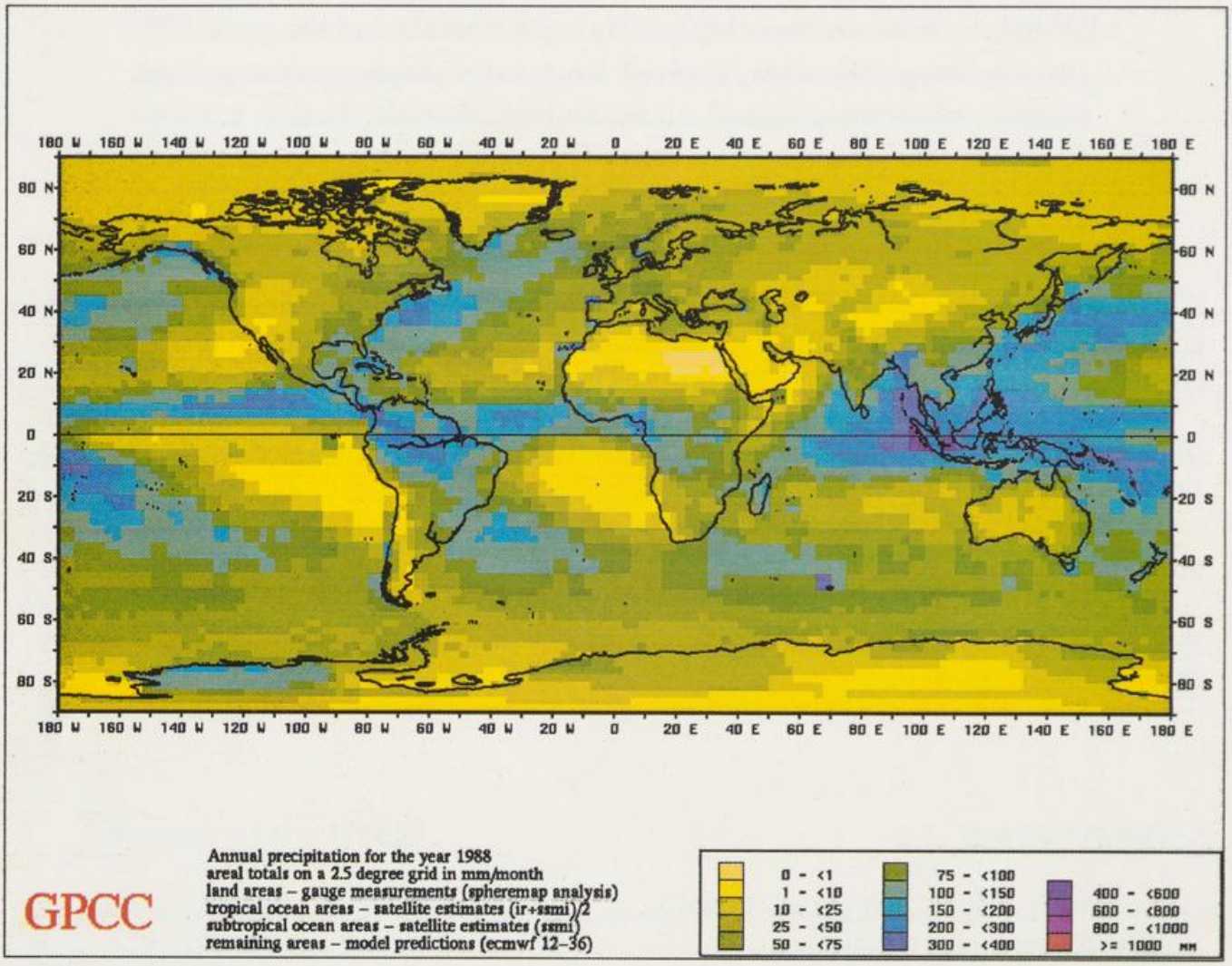
WCRP — DWD



Global area-mean monthly precipitation totals for the year 1988 (preliminary estimates, derived from rain-gauge measurements, satellite observations and numerical weather prediction results)

Global Precipitation Climatology Centre **G P C C**

Deutscher Wetterdienst, Offenbach am Main, July 1993

Global area-mean monthly precipitation totals for the year 1988 (preliminary estimates, derived from rain-gauge measurements, satellite observations and numerical weather prediction results)

Data compiled by the Global Precipitation Climatology Centre (GPCC) at the Deutscher Wetterdienst (DWD) in cooperation with the World Climate Research Programme (WCRP) - Global Precipitation Climatology Project (GPCP),

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c/o Deutscher Wetterdienst
Postfach 10 04 65
D-63004 Offenbach am Main
Federal Republic of Germany

Cover figure (front):

Global area-mean monthly precipitation totals on a 2.5° grid for the year 1988
(preliminary results, derived from rain-gauge measurements, satellite observations and numerical weather prediction results)

Global area-mean monthly precipitation totals for the year 1988 (preliminary estimates, derived from rain-gauge measurements, satellite observations and numerical weather prediction results)

List of contents

1 Function of the GPCC

The purpose of the Global Precipitation Climatology Project (GPCP) is to derive gridded data sets of monthly precipitation totals covering the entire globe based on all available observation technologies and data. The specific functions of the Global Precipitation Climatology Centre (GPCC), as a central element of the GPCP, resulting from this objective are defined by the World Climate Research Programme (WCRP, WMO/ICSU 1990) and comprise:

(a) the collection of gauge-measured precipitation data world-wide received via GTS and acquisition of non-GTS precipitation data as far as available,
(b) calculation of areal mean monthly precipitation totals on the basis of the conventional measurements (over land) using an objective analysis method,
(c) merging these analyses with monthly precipitation estimates from other observation techniques (satellite images provided by other GPCP centres) or model simulations to obtain global precipitation data sets, and
(d) determination of the error range of the result for each individual grid area of the final product.

The GPCP contributes to the Global Energy and Water Cycle Experiment (GEWEX) and is expected to be a component of the Global Climate Observing System (GCOS).

The gridded global analyses are available in digital format to interested organizations and institutions in the framework of the global climate research on a non-profit basis (cf. Section 7). These results will also be an important basis for the hydrological projects of the World Climate Programme -Water and for the study on Biospheric Aspects of the Hydrological Cycle of the International Geosphere-Biosphere Programme (IGBP-BAHC). The United Nations Environment Programme (UNEP) has called these products to be of general interest.

In his letter of 25 September 1992, the Secretary-General of WMO asked all countries to support the GPCC by supplying data (monthly precipitation totals), as the quality of the products is entirely dependent upon the database.

The GPCC is operated by the Deutscher Wetterdienst (DWD, national Meteorological Service of Germany) to fulfill these international tasks, as a contribution of the Federal Republic of Germany to the WCRP; the GPCC has no commercial function, its operation serves scientific and international interests only.

2 Present data base (conventional measurements)

Conventionally measured monthly precipitation depths are received at the Regional Hub Offenbach of the WWW Global Telecommunication System (GTS) in CLIMAT reports exchanged via GTS for about 1,500 stations each month. Additional monthly precipitation totals are calculated from synoptic reports received at Offenbach for about 3,500 stations. From about 5,000 partly different stations, SYNOP reports are received at the Regional Hub Washington, for which the NOAA-NWS Climate Analysis Centre (CAC) provides resulting monthly totals to the GPCC, too.

However, over many parts of the continents, the station density resulting from GTS is insufficient for a reliable calculation of the areal mean monthly precipitation.

To encourage all countries to deliver additional data to the GPCC, the WMO has asked all Members to support this international project (circular letter of the Secretary-General of WMO, 25. Sept. 1992). By the meantime, institutions of more than 30 countries have supplied additional data, partly from very dense networks (see Table on page 3). Besides, other international organizations have supplied data from several international projects.

The GPCC highly appreciates this important support. The data base is still increasing. All countries are asked kindly but urgently for update data deliveries, and especially those which have not sent data up to now.

Table 1: Monthly precipitation data received from national Meteorological Services (partly overlapping the GTS-data collective) Status: 20th July 1993

country	series of monthly data		climatological normals	
	number of stations	period	number of stations	period
Argentine	75	1986-91	75	1951-80
Australia	7000	dif.- 1992	3000	1931-60
Austria	179	1961-92	179	1961-90
Belarus	47	1986-92	47	1891-90
Belgium	32	1986-91	---	---
Benin	51	1986-91	---	---
Bolivia	33	dif.- 1990	---	---
Brazil	2000	1986-87	---	---
Brunei	1	1986-91	1	1966-91
Chile	163	1986-91	xxx	1961-90
Costa Rica	4	dif.- 1990	4	1961-89
Cyprus	9	1986-92	---	---
Djibouti	2	1986-92	---	---
Egypt	23	1986-91	23	dif.
Ethiopia	22	1986-91	22	1961-90
Finland	440	1986-91	---	---
France	123	1986-92	123	1961-90
Germany	4000	1986-93	4000	1931-60
Ghana	22	1986-91	22	1961-90
Guatemala	22	1980-92	---	---
Hong Kong	50	1986-92	40	1953-82
Hungary	91	1986-92	91	1961-90
Ireland	160	1986-91	160	1951-80
Kenya	xxx	1969-90	---	---
Kuwait	1	1958-90	---	---
Latvia	24	1986-92	---	---
Libya	182	1986-92	182	1962-90
Lithuania	14	1986-91	14	1961-90
Malaysia	1	1986-90	---	---
Mali	173	1987-91	173	dif.
Mongolia	40	1986-91	40	1961-90
Morroco	31	1989	---	---
Netherlands	100	1986-92	---	---
New Zealand	260	1986-88	---	---
Peru	22	1986-91	---	---
Russia	500	1986-90	---	---
Ruanda	174	dif.- 1991	---	---
Spain	51	1961-90	---	---
Sri Lanka	16	1961-90	---	---
Switzerland	130	1986-91	---	---
Taiwan	25	1981-90	---	---
Uganda	16	dif.- 1992	---	---
U.K.	400	1986-91	350	1961-90
USA	8000	1986-89	8000	1951-80
Zambia	12	1992	---	---

3 Global gridded precipitation maps for the months and the seasons of 1988

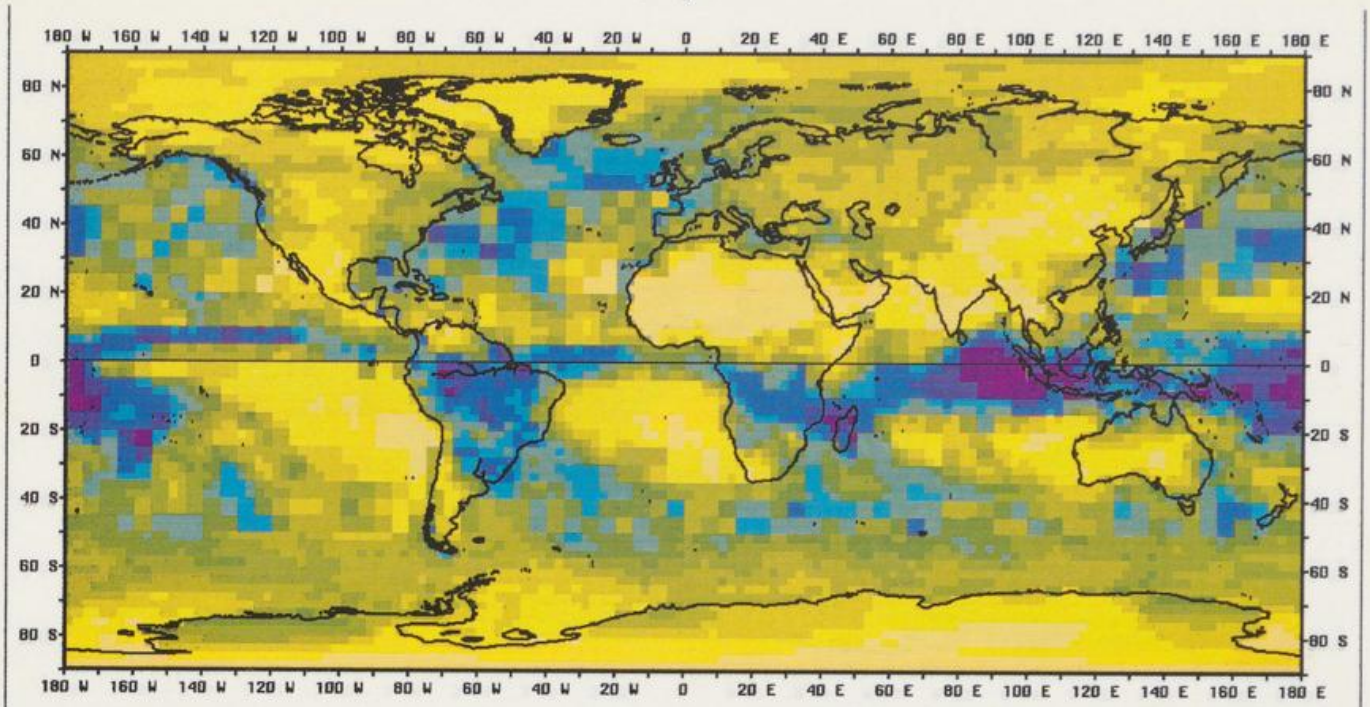
The GPCC is still operating on a trial basis using a limited data set of conventional measurements from about 6,700 stations, mainly derived from the GTS reports and few additional data from other sources. A reanalysis for all months of th period beginning with January 1986 will be made, starting in year 1994, and using all supplied data.

