Preparing Your Community for Extreme Heat Events

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Session One: Dimensions of the Threat

Extreme heat events have become the most lethal weather disasters in the world. While cyclones cause more monetary damage, heat is more deadly both as long-term heat build-ups and as rapid meteorologic developments. The past ten years have seen their growth in numbers and intensity.

Historical Disasters: In these days of Climate Crises, history of lethal heat doesn't go back very far.

- 2003 European Heat wave. 30 days of temps over 100F. Excess deaths more than 70,000.
- 2010 Russian Heat Wave. Two months of temps over 100F. Excess deaths over 56,000.
- 1980 South and Midwest US Heat Wave. Four months of temps over 108F. Deaths up to 10,000.
- 2015 Indian Heat Wave. Week of temps over 118F. Deaths at least 2,500.
- 2015 Pakistan Heat Wave. Week of temps over 120F. Deaths over 2,000.
- 2021 West Coast Heat Wave. Month of temps up to 150F. Excess deaths of more than 1000.
- 1995 Chicago Heat Wave. Month of temps up to 106F. 739 deaths including 215 on July 15.

- **Causation:** Intense heat events are a direct cause of general heating of the earth's surface as caused by an increase in the heat-holding capacity of the earth's atmosphere in turn caused by build-up of "Greenhouse Gases" (**GHG**) including Carbon Dioxide, Methane, Sulphur Dioxide, Nitrous Oxide, and a myriad oil organic compounds. While small quantities of these gases have been sourced by natural processes such as respiration of animals, vulcanism, forest fires, and others that have happened throughout the earth's history. The level of GHGs has remained remarkably steady for the past 12,000 yrs since the last glacial stage at approximately 250 ppm.

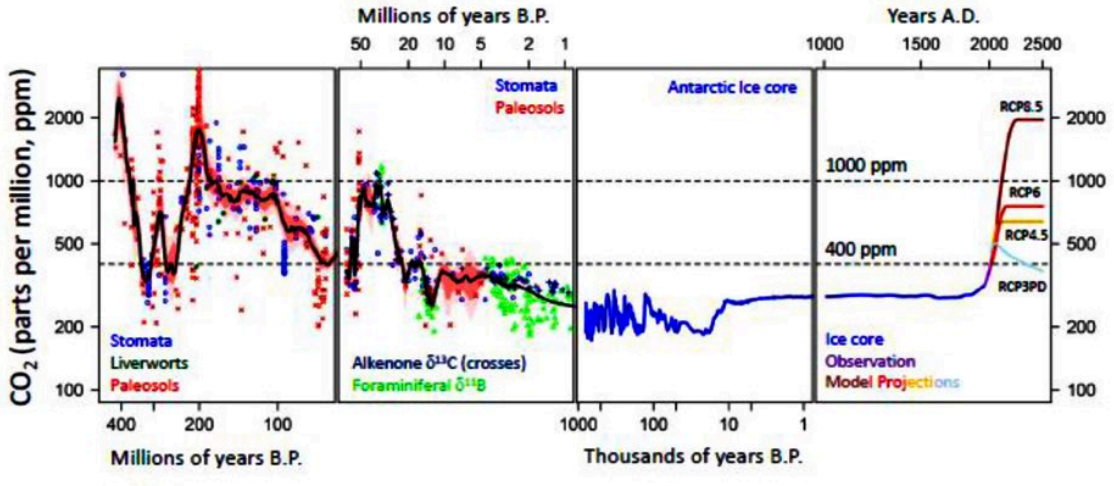


Exhibit 1: Source: Foster et al — "Descent into the Icehouse"

As shown in **Exhibit 1,** starting with the dawn of the Industrial Age about 1750, the level of GHGs began gradually increasing so that by 1950, the level was over 300 ppm. At that point enormous amounts of coal and oil were burned to raise global CO2 levels to approximately 421 ppm today.

So closely do CO2 levels parallel surface temperature that we can think in terms of temperature. The graph in **Exhibit 2** shows the average surface temperatures and CO2 emissions since the time of Charlemagne (1000 BP). The graph is wobbly but within a narrow range until WW1 and then rises at an accelerating rate up to today.

