The stable stationary value of the Earth's global average atmospheric infrared optical thickness

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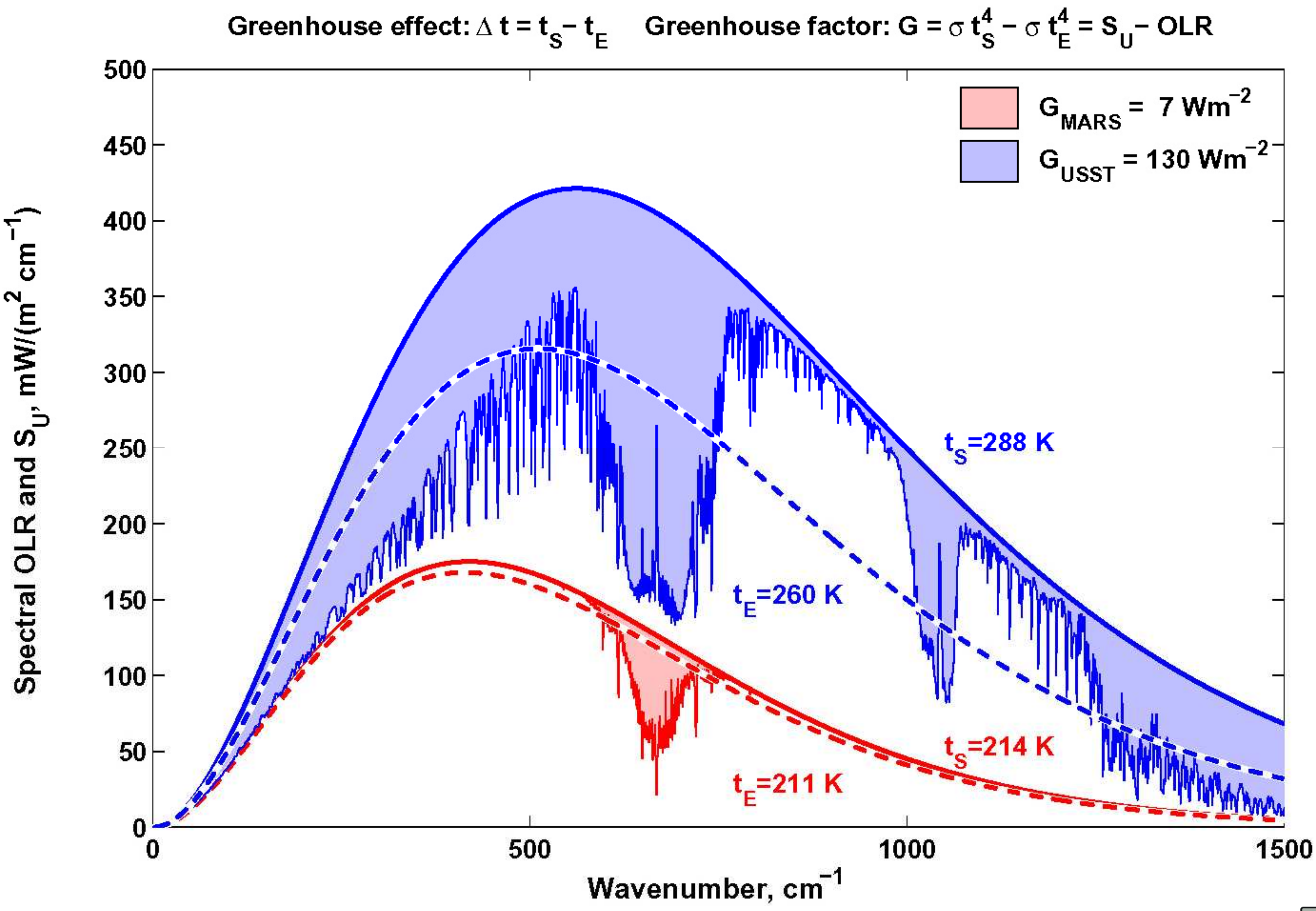
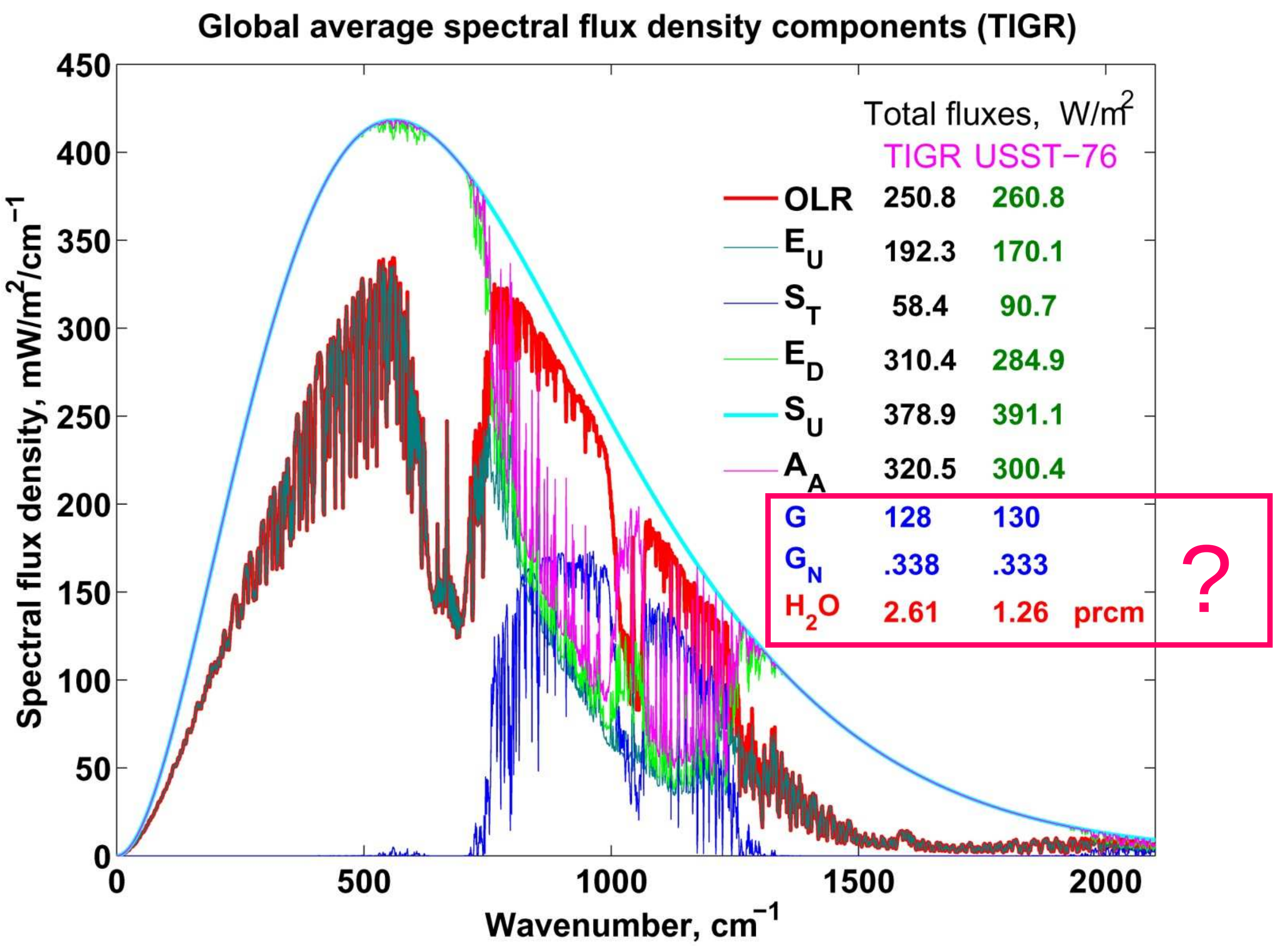
PLANETARY GREENHOUSE EFFECT LINKED TO ATMOSPHERIC IR ABSORPTION