For the spatial objective analysis of the monthly precipitation totals over land, the GPCC is using the conventionally measured data and a distance and angular weighting scheme for spatial interpolation (Willmott et al. 1985, Rudolf et al. 1992). The use of satellite data in order to estimate the precipitation depths over land areas is still problematic, as it can be seen from the comparison of the results from different observation techniques (based on rain-gauges, or infrared and microwave satellite data) and from model results, illustrated in the diagram on page 13.

To obtain complete global data sets, the gauge-data based analyses are combined with the satellite estimates and, since no other data are available over the high-latitude and polar oceanic regions, with monthly accumulated daily numerical weather forecasts. At present, the GPCC is using a simple blending scheme to combine the data from the different sources to global estimates, whereby the grid values are selected by predefined priorities depending on the geographical location: gauge-based analyses for all land-covered grids, IR-SSM/I mixed estimates over tropical oceans (latitude belt is varied with the seasons), SSM/I estimates over subtropical to mid-latitude oceans, and forecast model results over high-latitude oceans. The satellite-based estimates are prepared by the other GPCP centres at the Climate Analysis Center of the NOAA (Janowiak and Arkin) and the Goddard Space Flight Center of the NASA (Wilheit et al.); the forecast results are supplied by the European Centre of Medium Range Weather Forecasts (ECMWF).

Up to now, gridded data are available for 24 months (January 1987 to December 1988). These results are preliminary in consideration of the insufficient data basis, and will be re-analyzed based on all additionally supplied data (cf. Table 1 on page 3). The preliminary results for the continents for the year 1987 are published in GPCC (1992), the global results for the year 1988 are shown in the maps on the next pages. The winter season contains per definition the months December 1987 and January and February 1988; the year, however, is the calendar year.

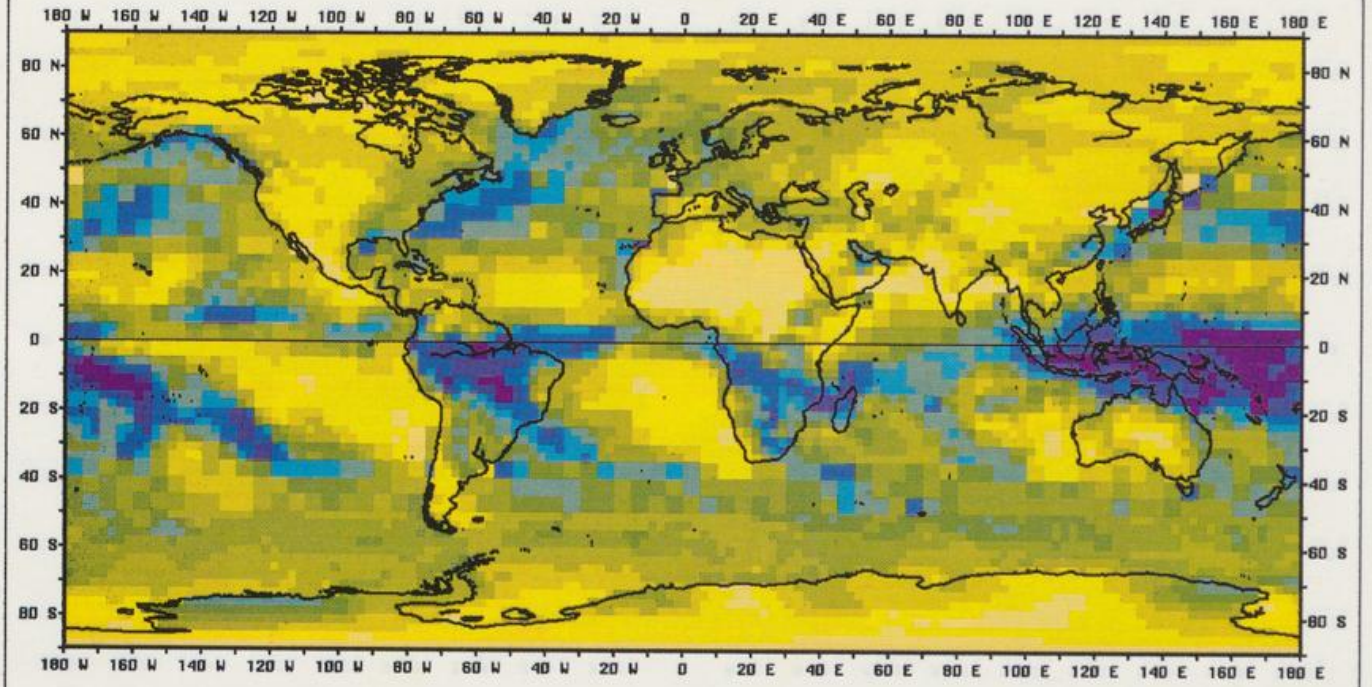
A method for merging the results of the different sources based on a quality dependent weighting scheme is in development in cooperation with the Goddard Space Flight Centre (Adler et al. 1993). The weighting function is based on assumptions of the uncertainties of each of these data sets. The error variance of the combined final product will be minimized by using such an optimum estimation technique.



GPCC

Global precipitation (mm/month) for January 1988
based on blending of data from different sources :
land areas – gauge measurements (spheremap analysis)
oceans 20N–40S – satellite estimates (ir+ssmi)/2
oceans 50N–20N/40S–50S – satellite estimates ssmi
remaining areas – model prediction (ecmwf 12–36h)

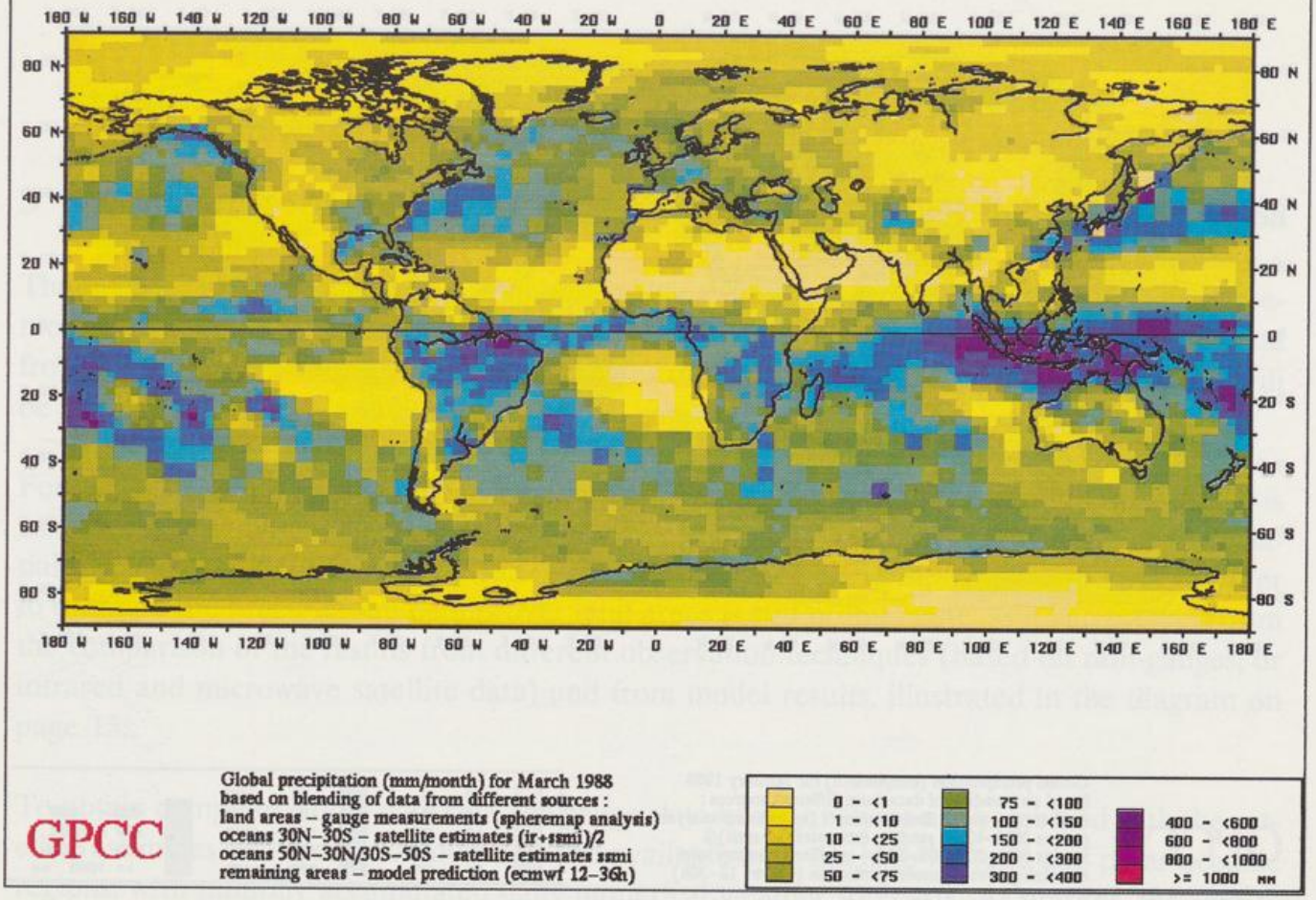
0 - <1	75 - <100	400 - <600
1 - <10	100 - <150	600 - <800
10 - <25	150 - <200	800 - <1000
25 - <50	200 - <300	>= 1000 mm
50 - <75	300 - <400	



GPCC

Global precipitation (mm/month) for February 1988
based on blending of data from different sources :
land areas – gauge measurements (spheremap analysis)
oceans 25N–35S – satellite estimates (ir+ssmi)/2
oceans 50N–25N/35S–50S – satellite estimates ssmi
remaining areas – model prediction (ecmwf 12–36h)

