BMKG

The Agency for Meteorology, Climatology and Geophysics of Republic Indonesia

Assessment of ECMWF SEAS5 Seasonal Forecast Performance over Indonesia

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With thanks to all members of the Climate Variability Analysis Division of BMKG

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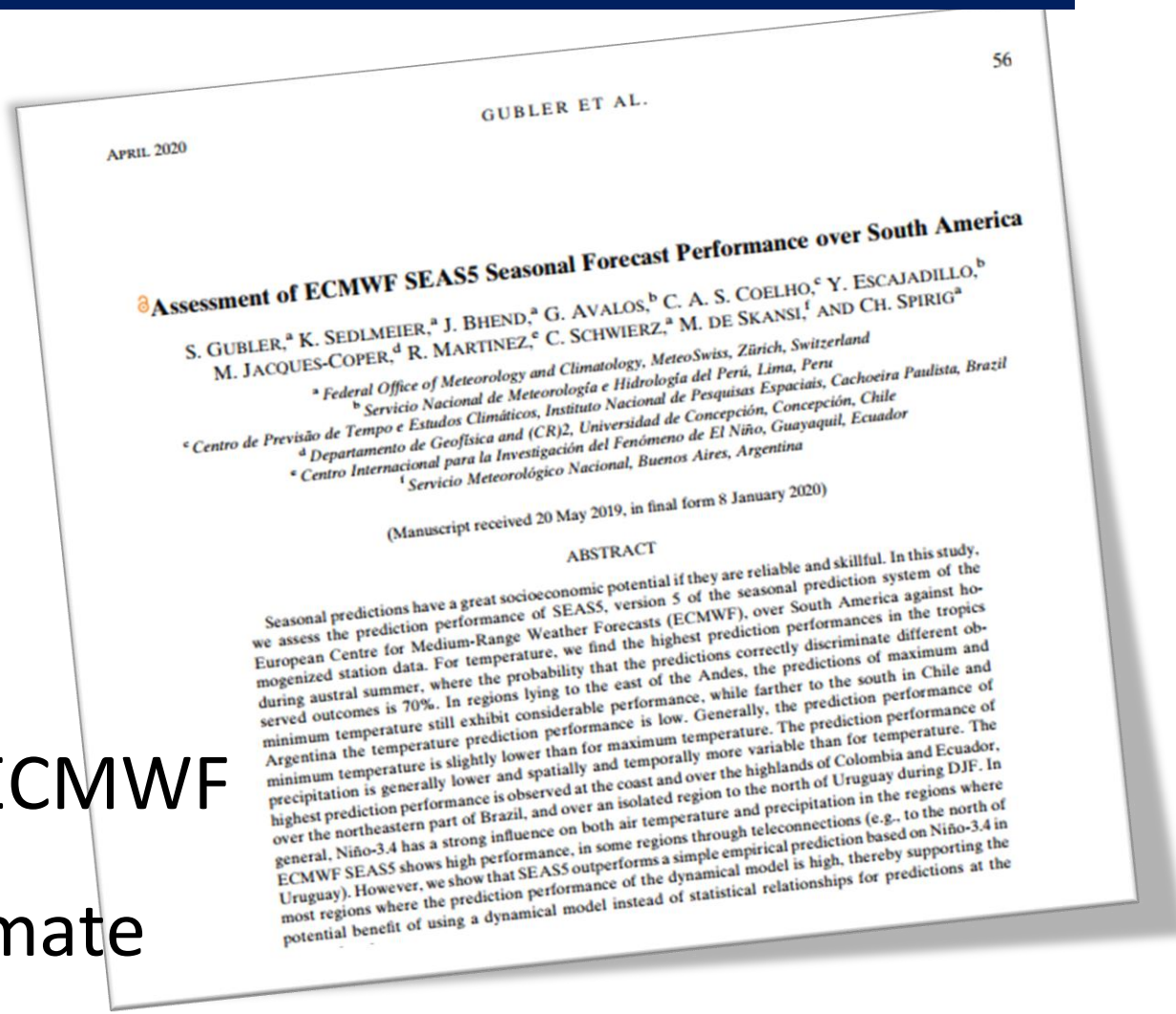
Using ECMWF Forecast 2023

OUTLINE

- ❑ Introduction
- ❑ Data and Method
- ❑ Results and Discussion
- ❑ Conclusions
- ❑ Additional Information: “Using ECMWF SEAS5 as the main model for climate prediction in BMKG”



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GUBLER ET AL.

APRIL 2020

Assessment of ECMWF SEAS5 Seasonal Forecast Performance over South America

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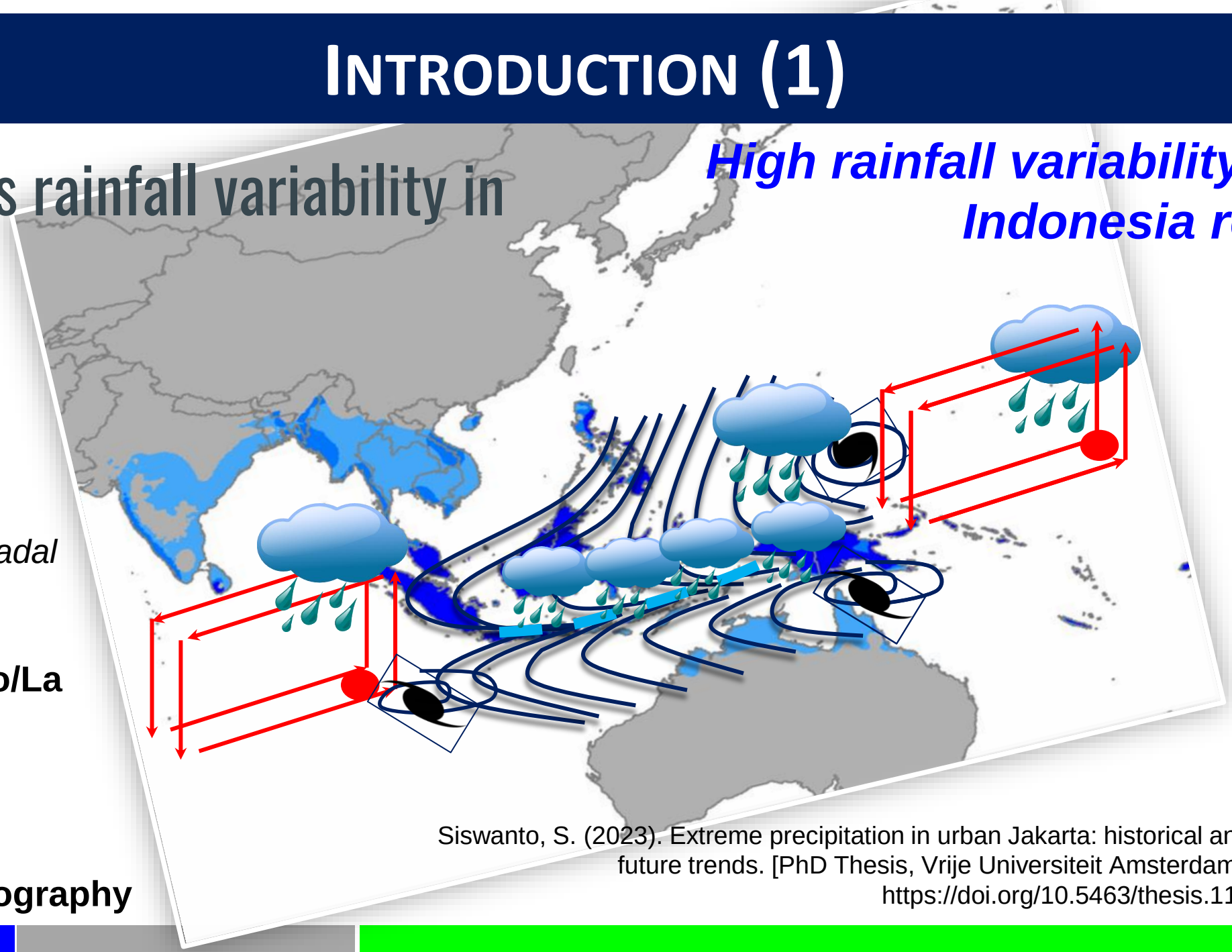
ABSTRACT

Seasonal predictions have a great socioeconomic potential if they are reliable and skillful. In this study, we assess the prediction performance of SEAS5, version 5 of the seasonal prediction system of the European Centre for Medium-Range Weather Forecasts (ECMWF), over South America against homogenized station data. For temperature, we find the highest prediction performances in the tropics during austral summer, where the probability that the predictions correctly discriminate different observed outcomes is 70%. In regions lying to the east of the Andes, the predictions of maximum and minimum temperature still exhibit considerable performance, while farther to the south in Chile and Argentina the temperature prediction performance is low. Generally, the prediction performance of minimum temperature is slightly lower than for maximum temperature. The prediction performance of precipitation is generally lower and spatially and temporally more variable than for temperature. The highest prediction performance is observed at the coast and over the highlands of Colombia and Ecuador, over the northeastern part of Brazil, and over an isolated region to the north of Uruguay during DJF. In general, Niño-3.4 has a strong influence on both air temperature and precipitation in the regions where ECMWF SEAS5 shows high performance, in some regions through teleconnections (e.g., to the north of Uruguay). However, we show that SEAS5 outperforms a simple empirical prediction based on Niño-3.4 in most regions where the prediction performance of the dynamical model is high, thereby supporting the potential benefit of using a dynamical model instead of statistical relationships for predictions at the

INTRODUCTION (1)

What controls rainfall variability in Indonesia?

High rainfall variability over Indonesia region



Climate Variability:
Sub-seasonal
→ inter-decadal

- **Monsoon**
- **ITCZ**
- **ENSO (El Nino/La Nina)**
- **IOD(+/-)**
- **MJO(Wet/Dry)**
- **Siklon Tropis**
- **Complex Topography**

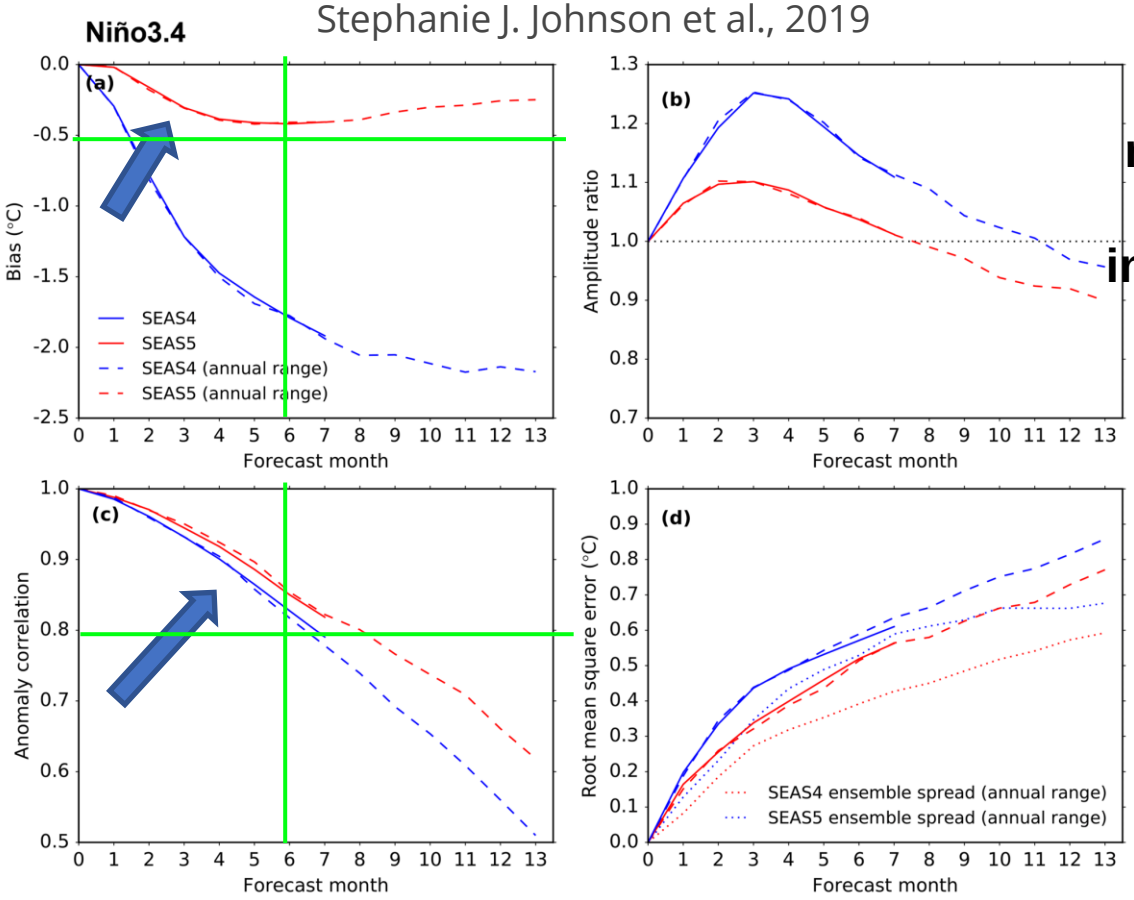
Siswanto, S. (2023). Extreme precipitation in urban Jakarta: historical and future trends. [PhD Thesis, Vrije Universiteit Amsterdam]. https://doi.org/10.5463/thesis.112

INTRODUCTION (2)

Skill SST Nino 3.4 of SEAS5

Bias less than 0.5 deg C and Correlation 0.8 – 1 for LT0 – LT6

Stephanie J. Johnson et al., 2019



ENSO (El Niño/La Niña) significantly affects precipitation, reducing it during dry periods and increasing it during wet periods.

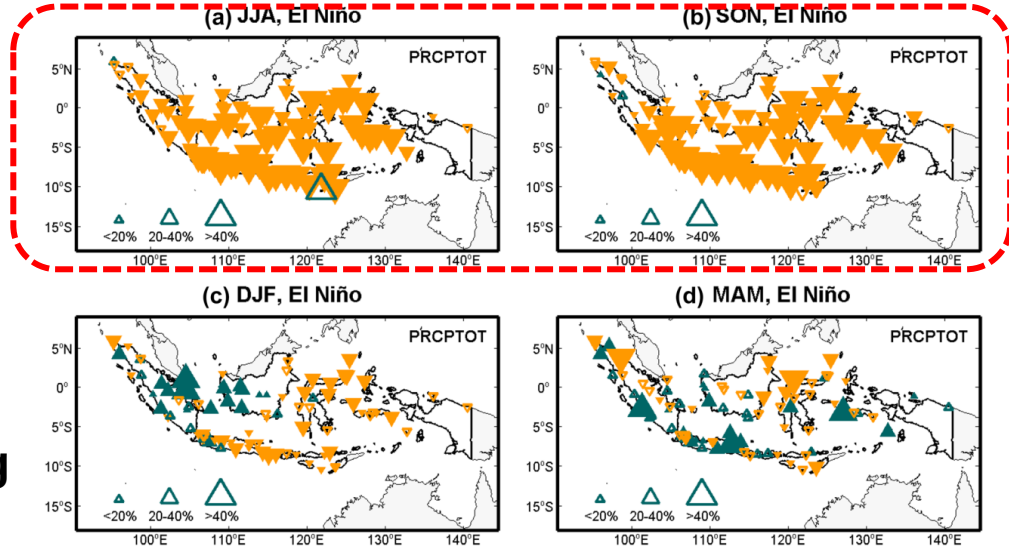
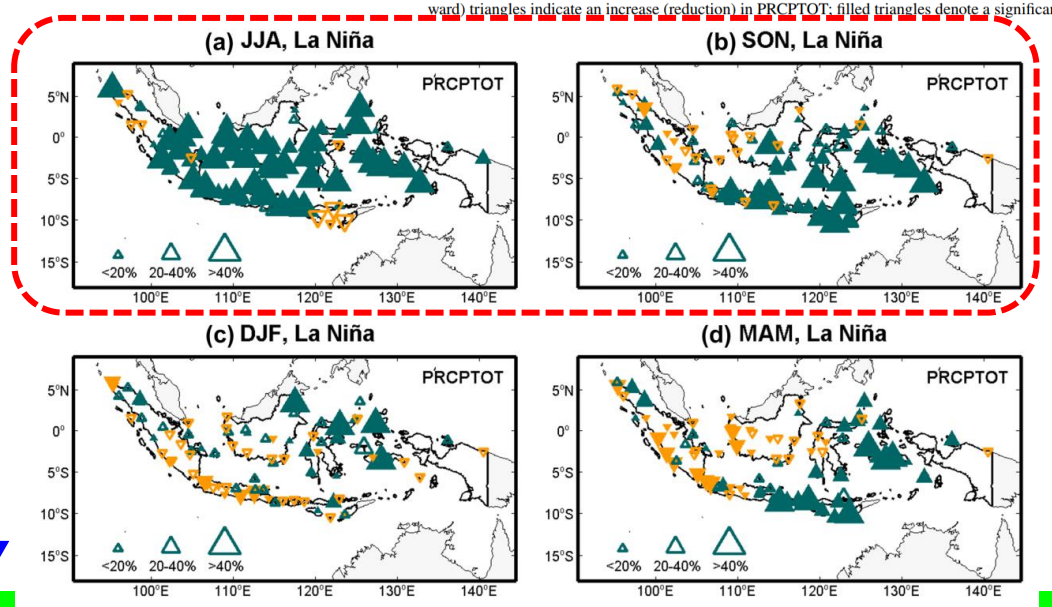


