Ventura Photonics

Photonics Solutions

The Seven Sins of the Equilibrium Climate Models

Roy Clark PhD

Ventura Photonics Climate Note 1, VPCN 001.1
Ventura Photonics
Thousand Oaks, CA
September 2019

Simple comparison of climate model results with the measured climate record shows that the two do not agree and that the climate models have failed. This is illustrated in Figure 1.

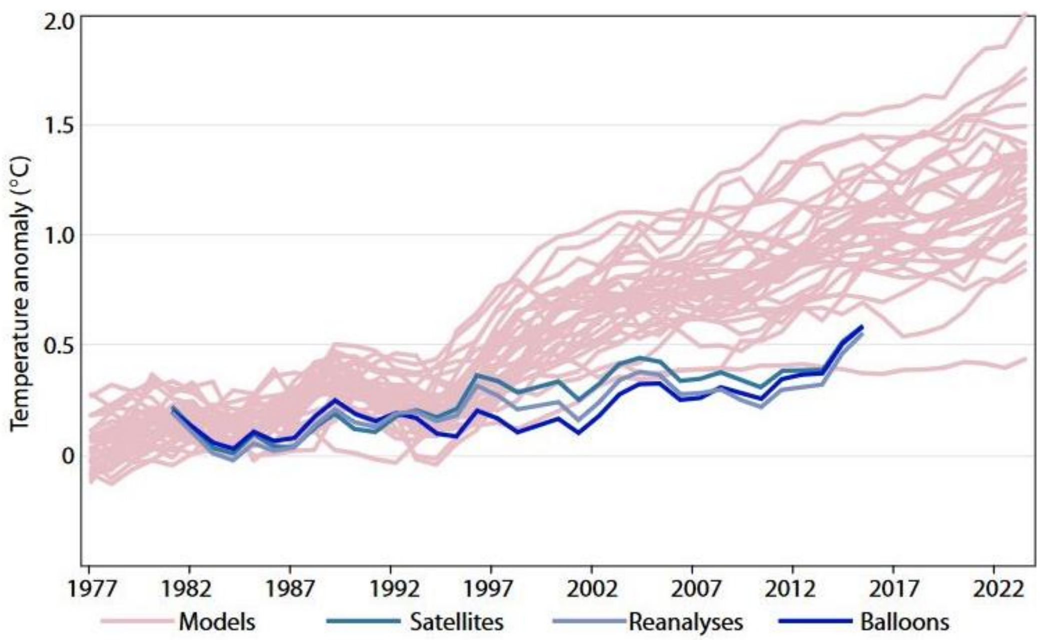

Figure 1: Tropical mid-tropospheric temperatures, models vs. observations. Models in pink, against various observational data sets in shades of blue. Five year averages, 1979-2017. Trend lines cross zero at 1979 for all series [Christie, 2019].

However, in order to understand the reasons for the failure it is necessary to delve quite deeply into the underlying modeling assumptions and compare them to the basic physics of the climate energy transfer. When this is done, it is found that seven fundamental scientific errors are created using the assumptions described in just two of the earlier modeling papers:

1) Manabe, S. and R. T. Wetherald, J. Atmos. Sci., **24** 241-249 (1967), 'Thermal equilibrium of the atmosphere with a given distribution of relative humidity'
http://www.gfdl.noaa.gov/bibliography/related_files/sm6701.pdf

2) Hansen, J.; D. Johnson, A. Lacis, S. Lebedeff, P. Lee, D. Rind and G. Russell Science **213** 957-956 (1981), 'Climate impact of increasing carbon dioxide'
https://pubs.giss.nasa.gov/docs/1981/1981_Hansen_ha04600x.pdf

The 1967 paper by Manabe and Wetherald (M&W) described the first generally accepted climate model and provided the foundation for later [fraudulent] model development. It was really just a platform for the development of improved radiative transfer algorithms and created global warming as a mathematical artifact of the initial assumptions. These lead to four fundamental scientific errors:

1) There is no equilibrium climate on any time or spatial scale.
2) There is no such entity as a blackbody surface with zero heat capacity.
3) The concept of an 'equilibrium atmosphere' with a fixed relative humidity distribution is incorrect.
4) The upward and downward LWIR fluxes through the atmosphere are not equivalent. Instead, they are decoupled by molecular linewidth effects. This leads to the formation of two independent tropospheric thermal reservoirs.