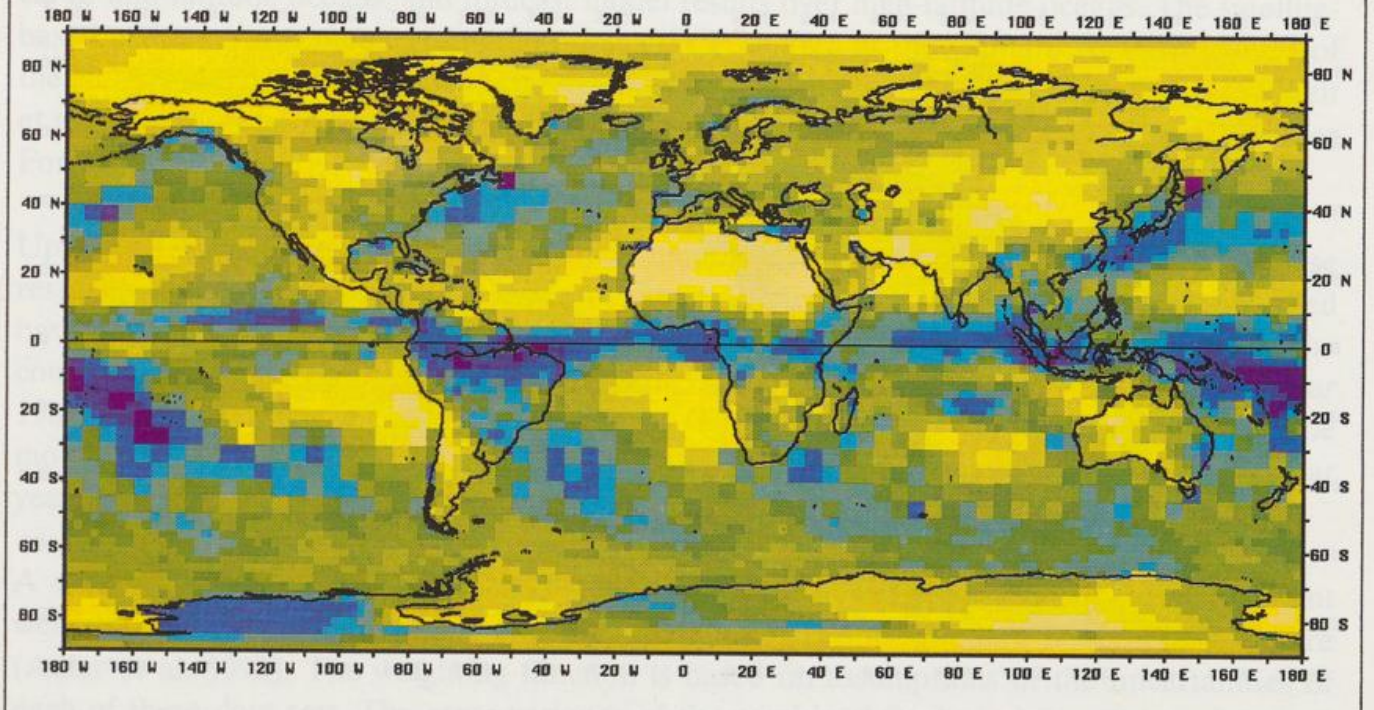
0 - <1	75 - <100	400 - <600
1 - <10	100 - <150	600 - <800
10 - <25	150 - <200	800 - <1000
25 - <50	200 - <300	>= 1000 mm
50 - <75	300 - <400	



GPCC

Global precipitation (mm/month) for March 1988
based on blending of data from different sources :
land areas – gauge measurements (spheremap analysis)
oceans 30N–30S – satellite estimates (ir+ssmi)/2
oceans 50N–30N/30S–50S – satellite estimates ssmi
remaining areas – model prediction (ecmwf 12–36h)

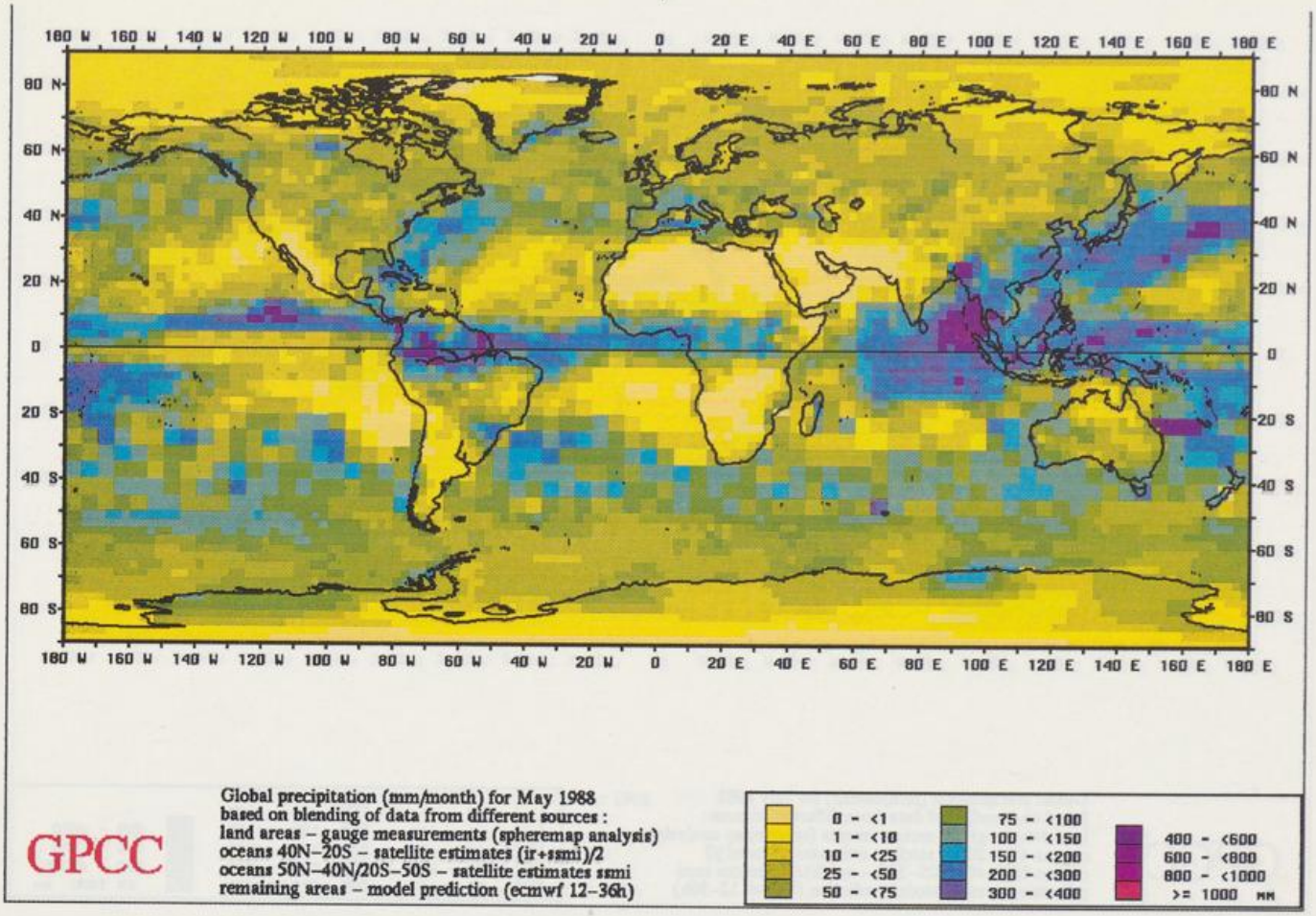
0 - <1	75 - <100	400 - <600
1 - <10	100 - <150	600 - <800
10 - <25	150 - <200	800 - <1000
25 - <50	200 - <300	>= 1000 mm
50 - <75	300 - <400	



GPCC

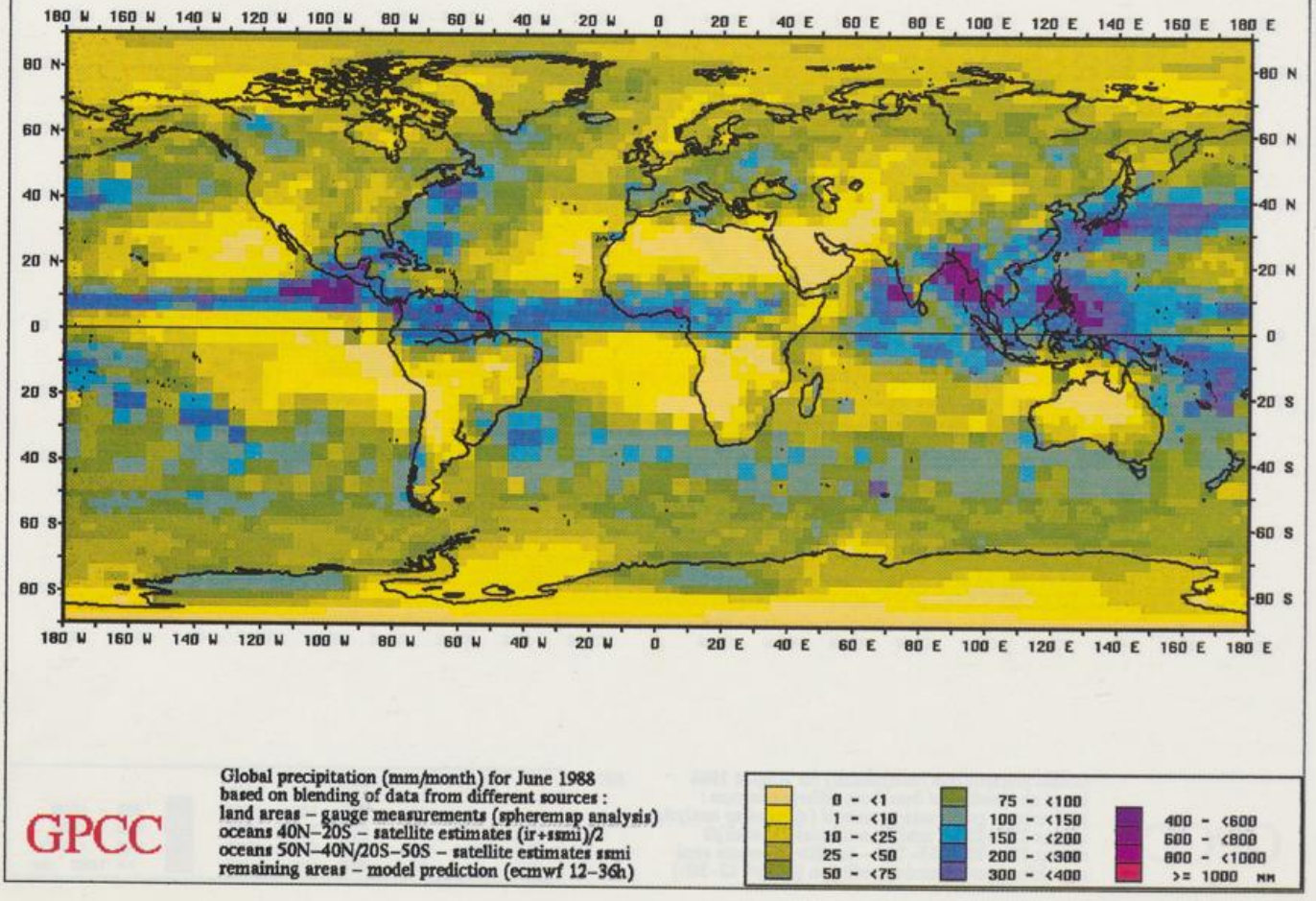
Global precipitation (mm/month) for April 1988
based on blending of data from different sources :
land areas – gauge measurements (spheremap analysis)
oceans 35N–25S – satellite estimates (ir+ssmi)/2
oceans 50N–35N/25S–50S – satellite estimates ssmi
remaining areas – model prediction (ecmwf 12–36h)

0 - <1	75 - <100	400 - <600
1 - <10	100 - <150	600 - <800
10 - <25	150 - <200	800 - <1000
25 - <50	200 - <300	>= 1000 mm
50 - <75	300 - <400	



