Report of the 2010-2016 assessment of the research and operations of the Koninklijk Nederlands Meteorologisch Instituut

assessment committee

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August 2017

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Preface

This report summarizes the findings of the assessment of the Royal Netherlands Meteorological Institute (KNMI) . The assessment took place in June 2017. The assessment committee of five international experts was asked to judge the quality and relevance of the individual technologies in relation to the demands/expectations of stakeholders and compare to “peer groups” for bench marking

Overall, our assessment is very positive and underpins the well-known role of KNMI as an active player. At the same time the role of meteorology in the public and political arena should not be underestimated.

The committee noticed great enthusiasm and commitment with the people they met during the site visit. We recommend in this respect to give young people enough freedom to express and explore new ideas and stimulate them to cross boundaries between different disciplines and mind sets.

It was a pleasure and an honour to chair the committee and a great privilege to work with such distinguished colleagues. Their independent and perceptive judgements form the basis of this report, which represents our common view on conclusions and recommendations.

On behalf of the assessment committee I wish to express our gratitude to the staff of KNMI for their excellent presentations and very helpful discussions during our site visit. We received excellent support from our secretary Peter Siegmund, who assisted us in organising the outcome of our work and compiled the report based on inputs of the committee.

The committee hopes that the results of this assessment will help KNMI to further continue its important work and to make appropriate choices for the future.

Jacob Fokkema

chairman

Executive summary

The assessment committee (AC) concluded that KNMI is a small but extremely efficient National Meteorological Agency recognized in the Netherlands as the authoritative voice for issuing warnings of severe weather events and seismological risks and also for handling weather, climate, and seismology related data and science issues. KNMI also achieves world class performance in the field of satellite observations.

The AC found that KNMI has reached excellence in its research quality both for weather and climate model development, for satellite and surface based observations, as well as for seismology. It is essential for KNMI to maintain such forefront position. The operational weather department is very good compared to that in many other European countries, and the operational observations department performs excellent work including a high class calibration facility.

The AC was of the opinion that this success has been achieved due to a close interaction between science and operational work and the personal engagement of the collaborators at the institute as a result of a good "team spirit". This positive evolution of KNMI over the last couple of years was highlighted during interviews with key KNMI stakeholders, who were more than satisfied by the cooperation with and the support by KNMI.

The AC also observed that steadily decreasing funds from the responsible governmental ministry endangers the ability of KNMI to sustain its high level of research quality and service provision. The breaking point may be reached soon, after which service quality and reliability will be visibly affected. The AC appraises that KNMI's cost/benefit ratio is very low compared to that of most other high-level national meteorological services.

For the future, the main conclusions and recommendations by the AC are as follows:

1. The AC endorses KNMI's ambition to implement an Early Warning Centre (EWC), and recommends this Centre be realized in close collaboration with other research centres and governmental institutes in The Netherlands. The EWC promotes a cross-cutting work flow involving all departments at KNMI. The EWC requires a considerable upgrade of infrastructure and software, as well as some new staff competencies.

2. KNMI has introduced as a central notion a risk reduction cycle with a front office (service) and a back office (R&D) component. However, this risk reduction cycle is to some extent still only a concept and needs further consolidation.

3. The AC realizes the financial and scientific challenges faced by KNMI with many staff members being employed on soft funding. This produces a high risk for maintaining the required knowledge base on a long-term basis within the Institute.

4. The AC recommends further development of the atmospheric modelling strategy, including a plan for model improvements across the hierarchy of models, detailing the role of ensemble

prediction, and with enhanced work on diagnostic methods.

5. The AC recommends enhanced support for KNMI's satellite data developments and for their valorization for its weather and climate forecasts, but also in view of its strategic involvement in the Early Warning Center.

6. The AC believes that the seismology group, as a scientifically independent authority that is trusted by the public, could be the right entity to lead country-wide studies of the consequences from the effects of induced seismicity in the Netherlands.

7. For operational weather forecasts, the AC recommends an enhanced use of crowd-sourced data, merged data from different sources, and ensemble data assimilation methods.

8. The business managers shall either more strongly emphasize the science support function rather than the income function, or resources might be (partly) reallocated to KNMI cross-cutting management functions that are critical for maintaining an effective organization.

