Supplement of

Further validation of the McClear estimates of the downwelling solar radiation at ground level in cloud-free conditions: The case of the Sub-Saharan Africa and Maldives Archipelago

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Here are given graphs of the comparisons between McClear-v3 estimates and ground-based measurements for all stations ordered by decreasing latitude and for (1) global irradiance $G$, (2) direct component at normal incidence $B_N$, (3) clearness index $K_T$ and (4) direct clearness index $K_T^B_N$. At each station, the description is as follows:

- Top left graph shows the 2D histogram between measurements (horizontal axis) and McClear-v3 estimates (vertical axis). The color indicates the number of pairs in each class.
- Top right graph shows statistical indicators (correlation coefficient, relative bias and relative root mean square error) per month. Each year being represented by one color.
- Bottom left graph shows boxplots of the ratios between the McClear estimates (Est) and the measurements (Meas) for several classes of various variables. In each boxplot, the red point is the mean while the lower, middle, and upper lines are respectively the 25, 50 and 75 percentiles. The number of samples is given for each class. Only classes with at least 50 samples are drawn.
- Bottom right graph. Same as Bottom left graph but for the difference between the McClear estimates (Est) and the measurements (Meas).
Figure S1: Comparison on global irradiance at Touba
Figure S2: Comparison on direct component at normal irradiance at Touba

BN. Touba (lat: 14.77; lon: -15.92; 37 m) 2016-10 / 2017-09

- Nb data = 16643
- Mean = 794 W m⁻²
- Bias = -33 W m⁻² (-4.1%)
- RMSE = 69 W m⁻² (8.7%)
- $R^2 = 0.676$
- Est = +0.81 Meas +122
- STD = 51 W m⁻² (7.7%)
Figure S3: Comparison on clearness index at Touba

KT. Touba (lat: 14.77; lon: -15.92; 37 m) 2016-10 / 2017-09

- Nb data = 16643
- Mean = 0.75
- Bias = 0.00 (0.5%)
- RMSE = 0.02 (2.8%)
- R = 0.736
- Est = +0.70 Meas +0.226
- STD = 0 W m⁻² (2.7%)

The diagram shows a scatter plot comparing the estimated clearness index (KT) against the measured clearness index. The graph includes a 1:1 line for reference. The histograms on the right side display the distribution of bias and RMSE for different months.

Additional graphs show the comparison for solar zenith angle, albedo, total ozone content, total water vapor, and aerosol optical depth at 550 nm.
Figure S4: Comparison on direct clearness index at Touba

KTBN, Touba (lat: 14.77°, lon: -15.92°, 37 m) 2016-10/2017-09

- Nbr. data = 1663
- Mean = 0.59 (42.2%)
- Bias = -0.02 (4.2%)
- RMSE = 0.05 (8.6%)
- Est = 0.73 (Bias = 0.132)
- STD = 0.51 (7.8%)

- Solar zenith angle (°)
- Total ozone content (DU)
- Total water vapor (kg m⁻²)
- Aerosol optical depth at 550 nm

KTBN, Touba (lat: 14.77°, lon: -15.92°, 37 m) 2016-10/2017-09

- Nbr. data = 1663
- Mean = 0.59 (42.2%)
- Bias = -0.02 (4.2%)
- RMSE = 0.05 (8.6%)
- Est = 0.73 (Bias = 0.132)
- STD = 0.51 (7.8%)
Figure S5: Comparison on global irradiance at Fatick
Figure S6: Comparison on direct component at normal irradiance at Fatick
Figure S7: Comparison on clearness index at Fatick
Figure S8: Comparison on direct clearness index at Fatick
Figure S9: Comparison on global irradiance at Kahone

G. Kahone (lat: 14.17; lon: -16.03; 10 m) 2016-10 / 2017-09

- Nb data = 17084
- Mean = 872 W m⁻²
- Bias = 3 W m⁻² (0.3%)
- RMSE = 27 W m⁻² (3.1%)
- R² = 0.967
- Est = +0.88 Meas +112
- STD = 27 W m⁻² (3.1%)

Figure S9: Comparison on global irradiance at Kahone
Figure S10: Comparison on direct component at normal irradiance at Kahone
Figure S11: Comparison on clearness index at Kahone

KT. Kahone (lat: 14.17; lon: -16.03; 10 m) 2016-10 / 2017-09

- Nb data = 17684
- Mean = 0.74
- Bias = 0.00 (0.4%)
- RMSE = 0.02 (3.3%)
- R = 0.687
- Est = +0.62 Meas +0.290
- STD = 0 W m$^{-2}$ (3.2%)

