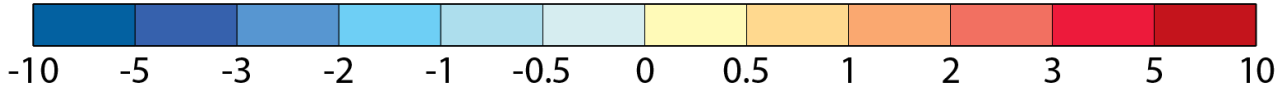
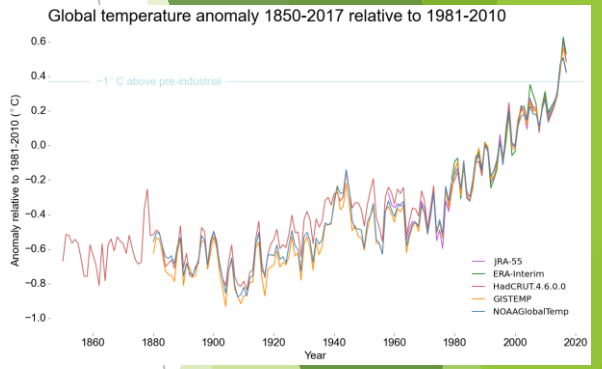
Average for January to October 2017

Adrian Simmons
&
Re-analysis
by
David Burridge (pay-back time!)

Credits: Dick Dee, Hans Hersbach, Adrian and a cast of thousands .....



Temperature difference (^{o}C) from the 1981-2010 average



European Commission

Copernicus Europe's eyes on Earth

Climate Change Service climate.copernicus.eu

IMPLEMENTED BY ECMWF

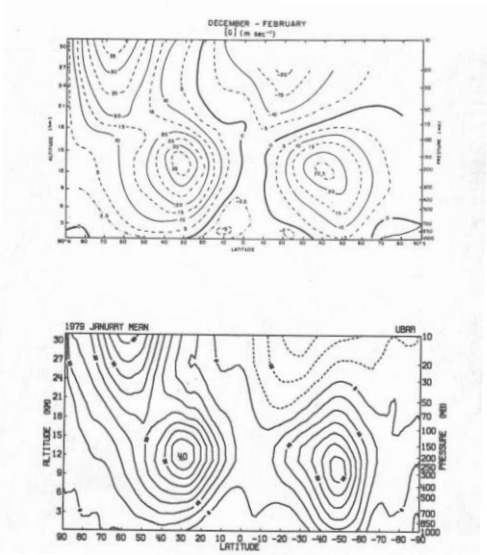
A brief history of atmospheric reanalysis productions at ECMWF

1990 2000 2010

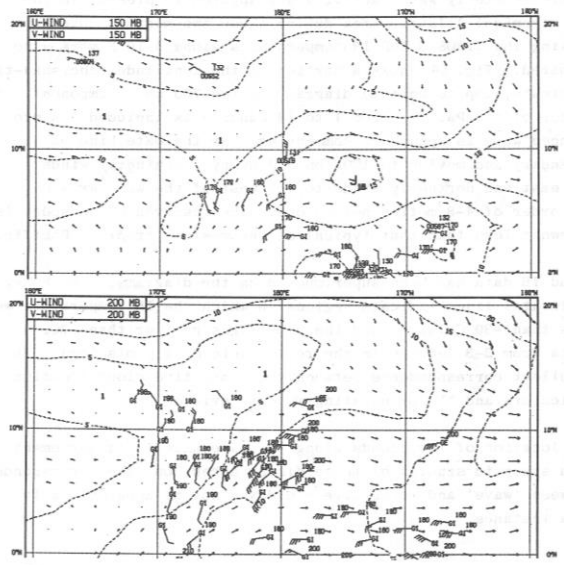
FGGE | **ERA-15** | **ERA-40** | **ERA-Interim** | **ERA5**

Atmosphere/land *Atmosphere/land/waves*

- The **FGGE** analyses provided the first global atmospheric dataset for scientific research
- Numerous seminal studies on atmospheric circulation
- Many case studies performed at ECMWF
- **FGGE** = First GARP Global Experiment
- GARP = Global Atmospheric Research Program



Kanamitsu 1980



Julian 1980

ECMWF Council decisions 1991 - 1992

91.30 approved in principle a proposal from the Centre to re-analyse 15 years of archive data, to generate a data set suitable for studies of climate change. In the first instance, funding would be sought through the environment programme of the European Community. To the extent that this approach was unsuccessful, the project could be submitted to Council for consideration as an optional project;

92.4 requested the Director to explore the possibility of funding, and the provision of computer resources, for the re-analysis project, from sources outside the Centre;

No EC framework programme support – there was considerable skepticism in the climate community;

NWP re-analyses are best ephemeral; we can always "knock off" analysis any time we need one …….

92.46 in relation to the Re-analysis Project:

i. adopted a supplementary Budget 1992 for the financing of the upgrade of the computer equipment for the Re-analysis Project;

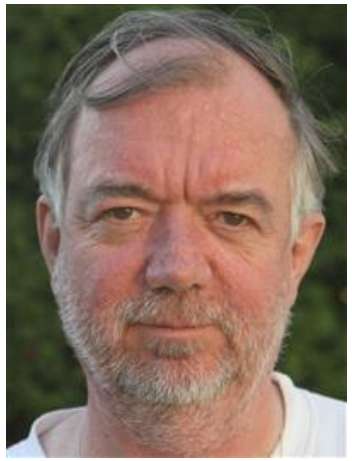
ii. waived for the required amount of £250,000 the provision of Article 39 of the Financial Regulations regarding the return of budgetary surplus to the Member States;

iii. approved the provision of £64,500 to be funded out of the budgets for the years 1993 to 1995 for appointment of a consultant team leader for the project;

iv. waived the limitation of two years‟ maximum employment for consultants employed on the Re analysis Project;

ERA-15 Angels and mustard seeds

Larry Gates
PCMDI



Ib Troen
EU Commission

Jagadish Shukla
COLA

David Blaskovich
Cray Research

December 1992 - ECMWF Council decides to commit resources to ERA-15

- **ERA-15**: Reanalysis data for 1979 - 1993
- Designed for climate studies
- Using observations from operational archive + FGGE, COADS, TOGA COARE, …
- Major contributions from US, Japan, EU and ECMWF member states

ERA

ECMWF Re-Analysis

Project Report Series

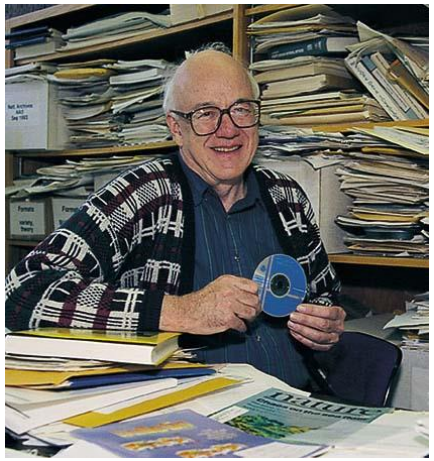
1. ERA-15 Description
(Version 2 - January 1999)

