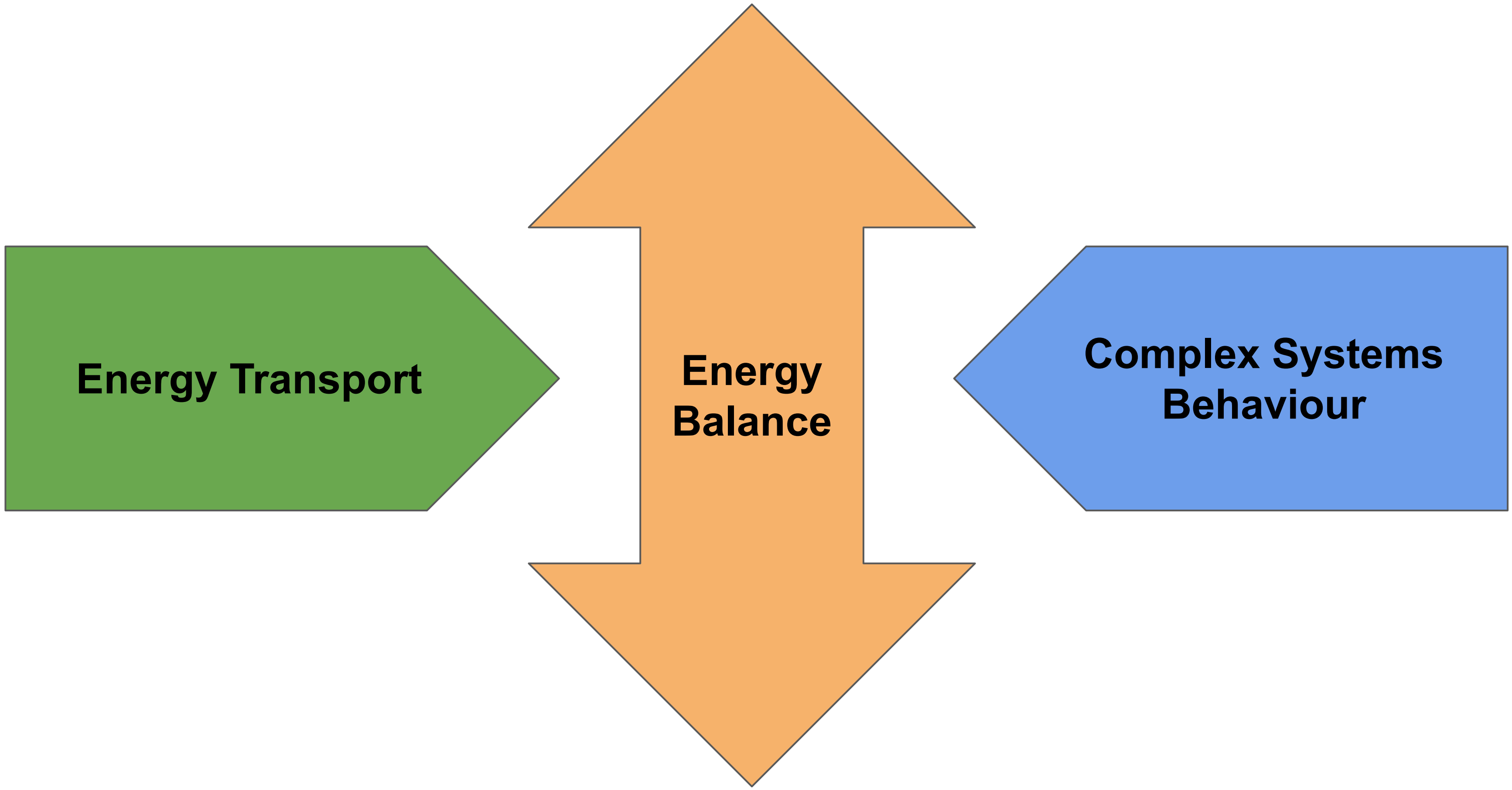
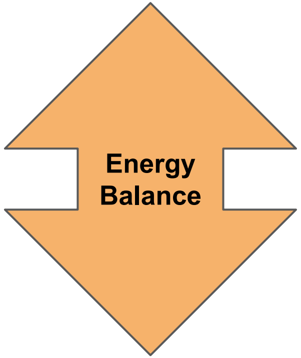
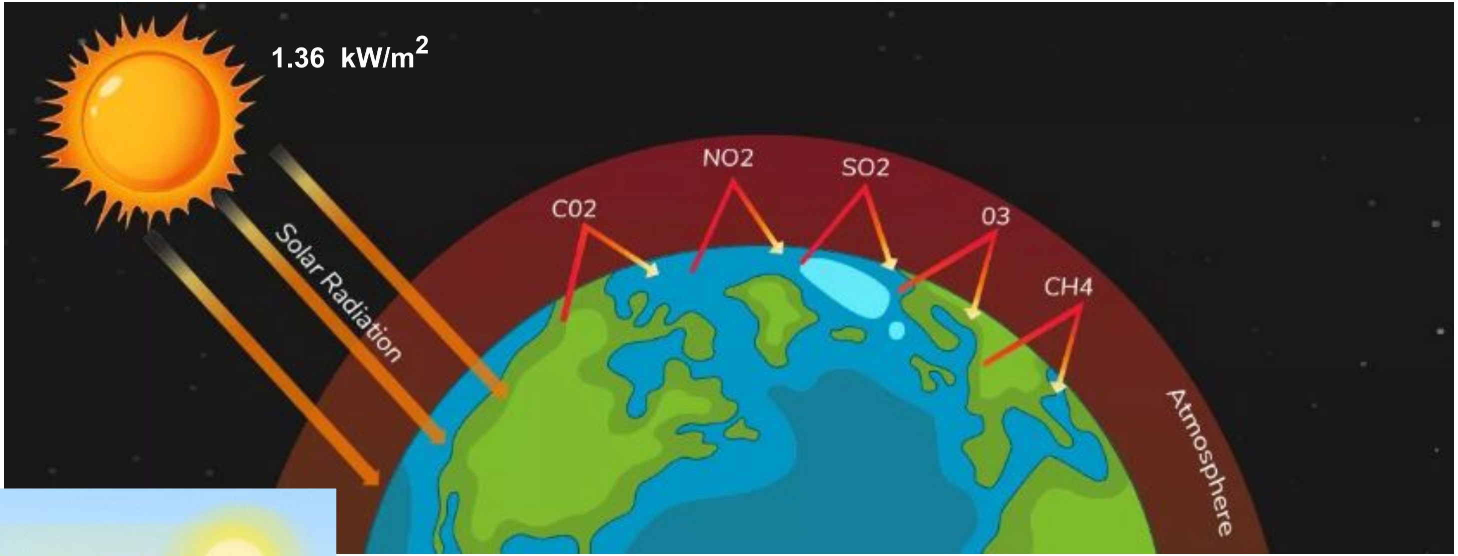
Heat Loss & Climate Change

