Comparison of Recently Proposed Causes of Climatic Changes

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Pre-World War II ideas on Climate.

- **During the mid-19th century, the German and French climatologists had made good maps classifying the range of climates based on exploration of most of the world which are still used today.**
- **Adhemar had outlined the Earth-Sun relationships and these were developed further by J. Croll (1867; 1875). These determine the range of insolation reaching the surface of the Earth.**
- **Little progress other than to correct the earlier maps until M. Milankovitch (1922; 1941) refined the calculations of the three kinds of Earth's orbital movements relative to the sun.**

Post World War II changes.

The War in Europe emphasized the need for a good reliable data base of the constituent properties to obtain a good 30-year average. New studies using revolutionary methods of instrumentation by oceanographers and environmental scientists, continuous monitoring of environmental factors, satellite measurements, and a fast-growing data bank using-up-to date methods have resulted in a number of key discoveries.

This talk compares and contrasts the resulting theories that generally support one another with one exception. Together, they represent a considerable advance in our understand of climatic change.

New data on the mechanisms of climate change.

- **The sun supplies more than 99% of the total energy driving the world's climate.**
- **The shape of the Earth results in greater insolation reaching the Earth's surface in the Tropics than at the Poles.**
- **This sets up a considerable thermal gradient which drives the ocean currents, the movements of the air masses and associated frontal systems.**
- **Differences between day and night and the seasonal insolation add further modifications.**

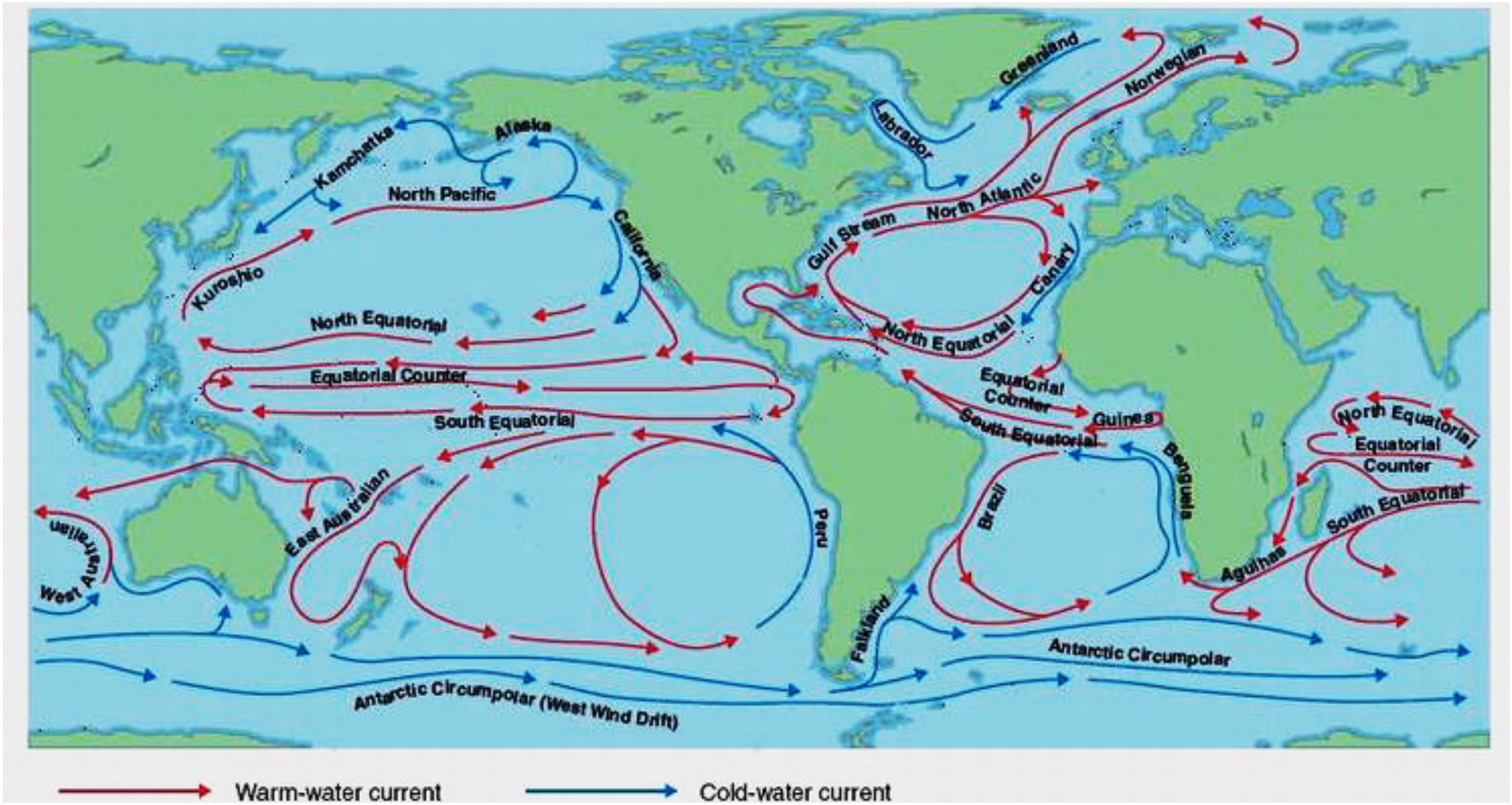
Thermal properties of the Earth's surface.

- About 70% of the Earth's surface is occupied by water together with only c.30% consisting of land (rock, soil or ice).
- The albedo of ice ranges from 0.5-0.7, so ice and snow-covered surfaces reflect back into space much of the incoming radiation.
- Water has a very high heat capacity so it can store or transport large amounts of heat energy. It is also translucent, so it absorbs over five times of energy compared with soil. Wave action modifies the heat distribution.
- Transmission of solar energy into soil or rock is by conduction.

Transport of heat towards the Poles.

- **Dry air has low heat capacity, but moist air can carry moisture in the form of water vapour, water droplets or snow/hail. Actual water contents can be enormous in Monsoons, Hurricane or "rivers of water".**
- **Warm ocean currents carry large quantities of heat Polewards from the Tropics but are constrained by the distribution of land and water.**
- **Gateways between continents facilitate this process, e.g., the North Atlantic Ocean and Gulf Stream.**
- **The circular shape of Antarctica and the cold halo of cold water around it stops the warm surface ocean currents from warming it.**

Map showing the distribution of warm and cold currents around the World.



