Strategic plan RMI 2019-2025

Executive summary

The mission of the Royal Meteorological Institute of Belgium is to provide reliable weather, climate and geophysical services, based on high quality observations and research, in a context of national and international cooperation.

Weather

The protection of people and goods against weather events is at the heart of the services delivered by the RMI. This objective justifies the organisation of operational teams 24h/7d and the permanent quality improvement by means of research; from observation through model outputs and forecasting, it combines technical and scientific skills with the expertise of the forecasters. End users, such as citizens as well as the private and public sectors are demanding more localised forecasting, in particular during high impact weather events. This must be achieved through new communication channels improving the availability of the forecast and allowing to reach the public and the authorities as quick as possible and at any time. Specialized users are also requiring support for specific activities like transport, energy distribution or renewable energy production.

Climate

The RMI has a longstanding experience in climatology. This field is evolving rapidly, and the RMI has embraced those changes through the goal of initiating the Belgian Climate Centre. The WMO organized in 2009 the Third World Climate Conference and promoted the concept of Climate Services serving the whole population. These services are intended to inform the society about the state of the climate, its evolution in the past but above all about what will happen in the future. Since then these services are progressively implemented all over the world but in Belgium. The RMI as National Meteorological Service has introduced them by many practical actions such as developing a web-based climatological atlas but needs more support from the government to reach this target. This long-term strategy has been supported by different scientific projects funded by external sources such as the CORDEX.be, the GERB, EUMETSAT SAFs, ESA Earthcare, Copernicus Climate Change Services or the DIGIT projects, which will propose *in fine* a kernel of climate information around the RMI's expertise domains.

Observations

Collecting and making high quality observations is the first basic and historical activity of a NMS, not only for its own use, but also in support of the forecasting capability all over the world. Since about 2000, satellite observations have become the dominant source of observations for NWP. Precipitation radars are important for the characterisation of high impact weather, and form the basis of the popular INCA nowcasting tool integrated in the RMI weather app. The challenges for the coming years are: the start of the modernisation of the RMIB climatological network, the upgrade of the Wideumeont radar the development of a seamless forecasting system based on INCA tool and Aladin NWP, and the introduction of the next generation EUMETSAT satellites.

Research

The activities of the RMI are settled by its scientific activity and a strong endorsement in operational and fundamental research. As Federal Scientific Institution, the research needed to develop the core

tasks of the RMI is originally supported by statutory staff. Nevertheless, external funds for hiring contractual staff members have become badly needed to develop new expertise domains related to our activities or simply to improve the products and services delivered to the end users. Fundamental research required for long-term developments is suffering from structural budget cuts and can only be maintained at a high-level by external funds. New developments for the coming years include the introduction of data assimilation in the Alaro NWP model, the introduction of crowd data, machine learning and big data techniques in the data processing and the development of seasonal to decadal forecasting.

Geophysics

Thanks to the Magnetic Valley initiative, the RMI has an international leading position in the development of instruments for magnetic field observation. This development will be valorised in the coming years through the delivery of this type of instruments to international customers. In collaboration with its Space Pole partners, the ROB and BISA, in the context of the Solar-Terrestrial Centre of Excellence (STCE), the RMIB will contribute to the various space-weather services for the international civil aviation in the frame of the long-term ICAO PECASUS (Pan-European Consortium for Aviation Space weather User Services) project. Other R&D activities will be focused on advanced ionospheric and space weather characterization, on novel technologies for detection, monitoring and mitigation of deleterious space weather effects.

National role of the RMI

Since 2011 the Belgian institutional landscape related to the Belgian Science Policy Office is evolving slowly and large uncertainties remain about the future structure that will be adopted for the FSIs. To manage its activities and to realize its strategy, the RMI needs more autonomy. This has been promised by the government Michel I in 2014 but in the meantime autonomy and budgets have nevertheless been strongly reduced. Recently the government took however actions to strengthen the links between the universities of the country and the FSIs by means of shared positions. This FED-tWIN support, which is a challenging opportunity, will start in 2020 and has as main goal to establish long-term cooperation in strategic advanced domains of R&D.

RMI is playing a pioneering role in federal-regional cooperation thanks to its cooperation agreements with the Flemish region concerning coastal weather forecast and with the Walloon region concerning hydrological applications and archaeomagnetic dating. For the coming years new cooperation agreements concerning road weather forecast and hydrology are being elaborated.

