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WALTHÈRE VICTOR SPRING – A FORERUNNER IN THE STUDY OF THE GREENHOUSE EFFECT

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ABSTRACT: In 1886, an article by Walthère Spring and Léon Roland, two scientists from the University of Liège, dealing with the carbon dioxide content in the atmosphere in Liège appeared in the "*Mémoires*" of the Royal Academy of Belgium. In order to explain the difference between temperatures in the city of Liège and those observed in that city's environs, the authors invoked the high level of atmospheric CO_2. Although the climatological argument was rather weak and the article concerned only a local impact, it is obvious that Spring can be viewed as a precursor of Svante Arrhenius who foresaw global warming in 1895–1896.

KEY WORDS: Walthère Victor Spring, Léon Roland, Svante Arrhenius, the University of Liège, Belgium, the greenhouse effect, atmospheric CO_2, global warming.

WHAT IS THE GREENHOUSE EFFECT? AND MORE ABOUT ITS NAME

The sun warms the Earth, after which the latter irradiates the heat. A temperature equilibrium is reached when the amount of incoming energy equals the amount outgoing. This equilibrium temperature should be –18°C, while it is in fact about +15°C. This difference of 33°C is caused by the Earth's atmosphere, in which the amounts of CO_2 and water vapor present absorb the infrared rays, resulting in an increase in the

equilibrium temperature. Without this natural 'greenhouse effect', life as we know it would not be possible.

It was in fact quite quickly that the term 'greenhouse effect', by analogy with a greenhouse, began to be used. However, the term is actually a misnomer on two counts. What exactly heats a classic greenhouse has very little (only 20%) to do with the capturing of the infrared radiation by the glass. Rather the greater part of the elevation in temperature inside, as opposed to outside, is simply attributable to lack of ventilation.

In turn, an atmosphere loaded with CO_2 and water vapour absorbs energy in the infrared but does 'not hold back' as does a greenhouse. The mechanisms involved are completely different. The term 'atmospheric effect' would have been more appropriate. However because of the immense popularity of the term 'greenhouse effect', this term is retained, and now made use of universally.

A BRIEF HISTORY OF THE GREENHOUSE EFFECT

Words such as greenhouse effect, greenhouse gases, global warming, climate model, climate scenario and many others belong to 2016's everyday vocabulary as used by the press, or on radio or television. Jim Fleming (1998a, 1998b, 1999) credits Joseph Fourier (1768–1830) for early claims about the greenhouse effect. Although not using the term 'greenhouse' (or its French equivalent) as such, Fourier used a lecture of Monday September 20th, 1824, to allude to the greenhouse by saying:

> "the temperature [of the Earth] can be augmented by the interposition of the atmosphere, because heat in the state of light finds less resistance in penetrating the air, than in repassing into the air when converted into obscure heat." (Fourier 1824, p. 155)

Nowadays researchers usually recognize the Swede Svante Arrhenius for the paternity of the greenhouse effect discovery. In 1896, Arrhenius published an article (based on a presentation made in Sweden in December 1895) in the London scientific journal '*Philosophical Magazine*' titled '*On the influence of CO_2 in the atmosphere on the surface temperature*' (Arrhenius 1896). It took half a century more for other scientists to play their part in developing the concept of the greenhouse effect. An argument based on statistical studies in the 1930s showed a rise in global temperature. Since then, the vast majority of scientists have agreed on the increment in the CO_2 concentration in the atmosphere. This increase intercepts a growing portion of the infrared radiation, explaining why the temperature of the Earth is rising. Current research focuses on the relationship between CO_2 and the biosphere, feedback via water vapour, sea and ice, snow and clouds; and global, regional or LAM climate modelling. In checking the validity of models that go back further and further into a distant past, the focus is increasingly on the old series of observations, especially those that predate the creation of national weather services in the mid-19th century.

WHO WAS WALTHÈRE SPRING?

Walthère Victor Spring was born in 1848 in Liège, where his father Antoine Spring (1814–1872) was a Professor at the Faculty of Medicine. He preferred manual work and experimentation on chemistry and physics with instruments of his own making to studies of the Greco-Latin humanities at the Athenaeum of his hometown. He likewise worked at the workshop of an arms manufacturer in Liège, which allowed him to acquire an ability to do mechanical work. Encouraged by the Belgian chemist Jean-Servais Stas (1813–1891), he resumed his studies and made a successful entry examination at the Mining School, where he obtained the diploma of Mining Engineer in 1871. He went to Bonn to follow the classes of Friedrich August Kékulé (1829–1896) at the Chemistry Institute, and of Rudolf Clausius (1822–1888) at the University's Physics Institute.