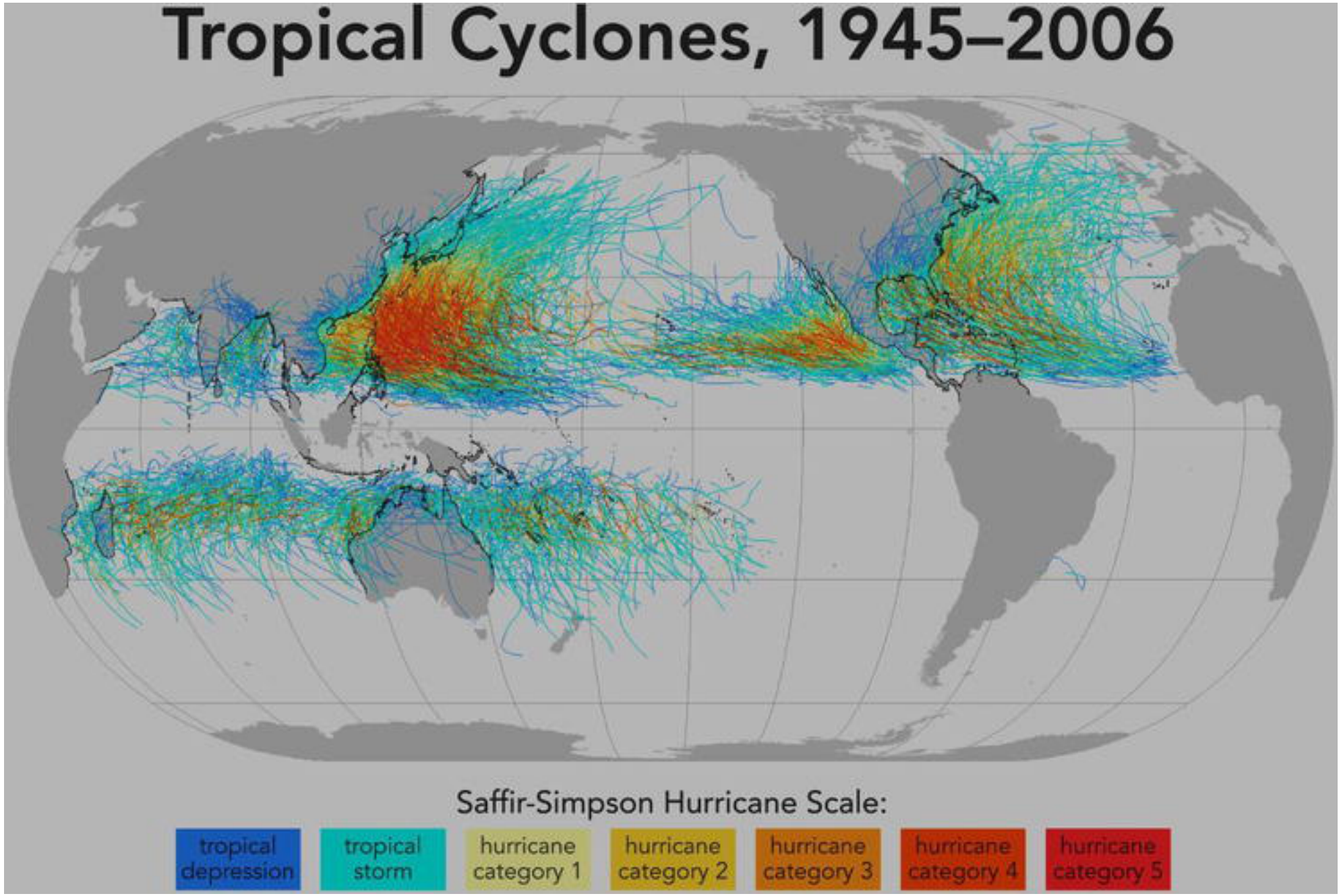
Sources of Cold Air Masses.

- **The primary source of cold dense Arctic Air is in the interior valleys of the of northeast Siberia with the coldest air temperatures are commonly below -65°C in winter.**
- **This cold Siberian air mass moves eastwards along three main paths, each producing distinct ice caps in North America during cold cyclic events.**
- **This eastward movement is caused by the rotation of the Earth and the Arctic Air Mass is warmed by the Gulf Stream resulting in warmer weather over western Europe.**
- **This air the cools as it passes over Eastern Europe and Western Siberia.**

Circulation of Arctic Air Masses around the Northern Hemisphere.

Sources of Warm Air Masses

- **Over oceans, this is centered on the zone of Intertropical Convergence between the Tropics of Cancer and Capricorn where the sun is directly overhead twice a year. These areas are the main source of the warm ocean currents as well as the Monsoons/ Typhoons and “rivers of rain”.**
- **On large continents in the Tropics and Subtropics, the main sources of dry Subtropical air are the desert areas such as the Sahara in Africa, the Mohave Desert and Northern Mexico in North America, the Gobi in Asia, and the central area in Australia.**


Tropical Cyclones, 1945–2006
Saffir-Simpson Hurricane Scale:
tropical depression
tropical storm
hurricane category 1
hurricane category 2
hurricane category 3
hurricane category 4
hurricane category 5

Identification of Cold Events on land areas.

