Climate change studies and downscaling activities in Thailand

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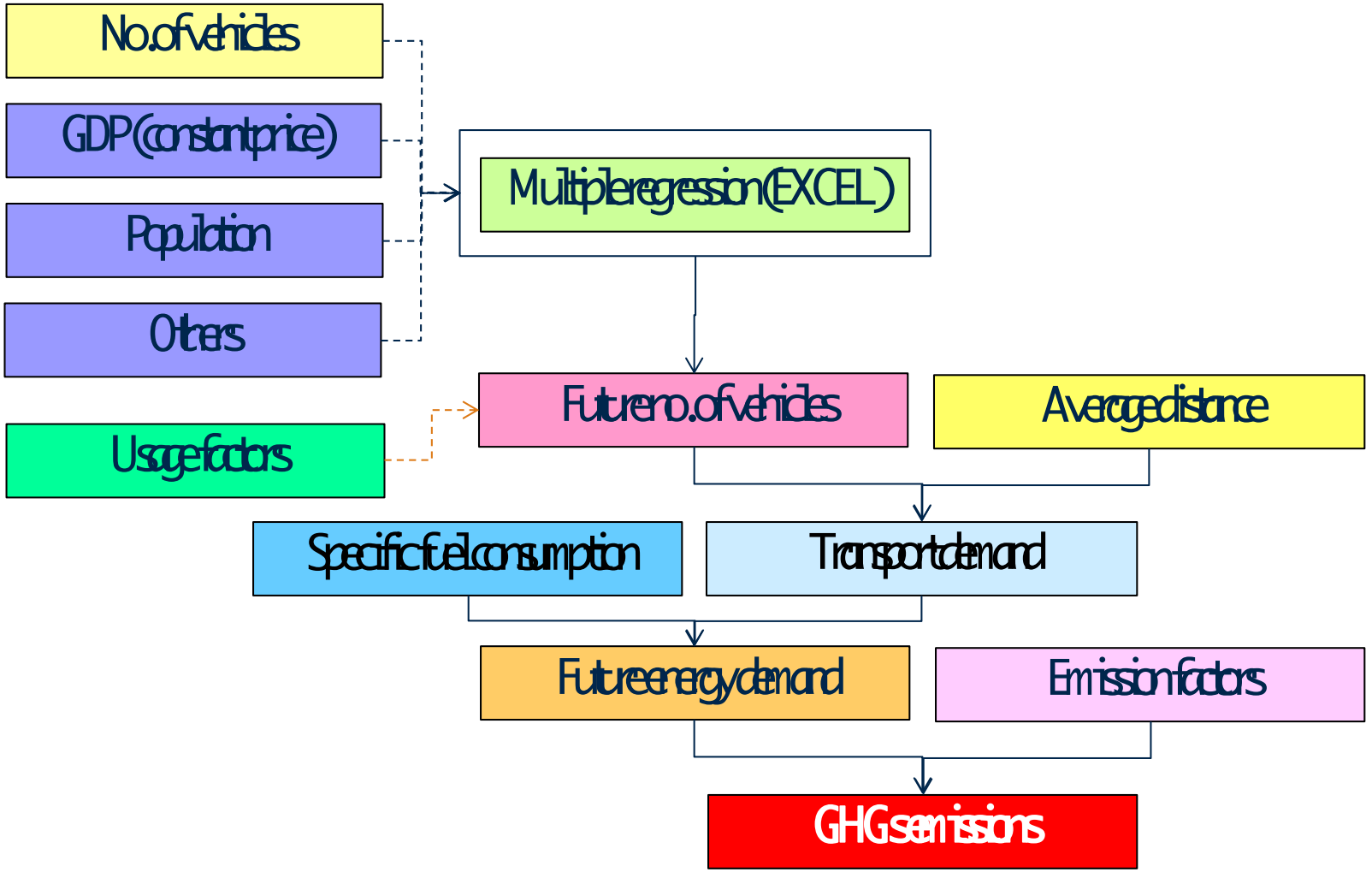
Climate change studies

- Working group I : Science of climate
  - Downscaling
  - Monsoon
  - etc.
- Working group II : Impact, adaptation and vulnerability
  - Impact on agricultural produces
  - Health impacts
  - etc.
- Working group III : Mitigation
  - Transport
  - Power generation
  - Industrial
  - etc.

Mitigation in Transport Sector



Downscaling

- Because of significant complexity and the need to provide multi-century integrations, horizontal resolutions of the atmospheric components of the AOGCMs range from 400 to 125 km.
- Generating information below the grid scale of AOGCMs is referred to as downscaling.
- There are two main approaches, dynamical and statistical.

Statistical Downscaling

Statistical downscaling comprises 3 broadly techniques:

- Weather generators
- Transfer function and
- Weather typing

Transfer function

- Transfer function achieved from linear and non-linear regression analyses as well as linear and non-linear interpolation.
- One of the transfer function technique is to develop quantitative relationships between large-scale atmospheric variables (predictors) and local surface variables (predictand).

Statistical downscaling activities

There are 2 projected of statistical downscaling supported by the Thailand Research Fund (TRF)

1) Statistical Downscaling of GFDL-R30 in the area of Thailand
2) Downscaling of GCMs for the impacts study of climate change on rice production in Thailand

Scope of the study of 1st project

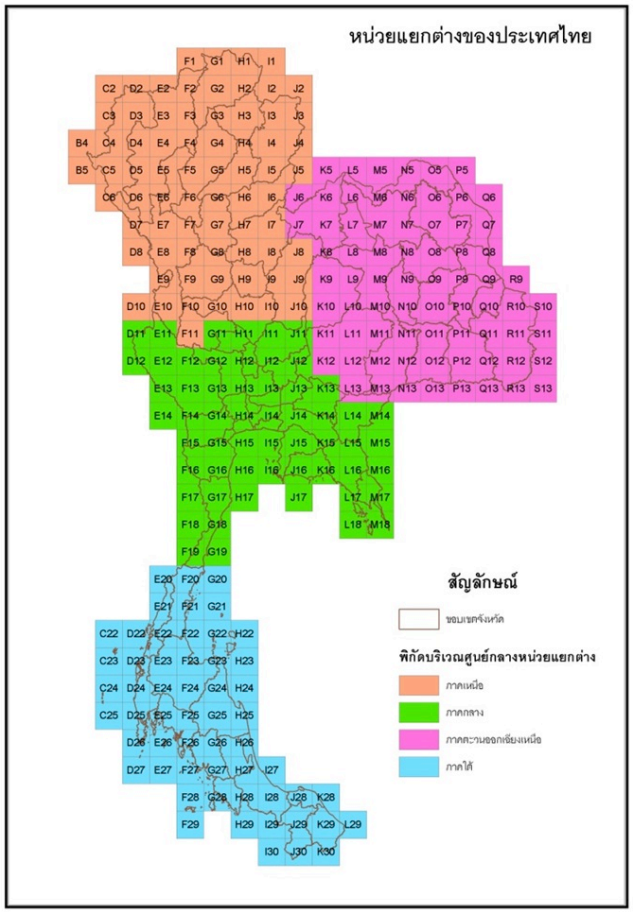
Regionalization technique:	Statistical downscaling Linear transfer function
GCM:	GFDL-R30 2.2° latitude x 3.75° longitude
SRES scenario:	A2, B2
Base year horizon:	1961 – 1990
Scenario horizon:	2010 – 2029 and 2040 - 2059
Grid resolution:	0.5° latitude x 0.5° longitude/ 50 km x 50 km
Output:	daily data of max, min, mean temperature, precipitation, %RH, sunshine duration.

Procedure

Statistical downscaling technique applied in this study has 4 main steps:

1) Developing quantitative relationships between predictors and predictands.
2) Apply the relationships to project future local surface variable.
3) Interpolation of predictands to the grid resolution.
4) Calibration of grid resolution if needed.

Grid resolutions



- Grid resolution :

  0.5^{o} latitude × 0.5^{o} longitude
- Total number of grids: 257

Predictors and Predictands

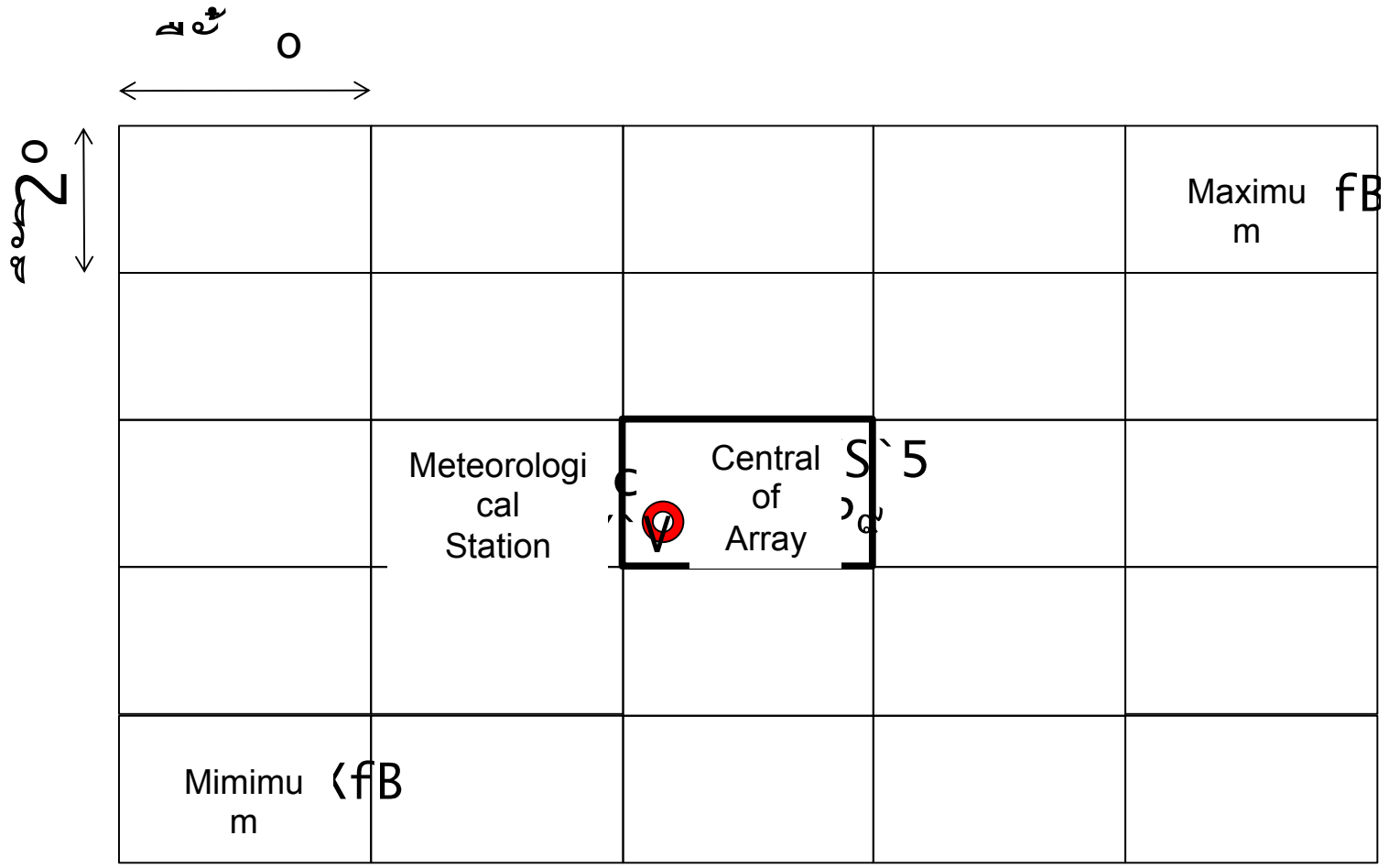
Predictors

- Temperature
- Atmospheric pressure
- Precipitation
- Solar radiation
- Evaporation

Predictands

- Average, Maximum and Minimum Temperature
- Relative Humidity
- Precipitation
- Atmospheric pressure
- Wind speed
- Sunshine duration

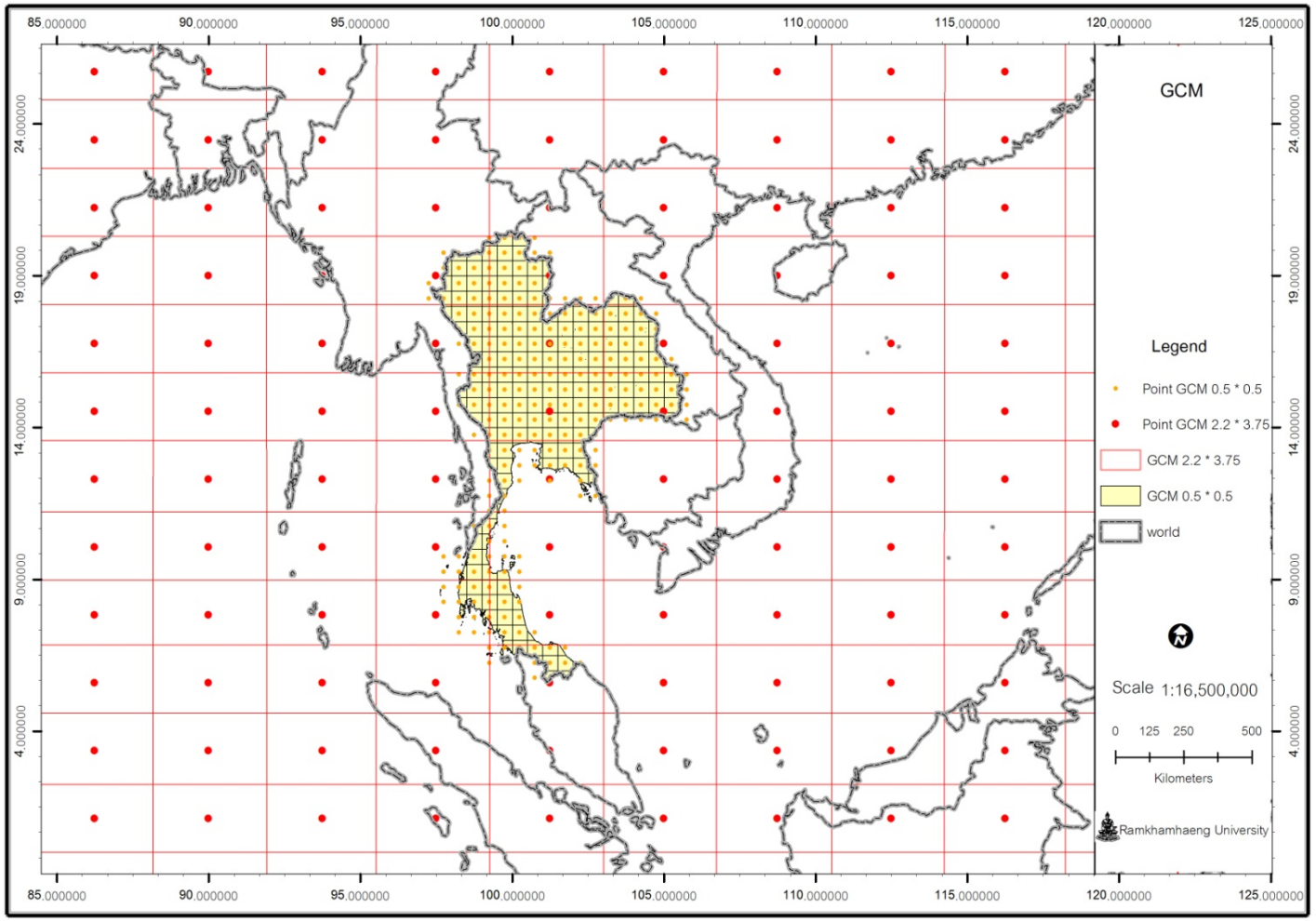
Selection of GCMs grids for predictors



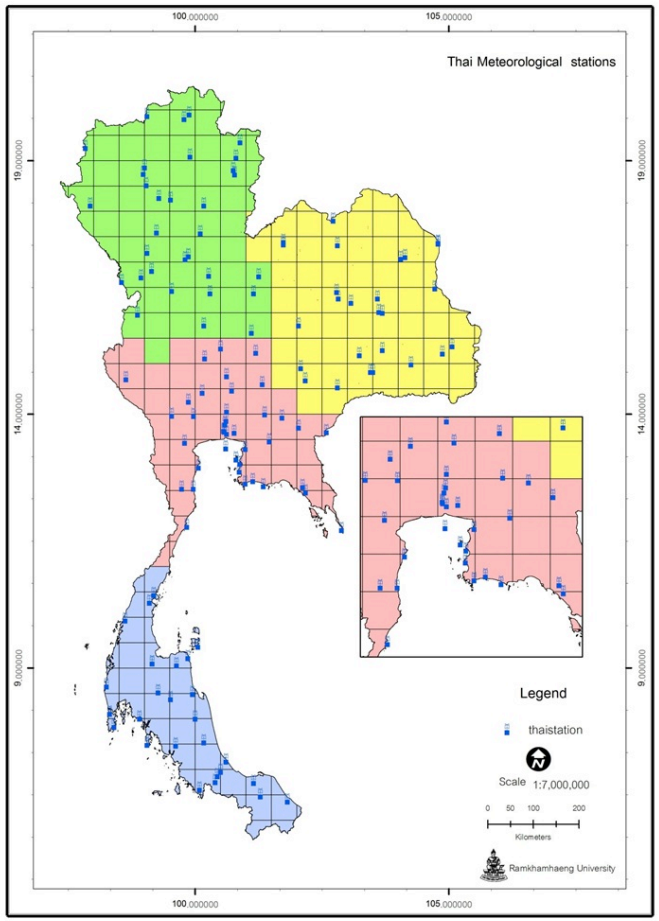
Description of selected GCMs grids

- No. of grid from GCM-GFDL 130
- Minimum selected grid
  - Latitude -1.11799
  - Longitude 86.25000
- Maximum selected grid
  - Latitude 25.71375
  - Longitude 120.00000

