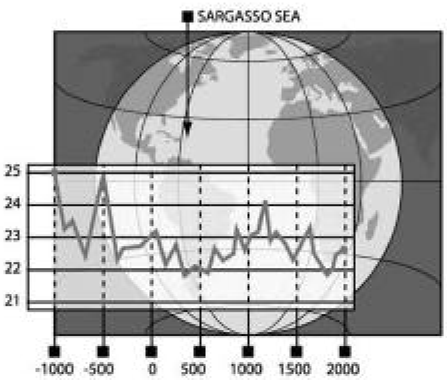
How modern climate evolved 150 years ago

Global warming is not a new thing, and the matter did not started just 25 years ago. Since 1850, global air temperatures have started to get warmer. Warming in this sense can only be measured and evaluated against previous temperature records in an endless chain of repeatable cycle of Earth's climate changes going from warm periods to glacial conditions and vice versa during the past one million years. With the end of the Ice Age, the globe became about 4-5°C warmer. More recently, a medieval warm period (between 900 and 1450 AD) was at the upper most level, followed by the so-called Little Ice Age (between about 1450 and 1850 AD). This period shall be briefly discussed as it may hold some clues to how the world climate evolved until it reached the current status, at least with regard to the general trend.



The Little Ice Age

The world was cooler through out the Middle Ages. Even though during the Little Ice Age the temperature fluctuation was in the average just 1-2°C colder than during the previous warm period (from 900 to 1450 AD), the social implications of this phenomenon were immense. Life in the Northern Hemisphere became rather uncomfortable. Low temperatures and higher cloud coverage affected farming severely. Several great famines occurred, which led to a number of wars in Europe.

Possible causes for this cold phase that prevailed for almost 400 years are still being debated[1]. The number of contributing causes is numerous and includes, among others, notions like: intensity of the sun's rays, earth's rotation around the sun, surface albedo by ice and snow, volcanic activities, ocean-atmosphere conveyor system, etc. Current climatic conditions and processes could be better analysed if the natural processes of the Little Ice Age were understood properly. In the absence of either an earth science or even of a reliable data collection during the above mentioned cold phase, a complete picture of the causes which triggered and sustained the cold phase would probably never be established.

Despite this incertitude, it can be said with a certain amount of certainty that a high volcanic activity had considerably contributed to this scenario. For example: the eruption of the Huaynaputina (Peru), in 1600 AD, caused the most severe short-term cooling effect in the Northern Hemisphere, in the past 600 years. The huge fissure eruption of the volcano Laki, in Iceland, between 1783 and '84, was the greatest historical volcanic eruption hitherto recorded anywhere in the world. The explosion of Mount Tambora (Indonesia), in 1815, catapulted 150 cubic kilometres of rock dust into the air, this resulting in the coldest single year on record in many places in Europe and North America and producing, in 1816, a "year without a summer".

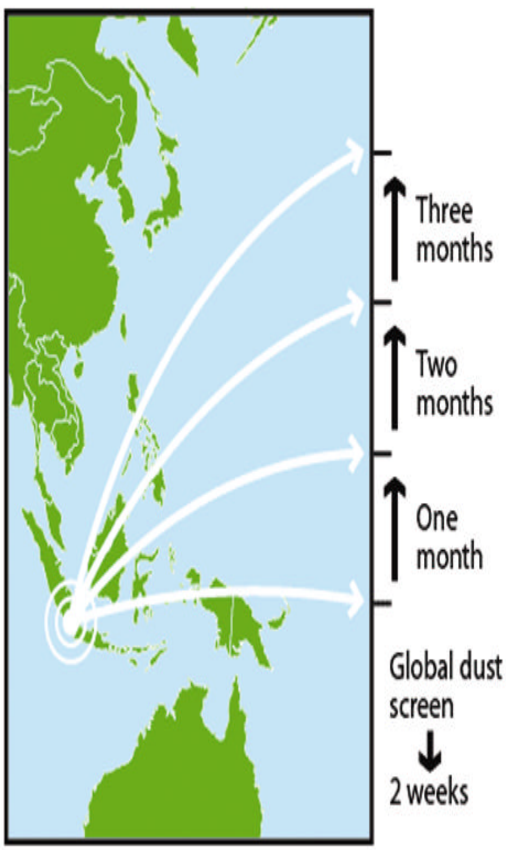
1 Richard D. Tkachuck (//www.grisda.org/origins/10051.htm) states: The causes for this cooling may have derived from a combination of changes in the energy output of the sun and changes in the atmosphere of the earth which resulted from volcanic activity that reduced the amount of energy absorbed.

The last big one, Krakatoa, in the Sunda Strait (Indonesia), erupted with tremendous force in 1883.

The Krakatoa volcano and science

(a) An event leading to climate change?[2]

After a long row of severe volcanic eruptions during the Little Ice Age, the Krakatoa was the last major volcanic eruption in the world. As a result, the world got warmer. When Krakatoa erupted, on the 27th of August 1883, about 50 cubic kilometres of lava, mud and ashes reached heights of more than 10,000 metres. It took about three months for the volcano 'dust' to have circled the whole global atmosphere from the South Pole to the North Pole.



Krakatoa, 27th August 1883

During the following years, air circulation in the atmosphere was above normal and then sank to a bare minimum in 1888[3]. For more than three years, the solar radiation intensity was about 10 to 15 % lower than the normal level. The minimum value of 76% was reached in the late summer of 1885[4]. The high drop of the radiation values during such a long period should have left significant marks in the weather records. But nothing serious happened. Neither did the Little

Ice Age return, nor did 'a summer without sun' happen again as it did in 1816. Does it really not matter if warming coming from the sun is partly blocked out? Did the laws of physics refuse to work in this case, or were the emerging community of meteorologists not able to grasp what was going on in those days?

