5 May 2026

Veriground™ vs. ERA5 Precipitation Data in Cocoa Growing Regions: Comparisons, Contrasts, and Conclusions

Executive Summary

This study looks at daily rainfall information from two different weather sources in selected cocoa-growing areas, covering the period from January 2020 to February 2026. The two sources gather rainfall information in very different ways.

The first source, Veriground, collects rainfall measurements directly from small weather stations placed in specific locations. These stations record rainfall and regularly send information to online data systems throughout the day.

The second source, called ERA5, does not measure rainfall directly at the ground level. Instead, it combines satellite observations, past rainfall records, and computer models to estimate how much rain falls over specific geographic areas.

The study focused on two main questions. First, it examined how closely the two sources agree when reporting rainfall in the same locations at the same time. Second, it explored whether information from both sources could be combined in a way to provide faster and more accurate rainfall information for cocoa-growing regions.

To answer these questions, the researchers compared the data using summary statistics, how rainfall amounts were distributed, and statistical tests that measure how closely the two data sets are related.

The results showed that the two sources describe rainfall very differently for the same regions and time periods. Because of these large differences, the study found no reliable way to combine the two data sources to improve rainfall estimates.

Veriground Precipitation Data[1]

Veriground is a network of weather stations built by Commodities Risk Analysis (CRA), a company that helps the chocolate and confectionery industry understand global cocoa markets. CRA wanted better weather information from cocoa-growing areas but discovered a major problem: in many of these regions, reliable local weather data simply did not exist.

For decades, weather stations around the world were placed mainly to serve aviation. As a result, large parts of the world—especially outside North America, Europe, and other developed regions—had very few stations. In many cases, weather reports were created by estimating conditions across huge distances between airports. These estimates were often inaccurate and slow. In some countries, weather records were still kept on paper and shared internationally months later, sometimes with errors. This was especially problematic in tropical farming areas near the equator, where weather can vary significantly over just a few kilometers.

[1] Summarized from information found at https://www.veriground.io/, accessed March 16, 2026.

CRA realized that modern mobile phone networks and small, low-cost electronics made a better approach possible. The result was the Veriground station—designed to be installed wherever there is mobile coverage, need little ongoing maintenance, and collect data directly from the places where crops are actually grown.

Each station measures weather conditions every hour and sends reports every two hours during the day. They track rainfall, temperature, humidity, sunlight, and air pressure. Rainfall is measured using a dedicated rain gauge that is carefully cleaned during routine maintenance to ensure accuracy. Stations include backup sensors, and CRA closely monitors and checks all measurements on an ongoing basis.

The data is sent through mobile networks to secure cloud servers. Built-in checks make sure the information arrives correctly, and if anything is missing or unclear, the system automatically requests a resend. From even the most remote locations, new data is usually available within a few hours.

This steady flow of accurate, local rainfall data feeds into modern weather forecasting systems, improving predictions for each station's exact location. As newer AI-based forecasting models continue to improve, the growing Veriground data set is helping build a clearer picture of weather in regions that have long been poorly measured—and helping farmers, traders, and companies make better-informed decisions.

ERA5 Precipitation Data[2]

ERA5 is a global weather and climate dataset produced by ECMWF (European Centre for Medium-Range Weather Forecasts), a European weather research organization. Think of it as a long, consistent record of what the atmosphere has been doing worldwide, going back to 1940. Instead of relying on a single type of measurement, ERA5 combines many sources of weather information—such as weather balloons, satellites, ground stations, and ship reports—with a modern weather model. This approach fills in gaps where measurements are missing and creates a complete, regularly spaced picture of the atmosphere, as if the same weather system had been running continuously for more than 80 years.

For rainfall, ERA5 provides two main kinds of information. One shows total precipitation, which includes all rain that reaches the ground, regardless of how it formed. The other focuses only on precipitation from thunderstorms and similar intense weather systems. These data are available worldwide, updated every hour, and detailed enough to show variations over areas about 30 kilometers across, making ERA5 one of the most detailed long-term global precipitation records available.

ERA5 precipitation data do have some known limitations. Rainfall in mountainous areas is often underestimated because the model cannot fully capture complex terrain. Very heavy rain events are usually smoothed out and may appear weaker than they do in local rain gauge or

[2] Summarized from information found at https://www.ecmwf.int/en/forecasts/dataset/ecmwf-reanalysis-v5, accessed March 16, 2026.

high-resolution satellite data. The earliest part of the record, especially before about 1950, is less certain because fewer measurements were available at that time. In general, precipitation is harder to estimate accurately than variables like temperature or wind, because it is not directly measured everywhere and must be inferred by the model.

Even with these limitations, ERA5 is widely used for studying climate trends, droughts and floods, and for supplying weather input to water and hydrology models. The data are freely available through the Copernicus Climate Data Store.

In this study, the term “observations” will be used to describe ERA5 data, even though “estimates” would be more technically accurate. Using the term “observations” makes it easier to compare ERA5 data with Veriground data.

Data Preparation

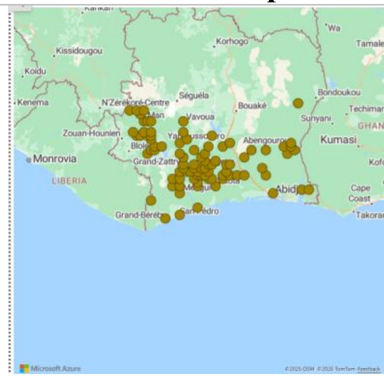
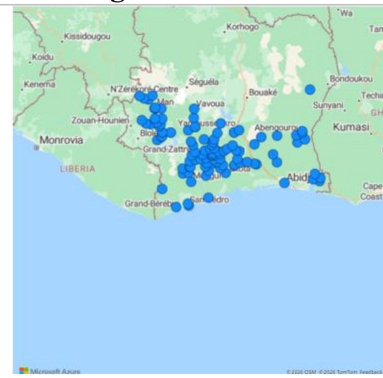
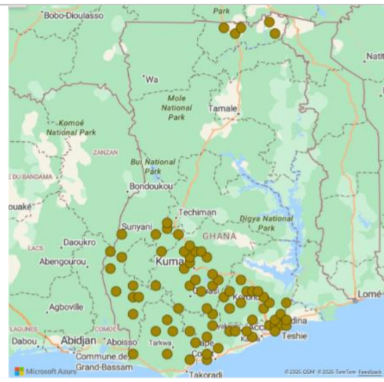
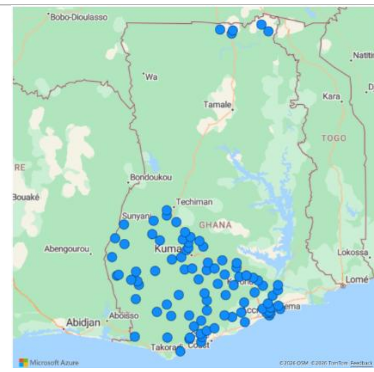
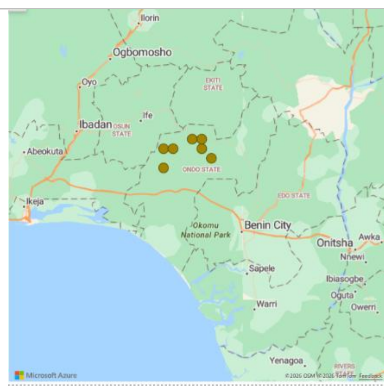
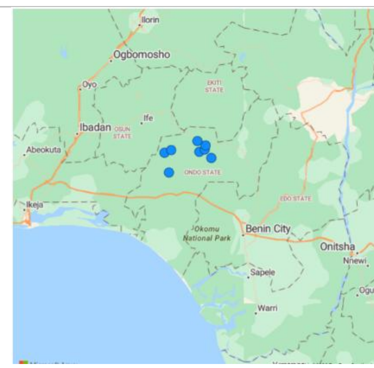
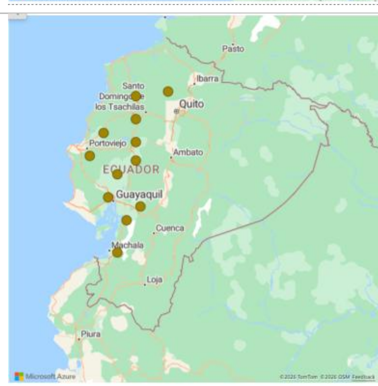
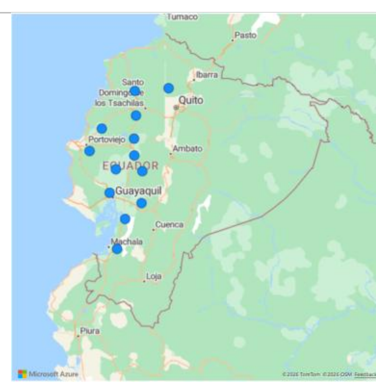
To make a fair comparison between the two weather data sources (ERA5 and Veriground), the data needed to refer to the same places and the same days. To do this, each ERA5 grid area was represented by its center point. Each Veriground weather station was then linked to the nearest ERA5 grid mid-point by rounding its latitude and longitude to one decimal place. This allowed each Veriground station to be paired with the most comparable ERA5 location.