Selected GCM grid

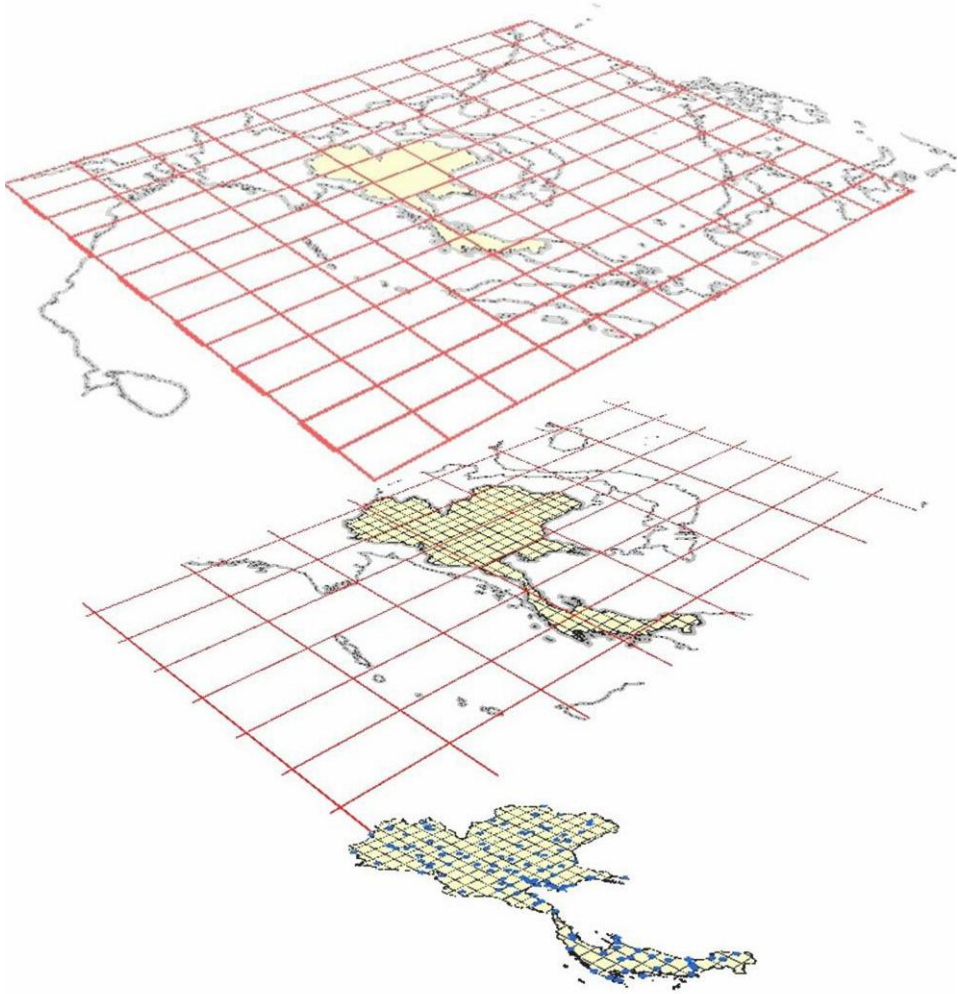


Meteorological stations

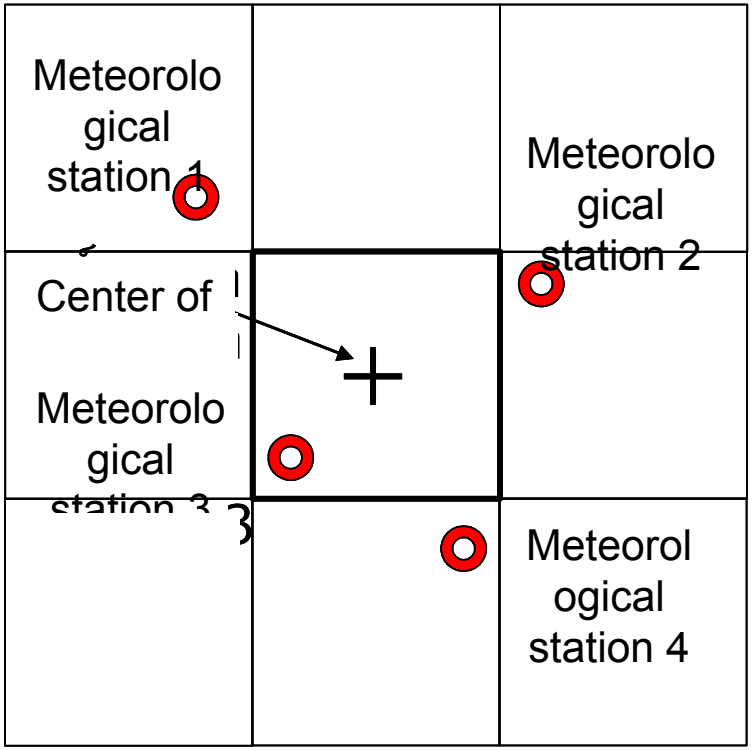


- Total no. of meteorological stations: 124
- Meteorological stations are not located at the centre of grids.

Statistical Downscalling



Interpolation and Extrapolation



$$\mathrm{ClmVar}_{\text{grid i}} = \frac{\sum_{j=1}^{4} \mathrm{ClmVar}_{\text{station j}} / \mathrm{D}_{\text{station j-grid i}}}{\sum_{j=1}^{4} 1/\mathrm{D}_{\text{station j-grid i}}}$$

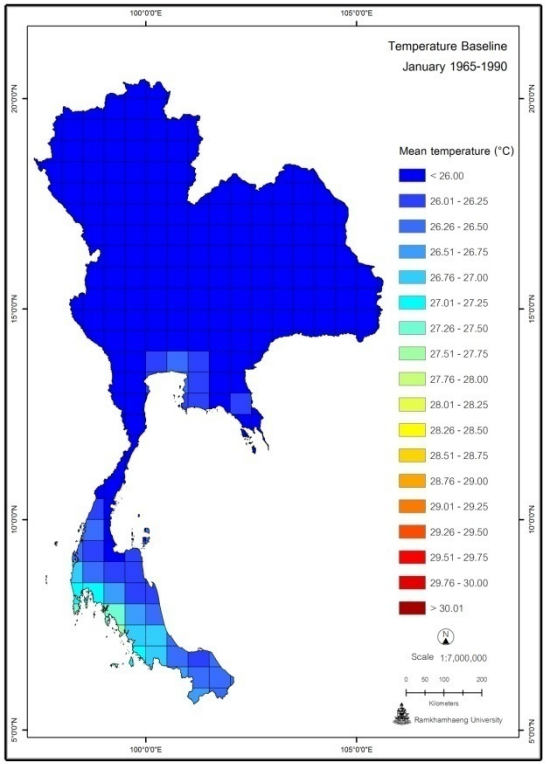
Baseline temperature (1965 – 1990)

	Temperature (°C)	Month
Min. of monthly avg. **maximum temperature**	27.00	December
Max. of monthly avg. **maximum temperature**	37.99	April
Min. of monthly avg. **minimum temperature**	12.53	January
Max. of monthly avg. **minimum temperature**	26.78	April
Min. of monthly avg. **mean temperature**	20.07	December
Max. of monthly avg. **mean temperature**	31.42	April

Baseline: Mean Temperature

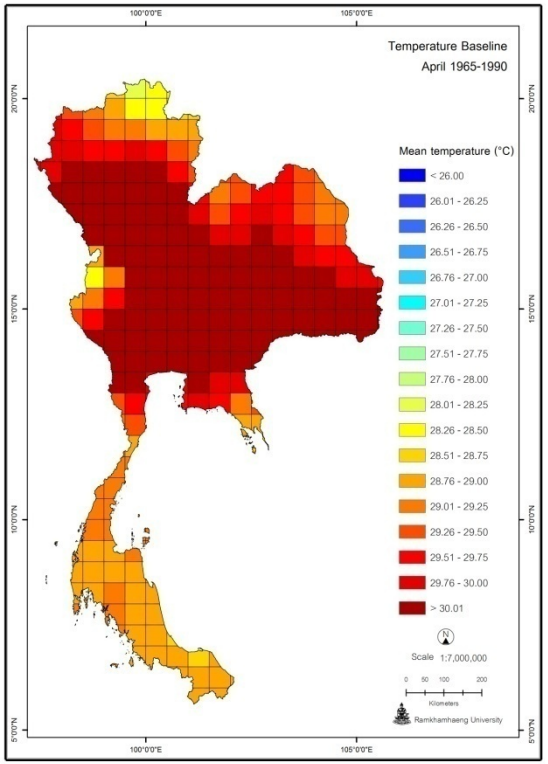
Mean Temp 24.25°C

50.2% < Average



Mean Temp 29.70°C

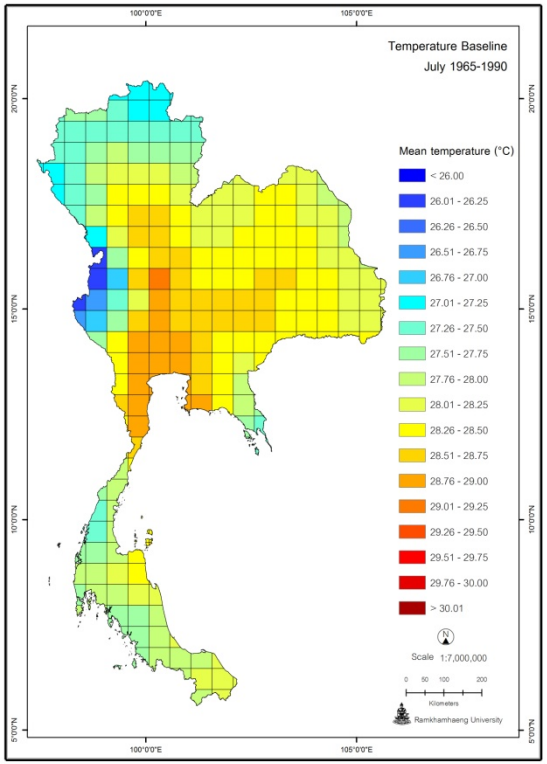
51.4% < Average



Baseline: Mean Temperature

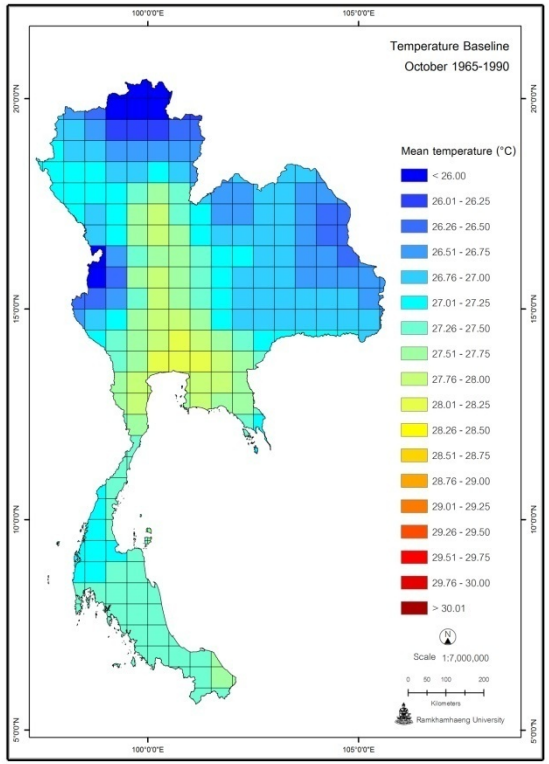
Mean Temp 28.03°C

43.6% < Average



Mean Temp 27.10°C

47.5% < Average



Baseline precipitation (1965 – 1990)

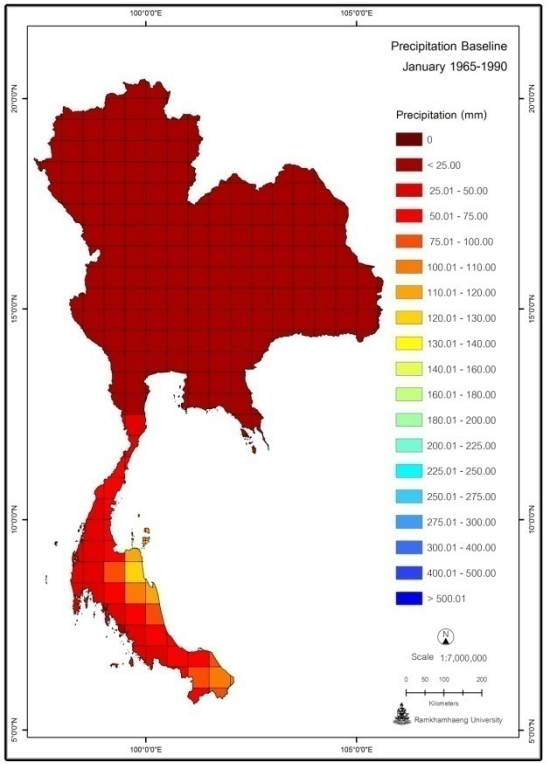
Month	Monthly average precipitation (mm.)		
	Avg.	Min.	Max.
January	20.62	1.34	141.06
February	18.79	2.81	60.19
March	34.93	6.78	88.93
April	85.00	38.80	173.86
May	202.27	**113.35**	440.84
June	204.21	77.68	762.02
July	209.15	85.34	699.00
August	247.11	107.70	**826.58**
September	**254.29**	109.45	547.99
October	177.99	77.63	413.99
November	111.51	6.24	571.89
December	45.89	1.49	450.15
Total	1611..78		

Baseline: Precipitation

Baseline: Precipitation

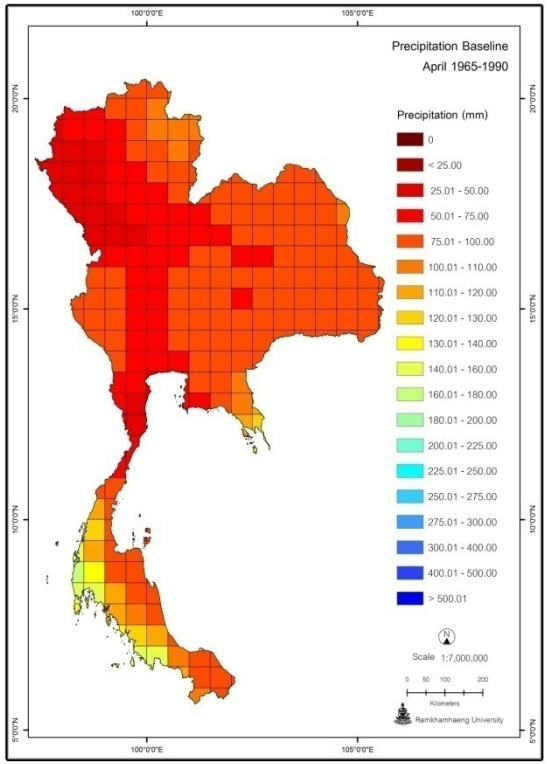
Avg. Precipitation 20.62 mm.

74.3% < Average



Avg. Precipitation 85.00 mm.

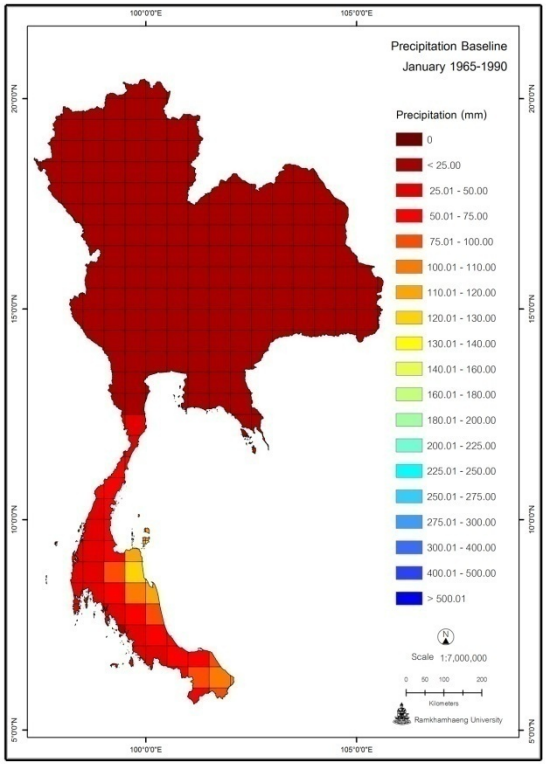
51.0% < Average



Baseline: Precipitation

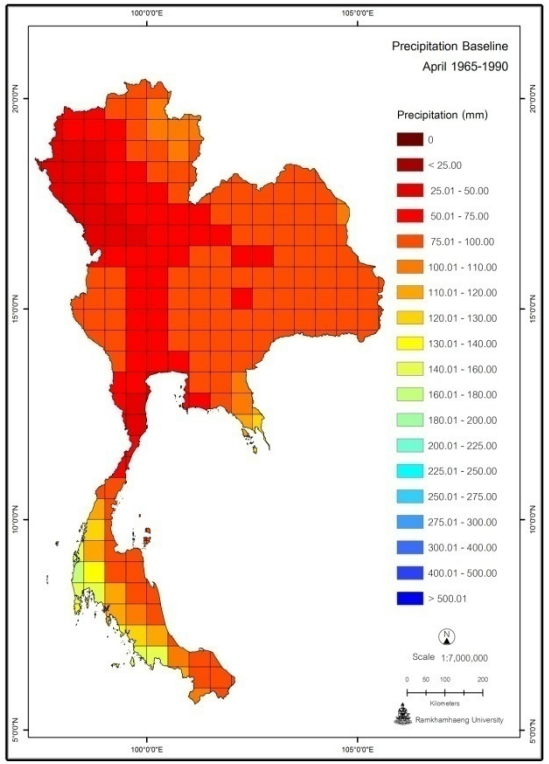
Avg. Precipitation 20.62 mm.

74.3% < Average



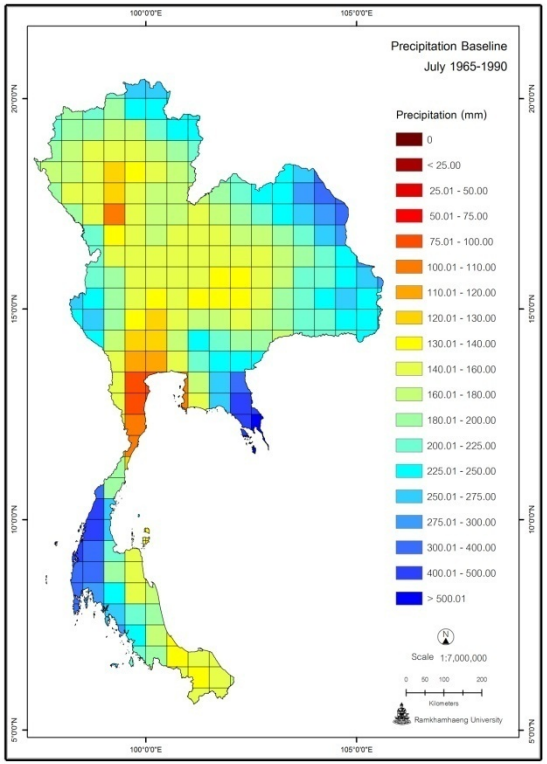
Avg. Precipitation 85.00 mm.