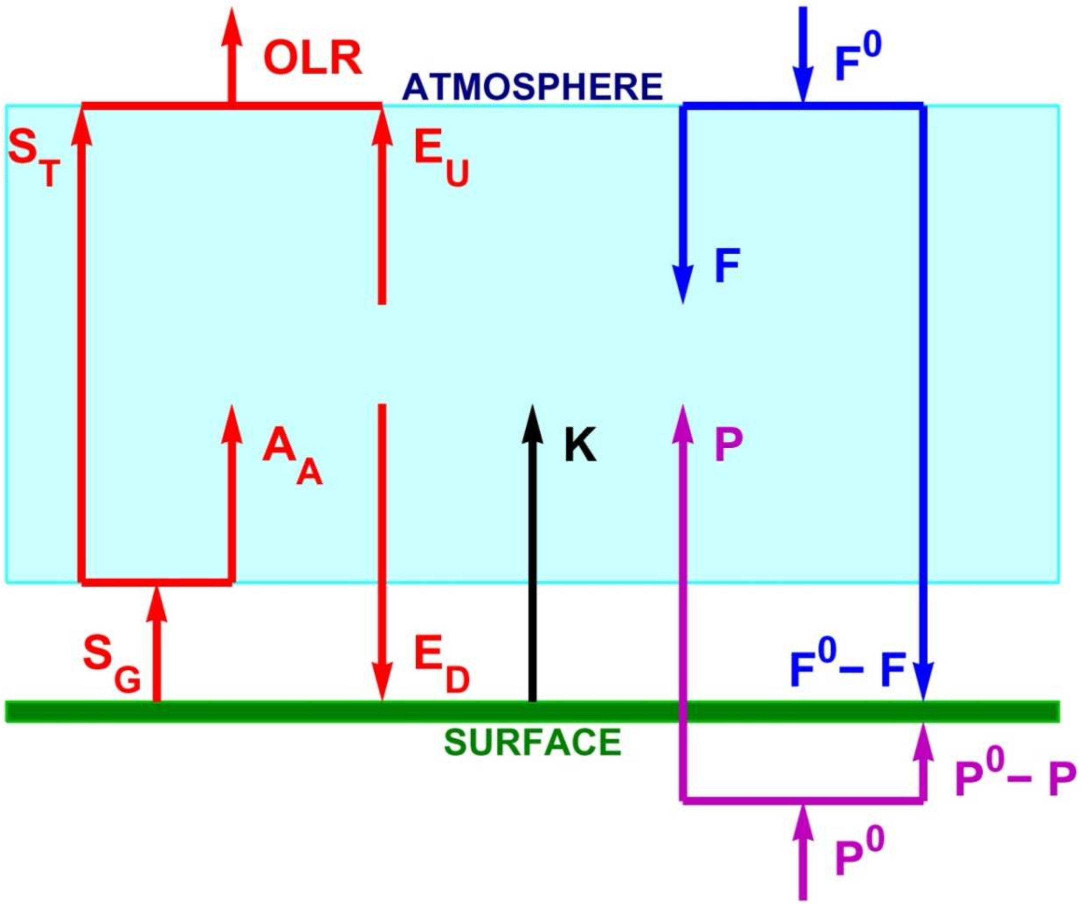


THE $G = S_U - OLR$ GREENHOUSE FACTOR IS NOT THE DIRECT MEASURE OF ATMOSPHERIC IR ABSORPTION



NEED TO QUANTIFY THE ROLE OF THE GHG's IN GLOBAL WARMING

CLEAR-SKY RADIATIVE TRANSFER MODEL



Greenhouse effect:

$G = S_G - OLR$

$G_N = G / S_G$

All-sky measurements:

$S_G = 391\ Wm^{-2}$

$OLR = 235\ Wm^{-2}$

$G_N \sim 0.4$

QUESTIONS:

What is the mechanism of the greenhouse effect ?

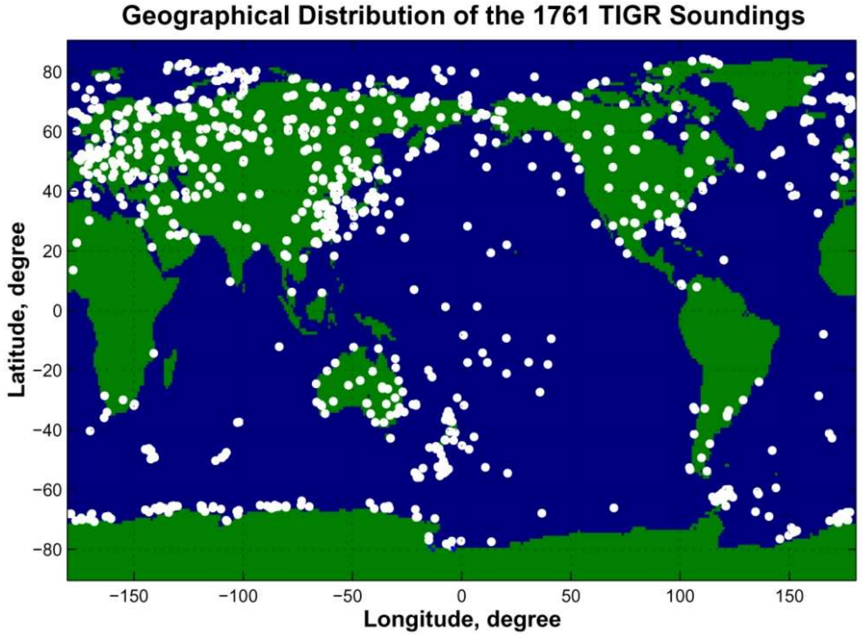
What are the theoretical relationships among the global average IR flux density terms ?

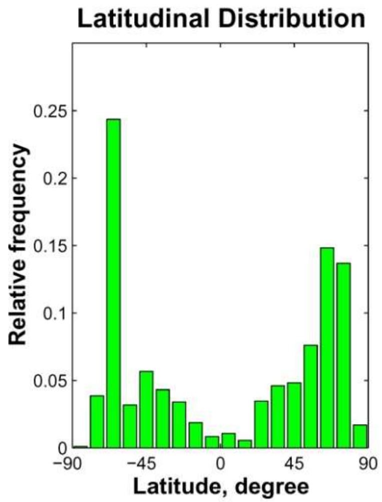
NET ATMOSPHERE: (1) $F + P + K + A_A - E_D - E_U = 0$

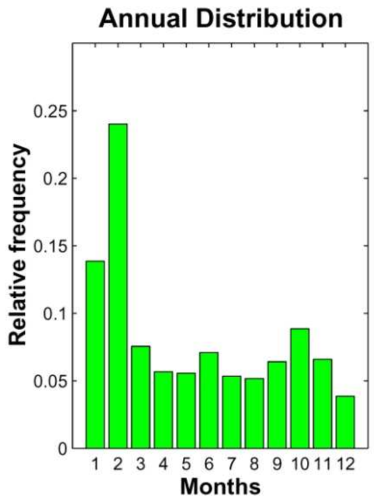
NET SURFACE : (2) $F^0 + P^0 + E_D - F - P - K - A_A - S_T = 0$

(3) $F^0 + P^0 = OLR$

GLOBAL SCALE LBL SIMULATIONS







INPUT DATA SET

RADIOSONDE OBSERVATIONS ARE FROM A SUB-SET OF THE TIGR COMPILATION

(A. Chedin and N. Scott 1983)

PROCESSING LBL CODE

High-resolution atmospheric radiative transfer code HARTCODE

(F. Miskolczi, M. Bonzagni and R. Guzzi, 1990)

SPECTROSCOPIC DATA SET

HITRAN 2K

(http://cfa-www.Harvard.edu/HITRAN/hitrandata)

