CHARACTERISTICS OF GRIDDED RAINFALL DATA OF THAILAND FROM 1981–2017

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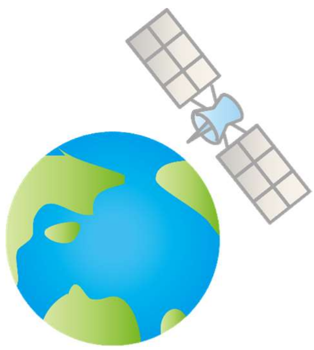
Introduction

- Precipitation is a critical meteorological factor; however, to conduct accurate observations are difficult due to large spatiotemporal variation.
- Recently, satellite data covering wide areas are being used with increased frequency.
- However, the observational periods are short and errors can arise due to the indirect nature of the measurements.
- For example, to verify high-resolution climate models, the temporal spatial resolution of existing precipitation data is inadequate.



Purpose of this study

- To develop Thai Meteorological Department (TMD) spatially interpolated gridded rainfall dataset.
- However, the properties of rainfall data result may differ as the interpolation method applied.
- Here, **we explore the features of such rainfall data for long-term trends**.

Study area and dataset

- TMD/ADAP-T Dataset; RainGridDataVer1.0_1981-2017
- Interpolating rainfall data point for 1981–2017 into a 0.5° grid using the Kriging method.
- We evaluated the accuracy of spatially interpolated data using rain-gauge data from six stations
  - Nakhon Sawan [2007–2017]
  - Bangna [2008–2017](Bangkok)
  - Khao Kheow [2008–2017]
  - Khon Kaen [2008–2017]
  - Trang [2008–2017]
  - Nan [2016–2017]).

Statistical methods (GEV)

The generalized extreme value (GEV) distribution is a flexible three-parameter formulation that combines the Gumbel, Fréchet, and Weibull maximum extreme value distributions, and can be expressed as:

$$f(x)=\begin{cases}\frac{1}{\sigma}\exp(-(1+kz)^{-1/k})(1+kz)^{-1-1/k} & k\neq 0\\ \frac{1}{\sigma}\exp(-z-\exp(-z)) & k=0\end{cases}$$

where z = (x-μ)/σ; and k, σ, and μ are shape, scale, and location parameters, respectively. The scale must be positive (sigma > 0); shape and location can assume any real value. The range embraced by the GEV distribution depends on k, as follows:

$$1+k\frac{(x-\mu)}{\sigma}>0 \quad \text{for} \quad k\neq 0$$

$$-\infty<x<+\infty \quad \text{for} \quad k=0$$

Various values of the shape parameter yield extreme value distributions of types I, II, and III. Specifically, the three cases in which k = 0, k > 0, and k < 0 correspond to the Gumbel, Fréchet, and “reversed” Weibull distributions, respectively; the latter distribution is rarely used but has an upper bound. When fitting the GEV distribution to sample data, the sign of the shape parameter k usually indicates which of the three models best describes the random process under evaluation.

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Statistical methods (Mann-Kendall trend test)

The Mann–Kendall trend test, which is frequently used to evaluate hydro meteorological data, is a nonparametric method employing ranked data without assuming a probability distribution. The Mann–Kendall test statistic (S) is:

$$S=\sum_{k=1}^{n-1}\sum_{j=k+1}^{n}\operatorname{sgn}(x_j-x_k) \qquad \begin{cases} if \quad \theta>0,\ \operatorname{sgn}(\theta)=1\\ if \quad \theta=0,\ \operatorname{sgn}(\theta)=0\\ if \quad \theta<0,\ \operatorname{sgn}(\theta)=-1\end{cases}$$

where n is the dataset length and x_j and x_k are sequential data values.
Under the null hypothesis , the distribution of S would be expected to exhibit the following mean and variance:

$$E(S)=0 \qquad \operatorname{var}(S)=\frac{n(n-1)(2n+5)}{18}$$

The normal Z statistic is:

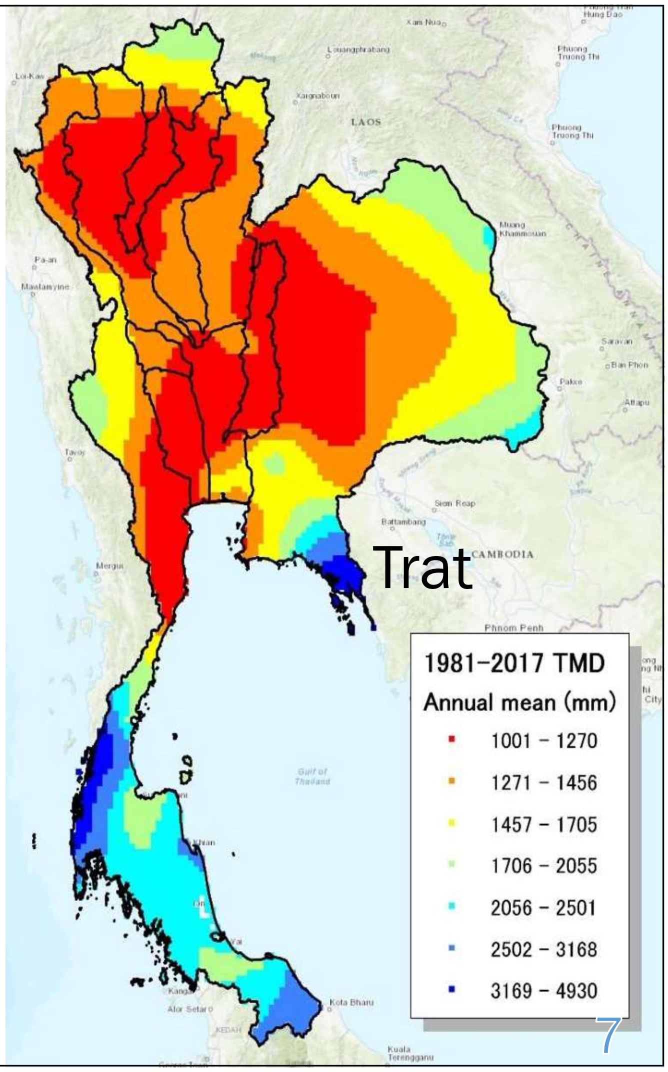
$$Z=\begin{cases}\frac{S-1}{\sqrt{\operatorname{var}(S)}} & if \quad S>0\\ 0 & if \quad S=0\\ \frac{S+1}{\sqrt{\operatorname{var}(S)}} & if \quad S<0\end{cases}$$

The null hypothesis is rejected at the significance level of α if $|Z|>Z_{1-\alpha/2}$, where $Z_{1-\alpha/2}$ is the probability that the standard normal distribution will exceed $\alpha/2$.

S > 0 indicates a positive trend and S < 0 a negative trend within a data time series x_i. 6

Mean annual rainfall distributions over 37 years (1981–2017)

- These ranged from 1,001 to 4,930 mm, and exhibited a very large spatial deviation.
- The annual rainfall in the south and Trat province was ≥ 2,000 mm
- The maximum standard deviation of annual rainfall was 870 mm in the southeastern coastal area.



