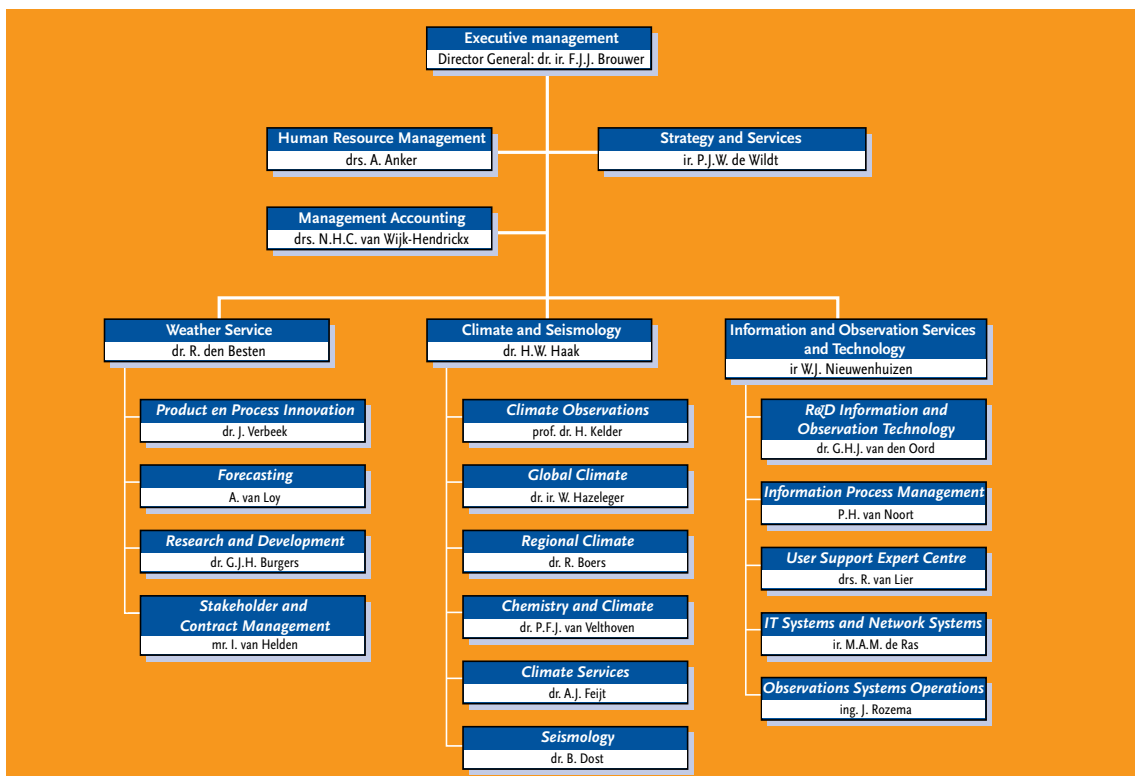
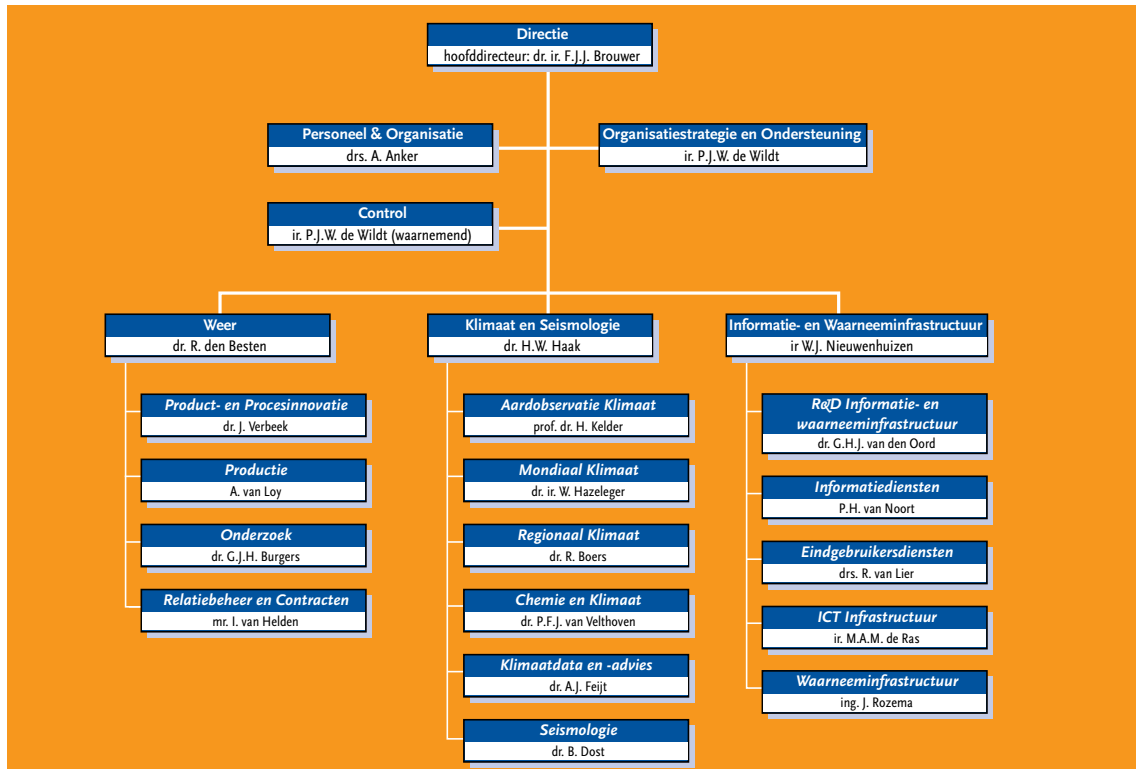
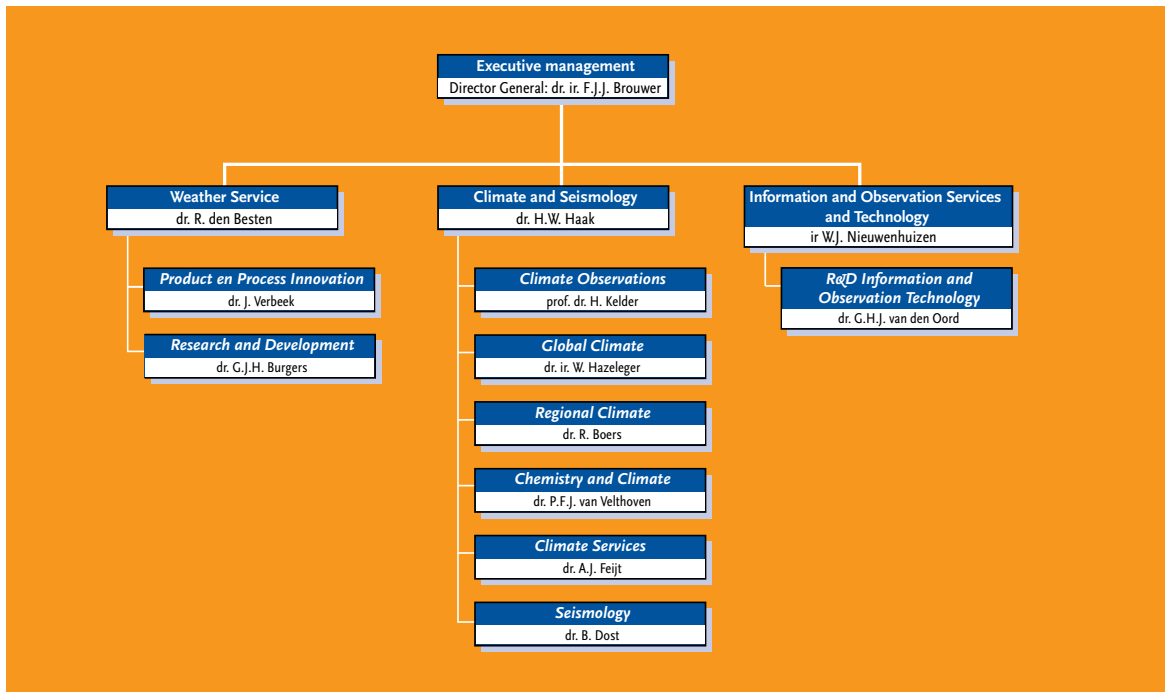


