# Earth's Global Mean Energy Flow System Derived from a Simple Greenhouse Model Using Total Solar Irradiance as a Single Input Parameter

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## A Sun-Climate Symposium

*The Sun*:

– I give you a TSI. What would you do with it?

*The Climate*:

– I would call it **17**. Then I'd reflect **5** and absorb **12**. I would do it already on the intercepting cross-section disk. Then I would divide the absorbed **12** by four for spherical weighting. From this **3** I would create **5** terrestrial upward emission at the lower boundary and evidently **3** outgoing emission at the upper boundary.

*The Sun*:

– How do you know that your numbers are correct?

*The Climate*:

– I look at the CERES (Loeb 2015 Sun-Climate Symposium) energy flow estimate and I can see that albedo $\alpha_p$ = 100/340, identical to my 5/17.
I can also see there that the planetary emissivity (TOA LW up / SFC LW up) $\varepsilon_p$ = 240/398 = 0.603, while my 3/5 = 0.6. GEWEX (BAMS 2023) is similar.

*The Sun*:

– Okay, but how do you know how much energy I give you in my TSI?

*The Climate*:

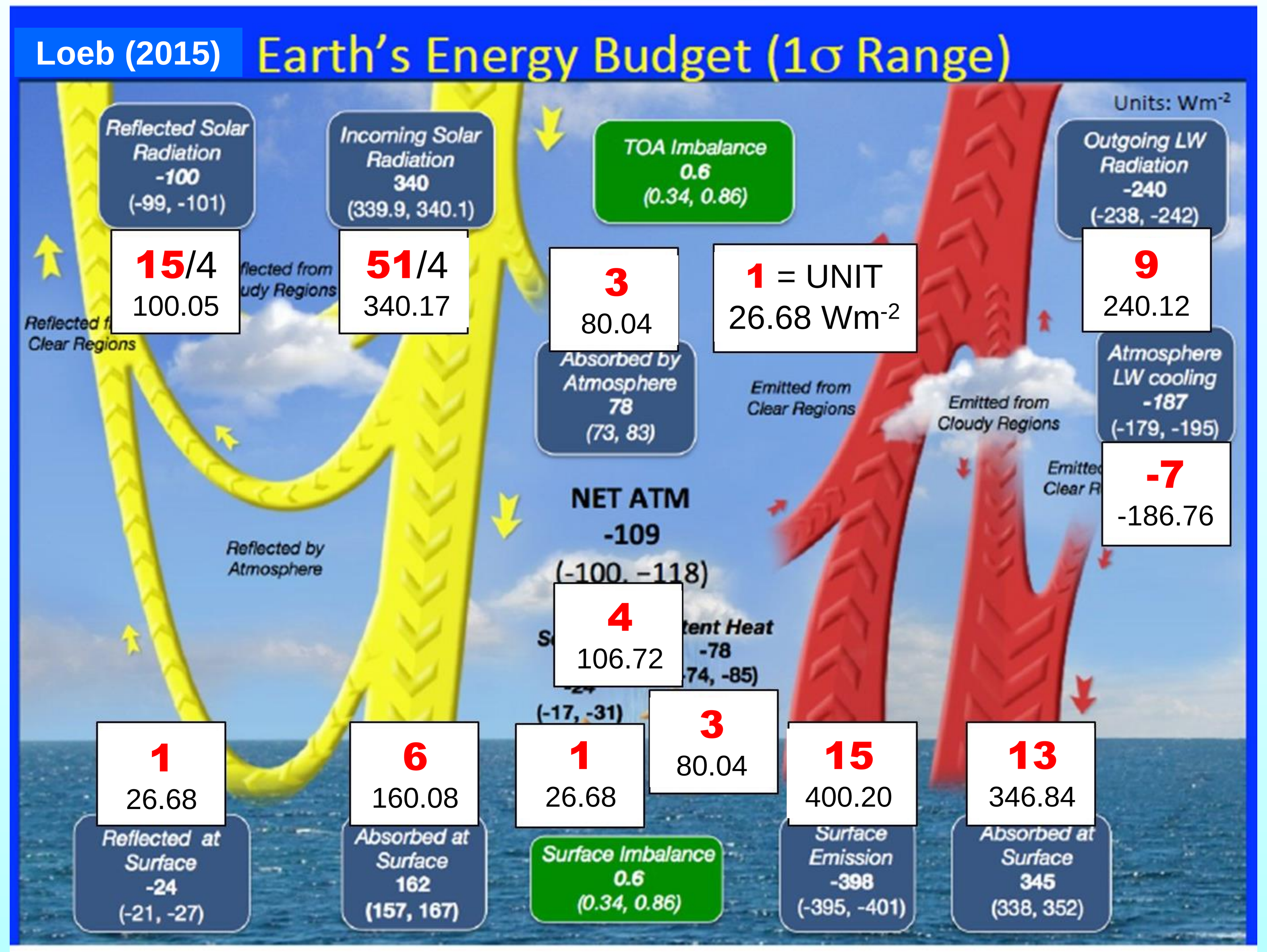
– It is easy. I look into data products and I can see that my **3** (TOA LW Up; OLR) is 240.12 $Wm^{-2}$, and my **5** (Surface LW Up, ULW) is around 400.20 $Wm^{-2}$ in their estimates. From this I know that my **1** is 80.04 $Wm^{-2}$, so you have given me **17** = 1360.68 $Wm^{-2}$, if I count with spherical weighting.
But if I use their geodetical weighting factor of 4.0034, then I know that you gave me TSI = 1361.84 $Wm^{-2}$.