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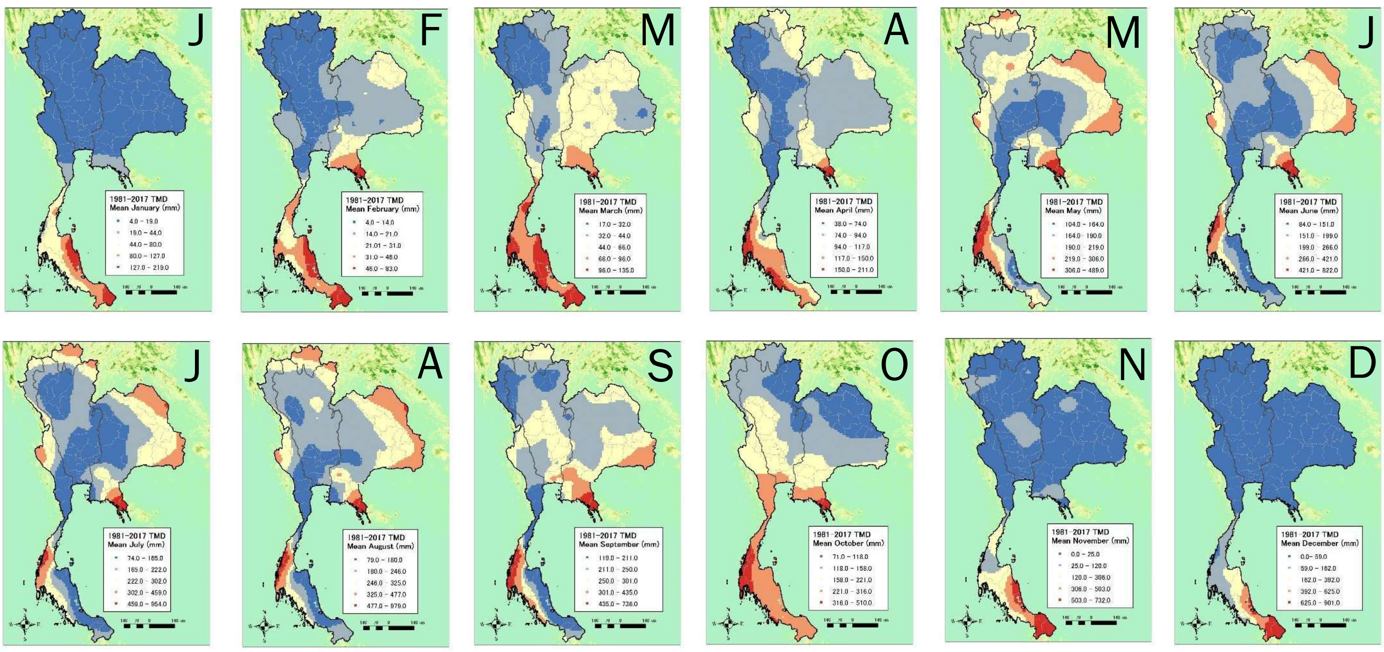
ADAP-T

Mean monthly rainfall



- Time series in mean monthly rainfall distribution from 1981-2017.
- There was a large difference of spatial distribution.
- The rainfall in the south was higher than in other areas throughout the year.

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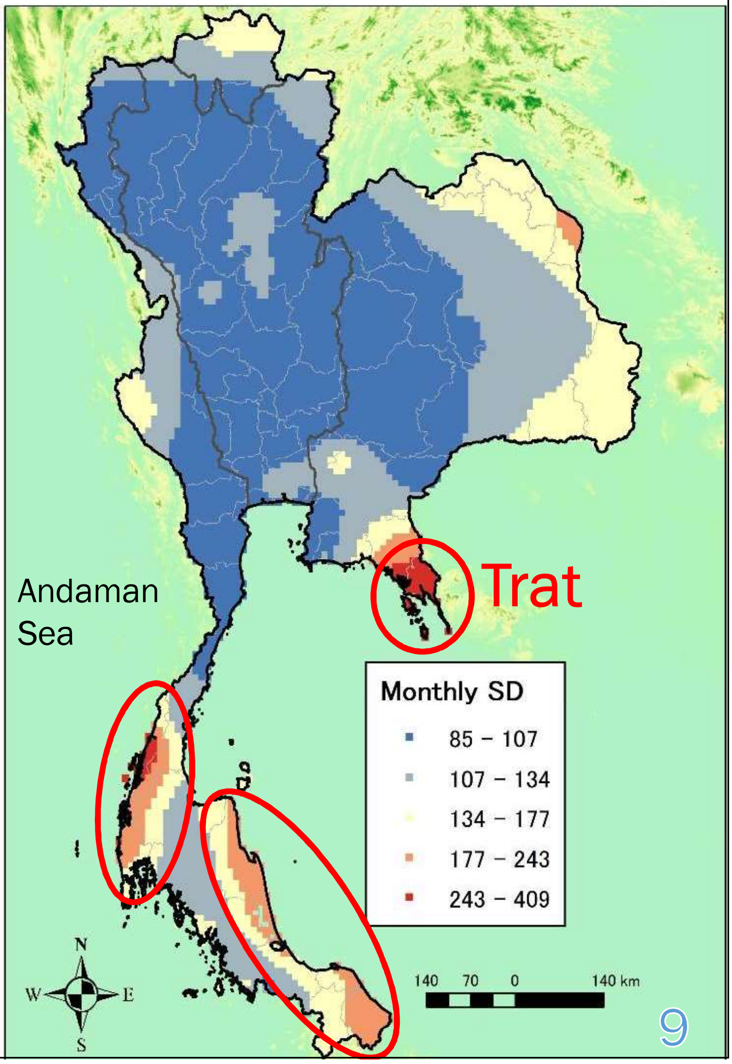
Monthly rainfall standard deviations from 1981–2017