Appendices A through D show how ERA5 grids and Veriground stations were matched for Côte d’Ivoire, Ghana, Nigeria, and Ecuador (see also the maps in Figure 1). These appendices also list how many daily reports were available from each data source between January 2020 and February 2026, as well as the distance between each Veriground station and its matching ERA5 grid center.

Next, the two datasets were combined into a single table so that rainfall values from both sources could be compared day by day at the same locations. In a small number of cases, two or three Veriground stations were linked to the same ERA5 grid. When this happened, the rainfall readings from those Veriground stations were averaged for each day.

ERA5 provides rainfall estimates for every day, but Veriground stations occasionally have missing data due to maintenance or when faulty readings are removed. When Veriground data was missing for a given day and location, the corresponding ERA5 data was removed as well. As a result, the final dataset contains only days and locations where both sources reported data, making the comparison fully consistent. All data preparation and analysis were carried out primarily using Power BI.

Finally, a note about dew: Dew forms when surfaces cool and water condenses, while precipitation refers to water that falls from the atmosphere, such as rain. Standard weather stations do not count dew as precipitation, and Veriground follows this same practice by removing very small measurements that are likely caused by dew. It is not clear how the ERA5 model accounts for dew formation in its estimates.

Figure 1. Maps		
	ERA5 Grid Midpoints	**Veriground Locations**
Côte d'Ivoire		
Ghana		
Nigeria		
Ecuador		

Precipitation Comparison Methodology

This study compares two sources of rainfall data using three steps.

1. **Basic summaries of the data.**
   First, we look at general features of each data set—such as typical values and overall ranges—to see how similar or different the two sources are.

2. **How the data is distributed.**
   Rainfall data behaves differently from many other types of data. In this step, we examine whether the two data sources show similar or different patterns in how rainfall amounts are distributed.

3. **Relationship between the two sources.**
   Finally, we use regression analysis to see whether there is a clear and meaningful relationship between the rainfall measurements from the two sources.

Together, these steps help answer key questions about how the two datasets compare and provide a foundation for future research.

Analysis Results

Descriptive statistics.

Table 1 provides a side-by-side summary of the main features of the two rainfall data sets. The most important differences are briefly explained here and explored in more detail later.

Table 1. Summary Statistics

Statistic	ERA5	Veriground
No. of Observations	189,278	189,278
Minimum Value	0.00	0.00
Maximum Value	561.31	238.60
Average Value	4.15	2.74
Median Value	1.45	0.00
Standard Deviation	10.02	7.95
Fisher-Pearson skewness coefficient	10.04	5.76
No. Obs. Equal to 0.00 mms	11,073	131,927
Pct. of Obs. Equal to 0.00 mms	5.9%	69.7%

A first and very noticeable difference is how large the highest rainfall values are. The largest rainfall amount in the ERA5 data is almost two and a half times higher than the largest value recorded by Veriground. It is also about one and a half times higher than the second-highest ERA5 value. This extreme ERA5 reading (561.31mms) occurred on April 10, 2023, in Ecuador, near the end of the main rainy season and during a shift from weak La Niña conditions to strong El Niño conditions. On that same day and at the same location, the nearby Veriground weather station reported far less rainfall (88.60 mms).

On average, ERA5 reports more rainfall than Veriground. Across all observations, the ERA5 average is about one and a half times higher (4.15 vs. 2.74 mms). This pattern appears consistently in every country covered by the data. The difference is especially striking in Ecuador, where ERA5 reports much higher typical daily rainfall than Veriground over the same time period (16.22 vs. 2.84 mms).

Both data sets show large swings from day to day, which means rainfall amounts vary widely. This is reflected in the large spread of values in each data set, as shown in the standard deviation. In relative terms, variability is high for both, but it is more pronounced for Veriground.

Both data sets also show a strong tendency toward occasional very large rainfall events, as shown in the skewness coefficient. This is expected for daily rainfall data, since most days have little or no rain while a few days have very heavy rain. However, this pattern is much stronger in the ERA5 data. In practical terms, ERA5 contains more extreme high-rainfall values, and those extremes are larger than those seen in Veriground.

Finally, the two data sets differ sharply in how often they report no rain at all. Veriground shows zero rainfall on nearly 70 percent of days, while ERA5 reports zero rainfall on fewer than 6 percent of days.

Taken together, these differences show that the two data sets behave very differently. These contrasts become even clearer in the analyses that follow.

Distribution of the data

Because the data are heavily uneven, we closely reviewed the largest and most unusual rainfall values in both data sets. Tables 2 and 3 list the 20 highest rainfall measurements from ERA5 and Veriground, respectively. Each table compares measurements from both data sources for the same dates and locations, allowing the largest values in each data set to be examined side by side.

