A Discussion About Climate Change

Proposed:

Proposed that the data now available indicates that human enhanced water evaporation, rather than human enhanced greenhouse effect, is the primary cause of climate changes currently being observed.

Agreed to:

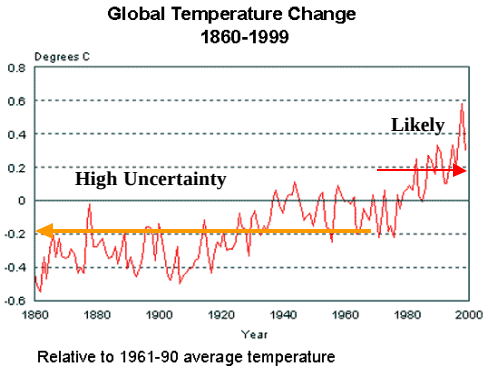
- Data collected over the last 5-10 years indicates that climate changes are occurring on at least a regional basis.
- Human activities are likely a major contributor to these changes. The consensus statement that: "the balance of evidence suggests a discernible human influence on global climate" is being confirmed.
- While change is occurring it does not appear to be global change, as many areas (southern hemisphere, tropical latitudes, and ocean areas) are showing no significant changes in temperature or climate patterns.
- While change is occurring the attribution, or reasons, for the changes observed have not been established with any certainty, and is therefore the primary source of a disruptive on-going debate, which prevents reaching agreement on appropriate responses.
- Human impacts potentially large enough to impact hemispheric, or global, climate are:
  - **Energy Use** – From sources other than natural biological processes. Result is increased CO2 and hydrocarbon emissions from fossil fuel use, and changes in geographic distribution and patterns of energy emissions in the form of light, heat and water vapour.
  - **Land Use** – Conversion of large areas of jungle, forest, prairie and desert habitat to other purposes: agricultural, industrial or urban. Result is changes in radiative properties of the land areas affected, as well as changes in the exchanges of energy, water and chemical components between large areas of the earth's land surface and the atmosphere in those regions.
  - **Water Use** – The growth of agriculture, to support food production, and industry, to support economic growth, have both caused significant diversions and redistributions of water. Result is a major change in the land to atmosphere water cycle as most of the water used is evaporated from land surfaces, mainly in the northern hemisphere.
- All three of the above impact areas are interrelated to a large degree as changes in one will impact, or are facilitated by, one or both of the others. All three areas have increased dramatically in the last 30-50 years, although not to the same degree in all regions. To determine the best methods of mitigating climate change, impacts in all three must be assessed and addressed before solid conclusions can be drawn.
- To date climate models have been based on the assumption that changes in GHG emissions are the primary cause of climate change and warming, and are adjusted to more or less match

historical trends. However, the current models do not have the resolution to simulate or predict regional climate, and do not yet include the ability to model other human caused changes in land use and water use.

Data:

This discussion is based primarily on data contained in the 2001 IPCC Technical Report on Climate Change, and conclusions concerning measured trends reported by the IPCC. This data, rather than the model results and projections drawn from it, has been adequately challenged, tested and peer reviewed by researchers outside of the IPCC group. It is based on direct measurement, with data collected over the past 20-30 years being the most reliable. The main conclusions of the 2001 IPCC report concerning the evidence for climate change are:

- **GHG Concentrations** – Carbon dioxide and methane in the atmosphere are climbing and are globally consistent so there is no major concentration difference between hemispheres.
- **Global average temperatures** - Are higher, however, the higher temperatures are predominantly seen in temperate and arctic regions. Temperature data collected prior to the 1970's has a high degree of uncertainty for a number of reasons, while more recent data has shown a distinct increase in temperature. The average increase should not be interpreted as meaning that warming has been observed everywhere. Some arctic areas are warmer by several degrees while some ocean and other locations are actually cooling and much of the earth's surface has shown no change in the past three decades.