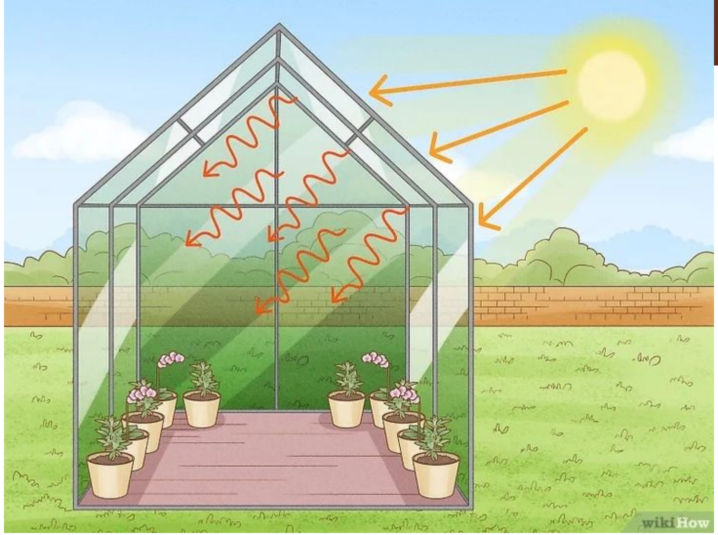
A brief inspirational introduction

… without "driving information" in order to leave room for your own thoughts!


Energy Transport
Energy Balance
Complex Systems Behaviour







A very simple modeling for Greenhouse Effects: the atmosphere is partially transparent to the solar radiation.

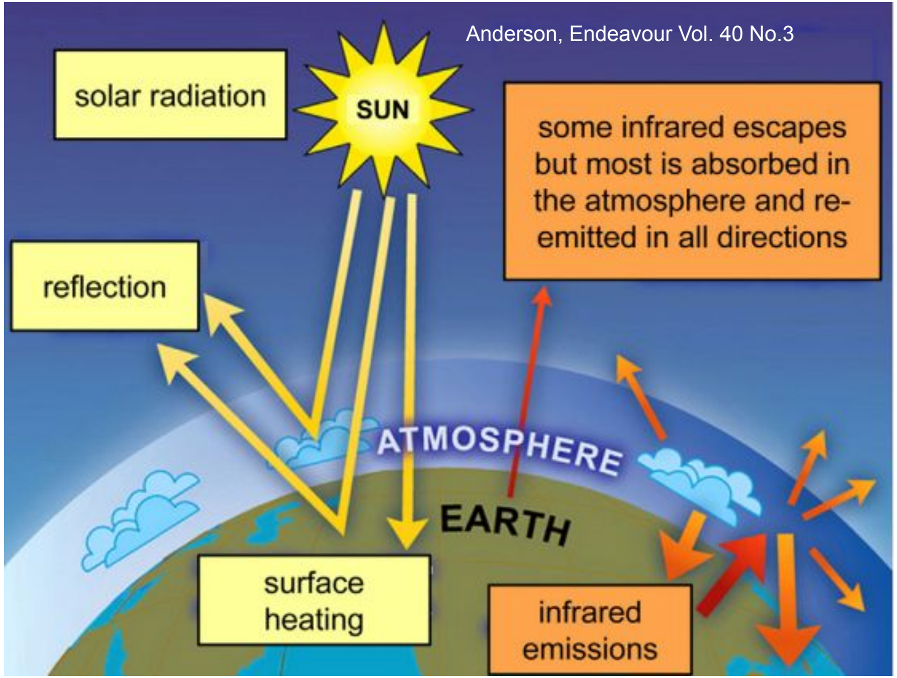
The surviving radiation is then reflected by the soil and partially reflected by gases in atmosphere (CO2, NO2, O3 etc…) That’s a NATURAL process, allowing life on Earth.

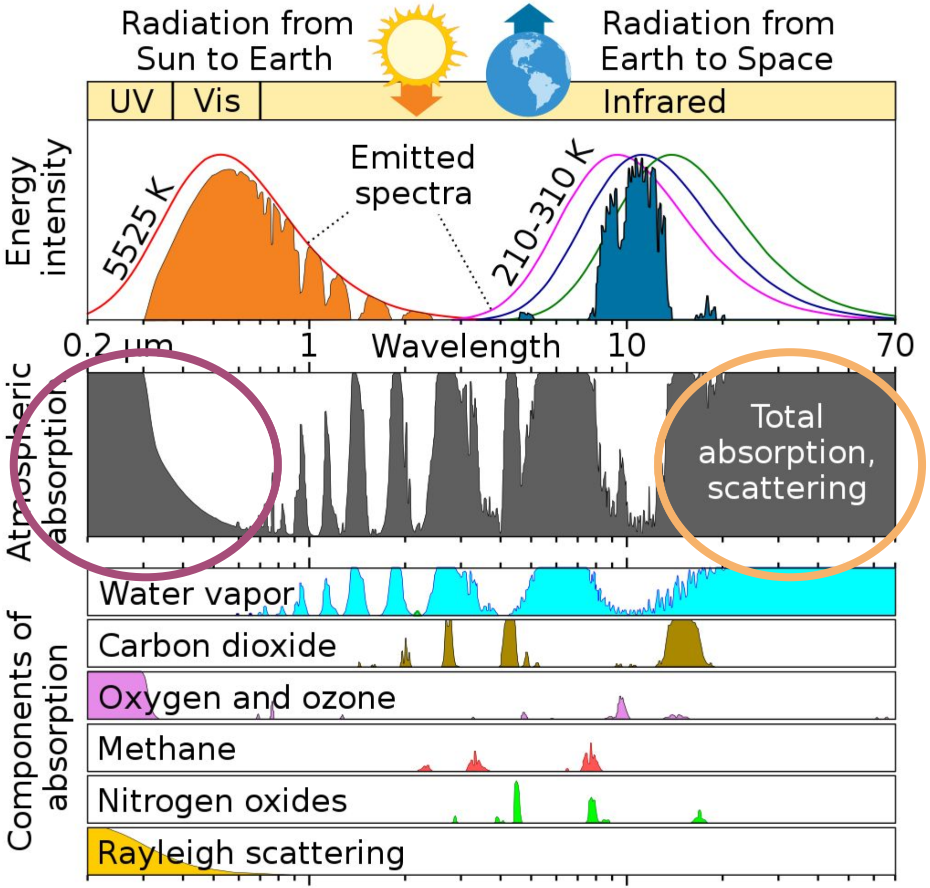
Without Greenhouse Effects strong UV would penetrate and kill surface life.

