



“ YMC ”

Years of the Maritime Continent 20

Possible Next Steps of the YMC

- What we learned and obtained so far -

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

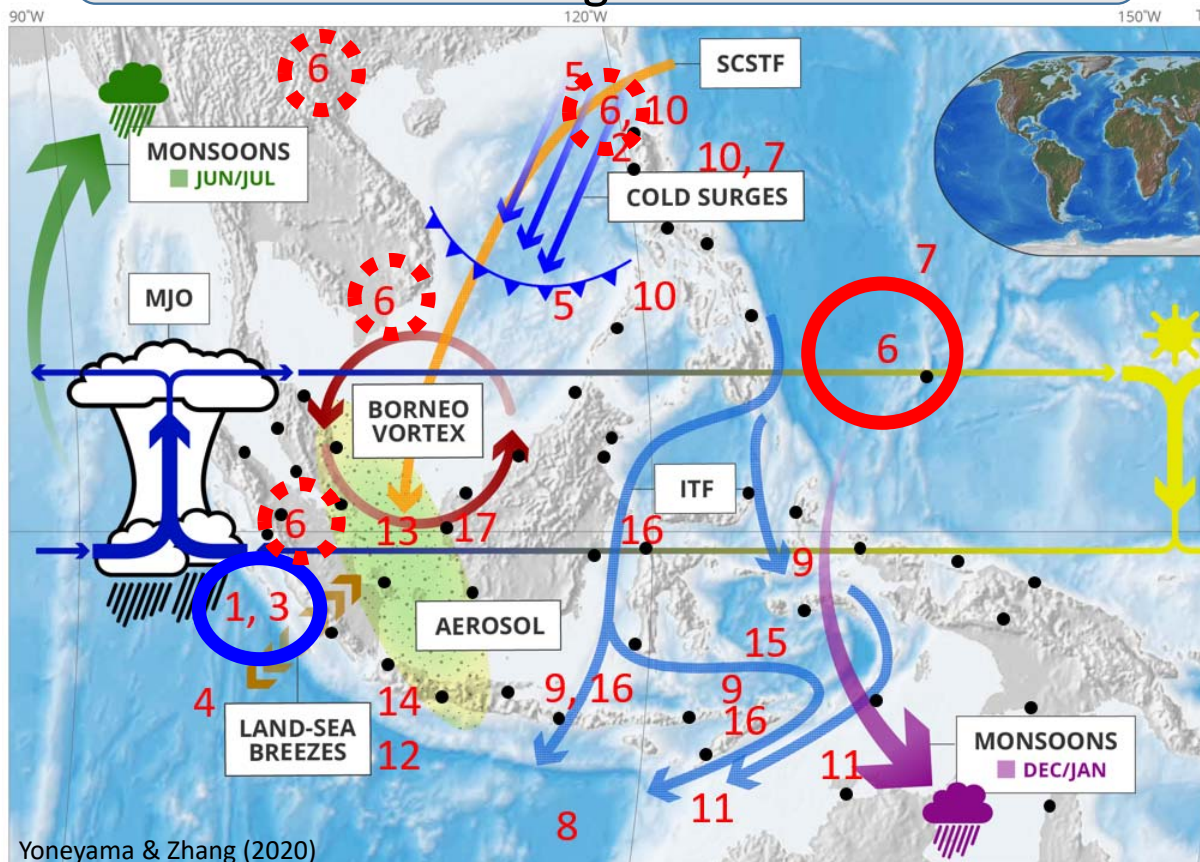
Observing the weather-climate system of Earth's largest archipelago to improve understanding and prediction of its local variability and global impact

< 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

Intensive Observations (including relevant projects)

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

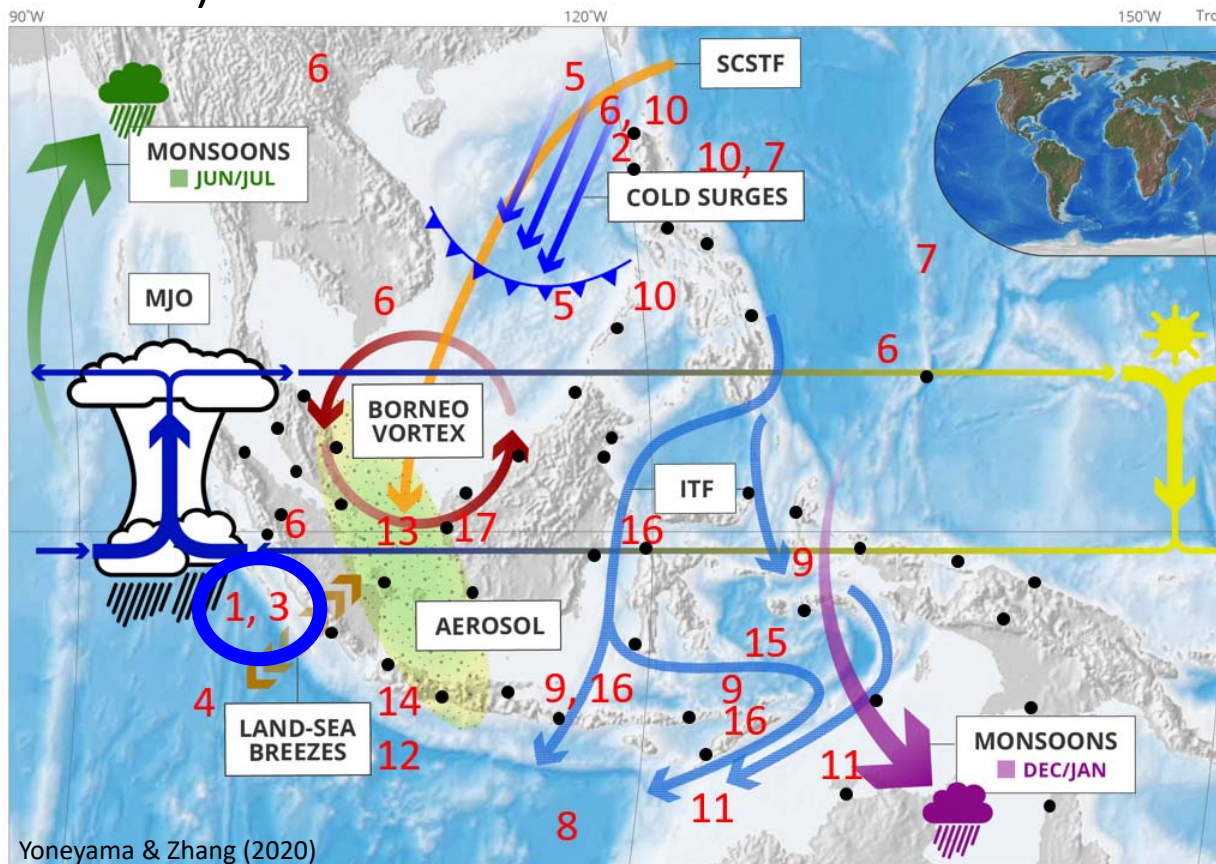


Number Conducted or Planned Intensive Observation Areas
 ● Radiosonde sounding stations

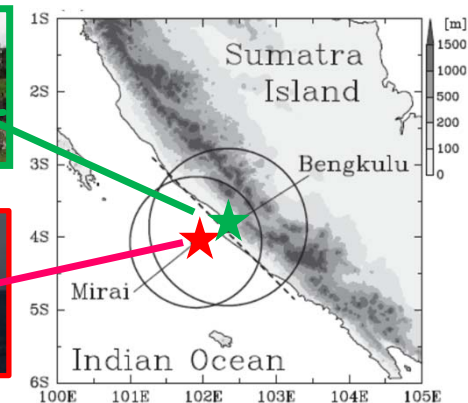
2015.10-12	1	Pre-YMC in Sumatra
2017.08	2	RSVP (air-sea)
2017.11-01	3	Sumatra (MJO, DC)
2017.11-02	4	EIOURI (Upwelling)
2017.12	5	SCSTIMX (monsoon)
2018.03-04	5	SCSTIMX (monsoon)
2018.05-06	5	SCSTIMX (monsoon)
2018.06-08	6	BSM (monsoon)
2018.08-10	7	PISTON (DC, ISV)
2018.11	8	MAMOS/CWPDIP (MJO, Monsoon)
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