Figure S11: Comparison on clearness index at Kahone
Figure S12: Comparison on direct clearness index at Kahone
Figure S13: Comparison on global irradiance at Hanimaadhoo

G. Hanimaadhoo (lat: 6.75; lon: 73.17; 2 m) 2016 / 2017

- Nb data = 37259
- Mean = 879 W m⁻²
- Bias = -20 W m⁻² (-2.3%)
- RMSE = 29 W m⁻² (3.3%)
- R² = 0.977
- Est = +0.96 Meas +25
- STD = 21 W m⁻² (2.4%)

Solar zenithal angle (°)

Albedo

Total ozone content (DU)

Total water vapor (kg m⁻³)

Aerosol optical depth at 550 nm
Figure S14: Comparison on direct component at normal irradiance at Hanimaadhoo
Figure S16: Comparison on direct clearness index at Hanimaadhoo

KTBN. Hanimaadhoo (lat: 6.75; lon: 73.17; 2 m) 2016 / 2017

- Nb data = 37259
- Mean = 0.55
- Bias = 0.01 (1.9%)
- RMSE = 0.04 (7.1%)
- R = 0.732
- Est = +0.92 Meas +0.054
- STD = 0 W m^2 (6.9%)

Figure S16: Comparison on direct clearness index at Hanimaadhoo
Figure S17: Comparison on global irradiance at Male

G. Male (lat: 4.19; lon: 73.53; -8 m) 2016 / 2017

- Nb data = 29399
- Mean = 890 W m⁻²
- Bias = -27 W m⁻² (-3.1%)
- RMSE = 37 W m⁻² (4.1%)
- R² = 0.977
- Est = 0,94 Meas +27
- STD = 24 W m⁻² (2.7%)

Estimated G (W m⁻²)

Measured G (W m⁻²)

Counts

Figure S17: Comparison on global irradiance at Male
Figure S18: Comparison on direct component at normal irradiance at Male
Figure S19: Comparison on clearness index at Male

KT. Male (lat: 4.19; lon: 73.53; -8 m) 2016 / 2017

Nb data = 29399
Mean = 0.75
Bias = -0.02 (-3.1%)
RMSE = 0.03 (4.1%)
R = 0.623
Est = +0.53 Meas +0.330
STD = 0 W m^-2 (2.7%)
Figure S20: Comparison on direct clearness index at Male
Figure S22: Comparison on direct component at normal irradiance at Wadelai
Figure S23: Comparison on clearness index at Wadelai
Figure S24: Comparison on direct clearness index at Wadelai
Figure S25: Comparison on global irradiance at Kadhdhoo
Figure S26: Comparison on direct component at normal irradiance at Kadhdhoo
Figure S27: Comparison on clearness index at Kadhdhoo
Figure S28: Comparison on direct clearness index at Kadhdhoo

KTBN, Kadhdhoo (lat: 1.86; lon: 73.52; 0 m) 2017

- Nb data = 13435
- Mean = 0.57
- Bias = 0.02 (3.6%)
- RMSE = 0.04 (6.8%)
- R = 0.76
- Est = +0.71 Meas +0.186
- STD = 0 W m$^{-2}$ (5.8%)
Figure S29: Comparison on global irradiance at Laisamis.

- **G. Laisamis (lat: 1.60; lon: 37.80; 576 m) 2020**

  - Nb data = 13837
  - Mean = 902 W m\(^{-2}\)
  - Bias = 14 W m\(^{-2}\) (1.5%)
  - RMSE = 21 W m\(^{-2}\) (2.3%)
  - R\(^2\) = 0.987
  - Est = +1.01 Meas +3
  - STD = 16 W m\(^{-2}\) (1.7%)

- **Corr coeff.**

  - Bias (%)
  - RMSE (%)

