Climate change studies and downscaling activities in Indonesia

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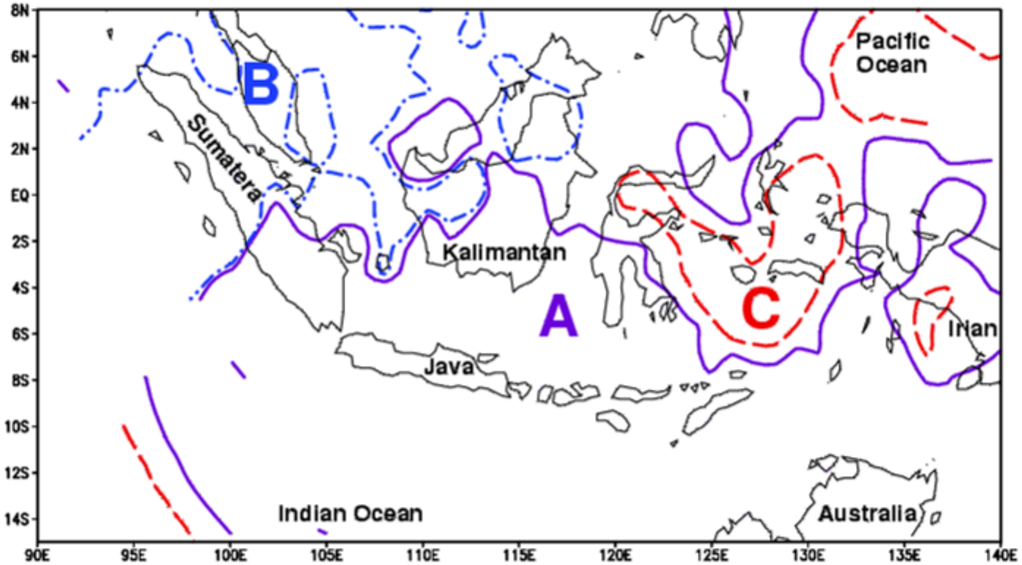
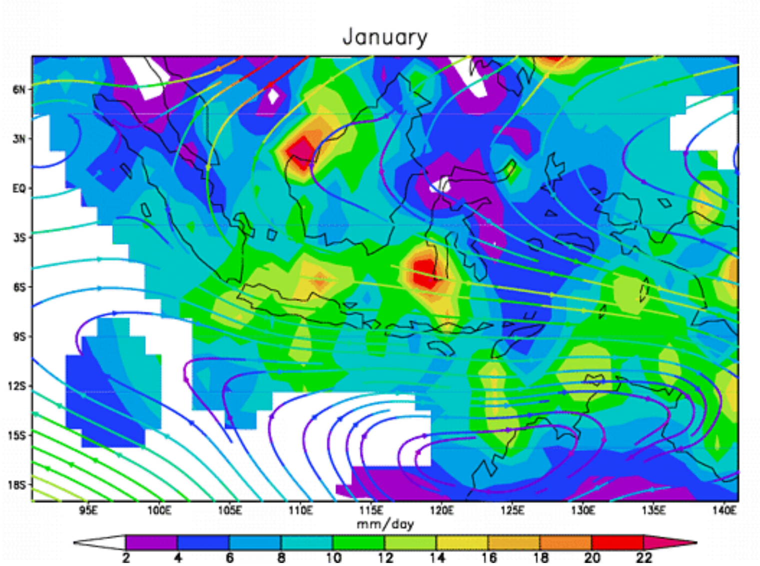
Outline

- Background
- Climate background of the maritime continent
- Climate Change science
- El Nino and Indonesian climate
- Climate Change Policy in BMKG
- Human resource development and future collaboration

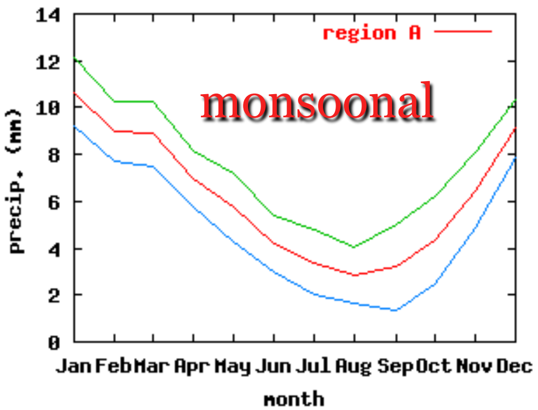
Climatology of regional rainfall

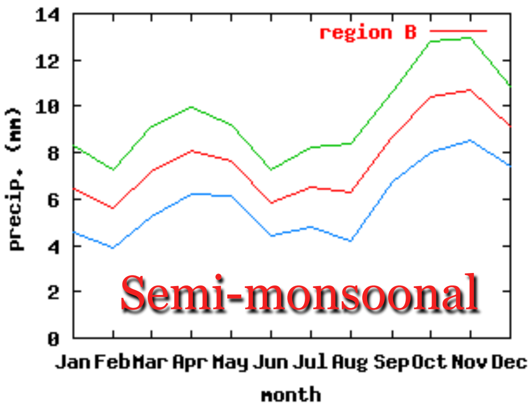
- Mainly monsoonal
- Three distinct rainfall climate regions

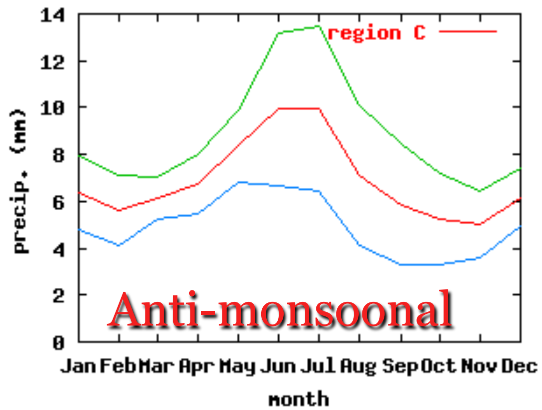




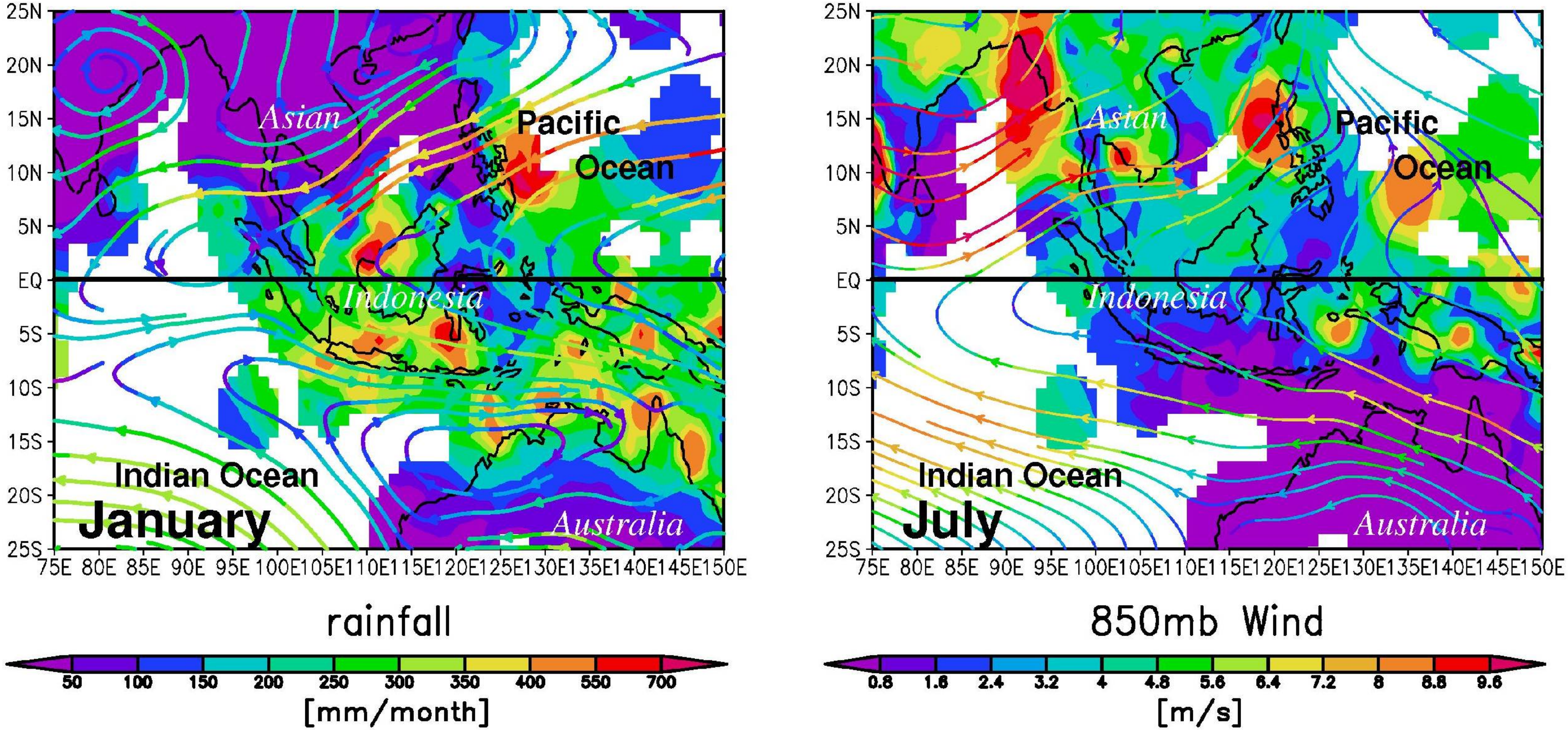
Aldrian and Susanto, 2003, Intl J Climatol.



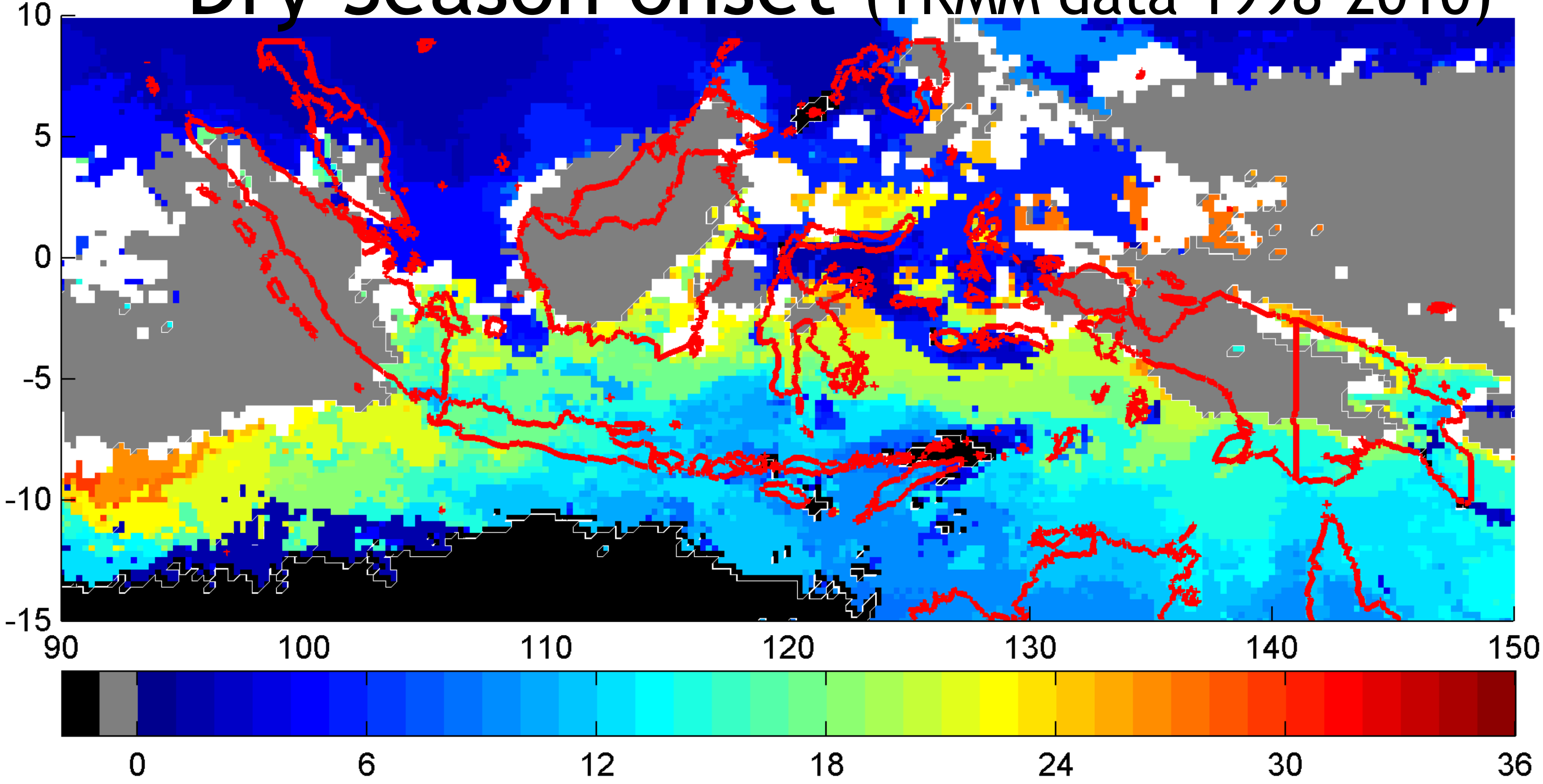




Monsoonal climatology of Southeast Asia



Dry Season onset (TRMM data 1998-2010)

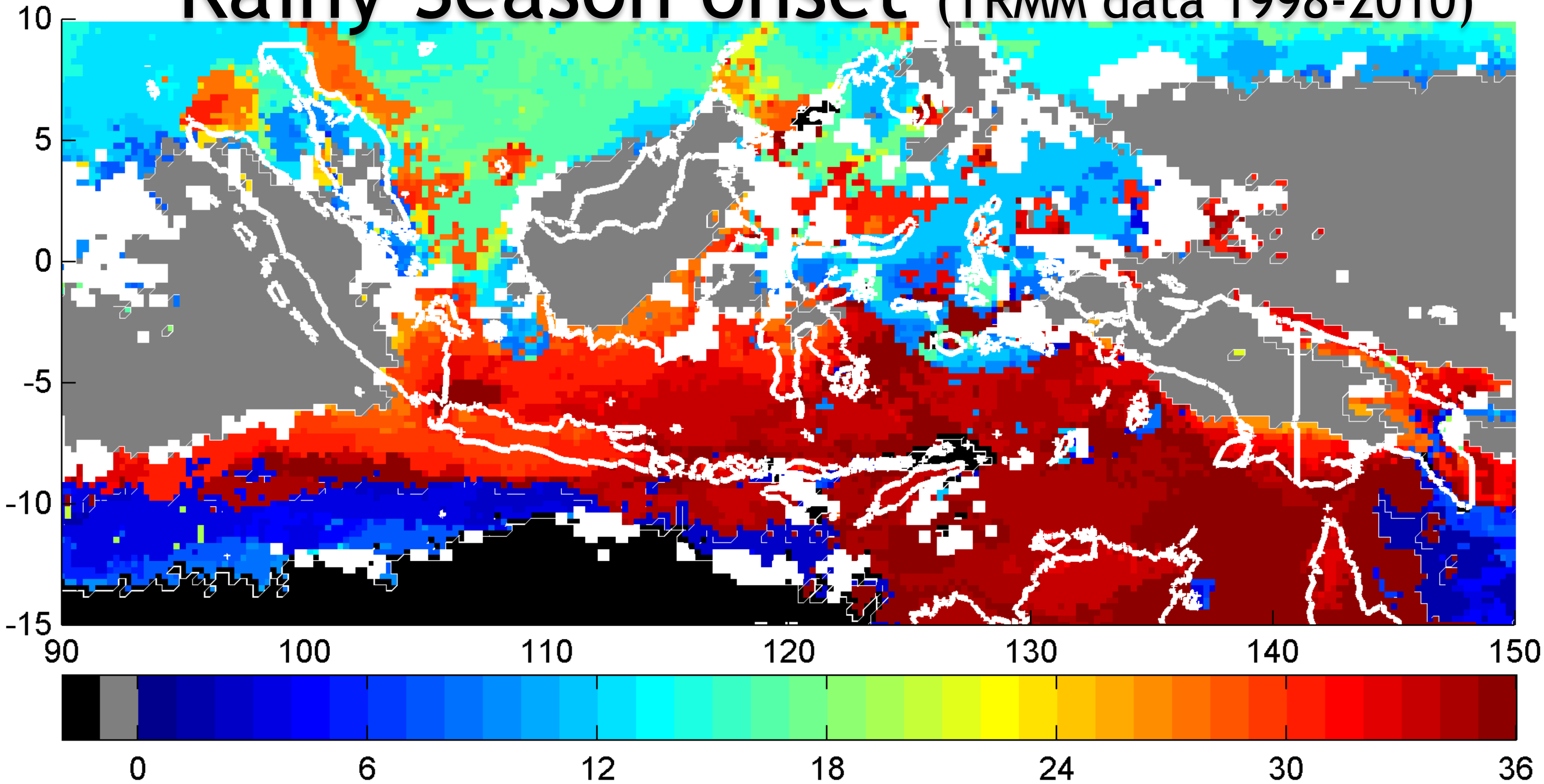


Area with rainfall > 50mm/10 days (Non Monsoon)

Areas with rainfall < 50mm/10 days (Non Monsoon)

Colour indicates 10 days

Rainy Season onset (TRMM data 1998-2010)

