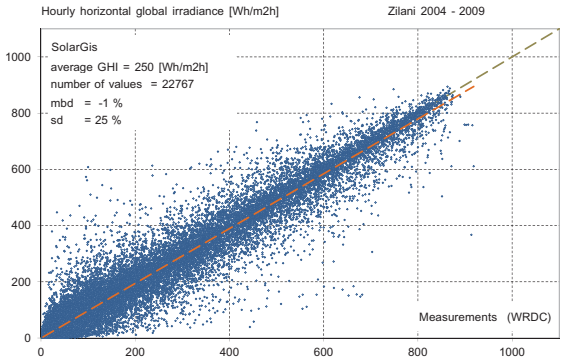
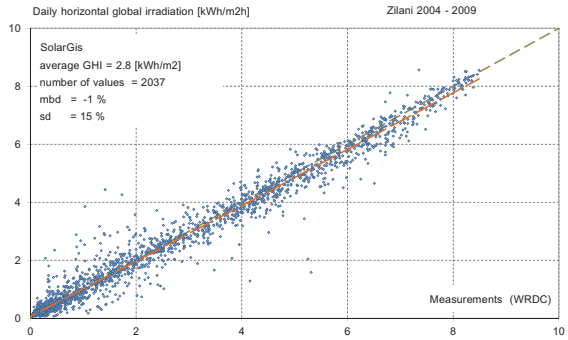
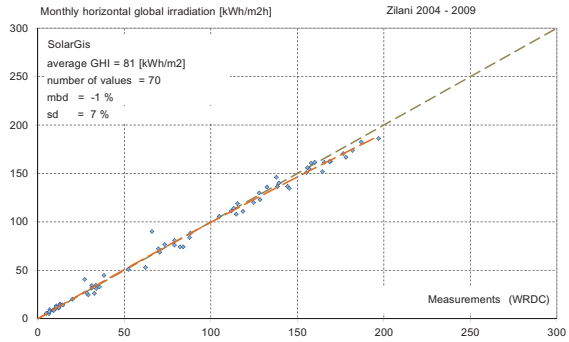
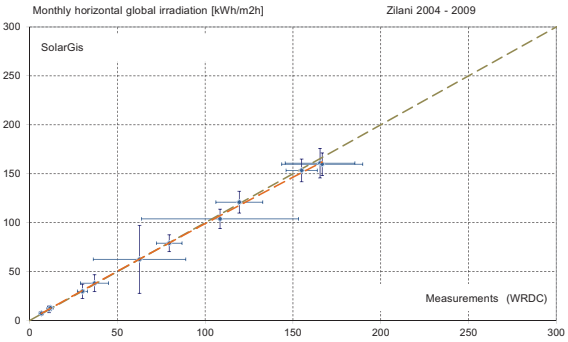
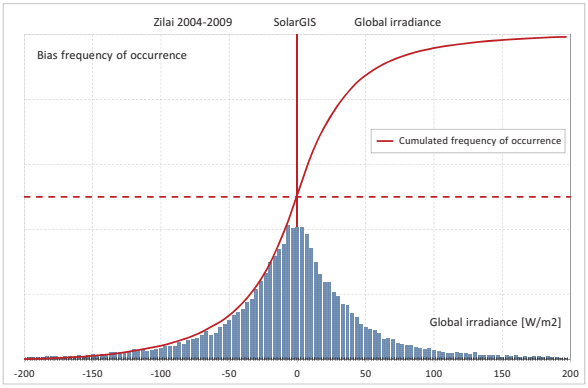
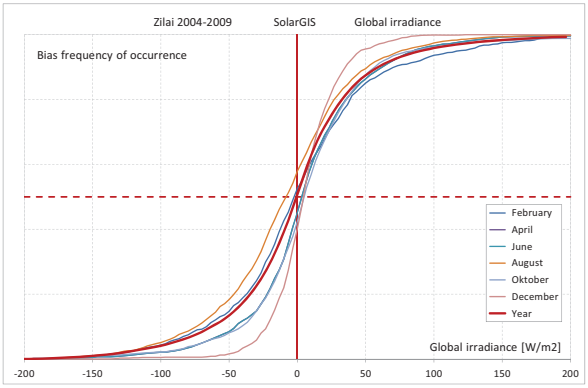

Hourly horizontal global irradiance [Wh/m2h]
Zilani 2004 - 2009
SolarGis
average GHI = 250 [Wh/m2h]
number of values = 22767
mbd = -1 %
sd = 25 %
Measurements (WRDC)

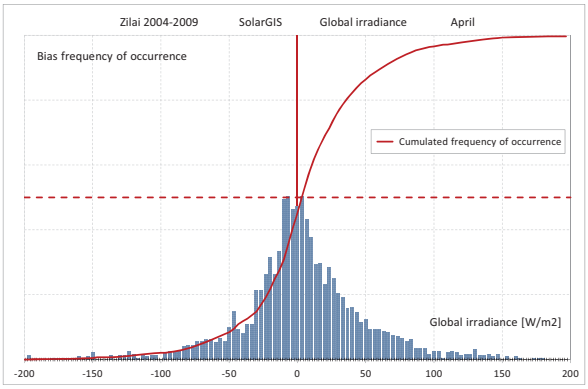

Daily horizontal global irradiation [kWh/m2h]
Zilani 2004 - 2009
SolarGis
average GHI = 2.8 [kWh/m2]
number of values = 2037
mbd = -1 %
sd = 15 %
Measurements (WRDC)

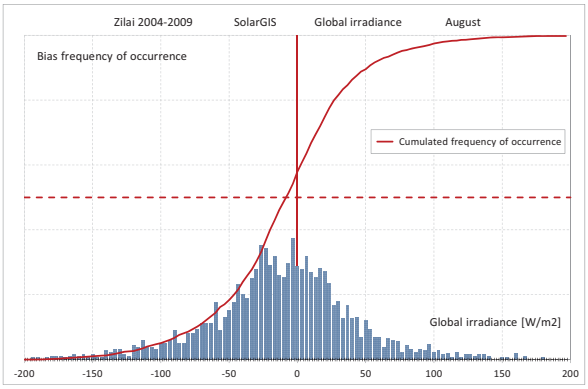

Monthly horizontal global irradiation [kWh/m2h]
Zilani 2004 - 2009
SolarGis
average GHI = 81 [kWh/m2]
number of values = 70
mbd = -1 %
sd = 7 %
Measurements (WRDC)

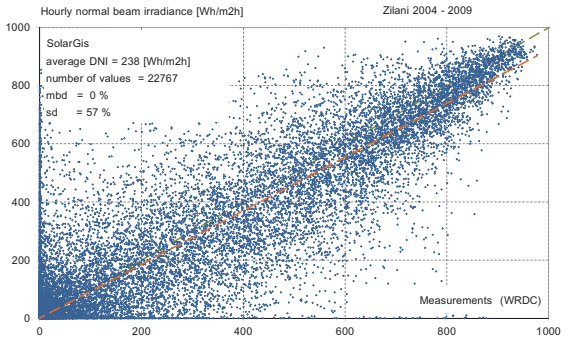

Monthly horizontal global irradiation [kWh/m2h]
Zilani 2004 - 2009
SolarGis
Measurements (WRDC)

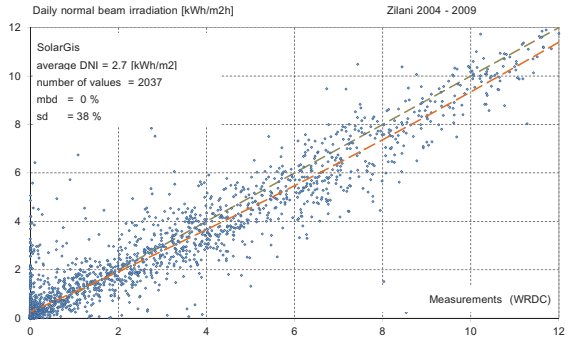

Zilai 2004-2009
SolarGIS
Global irradiance
Bias frequency of occurrence
Cumulated frequency of occurrence
Global irradiance [W/m2]

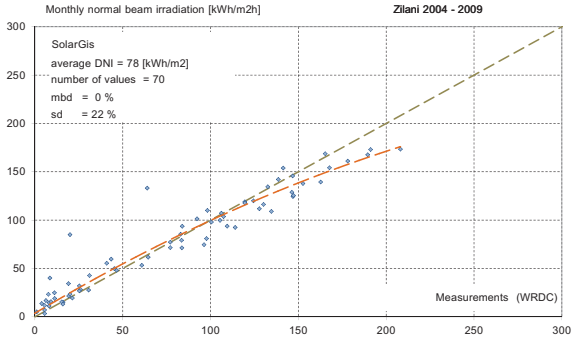

Zilai 2004-2009
SolarGIS
Global irradiance
Bias frequency of occurrence
February
April
June
August
Oktober
December
Year
Global irradiance [W/m2]

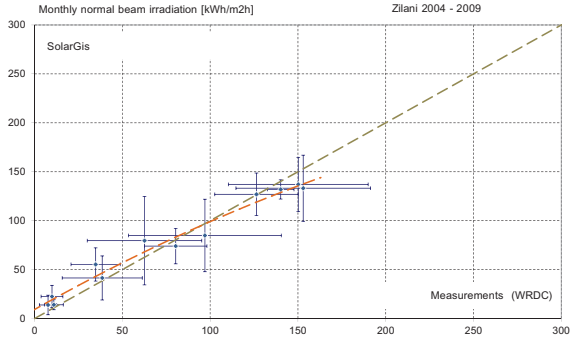

Zilai 2004-2009
SolarGIS
Global irradiance
April
Bias frequency of occurrence
Cumulated frequency of occurrence
Global irradiance [W/m2]

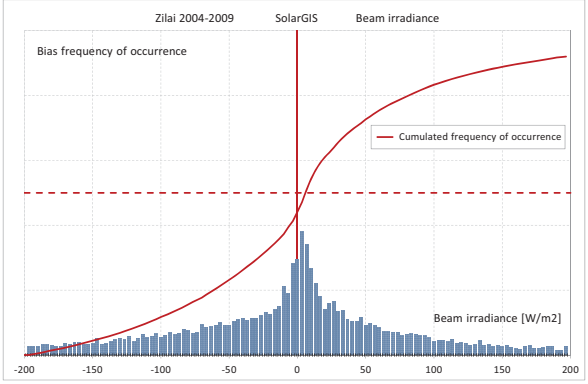

Zilai 2004-2009
SolarGIS
Global irradiance
August
Bias frequency of occurrence
Cumulated frequency of occurrence
Global irradiance [W/m2]

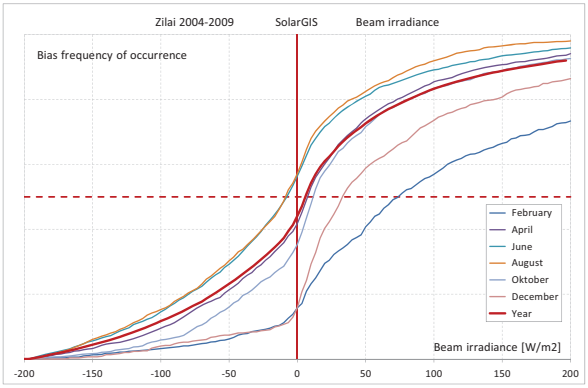

Hourly normal beam irradiance [Wh/m2h]
Zilani 2004 - 2009
SolarGis
average DNI = 238 [Wh/m2h]
number of values = 22767
mbd = 0 %
sd = 57 %
Measurements (WRDC)

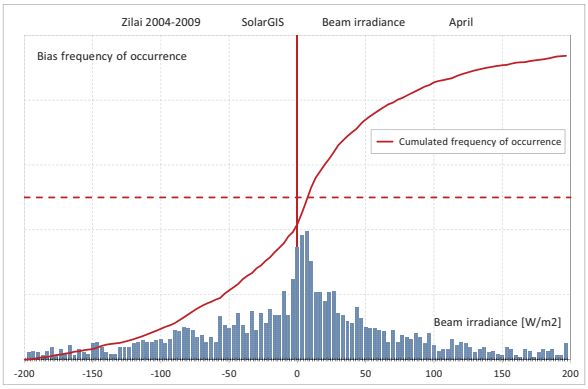

Daily normal beam irradiation [kWh/m2h]
Zilani 2004 - 2009
SolarGis
average DNI = 2.7 [kWh/m2]
number of values = 2037
mbd = 0 %
sd = 38 %
Measurements (WRDC)

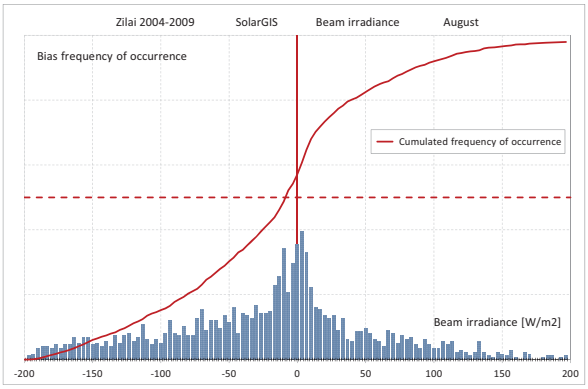

Monthly normal beam irradiation [kWh/m2h]
Zilani 2004 - 2009
SolarGis
average DNI = 78 [kWh/m2]
number of values = 70
mbd = 0 %
sd = 22 %
Measurements (WRDC)

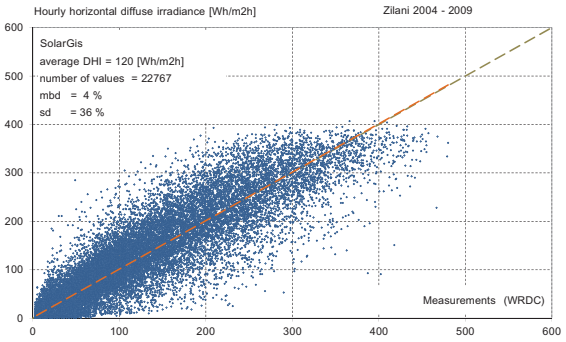

Monthly normal beam irradiation [kWh/m2h]
Zilani 2004 - 2009
SolarGis
Measurements (WRDC)

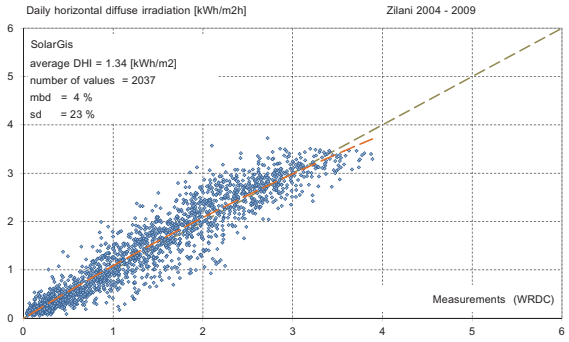

Zilai 2004-2009
SolarGIS
Beam irradiance
Bias frequency of occurrence
Cumulated frequency of occurrence
Beam irradiance [W/m2]

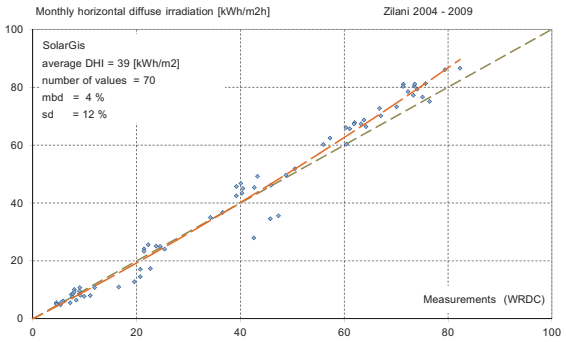

Zilai 2004-2009
SolarGIS
Beam irradiance
Bias frequency of occurrence
February
April
June
August
Oktober
December
Year
Beam irradiance [W/m2]

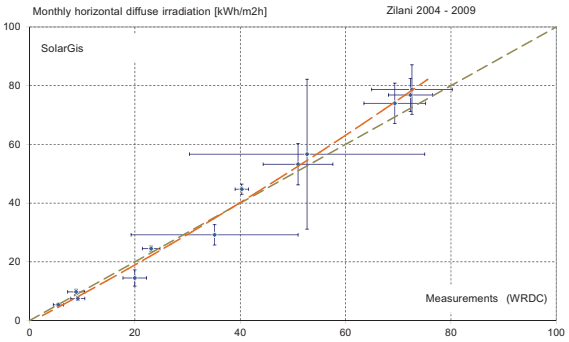

Zilai 2004-2009
SolarGIS
Beam irradiance
April
Bias frequency of occurrence
Cumulated frequency of occurrence
Beam irradiance [W/m2]

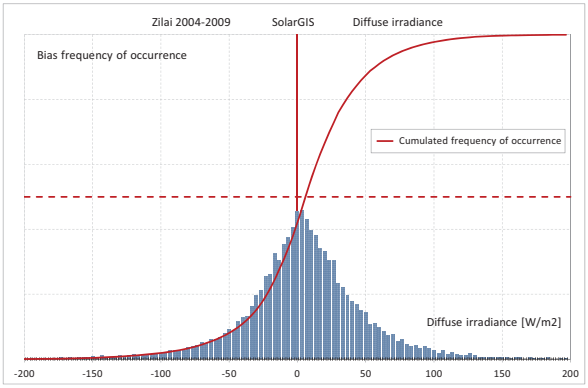

Zilai 2004-2009
SolarGIS
Beam irradiance
August
Bias frequency of occurrence
Cumulated frequency of occurrence
Beam irradiance [W/m2]

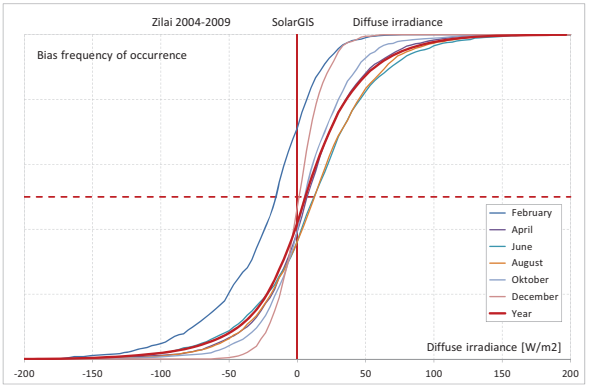

Hourly horizontal diffuse irradiance [Wh/m2h]
Zilani 2004 - 2009
SolarGis
average DHI = 120 [Wh/m2h]
number of values = 22767
mbd = 4 %
sd = 36 %
Measurements (WRDC)

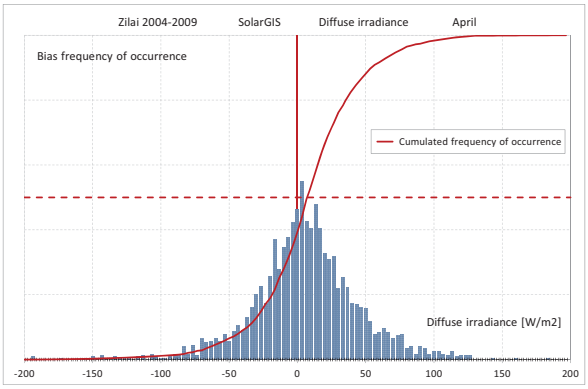

Daily horizontal diffuse irradiation [kWh/m2h]
Zilani 2004 - 2009
SolarGis
average DHI = 1.34 [kWh/m2]
number of values = 2037
mbd = 4 %
sd = 23 %
Measurements (WRDC)

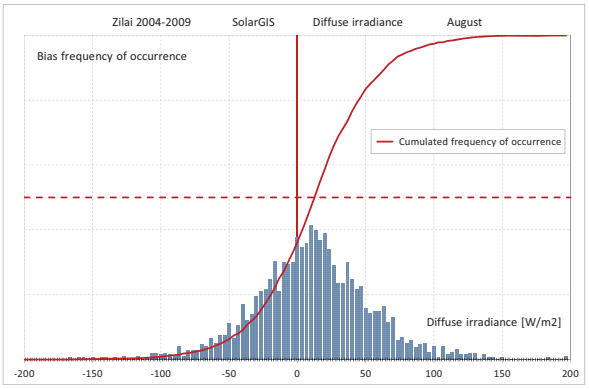

Monthly horizontal diffuse irradiation [kWh/m2h]
Zilani 2004 - 2009
SolarGis
average DHI = 39 [kWh/m2]
number of values = 70
mbd = 4 %
sd = 12 %
Measurements (WRDC)

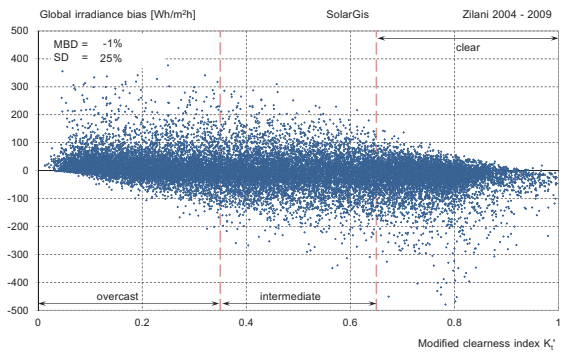

Monthly horizontal diffuse irradiation [kWh/m2h]
Zilani 2004 - 2009
SolarGis
Measurements (WRDC)

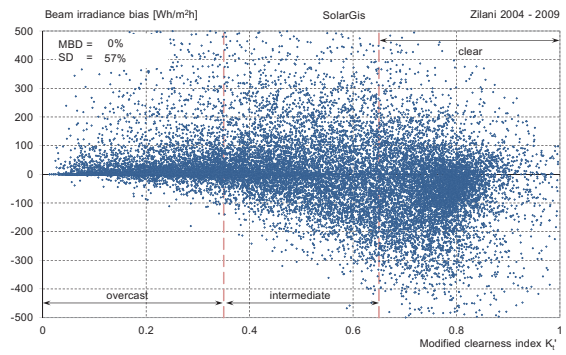

Zilai 2004-2009
SolarGIS
Diffuse irradiance
Bias frequency of occurrence
Cumulated frequency of occurrence
Diffuse irradiance [W/m2]

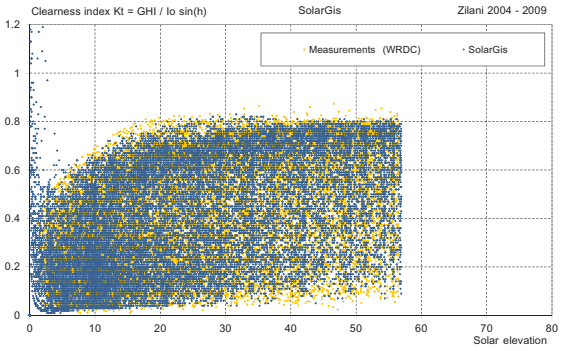

Zilai 2004-2009
SolarGIS
Diffuse irradiance
Bias frequency of occurrence
February
April
June
August
Oktober
December
Year
Diffuse irradiance [W/m2]

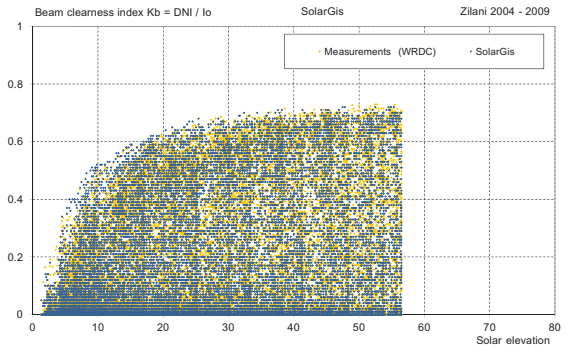

Zilai 2004-2009
SolarGIS
Diffuse irradiance
April
Bias frequency of occurrence
Cumulated frequency of occurrence
Diffuse irradiance [W/m2]

