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Broadband surface solar irradiance derived from OMI

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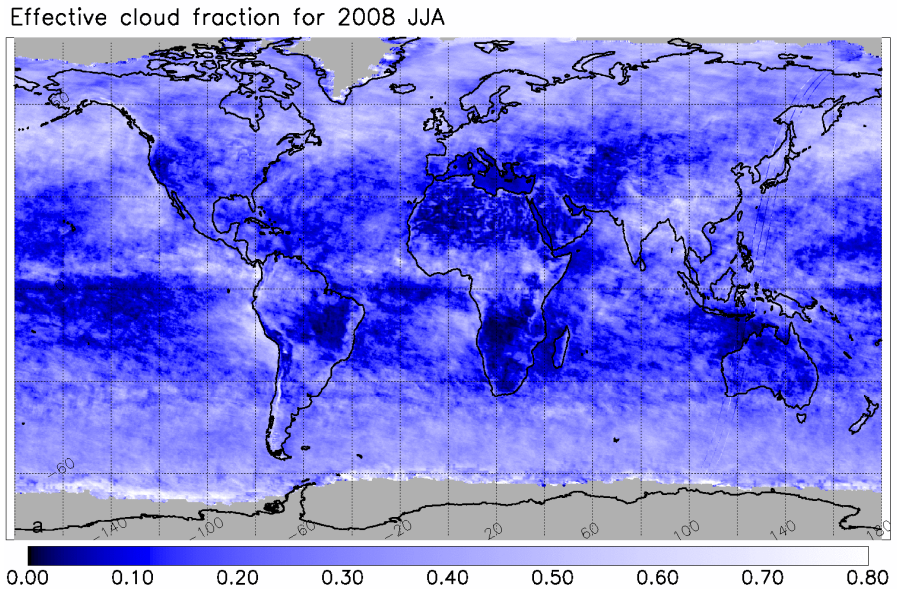
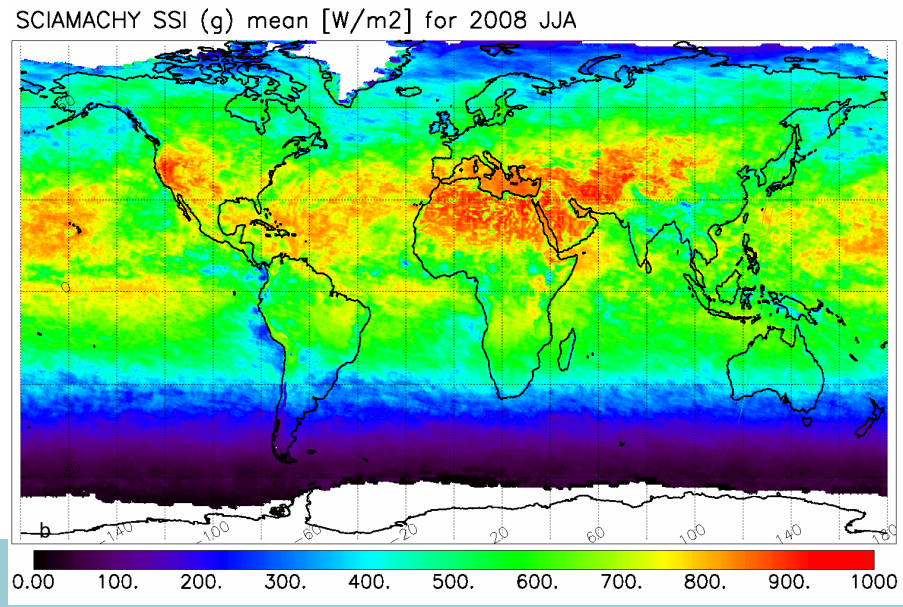
Overview

- Why broadband surface solar irradiance (SSI 0.2-4 micron) is important
- Method: Heliosat
- Data: OMI O_2-O_2 effective cloud fraction
- Validation: Baseline Surface Radiation Network (BSRN) data in 2008