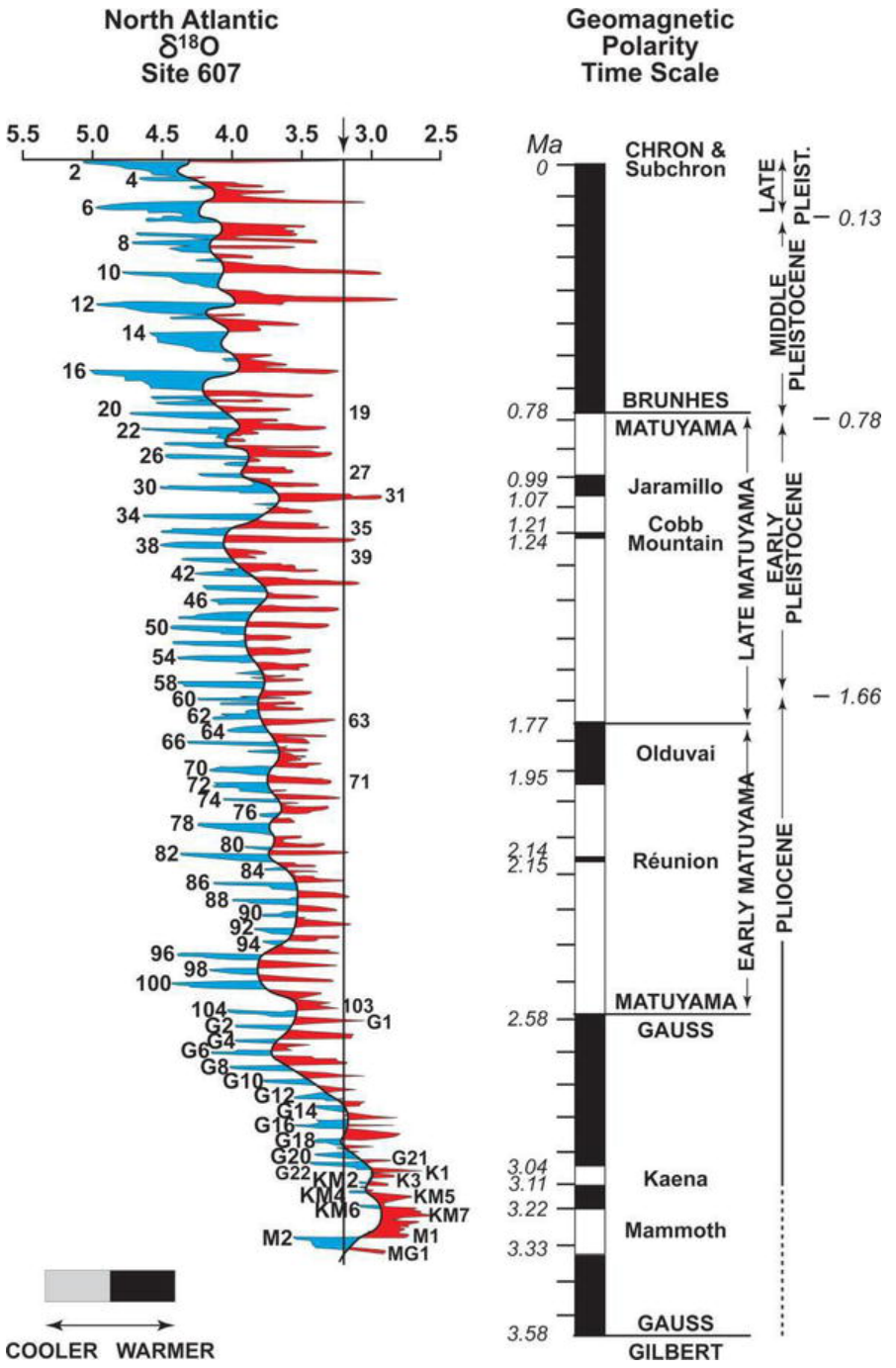
These are best known today from the glaciers remaining from the last Ice Age and areas of permafrost. Unfortunately, complete stratigraphic sections exhibiting the complete sequence of the past cold events on land cannot be found due to erosion of the glacial tills during warmer weather.

A reasonable but incomplete record can be obtained by putting all the available dates of cold events in a histogram. This shows that there have been at least 13 cold events starting about 3.6 Ma B.P.

For a more complete record, we must look at ocean cores in which a more complete record is preserved.

Oxygen isotope palaeotemperature record and geomagnetic polarity timescale.

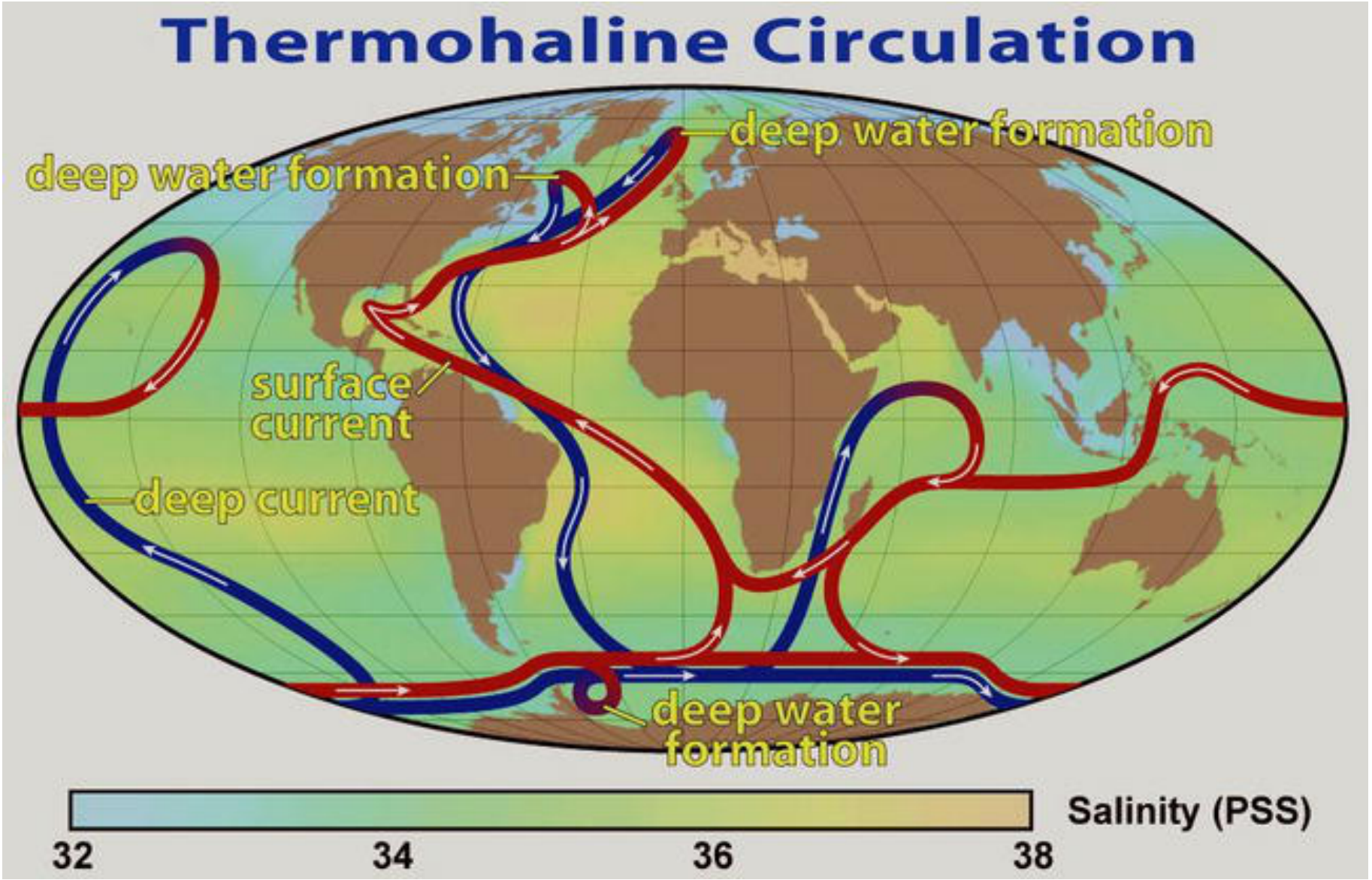
Black and white areas are normal and reversed polarity respectively.



