Recent Evapotranspiration Research Activities in Puerto Rico

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[3]Undergraduate students, UPRM

Some Recent ET Reserch Projects

1. Climate parameter estimation procedure for PR
2. ET measurement station
3. ET crop coefficients for two bean varieties
4. ET under climate change conditions
4. Water and energy balance algorithm for PR
5. Irrigation Scheduling tools
    a. PRET
    b. Spreadsheet water balance
    c. Satellite/Radar approach

http://pragwater.com

CALIBRATION GOES-PRWEB REFERENCE EVAPOTRANSPIRATION

CIAG 4999
UNDERGRADUATE RESEARCH COURSE

Start

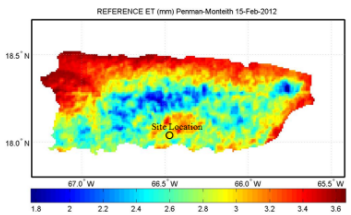
Calibrate Weather Station Equipment

Select reliable Weather Station Sensors

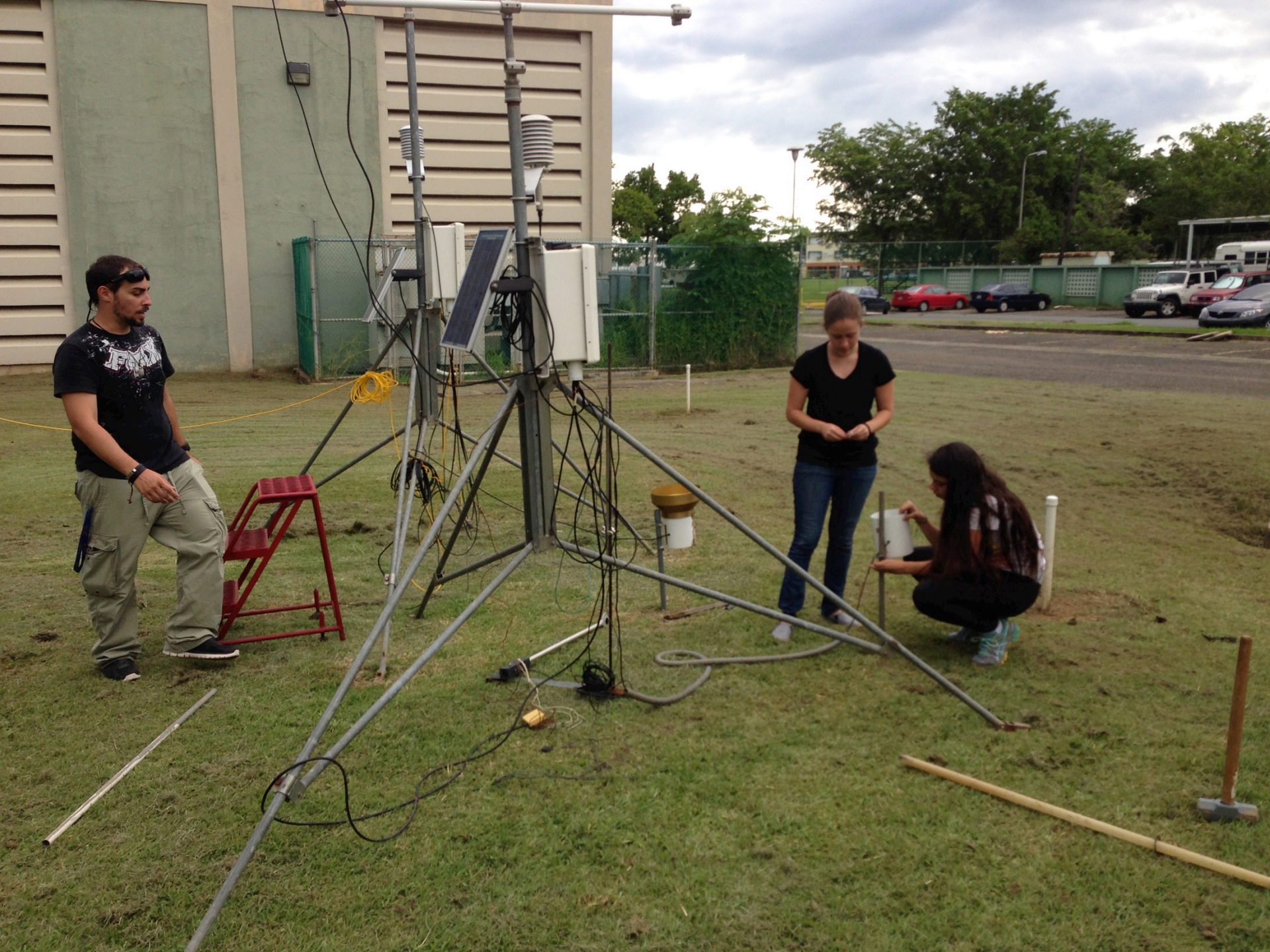
Calibrate weather Parameters used in GOES-PRWEB with NRCS SCAN data.

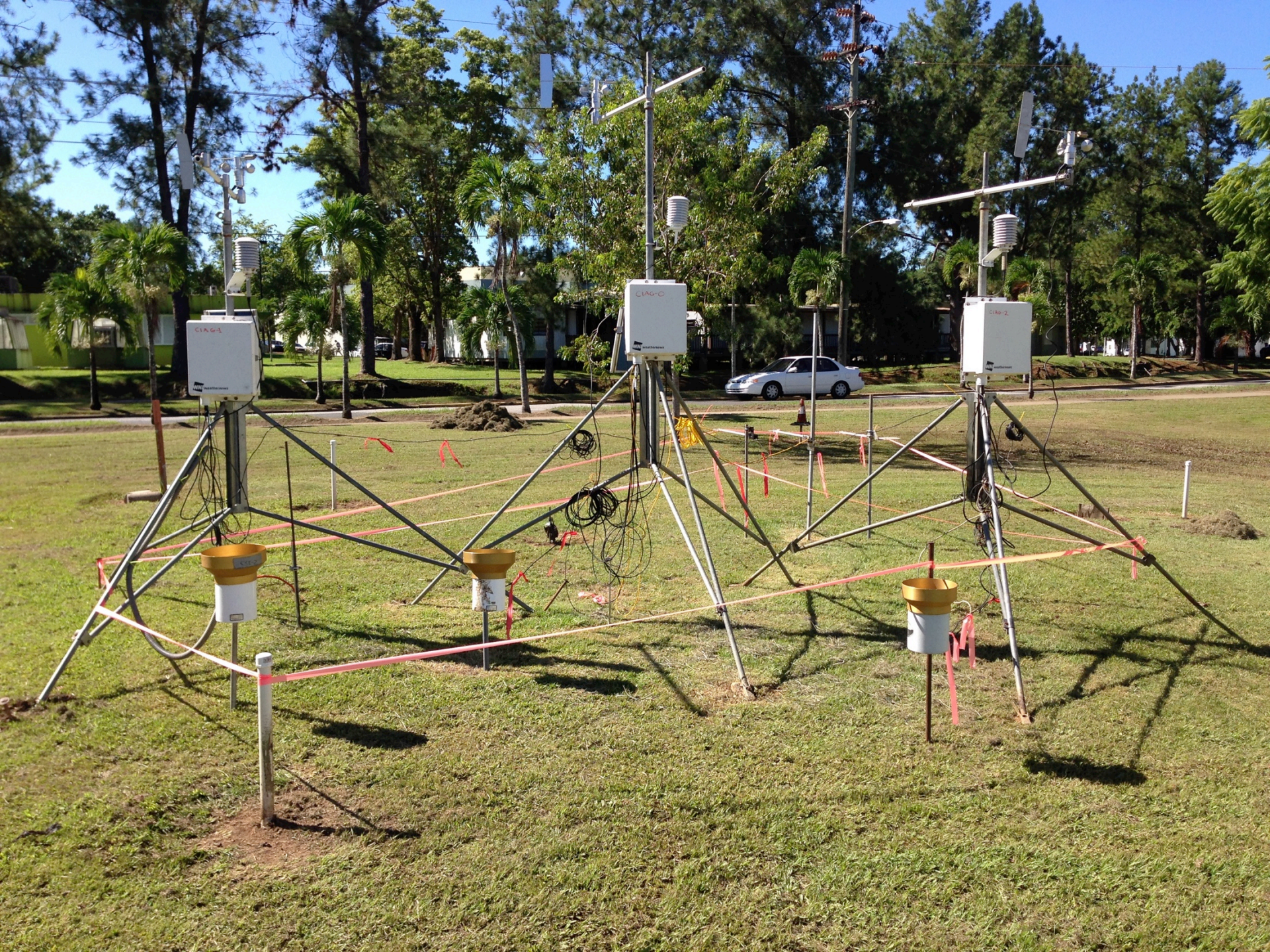
Install stations at Isabela and Lajas

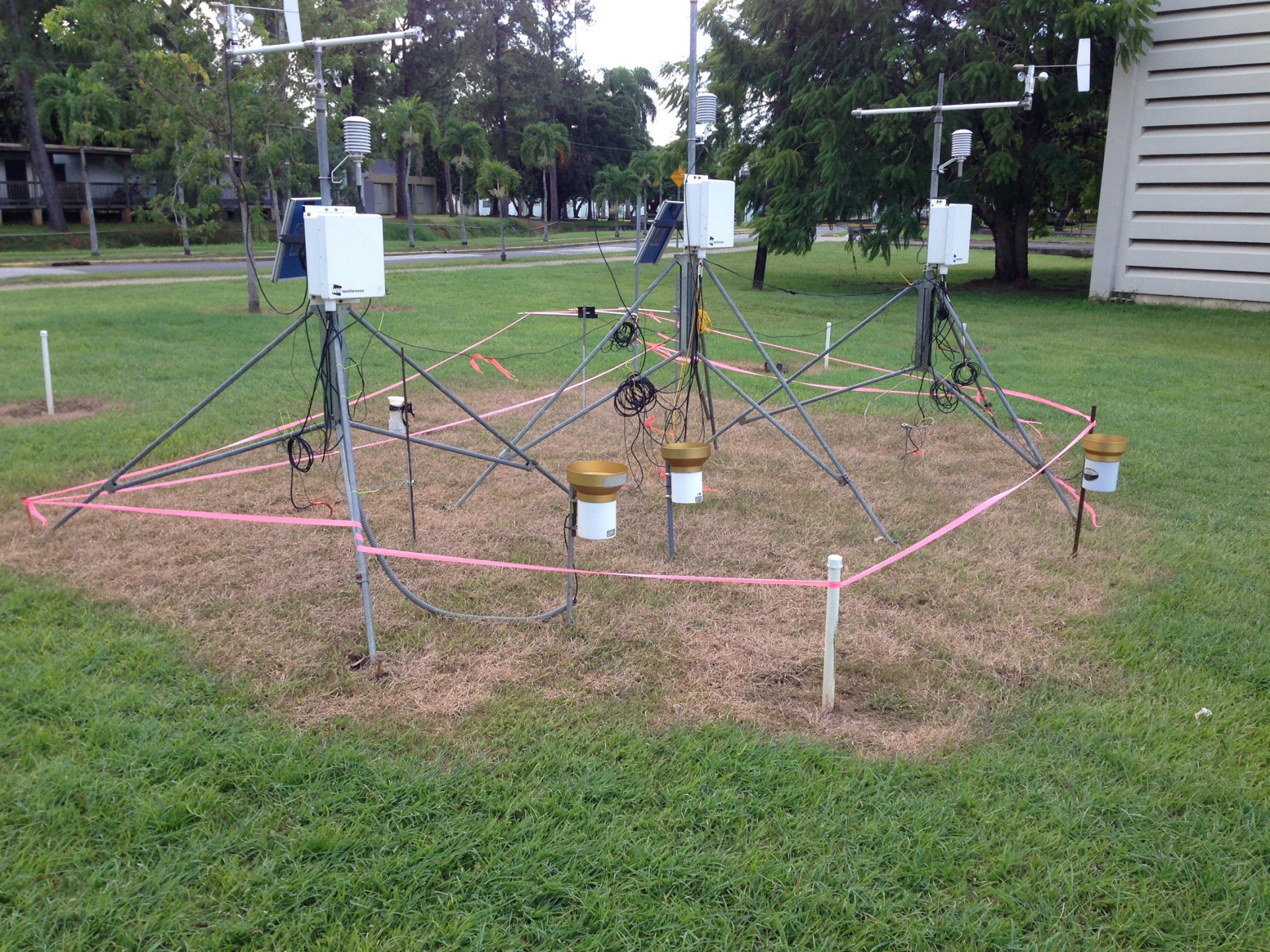
Compare ETo with NRCS SCAN stations and Stations at Isabela and Lajas

