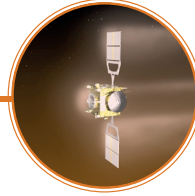
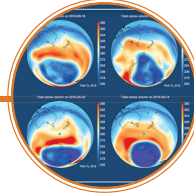
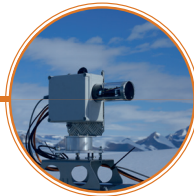
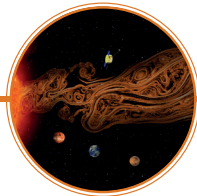




ANNUAL REPORT 2015-2016

More than 40 inspiring stories



COLOPHON

Royal Belgian Institute for Space Aeronomy (BIRA-IASB)

Ringlaan-3-Avenue Circulaire,
1180 Brussels - Belgium
www.aeronomie.be

2 Responsible editor

Martine De Mazière

Coordination and final editing

Karolien Lefever

Concept and realisation

C-company

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MARTINE DE MAZIÈRE

DIRECTOR GENERAL A.I.

“ To me, it is clear that the successes are owed to the motivation and commitment of all employees, and to our fruitful and numerous collaborations with many partners, at home and abroad. ”



Preface

4

Upon completion of this report on the activities of the Royal Belgian Institute for Space Aeronomy, we look back on two years during which the management of the institution has not become easier. The continuous reductions in the budgets allocated by federal Belgium, the increased checks on all expenditure, both for staff and for operation and investment, and the inability to save for major investments, cause significant problems. I want to mention in particular the increased workload of the administrative and HR staff as well as the lack of investment resulting in aging of our infrastructure. The reduction of the statutory framework creates a risk of lack of continuity and direction. A similar problem with the “Regie der Gebouwen/Régie des Bâtiments” also causes serious problems in our buildings. Especially the renewal of our mechanical workshop being postponed again and again, already for several years, has turned the workplace into a particularly inappropriate working environment for our employees. In addition, there are plans for reforming the Interfederal Space Agency of Belgium, the Federal

Public Planning Service Science Policy (Belspo) and the Federal Scientific Institutes causing considerable uncertainty and therefore additional stress for the staff. For more than five years now, these plans make us work without a director appointed and without mandate holders.

The audit of our operation, which took place in late 2015 to mid 2016, took all the above facts indeed as problematic for now and the future. The same audit on the other hand resulted in very positive conclusions with regard to our scientific activity, and confirmed that (I quote) “BIRA-IASB is a flagship of Belgian research. It is internationally well recognised and makes important contributions to atmospheric and space science nationally and internationally. BIRA-IASB generates high-quality science and high-quality scientific services across all departments and research areas.” Also our role for the high tech industry in Belgium is in the audit considered as a very strong point that, in addition, is beneficial for the economy of the country.

Despite the savings and restrictions, BIRA-IASB can look back on a number of impressive achievements that are covered in this report, such as the success of the Rosetta mission to the comet Churyumov-Gerasimenko, which offers a lot of new insights into our solar system, the successful launch of NOMAD, which looks for traces of methane and life on Mars, and the confirmation of ALTIUS as Earth Watch mission of ESA, and so many other less spectacular but not less important scientific studies and service activities.

To me, it is clear that its successes are owed to the motivation and commitment of all employees, and to our fruitful and numerous collaborations with many partners, at home and abroad. Although the uncertainties and the limitations imposed on us are not making it easy for nobody, our people remain fascinated by their work and are proud of the results. Everyone contributes to achieve a common goal: to provide high-quality dis-

covering us scientific research and services in a pleasant atmosphere. I am deeply grateful to everyone for this, and I hope we can continue in the same spirit in the future.

This written report aims to provide a snapshot of our activities on the basis of a limited selection of the most fascinating results and some key numbers, and lure you to our online publication where you can find more details and background information. I hope you'll find this annual report both enjoyable and fascinating, and that you are indeed tempted to continue discovering us.

Martine De Mazière
Director General a.i.
February 12, 2017

A large graphic on the left side of the slide. It features a dark space background with a satellite in the upper left, a complex brown and orange plasma structure in the center, and three planets (Mars, Earth, and another Mars) at the bottom. A large orange circle with a white border is positioned in the center, containing the text 'SPACE PHYSICS'. To the left of this circle is a small white circle with the number '6'. To the right is a small white circle with two right-pointing arrows '»'.

SPACE PHYSICS

A circular inset image showing a compact wooden instrument mounted on a wooden stand in a snowy, mountainous landscape under a clear blue sky.

New instrument in Antarctica

A compact magnetic antenna has been installed at the Belgian Antarctic base, the Princess Elisabeth station. This antenna records whistler waves, which are low frequency (~ 10 kHz) electromagnetic waves that propagate from one hemisphere to another in the magnetic bubble surrounding the Earth, the magnetosphere. From such data we can infer information about the state of the plasmasphere, an inner part of the magnetosphere. The Princess Elisabeth station is a very interesting place for such an instrument because of its geomagnetic position, ideal to monitor the variability of the plasmasphere. In addition, the low electromagnetic activity of human origin at and around the station guarantees perturbation-free measurements.



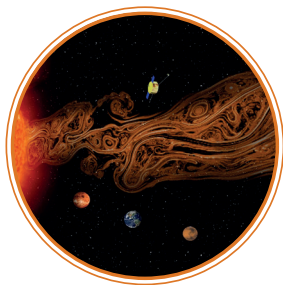
A comet up close and personal

ROSINA, an instrument onboard Rosetta that measures the atmosphere of comet 67P/Churyumov-Gerasimenko, has discovered a zoo of molecules. A lot of these have never been detected in comets before. Researchers at BIRA-IASB are analyzing data from ROSINA in search of these molecules, comparing the results to other Rosetta instruments, and trying to answer some of the open questions. Following the unexpected discovery of molecular oxygen (O_2) in the comet, our researchers have examined O_2 formation by cosmic rays, as well as the impact of O_2 on the photochemistry in the comet.



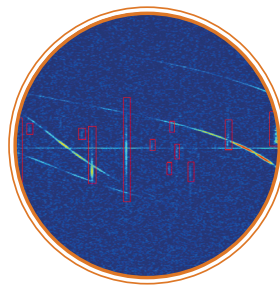
Simulating the aurora borealis

The aurora borealis, also known as the northern lights, can be seen as bright emissions of light in the polar regions. These emissions are caused by electrons that come in from space and collide with atoms and molecules in the upper atmosphere. In the dark parts of the sky, next to the bright region, electrons return upward into space to close the current circuit. Computer simulations have shown that the electric forces that accelerate these electrons (both in upward and downward direction) are mostly concentrated in thin sheaths called double layers, moving themselves in the same direction.



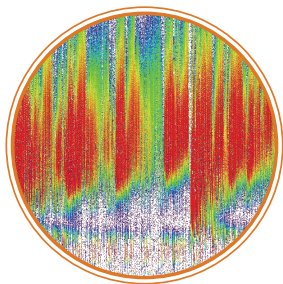
New insights in space plasma turbulence

- 8 Turbulence is one of the (last) unsolved fundamental physical processes. Turbulence is detected by spacecraft in the interplanetary medium and in planetary magnetospheres and ionospheres. The European FP7 project STORM (Solar system plasma Turbulence: Observations, inteRmittency and Multifractals) led by BIRA-IASB made a systematic survey of the in-situ data collected by ESA's solar system missions Ulysses, Venus Express, Cluster, Cassini, Giotto and revealed key properties of space plasma turbulence at the minimum and maximum phase of the solar cycle.



