The Effect of Water Vapor and Clouds on Temperature

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The Intergovernmental Panel on Climate Change (IPCC) with the UN was originally formed to determine the *human* effect on rising temperatures. They have never really attempted to find *natural* effects caused by solar variations or for that matter any other GHG other than CO_2. Water vapor is the GHG having a much larger effect on solar input and outflow to and from our global system than any of the other GHGs.

Figure 1. Picture of Solar Furnace Eppley pyrheliometer. Note the equatorial style tracking mount and clock drive.

I worked at the White Sands Missile Range solar furnace, which is located in the Chihuahuan desert of New Mexico, in the early 1980s. Daily solar input to the surface at the furnace location was measured with an Eppley pyrheliometer. The instrument was calibrated on a regular basis and the shortwave solar input value was measured in watts/m^2.

Seasonal solar noon readings gave us some interesting data. Readings during the summer monsoon rainy season on cloudless humid days averaged about 850 watts/m^2, while during the very dry autumn days at solar noon they were from 950 watts/m^2 to up to 1100 watts/m^2.

Figure 2. Picture of WSMR Solar Furnace with Organ mountains in the background.

The high water vapor content during the apparently clear days in the summer months significantly decreased solar input, while the very dry autumn fall and winter months allowed a large amount of solar energy to reach the earth's surface. CO_2 radiative effects are apparently about 4 watts/m^2 max. Thick clouds decreased the Eppley readings to zero. Thin clouds and aircraft contrails dropped overall readings to somewhere between 100 to 300 watts/m_2 at most.

Clearly effects from clouds and water vapor have a very large direct effect on incoming solar short wave radiation before any kind of long wave radiative effects from CO_2 can be seen. At night especially in the desert southwest clouds can be a very large factor in reducing radiative heat to space which on normally clear nights lose heat rapidly and turns cool in summer and very cold in winter.

Early morning and late afternoon readings (8am and 5pm) were quite low (down by half or more) even in the summer months. On clear autumn mornings Eppley readings could be seen rising very quickly once the sun had risen a few tens of degrees above the horizon.

Volcanic Eruptions of El Chichon 1982

The gases and aerosols from this volcano were blown so high into the atmosphere that they stayed up and were carried in a world wide pattern that lasted for more than a year. Within 3 weeks the stratospheric cloud had spread all around the world. Eppley readings in the spring of 1981 were compared to those of the spring of 1982 when El Chichon erupted and we noticed immediately that the difference in those readings dropped by 100 watts/m^2 and stayed close to that value for more than a year. Equatorial eruptions of this sort seem to put lots of material very high in the stratosphere and due to the nature of the winds aloft keep it up for a long time.

Clearly these blocking mechanisms can cause a very large decrease in short wave incoming solar radiation. Whatever fairly small radiative reduction of the reflected radiation by CO_2 of outgoing radiation is further diminished by this significant decrease in the incoming radiation from the sun

About the Furnace

The moveable tracking heliostat at the right side of Figure 2 consisted of 366 2'X2' flat glass mirrors that were mounted on a 4 story tall moveable structure. The fixed concentrator array seen at the left of Figure 2 is made up of 180 optically polished concave glass mirrors that are focused on a small 2.5 inch spot above a moveable test table found in the left end of the small rectangular building in the middle of the picture (two floors up). The furnace was originally at Natick, Massachusetts but was moved to WSMR due to a much more favorable solar environment. On a good day at noon the furnace can collect 30 kilowatts of solar thermal energy in the small spot for about 2 hours continuously.*

The structure just to the left of the test building is the attenuator shutter blinds assembly that can be rotated from full shut to fully open in a few seconds. In the shut position the concentrator is shaded from the full sun of the heliostat. Adjusting the shutters can give 0 to 100% energy in small increments.

