Royal Netherlands
Meteorological Institute
Ministry of Transport, Public Works
and Water Management

Annual report 2009

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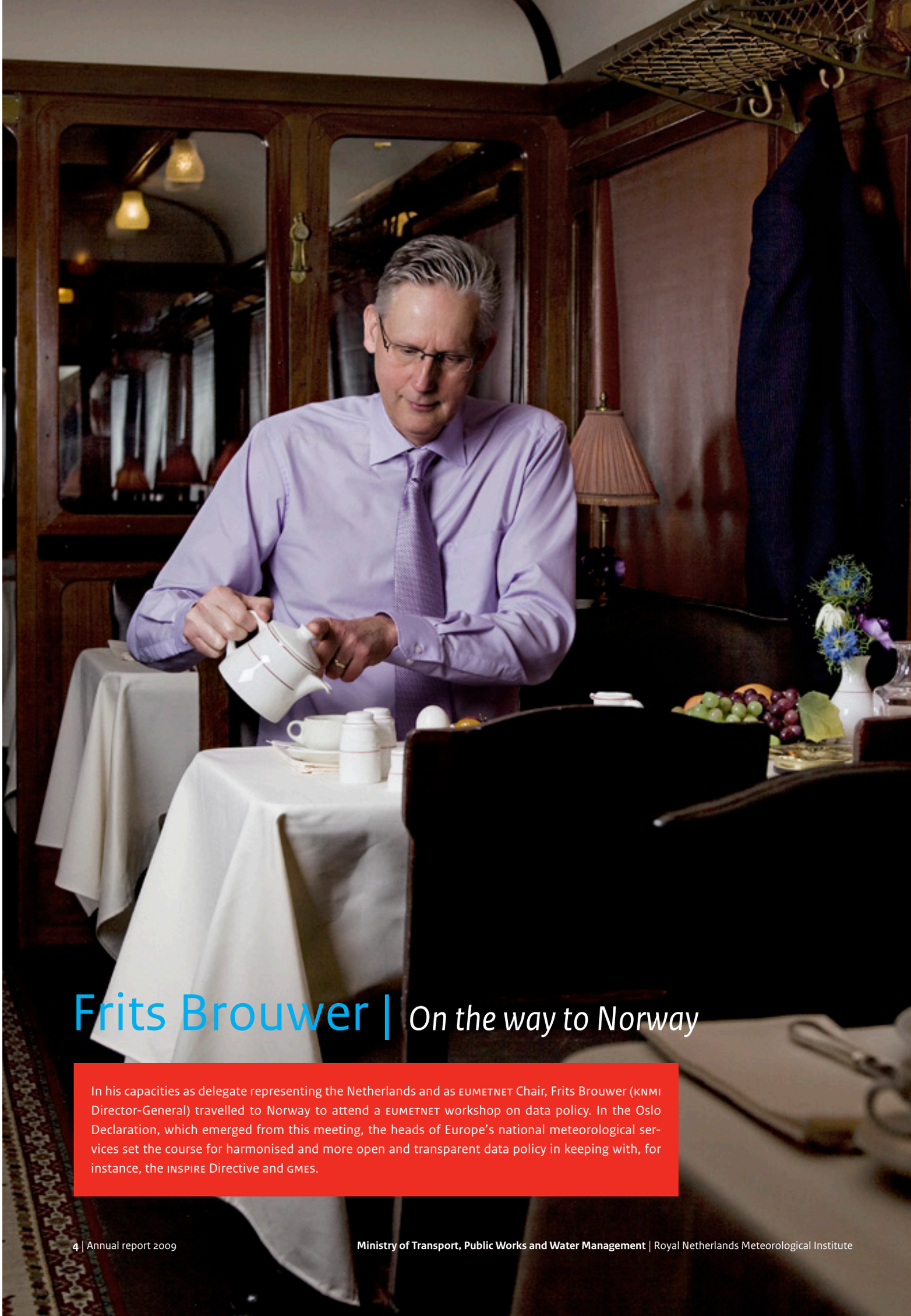


Frits Brouwer | *On the way to Norway*

In his capacities as delegate representing the Netherlands and as EUMETNET Chair, Frits Brouwer (KNMI Director-General) travelled to Norway to attend a EUMETNET workshop on data policy. In the Oslo Declaration, which emerged from this meeting, the heads of Europe's national meteorological services set the course for harmonised and more open and transparent data policy in keeping with, for instance, the INSPIRE Directive and GMES.

Foreword

The KNMI in international context

In meteorological terms, the months under review were some of the most turbulent in recent history: a white Christmas (the first since 1981), an Extreme Weather Warning for snow squalls (the first in history), the coldest winter in 14 years and the snowiest since 1979. What's more, for the first time ever, Dutch airspace was closed as a result of the eruption of the Eyjafjallajökull volcano on Iceland. These phenomena cause significant nuisance and inconvenience across society. The KNMI's core activities include providing effective warnings to the general public about slippery conditions and dangerously low temperatures caused by wind chill and offering specific advice to the authorities on the reopening of Dutch airspace. It's at times like these that the KNMI excels itself. Of course, new technology and advances in science mean that it can do an even better job. As highlighted in this annual report, after ten years of faithful service, the Extreme Weather Warning system was recently revamped, partly in response to questions from the Dutch Lower House.

Although the assessment of the KNMI Act in the spring of 2009 generated a fruitful hearing and debate in the Dutch Lower House, the amended legislation was only recently submitted to the Lower House. We will now have to wait to see what further action the Lower House will take on the subject. In the meantime, a completely open data policy for the KNMI's own data has been successfully implemented. In addition, a superb conference was held on the future of meteorology in the Netherlands, organised to mark the 10th anniversary of the hiving off of the KNMI's commercial activities.

As always, this year's KNMI annual report has a theme. This year it is: *the KNMI in international context*. If there is one discipline that pays no heed to national borders, it is meteorology. A range of interviews in this annual report show how the KNMI is integrated in a variety of international structures, the most important of which are the WMO, the IPCC, the ECMWF, EUMETSAT and EUMETNET. The report also includes features on KNMI staff active at international level and a look at the views held by international organisations on the KNMI's work in Europe and across the world. The obvious conclusion to be drawn is that this international cooperation makes the KNMI's state-of-the-art meteorological services and groundbreaking scientific research possible.

In 2009, the entire world waited in anticipation for the climate conference in Copenhagen and especially for the role that President Obama would play. Despite a highly active run-up to the conference, including the 3rd World Climate Conference organised in Geneva by the WMO, and the positive involvement of various KNMI colleagues in Copenhagen, the result proved rather disappointing. Events such as 'Climategate', in which e-mails sent by British climate researchers were intercepted, did nothing to help matters. The IPCC – with which the KNMI has close associations – were confronted with serious image problems as a result of this and of the discovery of a number of errors in the Fourth Assessment Report.

On a more positive note, a member of KNMI staff received an award as part of the Climate changes Spatial Planning Programme for her work in publicising climate scenarios. According to the jury's report: "The KNMI has also been selected for this award in recognition of its metamorphosis from a relatively closed institution just a few years ago into one which has actively adopted a more open approach in order to ensure the most effective dissemination of climate information in the sector." Anyone who has listened to me over recent years will understand how delighted I am to hear these words.

I therefore trust that this KNMI annual report for 2009 will provide you with a positive impression of the activities of our institute and that, after reading it, you will agree with me that the KNMI has fulfilled its mission to be the leading national institute for climate, weather and seismology and has lived up to its core values (professional, reliable, entrepreneurial and cooperative).

Dr Frits J.J. Brouwer
Director-General KNMI

De Bilt, May 2010

The year 2009 in brief

First quarter: January - February - March

Flags in the house style of the Dutch national government

Central government adopts standard corporate identity: KNMI crown disappears

The new government-wide corporate identity increases the recognisability and accessibility of the Dutch central government to citizens and businesses. All government communications gradually adopt and implement the new corporate identity. January sees the disappearance of the KNMI's own crown logo.

Transfer of HR and financial administration to SSO

On January the first, the KNMI transferred its HR and financial administration to the Shared Service Organisation (SSO) of the Ministry of Transport, Public Works and Water Management (V&W). The transfer has generated efficiency benefits for both the KNMI and V&W/SSO.

KNMI website offers more weather and climate information

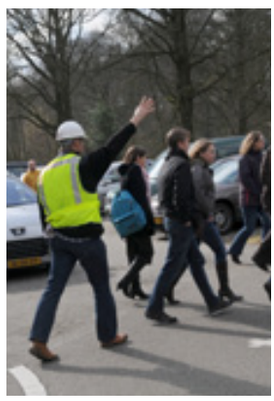
In response to a more open meteorological data policy, the KNMI expanded the weather information offered on its website. Daily observation data, monthly summaries of precipitation and humidity, and precipitation radar images are just a few examples of the information now digitally accessible to everyone.

Fruitful parliamentary hearing on the KNMI Act

On January 22, the Parliamentary Standing Committee for Transport, Public Works and Water Management held a hearing on the assessment of the KNMI Act, guided by the letter submitted to the Lower House by the State Secretary for Transport, Public Works and Water Management, Tineke Huizinga-Heringa, with the assessment conducted by KPMG. Issues discussed included the Extreme Weather Warning system, the division between public and private activities, aviation services, and the procedural aspects of the assessment. The hearing, held in preparation for the debate several weeks later, went well and proved highly constructive.

Cooperation on meteorology and water management in Indonesia

Deltares, the KNMI, and the *Badan Meteorologi Klimatologi dan Geofisika* (Indonesian Meteorological Institute, BMKG) and national water research institute PusAir have signed an agreement for the establishment of a long-term alliance on meteorology, water management, climate change, a flood warning system and a capacity building programme.



KNMI building evacuation.

Visit by German Meteorological Service

The President of the *Deutscher Wetterdienst* (German Meteorological Service, DWD), Dr Wolfgang Kusch, visited the KNMI in mid-February. The KNMI and the DWD both arrange regular visits to discuss the latest national and international developments and potential collaboration in specific areas.

Fog and mist less prevalent in the last 30 years

The number of days with fog and mist in Europe has fallen significantly in the last 30 years. This can largely be attributed to the cleaner air since the 1980s. This was one of the conclusions of research conducted in part by KNMI staff member Geert Jan van Oldenborgh.

KNMI buildings evacuated after carbon monoxide alarm

On the afternoon of Friday, March 6, two KNMI buildings in De Bilt were evacuated for almost an hour-and-a-half due to the level of carbon monoxide, later found to be caused by a short circuit in cabling just outside the premises. Despite the evacuation, service continuity was never under threat. All procedures and back-ups put into place for these types of situations worked effectively. The cause was identified and the problem completely resolved.

International Polar Year a great success

HRH Prince Willem-Alexander and Princess Máxima of the Netherlands marked the end of the International Polar Year (IPY) in Middelburg on March 6. During this successful year, hundreds of new projects were launched and numerous conferences and workshops organised leading to new research. The KNMI was involved in research into the ozone layer, air quality and climate using the Ozone Monitoring Instrument (OMI) on board the NASA EOS-AURA satellite. In addition to research, the IPY focused on knowledge transfer and public awareness of the importance of the polar areas for society.

Second quarter: April - May - June

Tilly Driesenaar, KNMI Works Council Chair.

Productive KNMI conference focusing on cooperation

During the special conference day held on April the first to mark the 10th anniversary of the KNMI's hiving off of its commercial activities, delegates were effectively persuaded that meteorological information can be made more streamlined and specific in nature. As a result of the conference, both customers and providers of weather and climate data plan to engage in even more intensive cooperation.

First woman to chair Works Council

On April 16, the KNMI saw the election of its Works Council's first female chair: Tilly Driesenaar. This is a positive result of the diversity policy launched in 2008. In the space of two years, this diversity policy has resulted in three female managers in addition to a female Works Council chair. The KNMI aims to effectively reflect broader society and evolve in line with the changing labour market.

Drier southern Europe leads to increased warming in western and central Europe

KNMI research has revealed that higher temperatures in the Mediterranean area could in the future also lead to warmer and drier summers in western and central Europe.

The State of the Climate

On April 20, Tineke Huizinga-Heringa, State Secretary for Transport, Public Works and Water Management was presented with the first copy of *De Staat van het Klimaat 2008* (The State of the Climate 2008). The brochure, published by the Platform Communication on Climate Change (PCCC), provides an overview of relevant developments in 2008 relating to the climate, climate change, climate research and climate policy.

New air quality forecasting method launched

The directors of the National Institute for Public Health and the Environment, the KNMI and the Netherlands Organisation for Applied Scientific Research introduced a new method for forecasting air quality in June. The new method enables more efficient forecasting of the timing and duration of smog episodes. Since June the first, KNMI has been producing operational air quality data from the Lotos-Euros model.

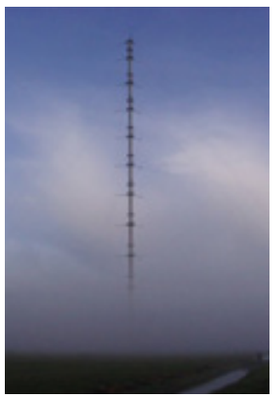
Unveiling of the KNMI sphere.

KNMI sphere in Madurodam

Just a stone's throw from the offices of the Ministry of Transport, Public Works and Water Management in The Hague, the Netherlands' third radar tower was unveiled on Wednesday, June 3. This was made possible by the website *buienradar.nl*, which came up with the idea for a third precipitation radar to monitor the microclimate at Madurodam more effectively.

Twentieth EGOWS meeting hosted by the KNMI

The 20th meeting of the European Working Group on Operational Meteorological Workstations (EGOWS) was hosted by the KNMI in June. The large group of international participants exchanged information about the technical and meteorological possibilities of meteorological workstations (MWS).



KNMI measurement mast in Cabauw.

New climate chamber proves a hit

The KNMI has acquired a new climate chamber for gauging sensors and conducting research into new sensors and measuring systems. The climate chamber will provide more accurate and stable measurements.

Experts discuss transport, air quality and climate

How will the transport sector impact air quality in a changing climate? This was the key question at the international conference of the KNMI and the German Aerospace Institute held in Maastricht and Aachen from June 22 to June 25. The conference was attended by experts from across the world.

International CINDI campaign measures air pollution

More than 30 innovative measurement instruments from across the world were put into action in the months of June and July to measure air pollution above the KNMI measurement mast in Cabauw near Lopik. The measurements were conducted as part of the international CINDI measurement campaign, the main aim of which was to compare and test the various instruments. The news programme *NOS Radio 1 Journaal* featured live coverage. KNMI researchers Pieternel Levelt, Folkert Boersma and Tim Vlemmix were on hand to explain the equipment and the reason for the measurements to listeners.

Third quarter: July - August - September

Extreme Weather Warning attracts record numbers of visitors to website

The Extreme Weather Warning for heavy storms issued on Friday, July 3, attracted a record number of visitors to the KNMI website. On that day, the number of page hits topped 2.9 million! A very high peak was observed half an hour after the Extreme Weather Warning was issued.

Climate satellite construction given the go-ahead

In July, the Minister of Economic Affairs, Maria van der Hoeven, signed an agreement with the European Space Agency for the construction of a new, primarily Dutch satellite. The satellite contains the space instrument TROPOMI, which will record the global distribution of greenhouse gases after its launch in 2014. TROPOMI is a collaborative effort of the KNMI, the Netherlands Institute for Space Research (SRON), the Netherlands Organisation for Applied Scientific Research (TNO) and Dutch Space, which were commissioned by the Netherlands Agency for Aerospace Programmes (NSO).

De Bilt municipal executive visits the KNMI

On Tuesday, July 7, the De Bilt municipal executive visited the KNMI. The KNMI management team received a delegation led by Mayor Gerritsen. Along with the National Institute for Public Health and the Environment (RIVM) and Grontmij, KNMI is one of the most important employers in the municipality of De Bilt.

Climate brochure 2009.

KNMI climate scenarios pass the test

The future climate scenarios published in the Netherlands by the KNMI in 2006 have been tested in line with the latest national and international scientific advances. The results are described in a brochure published in July by the KNMI. This evaluation shows that the climate in the Netherlands is changing significantly and that the KNMI's future scenarios published in 2006 accurately represent the most likely changes.

Storms arrive later than forecast

The heavy storms forecast in an Extreme Weather Warning issued in the morning by the KNMI on August 20 actually arrived at the end of the afternoon, rather than the beginning. The area of showers with heavy storms, hail the size of ping-pong balls and intense localised precipitation primarily hit the country during the evening, leading to press criticism of the KNMI.

World Climate Conference in Geneva

From August 31 to September 4, a major World Climate Conference (WCC-3) was held in Geneva. Around 1500 policymakers from more than 100 countries, including the Netherlands, held talks with scientists about the options for modifications to counter the variability and changes in the climate.

Frits Brouwer with the signed EUMETNET agreement.

The KNMI plays host to EOS-Aura

In September, the KNMI's OMI team played host to the annual EOS Aura meeting. The aim of this meeting is to present scientific results. The results in question have been collected with the help of data from instruments on board the Aura satellite, including OMI.

European meteorological cooperation given major boost

In Brussels on September 17, an agreement was signed to make EUMETNET into an independent legal entity. EUMETNET is the alliance of national meteorological institutes from 26 European countries. The KNMI represents the Netherlands in the alliance, and the KNMI's Director-General currently serves as its chair.

Temperature measurements in De Bilt

Following a report by weather company MeteoConsult, the Dutch Lower House posed questions at the end of September on the reliability of the KNMI's weather measurements in De Bilt. The KNMI had already announced that the measurement mast in question would be relocated, but MeteoConsult had not been informed of the date when this was planned to take place.

Fourth quarter: October - November - December

European funding for cloud research

At the start of October, it was announced that the European Union will provide €3.5 million in funding for the new cloud research programme EUCLIPSE. This research project aims to reduce uncertainties in existing climate models by highlighting the role played by clouds in climate change.

Governing Council of the Ministry of Transport, Public Works and Water Management meets at the KNMI

The Governing Council of the Ministry of Transport, Public Works and Water Management (V&W) held its regular October meeting at the offices of the KNMI. The Governing Council is the consultative body of V&W's administrative management. A special item on the agenda was a discussion of the Extreme Weather Warning system. After the meeting, V&W was given a guided tour of the measuring equipment and various instruments were subjected to a critical evaluation.