1. Introduction

The Royal Netherlands Meteorological Institute (KNMI) Supervisory Board established an international committee to assess both research and operations of KNMI, covering the period 2010-2016. The Board recommended a small assessment committee (AC) with members having a broad range of expertise. The AC consisted of six members, including the Chair (see Annex 3). The members of the AC have formally expressed their impartiality and confidentiality. In this report, the AC presents its conclusions and recommendations.

The assessment applies to the four R&D departments (Weather and Climate Models, Observations and Data Technology, Satellite Observations, and Seismology and Acoustics) and two operational departments (Weather and Climate Services and Operational Observations). Not included in the assessment are the support departments (ICT, human resources, finances and facilities).

The AC has followed the Standard Evaluation Protocol (SEP) 2015-2021 for research assessments in the Netherlands. This SEP consists of a self-evaluation and an external review, including a site visit. Previous versions of this protocol have been used for past assessments of KNMI's research. The most recent one was held in 2011.

The assessment procedure was largely similar to that of past assessments. Each member of the AC was sent a set of documents in advance, including the Terms of Reference (presented in Annex 1), KNMI's self-evaluation report over the period 2010-2016, and the Report of the 2011 AC. Using KNMI's website, the AC was informed on a large number of KNMI's research projects. The site visit by the AC was held on 7-9 June 2017, at KNMI, De Bilt.

During the site visit, the AC had interviews with the directorate, the department managers, and the strategic business managers of KNMI. The AC also interviewed a group of young KNMI staff, and a group of 10 key stakeholders of KNMI. For more details of the programme see Annex 2.

General conclusions and recommendations are presented in section 2, while section 3 contains the more detailed evaluation of the four research & development (R&D) departments, the two operational departments, and the role of the strategic business managers.

2. General conclusions and recommendations

As prescribed by the Standard Evaluation Protocol 2015-2021, the assessment committee bases its judgement on three assessment criteria: research quality (only for the R&D groups), relevance to society, and viability (see also Annex 1). This protocol also includes a quantitative assessment by assigning the research and operational units to a discrete category (1-4) for each of the criteria. In this assessment, criteria are applied only to the assessment as a whole, not to the individual departments. The quantitative assessment categories are: 1 = world leading / excellent; 2 = very good; 3 = good; 4 = unsatisfactory.

The research quality of the research departments as assessed by the AC ranges from very good to excellent. For KNMI's research as a whole the research quality is assessed as very good. The relevance to society of the research and operational units is, when compared to their peers, assessed as excellent. The viability of the research and operational units has both relatively strong and weak aspects. The units have high-quality staff that is successful in acquiring new projects. On the other hand, KNMI's infrastructure is vulnerable in the present financial situation, and KNMI faces the risk of losing personnel and knowledge because many personnel members rely on soft-funding while the structural funding from government side is decreasing. As the focus of this assessment is on research and operations rather than on infrastructure and finance, the viability is assessed, emphasizing its strong aspects, as very good.

In summary, the assigned categories for KNMI are as follows:

Criterium	*Category*
Research quality	2
Relevance to society	1
Viability	2

2.1 Conclusions

1. KNMI is a small but extremely efficient National Meteorological Agency recognized in the Netherlands as the authoritative voice for issuing warnings for severe weather events and seismological risks as well as for handling weather, climate and seismology related data and science issues.

2. The AC has the opinion that this success has been achieved due to the close interaction between science and operational work and the personal engagement of the collaborators at the institute as a result of a good "team spirit". This positive evolution of KNMI over the last couple of years was particularly highlighted during the interviews with key KNMI stakeholders. The stakeholders were, without exception, more than satisfied with the cooperation with and output of KNMI.

3. KNMI would benefit from a matrix-management that would further enhance cross-departmental collaboration on multi-disciplinary 'hot topic' projects.

4. Also, the AC recognizes that more work is still required in the effective transfer of products from science to operations. Finally, there needs to be development of additional information on performance goals, metrics, and time lines with milestones in order to maximize output.

5. KNMI has introduced, as a central notion, a risk reduction cycle with a front office (service) and a back office (R&D) component. However, the risk reduction cycle is to some extent still only a concept and needs further development and implementation.