*The Sun*:

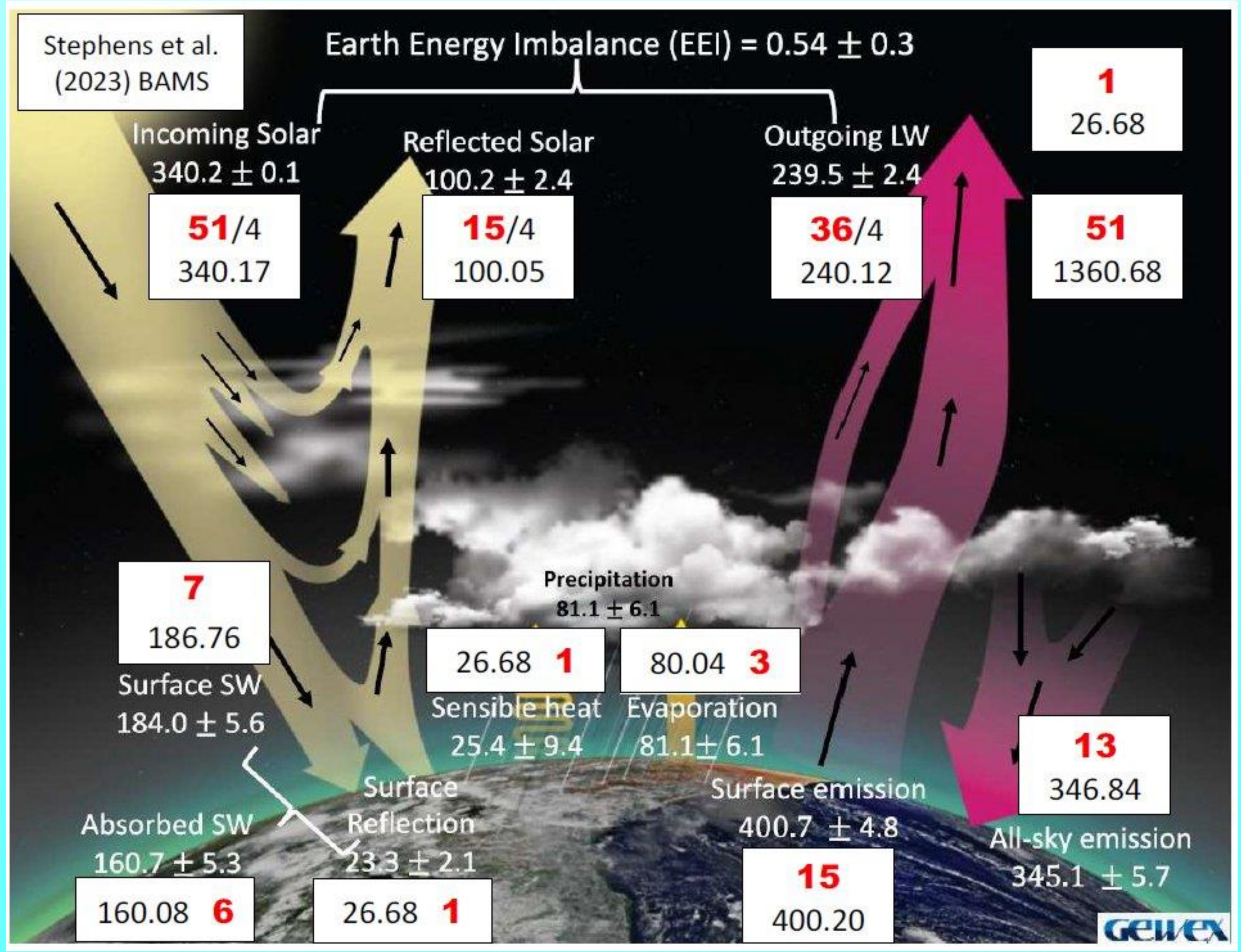
– Gee, really, I give you exactly this amount of energy in TSI.

