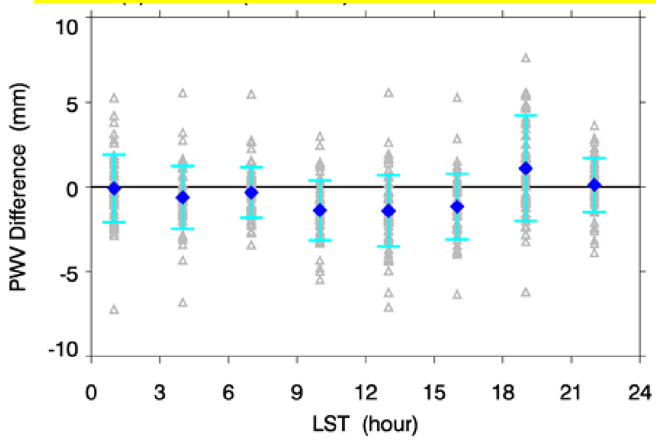
Before



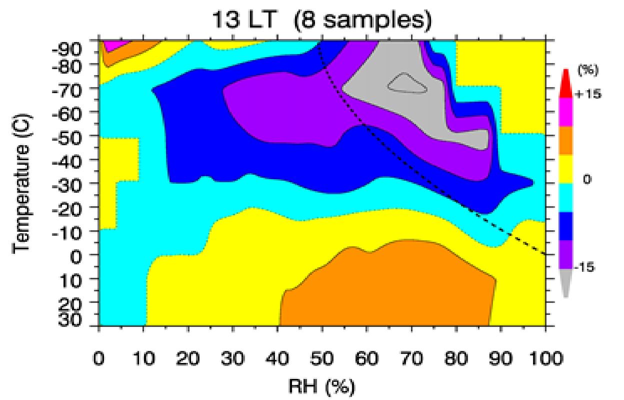
After



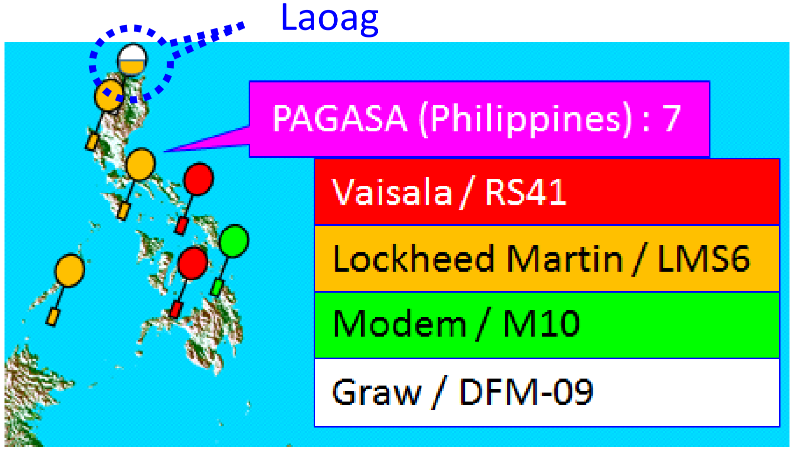
Precipitable Water Vapor
Sonde (Meisei) - GNSS



CDF Matching



Intercomparison at Laoag during YMC-BSM 2018



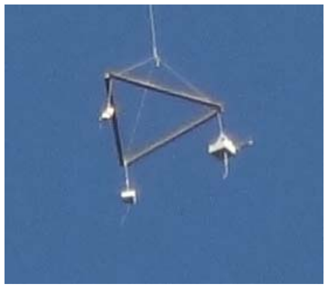
Period: July 27 - August 2, 2018

Location: Laoag Synop-Airport-Upper Air Station

Remarks: Usually PAGASA conduct twice daily sounding using two types of radiosonde (LMS and Graw). During the IOP, only LMS was adopted and conducted 6-hourly.

Method:

1) Simultaneous launch of Vaisala, LMS, and Graw for 20 times. (LMS was launched separately from other two for 0730/1330/1930 LT sounding.)
2) GNSS-derived PWV (July 27 - Aug 31)