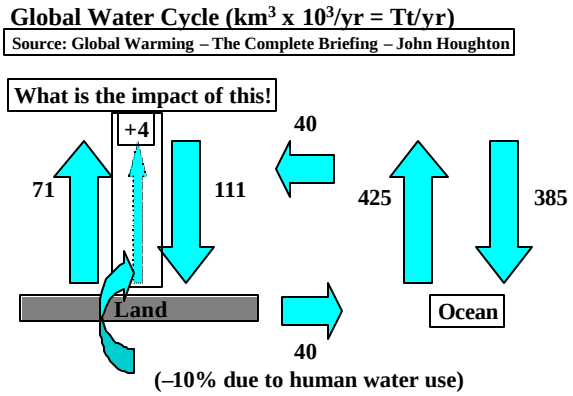


- **Diurnal Temperature Range –** Night time low temperatures are increasing at twice the rate of day time high temperatures. This change is positively correlated with cloud cover effects, which are too small to be resolved in global climate models.
- **Growing Season** – Increasing by 1 to 4 days per decade in the northern hemisphere.
- **Amount of Precipitation** – Has increased by 5-10% over most land areas in mid to high latitudes of the northern hemisphere. However, there is no observed increase in the southern hemisphere.
- **Heavy Precipitation Events** – Have increased in northern latitudes, likely between 2 to 4% over the past 50 years.
- **Atmospheric Water Content** – Has increased in the northern hemisphere by several percent per decade, some reports indicate lower atmospheric increases of 1% per year in the northern hemisphere.
- **Cloud Cover** – Has increased by 2% in the northern hemisphere and is positively correlated with the observed decrease in diurnal temperature range.

- **Sea-Ice** - In the northern hemisphere has been decreasing, however, there is no similar observed trend in Antarctic sea ice.
- **Non-polar Glaciers** – Widespread retreat at an increasing rate, except in coastal areas.
- **El Nino Events** – El Nino events are becoming more frequent, persistent and intense over the past 30 years, causing severe climate fluctuations in much of the northern hemisphere.
- **Sea Level Rise** – No acceleration in the historic rate of sea level rise has been detected over the last century. Many low-lying areas are subsiding due to non-sustainable depletion of fresh water aquifers in those regions.

Discussion Supporting the Proposal:

- Most of the data supports the conclusion that climate change is overwhelmingly a Northern Hemispheric phenomenon. Increases in temperature, water vapour in the atmosphere, cloud cover, rainfall, ice cover retreat, unusual weather events and increased severity of precipitation events and droughts have all been occurring primarily in the northern hemisphere. While mixing of atmospheric gases occurs between hemispheres, weather cycles tend to be isolated by hemisphere.
- A recent exception to the northern hemispheric bias, is the recent, March 2002, collapse of the ice shelves on the Antarctic Peninsula. However, this exception may prove the point, as the Peninsula is the part of the Antarctic continent closest to human influences as it receives air and water flow off the coasts of South America, which is less than 1000 miles from the deteriorating ice shelves. Indications are that no other point in Antarctica has shown any change in the last 150 years. Both Argentina and Chile have energy intensive industries and agricultural irrigation, and have economies similar to those in Canada.
- The largest changes in human water use have occurred in the northern hemisphere particularly in land areas where irrigated land and industry have been undergoing rapid growth over historic levels. The water use is large enough to have a significant impact on atmospheric water and energy balances. The IPCC and other scientific studies have shown that water withdrawals from fresh water sources (rivers, lakes and aquifers) for human use have reached over 4000 Gt/yr. This volume represents a 10% reduction in river outflow to the oceans and a 5% increase in land water evaporation. **This increased rate of evaporation is not due to atmospheric warming**, but is primarily due to the increased absorption of solar radiation to evaporate water from sources such as: large areas wetted by agricultural irrigation (2/3 of the water used); domestic water losses; or evaporation from open water reservoirs formed by

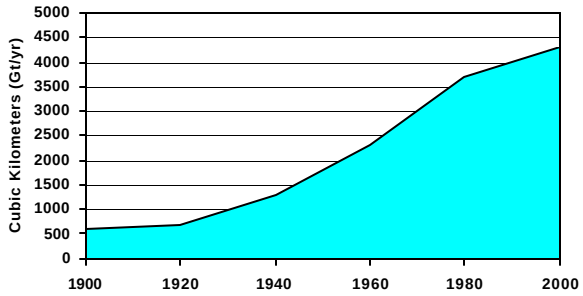


dams to support power generation and irrigation projects. Energy and water are also being dumped from nuclear plants and other industrial processes where cooling towers evaporate water to dissipate unutilized energy.

