Deutscher Wetterdienst
Department Climate and Environment

Heavy Precipitation during Autumn 2000 in Europe

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Many regions of Europe were affected by persistent and anomalous high precipitation during autumn 2000. Many countries bordering the North Sea and the Mediterranean Sea were influenced, most severly affected were regions in England and Wales as well as regions in Italy and Switzerland. Flooding (Fig.1) and landslides (Fig. 2) caused heavy damages.

Fig. 1 Photo of the English City of York from November 2000 (Picture: Ian Britton, from http://www.freefoto.com/floods/)

Fig. 2 Arial view of the collapsed bridge ‚Ponte Sul Sangone', Giaveno, Province Turin (Italien) from October 2000 (Picture: http://www.provincia.torino.it/emergenza/)

Data and analysis procedure

Near realtime analyses of large-scale precipitation events have to be based on synoptical data, which are exchanged via the Global Telecommunication System (GTS) of the World Meteorological Organization (WMO) and received at the DWD. These data are routinely analysed at the Global Precipitation Climatology Centre (GPCC) (Rudolf, 1995). The data used in an analysis are thoroughly controlled and (if possible) corrected.

The operational analysis system of the GPCC and the use of global synoptic data (SYNOP) allow for near realtime regional analyses of daily and multi-daily precipitation totals in case of special precipitation events as in autumn 2000. Data from more than 1500 European synoptic stations are available for such near realtime analyses. A new correction method regarding systematic measurement errors caused by wind influence and evaporation permits a more precise estimation of gauged precipitation totals (Fuchs et al., 2001). The spatial interpolation of point values to grid values was done with a Kriging method (see e.g. Journel and Huijbregts, 1978). Time series of monthly precipitation as well as normals for 1961-1990 were used for a climatological assessment of this episode.

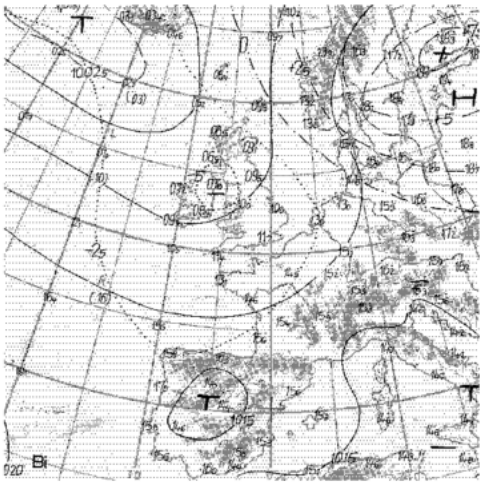

Fig. 3 Mean sea level pressure (solid lines) and deviations from mean sea level pressure of the period 1951-1960 (dotted lines) in the month of September 2000 (Source: Climatological Overview for Europe and the North Atlantic (KEU), regular annex to the Berliner Wetterkarte, FU Berlin, 2000)

During September 2000 the North Atlantic west wind zone was placed on the forward edge of a strong north Canadian trough, extending towards western Europe (Free University Berlin, 2000). Thus the influence region of the Icelandic low extended over the British Isles far into Central Europe (see Fig.3). Trough advances during the 2nd half of september reached into the Mediterranean area (DWD, 2000), which lead to intensive precipitation activity in upslope effect regions on the southside of the Alps.

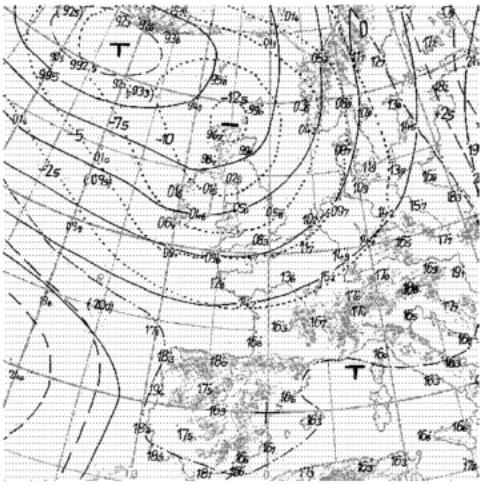

Fig. 4 like Fig. 3, but for the month October 2000

The cyclonal weather influence of the previous month intensified over the North Atlantic and in Western Europe during October (FU Berlin, 2000). A deep low covered the British Isles as well as northern France and south-west – Scandinavia (see Fig. 4) and deepened by the end of the month into a strong cyclone (DWD, 2000). Secondary lows on the forward edge of a very strong trough over Western Europe reached several times the Mediterranean area, which lead to heavy precipitation in the upslope flow region of the Alps.