Organisation charts

KNMI



KNMI Research



Publications

Numerical Modelling Research and Development

The Numerical Modelling Research and Development Division is responsible for research into and development of numerical weather prediction models and other meteorological applications, that are operationally used at KNMI. Within the division, the following activities are performed:

1. Applied research in the field of numerical weather prediction: atmospheric and oceanographic modelling, physical and statistical postprocessing methods and related applications on the interpretation, verification and economic value assessment of meteorological data.
2. Development and scientific maintenance of methods, models, applications and tools for operational weather forecasting.
3. Advice and transfer of expertise to external users, mainly in Dutch government agencies.

Research activities focus on:

1. Short range (0-48 hours) forecasting and nowcasting of the atmosphere and sea state in and

around The Netherlands on horizontal scales of ca. 10 km.

2. Improvement of the prediction and nowcasting of high-impact weather: wind storms and gusts, storm surges, severe precipitation, thunderstorms and strong convection, fog, high sea waves, road icing.
3. The development of detailed mesoscale models and downscaling techniques suitable to describe the atmosphere and sea state at horizontal scales of 1- 3 km.
4. The description of uncertainty in the development of the atmosphere and sea state, by means of probabilistic forecasting techniques. The emphasis is on optimising the use of probabilistic information in early warning systems for severe weather events and on the development of short-range ensemble forecasting methods.
5. The development of applications aiding the interpretation of weather forecasts for specific user groups such as aviation and water management.

Publications in reviewed journals

2005

- Jacobs, A.J.M. and N. Maat, 2005. *Numerical Guidance Methods for Decision Support in Aviation Meteorological Forecasting*. Weather and Forecasting, **20**, 82-100.
- Makin, V.K., 2005. *A note on the drag of the sea surface at hurricane winds*. Bound.-Layer Meteorol., **115**, 169-176.
- Schmeits, M.J., C.J. Kok and D.H.P. Vogelezang, 2005. *Probabilistic forecasting of (severe) thunderstorms in the Netherlands using model output statistics*. Weather and Forecasting, **20**, 2, 134-148. doi:10.1175/WAF840.1
- Verkley, W.T.M., P.W.C. Vosbeek and A.R. Moene, 2005. *Manually adjusting a numerical weather analysis using three-dimensional variational data-assimilation*. Quart. J. Royal Meteor. Soc., **131**, 1713-1736. doi:10.1256/qj.03.202

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- Dijkstra, H.A., L.A. te Raa, M.J. Schmeits and J. Gerrits, 2006. *On the physics of the Atlantic Multidecadal Oscillation*. Ocean Dynamics, **56**, 1, 36-50. doi:10.1007/s10236-005-0043-0

Other reviewed publications

2005

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Other publications

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Bruijn, E.I.F. de and E. van Meijgaard, 2005. *Verification of HIRLAM with ECMWF physics compared with HIRLAM reference versions*. HIRLAM Technical Report: HIRLAM-6 project, 39pp.

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Bruijn, E.I.F. de, A.B.C. Tijm and G.J. Steeneveld, 2006. *Single-column modeling versus mesoscale modeling for an episode with three diurnal cycles in CASES99*. Proc. 17th Symp. on Boundary Layers and Turbulence, May 22-25, 2006, San Diego, CA, USA, AMS.

Manders, A.M.M., W.T.M. Verkley, A.R. Moene and J.J. Diepeveen, 2006. *Modification of a weather analysis and its effect on the forecast*. Final report, NIVR, Delft, The Netherlands.

Rooy, W.C. de, K. Kok, A.B.C. Tijm and D.H.P. Vogelesang, 2006. *Een ontspoord Hirlam model?* Meteorologica, **13**, 4, 7-10.

Rooy, W.C. de and A.P. Siebesma, 2006. *A simple parameterization for detrainment in shallow cumulus*. Proc. 17th Symp. on Boundary Layers and Turbulence, May 22-26, 2006, San Diego, CA, USA, AMS.

Schmeits, M.J., C.J. Kok, D.H.P. Vogelesang and R.M. van Westrhenen, 2006. *Probabilistic 0-12 h forecasts of (severe) thunderstorms in the Netherlands*. Proc. 28th EWGLAM and 13th SRNWP Meetings, October 9-12, 2006, Zürich, Switzerland, EUMETNET/SRNWP.

Publications

Observations Research and Development

The Observations Research and Development Division is responsible for in situ and remote sensing (including satellite) observations and their:

- Content quality and functionality
- Enhancements
- Maintenance and availability of knowledge and expertise on observations.

The division is also responsible for the functional enhancements of systems for (automatic) data processing, storage, and the availability of data and metadata.

In various studies, the division has designed components of the future Dutch observational network: upper-air observations, the synoptical network, and meteorological observations in coastal areas. These designs are intended for implementation.

The division participates in the Ocean and Sea Ice SAF and the Numerical Weather Prediction SAF, being primarily responsible for the development of algorithms for the satellite scatterometers wind observations.

Although not a participant in the Nowcasting SAF, the division has validated some SAF products within

the EU project CLOUDMAP. KNMI installed the Nowcasting SAF software and the Meteosat Second Generation (MSG) products are demonstrated to the forecasters and implemented in the weather service. For the ESA Core Explorer Atmospheric Dynamics Mission, the division contributes to the specification of the Doppler wind lidar system to be flown (Aeolus), and to simulated impact studies.

To better exploit the potential of KNMI's two Doppler radars several algorithms are developed.

Vertical radar wind profiles are created routinely and can be implemented operationally.

To enable water managers to use radar rainfall data as quantitative information, radar precipitation sums have been calibrated against in-situ precipitation observations.

The division contributed significantly to the study of extracting integrated water vapour data from European Global Positioning System stations for meteorological applications.

Finally the division's ICT group is very active in R&D for database development (for satellite data) and GIS applications in Climate and Meteorology.

