Deutscher Wetterdienst
Wetter und Klima aus einer Hand

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Yearbook 2018
of the Deutscher Wetterdienst

The Reference for Meteorology is the Deutscher Wetterdienst

Virtually everyone is interested in the weather and virtually every area of our lives is affected by weather and climate. As the reference for meteorology in Germany, the Deutscher Wetterdienst (DWD) is the prime point of contact for all questions related to these areas. The range of duties is many and varied. The DWD records, analyses and monitors the physical and chemical processes in our atmosphere. It holds information on all types of meteorological events, offers a diverse range of services both for the general public and for special user groups and operates the national climate archive.

In its role as a national meteorological service, the DWD is also a provider of scientific and technical services and a competent and reliable partner for public and private partners in the field of meteorology and climatology. Its customers' increasing demands on quality not only oblige the DWD to supply high-quality products and services, but also are a continuous incentive to improve product quality, customer orientation and economic efficiency.

The DWD, which was founded in 1952, is, as the national meteorological service of the Federal Republic of Germany, responsible for providing services for the protection of life and property in the form of weather and climate information. This is its core task. Established as an executive agency of the Federal Ministry of Transport and Digital Infrastructure (BMVI), the DWD provides meteorological information to ensure the safety of aviation and maritime shipping, traffic routes and vital infrastructures, in particular those needed for energy supply and communication systems. It also issues warnings of meteorological events that could become a danger to public safety and order and have a high potential to cause damage. The DWD, however, also has other important tasks, such as serving the needs of the Federation, the Länder, the local governments and institutions of justice; monitoring the climate; analysing and projecting climate change and climate change impacts; providing climate and environment consultancy services; and ensuring the fulfilment of the international commitments entered into by the Federal Republic of Germany. The DWD thus co-ordinates the meteorological interests of Germany on a national level in close agreement with the Federal Government and represents the Government in intergovernmental and international organisations such as, for example, the World Meteorological Organization (WMO). These duties are embodied in the Deutscher Wetterdienst Act of 10 September 1998 (Federal Law Gazette I, p. 2871), last amended by Article 1 of the Act of 17 July 2017 (Federal Law Gazette I, p. 2642).

Photo on front and back cover
View from the western tower of the Marine Meteorological Office up- and downstream of the River Elbe.

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Photos in the Yearbook 2018

The special photo series in the Yearbook 2018 is dedicated to the 150th anniversary of the Norddeutsche Seewarte/Deutsche Seewarte. The photos not only present the pioneers of the Seewarte, the series also illustrates the extent to which this institution has laid the foundations for meteorology and climatology. Pairs of pictures compare the past and present.

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Prof. Dr Gerhard Adrian, President of the Deutscher Wetterdienst

Dear readers,

Out of the nine warmest years since the beginning of nationwide meteorological measurements in Germany 137 years ago, eight did occur in the 21st century. With an average temperature of 10.5 °Celsius, 2018 is in first place; it also comes first in terms of sunshine duration, recorded since 1951. The prolonged drought from March until November is another point worth mentioning. Despite more precipitation after this period, the deficit in precipitation has not been compensated by spring 2019.

With these key facts regarding the weather of the previous year, I welcome you warmly to the Yearbook 2018 of the Deutscher Wetterdienst.

In the 2018 edition of our new Yearbook, we will shine a light on the weather events of the previous year and assess them from a climatological point of view, as 2018 is one of the warmest years ever also on the global scale. One of the areas on which this review of the past year is focused is agriculture, which has been affected particularly strongly by the prolonged drought.

The DWD can look back at a successful year, both on a national and an international level. Our know-how is appreciated and sought after for a diverse range of initiatives, such as a project in Madagascar, our co-operation with Copernicus or the extension of the open data server. In addition to these topics, the main chapter of the Yearbook presents further interesting building blocks of our work. At this point, I would like to thank our employees for their excellent work as it is their commitment and dedication that have made all these achievements possible.

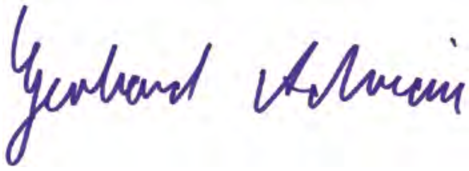
I am particularly pleased that the interview partner for the first edition of our Yearbook was Dr Thomas Reiter. He has worked in space for almost a year and has found, so he explained to us among other things, a parallel between the work of an astronaut and that of a meteorologist.

In 2018, the DWD and the Federal Maritime and Hydrographic Agency (BSH) jointly commemorated 150 years of maritime services in Germany. DWD and BSH are the successor organisations to the Norddeutsche Seewarte, established on 1st January 1868 as a private institute. For this reason, the photos for the Yearbook 2018 are dedicated to this anniversary to illustrate the development of meteorology and climatology since then. The founding fathers of the Norddeutsche Seewarte and its direct successor, the Deutsche Seewarte, acted with great insight and vision. They built the foundations for, among other things, the coastal warning services and the standardisation of weather observations and weather data transfer, which is still of great benefit to us.

Let me also draw your attention to a new feature: our Yearbook also comes with a poster the front of which presents meteorological topics, in this edition to the classification of clouds. The poster's back holds interesting climate statistics for Germany, such as the monthly temperature anomalies for the previous year.

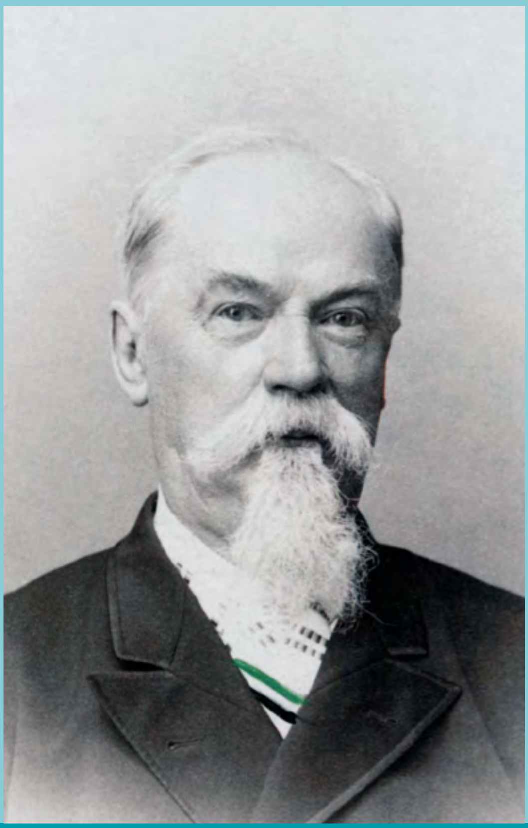
Another important topic in 2018 was the further development of our long-term strategy. Our Board of Directors uses this management tool to steer the DWD, as it allows us to deal with the constantly changing national and international framework in a flexible and future-proof way while, at the same time, we remain a reliable service provider for our mandating authorities, customers and partners. We will report in more detail on our strategic development lines until 2030 in next year's issue of the Yearbook. For now, however, I wish you a pleasant reading of the new Yearbook 2018 of the Deutscher Wetterdienst.

Yours faithfully,



Gerhard Adrian

Prelude



Wilhelm von Freeden officially opened the Norddeutsche Seewarte as a private institute on 1 January 1868, initially for a trial period of two years.

Georg von Neumayer directed the Deutsche Seewarte for 27 years. Under his leadership, it gained great national and international recognition for its work in the field of nautics, meteorology, climatology and polar research.

Wladimir Köppen was one of the Seewarte's most important meteorologists. Among the achievements credited to him are the provision of daily weather charts, the setting-up of the storm warning service, the description of climate zones around the world and the introduction of the term 'aerology'.

Alfred Wegener, Wladimir Köppen's son-in-law, became head of department at the Deutsche Seewarte in 1919; later, he moved to Graz as a professor of meteorology in 1924.

150 years

of Norddeutsche Seewarte and provision of maritime services in Germany

Making ocean voyages safer and quicker by using the different seasonal wind and current regimes in the world's oceans – this was what the rector of the Navigation School of the Dukes of Oldenburg in Elsfleth, Wilhelm Ihno Adolf von Freeden, aimed for when he inaugurated the Norddeutsche Seewarte (in English: North German Maritime Observatory) on 01 January 1868.

The institute, privately run and located in a few rooms in Hamburg's seamen's hostel, the Seemannshaus (which today houses the hotel Hafen Hamburg), was established with the support of 28 shipowners and the chambers of commerce of Bremen and Hamburg.

150 years later, under the motto of 'Above water – Under water', the Federal Maritime and Hydrographic Agency (Bundesamt für Seeschifffahrt und Hydrographie, BSH) and the Deutscher Wetterdienst (DWD) jointly commemorated the development which the nautical-hydrographic and meteorological services have undergone since then. These two federal institutions, both under the authority of the Federal Ministry of Transport and Digital Infrastructure (BMVI), are the successor organisations to the Deutsche Seewarte (in English: German Marine Observatory).

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Home of the Norddeutsche Seewarte in Hamburg's former seamen's hostel, the Seemannshaus (which today houses the hotel Hafen Hamburg).

Shorter voyage times

In 1868, hydrography and meteorology were still in their infancy. A little more than 20 years earlier, Lieutenant Matthew Fontaine Maury, an officer of the United States Navy, had presented his Wind and Current Charts. Sailing directions for new shipping routes enabled ships to reduce the length of sea voyages by using the ocean's natural currents and winds. It was these findings of Maury's that encouraged von Freeden's thoughts. Immediately after the Deutsche Seewarte had been established, he acquired meteorological instruments in order to compare these with the instruments aboard the ships. Measurements of the sea coastline were carried out. Von Freeden distributed a special type of logs (ship logbooks), in which the ships' crews recorded their meteorological observations during sea voyages every four hours according to a set scheme. This is how until 1940 around 37,000 of such logs were created and handed down to today's experts at the DWD's Seewetteramt (in English: Marine Meteorological Office), who are currently exploiting and digitising the records in order to make them available for research purposes. According to von Freeden the ships using his customised sailing directions were able to shorten their sailing time by 7.1 days for outbound trips and 4.0 days for homeward-bound journeys. Between 1868 and 1875, von Freeden wrote around 850 such sailing directions.

The Seewarte is transformed into an imperial institution

Shortly after the foundation of the German Empire, the Norddeutsche Seewarte was renamed by von Freeden to Deutsche Seewarte – a name which it also kept when it was transformed into an imperial institution of the German Imperial Admiralty in 1875. Following Georg von Neumayer's appointment as the Deutsche Seewarte's first director, von Freeden sold the entire equipment and all the ships' logbooks, sailing instructions and working documents to the German Empire.

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The Deutsche Seewarte moved into its news premises on Stintfang hill in 1881. The building was destroyed in 1945 and was not rebuilt.

Growing amount of tasks and recognition

During the 27 years under von Neumayer's aegis, the tasks and the Seewarte's recognition increased significantly on both a national and international level. For the advancement of maritime shipping, the Seewarte carried out numerous observations and measurements related to maritime-meteorological physics and the Earth's magnetic field, etc., tested nautical instruments and published sailing manuals. In support of the storm warning service, meteorological observation sites were set up along the coast and in inland areas, weather observations were recorded and transmitted by telegraph and bulletins were issued to inform about dangerous changes in the weather. From 16 February 1876 onwards, the Deutsche Seewarte published daily weather charts. This boost in significance became visible by virtue of the stately new building above Hamburg's quayside, into which the Deutsche Seewarte moved in 1881 and which remained its headquarters until the premises were destroyed in 1945. But by then, the Seewarte had already become 'Germany's central office for meteorology', which, by the end of the 19th century, turned into a hub for the first international exchanges of meteorological observation data.

From 16 February 1876 onwards, the Deutsche Seewarte published daily weather charts.

The scope of tasks was further extended to include, for example, polar research, oceanography, marine science, tidal information services and storm surge warning services. The Seewarte played a key role in the establishment of marine science in Germany. Renowned scientists at the Deutsche Seewarte contributed to advancing research in the areas of nautics, hydrography and meteorology. These include, among many others, Wladimir Köppen, Alfred and Kurt Wegener, and Christian Koldewey. In 1903, for example, a kite station was established at Gross-Borstel for collecting meteorological measurements at different heights in the free atmosphere.

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Today above Hamburg's quayside: the Marine Meteorological Office of the Deutscher Wetterdienst (left), the Federal Maritime and Hydrographic Agency (BSH, middle) and the hotel Hafen Hamburg (right).

