AL-MARSHAD: JURNAL ASTRONOMI ISLAM DAN ILMU-ILMU BERKAITAN
ISSN 2442-5729 (print) || ISSN 2598-2559 (online)
http://jurnal.umsu.ac.id/index.php/almarshad
DOI: https://doi.org/10.30596/jam.v12i1.30225|| Vol. 12, No. 1 June 2026

Evaluation of Temperature and Surface Humidity Variability of the Troposphere Using Radiosonde Observations

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Abstract

This study aims to evaluate the variability of surface atmospheric temperature and humidity and the implications for atmospheric stability based on observation data at the Juanda-Sidoarjo Class 1 Meteorological Station in February 2026. The method used is a quantitative approach with descriptive and evaluative analysis of temperature and humidity data at two observation times. So the results show that the temperature during the day has a greater variation of around 24.6°C to 30.0°C while the relative humidity is around 67% to 97%. Likewise, at night it has a larger variation, around 24.3°C to 26.3°C, while the relative humidity is higher, around 81% to 96%. This analysis shows an inverse relationship between temperature and humidity, where temperature increase is followed by a decrease in relative humidity. The atmospheric dynamics side of daytime conditions produces labile atmospheric conditions due to intense surface heating, while for nighttime it shows stable atmospheric conditions due to surface cooling. So that temperature and humidity variability play an important role in controlling atmospheric stability and weather dynamics in tropical regions.

Keywords: ***Temperature, Humidity, Troposphere, Atmospheric Stability, Radiosonde***

Article Info
Received:
13 April 2026
Revised:
21 May 2026
Accepted:
30 June 2026
Published:
30 June 2026

A. Introduction

The troposphere is the lowest layer of the atmosphere and has a role in controlling weather processes and climate dynamics. The meteorological phenomena that occur such as cloud formation, precipitation and atmospheric convection in the troposphere layer. Temperature and humidity parameters are fundamental variables in determining atmospheric thermodynamic conditions, including atmospheric stability and vertical energy distribution. Variations of both parameters can directly affect physical processes including cloud formation and energy transfer between the Earth's surface and the atmosphere. In the implementation of the latest study that shows that the vertical distribution of temperature

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and humidity is an indicator in understanding atmospheric dynamics in the meteorologically active troposphere layer[1] .

The relationship between temperature and humidity plays a role in determining the refractive properties of the atmosphere and the interaction of electromagnetic waves in the troposphere. Which suggests that small changes in temperature and humidity can have a significant impact on the overall characteristics of the atmosphere. In the research that has been conducted, it has been shown that the temperature parameter has a high sensitivity to changes in relative humidity in determining the physical properties of the atmosphere, especially in the vertical variation of the troposphere [2]

Atmospheric variability, especially in temperature and humidity in the troposphere layer, has a role in understanding climate change and weather dynamics. Uneven changes in troposphere temperature, both spatially and vertically, show a significant influence of global warming on the atmospheric system. These variations can affect the distribution of energy in the atmosphere as well as have an impact on changes in atmospheric circulation patterns and extreme weather phenomena. Changes in the characteristics of the troposphere are seen in the dynamics of the tropopause which is very sensitive to temperature and humidity variability so it is used as an indicator of global climate change. Radiosonde-based research in Indonesia shows that the use of upper atmosphere data is not optimal, so that there is limited understanding of vertical patterns of temperature and humidity. Therefore, the need for a study of temperature and humidity variability of the troposphere is important in improving understanding of atmospheric dynamics in the tropics.[3] [4]

The natural problem of the study of temperature and humidity variability of the troposphere lies in the coflexicity of atmospheric dynamics which is not easy to represent accurately. Variations in atmospheric parameters do not only occur vertically but are influenced by multi-scale interactions between atmospheric circulation convection processes and surface-atmosphere interactions. This causes the distribution of temperature and humidity to be dynamic and difficult to predict precisely, especially in tropical regions that have high convective activity.