Energy Balance

A slightly more descriptive model.

Let's take into account multiple transmission/reflection phenomena, due to clouds, soil and atmosphere ….



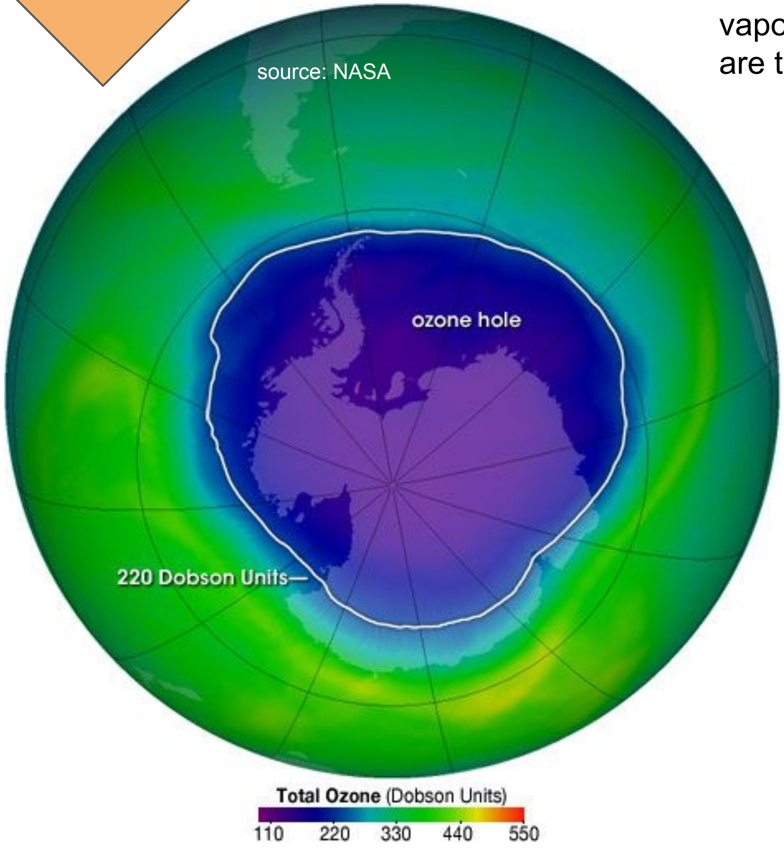


… and the specific wavelength absorption reflection for the different available molecules

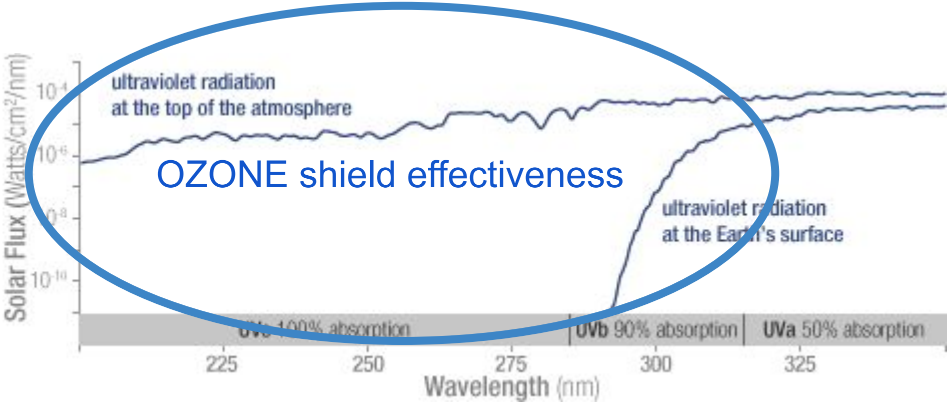
Energy Balance

OZONE: an example of "good reflection"

Ozone is a gas made up of three oxygen atoms (O_3). It occurs naturally in small (trace) amounts in the upper atmosphere (the stratosphere). Ozone protects life on Earth from the Sun's ultraviolet (UV) radiation. In the lower atmosphere (the troposphere) near the Earth's surface, ozone is created by chemical reactions between air pollutants from vehicle exhaust, gasoline vapors, and other emissions. At ground level, high concentrations of ozone are toxic to people and plants.



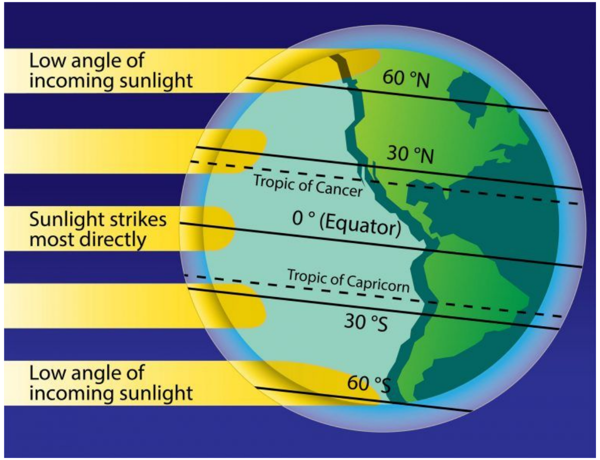
Solar ultraviolet radiation is largely absorbed by the ozone in the atmosphere—especially the harmful, high-energy UV-a and UV-b. The graph shows the flux (amount of energy flowing through an area) of solar ultraviolet radiation at the top of the atmosphere (top line) and at the Earth's surface (lower line). The flux is shown on a logarithmic scale.