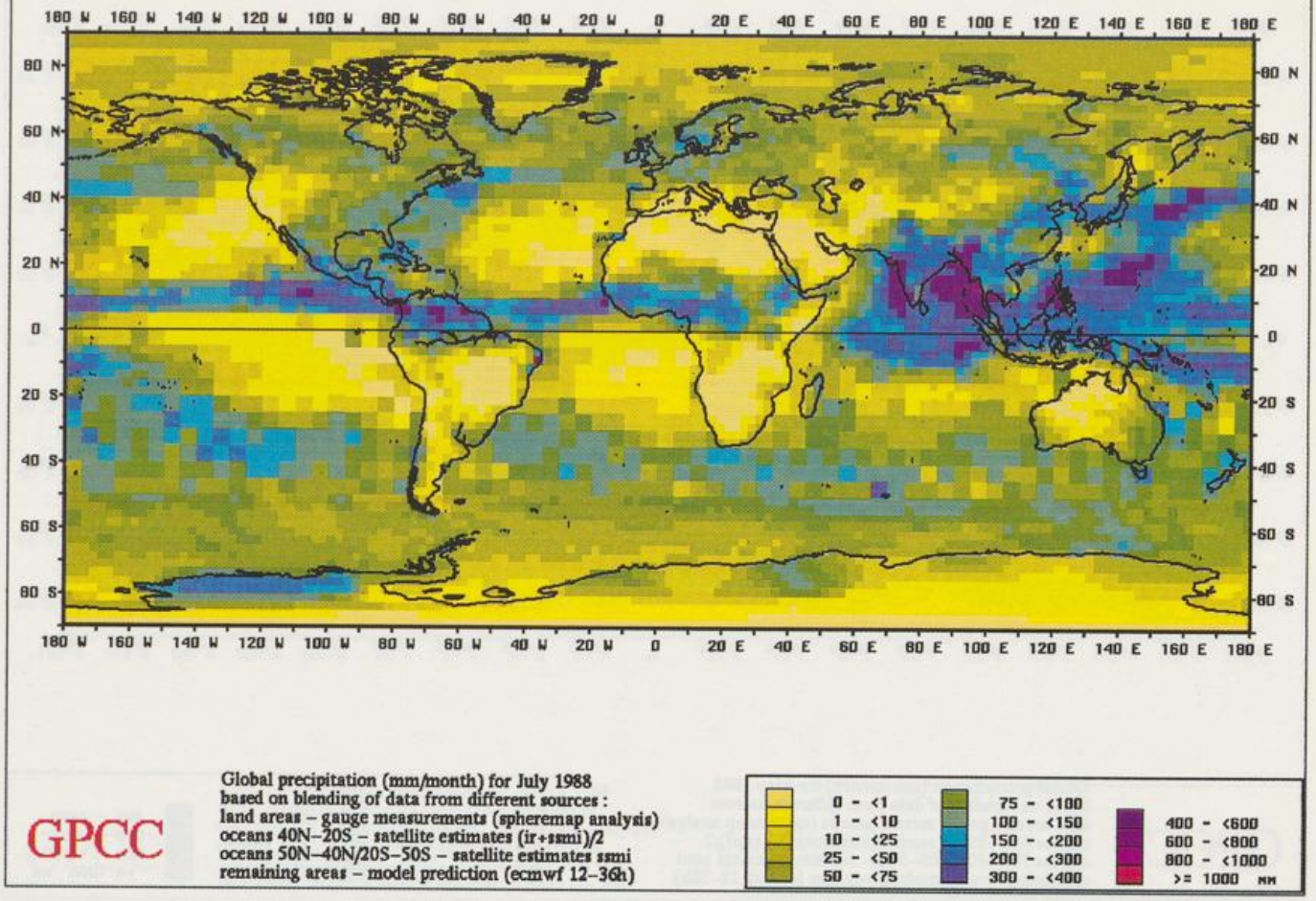
GPCC

Global precipitation (mm/month) for May 1988
based on blending of data from different sources :
land areas – gauge measurements (spheremap analysis)
oceans 40N–20S – satellite estimates (ir+ssmi)/2
oceans 50N–40N/20S–50S – satellite estimates ssmi
remaining areas – model prediction (ecmwf 12–36h)



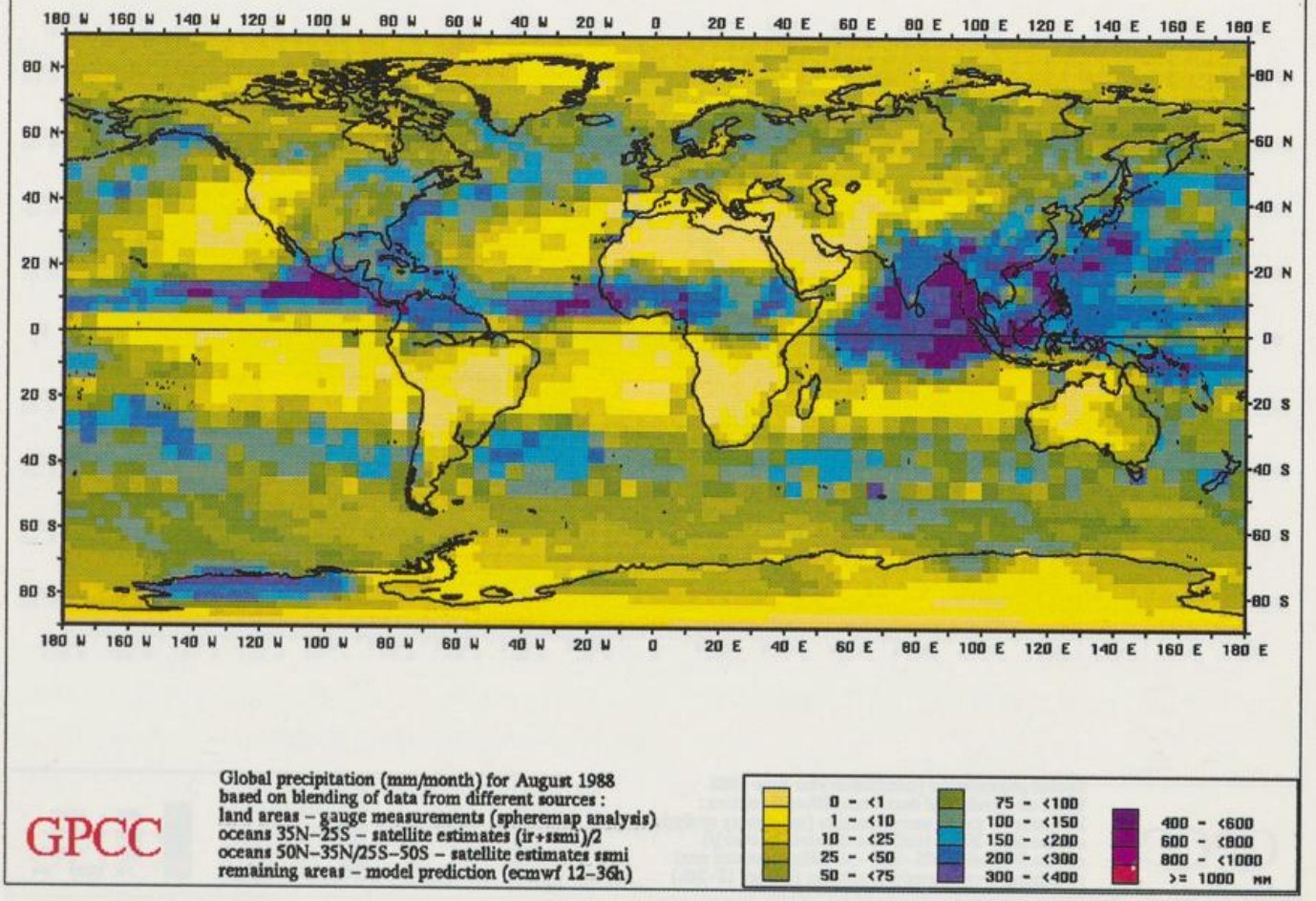
GPCC

Global precipitation (mm/month) for June 1988
based on blending of data from different sources :
land areas – gauge measurements (spheremap analysis)
oceans 40N–20S – satellite estimates (ir+ssmi)/2
oceans 50N–40N/20S–50S – satellite estimates ssmi
remaining areas – model prediction (ecmwf 12–36h)



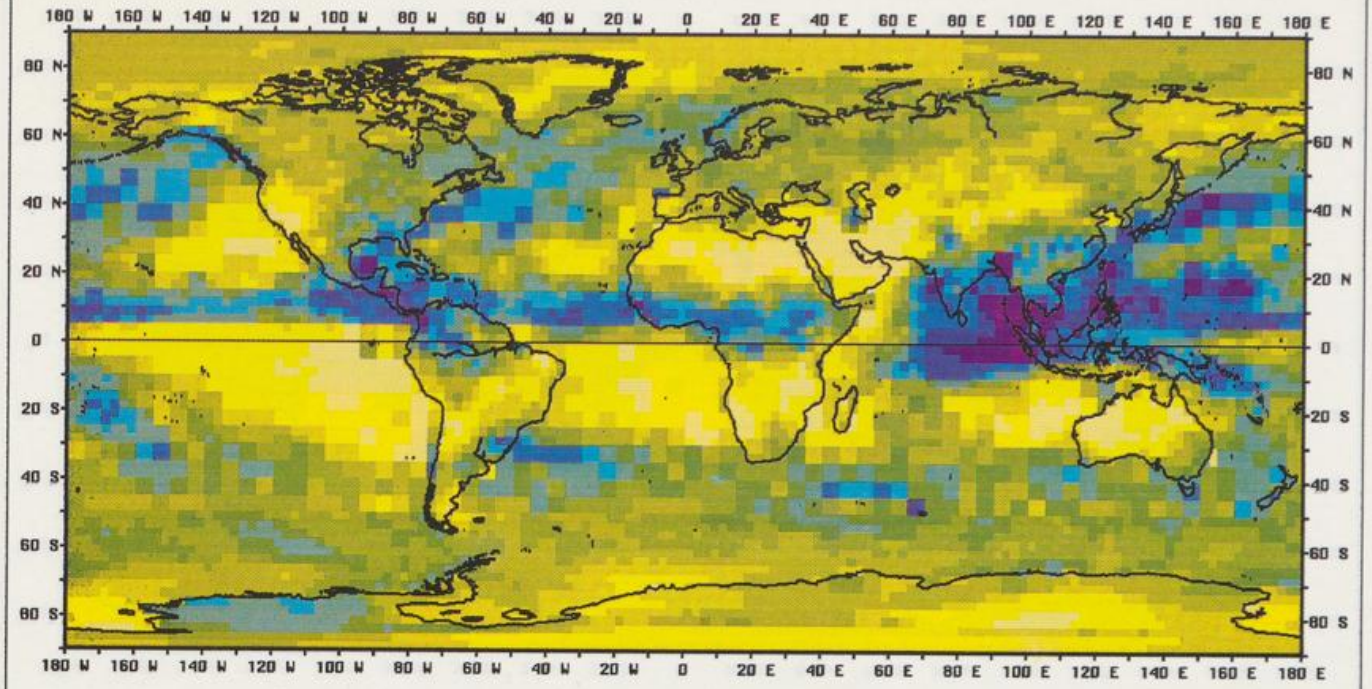
GPCC

Global precipitation (mm/month) for July 1988
based on blending of data from different sources :
land areas – gauge measurements (spheremap analysis)
oceans 40N–20S – satellite estimates (ir+ssmi)/2
oceans 50N–40N/20S–50S – satellite estimates ssmi
remaining areas – model prediction (ecmwf 12–36h)