The first three errors follow directly from the assumptions listed on the second page of the M&W paper. The fourth error requires a more detailed analysis of the atmospheric radiative transfer. Variants of the M&W model were used to create the global warming artifacts found in the 1979 Charney Report [Charney et al, 1979]. This gave a warming estimate of 3 ±1.5 C for a doubling of the atmospheric CO_2 concentration from about 300 to 600 ppm. Later climate modeling work failed to address the inadequacies in the underlying M&W assumptions. Instead 'improvements' were introduced that added three more fundamental scientific errors. These may be found in the 1981 paper by Hansen et al.

5) A 'slab' ocean model was used instead of the M&W blackbody surface.
6) A prescribed mathematical ritual of 'radiative forcing' was introduced.
7) There was a 'bait and switch' change from surface temperature to the weather station temperature record.

However, before these errors are considered in more detail it is necessary to understand how the earth's climate energy transfer really works [Clark, 2019a, b, c, d, 2013a, b].

At the local surface, the solar flux is always changing on both a daily and a seasonal time scale. The peak solar flux with the sun overhead is approximately 1000 W m^{-2}. This corresponds to a blackbody emission temperature of about 94 C. During the day as the sun warms the surface, heat is stored below the surface and released over a range of time scales. In order to dissipate the heat from the surface there must be a time dependent thermal gradient. This of course follows from the Second Law of Thermodynamics. For evaporation, a humidity gradient is required, which usually includes a thermal gradient.

The land and ocean surfaces behave differently and must be considered separately. Over land, the incident solar flux, the net LWIR flux, the convection or sensible heat flux and the latent heat flux interact with a thin surface layer. The net LWIR cooling flux is insufficient to dissipate the absorbed solar flux. The surface heating produces a thermal gradient both with the cooler air layer above and the subsurface layers below. The surface-air gradient drives the convection or sensible heat flux. The subsurface thermal gradient conducts heat into the first 0.5 to 2 meter layer of the ground. Later in the day this thermal gradient reverses and the stored heat is released back into the troposphere. The thermal gradients are reduced by evaporation if the land surface is moist. An important consideration in setting the land surface temperature is the night time convection transition temperature at which the surface and surface air temperatures equalize. Convection then essentially stops and the surface continues to cool more slowly by net LWIR emission. This convection transition temperature is reset each day by the local weather conditions.

The ocean surface is almost transparent to the solar flux. Approximately 90% of the solar flux is absorbed within the first 10 m layer. The surface-air temperature gradient is quite small, usually less than 2 K. The excess absorbed solar heat is removed through a combination of net LWIR flux emission and wind driven evaporation. The penetration depth of the LWIR flux into the ocean surface is 100 µm or less and the evaporation involves the removal of water molecules from a thin surface layer. These two processes combine to produce cooler water at the surface. This then sinks and is replaced by warmer water from below. This is a Rayleigh-Benard convection process, not simple diffusion. The upwelling warm water allows the wind driven ocean evaporation to continue at night. As the cooler water sinks, it carries with it the surface momentum or linear motion produced by the wind coupling at the surface. This establishes the subsurface ocean gyre currents.