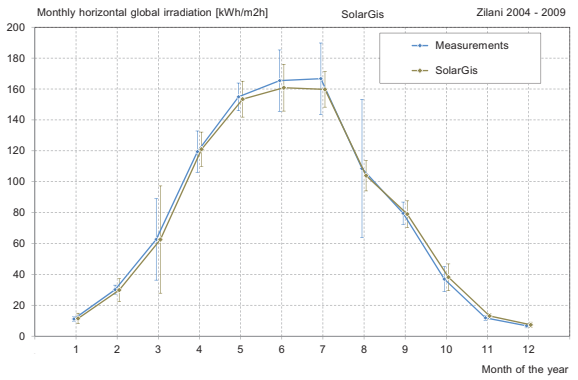

Zilai 2004-2009
SolarGIS
Diffuse irradiance
August
Bias frequency of occurrence
Cumulated frequency of occurrence
Diffuse irradiance [W/m2]

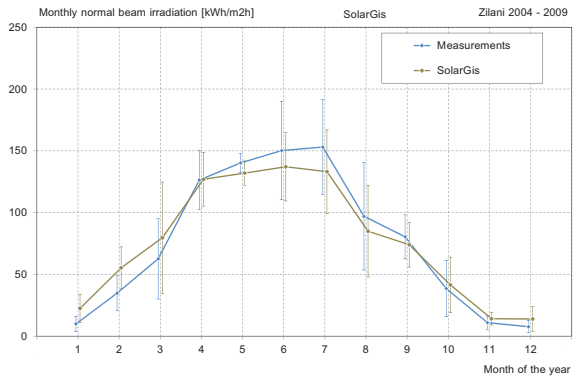

Global irradiance bias [Wh/m²h]
SolarGis
Zilani 2004 - 2009
MBD = -1%
SD = 25%
clear
overcast
intermediate
Modified clearness index Kt'

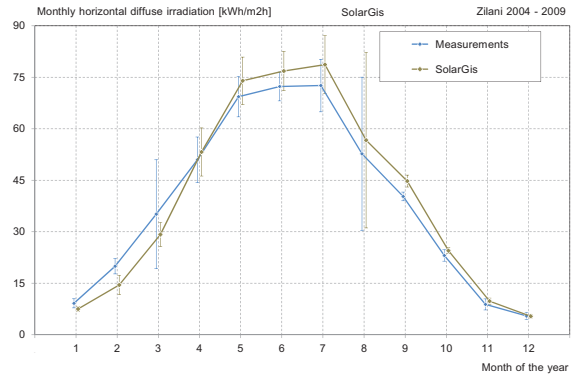

Beam irradiance bias [Wh/m²h]
SolarGis
Zilani 2004 - 2009
MBD = 0%
SD = 57%
clear
overcast
intermediate
Modified clearness index Kt'

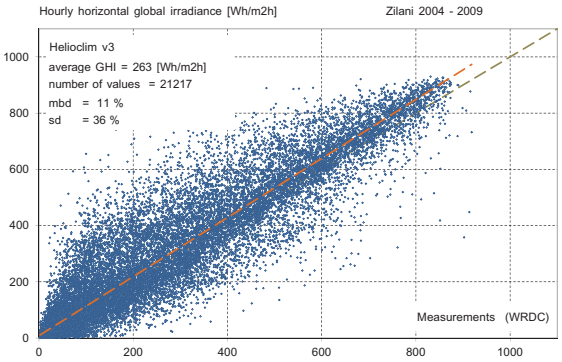

Clearness index Kt = GHI / Io sin(h)
SolarGis
Zilani 2004 - 2009
Measurements (WRDC)
SolarGis
Solar elevation

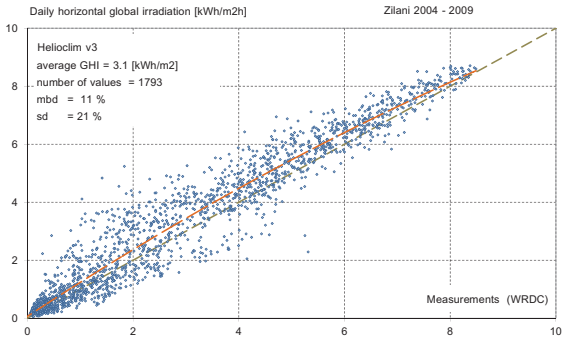

Beam clearness index Kb = DNI / Io
SolarGis
Zilani 2004 - 2009
Measurements (WRDC)
SolarGis
Solar elevation

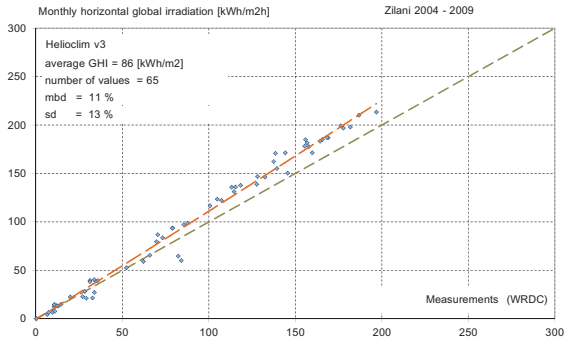

Monthly horizontal global irradiation [kWh/m2h]
SolarGis
Zilani 2004 - 2009
Measurements
SolarGis
Month of the year

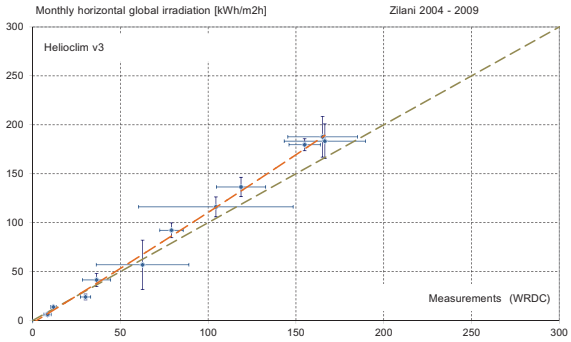

Monthly normal beam irradiation [kWh/m2h]
SolarGis
Zilani 2004 - 2009
Measurements
SolarGis
Month of the year

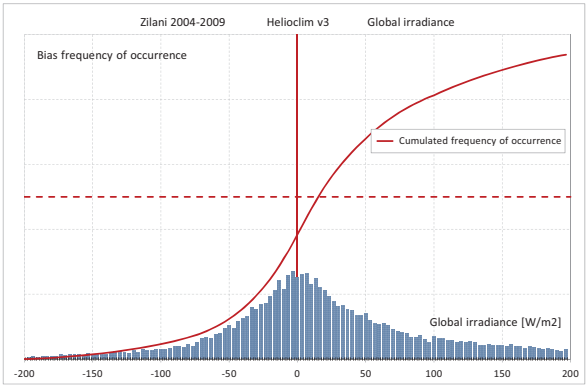

Monthly horizontal diffuse irradiation [kWh/m2h]
SolarGis
Zilani 2004 - 2009
Measurements
SolarGis
Month of the year

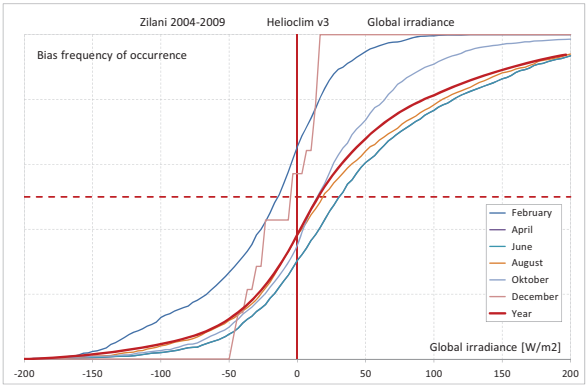

Hourly horizontal global irradiance [Wh/m2h]
Zilani 2004 - 2009
Helioclim v3
average GHI = 263 [Wh/m2h]
number of values = 21217
mbd = 11 %
sd = 36 %
Measurements (WRDC)

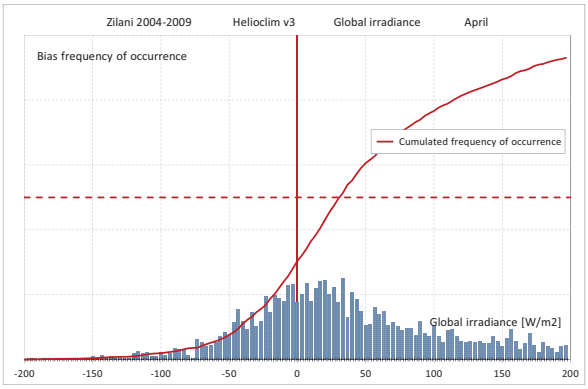

Daily horizontal global irradiation [kWh/m2h]
Zilani 2004 - 2009
Helioclim v3
average GHI = 3.1 [kWh/m2]
number of values = 1793
mbd = 11 %
sd = 21 %
Measurements (WRDC)

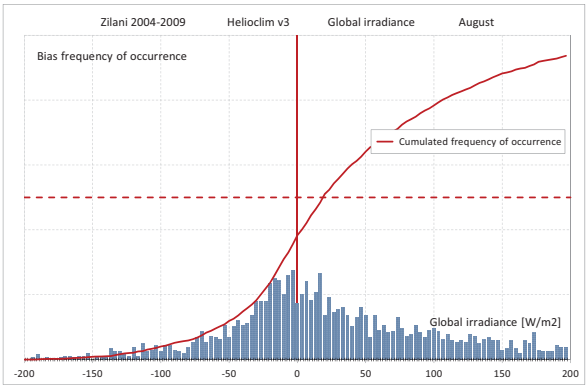

Monthly horizontal global irradiation [kWh/m2h]
Zilani 2004 - 2009
Helioclim v3
average GHI = 86 [kWh/m2]
number of values = 65
mbd = 11 %
sd = 13 %
Measurements (WRDC)

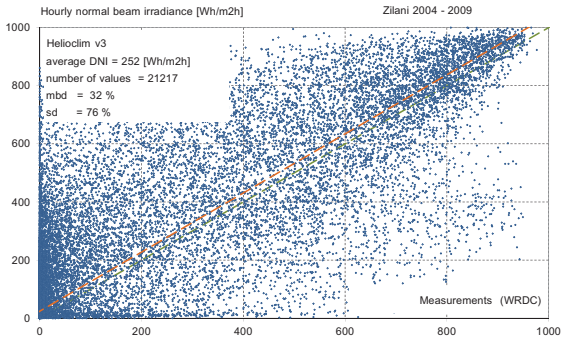

Monthly horizontal global irradiation [kWh/m2h]
Zilani 2004 - 2009
Helioclim v3
Measurements (WRDC)

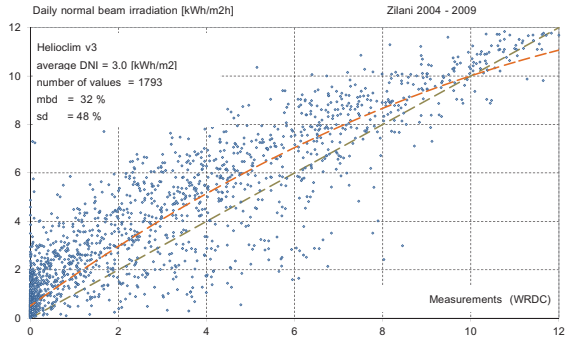

Zilani 2004-2009
Helioclim v3
Global irradiance
Bias frequency of occurrence
Cumulated frequency of occurrence
Global irradiance [W/m2]

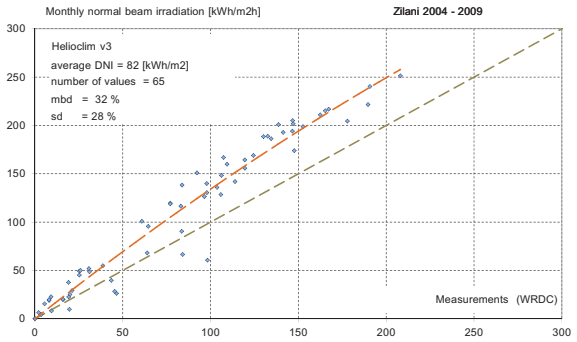

Zilani 2004-2009
Helioclim v3
Global irradiance
Bias frequency of occurrence
February
April
June
August
Oktober
December
Year
Global irradiance [W/m2]

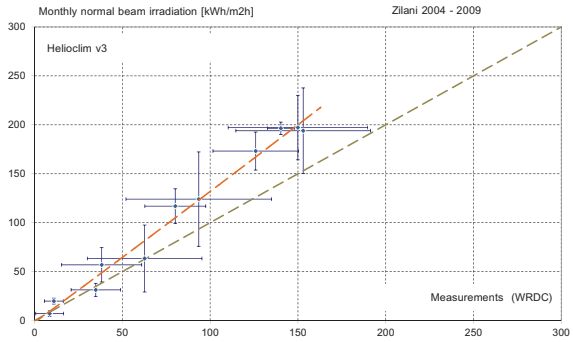

Zilani 2004-2009
Helioclim v3
Global irradiance
April
Bias frequency of occurrence
Cumulated frequency of occurrence
Global irradiance [W/m2]

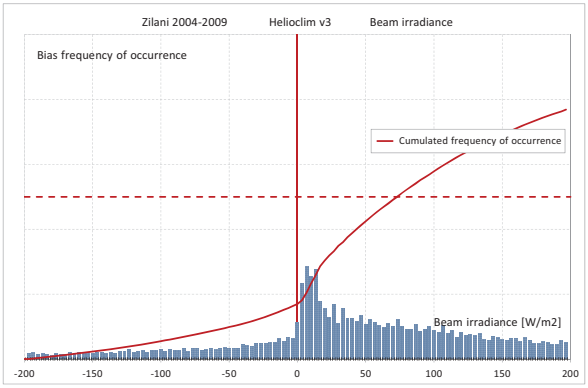

Zilani 2004-2009
Helioclim v3
Global irradiance
August
Bias frequency of occurrence
Cumulated frequency of occurrence
Global irradiance [W/m2]

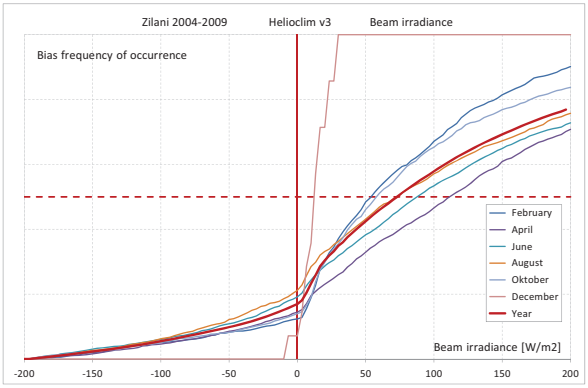

Hourly normal beam irradiance [Wh/m2h]
Zilani 2004 - 2009
Helioclim v3
average DNI = 252 [Wh/m2h]
number of values = 21217
mbd = 32 %
sd = 76 %
Measurements (WRDC)

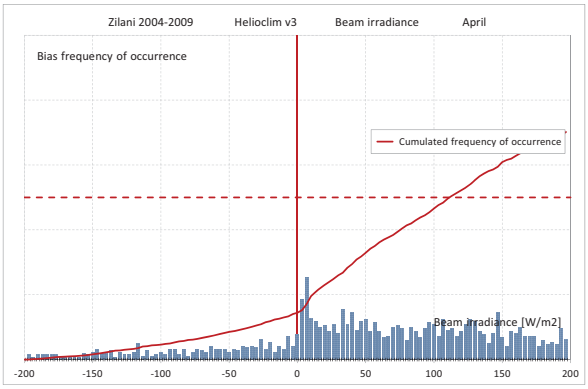

Daily normal beam irradiation [kWh/m2h]
Zilani 2004 - 2009
Helioclim v3
average DNI = 3.0 [kWh/m2]
number of values = 1793
mbd = 32 %
sd = 48 %
Measurements (WRDC)

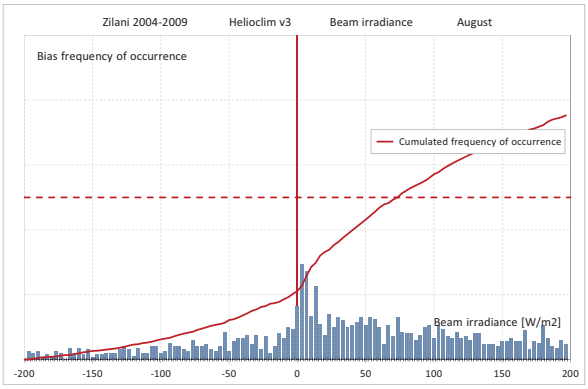

Monthly normal beam irradiation [kWh/m2h]
Zilani 2004 - 2009
Helioclim v3
average DNI = 82 [kWh/m2]
number of values = 65
mbd = 32 %
sd = 28 %
Measurements (WRDC)

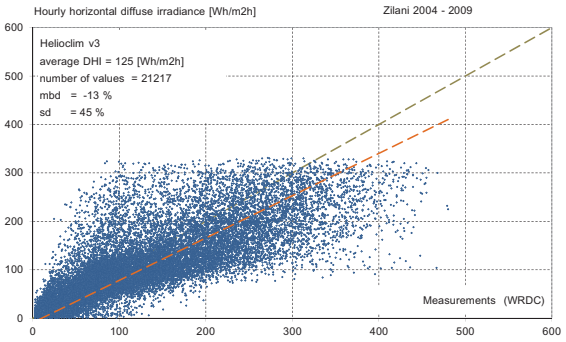

Monthly normal beam irradiation [kWh/m2h]
Zilani 2004 - 2009
Helioclim v3
Measurements (WRDC)

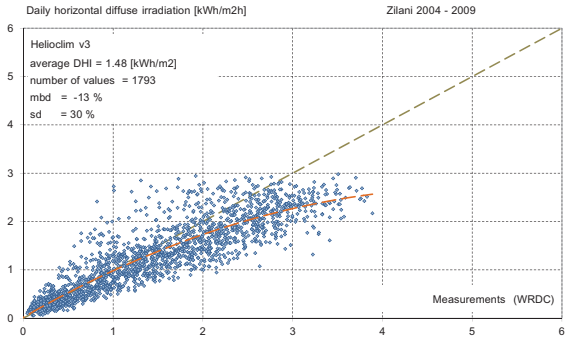

Zilani 2004-2009
Helioclim v3
Beam irradiance
Bias frequency of occurrence
Cumulated frequency of occurrence
Beam irradiance [W/m2]

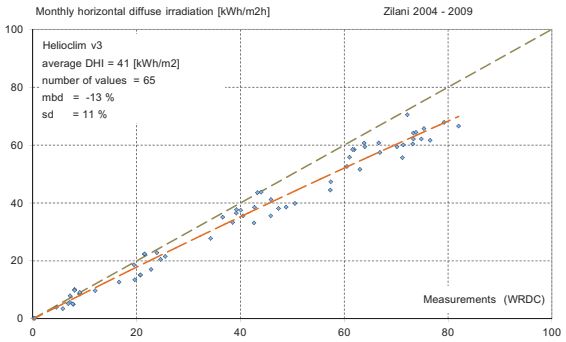

Zilani 2004-2009
Helioclim v3
Beam irradiance
Bias frequency of occurrence
February
April
June
August
Oktober
December
Year
Beam irradiance [W/m2]

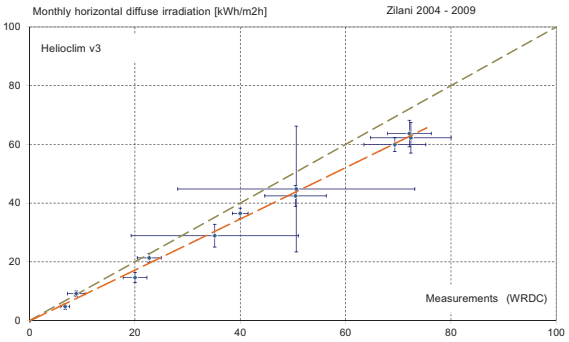

Zilani 2004-2009
Helioclim v3
Beam irradiance
April
Bias frequency of occurrence
Cumulated frequency of occurrence
Beam irradiance [W/m2]

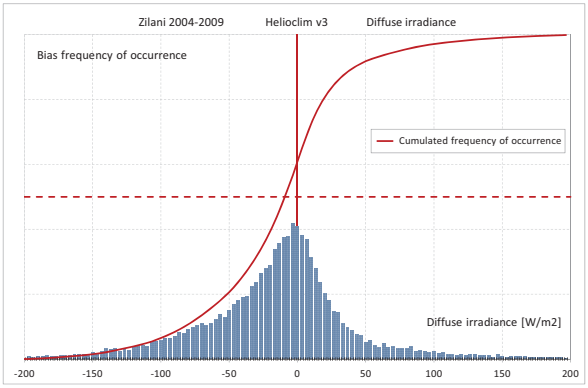

Zilani 2004-2009
Helioclim v3
Beam irradiance
August
Bias frequency of occurrence
Cumulated frequency of occurrence
Beam irradiance [W/m2]

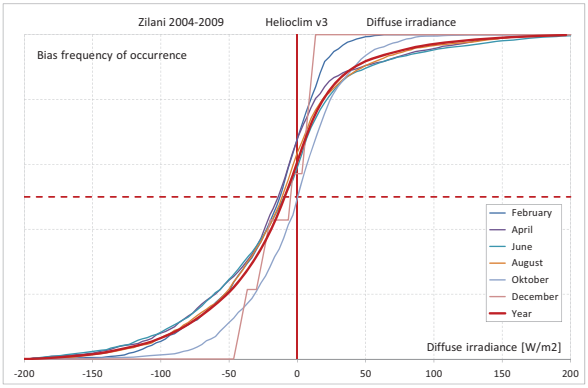

Hourly horizontal diffuse irradiance [Wh/m2h]
Zilani 2004 - 2009
Helioclim v3
average DHI = 125 [Wh/m2h]
number of values = 21217
mbd = -13 %
sd = 45 %
Measurements (WRDC)

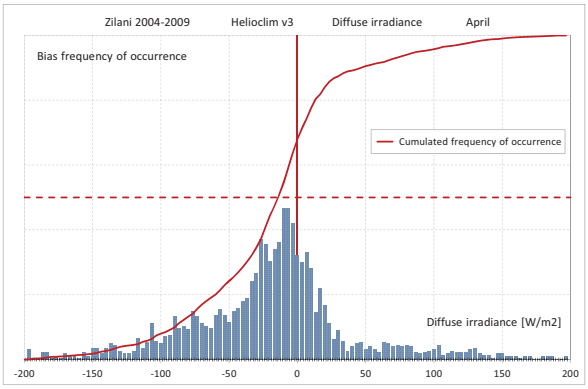

Daily horizontal diffuse irradiation [kWh/m2h]
Zilani 2004 - 2009
Helioclim v3
average DHI = 1.48 [kWh/m2]
number of values = 1793
mbd = -13 %
sd = 30 %
Measurements (WRDC)

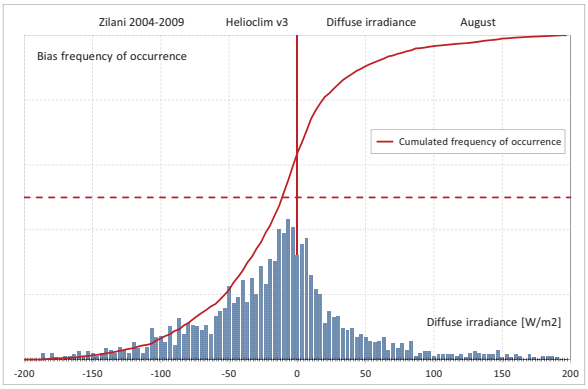

Monthly horizontal diffuse irradiation [kWh/m2h]
Zilani 2004 - 2009
Helioclim v3
average DHI = 41 [kWh/m2]
number of values = 65
mbd = -13 %
sd = 11 %
Measurements (WRDC)