Evidence for fluctuations in sea temperatures measured by δO^{18} in foraminifera.

- **Over 100 temperature fluctuations are preserved in deep sea cores from the Atlantic Ocean.**
- **The cycles were dated using oxygen isotope dating of foraminifera and by geomagnetic polarity.**
- **For the last 800 ka B.P., there were four 23 ka cycles per glaciation which lasted 85-91 ka with a 9-15 ka inter glacial separating them. This indicates that the presession cycle of Milankovitch controlled them.**
- **Previously, the cycles were more frequent and of lower amplitude.**
- **There was overall cooling with time.**

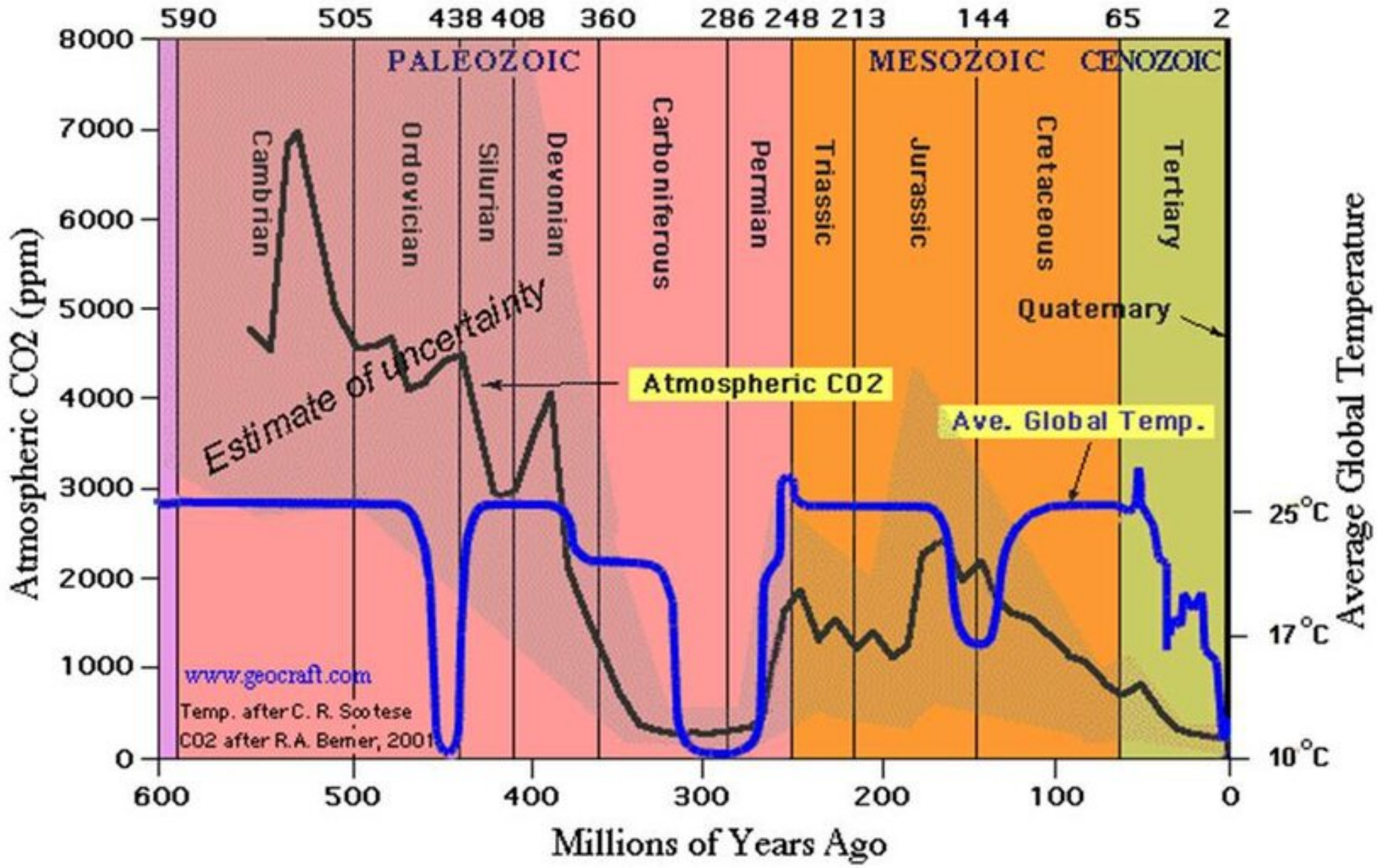
Paths of thermohaline deep-water circulation of warm bottom water (red) and the old Subarctic surface return flow (blue) around the oceans.



