The HyBMG Method for Onset of Seasonal Prediction in Pacitan East Java Province - Indonesia

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METEOROLOGICAL CLIMATOLOGICAL & GEOPHYSICAL AGENCY
(BMKG)

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OUT LINE

- Introduction
  - Geographycal Feature
  - The HyBMG method
  - Definition of the onset season
- Rainfall performance
  - Average of dry and rainy season
- Validation of rainfall prediction
  - A 10-day rainfall analysis
- Conclusions and Remarks

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Introduction

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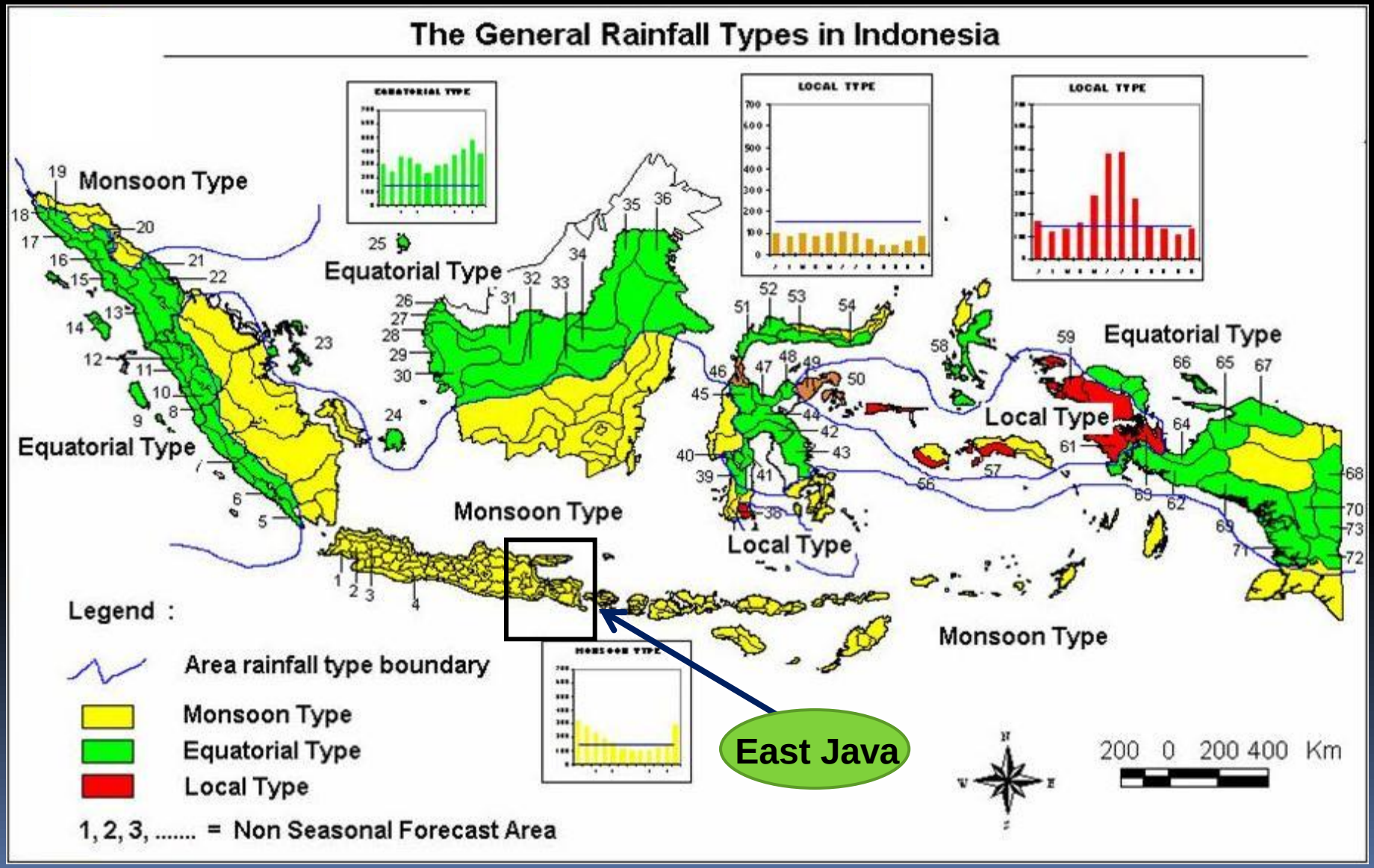
Geographycal Feature



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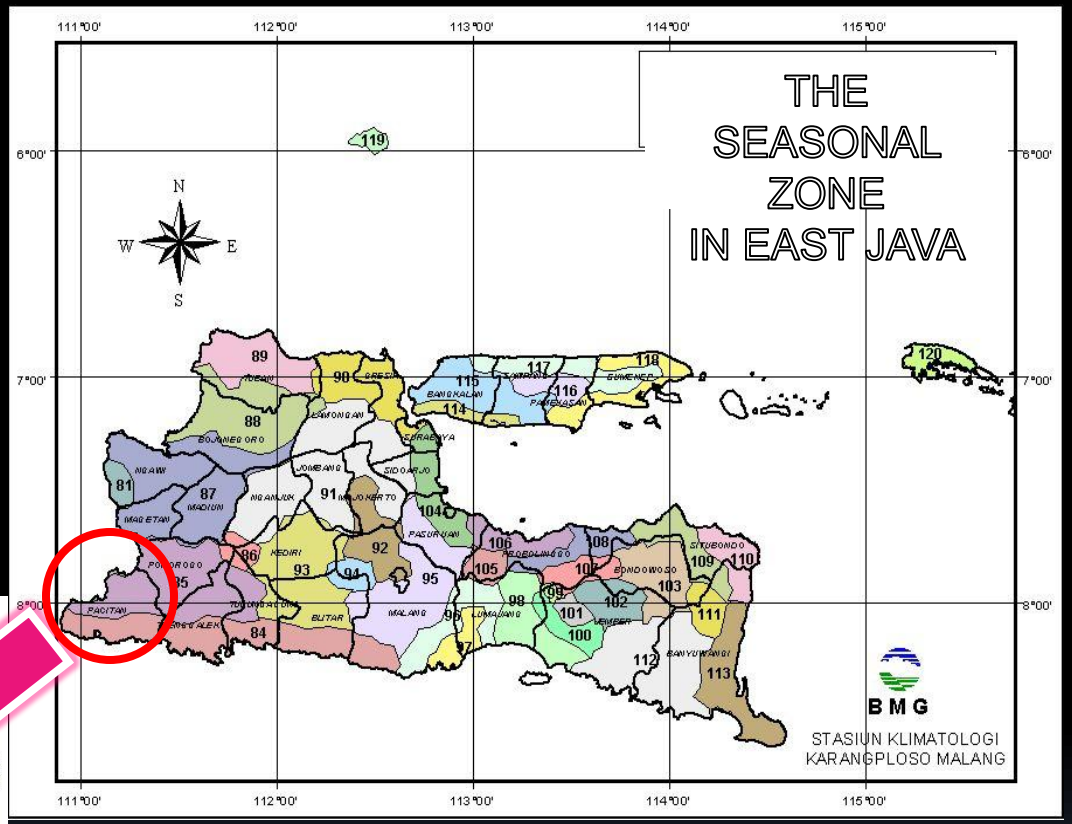
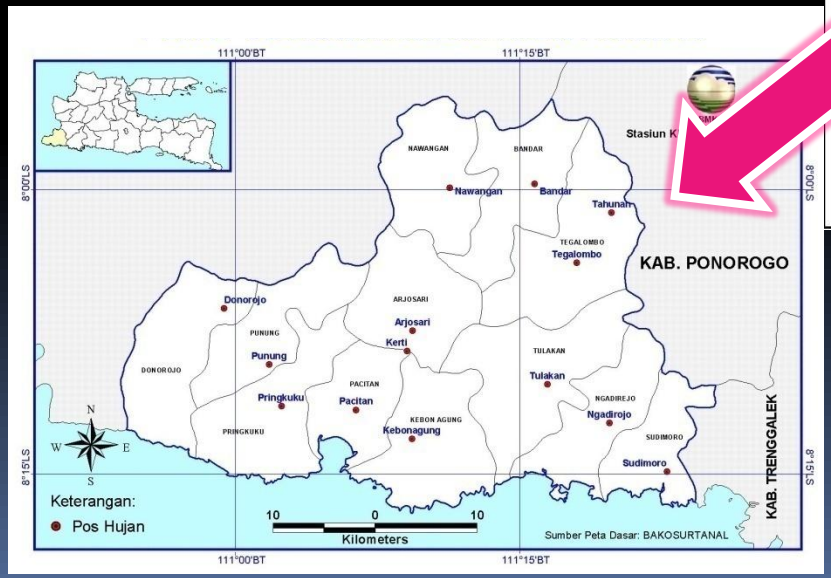
Geographycal Feature

The location of Pacitan Distric in East Java Province





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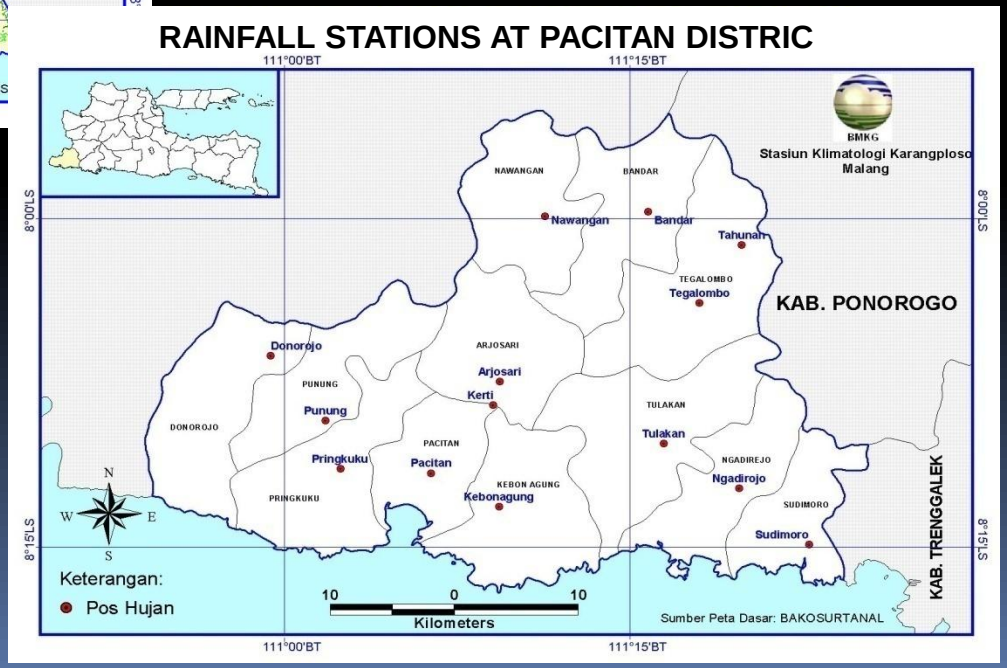
Geographycal Feature

The topography of Pacitan District East Java Province



The distribution of raingauge (13 stations) in Pacitan District East Java Province

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The HyBMG Method

- HyBMG (Hybrid BMG) :
  - GUI application which running in single PC, developed using MATLAB (MATrix LABoratory)
  - Compilation of non-conventional statistical models :
    - ANFIS (Adaptive Neuro Fuzzy Inference System)
    - WAVELET Transformation
    - ARIMA (AutoRegressive Integrated Moving Average)
    - TISEAN (Non Linear Dynamics / Time Series Analysis)
    - More models in the future (next version)
- Input → Time series of rainfall data (10-day data format)
- Output
  - 1 year prediction of rainfall data
  - Correlation and RMSE score

(Source : Donaldy, BMKG'S Research and Development Center, 2009)

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The HyBMG Method

- To run HyBMG, we need to install
  - MATLAB Component Runtime (**MCRInstaller.msi**)
  - HyBMG software (**HyBMG2.0.7.exe**).

(Source : Donaldy, BMKG'S Research and Development Center, 2009)

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The HyBMG Method

- HyBMG (Hybrid BMG) is a PC-based windows application interface that is built under MATLAB (MATrix LABoratory) software. Related to the term of "Hybrid", HyBMG is a compilation of non-conventional statistical models, combining newly developed time series forecasting techniques based on neural network (ANFIS), wavelet transform, AutoRegressive Integrated Moving Average (ARIMA) and non-linear dynamics (chaos theory). In this case, time series is specified for the rainfall time series data and HyBMG is used for long-range forecasting. It also includes validation procedures related the uses of the software.

(Source : Donaldy, BMKG'S Research and Development Center, 2009)

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The HyBMG Method

- In particular, the purpose of HyBMG is for the user simply needs in using several forecasting techniques in a single stand-alone application. It means that the user can use several forecasting techniques with the same input data and get the result (forecast) and then do validation easily using a user-friendly interface.
- Since July 2007, the development of HyBMG is still progressing, many changes has been implemented from the first version (v1.0.0) until the current version (v2.0.7). The changes covered of updating each forecasting techniques algorithm and also the design of HyBMG interface for the user convenience.

(Source : Donaldy, BMKG'S Research and Development Center, 2009)

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The HyBMG Historical

- MATLAB Scripts
- V.1.0
- V.1.1
- V.1.2
- V.1.5
- V.1.6
- V.1.6.5
- V.1.6.6
- V.2.0.7

(Source : Donaldy, BMKG'S Research and Development Center, 2009)