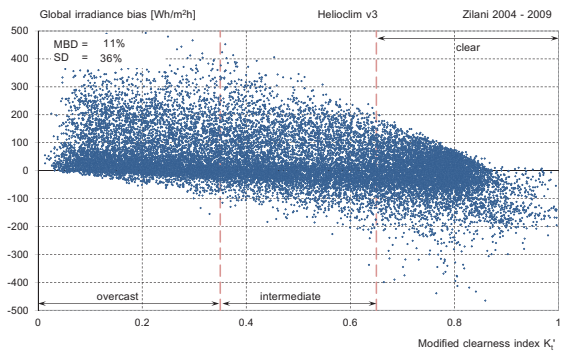

Monthly horizontal diffuse irradiation [kWh/m2h]
Zilani 2004 - 2009
Helioclim v3
Measurements (WRDC)

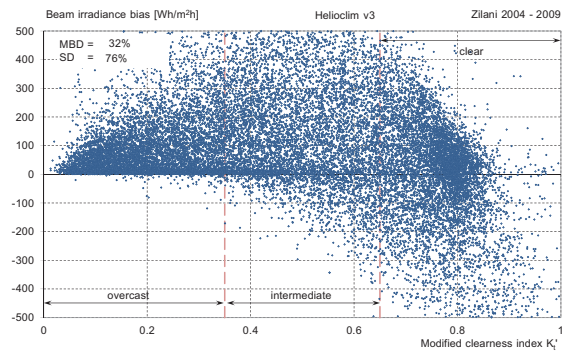

Zilani 2004-2009
Helioclim v3
Diffuse irradiance
Bias frequency of occurrence
Cumulated frequency of occurrence
Diffuse irradiance [W/m2]

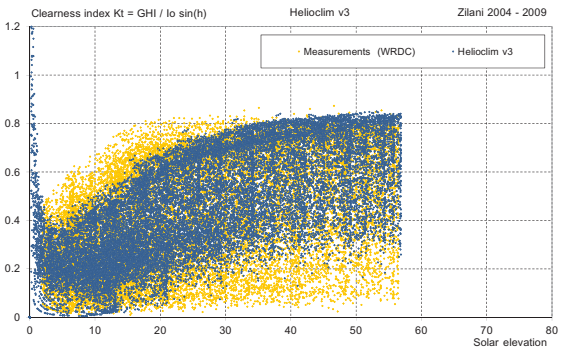

Zilani 2004-2009
Helioclim v3
Diffuse irradiance
Bias frequency of occurrence
February
April
June
August
Oktober
December
Year
Diffuse irradiance [W/m2]

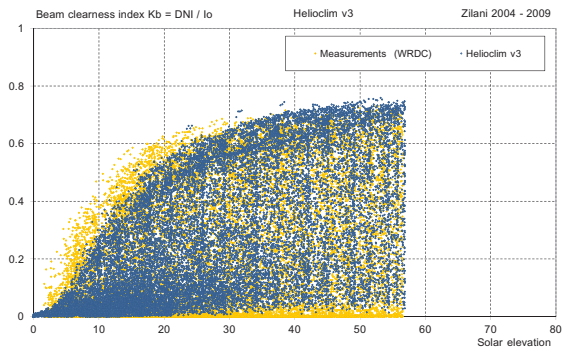

Zilani 2004-2009
Helioclim v3
Diffuse irradiance
April
Bias frequency of occurrence
Cumulated frequency of occurrence
Diffuse irradiance [W/m2]

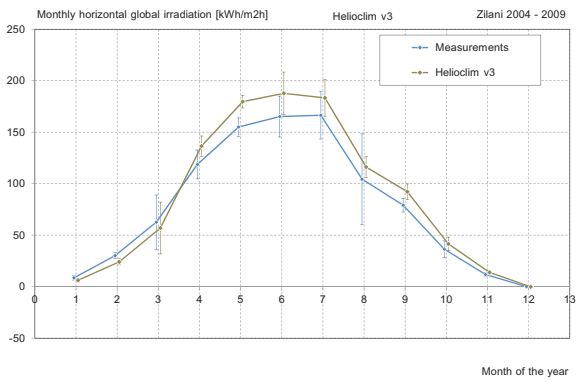

Zilani 2004-2009
Helioclim v3
Diffuse irradiance
August
Bias frequency of occurrence
Cumulated frequency of occurrence
Diffuse irradiance [W/m2]

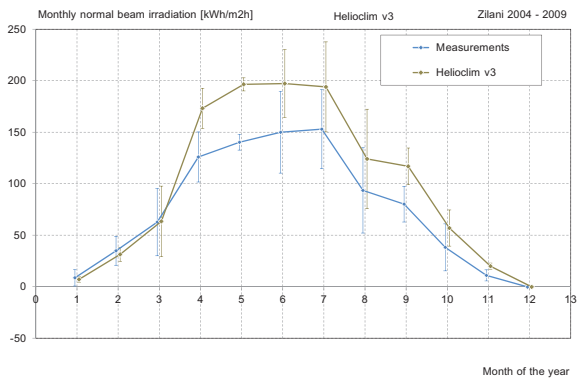

Global irradiance bias [Wh/m²h]
Helioclim v3
Zilani 2004 - 2009
MBD = 11%
SD = 36%
clear
overcast
intermediate
Modified clearness index Kt'

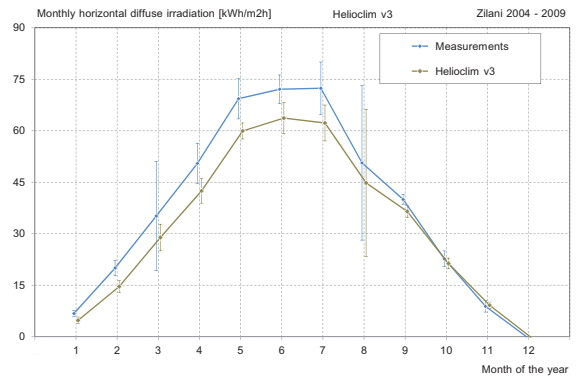

Beam irradiance bias [Wh/m²h]
Helioclim v3
Zilani 2004 - 2009
MBD = 32%
SD = 76%
clear
overcast
intermediate
Modified clearness index Kt'

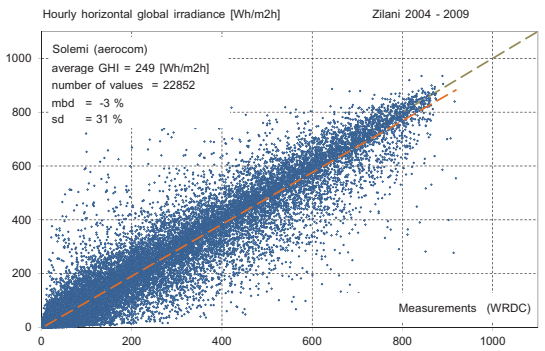

Clearness index Kt = GHI / Io sin(h)
Helioclim v3
Zilani 2004 - 2009
Measurements (WRDC)
Helioclim v3
Solar elevation

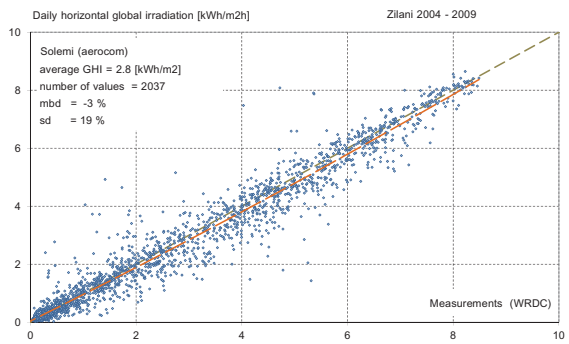

Beam clearness index Kb = DNI / Io
Helioclim v3
Zilani 2004 - 2009
Measurements (WRDC)
Helioclim v3
Solar elevation

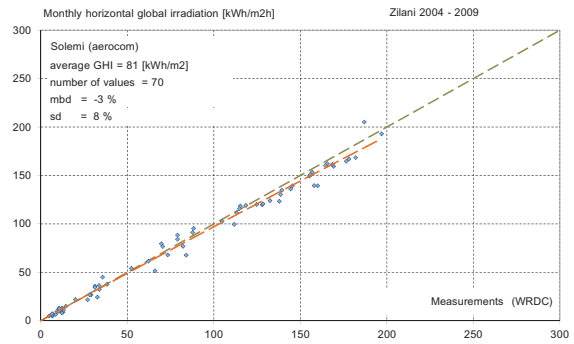

Monthly horizontal global irradiation [kWh/m2h]
Helioclim v3
Zilani 2004 - 2009
Measurements
Helioclim v3
Month of the year

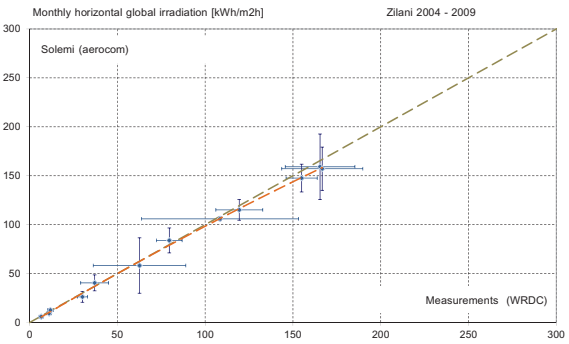

Monthly normal beam irradiation [kWh/m2h]
Helioclim v3
Zilani 2004 - 2009
Measurements
Helioclim v3
Month of the year

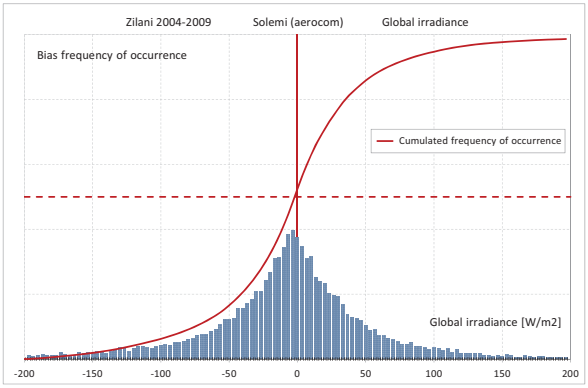

Monthly horizontal diffuse irradiation [kWh/m2h]
Helioclim v3
Zilani 2004 - 2009
Measurements
Helioclim v3
Month of the year

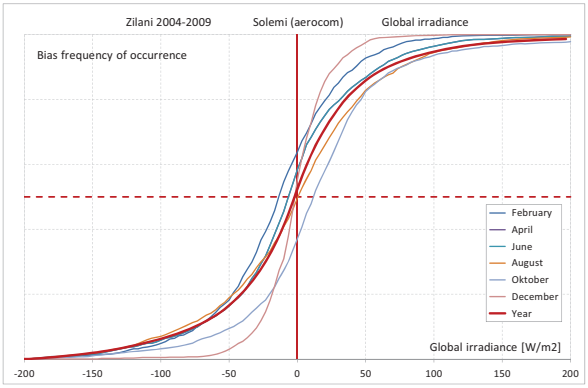

Hourly horizontal global irradiance [Wh/m2h]
Zilani 2004 - 2009
Solemi (aerocom)
average GHI = 249 [Wh/m2h]
number of values = 22852
mbd = -3 %
sd = 31 %
Measurements (WRDC)

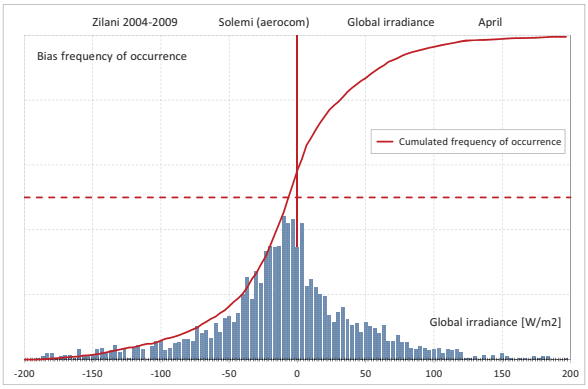

Daily horizontal global irradiation [kWh/m2h]
Zilani 2004 - 2009
Solemi (aerocom)
average GHI = 2.8 [kWh/m2]
number of values = 2037
mbd = -3 %
sd = 19 %
Measurements (WRDC)

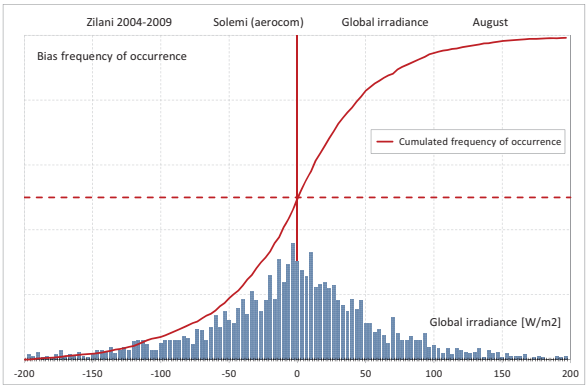

Monthly horizontal global irradiation [kWh/m2h]
Zilani 2004 - 2009
Solemi (aerocom)
average GHI = 81 [kWh/m2]
number of values = 70
mbd = -3 %
sd = 8 %
Measurements (WRDC)

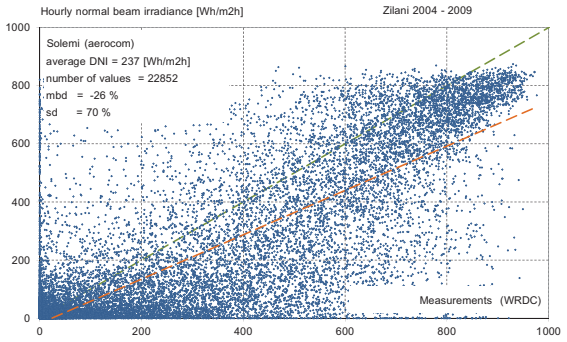

Monthly horizontal global irradiation [kWh/m2h]
Zilani 2004 - 2009
Solemi (aerocom)
Measurements (WRDC)

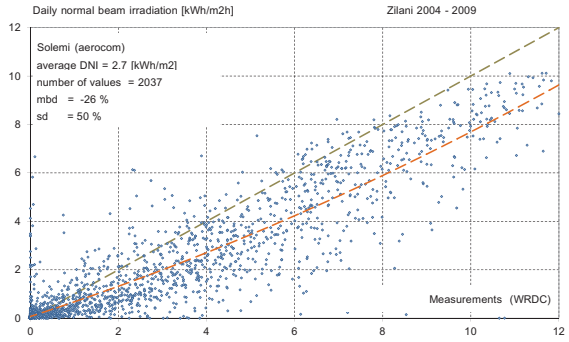

Zilani 2004-2009
Solemi (aerocom)
Global irradiance
Bias frequency of occurrence
Cumulated frequency of occurrence
Global irradiance [W/m2]

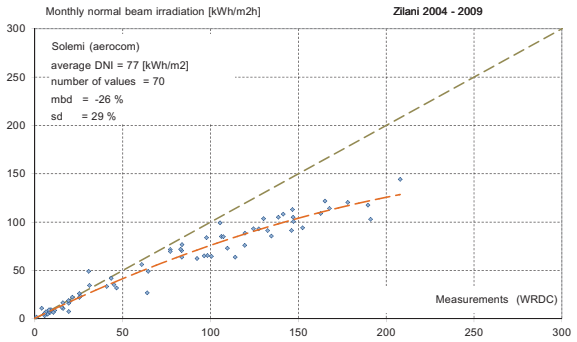

Zilani 2004-2009
Solemi (aerocom)
Global irradiance
Bias frequency of occurrence
February
April
June
August
Oktober
December
Year
Global irradiance [W/m2]

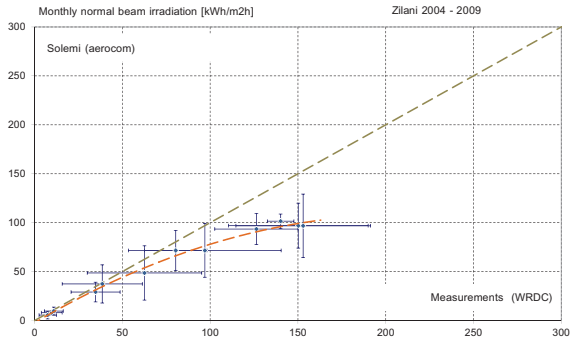

Zilani 2004-2009
Solemi (aerocom)
Global irradiance
April
Bias frequency of occurrence
Cumulated frequency of occurrence
Global irradiance [W/m2]

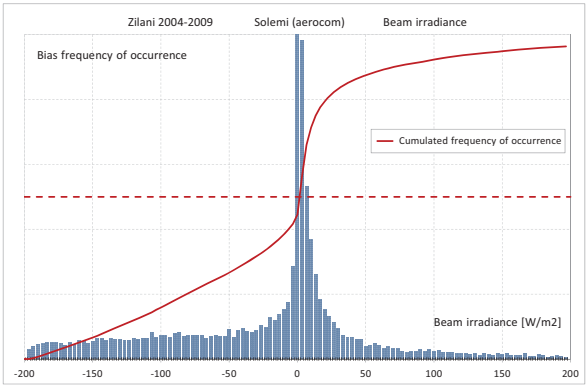

Zilani 2004-2009
Solemi (aerocom)
Global irradiance
August
Bias frequency of occurrence
Cumulated frequency of occurrence
Global irradiance [W/m2]

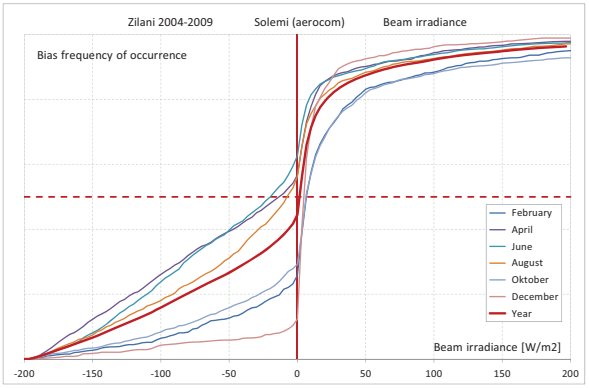

Hourly normal beam irradiance [Wh/m2h]
Zilani 2004 - 2009
Solemi (aerocom)
average DNI = 237 [Wh/m2h]
number of values = 22852
mbd = -26 %
sd = 70 %
Measurements (WRDC)

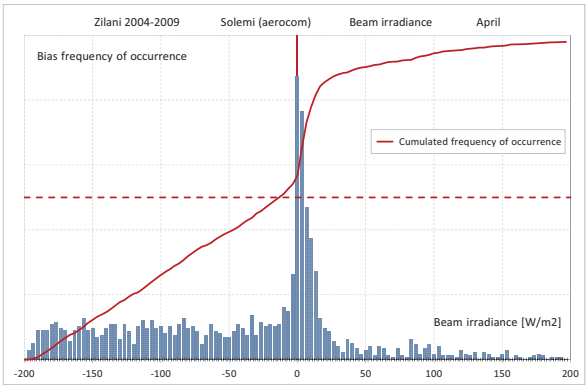

Daily normal beam irradiation [kWh/m2h]
Zilani 2004 - 2009
Solemi (aerocom)
average DNI = 2.7 [kWh/m2]
number of values = 2037
mbd = -26 %
sd = 50 %
Measurements (WRDC)

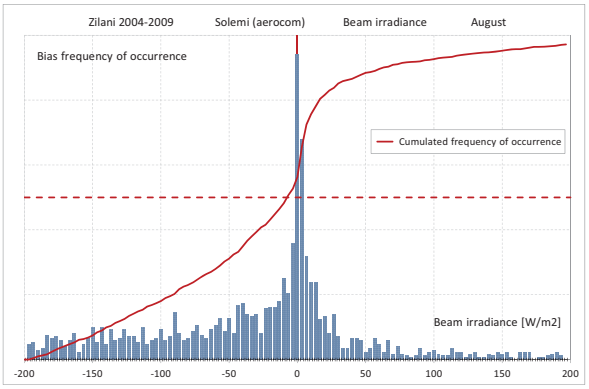

Monthly normal beam irradiation [kWh/m2h]
Zilani 2004 - 2009
Solemi (aerocom)
average DNI = 77 [kWh/m2]
number of values = 70
mbd = -26 %
sd = 29 %
Measurements (WRDC)

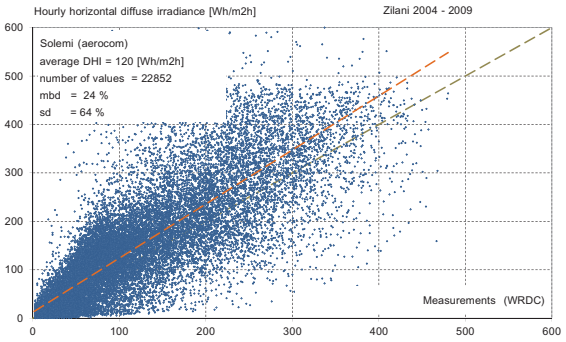

Monthly normal beam irradiation [kWh/m2h]
Zilani 2004 - 2009
Solemi (aerocom)
Measurements (WRDC)


Zilani 2004-2009
Solemi (aerocom)
Beam irradiance
Bias frequency of occurrence
Cumulated frequency of occurrence
Beam irradiance [W/m2]

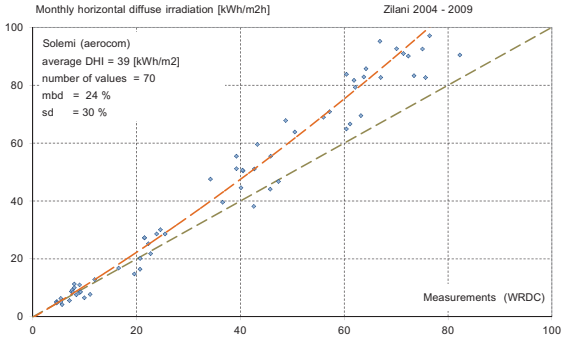

Zilani 2004-2009
Solemi (aerocom)
Beam irradiance
Bias frequency of occurrence
February
April
June
August
Oktober
December
Year
Beam irradiance [W/m2]

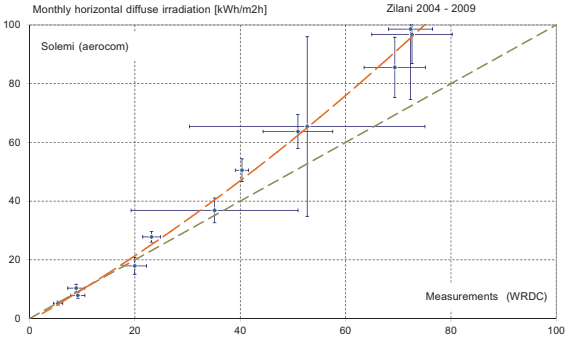

Zilani 2004-2009
Solemi (aerocom)
Beam irradiance
April
Bias frequency of occurrence
Cumulated frequency of occurrence
Beam irradiance [W/m2]

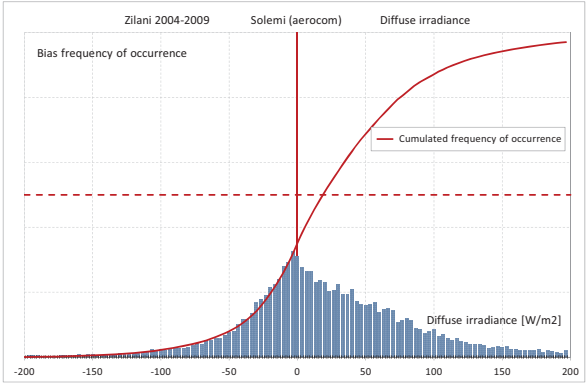

Zilani 2004-2009
Solemi (aerocom)
Beam irradiance
August
Bias frequency of occurrence
Cumulated frequency of occurrence
Beam irradiance [W/m2]