6. KNMI's research quality is very good both for weather and climate model development, for developing satellite missions and corresponding data and exploiting surface-based observations, as well as for seismology. It is of essential importance to maintain these forefront positions.

7. The high scientific level of KNMI is further reflected by its extensive cooperation with universities, with nine part-time professorships held by KNMI-staff, and by the continuous involvement of universities in many projects on both national and international level.

8. The multi-annual strategic research programme is known for its innovation and cross-department activities.

9. KNMI has been successful in acquiring soft funding, but this success produces a higher risk for maintaining the required knowledge base on a long-term basis within the Institute.

10. There is a risk in outsourcing core KNMI competencies e.g. in the field of operational observations (but also for IT services) that in turn may hamper the level of knowledge inside KNMI and lower data quality.

11. The primary concern of the AC is the steadily decreasing funding from responsible governmental Ministry of Infrastructure and the Environment. There is considerable concern about the ability of KNMI to sustain the high level of service provision if this trend is not reversed. The breaking point may be reached soon, after which service quality and reliability will be strongly and visibly affected.

2.2 Recommendations

1. The AC endorses KNMI's ambition to establish an Early Warning Center (EWC), and recommends this Center be implemented as it will provide a significant hazard response resource for the Netherlands. The EWC will be a center with cross-cutting expertise drawn from all KNMI departments, thus taking advantage of and reinforcing the on-going spirit of close collaboration at KNMI. The EWC requires a considerable upgrade in KNMI's infrastructure and software, as well as new staff competencies. The EWC could be implemented at the national level, as such offering an opportunity to reach out and cooperate with other research centers and public environmental agencies in the Netherlands (hydrology, air quality and health impact, etc.) for a more effective response to environmental events.

2. The regular and independent assessment of the science and technical programs of the Institute is motivated by the complexity and breadth of the problems addressed by KNMI. External input to the work of KNMI can provide the opportunity to facilitate this work. The AC suggests the consideration of the establishment of a scientific review panel that meets regularly at the request of the Director General to review programme development.

3. The AC recommends that KNMI carefully monitors, manages and enhances the operations-supporting tasks associated with R&D.

4. It is of critical importance to continuously support or even further increase the effective collaboration with universities focusing on topics (i) where KNMI is missing resources and universities can help, and (ii) which require more sustainable R&D than can be satisfied with occasional PhD studies. A template following the DWD HERZ centres-of-excellence co-funded approach could be formulated. KNMI could start with a pilot centre of excellence to test this method in the Netherlands. This may also be useful beyond the boundaries of the Netherlands.

5. The AC understands that KNMI was asked to add volcanic warning and space weather to its portfolio as services that are becoming increasingly important. For volcanology an expert has been hired, for space weather there is no resource at all. Given that expertise on space weather is available in other centers in Europe and that KNMI's base funding is decreasing, KNMI should reflect on how to obtain and fund expertise on this service.

6. Evidence was provided to the AC of the high regard that the citizens of the Netherlands have for KNMI. The criticality of responses to geophysical hazards for the country motivates consideration of an expanded education and outreach, documenting the scientific basis of response to these hazards by KNMI. This work will provide a valuable resource for the country and is thus recommended by the AC.

7. The continued development of the technical and scientific staff of KNMI is critical to its future. Many of the natural hazards that KNMI has the responsibility for are multi-disciplinary and require work across disciplinary boundaries, and thus require awareness and desire to work across these boundaries. The AC recommends the enhancement of a weekly seminar programme at KNMI to encourage and support these multi-disciplinary solutions to hazard assessment while improving their own expertise at KNMI. This will become even more relevant when the EWC will be established.

8. The AC is concerned that current HPC access may not be adequate. The AC recommends that KNMI document computing-related challenges accounting for modern software architecture principles, and enhance education of staff, as is currently elaborated by the RDWD department.

9. The AC recommends to improve computer access of KNMI-staff at home using the Linux environment.

11. The AC appraises that KNMI's cost/benefit ratio is very low compared to that of most other high-level national meteorological services, and recommends to further substantiate this

effectiveness.

12. The educational services to the public at large can be further improved, if this effort would be better supported by the responsible ministries.