- The incremental energy required to evaporate 4000+ Gt/yr of water, is over 9000+ ExaJoules/yr if the water is only evaporated once. This is equivalent to 15-20 times the global energy output from all fossil fuel and other electrical power sources, and is likely to be much larger as water added to the atmosphere in one location may fall and be re-evaporated a number of times before returning to the ocean as coastal rainfall.

Annual Global Water Withdrawals

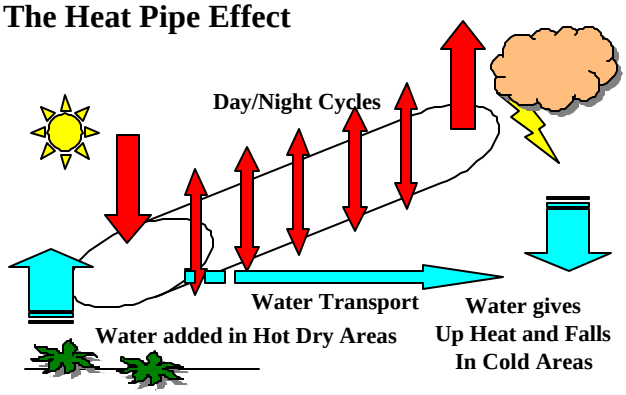
Source: Scientific American – February 2001 – Peter H. Gleick



Original Chart showed cubic miles x 4.6 to get cubic kilometers

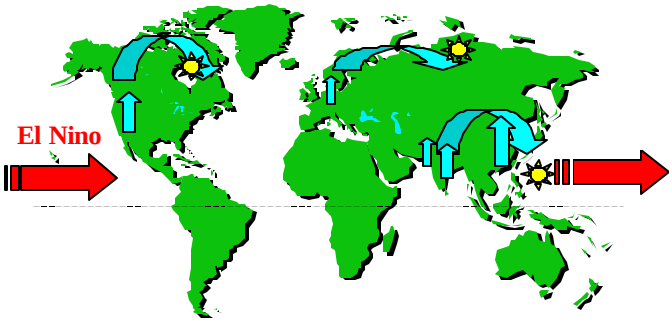
- The increased water and energy added to the atmosphere must then come out somewhere, resulting in the transport of water and energy through what might be described as a heat pipe effect. As the atmosphere is under saturated in water, it has a high capacity to absorb additional water emitted and will carry that water until it cools to the point where it is saturated and liquid water forms. The water may form at night as dew and re-evaporate in the morning, condense and vapourize inside clouds, or fall as precipitation to intensify the local water cycle, but it must at some point leave the atmosphere as precipitation. Moist tropical air masses lose their energy and their water content over cooler regions (temperate latitudes, arctic areas, mountain snowcaps and ocean areas downwind of land masses). Wherever the water forms, energy must be released to the air to allow the water to condense. The more water that condenses the more heat energy will be liberated. The energy released will result in temperature increases in those areas receiving the precipitation, causing warming but also increasing the air's ability to retain water. The net effect is that water and energy added in hot, dry regions through irrigation, or in other regions through industrial activity, will be transported through the atmosphere to colder regions in the same hemisphere. Once condensed, the water will fall and the energy will warm the air, melt ice or increase the temperature of the water falling as rain, vs. what would be the case with natural water transport only.