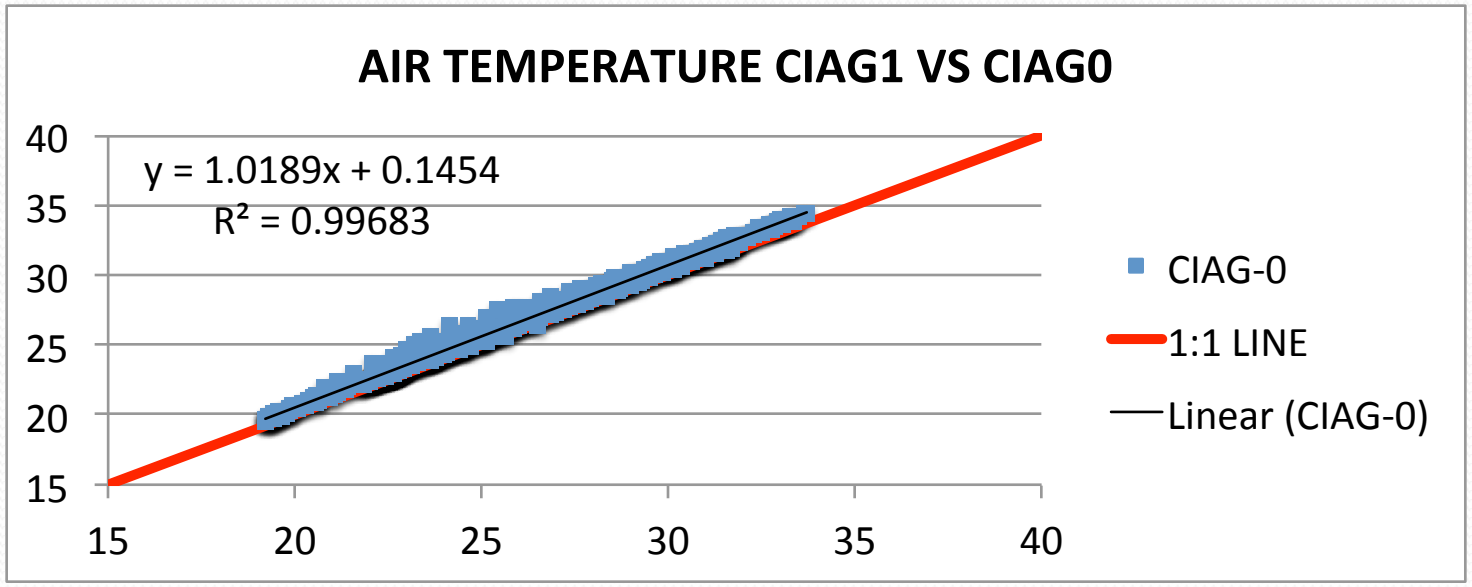


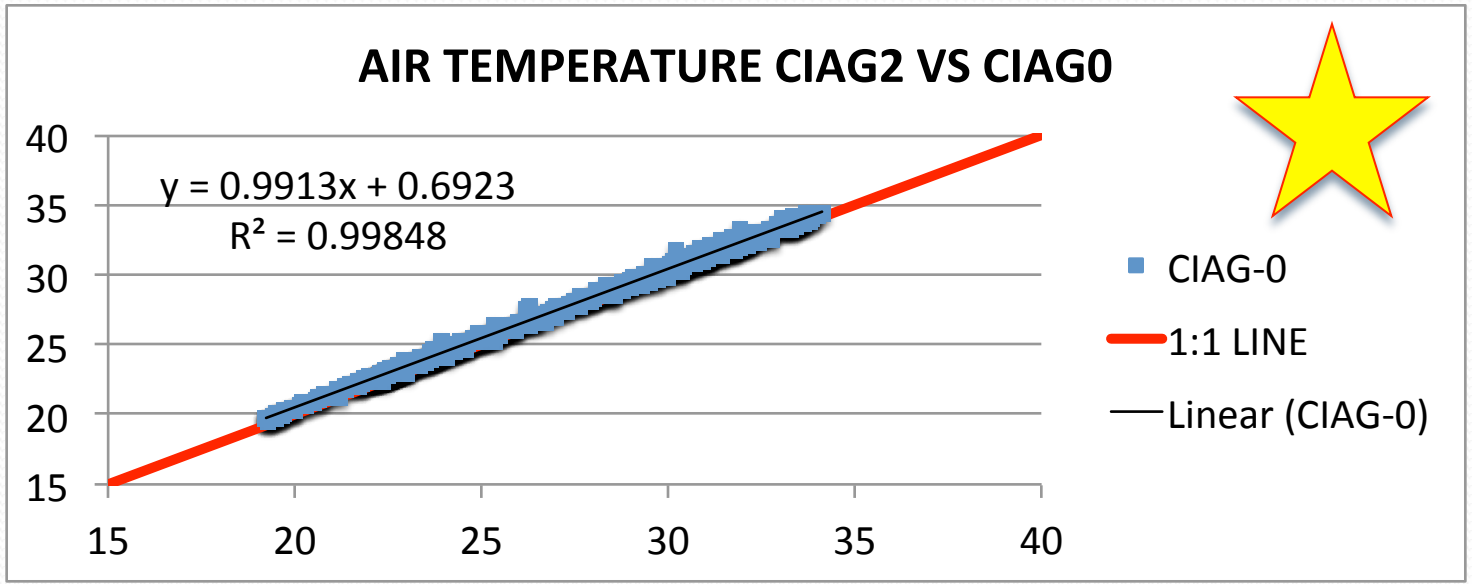
Student Reports And Presentations

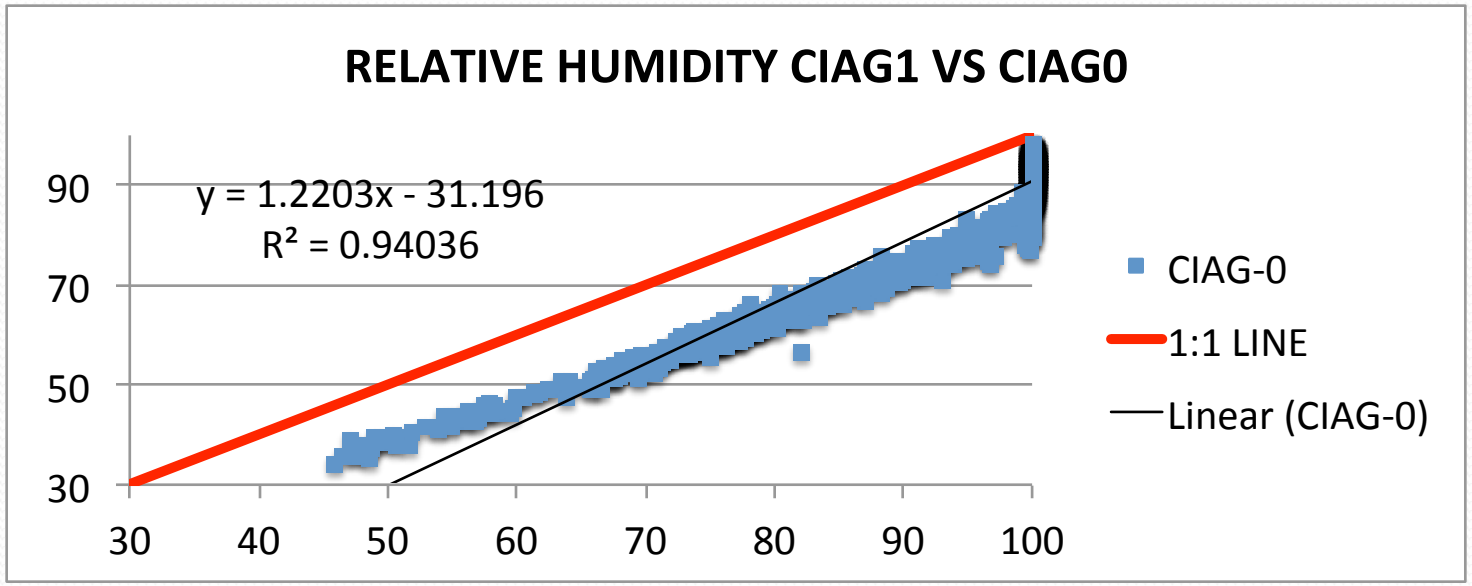


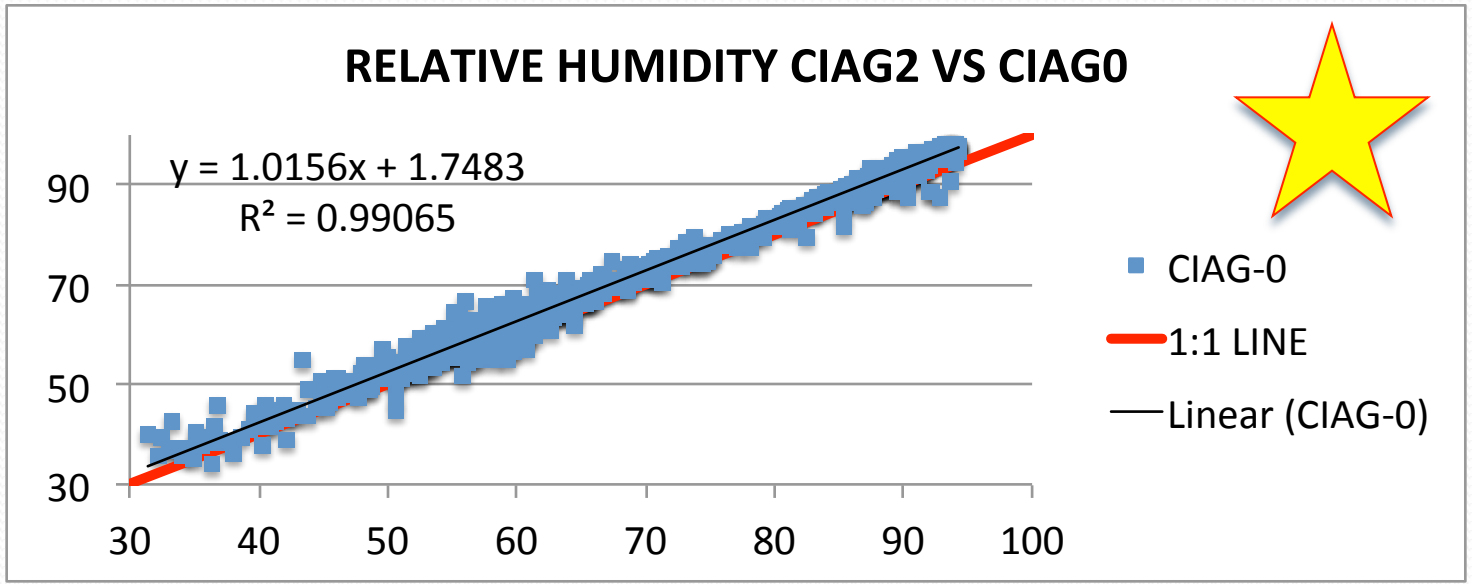

CIAG-1
CIAG-C
CIAG-2

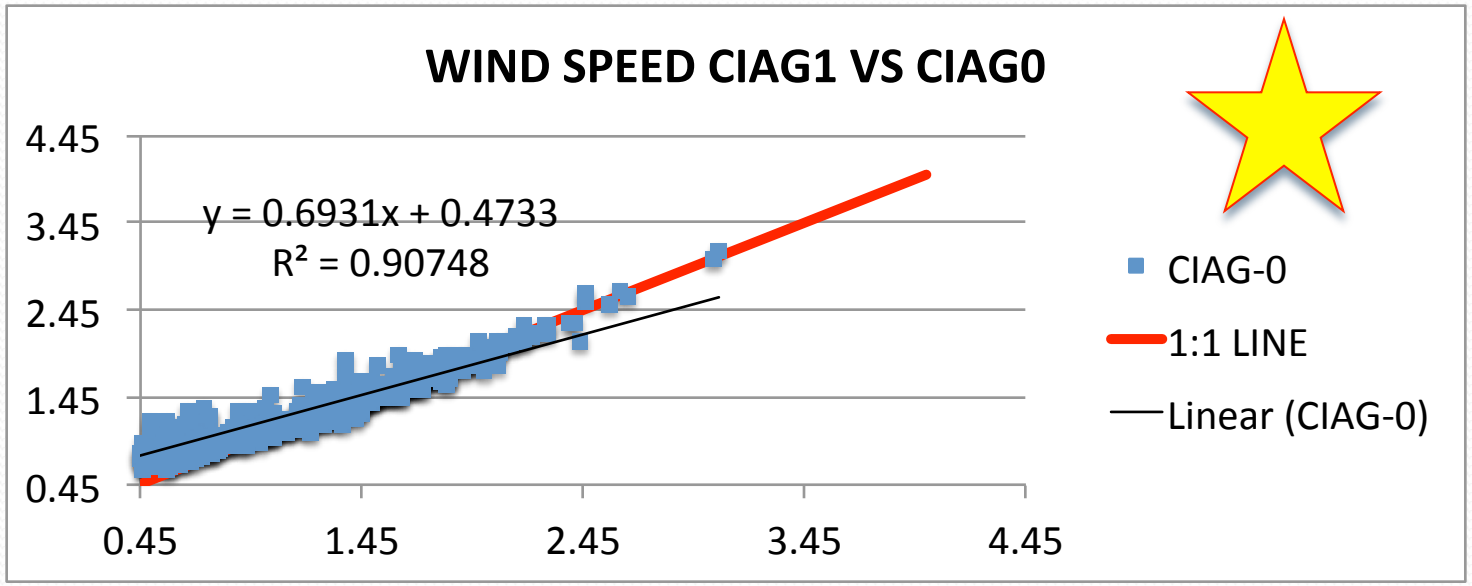


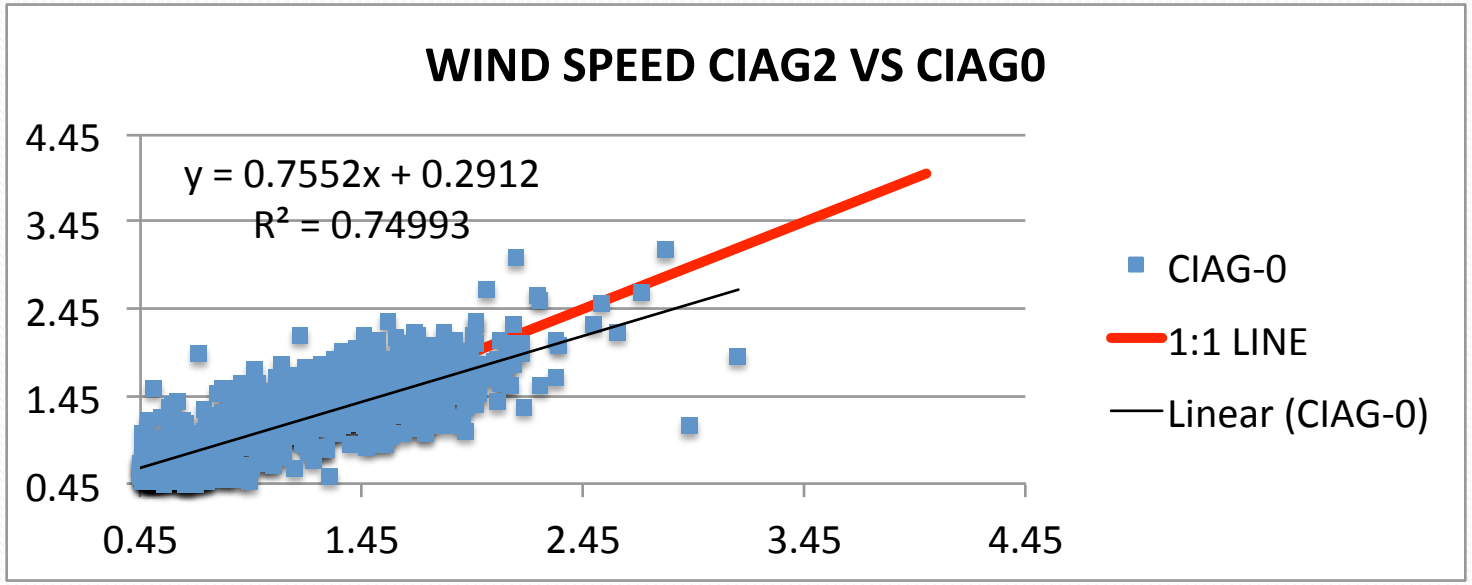

AIR TEMPERATURE CIAG1 VS CIAG0
y = 1.0189x + 0.1454
R² = 0.99683
40
35
30
25
20
15
15
20
25
30
35
40
CIAG-0
1:1 LINE
Linear (CIAG-0)

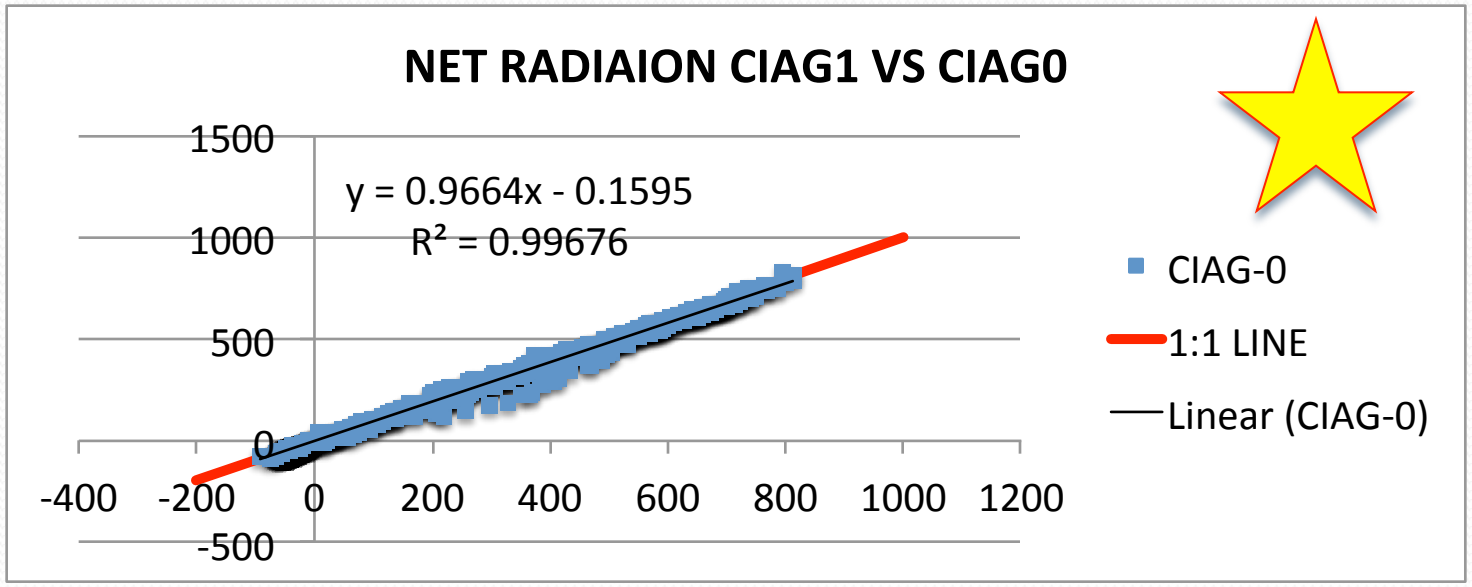