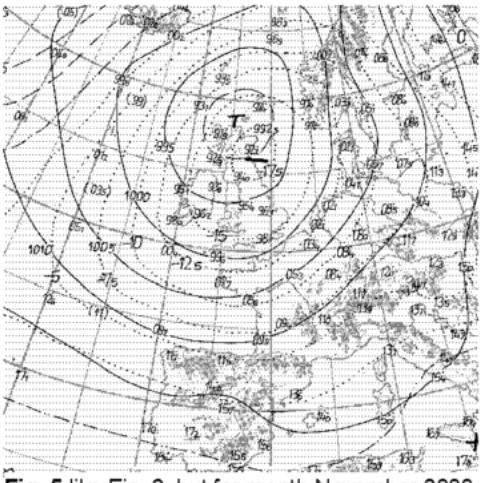

Fig. 5 like Fig. 3, but for month November 2000

The intensive low pressure activity from the previous month continued in November over wide parts of Western and Northern Europe and reached into the Mediterranean area (DWD, 2000). The centre of the low pressure activity was directly over the British Isles (see Fig. 5), which lead to persistent precipitation. Secondary lows of the deep Western European trough in connection with upslope effects triggered heavy precipitation in the Mediterranean area as well as in South-West Scandinavia.

Precipitation

The monthly routine analyses of GPCC (http://gpcc.dwd.de/visu_gpcc.html) give a first overview of the precipitation in autumn 2000. But a monthly time resolution is too coarse for an analysis of the temporal evolution of precipitation events leading to flooding events. Higher temporal resolutions like the following semi-monthly distributions are better suited for this purpose.