The cooperation in meteorology with Skeyes (former Belgocontrol) and the Meteo Wing of the Belgian army must be further developed by providing them a scientific support in R&D for their operational tasks in addition to shared NWP results and observations.

Financial perspectives

In a ten-year period, the public dotation provided by the Belgian State to finance the RMI lost approximatively 8% while the price index increased with approximately 17%. Together, this means the financial capacity of the RMI lost 25% of its strength. Obviously some planned actions in the present strategy will require new funding. In particular, the development of initiatives like the Climate Services, the implementation of a natural risk center or simply the implementation of the Open Data Policy must be supported by the Belgian government through additional funds.

Table of Contents

1. Introduction and context

The world in which we are living is highly sensitive to weather and climate. Weather conditions in general and storms, snowfall, heatwaves and dry spells in particular can impact deeply our lives and perturb strongly our society. Although the number of deaths due to the weather in Belgium remains small, the financial impact of each natural hazards can be severe.

The mission of the RMI is to make weather forecasts, to disseminate them to the public and the authorities, and to warn the population from the moment the weather might cause damages in Belgium. The RMI contributes thus to reducing the damage and the societal costs of these events. In addition, and as a consequence, the RMI collects, controls and archives meteorological data and monitors the climate and its evolution. As a Federal Scientific Institution (FSI), the RMI bases its activities and services on research, high quality observations and international as well as national collaboration.

Since 2011 the Belgian institutional landscape related to the Belgian Science Policy Office is evolving slowly and large uncertainties remain about the future structure that will be adopted for the FSIs. To manage its activities and to realize its strategy, the RMI needs more autonomy. This has been promised by the government Michel I in 2014 but in the meantime autonomy and budgets have nevertheless been strongly reduced. Recently the government took however actions to strengthen the links between the universities of the country and the FSIs by means of shared positions. This FED-tWIN support, which is a challenging opportunity, will start in 2020 and has as main goal to establish long-term cooperation in strategic advanced domains of R&D.

This overall and aforementioned evolution of the Belgian context coincides with a structural evolution of the missions of the National Meteorological Services (NMS) in Europe. NMSs are facing more and more new demands from users and from authorities but are getting reduced financial support. In addition, they all are under the pressure of the private sector on the meteorological market and of the large global weather enterprises. The political and economic decision process needs additional information related to the climate evolution. This phenomenon, which has rapidly grown during the last decade and which is at the origin of the development of climate services (see Section 4), is responding to current needs from citizens and from the private sector as well as from the public authorities. Citizens want to follow in real-time the weather for their daily activities but also for other purposes. The users of meteorological information are also more sensitive to climate and require a broader knowledge of weather, the past climate and its future evolution. In parallel, users of private and public sectors are demanding more advanced forecasting to ensure the safety of persons and properties, in particular during high impact weather events. They are also requiring support for specific activities like transport, energy distribution or renewable energy production for example. These new needs imply specific developments and require a new long-term strategy.

National and international collaborations are of uttermost importance in the development of the RMI. At the Belgian level, the synergies with the other FSIs and in particular with the Space Pole partners, the ROB and BISA, are well-developed but could be extended to new fields of cooperation. As an example of this existing cooperation, the Solar-Terrestrial Centre of Excellence (STCE) developed high-level, internationally-recognized skills in space weather research and monitoring that need to be supported by all three FSIs to become operational and successful in delivering space-

weather services to industry and public. The way in which synergies at the level of the Plateau of Uccle will evolve in the future depends obviously on the political decisions about the new structure and organization of the Belgian Science Policy Office and of the FSIs. But, whatever will or will not occur, the new structure will benefit from improving the synergies at the level of the Space Pole and extend them to a larger number of FSI.