Surface solar irradiance map

- Earth energy balance
- Surface energy balance
- Utilization of solar energy



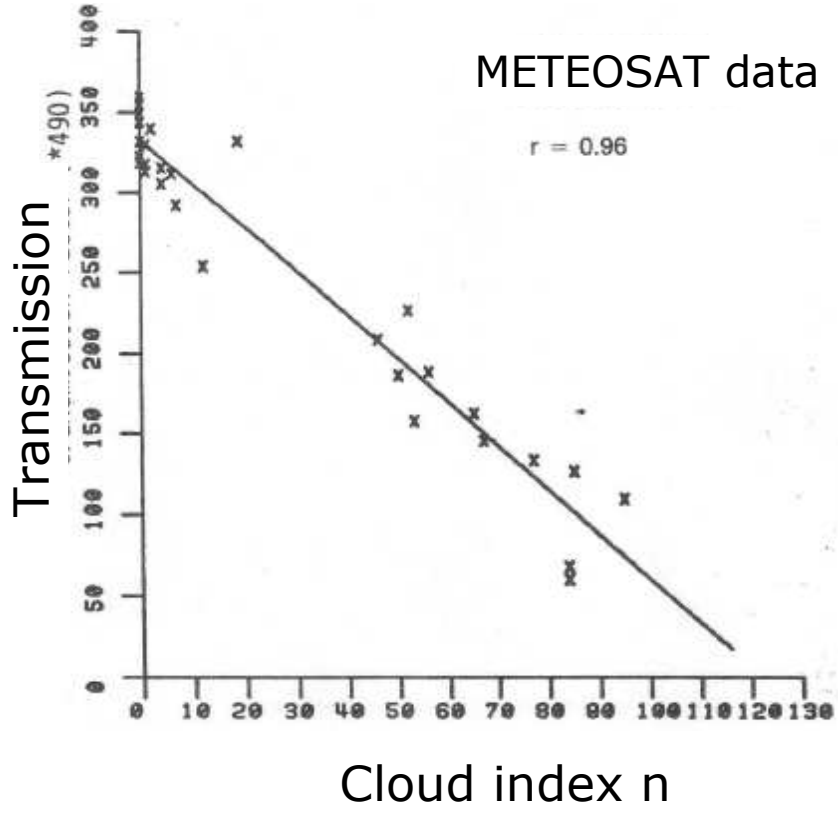


Principle of Heliosat method

Cloud cover fraction (n) determines the surface solar irradiance (G).

$$n = (R-R_{min})/(R_{max}-R_{min})$$
$$R_{max} = 0.95$$
$$R_{min} = R_{clr}(A_s)$$