Reallocation of tasks

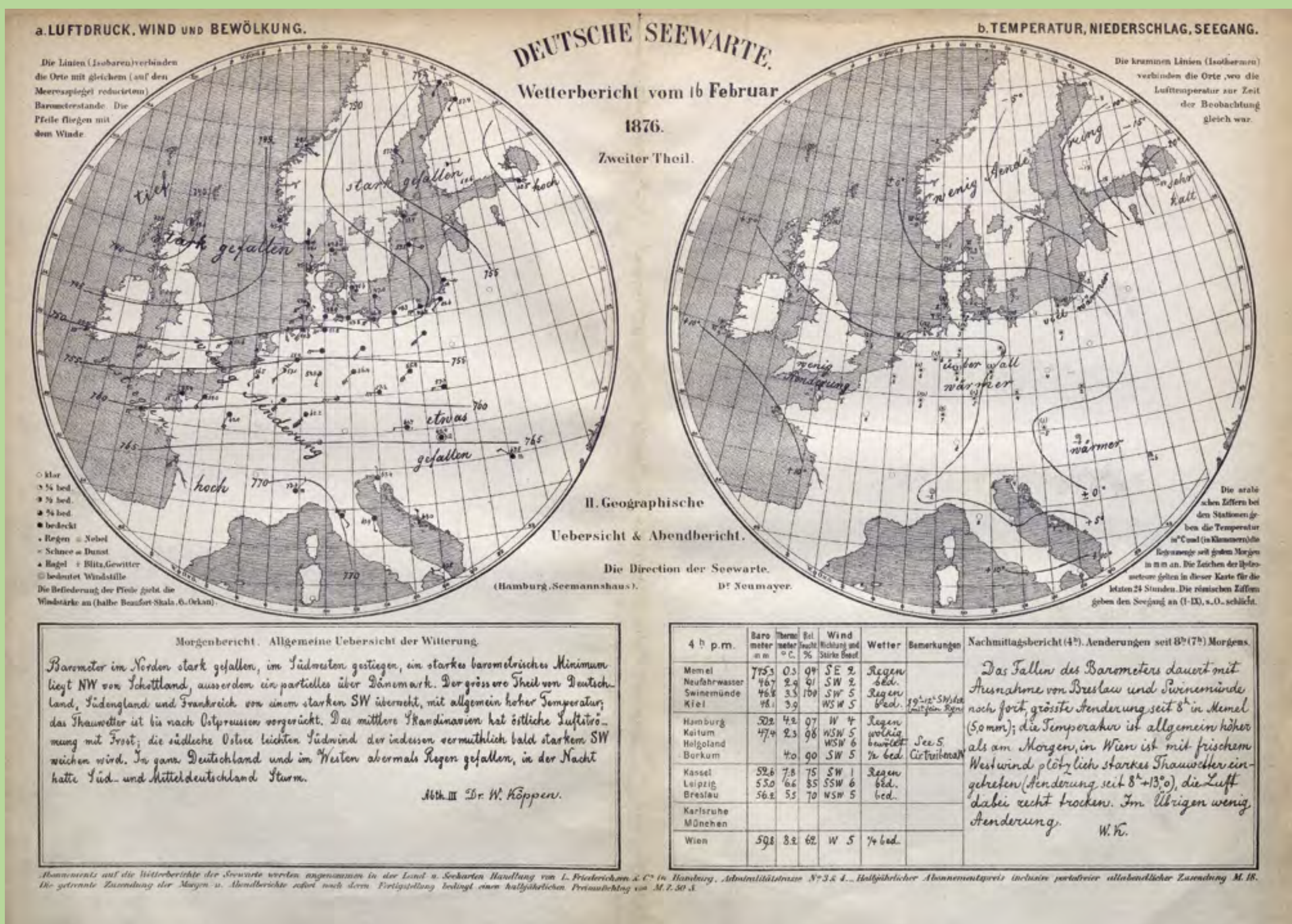
From 1919, the Deutsche Seewarte was under the supreme control of the Reich Transport Ministry. In 1935, it was split up for the first time: the meteorological service was put under the authority of the Reich Aviation Ministry, nautics and hydrography fell under the responsibility of the navy. Another change followed in 1945/1946, when the British occupying forces founded the German Hydrographic Institute (Deutsches Hydrographisches Institut, DHI) and the Meteorological Office for North-West Germany (Meteorologisches Amt für Nordwestdeutschland, MANWD). In 1948, the DHI moved into the former seamen's hostel whereas the MANWD had been assigned to the neighbouring navigation school the year before. The Soviet Occupation Zone saw the foundation of its Meteorological Service (Meteorologischer Dienst, MD) and the Marine Hydrographic Service (Seehydrographischer Dienst, SHD).

The further history up to 2018 is rapidly told: in 1990, at first, the DHI and the Federal Office of Tonnage Measurement (Bundesamt für Schiffsvermessung, BAS) were merged into today's Federal Maritime and Hydrographic Agency (Bundesamt für Seeschifffahrt und Hydrografie, BSH). During Germany's reunification, the tasks of former GDR institutions (mainly those of the SHD and which were comparable to those of the BSH) were assigned to the latter. Founded on 11 November 1952, the Deutscher Wetterdienst (DWD) united the three meteorological services of the federal states in the French occupation zone with the MANWD and the Meteorological Service for the US zone (Deutscher Wetterdienst in der US-Zone). The former GDR's Meteorological Service was incorporated into the DWD in 1990. To date, BSH and DWD have not only been direct neighbours in Hamburg, they are also closely interconnected with regard to the statutory tasks they have to fulfil.

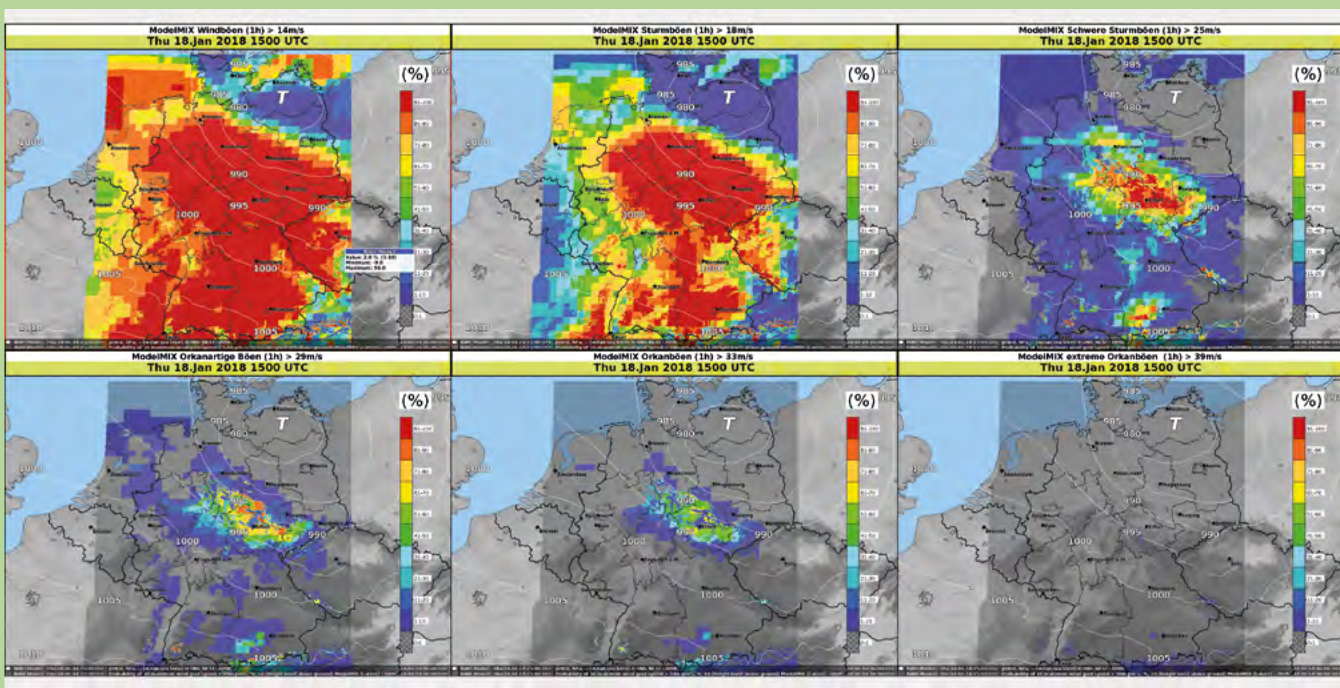
Photos in the Yearbook 2018

The special photo series in the Yearbook 2018 is dedicated to the anniversary of the Norddeutsche Seewarte. The photos not only present the pioneers of the Seewarte, the series also illustrates the extent to which this institution has laid the foundations for meteorology and climatology. Pairs of pictures compare the past and present.

Weather and climate in 2018



Over the course of its existence, the Seewarte has set numerous standards and milestones, such as issuing the first daily weather chart on 16 February 1876. Since that date, exchange markets, shipowners and newspaper editors have benefited from these weather reports and weather forecasts. The Seewarte, specifically its renowned meteorologist Wladimir Köppen, invented the 'handwritten weather map'. A special key for analysing the weather data, which is similar to the one still in use today at the meteorological services, enabled the draughtsmen at the newspapers to draw the isobars onto the weather maps.



The software system NinJo is able to process all types of meteorological observations and forecast data and display these graphically on the screen. NinJo greatly facilitates the work of the weather forecasters as it processes and displays the two terabytes of new data arriving every day in a clear and well-structured manner. The graphic shows the predicted wind speeds for deep depression FRIEDERIKE on 18 January 2018.

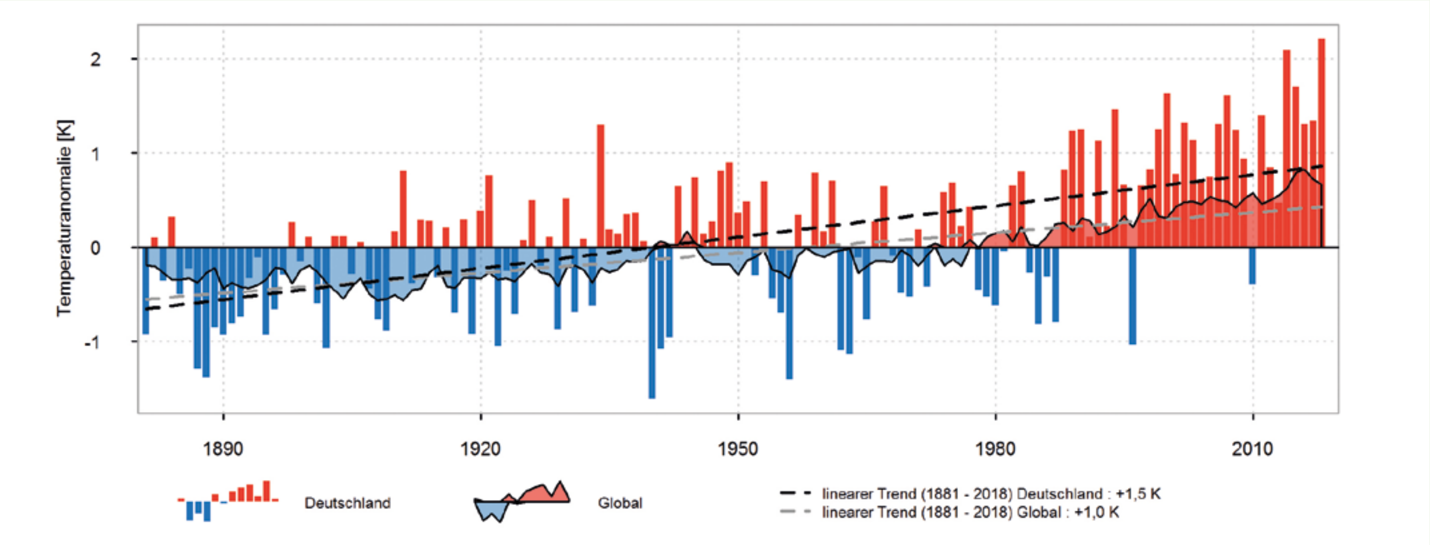
2018:
warmest year on record for Germany

At an average temperature of 10.5 degrees Celsius (°C), the year 2018 is the warmest year on record for Germany since regular measurements began in 1881.

Most noteworthy was the prolonged drought from February until November. The exceptional conditions in 2018 resulted from the combination of high temperatures and low precipitation. At 2,015 hours of sunshine, a new record was also set for sunshine duration.

The previous temperature record was set only four years ago, in 2014. At 10.3 °C, that year had brought the first double-digit average temperature for the whole of Germany. Temperatures in 2018 were even higher. When compared to the international reference period 1961 – 1990, there is a positive anomaly of + 2.3 °C. Despite the very cold temperatures in February (2.3 °C) and March (1.1 °C), this new record was set due to the high temperatures during the other months. Over six months, there was a deviation of even more than + 3 °C compared to the long-term average.

Both April and May were the warmest months ever in their respective series. In September, October and November, the anomalies amounted to + 1 to + 2 °C. The fairly cool March was followed by a first spell of ‘summer days’ (maximum temperatures ≥ 25 °C) during the last ten days in April. Even October still brought many summer days. The nationwide average number of summer days in 2018 was 74 days, which is significantly more than the 62 days in 2003. Very high temperatures, often above 30 °C, were recorded during the period from end-July to mid-August 2018. With regard to the average numbers of hot days (maximum temperatures ≥ 30 °C), the difference between the two years compared was much smaller: the nationwide average in 2018 was 20 hot days, compared to 19 hot days in 2003.



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Temperature development in Germany vs. global figures for 1881 to 2018

Precipitation also continued to be at a record-breaking low level until the end of November. December finally brought significantly more precipitation than the long-term average. Averaged over the whole of Germany, the precipitation total for 2018 was 586 l/m². This makes 2018 the fourth driest year on record since 1881, after 1959, 1911 and 1921. In Brandenburg and Saxony-Anhalt, it was even the driest year ever. Throughout the whole country, agriculture and shipping were extremely affected by the low availability of water, with an overall deficit of 200 l/m², or 25 per cent, compared to the long-term average for the 1961–1990 reference period. Nevertheless, the year had begun with full water reservoirs thanks to the large amounts of precipitation which had fallen in the second half of 2017 and in January 2018.

In 2018, a record-breaking annual average of 2,015 sunshine hours was registered, which just about beats the 2,014 hours recorded in 2003. The sun shone most in and around Berlin, the least sunshine (1,750 hours) was recorded in the Sauerland.

On the global scale, 2018 is the fourth warmest year on record since 1850. The globally averaged temperature was 0.38 °C (± 0.13 °C) above the 1981–2010 long-term average of 14.3 °C and around 1 °C above the pre-industrial baseline (1850–1900). The warmest year so far was 2016, due to the influence of a strong El Niño phase. 2015 and 2017 come second and third. This means that all the years from 2015 to 2017 had average temperatures of more than 1 °C above the level of pre-industrial times. The twenty warmest years all have occurred during the past 22 years.[1]

[1] https://public.wmo.int/en/media/press-release/wmo-confirms-past-4-years-were-warmest-record

Heat and drought – an agrometeorological review of the year 2018

The year 2018 was a year of extremes and, because of the experienced combination of heat and drought, it was unique in its kind from a climatological point of view. The changes resulting from climate change make it very likely that extreme years such as this one will occur more frequently in the future.