- **J F M A M J J A S O N D**

- **Solar zenithal angle (°)**

  - Est / Meas

- **Total ozone content (DU)**

  - Est / Meas

- **Total water vapor (kg m\(^{-2}\))**

  - Est / Meas

- **Aerosol optical depth at 550 nm**

  - Est / Meas

- **Albedo**

  - Est / Meas

- **Total ozone content (DU)**

  - Est / Meas

- **Total water vapor (kg m\(^{-2}\))**

  - Est / Meas

- **Aerosol optical depth at 550 nm**

  - Est / Meas
Figure S30: Comparison on direct component at normal irradiance at Laisamis.
Figure S31: Comparison on clearness index at Laisamis
Figure S32: Comparison on direct clearness index at Laisamis
Figure S33: Comparison on global irradiance at Homa Bay.
Figure S34: Comparison on direct component at normal irradiance at Homa Bay
Figure S35: Comparison on clearness index at Homa Bay
Figure S36: Comparison on direct clearness index at Homa Bay
Figure S37: Comparison on global irradiance at Narok
Figure S38: Comparison on direct component at normal irradiance at Narok
Figure S39: Comparison on clearness index at Narok
Figure S40: Comparison on direct clearness index at Narok
Figure S42: Comparison on direct component at normal irradiance at Shinyanga
Figure S43: Comparison on clearness index at Shinyanga
Figure S44: Comparison on direct clearness index at Shinyanga
Figure S45: Comparison on global irradiance at Dodoma
Figure S46: Comparison on direct component at normal irradiance at Dodoma
Figure S47: Comparison on clearness index at Dodoma

KT. Dodoma (lat: -6.18; lon: 35.70; 1139 m) 2020

- Nb data = 17419
- Mean = 0.77
- Bias = 0.02 (2.0%)
- RMSE = 0.02 (3.1%)
- R = 0.781
- Est = 0.57 Meas + 0.347
- STD = 0 W m⁻² (2.3%)

- Solar zenithal angle (°)
  - Est / Meas

- Total ozone content (DU)
  - Est / Meas

- Total water vapor (kg m⁻²)
  - Est / Meas

- Aerosol optical depth at 550 nm
  - Est / Meas

KT. Dodoma (lat: -6.18; lon: 35.70; 1139 m) 2020

- Solar zenithal angle (°)

- Albedo

- Total ozone content (DU)

- Total water vapor (kg m⁻²)

- Aerosol optical depth at 550 nm

Figure S47: Comparison on clearness index at Dodoma
Figure S48: Comparison on direct clearness index at Dodoma
Figure S49: Comparison on global irradiance at Dar Es Salaam-TZ
Figure S50: Comparison on direct component at normal irradiance at Dar Es Salaam-TZ
Figure S51: Comparison on clearness index at Dar Es Salaam-TZ

KT. Dar Es Salaam-TZ (lat: -6.78; lon: 39.20; -122 m) 2016

- Nb data = 9863
- Mean = 0.74
- Bias = 0.01 (1.2%)
- RMSE = 0.02 (2.8%)
- R = 0.596
- Est = +0.46 Meas +0.406
- STD = 0 W m^-2 (2.5%)
Figure S52: Comparison on direct clearness index at Dar Es Salaam-TZ
Figure S53: Comparison on global irradiance at Kasama
Figure S54: Comparison on direct component at normal irradiance at Kasama

BN. Kasama (lat: -10.17, lon: 31.23; 1379 m) 2016-01 / 2017-11

- Nb data = 47,832
- Mean = 795 W m$^{-2}$
- Bias = 38 W m$^{-2}$ (4.8%)
- RMSE = 73 W m$^{-2}$ (9.1%)
- $R^2$ = 0.778
- Est = -0.85 Meas + 153
- STD = 62 W m$^{-2}$ (7.8%)

The figure shows a comparison of estimated and measured BN (W m$^{-2}$) at Kasama station. The data includes parameters such as solar zenith angle, albedo, total ozone content, total water vapor, and aerosol optical depth at 550 nm, illustrating the agreement between estimated and measured values over the years 2016-2017.
Figure S55: Comparison on clearness index at Kasama

KT. Kasama (lat: -10.17; lon: 31.23; 1379 m) 2016-01 / 2017-11

- Nb data = 47832
- Mean = 0.74
- Bias = 0.03 (3.4%)
- RMSE = 0.03 (4.7%)
- R = 0.793
- Est = +0.64 Meas +0.293
- STD = 0 W m⁻² (3.2%)

Figure S55: Comparison on clearness index at Kasama
Figure S56: Comparison on direct clearness index at Kasama

KTBN, Kasama (lat: -10.17; lon: 31.23; 1379 m) 2016-01 / 2017-11

- Nb data = 47632
- Mean = 0.59
- Bias = 0.03 (4.8%)
- RMSE = 0.05 (9.1%)
- R = 0.79
- Est = +0.88 Meas + 0.102
- STD = 0 W m^-2 (7.8%)

Comparison of estimated and measured KTBN values.