- R -> n -> T
- Clear sky irradiances G_{clr}
- $G = T*G_{clr}$



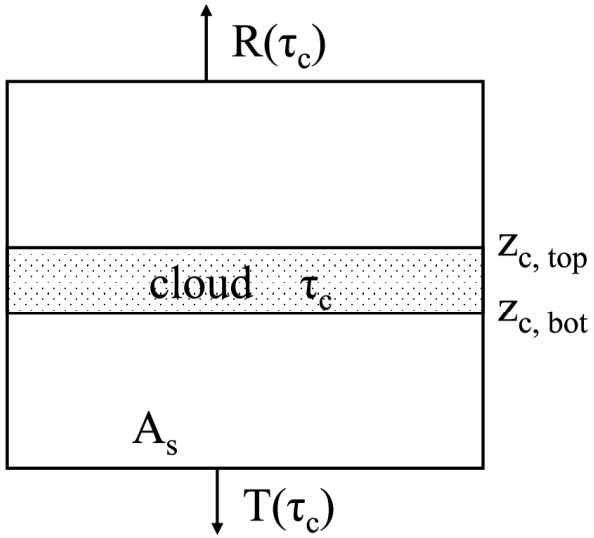
Cano et al., Solar Energy, 1986

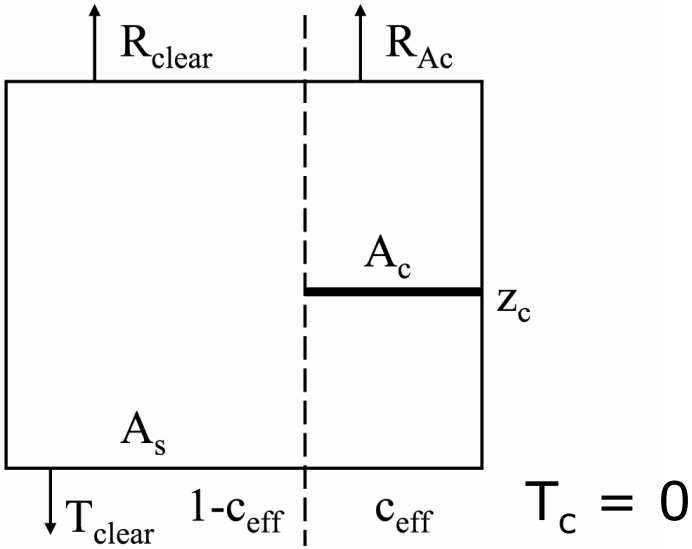
Effective cloud fraction

Scattering cloud **Lambertian cloud**

$$R = (1-c_{eff})R_{clr} + c_{eff}R_c$$

$$T = (1-c_{eff})T_{clr}$$





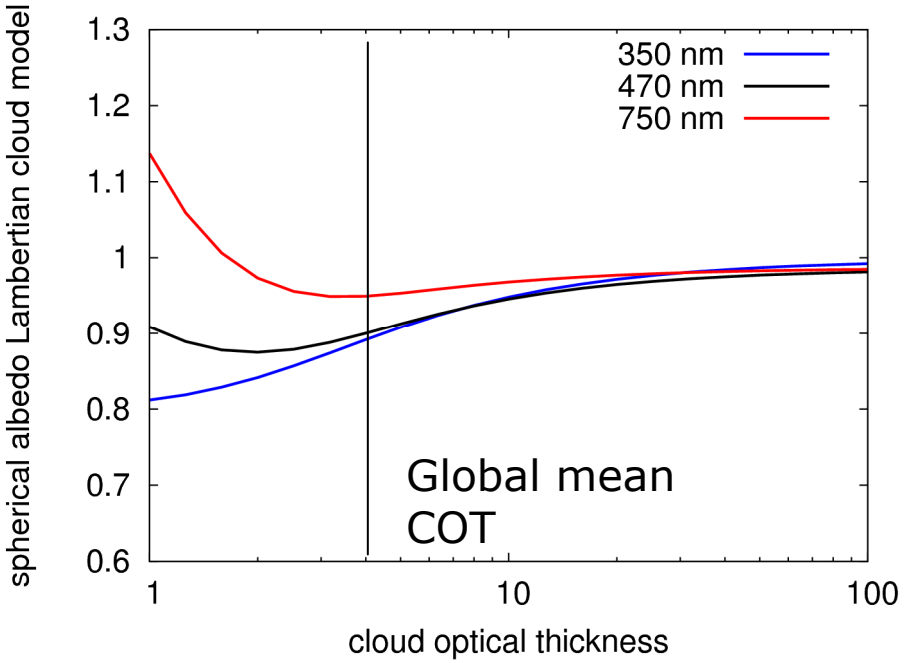
$T_c = 0$

$C_{eff} = (R- R_{clr})/(R_c-R_{clr})$ $n = (R-R_{min})/(R_{max}-R_{min})$

Choose proper $R_c(A_c)$ and R_{max}

Stammes et al., JGR, 2008

Selection of cloud albedo for SSI



$$\begin{cases} R_{Lam}=R_{sca} \\ T_{Lam}=T_{Sca} \end{cases}$$

O_2 A (750 nm) A_c=0.95

O_2-O_2 (470 nm) A_c=0.9

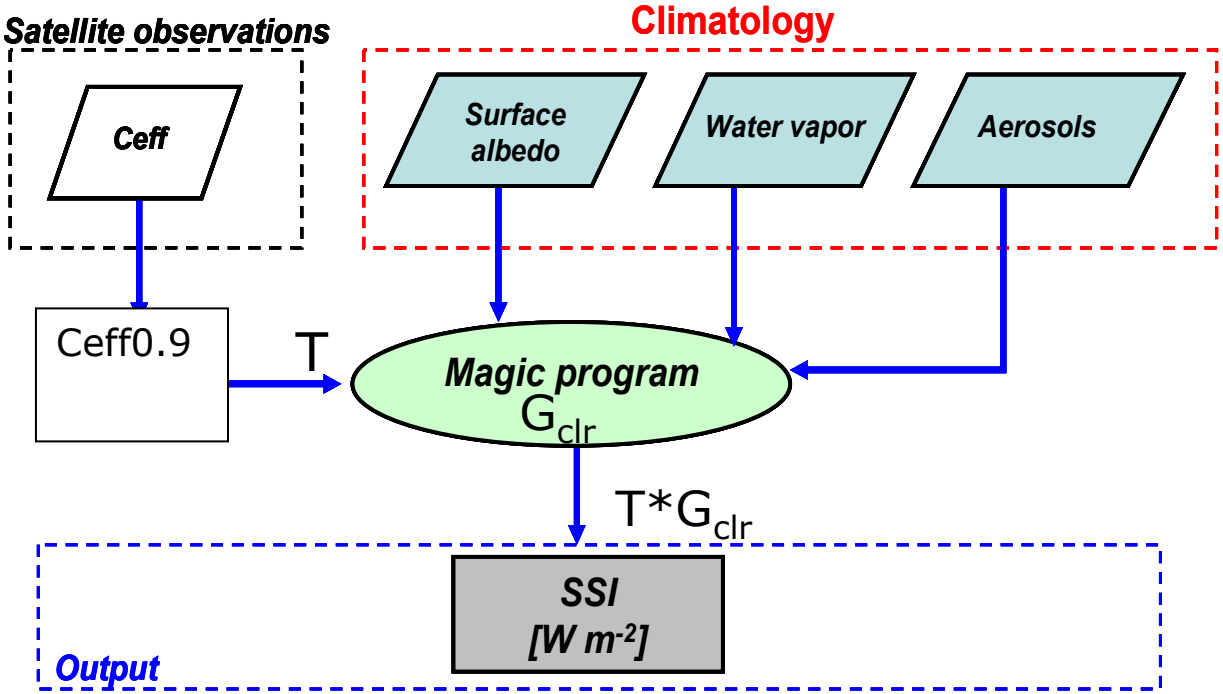
Cloud albedo A_c=0.8 is in the OMI O_2-O_2 cloud algorithm.

C_{eff} for A_c=0.8 is converted to C_{eff} for A_c=0.9.