Table 2. ERA5 – Top 20 Observations with Most Rainfall

Correlation Coefficient between ERA5 Top 20 Rain and Veriground Rain = 49.21%

Rank	ERA5 Rain	Date	ERA5 ID	Country	ERA5 Lat	ERA5 Long	VG ID	VG Rain
1	561.31	10-Apr-23	42161	Ecuador	-2.6	-79.6	9000102	88.60
2*	341.63	19-Feb-24	40272	Ecuador	-0.9	-79.4	9000055	127.90
3	308.30	31-May-21	7108	Ghana	5.2	-2.1	9000108	0.40
4	296.17	9-Feb-24	42161	Ecuador	-2.6	-79.6	9000102	46.40
5	290.16	2-Feb-24	40272	Ecuador	-0.9	-79.4	9000055	70.80
6	272.35	12-Feb-24	40272	Ecuador	-0.9	-79.4	9000055	44.50
7	268.34	6-Apr-25	42161	Ecuador	-2.6	-79.6	9000102	1.10
8	262.92	25-May-23	40272	Ecuador	-0.9	-79.4	9000055	3.20
9	261.71	24-Jan-21	40716	Ecuador	-1.3	-79.4	9000125	12.70
10	257.57	12-Apr-23	40272	Ecuador	-0.9	-79.4	9000055	32.60
11	253.94	8-Jan-21	40272	Ecuador	-0.9	-79.4	9000055	9.60
12	251.51	20-Mar-24	4633	Côte d'Ivoire	4.7	-7.0	9000214	4.80
13	249.55	18-May-25	4633	Côte d'Ivoire	4.7	-7.0	9000214	1.80
14	243.58	22-Feb-22	40272	Ecuador	-0.9	-79.4	9000055	0.00
15	242.03	26-Mar-21	40716	Ecuador	-1.3	-79.4	9000125	56.70
16	232.39	26-Mar-22	40272	Ecuador	-0.9	-79.4	9000055	0.00
17	230.23	5-Mar-21	40716	Ecuador	-1.3	-79.4	9000125	0.00
18	229.86	8-Jan-21	40716	Ecuador	-1.3	-79.4	9000125	6.70
19	229.05	15-Feb-21	40716	Ecuador	-1.3	-79.4	9000125	0.00
20	228.33	23-Apr-21	40272	Ecuador	-0.9	-79.4	9000055	0.00

Table 3. Veriground – Top 20 Observations with Most Rainfall
Correlation Coefficient Between Veriground Top 20 Rain and ERA5 Rain = −16.18%

Rank	VG Rain	Date	VG ID	Country	ERA5 Lat	ERA5 Long	ERA5 ID	ERA5 Rain
1	238.60	24-Jun-24	9000211	Côte d'Ivoire	4.8	-6.6	4646	19.56
2	237.50	31-Oct-24	(Mult. Stat.)	Côte d'Ivoire	6.1	-6.0	4951	6.20
3	229.10	10-Jun-23	9000212	Côte d'Ivoire	5.0	-6.1	4671	14.86
4	223.80	30-Jun-22	9000110	Ghana	5.2	-2.7	7102	29.23
5	207.00	22-Jul-23	9000108	Ghana	5.2	-2.1	7108	11.73
6	178.50	1-Jul-22	9000106	Ghana	6.4	-2.7	7022	3.80
7	173.80	28-Sep-25	9000134	Côte d'Ivoire	7.1	-7.9	5567	29.14
8	155.70	9-Aug-23	9000219	Ghana	10.9	-1.1	23621	34.63
9	150.10	28-May-20	9000095	Ghana	5.7	0.0	6725	6.27
10	144.40	25-Nov-21	9000144	Ghana	6.9	-1.7	6208	0.02
11	142.70	30-Oct-25	9000212	Côte d'Ivoire	5.0	-6.1	4671	3.68
12	135.00	10-Jun-21	9000088	Côte d'Ivoire	7.4	-6.5	5795	35.05
13	133.90	10-Jun-23	9000211	Côte d'Ivoire	4.8	-6.6	4646	13.06
14	133.60	24-May-22	9000199	Ghana	5.6	-0.2	6718	14.57
15	130.30	29-Jun-23	9000012	Côte d'Ivoire	5.5	-3.0	4874	9.65
16	130.20	15-Jul-22	9000110	Ghana	5.2	-2.7	7102	5.04
17*	127.90	19-Feb-24	9000055	Ecuador	-0.9	-79.4	40272	341.63
18	126.90	20-Jun-21	9000074	Côte d'Ivoire	6.7	-7.3	5532	14.04
19	125.20	10-Jun-20	9000070	Ghana	5.6	-0.9	6538	22.68
20	123.60	21-Apr-23	9000381	Ecuador	-2.3	-79.3	41825	64.18

Looking first at the 20 highest rainfall readings in the ERA5 data (shown in Table 2), most of them—17 out of 20—come from Ecuador. This pattern of unusually high rainfall values from Ecuador appears again and again in the ERA5 data. Many of these extreme readings occurred close together in time, especially in early 2021 and early 2024.

Most of these very high readings come from just two nearby locations (40272 and 40716). These two points are about 60 kilometers apart, with one located directly north of the other.

When we compare these 20 extreme ERA5 rainfall readings with rainfall measured on the ground at the same places and dates (the Veriground data in Table 2), the match is fairly weak. The two data sources show only a moderate relationship, and only one of the ERA5 top-20 readings also appears among the top 20 ground measurements. In five cases, the Veriground measurements recorded no rainfall at all, even though ERA5 reported very large amounts. On average, the matching ground measurements show more rain than usual, but nowhere near the extreme values reported by ERA5.

Table 3 tells a different story. Only two of the top 20 ground-based rainfall readings come from Ecuador. The rest are split evenly between Côte d’Ivoire and Ghana. Some of these high readings occurred during the West African rainy season in mid-2023, but otherwise there is no clear pattern over time. When we look at the ERA5 rainfall values for these same events, the amounts are again higher than average, but still not extreme.

Unexpectedly, when we compare the top 20 Veriground rainfall readings with the corresponding ERA5 values, the relationship is actually negative (-16.18%). This confirms that the two data sets can differ substantially, even though they are both trying to measure the same rainfall events at the same places and times.

To make this analysis more practical, rainfall amounts were grouped into ranges of 1 millimeter. All values from 0 to 1 millimeter were placed in the first group, values from 1 to 2 millimeters in the second group, and so on. Very large rainfall amounts—anything over 20 millimeters—were grouped together into a single category. The results of this grouping are shown in Table 4, and the corresponding charts for ERA5 and Veriground are shown in Figures 2a and 2b.

Table 4. Distribution of Rainfall Observations

Daily Rainfall Range (mm)	ERA5 Observations	Veriground Observations
0.0 <= 1.0	78,443	138,455
1.0 <= 2.0	31,319	10,745
2.0 <= 3.0	18,703	5,997
3.0 <= 4.0	11,347	4,061
4.0 <= 5.0	8,426	3,077
5.0 <= 6.0	6,545	2,548
6.0 <= 7.0	5,214	2,272
7.0 <= 8.0	4,312	2,001
8.0 <= 9.0	3,471	1,945
9.0 <= 10.0	2,910	1,562
10.0 <= 11.0	2,490	1,490
11.0 <= 12.0	1,992	1,279
12.0 <= 13.0	1,775	1,181
13.0 <= 14.0	1,402	980
14.0 <= 15.0	1,234	1,005
15.0 <= 16.0	1,049	786
16.0 <= 17.0	817	702
17.0 <= 18.0	768	647
18.0 <= 19.0	649	602
19.0 <= 20.0	543	577
greater than 20.0	5,869	7,366
Total Observations	**189,278**	**189,278**
Obs. exactly equal to 0.0 mms	**11,073**	**131,927**
Percentage equal to 0.0 mms	**5.9%**	**69.7%**

