

Visual Analytics for Singapore's Weather

User Guide




The background is a light blue sky with a gradient. There are two large, fluffy white clouds with smiling faces. One cloud on the left is raining, and one on the right is also raining. In the bottom center, a bright yellow sun with a smiling face is partially hidden behind a small white cloud. Two vibrant rainbows with pink, purple, yellow, green, and blue bands are visible on the left and right sides. Small white stars and blue raindrops are scattered throughout the scene.

01

Landing page

Landing Page

This page provides an overview of the application. It describes the key modules and the dataset used. It also shares some interesting information about the dataset like the hottest temperature recorded in the dataset. Lastly, there is a map showing the location of the weather stations from which the data was collected from.



Landing Page

Exploratory & Confirmatory Data Analysis


Univariate Forecasting

Spatial Interpolation

A Visual Exploration Tool for Singapore's Weather


Understanding Singapore's changing weather patterns is crucial, yet current tools for visualizing historical weather data are limited, often static, and lack depth. To fill this gap, we developed this interactive R Shiny application. Use this tool to explore and analyse Singapore's weather (2021–2023)!

Overview of modules in app




Exploratory & Confirmatory Data Analysis

Enables analysis of climate variables across stations and time periods, using statistical tests and interactive plots to identify weather patterns.



Univariate Forecasting

Combines exploratory analysis, decomposition, and advanced forecasting with seasonal adjustment for accurate weather predictions across multiple stations.



Spatial Interpolation

Generates isohyet/isotherm maps from sparse data, using interpolation techniques to estimate conditions at unmonitored locations, informed by data from Singapore's weather stations.

Click [here](#) to view the user guide.


About the Dataset: Singapore Climate Records (2021–2023)

The dataset comprises historical daily records of rainfall and temperature across 11 locations in Singapore, spanning from 2021 to 2023.

Show entries

Search:

Station	Date	Daily Rainfall Total (mm)	Mean Temperature (°C)	Maximum Temperature (°C)	Minimum Temperature (°C)	LAT
A		A	All	All	All	
Ang Mo	2021-	86.6	26	26.2	21.5	1.3766




37.9 °C

Hottest Temperature Recorded:

Station: East Coast Parkway

Date: 2021–12–27




34.7 °C

Coolest Temperature Recorded

Station: Seletar

Date: 2021–04–27




January 2021

Rainiest Month Recorded

Total Rainfall (mm): 5256.2 mm

(Across all stations in Singapore)



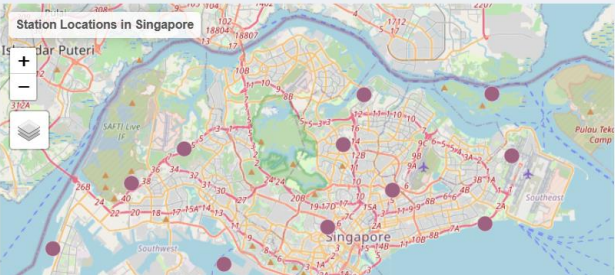
29

Highest number of Rainy Days

Station: Newton

Month & Year: December 2023

Station Locations in Singapore





02

Exploratory & Confirmatory Data Analysis

Exploratory & Confirmatory Data Analysis

Compare across Stations: This page allows users to conduct normality assumption test of daily rainfall or temperature across different stations. The outcomes of the test guide the selection of suitable statistical methods for further confirmatory data analysis.

Visual Analytics for Singapore's Weather



Landing Page

Exploratory & Confirmatory Data Analysis

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Exploratory & Confirmatory Data Analysis

Compare across Stations

Compare across Time

1 Data Selection Parameters

a Choose variable

Mean Temperature (°C)

b Select time resolution

Month

Year

c Select month and year

2021-01

d Select Station(s)

☒ Ang Mo Kio

☒ Changi

☒ Choa Chu Kang (South)

☐ East Coast Parkway

☐ Jurong (West)

☐ Newton

☐ Pasir Panjang

☐ Pulau Ubin

☐ Seletar

☐ Tai Seng

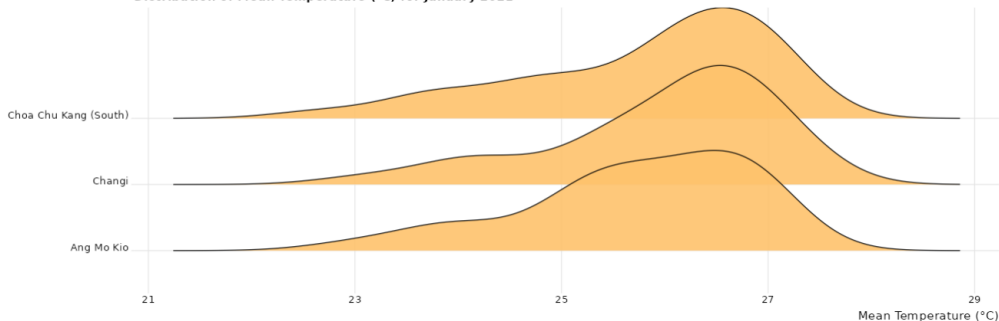
☐ Tuas South

2 Check Normality

Run Statistic Test

2 Run Normality Checks

Distribution of Mean Temperature (°C) for January 2021



Station	Anderson-Darling Statistic	Anderson-Darling p.value	Shapiro-Wilk Statistic	Shapiro-Wilk p.value
Ang Mo Kio	0.7892	0.0362	0.9178	0.0206
Changi	1.1115	0.0055	0.9011	0.0077
Choa Chu Kang (South)	1.1557	0.0043	0.8932	0.0049

