Forskningsrådet

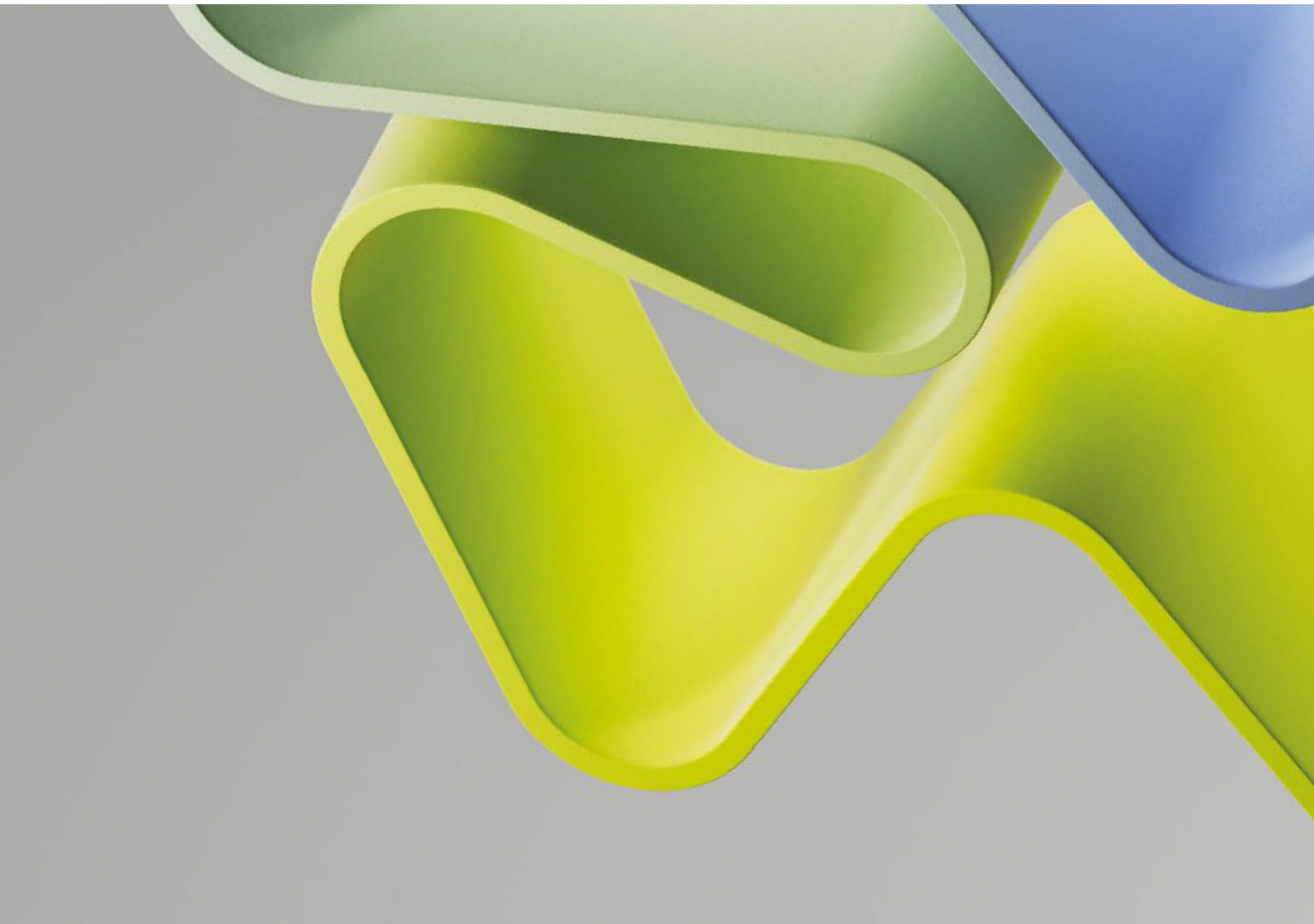
Evaluation of Natural Sciences 2022-2024

Evaluation report

Atmospheric and Climate Research Department

Norwegian Institute for Air Research (NILU)

January 2024



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Statement from Evaluation Committee – Institute II

The members of this Evaluation Committee have evaluated the following administrative units at the research institutes within natural sciences in 2022-2023 and submitted a report for each administrative units:

- CICERO Centre for Climate Research
- Norwegian Meteorological Institute – Weather and Climate (MET)
- Norwegian Institute for Sustainability Research (NORSUS)
- Norwegian Research Centre (NORCE) – Climate and Environment
- Norwegian Institute for Air Research (NILU) – Environmental Chemistry Department
- Norwegian Institute for Air Research (NILU) – Atmospheric and Climate Research Department
- Norwegian Water Resources and Energy Directorate (NVE)
- Nansen Environmental and Remote Sensing Centre (NERSC)

The members of the Evaluation Committee are in collective agreement with the assessments, conclusions and recommendations presented in this report. None of the committee members has declared any conflict of interest.