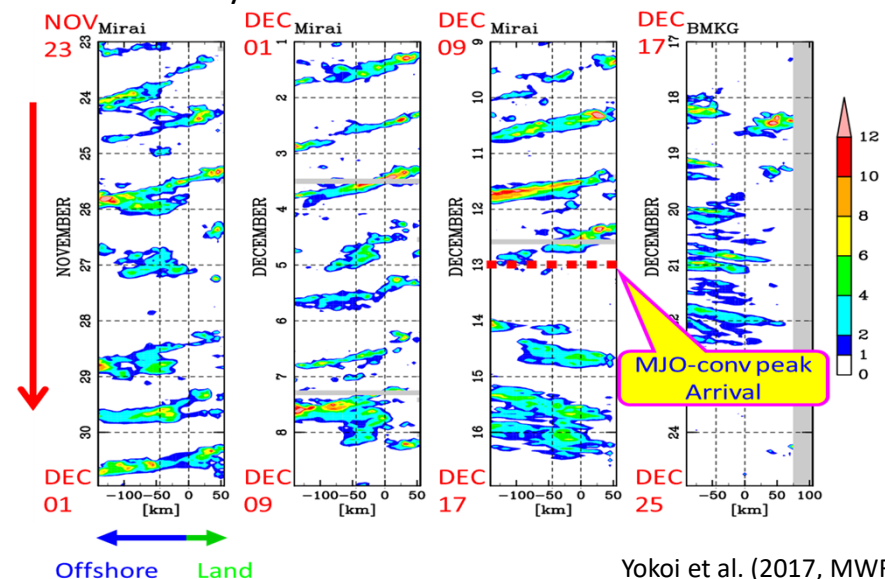
- 1) Nov. 2015 - Dec. 2015
- 2) Nov. 2017 - Jan. 2018



Pilot study area in 2015



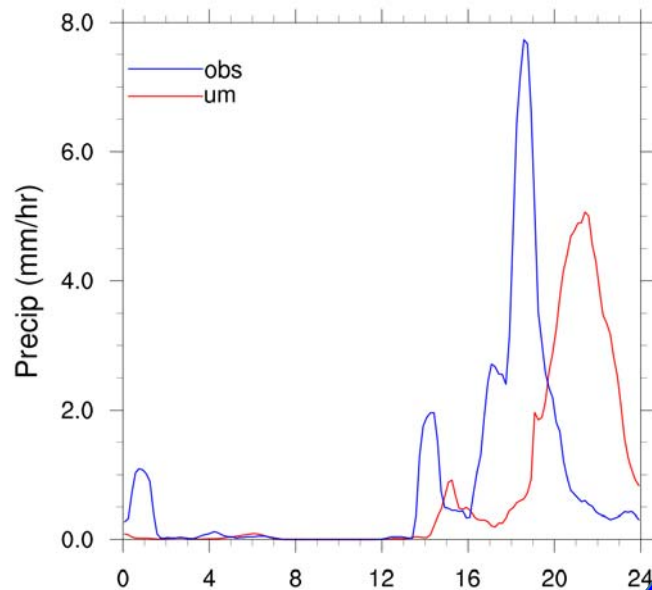
Time-distance from the coastline plot of rainfall intensity observed by radar onboard the Mirai and land-based



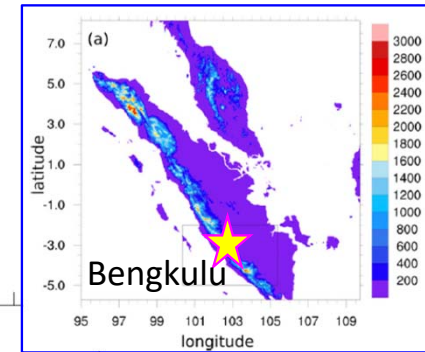
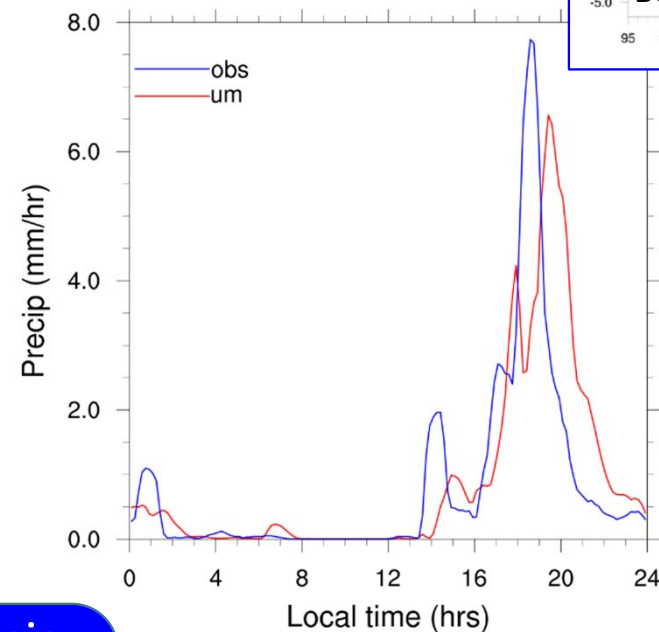
Improvement of Numerical Model Skill

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

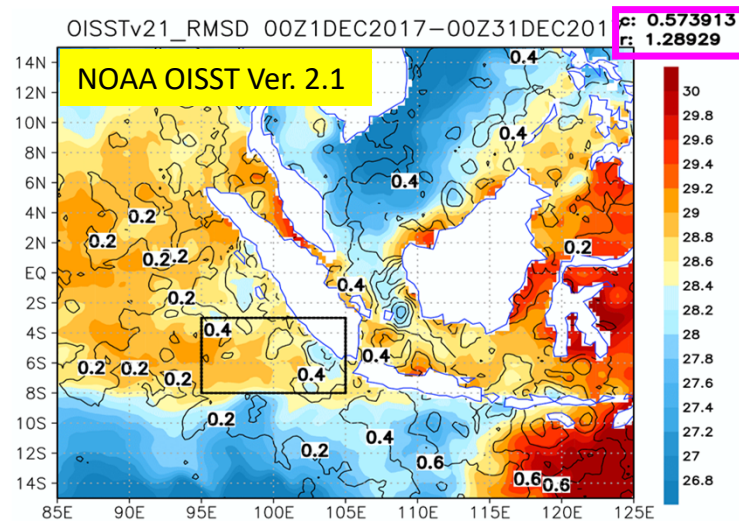
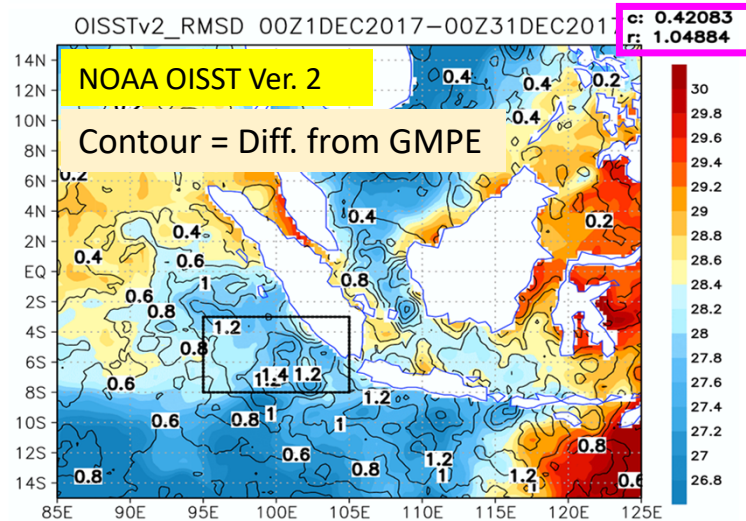
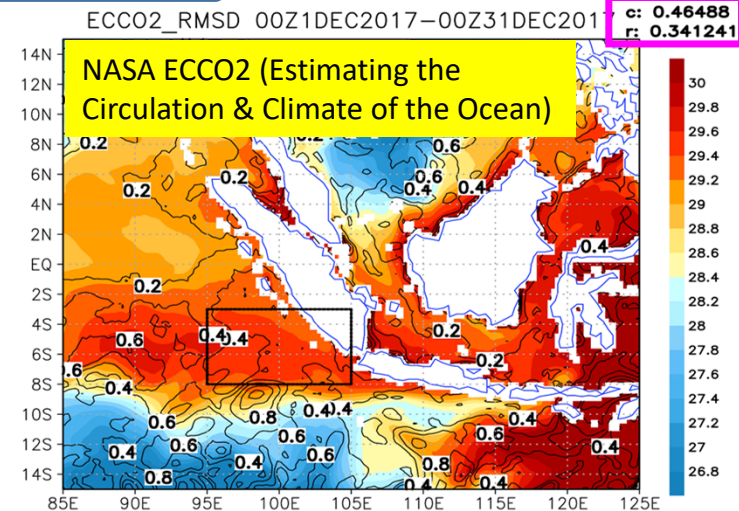
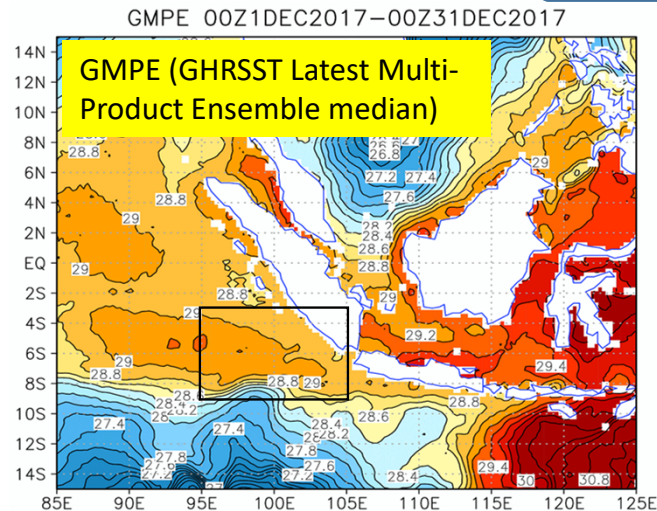