AIR TEMPERATURE CIAG2 VS CIAG0
y = 0.9913x + 0.6923
R² = 0.99848
40
35
30
25
20
15
15
20
25
30
35
40
CIAG-0
1:1 LINE
Linear (CIAG-0)

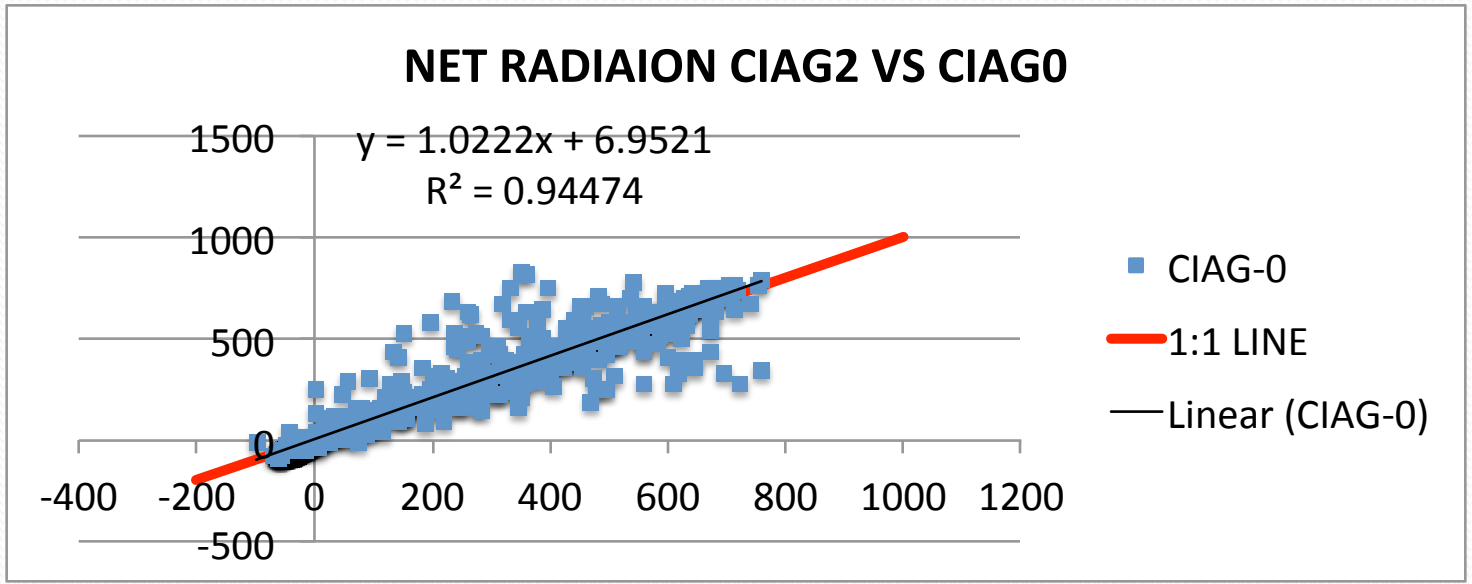

RELATIVE HUMIDITY CIAG1 VS CIAG0
y = 1.2203x - 31.196
R² = 0.94036
90
70
50
30
30
40
50
60
70
80
90
100
CIAG-0
1:1 LINE
Linear (CIAG-0)

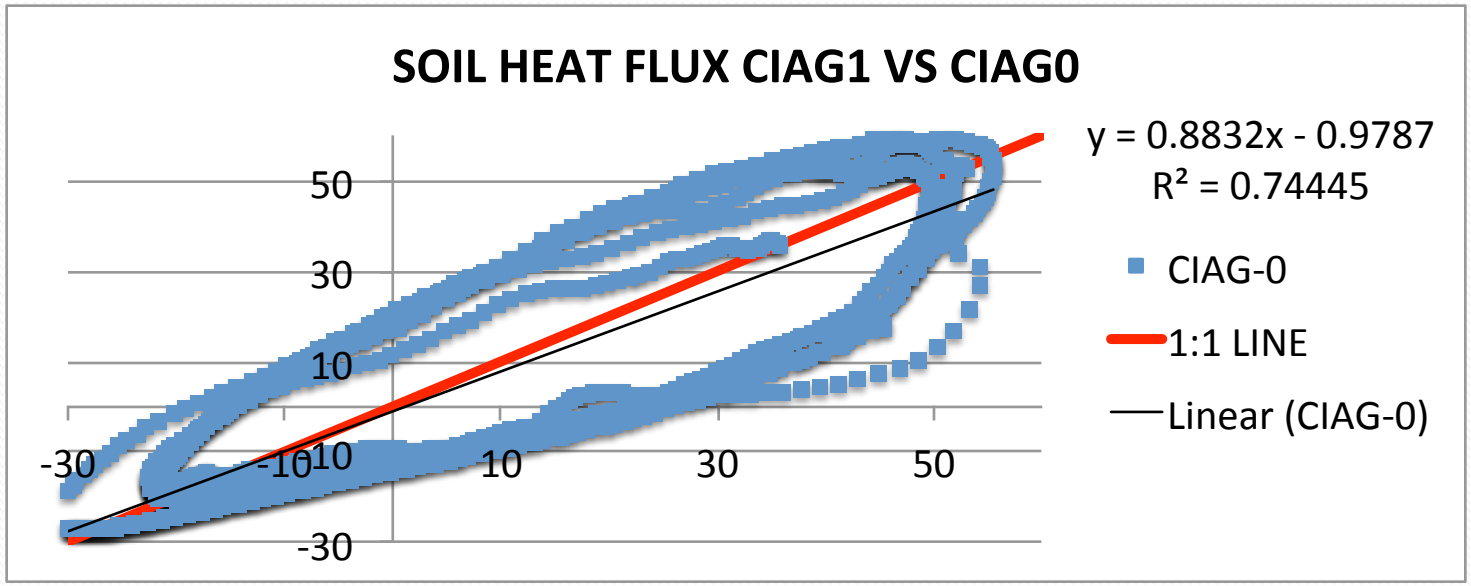

RELATIVE HUMIDITY CIAG2 VS CIAG0
y = 1.0156x + 1.7483
R² = 0.99065
90
70
50
30
30
40
50
60
70
80
90
100
CIAG-0
1:1 LINE
Linear (CIAG-0)

