

Kunio Yoneyama (JAMSTEC)

& Chidong Zhang (NOAA/PMEL)

Co-chairs of YMC Science Steering Committee

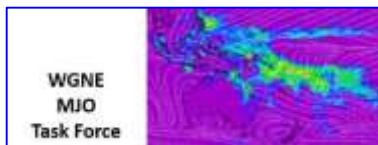
Outline


- 1) What is the YMC ?
- 2) Field Campaigns – Intensive Observation Periods (IOPs)
- 3) Data Management
- 4) Concluding Remarks

Endorsements

YMC has been endorsed by the following international organizations.

- WMO/WWRP since Nov. 2015
- WMO/WWRP/WGTMR since Nov. 2015
- WCRP+WWRP/S2S since Apr. 2016
- WCRP+CAS/WGNE/MJOTF since June 2016
- WCRP/CLIVAR since Mar. 2017





WMO OMM
World Meteorological Organization
Organisation météorologique mondiale
Organización Meteorológica Mundial
Всемирная метеорологическая организация
المنظمة العالمية للأرصاد الجوية
世界气象组织

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University of Miami
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Miami, FL 33149-1098
USA

Dr Kunio Yoneyama
Japan Agency for Marine-Earth Science &
Technology
(JAMSTEC)
2-15, Natsushima, Yokosuka 237-0061
Japan

GENEVA, 20 June 2016

Subject: Support letter, Years of the Maritime Continent (YMC) international project

Dear Professor Zhang and Dr Yoneyama,


On behalf of co-chairs of the Working Group on Numerical Experimentation (WGNE), Drs Keith Williams and Ayrton Zadra, we eagerly support the Years of the Maritime Continent (YMC) international project, which is expected to contribute significantly to the work of the WGNE Madden-Julian Oscillation Task Force (MJOTF). WGNE is a joint effort from the World Climate Research Programme (WCRP) and the WMO Commission for Atmospheric Sciences (CAS).

The MJOTF was recently renewed in early 2016 for a term of three years, including an explicit reference to advance our understanding of MJO interactions with the Maritime Continent (MC) so as to facilitate improvements in model bias and foster better subseasonal predictions across the MC and the globe. To foster this initiative, the MJOTF has a joint subproject with the Seasonal to Subseasonal (S2S) prediction project related to the MC. Both S2S and the MJOTF deem the interaction of the MC with the MJO a high research priority that has significant bearing on addressing shortcomings and improving operational MJO predictions, and because of the importance of region as a source for the global teleconnections of the MJO, enhanced extra-tropical prediction on sub-seasonal timescales.


While furthering process understanding of MJO-MC interactions that leads to enhanced predictions is one motivating principle of MJOTF activities related to the MC, current practicalities and opportunities have also inspired our recent efforts. In particular, the presence of existing modelling resource to bring to bear on MJO-MC interactions, as well as the impending YMC field project, have provided immediate impetus to this effort. We look forward to working with you and others involved in YMC to help refine the objectives of the field campaign and exploit the significant process study data to address deficiencies in our understanding, and make scientific progress through collaborative observational and modelling activities.

In summary, we envision the YMC project as being an important component of our MJOTF activities related to the Maritime Continent over the next several years, and wholeheartedly support the YMC project and science plan.

Yours sincerely,



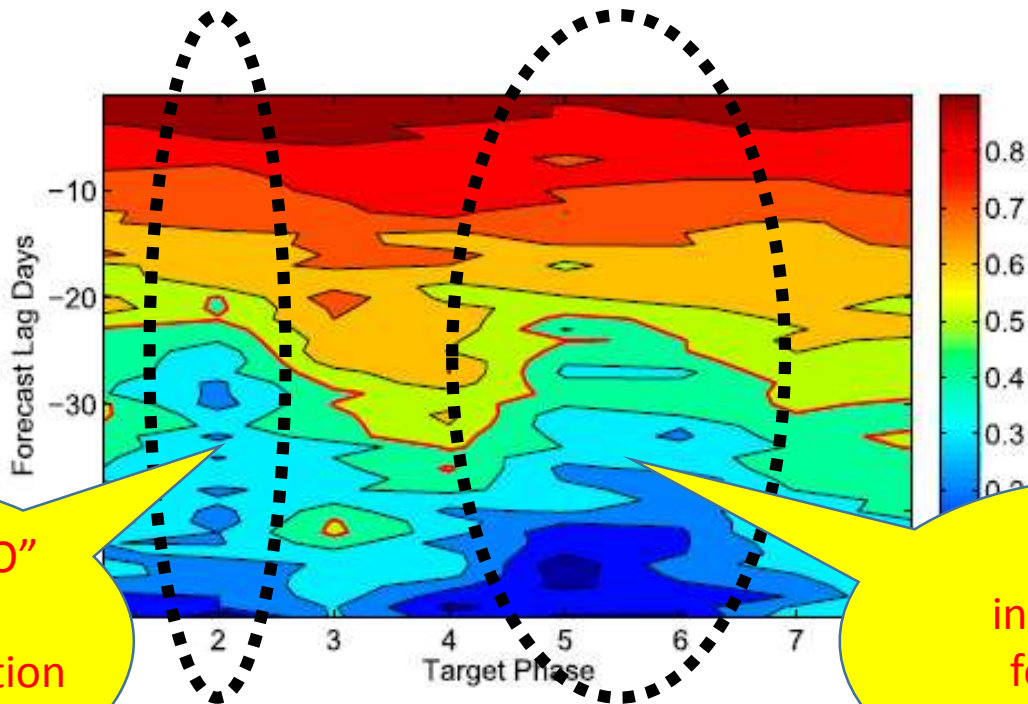
(D. Carlson)
Director, World Climate Research
Programme



(D. Terblanche)
Director, Atmospheric Research and Environment
Branch

cc: Drs Keith Williams and Ayrton Zadra, Co-Chairs WGNE
Drs Steve Woolnough and Eric Maloney, Co-Chairs MJOTF

MJO Prediction Skill as a function of RMM Phase



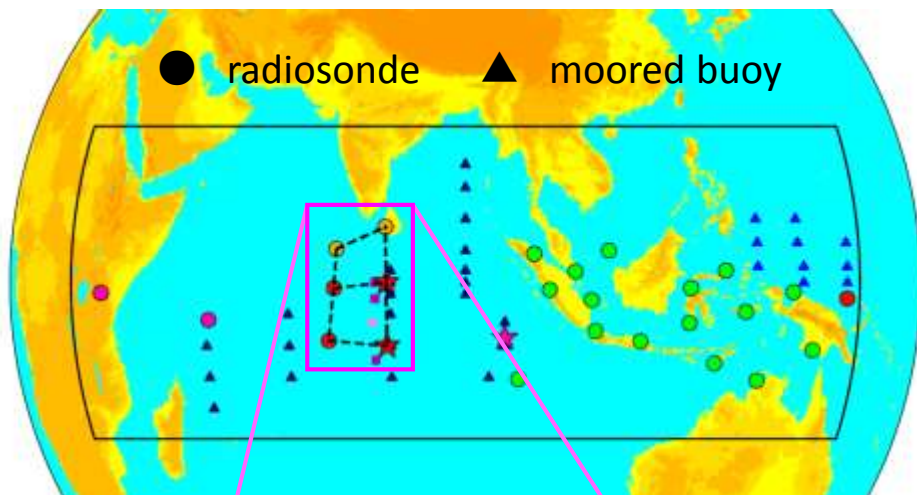
“CINDY/DYNAMO”
in 2011-2012
for the MJO initiation
processes study

“YMC”
in 2017-2020
for the MC
Barrier study

Xiang et al. (2015) for the
case of GFDL coupled model.



CINDY/DYNAMO



Purpose:

Collecting in-situ observations to advance our understanding of the initiation process to improve the skill of the MJO simulation & prediction

Intensive Observing Period:

October 2011 – January 2012

Participants:

69 institutes/universities from Australia, France, India, Indonesia, Japan, Kenya, Korea, Maldives, Papua New Guinea, Seychelles, Singapore, Sri Lanka, Taiwan, UK, and USA

<http://www.jamstec.go.jp/iorgc/cindy/>

https://www.eol.ucar.edu/field_projects/dynamo/

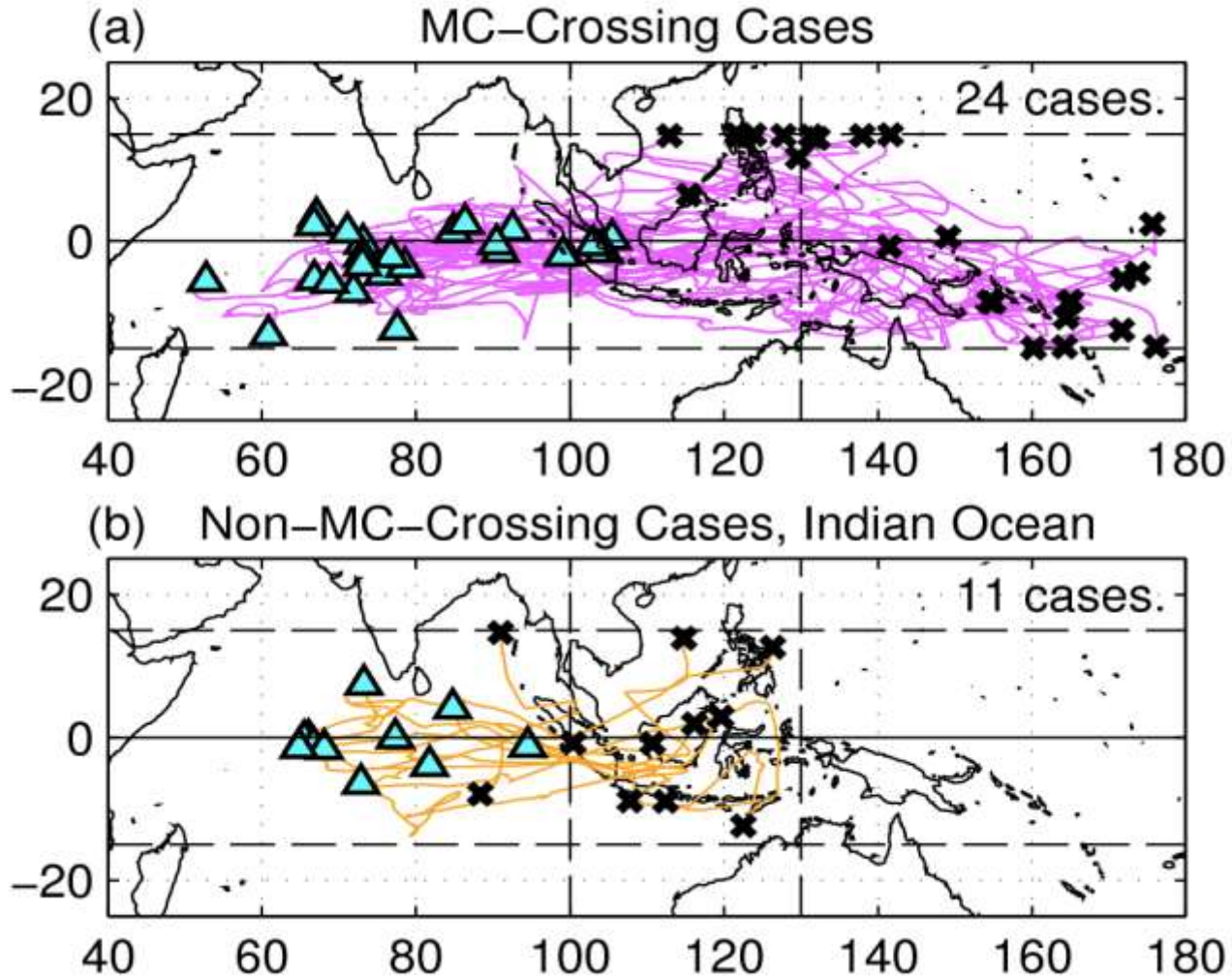
Special remarks:

- 1) C/D captured many MJO events. In particular, Nov. event is selected as one of benchmarks for modeling project “Vertical structure and physical processes of the MJO” owing to rich and high-quality observations.
- 2) Through the campaign, international community could establish a good relationship with the MC countries.

The biggest challenge is how we can conduct observations in the MC

MC Barrier Effect onto the MJO

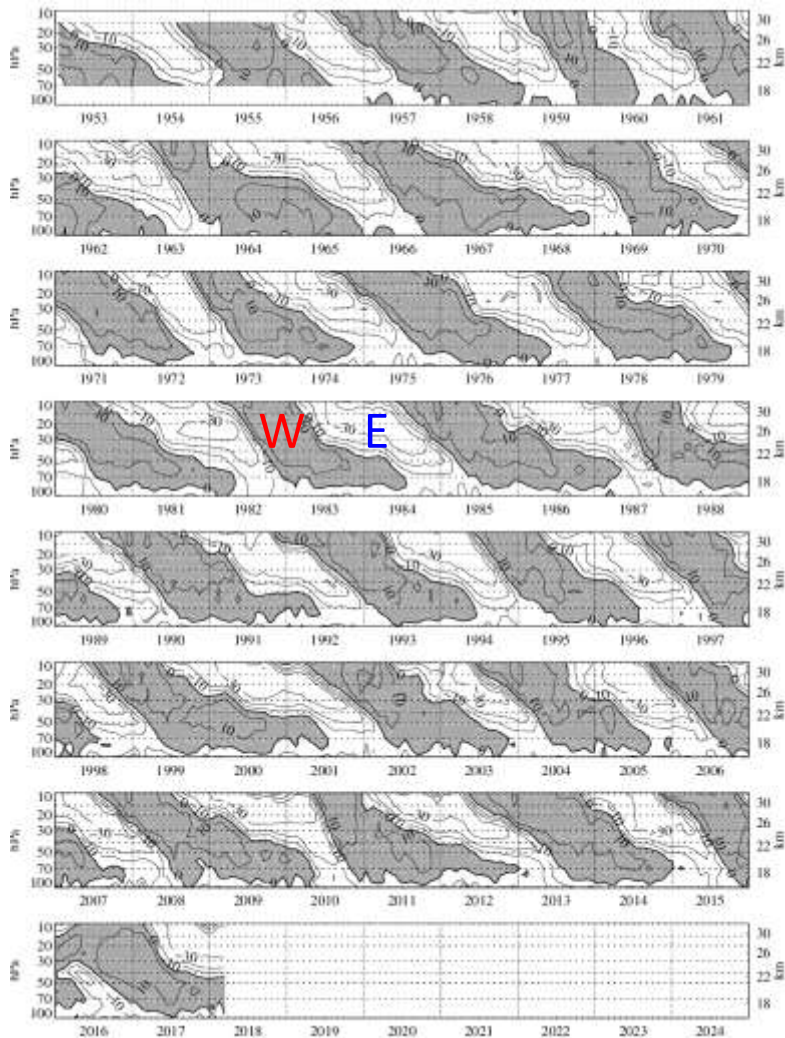
About 30% failed to pass by the MC region.