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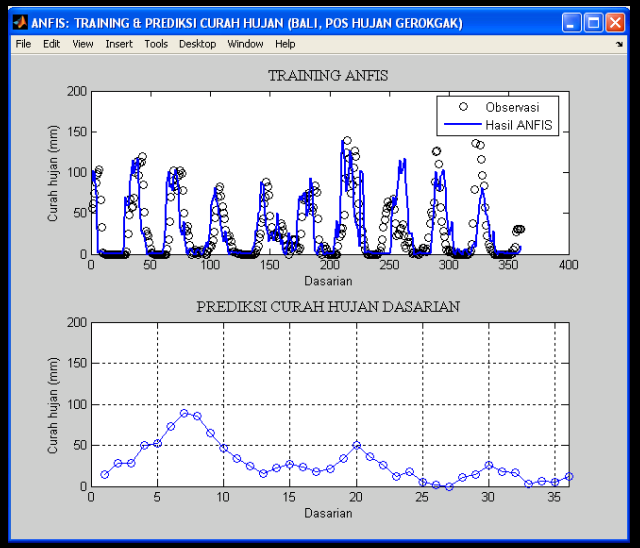
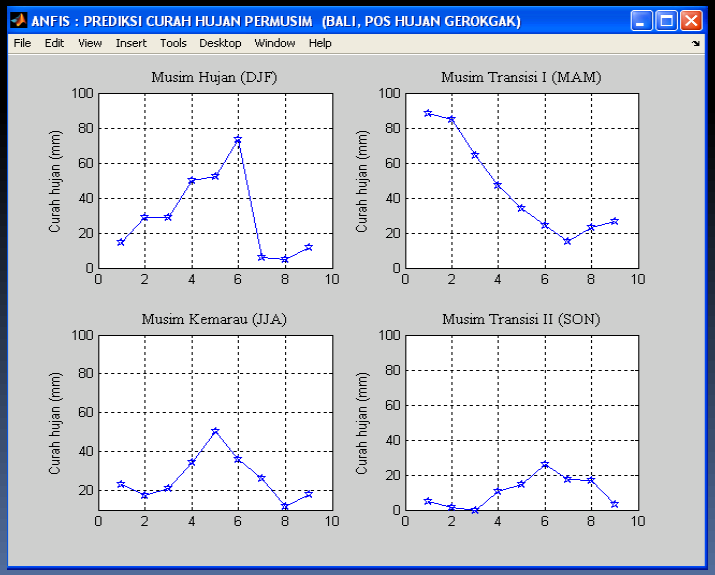
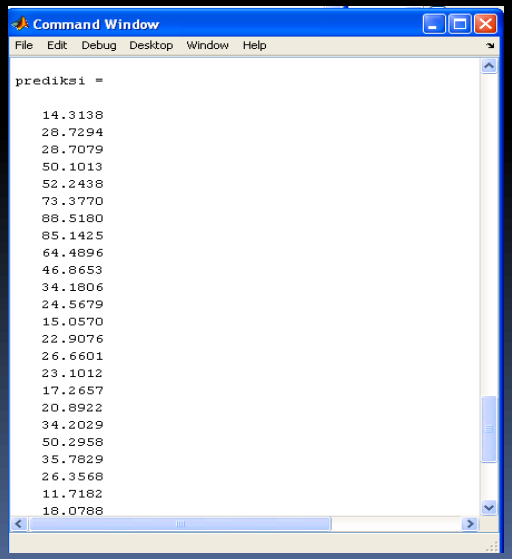
MATLAB Script

```
 xlabel(' Dasarian ')
 legend('Observasi','Hasil ANFIS');

x=361;
prediksi=(predik(x:x+35))
subplot(212),plot(prediksi,'o-b');grid on
ylabel('Curah hujan (mm)')
xlabel(' Dasarian ')
title('PREDIKSI CURAH HUJAN DASARIAN','FontName','Times','Fontsize',12)
axis ([0 36 0 200])

prebulanan=[sum(predik(x:x+2,:));sum(predik(x+3:x+5,:));sum(predik(x+6:x+8,:));sum(predik(x+9:x+11,:

figure('name', ...
    ['ANFIS: PREDIKSI DAN RMSE CURAH HUJAN (' stasiun ')'],'number', 'off');
subplot(211),plot(prebulanan,'o-b','linewidth',1.5);grid on
title('PREDIKSI CURAH HUJAN BULANAN','FontName','Times','Fontsize',12)
ylabel('Curah hujan (mm)')
xlabel(' Bulan ')
axis ([0 13 0 300])

predry=[prediksi(16:24,:)];
predwet=[prediksi(1:6,:);prediksi(34:36,:)];
pretrans1=[prediksi(7:15,:)];
pretrans2=[prediksi(25:33,:)];

figure('name', ...
    ['ANFIS : PREDIKSI CURAH HUJAN PERMUSIM  (' stasiun ')'],'number', 'off');

subplot(221);plot(predwet,'-p');grid on;
title('Musim Hujan (DJF)','FontName','Times','Fontsize',11);
ylabel(' Curah hujan (mm) ');


subplot(222);plot(pretrans1,'-p');grid on;
title('Musim Transisi I (MAM)','FontName','Times','Fontsize',11);
ylabel(' Curah hujan (mm) ');
```







(Source : BMKG'S Research and Development Center, 2009)

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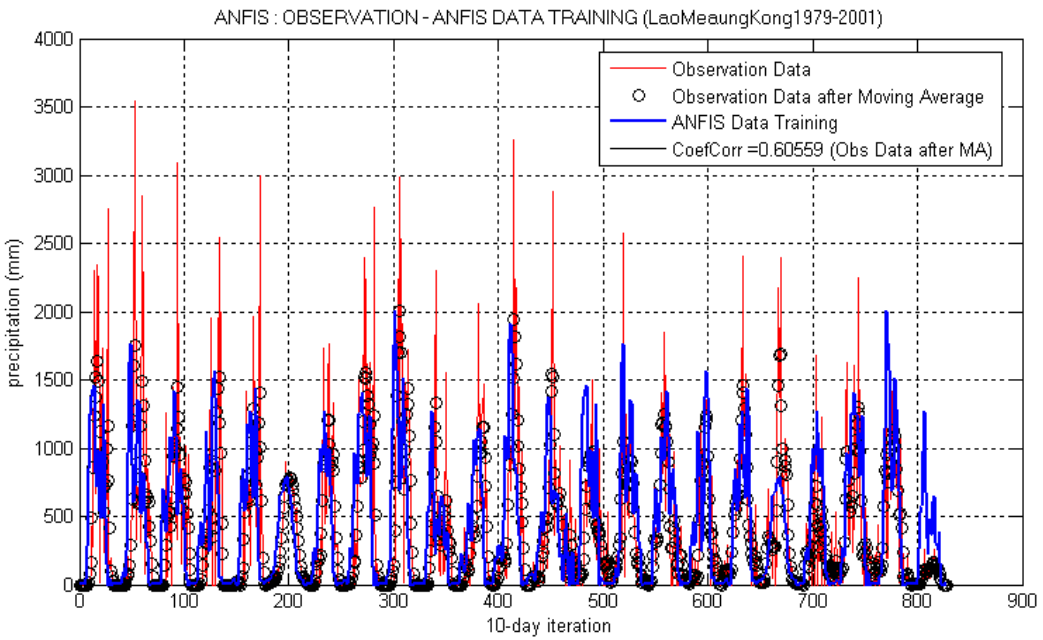
HyBMG V1.0

Indonesian Meteorological and Geophysical Agency (BMG)
Climate Forecast Application
= HyBMG V1.0 =

Data Title: LaoMeaungKong1979-2001

Added Data Training Length: 77

Output Graphic Type: Observation - Data Simulation



Ouput Graphic Values

(Source : BMKG'S Research and Development Center, 2009)

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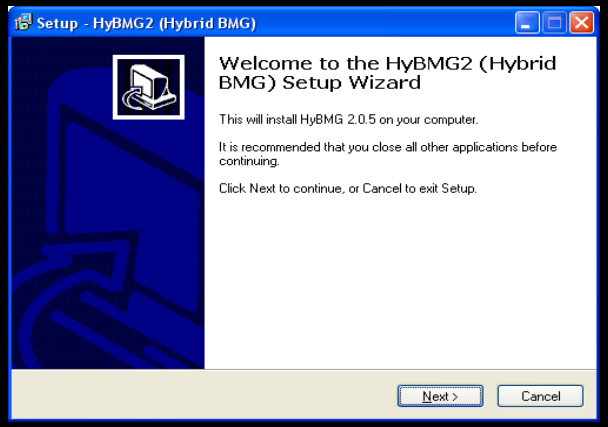
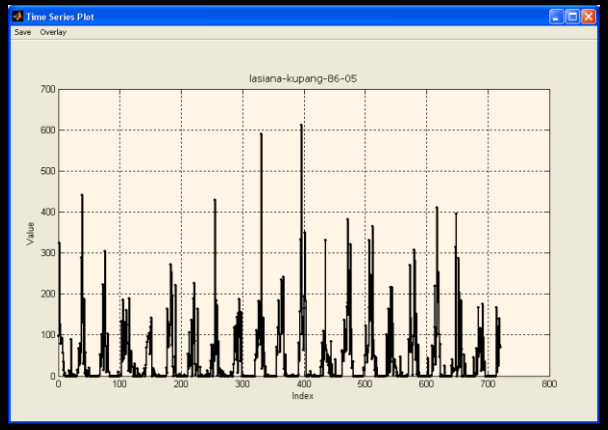
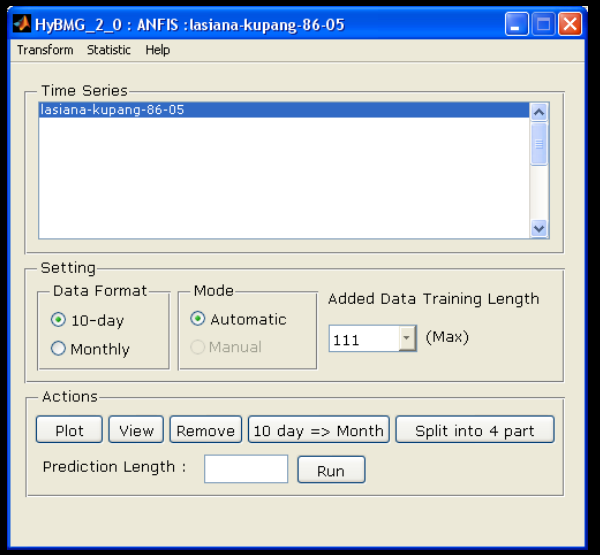
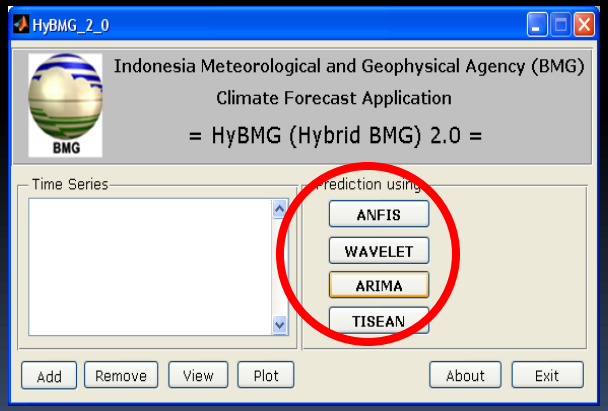
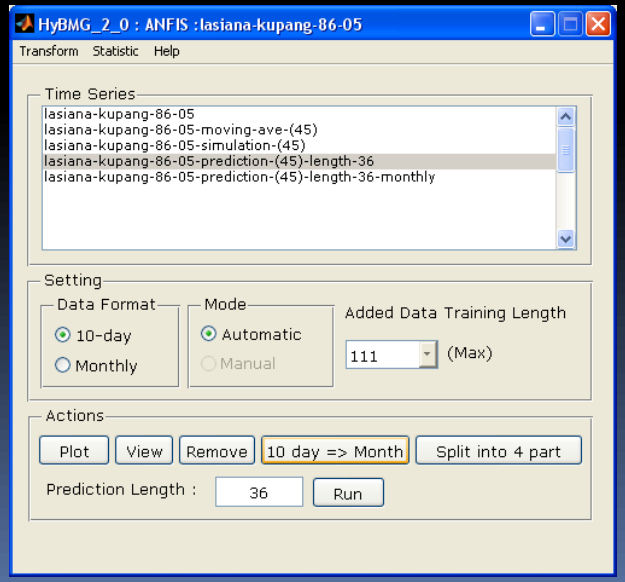
HyBMG V2.0.7 (last version)

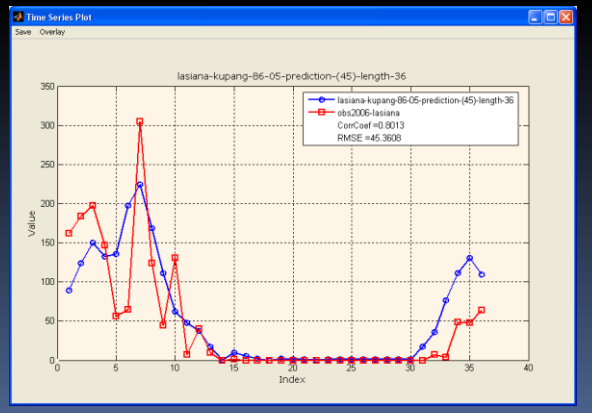












(Source : Donaldy, BMKG'S Research and Development Center, 2009)

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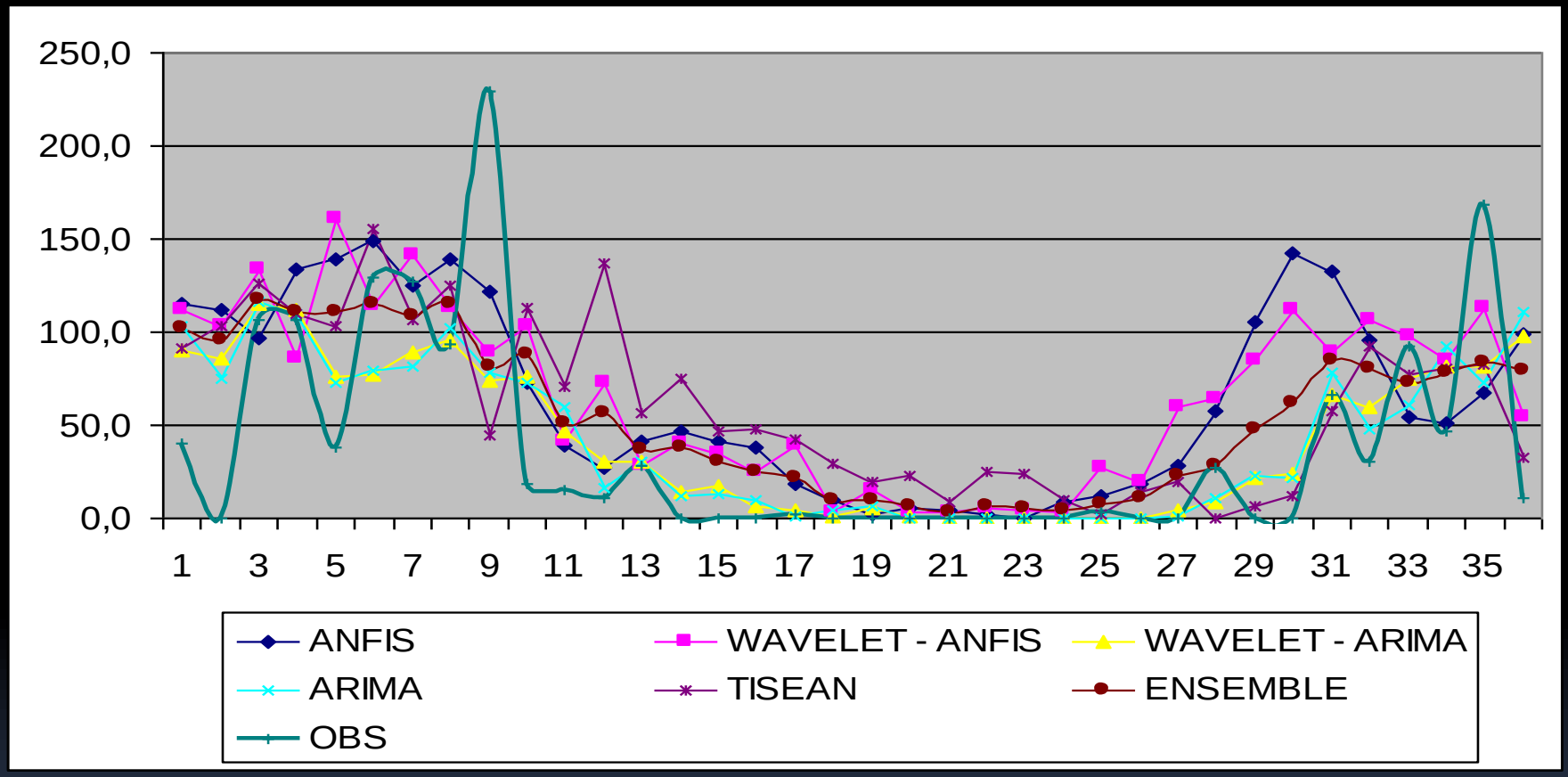
Example : Malang District – East Java (Karang Ploso Station)

Rainfall Forecasting and Validation 2008 (10-day format)



	ANFIS	WAV-ANFIS	WAV-ARIMA	ARIMA	TISEAN	ENSEMBLE
Correl	0.56	0.58	**0.67**	0.64	0.49	0.65
RMSE (mm)	56.52	54.65	**42.13**	43.28	55.85	45.98

(Source : BMKG'S Research and Development Center, 2009)

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DEFINITIONS :

The wet and dry season in this studies used of BMKG (Meteorological Climatological and Geophysical Agency definitions

WET/RAINY SEASON :

A ten-day period with the total rainfall is equal than 50 mm or above and continue for the next ten-day simultaneously.

