Tikrit Journal of Engineering Sciences (2025); 32(4): 2163
DOI: http://doi.org/10.25130/tjes.32.4.12

IRAQI Academic Scientific Journals

ISSN: 1813-162X (Print); 2312-7589 (Online)
Tikrit Journal of Engineering Sciences
available online at: http://www.tj-es.com

TJES Tikrit Journal of Engineering Sciences

Assessing the Accuracy of NASA Power Meteorological Data in Iraq

Laheab A. Al-Maliki *[a], **Sohaib Kareem Al-Mamoori** [b], **Khaled El Tawil** [c], **Nadhir Al-Ansari** [d], **Fadi G. Comair** [e]

a Department of Hydraulic Structures and Water Resources, Faculty of Engineering, University of Kufa, Najaf, Iraq.
b Department of Civil Engineering, Faculty of Engineering, University of Kufa, Najaf, Iraq.
c Lebanese University, Faculty of Engineering, Beirut, Lebanon.
d Department of Civil, Environmental and Natural Resources Engineering, Lulea University of Technology, Lulea, Sweden.
e President of the UNESCO IHP Council.

Keywords:
NASA Power; Climate Variables; Statistical Analysis; Iraq Climate.

Highlights:
- The accuracy of NASA Power data in Iraq was assessed over 12 years and 10 stations.
- Correlation tested with Kendall's Tau and Mean Bias Error (MBE).
- Strong match for temperature, solar radiation, humidity; weaker for rain, wind.

ARTICLE INFO
Article history:

Received	30 Apr. 2024
Received in revised form	04 Aug. 2024
Accepted	23 Oct. 2024
Final Proofreading	25 Aug. 2025
Available online	29 Aug. 2025

Citation: Al-Maliki LA, Al-Mamoori SK, El Tawil K, Al-Ansari N, Comair FG. **Assessing the Accuracy of NASA Power Meteorological Data in Iraq**. *Tikrit Journal of Engineering Sciences* 2025; **32**(4): 2163.
http://doi.org/10.25130/tjes.32.4.12

***Corresponding author:**
Laheab A. Al-Maliki
Department of Hydraulic Structures and Water Resources, Faculty of Engineering, University of Kufa, Najaf, Iraq.

Abstract: This study assesses the precision of NASA Power meteorological data in Iraq over a 12-year period, utilizing data from 10 meteorological stations. The research focuses on key meteorological parameters, i.e., average daily temperatures, rainfall, wind speed, solar radiation, and relative humidity. Through transparent data analysis and comparison, the validity of NASA Power in local climate monitoring within Iraq is evaluated. Through statistical analysis, the correlation between NASA Power data and meteorological station data is evaluated using Kendall's Tau correlation coefficient test and Mean Bias Error (MBE). The comparison of NASA Power meteorological data with observed data from ten meteorological stations in Iraq revealed significant findings. NASA Power data displayed a high correlation (0.748-0.912) with observed temperatures, indicating accuracy in temperature assessment. The data also showed weak to strong correlations (0.105-0.526) for rainfall and weak to moderate correlations (0.105-0.427) for wind speed, suggesting potential supplementary use, albeit with the need for calibration. For solar radiation, NASA Power data exhibited a strong to very strong correlation (r = 0.636-0.834), making it suitable for solar assessments. For relative humidity, a very strong correlation (r = 0.636-0.834) was demonstrated, indicating the need for further analysis. Despite its reliability as a meteorological data source in Iraq, NASA Power data should undergo validation across various applications and regions to ensure its accuracy and dependability.

تقييم دقة بيانات الأرصاد الجوية لوكالة ناسا في العراق

لهيب عباس المالكي [١]، صهيب كريم المعموري [٢]، خالد الطويل [١]، نظير الانصاري [١]، فادي جرجيس قمير [١]

[١] قسم هندسة المنشات الهيدروليكية الموارد المائية/ كلية هندسة / جامعة الكوفة / النجف – العراق.

[٢] قسم الهندسة المدنية/ كلية هندسة / جامعة الكوفة / النجف – العراق.

[٣] كلية الهندسة /الجامعة اللبنانية / بيروت – لبنان.

[٤] قسم الهندسة المدنية والبيئية والموارد الطبيعية، جامعة لوليا للتكنولوجيا / السويد.

[٥] رئيس مجلس البرنامج الهيدرولوجي الدولي لليونسكو / الرمادي – العراق.

الخلاصة

تقيم هذه الدراسة دقة بيانات الأرصاد الجوية NASA Power في العراق على مدى ١٢ عامًا، باستخدام بيانات من ١٠ محطات أرصاد جوية. يركز البحث على المعلمات الجوية الرئيسية: متوسط درجات الحرارة اليومية، وهطول الأمطار، وسرعة الرياح، والإشعاع الشمسي، والرطوبة النسبية. من خلال تحليل البيانات ومقارنتها بشكل شفاف، يتم تقييم صحة NASA Powerفي مراقبة المناخ المحلي داخل العراق. من خلال التحليل الإحصائي، يتم تقييم الارتباط بين بيانات NASA Powerوبيانات محطة الأرصاد الجوية باستخدام اختبار معامل ارتباط كيندال تاو وخطأ التحيز المتوسط .(MBE) أظهرت مقارنة بيانات الأرصاد الجوية لـ NASA Power مع البيانات المرصودة من عشر محطات أرصاد جوية في العراق نتائج مهمة: أظهرت بيانات NASA Power ارتباطًا عاليًا (٠,٧٤٨ - ٠,٩١٢) مع درجات الحرارة المرصودة، مما يشير إلى الدقة في تقييم درجة الحرارة، بينما أظهرت ارتباطًا ضعيفًا إلى قوي (٠,١٠٥ - ٠,٥٢٦) لهطول الأمطار وارتباطًا ضعيفًا إلى متوسط (٠,١٠٥ - ٠,٤٢٧) لسرعة الرياح، مما يشير إلى الاستخدام التكميلي المحتمل مع الحاجة إلى المعايرة. بالنسبة للإشعاع الشمسي، أظهرت بيانات NASA Power ارتباطًا قويًا إلى قوي جدًا (٠,٦٣٦ - ٠,٨٣٤)، مما يجعلها مناسبة لتقييمات الطاقة الشمسية، وبالنسبة للرطوبة النسبية، فقد أظهرت ارتباطًا قويًا جدًا (٠,٦٣٦ - ٠,٨٣٤) لمزيد من التحليلات. وعلى الرغم من موثوقيتها كمصدر للبيانات الجوية في العراق، يجب أن تخضع بيانات NASA Power للتحقق عبر تطبيقات ومناطق مختلفة لضمان دقتها وموثوقيتها.

الكلمات الدالة: طاقة ناسا؛ متغيرات المناخ؛ التحليل الإحصائي؛ مناخ العراق.

1.INTRODUCTION

Meteorological data is a must-have for improving climate research, hydrology, and infrastructure planning through regular and accurate data collection. The accuracy and timeliness of parameters such as temperature, rainfall, wind speed, and relative humidity are essential, as without them, it would be impossible to understand the prevailing climatic conditions and make informed decisions. Nevertheless, getting such high-quality meteorological observations for well-separated or data-void areas remains challenging [1, 2]. As the NASA Power project has commenced only in the last few years, it has become a reliable means for displaying all weather forecasting data [3-5]. These can be an option for regions with data voids arising from limited or non-existent ground measurements [6, 7]. Through enhancing the satellite parameters and historical data, NASA Power is determined to accomplish the collection and dissemination of surface meteorology data and solar energy information [8, 9]. NASA Power data precision has already been widely presented in multiple countries, like the Sultanate of Oman [10], Portugal [6], South America [11], and Iran [12]. However, its precision in Iraq has been improperly realized. Iraq has diverse climate zones and different land surface topographies, which makes it a unique place for evaluating the performance of NASA Power data. This study intends to assess how NASA Power data matches the meteorological parameters reported from these ten stations in Iraq. The meteorological parameters being studied are the average daily temperature, rainfall, wind speed, solar radiation, and relative humidity. These parameters need to be given the highest priority in comprehending the climate dynamic system, determining the water resources capability, and planning infrastructure projects effectively [8, 14]. Hence, conducting a thorough assessment and comparing NASA Power data and weather observations will be a very suitable way to confirm the dependability and usefulness of NASA Power for monitoring the local climatic trends in Iraq. Although these assessments will be performed, the credibility of NASA Power data will be ensured, and research dealing with climate change and infrastructure planning in this region will be enhanced. The following two sections of this paper describe the data and methods utilized for the analyses, examine the findings from the comparison of the NASA Power data and meteorological stations data, and discuss the implications and limitations of our findings. Eventually, accurate weather data is irreplaceable for activities such as hydro-engineering, climate research, and infrastructure planning. On the other hand, it is very challenging to obtain accurate and reliable data. This aspect is tackled through the NASA Power website using a different solution, which comprises providing meteorological data for free. The present study aims to evaluate the accuracy of the NASA Power database for Iraq by comparing it with the mean daily temperatures, rainfall, wind speeds, solar radiation, and relative humidity obtained from ten meteorological stations.

2.METHODOLOGY

2.1.The Study Area

Iraq, located in the Middle East, serves as an intriguing study area for assessing the accuracy of meteorological data from the NASA Power database. With a geographical location between latitudes 29°N and 38°N and longitudes 38°E and 49°E (Fig. 1), Iraq experiences a diverse climate influenced by its proximity to the Arabian Desert and the Arab Gulf [15]. The country's weather patterns are characterized by hot summers with seasonal mean maximum temperature exceeding 40°C (104 °F) in some regions [16], while winters can be relatively cool, with temperatures dropping below freezing in northern areas. The annual precipitation varies across Iraq, with the western and central regions receiving less than 100 mm (3.9 inches) of rainfall, while the northeastern and mountainous areas receive higher amounts, reaching up to 500 mm (19.7 inches) annually [17, 19]. The unique climatic conditions, coupled with the varying topography, make Iraq an intriguing case study for evaluating the accuracy of NASA Power data for meteorological parameters.

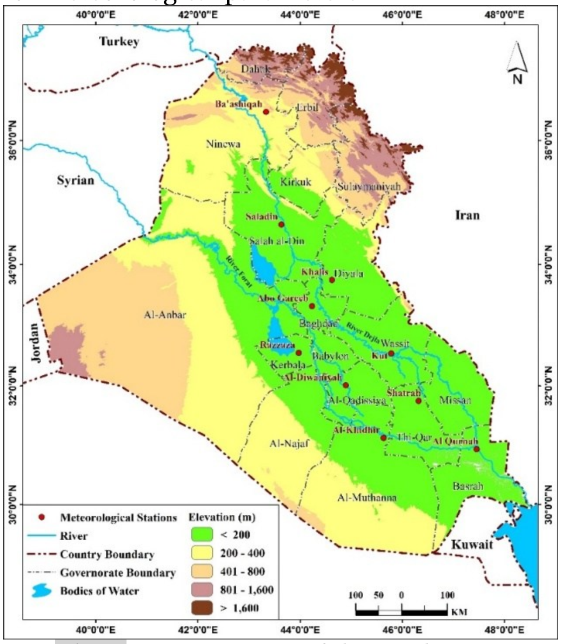


Fig. 1 Location Map of the Study Area Showing the Meteorological Stations.

2.2. Data Collection

The present study was conducted in Iraq using metrological data from ten stations to cover the study area. Table 1 shows the stations' names and locations. The data was obtained from the Iraqi Agrometeorological Center, affiliated with the Ministry of Agriculture. This center installed and has operated 42 automatic weather stations in different agricultural cities in Iraq to measure the different weather parameters. Most of these stations started working in 2011. The meteorological data for the same selected ten stations in Iraq have been collected from the NASA Power database website (https://power.larc.nasa.gov/data-access-viewer/). In 2003, the POWER project was initiated following the Surface Meteorology and Solar Energy initiatives. The original POWER project encompassed the SSE element. It introduced two fresh sets of data relevant to architecture and agriculture, aiming to consistently enhance and broaden the scope of parameters highlighted in every segment of POWER [20].

Table 1 The Selected Metrological Stations.

Station	Latitude	Longitude	Elevation above sea level (meters)
Abo Gareeb	33.32	44.23	38.44
Al-Khidhir	31.13	45.63	29.83
Al-Diwaniyah	32.01	44.89	20.61
Razzaza	32.55	43.97	69.12
Shatrah	31.45°	46.19°	7.64
Al Qurnah	30.94	47.45	4.48
Kut	32.54	45.78	18.23
Ba'ashiqah	36.45	43.33	343
Saladin	34.65	43.63	107.89
Khalis	33.75	44.62	53.84

The collected average daily data from the NASA Power database will be compared with the average daily data obtained directly from the meteorological stations for each parameter, namely temperature, rainfall, wind speed, solar radiation, and relative humidity.

2.3. Correlation Coefficient

The data was initially organized to align within the same location and time frame. Subsequently, utilizing SPSS software, an analysis was conducted to identify the suitable test for assessing the correlation between the observed data and the NASA power data. The Kendall's Tau correlation coefficient test was chosen because the data were not normally distributed [21, 22]. The correlation coefficient values are interpreted according to Table 2.

Table 2 Correlation Value Between Two Variables [3].

Meaning of correlation value	Correlation Coefficient r
No Correlation	0
Very Weak Correlation	0-0.25
Moderate Correlation	0.25-0.5
Strong Correlation	0.5-0.75
Very Strong Correlation	0.75-0.99
Perfect Correlation	0.99-1

The significance level (Sig. 2-tailed) along with the correlation coefficient reflects the probability of obtaining the observed correlation. If there were no true relationships in the population, they would typically be considered significant if below a chosen threshold, like 0.05. Lastly, N represents the sample size used in calculating the correlation, denoting the number of paired observations included in the analysis, where a larger N generally enhances the reliability of the correlation estimate.