Publications in reviewed journals

2005

Garcia-Herrera, R., G.P. Können, D. Wheeler, M.R. Prieto, P.D. Jones and F.B. Koek, 2005. *A climatological database for the world's oceans 1750-1854*. Climatic Change, **73**, 1-12.

Holleman, I., 2005. *Quality Control and Verification of Weather Radar Wind Profiles*. J. Atm. Oceanic Technol., **22**, 1541-1550.

Kerr, Y.H., G. Rochard, P. Tristant, S. English, M. Dreis, A. Stoffelen, J. Pla, B. Rommen, E. Marelli, K. Ruf and P. Bauer, 2005. *Comments on Interference from 24-GHz Automotive Radars to Passive Microwave Earth Remote Sensing Satellites*. IEEE Transactions on Geoscience and Remote Sensing, **43**, 1691-1692.

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Stoffelen, A., G.J. Marseille, E. Andersson and D.G.H. Tan, 2005. *Comments on The Impact of Doppler Wind Observations on a Single-Level Meteorological Analysis by L.P. Riishojgaard, R. Atlas and G.D. Emmitt*. J. Appl. Meteor., **44**, 1276-1277.

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DeLobbe, L. and I. Holleman, 2006. *Uncertainties in radar echo top heights used for hail detection*. Meteorological Applications, **13**, **4**, 361-374.

Haan, S. de, 2006. *Measuring atmospheric stability with GPS*. J. Appl. Meteor., **45**, 3, 467-475.

- Holleman, I., 2006. *Quality Control and Verification of Weather Radar Wind Profiles*. J. Atm. Oceanic Technol., **22**, 1541-1550.
- Portabella, M. and A. Stoffelen, 2006. *Scatterometer backscatter uncertainty due to wind variability*. IEEE Geosci. Remote Sensing Letters, **44**, 11, 3356-3362.
- Stoffelen, A., G.J. Marseille, F. Bouttier, D. Vasiljevic, S. de Haan and C. Cardinali, 2006. *ADM-Aeolus Doppler wind lidar Observing System Simulation Experiment*. Quart. J. Royal Meteor. Soc., **132**, 1927-1947.
- Stoffelen, A. and M. Portabella, 2006. *On Bayesian Scatterometer Wind Inversion*. IEEE Transactions on Geoscience and Remote Sensing, **44**, 6, 1523-1533.
- Stoffelen, A. and M. Portabella, 2006. *Scatterometer backscatter uncertainty due to wind variability*. IEEE Transactions on Geoscience and Remote Sensing, **44**, 11, 3356-3362.
- Wieringa, J. and I. Holleman, 2006. *If cannons cannot fight hail, what else?* Meteor. Z., **15**, 659-669.

Other reviewed publications

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- Beek, C.Z. van de, R. Uijlenhoet and I. Holleman, 2005. *Spatial Classification of Precipitation from Operational Radar Data*. Proc. 32nd Conf. on radar meteorology, 2005, Albuquerque, USA, AMS.
- DeLobbe, L. and I. Holleman, 2005. *Quality of Radar Echo Top Heights*. Proc. 32nd Conf. on radar meteorology, 2005, Albuquerque, USA, AMS.
- DeLobbe, L., I. Holleman, D. Dehenauw and J. Nemeghaire, 2005. *Verification of a Radar-Based Hail Detection Product*. Proc. WWRP Int. Symp. on Nowcasting and Very Short Range Forecasting (WSN05), 2005, Meteo France, Toulouse, France.
- Heijkers, J., I. Holleman and P. Schaper, 2005. *Hebben neerslagmeters hun langste tijd gehad?* H₂O, **18**, 38-40.
- Holleman, I., H. Benschop and J. van der Meulen, 2005. *Upper Air Wind Measurements by Weather Radar*. WMO Technical Conf. (TECO-2005), Bucharest, Rumania, WMO.
- Rossa, A., M. Bruen, D. Fruehwald, B. Macpherson, I. Holleman, D. Michelson and S. Michaelides (Eds), 2005. *Use of Radar Observations in Hydrology and NWP models*. COST 717 Final Report, EUR 21954, 292 pp, Brussels, Belgium.

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- Holleman, I., H. Beekhuis, S. Noteboom, L.G. Evers, H.W. Haak, H. Falcke and L. Bahren, 2006. *Validation of an operational lightning detection system*. Conf. paper ILDC.
- Noteboom, S., I. Holleman and H. Beekhuis, 2006. *Bliksemstatistieken uit het SAFIR/FLITS-systeem*. Meteorologica, **15**, 8-11
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- Elgered, G., H.P. Plag, H. Van der Marel, S.J.M. Barlag and J. Nash, 2005. *Exploitation of Ground-based GPS for Operational Numerical Weather Prediction and Climate Applications*. EC/COST EUR Technical Report, ISBN 92-898-0012-7, 234 pp. Brussels, Belgium.
- Haan, S. de, 2005. *Global Maps from GPS Radio Occultation Data*. DMI Scientific Report 05-08, Copenhagen, Denmark.
- Holleman, I. and H. Beekhuis, 2005. *Evaluation of three Radar Product Processors*. KNMI Internal Report IR-2005-03, KNMI, De Bilt, The Netherlands, 44pp.
- Holleman, I. and H. Beekhuis, 2005. *Review of the KNMI clutter removal scheme*. KNMI-Technical Report TR-284, KNMI, De Bilt, The Netherlands.
- Holleman, I., H. Mellink, T. de Boer and H. Beekhuis, 2005. *Evaluatie van Doppler Windscheringproduct*. KNMI Internal Report IR-2005-01, KNMI, De Bilt, The Netherlands, 33pp.

- Holleman, I., D. Michelson, G. Galli, U. Germann and M. Peura, 2005. *Quality information for radars and radar data*. EUMETNET Technical Report, OPERA 19, 77 pp.
- Michelson, D., T. Einfalt, I. Holleman, U. Gjertsen, K. Friedrich, G. Haase, M. Lindskog and A. Jurczyk, 2005. *Weather Radar Data Quality in Europe: Quality Control and Characterization*. Document COST 717, EUR 21955, 92 pp, Brussels, Belgium.
- Snoei, P., E. Attema, H. Hersbach and A. Stoffelen, 2005. *Uniqueness of the ERS scatterometer for typhoon forecasting and climate research*. Proc. IGARSS 25th Anniversary, July 25-29, 2005, Seoul, Korea.
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- Stoffelen, A., H. Bonekamp, J. de Kloe, M. Portabella and A. Verhoef, 2005. *OSI SAF scatterometer wind products*. Proc. Second OSI SAF User Workshop, March 15-17, 2005, Perros Guirec, France.
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- Verspeek, J.A., A. Stoffelen and S. de Haan, 2005. *C-band sea ice model*. EUMETSAT Ocean and Sea Ice Second Workshop, March 15-17, 2005, Perros-Guirec, France, UEMETSAT, ISBN 92-9110-072-2.

