Critical Review of IPCC Goals Due to Conflicts with CO_2 Theory and Increasing UHI Albedo and Humidity Forcing Concerns

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Abstract

We provide a critical review of current IPCC 2020 CO_2 goals which we show are very risky in light of increasing UHI albedo and humidity forcing that remains unaddressed by the IPCC over the years. Specifically we show that UHI albedo radiative forcing is in conflict with CO_2 global warming theory. Since many of these issues have been described but still ignored by the IPCC goals, what we do is connect key issues to form a critical review of IPCC past and current direction explaining that their well intentioned goals are likely incomplete putting our population at future risk.

Introduction

Greenhouse theory and early predictions started as far back as 1856 with CO_2 experiments by Foote, Tyndall in 1859, and what has become very popular, doubling theory by Arrhenius in 1896. So when global warming started to creep up on us since the industrial revolution, few questioned carbon dioxide as the root cause. There simply was not enough data to dispute predictions and overturn CO_2 established theory. Scientist soon picked up on CO_2 doubling estimations and more predictions were made, predictions based on theory and linked to environmental trends without any modern day microclimate experiments to support claims that this author could find. Table 1 summarizes some of the key CO_2 history and predictions with the next to last row calculated based on current data in the Reference column and Equation 1.

$$13.9C\ (57F)+2.07\ Ln\{412/300\}/Ln2=14.85C\ (58.73F),\ 0.93C\ (1.73F)\ Rise \qquad (1)$$

Table 1 Key CO2 doubling theory history and conflicts

Reference	CO_2 Doubling Temperature	CO_2 Temperature Effect Estimates	Moisture Percent Effect*	UHI Albedo % Forcing Estimates
Arrhenius (1896) [1, 2]	5 - 6°C	5 -6°C	0%	0
Gillbert Plass (1950's) [3]	3.6 °C	3.6 °C	0%	0
Manabe and Wetherald (1975) [4]	2.3 °C	2.3 °C	0%	0
McKitrick and Michaels (2007) [5]	Conflict	See Table 4	See Table 4	50%
Z.C. Zhao (2011) [6]	Conflict	See Table 4	See Table 4	30%
IPCC (1st-5th Assessment 1990-2014,[7]	1.5 - 4.5 °C	1/3	2/3	
Q. Huang, Y.Lu (2015) [8]	Conflict	See Table 4	See Table 4	30%
Current Trend, Eq. 1. Based on going from 300ppm to 412 PPM from 1950 to Dec 2019, with a *0.95°C (1.73°F)* rise	2.07 °C *	1/3 (0.31°C)	2/3 (0.63 °C)	0
UHI albedo modeling (this paper)	Conflict	See Table 4	See Table 4	33%

*Ignoring other GHG

1.1 Pushback Frustration of Non Peered Reviewed Articles

There has been a lot of pushback from scientists with heated assessments. Many scientists have written numerous non-peered reviewed articles all over the web. Pushback websites and chat rooms have popped up likely in frustration [9] with little anti-CO_2 data to dispute claims. These objections mostly are unrecognized by peer reviewed journals and as a result, the IPCC has forged ahead without appreciating common CO_2 criticisms. However, this presented initial ***ignored red flags***. Here is a select list of common objections by the author and other scientists easily found on the web:

1) Conflicts to CO_2 doubling theory (as illustrated Table 1 and in this paper)
2) No modern day microclimate experiment that can verify CO_2 doubling theory [9]
3) Difficulty understanding how fossil fuels can account for less than $0.1W/m^2$ of warming yet the byproduct, CO2, accounts for $>1.5\ W/m^2$ of radiative-forcing according to the IPCC [10]
4) How CO_2 increase of 112 PPM (2019 increase since 1950 and about 70 PPM in upper troposphere [9]) can account for 1/3 of global warming with half of the CO_2 emission radiating to outer space and spectrum absorption only at 2.7, 4.3 and 15μm

5) How CO_2 with only about 112 PPM increase since 1950 can be so influential in an atmosphere filled with water vapor averaging 25,000 ppm in the lower troposphere while moisture is on the rise [9] much higher than CO_2 levels.
6) How to account for Urban Heat Island estimated contributions to global warming that are in conflict with CO_2 theory as will be discussed in this paper and has been described by other authors [5,6,8]
7) Most common is the assertion that CO_2 is valuable for plant growth [9] so it's likely not bad for the planet.