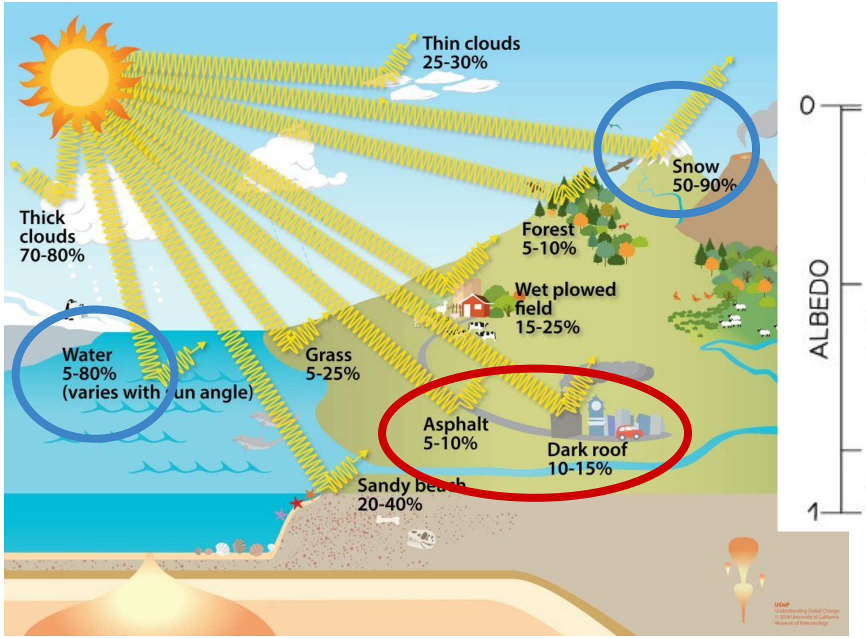


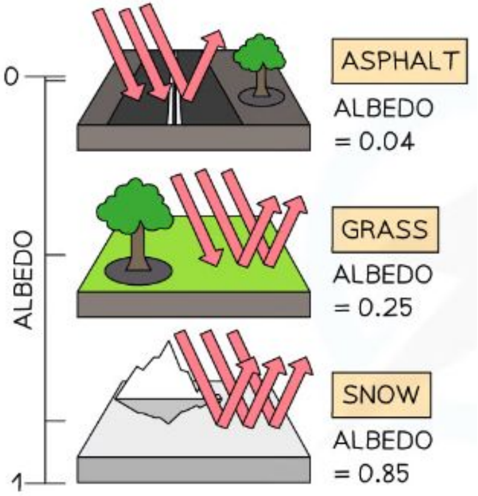
Energy Balance

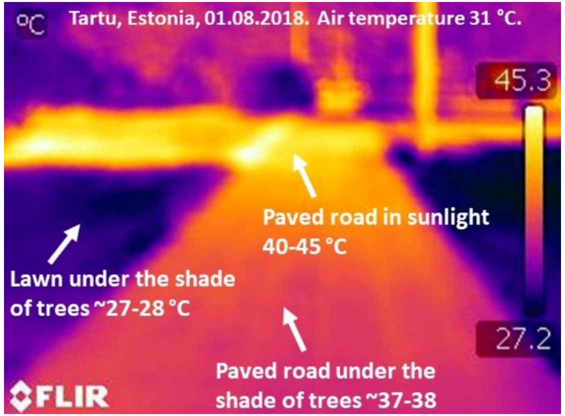
SOIL absorption and reflection (albedo).
A fundamental variable for the Earth Energy Budget

The ALBEDO is the fraction of the incident solar radiation re-emitted by a given surface.
The remaining fraction is ABSORBED by the surface and slowly re-emitted at a different wavelength (typically degraded to Infrared and Heat)