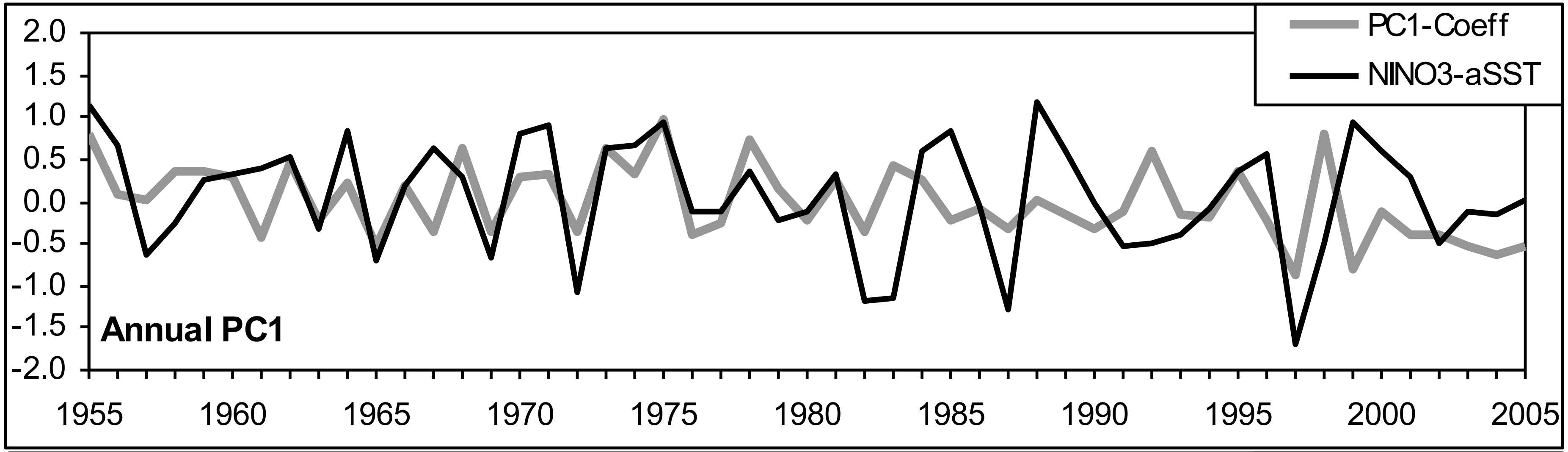


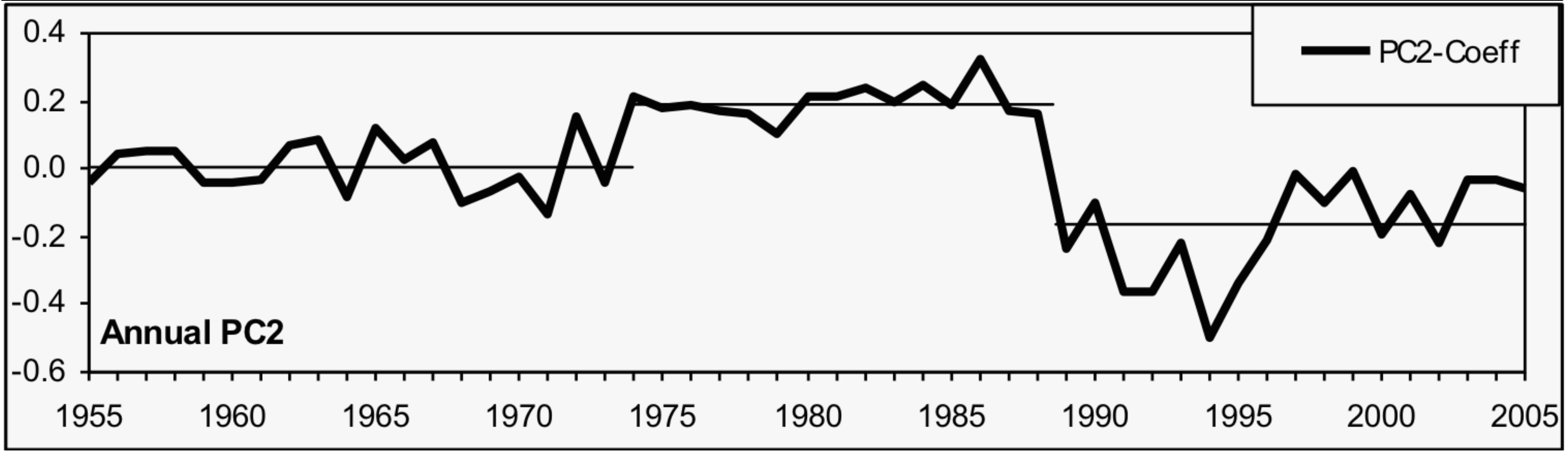
Area with rainfall > 50mm/10 days (Non Monsoon)

Areas with rainfall < 50mm/10 days (Non Monsoon)

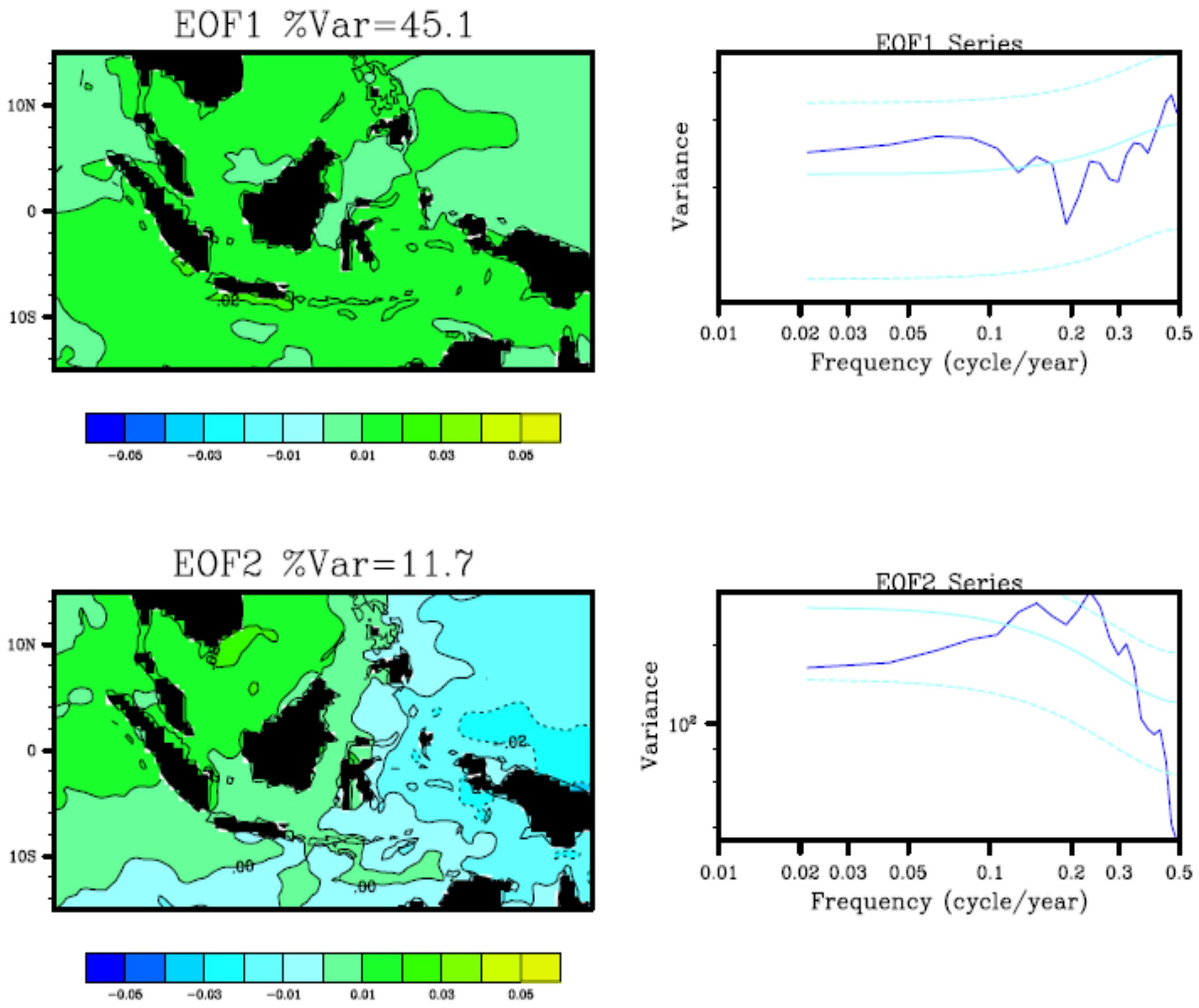
Colour indicates 10 days

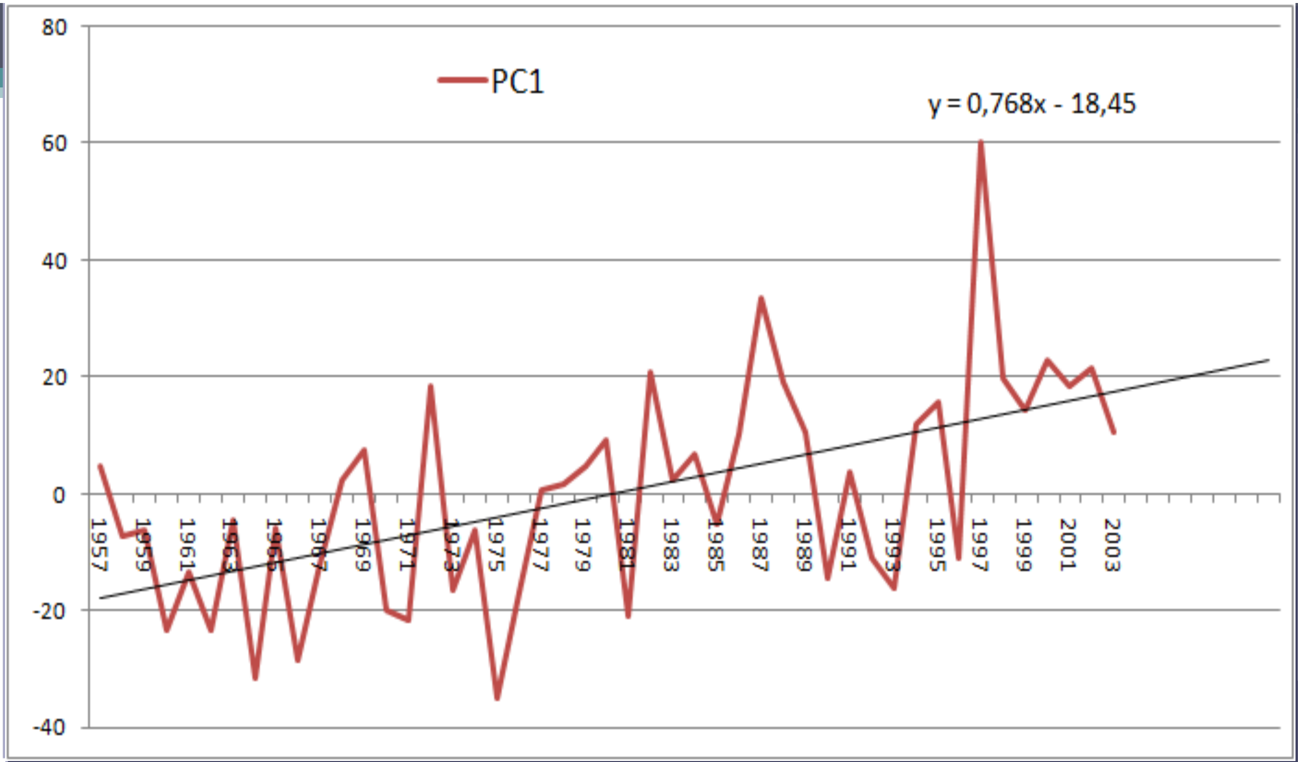
The leading annual eigen coefficients of PC1 and PC2 (black lines) along with the NINO3 aSST (grey lines; in unit °C) for the PC1. For the PC2, the linear straight grey lines highlight the bi-decadal variability at level 0.0, 0.2 and -0.18 during the period 1955-1973, 1974-1988 and 1989-2005, respectively.

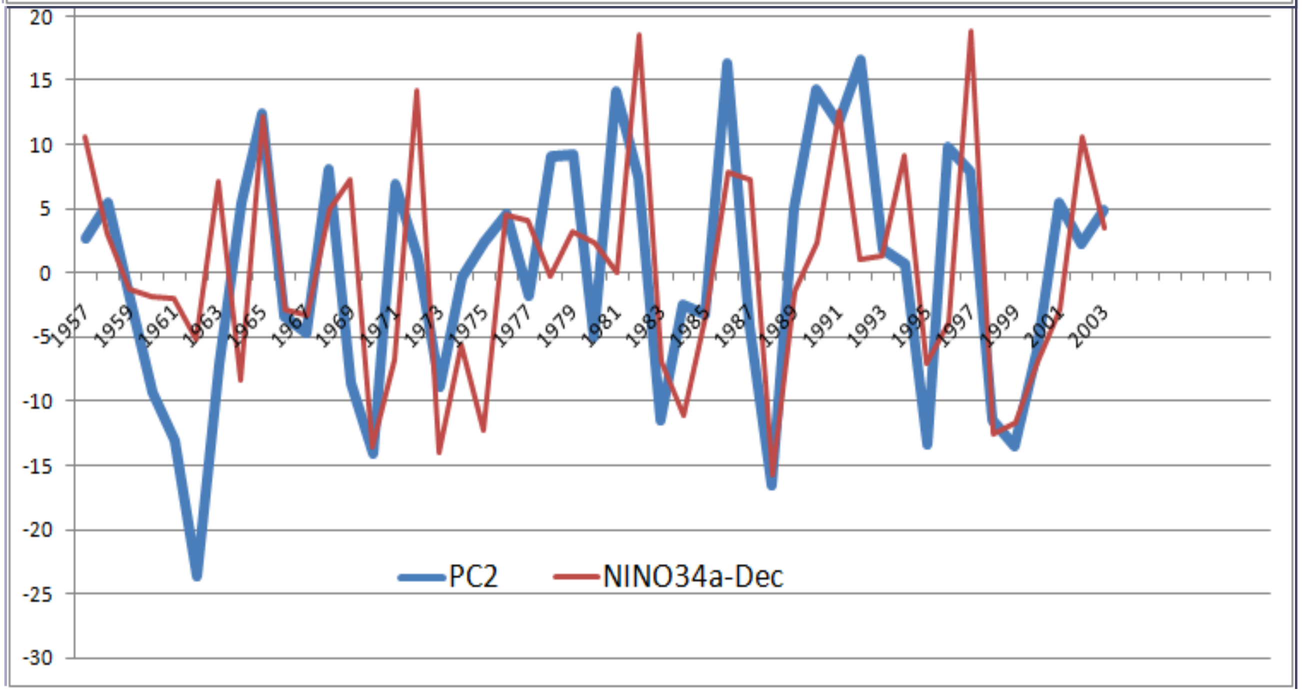




INDONESIA EOF SST– SODA (Int 47 Years monthly data–annual)







15LU – 15LS, 90 – 140BT

- First Principal component increase of SST 0.76C in 100 years
- Second Principal component is ENSO (El Nino) variability

Indonesia climate character from rainfall data

data of East Java (Aldrian and Djamil, 2008)

- The largest domination is from monsoon variability with 72% of variance means that monsoon contribute that much.
- ENSO is the second most dominant character of 49.9% variances (without monsoon).
- Decadal variability is the next dominant climate variability that dominate Indonesian climate with 8.29% variance (without monsoon).

Indonesia climate character from SST data

(15LU – 15LS, 90 – 140BT) between1957 - 2003

- The largest dominance comes from global warming phenomena with increase of SST (surface temperature) 0.0768°C. The dominance of global warming contribute to 45.1% variances.
- ENSO is the next largest climate phenomena that contribute to the ocean climate with contribution 11.7% variances.
- Indian Ocean Dipole (IOD) is the next largest dominance climate phenomena that contribute 9.2% variances. This is characterized with eigen map of upwelling in southwest Java.

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El Nino and Indonesian climate

During El Nino, the Indonesian water will be cooler → high surface pressure in the MC, winds from Australia will be diverted to the souththern coast of MC → create Ekman pumping and upwelling there → good for fishery there and western coast of Sumatera. Ironically cool SST will induce drought especially in the western part of MC or the eastern dipole of the Indian Ocean. Hence, most of El Nino will be associatively related to the positive Dipole Mode. Moreover El Nino usually shutdown the MJO potency in that year.