The Evaluation Committee has consisted of the following members:

Professor **Mat Collins**, (Chair)

University of Exeter, United Kingdom

Professor **Dorthe Dahl-Jensen**,

Niels Bohr Institute, Denmark

Professor **Hayley Fowler**,

Newcastle University, United Kingdom

Professor **Martin Siegert**,

Imperial College London, United Kingdom

Professor **Thomas Jung**,

Alfred Wegener Institut, Germany

Description of the administrative unit

The ATMOS department, both a research group and an administrative unit, has 30 employees, of which 20 are researchers or senior researchers, eight are technical researchers/developers and one is a PhD student.

NILU, the broader institute, consists of six departments, of which two departments participate in this evaluation (both are individual administrative units). These are the Atmospheric and Climate research department (ATMOS) and the Environmental Chemistry Department (MLK).

In their self-assessment form, ATMOS reports that their strategy goals are intrinsically linked with NILU's institutional strategies. In NILU's climate research strategy for 2010-2020, these include: (1) to contribute with relevant information, nationally and internationally, on the understanding of the climate system and the importance of short-lived climate agents, (2) to inform national and international authorities on the capabilities of combined greenhouse gas pollutant emission controls to improve health and quality of life. The department gives general support for participation in meetings, workshops, training courses and conferences. Furthermore, NILU states in their self-assessment form that they offer support for researchers to attend Norwegian language courses, and this has been taken up in a handful of instances.

Both in NILU's new *strategy document 2023-2027* and in the self-assessment form, it states that NILU's strength is its specific scientific disciplines and competence in utilising strong scientific competence in collaboration with other domains and disciplines. Additionally, it states that NILU and ATMOS have a targeted and long-term collaboration with institutes and universities to secure broader participation. On their self-assessment form, they state that they seek collaboration with Norwegian universities (UiB, NTNU, UiT, NMBU). ATMOS seeks to deliver policy relevant research and advice through direct engagement with the key stakeholders in the climate and environment sector. In their self-assessment form, ATMOS states that work included in nearly all international treaties related to air pollution has resulted from collaborative research where NILU has had prominent participation. ATMOS has directly had collaboration with both the Norwegian Environment Agency and with the Ministry of Climate and Environment and serves in this respect as a formal advisor to the Norwegian government.

In their self-assessment form, ATMOS states several strengths that include: (1) A large network with key players in international monitoring and research programs, partner, and advisor to international institutions, (2) A flat organisation that encourages everyone to participate in develop, allowing the unit to be fast, flexible and adaptable and (3) A good reputation and wellrecognised, knowledgeable researchers in atmospheric and climate sciences, European research infrastructures, model development, remote sensing and international databases. ATMOS reports that they have relatively low basic funding. Furthermore, the shift from research funding to larger and more complex interdisciplinary projects provides a threat, also when it comes to funding from the EU.

Overall assessment

The administrative unit stands out as a prominent research group, renowned for its very good to excellent scientific achievements and extensive international presence, focussing on addressing open scientific questions in atmospheric research. The unit is recognized for its pivotal role in atmospheric composition measurements, trend analyses, and evaluating significant disruptions such as volcanic eruptions and hazardous material releases, thereby contributing work of high societal relevance.

In terms of size, the unit has grown from 20 to around 30 members, representing diverse backgrounds in meteorology, chemistry, physics, and data science, contributing to a very good balance in terms of nationality and gender. An aging workforce together with a relatively low number of early career scientists is potentially an issue. The strategic approach and leadership team exhibit strength and a keen awareness of their strengths and weaknesses as well as existing challenges and opportunities.

The unit has effectively cultivated a dynamic research environment, securing impressive funding primarily through EU and RCN grants, supplemented by strategic initiatives from NILU. While the strong reliance on third-party funding poses a potential risk, this is a common challenge for many research institutes in Norway. The current number of projects, which is an expression of successful acquisition of third-party funds, may be too high – “fewer and larger” might be better.