Peter Baas charts maximum night-time winds

On pleasant sunny days with calm weather conditions, strong winds regularly develop at a height of around 200 metres during the evenings. KNMI researcher Peter Baas charted the climatology of this phenomenon for the very first time.

KNMI Knowledge Day a success

Releasing the weather balloon on KNMI Knowledge Day.

The KNMI Knowledge Day held in mid-October attracted almost 2000 visitors. KNMI Director-General Frits Brouwer recalls this highly successful event: "This proved the ideal showcase for highlighting the relevance of our institute to society."

The KNMI uses SMOS satellite data

At the start of November, a new European satellite was launched from the Plesetsk Cosmodrome space base in Russia. The Soil Moisture and Ocean Salinity (SMOS) will measure soil moisture and the salt content of the ocean. The KNMI plans to use the data provided by the satellite for research into ocean currents and options for longer-term weather forecasts.

Former KNMI staff updated on events during annual pensioners day

"When I left home this morning, I said I was expecting today to be like a warm blanket," were the opening words of Director-General Frits Brouwer's speech on pensioners day. This image perfectly captures the atmosphere at the annual pensioners day for former KNMI staff. The continued involvement, interest and sympathy for the KNMI of the more than 200 former staff were clearly evident.

DIVA wins GAIA Diversity Award 2009

DIVA, the KNMI's newly established women's network, received the GAIA Diversity Award, which recognises the individual or organisation for their commitment to the career development of women geoscientists and other female scientists. The network has already organised a range of activities for the female staff of the KNMI. DIVA has also established a peer review group. In addition, DIVA perfectly complements the diversity plan and has ensured that KNMI policy focuses more actively on the recruitment and appointment of female managers.

KNMI host for ECOMET

In November, the General Assembly of ECOMET held its 29th assembly at the KNMI. ECOMET is the Economic Interest Grouping of European national meteorological services. The representatives of almost all ECOMET countries attend meetings chaired by the Director-General of the Norwegian Meteorological Institute, Anton Eliassen. The meetings are attended by representatives of the secretariats of ECOMET and EUMETNET and by a representative of EUMETSAT.

Observations subjected to external review

At the request of the KNMI Council, the short-term weather forecast observations (excluding EUMETSAT) conducted by the KNMI were subjected to an external review. The review committee issued useful recommendations that will be incorporated in a new national observation system (NOS) to be used for meteorological and climatological observations. Although the committee did identify certain areas for improvement, its overall judgement was that the method used by the KNMI to make its observations effectively guarantees high quality.

Copenhagen Climate Conference.

The KNMI arranges presentations at Climate Conference in Copenhagen.

In December, the World Climate Conference was held in Copenhagen. In order to provide specific scientific information to support negotiations, the KNMI gave a range of different presentations about its climate related findings. The presentations were held in the Holland Climate House and covered such areas as satellite measurements of greenhouse gases, the climate of the 21st century and customised climate services.

Siebe Riedstra, the new Secretary-General of the Ministry of Transport, Public Works and Water Management.

New Secretary-General Siebe Riedstra visits the KNMI

The new Secretary-General of the Ministry of Transport, Public Works and Water Management, Siebe Riedstra, visited the KNMI on Thursday, December 17. This visit was part of a tour to become acquainted with all government services and agencies. Riedstra succeeds Wim Kuijken, who was appointed Delta Programme Commissioner.

Vidi subsidy for KNMI ozone researcher

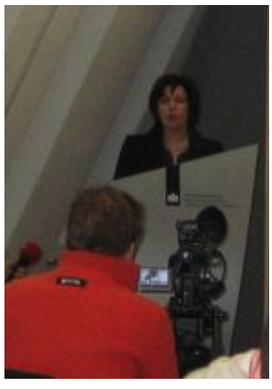
The Netherlands Organisation for Scientific Research (NWO) awarded a Vidi grant to the KNMI's Dr Folkert Boersma to conduct research into ozone gas as an air pollutant and a greenhouse gas.

New: wind-chill reports during especially cold weather

During moderate to severe frosty conditions, it feels a lot colder in the wind than it actually is. Whenever frost and wind combine to make it particularly cold, the KNMI began reporting both the wind-chill and the air temperature in early December.

New Extreme Weather Warning more effective

The New Extreme Weather Warning improves the quality of warnings and the way in which they are compiled. This was confirmed at the end of December by the State Secretary for Transport, Public Works and Water Management, Tineke Huizinga-Heringa, during the presentation of the new Extreme Weather Warning, effective as of February 1st, 2010, in the KNMI building in De Bilt,.



Tineke Huizinga during the launch of the new Extreme Weather Warning.

A white Christmas

The KNMI was able to add another white Christmas to its records. On Boxing Day morning, there was 4 cm of snow in De Bilt, and on Christmas Day there was actually 9 cm. This officially made Christmas 2009 the first white Christmas since 1981.

WMO appoints ECA&D project as Regional Climate Centre

The WMO has appointed the European Climate Assessment & Dataset (ECA&D) project, which is coordinated by KNMI, as Regional Climate Centre (RCC) for Europe and the Middle East. The appointment is seen as recognition of the significance the WMO places on the contribution made by the project's activities towards climate monitoring. An RCC is a Centre of Excellence that WMO members in a specific region support through the provision of climate products and services.

Interview | Steve Noyes

Joining forces in meteorology

"One of the programmes run by the KNMI is OPERA, a European radar network and one of the crown jewels of EUMETNET."

Instant access at any moment to information on when and where in Europe dangerous or extreme weather can be expected. This is made possible by the website www.meteoalarm.eu. It is just one of the concrete results of EUMETNET, the network of European weather services, in which the KNMI plays an instrumental role. This is not only because it is chaired by KNMI's Director-General Frits Brouwer. "The KNMI plays a leading and highly proactive role within EUMETNET."

"EUMETNET has 26 members, of which KNMI is just one," says Steve Noyes, secretary of the alliance. "But some members play a more active and leading role than others. The KNMI is clearly one of the more active and proactive members. It is responsible for running a range of programmes and is represented in various working groups. One of the programmes run by the KNMI is OPERA, a European radar network and one of the crown jewels of EUMETNET. The KMNI also plays a leading role when it comes to earth observation. In addition, it provides significant input at strategic and policy level."

That's quite surprising when you consider the other major players such as the UK, France and Germany. What do you think?
"Absolutely. Those three countries play a significant role within the alliance, but ultimately it is about cooperation, which means making compromises. That involves sometimes having to give way on certain issues. At times like that, it is useful to have a proactive member in our midst which – while smaller – actually proposes effective alternatives. In strategic and diplomatic terms, that works extremely well. In this respect, Frits Brouwer's work is crucial. It is his job to get all the different parties to engage in discussion. When required, he also doesn't mince his words. Although this can prove counter-productive with certain people, Frits is able to adopt a direct approach, without getting people's backs up. That is quite impressive. The KNMI is thoughtful, daring and dynamic."

How important is EUMETNET's work for Europe?
"There is a lot of demand for meteorological services within Europe. The forces united within EUMETNET contribute towards better quality and more accurate weather forecasts and increased understanding of climate change. All EU Member States benefit from this. From a political perspective, EUMETNET is also a powerful weapon. When required, we can raise issues on the political agenda. This applies within the European Commission, but also in the other countries associated with EUMETNET. EUMETNET strengthens the European approach both in practical and political terms. We complement each other and take optimum advantage of each other's knowledge and experience. United we stand!"

In conclusion, are there any improvements you would like the KNMI to implement?
"The KNMI is not always fully aware of the power it has as a relatively small member. As said, the institute exerts considerable influence within EUMETNET. I sometimes have the impression that they do not fully realise this. This could be an area for improvement. There is a lot of political manoeuvring behind the scenes, in which the KNMI can also exert some pressure. It does that already to a certain extent, but it could raise its profile in this role."

What is EUMETNET?

EUMETNET was founded in 1996 as an informal alliance of the national meteorological institutes of 26 countries. The KNMI represents the Netherlands. Its main purpose is to ensure that the basic objectives of the services offered are as effective and efficient as possible by means of close cooperation. EUMETNET is partly responsible for the development of the website www.meteoalarm.eu, the European weather alerts platform.

In September 2009, an agreement was signed in Brussels to create an independent legal entity for EUMETNET, the EUMETNET-EIG, governed by Belgian law and with its own separate EUMETNET Assembly. In December 2008, the KNMI's Director-General Frits Brouwer was appointed EUMETNET chair. He was also elected chair of the new EUMETNET-EIG.

An Economic Interest Grouping (EIG) is an independent legal entity which can enter into agreements with other parties. It is similar in nature to a foundation, but specifically intended for economic activities. Thanks to this EIG status, the European Commission can enable Europe's joint meteorological institutes to carry out projects. These might include projects relating to climate research or those that enable Europe to act in the event of emergencies or natural disasters. Thanks to this new legal status, EUMETNET can now provide a better service to the European Commission. It also improves the efficiency of EUMETNET's internal organisation. In alliance with the European Centre for Medium-Range Weather Forecasts (ECMWF) and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), EUMETNET now constitutes a powerful European meteorological infrastructure. This should ultimately lead to better quality and more accurate weather forecasts and increased understanding of climate change.

KNMI conference

KNMI Day focuses on needs of weather service providers and weather users

More weather information at local level. Specific climate data for wind turbines. Accurate weather forecasting for the very short term. The KNMI conference, held on April the first, revealed quite an impressive wish list from weather service providers and users.

Exactly ten years after the unbundling of the KNMI through the hiving off of its commercial arms, Director-General Frits Brouwer was eager 'to give something back to society'. The result was a conference held in Fort Voordorp in De Bilt. The more than 200 attendees were undeterred by the fact that the conference was held on April Fool's day. They played an active part in discussions and during the breaks were even able to enjoy the spring sunshine.

The Conference was well-attended, both by the demand and supply side.

The lectures and concluding debate revealed that the increasing options offered by meteorology have in turn led to an ever-increasing demand. Of course, everyone in the weather and climate sector knows that meteorological data is important for all manner of applications. However, this conference cemented the realisation that this information can be made even more streamlined and specific. Both users and providers of weather and climate data need to be fully aware of what the other party has to offer and needs.

Faster and more detailed

This is particularly true of new users of weather and climate products. The KNMI is often not yet fully aware of their needs. For example, in order to use wind energy, a great deal of knowledge about the wind at a height of 100 meters is required, and this often involves different information from that included in weather forecasts or provided to the aviation sector.

Frits Brouwer acknowledged that he was aware of the issue: "In previous decades, the KNMI knew what was good for society. But nowadays, we need to listen more to what society needs." The weather and climate information needs to be made available faster, more easily and more freely. For example, the Royal Dutch Touring Club ANWB is demanding additional and more detailed short-term weather forecasts, regional broadcasters need to know the exact time that showers will hit their region and the Dutch cancer society *KWF Kankerbestrijding* is lobbying for the inclusion of sun intensity levels in the weather forecast. Unfortunately, it is not possible to please everyone all of the time. The weather and climate sector does have its limits, but is certainly making good progress.

Climate scenarios

KNMI climate scenarios pass the test

The future climate scenarios published in the Netherlands by the KNMI in 2006 have been tested in line with the latest national and international scientific advances. In August, the KNMI presented the results to State Secretary Huizinga, which show that the climate in the Netherlands is changing significantly and that the KNMI's future scenarios published in 2006 accurately represent the most likely changes.

Climate scenarios are cohesive snapshots of the future climate, indicating the extent to which temperature, precipitation, wind and sea levels might change. They form the basis for measures to be taken to enable society to adapt to climate change as effectively as possible. Examples of such measures include improved flood defences, more effective drainage systems and modifications to buildings to combat excessive heat in urban areas.

Climate scenarios not only differ from weather forecasts in terms of the time horizon (usually 50 to 100 years, rather than 10 days), but also in the type of information they provide. Weather forecasts provide information about a specific day (e.g. the likelihood of rain tomorrow), whereas climate scenarios outline the average weather conditions and the likelihood of extreme weather over an extended period (e.g. the extent to which the likelihood of extreme precipitation or flooding will have increased by 2050).

Faster than forecast

Recent international research has revealed that the large ice caps in the Western Antarctic and Greenland are collapsing quickly, the Netherlands and Western Europe are heating up fast and the intensity of extreme showers is increasing. Some of these changes to the climate are taking place faster than expected. Despite this, the four KNMI climate scenarios published in 2006 still appear to be completely accurate. How is this possible? In drawing up the climate scenarios, certain recent developments were anticipated and uncertainties were also taken into account. This is why the changes remain largely within the margins of the scenarios.

Interview | Dominique Marbouty

Unity and cooperation is our motto

"The KNMI is part of the group that sets the standard in a variety of areas, including climate, atmosphere and air traffic. This ultimately benefits our model."

For its weather forecasts, the KNMI uses the computer calculations from the European Centre for Medium-Range Weather Forecasts (ECMWF). For its part, the KNMI supplies the ECMWF with satellite information on the ozone layer, for example. The ECMWF processes this information in a model that enables accurate and detailed forecasts on the state of the ozone layer. Dominique Marbouty, ECMWF Director-General, is very positive about the 'excellent interaction'.

Virtually all European weather institutes use the ECMWF weather calculations for their forecasts. This requires optimum cooperation. How would you assess the collaboration with all these institutes in recent years?

"Extremely positively. By making the best use of each other's strengths, we actually reinforce each other. The various institutes provide the best possible input. This in turn enables us to develop the best possible forecasting system. Ultimately, we need each other. There are no overlaps and we certainly do not tread on each others' toes. It would be extremely inefficient if every country were to develop its own model. It would also not benefit the resulting level of quality. Basically, you need the information and data from our partners and users in order to create a comprehensive and accurate forecasting system. The level of unity we've achieved works extremely effectively and has proven beneficial for everyone involved."

What does ECMWF-KNMI cooperation actually entail?

"As I said, we maintain a good relationship with all our partners and users. To a large extent, we are driven by what they want. We listen carefully to them and give our users every opportunity to indicate their preferences. Over the last five years, we have had some very good and usable suggestions from the KNMI to make our forecasting system more comprehensive. One example of this is in the area of early warnings. The KNMI is also active in the development of downstream applications, in particular using our ensemble prediction system. The KNMI provides us with satellite information relating to ozone and reactive gases. The KNMI is part of the group that sets the standard in a variety of areas, including climate, atmosphere and air traffic. This ultimately benefits our model. Another positive aspect about working with the KNMI is that it does all it can to prevent overlap. The KNMI is committed to cooperation and actively pursues this."

Diplomacy is essential. Is that a correct assumption?

"Absolutely. ECMWF is an international organisation with staff from all over Europe. This requires accepting and benefitting from different cultures. Without diplomacy, certain things would be extremely difficult to achieve. The KNMI's Director-General Frits Brouwer fully understands that and is a master of diplomacy."

Is there anything you would like to see improved in the collaborative venture with KNMI?

"As I said, I am very impressed with the way the cooperation works. Of course, there is always room for further improvement. I am thinking in particular of EUMETNET, the alliance of the national meteorological institutes in 26 countries, which KNMI chairs. There could be further improved cooperation between EUMETNET and the ECMWF, particularly as regards the further development of the high-resolution applications we really need. We could also benefit more from each other's expertise. The chairman could play a significant role in that."

What is the ECMWF?

The European Centre for Medium-Range Weather Forecasts (ECMWF) is an intergovernmental European organisation based in Reading, just outside London. Founded in 1975, the organisation has since grown into being the world leader in global numerical weather prediction . A total of 32 countries are (associated) members or cooperating members of the ECMWF, including Belgium (KMI) and the Netherlands (KNMI).

The ECMWF develops computer models that process meteorological data and mimic the behaviour of the atmosphere. It also makes computer facilities available to Member States and provides education to researchers and meteorologists. For several years, the ECMWF has been experimenting with seasonal forecasts.

The ECMWF's supercomputer system is one of the most powerful in the world. It has a peak performance of 325 trillion calculations per second. The data it uses comes primarily from satellites but also from land-based weather stations, buoys at sea, weather ships, aircrafts, weather balloons and radar systems. The number, completeness and accuracy of the observations are of crucial importance for the resulting quality of the products offered. The various results produced are used by meteorologists to develop medium-term weather forecasts.

The ECMWF forecasting system has recently experienced significant qualitative improvements. Forecasts two days ahead now have a reliability of over 95%. By comparison, 100% reliability would completely reflect the actual weather. If the forecast is for four days, the score is slightly below 90% and the five-day forecast is usable in 80% of cases. A modern five-day forecast is just as reliable as a two-day forecast was in the seventies.

The KNMI Act

Hearing and debate about the KNMI Act prove fruitful

On January 22, the Parliamentary Standing Committee on Transport, Public Works and Water Management, chaired by Christian Democrat (CDA) Rikus Jager, conducted a hearing on the assessment of the KNMI Act. The debate with the State Secretary was held a few weeks later in the Dutch Lower House and proved fruitful.

In addition to the chair, four other Members of Parliament from the Christian Democrat (CDA), Labour (PvdA), Liberal (VVD) and Socialist (SP) parties also participated in the hearing. The committee had invited the KNMI, the Dutch Coast Guard, Air Traffic Control the Netherlands (LVNL), the Royal Netherlands Air Force and a number of key market players, including MeteoConsult, WeerOnline, Buienradar and popular weather forecaster Piet Paulusma. Director-General Frits Brouwer responded to questions on behalf of the KNMI.

The mood of the hearing was both positive and constructive, focusing on the letter submitted to the Lower House by the State Secretary for Transport, Public Works and Water Management, Tineke Huizinga-Heringa, and the assessment conducted by KPMG. Issues discussed included the Extreme Weather Warning system, the division between public and private activities, aviation services and the procedural aspects of the assessment. The hearing served as preparation by the Lower House for the General Consultation (debate) held in February with the State Secretary.

Positive assessment

The debate held in February went well. The conclusion was that in recent years the KNMI had been successful in carrying out its tasks as outlined in the KNMI Act. The assessment highlighted the fact that the Netherlands had succeeded in developing a flourishing private weather market and was the first country in Europe to do so. This meant that it achieved the objective set in the Act by giving the private weather market the space it needs to be able to develop as an equal and mature player in the Dutch market. There is, however, a need for improved consultation between the KNMI and private weather agencies to reach agreement on new services. The Cabinet intends to put forward a proposal in this regard. During these consultations, agreements can also be made about warnings of extreme weather and the use of the Extreme Weather Warning system. According to the assessment, the Extreme Weather Warning is a government duty that must be provided exclusively by the KNMI since the information must be targeted as clearly as possible at citizens.