Graphs showing the comparison of solar zenithal angle, albedo, total ozone content, total water vapor, and aerosol optical depth at 550 nm.
Figure S57: Comparison on global irradiance at Mzuzu
Figure S59: Comparison on clearness index at Mzuzu
Figure S60: Comparison on direct clearness index at Mzuzu
Figure S61: Comparison on global irradiance at Mutanda
Figure S63: Comparison on clearness index at Mutanda


- Np data = 4424
- Mean = 0.03 (4.1%)
- Bias = 0.02 (6.3%)
- RMSE = 0.27 (22.7%)
- STD = 0.27 (22.7%)

- Correlation coefficient: 0.73

- Total ozone content (DU)
- Total water vapor (kg m$^{-2}$)
- Aerosol optical depth at 550 nm
- Solar zenith angle (°)

- Estimated KT vs. Measured KT

- 1:1 line
Figure S64: Comparison on direct clearness index at Mutanda
Figure S65: Comparison on global irradiance at Ndeke
Figure S66: Comparison on direct component at normal irradiance at Ndeke
Figure S67: Comparison on clearness index at Ndeke
Figure S68: Comparison on direct clearness index at Ndeke
Figure S69: Comparison on global irradiance at Kasungu

G. Kasungu (lat: -13.02; lon: 33.47; 1065 m) 2016-03 / 2017-12

- Nb data = 26341
- Mean = 874 W m⁻²
- Bias = 33 W m⁻² (3.8%)
- RMSE = 42 W m⁻² (4.8%)
- R² = 0.973
- Est = +0.93 Meas + 0.93
- STD = 22 W m⁻² (2.9%)
Figure S70: Comparison on direct component at normal irradiance at Kasungu
Figure S71: Comparison on clearness index at Kasungu

KT. Kasungu (lat: -13.02; lon: 33.47; 1065 m) 2016-03 / 2017-12

- Nb data = 26341
- Mean = 0.75
- Bias = 0.03 (3.9%)
- RMSE = 0.04 (4.9%)
- R = 0.723
- Est = +0.55 Meas +0.368
- STD = 0 W m⁻² (3.0%)

Corr coeff:

- '11: 0.75
- '12: 0.76
- '13: 0.77
- '14: 0.78
- '15: 0.79
- '16: 0.80
- '17: 0.81
- '18: 0.82
- '19: 0.83
- '20: 0.84

Bias (%):

- '11: 0.57
- '12: 0.53
- '13: 0.50
- '14: 0.47
- '15: 0.43
- '16: 0.40
- '17: 0.37
- '18: 0.34
- '19: 0.31
- '20: 0.28

RMSE (%):

- '11: 10.3
- '12: 10.1
- '13: 9.9
- '14: 9.7
- '15: 9.5
- '16: 9.3
- '17: 9.1
- '18: 8.9
- '19: 8.7
- '20: 8.5

Solar zenithal angle (°)

Albedo

Total ozone content (DU)

Total water vapor (kg m⁻³)

Aerosol optical depth at 550 nm

KT. Kasungu (lat: -13.02; lon: 33.47; 1065 m) 2016-03 / 2017-12

Est / Meas
Figure S72: Comparison on direct clearness index at Kasungu
Figure S73: Comparison on global irradiance at Kaoma
Figure S74: Comparison on direct component at normal irradiance at Kaoma

BN. Kaoma (lat: -14.84; lon: 24.93; 1170 m) 2016-01 / 2017-11

- Nb data = 52464
- Mean = 815 W m\(^{-2}\)
- Bias = 16 W m\(^{-2}\) (1.9%)
- RMSE = 58 W m\(^{-2}\) (7.1%)
- \( R^2 = 0.821 \)
- Est = 0.95 Meas + 55
- STD = 56 W m\(^{-2}\) (6.9%)

Solar zenithal angle (°)
Total ozone content (DU)
Total water vapor (kg m\(^{-2}\))
Aerosol optical depth at 550 nm
Figure S75: Comparison on clearness index at Kaoma

KT, Kaoma (lat: -14.84; lon: 24.93; 1170 m) 2016-01 / 2017-11

- Nb data = 52964
- Mean = 0.74
- Bias = 0.02 (3.3%)
- RMSE = 0.03 (4.4%)
- Est = 0.095
- STD = 0 W m^-2 (3.9%)

