Global Yield Gap Atlas

GYGA Weather Data Sources in Sub-Saharan Africa

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ICRISAT Science with a human face

Weather data used for simulations

- First choice: Observed, high quality, 10+ years
  - Tmin, Tmax, solar radiation, relative humidity, precipitation
- Acceptable: Observed, 3+ years of Tmin, Tmax
  - Missing data estimated by “propagation” (see detailed explanation in the next slides)
- Last resort: gridded data (NASA-POWER Agro-Climatic Data)

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Weather data used for simulations (cont.)

- The majority of the observed weather data was provided by country agronomists (CA).
- Simulations were based on all available observed data and, if there was not enough data, propagated data to supplement the observed data and reach an acceptable number of years
- If observed weather data were not available at all, we used crude weather data from NASA for the simulations
- Because we were not allowed to make observed data provided by CA publicly available, weather data posted in the GYGA website contains only propagated data (being calibrated using the observed data provided by CA) or crude NASA data for those locations for which weather data did not exist.

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Justification for propagated weather data

- A robust estimation of average yield potential using crop simulation models requires long-term daily weather data (15+ yrs)
- However, in many regions of the world, only few years of measured weather data (and for a limited number of variables) are available
- Even if observed weather data are available (and can be used for simulations), the underpinning data can be rarely made publicly available
- How can we use a few years of weather data to 'generate' suitable long-term weather records for crop simulations and/or to generate weather files that can be made publicly available?

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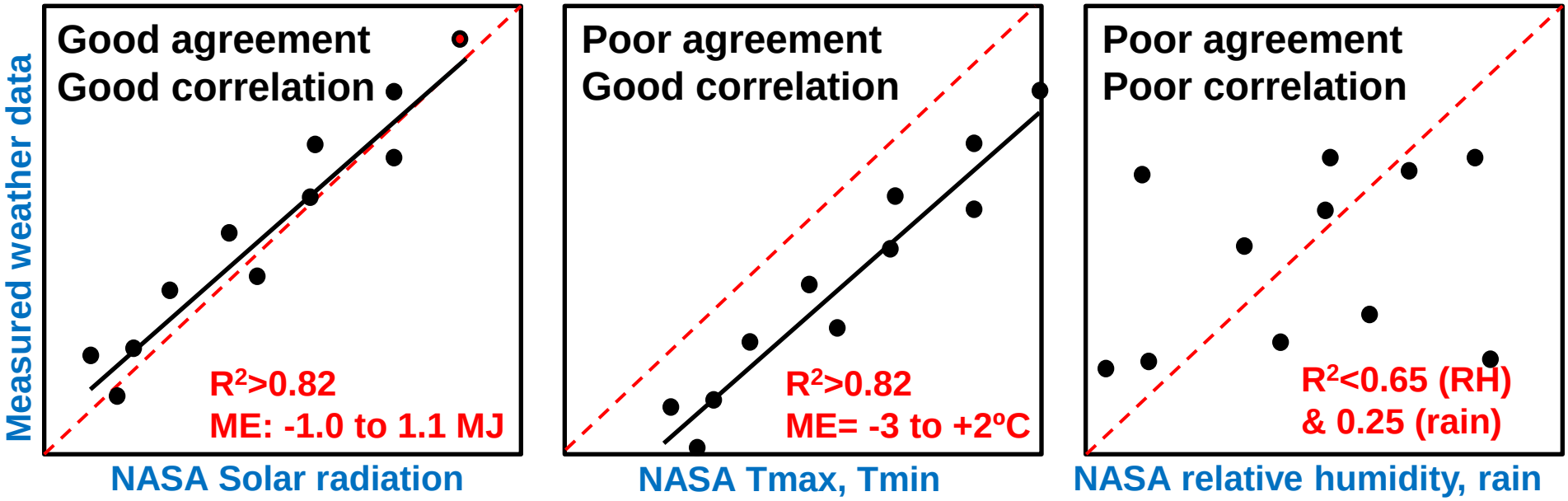
Summary of a the comparison between NASA and observed daily weather data

Red dashed line: 1-to-1 line; solid black line: linear regression. Note that dots do not represent actual data!