Tab: Check normality

1. Data Selection Parameters:

- Use the dropdown box to select a desired variable
- Use the radio button to select time resolution
- Use the month and year picker to specify the period
- Use the checkbox to select multiple stations for the normality test

2. Click 'Run normality checks' button to display the distribution plot and normality test results.

Tip: If at least one result shows **p-value < 0.05**, it indicates that the sample failed to confirm normality. Therefore, non-parametric test statistic will be used for confirmatory data analysis.

Exploratory & Confirmatory Data Analysis

Compare across Stations : This page allows users to compare daily rainfall or temperature across different stations. The comparison will enable users to identify patterns, trends, and irregularities over time that facilitate a deeper understanding of weather dynamics in Singapore.

Visual Analytics for Singapore's Weather

Exploratory & Confirmatory Data Analysis

Compare across Stations

Compare across Time

1 Data Selection Parameters

Choose variable

Mean Temperature (°C)

Select time resolution

Month

Year

Select month and year

2021-01

Select Station (s)

☒ Ang Mo Kio

☒ Changi

☒ Choa Chu Kang (South)

☐ East Coast Parkway

☐ Jurong (West)

☐ Newton

☐ Pasir Panjang

☐ Pulau Ubin

☐ Seletar

☐ Tai Seng

☐ Tuas South

Check Normality

Run Statistic Test

2 Statistical Approach

nonparametric

3 Confidence Level

95%

4 Plot Type

Boxviolin

5 Plot Title

Enter plot title

6 Run test

Insights

7 Enter your insights

8 Save insights

Mean Temperature (°C)

Ang Mo Kio
(n = 31)

Station

Changi
(n = 31)

Choa Chu Kang (South)
(n = 31)

Kruskal-Wallis rank sum test : 1.05525431354473 , p-value: 0.590003295342107

Centrality Measures

Station	Median
Ang Mo Kio	26.10
Changi	26.40
Choa Chu Kang (South)	26.20

Pairwise Comparison

group1	group2	statistic	p.value	alternative	distribution	p.adjust.method	test
Ang Mo Kio	Changi	1.03	0.63	two.sided	z	FDR	Dunn
Ang Mo Kio	Choa Chu Kang (South)	0.60	0.63	two.sided	z	FDR	Dunn

Tab: Run Statistic Test

1. Data Selection Parameters:

The input for this section automatically aligns with what user selected for the check normality tab

2. Use the dropdown boxes to select the statistical approach for the plot

3. Use the dropdown boxes to select the confidence level

4. Use the dropdown boxes to select a plot type

5. Input the plot title

6. Click on 'Run test' button to generate the plot

7. Input the insights

8. Click on 'Save insights' button to generate the insight text box under the graph

Tips: At the confidence level 95%, if p-value of the statistic test is less than 0.05, it implies that the mean of selected variables for different stations are not equal.

Exploratory & Confirmatory Data Analysis

Compare across Time : This page allows users to conduct normality assumption test of daily rainfall or temperature across different time-period. The outcomes of the test guide the selection of suitable statistical methods for further confirmatory data analysis.

Visual Analytics for Singapore's Weather

Exploratory & Confirmatory Data Analysis

Compare across Stations

Compare across Time

1 Data Selection Parameters

a Choose variable

Mean Temperature (°C)

b Select Station

Ang Mo Kio

c Compare across

Years

d Select years

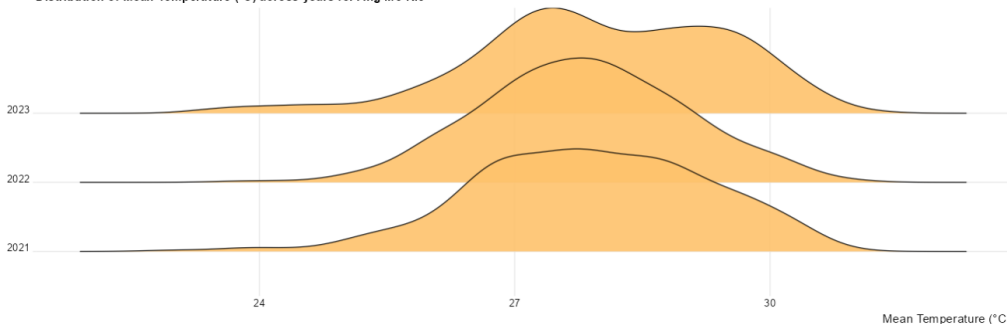
- ☒ 2021
- ☒ 2022
- ☒ 2023

2 Check Normality

Run Statistic Test

Run Normality Checks

Distribution of Mean Temperature (°C) across years for Ang Mo Kio



Year	Anderson-Darling Statistic	Anderson-Darling p.value	Shapiro-Wilk Statistic	Shapiro-Wilk p.value
2021	0.6711	0.0791	0.9875	0.0030
2022	0.2520	0.7365	0.9967	0.6732
2023	1.6345	0.0003	0.9769	0.0000