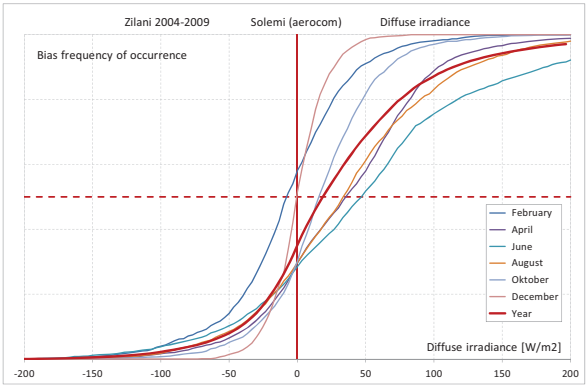

Hourly horizontal diffuse irradiance [Wh/m2h]
Zilani 2004 - 2009
Solemi (aerocom)
average DHI = 120 [Wh/m2h]
number of values = 22852
mbd = 24 %
sd = 64 %
Measurements (WRDC)

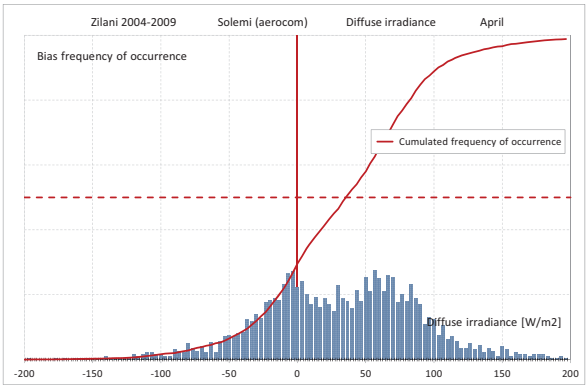
Daily horizontal diffuse irradiation [kWh/m2h]
Zilani 2004 - 2009
Solemi (aerocom)
average DHI = 1.34 [kWh/m2]
number of values = 2037
mbd = 24 %
sd = 49 %
Measurements (WRDC)

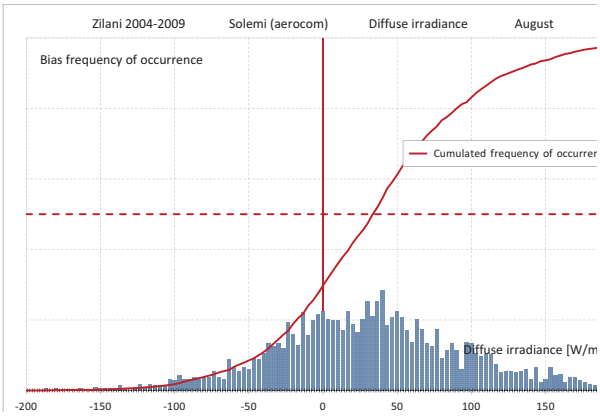

Monthly horizontal diffuse irradiation [kWh/m2h]
Zilani 2004 - 2009
Solemi (aerocom)
average DHI = 39 [kWh/m2]
number of values = 70
mbd = 24 %
sd = 30 %
Measurements (WRDC)

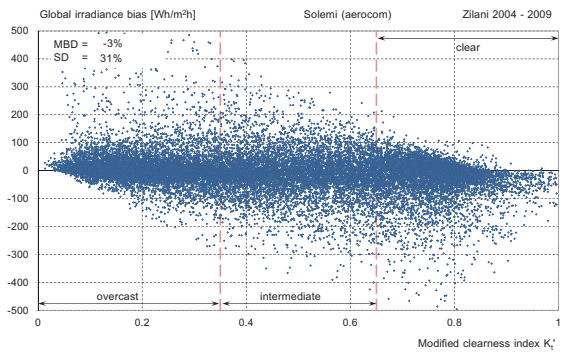

Monthly horizontal diffuse irradiation [kWh/m2h]
Zilani 2004 - 2009
Solemi (aerocom)
Measurements (WRDC)

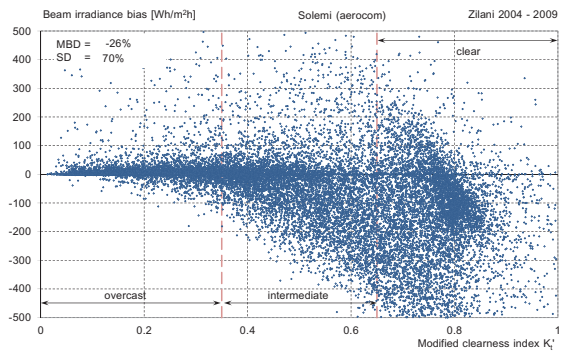

Zilani 2004-2009
Solemi (aerocom)
Diffuse irradiance
Bias frequency of occurrence
Cumulated frequency of occurrence
Diffuse irradiance [W/m2]

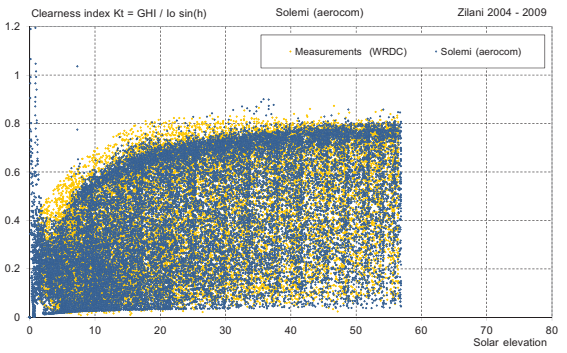

Zilani 2004-2009
Solemi (aerocom)
Diffuse irradiance
Bias frequency of occurrence
February
April
June
August
Oktober
December
Year
Diffuse irradiance [W/m2]

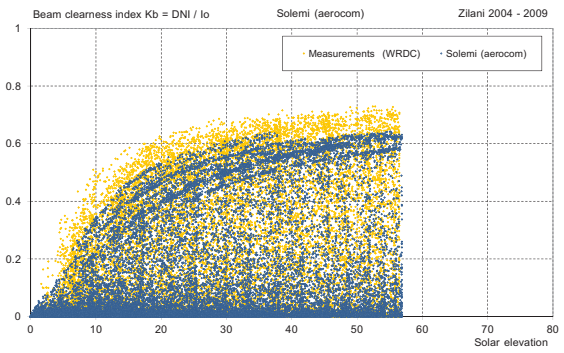

Zilani 2004-2009
Solemi (aerocom)
Diffuse irradiance
April
Bias frequency of occurrence
Cumulated frequency of occurrence
Diffuse irradiance [W/m2]

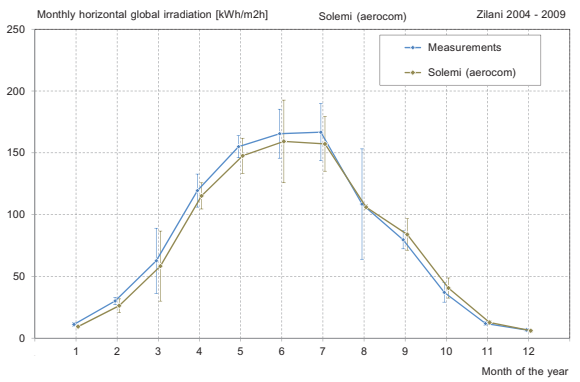

Zilani 2004-2009
Solemi (aerocom)
Diffuse irradiance
August
Bias frequency of occurrence
Cumulated frequency of occurrer
Diffuse irradiance [W/m

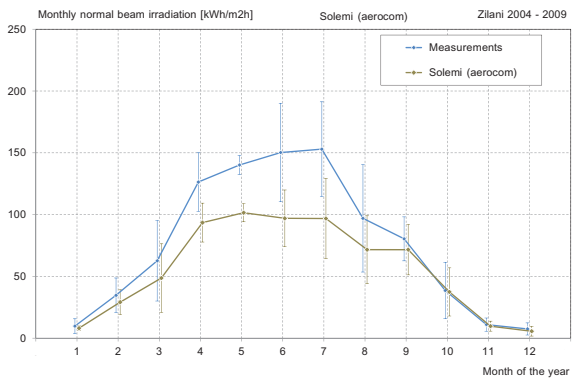

Global irradiance bias [Wh/m²h]
Solemi (aerocom)
Zilani 2004 - 2009
MBD = -3%
SD = 31%
clear
overcast
intermediate
Modified clearness index Kt'

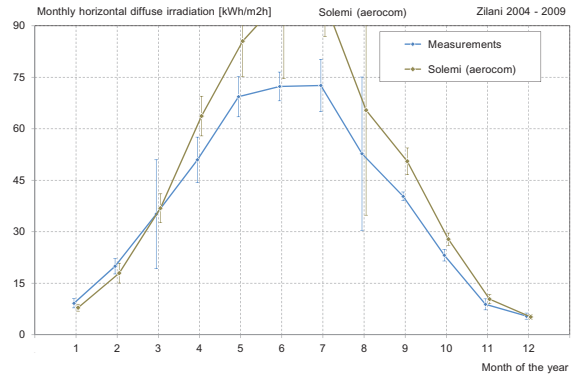

Beam irradiance bias [Wh/m²h]
Solemi (aerocom)
Zilani 2004 - 2009
MBD = -26%
SD = 70%
clear
overcast
intermediate
Modified clearness index Kt'

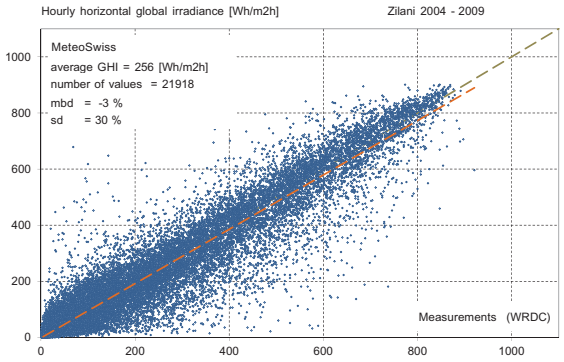

Clearness index Kt = GHI / Io sin(h)
Solemi (aerocom)
Zilani 2004 - 2009
Measurements (WRDC)
Solemi (aerocom)
Solar elevation

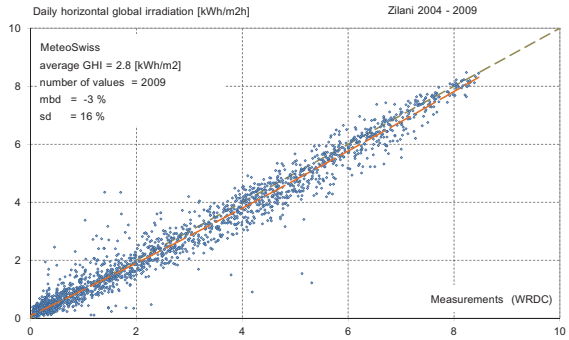

Beam clearness index Kb = DNI / Io
Solemi (aerocom)
Zilani 2004 - 2009
Measurements (WRDC)
Solemi (aerocom)
Solar elevation

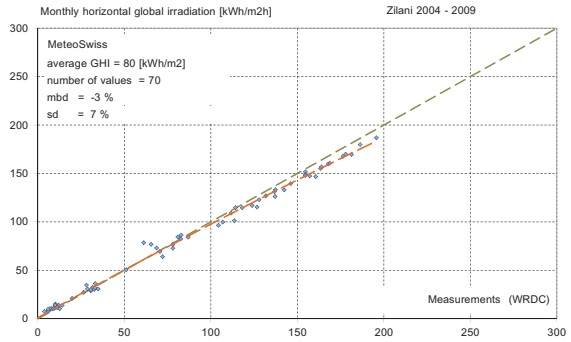

Monthly horizontal global irradiation [kWh/m2h]
Solemi (aerocom)
Zilani 2004 - 2009
Measurements
Solemi (aerocom)
Month of the year

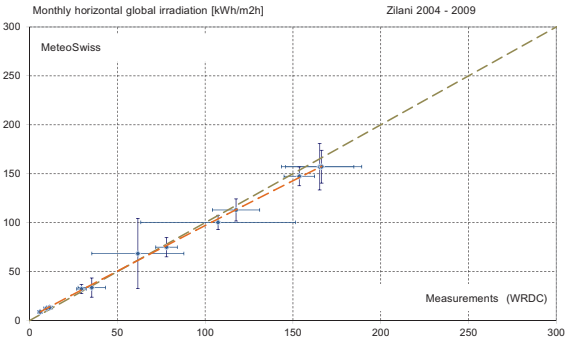

Monthly normal beam irradiation [kWh/m2h]
Solemi (aerocom)
Zilani 2004 - 2009
Measurements
Solemi (aerocom)
Month of the year

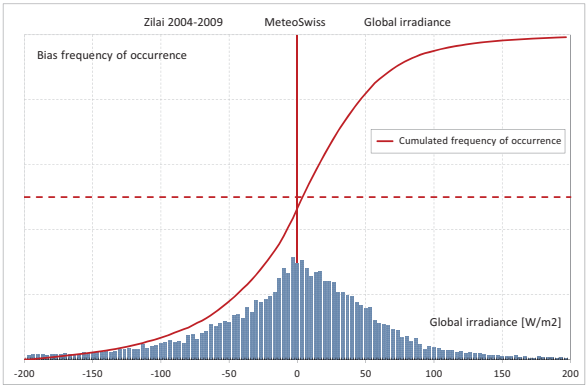

Monthly horizontal diffuse irradiation [kWh/m2h]
Solemi (aerocom)
Zilani 2004 - 2009
Measurements
Solemi (aerocom)
Month of the year

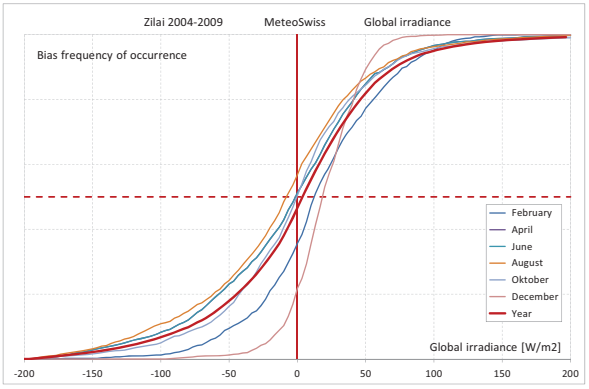

Hourly horizontal global irradiance [Wh/m2h]
Zilani 2004 - 2009
MeteoSwiss
average GHI = 256 [Wh/m2h]
number of values = 21918
mbd = -3 %
sd = 30 %
Measurements (WRDC)

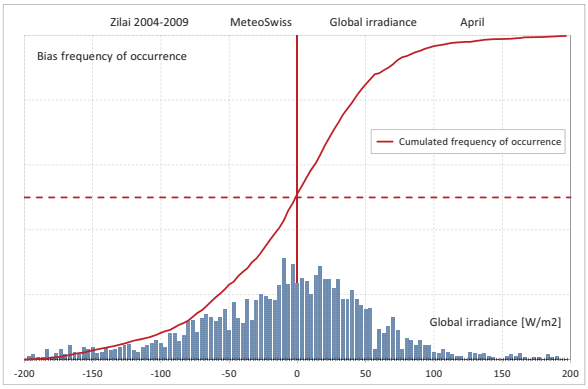

Daily horizontal global irradiation [kWh/m2h]
Zilani 2004 - 2009
MeteoSwiss
average GHI = 2.8 [kWh/m2]
number of values = 2009
mbd = -3 %
sd = 16 %
Measurements (WRDC)

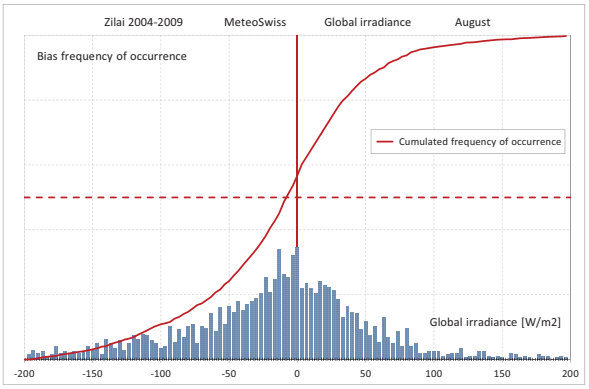

Monthly horizontal global irradiation [kWh/m2h]
Zilani 2004 - 2009
MeteoSwiss
average GHI = 80 [kWh/m2]
number of values = 70
mbd = -3 %
sd = 7 %
Measurements (WRDC)

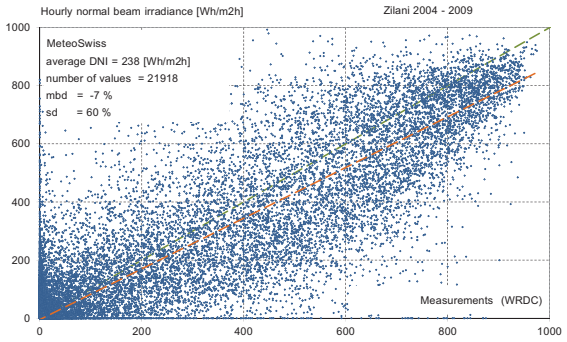

Monthly horizontal global irradiation [kWh/m2h]
Zilani 2004 - 2009
MeteoSwiss
Measurements (WRDC)

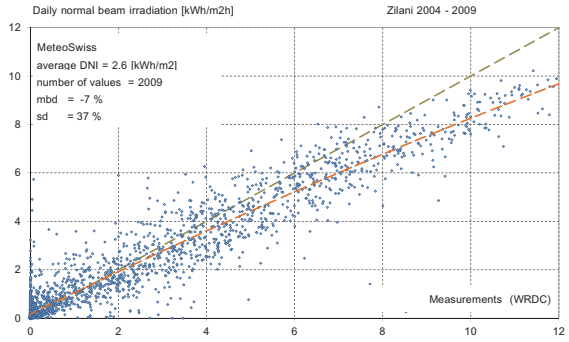

Zilai 2004-2009
MeteoSwiss
Global irradiance
Bias frequency of occurrence
Cumulated frequency of occurrence
Global irradiance [W/m2]


Zilai 2004-2009
MeteoSwiss
Global irradiance
Bias frequency of occurrence
February
April
June
August
Oktober
December
Year
Global irradiance [W/m2]

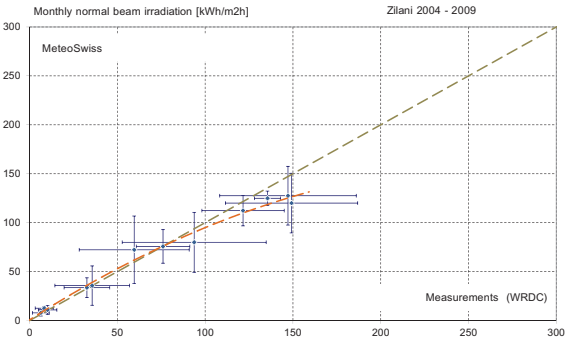

Zilai 2004-2009
MeteoSwiss
Global irradiance
April
Bias frequency of occurrence
Cumulated frequency of occurrence
Global irradiance [W/m2]

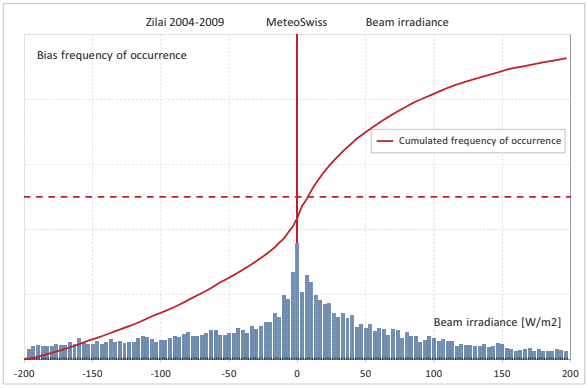

Zilai 2004-2009
MeteoSwiss
Global irradiance
August
Bias frequency of occurrence
Cumulated frequency of occurrence
Global irradiance [W/m2]

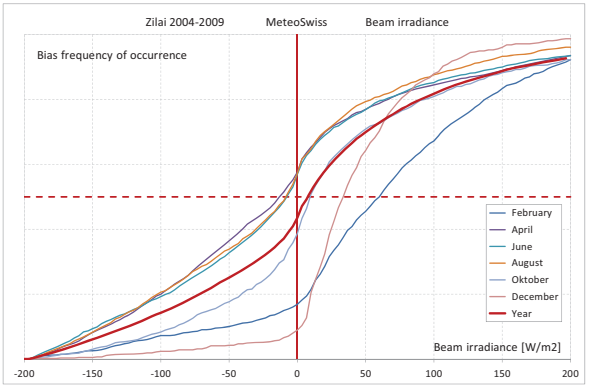

Hourly normal beam irradiance [Wh/m2h]
Zilani 2004 - 2009
MeteoSwiss
average DNI = 238 [Wh/m2h]
number of values = 21918
mbd = -7 %
sd = 60 %
Measurements (WRDC)

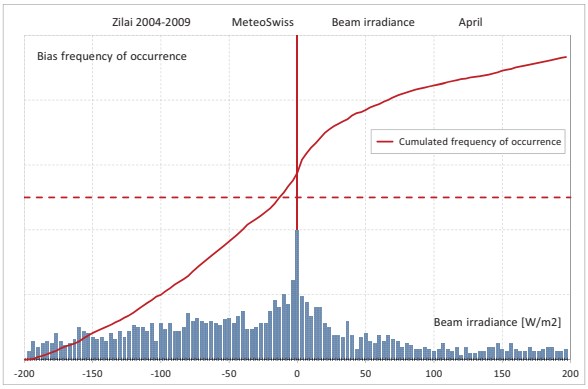

Daily normal beam irradiation [kWh/m2h]
Zilani 2004 - 2009
MeteoSwiss
average DNI = 2.6 [kWh/m2]
number of values = 2009
mbd = -7 %
sd = 37 %
Measurements (WRDC)

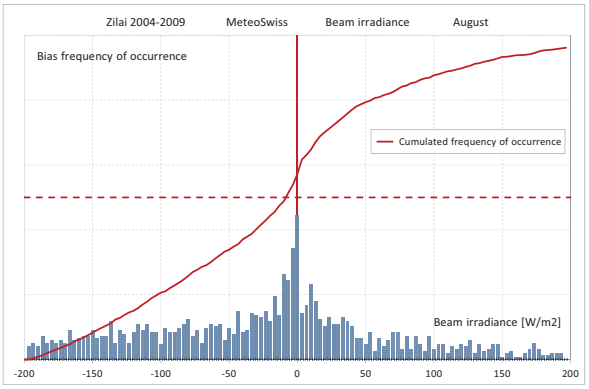
Monthly normal beam irradiation [kWh/m2h]
Zilani 2004 - 2009
MeteoSwiss
average DNI = 75 [kWh/m2]
number of values = 70
mbd = -7 %
sd = 17 %
Measurements (WRDC)

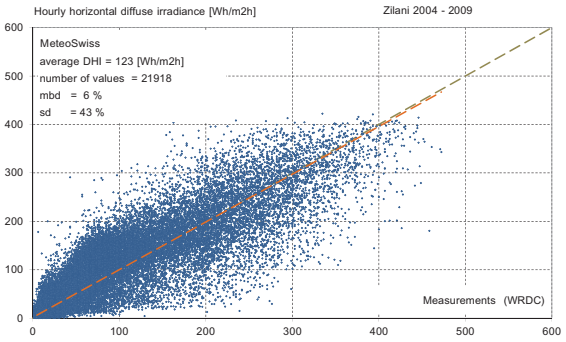

Monthly normal beam irradiation [kWh/m2h]
Zilani 2004 - 2009
MeteoSwiss
Measurements (WRDC)

