Diurnal Cloud Types and Meteorological Correlations in Thasala, Nakhon Si Thammarat

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Abstract This study investigates the relationships between key meteorological variables—air temperature, relative humidity, and wind speed—and cloud characteristics, including cloud type and percentage of cloud cover (% Cloud Cover), based on hourly observations during 16–17 January 2026. Meteorological data were obtained from instrumental measurements, while cloud type classification and cloud cover estimates were derived from direct field observations using the GLOBE Observer application.

The results show that air temperature strongly influences cloud type and structure. Higher temperatures favor the formation of convective cloud types, predominantly Cumulus, which are associated with moderate cloud cover and localized vertical development. In contrast, lower temperatures are associated with stratiform cloud types such as Stratocumulus and Altocumulus, which are characterized by higher cloud cover and extensive horizontal spreading. Relative humidity plays a critical role in cloud extent: high humidity supports widespread stratiform cloud cover, while moderate humidity favors convective cloud development and higher clear-sky fractions. Wind speed further modulates cloud characteristics, as low wind speeds promote extensive layered clouds, whereas higher wind speeds enhance atmospheric mixing and convective cloud formation.

Overall, the findings demonstrate that cloud type and cloud cover are governed by the combined effects of temperature, humidity, and wind speed, underscoring the importance of integrated meteorological and observational analyses of clouds for understanding local-scale atmospheric processes.
Keywords: Cloud type, Cloud cover, Air temperature, Relative humidity, Wind speed

1. Introduction

Clouds are a fundamental component of the Earth's atmosphere and play a crucial role in weather and climate systems. They influence precipitation, atmospheric stability, radiation balance, and surface temperature. In tropical regions such as Thailand, cloud formation is strongly influenced by monsoonal circulation, high humidity, and intense solar radiation, leading to frequent convective activity and a wide variety of cloud types.

Nakhon Si Thammarat Province, located in southern Thailand, is characterized by diverse geographical features, including coastal areas, lowlands, and mountainous terrain. The province is influenced by both the northeast and southwest monsoons, leading to high annual rainfall and frequent weather variability. These climatic and topographic conditions significantly affect cloud development and distribution, particularly clouds associated with heavy rain and thunderstorms.

Therefore, studying clouds in Nakhon Si Thammarat Province is essential for enhancing understanding of local atmospheric processes. This research aims to investigate cloud types, their formation mechanisms, and their relationships with local weather conditions. The findings are expected to contribute to meteorological knowledge and support weather forecasting, resource management, and sustainable development in the region.

2. Materials and methods

2.1 Study site

Thasala District, Nakhon Si Thammarat Province, is characterized by its coastal lowland topography along the Gulf of Thailand, with the landscape transitioning from the eastern coastline to the high mountain ranges of the Khao Nan and Khao Luang massifs to the west. Due to this geographical setting, the study area at Walailak University and the surrounding Thasala can be primarily divided into (1) Coastal zones influenced by maritime air masses, (2) Lowland plains and agricultural areas (where Walailak University is situated), and (3) Foothill and high altitude areas to the west that trigger orographic cloud formation.

During mid-January, specifically around **16-17 January 2026**, Thasala District remains under the influence of the Northeast Monsoon, which carries moisture from the Gulf of Thailand directly toward the coast of Nakhon Si Thammarat. This period typically sees frequent convective cloud development and stratiform clouds resulting from the interaction between monsoon winds and local topography. These conditions increase the likelihood of diverse cloud types, ranging from low-level Cumulus and Stratocumulus to high-level Cirrus, often accompanied by scattered rain showers. Furthermore, owing to its proximity to the sea and the presence of the western mountain barrier, Thasala experiences distinct diurnal cloud cycles, where surface heating during the day and land-sea breezes play a critical role in cloud formation and vertical distribution.