Fig. 2 Composite analysis of seasonal rainfall total (PRCPTOT) in El Niño years for JJA (**a**), SON (**b**), DJF (**c**) and MAM (**d**). Upward (downward) triangles indicate an increase (reduction) in PRCPTOT; filled triangles denote a significant anomaly at 95%



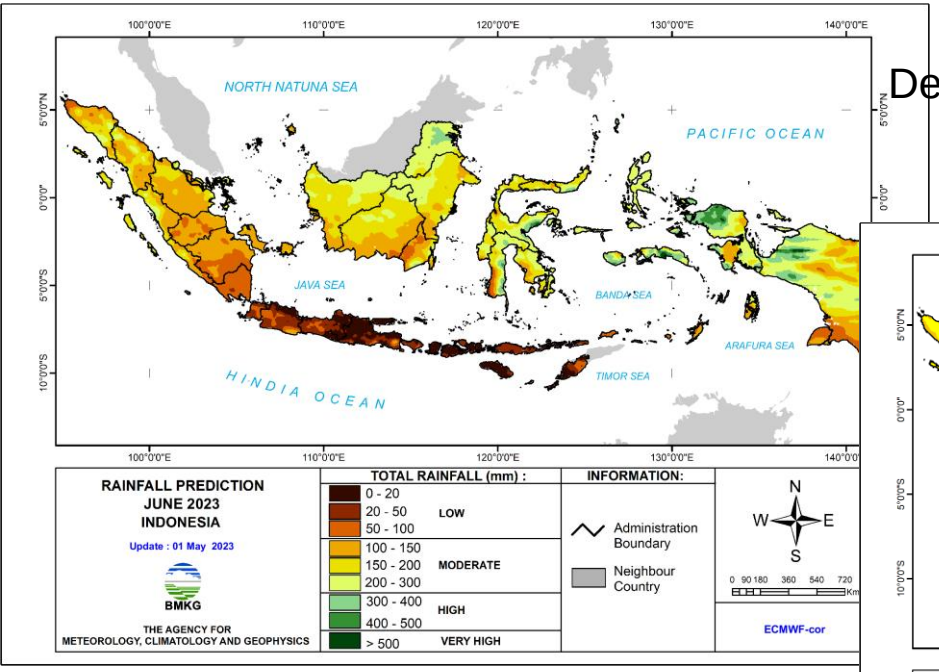
Supari et al., 2017
Climate Dynamics

Fig. 3 As in Fig. 2 except for seasonal rainfall total (PRCPTOT) in La Niña years

ENSO effect and its predictibility

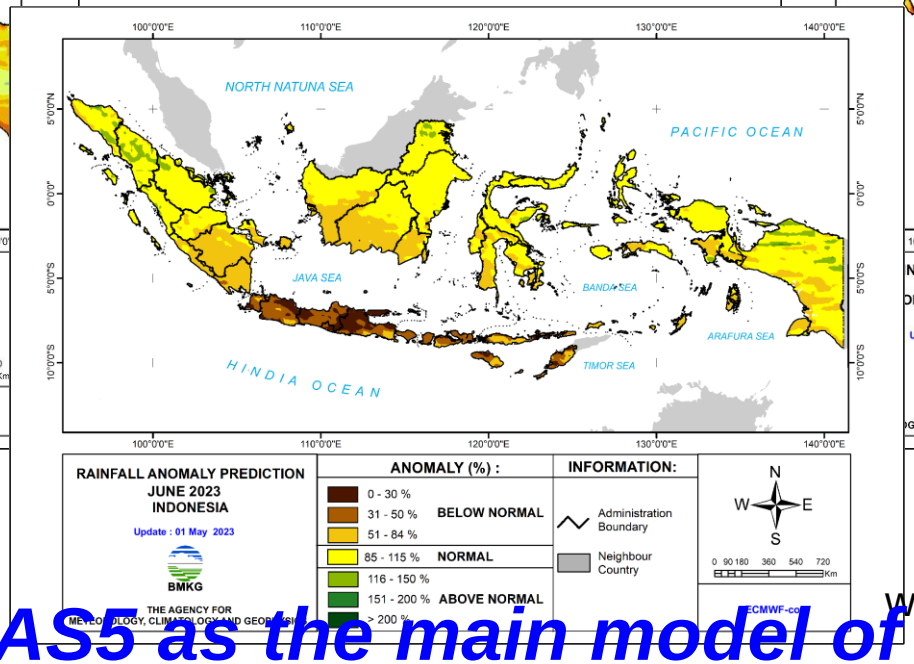
INTRODUCTION (3)

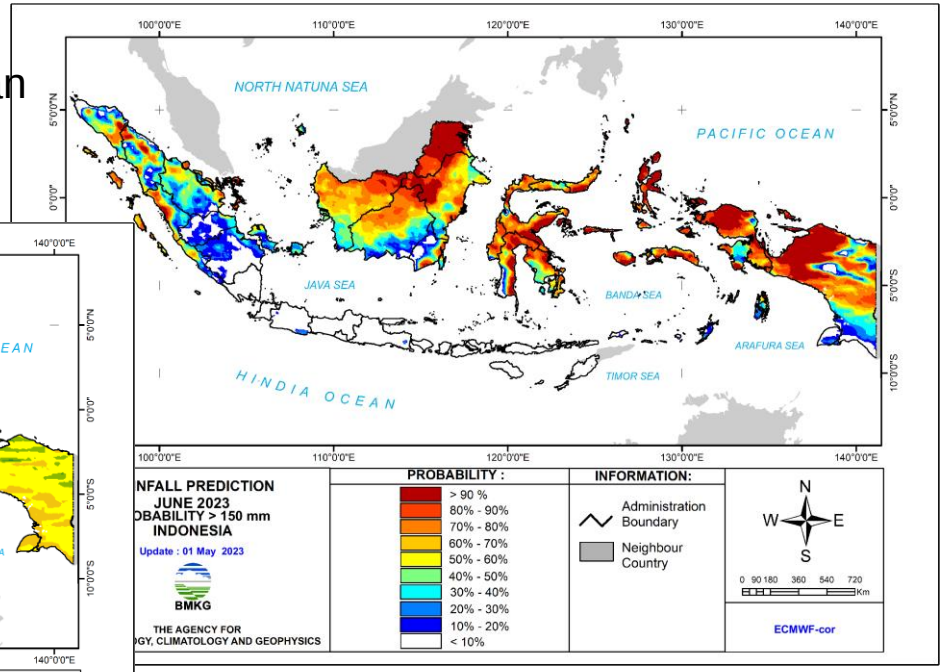
- An example of the monthly rainfall prediction of the SEAS5 model (corrected), that is routinely produced early in the month and disseminated to all of BMKG's regional offices and users



Deterministic Forecast- Ensemble Mean
Total Monthly rainfall

Deterministic Forecast- Ensemble Mean
total monthly rainfall compared
to Normal Period 91-20

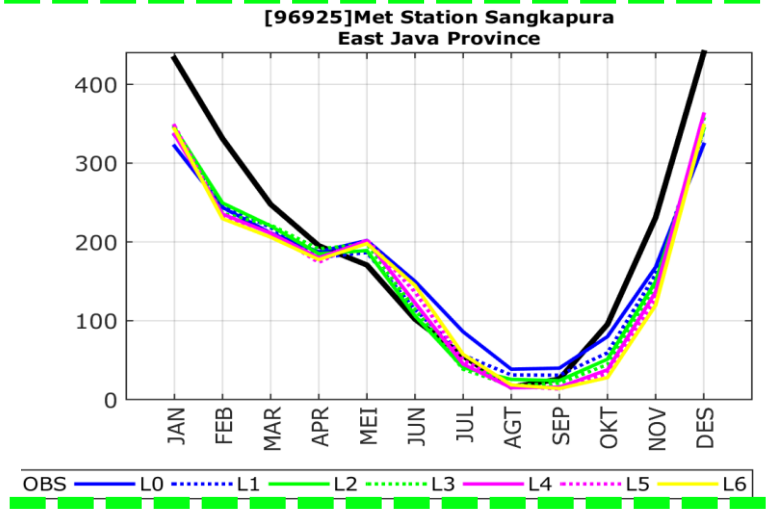


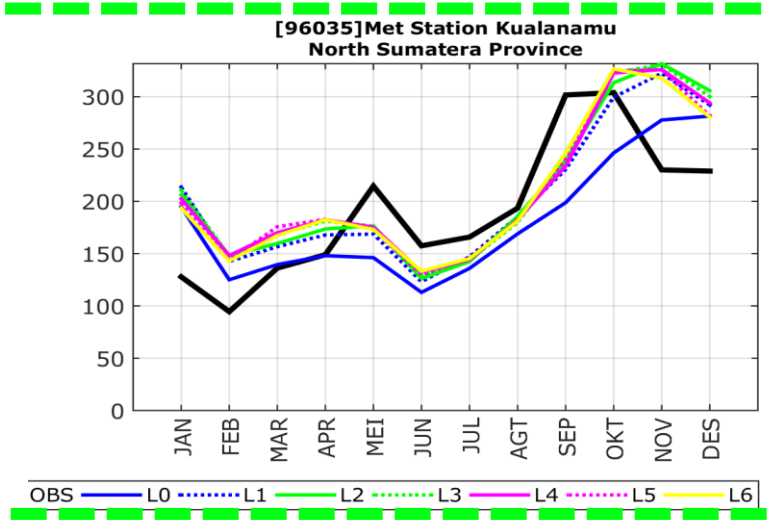


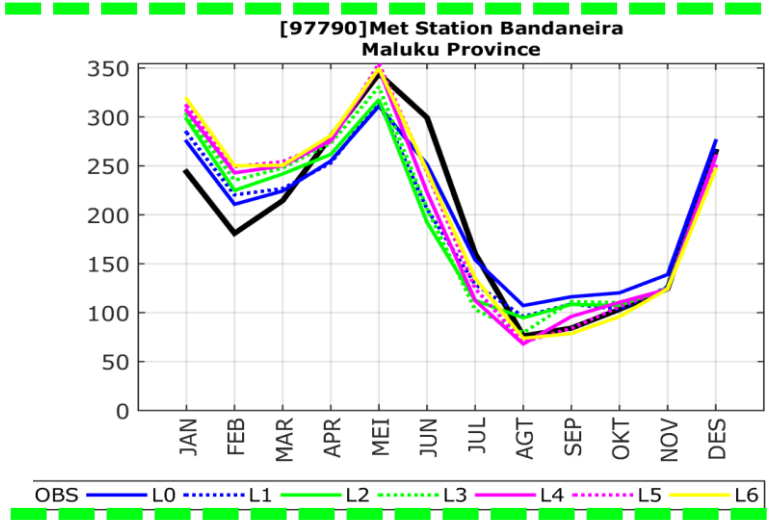
Probabilistic Forecast-
Probability of total Monthly rainfall
with category of more than 150 mm/month

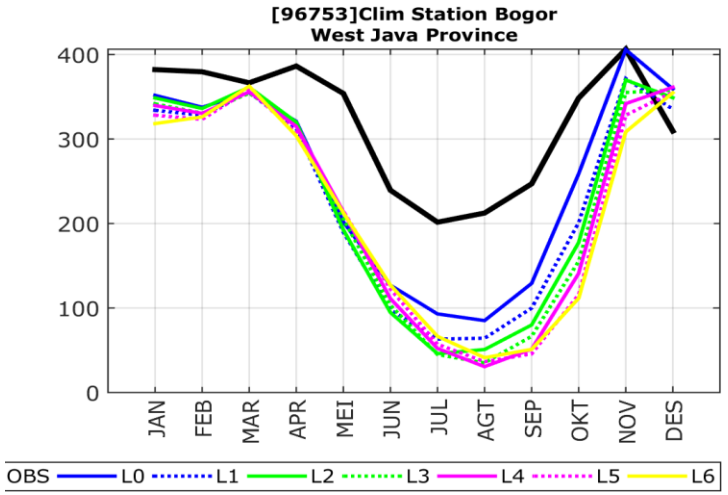
Utilization output of SEAS5 as the main model of seasonal forecast in Indonesia

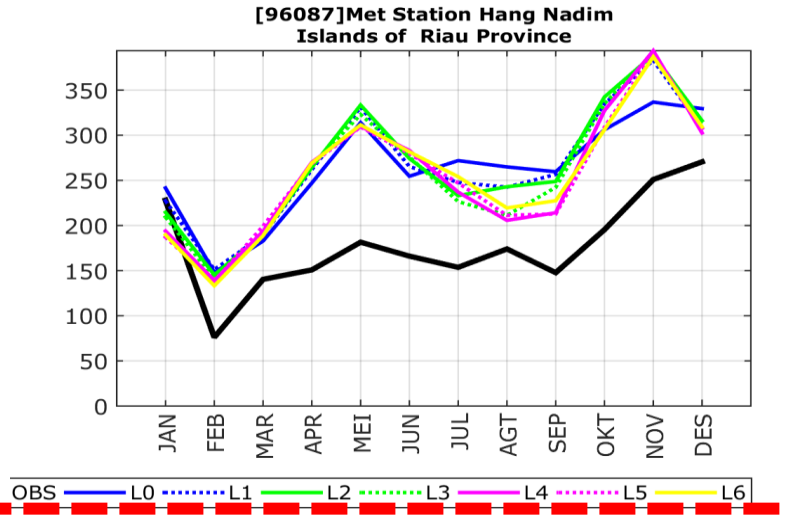
INTRODUCTION (4)

