The Centre for Solar Energy Research and Studies

Paper on

Testing Two Calibration Models Using Silicon-Photodiode Pyranometer (LICOR200) Measurements under the Libyan Geographic and Climatic Conditions:

Tripoli City Case

The content:

- The motivation
- The thesis.
- data filtration and the weather parameters.
- The methodology
- The analysis & results.
- Conclusion & recommendation.

The Motivation:

- This research reflects a move from theory to an application, since it is of first kind to be done in the national level,
- This calibration reflects one of serious attempts to move from being national center to regional center,
- It will be used as a model for the validation of an archive of global radiation data collected by LICO-200 in different regions across Libya,

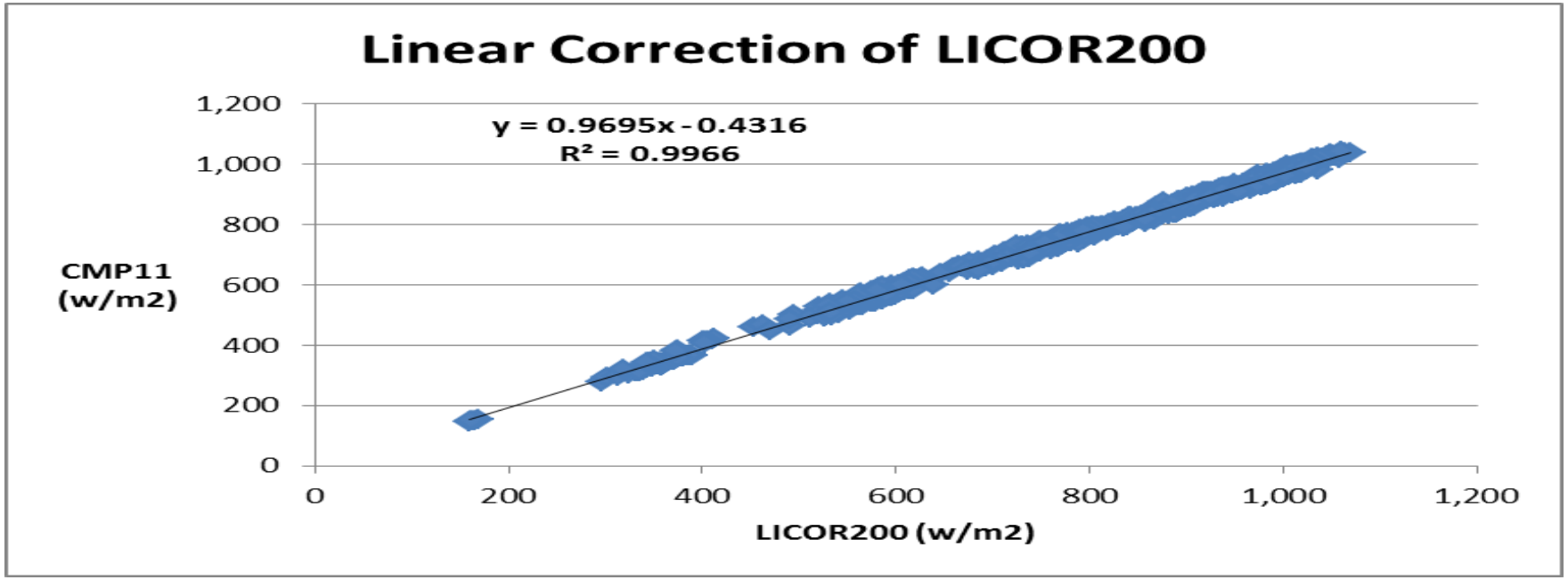
The thesis

- This study aims at testing two approaches of calibration for correcting data of total global radiation collected using silicon pyranometer (**LI-COR200.PY35515**) in order to decide which of either (King and Mayer,1998)'s approach or (Navaro, 1988) linear regression equation better suits the Libyan climatic and geographic conditions.