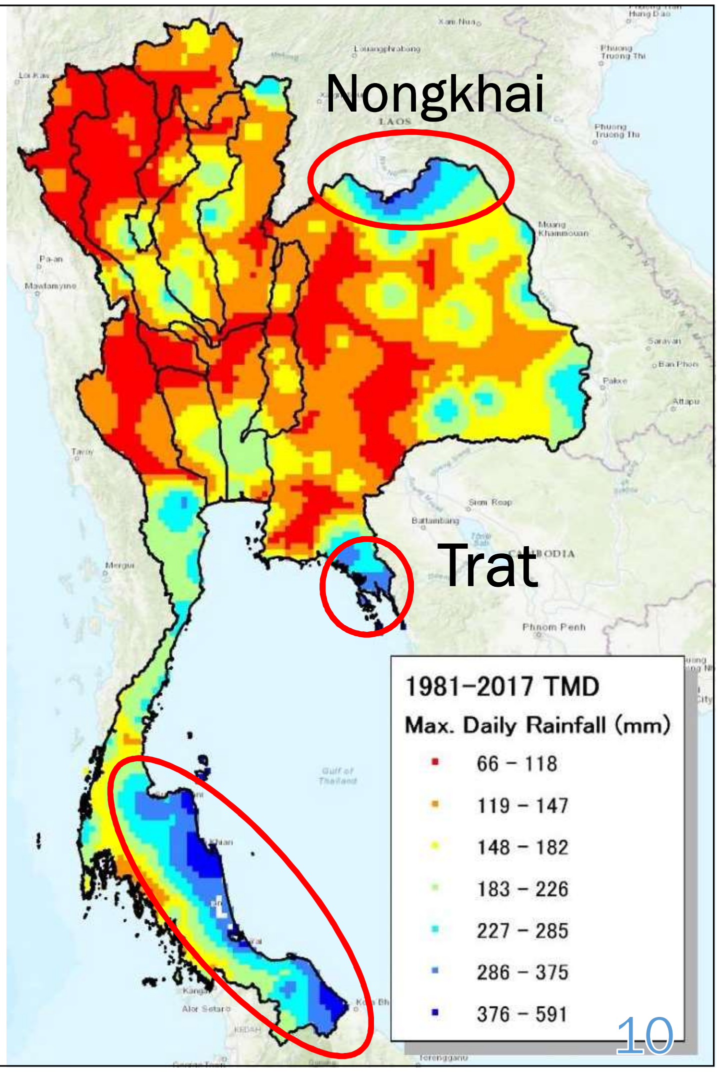
- The maximum standard deviation from the center to the northern and northeastern regions was about 100 mm.
- However, the standard deviations on the east coast and the Andaman Sea side of southern Trat province were very large, at about ≥ 200 mm.