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- Haan, S. de, 2006. *Potential use of GPS water vapour observations*. Proc. EMS Conf., September 4-8, 2006, Ljubljana, Slovenia.
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- Holleman, I., 2006: *Bias adjustment of radar-based 3-hour precipitation accumulations*. KNMI Internal Publication TR-290, KNMI, De Bilt, The Netherlands, 56 pp.
- Kloe, J. de, M. Portabella, A. Stoffelen, A. Verhoef, J. Verspeek and J. Vogelzang, 2006. *SDP User Manual and Reference Guide 1.3*. EUMETSAT Technical Report, NWPSAF-KN-UD-002, 117 pp.
- Marseille, G.J., A. Stoffelen and J. Barkmeijer, 2006. *The added value of spaceborne Doppler Wind Lidar for extreme weather - a cycled SOSE experiment*. Proc. THORPEX Meeting, December 4-8, 2006, Landshut, Germany.
- Marseille, G.J., A. Stoffelen and J. Barkmeijer, 2006. *SOSE - Sensitivity Observing System Experiment*. Proc. Second THORPEX Int. Science Symp. (STISS), December 4-8, 2006, Obergurgl, Tyrol, Austria.
- Meulen, J.P. van der, 2006. *The Challenge to Increase the Performance of an AWS*. Proc. 4th ICEAWS, 24-26 May, Lisbon, Portugal. SREF: http://web.meteo.pt/en/extras/webICEAWS/iceaws_home.htm.
- Stoffelen, A., 2006. *Scatterometer measurements in extreme weather*. Proc. IGARSS, July 30 – August 4, 2006, Denver, CO, USA.
- Stoffelen, A., J. Barkmeijer and G.J. Marseille, 2006. *SOSE - Sensitivity Observing System Experiment*. Proc. 8th IWW, April 24-28, 2006, Beijing, China.
- Stoffelen, A., G.J. Marseille and J. Barkmeijer, 2006. *SOSE - Sensitivity Observing System Experiment*. EUMETSAT Meteorological Satellites Conf. June 12-16, 2006, Helsinki, Finland.
- Stoffelen, A., J. Vogelzang, J. de Kloe, M. Portabella, A. Verhoef and J. Verspeek, 2006. *EUMETSAT SAF scatterometer activities*. Proc. 8th IWW, April 24-28, 2006, Beijing, China.
- Stoffelen, A., J. Vogelzang, J. de Kloe, M. Portabella, A. Verhoef and J. Verspeek, 2006. *High resolution scatterometer winds; a compromise of signal and noise*. Proc. IGARRS, July 30 – August 4, 2006, Denver, CO, USA.
- Wessels, H.R.A., 2006. *KNMI Radar Methods*. KNMI Technical Report TR-293, 125 pp.

Publications

Climatological Services

The Climatological Services Division has the (national) responsibility for the digital and documentary preservation and archiving, including access, of all meteorological observations carried out by or under auspices of KNMI.

Climatological research, carried out by this division, focuses on the quality management of the archived climatological data and the development, production and dissemination of high quality and high-resolution datasets and derived climatologies and assessments. These climatologies and assessments, developed by research with a predominantly applied character, contain detailed descriptions of the climate of The Netherlands within the context of its geographical environment (Europe). They inform customers about the present and past climate and weather including the probabilities and descriptions of extremes.

Results of climatological research are available for internal and external use. Important societal stakeholders are the general public and media

(general climatological information), governmental bodies (supporting policy decisions concerning safety, economy and environment) and the research community.

In 2005 and 2006 the Climatological Services Division had a leading role in the establishment and management of the European Climate Assessment and Dataset (ECA&D). This platform of scientific collaboration and data exchange is evaluating into and acknowledged as the European focal point for high-resolution climatic data and assessment with an emphasis on extremes and is clearly visible in international frameworks like IPCC and CLIVAR. In 2006 ECA&D is nominated to operate as a RCC (Regional Climate Centre) for WMO RAVI (Europe).

The Climatological Services Division collaborated strongly with the Climate Analysis Division, not only with respect to ECA&D, but also in the domain of the HISKLIM programme that aims at the preservation and reconstruction of historical instrumental

Publications in reviewed journals

2005

Klein Tank, A.M.G., G.P. Können and F.M. Selten, 2005. *Signals of anthropogenic influence on European warming as seen in the trend patterns of daily temperature variance*. Int. J. Climatology, **25**, 1-16. doi:10.1002/joc.1087
Smits, A., A.M.G. Klein Tank and G.P. Können, 2005. *Trends in storminess over the Netherlands, 1962-2002*. Int. J. Climatology, **25**, 1331-1344.

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Other reviewed publications

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Engelen, A.F.V. van, 2006: *Le climat du dernier millenaire en Europe*. In: L'Homme face au climat, Collège de

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- Verkaik, J.W., 2006. *On wind and roughness over land*. PhD-Thesis, April 25, 2006, Wageningen University, Wageningen, The Netherlands.

Other publications

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- Dorland, R. van, 2005. *2005 eindigt met maatschappij-ontwrichtend weer*. Zenit, **33**, 2, 96.
- Dorland, R. van, 2005. *Eerste tropische cycloon in Spanje*. Zenit, **32**, 12, 581.
- Dorland, R. van, 2005. *Extreme luchtdrukdaling leidt tot storm*. Zenit, **33**, 1, 45.
- Dorland, R. van, 2005. *Extreme sneeuwval en barre kou*. Zenit, **32**, 5, 253.
- Dorland, R. van, 2005. *Felle buienlijn komt uit bijzondere hoek*. Zenit, **32**, 7, 371.
- Dorland, R. van, 2005. *Klimaat in een notendop: wetenswaardigheden en kengetallen*. CDA Pamflet, Duurzaamheidsberaad.
- Dorland, R. van, 2005. *Nederland ontsnapt aan novemberstormen*. Zenit, **32**, 1, 47.
- Dorland, R. van, 2005. *Overstromingen in het Alpengebied*. Zenit, **32**, 10, 477.
- Dorland, R. van, 2005. *Slechts één Biltse ijsdag in december*. Zenit, **32**, 2, 96.
- Dorland, R. van, 2005. *Storm en windstoten leiden tot eerste weeralarm 2005*. Zenit, **32**, 3, 149.
- Dorland, R. van, 2005. *Warmste decade september eindigt met zware buien*. Zenit, **32**, 11, 529.
- Dorland, R. van, 2005. *Zwabberende fronten in het Nederlandse luchtruim*. Zenit, **32**, 6, 305.
- Dorland, R. van, 2005. *Zware buien teisteren Nederland*. Zenit, **32**, 9, 423.
- Dorland, R. van and G.J. Komen, 2005. *Klimaatveranderingen en klimaatvoorspellingen*. Geografie, **14**, 6, 42-45.
- Geurts, H. and R. van Dorland (Eds.), 2005. *Klimaatverandering: wat is er aan de hand met het weer in Nederland en België?* TELEAC/KNMI, 128 pp, ISBN 9021580829.
- Wijngaard, J.B., M. Kok, I. Smits and M. Talsma, 2005. *Nieuwe statistiek voor extreme neerslag*. H2O, **6**, 35-37.