Stammes et al., JGR, 2008

Flowchart of SSI from OMI

C_{eff} from OMI O_2-O_2 (477 nm) or SCIAMACHY FRESCO (760 nm)



MAGIC = Mesoscale Atmospheric Global Irradiance Code

Mueller et al., Remote Sen. Environ.,2004

Baseline Surface radiation Network (BSRN) Cabauw site

Pyrheliometer
200 - 4000 nm

Direct irradiance,
diffuse irradiance

Pyranometer

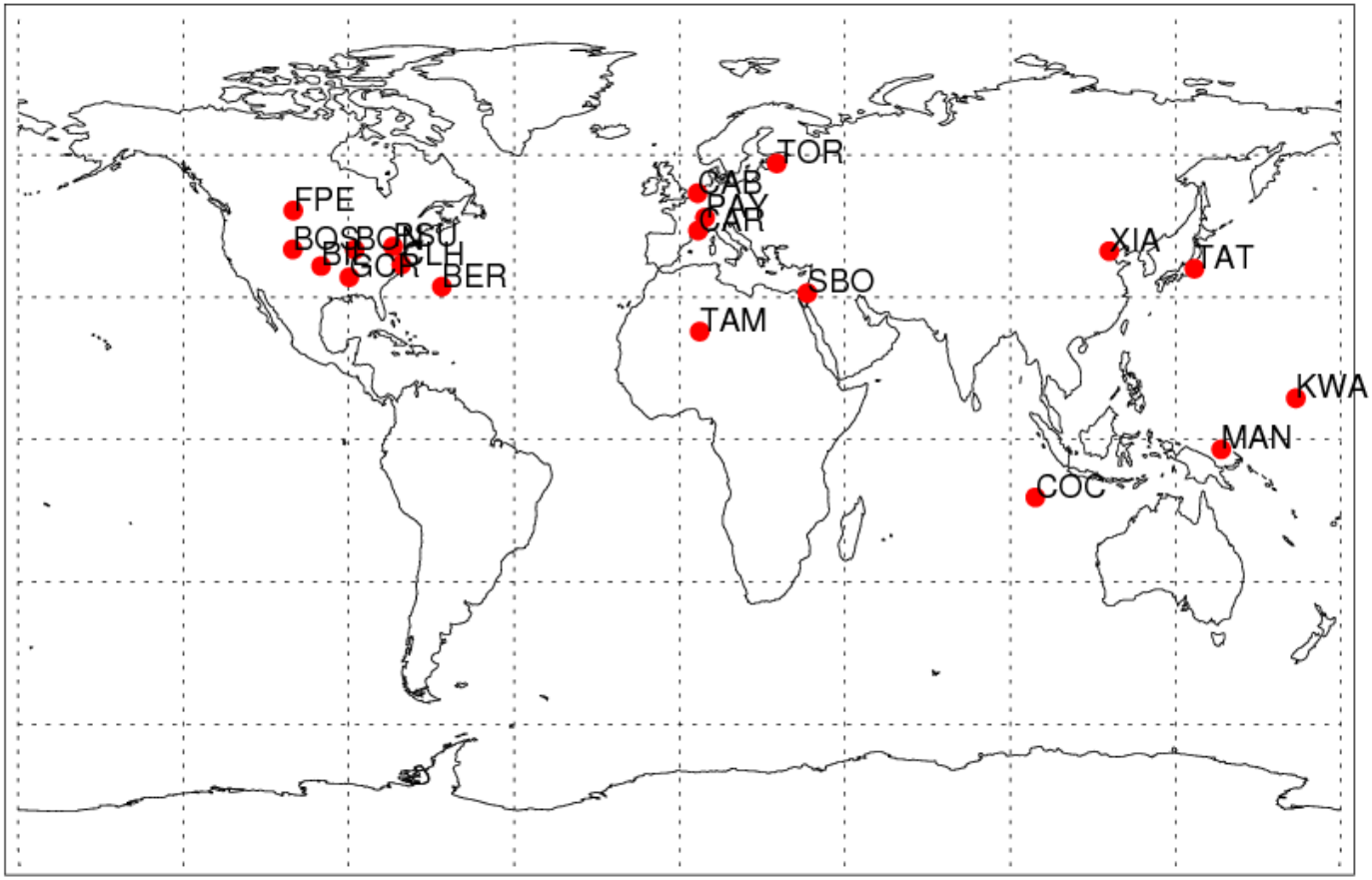
Global irradiance