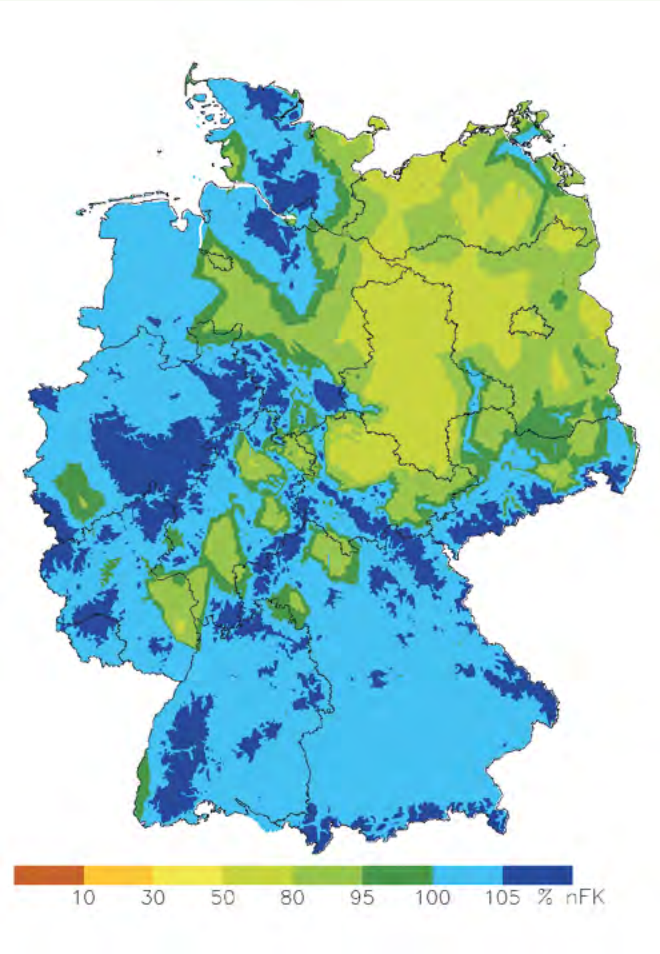
Well saturated soils at the beginning

Above-average precipitation from October 2017 to January 2018 had led to well saturated soils so that agriculture had a good start into the vegetation period 2018. In some regions, the fields held so much water that the maize could not be harvested in autumn 2017; it also was extremely difficult to sow the autumn crops.

January was mild, which brought the first signs of new growth, such as hazels shedding their pollen and snowdrops flowering in many places. But then, however, the winter returned, interrupting the phenological development for nearly two months. It was not until around the beginning of April that the air temperatures, and with them the soil temperatures, finally made a quick rise to above 5 °C and spring soon was in full swing. In Germany, the vegetation stages from early spring (flowering of forsythia, leaf unfolding of gooseberry) through to the end of early summer (flowering of large-leafed lime) normally last slightly over 80 days. In 2018, nature went through these stages about three weeks faster. Obviously, this also applied to agricultural crops, which benefited from the high air temperatures in combination with the equally strong global radiation.

Drought stress due to decreasing soil moisture

Due to these temperature and radiation conditions, real evapotranspiration began to increase from April onwards. At first, evaporation needs were still satisfied as there was a sufficient supply of water. However, when the warm and very sunny weather continued beyond May, the first signs of drought stress in agricultural crops started to show in those regions of Germany where light soils with a low water retention capability prevail. At the end of May, the soil moisture content was already down to an available field capacity (AFC) of less than 50 per cent at depths between 0 to 60 cm. Ideal levels of water supply range from 50 to 80 per cent AFC.



Available field capacity

Field capacity (FC) is the amount of water a drained soil can hold against gravity. This threshold is usually reached two or three days after complete saturation with water and once the excess water has drained away into the underground. Not all the water contained in soils is available to the plants; for this reason, the amount of plant-available water is given as the available field capacity (AFC).

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After the prolonged drought during 2018, the soils began to recover in December 2018 so that a state of water saturation was reached again in widespread parts of the country in January 2019.

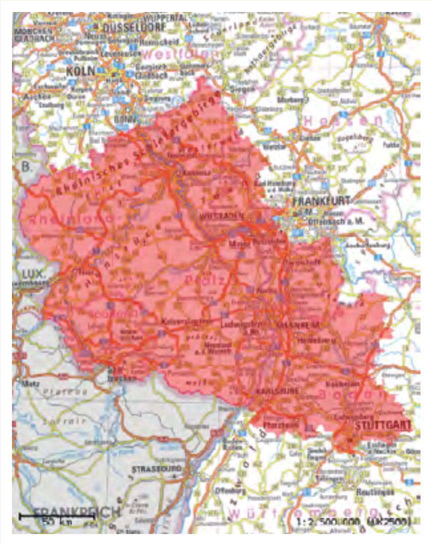
In the end, the lack of soil moisture affected nearly the entire German territory. In July, for example, only winter wheat fields in areas to the south of the Danube were still sufficiently supplied with water, whereas in the areas to the north of the Main the important grain filling stage was more and more affected by the growing drought in soils. By the end of August, soil moisture figures had dropped even further to a level of below 10 per cent AFC and the plants in widespread parts of Germany were suffering from a considerable drought stress. This situation led to yield reductions not only in winter wheat but also in many other cultivated crops and even in grass, which could not be cut a second time in many places.

But this is not all: the dry and warm weather conditions continued to persist even into the sowing period for the secondary season crops. This resulted in a largely reduced emergence of winter oilseed rape in some regions; in a number of places, the fields had to be ploughed up again. The crops developed reasonably well in those areas where occasional showers had fallen. Also, the later the seeds had been planted the better this was as dew formed due to the large temperature differences which occurred as the nights were getting longer. This helped the plants to survive. The weather situation did not change until November. From December onwards, above-average amounts of precipitation, compared to the long-term climate average, fell in widespread parts of all regions.

Warnings of extremely severe weather now also included in MoWaS

Since 5 February 2018, the DWD's warnings of extremely severe weather have also been fed into the satellite-based modular warning system MoWaS operated by the Federal Office of Civil Protection and Disaster Assistance (BBK).

The MoWaS warning system is designed to inform the population immediately of imminent danger situations via as many communication channels as possible. Transmission of the warning messages by satellite and redundantly by cable makes the system invulnerable to power outages or disruptions to terrestrial transmission networks. In these cases, the dissemination of severe weather warnings is ensured by a MoWaS station specifically installed at the DWD for the purpose of a backup.



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MoWaS graphic of the area for which warnings of extremely severe thunderstorms were distributed (night of 01 June 2018).

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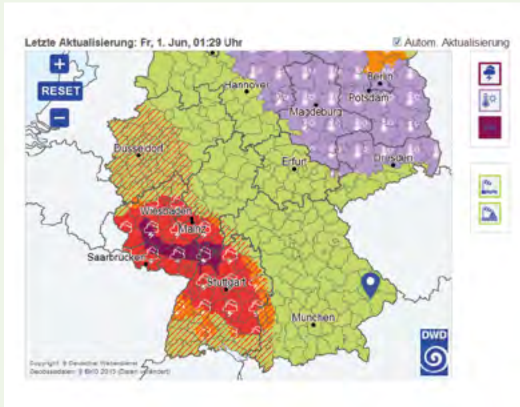

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Map on website showing the warning situation over western Germany for heavy thunderstorms (red) and extremely severe thunderstorms (violet enclosures in the red patches).

In addition to the events that fall into the DWD's highest weather warning category, i. e. extremely severe weather (level 4), MoWaS also includes warnings of severe weather with an unusually high potential to cause damage (severe weather warnings, level 3). Examples for such level-3 situations would be a storm event affecting a larger, supra-regional area with violent to hurricane-force winds in summer, when the trees are fully in leaf, or a storm accompanied by severe thunderstorms and hurricane-force gusts, both of which feature a very high potential to endanger outdoor events that attract a large numbers of visitors.

Extreme weather or impacts of extreme weather can be unusual wind, thunderstorms, heavy and persistent rain, snowfall, ice and power line vibration. MoWaS warning messages are invariably sent out in addition to the detailed severe warnings officially issued by the DWD and to the official emergency information bulletins disseminated in Bavaria and Baden-Württemberg. They require a lead time of at least 30 minutes between the decision to issue a warning and the time at which the dangerous event is expected to occur. This will allow, for example, radio and TV broadcasters to interrupt their programmes at suitable moments or display tickers with warning information, respectively.

Considering these tight requirements and due to the prolonged period of dry high-pressure conditions over the summer, there were only a few occasions in 2018 when MoWaS became active. The first time that the preconditions were fully met was in the night of 01 June 2018. On this occasion, a MoWaS warning message with embedded severe weather warnings was sent out for a relatively large area 25 minutes after the DWD had issued its large-scale warning (first issuance on 31 May, 23:51, standard time). Further official warnings of extremely severe weather were issued successively by the DWD for the various parts within the MoWaS warning area.

During this start-up phase of MoWaS operational services, it became clear that the implementation of MoWaS warning messages by the users was not yet fully functioning. None of the affiliated TV channels displayed the ticker texts included in the MoWaS messages. Here, the processes need to be further improved in order to ensure that the people concerned are reached through this channel, too. According to the manufacturer of MoWaS, the software will be adjusted accordingly in the system's next version, version 2.0, which will be available in autumn 2019.

Eleven years after KYRILL: Storm FRIEDERIKE

Deep depression FRIEDERIKE, which crossed northern Germany from the British Isles towards Poland on 18 January 2018, caused wind gusts up to hurricane force. The instruments on the Brocken (Harz Mountains) even recorded one gust of 203 km/h.

The depression was preceded by heavy snowfall, with very deep fresh snow especially in the low mountain ranges and in the northern parts of Germany. This was followed by above-freezing temperatures, which mostly persisted even overnight, and rain, causing the snow cover to melt away. Consequently, the measurements of fresh snow depth at 7:00 CET on the following day amounted in many places to no more than six centimetres.

In Germany and the other European countries affected, schools were closed, flights cancelled and long-distance railway journeys suspended. Due to snowfall, ice and fallen trees, there were major travel disruptions and power outages occurred. Several fatalities were reported.

Comparison between FRIEDERIKE (2018) and KYRILL (2007)

The peak gusts produced by FRIEDERIKE are comparable to those observed during other severe winter storms, such as KYRILL, which raged across the whole of Germany on 18 and 19 January 2007 exactly 11 years ago. Deep depression KYRILL qualifies as one the most severe winter storms of the past years. Back then, KYRILL tracked eastwards across Scotland, the North Sea and Denmark. The storm's lowest core pressure was 965 hPa. At its southern flank, very high wind speeds ravaged over an area as large as Germany.

By comparison, deep depression FRIEDERIKE passed slightly more to the south. Its lowest core pressure was 974 hPa.

The storm field at the depression's southern flank mainly centred over the central parts of Germany, stretching in a band from Rhineland-Palatinate to Saxony. North Germany was less affected by the storm. Compared to FRIEDERIKE, KYRILL's storm field extended over a wider area and its wind speeds were mostly higher than those caused by FRIEDERIKE. The latter produced stronger peak gusts only in central Germany. The following table shows a comparison between the peak gust speeds of the two deep depressions. The stations highlighted in green are those where FRIEDERIKE's wind gusts were stronger than KYRILL's.

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Satellite image by METEO-SAT 10 of 18 January 2018, 12 UTC

02
Storm FRIEDERIKE's track across Europe from 17 to 19 January 2018

Peak gusts (in km/h) at selected stations in Germany (Source: DWD)

Station	KYRILL 18/19 Jan. 2007	FRIEDERIKE 18 Jan. 2018
Helgoland	120	70
Schleswig	108	39
Bremerhaven	110	57
Rostock-Warnemünde	121	55
Ahaus	107	127
Münster/Osnabrück	111	126
Berlin-Schönefeld	112	80
Lindenberg	119	77
Werl	112	122
Göttingen	105	111
Brocken	199	203
Leipzig/Halle	112	129
Dresden-Klotzsche	123	122
Wasserkuppe	172	132
Erfurt	119	130
Gera-Leumnitz	116	138
Frankfurt/Main	95	86
Bamberg	92	64
Stuttgart-Echterdingen	108	80
München (City)	104	92
Feldberg (Black Forrest)	166	144
Zugspitze	183	158

High wind speeds up to hurricane-force were recorded not only in Germany, but also in other European countries, in particular Great Britain, the Low Countries, northern France as well as Poland and the Czech Republic especially on mountain tops. Switzerland recorded storm-force gusts close to 100 km/h in the lowland parts on the north side of the Alps and hurricane-force gusts of up to 130 km/h at higher altitudes. In some of these countries, FRIEDERIKE was known by a different name.

Climatological assessment

FRIEDERIKE's highest impact over Germany was focused over a band stretching from North Rhine-Westphalia to Saxony. The peak gust speeds measured there are among the highest recorded during the whole reference period of 1981–2010. The highest wind speed which FRIEDERIKE produced over Germany was 203 km/h on the Brocken. This is slightly higher than KYRILL's maximum of 199 km/h. The Brocken has already seen even higher wind speeds, especially during the 1990s and a few earlier years: windstorms DARIA (25/26.1.1990), VIVIAN (26./27.2.1990) and CAPELLA (3.1.1976), all with wind gusts of up to 230 km/h, and YRA (24.11.1984), which even produced wind gusts of up to 263 km/h. Based on an analysis of various sources carried out by Mölter et al. (2016), projections for the future (2020–2190) indicate that the frequency and intensity of storms over western and central Europe will increase whereas a decrease is expected over southern Europe. For northern and eastern Europe, the results are inconclusive.[1]

[1] Note: Validity of the figures above is as of the date of publication of this report.