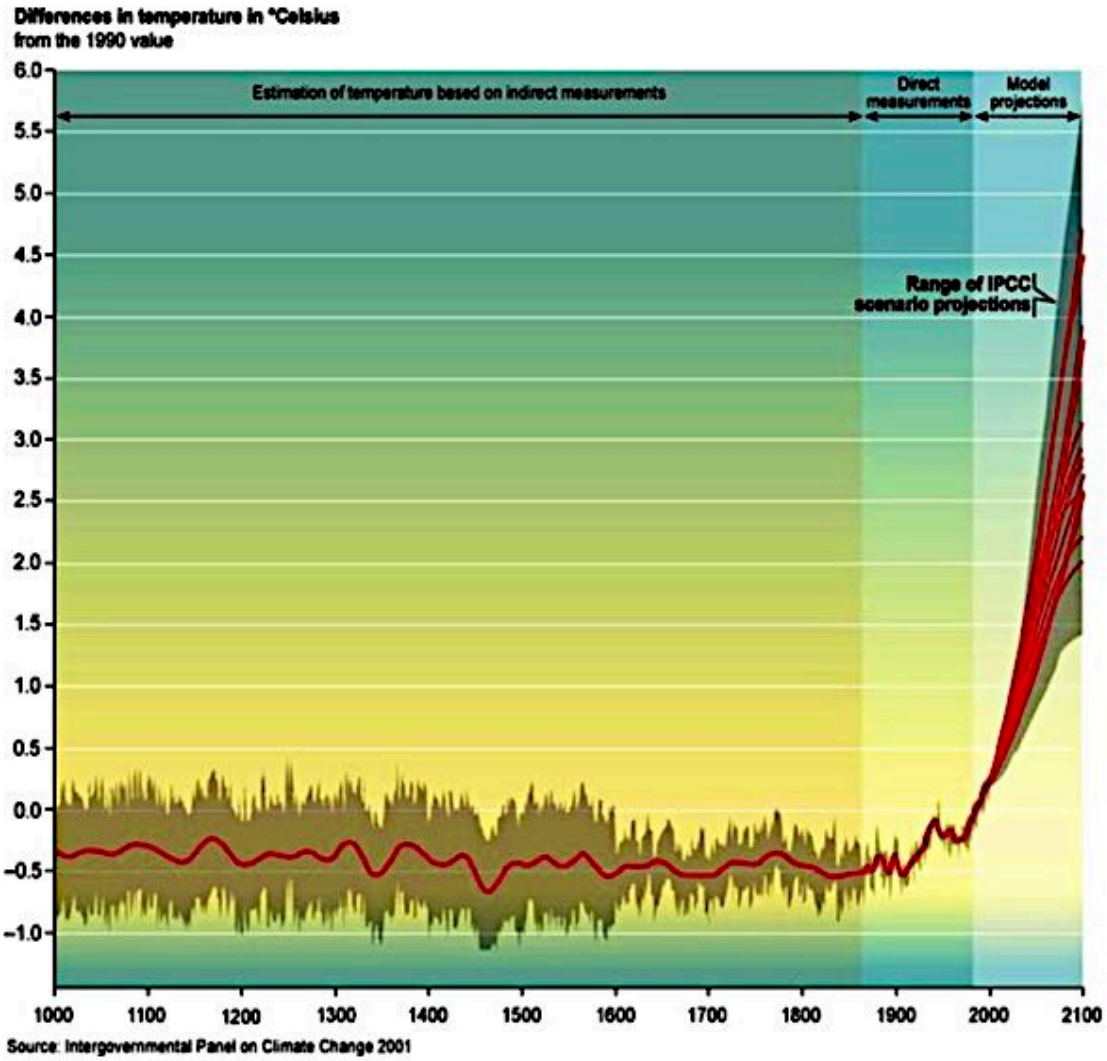


Exhibit 2

Exhibit 3 details the interesting portion of the previous temperature graph and documents a very brief temperature rise during WW1 and a larger one during WW2. The most important part of the graph is the steady rise in temp starting 1970 to approximately 1980. Beginning in 1980 graph becomes chaotic. Also shown are the points of "Super El Nino" where we seemed to be headed at the present. The green trend line at .18C/decade has persisted since approximately 1970 and is approximately also where we are at present but there have been interesting perturbations. "Super El Nino events have influenced temperatures more than other El Nino events in the past 50 years.

