

THE CLIMATE DRIVERS – ON ALL TIME SCALES

The overall pattern of climate change can be broadly understood by referring to four different orders of climate drivers. This realisation helps to explain why global temperature has varied through geological time and at all scales.

TEXT: Halfdan Carstens

Global climate has varied since the dawn of the first atmosphere more than 4 billion years ago. It is correct to say that the climate has changed continuously and on all time scales (see following article). The same is true for the composition of the atmosphere, and we have ample proof that past climates have varied from cold “icehouse” to warm “greenhouse”. This we know from geological records measured in stones, sediments and ice cores.

Climate change is driven by geological

processes that operate on different time scales. Four different orders are suggested by Gerhard, Harrison and Hanson (2001).

1ST ORDER CONTROLS

One basic ingredient for a life-supporting Earth is solar luminosity, which is directly linked to the distance from the sun and the intensity in solar energy. The other is the evolution of an atmosphere with water vapour, methane and CO₂ as the most important greenhouse gases. It is accepted by the scientific community that the greenhouse effect makes the atmosphere 15-30 °C warmer than it would be other-

wise, and no one is disputing that the greenhouse gases are the primary temperature control permitting life on Earth.

The 1st order climate controls operate on a time scale measured in billions of years.

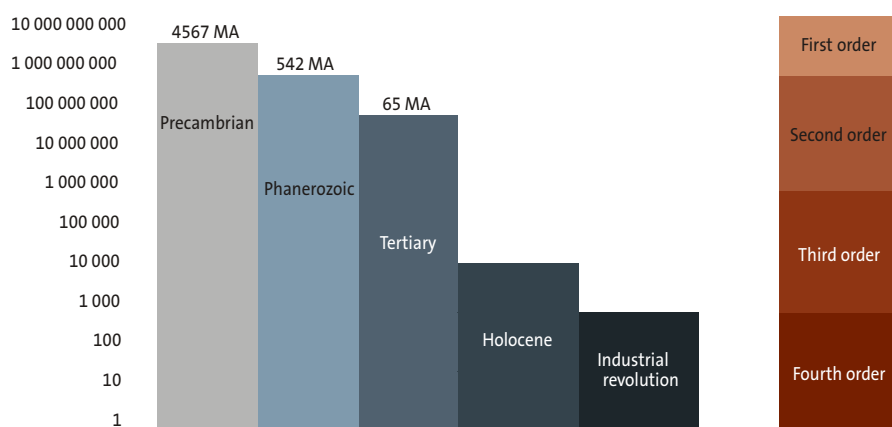
2ND ORDER CONTROLS

The overall climate on Earth is determined by heat distributing ocean currents that are largely controlled by the distribution of oceans and continents. This fundamental concept can possibly explain 15°-20°C climate variations over hundreds of millions of years, variations that are exemplified by glacial “icehouse” and tropical “greenhouse”. The theory says that when continental landmasses are positioned so that equatorial oceanic circulation prevails, global climate conditions are warmer. Conversely, when landmasses are positioned so as to impede equatorial circulation, the climate gets colder. When warm waters are moved to polar regions, evaporation creates glaciers and causes cooling.

The 2nd order climate controls operate on a time scale measured in tens to hundreds of millions of years.

3RD ORDER CONTROLS

Variability in solar energy caused by differences in luminosity, and orbital changes that alter the distance between the Earth and the sun are generally



In order to understand how geological processes drive climate change through time, it has been proposed to differentiate between four orders of change. Note that the vertical axis is logarithmic. The drawing is based on an idea by Gerhard, Harrison and Hansson (2001).



Photo: Halfdan Carstens

1st order controls

The sun's brilliance and the atmosphere's greenhouse gases constitute the 1st order climate driving mechanisms.