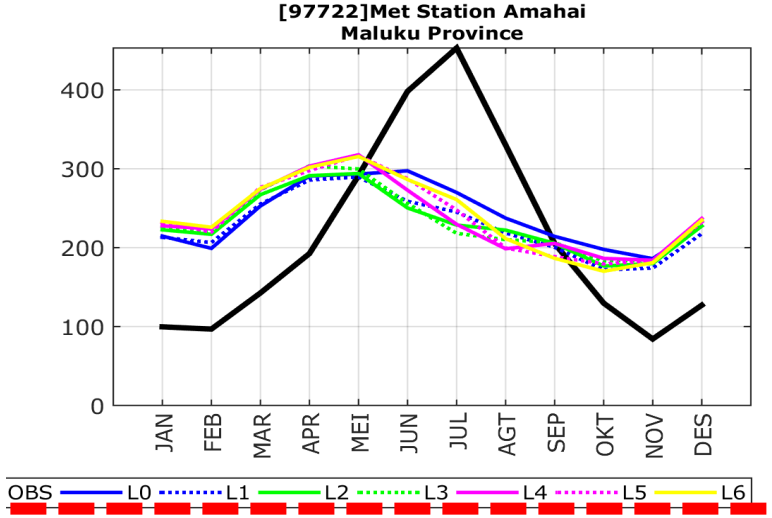






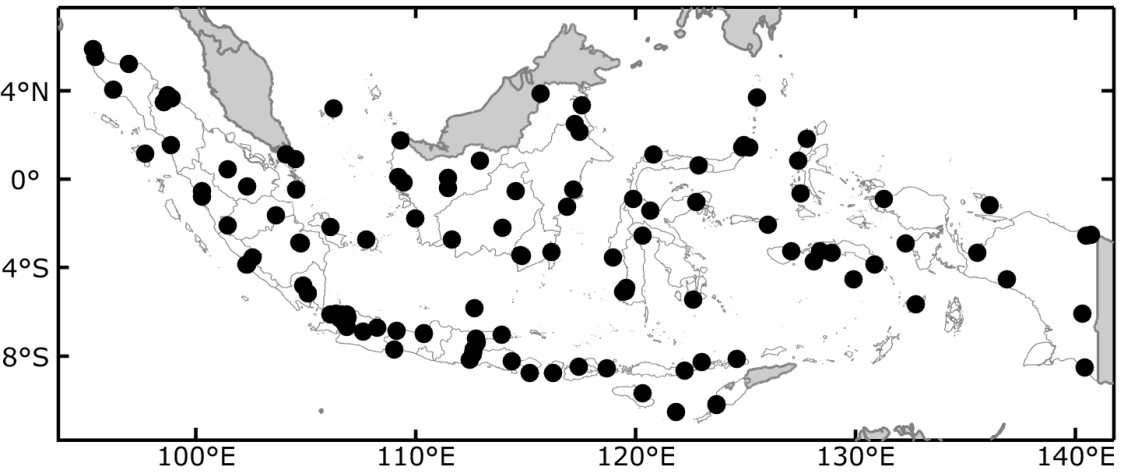






How the performance of SEAS5 in predicting seasonal rainfall in Indonesia

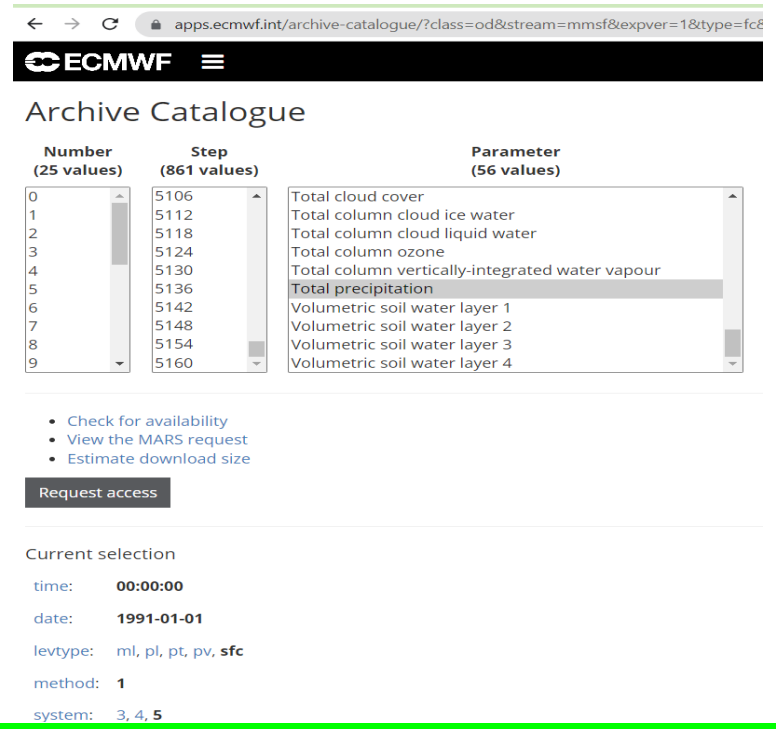
DATA



- The observation data come from BMKG's station. Most of the stations that we have selected for this study are the same as those in Supari et al., 2017 and Wati et al., 2021.

Islands	Number of Stations
BALI and Nusa Tenggara	11
JAVA	25
KALIMANTAN	19
MALUKU	11
PAPUA	9
SULAWESI	16
SUMATERA	29
Total	**120**

- For the SEAS5 models, we retrive from https://apps.ecmwf.int/ from 1982 – 2018, and then we extend 2019-2020 by using our archive that we collect from ECMWF



METHODS (1)

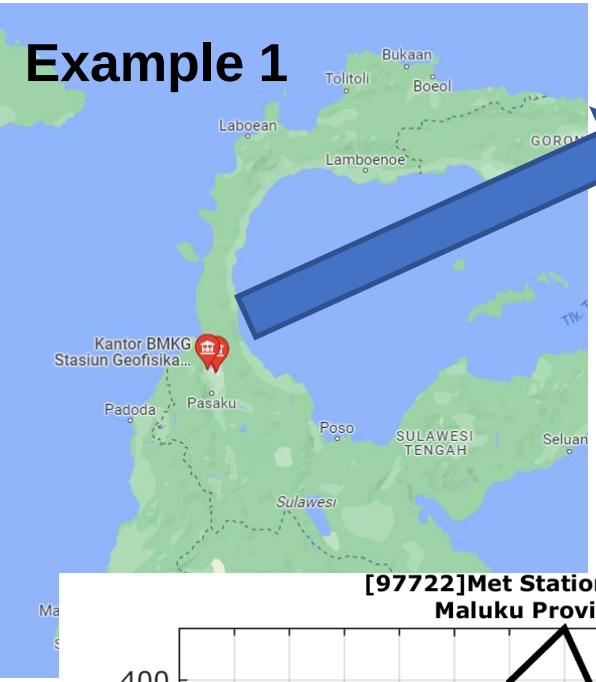
- ✓ The verification was conducted on the **direct output of SEAS5** (SEAS5-RAW) and **the corrected SEAS5 using simple or linear scaling** bias correction (SEAS5-BCLS) (Gudmunsson et al., 2012). It was carried out for the overlapping time period of the observation and SEAS5 datasets, spanning from 1982 to 2020.
- ✓ The verification was performed for the **total monthly rainfall** forecasts with **lead times of 1-2-3 months lead time (L1, L2, L3)** out of the L0-L6 range, similar to the ones used in our operational activities.
- ✓ For deterministic forecasts (**ensemble mean**), we evaluate the accuracy using scores RMSESS, Pearson correlation, and PC (Percent of Correct)
- ✓ For probabilistic forecast, we evaluate the skill of the **lower tercile** referred to as **dry (Below Normal condition)**, and **upper tercile** reffered as wet **(Above Normal condition)** for rainfall

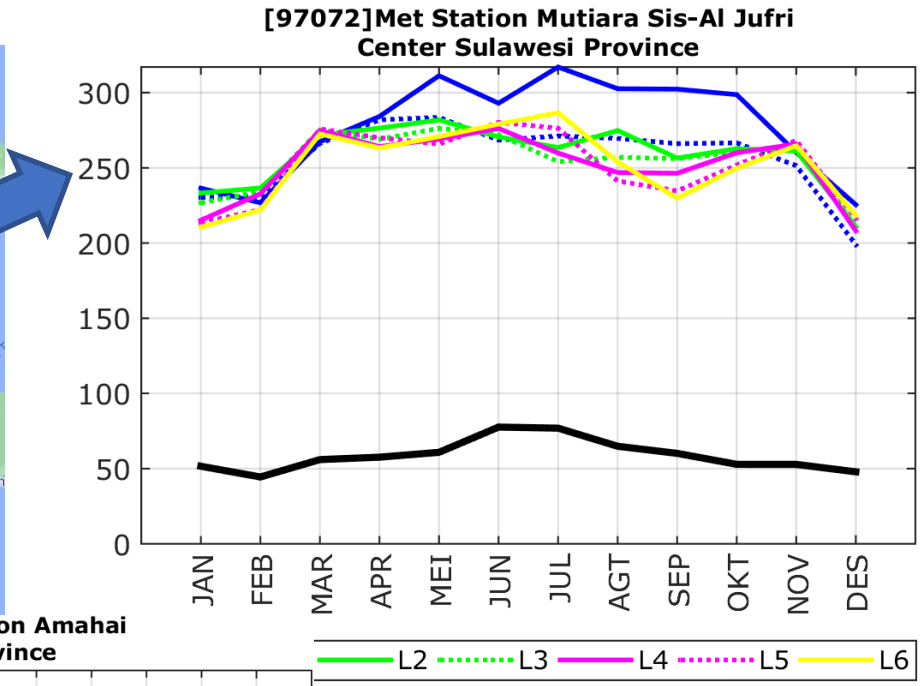
METHODS (2)

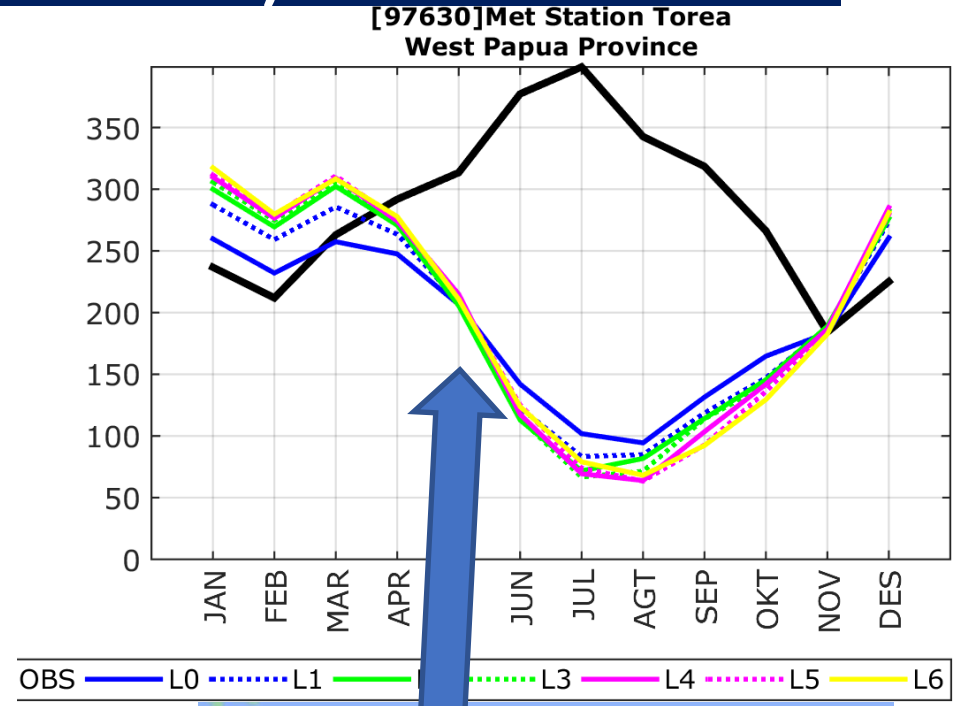
Steps of analysis:

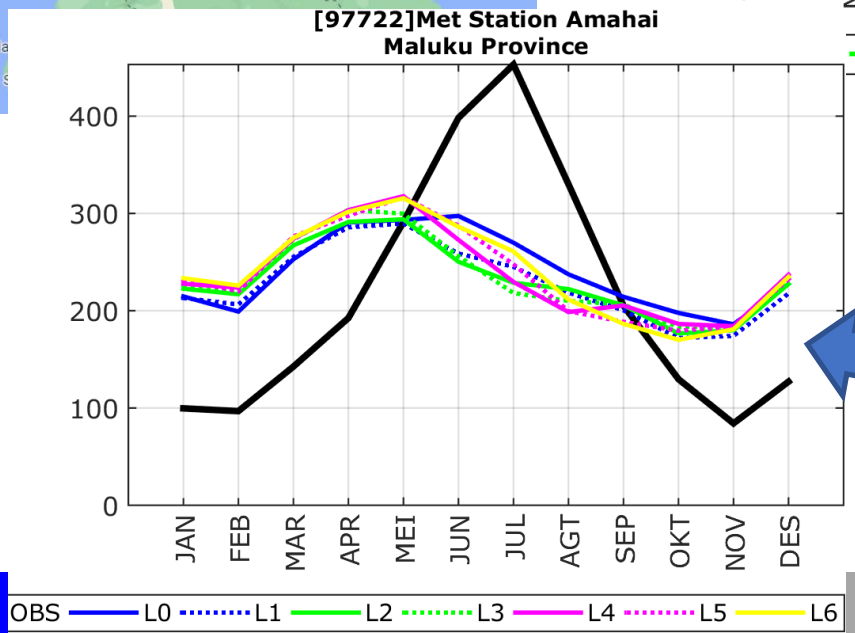
- ✓ Identified the main problem inside the uncorrected (SEAS5-RAW) and corrected-SEAS5 (SEAS5-BCLS), related to (1) **bias**, (2) **similarity of annual cycle pattern** for each station, and (3) PC, **percentage of correct reach of 75%** to estimate four categories (**Low**: 0-100 mm/month, **Medium**;100-300 mm, **High**: 300-400 mm and **Very high**: > 500 mm)
- ✓ Apply the clustering method: **Double Correlation Method** (Aldrian and Susanto., 2003) to group the observation stations in to **Region A, B and C**
- ✓ Evaluate the performance of SEAS5-BCLS for each region using several verification metrics: **Pearson Correlation, RMSESS, ROCSS**, and **Reliability using Weisheimer Score**

RESULTS : ANNUAL CYCLE OF DIRECT OUTPUT OF SEAS5 (SEAS5 -RAW VERSUS OBSERVATION)



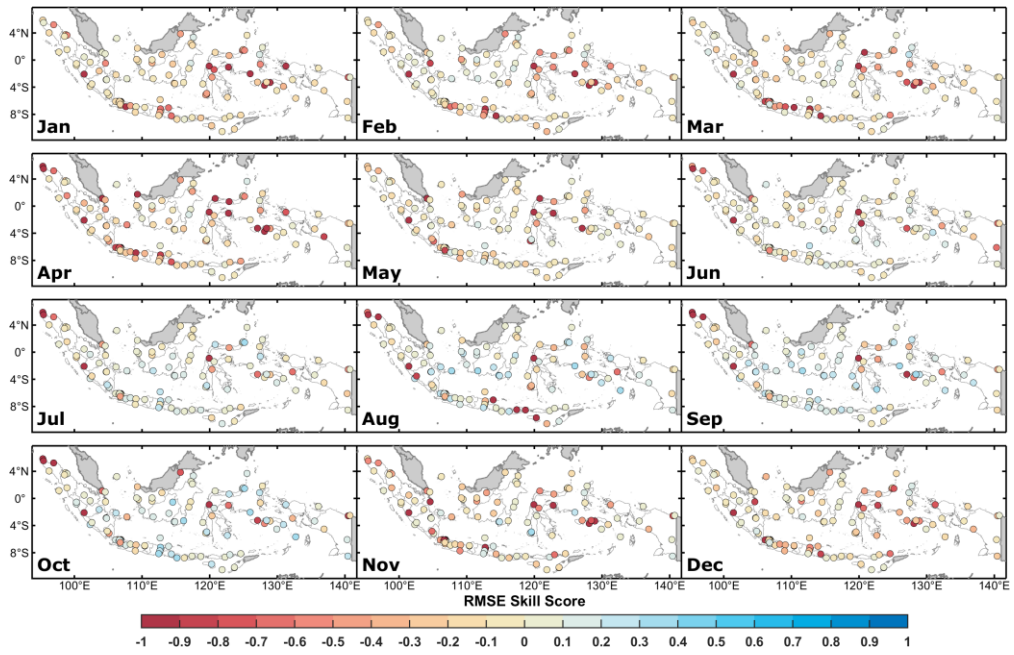




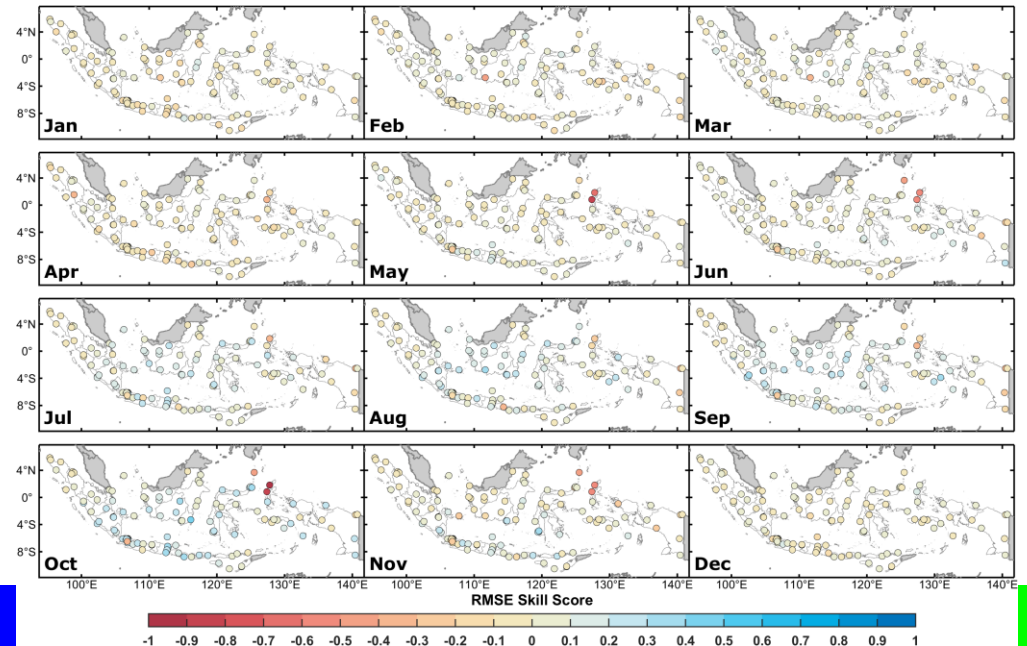


RESULT: EFFECT OF CORECTION FACTOR (1)