When they changed initial condition data from analysis product to in-situ, modeled result showed one similar with observation. This suggests a low-SST bias in initial condition caused a delay of simulated rain over land.

Dipankar et al. (2019, MWR)
Model: SINGV Tropical Ver. of UK Met Office
Unified Model (UM) (res =1.5km)

SST Bias in Analysis Products ?

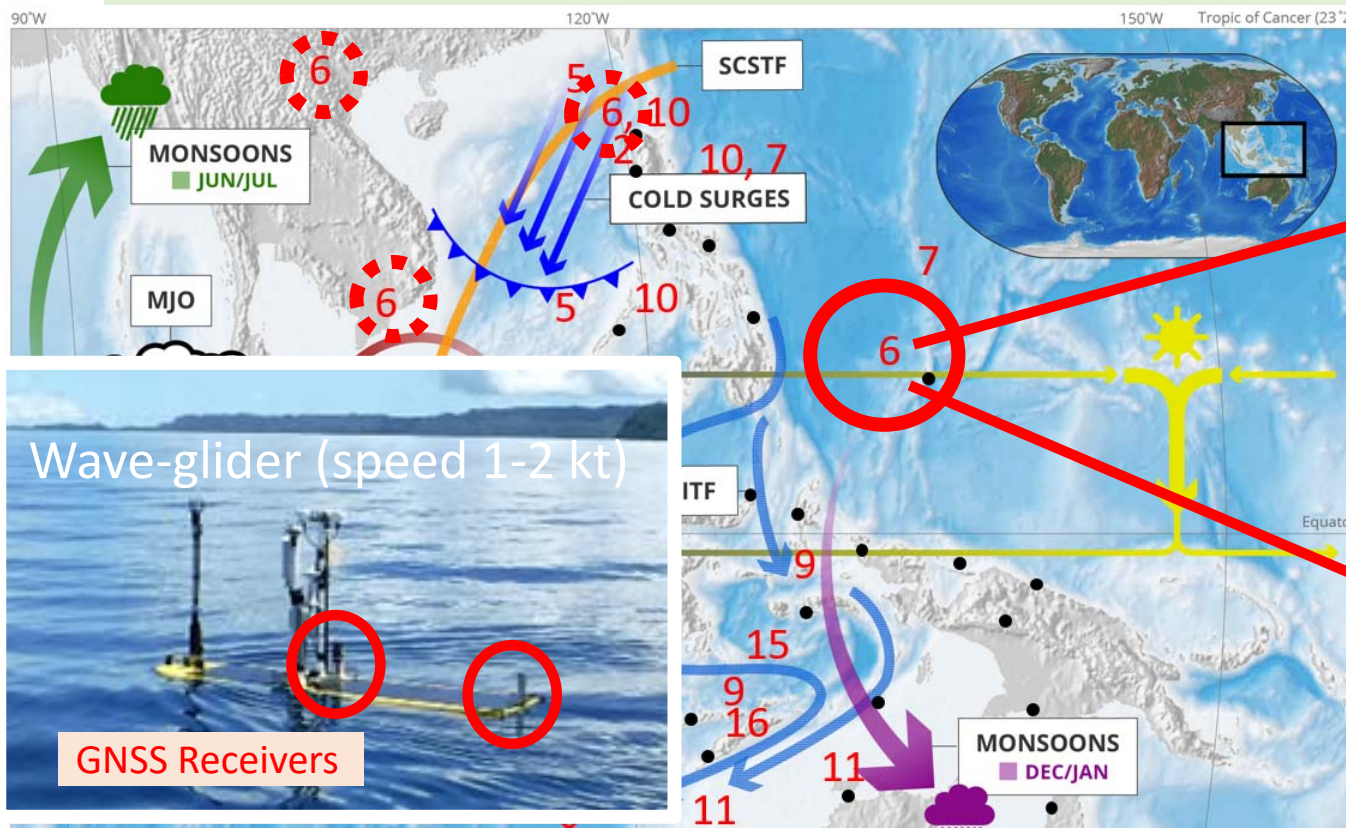
Mean SST (Dec. 2017)



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

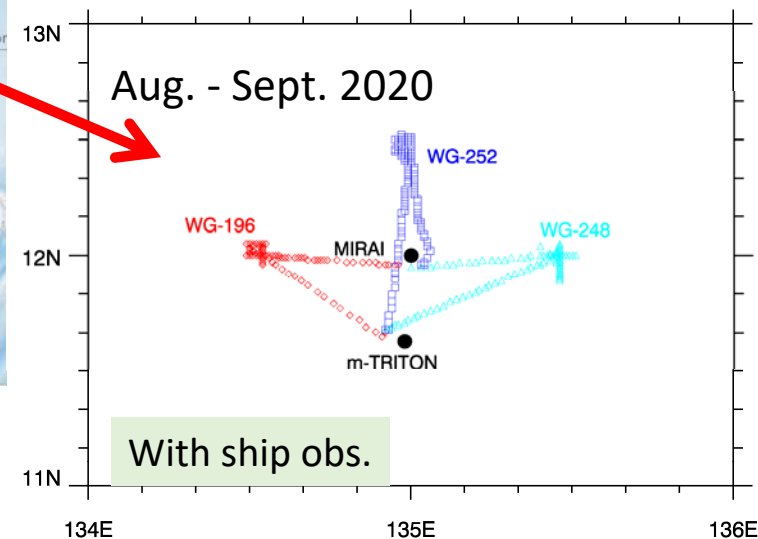
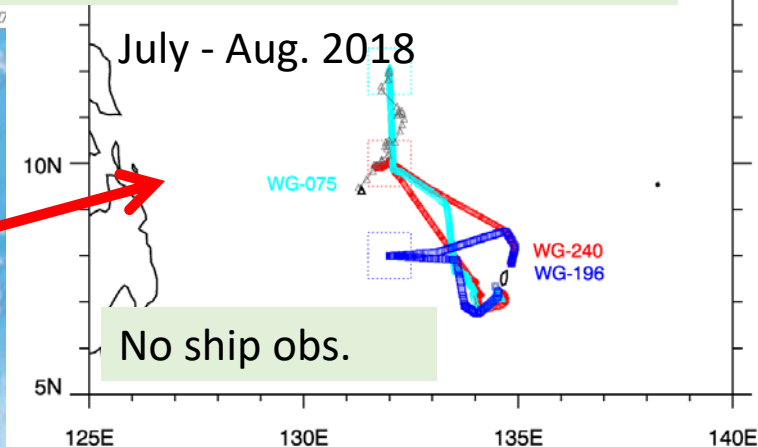