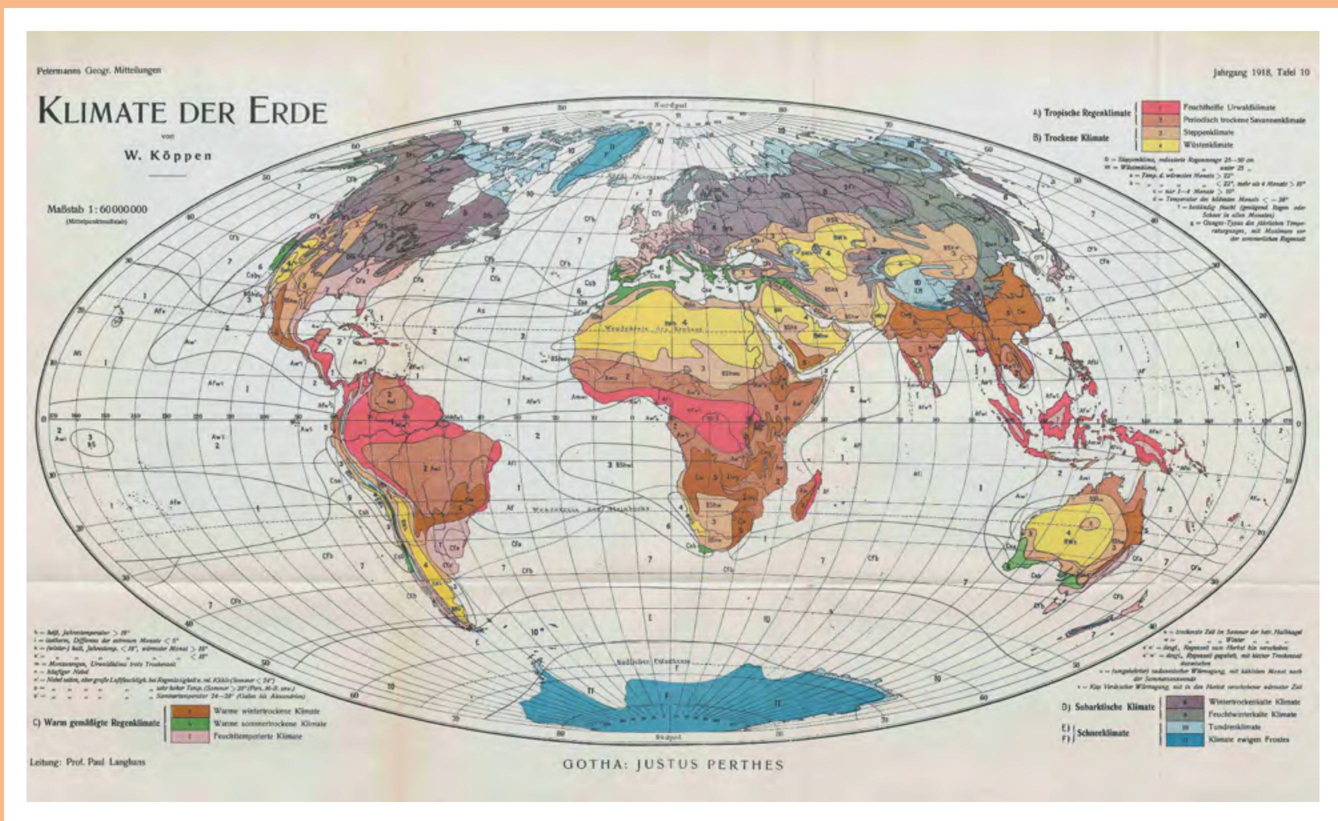
Weather in Germany 2018

	Average temperature in °C	Highest temperature in °C	Lowest temperature in °C
January	**3.7 (–0.5)**	**16.2** on the 3rd in Rheinfelden	**–18.5** on the 21st on the Zugspitze
February	**–1.9 (0.4)**	**11.7** on the 15th in Müllheim	**–30.5** on the 26th on the Zugspitze
March	**2.4 (3.5)**	**20.3** on the 11th in Olbersleben	**–22.2** on the 20th on the Zugspitze
April	**12.3 (7.4)**	**30.4** on the 22nd in Ohlsbach	**–14.3** on the 2nd on the Zugspitze
May	**16 (12.1)**	**34.2** on the 29th in Lingen	**–5.7** on the 15th on the Zugspitze
June	**17.7 (15.4)**	**33.4** on the 9th in Demker	**–6.9** on the 23rd on the Zugspitze
July	**20.3 (16.9)**	**39.5** on the 31st of July in Bernburg/Saale (Nord)	**–2.8** on the 11th on the Zugspitze
August	**19.9 (16.5)**	**38.4** on the 8th in Langenlipsdorf	**–7.1** on the 26th on the Zugspitze
September	**15.1 (13.3)**	**33.1** on the 18th in Köln-Bonn and Huy-Pabstorf	**–11.4** on the 24th and 25th on the Zugspitze
October	**10.7 (9)**	**28.6** on the 13th in Tönisvorst	**–12.3** on the 2nd on the Zugspitze
November	**5.2 (4)**	**24.2** on the 6th in Rosenheim	**–15.4** on the 28th on the Zugspitze
December	**3.9 (0.8)**	**16.3** on the 3rd in Rheinfelden	**–18.6** on the 12th on the Zugspitze
Winter 2017/18	**1.5 (0.2)**	**16.2** on the 3rd of January in Rheinfelden	**–30.5** on the 26th of February on the Zugspitze
Spring	**10.2 (7.7)**	**34.2** on the 29th of May in Lingen	**–22.2** on the 20th of March on the Zugspitze
Summer	**19.3 (16.3)**	**39.5** on the 31st of July in Bernburg/Saale (Nord)	**–7.1** on the 26th of August on the Zugspitze
Autumn	**10.3 (8.8)**	**33.1** on the 18th of September in Köln-Bonn and Huy-Pabstorf	**–15.4** on the 28th of November on the Zugspitze
Year	**10.5 (8.2)**	**39.5** on the 31st of July in Bernburg/Saale (Nord)	**–30.5** on the 26th of February on the Zugspitze

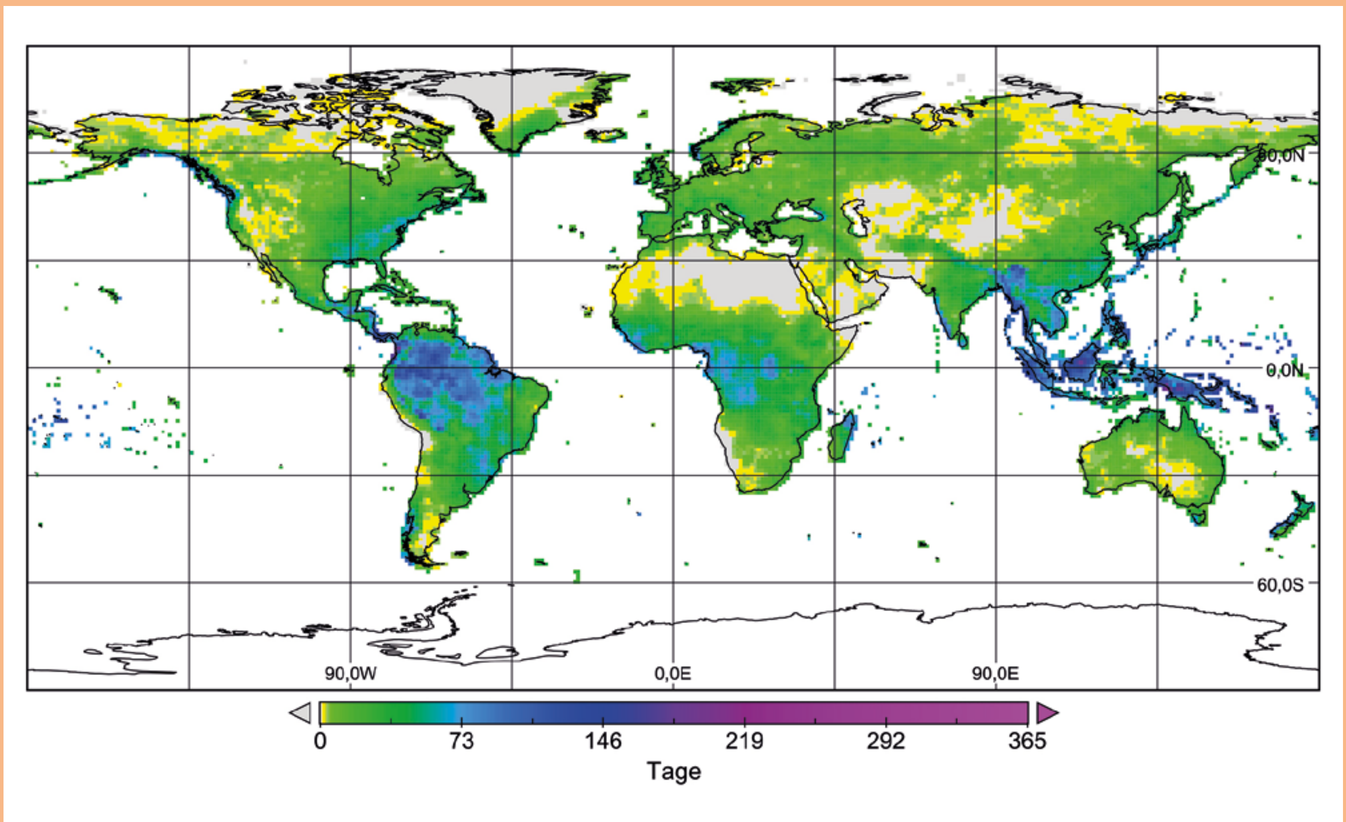
The figures in parenthesis indicate the long-term mean values according to the internationally agreed 1961 to 1990 reference period.

Precipitation in l/m²	Sunshine duration in hours	Memorable facts
101.7 (60.8)	**33.2 (43.6)**	Very mild month with plenty of precipitation; storm cyclones BURGLIND and FRIEDERIKE brought wind speeds up to hurricane force.
17.8 (49.4)	**113.7 (71.5)**	High-pressure areas bringing cold polar air into Germany from the middle of the month; double-digit minus temperatures in widespread parts of the country.
50.9 (56.5)	**112.6 (111.2)**	Very cold start to the month; wet and mild at the end of the month
37.7 (58.2)	**225.6 (153.7)**	Warmest April since measurements began; first summer days (Tmax >= 25 °C) at the end of the month
52 (71.1)	**287.7 (201.6)**	Warmest May since measurements began; first tropical nights in Frankfurt
47.4 (84.6)	**218.2 (203.3)**	Continuation, especially in central Germany, of the dry weather lasting since April
40 (77.6)	**311.4 (210.7)**	Very high temperatures during the course of the month; beginning of a pronounced heatwave towards the end of the month
42 (77.2)	**248.9 (199.5)**	After a short break, continuation of the heatwave into the third ten days of the month
44.2 (61.1)	**206.5 (149.6)**	Continuation of the period of very warm, dry and sunny weather lasting since April
28.4 (55.8)	**157.2 (108.5)**	Still many summer days in widespread parts of Germany in the first half of the month
20.2 (66.3)	**75.1 (52.8)**	Eighth consecutive month with above-normal temperatures; tenth consecutive month that was too dry
104.1 (70.2)	**25.2 (38)**	End of the period of dry and very sunny weather lasting since February
198.6 (180.7)	**174.7 (152.9)**	Mild and wet winter, but with much sunshine
140.6 (185.9)	**625.9 (466.6)**	Abrupt change from the late winter temperatures in March to summer-like levels in April
129.4 (239.4)	**778.6 (613.5)**	Extremely high temperatures in combination with low rainfall caused summer to be one of the most extraordinary weather periods with extreme drought conditions.
92.8 (183.3)	**438.8 (310.9)**	Very dry with much sunshine; temperatures clearly above the long-term average
586.3 (788.9)	**2.015.4 (1.544)**	Warmest and fourth driest year since measurements began in 1881; sunniest year since measurements began in 1951

The year in review



Climatology was known to be Wladimir Köppen's childhood love. In 1918, his map "Klimate der Erde" (Climates of the Earth) was published in Petermanns Geographische Mitteilungen. He used to say that this work helped him to fulfil his wish "to combine climatologically similar areas into superordinate units and thus obtain a uniform system of the Earth's climates and habitats." Today's German school atlases still contain the Köppen-Geiger climate map.



Climatology worldwide thanks to the Global Precipitation Climatology Centre (GPCC) at the DWD. The graphic shows the number of days with at least 10 mm of precipitation. In the areas coloured in grey, there was no day in 2018 when this amount was reached. The highest number, i. e. 203, of days with at least 10 mm of precipitation was observed in the Indonesian part on the south-western coast of the island of Papua New Guinea.

Weather prediction model COSMO-D2: extended model area, reduced mesh width, increased number of layers, longer forecast time

top
The new model area of COSMO-D2, which was extended towards the north, west and south (the red frame shows the area covered by the previous COSMO-DE model).

These are the main advantages of the weather prediction model COSMO-D2, which the DWD has introduced recently to replace the previous COSMO-DE model. At the same time, COSMO-D2-EPS supersedes its predecessor COSMO-DE-EPS as ensemble prediction system.

The model area has been extended mainly towards the west. This allows for the use of additional observations from the eastern parts of the British Isles and, more importantly, of more radar data over France. The model was also extended towards the south in order to include the whole mountain range of the Alps. Thanks to the extension towards the north and west, it is now possible to capture a considerably larger part of the North Sea, which will help to improve the wind forecasts for offshore wind parks and the warnings of storm surges. The horizontal mesh width of the grid has been reduced from 2.8 km to 2.2 km, i.e. the resolution was increased. The number of vertical layers has been raised from 50 to 65, which means a much better resolution especially of the near-surface boundary.

The main reason for the extension of the model configuration was to improve the presentation of convective events such as the showers which occur especially in the spring and summer months. Based on individual cases, it could be shown that the westward extension of the model area and the assimilation of radar data allows for larger convective structures to be detected at an earlier stage. If structures of this type persist long enough to arrive over Germany, they may now be detected one or two forecast cycles earlier, which represents a gain in forecast time of possibly three to six hours.

Setting standards through the ICAO

left
The participants to the WG-MOG meeting in April 2018 in front of the DWD headquarters in Offenbach

In 2012, the Council of the Montreal-based International Civil Aviation Organization (ICAO) decided to modernise the civil air traffic services. This led to the formation of 17 expert panels tasked with the elaboration of international standards regarding various aspects of civil aviation. One of these panels is the Meteorology Panel (METP), which currently comprises around 20 Member States of the United Nations (UN), including Germany. The ICAO is a specialised agency of the UN.

The Federal Ministry of Transport and Digital Infrastructure (BMVI) delegated the participation in the METP to the Deutscher Wetterdienst. Various Working Groups (WG) of the METP discuss operational as well as new topics, such as space weather, data formats, radioactivity and the establishment of new regional centres for aeronautical meteorological warnings. The results are recommendations for each of the Member States concerned.