- **'Crude' NASA radiation can be used for simulations, except at sites with complex topography**
- **Good correlation between NASA vs. measured Tmax & Tmin but poor agreement. NASA temperature can be used for simulations after calibration against few years of measured data**
- **Very poor agreement and correlation between NASA vs. measured relative humidity and precipitation**

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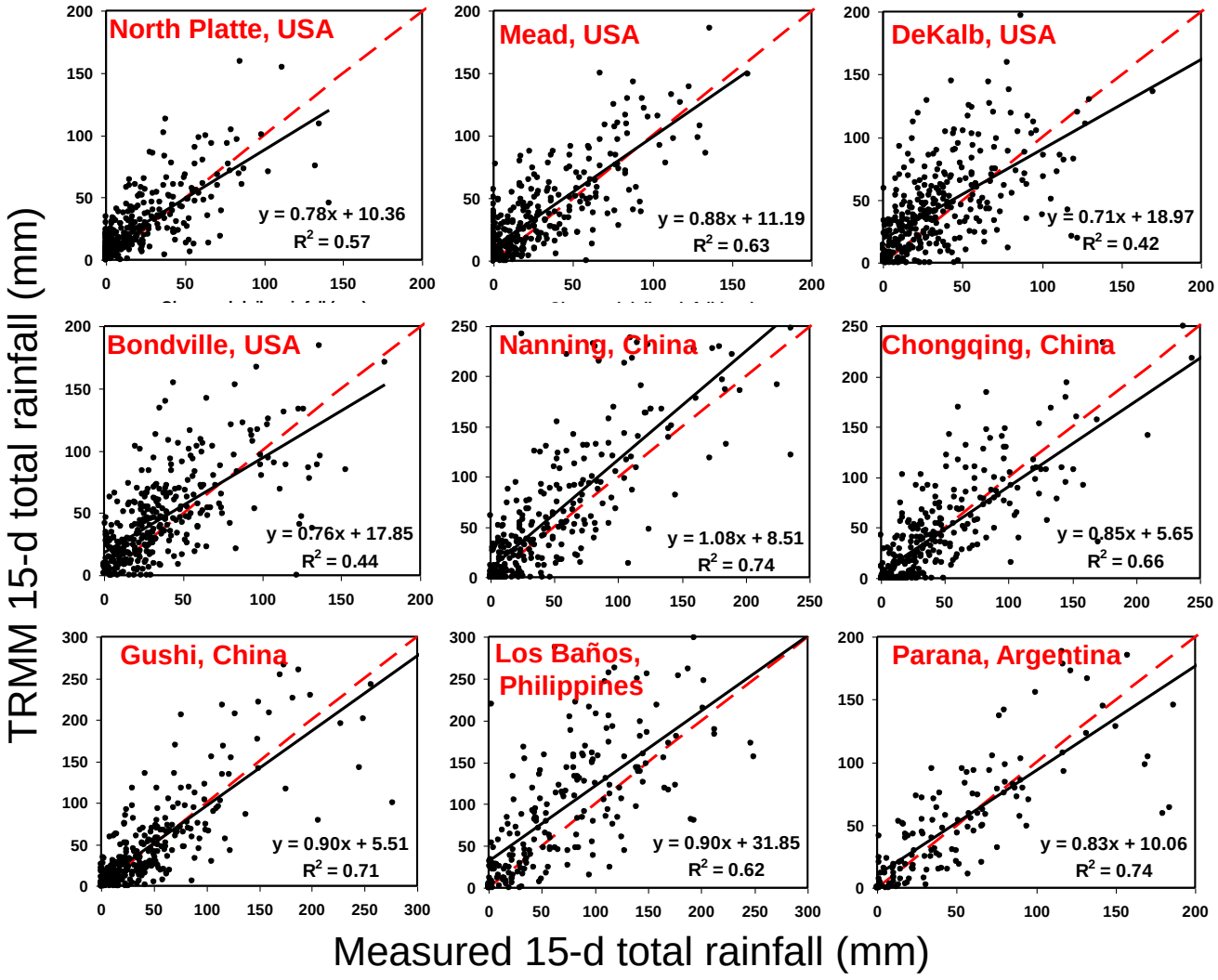
TRMM *versus* observed 15-day total precipitation

Red dashed line: 1-to-1 line; solid black line: linear regression.