J. K. Gibson, P. Kållberg, S. Uppala,
A. Hernandez, A. Nomura, E. Serrano

European Centre for Medium-Range Weather Forecasts

Europäisches Zentrum für mittelfristige Wettervorhersage

Centre européen pour les prévisions météorologique à moyen terme



Roy Jenne
NCAR

Rick Anthes
NCAR & UCAR

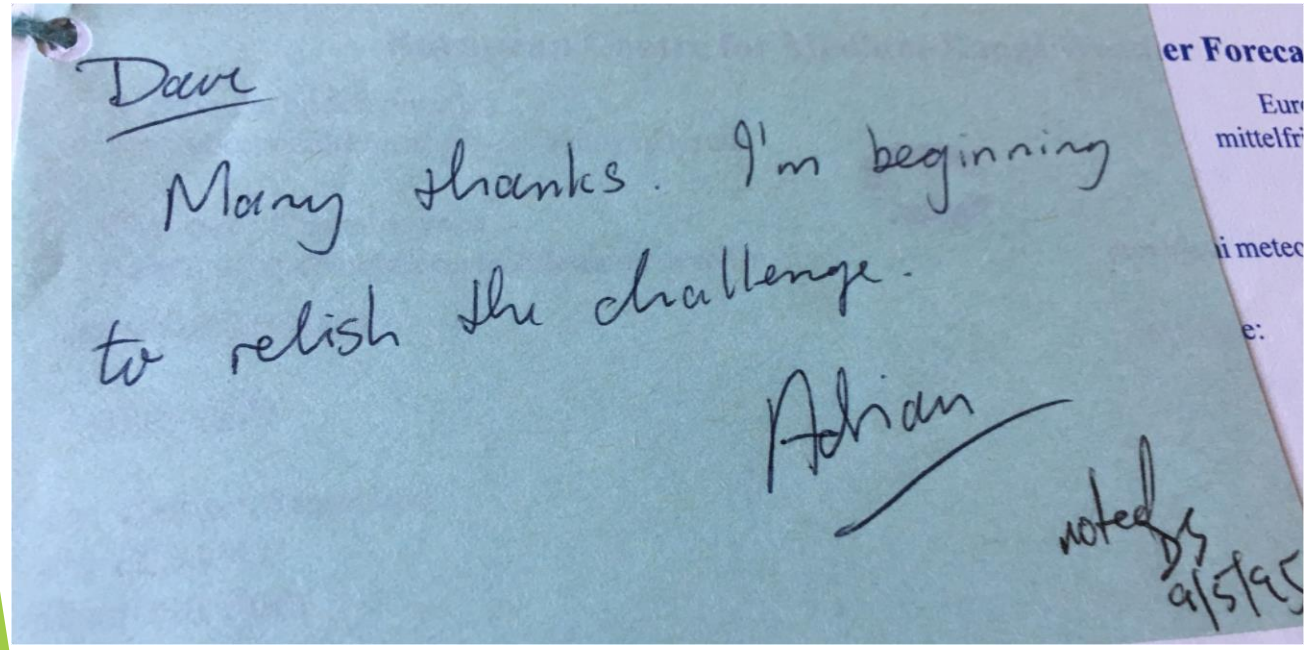
Gibson, Kallberg, Uppala, Hernandez, Nomura and Serrano

Adrian Simmons at ECMWF

1978 – Head of Numerical Aspects section
1992 - Head of the Model Division
1995 – Head of the Data Division comprising

i. Data Assimilation
ii. Satellite data
iii. Predictability and Diagnostics
iv. Seasonal Prediction
v. Re-analysis (quid pro quo/blackmail)
vi. Moon-lighting on Methane oxidation parametrization

70% of the Research Department



2007 – resigned from the Head of the Data Division!

2011 – retired!

2017 - ?

FGGE analyses (1978/79)

ERA-15 (1979/93) - getting started

Re-analysis - acceptance by the European Community and ERA-40 funded

Abisko 1997

A brief history of atmospheric reanalysis productions at ECMWF

1980 1990 2000 2010

FGGE → ERA-15 → ERA-40 → ERA-Interim → ERA5

Atmosphere/land — *Atmosphere/land/waves*

- **ERA-40:** Reanalysis data for 1957-2002
- Includes ocean wave height analyses
- Use of level-1b satellite radiances
- Improved SST and sea-ice data

QUARTERLY JOURNAL
OF THE
ROYAL METEOROLOGICAL SOCIETY

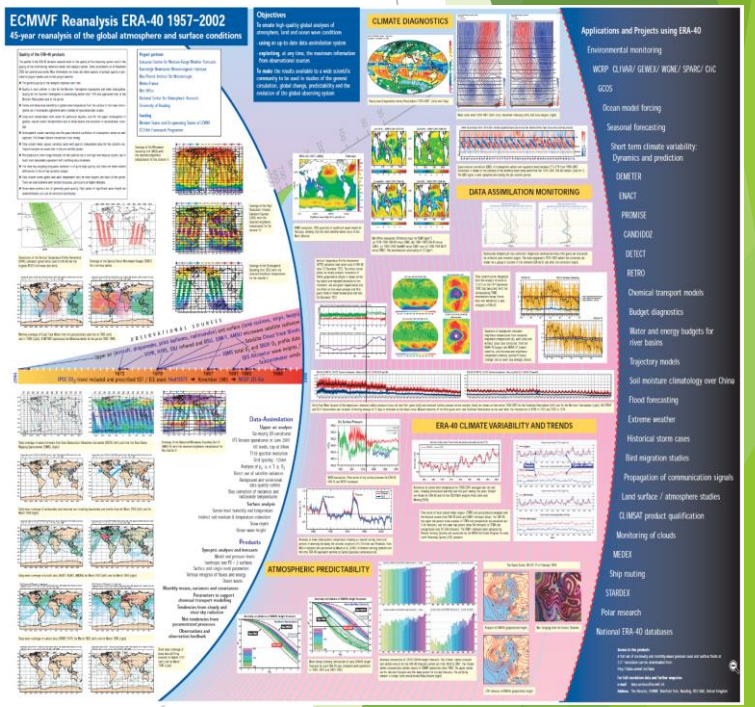
Vol. 131 OCTOBER 2005 Part B No. 612

Q. J. R. Meteorol. Soc. (2005), **131**, pp. 2961–3012 doi: 10.1256/qj.04.176

The ERA-40 re-analysis

By S. M. UPPALA[1], P. W. KÅLLBERG[1], A. J. SIMMONS[1]*, U. ANDRAE[1], V. DA COSTA BECHTOLD[1], M. FIORINO[2], J. K. GIBSON[1], J. HASELER[1], A. HERNANDEZ[1], G. A. KELLY[1], X. LI[3], K. ONOGI[4], S. SAARINEN[1], N. SOKKA[1], R. P. ALLAN[5,11], E. ANDERSSON[1], K. ARPE[6], M. A. BALMASEDA[1], A. C. M. BELJAARS[1], L. VAN DE BERG[7], J. BIDLOT[1], N. BORMANN[1], S. CAIRES[8], F. CHEVALLIER[1], A. DETHOF[1], M. DRAGOSAVAC[1], M. FISHER[1], M. FUENTES[1], S. HAGEMANN[6], E. HÓLM[1], B. J. HOSKINS[9], L. ISAKSEN[1], P. A. E. M. JANSSEN[1], R. JENNE[10], A. P. MCNALLY[1], J.-F. MAHFOUF[1], J.-J. MORCRETTE[1], N. A. RAYNER[11], R. W. SAUNDERS[11], P. SIMON[12], A. STERL[8], K. E. TRENBERTH[10], A. UNTCH[1], D. VASILJEVIC[1], P. VITERBO[1] and J. WOOLLEN[13]