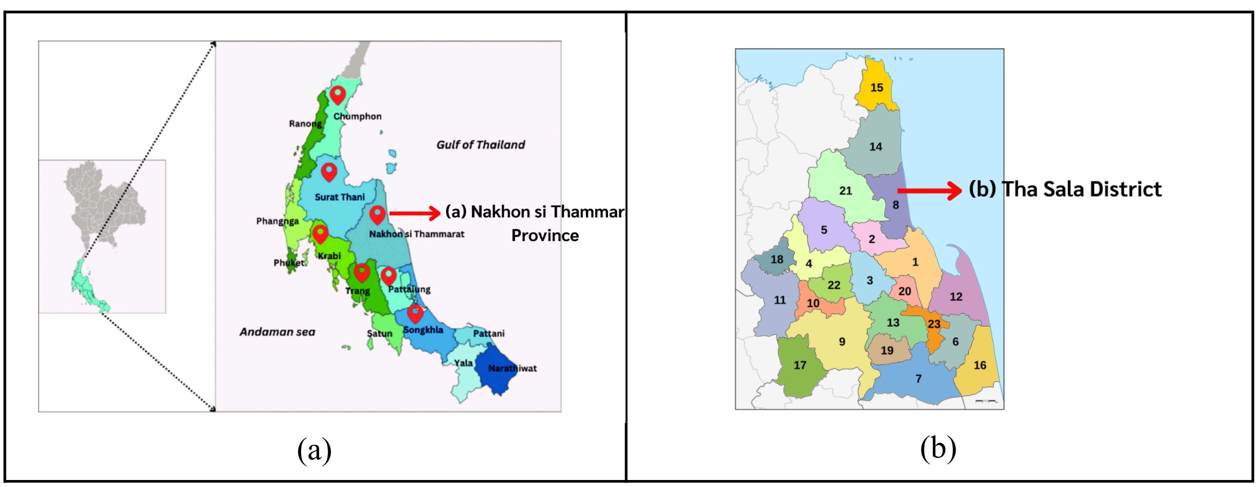


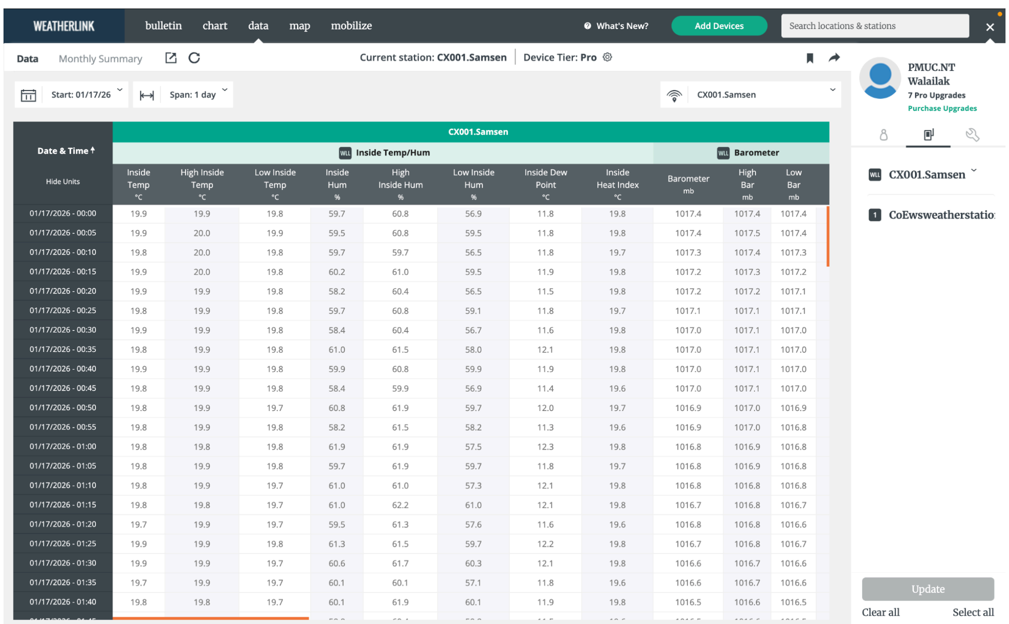
Figure 1. (a) Map of Nakhon Si Thammarat, Southern Thailand (b) Map of Tha Sala District

2.2 Monitoring stations

Meteorological data used in this study were obtained from an automated weather monitoring station equipped with a Davis weather station system and accessed through the WeatherLink online platform (www.weatherlink.com). The Davis station provides high-resolution, continuous measurements of key atmospheric parameters, including maximum, minimum, and average air temperature, relative humidity, and wind speed.