Tab: Check normality

1. Data Selection Parameters:

- Use the dropdown box to select a desired variable
- Use the dropdown box to select a station for the normality test
- Use the dropdown box to select one type of period (years, months, months for specified a year, months of different years)
- Use checkbox to select a specified period.

2. Click 'run normality checks' button to display the distribution plot and normality test results.

💡 Tips: If at least one result shows **p-value < 0.05**, it indicates that the sample failed to confirm normality. Therefore, non-parametric test statistic will be used for confirmatory data analysis.

Exploratory & Confirmatory Data Analysis

Compare across Time : This page allows users to compare daily rainfall or temperature across different time-period. The comparison will enable users to identify patterns, trends, and irregularities over time that facilitate a deeper understanding of weather dynamics in Singapore.

Visual Analytics for Singapore's Weather



Landing Page

Exploratory & Confirmatory Data Analysis

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Exploratory & Confirmatory Data Analysis

Compare across Stations

Compare across Time

1 Data Selection Parameters

Choose variable

Mean Temperature (°C)

Select Station

Ang Mo Kio

Compare across

Years

Select years

☒ 2021

☒ 2022

☒ 2023

Check Normality

Run Statistic Test

2 Statistical Approach

nonparametric

3 Confidence Level

95%

4 Plot Type

Boxviolin

5 Plot Title

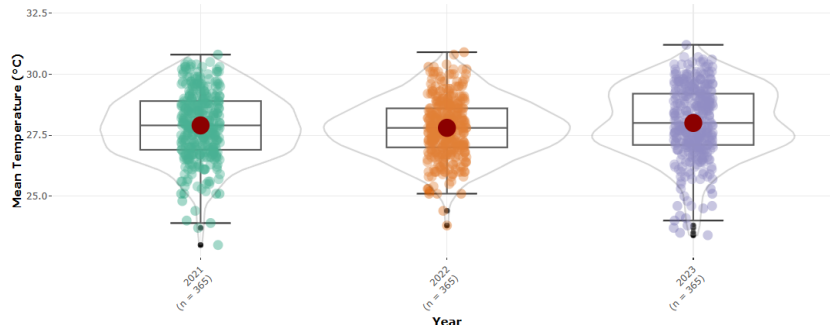
Enter plot title

6 Run test

Insights

Enter your insights

8 Save insights



Kruskal-Wallis rank sum test : 7.60319520745277, p-value: 0.0223350607613707

Centrality Measures

Year	Median
2021.00	27.90
2022.00	27.80
2023.00	28.00

Pairwise Comparison

group1	group2	statistic	p.value	alternative	distribution	p.adjust.method	test
2021	2022	1.08	0.28	two.sided	z	FDR	Dunn
2021	2023	1.65	0.15	two.sided	z	FDR	Dunn
2022	2023	1.08	0.28	two.sided	z	FDR	Dunn

Tab: Run Statistic Test

1. Data Selection Parameters:

The input for this section automatically aligns with what user selected for the check normality tab

2. Use the dropdown boxes to select the statistical approach for the plot

3. Use the dropdown boxes to select the confidence level

4. Use the dropdown boxes to select a plot type

5. Input the plot title

6. Click on 'Run test' button to generate the plot

7. Input their own insights

8. Click on 'Save insights' button to generate the insight text box under the graph

Tips: At the confidence level 95%, if p-value of the statistic test is less than 0.05, it implies that the mean of selected variables for different time-periods are not equal.

The background is a light blue gradient with stylized white-outlined clouds in the corners. A yellow sun is partially visible in the top-left corner. Small blue raindrops are scattered across the slide. In the center, the number '03' is enclosed in a dark teal circle.

03

Univariate Forecasting

Univariate Forecasting: Exploratory Time Series

Line graph: This exploration page enables users to dynamically compare weather data from different stations on the same line graph, supplemented by a detailed data table for in-depth analysis.