Large seasonal SD

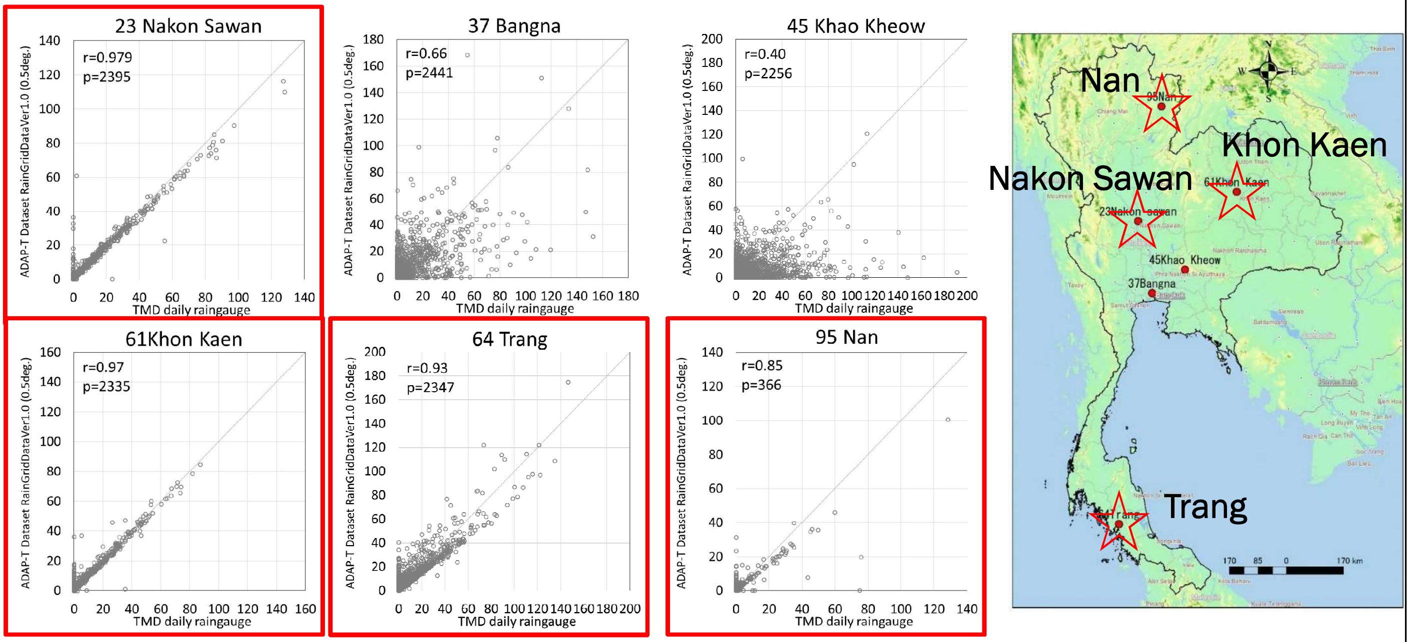


Maximum daily rainfall over 37 years (1981–2017)

- The highest values were on the southeast coast (Trat and Nongkhai provinces).
- The maximum, minimum, and mean standard deviations of the maximum daily rainfall were 100.5, 10.0 and 26.5 mm, respectively.



Relationships between daily rain-gauge and gridded data at Nakhon Sawan, Bangna, Khao Kheow, Khon Kaen, Trang, and Nan.



The correlations between Nakhon Sawan, Khon Kaen, Trang, and Nan were strong. However, the scatterplot variations of Bangna and Khao Kheow were very large due to rain-gauge placement variation over the years.