The monitoring station is located in the vicinity of Thasala District, Nakhon Si Thammarat Province, and was selected to represent local atmospheric conditions during the study period from January 16 to 17, 2026. WeatherLink enables the retrieval of time-stamped meteorological data at short temporal intervals, allowing detailed analysis of diurnal variations and short-term atmospheric changes relevant to cloud-formation processes.

Raw data from the WeatherLink platform were processed and aggregated to produce hourly values for temperature, relative humidity, and wind speed. These parameters were subsequently analyzed in relation to cloud type and percentage of cloud cover obtained from field observations. The high temporal resolution and reliability of the Davis weather station data ensure accurate representation of local meteorological conditions and provide a robust foundation for examining relationships between atmospheric variables and cloud characteristics. Figure 2 presents an example of the recorded meteorological parameters obtained from the WeatherLink platform during the study period.



Date & Time	Inside Temp °C	High Inside Temp °C	Low Inside Temp °C	Inside Hum %	High Inside Hum %	Low Inside Hum %	Inside Dew Point °C	Inside Heat Index °C	Barometer mb	High Bar mb	Low Bar mb
01/17/2026 - 00:00	19.9	19.9	19.8	59.7	60.8	56.9	11.8	19.8	1017.4	1017.4	1017.4
01/17/2026 - 00:05	19.9	20.0	19.9	59.5	60.8	59.5	11.8	19.8	1017.4	1017.5	1017.4
01/17/2026 - 00:10	19.8	20.0	19.8	59.7	59.7	56.5	11.8	19.7	1017.3	1017.4	1017.3
01/17/2026 - 00:15	19.9	20.0	19.8	60.2	61.0	59.5	11.9	19.8	1017.2	1017.3	1017.2
01/17/2026 - 00:20	19.9	19.9	19.8	58.2	60.4	56.5	11.5	19.8	1017.2	1017.2	1017.1
01/17/2026 - 00:25	19.8	19.9	19.8	59.7	60.8	59.1	11.8	19.7	1017.1	1017.1	1017.1
01/17/2026 - 00:30	19.9	19.9	19.8	58.4	60.4	56.7	11.6	19.8	1017.0	1017.1	1017.0
01/17/2026 - 00:35	19.8	19.9	19.8	61.0	61.5	58.0	12.1	19.8	1017.0	1017.1	1017.0
01/17/2026 - 00:40	19.9	19.9	19.8	59.9	60.8	59.9	11.9	19.8	1017.0	1017.1	1017.0
01/17/2026 - 00:45	19.8	19.9	19.8	58.4	59.9	56.9	11.4	19.6	1017.0	1017.1	1017.0
01/17/2026 - 00:50	19.8	19.9	19.7	60.8	61.9	59.7	12.0	19.7	1016.9	1017.0	1016.9
01/17/2026 - 00:55	19.8	19.9	19.8	58.2	61.5	58.2	11.3	19.6	1016.9	1017.0	1016.8
01/17/2026 - 01:00	19.8	19.8	19.8	61.9	61.9	57.5	12.3	19.8	1016.8	1016.9	1016.8
01/17/2026 - 01:05	19.8	19.9	19.8	59.7	61.9	59.7	11.8	19.7	1016.8	1016.9	1016.8
01/17/2026 - 01:10	19.8	19.9	19.7	61.0	61.0	57.3	12.1	19.8	1016.8	1016.8	1016.8
01/17/2026 - 01:15	19.8	19.8	19.7	61.0	62.2	61.0	12.1	19.8	1016.7	1016.8	1016.7
01/17/2026 - 01:20	19.7	19.9	19.7	59.5	61.3	57.6	11.6	19.6	1016.8	1016.8	1016.6
01/17/2026 - 01:25	19.9	19.9	19.8	61.3	61.5	59.7	12.2	19.8	1016.7	1016.8	1016.7
01/17/2026 - 01:30	19.9	19.9	19.7	60.6	61.7	60.3	12.1	19.8	1016.6	1016.7	1016.6
01/17/2026 - 01:35	19.7	19.9	19.7	60.1	60.1	57.1	11.8	19.6	1016.6	1016.7	1016.6
01/17/2026 - 01:40	19.8	19.8	19.7	60.1	61.9	60.1	11.9	19.8	1016.5	1016.6	1016.5