TRUE INFRARED FLUX OPTICAL THICKNESS

$$S_T = S_U \exp(-\tau_A)$$

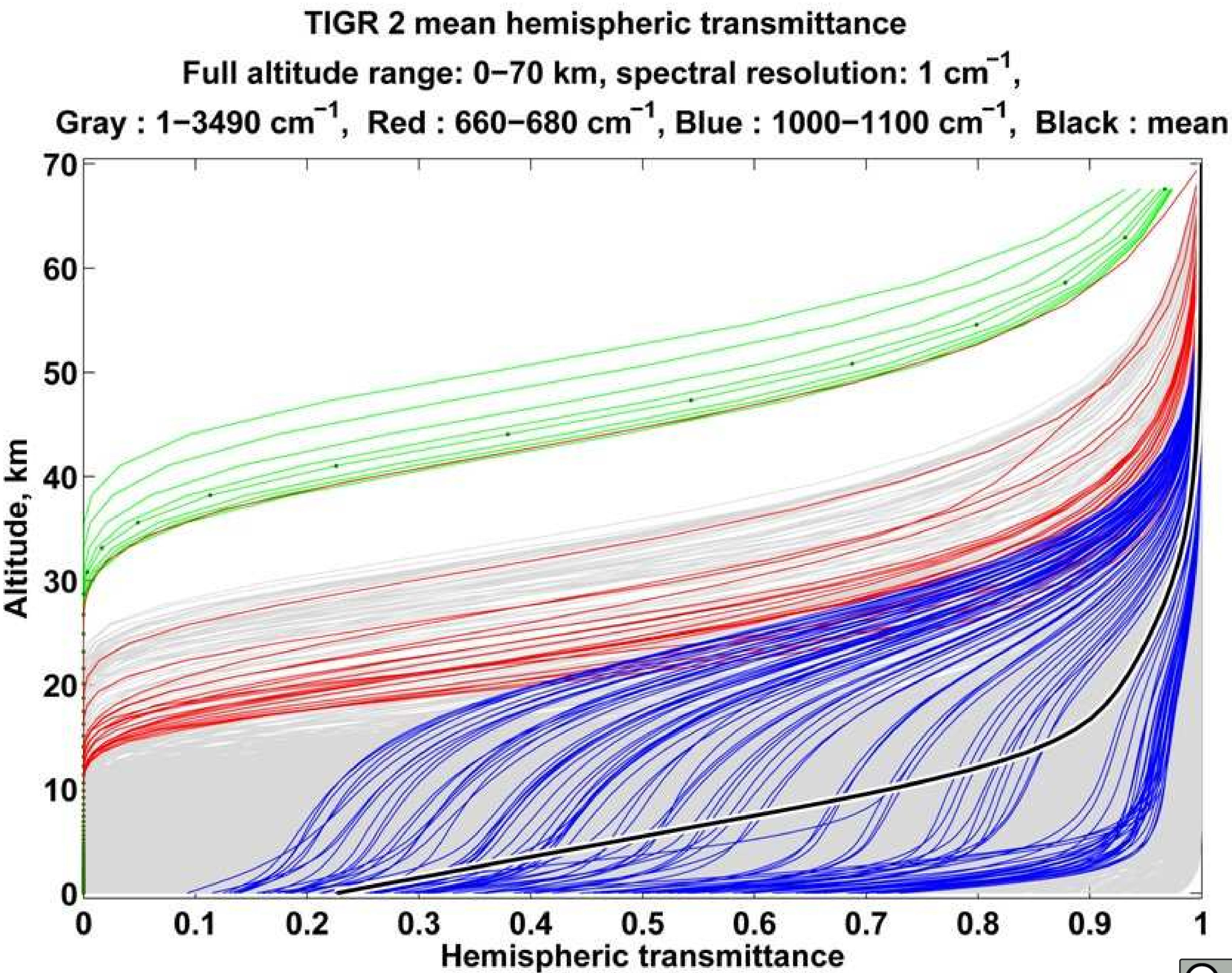
$$\tau_A = -\ln\left[\frac{1}{\sigma t_A^4}\sum_{j=1}^{M}\pi B(\Delta\nu_j, t_A)\sum_{k=1}^{K} w^k\, T_A(\Delta\nu_j, \mu^k)\right]$$

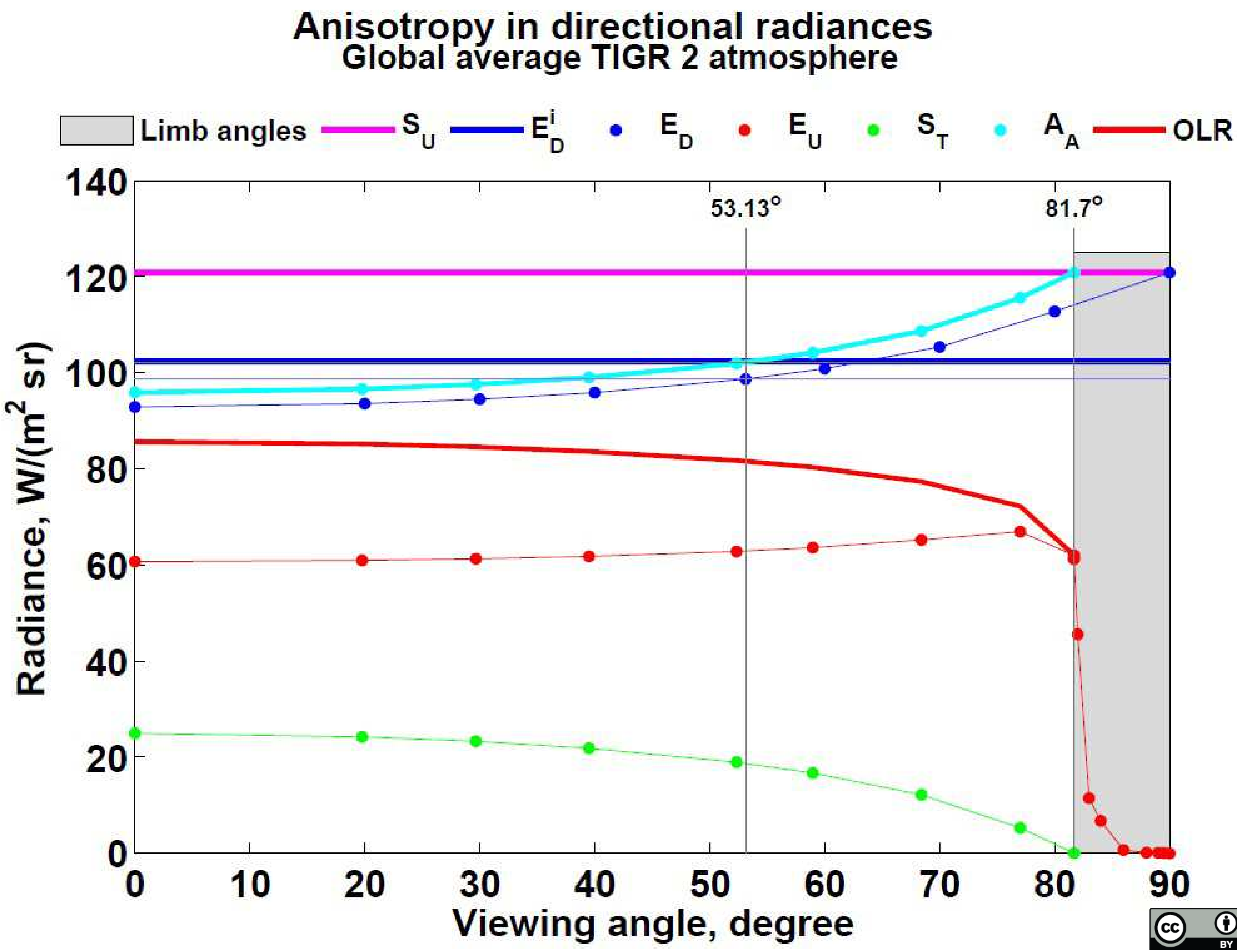
$$T_A(\Delta\nu_j, \mu^k) = \frac{1}{\Delta\nu_j}\int_{\Delta\nu_j}\exp\left[-\sum_{l=1}^{L}\sum_{i=1}^{N}\left[c^{i,l} + k_\nu^{i,l}\right]\frac{u^{i,l}}{\mu^{l,k}}\right]d\nu$$

M=3490 is the total number of spectral intervals, ***K=9*** is the total number of streams, w^k is the hemispheric integration weight associated with the k-th direction (stream), T_A is the directional mean transmittance over a suitable short wave number interval,

$$\mu^{l,k} = \cos(\theta^{l,k}) / dz^l$$

$\theta^{l,k}$ is the local zenith angle of a path segment, dz^l is the vertical layer thickness, ***N=11*** is the total number of major absorbing molecular species, ***L=150*** is the total number of layers. $u^{i,l}$, $c^{i,l}$ and $k^{i,l}$ are the absorber amounts, and the continuum and line type absorption coefficients.