The unit shows impressive levels of openness in their approach to science in general and data in particular, taking a leading role in many aspects.

Recommendations

The evaluation committee suggests that the unit should maintain its influential role in existing highprofile initiatives while leveraging personnel fluctuations and impending retirements to reconsider its portfolio.

The evaluation committee recommends that ATMOS regularly reviews staff composition, particularly the high number of permanent contracts and the scarcity of younger scientists, which may pose challenges in adapting to changes like new funding patterns. Improving training for the upcoming generation, especially in non-permanent positions, could be achieved through participation in national initiatives (research schools) and international engagement (EU).

The evaluation committee advises a continuous reassessment of the number of funded projects, proposing that a "fewer and larger" approach might be more effective.

The evaluation committee perceives the strong reliance on insecure funding, in contrast to a more strategic long-term funding, as a potential risk.

With a flat hierarchy granting significant freedom to scientists, there is a recommendation to consistently evaluate the balance between bottom-up and top-down management.

The table below presents the specific aspects of the evaluation the administrative Unit requested the evaluation explore and indicated where these are addressed in more detail in the subsequent report.

Specific Request from the Unit's Terms of Reference	**Where it is addressed in the report**
Assessment of how well the observational efforts, data base activities and modelling efforts at ATMOS are linked together and if the potential for integration is reached	Addressed in sections 1, 4 and 5
Assessment of if these research-based services can be made more useful for solving the societal challenges for supporting policy relevant decisions to improve air pollution and climate change at large	Addressed in a number of recommendations throughout the evaluation report

1. Strategy, resources, and organisation of research

The unit adopts a strategic approach with a clear focus on atmospheric research, monitoring, modelling, and providing guidance to society and policymakers. Acknowledging strengths, weaknesses, challenges, and opportunities, the unit takes actions to address identified threats and weaknesses. Future plans involve working on the same topics with improved methods (e.g., AI), while the evaluation committee suggests periodically also reviewing core themes to explore new opportunities.

The unit operates efficiently with a project-related matrix framework, offering flexibility in its largely externally funded projects. A flat hierarchy grants scientists significant freedom, prompting the recommendation to consistently assess the balance between bottom-up and top-down management. While impressive third-party funding is secured, concerns arise about the high number of projects, suggesting that fewer, larger projects may be beneficial.

The unit actively participates in national and international infrastructures, notably taking a leading role in initiatives like ACTRIS-Norway. Collaboration is a key strength, particularly at the international level. Adapting to changing funding patterns may involve seeking new collaborations, including with social scientists.

Staff diversity and gender balance are commendable, with high staff satisfaction. However, there's a limited number of early career scientists, prompting the evaluation committee to recommend an increase, considering substantial upcoming staff turnover.

1.1 Research Strategy

The focus has been on research and development (R&D) efforts to assess atmospheric composition at regional and global scales. The group is highly engaged with observational work of atmospheric constituents, particularly at permanent observatories. The unit has a very clear strategy (assess atmospheric composition at regional and global scales) that is well embedded in the institute's overall strategy and that contributes to NILU's mission of informing environmental policy. The activities match well with the strategic goals. The unit directly supports the overall strategy of NILU

research (most recent NILU strategic plan 2018–2022) and contributes to NILU's future strategy for 2023–2027.
Given the strong reliance on external funding, it is impressive to see how closely activities are related to the strategy (response to calls can easily lead to a large diversification of the research portfolio). They appear to have mechanisms in place to control this (e.g., by supporting applications for strategically relevant projects only).

The unit thinks very strategically, involving all staff members. A good example for this is the SWOT analysis, which reads as very strategic and shows that the unit is well aware of their strengths and weaknesses, as well as their challenges and opportunities. Actions have been taken to address the threats and weaknesses identified. Most of the opportunities identified in the SWOT analysis are very reasonable, but do look very much related to the existing portfolio. Thinking more explicitly about transformative opportunities that may lead to changes in the portfolio is recommended. The fact that all staff members were involved in developing the SWOT analysis is very positive, as it raises awareness of strategic issues as well as the acceptance of actions taken in response to weaknesses and threats.

For the future the unit considers “working on the same things, but with better methods” (e.g., AI) as the way forward. While the evaluation committee agrees that novel methods will provide transformative opportunities, it may be worth regularly reviewing the portfolio of core themes – given that this might open other opportunities and help to remain competitive.