Impact of global warming on the evolution of El Nino (higher frequency) (present decade and last 3 decade)

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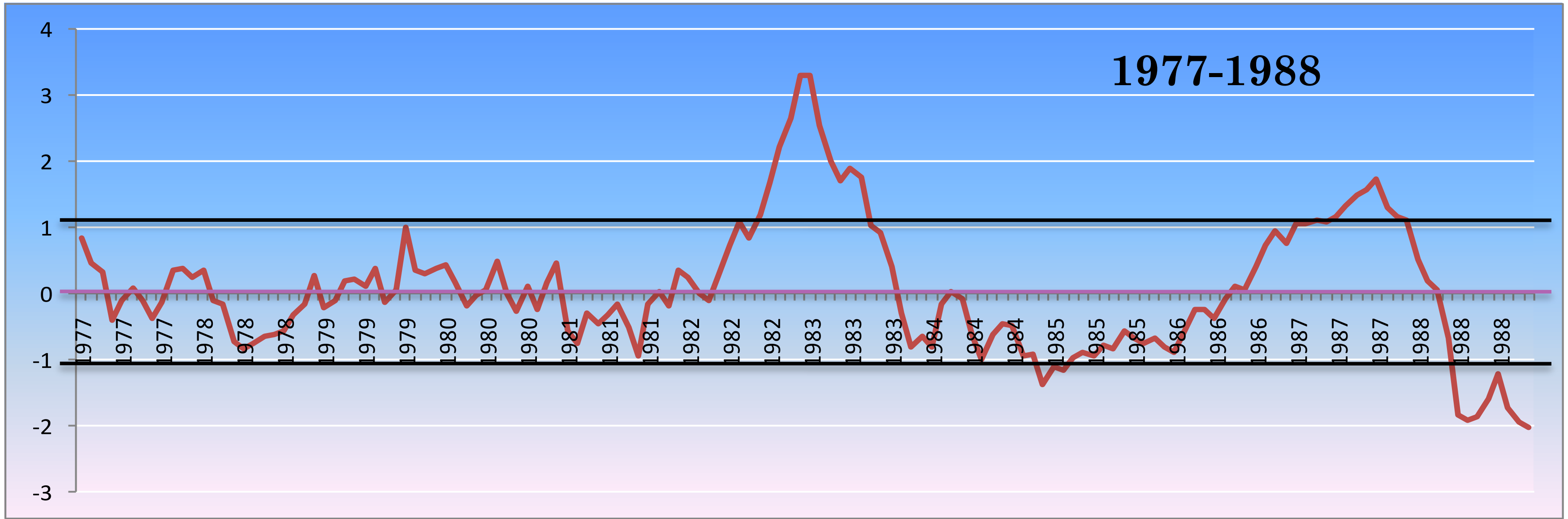

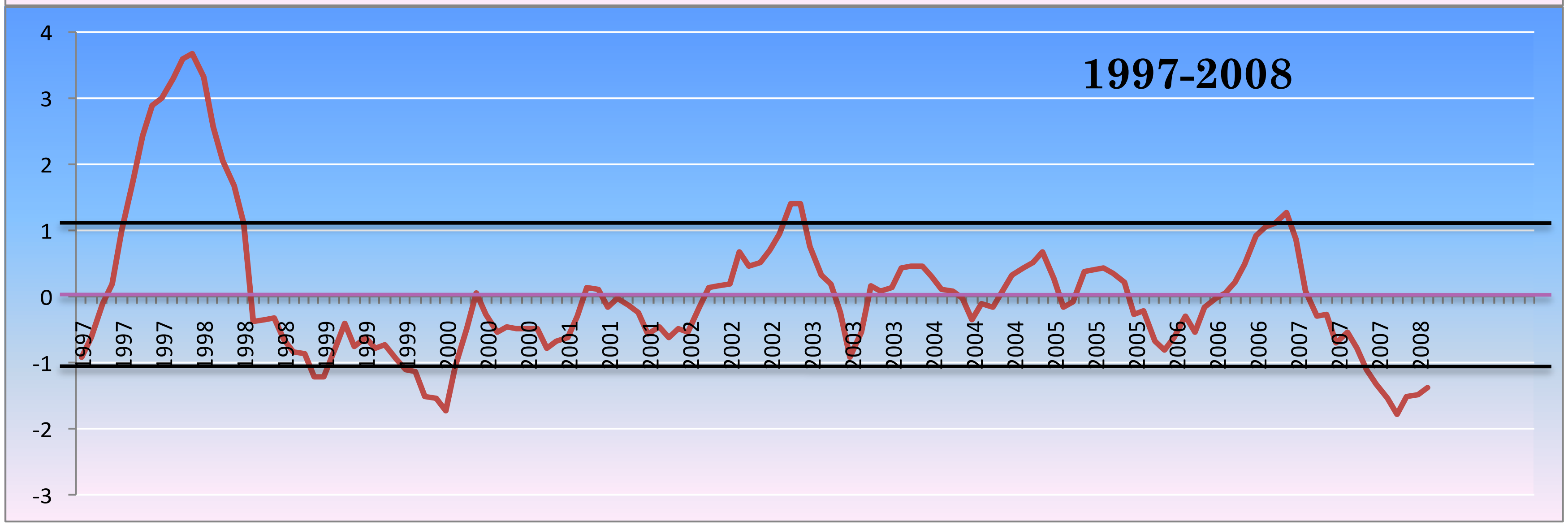

Impact of global warming on the evolution of El Nino (higher intensity)

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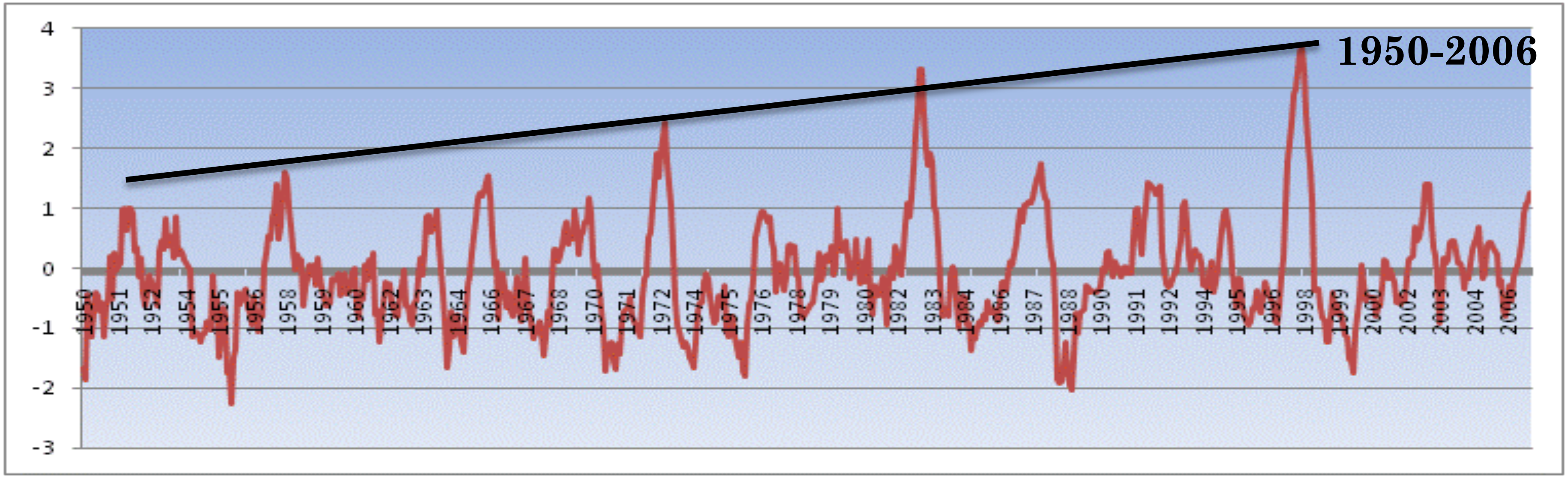

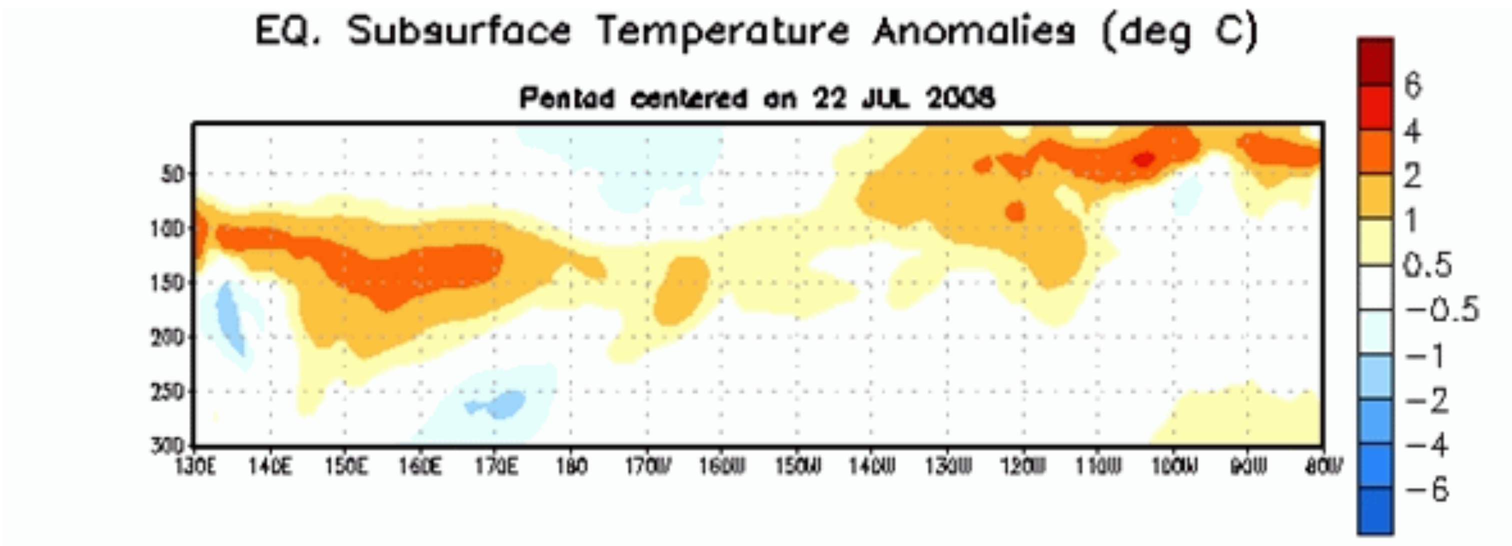

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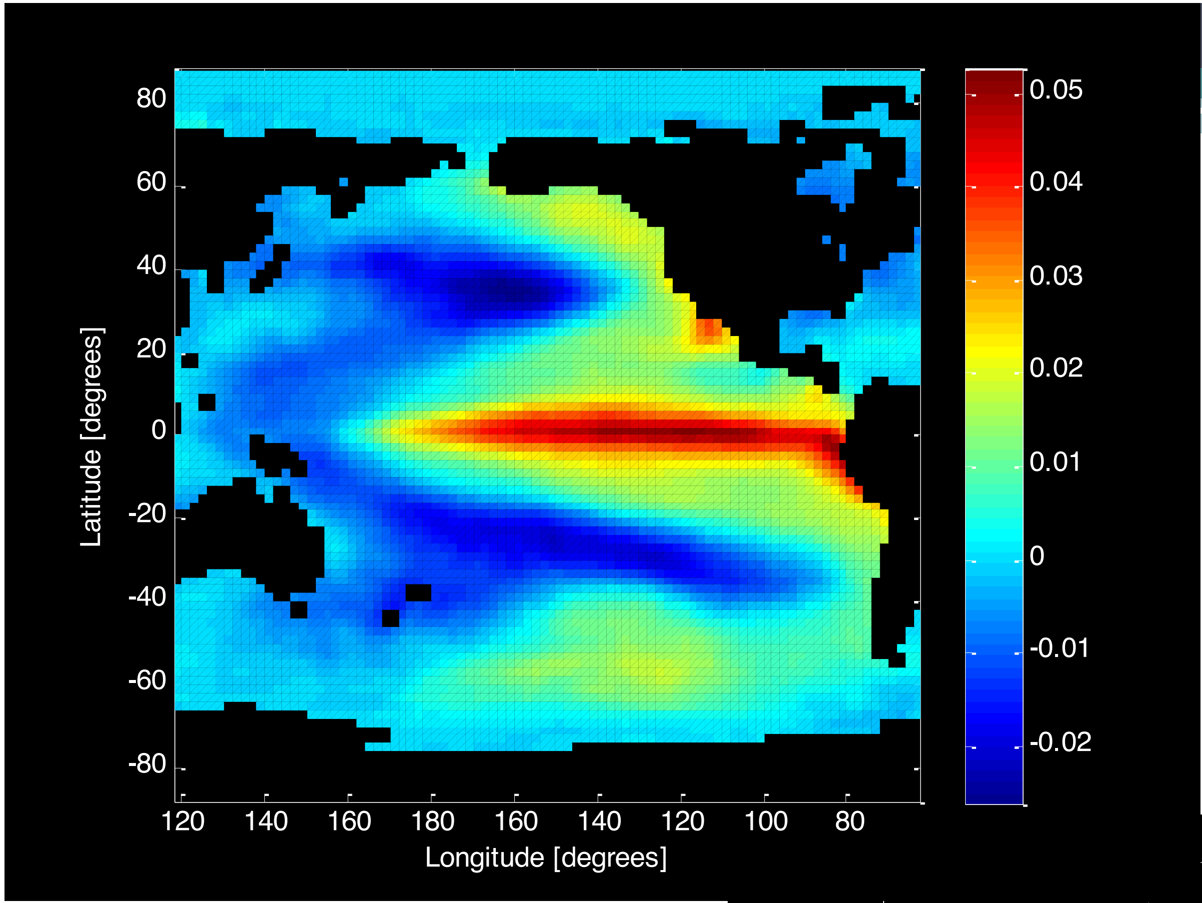
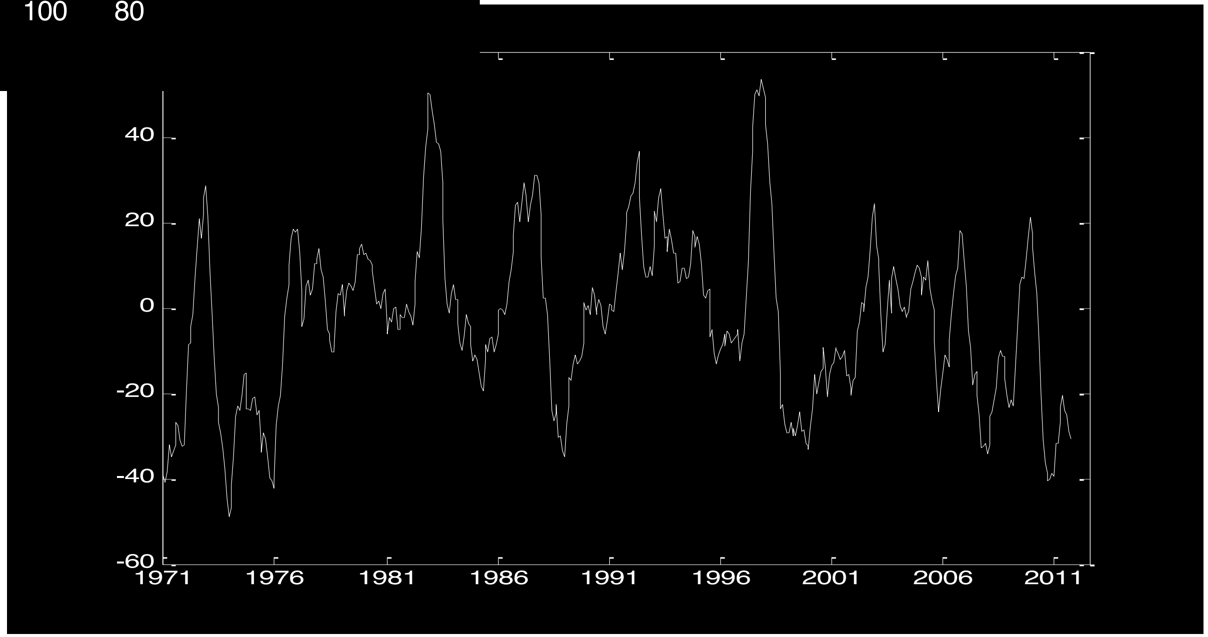
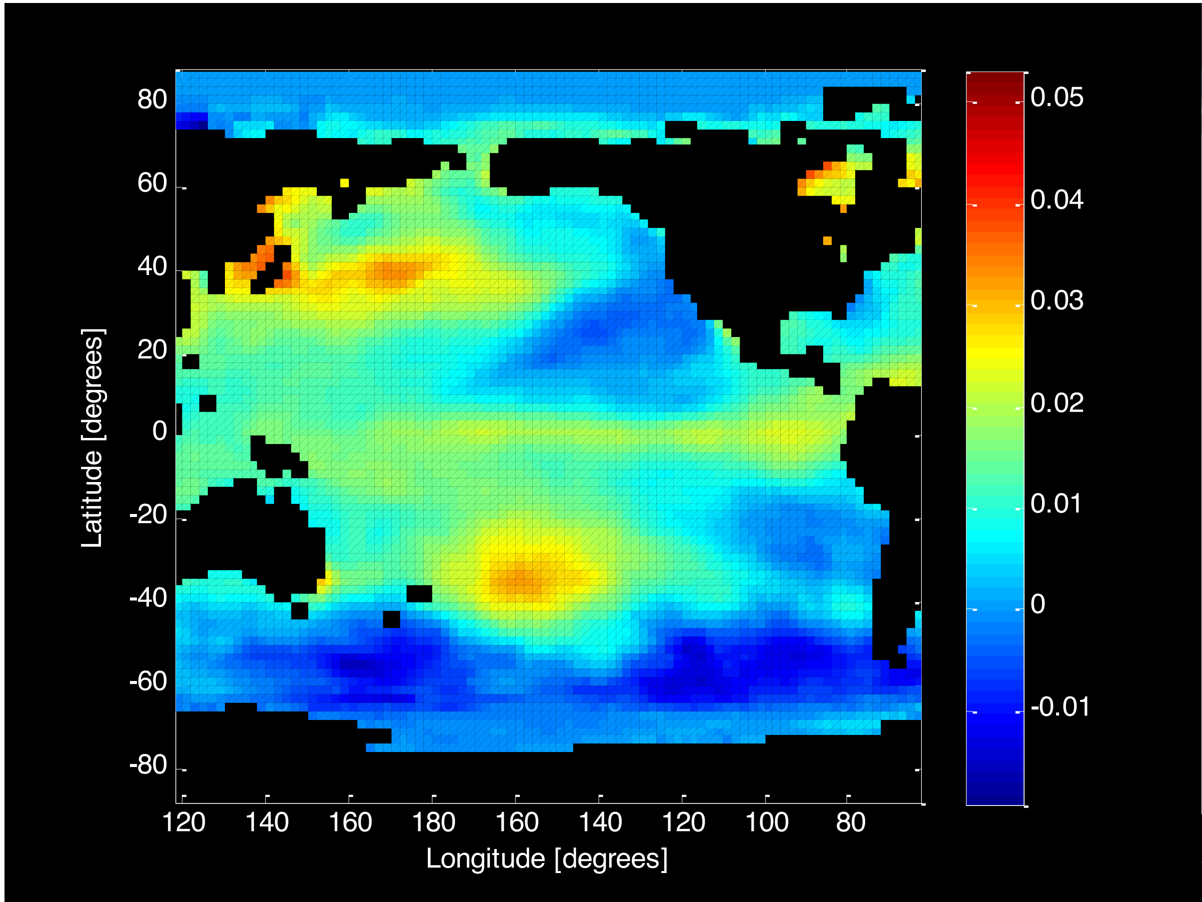
Why El Nino intensifier due to global warming

