$F = F_0 + \Delta F$ Global energy budget, flux integer tables and the greenhouse effect of clouds $F_0 = N \times UNIT$

GREENHOUSE METRICS UNITS

G(all) – G(clear)	= OLR(clear) – OLR(all)	= LWCRE	≡ 1 UNIT = 26.68 Wm^{-2}	⇨ ULW = 15	OLR(clear) = 10	G(clear) = 5
G(cloudy) – G(clear)	= OLR(clear) – OLR(cloudy)	= LWCRE / β_0	≡ 1 UNIT = 44.47 Wm^{-2}	⇨ ULW = 9	OLR(clear) = 6	G(clear) = 3
1 / f_0(all) = 1 ;	1 / f_0(clear) = 1	= STI(clear)	≡ 1 UNIT = 66.70 Wm^{-2}	⇨ ULW = 6	OLR(clear) = 4	G(clear) = 2

Integer tables of Earth's energy flows. F_0 values in unit flux:

F_0 RELATIONSHIPS

• E(SFC, all) = 2OLR(all) + LWCRE = OLR(all) + OLR(clear)

E(SFC, cloudy) = OLR(cloudy) + OLR(clear)

E(SFC, clear) = 2OLR(clear)

• Solar absorbed by surface serves the energy content of the all-sky greenhouse effect.

• The cloud-covered part of the surface radiates as much energy as in the outgoing longwave radiation: ULW × β_{eff} = OLR(all)

• 'Cooling to space':

All-sky: LWQ + CTS(atm) = 0, LWQ + CTS(all) = LWCRE.

Cloudy sky: β_{eff} × [LWQ + CTS(atm, cloudy)] = –LWCRE /5

Clear-sky: (1 – β_{eff}) × [LWQ + CTS(clear)] = LWCRE / 5

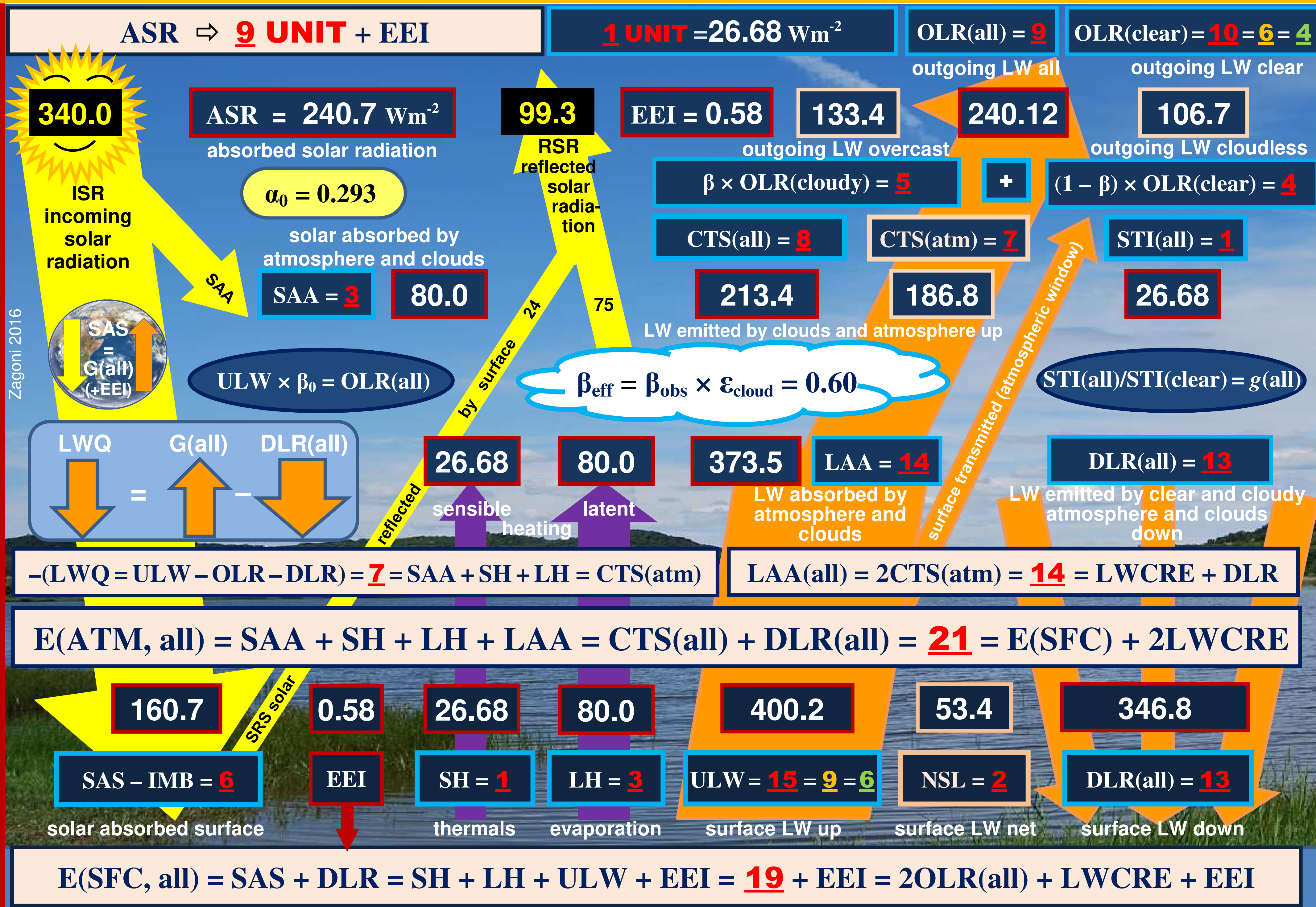
• The effective LW-opaque single-layer cloud area fraction is equal to the all-sky transfer function, β_{eff} = f_0(all), and f_0(all) × f_0(clear) = g_0(all).