The WGs of the METP generally meet once a year in different places in order to elaborate and review the Standards and Recommended Practices (SARPs) for civil aviation. The SARPs are documented in Annex 3 to the Convention on International Civil Aviation, signed in Chicago in 1947, and constitute the globally valid regulations for aeronautical meteorology. The standards of Annex 3 have been translated into European law by the European Union Aviation Safety Agency (EASA). This obliges the DWD to implement these standards and comply with the requirements set by them. The DWD is a member of all WGs.

In April 2018, WG 4, i. e. the Meteorological Operations Group (WG-MOG), held a week-long meeting hosted by the DWD in Offenbach. Key topics on the agenda were related to the World Area Forecast System (WAFS) and the Secure Aviation Data Information Service (SADIS). The discussions also touched new topics to be integrated into the MOG's work, such as the establishment of Regional Hazardous Weather Advisory Centres (RHWAC). The DWD showcased its expert knowledge in this field by presenting a number of expert papers. Being a member of the METP and participating in the various WGs has enabled the DWD to contribute to the setting up of new meteorological standards for civil aviation.

Extended release of free data

Since the amended Act on the Deutscher Wetterdienst came into force in July 2017, the DWD has steadily extended the range of contents offered on the new open data server. The spectrum of contents provided there relating to weather and climate & environment covers the full range of the DWD's spatial data. On https://opendata.dwd.de/weather/, users can find important real-time data sets, which are subdivided into the following categories:

- Warnings: /alerts
- Observations: /weather_reports
- Radar data: /radar
- Model forecasts: /nwp
- Point forecasts: /local_forecasts
- Maritime forecasts: /maritime
- Reports: /text_forecasts

The website https://opendata.dwd.de/climate_environment/ offers data relating to the following thematic areas:

- Climate Data Center: /CDC
- Global Precipitation Climatology Centre /GPCC
- COSMO re-analyses: /REA
- Health care: /health

The data can be downloaded and used by everyone free of charge and without any registration. In addition to the traditional customers who had used DWD data already before the DWD Act was changed, the DWD's treasure trove of data is now also accessible to new user groups for integration into their processes and procedures. Through the e-mail address opendata@dwd.de, the DWD receives feedback regarding new applications for a wide spectrum of areas, ranging from simple integrations of a single forecast or set of observation data to complex web applications based on a multitude of open data.

After a strong initial increase in downloads, usage figures have stabilised at a relatively high level. Currently, more than five terabytes of data are downloaded every day from the DWD's open data servers on the Internet.

In order to fully meet all legal requirements and thus enhance the user-friendliness of the open data server, there are plans to supplement the current download service with further INSPIRE-compliant services, such as search, display and transformation services.

Past

In 1881, the Deutsche Seewarte moved into its news premises on Stintfang hill, where Emperor Wilhelm I attended the inauguration ceremony. The building was affectionately referred to as 'upside down weather chest'. In April 1945, the premises were destroyed during a bomb attack and were not rebuilt.

Today

After World War II, the tasks of the Seewarte were reallocated, with all the meteorological responsibilities transferred to the Meteorologische Amt für Nordwestdeutschland (MANWD). Then, on 1 January 1953, the MANWD was integrated into the newly founded Deutscher Wetterdienst. The MANWD had already moved into the premises of the former navigation school in 1947, the same building which today houses the Marine Meteorological Office of the Deutscher Wetterdienst, the Seewetteramt.

WarnWetter app 2.0: weather timeline to surf on

The DWD has fundamentally revised the fee-paying version of its weather warning app (one-off price of € 1.99). The most important new feature of version 2.0 of the WarnWetter app is the timeline. It enables the user to view all time phases of the weather, from the 24-hour view back into the past, the current weather through to the 24-hour forecast and the weather trend for the next seven days, on one screen and without having to switch to another view. In addition, by displaying several meteorological parameters together, such as precipitation, lightning and wind direction during thunderstorms, WarnWetter 2.0 enables a better understanding and evaluation of the weather situation and thus also of threatening weather hazards. The new, free version, which exclusively focusses on explicit warnings of weather hazards, has been equipped with a new warning monitor.

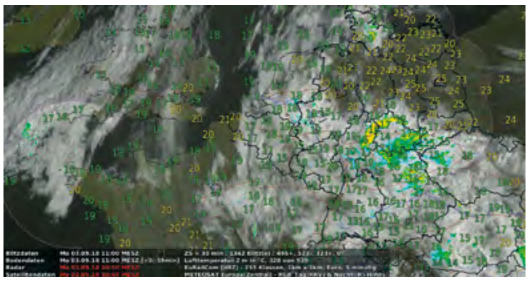
Key features of the full version of the WarnWetter app

- Official warnings for a specific warning situation, information regarding the evolution of the warning situation
- Individually configurable warning elements and warning levels
- Add-on alert function to be informed about changes in the local warning situation
- Early warning by distributing severe weather watches as push messages
- Widgets on the start screen for individually chosen locations or warnings
- Severe weather videos from the DWD TV studio during serious severe weather situations
- Timeline for viewing the weather development over a total of nine days
- Possibility of displaying several weather phenomena concurrently
- Latest weather radar images with detected lightning
- Latest warning monitor for thunderstorms, ice, heavy rain and snowfall
- Integration of heat warnings and information about local heat stress
- Local or map display of UV warnings
- Flood warnings and information about flood situations at federal state level
- Storm tide warnings and water level forecasts for German coasts
- Evaluation of avalanche danger for weather stations in the Bavarian Alps
- Sharing of warning information on social media
- Further options for customising severe weather information

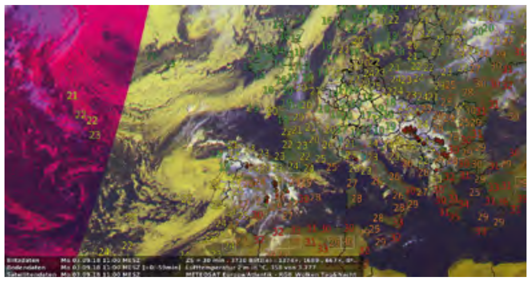
Past

Today

NinJo wins Technology Achievement Award



01



02

01
NinJo graphic of central Europe, 3.9.18, 11:00 o’clock – Overview of the weather situation including temperatures, cloud cover, weather radar and lightning data

02
NinJo graphic of Europe, 3.9.2018, 11:00 o’clock – ’False colour’ satellite image of cloud cover, for example to visualize low-level clouds (yellow)

During its Annual Meeting, the European Meteorological Society (EMS) presented the technology award to the NinJo Consortium. The development of the meteorological workstation system NinJo was started in 1999 by the DWD in co-operation with the Bundeswehr Geoinformation Service. Between 2001 and 2003, the Consortium was joined by the national meteorological services of Switzerland, Denmark and Canada. Today, the software system NinJo is used by a number of other meteorological services as well as by numerous national and international institutions.

NinJo processes all meteorological data available at the time in order to support the generation of both weather forecasts and warnings. The system is able to display all types of meteorological observations and forecast data graphically on the screen. It facilitates the work of the weather forecasters considerably, given that it presents the two terabytes of new data which arrive every day in a clear and well structured manner. The data mainly consist of

- data collected at weather stations, such as temperature, air pressure and rainfall, and measurements taken aboard ships and aircraft or by weather balloons and buoys at sea;
- data provided by the DWD’s own and other European weather radar stations, the global network of meteorological satellites and the European lightning network;
- analyses and forecasts from the different weather prediction models with forecast ranges up to ten days ahead for global forecasts and, with a considerably higher accuracy, up to 27 hours ahead for central Europe;
- data intended for the generation of very short-range forecasts up to six hours ahead for early detection of extreme or high-impact events, such as heavy precipitation, storms, thunderstorms or ice.

NinJo allows for the overlay of many different data in the form of ‘layers’ which can then be displayed in one and the same view. Based on this, the forecasters can generate a varied range of data, maps and warnings for a multitude of customers, especially in the field of disaster management and aviation.

DWD plays an active role in Copernicus

The European Earth observation programme Copernicus, officially launched in 2014, has by now become the largest of its kind in the world. Copernicus supplies its users, primarily policy makers, but also stakeholders in business and science, with freely accessible information free of any charge. 2018 was a very busy year, especially for the further development of the Copernicus Climate Change Service (C3S), which is delivered by the European Centre for Medium-Range Weather Forecasts (ECMWF) on behalf of the European Union (EU).

June 2018, for example, saw the start of the Climate Data Store (CDS), which provides free access to all of the C3S's climate data and data processing tools. The free data policy and easy online access to Copernicus data represent great added value for business and government users. At the same time, the new Data and Information Access Services (DIAS) platform became operational, offering users easy access to Copernicus' satellite data as well as the possibility of cloud-based processing of huge data volumes. The EU's operational Copernicus programme will thus continue to set standards and make vital contributions to satellite-based Earth observation and to the services based thereon.

These achievements were also made possible thanks to the DWD's intense and close co-operation with its European partners. During 2018, for instance, the DWD actively contributed to the two Copernicus services C3S (Climate Change Service) and CAMS (Copernicus Atmosphere Monitoring Service) and supplied these with the required data and products. The DWD's contributions to the operational services include seasonal forecasts, satellite-based climate monitoring data sets, observation-based climate monitoring products for Europe, quality assurance of meteorological data collections for the European Flood Awareness System (EFAS) and of the C3S data portal, including the information it contains.

The fact that two important Copernicus events were organised in Germany last year clearly shows Germany's strong involvement in the Copernicus programme. The first of these events was the second Europe-wide C3S General Assembly, which took place in September in Berlin under the auspices of the Federal Ministry of Transport and Digital Infrastructure (BMVI). This was followed in November by the National Forum for Remote Sensing and Copernicus, organised at the BMVI in Berlin under the motto "Copernicus gestaltet" (Copernicus configured). The DWD organised the expert sessions on climate change (C3S) and atmosphere monitoring (CAMS).

At present, the C3S is preparing the next financial phase from 2021. Based on EU-wide user needs, the CDS will be extended to include further data sets covering a wide range of climate variables, climate indicators and sectors. In addition, new components are planned to be developed and become operational. In the context of new services, a key focus is put on decadal climate forecasts, greenhouse gas monitoring and the quantification of the role that climate change played in an extreme climatic situation ("attribution"). The DWD will make substantial contributions to each of these new topics.

top
General assembly of the Climate Change Service (C3S) in September at the Federal Ministry of Transport and Digital Infrastructure (BMVI)

Federal Government launches new portal for climate impact preparedness

Since September 2018, German authorities, businesses and interested private citizens can access information on possible measures to adapt to climate change through the German Climate Preparedness Portal (KliVO). Together with the Deutscher Wetterdienst, Federal Environment Minister Svenja Schulze presented the portal to the public in Berlin. KLiVO offers up-to-date and officially certified information about climate change in Germany and gives recommendations about what to do in order to be prepared for climate impacts. KLiVO helps interested users to identify needs for climate change preparedness in their specific region and area of activity and provides them with information on suitable measures. The portal is available on the internet at www.klivoportal.de.

KLiVO combines data, guidelines, web tools and maps provided by federal and federal-state authorities. The information is made available through two networks: the German Climate Service run by the DWD publishes data sets and information relating to climate change, whereas the KlimAdapt network operated by the Federal Environment Agency (UBA) offers recommendations regarding climate change adaptation, which are continuously enhanced in co-operation with the users. Scientific and objective facts as well as reliable data are needed as a basis for deciding on measures to adapt to and mitigate the imminent climate change. The portal offers tailor-made information and advice on how to avoid climate change damage, such as may be caused by heat and drought or storms, heavy rain and flooding.

Past

The meteorological department of the Deutsche Seewarte around 1925. The instrument on the wall on the left is a Sprung balance barograph, which the meteorologists used to record the air pressure. At that time, it was only possible to forecast the weather for a maximum of one day ahead.

Today

The Regional and Marine Weather Centre at the DWD's Marine Meteorological Office today: there are no more instruments to be seen. In modern days, weather forecasting relies indispensably on information technology. The duty meteorologist is supplied with comprehensive near-real time information displayed on the different screens. Current 7-day forecasts are better than the 1-day forecasts 50 years ago.

Interdisciplinary point of contact for agrometeorology (inKA)

top
Signing of the joint agreement on 21 September 2018 in Braunschweig: Prof. Dr Paul Becker (Vice-President of DWD), Prof. Dr Georg Backhaus (President of the Julius Kühn Institute) and Prof. Dr Folkhard Isermeyer (President of the Thünen Institute) (from left to right)

In 2018, a new contact point, inKA (derived from its full name in German 'interdisziplinäre Kontaktstelle Agrarmeteorologie'), was established to act as a liaison office for German federal and federal-state authorities on interdisciplinary issues relating to agrometeorology. inKA is hosted at the Agrometeorological Research Centre (ZAMF) in Braunschweig. It is expected that this pooling of expertise available at the DWD, the Julius Kühn Institute and the Thünen Institute will result in good synergies and increased efficiency when dealing with requests. Working together is highly reasonable, especially when tackling topics around the impacts of weather and climate on agriculture and forestry; at the same time, it also strengthens the collaboration between the institutions involved. When it came to interdisciplinary issues in the past, it was often difficult to find the right person to contact at the different authorities. The new network will help to provide rapid and well-founded answers to incoming requests.

inKa also serves as a platform for joint collaboration on research topics, the development of agrometeorological products and the identification of needs for further research.