Visual Analytics for Singapore's Weather

Exploring timeseries across stations

1 Data Selection Parameters

Choose variable

Mean Temperature (°C) ▼

Select time resolution

- ☒ Day
☐ Week
☐ Month

Select Station

- ☒ Ang Mo Kio
☒ Changi
☒ Choa Chu Kang (South)
☐ East Coast Parkway
☐ Jurong (West)
☐ Newton
☐ Pasir Panjang
☐ Pulau Ubin
☐ Seletar
☐ Tai Seng
☐ Tuas South

Start Date

2021-01-01

End Date

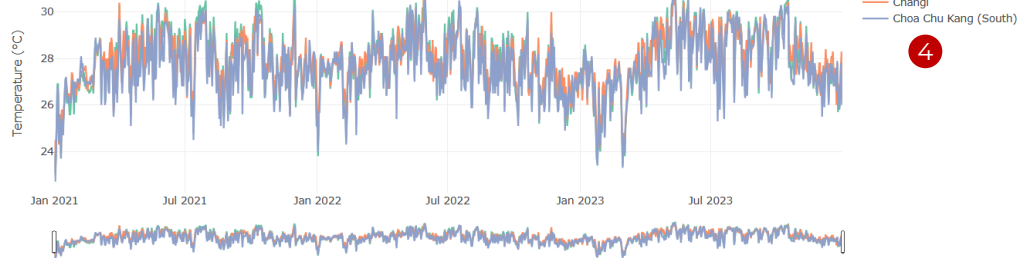
2023-12-31

Please select a period of at least 1 month for plotting

Line graph

Horizon plot

Daily Mean Temperature (°C)
2021-01-01 to 2023-12-31



Show 10 entries

Station

Date

Mean Temperature (°C)

All	All	All
Ang Mo Kio	2021-01-01	24
Ang Mo Kio	2021-01-02	23
Ang Mo Kio	2021-01-03	23.9
Ang Mo Kio	2021-01-04	25.1
Ang Mo Kio	2021-01-05	26.9
Ang Mo Kio	2021-01-06	26.9

1. Data Selection Parameters:

- Use the dropdown box to select a desired variable
- Use the radio button to select the time resolution
- Use the checkbox to select multiple stations for comparison
- Use the date picker to specify the start date and end date

2. Apply a filter to view data as stations selected in (c) for a specific station

3. Sort the data table in ascending or descending order

4. Click on the legend to toggle the visibility of specific stations' lines on the graph

Tips for date selection: Note that the minimum period is one month. If users select an end date that is earlier than the start date, the start date will automatically adjust to one month before the selected end date.

Univariate Forecasting: Exploratory Time Series

Horizon Plot: It shows rain and temperature changes over time using colors. Blue shades represent rainfall, with darker blues indicating more rain, while a range from yellow to darker red colors shows temperature changes, with darker reds indicating higher temperature. If multiple stations are selected, the plot switches to a facet view, presenting separate charts for each station for easy comparison.

Visual Analytics for Singapore's Weather



Landing Page

Exploratory &
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Univariate Forecasting

Exploratory Time
Series

Time Series
Decomposition

Forecasting

Spatial Interpolation

Exploring timeseries across stations

1 Data Selection Parameters

Choose variable

Mean Temperature (°C) ▼

Select time resolution

- ☒ Day
- ☐ Week
- ☐ Month

Select Station

- ☒ Ang Mo Kio
- ☒ Changi
- ☒ Choa Chu Kang (South)
- ☐ East Coast Parkway
- ☐ Jurong (West)
- ☐ Newton
- ☐ Pasir Panjang
- ☐ Pulau Ubin
- ☐ Seletar
- ☐ Tai Seng
- ☐ Tuas South

Start Date

2021-01-01

End Date

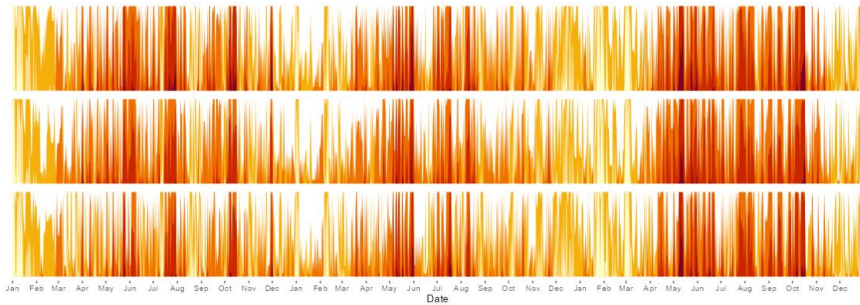
2023-12-31

Please select a period of at
least 1 month for plotting

Line graph

Horizon plot

Daily Mean Temperature (°C)
2021-01-01 to 2023-12-31



Cutpoints

- (30.05, 31.2)
- (28.9, 30.05)
- (27.75, 28.9)
- (26.6, 27.75)
- (25.45, 26.6)
- (24.3, 25.45)

1. Data Selection Parameters:

The input for this section automatically aligns with what user selected for the line graph tab

Univariate Forecasting: Time Series Decomposition

ACF & PCF: This page allows users to analyze the time-dependent characteristics of selected time series data through ACF (Autocorrelation Function) and PACF (Partial Autocorrelation Function). ACF measures the linear relationship between lagged values of the series, while PACF identifies the direct correlation between observations at different lags, with the influence of intermediary observations removed.