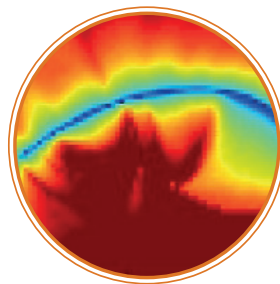
The Radio Meteor Zoo: a citizen science project to study meteor showers with BRAMS data

A meteor shower occurs every year at approximately the same period when Earth is crossing the orbit of a comet. During a meteor shower, radio observations obtained with the BRAMS network, presented as spectrograms, exhibit a lot of complex shapes that automatic detection algorithms fail to detect. In this case the best detector remains the human eye. With the citizen science project "Radio Meteor Zoo" (RMZ), many eyes were requested to analyze spectrograms and identify thousands of meteor echoes. The RMZ was successfully launched on August 12, 2016 the Perseid meteor shower, showing very encouraging preliminary results.



Strong geomagnetic storms modified the space radiation environment in 2015

On board the ESA satellite PROBA-V, the Energetic Particle Telescope (EPT) provides high-resolution electron and proton measurements of the charged particle radiation environment at LEO (Low Earth Orbit, 820 km). Many strong geomagnetic storms have been observed during the year 2015, much more than in 2013 and 2014. During these events, EPT electron measurements show penetration of high energy fluxes at radial distances lower than 2 Earth radii, in the radiation belts, filling completely the usual slot region. This happened especially during the biggest geomagnetic storm event of the present solar cycle (called St Patrick storm) on March 17, 2015.



Solar wind predictions at the Earth's orbit

The kinetic solar wind model developed at BIRA-IASB has been constrained by photospheric observations to obtain a predictive tool of the solar wind conditions at 1 AU at the orbit of the Earth and more generally in the whole heliosphere. Photospheric magnetograms serve as observational input in semi-empirical coronal models that are used as boundary conditions in the solar wind model. A clear and narrow undulating neutral sheet showing clear discrimination between low and high latitude solar wind is obtained during minimum solar activity. This undulating sheet is characterized by higher density and lower velocity than other regions. It separates the outward (south hemisphere) and inward (north hemisphere) magnetic field topologies.



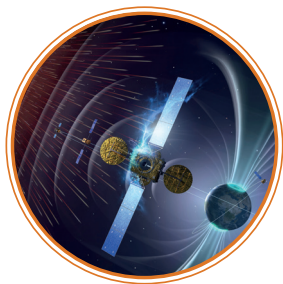
A book about space weather addressing the large public

- 10 The Sun is our star: it provides light and heat necessary for life on Earth. It emits also a continuous flux of particles that fills the interplanetary space: the solar wind. Sometimes, sudden eruptions appear at the surface of the Sun. Such eruptions can generate nice auroras but they also modify the characteristics of the space environment of the Earth where artificial satellites circulate, thereby disturbing the communications or GPS positioning, for instance. Many other effects concerning space weather are presented in this book entitled « Les colères du Soleil » from Viviane Pierrard published in 2016 at Académie en Poche Editions:
<http://academie-editions.be/accueil/242-les-coleres-du-soleil.html>



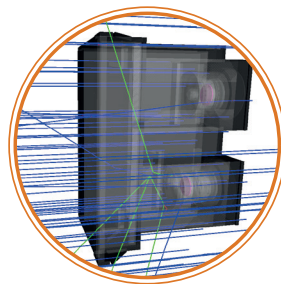
Natural hazard assessment for aviation

The adverse impact of natural hazards on modern technologies has become an important motivation for research into the involved physical processes and for the study of the vulnerable technologies. On 2 June 2015, the Space Weather Section at BIRA-IASB organized the workshop "Natural Hazard Assessment for Aviation" to explore how the Belgian scientific community can best respond to this motivation in the aviation domain. People from Eurocontrol, Belgocontrol, NATO and Meteo Wing were invited as representatives of the aviation community.



Setting up the expert service centre for space radiation

The Space Weather Segment of the Space Situational Awareness programme of the European Space Agency is establishing a service network to support end-users in a wide range of affected sectors. The network is organised around five Expert Service Centres (ESCs) focusing on Solar Weather, Heliospheric Weather, Space Radiation Environment, Ionospheric Weather and Geomagnetic Conditions. BIRA-IASB is coordinating the activities of ESC Space Radiation Environment, an interdisciplinary network of 11 Expert Groups supplying products related to particle radiation and micron-size particulates.



SPENVIS – Space Environment Information System

SPENVIS (<https://www.spENVIS.oma.be>) is a web application for modeling the space environment and its effects on spacecrafts and astronauts. It has been developed at BIRA-IASB since 1996 on behalf of the European Space Agency and has been successfully operational for more than fifteen years. Recently, a novel system called SPENVIS Next Generation (SPENVIS-NG) has been developed under ESA's GSTP-5 programme by an international consortium led by the space weather section of BIRA-IASB.

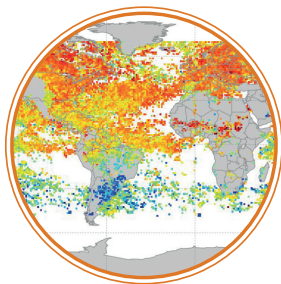


CHEMICAL COMPOSITION AND CLIMATE



Measuring greenhouse gases at Réunion Island

On 26 October 2015, the EU initiated the Integrated Carbon Observation System (ICOS) European Research Infrastructure Consortium (ERIC) with the goal to build a long-term research infrastructure. Our ground-based solar absorption FTIR and Picarro instruments at Reunion Island are an integral part of this network, measuring in situ and total column abundances of various key greenhouse gases. Its location, in a poorly sampled region, makes it ideally suited for monitoring African emissions and for satellite validation studies.



A new global atmospheric methane product

BIRA-IASB recently developed a global tropospheric methane (CH_4) product from METOP/IASI satellite observations. Interesting about this satellite are its follow-up missions, providing at least 15 years of global coverage twice a day. This extensive timeseries allows us to study the evolution of CH_4 in detail, including its seasonal cycle, and to investigate possible long-term trends.



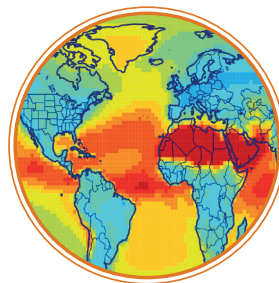
Maize fields are small BVOC exchangers

Biogenic volatile organic compound (BVOC) fluxes have been measured in a maize field in Belgium at ecosystem scale using the disjunct eddy covariance by mass scanning technique over a whole growing season. The major emitted compound was methanol, although exchanges were bi-directional. The study also showed that BVOC exchanges are of the same order of magnitude on bare soil conditions as on well-developed vegetation. The results suggest that maize fields in north-western Europe are smaller BVOC exchangers than originally assumed.