Figure 2a. ERA5 Observations

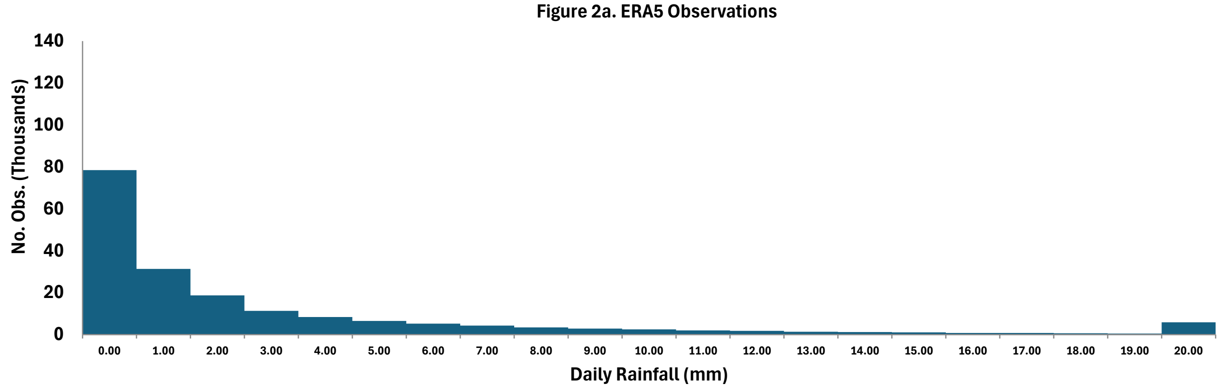
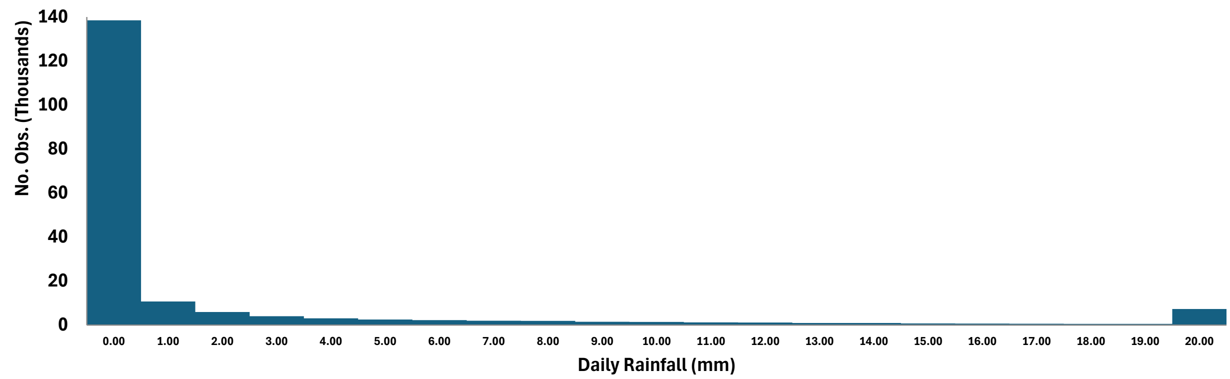


Figure 2b. Veriground Observations



When we compare the two charts, a clear difference appears. In the Veriground data, most measurements fall into the very lowest category of rainfall (0 to 1 mm). In fact, nearly three-quarters of all Veriground observations are in this range. In the ERA5 data, fewer than half of the measurements fall into this same category.

The difference is even larger when we look only at days with no rain at all. ERA5 reports no rain on about 6% of days, while Veriground reports no rain on nearly 70% of days. Put another way, ERA5 suggests that it rains on almost every day of the week—about 6 to 7 days out of 7. Veriground, however, suggests rain occurs on only about 2 days per week.

Everyday experience of rainfall, especially in West Africa, lines up much more closely with the Veriground results than with ERA5.

Both data sets show overall patterns that match what scientists often see in tropical rainfall[3]. However, ERA5 includes many more very small rainfall amounts. Veriground, by contrast, drops off quickly once rainfall moves above zero. This suggests that the ERA5 method may be producing too many small "rain" values—possibly because of how its calculation method works, or because it is counting moisture such as dew as rainfall, even when people would not experience it as rain.

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[3] For instance:
Malaysia. Ab Malek et al. (2021). Modelling the Distribution of Rainfall Amount, Mathematical Sciences and Informatics Journal Vol. 2, No. 2, Nov. 2021, pp. 26-34

Bangladesh. Sanjib Ghosh et al. (2016). Determination of the Best Fit Probability Distribution for Monthly Rainfall Data in Bangladesh, American Journal of Mathematics and Statistics 2016, 6(4): 170-174.

India. Mohita Anand Sharma and Jai Bhagwan Singh (2010). Use of Probability Distribution in Rainfall Analysis. New York Science Journal 2010;3(9)

India. Deka S., and Borah M., (2009). Distribution of Annual Maximum Rainfall Series of Northeast India, European Water Publications 27/28: 3-14.

Regression Analysis

We used regression analysis to see whether the two data sets show a consistent relationship under different conditions, and to explore whether information from one data source could help improve the other. To do this, we started with a basic statistical comparison that measures how changes in one data set relate to changes in the other.

$$y_i = a + bx_i$$

Where:

y_i = *Veriground observation for date/location combination i.*

a = y intercept

b = slope; expected change in y for a one mms change in x

x_i = *ERA5 observation for date/location combination i.*

The full data set, which includes about 189,000 observations, was sorted into smaller groups to make comparisons easier. These groups were created based on different time periods and locations. Specifically, the data were organized into eight categories:

1. All observations together
2. Broken down by year, combining all countries
3. Broken down by country, combining all years
4. Rainy-season months, by country
5. Dry-season months, by country
6. Months influenced by El Niño, by country
7. Months influenced by La Niña, by country
8. Months with neutral ENSO conditions, by country

Using these groups, we ran a total of 36 separate comparisons to see how the two data sources relate to each other under different conditions. The results of these comparisons are summarized in Table 5.