Visual Analytics for Singapore's Weather



Landing Page

Exploratory & Confirmatory Data Analysis

Univariate Forecasting

Exploratory Time Series

Time Series Decomposition

Forecasting

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Time Series Decomposition and ACF PACF plots

1 Data Selection Parameters

a Choose variable

Mean Temperature (°C)

b Select time resolution

☒ Day

☐ Week

c Select Station

Ang Mo Kio

d Start Date

2021-01-01

End Date (fixed)

2023-12-31

Please select a period of at least 30 days for plotting.

2 ACF & PACF

STL Decomposition

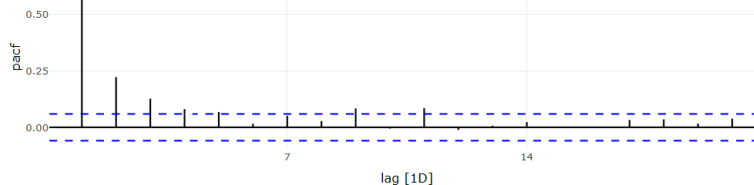
Number of Lags



ACF plot of Daily Mean Temperature (°C) for Ang Mo Kio
2021-01-01 to 2023-12-31



PACF plot of Daily Mean Temperature (°C) for Ang Mo Kio
2021-01-01 to 2023-12-31



1. Data Selection Parameters:

- Use the dropdown box to select a desired variable
- Use the radio button to select the time resolution
- Use the dropdown box to select a specific station
- Use the date picker to specify the start date

- Use the slider to specify the number of lags

Univariate Forecasting: Time Series Decomposition

STL Decomposition: This page enables users to decompose a time series from a specific station into three key components using STL: trend, seasonality, and residuals. The 'remainder' component, displayed in the last panel, represents what remains after the seasonal and trend-cycle components have been removed from the data.

Visual Analytics for Singapore's Weather



Time Series Decomposition and ACF PACF plots

1 Data Selection Parameters

a Choose variable

Mean Temperature (°C)

b Select time resolution

Day

Week

c Select Station

Ang Mo Kio

d Start Date

2021-01-01

End Date (fixed)

2023-12-31

Please select a period of at least 30 days for plotting.

ACF & PACF

STL Decomposition

2 Use Auto STL?

Yes

No

Trend Window

1 20

365

1 38 75 112 149 186 223 260 297 334 365

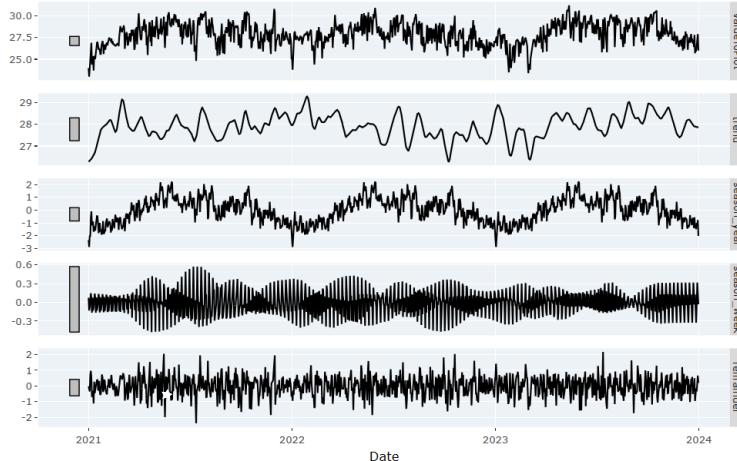
Season Window

1 20

365

1 38 75 112 149 186 223 260 297 334 365

Daily Mean Temperature (°C) for Ang Mo Kio
2021-01-01 to 2023-12-31



1. Data Selection Parameters:

- Use the dropdown box to select a desired variable
- Use the radio button to select the time resolution
- Use the dropdown box to select a specific station
- Use the date picker to specify the start date

2. Choose 'Auto STL' by selecting 'Yes' for automatic settings or 'No' for manual configuration.

3. If 'No' is selected for Auto STL, specify the 'trend' and 'season' windows to customize your decomposition.

Univariate Forecasting: Forecasting

Model Calibration: This page allows users to select a station and compare multiple forecast models, showcasing a forecast validation plot, error plot, and key metrics (RMSE, MAE, MAPE) in an error table for comprehensive model assessment.

Visual Analytics for Singapore's Weather

Forecasting with different models

1 Data Selection Parameters

Choose variable

Mean Temperature (°C)

2 Select Station

Ang Mo Kio

3 Select time resolution

☒ Day

☐ Week

4 Start Date

2021-01-01

End Date (fixed)

2023-12-31

Please select a period of at least 30 days for plotting.