Other recommendations

The assessment also proposes that the KNMI should, as is currently the case, be the only party given responsibility for issuing meteorological information to aviation, because, as in other European countries, guaranteeing safety in aviation is a government responsibility.

The assessment also included a proposed exception for meteorological information for helicopter flights to drilling platforms. This position was not adopted by government. The Cabinet was of the opinion that in view of aviation safety this service should also remain one of the KNMI's public tasks.

The Ministry of Transport, Public Works and Water Management also established the meteorological consultative body *(Overleg Meteo)*. This body operates as a platform for consultation between policy and market players and is coordinated by its independent chair Menno Knip, former Mayor of Almelo. In 2009, *Overleg Meteo* had discussions about the new KNMI Act and updates to the weather warning system. In 2010, meetings of *Overleg Meteo* will be organized as needed.

Frits Brouwer speaking at the hearing.

CINDI measurement campaign

Air pollution over the Netherlands investigated

More than 30 innovative measurement instruments from across the world were put into action in the months of June and July to measure air pollution above the KNMI measurement mast in Cabauw near Lopik. The measurements were conducted as part of the international CINDI measurement campaign coordinated by project manager Ankie Piters. The primary aim of the Cabauw Intercomparison Campaign for Nitrogen Dioxide Measuring Instruments (CINDI) was to compare and test the various instruments. The measurements will also be used for research into the source and distribution of air pollution and greenhouse gases.

Thanks to its location, the KNMI measurement mast in Cabauw is ideal for international measurements. The flat landscape, rural environment, proximity to both urban areas and highways, the Dutch climate and the measurement mast's excellent facilities make this an ideal research setting. The changing wind direction means the measurement location is exposed alternately to clean air (from the sea) and polluted air (from the Ruhr Area in Germany).

Measurements from a single location

The unique feature of this measurement campaign is that air pollution could be charted to a height of several kilometres by various different instruments simultaneously. Above and around the 213 metre KNMI measurement mast, the newly developed measurement equipment used optical remote-sensing technology to identify nitrogen dioxide, formaldehyde, particulate matter and ozone. CINDI has now set the standard for these types of innovative ground-based measurements. By applying this standard, air quality in Japan, for example, can now be measured in the same way as in Spain or the United States.

Air quality forecasts

The measurements will also be used to test and improve the observations from space made by the KNMI with the satellite instruments OMI, SCIAMACHY and GOME-2, which collect data used to compile air quality forecasts. These forecasts have been developed by the National Institute for Public Health and the Environment (RIVM), the Netherlands Organisation for Applied Scientific Research (TNO) and the KNMI and are posted on the Internet by the National Institute for Public Health and the Environment on a daily basis.

What is CINDI?

CINDI is an international measurement campaign for the development of a single standard for pollution measurements. The CINDI campaign was a joint initiative of the KNMI, the National Institute for Public Health and the Environment, the Belgian Institute for Space Aeronomy (BIRA), the University of Bremen, European Space Agency, NASA, the ACCENT and GEOMON EU projects and the Network for the Detection of Atmospheric Composition Change.

Interview | Klaus Sturm

Overcoming borders

"The KNMI makes invaluable contributions to various areas of meteorology, including research, development and innovation. MET Alliance is more than happy to enjoy the fruits of this work."

Although the weather pays no heed to state borders or dividing lines, European airspace is still divided according to national borders. From a meteorological perspective, this is far from an efficient solution. The introduction of Single European Sky will mark a significant step forward. In order to avoid becoming lost in that sizeable entity, the meteorological organisations serving air traffic in some Western European countries have decided to join forces in MET Alliance, at a later stage followed by Germany and France. Klaus Sturm, who works for the German Meteorological Service (DWD) and currently chairs MET Alliance, is quite impressed by the contribution made by the KNMI.

How do the KNMI and the DWD cooperate?
"The two organisations have enjoyed a relationship of close cooperation and mutual trust for quite some time, and these ties continue to intensify. We collaborate on a range of issues and shared services at a high level. This will prove crucial for Single European Sky which calls for combined forces, harmonised processes and the breaking down of national borders."

"Air traffic is highly dependent on weather conditions," continues Sturm. "This dependency is growing as European airspace becomes increasingly congested. The solution is continued innovation and robust, standardised systems. If countries attempt this individually, the intended improvements will never be achieved. Such far-reaching collaboration also has the benefit of significantly reducing costs. In the past, the various national institutes made huge investments in infrastructure, leaving scarce funding for development. That's another reason why joining forces as the MET Alliance is so crucial. It will result in a joint, European model which we can all use."

MET Alliance prioritises on education and training. Can you explain this?
"Forecasting weather conditions for aviation is specialist work. The limited number of these kinds of specialists makes training and education crucial. We want to achieve a standardised qualification that transcends national borders. People often jokingly say that if you ask two meteorologists for a weather forecast, you end up with three different forecasts. Without putting too fine a point on it, that can lead to awkward airspace situations. MET Alliance is committed to harmonised processes and products and this also applies to training and qualifications. If everyone applies the same standards and processes in their work, there will be fewer fluctuations in the result."

There was some controversy about Germany and France joining MET Alliance. How is the alliance progressing now?
"The founders were concerned that if these major nations joined up, certain things would be overruled. This mistrust has now been overcome. Everyone understands the importance of working together and acknowledges that we must not attempt to dominate each other. We need to be ready for Europe by 2012. That is our shared objective. We need to grow together by sharing and combining our knowledge, experience, expertise and infrastructure. There is no room for domination or resistance. As soon as I see anything like that happening, I will not hesitate to deal with it."

Finally, what is your opinion about the KNMI?
"It is an extremely modern, efficient and well-organised institute. The KNMI operates in a competitive environment. In the Netherlands, there are various commercial organisations competing with the KNMI, which can pose problems. As a relative outsider, I think it actually keeps the KNMI on its toes. The KNMI makes invaluable contributions in various areas of meteorology, including research, development and innovation. The parties affiliated in the MET Alliance, including the DWD, can only benefit from that. I am also

What is MET Alliance?
On January 11 2005, a significant milestone was reached in European aviation meteorology. On that day, the directors of the meteorological organisations responsible for air traffic in Austria, Belgium, Switzerland, Ireland and the Netherlands set up MET Alliance. The cooperation agreement was signed at the KNMI offices in De Bilt. At that time, the organisations involved were Austro Control, Belgocontrol, MeteoSwiss, Met Éireann and the KNMI.

MET Alliance has an important role to play in maintaining and increasing air safety and will also be instrumental in increasing the capacity and effectiveness of the air transport system, taking environmental aspects into account. The latter will be achieved by delivering optimised meteorological services for air traffic, made possible by the efficient use of the combined available resources of the affiliated organisations. The countries involved collaborate on data traffic, weather forecasting for aviation, research, training and quality management. Organisations in France and Germany have also recently joined the alliance and Luxembourg is prospective member. Klaus Sturm, who works for the German Meteorological Service, currently chairs MET Alliance.

impressed by the way in which the KNMI raises the Dutch public's awareness of such issues as climate change and its potential consequences. This is essential, and the KNMI is helping achieve it both nationally and internationally. In Germany, we could learn some very useful lessons from that."

Single European Sky

A project of the European Commission, Single European Sky aims to unify the fragmented European airspace into a cohesive whole. The Netherlands is part of the Functional Airspace Block Europe Central (FAB-EC), which covers the Benelux, France, Germany and Switzerland. The key objective of joint European airspace is to increase safety, efficiency and capacity for aviation whilst reducing the fragmentation and complexity of the airspace. It also provides a framework for system modernisation and cost reductions for the users of European airspace.

All members of the MET Alliance Steering Committee.

Frank Lantsheer | *On the way to Denmark*

The purpose is to attend the meeting of the ECOMET General Assembly (GA). The management body of Ecomet, the GA, meets twice a year to decide on such issues as the provision of meteorological data in Europe. As an ECOMET member, the KNMI has a voice in determining policy. The decisions are prepared in part by the ECOMET Working Group of which I am a member.

Climate Conference

The KNMI plays active role at 15th climate conference in Copenhagen

The 15th UN Climate Conference (COP, Conference of the Parties), held from December 7 to December 18 in Copenhagen, was intended to result in new global climate agreements. Combating rising temperatures, adapting to a changing climate and providing support to developing countries were the key issues under discussion at the COP.

In Copenhagen, the KNMI joined forces with various Dutch knowledge institutes and government to present a range of internationally relevant climate issues. A KNMI representative took part as a delegate on the theme Research and Systematic Observation. During COP15, the Holland Climate House played host to daily presentations and lectures on Dutch research results, practical examples and climate and energy initiatives which were attended by politicians, negotiators, policymakers and the media.

The main hall in Bella Centre.

Dutch delegates

In addition to the KNMI, delegates from the Netherlands included the Ministry of Transport, Public Works and Water Management, the Ministry of Housing, Spatial Planning and the Environment, the Netherlands Environmental Assessment Agency, Deltares, TNO, Alterra, the Knowledge for Climate and Climate Changes Spatial Planning research programmes, Utrecht University, Watercycle Research Institute KWR, the Cooperative Programme on Water and Climate (CPWC), Eneco, the Association of Provincial Authorities (IPO), the Association of Water Boards, Rotterdam Climate Initiative, the Energy Research Centre of the Netherlands (ECN) and the Institute for Environmental Studies (IVM).

No legally binding agreement

The result of Copenhagen is an agreement which has been adopted by the developed countries and emerging economies and of which many developing countries have also taken note. This means that it is not a legally binding agreement, but it does have political significance as a formal part of the negotiating process under the auspices of the United Nations.

Fund

It was agreed that a fund will be established for poor countries facing the consequences of climate change. In the initial period from 2010 to 2012, wealthy nations will be expected to invest a total of €21 billion in the fund. The text of the agreement also states that the countries will strive to draft a legally binding document at the next climate summit in December 2010. It will aim to set a target of limiting global warming to 2°C.

At COP15, the KNMI gave the following presentations:

- Satellite measurements of greenhouse gases
- Customised climate services
- The climate in the 21st century
- Climate science updates
- An investigation of 13 uncertain climate developments

The Dutch delegation could count on declaration of support.

The central Hall where heads and deputies of different countries gave speeches and proclaimed views.

Interview | Henk Cor van der Kwast

Ministry of Foreign Affairs and the KNMI work together as a government agency

"We are taken seriously at international level and for good reason: the knowledge and expertise we have at our disposal thanks to the KNMI."

The KNMI has been actively involved in the Nuclear-Test-Ban Treaty (CTBT) ever since its inception. Since the signing of the CTBT in 1996, seismologist Hein Haak has been advising the Dutch Ministry of Foreign Affairs and the CTBT Organisation (CTBTO) on the technical and scientific aspects of the control mechanism underpinning the treaty – to the full satisfaction of everyone involved.

"Truly excellent," states Henk Cor van der Kwast, Head of the Non-proliferation, Disarmament, Arms Control and Export Control Policy Division, clearly indicating his assessment of the alliance with the KNMI. He is referring in particular to the contribution made by seismologist Hein Haak. "As soon as anything happens or we need specific information, we know exactly where to go."

Such incidences arise, for instance, when a country conducts a nuclear test, as North Korea did in October 2006. "Within half an hour, Hein Haak was able to tell me the exact power of the explosion, based on his seismological measurements," explains Van der Kwast. "When it comes to this kind of crucial information, we do have lines of communication with the CTBTO. These contacts are sometimes less efficient because outgoing information has to go through a variety of different processes. The KNMI can immediately provide the data that is relevant to us."

What happens to the data you receive?

"One way in which the information is used is to help determine the Dutch political and diplomatic position with regard to the nuclear test. We also take into account information from other countries. The political statement we ultimately issue is largely based on KNMI data."

Aside from political and diplomatic circles, is the alliance with the KNMI also important in terms of national and international awareness?

"For many people, the CTBT is highly complicated. What exactly does it mean? What are its implications? And why is it so important? In answering these kinds of questions, Hein Haak's role is invaluable, especially when it comes to explaining the CTBT to foreign delegations. To some extent, I could do that myself, but I am too closely tied to the policy. Hein Haak's position is much more neutral. He is also better equipped to explain the technical aspects of issues."

Does this mean that on this point the KNMI and the Ministry are acting as a single government agency?

"Absolutely. It has to be that way. The Netherlands is a small to medium-sized country with limited weight in terms of power, but in this area we are a significant player. Take, for example, the role 'we' played in the development of the CTBT and the global verification system (CTBTO). In that respect, we do much more than might be expected of the Netherlands – thanks largely to the collaborative partnership with the KNMI. We are taken seriously at international level and for good reason: the knowledge and expertise we have at our disposal thanks to the KNMI."

How important is the alliance with the KNMI in terms of global security?

"Very important. The alliance strengthens our ability to ensure monitoring of and compliance with the CTBT. Its impact is global. With the exception of North Korea, there has been no other nuclear testing in almost 20 years. Thanks to the detection system, the test in North Korea was detected immediately. It came as an enormous shock. Even countries with ambitions to develop nuclear weapons are careful about conducting tests. They understand that every test will be immediately detected and will have political and diplomatic repercussions. In addition, for some years now, the system has also been used in the tsunami warningsystem. We cannot prevent disasters, but the system does enable countries to effectively anticipate threats."

What is the Comprehensive Nuclear-Test-Ban Treaty?

The Comprehensive Nuclear-Test-Ban Treaty (CTBT) aims to prohibit all nuclear testing. The CTBT arose in 1996 under the leadership of the Dutch Ambassador Jaap Ramaker. Since then, a large number of countries have worked on a technically advanced global verification system to monitor compliance with the CTBT. Although 176 countries have now signed the CTBT, it can only be enforced after all 44 countries listed in a special annex to the CTBT have signed and ratified it. The Netherlands signed and ratified the treaty in 1999. However, some countries, including India, Pakistan, Iran, the USA and Israel, have for various reasons neither signed nor ratified the treaty.

The verification system consists of 321 observation stations, spread across the globe at equal intervals to conduct measurements of radioactivity and monitor noise and seismic activity in the atmosphere and oceans. At the request of the Ministry of Foreign Affairs, the KNMI is part of the international alliance that developed the verification system.

KNMI opens its doors

KNMI Knowledge Day

The KNMI Knowledge Day held on October 17 attracted almost 2000 visitors. KNMI Director-General Frits Brouwer recalls this highly successful event: "This proved the ideal showcase for highlighting the relevance of our institute to society."

The Knowledge Day was organised as part of Dutch Knowledge Month in October, as part of which more than 160 knowledge institutions from across the country opened their doors to the public. The KNMI also planned a large number of activities, showing visitors, for example, how

weather balloons are released. They also had the opportunity to release a weather balloon themselves, take observations and carry out experiments, find out the weather on their date of birth and discover more about seismology, tornadoes and how meteorologists compile forecasts.

Calls for a repeat event

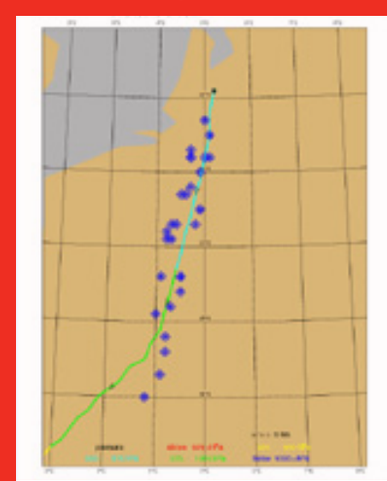
The lecture series, which addressed such topics as the Extreme Weather Warning, climate change, the wind-chill factor in winter and earthquakes, also proved enormously popular. Many visitors called for the KNMI to organise the open day more often.

The KNMI opens its doors

The KNMI Knowledge Day was organised as part of Dutch Knowledge Month in October. Throughout the day, the general public was invited to visit the KNMI and find out more about the many areas the KNMI's work encompasses.

Numerous activities were also organised for children. There was a puzzle trail across the KNMI site, during which children had the opportunity to find out what air pressure is, how windy it is, how quickly they could blow, how earthquakes develop, how rainbows arise, how warm the water in the KNMI pond was and what types of clouds that they could see in the sky. Of course, they also had the opportunity to help release the KNMI weather balloon.

A great deal of interest was generated by the competition in which children were asked to guess where they thought their helium-filled balloon would end up. A computer program was available to provide assistance in this. The winner of the balloon competition, Tom Kokkelkoren from Bilthoven, was given a guided tour of the KNMI with his classmates and was allowed to visit the weather chamber. The illustration shows the route followed by his balloon.



Delta Programme

Facing the threat of water

There is nothing in the world more soft and weak than water, and yet for attacking things that are firm and strong, there is nothing that can take precedence over it. These words of the Chinese philosopher Laozi date from 600 BC. In order to ensure that water in the Netherlands is never given the opportunity to demonstrate its devastating power, work on the Delta programme continued in earnest throughout 2009.

The aim of the Delta programme is to protect the Netherlands from floods in the longer term and to safeguard fresh water supplies. The Delta Act is the legal basis for this programme and was submitted to the Dutch Lower House on February 1, 2010. The Act and the associated Delta Fund and Delta programme are based on the advisory report *Samen werken met water* (Working with Water), compiled by the Delta Committee, chaired by former minister Veerman. The Delta programme has an integrated structure, which means that alongside the central government (with the Ministry of Agriculture, Nature and Food Quality, the Ministry of Housing, Spatial Planning and the Environment and the Ministry of Transport, Public Works and Water Management as lead agencies), other government authorities (provincial and municipal authorities and water boards) are also involved in the programme. Knowledge institutes such as the KNMI and the business community will play a leading role in the implementation of the Delta programme.

The KNMI and the Delta programme in 2009

The KNMI was intensely involved in the drafting of the National Water Plan (NWP). Much of the knowledge on which this plan is based originates from the KNMI scenarios. The NWP is the first implementation plan for the Delta programme and was adopted by the Cabinet in December 2009. The plan outlines central government policy for achieving sustainable water management during the 2009-2015 period. The NWP addresses issues as flood protection and the availability of sufficient clean water. The plan also includes a timeline indicating the areas on which important decisions will need to be made and detailing when the KNMI will need to publish new climate scenarios.
The KNMI was in regular contact with the Delta programme coordination team. The KNMI participates in the Delta programme knowledge network group and in working groups responsible for providing specific details of the programme. A key feature of these details will be the Delta model, which will be largely based on the KNMI climate scenarios. The KNMI held regular consultations in 2009 with users, knowledge institutes and policymakers.

