Project no. GOCE-CT-2003-505539

Project acronym: ENSEMBLES

Project title: ENSEMBLE-based Predictions of Climate Changes and their Impacts

Instrument: Integrated Project

Thematic Priority: Global Change and Ecosystems

D5.20 Note on observational data collected for the ENSEMBLES daily dataset for Europe (submitted to Int.J.Climatol.)

Due date of deliverable: August 2007
Actual submission date: 27 September 2007

Start date of project: 1 September 2004 Duration: 60 Months

Organisation name of lead contractor for this deliverable: KNMI

Revision [draft, 1, 2, ..]

Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)		
Dissemination Level		
PU	Public	✓
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the Consortium (including the Commission Services)	

Updated and extended European dataset of daily climate observations

E.J. Klok and A.M.G. Klein Tank

Royal Netherlands Meteorological Institute KNMI, PO Box 201, 3730 AE De Bilt, The Netherlands, telephone ++31 30 2206705, fax ++31 30 2210407, klok@knmi.nl

Abstract

The European Climate Assessment (ECA) dataset of daily observations, which has been widely used for studies on climate extremes, has been updated and extended. It now contains observational series of 2191 stations located in Europe and the Mediterranean (average inter-station distance: ~75km). About 1200 precipitation series and 750 temperature series cover the period 1960 to 2000. For a small number of stations (< 15%) air pressure, cloud cover, sunshine duration, snow depth and relative humidity series exist. All series are quality controlled and the homogeneity of the precipitation and temperature series is assessed. About 50% of the daily series is publicly available for climate studies through the website http://eca.knmi.nl. The main potential of the ECA dataset follows from its daily resolution, enabling studies of impact relevant climate extremes and variability. To guide these studies, climate indices calculated from the ECA series are presented on the website too. In the near future, gridded versions of the daily ECA data will be available for easy comparison with climate model simulations. A trend analysis for the diurnal temperature range (DTR) demonstrates the dataset. Seasonal and annual DTR trends were calculated for 333 homogeneous temperature series in ECA and a Europe average trend was estimated. In spring and summer, the DTR increased from 1979 to 2005, whereas in autumn and winter the DTR generally decreased. The European average trend in annual DTR was 0.09 °C decade^{-1}.

Key words: daily climate series, dataset, climate extremes, climate indices, Europe, Mediterranean, diurnal temperature range, observations

1. Introduction

The European Climate Assessment (ECA) dataset contains long series of daily station observations such as air temperature and precipitation. Since its presentation (Klein Tank et al., 2002), this dataset has been effectively used for climate extremes studies on a regional scale (Della Marta et al., 2007; Fischer et al., 2007; Haylock and Goodess, 2004; Klein Tank et al., 2005; Moberg and Jones, 2005; Moberg et al., 2006; Norrant and Douguédroit, 2003; Zolina et al., 2005) and global scale (Alexander et al., 2006; Frich et al., 2002). Its success is the compilation of a large number of quality-controlled daily series from all European countries, as well as its public accessibility through the Internet (http://eca.knmi.nl).

Monitoring and analyzing climate variability and extremes, such as wet spells and heat waves, is very important because of the large impacts of climate extremes on society and environment. Consequently, climate extremes were given much attention in the latest IPCC report (Trenbert et al., 2007). It was concluded from observations that the number of warm extremes and the duration of heat waves have increased for all regions with data and the number of daily cold extremes has reduced. The daily resolution of the ECA dataset supports this type of climate studies. For this purpose, an internationally agreed set of indices for weather and climate extremes (Peterson, 2005) is calculated for each station, year and season. Both the derived indices series and the trends in these series are presented on the ECA website.

The ECA dataset has been updated and extended rigorously over the past years. The number of stations is at present 2191 (Figure 1), a tenfold increase over the number in 2002. With an average distance between the stations of 75 km, the spatial resolution is high enough for gridding and comparison to RCM simulations, which is done as part of the EU-ENSEMBLES project (Hewitt and Griggs, 2004; Malcolm et al., in prep.). This short communication presents the new version of the dataset. The climate series and data providers are described in Section 2. The quality control and homogeneity testing procedures are presented in Section 3. An illustration of the dataset, a study on trends in the diurnal temperature range, is given in Section 4 and an outlook concludes this short communication.

2. Daily climate series

The new ECA dataset includes station series for nine daily climate variables: minimum, mean and maximum temperature, precipitation amount, sea level air pressure, snow depth, sunshine duration, relative humidity, and cloud cover. The total number of series in the dataset is highest for temperature and precipitation. For the other variables the total number is relatively low (Table I), since their gathering has only just started. The dataset exists of daily time series provided by the National Meteorological Services of all countries in the region, augmented with data from other institutes and from earlier research projects. Appendix 1 presents the full list of data sources.

All series in the ECA dataset are continuously being updated with SYNOP messages from the ECMWF MARS-archive (ECMWF, 2006) to enable near real time climate monitoring. Updating from this source is necessary, because updates from the data providers are usually received with some delay and the insertion of the series in the database takes time. The SYNOP messages are also used to fill gaps in the time series together with data from nearby stations, provided that they are within 25 km distance and 50 m height difference.