Figure 2. Temperature, Wind speed, and Relative humidity data from the WeatherLink platform, January 2026

2.3 Data collection

This study aimed to investigate changes in cloud characteristics through observations conducted by primary school students. Data were collected from students who served as the sample group participating in hands-on learning activities related to weather and atmospheric phenomena.

Data collection was carried out through sky observation activities in which students observed cloud characteristics at regular 1-hour intervals during the designated observation period. The observations were conducted using direct visual inspection from the school area, and the results were recorded using observation sheets prepared by the researcher.

The collected data included the time of observation, the characteristics or types of clouds observed at each time, and changes in cloud characteristics compared with the previous observation period. The observation sheets were designed for primary school students' cognitive level and included clear descriptions and visual illustrations to help students accurately identify and describe cloud characteristics.

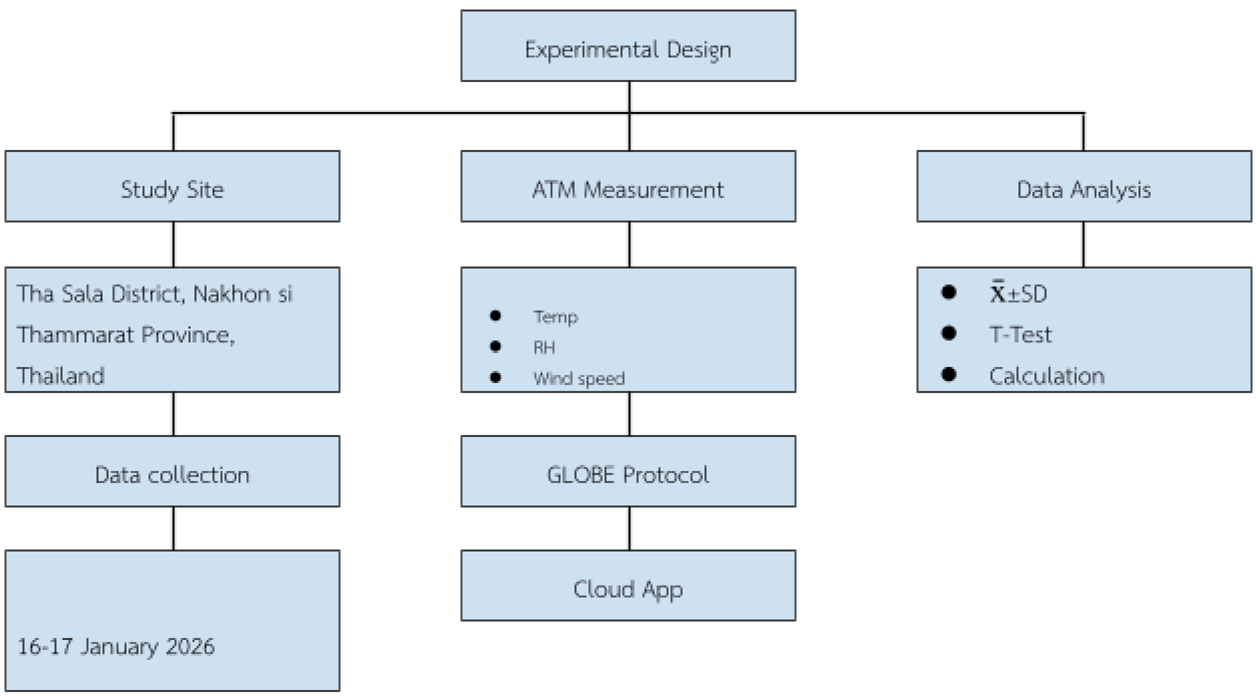


Figure 3. Conceptual Experimental Design.