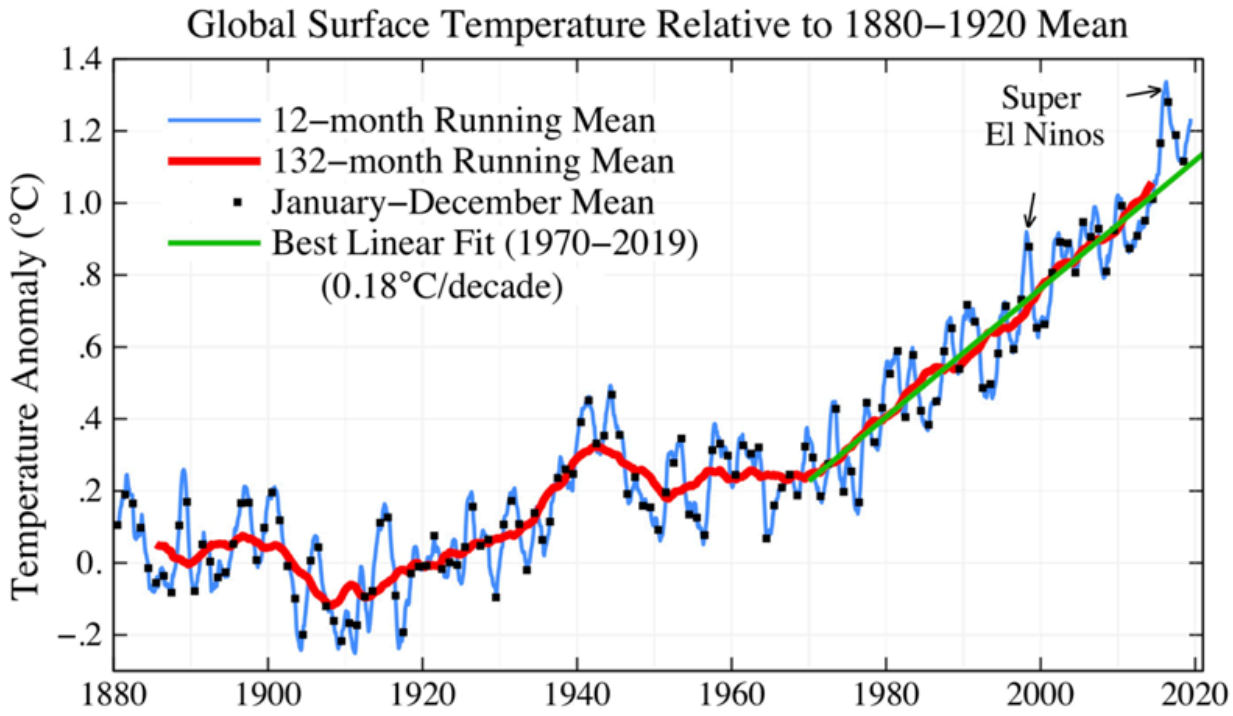


Exhibit 3

"Super El Ninos" are identified in **Exhibit 4** at 1982, 1998, and 2017; these events elevated temperatures more than other El Ninos and are above the trendline of 0.18C/ decade. The 1982 event raised the average temperature by approximately 0.02C, the 1998 event by approximately 0.04C, and the 2017 event by approximately 0.10C. The intervals between the Super El Ninos sees the return to the 0.18C/decade. We appear to be heading toward a Super El Nino in 2023 or 2024, suggesting that this next event may bring us close to an average surface temperature of approximately 1. 40C above the later Industrial Age of 1880 to 1920. Such a Super El Nino may very well place the global average at about 1.86C in 2050 plus the step-functions of Super El Ninos between now and then.