Deep water thermohaline currents

- Obviously, the buildup in heat in the North Atlantic requires periodic drastic changes. This consists of a slow accumulation of denser warm saline water produced by evaporation of water into the cold dry Arctic Air Mass leaving a higher density body of water that slowly sinks down to the sea floor. Periodically, this denser water flows south along the bottom of the ocean until it reaches the South Atlantic Ocean where it joins other deep-water flows.
- Cold Antarctic water moves north to the North Atlantic to replace it. Although it has been suggested that this can cause a new glaciation, this is not currently occurring.
- Together with the evidence for heating of the North Atlantic, this seems to explain the Cold-Warm cycles that are recorded in the ocean sediments.

Graph from: https://geocraft.com/WVFossils/GlobWarmTest/A6a.html



The Intergovernmental Panel on Climate Change proposal (IPCC).

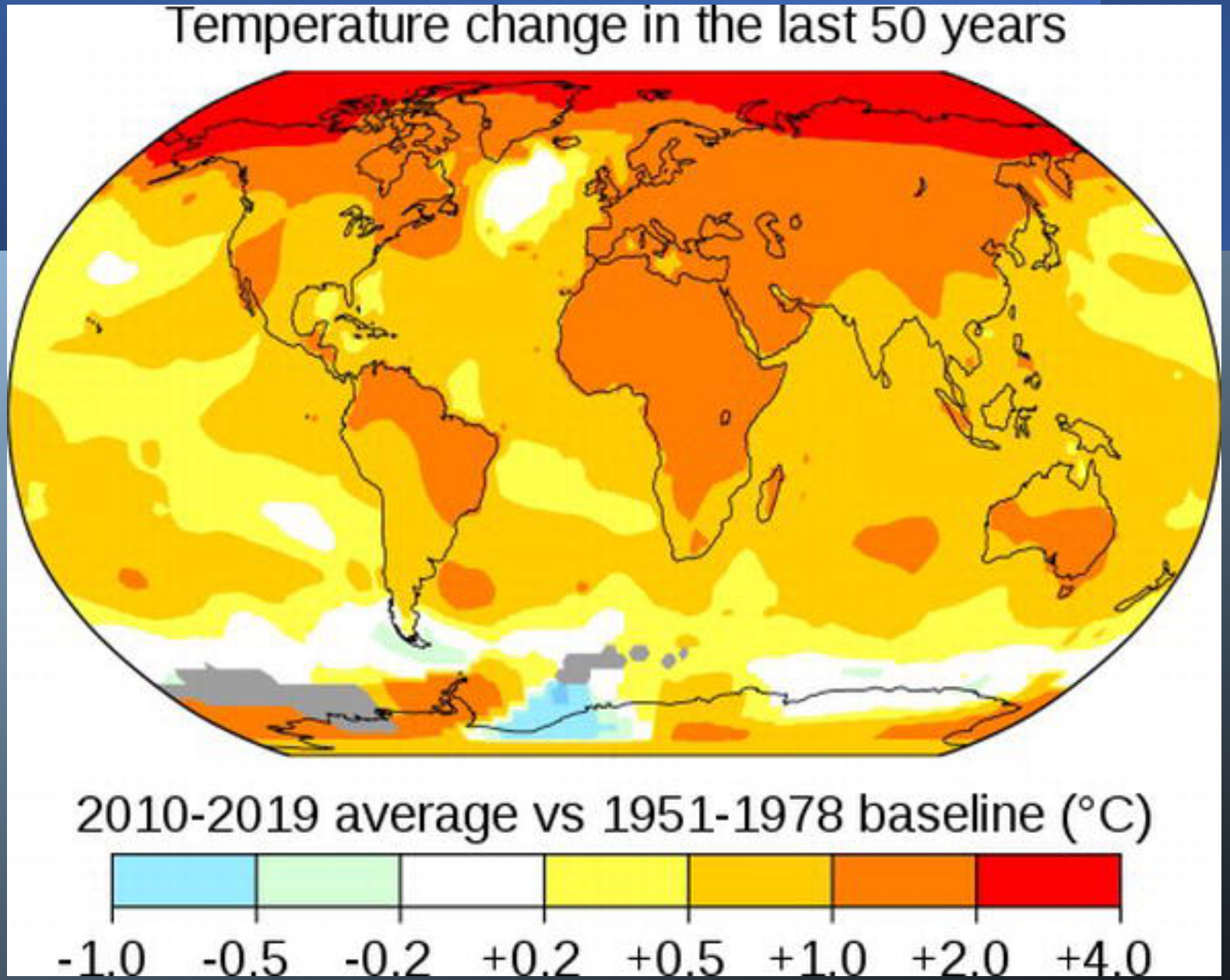
- In 1988, the IPCC proposed that human activities have resulted in increased atmospheric levels of carbon dioxide causing an increase in global temperatures that overrides all other causes. Specifically, the increase in carbon dioxide since the beginning of the industrial revolution is the culprit.
- It is true that carbon dioxide is a greenhouse gas, but it only affects a small range of the longwave radiation emitted by the surface of the Earth.
- The content of atmospheric carbon dioxide is measured at the summit of Mauna Loa and its present day increase parallels that of the mean annual air temperature. However, this is certainly not the case in the geological past.

Properties of carbon dioxide

- **Carbon dioxide is an odorless, colourless gas with a molecular weight of 44 compared with the average for air being 29. It therefore tends to sink into low places such as hollows. All theories involving forming a layer in the stratosphere are wrong.**
- **It is unusual in becoming more soluble in water at lower temperatures. Conversely, it is degassed when the seas warm up. This can explain the parallel reaction of the gas to the warming temperatures today.**
- **As a chemical substance, it can react with other substances such as calcium ions in the seas to form calcium carbonate and does so in all water bodies where there is an abundant supply of calcium ions in the water.**

- **Dissolved in water, it forms carbonic acid that can react with calcium ions stored on the exchange complex of the ocean sediments These were formed from the weathering of basaltic rock over a period of 3 billion years prior to the appearance of marine animals.**
- **The appearance of numerous marine animals resulted in a great increase in atmospheric carbon dioxide, most of which dissolved back into the seas during the 600 million-year Karoo glaciation during the Carboniferous and Permian periods depleted it to dangerously low levels from which it has never fully recovered.**