- 1:1 line
- Green indicates measured values
- Yellow indicates estimated values

Counts

- Total ozone content (DU)
- Total water vapor (kg m^-2)
- Aerosol optical depth at 550 nm
- Solar zenith angle (°)
Figure S76: Comparison on direct clearness index at Kaoma
Figure S78: Comparison on direct component at normal irradiance at Fig Tree
Figure S79: Comparison on clearness index at Fig Tree
Figure S80: Comparison on direct clearness index at Fig Tree
Figure S81: Comparison on global irradiance at Mumbwa.
Figure S82: Comparison on direct component at normal irradiance at Mumbwa
Figure S83: Comparison on clearness index at Mumbwa
Figure S84: Comparison on direct swirldness index at Mumbwa
Figure S85: Comparison on global irradiance at Lusaka
Figure S86: Comparison on direct component at normal irradiance at Lusaka
Figure S87: Comparison on clearness index at Lusaka

KT. Lusaka (lat: -15.39; lon: 28.34; 1262 m) 2016-01 / 2017-11

NADB = 41389
Mean = 0.74
Bias = 0.03 (4.6%)
RMSE = 0.04 (5.4%)
R = 0.814
Est = +0.63 Meas +0.309
STD = 0 W m⁻² (2.8%)
Figure S88: Comparison on direct clearness index at Lusaka
Figure S89: Comparison on global irradiance at Chilanga.
BN. Chilanga (lat: -15.55; lon: 28.25; 1224 m) 2016-01 / 2017-11

Figure S90: Comparison on direct component at normal irradiance at Chilanga
Figure S91: Comparison on clearness index at Chilanga
Figure S92: Comparison on direct clearness index at Chilanga
Figure S93: Comparison on global irradiance at Chileka

G. Chileka (lat: -15.68; lon: 34.97; 767 m) 2016-03 / 2017-12

- Nb data = 28205
- Mean = 853 W m\(^{-2}\)
- Bias = 40 W m\(^{-2}\) (4.6%)
- RMSE = 50 W m\(^{-2}\) (5.9%)
- R\(^2\) = 0.965
- Est = +0.91 Meas +120
- STD = 31 W m\(^{-2}\) (3.7%)
Figure S94: Comparison on direct component at normal irradiance at Chileka
Figure S95: Comparison on clearness index at Chileka
Figure S96: Comparison on direct clearness index at Chileka
Figure S97: Comparison on global irradiance at Choma
Figure S98: Comparison on direct component at normal irradiance at Choma
Figure S99: Comparison on clearness index at Choma
Figure S100: Comparison on direct clearness index at Choma
Figure S101: Comparison on global irradiance at Windhoek
Figure S102: Comparison on direct component at normal irradiance at Windhoek
Figure S103: Comparison on clearness index at Windhoek.
Figure S104: Comparison on direct clearness index at Windhoek
Figure S105: Comparison on global irradiance at Vuwani

G. Vuwani (lat: -23.13; lon: 30.42; 628 m) 2016 / 2019

- Nb data = 77020
- Mean = 879 W m\(^{-2}\)
- Bias = 23 W m\(^{-2}\) (2.7%)
- RMSE = 33 W m\(^{-2}\) (3.7%)
- R\(^2\) = 0.986
- Est = +0.93 Meas +87
- STD = 23 W m\(^{-2}\) (2.6%)

Counts

E: 1100 - 1300
M: 300 - 1100
G: 700 - 900
H: 500 - 700
I: 300 - 500
J: E, M, G, H, I

Corr coeff

Bias [%]

RMSE [%]

J: 0.11, 0.12, 0.13, 0.14, 0.15, 0.16, 0.17, 0.18, 0.19, 0.20

Solar zenithal angle (°)

Albedo

Total ozone content (DU)

Total water vapor (kg m\(^{-2}\))

Aerosol optical depth at 550 nm

G. Vuwani (lat: -23.13; lon: 30.42; 628 m) 2016 / 2019

Solar zenithal angle (°)

Albedo

Total ozone content (DU)

Total water vapor (kg m\(^{-2}\))

Aerosol optical depth at 550 nm

G. Vuwani (lat: -23.13; lon: 30.42; 628 m) 2016 / 2019
Figure S106: Comparison on direct component at normal irradiance at Vuwani
Figure S107: Comparison on clearness index at Vuwani
Figure S108: Comparison on direct clearness index at Vuwani