The climate scenarios and the Delta programme

As a follow-up to the climate scenarios presented in 2006, the KNMI is currently working on a new series of climate scenarios which should be published in 2013. The KNMI is working in close consultation with various Dutch institutes responsible for water management and water related research. Intensive contact was held with the Directorate-General for Public Works and Water Management's *Waterdienst* (Water Agency) and with Deltares.

The Delta model and the Delta programme

The KNMI also worked actively on the Delta model. The model is intended to provide an array of instruments that will identify the consequences of and provide direction for policy decisions within water management in the next 10 to 30 years with an ultimate 100-year horizon. Alongside the Welfare, Prosperity and Quality of the Living Environment (Welvaart en Leefomgeving, WLO) scenarios developed by the Netherlands Environmental Assessment Agency, the KNMI scenarios will form the basis for this model. The model will be developed on the instructions of the ministries involved (the Ministry of Housing, Spatial Planning and the Environment, the Ministry of Agriculture, Nature and Food Quality, the Ministry of Economic Affairs and the Ministry of Transport, Public Works and Water Management) and will be coordinated by the Ministry of Transport, Public Works and Water Management and was commissioned by the Directorate-General for Public Works and Water Management (DGW). Within the Delta model, the KNMI and WLO will be linked. This will prove difficult in practice, in terms of developing consistent (socio-economic) future perspectives and in translating the information for the subareas within the Delta programme. The Delta programme knowledge network group aims to achieve effective coordination between the preferences of the subareas and the Delta model products. This means that one of the key tasks of the KNMI will be to maintain close contact with policymakers and the end-users of the scenarios in order to ensure that the data is correctly interpreted and applied and that the correct data is supplied. The key task for the subareas is to compile an action plan and the knowledge agendas and to ensure that these are effectively structured. This will call for empathy and active involvement from both sides.

Interview | Domenico Giardini

Unity in a highly fragmented discipline

"How should we interpret all the incoming data? Is there a genuine risk of damage by an earthquake in a certain area? These are the types of issues the KNMI actively addresses."

The KNMI plays a leading role in many aspects of the work of Observatories and Research Facilities for European Seismology (ORFEUS). "The KNMI is an important and active proponent in encouraging various international institutes to adopt common standards for seismological data collection, interpretation and provision," says Domenico Giardini, Director of the Swiss Earthquake Research Centre.

In the world of seismology, collaboration is perhaps the central maxim. Why is this so essential?

"Effective standards and complete data sets are only possible with close collaboration. Collecting and analysing data on an individual basis is simply not feasible. Effective and well-coordinated communication and cooperation are required."

"This is the idea behind ORFEUS," according to Giardini, "This type of organisation prevents data from not going further than local or national databases. It would otherwise be impossible to access key data. Compiling data from all over the world is the only way to develop an accurate and complete view of any given situation. Major international centres, such as ORFEUS, are a necessity. They enable us to identify risks and issue warnings to the world in a timely manner, making it possible to implement preventive measures in the face of a looming threat that ultimately benefit public safety. Moreover, it achieves unity in a highly fragmented discipline. While each country has its own priorities – after all, the risk of earthquakes in the Netherlands does not compare with the risk in Italy – incorporating information from neighbouring countries at the national level is a key aspect of an effective comparative assessment.

How important is the KNMI's role in this?

"In many ways, it is crucially important. In addition to housing the ORFEUS data and service centre (ODC), the KNMI makes a significant financial contribution to ORFEUS. The KNMI also plays an active role in ORFEUS' national and international monitoring activities. How should we interpret the available data? Is there a genuine risk of earthquake in a certain area? These are the types of issues the KNMI addresses. In addition, the KNMI actively encourages various international institutes to adopt common standards for data collection, interpretation and provision. This is why I feel the KNMI plays a leading role in ORFEUS."

Are you pleased with how the KNMI's fulfils its role?

"Very much so. Without the KNMI's contribution, ORFEUS would be less able to set standards. The KNMI is well equipped to do the job, with skilled personnel, an efficient administration and good instrumentation. The KNMI is the leading meteorological and seismological authority in the Netherlands. Particularly with regard to seismological monitoring and other assessment, it doesn't have to compete nationally with other institutes, such as universities. This makes it easier for the KNMI to have a strong international presence."

How would you assess the KNMI in a more general sense?

"The institute I head in Switzerland is comparable to the KNMI, but it focuses exclusively on seismology. The scope of the KNMI's activities is much more extensive. I'm less familiar with its work in meteorology. I am well aware that this prolific institute produces solid results. I regularly come across KNMI documents and reports and I have observed its substantial contribution in the GEO framework. I can't really make any substantive statements other than that the work of the KNMI is

What is ORFEUS?

Non-profit organisation, ORFEUS (Observatories and Research Facilities for European Seismology) is the European data, service and coordination centre for seismic observations and seismological research.

The organisation was founded in 1987 and operates under Dutch law. Since 1993, the ORFEUS offices have been located in De Bilt within the Seismology Department of the KNMI. The data centre (ODC), which processes, archives and distributes digital seismic data from stations in the participating European countries, constitutes the ORFEUS foundation's core activity. For the most part, the data and services are supplied online both via ORFEUS (www.orfeus-eu.org) and through a broader-based partnership via the web portal www.seismicportal.eu. Coordination is achieved mainly by organising working groups and conferences and arranging large-scale EC infrastructure projects.

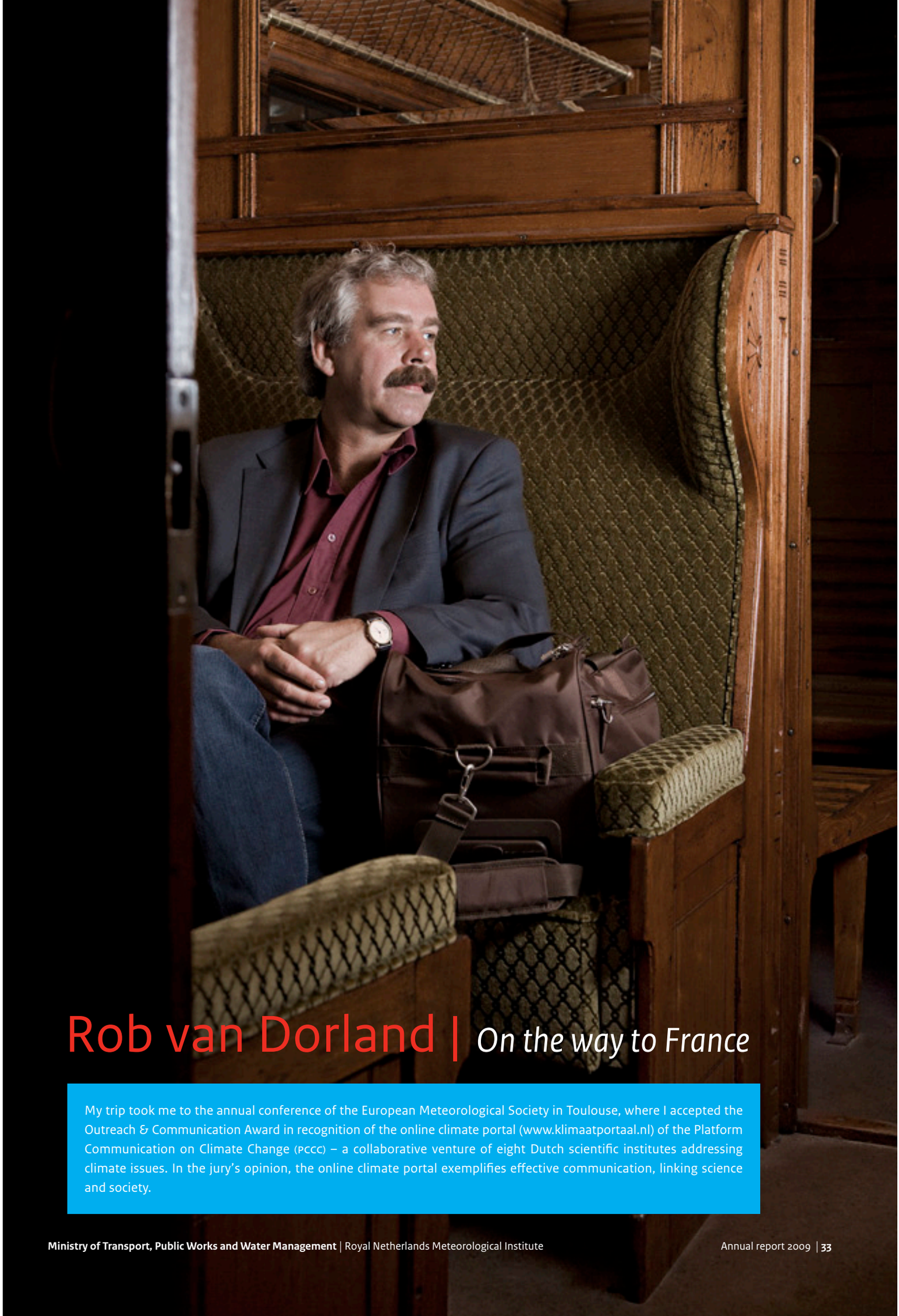
In 2006, the EU Network of Research Infrastructures for European Seismology (NERIES) project was initiated under the management of the KNMI, with ORFEUS as coordinator. This project aims to integrate European research institutes and observatories into a single European research infrastructure for seismological data, thereby making earthquake data quickly and easily available for research and public awareness. The initial results were achieved in 2007. Currently, the data of more than 500 broadband seismographic observation stations can be accessed online.

authoritative. As far as its work in seismology is concerned, however, the KNMI is a rock solid institute both nationally and internationally."

The earth has been relatively active in recent months, to say the least. Could this have been predicted?

"While we cannot forecast precisely where and when an earthquake will strike, it is possible to identify high-risk areas based on our data. This can serve as the basis for preventive measures, such as earthquake-resistant construction techniques. In short, while it is impossible to predict the exact time and location of an earthquake, it is within our power to minimise its consequences. Consider, for example, the February 2010 earthquake in Chile, with a magnitude of 8.8 on the Richter scale. That is large. Even in the Netherlands the tremor was very well recorded. Despite the tremendous force of the earthquake, the number of fatalities – nearly 800 – was relatively low."

Havoc by the earthquake in L'Aquila, Italy, April 2009.



Rob van Dorland | *On the way to France*

My trip took me to the annual conference of the European Meteorological Society in Toulouse, where I accepted the Outreach & Communication Award in recognition of the online climate portal (www.klimaatportaal.nl) of the Platform Communication on Climate Change (PCCC) – a collaborative venture of eight Dutch scientific institutes addressing climate issues. In the jury's opinion, the online climate portal exemplifies effective communication, linking science and society.

Orations, PhDs and Awards

Robert Leander's PhD thesis on the river Meuse

On May 7, Robert Leander successfully defended his PhD thesis 'Simulation of precipitation and discharge extremes of the river Meuse in current and future climate' in the University Hall *(Academiegebouw)* in Utrecht.

The river Meuse is the second-largest river in the Netherlands and is characterised by significant variations in water discharge. What is known as a resampling method was developed in order to estimate the extreme discharge risk levels. The method uses historic precipitation and temperature data series to generate long-term series with comparable statistical characteristics (variability, spatial correlation, persistence and medium-term precipitation totals). A precipitation-discharge model makes its calculations on the basis of these river discharge data series. The resampling method is particularly useful because it does not require any explicit assumptions for estimations of precipitation statistics in advance. For part of the Meuse river basin, an alternative resampling algorithm capable of generating larger daily precipitation totals was also tested. The difference between the two algorithms appears to have little consequence on the simulated discharge extremes.

Regional climate models

In order to investigate the effects of climate change on extreme discharges in the river Meuse, this method was also applied on the output of regional climate models (RCMs) for both the control climate (1961-1990) and for a potential future climate for the SRES scenario A2 (2071-2100). Changes in extreme medium-term precipitation and extreme wintertime discharge (when high water is more likely) seemed to be less dependent on the regional model than on the general circulation model (GCM) which affects the regional model at the periphery. One of the two GCMs in question does suggest a significant increase in extreme discharges.

Scenario simulations

The scenario simulations influenced by the other GCMs show little change in extreme discharges. The combination of resampling, applied to the output of RCMs, and precipitation discharge helps provide an understanding of the possible consequences of climate change for extreme discharges in the river Meuse. The systematic deviations within the climate models and their correction will, however, require careful examination. In this, the variation in precipitation is just as important as average precipitation levels. Since the influential GCMs play such a dominant role in changes to extreme wintertime discharges, this uncertainty is best represented by model simulations based on as many different GCMs as possible.

Peter Baas awarded PhD for work on maximum night-time winds

On October 14 2009, Peter Baas defended his PhD thesis, 'Turbulence and Low-Level Jets in the Stable Boundary Layer', at Wageningen University & Research Centre.

At night, wind levels close to the ground tend to drop. What is less known, however, is that the wind can actually increase significantly at a height of several hundred metres. This usually happens during nice weather, when the verti-

cal profile of the wind speed shows a clear maximum. This phenomenon is known as the night-time wind maximum (NWM) or low-level jet. Knowledge of low-level jets is useful for aviation, wind energy generation and air pollution distribution. Peter Baas' PhD thesis details the climatology for the characteristics of low-level jets (including their frequency and the typical height at which the phenomenon occurs) for the KNMI measurement site in Cabauw.

The development of low-level jets depends heavily on the level of turbulence in the night-time boundary layer. Peter Baas tested various ways of modelling the turbulence and discussed different strategies for evaluating the models. The aim of this thesis is to increase understanding of physical processes and improve the way in which these are reflected in weather and climate models.

Pier Siebesma, coordinator of EUCLIPSE European cloud research programme

The EU has earmarked € 3.5 million for the new EUCLIPSE cloud research programme. This was announced on October 7 by EUCLIPSE coordinator Pier Siebesma in his inaugural address as part-time professor in the Clouds, Climate and Air Quality section at Delft University of Technology. This research aims to reduce the uncertainties in existing climate models by highlighting the role played by clouds in climate change.

The KNMI is one of the participants in this European programme, launched in December 2009 with a new global climate model, EC-Earth. Professor Pier Siebesma is the coordinator of the EUCLIPSE programme and is an associate of both the KNMI and Delft University of Technology. In addition to Delft University of Technology and the KNMI, ETH Zurich and the German Max Planck Institute are also involved in the research.

A-train

A new generation of satellites, known as the A-train, is set to play a key role in the research. This train of satellites is equipped with active radar and lidar systems, which make it possible to generate three-dimensional cloud images for the first time. The satellite observations and the results of the high-resolution models will be used to subject the climate models to critical testing. This will make it possible to improve the way in which the models factor in the clouds and to rank the models in terms of their ability to represent the clouds in our atmosphere.

Sjoukje Philip: El Niño will not intensify

The intensified greenhouse effect is unlikely to cause El Niño to become more intense. This is the claim made by Sjoukje Philip in her thesis 'Exploring El Niño mechanisms in climate models', which she defended at Utrecht University at the end of November.

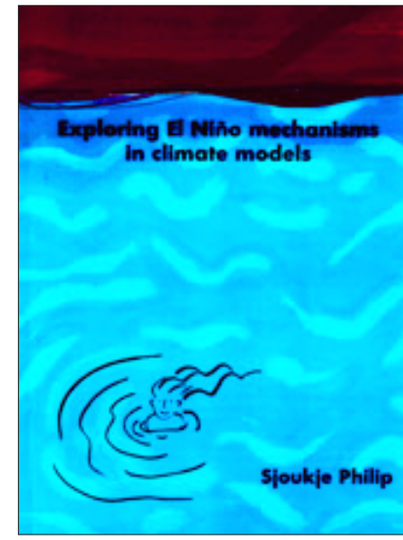
From 2005 to 2009, Sjoukje Philip conducted research at the KNMI into climate model predictions of El Niño. The research is part of the NWO's Earth and Life Sciences (ALW) programme on Climate Variability. She ascertained that El Niño influences the weather in large parts of the world, which means that an accurate prediction of how El Niño is likely to behave in the future is extremely important. The research showed that some climate models already provide a fairly realistic representation of El Niño. These models do not show any significant changes. "Although the climate is changing in lots of different ways, the effects on El Niño cancel each other out, so the total impact is actually quite small," says Sjoukje Philip.

Rising seawater temperatures in the Pacific Ocean

Climate models are the most important tool used to predict average weather conditions far into the future. El Niño is the Earth's largest natural climate fluctuation and is the term used to describe the rising seawater temperatures in the Pacific Ocean that occur once every three to seven years. As such, El Niño holds the key to monthly and seasonal forecasts and also makes it possible to predict the consequences of weather conditions, such as persistent drought or excessive rainfall.

Changing character

In the longer term, it is important to know how global warming will change the character of El Niño: is El Niño likely to become more or less intense? The research reveals that the changes in El Niño will probably be slight compared to the natural fluctuations in the weather. Other effects of climate change are much more important.



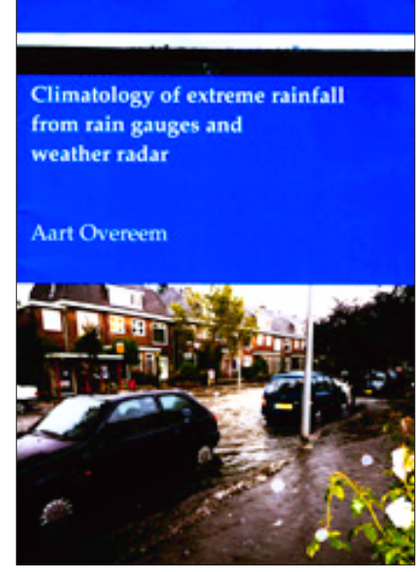
Climate models

Sjoukje Philip investigated whether the impact of El Niño described in the models actually corresponds with reality. Warmer seawater generally cools down relatively quickly. With El Niño, a slight deviation of just a few degrees can persist for several months because the rising temperatures also affect the wind. This means that during El Niño, the winds bring in warmer water, preventing colder water from rising from deep in the ocean. The fact that there are more frequent storms above the warm waters of an El Niño also appears to play a significant role. Climate models have now been developed to such a level that some are capable of representing these factors reasonably accurately. These models predict that the essential character of El Niño will not change during this century.