[1]*European Centre for Medium-Range Weather Forecasts, Reading, UK*
[2]*Program for Climate Model Diagnosis and Intercomparison, Lawrence Livermore National Laboratory, USA*
[3]*Institute for Atmospheric Physics, Chinese Academy of Sciences, Beijing, China*
[4]*Japan Meteorological Agency, Tokyo, Japan*
[5]*Environmental Systems Science Centre, University of Reading, UK*
[6]*Max-Planck-Institut für Meteorologie, Hamburg, Germany*
[7]*European Organisation for the Exploitation of Meteorological Satellites, Darmstadt, Germany*
[8]*Koninklijk Nederlands Meteorologisch Instituut, De Bilt, the Netherlands*
[9]*Department of Meteorology, University of Reading, UK*
[10]*National Center for Atmospheric Research, Boulder, Colorado, USA*
[11]*Met Office, Exeter, UK*
[12]*Météo-France, Toulouse*
[13]*NOAA/NWS/National Centers for Environmental Prediction, USA*



Dick Dee 2016

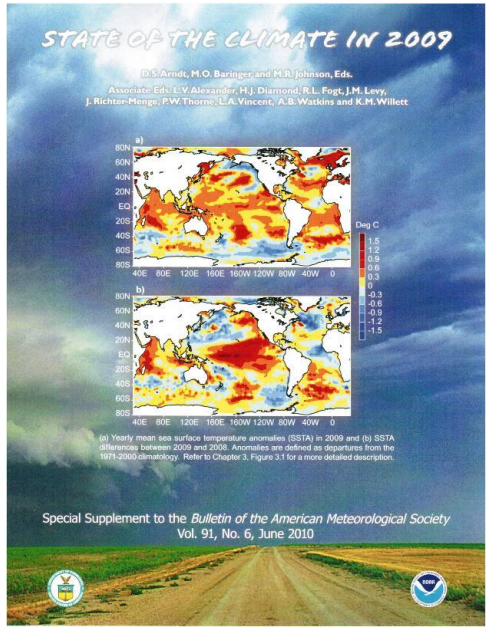
A brief history of atmospheric reanalysis productions at ECMWF

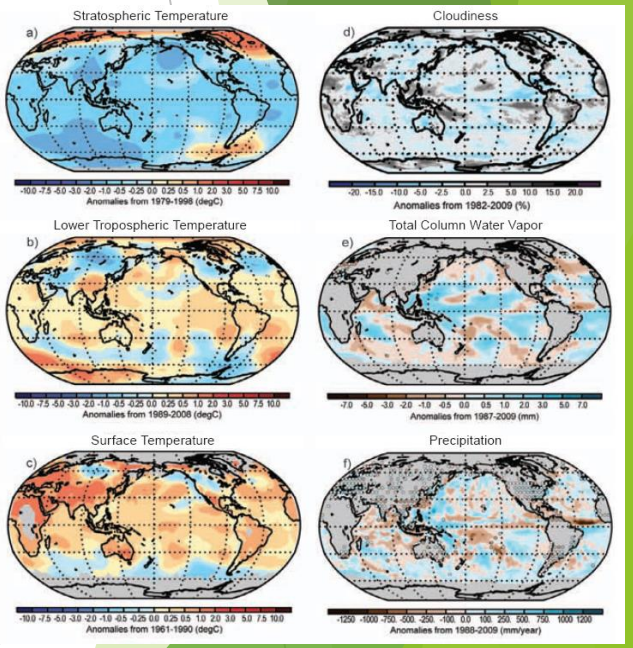
1980 1990 2000 2010

FGGE ERA-15 ERA-40 ERA-Interim ERA5

Atmosphere/land *Atmosphere/land/waves*

- **ERA-Interim:** Data from 1979 onward
- Continuously updated close to real time
- 4D-Variational data assimilation
- Improved use of satellite data
- Increasingly important for ECMWF research and operations
- ERA-Interim has a major role in Copernicus Services development





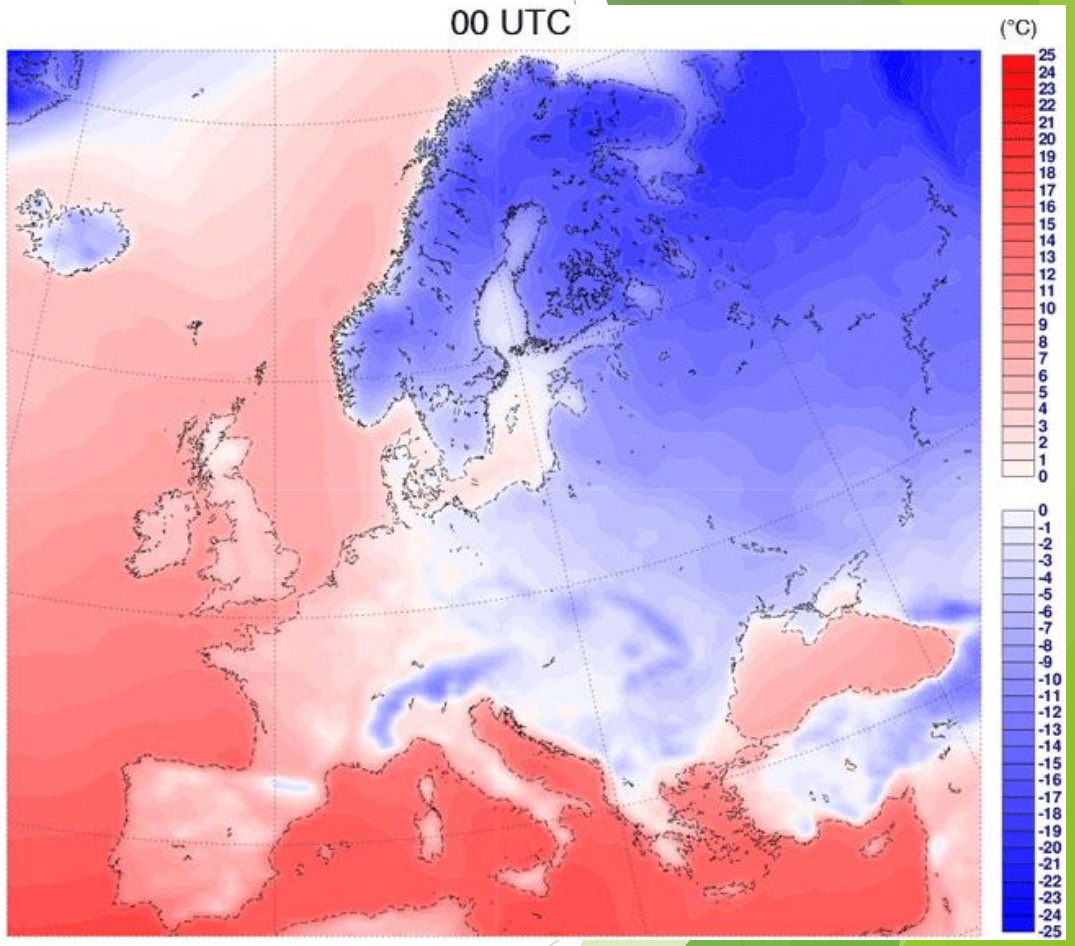
ERA5: The latest ECMWF reanalysis is now in