Many of these objections including UHI numerous complex issues are well known, yet the IPCC has apparently chosen to focus solely on CO_2. In this article we will formalize risks associated with their decision. We will discuss this trend and formalize our objection to IPCC goals by discussing UHI conflict with an albedo model. The goal of this paper is to provide

- A strong criticism that demonstrate the enormous risk associated with current IPCC goals
- Bring to the forefront the need for albedo UHI goals
- Questioning CO_2 theory systematically, as we have started to, in a formal critical review.

2. IPCC 2020 Goals and Risks

The IPCC report SYR_AR5 [7] recommendations are to meet a goal of less than 2^{o}C rise. This to be achieved by focusing only on CO_2 reduction:

> "Multi-model results show that limiting total human-induced warming to less than 2°C relative to the period 1861–1880 with a probability of >66% would require total CO2 emissions from all anthropogenic sources since 1870 to be limited to about 2900 GtCO2 when accounting for non-CO2 forcing as in the RCP2.6 scenario, with a range of 2550 to 3150 GtCO2 arising from variations in non-CO2 climate drivers across the scenarios considered by WGIII. About 1900 [1650 to 2150] GtCO2 were emitted by 2011, leaving about 1000 GtCO2 to be consistent with this temperature goal"

2.1 IPCC Risk of Ignoring UHI Albedo Forcing

Risk is defined as the Probability of Failure x Severity, where severity can be taken as the world population of 7.7 x 10^9 people. If the IPCC is 99% certain that CO_2 is the only issue causing global warming then their Probability of Failure is 1% and the risk can be quantified

$$\textit{Global Warming Risk} = 1\% \times 7.7 \textit{ Billion People} = 77 \textit{ Million people at risk} \tag{2}$$

This risk represents a ***strong red flag***. This same risk would alternately occur if we put all our effort into UHI albedo reduction and CO_2 turned out to be the main reason for global warming. Unfortunately, this means we should be addressing all possible known issues.

3. UHI Albedo Forcing Conflict with CO_2 Theory and IPCC Goals

CO_2 theory and IPCC goals are in conflict with other authors who have presented alternate global warming information on UHI starting as early as 2007 (Table 1).

3.1 IPCC Reports Show No Serious Attention Given to UHI Radiative Albedo Forcing

We see that over the years, the doubling temperature has crept down and conflict had occurred as early as 2007 with alternate warming albedo forcing issues shown in Table 1. Estimates have been ignored by the IPCC reports:

- In WG1-AR4 (Chapter 2) city areas were totally underestimated and taken 0.046% of the Earth's surface (reference to Loveland et al. 2000), and only 0.03 W-m2 heat flux (reference to Nakicenovic, 1998).

The actual paragraph and statements made about UHI is narrow in scope and superficial. The very minor assessment is not only unclear but irrelevant in terms of solar city heating estimates. Their statement is unfocused and seems to only be concerned about anthropogenic activities of local appliance and building heating flux, possibly in regard to CO_2 emissions. As we know, fossil fuels to begin with account for <0.1 Watt/M^2 so there is no reason for this type of issue. The surface area described is misleading by quoting a Loveland et. al. study unrelated to city solar heating, which was only intended to describe global urban surface area. This IPCC assessment presents another ***major red flag*** as it is very dismissive and remains concerning.

3.1 UHI Global Warming Conflicting Estimates to CO_2 Theory

Of the numerous studies on Urban Heat Island (UHI) effects, the main conflicts with CO_2 theory comes from a few publications that showed significance in UHI contributions to global warming in Table 1. McKitrick and Michaels [5] found that half of global warming trend from 1979 to 2002 is caused by UHI. Research in China [6, 8] indicates that UHI effects contribute to climate warming by about 30%. Another study found that UHI changes the climate in area 2–4 times larger than its own area [13].