Aart Overeem: use KNMI precipitation radar to determine extreme precipitation

The KNMI's precipitation radar images, used in weather forecasting, are also useful for determining the likelihood of extreme levels of precipitation. This is according to Aart Overeem in his thesis 'Climatology of extreme rainfall from rain gauges and weather radar', which he defended at the Wageningen University & Research Centre on December 4.

Extreme precipitation events significantly impact everyday life and can cause material damage and even injury or death. This is why reliable statistics of extreme precipitation are vitally important, for example, for the design of drainage systems. The statistics can be used to extrapolate the average precipitation that could fall in one hour's time at a specific location once every 50 years.



Long-term datasets

Long-term datasets are required to determine the probability distribution of precipitation extremes. This is usually based on rain gauge data. However, there are very few datasets available which can be used to determine quantities over a short duration, such as a quarter of an hour. Rain gauges are located at specific sites, but for effective water management, it is important to be able to determine the likelihood of precipitation over larger areas.

Latest information

The KNMI precipitation radars provide the latest information on precipitation intensities across the whole of the Netherlands every five minutes. For his research, Aart Overeem constructed a 10-year archive of radar images, corrected with the help of data from rain gauges. Each image covers more than 6000 measurement sites over the land surface of the Netherlands. This kind of long dataset opens up new possibilities for generating statistics on extreme precipitation, especially for brief periods of precipitation like 15 minutes for which only limited measurement data is available. Regional differences can also be charted better than ever before.

The research was conducted at the KNMI in alliance with Wageningen University's Hydrology and Quantitative Water Management Group. The doctoral research post held by Aart Overeem was established in 2004 by the State Secretary for Transport, Public Works and Water Management to mark the KNMI's 150th anniversary.

Folkert Boersma investigates links

The Netherlands Organisation for Scientific Research has awarded a Vidi grant to the KNMI's Dr Folkert Boersma for research into ozone as an air pollutant and greenhouse gas.

Folkert Boersma is one of the 89 innovative young scientists awarded a Vidi grant by the Netherlands Organisation for Scientific Research in 2009. The grant will enable him to develop his own line of research and a research team over a five-year period. The research will focus on ozone, an air pollutant that is damaging to human and animal health and vegetation. Ozone is also an important greenhouse gas.

Ozone: the big unknown

Ozone is a natural constituent of the Earth's atmosphere, but its concentrations are increased by human activities. Air-polluting nitrogen oxides and hydrocarbons interact with sunlight to form ozone. However, our knowledge of ozone remains limited, because of the complexity of this process and the rapidly changing emissions of nitrogen oxides and hydrocarbons. In addition, the existing measurement network of ozone instruments is not sufficient to provide an accurate impression of changing ozone concentrations.

Satellite measurements

Boersma's Vidi project aims to improve the situation through the use of satellite measurements, including those conducted by the instruments OMI and TROPOMI, which are coordinated at a scientific level by the KNMI. The main advantage of satellite measurements is their global coverage and the fact that they provide a consistent picture of the changing atmosphere.

Satellite measurements of nitrogen dioxide will be used to provide a better estimation of nitrogen oxide emissions from industry and transport, but also from natural sources such as lightning. Satellite measurements of formaldehyde, a hydrocarbon compound which plays a key role in the formation of ozone, will also be used to provide an improved understanding of the biogenic emission and chemistry of volatile hydrocarbons.

Calculations

By extrapolating the measurements taken during the last ten years, it is possible to gain a good impression of trends in emissions caused by human activities and natural variability. Boersma: "By including improved knowledge of ozone precursors in the models, we can also improve our understanding of the changes in the ozone budget in space and time. This will ultimately enable us to trace the natural and human-influenced sources of ozone pollution down to the finest detail. It will prove useful to policymakers for determining the most effective strategies for counteracting ozone pollution."

Boersma's research project is being conducted in alliance with Eindhoven University of Technology.

International award for climate portal

During the European Meteorologists Conference held in Toulouse at the start of October, Platform Communication on Climate Change (PCCC) received the EMS Outreach & Communication Award for its website *klimaatportaal.nl*.

KNMI climate researcher Rob van Dorland, chairman of the PCCC's scientific editorial board and secretary of its steering group, accepted the award in Toulouse. Van Dorland: "The Award is highly appreciated and is received as acknowledgement of the team of scientists involved in the PCCC."

Bridge between science and wider society

The European Meteorological Society (EMS) jury considers the website an excellent example of communication bridging the gap between science and wider society. The climate portal is the digital gateway to Dutch knowledge institutes providing integrated access to the latest knowledge on climate, climate change and its consequences, adaptation options and migration measures for policymakers, the business community, special interest groups, the media and the general public.

The climate portal is managed by the PCCC, a cooperative alliance between the KNMI, the Netherlands Environmental Assessment Agency, the Netherlands Organisation for

Scientific Research, Wageningen University & Research Centre, VU University Amsterdam, the Energy Research Centre of the Netherlands (ECN), Utrecht University and Deltares.

Perfect example

The PCCC also received praise in the January 2008 issue of *Nature Geosciences* ('From climate assessment to climate services') as a perfect example of an information network offering integrated knowledge about international climate research on a single website.

Flemish government awards Spits award to Nature Simulator

The KNMI shared the honour of winning the Flemish government's Spits prize for innovation, awarded by the Flemish Research Institute for Nature and Forest (INBO). Along with the Royal Meteorological Institute of Belgium and the Catholic University of Leuven, KNMI employees Arie Kattenberg, Geert Lenderink, Janette Bessembinder, Alexander Bakker and Jules Beersma developed the climate scenarios for the prize winning Nature Simulator project.

The Nature Simulator consists of a large number of computer models, each of which generates future projections. What is the situation likely to be with regard to population, spatial planning and the climate in 30 years'

time? The researchers tried to highlight a range of factors that have a significant impact on the development of nature and woodlands: how will we live, what forms of transport will we use and what different ways will we find of using the land?

Different scenarios

The Nature Simulator is used to make calculations, such as how the number of swallows changes in different scenarios. What will happen if policy remains unchanged? What would be the consequences of a spatial separation policy? This would involve farmers doing nothing about the natural environment and prohibiting the use of motorbikes or quad bikes in natural reserves. Integrated land use is a third option, as part of which farmers ensure that there is space for larks and allow their livestock to graze in natural reserves. The Nature Simulator is a kind of long-distance time machine that takes into account as many factors as possible and can extrapolate a number of realistic natural scenarios. It provides a glimpse of the possible future.

Janette Bessembinder and the KNMI receive KvR Pluim award

On the projects day of the Climate changes Spatial Planning Programme *(Klimaat voor Ruimte, KvR)* held on October 30 2009, Janette Bessembinder was singled out for the KvR Pluim award in recognition of her efforts on behalf of the KNMI in communicating climate information and scenarios.

In recent years, Janette Bessembinder has devoted a large amount of energy to assisting users in selecting or interpreting these scenarios. She also provides regular feedback to KNMI researchers on questions posed by users.

"The KNMI was praised by the jury for its metamorphosis from a relatively closed institution just a few years ago into one which has actively adopted a more open approach in order to ensure the most effective dissemination of climate information in the sector."

Scientific publications

As a scientific institute, the KNMI produces many publications. The year 2009 also saw hundreds of publications in the form of theses, presentations, articles, scientific reports, technical reports and internal reports. These publications are available via the searchable database on the KNMI website. Below we highlight two examples.

Fog and mist less prevalent in the last 30 years

The number of days with fog and mist in Europe has fallen significantly in the last 30 years. This can largely be attributed to the cleaner air since the 1980s. This reduction in mist may have made a small, but measurable contribution to warming in Europe. This is the conclusion reached by the KNMI's Geert Jan van Oldenborgh and by Robert Vautard and Pascal Yiou from the French research institute for climate and environment in their article '*The decline of fog, mist and haze in Europe during the last 30 years; a warming amplifier?*' published in *Nature Geoscience* in early 2009.

The scientists analysed visibility measurements from 342 meteorological stations in Europe. Their analysis showed that the number of misty days has fallen by half since 1980. The reduction is greatest in those areas in which air pollution has fallen the most. Because mist and fog protect against the sun's rays, the cleaner air indirectly causes an increase in daytime temperatures. Reduced mist and fog does not impact night-time temperatures.

Global warming

The researchers estimate that the 50% reduction in the number of misty days may account for 5 to 10% of warming in Europe. This research therefore only explains a relatively small part of accelerated warming. If the reduction in mist is taken into account in calculations, the warming is still faster than the climate models indicate. In addition, the reduction in the number of misty days has slowed since 2000, as it has become more difficult to make further improvements to air quality. For this reason, the researchers also expect the influence of reduced mist on warming will gradually disappear.

Warming intensified by drier southern Europe

A study conducted by the KNMI's Reindert Haarsma, Frank Selten, Bart van den Hurk, Wilco Hazeleger and Xueli Wang has revealed that future higher temperatures in the Mediterranean area could also result in warmer, drier summers in western and central Europe. The increased heat in southern Europe means that the winds in western and central Europe are more likely to come from the east bringing with them hot and dry continental air.

Climate model simulations demonstrate this shift to a more continental climate in western and central Europe. The KNMI researchers have shown that this is caused by the strong increase in temperatures in countries around the Mediterranean.

This increase is caused primarily by the drying out of Mediterranean soil as a result of reduced precipitation during the winter. Consequently, warming resulting from the greenhouse effect and drought are intensifying each other. It is expected that the summer temperatures in the Mediterranean area will increase by 2°C to 3°C more than the global average temperature in the future.

However, this climate research reveals nothing about the potential weather conditions in upcoming summers. This is a long-term analysis (i.e. through to 2100) based on climate models that show an increase in easterly winds. However, there are also climate calculations that show no such change in wind direction. For this reason, the KNMI uses various climate scenarios with and without changes in the wind.

Ankie Piters | *On the way to Switzerland*

Destination: GEOMON General Assembly. Forty European research institutes collaborate as part of GEOMON to analyse and harmonise greenhouse gas and air pollution measurement data and to make them centrally available. The KNMI contributes to atmospheric modelling and satellite measurements, as well as the measurement data facility in Cabauw, which is one of the European super sites. This annual meeting brings together those who do the painstaking data measurement work and the users. It is wonderful to see how these groups learn from each other.

Interview | Noer Hayati

The KNMI helps with DiDaH project Indonesia to secure its data

"Ultimately, we plan to make as much data as possible available to the international community. There is a very good reason why this project has gained worldwide recognition."

Corporate social responsibility is high on the KNMI's policy agenda, as exemplified by the Digitisasi Data Historis (DiDaH) project. A collaborative joint venture involving the KNMI and the Office for Meteorology, Climatology and Geophysics (BMKG) in Indonesia, the DiDaH project aims to digitise the Indonesian climate data series back to 1870. This development is so significant because digitised data can make serious climatological research possible.

This is not the first time the KNMI and the BMKG have worked together. The two meteorological institutes have been collaborating on a range of issues since 1999, including projects relating to water management and climate change. The KNMI and the BMKG are also cooperating on a flood warning system. In all these areas, both countries have much in common. Both the Netherlands and Indonesia are densely populated deltas facing rising sea levels and soil subsidence.

Launched in July 2009 when the project plan was signed, the DiDaH project involves the digitisation of historical climate data about Indonesia. Noer Hayati works for the BMKG and is the project manager on the Indonesian side: "By doing this, we are making it possible for the scientific world to conduct research into climate change. But we are also increasing our understanding of the characteristics and nature of climate data about Indonesia."

Making research possible

"All the climatological data about Indonesia, which originates from the colonial era, is owned by the KNMI," continues Noer. "We now plan to digitise these data. As Indonesia is situated in a region where such data is limited, the information is of major significance for climate research. Digitised data can make serious climatological research possible and is also important to both the economy and public safety. Furthermore, it will increase our understanding of climate change and our ability to anticipate its impact.

Worldwide recognition

All digital observations are stored in a database. During the project, both the KNMI and the BMKG have full access to all input, enabling them to carry out rapid and efficient analyses. "When the project is completed, we plan to make as much data as possible available to the international community. There is a very good reason why this project has gained worldwide recognition by the WMO."

Knowledge transfer

In addition to data digitisation, the project also facilitates significant knowledge transfer, particularly with regard to the use of digital data. "Examples include a workshop on Data Rescue and Climate Index. There are also exchanges between scientists in the two countries and knowledge-sharing initiatives."

Participants to the workshop in Bogor, December 2009.

Sustainable water management in Indonesia

At the end of January 2009, Deltares and the KNMI signed an agreement with the Indonesian meteorological institute BMKG and the Indonesian water research institute PusAir. The agreement focuses on meteorology, water management, climate change, a flood warning system and a capacity-building programme (2010-2015).

The agreement was signed in the presence of Dutch State Secretary for Transport, Public Works and Water Management (Tineke Huizinga), the Dutch ambassador and the Indonesian Director-General of the Ministry of Transport and Water Management. One of the main reasons for Huizinga's visit to Indonesia was to strengthen cooperation between both countries with regard to water management, good governance and climate change.

The Dutch and Indonesian research institutes – Deltares and PusAir – have been working closely together since the 1970s and jointly developed the basic structure for water management in Indonesia. The KNMI and the BMKG have been collaborating since 1999. Their joint efforts are of crucial importance for ensuring more sustainable water management in Indonesia.

Facts and figures

Annual weather summary 2009: 13th consecutive warm year

For meteorologists, 2009 was an unusual and interesting year. January and December were cold, presenting plenty of opportunities for fun on the ice. April was the second warmest for three centuries and the other months were all warmer than normal. The average annual temperature in De Bilt was 10.5°C compared to a long-term average of 9.8°C. This made 2009 the 13th warm year in a row.

January: finally a chance to skate again

The year started off cold. With an average temperature of 0.8°C in De Bilt, compared to a normal average of 2.8°C, January was the coldest since January 1997. For the first time in years, skating was possible for an extended period, although the popular *Elfstedentocht* ice skating marathon could not be held. The cold wintry weather that started during Christmas 2008 lasted until January 10. During this period, there were moderate to severe night frosts. Above the snow cover in some places in the south-east of the Netherlands, there were even four nights of extremely severe frost (lower than -15.0°C). The lowest national temperature of 2009, -20.8°C, was recorded on January 6, in Ell in Limburg during a cloud-free night above a deep layer of snow.

Summer in April

A cold January was followed by ten months of above-average temperatures compared to the long-term average. With an average monthly temperature of 12.2°C in De Bilt, compared to a long-term average of 8.3°C, April 2009 was the second mildest April since records begin in 1706. The mildest April in more than three centuries of records was actually just two years ago, when the average temperature in April 2007 was 13.1°C. Particularly during the middle of the month, the temperature was regularly five to ten degrees higher than normal. April was also a very sunny month with a national average of 226 hours of sun compared to the normal figure of 162. In most places, this month ended up ranking among the ten sunniest Aprils in over a century.

Spectacular night-time storms

In the night of May 25 to May 26, heavy storms hit large sections of the country and were accompanied by unusually active lightning. A total of around 75,000 lightning strikes were recorded. Locally, there were also wind gusts up to 105 kph. In the area around Woensdrecht, five-centimetre hail stones were reported. Between 40 mm to more than 50 mm of rain was recorded in some places in an area extending from Zuid-Holland to the Noordoostpolder. The storms wreaked havoc and caused significant damage.

Three Extreme Weather Warnings issued in 2009

The first Extreme Weather Warning of the year was issued on July 3, when mainly the north of the country was under threat of storms, bolts of lightning, hail and wind gusts. The second Extreme Weather Warning was issued on August 20, due to extremely heavy wind gusts of up to 110 kph. The third and final Extreme Weather Warning was issued on Sunday, December 20. On this day, heavy snow fall led to serious problems.

Extreme heat on August 20

It was the ninth warm summer in a row. Throughout most of the summer, the weather from day to day proved highly variable. There were no long periods of beautiful, warm weather or periods of cool, wet weather. During the night of August 19 to August 20 and during the day on August 20, there was a short lasting area of extremely warm air over the country. In some places, the night-time temperature did not drop below 20°C, an exceptional occurrence for the Netherlands. On August 20, nearly the entire country was subjected to tropical temperatures (i.e. maximum temperature of at least 30°C). The highest temperature in the country (37.0°C) was recorded again in Ell in Limburg. For most KNMI stations, the maximum temperatures recorded on that day were the highest since records began, which often go back anywhere from 50 years to more than a century.

One of the mildest autumns in a century

The autumn proved extremely mild, with an average temperature of 11.7°C in De Bilt, compared to the normal 10.2°C. The autumn of 2009 was the third mildest autumn since 1901. Only the autumns of 2005 and 2006 were milder, with average temperatures of 12.0°C and 13.6°C, respectively. November was particularly unusual. With an average temperature of 9.5°C compared to the normal of 6.2 °C, November 2009 was the third mildest November since 1706. The period from 13 November to 25 November was exceptionally mild. The average daily temperature of more than 10°C during this period was five to seven degrees higher than normal for this time of year. These temperatures are generally recorded during the first half of May.

December: more ice skating and lots of snow

From mid-December onwards, it was cold and a lot of snow fell. On December 17 and December 18 in the area between the tip of Noord-Holland and Groningen, there was a total of between 10 cm and more than 30 cm of snow. On Sunday, December 20, large sections of the central and southern part of the country received between 10 cm and 20 cm of snow. On the same day, the snow reached thicknesses exceeding 40 cm in some areas. Just before and during Christmas, it rained and the snow melted relatively quickly everywhere. Despite this, on both Christmas Day and Boxing Day there was still snow cover in De Bilt, making this the first white Christmas since 1981.

Sunshine

It was an extremely sunny year with a national average of 1888 hours of sun compared to the normal figure of 1550. The sunniest areas were in the vicinity of the Wadden Sea and Zeeland. The KNMI weather station in Vlissingen recorded 2032 hours of sun, De Kooy 2031. In Den Helder, this year made it the second sunniest year since 1908 and in Vlissingen the third sunniest since records began in 1907. The weather station in Arcen recorded the lowest number of hours of sun: 1659. De Bilt recorded 1838 hours of sun compared to the normal figure of 1524.