13. The overhead on external projects that is needed for an appropriate basic infrastructure consists of a fixed part, which is independent of the total project funding, and a variable part, which increases with the total project funding. Therefore, the rate of the needed overhead (i.e. the fraction of the project funding used for overhead) decreases with increasing total project funding. However, the overhead rate charged by KNMI is independent of the total project funding and is assessed by the AC as presently being higher than needed. The AC recommends the application for external projects of a realistic overhead rate that decreases with increasing total project funding.

14. The AC recommends to consider the importance of sustainability and of keeping knowledge inside KNMI and of attracting young scientists when making the choice between internal developments and outsourcing.

3. Conclusions and recommendations for the departments

3.1 R&D Weather and Climate Models (RDWK)

1. RDWK has undergone dramatic changes during the current evaluation period. On an organizational level, this coincides with the restructuring of KNMI's departments in 2014. As part of this reorganization, KNMI's modeling activities, which were in four departments in the past, have been consolidated into one single department. This reorganization yields a convincing structure and is commended by the committee. The new structure will allow better exploitation of synergies between different modeling components.

2. The committee took note of both the high publication output of RDWK, and the high citation rates of many of the senior scientists. The committee also took note that some elements of KNMI's modeling activities are well known and highly regarded internationally. This global visibility applies in particular to EC-Earth, the LES modeling, and the Climate Explorer. In addition, KNMI is well known for its former contributions to HIRLAM.

3. KNMI has been at the forefront in building and supporting the EC-Earth initiative for global climate modeling. It represents the primary contribution of the Netherlands to the international global climate modeling (in particular in CMIP5 and CMIP6). These activities should be commended for their high level of international cooperation and for their high quality. Indeed, the EC-Earth model is recognized as a leading European model in this area. The AC is concerned that the handing over of the EC-Earth management to SMHI has impacted the modelling work and the importance of EC-Earth at KNMI.

4. On the level of the limited-area weather modeling, there is currently a transition in the operational service from the HIRLAM to the HARMONIE model. This transition is still ongoing and finalizing it will require strong leadership. KNMI will not be able to maintain too many modeling systems and must make educated choices. It is understood that KNMI's climate version of HIRLAM (i.e. RACMO) will continue to be used during an extended transition phase for ongoing projects (e.g. CORDEX). However, further planning is needed to shape the transition of RACMO towards the climate version of HARMONIE.

5. Much of the current air quality modeling is based on the LOTOS-EUROS model. This model is driven by meteorological data, and can exploit data from various models and re-analyses. The AC recommends assessment and consideration of possible changes to this modelling work after the reorganization.

6. The large eddy simulation (LES) capability developed in collaboration with Delft University is a highly promising initiative. Further work will be needed to develop its potential application for the operational service.

7. Another highly regarded element of KNMI's portfolio is the Climate Explorer. This model analysis tool is used nationally and internationally for climate studies and climate adaptation purposes, by Dutch stakeholders, and also for the climate atlas of the last IPCC report. Ensuring the future maintenance of this tool is essential.

8. The committee felt that the overall modeling strategy could be presented more convincingly. It would be helpful to have a more explicit strategy similar to the 10-year strategy for observations. During the assessment, only a brief summary of this topic was provided. The model hierarchy should be better framed based on identified objectives (short and medium-range weather, climate, air quality, research), computational domains (global versus regional), and the underlying modeling paradigms (assimilation, deterministic, ensemble, and climate mode simulations). Also, the model improvement process along the hierarchy should be considered, e.g. the use of LES to support parameterization development for HARMONIE and EC-Earth. The strategy should also cover the use of model data from other centres, e.g. ECMWF. The role of ensemble prediction in RDWK is not clear and needs much strengthening. Model development needs research into uncertainty formulation, also feeding data assimilation. The methodological developments will also have great benefit for verification and diagnostics methods.

9. The role played by these modeling systems for weather prediction in the Netherlands should be highlighted, covering both KNMI's own weather prediction efforts, and those of third parties using elements of the KNMI modeling suite. The committee also recommends developing a thorough long-term validation strategy, which should enable monitoring of the NWP simulation quality over several decades.

10. The AC recommends consideration of a shift from the current focus on CMIP towards an increased use of existing climate services such as Copernicus.

11. There needs to be much more investment in cross-departmental work on diagnostic methods, particularly with WKD. These methods are at the heart of model development. (see also WKD item no. 6).