2.4. Mean Bias Error (MBE)

In meteorological and forecasting research, the Mean Bias Error (MBE) is used to assess the effectiveness and accuracy of the models in providing predictions. MBE measures the average of the sum of the differences between the forecasted value and the observed data within a specific period. If the MBE is negative, then it means that the forecasts are underestimated. If it is positive, then it means that forecasts are overestimated. The magnitude and direction of the bias estimated by MBE are crucial to optimizing the prognosis models, increasing the accuracy of the forecasts, and promoting the decision-making processes based on meteorological data. When MBE analysis is incorporated into methodologies used by meteorologists and scientists, biases can be pinpointed and corrected, thereby improving the accuracy and reliability of weather forecasting and climate modeling. To calculate the MBE, the following formula is used:

$$\mathbf{MBE = \Sigma(Observed - Forecast) / n} \quad (1)$$

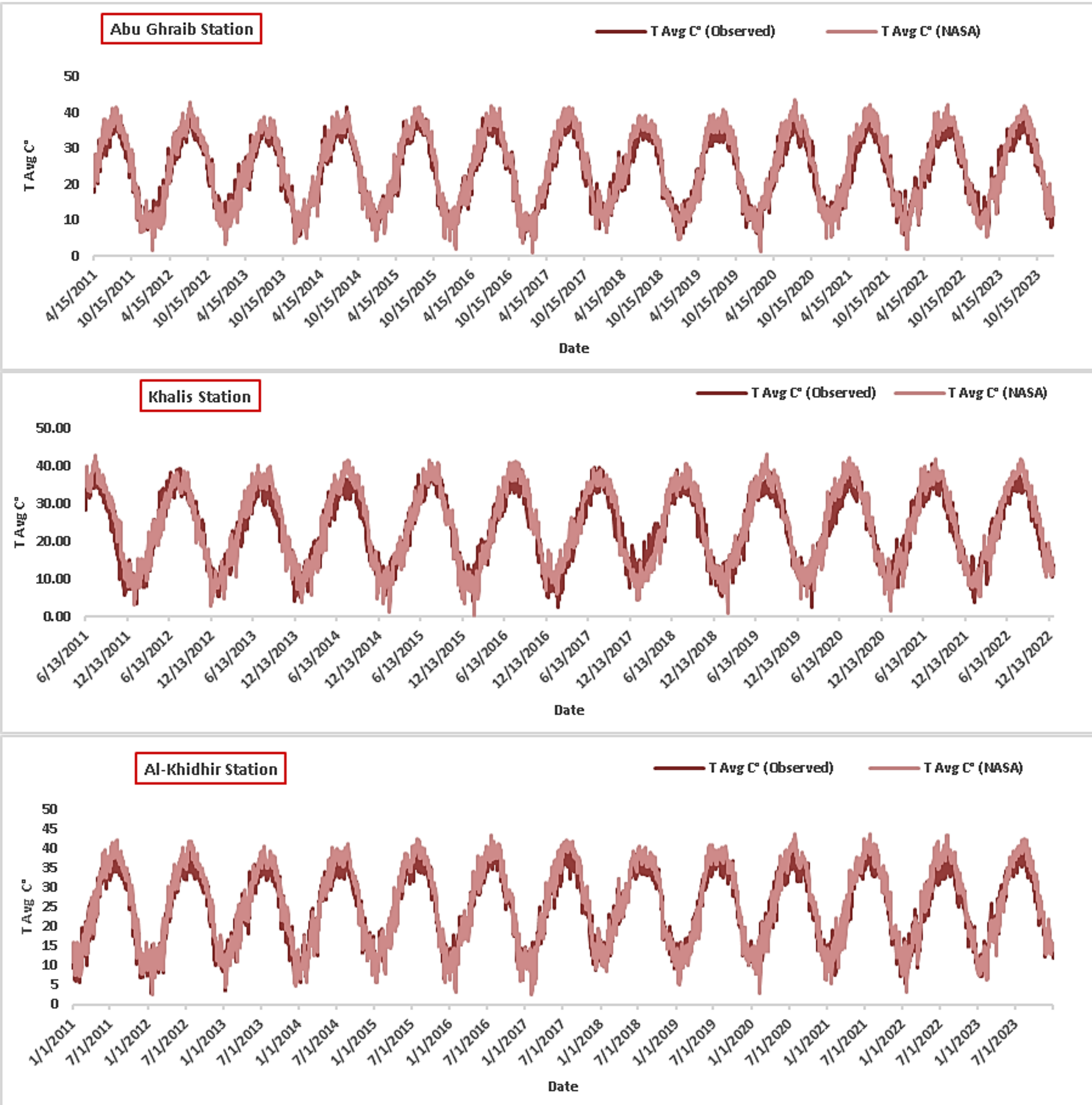
where Σ denotes the sum of the values, Observed is the actual observed value, Forecast is the predicted or forecasted value, and n is the total number of observations. If the value of MBE is negative, this means that, on average, the forecasted values are below the observed ones. In other words, the forecasts are generally below the observed actual values, and the positive values mean that the model overestimated the actual values.

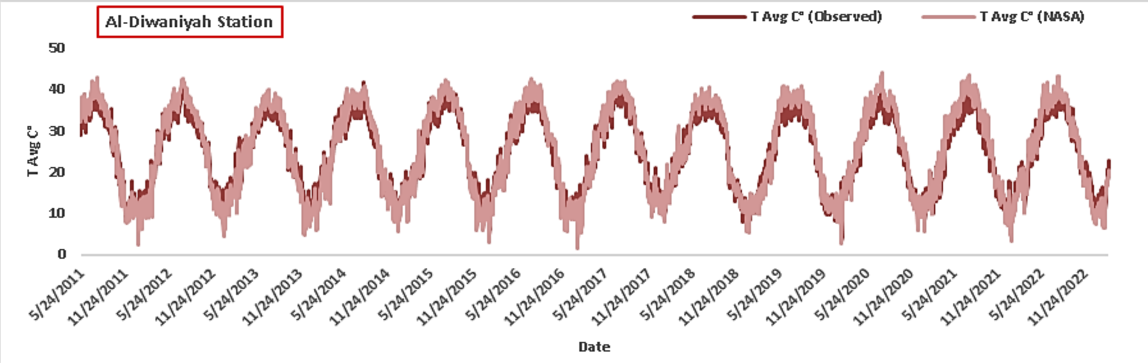
3.RESULTS AND DISCUSSION

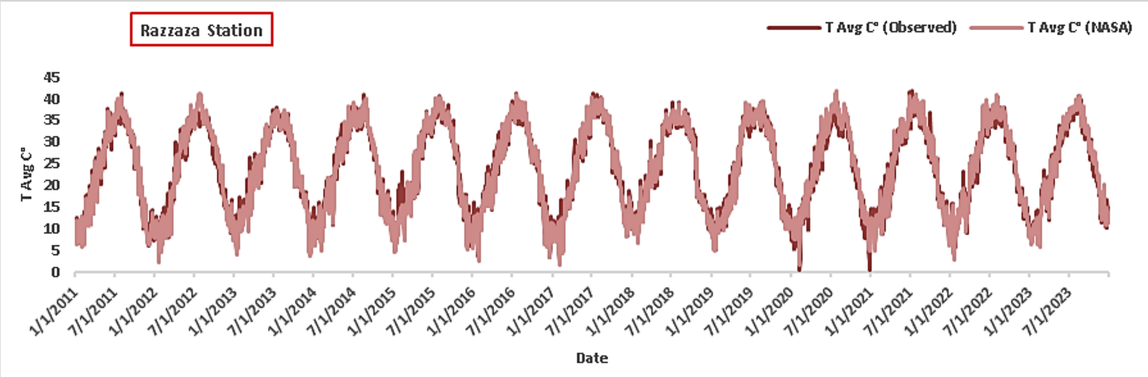
The present study used 11 years of data collected from ten meteorological stations in Iraq from 2011 to 2022 to analyze Average temperature, Rainfall, Wind Speed, Solar radiation, and Relative Humidity. The observed data were then compared to the data obtained from NASA Power for the respective locations during the same periods. Figure 1 compares the average temperature at each station, and the variation between the two data resources can be observed.

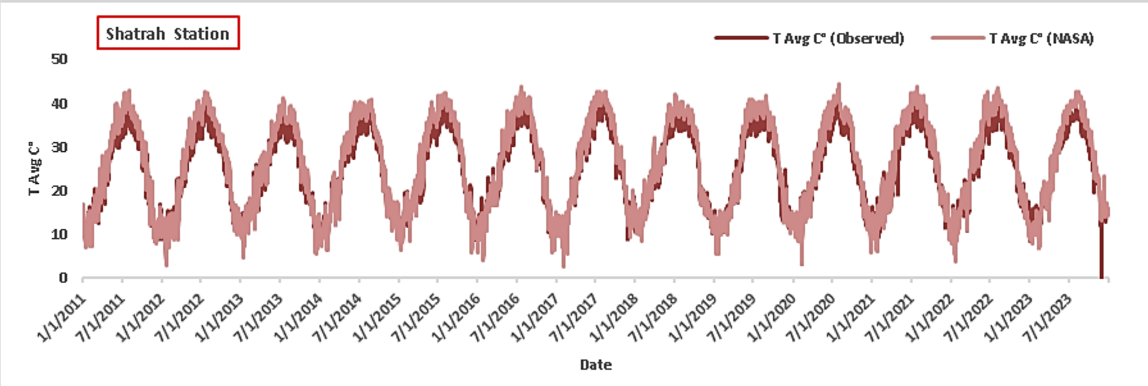
3.1.Temperature

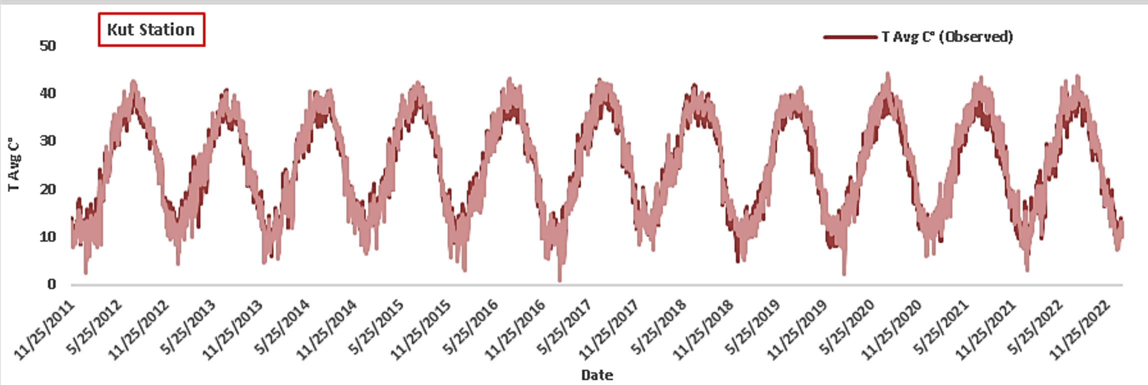
Figure 2 compares the temperature at each station.

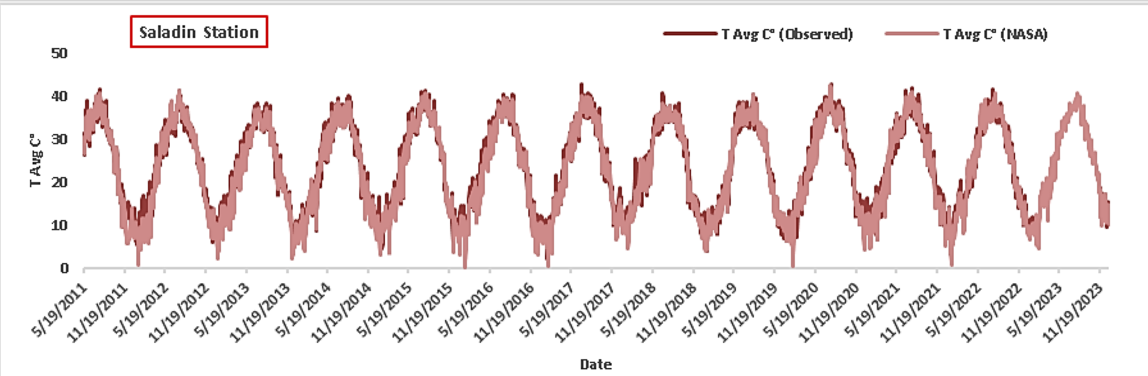



Al-Diwaniyah Station
T Avg C° (Observed)
T Avg C° (NASA)
T Avg C°
Date


Razzaza Station
T Avg C° (Observed)
T Avg C° (NASA)
T Avg C°
Date


Shatrah Station
T Avg C° (Observed)
T Avg C° (NASA)
T Avg C°
Date


Kut Station
T Avg C° (Observed)
T Avg C°
Date


Saladin Station
T Avg C° (Observed)
T Avg C° (NASA)
T Avg C°
Date

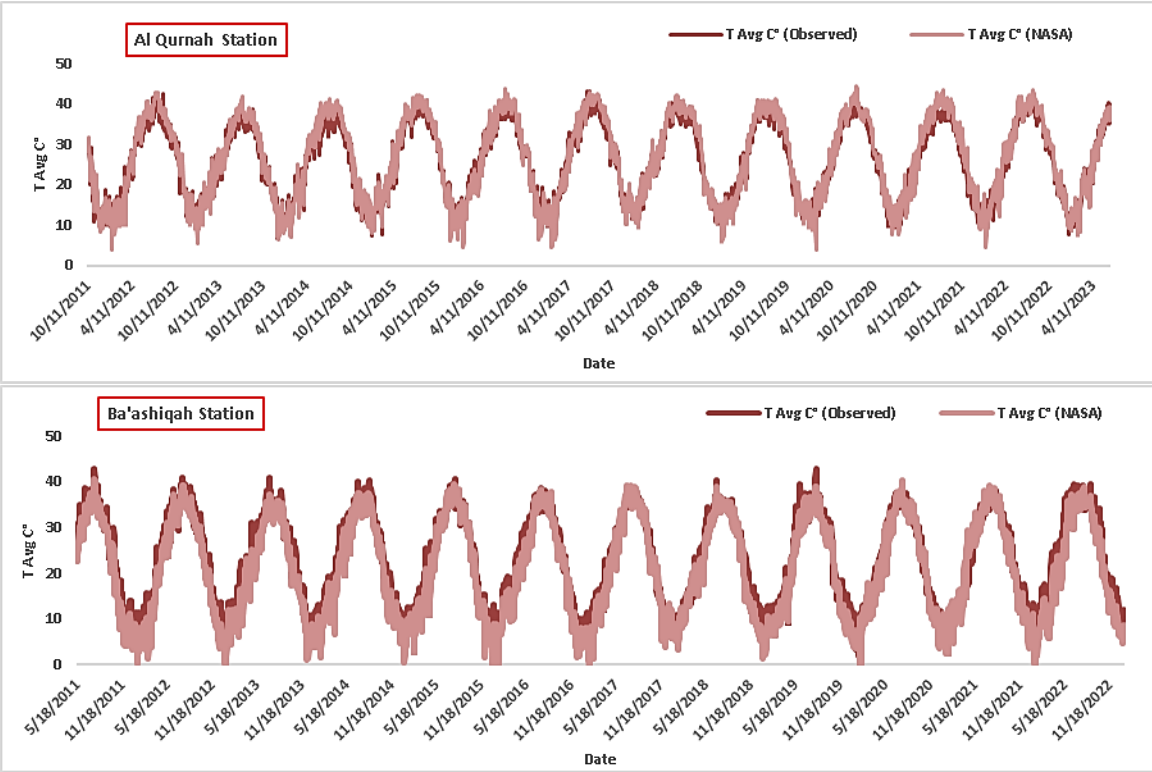
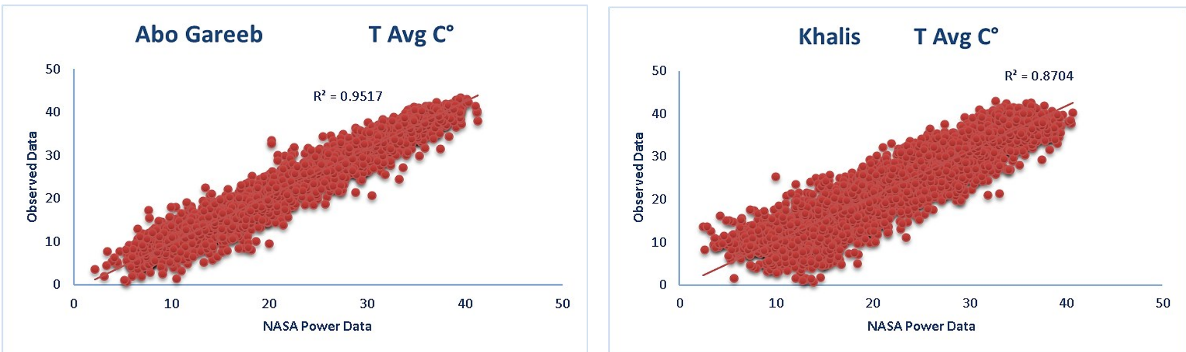


Fig. 2 Average Daily Temperature Compression for the Ten Stations.