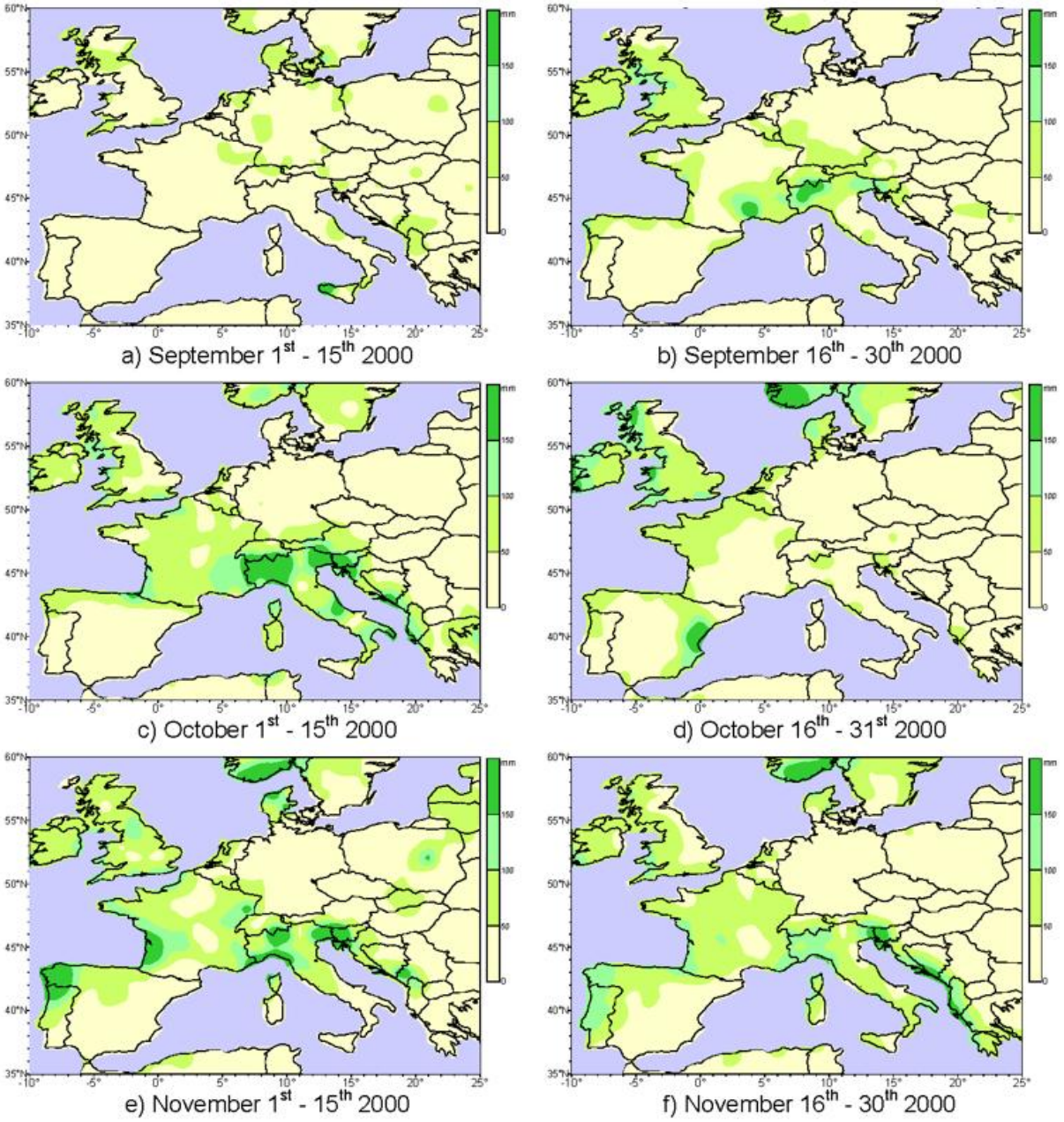

Fig. 6 Regional distribution of the precipitation totals (mm) measured on Europe's landsurface (mm) during 6 periods in Autumn 2000.

The semi-monthly analyses in Fig. 6 show, that the precipitation activity (precipitation totals > 50 mm) started in the 2nd half of September (Fig. 6b) over the British Isles and in the influence area of the Adria and the Riviera. Fig. 6c shows the precipitation distribution for the first half of the month of October. Widespread precipitation totals of more than 100 mm were measured in the East and the South of Great Britain, in the South of Norway and Sweden, in the North of Portugal and Spain, in great parts of France and in the areas bordering the Riviera and Adria. The highest amounts

were found at the South-Eastern end of the Bay of Biscay as well as in the South of Switzerland, North of Italy and in Slovenia. Widespread more than 200 mm precipitation, locally more than 300 mm, were measured. Maximum precipitation in the South of Switzerland and Northern Italy was even higher, which triggered landslides (Fig. 2) and flooding. In the second half of October 2000 (Fig. 6d) appeared precipitation maxima in the West of Great Britain and Ireland, in the South of Norway (locally more than 400mm) as well as in the South East of Spain.