TIGR 2 mean hemispheric transmittance
Full altitude range: 0−70 km, spectral resolution: 1 cm^{-1},
Gray : 1−3490 cm^{-1}, Red : 660−680 cm^{-1}, Blue : 1000−1100 cm^{-1}, Black : mean
Altitude, km
Hemispheric transmittance
0
10
20
30
40
50
60
70
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1



Anisotropy in directional radiances
Global average TIGR 2 atmosphere
Limb angles
S_U
E_D^i
E_D
E_U
S_T
A_A
OLR
53.13°
81.7°
Radiance, W/(m^2 sr)
Viewing angle, degree
0
10
20
30
40
50
60
70
80
90
140
120
100
80
60
40
20
0

TIGR2 SIMULATION RESULTS

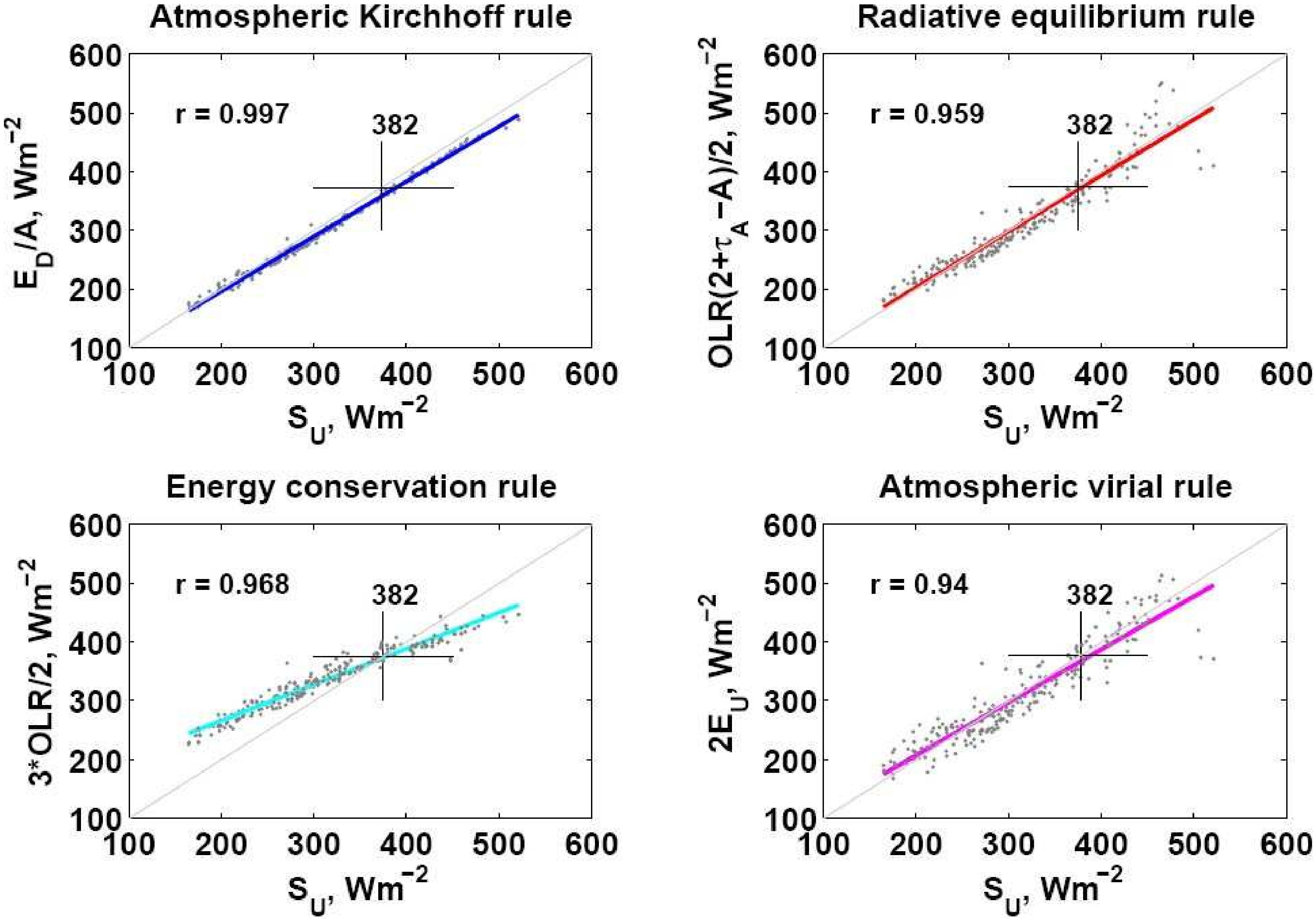
Quantity	Minimum	Maximum	Global Average	GAT
t_A	232.25	309.62	285.34	286.04
S_U	164.98	521.10	381.88	379.64
u	0.0507	6.836	2.533	2.637
E_U	83.74	256.71	188.94	192.7
E_D	103.35	429.69	308.70	310.49
T_A	0.0497150	0.391204	0.173344	0.15422
$S_T = S_U T_A$	22.246	111.92	61.094	58.54
$OLR = E_U + S_T$	150.64	297.62	250.05	251.25
$\tau_A = -\ln(T_A)$	0.9385	3.0014	1.8736	1.8693

