A STORM IN A TEACUP

Al Gore points to the recent storms, floods and bushfires in Australia and around the world as proof of impending Climate Armageddon. Professor Flannery, an advisor to the Australian Government, expands on the theme and warns of catastrophic weather events. Our politicians[1] unthinkingly accept all these assertions. A leading Green scientist from Hadley's Climate Research unit in the UK asserts that the days of extensive snow in the UK are gone forever, all because of dangerous global warming. These assertions are then repeated over and over until they become factoids, but not facts.

Although "catastrophic weather events" are rarely defined, in any discussion about such events it is implied they would be significantly more powerful than "normal" events. Unfortunately, the extra energy provided by global warming in the twentieth century is so small no-one will be able to detect the effects of global warming on weather events. Even the most alarming predictions for the future will still not provide enough energy to cause a detectable change in our weather.

This handout will first identify the elements of our weather and what drives changes in our weather. Finally, it will measure the change in energy that global warming has caused between 1900 and 2000, and examine the idea that, today, people can easily identify the dangerous weather events caused by man-made global warming.

ELEMENTS OF WEATHER

When describing our weather, you will hear terms like; a wet and windy day, it was hot and humid, it was cold and cloudy, and the cyclone brought torrential rain and extreme winds. So, our weather seems to be made up of the following elements:

- Air temperature,
- Wind speeds,
- Humidity,
- Clouds, and
- Various forms of precipitation (e.g. rain, snow, sleet)

Air Temperature. It is predominantly air temperature that gives us what we call cold, warm, or hot days.

Winds. Lack of any wind will give us 'still days', changing wind speed will give us gusty winds, and steady winds can range from speeds of a few kilometres an hour to hundreds of kilometres per hour seen in cyclones.

Humidity. Evaporation of water leads to water vapour in the atmosphere and gives us varying degrees of humidity.

Clouds. Given the right circumstances, evaporated water can condense into small droplets and form clouds.

Precipitation. When the size of the droplets of evaporated water in clouds become large enough, precipitation occurs. We can then experience rain, snow, hail etc.

At this stage we should note the interrelationship between evaporation, and the three elements of weather; humidity, clouds and precipitation. Without evaporation we cannot get humidity, clouds or precipitation. It also should be noted that although evaporation will always lead to humidity, it will not necessarily lead to clouds and then precipitation. Likewise, just because clouds are formed there is no certainty that precipitation will occur. However, if there are perfect conditions for cloud formation and precipitation, then all the evaporated water (causing humidity) ***may*** fall as rain or other forms of precipitation.

Consequently, it can be argued that there are only three primary elements of weather: air temperature, evaporation, and winds.

ENERGY DRIVES OUR WEATHER

The Greens tell us that man-made global warming will lead to catastrophic or dangerous weather. So how will this happen, or more specifically, what drives our weather? Energy is the driver behind the three primary elements of weather. Any increase in global warming will produces additional thermal energy that may drive the weather.

Air Temperature. For any given mass of air it will take one unit of thermal energy to raise its temperature by one degree. If you wish to raise the temperature by another degree, this can only be done with a second unit of thermal energy of the same size. Each increase in every degree of temperature will require the same unit of energy to be added. Assuming that there is no heat loss, the relationship between temperature and thermal energy is a linear relationship[2].

Evaporation. Thermal energy is the driver behind evaporation and in theory this is also a linear relationship[3&5]. Under perfect conditions you will need a unit of energy to totally evaporate a unit of water. You will need the same amount of energy to evaporate each and every additional unit of water. However, in practice, there are several variables that can degrade this one to one linear relationship[3]. However, none of these variables can enhance this linear relationship.

Energy is a perquisite for evaporation. Without energy, evaporation will not take place. As discussed before, this means that without energy there is no evaporation and consequently no cloud formation or precipitation.

Winds. Energy is needed to move a mass of air. In theory it will take one unit of energy to accelerate that mass of air to a certain velocity. If you wish to double the velocity of that mass of air you will need to double the energy. So once again we have a linear relationship between energy and wind speed^{4}. However, like evaporation, there are factors (e.g. friction) that can degrade this one to one relationship. However, none of these factors can enhance this linear relationship.

Unlike air temperature and evaporation which is solely driven by thermal energy (heat), wind is driven both by kinetic energy and thermal energy. Because of air friction, the rotation of earth transfers kinetic energy to the atmosphere and causes "wind". Because this handout is focussed on global warming, that is thermal energy that can vary with global warming, the effect of kinetic energy on winds will not be pursued. However, it should be remembered that any percentage increase in thermal energy driving the winds, will not result in the same increase in the total energy (kinetic and thermal) affecting winds. The percentage increase in thermal energy will cause a smaller percentage increase in the total energy that drives all winds.

The Greens' Stance. The Greens do not define what they mean by dangerous or catastrophic weather events, but by looking at the examples used in their global warming campaign, we are being led to believe that the change in weather caused by global warming will be very large. To achieve this very large change in our weather, man-made global warming must produce a very large increase in the thermal energy that drives our weather.

ENERGY PROVIDED BY GLOBAL WARMING

How much additional energy has global warming, both natural and man-made, contributed to the Earth's climate system's energy "budget" in the past century (1900-2000)?

We measure 'heat' (thermal energy) using thermometers. Although these thermometers use different scales, the use of the Kelvin temperature scale is the most useful in this case, as this scale was designed to measure thermal energy. When matter reaches zero degrees Kelvin, which occurs at minus 273.15 Celsius, there is no motion (i.e. no energy) within the molecules of that matter. Zero degrees Kelvin is a measure of no energy. For every degree Kelvin that we raise this temperature we will be adding the same amount of energy.