• From a surface perspective, the energy being lost in the all-sky atmospheric window is gained back by the greenhouse effct of clouds: LWCRE = STI(all) = (1 – β_{eff}) × STI(clear).

• A 'grid' albedo position = $\alpha_0 = 1 - \sin 45° = 1 - \sqrt{2}/2$

• F observed data ⇨

• Their sources ⇨



OLR(clear) = 266.8

CTS(clear) = 200.1

STI(clear) = 66.7

CTS(clear)/ULW=1/2

STI(clear)/ULW=1/6

G ≡ ULW – OLR

G(clear) = 133.4

G(all) = 160.1

G(clear) = 5 = 3 = 2

G(all) = 6

g ≡ G / ULW
f ≡ OLR / ULW

g_0(clear) = 1/3

g_0(all) = 2/5

f_0(clear) = 2/3

f_0(all) = 3/5

f_0(all) = β_{eff}

ALL-SKY = 26.68 Wm^{-2}

STI(all)	= 1	= 26.68
LWCRE	= 1	= 26.68
SH	= 1	= 26.68
NSL(all)	= 2	= 53.4
LH	= 3	= 80.0
SAA(all)	= 3	= 80.0
G(clear)	= 5	= 133.4
G(all)	= 6	= 160.1
SAS(all)	= 6	= 160.1
–LWQ	= 7	= 186.8
CTS(atm)	= 7	= 186.8
CTS(all)	= 8	= 213.4
OLR(all)	= 9	= 240.1
OLR(clear)	= 10	= 266.8
DLR(clear)	= 12	= 320.2
DLR(all)	= 13	= 346.8
LAA(all)	= 14	= 373.5
ULW	= 15	= 400.2

CLOUDY = 44.47 Wm^{-2}

STI(cloudy)	= 0	
LWCRE / β_{eff}	= 1	= 44.47
(SH+LH)(cloudy)	= 2	= 88.94
G(clear)	= 3	= 133.4
G(cloudy)	= 4	= 177.9
CTS(atm, cloudy)	= 4	= 177.9
CTS(all, cloudy)	= 5	= 222.3
OLR(cloudy)	= 5	= 222.3
OLR(clear)	= 6	= 266.8
LAA(cloudy)	= 9	= 400.2
ULW	= 9	= 400.2

CLEAR-SKY = 66.7 Wm^{-2}

STI(clear)	= 1	= 66.7
(SH + LH)(clear)	= 2	= 133.4
G(clear)	= 2	= 133.4
CTS(clear)	= 3	= 200.1
OLR(clear)	= 4	= 266.8
LAA(clear)	= 5	= 333.5
ULW	= 6	= 400.2

CLEAR-SKY WEIGHTED CONTRIBUTION
f(clear) = OLR(clear) / ULW = 2/3 ⇨ STI(clear) = 1; G(clear) = 2; CTS(clear) = 3; OLR(clear) = 4; LAA(clear) = 5; ULW = 6
(1–β) × G(clear) = 2; (1–β) × CTS(clear) = 3; (1–β)×OLR(clear) = 4; (1–β) × LAA(clear)=G(clear) = 5 ; (1 – β) × ULW = G(all) = 6
LWQ + CTS(clear) = LWCRE / 2 = + 13.3 Wm^{-2}; (1–β) × [LWQ + CTS(clear)] = LWCRE / 5 = 1 / 5 = + 5.34 Wm^{-2}

CLOUDY WEIGHTED CONTRIBUTION
f(cloudy) = OLR(cloudy)/ULW = 5/9 ⇨ G(clear) = 3; CTS(atm, cloudy)= G(cloudy)= 4; OLR(cloudy)= 5; OLR(clear)= 6; ULW = 9
β × G(cloudy) = 4 ; β × CTS(atm, cloudy) = 4 ; β × OLR(cloudy) = 5 ; β × LAA(cloudy) = OLR(all) = 9 ; β × ULW = OLR(all) = 9
LWQ + CTS(atm, cloudy) = – LWCRE / 3 = – 8.86 Wm^{-2}; β × [LWQ + CTS(atm, cloudy)] = – LWCRE / 5 = – 1 / 5 = – 5.34 Wm^{-2}

LWQ = – 186.8 ± 6 SAS = 160.1 ± 5	SH = 25 ± 4 LH = 81 ± 4	ULW = 398.3 ± 4 Net SFC LW = 53.4 ±5 OLR(all) = 240.1 ± 2 OLR(clear) =268.1 ± 3	DLR = 345.0 ± 5 STI(clear) = 66 ± 2	β_{eff} = 0.58 ± 0.02 g(clear) = 1/3
CERES EBAF Ed4.0 Wild et al. (2015)	L'Ecuyer et al. (2015)	CERES EBAF Ed4.0 Wild et al. (2015)	CERES EBAF Ed4.0 Costa and Shine (2012)	CERES SYN1deg Ed4 Ramanathan (2006)

ΔF < ± 1σ