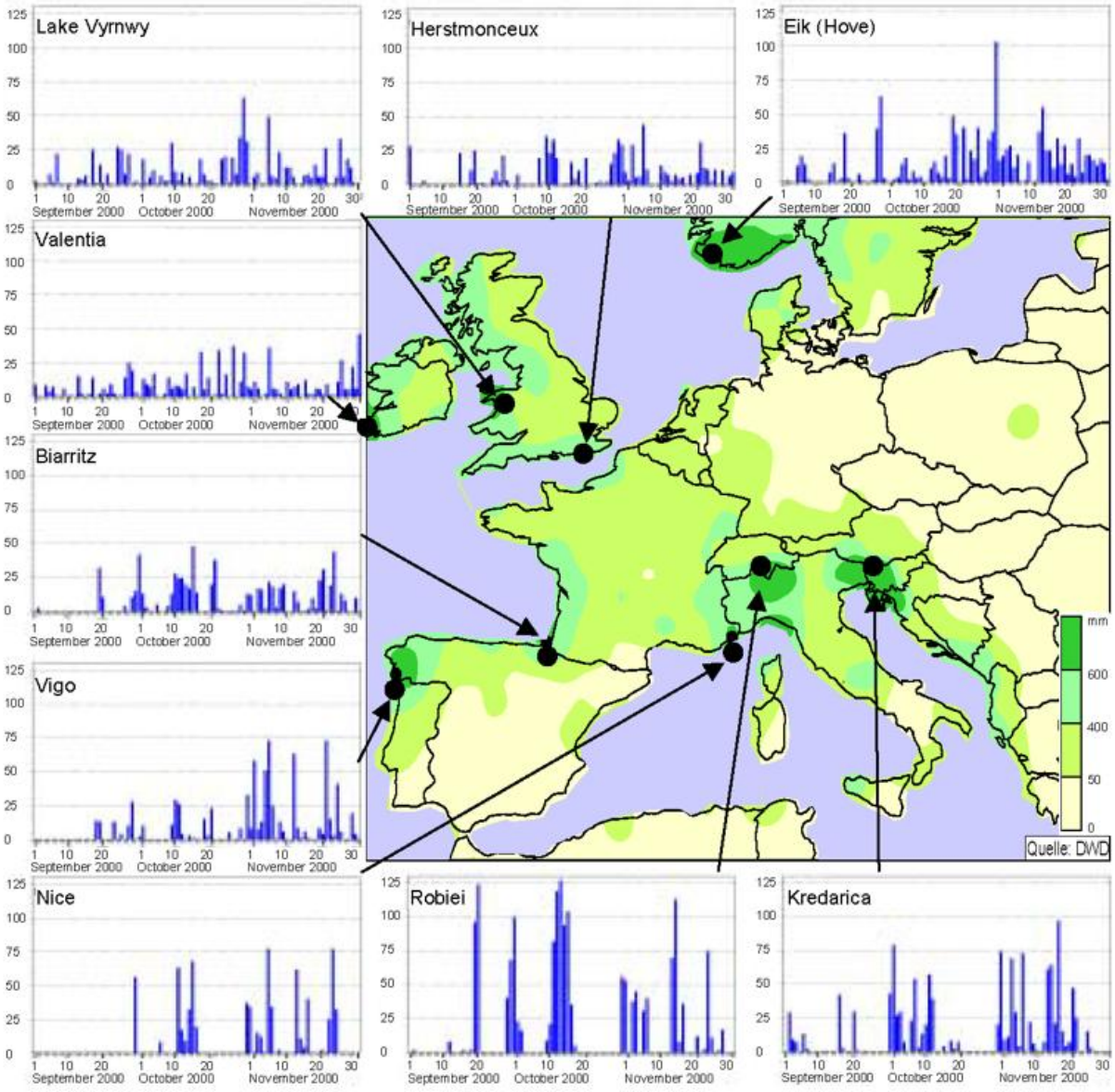

Fig. 7: Spatial distribution of the precipitation totals measured on the land surfaces of Europe in Autumn 2000 (large figure) and time series of the daily precipitation totals at 9 stations in the analysis period (small figure).

The rainy period continued in Europe also in the first half of the November (Fig. 6e), heaviest with values of widespread more than 200 mm and locally even more than 300 mm in North-West of Spain, at the Bay of Biscay, in the South of Norway, in the North of Italy and Slovenia (see Cegnar, 2001). The regions in England and Wales, already affected by flooding, received at the beginning of November further water from above. The precipitation activity continued also in the second half of November (Fig. 6f), when the highest precipitation with widespread more than 200 mm and

locally even more than 300 mm fell East of the Adriatic Sea (from Slovenia down to Greece) as well as in the South of Norway. In England and Wales it was raining a little less than in the previous weeks, but the moist weather still continued.

The different character of the precipitation events at places with similar autumnal precipitation totals is clearly visible in the time series of the daily precipitation totals from 1st September – 30th November 2000 (Fig. 7). Persistent precipitation of partly more than 50 mm appeared from the end of September onwards on nearly each analysis day in the North Sea bordering countries and at the Bay of Biscay. Heavy precipitation totals as high as 130 mm are recognisable only during a few days in the Mediterranean area. The precipitation totals in the North and the West of Europe were mostly caused by fronts in the main influence area of strong, nearly stationary, cyclones (see '*weather conditions*'). The precipitation events in the Mediterranean area however had mostly convective character, caused by heavy thunderstorms, which were triggered over the warm ocean water in the influence area of extensive troughs and intensified by upslope effects in mountaineous areas.