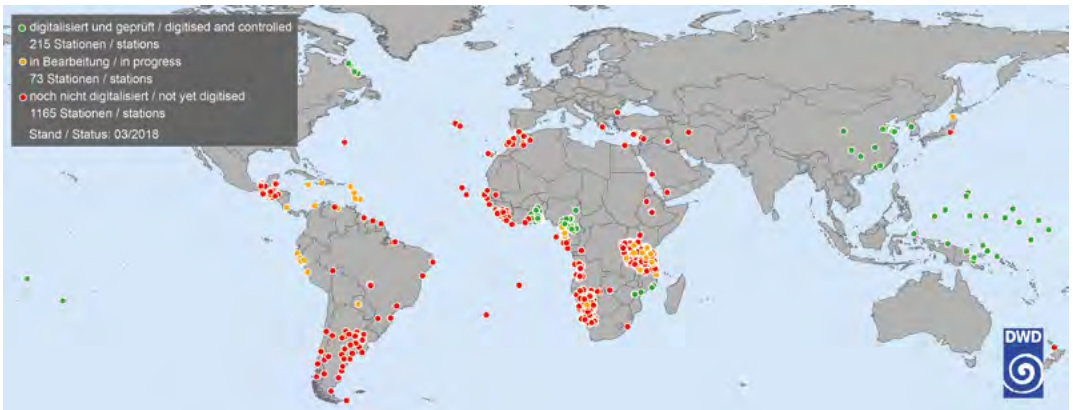
Past

Today

Past
In 1876, Wladimir Köppen began to reorganise the storm warning service at the Seewarte. A total of 164 signal stations were set up on the German coasts from East Friesland to East Prussia. At these stations, weather data were recorded for weather bulletins and optical signs were sent out from masts to warn of strong wind and storms.

Today
Nowadays, the DWD's weather radio station at Pinneberg transmits weather forecasts and warnings for the ships on the North and Baltic Sea using the so-called NAVTEX service. It is a worldwide system for distributing meteorological and nautical warnings and maritime weather forecasts as well as search and rescue notices to ships.

Overseas data collections of the Deutsche Seewarte



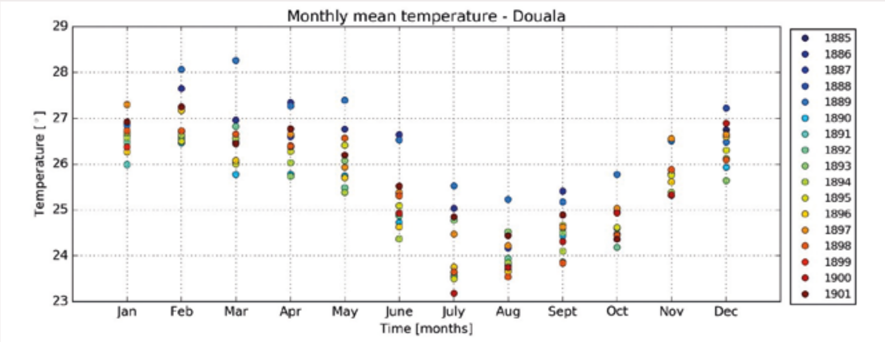
top
Locations of the 1,880 overseas stations of the Deutsche Seewarte Hamburg (1830 – 1943)

Germany's former Marine Observatory, the Deutsche Seewarte in Hamburg (1875 to 1946), established meteorological observing networks in the colonies of the German Empire and many other regions around the world. Regular observations and measurements were carried out there and transmitted to the Seewarte until the beginning of the First World War, in some areas even until 1943. Today, all the observation records and climate diaries are stored in the DWD's archives in Hamburg. They are currently being digitised and are then made available in digital form to the countries of origin and to the WMO's World Data Center for Meteorology maintained at the US National Oceanic and Atmospheric Administration (NOAA).

At the time, the data were used for qualitative descriptions of the climate in the overseas colonies. They formed the main basis for Wladimir Köppen's global climate classification. As a data source, these historical data are of essential importance for research into climate change and are used in the re-analyses in order to reconstruct the atmospheric conditions of the past. 2018 saw the completion of the digitisation and quality control of the weather records from Cameroon.

Data from Cameroon

The measuring network operated by Cameroon's national meteorological service today comprises no more than 21 weather stations. The Deutsche Seewarte maintained 228 measuring and observing stations in Cameroon, one of them was located in Douala. This city is situated on the Atlantic coast in the equatorial climate zone; its air temperatures show only little variation throughout the year. When comparing the old records with current data, it is found that the monthly mean temperatures over the past 20 years are about 1 °C higher. They vary between around 25 °C in July and August and 28 °C in the period from January to March. A comparison between the data collected at the time of the Seewarte and those generated by the NOAA Twentieth Century Reanalysis (20CR v2c) (Compo et al., 2011) shows that, for the grid points around Douala, the mean annual temperatures established by the reanalysis are up to around 2 K below those in the historic observations. Including the digitised data in the meteorological analysis contributes, for example, to raising the quality of reanalysis studies.



Today

Past

Past

Buea main meteorological station in Cameroon was set up at an altitude of 950 m at the foot of Mount Cameroon. The meteorological observations recorded there between 1891 and 1914 were sent to the Deutsche Seewarte in Hamburg by diplomatic bag. Buea is one of altogether 228 stations for which the digitisation of meteorological records was completed in 2018.

Today

The measuring network operated by Cameroon's national meteorological service today comprises no more than 21 weather stations. At Mount Cameroon, the weather is no longer recorded. Its closest weather station is situated at the airport of Douala more than 50 km away. The diagram shows the monthly mean of air temperature for Douala from 1885 to 1901.

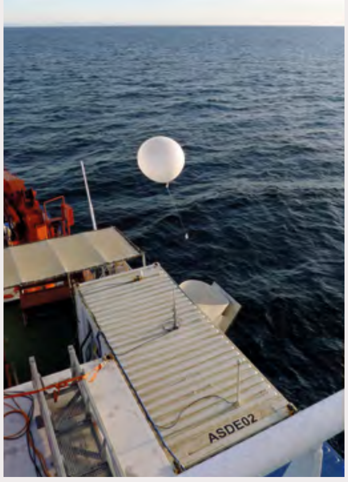
World Meteorological Organization (WMO) DWD designated as a World Meteorological Centre

With the introduction of its ICON-EPS ensemble forecasting system, the DWD was able to apply as a World Meteorological Centre (WMC) of WMO. In order to be successful with such application, a meteorological service has to produce global deterministic forecasts as well as ensemble and seasonal forecasts.

In 2017, the DWD had already been designated as a Global Producing Centre for Long-Range Forecasts, which covers the seasonal range of forecasting. In 2018, this was followed by the designation as a Regional Specialized Meteorological Centre (RSMC) for Global Deterministic Numerical Weather Prediction and as a RSMC for Global Ensemble Numerical Weather Prediction. This satisfied the deterministic and ensemble forecast elements so that all the requirements for being designated as a WMC were fully met.

As a WMC, the DWD publishes forecasts and meteograms in English and makes them available online. In addition, verification results are regularly transmitted to the corresponding lead centres. The WMO will periodically audit the DWD's implementation of the functions it has assumed.

Past



Today

Past
Around 1905: launch of a kite from the ship PLANET to measure parameters, such as air pressure, temperature and upper-air wind. Such upper-air soundings have been carried out on behalf of the Deutsche Seewarte since the beginning of the 20th century. Wladimir Köppen had installed a kite station in Gross-Borstel as early as in 1903.

Today
Automatic launch of a radiosonde from a ship. Presently, there are around 20 of such ASAP stations installed worldwide aboard ships. ASAP is the abbreviation of Automated Shipboard Aerological Programme. Every year, the European E-ASAP fleet launches more than 4,000 weather balloons to carry out upper-air soundings up to a height of around 20 km.

European Meteorological Network EUMETNET: start of the new programme phase

At the General Assembly of EUMETNET in Zagreb (Croatia) in November 2018, the 31 participating national meteorological and hydrological services (NMHS) adopted the new 5-year programme phase. In addition to continuing the ongoing programmes, which the DWD continues to participate in, a couple of new activities were established.

The new AutoPollen programme for exploring methods for the automatic collection of pollen was started in 2018. Its aim is to improve the real-time monitoring of pollen. With climate change coming, there is a clear trend for pollen seasons getting longer, which will affect an increasing number of people with allergies.

Since 2009, EUMETNET has been an Economic Interest Grouping (EIG) under Belgian law with its headquarters in Brussels and a contract valid until 2019. The Directors and Presidents of the participating NMHSs have now signed an amending agreement to the original EIG agreement, renewing the latter for another ten years from 2019.

Past

After all the documents concerning the Seewarte's studies in the field of cargo-hold meteorology were lost during World War II, the ship M.S. STECKELHÖRN set off in 1955 for its first cargo-hold research trip to West Africa. The picture shows the ship's return to Hamburg. The DWD's instrument office for northern Germany supported the meteorologists of the Marine Meteorological Office by developing and improving the measurement instruments used aboard the ships.

Today

Map of areas where cargoes may be at risk: the goods carried by a ship can be damaged during voyages through different climate zones. The risk is even greater if the air temperature and/or air humidity fluctuate widely and condensation forms in the cargo hold. Depending on the humidity of the outside air, this can be avoided by suitable ventilation of the cargo compartment.

EUMETSAT and ESA: three successful launches

The year 2018 saw as many as three successful launches of Earth observation satellites: Sentinel-3B in April as part of the EU's Copernicus programme, Aeolus Atmospheric Dynamic Mission (ADM) in August under the Earth Explorers programme of ESA and Metop-C in November under the EUMETSAT Polar System (EPS) programme.

All three satellites offer innovative opportunities for observing the tropospheric wind field, enhancing the meteorological observation of land and sea surfaces and, above everything else, securing the operational continuity of observational data required for numerical weather prediction. Satellite-based remote sensing is a major source of observational data, without which today's high quality of weather forecasting would be inconceivable.

The development work on the future satellites of the geostationary Meteosat Third Generation (MTG) programme and the polar-orbiting EUMETSAT Polar System Second Generation (EPS-SG) is well underway. In 2018, the contributions to be paid by the altogether 30 Member States of EUMETSAT reached a peak of 594 million euros. The first new satellites of both programmes are scheduled to become operational at the beginning of the next decade.

Past

Shipboard weather station with its crew aboard the fishing research ship MEERKATZE in the 1950s. The weather observations were sent or received via radio (in the front). The ship's meteorologist (in the back) analyses the weather maps, which were still partly drawn by hand.

Today

Nowadays, satellites are the first choice for the transmission of data from staffed weather stations aboard the research ships METEOR and POLARSTERN (shown in the picture). Via a permanent line, the meteorologist is connected to a communication satellite, which transmits the satellite images and other information needed for the weather forecasts. In addition to providing marine meteorological advice, which, for example, also includes information needed for efficient realisation of research experiments, another focus of the work aboard the POLARSTERN is on aeronautical meteorological consultation.

DWD and GIZ: PrAda

top
Rizinus, one of the three main cultivated plants in Madagascar, on the ZAMF's test field in Braunschweig

PrAda is an agrometeorological project dealing with the 'Adaptation of agricultural value chains to climate change' in Madagascar and is jointly led by the DWD and Germany's agency for international co-operation, the Gesellschaft für Internationale Zusammenarbeit (GIZ). The project aims to increase the performance of players in Madagascar in selected agricultural value chains that are especially vulnerable to climate change. In practical terms, this means that the DWD contributes to PrAda by supporting Madagascar's Direction Générale de la Météorologie (DGM) to set up and enhance agrometeorological and agronomic consultancy services.

The project focusses on building the capabilities in Madagascar for a sustainable use of the agrometeorological advice tool AMBER (abbreviated from the German expression 'Agrar-Meteorologische BERatung'), which has been developed by the DWD's Agrometeorological Research Centre (ZAMF). The first step consists in adapting the submodel AMBAV to enable it to calculate evapotranspiration and soil moisture in agricultural crops. At the ZAMF, first measurement series have been carried out to study three cultivated plants of key importance for Madagascar: ricinus, ginger and coffee. Another aim is to help the DGM to build up an appropriate set of data which will allow the provision of agrometeorological information products beyond the duration of the project.

During two missions to Madagascar, DWD staff members discussed tangible plans for future co-operation. They also gave an on-site presentation of the AMBAV model and a first version of an application software of the model. In addition to meetings with representatives from Malagasy ministries and DGM and GIZ staff members, the missions also included excursions to the main study region in the south of the country.

DWD staff and the DWD's international human resources policy

In 2018, altogether 203 DWD staff members were involved in international expert groups, mostly as delegates of certain bodies or as contact persons (focal points) for specific topics. The organisation with the largest number of DWD colleagues acting as experts was the WMO, followed by EUMETNET and EUMETSAT. Some staff members had several functions: for instance, 85 DWD employees were actively involved in 175 different functions at the WMO (this statistic only takes account of functions).

Seven staff members took part in the DWD's expert knowledge programme "Expand your knowledge going abroad for DWD" and collected further experience at partner organisations. One staff-member, for example, job shadowed at the European Emergency Response Coordination Centre (ERCC) in Brussels, where a European Natural Hazard Scientific Partnership is being established on behalf of the European Union. In addition, two DWD staff members were seconded to the WMO, three others to EUMETSAT.

As in previous years, the UN's Junior Professional Office (JPO) programme, with the support of the DWD, made it possible for German experts to be placed in positions at the WMO. In 2018, five young German scientists were thus allowed to work at WMO under this scheme.

Damals

Today

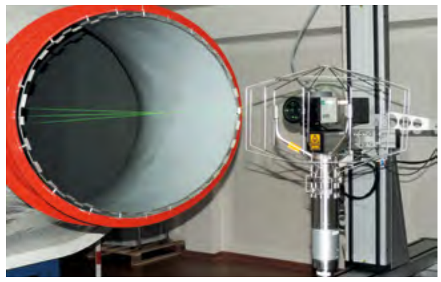
Past

Combe's apparatus for verifying wind sensors, installed in the atrium of the Deutsche Seewarte. The apparatus was powered by a gas-driven motor. The wind sensors mounted on its arm were thus subjected to a given airflow.

Today

The DWD owns two wind tunnels. The picture shows the wind tunnel in Hamburg-Sasel; the other tunnel is installed in Oberschleissheim. All wind sensors used in the DWD measuring network are regularly calibrated in one of these two wind tunnels. State-of-the-art laser Doppler anemometers, which allow for the speed of particulates (trace particles) in the airflow to be measured with great accuracy, are used to produce reference values for wind speed calibration.

Comparing measurements – using calibrated instruments



top
Calibration stand of the wind tunnel at Hamburg-Sasel

In order to be able to compare meteorological values internationally, it is important that the instruments used are calibrated. In September, the calibration laboratories at the DWD's instrumentation sites Hamburg-Sasel and Oberschleissheim were designated by the World Meteorological Organization (WMO) as so-called Regional Instrument Centres (RIC) for WMO Region VI (Europe, Middle East). Both RICs can calibrate temperature, relative humidity, air pressure and wind sensors for other meteorological services in RA VI (metrological traceability).