2.4 Data Analysis

Data Analysis. In the context of Nakhon Si Thammarat, data analysis must prioritize the influence of geographical features. Collected data frequently highlights the formation of vertical development clouds, specifically Cumulonimbus, which occur often during the Northeast Monsoon. This phenomenon is driven by moisture from the Gulf of Thailand, pushed inland by prevailing winds, which strikes the Nakhon Si Thammarat mountain range and undergoes rapid orographic lift. Analyzing the movement patterns and scale of these cloud formations not only predicts forthcoming rainfall but also serves as a critical tool for forecasting storm intensity and shifts in visibility. Consequently, this analysis directly impacts transportation safety and the broader economic activities of the local community.

2.5 GLOBE Observer Application: Air temperature and Relative humidity

The GLOBE Observer Cloud App was used to collect data on cloud types and cloud cover percentages at the five study sites. This application, part of the GLOBE Program, facilitates environmental observations that supplement NASA satellite data, supporting scientists studying Earth and the global environment (Figure 4).

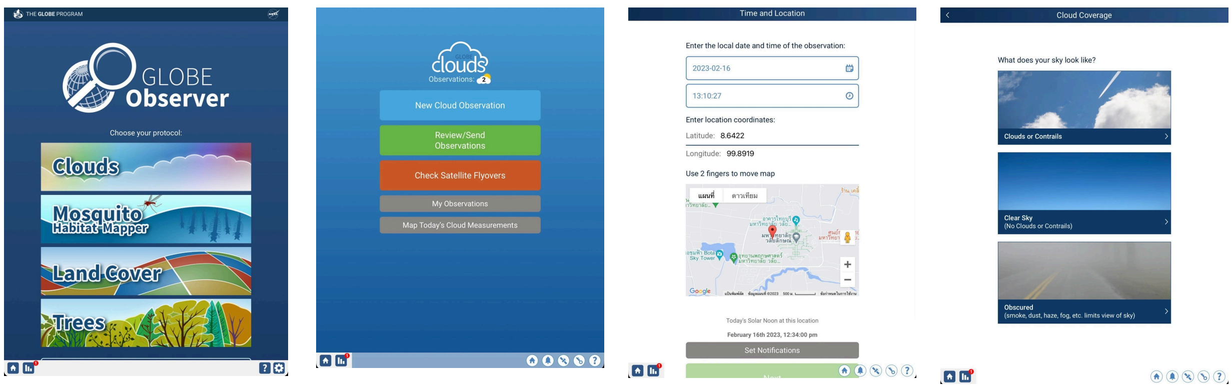
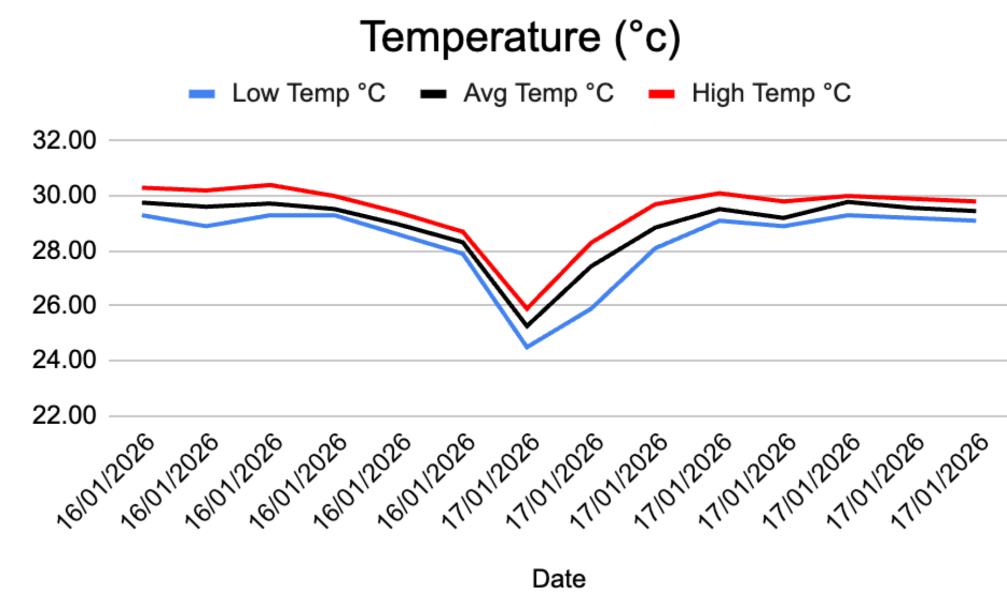