- The Warm pool is formed due to global thermohaline circulation (the great ocean conveyor belt) and brings surface sea water from north, south and equatorial Pacific. Those surface water is notable warm because direct solar radiation. The warm pool is the main gate of water flow from the Pacific to the Indian Ocean
- El Nino occurs during the movement of subsurface warm pool from north of Papua to central Pacific because the subsurface temperature gradient over the warm pool and central Pacific exceed the critical threshold. By classic fluid dynamics this condition will allow propagation of water masses, thus creating El Nino
- Global warming will make faster warmer warm pool
- With faster and warmer warm pool, the potency to exceed the threshold level will be faster and allowing propagation of water mass → El Nino

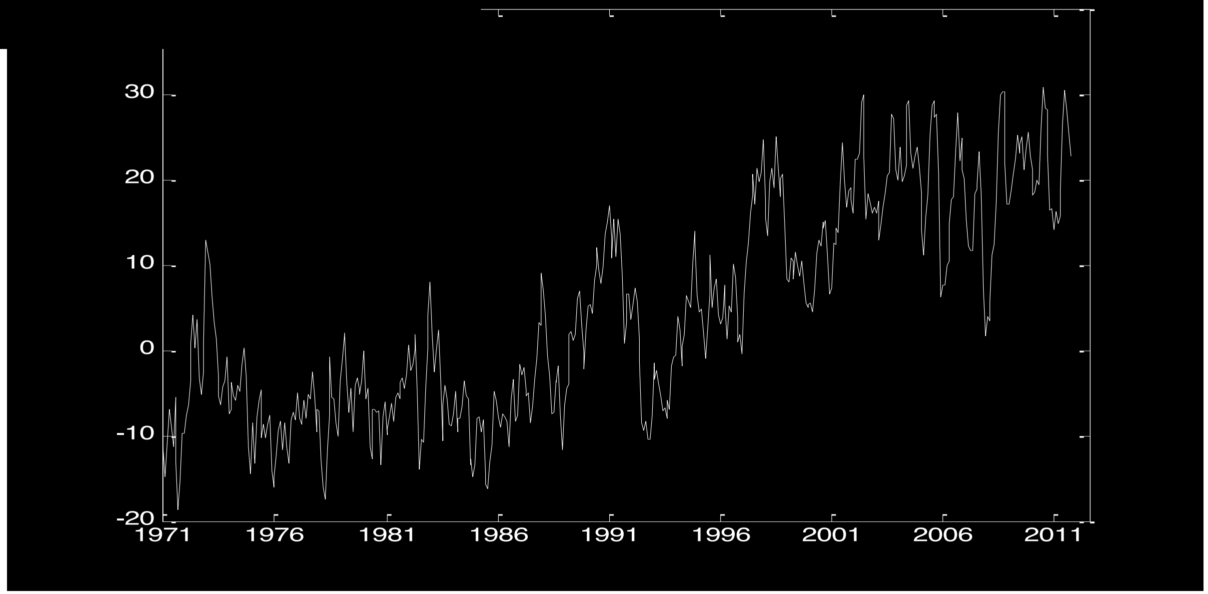
1st EOF Component of Pacific Basin





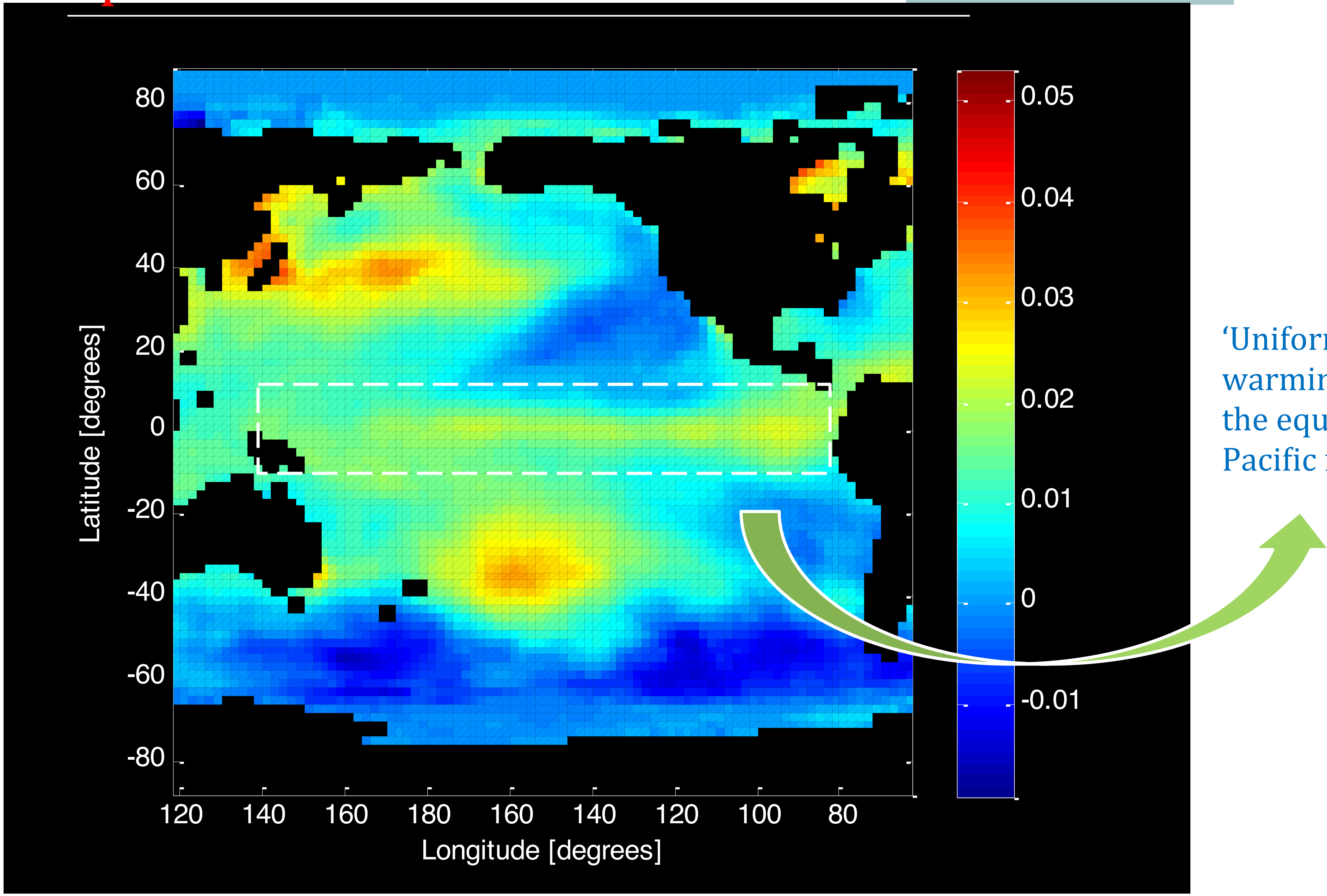


2nd EOF Component of Pacific Basin Represent Global Warming that affecting ENSO



Increase of ~0.45°C contributed by global warming over 40 years to the Nino3.4 index

Spatial distribution of mode 2



'Uniform' warming over the equatorial Pacific region

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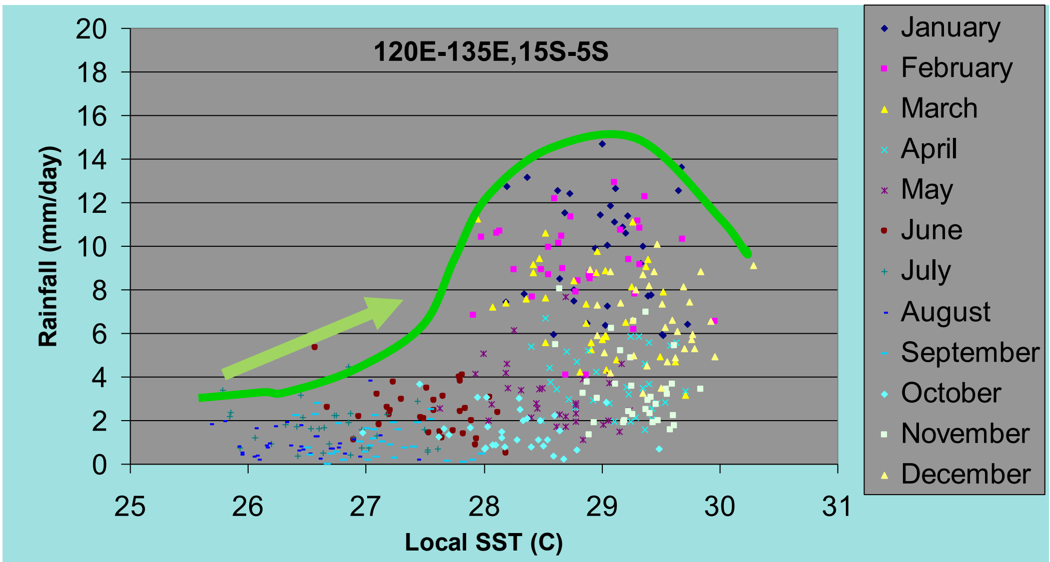
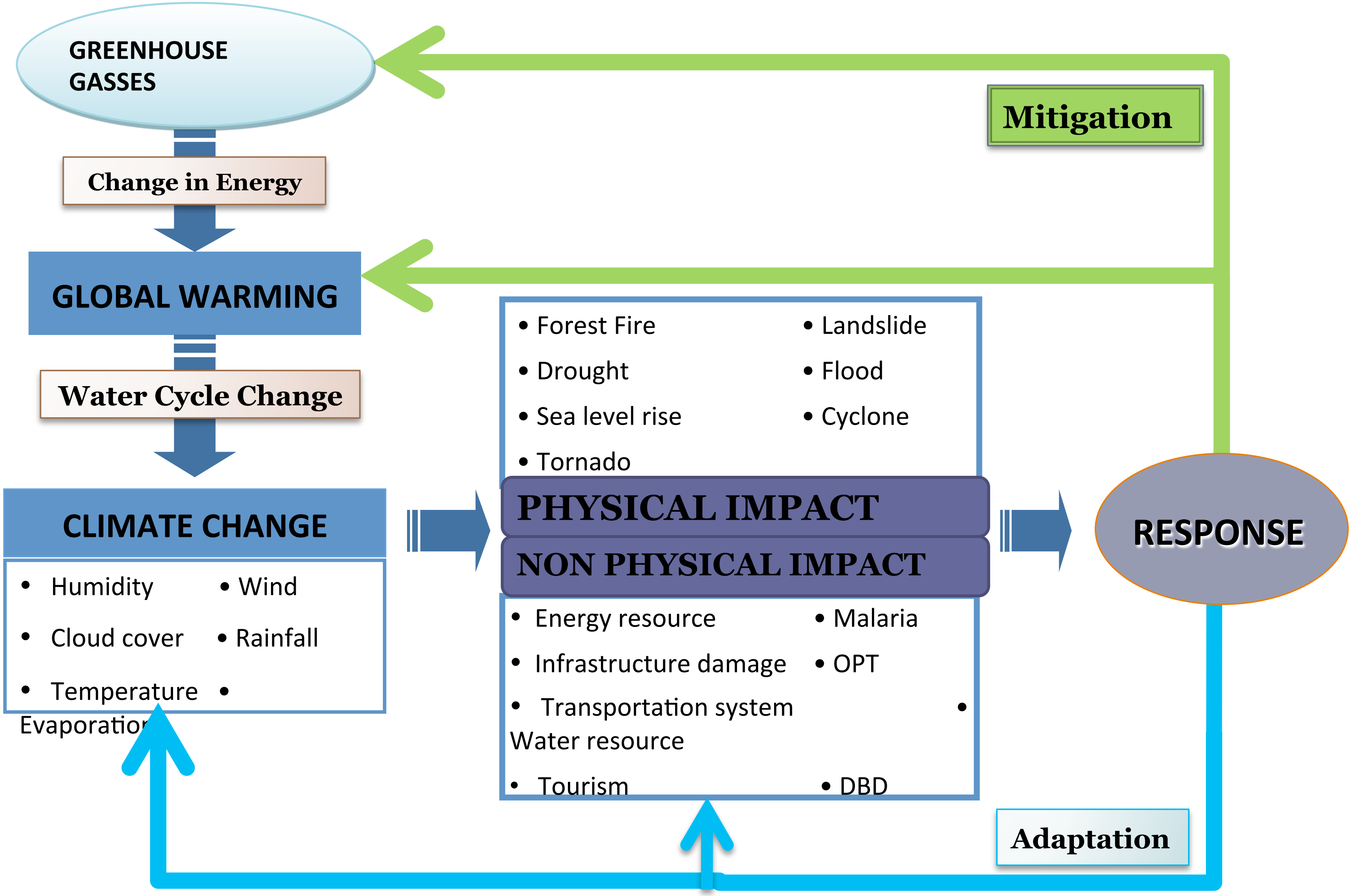
Competing feature of ENSO and global warming in the region

- As the earth surface temperature warmer, the evaporation rate over the tropics will increase → faster and higher water cycle
- There is a tendency of wetter dry season over the maritime continent → case 2009, 2010

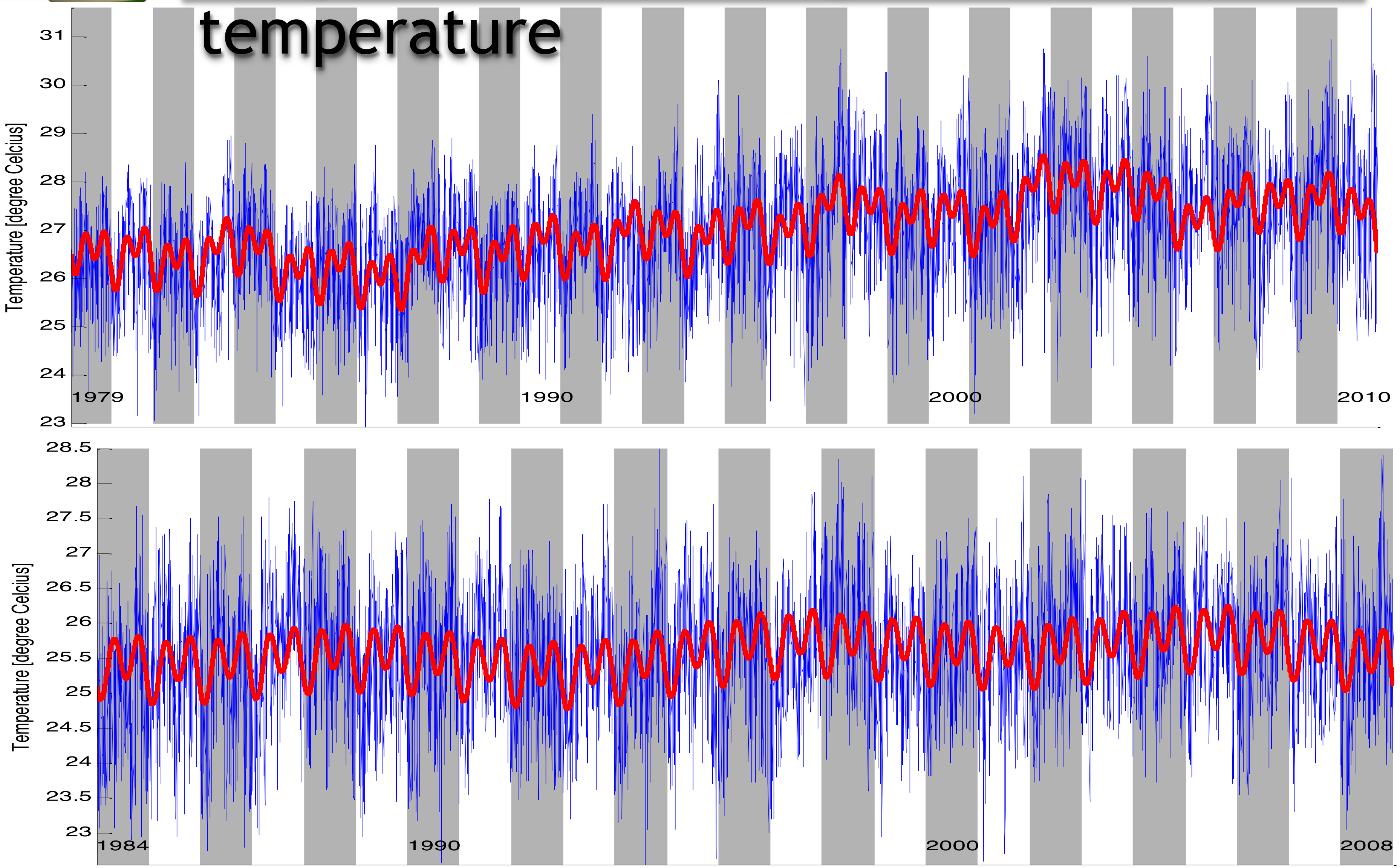


Aldrian and Susanto, 2003, Intl J Climatol.