- Atmosphere/land/wave parameters
- 31 km global resolution, 137 levels
- Hourly output from 1979 onward

- Based on IFS Cy41r2 (March 2016)
- Using improved input observations
- Ensemble data assimilation
- Providing uncertainty estimates

Public release plan:

Nov 2016	Test data (Jan-Feb 2016)
Apr 2017	Hourly data from 2010 - 2016
May 2017	Daily updates at short delay
Apr 2018	Complete from 1979 onward



ERA5 hourly temperatures for January 2016

Re-analysis applications

- Research
- Evaluation of the long-term performance of the forecasting system
- Ensemble products – probabilities, indices, reliability estimates
- Long-term predictions/simulations - climatology for calculating anomalies
- Extreme indices
- Operational commercial applications
- Climate research and assessment

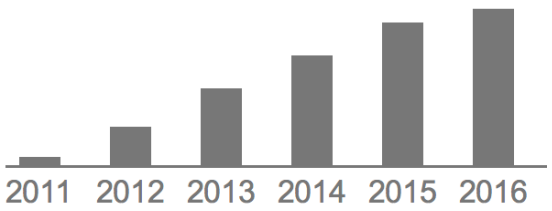
Use of reanalysis for scientific research

The ERA-40 re-analysis
SM Uppala, PW Kållberg, AJ Simmons… - Quarterly Journal of …, 2005 - Wiley Onli
Abstract ERA-40 is a re-analysis of meteorological observations from September 195
August 2002 produced by the European Centre for Medium-Range Weather Forecas
(ECMWF) in collaboration with many institutions. The observing system changed ...
Cited by 6039 Related articles All 24 versions Cite Saved

[HTML] The ERA-Interim reanalysis: Configuration and performan
assimilation system
DP Dee, SM Uppala, AJ Simmons… - Quarterly Journal of …, 2011 - Wiley Online
Abstract ERA-Interim is the latest global atmospheric reanalysis produced by the E
Centre for Medium-Range Weather Forecasts (ECMWF). The ERA-Interim project
conducted in part to prepare for a new atmospheric reanalysis to replace ERA-40,
Cited by 6429 Related articles Cite Saved More