3.2 R&D Observations and Data Technology (RDWD)

1. A clear strategy was presented supported by a reference document dated 2015, with a clear vision to integrate all observations into optimal products as the best state of the atmosphere at any place in time and in 3 dimensions. The AC underlined the quality of this clear observing strategy as well as its clear targets and future-oriented perspectives in the field of data integration, as well as in using the value of third party data and new sources of information such as the DataLab and the WOW web portal for enabling impact-based warnings

2. The committee underlined the importance right at the beginning of a strategy to really understand and address first "what are the users' needs" and include users' requirements from inside KNMI as well as from major stakeholders outside KNMI. When the requirements are clear,

an analysis of what is available, and what is missing (a gap analysis), will provide clear guidance on what is required for the future.

3. The committee was impressed by the excellent work and high productivity of the RDWD department, with a clear portfolio including major activities in 3 areas, namely innovation in observation methods, data technology usage, and international climate services.

4. RDWD is driven as well by research and science excellence with some specific focus on Data driven innovations, future observation network, climate services, and the Early Warning Centre.

5. The committee recognized that the KNMI work on DataLab in RDWD is a R&D effort designed to address modern impact-based warning issues (e.g. in air quality, health, crime, road traffic) using the most recent geo reference information system GIS and its time component (dynamic GIS): this work is clearly of high value and recognized internationally (e.g. two Väisälä awards in the last four years).

6. The world-class reputation of the CESAR CABAUW site with application to planetary boundary layer meteorology and ground truth for satellite validation is recognized by the committee. CESAR is having regular international inter-comparison campaigns and offers an open data portal of high-quality data sources for both research and the public. CESAR is very well managed by KNMI.

7. The committee also noted the goal of better and more active developments of techniques designed to merge data sources. The development of very short-term nowcasting based on statistical analysis to support the nowcasting techniques, and subsequent seamless integration into the Harmonie NWP, is recommended.

8. This short-term nowcasting activity would play a key role in the proposed Early Warning (and cross cutting) Center at KNMI, drawing on resources from both the RDWD department and the WO department.

3.3 R&D Satellite Observations (RDSW)

1. The RDSW department is a key player in Europe and globally in the area of space-borne research on atmospheric composition, with important applications in the areas of air quality, greenhouse gases, climate change, and data assimilation. It has an internationally recognized expertise in this area.

2. RDSW is active across all aspects of the work from mission requirements to development to exploitation. The department is an important and appreciated partner in ESA and EUMETSAT projects, and is effectively expanding its space partners to include China and other countries.

3. The AC noted that the overwhelming majority of the funding is from third-party funded projects. This reliance of key activities on potentially unstable funding sources is a concern. Nevertheless, it is crucial.

4. Therefore, one key recommendation is to justify and focus the activity on the valorization of the satellite data for climate and weather forecast models, which is a core business of KNMI. This implies:
    i. Strengthening the development of user-driven products based on satellite data;
    ii. Enhancing the link between air quality and climate;
    iii. Enhancing the synergies with the R&D Weather and Climate Models department;
    iv. Be a key player in the EWC;
    v. Highlight the economic impact of satellite missions on Dutch industry and technology sectors, job creation, and educational aspects;
    vi. Highlight the importance of maintaining KNMI's expertise and involvement in satellite mission development and exploitation because of its important roles in EUMETSAT and ESA advisory and programmatic bodies and in supporting NSO;
    vii. Include greenhouse gases and aerosols in the development of future satellite missions.

5. The AC recommends solving at the management/ministerial level collaboration issues with RIVM and the definition of responsibilities for providing air quality information in the Netherlands. RIVM can logically make the link to the health impact.

6. The AC recommends that adequate base funding is provided to RDSW to bridge gaps between satellite projects in order to keep the expertise alive, prepare for future missions, and to fully exploit past missions. Such funding is difficult to find elsewhere; it can hardly be provided project-wise. Being a long-term activity, satellite development is most demanding. Institute support should also be provided for highly-demanding management of satellite projects, and operational activities linked to satellite observations.

3.4 R&D Seismology and Acoustics (RDSA)

1. This research department is young and energetic as reflected in both the range of projects and the associated innovative approaches to critical geophysical hazards ranging from induced earthquakes to nuclear explosion monitoring that impact society in the Netherlands.