51.0% < Average

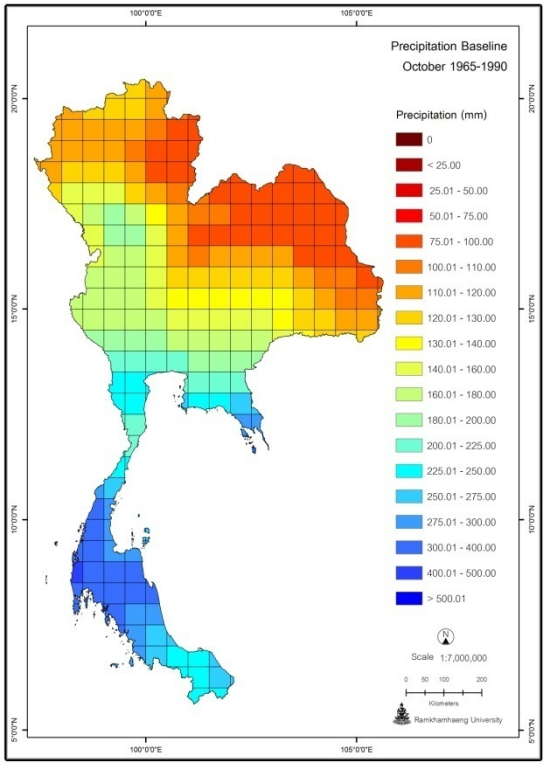


Baseline: Precipitation

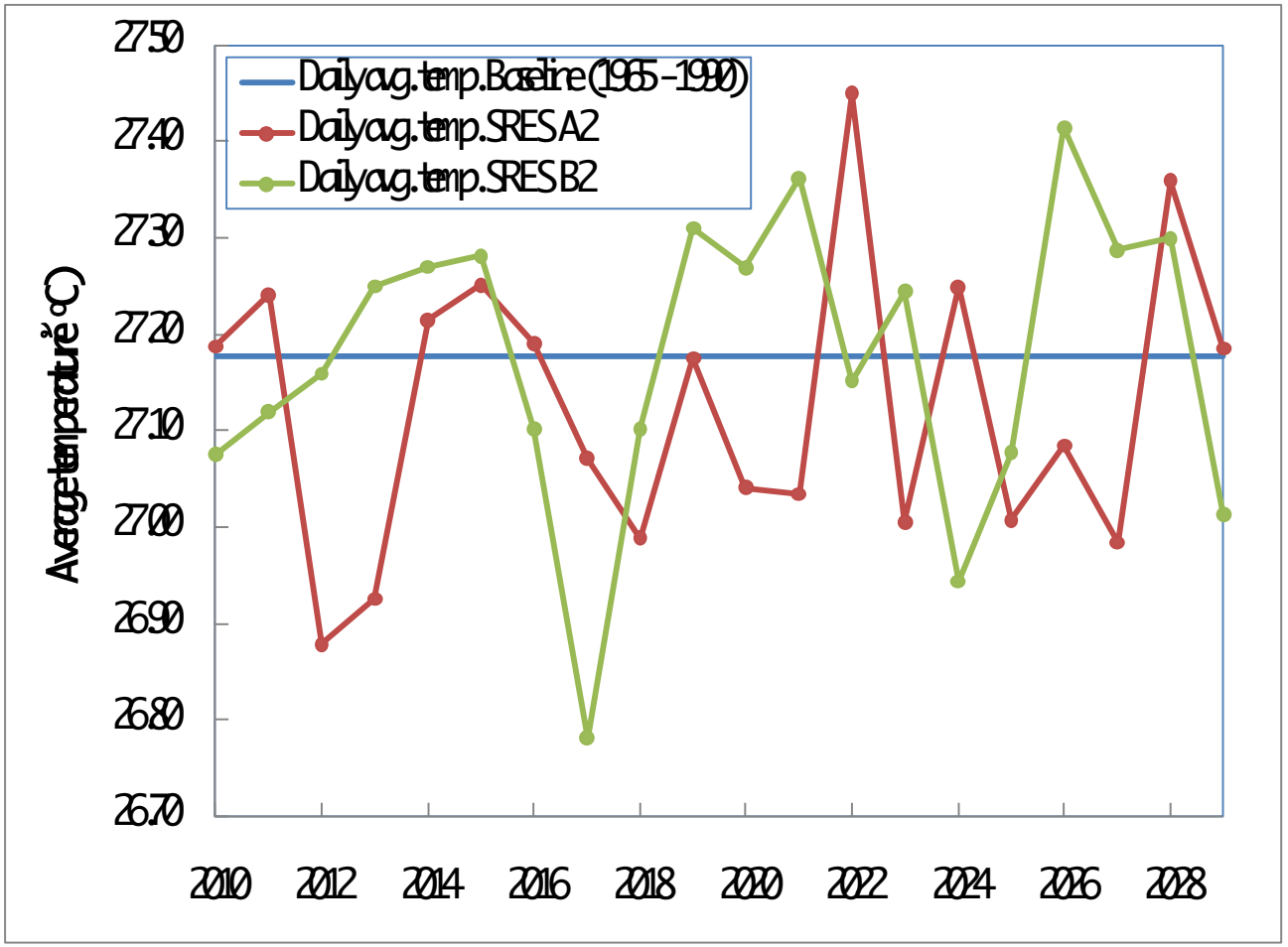
Avg. Precipitation 209.15 mm.
60.3% < Average



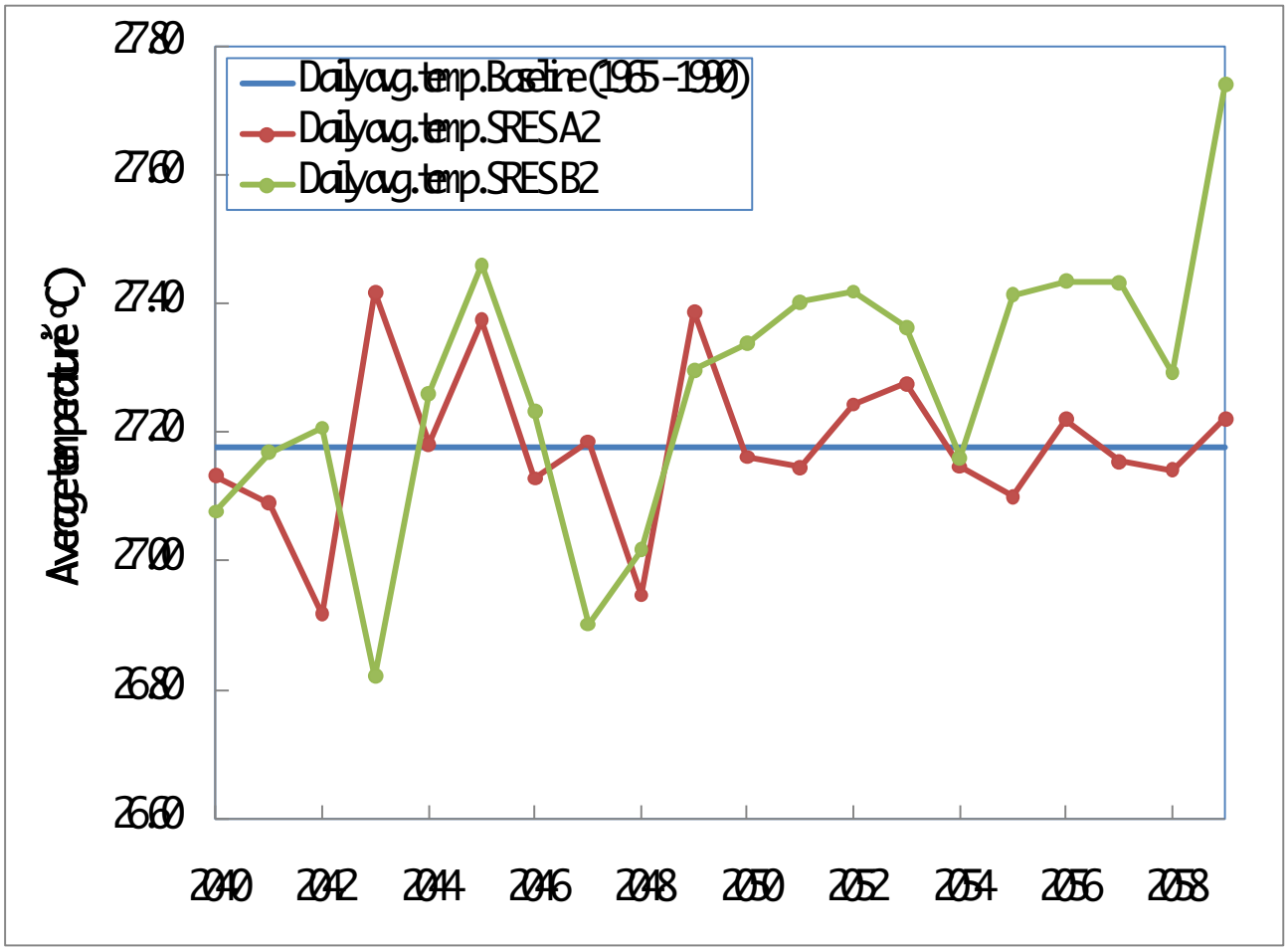
Avg. Precipitation 177.99 mm.
59.9% < Average



Mean temp. (2010-2029)

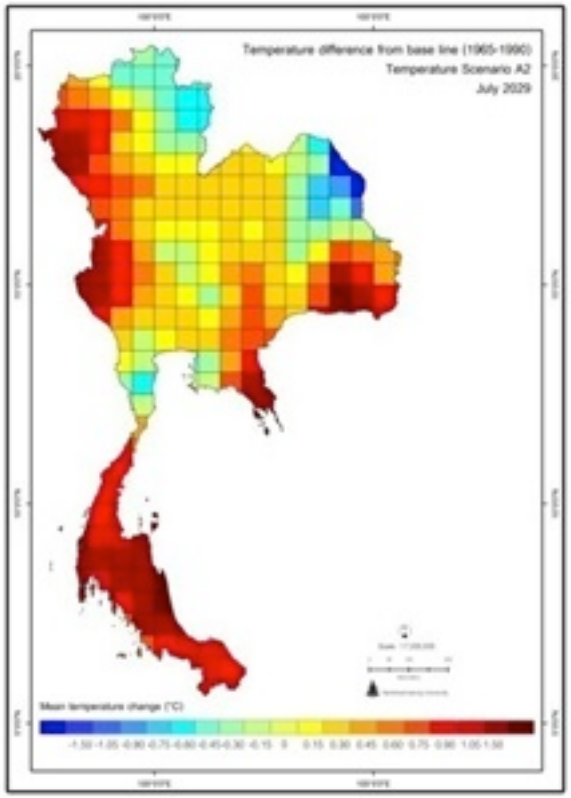


Mean temp. (2040-2059)

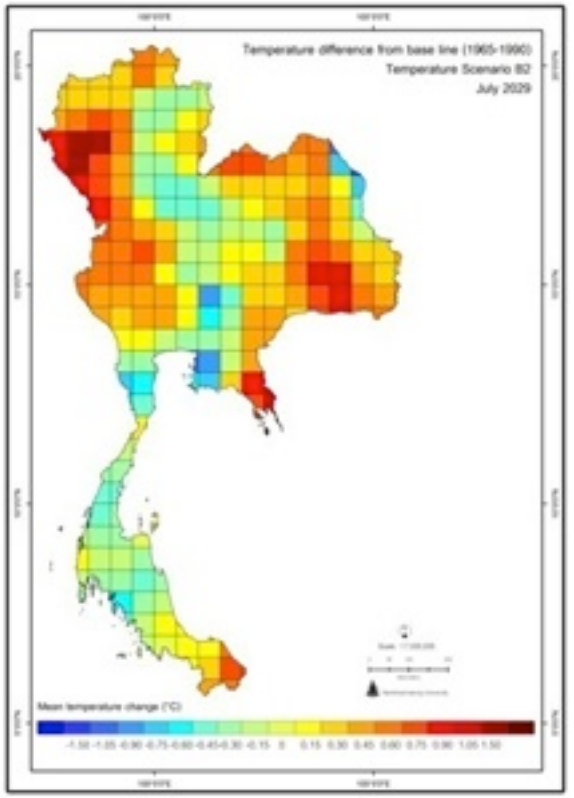


Mean Temperature Difference from Baseline

A2 July 2029



B2 July 2029

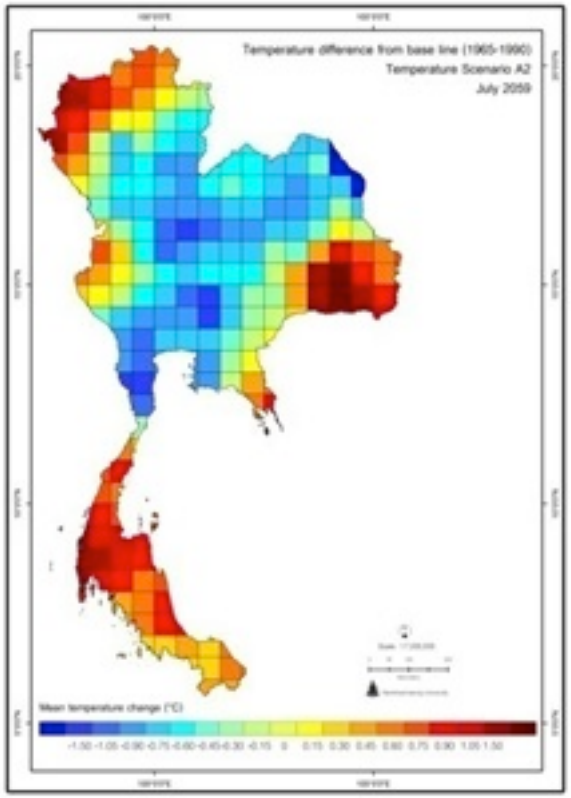


Mean temperature change (°C)

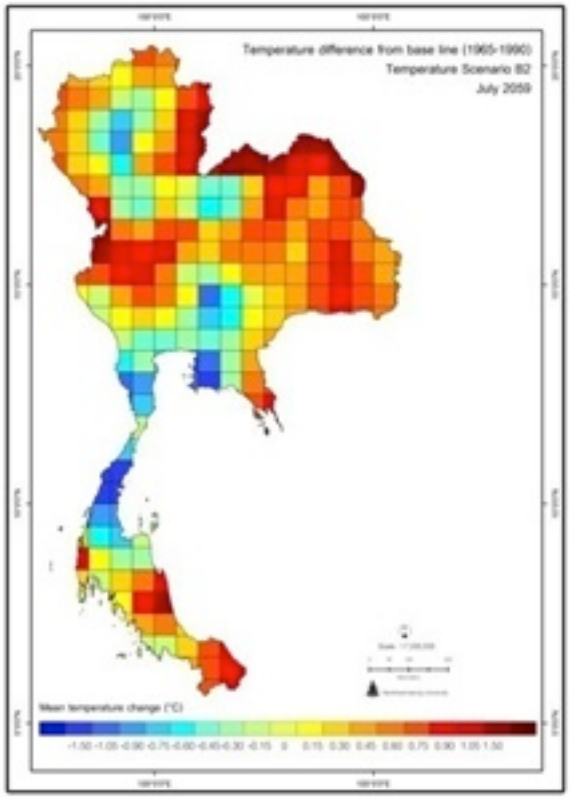
-1.50 -1.05 -0.90 -0.75 -0.60 -0.45 -0.30 -0.15 0 0.15 0.30 0.45 0.60 0.75 0.90 1.05 1.50

Mean Temperature Difference from Baseline

A2 July 2059



B2 July 2059

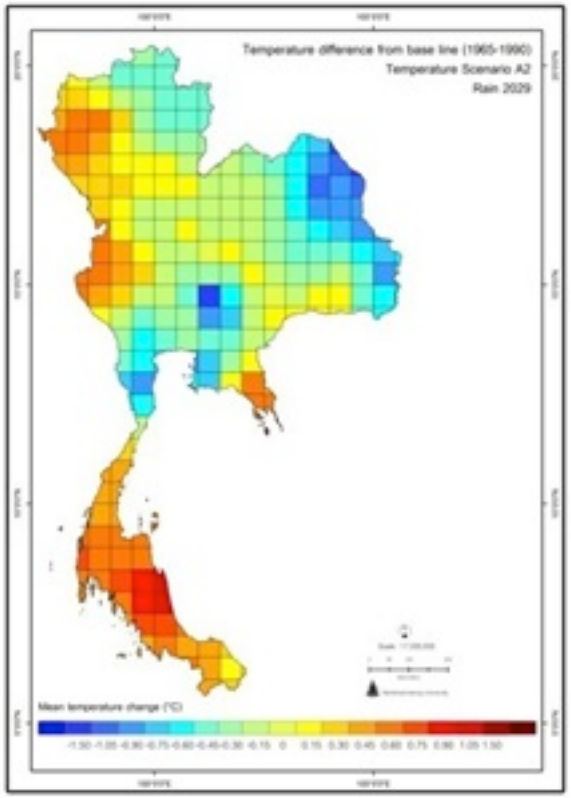


Mean temperature change (°C)

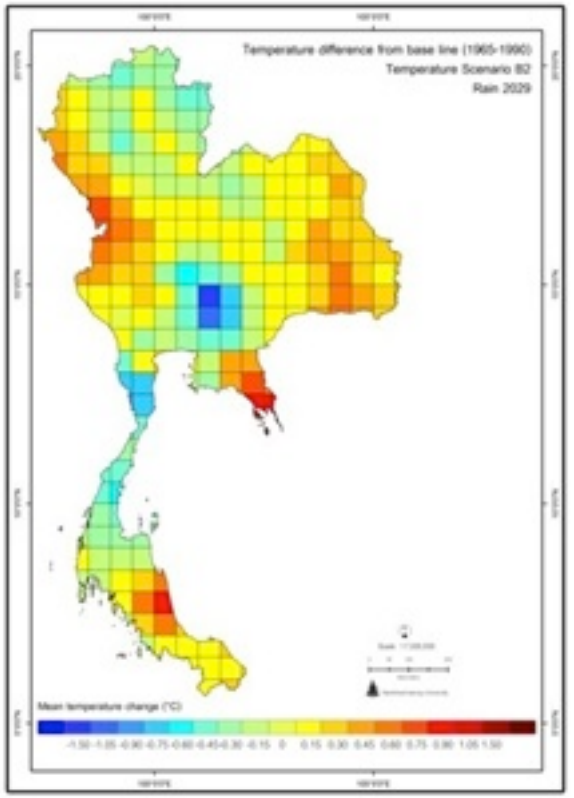
-1.50 -1.05 -0.90 -0.75 -0.60 -0.45 -0.30 -0.15 0 0.15 0.30 0.45 0.60 0.75 0.90 1.05 1.50

Mean Temperature Difference from Baseline

A2 Rain 2029



B2 Rain 2029

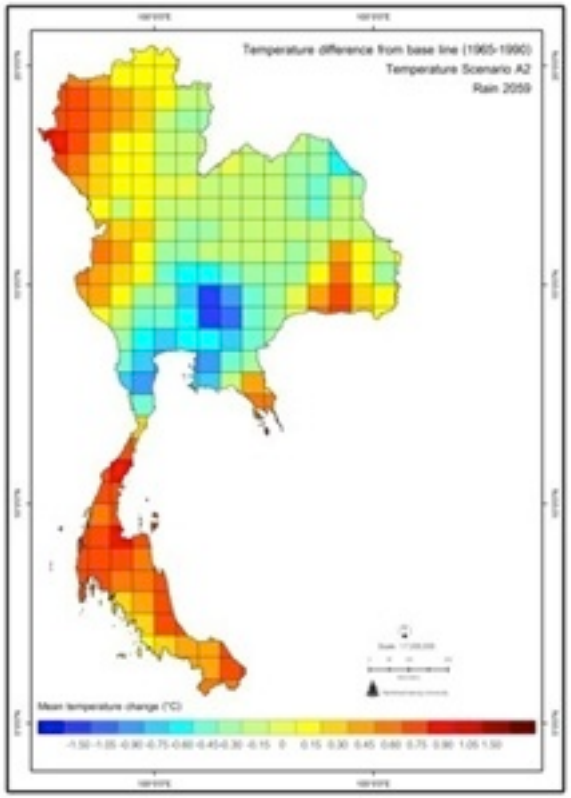


Mean temperature change (°C)

