# BELGIAN INSTITUTE FOR SPACE AERONOMY
# Belgium and its involvement in European Space Programmes

When he started his PhD in physical chemistry, in 1961, Professor Paul C. Simon had no idea that his research would lead him seven years later towards atmospheric chemistry at the Belgian Institute for Space Aeronomy (BIRA-IASB)[1]. Undoubtedly a question of passion... One thing is sure; the Space Pole, which groups the Royal Observatory of Belgium (KSB-ORB), the Royal Meteorological Institute of Belgium (KMI-IRM) and the Belgian Institute for Space Aeronomy, gives the feeling of reaching a "higher" vision of the world, given its continuous preoccupation with the future of our planet; which is in danger, today even more than ever!


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**By Professor Paul C. SIMON,**
*Director of the BIRA-IASB*

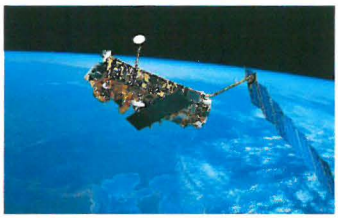
The beginning of my career as experimental researcher coincided with the upcoming of the computer era. At that time it was already clear that this latter discipline would have to be taken seriously into account, even when a computer in those days still filled an entire room and one had to wait a whole day for results. On the advice of my doctoral counsellor, I decided to put my assignment as teacher[2] on hold, but I kept close contact with the molecular physical chemistry department of the "Université Libre de Bruxelles" (ULB).

## The attraction of space

*View from the Olympus Mountain on the planet Mars.*

At the end of the sixties, the space sector received a lot of attention, especially after the conquest of the moon. I began studying the ultraviolet solar radiation, using the data from European sounding rockets, launched from Sardinia during the early seventies. The experimental techniques used in this project were far different from the ones I was familiar with during my PhD. In addition, close collaboration with the Belgian industry manufacturing the space instruments gave another dimension to the project. Consequently, I participated in numerous meetings at ETCA in Charleroi. The purpose of this project was to measure the energy associated with ultraviolet radiation and to develop calibration methods in the laboratory. To reach this goal, we needed an instrument capable of splitting up the solar UV spectrum and converting the signal of the detector in a physical value (energy). This required complex and rigorous work.

These kinds of experiments have been continued with the use of stratospheric balloons launched from the ground and reaching the upper stratosphere at an altitude of 40 km. These balloons had a volume of more than 100.000 cubic metres and a diameter of about 100 metres and carried several scientific instruments, which weighed hundreds of kilos and were recovered after the observations.



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*ENVISAT Satellite. Its mission is to achieve a complete stocktaking of the state of the environment of our planet, more precisely in relation with pollution and global warming.*

At the same time joint French-English and American programmes were carried out as a result of the threat of supersonic airplane emissions to the ozone layer. The US, who were planning a fleet of 500 supersonic airplanes, abandoned their programme and the cost of the Concorde limited its production. Anyhow, this episode reminds us of the intense scientific collaboration between Europe and the United States at that time.

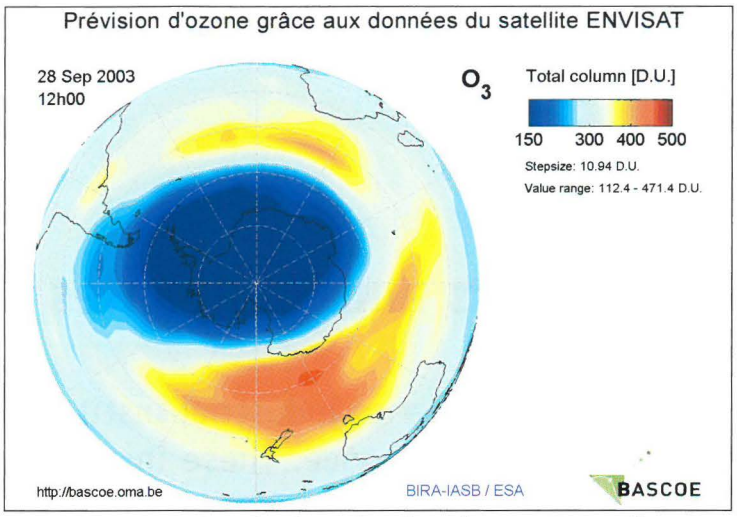
## The ozone hole shock

During the same decade, thorough studies showed that under the effect of solar UV radiation, chlorofluorocarbons (CFC's), chemical products of anthropogenic origin, were broken down in active chlorine atoms destroying the ozone layer. This finding did not have an immediate impact on the regulation of CFC production. The real shock came in 1985 with the discovery of the ozone hole over Antarctica each spring. An agreement between the political authorities and the industry to phase out the production of these CFC's was initiated in 1987, and is applied since 1996. Yet we will have to wait until 2050 before the ozone layer recovers to its normal abundance in the stratosphere.

Thanks to these intensive studies of the stratosphere and the ozone layer, Belgium could actively participate in the conception and the realisation of three international experiments for the space shuttle laboratory "Spacelab" in November 1983. Our experience, acquired with atmospheric balloons, allowed us to develop a new generation of space-borne instruments. These observations were renewed in 1992, 1993 and 1994. One can note that it is often because of an occurrence caused by human activities that fundamental studies are undertaken, to understand what has happened and which brings decision-making up to a political level.