Despite WMO intentions of standardization, the time interval for observing and recording minimum and maximum temperatures or for accumulating 24-hour rainfall amounts sometimes differs between countries and even within countries between stations. For instance, precipitation observations made early in the morning are frequently recorded on the same day, whereas at other stations on the previous day. An additional complication is that observation rules sometimes change within a series over time. This leads to problems if for instance the relationship between daily temperature and daily rainfall is analyzed or if daily values are interpolated onto daily grids. Therefore, each single series in the database is identified with an element code as much as possible, providing information about the measurement procedure.

About 50% of all series in the dataset is currently publicly available (status August 2007; Table I) and can be downloaded from the ECA website. For the other half, only the derived indices series can be released due to data policy restrictions. Figure 2 shows the total number and the number of public series in the dataset for each variable and year. The plots illustrate that the totals for precipitation are greatest. The strong decline in the number of precipitation series over the last 15 years is mainly caused by series from the former Soviet Union, ending in the early nineties. In 1995, the number of temperature series abruptly increases, primarily due to a rise in series from Russia and Ukraine. For all variables, the data coverage is best between 1960 and 2000. About 1200 precipitation series and 750 temperature series cover this period. Unfortunately, data from the most recent years are often missing, even though SYNOP data have been considered to update the series.

3. Data quality and homogeneity

The data in all series are automatically quality checked and flagged accordingly as useful (i.e. the data value passes the test), suspect (i.e. the data value does not pass the test) or missing. Within the dataset no corrections or adjustments are made to the data values. If possible, data values that are flagged as suspect or missing are replaced by data from nearby stations or by SYNOP data (see Section 2).

All quality tests are absolute, implying that data are not compared with respect to neighbouring station series. The quality checks detect several types of errors: anomalous values (i.e. temperatures exceeding 60 °C, precipitation values exceeding 300 mm day^{-1} or negative precipitation values), repetitive values (i.e. repetitive precipitation data over more than 10 days of non-zero values), outliers (i.e. temperatures that exceed a certain zscore in the normal distribution for that calendar day) and inconsistencies (i.e. minimum temperatures that exceed the daily maximum). According to these checks, about 0.5% of all data values in the ECA dataset is currently considered suspect. In some cases, the automatically generated quality control flags have been overruled by manual intervention. This is for example necessary for extreme precipitation events exceeding 300 mm day^{-1}. Additional evidence has proven that such events occasionally occur in Locarno (Switzerland), Genoa (Italy) or Mont-Aigoual (France).

Long climatological time series often contain variations due to non-climatic factors, such as site-relocations, or changes in instrumentation and observing practices. This can lead to shifts in the mean or the variance and to spurious trends. As these inhomogeneities can distort or even hide the true climatic signal, homogeneity testing is a key issue for climate change studies. Within ECA, the homogeneity procedure of Wijngaard et al. (2003) is used to test the homogeneity of the precipitation and temperature series. This method classifies the series in three homogeneity classes: useful, doubtful, and suspect, depending on the number out of four statistical tests that reject the null hypothesis of no break in the series. Table II presents the homogeneity results of the precipitation and temperature series that are complete for the periods 1961-2006 and 1901-2006. The percentage of useful series (rejection of 0 or 1 test) is smaller for the latter period, since the number of detected breaks increases when the period of investigation is extended. The percentage of precipitation series classified as useful is much larger than the percentage of useful temperature series. This is partly due to the high variability of precipitation, which hampers the detection of breaks in series. With regard to the total number of precipitation (temperature) series in the dataset, 39% (25%) is homogenous (i.e. useful) over 1961 to 2006. Note that according to this strict test only 5 out of 107 temperature series covering the period 1901-2006 are useful.

Similar results for the number of homogeneous series were found using an alternative homogeneity testing method, which was recently applied to the same data set by Begert et al. (in prep.) This method involves an automated relative homogenization procedure to detect shift inhomogeneities in climatological time series. It combines VERAQC (Vienna Enhanced Resolution Analysis Quality Control; Steinacker et al. (2000)) output with Alexandersson's Standard Normal Homogeneity Test (Alexandersson, 1986). The results of this procedure show that 59% (20%) of all precipitation (temperature) series are classified as homogeneous over the period 1960-2004.

4. Demonstration of the dataset: changes in the diurnal temperature range

As an illustration of the ECA dataset, we describe in this section the European trends in the diurnal temperature range (DTR) as derived from the daily maximum and minimum temperature series in ECA. Globally, maximum and minimum temperatures have increased at similar rates between 1979 and 2005, with no trend in DTR (Vose et al., 2005; Trenberth et al., 2007). Using the ECA data, we estimated the contribution of Europe to this basically trendless global DTR and investigated the seasonal DTR trends in more detail.