GPCC

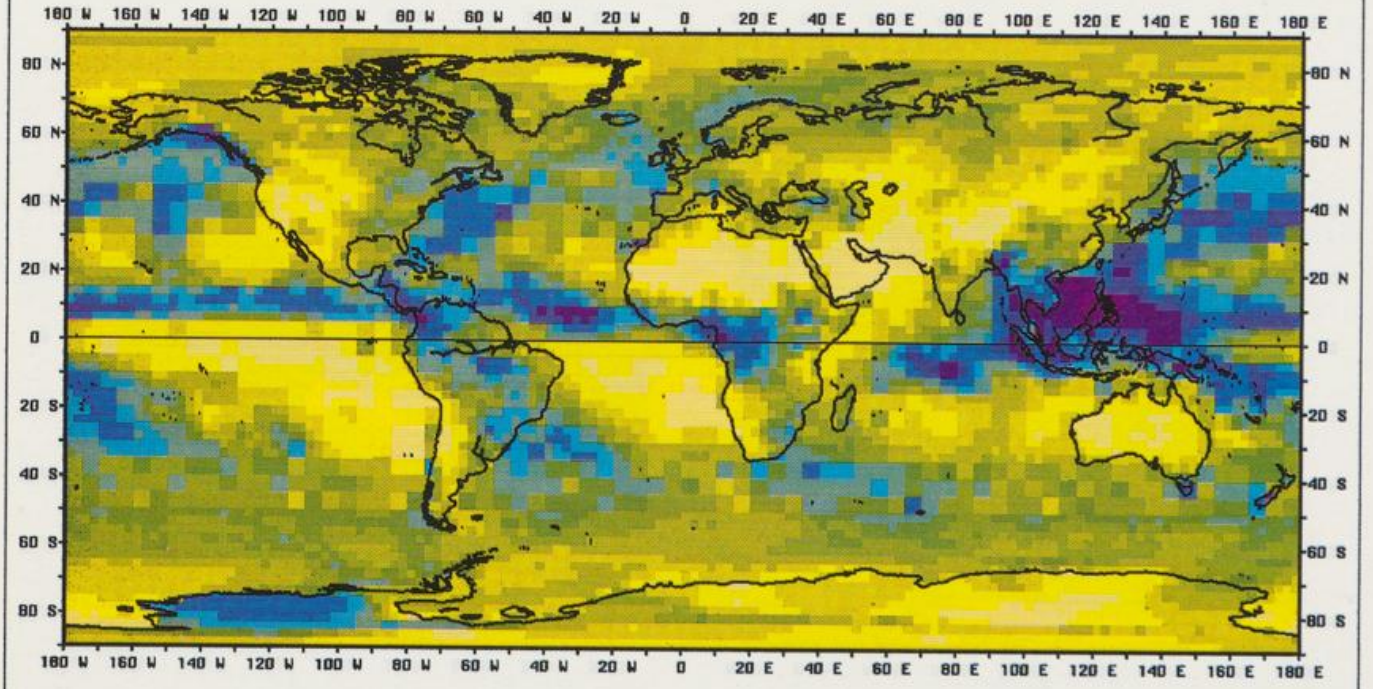
Global precipitation (mm/month) for August 1988
based on blending of data from different sources :
land areas – gauge measurements (spheremap analysis)
oceans 35N–25S – satellite estimates (ir+ssmi)/2
oceans 50N–35N/25S–50S – satellite estimates ssmi
remaining areas – model prediction (ecmwf 12–36h)



GPCC

Global precipitation (mm/month) for September 1988
based on blending of data from different sources :
land areas – gauge measurements (spheremap analysis)
oceans 30N–30S – satellite estimates (ir+ssmi)/2
oceans 50N–30N/30S–50S – satellite estimates ssmi
remaining areas – model prediction (ecmwf 12–36h)

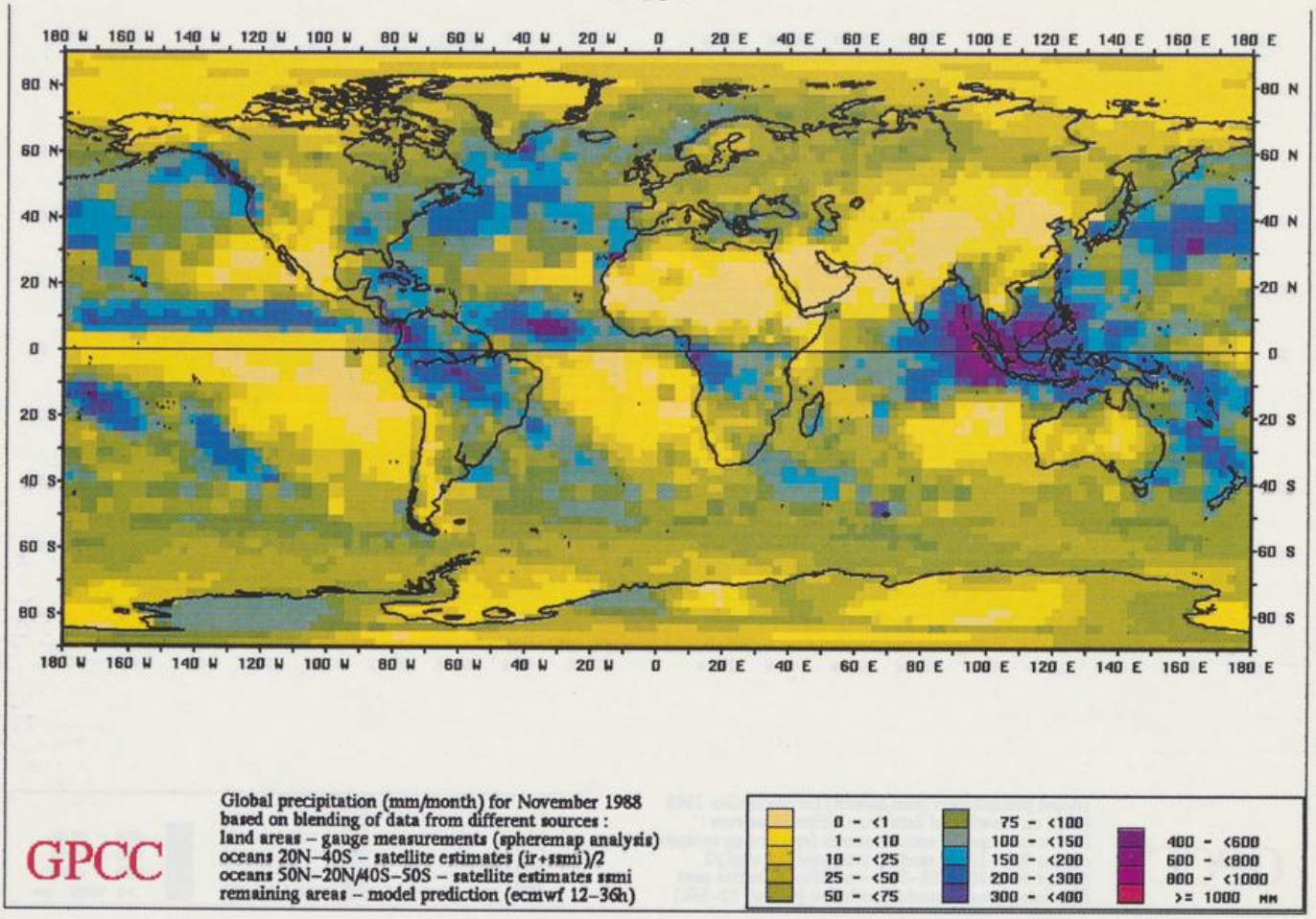
0 - <1	75 - <100	400 - <600
1 - <10	100 - <150	600 - <800
10 - <25	150 - <200	800 - <1000
25 - <50	200 - <300	>= 1000 mm
50 - <75	300 - <400	

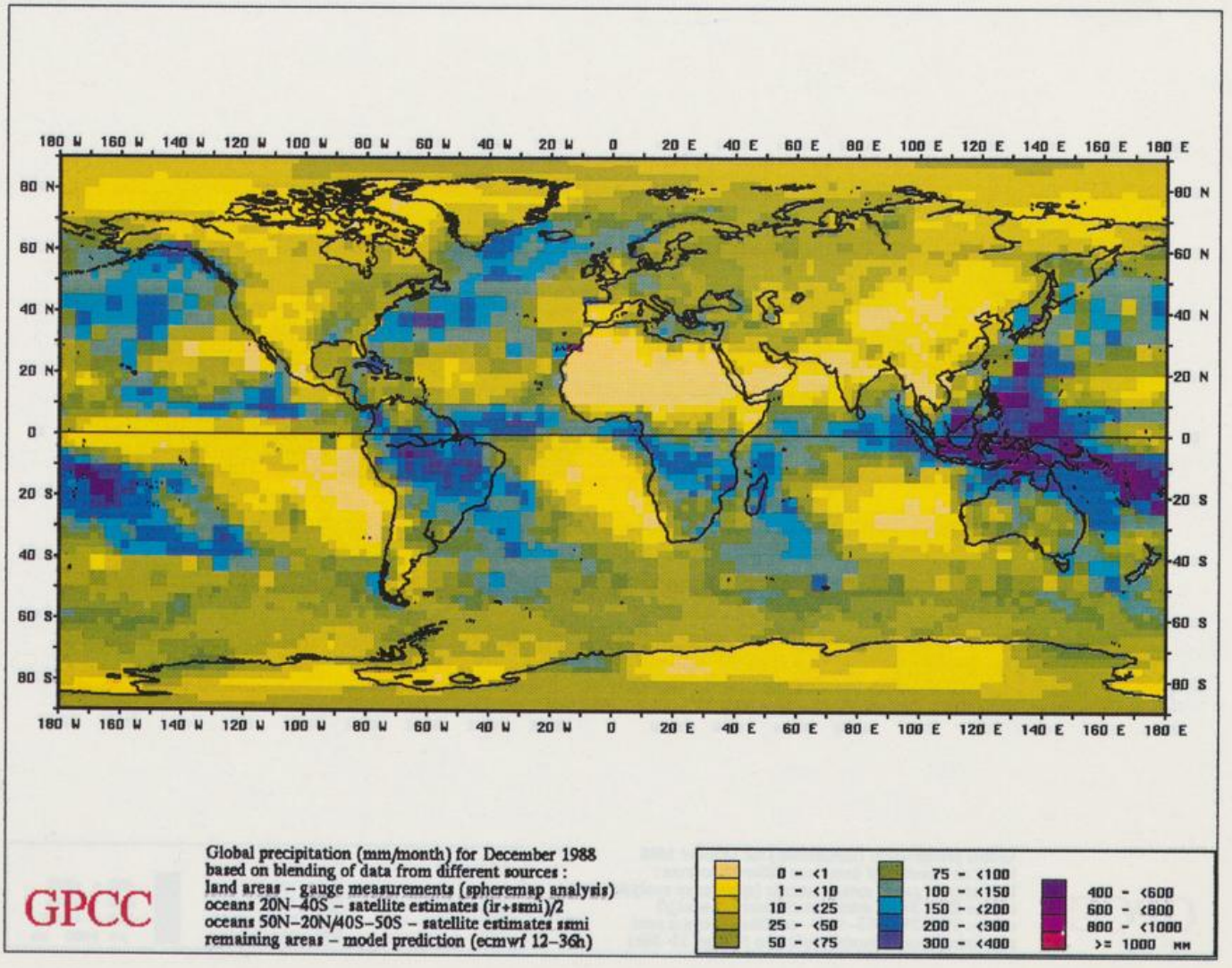


GPCC

Global precipitation (mm/month) for October 1988
based on blending of data from different sources :
land areas – gauge measurements (spheremap analysis)
oceans 25N–35S – satellite estimates (ir+ssmi)/2
oceans 50N–25N/35S–50S – satellite estimates ssmi
remaining areas – model prediction (ecmwf 12–36h)