Total citations

Cited by 6429



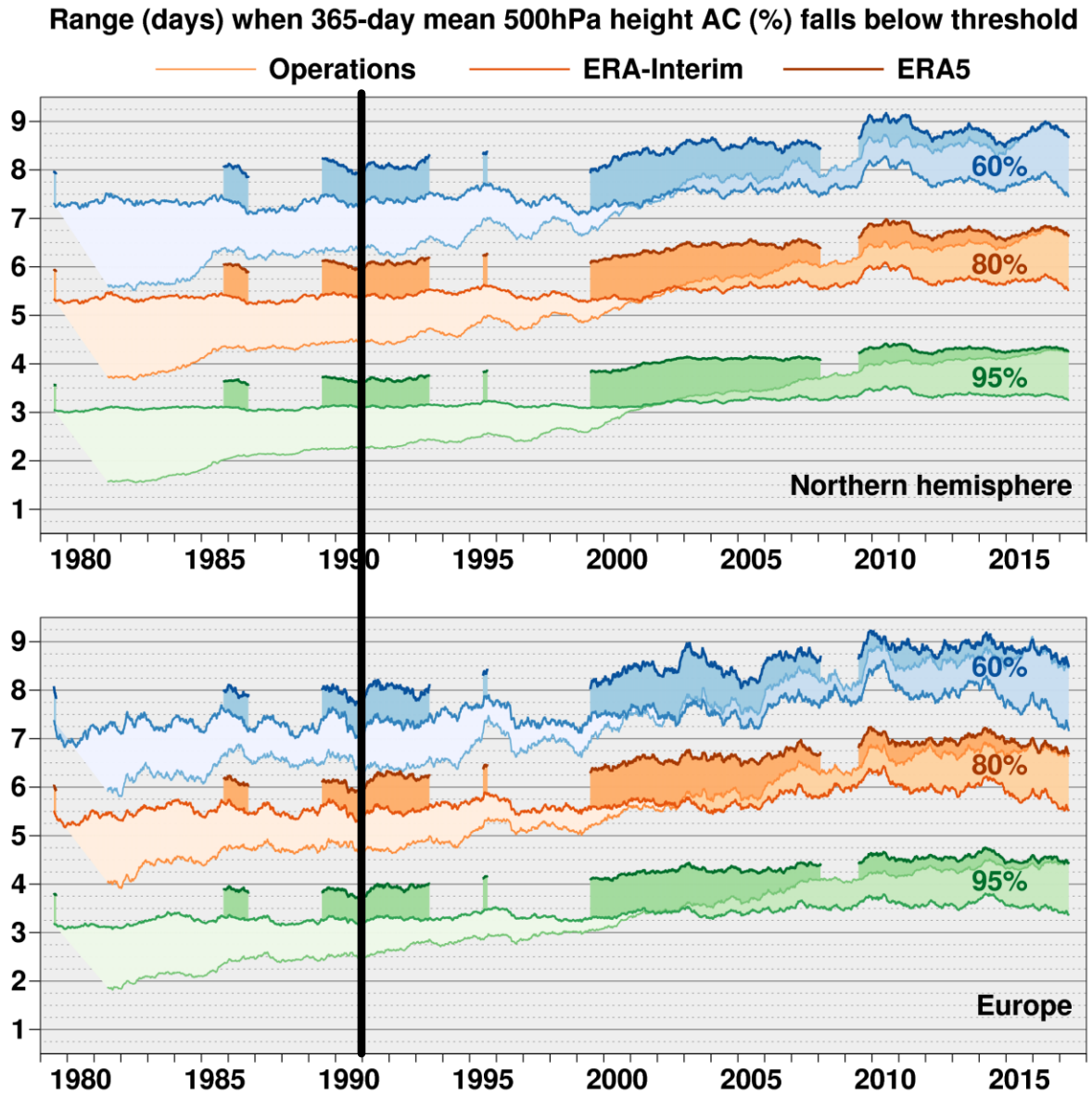
Currently 180 new citations each month

European Centre for Medium-Range Weather Forecasts

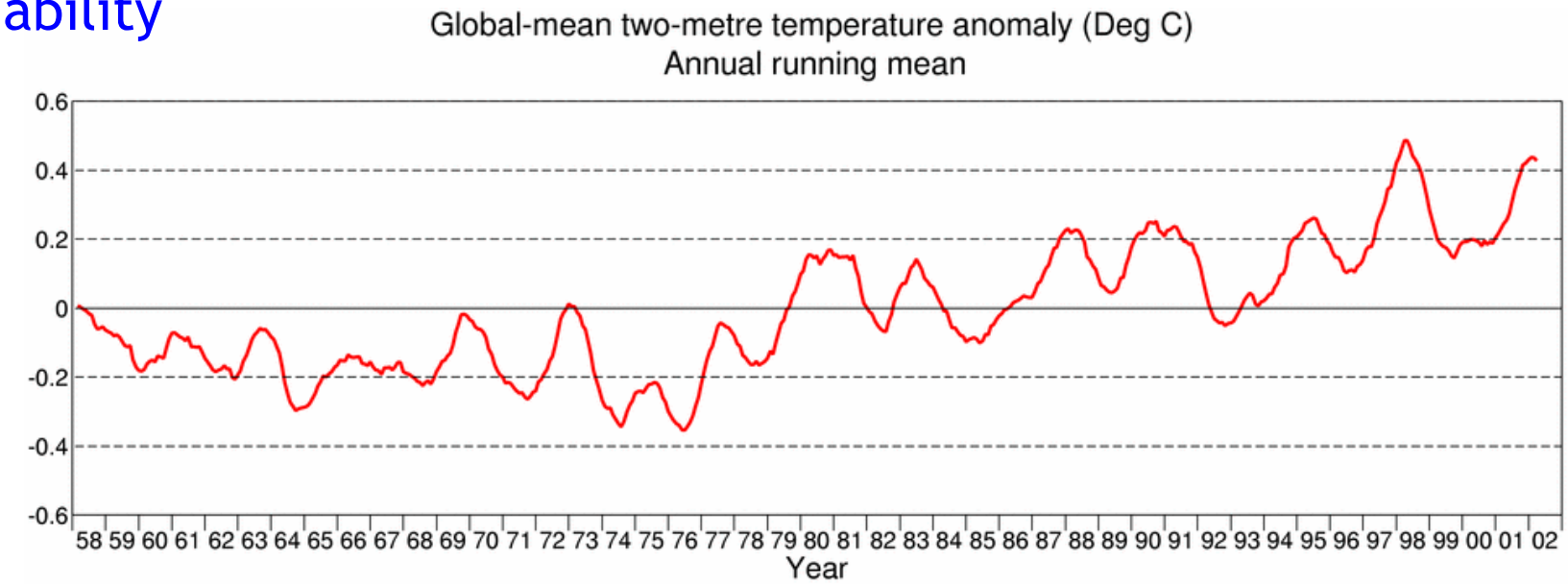
Dick Dee 2016

Simmons exonerates Burridge

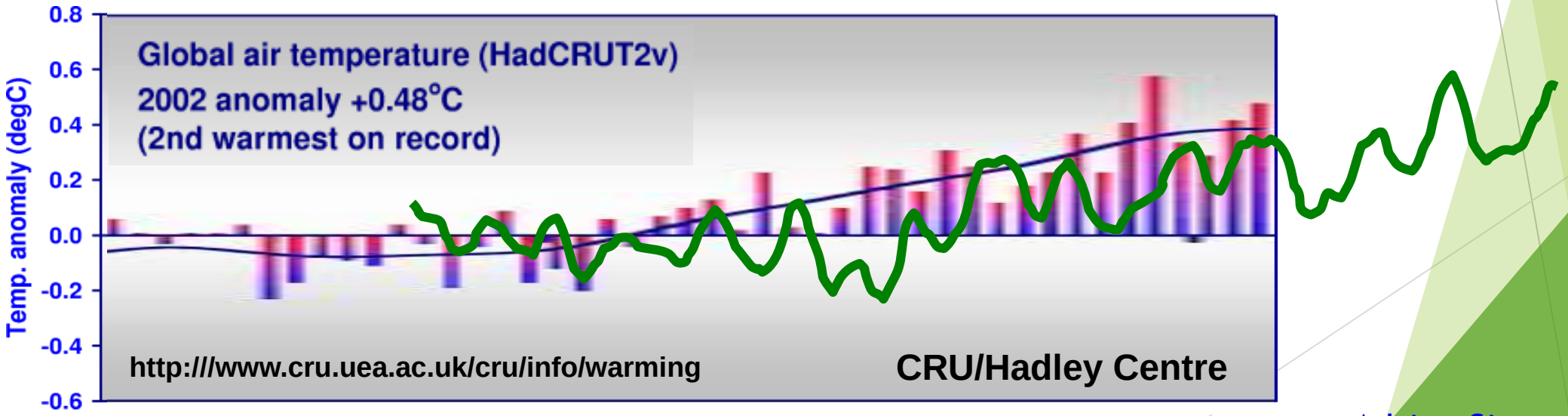
17 September 1991
A high resolution analysis and forecasting system at T213 31 levels was put into operations as cycle 39.