There is a strong growth strategy at NILU as part of which they are working to generate new inhouse competence. In this context, it is not the number of scientists that has increased significantly – a big increase is observed for staff working on computer systems and development of databases.

During interviews, discrepancies emerged between top management's desire for NILU to move into solutions and collaborate with industry, and the unit's inclination to focus on their mission as atmospheric process experts. This potential conflict within the institute is deemed important to resolve, with the evaluation committee highlighting the need for alignment between top-down expectations and the unit's perceived capabilities and mission fulfilment.

1.2 Organisation of research

The unit seems to work effectively and smoothly, with a project-related matrix framework, which allows for flexibility and reflects their way of working (largely in form externally funded projects). ATMOS is also organised along focus areas: i) observations and monitoring activities, ii) data bases, and iii) modelling. The last seems to be less important for the shorter-term scientific agenda, but gives a solid base for long term organisational issues.

Scientists are generally offered large freedom to pursue funding opportunities enabling them to conduct research and services within the unit’s core areas. This “flat hierarchy” or “bottom-up” approach has worked well in the past. However, the unit is invited to constantly review whether adjustments to this approach could be beneficial.

Scientists in the unit are supported by technical staff, which is very positive to increase effectiveness and hence productivity. In this context, the evaluation committee applauds NILU for having

established a new department called Digital and having recruited three to four additional experts in AI.

The unit provides excellent training opportunities for its staff. Recent examples include workshops on how to better relate applications to SDGs, how to write chronicles and how to be better at outreach activities. Additionally, provided special training to project leaders on project management. Scientists are supported in-house in when writing proposals.

1.3 Research funding

The unit secured an impressive amount of third-party funding. During the period 2017–2021 external projects made up 59% of the total capacity in terms of the hours worked: EU-funding represented 19%, RCN represented 14%, basic funding represented 11%, while client-based funding represented 27%. Thus, 60% of research activities are covered by external competitive funding (EU, RCN, clients). There is support in form of 3% of the total capacity for strategic developments with internal funding in case external funding is not available.

The large number of funded projects (about 240) is a reason for concern, since it comes with a lot of administrative burden and may dilute the strategic focus. Having fewer, bigger projects may be a distinct advantage.

The unit has successfully secured and hosted ERC projects, a strategic achievement signalling excellence. This success is further underscored by a substantial number of recent EU projects, reflecting the unit's competitiveness and capability.

A noteworthy positive aspect is the unit's receipt of permanent funding to sustain its long-term observations, supported by entities such as the Ministry of Environment and the Norwegian EPA. The continuity of this funding is crucial for ongoing operations and should be safeguarded in the future.

However, like other research institutes in Norway, the unit faces a significant risk due to its relatively low level of core funding, constituting approximately 15% for NILU. Insufficient core funding can result in elevated person-month rates, rendering the unit a costly partner at the European level and potentially limiting the allocation of person-months. Addressing this challenge is crucial for sustaining the unit's competitiveness and collaborative engagements.

1.4 Use of infrastructures

The unit’s participation in and use of national and international infrastructures is impressive, especially given the leading role it often takes.

The unit is leading ACTRIS-Norway and contributes to the Integrated Carbon Observing System (ICOS)-Norway, the Norwegian contribution to ACTRIS and ICOS, the Svalbard Integrated Arctic Earth Observing System (SIOS) and the Troll Observing Network (TONe).
At the European level the unit is leading the development of the ESA Atmospheric Validation Data Centre (EVDC, evdc.esa.int), which is the central, long-term repository in Europe for archiving and

the exchange of correlative data for validation of atmospheric composition products from satellite platforms.

The e-infrastructure EBAS is extremely important to the unit, both in terms of data storage, database operations, service developments and to serve data for wider scientific use.

FLEXPART and FLEXINVERT are very important and widely used modelling infrastructures for atmospheric transport calculations and improving emission inventories based on observations and source receptor relationships.

1.5 National and international collaboration

Collaborations are an essential part of the unit's strategy and considered a major strength according to the SWOT analysis.

The wide portfolio of large-scale collaborative projects (e.g., EU and RCN) demonstrates successful collaborations both nationally and internationally. Overall, the portfolio of collaborators is impressive, both in terms of number and diversity.