DRY SEASON :

A ten-day period with the total rainfall is less than 50 mm and continue for the next ten-day simultaneously.

Source: Meteorological Climatological and Geophysical Agency (BMKG)

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- On the operational BMKG has made for the seasonal rainfall prediction with the *basic seasonal forecast area*, which technique used by ARIMA, exp. smoothing dan regresi Linier model.

- The Statistical approvement models has used on applied of climatology for each parameters climate prediction, include the *applied of advanced statistics* and can to *capture for the data variabilty* caused by the regional or global atmosphere phenomena.

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Rainfall Performance in Pacitan - East Java

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Pacitan District in East Java Province, one of area affected by the monsoon rain type, has two seasons which are very different. They are wet/rainy season and dry season. Based on season area zoning made by the Centre of Meteorological Climatological and Geophysical Agency.

The information about onset whether rainy season or dry season is necessary for the tactical activities and strategic to anticipate the impact of global warming or climate change such as flood, drought and cropping pattern.

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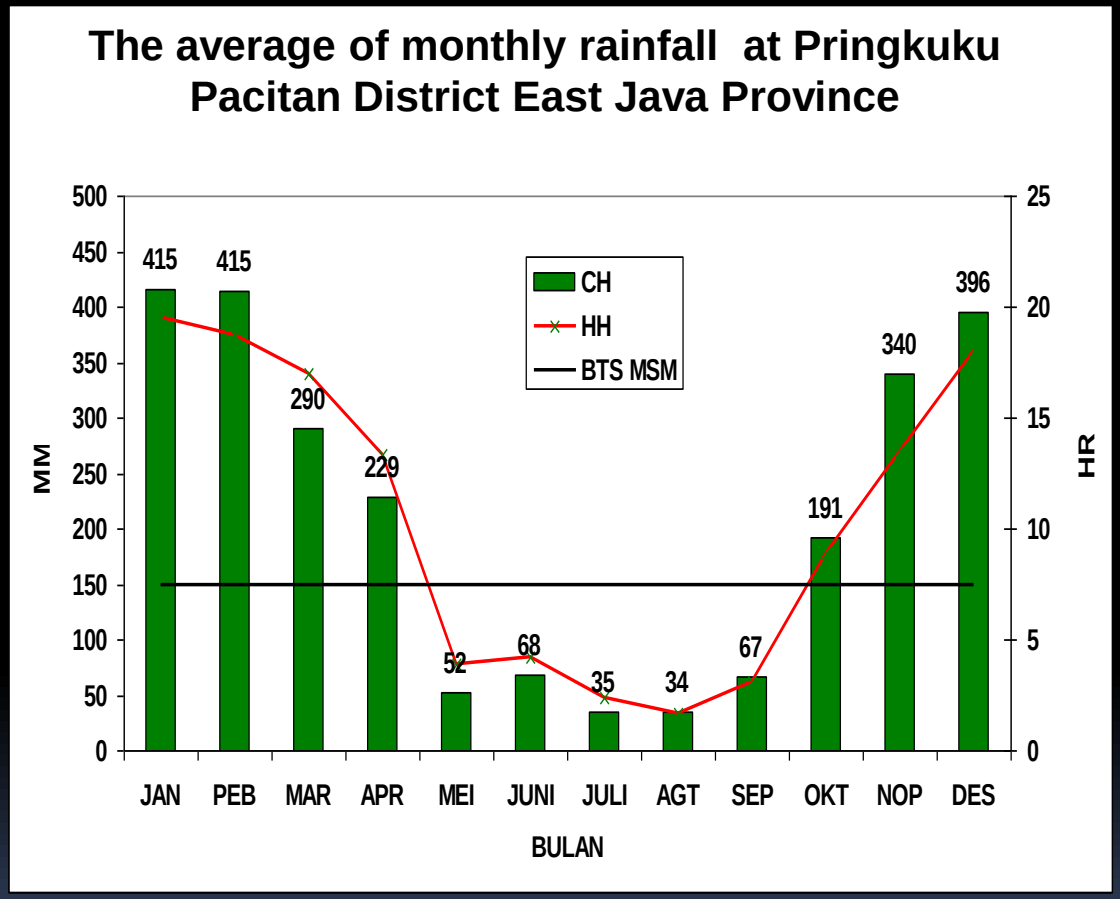

The period of dry season from May to September (5 months) with the monthly rainfall less than 150 mm, and the rainy season from October to April (7 months).

The average of monthly rain days on dry season less than 7 day

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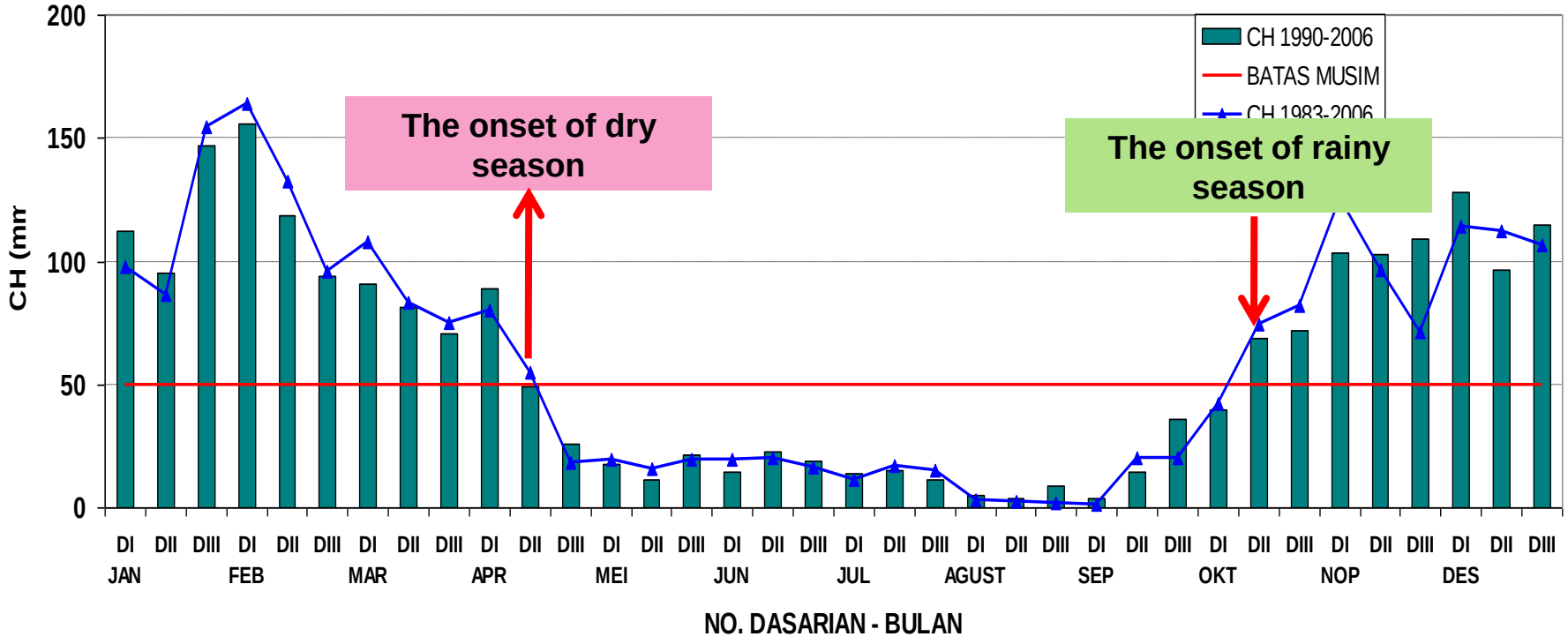
AVERAGE FOR 10-DAY RAINFALL AT PRINGKUKU PACITAN DISTRICT EAST JAVA



The onset of dry season begining from Apr-2 with 180 days period, and for rainy season from Oct-2 with 180 days period.

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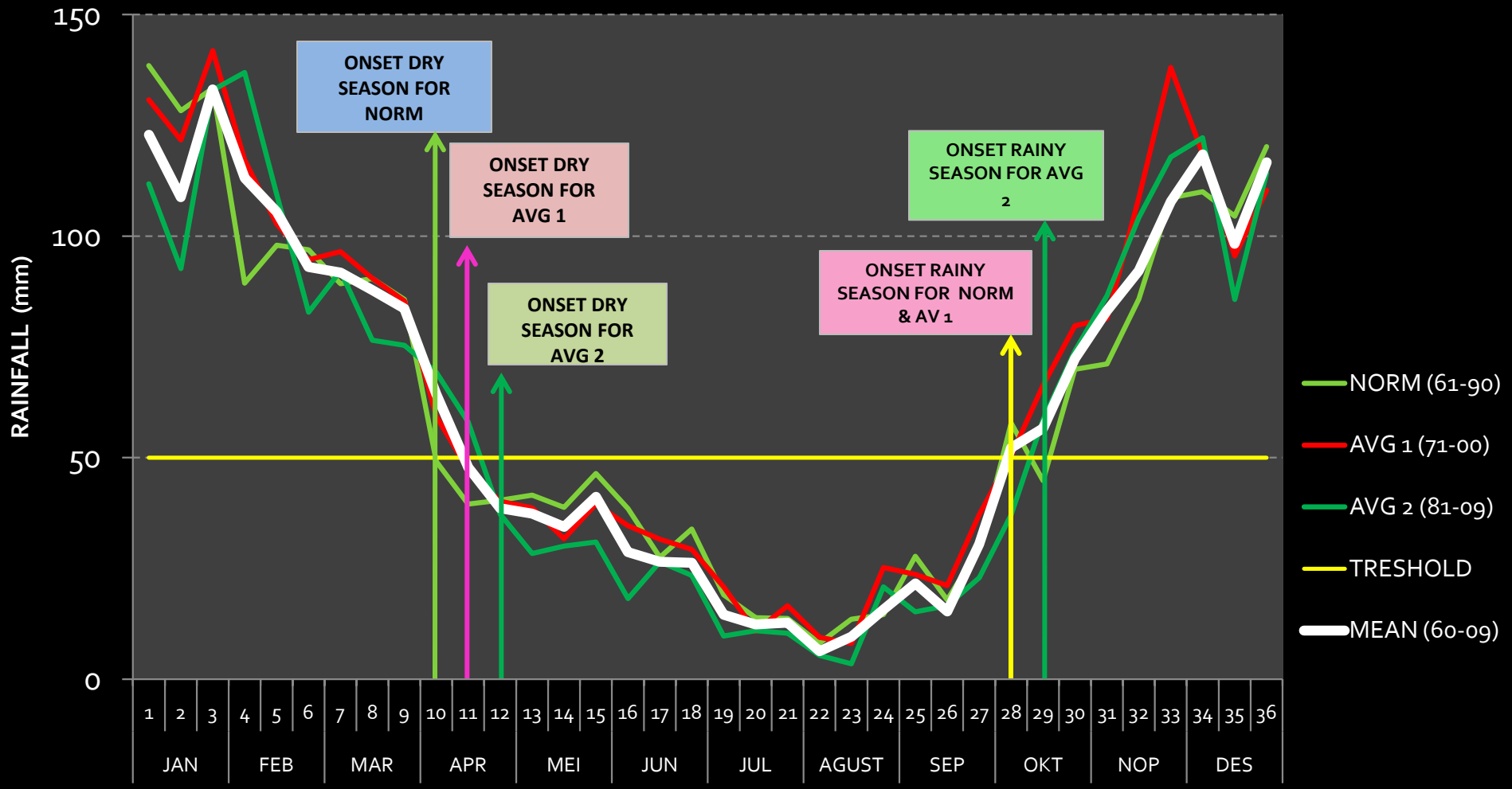
NORMALY AND AVERAGE 10-DAYS RAINFALL IN PU-PACITAN EAST JAVA PROVINCE



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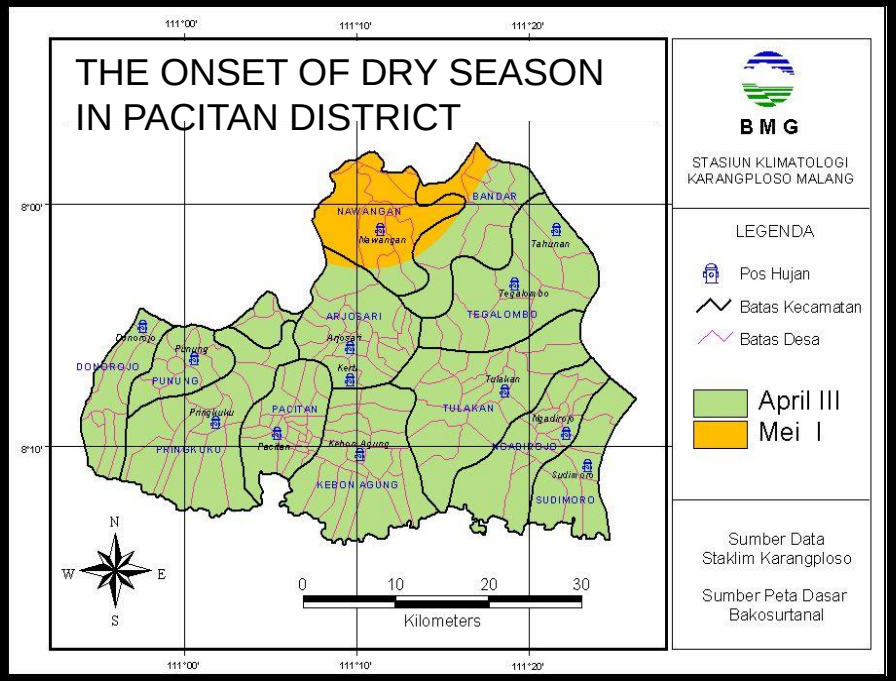
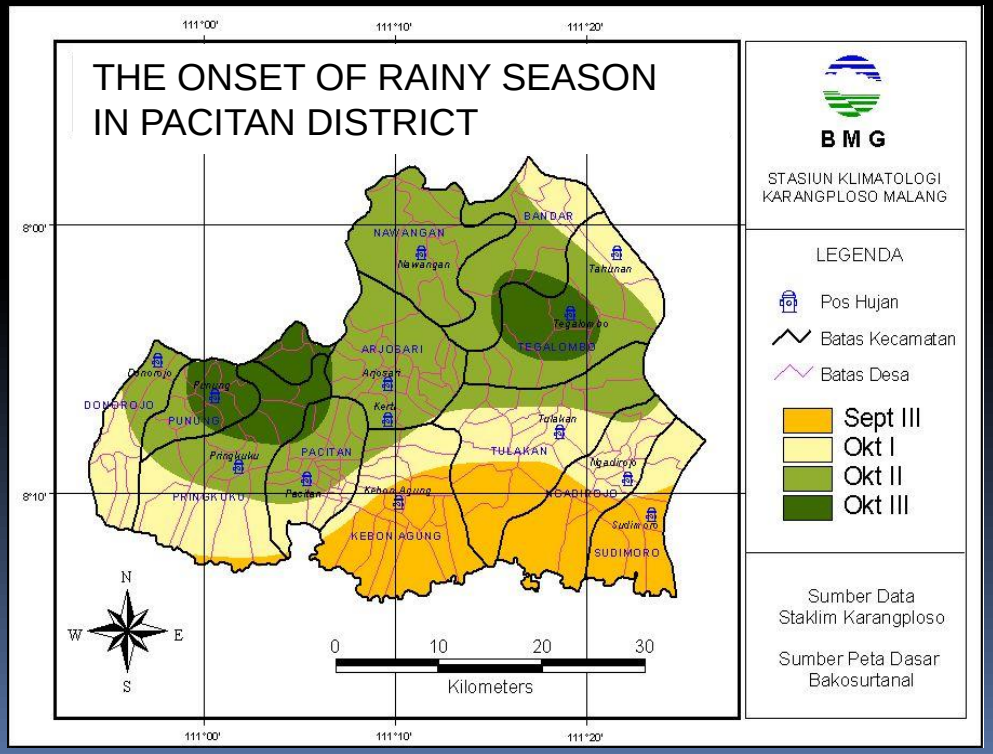


- The normal onset of dry season beginning on April-III (10-day number for 12) to May-I (10-day number for 13) with the lengt of dry season for 170 days.