Climatological assessment

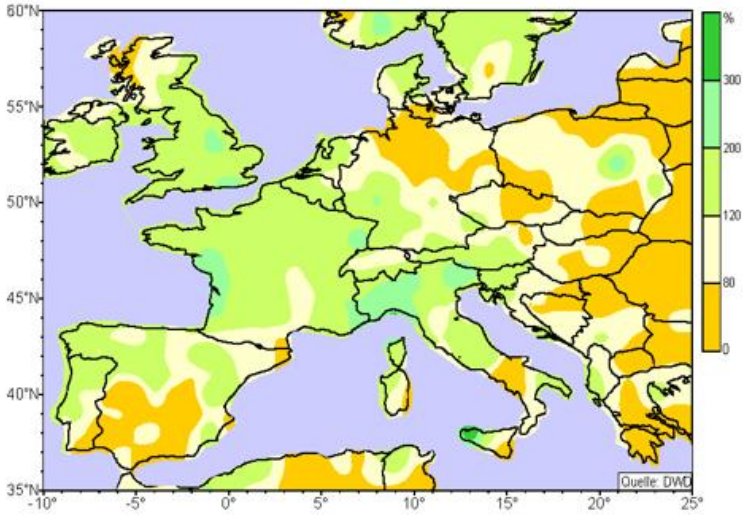

Fig. 8 Spatial distribution of the relative precipitation totals of Autumn 2001 in percent of the normal values from the time period 1961 – 1990.

In Abb. 8 the precipitation totals of the Autumn 2001 are compared with the normal values from 1961-1960. In widespread regions of Western, Central and Southern Europe were the normal autumnal precipitation totals exceeded. The precipitation totals reached often up to or more than the double of the normal value. Only in the South of the Iberian Peninsula as well as in Eastern Europe and the North East of Germany were widespread areas too dry.

As a result of the heavy precipitation (according to the information of the British Met. Office was the September the wettest since 1981, the October even the wettest since 1908 and the November was the most humid since 1970) occured in England and Wales the strongest floodings since 1947. The 492 mm (191% of the reference value of 1961 – 1990) measured in autumn 2000 indicate the wettest autumn since begin of the regular precipitation measurements in year 1766 (Fig. 9).

The latest results (IPCC, 2001) of the IPCC (Intergovernmental Panel on Climate Change) show: The temperature increase caused by the increase of the greenhouse gases can yet be observed in many regions of the earth and it will be further intensified according to the latest climate model prognoses. That will lead to an increase of evaporation, which will very often lead to increasing precipitation (an increase of the winter precipitation in Central and Western Europe caused by an increasing fre-

quency of westerly airflow can yet be observed (see Rapp, 2000). If the mean precipitation increases, extreme precipitation and flood events will most probably appear more frequent and intense. The IPCC (IPCC, 2001) predicts therefore an increase of intensive precipitation events in the lapse of the 21st century as very likely for many regions of the earth (and consequential i.a. more frequent floodings, landslides and avalanches).