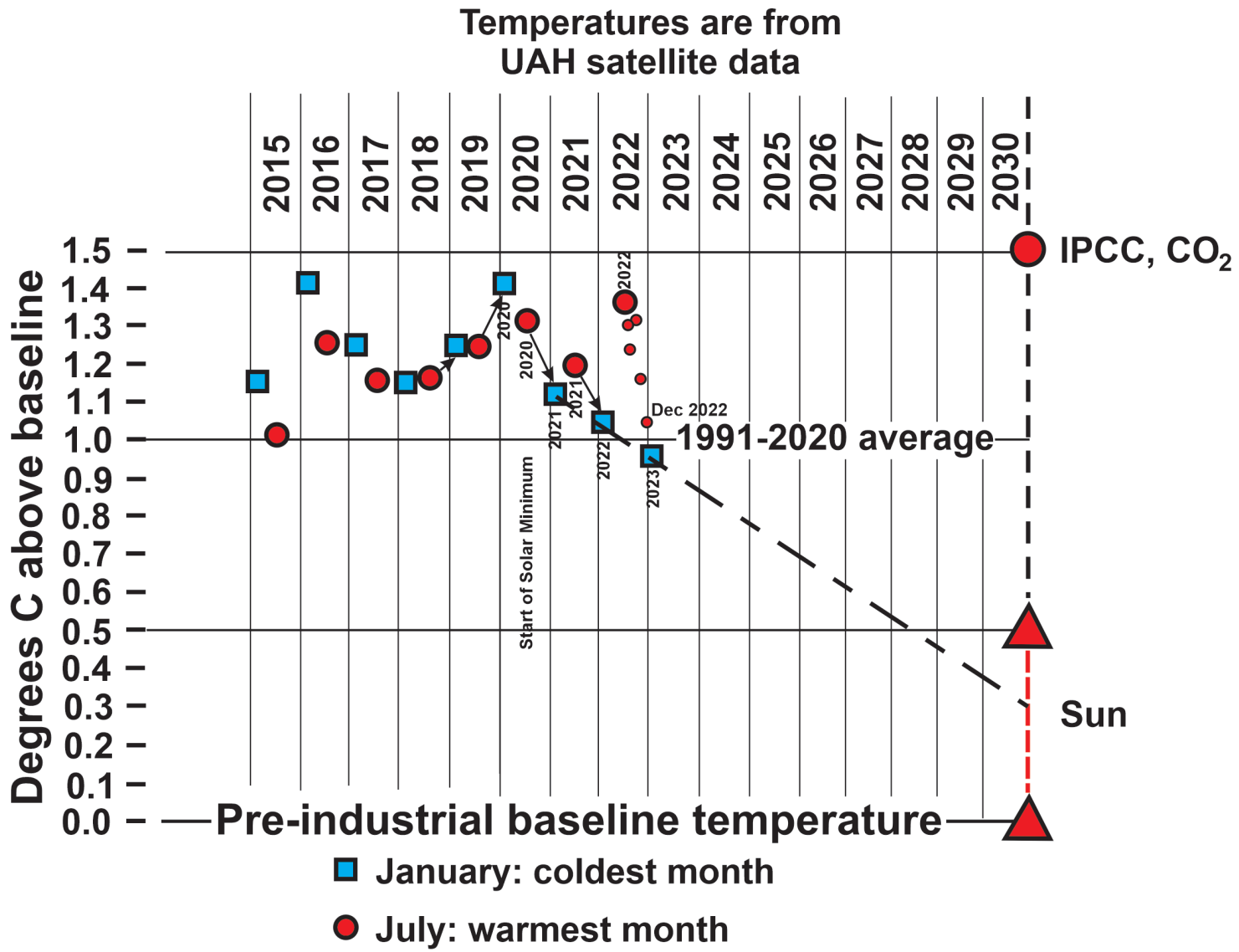
- **The atmospheric carbon dioxide rose to ~2000 ppm at the end of the Jurassic Period, after which it has steadily decreased until the present time. Each time there is a cold period (glaciation), the carbon dioxide increasingly dissolves in the oceans where it can partly form limestone, so that not all the gas is returned into the atmosphere.**
- **During the last two glaciations, the atmospheric carbon dioxide decreased to within 100 ppm of the concentration at which plants cannot carry out photosynthesis. This means that too much decarbonization may result in too low a concentration of the gas in the atmosphere to support life on Earth as we know it.**


Temperature change in the last 50 years
2010-2019 average vs 1951-1978 baseline (°C)
-1.0
-0.5
-0.2
+0.2
+0.5
+1.0
+2.0
+4.0

Comparison of past (1951-1978) and present air temperatures (2010-2019) by NASA.

- The main warming areas are Northern Canada and the Arctic, with lesser warming in the Sahara and Australian outback! Eastern China and Germany show no obvious warming, although they are among the main industrial centres of the world.
- Antarctica shows evidence of cooling.
- Obviously, this disagrees with the basic claim of the IPCC.
- The IPCC theory ignores all the other discoveries outlined above.

Comparison of incoming solar radiation measured by satellites at the outer surface of the atmosphere over Salt lake city, Utah.



Incoming solar radiation at the surface of the atmosphere.