TRMM 15-d total precipitation and occurrence of wet/dry days are in reasonable agreement with observed precipitation data making TRMM a viable alternative for crop model simulations when observed precipitation data are not available

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Propagation of long-term daily weather data

- **Crude solar radiation** from NASA-POWER
- **Calibrated-NASA Tmax and Tmin** based on correlations between NASA and ground-measured Tmax and Tmin for a few number of years
- **Humidity is derived from crude NASA Tdew** (unless measured Tdew or RH are available)
- **Crude TRMM rainfall data**

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Testing propagated weather data

- By the end of the day, we want to see how well simulated yields based on propagated weather compare against simulations based on measured weather data
- In practice, we won't know *a priori* which subset of years of measured weather data will be available for calibrating NASA Tmax and Tmin.
- To evaluate the sensitivity to 'year effect', we calibrated NASA Tmax and Tmin based on all possible subsets of 3 consecutive years of measured Tmax and Tmin. This yielded into multiple files of propagated weather data and multiple simulated average yields.
- The distribution of average simulated yields based on propagated weather data was compared against the (single) average simulated yield based on long-term measured weather data
- In the comparison, we also included the average yield simulated using crude NASA, crude NASA + TRMM rain, and generated weather data derived from monthly means using MarkSim
- The comparison was performed for 18 locations (including sites in South and North America, Europe, Africa, and Asia) using well-validated models based on site-specific management practices and soil type.

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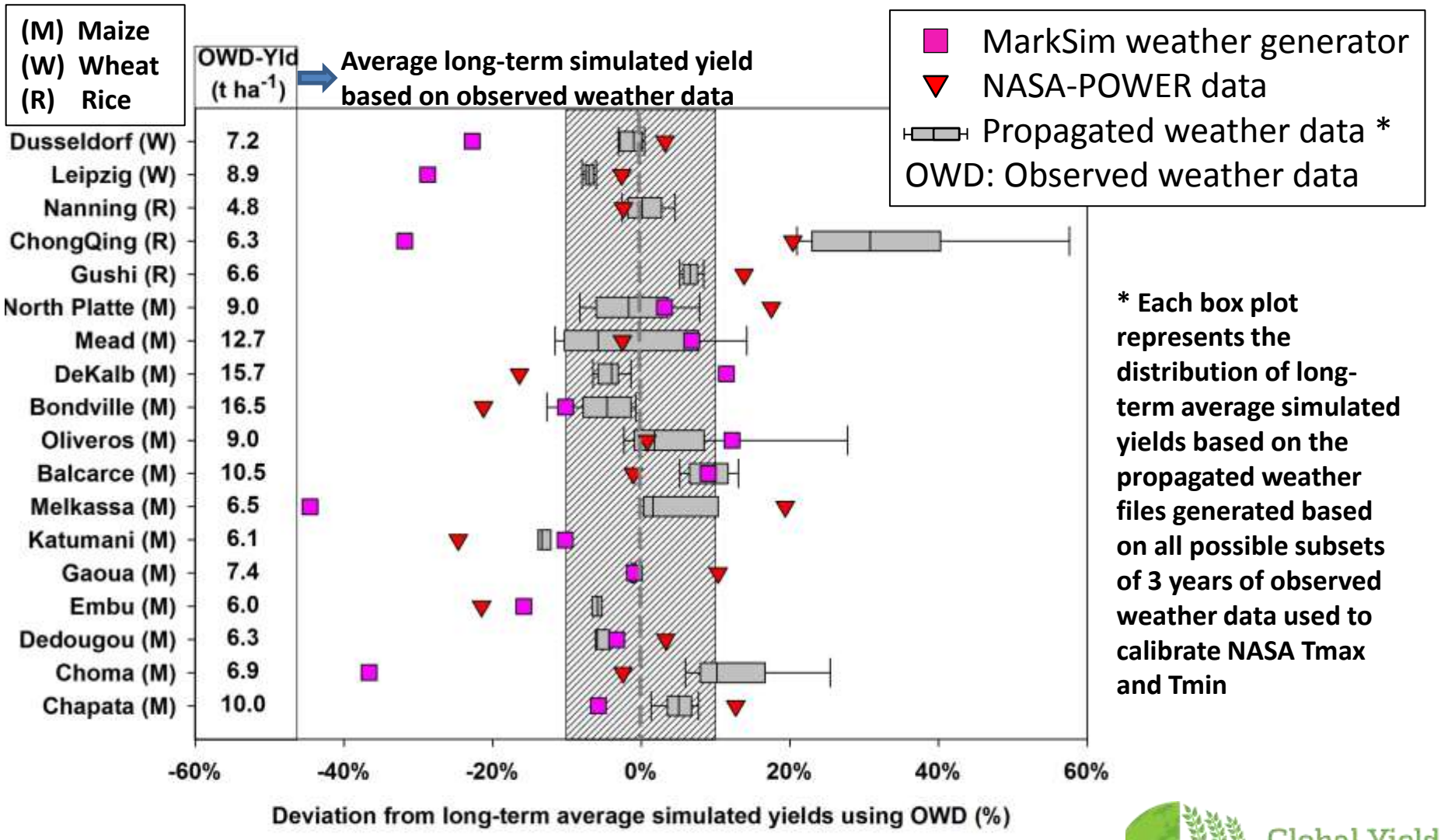
Simulations of yield potential based on propagated *versus* observed and gridded weather data