Precipitation

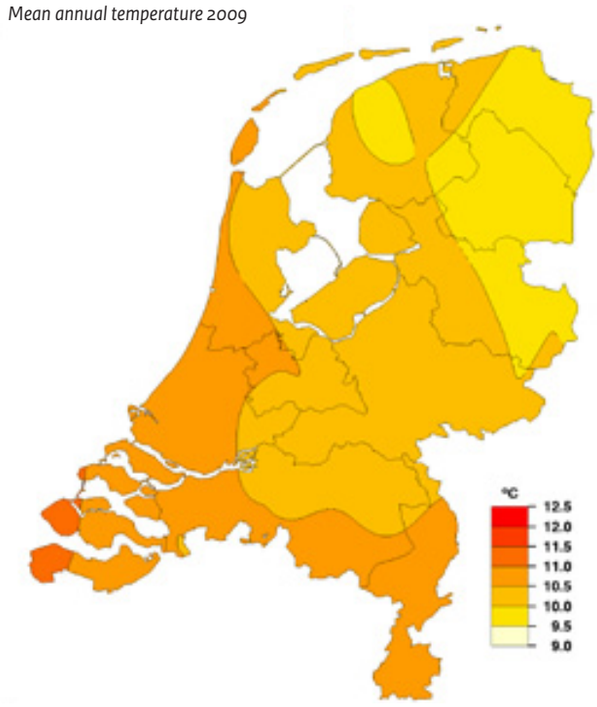
The total national annual precipitation was 738 mm compared to the normal figure of 797 mm. The least precipitation was recorded in the north-west of the country. De Kooy was the driest KNMI weather station with only 623 mm of precipitation recorded. Westdorpe in Zeeland recorded the highest figure of 832 mm. The annual total in De Bilt was 777 mm, compared to the multi year average of 793 mm.

The values recorded for De Bilt are presented in the overview below.

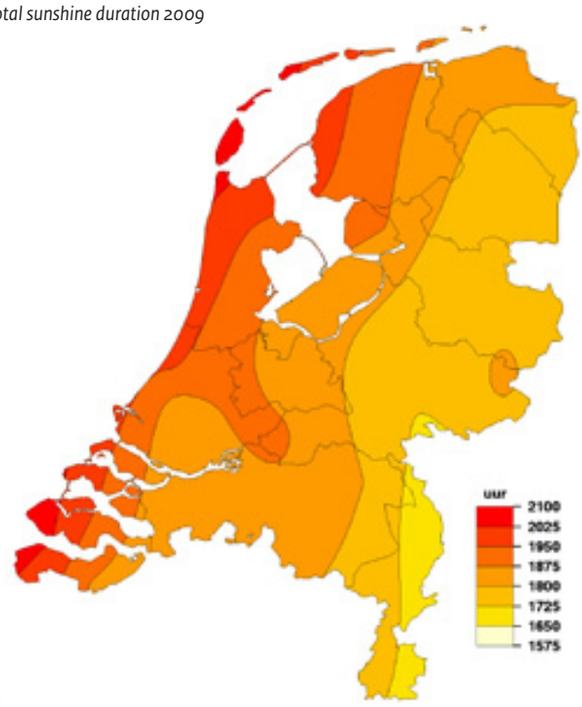
	Normal	2009	
Freezing days	8	9	Maximum temperature below 0.0°C
Cold days	58	56	Minimum temperature below 0.0°C
Warm days	77	94	Maximum temperature of at least 20.0°C
Summery days	22	27	Maximum temperature of at least 25.0°C
Tropical days	3	1	Maximum temperature of at least 30.0°C

	Monthly average temperature (°C) De Bilt		Total sunshine duration (hours) De Bilt		Monthly precipitation amount (mm) De Bilt	
	Normal	2009	Normal	2009	Normal	2009
Jan	2.8	0.8	52.4	100.8	67.0	53.7
Feb	3.0	3.3	78.7	47.5	47.5	55.1
Mar	5.8	6.3	113.7	142.1	65.4	48.2
Apr	8.3	12.2	158.2	226.5	44.5	19.9
May	12.7	13.9	203.7	236.4	61.5	65.0
Jun	15.2	15.6	186.5	231.6	71.7	53.7
Jul	17.4	18.1	196.1	233.1	70.0	107.1
Aug	17.2	18.5	192.0	226.2	58.2	46.9
Sep	14.2	15.0	132.8	159.9	72.0	33.5
Oct	10.3	10.7	105.6	122.8	77.1	89.8
Nov	6.2	9.5	59.9	51.3	81.2	120.0
Dec	4.0	2.2	44.2	59.7	76.8	84.4
Total	**9.76**	**10.5**	**1523.8**	**1837.9**	**792.9**	**777.3**

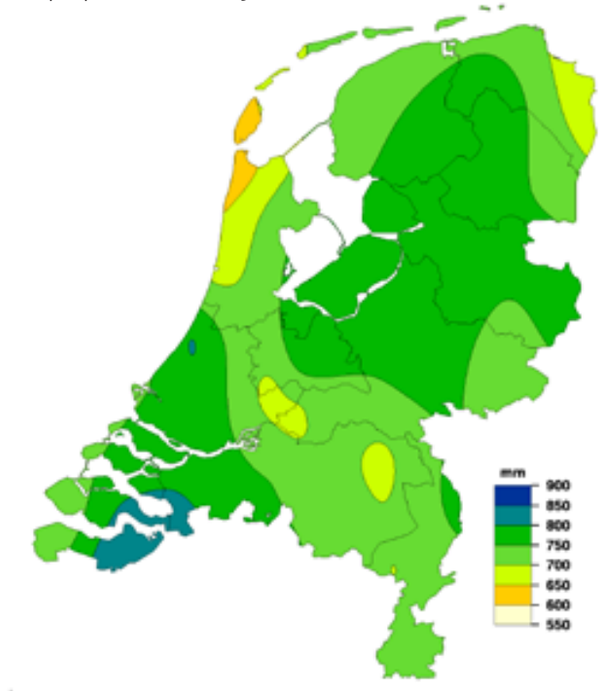
Mean annual temperature 2009



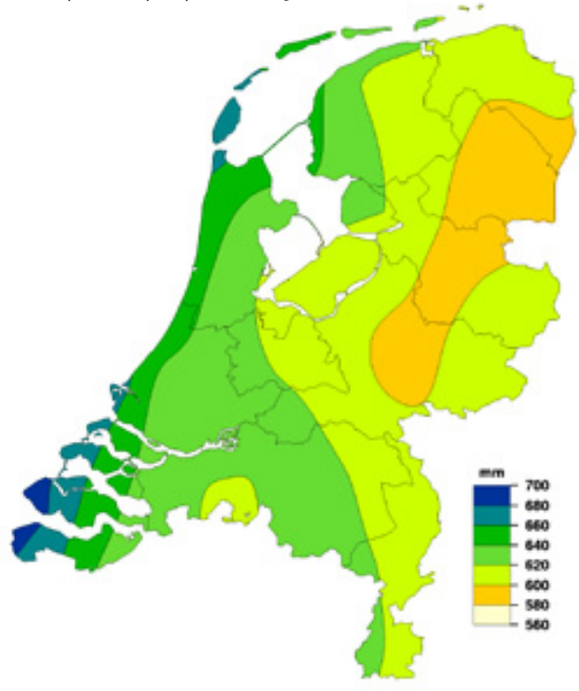
Total sunshine duration 2009



Total precipitation amount 2009



Potential reference crop evaporation 2009



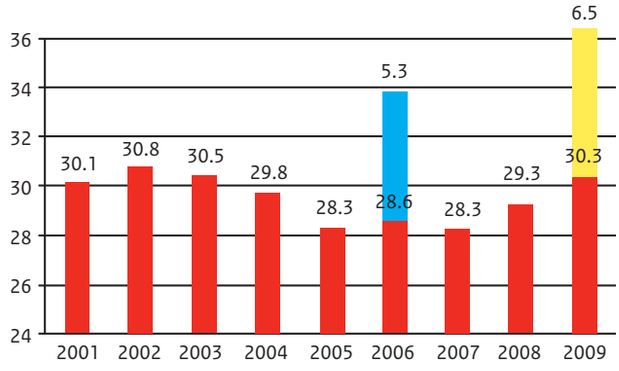
Financial

A financially sound KNMI

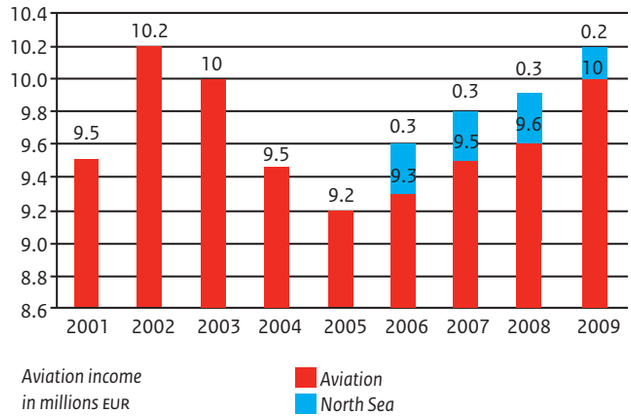
The KNMI's turnover increased from € 48.5 million in 2008 to nearly € 57 million in 2009. As a result of the reorganisation of tasks, responsibilities and budgets for space exploration, the meteorological terrestrial observation activities (satellite observations) which contributed directly to the KNMI's weather and climate forecasts in 2009, have been incorporated into those of the KNMI.

This explains the increase in the contribution by the Ministry of Transport, Public Works and Water Management and the increase in the subscription fees. In addition, the product group 'Earth Observation' was made more transparent in the 'Product group costs' table for 2009.
At the start of 2009, the Ministry of Transport, Public Works and Water Management made a substantial financial contribution to implement the Delta Plan for the KNMI Infrastructure. As part of the first phase of this plan, the qualitative aspects of the computer centre have been raised to a substantially higher level and its capacity has been expanded.

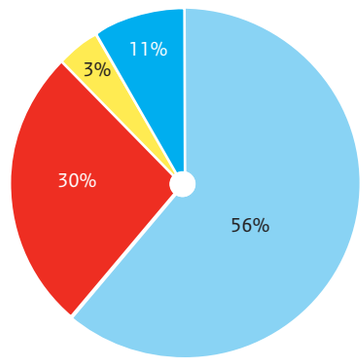
A more compact functional approach has been given shape as part of the 'Renewal, Connection, Trust' programme of the Ministry of Transport, Public Works and Water Management. Starting in 2009, the KNMI's administrative activities have been implemented by the Shared Service Organisation (SSO) of the Ministry of Transport, Public Works and Water Management.



Agency contribution in millions EUR



Aviation income in millions EUR



Total productgroup costs

- *Weather*
- *Climate*
- *Seismology*
- *Earth observation*

Balance sheet *)		
Assets	Dec 31, 2009	Dec 31, 2008
Fixed assets	5,561	6,176
Work in progress	1,698	2,808
Accounts receivable	6,884	3,714
Liquid funds	8,020	2,700
Totaal assets	**22,163**	**15,398**
Liabilities	Dec 31, 2009	Dec 31, 2008
Reserves	1,391	1,391
Results 2009	-100	**)
Equalisation account	0	91
Provision	1,791	2,512
Accounts payable	19,081	11,404
Total liabilities	**22,163**	**15,398**

Costs per product group *)		
Product group	2009	2008
Weather	31,059	29,611
Climate	17,257	16,612
Seismology	1,973	2,140
Earth observation	6,497	0
Donation reserves	64	64
Extraordinary expenses	0	54
Total costs	**56,850**	**48,481**

Profit and loss account *)		
Income	2009	2008
Agency contribution	36,818	29,311
Third-party revenue	19,616	18,658
Interest received	3	94
Release of provisions	222	0
Extraordinary revenue	91	91
Total income	**56,750**	**48,154**
Expenditure	2009	2008
Staff	34,419	33,033
Material		
- Outsourcing	981	1,583
- Maintenance and operation	4,578	4,102
- Rent and lease	3,296	3,236
- Contributions	9,006	2,403
- Remaining	2,553	1,911
Interest	140	108
Depreciation	1,813	1,987
Donation reserves	64	64
Extraordinary xpenses	0	54
Total expenses	**56,850**	**48,481**

**) Amounts in euro 1.000*
***) Result 2008 amounting to € -327,000 in Capital and Reserves incorporated as at January 1 2009*

Earthquakes

L'Aquila, Samoa and Groningen

Earthquakes are nothing new, but their impact remains - as always - enormous. They often claim the lives of countless victims and cause major damage to the local area. It can sometimes take years to repair everything, assuming repair is even possible. In such cases, external assistance, especially of a financial nature, is incredibly important. In the Netherlands, and particularly in the north of the country, around 40 earthquakes or tremors are recorded every year. They rarely make the news because there is minimal damage or because they have not even been noticed. The earthquake that had the greatest impact in 2009, partly because it was relatively close to home, happened at the start of April in L'Aquila, Italy. Below is a summary of a turbulent year.

L'Aquila shakes the foundations of Europe

At 3:32 a.m. on April 6, a major earthquake caused significant damage in the area around the Italian town of L'Aquila, 95 km to the northeast of Rome. Its magnitude registered 6.3 on the Richter scale. The greatest damage occurred in the town of L'Aquila itself, but many towns and villages in the area were also badly hit. The earthquake occurred at a depth of 10 km and could be felt as far away as Rome and Pescara on the Adriatic coast in the east of the country. The death toll reached around 300, and 1100 people were injured. About 40,000 people were made homeless, and approximately 15,000 buildings were damaged partly as a result of the shocks that occurred before and after the main earthquake.

First Dutch earthquake hits Huizinge

The first earthquake to be felt this year in the Netherlands took place at 11 p.m. on Tuesday, April 14. It happened in the village of Huizinge, between Middelstum and Westeremden, 15 km to the northeast of the city of Groningen. The strength of the quake was 2.6 on the Richter scale.
There have been regular earthquakes in the northern Netherlands since 1986, caused by gas field development. In the last 24 years, the KNMI has recorded 600 such earthquakes, most of them in the Groningen gas field.

Earth tremor in Appingedam

At 7:12 p.m. on April 16, there was a minor earthquake 2.5 km to the southwest of the centre of Appingedam. The quake measured 2.5 on the Richter scale. No significant damage was reported.

Zeerijp shaken up...

At 7:23 a.m. on May 8, the area around Zeerijp experienced a slight tremor. The epicentre of the earthquake, which measured 3.0 on the Richter scale, was 1 km outside the village near Groningen. On that day, the KNMI received 47 reports from people who had felt the earthquake.

Java hit by earthquake at great depth

At 2:55 p.m. local time on Wednesday, September 2, an earthquake struck to the west of the Indonesian island of Java. The earthquake, which happened at a depth of almost 50 km, measured 7.3 on the Richter scale. Despite initial fears of a tsunami, the alert was withdrawn an hour after the earthquake.
The quake could be felt as far away as the capital of Jakarta, 200 km away. The earthquake left around 40 dead, many injured and at least 1300 buildings in ruins or damaged. The region to the south of Jakarta and Bandung were particularly hardest hit. More than 2.5 hours after the main earthquake, there was an aftershock with a magnitude of 4.9.

Heavy earthquake and tsunami in Samoa Islands

The earthquake close to the Samoa Islands that occurred on September 29, was caused by the large-scale plate tectonics in the Tonga region in which the Samoa Islands are situated. The quake measured 8.0 on the Richter scale, making it the largest and heaviest earthquake in 2009. Because the earthquake took place beneath the ocean floor at a depth of only 22 km, it triggered a tsunami. The 4 m high tidal wave claimed around 200 lives and caused devastation to buildings along the coast of the Samoa Islands and Tonga.

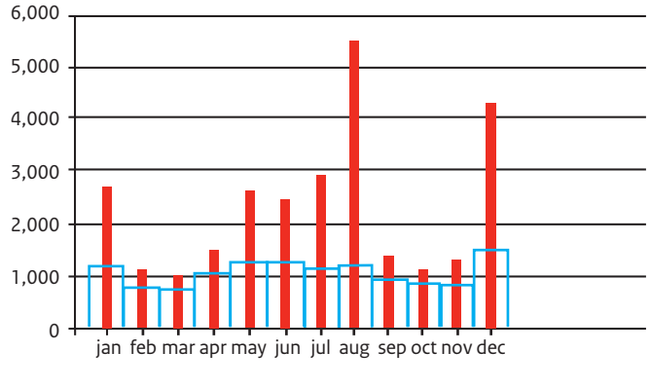
Two heavy earthquakes on Sumatra

At 5:16 p.m. local time on September 30 and at 8:52 a.m. The earthquake on October 1 occured, the Asian region was again visited by devastation. At these times, two major earthquakes struck off the coast of Sumatra and on the island itself, measuring 7.6 and 6.6 on the Richter scale, respectively. The earthquake on 30 September was offshore, but did not trigger a tsunami as it occurred at a depth of approximately 80 km. The epicentres of the two earthquakes were 45 km to the northwest of the capital Padang and 220 km to the southwest of Pekanbaru, respectively. The death toll exceeded 1100. The earthquake occurring on October 1 occurred 270 km to the southeast of the first, along a different fault line, at a depth of 15 km beneath the island itself.

Web Statistics

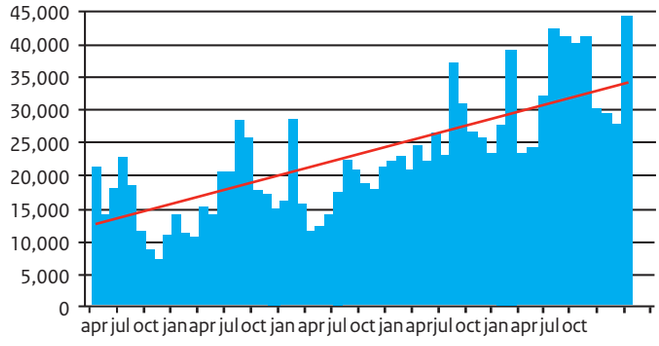
KNMI website increases in popularity

On August 20, the website www.knmi.nl had a record number of page hits in response to an Extreme Weather Warning about extremely heavy gusts of wind and heavy storms.