Standard Parameters:

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

Additional Parameter:

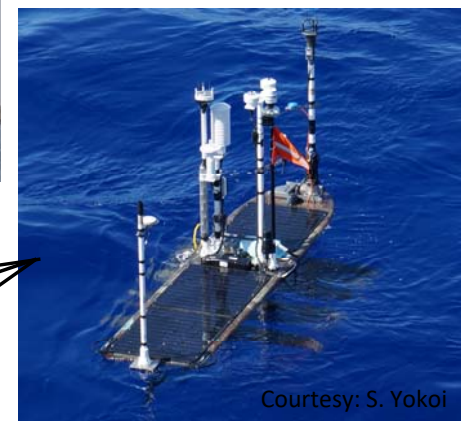
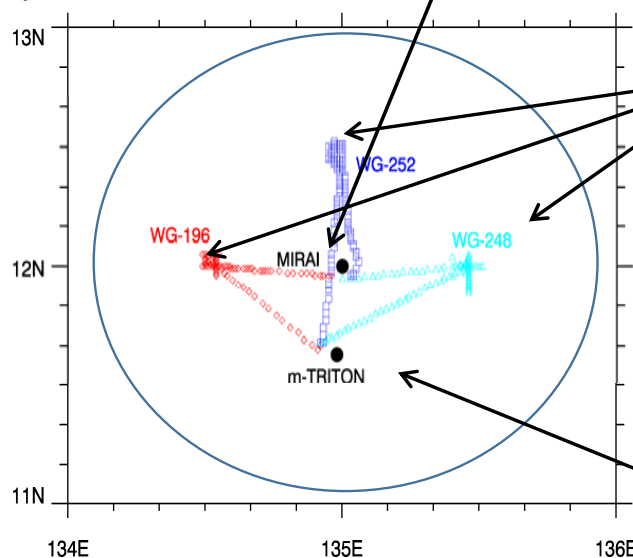
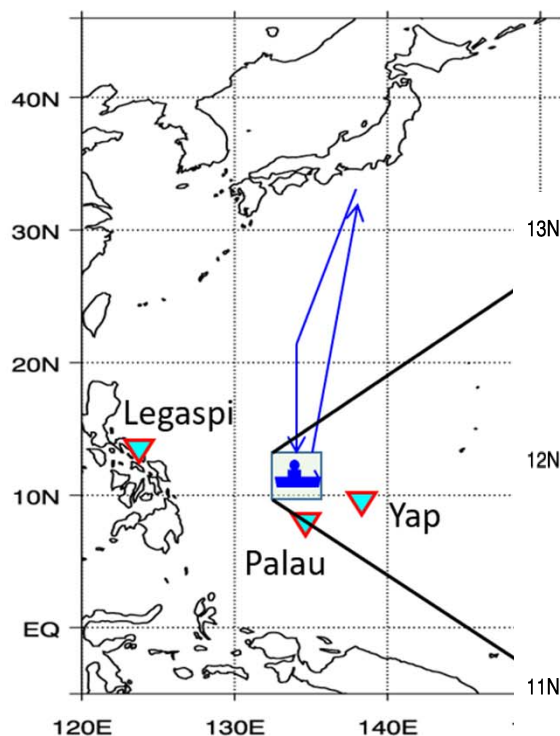
GNSS-derived Precipitable Water Vapor



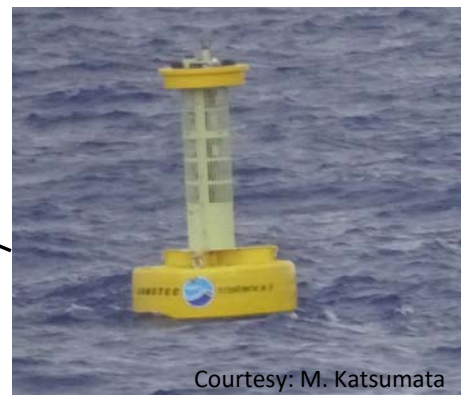
Boreal Summer Monsoon Study in 2020

Period: Aug. 1 - Sept. 14, 2020

IOP: Aug. 8 - Sept. 4, 2020



Courtesy: S. Yokoi



Courtesy: M. Katsumata

Surface Meteorology

Tair
SST

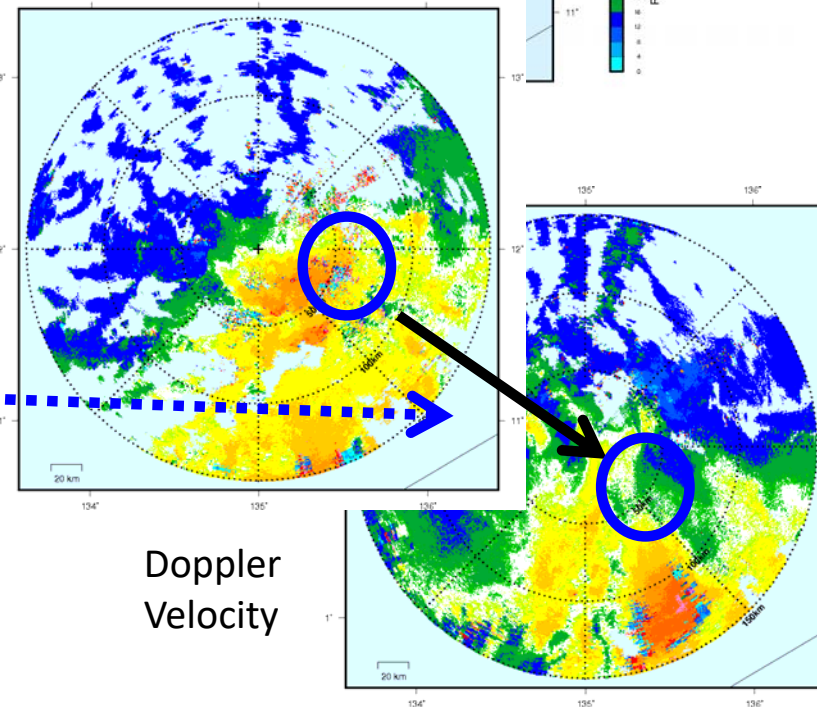
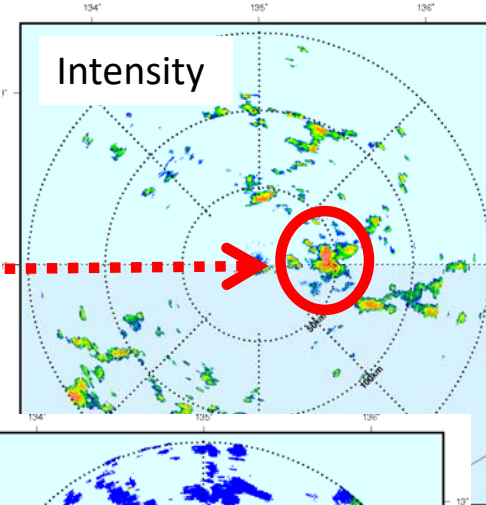
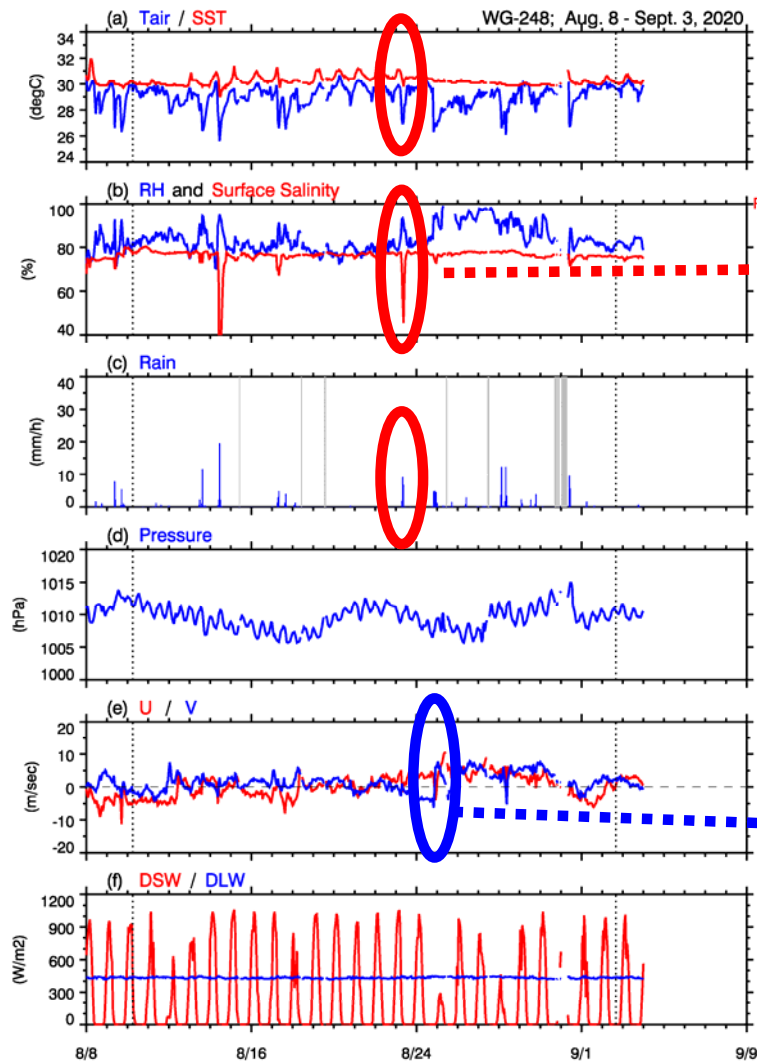
RH
SSS