The Correlation Coefficients for the average temperature are computed and listed in Table 3. The results showed that the correlation between the observed and the NASA Power data was very strong and ranged between 0.748 and 0.912. Moreover, the MBE ranged between 1.6660 and 0.0873, which means that the forecasting model exhibits varying degrees of bias, both in overestimating and underestimating the daily average temperatures. The scatter plots for the observed and the NASA Power data are presented in Fig. 3. The figure shows the linear relationship between the observed and NASA Power average daily temperature data. The correlation is very strong, with Correlation Coefficient values above 0.75 for all stations.

Table 3 Average Temperature Correlation Coefficients.

	Station									
	Abo Gareeb	Khalis	Al-Khidhir	Al-Diwaniyah	Razzaza	Shatrah	Kut	Saladin	Al Qurnah	Ba'ashiqah
Correlation Coefficient	0.853	0.748	0.860	0.858	0.892	0.912	0.859	0.879	0.869	0.871
Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
N	4644	4220	4748	4303	4748	4722	4081	4329	4277	4263
MBE	-1.0157	-.9138	-1.1827	-.7608	-.0873	-1.4059	-.4033	.5904	-.6972	1.6660



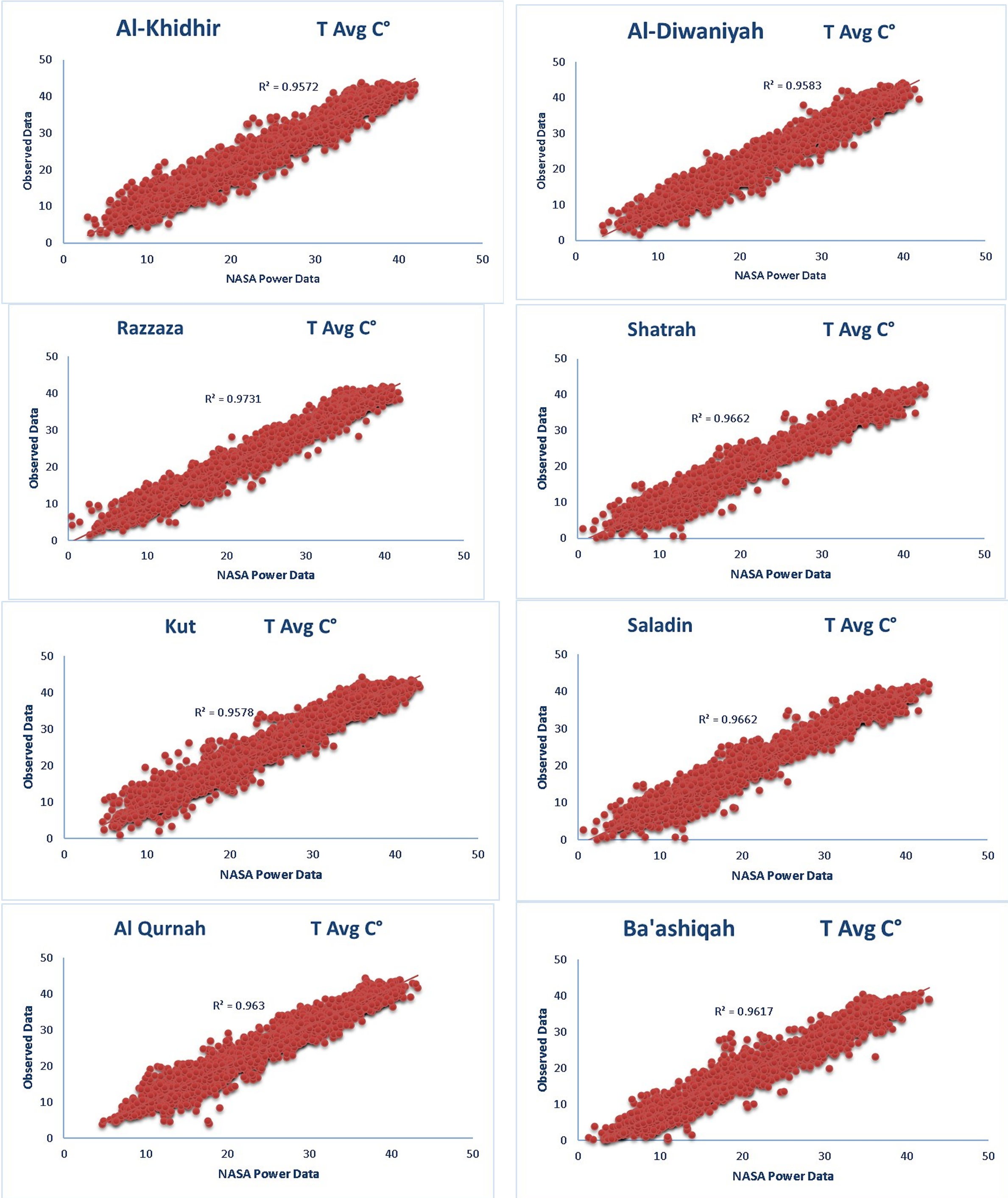
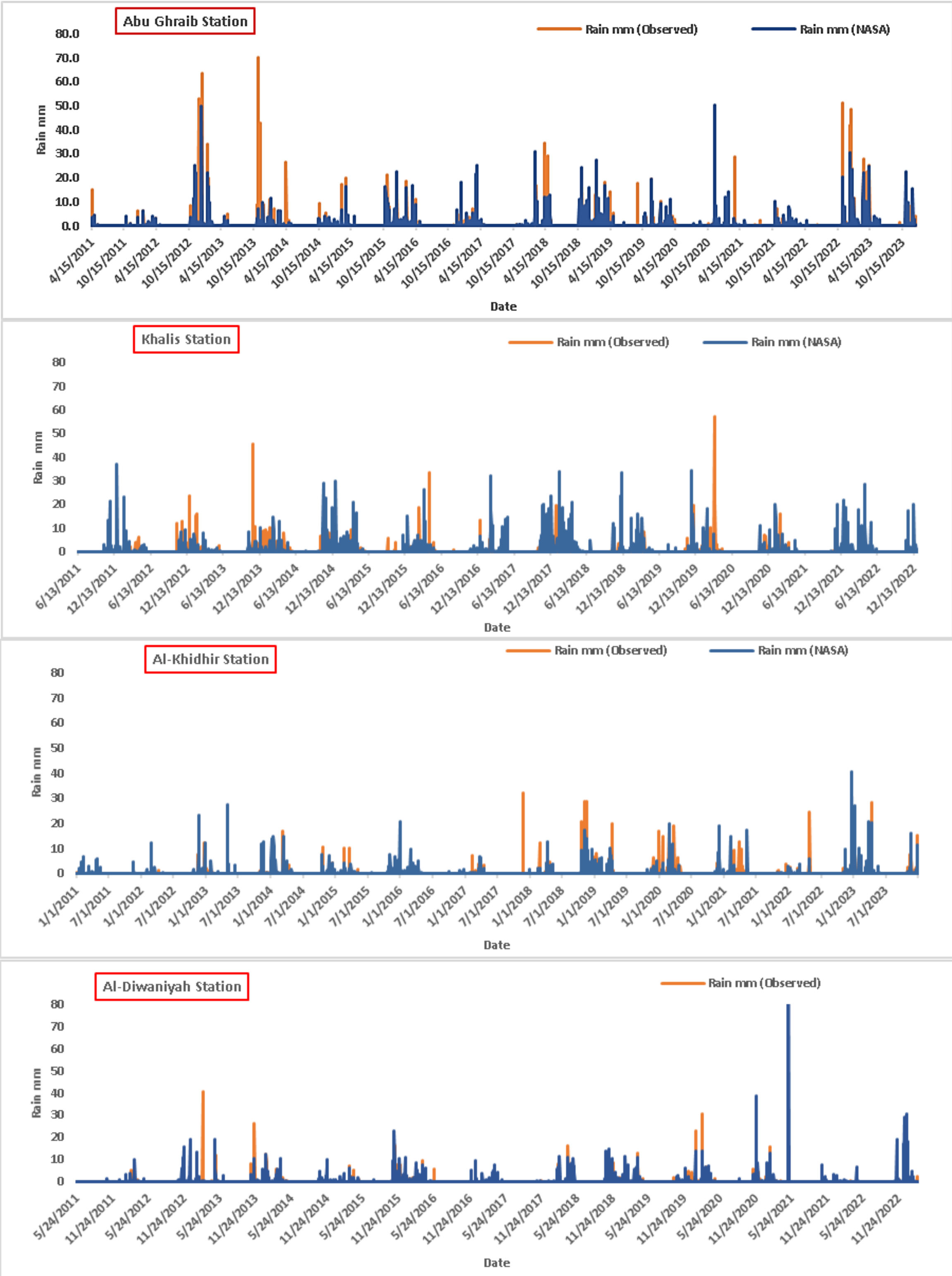
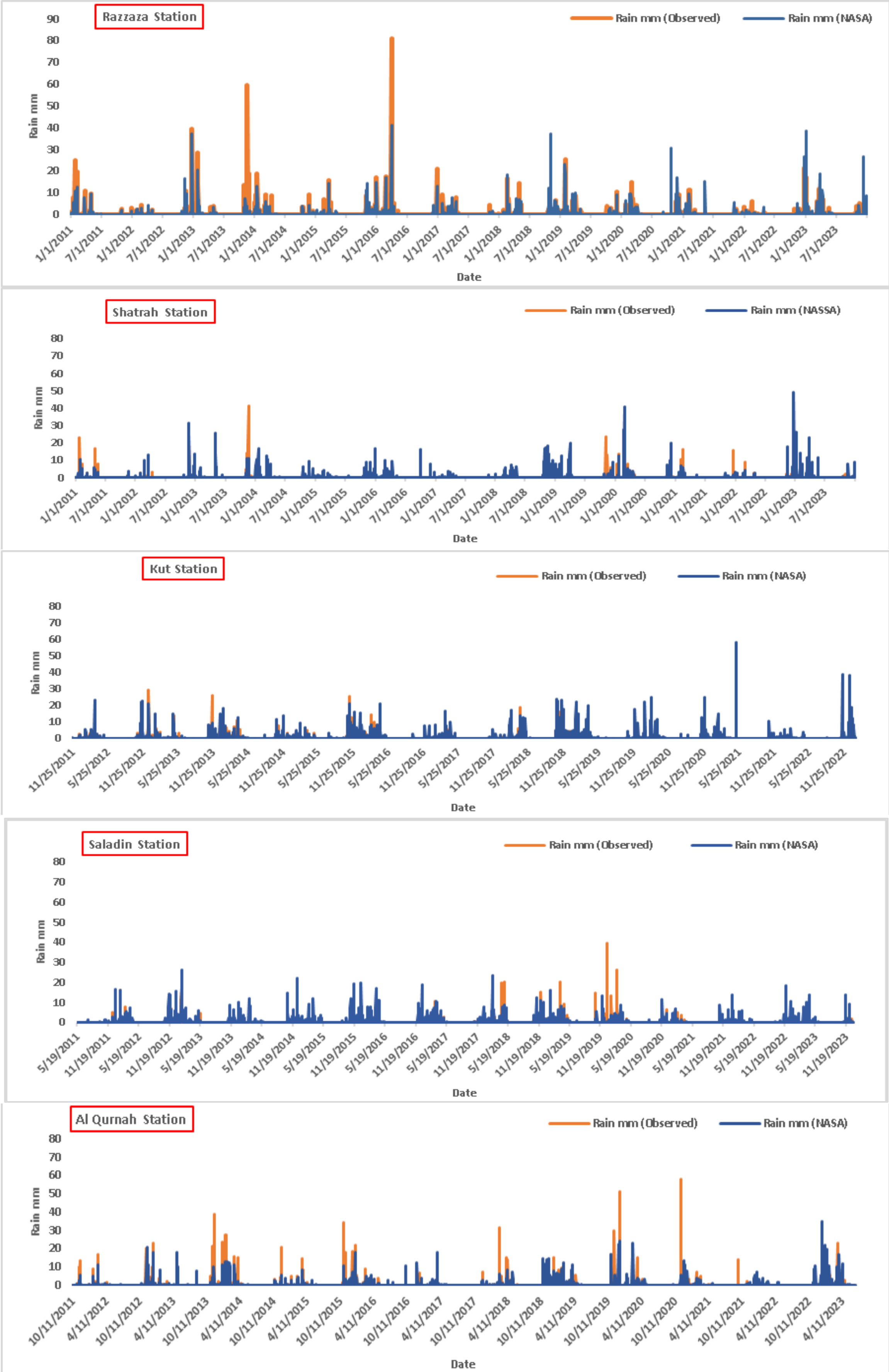


Fig. 3 Average Daily Temperature Scatter Plots for the Ten Stations

3.1. Rainfall

Figure 4 compares the rainfall at each station. The variety of the two data resources can be observed. The Correlation Coefficients for the Rainfall are listed in Table 4. The results showed that the correlation between the observed and the NASA Power data was very weak to moderate and ranged between 0.105 and 0.526. These results are similar to those of Tan et al. [23]. Furthermore, the MBE values suggested an overall tendency towards underestimation in the forecasts. This pattern may indicate a consistent bias in the model towards predicting lower temperatures. At the same time, the MBE values were very close to zero, i.e., 0.0285 and -0.0346, indicating that, on average, the forecasts aligned closely with the observed values. Figure 5 presents the rain scatter plot. The data points are scattered around the trend line, indicating a poor correlation between the observed and the actual data, likely due to the presence of substantial variability or noise within the dataset. This behavior suggests that the relationship between the variables being examined is not strong or consistent, leading to a lower correlation coefficient. The scattered nature of the data points implies that the observed values do not closely follow the trend suggested by the model or the actual data, highlighting the lack of a clear and robust association between the analyzed variables.