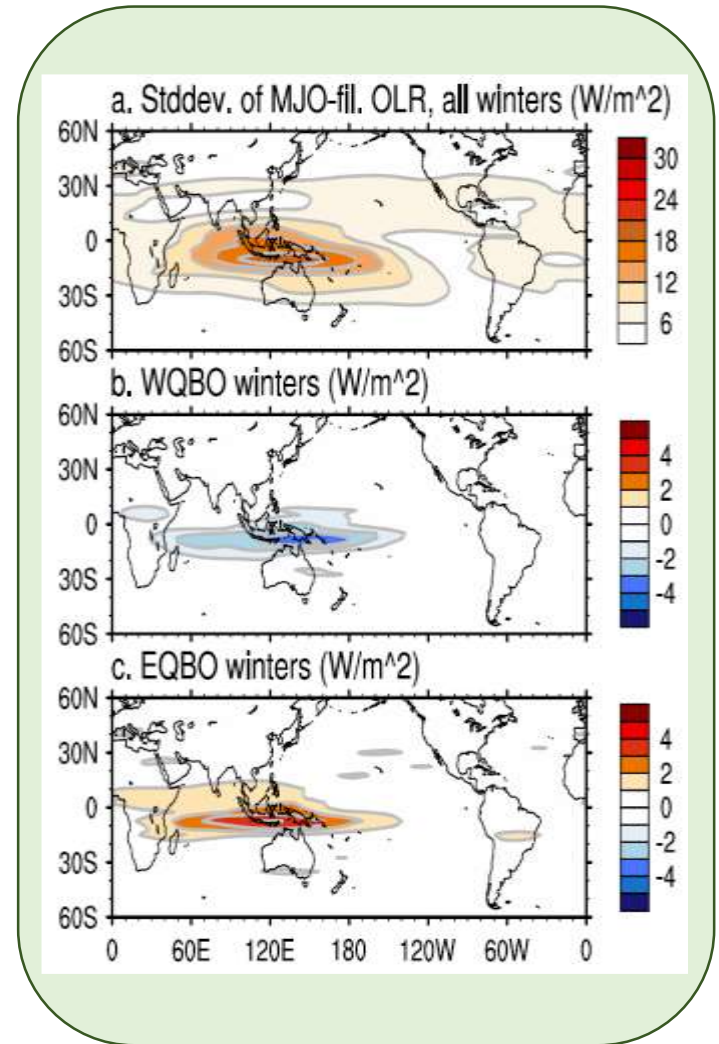
MJO Precipitation Tracking observed in Oct – March, 1998-2015.

Kerns and Chen (2016)

MJO activity over the MC in the boreal winter is active in QBO Easterly phase than Westerly.



<http://www.geo.fu-berlin.de/>



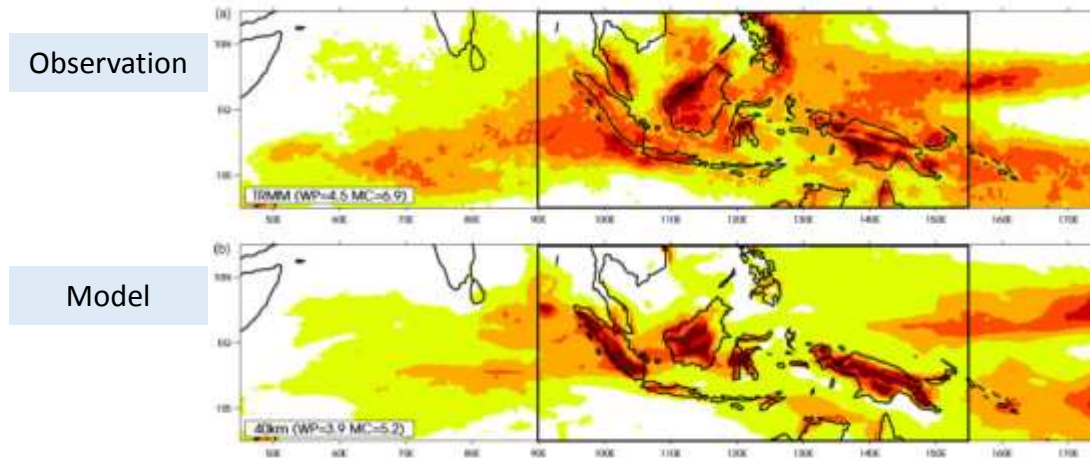
Yoo & Son (2016)

QBO (Quasi-Biennial Oscillation):

Alternate zonal wind pattern in the equatorial stratosphere with 24-30 months cycle.

Purpose

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



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

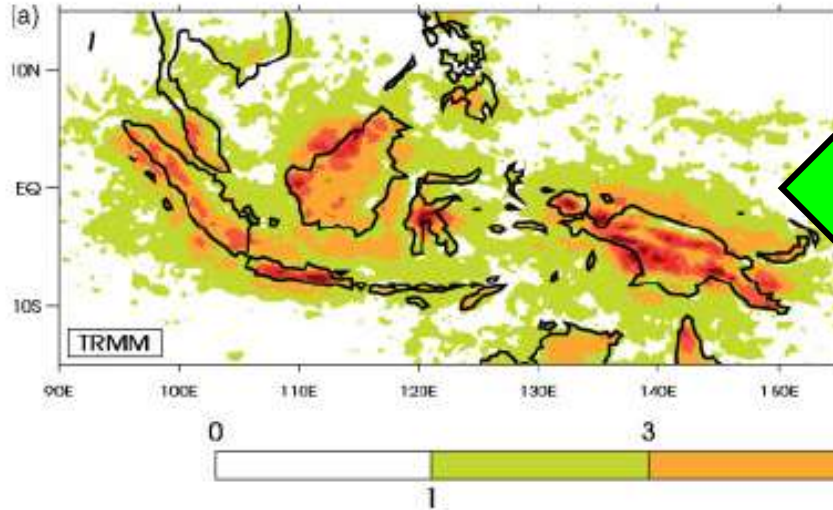
Comparison of monthly mean rainfall for February.
Taken from Love et al. (2011)

Main Science Themes

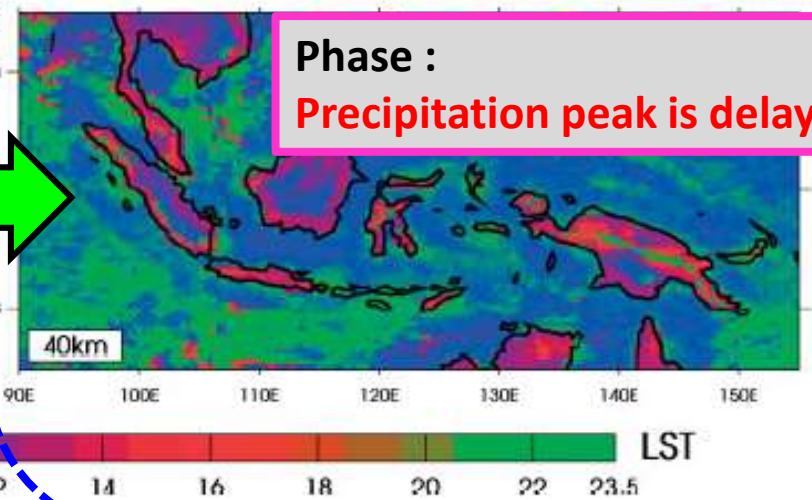
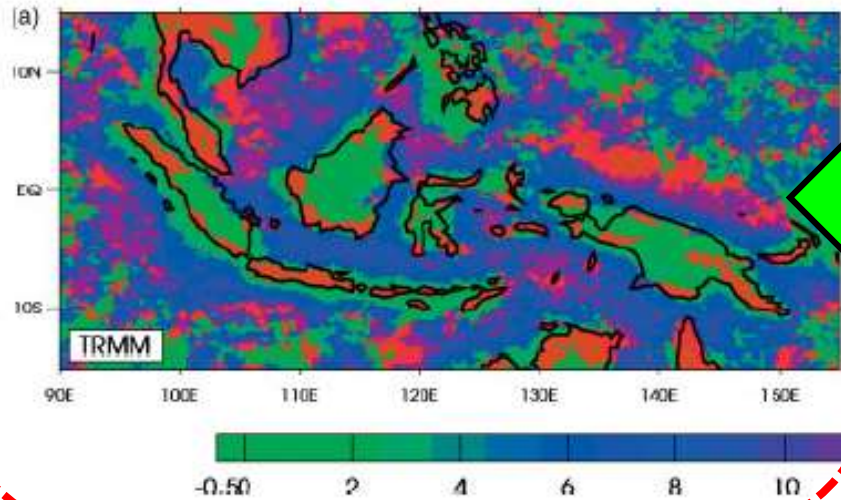
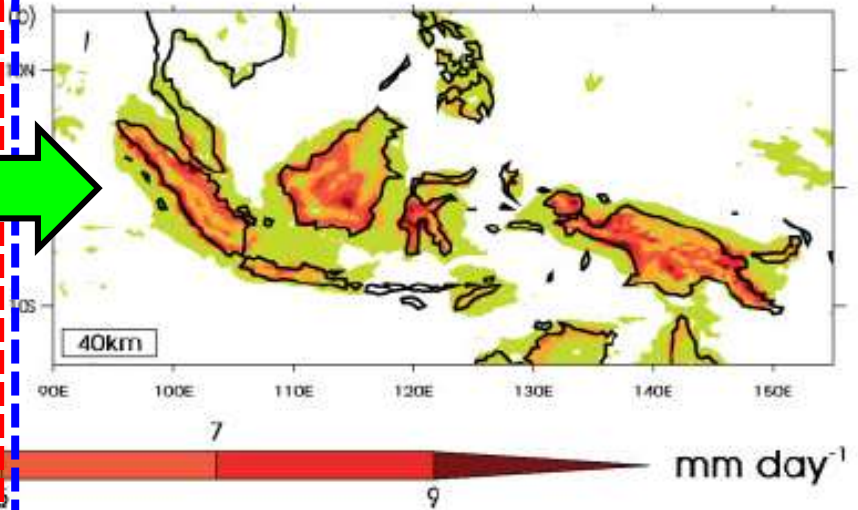
- 1) Atmospheric convection (ex. Diurnal cycle, MJO, monsoon)
- 2) Ocean and air-sea interaction
- 3) Stratosphere-troposphere interaction
- 4) Aerosols
- 5) Prediction

Diurnal Cycle is still a big challenge

Observation



Model



Phase :
Precipitation peak is delayed

Period

July 2017 – ~~July 2019~~ February 2020

Participants as of July 2017

Over 70 institutes/universities from

Australia, China, France, Germany, **Indonesia**, Italy, Japan, Korea,
Malaysia, Mexico, New Zealand, **Palau**, **Philippines**, Poland,
Singapore, Taiwan, Thailand, UK, US, Vietnam

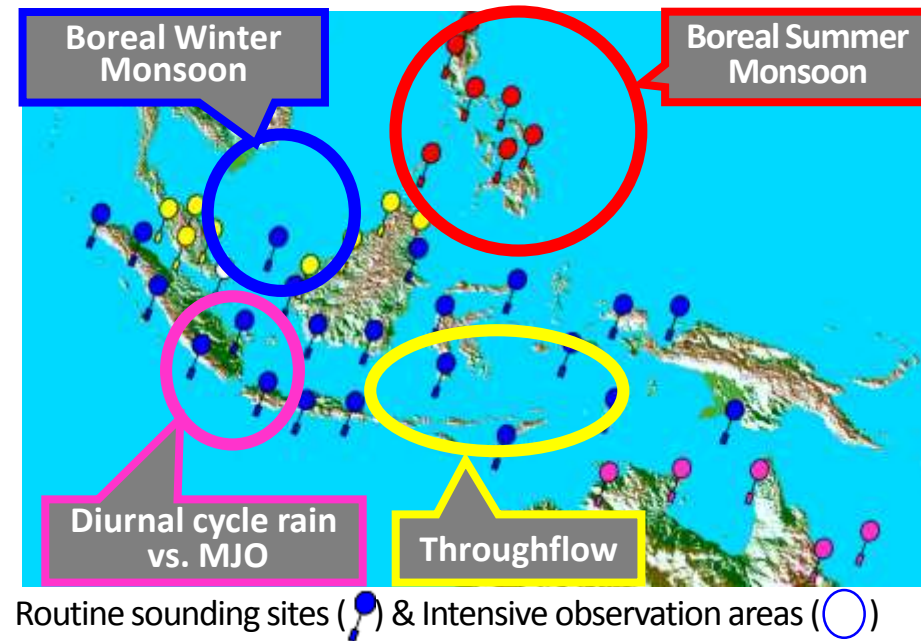
Web sites

Main <http://www.bmkg.go.id/ymc/>

Ancillary <http://www.jamstec.go.jp/ymc/>

Main Activities

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



Basic Strategy

YMC campaign consists of

- 1) Intensive Observations including modeling for specific research topics,
- 2) Provision of routine observation data from the MC Met Agencies

Kunio Yoneyama (JAMSTEC)

& Chidong Zhang (NOAA/PMEL)

Co-chairs of YMC Science Steering Committee

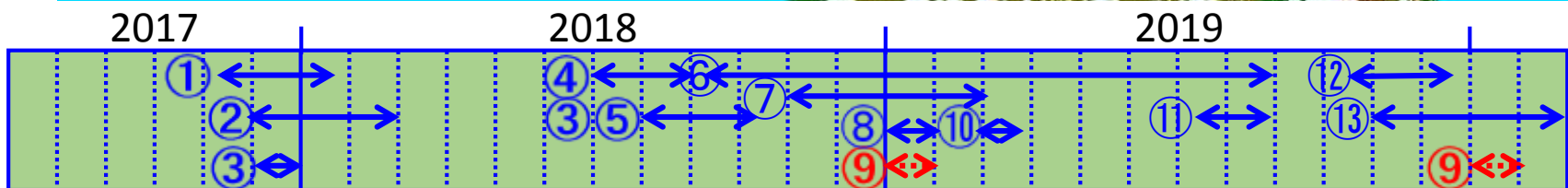
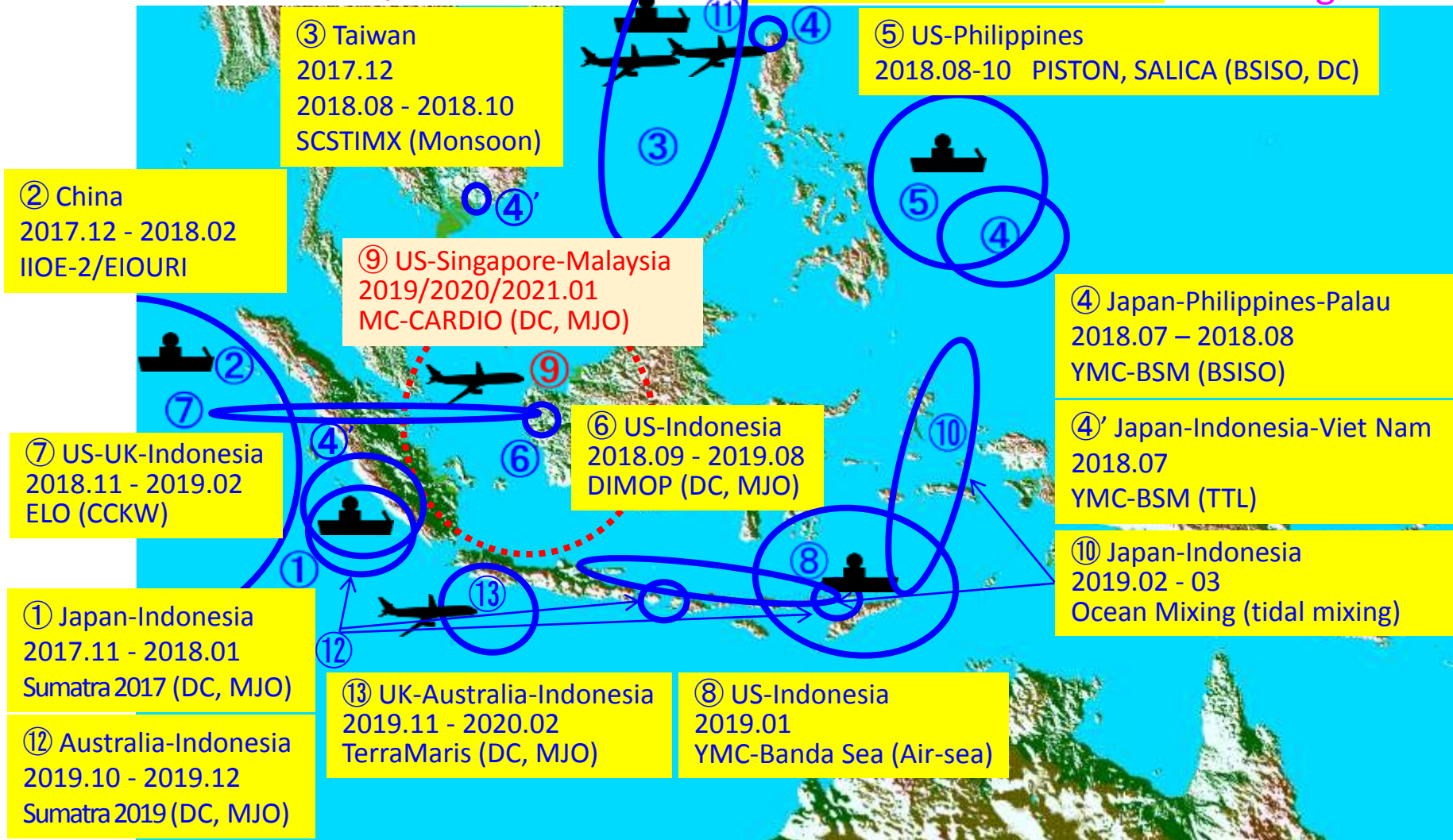
Outline