Figure 4. GLOBE Observer: Cloud App

3. Results and Discussion

(a)



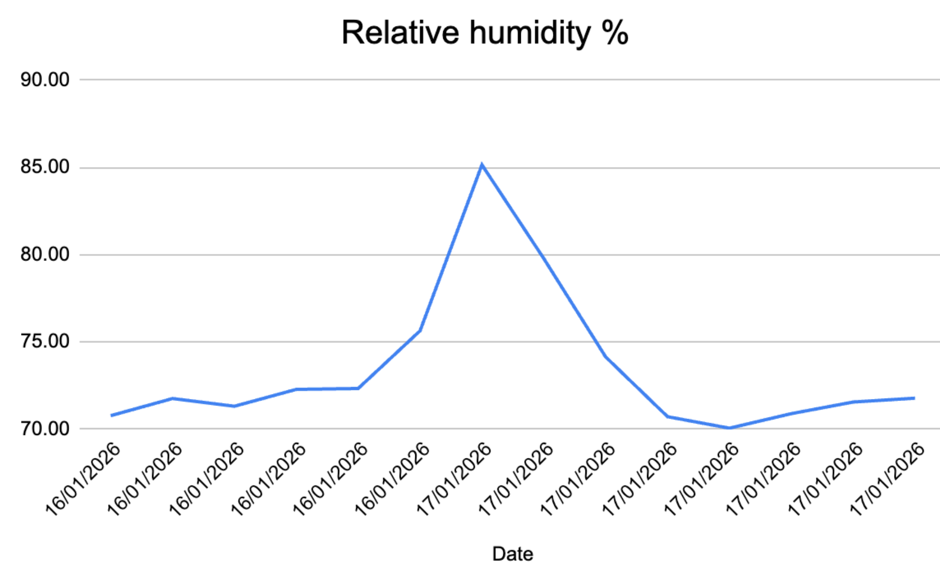
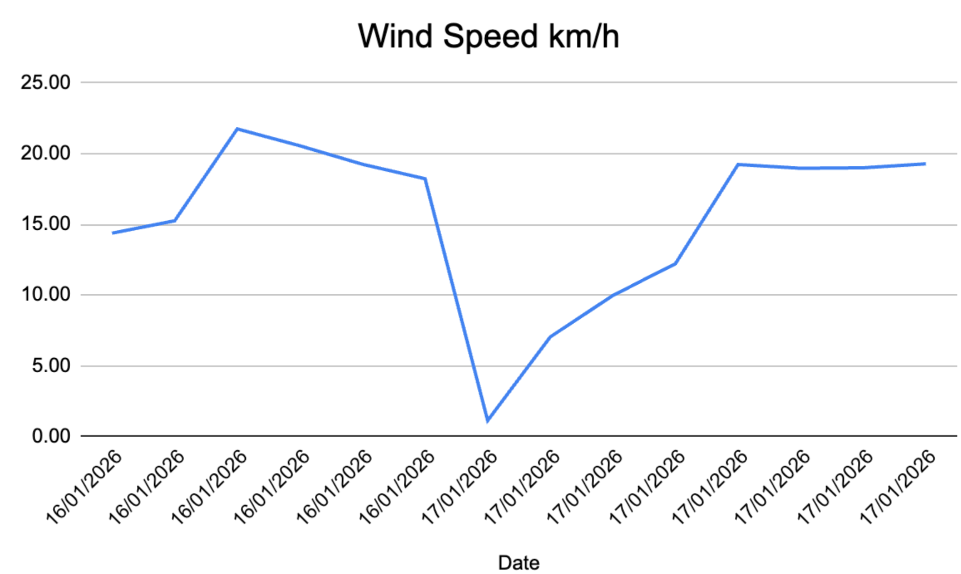
(b)	
(c)	

Figure 5 (a) Temperature °c (Max, Min, Average), (b) Relative humidity (%), and (c) Wind Speed (km/h) in Tha Sala District, Thailand

3.1 Temperature (°c)

Analysis of hourly observations for 16–17 January 2026 indicates a clear relationship among air temperature, cloud types, and the percentage of cloud cover (% Cloud Cover). Distinct cloud patterns were observedacrossr different temperature regimes, reflecting changes in atmospheric stability and cloud-forming processes.