This is a key task of a RIC: support for other meteorological services in the field of calibration and metrological traceability. Immediately after the designation in September 2018, the Slovenian meteorological service Agencija Republike Slovenije za Okolje (ARSO) made use of the offer and had several ultrasonic wind sensors calibrated at Hamburg-Sasel. On ARSO's request, one of the sensors was fitted with a special bird deflecting device. Accordingly, tests were run at the Hamburg laboratory in order to examine the effects of this bird deflector on the measurement results.

Besides the two DWD sites, there are only a few other calibration laboratories in WMO Region VI, i. e. Toulouse, Bratislava, Ljubljana and Ankara, which also act as RIC to a varying degree. The preconditions for applying as RIC include the ability to perform calibration activities in line with ISO17025 and a successful evaluation by the WMO. The two DWD laboratories had already been accredited by the German national accreditation body Deutsche Akkreditierungsstelle GmbH (DAkkS) in September 2017 for compliance with the DIN EN ISO/IEC 17025:2005 requirements. This meant that an evaluation by the WMO was no longer necessary.

Short-wave transmitters with semiconductor technology for Pinneberg weather radio station

top
The new short-wave emitters in the transmitter room of Pinneberg weather radio station

The Pinneberg weather radio transmitter site of the Deutscher Wetterdienst (DWD) is located right next to the German motorway A 23 direction North, exit Pinneberg-Nord. It is the only installation of its kind in the Federal Republic of Germany. By running the weather radio transmitter, the DWD satisfies its legal mandate to provide meteorological information and services necessary for ensuring the safety of maritime shipping. As agreed under the International Convention for the Safety of Life at Sea (SOLAS), the radio transmitters broadcast weather reports as well as severe weather and nautical warnings around the clock to ships at sea. The DWD thus makes a vital contribution to the protection of life at sea.

The centrepiece of a weather radio station is the so-called transmitter room: from here, the messages are broadcast all over the world on long-, medium- and short-wave radio. The data originate directly from the DWD headquarters in Offenbach as well as from the DWD's Marine Meteorological Office and the Federal Maritime and Hydrographic Agency (BSH), both in Hamburg. After up to 30 years of service, the 10 kW and 20 kW short-wave transmitters used so far had become obsolete and increasingly prone to failure. Replacement parts for the tube transmitters were running out of stock or were no longer available at all. Therefore, it was time to invest in six new short-wave transmitters with semiconductor technology.

After completion of the planning, procurement and testing phases the six new computer-controlled 10 kW short-wave transmitters are now operational. Running at a maximum power of 10 kW, they can operate in picture mode (fax) or telex mode and, from now on, also be used for voice messages.

After the broadcasting organisations had stopped the transmission of marine weather reports on short-wave, the DWD decided to broadcast its own voice messages to meet the great demand from commercial ships and sports boats. In addition to the traditional fax, telex and NAVTEX messages, spoken weather reports and forecasts for the seas are now being broadcast on a test basis four times a day on the short-wave frequencies of 5905 kHz and 6180 kHz. These broadcasts are emitted in the fax transmission breaks when the new short-wave transmitters change frequencies and operating modes.

Short-wave messaging has the great advantage that the broadcasts can be received nearly everywhere in the world using different short-wave frequency channels. German ships sail very frequently in all areas of the North and Baltic Seas, in western European waters and, all year round, in the Mediterranean. Long-wave broadcasts are reliably received as far as the IJsselmeer to the west, the Skagerrak to the north and Sweden (latitude of Stockholm) to the east. A transmission over even longer distances is only possible via short-wave. This means that short-wave broadcasts are needed, for example, during the voyages of German research ships such as the POLARSTERN to the Arctic or Antarctic in order to provide the crews with the information they require. In these areas at high latitudes, accessing the Internet via satellite links is only possible to a limited extent.

Modern study programme

The DWD's centre for meteorological training and continuous professional development is located on the campus of the DFS Deutsche Flugsicherung (DFS) in Langen. The Meteorological Training Centre employs a team of full-time and visiting teachers, lecturers for professional training and service staff. The centre's equipment in terms of rooms and technology complies with the latest state-of-the-art and offers ideal conditions for working and learning.

The teachers and lecturers at the training centre, supported by many other staff members of the DWD, organised numerous training programmes in Langen. In addition, three cohorts of the higher intermediate meteorological service programme and two cohorts of the intermediate meteorological service of the Bundeswehr passed their examinations. Two cohorts of bachelors of meteorology successfully went through the introductory programme before being employed as meteorologists. The DWD's Business Area Weather Forecasting Services organised training seminars for obtaining the forecasting licence a meteorologist needs to work as forecaster at the DWD Weather Forecasting and Advisory Centre in Offenbach, at one of the DWD Regional Weather Advisory Offices (Essen, Leipzig, Munich, Potsdam and Stuttgart), at the Regional and Marine Weather Centre in Hamburg or at one of the five MET Advisory Centres of DWD.

Future weather forecasters study at the Federal University of Applied Administrative Sciences, which offers both the undergraduate and graduate courses preparing the students for the diploma degree in Meteorology (FH). During 2018, the DWD undertook important initial steps to make this study programme fit for the future. To start with, both undergraduate and graduate courses were updated to comply with current requirements. Work to revise and restructure the practical work part of the programme is still ongoing. The idea is to integrate parts of the course programme for the weather forecasting licence into the university curriculum or the diploma examination in order to considerably reduce the very long training period, while, at the same time, offering a high-quality and modern programme for the meteorological degree.

Past

From 1951 onwards, a meteorologist of the Marine Meteorological Office presented the latest weather report live on television – at first two or three times a week – directly after the Tagesschau, Germany's traditional news programme. The forecast was drawn on a board, as it is done on the photo by Dr Gerd Roediger. The Meteorological Service of the former GDR broadcast its first weather report on television shortly before Christmas 1952.

Today

The TV studio at the DWD headquarters in Offenbach, meteorologist Jacqueline Kerrn during the production of a clip: computers have long replaced manual drawing of weather maps. The studio is used for producing severe weather or educational clips as well as for live broadcasts during unusual weather situations. The severe weather clips are then sent out Germany-wide via the DWD's website and YouTube channel.

Ceremony for laying the foundation stone of the new building of Potsdam branch office

top
Laying of the foundation stone for the DWD's branch office in Potsdam: Guido Beermann (State Secretary of the Federal Ministry of Transport and Digital Infrastructure (BMVI), Jann Jakobs (Lord Mayor of Potsdam), Prof. Dr Paul Becker (DWD Vice-President), Christian Görke (Minister of Finance of the Federal State of Brandenburg), Christine Hammann (Director, Federal Ministry of the Interior, Building and Community (BMI)) (from left to right)

Potsdam is the DWD's third largest branch office, behind Offenbach headquarters and Hamburg branch office (which includes the Marine Meteorological Office). The structural work for the new building to be built at Potsdam was started in May 2018; the ceremony to lay the foundation stone followed in October. In his speech, State Secretary Guido Beermann, who attended the ceremony on behalf of the Federal Ministry of Transport and Digital Infrastructure (BMVI), highlighted the importance of the DWD's local presence, especially given the reality of climate change. The BMVI is investing around 37 million euros in this new building, which, once finished in 2022, will offer space for 200 workplaces. The new complex will consist of altogether six parts, providing for offices, electronics laboratories, workshops and storage rooms. On the ground floor, a 'weather boulevard' will link all the parts of the building with one another and with the outdoor area. One section of the 11,000 m^2 of total net area will be set up as a secondary site of the German Meteorological Computing Centre (DMRZ) in Offenbach. An antenna mast is being built in the outdoor area. It will carry a slewable antenna to receive the data transmitted by the meteorological satellites that orbit the Earth at a height of about 850 km passing over the poles while transmitting information about the weather.

The staff at the DWD's Potsdam branch office has the following tasks:

- Provision of regional weather forecasts and meteorological consultancy; provision of demand-oriented and customised weather forecasts for the federal states of Mecklenburg-Western Pomerania, Brandenburg and Berlin
- Production of weather warnings
- Close collaboration with disaster management authorities at all levels
- Provision of information for ensuring the security of aviation for the federal states of Mecklenburg-Western Pomerania, Brandenburg, Berlin, Saxony, Saxony-Anhalt and Thuringia
- Continuous verification of forecasting procedures
- Development of the meteorological visualisation system NinJo
- Provision of climate services for the federal states of Berlin, Brandenburg, Saxony, Saxony-Anhalt and Thuringia
- Preparation of planning reports and expert opinions, expert reports on ice, snow and wind, and hydrometeorological budget reports (e. g. water budget)
- Consultancy services for the federal states and municipalities in the field of disaster management, especially relating to climate change-induced extreme events
- Management of the mobile measuring units
- Maintenance of meteorological observation, communication and information systems in the federal states of Berlin, Brandenburg, Mecklenburg-Western Pomerania, Saxony, Saxony-Anhalt and Thuringia
- DWD-wide quality assurance of measurements and observations
- Maintenance of the main and the secondary measuring and observation network in the federal states of Berlin, Brandenburg, Mecklenburg-Western Pomerania, Saxony, Saxony-Anhalt and Thuringia

Past

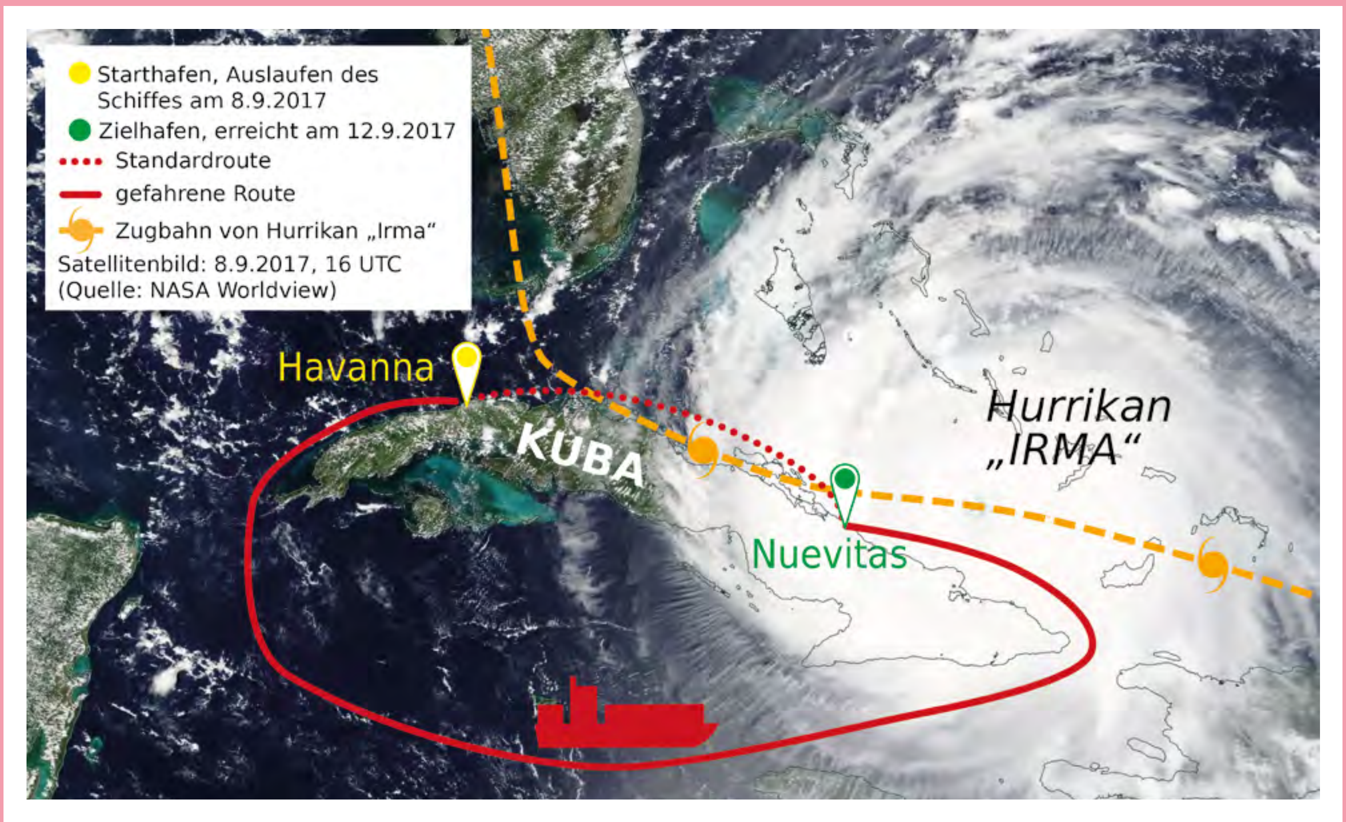
Today

Past
A photo opportunity in 1900 on the occasion of the 25th anniversary of the Deutsche Seewarte as an institution of the German Empire. The Seewarte had been transferred to the responsibility of the German Imperial Admiralty by an act passed on 9 January 1875. The photo shows the Seewarte's first director, Georg von Neumayer, in the front (middle).

Today
Reception given by the Senate of the Free and Hanseatic City of Hamburg on the occasion of the 150th anniversary of the provision of maritime services in Germany in March 2018: Monika Breuch-Moritz (President of BSH), Olaf Scholz (then First Mayor of the Free and Hanseatic City of Hamburg), Enak Ferlemann (Parliamentary State Secretary at BMVI), Prof. Dr Gerhard Adrian (President of DWD) (from left to right).

Interview

The Norddeutsche Seewarte, which initially was a privately run institution, provided ship captains with standardised templates to be filled with meteorological observations. The forms were then returned to the Seewarte to be analysed. These data were the basis of the Seewarte's sailing directions. Apart from a few exceptions, they all were written by Wilhelm von Freeden himself. The example here shows the sailing direction from 6 August 1869.