- 1) What is the YMC ?
- 2) **Field Campaigns – Intensive Observation Periods (IOPs)**
- 3) Data Management
- 4) Concluding Remarks

Funded / Proposed IOPs

⑪ US-Philippines
2019.07-08 CAMP²Ex (Aerosol)

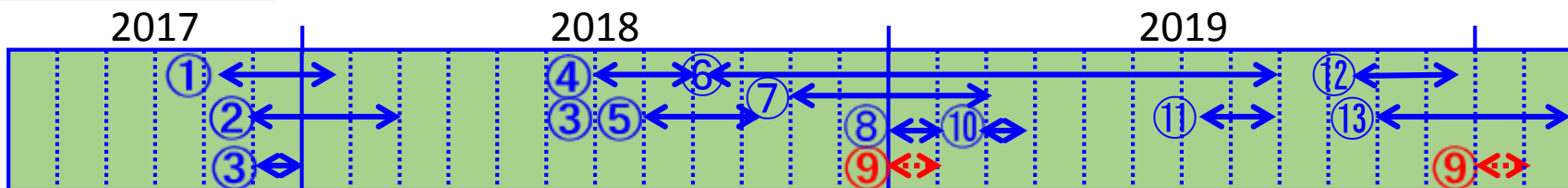
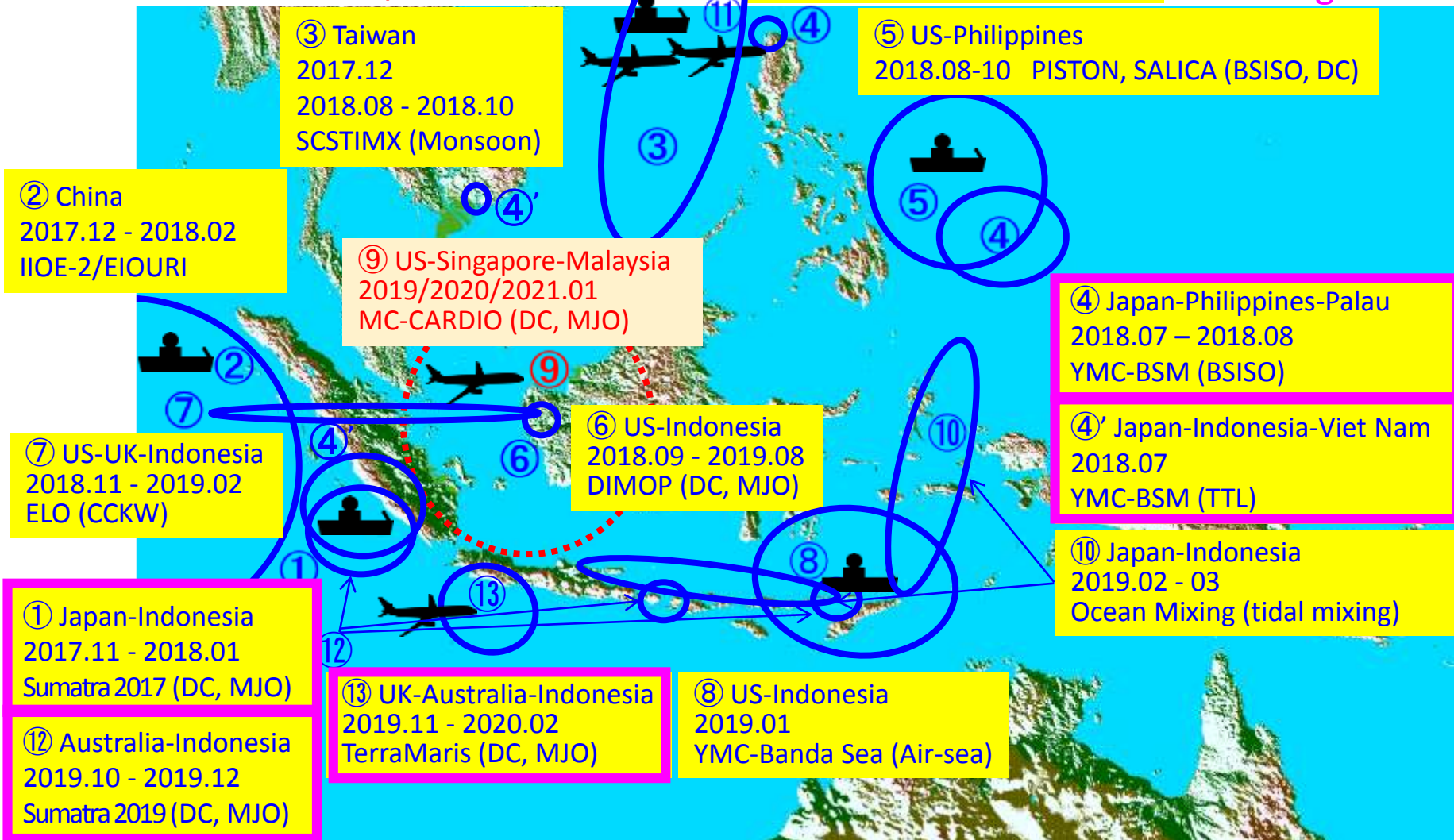
As of Aug. 2018

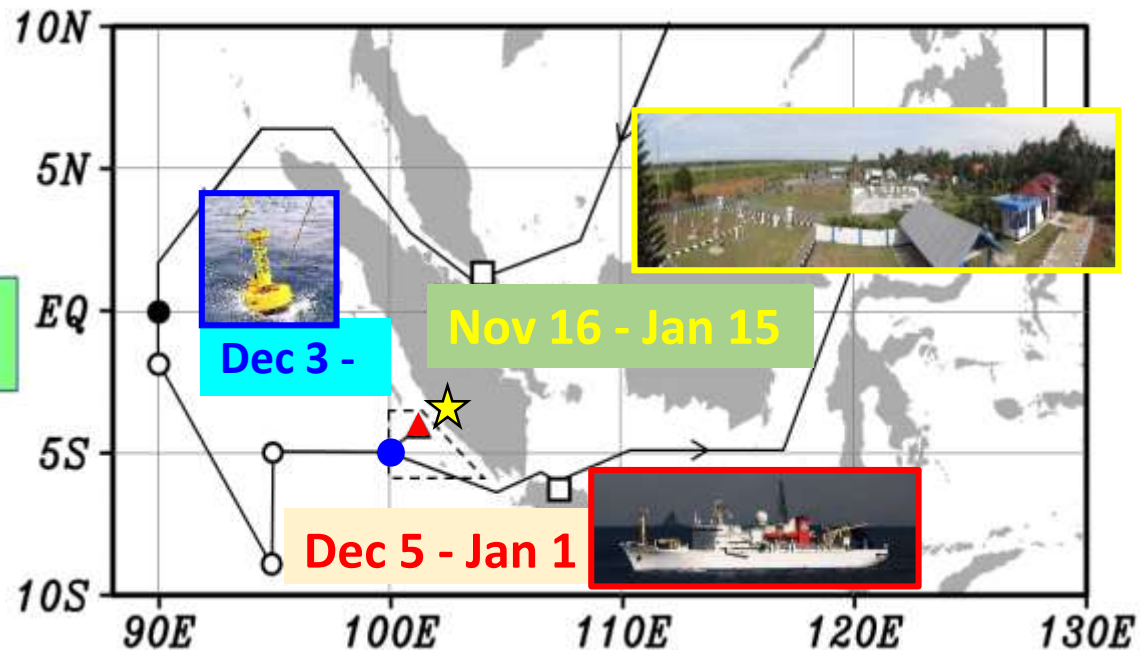
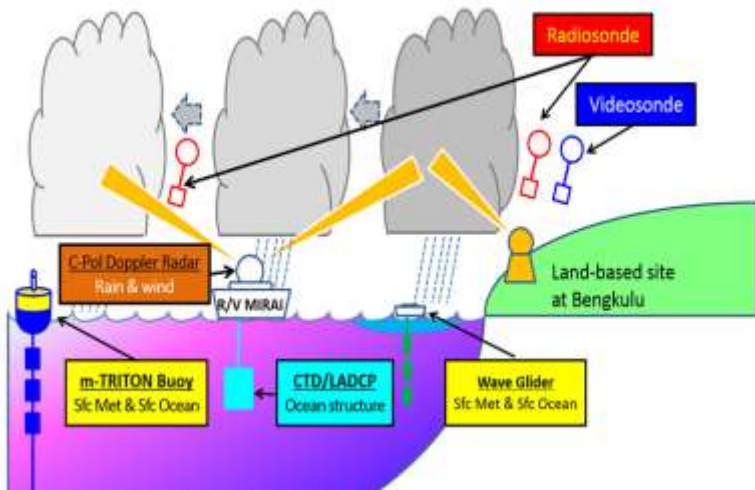


Funded / Proposed IOPs

⑪ US-Philippines
2019.07-08 CAMP²Ex (Aerosol)

As of Aug. 2018





Target: MJO vs. Diurnal cycle in rain near the coast line

Period: Land-based Nov 16, 2017 – Jan 15, 2018 (61 days)
 Ship-based Dec 5, 2017 – Jan 1, 2018 (28 days) (Jp-Jp; Nov 11, 2017 – Jan 18, 2018)

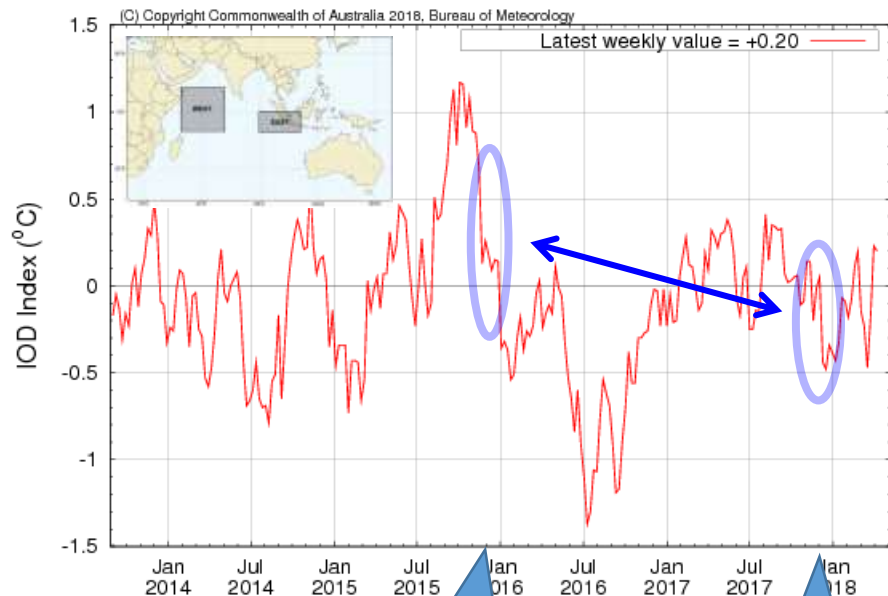
Obs: Land-based C-band Doppler radar, X-band MPR, Radiosonde, AWS, Special-sonde, etc.
 Ship-based C-band Polarimetric Doppler Radar, Radiosonde, LIDAR, Surface Met, CTD, ADCP, Sampled water chemical analyses, Buoy, Wave-glider, etc.

Modeling: Forecast using global cloud-system resolving model “NICAM”

Participants: Japan JAMSTEC, Kyoto U, U Tokyo, U Toyama, NDA, NME, MWJ
 Indonesia BPPT, BMKG, U Bengkulu
 US UH/IPRC

IOD & ENSO Phases

IOD Index

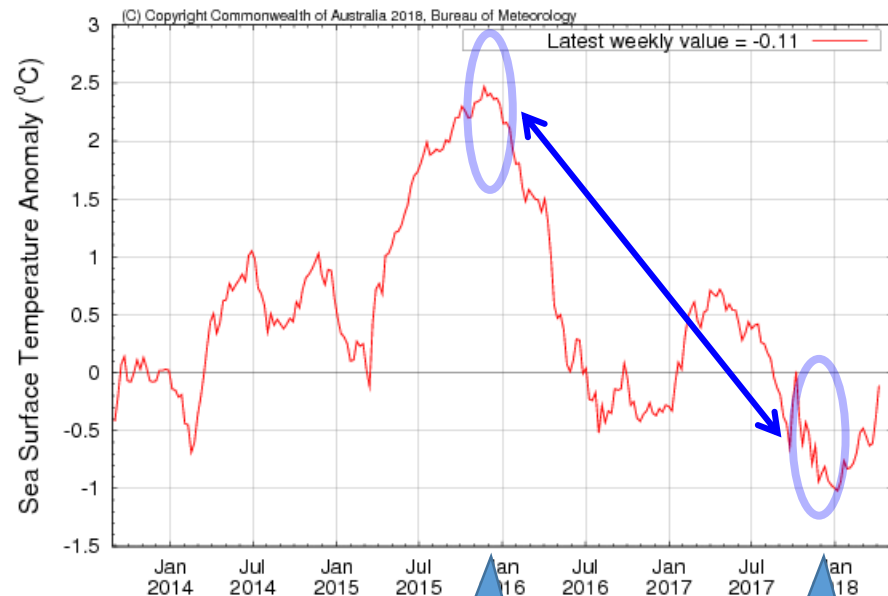


<http://www.bom.gov.au/>

2015. 11-12
P-IOD to Normal

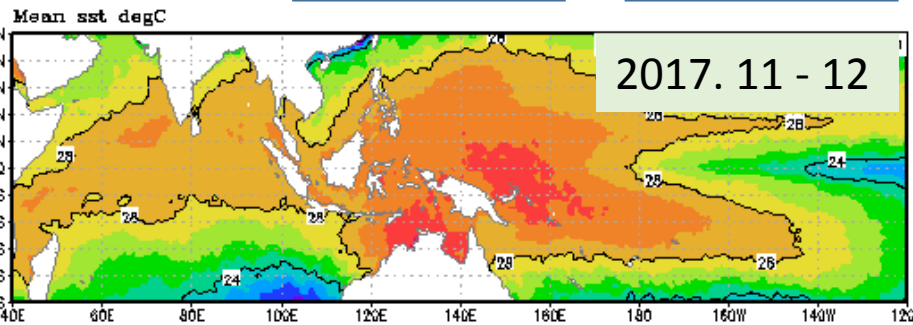
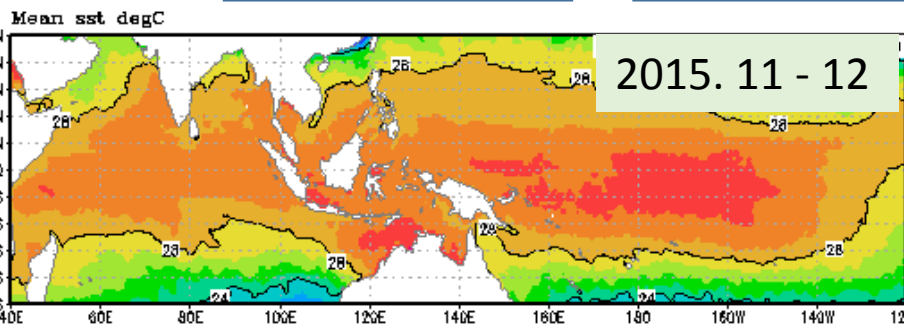
2017. 11-12
Normal