The main task of the WSMR solar furnace was for nuclear bomb thermal effects testing. Materials testing was the main focus of these nuclear effects events. General testing of materials under

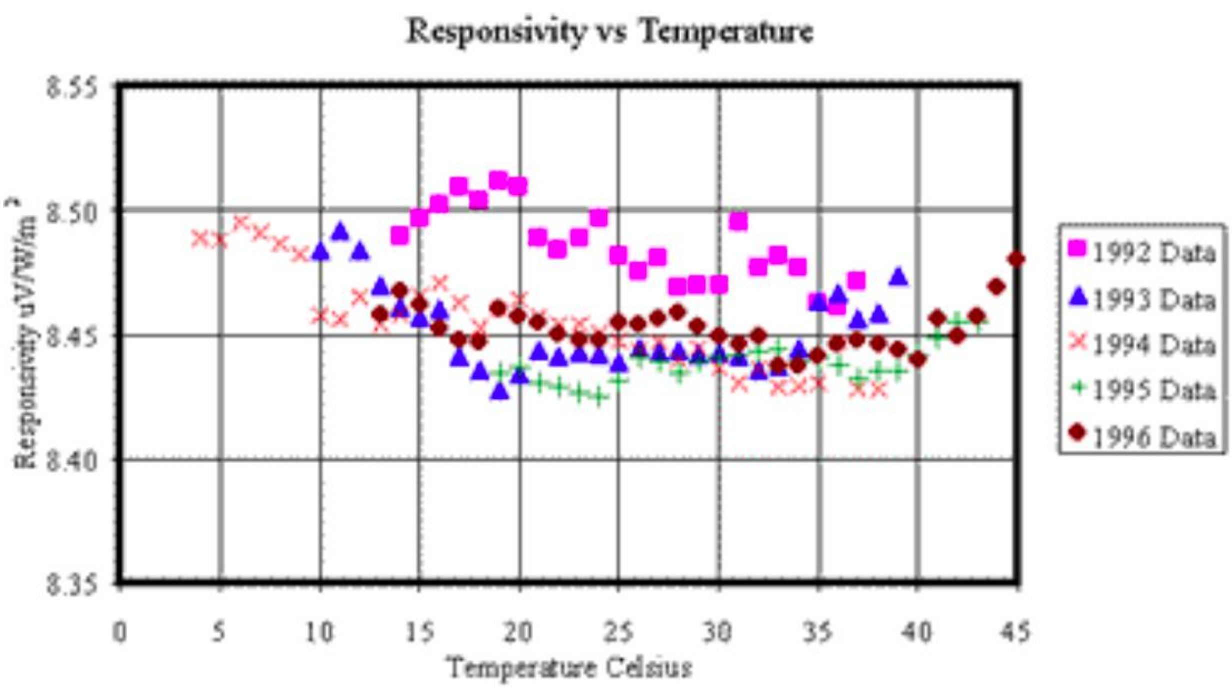
* When I worked in the 1960s on a mobile satellite tracking system that was deployed world-wide to often remote sites, we used old WW II small pick-up sized diesel generators that produced about 30 kw of electricity (just to give an idea of energy density)

Solar energy projects for emerging technologies were carried out at the furnace. One unusual project was solar high temperature extraction of oil from shale. This was well before fracking of in situ shale formations was found to liberate much of the oil from those deep and high pressured fractured structures. A number of tests of high temperature ceramic and foam protective materials were done at the furnace.

Eppley Normal Incidence Pyrheliometer (NIP) Specification

This instrument is a World Meteorological Organization (WMO) First Class Pyrheliometer designed for the measurement of solar radiation at normal incidence. The NIP incorporates a wire-wound thermopile at the base of a tube. The aperture subtends an angle of 5.725 degrees.