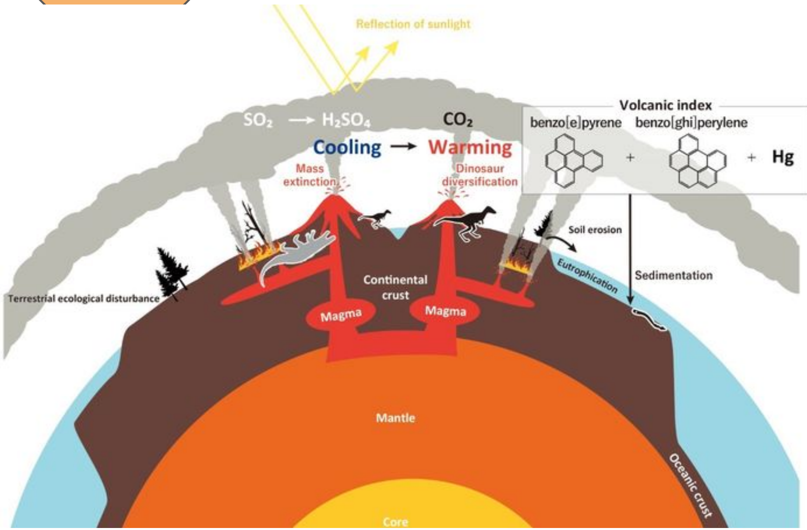






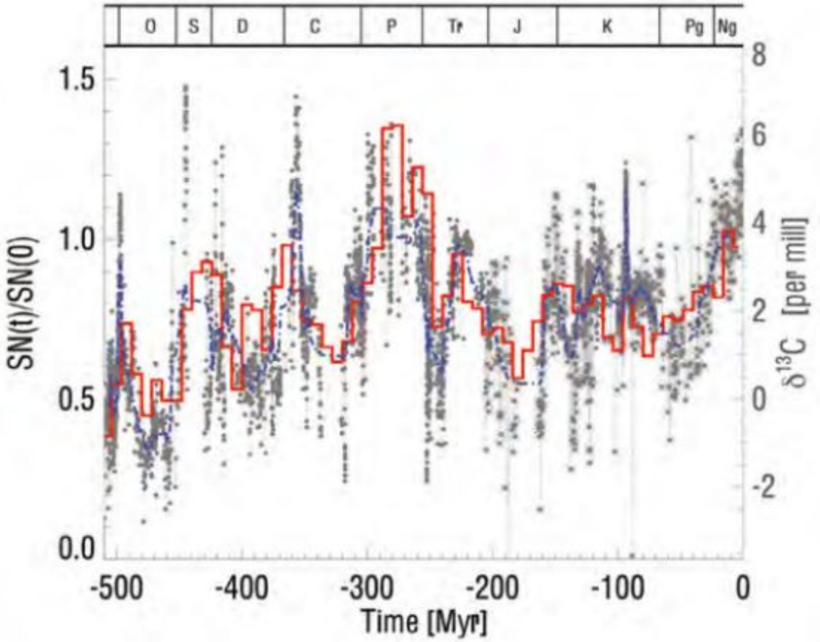
Energy Balance

A VERY limited list of examples for prompt and non-prompt condition-changing variables



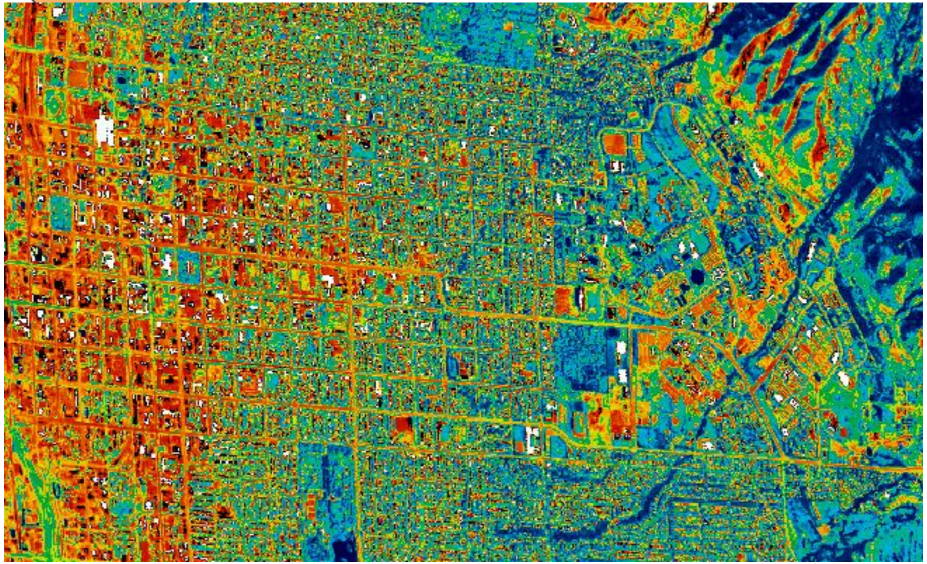
Volcanic activities have been likely involved into the 5 mass extinctions from 500 to 65 million years ago, but with controversial interpretations. In some cases they could be related to life diversification as well.

Cosmic Rays and Life. Bioactivity on Earth is correlated to CR flux modulation (here estimated with the expected local supernova rate during last 500 Myears). Clouds formation (and solar radiation reflection) is in effects related to cosmic rays flux



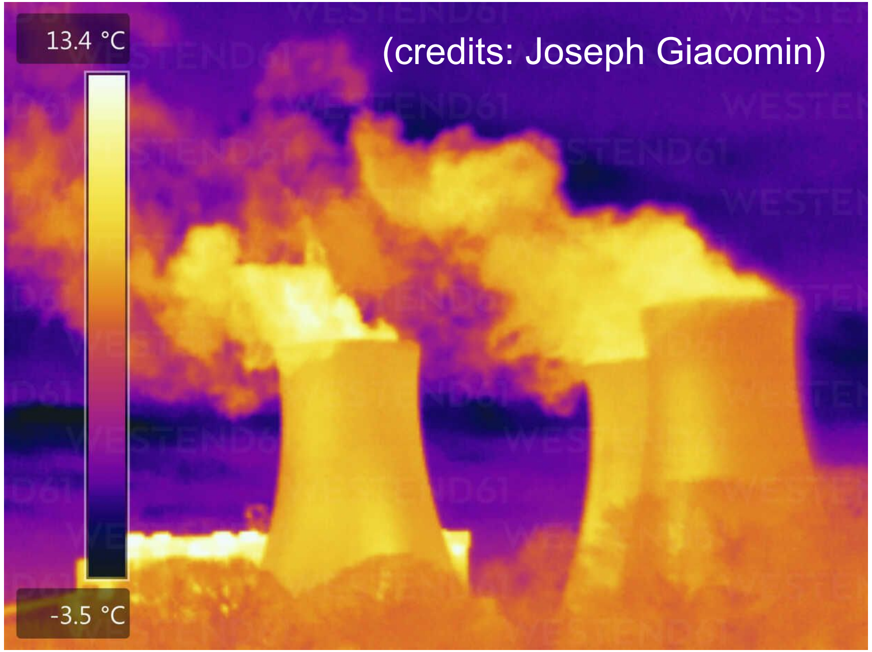
Energy Balance

A VERY limited list of examples for prompt and non-prompt condition-changing variables



Salt Lake City (credits: NASA)
The emissivity of urban area is compared with the low-density area at the boundaries of the city

Industrial Activities release heat (mainly IR and far IR) to the atmosphere.
Can we estimate the contribution of such a heating factor to the total amount of heat naturally released and captured by Greenhouse effects on Earth?