Table 5. Regression Runs

Run Number	Area Specification	Month Specifications	n	ERA5 Avg.	VG Avg.	a	b	r2 (%)	SE
1	All areas	All	189,278	4.15	2.74	2.06	0.16	4.28%	7.78
2	All areas	2020 only	7,807	4.45	2.10	1.73	0.08	1.70%	6.25
3	All areas	2021 only	27,353	5.22	3.06	2.38	0.13	4.32%	7.73
4	All areas	2022 only	32,747	4.16	2.78	2.13	0.16	3.59%	8.32
5	All areas	2023 only	35,748	4.48	3.33	2.45	0.20	4.79%	9.23
6	All areas	2024 only	32,942	3.95	2.10	1.43	0.17	5.94%	6.49
7	All areas	2025 only	44,651	3.77	2.77	2.13	0.17	3.73%	7.35
8	All areas	2026 Jan-Feb only	8,035	1.49	1.87	1.26	0.41	8.06%	6.50
9	West Africa only	All	179,048	3.46	2.73	1.17	0.26	6.77%	7.18
10	Côte d'Ivoire only	All	107,564	3.51	2.74	1.92	0.23	5.23%	7.61
11	Ghana only	All	67,743	3.32	2.74	1.76	0.30	6.16%	7.68
12	Nigeria only	All	3,741	4.36	2.31	1.17	0.26	6.77%	7.18
13	Ecuador only	All	10,230	16.22	2.84	1.42	0.09	6.72%	9.09
14	Côte d'Ivoire only	Rainy season[1]	44,704	4.38	3.53	2.48	0.24	4.56%	8.77
15	Ghana only	Rainy season	28,387	4.50	3.77	2.58	0.26	4.81%	9.27
16	Nigeria only	Rainy season	1,572	5.83	2.99	1.56	0.24	6.16%	8.11
17	Ecuador only	Rainy season	5,368	24.02	4.72	2.90	0.08	4.77%	11.86
18	Côte d'Ivoire only	Dry season[2]	62,565	2.90	2.18	1.55	0.22	5.46%	6.64
19	Ghana only	Dry season	39,358	2.47	2.00	1.23	0.31	6.82%	6.24
20	Nigeria only	Dry season	2,169	3.30	1.82	0.92	0.27	6.55%	6.42
21	Ecuador only	Dry season	4,862	7.62	0.75	0.41	0.05	1.97%	3.86
22	All areas	El Niño impact[3]	17,386	2.99	1.97	1.42	0.18	8.09%	6.37
23	Côte d'Ivoire only	El Niño impact	10,347	1.78	1.73	1.35	0.21	3.39%	5.32
24	Ghana only	El Niño impact	5,550	1.66	1.66	0.73	0.56	10.65%	5.54
25	Nigeria only	El Niño impact	374	1.52	1.43	1.06	0.25	1.98%	5.49
26	Ecuador only	El Niño impact	1,115	21.35	5.87	2.79	0.14	10.11%	14.04
27	All areas	La Niña impact[4]	88,281	3.84	2.63	2.04	0.16	3.96%	7.59
28	Côte d'Ivoire only	La Niña impact	49,904	3.36	2.71	1.93	0.23	5.62%	7.42
29	Ghana only	La Niña impact	32,054	2.91	2.62	1.80	0.28	5.74%	7.71
30	Nigeria only	La Niña impact	2,286	3.70	1.69	0.57	0.30	10.23%	5.91
31	Ecuador only	La Niña impact	4,037	17.13	2.30	1.16	0.07	5.37%	8.05
32	All areas	ENSO-Neutral[5]	83,318	4.73	3.02	2.23	0.17	3.96%	8.21
33	Côte d'Ivoire only	ENSO-Neutral	47,018	4.06	3.07	2.06	0.23	4.84%	8.22
34	Ghana only	ENSO-Neutral	30,141	4.06	3.06	1.89	0.29	6.05%	7.96
35	Nigeria only	ENSO-Neutral	1,081	6.74	3.93	2.71	0.18	2.90%	9.61
36	Ecuador only	ENSO-Neutral	5,078	14.39	2.59	1.38	0.08	6.42%	8.31

[1]Rainy season: For West Africa = May through July and October through November. For Ecuador = December through May.
[2]Dry season: For West Africa = December through April and August through September. For Ecuador = June through November.
[3]El Niño Impact= For the months November 2023 through April 2024.
[4]La Niña Impact= For the months August 2020 through March 2023 and November 2025 through February 2026.
[5]ENSO-Neutral Conditions= For all months remaining after removing El Niño and La Niña impact months.
ENSO Source: Climate Prediction Center, *https://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/ensodisc.shtml*

Summary of key findings:

- Across all the comparisons we ran, the relationship between the two data sets was weak, as shown by R-squares less than 11 percent. Measures of how closely they move together were consistently low, meaning the two sources rarely agree in a reliable way. Results were slightly better during El Niño, La Niña, and neutral climate periods, but still weak overall.
- The baseline rainfall levels estimated by the models, as shown by the value of “a”, varied widely. Ecuador showed the largest differences, with much higher rainfall levels reported by ERA5 than by Veriground in both wet and dry seasons. For example, during the rainy season, ERA5 suggests average daily rainfall about five times higher than what Veriground reports.

- The amount of uncertainty in the results was large, as shown by the Standard Error. This uncertainty is big enough that none of the comparisons can be trusted to make accurate predictions.
- The strength of the relationship between the two data sets, as shown by the value of “b”, also varied widely, and no clear reason explains why some cases looked slightly better than others.
- Taken together—weak relationships, high uncertainty, and wide variability—these results show that data from one source cannot be reliably used to improve or correct information from the other.

Conclusions

This study sets out to answer two basic questions. First, how well do Veriground and ERA5 data describe local rainfall in cocoa-growing areas? Second, can information from the two sources be combined to produce more accurate and timely rainfall insights? To answer these questions, we compared basic statistics, rainfall patterns, and direct relationships between the two data sets.

On the first question, the results show that Veriground and ERA5 differ in major and meaningful ways. Although both aim to describe rainfall in the same places and time periods, they tell very different stories. Across the full data set, ERA5 consistently reports more rainfall than Veriground—on average about 50% more. The difference is especially large in Ecuador, where ERA5 reports nearly six times as much daily rainfall as Veriground.

ERA5 also produces far more extreme rainfall readings. Large rainfall events appear much more often in ERA5 than in Veriground. One striking example occurred in April 2023, when ERA5 reported more than 560 millimeters of rain in Ecuador, while Veriground recorded less than 90 millimeters for the same event. In fact, that single ERA5 reading is far larger than any rainfall value ever recorded by Veriground, highlighting just how far apart the two sources can be.

Looking at how often rain is reported paints a similar picture. Veriground shows that most days have little or no rain, with nearly 70% of observations reporting zero rainfall. ERA5, by contrast, reports zero rainfall on only about 6% of days, implying that some rain falls almost every day. While both data sets follow broadly similar statistical patterns, ERA5 shows many more small rain events, whereas Veriground drops off quickly after zero rainfall.

It is not possible from this study alone to say whether ERA5 is capturing real but very light precipitation or whether its methods tend to overstate rainfall. However, everyday experience—especially in West Africa—matches the Veriground data much more closely, suggesting it provides a more realistic picture of when rain actually occurs.

The second question—whether one data set could be used to improve the other—was tested by comparing the two directly under many different conditions with regression analysis. The results were clear. Across dozens of comparisons, the relationship between ERA5 and Veriground was consistently weak. In some cases, the biggest rainfall events measured by Veriground actually moved in the opposite direction from those reported by ERA5, further showing how disconnected the two sources can be—especially for extreme events.

Based on these findings, there is no reliable way to improve one data source by using information from the other. The differences between Veriground and ERA5 are not simply a matter of adjusting scales or fine-tuning assumptions. They reflect two fundamentally different approaches to measuring rainfall: one based on local, ground-level observations, and the other based on large-scale models designed to cover the entire globe.

Future research should focus on understanding why these differences are so large, particularly in Ecuador, where the gaps between the two sources are the greatest.

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Appendix A
Côte d'Ivoire Matching Station Reports