*** Each box plot represents the distribution of long-term average simulated yields based on the propagated weather files generated based on all possible subsets of 3 years of observed weather data used to calibrate NASA Tmax and Tmin**

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Conclusions

- Distribution of simulated yields based on propagated weather was within (or very close to) ± 10% of the simulated yield based on measured weather in 83% of the cases
- Simulations based on propagated weather had better agreement with simulations based on measured weather than other sources of weather data (such as crude NASA or weather generators)
- Wherever only few years of measured Tmax & Tmin data are available, the propagation technique is a viable and superior alternative to generate long-term weather for crop simulations.

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Conclusions (cont.)

- After phase-1, GYGA has one of the most complete, site-specific, weather database for Sub-Sahara Africa
- Simulations were based on all available observed data (provided by country agronomists), and, if there was not enough data, propagated data to supplement the observed data and reach an acceptable number of years
- Because we are not allowed to post observed data provided by country agronomists, weather data posted in the GYGA website contains only propagated data (being calibrated using the observed data provided by CA) or crude NASA data for those locations for which weather data did not exist.
- Different types of weather data will be distinguished by colour coding – SEE NEXT SLIDE

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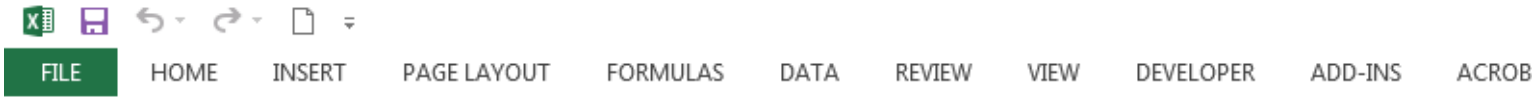
Observed data



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	A	B	C	D	E	F	G	H	I	J	K	L
1	Country:	Burkina Faso										
2	Station:	Fada Ngourma		Private weather data based on observed, NASA data for 1990-2006								
3	Station #:	4000004										
4	Years:	1990-2006										
5	Source:	Lieven Classen and Korodjouma Ouattara										
6	Longitude:	0.367										
7	Latitude:	12.033										
8	Elevation (	294		**GYGA private weather data for Fada Ngourma, 1990-2006**								
9	Year	Month	Day	Solar (MJ/m2)	MaxT (°C)	MinT (°C)	Mean RelHum (%)	Precip (mm)	Mean WndSpd (m/s)	Mean Vapour Pressure (kPa)	Mean Tdew (°C)	Sunshine Hours
10	1990	1	1	20.8	30.4	19.4	26	0	2		5	
11	1990	1	2	20.3	31.8	17.6	18	0	2		-0.1	
12	1990	1	3	19.8	33.3	18.1	17	0	2		0.1	
13	1990	1	4	19.5	34.2	17.7	16	0	2		-0.1	
14	1990	1	5	18.6	35	18.6	15	0	2		-0.6	
15	1990	1	6	18.8	35.1	19.2	15	0	2		-0.2	
16	1990	1	7	18.1	35.4	18.5	16	0	2		0.7	
17	1990	1	8	18.2	33.1	20.1	18	0	2		1.4	
18	1990	1	9	21.5	33.2	17.8	18	0	2		0.9	
19	1990	1	10	14.9	32.6	19.8	18	0	2		1.1	
20	1990	1	11	16.3	32	19.4	19	0	2		0.9	
21	1990	1	12	15	33.5	20.4	19	0	2		1.9	
22	1990	1	13	16.6	34.4	19.9	18	0	2		2	