Today, a whole group of experts at the Marine Meteorological Office is responsible for the provision of individual marine meteorological consultancy services. The target group of this type of fee-paying service includes all the seafarers with a specific task to fulfil, such as to safely cross the Atlantic on a route which is both safe and economically efficient or to transport a new wind turbine to its offshore site. The graphic shows the route a ship had to take to avoid hurricane IRMA in September 2017 to safely reach its destination – thanks to the advice provided by the Marine Meteorological Office in Hamburg.

“Overwhelming beauty, but also vulnerability”

Interview with Thomas Reiter

Thomas Reiter has spent almost a whole year in space as an astronaut, at first on the Russian space station MIR in 1995/96 and then on the international space station ISS in 2006. In our conversation, he talks about the future of space flight, parallels in the work of astronauts and meteorologists as well as about his observations on climate change.

DWD:
How important is the weather forecast for an astronaut?

Thomas Reiter:
In space exploration, a precise weather forecast is of great importance for the launches of the carrier rockets and, in manned space flight, also for the landings. Reliable weather forecasts were indispensable especially for my second mission to the international space station ISS on board of the American space shuttle: the launch of the Discovery at Cape Canaveral had to be reported twice due to approaching thunderstorms.

This is also true for the launches of carrier rockets from the European spaceport at Kourou, where the reliability of weather forecasts for the ground level and for lower layers of the troposphere is just as important as knowing the upper winds in the stratosphere. Likewise, on our return from the ISS to the Earth, the conditions regarding the main cloud base and the visibility for landing in Florida were near the limit. This shows the importance of a reliable weather forecast in such extreme situations.

top
Thomas Reiter already suited up for his space shuttle flight to ISS under the long-term Astrolab mission in 2006

DWD:
What is the importance of space research for mankind and for the evolution of planet Earth as a whole?

Thomas Reiter:
Services which originated from space exploration have become indispensable, both for our daily lives and for our technologically advanced economies as a whole. In addition to weather forecasts, Earth observation data, telecommunication services and satellite navigation are essential for a wide range of applications.

Scientific missions exploring the planets in our solar system and the depths of space expand our understanding of our environment beyond the limits of the atmosphere. Research under space conditions on board of the ISS not only provides fundamental insights into physical and biological processes, but also contributes to improving materials and to fighting diseases. Space exploration touches the limits of what is technically feasible and therefore constitutes a key driver of innovation.

DWD:
How will space research and the monitoring of the Earth via satellites, including weather satellites, evolve in the future?

Thomas Reiter:
Space exploration, which was originally characterised by institutionally financed fundamental research and development, has evolved in the last 60 years towards a ‘space economy’. This is a trend which will accelerate further in the coming years.

In the next decade, the international space station ISS will offer unique opportunities for fundamental and applied research. In addition, an increasing number of industrial customers is using these unique possibilities provided by the conditions in space to enhance their products.

Serial production and an increasing miniaturisation of satellites allow for cost savings and the establishment of constellations which will provide new telecommunication structures as well as Earth observation data with a higher temporal resolution.

The merging of data and the international integration will create new possibilities for the meteorological services.

The advancement of sensors on platforms such as MTG[1] will lead to further improvements of the spatial, temporal and spectral resolution of measurements. In addition, there will be new measurement methods, such as the determination of wind profiles in the atmosphere by means of lidar. The increasing merging of data from different parts of the electromagnetic spectrum, combined with an even stronger international integration, will certainly also create completely new possibilities for the further development of meteorological services, including for space weather.

Men will return to the moon – this is expected to happen in the first half of the next decade – and use it as a springboard for additional missions into our solar system and as a source of raw materials and platform for research. The exploration of planet Mars, our nearest neighbour, and other planets in our solar system will also result in synergies with climate research on our planet Earth.

These developments are linked to continuously increasing data volumes, which, in the future, will be transmitted from satellites to the Earth via optical links.

All in all, our technologically advanced economies will depend even more on this infrastructure in the Earth's orbit, which will also increase their vulnerability to satellite failure. Operating a steadily increasing number of satellites in a low Earth orbit will pose new challenges for space exploration, for example the question of how to deal with the growing threat of space debris. All these new developments are promoted by the European Space Agency (ESA), together with its 22 Member States and their industrial and scientific capabilities, several other European organisations, such as EUMETSAT and the EU, and our international partners.

[1] MTG stands for Meteosat Third Generation, EUMETSAT's third generation of geostationary weather satellites, which are due to become operational at the beginning of the next decade.

left
Thomas Reiter during a spacewalk from the ISS in 2006

DWD:
Do you see any parallels between the work of an astronaut and that of a meteorologist?

Thomas Reiter:
Yes. They both deal with a range of activities, because both the meteorologist and the astronaut must be familiar with many different scientific fields. Another similarity is the view of our planet: every day, meteorologists look at our planet via satellite images, while astronauts see the Earth with their own eyes.

DWD:
You visited the DWD headquarters for the first time in September 2018 and also addressed the topic of climate change during this visit. How can climate change on Earth be seen from space?

Thomas Reiter:
Although it is possible to discover human influence on Earth from a height of 400 km – you can see cities, brown haze above industrial regions, agricultural structures and unfortunately also huge clearings in the rainforests of South America and East Asia – climate change cannot be 'identified' directly with the naked eye. It manifests itself, for instance, by an increase in greenhouse gases and the resulting long-term effects; and these can only be detected by comparing data over a period of several years.

From a height of 400 km, this view of the Earth also showed the vulnerability of nature and the environment.

However, I could notice a difference between my first mission to the Russian space station MIR from 1995 to 1996 and my mission to the ISS in 2006. After eleven years, the glaciers in the mountainous regions of our planets had shrunk, clearings in the rain forests had increased in size and the Aral Sea was hardly visible any more. In any case, this view of the Earth from space, on the one hand, revealed the overwhelming beauty of our planet; on the other hand, it also showed the vulnerability of nature and the environment in a very direct and striking way.

DWD:
What is your strongest memory of your visit at the DWD?

Thomas Reiter:
The enormous amounts of data, which have to be processed and stored there every day, the computing power and storage capacity needed to do this and the need for constant model improvement and for the integration of data provided by new sensors such as Aeolus[2]. And mainly, the remarkable know-how and commitment of all employees of the DWD, as well as the fact that today and in the future, these clever minds are needed to master all these tasks, despite the impressive array of data sources, computers and software.

DWD:
Thank you very much for talking to us.

[2] Aeolus is a Satellite of the European Space Agency (ESA), which was launched in August 2018. It is used to obtain high-precision measurements of air currents by means of a so-called Doppler lidar, which can improve numerical weather forecasts.

Finale

DWD meteorologist aboard the fishing research ship ANTON DOHRN in the 1950s. Using a whirling psychrometer he measures the air temperature and air humidity aboard the ship in a heavy sea – without weatherproof clothing and holding tight to the guard rail this would not be possible. The data were transmitted every three hours via radio.

DWD technician installing the EUropean Common Automated Weather Station, EUCAWS, aboard the ARAUCO in March 2017. The EUCAWS systems take automatic measurements of air temperature, air humidity, air pressure, sea surface temperature, wind speed and true wind (which excludes the ship's velocity); the latter, however, is only measured if the system is connected to the ship's compass. Depending on the settings, the data are transmitted every 60, 20 or 10 minutes via an iridium sender.

Services and products delivered annually

About **90,000** forecasts

Approximately **197,000** weather and severe weather warnings (heat and UV warnings not counted), of which **643** were of the highest warning level (extremely severe weather)

More than **14,000** advisory statements on weather and climate as well as expert reports for public authorities, disaster control units and other customers

Approximately **500,000** forecasts and warnings for aviation

Around **42,000** telephone briefings for aviation

Provision of self-briefing systems for civil aviation, aerodromes & airports and air services providers (around **420 million** requests)

Around **200,000** reports, warnings and advisory services for maritime shipping, coastal protection and offshore projects

Over **15,000** products for climate monitoring

DWD sites throughout Germany

Headquarters in Offenbach am Main

6 branch offices (Hamburg, Potsdam, Leipzig, Essen, Stuttgart, Munich), partly with more than 100 staff members

5 regional climate offices providing consultancy services in the field of climate and environment

5 MET advisory centres

3 agrometeorological advisory centres

182 main weather stations, of which

5 are manned around the clock and **1** is manned part time,

160 are fully automated and

16 are aeronautical meteorological stations at airports

1,744 secondary weather and precipitation stations,

of which **838** are online stations that report half-hourly,

whereas **809** send their hand-recorded reports on a daily basis

1,088 phenological observation sites

2 staffed main weather stations aboard research ships

47 automated shipboard weather stations

413 weather reporting stations aboard merchant ships

5 moored buoys in the North and Baltic Seas

4 automated shipboard aerological stations

18 weather radar sites in Germany

2 meteorological observatories

10 upper-air stations with around 7,000 radiosonde launches per year

48 stations where radioactivity is measured

3 mobile measuring units

Figures relating to the DWD's budget

The DWD total budget amounted to:

2017

around 369 million euros

2018

around 343 million euros

Every citizen of Germany thus paid[1]:

2017

4.01 euros

2018

3.82 euros

In 2018, the DWD's expenditure was distributed as follows:

Appropriations/Subsidies (external funds not included):

147.7 million euros

Investments:

33.5 million euros

Expenditure on material:

42.3 million euros

Personnel:

117.4 million euros

In 2018, appropriations and subsidies went to the following organisations (external funds included):

EUMETSAT:

91.4 million euros

ESA:

41.8 million euros

ECMWF:

9.7 million euros

EUMETNET, WMO, others:

8.9 million euros

[1] Number of inhabitants at the end of December 2017: 82.792 million; source: Wikipedia

Figures relating to the DWD's staff

Number of established posts:

2017	**2018**
2,197	2,178.5

Number of staff members[2]:

2017		**2018**	
2,296		2,248	
Men	Women	Men	Women
1.442	854	1.412	836

[2] The difference between the number of established posts and the total number of staff members is partly due to temporary or part-time employment.

10^{12}

Ten to the power of twelve = terabytes

In May and in June 2018, nearly **240** terabytes of data were downloaded each month free of charge from www.dwd.de/opendata.

In July 2018, more than **70** terabytes of free data were retrieved via https calls from www.dwd.de/geodaten-serverdienst.

The **500** terabytes of meteorological satellite data and satellite-based climate data, which were freely accessible in the DWD's archives in 2018, were mainly used for research.

Currently, more than **five** terabytes of data are downloaded every day alone from the DWD's open data servers accessible through the Internet.

… and some more facts from the DWD's daily routine

The pages on www.dwd.de visited most frequently are those containing the severe weather warnings and the severe weather clips produced in the DWD's TV studio.

As the host of the Global Precipitation Climatology Centre (GPCC), the DWD maintains and continuously extends the world's largest database of in-situ precipitation measurements from close to 120,000 stations around the globe.

The DWD also participates in around 50 large national and international climate and weather research projects.

Staff members published 230 scientific publications, 150 of which in international, peer-reviewed specialist journals.

Last but not least:

a message in a bottle

"Drift bottle thrown overboard" – This is the entry in the meteorological journal of the German barque PAULA at 12.00 noon on 12 June 1886. Almost 132 years later, on 21 January 2018, this bottle was found by the Australian couple Tonya and Kym Illman on a beach in western Australia, well over 180 km to the north of Perth.

left

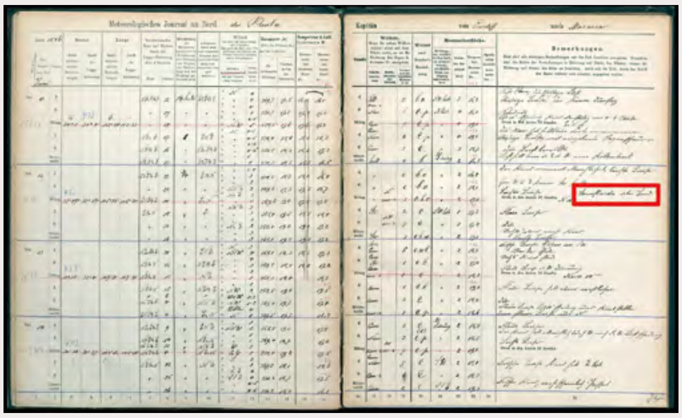
Map showing the route of barque PAULA on its voyage from Cardiff to Macassar in 1886. The bottle was jettisoned about 1,000 km to the west of Perth/ Australia on 12 June 1886.

The Deutscher Wetterdienst (DWD) and the Federal Maritime and Hydrographic Agency (BSH), the two successor organisations to the Norddeutsche Seewarte/ Deutsche Seewarte, were able to confirm the authenticity of this find: bottle, paper and style of the message all originate from the 1880s. This is complemented by the fact that the co-ordinates and the handwriting on the message slip in the bottle agree with those on the entry in the meteorological journal of the PAULA.

At that time, such bottle messages were used on behalf of the Deutsche Seewarte to explore the ocean currents. The bottle, which served scientific purposes in the 19th century, attracted a lot of attention of the media and the general public – especially as it was found in the anniversary year of the Seewarte. The news of finding this bottle, which most likely has been on its way for a record length of time, spread around the world. In July 2018, the finder couple as well as the bottle and the message slip spent one day as the guests of the International Maritime Museum (IMMH) in Hamburg. The presentation of the find was embedded into the exhibition “Above water – Under water”, which was jointly conceived by DWD and BSH, showing the evolution of maritime services from 1868 to this day.

Will this bottle message ever return, perhaps even permanently, to the headquarters of its former initiator? At any rate, the finders, who are its owners according to Australian law, have not ruled this out.

01



02

01

Bottle and message slip

02

Entry “Drift bottle thrown overboard” (marked in red) in the PAULA’s meteorological journal, which is kept together with 37,000 other journals in the archives of the Marine Meteorological Office in Hamburg. This journal provided the conclusive evidence of the find’s authenticity.

Contact, publishing details and source references

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When calling the weather hotline you will automatically be connected with the closest DWD Branch Office.

[1] Availability and costs depending on foreign telephone provider

Further telephone- and service numbers
www.dwd.de/kontakt

Important links

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Photos and graphics

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Sources and other information

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Further information

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www.bbk.bund.de/mowas

Regarding page 33, Copernicus
www.d-copernicus.de

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www.dwd.de/wmc

Regarding page 39, EUMETNET
www.eumetnet.eu

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