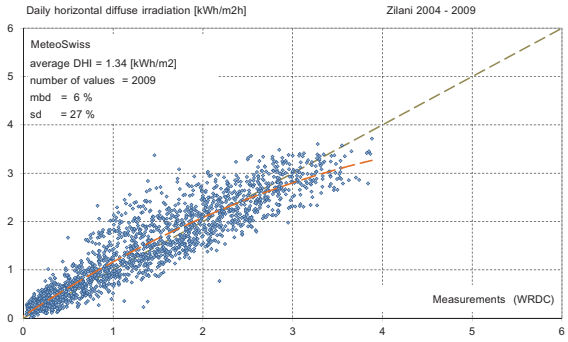

Zilai 2004-2009
MeteoSwiss
Beam irradiance
Bias frequency of occurrence
Cumulated frequency of occurrence
Beam irradiance [W/m2]

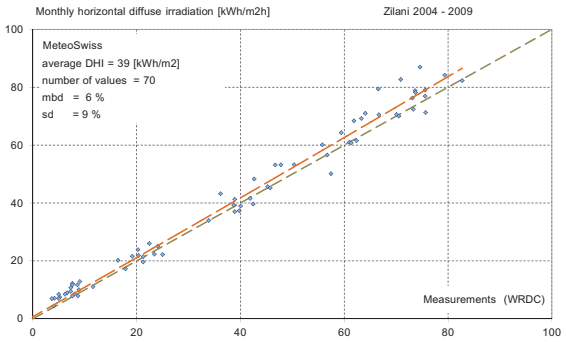

Zilai 2004-2009
MeteoSwiss
Beam irradiance
Bias frequency of occurrence
February
April
June
August
Oktober
December
Year
Beam irradiance [W/m2]

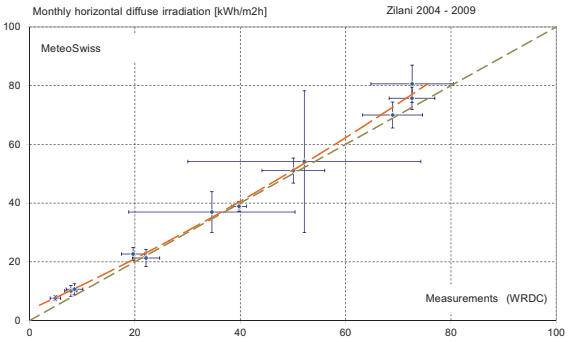

Zilai 2004-2009
MeteoSwiss
Beam irradiance
April
Bias frequency of occurrence
Cumulated frequency of occurrence
Beam irradiance [W/m2]

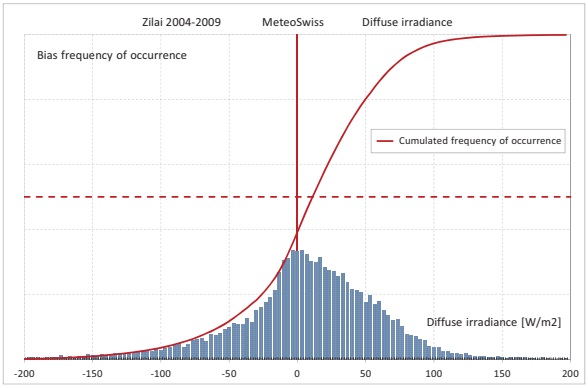

Zilai 2004-2009
MeteoSwiss
Beam irradiance
August
Bias frequency of occurrence
Cumulated frequency of occurrence
Beam irradiance [W/m2]

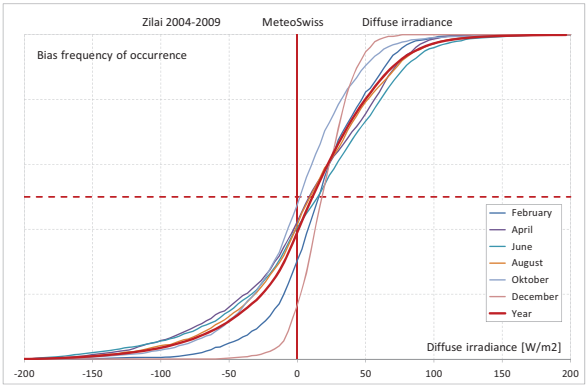

Hourly horizontal diffuse irradiance [Wh/m2h]
Zilani 2004 - 2009
MeteoSwiss
average DHI = 123 [Wh/m2h]
number of values = 21918
mbd = 6 %
sd = 43 %
Measurements (WRDC)

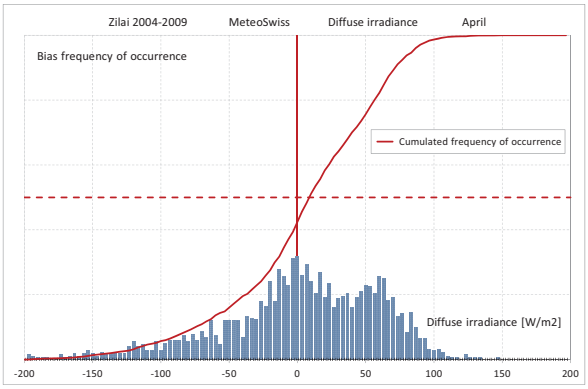

Daily horizontal diffuse irradiation [kWh/m2h]
Zilani 2004 - 2009
MeteoSwiss
average DHI = 1.34 [kWh/m2]
number of values = 2009
mbd = 6 %
sd = 27 %
Measurements (WRDC)

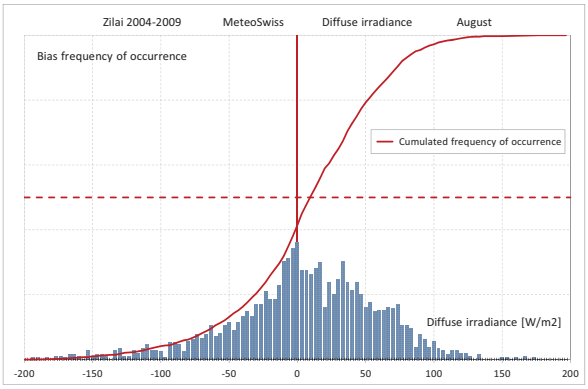

Monthly horizontal diffuse irradiation [kWh/m2h]
Zilani 2004 - 2009
MeteoSwiss
average DHI = 39 [kWh/m2]
number of values = 70
mbd = 6 %
sd = 9 %
Measurements (WRDC)

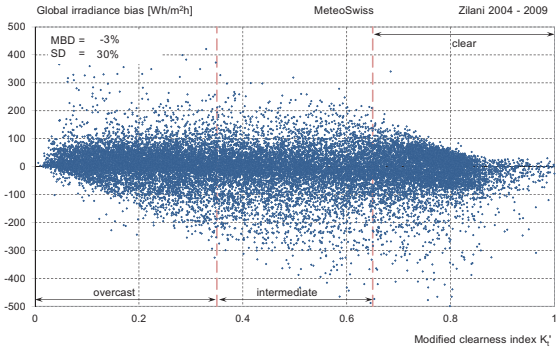

Monthly horizontal diffuse irradiation [kWh/m2h]
Zilani 2004 - 2009
MeteoSwiss
Measurements (WRDC)

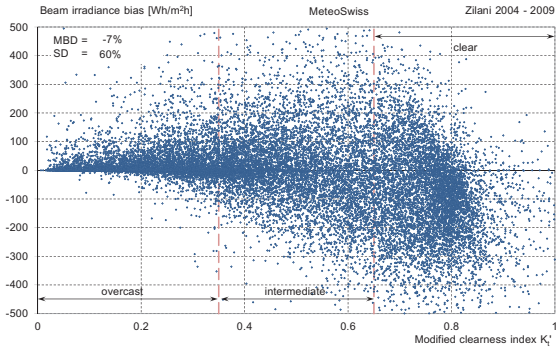

Zilai 2004-2009
MeteoSwiss
Diffuse irradiance
Bias frequency of occurrence
Cumulated frequency of occurrence
Diffuse irradiance [W/m2]

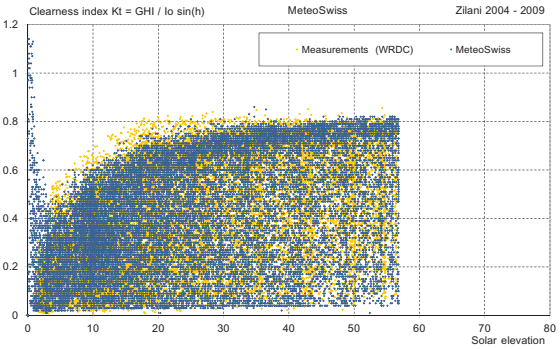

Zilai 2004-2009
MeteoSwiss
Diffuse irradiance
Bias frequency of occurrence
February
April
June
August
Oktober
December
Year
Diffuse irradiance [W/m2]

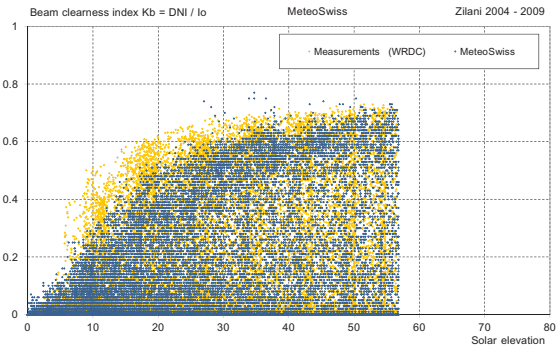

Zilai 2004-2009
MeteoSwiss
Diffuse irradiance
April
Bias frequency of occurrence
Cumulated frequency of occurrence
Diffuse irradiance [W/m2]

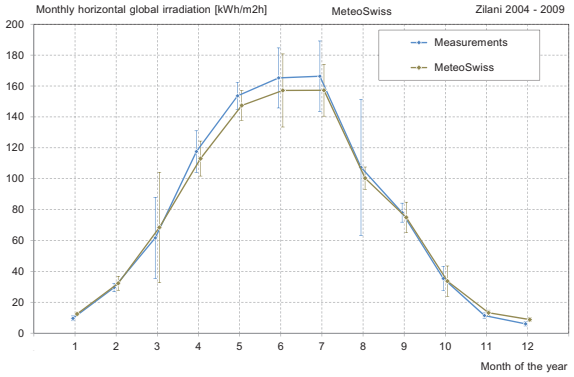

Zilai 2004-2009
MeteoSwiss
Diffuse irradiance
August
Bias frequency of occurrence
Cumulated frequency of occurrence
Diffuse irradiance [W/m2]

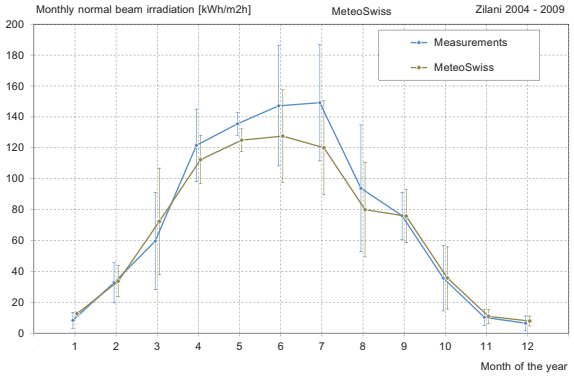

Global irradiance bias [Wh/m²h]
MeteoSwiss
Zilani 2004 - 2009
MBD = -3%
SD = 30%
clear
overcast
intermediate
Modified clearness index Kt'

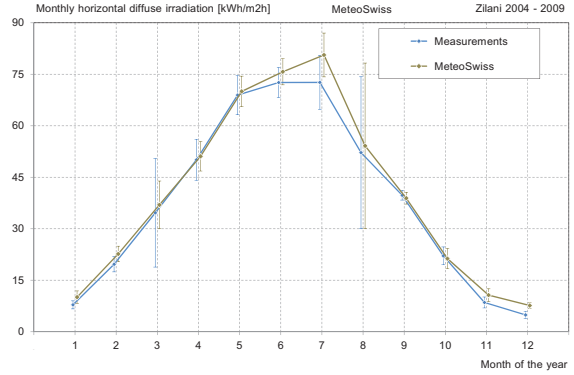

Beam irradiance bias [Wh/m²h]
MeteoSwiss
Zilani 2004 - 2009
MBD = -7%
SD = 60%
clear
overcast
intermediate
Modified clearness index Kt'

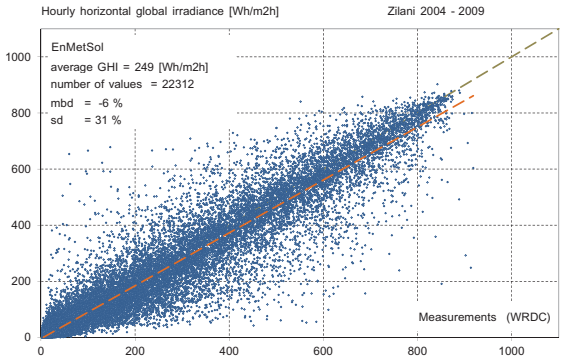

Clearness index Kt = GHI / Io sin(h)
MeteoSwiss
Zilani 2004 - 2009
Measurements (WRDC)
MeteoSwiss
Solar elevation

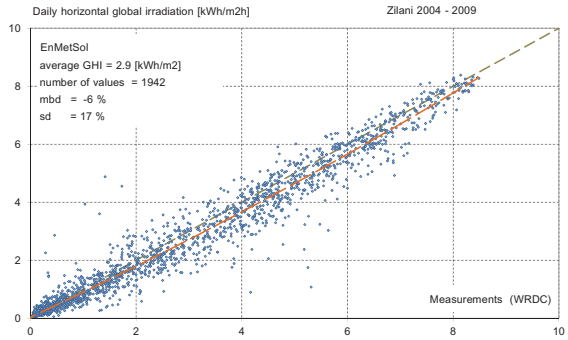

Beam clearness index Kb = DNI / Io
MeteoSwiss
Zilani 2004 - 2009
Measurements (WRDC)
MeteoSwiss
Solar elevation

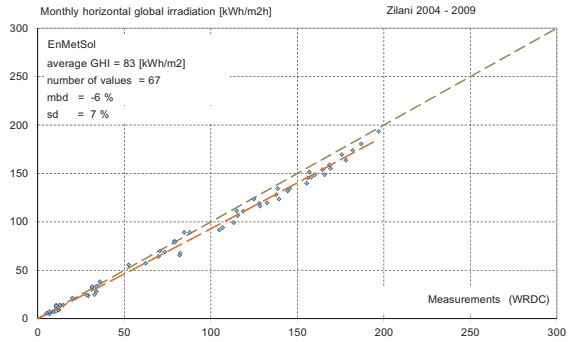

Monthly horizontal global irradiation [kWh/m2h]
MeteoSwiss
Zilani 2004 - 2009
Measurements
MeteoSwiss
Month of the year

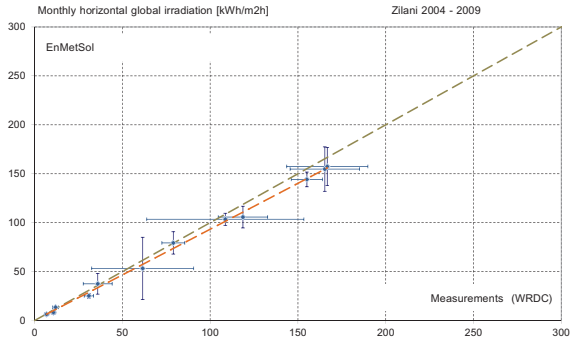

Monthly normal beam irradiation [kWh/m2h]
MeteoSwiss
Zilani 2004 - 2009
Measurements
MeteoSwiss
Month of the year

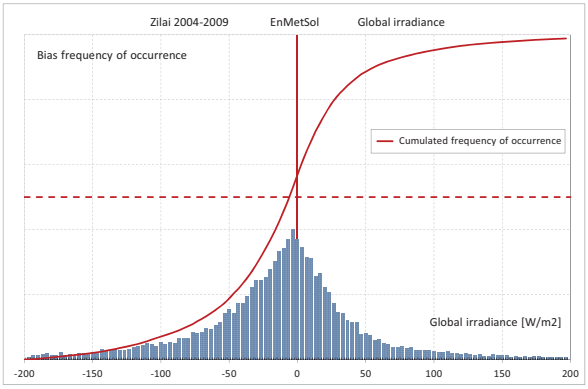

Monthly horizontal diffuse irradiation [kWh/m2h]
MeteoSwiss
Zilani 2004 - 2009
Measurements
MeteoSwiss
Month of the year

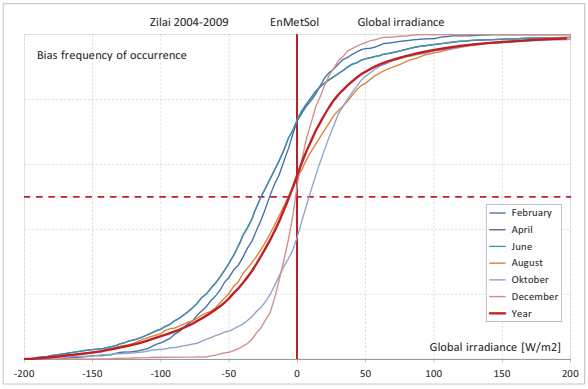

Hourly horizontal global irradiance [Wh/m2h]
Zilani 2004 - 2009
EnMetSol
average GHI = 249 [Wh/m2h]
number of values = 22312
mbd = -6 %
sd = 31 %
Measurements (WRDC)

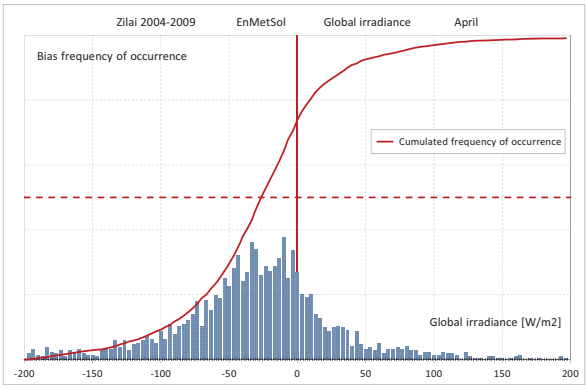

Daily horizontal global irradiation [kWh/m2h]
Zilani 2004 - 2009
EnMetSol
average GHI = 2.9 [kWh/m2]
number of values = 1942
mbd = -6 %
sd = 17 %
Measurements (WRDC)

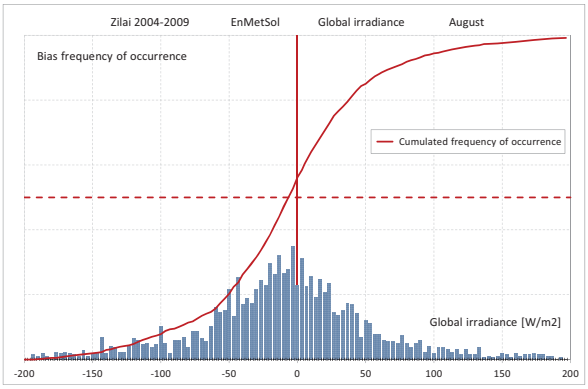

Monthly horizontal global irradiation [kWh/m2h]
Zilani 2004 - 2009
EnMetSol
average GHI = 83 [kWh/m2]
number of values = 67
mbd = -6 %
sd = 7 %
Measurements (WRDC)

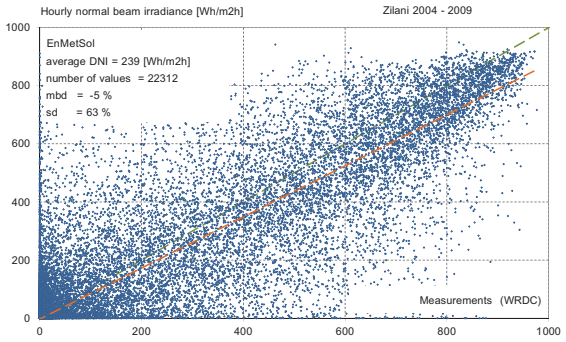

Monthly horizontal global irradiation [kWh/m2h]
Zilani 2004 - 2009
EnMetSol
Measurements (WRDC)

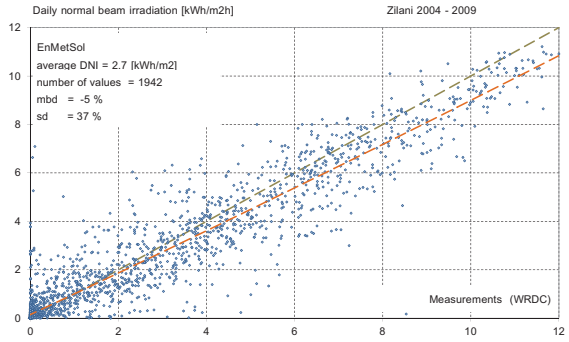

Zilai 2004-2009
EnMetSol
Global irradiance
Bias frequency of occurrence
Cumulated frequency of occurrence
Global irradiance [W/m2]

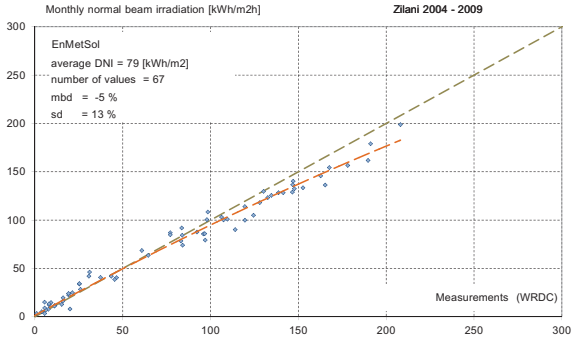

Zilai 2004-2009
EnMetSol
Global irradiance
Bias frequency of occurrence
February
April
June
August
Oktober
December
Year
Global irradiance [W/m2]

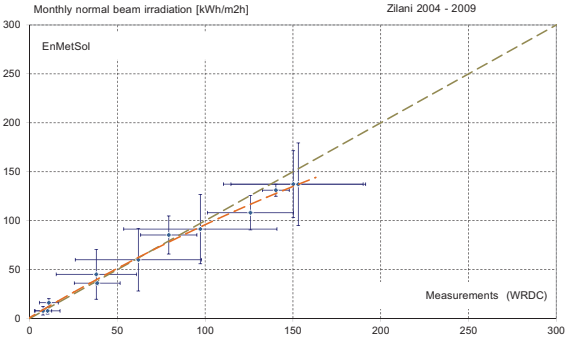

Zilai 2004-2009
EnMetSol
Global irradiance
April
Bias frequency of occurrence
Cumulated frequency of occurrence
Global irradiance [W/m2]

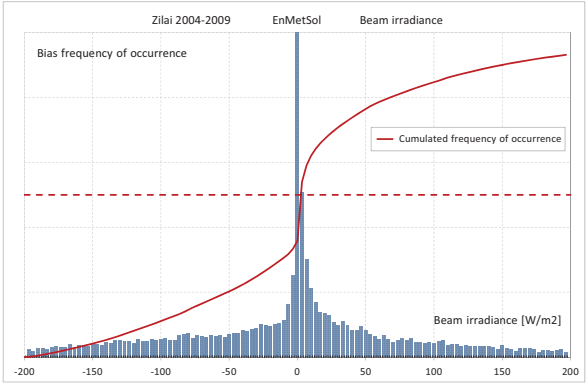

Zilai 2004-2009
EnMetSol
Global irradiance
August
Bias frequency of occurrence
Cumulated frequency of occurrence
Global irradiance [W/m2]