Nino3 SST Index



2015. 11-12
El Nino

2017. 11-12
La Nina

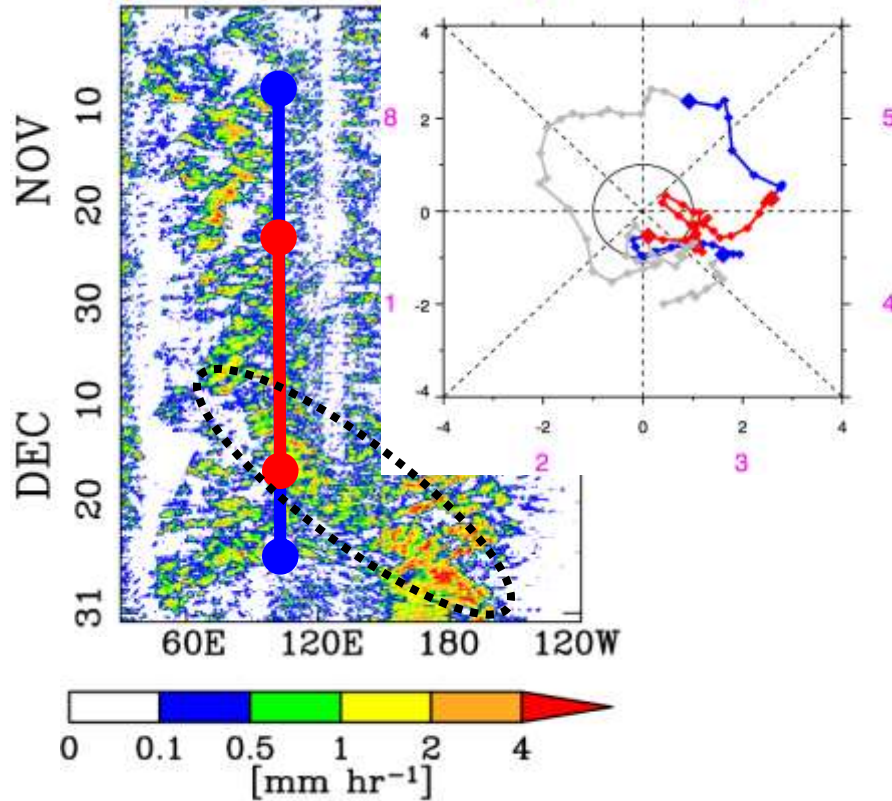


Nov-Dec Mean Sea Surface Temperature (<http://www.esrl.noaa.gov/>)

MJO Phase

2015

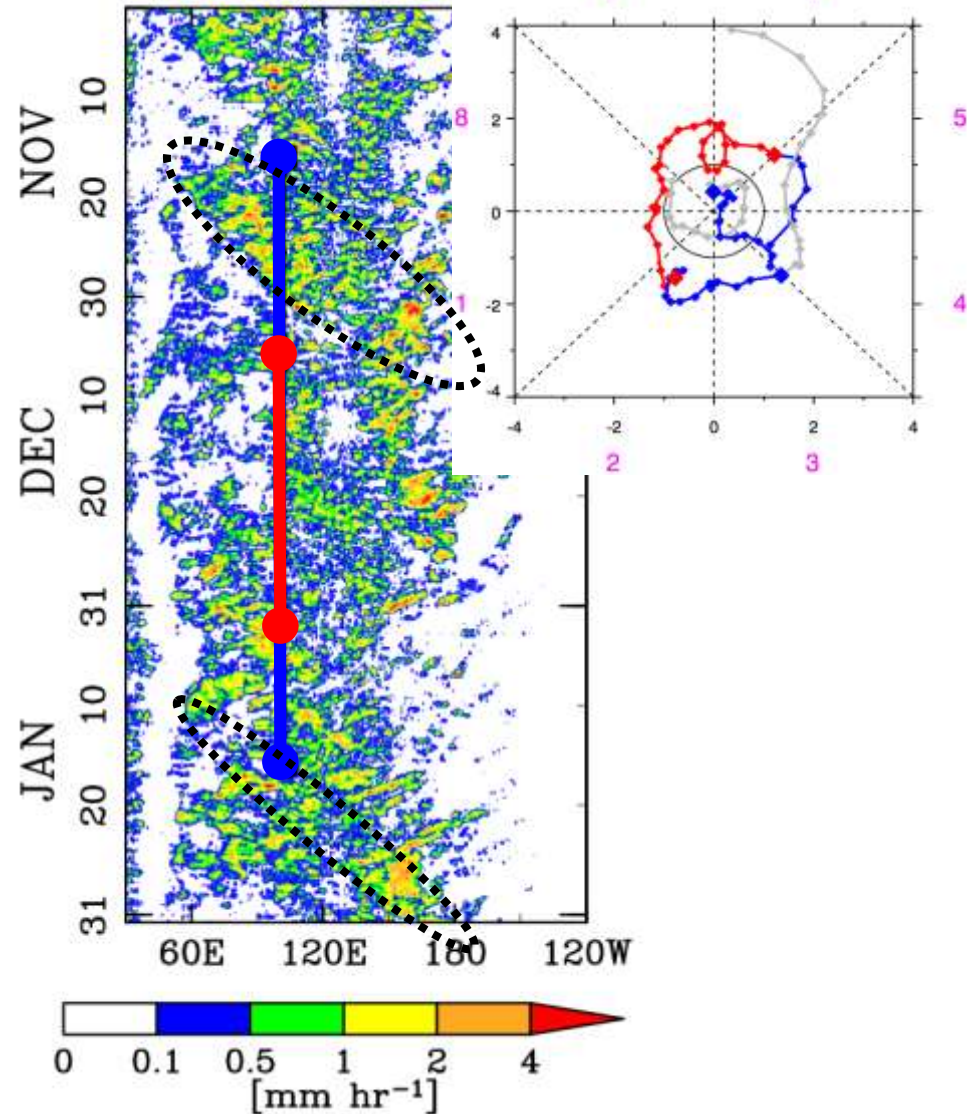
Suppressed → Active



●—● Bengkulu
●—● R/V MIRAI

2017

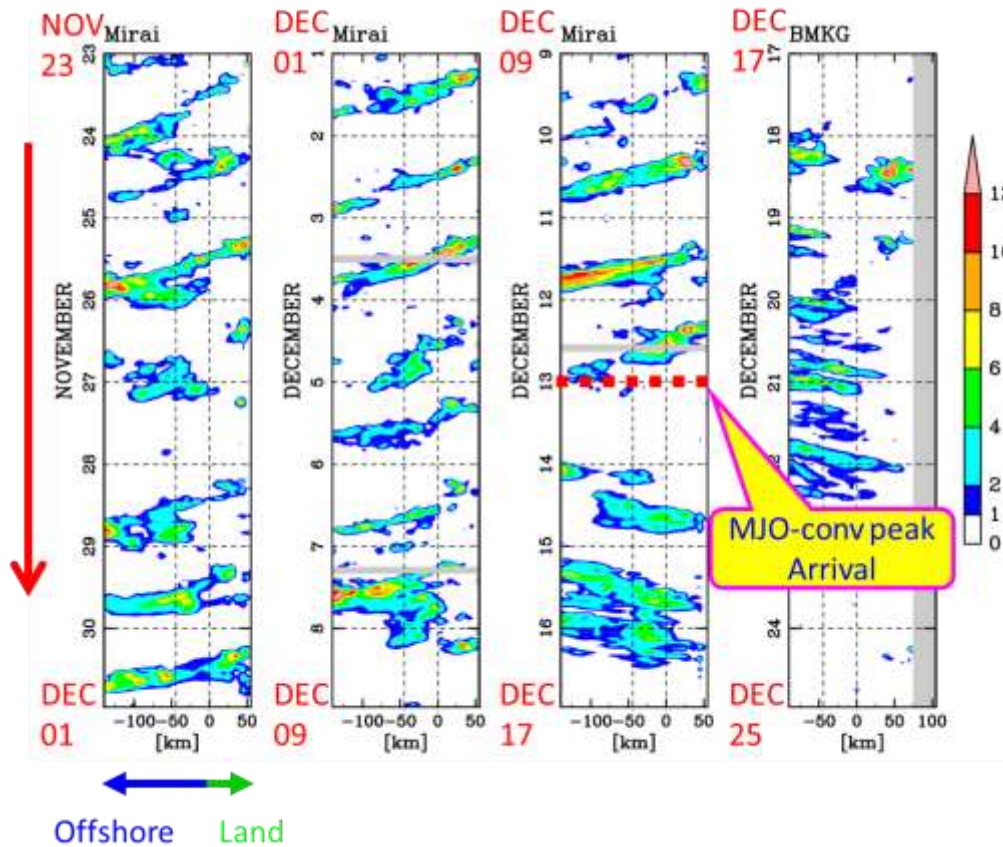
Active → Suppressed



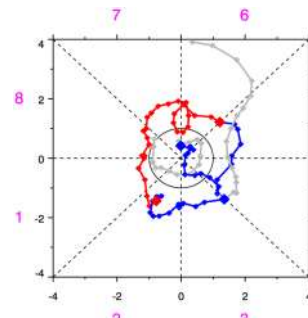
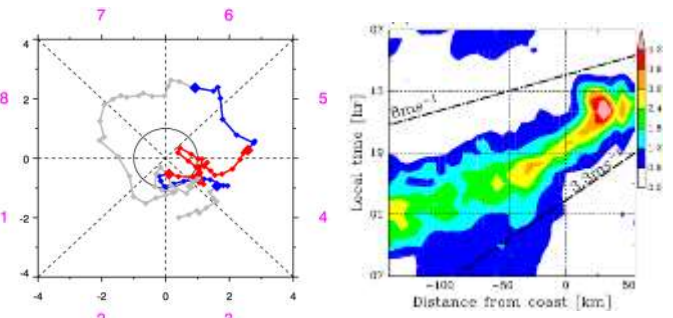
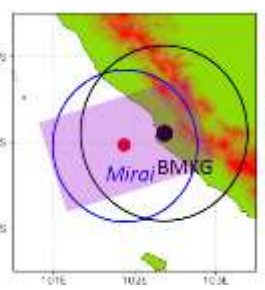
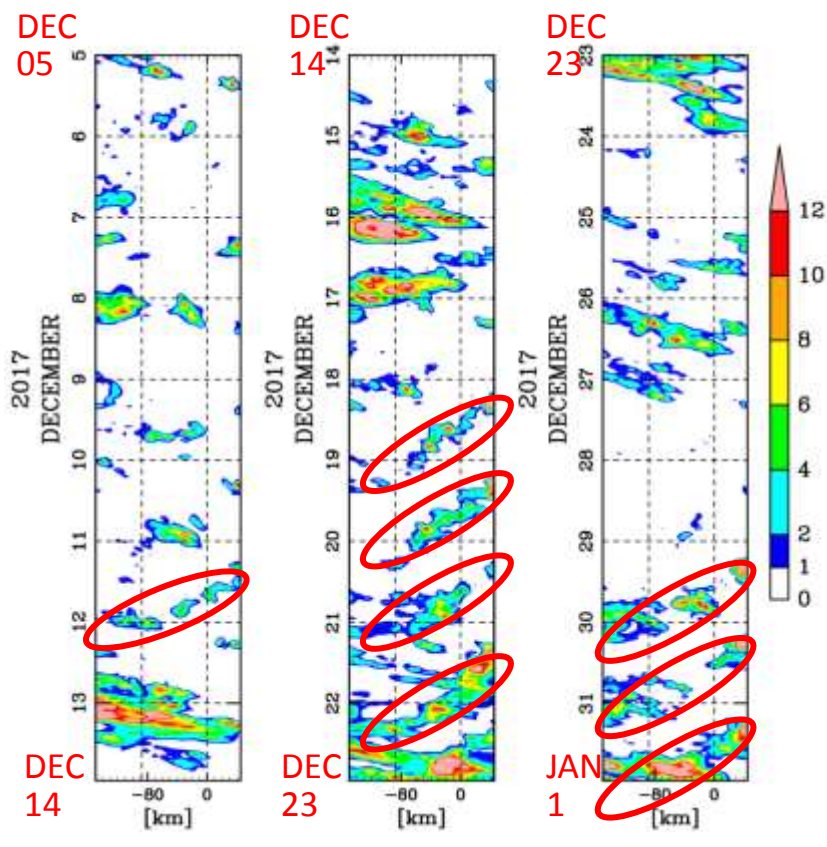
Rain (GSMaP) : <http://sharaku.eorc.jaxa.jp/GSMaP/>
RMM: <http://www.bom.gov.au/climate/mjo/>