0 - <1	75 - <100	400 - <600
1 - <10	100 - <150	600 - <800
10 - <25	150 - <200	800 - <1000
25 - <50	200 - <300	>= 1000 mm
50 - <75	300 - <400	


180 W 160 W 140 W 120 W 100 W 80 W 60 W 40 W 20 W 0 20 E 40 E 60 E 80 E 100 E 120 E 140 E 160 E 180 E
80 N 60 N 40 N 20 N 0 20 S 40 S 60 S 80 S
GPCC
Global precipitation (mm/month) for November 1988
based on blending of data from different sources :
land areas – gauge measurements (spheremap analysis)
oceans 20N–40S – satellite estimates (ir+ssmi)/2
oceans 50N–20N/40S–50S – satellite estimates ssmi
remaining areas – model prediction (ecmwf 12–36h)
0 - <1
1 - <10
10 - <25
25 - <50
50 - <75
75 - <100
100 - <150
150 - <200
200 - <300
300 - <400
400 - <600
600 - <800
800 - <1000
>= 1000 mm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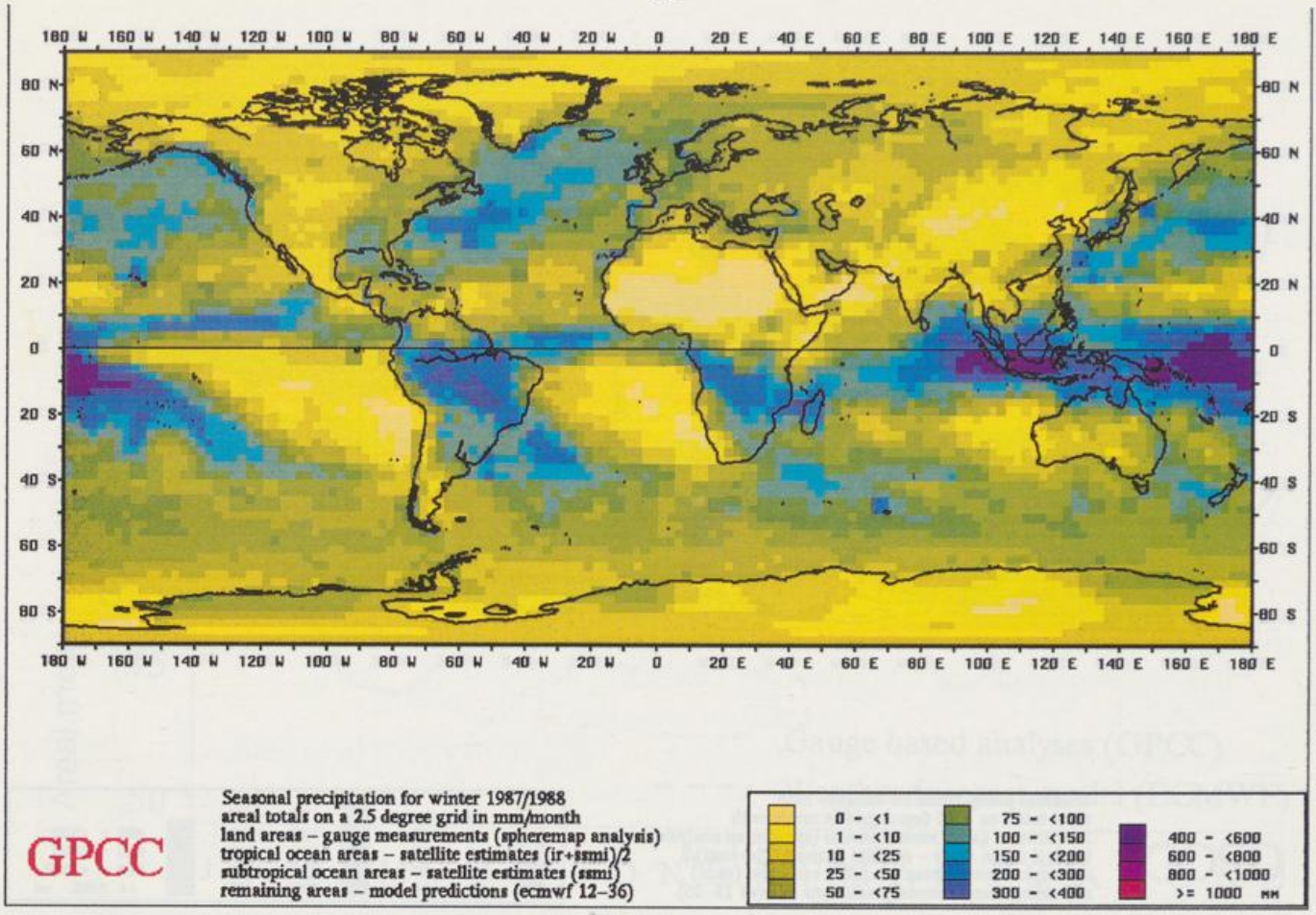
80 N 60 N 40 N 20 N 0 20 S 40 S 60 S 80 S
GPCC
Global precipitation (mm/month) for December 1988
based on blending of data from different sources :
land areas – gauge measurements (spheremap analysis)
oceans 20N–40S – satellite estimates (ir+ssmi)/2
oceans 50N–20N/40S–50S – satellite estimates ssmi
remaining areas – model prediction (ecmwf 12–36h)
0 - <1
1 - <10
10 - <25
25 - <50
50 - <75
75 - <100
100 - <150
150 - <200
200 - <300
300 - <400
400 - <600
600 - <800
800 - <1000
>= 1000 mm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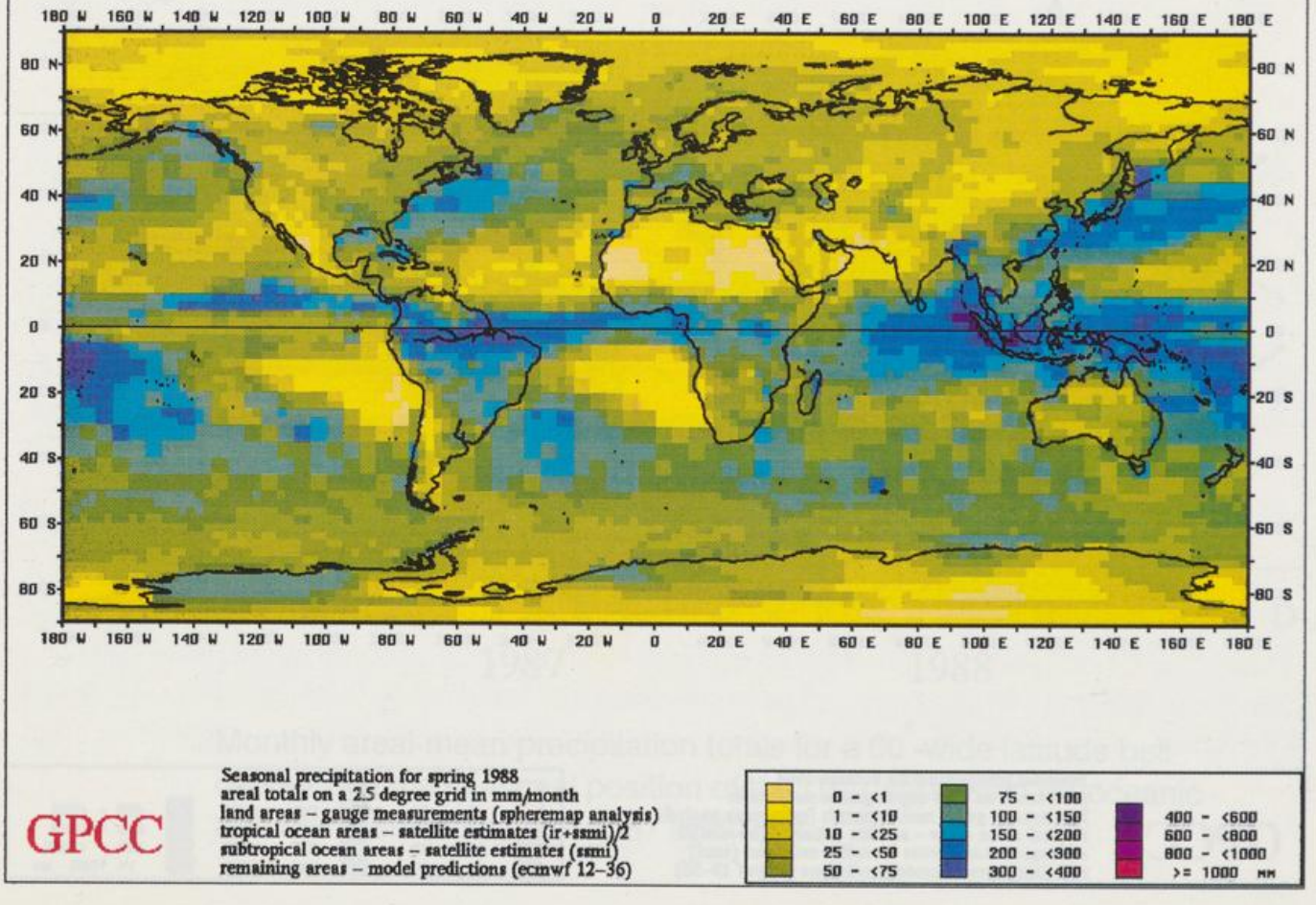
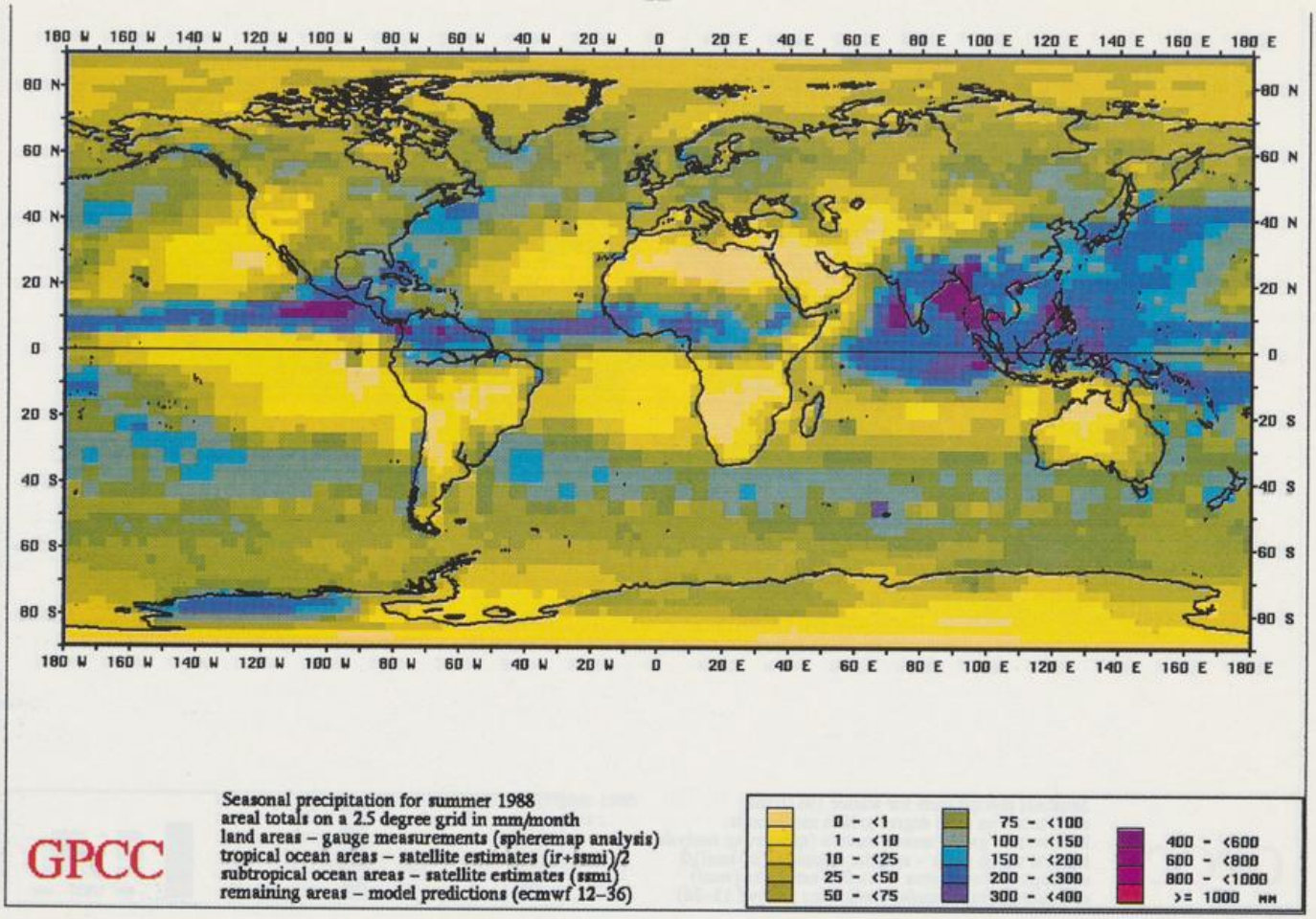
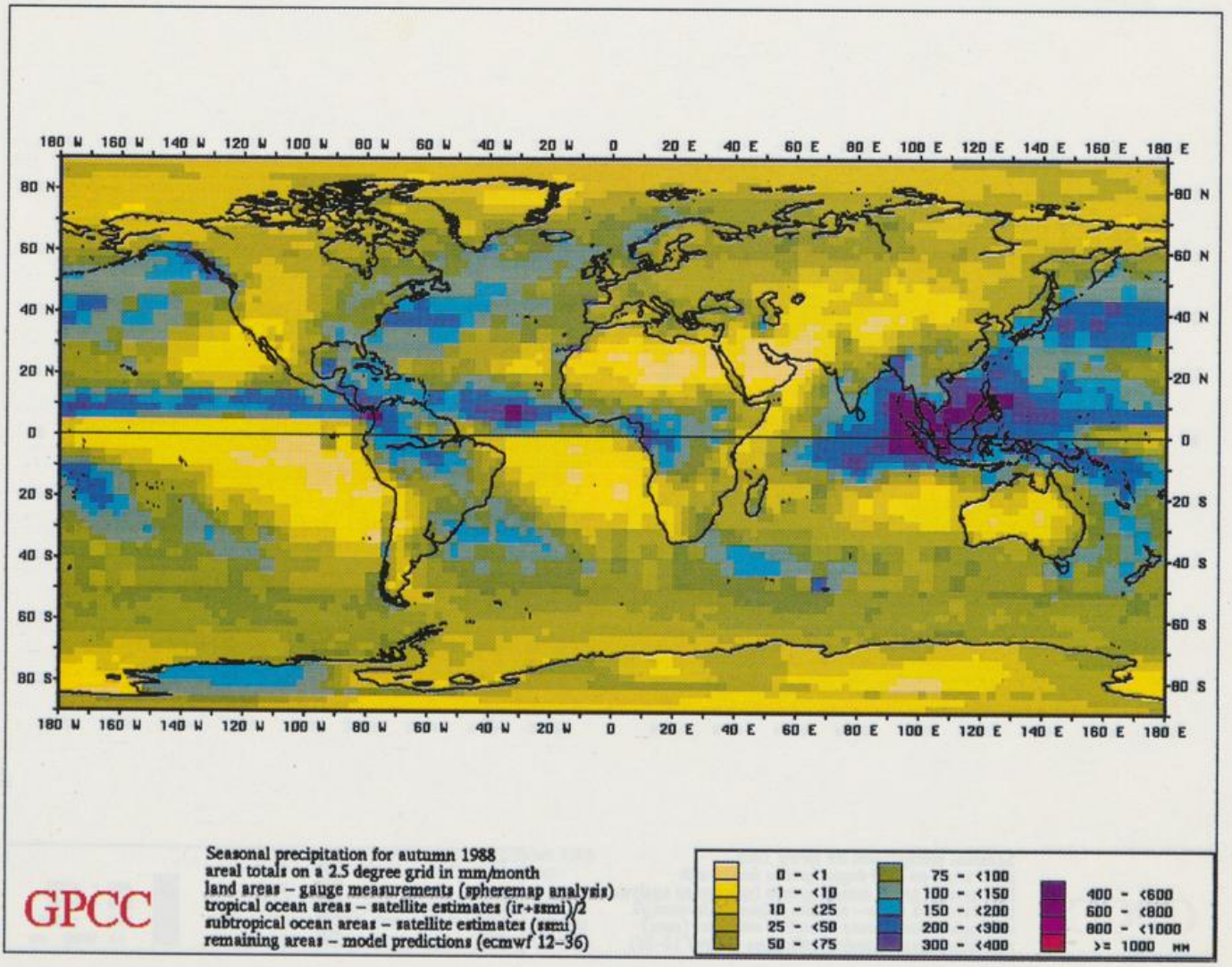
80 N 60 N 40 N 20 N 0 20 S 40 S 60 S 80 S
GPCC
Seasonal precipitation for winter 1987/1988
areal totals on a 2.5 degree grid in mm/month
land areas – gauge measurements (spheremap analysis)
tropical ocean areas – satellite estimates (ir+ssmi)/2
subtropical ocean areas – satellite estimates (ssmi)
remaining areas – model predictions (ecmwf 12–36)
0 - <1
1 - <10
10 - <25
25 - <50
50 - <75
75 - <100
100 - <150
150 - <200
200 - <300
300 - <400
400 - <600
600 - <800
800 - <1000
>= 1000 mm