In order to investigate further ***this red flags***, we looked at a simplified global weighted albedo model with solar surface area assessed in Appendix A and the model in Appendix B. Table 2 illustrates what basic assumptions would be needed for albedo change of city and their solar surface areas since the 3rd industrial revolution (~1950) to observe significant conflicting warming issues. Column 2, 3, and 4, indicate numbers that did not seem unreasonable to obtain such results supporting the opinion that one-third of warming trends could be due to cities and roads in agreement with these authors [5,6,8]. We were also able to provide (last row), a corrective action "what if" scenario for albedo increase to 0.5 in cities and roads.

Table 2 Results of GW Temperature Budget Change With City Surface Areas and Albedos

Year	Solar Surface Area of Cities	Albedo Roads	Albedo Cities	Global Albedo	Temperature**	UHI Radiative Forcing
IPCC	0.046	0.04	.12	28.92	0.33 °F	0.14 W/m^2
1950	1.20%*	0.04	0.12	29%	0.2°F	3.46W/m^2
2019	2.95% *	0.04	0.12	28.72	0.65°F	8.45 W/m^2
2019	2.95% *	0.5	0.5	29.45	-0.53°F	4.9 W/m^2

***Area assessment in Appendix A, **where Temp is given by:** P_{Total}= 1361W/m2 {0.25 x (1-Albedo)} =σT^4

We note that the model finds that only a 0.31% global albedo changes would need to have occurred since 1950 which in itself is ***a red flag*** since city solar area growth has been very aggressive since 1950. Such a small change would likely be hard to verify from satellites due to cloud coverage. Since city urban areas are not well known and certainly, the solar heating surface area is even more complex to estimate, it is likely that a more complex albedo weighted model would not be helpful without detailed solar heating area data. From this feasibility assessment we find:

- Actual shift from 1950 may be 0.45°F (0.65-0.2) due to Cities & Road increases, which is about 33% responsible for global warming in agreement with the quoted authors [5,6,8].
- A "what if" corrective action results shows if we can change city albedos to 0.5 and roads, total shift is 1.2°F ={0.65-(-0.53)}. This almost equates to the observed global warming.

Results strengthen our critical review that albedo forcing of cities and roads are certainly logical issues to be ~~a~~ concerned about and not continually ignore in IPCC goals. This is especially true since it is in direct conflict with CO_2 doubling theory.

3. Humidity Forcing Contribute to Atmospheric Humidity Conflicts with Ocean Feedback Theory?

It is well known that water vapor in the atmosphere has increased over land and ocean since the 1970s as indicated by a rise in specific humidity [14,15], while the relative humidity is in general dropping [18,19] (also in conflict with some constant relative humidity theories). These changes are illustrated in Table 3.

Table 3 Specific Humidity, Relative Humidity, and Warm Mixed Asphalt changes

Source	Change	Period of Change
Specific Humidity Change [14]	Specific Humidity Change Land & Ocean about the same Increase of 0.45 g kg^{-1}	1960-2013
Total Atmosphere Water [15]	18.4-19.3kg/m2 NECP R2 25.5-26.6 kg/m2 RSS	1980-2017 1990-2017
Relative Humidity Change [14]	Δ%RH (land)~1% decrease Δ%RH (ocean)~0.5% decrease	1960-2013
Albedo Change [14]	ΔAlbedo (land)~4 units Units not defined (possibly reflectivity %)	2003-2012
US Warm Mixed Asphalt [16]	16.8 to 86.7 Million Tons ΔWMA=69.9 Million Tons	2009-2012

The IPCC and it authors assert that two-thirds of global warming trends are caused by increase moisture content in the atmosphere [7, 17-20] due to ocean evaporation feedback. Here CO_2 creates initial warming raising ocean temperatures with warmer air that holds more water vapor (i.e. Clausius-Clapeyron relation)

This could also be in conflict with CO_2 theory when we ask, where does the actual water vapor come from? Is it feedback or in part humidity forcing related to UHI?