KTBN. Vuwani (lat: -23.13; lon: 30.42; 628 m) 2016 / 2019

- Nb data = 77,200
- Mean = 0.63
- Bias = 0.03 (4.0%)
- RMSE = 0.06 (7.7%)
- R = 0.786
- Est = +0.72 * Meas + 0.202
- STD = 0 W m⁻² (6.6%)
Figure S109: Comparison on global irradiance at Gobabeb

G. Gobabeb (lat: -23.56; lon: 15.04; 407 m) 2013 / 2020

Estimated G (W m⁻²) vs Measured G (W m⁻²)

- Nb data = 399252
- Mean = 983 W m⁻²
- Bias = 3 W m⁻² (0.3%)
- RMSE = 17 W m⁻² (1.7%)
- R² = 0.989
- Est = +0.98 Meas +16
- STD = 17 W m⁻² (1.7%)

Corr coeff (%) vs Year

- Bias (%) vs Year

- RMSE (%) vs Year

Solar zenithal angle (°)

Albedo

Total ozone content (DU)

Total water vapor (kg m⁻²)

Aerosol optical depth at 550 nm

Figure S109: Comparison on global irradiance at Gobabeb
Figure S110: Comparison on direct component at normal irradiance at Gobabeb
Figure S111: Comparison on clearness index at Gobabeb
Figure S112: Comparison on direct clearness index at Gobabeb
Figure S113: Comparison on global irradiance at Gaborone

G. Gaborone (lat: -24.66; lon: 25.93; 1014 m) 2015 / 2018

- Nb data = 88168
- Mean = 919 W m$^{-2}$
- Bias = 37 W m$^{-2}$ (4.1%)
- RMSE = 43 W m$^{-2}$ (4.7%)
- $R^2$ = 0.983
- Est = +0.97 Meas +68
- STD = 22 W m$^{-2}$ (2.4%)

G. Gaborone (lat: -24.66; lon: 25.93; 1014 m) 2015 / 2018

G. Gaborone (lat: -24.66; lon: 25.93; 1014 m) 2015 / 2018

Figure S113: Comparison on global irradiance at Gaborone
Figure S114: Comparison on direct component at normal irradiance at Gaborone
Figure S115: Comparison on clearness index at Gaborone

KT. Gaborone (lat: -24.66; lon: 25.93; 1014 m) 2015 / 2018

- Nb data = 88168
- Mean = 0.76
- Bias = 0.03 (4.1%)
- RMSE = 0.04 (4.9%)
- R = 0.765
- Est = +0.69 Meas +0.267
- STD = 0 W m⁻² (2.7%)

Sun angle, Albedo, Total ozone content, Total water vapor, Aerosol optical depth at 550 nm
Figure S116: Comparison on direct clearness index at Gaborone
Figure S117: Comparison on global irradiance at Pretoria-CSIR.
Figure S118: Comparison on direct component at normal irradiance at Pretoria-CSIR

BN. Pretoria-CSIR (lat: -25.75; lon: 28.28; 1400 m) 2018 / 2020

- NBData = 46943
- Mean = 894.6 W m⁻²
- Bias = 9 W m⁻² (1.0%)
- RMSE = 53.3 W m⁻² (5.9%)
- R² = 0.930
- Est = +0.76 Meas +226
- STD = 52 W m⁻² (5.9%)

Count

1300
1100
900
700
500
300

BN. Pretoria-CSIR (lat: -25.75; lon: 28.28; 1400 m) 2018 / 2020

- Corr coeff

- Bias (%)

- RMSE (%)

J F M A M J J A S O N D

Solar zenithal angle (°)

Albedo

Total ozone content (DU)

Total water vapor (kg m⁻²)

Aerosol optical depth at 550 nm

BN. Pretoria-CSIR (lat: -25.75; lon: 28.28; 1400 m) 2018 / 2020

- Est - Meas in W m⁻²

200
100
0
-100
-200
-300

200-225 250-275 300-325 350-375 400-425

BN. Pretoria-CSIR (lat: -25.75; lon: 28.28; 1400 m) 2018 / 2020

- Est - Meas in kg m⁻²

200
100
0
-100
-200
-300

200-225 250-275 300-325 350-375 400-425
Figure S119: Comparison on clearness index at Pretoria-CSIR
Figure S120: Comparison on direct clearness index at Pretoria-CSIR
Figure S121: Comparison on global irradiance at Pretoria-GIZ
BN. Pretoria-GIZ (lat: -25.75; lon: 28.23; 1410 m) 2014 / 2020