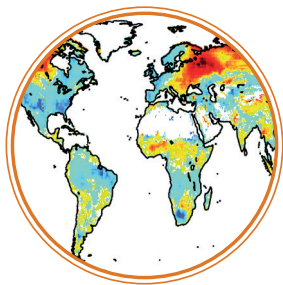
Leaf age strongly affects VOC emissions

- 14 Volatile organic compound (VOC) emissions strongly influence the chemistry of the troposphere. Plants are a major source of VOCs and the emission capacity and the VOC bouquet vary during the lifetime of the plant. More data on this ontogenetic dependence of BVOC emissions are needed for correct implementation in atmospheric chemistry models. Therefore, leaf level VOC emissions from maize, an important agricultural crop species, have been measured in controlled environmental conditions from leaf sprouting to leaf senescence.



A major source of methanol identified

Since 20 years, scientists wondered why models underestimated methanol concentrations over remote oceans. Researchers at BIRA-IASB were able to identify the missing source: a reaction ($\text{CH}_3\text{O}_2 + \text{OH}$) shown recently to be very fast. Their model calculations, guided by theoretical results obtained at University of Leuven, show a marked improvement in comparisons with measurements at remote locations all over the globe when this reaction is included. Globally, this reaction produces as much methanol as all known terrestrial sources of methanol!



Biogenic emissions and their trends derived from satellite

Isoprene is the most abundantly emitted hydrocarbon in the atmosphere, but its emissions remain highly uncertain. Based on one decade of satellite measurements of formaldehyde combined with a global model and advanced inversion tools, we have narrowed down this uncertainty. With respect to current estimates, the satellite observations suggest significant reductions of isoprene fluxes in tropical ecosystems, and increased fluxes in Eurasia and over semi-arid areas. The satellite-based isoprene trends show a strong temperature response over boreal ecosystems, reflecting warming trends and forest expansion, while negative trends are found over Amazonia.



Quality assurance for the Copernicus Climate Change Service

In the framework of its Earth Observation programme Copernicus, the EU is developing a Climate Change Service (C3S). Building on its previous system engineering activities for the successful Copernicus Atmosphere Monitoring Service (CAMS), entered recently into operational phase, BIRA-IASB contributes to this new line of developments by providing key elements of the needed Quality Assurance (QA): a generic QA framework, a suite of tailored tools and methods, and in-depth metrology support.



Stratospheric aerosol data records to better model climate evolution

- 16 The ESA Climate Change Initiative (CCI) aims at developing climate records fulfilling IPCC's requirements, which meet the accuracy, reliability, and resolution needs of today's climate models. BIRA-IASB is responsible for the stratospheric aspects of CCI's aerosol component (Aerosol_CCI), and sets up climate records based on the Envisat/GOMOS dataset. The use of these records in climate simulations contributes to a better estimate of the radiative forcing during the 2002-2012 period.

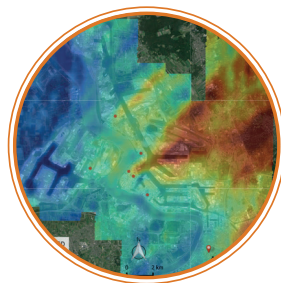
AIR QUALITY





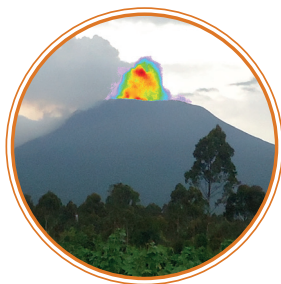
Measuring aerosols in East Antarctica

As the Antarctic ice sheet is expected to be a dominant contributor to sea-level rise in the 21st century, it is essential to gain insight in the precipitation process, which is the only source of additional mass to the ice sheet. Precipitation is closely linked with clouds and aerosols, which are liquid or solid particles in air. However, little is known about this interaction in Antarctica. By measuring aerosols at the Princess Elisabeth Station, the UV-visible DOAS group at BIRA-IASB contributes to our knowledge of aerosol-cloud coupling. This work is done in collaboration with KU Leuven and the Royal Meteorological Institute of Belgium through the Belspo project AEROCLOUD.



High resolution mapping of the urban NO₂ distribution based on airborne APEX remote sensing

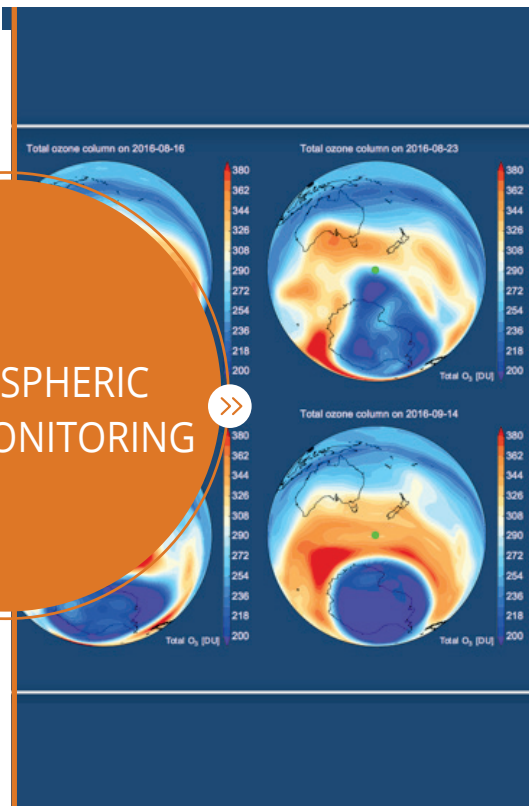
The Belspo funded BUMBA project, which is a collaboration between BIRA-IASB, VITO and IRCEL-CELINE, started in January 2015. A major objective is the retrieval and mapping of the NO₂ horizontal distribution at the scale of cities, based on the DOAS analysis of Airborne Prism EXperiment (APEX) observations. Results demonstrate that (1) the urban NO₂ distribution, and its fine scale variability, can be mapped accurately with high spatial resolution in a relatively short time frame, and (2) contributing emission sources can be distinguished. High resolution data about the atmospheric NO₂ spatial variability is currently unique, and very valuable for (air quality) studies at the urban scale.



Tracking changes of volcanic SO_2 emissions in the Kivu rift area

18 Nyiragongo and Nyiamulagira (DR Congo) are the most active African volcanoes and pose a direct threat to the local population. The UV-visible DOAS group is monitoring the emissions of sulphur dioxide (SO_2) from these volcanoes, using remote-sensing techniques. Measurements from hyperspectral satellite instruments and a ground-based fast sampling UV camera provide insight on emissions changes, at different temporal and spatial scales. Combining this information with observations of ground deformation, seismicity and infrasound, enables better mechanisms to study the underlying pre-eruptive activity of the volcanoes. This research is part of the RESIST project funded by Belspo's STEREO III Research Programme and the Luxemburg National Fund for Research (FNR).

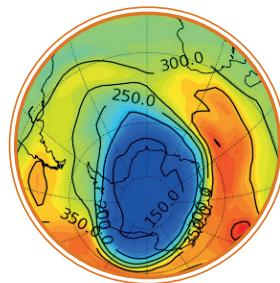
STRATOSPHERIC OZONE MONITORING





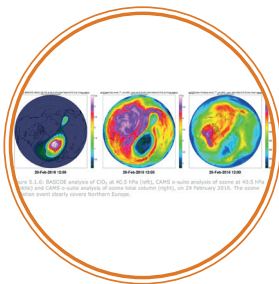
Impact of the Montreal Protocol is now observed at NDACC stations

The 1987 Montreal Protocol had the objective to stop the CFCs (Chlorofluorocarbons) emissions that destroy the stratospheric ozone layer. Recent observations at our Reunion Island station indeed show a decrease of CFCs in the atmosphere (Zhou et al., 2016). However, due to the small impact on ozone (a few % per decade) compared to ozone's natural variability (up to 30%), it is only in 2015 that significantly positive ozone trends were observed in the upper stratosphere at mid-latitude stations (47°N; 34°S; 45°S).