- One could logically draw from these assertions that the initial 1/3 heating instead of being mainly due to CO_2, can at least in part be due to UHI albedo effect (Table 2) and [5,6,8])

- Then instead of mainly ocean feedback, since impermeable surfaces of cities and roads create what we can call Hydro-HotSpots (HHS) from highly evaporating hot surfaces, perhaps they significantly contribute to increase observed humidity. We denote this as a form of humidity forcing or just another type of feedback as the air is warmed. This would require studies to try and make estimates. Certainly most of the evaporation recycles rapidly in and out of the atmosphere when average temperatures are maintained.
- One would suspect that there is really not much difference between atmospheric humidity feedback/forcing from cities and roads compared to ocean surface evaporation. It is largely a magnitude issue as to which contributes more significantly to the 2/3 effect.

To investigation atmospheric humidity contribution to global warming, we looked at the evaporation rate as a metric. We investigate the rate of evaporation growth since 1950 from cities HHS compared to the ocean evaporation rate in Appendix D.

- What we estimated was that the evaporation rate increased enough over the years to actually be a significant contributor to atmospheric global warming humidity increase.

This strengthens our opinion that cities are a root cause and possibly much more than 33% of global warming trends due to humidity forcing/feedback adding to our conflicts found with CO2 doubling theory. This is certainly, ***another red flag***.

3.1 Urban Local Greenhouse Amplification Effect from Hydro-Hotspots

Due to the fact that warm air holds more greenhouse gas, then HHS during precipitation periods could also keep city heat in increasing infrared radiation during periods of higher relative humidity. For example, (using the Clausius-Clapeyron relation) if the ambient condition when it rains is 25°C/98%RH and the HHS surface temperature is 60°C (1000Watt/m^2, albedo=0.3, prior to rain cooling) then the local relative humidity at the hotspot surface is reduced from 98%RH to 15.6%RH. This increases temporarily locally humidity concentration building up more city heat amplifying temperature radiation which can contribute to warming anomalies with the root cause due to city surface albedo problems. This is ***another red flag*** reason for asserting that IPCC goals need to be changed.

3.2 Global Warming Alternate Contributing Estimates to IPCC

In order to estimate better the critical issues of UHI global warming trends, we decided to study the possibilities that UHI could be playing given that it is actually the major role in global warming (rather than CO_2, as in doubling theories). Under this conflicting view, we would have to clarify assessments by looking at potential contributions of greenhouse gases using basic blackbody spectral absorption probabilities. Table 4 provide our alternate estimates (to IPCC [7]) of contributions when UHI dominate global warming due to albedo, CO_2, and water vapor increases (ignoring other greenhouse gases) from 1950 to 2019. Estimates are detailed in Appendix C. Appendix D uses these findings to look at humidity increases issues.

Table 4 Calculated Forced Effects Causing Global Warming from 1950 to 2019

Forced Effect	Contributing Change	Temperature Increase	Percentage
Albedo (Cities & Roads)	0.29 to 0.287	0.5°F	33.33%
Water Vapor	225.6-243.9 PPM increase	0.89-0.96°F	61.03-65.26%
CO_2	9-27.4 PPM increase	0.036-0.11°F	1.41-4.23%
Greenhouse Gas Increase	1%=60.3%-59.3	(~1°F, $H_2O + CO_2$)	
Totals	430PPM	1.5°F	100%

It may be likely that global warming contributions come from both CO_2 doubling effect and partially as described in Table 4. In Table 4, the 1% greenhouse gas increase is most significant as most of it would be due to moisture.

4. Data Information on Rainwater Management, Drought, Global Warming Trends

Another red flag that adds conflict is the significance of UHI issues related to RainWater Management (RWM) as it too can influence global warming trends. It is concerning since as it has been reasonably well studied and is also highly conflicting with CO_2 doubling theory.