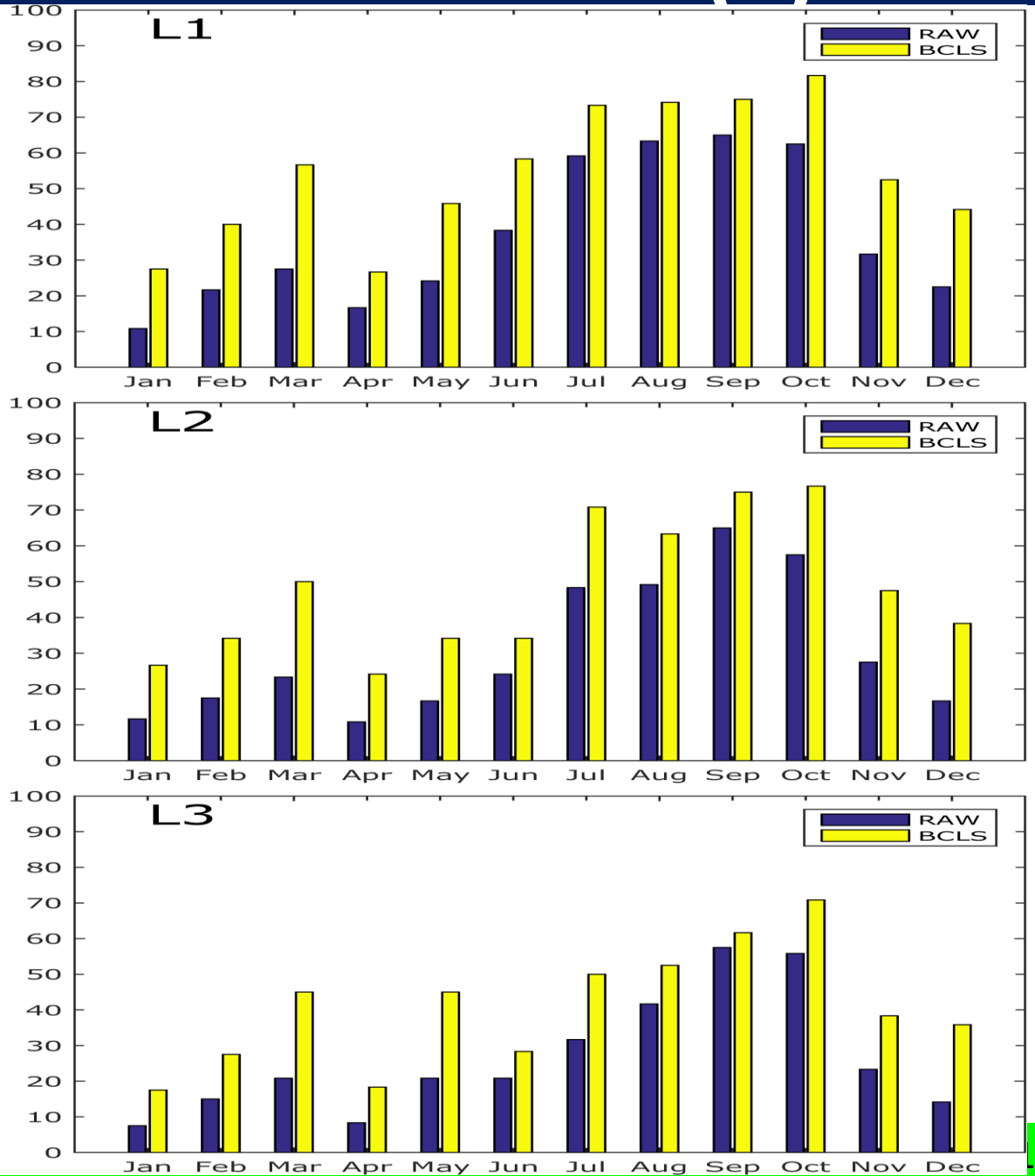
L1 RAW



L1 BCLS



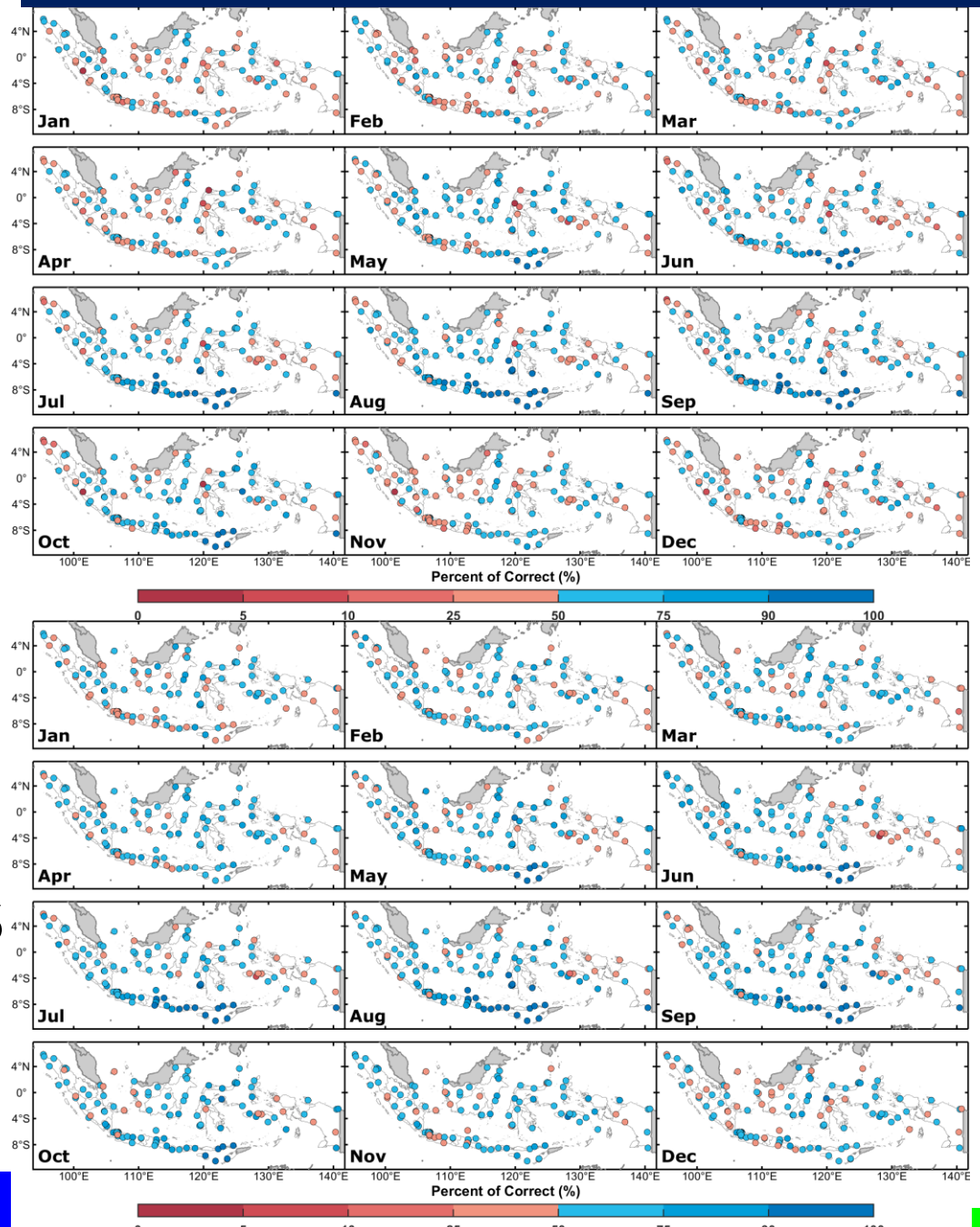
Percentage of Stations with RMSE-SS positive

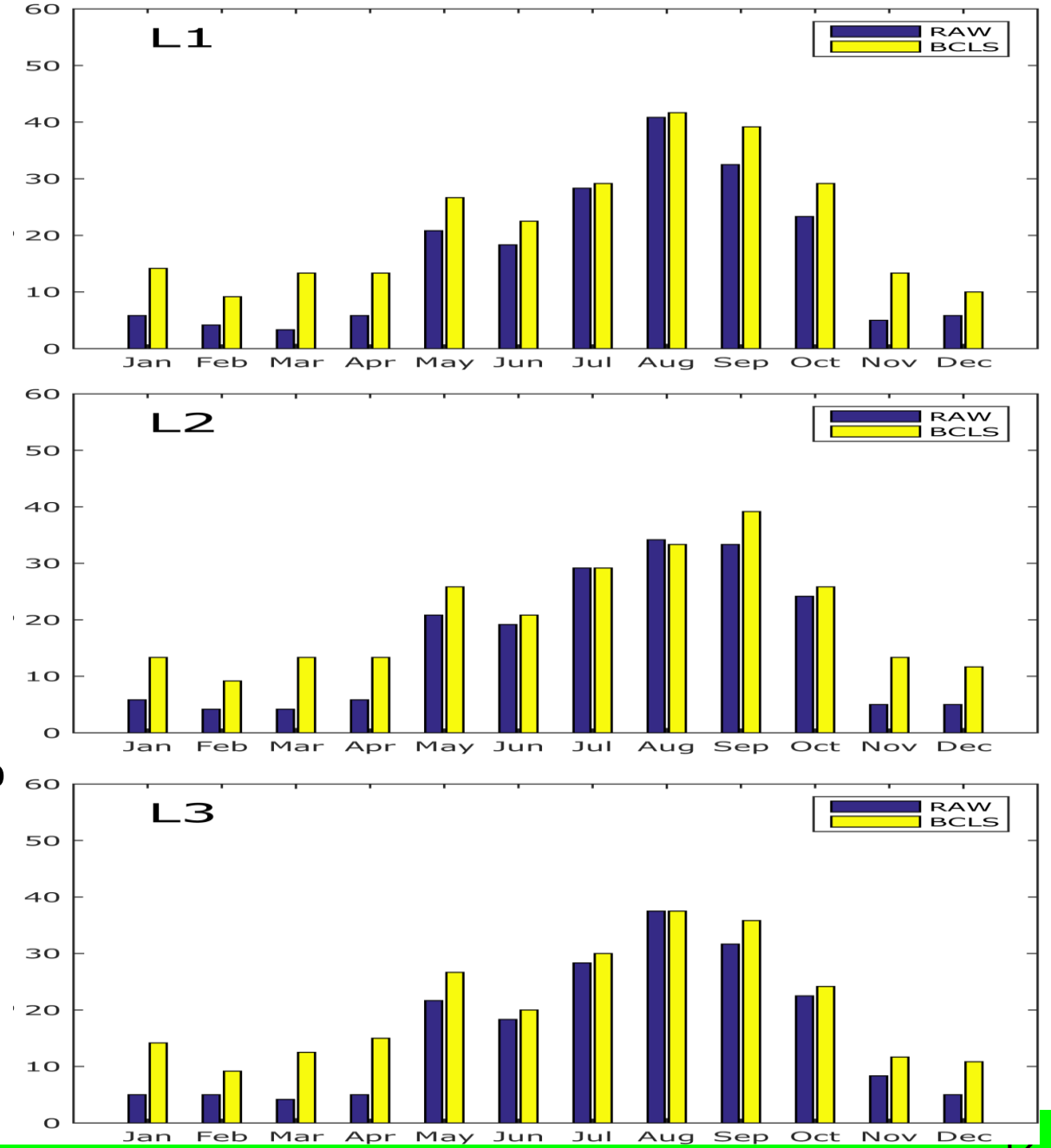


RESULT: EFFECT OF CORECTION FACTOR (2)

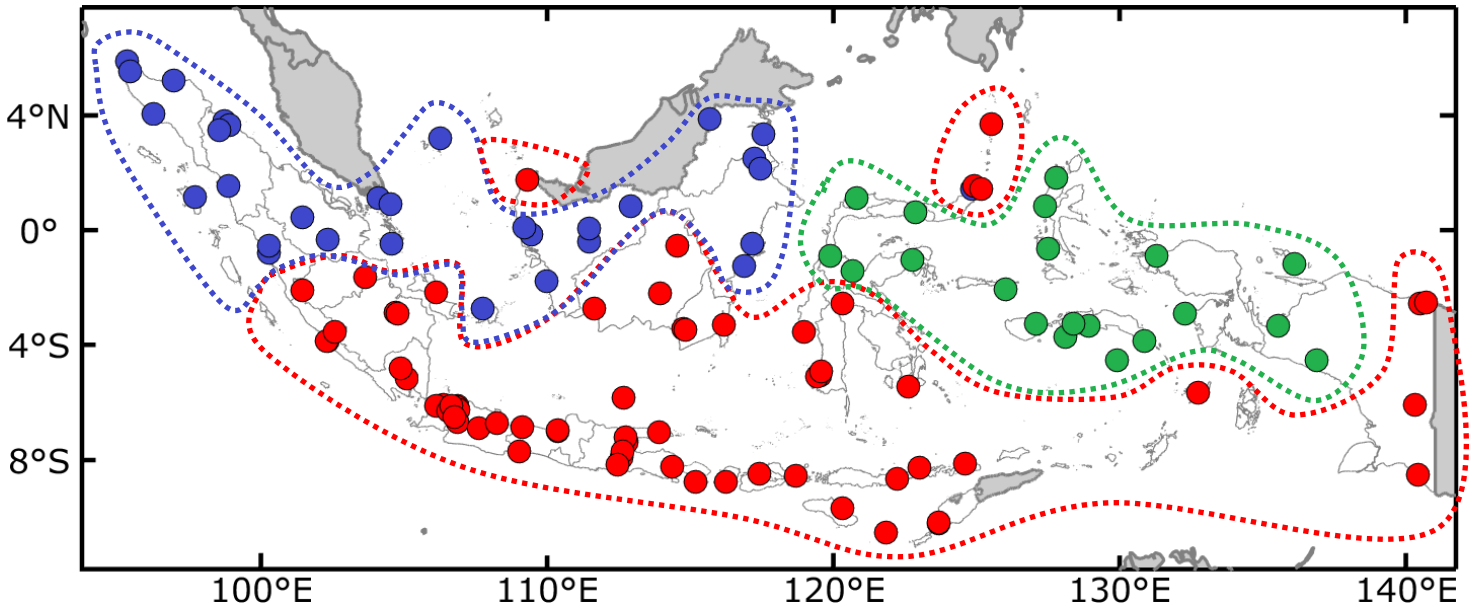
L1 RAW

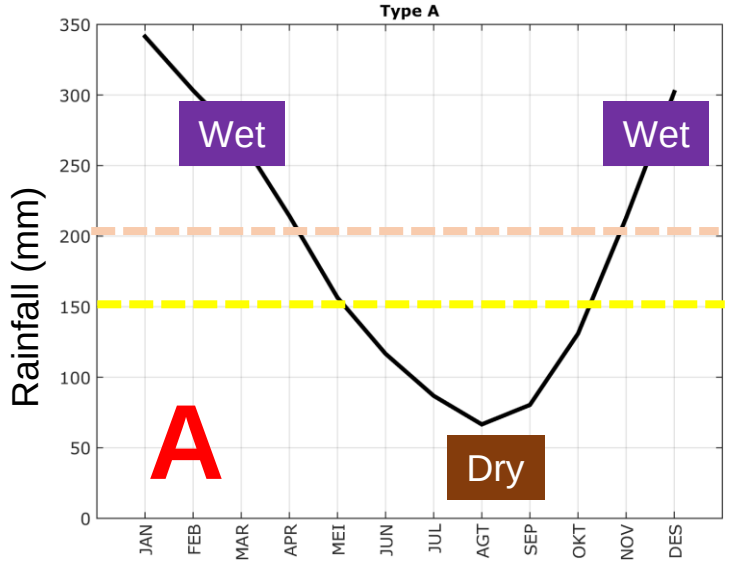
L1 BCLS





RESULTS: STATIONS CLUSTERING

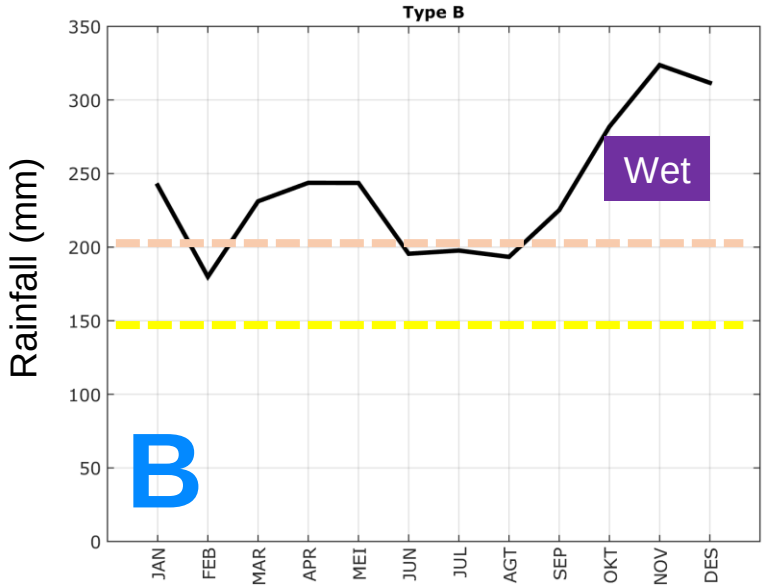


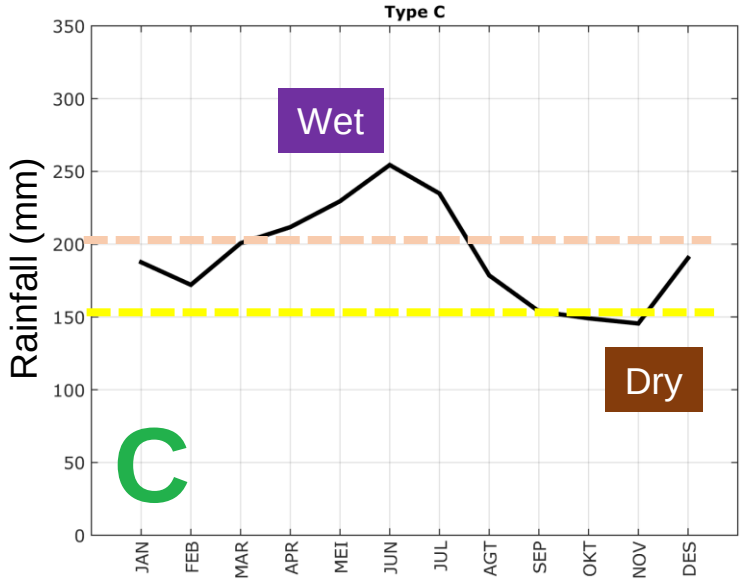


Region A = monsunal (68)