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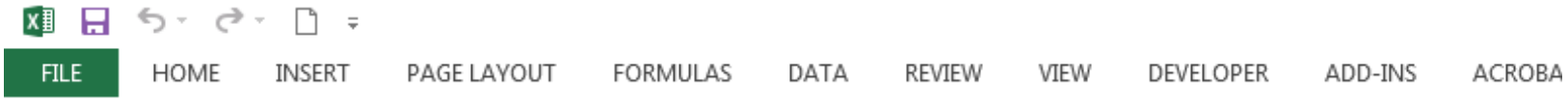
Propagated data



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	A	B	C	D	E	F	G	H	I	J	K	L
1	Country:	Kenya										
2	Station:	Kericho		Propagated weather data based on calibration with NASA data for 1992-2012								
3	Station #:	9035279										
4	Years:	1992-2012										
5	Source:	Lieven Classen and Adimo Ochieng										
6	Longitude:	35.16										
7	Latitude:	-0.22										
8	Elevation (	2093		**GYGA propagated weather data for Kericho, 1992-2012**								
9	Year	Month	Day	Solar (MJ/m2)	MaxT (°C)	MinT (°C)	Mean RelHum (%)	Precip (mm)	Mean WndSpd (m/s)	Mean Vapour Pressure (kPa)	Mean Tdew (°C)	Sunshine Hours
10	1992	1	1	19.4	23.6826	10.96202	55	0	2		9.2	
11	1992	1	2	19.5	24.37966	10.98333	47	0	2		7.2	
12	1992	1	3	21.7	24.10084	10.68492	50	0	2		7.9	
13	1992	1	4	22.7	23.26436	11.45226	55	0	2		9	
14	1992	1	5	26.2	24.24025	11.00465	40	0	2		4.8	
15	1992	1	6	21.2	23.6826	10.57835	55	0	2		9.1	
16	1992	1	7	17.5	22.84612	11.23911	65	0	2		11.2	
17	1992	1	8	23.4	24.03113	10.57835	50	0	2		7.8	
18	1992	1	9	23.8	23.89172	10.9407	51	0	2		8.2	
19	1992	1	10	21.6	24.58878	11.02596	45	0	2		7	

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Crude data from NASA

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	A	B	C	D	E	F	G	H	I	J
1	* Country:	Kenya								
2	* Station:	Ken_rfmz2		Propagated weather data based on calibration with NASA data for 1998-2012						
3	* Station #:	9000104								
4	* Years:	1998-2012								
5	* Source:	NASA-POWER								
6	* Longitude:	37.922								
7	* Latitude:	-2.629								
8	* Elevation (m)	1256		**GYGA propagated weather data for Ken_rfmz2, 1998-2012**						
9	Year	Month	Day	Solar (MJ/m2)	MaxT (°C)	MinT (°C)	Mean RelHum (%)	Precip (mm)	Mean WndSpd (m/s)	Mean Va Pressure
10	1998	1	1	20.3	24.7	15.3	81.2	0	2.00	
11	1998	1	2	21.6	24.8	13.8	85.5	5.3	2.00	
12	1998	1	3	13.5	23.9	15.2	86.2	7.9	2.00	
13	1998	1	4	18.1	24.2	16.7	86.4	0	2.00	
14	1998	1	5	16.8	23.4	17.7	81.1	2.8	2.00	
15	1998	1	6	16.3	22.5	17.6	88	2.1	2.00	
16	1998	1	7	17.2	23.5	17.8	87.1	0.9	2.00	
17	1998	1	8	14.8	23.9	17.6	84.9	1.9	2.00	
18	1998	1	9	16.4	22	14.2	90.9	7	2.00	
19	1998	1	10	18.4	23.9	13.5	86.9	11.6	2.00	

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References

Van Wart, J., Grassini, P., Yang, H.S., Claessens, L., Jarvis, A., Cassman, K.G.. Creating long-term weather data from the thin air for crop simulation modelling. Submitted to *Agric. For. Meteoro.*

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