Figure S122: Comparison on direct component at normal irradiance at Pretoria-GIZ
Figure S124: Comparison on direct clearness index at Pretoria-GIZ

- Nb data = 136636
- Mean = 0.65
- Bias = 0.01 (1.7%)
- RMSE = 0.05 (8.1%)
- R = 0.721
- Est = +0.73 * Meas + 0.186
- STD = 0 W m⁻² (7.9%)
Figure S126: Comparison on direct component at normal irradiance at Witbank
Figure S127: Comparison on clearness index at Witbank
Figure S128: Comparison on direct clearness index at Witbank
Figure S129: Comparison on global irradiance at Alexander Bay
Figure S130: Comparison on direct component at normal irradiance at Alexander Bay

- Nb data = 164366
- Mean = 982 W m\(^{-2}\)
- Bias = -23 W m\(^{-2}\) (-2.3%)
- RMSE = 51 W m\(^{-2}\) (5.2%)
- R\(^2\) = 0.764
- Est = +0.81 Meas +167
- STD = 46 W m\(^{-2}\) (4.7%)

The figure shows a comparison of estimated BN (W m\(^{-2}\)) against measured BN (W m\(^{-2}\)) for different parameters such as solar zenithal angle, albedo, total ozone content, total water vapor, and aerosol optical depth at 550 nm. The data is presented for different months and years, indicating a comparison across various environmental conditions.
Figure S131: Comparison on clearness index at Alexander Bay
Figure S32: Comparison on direct clearness index at Alexander Bay
Figure S133: Comparison on global irradiance at Kwadlangezwa

- Nb data = 39000
- Mean = 865 W m⁻²
- Bias = 16 W m⁻² (1.8%)
- RMSE = 24 W m⁻² (2.7%)
- R² = 0.991
- Est = 0.96 Meas + 47
- STD = 18 W m⁻² (2.0%)

G. Kwadlangezwa (lat: -28.85; lon: 31.85; 90 m) 2016-02 / 2020-12
Figure S134: Comparison on direct component at normal irradiance at Kwadlangezwa
Figure S135: Comparison on clearness index at Kwadlangezwa
Figure S136: Comparison on direct clearness index at Kwadlangezwa
Figure S137: Comparison on global irradiance at Bloemfontein-CUT
Figure S138: Comparison on direct component at normal irradiance at Bloemfontein-CUT
Figure S139: Comparison on clearness index at Bloemfontein-CUT
Figure S140: Comparison on direct clearness index at Bloemfontein-CUT
Figure S141: Comparison on global irradiance at Durban-KZW

Nb data = 26023
Mean = 883 W m\(^{-2}\)
Bias = 8 W m\(^{-2}\) (1.0%)
RMSE = 23 W m\(^{-2}\) (2.6%)
R\(^2\) = 0.987
Est = +0.96 Meas +44
STD = 22 W m\(^{-2}\) (2.4%)
Figure S142: Comparison on direct component at normal irradiance at Durban-KZW
Figure S143: Comparison on clearness index at Durban-KZW

- Nb data = 26625
- Mean = 0.75
- Bias = 0.01 (1.0%)
- RMSE = 0.02 (2.8%)
- R = 0.745
- Est = +0.70 Meas +0.231
- STD = 0 W m⁻² (2.6%)
Figure S14: Comparison on direct clearness index at Durban-KZW
Figure S147: Comparison on clearness index at Durban-KZH
Figure S148: Comparison on direct clearness index at Durban-KZH
Figure S149: Comparison on global irradiance at De Aar

G. De Aar (lat: -30.67; lon: 23.99; 1287 m) 2015 / 2019

- Nb data = 90684
- Mean = 1056 W m^{-2}
- Bias = 3 W m^{-2} (0.3%)
- RMSE = 19 W m^{-2} (1.8%)
- R^2 = 0.978
- Est = +0.93 Meas +74
- STD = 16 W m^{-2} (1.8%)

Solar zenithal angle (°)

Albedo

Total ozone content (DU)

Total water vapor (kg m^{-2})

Aerosol optical depth at 550 nm

G. De Aar (lat: -30.67; lon: 23.99; 1287 m) 2015 / 2019

Solar zenithal angle (°)

Albedo

Total ozone content (DU)

Total water vapor (kg m^{-2})