2006

- Buisman, J. and A.F.V. van Engelen (Ed), 2006. *Duizend jaar Weer Wind en Water in de Lage Landen*, Vol. 5: 1675-1570, Van Wijnen, Franeker, The Netherlands, 998 pp.
- Dorland, R. van, 2006. *Hoe bijzonder is de hitte van september 2006?* Zenit, **33**, 11, 545.
- Dorland, R. van, 2006. *Langste hittegolf in 30 jaar*. Zenit, **33**, 9, 440.
- Dorland, R. van, 2006. *Natste augustus sinds 1901*. Zenit, **33**, 10, 493.
- Dorland, R. van, 2006. *Uitsneeuwende mist*. Zenit, **33**, 4, 201.
- Dorland, R. van, 2006. *Slechts één warme dag in april*. Zenit, **33**, 6, 321.
- Dorland, R. van, 2006. *Windhoos in Bergeijk*. Zenit, **33**, 12, 597.
- Dorland, R. van, 2006. *Windhoos in Noordwijkerhout*. Zenit, **33**, 7, 387.
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- Dorland, R. van and B. Jansen, 2006. *De Staat van het Klimaat 2006; actueel onderzoek en beleid nader verklaard*. PCCC Brochure.
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- Dorland, R. van and K. Verbeek, 2006. *Hockeystick onder vuur* In: Jaarverslag KNMI 2005.
- Engelen, A.F.V. van, 2006. *The EU-Millennium project – a reconstruction of the climate of Europe for the last thousand years*. Proc. 6th European Conf. on Applied Climatology, September 4-8, 2006, Ljubljana, Slovenia, EMS-ECSN.
- Wijngaard, J.B., 2006. *MARKIS: the Dutch marine database and its quality control system*. KNMI Technical Report TR 286, KNMI, De Bilt, The Netherlands, 48 pp.

Publications

Climate Variability Research

The division investigates the

1. Dynamics of weather and climate
2. Variability of the coupled atmosphere-ocean system
3. Paleo-climate and climate change.

The study of extremes in current and future climate through the use of massive ensembles is a focus of the group. For example, in the ESSENCE project, a large-member ensemble of runs with a state-of-the-art

climate model is performed to investigate the range of possible future climate change. The development of weather forecasting techniques is done in collaboration with developers of weather models and with weather forecasters at KNMI. Together with the Oceanographic Research Division and the physics of weather and climate group of ICTP Trieste, the division has developed the SPEEDO coupled atmosphere-ocean model.

Publications in reviewed journals

2005

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- Haarsma, R.J., F.M. Selten, S.L. Weber and M. Kliphuis, 2005. *Sahel rainfall variability and response to greenhouse warming*. Geophys. Res. Lett., **32**. doi:10.1029/2005GL023232
- Schrier, G. van der and J. Barkmeijer, 2005. *Bjerknes' hypothesis on the coldness during 1790-1820 revisited*. Clim. Dyn., **24**, 355-371. doi:10.1007/s00382-004-0506-x Erratum: Clim. Dyn. doi:10.1007/s00382-005-0053-0
- Tuenter, E., S.L. Weber, F.J. Hilgen and L.J. Lourens, 2005. *Sea-ice feedbacks on the climatic response to precession and obliquity forcing*. Geophys. Res. Lett. **32**, L24704. doi:10.1029/2005GL024122
- Tuenter, E., S.L. Weber, F.J. Hilgen, L.J. Lourens and A. Ganopolski, 2005. *Simulation of climate phase lags in the response to precession and obliquity forcing and the role of vegetation*. Clim. Dyn., **24**, 2-3, 279-295. doi: 10.1007/s00382-004-0490-1
- Verkley, W.T.M., P.W.C. Vosbeek and A.R. Moene, 2005. *Manually adjusting a numerical weather analysis in terms of potential vorticity using three-dimensional variational data-assimilation*. Quart. J. Roy. Meteor. Soc., **131**, 1713-1736.
- Weber, S.L., 2005. *A timescale analysis of the NH temperature response to volcanic and solar forcing in the past millennium*. Climate of the Past, **1**, 9-17.
- Weber, S.L. and P. de Vries, 2005. *The Atlantic freshwater budget as a diagnostic for the existence of a stable shut-down of the meridional overturning circulation*. Geophys. Res. Lett., **32**, L09606. doi:10.1029/2004GL021450

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- Breugem, W.P., W. Hazeleger and R.J. Haarsma, 2006. *Multimodel study of tropical Atlantic variability and change*. Geophys. Res. Lett., **33**, doi:10.1029/2006GL027831
- Jung, T. and J. Barkmeijer, 2006. *Sensitivity of the tropospheric circulation to changes in the strength of the stratospheric polar vortex*. Mon. Wea. Rev., **134**, 2191-2207.

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2005

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Selten, F.M., 2005. *Extreem weer, nu en in de toekomst*. In: *Klimaatverandering*, H. Geurts en R. van Dorland (Eds), Kosmos-Z&K, Utrecht, ISBN 90 215 8082 9, 69-72.

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Publications

Oceanographic Research

The division studies the

1. Variability and predictability of the ocean and the climate system
 2. Interaction of the ocean with the atmosphere, including seasonal forecasting research
 3. Large-scale ocean circulation and sea-level rise.
- The division has made a significant contribution to the New Climate Change Scenarios for The Netherlands. The study of climate scenarios is an important focus of the group. This includes extreme scenario's

that may result from large changes in the Meridional Overturning Circulation. The division contributes to the international ARGO float programme for observing the deep ocean. The seasonal forecasting research has had practical applications through collaborations with the ECMWF. Information on seasonal forecasting is provided to the general public and to Service Providers. The Climate Explorer website for the analysis climate data sets has been made available to the public.

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Publications

Atmospheric Research

The central theme of the Regional Climate Department is the understanding of the regional heat and water balance of the atmosphere using the observations of the surface, boundary layers, clouds and aerosols from satellite and ground, and the determination of their physical properties and radiative effects. The ground observations are made at the Cabauw observatory which hosts CESAR (Cabauw Experimental Site for Atmospheric Research), the national consortium for atmospheric

and surface observations. These observations, in combination with products derived from satellite instruments (such as CloudSat/Calipso, EarthCare), are necessary for high-level research that aims at answering scientific and social questions related to climate change and air quality. Amongst others they are used for process studies, model evaluation and improvement, climate monitoring and satellite validation.

Publications in reviewed journals

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Publications

Atmospheric Composition Research

The focus of this division is observing and modelling the atmospheric composition and climate variables in relation to climate change, the ozone layer and air quality. The approach is along three ways:

- 1 Observations from satellites and from the ground. The division is an internationally recognized group in monitoring the atmosphere and climate from space. They are involved in observations with the satellite instruments SCIAMACHY, OMI and GOME-2. The division is also prominent in formulating the user requirements for future satellite missions both on national level as well as in ESA, EUMETSAT, EU and NASA panels. For monitoring, satellite and model evaluation, and process studies the division operates ground stations at De Bilt and Paramaribo and is involved in international measurement campaigns. The data are the basis for research and monitoring in line with the KNMI mission and are made available to the society, policy makers and the national and international scientific community via the KNMI data centre as well as international (world) data centres.