Adaptation : Coping the effect – managing the unavoidable
Mitigation : Coping the cause– avoiding the unmanagable



Long term trends – avg. land temperature



Top: Pondok Betung – Jakarta ; Bottom: Darmaga – Bogor

Role of "Scientific Actions" on the Application of Adaptation & Mitigation Measures

1 SCIENTIFIC ACTS

BMKG –UNIVERSITIES-RELATED INSTITUTIONS-CLIMATE SEN.SECTOR

→ **Climate change information** (Historical and Projection/Trend)

→ **KLH**

NAT'L POLICY
(RAN MAPI 2007)

2 ADAPTATION

Climate Sensitive ☆ Sectors

"Adaptation is managing the unavoidable"
"Mitigation is avoiding the unmanageable"

3 MITIGATION

Climate Sensitive ☆ Sectors

- Observation - Data Collection
- Research & Modeling
- Capacity Building
- Dissemination of Climate Information

Dep.Finance
BAPPENAS
DNPI
Nat'l Dev.Planning Agency
Nat'l Council of C.Change

☆ **CLIMATE SENSITIVE SECTORS :**
Deptan – Depkes – Dep PU – Dephut – Depbudpar – ESDM – Dephub – DKP

Climate Change Management In Indonesia (BMKG Concept)

BAPPENAS KLH RISTEK DIKNAS DNPI

1 **"SCIENTIFIC ACTS"/ PROCESS** and **TREND** of Climate Change

- ❖Observation & Dt.Collection ---------- **BMKG**
- ❖Data Analysis ----------BMKG + Univ + Climate Related Inst.
- ❖Climate Modeling -----BMKG + Univ + Climate Related Inst.
- ❖Capacity Building -----BMKG + Univ + Climate Related Inst.

2 "**ADAPTATION**" coping with the **effect** of C.Ch (Ref: RAN MAPI)

- ❖Historical Climate Change Information (Research Finding)- **BMKG**
- ❖S & T Implementation...Climate Sensitive Sector + Univ
- ➡ Monitoring & Evaluation of the Adaptation activities **progress**

3 **"MITIGATION"** coping with the **cause** of C.Ch (Ref: RAN MAPI)

- ❖Future/ Trend Projection of Climate Change (Research Finding)-**BMKG**
- ❖S & T Implementation...Climate Sensitive Sector + Univ
- ➡ Monitoring & Evaluation of the Mitigation activities **progress**

Nat'l Dev.Planning Agency

The Nat'l Council on C.Change

Min of R-Tech

Climate Sensitive Sector
Min of R-Tech
Min of Envrnt

Climate Sensitive Sector
Min of R-Tech
Min of Envrnt

NOTE:

- **RAN MAPI** = Nat'l Planing on Mitigation and Adaptation on Climate Change (KLH, 2007)
- ***Science*** *is more essential for* ***our prosperity, our security, our health, our environment, our quality of life,*** *then it has ever been before* **(US President, B. Obama)**
- *"Mitigation and Adaptation are decisions to be made by society, but they should be informed by* ***science****"*
- "Adaptation is **managing** the unavoidable"
- "Mitigation is **avoiding** the unmanageable" **(NOAA Director, Jane Lubchenco – 2010)**
- **Climate Sensitive Sector.**

1. Agriculture	**5. Health**
2. Water Resource	**6. Fishery**
	7. Energy
3. Transportation	**8. Tourism**

BMKG nine climate sensitive sectors

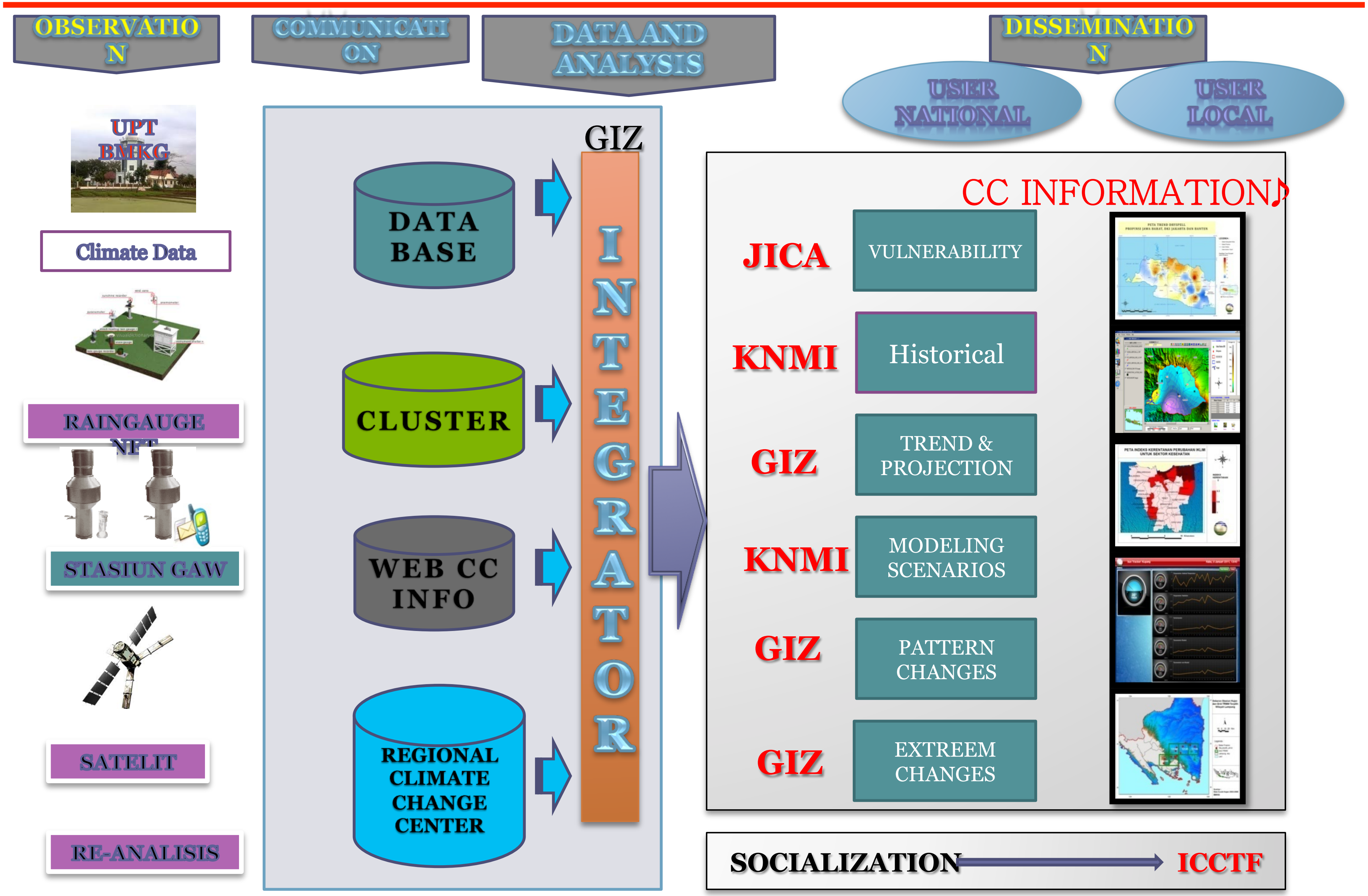
- AGRICULTRE
- COASTAL INFRASTRUCTURE
- PUBLIC INFRASTRUCTURE
- HEALTH
- FISHERY
- WATER RESOURCE
- TOURISM

Adaptation

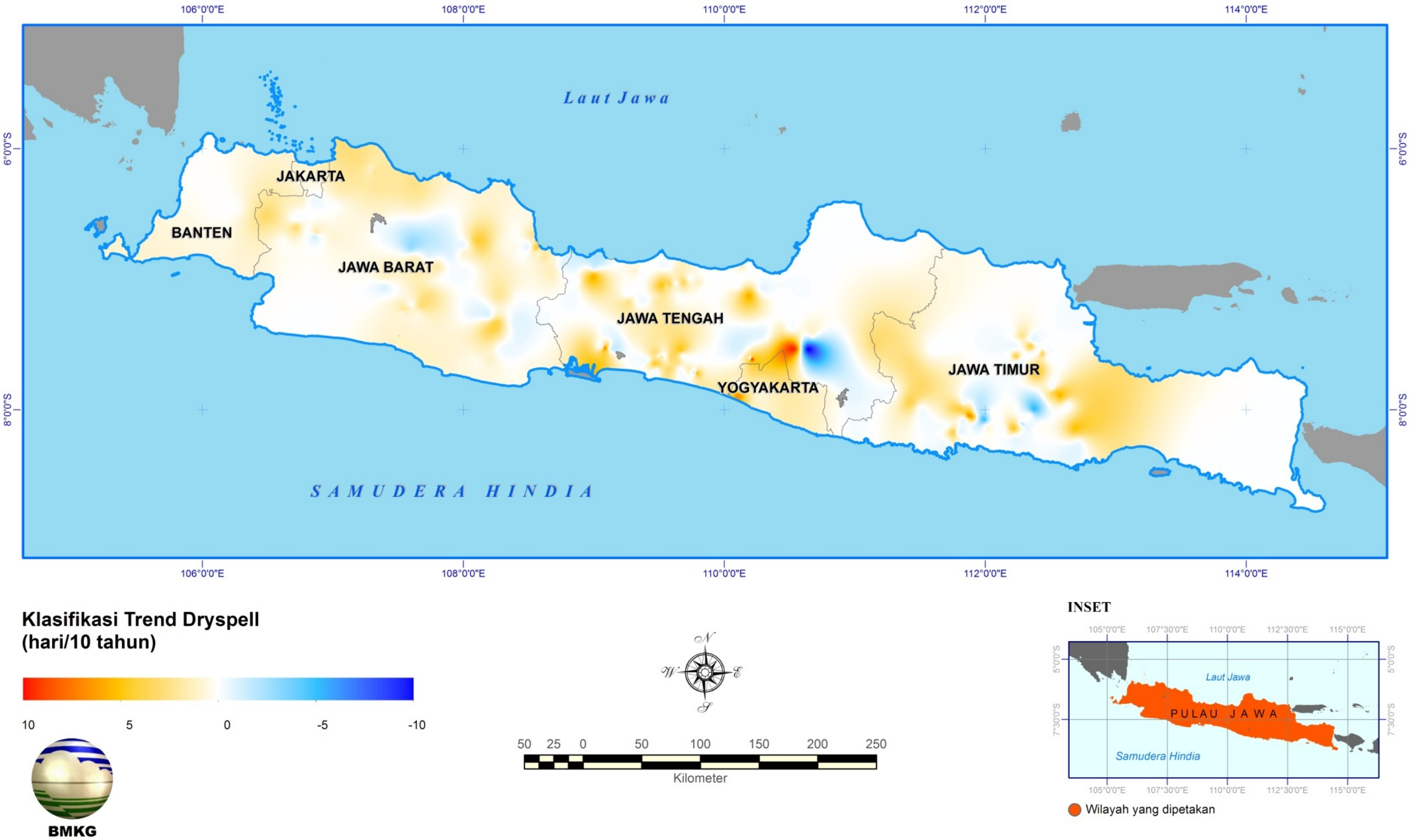
- TRANSPORTATION
- ENERGY
- FORESTRY

Mitigation

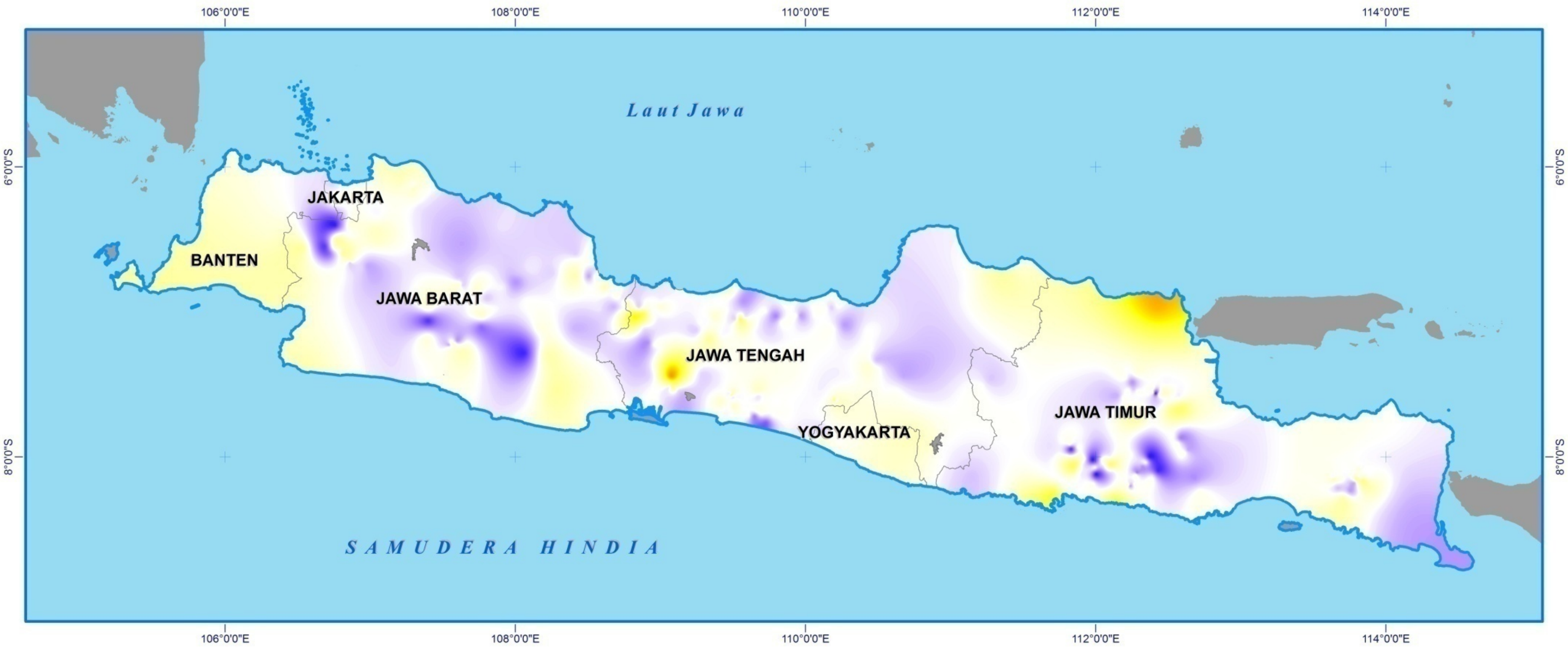
CLIMATE CHANGE INFORMATION SYSTEM OF BMKG



PETA TREND DRYSPELL JAWA



PETA TREND WETSPELL JAWA



Klasifikasi Trend Wetspell
(hari/10 tahun)