It is also important to understand that the surface energy transfer processes are part of the tropospheric heat engine. This removes heat from the surface and transfers it to higher altitudes by convection. From here it is radiated back to space. This heat engine has some unusual properties. It operates at low temperatures and pressures. This means that the LWIR flux cannot be described simply in terms of blackbody radiation. Instead, a high spectral and spatial resolution radiative transfer analysis is required. Most of the heat is removed from the surface by moist convection. This is a mass transport process that is coupled both to the earth’s gravitational field and the earth’s axial rotation or angular momentum. As a warm air parcel ascends from the surface it must expand and cool as it performs mechanical work to overcome the gravitational potential. This establishes the tropospheric temperature profile or lapse rate. If the air moist, water may condense and release its latent heat of evaporation. This reduces the local lapse rate. The cooling produced by convection is usually much larger than that produced by net LWIR emission. The LWIR flux cannot be separated from the convection and analyzed independently. The local LWIR flux is emitted at the local air temperature. The coupling of the ascending air parcel to the rotation of the earth establishes the basic Hadley, Ferrell and Polar convective cell structure which in turn drives the trade winds and the ocean gyre circulation. The earth's weather patterns are determined mainly by the thermodynamic and fluid dynamic properties of the tropospheric heat engine, not the LWIR flux. The earth's climate is the long term (30 year) average of these weather patterns.

The land and especially the oceans are the hot reservoirs ('boilers') of the tropospheric heat engine. The troposphere divides naturally into two independent thermal reservoirs. Almost all of the downward LWIR flux reaching the surface originates from within the first 2 km layer that forms the lower tropospheric reservoir. The LWIR emission to space originates mainly from the upper tropospheric reservoir that extends from 2 km to the tropopause. This acts as the cold reservoir of the heat engine. The heat lost by LWIR emission to space is replaced by convection from below. Above the tropopause, the stratosphere forms a third independent thermal reservoir. The main heat source here is absorption of the UV solar flux by ozone and the cooling is dominated by LWIR emission from CO_2. The downward LWIR flux to the surface and the outgoing LWIR radiation to space are decoupled by the molecular line broadening effects. The energy transfer processes associated with the tropospheric heat engine are illustrated schematically in Figure 1.

1) The Radiative Convective Equilibrium Assumption.

The first generally accepted climate model was developed by Manabe and Wetherald (M&W) in 1967. This was based on the assumption of radiative convective equilibrium. M&W stated their assumptions quite clearly and honestly on the second page of their paper. Their first assumption was that:

> At the top of the atmosphere (TOA), the net incoming radiation should be equal to the net outgoing radiation.

At a local TOA reference point, the solar radiation is always changing on a daily and a seasonal time scale. At night it is zero. The net incoming radiation used by M&W is the mathematical construct of a 24 hour average solar flux. In making this assumption, they have thrown out the time dependence of the solar flux and abandoned the Laws of Physics, starting with the Second Law of Thermodynamics. As soon as the climate equilibrium assumption is made, physical reality is left behind and one enters the realm of computational climate fiction.

M&W were not the first to use the climate equilibrium assumption. It was used by Arrhenius in his 1896 estimate of global warming from CO_2 and he traced the concept back to Pouillet in 1838.