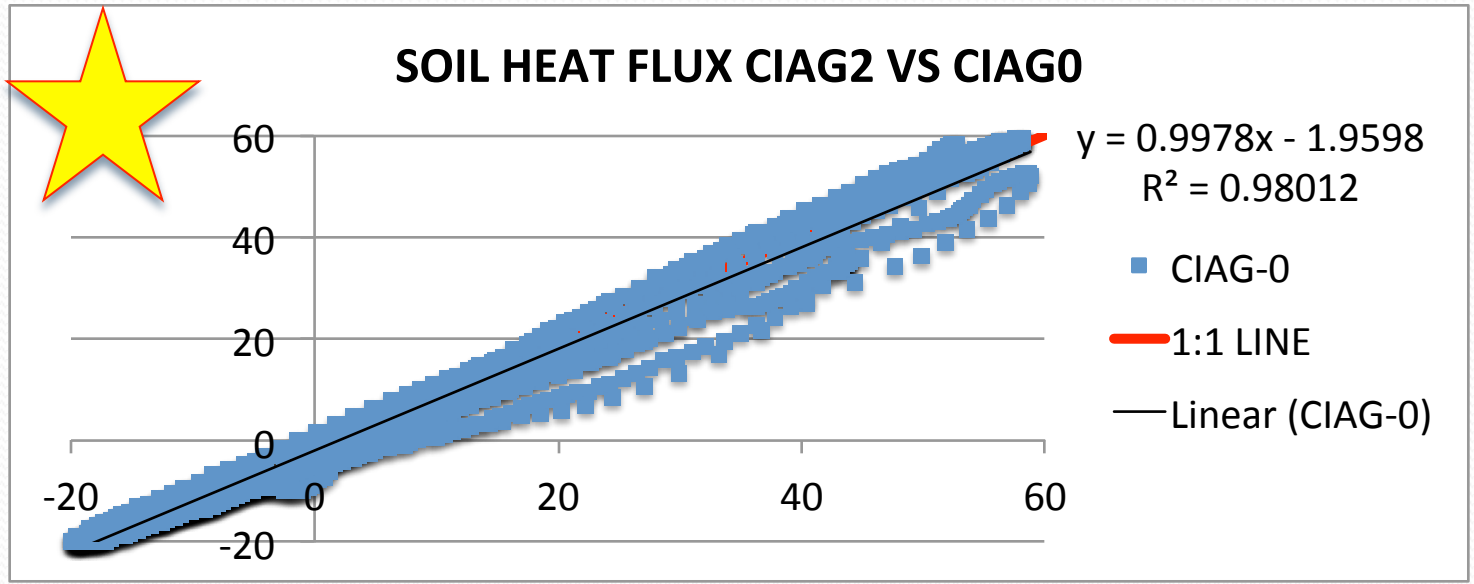

WIND SPEED CIAG1 VS CIAG0
y = 0.6931x + 0.4733
R² = 0.90748
4.45
3.45
2.45
1.45
0.45
0.45
1.45
2.45
3.45
4.45
CIAG-0
1:1 LINE
Linear (CIAG-0)

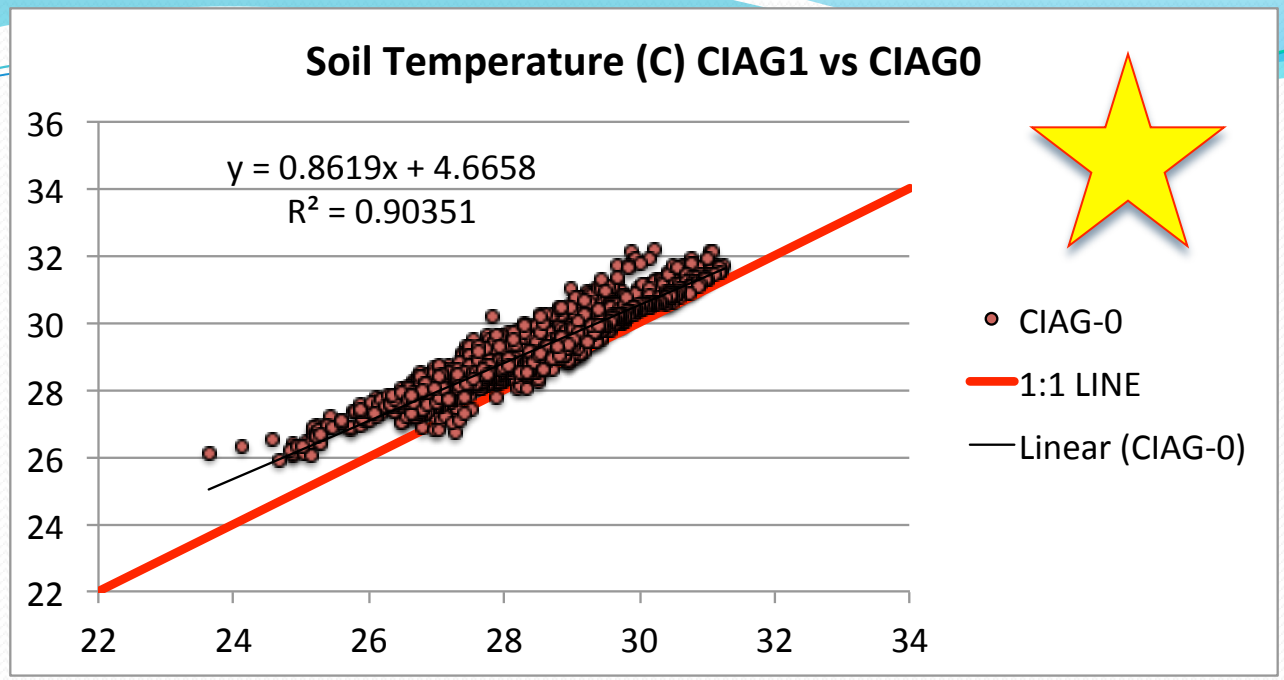

WIND SPEED CIAG2 VS CIAG0
y = 0.7552x + 0.2912
R² = 0.74993
4.45
3.45
2.45
1.45
0.45
0.45
1.45
2.45
3.45
4.45
CIAG-0
1:1 LINE
Linear (CIAG-0)

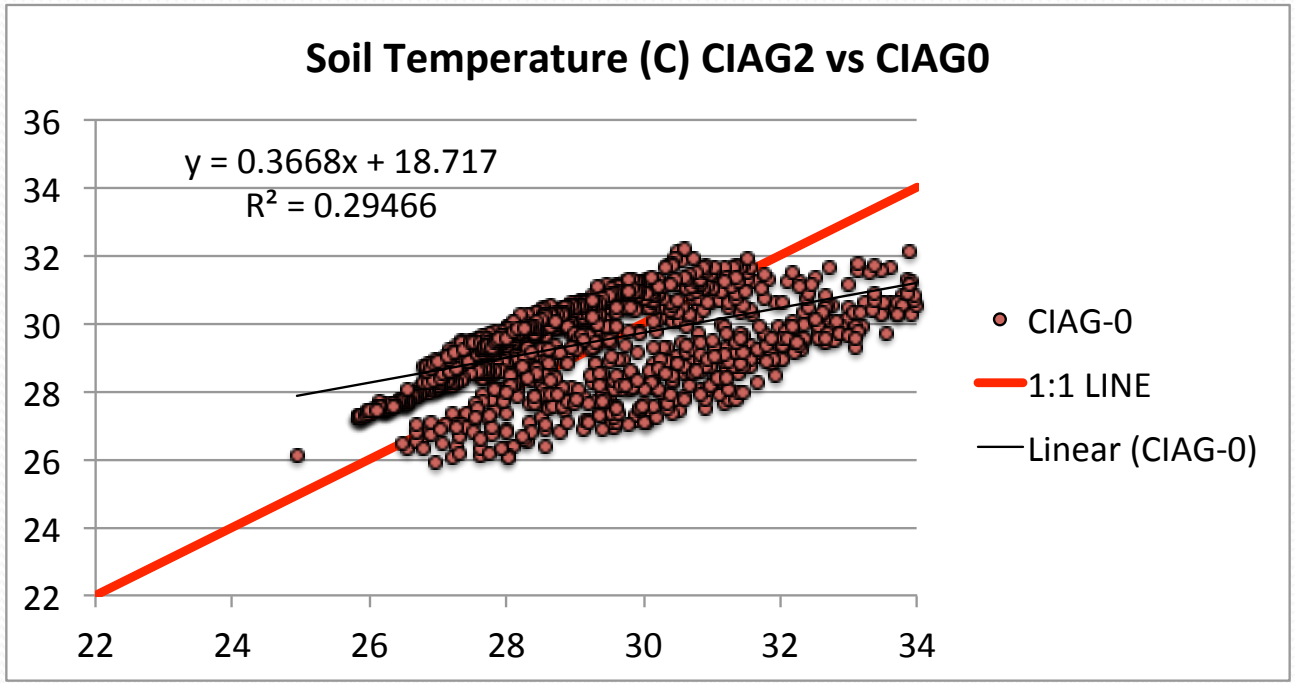

NET RADIAION CIAG1 VS CIAG0
y = 0.9664x - 0.1595
R² = 0.99676
1500
1000
500
0
-500
-400
-200
0
200
400
600
800
1000
1200
CIAG-0
1:1 LINE
Linear (CIAG-0)

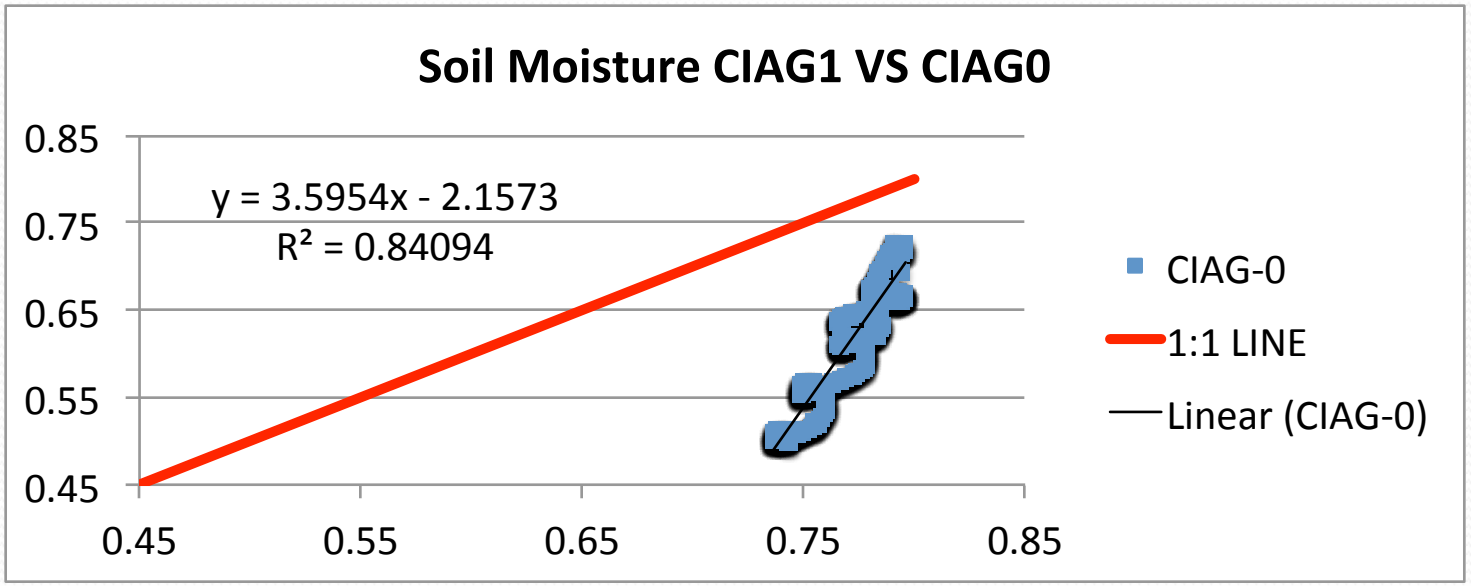

NET RADIAION CIAG2 VS CIAG0
y = 1.0222x + 6.9521
R² = 0.94474
1500
1000
500
0
-500
-400
-200
0
200
400
600
800
1000
1200
CIAG-0
1:1 LINE
Linear (CIAG-0)