In 1876, Spring was appointed lecturer in Mathematical Physics at the University of Liège, only to gradually (by 1877, 1880 and 1884) obtain all of the teaching of inorganic chemistry taking place at the University of Liège. Spring's research focused on the areas of physical chemistry, inorganic chemistry, and materials. He became a corresponding member of the Belgian Royal Academy of Sciences in 1877, a full member in 1884 and Academy President in 1899.

He died at Tilff near Liège in 1911 (Crismer 1914, Timmermans 1964, Schwers 1912, BESTOR).

Figure 1. Spring, Walthère-Victor (1848–1911) – courtesy, BESTOR

His co-author, Léon Roland, had a Ph.D. in natural sciences.

SPRING AND HIS WORK ON THE CO_2 CONTENT IN THE ATMOSPHERE

In January 1886 the Royal Belgian Academy of Sciences published the text of a presentation given by Walthère Spring in May 1885 at the Academy. This paper was entirely reproduced in Spring's '*Œuvres complètes*' (Spring 1923). In the first part, the variability of the CO_2 content in the atmosphere is described, on the basis of study of the scientific literature. The second part is devoted to the study of atmospheric CO_2 in Liège, and it is here that the proposal regarding the greenhouse effect is made. A third chapter describes the experimental aspects of atmospheric CO_2 dosing measurements.

Based upon 266 measurements, Spring concludes that the CO_2 content in the atmosphere of Liège was definitely higher than that in the countryside or even in Paris. The authors incriminate the massive use of coal for heating homes and in the steel industry. A second reason is that the soil of Liège contains coal. In support of this thesis, Spring referred to the results of a report of the Council of Public Health of the Province of Liège (Dewalque 1863) in which a common very abnormally high temperature of the ground, observed in the Saint-Jacques district, had been allocated to the slow burning of '*grisou*'[1] of which the main component is methane (CH_4).

On the basis of mid-19th century climatological observations, the authors noted a higher average air temperature in Liège than in the immediate environment. This is especially true in summer during calm and serene days, defined as '*heavy*' by the people of Liege. The higher temperature in Liège is, no doubt, attributable to the high CO_2 content. Spring refers to the works of Heinrich Gustav Magnus and of John Tyndall (1861, 1863) on the absorption of the rays by CO_2 and used the speaking image that "*the atmosphere charged with water vapor and CO_2 protects the earth against a cooling as does a greenhouse*".

REACTIONS AND COMMENTS IN '*CIEL ET TERRE*'

Spring and Roland also published an extended summary of their paper in '*Ciel et Terre*', a periodical scientific journal attached to the Royal Observatory of Belgium (Spring and Roland 1886a, 1886b). When, in February 1898, Svante Arrhenius' paper was noted in '*Ciel et Terre*' (Arrhenius 1898), Spring wrote a readers' letter in which he reported that he came to the same conclusions as the eminent scientist, and that the journal '*Ciel et Terre*' had alluded to it (Spring 1897–1898).

[1] *grisou*, according to the Walloon language spoken at Liège.

CONCLUSIONS

Spring and Roland, researchers at the University of Liège, Belgium, show up with their article from 1886 as forerunners of greenhouse effect research. Nevertheless, until today their contribution has remained completely unnoticed in the literature on the history of the greenhouse effect (Plass 1956, Jones and Henderson-Sellers 1990, Mudge 1997, Fleming 1998a; Weart 2015). Spring and Roland based the climatological argument on a limited number of mid-19th century meteorological observations, which were not performed under standard procedures, and as such remain weak, even if the description of the greenhouse effect in its 19th century context is correct. The effect of the temperature increase suggested by Spring and Roland, is **local** while Arrhenius implies a **global** effect. The scientific journal '*Ciel et Terre*' at the Royal Observatory of Belgium rightly recognized Spring's contribution to the advancement of knowledge on the greenhouse effect; furthermore, it also mentioned Arrhenius'a contribution (Demarée, Brouyaux and Verheyden 2009).

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