Razzaza Station
Rain mm (Observed)
Rain mm (NASA)
Rain mm
Date
Shatrah Station
Rain mm (Observed)
Rain mm (NASSA)
Rain mm
Date
Kut Station
Rain mm (Observed)
Rain mm (NASA)
Rain mm
Date
Saladin Station
Rain mm (Observed)
Rain mm (NASA)
Rain mm
Date
Al Qurnah Station
Rain mm (Observed)
Rain mm (NASA)
Rain mm
Date

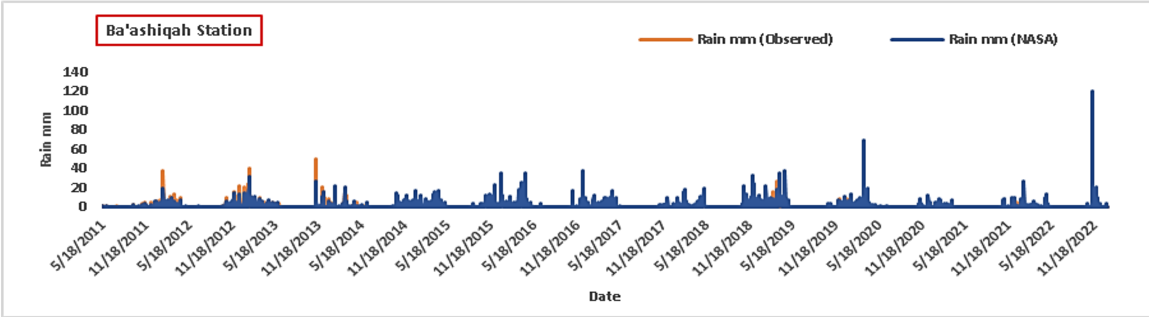
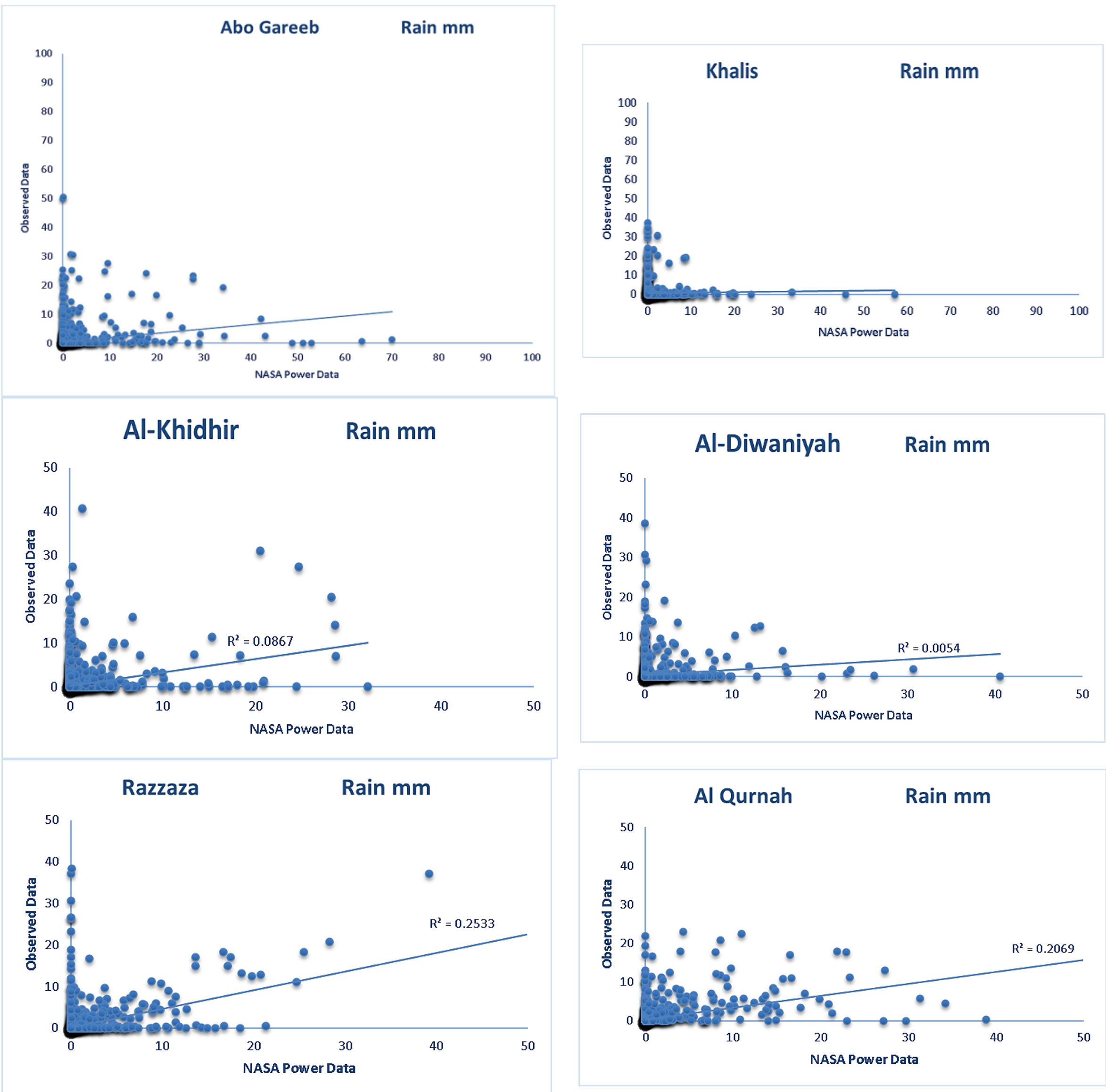


Fig. 4 Average Daily Rainfall Compression for the Ten Stations.

Table 4 Rainfall Correlation Coefficients.

	Station									
	Abo Gareeb	**Khalis**	**Al-Khidhir**	**Al-Diwaniyah**	**Razzaza**	**Shatrah**	**Kut**	**Saladin**	**Al Qurnah**	**Ba'ashiqah**
Correlation Coefficient	0.384	0.105	0.344	0.301	0.426	0.474	0.406	0.342	0.526	0.505
Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
N	4463	3475	4245	3806	4540	2402	3981	3825	3683	2063
MBE	-.0272	-0.3655	-.0533	-.1342	-.0346	-.0140	-.3789	-.2537	.0285	-.2526



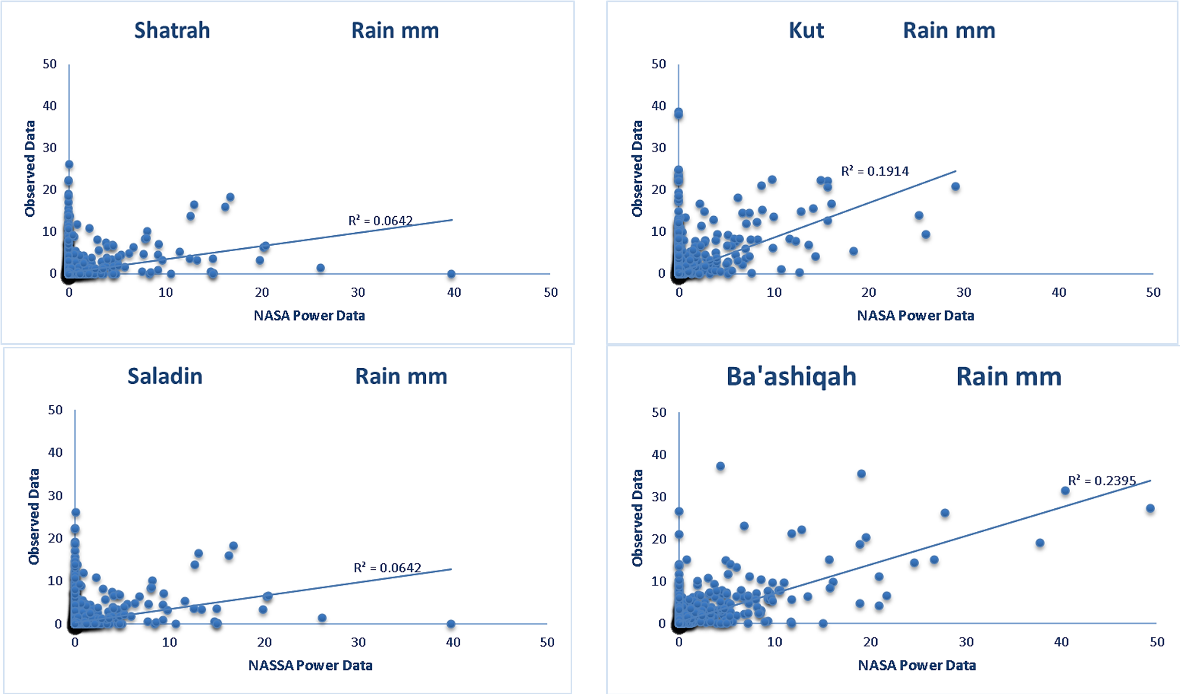
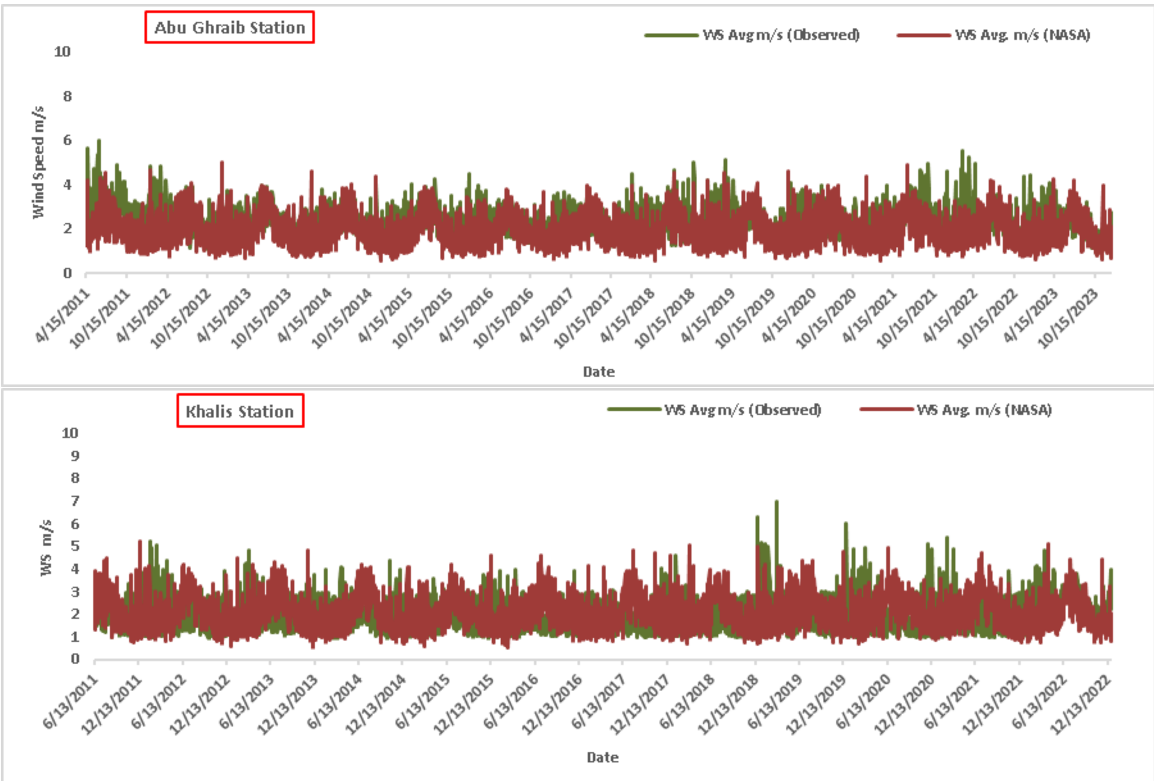
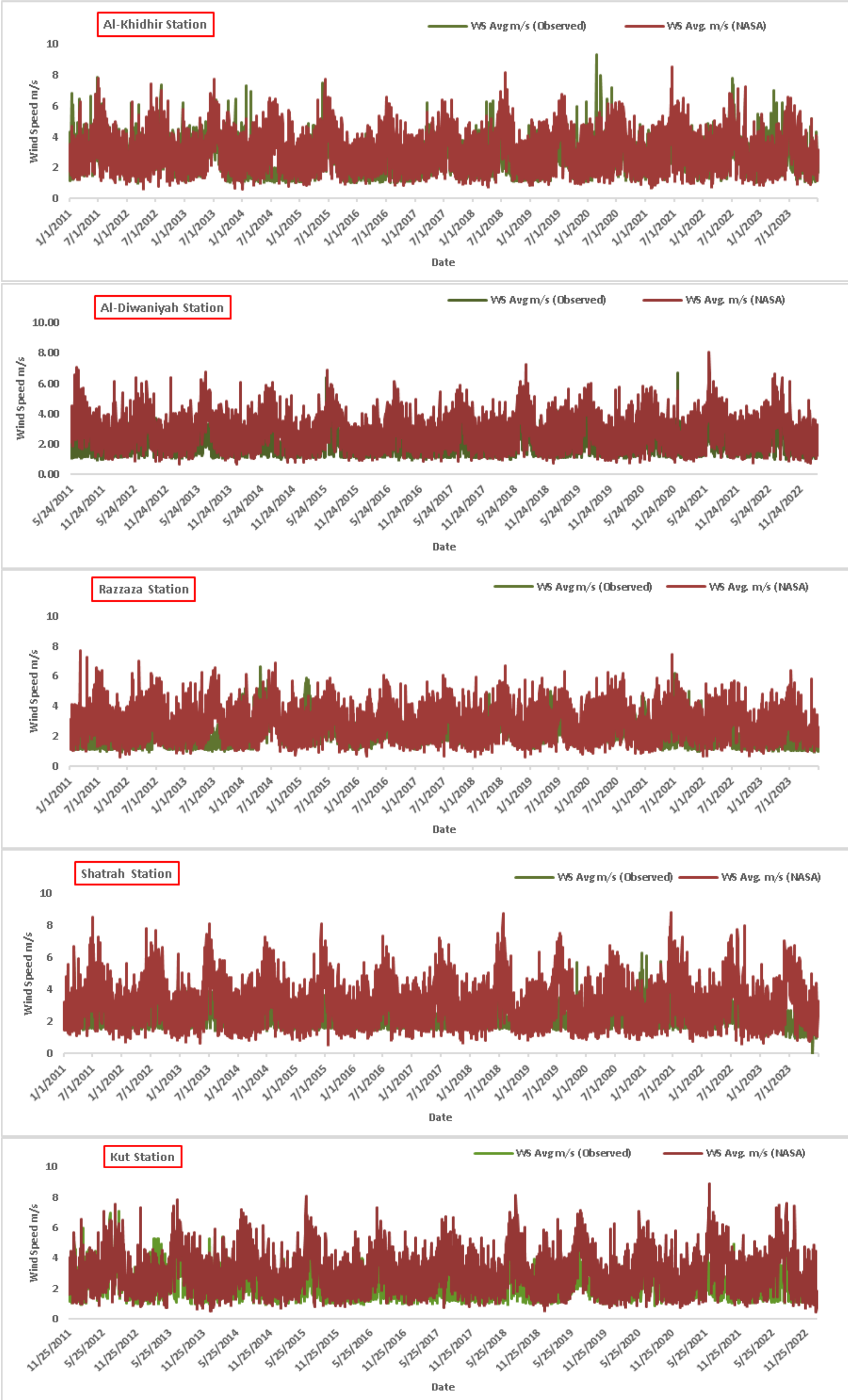