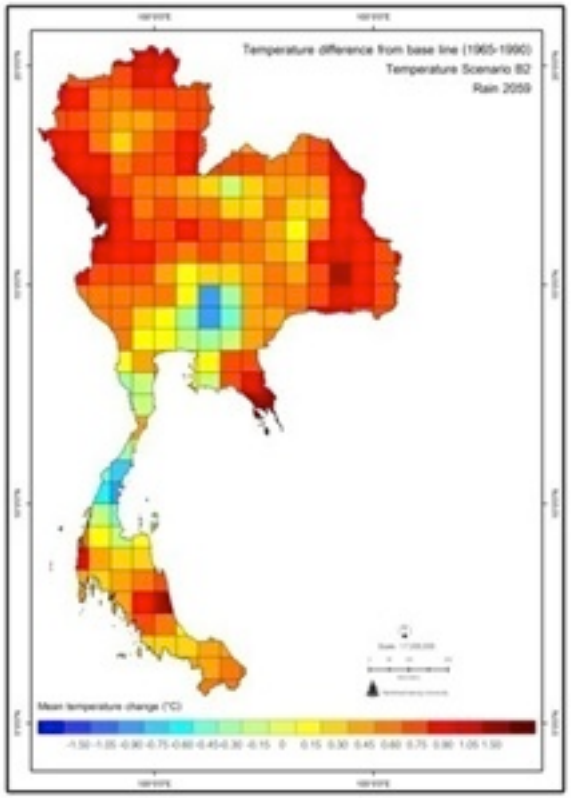
-1.50 -1.05 -0.90 -0.75 -0.60 -0.45 -0.30 -0.15 0 0.15 0.30 0.45 0.60 0.75 0.90 1.05 1.50

Mean Temperature Difference from Baseline

A2 Rain 2059



B2 Rain 2059



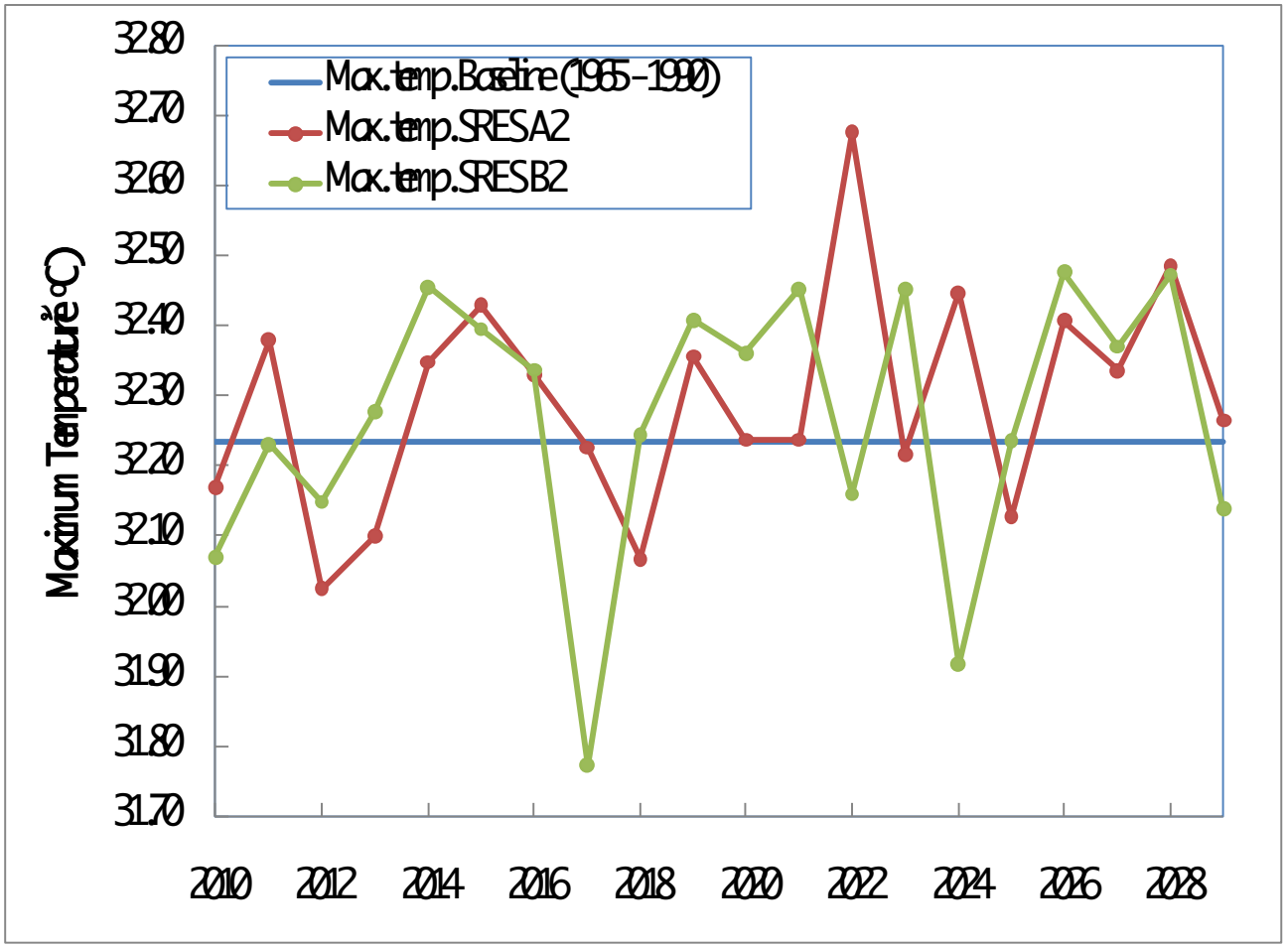
Mean temperature change (°C)

-1.50 -1.05 -0.90 -0.75 -0.60 -0.45 -0.30 -0.15 0 0.15 0.30 0.45 0.60 0.75 0.90 1.05 1.50

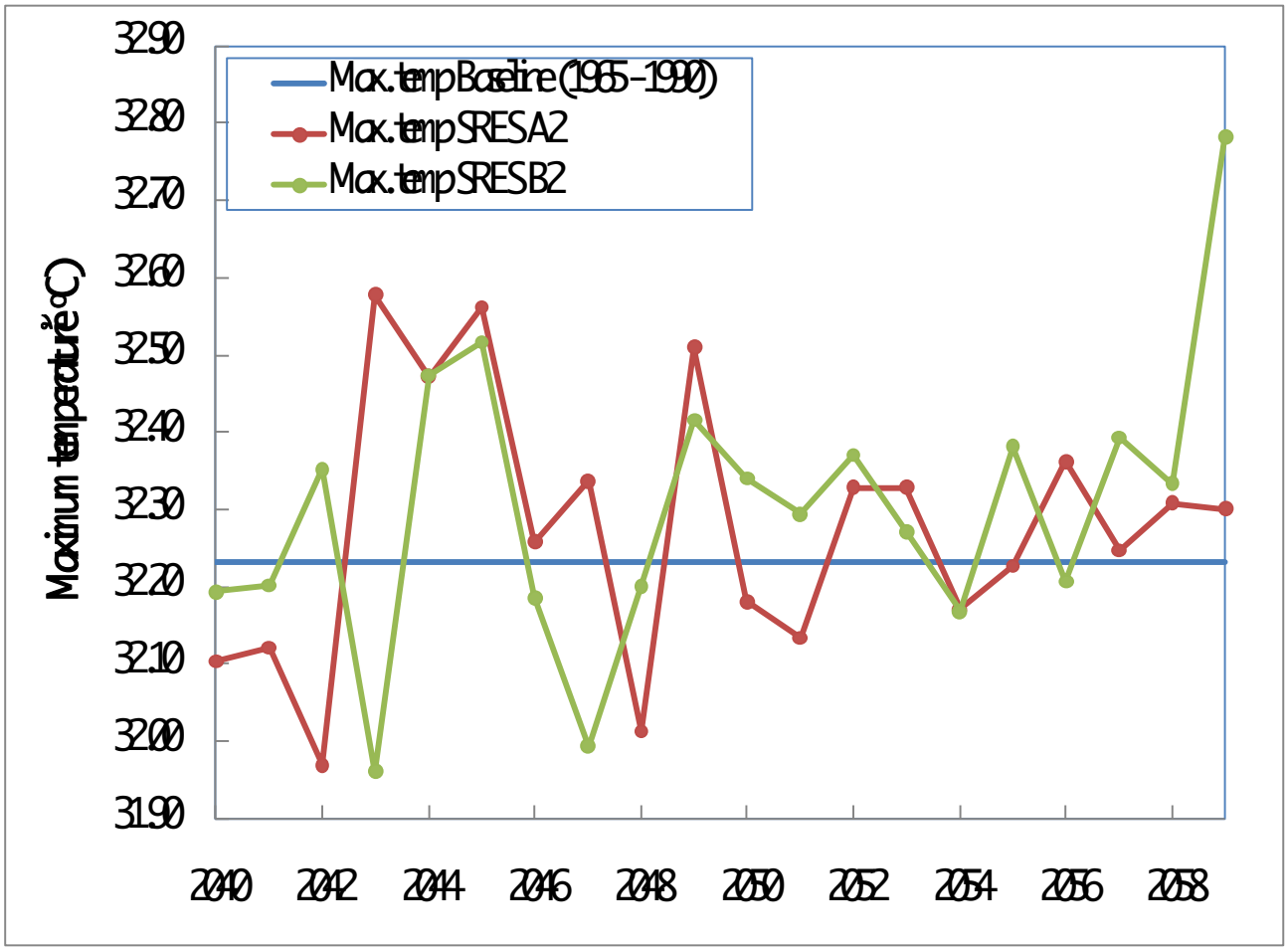
Future Max. Temp.

- Baseline: max. temp. = 32.23^{o}C
- 2010 – 2029:
  - SRES A2: max. in 2022: 0.44^{o}C > Baseline
  - Average max. : SRES A2 = 32.29^{o}C
  - : SRES B2 = 32.27^{o}C
- 2040 – 2059:
  - SRES B2: max. in 2059: 0.54 ^{o}C > Baseline
  - Average max. : SRES A2 = 32.28^{o}C
  - : SRES B2 = 32.30^{o}C

Max temp. (2010-2029)

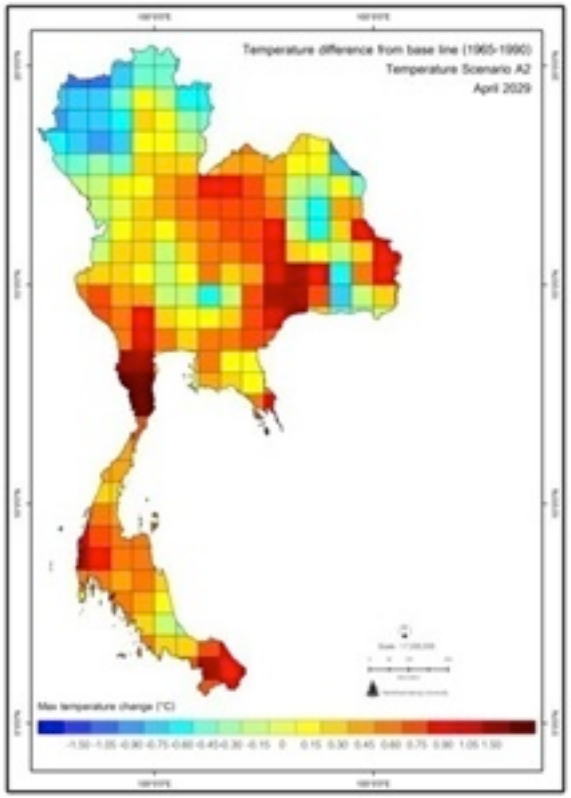


Mean temp. (2040-2059)

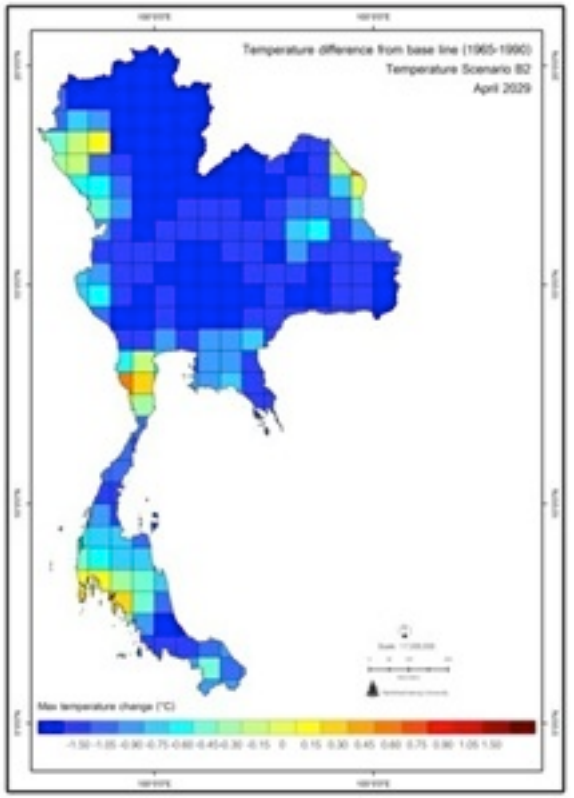


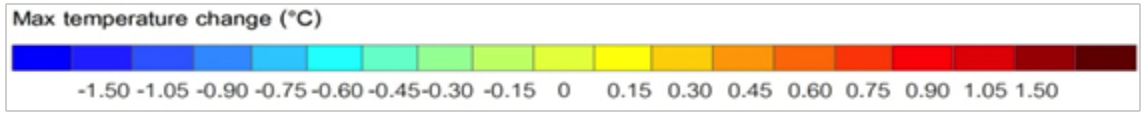
Max. Temperature Difference from Baseline

A2 April 2029



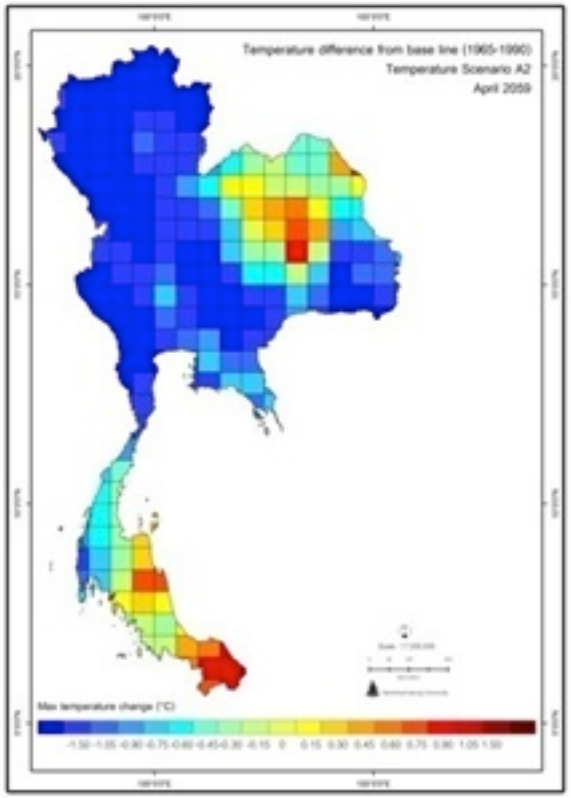
B2 April 2029



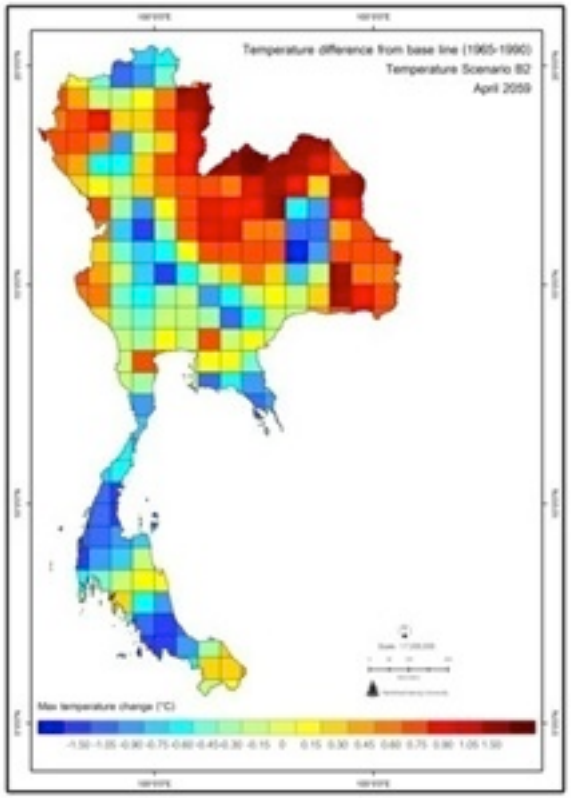


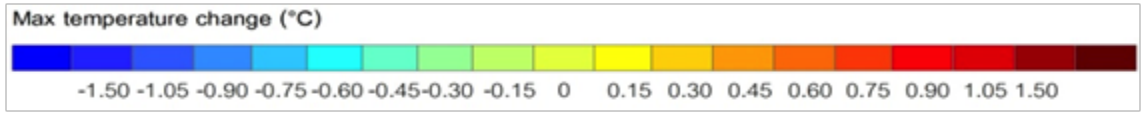
Max. Temperature Difference from Baseline