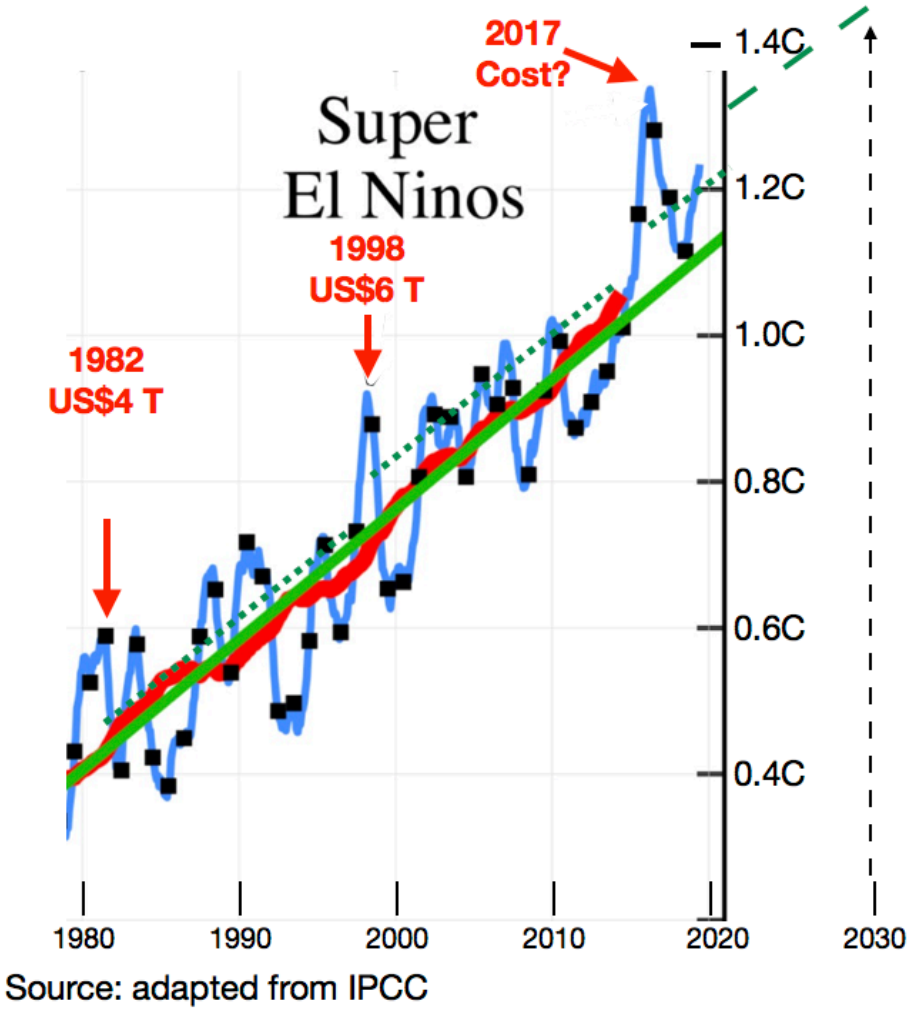


Exhibit 4

- **La Nina or El Nino?** Global atmospheric circulation systems exert powerful effects on the world's weather on a multi-year, erratic time-table. El Nino circulation causes higher levels of warming to the Pacific Ocean waters while La Nina patterns delays heating to those same waters. The temperature effects also influence widespread humidity patterns to affect storms. We have seen how the presence of Super El Ninos have exaggerated global heating in the past 20 years and La Ninas have slightly slowed heating in the past three years.

- **Immediate and Long-term Health Effects:** Extreme heat has well known health effects — heat cramps, rash, swelling, heat exhaustion, and heat stroke — to people in its path but these are the immediate effects. More important is the long-term damage to cardiovascular and respiratory systems as well as aggravation of existing conditions such as diabetes and asthma. Serious heat exposure damage is also cumulative. People do not build up a tolerance to extreme heat, they build up damage to vital systems within their bodies. **Exhibit 5** diagrams the many physiological pathways of human heat strain (Source: **https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(21)01208-3/fulltext**) .