Trends and interannual variability

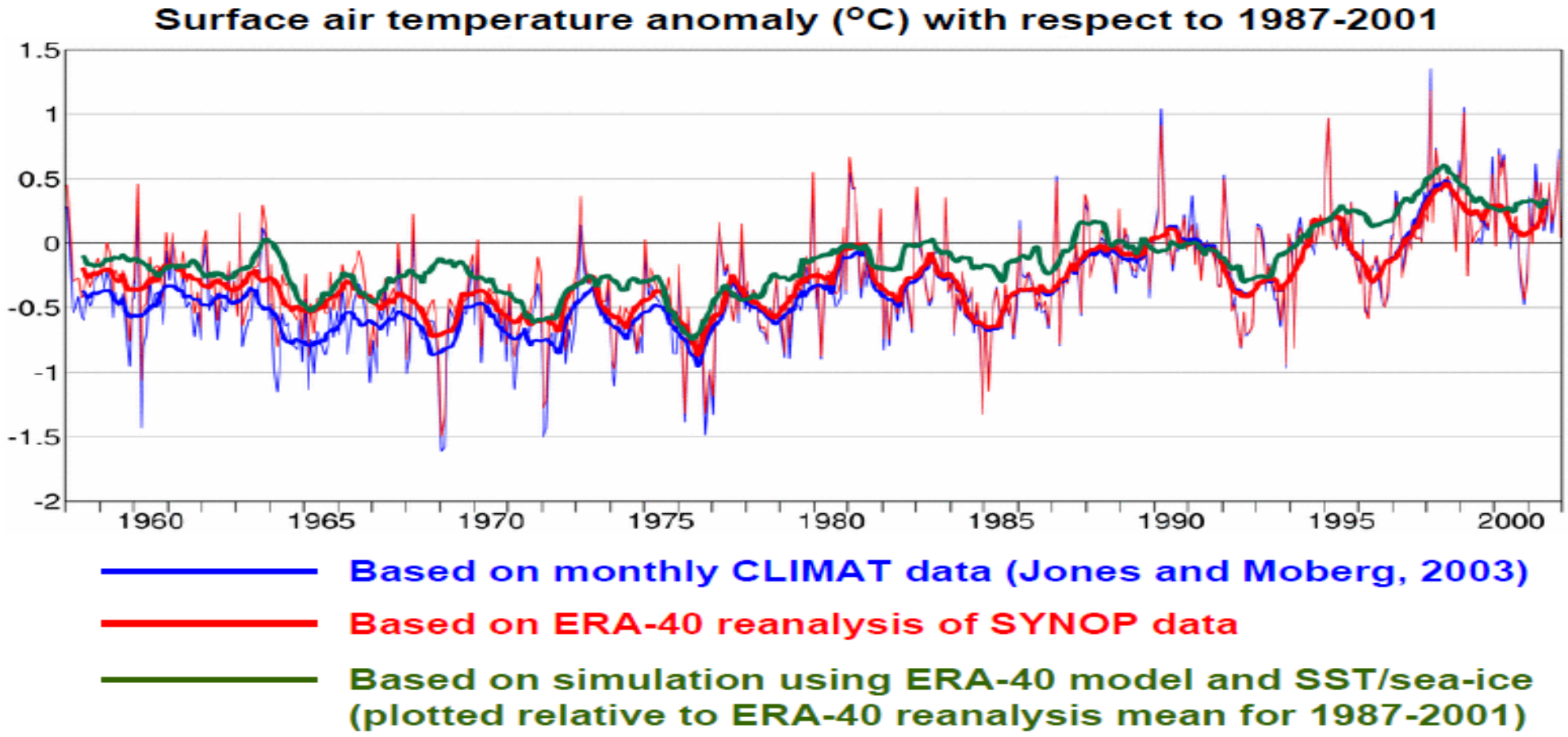


ERA-40



Adrian Simmons, 2002

Comparison of reanalysis and land-station values



Adrian Simmons, 2004

In summary

- Reanalysis does have a role to play in the study of recent climate trends
- It can help in the detection and correction of problems in the instrumental record
- ERA-40 represents a clear step forward from the NCEP/NCAR reanalysis for the depiction of trends
- Insights into deficiencies are provided by analysis and background fits to observations, analysis increments and comparisons with simulations
- There is considerable potential for improvement of reanalysis – more so than for improvement of the database of past observations?

Adrian Simmons, 2004

AJS and Climate applications

- Simmons et al 2004: Comparison of trends and low-frequency variability in CRU, ERA-40, and NCEP/NCAR analyses of surface air temperature. Journal of Geophysical Research, 109, D24.

- Simmons et al 2010: Low-frequency variations in surface atmospheric humidity, temperature, and precipitation: Inferences from reanalyses and monthly gridded observational data sets. Journal of Geophysical Research, 115, D01110.

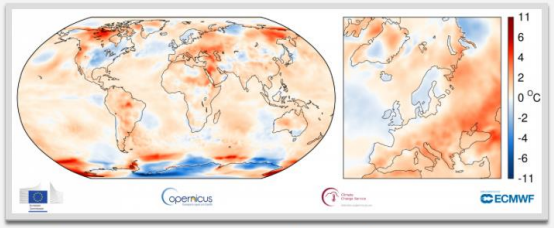
- Simmons et al 2014: Estimating low-frequency variability and trends in atmospheric temperature using ERA-Interim. Quarterly Journal of the Royal Meteorological Society, 140, 679.

- Simmons et al 2014: Arctic warming in ERA-Interim and other analyses. Quarterly Journal of the Royal Meteorological Society, 141, 689.

- Simmons et al 2017: A reassessment of temperature variations and trends from global reanalyses and monthly surface climatological datasets. Quarterly Journal of the Royal Meteorological Society, 143, 702.

Surface air temperature for August 2017

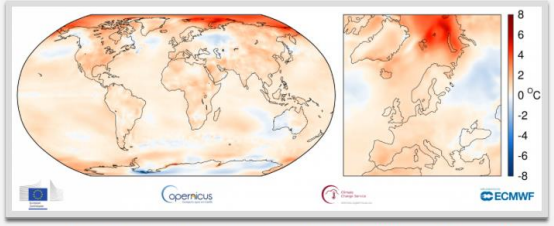
home » resources » data analysis » average surface air temperature analysis » monthly maps » Surface Air Temperature For August 2017



Surface air temperature anomaly for August 2017 relative to the August average for the period 1981-2010. Source: ERA-Interim. (Credit: ECMWF Copernicus Climate Change Service)
Download the original image

August 2017 was warmer than the 1981-2010 average over much of Europe. It was particularly warm over the south and east of the continent, where wildfires continued to trouble several countries and sustaining water supplies remained a challenge in places. Temperatures continued to be below average over the north-west.

Unusually warm summer conditions prevailed over the western USA and western and northern Canada, although central and eastern North America was not as warm as usual for August. Temperatures were much above average over parts of the Middle East and eastern Siberia. Most other continental areas were also warmer than average. Temperatures were well below average over much of Antarctica, although pronounced warm anomalies occurred where the surrounding winter sea-ice cover was lower than usual.

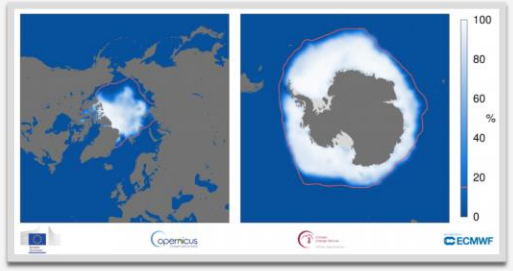


Surface air temperature anomaly for September 2016 to August 2017 relative to the average for 1981-2010. Source: ERA-Interim. (Credit: ECMWF Copernicus Climate Change Service)
Download the original image

Average temperatures for the twelve-month period from September 2016 to August 2017 were:

- most above the 1981-2010 average in the Arctic;
- much above average offshore of West Antarctica, over much of North America, and over south-western Europe, the Middle East, north-western and central Africa, and eastern and southern Asia;
- higher than average over most other areas of land and ocean;
- lower than average over only a few oceanic and land areas.

Sea-ice cover for August 2017

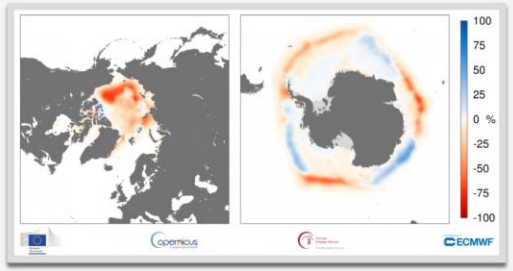


Sea-ice cover for August 2017. The pink line denotes the climatological ice edge for August for the period 1981-2010. Source: ERA-Interim. (Credit: ECMWF Copernicus Climate Change Service)
Download the original image

Sea-ice was much less widespread in August 2017 than in the average for August from 1981 to 2010.

Arctic sea-ice was either absent or at a lower concentration than normal almost everywhere. Ice cover was especially below average in a region extending outwards into the Arctic Ocean from the Beaufort Sea and the East Siberian Sea.