Use of KNMI-webservers (page hits in thousands)

Maximum usage during 1 day
Average daily usage



Use of KNMI-webservers (page hits in thousands)

Monthly totals
Trend (monthly totals)

Throughout the year 2009, the KNMI website was visited a record number of times. As early as January 6, a new daily record was recorded with over 2.6 million page hits. Six months later on July 3, when an Extreme Weather Warning was issued for heavy storms, the daily record was broken again with over 2.9 million page hits. However, August 20 proved to be the overall record breaker with 5.5 million page hits on a single day, which is nearly twice as many as the previous record established six weeks earlier. Other days on which the website attracted large numbers of visitors were May 28 and June 2 (around 2.5 million page hits per day) and December 20 (over 4 million page hits). On this day, an Extreme Weather Warning was issued for heavy snowfall.

New monthly record

A new monthly record was reached at the very end of 2009: with more than 49 million page hits was December the busiest month ever in the history of the KNMI website. Visitor numbers were significantly higher than normal. Not only on December 20, but for the entire week leading up to Christmas. This was of course due to the wintry weather.

The previous monthly record dated from July 2009 when there were 37 million page hits. July 2009 was characterised by highly variable and wet weather.

The total number of page hits for all of 2009 was 418 million. This amounts to an average daily figure of 1,147,000 pages, an increase of nearly 25% compared to 2008. This increase was definitely due to the availability of new information such as daily observation data and precipitation radar images.

Infrastructure

The KNMI has its own Delta Plan

The use of the KNMI's ICT infrastructure both by the KNMI's own staff and by external users of KNMI information is increasing every year. This places ever greater demands on the capacity and operational security of this infrastructure.

The KNMI's activities and processes increasingly involve computers and automation, which means that it is becoming increasingly dependent on ICT. To continue to satisfy the requirements of our clients, the KNMI has begun implementing the Delta Plan for the ICT Infrastructure, the aim of which is to bring about a solid ICT infrastructure, which must be state-of-the-art and serve as the foundation for reliable and high quality service. In addition, the infrastructure must be structured and monitored in accordance with modern principles of quality.

The multi-year Delta Plan consists of the following elements:

- Update of the existing computer centre.
- Design and implementation of a monitoring infrastructure, which will monitor the entire production chain 24 hours a day, seven days a week. This monitoring will focus on the effective performance of the production process and is essential to prevent and track down disruptions in service.
- Improving the fault tolerance of operational software, which includes adherence to modern principles of information architecture and software development. This will enable us to continue to meet the qualitative requirements.
- Design and implementation of a national system for storing satellite observation data and making it available. In the Netherlands, the KNMI plays a central role in the processing of satellite observations (SCIAMACHY, OMI, GOME, GOME2, MSG and in future MTG and TROPOMI). Standardised forms of data storage and distribution in accordance with INSPIRE guidelines serve as the guiding principle.

New access to the KNMI

In order to prevent bottlenecks in the infrastructure, in the run-up to the implementation of the Delta Plan, the ICT facilities for customers, general visitors and for internal users have been separated. As a result, the information has become much more accessible and the total transport capacity has increased significantly. Access to the infrastructure provided to these user groups is now geared more effectively to their specific needs. The infrastructure has also improved security to keep unwanted visitors out and to secure confidential information.
In combination with a new ICT platform for web services, this infrastructure already proved its worth in 2009 – even during extreme peak usage (see the section on Web Statistics on page 51), the KNMI has had access to technology that is fast and reliable enough to meet public demand.

CESAR Database System

The new CESAR Database System (CDS) was launched with some celebration. The CDS was developed by the KNMI on the instructions of and in alliance with the CESAR consortium. Cabauw Experimental Site for Atmospheric Research (CESAR) is an international consortium comprising the Energy Research Centre of the Netherlands (ECN), the Netherlands Organisation for Applied Scientific Research (TNO), Delft University of Technology, the National Institute for Public Health and the Environment, Wageningen University, European Space Agency/European Space Research and Technology Centre (ESA-ESTEC), Utrecht University and the KNMI. CESAR involves the compilation in Cabauw of an extensive set of observations, both on a continual basis and during (intensive) measurement campaigns such as CINDI. This makes Cabauw one of the world's most important atmospheric profiling stations.
In order to justify this leading position, the CESAR measurement data and data products are now available to partners and the outside world in an easy to understand, cohesive and user-friendly form.

The development of the system involved the use of open source software such as Java, MySQL, Python and struts.

Intragovernmental cooperation

Other government agencies have been using the KNMI's expertise in collecting and processing measurement data for quite some time. In 2009, agreements were signed with the meteorological group of the Royal Dutch Air Force and with the Directorate-General for Public Works and Water Management for the KNMI to provide permanent services in the management and maintenance of these organisations'

Staff

The KNMI offers staff new horizons

In 2009, a Strategic HRM plan was drafted under the motto, 'The KNMI offers you new horizons'. In doing so, the KNMI impressed upon its staff that personal development is a vital core value. This not only applies to people who work at the KNMI, but also to the further development of the KNMI as a whole. The KNMI is on the threshold of significant progress in this area and will soon be able to measure the progress in the staff satisfaction survey in 2010. The personal responsibility of staff remains the guiding principle.

The HRM plan highlights three areas of focus:

1. Strengthening and operationalising competency management and long-term deployability;
2. Conducting a strategic staff analysis (SPA);
3. Supporting staff to enable them to increase their mobility within the labour market.

Diversity

In 2008, the women's network DIVA was launched and it continued to organise a number of inspirational activities in 2009. The regional women's network *Vrouwennetwerk Plus* was also launched at the initiative of the KNMI. In alliance with the National Institute for Public Health and the Environment, the Netherlands Organisation for Applied Scientific Research, the Directorate-General for Public Works and Water Management, the Dutch Tax and Customs Administration, Utrecht University and *Hogeschool Utrecht* university of applied sciences, the network organises a twice-yearly information meeting that aims to offer participants a look behind the scenes. The meetings help increase mobility between the organisations involved.

In the spring of 2009, the Governing Council adopted the Diversity Policy of the Ministry of Transport, Public Works and Water Management. This policy reflects government-wide diversity targets. All agencies of the Ministry of Transport, Public Works and Water Management, including the KNMI, were closely involved in its development. At the end of 2009, the KNMI responded by setting the following objectives: 'The KNMI aims to effectively reflect wider society and evolve in line with the changing labour market. The KNMI also acknowledges that teams that include diverse groups of people can facilitate qualitative improvements if effectively managed.' To this end, the following specific targets have been formulated:

- Proportion of bicultural staff by the end of 2013: 7.5%
- Influx of female staff by the end of 2011: 50%
- End of 2011: one female director
- End of 2011: three female managers
- In 2011: 30 interns

Three female managers have been appointed in 2009.

Central staff reorganisation

The new central staff organisation was implemented on September 21. Central staff comprises the Operations and Organisational Strategy and Support departments and supports the primary processes by contributing to overall decision-making. It is responsible for effectively preparing and implementing the decisions of the Management Team. In carrying out its duties, quality, a proactive and flexible approach combined with standardised working methods and processes play a central role.

Centralisation

Starting on January 1, the Shared Service Organisation (SSO) of the Ministry of Transport, Public Works and Water Management (V&W) is responsible for HR, Finance and staff management activities. Although the transition to the new working methods took some time, experiences with the SSO have been generally positive. There is now a closer link between management, the implementation of personnel administration and the SSO. Questions concerning salary, etc. can now be directed to the SSO service desk.

P-Direkt

The P-Direkt self-service system was developed further in 2009. This system enables staff to select and update their preferred HR aspects. P-Direkt assumes a great deal of independence on the part of employees and managers. As everything is checked retrospectively, the element of trust plays a significant role.

In 2009 the following P-Direkt elements became available: all types of leave, absence and recovery record keeping, travel expense claims, changes to working times and the introduction of the digital P-dossiers.

Work force reductions

In accordance with government agreements, the work force was reduced by 2.5%. In the next two years, the work force will be reduced slightly in excess of 2% annually as a result of agreements related to austerity measures.

The tables for 2008 and 2009 reveal a clear decrease in both part-time and full-time staff.
The increase in the work force primarily involved young women who on average began working more than in 2008.

2008	Men	%	Women	%	Total
Number of staff	387	78%	110	22%	497
Average age	46.1		42.0		45.2
Part-time employees	68	18%	76	70%	29%
Average working week	34.67 hours		27.67 hours		33.12 hours
Absence due to illness					3.21%

2009	Men	%	Women	%	Total
Number of staff	371	76.5%	114	23.5%	485
Average age	46.6		40.9		45.3
Part-time employees	57	15.4%	65	57%	25%
Average working week	34.85 hours		28.27 hours		33.30 hours
Absence due to illness					3.12% *)

*) *The rate of absence due to illness has shown a downward trend in recent years. In 2007, it was 3.4%, falling to 3.21% in 2008 and further to 3.12% in 2009.*

Tilly Driesenaar | *First female chair of KNMI Works Council*

The KNMI aims to effectively reflect wider society and evolve in line with the changing labour market. The election in mid-April 2009 of Tilly Driesenaar as the chair of the Works Council is in line with that objective. It also seamlessly dovetails the diversity policy launched in 2008 and the DIVA women's network which emerged from it.

"The basic idea behind the diversity policy is that groups made up of different types of people actually operate more successfully," begins Tilly Driesenaar. "Diversity increases innovation and creativity. In order to flesh out the policy, various measures were initiated. DIVA is one of those measures. One of DIVA's core objectives is to enable KNMI women to achieve their ambitions. I believe that having space to develop is key to this. Creating space for women to develop enables them to come into their own, enabling them to feel more comfortable and perform even better."

In your view, what is the most important theme or objective of the Works Council?
"I believe that diversity is an essential theme. It is something that I stressed during the campaign for the Works Council election and still work hard in my role within the Works Council. The fact that I am a woman is a major advantage. It makes diversity visible. Women tend to think that the results of their diligence speak for themselves. This is why I am delighted that women are emerging from their isolation, making themselves visible, and I aim to serve as an example of this. In a male-dominated environment, this can be difficult, but it is certainly not impossible. Within the KNMI, for example, the visibility of women is increasing all the time. This is major progress, but we still have a long way to go. I shall continue to call for a focus on this issue and to look for allies. Having more women in an organisation actually makes it more pleasant. It changes the mood entirely."

The KNMI has already achieved a great deal in terms of diversity. There are now three female heads of department, a female Works Council chair…
"It's certainly a step in the right direction. I also feel that our Director-General Frits Brouwer is adopting a more active approach than was previously the case. He has even placed the subject on the agenda within the council of the European organisation for weather satellites EUMETSAT. When the council was discussing the appointment of a male controller, he did not hesitate to ask whether a woman had been considered for the post. He then went on to explain KNMI policy in this respect and its motivation. In other words, he is now actively pursuing this theme."

What difference does it make to the world if there are more women active within the KNMI?
"Most importantly, I believe that women are more able to empathise. They often have better communication skills and are more sensitive… It is no coincidence that women often serve as intermediaries. They are obviously much less likely to adopt a macho approach, but it is actually less about the personal characteristics of individual women than the power of the teams of which they are a part."

"Increased numbers of women make teams more diverse, and diverse teams are more sensitive to developments in the outside world and more innovative when it comes to responding. This also applies to the teams within the KNMI and to the international teams in which the KNMI participates. This means that the outside world in the Netherlands and beyond benefits directly."

Finally, what exactly is your role at the KNMI?
"I am the scientific secretary for the HIRLAM programme. In collaboration with the Netherlands, Denmark, Finland, Iceland, Norway, Sweden, Ireland, Spain, Estonia, Lithuania and Latvia, the KNMI is developing what is known as the High Resolution Limited Area Model for short-term weather forecasts, or HIRLAM for short. This model makes it possible to zoom into small areas down to a ten-kilometre square. We are also working on an even more detailed weather model called HARMONIE in close collaboration with the ALADIN consortium, in which 16 other – primarily European – countries are participating. As part of HIRLAM, I am primarily responsible for communications. For example, I have set up a website to facilitate information exchange between scientists, and I publish newsletters. My background in applied mathematics has proved extremely useful in this."

"I am delighted that women are emerging from their isolation, making themselves visible."

Interview | Marisa Gerards

VROM and the KNMI: powerful alliance within IPCC

"When it comes to knowledge about scientific facts or processes, VROM is highly dependent on the KNMI's expertise."

In the areas of science and policy, respectively, the Ministry of Housing, Spatial Planning and the Environment (VROM) and the KNMI have a close working relationship, especially when it comes to climate change, with clear responsibilities and demarcation of tasks. The climate debate is very much a hot issue at the moment, due in part to several errors found in the IPCC report issued in 2007. This caused the debate about the reliability of climate science to enter the political arena. Marisa Gerards, VROM Director of International Affairs: "The technical nature of the discussion can complicate the political debate."

Marisa Gerards is happy to come to the defence of climate science. Whereas discussions in the past took place within the scientific world, nowadays climate science - and the associated debate - has literally become part of the public domain. The emergence of new media has also meant that all kinds of knowledge and opinions are immediately accessible to everyone. However, the extent to which this knowledge is actually based on evidence is not always obvious. Gerards: "This increased interest has also led to a lot of debate both in society at large and in scientific articles. That reflects how involved people are. This is actually a positive development."

What is VROM's response to this all?

When the debate emerged, we had to take rapid measures to respond to the growing demand from Parliament and wider society. Very quickly, three urgent debates were held in the Dutch Lower House, there were a lot of Parliamentary questions and the general public also aired their views and raised questions. In order to respond effectively, we are heavily reliant on our alliances with knowledge institutes like the KNMI and the Netherlands Environmental Assessment Agency (PBL). Ultimately, it is all about translating the scientific discussion into terms that politics and society can understand.

"When it comes to climate science, we have a close alliance with the KNMI," continues Gerards. "For example, the head of the delegation to the IPCC comes from the KNMI. VROM is also part of this delegation *(with staff member Ronald Flipphi, who also contributed to this interview, ed.)* along with representatives from various other ministries. This delegation is responsible for the Dutch contribution to the IPCC."

In response to a parliamentary question on the IPCC report from Freedom Party (PVV) member of parliament Richard de Mos, the KNMI responded at the start of 2010 on behalf of the departing VROM Minister, Tineke Huizinga-Heringa. Is that common practice?

"It's true that in a recent response to a technical question from Parliament, the Minister referred to an additional document in which the KNMI outlined the technical details. The KNMI is particularly well equipped to respond to this kind of purely scientific question. For this reason, it was decided in this specific case to respond by referring to a KNMI document. For VROM, the expertise offered by knowledge institutes like the KNMI is essential for clarifying scientific facts and placing them in the appropriate context. This information can then be used as the basis for political considerations and for formulating policy. However, specialist knowledge alone is not relevant to policy. This relevance comes from the synthesis and the translation of this knowledge. This is why the cooperation between the KNMI and government agencies is so invaluable."

Doesn't science raise debates almost as a matter of course?

"Uncertainty is inherent to science. Climate science also works with margins of uncertainty, scenarios and calculations of probability. In IPCC reports, probability indications are included where relevant. It is possible to track the development of science in consecutive IPCC reports. Certain findings can be established with increasingly narrow margins of uncertainty whereas others actually become more uncertain. Debate is one of the key drivers for further development. In the public arena, this debate is being conducted from different scientific perspectives. This can of course enrich the debate, but it may also lead to confusion.

One of the most important achievements of bringing together this scientific knowledge within the IPCC is that it has led to international consensus on the main conclusions. During international climate negotiations, there are of course plenty of issues to negotiate, but no one questions the need to take measures. There is no argument about the necessity to take action quickly. The international debate is not about the essential truth of the matter, but about how the pain can be fairly shared. It is about sharing our use of the environment internationally."

Is it still possible to bridge the gap between citizens and science?

"The fact that climate science is currently under so much pressure should be a lesson to us all. We need to work transparently and communicate clearly and ensure that our work is easy to interpret and monitor. Citizens' questions must be answered quickly and clearly. Actually, the KNMI's and the IPCC's excellent websites already go a long way towards achieving this transparency.

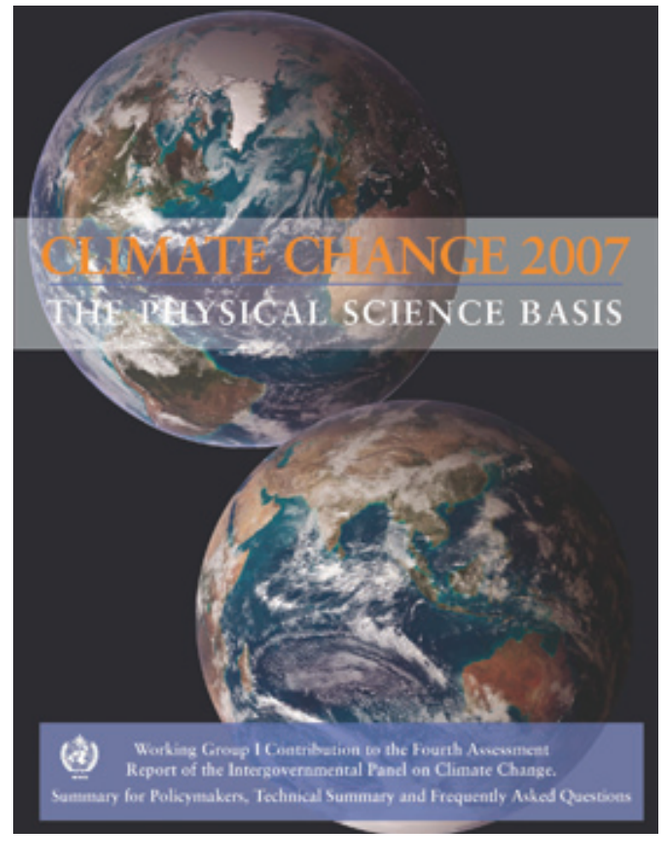
During a parliamentary debate, the VROM Minister pointed out that everything would be a lot simpler and more inexpensive if humans had no impact on climate change," continues Gerards. "Sadly, that does not seem to be the case. The climate issue is serious and urgent, and requires rapid action."