Fig. 5 Average Daily Rain Scatter Plots for the Ten Stations.

3.3. Wind Speed

Figure 6 compares the wind speed at each station, and the variation between the two data resources can be observed. The Correlation Coefficients for the wind speed are listed in Table 5. The results showed that the correlation between the observed and the NASA Power data was a very weak to moderate correlation and ranged between 0.105 and 0.427. These results agree with the results presented by Marzouk [10]. The consistent negative sign across all MBE values indicated a systematic error in the forecasting model. This consistency can help identify and address the underlying reasons for the bias. A negative bias generally suggests room for improvement in the forecasting model to better align with observed values. The magnitude of the bias is crucial. Smaller biases closer to zero, like -0.0154 and 0.3416, may indicate relatively more accurate forecasts than larger biases. Figure 7 shows the wind speed scatter plots. The correlation looks intermediate.




Al-Khidhir Station
WS Avg m/s (Observed)
WS Avg. m/s (NASA)
Wind Speed m/s
0
2
4
6
8
10
1/1/2011 7/1/2011 1/1/2012 7/1/2012 1/1/2013 7/1/2013 1/1/2014 7/1/2014 1/1/2015 7/1/2015 1/1/2016 7/1/2016 1/1/2017 7/1/2017 1/1/2018 7/1/2018 1/1/2019 7/1/2019 1/1/2020 7/1/2020 1/1/2021 7/1/2021 1/1/2022 7/1/2022 1/1/2023 7/1/2023
Date
Al-Diwaniyah Station
WS Avg m/s (Observed)
WS Avg. m/s (NASA)
Wind Speed m/s
0.00
2.00
4.00
6.00
8.00
10.00
5/24/2011 11/24/2011 5/24/2012 11/24/2012 5/24/2013 11/24/2013 5/24/2014 11/24/2014 5/24/2015 11/24/2015 5/24/2016 11/24/2016 5/24/2017 11/24/2017 5/24/2018 11/24/2018 5/24/2019 11/24/2019 5/24/2020 11/24/2020 5/24/2021 11/24/2021 5/24/2022 11/24/2022
Date
Razzaza Station
WS Avg m/s (Observed)
WS Avg. m/s (NASA)
Wind Speed m/s
0
2
4
6
8
10
1/1/2011 7/1/2011 1/1/2012 7/1/2012 1/1/2013 7/1/2013 1/1/2014 7/1/2014 1/1/2015 7/1/2015 1/1/2016 7/1/2016 1/1/2017 7/1/2017 1/1/2018 7/1/2018 1/1/2019 7/1/2019 1/1/2020 7/1/2020 1/1/2021 7/1/2021 1/1/2022 7/1/2022 1/1/2023 7/1/2023
Date
Shatrah Station
WS Avg m/s (Observed)
WS Avg. m/s (NASA)
Wind Speed m/s
0
2
4
6
8
10
1/1/2011 7/1/2011 1/1/2012 7/1/2012 1/1/2013 7/1/2013 1/1/2014 7/1/2014 1/1/2015 7/1/2015 1/1/2016 7/1/2016 1/1/2017 7/1/2017 1/1/2018 7/1/2018 1/1/2019 7/1/2019 1/1/2020 7/1/2020 1/1/2021 7/1/2021 1/1/2022 7/1/2022 1/1/2023 7/1/2023
Date
Kut Station
WS Avg m/s (Observed)
WS Avg. m/s (NASA)
Wind Speed m/s
0
2
4
6
8
10
11/25/2011 5/25/2012 11/25/2012 5/25/2013 11/25/2013 5/25/2014 11/25/2014 5/25/2015 11/25/2015 5/25/2016 11/25/2016 5/25/2017 11/25/2017 5/25/2018 11/25/2018 5/25/2019 11/25/2019 5/25/2020 11/25/2020 5/25/2021 11/25/2021 5/25/2022 11/25/2022
Date

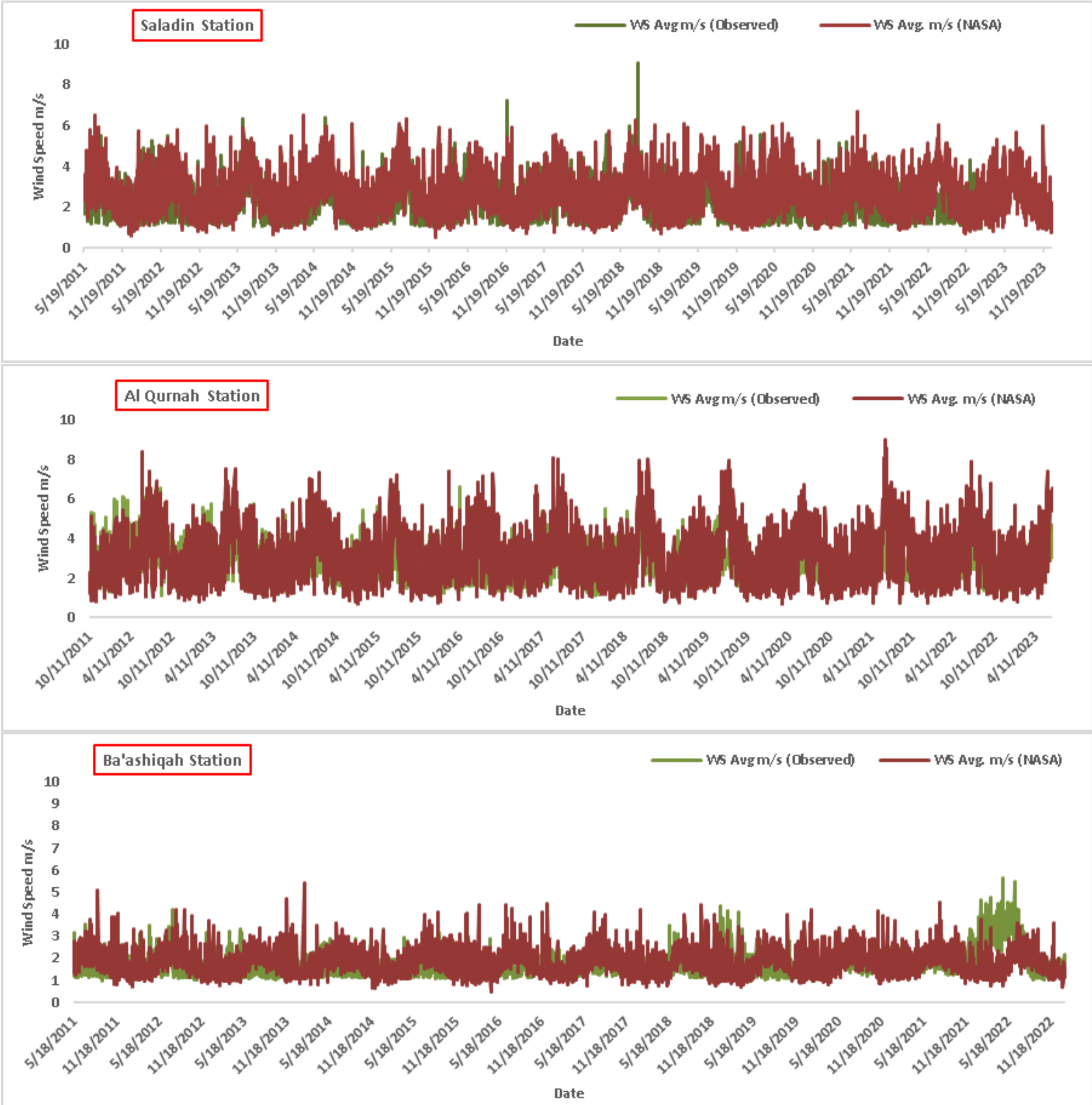
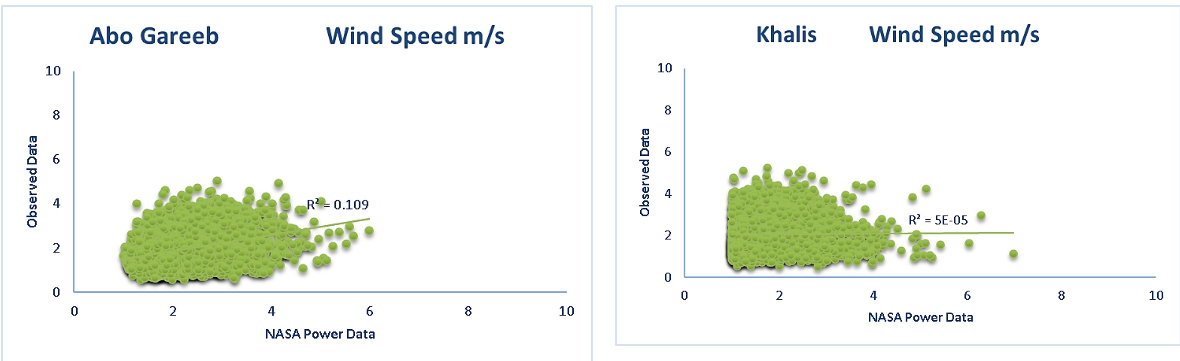


Fig. 6 Average Daily Wind Speed Compression for the Ten Stations.

Table 5 Wind Speed Correlation Coefficients.

	Station									
	Abo Gareeb	Khalis	Al-Khidhir	Al-Diwaniyah	Razzaza	Shatrah	Kut	Saladin	Al Qurnah	Ba'ashiqah
Correlation Coefficient	0.226	0.029	0.251	0.259	0.131	0.273	0.386	0.376	0.427	0.105
Sig. (2-tailed)	0.000	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
N	4644	4220	4748	4302	4748	4722	4081	4329	4277	4263
MBE	.3416	-.1984	-.3713	-.8862	-.7996	-.9179	-.8649	-.3722	-.4841	-.0154