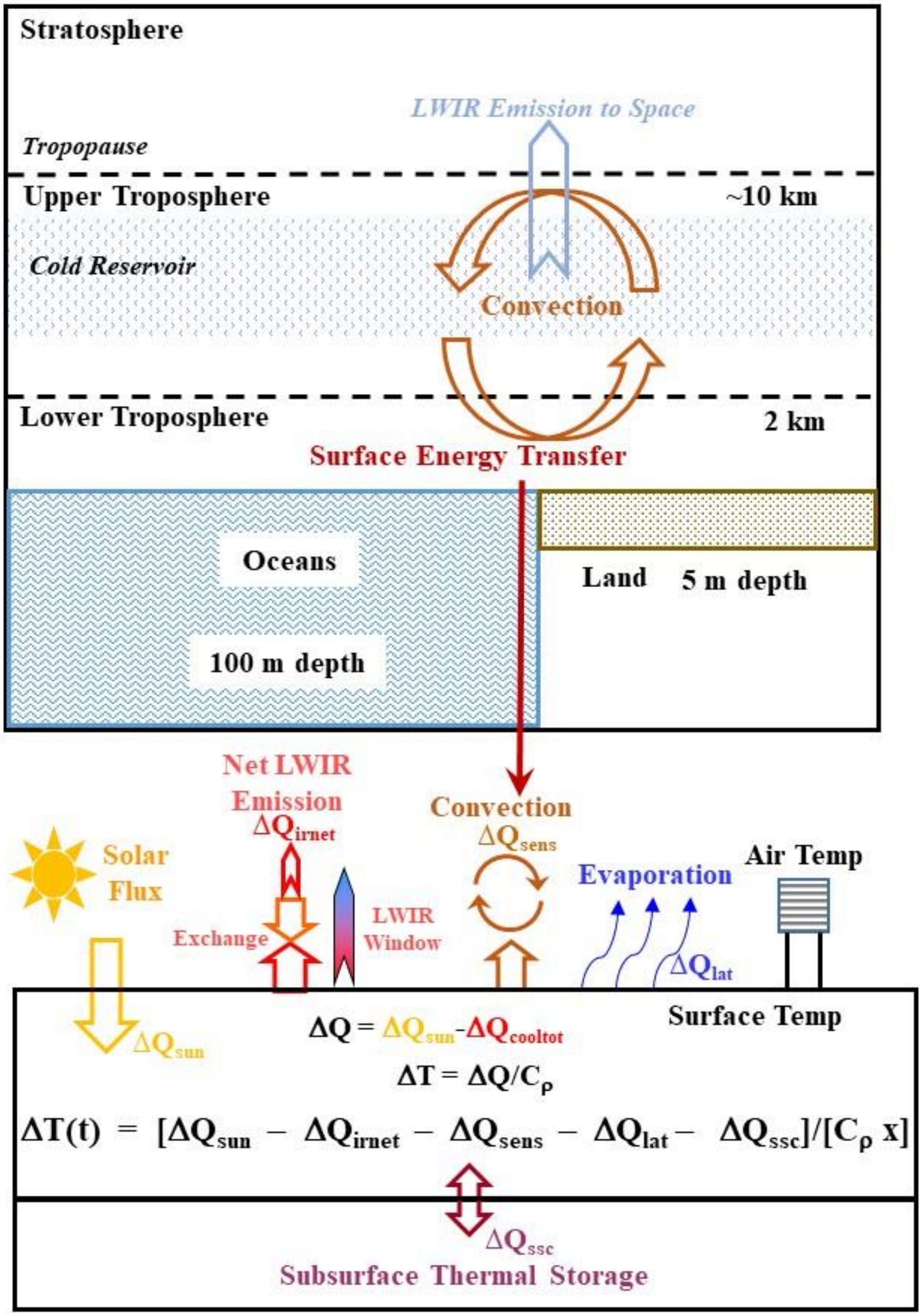

Figure 2: Thermal reservoirs, surface energy transfer and thermal storage (schematic). The surface is heated by the sun and cooled by a combination of net LWIR emission, convection and evaporation. Heat is stored below the surface and released over a range of time scales. There is no 'equilibrium average temperature'.

2) A Blackbody Surface with Zero Heat Capacity

This assumption adds another layer of computational climate fiction to the M&W model. In reality, the change in surface temperature is determined by the time dependent change in heat content or enthalpy of the surface reservoir. The surface layer heat capacity must be included in the time dependent calculation of the surface temperature. The LWIR flux cannot be separated from the other flux terms and analyzed independently. The net LWIR flux emitted by the surface defines both a rate of cooling and the temperature at the time of the flux measurement. However, a change in LWIR flux absorbed by the surface has to be added to the heat content of the local thermal reservoir along with the rest of the coupled flux terms. The change in temperature is the change heat content divided by the heat capacity. There is also a phase shift or time delay between the peak solar flux and the temperature response. The time dependence of the subsurface temperature response was understood by Fourier in 1827. The phase shift is discussed in more detail by Clark [Clark 2019a].