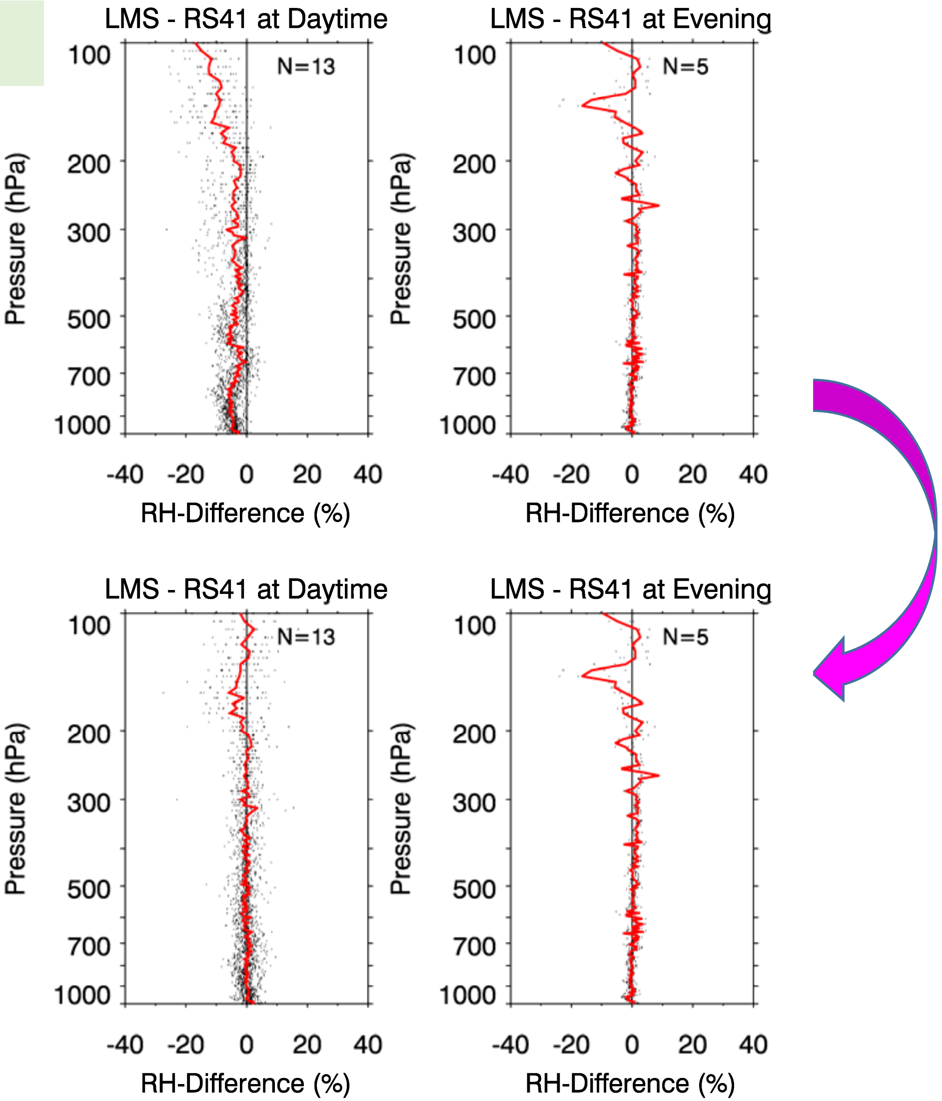


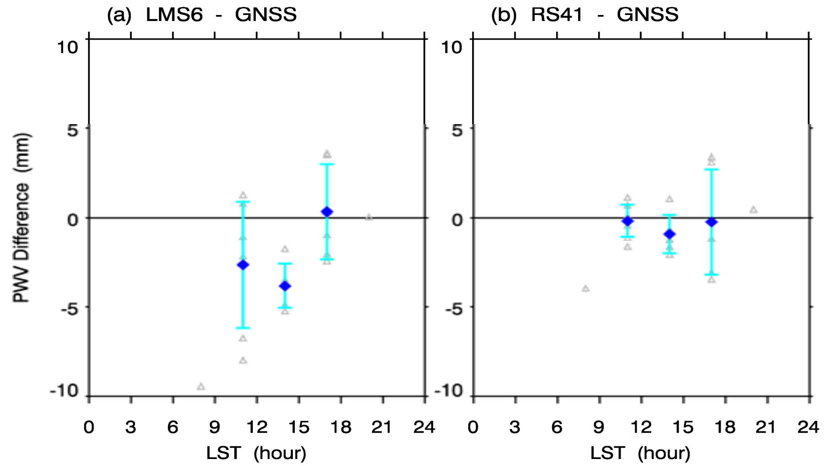
CDF Matching between LMS6 and Vaisala RS41

RH Diff.

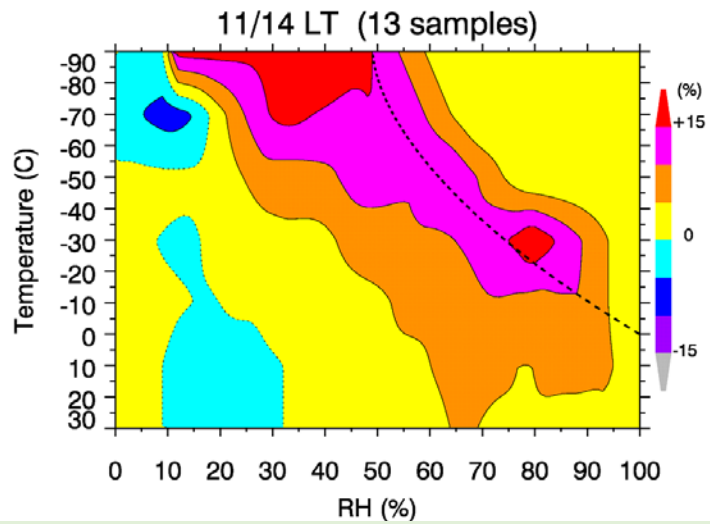
Before

After





Difference of PWV between GNSS & (a) LMS, (b) Vaisala.



RH difference as a function of Temp. & RH based on CDF matching.

Concluding Remarks

1. Key points we learned/obtained so far;
   a) Precise SST is a key to simulate diurnal cycle of rain developed over the coastline, where uncertainty of SST by satellite-based measurement exists. But, SST and other ocean surface measurement can be made using USVs.
   b) Quality control for radiosonde humidity data is still necessary, and we have developed correction scheme. This was done in collaboration with the MC agencies.

2. Possible next steps
   a) Based on the establishment of tight and good relationship with the MC countries through the YMC, we can anticipate observations of ocean surface near the coast through collaboration with their agencies. Indeed, recently BMKG/Indonesia and PAGASA/Philippines have introduced USVs for their own purpose. Expansion of collaboration should be possible. It will also lead to long-term measurement apart from specific campaign.
   b) In addition, BMKG and PAGASA have gained QC technique/knowledge through collaborative work, they have now produced data not only for operational use but also for research use. Those will be a basis for future campaigns. YMC's feedback phase will be a key for success.

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

Acknowledgments. Thanks to many MC agencies/universities.