t_A : K; S_U, E_U, E_D, S_T, OLR : Wm^{-2}; u : prcm; T_A, τ_A : dimensionless

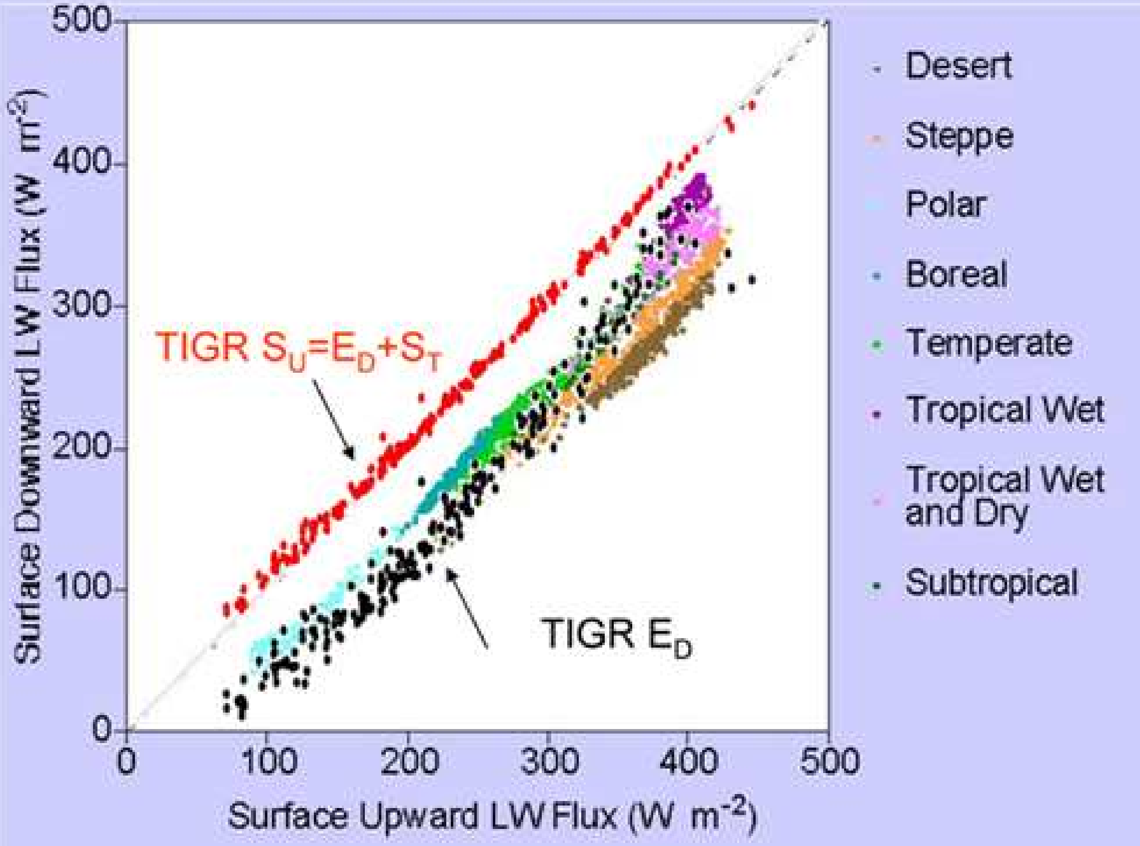
GAT : global average TIGR2 profile

EMPIRICAL FACTS

IR radiative structure of the atmosphere from TIGR2



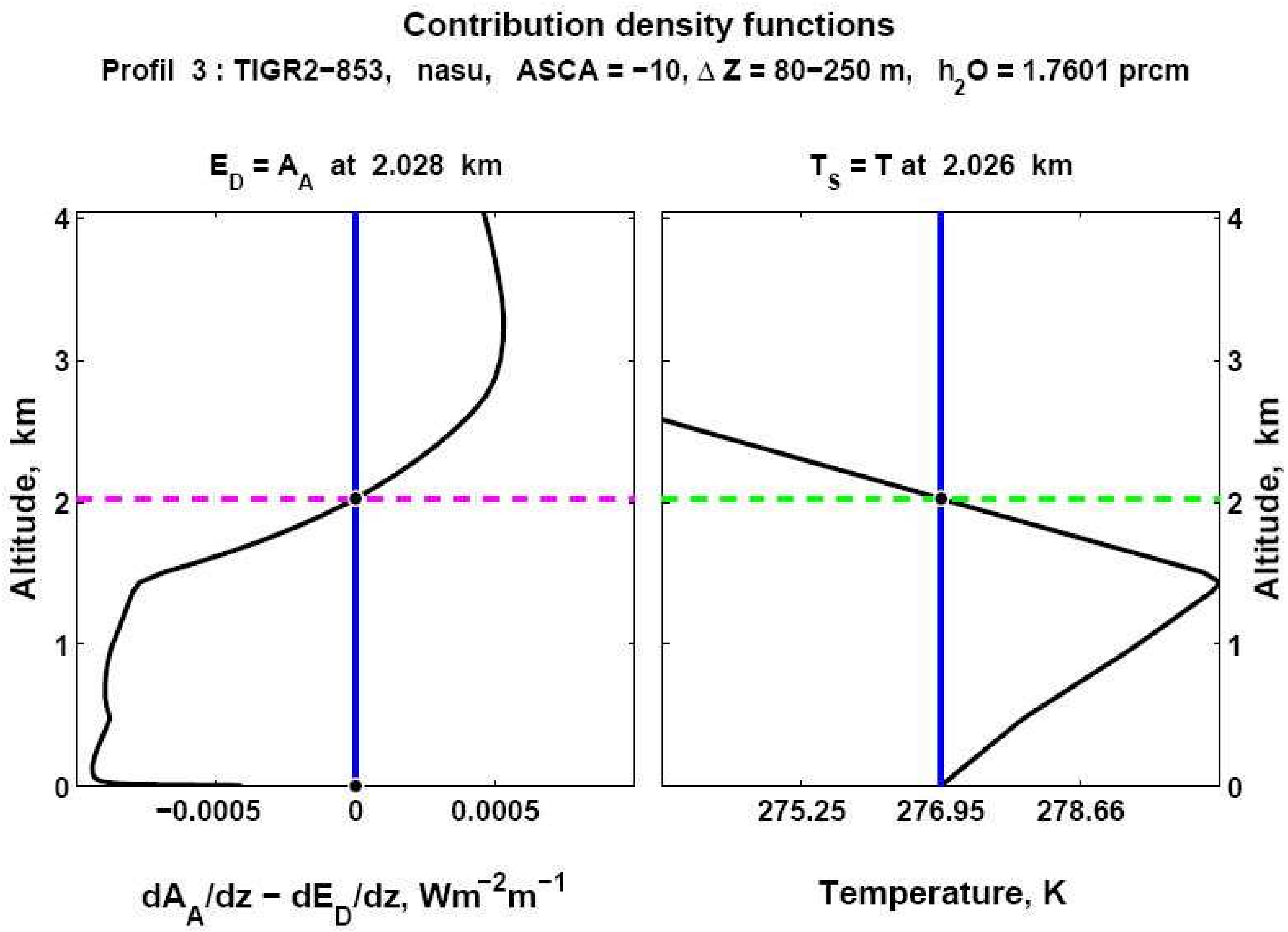
SATELLITE OBSERVATVATIONS ARE CONSISTENT WITH THE ATMOSPHERIC RADIATIVE EXCHANGE EQUILIBRIUM RULE



Annual Mean Downward Longwave Flux as Function of Mean Upward Flux Separated by Climate Type for Land

From: Longwave Surface Radiation and Climate; Lou Smith, Anne Wilber, David Kratz, Shashi Gupta and Paul Stackhouse, NASA LARC

KIRCHHOFF LAW AND RADIATIVE EXCHANGE EQUILIBRIUM



THEORETICAL CONSIDERATIONS

$$A_A = E_D \qquad S_U = 2E_U$$

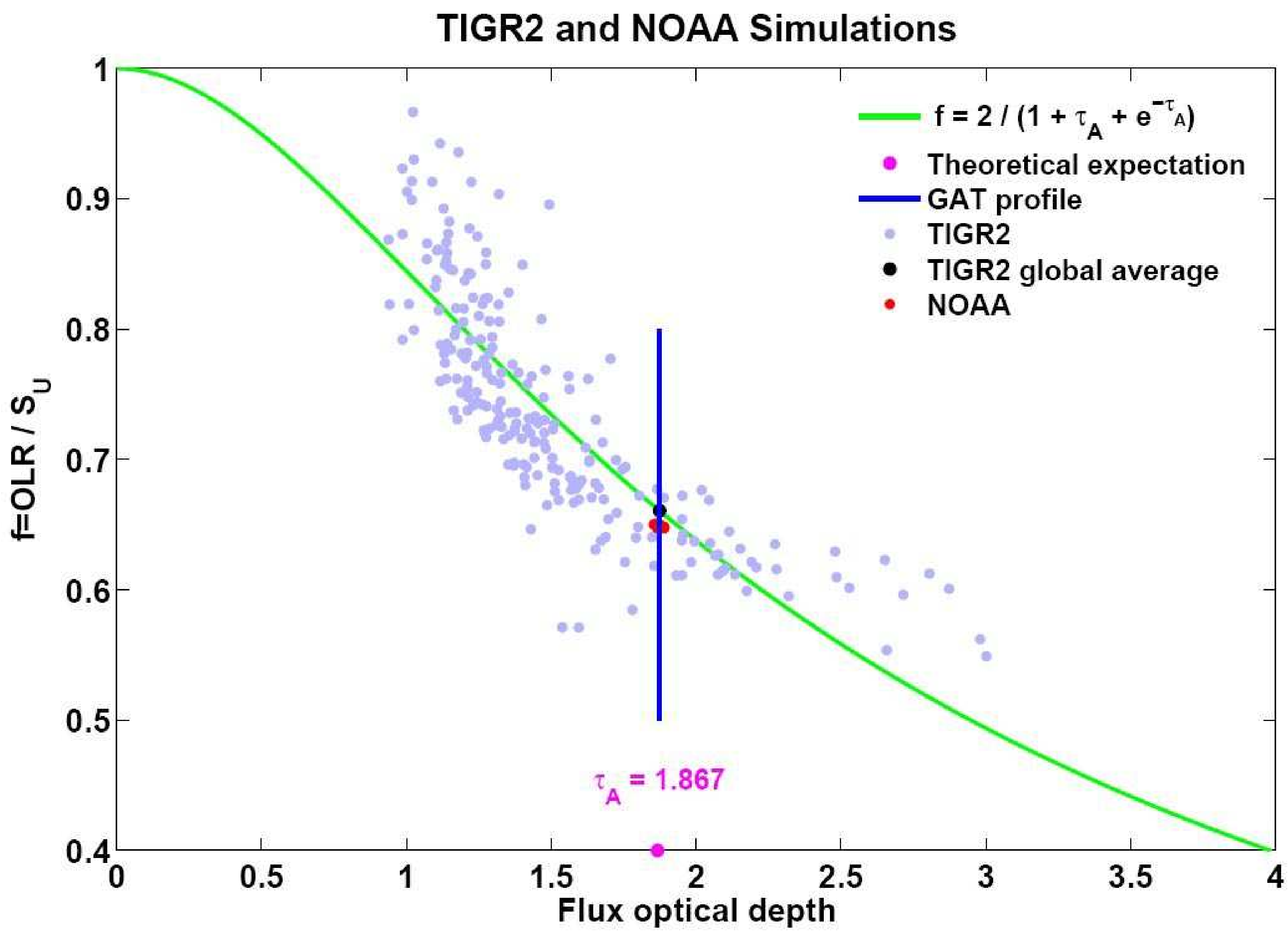
$$S_U = \frac{3}{2} OLR \qquad S_U = \frac{OLR}{f}$$