- 2 The use of the measurements has also high priority. The data are used to study atmospheric processes and validate chemistry transport and climate chemistry models. Furthermore on basis of the data, time series are constructed, trends in concentrations and emissions are determined and data are assimilated providing a four-dimensional description of the state of the atmosphere and climate. This is mostly done in projects together with other KNMI divisions and national and international partners.
- 3 The cycles of greenhouse gases, aerosols and their precursors are modelled with the global atmospheric chemistry model TM. TM is applied to produce high level assimilated satellite products and to calculate the impact of future emission scenarios, e.g. of aviation, shipping and road traffic. For model evaluation and process studies reconstructions of past atmospheric composition are made. With TM, KNMI has contributed to multiple international climate (IPCC) and ozone (WMO-UNEP) assessments.

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Publications

Climate Analysis

The research in the Climate Analysis division is a well-balanced mixture of applied research (services mainly for stakeholders in water management) and strategic research (papers in scientific journals). Focus is on the analysis and description of the past, present and future state of the climate. Main objectives are to:

1. obtain a better understanding of observed climate variability and change, in particular for near-surface climate variables (precipitation, temperature, etc.) in The Netherlands and Europe and for wind over the North Sea.
2. develop, update and disseminate KNMI climate scenarios for impact studies relevant for the Netherlands.
3. simulate high-resolution time series representative for the present and for the future climate, in particular for the catchments of the rivers Rhine and Meuse (on the basis of statistical resampling techniques).

4. reconstruct instrumental time series from Dutch sources by digitization, quality control and homogenization (HISKLIM programme).
5. develop and disseminate datasets of Dutch climate and datasets for which KNMI has international responsibility.

The emphasis is on climate extremes and severe weather events, because the impact of climate change is likely to be felt most strongly through changes in extremes. To ensure best scientific quality and to profit from international developments the strategic research in the area of climate analysis, scenarios and observational datasets is embedded in international programmes and networks (such as ENSEMBLES, IPCC and CLIVAR).

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Publications

Policy Advice and Related Services

A small staff unit ('CKB') coordinates KNMI's climate outreach and represents KNMI in a number of relevant international bodies such as the Intergovernmental Panel on Climate Change (IPCC), the Global Climate Observing System (GCOS) and the United Nations Framework Convention on Climate Change (UNFCCC).

Public Information

An important task of KNMI is to provide reliable information on climate and climate change to The Netherlands' society. By 'reliable' we mean: of high scientific quality, with balanced attention given to uncertainties, with proper attention to both natural and human induced climate variations, not policy descriptive and, more generally speaking, without value judgements. Public interest in climate change science has grown steadily in recent years and KNMI researchers quite frequently appear in the media.

Science support to national policymakers

In 2005 KNMI became chairman of both the PCCC bureau and its steering group. Several successful activities (symposia, brochures) have been organised to facilitate national policy making. A document was prepared in collaboration with the Adviesdienst Verkeer en Vervoer to explore the relation between transport, weather and climate change. This document was presented to policymakers. It was received favourably by Rijkswaterstaat. Both the Ministry of Housing, Spatial Planning and Environmental Protection and several members of parliament were advised on the McIntyre-McKittrick versus Mann debate (the hockeystick affair). The unit organised a discussion meeting, with (former) members of cabinet, politicians, civil servants and NGO's on Post Kyoto policy to celebrate the Kyoto Protocol entering into force.

Improving global climate monitoring: meetings of CoP and SBSTA

Support was provided to The Netherlands delegations at meetings of the bodies of the UNFCCC, the Subsidiary Body for Scientific and Technological Advice (SBSTA) and the Conference of the Parties (CoP) to the UNFCCC. With expertise in climate monitoring and the Global Climate Observing System (GCOS), and as national focal point for GCOS, The

Netherlands was represented by KNMI at discussions and negotiations aiming at improving global systematic climate observations at meetings of SBSTA and at CoP11 (Montreal) and CoP12 (Nairobi). A highlight at CoP12 in November 2006 was the announcement by The Netherlands of a contribution of 200 k€ per year for 2007-2010 for the realisation of the GCOS Action Plans for Africa, that aim at essential improvements of climate monitoring. As a result of an initiative by KNMI, this support is provided by the Ministry of Transport, Public Works and Water Management (VenW) and the Ministry of Housing, Spatial Planning and the Environment (VROM).

Intergovernmental Panel on Climate Change (IPCC)

The Netherlands' contribution to the IPCC (nominations, reviews, participation in meetings) was coordinated. At KNMI the first order draft of the Fourth Assessment Report was discussed by a broad group of scientists, to assist the individual expert reviewers. The unit acted as Head of Delegation to IPCC's 24-st Plenary in Montreal.

Climate Monitoring and the Global Climate Observing System (GCOS)

A contribution was made to the GCOS Regional Workshop for Eastern and Central Europe on Improving Observing Systems for Climate, held in April 2005 in Leipzig, Germany. Acting as national focal point for GCOS, a WAB project was started in 2006 (WAB, Scientific Assessment and Policy Analysis), aiming at improving climate observations in The Netherlands in coordination with a number of national institutes that are active in this field. The programme Global Monitoring for Environment and Security (GMES), an initiative of the EC and ESA, covers among others climate monitoring, and is seen as an important contribution to the GCOS Implementation Plan. GMES is also the European contribution to the quickly developing worldwide Global Earth Observation System of Systems (GEOSS). In relation to GCOS, contributions were made to the further development of these initiatives.

Other international bodies

Several members of the research divisions serve on international committees of WCRP and IGBP. The

Head of Climate Research and members of the staff unit complemented this activity by contributing to the IGBP programme SOLAS, to the European Network on Earth System Modelling, a COST project on the integration of ground-based remote-sensing systems and national and international programmes on the allocation of radio frequencies.

strategy for the Climate and Seismology Section of the KNMI. This initiative resulted in a conceptual document that forms the basis for (1) further specific description of the strategy and (2) more imbedded in the KNMI organisation (including the sections Weather and Infra. The goal is to provide a more extended strategy that is suitable for KNMI policy on sustainable external interrelationships.

Internal Services

In 2006 the Coordinator Climate Services (CKB) set up the first document on Relation Management and

Publications

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Bregman, A., 2006. *Zin en Onzin over Klimaatverandering*. Idee, juni, 5-7.

Komen, G.J., 2006. *Communicatie over Klimaatonderzoek*. Meteorologica, **15**, 3, 17-21.

Komen, G.J. and R. van Dorland, 2006. *Klimaatveranderingen en klimaatvoorspellingen*. Topos, **16**, 2, 10-13.

Monna, W.A.A., 2006. *Klimaatmonitoring: Wat meten, Waar en Waarom; Optimalisatie van de Nederlandse bijdrage*. Accepted project proposal for VROM Wetenschappelijke Assesments en Beleidsanalyse (WAB).