Radar-derived Rain Rate as a function of time & distance from Coast Line

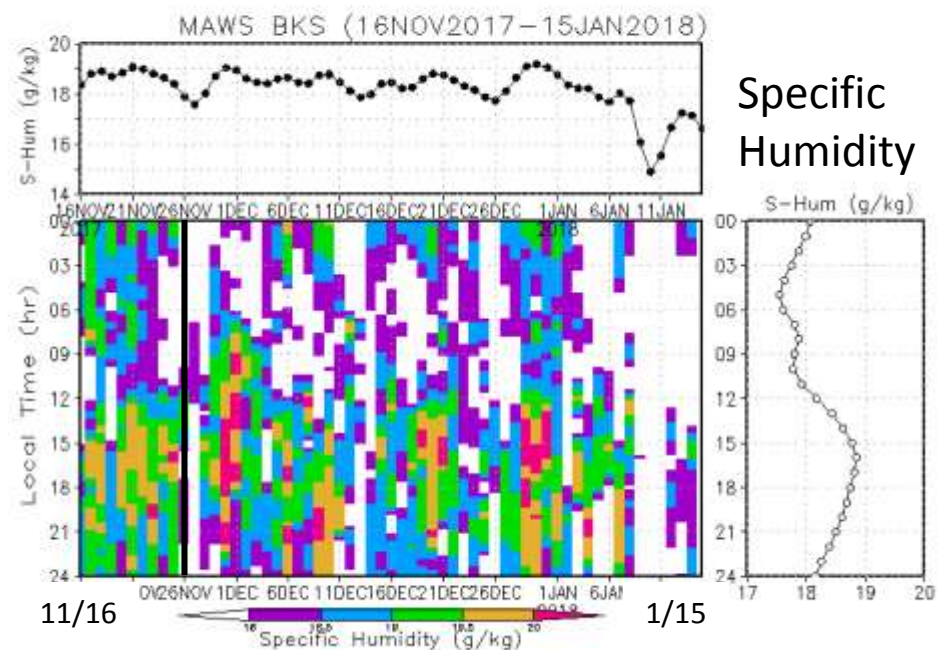
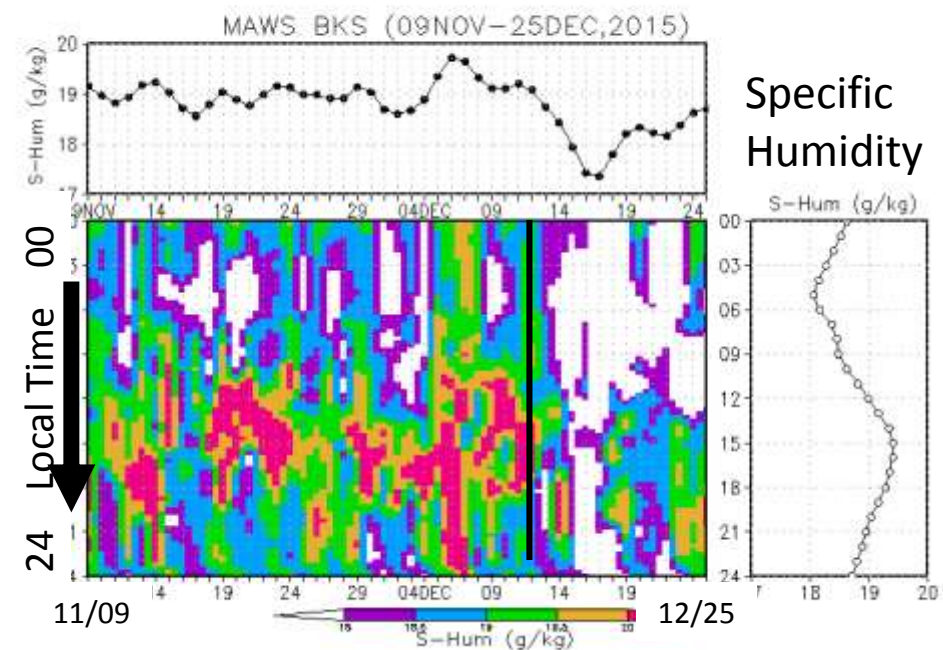
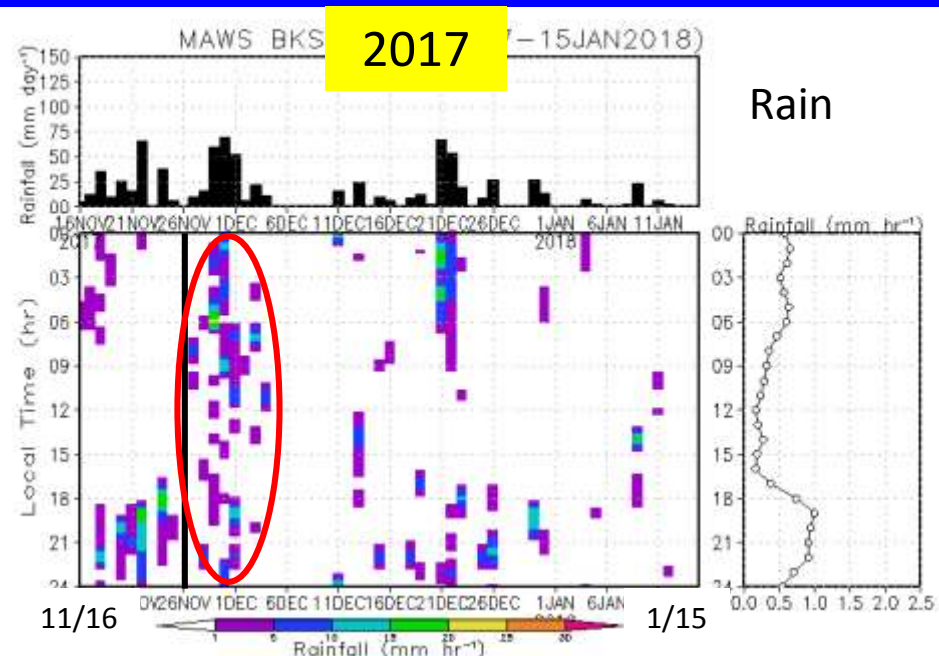
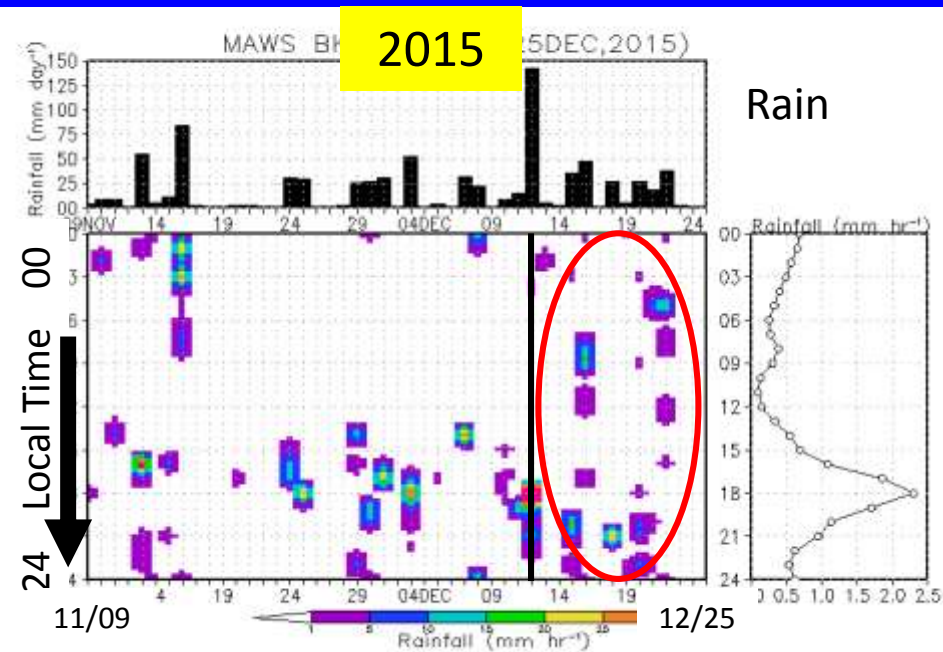
2015



2017

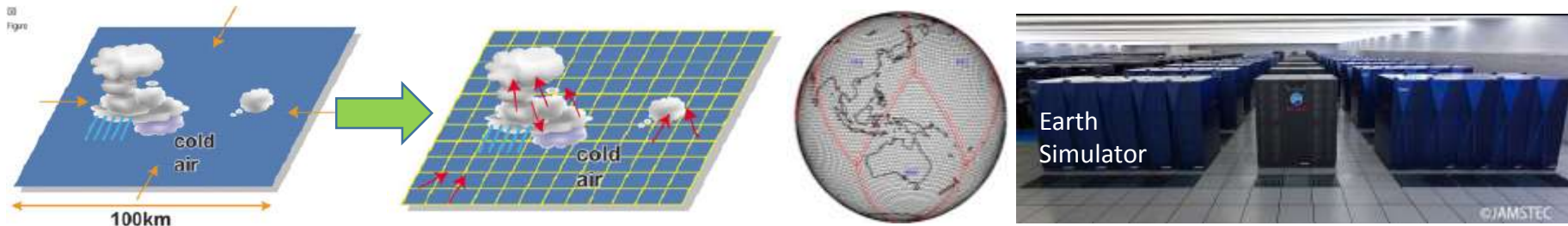


Diurnal Cycle of Rain & Humidity - 2015 vs 2017 -



Near-Real time Forecasting using NICAM

Non-hydrostatic Icosahedral Atmospheric Model (NICAM) ... Global cloud-system resolving model



<http://nicamfcst.jamstec.go.jp/>



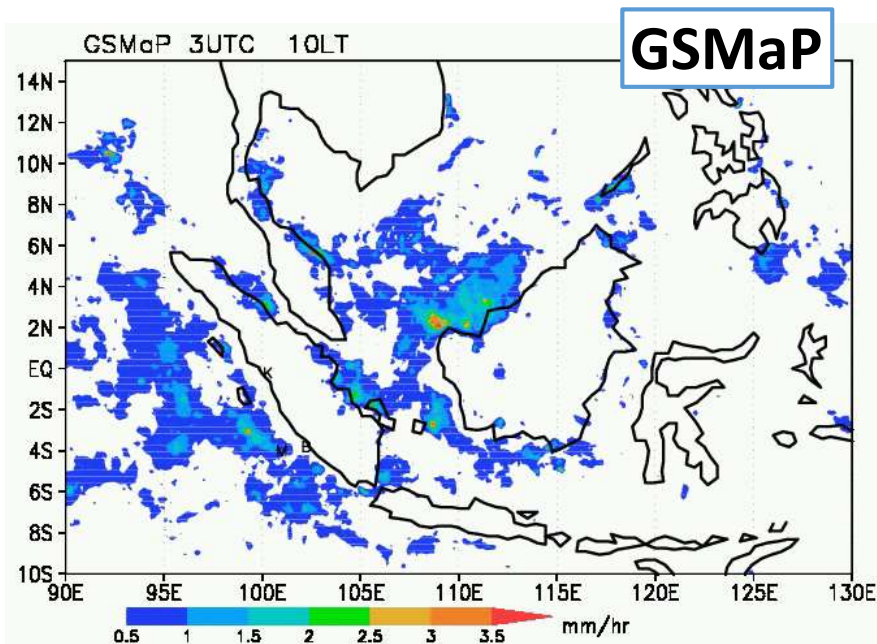
Settings:

- cloud microphysics : NSW6 (Tomita 2008)
- convective parameterization: off
- turbulence : MYNN level 2
(Nakanishi and Niino 2004; Noda et al. 2010)
- radiation : MSTRN X (Sekiguchi and Nakajima 2008)
- land surface : MATSIRO
- initial data : interpolated from NCEP final analysis (1.0x1.0)
- SST: prescribed (daily climatology + initial anomaly)

Global 7-km mesh, 14-day forecast, daily update

Global 14-km mesh, 30-day forecast, weekly update

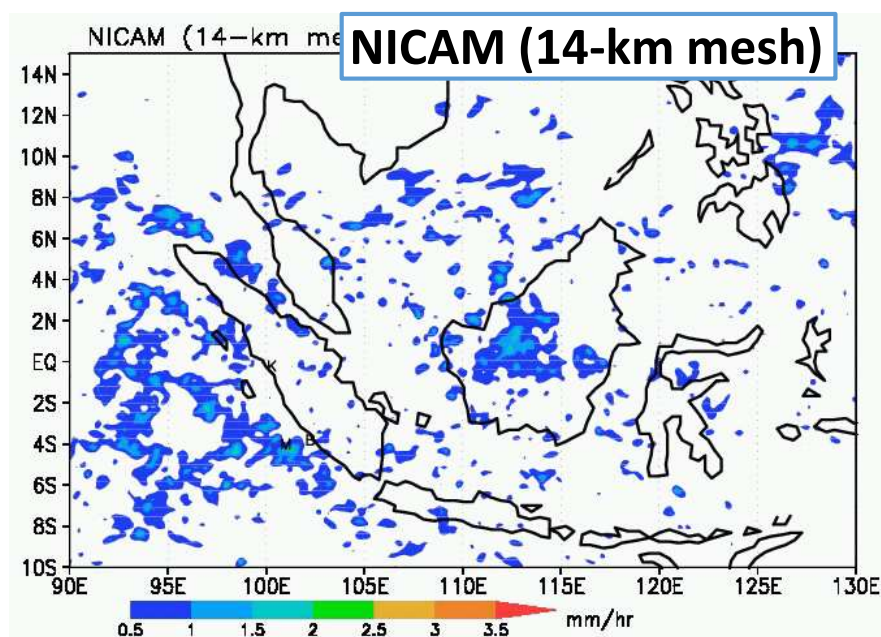
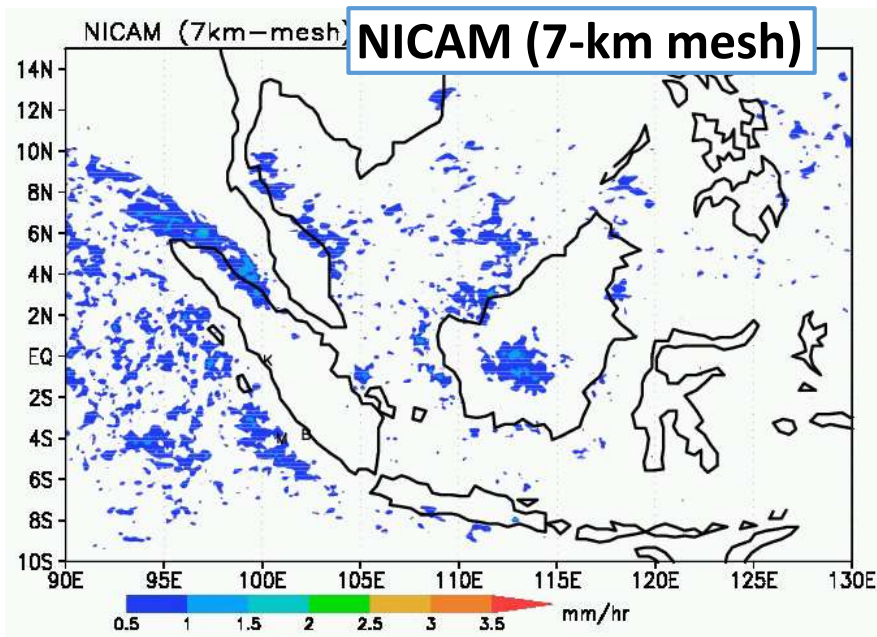
Simulation - Diurnal Cycle of Rain during November 2015



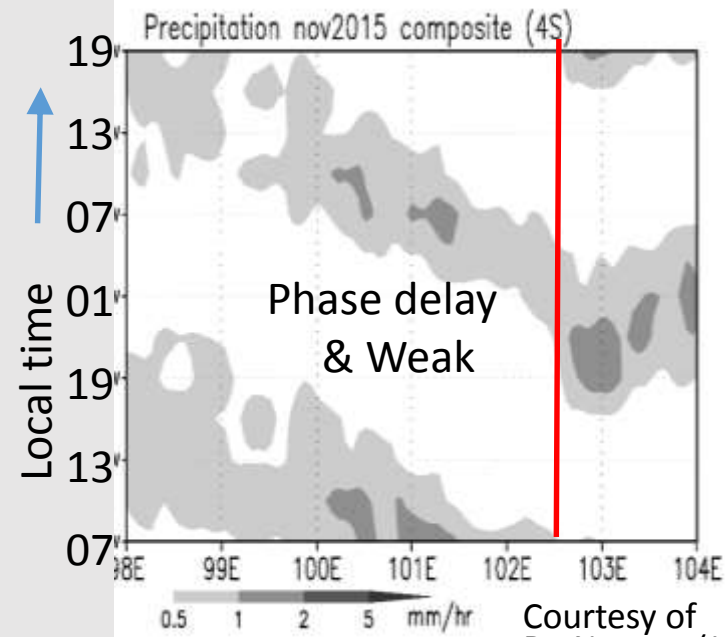
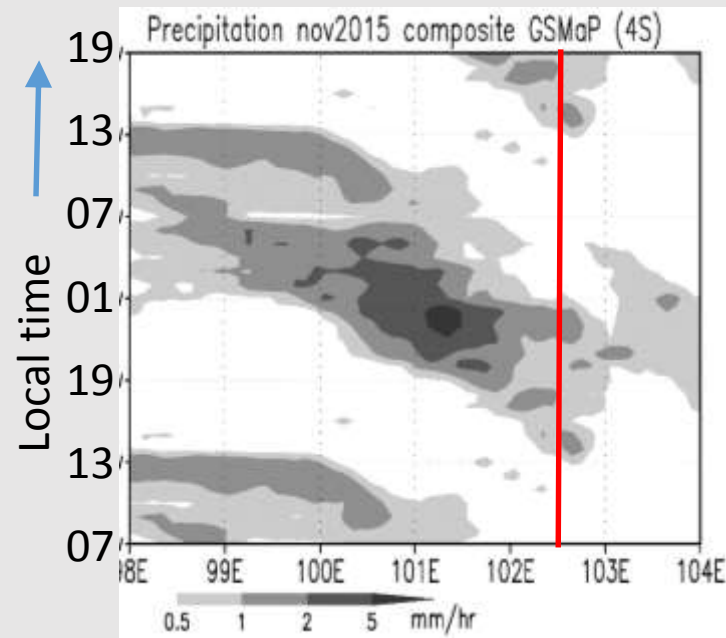
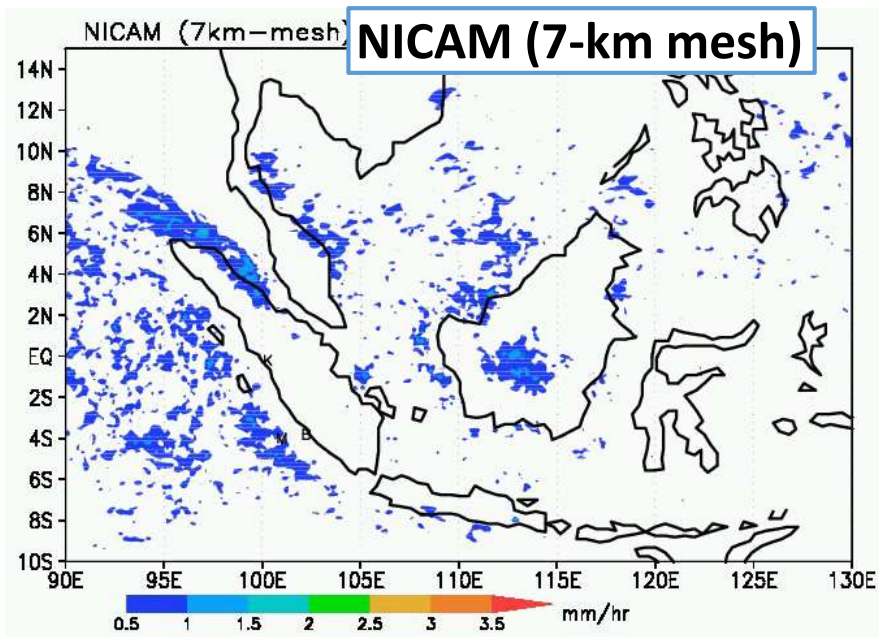
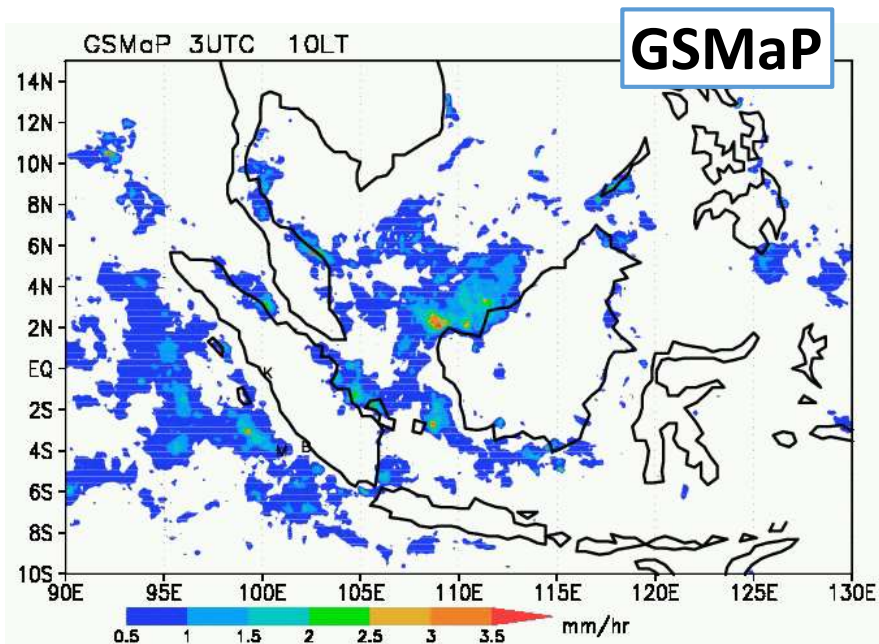
NICAM Simulation shows:

- Weak coastal peak
- Phase delay by several hours
→ better with high resolution
- Sharper peak along mountain

Courtesy of Dr. T. Nasuno (JAMSTEC)



Simulation - Diurnal Cycle of Rain during November 2015



Courtesy of
Dr. Nasuno (JAMSTEC)

R/V Investigator Cruise

Purpose: Diurnal cycle vs. MJO, ITF, etc.

Period: Oct 19 - Dec 18, 2019

Courtesy: Dr. M. Wheeler (BoM)



RV Investigator – Australia's Marine National Facility



TerraMaris

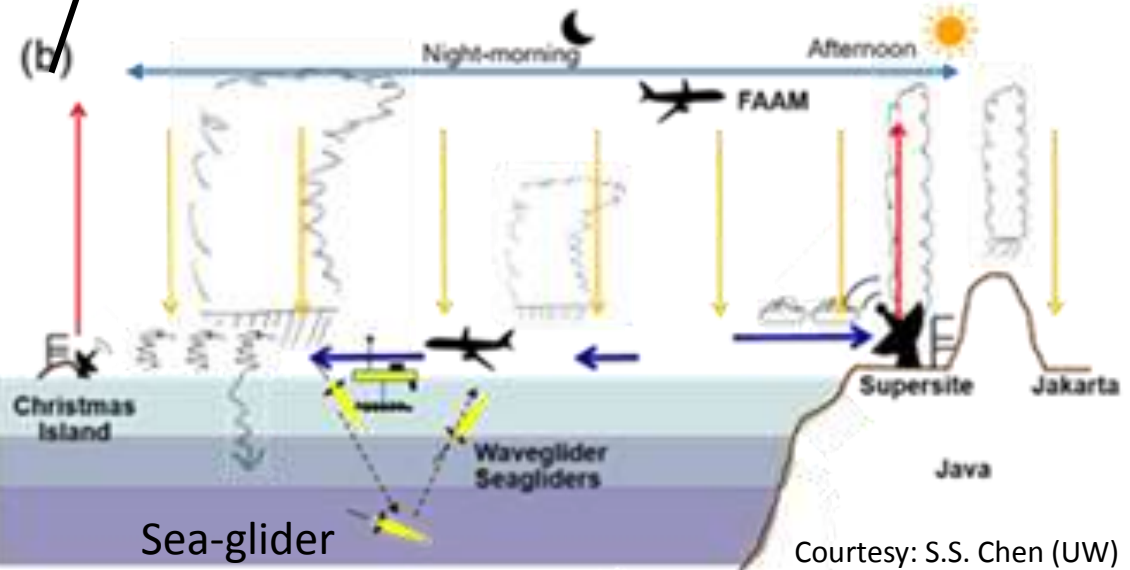
Purpose: Diurnal cycle vs. MJO

Period: Nov 2019 - Feb 2020



FAAM BAe-146

Courtesy : Dr. A. Matthews (UEA)
Mr. P. Barrett (UKMet)



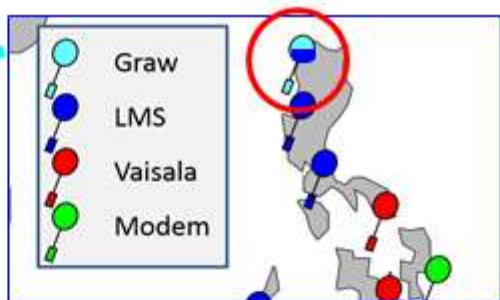
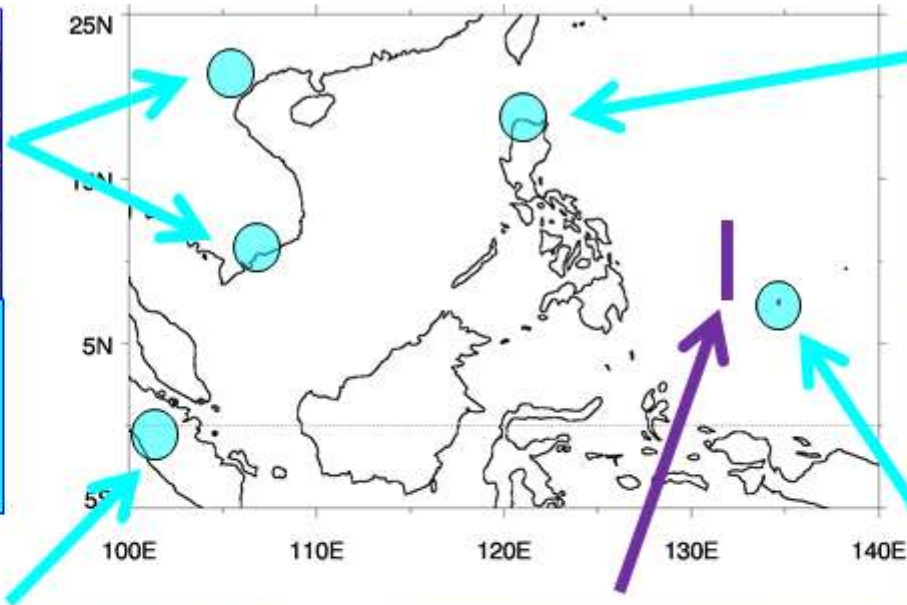
Courtesy: S.S. Chen (UW)

IOP - Example (3) : YMC - BSM 2018

Main targets : Boreal Summer Monsoon focusing on Northward Propagating ISV
 Period: July 1 – August 31, 2018
 Participants: Japan (JAMSTEC, Kyoto Univ, NME), Philippines (PAGASA, UP),
 Indonesia (LAPAN, BMKG), Viet Nam (NHMS), Palau (KWS)



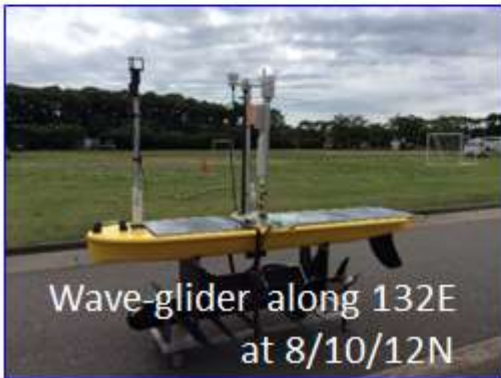
Ozone-sonde (15 times) both at **Hanoi, Ho Chi Minh**



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



CFH/ECC/CPS-sonde (10 times)
 & EAR operation at **Kototabang**



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



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

Kunio Yoneyama (JAMSTEC)

& Chidong Zhang (NOAA/PMEL)

Co-chairs of YMC Science Steering Committee

Outline

- 1) What is the YMC ?
- 2) Field Campaigns – Intensive Observation Periods (IOPs)
- 3) **Data Management**
- 4) Concluding Remarks

Data Policy & Management

YMC adopts “timely release & free/open sharing data policy”.

All QCed data will be opened from YMC data archive centers (web sites). Basically researchers are requested to provide QCed data within 1 year after the campaign.

We should keep in mind about “Availability” & “Accuracy”.

Data Archive Centers

BMKG, Indonesia

<http://www.bmkg.go.id/ymc/>

JAMSTEC, Japan

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



The screenshot shows a web browser window displaying the JAMSTEC YMC website. The browser address bar shows <http://www.jamstec.go.jp/>. The page features a large banner with a map of the Maritime Continent and the text: “YMC” Years of the Maritime Continent 2017 - 2019. Below the banner, there is a navigation menu with buttons for Menu, Home, About, Meetings, Campaigns, Data (highlighted with a red circle), Publications, Links, Members Only, and Japanese Page. The main content area includes a section titled “This is JAMSTEC YMC Page.” with a link to the BMKG YMC page, a “What’s New” section with a list of recent events and publications, and a “What is YMC?” section with a brief description of the campaign. The footer contains copyright information for 2015 JAMSTEC and contact information for ymc-office@jamstec.go.jp.

Main Activities

1) Data sharing

Through collecting, archiving, and sharing data from observing networks in the MC region, satellites, and NWP products, build a two-year comprehensive database for detailed documentation of multi-scale variability and interaction of the MC weather-climate system.

2) Field campaign

3) Modeling

4) Prediction and applications

5) Outreaching and capacity building

“Availability” : Data Collection

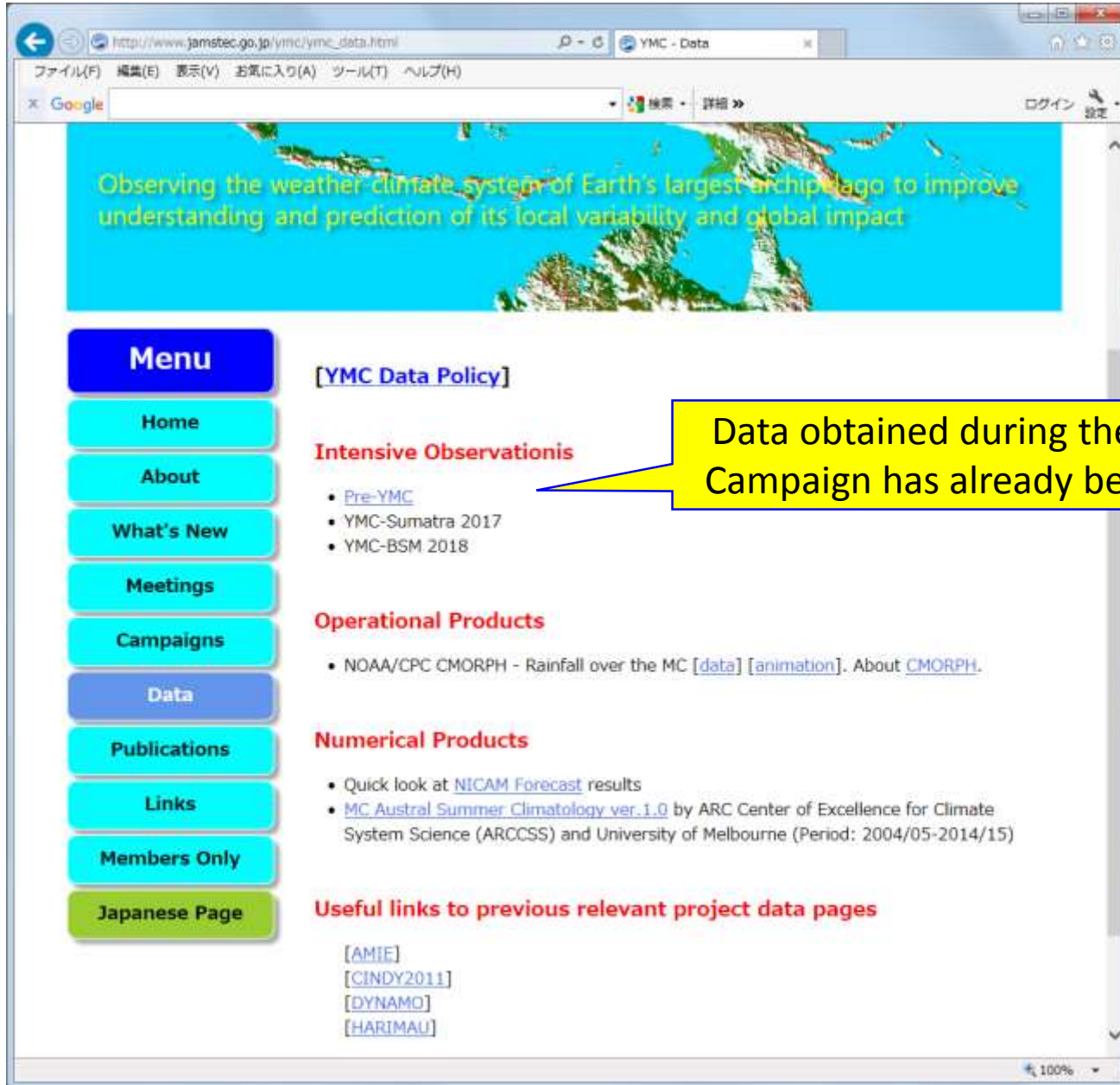
Example. Radar data collection from PAGASA Stations in the Philippines



	2017							2018						
	7	8	9	10	11	12	1	2	3	4	5	6	7	
Appari	○	○	○	○	○	○	○	○	○	○	○	○	○	
Baguio	x	x	x	x	x	x	x	x	x	x	x	○	○	
Cebu	○	○	○	○	○	○	○	○	○	○	○	○	x	
Guiuan	x	x	x	x	x	x	x	x	x	x	x	x	x	
Hinatuan	○	○	○	○	○	○	○	○	○	○	○	○	○	
Iloilo	x	x	x	x	○	x	○	○	○	○	○	○	○	
Mactan	x	x	x	x	x	x	x	x	x	x	x	○	○	
Palawan	x	x	x	x	x	x	x	x	x	x	x	x	x	
Subic	○	○	○	○	○	○	○	○	○	○	○	○	○	
Tagaytay	○	x	○	○	x	x	○	○	○	○	○	○	○	
Tampakan	x	x	x	x	x	x	x	x	○	○	○	○	x	

Courtesy of  PAGASA
The Weather and Climate Authority

“Availability” : Data Release from YMC Web site



The screenshot shows a web browser window displaying the YMC Data website. The browser's address bar shows the URL http://www.jamstec.go.jp/ymc/ymc_data.html. The page features a header with a map of the Indonesian archipelago and the text: "Observing the weather-climate system of Earth's largest archipelago to improve understanding and prediction of its local variability and global impact".

On the left side, there is a vertical navigation menu with the following items: Menu, Home, About, What's New, Meetings, Campaigns, Data (highlighted in blue), Publications, Links, Members Only, and Japanese Page.