$$f = 2/(2 + \tau - A) \qquad OLR = E_U + S_T$$

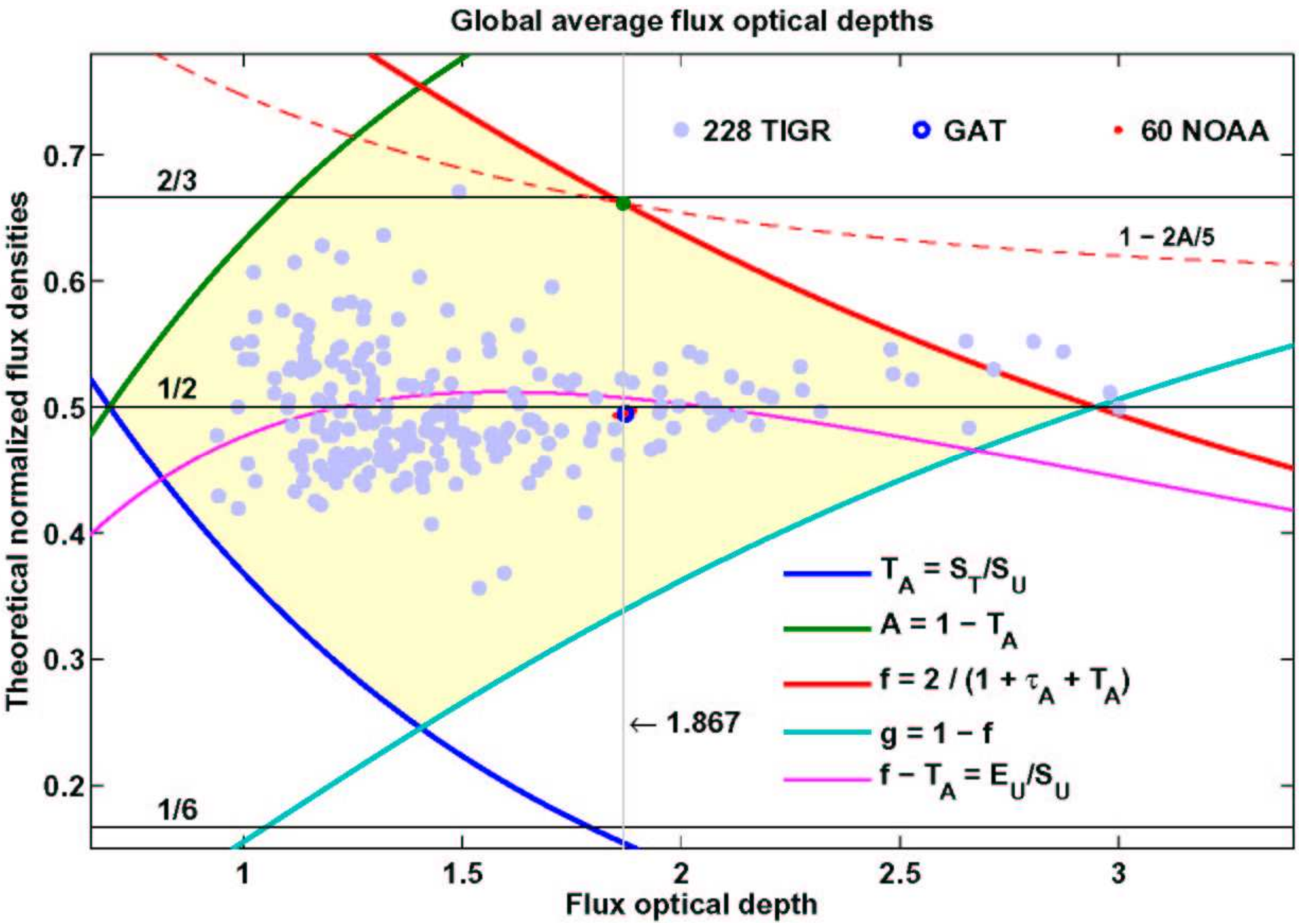
$$A_A = S_U(1 - \exp(-\tau_A))$$

SIMULTANEOUS SOLUTION OF THE FOUR EQUATIONS:

$$g = 1 - f = \frac{2A}{5} \qquad \rightarrow \qquad \boxed{\tau_A = 1.867}$$


TIGR2 and NOAA Simulations
f = 2 / (1 + τA + e^-τA)
Theoretical expectation
GAT profile
TIGR2
TIGR2 global average
NOAA
τA = 1.867
f=OLR / SU
Flux optical depth
1
0.9
0.8
0.7
0.6
0.5
0.4
0
0.5
1
1.5
2
2.5
3
3.5
4