Monna, W., D. Engelbart, J. Nash and D. Ruffieux, 2006. *EU COST Action 720; Integrated ground-based remote-sensing stations for atmospheric profiling, an overview*. Proc. 7th Int. Symp. on Trpospheric Profiling: Needs and technologies, June 11-17, Boulder, Co., USA.

Publications

Seismology

The Seismology Division is responsible for the monitoring of seismicity in The Netherlands and carries out applied research. The research is focused on seismic hazard, which includes studies related to instrumentation, earth structure and the earthquake source. In addition to seismology, the department is also actively involved in infrasound research, focussing on identification of sources.

The devastating earthquake and tsunami in the Indian Ocean at the end of 2004 showed the vulnerability of modern society to the violence of nature. It resulted in a renewed awareness for tsunami warning and the build-up of new infrastructure. In 2005 and 2006, KNMI was involved

in advising the Indonesian government, and contributed to a tsunami warning system in the Caribbean by installing seismographs on the lesser Antilles (Saba, St-Eustace and St Maarten). In the same period applied research was focused on the seismic hazard of induced seismicity in The Netherlands.

ORFEUS, the European organization for the coordination of broad-band seismology, is integrated into the Seismology Division. In 2006 the EC funded NERIES project was realized, coordinated by ORFEUS. Networking the infrastructure and part of the applied research of the seismology division is structured within NERIES.

Publications in reviewed journals

2005

Bakun, W.H., B. Aagaard, B. Dost, W.L. Ellsworth, J.L. Hardebeck, R.A. Harris, C. Ji, M.J.S. Johnston, J. Langbein, J.J. Lienkaemper, A.J. Michael, J.R. Murray, M.S. Reichle, P.A. Reasenber, E.A. Roeloffs, A. Shakal and R.W. Simpson. *The 2004 Parkfield Earthquake: Implications for Earthquake Hazard*. Nature, **437**, 969-974. doi: 10.1038/nature04067

Evers, L.G. and H.W. Haak, 2005. *The detectability of infrasound from the Italian Mt. Etna in the Netherlands*. J. Atmos. and Sol. Terr. Phys., **67**, 3, 259-268. doi: 10.1016/j.jastp.2004.09.002

2006

Cloetingh, S., T. Cornu, P.A. Ziegler, F. Beekman, B. Dost, T. van Eck and co-authors, 2006. *Neotectonics and Intraplate Continental Topography of the northern Alpine Foreland*. Earth-Science Reviews, **74**, 127-196. doi:10.1016/j.earscirev.2005.06.001

Dost, B. and H.W. Haak, 2006. *Comparing waveforms by digitization and simulation of waveforms for four Parkfield earthquakes observed in station DBN, the Netherlands*. Bulletin of the Seismological Society of America, **96**, 4, S50-S55. doi:10.1785/0120050813

Eck, T. van, F.H. Goutbeek, H.W. Haak and B. Dost, 2006. *Seismic hazard due to small-magnitude, shallow-source, induced earthquakes in the Netherlands*. Engineering Geology, **87**, 105-121. doi:10.1016/j.enggeo.2006.06.005

Sleeman, R., A. van Wettum and J. Trampert, 2006. *Three-channel correlation analysis: a new technique to measure instrumental noise of digitizers and seismic sensors*. Bulletin of the Seismological Society of America, **96**, 1, 258-271. doi:10.1785/0120050032

Other reviewed publications

2005

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2005

Dohmen-Janssen, M., J. A. Battjes and F.H. Goutbeek, 2005. *Hoe ontstaan tsunami's en waarom?* Nederlands Tijdschrift voor Natuurkunde, **71**, 12, 380-386.

Eck, T. van, 2005. *Euro-Mediterranean Seismology in the virtual age*. RTD info, Magazine on European Research, **43**, 11, 9.

Eck, T. van, 2005. *MEREDIAN 8th Management Report (period: May 1, 2004- October 30, 2004)*. EC-project EVR1-CT-2000-4007.

Eck, T. van, 2005. *MEREDIAN Final Report*. EC-project EVR1-CT-2000-4007.

Eck, T. van, 2005. *MEREDIAN Fourth Annual Report (period: November 1, 2003- October 31, 2004)*. EC-project EVR1-CT-2000-4007.

Evers, L.G., 2005. *Infrasound monitoring in the Netherlands*. NAG Journaal, **176**, 1-11.

Haak, H.W. and F.H. Goutbeek, 2005. *Aardbevingen – Wat beweegt de aarde*. KNMI Publication 211.

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Garcia, A., J. Vila, R. Ortiz, R. Macia, R. Sleeman, J.M. Marrero, N. Sanchez, M. Tarraga and A.M. Correig, 2006. *Monitoring the reawakening of Canary Islands' Teide volcano*. EOS, Transactions, American Geophysical Union, **87**, 6, 61-65.

Holleman, I., H. Beekhuis, S. Noteboom, L.G. Evers, H.W. Haak, H. Falcke and L. Bühren, 2006. *Validation of an operational lightning detection system*. Conf. paper ILDC.

Acronyms

AAI	Absorbing Aerosol Index
ADAGUC	Atmospheric Data Access for the Geospatial User Community
ADM	Atmospheric Dynamics Mission
AEM	Assimilation Ensemble Method
AOT	Aerosol Optical Thickness
AR ₄	IPCC Fourth Assessment Report
ArcGIS	Family name for ESRI GIS software products
ARM	Atmospheric Radiation Measurement Program (US governmental programme)
ASCAT	Advanced Scatterometer
BALTEX	Baltic Sea Experiment
BBC	BALTEX Bridge Campaign
BOMEX	Barbados Oceanographic and Meteorological Experiment
BSIK-KvR	Besluit Subsidies Investerings Kennisinfrastructuur – Klimaat voor Ruimte
BSRN	Baseline Surface Radiation Network
BSS	Brier Skill Score
BWER	Bound Weak Echo Region
CAPE	Convective Available Potential Energy
CCSP	Climate Changes Spatial Planning
CESAR	Cabauw Experimental Site for Atmospheric Research
CHIMERE	Chemical Transport Model developed at the Institut Pierre Simon Laplace, France
CLIWOC	Climatological Database for the World's Oceans (EU project)
CMOD ₅	radar C-band GMF, version 5
COST	European Cooperation in the field of Scientific and Technical Research
DBN	Seismic Station De Bilt
DOAS	Differential Optical Absorption Spectroscopy
DU	Dobson Unit
DWL	Doppler Wind Lidar
ECHAM ₅	European Centre Hamburg (atmosphere model of the Max-Planck-Institute for Meteorology in Hamburg, version 5)
ECMWF	European Centre for Medium-Range Weather Forecasts
ED Eddy	Diffusivity
EDCG	Eddy Diffusivity Counter Gradient
EDGAR	Emission Database for Global Atmospheric Research
EDMF	Eddy Diffusivity Mass Flux
E-GVAP	EUMETNET GPS Water Vapour programme
EMEP	cooperative programme for monitoring and evaluation of long-range transmission of air pollutants in Europe
ENVISAT	Environmental Satellite
EPA	Environmental Protection Agency
ERS	European Remote-sensing Satellite
ESA	European Space Agency
ESRI	Environmental Systems Research Institute, Inc.
ESRL	Earth System Research Laboratory
ESSENCE	Ensemble Simulations of Extreme Weather Events under Nonlinear Climate Change
ETHMEG	Eidgenössische Technische Hochschule Model Evaluation Global Database
EU	European Union
EUMETNET	European Meteorological Network (cooperative network of meteorological services)
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
FRESCO	Fast Retrieval Scheme for Clouds from the O ₂ A band