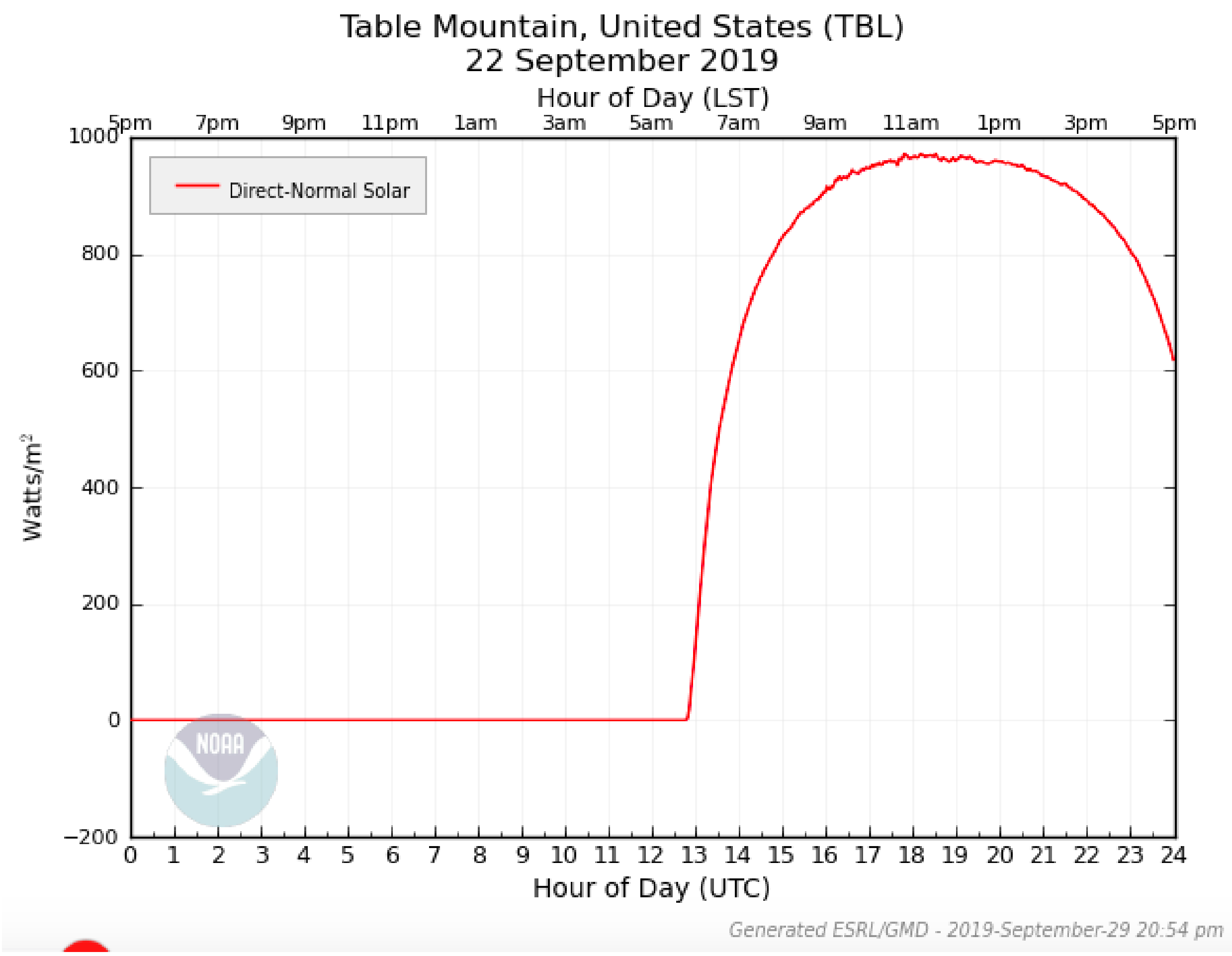
The sensitivity is approximately 8 micro volts/watts/m^2. The temperature dependence is +/-1% over an ambient temperature range of -20 to +40^o C. Linearity is +/-0.5% from 0 to 1400 W/m^2. The spectral range is 250-3000 nm.