180 W 160 W 140 W 120 W 100 W 80 W 60 W 40 W 20 W 0 20 E 40 E 60 E 80 E 100 E 120 E 140 E 160 E 180 E
80 N 60 N 40 N 20 N 0 20 S 40 S 60 S 80 S
GPCC
Seasonal precipitation for spring 1988
areal totals on a 2.5 degree grid in mm/month
land areas – gauge measurements (spheremap analysis)
tropical ocean areas – satellite estimates (ir+ssmi)/2
subtropical ocean areas – satellite estimates (ssmi)
remaining areas – model predictions (ecmwf 12–36)
0 - <1
1 - <10
10 - <25
25 - <50
50 - <75
75 - <100
100 - <150
150 - <200
200 - <300
300 - <400
400 - <600
600 - <800
800 - <1000
>= 1000 mm


180 W 160 W 140 W 120 W 100 W 80 W 60 W 40 W 20 W 0 20 E 40 E 60 E 80 E 100 E 120 E 140 E 160 E 180 E
80 N 60 N 40 N 20 N 0 20 S 40 S 60 S 80 S
GPCC
Seasonal precipitation for summer 1988
areal totals on a 2.5 degree grid in mm/month
land areas – gauge measurements (spheremap analysis)
tropical ocean areas – satellite estimates (ir+ssmi)/2
subtropical ocean areas – satellite estimates (ssmi)
remaining areas – model predictions (ecmwf 12–36)
0 - <1
1 - <10
10 - <25
25 - <50
50 - <75
75 - <100
100 - <150
150 - <200
200 - <300
300 - <400
400 - <600
600 - <800
800 - <1000
>= 1000 mm


180 W 160 W 140 W 120 W 100 W 80 W 60 W 40 W 20 W 0 20 E 40 E 60 E 80 E 100 E 120 E 140 E 160 E 180 E
80 N 60 N 40 N 20 N 0 20 S 40 S 60 S 80 S
GPCC
Seasonal precipitation for autumn 1988
areal totals on a 2.5 degree grid in mm/month
land areas – gauge measurements (spheremap analysis)
tropical ocean areas – satellite estimates (ir+ssmi)/2
subtropical ocean areas – satellite estimates (ssmi)
remaining areas – model predictions (ecmwf 12–36)
0 - <1
1 - <10
10 - <25
25 - <50
50 - <75
75 - <100
100 - <150
150 - <200
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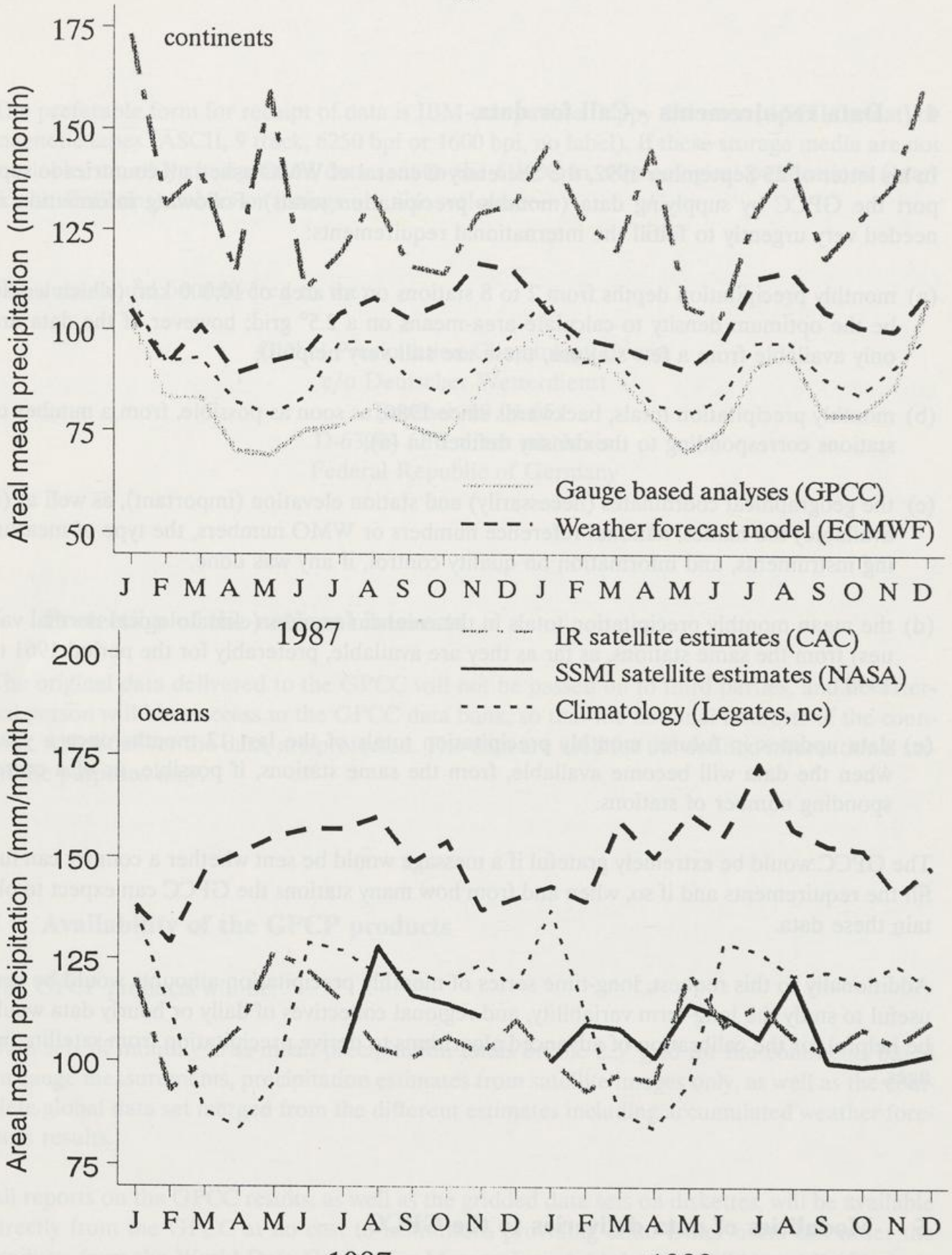
>= 1000 mm



Monthly areal-mean precipitation totals for a 60° -wide latitude belt centered at the seasonal position of the ITCZ separated for oceanic and continental areas for 1987 and 1988

4 Data requirements - Call for data

In his letter of 25 September 1992, the Secretary-General of WMO asked all countries to support the GPCC by supplying data (monthly precipitation totals). Following information is needed very urgently to fulfill the international requirements:

(a) monthly precipitation depths from 2 to 8 stations on an area of 10,000 km^2 (which would be the optimum density to calculate area-means on a 2.5° grid; however, if the data are only available from a few stations, these are still very helpful),

(b) monthly precipitation totals, backwards since 1986, as soon as possible, from a number of stations corresponding to the density defined in (a),

(c) the geographical coordinates (necessarily) and station elevation (important), as well as (if available) the names, national reference numbers or WMO numbers, the type of measuring instruments, and information on quality control, if any was done,

(d) the mean monthly precipitation totals in the calendar months (climatological normal values) from the same stations, as far as they are available, preferably for the period 1961 to 1990.