Figure 3 shows the annual and seasonal DTR trends (using least squares regression) for 1979 to 2005 as derived from 333 homogeneous (useful) maximum and minimum temperature series in ECA. An overall DTR increase is evident in spring and summer, with more increasing than decreasing trends (Table III). Also annually, the number of series with an increasing DTR trend exceeds the number of series with a decreasing trend, and about 50% of the trends is significant at the 25% level (*t* test). For autumn and winter, the DTR generally decreased, but the pattern is less consistent with decreasing trends in southern Europe in autumn and in northern Europe in winter.

A Europe average DTR trend was calculated by first averaging all 333 DTR series and then doing the trend analysis. The trend in the Europe average DTR is positive for the year, spring and summer and negative for the autumn and winter (Table III). Although none of these average trends is statistically significant at the 5% level, the trends in the annual, summer and winter DTR are significant at the 10% level (and thus very likely in IPCC terms). Since for all seasons, minimum as well as maximum temperatures have increased from 1979 to 2005 (not shown), positive (negative) DTR trends are associated with maximum temperatures having increased at a larger (smaller) rate than minimum temperatures. The results indicate that Europe contributed to a positive trend in global annual DTR in recent decades that must have been compensated elsewhere (Vose et al., 2005; Trenberth et al., 2007). Whether this is related to regional specific changes in cloud cover, precipitation, or to variations in atmospheric circulation is a topic for future research.

5. Outlook

Besides the production of European high-resolution gridded daily datasets based on the series in ECA (Malcolm et al., in prep.), other prospects for the ECA dataset are a continuous improvement of the number and length of the series, especially for the new variables air pressure, snow depth, sunshine duration, cloud cover and relative humidity. The ultimate target would be to collect the daily series of a network comparable to all SYNOP stations in Europe (~3000). As the number of series of the new variables will grow, indices of climate extremes based on these variables will be analyzed and presented on the website (e.g. the number of snow days, heat wave indices taking into account air humidity, drought indices). We also started to collect more metadata of the station series (such as pictures of all stations and information on soil type and land use) to aid the interpretation of the homogeneity test results. At present, a minority of the series (roughly 30%) is identified as homogeneous. When new techniques (e.g. Vincent et al., 2002; Della Marta and Wanner, 2006) for homogenizing daily series become available, this figure may improve.

Acknowledgements

This work was supported by the European Climate Support Network ECSN, the Network of European Meteorological Services EUMETNET and the ENSEMBLES project (contract number GOCE-CT-2003-505539) of European Commission's 6th Framework Programme. Many thanks are due to all data providers listed in Appendix 1. We also thank our KNMI colleagues Janet Wijngaard, Maarten van der Hoeven, Job Verkaik, Aryan van Engelen and Gerard van der Schrier for their contribution to the ECA dataset.

References

Alexander LV, Zhang X, Peterson TC, Caesar J, Gleason B, Klein Tank A, Haylock M, Collins D, Trewin B, Rahimzadeh F, Tagipour A, Ambenje P, Rupa Kumar K, Revadekar, Goodess C. 2004: Interannual variability of European extreme winter rainfall and links with mean large-scale circulation. International Journal of Climatology 24, 759-776.

Alexandersson H. 1986. A homogeneity test applied to precipitation data. International Journal of Climatology 6: 661-675.

Ansell T, Jones P, Allan R, Lister D, Parker D, Brunet M, Moberg A, Jacobeit J, Brohan P, Rayner NA, Aguilar E, Barriendos M, Brandsma T, Cox NJ, Della-Marta P, Drebs A, Founda D, Gerstengarbe F, Hickey K, Jonsson T, Luterbacher J, Nordli O, Oesterle H, Petrakis M, Philipp M, Rodwell MJ, Saladie O, Sigro J, Slonosky V, Srnec L, Garcia-Suarez L, Tuomenvirta H, Wang X, Wanner H, Werner P, Wheeler D, Xoplaki E. 2006. Daily mean sea level pressure reconstructions for the European - North Atlantic region for the period 1850-2003. Journal of Climate 19(12): 2717-2742. DOI: 10.1175/JCLI3775.1

Begert M, Zenklusen E, Häberli C, Appenzeller C, Klok EJ. 2007. Testing an automated homogenization procedure for large multivariate data sets. In preparation.

Bougeault P, Binder P, Buzzi A, Dirks R, Houze R, Kuettner J, Smith RB, Steinacker R, Volkert H. 2001. The MAP Special Observing Period. Bulletin of the American Meteorological Society 82: 433-462.

Della-Marta PM, Luterbacher J, von Weissenfluh H, Xoplaki E, Brunet M, Wanner H. 2007. Summer heat waves over western Europe 1880–2003, their relationship to large-scale forcings and predictability. Climate Dynamics: D15103. DOI: 10.1007/s00382-007-0233-1

Della-Marta PM, H Wanner H. 2006. A method of homogenising the extremes and mean of daily temperature measurements. Journal of Climate 19: 4179–4197.

ECMWF. 2006. MARS User Guide User Support Operations Department. ECMWF Technical Notes, European Centre for Medium-Range Weather Forecasts, Reading, United Kingdom.