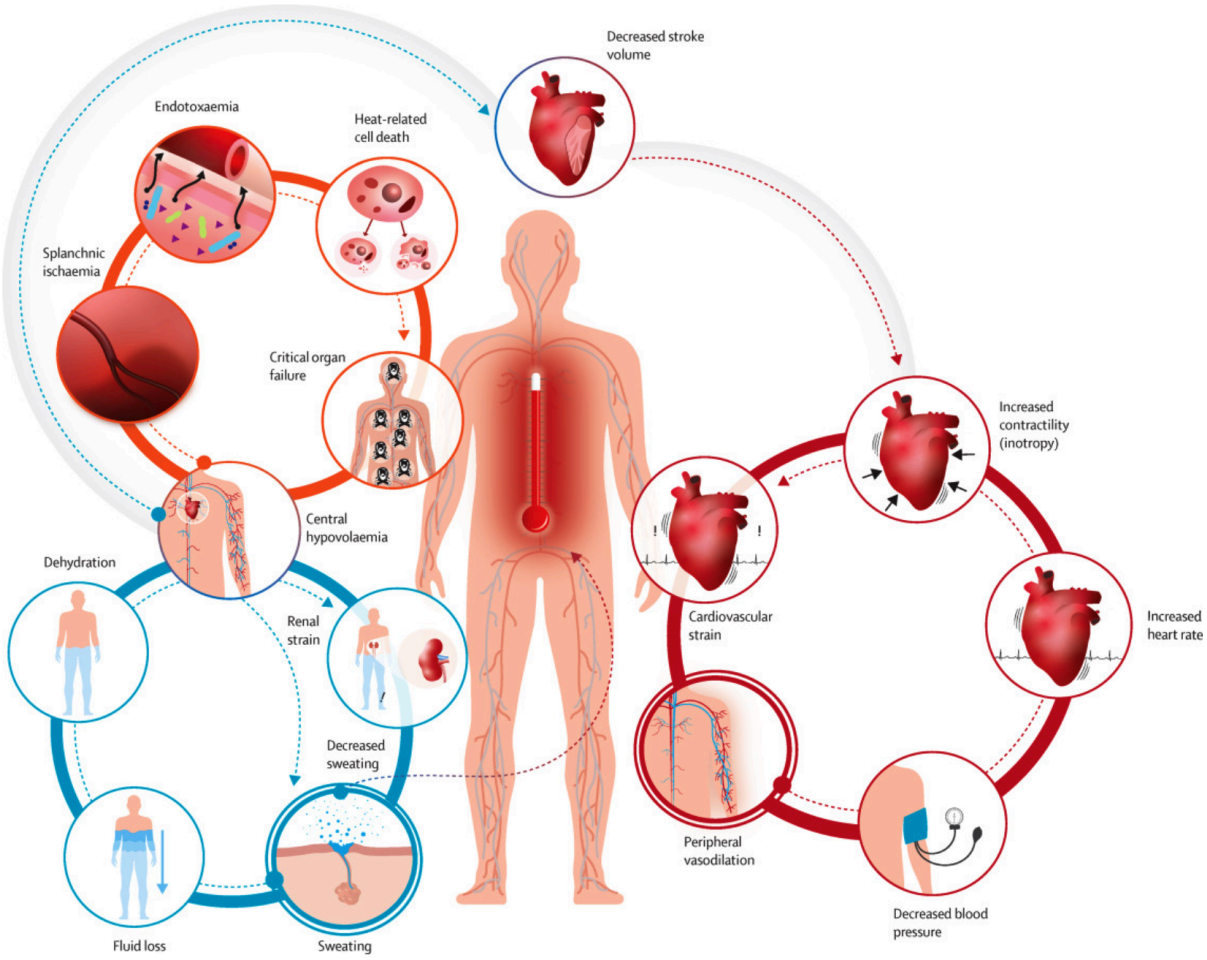


Exhibit 5: Examples of Physiological harms from Extreme Heat

- **Cascading Crises:** Extreme heat events are often so strong that they lead to other disasters such as droughts, regional power failures, breakdown of safety systems, and the breakdown of health services.
  - **Droughts** accompany heat events when hot air drys out the ground. This can happen very quickly when a "flash drought" occurs. The Southern Great Plains suffered through a flash drought in 2022 and the Northeast also experienced one in 2021. Both damaged valuable crops and the Great Plains saw the death of thousands of livestock. Droughts can lead to economic hardship on a huge scale, causing residents to lose their very livelihood and emigration.

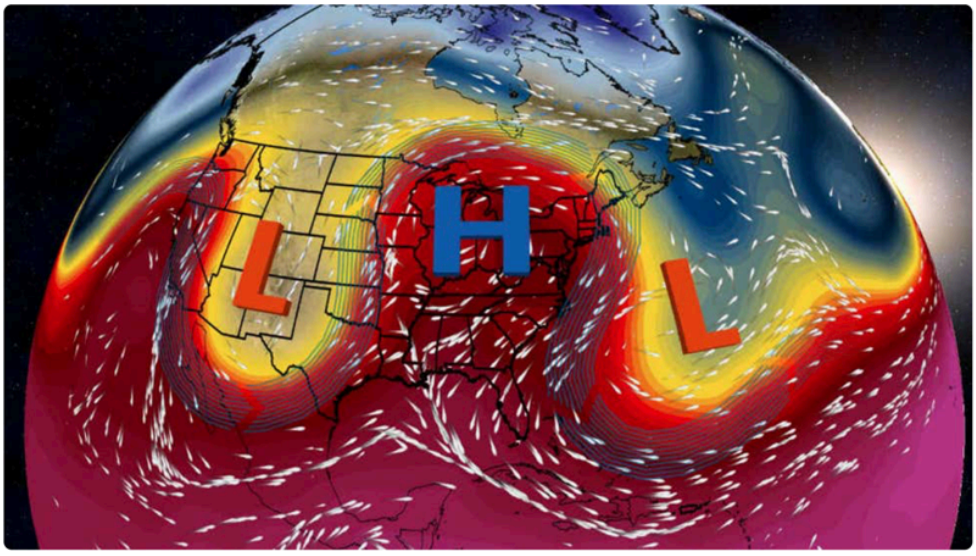
- **Power outages** are often caused by heavier-than-average use of air conditioning and damage to electric grid equipment. Such outages can last weeks and cause a major increase in fatalities, especially among those confined indoors.