5 Select Forecasting Models

☒ STL_Naive

☒ STL_ARIMA

☒ STL_ETS

☒ AUTO_ARIMA

☒ AUTO_Prophet

☒ AUTO_ETS

6 Use Auto STL?

☒ Yes

☐ No

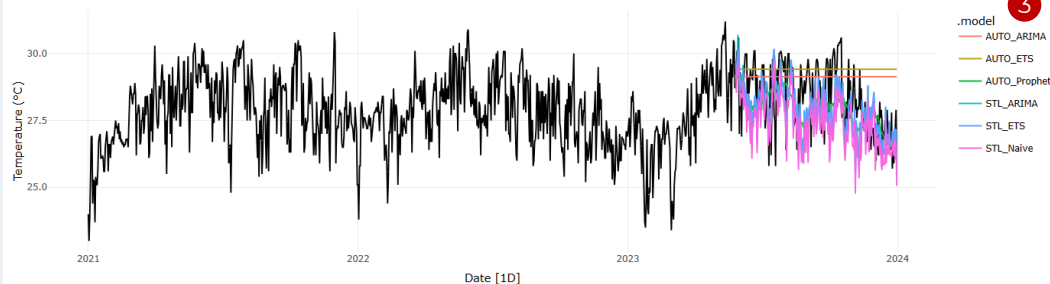
7 Select Train-Test Split

0.8 0.9 1

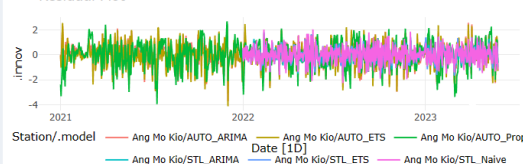
2 Build Model

Forecast Result

Forecast Validation Daily Mean Temperature (°C) for Ang Mo Kio



Residual Plot



Show 10 entries

Search:

.model	.type	RMSE	MAE	MAPE
AUTO_ARIMA	Test	1.4	1.13	4.08
AUTO_ETS	Test	1.57	1.24	4.52
AUTO_Prophet	Test	1.14	0.95	3.32
STL_ARIMA	Test	1.35	1.13	3.95
STL_ETS	Test	1.34	1.11	3.9
STL_Naive	Test	1.57	1.3	4.54

Showing 1 to 6 of 6 entries

Previous

1

Next

1. Data Selection Parameters:

- Use the dropdown box to select a desired variable
- Use the radio button to select the time resolution
- Use the dropdown box to select a specific station
- Use the date picker to specify the start date
- Use the checkbox to select multiple models for comparison
- Choose 'Auto STL' by selecting 'Yes' for automatic settings or 'No' for manual configuration. If 'No' is selected for Auto STL, specify the 'trend' and 'season' windows to customize your decomposition.
- Use the slider to specify the train-test split

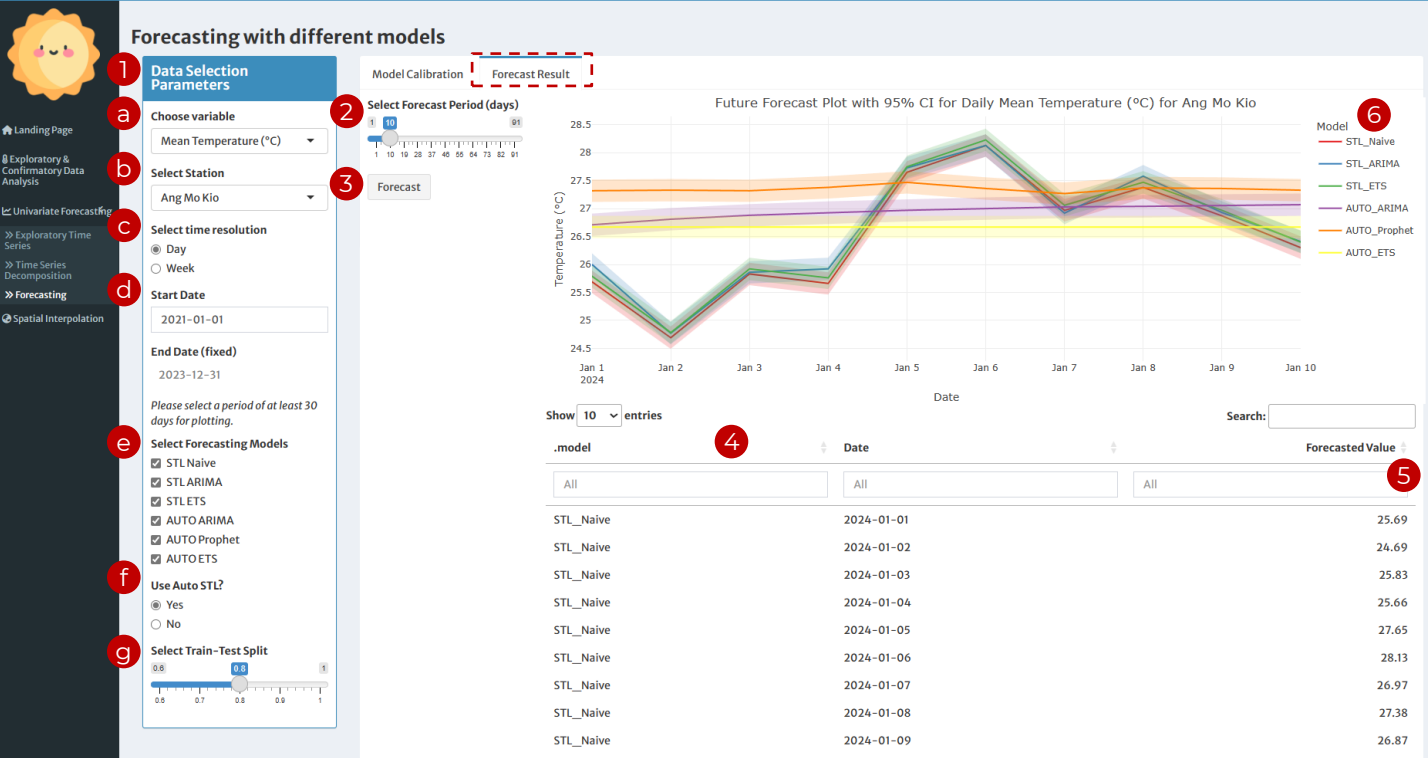
2. Click the "Build Model" button to update the plot and table with the results