(e) data updates in future: monthly precipitation totals of the last 12 months once a year, when the data will become available, from the same stations, if possible, or of a corresponding number of stations.

The GPCC would be extremely grateful if a message would be sent whether a country can fulfill the requirements and if so, when and from how many stations the GPCC can expect to obtain these data.

Additionally to this request, long-time series of monthly precipitation amounts would be very useful to study the long-term variability, and regional collectives of daily or hourly data would be helpful for the calibration of advanced algorithms to derive precipitation from satellite images.

5 Modalities of data deliveries to the GPCC

In consideration of its international tasks the GPCC can not pay for data deliveries. However, the GPCC may help in technical problems, for example providing diskettes on request.

The preferable form for receipt of data is IBM-compatible floppy diskettes (ASCII format) or magnetic tapes (ASCII, 9 track, 6250 bpi or 1600 bpi, no label). If these storage media are not available, monthly precipitation data sent to the GPCC in climatological publications (yearbooks, Bulletins), tables or listings are also welcome.

The data should be delivered to the:

Global Precipitation Climatology Centre
c/o Deutscher Wetterdienst
Postfach 10 04 65
D-63004 Offenbach am Main
Federal Republic of Germany

6 Protection of the national interests

The original data delivered to the GPCC will not be passed on to third parties, and no external person will have access to the GPCC data bank, so that the national interests of the countries, which deliver the data, are protected. The data are used for the defined international scientific purposes only.

7 Availability of the GPCP products

The GPCP products will be:

Data sets of monthly area-mean precipitation totals on the 2.5° grid for the continents based on gauge measurements, precipitation estimates from satellite images only, as well as the complete global data set merged from the different estimates including accumulated weather forecasts results.

All reports on the GPCC results, as well as the gridded data sets on diskettes, will be available directly from the GPCC at no cost to institutions providing data. Other users can order the products from the World Data Centres for Meteorology A (Asheville, USA) and B (Obninsk, Russia) or directly from GPCC. In this case only the marginal costs of reproduction and distribution or filling a specific users request will be required. The data itself is free of charge.

8 References

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Cover figures (back):

Precipitation anomalies for the year 1988 for the continents, in millimeters per month (above) and in percent (below), derived from rain-gauge measurements of the year 1988 related to the long-term means provided by Legates.

Global Precipitation Climatology Centre
c/o Deutscher Wetterdienst
Postfach 10 04 65
D-63004 Offenbach a.M.
Federal Republic of Germany

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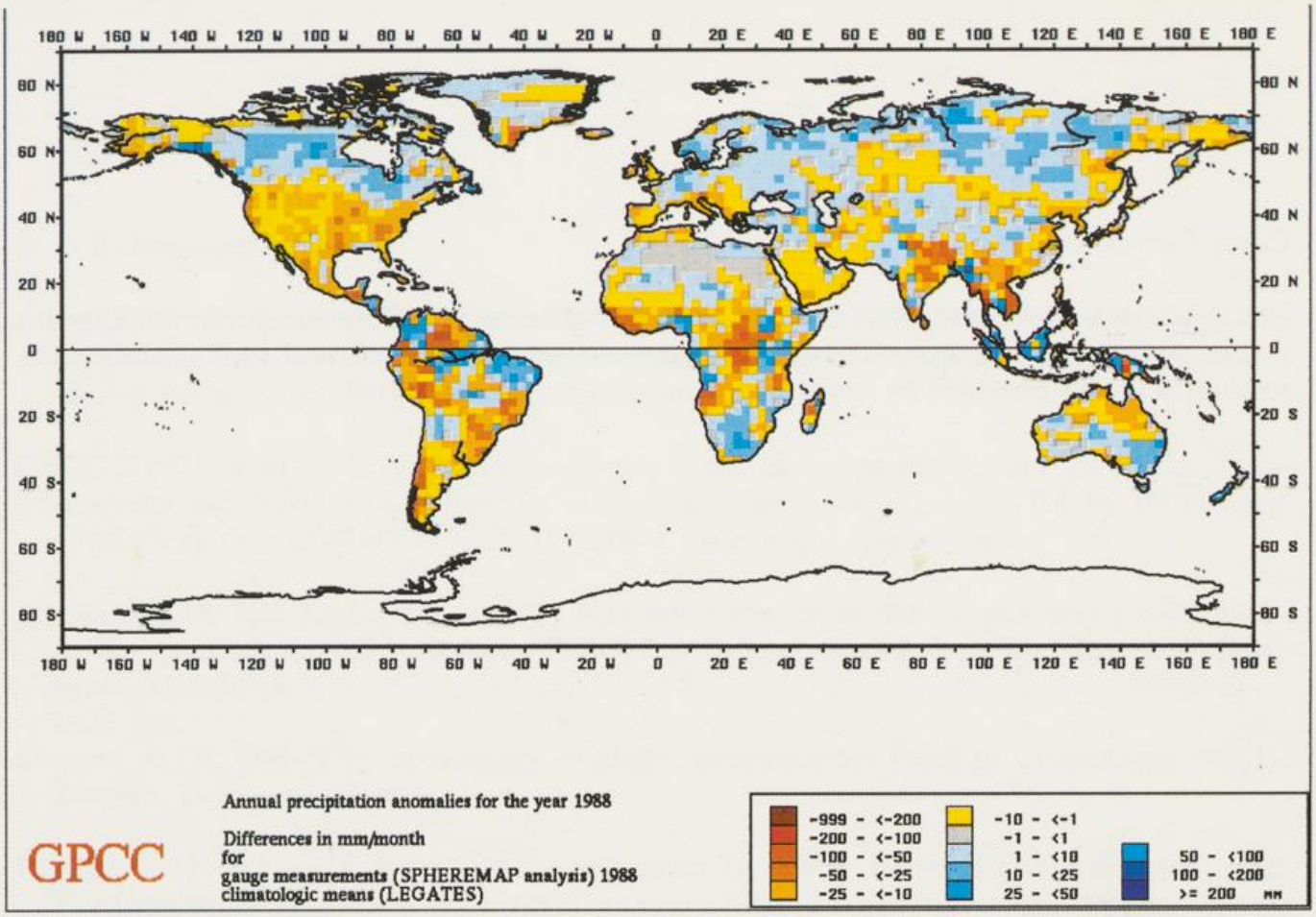
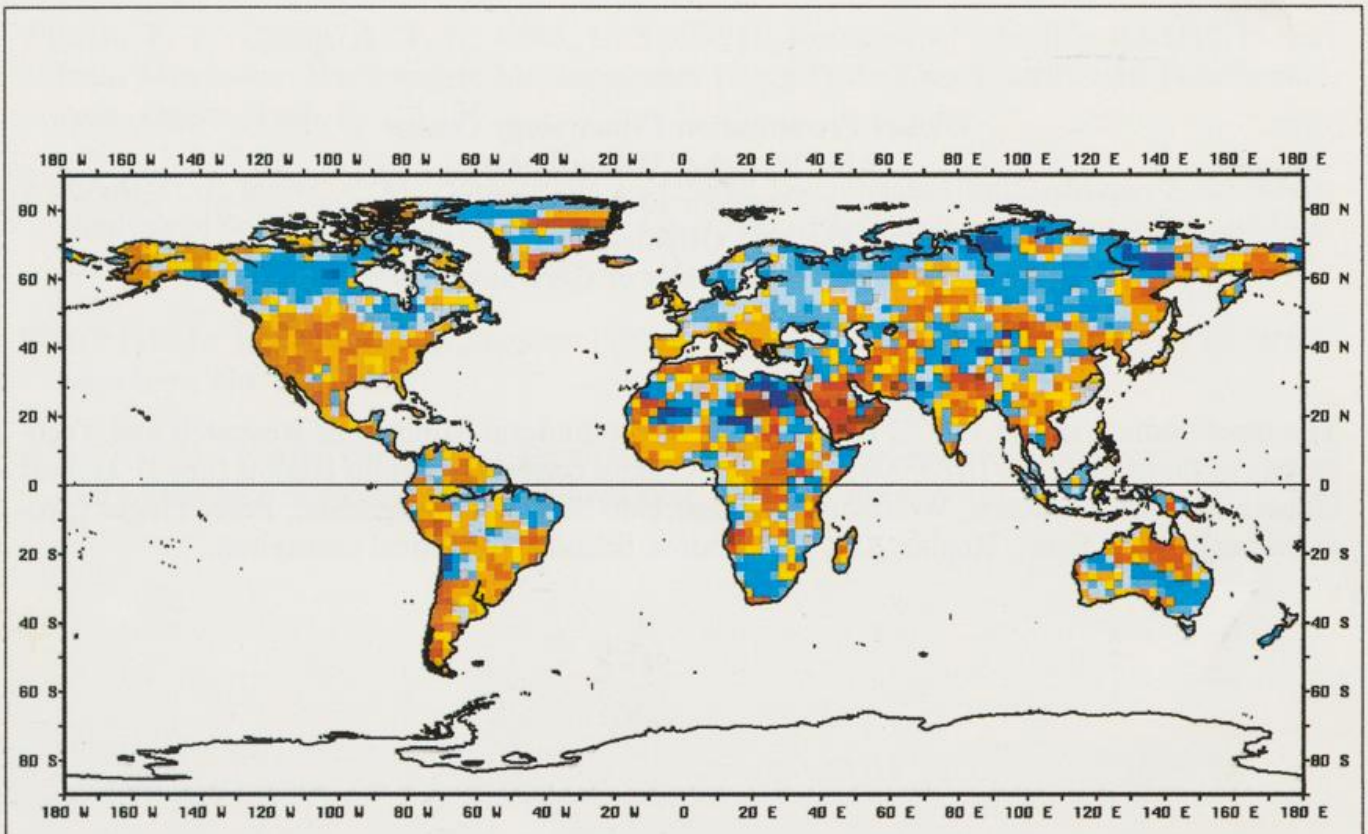


Annual precipitation anomalies for the year 1988

Differences in mm/month
for
gauge measurements (SPHEREMAP analysis) 1988
climatologic means (LEGATES)

GPCC

-999 - <-200	-10 - <-1	
-200 - <-100	-1 - <1	
-100 - <-50	1 - <10	50 - <100
-50 - <-25	10 - <25	100 - <200
-25 - <-10	25 - <50	>= 200 mm



Annual precipitation anomalies for the year 1988

Ratios in %
for
gauge measurements (SPHEREMAP analysis) 1988
climatologic means (LEGATES)

GPCC

0 - <33	91 - <99	
33 - <50	99 - <101	
50 - <67	101 - <110	150 - <200
67 - <80	110 - <125	200 - <300
80 - <91	125 - <150	>= 300 %