The Heat Pipe Effect



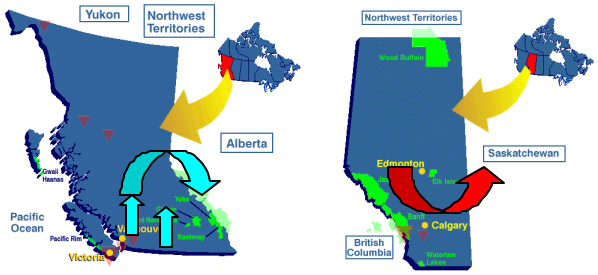
- Since the water and energy added to the atmosphere will primarily be in geographic areas that normally experience little water evaporation, the change in water emissions is more likely to generate unusual weather patterns in cooler areas receiving the moister air flow. In some mountainous regions, or areas with large bodies of water or ice, the result will be increased precipitation, increases in the rate of melting of ice masses, and/or changes in atmospheric humidity and cloud cover. Further down weather, in flat prairie areas, the result may be less rainfall, as the air is warmer than normal and can therefore better retain the water that remains in it, until it can dissipate the warmth through radiation or until it encounters colder arctic air further north or over coastal areas.
- In the source regions the evaporation of water would likely not cause ambient temperature changes, as more radiant solar energy would be absorbed by darker, wet ground, to provide the energy required for evaporation. In areas with enhanced evaporation, where there is less ability to absorb additional solar radiation, because of clouds or soils that do not darken when they are wet, cooling will occur as the energy to evaporate the water must come from a fixed or only slightly increased energy budget.
- Human Enhanced Water Evaporation better explains the general climate change effects observed in the northern hemisphere. When the geographic distribution of enhanced water evaporation is considered the impacts on global and regional climate change become even clearer. As indicated earlier most of the water withdrawals are in the northern hemisphere, but also their location with respect to movement of air masses is even more telling. **Over half of the irrigated agricultural land is located in only four countries, which are India, China, U.S. and Pakistan.** While industrial water output from nuclear power and manufacturing are in those same areas, and from European countries, which also contribute water from irrigation. These regions are the likely source of the large volumes of water and energy that are being transmitted to cooler Arctic areas, and to the Pacific Ocean. Water emitted in India, Pakistan and China likely condenses and falls just at the location where El Nino begins, driven by warming of surface waters.

Feeding El Nino & Arctic Warming?



- On a more regional level, similar effects can be observed. In Western Canada, the Fraser River Valley and Okanagan Valley areas in southcentral and southwestern British Columbia are similar to southern California in being warm and dry, but ideal for growing fruit and other crops with the application of irrigation. These valleys have turned from dry desert like conditions to green fields and orchards over the past 30-40 years. During the hottest times of the year water sprays on to fruit orchards and fields on an almost continual basis. Just to the east of these areas are Canada's Columbia Icefields and Glacier parks, which have been melting and retreating at ever increasing rates in recent years. Air currents, flowing from the irrigated areas, move over the ice sheets before reaching the Canadian prairies, which are experiencing warmer temperatures and higher humidity, but less precipitation. This interaction between irrigation in the B.C. valleys, meltdown of the glaciers in national parks, and reduced rainfall on the prairies might be an area where the theory of human enhanced water evaporation could be tested to see if the changes in these three areas are directly linked. A similar effect, with fewer variables, might be studied in the Antarctic Peninsula, which would be less impacted by El Nino events and should be most affected by water emissions from smaller regions of one country, Argentina.

Feeding Energy to Melt the Glaciers & Warm/Dry Out the Prairies?



Discussion Against Alternate Proposals:

- **The Greenhouse Effect** – The greenhouse effect does exist and directionally changes in the composition of the atmosphere will impact the radiative balance. The issue is whether or not the low concentrations of GHG's in the atmosphere could be wholly responsible for the climate change effects observed. We feel the evidence does not support this being the most significant effect since:
  - The greenhouse effect is global in distribution. As the changes in GHG concentrations in the atmosphere have been measured and shown to be consistently increasing worldwide the effects of warming should also be worldwide. Yet many areas (southern hemisphere, oceans, tropical latitudes, and isolated regions e.g. the state of Wyoming in the U.S.) are not yet showing discernable changes in climate or temperature.
  - The greenhouse effect is radiative in nature. Radiative balances based on changes in GHG concentrations should result in larger impacts where the radiation is the most intense and prolonged. I.e. tropical areas rather than temperate or arctic areas where the warming and climate changes are actually being observed.
  - The greenhouse effect does impact the natural water cycle, and at least half of the impacts indicated by modeling are due to estimations of GHG enhanced water cycle effects.