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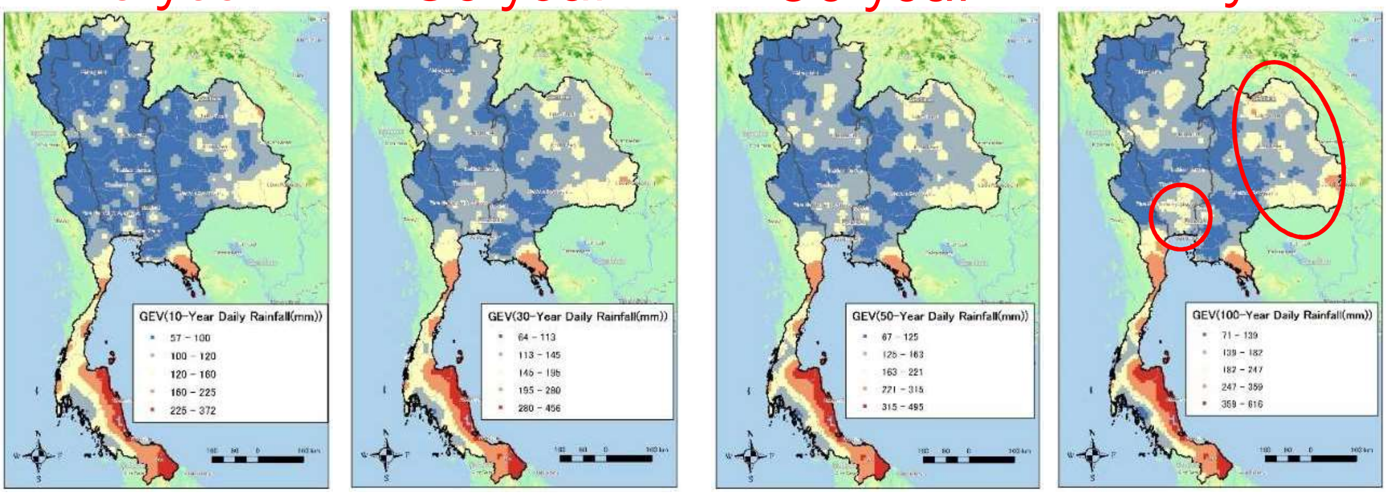
Maps of the 10-, 30-, 50-, and 100-year probabilities of precipitation derived using the generalized extreme value (GEV)

10-year 30-year 50-year 100-year



All distributions were recorder to have nearly identical trends. The probability of precipitation was high on the east side of the southern coast, but slightly higher for the Mekong River basin in the northeast, and for Bangkok.

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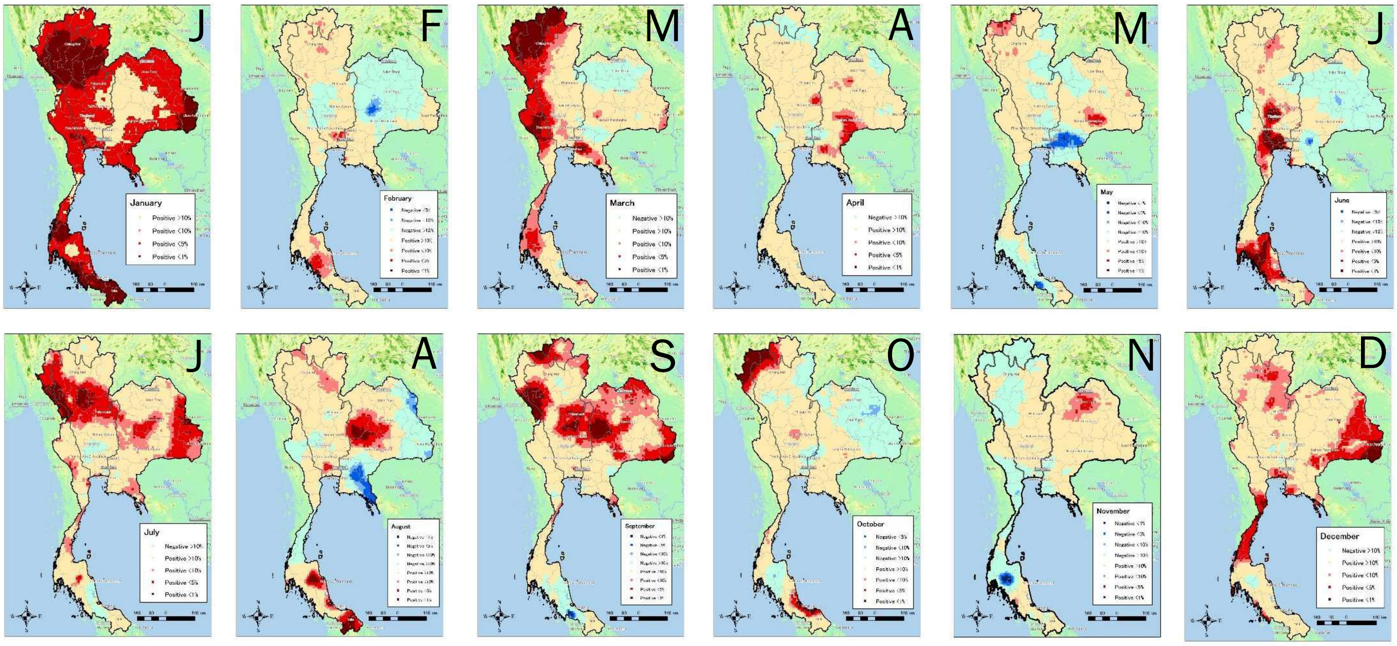
Maps of Mann–Kendall trends in mean monthly rainfall