There are also significant limitations in the availability and quality of atmospheric data. In radiosonde observations, which have high vertical resolution, they are still limited spatially and temporally, so they are not able to describe atmospheric conditions as a whole. Meanwhile, alternative data such as satellites and reanalyses often show biases, especially in the humidity parameters in the lower troposphere, causing inconsistencies with direct observation data [4]

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The complexity between temperature and humidity contributes to the emergence of extreme weather phenomena such as humid heat waves which show that atmospheric variability is not only linear but is influenced by environmental factors such as rainfall and surface conditions. Therefore, an approach with a direct observation database is needed as a study to evaluate the variability of temperature and humidity in the troposphere more accurately.[5]

B. Research Methods

In this study, a quantitative approach is used through descriptive and evaluative analysis of surface observation data before radiosonde observation is carried out to examine the variability of temperature and humidity in the troposphere layer. The surface data used is surface data from the observation unit at the Class 1 Meteorological Station Juanda-Sidoarjo, which was obtained through the launch of radiosondes twice a day. The analysis aims to identify the pattern of temperature distribution and moisture structure in the troposphere layer. A vertical profile-based approach is used in observations to determine the characteristics of atmospheric layers. This analysis aims to identify fluctuations in atmospheric parameters and patterns of change that occur in various layers of the troposphere. Temperature and humidity variability are important indicators in understanding weather dynamics and climate change, especially in the tropics of Indonesia which have quite complex atmospheric characteristics [6] [7] .

C. Results and discussion

Observation Results

Based on table and graph data from the results of observations of surface temperature and humidity during the month of February at the Juanda-Sidoarjo Class 1 Meteorological Station, using atmospheric variability characteristics between the night period (23.30 UTC) and the daytime period 11.30 UTC). Before the radiosonde observation at 00.00 UTC, surface observations were made at 23.30 UTC, then before the radiosonde observation at 12.00 UTC, surface observations were made at 11.30 UTC. As follows

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Data Suhu dan Kelembapan Hasil Pengamatan Permukaan Bulan Februari 2026 Jam 23.30 UTC		
Tanggal	Suhu	Kelembapan
1	26.0	92
2	25.3	91
3	25.4	94
4	25.2	93
5	25.1	91
6	25.5	91
7	26.2	86
8	25.7	89
9	25.5	95
10	25.1	89
11	25.0	95
12	25.1	95
13	25.1	91
14	25.6	93
15	24.8	95
16	25.8	96
17	26.3	91
18	25.7	91
19	25.5	89
20	25.6	88
21	25.5	84
22	25.8	92
23	24.6	95
24	25.2	94
25	25.4	81
26	25.1	83
27	25.8	84
28	24.3	95

Figure 1. Table of Temperature and Humidity Data from Surface Observations

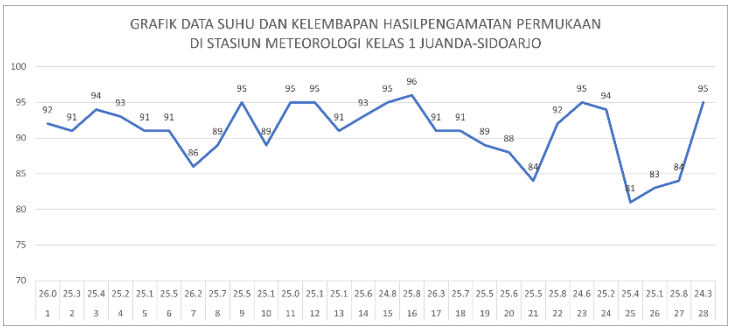

Figure 2. Temperature and Humidity Data Graph of Surface Observations at 23.30

Based on temperature and humidity data from surface observations in February 2026 conducted at 23.30 UTC, the temperature variability is relatively smaller compared to daytime observations, in the temperature range ranging from 24.3°C to 26.3°C. With the minimum temperature recorded on February 28 of 24.3°C while the maximum temperature recorded on February 17 was 26.3°C. This shows that if the temperature at night tends to be more stable at an average of 25-26°C, this reflects a more homogeneous atmospheric condition due to the absence of direct solar radiation. Meanwhile, the relative humidity at night showed relatively high values with a humidity range between 81% to 96%. The maximum humidity recorded on February 16 was 96% while the minimum value recorded on February 25 was 81%. Because the high humidity at night is caused by a decrease in air temperature so as to reduce the air capacity to hold water vapor, therefore

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the relative humidity will increase. This uses the principle of atmospheric thermodynamics, if the temperature is lower, the relative humidity will increase.