The unit seems to be aware of their role and position in the Norwegian system. From the publication analysis given in the bibliometric data it can be inferred that most of the collaboration is with partners from outside of Norway (e.g., for the period 2012–2021 the share of publications with international co-authors was consistently above 90%, compared to 20–30% in the early period and 40–50% more recently for national co-authors).

As part of the SWOT analysis, the unit has identified changing funding patterns that come with more interdisciplinarity and increased relevance of social science as a potential threat. The evaluation committee recommends starting to explore possible new strategic partnerships at the national and international, given that it will be difficult to build correspondence expertise in-house at the necessary scale.

1.6 Research staff

The unit grew from 20 members to about 30 in recent years (20 researchers/senior researchers, 8 technical researchers/developers and one PhD student), with most of the new hires focussing on technical aspects (e.g., digital). Their staff, which is very diverse in terms of nationalities (11 countries), have backgrounds in meteorology, chemistry, physics, and data sciences. The gender balance is very good. All research group members have permanent positions. There are measures in place to measure diversity and balance, and numbers are regularly presented and discussed.

The unit has only one PhD student, which the evaluation committee considers insufficient. It seems that the unit had some negative experiences in the past with more than half of the PhD students leaving before finishing projects, and they therefore perceived PhD students as high risk. It may be worth to establish the reasons for the negative experience and check whether other research institutes have similar experiences. There may be way of lowering the risk. Furthermore, training of and working with PhD student should be seen as an investment into the future.

Importantly the work satisfaction in the unity is very high, as revealed by a recent survey (takes placed every two years). This is the results of a number of strategic measures that start with hiring, include social events, clear communication of decisions and a high degree of freedom given to the scientists.

2. Research production, quality and integrity

The quality of the research can be considered very good to excellent, also by international standards in this discipline. This is also expressed by the number of publications and their impact, which according to the bibliometric data is consistently above average. The unit also publishes in high-impact journals. The most impactful publications tend to be many-author papers with a lot of international co-authors, which reflects the strong collaborative approach of this unit. There seems to be some evidence for a slight reduction in the total number of publications in more recent years, despite the number of staff in the unit having grown from 20 to 30 in recent years. Although this new staff is working mostly on technical matters and therefore does not directly contribute to publications, it should enable enhanced productivity of the scientists within the unit. Some of the stagnation in the number of publications may be explained by the fact that some of the more recent funded projects are related to infrastructure and therefore more technical in nature, also allowing less time for publishing. However, there are hardly any teaching obligations, and with few students and early career scientists less efforts in supervision and education.

While the unit is aware of issues related to research integrity, it seems that no written documents exists that the unit refers to and that provide guidance to its staff. However, there is some detailed information on gender etc.

2.1 Research quality and integrity

Department for Atmospheric and Climate Research: an overall assessment

The grades overall reflect the high international excellence of the research group. Strengths are the clear, almost stand-alone position in the Norwegian research landscape. Staff members have a strong international reputation, very good success with funding, high impact publications and there is strong societal relevance of the work on atmospheric pollution. There is room for improvement in training the next generation of researchers and gaining more flexibility in staff composition.

2.2. Open Science

The unit’s approach towards Open Science can be considered excellent. A high level of openness can be observed for quite a few years already, starting long before the FAIR principle was introduced. The leading role of this unit in this field is further demonstrated, for example, by its contributions to developing new standards, the mentioning of their services in the National strategy for sharing of research data and their lead role in the EOSC project ENVIR-FAIR (forefront of European development in relation to the FAIR principles).

The strong focus on openness is very appropriate, given the central role that the provision of observations and monitoring data to the wider community play for the unit, and given the level of external funding, which usually come with high expectations on openness.

The unit does an excellent job by national and international standards at delivering open access publications. In 2020 and 2021 only less than 4% of all publications were not open access, according to bibliometric data.

3. Diversity and equality

The staff composition is notably robust, showcasing impressive diversity in terms of factors such as gender and nationality. However, there are noteworthy considerations, particularly regarding the age distribution. A significant proportion, slightly exceeding half of the staff members, are over 50 years old.

Moreover, the unit currently accommodates only one PhD student. To strengthen the team, there could be advantages in actively recruiting more early-career scientists into non-permanent positions.

The unit's commendable measures to prevent discrimination align with international standards.

Additionally, the unit has implemented a gender awareness plan, and its performance reflects diversity, with 60% females in upper management.