A2 April 2059



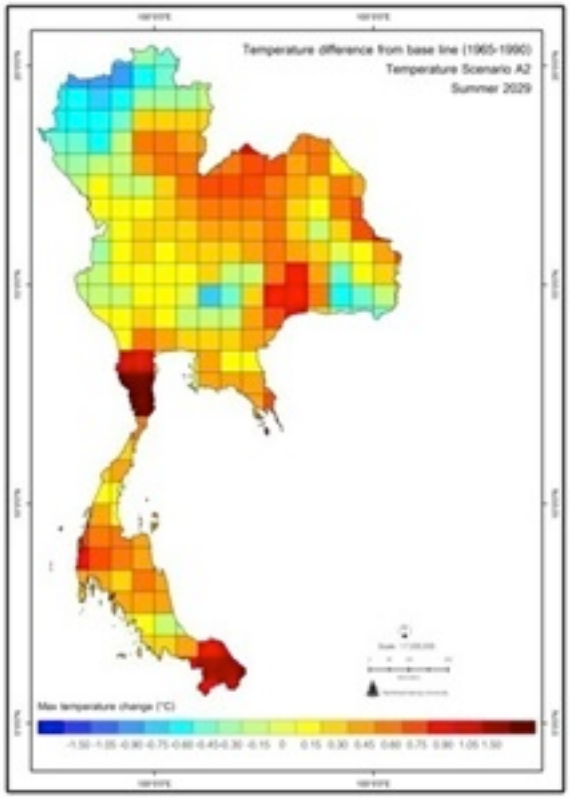
B2 April 2059



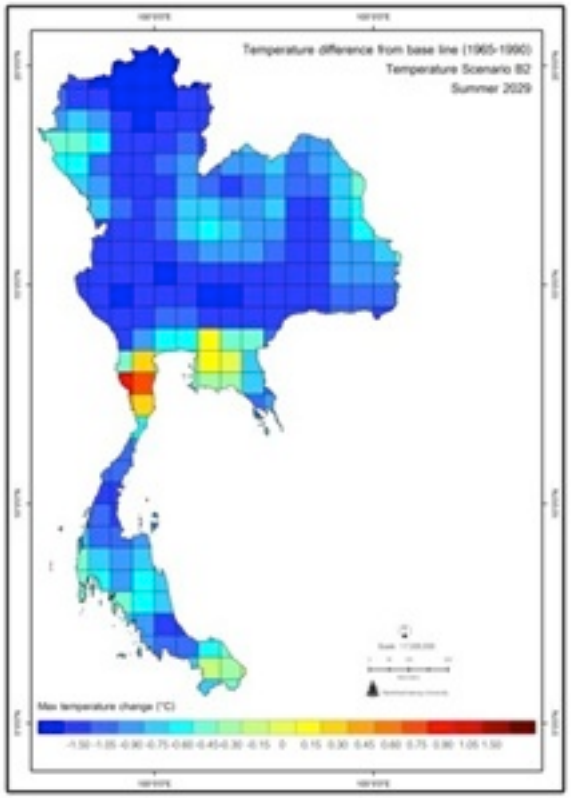


Max. Temperature Difference from Baseline

A2 Summer 2029



B2 Summer 2029

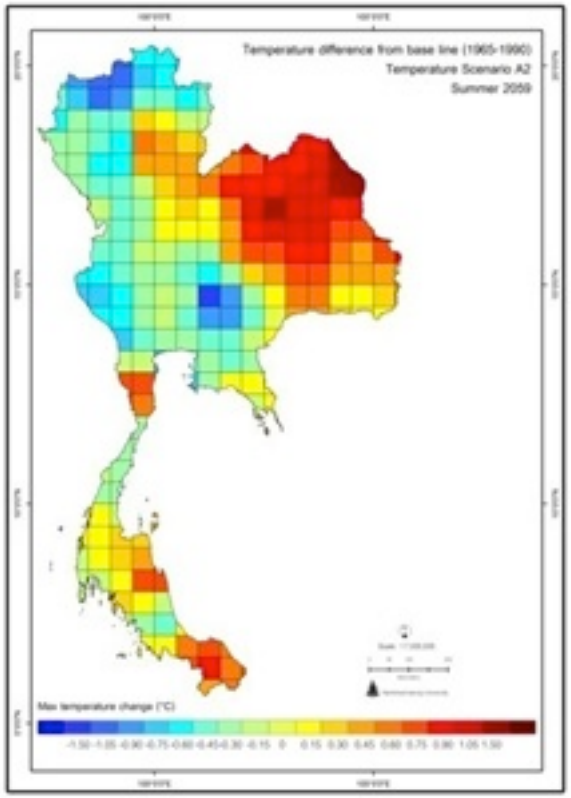


Max temperature change (°C)

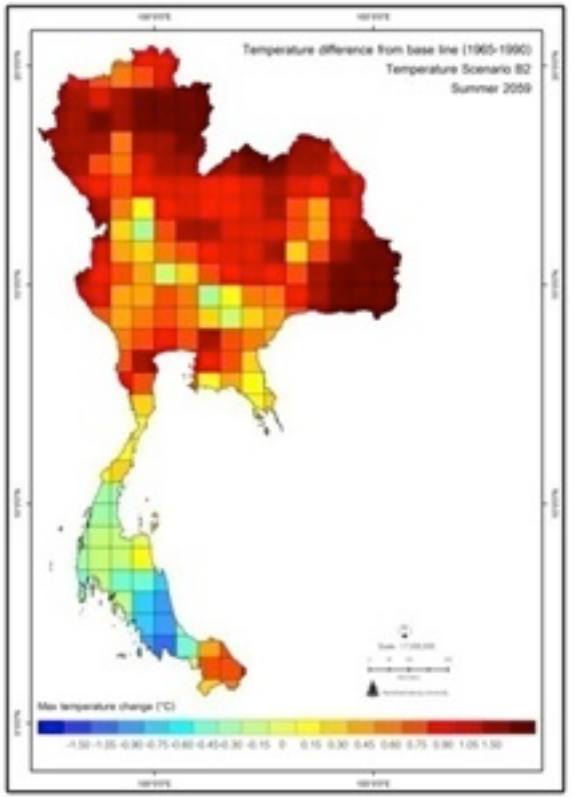
-1.50 -1.05 -0.90 -0.75 -0.60 -0.45 -0.30 -0.15 0 0.15 0.30 0.45 0.60 0.75 0.90 1.05 1.50

Max. Temperature Difference from Baseline

A2 Summer 2059



B2 Summer 2059



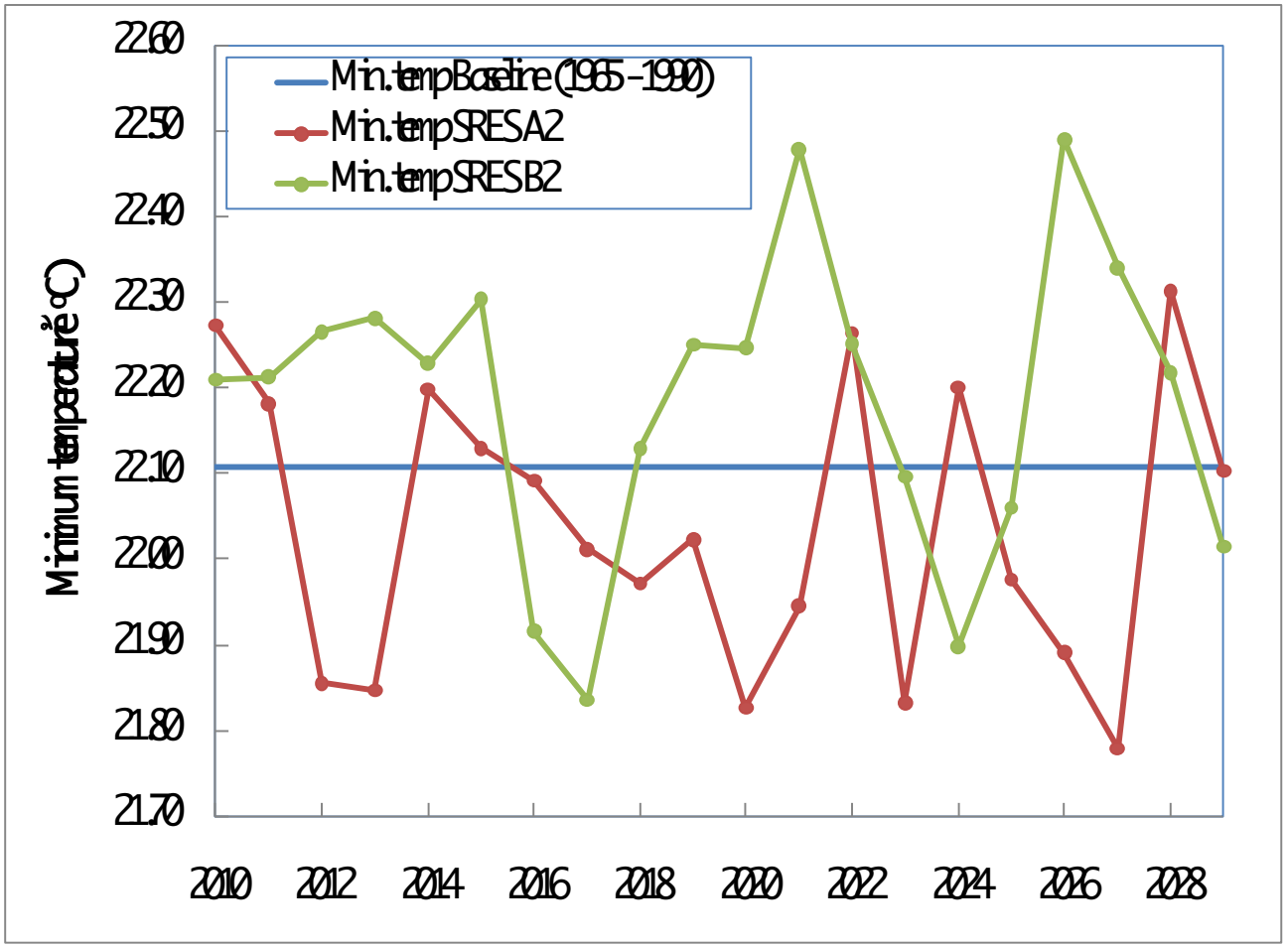
Max temperature change (°C)

-1.50 -1.05 -0.90 -0.75 -0.60 -0.45 -0.30 -0.15 0 0.15 0.30 0.45 0.60 0.75 0.90 1.05 1.50

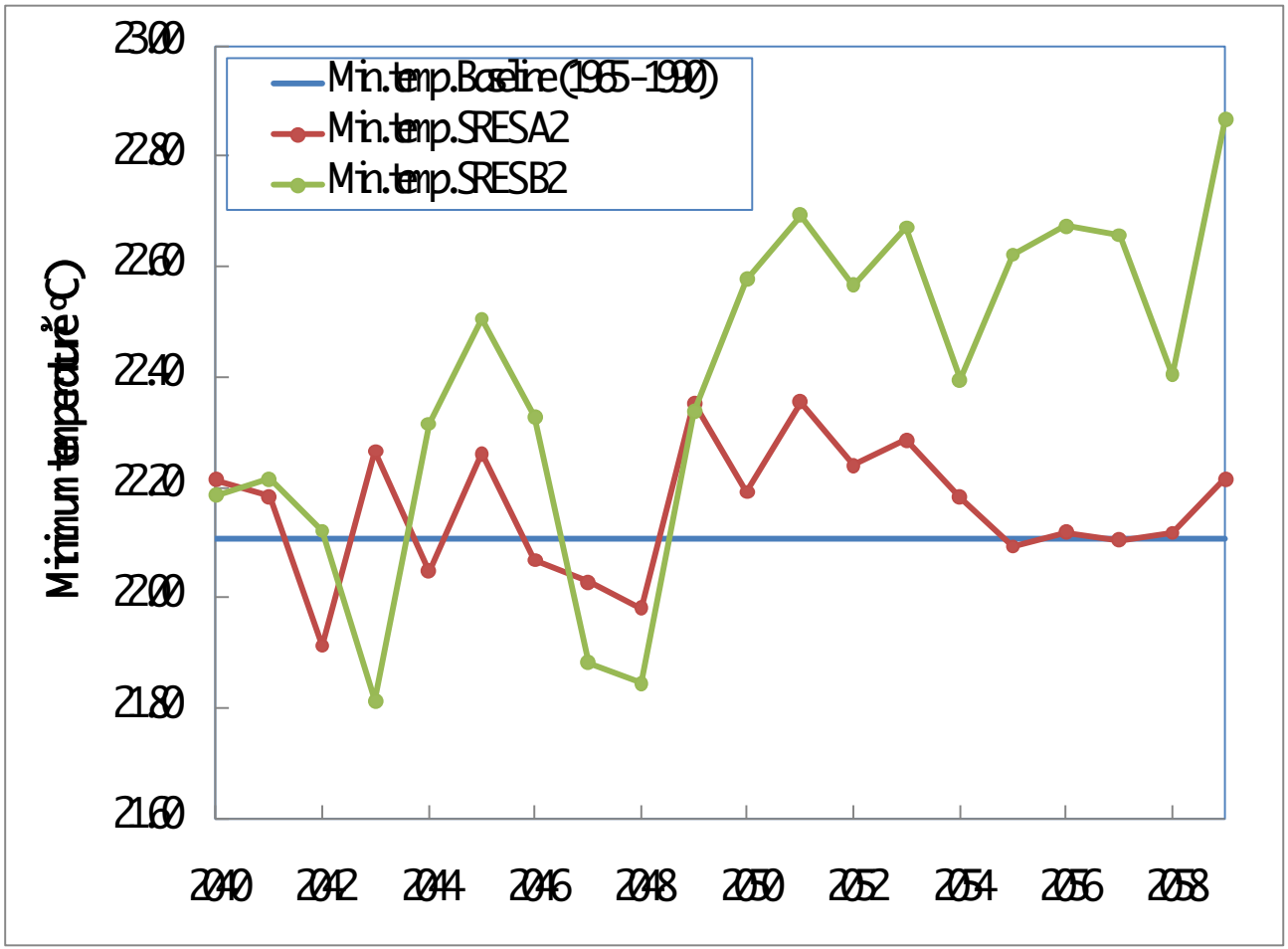
Future Min. Temp.

- Baseline: min. temp. = 22.11^{o}C
- 2010 – 2029:
  - SRES A2: min. in 2027: 0.33^{o}C < Baseline
  - Average max. : SRES A2 = 22.04^{o}C
  - : SRES B2 = 22.19^{o}C
- 2040 – 2059:
  - SRES B2: min. in 2043: 0.29^{o}C < Baseline
  - Average min. : SRES A2 = 22.16^{o}C
  - : SRES B2 = 22.38^{o}C

Min. temp. (2010-2029)

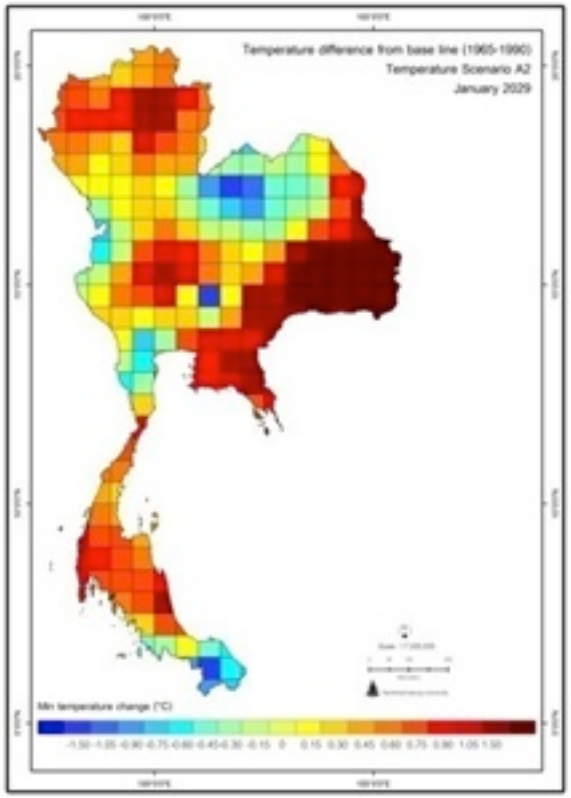


Min. temp. (2040-2059)

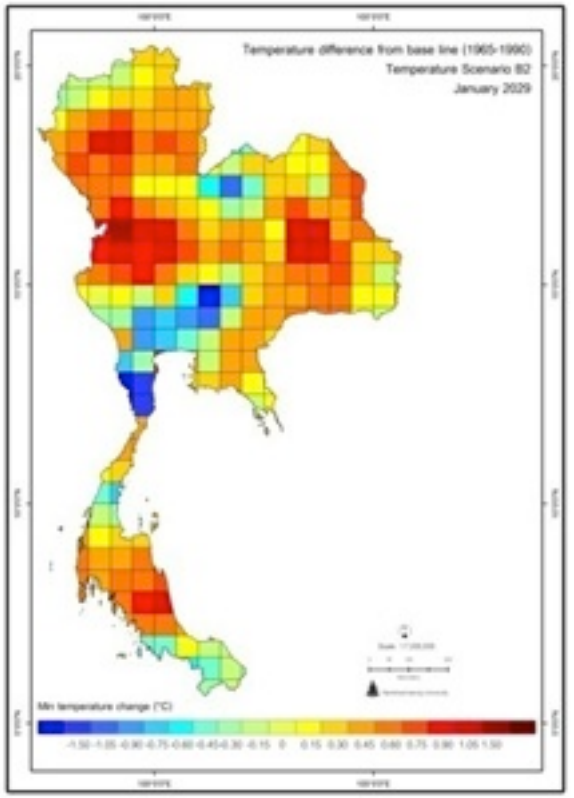


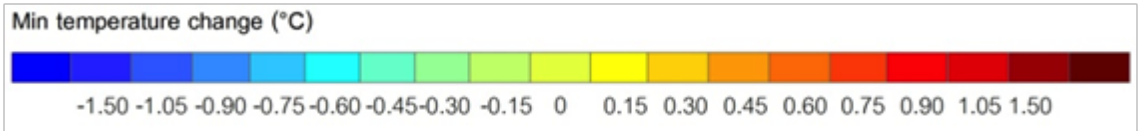
Min. Temperature Difference from Baseline