Data Suhu dan Kelembapan Hasil Pengamatan Permukaan Bulan Februari 2026 Jam 11.30 UTC		
Tanggal	Suhu	Kelembapan
1	26.7	80
2	25.0	96
3	24.9	97
4	25.2	87
5	28.8	72
6	27.6	89
7	28.5	74
8	25.1	95
9	27.3	83
10	25.7	94
11	25.1	96
12	26.7	88
13	26.9	88
14	25.3	94
15	29.1	78
16	29.0	76
17	27.8	80
18	25.4	86
19	26.2	85
20	27.9	68
21	25.5	84
22	28.4	75
23	24.6	95
24	25.2	94
25	30.0	67
26	26.6	85
27	25.8	84
28	27.3	91

Figure 3. Table of Temperature and Humidity Data from Surface Observations

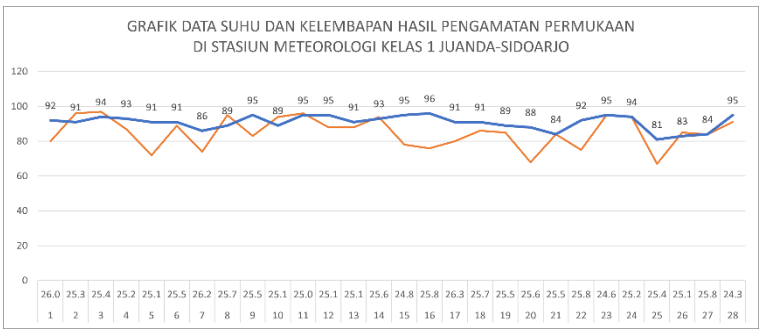

Figure 4. Temperature and Humidity Data Graph of Surface Observations at 11.30

Based on temperature and humidity data from surface observations during February 2026 at 11.30 UTC. There is significant variation using two parameters, namely temperature and humidity. The air temperature data is recorded in the temperature range ranging from 24.6°C to 30.0°C, with the minimum value occurring on February 23 and then the maximum value occurring on February 25. This shows that temperatures tend to be at an average of 25-28°C, which is a typical thermal condition in the tropics. Meanwhile relative humidity can be shown to vary between 67% to 97%, with the maximum value recorded on February 3 while the minimum value recorded on February 25. The pattern that occurs shows a tendency to inverse the relationship between temperature and humidity,

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as there is an increase in temperature followed by a decrease in relative humidity. This was recorded on February 25 when the temperature reached a maximum value of 30.0°C while for humidity it reached a minimum value of 67%, and vice versa which was recorded on February 2 the temperature value was 25.0°C then the humidity value was 96% and on February 3 the temperature value was 24.9°C with a humidity value of 97% so that on that date it had a low temperature value while for the humidity value obtained was relatively high. Therefore, the increase in temperature can increase the capacity of the air to accommodate water vapor so that the relative humidity decreases.

The fluctuations that occur indicate atmospheric dynamics influenced by local factors including solar radiation, evaporation processes and there is a possibility of convection activity. This variability can indicate that the surface sample conditions during the observation period in February were not constant but were influenced by the complex interaction between temperature and humidity. The data is used to describe the characteristics of surface atmospheric variability as a follow-up analysis of atmospheric stability and the potential for weather formation.

When comparing the two surface observation data at 23.30 UTC and 11.30 UTC, there was a significant difference in characteristics between day and night conditions. If during the day the temperature has greater variability and humidity will experience lower while at night the temperature is recorded to be more stable and the humidity is also relatively higher. The relationship between temperature and humidity at night (23.30 UTC) is not as strong as during the day (11.30 UTC), this is due to small temperature fluctuations that cause relatively limited changes in humidity.

The data show a clear daily cycle in surface temperature and humidity variability. During the day, heating by solar radiation occurs which can increase the temperature and can also decrease relative humidity, while at night there is a process that causes the temperature to decrease and the humidity will increase. So that the pattern can reflect the atmospheric dynamics of the surface which can be controlled by the energy balance of radiation and the heat exchange process between the surface and the atmosphere.