- The normal onset of rainy season on September III (10-days number for 27) to Oct-III (10-day number for 30) with the lengt of rainy season for 190 days.

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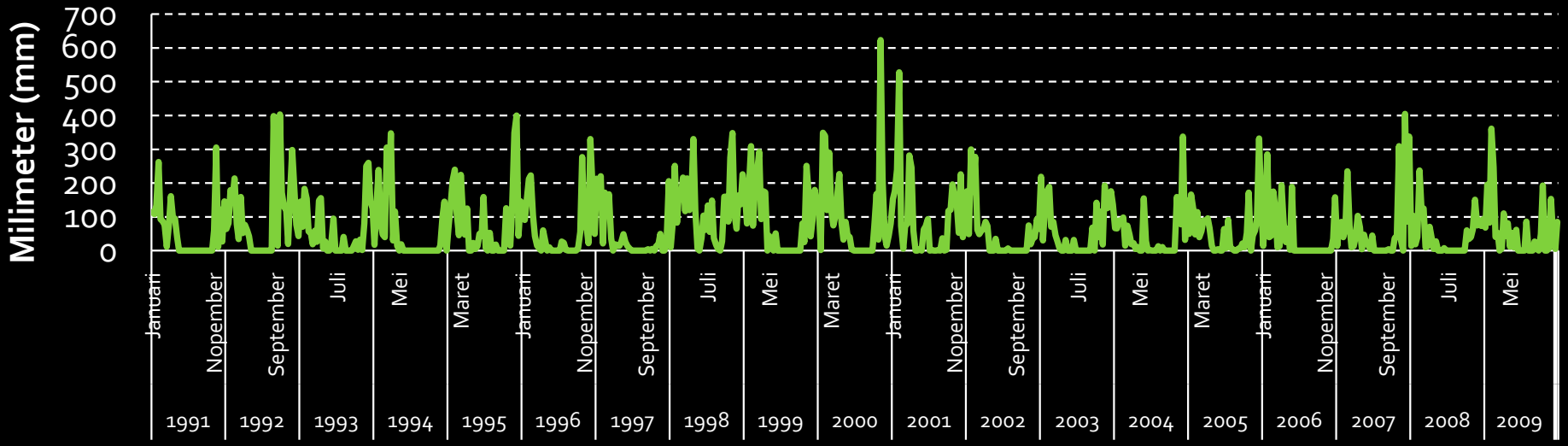
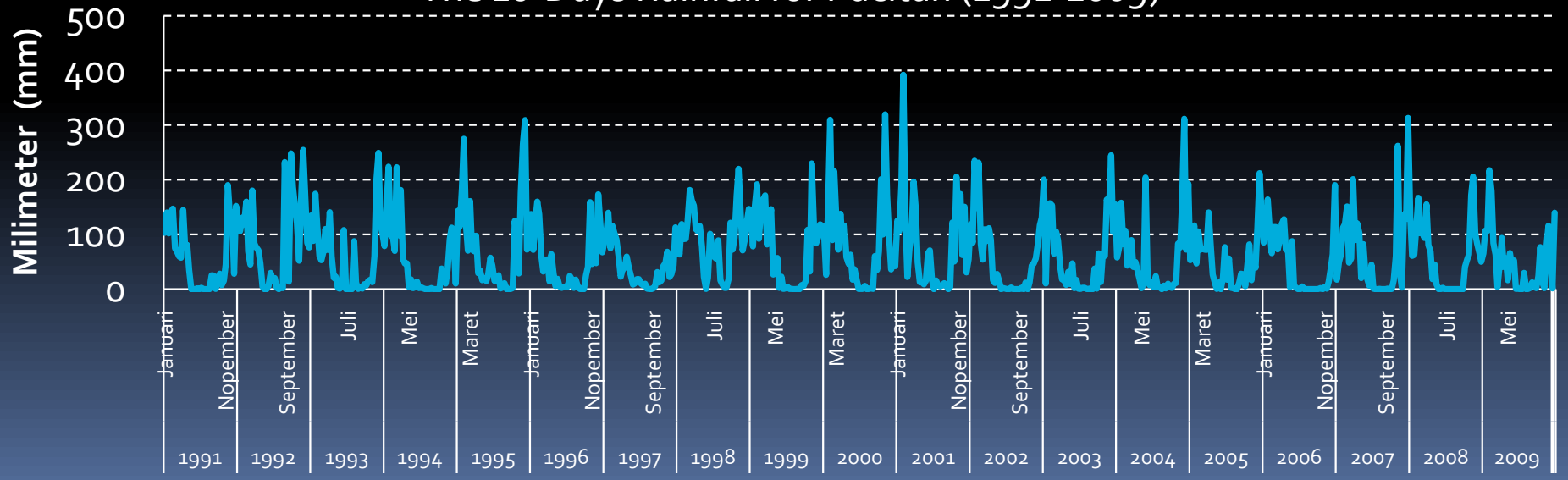
The 10-Days Rainfall at Pringkuku Pacitan (1991-2009)



The 10-Days Rainfall for Pacitan (1991-2009)



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Validation of Rainfall Prediction at Pacitan District

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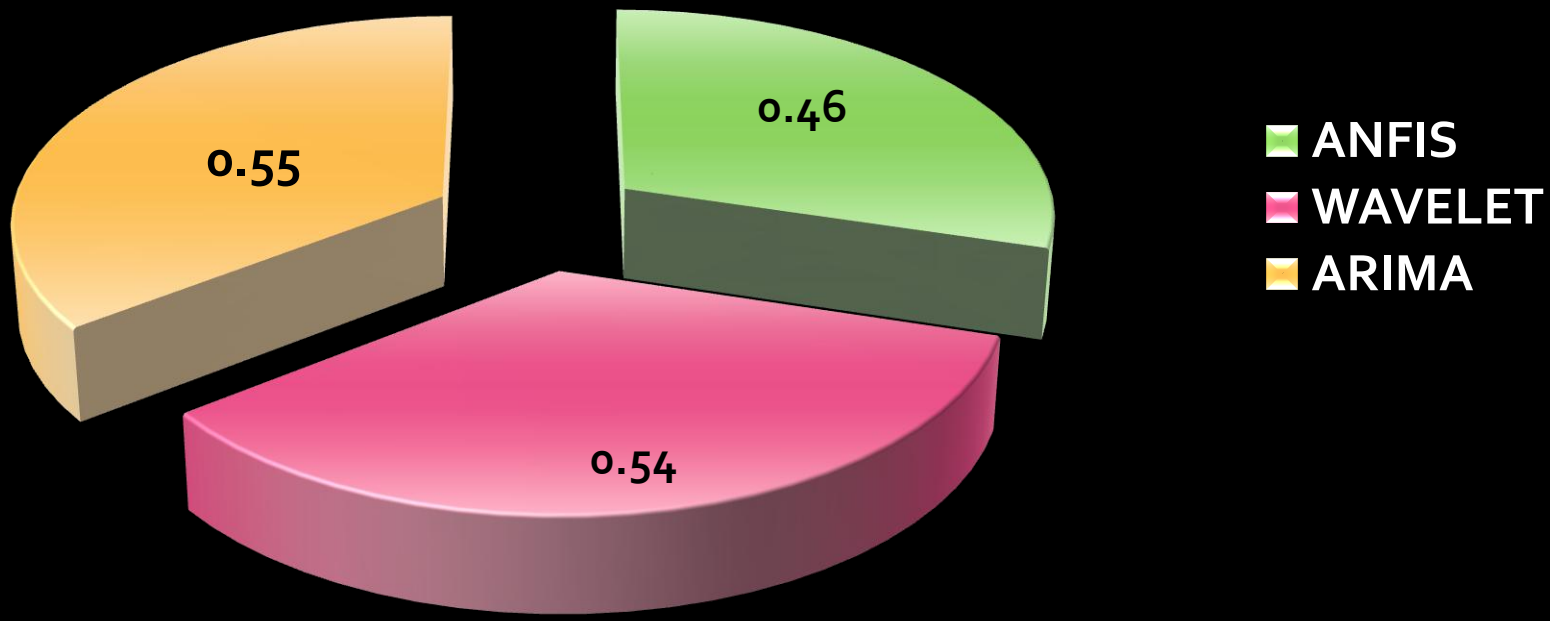
VALIDATION OF 10-DAY RAINFALL PREDICTION (r ,CORRELATION) IN PACITAN DISTRICT (2000-2009)



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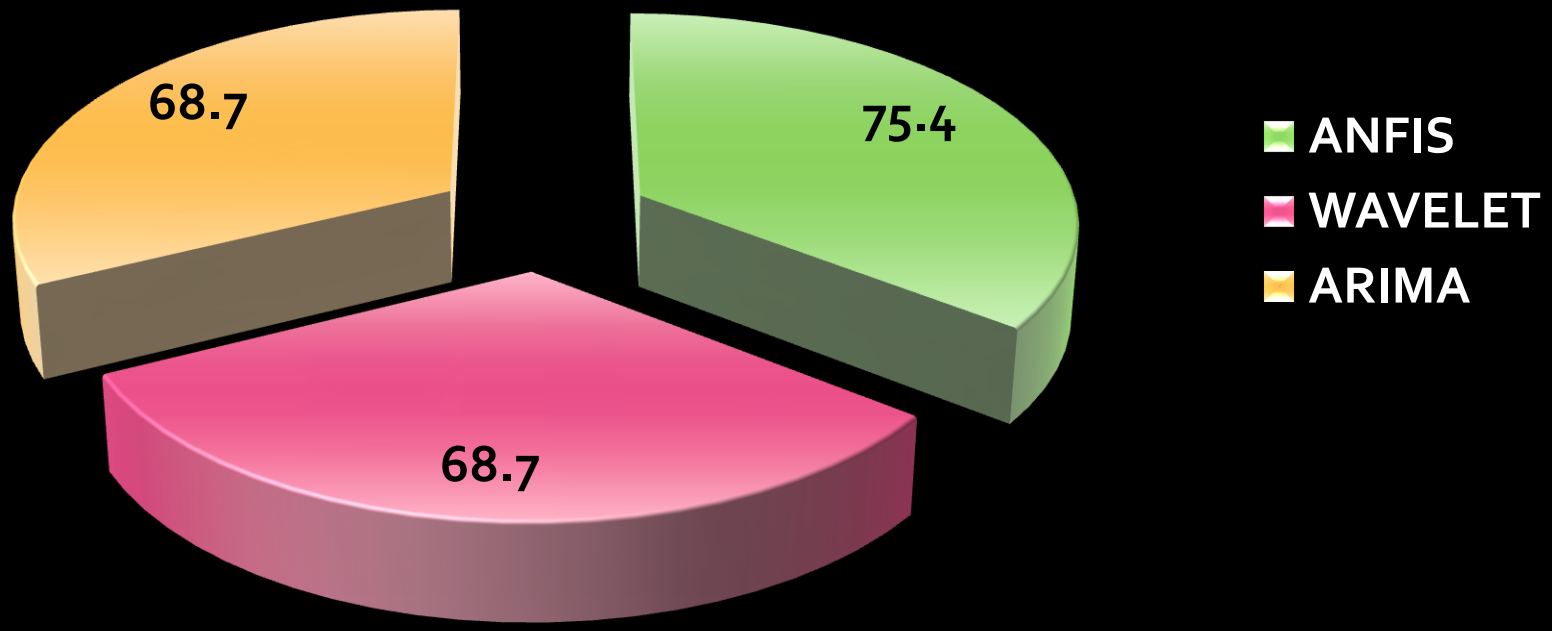
VALIDATION OF 10-DAY RAINFALL PREDICTION (RMSE) IN PACITAN DISTRICT (2000-2009)