During August rainfall, Trat, Chanthaburi, Chachoengsao, and Nakhonphanom provinces exhibited significant negative trends ($p<0.01$) while the central northeastern region showed significant positive trend ($p<0.05$, $p<0.01$).

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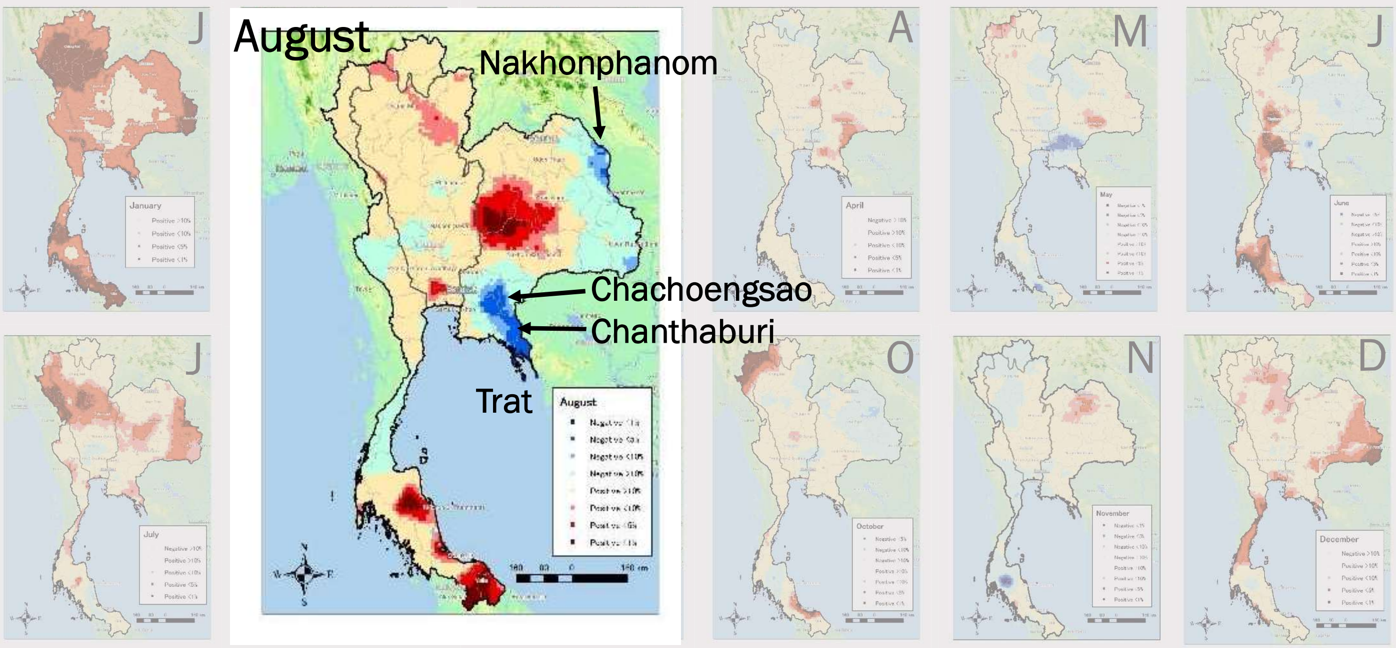