Rain

Press

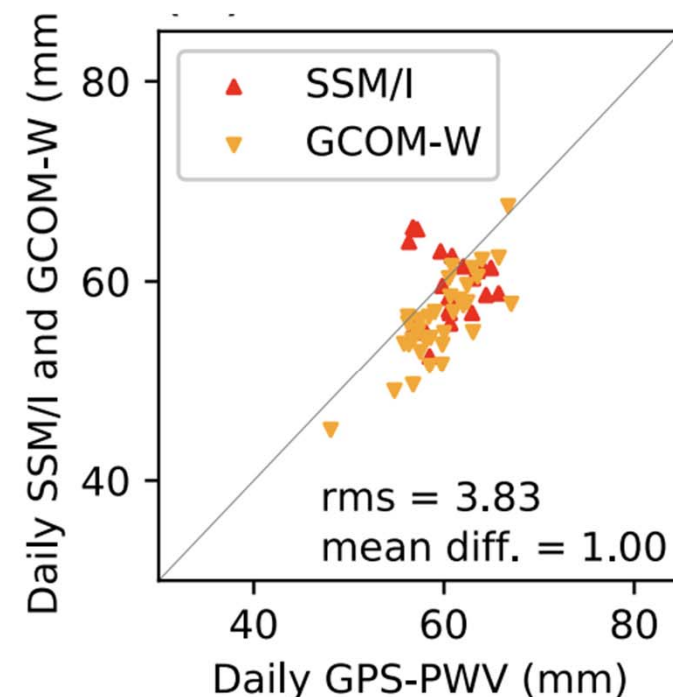
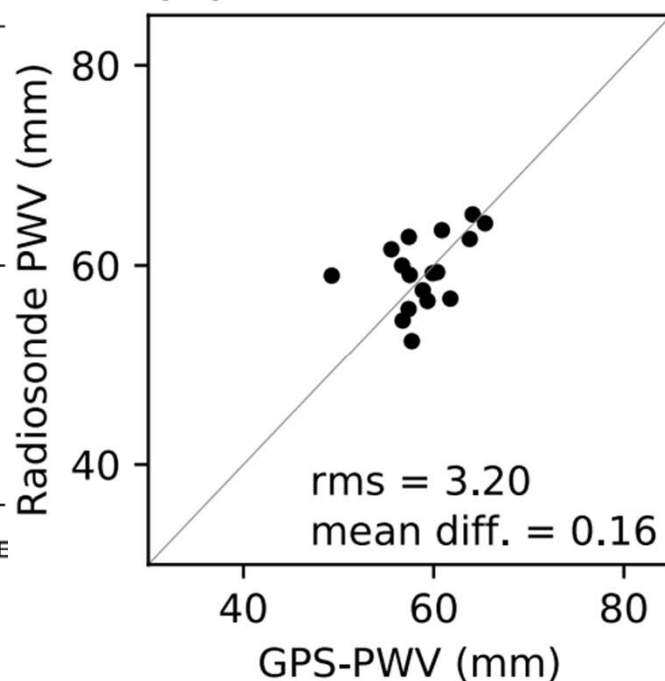
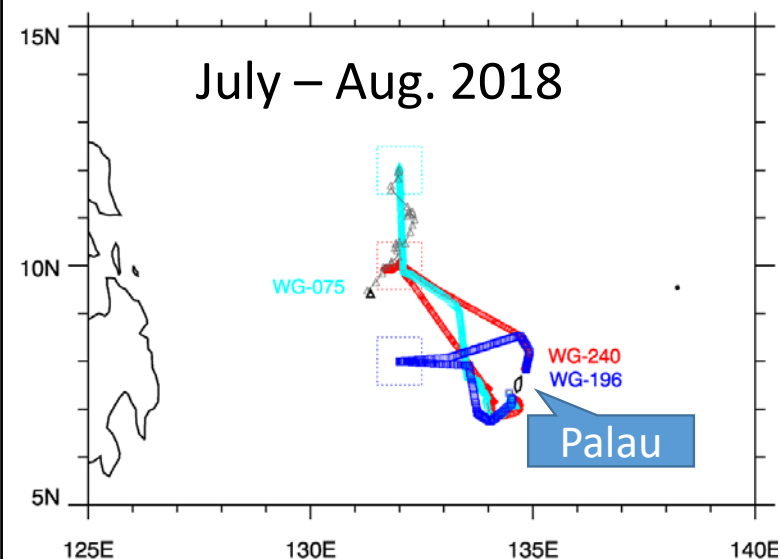
U
V