The process of data filtration:

- **The AWS site's standard conditions is (long: 13*.26 E, Lat: 32*.48 N, Elevation: 65 M.S.L, Atmospheric Pressure: 1020 mb).**
- Temperature AVG ranged from (25-30), RH AVG (%60) and atmospheric pressure AVG (1016 mb), this is only during the period of data collection.
- **Data of 1-minute intervals were recorded using INTAB2000 datalogger. An hourly average was calculated for the analyses. For the period (05, Mar – 31, Jul 2021)**
- For the filtration of the data, zenith angles of greater than (80*) were eliminated. The threshold for clear sky index used for determining the clear sky days for the calibration is (Kt = 0.75), (Ineichen,2005).
- Having the data filtered, the number of (32) days left from the whole period (5 Mar- 31 Jul), while the zenith angles ranged from (80* – 10*), (AM) ranged from (1 - 3.6). and the sunshine duration hours reached 12 Hrs in Jun month.

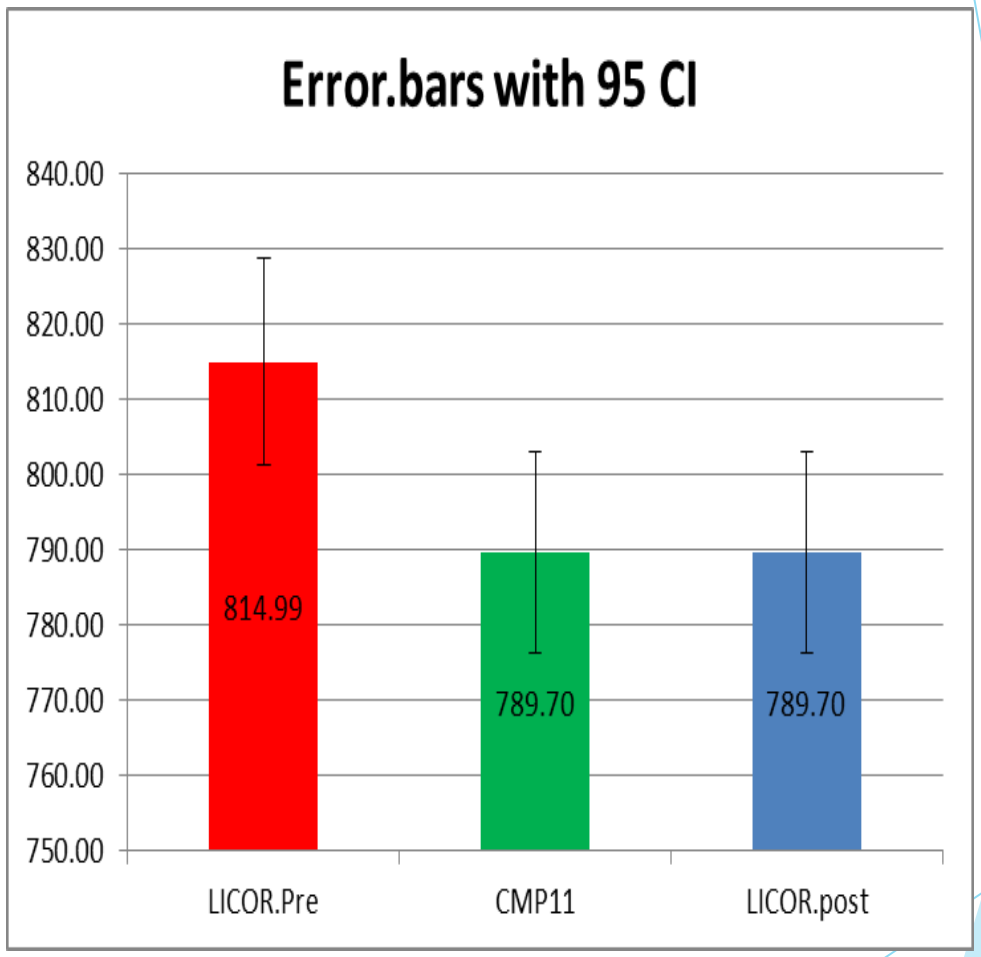
- **The methodology:**
- **Applying linear regression correction by (Scesves-Navarro,1988)**



- **Y = 0.9695*(X) – 0.4316**

- After extracting the equation above, the correction was applied to the data for the same period first filtered (Mar,5 – Jul,31) and the results are reflected in the following figures:

	LICOR.Pre	CMP11	LICOR.post
AVG	814.99	789.70	789.70
STDEV	196.29	190.62	190.30
SE	7.037	6.834	6.823
CI	13.79	13.39	13.37
deviation	25.29		0.00
%	3.202		9.88E-05