*The Climate*:

– And for your pleasure, I then break my **1** into three "climate quarks", **1** = **3** = 26.68 $Wm^{-2}$, and I show you that the global mean energy flow components (clear-sky and all-sky, shortwave and longwave, at the TOA, within the atmosphere and at the surface, even the non-radiative energy fluxes separately (latent and sensible heat) can be expressed in these units, within the stated range of uncertainty of the observations.

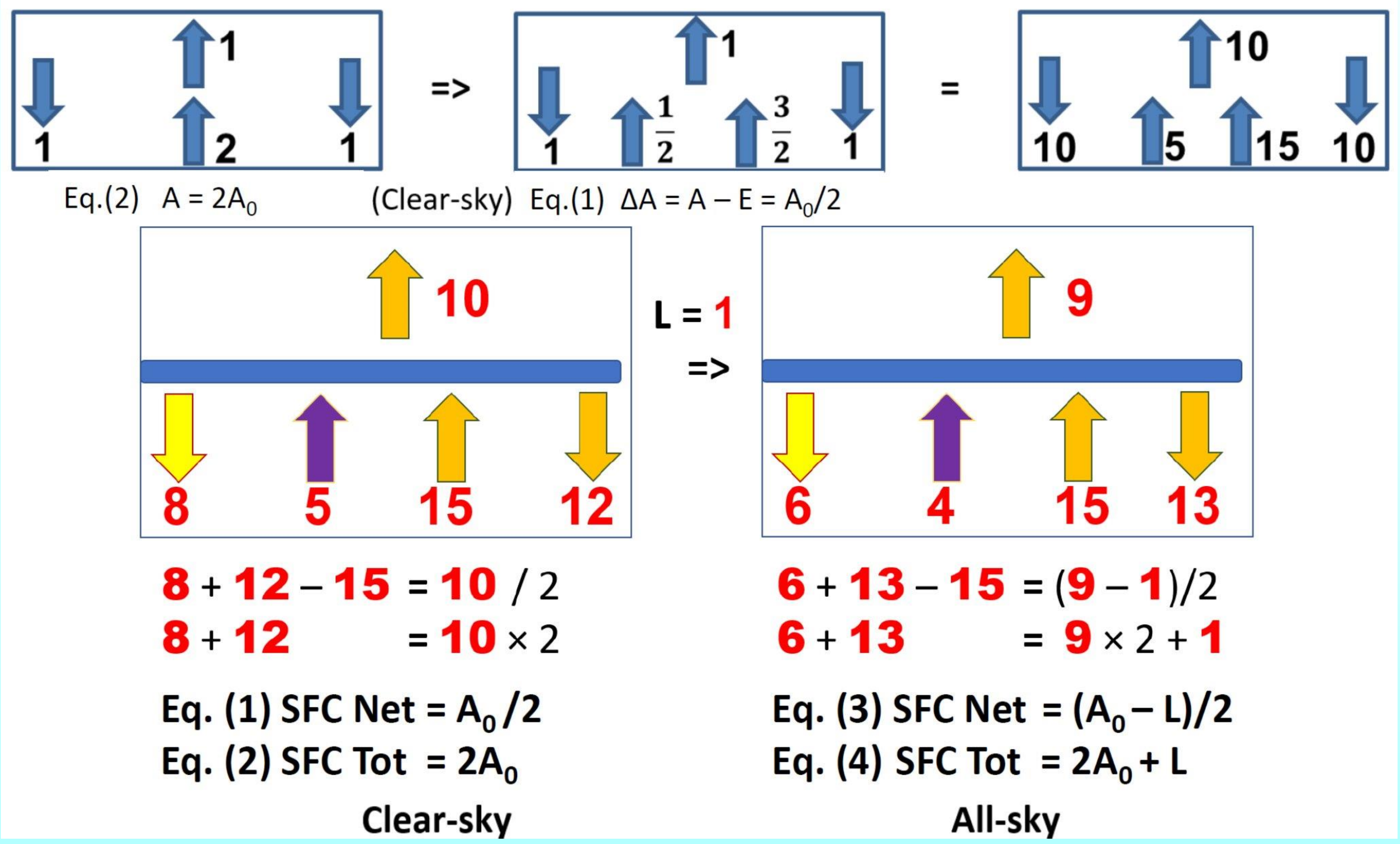



CERES (Loeb 2015 SCS), $\alpha_p$ = 100/340 = 5/17, $\varepsilon_p$ = 240/398 = 0.60




GEWEX (Stephen et al. BAMS 2023)

## Geometric deduction of the Ns




Four equations: two clear-sky identical to Schwarzschild's (1906, Eq.11); and two all-sky version.
Pure geometry, no atmospheric composition, GHGs or lapse rate was assumed.

Table 2-1. Theory vs CERES observation for global mean clear-sky fluxes for April 2000-March 2022 (W $m^{-2}$)

| | Clear-sky | N | N × Unit | EBAF Ed4.2 | Difference |
|---|---|---|---|---|---|
| Clear-Sky TOA | SW insolation | 51/4 | 340.17 | 340.18 | 0.01 |
| | LW | 40/4 | 266.80 | 266.13 | -0.67 |
| | SW | 8/4 | 53.36 | 53.76 | 0.40 |
| | Net | 3/4 | 20.01 | 20.29 | 0.28 |