At the Belgian level, the cooperation in meteorology with Skeyes (former Belgocontrol) and the Meteo Wing of the Belgian army must be further developed by providing them a scientific support in R&D for their operational tasks in addition to shared NWP results and observations. In parallel at international level, the European context is also evolving towards more cooperation between all the NMSs. EUMETNET, which is the expression of the strong cooperation between NMSs, is presently preparing a new strategy for the next years and is starting new cooperation programs. In this framework, steps towards more transnational synergies are made by the RMI. Bi- or multilateral cooperation is already leading to the development of meteorological core tasks. These synergies will be more and more critical in terms of optimizing budgets and human resources. At the global level, the WMO is overarching the trends for more collaboration by establishing general objectives such as the standardization of observation and communication methods and the implementation of common platforms such as WIGOS.

The European community is also adapting progressively the legal framework of activities related to weather and climate. It is also modifying the practices related to public data with the implementation of the Public Services Information (PSI) regulation. The Open Data Policy (ODP) largely adopted by the European meteorological community is a threat for the NMSs' incomes which are partially based on data delivery, but is also an opportunity to valorize the NMSs' expertise on weather and climate. In addition, the development of the Copernicus programs will make a lot of meteorological products and data available that are financed by the Community. Therefore, the RMI will in the future orient its commercial activities towards more added value and users tailored services.

Moving forward and tackling the new challenges request a new strategy for the RMI.

2. Vision and strategy

Whether it is to warn the local authorities of the arrival of a destructive weather event or to allow friends to prepare a BBQ during the coming weekend, the quality of forecasts and warnings is essential. With this increasing diversity of the users' demand, the RMI needs to increase the accuracy of the weather forecasts and provide it for a longer period. This evolution will result from the exploitation of more observations collected on the ground and remotely, and the development of accurate numerical prediction models.

Our vision is to promote "The RMI," as "the Belgian reference for research, observations and services in weather, climate and geophysics at national and international level."
In order to achieve this vision, the RMI wants to achieve the three following strategic objectives by 2025:

1 Be the Belgian centre for weather, climate and geophysical services;

2 Develop/exploit data sets and expertise for weather, climate and geophysical applications, including the maintenance of the production infrastructure and the data access facilities;
3 Strengthen the scientific foundation of the warnings, meteorological observation and climate services.

Practically, the RMI will develop its activities around two major application domains related to its core tasks: "**safety**" and "**climate services and global change**".

Therefore, the RMI will also adapt its structure to the needs of internal and external users, with a particular focus on the central role of research, and an improvement of the knowledge, expertise and people management.

Scientific research is the foundation of our activities and this makes the RMI unique compared to the other Belgian services providing forecasts or climate projections. The position in the RMI's organization of all the scientific activities has to be adapted to the new needs and constraints.

In the remainder of this document, we will give more details about: (1) how the first two strategic objectives will be implemented in each of the two major application domains (Sections 3 and 4), (2) describe the main topics of our third objective (Section 5), (3) give an overview of possible actions to revise the structure and functioning of the institute (Section 6) and (4) draw some financial perspective (Section 7).

3. Safety

The protection of people and goods against weather events is at the heart of the concerns of the services delivered by the RMI. This objective justifies the organisation of operational teams 24h/7d and the permanent quality improvement by means of research; from observation through model outputs and forecasting, it combines technical and scientific skills with the expertise of the forecasters. This must be also achieved through new communication channels that will improve the availability of the forecast and allow to reach the public and the authorities as quick as possible and at any time. It is only by investing in research and equipment that the impact of meteorological events causing large damages can be reduced by planning the prevention in a more accurate way.

3.1 Be the Belgian centre for weather, climate and geophysical services

Interested users of meteorological and climatological services have unlimited options to gather a lot of information on the internet. To attract them with RMI services, and in particular convince the young generation, forecasts and meteorological information have to be provided with high quality, but also with an added value and presented in an attractive, up to date, format. As a first step, the RMI will further develop its warnings. The RMI will propose more readily usable products close to the end-users and fitted for their activities; for example, more local and more frequently updated forecasts.

Therefore the RMI plans to:

- Provide high quality warnings from nowcast through early warnings for potentially dangerous phenomena such as intense rainfall, wind, hail, UV, and lightning, and adapt the

warnings to the needs of the citizens and of the key stakeholders (crisis centre, local authorities, police, fire brigades, etc.) up to four days ahead;
- Provide high quality forecast from nowcast up to 15 days ahead;
- Support the STCE partners in providing timely and accurate alerts for major oncoming space-weather events, such as solar, geomagnetic, and ionospheric storms;
- Improve communication with the main stakeholders by implementing regular and structured relationships with them;
- Support the creation of a natural risk centre based on the expertise of the FSIs.