During periods of relatively high air temperature, particularly from late morning to afternoon on 16 January and from mid-morning onward on 17 January, average temperatures ranged from approximately 28.9 to 29.8 °C. Under these conditions, convective cloud types, predominantly Cumulus, were consistently observed. These clouds were associated with moderate cloud cover values, generally between 35% and 45%. Cumulus clouds frequently co-occurred with small proportions of high-level clouds, such as Cirrus, or mid-level clouds, including Altocumulus. This cloud configuration suggests localized vertical cloud development driven by enhanced surface heating, resulting in cloud formation that does not fully cover the sky.

In contrast, lower air temperatures were recorded during the early morning hours of 17 January, with average temperatures ranging from approximately 25.3 to 27.4 °C. During these periods, stratiform cloud types, particularly Stratocumulus and Altocumulus, became more dominant. These cloud types were associated with higher cloud cover, typically 45%-50%. The increased cloud cover under lower-temperature conditions indicates a more stable atmospheric environment, with vertical air motion limited and cloud formation mainly through horizontal spreading.

Overall, the variation in % Cloud Cover across different temperature ranges highlights the strong influence of air temperature on cloud characteristics. Higher temperatures favor the development of convective clouds with moderate cloud cover and greater clear-sky fractions, whereas lower temperatures are associated with stratiform clouds exhibiting more extensive sky coverage. These results are consistent with fundamental principles of atmospheric thermodynamics and cloud physics and demonstrate the role of temperature in controlling cloud type and spatial distribution.

3.2 Relative humidity (%)

This study analyzes the relationships among relative humidity, cloud types, and the percentage of cloud cover (% Cloud Cover) using hourly meteorological observations. Relative humidity data were obtained from instrumental measurements, while cloud type classification and cloud cover percentages were derived from direct field observations using the GLOBE Observer application. The integration of these datasets enables a comprehensive assessment of atmospheric moisture conditions and cloud-forming characteristics.

The analysis indicates that higher relative humidity values are strongly associated with increased cloud cover and the presence of stratiform cloud types. During periods when relative humidity exceeded approximately 75–85%, cloud types such as *Stratocumulus* and *Altocumulus* were frequently observed. These periods were characterized by relatively high total cloud cover, often greater than 45–50%, indicating widespread cloud layers covering a large portion of the sky. High humidity promotes condensation in the lower and middle levels of the atmosphere, supporting the formation and persistence of horizontally extensive cloud structures under relatively stable atmospheric conditions.

In contrast, during periods of moderate relative humidity (typically 70–73%), convective cloud types, such as *Cumulus,* were predominantly observed. These conditions were associated with moderate cloud cover values, generally between 35% and 45%, and a higher proportion of clear sky. The presence of Cumulus clouds under moderate humidity suggests localized cloud development driven by surface heating and vertical air motion rather than widespread atmospheric saturation.

Furthermore, variations in % Cloud Cover provide quantitative support for the observed relationship between humidity and cloud type. Higher cloud cover values correspond to higher humidity and stratiform cloud dominance, while lower to moderate cloud cover values coincide with convective clouds under relatively drier atmospheric conditions. This pattern highlights the critical role of atmospheric moisture availability in controlling cloud extent and structure.

Overall, the results demonstrate that relative humidity is a key factor influencing both cloud type and cloud cover. High humidity favors extensive, layered clouds with ample sky coverage, whereas moderate humidity supports convective cloud formation with limited spatial extent. These findings are consistent with established principles of cloud physics and atmospheric moisture dynamics.