Fischer EM, Seneviratne SI, Lüthi D, Schär C. 2007. Contribution of land-atmosphere coupling to recent European summer heat waves. Geophysical Research Letters 34, L06707. DOI:10.1029/2006GL029068

Genovese GP. 2001. Introduction to the MARS Crop Yield Forecasting System (MCYFS). Meeting on 4 and 5 October 2001, Luxembourg. Space Applications Institute, Joint Research Centre of the European Commission, Ispra, Italy.

Haylock M, Goodess C. 2004. Interannual variability of European extreme winter rainfall and links with mean large-scale circulation. International Journal of Climatology 24: 759-776.

Haylock et al. 2007. In preparation.

Hewitt CD, Griggs DJ. 2004. Ensembles-Based Predictions of Climate Changes and Their Impacts. Eos Transactions AGU 85(52): 566. DOI: 10.1029/2004EO520005

Klein Tank AMG, Wijngaard JB, Können GP, Böhm R, Demarée G, Gocheva A, Mileta M, Pashiardis S, Hejkrlik L, Kern-Hansen C, Heino R, Bessemoulin P, Müller-Westermeier G, Tzanakou M, Szalai S, Pálsdóttir T, Fitzgerald D, Rubin S, Capaldo M, Maugeri M, Leitass A, Bukantis A, Aberfeld R, van Engelen AFV, Forland E, Mietus M, Coelho F, Mares C, Razuvaev V, Nieplova E, Cegnar T, Antonio López J, Dahlström B, Moberg A, Kirchhofer W, Ceylan A, Pachaliuk O, Alexander LV, Petrovic P. 2002. Daily dataset of 20th-century surface air temperature and precipitation series for the European Climate Assessment. International Journal of Climatology 22: 1441-1453.

Klein Tank AMG, Können GP, and Selten FM. 2005. Signals of anthropogenic influence on European warming as seen in the trend patterns of daily temperature variance. International Journal of Climatology 25: 1-16.

Frich P, Alexander LV, Della-Marta P, Gleason B, Haylock M, Klein Tank AMG, Peterson T. 2002. Observed coherent changes in climatic extremes during 2nd half of the 20th century. Climate Research 19: 193-212.

Moberg A, Jones PD. 2005. Trends in indices for extremes in daily temperature and precipitation in central and western Europe, 1901-99. International Journal of Climatology 25(9): 1149-1171.

Moberg A, Jones PD, Lister D, Walther A, Brunet M, Jacobeit J, Alexander LV, Della-Marta PM, Luterbacher J, Yiou P, Chen D, Klein Tank AMG, Saladié O, Sigró J, Aguilar E, Alexandersson H, Almarza C, Auer I, Barriendos M, Bergert M, Bergström H, Böhm R, Butler J, Caesar J, Drebs A, Founda D, Gerstengarbe F-W, Micela G, Maugeri M, Österle H, Panzic K, Petrakis M, Srnec L, Tolasz R, Tuomenvirta H, Werner P, Linderholm H, Philipp A, Wanner H, Xoplaki E. 2006. Indices for daily temperature and precipitation extremes in Europe analyzed for the period 1901-2000. Journal of Geophysical Research. 111, D22106. DOI:10.1029.2006JD007103

NCDC, 2004. Data documentation for data set 9300 (DSI-9300) Global Historical Climatology Network – Daily, V1.0. National Climatic Data Center, Asheville, USA.

Norrant C, Douguédroit A. 2006. Monthly and daily precipitation trends in the Mediterranean (1950-2000). Theoretical and Applied Climatology 83: 89-106.

Peterson T, Daan H, Jones P. 1997. Initial selection of a GCOS Surface Network. Bulletin of the American Meteorological Society 78: 2145-2152.

Peterson TC. 2005. Climate Change Indices. WMO Bulletin, 54(2), 83-86.

Smith TM, Reynolds RW. 2005. A global merged land and sea surface temperature reconstruction based on historical observations (1880–1997). Journal of Climate 18: 2021–2036.

Steinacker R, Häberli C, Pöttschacher W. 2000. A transparent method for the analysis and quality evaluation of irregularly distributed and noisy observational data. Monthly Weather Review 128(7): 2303-2316.

Trenberth KE, Jones PD, Ambenje P, Bojariu R, Easterling D, Klein Tank A, Parker D, Rahimzadeh F, Renwick JA, Rusticucci M, Soden B, Zhai P. 2007. Observations: Surface and Atmospheric Climate Change. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon S, Qin D, Manning M, Chen Z, Marquis M, Averyt KB, Tignor M, Miller HL(eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Vincent LA, Zhang X, Bonsal BR, Hogg WD. 2002. Homogenization of daily temperatures over Canada. Journal of Climate15:1322-1334.

Vose RS, Easterling DR and Gleason B. 2005. Maximum and minimum temperature trends for the globe: An update through 2004. Geophysical Research Letters 32, L23822. DOI:10.1029/2005GL024379

Wijngaard JB, Klein Tank AMG, Können GP. 2003. Homogeneity of 20th century European daily temperature and precipitation series. International Journal of Climatology 23: 679-692.