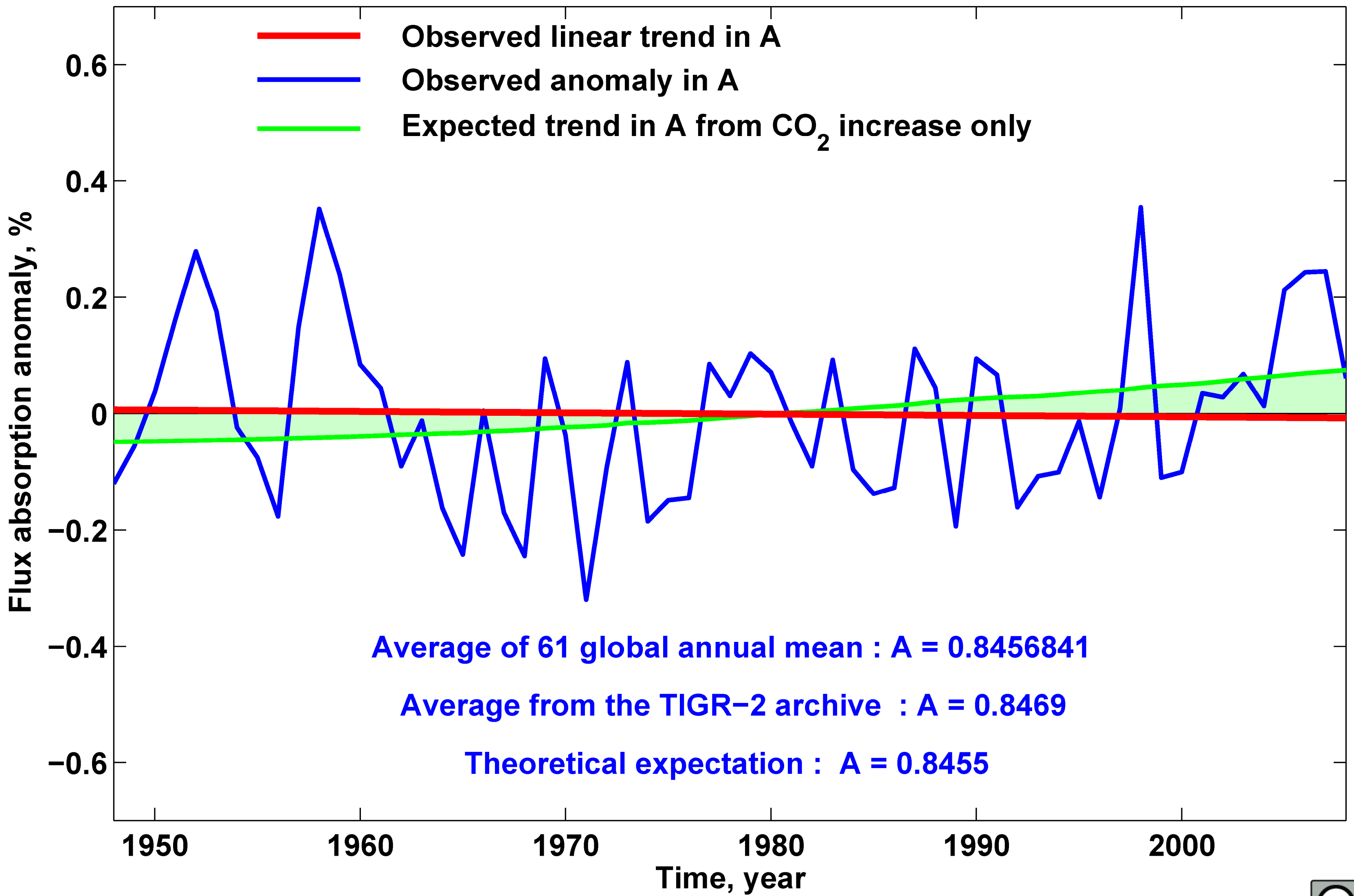
TRANSMITTANCE, ABSORPTION, TRANSFER AND GREENHOUSE FUNCTIONS



Linear trends in the flux absorption between 1948 and 2008, $A = 1 - e^{-\tau}$

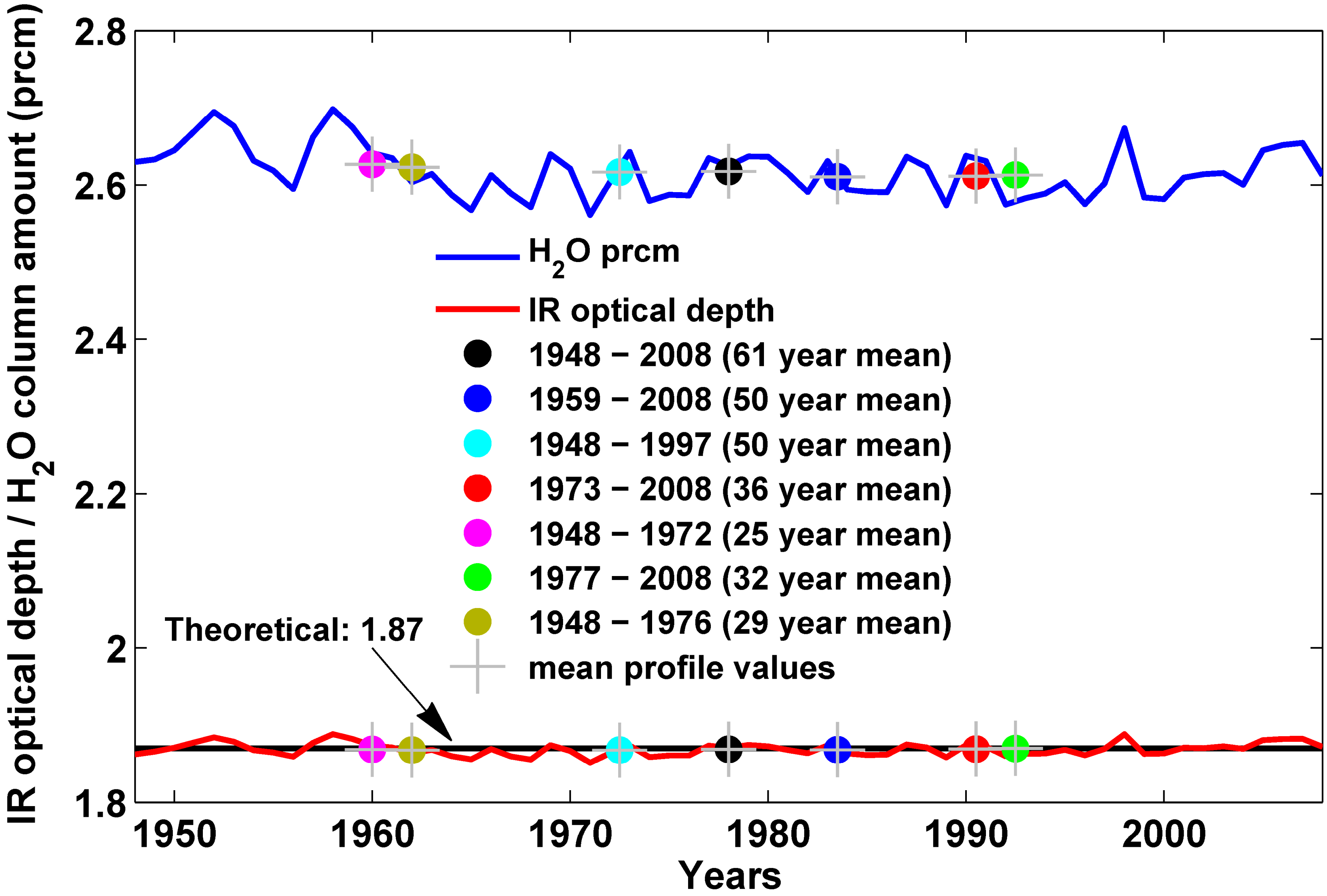
NCEP/NCAR R1 Reanalysis data from http://www.cdc.noaa.gov

Global mean IR absorption does not follow the CO_2 increase



Greenhouse effect and the 21.6 % increase of CO_2 in the last 61 years are unrelated
Atmospheric H_2O does but CO_2 does not correlate with the IR optical depth