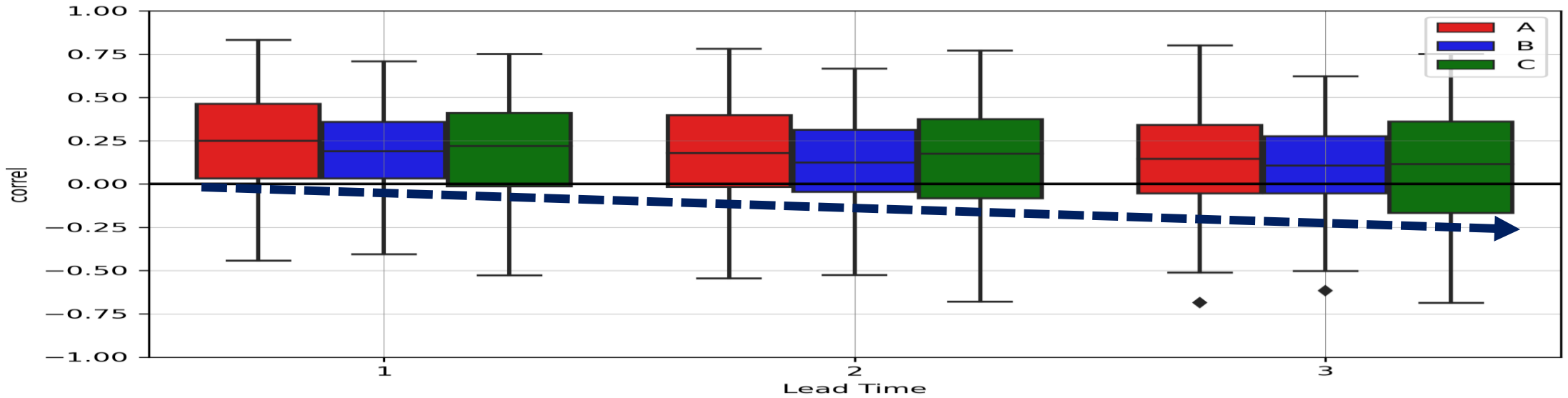
Region B = Semi-monsunal (32)

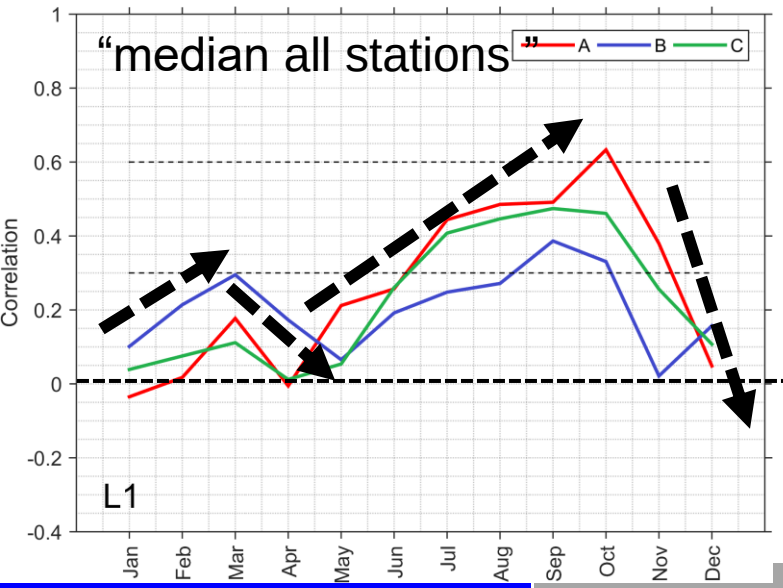
Region C = Local (20)

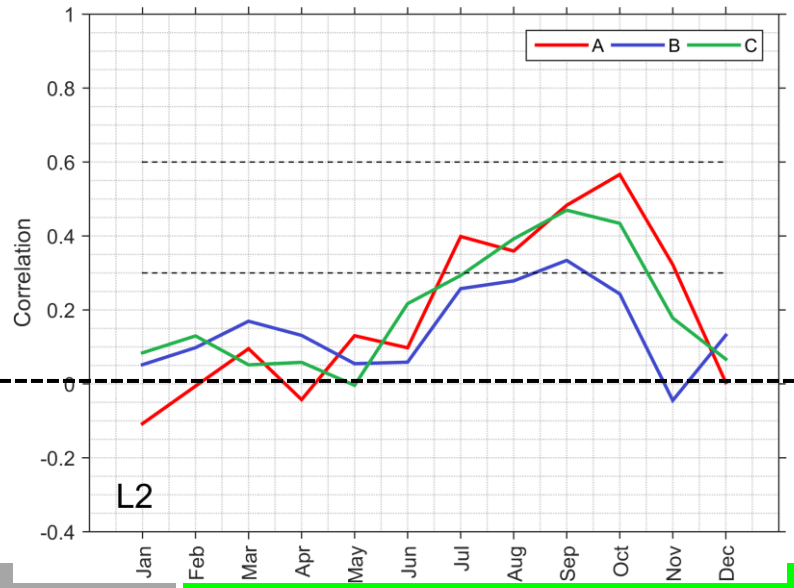


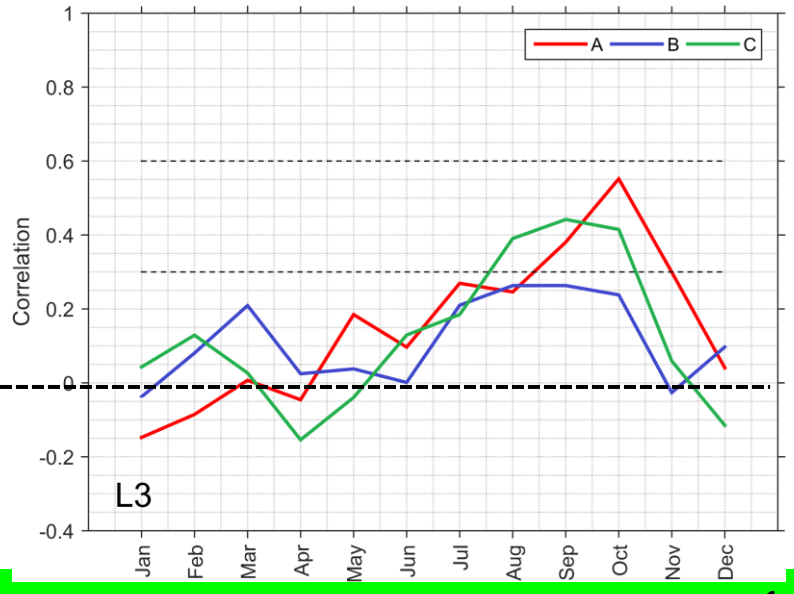


RESULTS: CORRELATION SEAS5-BCLS VS OBS (1)

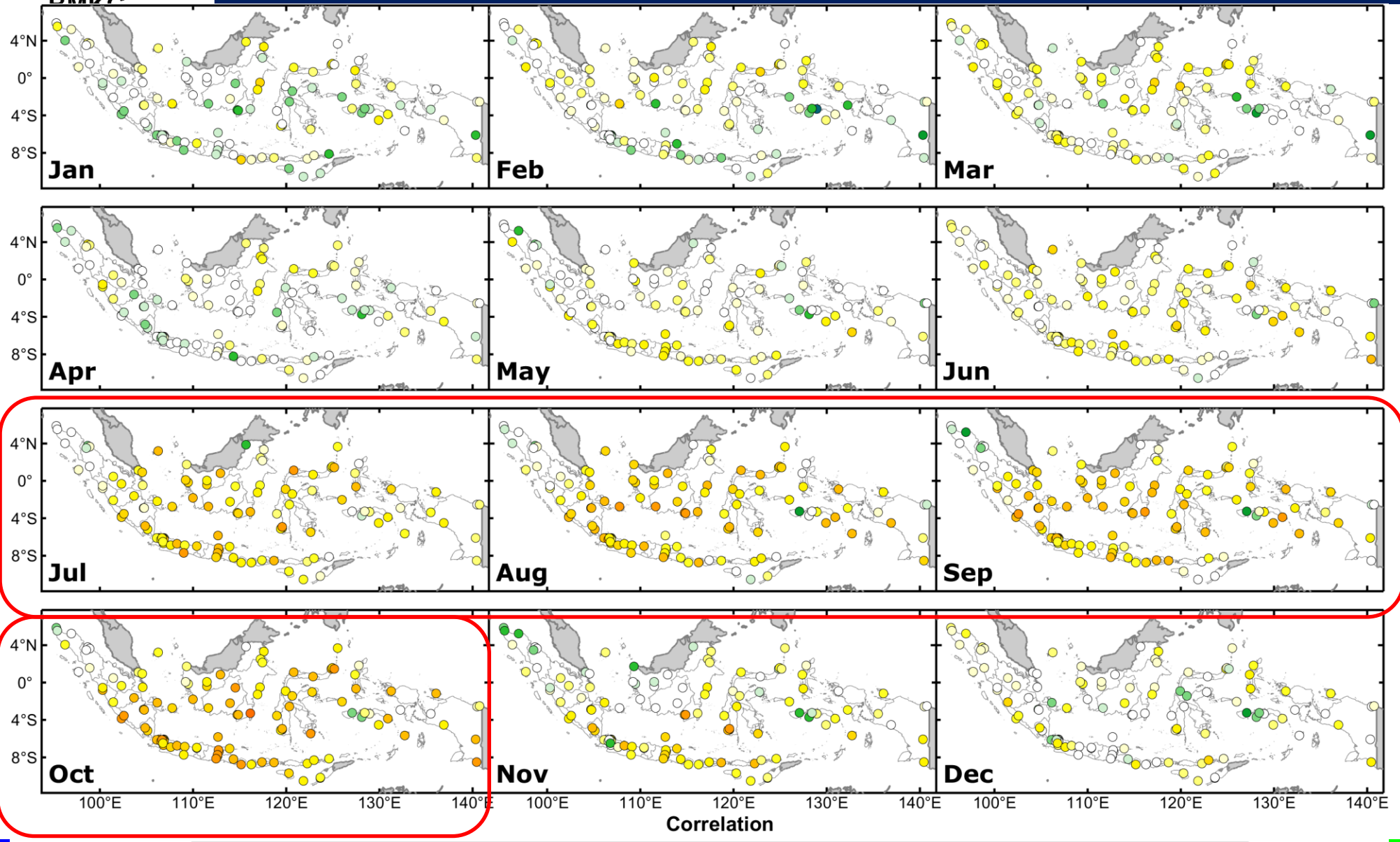








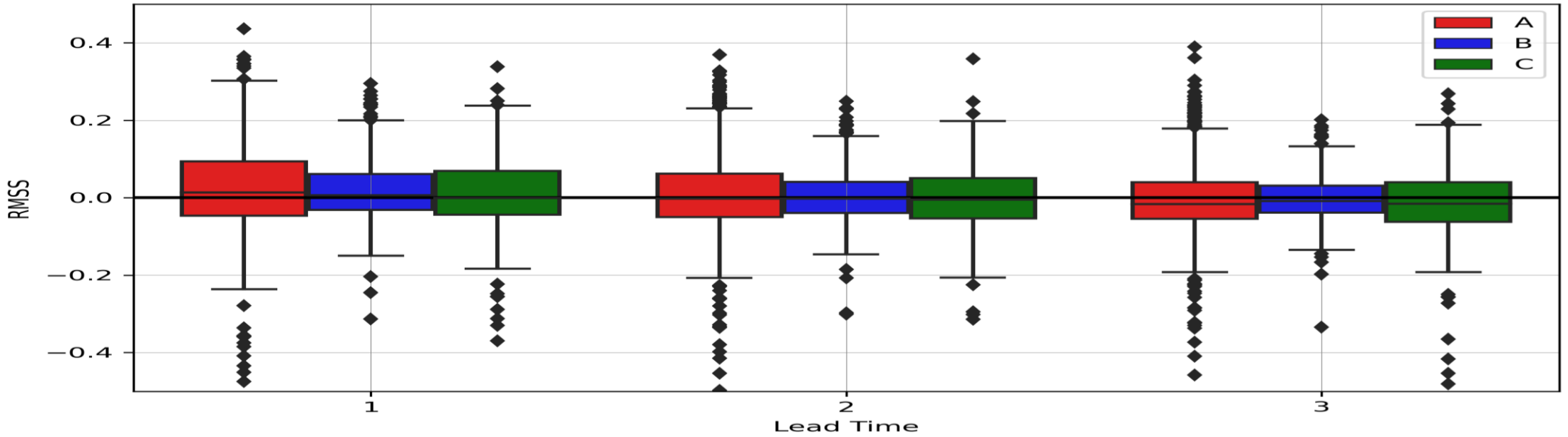
RESULTS: CORRELATION SEAS5-BCLS VS OBS (2)