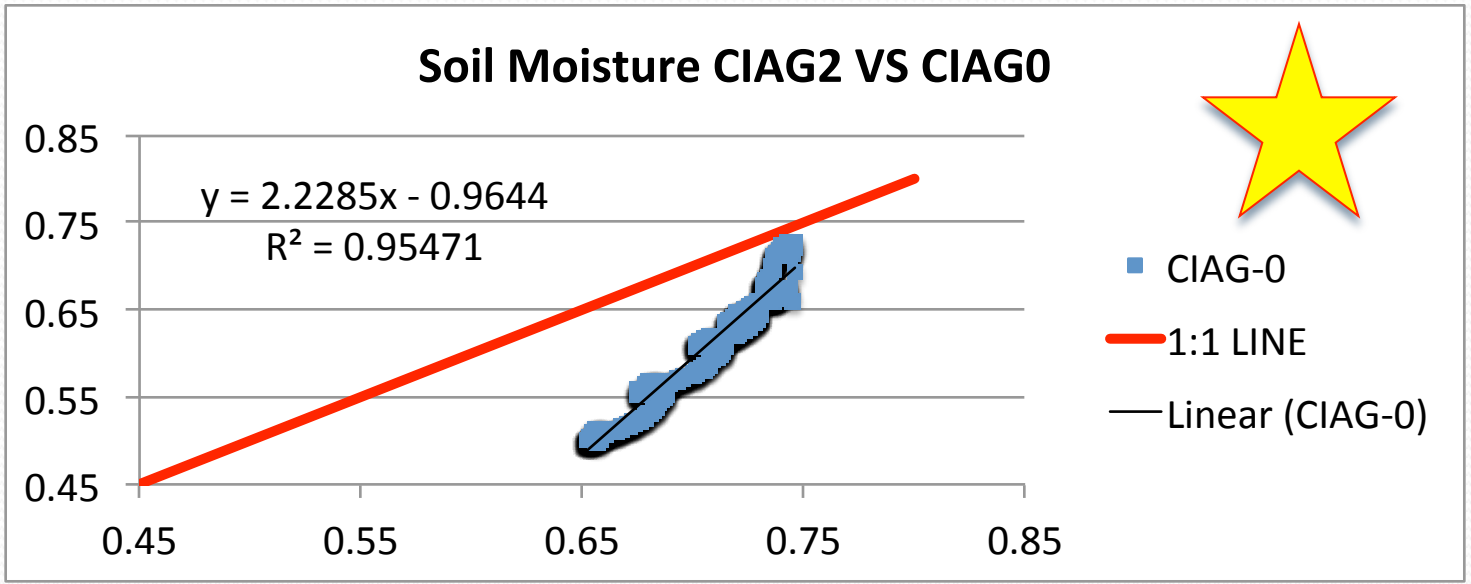

SOIL HEAT FLUX CIAG1 VS CIAG0
y = 0.8832x - 0.9787
R² = 0.74445
CIAG-0
1:1 LINE
Linear (CIAG-0)
50
30
10
-10
-30
-30
-10
10
30
50


SOIL HEAT FLUX CIAG2 VS CIAG0
y = 0.9978x - 1.9598
R² = 0.98012
CIAG-0
1:1 LINE
Linear (CIAG-0)
60
40
20
0
-20
-20
0
20
40
60

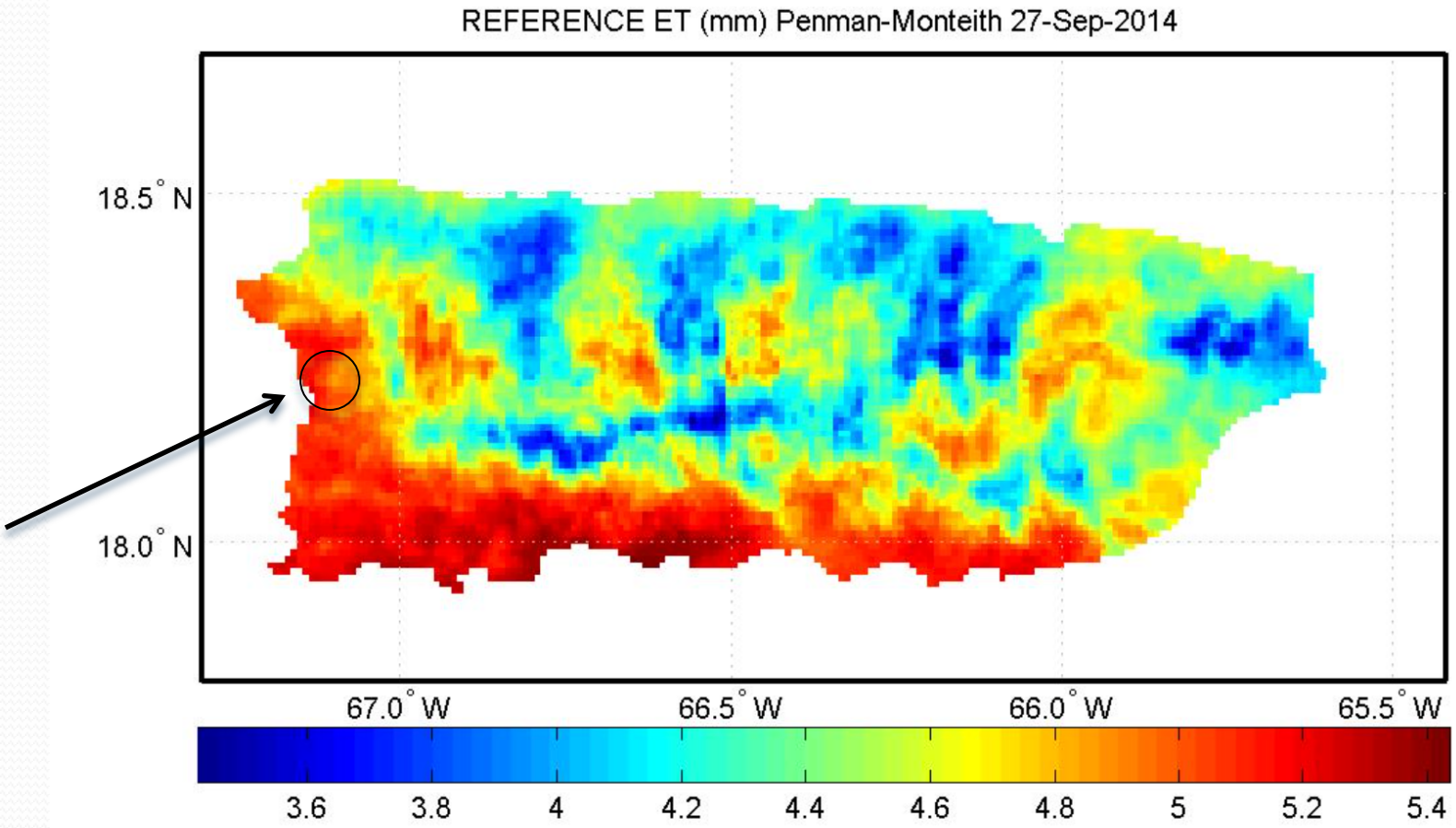

Soil Temperature (C) CIAG1 vs CIAG0
y = 0.8619x + 4.6658
R² = 0.90351
36
34
32
30
28
26
24
22
22
24
26
28
30
32
34
CIAG-0
1:1 LINE
Linear (CIAG-0)

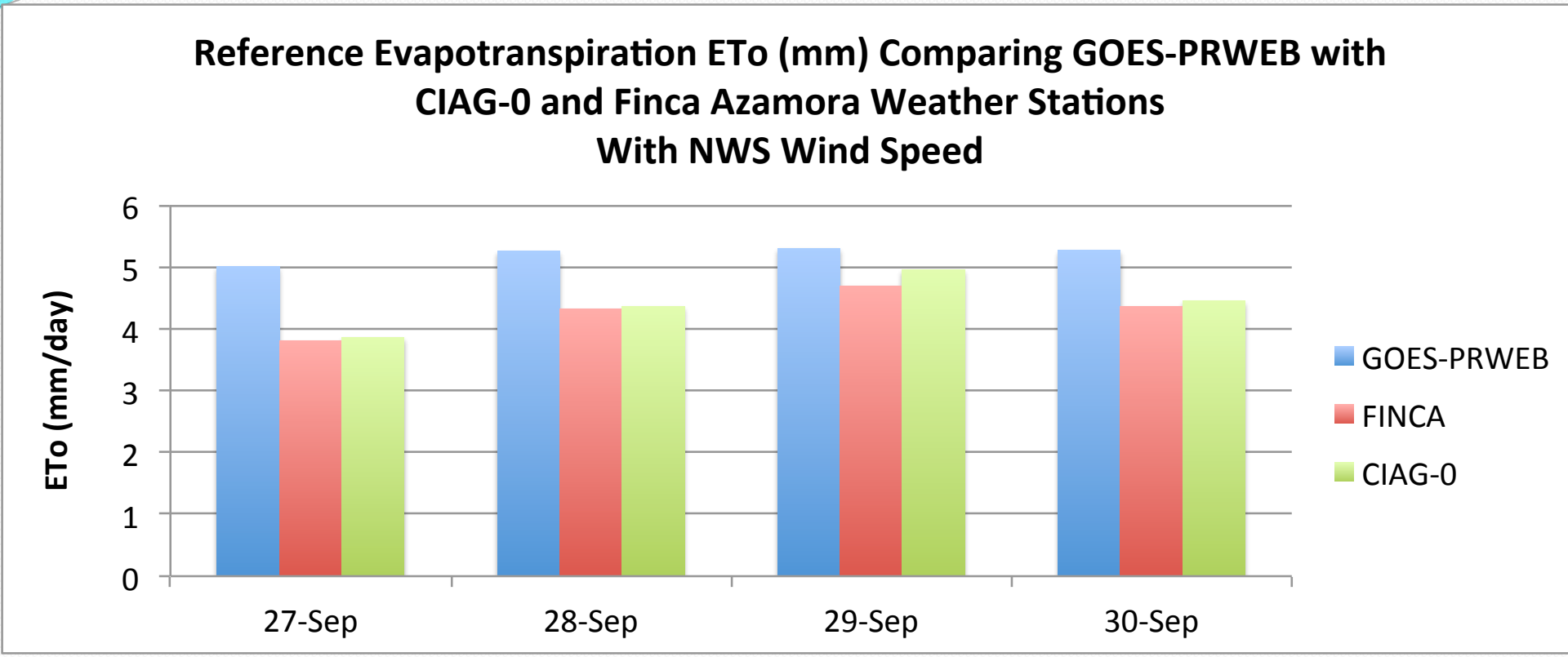

Soil Temperature (C) CIAG2 vs CIAG0
y = 0.3668x + 18.717
R² = 0.29466
36
34
32
30
28
26
24
22
22
24
26
28
30
32
34
CIAG-0
1:1 LINE
Linear (CIAG-0)


Soil Moisture CIAG1 VS CIAG0
0.85
0.75
0.65
0.55
0.45
y = 3.5954x - 2.1573
R² = 0.84094
0.45
0.55
0.65
0.75
0.85
CIAG-0
1:1 LINE
Linear (CIAG-0)

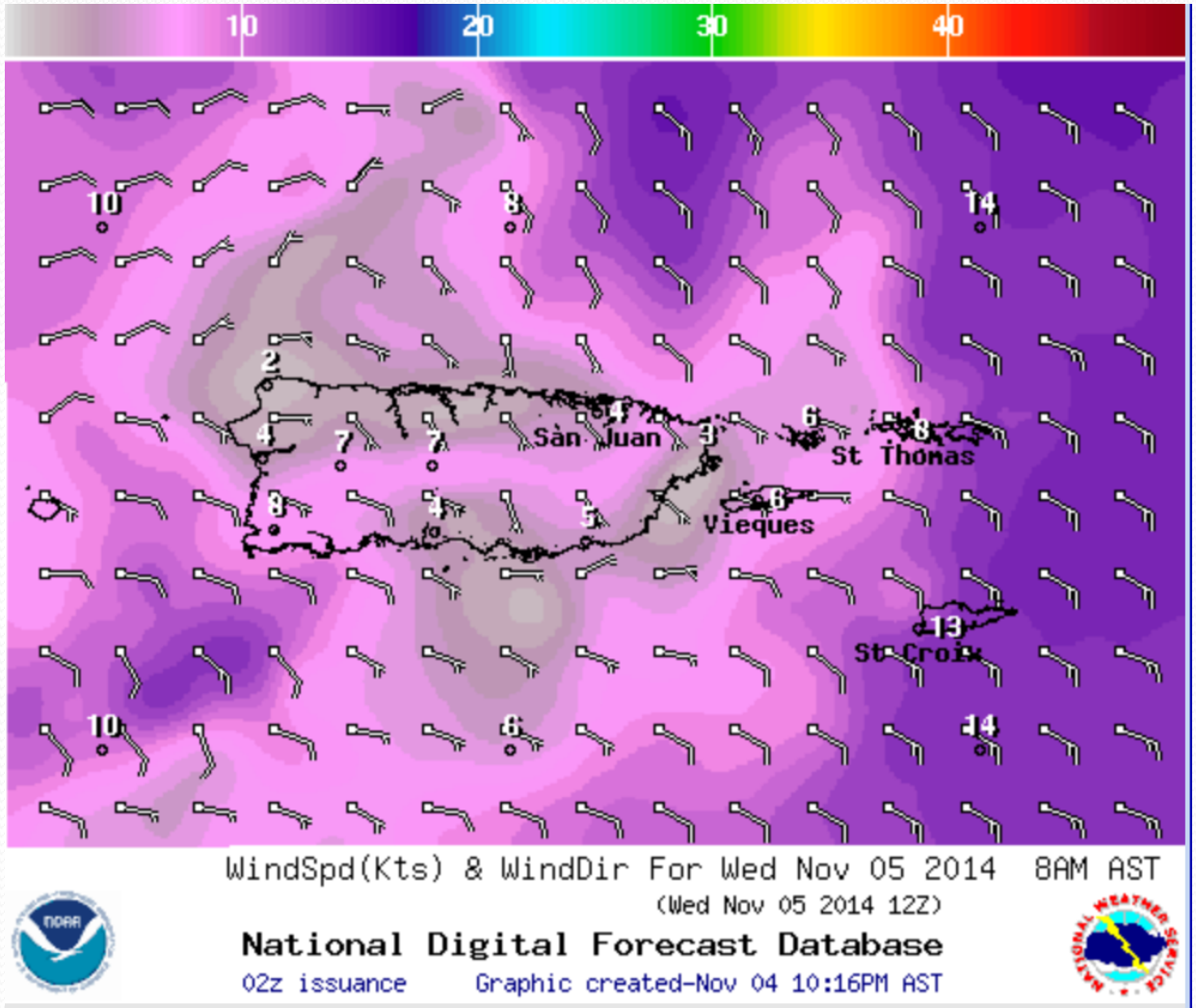

Soil Moisture CIAG2 VS CIAG0
0.85
0.75
0.65
0.55
0.45
y = 2.2285x - 0.9644
R² = 0.95471
0.45
0.55
0.65
0.75
0.85
CIAG-0
1:1 LINE
Linear (CIAG-0)