Estimation of the stratospheric composition

In the framework of the EU Copernicus Atmosphere Monitoring Service (CAMS), BIRA-IASB is producing daily analyses of the stratospheric composition since 2009. These analyses are helpful for the international community to monitor the state of the stratosphere, in particular for the ozone layer. In 2011, it was decided to change the method that calculates these analyses in order to take full advantage of the planned High Performance Computer, which was finally installed at the Space Pole in 2015. This new method, called EnKF, is now fully functional and will be implemented in the operational system in 2017.



Validation of the Copernicus Atmosphere Monitoring Service

- 20 BIRA-IASB is strongly involved in the atmospheric component of the EU Copernicus programme. The Copernicus Atmosphere Monitoring Service (CAMS) is implemented at ECMWF. It started operational monitoring and forecasting in 2015, using both global and regional models. BIRA-IASB is responsible for the validation of stratospheric ozone using independent groundbased reference data, satellite data and model results. Additionally, BIRA-IASB is responsible for validation of both tropospheric and stratospheric gases against groundbased data from the entire NDACC network. NDACC FTIR measurements at Réunion Island and the UVVIS measurements at Xianghe near Beijing, both operated by BIRA-IASB teams, are invaluable time series in this respect.

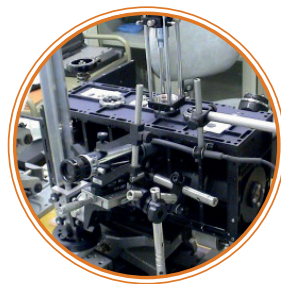
SOLAR RADIATION





SOLAR/SOLSPEC: an entire solar cycle observed from space

The development of a space qualified spectroradiometer for measuring with success the Solar Spectral Irradiance (SSI) on board the International Space Station is always fascinating. It is true story since Feb 2008 for SOLAR/SOLSPEC, an instrument developed through a joint collaboration between LATMOS (France) and BIRA-IASB. If the mission succeeds to measure the SSI during a whole 11-year cycle of solar activity, then it is the perfect one! The SSI variability in the UV as observed by SOLAR/SOLSPEC during the solar cycle and the determination of reference solar spectra for different phases of the cycle are key input for solar physics and for the photochemistry of planetary atmospheres and for the Earth climatology.



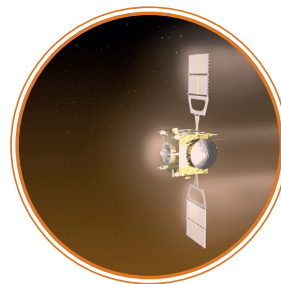
The optics laboratories: the right place for accurate calibrations and characterizations

A powerful and robust optical laboratory equipment, an expertise for developing dedicated facilities and making accurate measurements on demand, for BIRA-IASB projects or visitors, for space applications or ground-based measurements: this is the course of action of the optics laboratories of BIRA-IASB. Spectral or broadband measurements can be performed in the UV (under vacuum or not), VIS and IR, with special detectors, calibrated lamps, spectroradiometers. Sometimes with UV doses or the use of solar simulators as recently for visitors (tests on sunscreens, research on ants). The activity will grow in the future, to be better recognized and to support newly acquired space projects involving BIRA-IASB scientists.



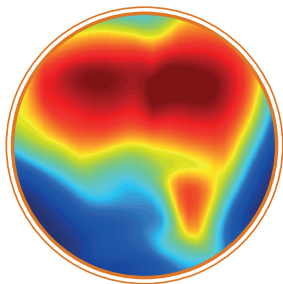
22

PLANETARY AERONOMY



Surfing through Venus' atmosphere

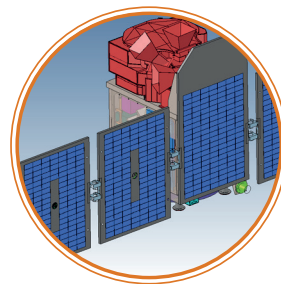
After orbiting Venus for eight years, Venus Express (VEx), carrying on its board the Belgian spectrometer SOIR amid several other instruments, left behind an important heritage, but also new mysteries to solve. The mission ended with an ambitious aerobraking campaign until the probe dived into Venus' atmosphere. Analysis of the deceleration of VEx as it surfed through the atmosphere strengthened the main discovery made by SOIR: the atmospheric density is unexpectedly variable at the terminator, the transition region between day and night.



Formation of methane layers on Mars

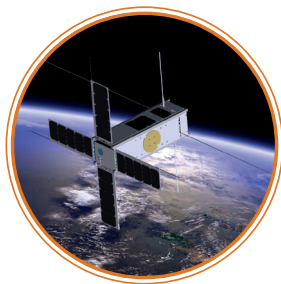
The discovery of methane on Mars in 2003 has considerably changed our view of the red planet. As this molecule cannot survive on a long time scale in the oxidizing atmosphere, Mars appears to be much more active than expected. Understanding its behavior in the atmosphere is thus crucial to determine its origin. In this context, our model study predicted that methane released from the surface does not spread uniformly in the atmosphere but forms layers at high altitudes. This result has potentially implications on our understanding of the fate of methane.

SPACE MISSION DEVELOPMENT



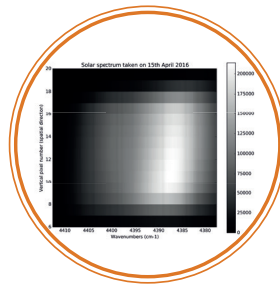
ALTIUS becomes an official ESA Earth Watch Mission

Exciting news has arrived on the satellite mission ALTIUS, proposed by BIRA-IASB. After several ESA-organized reviews in 2015, BELSPO officially announced in early 2016 its support for the mission, end-to-end. Furthermore, the ESA Earth Observation Programme Board has officially accepted ALTIUS as an element of the Earth Watch programme. The road is wide open for the development of the instrument, space platform, ground segment, algorithms and launch in the nearby future!



PICASSO, on its way for launch in 2018!

PICASSO is a CubeSat ESA mission initiated by our institute. With this very low-cost satellite, the ambition is to retrieve the ozone distribution in the stratosphere, the temperature profile up to the mesosphere and the electronic density and temperature in the ionosphere. The launch of PICASSO is foreseen in 2018. It will measure for 2 years from a polar orbit at about 500 km altitude. Its payload consists of a miniaturized imaging spectrometer (VISION) and a 4-needle-like Sweeping Langmuir Probe (SLP).



NOMAD ready to start measuring the Martian atmosphere

On 14 March 2016, the ExoMars Trace Gas Orbiter was launched from Kazakhstan. It carries along three spectrometers collectively known as NOMAD (Nadir and Occultation for MArS Discovery). NOMAD was built in Belgium, with the goal to measure the atmosphere of Mars in unprecedented detail. During its 7-month journey to the red planet, we occasionally performed tests in order to check that everything was still working as expected. NOMAD survived the undocking of Schiaparelli in October 2016 and was able to record its very first spectra of the Red Planet during the Mars Capture Orbit in November 2016.