Antarctic sea-ice cover was also lower than average overall. It extended less to the north than is normal for August in all but one sector, although concentrations close to the northern limit of sea-ice were also higher than average in two other sectors.

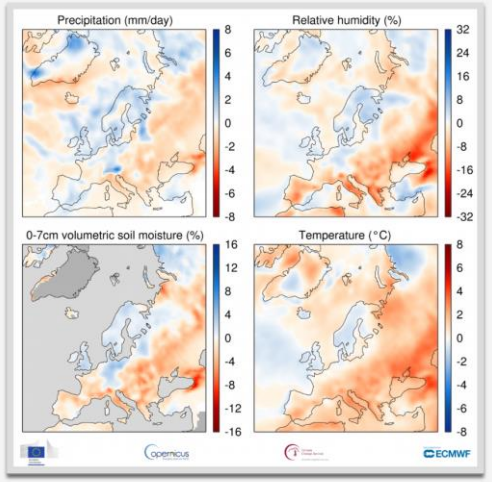


Sea-ice cover anomaly for August 2017 relative to the August average for the period 1981-2010. Source: ERA-Interim. (Credit: ECMWF Copernicus Climate Change Service)
Download the original image

climate.copernicus.eu

Precipitation, relative humidity and soil moisture for August 2017

The surface hydrological variables are more difficult to observe and analyse than surface temperature. The surface hydrological variables page explains more about the reliability of the data and information presented here, including comparisons with alternative datasets. The data on soil moisture is currently of qualitative rather than quantitative value. This summary is intended to provide European and near-global views of conditions for the month. Specific information for many countries can be found on the websites of their weather or climate services.

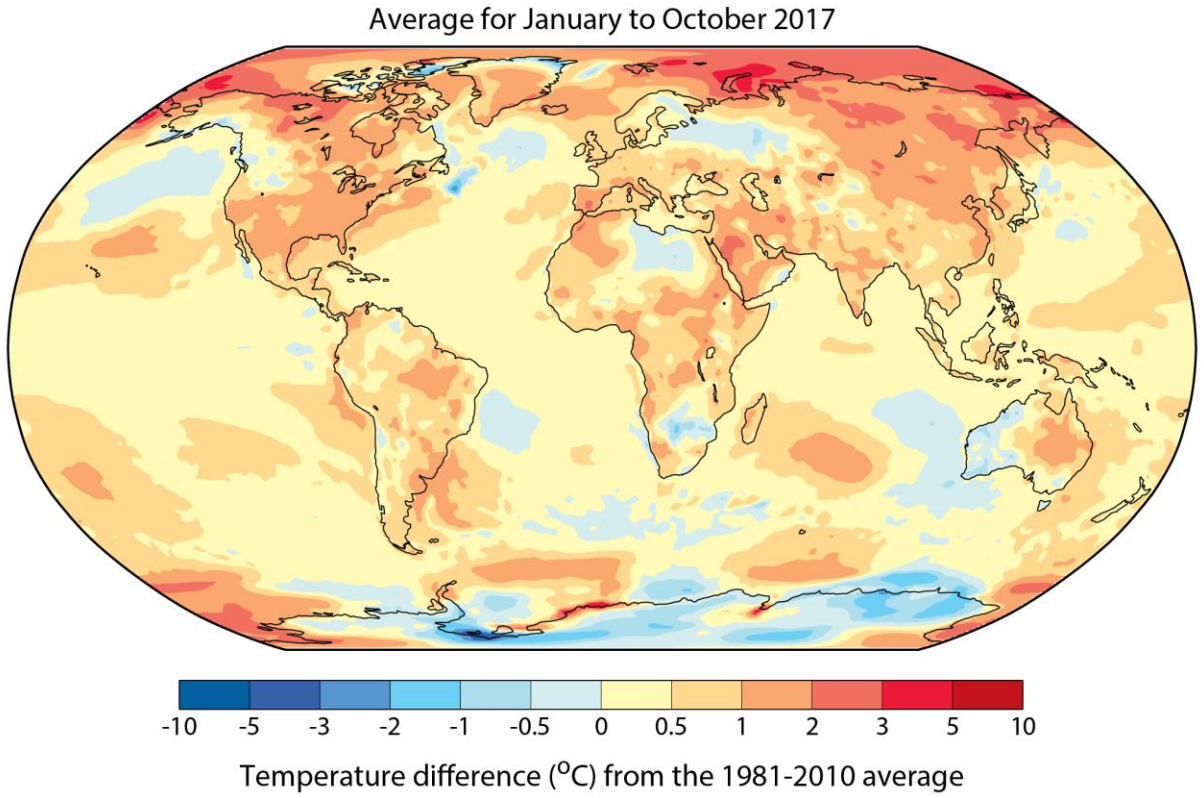


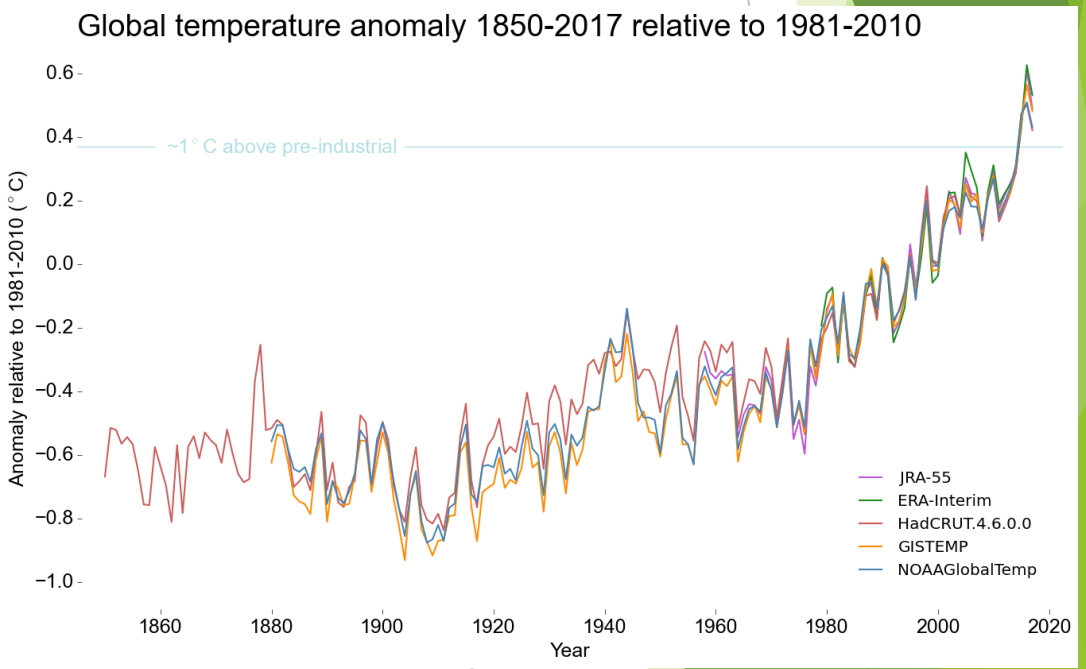
Anomalies in precipitation, the relative humidity of surface air, the volumetric moisture content of the top 7 cm of soil and surface air temperature for August 2017 with respect to August averages for the period 1981-2010. The darker grey shading denotes where soil moisture is not shown due to ice cover or climatologically low precipitation. Source: ERA-Interim. (Credit: ECMWF Copernicus Climate Change Service)
Download the original image

August 2017 was in general drier than the 1981-2010 average over south-western and central Europe, in terms of surface atmospheric relative humidity and the moisture content of the soil. Temperatures were also well above average over this part of the continent. The distribution of precipitation was more mixed. Rainfall totals were particularly high over the Alps, where relative humidity and soil moisture were above average. The month was also generally wetter than normal over northern Europe, in terms of precipitation, relative humidity and soil moisture.