Conclusion

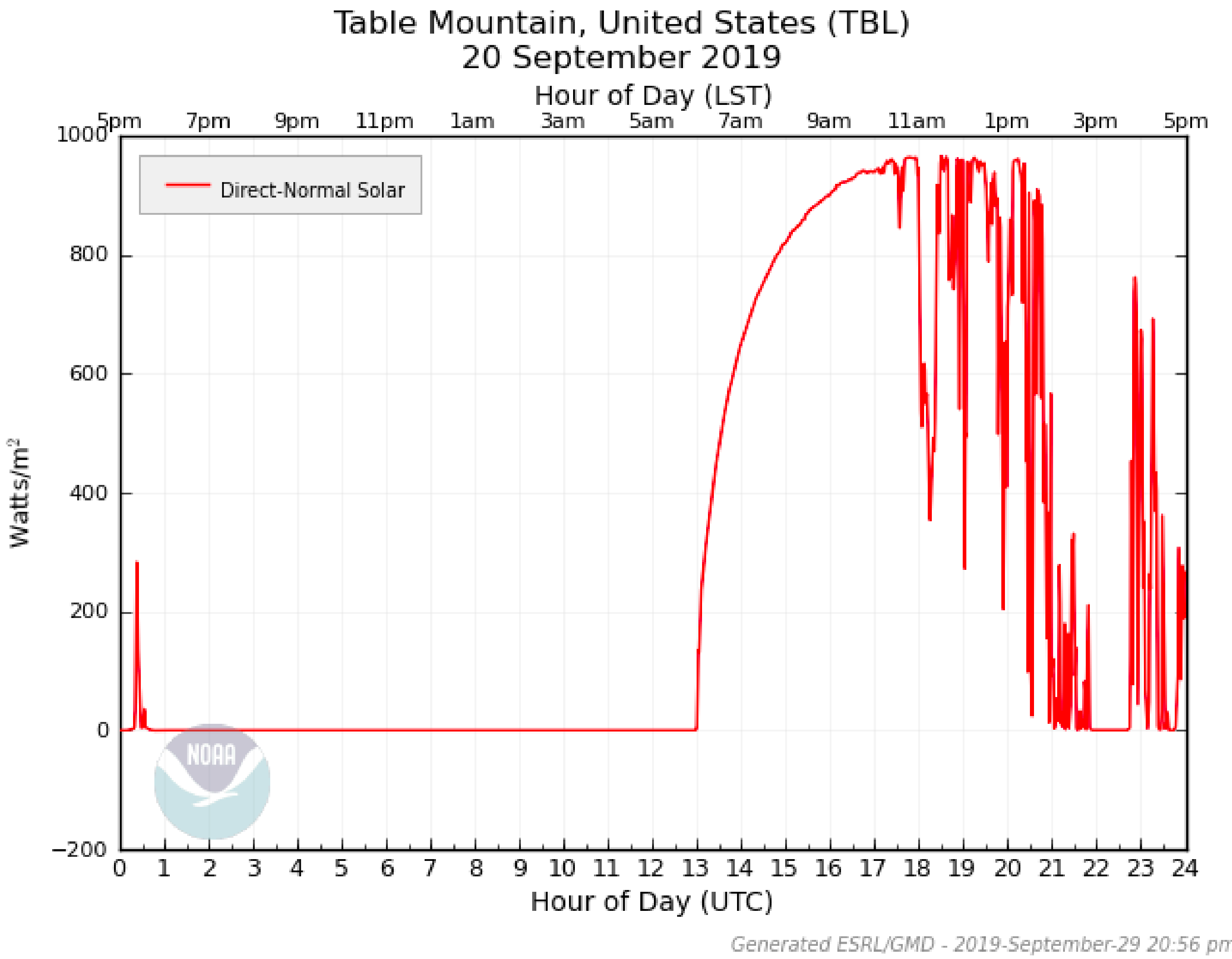
I no longer have actual data charts since, at the time that I worked at the furnace, I really did not foresee any climate implications. Data like this is still being collected by NOAA SURF RAD sites. Look here: https://www.esrl.noaa.gov/gmd/grad/surfrad/

Here is a recent really good cloudless day reading from one of the Colorado SurfRad sites.