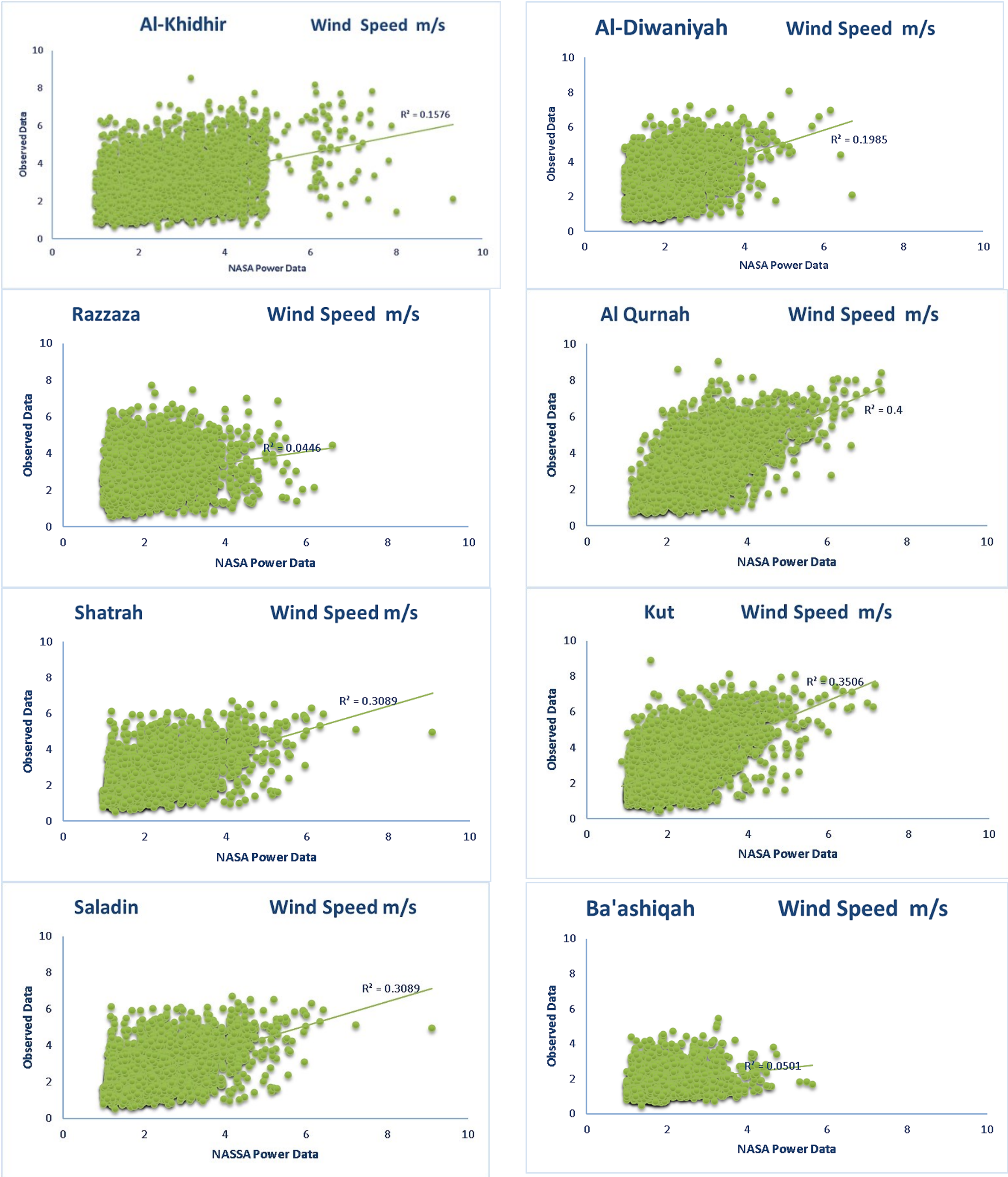
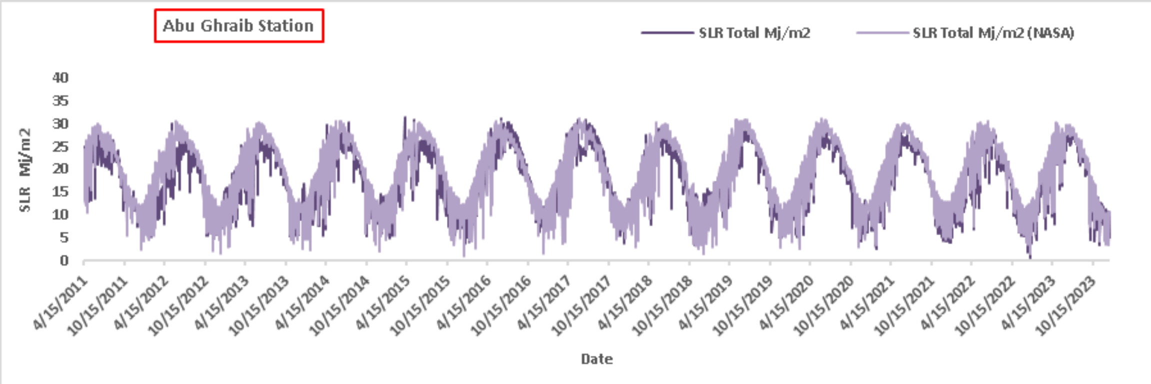
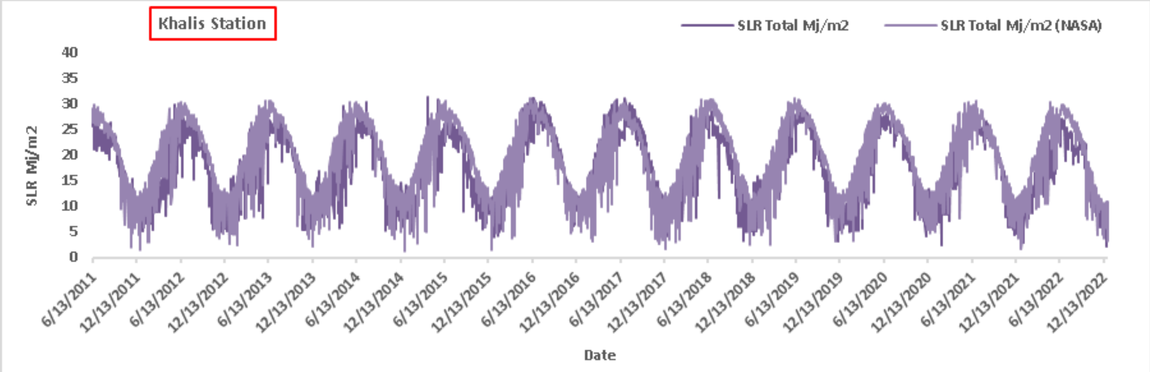


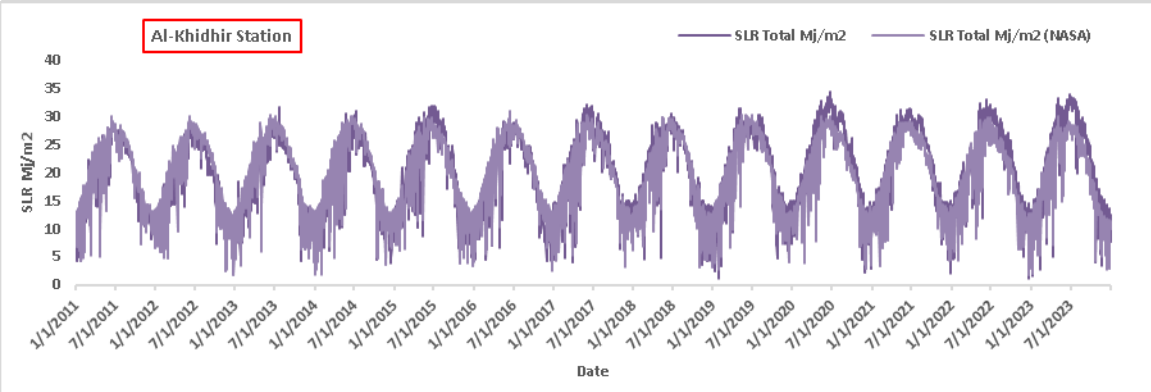
Fig. 7 Average Daily Wind Speed Scatter Plots for the Ten Stations.

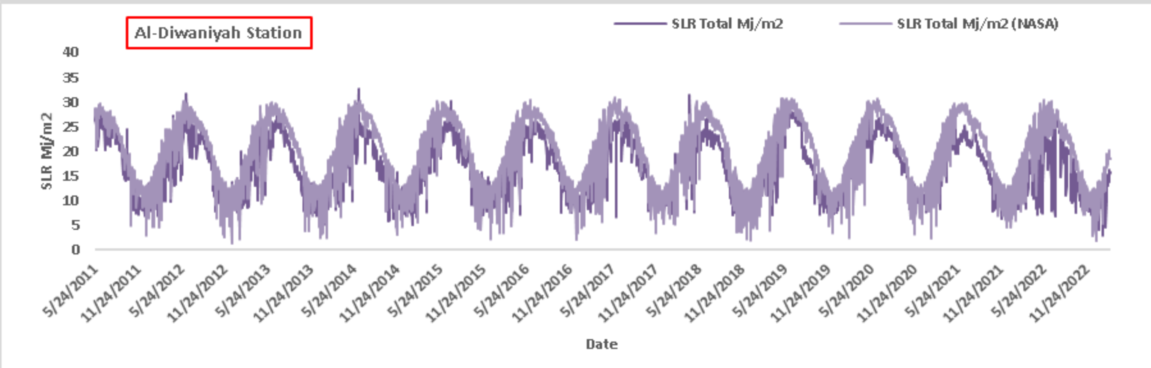
3.4.Daily Solar Radiation

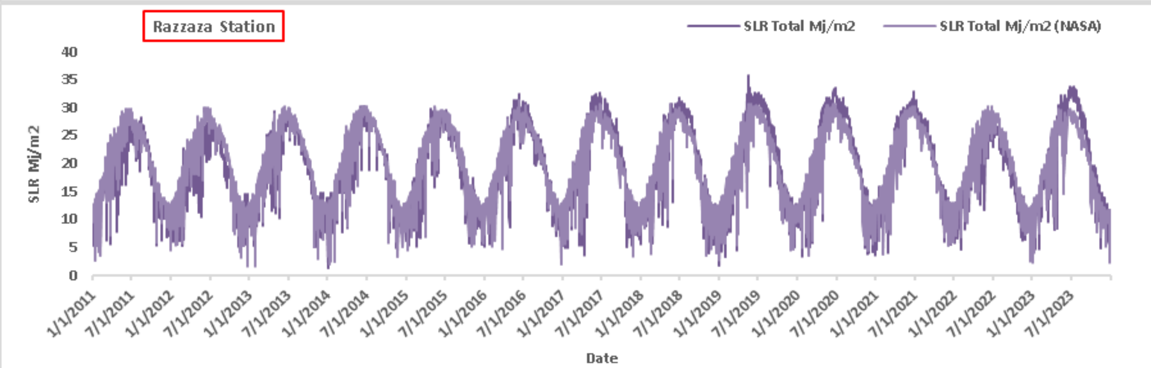
Figure 8 compares the average daily solar radiation at each station. The variety of the two data resources can be observed. The Correlation Coefficients for the wind speed are listed in Table 6. The results showed that the correlation between the observed and the NASA Power data was strong to very strong and ranged between 0.636 and 0.834. The MBE varied significantly, ranging from -3.8462 to 0.4071. Larger absolute values, such as -3.8462 and -2.7338, indicate a substantial underestimation bias. While values closer to zero, like 0.1267 and 0.4071, suggest a smaller bias. Simultaneously, the consistently negative MBE values indicate a notable underestimation bias in the Solar Radiation forecasts. Figure 9 shows the solar radiation scatter plot, indicating a good correlation between the observed and the NASA Power data.


Abu Ghraib Station
SLR Total Mj/m2
SLR Total Mj/m2 (NASA)
SLR Mj/m2
Date


Khalis Station
SLR Total Mj/m2
SLR Total Mj/m2 (NASA)
SLR Mj/m2
Date


Al-Khidhir Station
SLR Total Mj/m2
SLR Total Mj/m2 (NASA)
SLR Mj/m2
Date


Al-Diwaniyah Station
SLR Total Mj/m2
SLR Total Mj/m2 (NASA)
SLR Mj/m2
Date


Razzaza Station
SLR Total Mj/m2
SLR Total Mj/m2 (NASA)
SLR Mj/m2
Date

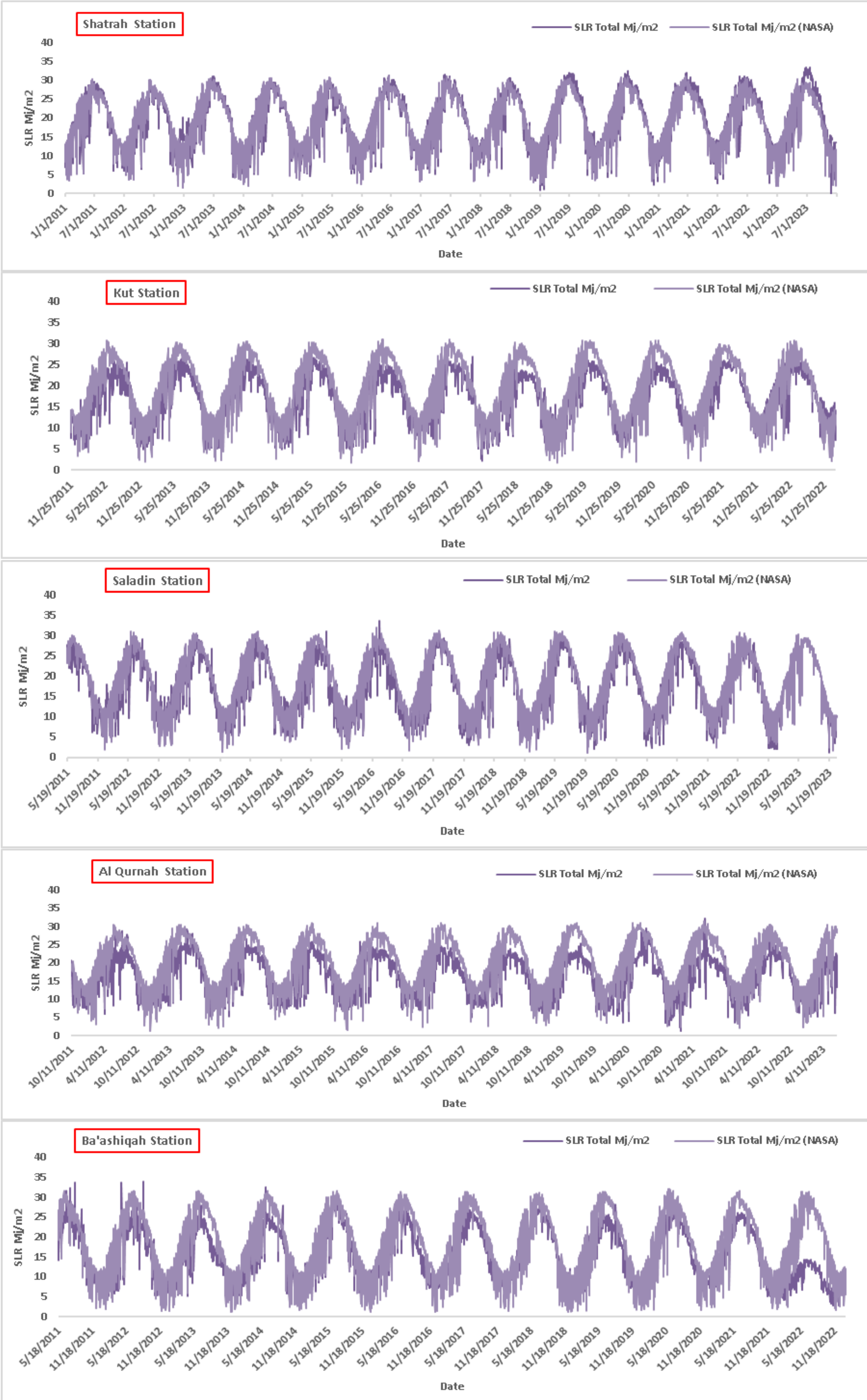


Fig. 8 Average Daily Solar Radiation Compression for the Ten Stations.

Table 6 Solar Radiation Correlation Coefficients.