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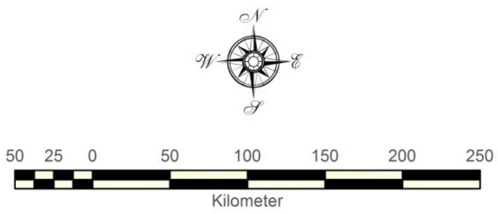
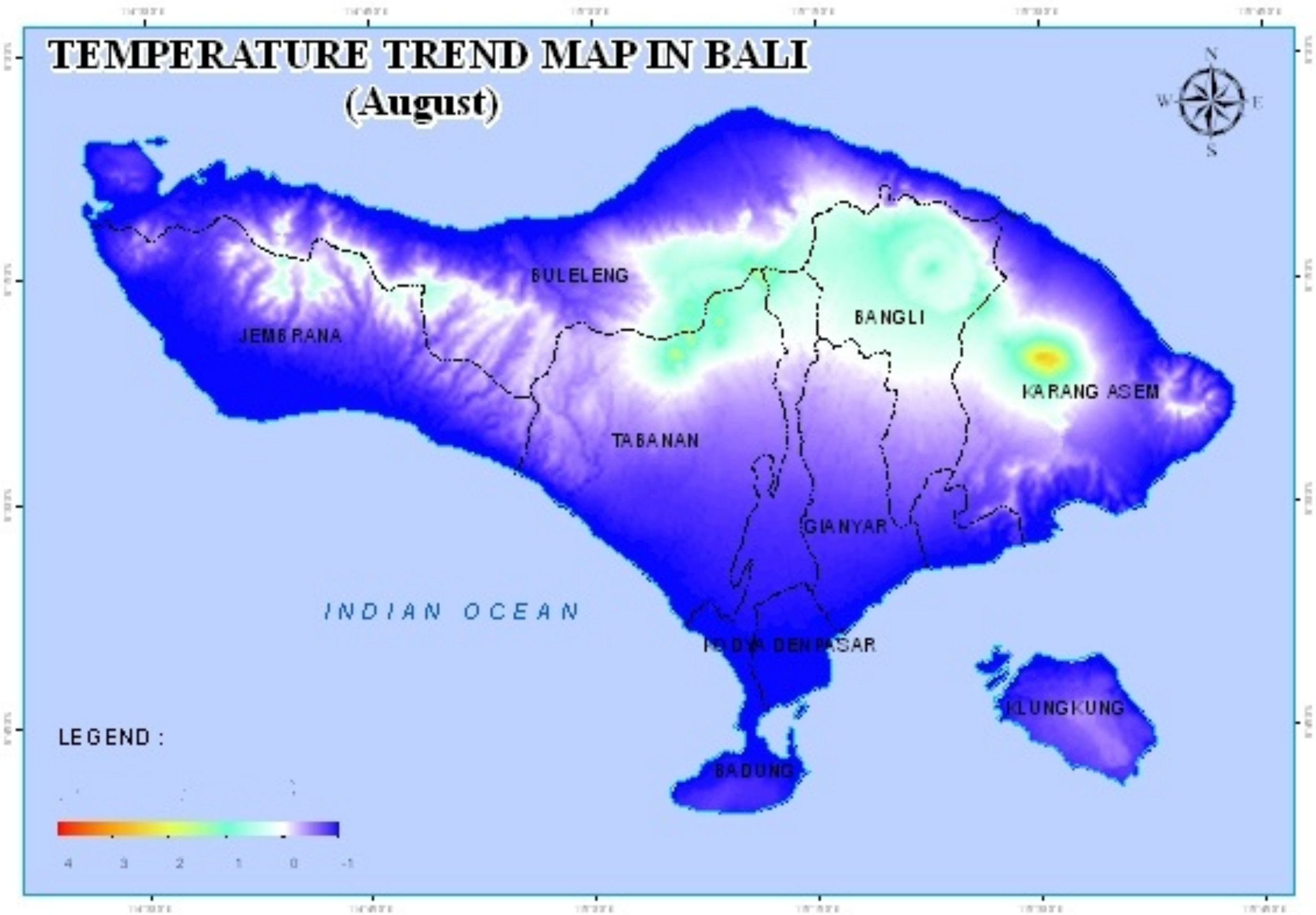
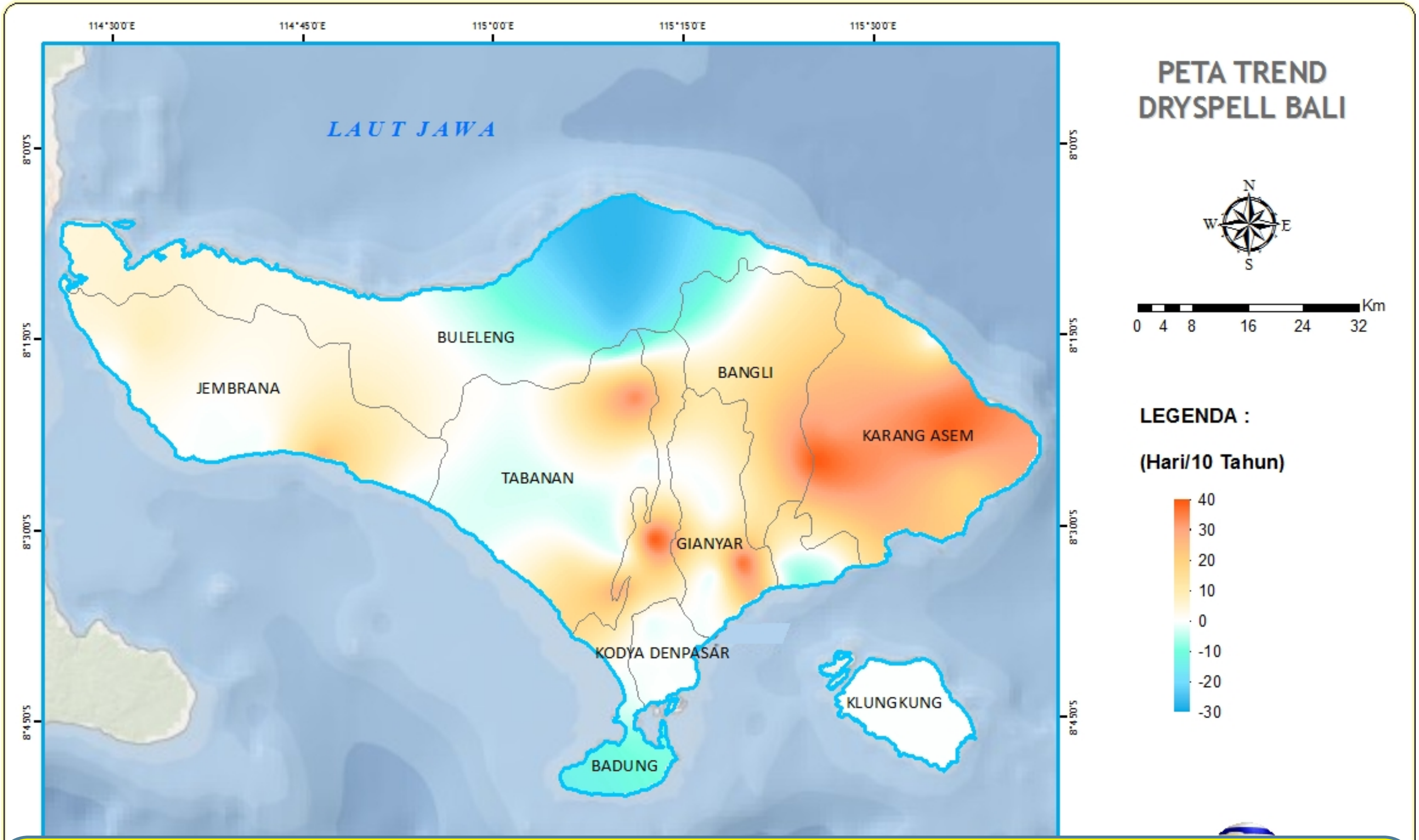


INSET

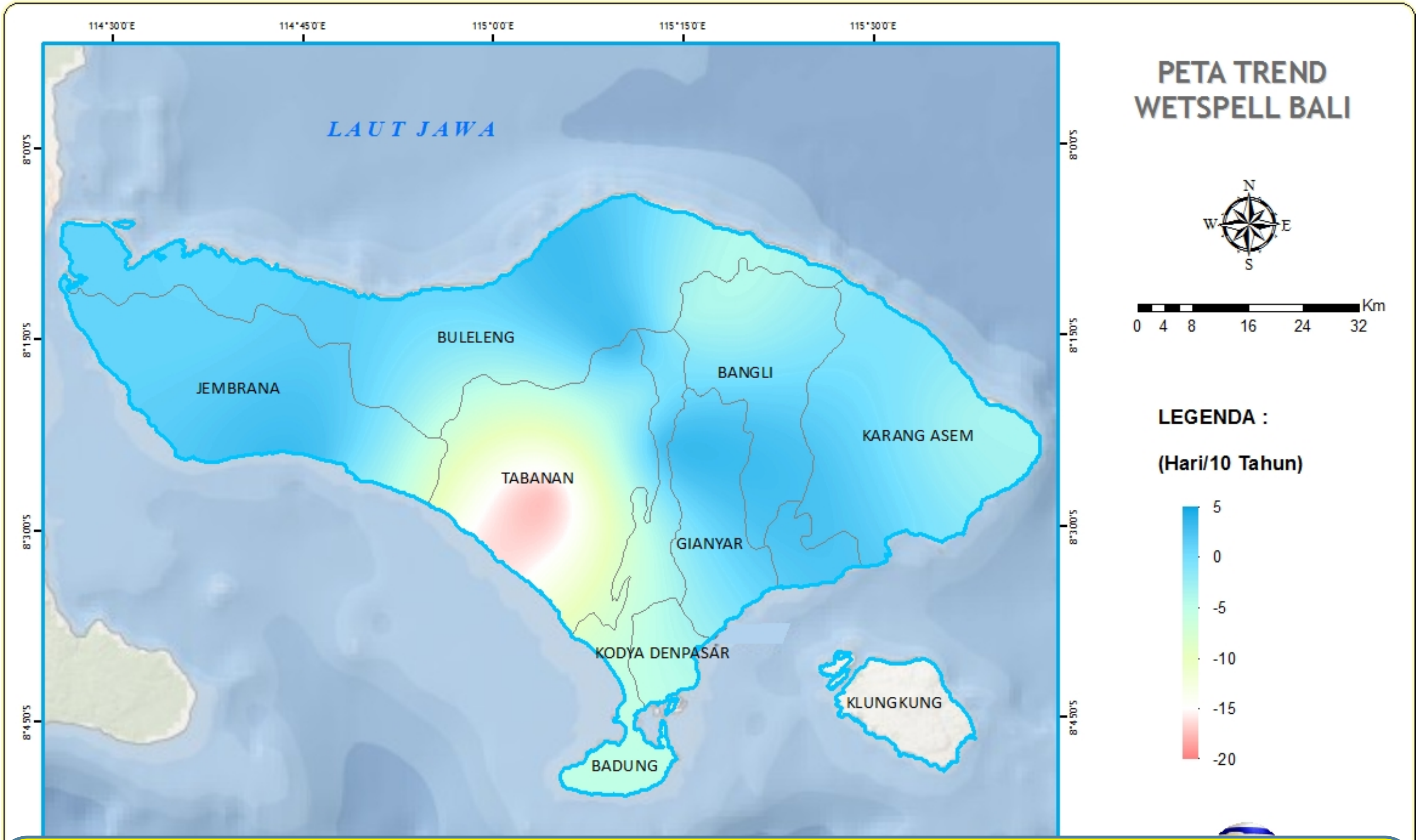
Trend maps – average



Other (major) islands are in progress …



Bali Climate exposure, Dry spell



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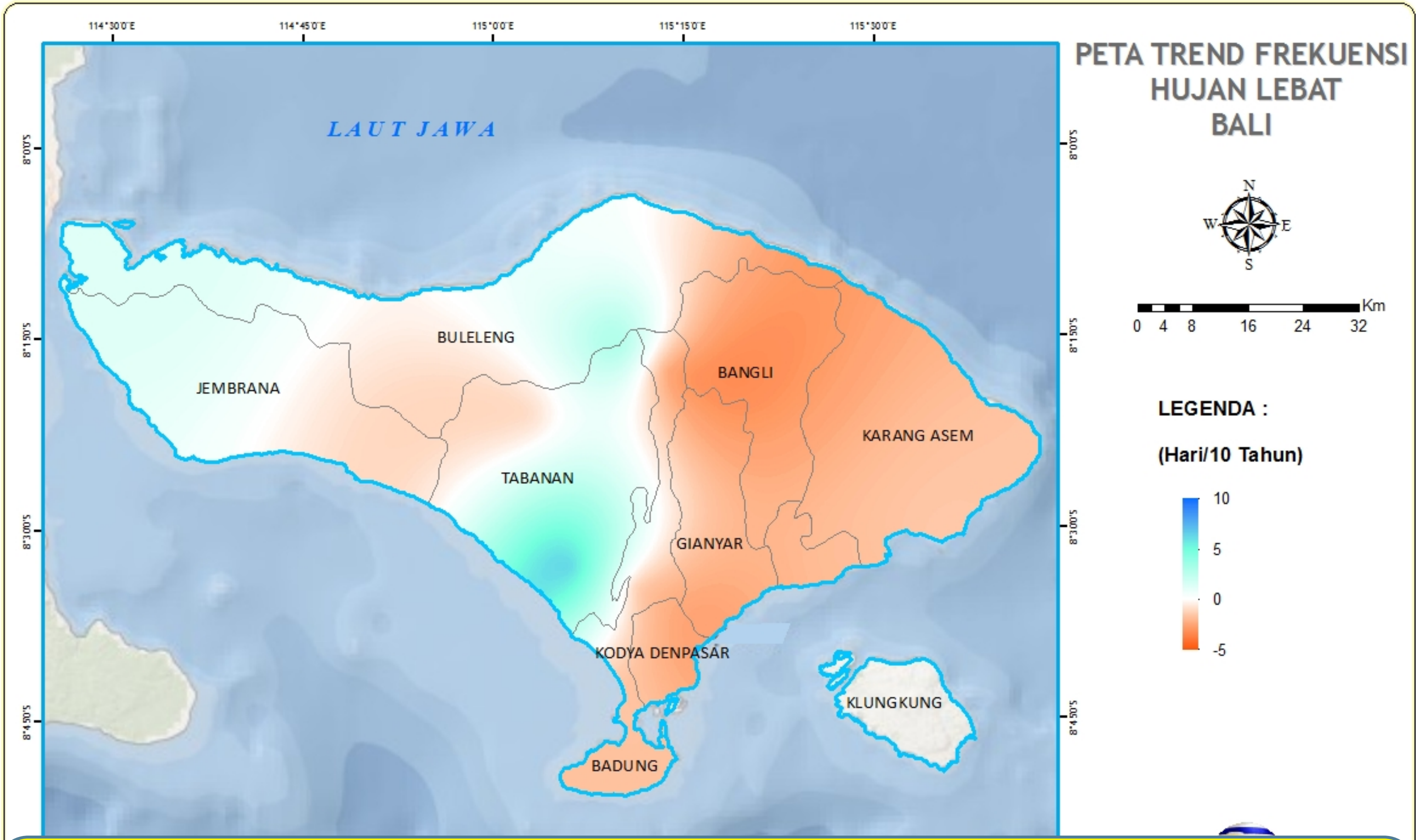


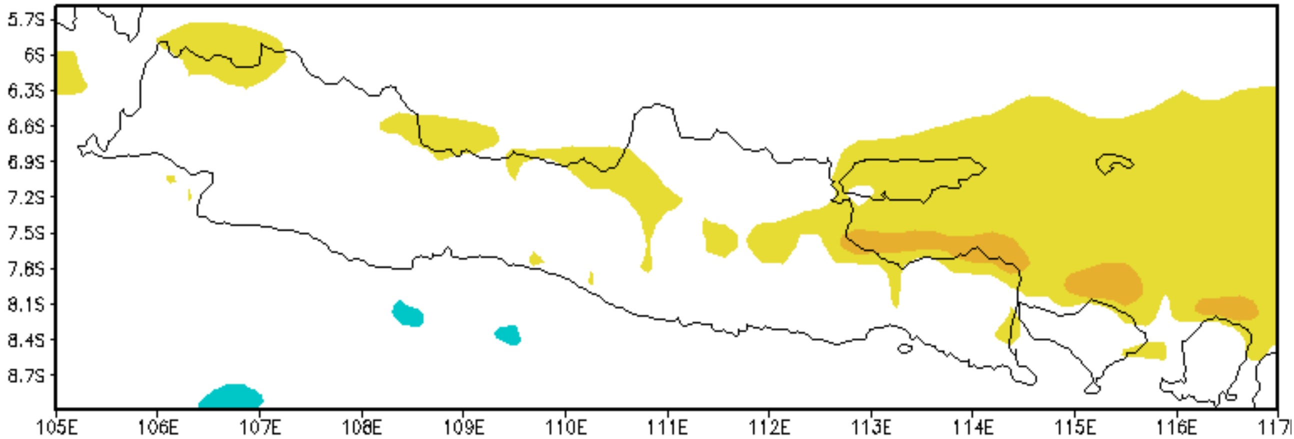
Bali Climate exposure, Extreme rainfall

RAINFALL INCREASE PROJECTION IN JAVA

2015-2039 vs 1979-2003 (IN%)

Collaboration between BMKG and MRI Japan

Annual Total Rainfall (N–P)/P unit percent



Annual rainfall changes

- 2015-2030 : - 5 s/d + 5 %

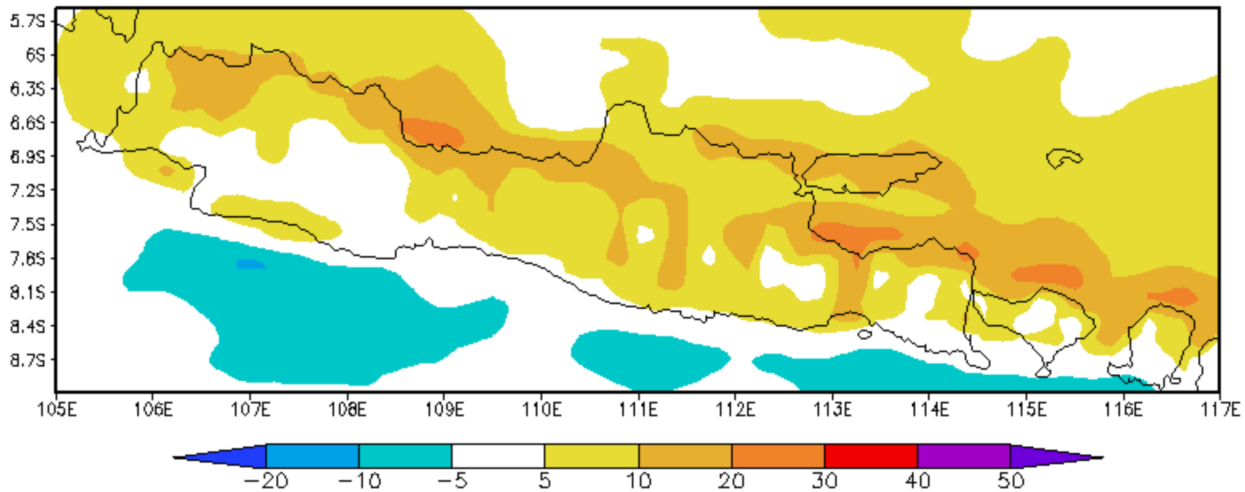
Central food production:
Jabar, Jateng, Jatim !!