Zolina O, Simmer C, Kapala A, Gulev SK. 2005. On the robustness of the estimates of centennial-scale variability in heavy precipitation from station data over Europe. Geophysical Research Letters 32, L14707. DOI: 10.1029/2005GL023231

Appendix 1

List of data provide (abbreviations: rr – precipitation, tx – maximum temperature, tn – minimum temperature, tm – mean temperature, pp – sea level pressure, rh – relative humidity, sd – snow depth, cc- cloud cover, ss – sunshine duration).

ECA participants *Climate variables: rr, tx, tn, tm, pp, rh, sd, cc, ss; 989 stations*	
Hydrometeorological Institute	ALBANIA
Office National de la Météorologie	ALGERIA
Hydrometeorology and Environmental Agency	ARMENIA
Central Institute for Meteorology and Geodynamics	AUSTRIA
Koninklijk Meteorologisch Instituut	BELGIUM
Federal Meteorological Institute of Bosnia and Herzegovina	BOSNIA AND HERZEGOVINA
National Institute of Meteorology and Hydrology	BULGARIA
Meteorological and Hydrological Service of Croatia	CROATIA
Meteorological Service of Cyprus	CYPRUS
Czech Hydrometeorological Institute	CZECH REPUBLIC
Danish Meteorological Institute	DENMARK
Estonian Meteorological and Hydrological Institute	ESTONIA
Finnish Meteorological Institute	FINLAND
Météo-France	FRANCE
Deutscher Wetterdienst	GERMANY
Hellenic National Meteorological Service	GREECE
Hungarian Meteorological Service	HUNGARY
Icelandic Meteorological Office	ICELAND
Met Éireann	IRELAND
National University of Ireland, Galway	IRELAND
Israel Meteorological Service	ISRAEL
Universita degli Studi di Milano	ITALY
Servizio Meteorologico dell' Aeronautica	ITALY
Latvian Hydrometeorological Agency	LATVIA
Institute of Geology and Geography	LITHUANIA
Service Météorologique du Luxembourg	LUXEMBOURG
Centre de Recherche Public Gabriel Lippmann	LUXEMBOURG
Royal Netherlands Meteorological Institute	NETHERLANDS
Det Norsk Meteorologiske Institutt	NORWAY
Institute of Meteorology and Water Management	POLAND
Instituto de Meteorologia	PORTUGAL
Universidade do Algarve	PORTUGAL
Republic Hydrometeorological Institute	REPUBLIC OF MACEDONIA
National Institute of Meteorology and Hydrology	ROMANIA
Russian Federal Service for Hydrometeorology and Environmental Monitoring	RUSSIAN FEDERATION
Republic Hydrometeorological Institute of Serbia	SERBIA AND MONTENEGRO
Slovak Hydrometeorological Institute	SLOVAKIA
Environmental Agency of the Republic of Slovenia	SLOVENIA
Instituto Nacional de Meteorologia	SPAIN
Swedish Meteorological and Hydrological Institute	SWEDEN
Stockholm University	SWEDEN
MeteoSwiss	SWITZERLAND
Devlet Meteoroloji Genel Mudurluou	TURKEY

Central Geophysical Observatory	UKRAINE
Met Office	UNITED KINGDOM
EMULATE[1] data providers	
http://www.cru.uea.ac.uk/cru/projects/emulate/	
Climate variables: rr, tx, tn, tm, pp; 197 stations	
Central Institute for Meteorology and Geodynamics	AUSTRIA
Meteorological and Hydrological Service of Croatia	CROATIA
Czech Hydrometeorological Institute	CZECH REPUBLIC
Finnish Meteorological Institute	FINLAND
Potsdam Institute for Climate Impact Research	GERMANY
Universität Augsburg, Institut für Geographie	GERMANY
National Observatory of Athens	GREECE
Icelandic Meteorological Office	ICELAND
Universitá di Milano, Instituto di Fisica Generale Applicata	ITALY
Instituto Nazionale di Astrofisica, Osservatorio Astronomico di Palermo	ITALY
Royal Netherlands Meteorological Institute	NETHERLANDS
University of Barcelona, Department of Astronomy and Meteorology	SPAIN
Universitat Rovira I Virgili, Physical Geography	SPAIN
Swedish Meteorological and Hydrological Institute	SWEDEN
Uppsala University, Department of Earth Sciences, Air and water Science-Meteorology	SWEDEN
MeteoSwiss	SWITZERLAND
Met Office	UNITED KINGDOM
Armagh Observatory	UNITED KINGDOM
STARDEX[2] data providers	
http://www.cru.uea.ac.uk/cru/projects/stardex/	
Climate variables: rr, tx, tn, tm; 248 stations; series cover the period 1958-2000 only	
Central Institute for Meteorology and Geodynamics	AUSTRIA
Czech Hydrometeorological Institute	CZECH REPUBLIC
Danish Meteorological Institute	DENMARK
Finnish Meteorological Institute	FINLAND
Meteo France	FRANCE
Deutscher Wetterdienst	GERMANY
Department of Meteorology and Climatology, Aristotle University of Thessaloniki	GREECE
Hungarian Meteorological Service	HUNGARY
Servizio Meteorologico Regional, ARPA-Emilia Romagna	ITALY
Royal Netherlands Meteorological Institute	NETHERLANDS
Det Norsk Meteorologiske Institutt	NORWAY
Instituto de Meteorologia	PORTUGAL
Russian Federal Service for Hydrometeorology and Environmental Monitoring	RUSSIAN FEDERATION
Instituto Nacional de Meteorología	SPAIN
Swedish Meteorological and Hydrological Institute	SWEDEN
MeteoSwiss	SWITZERLAND
University of East Anglia, Climate Research Unit	UNITED KINGDOM
MAP[3] data providers	
http://www.map.meteoswiss.ch/	
Climate variables: rr, tx, tn, tm; 108 stations; Italian series only	
Ufficio Idrografico Provincia Autonoma di Trento	ITALY