Applying the compensation calibration by (King & Myer ,1998)

This process was passed through three stages:

Compensating for ambient temperature effect using the Temp coefficient equation:

$$R = 1/ ((LICOR\ w/m2) * (1-\alpha*(T-T0))$$

Then compensating for F(AOI) effect is done by using the polynomial fit equation suggested by (King & Myers 1998):

$$F(AOI) = F(AIO)= -4.504*10^{-7}(AIO)^3+1.357^{-5}(AOI)^2+6.074^{-4}(AIO)+1$$

(AIO) = Zenith angle (Z) since the (LICOR200) is installed horizontally.

Then compensation for F(AMa) effect is done by using the polynomial fit equation suggested by (King & Myers 1998):

$$F(AMa)= 2.o3*10^{-4}(Ama)^3-6.32*10^{-5}(Ama)^2+5.04*10^{-2}(Ama)+0.932$$

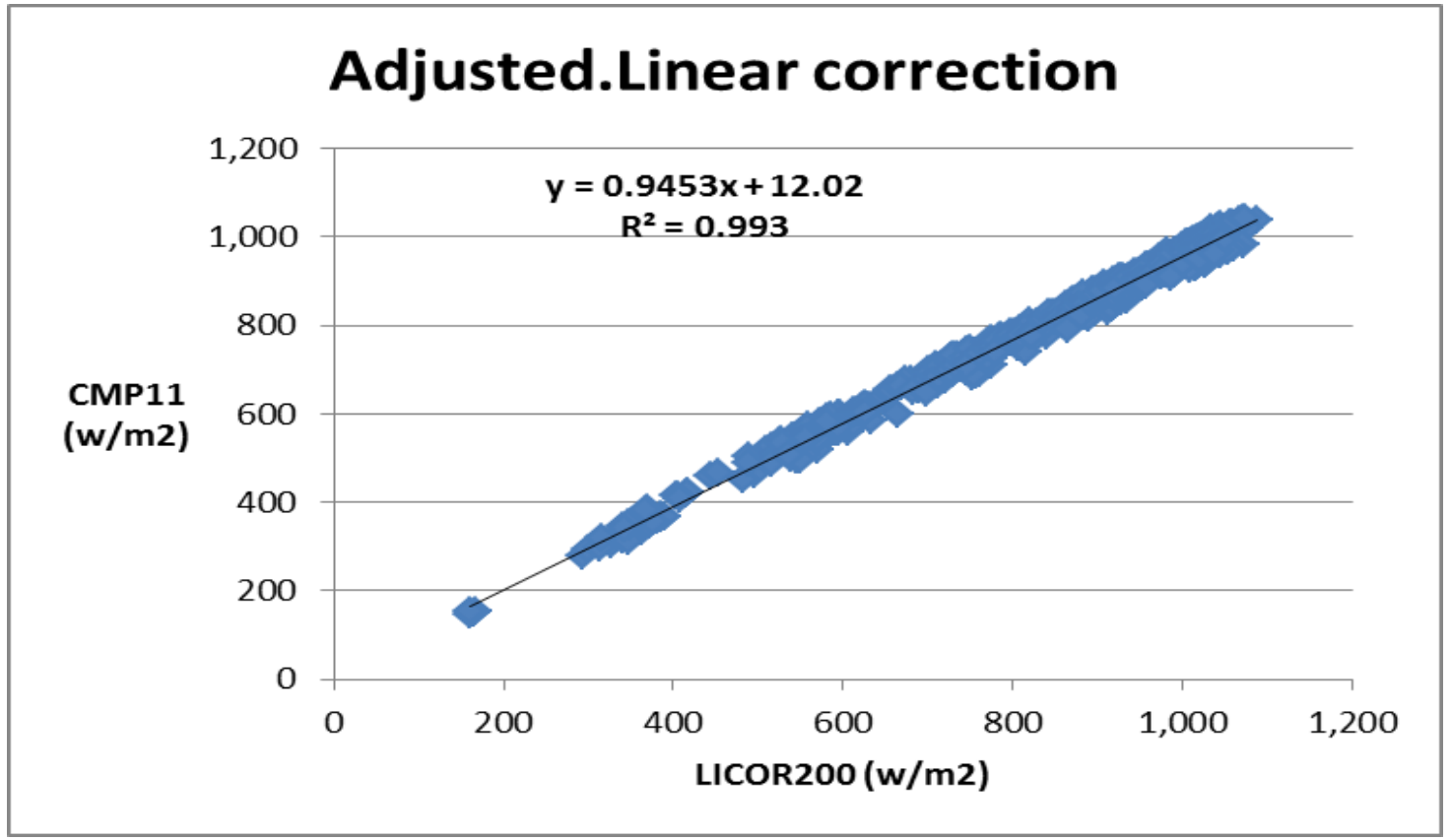
Having compensated for the three factors, the effect on the LICOR200 responsivity was calculated using:

$$R = (LICOR(w/m2)/1000)* ((1-\alpha(T-T0)*F(AIO)*F(AMa))$$

Having corrected the LICOR's response, the corrected readings from LICOR (w/m2) were calculated using this equation:

$$Et = R*1000* (1 – \alpha(T-T0)*(F(AIO))/F(AMa)$$

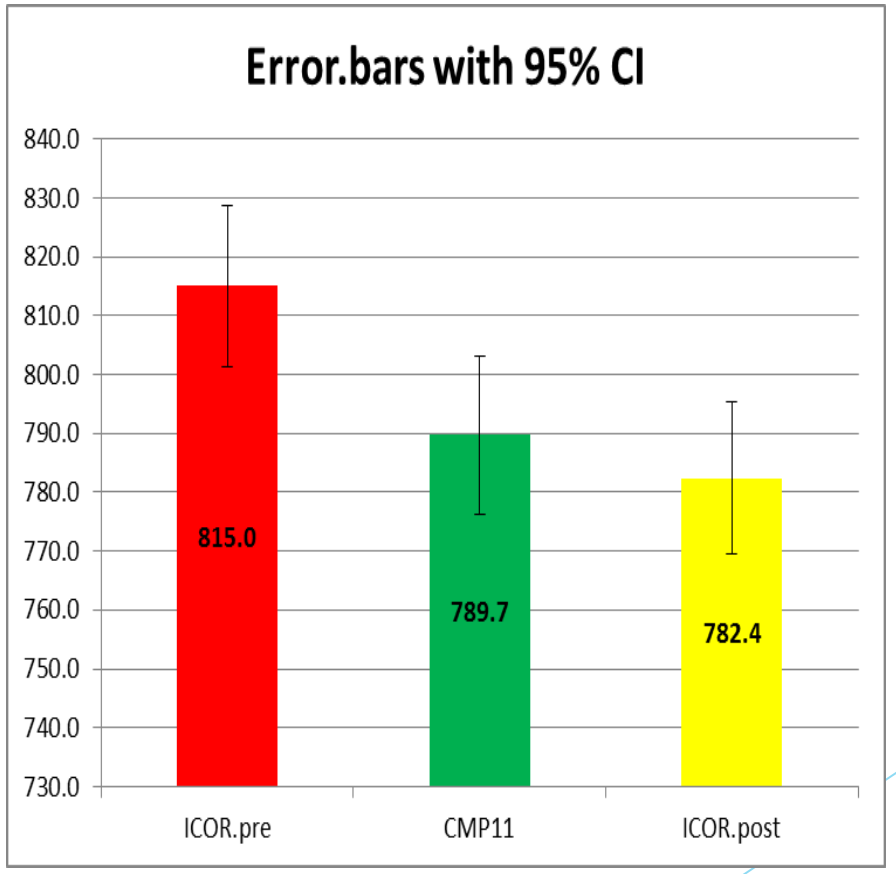
- Having readings from LICOR (200) corrected, they were linearly compared by plotting them against readings from the standard (CMP11) pyranometer, to obtain the final linear equation to be used as a model for correcting other data.