FT	Fast Track
GCM	Global Climate Model
GCOS	Global Climate Observing System
GEV	Generalized Extreme Value
GFED	Global Fire Emissions Database
GHG	Greenhouse Gas
GIS	Geographical Information System
GMD	Global Monitoring Division
GMES	Global Monitoring for Environment and Security (EU programme)
GMF	Geophysical Model Function
GNSS	Global Navigation Satellite System
GOES	Geostationary Operational Environmental Satellite
GOME	Global Ozone Monitoring Experiment
GOS	Global Observing System
GPS	Global Positioning System
GSN	Global Seismographic Network
HadCRUT3	Hadley Centre - Climate Research Unit Temperature data set 3
HARMONIE	Hirlam - Aladin Research on Mesoscale Modelling for Operational NWP in Euromed
HC	Hydrocarbons
HDF	Hierarchical Data Format
HFS	Hirlam Forecasting System
HGN	Seismic Station Heimansgroeve
HIRLAM	High Resolution Limited Area Model
HISKLIM	Historical Climate, KNMI programme on data rescue, digitising and series homogenisation
HLOS	Horizontal Line of Sight
HYMN	Hydrogen Methane and Nitrous oxide: Trend variability, budgets and interactions with the biosphere (EU project)
HZS	Horizontal wind shear from Doppler radar
IMAU	Institute for Marine and Atmospheric Research Utrecht, the Netherlands
INSPIRE	Infrastructure for Spatial Information in Europe (EU project)
IPC	International Pyrheliometer Comparison
IPCC	Intergovernmental Panel on Climate Change
IPT	Integrated Profiling Technique
IR	Infrared
ISA	International Standard Atmosphere (recommended by WMO)
ISCCP	International Satellite Cloud Climatology Project
ISO	International Organization for Standardization
ITCZ	Inter-Tropical Convergence Zone
KML	Keyhole Markup Language
KNMI	Koninklijk Nederlands Meteorologisch Instituut (Royal Netherlands Meteorological Institute)
KODAC	KNMI Operationeel Data Centre
KOUW	Kansverwachtingen voor onweer ten behoeve van uitgifte weeralarm (Probabilistic forecasts of thunderstorms for the purpose of issuing a weather alarm)
LES	Large Eddy Simulation
LIDAR	Light Detection And Ranging
LOS	Line of Sight
LWC	Liquid Water Content
MESOMOD	Mesoscale Model Development
MesoNH	Mesoscale Non Hydrostatic
METEOSAT	EUMETSAT Geostationary Meteorological Satellite
MetOp	Meteorological Operational Polar Orbiting Satellite
MetOp-A	First (A) EUMETSAT MetOp
MLH	Mixing Layer Height
MOC	Meridional Overturning Circulation

MODIS	Moderate-resolution Imaging Spectrometer
MOS	Model Output Statistics
MPI-OM	Max-Planck-Institute - Ocean Model
MSG	Meteosat Second Generation
NARS	Network of Autonomously Recording Seismographs
NASA	National Aeronautics and Space Administration (US)
NCAR	National Center for Atmospheric Research (US)
NCC	Normalised Correlation Coefficient
NCEP	National Centers for Environmental Prediction
NetCDF-COARDS	Network Common Data Format, Cooperative Ocean/Atmosphere Research Data Service
NetCDF-CF	Network Common Data Format, Climate and Forecasting Data
NETPOS	Netherlands Positioning Service
NHNM	New High Noise Model
NLNM	New Low Noise Model
NOAA	National Oceanic and Atmospheric Administration
NWP	Numerical Weather Prediction
OGC	Open Geospatial Consortium
OMI	Ozone Monitoring Instrument
OPERA	Operational Programme on the Exchange of Radar Data (EU project)
OSSE	Observing System Simulation Experiment
PBL	Planetary Boundary Layer
PCMDI	Program for Climate Model Diagnosis and Intercomparison
PMSL	Pressure reduced to Mean Sea Level
ppb	Parts per Billion
ppbv	Parts per Billion by Volume
PRF	Pulse Repetition Frequency
PROMOTE	Protocol Monitoring for the GMES Service Element Atmosphere
QC	Quality Control
QUANTIFY	Quantifying the Climate Impact of Global and European Transport Systems
QuikScat	NASA SeaWinds Scatterometer Mission
RACMO	Regional Atmospheric Climate Model
RCM	Regional Climate Model
RDS	Radiosonde
RGI	Space for Geo-Information Programme
RICO	Rain In Cumulus over the Ocean Experiment
RMS	Root Mean Square
RNLAF	Royal Netherlands Air Force
SAF	Satellite Application Facility (EUMETSAT programme)
SAFIR	Surveillance et Alerte Foudre par Interférométrie Radioélectrique (lightning detection network)
SARA	Stichting Academisch Rekencentrum Amsterdam
SCIAMACHY	Scanning Imaging Absorption Spectrometer for Atmospheric Chartography
SCM	Single Column Model
SDRV	Standard Deviation of Radial Velocity
SDSIM	Slant Delay Simulation
SLR	Sea Level Rise
SNR	Signal-to-Noise Ratio
SOA	Service Oriented Architecture
SODAR	Sound Detection and Ranging
SOSE	Sensitivity Observing System Experiment
SPM	Summary for Policy Makers
SRES	IPCC Special Report on Emission Scenarios
SRON	Netherlands Institute for space Research
SSE	System Simulation Experiment
SST	Sea Surface Temperature

Sv	Sverdrup
TEMIS	Tropospheric Emission Monitoring Internet Service
Tg	Teragram (10^{12} gram)
THC	ThermoHaline Circulation
THORPEX	The Observing System Research and Predictability Experiment
TM ₃	Tracer Model version 3
TM ₄	Tracer Model version 4
UK	United Kingdom
US	United States
USA	United States of America
USGS	United States Geological Survey
UTC	Universal Time, Coordinated
UV	Ultraviolet
VAAC	Volcanic Ash Advisory Center
VAD	Velocity Azimuth Display
VEBSN	Virtual European Broadband Seismograph Network
VMR	Volume Mixing Ratio
VVP	Volume Velocity Processing
W ₃ C	World Wide Web Consortium
WCRP	World Climate Research Programme
WIS	WMO Information System
WIT	Seismic Station Witteveen
WMO	World Meteorological Organization
WRR	World Radiometric Reference
WRWP	Weather Radar Wind Profiles
WTSB	Seismic Station Winterswijk
WUR	Wageningen University and Researchcentre
WVC	Wind Vector Cell
ZHD	Zenith Hydrostatic Delay
ZTD	Zenith Total Delay
ZWD	Zenith Wet Delay