Accuracy +/- 5 W/m^2

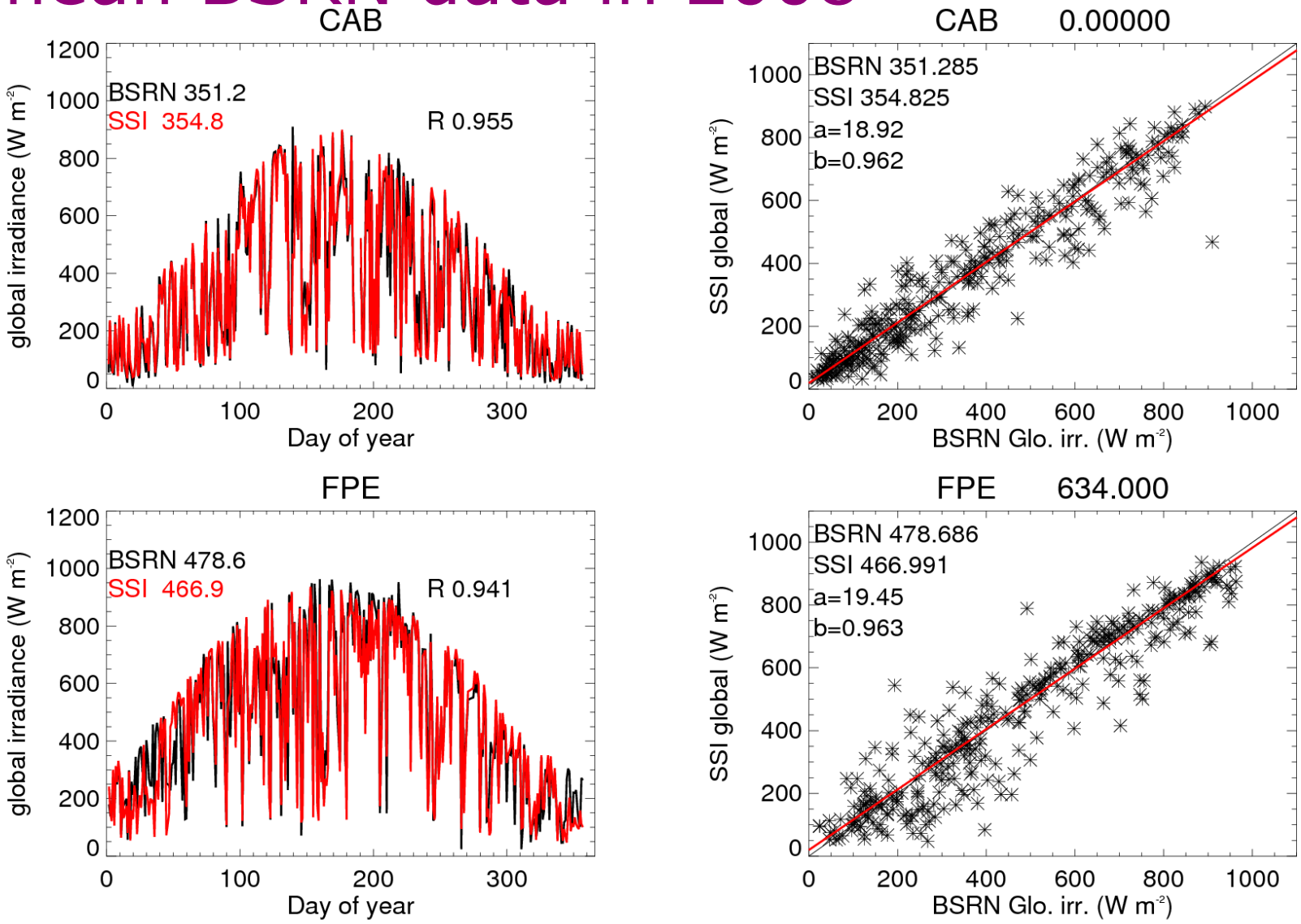
Photos from W. Knap

Evaluation of OMI SSI in 2008: 19 BSRN stations

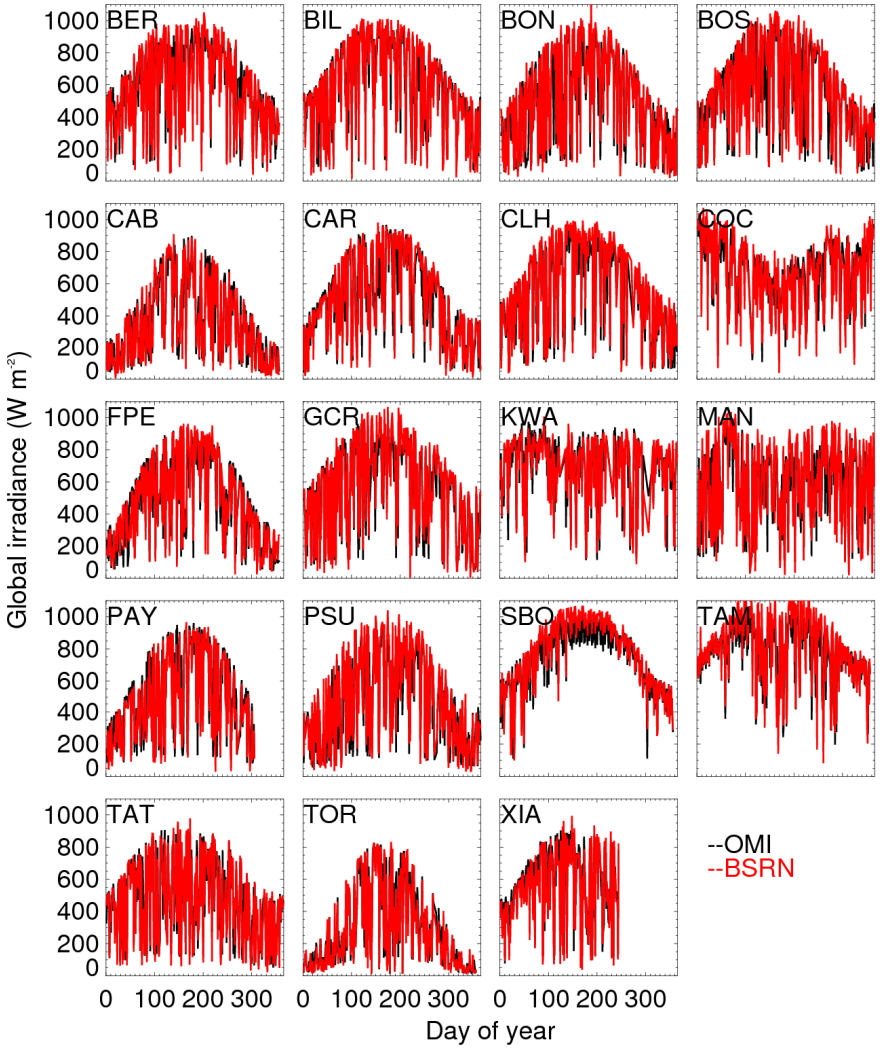
validation sites for 2008

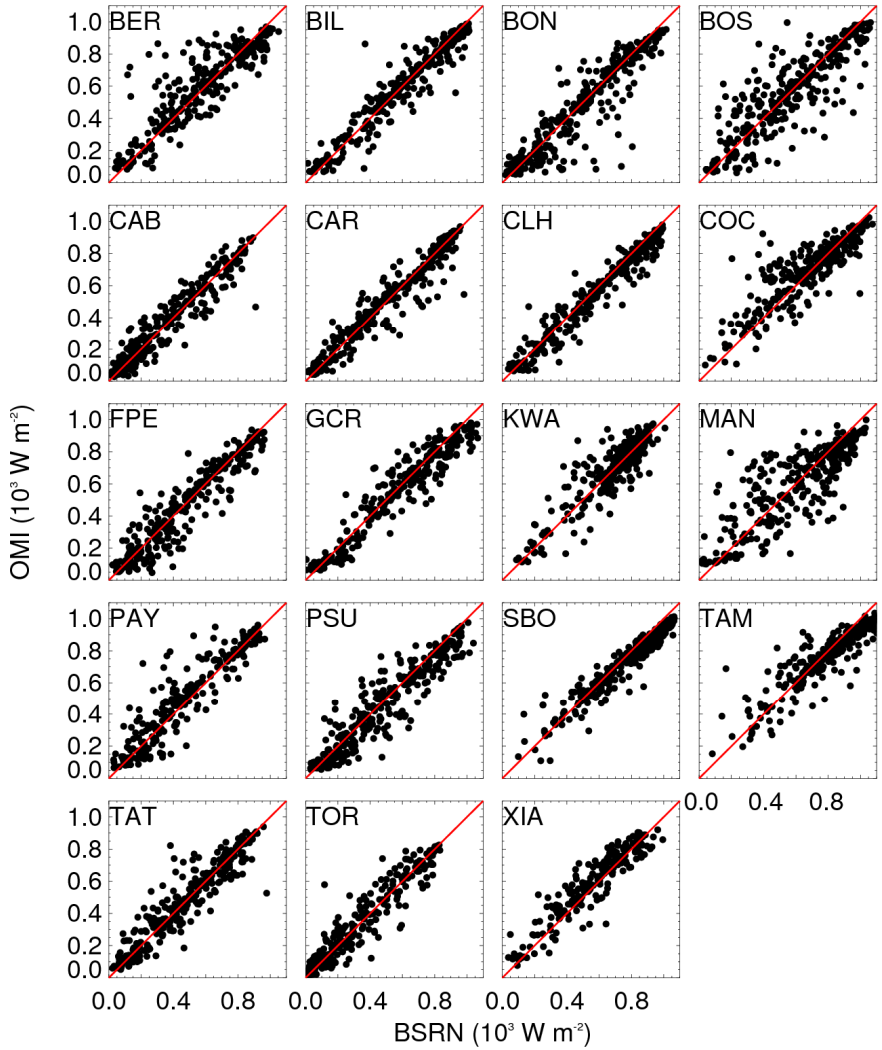


Instantaneous OMI SSI vs. hourly mean BSRN data in 2008

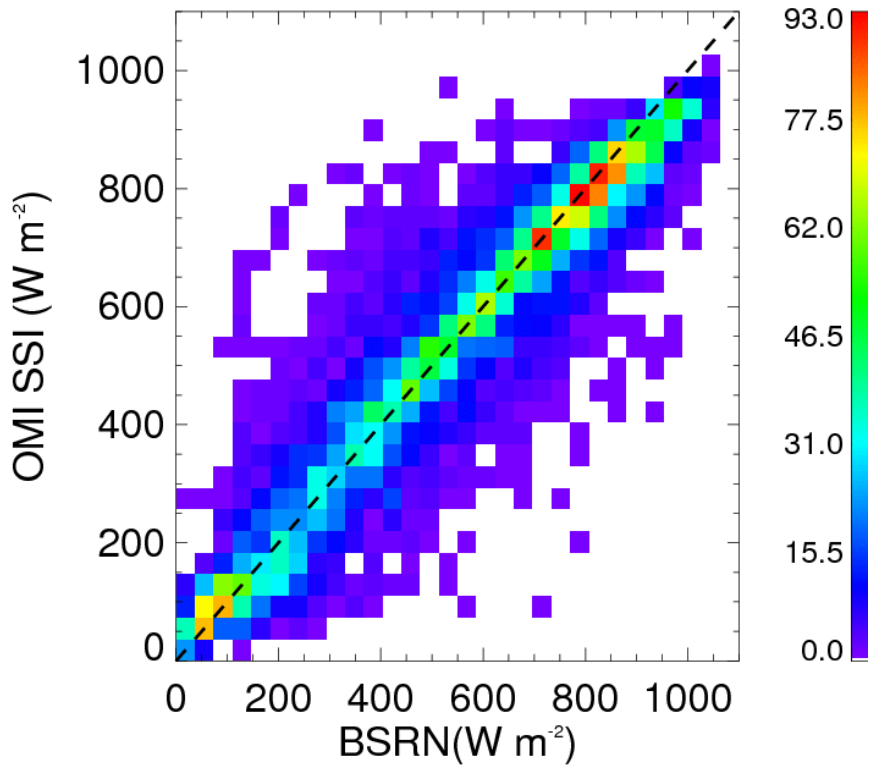


Instantaneous OMI SSI vs. hourly mean BSRN data in 2008, all stations