	Station									
	Abo Gareeb	Khalis	Al-Khidhir	Al-Diwaniyah	Razzaza	Shatrah	Kut	Saladin	Al Qurnah	Ba'ashiqah
Correlation Coefficient	0.695	0.636	0.699	0.689	0.769	0.834	0.758	0.778	0.765	0.681
Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
N	4644	4220	4748	4303	4748	4722	4081	4329	4276	4263
MBE	-1.4724	-1.5599	.4071	-2.7338	-.2941	.1267	-2.4391	-1.4413	-3.8462	-.2526

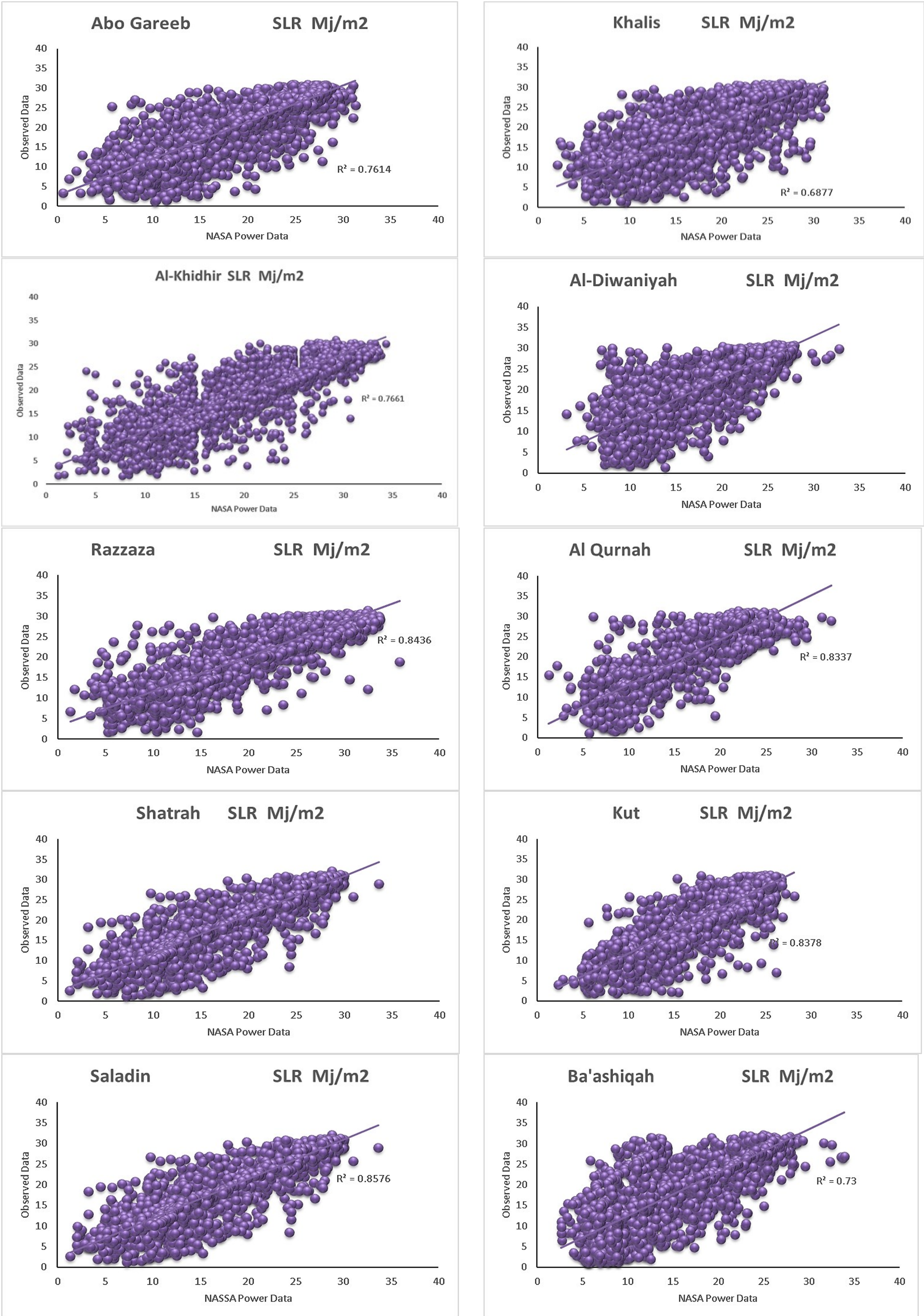
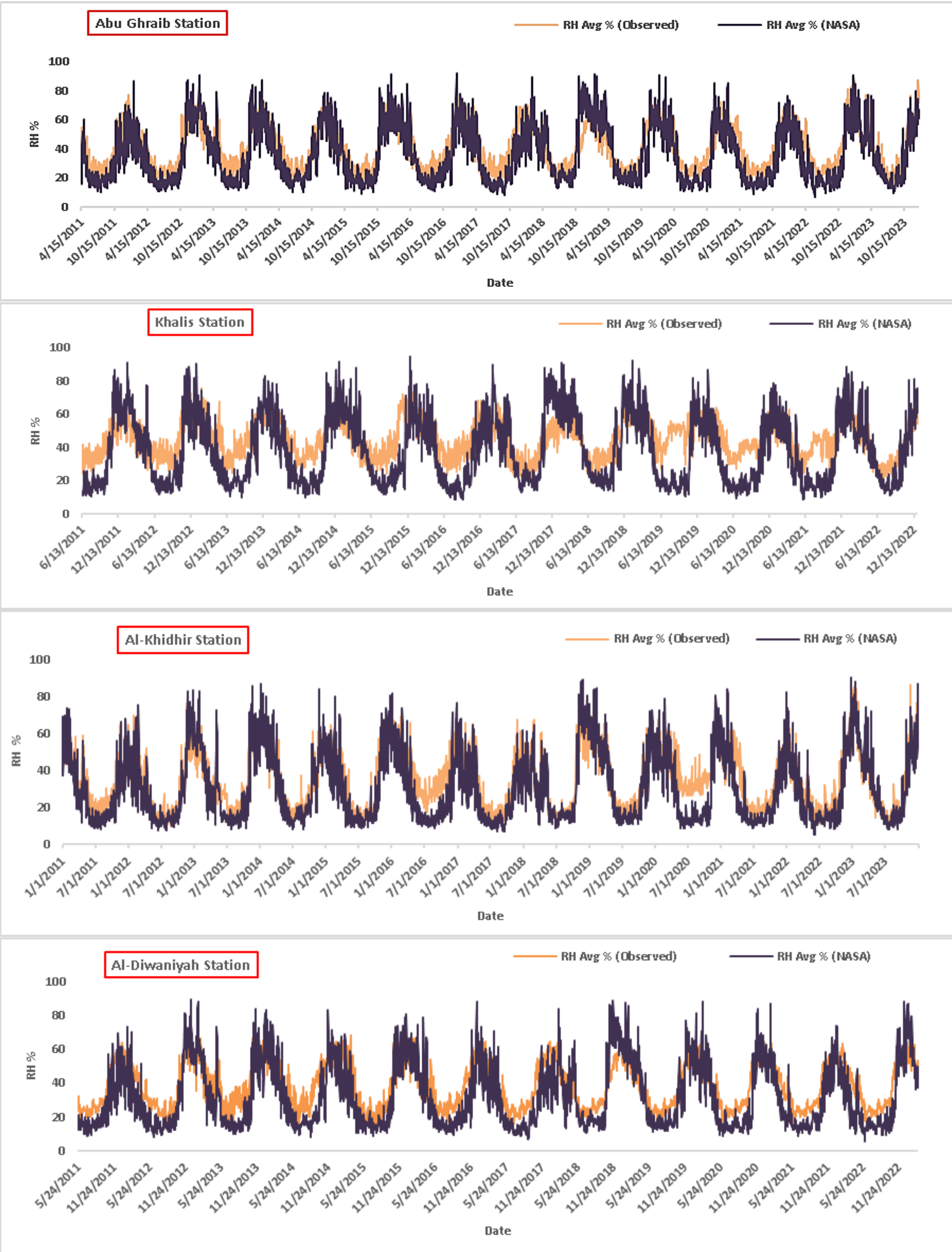
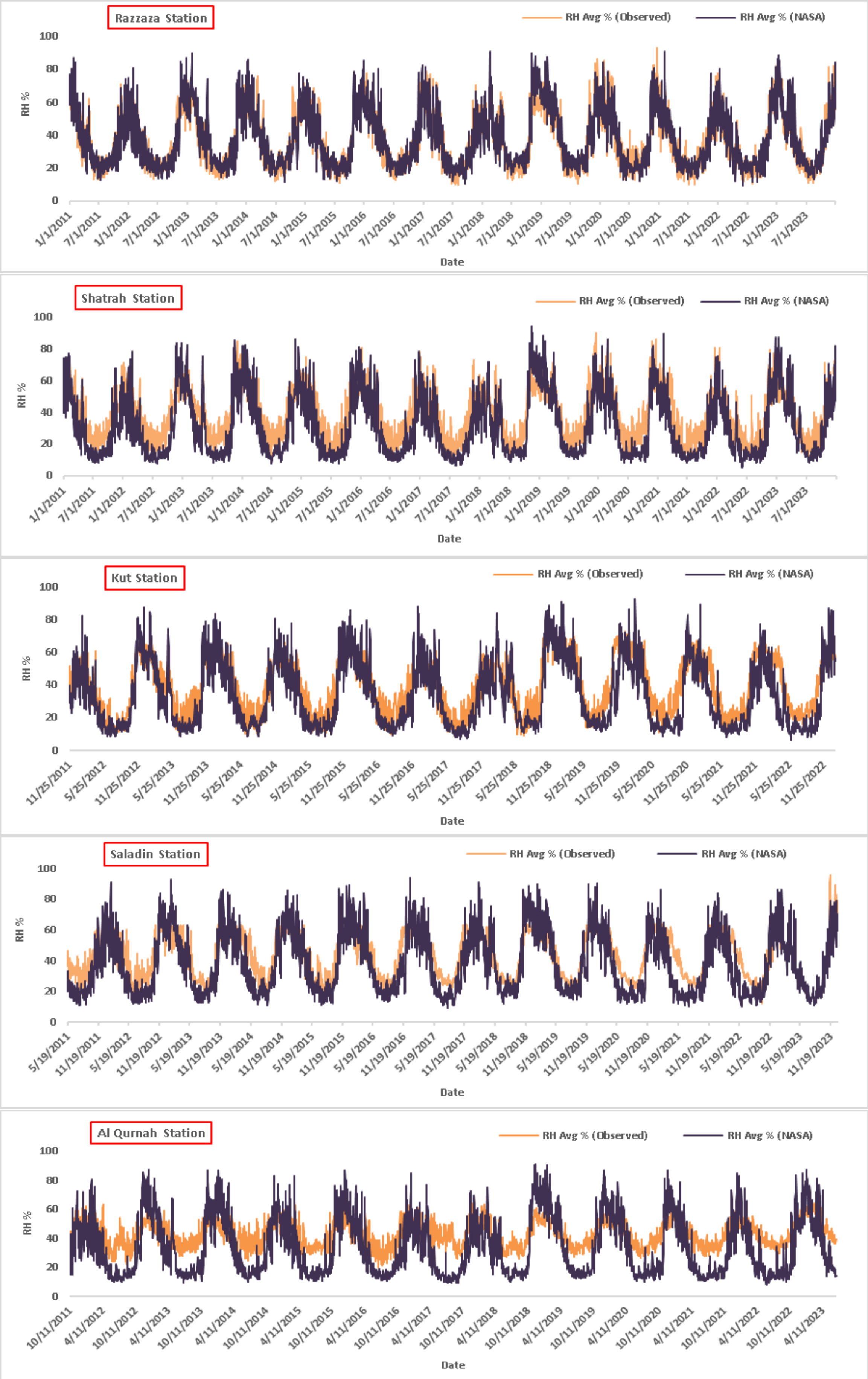


Fig. 9 Average Daily Solar Radiation Scatter Plots for the Ten Stations.

3.5. The Relative Humidity

Figure 10 compares the relative humidity of each station. The variety of the two data resources can be observed. The Correlation Coefficients for the relative humidity are listed in Table 7. The results showed that the correlation between the observed and the NASA Power data was moderate to strong and ranged between 0.459 and 0.701, which is in agreement with Rodrigues et al. [6]. The MBE values exhibited a mix of positive and negative values, indicating both overestimation and underestimation in the relative humidity forecasts compared to the observed values. The magnitudes of the biases significantly varied, with values ranging from -2.6115 to 7.9351. Larger absolute values imply more substantial deviations between the forecasted and observed relative humidity levels. These results agree with Aboelkhair et al. [24]. The relative humidity scatter plot is presented in Fig. 11. The figure shows a good correlation between the observed and the NASA Power data.




Razzaza Station
RH Avg % (Observed)
RH Avg % (NASA)
RH %
Date
Shatrah Station
RH Avg % (Observed)
RH Avg % (NASA)
RH %
Date
Kut Station
RH Avg % (Observed)
RH Avg % (NASA)
RH %
Date
Saladin Station
RH Avg % (Observed)
RH Avg % (NASA)
RH %
Date
Al Qurnah Station
RH Avg % (Observed)
RH Avg % (NASA)
RH %
Date