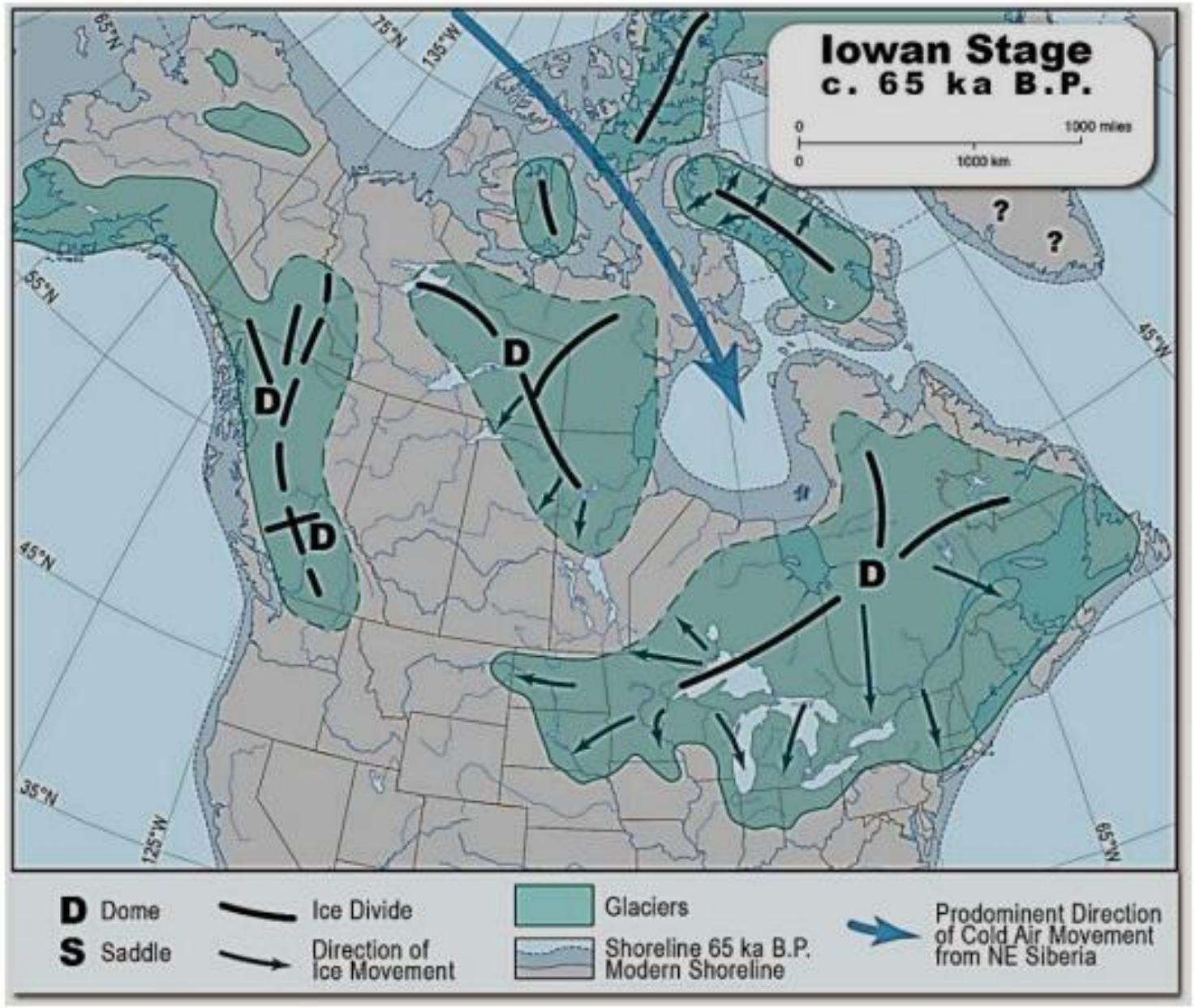
- **Measurements of the incoming solar radiation at the surface of the atmosphere measured by satellites show a marked change in 2020 suggesting the beginning of the next cooling phase of the 23-ka cycle as indicated by the winter readings (in blue).**
- **The summer values (in red) continue to increase indicating that the source of the Subtropical Air Mass is still warming. This is likely to continue until the position of the overhead sun moves south of the source area, whereupon summer temperatures will also decrease.**
- **This out of phase relationship complicates the weather since it causes a temporary increase in the temperature gradient between the Arctic Air Mass and the Subtropical Air Mass despite the winter cooling.**
- **These will be modified by local environmental factors such as ENSO.**

- **These changes measured by satellite match the evidence from the timing and much more extreme weather in Canada that has occurred in the last three years. These include increasing numbers of new snow avalanches in the Rogers Pass (+7), extreme flooding events across Canada, droughts across the Boreal Forest and Prairies resulting in spectacular fires across the country, many more tornadoes over much of eastern and western Canada, record summer temperatures, etc..**
- **Similar changes are occurring throughout the world.**

Probable Future Climate changes.

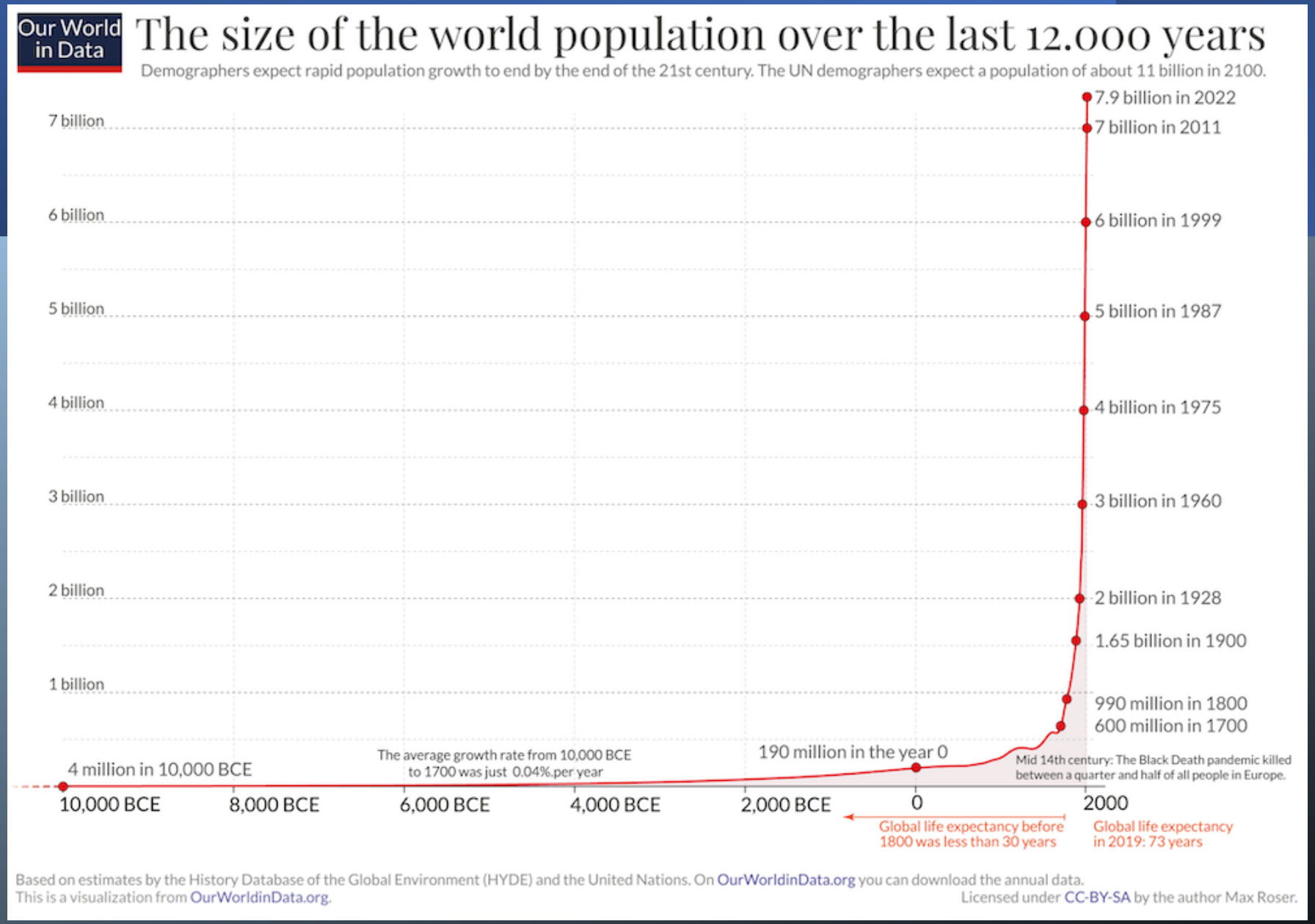
- **Assuming that the next two 25-ka climatic cycles evolve like that during the early Wisconsin event, a good idea of the resulting changes can be obtained by looking at the map of the distribution of land and sea and the ice caps that had developed in Canada by 65 ka B.P.**
- **The Keewatin, Baffin Island, Inuitian, Labradorian, and Cordilleran ice caps were well developed and the passes through the Western Cordillera were covered in ice.**
- **The Arctic Islands were connected as a land area and the Grand Banks and Newfoundland were connected to Eastern Canada.**