Rain sometimes follows local evapotranspiration. Apart from precipitation, evapotranspiration is the major component in the hydrologic budget. When it rains in a city, much of the land in urban areas is covered by pavement or asphalt. These impermeable surfaces in urban cities commonly estimated around 55% runoff, with 30% for evapotranspiration, 10% shallow soil infiltration, 5% deep soil infiltration. Water temperatures from runoffs are often hotter due to hot city surfaces and roads. For example,

- The New York Environment Report, in 2014 reported [21], “Every year, old sewers flooded by storm water release more than 27 billion gallons of untreated sewage into New York Harbor.”
- Fry et al. [22] reported that in February of 2019 California estimated that 18 trillion gallons of rain in February alone had most of the water going to the Pacific Ocean. The article goes on to point out the LA dept. of water captured 22 billion gallons of water during recent storm.
- In August 2001, rains over Cedar Rapids, Iowa, led to a 10.5C rise in the nearby stream within one hour, which led to a fish kill. Similar events have been documented across the American Midwest, as well as Oregon and California [23]
- Sydney Paper reported [24]: “Every year around 132 billion gallons of storm water – enough to fill Sydney Harbor – runs from Sydney to the sea.”

It is of course very difficult to tell the global thermal influences of higher temperature city water cycling. However, coastal cities could certainly increase evaporation rates from hot water runoff to lakes and local ocean areas. Australia might be a good extreme example! On the Sydney-Melbourne South-East side, the Tasman Sea is about 1 to 2 deciles range warmer (NOAA Sea Map [25]) than the South -West coast of Australia and about 5 deciles range warmer that the far south west coast. This might in part be an example of cyclic ocean heating. We tend to think of the ocean as an infinite temperature sink, but over 70 years of higher temperature city cycling, it can take a toll and perhaps this is somewhat of what we are seeing on the Sydney – Melbourne side and costal issues. Such issues are ***another likely red flag***.

6. Conclusion

From data and analysis presented, it is our opinion that the IPCC goals focused solely on CO_2 reduction is highly risky as they are not: 1) recognizing opposing viewpoints, 2) working on UHI albedo obvious data trends, 3) looking at forcing or all feedback humidly sources from UHI HHS and 4) recognizing UHI albedo forcing conflicts with CO_2 theory. It seems highly unlikely that focusing only on CO_2 reduction will not stop global warming trends from occurring as has been critically assessed in this review. Albedo reduction goals of UHI have been ignored by IPCC committees long enough even in very latest meetings by the IPCC [7, COP 25]. The IPCC has wasted valuable time as albedo goals could have been set early on for cities. City design efforts of “cool roofs” for example have lagged behind compared to say automotive efforts to reduce CO_2 emission standards. The IPCC goals are highly influential and are suppose to speak for all of mankind. Possibly they are so concerned that city buildings with higher albedo changes might create a need for more fossil heating fuel in the winter months, biased by CO_2theory, thus ignoring UHI albedo serious issues. We conclude with a number of IPCC suggestions that should be occurring:

- Create new IPCC goals to include and recognize albedo forcing issue of UHI and roads
- Provide new studies on albedo and humidity forcing from UHI to better understand their effects, conflict with CO2 theory, and actual radiative forcing contribution to GW
- Recommend changes for albedo of roads and cities to reducing HHS and the area effect dramatically, i.e. paint roads and building with reflective colors (have minimally albedo requirements, 0.25 – 0.5)
- Mandate future albedo design requirements of city and roads
- Roads to be more HHS eco-friendly
- Reduce driving speeds during rain to reduce evaporation rates can also reduce KE molecules
- Change to electric cars with HHS - cooler hoods
- Paint all cars silver or white
- Thoroughly assess and make goals for rain water management issues including evapotranspiration and rainwater runoff allowed temperatures released into streams, rivers, lakes and oceans

Appendix A Solar City Surface Area Estimates:

One of the main criteria needed for UHI albedo modeling are estimates of solar surface areas covered by cities and roads. The effect of area increase by a factor of about 3 in 2019 Column 2 compared to 6 in Table A1 is somewhat supported by Decheng et al. [13] that found UHI changes the climate in area 2–4 times larger than its own area. We have used an average factor of 3. Certainly, estimating solar city areas of cities globally from 1950 to 2019 is an impossible task. Therefore, we use this estimate of Decheng et al [13] and illustrate how this estimate could be justified.