Servizio Meteorologico dell' Aeronautica	ITALY
GCOS Surface Network[4] *http://www.wmo.ch/web/gcos/gcoshome.html* *Climate variables: rr, tx, tn, tm, pp; 47 stations* National Climate Data Center	USA
GHCND[5] *http://www.ncdc.noaa.gov/oa/climate/research/ghcn/ghcn.html* *Climate variables: rr, tx, tn, tm; 642 stations; version DSI-9300* National Climate Data Center	USA
Mars-Stat Database[6] *http://agrifish.jrc.it/marsstat/* *Climate variables: rr, tx, tn, tm; 263 stations* Joint Research Centre, Ispra	ITALY
University of Silesia *Climate variables: rr; 22 stations; Polish series only*	POLAND
University of Lodz *Climate variables: tx, tn, tm; 6 stations; Polish series only*	POLAND
SYNOP/CLIMAT *http://www.ecmwf.int/* *Climate variabless: rr, tx, tn, tm, pp, rh, sd, cc, ss; 1291 stations* ECMWF	UNITED KINGDOM

1) EMULATE (European and North Atlantic daily to MULtidecadal climATE variability, Moberg and Jones, 2005; and Ansell, 2006) is a European 5th framework programme.

2) STARDEX (Statistical and Regional dynamical Downscaling of Extremes for European regions, Haylock and Gooddess, 2004) is a European 5th framework programme.

3) The Mesoscale Alpine Programme (MAP) is a project that investigated the atmospheric and hydrological processes over the Alps (Bougeault et al., 2001).

4) GCOS is the Global Climate Observing System. The GCOS Surface Network (GSN) is a global surface reference climatological station network (Peterson et al., 1997).

5) The Global Historical Climatology Network – Daily (GHCND) is developed by the National Climatic Data Center (NCDC, 2004).

6) The Joint Research Centre in Ispra, Italy houses the MARS-STAT Database containing daily series to develop an interpolated 50-km meteorological European dataset for crop forecasting (Genovese, 2001).

Table I. For each climate variable, the number of series in the database and the percentage that is publicly available from the ECA&D website (status August 2007).

Climate variable	Number of series (and percentage publicly available)
Maximum temperature	1368 (48%)
Minimum temperature	1371 (48%)
Mean temperature	1233 (42%)
Precipitation	2052 (48%)
Air pressure	321 (53%)
Snow depth	187 (24%)
Relative humidity	189 (71%)
Cloud cover	128 (70%)
Sunshine duration	184 (59%)

Table II. Total number of precipitation and temperature series that covers the periods 1961-2006 and 1901-2006 and the number (percentage) classified as useful, doubtful and suspect following the homogeneity test of Wijngaard et al. (2003).

Period	Climate variable	Total number	Useful	Doubtful	Suspect
1961-2006	Precipitation	843	793 (94%)	21 (3%)	29 (3%)
	Temperature	642	345 (54%)	56 (9%)	241 (7%)
1901-2006	Precipitation	267	186 (70%)	26 (10%)	55 (20%)
	Temperature	107	5 (5%)	3 (3%)	99 (92%)

Table III. Number of series with increasing, decreasing and insignificant (t test) trends in annual and seasonal DTR for 1979-2005 at the 25% (5%) level. The last column presents the trend in the European average DTR with the 95% confidence interval in parentheses.

Season	increasing	decreasing	not significant	Average trend (°C $decade^{-1}$)
Annual	125 (52)	41 (14)	167 (267)	0.09 (0.00-0.18)
Winter (DJF)	49 (15)	83 (43)	201 (275)	-0.11 (-0.21-0.00)
Spring (MAM)	146 (56)	18 (8)	169 (269)	0.15 (0.00-0.30)
Summer (JJA)	140 (52)	26 (5)	167 (276)	0.14 (-0.03-0.31)
Autumn (SON)	47 (11)	72 (29)	214 (293)	-0.01 (-0.14-0.11)