[1] *Created in 1964, the BIRA-IASB counts one hundred employees and maintains numerous collaborations, both in Belgium as internationally. Professor Simon joined the Institute in 1968 as an assistant and became its Director in 1996.*

[2] *Professor Simon returned to teaching in 1988, with a course on atmospheric chemistry given at the Science Faculty and another one given within the framework of the Environmental Management and Territorial Planning Institute.*

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*Ozone prevision, thanks to data from the ENVISAT satellite.*

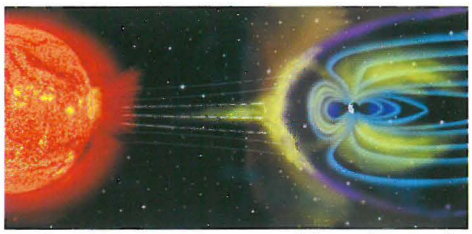
## View on the Planet and the Sun

In 1995, the *BIRA-IASB* participated in the first satellite experiment of the European Space Agency (ESA) for the global surveillance of ozone. Since 2002, three experiments on atmospheric chemistry are conducted on board of the European satellite ENVISAT, devoted to the study of the environment. As a member of the expert groups within ESA, the Institute played a significant role in the definition of the instruments. A role that is nowadays still ongoing with the validation and the interpretation of data obtained in orbit.

In the meantime, our colleagues at *BIRA-IASB* developed complex atmospheric models that allowed analysing and understanding the atmospheric processes. They were also used to make predictions on the evolution of the changes in the atmosphere in relation to human activity.

Another theme of our research is the Sun with its electromagnetic and corpuscular radiation (ejection of free electrons and ions). These emitted particles constitute the solar wind and affect our planet. The Earth's magnetic field works as a protective shield around our planet, which succeeds in blocking most of these particles. Still, a certain number succeed in penetrating deep into the atmosphere, more precisely at the poles. They lie at the origin of the ionisation of the higher atmosphere and trigger off phenomena such as the auroras borealis or the northern lights. This penetration of particles shows that the magnetic filter is not perfect. Trapped around the Earth in "radiation belts", these particles can sometimes cause substantial damage to satellites, even to such a degree that they could become unusable. Another problem of their nuisance is their repercussion on electric networks or, -even worse-, on astronauts in orbit during a space walk. These studies developed at the Institute are used in particular by ESA for its operational needs.

To be even more exhaustive, I would like to mention that we participate in the current Mars Express mission with French and Russian teams. The experiments that are conducted at this moment in orbit around Mars, allow us to collect unique observations on the Martian atmosphere. Furthermore, the Rosetta mission (rendezvous with a comet in 2014 to analyse its composition) has been successfully launched in March 2004.



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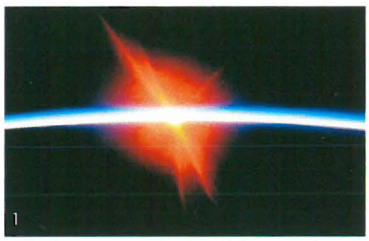
*Schematic representation of the solar wind.*

## Active Belgian participation

Satellites are submitted to extreme UV solar radiation and consequently have the unfortunate tendency to age fast. It is therefore of primary importance to continuously verify the correct functioning of instruments onboard satellite experiments against validated ground-based data. The *BIRA-IASB* participates to satellite validation with three permanent stations integrated in an international monitoring network of the atmosphere, the first at Jungfraujoch in the Swiss Alps at an altitude of 3.600 metres, the second in France at the "Observatoire de Haute Provence" and the third in Northern Oslo. This scientific work, a vital complement to all satellite measurements of the atmosphere, is done in collaboration on a European and worldwide level.

Moreover, all Belgian scientific experiments that are realised on board of the space station are controlled from the "Belgian User Support and Operation Centre". This centre, located at the *BIRA-IASB*, is managed in collaboration with the Federal Science Policy Office, and feeds the experiments with a technical, operational and communication support.



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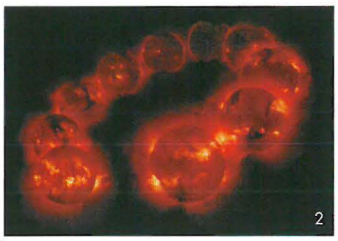

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*1 - The atmosphere of the Earth, seen from space.*

*2 - The changing Sun: 1991-1999*
*Solar X-ray images from the Yohkoh mission of ISAS Japan.*

## Is the Earth in danger?

More generally, observing the atmosphere leads the international scientific community to one identical conclusion: the Earth is in danger. Our work shows that if drastic measures to protect our environment are not urgently taken to reduce pollution, the most pessimistic forecasts could become reality faster than we dare to imagine. But it is important to note that the weight of scientific arguments is weak compared to that of the economic power and the lobbies driven by the logic of profit. To save our planet, we can only hope for a massive revival of the citizens' consciousness all over the world.

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ANNÉE GÉOPHYSIQUE INTERNATIONALE 1957 1958 INTERNATIONAL GEOPHYSICAL YEAR