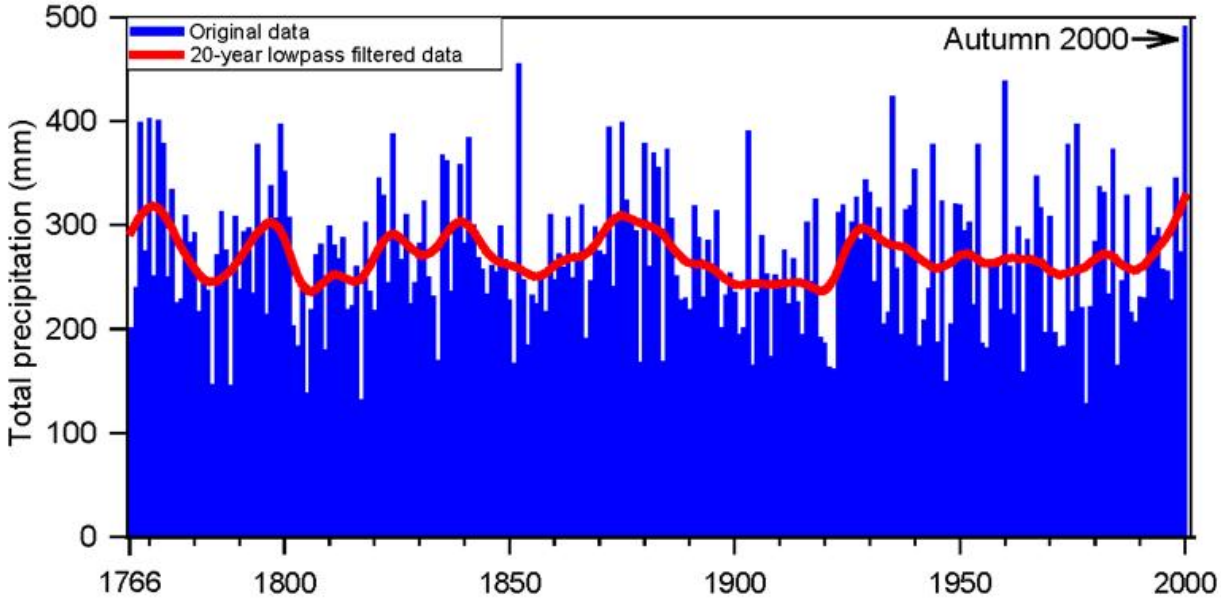

Fig. 9 Time series of the autumn precipitation (original values: blue; 20-year lowpass values: red) in England and Wales during 1766 - 2000 (Database: Climatic Research Unit, Univ. East Anglia, Norwich, UK and Hadley Centre, UK Met. Office, Bracknell, UK).

The accumulation of heavy precipitation (Easterling et al., 2000) and flood situations (like during the precipitation period in autumn 2000) during the last years in Europe is a first indicator, that beside temperature probably the precipitation distribution is changing in Europe, too.

Literature

FU Berlin (2000): Klimatologische Übersicht für Europa und den Nordatlantik (KEU), monthly supplement to the 'Berliner Wetterkarte'. Selbstverlag, Berlin.

Cegnar, T. (2001): Impacts of heavy precipitation in November 2000 in Slovenia. Presentation at the DACH-Tagung, 18.-21. September 2001, Vienna. Internet: http://www.zamg.ac.at/~DACH2001/dachneu/Session9/a/Vortrag/cegnar.pdf

DWD (2000): Die Großwetterlagen Europas. Monthly Publication. Selbstverlag, Offenbach.

Easterling, D.R., J.L. Evans, P. Ya. Groisman, T.R. Karl, K.E. Kunkel and P. Ambenje (2000): Observed variability and trends in extreme climate events: A brief review. Bull. Amer. Meteor. Soc., 81, 417-425.

Fuchs, T. (2000): Starkniederschläge im Herbst 2000 in Europa. Beilage Nr. 263/2000 zur Wetterkarte des Deutschen Wetterdienstes. Ergänzt in Beilage SO 2/01 zur Berliner Wetterkarte (in German language only). Internet: http://www.dwd.de/research/klis/produkte/monitoring/hw200010/

Fuchs, T., J. Rapp, F. Rubel and B. Rudolf (2001): Correction of synoptic precipitation observations due to systematic measuring errors with special regard to precipitation phases. Phys. Chem. Earth. (B), 26, 689-693.

IPCC Third Assessment Report (ed. by J.T. Houghton et. al., 2001): Climate Change 2001: The Scientific Basis. Cambridge University Press, UK.

Journel, A.G. and Huijbregts, C. (1978): Mining Geostatistics, Academic Press, 600 pp.

Rapp, J. (2000): Konzeption, Problematik und Ergebnisse klimatologischer Trendanalysen für Europa und Deutschland. Berichte des Deutschen Wetterdienstes Nr. 212, 145 S., Selbstverlag, Offenbach/Main.

Rudolf, B. (1995): Die Bestimmung der zeitlich-räumlichen Struktur des globalen Niederschlags. Berichte des Deutschen Wetterdienstes Nr. 196, 153 S., Selbstverlag, Offenbach/Main.