2. Unique to this research department is the integration of operations and research into a single unit. Although this integration is unique relative to the other KNMI departments, the AC saw merit in this approach as a result of the size of the group and the utilization of operations and research perspectives to improve the products delivered to a variety of customers. The AC endorses this approach.

3. A number of the technical areas under study by this department reach across disciplines that are outside its direct expertise. The department should be encouraged to reach out both internal and external to KNMI to fully develop solutions to these problems while providing career

broadening experiences for staff members. Concrete examples of this outreach include acquiring input on atmospheric models from within KNMI in refining infrasound propagation models, developing subsurface geologic models necessary for fluid flow and stress models for purposes of assessing induced earthquakes and ultimately developing mitigation strategies that can reduce risks from induced earthquakes, and the inclusion of InSAR analysis constraining surface deformation for problems such as volcano monitoring.

4. The portfolio of the group contains the study of the consequences of the effects of induced seismicity in Groningen. This work gets much attention from the public because of the damage to buildings close to the earthquakes. The NAM and Economic Affairs are held responsible but are not the right parties to mitigate this process. The seismology group of KNMI has the expertise, visibility and independence to be the lead of this process. In addition, KNMI has historically executed the task of measuring and warning for potential hazards and maintains the trust of the public. Appropriate additional funding would be necessary to support this added effort.

5. Like many of KNMI's departments, funding for the seismology and infrasound group includes a blend of long-term government mandated work and shorter term contractual work. The AC recommends an assessment of the level of mandated work in order to assure that that the permanent funding level is appropriate for this mandated work.

3.5 Weather and Climate Services (WKD)

1. The EWC is at the core of the future profile, ideally including responsibilities outside the scope of KNMI. This proposed new focus is very good but needs resource allocation beyond KNMI as the responsibility for some of the services (e.g. air quality) lie currently outside the realm of KNMI. Planning the EWC also comes with a critical need for new infrastructure, software modernization and staff commitments in order to meet future requirements. This need must be formulated and translated into actions and budgetary needs so that planning can progress.

2. The future role of automated data processing, away from forecaster-dependent judgement, is recommended to be taken into consideration while developing the EWC strategy.

3. The AC recommends enhanced use of crowd-sourced data for weather diagnostics, such as surface pressure data, precipitation diagnostics, weather impact photos, etc.

4. The AC recommends an enhanced development to merge data sources for very short-term nowcasting based on statistical analysis with a seamless integration into the Harmonie model for short-range prediction. This development would be a key contributor to the EWC, with the ability to bring together operations and R&D related to observations.

5. The AC strongly recommends an enhanced use of ensemble methods, in particular for extended forecast ranges, as providing forecast uncertainties is essential for decision making.

6. The AC recommends the assessment of the research-to-operations (R2O) process/hand-over work (steps, monitoring, quality assurance, response to short-term issues) including documentation of how R2O has improved since the last review and the reorganization. Questions to be considered are, e.g.:
    a. Has these cross-department hand over become faster and more agreeable for RDWK and WKD?
    b. Are daily weather bulletins and regular common RDWK-WKD meetings organized to foster a dialogue and to stimulate targeted research?
    c. Is there sufficient investment in the development of diagnostic methods that allow tracing back performance to potential error sources in models, observations, and data assimilation?

7. The level/number of scientists in WKD should be increased to enable a more educated analysis of forecast performance issues on the spot.

8. The AC regards the climate change information in the weather & climate plume as misleading. It makes no sense to show future minimum/maximum limits with a prediction of current weather because the relevant question is what future weather would look like.

9. It is not clear to the committee whether an “exciting” focus project has been developed, as was recommended by the 2010 review panel.

10. The portfolio of weather and climate services is not well defined. Weather is well established but climate services are different and the two should not be confused. Occasionally, medium-range, monthly and seasonal forecasts were labelled as climate information, which they are not. How in the future climate services will be developed needs a clear vision and plan. In this context, the role of output from the Copernicus Climate Change Service should be emphasized.

11. WKD should assess the possible risk that the aviation responsibility may be lost in 2019, given the development of the Single European Sky initiative.