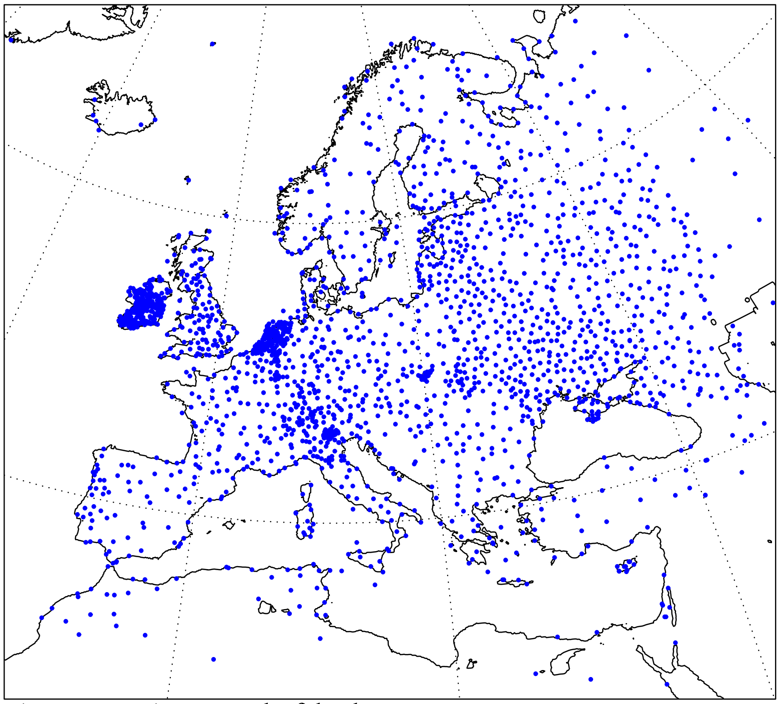

Figure 1. Station network of the dataset (status August 2007).