ERA5				Veriground					
Grid ID	Latitude	Longitude	No. of Reports	Locality ID	Locality Name	Latitude	Longitude	No. of Reports	Distance to ERA5 grid midpoint (km)
4611	5.4	-4.0	2251	9000368	Abidjan CCC	5.3626	-3.9959	1084	4.176
4633	4.7	-7.0	2251	9000214	Youwasso	4.7041	-6.9684	830	3.537
4646	4.8	-6.6	2251	9000211	San-Pédro	4.7954	-6.6463	967	5.165
4671	5.0	-6.1	2251	9000212	Sassandra	4.9569	-6.0817	959	5.197
4696	5.2	-7.4	2251	9000213	Néka Ounié	5.1953	-7.3524	826	5.309
4743	5.4	-6.6	2251	9000022	Méagui	5.3917	-6.5578	859	4.774
4776	5.6	-6.8	2251	9000099	Zuguagui	5.6187	-6.7812	194	2.943
4778	5.6	-6.6	2251	9000064	Gblettia Meagui	5.6327	-6.6290	1362	4.851
4783	5.6	-6.1	2251	9000174	Dogopié	5.5585	-6.1495	1628	7.170
4793	5.7	-6.1	2251	9000173	Guéyo	5.6882	-6.0718	1435	3.393
4797	5.8	-6.8	2251	9000170	Takoréagui	5.7556	-6.7917	1788	5.014
4799	5.8	-6.6	2251	9000026	Soubré	5.7963	-6.5787	1514	2.400
4799	5.8	-6.6	2251	9000371	Soubré CCC	5.7899	-6.5971	1087	1.166
4812	6.0	-6.6	2251	9000169	Yabayo	5.9553	-6.5958	1755	4.984
4814	6.0	-6.4	2251	9000161	Bakayo II	5.9930	-6.4363	1385	4.104
4821	6.1	-6.5	2251	9000057	Grand-Zattry	6.1105	-6.5398	1970	4.569
4830	6.2	-6.5	2251	9000168	Mayéoua	6.2020	-6.4547	1734	5.033
4837	6.7	-3.7	2251	9000080	Ettienkro	6.6605	-3.6723	214	5.355
4839	6.7	-3.5	2251	9000377	Abengourou CCC	6.7247	-3.5093	1072	2.930
4872	5.5	-3.2	2251	9000366	Aboisso CCC	5.4629	-3.2098	559	4.259
4874	5.5	-3.0	2251	9000012	Maféré	5.5003	-3.0118	1573	1.310
4914	6.5	-3.6	2251	9000242	Amien-Kouasikro	6.4674	-3.6414	131	5.849
4920	6.6	-3.4	2251	9000128	Appoisso	6.5500	-3.4333	254	6.668
4924	6.8	-3.5	2251	9000124	Akoikro	6.7727	-3.5068	139	3.123
4947	6.0	-6.3	2251	9000059	Galebre-Galébouo	6.0040	-6.2980	1762	0.496
4949	6.1	-6.2	2251	9000205	Basséhoa	6.1349	-6.2466	1056	6.462
4951	6.1	-6.0	2251	9000018	Gagnoa	6.1194	-5.9676	31	4.192
4951	6.1	-6.0	2251	9000180	Gagnoa Agara	6.1199	-5.9686	1704	4.126
4951	6.1	-6.0	2251	9000068	Guessihio	6.1032	-6.0035	2248	0.526
4952	6.1	-5.9	2251	9000369	Gagnoa CCC	6.1115	-5.9343	1057	4.016
4952	6.1	-5.9	2251	9000083	Mocko	6.1332	-5.9052	2040	3.730
4962	6.2	-5.3	2251	9000171	Moussadougou	6.2485	-5.3233	14	5.973
4967	6.2	-6.2	2251	9000137	Guibéroua	6.2467	-6.1803	1191	5.626
4970	6.2	-5.9	2251	9000180	Gagnoa Agara	6.1545	-5.9460	2128	7.182
4971	6.2	-5.8	2251	9000079	Logobia-Abolikro	6.2110	-5.8022	1208	1.245
4971	6.2	-5.8	2251	9000069	Zikisso Niabre	6.1533	-5.7612	1657	6.739
4972	6.2	-5.7	2251	9000151	Tiégba	6.2362	-5.6505	1345	6.807
4976	6.2	-5.2	2251	9000195	Léléblé	6.2280	-5.2326	1208	4.770
4981	6.3	-5.9	2251	9000190	Ouragahioville	6.3132	-5.9271	1609	3.346
4984	6.3	-5.6	2251	9000165	Diégonéfla	6.2882	-5.5702	1644	3.558
4987	6.4	-6.0	2251	9000188	Téhiri	6.3974	-5.9851	1156	1.679
5022	5.8	-6.2	2251	9000176	Jean-Baptistekro	5.8080	-6.1670	1741	3.769
5026	5.8	-5.8	2251	9000196	Gobouet	5.7570	-5.7536	983	7.022
5027	5.8	-5.7	2251	9000093	Lakota	5.8407	-5.6832	2173	4.887
5030	5.8	-5.4	2251	9000370	Divo CCC	5.8345	-5.3762	1060	4.652
5036	5.9	-6.1	2251	9000394	Sérihio	5.9018	-6.1220	372	2.450
5037	5.9	-6.0	2251	9000122	Niahirio	5.8960	-5.9550	1191	5.015
5038	5.9	-5.9	2251	9000182	Gnamagnoa	5.9362	-5.8517	1616	6.700
5043	5.9	-5.4	2251	9000063	Divo Konankro	5.8539	-5.3624	1926	6.603
5045	5.9	-5.2	2251	9000206	Ogoudou Obié	5.9143	-5.2153	859	2.325

ERA5				Veriground					
Grid ID	Latitude	Longitude	No. of Reports	Locality ID	Locality Name	Latitude	Longitude	No. of Reports	Distance to ERA5 grid midpoint (km)
5047	5.9	-5.0	2251	9000062	Hermankono-Garo	5.9310	-5.0189	1041	4.030
5049	6.0	-6.1	2251	9000138	Petit Adjamé	6.0373	-6.1451	1716	6.496
5051	6.0	-5.8	2251	9000202	Gogne	6.0210	-5.7579	1398	5.222
5056	6.0	-5.3	2251	9000143	Didoko	6.0126	-5.2898	1383	1.799
5067	6.5	-5.9	2251	9000166	Sinfra-Yaokro	6.5489	-5.9290	1461	6.311
5088	6.4	-4.8	2251	9000164	Didayaokro	6.4148	-4.8217	1632	2.916
5113	6.6	-4.6	2251	9000204	Ebimolossou	6.6132	-4.6335	1294	3.997
5117	6.6	-4.2	2251	9000376	Bongouanou CCC	6.6499	-4.1998	1069	5.539
5374	5.9	-4.8	2251	9000023	N'douci	5.8701	-4.7670	1773	4.943
5374	5.9	-4.8	2251	9000027	Tiassalé	5.8882	-4.8238	1818	2.949
5380	5.9	-4.2	2251	9000367	Agboville CCC	5.9268	-4.2033	971	2.997
5409	6.1	-4.3	2251	9000187	Rubino	6.1387	-4.3097	555	4.429
5517	6.6	-7.4	2251	9000129	Lokossou	6.6062	-7.3821	729	2.103
5518	6.6	-7.3	2251	9000034	Duékoué Pinhou	6.6343	-7.3498	164	6.712
5532	6.7	-7.3	2251	9000074	Duékoué	6.7365	-7.3438	1390	6.329
5532	6.7	-7.3	2251	9000373	Duekoué CCC	6.7434	-7.3466	1062	7.068
5534	6.7	-7.1	2251	9000072	Duékoué Guézon	6.7378	-7.1175	325	4.624
5534	6.7	-7.1	2251	9000177	Guézon	6.7333	-7.1167	1162	4.135
5559	6.9	-7.4	2251	9000130	Guéhiébly	6.9000	-7.4333	372	3.696
5567	7.1	-7.9	2251	9000134	Zérégbo	7.0725	-7.9097	1734	3.237
5570	7.1	-7.6	2251	9000133	Logoualé	7.1167	-7.5500	1686	5.851
5572	7.1	-7.4	2251	9000141	Gloplou	7.1115	-7.3523	1771	5.446
5609	7.4	-7.6	2251	9000374	Man CCC	7.3947	-7.5658	1066	3.842
5610	7.4	-7.5	2251	9000073	Man	7.4120	-7.5445	89	5.116
5610	7.4	-7.5	2251	9000158	Man (South)	7.3840	-7.5420	447	4.989
5611	7.4	-7.4	2251	9000159	Facobly	7.3877	-7.3762	1773	2.974
5620	7.6	-7.7	2251	9000117	Blapleu	7.6349	-7.7276	1156	4.939
5628	7.7	-8.0	2251	9000167	Guelemou	7.7298	-7.9722	286	4.524
5630	7.7	-7.8	2251	9000156	Santa	7.6660	-7.8492	251	6.638
5632	7.7	-7.6	2251	9000157	Biankouma	7.7440	-7.6197	1812	5.351
5657	6.4	-6.5	2251	9000209	Tapéguia	6.3872	-6.5128	1006	2.009
5664	6.5	-6.6	2251	9000019	Issia	6.4917	-6.5618	1897	4.339
5678	6.6	-6.2	2251	9000183	Kouakou-Oussoukro	6.5501	-6.2050	740	5.567
5697	6.7	-5.8	2251	9000078	Sinfra	6.7240	-5.8408	184	5.254
5704	6.8	-6.6	2251	9000160	Korea	6.7971	-6.6385	1573	4.286
5722	6.9	-6.4	2251	9000071	Daloa	6.8842	-6.4428	1183	5.064
5722	6.9	-6.4	2251	9000372	Daloa CCC	6.8903	-6.4493	1083	5.577
5722	6.9	-6.4	2251	9000017	Daloa Northwest	6.8838	-6.4475		5.571
5743	7.0	-5.7	2251	9000067	Bouaflé	6.9855	-5.7455	252	5.301
5751	7.1	-6.5	2251	9000172	Bonoufla	7.1333	-6.4833	789	4.135
5795	7.4	-6.5	2251	9000088	Vavoua	7.3833	-6.4753	2052	3.310
5915	6.7	-5.4	2251	9000030	Zambakro east	6.7372	-5.3740	1570	5.038
5915	6.7	-5.4	2251	9000065	Zambakro north-center	6.7382	-5.3770	2192	4.949
5915	6.7	-5.4	2251	9000066	Zambakro west	6.7379	-5.3776	1701	4.887
5920	6.8	-5.2	2251	9000378	Yamoussoukro CCC	6.8009	-5.2429	1067	4.763
6057	7.9	-3.3	2251	9000208	Tiedo	7.9043	-3.2962	1125	0.637
10384	7.0	-7.8	2251	9000132	Zou	6.9793	-7.7935	1390	2.408
10385	7.0	-7.7	2251	9000135	Banguehi	6.9637	-7.6677	1527	5.393
10387	7.0	-7.5	2251	9000032	Bangolo	7.0148	-7.4892	885	2.034
10388	7.0	-7.4	2251	9000136	Bahé	6.9521	-7.3977	1414	5.323
10880	6.5	-7.5	2251	9000035	Guiglo	6.5307	-7.4856	1816	3.764