3) Fixed Relative Humidity Distribution

M&W also assumed that the atmosphere maintains the given distribution of relative humidity set by the model. This is not the case. Near the surface, the initial water vapor concentration is set by the local weather system. The relative humidity changes during the day with solar heating and evaporation. Diurnal and seasonal temperature variations lead to significant changes in the relative humidity near the surface. As the surface cools at night, condensation (dew formation) may also occur. The tropospheric lapse rate or temperature profile is set locally by moist convection. This transfers the absorbed solar heat from the surface to the middle troposphere. Here, the LWIR emission from the water bands forms the cold reservoir of the tropospheric heat engine. The emission to space occurs at a temperature near 260 K. This emission band changes in altitude as the surface temperature and lapse rate change.

At the surface, the LWIR flux must be included with the other flux terms and coupled to the thermal reservoirs. There can be no water vapor feedback to amplify the nonexistent increase in temperature from the increase in CO_2 flux. This is considered in more detail by Clark [Clark, 2019a, b, c].

4) Molecular Linewidth Effects

Although it was not explicitly stated by M&W, they also assumed that the upward and downward LWIR fluxed were equivalent. The atmospheric LWIR flux consists of IR emission and absorption involving many overlapping lines from specific molecular ration-vibration transitions. At higher altitudes, these lines become narrower as the temperature and pressure decrease. Some of the upward LWIR flux can pass through the gaps between these narrower lines above and continue to space without additional absorption/emission. The downward flux is absorbed by the broader lines below. This is illustrated schematically in Figure 3. The idea that changes in LWIR flux at higher levels in the atmosphere can couple to the surface is incorrect. Almost all of the downward LWIR flux that reaches the surface originates from within the first 2 km layer of the troposphere. Approximately half of this downward flux originates from the first 100 m layer. This is shown in Figure 4. Linewidth effects are considered in more detail in '*The Greenhouse Effect*' [Clark, 2019d]

5) The Slab Ocean Model

The first Hansen et al error described an M&W type climate model in which the 'surface with zero heat capacity' was replaced by a 2 layer 'slab' ocean model. The upper layer was a 'mixed' layer, 100 m thick and the lower layer included everything below this. The ocean 'slab' added heat capacity and a delayed thermal response, but little else. The surface energy transfer was ignored. The penetration depth of the LWIR flux into the ocean is approximately 100 micron. In this layer, the LWIR flux is fully mixed with the wind driven evaporative flux. The small increase in flux from CO_2 cannot couple below this layer and produce any measurable change in ocean temperature.

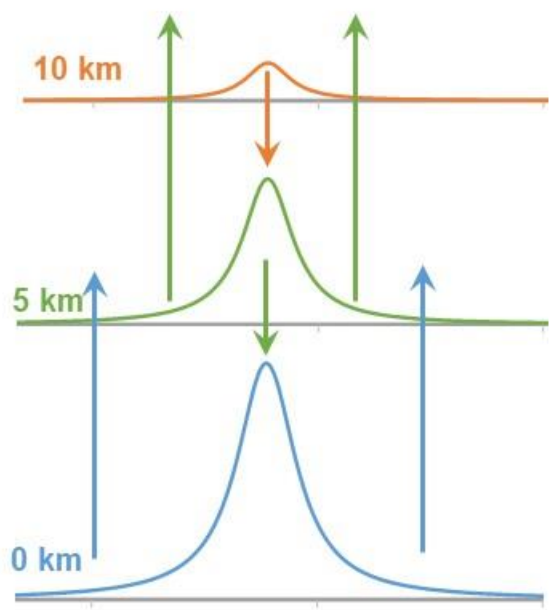

Figure 3: Transition from absorption-emission to free photon flux as the linewidth decreases with altitude. H_2O line near 231 cm^{-1}.