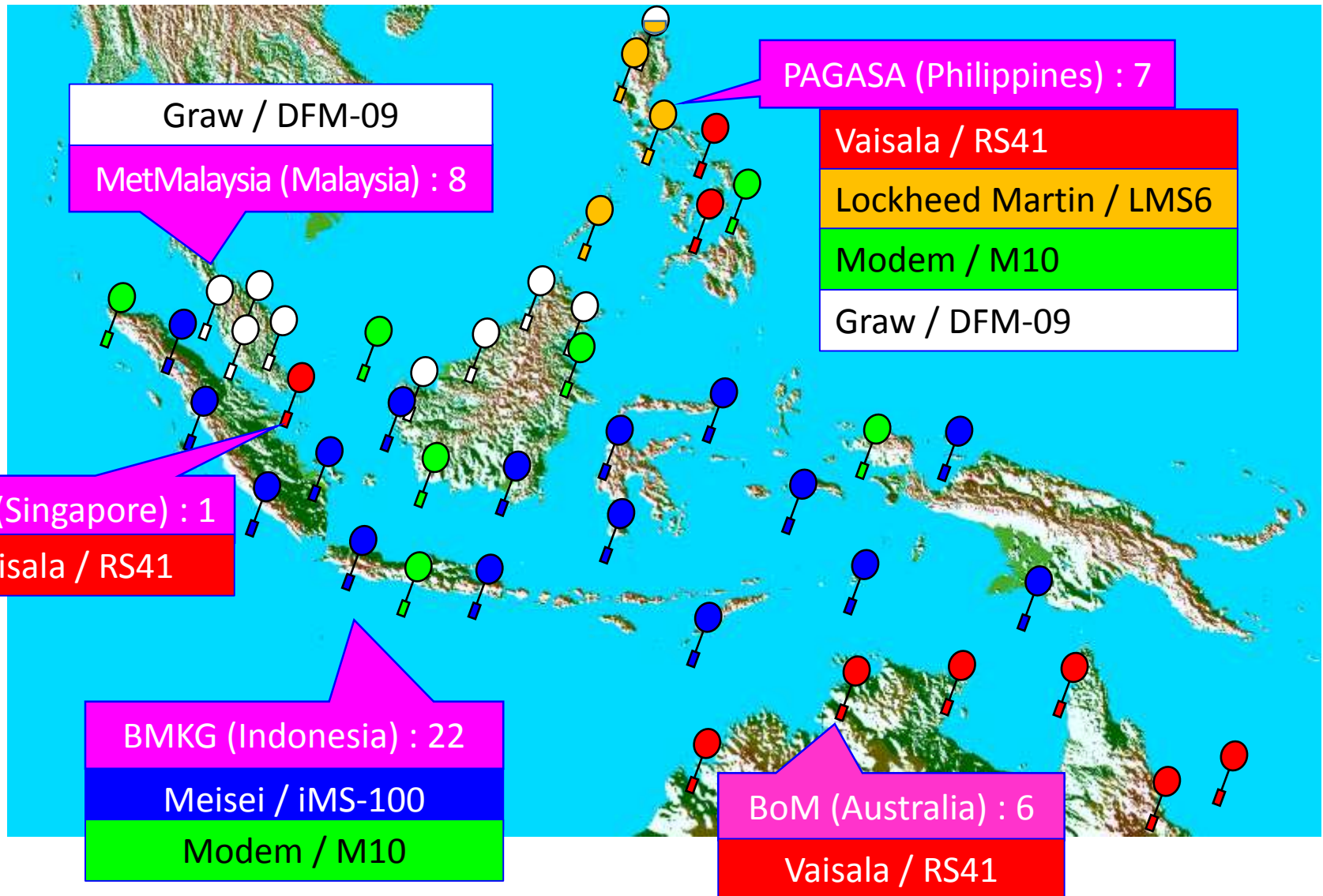
The main content area is organized into several sections:

- [YMC Data Policy]**
- Intensive Observationis**
 - [Pre-YMC](#)
 - [YMC-Sumatra 2017](#)
 - [YMC-BSM 2018](#)
- Operational Products**
 - NOAA/CPC CMORPH - Rainfall over the MC [[data](#)] [[animation](#)]. About [CMORPH](#).
- Numerical Products**
 - Quick look at [NICAM Forecast](#) results
 - [MC Austral Summer Climatology ver.1.0](#) by ARC Center of Excellence for Climate System Science (ARCCSS) and University of Melbourne (Period: 2004/05-2014/15)
- Useful links to previous relevant project data pages**
 - [[AMIE](#)]
 - [[CINDY2011](#)]
 - [[DYNAMO](#)]
 - [[HARIMAU](#)]

A yellow callout box with a blue border points to the "Intensive Observationis" section, containing the text: "Data obtained during the Pilot Study Campaign has already been released."

“Accuracy” : Data Correction

Operational Radiosonde Observations by the MC Meteorological Agencies



Intercomparison during YMC-Sumatra 2017



Inter-comparison: **18 times (10 daytime, 5 dawn/dusk, 3 nights)**

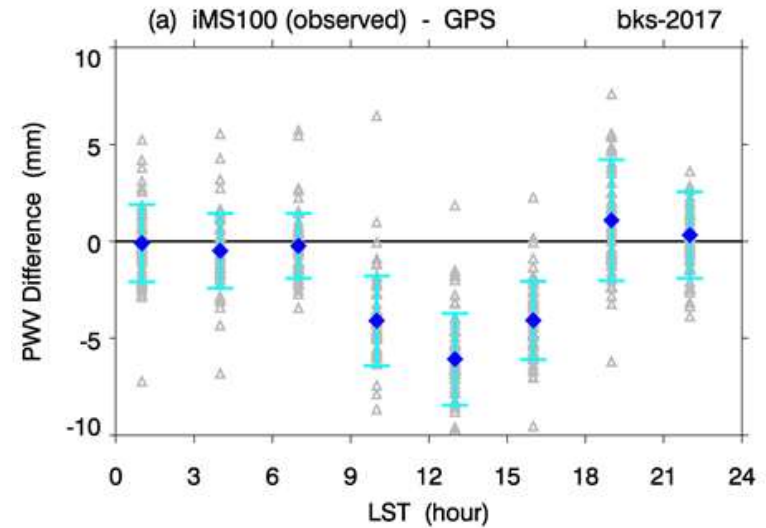
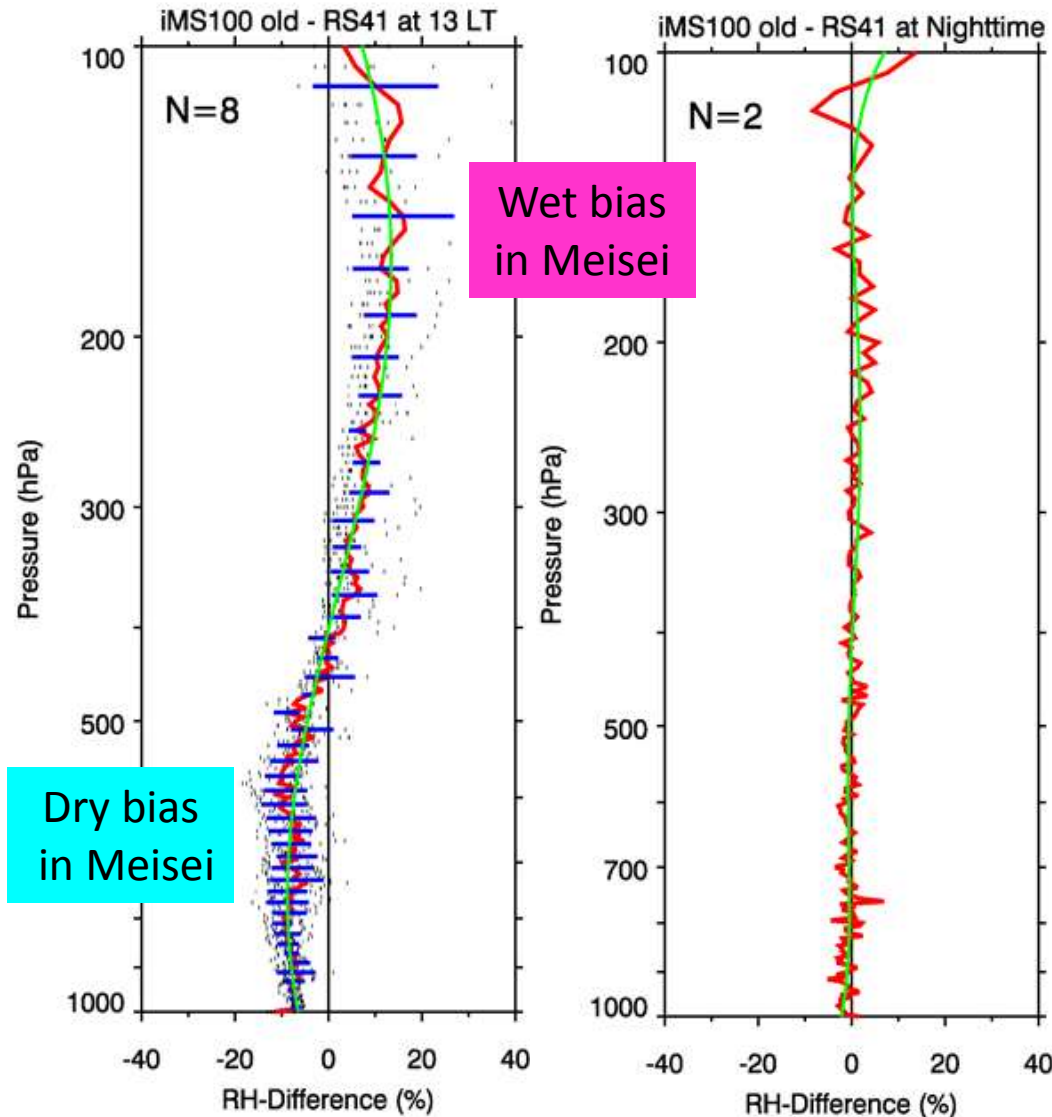
- 1) Meisei (iMS-100) ... BMKG Routine observations + IOP
- 2) Vaisala (RS41-SGDP) ... onboard the R/V MIRAI
- 3) CFH (Cryogenic Frost-point Hygrometer) ... 7 times
- 4) GNSS-derived Water Vapor