Although there is significant debate about the exact global temperature rise that has occurred from 1900 to 2000, let us accept the Greens' estimate of 0.7^{0}C.

Then for mathematical convenience let us assume that the rise is 0.86^{o}C[6], not 0.7^{0}C, and the average global temperature was 14.5^{o}C (or 287.65^{0}K) in 1900. By using these figures the percentage increase in energy that has been caused by global warming of 0.86^{0}C since 1900 **is 0.3%** (i.e. ((273.15 +14.5+0.86) - (273.15 + 14.5))/ (273.15 + 14.5) = 0.3%)

With only a 0.3% rise in the climate system's energy budget in 100 years, under perfect conditions, we will only see, on average, a 0.3% increase in air temperature, precipitation, and wind speeds. In less than perfect conditions, such increases will be smaller than 0.3%. What should not be forgotten is that part of this global warming has natural causes, so Man's contribution to this energy rise is even smaller.

In anyone's language this is a trivial increase over such a long period.

NATURAL WEATHER VARIATION

Most people today were not alive in 1900, so it is unrealistic to remember or gauge changes in our climate over this period. Most people would have difficulty remembering and detecting changes in our climate over a decade. Their task is made harder now as they have to detect an underlying rise of less than 0.03% over the decade not the 0.3% over 100 years.

Even making the 'courageous' assumption that each person has a perfect measurement device and memory about the weather over a decade, the large natural variations in our weather will make this task of detecting such a small change in our weather nearly impossible.

Over a decade, winds vary by minus100% (e.g. nil wind) to plus hundreds if not thousands of per cent (e.g. cyclonic winds) around the average wind speed. Similarly, the variation around the average precipitation and temperature is measured in high tens if not hundreds of per cent. Even daily movements will have at least plus or minus 20-40% variations. After experiencing such variations over several years, we subconsciously declare that this is normal and will only detect the larger natural fluctuations. Yet the Greens are encouraging us to say we can detect the underlying 0.03% change over a decade.

To create dangerous weather events out of such a small increase in the climate system's energy budget, the Greens are encouraging us to believe you can make something out of little to nothing.

So, what are we seeing if it is not dangerous weather from global warming? It is normal weather that has always had large variations over time. We just do not remember these past events.

The following sample of historical events should be considered in this context before accepting that something new is happening in Australia's weather today:

- between 1803 and 1992, at least 4,200 people in Australia died as a direct result of heatwaves, including the 1895-96 heatwave, which killed 437 people;
- 24 June in 1852, 89 people were drowned in a flood in Gundagai;
- March 1899, 410 people were killed when Cyclone Mahina hit Bathurst Bay;
- March 1934 another cyclone killed 99 people by creating a nine metre storm surge in northern Queensland;
- 29 November 1934, torrential rain turned Melbourne's Yarra River into a raging torrent, leaving 35 dead, 250 injured, and 3,000 homeless;
- Within a few years of opening, bushfires swept through Port Arthur's penal site requiring both convicts and their keepers to stand chest high in the sea to survive.

CONCLUSION

Although we may believe that we can identify dangerous weather events caused by man-made global warming, we are mistaken. First there has only been a small change (i.e. maximum 0.3%) in our weather since 1900. Second, this change has taken place over a long period (i.e. 100 years). Finally, the very large natural variations that we experience on a daily, seasonally, and annual basis will totally mask this very small underlying trend. Although we are encouraged to see such changes as man-made dangerous weather, we are only seeing natural weather events.

Even the small underlying change in the weather cannot be solely attributed to Man, as a significant amount of this change is a natural change in our weather as we come out of the Little Ice Age – the coldest 550 year period in the past 11,000 years.

Notes:

1. Malcolm Turnbull, a Liberal politician, discusses dangerous weather caused by Man – "*Cut & Paste"*, The Australian, page15, Wednesday 14th March 2012.
2. All temperature scales (e.g. Celsius, Fahrenheit, or Kelvin) on thermometers are designed to reflect this linear relationship between thermal energy and the measured temperature.
3. One equation for evaporation is given by Penman below. It should be noted that some of these variables can significantly reduce evaporation (i.e. reduce the one to one linear relationship between energy and evaporation).

$$E_{mass} = \frac{mR_n + \rho_a c_p (\delta e) g_a}{\lambda_v (m + \gamma)}$$

Where:

m = Slope of the saturation vapor pressure curve (Pa K^{-1})
R_n = Net irradiance (W m^{-2})
ρ_a = density of air (kg m^{-3})
c_p = heat capacity of air (J kg^{-1} K^{-1})
g_a = momentum surface aerodynamic conductance (m s^{-1})
δe = vapor pressure deficit (Pa)
λ_v = latent heat of vaporization (J kg^{-1})
γ = psychometric constant (Pa K^{-1})

4. The physical law of motion (F=m*v) shows that there is a theoretical linear relationship between energy and speed of any mass (e.g. a mass of air).
5. The following is one definition of energy which shows this linear relationship between water temperatures and energy which leads to evaporation. **"**A British Thermal Unit (BTU) is the amount of heat energy needed to raise the temperature of one pound of water by one degree Fahrenheit."
6. Obviously other figures can be used, but you will find that with each figure the rise in energy is a fraction of one per cent. For instance, a 0.86^0C rise = 0.3% rise in energy, 1.15^0C rise = 0.4% rise in energy, 1.44^0C rise = 0.5% rise in energy, and 1.73^0C rise = 0.6% rise in energy. Even the most alarmist estimates of global temperature rise of 5^0C by the 2100 made by the IPCC will still only show a small single digit percentage (1.7%) rise in energy.