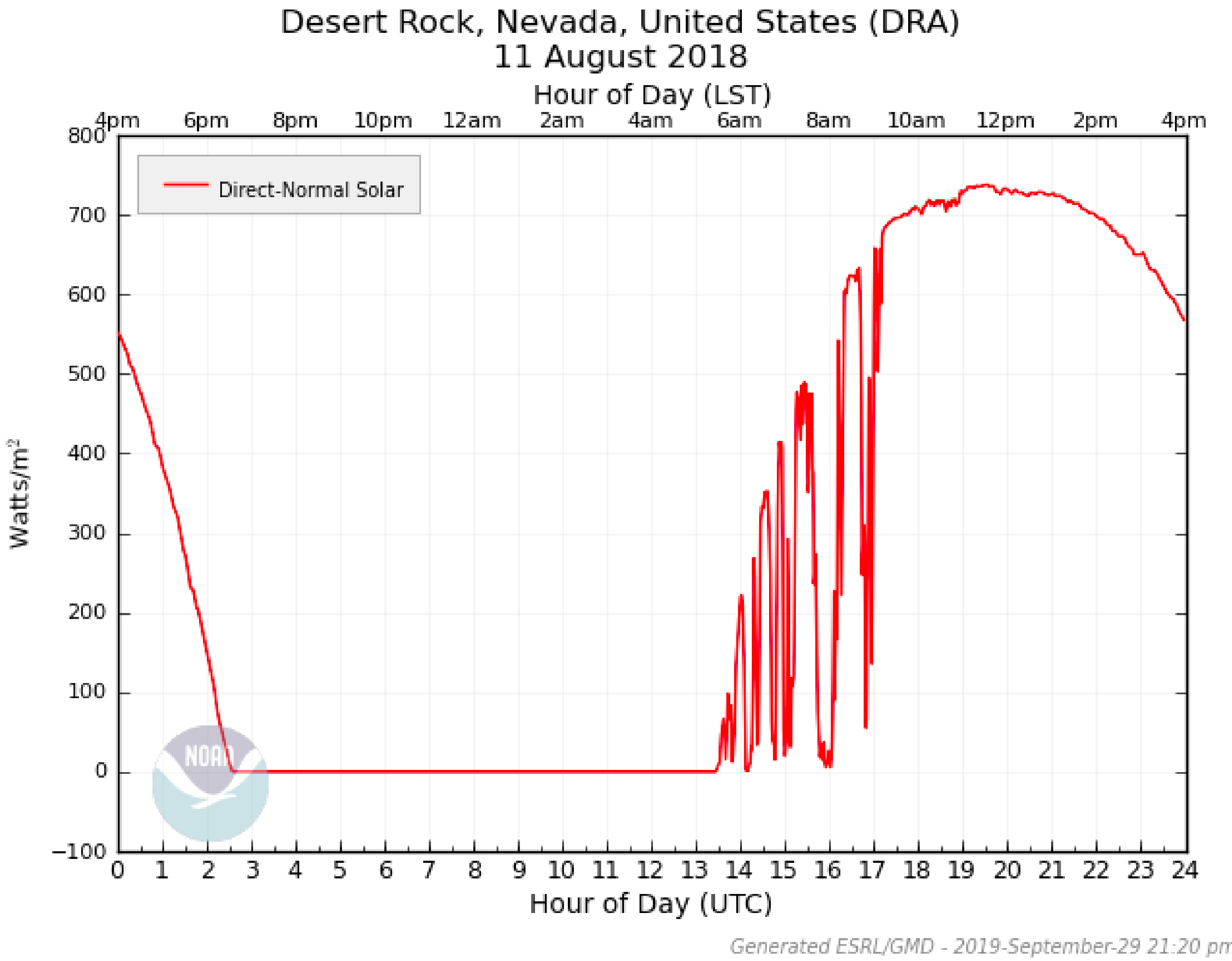


With both volcanic activity and summer water vapor the above 950 watts/m^2 at solar noon could be as low as 700 watts/m^2. And fall plots might be 1000 to 1050 watts/m^2 when the fall moisture content drops to very low levels.

And an earlier time a few days before the above run shows the dramatic effects of clouds. An integrated value of solar input for this 20 September plot might be lower by 50% than it would be for the plot two days later shown on the previous page.



Here’s an August plot for last year from Nevada that indicates summer monsoon noon readings of only 750 watts/m^2:



Data from these NOAA sites, depending on the times and years that are available, could easily document my findings in the 1980s and validate these large “forcings” from water vapor and volcanic gases and particulates that I saw at that time. The tiny at most 4 watts/m^2 forcing from CO_2 is probably less than 5% of what the effects from water and volcanic activity are known to be. CO_2 effects compare more closely to small changes in solar irradiance values at the top of the atmosphere during long term solar cycles. Since the Maunder Minimum, solar irradiance has increased by 3%.