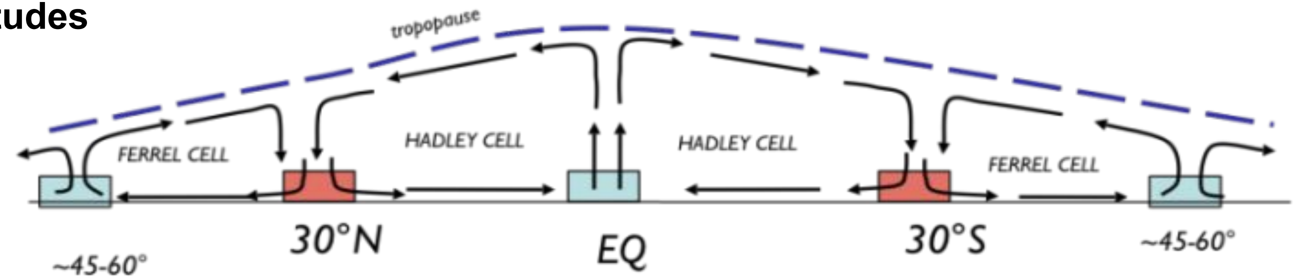


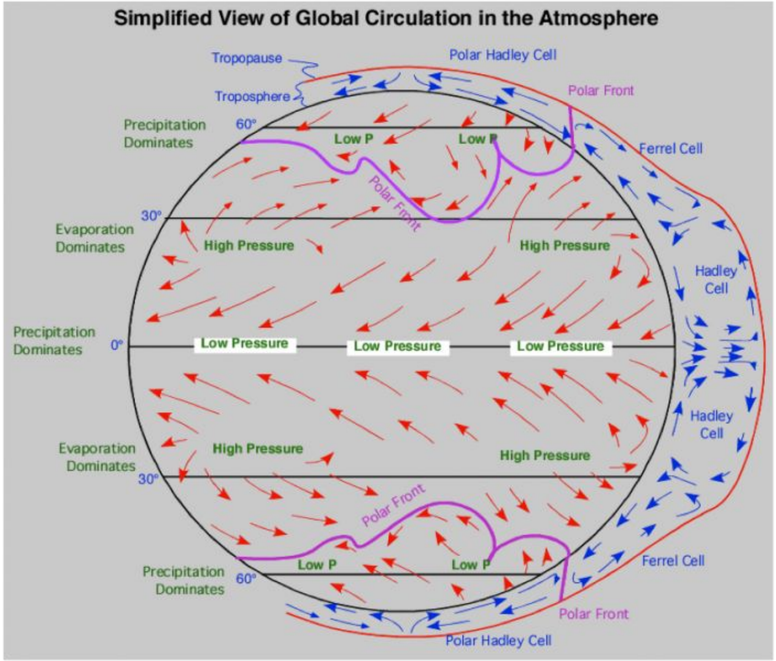
(credits: Joseph Giacomin)

Energy Transport

Energy Transport

The WIND as a fundamental engine for heat transport and exchange at various latitudes and longitudes





At the equator, air is warmed and evaporation adds water giving it a low density:

This air rises until it gets to the top of the tropopause. It then diverges, flowing north and south. Moving away from equator, air gets colder, water vapor condenses and rains out and the air grows drier — the air grow denser and reaches about 30°N and 30°S, it begins to sink down to the surface.

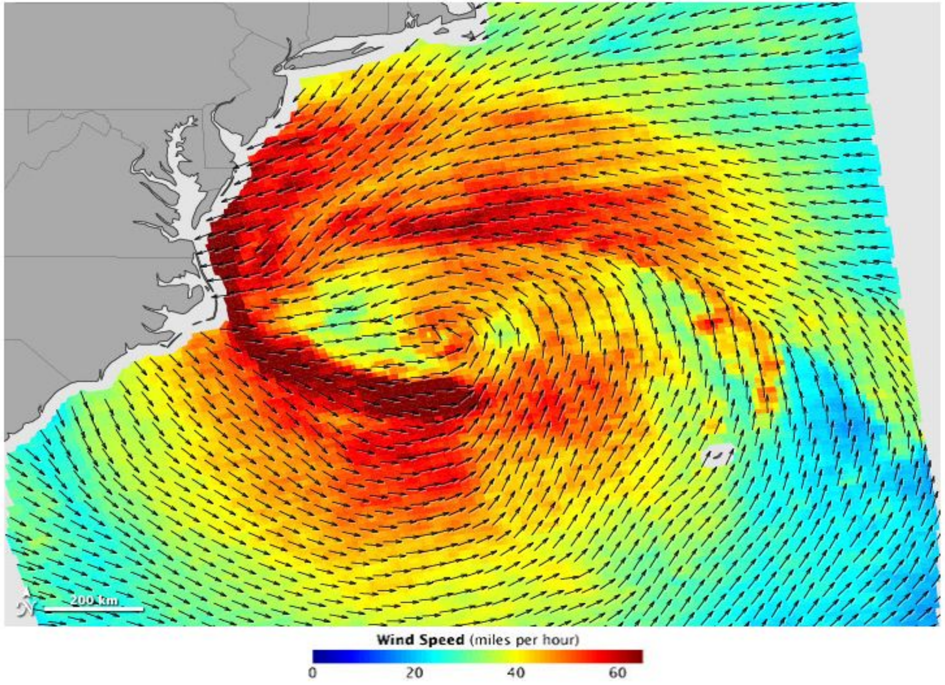
The sinking air is dense and dry, creating zones of high pressure associated with very few clouds — the desert latitudes. The sinking air hits the ground and diverges. Some flows south and some flows north; the parts of this divergent flow that return towards the equator ia a Hadley convection cell.

At the end of the first Hadley Cell, the rising air runs into the tropopause and diverges, with some of it returning toward the equator, thus completing another cell called the Ferrel Cell.