A2 January 2029



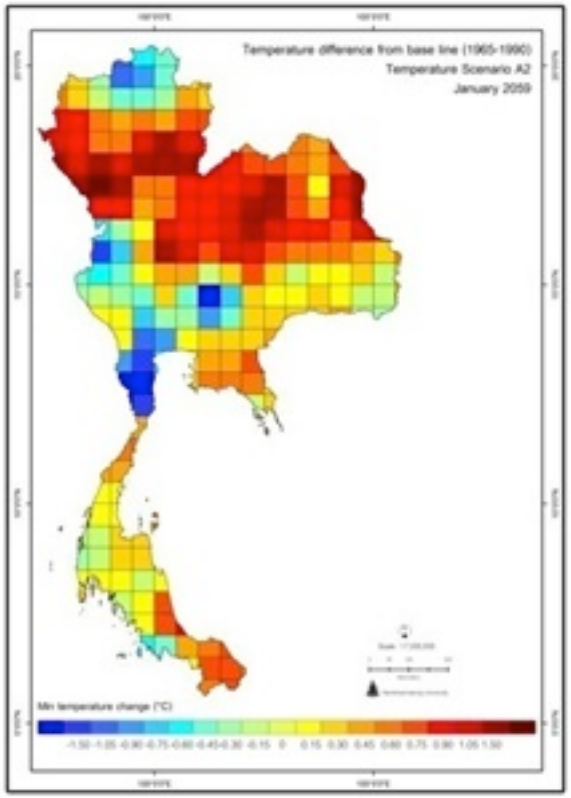
B2 January 2029



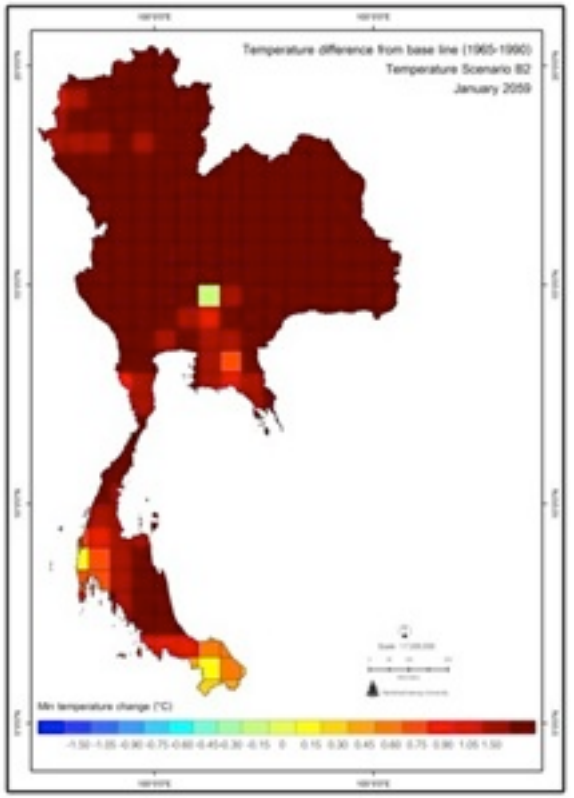


Min. Temperature Difference from Baseline

A2 January 2059



B2 January 2059

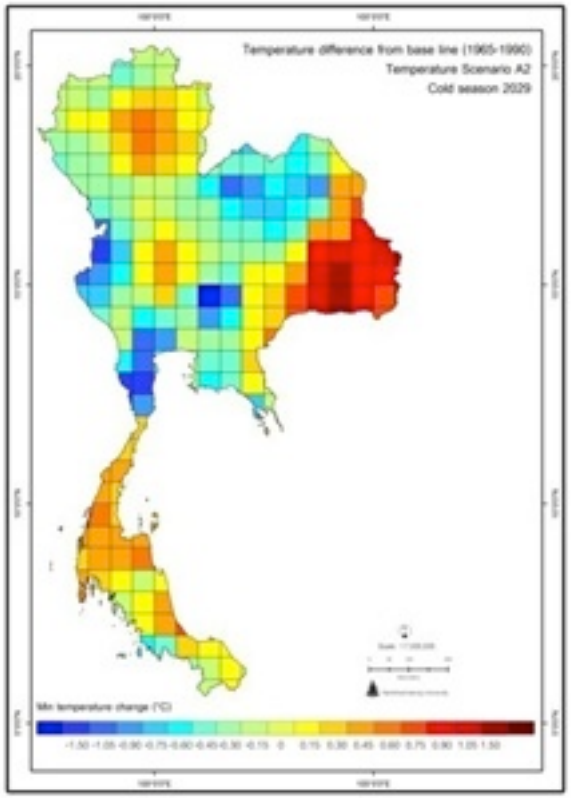


Min temperature change (°C)

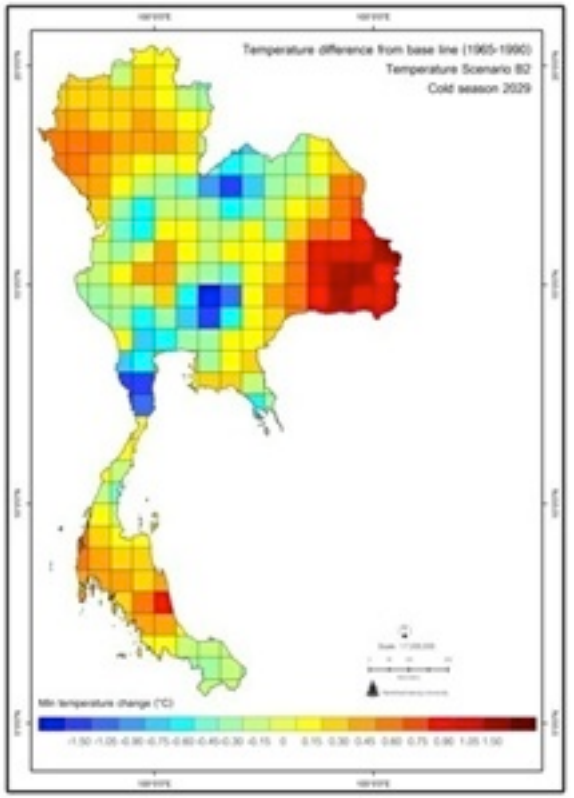
-1.50 -1.05 -0.90 -0.75 -0.60 -0.45 -0.30 -0.15 0 0.15 0.30 0.45 0.60 0.75 0.90 1.05 1.50

Min. Temperature Difference from Baseline

A2 Cold 2029



B2 Cold 2029

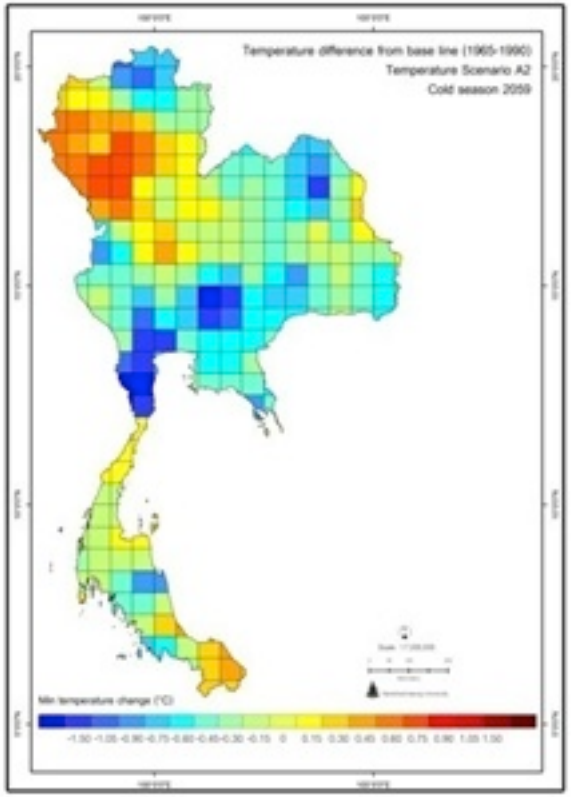


Min temperature change (°C)

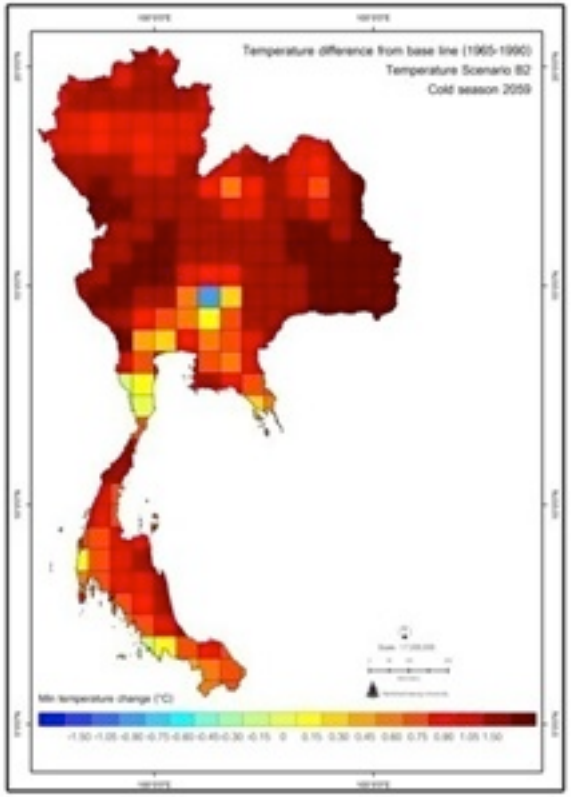
-1.50 -1.05 -0.90 -0.75 -0.60 -0.45 -0.30 -0.15 0 0.15 0.30 0.45 0.60 0.75 0.90 1.05 1.50

Min. Temperature Difference from Baseline

A2 Cold 2059



B2 Cold 2059



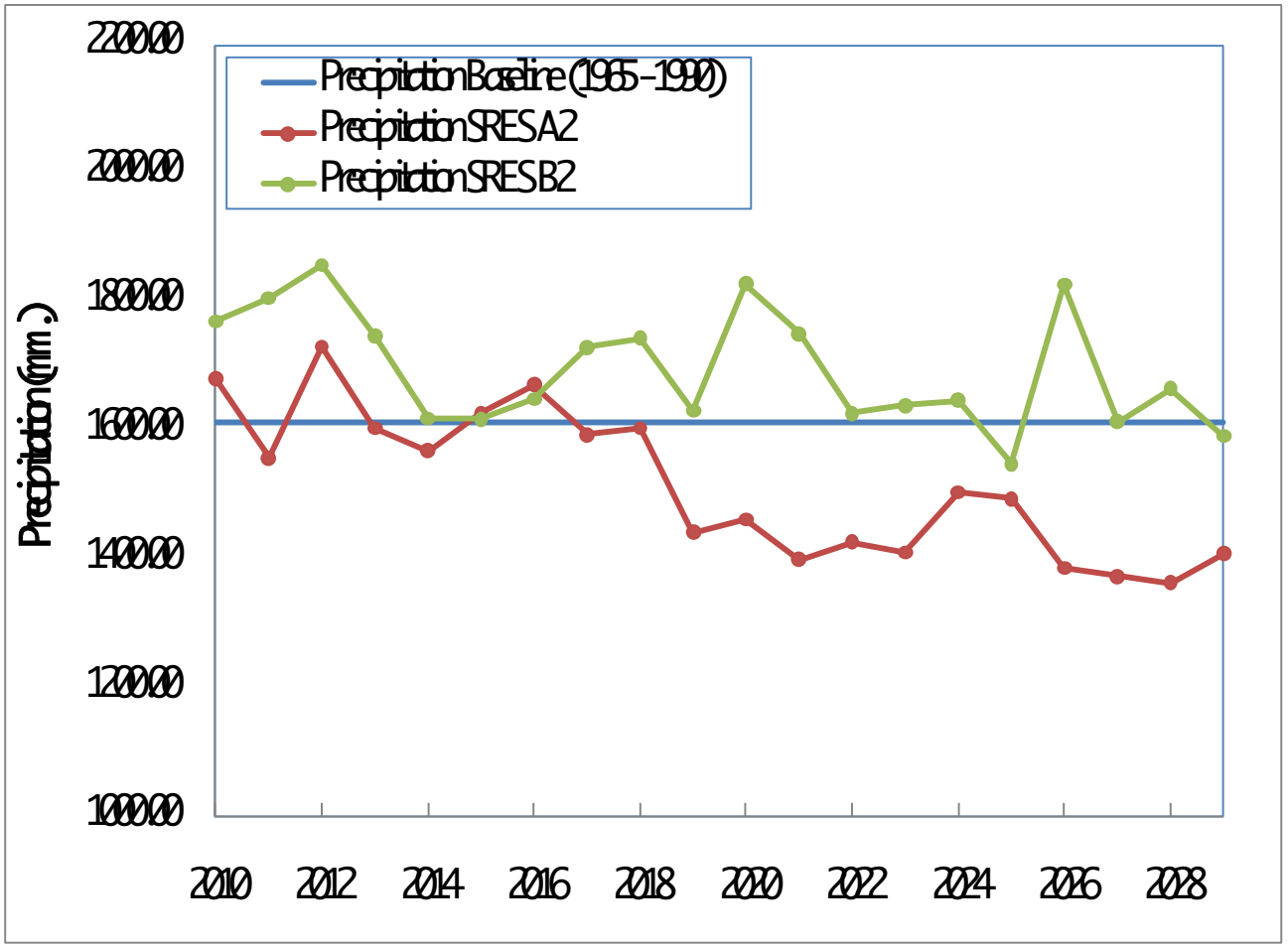
Min temperature change (°C)

-1.50 -1.05 -0.90 -0.75 -0.60 -0.45 -0.30 -0.15 0 0.15 0.30 0.45 0.60 0.75 0.90 1.05 1.50

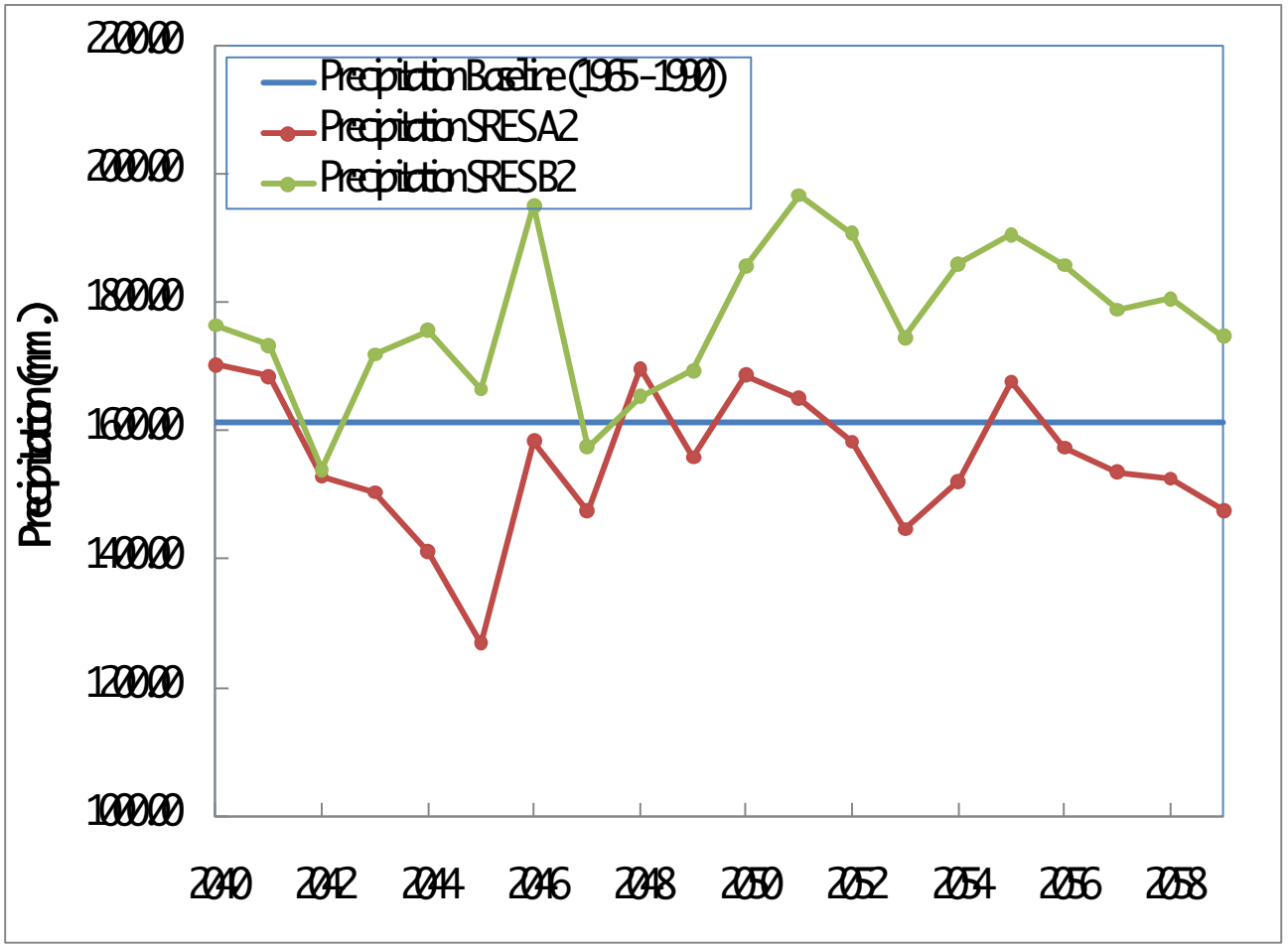
Future Precipitation

- Baseline: precipitation = 1,612 mm
- 2010 – 2029:
  - SRES B2: max in 2012: 246 mm > Baseline
  - Average max. : SRES A2 = 1,515 mm
  - : SRES B2 = 1,695 mm
- 2040 – 2059:
  - SRES B2: max. in 2046: 354 mm > Baseline
  - Average max. : SRES A2 = 1,554 mm.
  - : SRES B2 = 1,774 mm.

Precipitation (2010-2029)

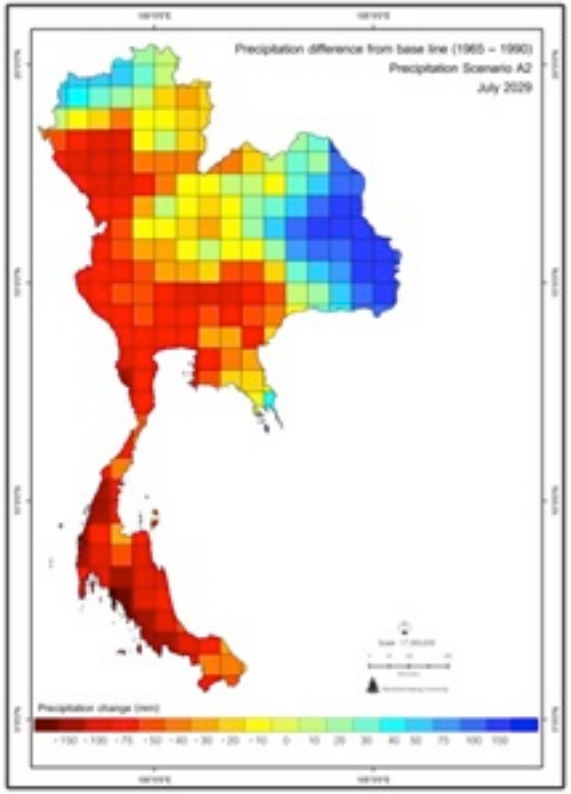


Precipitation (2040-2059)

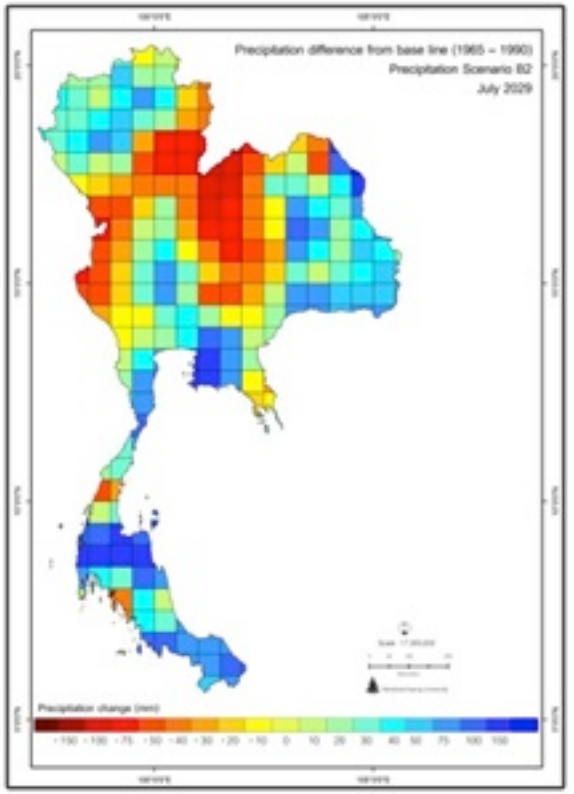


Precipitation Difference from Baseline

A2 July 2029



B2 July 2029

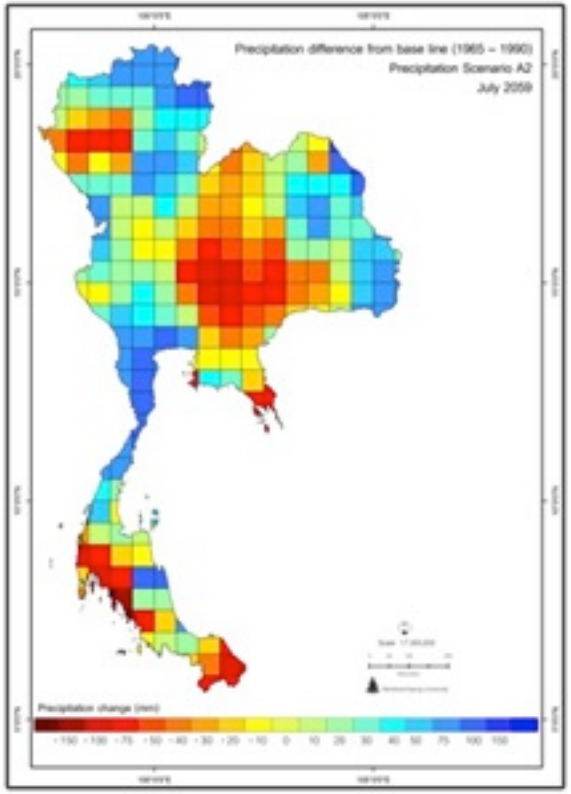


Precipitation change (mm)