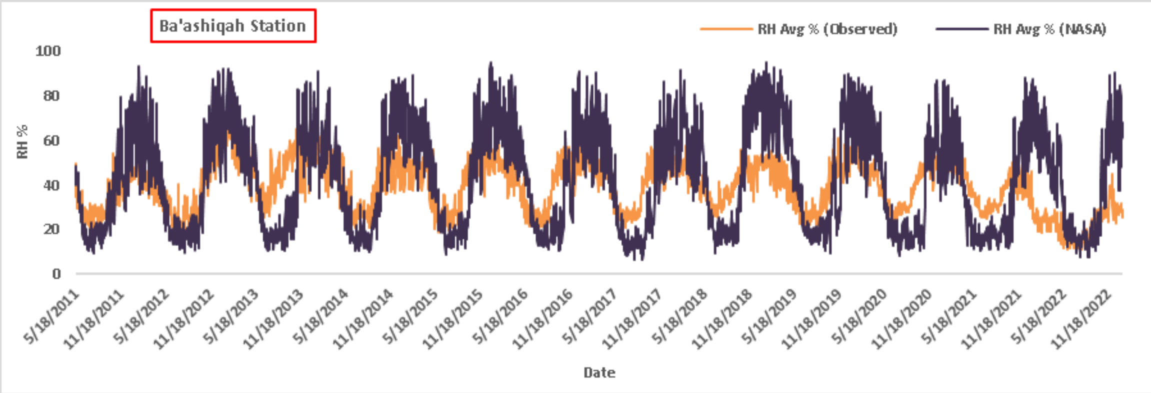
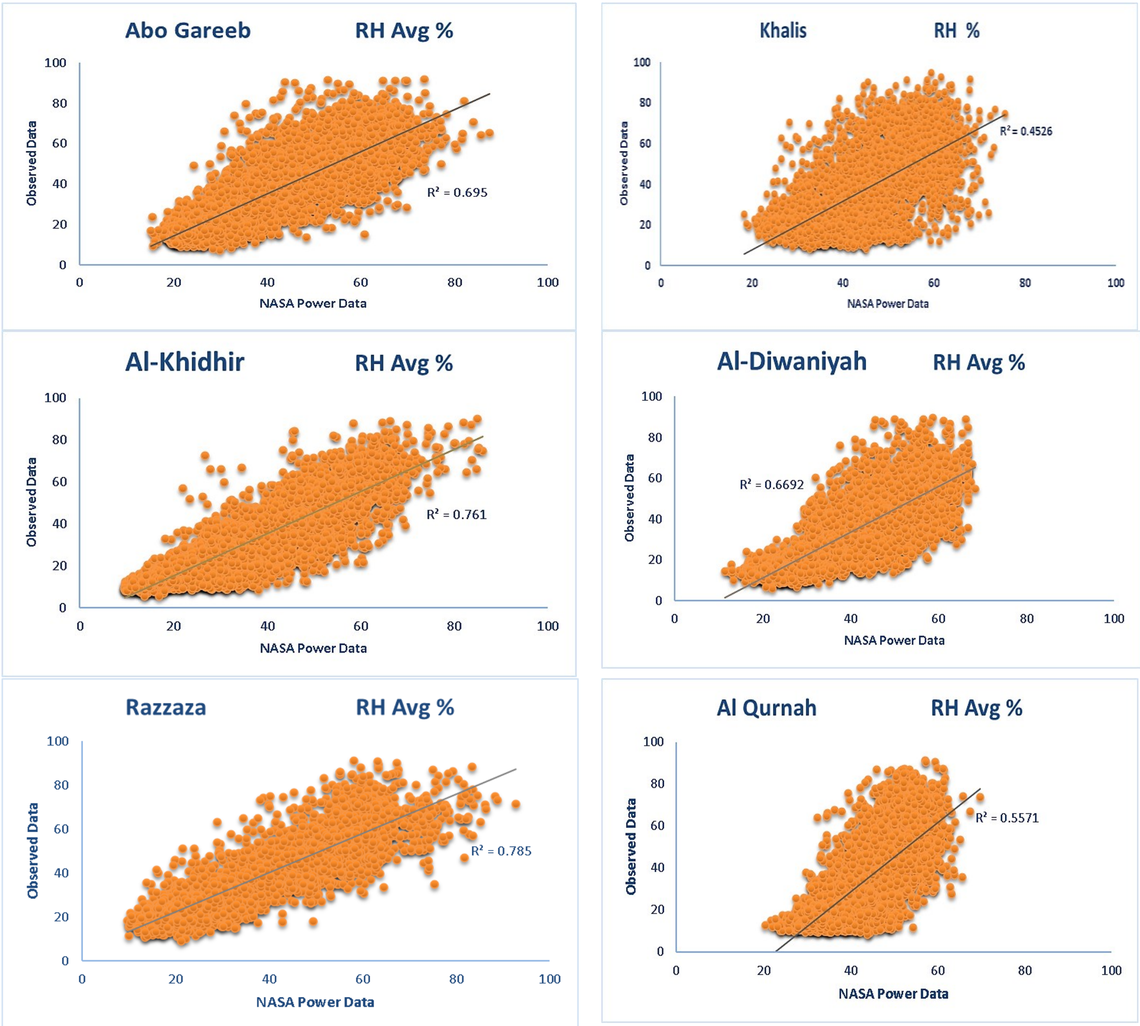


Fig. 10 Average Daily Relative Humidity Compression for the Ten Stations.

Table 7 Relative Humidity Correlation Coefficients.

	Station									
	Abo Gareeb	**Khalis**	**Al-Khidhir**	**Al-Diwaniyah**	**Razzaza**	**Shatrah**	**Kut**	**Saladin**	**Al Qurnah**	**Ba'ashiqah**
Correlation Coefficient	0.627	0.459	0.671	0.621	0.693	0.701	0.660	0.610	0.499	0.421
Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
N	4644	4220	4748	4303	4748	4722	4081	4329	4277	4263
MBE	4.9150	7.4250	4.7019	6.7064	-.4647	7.9351	5.8490	5.7513	-.6972	-2.6115



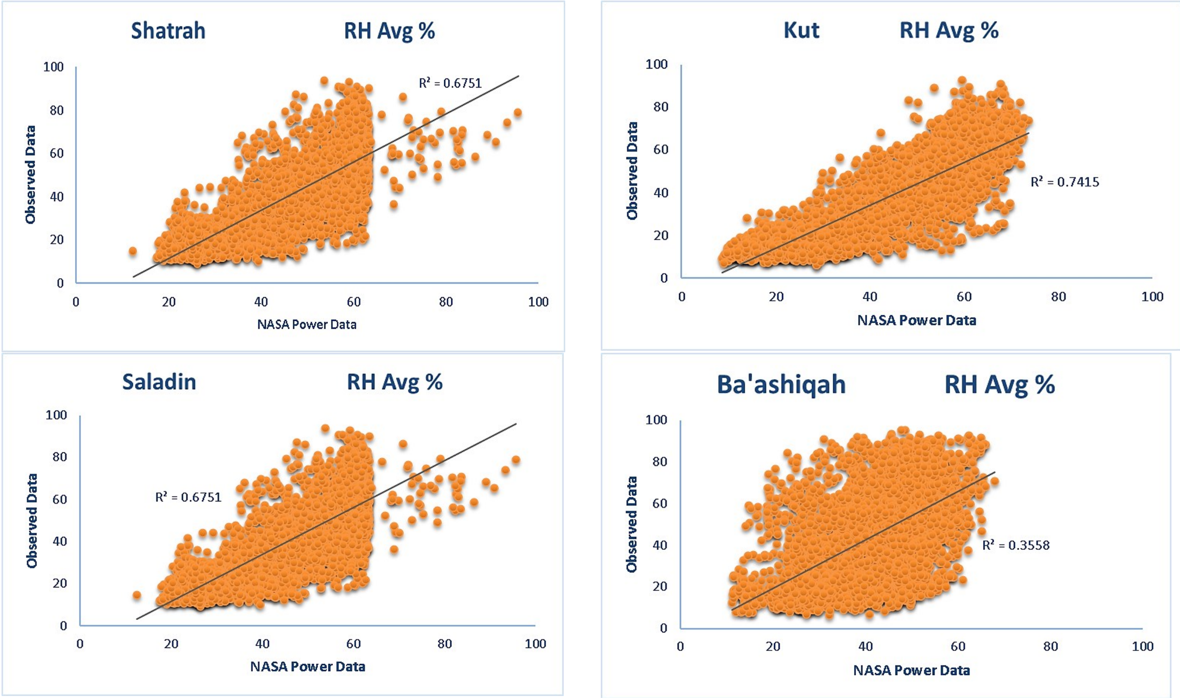


Fig. 11 Average Daily Relative Humidity Scatter Plots for the Ten Stations.

4.CONCLUSIONS

Based on the comparison and analysis of the meteorological data from the NASA Power database and the observed data from ten meteorological stations in Iraq, the following conclusions can be drawn:

1- Temperature: The NASA Power data demonstrated a very high R-value (0.748-0.912) with the observed data for average daily temperatures, indicating that the NASA Power data is accurate for assessing and modeling temperature.

2- Average daily Rainfall: The NASA Power data showed a very weak to strong correlation (0.105 and 0.526) with the observed rainfall data. Hence, it could be used as supplementary data; however, it may need further calibration to provide an accurate rainfall analysis.

3- Average Daily Wind Speed: The NASA-Wind data showed a weak to moderate correlation between the observed data and wind speed (r = 0.105 and 0.427). This weak correlation could be due to many reasons. For instance, the methodology used by the NASA POWER website to calculate wind speed may have limitations or assumptions that do not align with the observed data, resulting in a weak correlation. Moreover, wind speed patterns can vary over time and space, leading to discrepancies.

4- Solar Radiation: The NASA Power data demonstrated a strong to very strong correlation (values ranging between 0.636 and 0.834) with the observed solar radiation data, making it an appropriate source for solar assessment and applications related to it.

5- Relative Humidity: The NASA Power correlation data demonstrated a very strong correlation (ranging from 0.636 to 0.834) and were suitable for further analyses and studies related to relative humidity.

The NASA Power database can be a reliable source for accessing meteorological data in Iraq. However, the data needs to be tested and validated in different application levels and regions to meet the required accuracy and reliability.

ACKNOWLEDGMENTS

Special thanks to Prof. Dr. Hussain Musa Hussain for his help and guidance. Conflicts of Interest: The authors declare no conflict of interest of any kind. Funding: This research received no external funding. Code availability: Not applicable

REFERENCES

[1] Banda VD, Dzwairo RB, Singh SK, Kanyerere T. **Hydrological Modelling and Climate Adaptation under Changing Climate: A Review with a Focus in Sub-Saharan Africa**. *Water* 2022; **14**(24): 4031.

[2] Kim S, Zirkelbach D, Künzel HM. **Review of Methods to Create Meteorological Data Suitable for Moisture Control Design by Hygrothermal Building Envelope Simulation**. *Energies* 2023; **16**(7): 3271.

[3] Dharmayasa IGNP, Simatupang CA, Sinaga DM. **Nasa Power's: An Alternative Rainfall Data Resources for Hydrology Research and Planning Activities in Bali Island, Indonesia**. *Journal of Infrastructure*

Planning and Engineering (JIPE) 2022; **1**(1): 1–7.

[4] Orwig KD, Clark C, Monahan A, Buster G, Wang J, Hinkleman K, Cline J, Haupt SE. **Recent Trends in Variable Generation Forecasting and Its Value to the Power System**. *IEEE Transactions on Sustainable Energy* 2014; **6**(3): 924–933.

[5] Saeed IM, Tarkhany A, Hama Y, Al-Shatri S. **Environmental Considerations, Sustainability Opportunities and Iraqi Government's Energy Policies: A Comparative Study**. *Environment, Development and Sustainability* 2023; **25**(7): 6879–6895.

[6] Rodrigues GC, Braga RP. **Evaluation of Nasa Power Reanalysis Products to Estimate Daily Weather Variables in a Hot Summer Mediterranean Climate**. *Agronomy* 2021; **11**(6): 1207.

[7] Walker D, Forsythe N, Parkin G, Gowing J. **Filling the Observational Void: Scientific Value and Quantitative Validation of Hydrometeorological Data from a Community-Based Monitoring Programme**. *Journal of Hydrology* 2016; **538**: 713–725.

[8] Sağlam Ş. **Meteorological Parameters Effects on Solar Energy Power Generation**. *WSEAS Transactions on Circuits and Systems* 2010; **9**(10): 637–649.

[9] Sengupta M, Habte A, Gueymard C, Wilbert S, Renne D. **The National Solar Radiation Data Base (Nsrdb)**. *Renewable and Sustainable Energy Reviews* 2018; **89**: 51–60.

[10] Marzouk OA. **Assessment of Global Warming in Al Buraimi, Sultanate of Oman Based on Statistical Analysis of Nasa Power Data over 39 Years, and Testing the Reliability of Nasa Power against Meteorological Measurements**. *Heliyon* 2021; **7**(3): e06625.

[11] Orte F, Wolfram E, Salvador J, D'Elia R, Casiccia C, Lakkis G, Paes Leme NM, Paladini A, Marrero S. **Comparison of Nasa-Power Solar Radiation Data with Ground-Based Measurements in the South of South America**. *2021 XIX Workshop on Information Processing and Control (RPIC)*; 2021. pp. 1–4.

[12] Kheyruri Y, Sharafati A, Ahmadi Lavin J. **Performance Assessment of Nasa Power Temperature Product with Different Time Scales in Iran**. *Acta Geophysica* 2024; **72**(2): 1175–1189.

[13] Juarez PD, Tabatabai M, Burciaga Valdez R, Matthews-Juarez P, Al-Hamdan MZ, Beier JC, Zhang R, Al-Hamdan M, Luke D, Ramesh A. **The Effects of Air Pollution, Meteorological Parameters, and Climate Change on Covid-19 Comorbidity and Health Disparities: A Systematic Review**. *Environmental Chemistry and Ecotoxicology* 2022; **4**: 194–210.

[14] Mohammed DR, Mohammed RK. **Climate Change's Impacts on Drought in Upper Zab Basin, Iraq: A Case Study**. *Tikrit Journal of Engineering Sciences* 2024; **31**(1): 161–171.

[15] Jasim IA, Al-Maliki LA, Al-Mamoori SK. **Water Corridors Management: A Case Study from Iraq**. *International Journal of River Basin Management* 2022; **20**(4): 501–525.

[16] De Pauw E, Saba M, Ali SH. **Mapping Climate Change in Iraq and Jordan**. International Center for Agricultural Research in the Dry Areas; 2015.

[17] Al-Maliki LA, Al-Mamoori SK, Al-Ansari N, El-Tawel K, Comair FG. **Climate Change Impact on Water Resources of Iraq (a Review of Literature)**. *IOP Conference Series: Earth and Environmental Science* 2022; **1120**(1): 012025.

[18] Name IAJ, Al-Jameel HA, AL-Maliki LA, Al-Mamoori SK, AL-Ansari N. **Spatial Analyses Model for the Public Transportation and the Urban Form Relationship**. *AIP Conference Proceedings* 2023; **2651**(1): 020001.

[19] Al-Bahrani HS, Al-Rammahi AH, Al-Mamoori SK, Al-Maliki LA, Al-Ansari N. **Groundwater Detection and Classification Using Remote Sensing and Gis in Najaf, Iraq**. *Groundwater for Sustainable Development* 2022; **19**: 100838.

[20] Sparks AH. **Nasapower: A Nasa Power Global Meteorology, Surface Solar Energy and Climatology Data Client for R**. *Journal of Open Source Software* 2018; **3**(30): 1035.

[21] Temizhan E, Mirtagioglu H, Mendes M. **Which Correlation Coefficient Should Be Used for Investigating Relations between Quantitative Variables**. *Academic Science Research Journal of Engineering and Technology Sciences* 2022; **85**: 265–277.

[22] Sözeyatarlar M, Şahin M, Yavuz E. **Statistical Relations Measures**. *Journal of Universal Mathematics* 2021; **4**(2): 283–295.

[23] Tan ML, Gassman PW, Sampson A, Yang X, Haywood J. **Evaluation of Nasa Power and Era5-Land for Estimating Tropical Precipitation**

and Temperature Extremes. *Journal of Hydrology* 2023; **624**: 129940.

[24] Aboelkhair H, Morsy M, El Afandi G. **Assessment of Agroclimatology Nasa Power Reanalysis Datasets for Temperature Types and Relative Humidity at 2 M against Ground Observations Over Egypt**. *Advances in Space Research* 2019; **64**(1): 129–142.