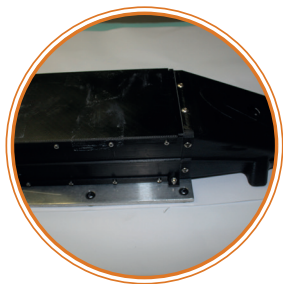
SUPPORTING SERVICES



NOMAD on its way to Mars

ENGINEERING

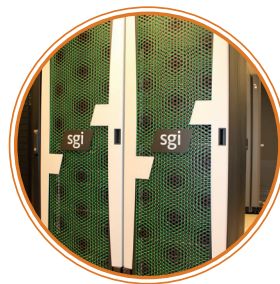
On 14 March 2016 ESA's Trace Gas Orbiter (TGO) was successfully launched from the Baikonour Cosmodrome in Kazakhstan. On board this satellite the NOMAD spectrometer (Nadir and Occultation for Mars Discovery) will study the composition of the Martian atmosphere. NOMAD is a Belgian instrument that was built in collaboration between the Engineering and Planetary Aeronomy divisions of BIRA-IASB, and Belgian industry. BIRA-IASB's Engineering division is also in charge of all NOMAD in-flight operations.



"SWING"ing in the air

ENGINEERING

Besides applications for space, the Engineering service of BIRA-IASB is active in the design and construction of ground-based and air-borne instrumentation. One of many examples where Engineering supports an experimental science team is SWING (Small Whiskbroom Imager for trace gases monitoring) from BIRA-IASB's UV-visible DOAS group. Engineering manufactured a light-weight mechanical support structure and housing for this spectrometer.



Extended supercomputing infrastructure

IT

The aeronomy ICT team kicks off a new era of high performance computing at the institute with the installation of a new HPC infrastructure for the Space Pole. Bigger, better and more versatile than the previous one, this new supercomputing infrastructure provides the researchers with unprecedented computing power, allowing them to shift their data processing, modeling and assimilation in high gear.



Big-Data@aeronomy!

28 IT

A new record-breaking storage infrastructure has been taken into production by the aeronomy ICT team. The installation of the new Space Pole storage infrastructure allows our researchers to store and process the massive volumes of data generated by the next generation of earth-observation experiments and atmospheric models. With this system we break for the first time the Petabyte barrier, adding another three zeroes to our data volume dictionary (1 Petabyte=1.000.000.000.000.000 bytes).@



Focus on ExoMars

COMMUNICATION

The final preparations for the NOMAD instrument, the launch of the ExoMars satellite, the arrival of the satellite around Mars and capturing the very first spectra are just a few of the highlights from the past two years. 2015-2016 has been a rewarding period for communicating about ESA's ExoMars mission. The communication cell grabbed and created many opportunities to put this Belgian contribution into the spotlights: press meetings, an extended travelling exhibition, NOMAD in the spotlights on the Flemish Space Days, presentations addressing a general public,...



BIRA-IASB invests in internal communication

COMMUNICATION

Many communication professionals will confirm that “an organization is only as good as the quality of communication between the employees themselves.” Hence, in 2015 and 2016, the communication service has made an extra effort to provide opportunities to improve internal communications. Internal poster sessions were organised, the lobby got updated regularly with temporary exhibitions and to strengthen the team spirit, we organised a team building day at the Euro Space Center.



Increasing visibility for our researchers

COMMUNICATION

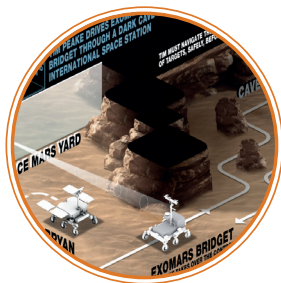
In order to increase the visibility for our researchers, two new institutional repositories have been created: (1) a research data repository (<http://repository.aeronomie.be/>), where all data created by BIRA-IASB and their accompanying metadata are accessible, and (2) an institutional open access repository (ORFEO, <https://orfeo.kbr.be>), giving free access to publications of scientific research financed by Belspo and the Federal Scientific Institutions. ORFEO currently contains records of all relevant BIRA-IASB publications from 1994 onwards, i.e. metadata and full text of more than 1800 publications.

B.USOC



B.USOC participated in the 2015 Short Duration Mission of Andreas Mogensen

In September 2015, during the so-called Short Duration Mission (SDM), the ESA astronaut Andreas Mogensen spent about 10 days onboard the International Space Station (ISS) conducting a series of scientific, technological and educational experiments. B.USOC was in charge of the operation preparation and execution for both the THOR experiment and the METERON project.



B.USOC participates in METERON Operations

On April 29, 2016, a new METERON test was performed: SUPVIS-M. It involved the BRIDGET robot, a development model of the ESA ExoMars rover. British ESA astronaut Tim Peake had to look for marked rocks in a dark cave in the Stevenage AIRBUS facility near London with the help of the rover's UV lights. This test is an important step towards the exploration of Mars, where the lack of planetary protection currently makes human presence impossible.

PEOPLE AND FIGURES



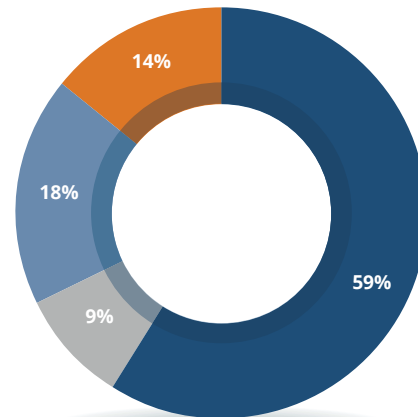
WORKFORCE

The BIRA-IASB employee within the federal government landscape: atypical and diverse.

At the end of 2016, 163 employees are working at BIRA-IASB. A slight growth compared to recent years and an increase of 5% compared to 2014. But who's behind this figure? True to our academic vocation, we try to summarize the complex reality in a model, to summarize the motley collection of talent, knowledge, experience and diversity into one reference person. In other words: who's the average BIRA-IASB employee?

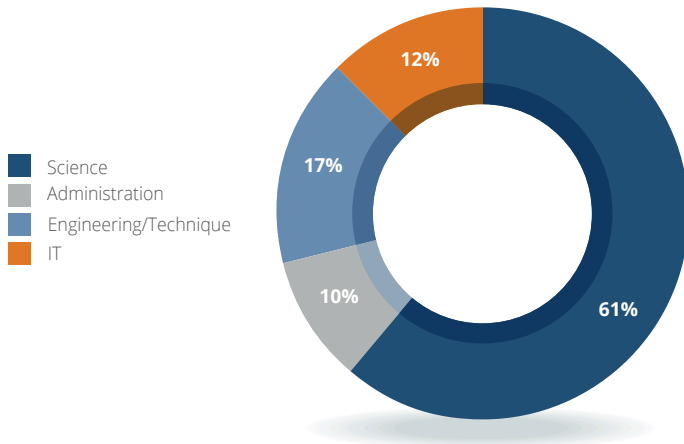
WORKFORCE 2014

100% = 155



WORKFORCE 2016

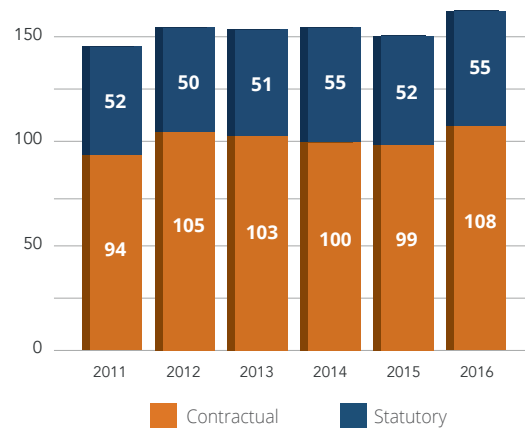
100% = 163



Highest number of scientists ever recorded at BIRA-IASB (exactly 100).