GOES-PRWEB Reference Evapotranspiration

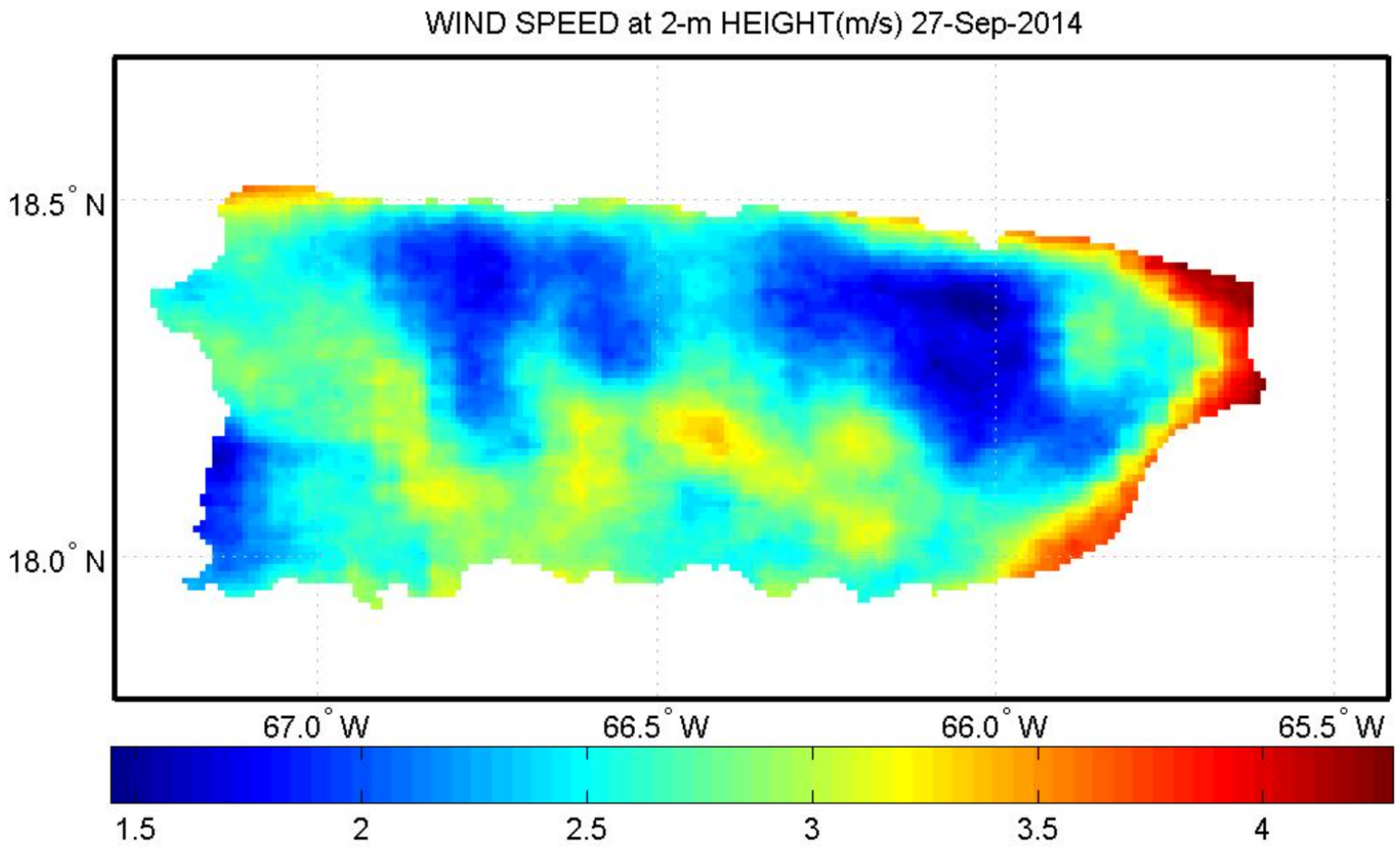


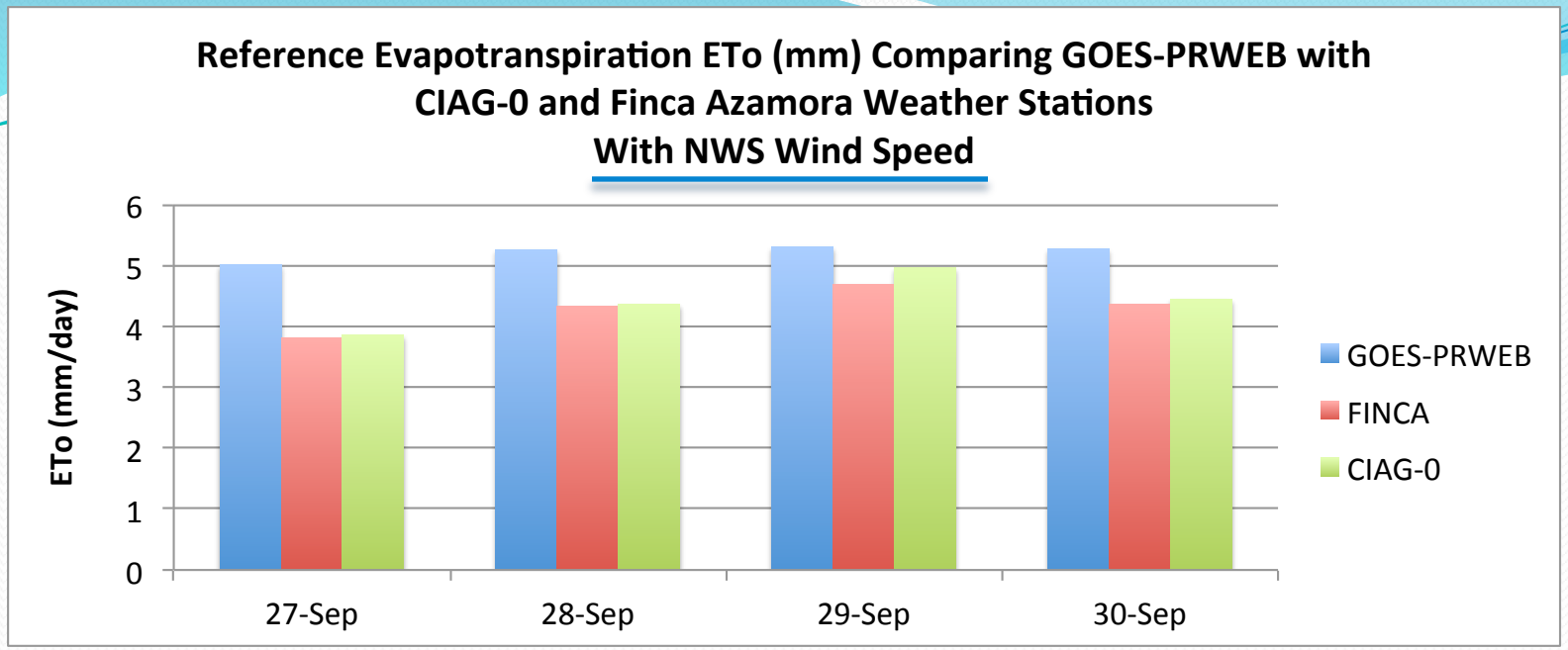

Reference Evapotranspiration ETo (mm) Comparing GOES-PRWEB with CIAG-0 and Finca Azamora Weather Stations With NWS Wind Speed
ETo (mm/day)
6
5
4
3
2
1
0
27-Sep
28-Sep
29-Sep
30-Sep
GOES-PRWEB
FINCA
CIAG-0

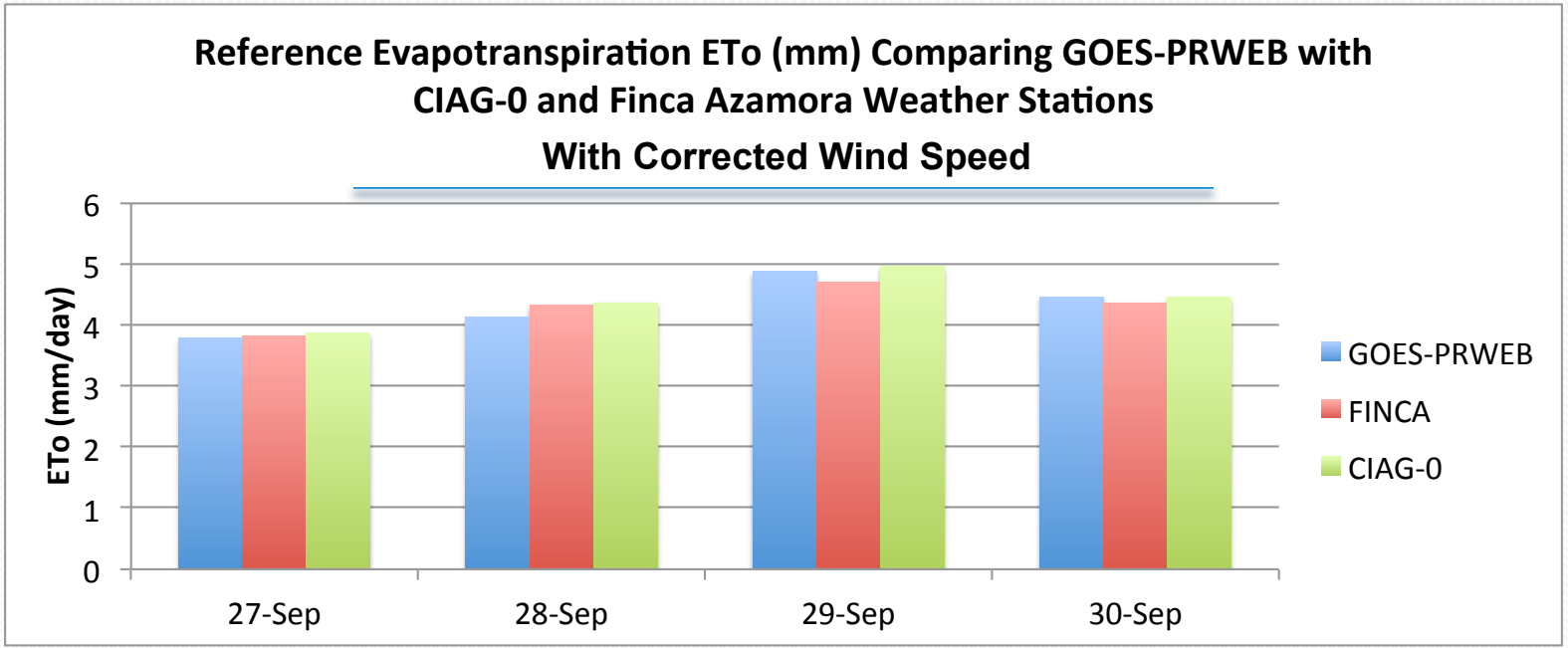
National Weather Service (NWS) Wind Speed used in GOES-PRWEB



NWS Wind Speed Used in GOES-PRWEB

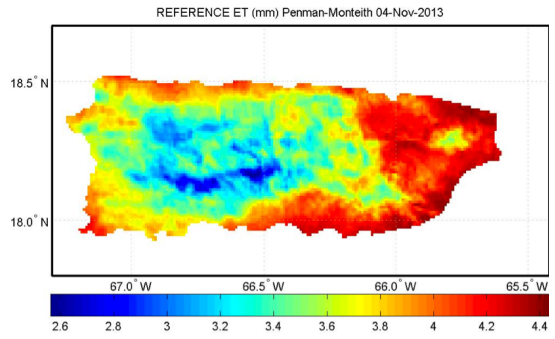



Reference Evapotranspiration ETo (mm) Comparing GOES-PRWEB with CIAG-0 and Finca Azamora Weather Stations With NWS Wind Speed
ETo (mm/day)
0
1
2
3
4
5
6
27-Sep
28-Sep
29-Sep
30-Sep
GOES-PRWEB
FINCA
CIAG-0