3.6 Operational Observations (WO)

1. The committee noted that the operational department is driven by a very clear observation strategy in close support from RDWD and in partnership with Royal air force, the Dutch airports, the road authorities, the ship authorities, and other partners. The committee appreciates the cooperation with RDWD on e.g. quality assessment in connection to citizen science, and mobile stations.

2. The WO department should be proud of the excellent work performed as demonstrated during the commissions’ visit to the calibration lab, and the maintenance office responsible for all

networks (surface observations, airports, lightning detection, weather radar, buoys, seismology, etc.). The recognition of this department by the other departments should be evident.

3. This operational department is acting as the backbone for all measurements at KNMI with clear requirements for reliable high-quality data, the seismological network, remote sensing and others. This responsibility includes maintenance at all sites, calibration facilities, documentation, and an open data policy.

4. The committee also took note that WO has successfully undergone two recent ISO audits from which no findings were declared: this is a sign of an excellent quality-driven organization, where processes are followed as defined.

5. All dimensions ranging from operational services, innovation in support with RDWD, quality, traceability, and validation were addressed with clear objectives and concerns.

6. The committee noted that the scientific output is not directly a measure of the WO department: further engagements of the leadership of WO in expert conferences and in partnership with the research community are recommended which will provide WO the ability to identify new opportunities in the field of operational observations.

7. The committee also sees that there is a clear change of business in the future of the operational observations, and noted that over the next 5 years 2/3 of the WO coworkers will be replaced, thus offering a chance for a modern evolution in WO, but also posing strong challenges in transferring the valuable knowledge at disposal of today's staff to new young staff.

3.7 Strategic Business Managers

1. The implementation of business managers is a result of the reorganization and follows an innovative approach complementing science domain leaders with management support that looks into new application areas and economic opportunities. The presentation by this group provided good examples (e.g., 'unconventional' data usage, citizen weather observer, KNMI phone app) of such opportunities. The position for the lead of the important area of climate change adaptation, is currently not filled and needs a competent scientist, as this area is likely to provide many opportunities for KNMI in the future. The interaction between the business managers and the research and operations department heads was presented as being highly interactive, leading to consensual decision-making.

2. The committee was concerned about selected aspects of the organizational structure related to the positions of the business managers. While the committee felt that it was important to increase the income from third-party funding and external projects, there were concerns in two areas:
   Firstly, it appears that the decision-making process at the level of the business managers / department heads needs further development. The lack of a clear decision-making process is

a great risk in difficult situations with potential conflicts as priorities of business managers and department heads may be different. In addition, the committee did not understand how it was ensured that the different challenges (budgetary planning, externally funded contracts, KNMI strategy, sparse manpower resources, etc.) are traded off against each other in the decision-making process.

Secondly, the committee noted that the responsibility of the business managers has been primarily defined in terms of financial income from outside sources. The committee is concerned because the level of income is difficult to specify. The committee also feels that the currently small level of extra income (i.e. 5-10% of KNMI's income) provided by the business managers may be given too much weight in the overall decision-making process. The committee, however, notes that the directorate has recently expanded the target of the business managers.

3. Given the early stage of the business manager function at KNMI, it seems too early to make a well-founded judgment of the efficiency and sustainability of this function. However, given the above concerns, three options could be pursued:
    i. Retain the business manager concept in the four thematic areas, (1) reduce the primary focus on income generation (=annual key performance indicator) and (2) enhance their science support function. A key concern is to promote an organization that is too opportunity-driven imposing excessive strain on research and operations. Business managers should have great potential for lobbying for the KNMI thematic areas at the European Commission, they could seed topics of interest for KNMI in future funding programs, and they could support consortia building and project implementation.
    ii. Redirect these resources into KNMI cross-cutting management functions that are critical for an effective organization (see general recommendations in section 2):
        a. Strategic research project coordination, and research-to-operations process handling;
        b. Infrastructure management, including computing/software strategic and project coordination.
    iii. A combination of both, e.g. two business managers + two cross-cutting managers.

In any case, the committee feels that the decision-making process at management level needs to be defined more clearly.