Appendix B
Ghana Matching Station Reports

ERA5				Veriground					
Grid ID	Latitude	Longitude	No. of Reports	Locality ID	Locality Name	Latitude	Longitude	No. of Reports	Distance to ERA5 grid midpoint (km)
6105	5.9	-1.3	2251	9000231	Assin Bereku	5.8580	-1.3325	285	5.895
6110	6.0	-1.4	2251	9000229	Assin Apagya	5.9913	-1.3741	279	3.033
6134	6.3	-1.5	2251	9000225	Adansi Brofoyedru	6.2514	-1.4867	247	5.593
6144	6.4	-1.7	2251	9000222	Sarfokrom	6.4369	-1.7473	301	6.659
6148	6.4	-1.3	2251	9000224	Asiwa	6.4220	-1.3352	299	4.608
6159	6.5	-1.6	2251	9000223	Bekwai Denyase	6.4529	-1.6068	255	5.282
6163	6.5	-1.2	2251	9000237	Banso	6.4547	-1.1877	269	5.210
6176	6.6	-1.3	2251	9000109	Adumasa	6.5641	-1.3124	1264	4.216
6180	6.7	-1.8	2251	9000185	Nkawie CHED	6.6646	-1.8102	1692	4.089
6192	6.8	-1.7	2251	9000247	Adankwame	6.7968	-1.7126	10	1.443
6192	6.8	-1.7	2251	9000250	Penteng	6.8390	-1.6774	9	5.003
6208	6.9	-1.7	2251	9000144	Offinso CHED	6.9360	-1.6750	1779	4.865
6211	6.9	-1.4	2251	9000246	Effiduase	6.8610	-1.3989	11	4.331
6218	7.0	-2.2	2251	9000103	Akwesiase	6.9773	-2.2118	1227	2.840
6222	7.0	-1.8	2251	9000220	Apotosu	6.9956	-1.7825	253	2.003
6224	7.0	-1.6	2251	9000248	Tetrem	7.0402	-1.6386	9	6.186
6225	7.0	-1.5	2251	9000142	Agona Jamasi SPD	6.9660	-1.4702	1359	5.018
6235	7.1	-1.7	2251	9000221	Abofour	7.1300	-1.7396	302	5.515
6262	7.3	-1.9	2251	9000389	Nkenkaasu	7.3171	-1.9037	840	1.942
6278	7.4	-2.1	2251	9000249	Tanokeam	7.4405	-2.0836	9	4.850
6295	6.9	-2.9	2251	9000104	Kwesifrekrom	6.9087	-2.8762	1737	2.813
6296	7.0	-3.1	2251	9000147	Nkrankwanta	7.0167	-3.0500	701	5.851
6310	7.3	-2.9	2251	9000146	Dormaa CHED	7.2720	-2.8841	1476	3.574
6316	7.3	-2.3	2251	9000184	Sunyani CHED	7.3422	-2.3294	1137	5.709
6503	5.3	-1.2	2251	9000230	Abura Dunkwa	5.3402	-1.1908	238	4.578
6521	5.5	-1.4	2251	9000233	Denkyire-Bobi	5.4822	-1.4372	296	4.578
6529	5.5	-0.6	2251	9000375	Gomoa East	5.4551	-0.6189	434	5.407
6537	5.6	-1.0	2251	9000235	Breman Asikuma	5.5802	-1.0018	290	2.207
6538	5.6	-0.9	2251	9000070	Agona Bobikumah	5.5503	-0.8575	1783	7.259
6540	5.6	-0.7	2251	9000092	Agona Duakwa	5.6333	-0.6860	1894	4.010
6547	5.7	-1.3	2251	9000385	Assin Adiembra	5.6727	-1.3313	1005	4.610
6581	5.9	-0.1	2251	9000098	Akropong Akuapem	5.9480	-0.1002	1715	5.328
6583	6.0	-1.0	2251	9000097	Nyamennea	5.9588	-0.9795	1804	5.108
6589	6.0	-0.4	2251	9000119	Suhum	6.0077	-0.4365	1465	4.141
6596	6.1	-0.8	2251	9000398	Kade	6.1442	-0.8295	301	5.899
6601	6.1	-0.3	2251	9000383	Oyoko CHED	6.1333	-0.2815	1038	4.228
6604	6.1	0.0	2251	9000120	Odumase-Krobo	6.1453	-0.0003	1872	5.028
6604	6.1	0.0	2251	9000380	Shai Osudoku	6.0549	0.0020	827	5.011
6606	6.2	-1.1	2251	9000399	Ofuase	6.1677	-1.1259	298	4.596
6613	6.2	-0.4	2251	9000384	Koforidua Tafo SPD	6.2321	-0.3755	1025	4.482
6620	6.3	-1.0	2251	9000400	New Abirem	6.3406	-0.9975	301	4.515
6623	6.3	-0.7	2251	9000401	Abomosu	6.3005	-0.7235	304	2.609
6624	6.3	-0.6	2251	9000121	Akim Kwabeng	6.3218	-0.5915		2.597
6624	6.3	-0.6	2251	9000388	Akyem Kwabeng	6.3219	-0.5915	1639	2.608
6625	6.3	-0.5	2251	9000096	Bunso	6.2823	-0.4662	1613	4.235
6646	6.5	-0.8	2251	9000236	Kwame Nkrumah	6.4725	-0.7771	269	3.972
6710	5.8	-0.6	2251	9000397	Asuokaw	5.8208	-0.6327	226	4.302
6714	5.8	-0.2	2251	9000201	Peduase	5.8028	-0.1873	1152	1.444
6718	5.6	-0.2	2251	9000199	Accra Cantonments	5.5799	-0.1602	1436	4.949
6718	5.6	-0.2	2251	9000251	Achimota School	5.6282	-0.2121		3.406