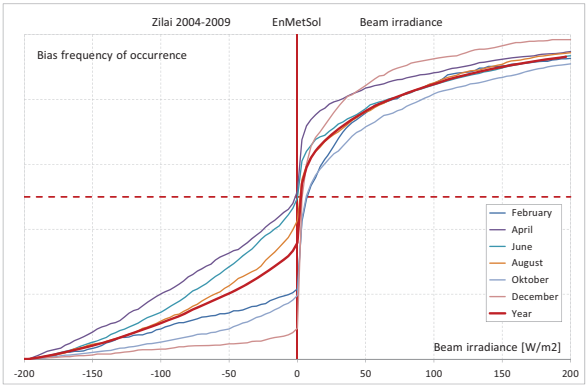

Hourly normal beam irradiance [Wh/m2h]
Zilani 2004 - 2009
EnMetSol
average DNI = 239 [Wh/m2h]
number of values = 22312
mbd = -5 %
sd = 63 %
Measurements (WRDC)

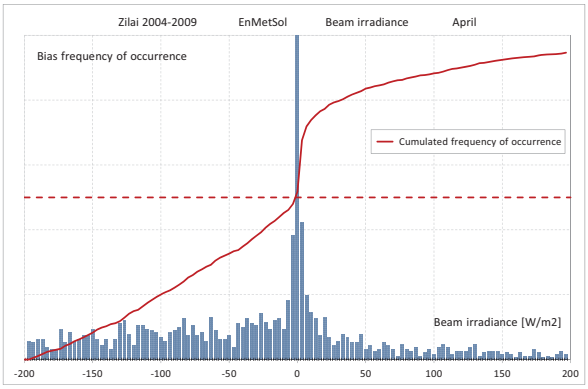

Daily normal beam irradiation [kWh/m2h]
Zilani 2004 - 2009
EnMetSol
average DNI = 2.7 [kWh/m2]
number of values = 1942
mbd = -5 %
sd = 37 %
Measurements (WRDC)

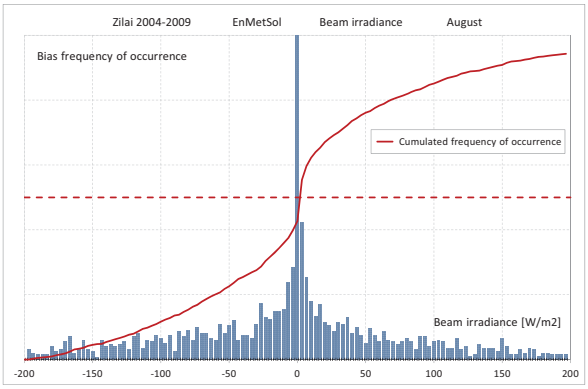

Monthly normal beam irradiation [kWh/m2h]
Zilani 2004 - 2009
EnMetSol
average DNI = 79 [kWh/m2]
number of values = 67
mbd = -5 %
sd = 13 %
Measurements (WRDC)

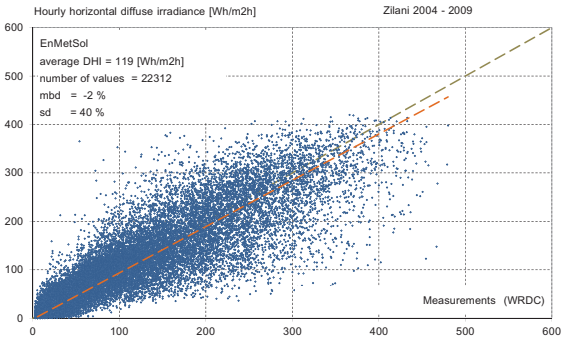

Monthly normal beam irradiation [kWh/m2h]
Zilani 2004 - 2009
EnMetSol
Measurements (WRDC)

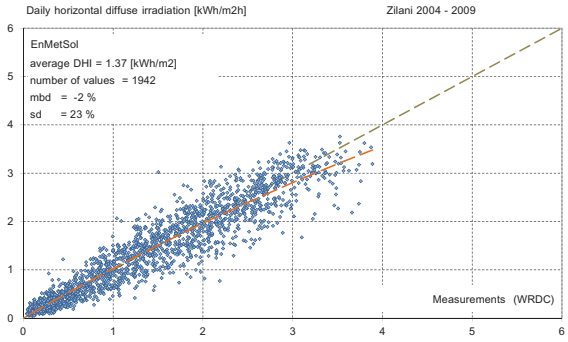

Zilai 2004-2009
EnMetSol
Beam irradiance
Bias frequency of occurrence
Cumulated frequency of occurrence
Beam irradiance [W/m2]

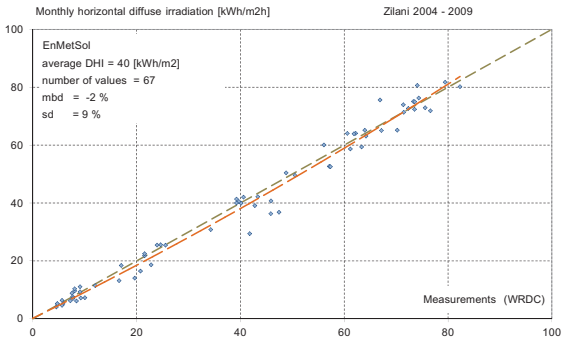

Zilai 2004-2009
EnMetSol
Beam irradiance
Bias frequency of occurrence
February
April
June
August
Oktober
December
Year
Beam irradiance [W/m2]

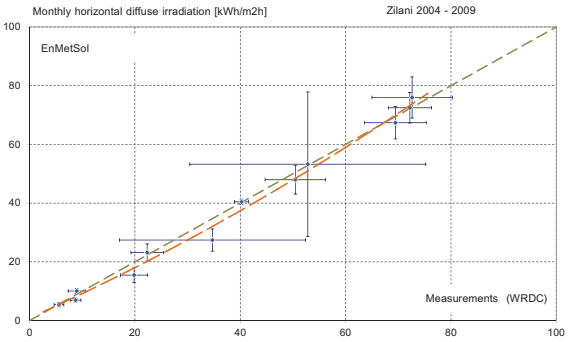

Zilai 2004-2009
EnMetSol
Beam irradiance
April
Bias frequency of occurrence
Cumulated frequency of occurrence
Beam irradiance [W/m2]

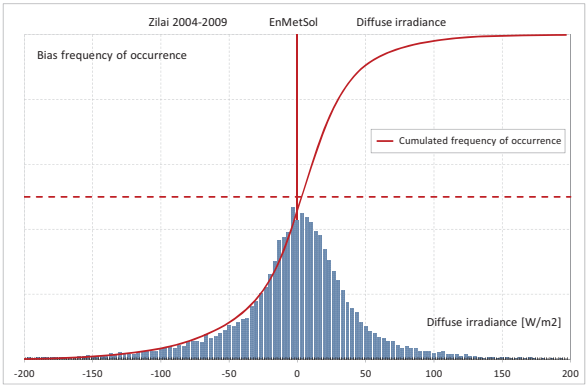

Zilai 2004-2009
EnMetSol
Beam irradiance
August
Bias frequency of occurrence
Cumulated frequency of occurrence
Beam irradiance [W/m2]

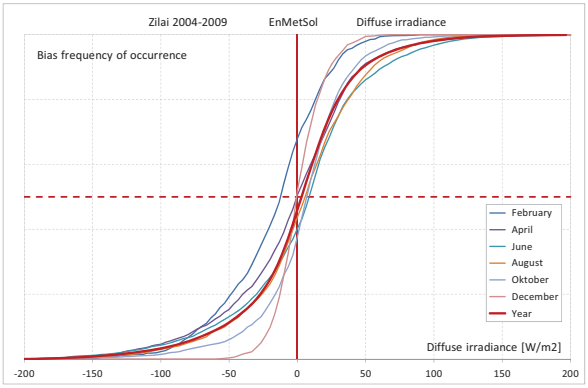

Hourly horizontal diffuse irradiance [Wh/m2h]
Zilani 2004 - 2009
EnMetSol
average DHI = 119 [Wh/m2h]
number of values = 22312
mbd = -2 %
sd = 40 %
Measurements (WRDC)

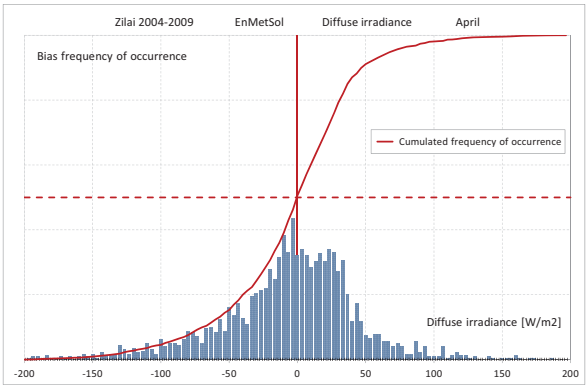

Daily horizontal diffuse irradiation [kWh/m2h]
Zilani 2004 - 2009
EnMetSol
average DHI = 1.37 [kWh/m2]
number of values = 1942
mbd = -2 %
sd = 23 %
Measurements (WRDC)

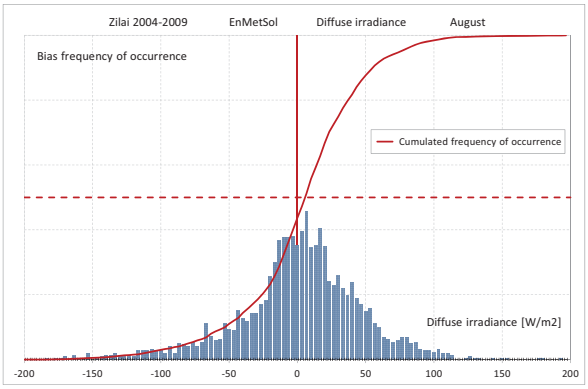

Monthly horizontal diffuse irradiation [kWh/m2h]
Zilani 2004 - 2009
EnMetSol
average DHI = 40 [kWh/m2]
number of values = 67
mbd = -2 %
sd = 9 %
Measurements (WRDC)

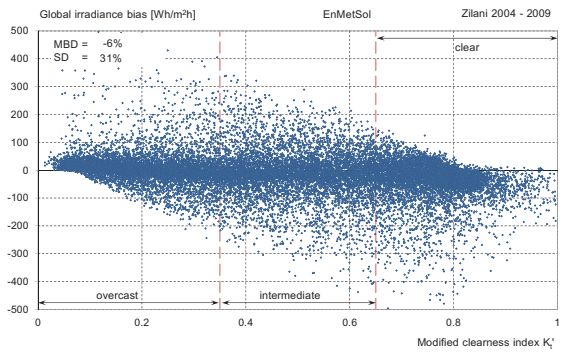

Monthly horizontal diffuse irradiation [kWh/m2h]
Zilani 2004 - 2009
EnMetSol
Measurements (WRDC)

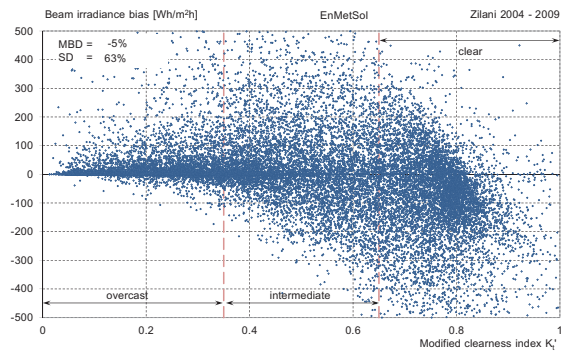

Zilai 2004-2009
EnMetSol
Diffuse irradiance
Bias frequency of occurrence
Cumulated frequency of occurrence
Diffuse irradiance [W/m2]

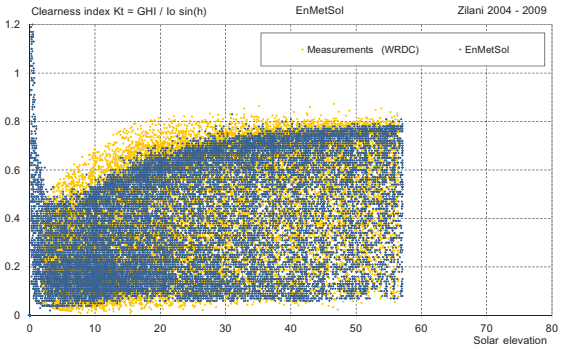

Zilai 2004-2009
EnMetSol
Diffuse irradiance
Bias frequency of occurrence
February
April
June
August
Oktober
December
Year
Diffuse irradiance [W/m2]

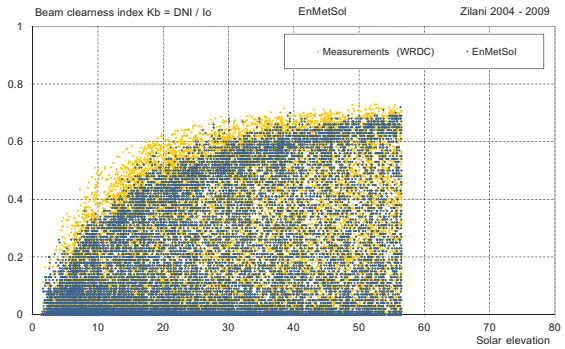

Zilai 2004-2009
EnMetSol
Diffuse irradiance
April
Bias frequency of occurrence
Cumulated frequency of occurrence
Diffuse irradiance [W/m2]

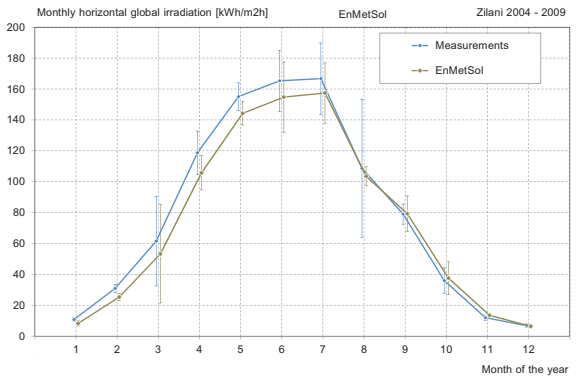

Zilai 2004-2009
EnMetSol
Diffuse irradiance
August
Bias frequency of occurrence
Cumulated frequency of occurrence
Diffuse irradiance [W/m2]

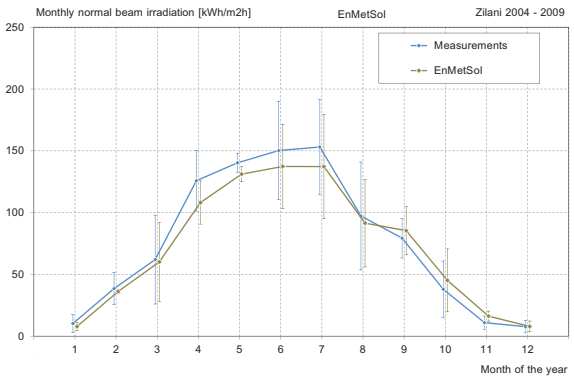

Global irradiance bias [Wh/m²h]
EnMetSol
Zilani 2004 - 2009
MBD = -6%
SD = 31%
clear
overcast
intermediate
Modified clearness index Kt'

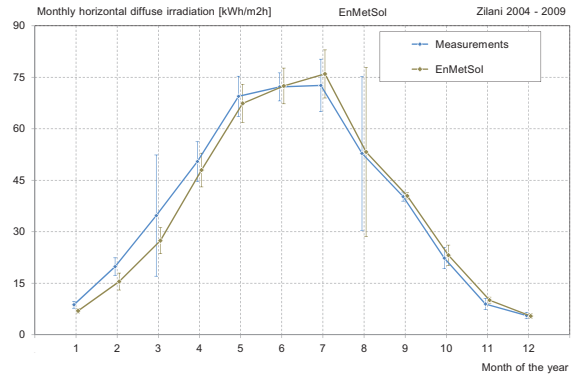

Beam irradiance bias [Wh/m²h]
EnMetSol
Zilani 2004 - 2009
MBD = -5%
SD = 63%
clear
overcast
intermediate
Modified clearness index Kt'

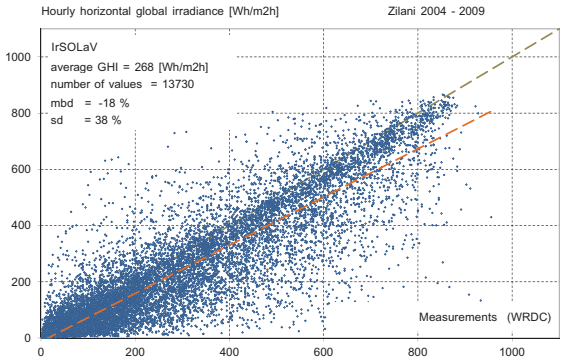

Clearness index Kt = GHI / Io sin(h)
EnMetSol
Zilani 2004 - 2009
Measurements (WRDC)
EnMetSol
Solar elevation

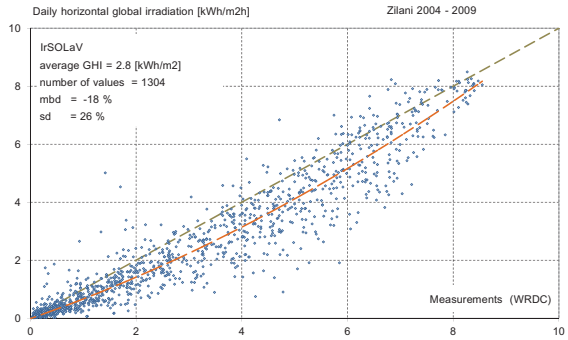

Beam clearness index Kb = DNI / Io
EnMetSol
Zilani 2004 - 2009
Measurements (WRDC)
EnMetSol
Solar elevation

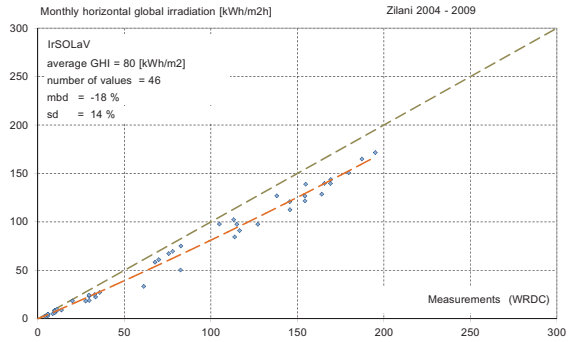

Monthly horizontal global irradiation [kWh/m2h]
EnMetSol
Zilani 2004 - 2009
Measurements
EnMetSol
Month of the year

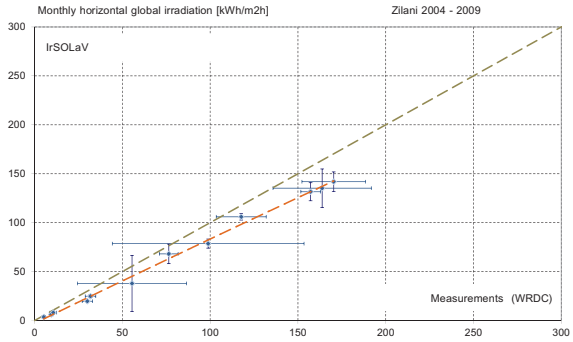

Monthly normal beam irradiation [kWh/m2h]
EnMetSol
Zilani 2004 - 2009
Measurements
EnMetSol
Month of the year

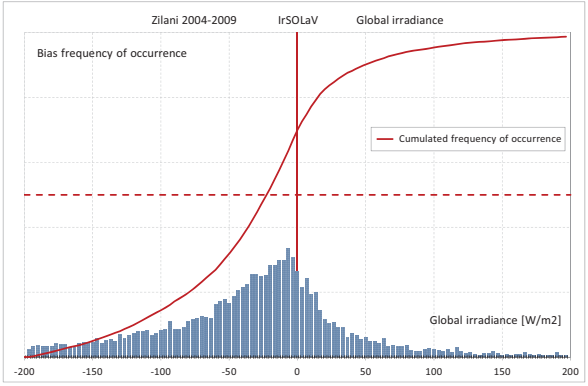

Monthly horizontal diffuse irradiation [kWh/m2h]
EnMetSol
Zilani 2004 - 2009
Measurements
EnMetSol
Month of the year

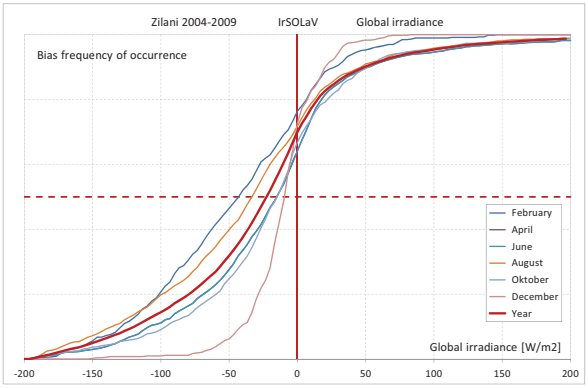

Hourly horizontal global irradiance [Wh/m2h]
Zilani 2004 - 2009
IrSOLaV
average GHI = 268 [Wh/m2h]
number of values = 13730
mbd = -18 %
sd = 38 %
Measurements (WRDC)

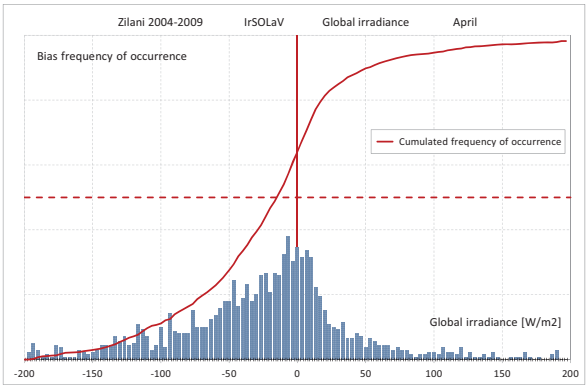

Daily horizontal global irradiation [kWh/m2h]
Zilani 2004 - 2009
IrSOLaV
average GHI = 2.8 [kWh/m2]
number of values = 1304
mbd = -18 %
sd = 26 %
Measurements (WRDC)

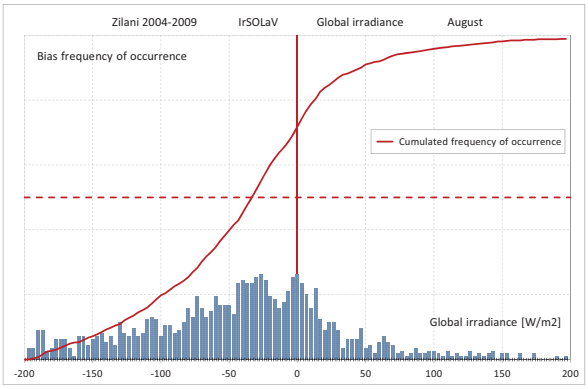

Monthly horizontal global irradiation [kWh/m2h]
Zilani 2004 - 2009
IrSOLaV
average GHI = 80 [kWh/m2]
number of values = 46
mbd = -18 %
sd = 14 %
Measurements (WRDC)

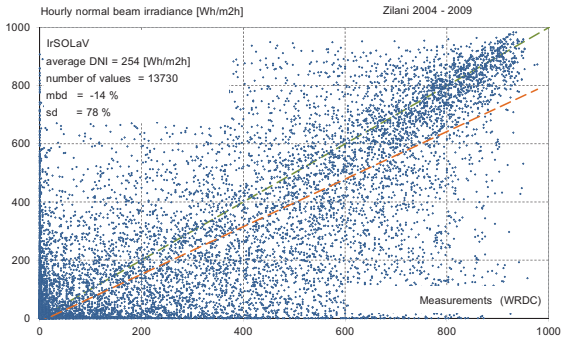

Monthly horizontal global irradiation [kWh/m2h]
Zilani 2004 - 2009
IrSOLaV
Measurements (WRDC)