Wisconsin Glaciation, Iowan Stage, 65 ka B.P.



Effect on the Population of Canada

While there is plenty of time before the glaciers cause the North American population to adjust to these changes, there will have to be enormous adjustments to cope with them. *Homo sapiens* has survived two such glaciations in the past although the numbers of survivors was quite low. The presently expanding world population will have to adjust to the changing environments and this will undoubtedly involve reductions in the current population of Canada instead of the current migration to this country. Immigrants coming to Canada are "jumping out of the frying pan into the fire" in the long term. This will be a common problem throughout the world.


Our World in Data
The size of the world population over the last 12.000 years
Demographers expect rapid population growth to end by the end of the 21st century. The UN demographers expect a population of about 11 billion in 2100.
7 billion
6 billion
5 billion
4 billion
3 billion
2 billion
1 billion
7.9 billion in 2022
7 billion in 2011
6 billion in 1999
5 billion in 1987
4 billion in 1975
3 billion in 1960
2 billion in 1928
1.65 billion in 1900
990 million in 1800
600 million in 1700
4 million in 10,000 BCE
The average growth rate from 10,000 BCE to 1700 was just 0.04% per year
190 million in the year 0
Mid 14th century: The Black Death pandemic killed between a quarter and half of all people in Europe.
10,000 BCE
8,000 BCE
6,000 BCE
4,000 BCE
2,000 BCE
0
2000
Global life expectancy before 1800 was less than 30 years
Global life expectancy in 2019: 73 years
Based on estimates by the History Database of the Global Environment (HYDE) and the United Nations. On OurWorldinData.org you can download the annual data.
This is a visualization from OurWorldinData.org.
Licensed under CC-BY-SA by the author Max Roser.

Future power sources.

- **Electric Grids:** Overhead cables are very susceptible to collapse due to icing-up. Underground cables break in permafrost areas. The current hydroelectric reservoirs will be covered ice. They are extremely expensive to construct in large countries.
- **Solar Power: H**eavy snowfalls and bad weather will be problems.
- **Wind Power:** Problems with extreme winds in the short term.
- **Atomic power plants:** Should only be constructed in areas least likely to be glaciated owing to the problem of disposal of radioactive waste.
- **Oil and gas**: Will have to be the backup means of producing energy. They require pipelines in areas not susceptible to glaciation.
- **Coastal wave energy:** Problematic due to sea level changes.
- **Coal and wood: L**ast resort.

Carbon dioxide, Photosynthesis and Life.

- Photosynthesis requires chlorophyll in vegetation, sunlight, and carbon dioxide.
- The atmospheric carbon dioxide is depleted during cold events by dissolving in water.
- During the last two main cold events (Wisconsin and Illinoian), The atmospheric carbon dioxide dropped to within 100 ppm of the lower limit for photosynthesis in vegetation.
- Presently, it is degassing from the warming ocean water, but unfortunately is being sequestered underground by Governments who are trying to achieve ”net zero carbon dioxide”.
- When the next cold event occurs, the atmospheric carbon dioxide content may fall below the level required for photosynthesis, the plants will die off and the Earth will develop the barren landscape found on other planets.

Climatic change and Economics.

- Climate change has an enormous effect on economics. Although Mankind may like to think that they control climate change, they actually have to adjust to it. An enormous amount of money is being spent on decarbonization when the cause of the changes are quite different. The carbon tax should be abolished.
- Carbon dioxide is essential for life so it should not be feared.
- It is necessary to adapt to the changes as they occur if we are to survive successfully.
- Changing to electricity as the main power source will be too expensive and will create its own problems especially for large countries with the population spread out over long distances especially in a northern climate.

- **Oil and gas are going to be of continued importance, partly to have a means of moving around and making repairs during power failures.**
- **Pipelines to get the hydrocarbons to where they are needed will be essential.**
- **The best way to cope with energy problems is to use all the possible sources together. An electric grid is subject to hacking.**
- **Adaptation to climatic changes will be essential, e.g., fire resistant building materials.**
- **Insurance costs are going to be high and problematic.**
- **It is important to realize that changing sea levels and shorelines will be part of the problems we shall have to adjust to.**