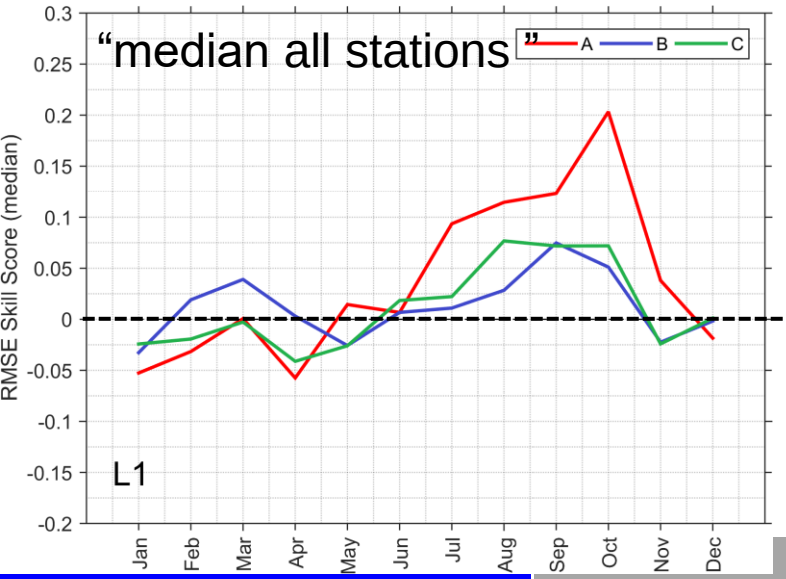


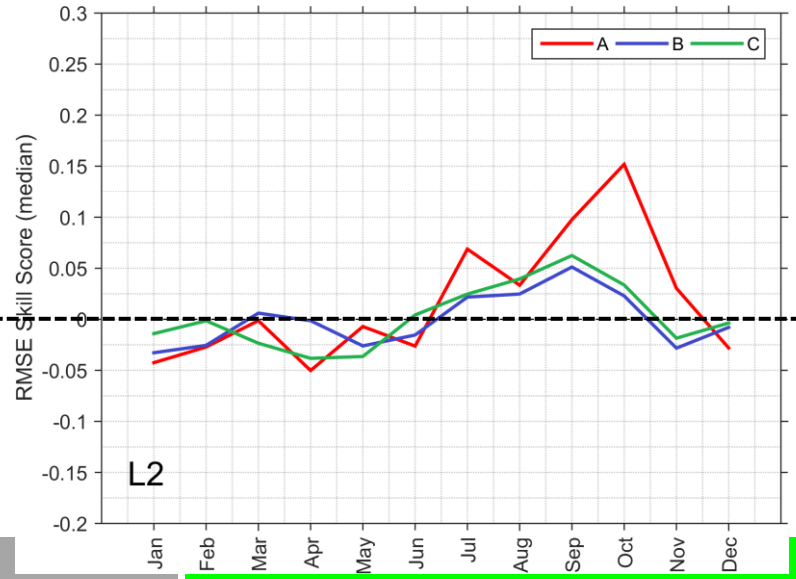
Lead Time 1

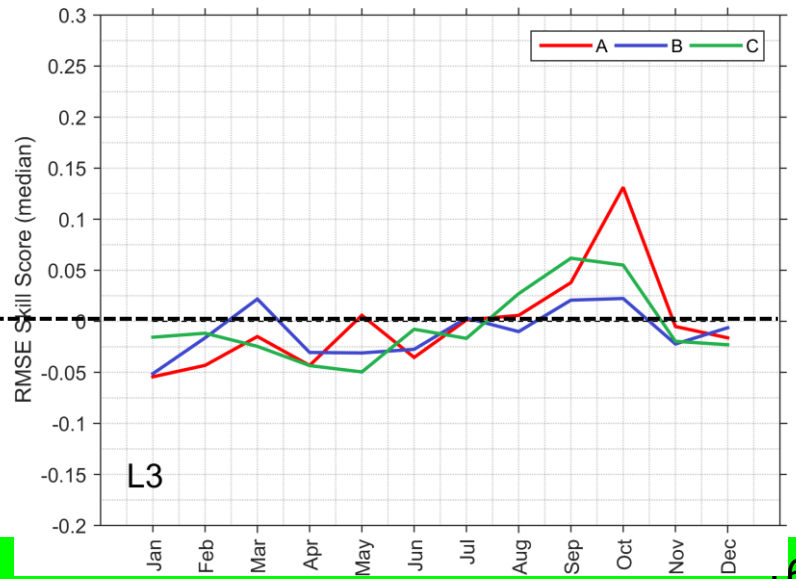
Correlation around 0,7 – 0,9 in particular for Type A, in July to October (dry season period)

RESULTS: RMSESS SEAS5-BCLS vs OBS (1)





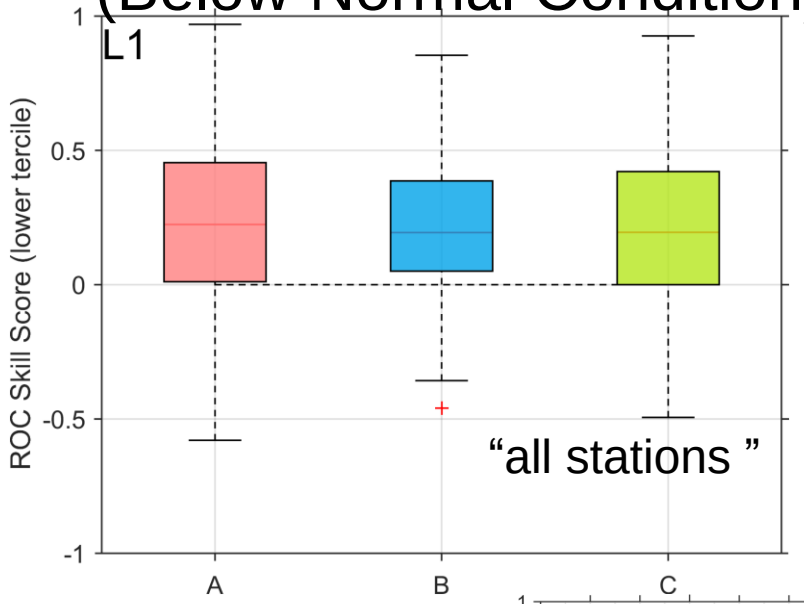




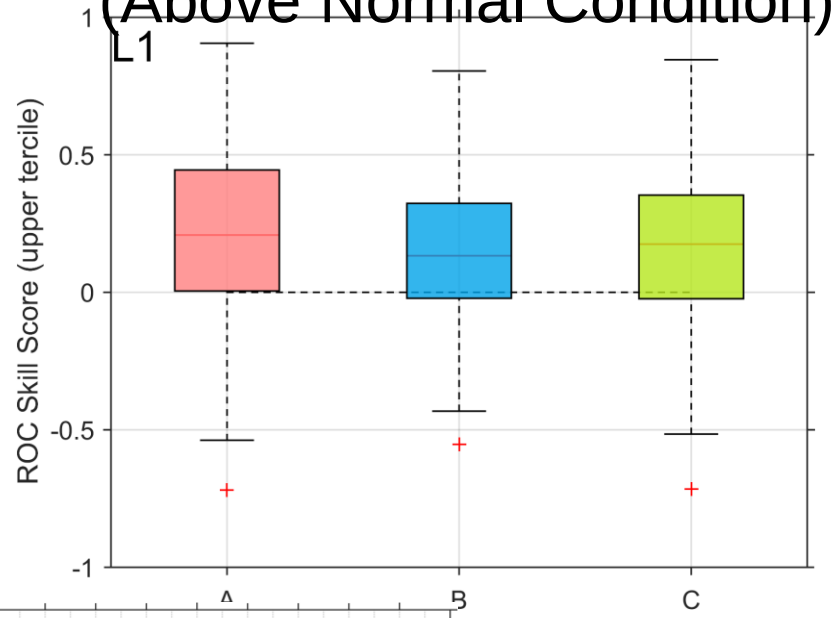
RESULTS: ROCSS SEAS5-BCLS vs OBS (1)

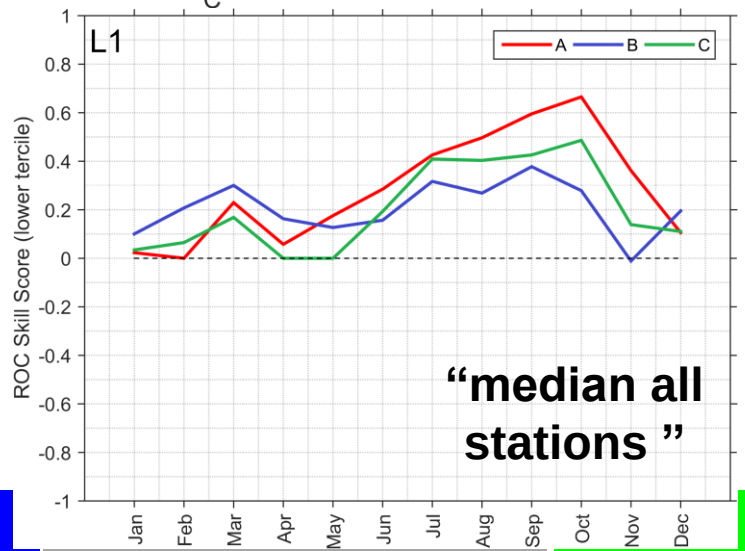
Lead Time 1

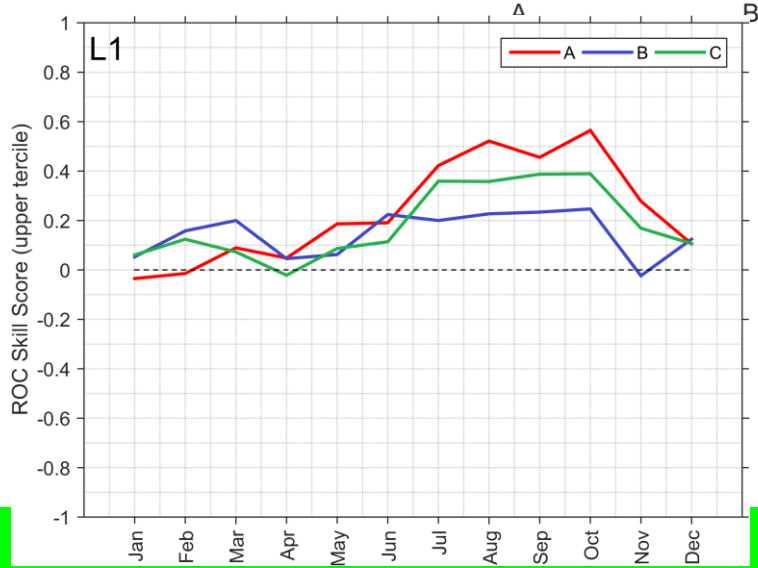
Lower Tercile
(Below Normal Condition)



Upper Tercile
(Above Normal Condition)

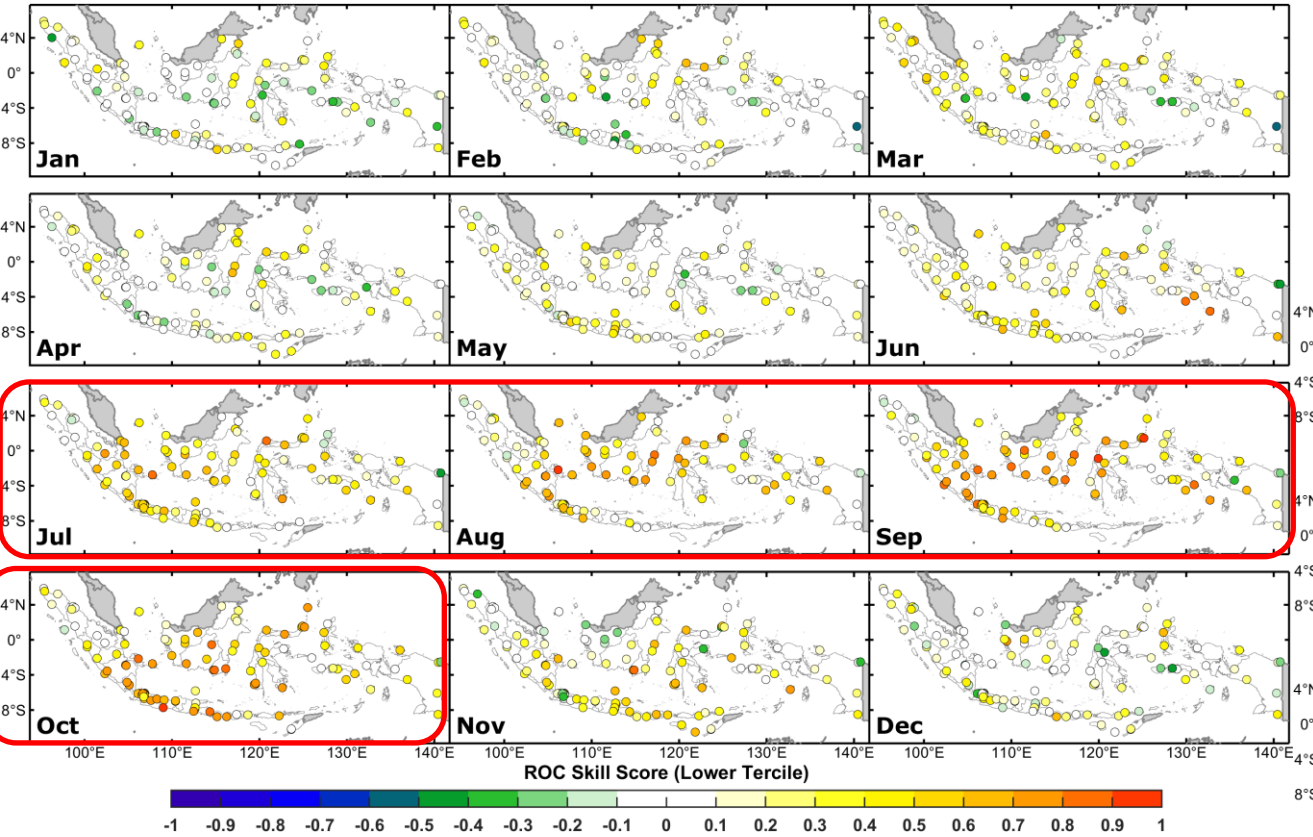




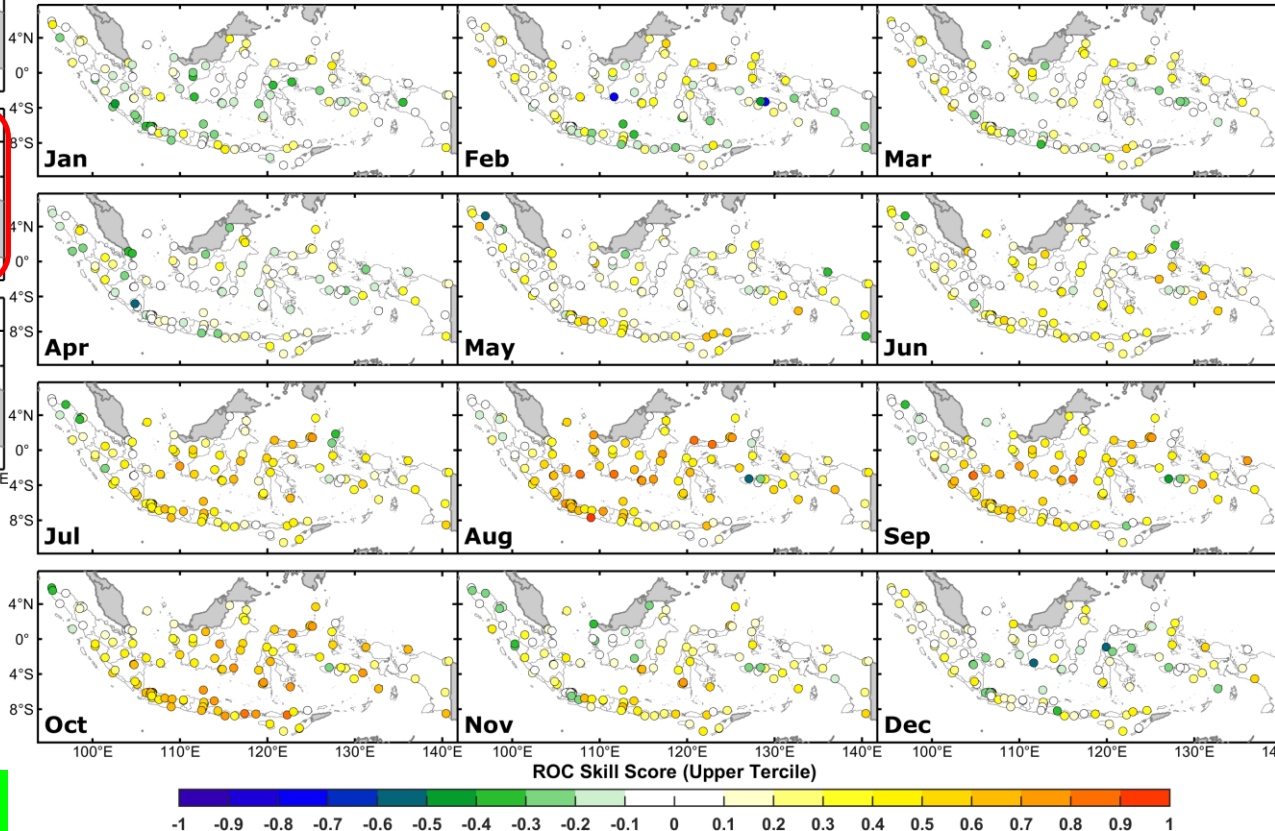


RESULTS: ROCSS SEAS5-BCLS vs OBS (2)

Lower Tercile
(Below Normal Condition)