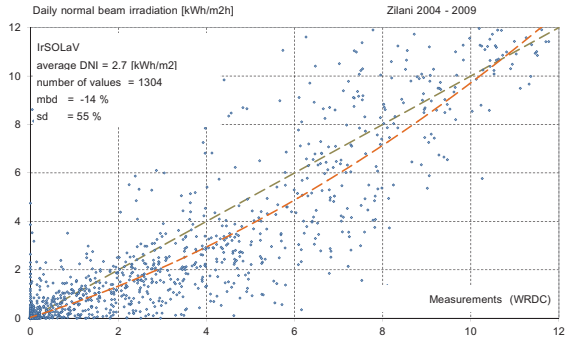

Zilani 2004-2009
IrSOLaV
Global irradiance
Bias frequency of occurrence
Cumulated frequency of occurrence
Global irradiance [W/m2]

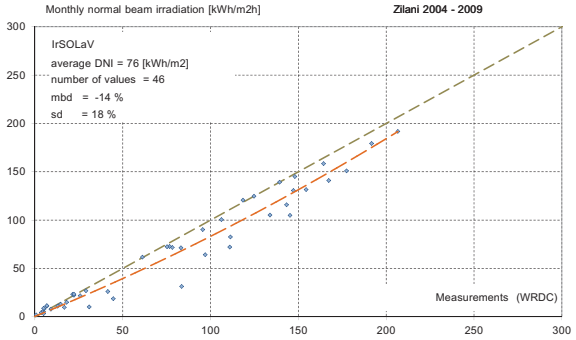

Zilani 2004-2009
IrSOLaV
Global irradiance
Bias frequency of occurrence
February
April
June
August
Oktober
December
Year
Global irradiance [W/m2]

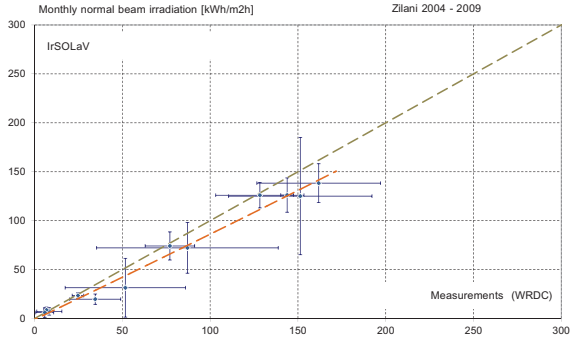

Zilani 2004-2009
IrSOLaV
Global irradiance
April
Bias frequency of occurrence
Cumulated frequency of occurrence
Global irradiance [W/m2]

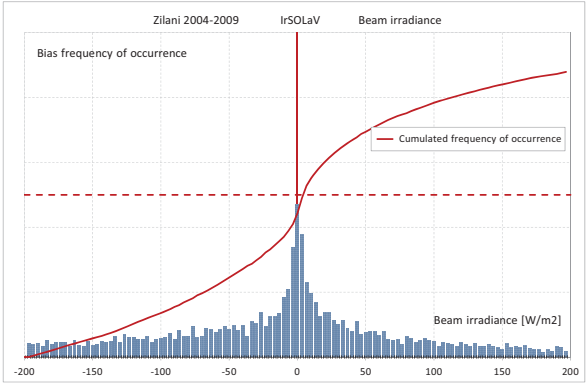

Zilani 2004-2009
IrSOLaV
Global irradiance
August
Bias frequency of occurrence
Cumulated frequency of occurrence
Global irradiance [W/m2]

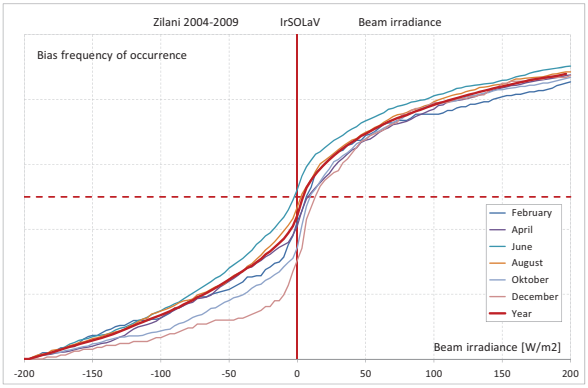

Hourly normal beam irradiance [Wh/m2h]
Zilani 2004 - 2009
IrSOLaV
average DNI = 254 [Wh/m2h]
number of values = 13730
mbd = -14 %
sd = 78 %
Measurements (WRDC)

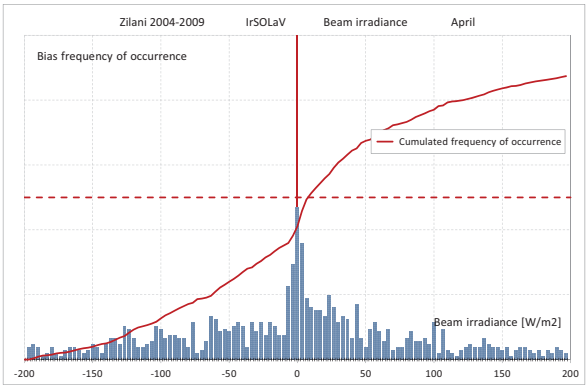

Daily normal beam irradiation [kWh/m2h]
Zilani 2004 - 2009
IrSOLaV
average DNI = 2.7 [kWh/m2]
number of values = 1304
mbd = -14 %
sd = 55 %
Measurements (WRDC)

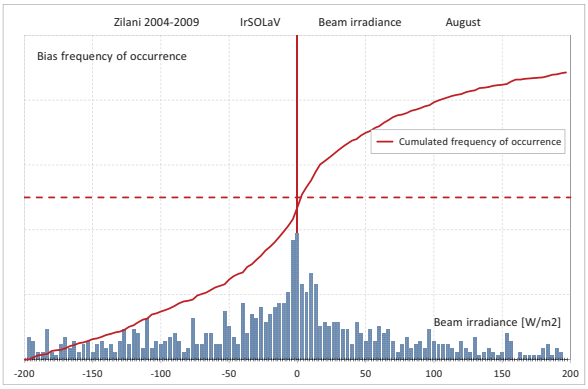

Monthly normal beam irradiation [kWh/m2h]
Zilani 2004 - 2009
IrSOLaV
average DNI = 76 [kWh/m2]
number of values = 46
mbd = -14 %
sd = 18 %
Measurements (WRDC)

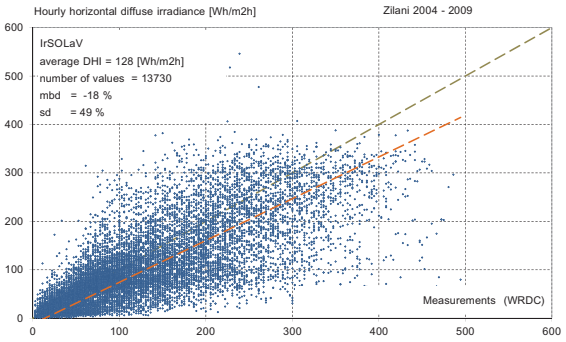

Monthly normal beam irradiation [kWh/m2h]
Zilani 2004 - 2009
IrSOLaV
Measurements (WRDC)

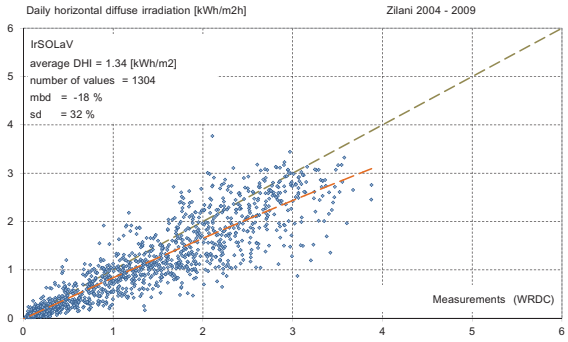

Zilani 2004-2009
IrSOLaV
Beam irradiance
Bias frequency of occurrence
Cumulated frequency of occurrence
Beam irradiance [W/m2]

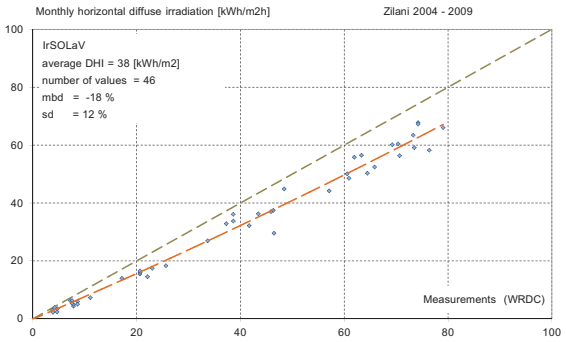

Zilani 2004-2009
IrSOLaV
Beam irradiance
Bias frequency of occurrence
February
April
June
August
Oktober
December
Year
Beam irradiance [W/m2]

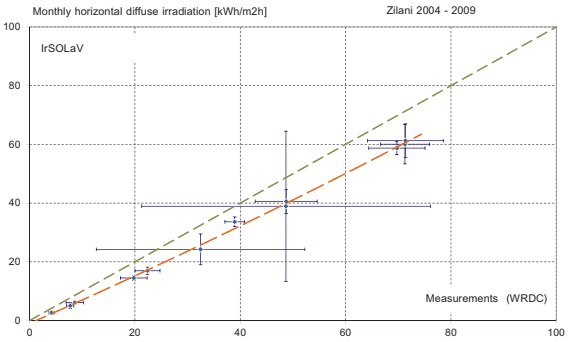

Zilani 2004-2009
IrSOLaV
Beam irradiance
April
Bias frequency of occurrence
Cumulated frequency of occurrence
Beam irradiance [W/m2]

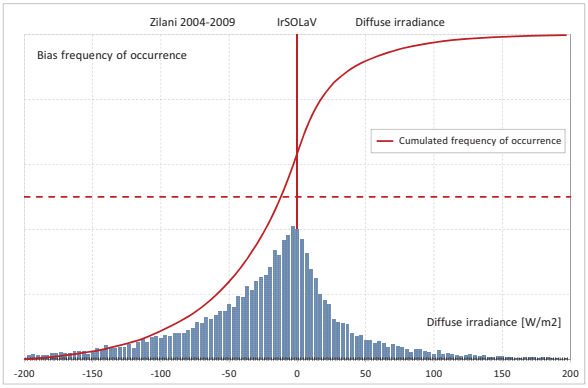

Zilani 2004-2009
IrSOLaV
Beam irradiance
August
Bias frequency of occurrence
Cumulated frequency of occurrence
Beam irradiance [W/m2]

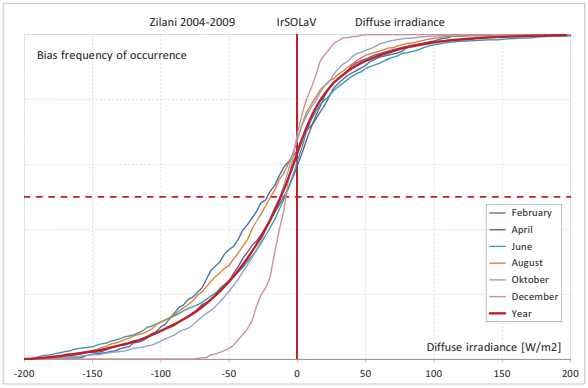

Hourly horizontal diffuse irradiance [Wh/m2h]
Zilani 2004 - 2009
IrSOLaV
average DHI = 128 [Wh/m2h]
number of values = 13730
mbd = -18 %
sd = 49 %
Measurements (WRDC)

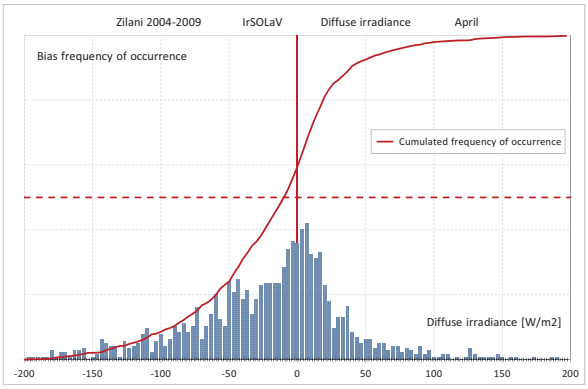

Daily horizontal diffuse irradiation [kWh/m2h]
Zilani 2004 - 2009
IrSOLaV
average DHI = 1.34 [kWh/m2]
number of values = 1304
mbd = -18 %
sd = 32 %
Measurements (WRDC)

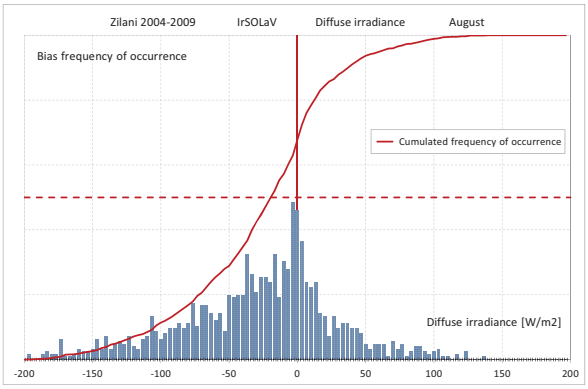

Monthly horizontal diffuse irradiation [kWh/m2h]
Zilani 2004 - 2009
IrSOLaV
average DHI = 38 [kWh/m2]
number of values = 46
mbd = -18 %
sd = 12 %
Measurements (WRDC)

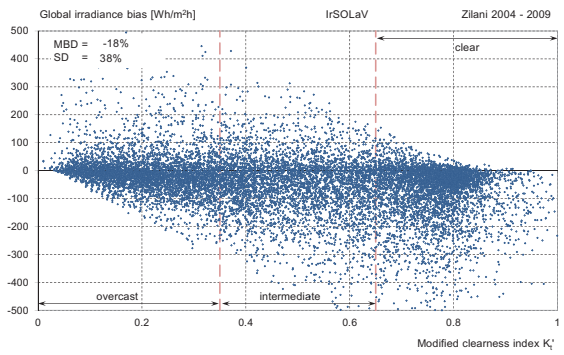

Monthly horizontal diffuse irradiation [kWh/m2h]
Zilani 2004 - 2009
IrSOLaV
Measurements (WRDC)

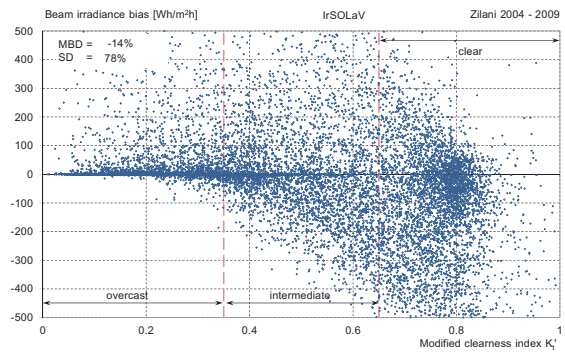

Zilani 2004-2009
IrSOLaV
Diffuse irradiance
Bias frequency of occurrence
Cumulated frequency of occurrence
Diffuse irradiance [W/m2]

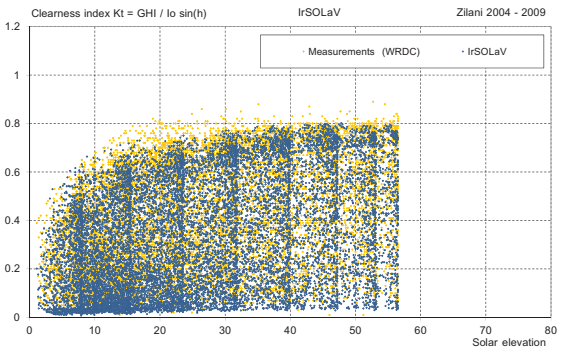

Zilani 2004-2009
IrSOLaV
Diffuse irradiance
Bias frequency of occurrence
February
April
June
August
Oktober
December
Year
Diffuse irradiance [W/m2]

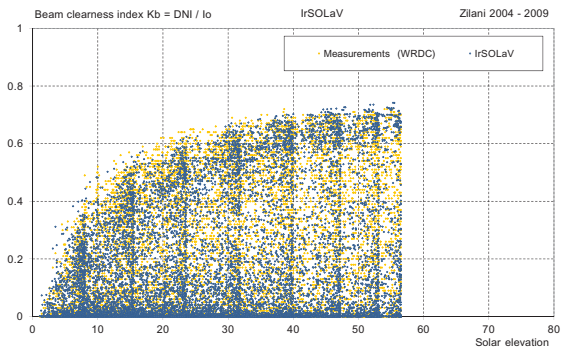

Zilani 2004-2009
IrSOLaV
Diffuse irradiance
April
Bias frequency of occurrence
Cumulated frequency of occurrence
Diffuse irradiance [W/m2]

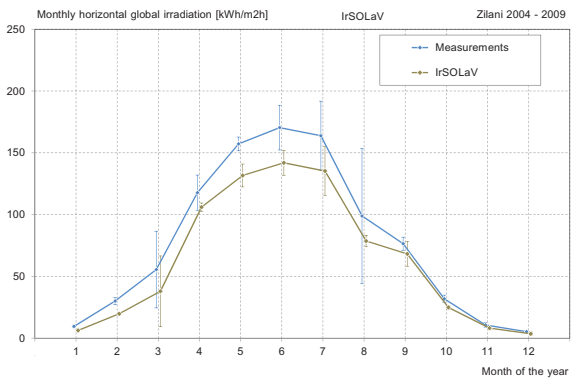

Zilani 2004-2009
IrSOLaV
Diffuse irradiance
August
Bias frequency of occurrence
Cumulated frequency of occurrence
Diffuse irradiance [W/m2]

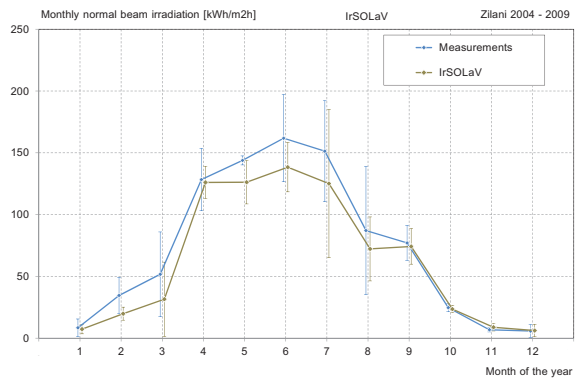

Global irradiance bias [Wh/m²h]
IrSOLaV
Zilani 2004 - 2009
MBD = -18%
SD = 38%
clear
overcast
intermediate
Modified clearness index Kt'

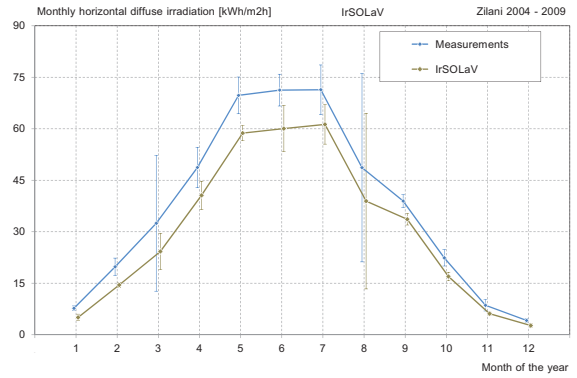

Beam irradiance bias [Wh/m²h]
IrSOLaV
Zilani 2004 - 2009
MBD = -14%
SD = 78%
clear
overcast
intermediate
Modified clearness index Kt'

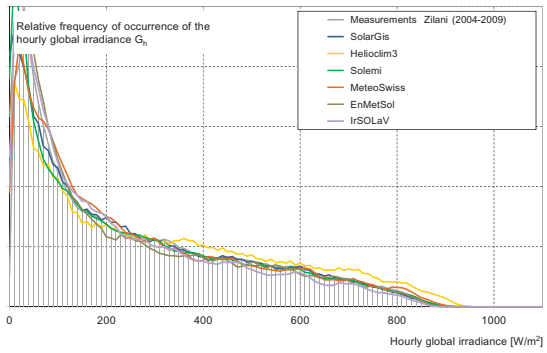

Clearness index Kt = GHI / Io sin(h)
IrSOLaV
Zilani 2004 - 2009
Measurements (WRDC)
IrSOLaV
Solar elevation

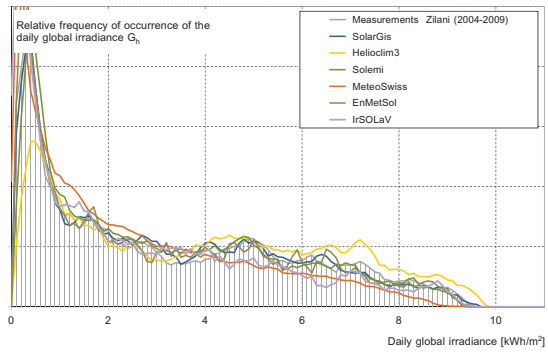

Beam clearness index Kb = DNI / Io
IrSOLaV
Zilani 2004 - 2009
Measurements (WRDC)
IrSOLaV
Solar elevation

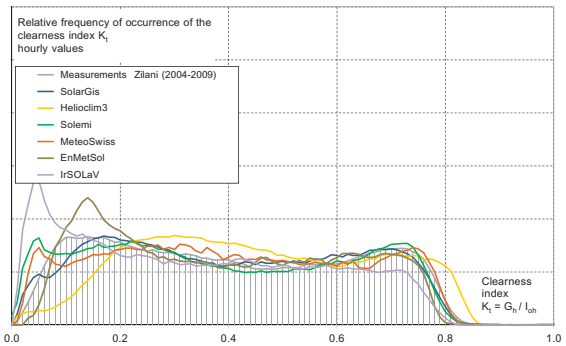

Monthly horizontal global irradiation [kWh/m2h]
IrSOLaV
Zilani 2004 - 2009
Measurements
IrSOLaV
Month of the year

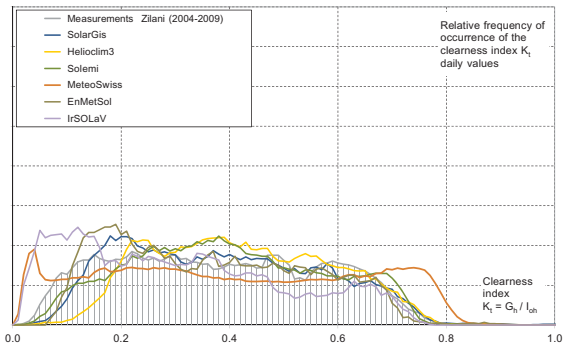

Monthly normal beam irradiation [kWh/m2h]
IrSOLaV
Zilani 2004 - 2009
Measurements
IrSOLaV
Month of the year

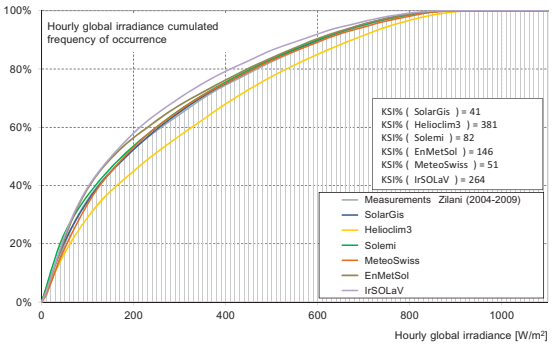

Monthly horizontal diffuse irradiation [kWh/m2h]
IrSOLaV
Zilani 2004 - 2009
Measurements
IrSOLaV
Month of the year