EVOLUTION WORKFORCE

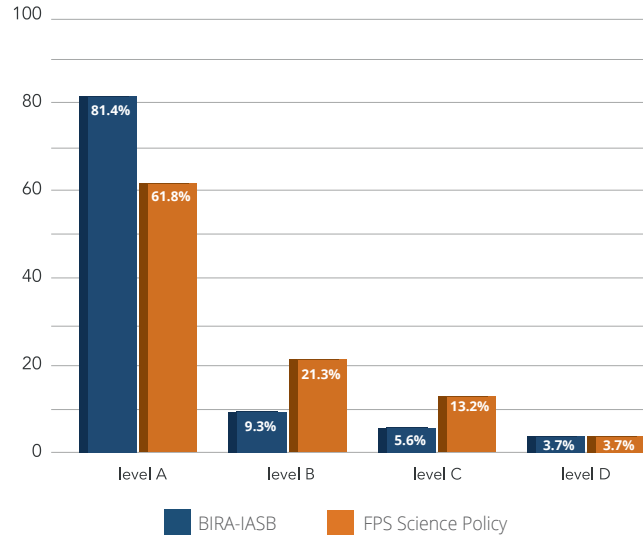
Comparison in statute



On average, 2/3 of the personnel is contractual. This is related to the increasing number of externally financed projects compared to a shrinking dotation.

SHARE BY LEVEL - 2016

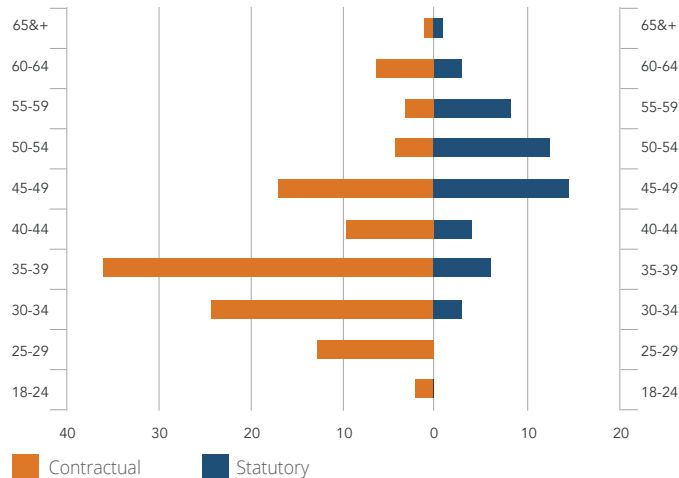
Compared to FPS Science Policy



A high percentage of the BIRA-IASB personnel has a university level function (A or SW). This is mainly due to the high technology environment within which BIRA-IASB operates and the resulting assignments and activities within the institute, in particular scientific knowledge creation and high tech activities in support of scientific work (instrument development, data acquisition, high-performance IT tools).

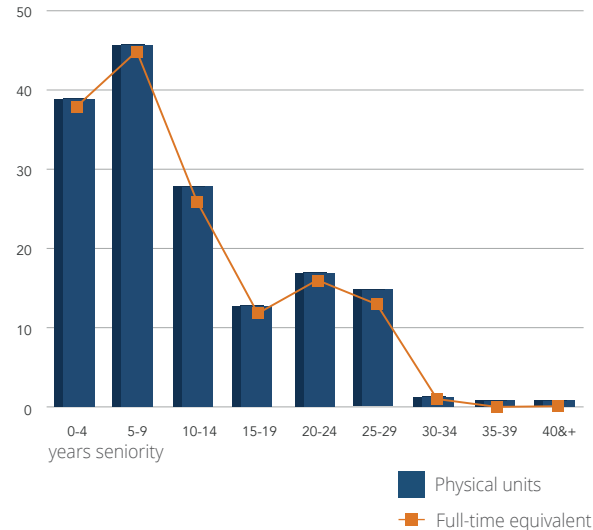
The difference with FPS Science Policy is due to the fact that in addition to their scientific activities, a large number of the other federal scientific institutions also perform a major public role, especially museum activities or public document disclosure.

AGE PYRAMID AND STATUTE - 2016



Both the average age (42 years) and seniority (11 years and 9 months) of the BIRA-IASB employee have a constant steady growth curve. Over the past 10 years, the average age has increased with almost 3 years.

SENIORITY - 2016



DIVERSITY

Nationality personnel 2016

129

Belgium

9

France

3

Germany – Portugal

2

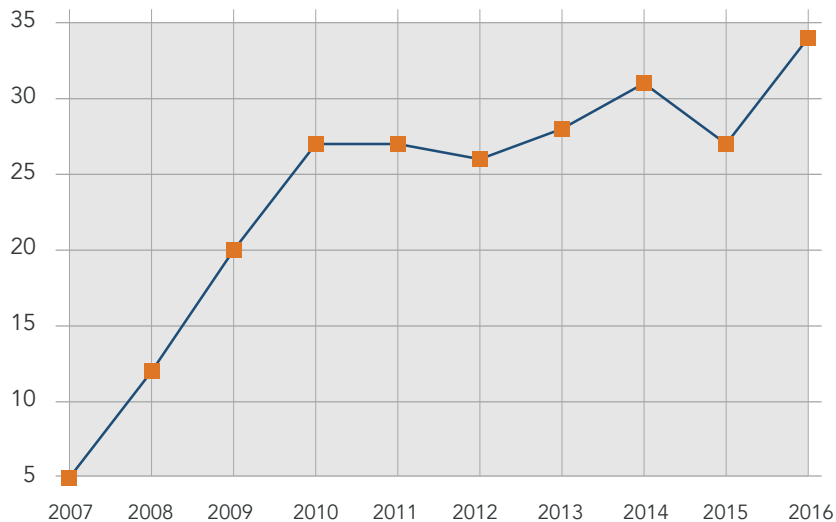
Canada – China – Denmark
Italy – Netherlands

1

Chili – Cyprus – United Kingdom
Greece – Japan – Ukraine
Romania – Spain – Sweden