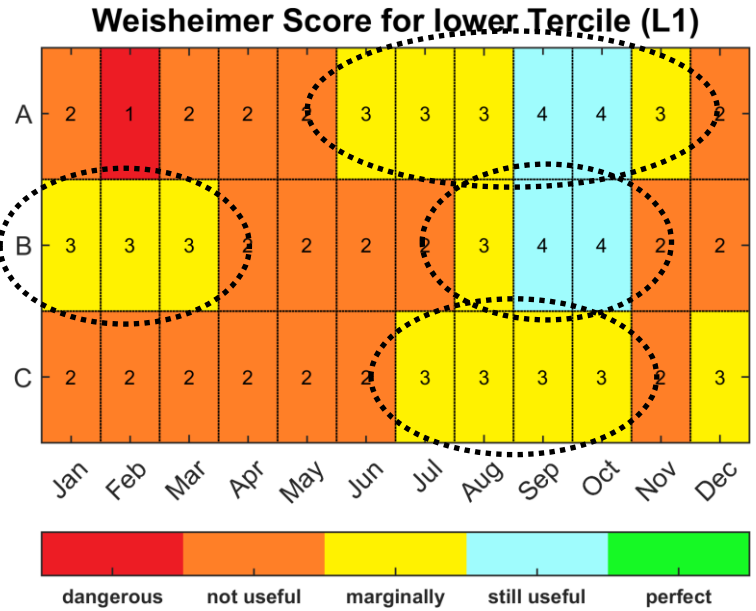


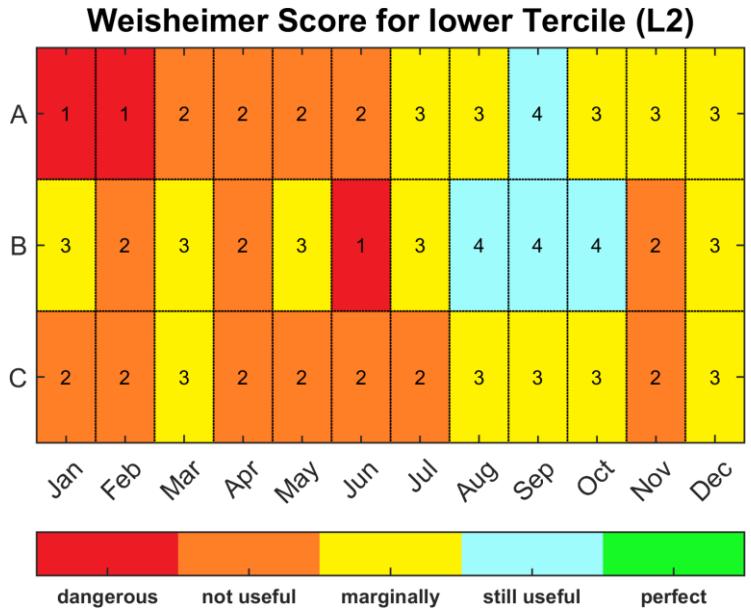
Upper Tercile
(Above Normal Condition)

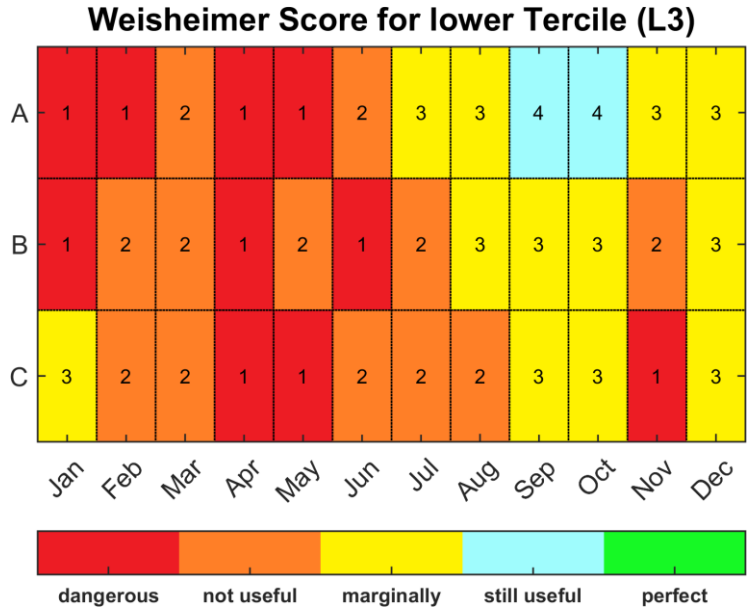


Lead Time 1

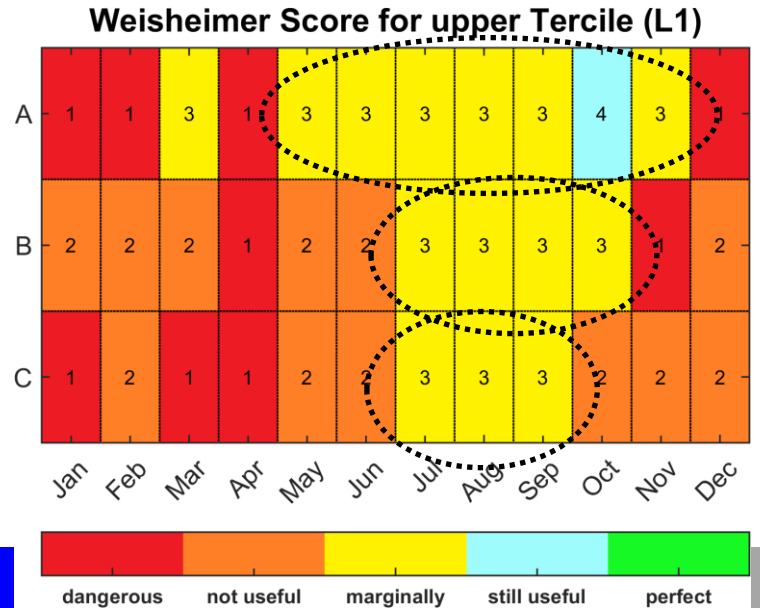
RESULTS: RELIABILITY - WEISHEIMER SCORE

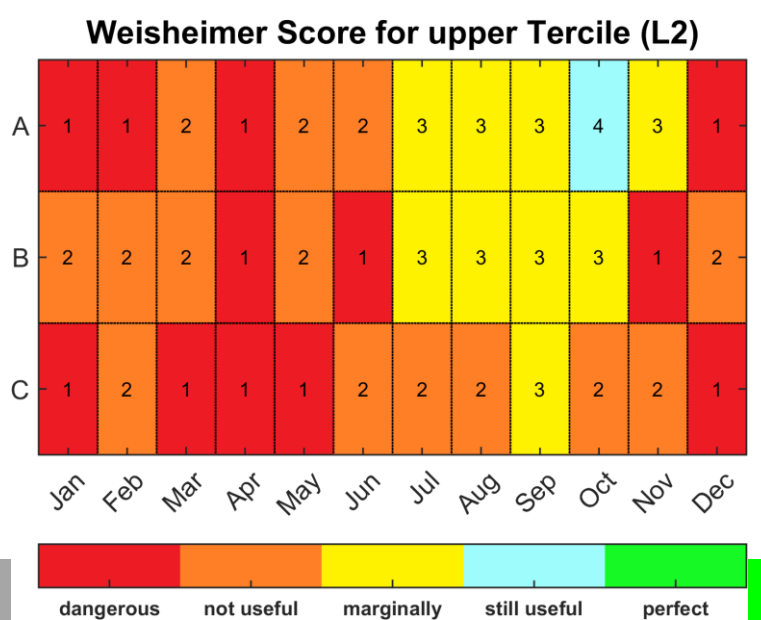


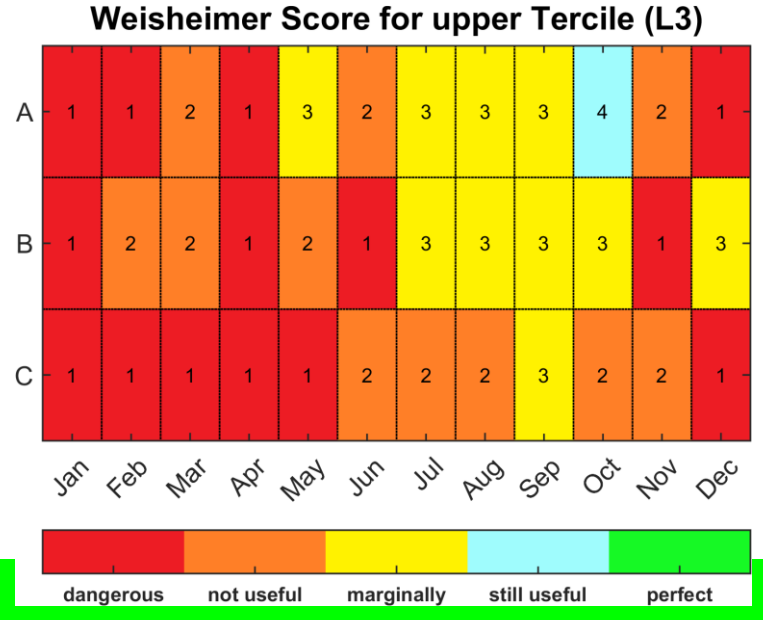




Lower Tercile

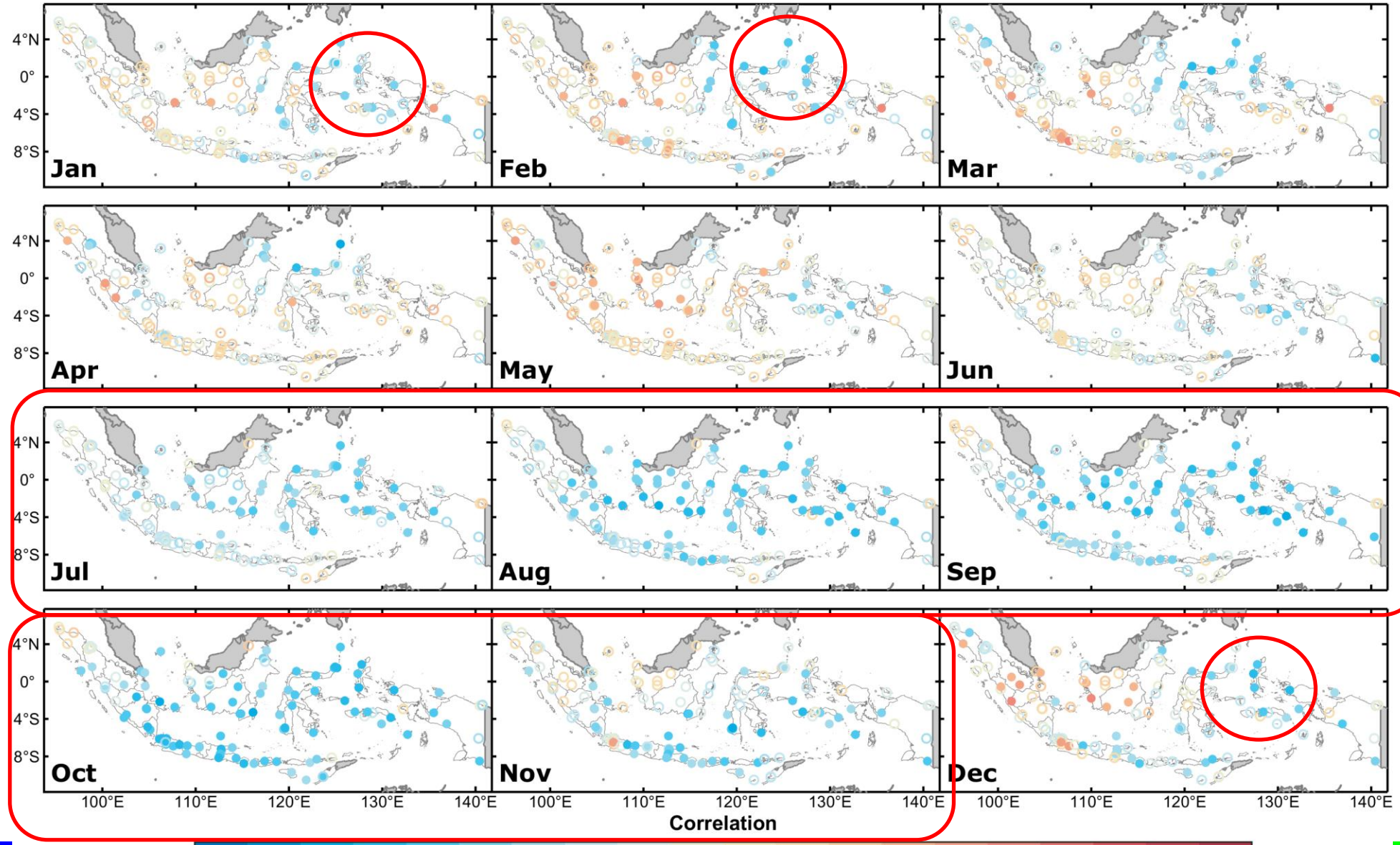






Upper Tercile

RESULTS: CORRELATION LAG-1 ASST NINO3.4 VS OBS



CONCLUSIONS

- ✓ This study is the first to investigate the capability of the SEAS5 model for all rain observation stations in Indonesia.
- ✓ Basically, the performance of direct output of SEAS5 (SEAS5-RAW) is quite good, especially in the ENSO-affected time period between July and October and mainly for the southern and eastern parts of Indonesia.
- ✓ Applying bias correction to the SEAS5 model SEAS5-BCLS), is quite capable of improving the accuracy of the model, because there is an increase in the number of stations with PC > 75% and positive RMSESS.
- ✓ Especially for LT1, performance of SEAS5-BCLS model show:
    - ✓ Positive correlation around 0,2-0,6 for all station in the region A, B and C
    - ✓ Various RMSE skill score ranging from negative to positif skill
    - ✓ Positive ROC skill score for all station
    - ✓ Various Relaiability, ranging from 1 – 4 Weisheimer score for lower and upper tercile
- ✓ SEAS5-BCLS also shows a better performance in dry period compared to wet period
- ✓ If we summarize all the score of verification metric, we conclude that the performance of the SEAS5 model is superior in the dry period and is sequentially more useful as in regions A, C and B

