The didactic importance of the historical context in the teaching of Climatology

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1. Introduction

Scientific progress is seen as an independent agent of change, but some determinative powers such as socio-economic, political and ideological forces are behind these advances. This statement suggests that science follows a developmental sequence rather than arriving in a more chancy manner, and that history is a driven force of science, since its advances had changed the functioning of the social organisation, reconfiguring its internal structure.

This paper evaluates the connections between the atmospheric science evolution and the historical circumstances in which some specific improvements were achieved. It aims to underline that the atmospheric science developments are strongly related to the historical context and therefore a comprehensive knowledge of the atmospheric sciences must take into account this aspect, in view of enlarging and enriching the acquaintance with atmospheric behaviour. It also plans to demonstrate the importance of presenting any process in Climatology lectures in terms of a comprehensive framework that considers not only the physical and the human contributors, but the historical context in which a certain knowledge was reached. It also underlines that scientific acquaintance is an endless construction made of previous contributions, so that the impressive current gains should not obfuscate the ones of the past.

2. The beginning – empirical and speculative knowledge in the atmospheric science

Knowledge in societies such as the Fertile Crescent and the Egyptian was connected to the ways in which water could be controlled and stored to obtain good harvests. In Fertile Crescent the inhabitants developed a pattern of irrigation and a system of flood control to farm the land. Ancient Egypt was a rural state, depending on rainfall and the Nile. Droughts are reported to have brought starvation and political disorder in those areas.

Chaldeans, Egyptians, Babylonians, Assyrians and Chineses associated diseases to planets, stars and winds, many times in a fatalistic way. Pythagoras (580 to 489 BC) believed that incorrect proportions of fire, earth, water and air could cause sickness. These approaches were considered by some scientists as an obstacle to medicine improvements (Sulman, 1982).

The treat *Meteorologica* (Aristotle, 340 BC) deserves to be highlighted. The author put the principles of his natural philosophy into practice, presenting meteors as components of an all-inclusive doctrine of the natural world. Notwithstanding, *Meteorologica* is concerned with meteors rather than weather pattern in a place by (Jankovi_ 2000). Moreover, Lamb (1982) underlined that Aristotle had described the "natural character" of men in different climatic regimes and arrived at a basis for believing in the superior quality of the Greeks.

3. The Middle Ages

Science during the Middle Ages was a complex arrangement within the context of medieval religious and intellectual culture. During this time on quote the origin of the modern university, windmill, magnetic compass and improvements in ship design. Science was almost completely theoretical, with little or no observation of nature. Superstitious hopes and fears were present in science, situation which started to change in late Middle Ages.

In 916 the Arab geographer Abu Zayd described the physical characteristics and the societal importance of the monsoon (*basadra*). Notwithstanding, the Arab science --a mixture

of Aristotelian natural philosophy, Islamic religion, astrology and folklore-- was not able to explain the mechanisms behind the climate variations in time and space (Fagan, 2000).

4. Improvements in the knowledge of the atmospheric circulation

In the 15th. century the new requirements for long-distance navigation put the study of the atmosphere and ocean circulation on a firmer basis. Speculation gave way to experimentation and many progresses in sciences made contributions to the knowledge of the atmosphere. The invention of instruments constituted important steps towards systematic measurements of the weather, reflecting the tendency of this period in studying and demonstrating the nature. The knowledge of the atmosphere motion gained impulse, as can be exemplified by the recognition of a region of subsiding dry air and weak winds named as the Horse Latitudes (in German, *Rossbreiten*) since when ships were becalmed in mid-ocean the voyage was prolonged and the horses in the vessels were thrown away due to water shortages (McKnight,1996; The Columbia Electronic Encyclopedia, 2003). During the same period, sailors noticed the stillness of the rising air near the equator, giving the region the depressing name "doldrums" (nowadays, the Inter-tropical Convergence Zone --ITCZ).

In 1666 The Royal Society of London prepared instructions for collecting data on winds and currents. In 1686 the astronomer Edmund Halley organised a meteorological flowchart of the tropical oceans, explaining the monsoon circulation as a regional alteration of the trade winds (Fagan, *op.cit.*). In 1735 the British meteorologist George Hadley described the deflection of the atmospheric motion, evaluation enriched one century later by the study of the French engineer and mathematician Gaspard-Gustave Coriolis, who showed that the rotation of Earth deflects the wind's path.

The German geographer Alexander von Humboldt elucidated the differences of the atmospheric motion along the same latitude in terms of the land-sea distribution modified by local features, considering from 1817 the linkages between the living nature and the rest of the conditions of existence on earth (Fagan, *op.cit.*).