Annex 1. Terms of Reference

The KNMI supervisory board has decided in its meeting on 26 January 2016 that a scientific assessment of KNMI research and operations will be carried out in 2017, covering the period 2010-2016. The assessment applies to the four R&D groups (Weather and Climate Modeling, Observations and Data Technology, Satellite Observations, Seismology and Acoustics) and two operational groups (Weather and Climate Services and Operational Observations). Not included in the assessment are the support departments (ICT, human resources, finances and facilities).

The assessment will be largely based on the Standard Evaluation Protocol 2015-2021, https://www.knaw.nl/nl/actueel/publicaties/standard-evaluation-protocol-2015-2021
This (recently revised) Standard Evaluation Protocol (SEP) describes the methods used to assess research conducted at Dutch universities and NWO and Academy institutes, as well as the aims of such assessments and criteria that will be assessed. Previous versions of this protocol have been used for past assessments of KNMI's research.

The protocol serves to guarantee, reveal and confirm the quality and relevance of academic research. The assessment committee will base its judgement on three assessment criteria: scientific quality (only for the R&D groups), relevance to society, and viability. The committee will also make recommendations for the future, the education of young scientists and research integrity. In response to the review the KNMI directorate will state what consequences it attaches to the assessment. Both the assessment and the response will be presented to the KNMI supervisory board (RvT).

Whereas for research all three assessment criteria will be used, i.e. research quality, relevance to society, and viability, for operations only the latter two criteria will be applied. For operations, as a third criterion 'quality of operations' will be used, for which the following sub-criteria will be applied:

- scientific basis of the applied procedures and processes
- reliability, consistency and documentation of the operations
- quality of services in terms of achieving operational targets, including availability
- innovative strength and opportunities
- conditions for delivering quality of operations: staff, management, budget, facilities
- appreciation of quality of operations by customers, clients and users

Annex 2. Program of the site visit

Wednesday 7 June 2017

16:30	Informal welcome (assessment committee (AC), members of Board KNMI, Director General KNMI)
18:00	Dinner with AC, Board, directorate, department managers

Thursday 8 June 2017

09:00-10:00	Director General, *Gerard van der Steenhoven*
10:00-11:00	R&D Weather and Climate Models, *Bart van den Hurk*
11:00-11:45	Visit facility 1
11:45-12:45	Weather and Climate Services , *Jan Rozema*
12:45-13:30	Lunch
13:30-14:30	R&D Satellite Observations, *Pieternel Levelt*
14:30-15:30	R&D Seismology and Acoustics, *Läslo Evers*
15:30-15:45	Break
15:45-16:30	Interview with young staff
16:30-17:15	Interview with stakeholders
17:15-18:00	Interview with directorate, *Gerard van der Steenhoven and Myriam van Rooij*
18:00	Dinner of AC

Friday 9 June 2017

09:00-10:00	R&D Observations and Data Technology, *Albert Klein Tank*
10:00-10:45	Visit facility 2
10:45-11:45	Operational Observations, *Sandra van Dijke-Langezaal*
11:45-12:30	Strategic Business Managers, *Jan Dekker*
12:30-13:00	Lunch
13:00-16:00	Internal discussions
16:00-16:30	Preliminary conclusions
16:30	Presentation of main conclusions (AC, members of Board, directorate, department managers)

Annex 3. Members of the assessment committee

prof. dr. ir. Jacob Fokkema (chairman) is geophysicist, and former Principal of the Delft University of Technology.

dr. Peter Bauer is Deputy Director of Research at the European Centre for Medium-range Weather Forecasts, Reading, UK.

prof. dr. Bertrand Calpini is Deputy Director of MeteoSwiss, Professor at the École polytechnique fédérale de Lausanne, and President of the World Meteorological Organization Commission for Instruments and Methods of Observation.

prof. dr. Martine De Mazière is Director general ad interim and Head of the Division 'Scientific Directorate' at the Royal Belgian Institute for Space Aeronomy, and visiting Professor at the Ghent University.

prof. dr. Christoph Schär is Head of the Institute for Atmospheric and Climate Science at the ETH in Zurich.

prof. dr. Brian Stump is Professor of seismology at the Southern Methodist University, Dallas.

dr. ir. Peter Siegmund (secretary) is a scientist at KNMI.

Bertrand Calpini *Peter Siegmund* *Peter Bauer*

Jacob Fokkema *Martine De Mazière* *Brian Stump* *Christoph Schär*