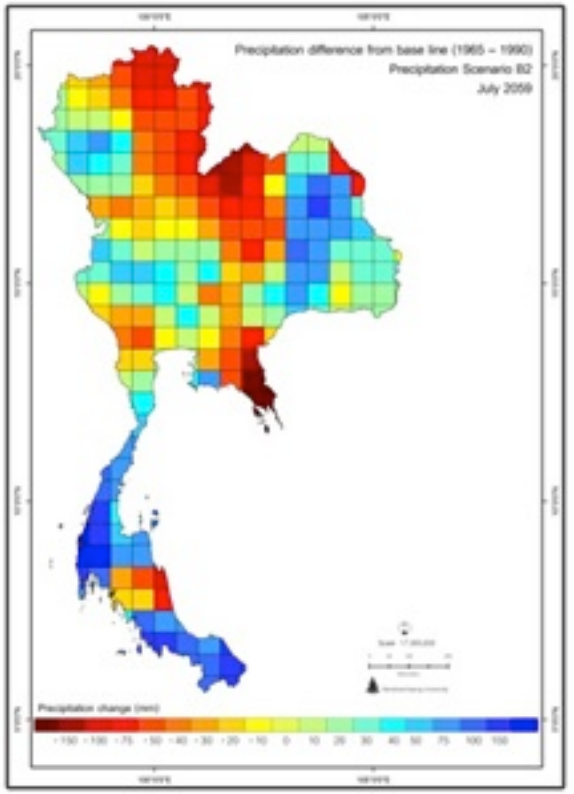
- 150 - 100 - 75 - 50 - 40 - 30 - 20 - 10 0 10 20 30 40 50 75 100 150

Precipitation Difference from Baseline

A2 July 2059



B2 July 2059

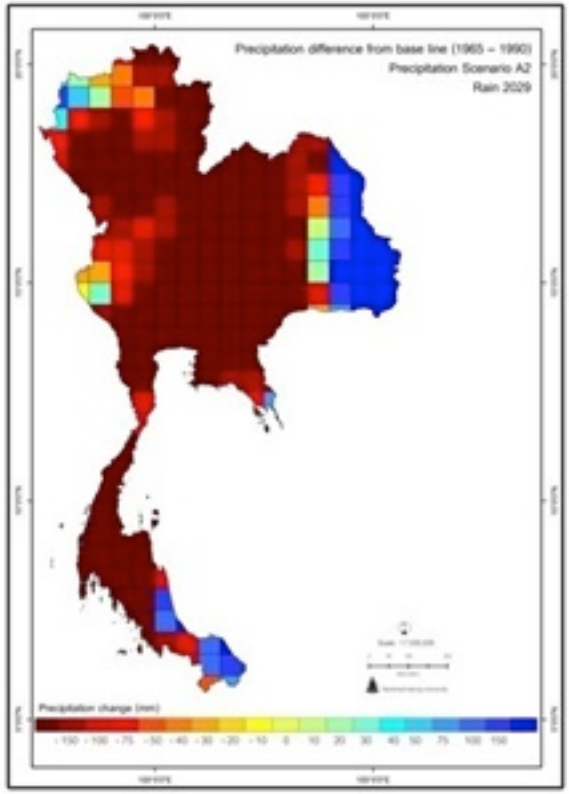


Precipitation change (mm)

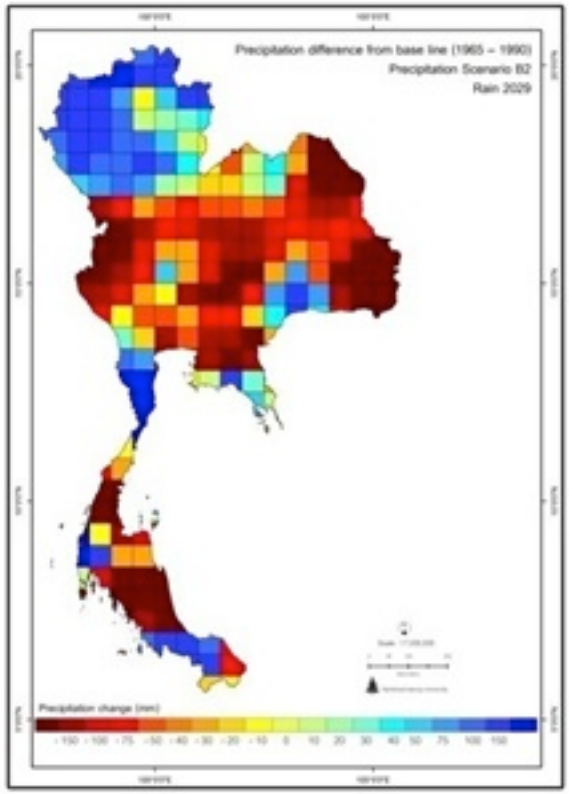
- 150 - 100 - 75 - 50 - 40 - 30 - 20 - 10 0 10 20 30 40 50 75 100 150

Precipitation Difference from Baseline

A2 Rain 2029



B2 Rain 2029

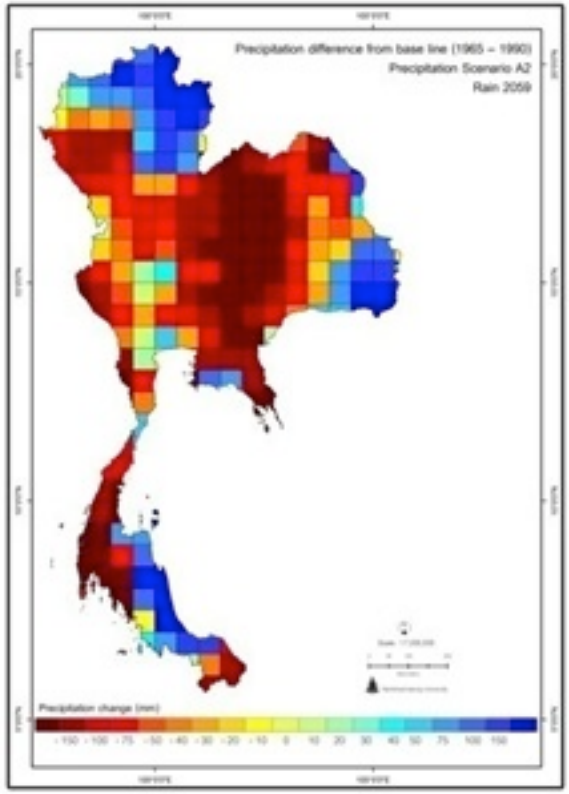


Precipitation change (mm)

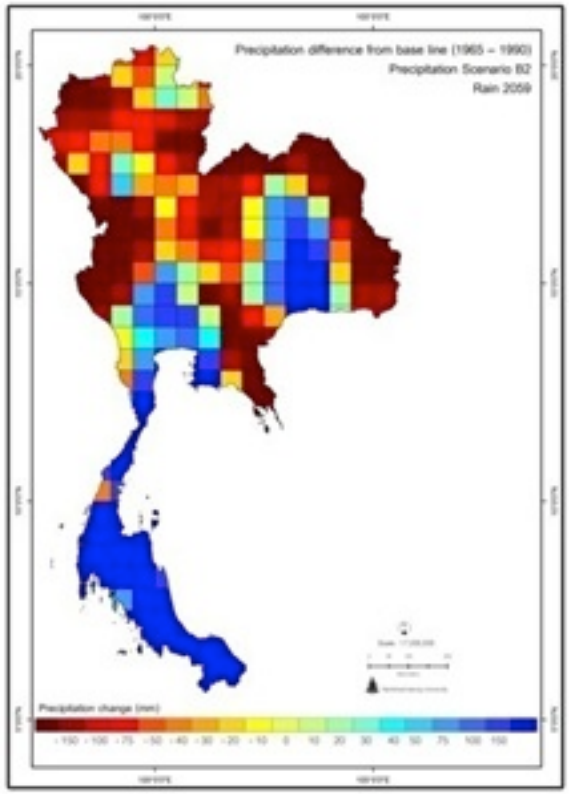
- 150 - 100 - 75 - 50 - 40 - 30 - 20 - 10 0 10 20 30 40 50 75 100 150

Precipitation Difference from Baseline

A2 Rain 2059



B2 Rain 2059

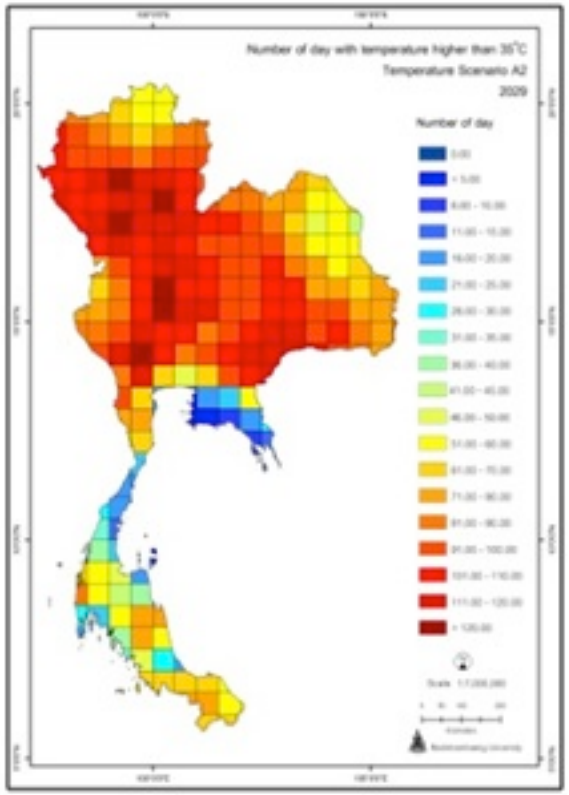


Precipitation change (mm)

- 150 - 100 - 75 - 50 - 40 - 30 - 20 - 10 0 10 20 30 40 50 75 100 150

No. of day with temp. higher than 35°C

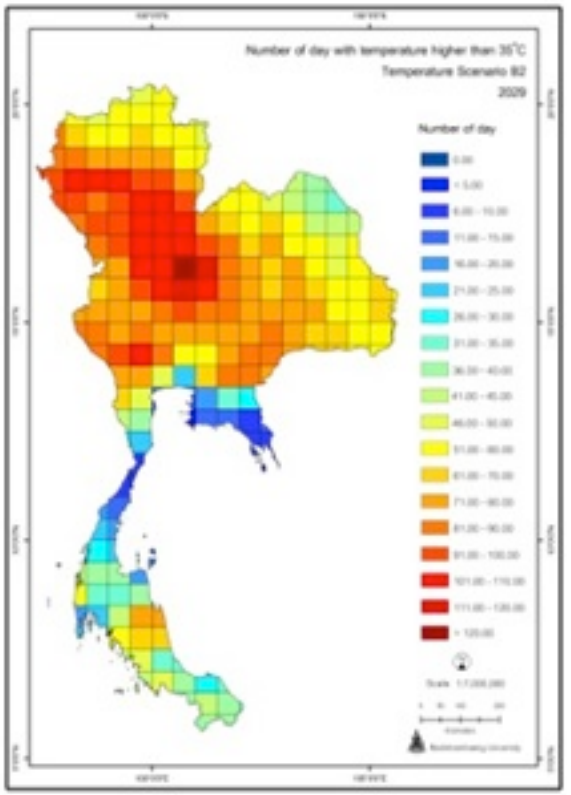
A2 2029



Number of day

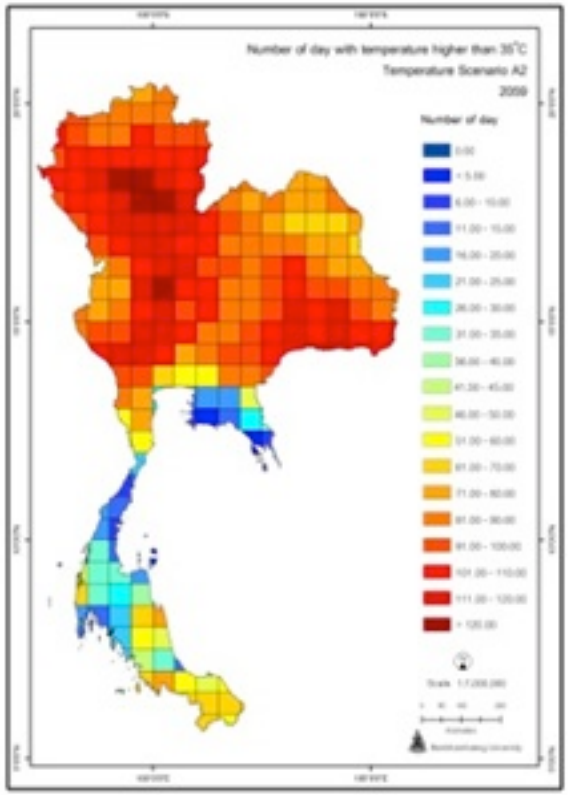
0
< 5.00
6.00 - 10.00
11.00 - 15.00
16.00 - 20.00
21.00 - 25.00
26.00 - 30.00
31.00 - 35.00
36.00 - 40.00
41.00 - 45.00
46.00 - 50.00
51.00 - 60.00
61.00 - 70.00
71.00 - 80.00
81.00 - 90.00
91.00 - 100.00
101.00 - 110.00
111.00 - 120.00
> 120.00

B2 2029



No. of day with temp. higher than 35°C

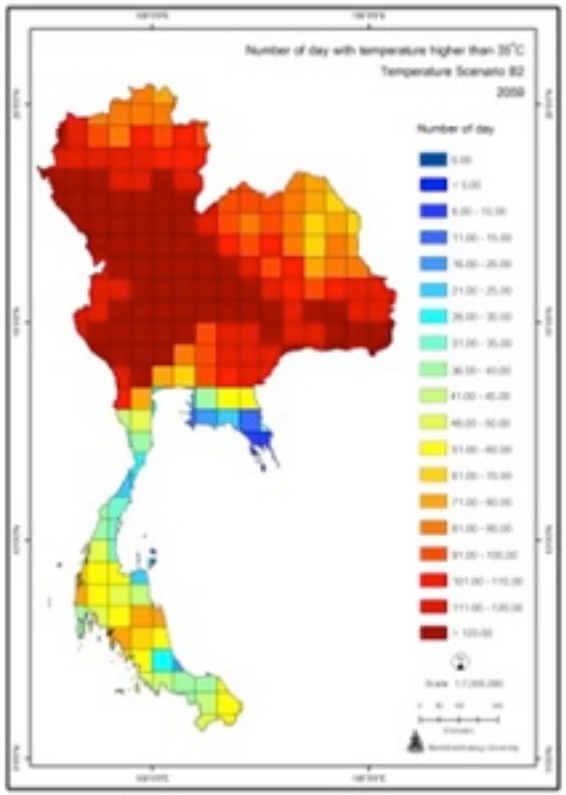
A2 2059



Number of day

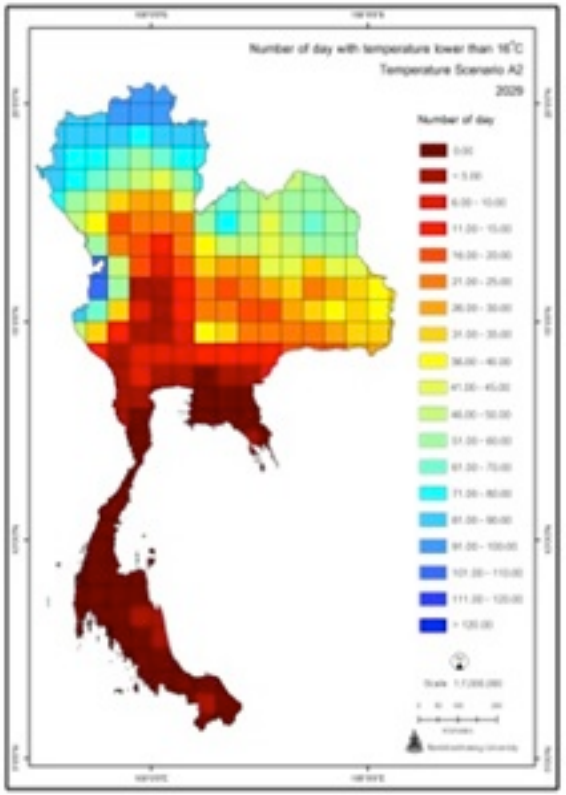
0
< 5.00
6.00 - 10.00
11.00 - 15.00
16.00 - 20.00
21.00 - 25.00
26.00 - 30.00
31.00 - 35.00
36.00 - 40.00
41.00 - 45.00
46.00 - 50.00
51.00 - 60.00
61.00 - 70.00
71.00 - 80.00
81.00 - 90.00
91.00 - 100.00
101.00 - 110.00
111.00 - 120.00
> 120.00