3. Click on the legend to toggle the visibility of specific models' lines on the graph

Univariate Forecasting: Forecasting

Forecast Result: This page displays future forecasts for a selected station by plotting multiple forecast models on the same line graph and providing a data table of forecasted values. This setup allows users to visually compare the forecasts from different models, offering a straightforward way to assess their relative outcomes.

Visual Analytics for Singapore's Weather



1. Data Selection Parameters:

- Use the dropdown box to select a desired variable
- Use the radio button to select the time resolution
- Use the dropdown box to select a specific station
- Use the date picker to specify the start date
- Use the checkbox to select multiple models for comparison
- Choose 'Auto STL' by selecting 'Yes' for automatic settings or 'No' for manual configuration. If 'No' is selected for Auto STL, specify the 'trend' and 'season' windows to customize your decomposition.
- Use the slider to specify the train-test split

2. Use the slider to specify the forecast period.

3. Click the "Forecast" button to update the plot and table with the results.

4. For the models selected in (e), apply a filter to view data for a specific model.

5. Sort the data table in ascending or descending order

6. Click on the legend to toggle the visibility of specific models' lines on the graph

The background is a solid teal color. It features several stylized, light blue clouds of various sizes. Some clouds have simple smiley face expressions. Scattered throughout the background are small, white, five-pointed stars.

04

Spatial Interpolation

Spatial Interpolation

Map of stations: This page allows users to visually explore the geographical distribution of weather stations across Singapore, displaying precise locations where temperature and rainfall data are collected. The data can be displayed for specific days or aggregated over months or years.

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Spatial Interpolation

Data Selection Parameters

Choose variable

Mean Temperature (°C)

Time resolution

Month

Select month and year

2021-01

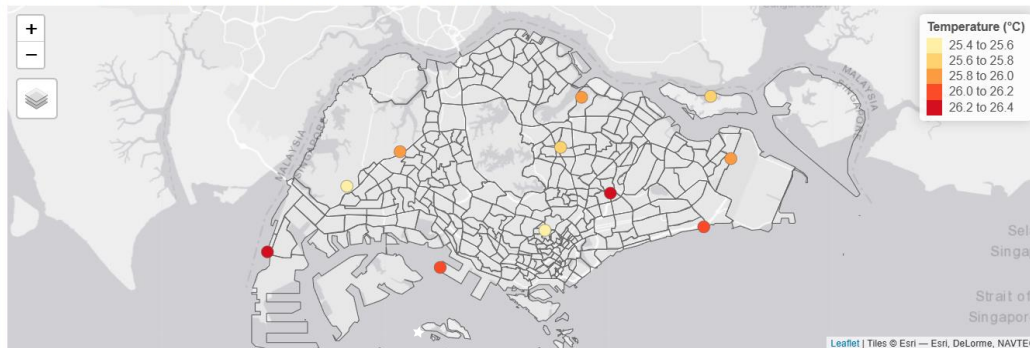
Map of stations

Inverse Distance Weighted Interpolation Method

Ordinary Kriging Method

Update map

Monthly Average Mean Temperature (°C) for January 2021 across 11 stations in Singapore



Show 10 entries

Search:

Station	LAT	LONG	Temperature (°C)
All	All	All	All
Ang Mo Kio	1.3764	103.8492	25.74
Changi	1.3678	103.9826	25.98
Choa Chu Kang (South)	1.3729	103.7224	25.81
East Coast Parkway	1.3134	103.9619	26.18

1. Data Selection Parameters:

- Use the dropdown box to select a desired variable
- Use the dropdown box to select the time resolution to display the data.
- Use the date picker to specify the period of data to display

2. Click 'Update map' button to display the data on the interactive map

Spatial Interpolation

Inverse Distance Weighted Interpolation Method: This page allows users to apply the inverse distance weighted interpolation method to generate an isohyet/isotherm map. This method calculates values based on the proximity and influence of nearby monitored points.