| Clear-sky Surface | LW down | 12 | 320.16 | 317.86 | -2.30 |
| | LW up | 15 | 400.20 | 398.61 | -1.59 |
| | LW Net | -3 | -80.04 | -80.75 | -0.71 |
| | SW Net | 8 | 213.44 | 211.41 | -2.03 |
| | SW + LW Net | 5 | 133.40 | 130.66 | -2.74 |

Table 4-1. Theory vs observation for global mean TOA and surface fluxes and CREs for CERES EBAF Edition 4.2 for April 2000 to March 2022 (W $m^{-2}$).

| | All-sky | N | N × Unit | EBAF Ed4.2 | Diff |
|---|---|---|---|---|---|
| TOA | SW insolation | 51/4 | 340.17 | 340.18 | 0.01 |
| | SW up | 15/4 | 100.05 | 99.05 | -1.00 |
| | LW up | 36/4 | 240.12 | 240.33 | 0.21 |
| | TOT Net | 0 | 0 | 0.8 | 0.80 |
| Surface | SW Net | 6 | 160.08 | 163.65 | 3.57 |
| | LW down | 13 | 346.84 | 346.11 | -0.73 |
| | LW up | 15 | 400.20 | 398.42 | -1.78 |
| | LW Net | -2 | -53.36 | -52.31 | 1.05 |
| | TOT Net | 4 | 106.72 | 111.34 | 4.62 |
| | CRE | | | | |
| TOA | SW | -7/4 | -46.69 | -45.28 | 1.41 |
| | LW | 1 | 26.68 | 25.80 | -0.88 |
| | Net | -3/4 | -20.01 | -19.48 | 0.53 |

For further details: radiative transfer equations, arithmetic solution, geometric deduction, explantions, interpretations, AMS, AGU and CERES presentations, please visit my website

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