B2 2059



No. of day with temp. lower than 16°C

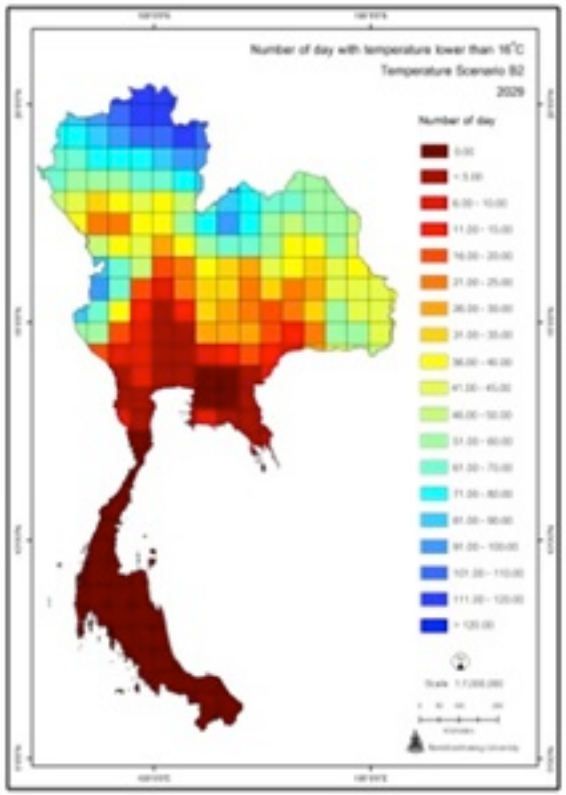
A2 2029



Number of day

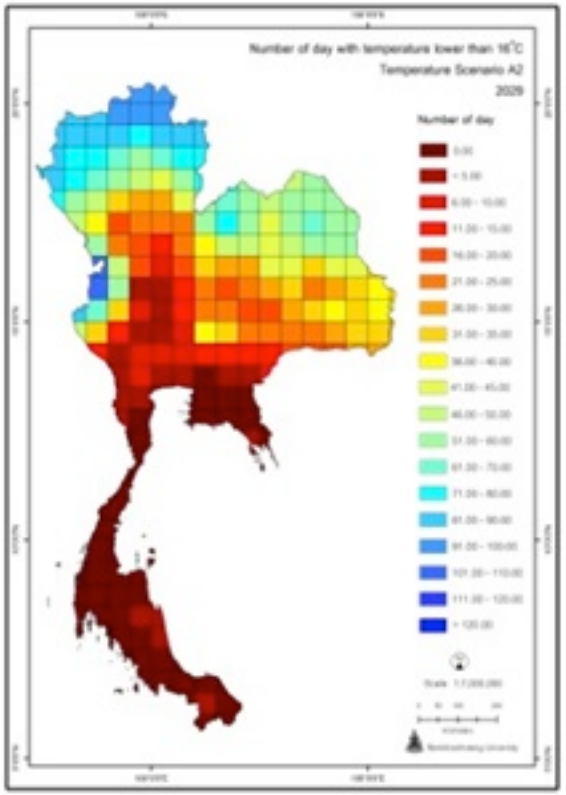
0
< 5.00
6.00 - 10.00
11.00 - 15.00
16.00 - 20.00
21.00 - 25.00
26.00 - 30.00
31.00 - 35.00
36.00 - 40.00
41.00 - 45.00
46.00 - 50.00
51.00 - 60.00
61.00 - 70.00
71.00 - 80.00
81.00 - 90.00
91.00 - 100.00
101.00 - 110.00
111.00 - 120.00
> 120.00

B2 2029



No. of day with temp. lower than 16°C

A2 2029



Number of day

0
< 5.00
6.00 - 10.00
11.00 - 15.00
16.00 - 20.00
21.00 - 25.00
26.00 - 30.00
31.00 - 35.00
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41.00 - 45.00
46.00 - 50.00
51.00 - 60.00
61.00 - 70.00
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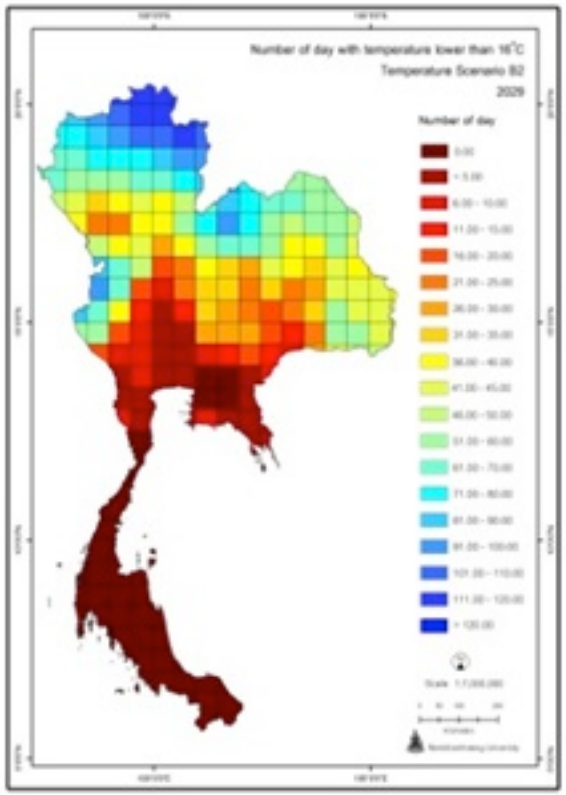
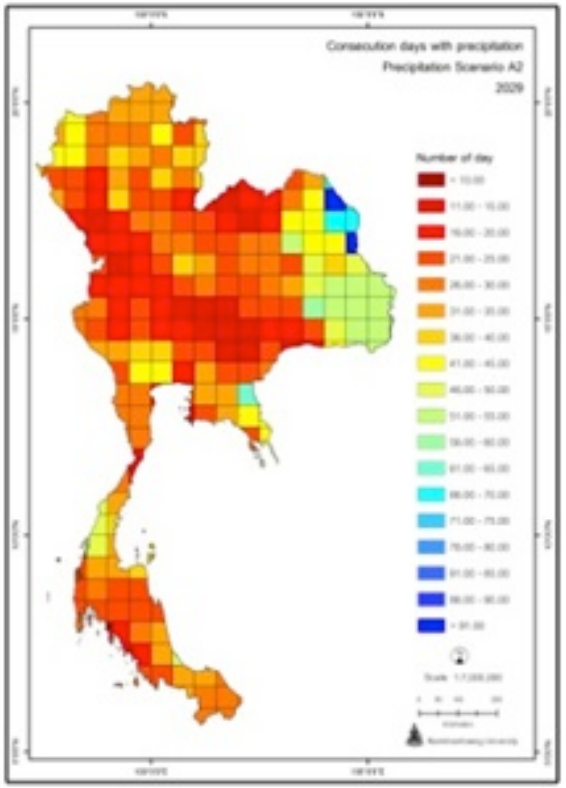
81.00 - 90.00
91.00 - 100.00
101.00 - 110.00
111.00 - 120.00
> 120.00

B2 2029



Consecution days with precipitation

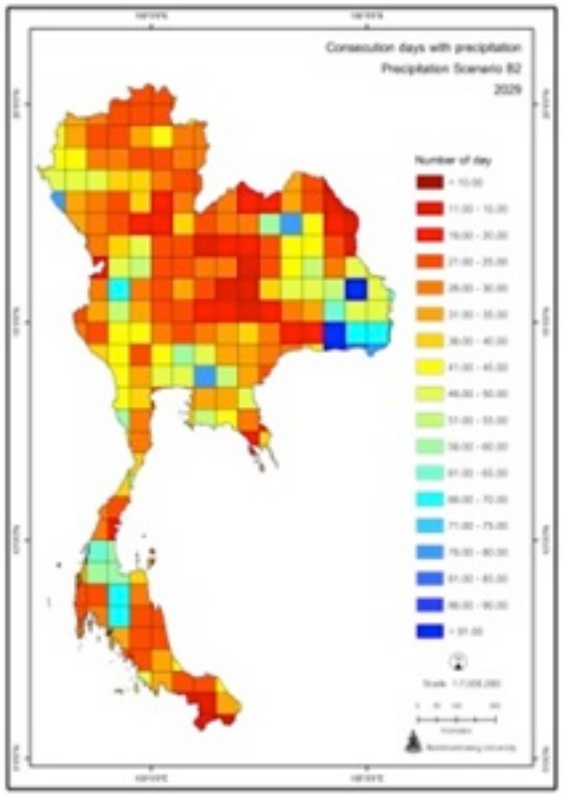
A2 2029



Number of day

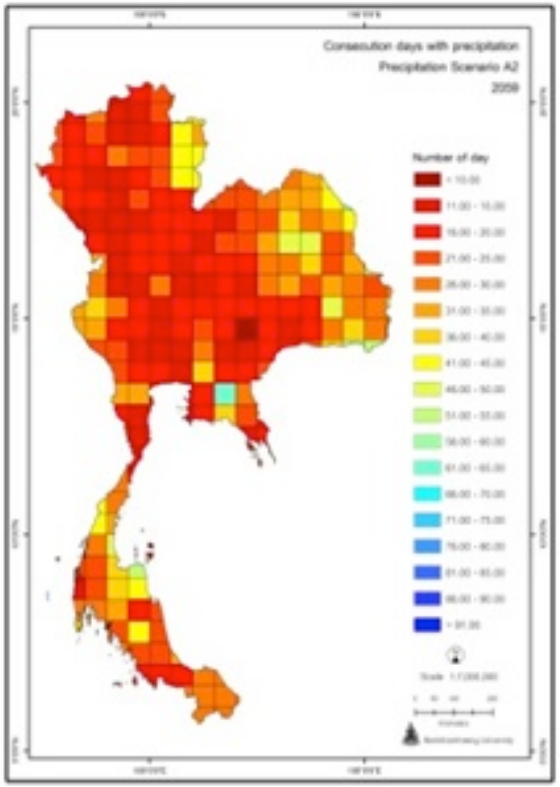
- < 10.00
- 11.00 - 15.00
- 16.00 - 20.00
- 21.00 - 25.00
- 26.00 - 30.00
- 31.00 - 35.00
- 36.00 - 40.00
- 41.00 - 45.00
- 46.00 - 50.00
- 51.00 - 55.00
- 56.00 - 60.00
- 61.00 - 65.00
- 66.00 - 70.00
- 71.00 - 75.00
- 76.00 - 80.00
- 81.00 - 85.00
- 86.00 - 90.00
- > 91.00

B2 2029



Consecution days with precipitation

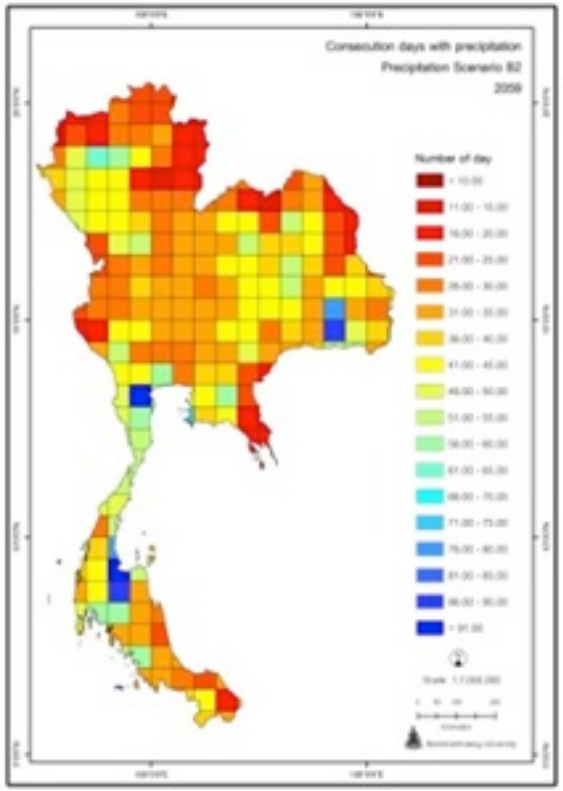
A2 2059



Number of day

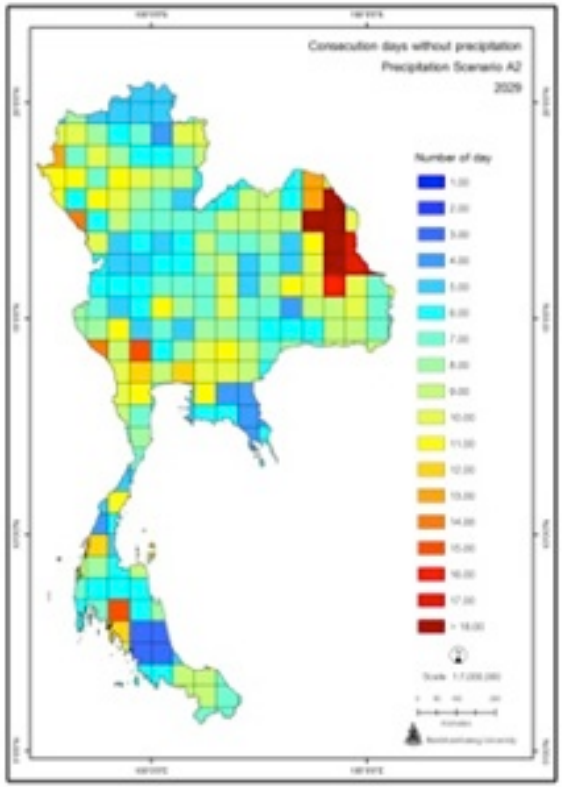
- < 10.00
- 11.00 - 15.00
- 16.00 - 20.00
- 21.00 - 25.00
- 26.00 - 30.00
- 31.00 - 35.00
- 36.00 - 40.00
- 41.00 - 45.00
- 46.00 - 50.00
- 51.00 - 55.00
- 56.00 - 60.00
- 61.00 - 65.00
- 66.00 - 70.00
- 71.00 - 75.00
- 76.00 - 80.00
- 81.00 - 85.00
- 86.00 - 90.00
- > 91.00

B2 2059



Consecution days without precipitation

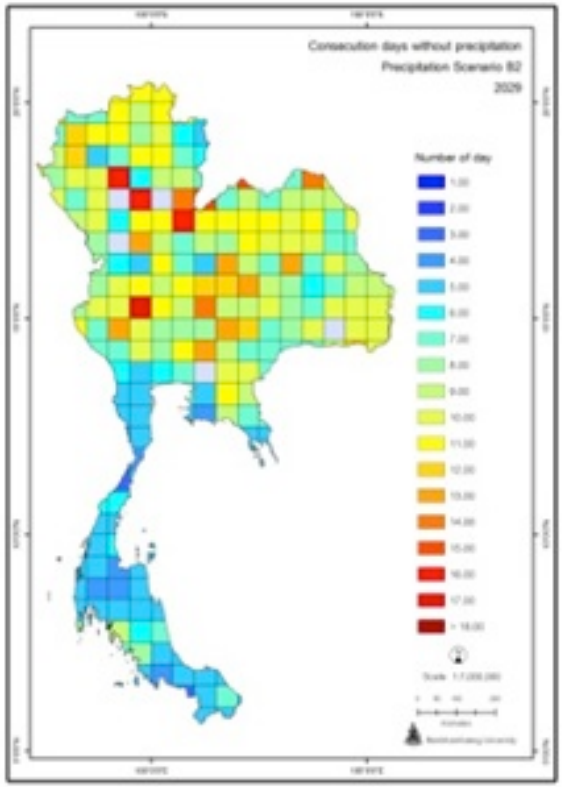
A2 2029



Number of day

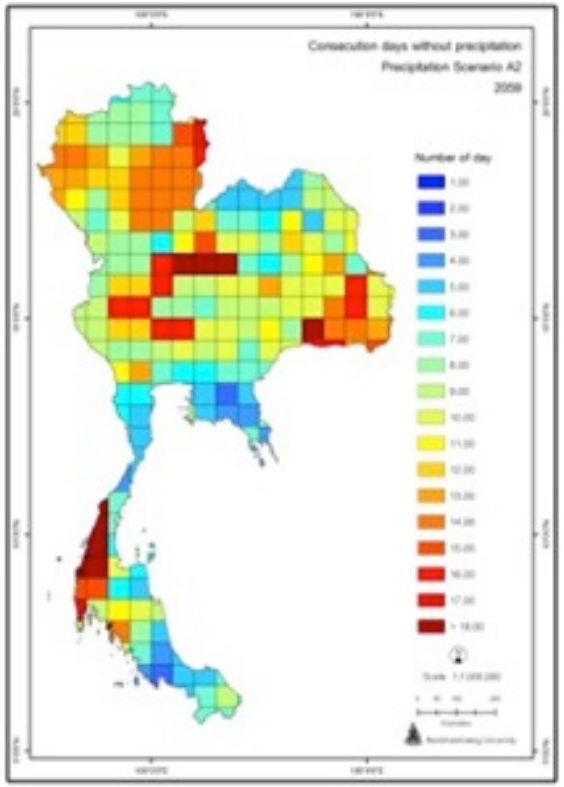
- 1.00
- 2.00
- 3.00
- 4.00
- 5.00
- 6.00
- 7.00
- 8.00
- 9.00
- 10.00
- 11.00
- 12.00
- 13.00
- 14.00
- 15.00
- 16.00
- 17.00
- > 18.00

B2 2029



Consecution days without precipitation

A2 2059



Number of day

- 1.00
- 2.00
- 3.00
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- 5.00
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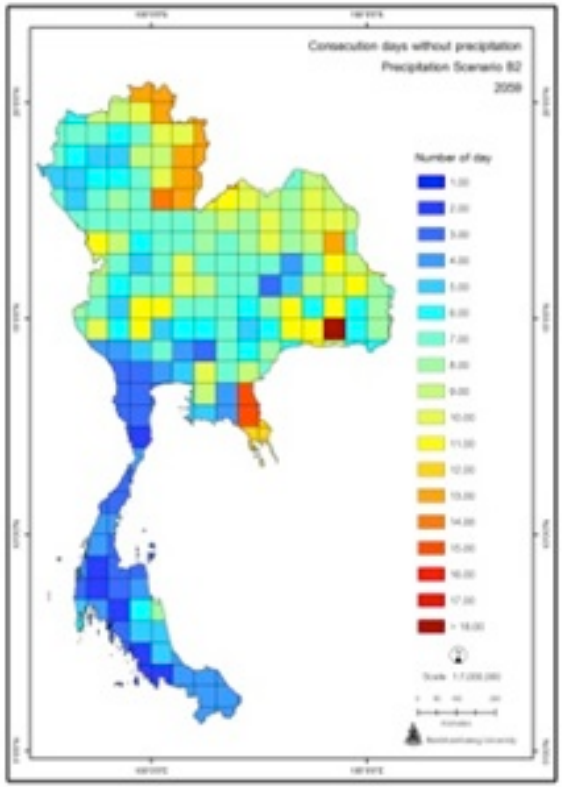
- 11.00
- 12.00
- 13.00
- 14.00
- 15.00
- 16.00
- 17.00
- > 18.00

B2 2059



Scope of the study of 2nd project

Regionalization technique:	Statistical downscaling Non-linear transfer function Artificial Neural Networks
GCM:	GFDL-cm2.1, ECHAM5, HadCM3
	2.2° latitude x 3.75° longitude
SRES scenario:	A2, B1, A1B
Grid resolution:	0.2° latitude x 0.2° longitude/ 20 km x 20 km
Output:	daily data of max, min, mean temperature, precipitation, %RH, solar radiation and sunshine duration.
Project duration	March 2012 – March 2014 (on going)

Scope of the study of 2nd project (continue)

	GFDL (cm2.1)	ECHAM5	HadCM3
Base year horizon	1961-2000	1961-2000	1960-1989
Scenario horizon	2001-2100	2046-2065 2081-2100	2000-2100
Time resolution	Daily	Daily	Monthly
GCMs grid resolution	2° × 2.5°	1.9° × 1.9°	2.5° × 3.75°
Predictors	Temperature (max,min,av) Precipitation Specific humidity Pressure	Temperature (max,min,av) Precipitation Specific humidity Pressure	Temperature (av) Precipitation Specific humidity Pressure

Thank you