SW
LW

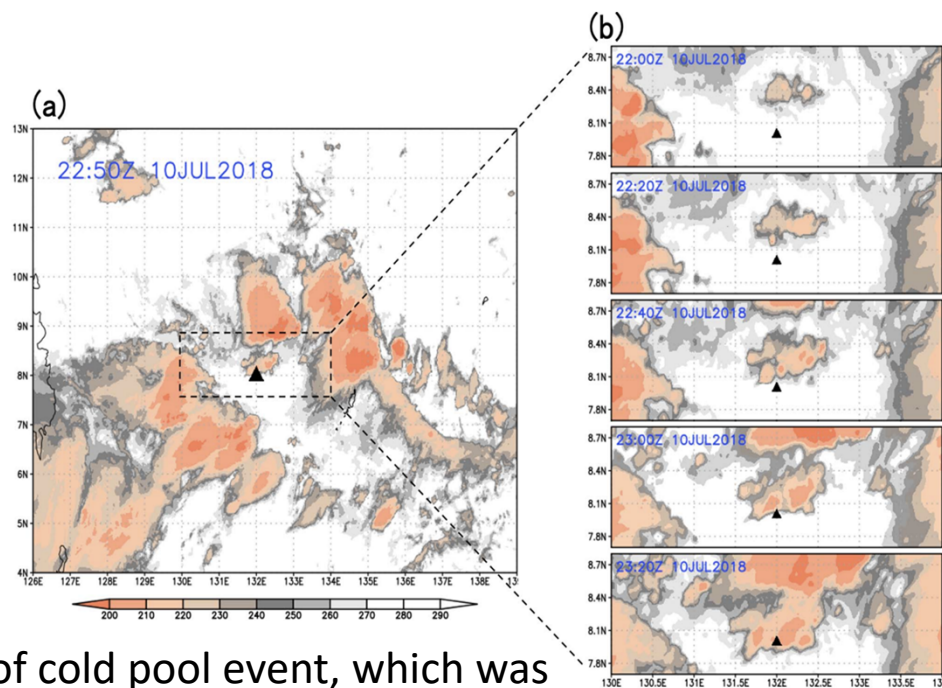


GNSS-derived Precipitable Water Vapor during BSM 2018

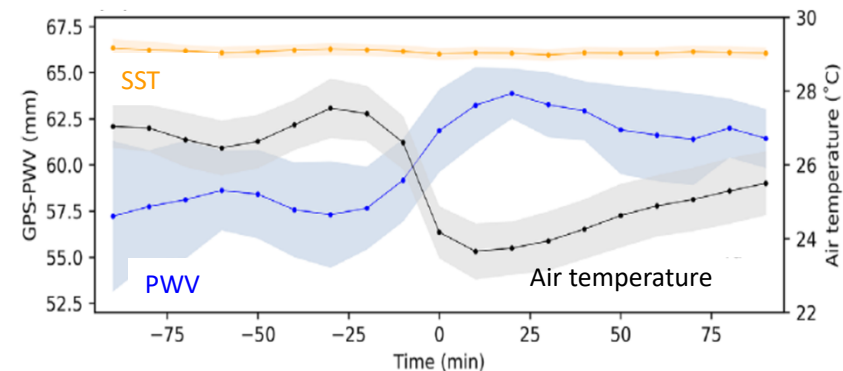
Comparison of PWV between GNSS-derived and (a) Radiosonde within 50 km from Palau
(b) Microwave-based satellite data (daily)



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.



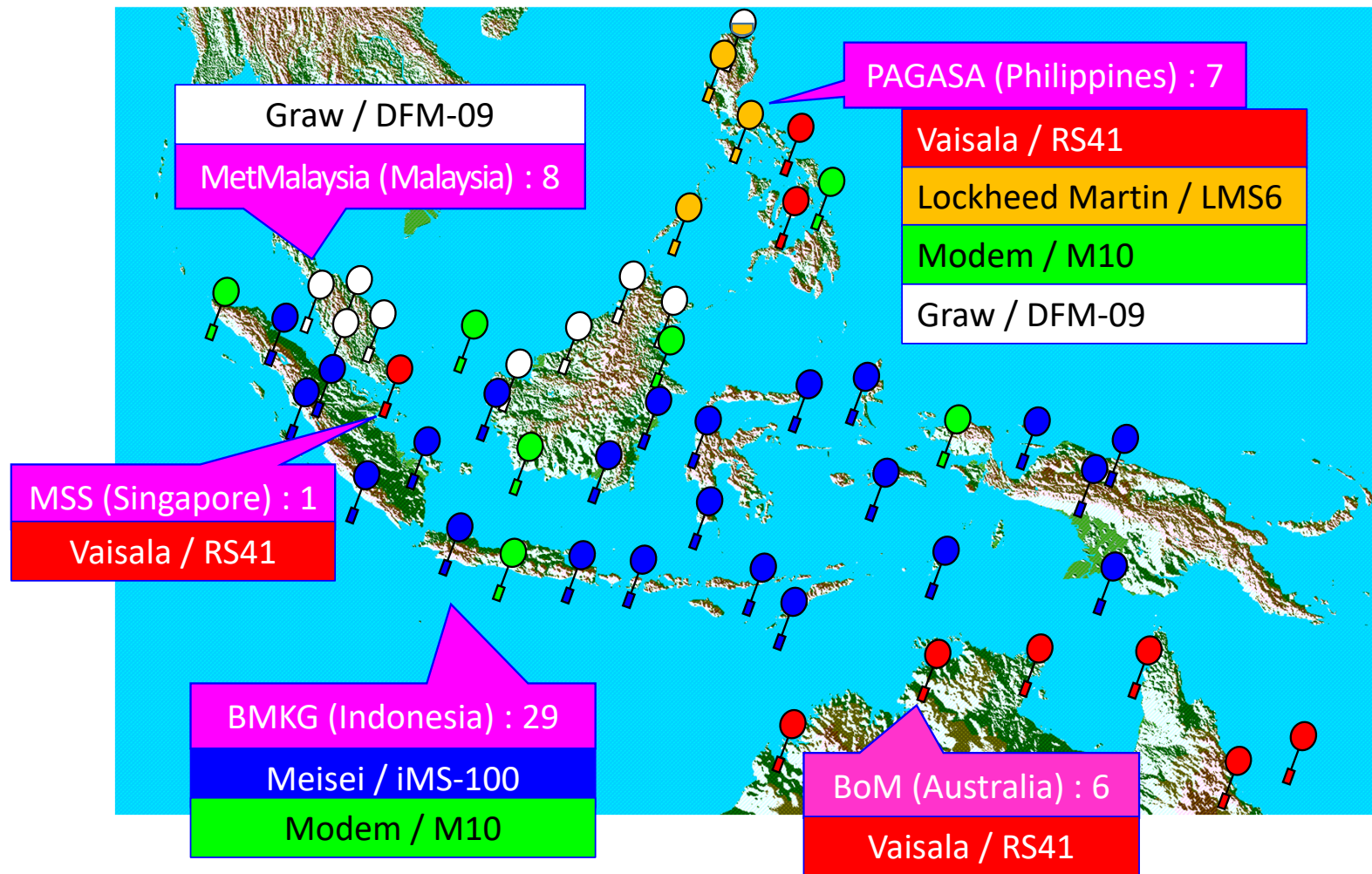
Composite of **PWV**, Air Temperature, and **SST** variations during cold event passage. Shading indicates standard deviation.