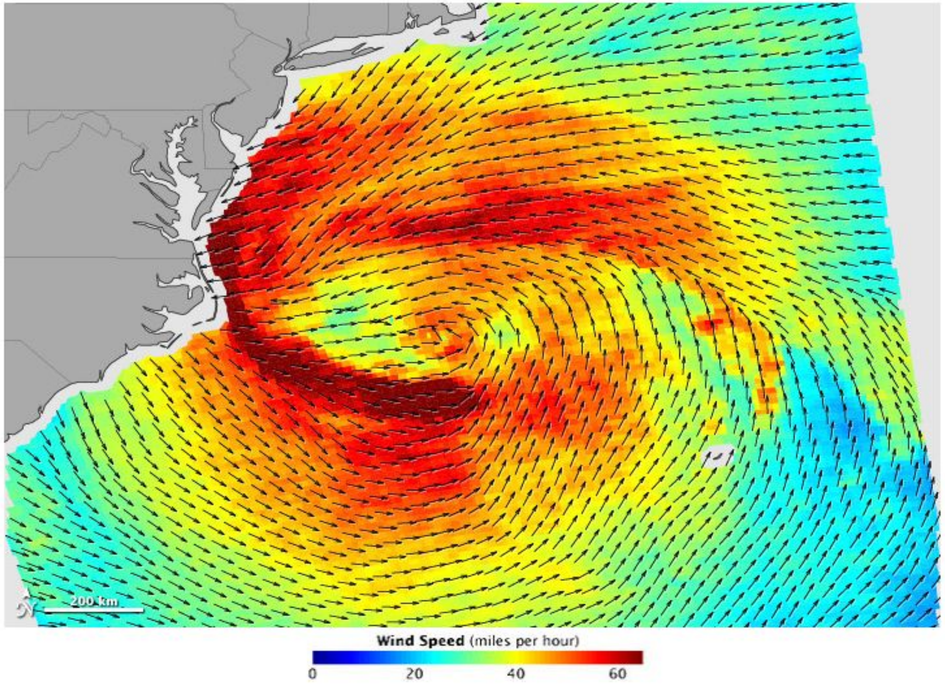
These convection cells create bands of low and high pressure that roughly follow lines of latitude that exert a big influence on the climate at different latitudes. The air flowing within these convection cells does not simply move north and south as depicted above — the Coriolis effect alters the flow directions, giving us a surface pattern that is dominated by winds flowing east and west.

Energy Transport

Hurricanes: a prompt heat and energy transport. Hints of instability of a complex system. Again a natural behaviour. What about measuring the anthropic contribution?



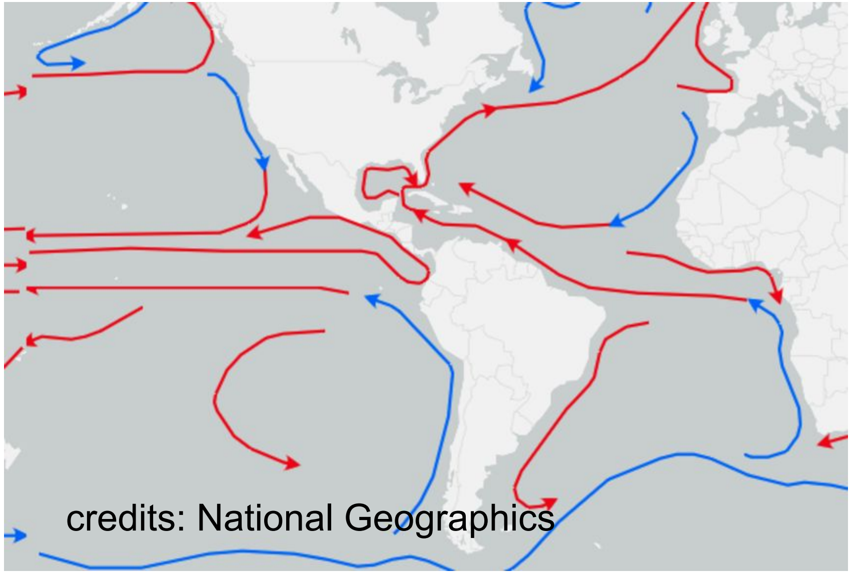
Sandy, October 28, 2012



Katrina, August 28, 2005

Energy Transport

WATER as another fundamental engine for heat transport and exchange at various latitudes and longitudes


credits: National Geographics

5 main Gyres:

- North and South Pacific Subtropical
- North and South Atlantic Subtropical
- Indian Ocean Subtropical

These surface currents play an important role in **moderating climate by transferring heat** from the equator towards the poles. Subtropical gyres are also responsible for concentrating plastic trash in certain areas of the ocean.

In contrast to wind-driven surface currents, **deep-ocean currents are caused by differences in water density**. Both are driven by Earth rotation as well. The process that creates deep currents is called thermohaline circulation - “thermo” referring to temperature and “haline” to saltiness.

Energy Transport

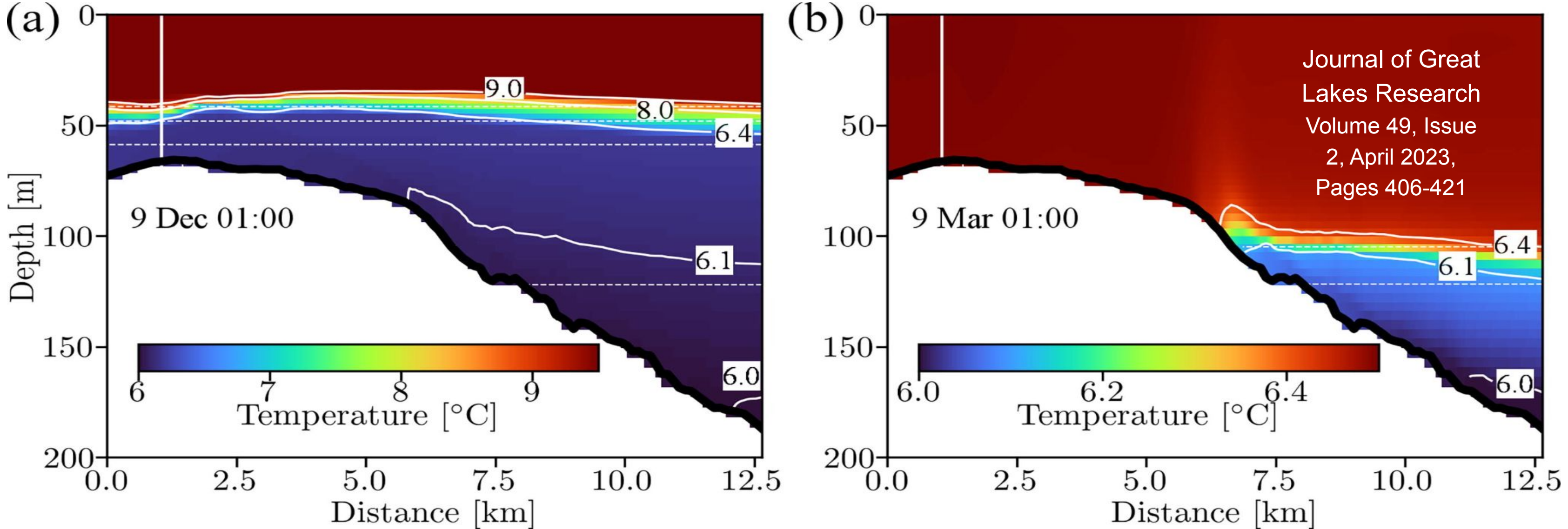
WATER as heat buffer with high thermal inertia

Lakes, seas and oceans are heat buffer as well. Thanks to the thermal inertia the heat is accumulated in summer and slowly released in winter, strongly modifying the climate of the surrounding lands.