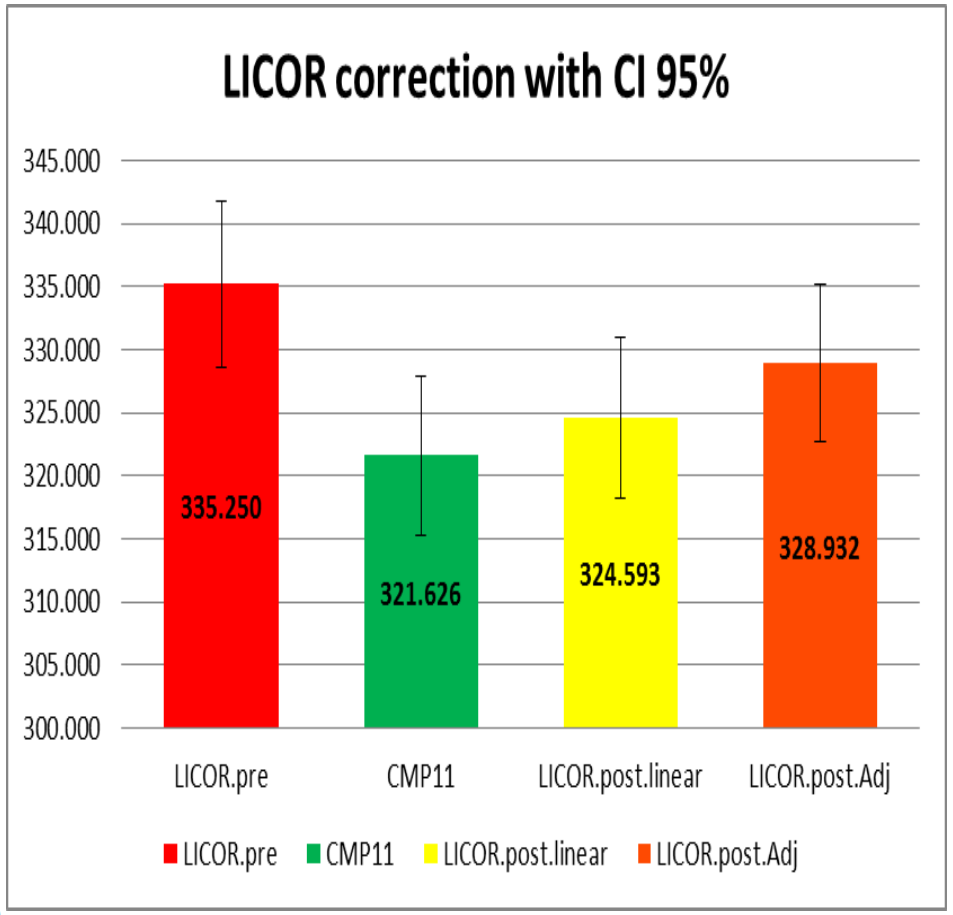
- **Y=0.9453(X)+12.02**

After extracting the equation above, the correction was applied to the data for the same period filtered first (Mar,5 – Jul,31) and resulted in the following figures:

	ICOR.pre	CMP11	ICOR.post
AVG	815.0	789.7	782.4
STDEV	196.3	190.6	185.6
SE	7.037	6.834	6.652
CI	13.8	13.4	13.0
deviation	25.3		-7.3
%	3.202		-0.921



Applying two extracted models to data collected during the period (1-10 Agu 2021).



	LICOR.pre	CMP11	LICOR.post.linear	LICOR.post.Adj
AVG	335.250	321.626	324.593	328.932
STDEV	386.434	372.268	374.648	365.296
SE	3.349	3.227	3.247	3.166
Alpha	0.05	0.05	0.05	0.05
CI	6.565	6.324	6.365	6.206
deviation	13.624		2.968	7.306
%	4.236		0.923	2.272

The conclusion

It is concluded that both models had reduced the percentage of an error from 4.236%, reflecting 13 w/m2, to 0.923%, with the use of based-linear regression model. while the use of based compensation linear regression model reduced the error to 2.272%. The latest is dependent on the site's location and climatic conditions.

This study gives a slight advantage of linear regression model over the compensation model.

The recommendation:

it is recommended that both extracted models should be applied to different locations in Libya, since this is applied to the Tripoli city case, in order

Thank you for your listening and attention

References:

David L. King & Daryl R. Myers (1997) *Silicon-Photodiode: Operational Characteristics, Historical Experiences, and New Calibration procedures*. Available at: https://www.osti.gov/servlets/purl/548688 (accessed: 07/03/2020).

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