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Spatial Interpolation

Data Selection Parameters

Choose variable

Mean Temperature (°C)

Time resolution

Month

Select month and year

2021-01

Map of stations

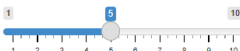
Inverse Distance Weighted Interpolation Method

Ordinary Kriging Method

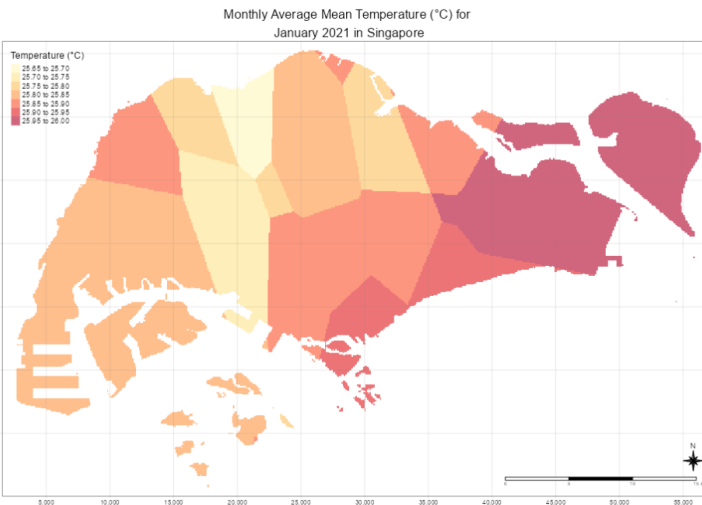
res



nmax



Show Result



1. Data Selection Parameters:

The input for this section automatically aligns with the user's selections from the "Map of Stations" tab.

2. Use the slider to specify *res* for the generated plot

3. Use the slider to specify *nmax*, which is the number of nearest point observations to be used for the model

4. Click 'Show Result' button to display the isohyet / isotherm map

Tips: A lower *res* value will make the plot more detailed and clearer because the raster layer would be created with a finer grid for higher resolutions.

Spatial Interpolation

Ordinary Kriging Method: This page allows users to apply ordinary kriging, to generate an isohyet/isotherm map. This method can generate more accurate estimates of weather conditions at unmonitored locations, because it considers distance and spatial relationship between points.

Visual Analytics for Singapore's Weather

Spatial Interpolation

Data Selection Parameters

Choose variable
Mean Temperature (°C)

Time resolution
Month

Select month and year
2021-01

Map of stations

Inverse Distance Weighted Interpolation Method

Ordinary Kriging Method

res

100

300

100

200

250

300

model

Gau

psill

0.5

0.5

1.5

2.5

3.5

4.5

5.5

6.5

7.5

8.5

9.5

range

2,000

5,000

10,000

2,000

3,000

4,000

5,000

6,000

7,000

8,000

9,000

nugget

0.1

0.1

1.1

2.1

3.1

4.1

5.1

6.1

7.1

8.1

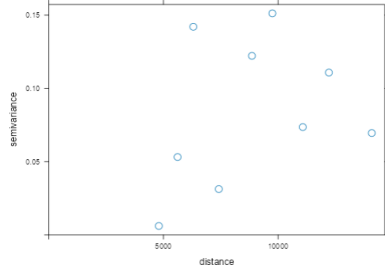
9.1

10

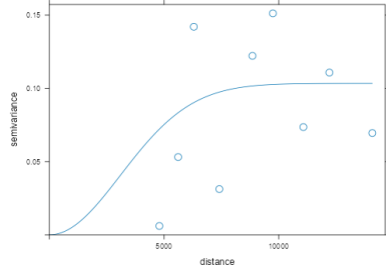
Show Result

Experimental and Fitted Variograms

Experimental Variogram

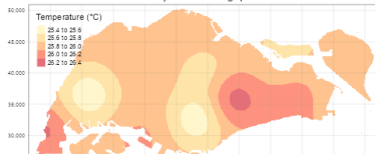


Fitted Variogram

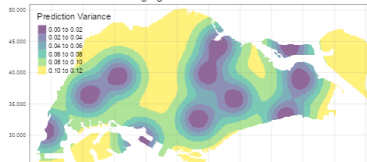


Result of Interpolation

Monthly Average Mean Temperature (°C) for January 2021 in Singapore



Kriging Prediction Variance



1. Data Selection Parameters:

The input for this section automatically aligns with the user's selections from the "Map of Stations" tab.

2. Use the slider to specify *res*

3. Use dropdown box to select variogram *model* for kriging

4. Use the slider to specify *psill* (partial sill).

5. Use the slider to specify *range*, which is the range parameter of the variogram.

6. Use the slider to specify *nugget*, which represents the variance at zero distance.

7. Click 'Show Result' button to display the plots of experimental variogram, fitted variogram, isohyet/isotherm map and prediction variance.

Tip: The *range* parameter is likely to have the most impact on the resultant map. It affects how far the influence of a known data point reaches in the interpolation process, which can alter the smoothness and extent of interpolated values across the plot