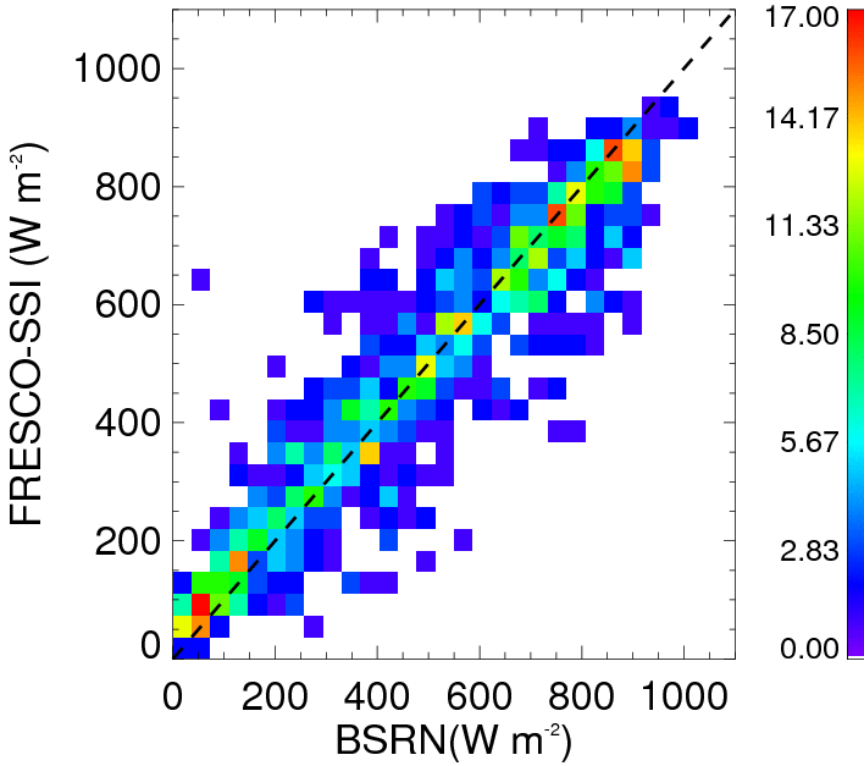




OMI and SCIAMACHY SSI



OMI



SCIAMACHY

SCIAMACHY SSI is available in FRESCO v6 at www.temis.nl

Wang et al., AMT, 2011

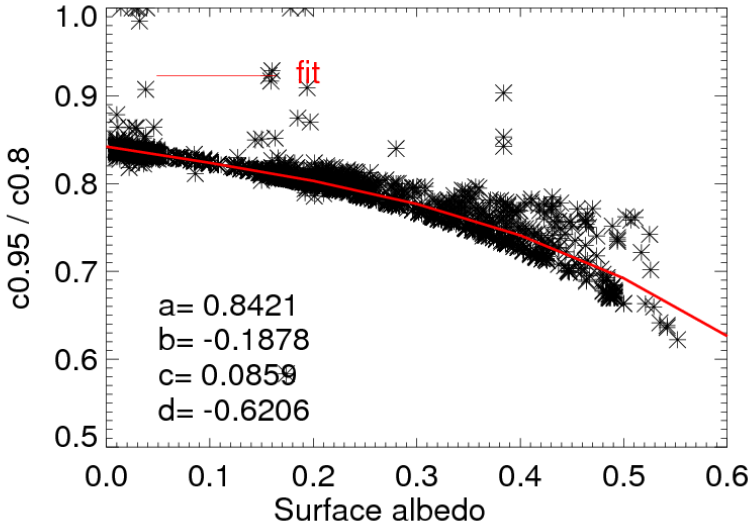
OMI and SCIAMACHY SSI

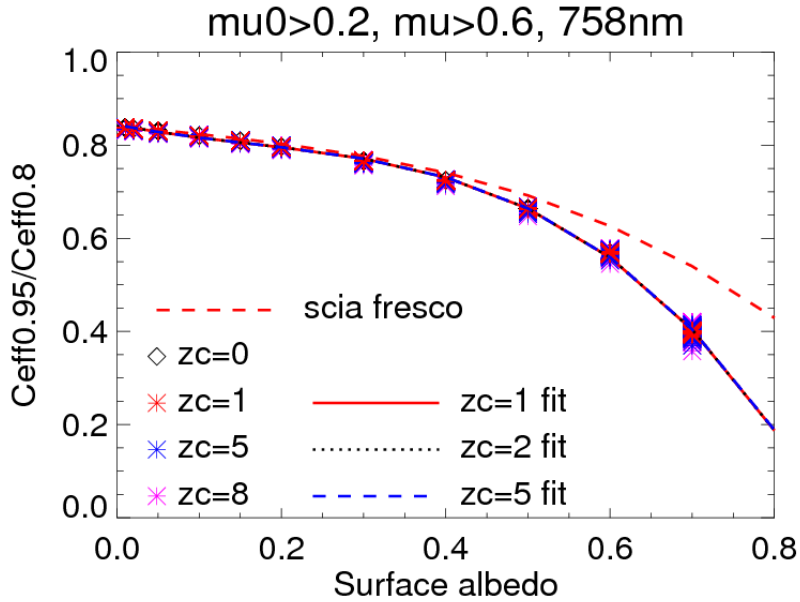
	OMI	SCIAMACHY
BSRN Mean global irradiances [W/m^2]	554.3	509.0
Mean differences (SSI-BSRN) [W/m^2]	-4.7	-4.2