3.2 Produce reliable data sets for weather, climate and geophysical applications

Collecting and making high quality observations is the first basic and historical activity of a NMS, not only for its own use, but also in support of the forecasting capability all over the world. These data sets covering the main atmospheric variables, are directly used for the analysis of the weather and for producing forecasts by means of nowcast tools and NWP models. Their availability for further users will also stimulate the economy.

The RMI intends therefore to:
- Further improve the observation networks based on the most recent technologies (new instruments, new communication channels, smartphone apps, public science, crowdsourcing, opportunistic data, Internet of Things);
- Improve the processing chains and enhance the quality control to assimilate the available data in the forecasting chain and deliver more precise data, weather forecasts and warnings.

4. Climate Services and Global Change

The RMI has a longstanding experience in climatology and geophysics. These fields are evolving rapidly, and the RMI has embraced those changes through the goal of initiating the Belgian Climate Centre. The WMO organized in 2009 the Third World Climate Conference and promoted the concept of Climate Services serving the whole population; from the citizen to the private sector and the authorities. These services are intended to inform the society about the state of the climate, its evolution in the past but above all about what will happen in the future. Since then these services are progressively implemented all over the world. The RMI as NMS has introduced them by many practical actions such as developing a web-based climatological atlas, in view to become the coordinator of the Belgian Climate Centre. This long-term strategy is supported by different scientific projects funded by external sources such as the CORDEX.be, the GERB, EUMETSAT SAFs, ESA Earthcare, Copernicus Climate Change Services or the DIGIT projects, which will propose *in fine* a kernel of climate information around the RMI's expertise domains. The leading position in developing geomagnetic instruments and observations will also be marketed as a brand for the services developed by the team in Dourbes.

4.1 Be the Belgian centre for weather, climate and geophysical services

With the strong knowledge in meteorology, climatology, atmospheric modelling and geophysical research, the RMI will offer more services for the users targeting to answer their specific needs. This

means providing general purpose information about the past, present and future of the weather and climate based on its own independent expertise and objective scientific approach, but also providing dedicated products to meet specific needs of the users.

The RMI will:

- Develop climate services for the public and fulfil requests from specific stakeholders by further exploiting the Belgian long-term climatic series available in database and archives, refining the projections of the future climate and climate change scenarios in Belgium, exploring long-term sets of ground-based/remotely-sensed atmospheric and terrestrial data (gathered by RMI or from EUMETSAT, NASA, ESA, etc.), to support the regional and the federal adaptations plans and to contribute to IPCC and its spin-offs;
- Promote the establishment of a Belgian Climate Centre;
- Develop specialized geomagnetic support for the aeronautical - marine community, mapping agencies and industry with magnetic navigation solutions and declination data, and provide new techniques and instruments for specific magnetism-based tasks (large scale demagnetization, sea-floor measurements, archaeological sites, etc.).

4.2 Produce reliable data sets for weather, climate and geophysical applications

As a complement to the increased production of high-quality services, the RMI has to propose additional high quality data (see also section 3.2) and maintain and improve the existing observation networks.
In particular, the RMI will:

- Assure the quality and the continuity of long-term observations of reference stations, thus ensuring the adequate spatial coverage of Belgium in weather data;
- Maintain a leading role in ground-based monitoring of the space weather, including the long-term cosmic rays, ionospheric, and geomagnetic observations performed at Dourbes;
- Construct a data hub for climate and climate impact studies to facilitate data use and develop further synergies or partnerships with external organizations using observation networks. Be the Belgian contact point for stakeholders seeking to use climate data and provide consultancy to optimally use them;

- Monitor the global changing geomagnetic field by supporting less advanced countries with training, instrumentation and data processing, by improving archaeomagnetic dating of archaeological sites, by exploiting the magnetic properties that connect to environmental changes and anthropogenic pollution.

5 Strengthening the scientific foundation

The activities of the RMI are settled by its scientific activity and a strong endorsement in operational and fundamental research. As FSI, the research needed to develop the core tasks of the RMI is originally supported by statutory staff. Nevertheless, external funds for hiring contractual staff members have become badly needed to develop new expertise domains related to our activities or simply to improve the products and services delivered to the end users. Fundamental research

required for long-term developments is suffering from structural budget cuts and can only be maintained at a high-level by external funds.