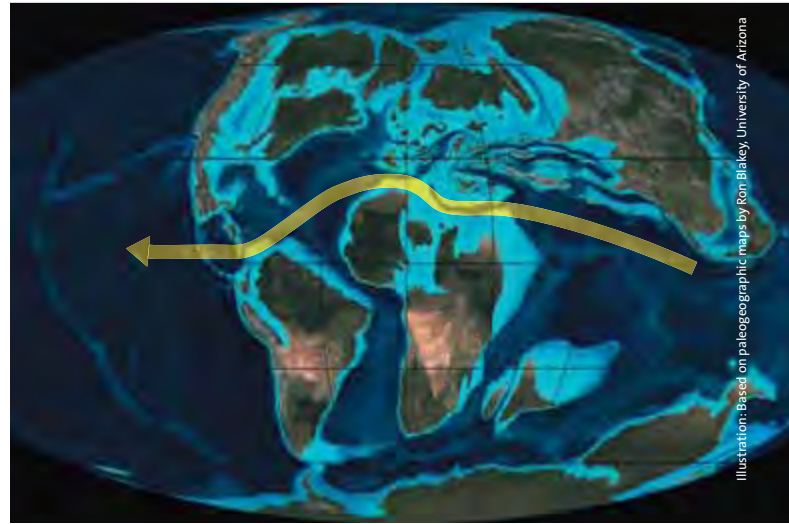


Illustration: Based on paleogeographic maps by Ron Blakey, University of Arizona

2nd order controls

A free and open global circulation system in the Cretaceous favoured a warm climate.

accepted as a cause of climate change. Temperature changes caused by orbital "wobbles" are named "Milankovitch cycles" (see following article). Potential temperature changes driven by these variations can be as much as 10°C. In addition, large scale changes in ocean circulation can be a significant climate driver.

The 3rd order climate controls operate on a time scale measured in hundreds of thousands to millions of years.

4TH ORDER CONTROLS

Many natural phenomena control small scale temperature changes over short periods

of time. These include small scale oceanographic oscillations (e.g. El Nino), volcanic activity (cooling because of particles blown into the upper atmosphere), solar storms and meteorite impact. In addition, human influence on the atmospheric composition (CO₂ and methane) may have an impact on climate.

The 4th order climate controls operate on a time scale measured up to tens and hundreds of years.

EXTERNALLY – AND INTERNALLY

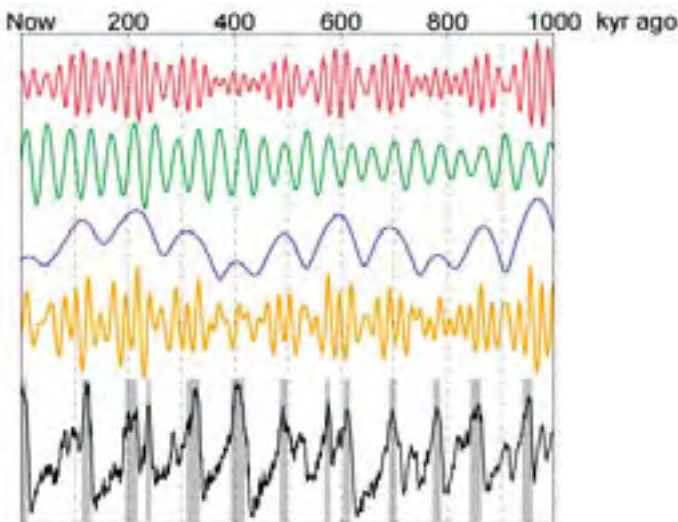
Changes in the Earth's climatic system can occur externally, because of variations in

the extraterrestrial systems, or internally, because of a dynamic Earth with an ocean, continents and an atmosphere.

If mankind is also capable of influencing the climate through excessive use of fossil fuels and intensive farming, remains to be proved. It is politically incorrect to dispute the conclusion of the IPCC panel, but we also have to respect numerous geoscientists who are not comfortable with this report.

Reference:

Lee C. Gerhard, William E. Harrison, and Bernold M. Hanson: Geological perspectives on climate change, 2001.



www.ofshaharminisatf.com Source: Global Warming Art

3rd order controls

The Milankovitch theory suggests that normal cyclical variations the Earth's orbital characteristics are probably responsible for some past climatic change.



Photo: USGS

4th order controls

In 1992 Mount Pinatubo ejected about 20 million tons of sulfur dioxide into the stratosphere and probably resulted in a drop in global average air temperature of 0.8 °C.