Standard deviation [W/m^2]	99.6	101.1
Correlation	0.937	0.932
Number of data	5651	1006

Summary

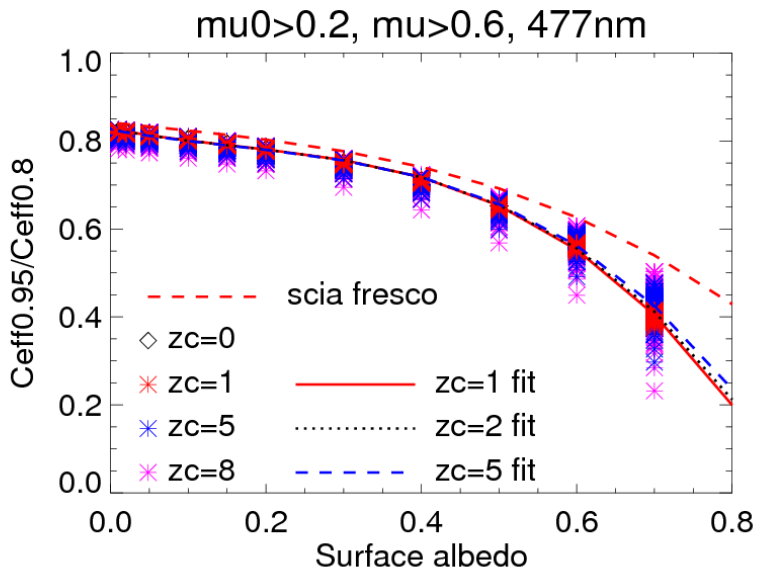
- Broadband surface solar irradiance is derived from OMI O_2-O_2 effective cloud fraction using the Heliosat method.
- OMI SSI is validated with global irradiances measured at 19 BSRN stations in 2008.
- OMI SSI shows good agreement with hourly mean BSRN global irradiances.
- OMI SSI is comparable to the SCIAMACHY SSI. It is possible to make combined SSI product using OMI and SCIAMACHY data.
- OMI SSI is a ground-based validation of the effective cloud fraction.
- SSI could be a new OMI product.

Convert OMCLDO2G $C_{0.8}$ to $C_{0.95}$





$$\frac{c_{Ac0.95}}{c_{Ac0.8}} = \frac{R_{Ac0.8} - R_{clr}}{R_{Ac0.95} - R_{clr}}$$

$c_{0.95} = c_{0.8}\,(a+bx+cx^2+dx^3)$

x: surface albedo