(b) Krakatoa raise the interest in meteorology as a science

Eruption of Krakatoa was widely acknowledged with interest. The Deutsche Kaiser was so impressed that he ordered the establishment of a scientific institution, the German Sea Observatory, within weeks from the Indonesian event. The institute started publishing the

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2 From: Bernaerts, Arnd, 'Conditions necessary for the protection of world climate', Geesthacht 1992; (available on www. seaclimate.com, Previous Essays (8_13); published in German by Verein der Freunde und Foederer des GKSS-Forschungszentrum Geesthacht e.V. : ISSN 0934-9804

3 Wagner, Artur; Climatic Changes and Climate Fluctuations, Brunswich 1940, p.42.

4 Wexler, H., On the effects of volcanic dust on insulation and weather', in: Bulletin American Meteorological Society, Vol. 32, No. 1 & 2, January 1951, pp. 10-15, and pp. 48-52

venerable magazine *Meteorologische Zeitschrift* in January 1884. Its first article was a report on the volcanic eruptions from 1883, particularly that of Krakatoa. The first sentence says: "The year 1883 will occupy a remarkable place in the history of earth with respect to the effects of the earth's interior on its crust and everything found upon it." That sounded very promising. The British journal NATURE also published frequent scientific findings for a couple of years. But nothing exciting happed in climatic terms. The weather continued just as it had before. Only in some continental regions, average temperature decreased during the next five years. Because the Krakatoa eruption did not cause major changes to the weather statistics, science lost interest after a few years. Was Krakatoa so unspectacular indeed? No! The stability of the weather was extremely interesting, because only the oceans saved the world from a new dramatic cold period for a couple of years.

(c) Ocean as a stabilizer

After the eruption of Krakatoa, on the 21st of August 1883, unusual observations were reported. For example:

On the 3rd of September: During the past few days, there has been a fairly even, gray Cloud mass, normally covering the entire sky, above the cumulus and Stratus clouds;
On the 3rd of September: At midday hazy gray air. Hazy, gray air condensing into Dew towards evening;
On the 5th of September: Air appears yellow and watery;
On the 7th of September: The atmosphere appears to be filled with very small, evenly distributed clouds of vapor;
On the 13th of September: The yellowish "haze" continues in the upper atmosphere;
On the 11th of October: Fiery atmosphere, cloudless sky;
On the 5th of November: Pale atmosphere;
On the 10th of December: The air was very clear and looked like the air in the Southern Indian Ocean during the typhoon season;
On the 13th of December: Lead-colored sky.

These early observations could possibly have been dismissed as coincidence if the period until 1886 had not been accompanied by a permanent phenomenon, a "hazy fog", a strange, smoky cloudiness in the atmosphere, which was observed everywhere around the globe, in the tropical as well as in sub-polar areas. One of the descriptions given was: "The hazy fog appears as a constant companion of the extraordinary optical phenomena in the atmosphere during the entire period of the atmospheric-optical disturbance". How the young science viz. meteorology could not be concerned with what was going on? Had the oceans been recognized as stabilizers, the greenhouse effect would be understood much better today. The explanation is easy.

The "hazy fog" was a compound of volcanic dust and oceanic water vapor. This "extra stuff" from the atmosphere wrapped the earth like in a blanket. This blanket protected the earth from losing heat too quickly and thus compensated for the deficiency of blocked-out sunrays (10-15%) for a few years. The interdependence is evident:

- Air circulation, initially above normal, decreased to a 'bare minimum' in 1888. The above mentioned blanket determined a more maritime climate during the early period, while the continuing lack of 'usual' energy supply for the oceans over a longer time period pushed the water body temperature so much down that high air pressure systems got the 'upper hand'.

- The "hazy fog" was stronger at the tropics. The warm tropical oceans released more vapor than colder pole water areas.

- During the Krakatoa-relevant five years, the average temperature in inner continental areas dropped more than in coastal zones; a clear indication that the heat capacity of the oceans had weakened over the period in discussion.

Oceans as a climate factor were inexistent in those days as far as science was concerned. One can only wonder how the matter had been discussed then. One serious opinion was whether the eruption had thrown a huge amount of water vapor into the air; while an opposing opinion was that the "hazy fog" was predominantly dry dust fog. There was no mention about the highly dominant role of the oceans.

(d) Relevance of Krakatoa in modern climatic study

It does not seem reasonable to discuss carbon dioxide (CO2) and Greenhouse effect on climate seriously as long as the impacts of more climatically relevant Krakatoa eruption on global weather conditions are not debated. The eruption of Krakatoa was the first scientific phenomenon of its kind which was carefully observed. But the unique and early opportunity to understand the principal mechanism of climate was not used properly because the mechanism of the weather and its reliance on the oceans were so poorly understood. Any convincing assessment on the former is still not available today. It would be particularly a matter for the Intergovernmental Panel on Climate Change (IPCC) to explain the historical conditions of the climate change issue to further and broader understanding. The perpetuation of the moderate climatic conditions from the explosion of the Krakatoa (1883) until the end of the decade was a physic-dynamical sensation, with many interesting clues on how to handle the CO2 issue.

However, the Krakatoa was the last major worldwide volcanic eruption after a long row of severe volcanic eruptions during the Little Ice Age. As a result, the world got warmer. Without industrialization, global air temperature would have been rising. A strong increasing trend is therefore defiantly natural and man is not to blame. This is widely undisputed. The next section will give an overview of other possible reasons which could have contributed to global temperature status during the last 150 years.