Table A1 Values used to estimate the Solar Surface area in cities

Year	Urban Area Percent	Buildings % Coverage	Surface area & Height factor	Solar surface Area %	50% Illumination
1950	0.62	0.50	7	2.48	1.2
2019	1.10	0.50	10	6.05	3.0

To further justify the rough facto of 3, we use a 2010, estimates from a GRUMP [26] study (and its critics [27] of the study) indicate the surface area relative to the Earth's coverage is somewhere between 0.85% and 2.7%. We will take a round number of 1% coverage of the Earth surface area in 2010. Next for an area growth rate of cities we used the U.S. Census of 0.8% per year [28]. We are interested in Global Warming trends from 1950 to 2019. The extrapolation using this growth rate is shown in Column 2. We then need to make some rough estimate that buildings occupied 50% of the urban land (Column 3). Finally we add a multiplication factor assume each building sides equates to 7 times the bottom surface area in 1950 and as buildings have become taller [29] about 10 times in 2019 (Column 4). The estimates are shown in Table A1 for example the 1950 estimate is 0.62x0.5+0.62x.5x7=2.48 (column 5) and then we take 50% illumination factor (Column 6). This agrees more or less with Decheng et al. [13].

Appendix B Simplified Weighted Albedo Model 1950 & 2020

Below is a simplified author's model to estimate the Earth's total albedo decrease with increase in city and road areas and a decrease in grass lands since 1950. A simplified global albedo model is really all that is needed to illustrate the sensitivity of global albedo change from 1950 to 2019 when illustrating feasibility.

Table B1: Albedo=0.29 [30], 1950

Surface	Enter % of Earth Area	Enter Albedo (0-1)	Weighted Albedo % Results
Water	71		
Snow	12	0.8	2.40
Ice	10	0.6	4.00
Open Ocean	49	0.06	46.06
Land	29.1		
Roads (0.04)	0.8	0.04	0.77
Urban Cov (0.12)	1.2	0.12	1.06
Forest (0.17)	8.6	0.17	7.14
Grass lands (0.26)	8.6	0.26	6.36
Desert (0.4)	9.9	0.4	5.94
Sum % of Earth Area	100.1		
Weighted Earth			26.27
Clouds (0.47)	60	0.472	31.68
			Global Weighted Albedo in
Global=Average(Clouds & Weighted Earth) %			28.98
Global=Average(Clouds & Weighted Earth)			0.2898

Table B2: Albedo=0.287, 2019

Surface	Enter % of Earth Area	Enter Albedo (0-1)	Weighted Albedo % Results
Water	69.45		
Snow	11.39	0.8	2.28
Ice	9.63	0.6	3.85
Open Ocean	48.43	0.06	45.52
Land	30.54		
Roads (0.04)	0.78	0.04	0.75
Urban Cov (0.12)	2.95	0.12	2.60
Forest (0.17)	8.45	0.17	7.01
Grass lands (0.26)	8.64	0.26	6.39
Desert (0.4)	9.72	0.4	5.83
Sum % of Earth Area	99.99		
Weighted Earth			25.76
Clouds (0.47)	60	0.472	31.68
			Global Weighted Albedo in
Global=Average(Clouds & Weighted Earth) %			28.72
Global=Average(Clouds & Weighted Earth)			0.2872

Results of the simplified weighted model are exemplified in Table B1-B3 with the full estimates provided in Table 2. Equation B1 is the weighted albedo by area,

$$Earth\ Weighted\ \ Albedo = \sum_i \{\%\,Earth\ Area_i\ x\,(1 - Surface\,Item\ Albedo_i)\} \quad \text{(B1)}$$

Equation B2 is the average weighted albedo with clouds.

$$Global\,Weighted\ Albedo = Average\{((1 - Clouds\ Albedo)\,x\,\%\ Coverage) + (1 - Earth\ Weighted\ Albedo)\} \quad \text{(B2)}$$

Below we show a "what if" scenario illustrating if roads and urban coverage could have an increase albedo to 0.5.