The relationship between inverse temperature and humidity seen in the data also has implications for atmospheric stability. So that if the temperature increases and the relative humidity decreases, the air capacity to accommodate water vapor will increase and then the air becomes drier relatively speaking. However, the absolute moisture content remains high because in this condition it can increase the potential for convection when further heating occurs **[**8**] .**

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D. Conclusion

Based on the results of the analysis of surface temperature and humidity data during February 2026, the variability of the two parameters shows a pattern strongly influenced by the daily cycle. During the day, the variability of air temperature tends to be higher and has a large variation, while the relative humidity will be lower. On the other hand, at night the temperature will be more stable and low, while the relative humidity will be higher. The relationship between temperature and humidity shows an inversely proportional tendency where the increase in temperature is caused by a decrease in relative humidity and vice versa. With this pattern, it can reflect the characteristics of atmospheric thermodynamics that often occur. If from the aspect of atmospheric stability in daytime conditions which shows a tendency for the astmosphere to be more labile due to surface heating which increases the vertical temperature gradient and supports the convection process. Meanwhile, night conditions tend to be stable due to surface cooling that inhibits the vertical movement of air. Therefore, the variability of surface temperature and humidity has a role in determining atmospheric stability conditions in radiosonde observations and the potential for the formation of weather phenomena.

References

[1] Y. Gong *et al.*, "The first decadal-scale ground-based microwave radiometer dataset in China: Brightness temperature and thermodynamic profiles from Xianghe (2013–2022)," Feb. 19, 2026. doi: 10.5194/essd-2025-760.

[2] O. Fiser, V. Krcmar, V. Schejbal, and Z. Sokol, "Measurement, analysis and utilization of meteorological parameters for radio signal propagation modeling – tropospheric refraction," *Theor. Appl. Climatol.*, vol. 156, no. 2, p. 140, Feb. 2025, doi: 10.1007/s00704-025-05367-5.

[3] A. J. Simmons, "Trends in the tropospheric general circulation from 1979 to 2022," *Weather and Climate Dynamics*, vol. 3, no. 3, pp. 777–809, Jul. 2022, doi: 10.5194/wcd-3-777-2022.

[4] Y. Gou, J. Zhang, W. Wang, K. Huang, and S. Zhang, "Intercomparison of tropopause height climatologies: high-resolution radiosonde measurements versus ERA5 reanalysis," *Atmos. Chem. Phys.*, vol. 25, no. 23, pp. 17319–17330, Dec. 2025, doi: 10.5194/acp-25-17319-2025.

[5] L. S. Jackson, C. E. Birch, G. Chagnaud, J. H. Marsham, and C. M. Taylor, "Daily rainfall variability controls humid heatwaves in the global tropics and subtropics," *Nat. Commun.*, vol. 16, no. 1, p. 3461, Apr. 2025, doi: 10.1038/s41467-025-58694-6.

[6] M. R. Fadilah and S. Rizal, "Estimasi Ketinggian Planetary Boundary Layer Berdasarkan Data Radiosonde RS92 Menggunakan Gradien Vertikal Kelembapan Udara," *KLIK: Kajian Ilmiah Informatika dan Komputer*, vol. 4, no. 2, pp. 709–717, Oct. 2023, doi: 10.30865/klik.v4i2.1203.

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DOI: https://doi.org/10.30596/jam.v12i1.30225|| Vol. 12, No. 1 June 2026

[7] S. S. Pabontongan, P. Palloan, and A. Susanto, "Analisis Hubungan Suhu, Kelembapan Dan Curah Hujan Di Tana Toraja Dengan Fenomena Perubahan Iklim," *Jurnal Fisika Unand*, vol. 13, no. 4, pp. 557–563, Jul. 2024, doi: 10.25077/jfu.13.4.557-563.2024.

[8] Apriadi and H. Suroyo, "Analisa Data Radiosonde Dengan Menggunakan Bahasa Pemrograman Phyton," *KLIK: Kajian Ilmiah Informatika dan Komputer*, vol. 4, no. 2, pp. 1002–1010, Oct. 2023, doi: 10.30865/klik.v4i2.1278.