Intercomparison during YMC-Sumatra 2017

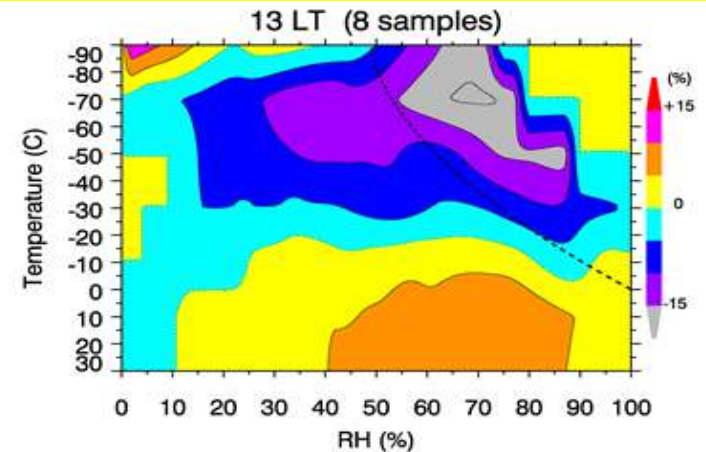
Daytime

Nighttime

Precipitable Water Vapor
Sonde (Meisei) - GNSS

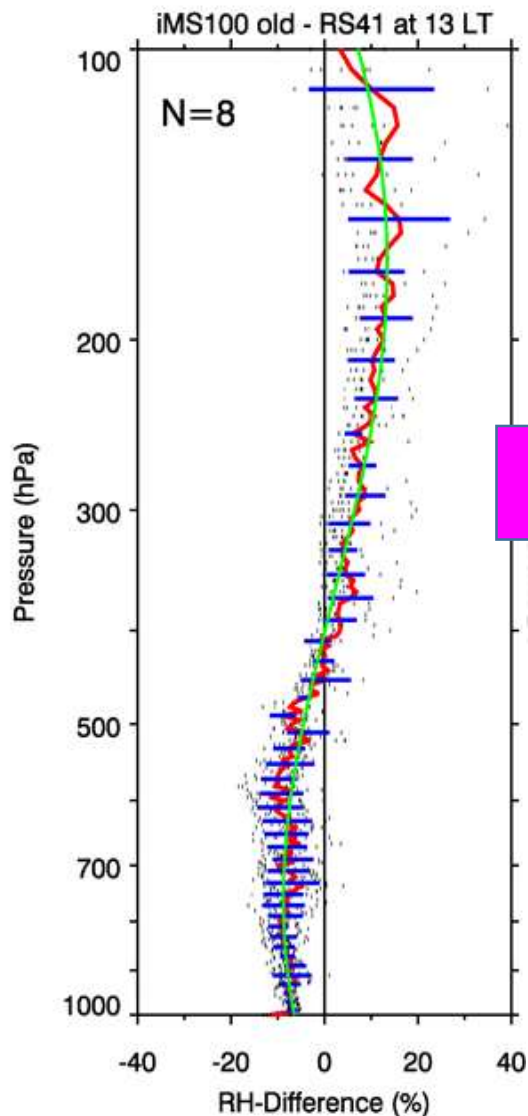


Correction based on intercomparison

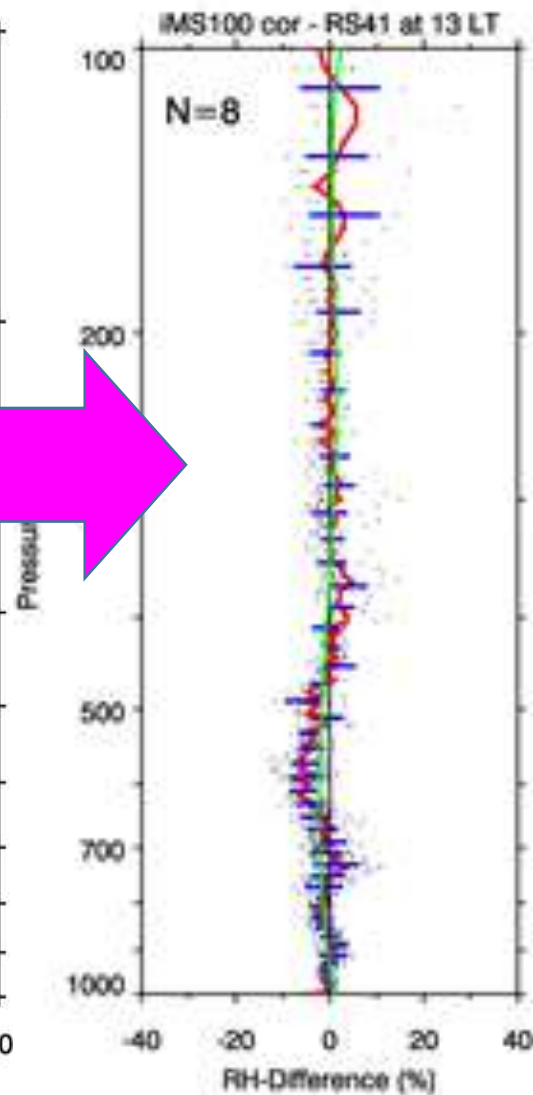


Intercomparison during YMC-Sumatra 2017

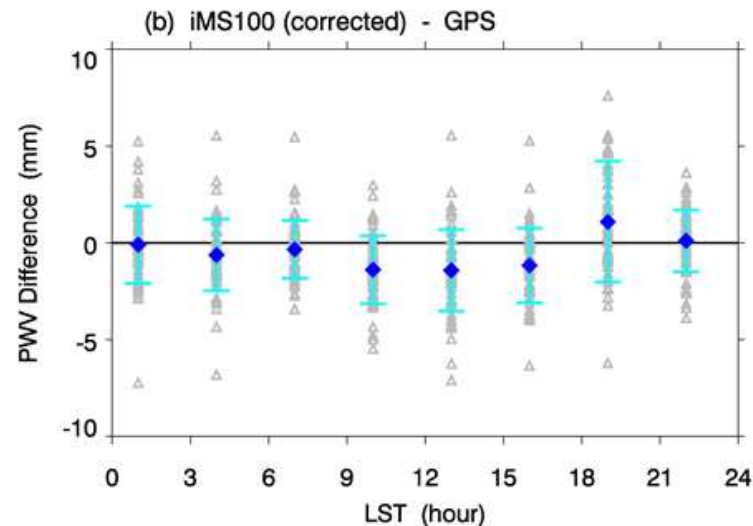
Before



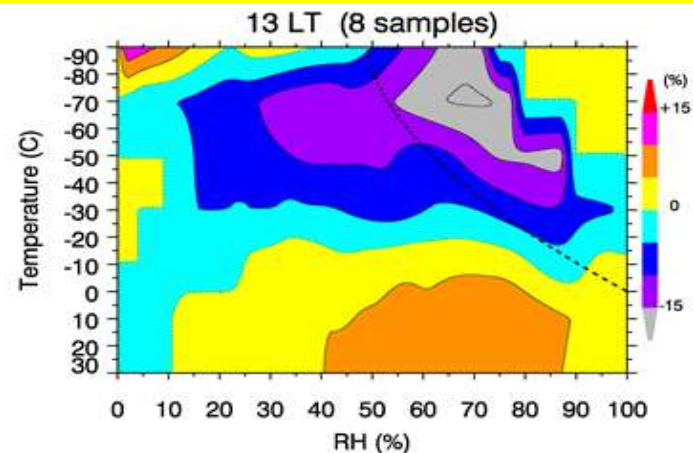
After



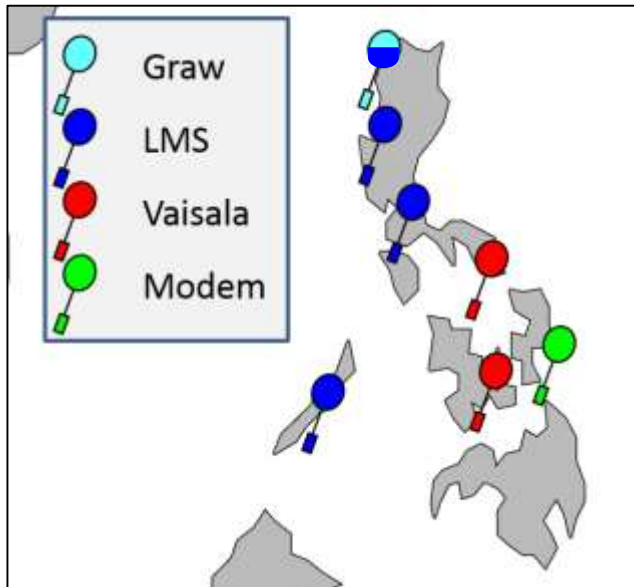
Precipitable Water Vapor
Sonde (Meisei) - GNSS



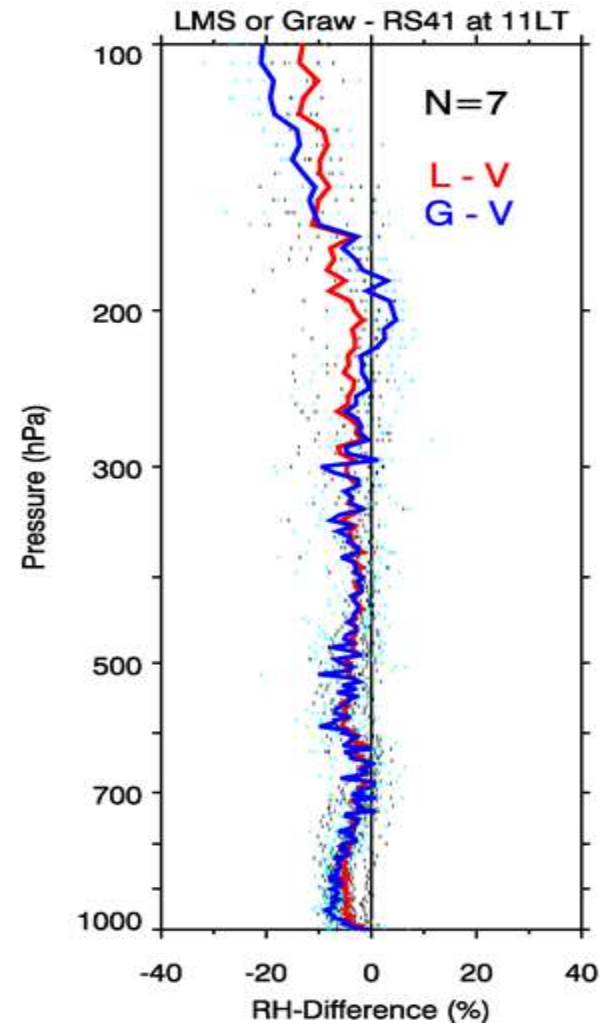
Correction based on intercomparison



Intercomparison during YMC-BSM 2018 at Laoag



Intercomparison among different types of radiosonde (Graw, LMS, and Vaisala) has been done at PAGASA Laoag station during July 27 – Aug. 2, 2018.



Kunio Yoneyama (JAMSTEC)

& Chidong Zhang (NOAA/PMEL)

Co-chairs of YMC Science Steering Committee

Outline

- 1) What is the YMC ?
- 2) Field Campaigns – Intensive Observation Periods (IOPs)
- 3) Data Management
- 4) **Concluding Remarks**

- 1) YMC field campaign has started since July 2017, and its first IOP has been conducted west coast of Sumatra during Nov 2017 – Jan 2018. Currently, several IOPs focusing on the boreal summer monsoon & ISO have been conducted around the Philippine Sea.
- 2) So far, 12 IOPs have been funded, and one proposed project is under review.
- 3) While quality control for observations have been made, many preliminary results have been brought out by the IOP participants. YMC sessions have been arranged at various scientific meetings including AGU, AMOS, AOGS, etc. QCed data will be available through YMC Archive Centers in a timely manner.
- 4) Currently, YMC is scheduled to continue until early 2020, when the last IOP campaign is expected to take place. However, another discussion has been initiated to extend it as Phase-2. It will not be the same as the current one, but it will mainly focus on interaction among MC-local and international scientists to verify the improvement of numerical prediction skill.

Purpose

To expedite progress of improving 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, Germany, Indonesia, Italy,
 Japan, Korea, Malaysia, Mexico, NZ, Palau, Philippines,
 Poland, Singapore, Taiwan, Thailand, UK, US, Vietnam
 (as of July 2017)

Period

July 2017 – early 2020

Main Science Themes

- 1) Atmospheric convection (ex. Diurnal cycle, MJO, monsoon)
- 2) Ocean and air-sea interaction
- 3) Stratosphere-troposphere interaction
- 4) Aerosols
- 5) Prediction

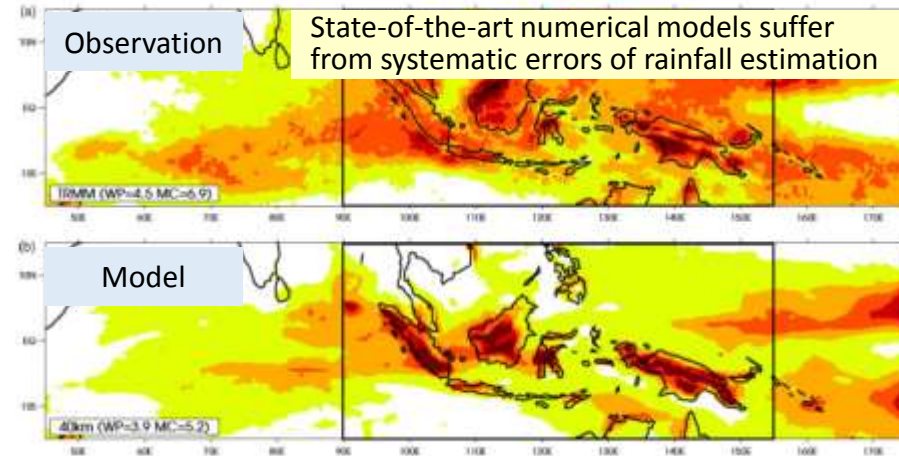
Main Activities

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

Remarks

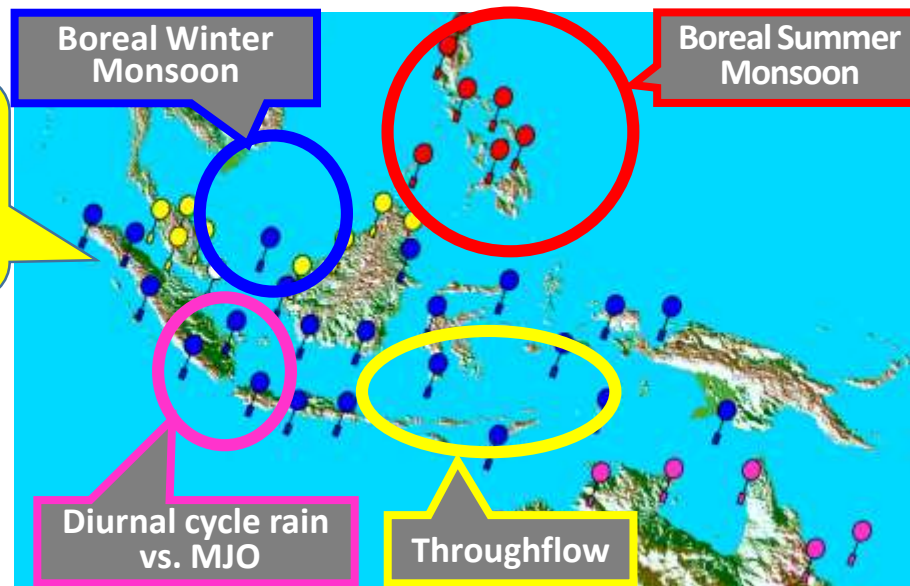
YMC has been endorsed by many international bodies including WMO/WWRP, WCRP/CLIVAR, etc.

<http://www.bmkg.go.id/ymc/>
<http://www.jamstec.go.jp/ymc/>



Comparison of monthly mean rainfall for February.
 Taken from Love et al. (2011)

Key:
 YMC campaign consists of;
 1) Intensive Obs + Modeling, &
 2) Long-term routine obs.



Routine sounding sites (●) & Intensive observation areas (○)

Additional Notes

- 2013.07 Initial Idea of YMC was born based on the success of CINDY/DYNAMO and others
- 2014.09 YMC Kick-off Meeting in Jakarta
- 2015.01 The 1st YMC Workshop in Singapore
- 2015.11 Endorsement from WMO/WWRP
- 2015.11 The 2nd YMC Workshop in Jakarta
- 2015.11 Pre-YMC Field Campaign along the west coast of Sumatra
- 2016.04 Endorsement from S2S
- 2016.06 Endorsement from WMO/CAS, WGNE/MJO Task Force
- 2017.03 Endorsement from WCRP/CLIVAR
- 2017.03 The 3rd YMC Workshop in Bangi, Malaysia
- 2017.07 Start of the Field Campaign Phase
- 2017.11 The 1st IOP along the west coast of Sumatra
- 2018.07 IOPs on Boreal Summer Monsoon
- 2018.09 The 1st ICTMAS in Bandung
- 2019.02 The 4th YMC Workshop in Quezon, Philippines
- 2019.11 The last IOP (~ 2020.02)

Some examples of Educational training and Joint research activities ...

...

- 2018.06 US delegation to BMKG for training of radar analysis/modeling, etc.
- 2018.07 Training for U Philippines students during YMC-BSM 2018 campaign at Laoag
- 2018.09 Lectures by JAMSTEC scientists at LAPAN
- 2018.11 BPPT & BMKG scientists visit JAMSTEC for joint analysis of YMC-Sumatra 2017
- 2018.11 JAMSTEC plan to invite U Philippines students for data analysis training
- 2019.02 JAMSTEC plan to invite PAGASA staff for data analysis training

...



Increase the number of presentation by Indonesian young scientists at the YMC session of AGU, AMS, etc.



AMS-HTM, 2018.04

Press Release at BMKG on July 17, 2017
telling the start of YMC & its social impacts



Bisnismetro, Kompas, Journal Nusantara,
Kompas, Metrotv, Suarakarya, etc.

Press Release at Bengkulu on Dec 27, 2017
arranged by BPPT



Kompas, TVRI, Nusantara Terkini, etc.

Before/after the IOP of YMC-Sumatra 2017 campaign, discussion forum at Bengkulu
was arranged by BMKG to interact with local stakeholders for mutual understanding.



Possible reasons of RH difference btwn RS41 & iMS100

Dry bias in the lower troposphere

Meisei iMS100 calculates RH using thermistor temperature data as below.

$$T_s = K_{Ta} \times T_{s_obs} + (1 - K_{Ta}) \times T_a$$

where T_s ; RH-sensor temperature,
 T_{s_obs} ; measured RH-sensor temperature,
 T_a ; air temperature, and
 K_{Ta} ; weighting function

$$K_{Ta} = \begin{cases} 0 & (\text{for } P > 600 \text{ hPa}) \\ 1 - \frac{\ln P - \ln 400}{\ln 600 - \ln 400} & (\text{for } 400 < P < 600 \text{ hPa}) \\ 1 & (\text{for } P < 400 \text{ hPa}) \end{cases}$$

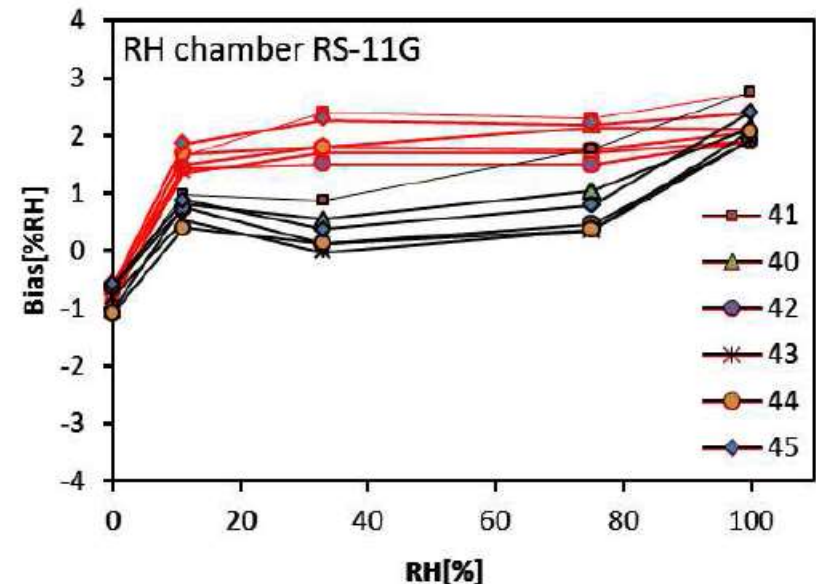
“iMS100” calculates RH using air temp data below 600 hPa level.
But, T_a is warmed by solar radiation even in the lower troposphere.

Taken from GRUAN Technical Document (GRUAN-TD-5). Kizu et al. (2018)
& Personal communication (Drs. Shimizu and Sugidachi/Meisei Electric Co. Ltd)

Possible reasons of RH difference btwn RS41 & iMS100

Wet bias in the upper troposphere

The RH sensor has a small hysteresis property, which causes wet biases (~ 1.8 %RH) when the sensor goes from a wet condition to a dry condition, based on chamber experiment. It might be insufficient correction of this hysteresis.



Taken from GRUAN Technical Document (GRUAN-TD-5). Kizu et al. (2018)
& Personal communication (Drs. Shimizu and Sugidachi/Meisei Electric Co. Ltd)



US DOE's ARM project - DIMOP Diurnal Cycle Interactions with MJO Propagation

This is a different style of IOP than others. To fill the gap of subseasonal-to-seasonal prediction skill, a suite of surface meteorological measurement system is deployed for one year, based on the hypothesis that the strength of diurnal cycle and the disruption of the MJO largely depends on the net radiation flux.