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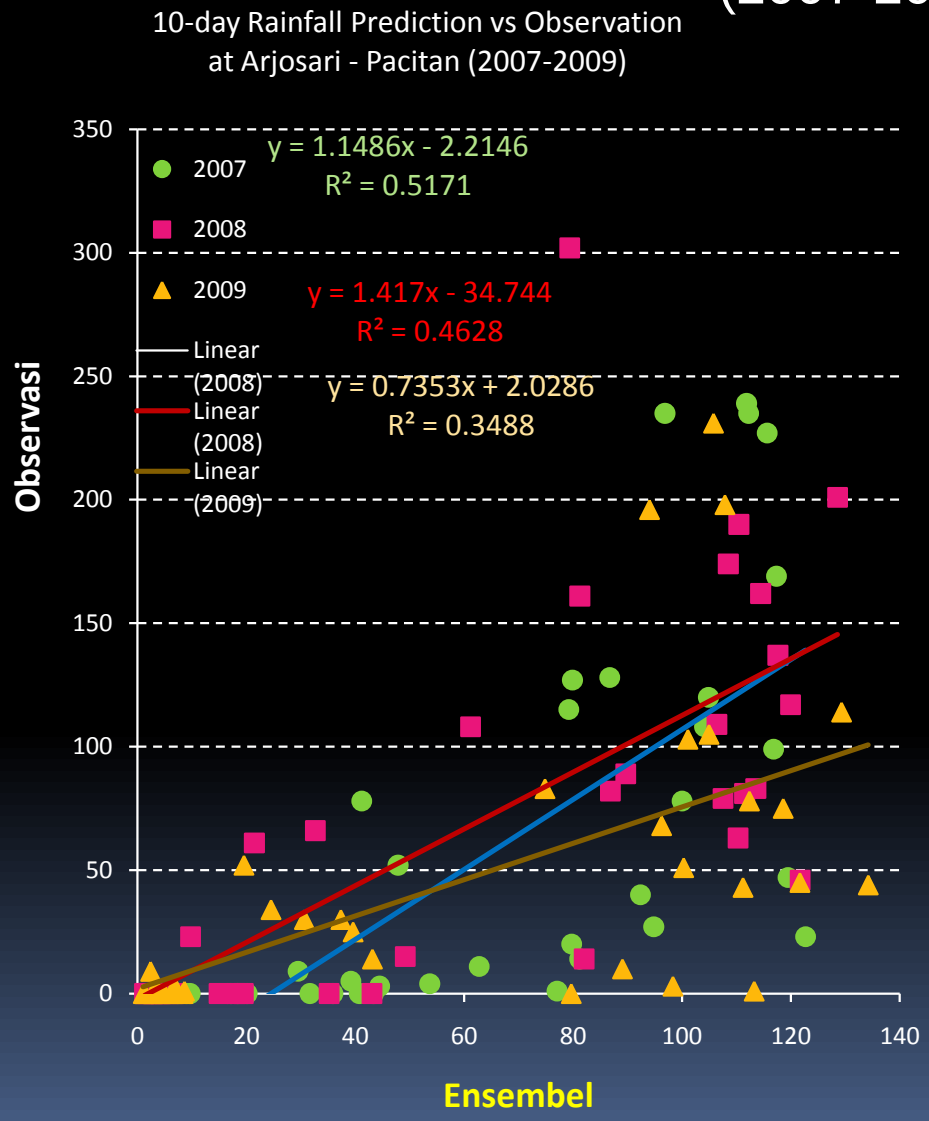
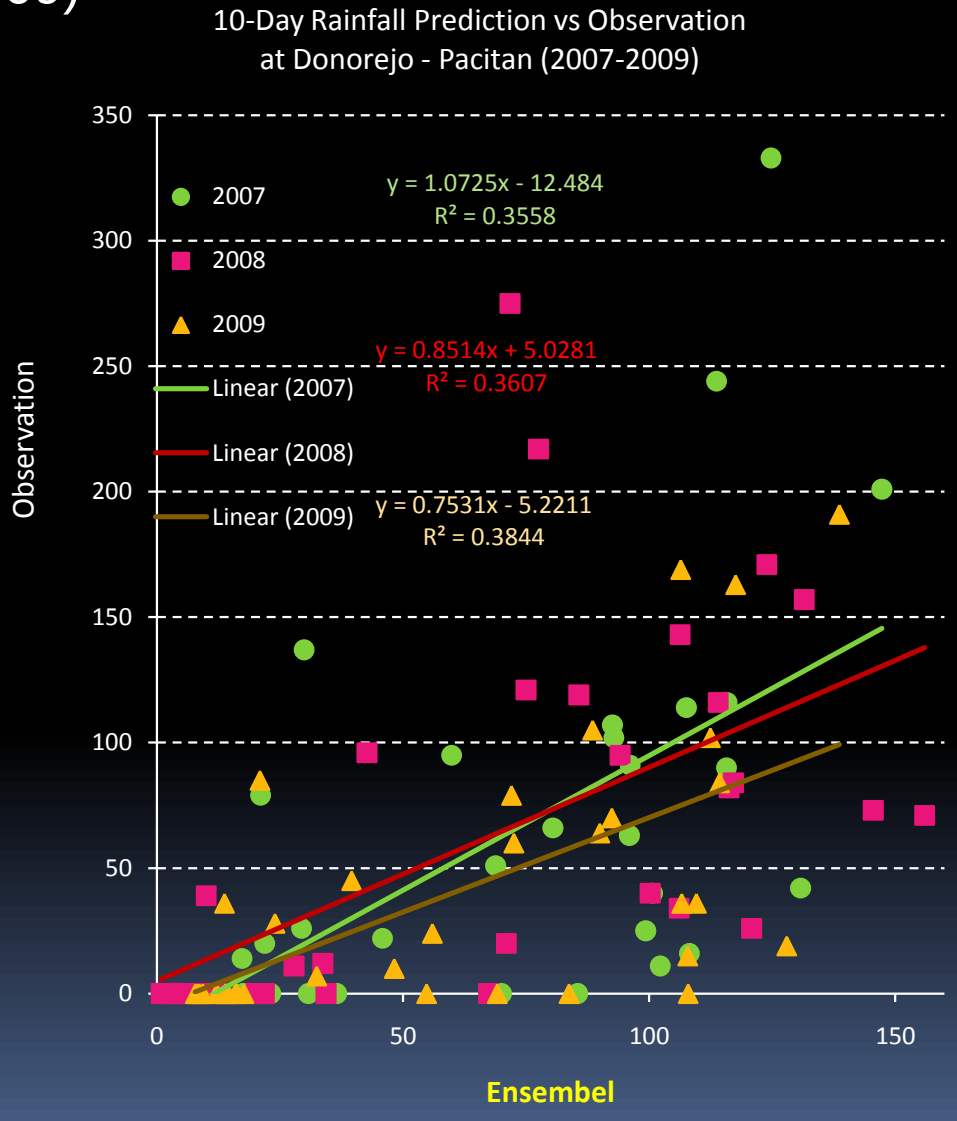
Correlation 10-Day Rainfall Prediction vs Observation in Pacitan (2007-2009)





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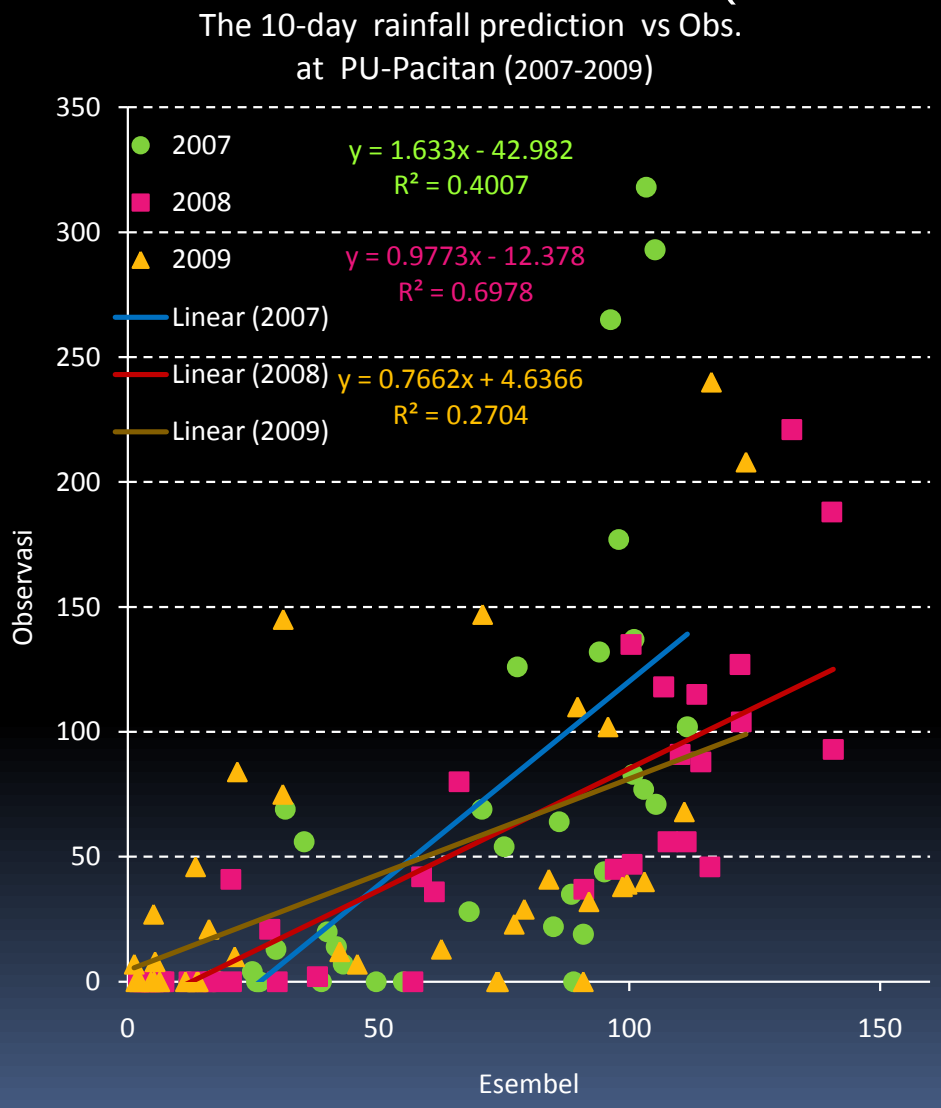
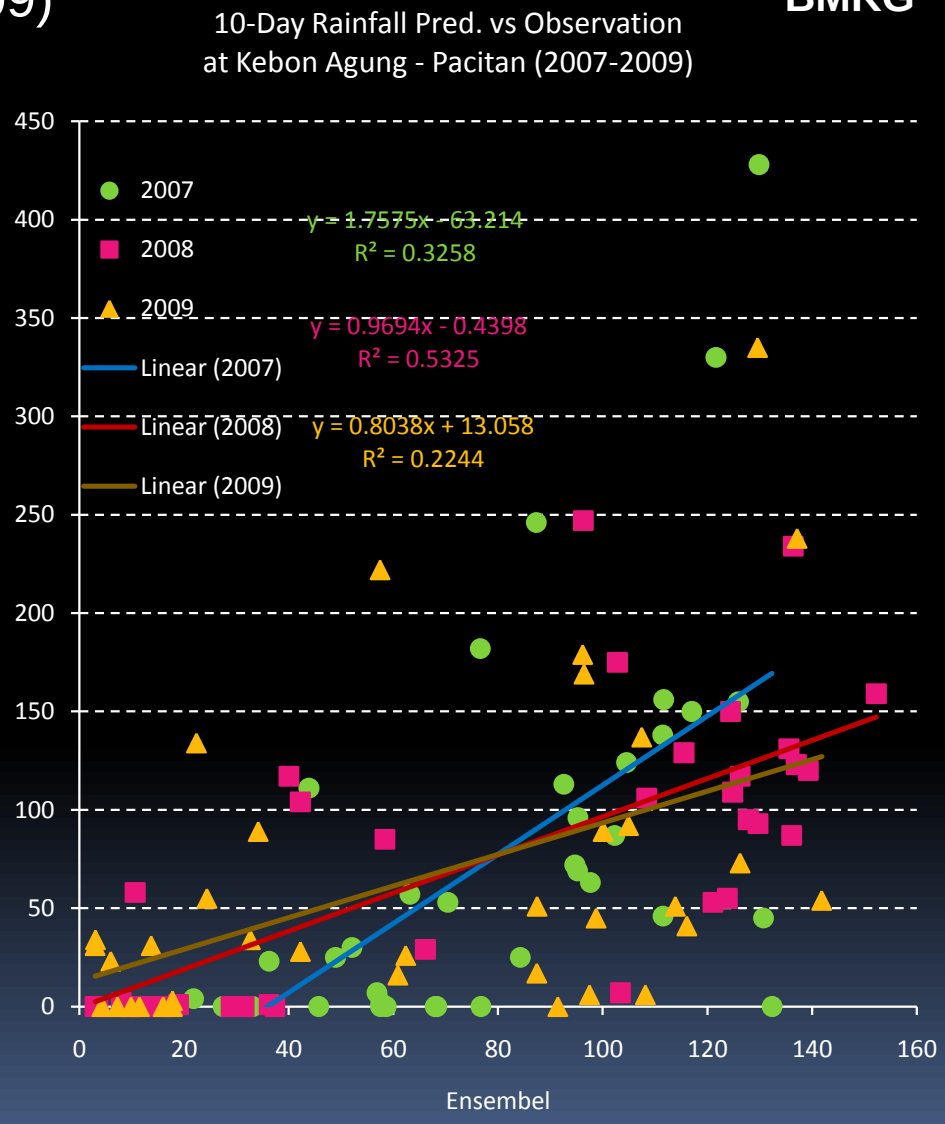
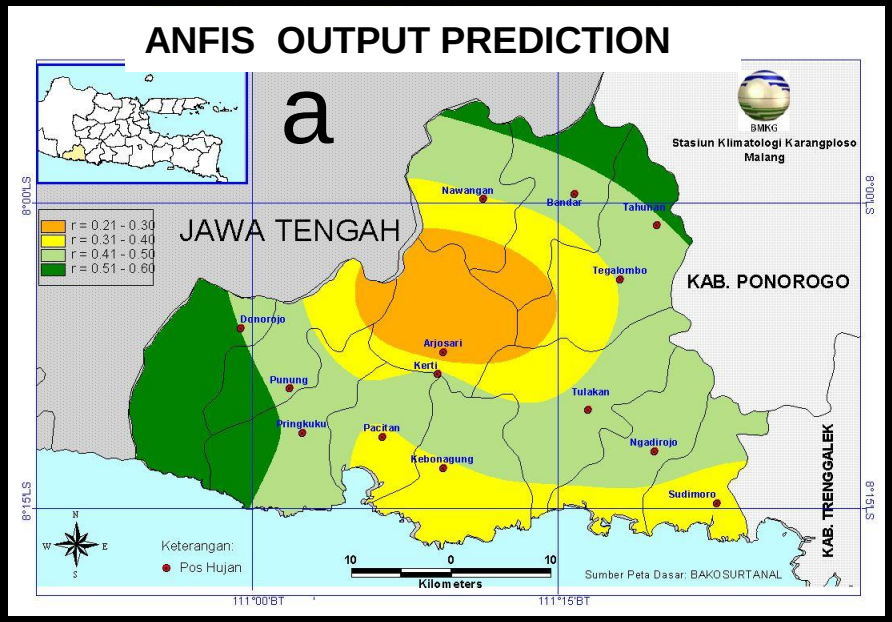
Correlation 10-Days Rainfall Prediction vs Observation in Pacitan (2007-2009)

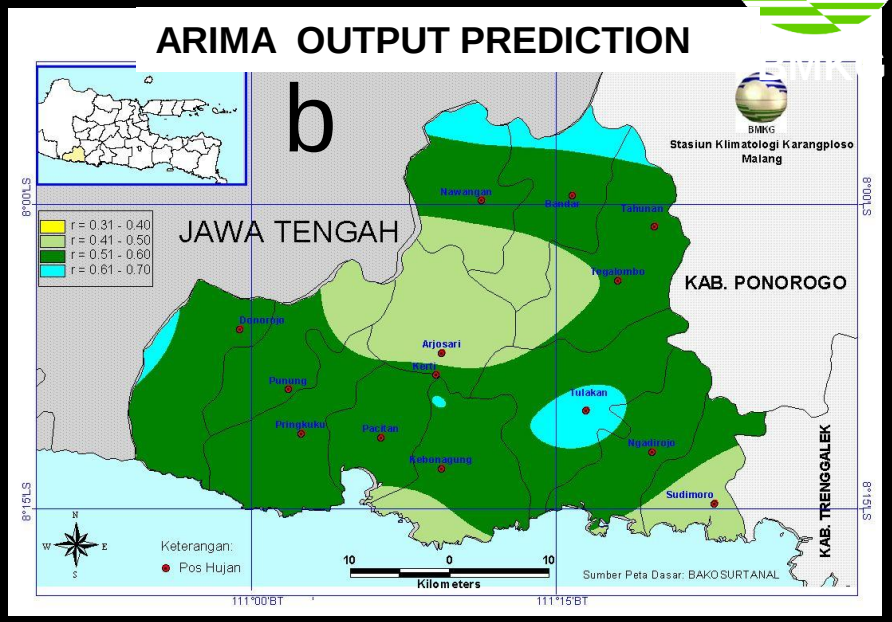




ANFIS OUTPUT PREDICTION



ARIMA OUTPUT PREDICTION



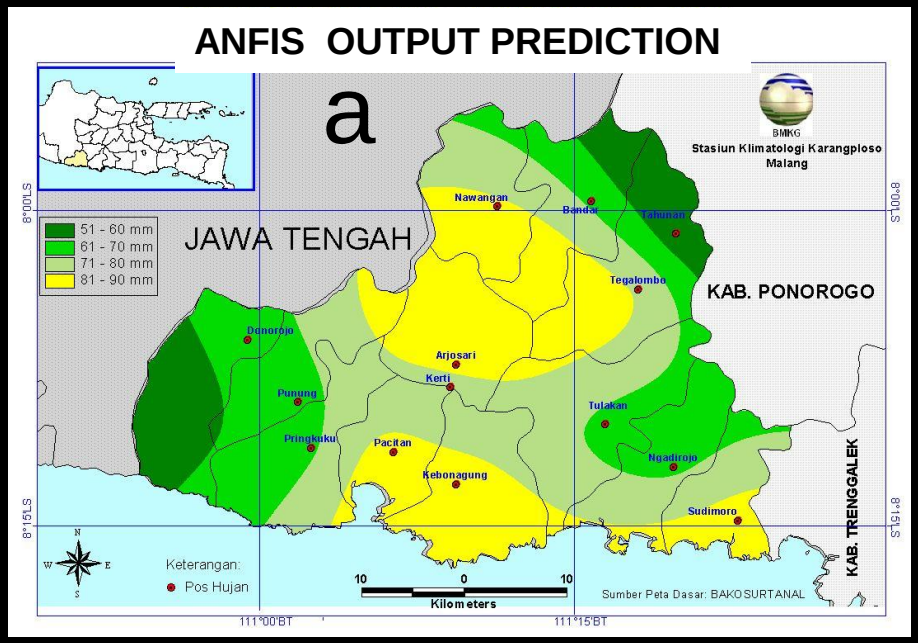
WAVELET OUTPUT PREDICTION

CORRELATION (r) FOR 10-DAYS RAINFALL PREDICTION WITH HyBMG METHOD (ANFIS (a) ARIMA (b), WAVELET (c)) BASED ON 2000-2009 AT PACITAN DISTRICT EAST JAVA PROVINCE