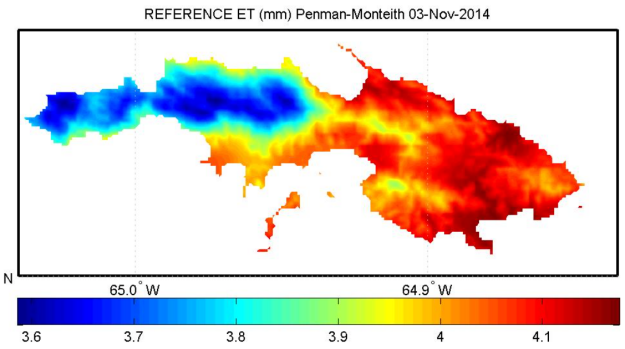

Reference Evapotranspiration ETo (mm) Comparing GOES-PRWEB with CIAG-0 and Finca Azamora Weather Stations With Corrected Wind Speed
ETo (mm/day)
0
1
2
3
4
5
6
27-Sep
28-Sep
29-Sep
30-Sep
GOES-PRWEB
FINCA
CIAG-0

Real-Time and Archived Reference ET for Puerto Rico, USVI, Hispaniola and Jamaica (http://pragwater.com)

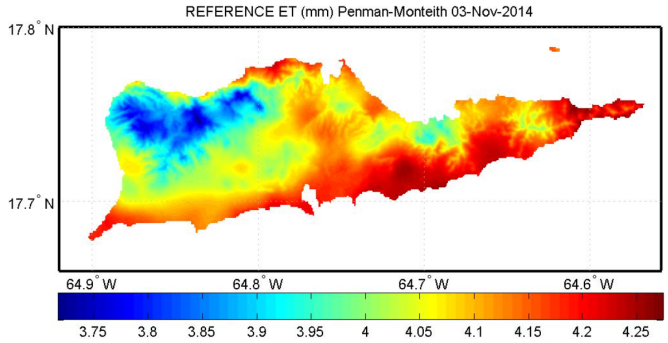
Puerto Rico



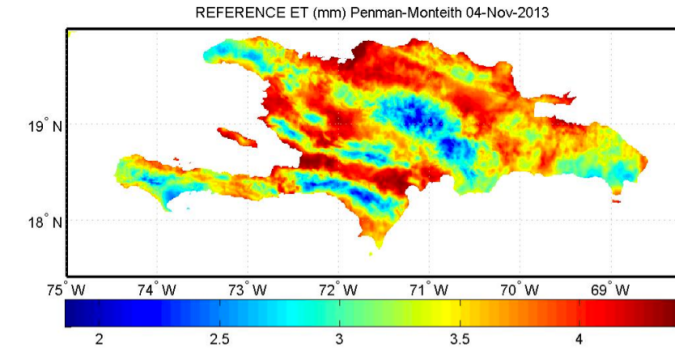
St. Thomas



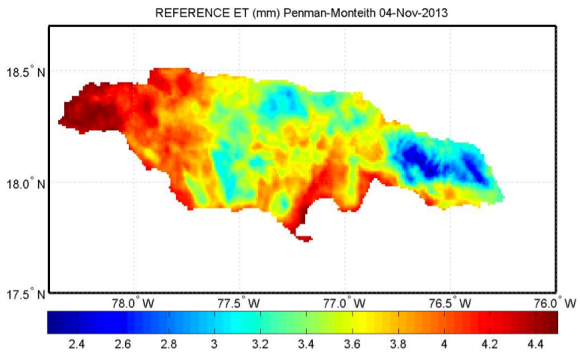
St. Croix



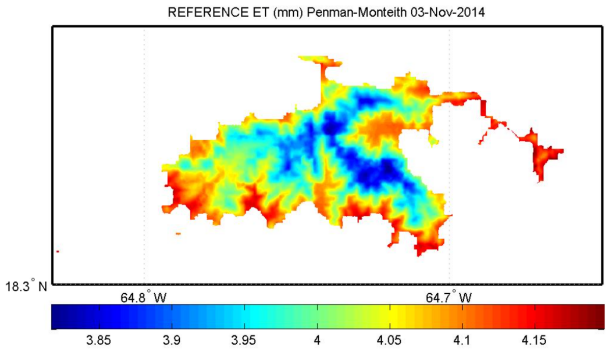
Hispaniola



Jamaica



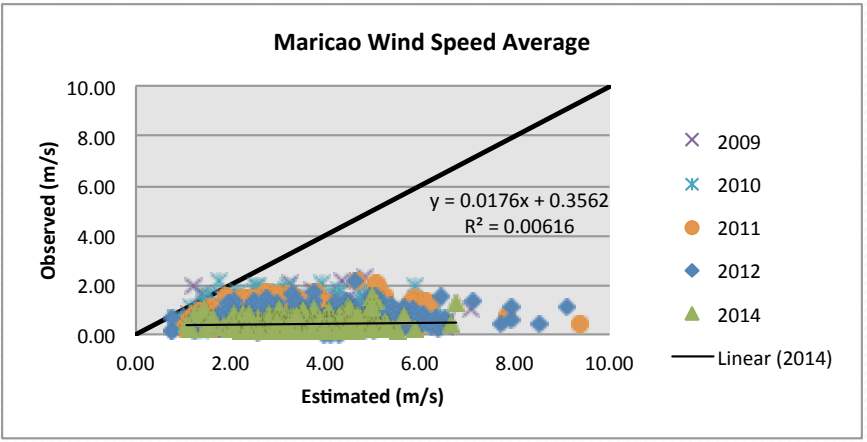
St. John



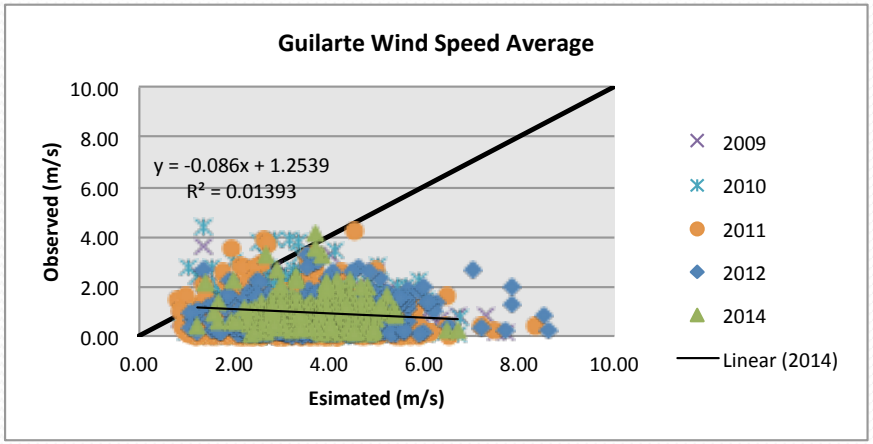
Natural Resource Conservation Service (NRCS) Soil Climate Analysis Network (SCAN) Weather Stations