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

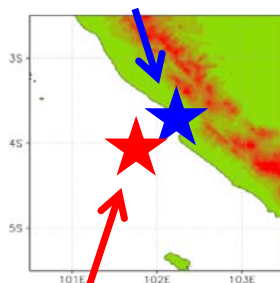


Intercomparison (Meisei vs. Vaisala) at BMKG Bengkulu Station

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



Meisei @ Bengkulu

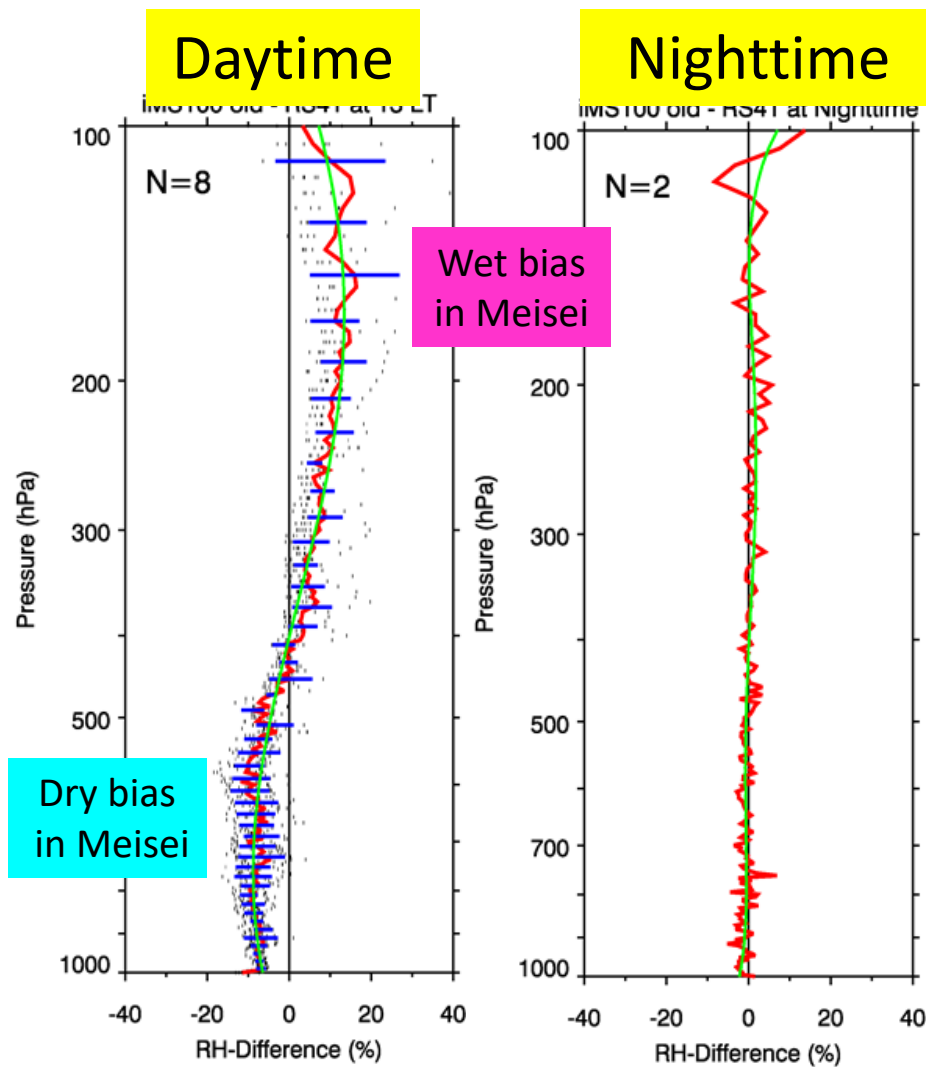


Vaisala @ Mirai

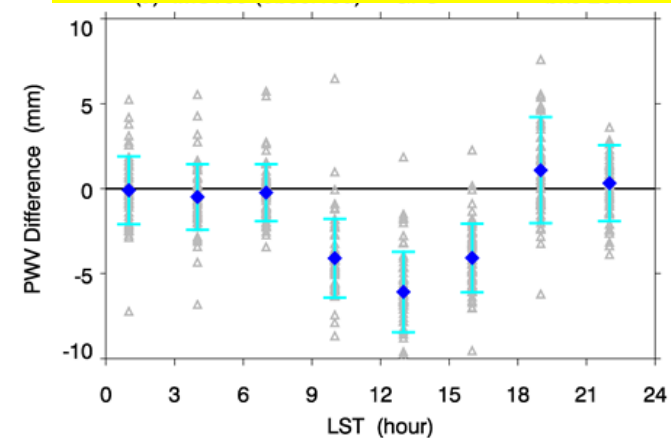
Inter-comparison: **17 times (15 daytime, 2 nights)**

- 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

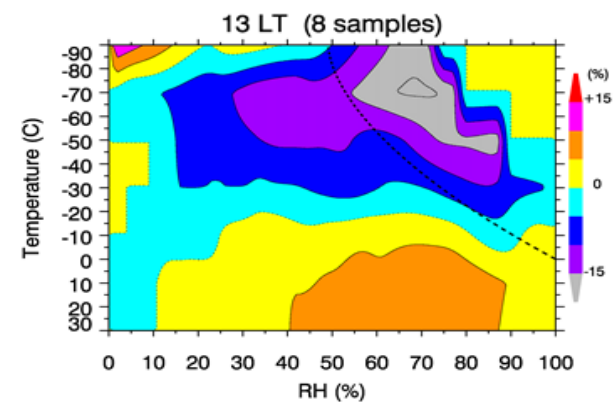
Intercomparison (Meisei vs. Vaisala) at BMKG Bengkulu Station