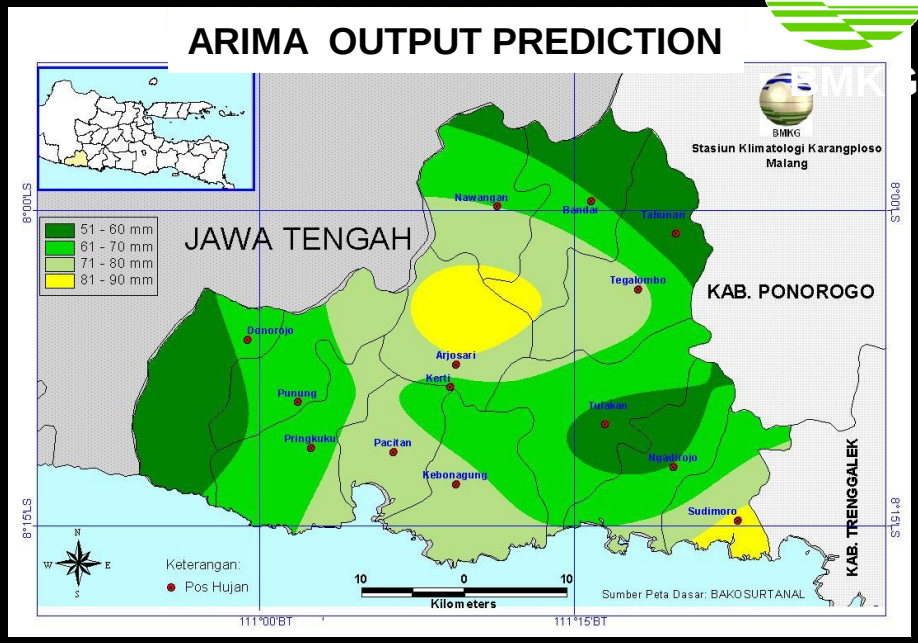
r > 0.50 / 10-day

r < 0.50 / 10-day

ANFIS OUTPUT PREDICTION



ARIMA OUTPUT PREDICTION

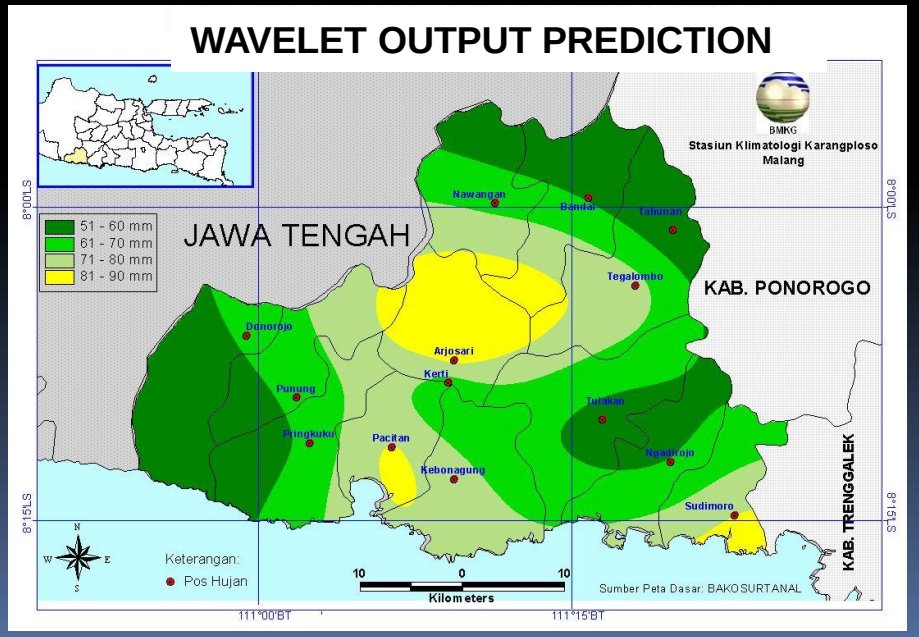


RMSE VALUE FOR 10-DAYS RAINFALL PREDICTION WITH HyBMG METHOD : ANFIS (a) ARIMA (b), WAVELET (c) BASED ON 2000-2009 AT PACITAN DISTRICT EAST JAVA PROVINCE

< 60 mm / 10-day

> 70 mm / 10-day

WAVELET OUTPUT PREDICTION



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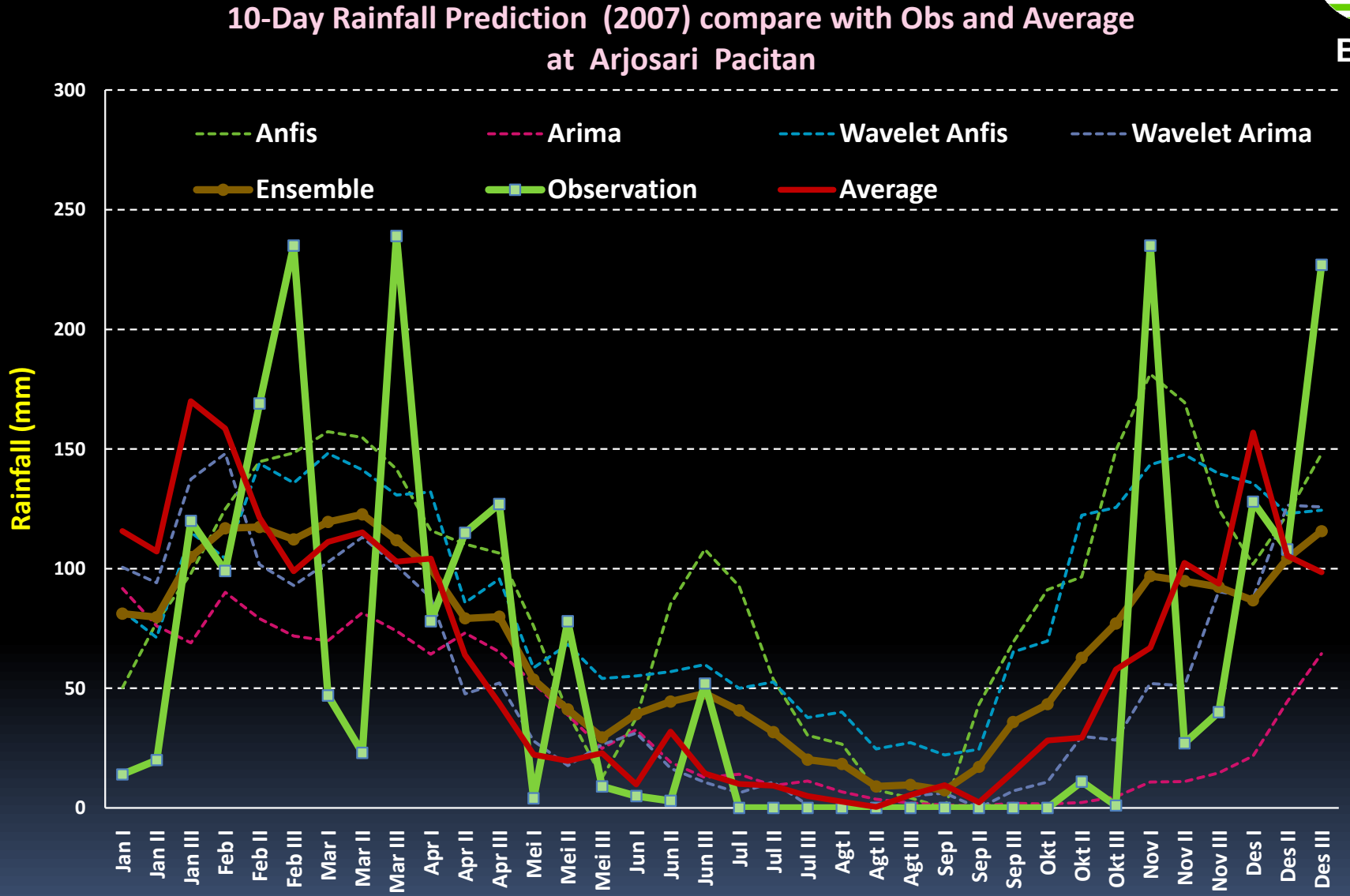
10-Day Rainfall Prediction (2007) compare with Obs and Average
at Arjosari Pacitan
Anfis
Arima
Wavelet Anfis
Wavelet Arima
Ensemble
Observation
Average
Rainfall (mm)
300
250
200
150
100
50
0
Jan I
Jan II
Jan III
Feb I
Feb II
Feb III
Mar I
Mar II
Mar III
Apr I
Apr II
Apr III
Mei I
Mei II
Mei III
Jun I
Jun II
Jun III
Jul I
Jul II
Jul III
Agt I
Agt II
Agt III
Sep I
Sep II
Sep III
Okt I
Okt II
Okt III
Nov I
Nov II
Nov III
Des I
Des II
Des III

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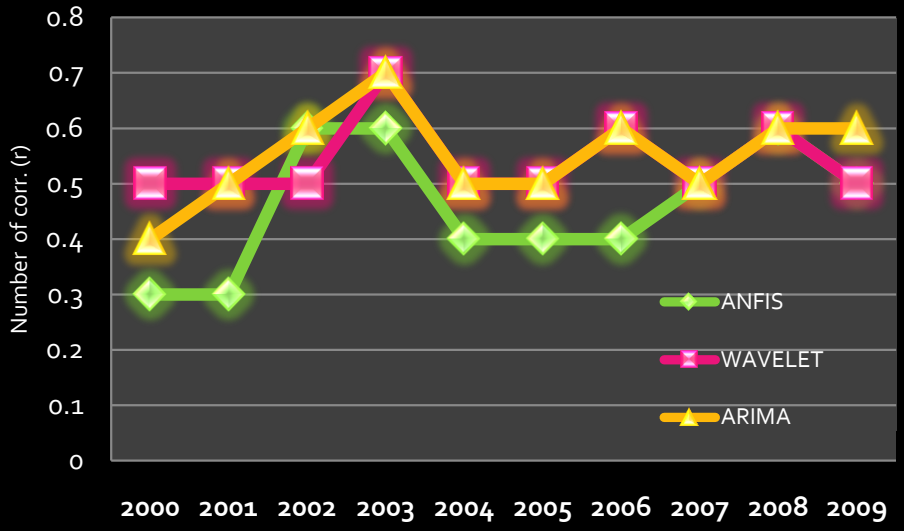
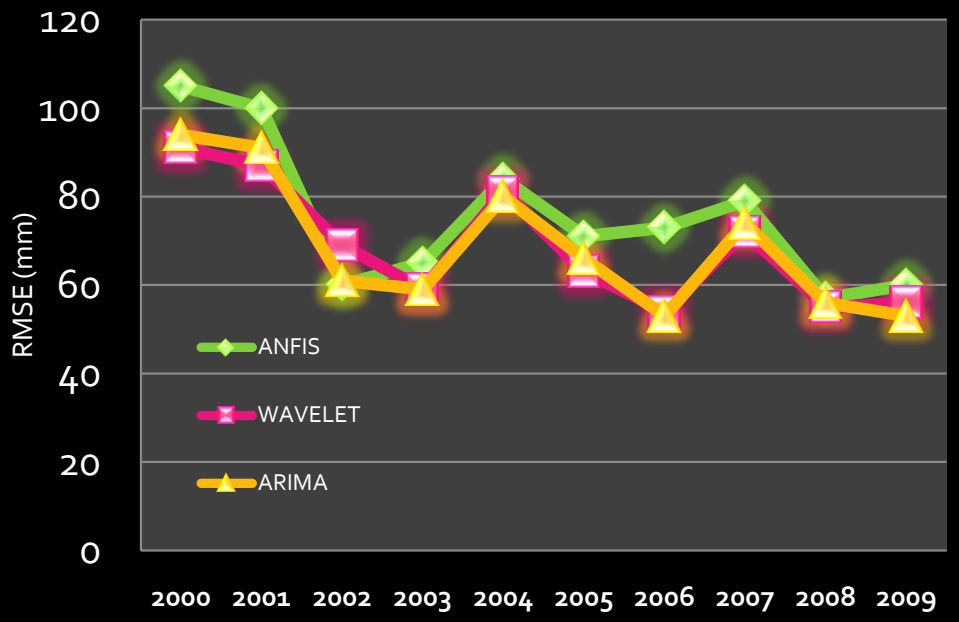


ANNUAL COORELATION (r) FOR 10-DAYS RAINFALL PREDICTION AT PACITAN (2000-2009)



ANNUAL RMSE FOR 10-DAYS RAINFALL PREDICTION AT PACITAN (2000-2009)