Comparison of NWS Wind Speed and NRCS SCAN Stations

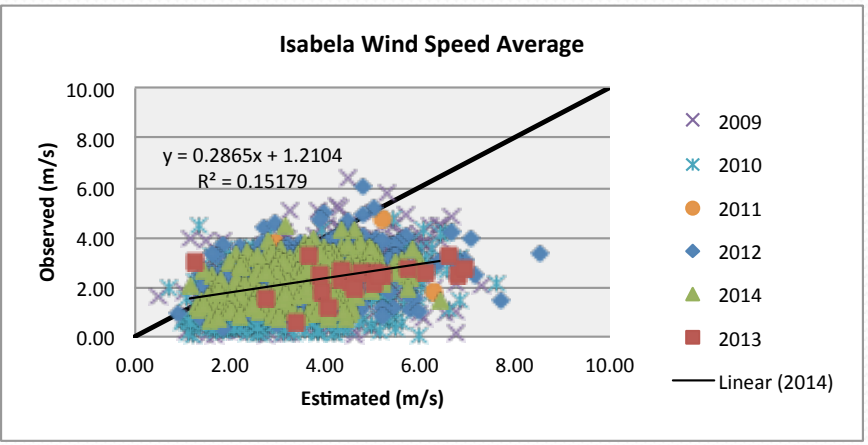
BIAS = 0.18



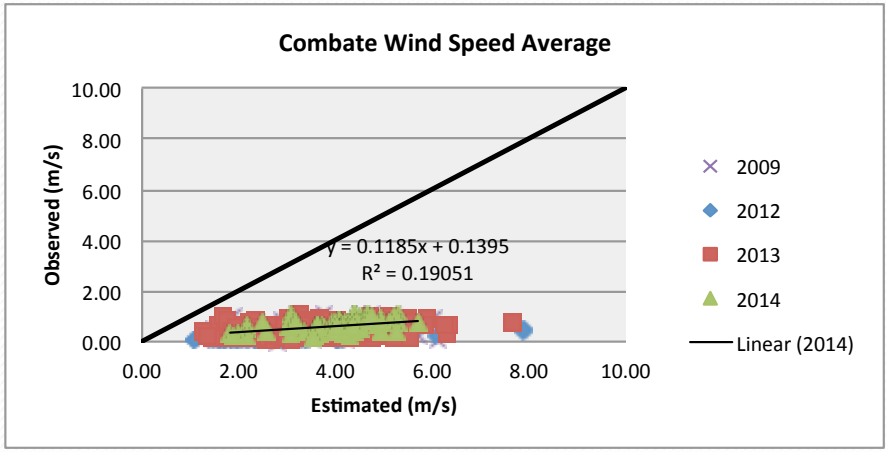
BIAS = 0.24



BIAS = 0.60

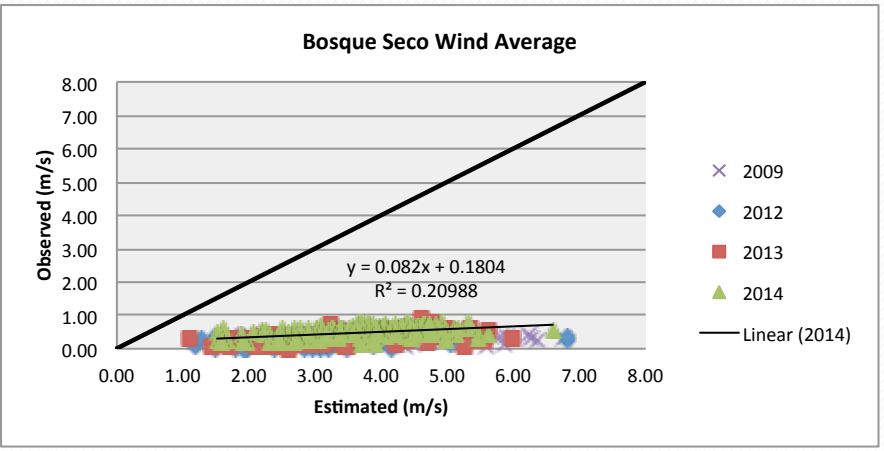


BIAS = 0.11

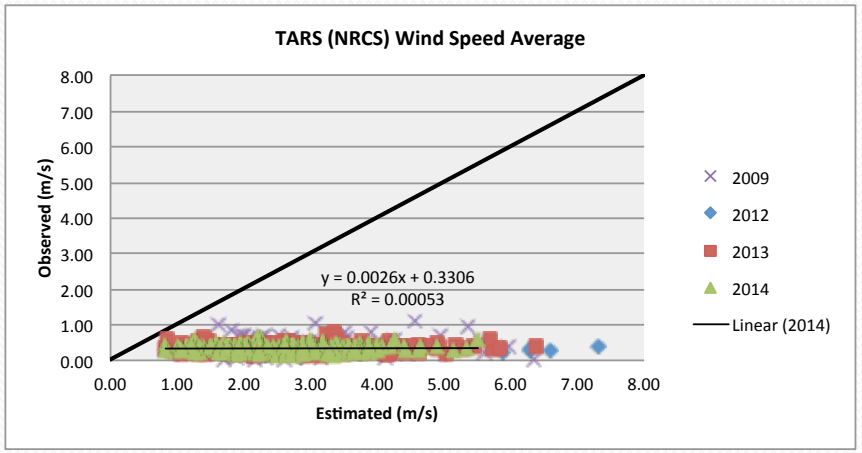


Comparison of NWS Wind Speed and NRCS SCAN Stations

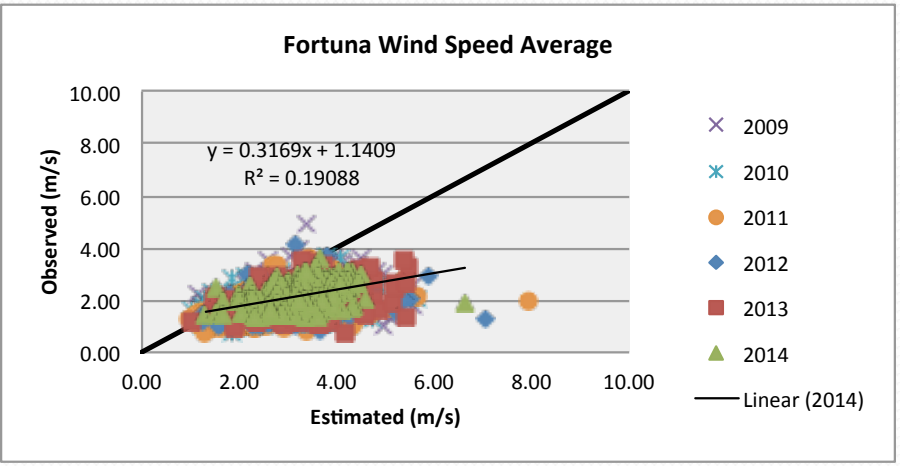
BIAS = 0.09



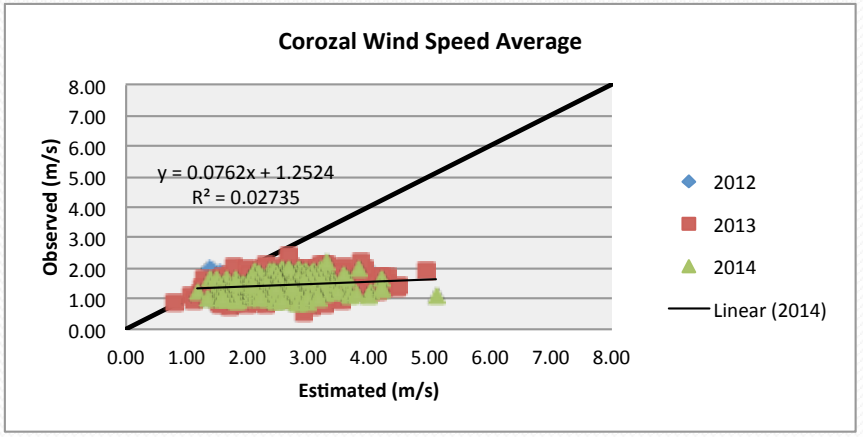
BIAS = 0.12



BIAS = 0.63



BIAS = 0.56



BIAS = $\frac{\text{Mean SCAN Weather Station Wind Speed}}{\text{Mean NWS Wind Speed}}$

- NRCS SCAN Data Pairs Evaluated:

Maricao Forest = 1,740, Guilarte Forest = 1,828,
Isabela = 1,368, Combate = 587, Bosque Seco = 593,
TARS= 1,013, Fortuna = 1,818, Corozal = 752

- Weather Underground Data Pairs Evaluated:

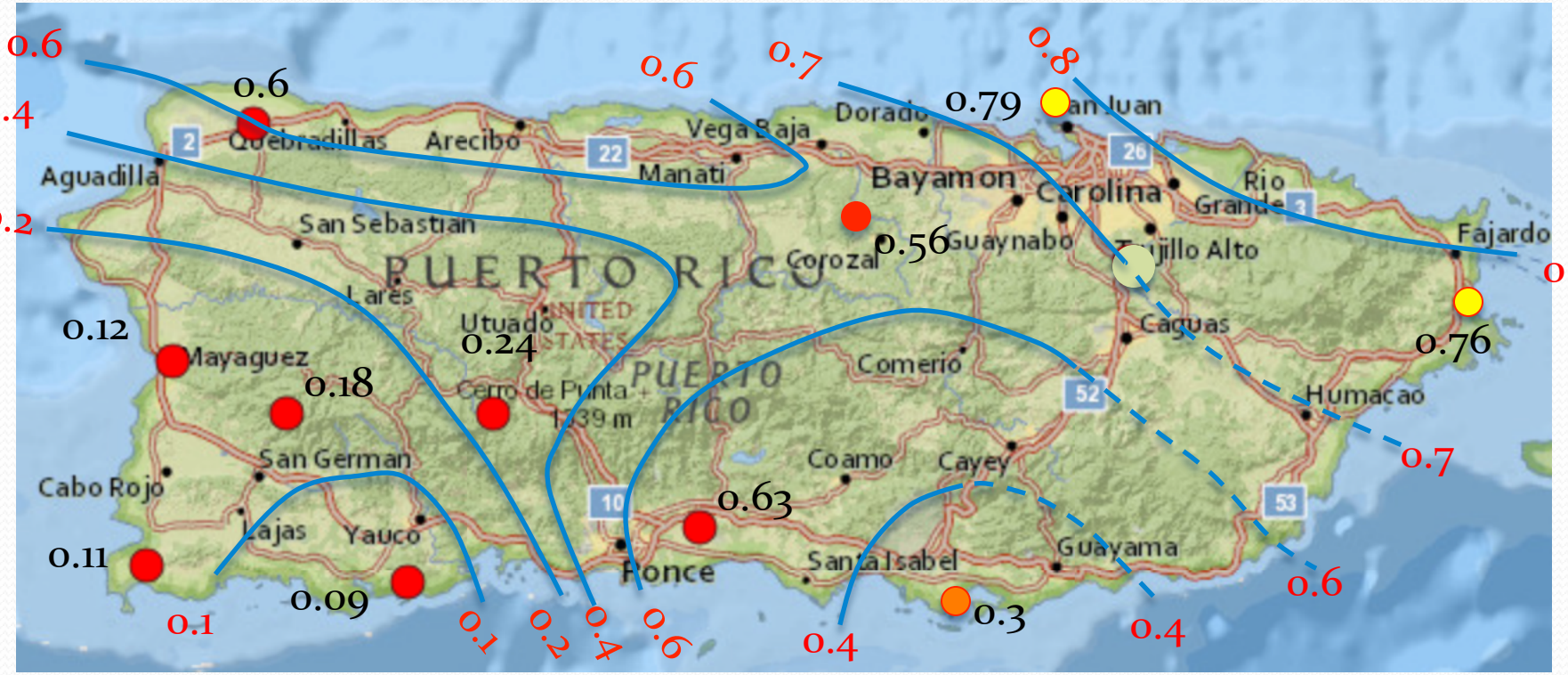
San Juan = 1095, Roosevelt Roads = 885

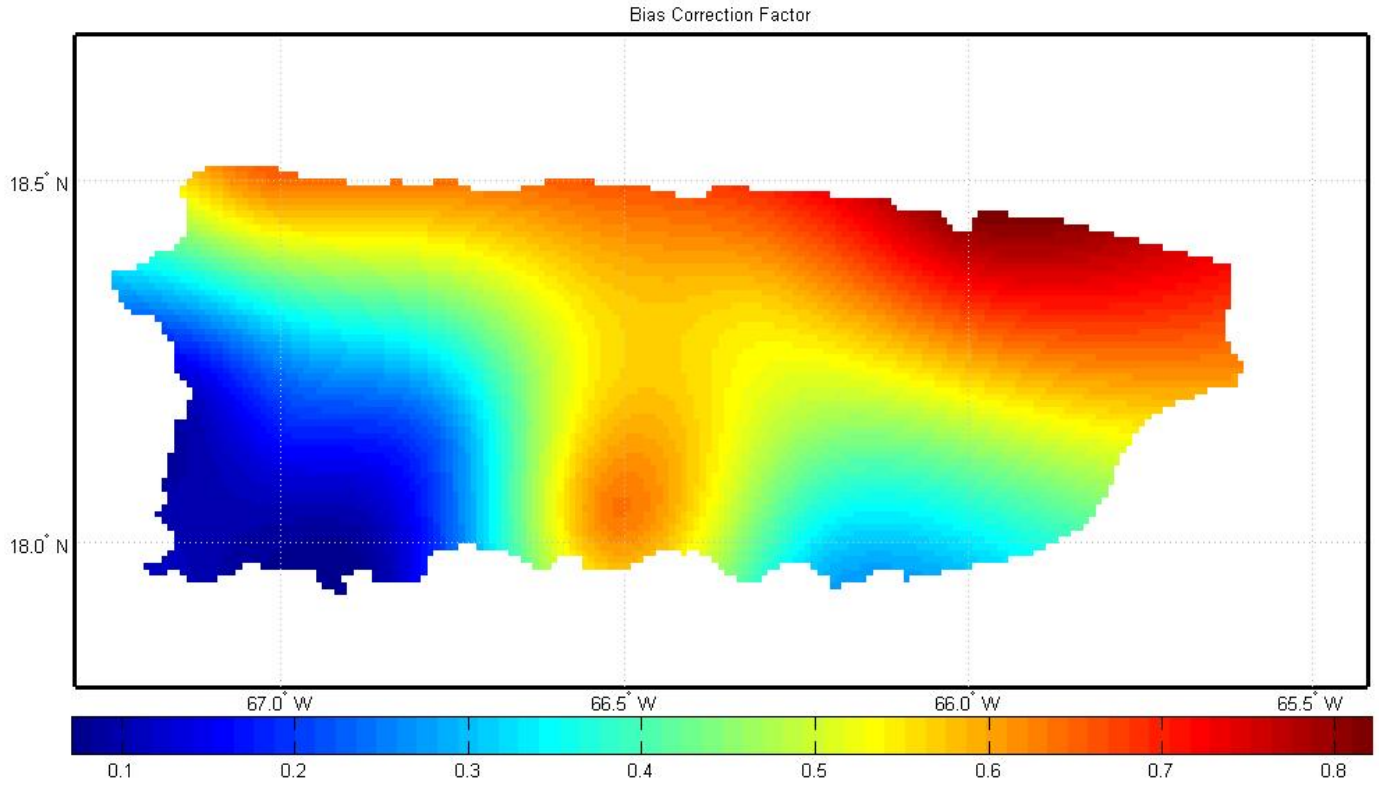
- Jobos Bay National Estuarine Research Reserve = 1,826

Total Data Pairs = 13,505

WIND SPEED BIAS CORRECTION

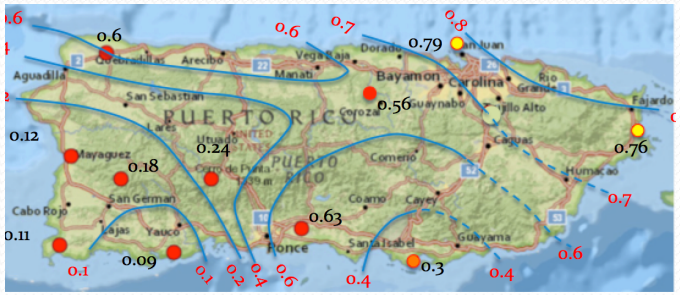
NRCS SCAN Weather Underground Jobos Bay



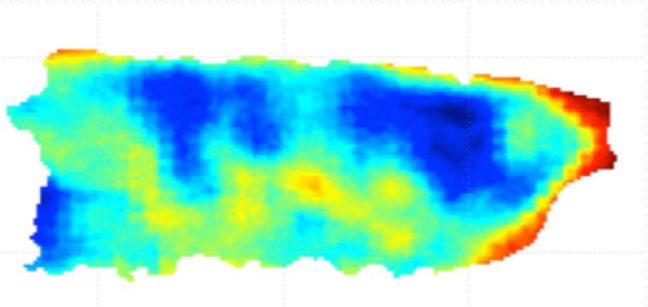

Bias Correction Factor
18.5° N
18.0° N
67.0° W
66.5° W
66.0° W
65.5° W
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8

Implementation of the Bias Correction Map

Bias Correction Map

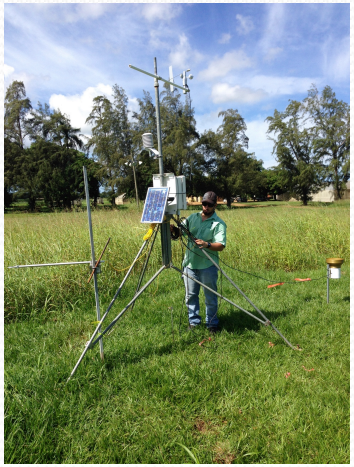


X



= Improved wind daily wind speed estimates

ISABELA SUBSTATION



LAJAS SUBSTATION

Preliminary Conclusions

- The NWS wind product from the National Digital Forecast Database (NDFD) produces unreliable results for Puerto Rico.
- Using the NWS wind speeds cause GOES-PRWEB to overestimate ETo.
- Errors in wind speed were not spatially constant. The largest errors for a five year period occurred in the southwest.
- The FAO recommendation of using the world-wide average wind speed of 2 m/s with the absence of measured data will lead to significant errors in ETo in Puerto Rico.
- Reliable wind speed is needed to obtain reliable estimates of ETo in Puerto Rico.
- A goal of the undergraduate research project is to produce a reliable ETo product by the end of the semester.

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