"In order to restore confidence and bridge the 'gap', it is important to quickly correct

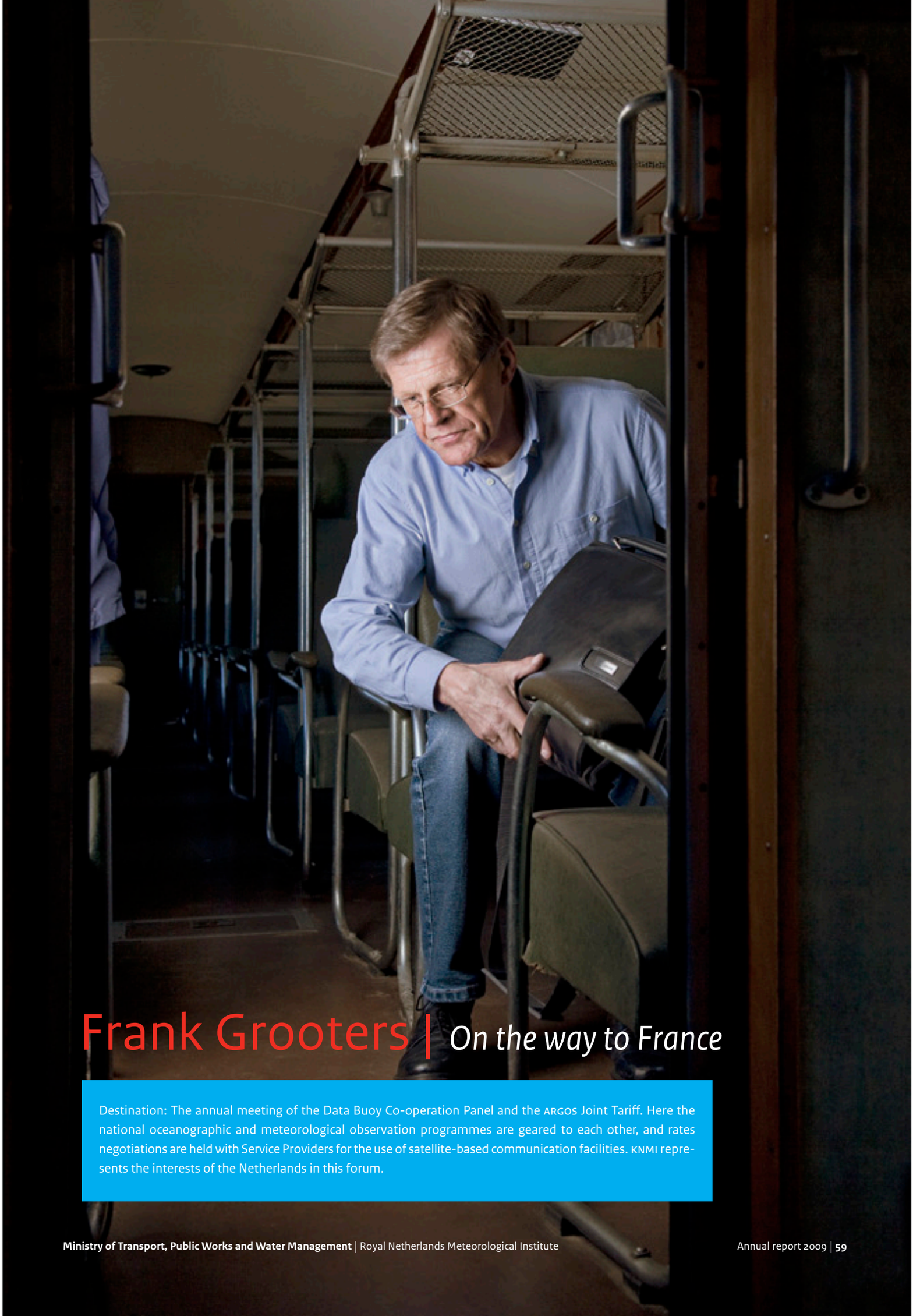
any errors in IPCC reports and if necessary to make changes to the IPCC procedures in order to prevent further errors. Indeed, the Netherlands has stressed the need for worldwide independent research. The InterAcademy Council *[umbrella council of science academies, ed.]* was commissioned by the UN to establish a panel which is currently conducting independent research into the working methods adopted by the IPCC. The results are expected in August 2010. It is important that the IPCC member states take on board its recommendations and translate these into agreements to reinforce the process. The October meeting of the IPCC, in which the Netherlands will participate, led by the KNMI, therefore promises to be a very important event."

About the IPCC

In 1988, the United Nations (UNEP and WMO) established the Intergovernmental Panel on Climate Change, the aim of which is to provide policymakers with a carefully considered overview of knowledge relating to climate change. Thousands of scientists from across the world are involved in compiling the IPCC reports. Approximately every five years, the IPCC publishes an overview of worldwide climate research, with a special summary for policymakers. The IPCC is divided into three working groups. Working Group I focuses on the scientific aspects of both natural and anthropogenic climate change. Working Group II examines the vulnerability of social and natural systems to climate change and the options for modification. Working Group III investigates the options for reducing anthropogenic climate change.



IPCC Fourth Assessment Report - Climate Change 2007: The Physical Science Basis



Frank Grooters | *On the way to France*

Destination: The annual meeting of the Data Buoy Co-operation Panel and the ARGOS Joint Tariff. Here the national oceanographic and meteorological observation programmes are geared to each other, and rates negotiations are held with Service Providers for the use of satellite-based communication facilities. KNMI represents the interests of the Netherlands in this forum.

Interview | Stephen Briggs

The KNMI's high-profile role in space

"The KNMI not only has an operational mandate, it also brings a great deal of intellectual and scientific added value to ESA."

What is the exact composition of the earth's atmosphere? How much greenhouse gas do 'we' produce and where does it all end up? The answers to these earthly questions are to be found in space. The KNMI plays a leading role in our atmospheric research activities. The institute took the scientific lead in the development of TROPOMI, the measurement instrument that will study the earth's atmosphere from an ESA satellite. Stephen Briggs, Programme Head at ESA: "The KNMI understands the art of bridging the gap between research and operations."

"The rationale behind the construction of TROPOMI is quite clear," explains Stephen Briggs. "This instrument will be sufficiently equipped to map the composition of the troposphere, the lowest part of the atmosphere better than ever before. As this is where the gases produced by humans can be found, it is extremely significant. The impact of these gases is not yet fully known. It is quite likely that climate change on earth is closely linked to these gases. TROPOMI will shed more light on these issues."

In addition to the call for action on climate change, there is also a continual demand from politicians and society at large for increased knowledge and information about the processes within the earth's atmosphere. How important is the role played by satellites in this?

"Very important. They offer enormous benefits as they are capable of charting the whole of the earth's atmosphere in just a few days. They are not only of use for scientific research, but also show whether any environmental measures taken are having an effect. A key aspect is that the satellite instruments must be able to see the relevant polluting gases or greenhouse gases with the highest possible level of detail. In these areas, the Sentinel-5 Precursor mission with TROPOMI on board will provide continuity of observations made by its predecessors SCIAMACHY and OMI. The instrument will also be capable of scanning the atmosphere between the clouds and it will even be able to better estimate the emission of air pollutants at the level of cities and suburban areas."

To return more specifically to the subject of the KNMI, what does the cooperation between ESA and KNMI actually entail?

"The KNMI not only has an operational mandate, it also brings a great deal of intellectual and scientific added value to ESA. It is a highly experienced user of meteorological data from satellites. KNMI also plays a significant scientific role in our programmes and missions, and KNMI staff are very active in working groups related to ESA missions. Furthermore, the KNMI took the scientific lead in the development of the TROPOMI instrument. The KNMI understands the art of bridging the gap between research and operations."

How unusual is it for an institute from a small country like the Netherlands to fulfil such a role?

"The Netherlands is not really a small country – it is in the middle of the scale of ESA Members. As we have said, the KNMI is closely involved in ESA, both in terms of the advice it offers and development and plays an important role in defining and developing ESA missions."

What is ESA?

The European Space Agency (ESA), formed in 1975 by the amalgamation of the European Space Research Organisation (ESRO) and the European Launcher Development Organisation (ELDO), focuses on European space projects, earth science research, space science, the development of technologies based on satellite systems, the utilisation of space for practical applications and the promotion of the European economy in space technology. By bringing together financial and intellectual forces, ESA can realise projects that would not be feasible for the individual Member States. ESA works closely with national and international space organisations, including NASA, JAXA (Japan) and others.

ESA now has eighteen Member States: Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

ESA's central administrative authority is its Council, which sets the general guidelines on which ESA bases its space policy. The Council has representatives from each Member State, each of which has a vote, irrespective of size or financial contribution. The Ministry of Economic Affairs represents the Netherlands.

ESA does not develop and construct its own satellites, but defines and specifies a detailed package of requirements and then plays the role of commissioning body. Consequently, space industries in the ESA Member States then work on the development and construction of advanced satellites. ESA also has a launcher Directorate which ensures an independent European launch capability for its satellites and those of other users.

ESA also has a technical and scientific centre (ESTEC in Noordwijk), that develops new space technologies and where satellites are assembled, integrated and tested.

As regards the alliance with the KNMI, is there anything specific that you believe could be improved?

"The KNMI has a close understanding of our missions and programmes. It has a lot of technical and intellectual expertise and plays an instrumental role within ESA. There is a very positive and professional working relationship between ESA and KNMI.

TROPOMI:

Valuable data on air pollution and climate change

The Dutch satellite instrument TROPOMI is scheduled to be launched on board the Sentinel 5 Precursor mission in 2014. The Dutch government is providing the bulk of the funding for the construction of the payload. The Tropospheric Monitoring Instrument (TROPOMI) will provide scientists with valuable data for research into air pollution and climate change. Representing the KNMI, Pepijn Veefkind took the scientific lead of this mission.

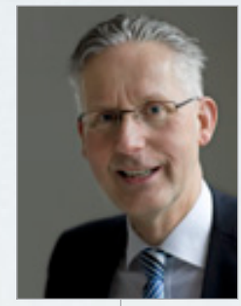
Thanks to TROPOMI, the Netherlands continues to make a significant contribution to the European space programme in areas in which the Netherlands is receiving international acclaim. Dutch aeronautical companies and institutes have long been key suppliers of advanced space technology for astronomical and Earth observation missions. Dutch astronomers and climate and environmental researchers play a key role both in the preparation of new missions and in using the data ultimately provided. The Dutch expertise, acquired in part through SCIAMACHY and OMI, the forerunners of TROPOMI, gives ESA and its Member States confidence in the ability of TROPOMI to deliver the necessary high quality data for monitoring and understanding atmospheric composition.

Heleen ter Pelkwijk | *On the way to Germany*

Destination: EumetCal workshop. Europe, the USA, Canada and Australia collaborate on a range of education issues as part of EumetCal. During this workshop, a tremendous amount of information is exchanged on pedagogical aspects and didactics, training methods, available training tools and educational modules. In addition, developments in education at the meteorological institutes are discussed. I always emerge from a week's hard work at a EumetCal workshop fully recharged and brimming with new ideas.

Management Team KNMI

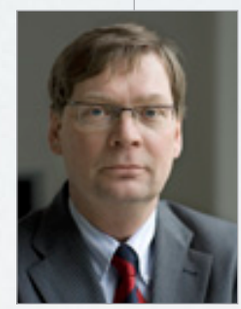
The KNMI Management Team (MT) consists of the Director-General, the Directors of the three departments – Weather Service, Climate and Seismology and Infrastructure – and the Executive Secretary. The Head of Organisational Strategy & Support and the Head of Operations also attend MT meetings where necessary.



Director-General
Dr F.J.J. Brouwer

Weather Service
Dr R. den Besten

- **Product and Process Innovation** – *Dr J. Verbeek*
- **Forecasting** – *A. van Loy*
- **Research and Development** – *Dr G.J.H. Burgers*
- **Stakeholder and Contract Management** – *F. Hanneman*



Climate and Seismology
Dr H.W. Haak

- **Climate Observations** – *Prof. P.F. Levelt*
- **Global Climate** – *Dr W. Hazeleger*
- **Regional Climate** – *Dr R.F. van Oss*
- **Chemistry and Climate** – *Dr P.F.J. van Velthoven*
- **Climate Services** – *Dr A.J. Feijt*
- **Seismology** – *Dr B. Dost*

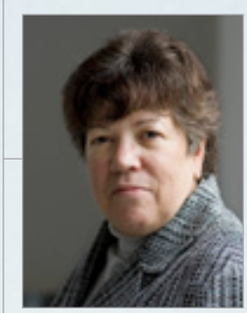
Information & Observation Services and Technology
W.J. Nieuwenhuizen

R&D Information and Observation Technology
Dr G.H.J. van den Oord

Information and Process Management
P.H. van Noort

IT Systems and Network Systems
Dr C.M. Spaltro

Observations Systems Operations
J. Rozema



Executive Secretary
M. Collet-van Laere

Strategy and Services
P.J.W. de Wildt

Operational management
J.F.J.M. de Bel

Interview | Isabelle Rüedi

Working together towards standardisation and homogeneity

"The KNMI is a comprehensive, globally oriented institute with access to an extensive international network. The WMO is more than happy to benefit from its work."

The KNMI actively engages in international collaboration with other institutes and research bodies. In addition, it participates in a large number of international bodies as the representative of the Netherlands. Of these, the World Meteorological Organisation (WMO) is significant. The KNMI is closely affiliated with the Commission for Instruments and Methods of Observation (CIMO), a technical commission of the WMO, which focuses on the standardisation and homogeneity of meteorological instruments and methods of observation.

What would the world be like without the WMO?

Isabelle Rüedi, WMO Senior Scientific Officer: "WMO is making a difference. To start, weather forecasts as we know them today would be impossible as these are based on meteorological observations from round the world. No member would be able to collect that alone. One of WMO's key tasks is to maintain a global observation network. Each day, three global, 189 national and 34 regional meteorological services process millions of pieces of data. WMO plays a significant role in international collaboration in the field of meteorology through the exchange of meteorological data and products, and the promotion of weather, water and climate research. In recent years, the WMO has actively been involved in the issue of climate change and variability."

Can you explain what CIMO does?

"In effect, CIMO serves as a technical guide, showing the way for the 'Members' affiliated with the WMO. CIMO promotes and facilitates international standardisation and compatibility of meteorological observing systems used by Members within the WMO Global Observing System to improve quality of products and services of Members. To achieve this, CIMO coordinates collective actions by Members that exceed what each Member could produce unilaterally to meet their critical needs. CIMO also supports the development of new observing equipment as well as capacity building in developing and least developed countries to bridge the gap between them and the developed countries."

Why is this significant?

"A large part of the WMO weather and climate activities is based on data from affiliated countries. A certain degree of homogeneity is essential to use these different datasets together, to compare them and to establish correlations. This is the only way to develop an accurate and complete view of the situation. It also facilitates drawing the correct conclusions. After all, weather and climate do not abide by national borders. For instance, reliable, well-substantiated weather forecasts and climate scenarios demand data from the rest of the world, which is measured, compiled and processed using clearly defined methods. Only then is an accurate and complete view of the situation possible. In this, an effective guide addressing instruments and methods of observation is indispensable to ensure that the instruments measuring the data have been installed and are being used optimally to meet the users' requirements. After all, you have to work with and help countries in gathering appropriate data. But what is 'appropriate data' and how do you gather it? This is what needs to be communicated to and understood by all Members, which are providing those data. In addition, meteorological observations are one of the sources of information used to develop policy and draw up lines of political action. This is another reason why it is vital for data to be accurate, homogeneous and standardised in an appropriate manner."

"This is particularly important in the context on the climate debate," continues Rüedi. "The debate features two primary schools of thought: the believers and the dissidents, who call into question the impact of human activity on the environment – climate change in other words. The veracity of the underlying facts and figures should never be subject to doubt. This, too, supports the need for standardisation and homogeneity. We need confidence in the way the data is being measured, among others: where and how are the instruments exposed and how are they maintained and calibrated."

Is it fair to say that this sounds heavily 'rule-based'?

"Not at all. We listen carefully to the requirements of the many and highly diverse range of users. What are their needs? How should operations be carried out to optimise our response to those needs? We do not determine how Members have to do their job, but we help them in coming to an agreement on the rules they want to set up and follow."

What is the KNMI's role in the WMO/CIMO?

"Four KNMI staff members have been actively involved with CIMO in the last years. These experts appreciate the importance of CIMO and make significant contributions to its activities. Without their efforts, CIMO would be much less able to set standards and to develop the appropriate guidance on instruments and methods of observation that is being followed throughout the world. One of them, Dr Van der Meulen, has been contributing to CIMO for over 20 years and has been a member of the CIMO Leadership for over 10 years. He has been a very strong contributor to CIMO over these years and his deep insight in technological matters has contributed to the development of important guidance to Members and to make strategic decisions for CIMO's activities as well as for its collaboration with other communities."

In addition, the KNMI contributes significantly to other technical commissions and programmes of WMO, like for example the Commission for Basic Systems and the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology. The KNMI is a comprehensive, globally-

oriented institute with access to an extensive international network. The WMO is more than happy to benefit from its contribution."

Joint meeting of a CIMO expert team and the International Organising Committee on Surface-Based Instrument Intercomparisons (Sestola, Italy 2009).

Michel Jarraud | *Secretary-General WMO*

A specialist agency of the United Nations, the World Meteorological Organisation (WMO) promotes international collaboration in the field of weather, water and climate. What exactly does the WMO do and why is its work so valuable? Secretary-General Michel Jarraud responds.

"A key task of the WMO involves coordinating the efforts of our 189 member states to gather observational data. The meteorological and climate data is exchanged between the Member States' national meteorological services. This information serves as the basis for large-scale numerical weather models, national weather forecasts and for input for climate models for the global climate assessment."

"In addition to this coordinating role in global meteorology, the WMO simulates and coordinates climate studies in each of the Member States," continues Jarraud. "The significance of this work is readily apparent. It enables us to assert that 'if nothing is done to address the greenhouse effect, it will lead to consequences in terms of rising temperatures, precipitation and natural disasters'. How will the Netherlands, Botswana or the South Pole be affected? These are all examples of the research questions we are trying to address as part of the world climate research programme. For this, it is essential that our participants, as well as all other stakeholders in the climate debate, have access to the most accurate and recent scientific information."

All WMO activities are rooted in the national activities of meteorological institutes, including the KNMI. These institutes play a crucial role in the global exchange of information by contributing to scientific research and to the development of appropriate services. In short, collaboration is key. What is the WMO's role in this context?

"Our task is to ensure that the countries actually collaborate with each other in this area. As far as the climate is concerned, collaboration is absolutely vital, a fact appreciated by all of the countries involved. After all, climate change pays no heed to national borders, it's a global issue. No country on earth – not even the very largest – can put an end to global warming on its own."

"No country on Earth – not even the very largest – can put an end to global warming on its own. Collaboration is absolutely vital."

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