3.3 Wind Speed (km/h)

This study examines the relationships among wind speed, cloud types, and the percentage of cloud cover (% Cloud Cover) based on hourly meteorological observations. Wind speed data were obtained from instrumental measurements, while cloud type classification and cloud cover percentages were derived from direct field observations using the GLOBE Observer application. The combined use of these datasets enables an assessment of how wind conditions influence cloud formation and spatial distribution.

The analysis indicates that periods of relatively low wind speed, typically below approximately 5 km/h, were associated with higher total cloud cover and the presence of stratiform cloud types such as Stratocumulus and Altocumulus. During these conditions, % Cloud Cover frequently exceeded 45–50%, suggesting extensive horizontal cloud layers. Low wind speeds limit vertical and horizontal air mixing, allowing moisture to accumulate and clouds to persist over a wide area under relatively stable atmospheric conditions.

In contrast, moderate to high wind speeds, generally ranging from approximately 10 to over 20 km/h, were more commonly associated with convective cloud types, particularly Cumulus. These periods exhibited moderate cloud cover values, typically between 35% and 45%, along with a higher proportion of clear sky. Increased wind speed enhances atmospheric mixing and supports vertical air motion, which promotes the development of convective clouds while preventing the formation of widespread, continuous cloud layers.

Furthermore, variations in % Cloud Cover provide quantitative evidence supporting the relationship between wind speed and cloud type. Higher cloud cover values correspond to lower wind speeds and stratiform cloud dominance, whereas lower to moderate cloud cover values are associated with stronger winds and convective cloud development. This pattern highlights the role of wind in regulating cloud extent and structure by influencing atmospheric stability and moisture distribution.

Overall, the results demonstrate that wind speed is an essential factor affecting both cloud type and cloud cover. Calm or weak wind conditions favor the formation of extensive layered clouds, while stronger winds are linked to the development of convective clouds with more limited sky coverage. These findings are consistent with fundamental principles of atmospheric dynamics and cloud physics.

4. Conclusion

This study examined the relationships between key meteorological variables—air temperature, relative humidity, and wind speed—and cloud characteristics, including cloud type and percentage of cloud cover (% Cloud Cover), based on hourly observations during 16–17 January 2026. The results demonstrate that cloud formation and spatial distribution are strongly governed by the combined effects of these atmospheric factors rather than by any single variable.

Air temperature was found to play a central role in determining cloud type and structure. Higher temperatures favored the development of convective cloud types, predominantly Cumulus, characterized by moderate cloud cover and localized vertical growth. In contrast, lower temperatures were associated with stratiform cloud types, such as Stratocumulus and Altocumulus, which exhibited higher cloud cover and greater horizontal extent, indicative of more stable atmospheric conditions.

Relative humidity significantly influenced cloud extent and persistence. High humidity promoted widespread stratiform cloud cover, while moderate humidity favored convective cloud development and higher clear-sky fractions. Wind speed further modulated these patterns, with low wind speeds favoring extensive layered clouds and higher wind speeds enhancing atmospheric mixing and convective cloud formation.

Overall, the findings highlight the interactive role of temperature, humidity, and wind speed in controlling cloud type and cloud cover. These results are consistent with established principles of atmospheric thermodynamics and cloud physics and underscore the importance of integrating meteorological measurements with cloud observations to improve understanding of local-scale atmospheric processes.

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I would like to claim IVSS badges

1. **I make an impact**

This research demonstrates impact by linking cloud types and cloud cover percentages to local atmospheric conditions. By integrating instrumental weather data with cloud observations from the GLOBE Observer application, the study provides clear insights into how clouds respond to changes in temperature, humidity, and wind. These findings support improved atmospheric observation and environmental awareness at the local scale.

2. **I am a STEM professional.**
This study applies scientific methods to analyze cloud formation using measured meteorological data and a systematic cloud classification scheme. The integration of quantitative and observational data reflects a structured STEM approach grounded in atmospheric science.
3. **I am a data scientist.**
This work employs data science techniques to integrate and analyze multi-source datasets of atmospheric and cloud observations. The analysis identifies patterns between cloud cover, cloud types, and meteorological variables under varying atmospheric conditions.

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