In example is shown the Lake Geneva temperature profile vs depth at the beginning and at the end of the winter season.

December 9th

March 9th

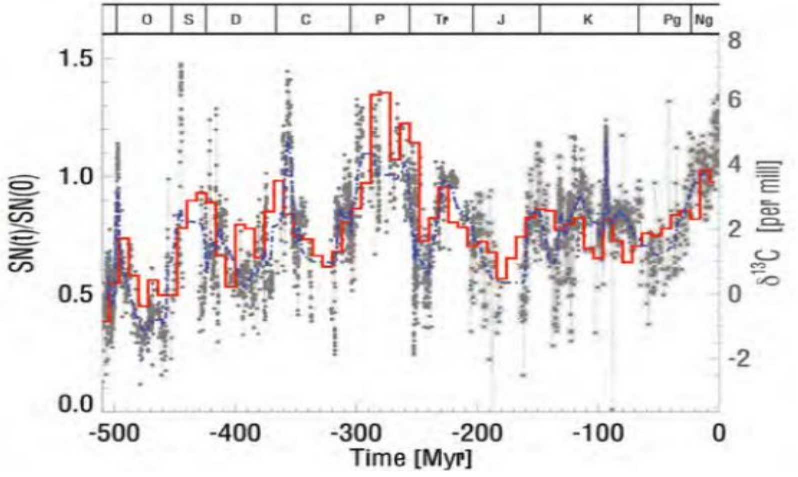


Complex Systems Behaviour

Complex Systems Behaviour

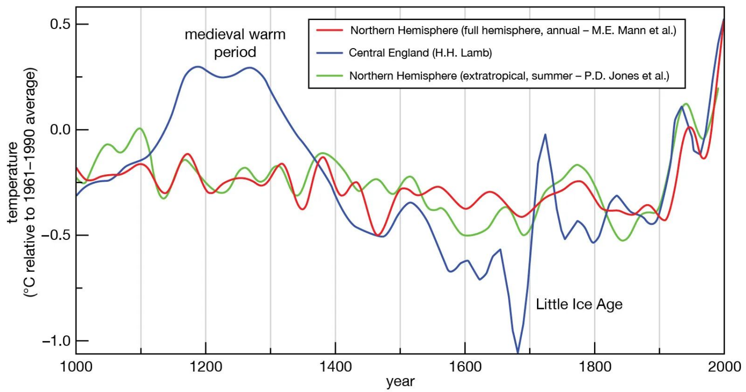
CLIMATE as a complex system ….with cyclic behaviours ….

100 My typical cycle phenomena



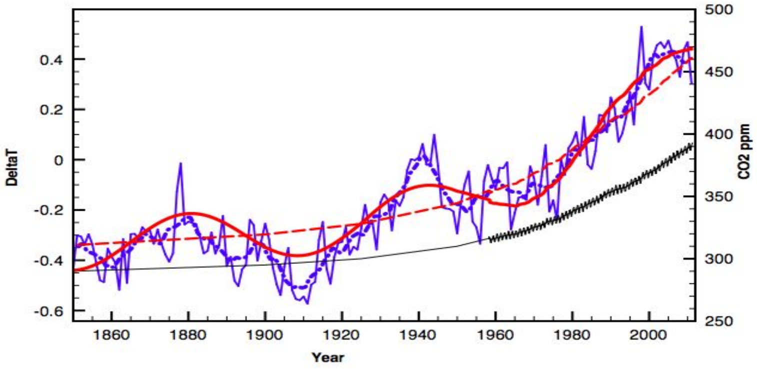
100 y typical cycles phenomena

Estimated temperature variations for the Northern Hemisphere and central England (1000–2000 CE)



Sources: M.E. Mann et al., "Northern Hemisphere Temperatures During the Past Millennium: Inferences, Uncertainties, and Limitations," *Geophysical Research Letters*, 26:759–762 (1999); P.D. Jones et al., "High-resolution Palaeoclimatic Records for the Last Millennium: Interpretation, Integration, and Comparison with General Circulation Model Control Run Temperatures," *Holocene*, 8:477–483 (1998); H.H. Lamb, "The Early Medieval Warm Epoch and Its Sequel," *Palaeogeography, Palaeoclimatology, Palaeoecology*, 1:13–37 (1965).

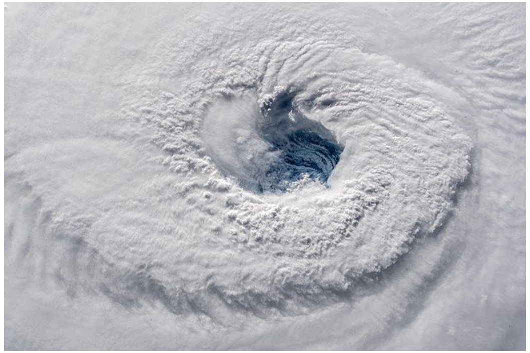
DT = -0.34+2.5ln(CO2(year)/290)) + 0.1*sin((2pi/60)*(year-1865))



…. and linear behaviours

Here, **yearly** and **60 year** cycle are superimposed with a **possible (anthropic)** contribution?

…. and prompt unexpected behaviours ….



Complex systems such as the climate are composed by a high number of participants and ruled by a high number of laws and variables

They are intrinsically hardly predictable

Any action on the evolution of a complex system is very difficult to predict

Therefore GOOD LUCK and let's open the investigation!!!!