Precipitable Water Vapor Sonde (Meisei) - GNSS

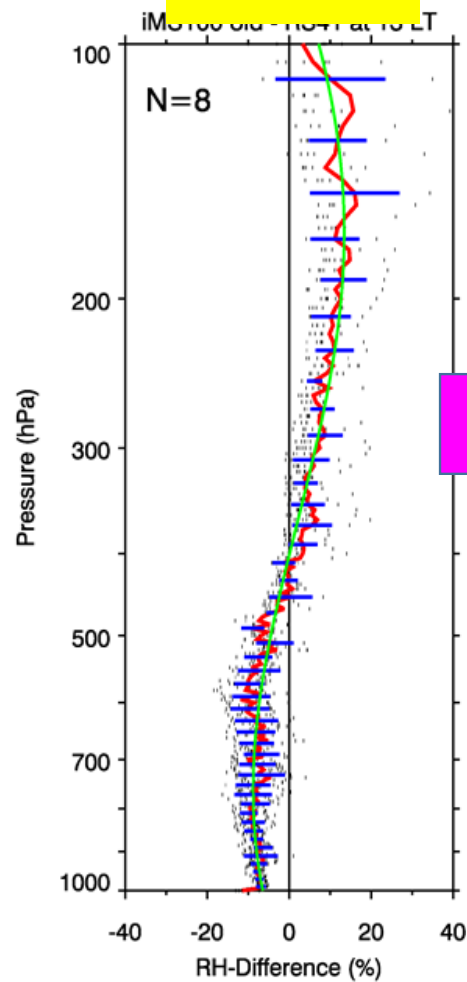


CDF Matching

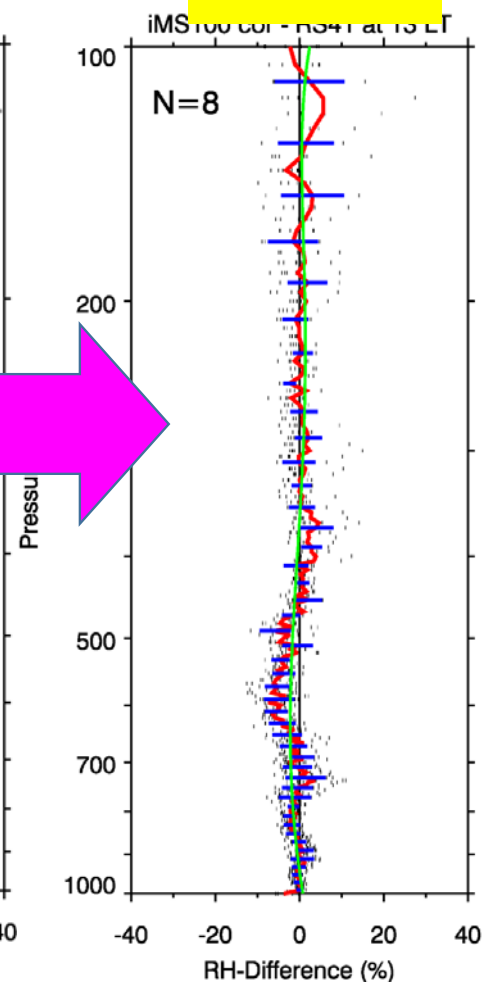


Intercomparison (Meisei vs. Vaisala) at BMKG Bengkulu Station

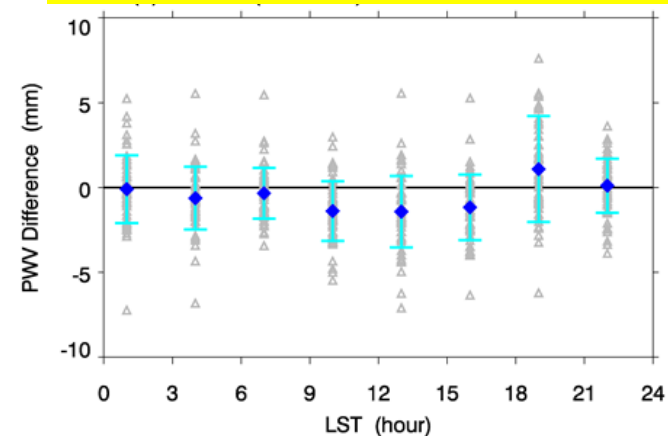
Before



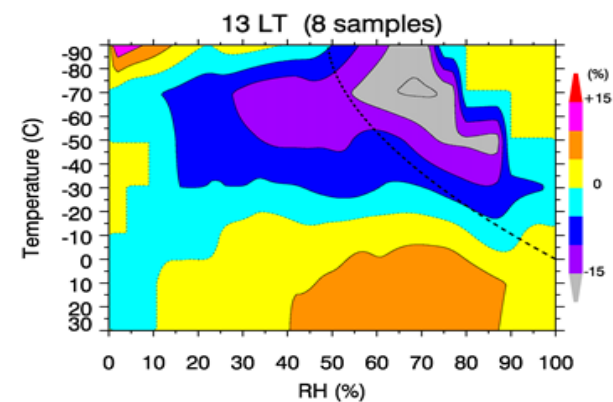
After



Precipitable Water Vapor
Sonde (Meisei) - GNSS

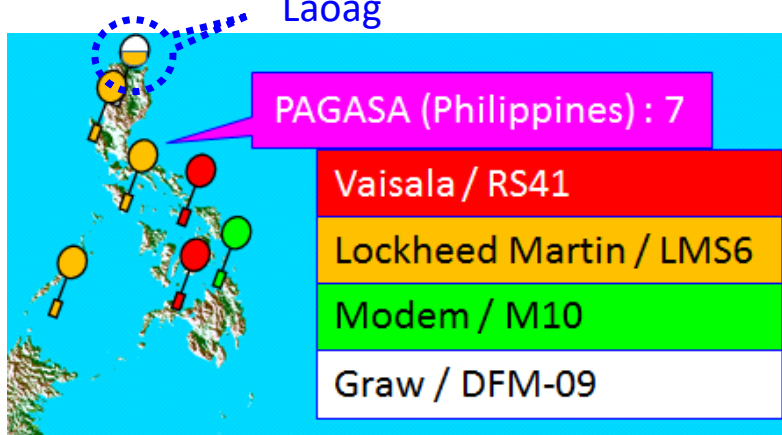


CDF Matching



Intercomparison at Laoag during YMC-BSM 2018

Laoag



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.

0730 LT - 1 time
1030 LT - 7 times
1330 LT - 6 times
1630 LT - 5 times
1930 LT - 1 time



Method:

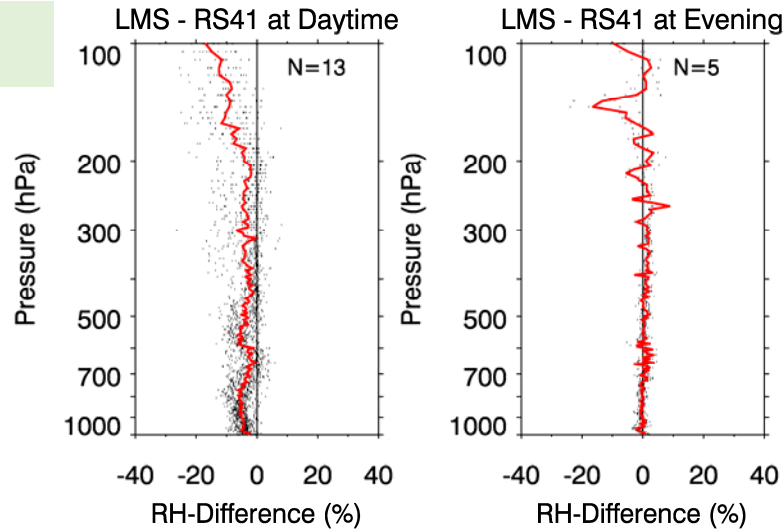
- 1) Simultaneous launch of Vaisala, LMS, and Graw for 20 times. (LMS was launched separately from other two for 0730/1330/1930 LT sounding.)
- 2) GNSS-derived PWV (July 27 - Aug 31)



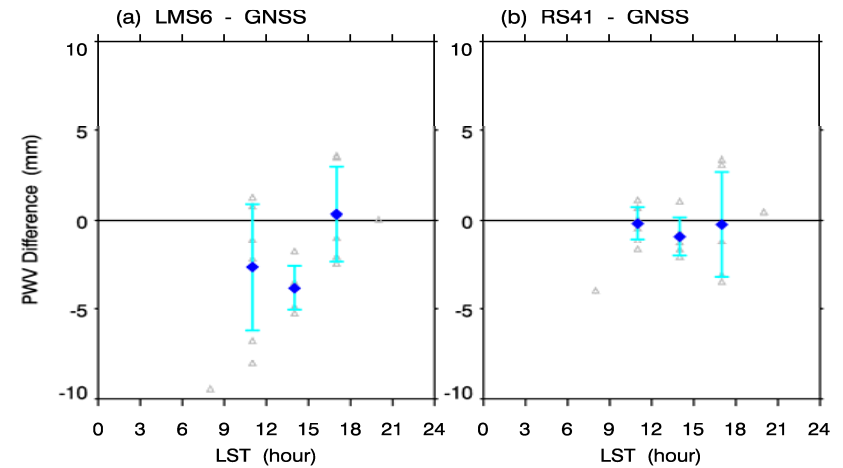
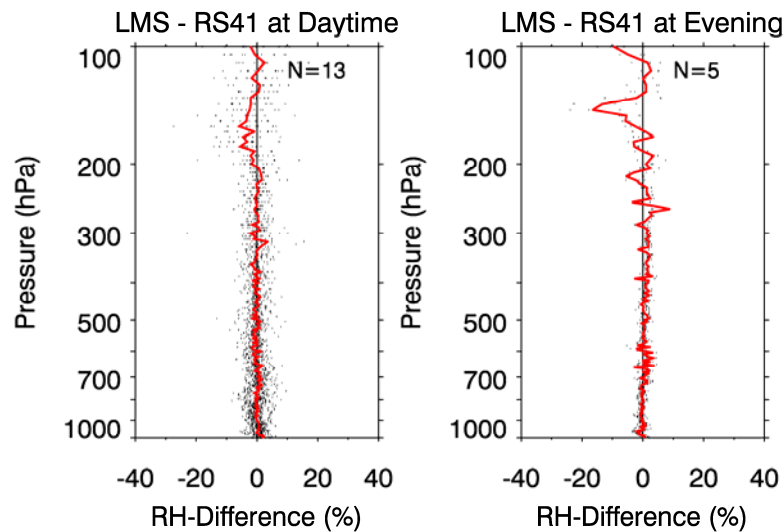
CDF Matching between LMS6 and Vaisala RS41

RH Diff.

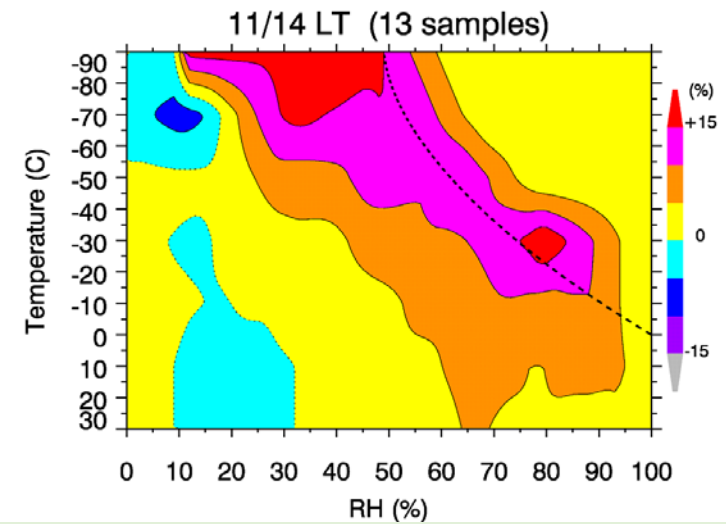
Before



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.