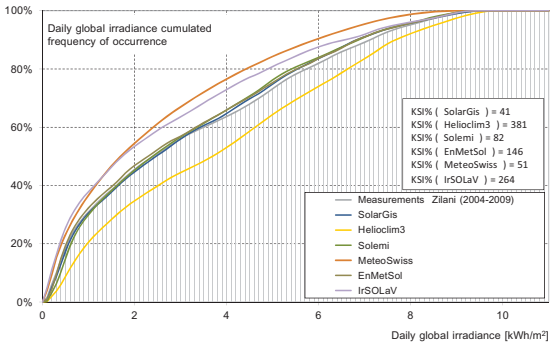

Relative frequency of occurrence of the hourly global irradiance G_h
Measurements Zilani (2004-2009)
SolarGis
Helioclim3
Solemi
MeteoSwiss
EnMetSol
IrSOLaV
0
200
400
600
800
1000
Hourly global irradiance [W/m²]

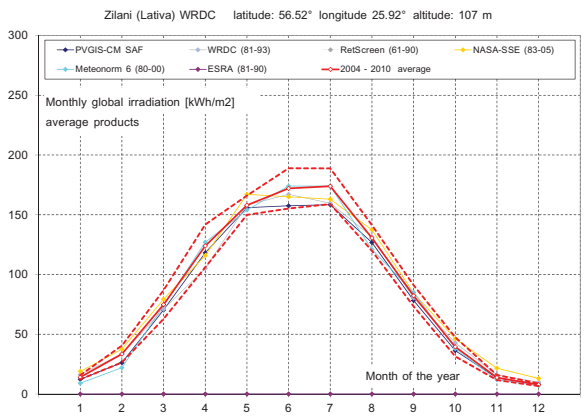

Relative frequency of occurrence of the daily global irradiance G_h
Measurements Zilani (2004-2009)
SolarGis
Helioclim3
Solemi
MeteoSwiss
EnMetSol
IrSOLaV
0
2
4
6
8
10
Daily global irradiance [kWh/m²]

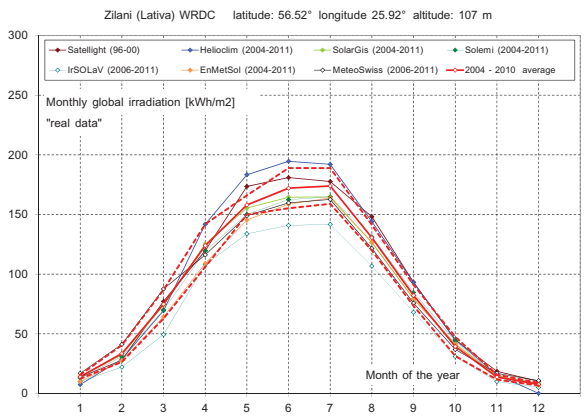

Relative frequency of occurrence of the clearness index K_t hourly values
Measurements Zilani (2004-2009)
SolarGis
Helioclim3
Solemi
MeteoSwiss
EnMetSol
IrSOLaV
Clearness index $K_t = G_h / I_{oh}$
0.0
0.2
0.4
0.6
0.8
1.0

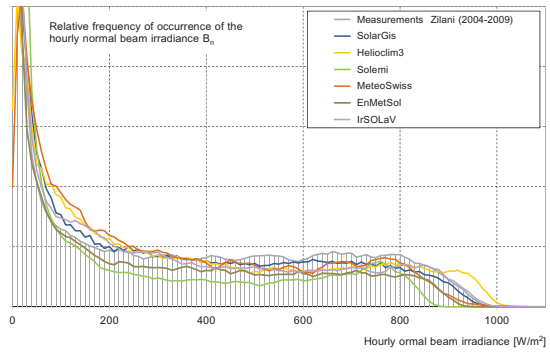

Measurements Zilani (2004-2009)
SolarGis
Helioclim3
Solemi
MeteoSwiss
EnMetSol
IrSOLaV
Relative frequency of occurrence of the clearness index K_t daily values
Clearness index $K_t = G_h / I_{oh}$
0.0
0.2
0.4
0.6
0.8
1.0

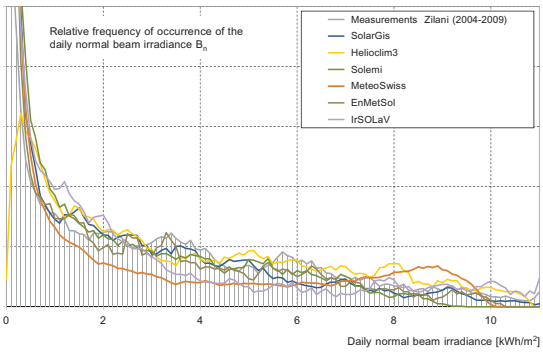

Hourly global irradiance cumulated frequency of occurrence
KSI% (SolarGis) = 41
KSI% (Helioclim3) = 381
KSI% (Solemi) = 82
KSI% (EnMetSol) = 146
KSI% (MeteoSwiss) = 51
KSI% (IrSOLaV) = 264
Measurements Zilani (2004-2009)
SolarGis
Helioclim3
Solemi
MeteoSwiss
EnMetSol
IrSOLaV
100%
80%
60%
40%
20%
0%
0
200
400
600
800
1000
Hourly global irradiance [W/m²]

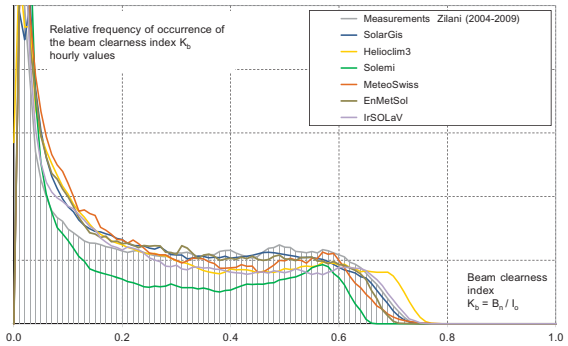

Daily global irradiance cumulated frequency of occurrence
KSI% (SolarGis) = 41
KSI% (Helioclim3) = 381
KSI% (Solemi) = 82
KSI% (EnMetSol) = 146
KSI% (MeteoSwiss) = 51
KSI% (IrSOLaV) = 264
Measurements Zilani (2004-2009)
SolarGis
Helioclim3
Solemi
MeteoSwiss
EnMetSol
IrSOLaV
100%
80%
60%
40%
20%
0%
0
2
4
6
8
10
Daily global irradiance [kWh/m²]

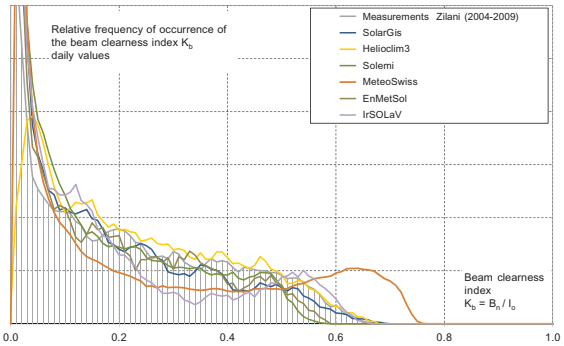

Zilani (Lativa) WRDC latitude: 56.52° longitude 25.92° altitude: 107 m
PVGIS-CM SAF
WRDC (81-93)
RetScreen (61-90)
NASA-SSE (83-05)
Meteonorm 6 (80-00)
ESRA (81-90)
2004 - 2010 average
Monthly global irradiation [kWh/m2]
average products
Month of the year
300
250
200
150
100
50
0
1
2
3
4
5
6
7
8
9
10
11
12

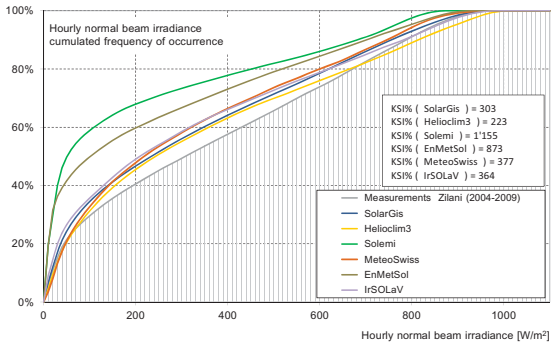

Zilani (Lativa) WRDC latitude: 56.52° longitude 25.92° altitude: 107 m
Satellight (96-00)
Helioclim (2004-2011)
SolarGis (2004-2011)
Solemi (2004-2011)
IrSOLaV (2006-2011)
EnMetSol (2004-2011)
MeteoSwiss (2006-2011)
2004 - 2010 average
Monthly global irradiation [kWh/m2]
"real data"
Month of the year
300
250
200
150
100
50
0
1
2
3
4
5
6
7
8
9
10
11
12

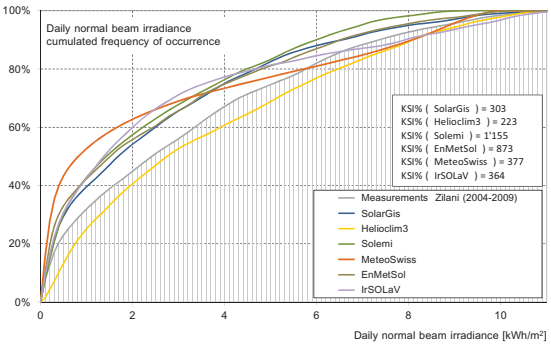

Relative frequency of occurrence of the hourly normal beam irradiance B_n
Measurements Zilani (2004-2009)
SolarGis
Helioclim3
Solemi
MeteoSwiss
EnMetSol
IrSOLaV
0
200
400
600
800
1000
Hourly ormal beam irradiance [W/m²]

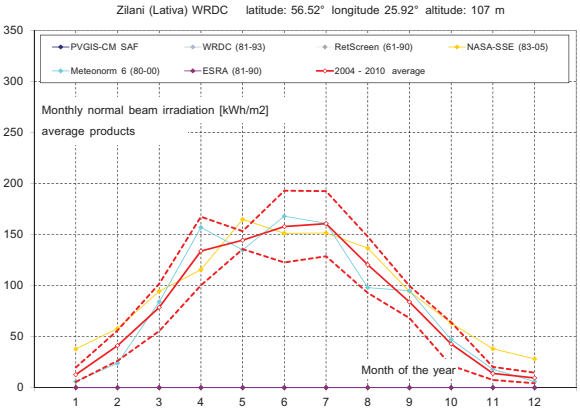

Relative frequency of occurrence of the daily normal beam irradiance B_n
Measurements Zilani (2004-2009)
SolarGis
Helioclim3
Solemi
MeteoSwiss
EnMetSol
IrSOLaV
0
2
4
6
8
10
Daily normal beam irradiance [kWh/m²]

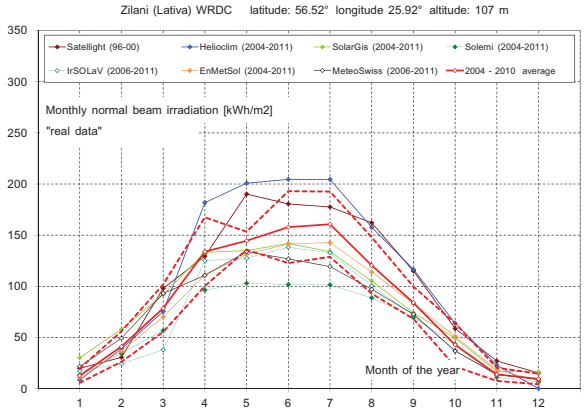

Relative frequency of occurrence of the beam clearness index K_b hourly values
Measurements Zilani (2004-2009)
SolarGis
Helioclim3
Solemi
MeteoSwiss
EnMetSol
IrSOLaV
Beam clearness index
$K_b = B_n / I_o$
0.0
0.2
0.4
0.6
0.8
1.0

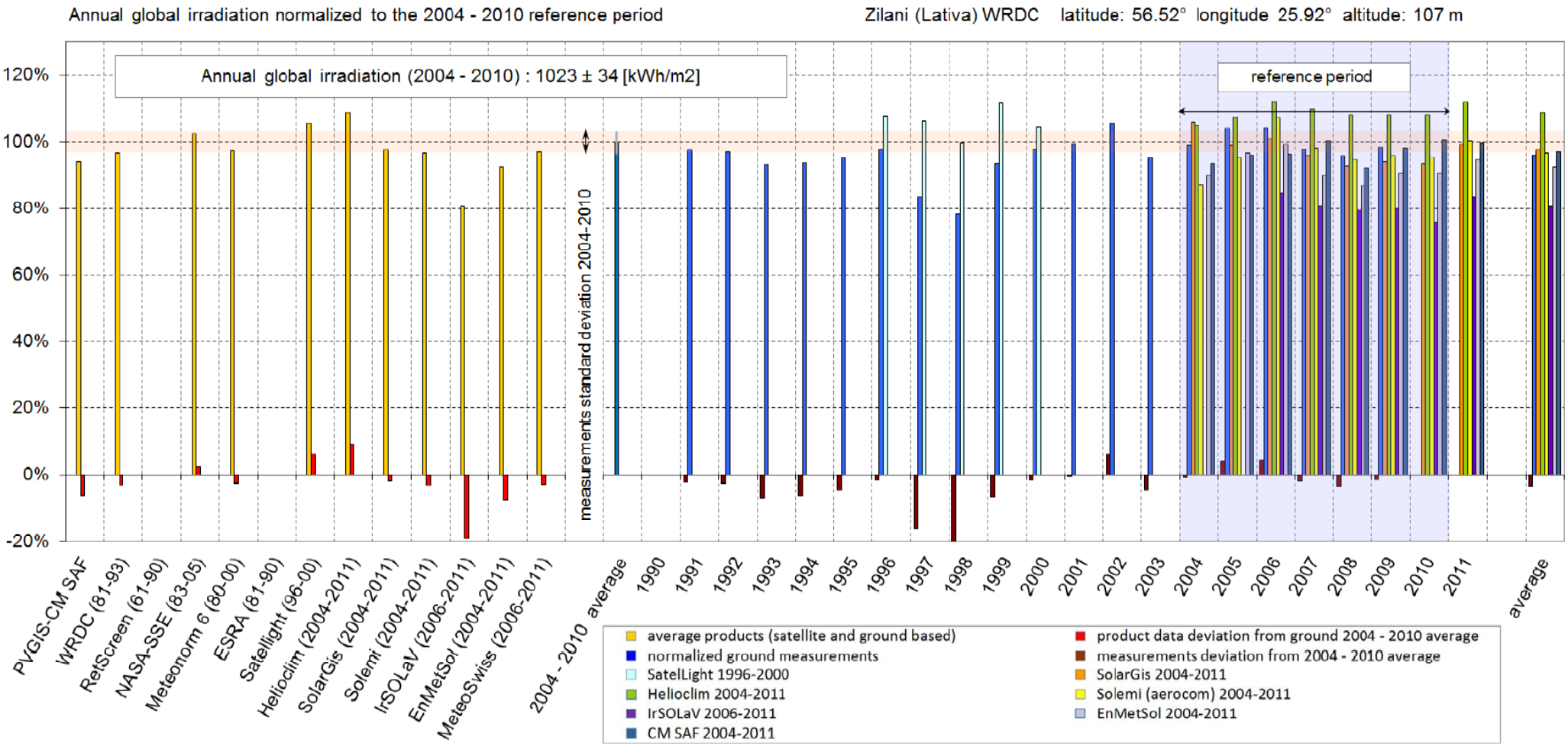

Relative frequency of occurrence of the beam clearness index K_b daily values
Measurements Zilani (2004-2009)
SolarGis
Helioclim3
Solemi
MeteoSwiss
EnMetSol
IrSOLaV
Beam clearness index
$K_b = B_n / I_o$
0.0
0.2
0.4
0.6
0.8
1.0

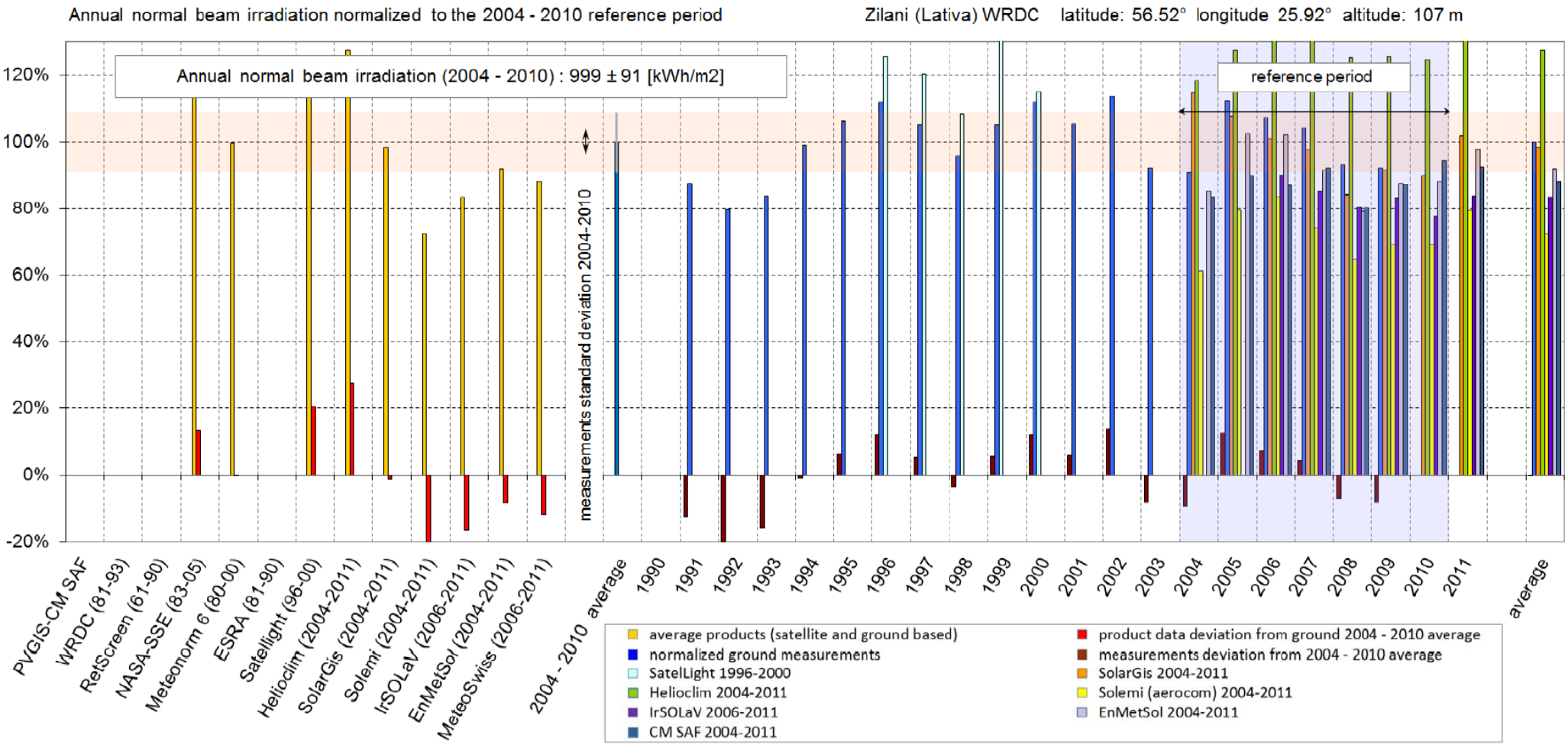

Hourly normal beam irradiance cumulated frequency of occurrence
KSI% (SolarGis) = 303
KSI% (Helioclim3) = 223
KSI% (Solemi) = 1'155
KSI% (EnMetSol) = 873
KSI% (MeteoSwiss) = 377
KSI% (IrSOLaV) = 364
Measurements Zilani (2004-2009)
SolarGis
Helioclim3
Solemi
MeteoSwiss
EnMetSol
IrSOLaV
100%
80%
60%
40%
20%
0%
0
200
400
600
800
1000
Hourly normal beam irradiance [W/m²]


Daily normal beam irradiance cumulated frequency of occurrence
KSI% (SolarGis) = 303
KSI% (Helioclim3) = 223
KSI% (Solemi) = 1'155
KSI% (EnMetSol) = 873
KSI% (MeteoSwiss) = 377
KSI% (IrSOLaV) = 364
Measurements Zilani (2004-2009)
SolarGis
Helioclim3
Solemi
MeteoSwiss
EnMetSol
IrSOLaV
100%
80%
60%
40%
20%
0%
0
2
4
6
8
10
Daily normal beam irradiance [kWh/m²]


Zilani (Lativa) WRDC latitude: 56.52° longitude 25.92° altitude: 107 m
PVGIS-CM SAF
WRDC (81-93)
RetScreen (61-90)
NASA-SSE (83-05)
Meteonorm 6 (80-00)
ESRA (81-90)
2004 - 2010 average
Monthly normal beam irradiation [kWh/m2]
average products
Month of the year
350
300
250
200
150
100
50
0
1
2
3
4
5
6
7
8
9
10
11
12


Zilani (Lativa) WRDC latitude: 56.52° longitude 25.92° altitude: 107 m
Satellight (96-00)
Helioclim (2004-2011)
SolarGis (2004-2011)
Solemi (2004-2011)
IrSOLaV (2006-2011)
EnMetSol (2004-2011)
MeteoSwiss (2006-2011)
2004 - 2010 average
Monthly normal beam irradiation [kWh/m2]
"real data"
Month of the year
350
300
250
200
150
100
50
0
1
2
3
4
5
6
7
8
9
10
11
12


Annual global irradiation normalized to the 2004 - 2010 reference period
Zilani (Lativa) WRDC latitude: 56.52° longitude 25.92° altitude: 107 m
Annual global irradiation (2004 - 2010) : 1023 ± 34 [kWh/m2]
reference period
measurements standard deviation 2004-2010
120%
100%
80%
60%
40%
20%
0%
-20%
PVGIS-CM SAF
WRDC (81-93)
RetScreen (61-90)
NASA-SSE (83-05)
Meteonorm 6 (80-00)
ESRA (81-90)
Satellight (96-00)
Helioclim (2004-2011)
SolarGis (2004-2011)
Solemi (2004-2011)
IrSOLaV (2006-2011)
EnMetSol (2004-2011)
MeteoSwiss (2006-2011)
2004 - 2010 average
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
average
average products (satellite and ground based)
normalized ground measurements
SatelLight 1996-2000
Helioclim 2004-2011
IrSOLaV 2006-2011
CM SAF 2004-2011
product data deviation from ground 2004 - 2010 average
measurements deviation from 2004 - 2010 average
SolarGis 2004-2011
Solemi (aerocom) 2004-2011
EnMetSol 2004-2011


Annual normal beam irradiation normalized to the 2004 - 2010 reference period
Zilani (Lativa) WRDC latitude: 56.52° longitude 25.92° altitude: 107 m
Annual normal beam irradiation (2004 - 2010) : 999 ± 91 [kWh/m2]
reference period
measurements standard deviation 2004-2010
120%
100%
80%
60%
40%
20%
0%
-20%
PVGIS-CM SAF
WRDC (81-93)
RetScreen (61-90)
NASA-SSE (83-05)
Meteonorm 6 (80-00)
ESRA (81-90)
Satellight (96-00)
Helioclim (2004-2011)
SolarGis (2004-2011)
Solemi (2004-2011)
IrSOLaV (2006-2011)
EnMetSol (2004-2011)
MeteoSwiss (2006-2011)
2004 - 2010 average
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
average
average products (satellite and ground based)
normalized ground measurements
SatelLight 1996-2000
Helioclim 2004-2011
IrSOLaV 2006-2011
CM SAF 2004-2011
product data deviation from ground 2004 - 2010 average
measurements deviation from 2004 - 2010 average
SolarGis 2004-2011
Solemi (aerocom) 2004-2011
EnMetSol 2004-2011