Getting funded national and international cooperation projects will be a continuous effort as well as developing stronger internal synergies between the teams. The collaboration with universities brings also more perspectives for in-depth research at the RMI.

By means of the scientific programmes funded by the Belgian Science Policy Office, like BRAIN 2.0, STEREO and FED-tWIN as well as by bilateral contacts, the RMI will continue to reinforce its links with the universities. Priorities based on the strategic vision will reinforce the scientific services willingness to innovate in proposing new developments fitting the scientific and operational objectives of the RMI.

At the national level, the RMI staff members contribute to courses and are teaching at university level. The postgraduate program at Ghent University on weather and climate modelling has proven to be very beneficial to attract new profiles for the RMI in meteorology and climatology. The RMI intends to elaborate this role in the future. The FED-tWIN initiative constitutes an opportunity to extend structured relationships with the academic community. The RMI will continue supervising PhDs with the universities but also intends to propose new PhD fellowships.

The RMI will therefore continue to:

5.1 Give a scientific settlement to the observation systems

A scientific knowledge of the observation systems will be provided by continuously storing, managing, updating and validating standardized reference meteorological datasets gathered from surface networks and from past, current and future remote sensing platforms

5.2 Develop new techniques related to data processing

Pursue and extend the existing research aiming at the production and analysis of climatological data sets in view to the characterization of the climate evolution. Develop expertise in machine learning and big data techniques for enhanced use of existing and innovative observations, e.g. fusion of satellite and radar data, quality control and fusion of WMO certified, crowdsourced AWS and citizen data, etc.

5.3 Contribute to NWP and modelling community

Pursue research in atmospheric, land surface and hydrometeorological modelling. Contribute to Aladin NWP and modelling community. In particular, develop seamless prediction on short and medium range based on general data assimilation techniques and of probabilistic forecasts to assess risk uncertainties and predictability.

5.4 Develop and improve seasonal-to-decadal forecasts based on EPS and data assimilation

5.5 Improve scenarios of climate change and their impact

Further develop climate change scenarios and impact studies by improving climate sub-models, data handling routines, statistical tools (IDF, …) and post-processing methods. A specific attention will be given to study the dynamics of climate changes and extreme events under transient forcing.

5.6 Further contribute to modelling of the solar-terrestrial environment

Further contribute to the international efforts for advanced global modelling of the solar-terrestrial environment by collecting high-resolution data on cosmic rays, ionospheric and geomagnetic phenomena in Belgium and Antarctica.

5.7 Develop Magnetic Valley

Further develop Magnetic Valley as a centre of excellence in geomagnetic instrumentation and environmental magnetism, including magnetic properties measurements.

6 Adaptation of the RMI functioning and structure

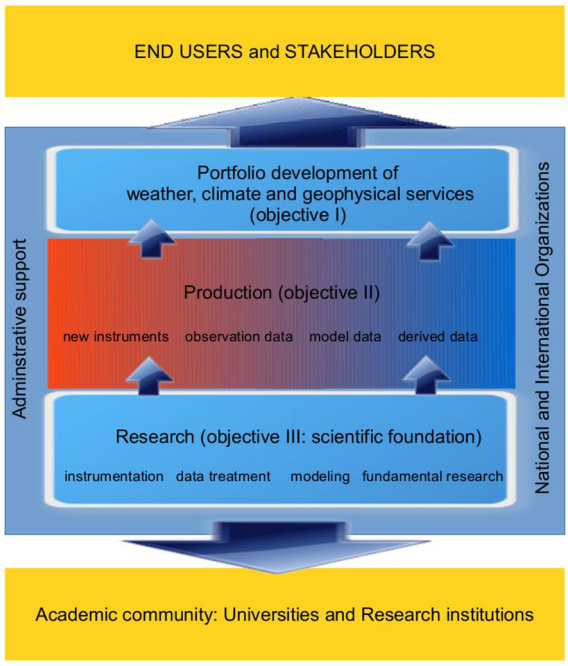

FIGURE 1: RMI NEW ORGANIZATIONAL FLOWCHART

The last evaluation of the research activities and scientific services finalized in 2017 mentioned the need to revise the current structure and operational functioning to enable the RMI to have quicker and more efficient interaction between science and operations. The present outdated structure is built on six scientific services. It is mainly translating the logical path from observation to products and services, placing data processing and research as intermediate steps. Practically, research is not restricted to one service but is extensively carried out in the observation domain, in meteorology or more generally in geophysics.