- 2075-2099 : + (5 s/d 20 %) except south of west Java

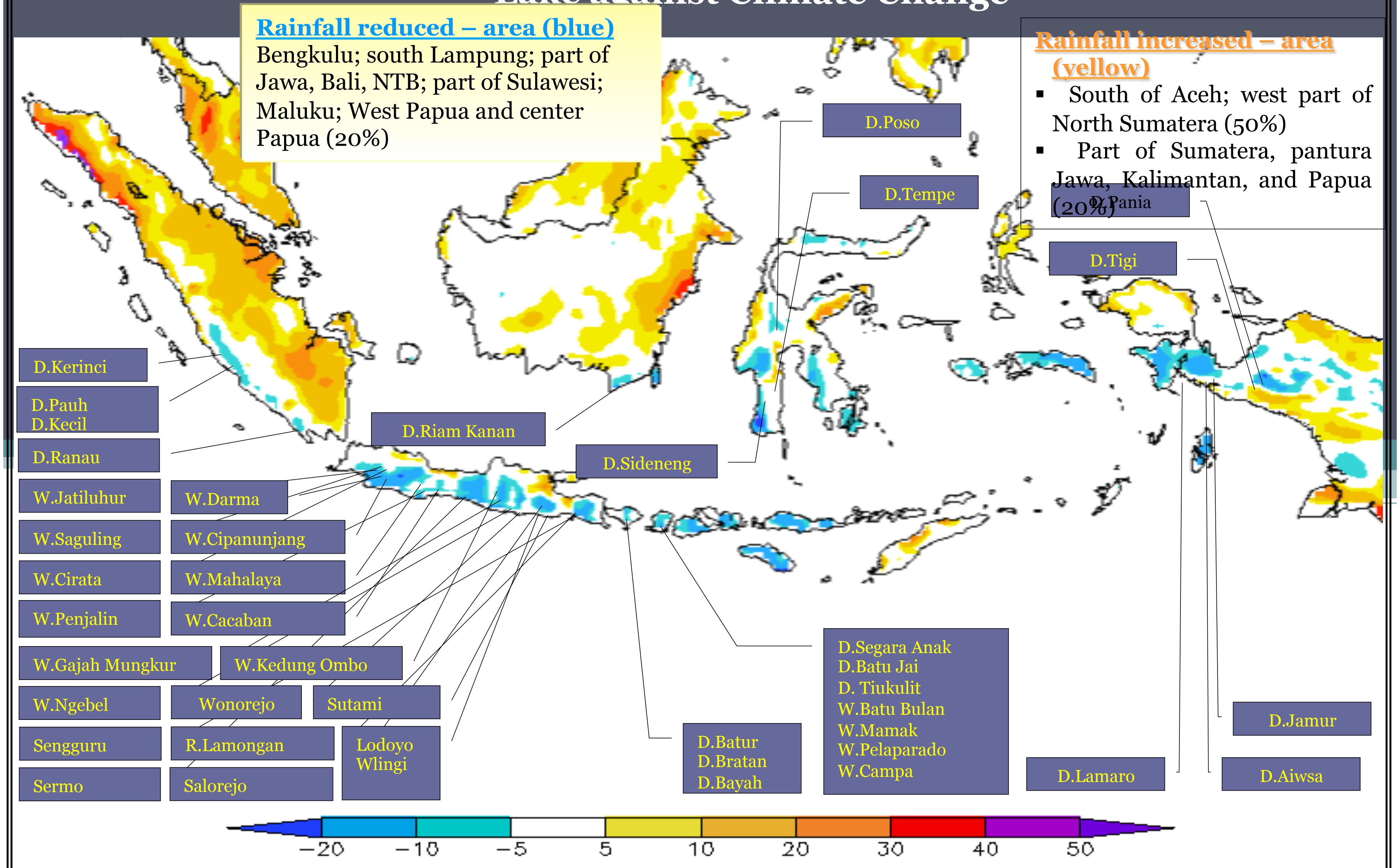
RAINFALL INCREASE PROJECTION IN JAVA

2075-2099 vs 1979-2003 (in %)

Annual Total Rainfall (F–P)/P unit percent

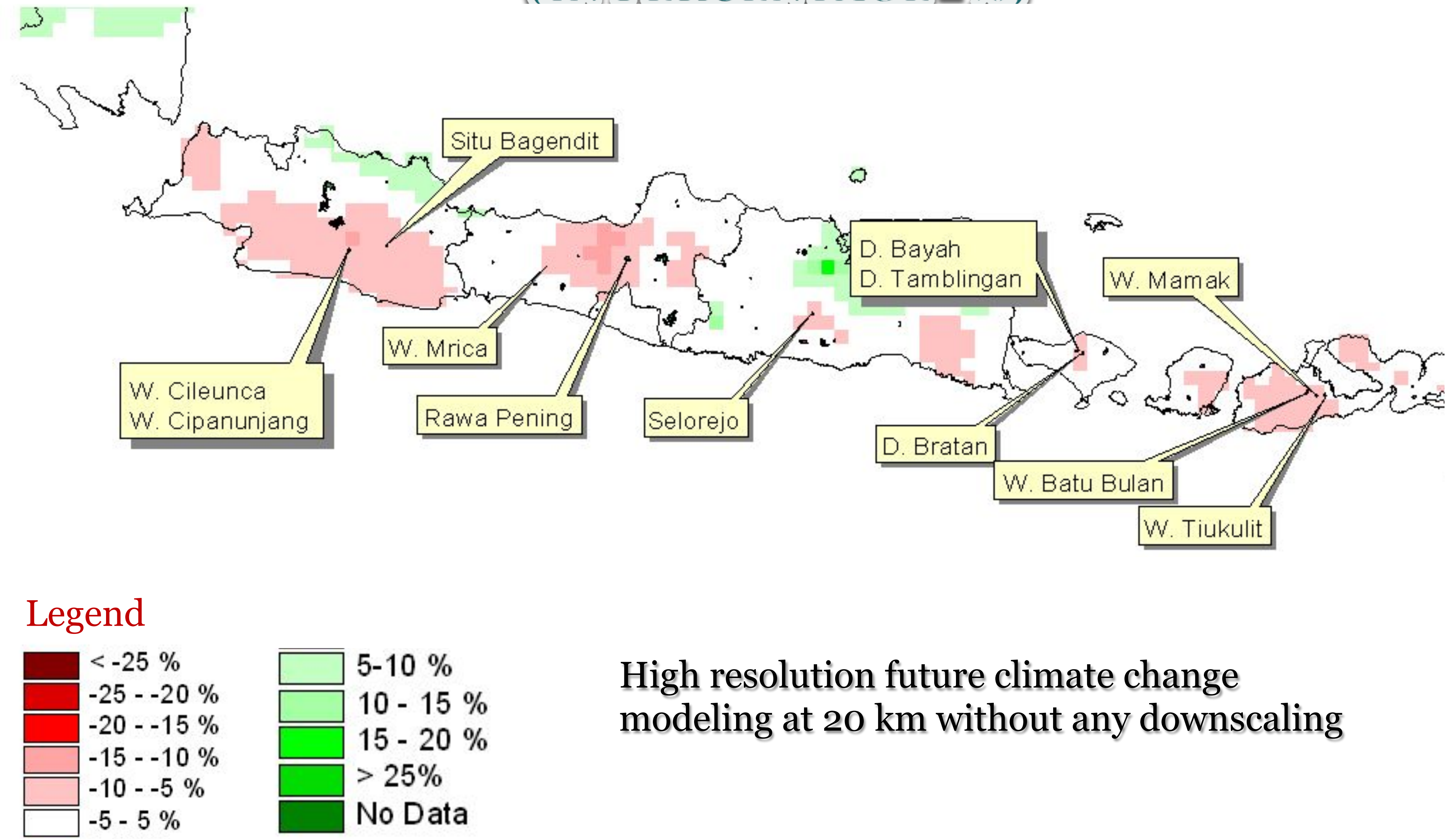


Percentage Rainfall Reduction (blue/-10%) and Rainfall Increase (yellow/+20%) in Future Climate (2075 – 2099) and Vulnerable Lake against Climate Change



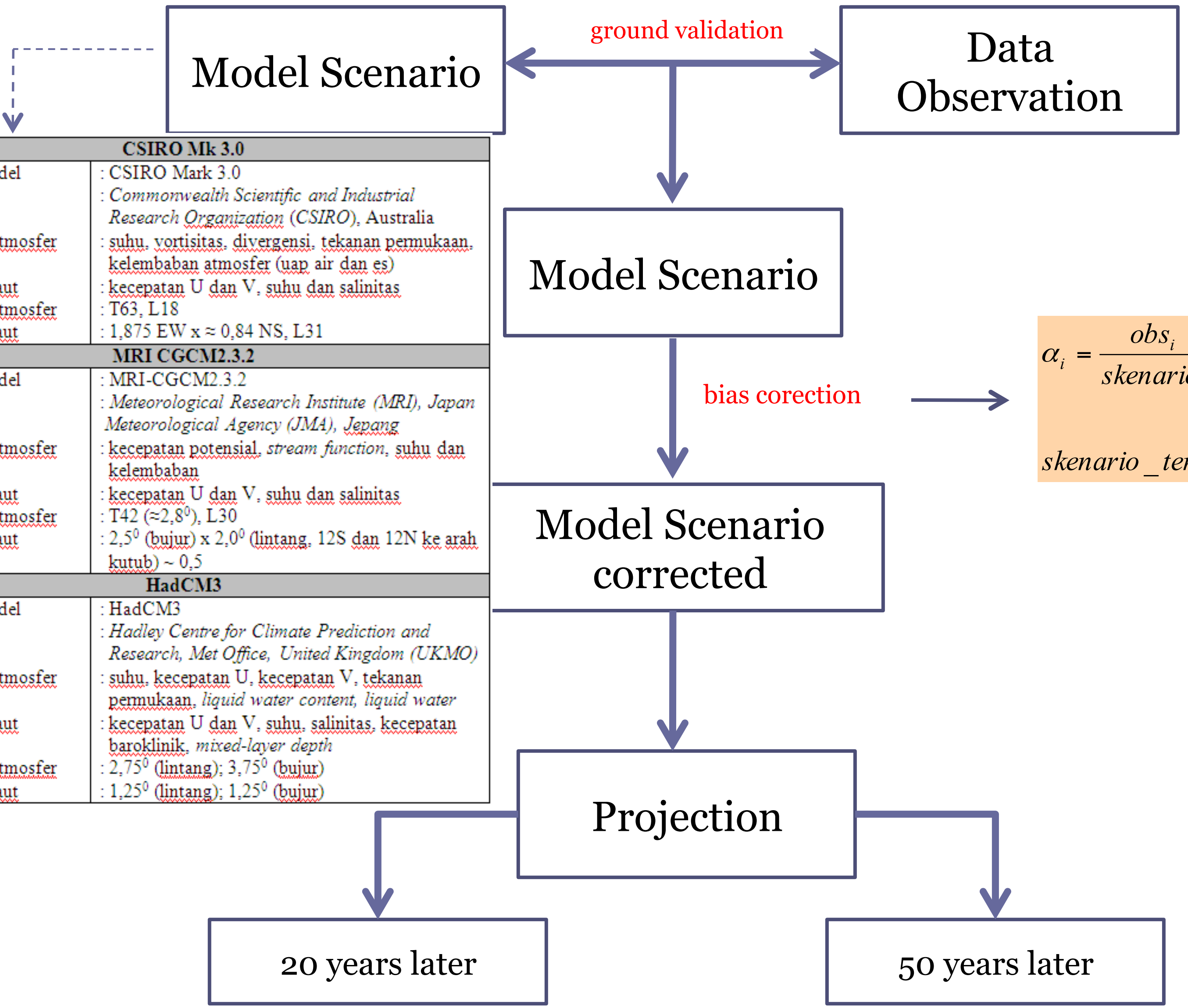
Prepared by: BMKG 2009

PROJECTION OF WATER DEFICIT DAMS AND LAKES OVER JAVA OVER 2015-2039 (IN PERCENTAGE - %)



High resolution future climate change modeling at 20 km without any downscaling

Example Flowchart of Future Climate Change Projection

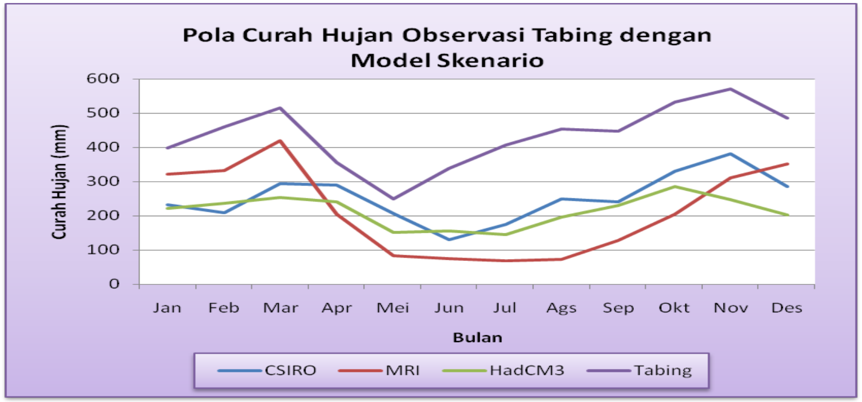


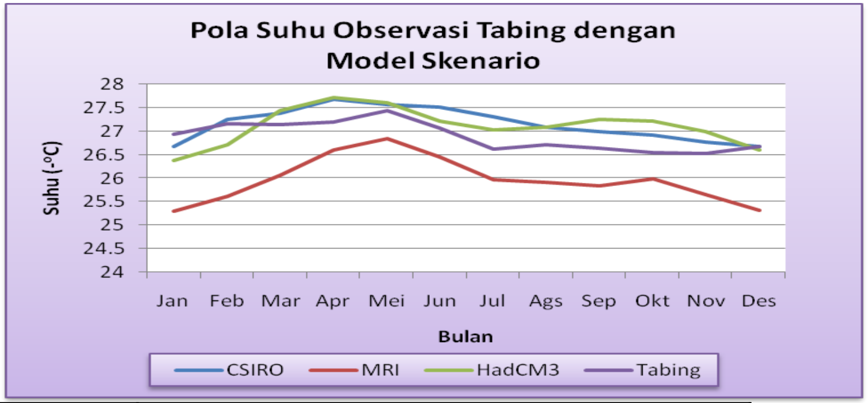
$$\alpha_i = \frac{obs_i}{skenario_i}$$

$$skenario\_terkoreksi_i = \alpha_i \times skenario_i$$

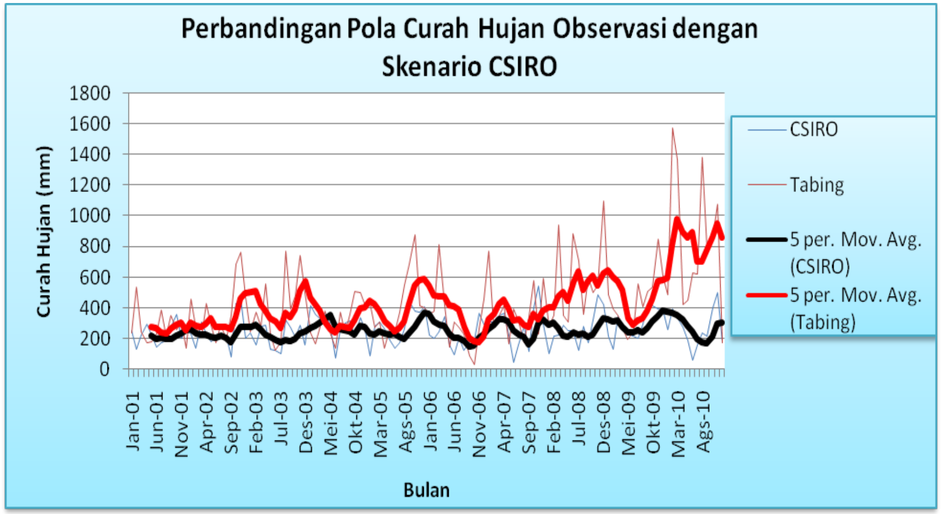
CSIRO Mk 3.0		
1	Nama Model	: CSIRO Mark 3.0
2	Institusi	: *Commonwealth Scientific and Industrial Research Organization* (CSIRO), Australia
3	Variabel atmosfer	: suhu, vortisitas, divergensi, tekanan permukaan, kelembaban atmosfer (uap air dan es)
4	Variabel laut	: kecepatan U dan V, suhu dan salinitas
5	Resolusi atmosfer	: T63, L18
6	Resolusi laut	: 1,875 EW x ≈ 0,84 NS, L31
MRI CGCM2.3.2		
1	Nama Model	: MRI-CGCM2.3.2
2	Institusi	: *Meteorological Research Institute (MRI), Japan Meteorological Agency (JMA), Jepang*
3	Variabel atmosfer	: kecepatan potensial, *stream function*, suhu dan kelembaban
4	Variabel laut	: kecepatan U dan V, suhu dan salinitas
5	Resolusi atmosfer	: T42 (≈2,8^0), L30
6	Resolusi laut	: 2,5^0 (bujur) x 2,0^0 (lintang, 12S dan 12N ke arah kutub) ~ 0,5
HadCM3		
1	Nama Model	: HadCM3
2	Institusi	: *Hadley Centre for Climate Prediction and Research, Met Office, United Kingdom (UKMO)*
3	Variabel atmosfer	: suhu, kecepatan U, kecepatan V, tekanan permukaan, *liquid water content, liquid water*
4	Variabel laut	: kecepatan U dan V, suhu, salinitas, kecepatan baroklinik, *mixed-layer depth*
5	Resolusi atmosfer	: 2,75^0 (lintang); 3,75^0 (bujur)
6	Resolusi laut	: 1,25^0 (lintang); 1,25^0 (bujur)