Aerosol optical depth at 550 nm

G. De Aar (lat: -30.67; lon: 23.99; 1287 m) 2015 / 2019

Figure S149: Comparison on global irradiance at De Aar
Figure S150: Comparison on direct component at normal irradiance at De Aar
Figure S151: Comparison on clearness index at De Aar
Figure S152: Comparison on direct clearness index at De Aar
Figure S153: Comparison on global irradiance at Vanrhynsdorp
Figure S154: Comparison on direct component at normal irradiance at Vanrhynsdorp
Figure S155: Comparison on clearness index at Vanrhynsdorp
Figure S156: Comparison on direct clearness index at Vanrhynsdorp
Figure S157: Comparison on global irradiance at Graaff-Reinet

G. Graaff-Reinet (lat: -32.49; lon: 24.59; 660 m) 2014 / 2015

- Nb data = 36457
- Mean = 1009 W m\(^{-2}\)
- Bias = 17 W m\(^{-2}\) (1.7%)
- RMSE = 22 W m\(^{-2}\) (2.1%)
- R = 0.989
- Est = +0.98 Meas +57
- STD = 13 W m\(^{-2}\) (1.3%)

Figure S157: Comparison on global irradiance at Graaff-Reinet
Figure S158: Comparison on direct component at normal irradiance at Graaff-Reinet

BN. Graaff-Reinet (lat: -32.49; lon: 24.59; 660 m) 2014 / 2015

- Nb data = 36457
- Mean = 1018 W m$^{-2}$
- Bias = 8 W m$^{-2}$ (0.8%)
- RMSE = 32 W m$^{-2}$ (3.1%)
- $R^2 = 0.851$
- Est. = +0.85, Meas. = +162
- STD = 31 W m$^{-2}$ (3.0%)

- Bias (%)
- RMSE (%)

- Est. / Mean
- Solar zenithal angle (°)
- Total ozone content (DU)
- Aerosol optical depth at 550 nm
- Albedo
- Total water vapor (kg m$^{-2}$)
- Total ozone content (DU)
- Aerosol optical depth at 550 nm

BN. Graaff-Reinet (lat: -32.49; lon: 24.59; 660 m) 2014 / 2015

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Figure S159: Comparison on clearness index at Graaff-Reinet.
Figure S160: Comparison on direct clearness index at Graaff-Reinet
Figure S161: Comparison on global irradiance at Alice

G. Alice (lat: -32.78; lon: 26.85; 540 m) 2017-02 / 2020-12

- NB data = 48409
- Mean = 958 W m\(^{-2}\)
- Bias = 10 W m\(^{-2}\) (1.0%)
- RMSE = 16 W m\(^{-2}\) (1.7%)
- R\(^2\) = 0.991
- Est = +0.98 Meas +28
- STD = 13 W m\(^{-2}\) (1.4%)

[Graphs showing comparisons of various parameters such as solar zenith angle, albedo, total ozone content, total water vapor, and aerosol optical depth at 550 nm for different months and years, including 2011 to 2020.]
Figure S162: Comparison on direct component at normal irradiance at Alice.
Figure S164: Comparison on direct clearness index at Alice
Figure S165: Comparison on global irradiance at Mariendal
Figure S166: Comparison on direct component at normal irradiance at Mariendal
Figure S167: Comparison on clearness index at Mariendal
Figure S168: Comparison on direct clearness index at Mariendal
Figure S169: Comparison on global irradiance at Stellenbosch
Figure S170: Comparison on direct component at normal irradiance at Stellenbosch
Figure S172: Comparison on direct cleanness index at Stellenbosch.
Figure S173: Comparison on global irradiance at Port Elizabeth

- Estimated G (W m⁻²) vs. Measured G (W m⁻²)
- Data from 2016 to 2017
- Nb. data = 2786
- Mean = 946 W m⁻² (0.8%)
- Bias = -8 W m⁻² (1.7%)
- RMSE = 16 W m⁻² (3.8%)
- R² = 0.99
- STD = 15 W m⁻² (1.5%)

- Solar zenithal angle (°)
- Total ozone content (DU)
- Aerosol optical depth at 550 nm
- Total water vapor (kg m⁻²)

Port Elizabeth (lat. 34.01°N; long. 25.67°E) 2016-2017
Figure S174: Comparison on direct component at normal irradiance at Port Elizabeth
Figure S175: Comparison on clearness index at Port Elizabeth
Figure S176: Comparison on direct clearness index at Port Elizabeth