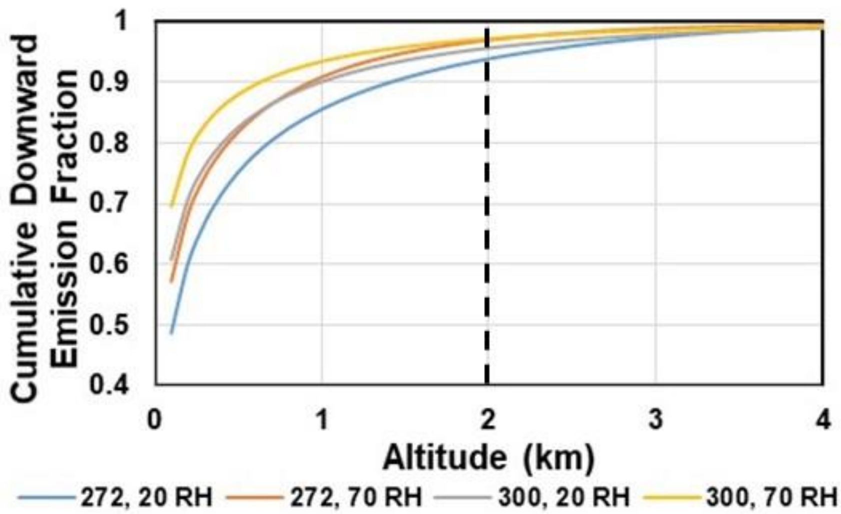

Figure 4: Cumulative fraction of the downward flux at the surface vs. altitude for surface temperatures of 272 and 300 K, each with 20 and 70% RH. Almost all of the downward flux reaching the surface originates from within the first 2 km layer. This is the location of the lower tropospheric reservoir.

In more quantitative terms, the increase in downward LWIR flux at the surface produced by a 120 ppm increase in atmospheric CO_2 concentration is approximately 2 W m^{-2}. Within the ±30° latitude bands, the rate of evaporation per unit wind speed is at least 15 W m^{-2} /m s^{-1}. [Yu et al, 2008, Clark 2019a, b]. The 2 W m^{-2} increase in flux from CO_2 concentration is equivalent to a change in wind speed of approximately 13 cm s^{-1}. Ocean wind speeds may easily vary over a range of 0 to 12 m s^{-1}, with additional short term higher speed wind gusts. This means that the increase in flux from CO_2 is simply overwhelmed by the magnitude and variability of the wind driven evaporation. The whole 'equilibrium climate response' argument is invalid.

6) Radiative Forcing

The second Hansen et al error was the introduction of radiative forcing. It is well known that an increase in surface temperature produces an increase in the OLR emission to space. The OLR response is approximately linear in surface temperature [Koll and Cronin, 2018]. Radiative forcing assumes that this process works in reverse. A calculated decrease in OLR flux produced by an increase in 'greenhouse gas concentration' leads to enhanced surface heating. Unfortunately, this is not the case. The increase in downward LWIR flux is blocked by the increase in molecular linewidth at lower altitudes. In addition, any increase in LWIR flux at the surface cannot couple into the ocean and produce a measurable rise in temperature. The penetration depth of the LWIR flux into the oceans is 100 micron or less. Radiative forcing is nothing more than a prescribed mathematical ritual with no basis in physical reality.

7) The Switch from Surface to Weather Station Temperature

The third Hansen error was a 'bait and switch' tactic. They substituted the weather station temperature for the surface temperature. The weather station temperature is the meteorological surface air temperature measured in a ventilated enclosure 1.5 to 2 m above the ground [Oke, 2006]. Even M&W is quite clear that the flux terms interact with the surface. This is a fundamental change in the model output variable. There was no discussion of the implications of this change. Nor were any changes made to the modeling algorithms to include the additional heat transfer processes involved. The change was concealed in the 'climate sensitivity constant'. Surface energy transfer and surface temperature are discussed in more detail in a separate note and by Clark [2019a].

Conclusions

The equilibrium climate models have failed. They consistently predict higher climate temperatures than those observed. The root cause of the failure can be traced back to the simplifying assumptions used to develop the early climate models. In particular, the assumptions made by M&W in 1967 created four fundamental scientific errors and Hansen et al by 1981 had added another three. These errors mean that the models must fail even before any computer code is written. The early model developers chose mathematical simplicity over physical reality. This created global warming as a mathematical artifact of the modeling assumptions.