ERA5				Veriground					
Grid ID	Latitude	Longitude	No. of Reports	Locality ID	Locality Name	Latitude	Longitude	No. of Reports	Distance to ERA5 grid midpoint (km)
6722	5.7	-0.3	2251	9000198	Accra Pokuase	5.7049	-0.2890	1429	1.337
6723	5.7	-0.2	2251	9000197	Accra-GMA Headquarters	5.6521	-0.1645	1403	6.618
6724	5.7	-0.1	2251	9000200	Adenta Frafraha	5.7260	-0.1392	1074	5.221
6725	5.7	0.0	2251	9000095	Tema	5.6987	0.0397	1944	4.409
6728	5.8	0.0	2251	9000194	Tema Afienya	5.7613	0.0084	194	4.396
6916	5.4	-1.6	2251	9000234	Wassa Dormama	5.3753	-1.5731	295	4.054
6929	5.6	-2.3	2251	9000107	Manso Amenfi	5.6453	-2.2677	1971	6.176
6932	5.6	-2.0	2251	9000244	Bogoso	5.5691	-2.0011	31	3.432
6935	5.6	-1.7	2251	9000386	Saponso No2 (Twifo Praso)	5.5785	-1.6629	1016	4.760
6946	5.8	-2.1	2251	9000243	Wassa-Akropong	5.7828	-2.0823	31	2.740
6982	5.9	-2.7	2251	9000152	Acquai Allah	5.8835	-2.6633	1607	4.466
7001	6.2	-2.7	2251	9000175	Bodi	6.2433	-2.7489	948	7.250
7002	6.2	-2.6	2251	9000154	Ackaakrom	6.2158	-2.6306	120	3.823
7002	6.2	-2.6	2251	9000193	Nsawora	6.1506	-2.6047	1318	5.508
7008	6.3	-3.0	2251	9000192	Bonsu Adamase	6.3206	-3.0172	877	2.979
7008	6.3	-3.0	2251	9000153	Prosohene Nkwanta	6.3377	-2.9839	126	4.550
7022	6.4	-2.7	2251	9000106	Asafo	6.3957	-2.6583	1880	4.653
7025	6.4	-2.3	2251	9000150	Chenchenase	6.4078	-2.3005	1376	0.868
7056	7.5	-2.1	2251	9000145	Techiman-Nsuta	7.5350	-2.0833	1014	4.305
7057	6.0	-1.9	2251	9000232	Adwenpakrom	5.9612	-1.8587	296	6.290
7058	5.1	-1.4	2251	9000245	Hope Academy - Ayensudo	5.0879	-1.4391	29	4.543
7060	5.2	-1.4	2251	9000178	Abrem Agona	5.1771	-1.4203	1113	3.397
7099	5.1	-1.7	2251	9000390	Daboase	5.1391	-1.6608	836	6.146
7102	5.2	-2.7	2251	9000110	Nyamebekyere	5.1825	-2.6803	1642	2.925
7108	5.2	-2.1	2251	9000108	Dompem	5.1655	-2.0707	2012	5.024
7116	6.7	-3.1	2251	9000105	Essam CHED	6.6658	-3.1082	1350	3.904
23372	10.8	-0.9	2251	9000396	Bolgatanga	10.8046	-0.8668	61	3.720
23379	10.8	-0.2	2251	9000216	Garu	10.8465	-0.1780	777	5.710
23621	10.9	-1.1	2251	9000219	Navrongo	10.8784	-1.0833	1221	3.031
23624	10.9	-0.8	2251	9000218	Gowrie Vea Dam	10.8610	-0.8450	535	6.610
23880	11.0	-0.3	2251	9000217	Binduri	10.9702	-0.3091	1055	3.459

Appendix C
Nigeria Matching Station Reports

ERA5				Veriground					
Grid ID	Latitude	Longitude	No. of Reports	Locality ID	Locality Name	Latitude	Longitude	No. of Reports	Distance to ERA5 grid midpoint (km)
10435	7.0	4.8	2251	9000076	Bagbe	6.9820	4.8467	380	5.555
12117	7.3	5.1	2251	9000112	Northwest Akure	7.3063	5.1428	1441	4.802
12118	7.3	5.2	2251	9000113	East Akure	7.2617	5.2280	1744	5.266
12210	7.2	4.8	2251	9000075	Afforestation	7.1862	4.8013	60	1.539
12211	7.2	4.9	2251	9000114	Ile Oluji	7.2142	4.8703	195	3.654
12214	7.2	5.2	2251	9000091	Akure	7.2202	5.2187	159	3.055
12214	7.2	5.2	2251	9000191	Southwest Akure	7.1962	5.1627	128	4.162
12311	7.1	5.3	2251	9000203	Ologere	7.1320	5.2870	14	3.834

Appendix D
Ecuador Matching Station Reports

ERA5				Veriground					
Grid ID	Latitude	Longitude	No. of Reports	Locality ID	Locality Name	Latitude	Longitude	No. of Reports	Distance to ERA5 grid midpoint (km)
39044	0.2	-78.7	2251	9000127	Nanegal Farm	0.1887	-78.6776	1633	2.785
39162	0.1	-79.4	2251	9000391	La Unión	0.1288	-79.4073	694	3.298
39717	-0.4	-79.4	2251	9000387	Puerto Limon	-0.4051	-79.3831	769	1.959
40057	-0.7	-80.1	2251	9000393	Chone	-0.6882	-80.1239	81	2.959
40272	-0.9	-79.4	2251	9000055	Chollo Farm	-0.9061	-79.4247	1323	2.824
40615	-1.2	-80.4	2251	9000382	Lodana	-1.1735	-80.3873	802	3.262
40716	-1.3	-79.4	2251	9000125	La Ercilia	-1.2722	-79.4195	643	3.769
41053	-1.6	-79.8	2251	9000115	Vinces	-1.5710	-79.8191	184	3.854
41610	-2.1	-80.0	2251	9000087	Guayaquil	-2.0815	-79.9524	1581	5.669
41825	-2.3	-79.3	2251	9000381	El Triunfo	-2.3039	-79.2638	862	4.041
42161	-2.6	-79.6	2251	9000102	Naranjal	-2.6491	-79.6179	1025	5.801
42940	-3.3	-79.8	2251	9000392	Cañaquemada	-3.2969	-79.7941	633	0.740