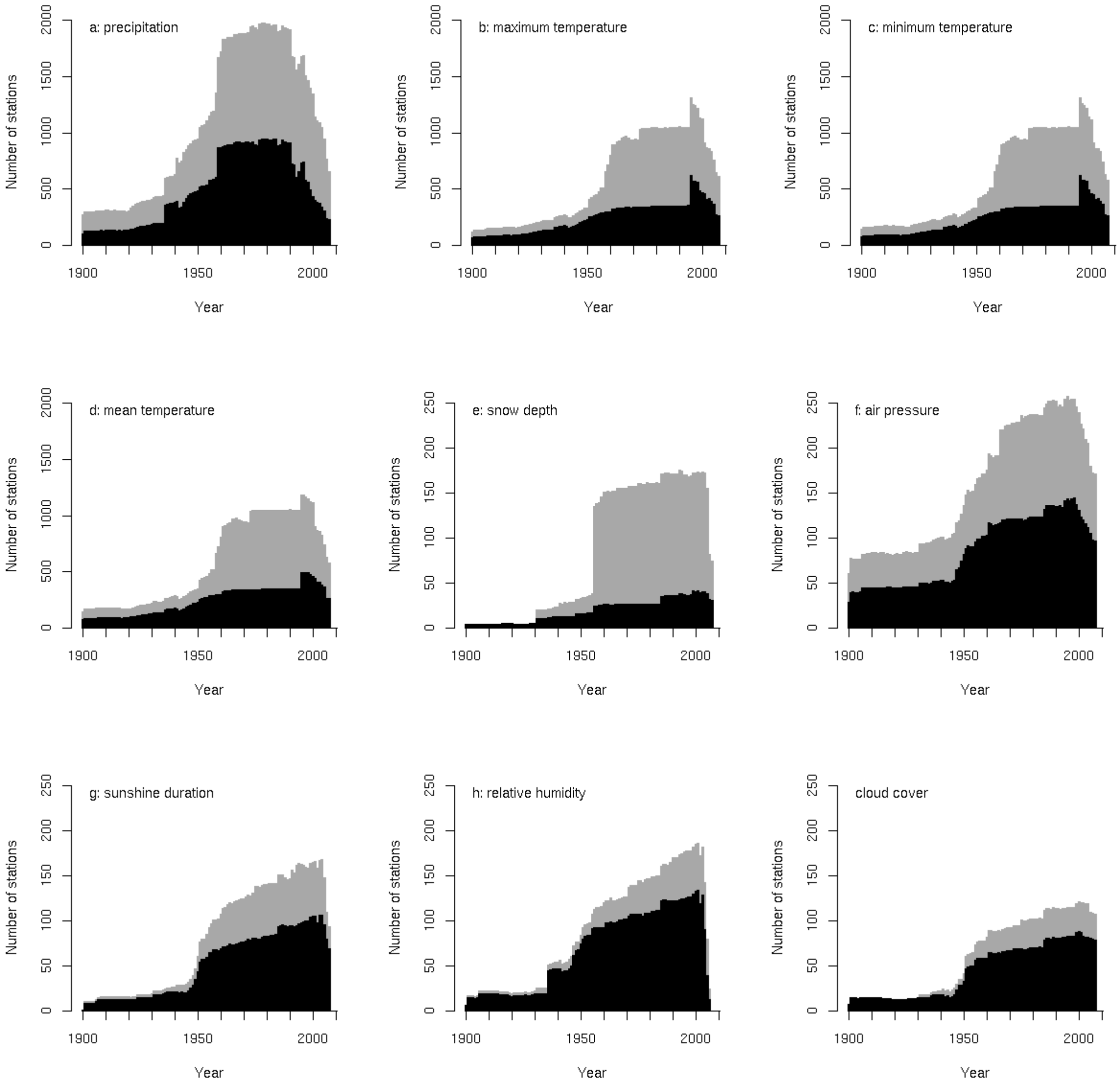

Figure 2. Number of series for each year for precipitation (a), maximum temperature (b), minimum temperature (c), mean temperature (d), snow depth (e), air pressure (f), relative humidity (g), cloud cover (h) and sunshine duration (i) (status August 2007). The grey bars indicates the total number of series, the black bars the number of publicly available series. Note the two different y-scales for plots a-d and e-i.

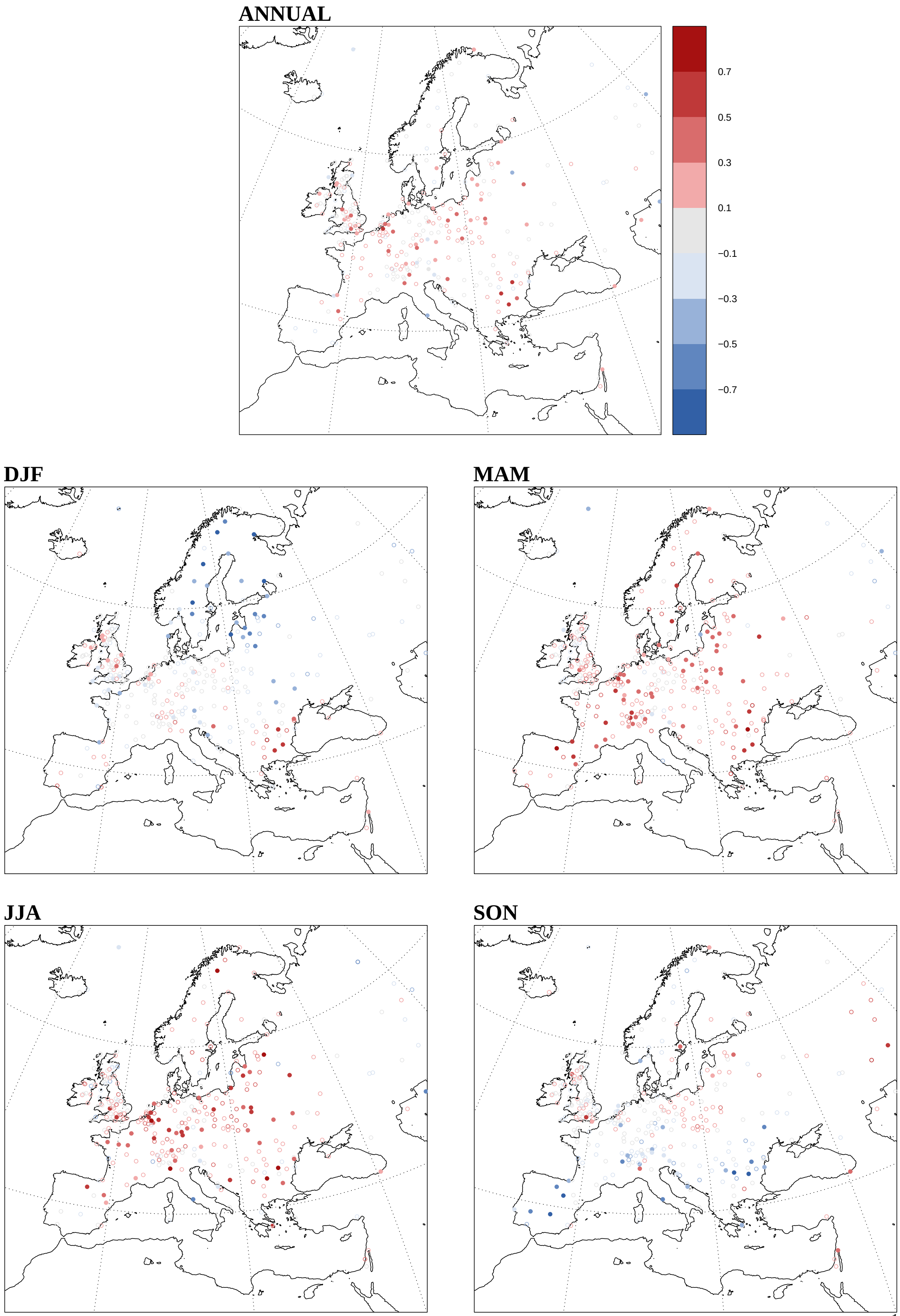

Figure 3. Linear trend in the annual and seasonal mean DTR for the period 1979 to 2005 (°C decade^{-1}). Trends significant at the 5% level are indicated by solid dots, insignificant trends by open dots.