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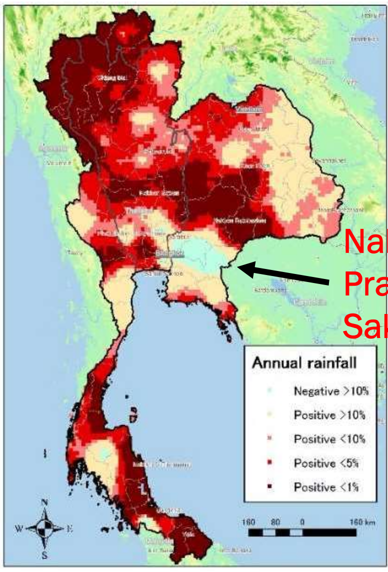
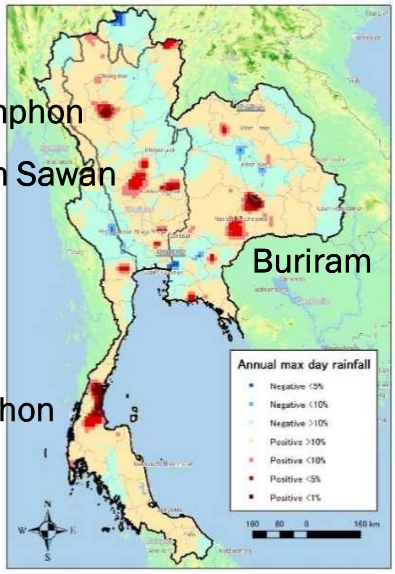
Maps of Mann–Kendall trends in annual and maximum daily rainfall





- These figures show the Mann–Kendall trends for annual and its maximum daily rainfall; the later time result showed an increase throughout the country.
- Although statistical significance was not attained, rainfall tended to decrease in Nakhonnayok, Prachinburi, and Sakaeo provinces.
- While in **Chumphon**, **Lamphun**, **Nakhon Sawan**, and **Buriram** provinces were exhibited significant positive trends in annual maximum daily rainfall ($p<0.05$, $p<0.01$). We found no region in which the annual maximum precipitation decreased significantly.

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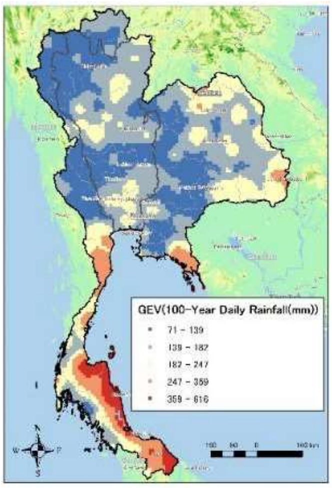
Conclusions

- We used rain-gauge data to compare and statistically analyze the characteristics of gridded data interpolated by the TMD.
- Some correlations between rain-gauge and gridded data were very strong; others were very weak. For example, the correlations between the adjacent of **Bangna** and **Khao Kheow** regions were weak, perhaps reflecting inappropriate rain-gauge positioning in one or both regions.
- We used the gridded data to draw 10-, 30-, 50-, and 100- year probability distribution maps of annual and August rainfalls, and the annual maximum daily rainfall, using the GEV and Mann–Kendall trend tests.
- We plotted the spatial distributions of extreme rainfall, trends in annual and August rainfall data, and the annual maximum daily rainfall, over 37 years (1981–2017).



100-year

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Thank you for listening
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