- **Breakdown of safety systems:** Extreme heat often leads to overcoming "911" systems, complete loss of ambulance service, and collapse of public peace and safety. The West Coast heat dome of 2021 led to the loss of 911 systems and ambulance service in many communities. Indeed many people died waiting for 911 operators to pick up their calls and waiting on ambulance personnel. Fire and police departments were overwhelmed during the days of the heat dome.

- **Breakdown of healthcare:** Clinics and hospitals can be

- **Unknown major outcomes:** Lethal heat extremes will certainly lead to wholesale movement of populations, the nature of which will depend on the timeline for the heat event. A heat-dome lasting for several days will lead to evacuations of cities and their urban heat-islands but a continent-wide "Omega Block" pattern can remain in place for a month or more and would cause emigration into neighbouring states or countries and stresses upon local resources.

Omega Block



Omega High Centered Over Ohio Valley Into Early Week

Source: The Weather Channel

The "Super El Nino" of 1998 was a US$6 Trillion chain of catastrophes while the 2017 "Super El Nino" was a similar chain of unknown total worldwide costs.

- **Multiple or Cascading Risks:** Modern Risk Analysis has been a common tool of public health for several decades but in that time few attempts have been made at formulating a methodology for combining risk agents. For example, the US EPA has published countless reports comparing the potency of various acute (one-time or short-term dosage) and chronic (recurring doses) toxins. Some studies differentiate between adult and child receptors but never do the studies compare healthy versus unhealthy receptors likewise the An excellent example is the hydrocarbon Benzene (C_6H_6), a common ingredient in motor fuels and industrial feedstocks. The EPA has determined that Benzene is only a "probable" human carcinogen as a pure chemical. The EPA has never tried to determine if it is a "proven" carcinogen when combined with other common hydrocarbon vapours or when the exposed individuals are asthmatic, smokers, or are otherwise pulmonarily compromised even though such people make up a significant portion of adults. Combined risk factors can be extremely important.

  Environmental Impact Analyses (EIAs) are vital for describing cost-benefit conclusions for regulators and planners who all need accurate information; if their information is incomplete, conclusions will also be incomplete. Planning officials will not be able to accurately predict health effects from extreme heat events unless government hygienists publish full health outcome scenarios. How to determine the effects of six hours of temperatures above 90F (32C) if all that's available are charts applicable for healthy adults 25 to 40 years of age? If your community contains a majority of residents over 60 years of age with an unknown percentage suffering from asthma or COPD?

Update: A new article ***(Indicators of Global Climate Change 2022: annual update of large-scale indicators of the state of the climate system and human influence, Earth Syst. Sci. Data, 15, 2295–2327, https://doi.org/10.5194/essd-15-2295-2023, 2023.)*** updates rate of CO_2 increase, CO_2 global emissions, and global average surface temperatures. According to the newest data, surface temperature average across the globe is currently 1.4C above the 1850 to 1900 baseline. More importantly, the rate of increase has increased to 0.20C per decade; this means we will cross the Paris Accord limit of 1.5C average during 2028. This new report does not take into account the likely influence of "Super El Nino" events in the next three years.

Another new article by the Australian Bureau of Meteorology (Dated June 17, 2023) released that day's modelling that forecasts the current Super El Nino as raising the world's average surface temperature by 3.2C by November of 2023. If this proves to be correct, it is catastrophic. Its impact on extreme heat events cannot be predicted.

A second follow-up report appeared in ***The Guardian*** Oct 4, 2023: *Global heat is now Gobsmackingly Bananas*. The author sites several climate scientists' fears initiated by the Sept 2023 heat wave that raised global average surface temperatures to 1.8C. This jump of 0.4C is almost identical as that shown in **Exhibit 4** above. Both

of these step-functions caused by a powerful El Nino' event, one in 2017 and this one in 2023. Note in **Exhibit 4** that the rate of temperature rise did not go down to the base rate. This certainly suggests that the internationally approved 1.5C limits has been passed this year. All bets are off for global temperatures in 2030 or 2050.

Sessions two through four to be added in to this series in the weeks to come.