Unfortunately, Eisenhower's warnings on the corruption of science by government funding have come true. Predictions of global warming have become a very lucrative source of research funding. The scientific method in climate science has collapsed. The peer review process has been abandoned in favor of blatant cronyism. Various political and environmental groups are using global warming to further their own agendas. The equilibrium climate hypothesis has degenerated into an unpleasant quasi-religious cult that supports a multi-trillion dollar fraud. Irrational belief in fraudulent climate models has replaced physical reality. In order to restore the scientific method to climate science, a massive fraud that extends to the highest levels of government must be dismantled [Clark, 2019e].

References

Arrhenius, S., Philos. Trans. **41** 237-276 (1896), 'On the influence of carbonic acid in the air upon the temperature of the ground'

Charney, J. G. et al, Carbon Dioxide and Climate: A Scientific Assessment, Report of an ad hoc study group on carbon dioxide and climate, Woods Hole, MA July 23-27 (1979), https://www.bnl.gov/envsci/schwartz/charney_report1979.pdf

Christy, J. R., GWPF Note 17, 2019, 'The Tropical Skies, Falsifying Climate Alarm', https://www.thegwpf.org/content/uploads/2019/05/JohnChristy-Parliament.pdf

Clark, R. 2019a, '*A Dynamic Coupled Thermal Reservoir Approach to Atmospheric Energy Transfer Part III: The surface Temperature*', Ventura Photonics Monograph, VPM 004.1, Thousand Oaks, CA, May 2019

http://venturaphotonics.com/files/CoupledThermalReservoir_Part_III_Surface_Temperature.pdf

Clark, R. 2019b, '*A Dynamic Coupled Thermal Reservoir Approach to Atmospheric Energy Transfer Part IV: The Null Hypothesis for CO_2*' Ventura Photonics Monograph, VPM 005.1, Thousand Oaks, CA, May 2019

http://venturaphotonics.com/files/CoupledThermalReservoir_Part_IV_The_Null_Hypothesis.pdf

Clark, R. 2019c, '*A Dynamic Coupled Thermal Reservoir Approach to Atmospheric Energy Transfer Part V: Summary*', Ventura Photonics Monograph, VPM 006, Thousand Oaks, CA, May 2019

http://venturaphotonics.com/files/CoupledThermalReservoir_Part_V_Summary.pdf

Clark, R. 2019d, '*The Greenhouse Effect*', Ventura Photonics Monograph, VPM 003.2, Thousand Oaks, CA, May 2019

http://venturaphotonics.com/files/The_Greenhouse_Effect.pdf

Clark, R. 2019e, '*50 Years of Climate Fraud*', Ventura Photonics Monograph, VPM 002.1, Thousand Oaks, CA, May 2019

http://venturaphotonics.com/files/50_Years_of_Climate_Fraud.pdf

Clark, R., 2013a, Energy and Environment **24**(3, 4) 319-340 (2013), 'A dynamic coupled thermal reservoir approach to atmospheric energy transfer Part I: Concepts'

http://venturaphotonics.com/files/CoupledThermalReservoir_Part_I_E_EDraft.pdf

Clark, R., 2013b, Energy and Environment **24**(3, 4) 341-359 (2013) 'A dynamic coupled thermal reservoir approach to atmospheric energy transfer Part II: Applications'

http://venturaphotonics.com/files/CoupledThermalReservoir_Part_II__E_EDraft.pdf

Koll, D. D. B and T. W. Cronin., PNAS, www.PNAS.Org/Cgi/doi/10.1073/pnas.1809868115 pp. 1-6 (2018), 'Earth's outgoing longwave radiation linear due to H_2O greenhouse effect'.

Oke T. R., WMO/TD-No. 1250, World Meteorological Association, 2006, '*Initial guidance to obtain representative meteorological observations at urban sites*'

Yu, L., Jin, X. and Weller R. A., *OAFlux Project Technical Report* (OA-2008-01) Jan 2008, 'Multidecade Global Flux Datasets from the Objectively Analyzed Air-sea Fluxes (OAFlux) Project: Latent and Sensible Heat Fluxes, Ocean Evaporation, and Related Surface Meteorological Variables' http://oaflux.whoi.edu/publications.html