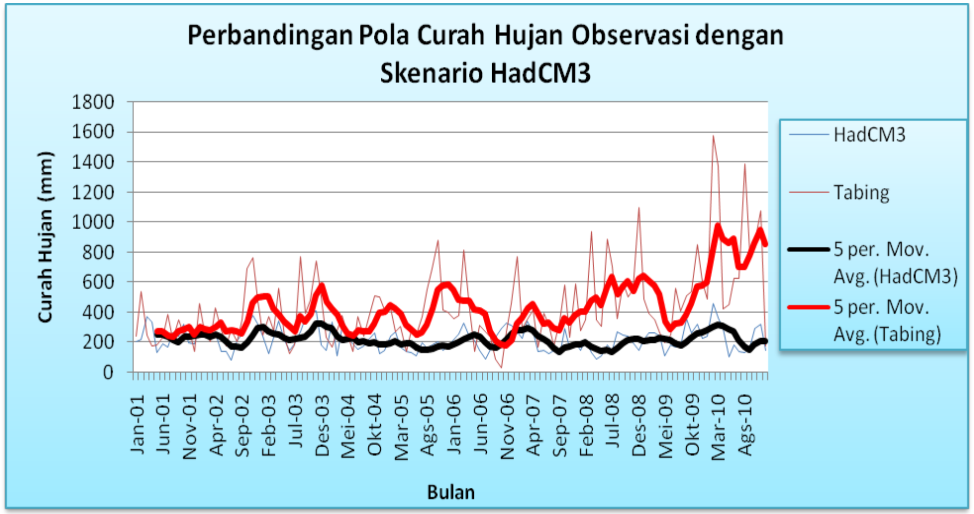
Ground validation



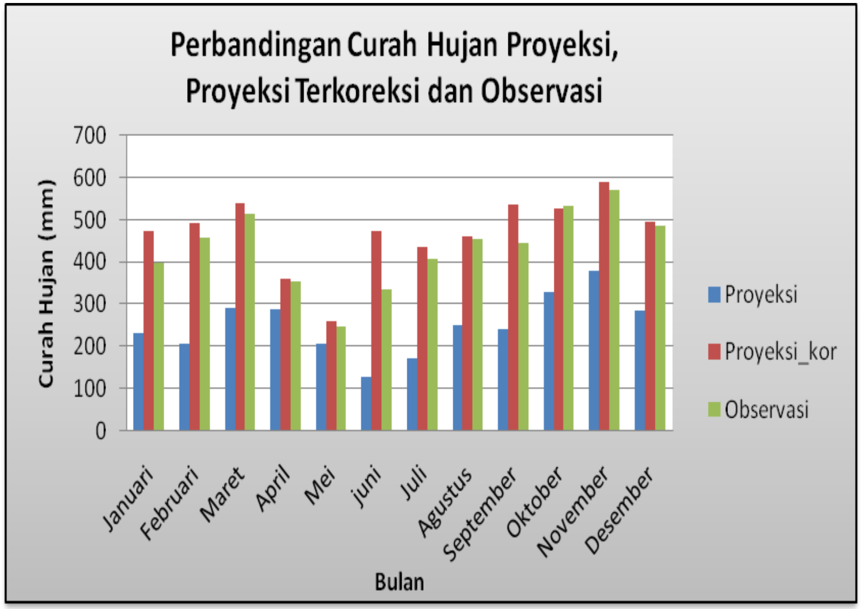


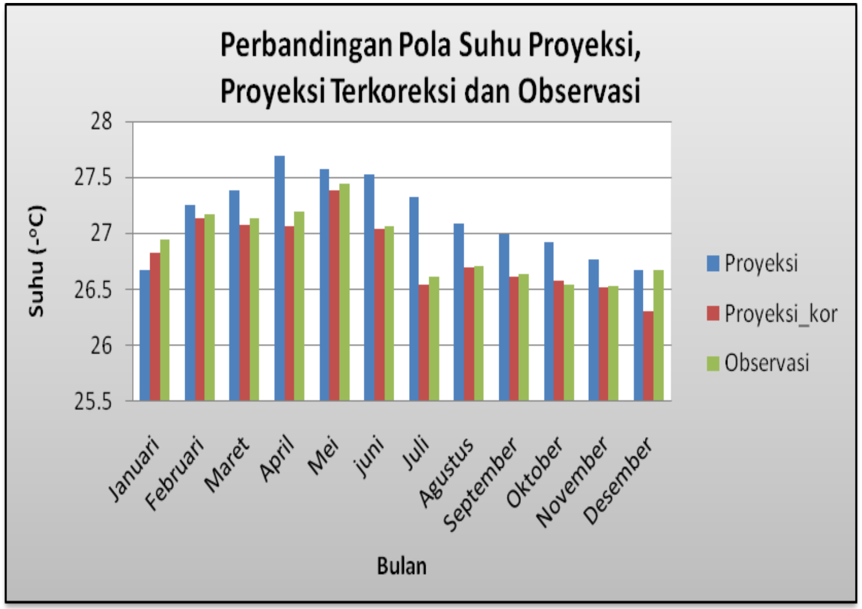
Lokasi Observasi	Suhu			Curah Hujan		
	CSIRO	MRI	HAD	CSIRO	MRI	HAD
Tabing	0.708	0.581	0.387	0.714	0.573	0.704
Sicincin	0.483	0.327	0.071	0.857	0.604	0.793
Padang Panjang	0.773	0.762	0.469	0.746	0.631	0.727





Sumatera Barat Bias Correction



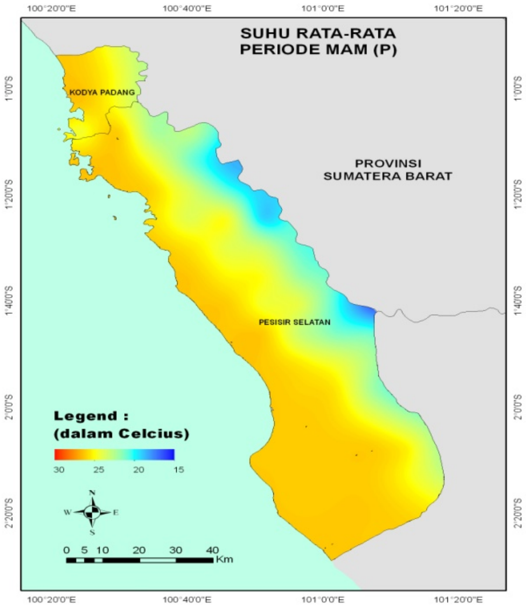


Observed Location	Temperature				Rainfall			
	Correlation		Error (der. celcius)		Correlation		Error (%)	
	Before	After	Before	After	Before	After	Before	After
Tabing	0.708	0.948	0.313	0.079	0.714	0.890	41.503	9.580
Sicincin	0.483	0.995	0.678	0.052	0.857	0.912	20.784	16.884
Padang Panjang	0.773	0.993	3.838	0.045	0.746	0.891	33.985	13.807

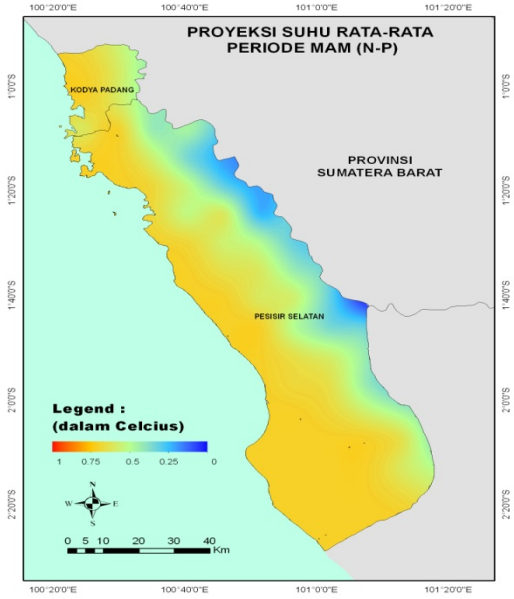
Jakarta Bias Correction

No	Wilayah	Before Correction		Before Correction	
		Correlation	MAPE	Correlation	MAPE
Rainfall					
1	Kemayoran	0,89	33,4%	0,97	28,7%
2	Cengkareng	0,86	52,4%	0,95	51,1%
3	Halim P.K.	0,89	38,8%	0,94	46,6%
4	Kedoya	0,83	32,5%	0,95	20,8%
5	Tanjung Priok	0,84	55,2%	0,97	37,3%
Average Temperature					
1	Kemayoran	0,78	5,5%	0,99	0,3%
2	Cengkareng	0,80	0,9%	0,97	0,3%
3	Halim P.K.	0,75	3,8%	0,96	0,5%
Maximum Temperature					
1	Kemayoran	0,79	12,4%	0,98	0,4%
2	Cengkareng	0,53	11,0%	0,98	0,4%
3	Halim P.K.	0,71	11,4%	0,96	0,5%

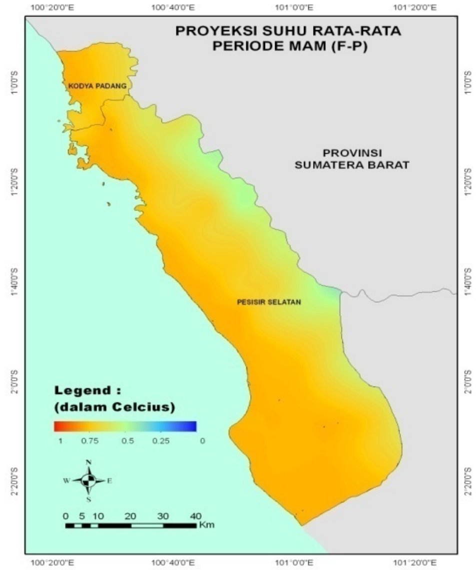
Period MAM



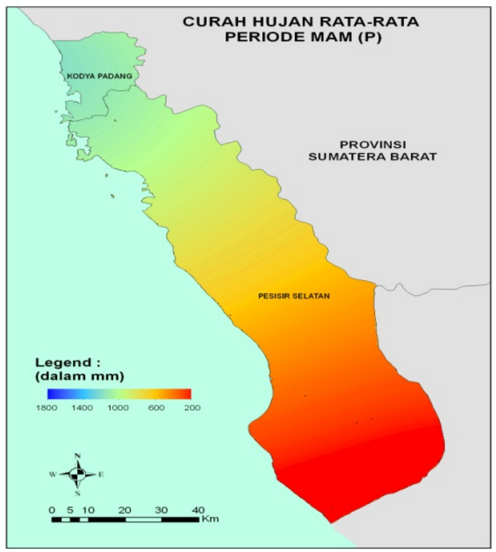
SUHU RATA-RATA
PERIODE MAM (P)
KODYA PADANG
PROVINSI
SUMATERA BARAT
PESISIR SELATAN
Legend :
(dalam Celcius)
30 25 20 15
0 5 10 20 30 40
Km



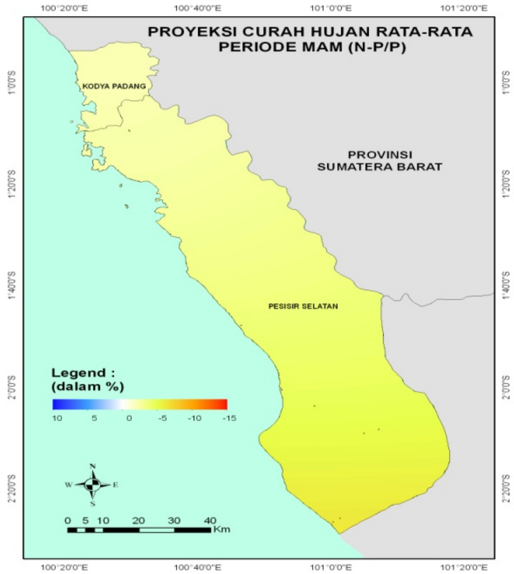
PROYEKSI SUHU RATA-RATA
PERIODE MAM (N-P)
KODYA PADANG
PROVINSI
SUMATERA BARAT
PESISIR SELATAN
Legend :
(dalam Celcius)
1 0.75 0.5 0.25 0
0 5 10 20 30 40
Km



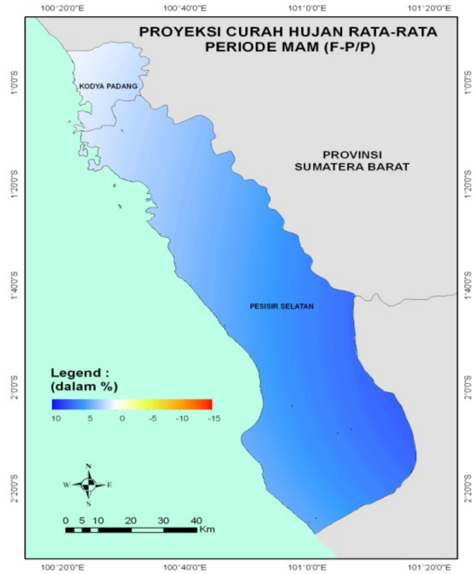
PROYEKSI SUHU RATA-RATA
PERIODE MAM (F-P)
KODYA PADANG
PROVINSI
SUMATERA BARAT
PESISIR SELATAN
Legend :
(dalam Celcius)
1 0.75 0.5 0.25 0
0 5 10 20 30 40
Km



CURAH HUJAN RATA-RATA
PERIODE MAM (P)
KODYA PADANG
PROVINSI
SUMATERA BARAT
PESISIR SELATAN
Legend :
(dalam mm)
1800 1400 1000 600 200
0 5 10 20 30 40
Km

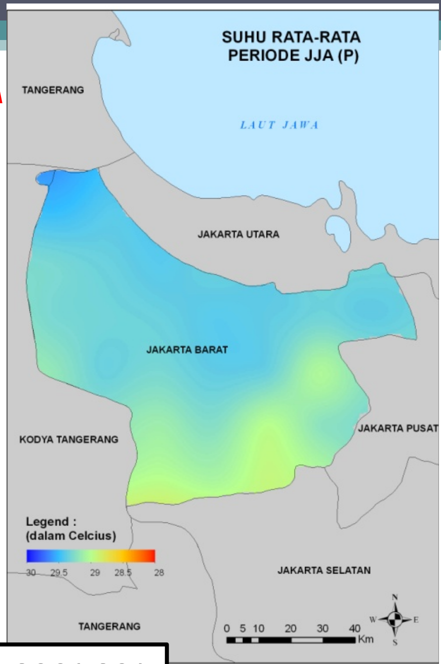


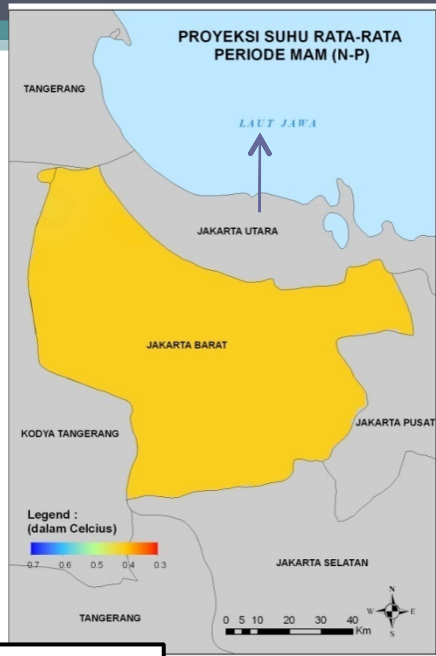
PROYEKSI CURAH HUJAN RATA-RATA
PERIODE MAM (N-P/P)
KODYA PADANG
PROVINSI
SUMATERA BARAT
PESISIR SELATAN
Legend :
(dalam %)
10 5 0 -5 -10 -15
0 5 10 20 30 40
Km



PROYEKSI CURAH HUJAN RATA-RATA
PERIODE MAM (F-P/P)
KODYA PADANG
PROVINSI
SUMATERA BARAT
PESISIR SELATAN
Legend :
(dalam %)
10 5 0 -5 -10 -15
0 5 10 20 30 40
Km

Period MAM

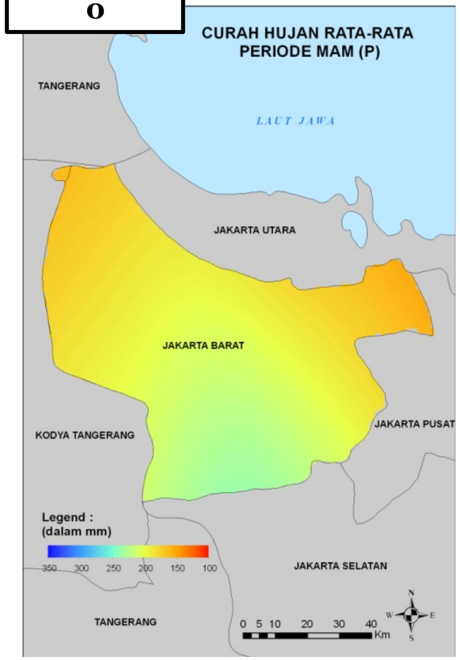


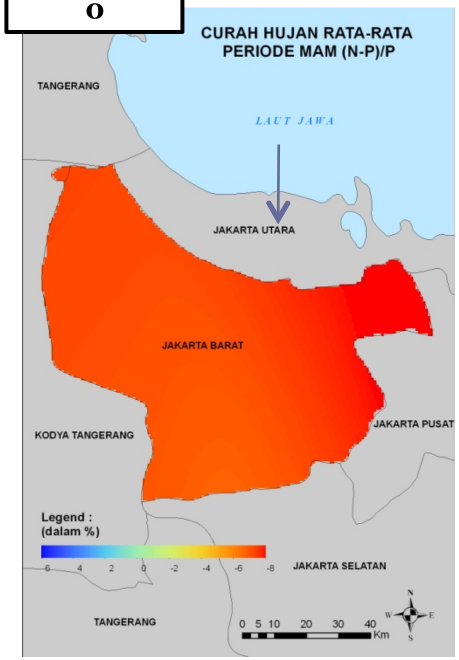


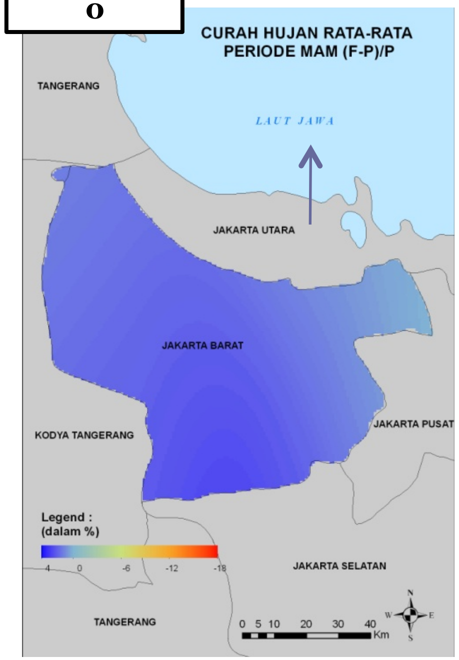
**2001-201
0**

**2011-203
0**

**2031-206
0**







BMKG human resource capacity building in Climate Change Modeling

- Development of IPCC SRES scenarios with CCAM model
- StuNed NESO the Netherland 20 people to Wageningen University May 2011
- APCC Korea Young Scientist research project, 2 persons
- StuNed NESO the Netherland 20 people to ITC U Twente September 2012
- JICA Japan 8 people to Meteorological Research Institute, October 2012
- ADB Project on Bengawan Solo and Brantas river Basin, 2 people to UC Davies California, 2013

Program in progress ...

- Future weather and climate projection using climate scenario
- Scenario will run automatically in FEWS/DEWS, and will generate input of flood and drought projection of the future
- Sea wave scenario over Jakarta bay could be produced using future surface wind projection
- DEWS system will support the BMKG Climate Early Warning System

Expectation from joint project

- Upgrade BMKG personal skill to run downscaling simulation
- Sharing data resources from developed countries of CMIP5 data
- Sharing knowledge on how to
- Sharing skill and distributed work load
- Training together for good and well maintaint capacity
- Fill in the gap of science in Southeast Asia (contribution to IPCC report)

BMKG

Thank you