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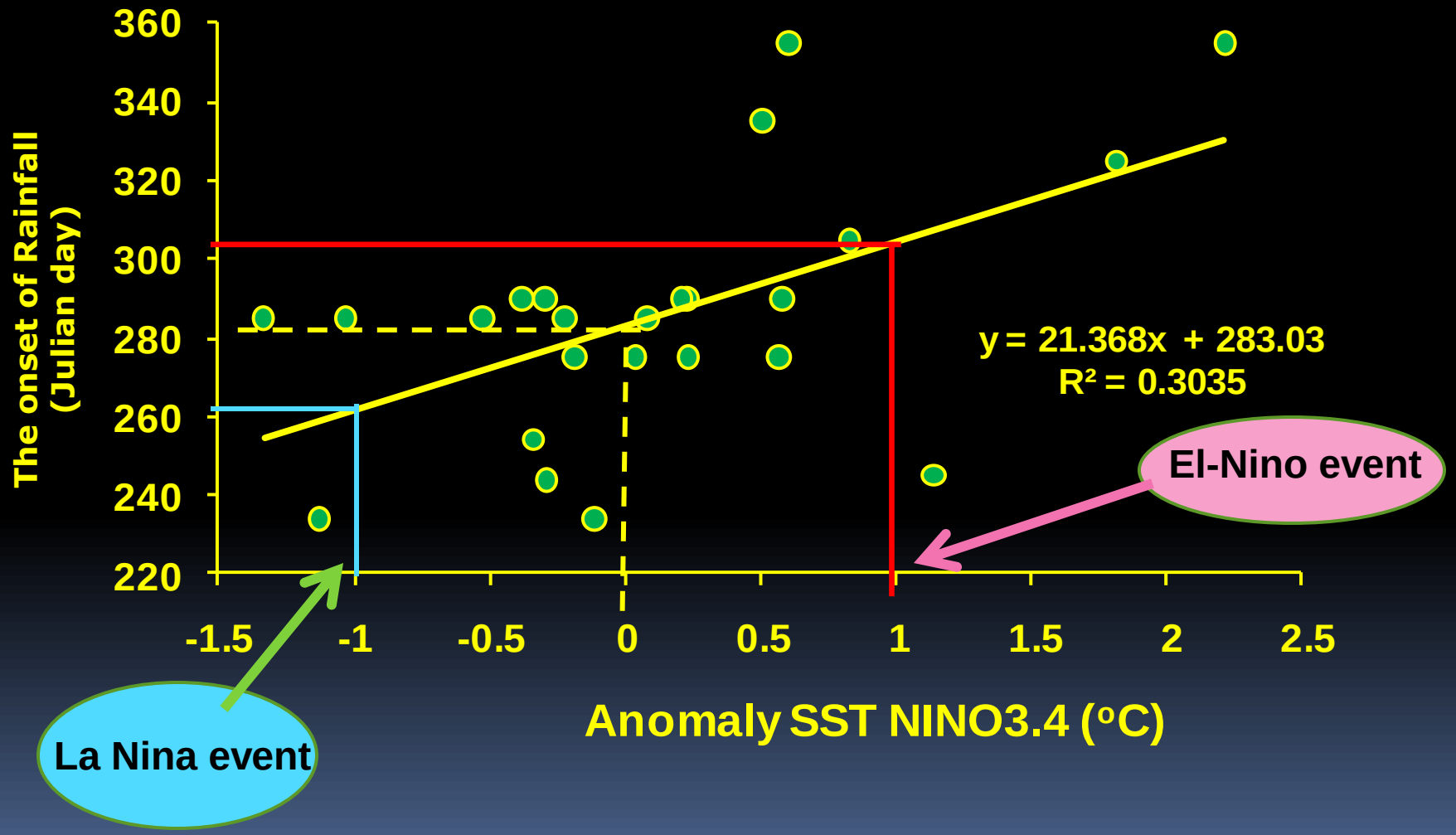
The correlation between anomalies SST Nino 3.4 and the onset of the rainy season at Pringkuku Pacitan East Java



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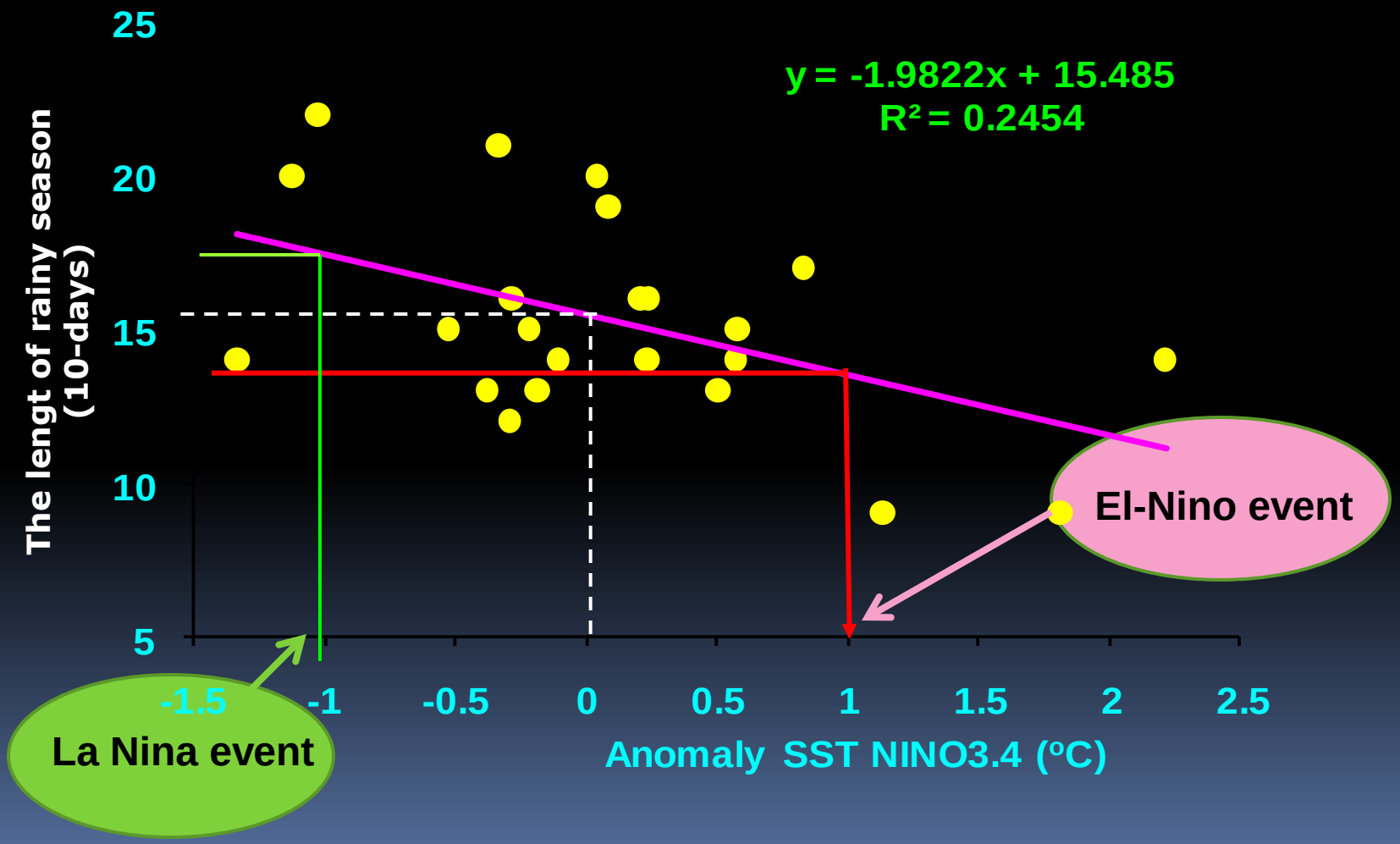
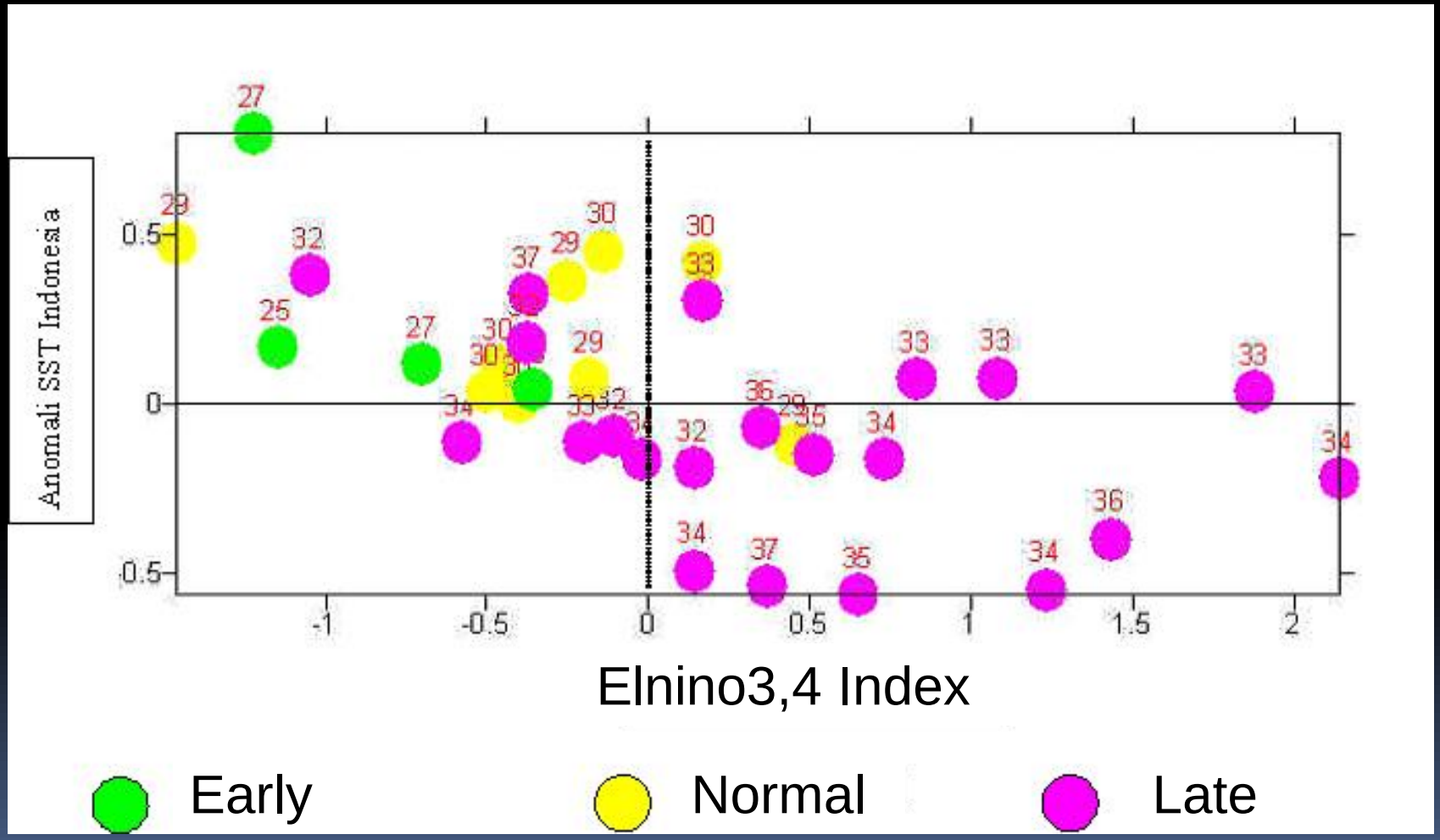
The correlation between SST Nino 3.4 and lengt of the rainy season at Pringkuku Pacitan East Java



BMKG

Impact of Elnino and Indonesia SSTA for Onset of Rainy Season in Blitar East Java



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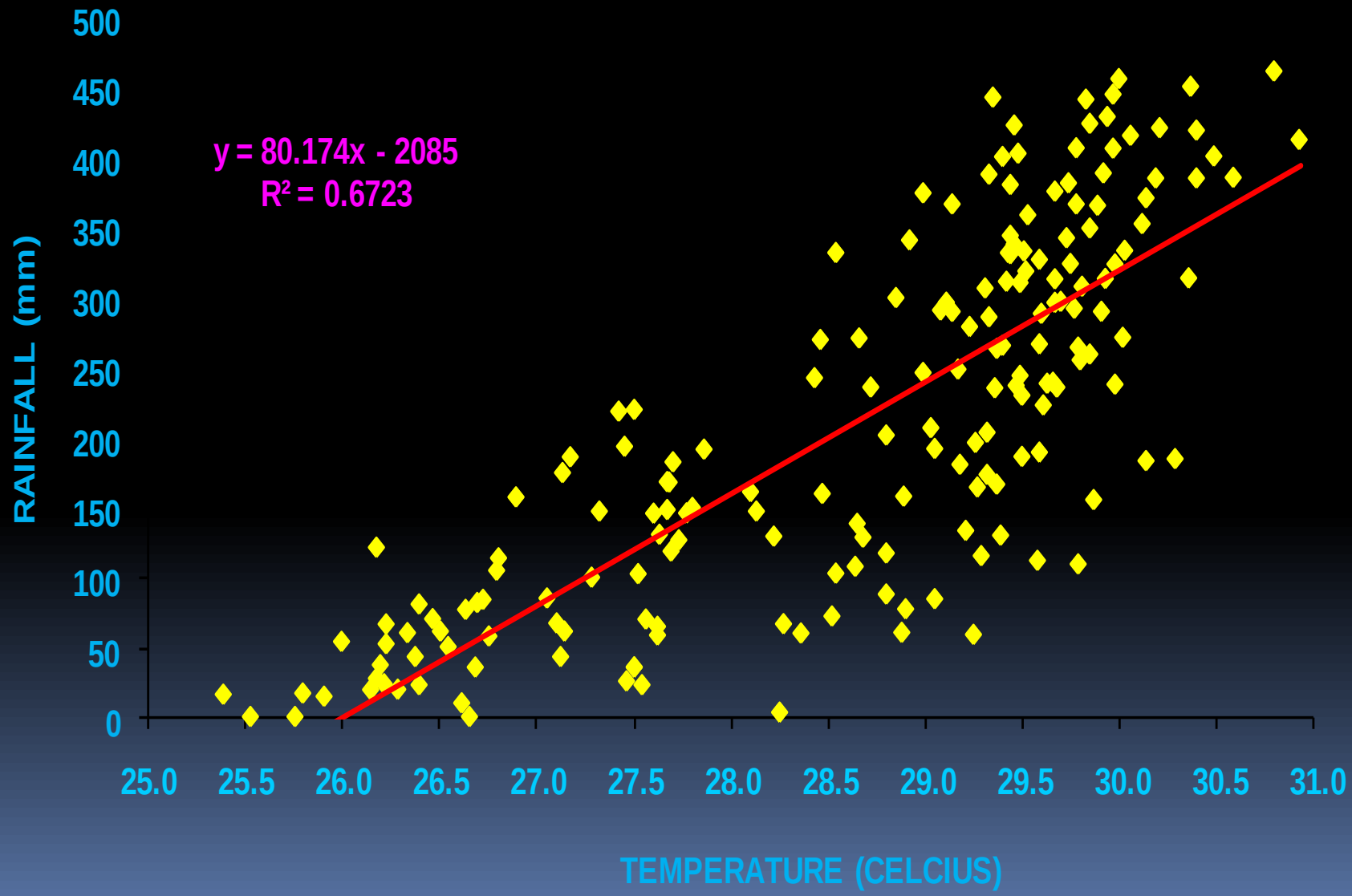
THE CORRELATION BETWEEN SST 19 (SOUTH NTT) WITH MONTHLY RAINFALL AT PRINGKUKU PACITAN EAST JAVA



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VERYFICATION THE ONSET SEASONAL PREDICTION AT PACITAN (2008-2009)

FCST VS OBS	SEASONAL ZONE NO. 84	SEASONAL ZONE NO.85
RAIN ONSET FCST 2008/2009	Oct - III	Nov I
OBS 2008/2009	Nov - I	Nov I
DRY ONSET FCST 2009	Apr I – Apr III	Apr II – May I
OBS 2009	Apr II	April I
RAIN ONSET FCST 2009/2010	Oct III - Nov II	Nov II - Dec I
OBS 2009/2010	Nov II	Nov III