Table B3: Albedo=0.294, "what if"

Surface	Enter % of Earth Area	Enter Albedo (0-1)	Weighted Albedo % Results
Water	69.45		
Snow	11.39	0.8	2.28
Ice	9.63	0.6	3.85
Open Ocean	48.43	0.06	45.52
Land	30.54		
Roads (0.04)	0.78	0.5	0.39
Urban Cov (0.12)	2.95	0.5	1.48
Forest (0.17)	8.45	0.17	7.01
Grass lands (0.26)	8.64	0.26	6.39
Desert (0.4)	9.72	0.4	5.83
Sum % of Earth Area	99.99		
Weighted Earth			27.24
Clouds (0.47)	60	0.472	31.68
			Global Weighted Albedo in
Global=Average(Clouds & Weighted Earth) %			29.46
Global=Average(Clouds & Weighted Earth)			0.2946

Appendix C: Table 4 Alternative Estimates

Table 4 estimates are made as follows:

In Table 2 we concluded the change from 1950 to 2019 due to albedo forcing was 0.5°F . We next note that the Earth's energy budget is 241.58 Watts/m^2 (where P_{Total}= 1361W/m2 {0.25 x (1-0.29)}). In 1950 the average temperature was 57°F. This yields 384.93 Watts/m^2 ($P=\sigma T^4$). This leaves 143.3Watts/m^2 of power emitted back by GH gases which is 59.34% of the 241.58 Watts/m^2. In 2019 Earth energy budget is 242.63 (P_{Total}= 1361W/m2 {0.25 x (1-0.2869)}, see Table 2), the average temperature is taken as 58.5°F yielding 389 Watts/m^2 which leaves 146.36 Watts/m^2 above the Earth's energy budget or 60.3% emitted back by GreenHouse (GH) gases. The difference of the emitted back radiation is 3.1 Watts/m^2 (note we took into account an albedo change in 2019 in the Earth's energy budget that makes this estimate lower than the 4.1 Watts/m^2 typically found) and the difference in the percent of emitted back Greenhouse gases is

$$1\%=143.3/241.58-146.36/242.63=60.3\%-59.3\% \qquad \text{(C-1)}$$

Therefore, this must be the percent of GH gases required to increase global temperatures 1.0°F. Using the approximate 300 PPM value for CO_2 in 1950 and an average estimate of 25,000 PPM for water vapor in our atmosphere [39-41], the 1% GH gas increase is estimated to be

$$25{,}300\text{PPM x } 1\%=253\text{PPM} \qquad \text{(C-2)}$$

increase in 2019. In 2019 the estimate increase in CO_2 is 114PPM (currently 414PPM). The typical contribution of blackbody spectrum absorption for CO_2 is 8%-24% leaving 76-92% for water vapor (where we are ignoring other GH gases) [31,32]. It is actually difficult to predict such percent GH gas contribution and we are using values from other authors [41, 32]. Using the low 8% value first for CO_2 and the 253 PPM we must have

$$243.9\text{PPM (H2O}\uparrow) + 114\text{PPMx}8\% \; (CO_2\uparrow)=253\text{PPM} \qquad \text{(C-3)}$$

The effect of water vapor and CO_2 vary depending on a clear day or cloudy day with precipitation. Dividing the LHS by 430 PPM yields the fractional GH of 1°F temperature contribution (1.5°F rise from 1950 with 0.5°F due to albedo). The full temperature sum is then

$$0.96^oF\ (H_2O\uparrow) + 0.036^oF\ (CO_2\uparrow) + 0.5^oF\ (\text{Albedo})=1.5^oF \text{ (from 1950 to 2019)} \qquad \text{(C-4)}$$

Since CO_2 can vary in it absorption strength, we consider higher values by a factor of 3 in its GH effect [31,32], this upper value yields the range in estimates to global warming contributions shown in Table 4.