7 different NOAA annual mean time series − NCEP/NCAR R1



NOAA NCEP/NCAR R1
Trendline correlation coefficient summary

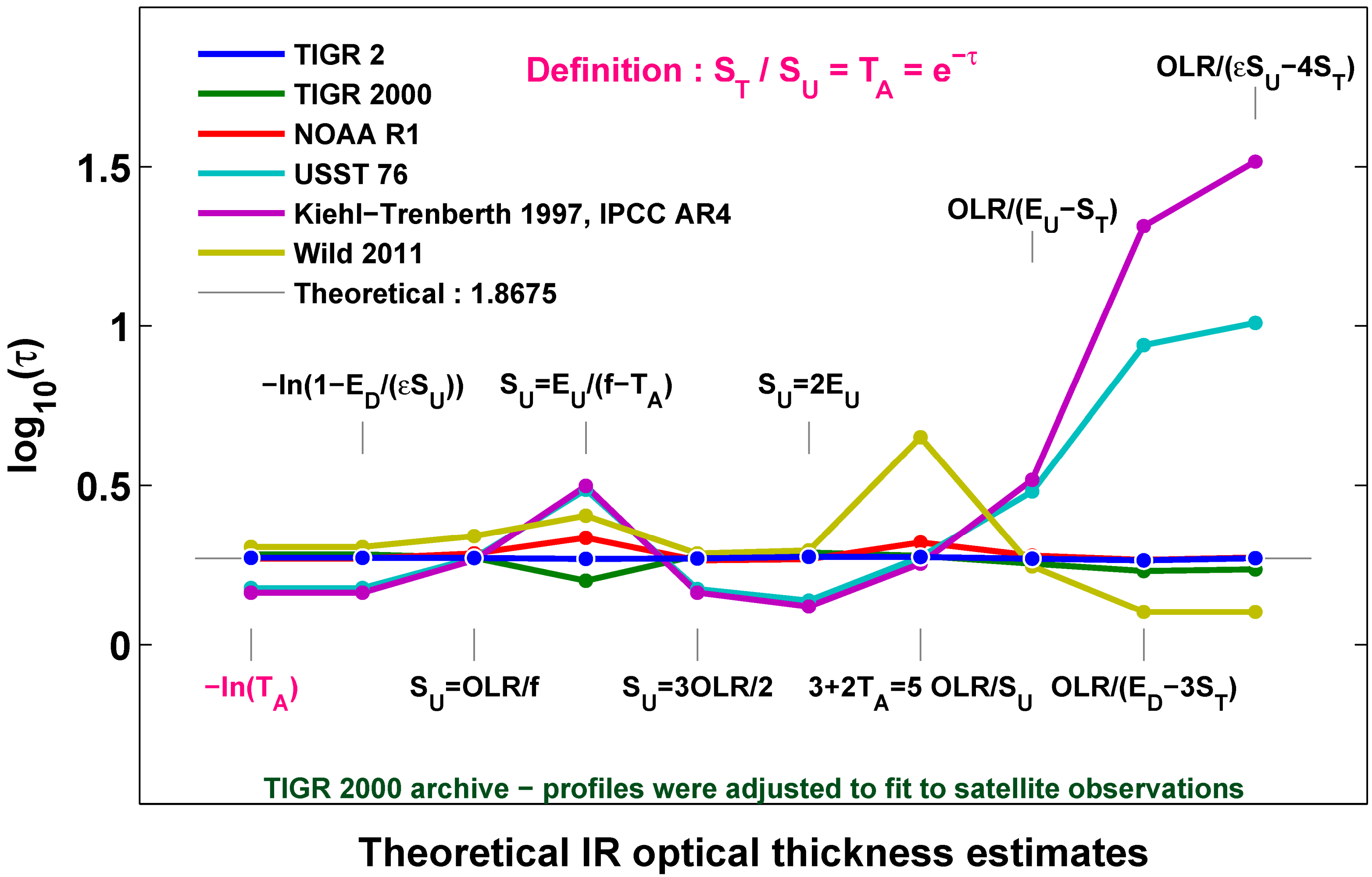
ATMOSPHERIC CO_2 INCREASE
CAN NOT BE THE REASON OF GLOBAL WARMING

Time period	Centre	Years	Altitude	Temperature	H_2O	CO_2	Tau
1948−2008	1978	61	0.7931	0.8183	−0.2841	0.9839	0.06488
1959−2008	1983.5	50	0.8059	0.8349	0.04499	0.9937	0.2976
1948−1997	1972.5	50	0.6621	0.6625	−0.4843	0.9827	−0.2284
1973−2008	1990.5	36	0.6947	0.7987	0.1148	0.9974	0.3491
1948−1972	1960	25	−0.005748	0.1731	−0.5907	0.983	−0.4184
1977−2008	1992.5	32	0.58	0.7424	0.03992	0.9973	0.267
1948−1976	1962	29	0.001769	0.0584	−0.6048	0.9804	−0.4396

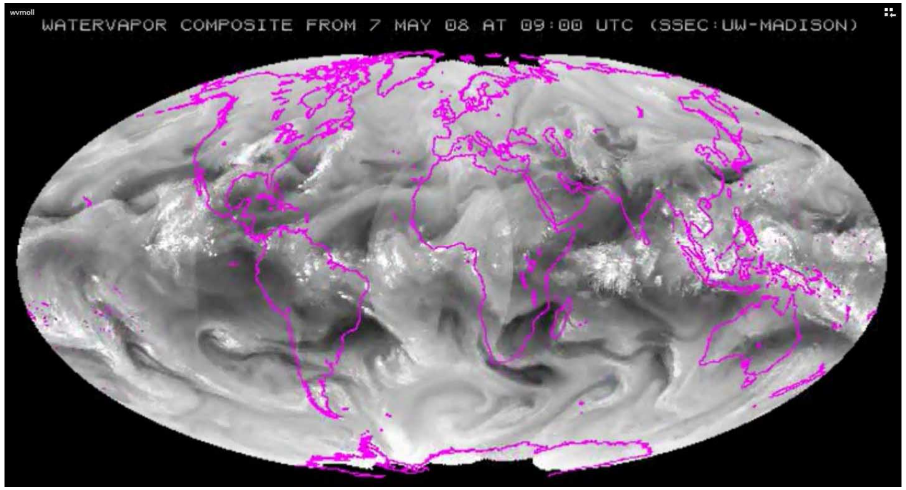
IR optical depth has no correlation with time.
The strong CO_2 signal in any time series is not present in the in the IR optical depth data.

GREENHOUSE THEORY:

Atmosphere must have a unique global average IR optical thickness which is consistent with all the observed empirical facts and the associated theoretical relationships.



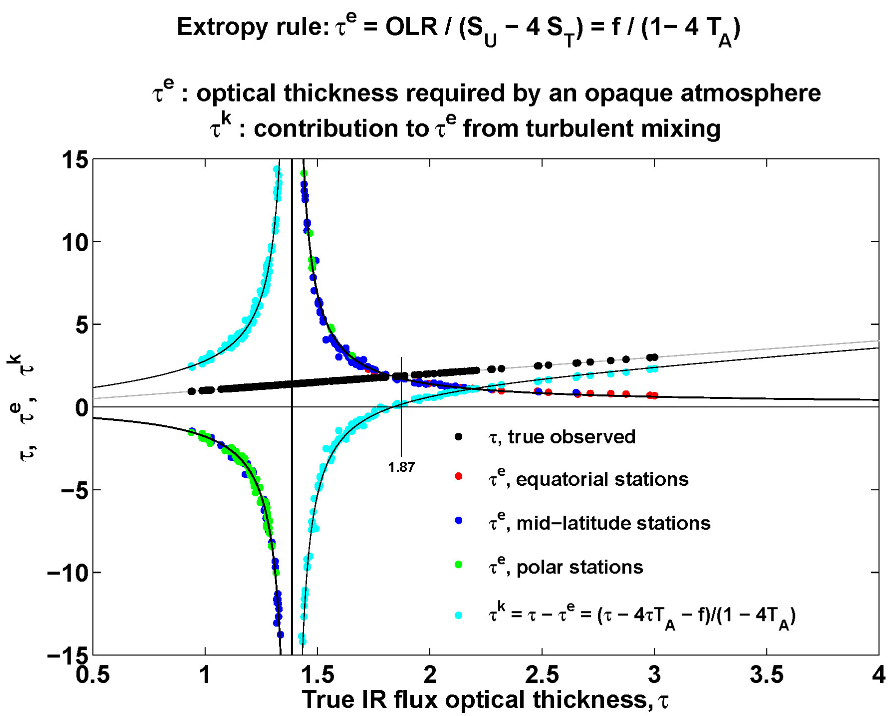
IR optical thicknesses were computed from observations using first principles. No assumptions, arbitrary constants, GCMs, and feedbacks are involved.



The dynamics of the greenhouse effect depend on the dynamics of the absorbed solar radiation and the space-time distribution of the atmospheric humidity. The global distribution of the IR optical thickness is fundamentally stochastic. The instantaneous effective values are governed by the turbulent mixing of H_2O in the air and the global (meridional) redistribution of the thermal energy resulted from the general (atmospheric and oceanic) circulation.

According to the simple-minded or 'classic' view of the greenhouse effect the global average greenhouse temperature change may be estimated by the direct application of the Beer-Lambert law moderated by local or regional scale weather phenomena (R. Pierrehumbert, A. Lacis, R. Spencer, R. Lindzen, A. P. Smith, H. deBruin, J. Abraham et al., J. Hansen et al.,and many others)*. This is not true.

The greenhouse effect is a global scale radiative phenomenon and can not be discussed without the explicit quantitative understanding of the global characteristics of the IR atmospheric absorption and its governing physical principles.



*R. Pierrehumbert, Physics Today, Jan. 2011; A. Lacis et al., Science, 330,2010; R. Lindzen, BAMS, March 2001; Spencer et al., GRL, 34, August 2007;A. P. Smith, AOPhysics, February, 2008; H. deBruin, Idojaras, 114,4,2010; J. Abraham et al., Letter: To the Members of the U.S. House of Represen-tatives and the U.S. Senate , January, 2011; J. Hansen et al., Science, 213, 1981