4. Relevance to institutional and sectorial purposes

The unit excels in pursuing both sector-specific objectives and broader contributions to the knowledge base, particularly in the field of "air pollution and climate change". Notably, it has actively contributed to various international treaties on air pollution and provides advisory services to the Norwegian government on relevant matters. The unit has proven its agility in responding to emergencies, such as volcanic eruptions.

While research commercialisation is not a central focus for the unit, valid reasons support this decision, such as the emphasis on openness. The unit's research infrastructure, through the transparent provision of data, software, and science, inherently supports potential research commercialisation.

Contributions extend to policy development, sustainable practices, and societal and industrial transformations, as evidenced by significant inputs into international assessment reports on air pollution and monitoring activities. There remains room for continued efforts to further enhance these contributions.

5. Relevance to society

The unit’s contribution to the long-term societal development of Norway can be considered very good, with many activities directly relating to Norwegian interests. The fastness with which the unit can respond to specific events is truly outstanding. This notion is underpinned by recent success

stories such as the analysis of Canadian forest fires in 2023 (large international media presence) and a rapid assessment of the North Stream explosion (24 hours after the event the unit produced a good estimate of how much methane was released into the atmosphere). Another example for quickly delivering a decision-making basis for national measures was the volcanic eruption at Eyjafjallajökul in 2010.

The unit has a strong influence on policy making, thereby contributing to its mission of informing environmental policy. A good example for policy relevance is that the unit was engaged in all international programmes on engagement of the atmosphere including EA, Stockholm convention, Arctic council AMAP. They also lead the topic centre for EA and have the Chemical coordinating centre. It provides strong societal contributions by leading reports for the policy development under the Convention on Long-Range Transboundary Air Pollution, directly supporting the EU legislation on Air Quality. NILU's data centre EBAS is used as the official database for a range of international programmes (UN-ECE CLRTAP, WMO-GAW, AMAP, HELCOM), and has been awarded long-term funding to serve the European ACTRIS RI. The unit also contributed to the Guttenberg review, which outlines policy limiting countries' emissions into the atmosphere in Europe.

Comments to impact case 1: Ash forecast for aviation in the event of a volcanic eruption

The evaluation committee considers the impact case to be a true success story. Due to its international credibility, the unit effectively mitigated financial damage during the Grimsvotn volcanic eruption in 2011 by recommending keeping the airspace open. ATMOS achieved results that were notably more detailed and accurate than the Norwegian Meteorological Institute's standard model. Subsequently, in 2016, a collaborative effort with the Norwegian Meteorological Institute led to the development of an operational system for volcanic ash warnings.

List of administrative unit´s research groups

Institution	Administrative Unit	Research Groups
Norwegian Institute for Air Research (NILU)	Atmospheric and Climate Research Department	Department for Atmospheric and Climate Research

Methods and limitations Methods

The evaluation is based on documentary evidence and online interviews with the representatives of Administrative Unit.

The documentary inputs to the evaluation were:

- Evaluation Protocol (see appendix 3 Evaluation Protocol) that guided the process
- Terms of Reference
- Administrative Unit's self-assessment report
- Administrative Unit's impact cases
- Administrative Unit's research groups evaluation reports
- Bibliometric data
- Personnel and funding data
- Data from Norwegian student and teacher surveys

After the documentary review, the Committee held a meeting and discussed an initial assessment against the assessment criteria and defined questions for the interview with the Administrative Unit. The Committee shared the interview questions with the Administrative Unit two weeks before the intervieFollowing the documentary review, the Committee interviewed the Administrative Unit in an hourlong virtual meeting to fact-check the Committee's understanding and refine perceptions. The Administrative Unit presented answers to the Committee's questions and addressed other follow-up questions.

After the online interview, the Committee attended the final meeting to review the initial assessment in light of the interview and make any final adjustments.

A one-page summary of the Administrative Unit was developed based on the information from the self-assessment, the research group assessment, and the interview. The Administrative Unit had the opportunity to fact-check this summary. The Administrative Unit approved the summary virtually without adjustments.

Limitations

The Committee judged the information received through documentary inputs and the interview with the Administrative Unit sufficient to complete the evaluation.

Appendices (link to website)

1. Description of the evaluation of EVALNAT
2. Invitation to the evaluation including address list
3. Evaluation protocol
4. Self-assessment administrative units
5. Grading scale for research groups

Website: https://www.forskningsradet.no/tall-analyse/evalueringer/fag-tema/naturvitenskap/

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