See our online annual report for a zoom on Europe:
www.aeronomie.be/annualreport

Evolution of non-Belgians at BIRA-IASB



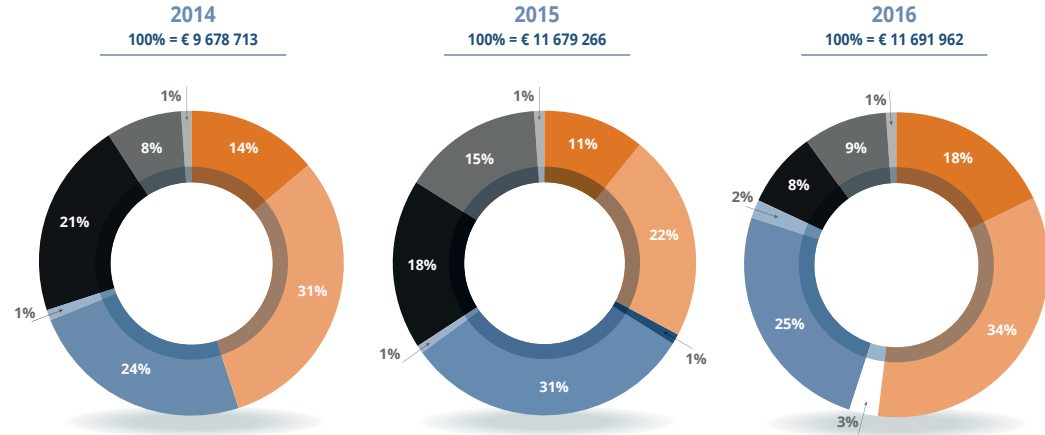
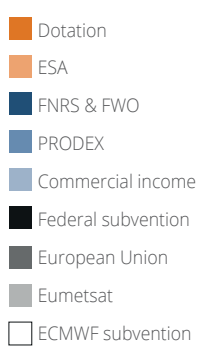
Scientific environments are particularly international environments. This is clearly reflected in the staff population of BIRA-IASB: 34 non-Belgians (i.e. 21% of the staff), 18 nationalities, 3 continents.

ACCOUNTING



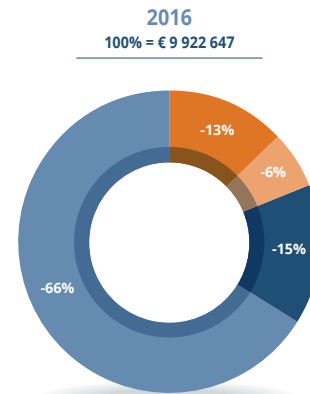
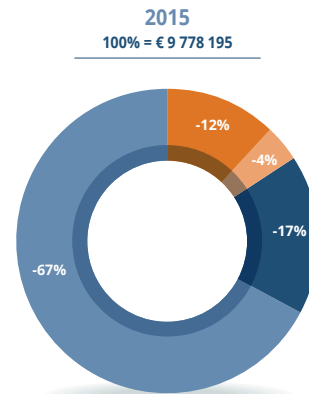
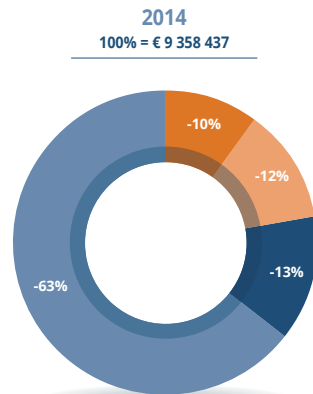
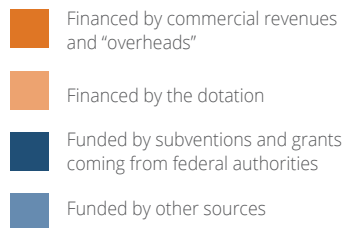
REVENUES BY SOURCE

Accountancy and program management are slowly recovering from a few difficult years. The accountant is still surrounded by only 3.3 FTE to ensure the reception, secretariat and accountancy, but on the other hand, program management has been complemented to 2 FTE to ensure the management of about 80 projects. The re-examination of third-parties, the restructuring of their codes as well as the development of the account chart are three reforms that have been accomplished successfully in 2016.



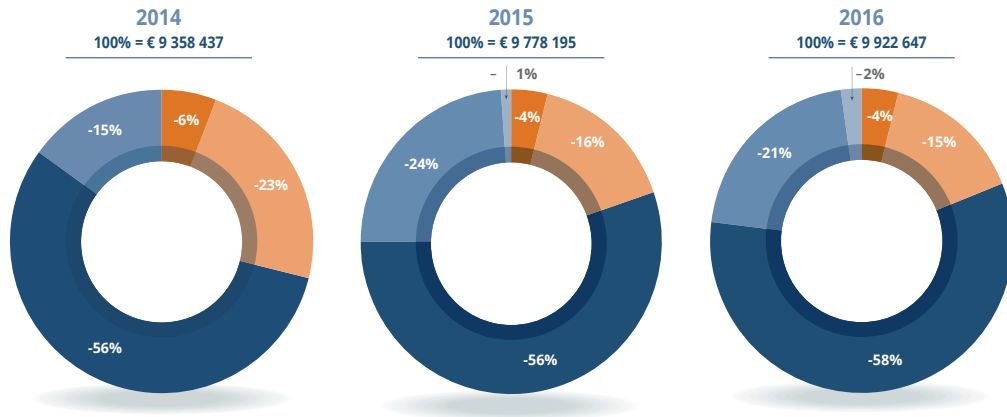
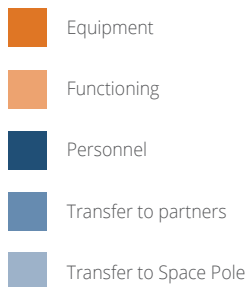
ESA and PRODEX (ESA) are, with a contribution of more than 50% in its income, of major importance for the institute. It should be noted that, until 2015, the STCE (Solar-Terrestrial Centre of Excellence) programme benefitted from a federal subvention (895 k€), while it moved to the dotation (908 k€) at the start of in 2016. This transfer is clearly reflected in the graph.

EXPENSES PER SECTION



It is clear that the major part of BIRA-IASB's income depends on "other" sources, such as FNRS, FWO, ESA, European Union, private sector, ...

EXPENSES PER CATEGORY



BIRA-IASB is leading many projects and can be proud of that. It means, however, that a large part of our income is contractually meant for partners. In 2016, this part amounts to about 2.1M€ (21% of the expenses). It should be noted that the proportion of expenses going to personnel does not take into account the envelope of statutory personnel paid by Belspo.

PUBLICATIONS

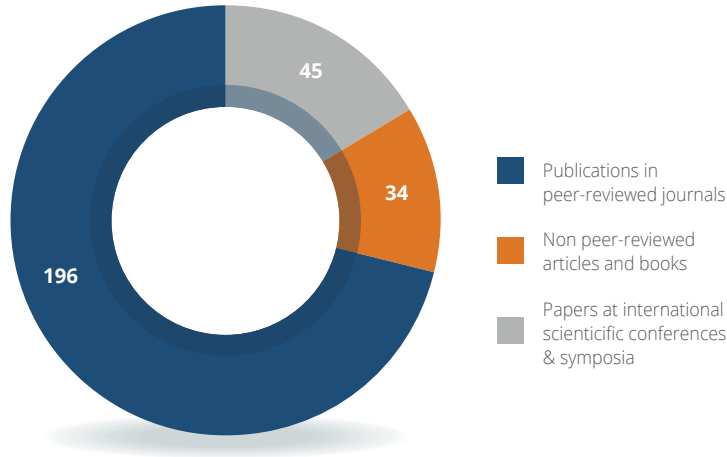


TOTAL NUMBER OF PUBLICATIONS IN 2015 & 2016

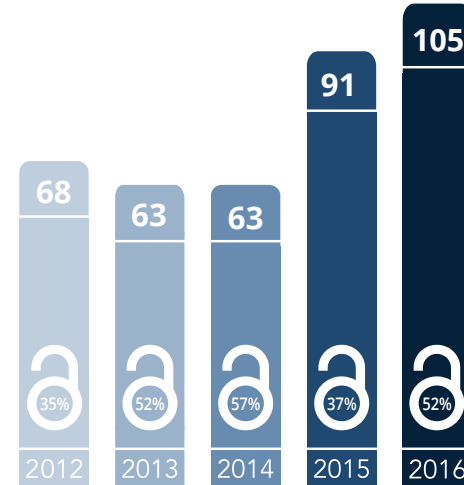


275

PUBLICATIONS PER TYPE



EVOLUTION OF PEER-REVIEWED PUBLICATIONS AND PERCENTAGE PUBLISHED IN OPEN ACCESS



PEER REVIEW



VERY GOOD MARKS FOR BIRA-IASB

From 13 November 2015 till 20 May 2016, a peer review of BIRA-IASB was carried out, as requested by Science Policy Cabinet via Belspo and headed by Technopolis Group. This audit consisted of several components including self-evaluation, interviews with external partners and own staff, a benchmarking investigation and a bibliometric study. The peer review concluded with a visit of a panel of 5 experts chaired by G. van der Veen, evaluation expert and director of Technopolis Group, The Netherlands. The Peer Review resulted in a very positive evaluation of BIRA-IASB.