Figure 1 shows the new organizational flowchart driving the logical interactions between the RMI and the end users but also with the scientific partners in universities and in research centres. This new flowchart will allow also a better alignment of operational procedures and is a step forward to an ISO 9001 conform quality management.

As the ODP will have an additional impact by reducing the resources of the RMI, the institution will have to find new income by developing service oriented products instead of data based products. Three functional axes will be developed around the themes of communication improvement, knowledge transfer and structural support.

6.1 Communication

Communication around RMI activities must be oriented into three major directions: the public, the scientific community and its internal communication. The public, and in particular the young generation, can gather a lot of tips on the web related to meteorology, meteorological events and

geophysical phenomena. It is therefore important to show the public the skills the RMI develops in the framework of its activities and to choose the appropriate media to reach as many users as possible.

The RMI will improve the communication of scientific information to the public, promote citizen based educational and scientific activities. It will improve its communication towards scientific community by increasing the visibility and impact of the RMI research in national and international peer-reviewed journals. ODP will also be used to enhanced the visibility of the services and of the reference observation data series.

Internal communication is also a priority and therefore the RMI will consolidate the links between research and operational tasks. In particular, the cooperation between the modellers and the forecasters to improve operational tasks and forecasting but also to make new products available to the forecasters. Internal communication between researchers will also be promoted.

6.2 Knowledge transfer

The knowledge transfer will be improved according to the RMI mission and new vision presented here above.

In order to increase the impact of the RMI on public and private sectors, ODP will be progressively implemented for all available data encouraging the development of collaborations with potential users of meteorological services and companies.

One added-value of the RMI is that a part of its staff, in particular the statutory staff, has the potential to transfer scientific knowledge by increasing consulting activities and by teaching or supervising bachelor-master-PhD research in close collaboration with universities. Participating proactively in research programs to achieve long-term cooperation with universities, other research institutions and international programs (EU H2020, EU COST, Aladin, EUMETSAT, ESA, NASA, etc.) and taking the lead of international research projects will be promoted.

Internal knowledge management for the purpose of transfer of expertise between staff members is also of huge importance inside RMI. Therefore, documenting investigated research topics (link to publications, reports, ...), developed tools and gathered data from outside RMI (e.g. datasets and their metadata) during projects must be enhanced. This will ease the resumption of the tasks by new members when staff members leave.

6.3 Structural support

A quality management system will be introduced and implemented in particular the ISO9001 standard. Furthermore, a structure must be adopted for increasing the efficiency in contacts and relationships to international organizations such as WMO, EUMETSAT, EUMETNET, ECMWF, INTERMAGNET, EGU etc. Support to participate in international research and network programmes (EUMETSAT, ESA, Copernicus, etc.) should be increased.

Structures to foster R&D valorisation, improve the administrative support and develop project management must be created as well as possibilities for all staff, including contractual researchers, to plan their carriers and to keep stimulating the in-house experts.

7 Financial perspectives

This document intends to show the direction RMI wants to follow in the next years to fulfil its mission. In a ten-year period, the public dotation provided by the Belgian State to finance the RMI lost approximatively 8% while the price index increased with approximately 17%. Together, this means the financial capacity of the RMI lost 25% of its strength. Obviously some planned actions in the present strategy will require new funding. In particular, the development of initiatives like the Climate Services, the implementation of a natural risk centre or simply the implementation of the ODP must be supported by the Belgian government through additional funds.

8 Acronyms

BISA: Royal Belgian Institute for Space Aeronomy
FSI: Federal Scientific Institution
IDF: Intensity-Duration-Frequency curve
NMS: National Meteorological Service(s)
NWP: Numerical Weather Prediction
ODP: Open Data Policy
PSI: Public Services Information
ROB: Royal Observatory of Belgium
STCE: Solar-Terrestrial Centre of Excellence
WMO: World Meteorological Organization