WORLD METEOROLOGICAL ORGANISATION

2017 is set to be in the three hottest years, with record-breaking extreme weather





Copernicus Europe's eyes on Earth

Climate Change Service climate.copernicus.eu

ECMWF

Climate Change

Reanalyses Produced at ECMWF

Atmosphere/land *including ocean waves*

1) 1979 - 1981 FGGE	2) 1994 - 1996 ERA-15	3) 2001 - 2003 ERA-40	4) 2006 - … ERA-Interim	5) 2016 - … ERA5

Ocean *including sea ice*

2006 ORAS3	2010 - … ORAS4	2016 - … ORAS5

Centennial *Coupled*

2013 - 2015 ERA-20CM/20C	2016 CERA-20C	2017 CERA-SAT

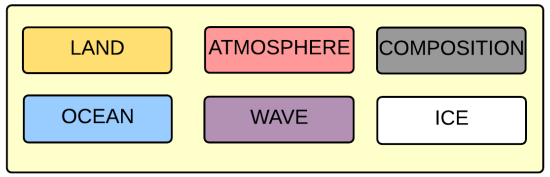
Enhanced land

2012 ERA-Int/Land	2014 ERA-20C/Land	ERA5L

Atmospheric composition

2008 - 2009 GEMS	2010 - 2011 MACC	2017 - … CAMS

Towards a coupled earth system



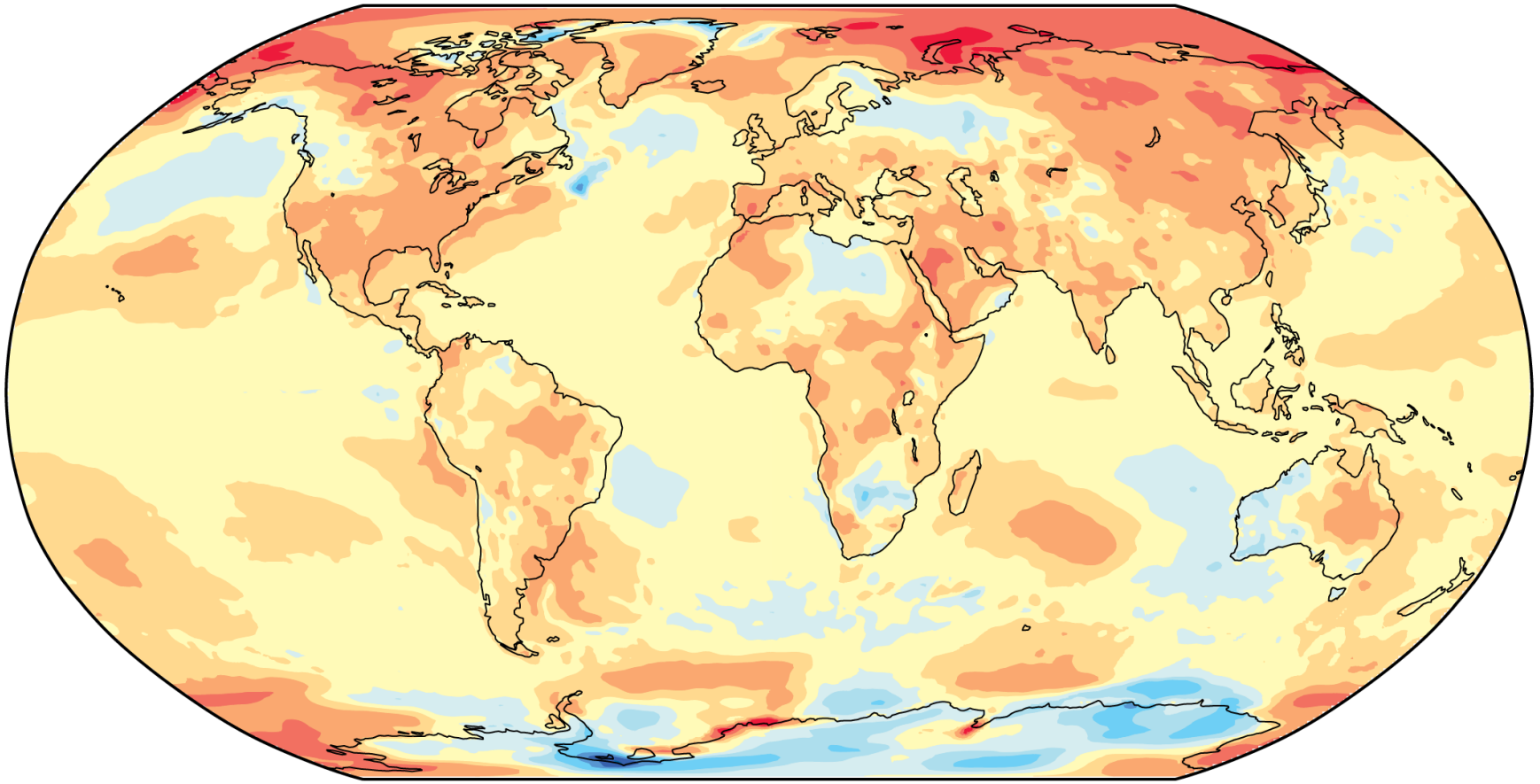
Credit: Hans Hersbach

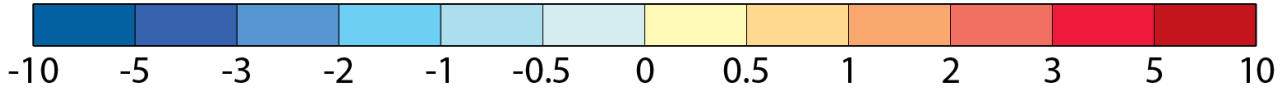
Adrian Simmons on the 25th Anniversary of ECMWF Reanalysis

One of Adrian's greatest achievements

Through his efforts, management, research output and advocacy, NWP reanalysis has matured to become an operational activity at ECMWF with ECMWF's reanalyses being the cornerstone of the Copernicus Climate Change Service (C3S)

Average for January to October 2017





Temperature difference (^{o}C) from the 1981-2010 average

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Europe's eyes on Earth

Climate Change Service
climate.copernicus.eu

IMPLEMENTED BY ECMWF

Global temperature anomaly 1850-2017 relative to 1981-2010