The economic interests of the British Empire in India reinforced the studies towards the understanding of wind patterns in the 19th. century. Initially, correlation between precipitation variability and sunspot cycle[1] was view as potential to affect the intensity of the monsoon, fact which clearly points out the searching for cycles in nature, aspect presented in much of the science produced in this period[2]. Another approximation towards the monsoon understanding was its correlation with the global pattern of the atmospheric circulation. Sir Gilbert Walker, who served as director of The Indian Meteorological Service early 20th. century, used data from different places to establish the relationship between monsoon and global atmospheric circulation. His theory was based on correct assumptions, but his formulas were poor and failed to predict monsoons. Meanwhile, in 1891 the Peruvian geographer Luis Carranza called attention to an occasional counter-current flowing along the Peruvian coast, called by the Paita sailors El Niño (in reference to the Child Jesus), observed to appear next to Christmas (Philander, 1990; Fagan, *op.cit.*).

The 19th. century witnessed the "new colonisation era" in Africa, justified in terms of pseudo-scientific allegations such as high temperature and humidity make inhabitants of the tropics lazy. These claims were presented as "acceptable" reasons to submit other lands and peoples to the interests of the dominant European nations. Only later the environmental determinism was rejected as lacking any real scientific basis. During the 18th. and the 19th. centuries European and North-American travelling naturalists spent some time in tropical

[1] In 1843 the German astronomer S. Heinrich Schwabe discovered that the sunspots vary in a regular and predictable way (Burroughs, 1997),

[2] Just to give one example: the geomorphic cycle, a model of landscape development proposed by the American geographer William Morris Davis in late 19th. century.

areas, bringing home to their studies and museums specimens classified and arranged in an order that obliterated connections to their environments of origin. The tropical areas were (and still is) called as "exotic" a term which carries in a negative connotation[3] although in its origin exotic is defined as something excitingly different, foreign, unusual. In taking this latter meaning and considering that the most important biodiversity is located in the tropics, it is clear that what can be seen as exotic is the extra-tropical environment rather than the tropical!

5. The twentieth century findings

The 20th. century has experienced the most remarkable scientific progress in the humankind history, but once again the interest in developing the knowledge and surveillance on the atmospheric conditions was dominated by military, political and economic purposes.

During the first decades science was marked for hunting cycles in view of anticipating the ways in which the natural processes would work, a mechanicist conception of the Earth, as exemplified by the theory proposed by the Serbian mathematician Milutin Milankovitch in view of explaining how alterations in the orbital parameters could cause advance and retreat of the polar ice caps due to changes in the amount of solar radiation striking different parts of the Earth at different times (Aguado and Burt, 1999).

Classification systems were another feature present in science of 19th. and 20th. century. The most popular was developed by the Russian-born German researcher Wladimir Köppen, who used a numerical basis founded on annual and monthly values of temperature, precipitation and vegetation, a static approach in contrast to the atmospheric dynamics.

In the period of the world wars meteorology gave uncountable contributions to military operations, and great progress in the atmospheric functioning came about. During the First World War the Norwegian scientist Vilhem Bjerknes developed the theories of mid-latitudes cyclones and the polar front --named due to the antagonism between the systems along a boundary separating cold and warm air, a clear analogy with the opposing armies in Europe (Aguado and Burt, 1999). During the Second World War the existence of the Jet Streams was realised by Japanese pilots, who noticed that it was faster to fly to the east due to the presence of high and fast winds. (Erau Communication). The undulations developed in westerlies flow were named Rossby waves after the Swedish meteorologist Carl-Gustave Rossby, who developed the equations for parameters governing the waves (Oliver and Hidore, 2002).

Improvements in computers, meteorological radars and means of intercommunication brought effective advances in numerical experiments in the middle of the 20th. century, period which witnessed again the rivalry among nations as a source of advances in atmospheric sciences. In the period of the cold war competition between the United States and the former Soviet Union, allied to a period of expanding economy, accelerated findings related to aerial operations, starting the era in which weather information became available globally.

In 1969 Jakob Bjerknes demonstrated the relation between the Southern Oscillation and the anomalous patterns verified in the Pacific, naming the zonal pressure gradient associated with the equatorial circulation the Walker Circulation. Still in the 60s, the nature of the atmosphere was defined as chaotic by Edward Lorenz, and mathematical advances made possible to describe the limits of its predictability.

Currently, global environmental changes are commanding much of the scientific developments in the atmospheric sciences. Attempts have been made to take the Earth as an integrated system, where atmosphere, ocean, vegetation, and man-made influences depend on each other. Climate models are improving, being one of their goals the investigation of long-term climate shifts, such as the effects caused by human emission of greenhouse gases.

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[3] from the Greek exotikós, besides relative to something different, nowadays defined as strange or unusual, extraneous, eccentric, strange, malformed, awkward

6. Final Notes

Progresses in the atmospheric sciences were always dominated by approaches derived from natural sciences, underestimating the weight of some components of the system. However, because a substantial part of the socio-environmental problems of the planet is connected to climate disruptions, the contribution of the human sciences towards a comprehensive knowledge of the climatic impacts should be increasingly pursued.

Hazardous episodes have been severe and registered at a time when the technological improvements are at their highest, emphasising the gap between the human capacity in promoting atmospheric alterations and its ability in managing these changes (Nunes, 2002).

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Biographical Sketch

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