CLIMATE INFORMATION IN BMKG
DERIVED FROM OUTPUT OF ECMWF SEASONAL FORECAST SEAS5

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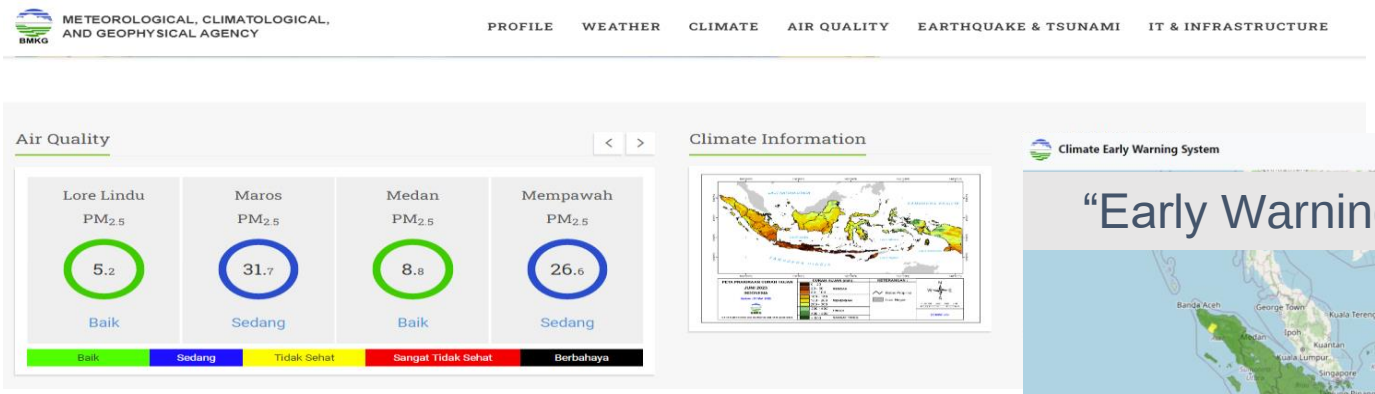
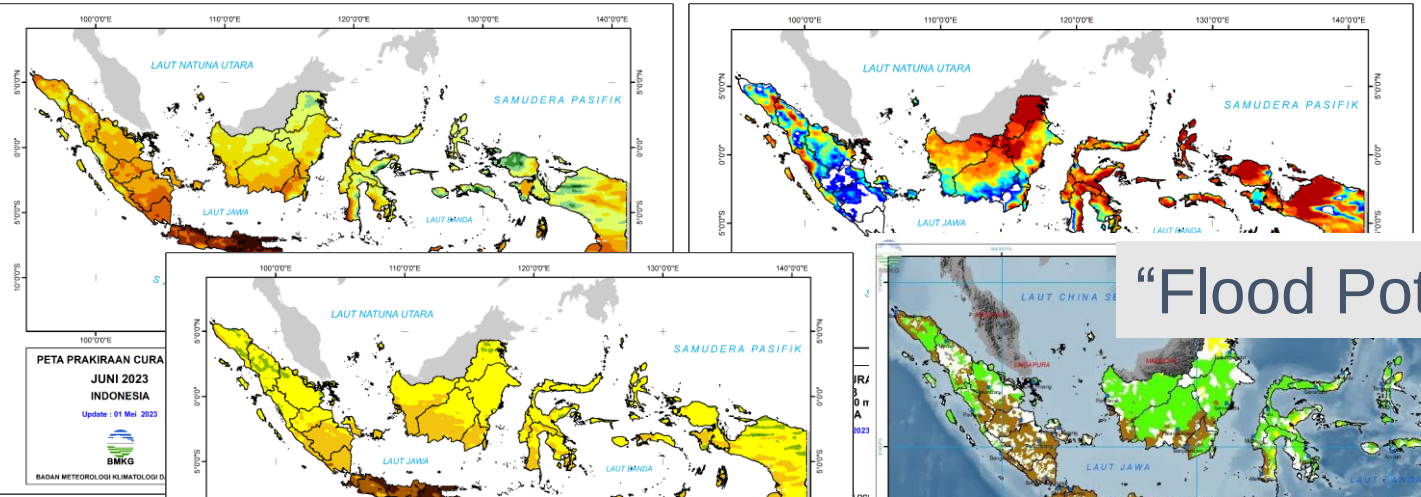
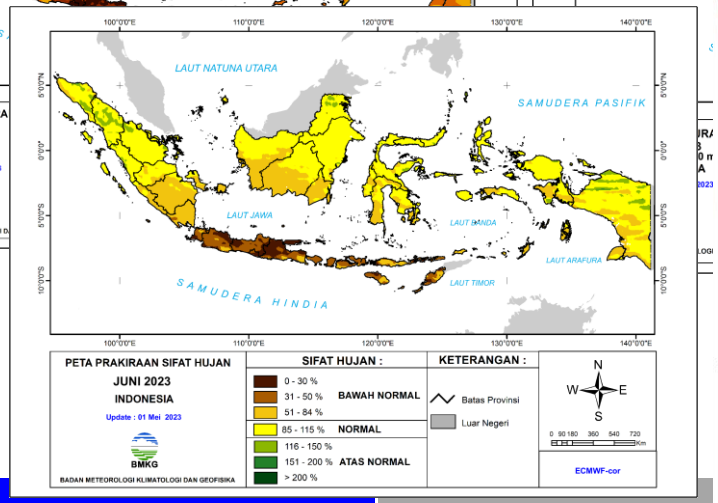
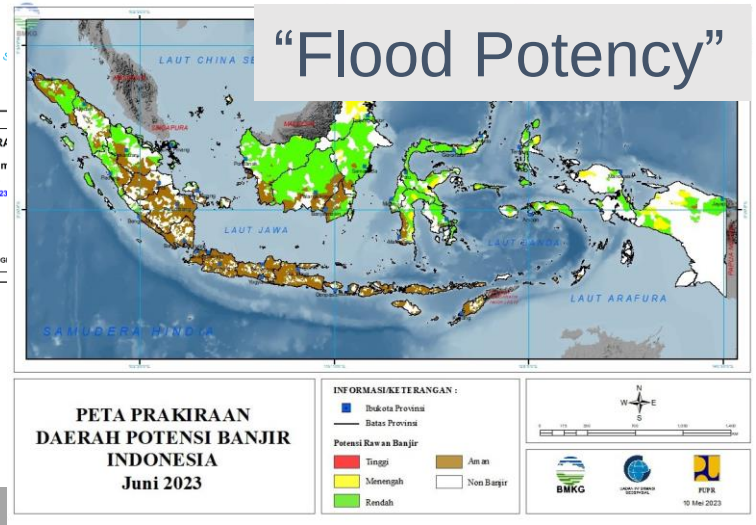




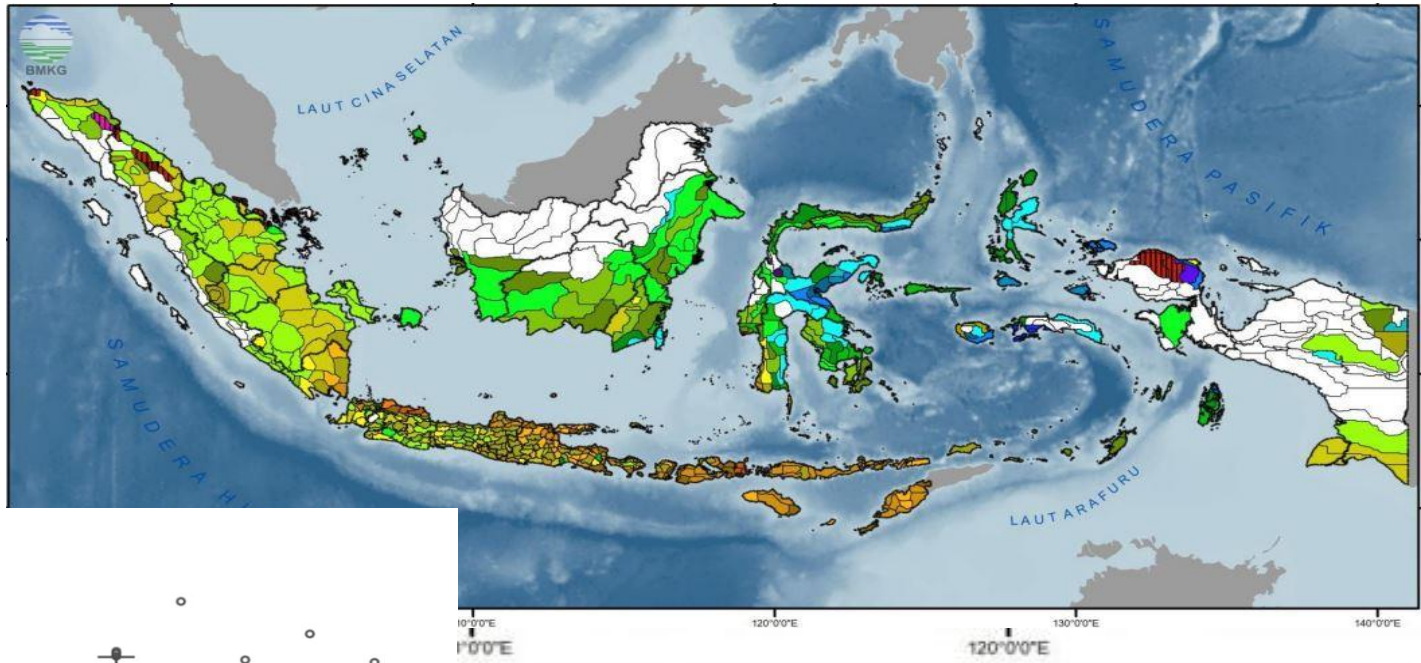


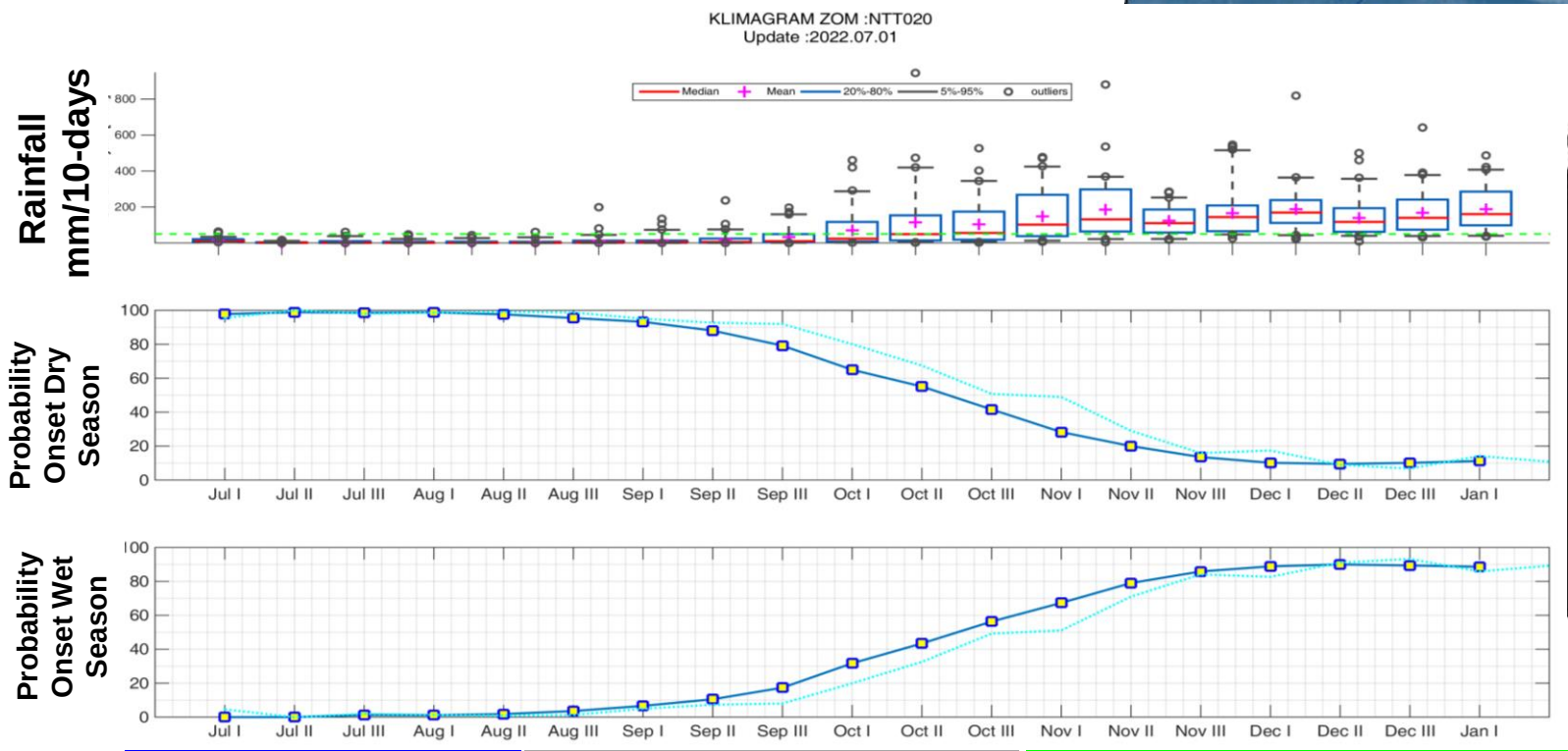
"Flood Potency"



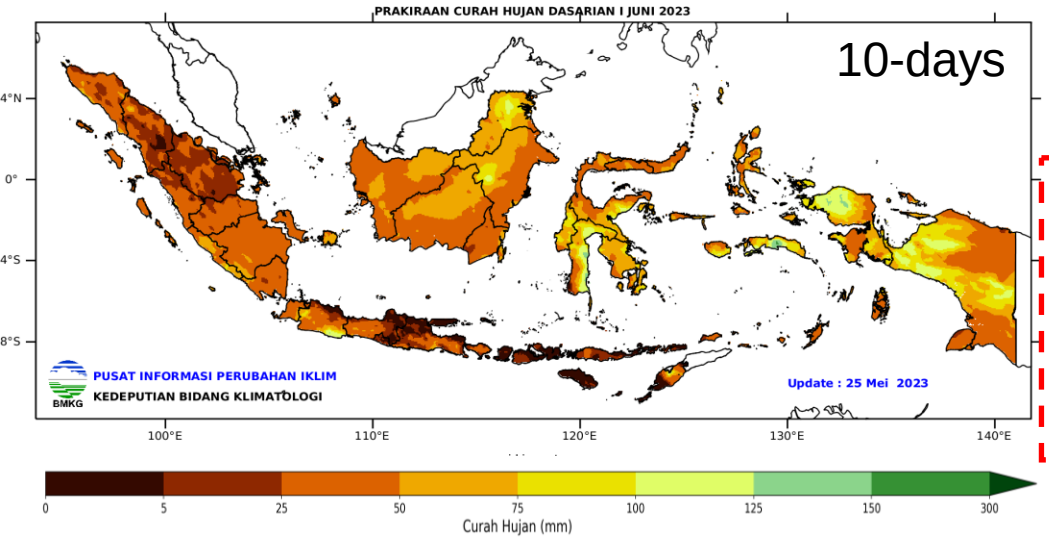
Seasonal forecast for Onset of Dry Season 2023 in 699 Climate Zones in Indonesia

- The prediction of the onset of the dry season is expressed in 10-day intervals, which we refer to as "Decad's day"
- We create a diagram known as a "Climagram", similar to a "meteogram", but with a temporal scale of 10 days.



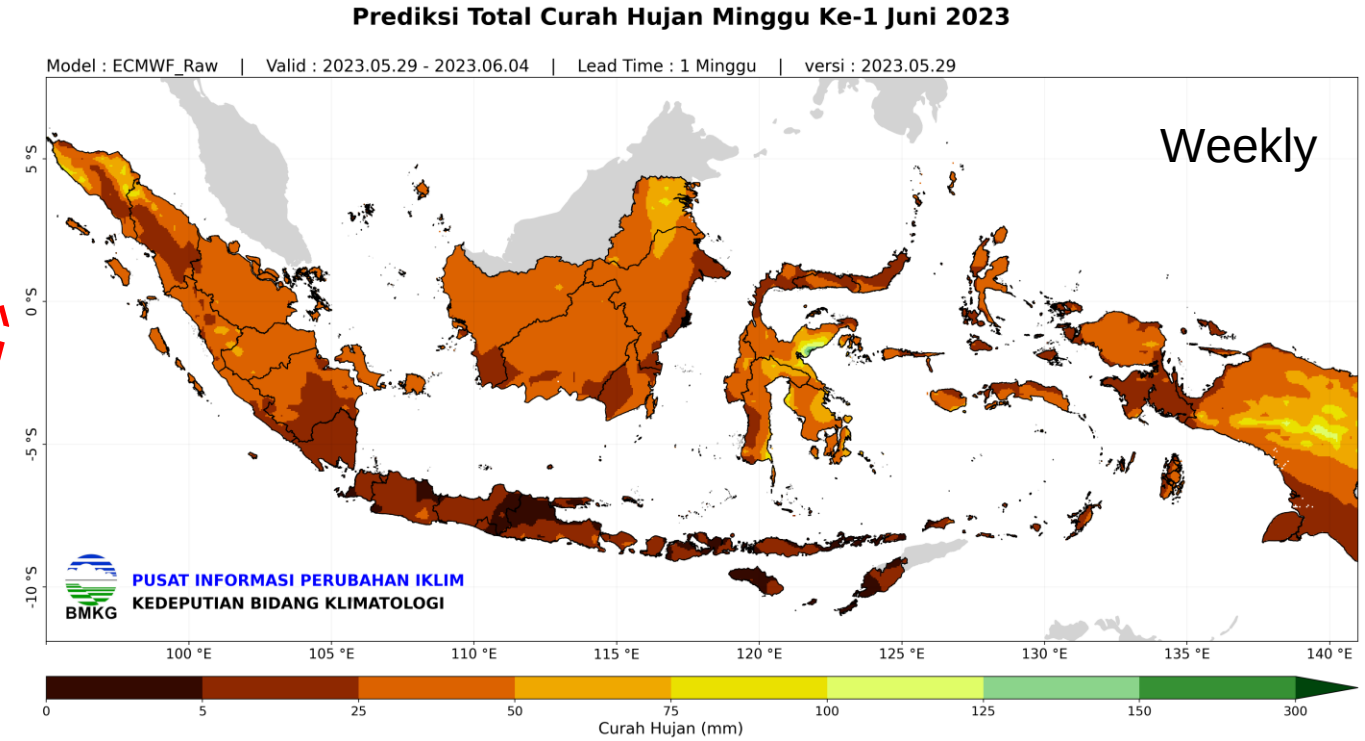


New Climate Information for S2S Prediction
From 10-days to Weekly Prediction



Accumulated rainfall prediction (corrected ensemble mean) for 10-days.

- This information is released every Tuesday and Friday
- For example: This figure shows the rainfall amount for the first 10 days of June 2023 (1 – 10 Jun 2023), using the initial prediction from May 25, 2023.
- This information has been used since 2015 and is still being produced



Our new product !!!,

- Accumulated rainfall prediction (corrected ensemble mean) for 7-days (weekly)
- This information is released every Tuesday and Friday for the next 7-days
- For example: This figure shows rainfall amount for the first 7-days (start from Monday) (29 May – 4 Jun 2023) using initial prediction for 25 May 2023.

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Thank You

Terima kasih