Appendix D: Evaporation Rate of Cities Vs. Ocean Feedback

In Table 4 feasibility assessment, the 1% increase and ppm levels of moisture are important as they indicate the increase in greenhouse gases. One could argue that the increase in humidity from 1950 to 2019 is due primarily to the global warming ocean feedback mechanism and perhaps some contribution due to HHS. Here we investigated the possibility of humidity contributions from HHS in cities.

In this example, the evaporation rate increase of HHS simulated area in Cities (Ec) vs that of the Ocean (Eo), we make comparison between 1950 and 2019 relative to a possible average hydro-hotspot of 50°C (using average range from 25°-75°C) for simulated area growth via the final ratio. We find that the evaporation rate increase is dominated more by city area growth rather than ocean temperature change. In this assessment, we will first ignore the evaporation wind effect. The comparisons for the effects are:

$$HHS_{effect-o}(1950) = \frac{E_O}{E_C} = \frac{A_O}{A_C} R(T_O, T_{HHS}) \frac{E_{WO}}{E_{WC}} \frac{RH_C}{RH_O} = 40.8x \frac{1}{6.69} x100x0.5 = 304.9 \quad \text{(D-1)}$$

and

$$HHS_{effect-o}(2019) = \frac{E_O}{E_C} = \frac{A_O}{A_C} R(T_O, T_{HHS}) \frac{E_{WO}}{E_{WC}} \frac{RH_C}{RH_O} = 16.3x \frac{1}{6.28} x100x0.5 = 129.8 \quad \text{(D-2)}$$

where E_O,E_C=Evaporation Rate of Ocean, Evaporation Rate of Cities
AO, AC= Surface Area of Ocean, simulated proportional Area of City Surfaces growth rate (Ao/AC=49%/3%=16.3 in 2019, Ao/AC=49%/1.2%=40.8 in 1950)
$R(T_O$=16C,T_{HHS}=50C,1950) Temp. rate factor Ocean to City HHS ~6.69
$R(T_O$=17C,T_{HHS}=50C,2019) Temp. rate factor Ocean to City HHS ~6.28
where $R = \exp\{\frac{E_a}{K_B}(\frac{1}{T_{HHS}} - \frac{1}{T_O})\}$, Ea=0.45eV [33]
E_{WO}, E_{WC}= Percent of time surface exposed to water, E_{WO}=100%, E_{wc}=1% ~100
RH_C, RH_O=Local relative humidity of ocean and RH of city near surface ~40/80

From Eq. D-1 and D-2 we find the percent increase in evaporation rate from HHS relative to the ocean since 1950 (ignoring wind) as

$$\%2019\, Increase = \frac{304.9 - 129.8}{304.9} = 57.4\% \quad \text{(D-3)}$$

We now look at the wind effect. We will consider that the ocean wind evaporation factor has not changed much from 1950 to 2019. However, city growth increases friction near the ground level so the wind evaporation effect factor is diminished in cities by comparison to the ocean from 1950 compared to 2019. Then the results in Eq. D-3 is now modified by this factor

$$57.4\%x \frac{W_{O/C}(1950)}{W_{O/C}(2019)} = 57.4\%x \frac{W_C(1950)}{W_C(2019)} = 57.4\%xf_W \quad \text{(D-4)}$$

where f_W is an unknown factor between 0 and 1. If we take f_W as a median value of 0.5, for a rough wind reduction estimate in cities, this would yield a 29% growth rate in evaporation compared to the ocean effect.

In summary, humidity forcing from HHS shows a strong evaporation growth rate compared to ocean changes in evaporation rate from 1950 to 2019. This supports reasonable strong feasibility that the 1% increase in moisture greenhouse gas (Table 4) can have high contributions from an urban humidity forcing/feedback effect.

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