The final report of this audit states that BIRA-IASB follows a clear strategy, has a management structure that meets the requirements of its assignments and has motivated staff. The report confirms that BIRA performs scientific research and provides scientific services that are both of high

quality and that there is a good balance between both. The report acknowledges that one of the strengths of the institute is the synergistic use of observations and modeling, with the benefit of a good knowledge of the instruments. It also states that BIRA-IASB has a significant impact on policy and on scientific programs. The importance of BIRA-IASB for industry is confirmed by the industrial world, and there is good cooperation with various national space agencies. The cooperation with the two other FSI on the Space Pole is experienced as adequate. BIRA-IASB is well integrated in the international research community and is a flagship of Belgian research.

In addition, the report also provides a number of recommendations such as strengthening strategic partnerships with Belgian universities and internal and external exchanges of expertise: from 2017 on we will start working on that internally. However, some of the recommendations are intended for Belgian Science Policy: especially the high savings, the lack of investment opportunities, and the difficult HR management as well as the increasing uncertainties related to the reforms are perceived as negative.

All in all, the Peer Review resulted in a very positive evaluation of BIRA-IASB.

The expert panel was composed of:

- Dr. A. Hauchecorne (LATMOS, Université de Versailles-St Quentin, France),
- Dr. D. Hauglustaine (Research director CNRS, Laboratoire des Sciences du Climat et de l'Environnement (LSCE), Gif-sur-Yvette, France),
- Prof. P. Levelt (Division head R&D Satellite Observations of the KNMI, professor at the Technical University of Delft, The Netherlands),
- Dr. R. Lundin (former director of IRF Kiruna, Sweden),
- Dr. M. Schultz (Group leader Global Atmospheric Modelling, FZ Jülich, Germany).



THANK YOU

Our sources of income:
Belspo, ESA, EU, EUMETSAT,
FWO&FNRS, PRODEX.

Amelynck Crist
Anciaux Michel
Aoki Shohei
Bauwens Maite
Beeckman Bram
Berkenbosch Sophie
Bevernaegie Jessica
Bingen Christine
Bogaerts Brigitte
Bolsée David
Bonnewijn Sabrina
Borremans Kris
Botek Edith
Brenot Hugues
Brouckmans Kristien
Brun Nicolas
Bulcke Johan
Calders Stijn
Cambier Pascale
Cardoen Pepijn
Cessateur Gael
Chabanski Sophie
Chabrilat Simon
Chamberlain Sarah
Christophe Yves
Cierkens Jana

Clairquin Roland
Compernelle Steven
Counerotte Frédéric
Crosby Norma
Da Pieve Fabiana
Daerden Frank
Danckaert Thomas
Darrouzet Fabien
De Donder Erwin
De Keyser Johan
De Mazière Martine
De Pauw Samuel
De Ridder Sven
De Rudder Anne
De Smedt Isabelle
De Wachter Evelyn
de Wergifosse Marc
Dekemper Emmanuel
Delanoye Sofie
Demoulin Philippe
Den Hoed Mirjam
Depiesse Cédric
Desmet Filip
Dhooghe Frederik
Dia Ablaye
Dierckxsens Mark


Dils Bart
Echim Marius
Egerickx Tom
Equeter Eddy
Errera Quentin
Erwin Justin Tyler
Fayt Caroline
Fedullo Leonardo
Ferriere Olivier
Fonteyn Dominique
Fourneau Thierry
Franssens Ghislain
Fratta Stéphanie
Frederick Pierre
Fussen Didier
Gaffé Dominique
Gamby Emmanuel
Gerard Pierre
Geunes Yves
Gibbons Andrew
Gielen Clio
Gillotay Didier
Granville José
Gunell Herbert
Haumont Etienne
Helderweirt Anuschka

Hemerijckx Geert
Hendrick François
Hermans Christian
Hetey Laszlo
Heymans Carine
Hizette Christiane
Hubert Daan
Iterbeke Philippe
Jacobs Lars
Kalb Nathalie
Keppens Arno
Kochenova Svetlana
Koubi Ismail
Kruglanski Michel
Kumps Nicolas
Lambert Jean-Christopher
Lamy Hervé
Langerock Bavo
Lazar Marian
Leclere Fabienne
Lefebvre Arnaud
Lefever Karolien
Lerot Christophe
Letocart Vincent
Litefti Karim
Lopez Rosson Graciela

Maes Jeroen
Maes Lukas
Maggiolo Romain
Mahieux Arnaud
Marcourt Loïck
Martinez Tarin Ana
Martins Pais Ana Cristina
Massano Santos Cristina
Mateshvili Nina
Merlaud Alexis
Messios Neophytos
Michel Alice
Middernacht Michael
Minganti Daniele
Minion Jean Louis
Moreau Didier
Morini Filippo
Moschou Sofia
Mozaffar Ahsan
Muller Alexis
Müller Jean-François
Nay Maité
Neary Lori
Neefs Eduard
Noel Christian
Ooms Tim

Pandey Praveen
Pauwels Dirk
Pereira Dos Santos Nuno
Piccialli Arianna
Pieck Gerry
Pieroux Didier
Pierrard Viviane
Pinardi Gaia
Queirolo Claudio
Ranvier Sylvain
Rasson Olivier
Ristic Bojan
Robert Séverine
Robert Charles
Sayyed Umar
Schoon Niels
Scolas Francis
Sha Kumar Mahesh
Skachko Sergey
Sluse Dominique Gilles
Somers Tim
Stavrakou Trissevgeni
Tack Frederik
Tetard Cédric
Theys Nicolas
This Nadia

Toemel Jan
Thomas Ian
Trompet Loic
Van den Wyngaert Guido
Van Gent Jeroen
Van Opstal Albert
Van Roozendaal Michel
Vandaele Ann Carine
Vandenbussche Sophie
Vanhamel Jorgen
Vanhellemont Philip
Verbracke Fabian
Verhoelst Tijl
Verstraeten Jean-Claude
Vigouroux Corinne
Viscardy Sebastian
Vlietinck Jonas
Voytenko Yuriy
Willame Yannick
Wilquet Valérie
Yu Huan
Zhou Minqiang



This booklet gives you at a glance insight in
the wealth of fascinating projects in which
BIRA-IASB was involved in 2015-2016.
We invite you to read the full stories of our
achievements, activities, people and figures
on our website:



www.aeronomie.be/annualreport