However, the impacts should be seen in areas where the most area of water is exposed to the radiative heating and with the highest ability to absorb the radiation, which are the ocean areas. This should result in larger changes being observed in the southern hemisphere which has the largest area of ocean surface, but no impacts of this can yet be seen in the data.

- **Land Use Changes Causing Climate Change** – Land use, aside from the energy and water effects, mainly impacts the amount of solar radiation absorbed, by changing the surface composition.
  - Desertification, draining of wetlands, monoculture cropping and clearing of forests or jungles for logging or agricultural uses would tend to increase the amount of solar energy reflected.
  - Irrigation or "greening" of dry areas, urbanization of large areas and large expanses of pavement increase the amount of energy absorbed, which must then be reradiated at night.
  - Land use induced changes are likely occurring but will mainly be a local effect since the areas impacted are small compared to the total surface of the earth, and radiative energy cannot be transported over long distances without a carrier medium such as water vapour.

Proposed Methods of Testing the Proposal:

- Human Enhanced Water Evaporation is happening and appears to have the potential to impact climate in the ways that have been observed. However, this theory requires review through additional scientific assessment and testing, with input from scientists from many disciplines. Proposed methods of testing the theory:
  - Conduct more detailed cause and effect studies on a smaller than global scale, in isolated regions such as western Canada, or the region including the lower portions of South America and the Antarctic Peninsula. Studies should consider water emission changes, weather patterns, and changing trends in ice-shelf or glacial degradation measured in the recent past and in the next 5-10 years.
  - Include human enhanced water evaporation in regional climate models and models studying El Nino on a priority basis to model the effects.
  - Researchers have indicated that water might have played a greater part in past climate changes and these studies should be expanded and not restricted to radiative effects, but should also consider changes in water distribution changes on land surfaces.

Implications if the Proposal is Tested and Verified:

- If the proposal is tested and verified the implications are that many of the proposed responses to climate change are inappropriate and may only lead to accelerated climate change. Options such as increased use of irrigation to produce biomass energy, increased use of nuclear energy which uses large amounts of evaporative cooling, north south water transfers to overcome effects of drought, and construction of dams to produce hydroelectric power should not be considered as climate change mitigation options.

- The response to climate change would have to change from a focus on simply reducing GHG emissions by changing energy sources, to one of continuing to reduce energy, land and water intensity in all agricultural and industrial activities.
- In agriculture more effort should be placed on reducing water use in irrigation practices by changing the irrigation methods, or by changing the crops grown to better suit the natural water precipitation available in a given area. E.g. fewer orchards in dry areas and more production of grapes and fruit or vegetables that prefer lots of sun and less water.
- In industry, greater efforts should be directed towards reducing energy wasted through the dumping of energy in the form of heat or water to the atmosphere. Processes exist to turn low quality energy streams into power, and these processes should be integrated into most power generation and process operations to reduce the amount of energy that is unutilized. Where the heat energy must be dumped it should be emitted through aerial cooling or hybrid systems, where as much as possible of the heat is radiated rather than converted to water vapour. Many of these options will be economically attractive by either generating a new revenue stream, from power sales or displacement of power purchases, or by lowering the cost of equipment required to dump unutilized energy.

Comment on Climate Change vs. Sustainability:

- **Need to Reduce All Waste** - While this discussion has focused on changing the current perceptions concerning the immediate and most pressing source of climate change, this does not mean that other forms of waste can be ignored. Human waste of water appears to be the root cause of current and future hardship for the populations and ecologies affected by climate change. Wasteful land use practices are a current and growing hardship for biodiversity and a healthy and robust environment. The waste of concentrated and easy to access fossil fuel energy sources will cause hardships for future generations who will have to cope with the loss of these valuable resources.
- **Greenhouse Effect and GHG Emission Reduction** - There is no reason to challenge the theory that, over the longer term, a human enhanced greenhouse effect might not also be demonstrated or that the on-going waste of land, energy and mineral resources are not, or will not, cause future hardship for humanity and the environment. The efforts to reduce greenhouse gas emissions are really efforts to reduce energy waste, and GHG emissions can be used as indicators of the level of waste (energy used and hydrocarbons emitted without being utilized) that is occurring.

"There is more to life than increasing its speed." - Mahatma Ghandi