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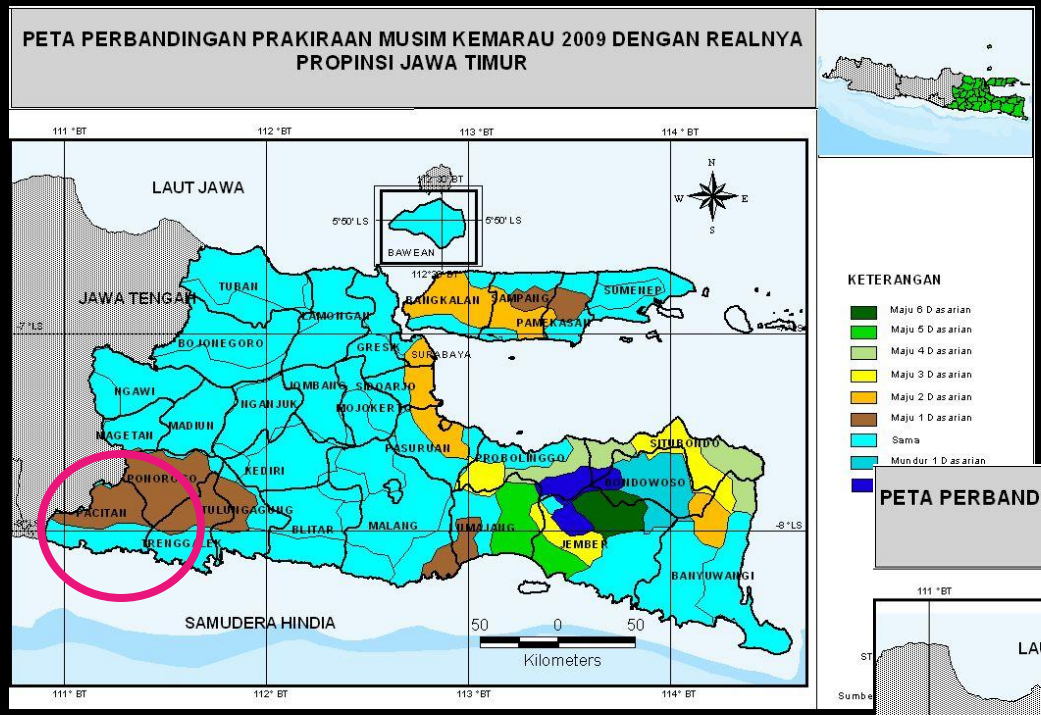
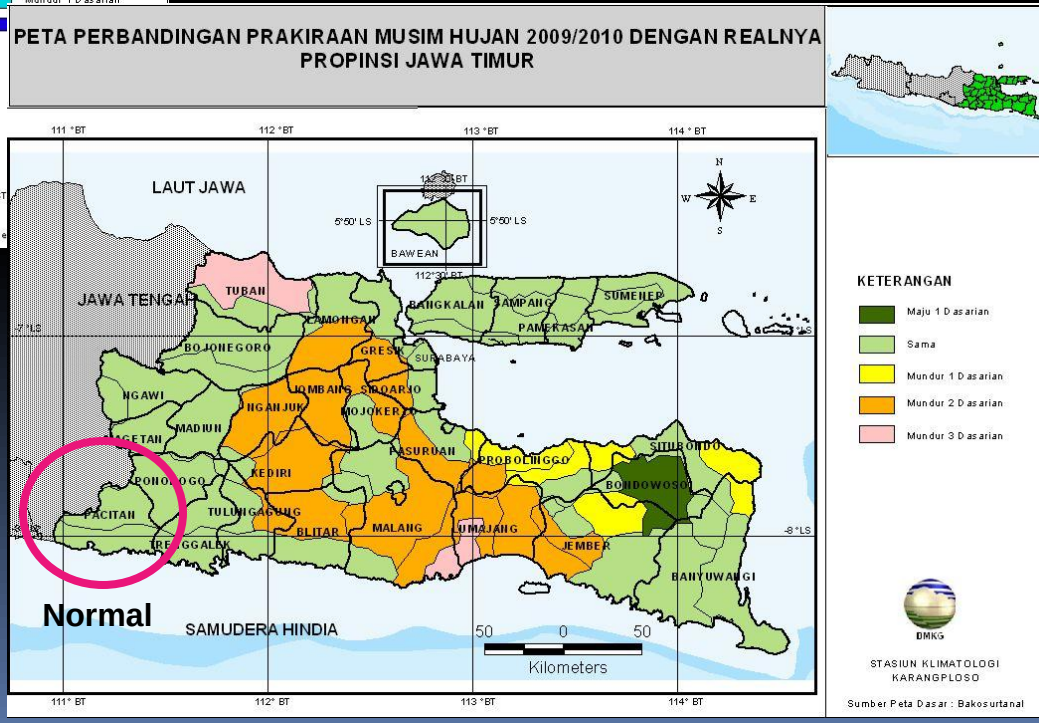
VERYFICATION THE ONSET SEASONAL PREDICTION AT PACITAN (2008-2009)



The onset of dry season forecast 2009 compare with the normal (1971-2000)

- Ealry a 10-days
- Normal



The onset of rainy season forecast 2009 compare with the nprmal (1971-2000)

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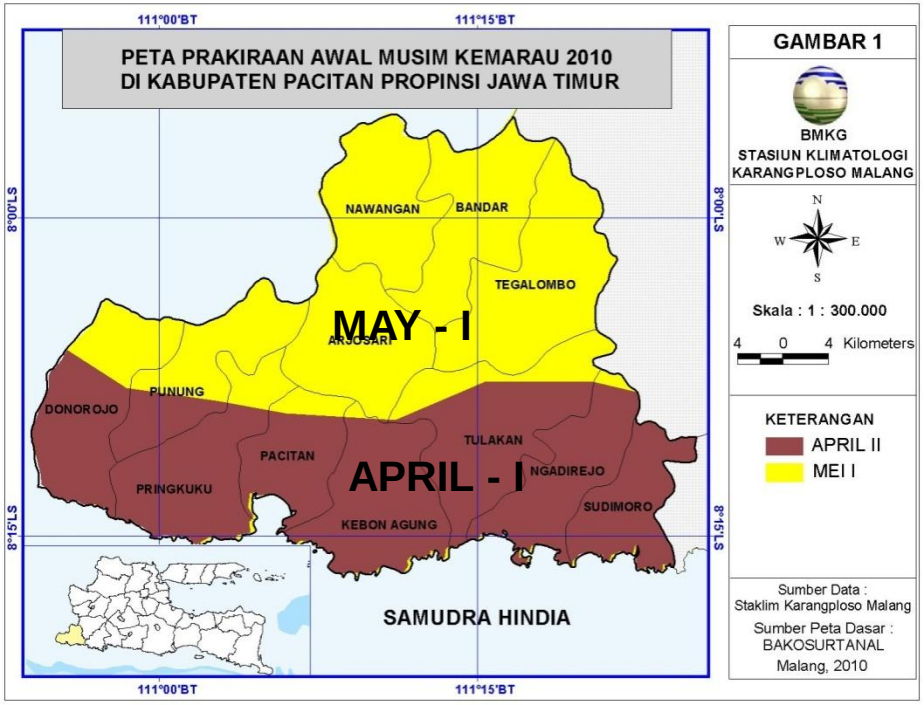
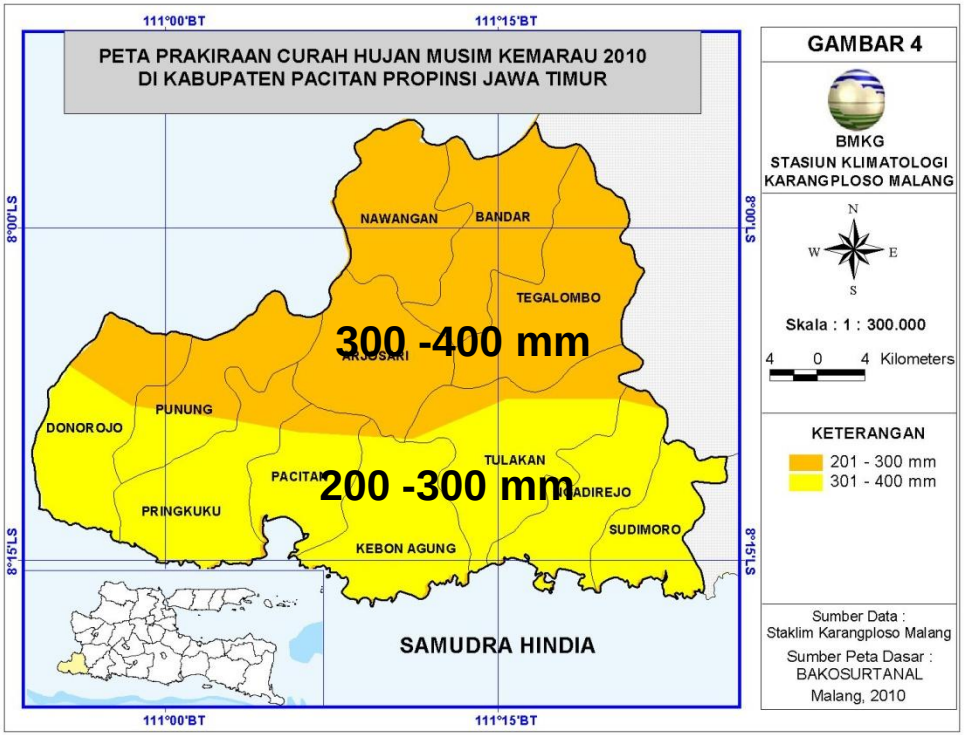
THE DRY SEASON PREDICTION 2010 AT EAST JAVA PROVINCE



THE ONSET OF DRY SEASON PREDICTION 2010 AT PACITAN - EAST JAVA

THE RAINFALL DURING DRY SEASON PREDICTION 2010 AT PACITAN EAST JAVA



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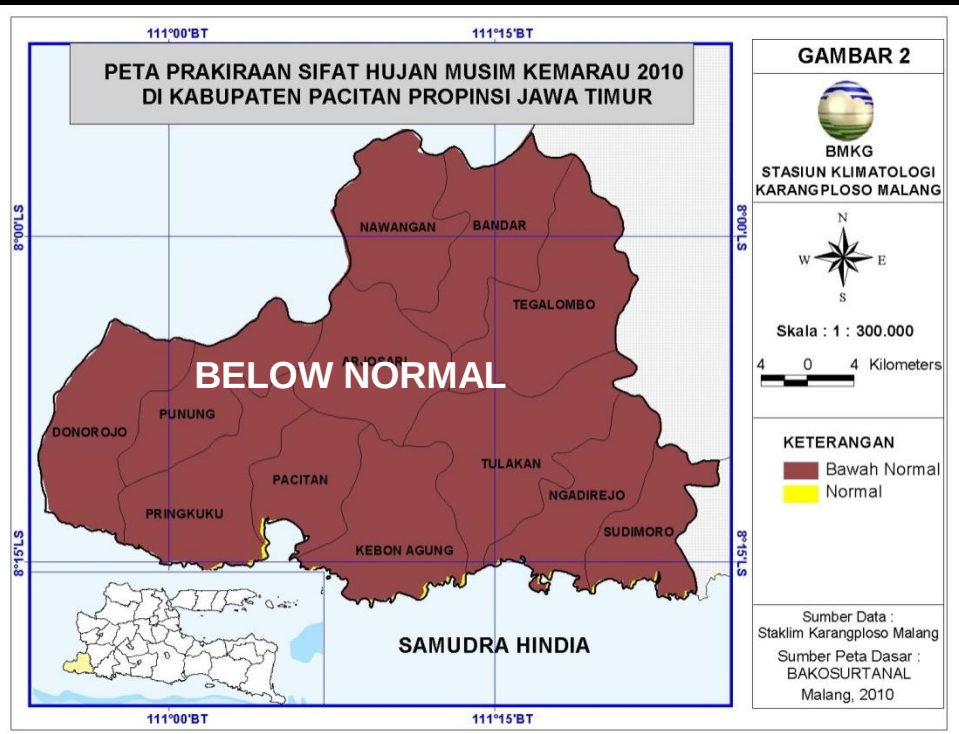
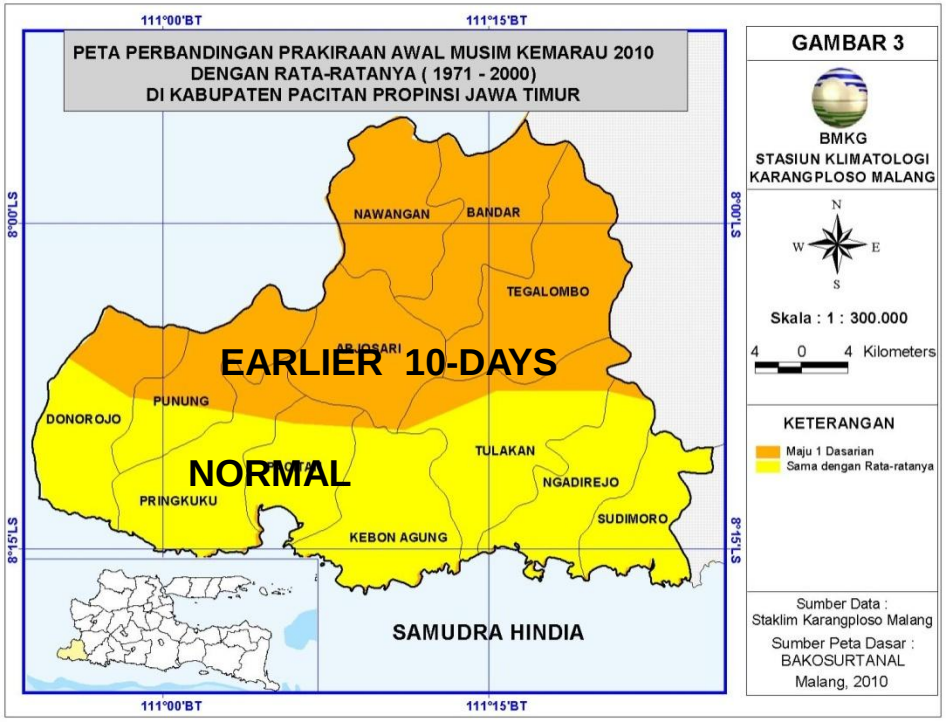
THE DRY SEASON PREDICTION 2010 AT EAST JAVA PROVINCE

CHARACTERISTIC FOR THE ONSET OF DRY SEASON PREDICTION 2010 AT PACITAN - EAST JAVA





THE CONDITION FOR THE ONSET OF DRY SEASON PREDICTION 2010 BASED NORMAL (1971-2000) AT PACITAN - EAST JAVA

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Conclusion

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(a) The HyBMG method's output shows 69% (9 of 13 raingauge stations) with r > 0.5 which ARIMA technique result most area coverage. For RMSE value show < 60 mm per 10-days which 38% by ARIMA technique in Pacitan East Java.

(b) Validation for the onset of rain season prediction in Pacitan derived from 3 models most better than the onset of dry season.

(c) The correlation betwen the SST at the Pacific Ocean (Nino 3.4) and the Hindia Ocean (South of East Nusatenggara) with the onset and the lengt of rainy season at Pacitan is relatively shows a good result.

(d) To improve the HyBMG method, it would be develop by multivariat technique with the ENSO, IOD, MJO and SOI index.

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Thank You

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