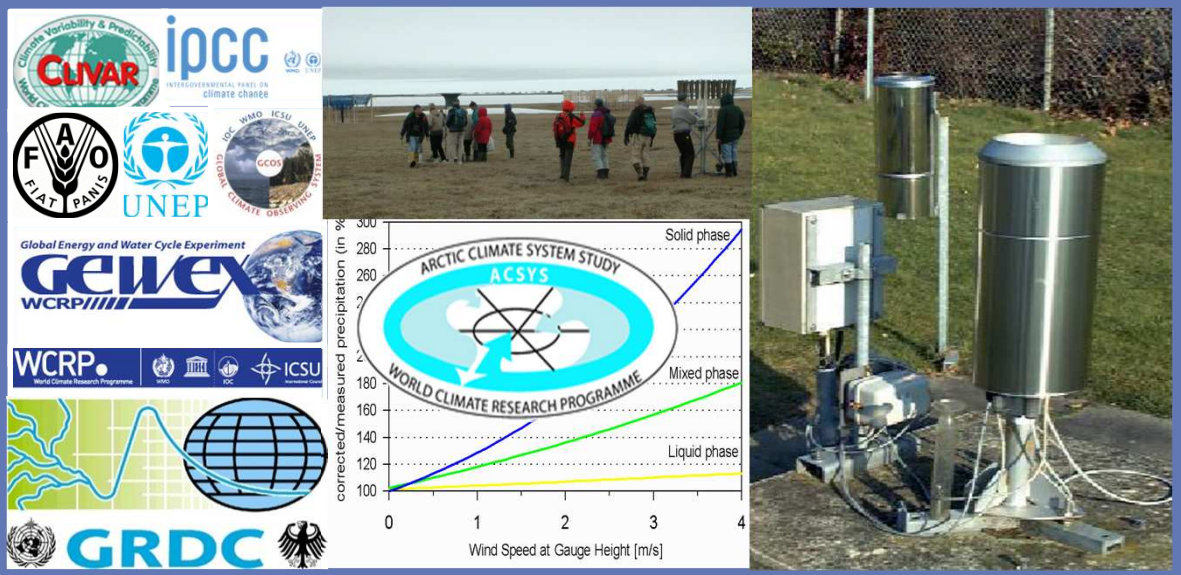
The Global Precipitation Climatology Centre (GPCC) to support the GCW on ECV Precipitation: Caps and Constraints



Andreas Becker

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Precipitation Monitoring Unit
Department of Hydrometeorology
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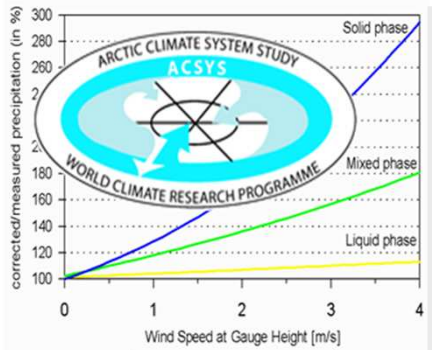
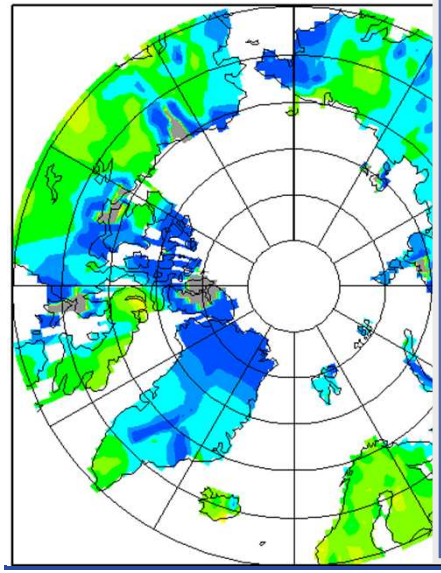
Email: andreas.becker@dwd.de, gpcc@dwd.de

with contributions of
Udo Schneider, Anja Meyer-Christoffer, Markus Ziese, Peter Finger, Peter Stender, Hermann Mächel, Bruno Rudolf

Outline



GPCC Relative gauge measuring error for January 2007 in % per r



1 GPCC - Basic Facts

2 GPCC - Latest Achievements and Products

3 GPCC - Arctic View

4 GPCCs role with GCW

The Global Precipitation Climatology Centre (GPCC)

Established by the World Meteorological Organization WMO in the year 1989

- undertaken by Deutscher Wetterdienst **DWD**

- contributes to the Global Climate Observing System **GCOS**
- and the World Climate Research Programme **WCRP**
- thousands of **users world-wide**
- scientific task: **quantitative assessment of global precipitation** and **investigation of the global water cycle**

The functions of the GPCC

- ➔ collection of observed precipitation data world-wide
  - ➔ data processing, quality control, storage
    - ➔ data analysis, production of gridded data fields
      - ➔ distribution of the gridded data fields
        - ➔ contribution to international programs

GPCC User and Partner

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Institution	Target Application
• GCOS	Global climate monitoring applications
• WCRP/GEWEX	Analyses of hydrometeorol. processes and adjustment of satellite-based observation
• WMO WWW	CLIMAT network monitoring (RBCN/GSN)
• WMO WCP	Annual Report on global climate status
• WMO HWRP	Contribution to GTN-H development
• IPCC	Climate variability and trend analyses
• ECMWF, UKMO	NWF model verification
• GEO	Contribution to GEOSS Implementation
• FAO	Input for drought monitoring applications
• UNESCO IHP	Water resources assessment

…and many researchers worldwide…

GPCC data sources

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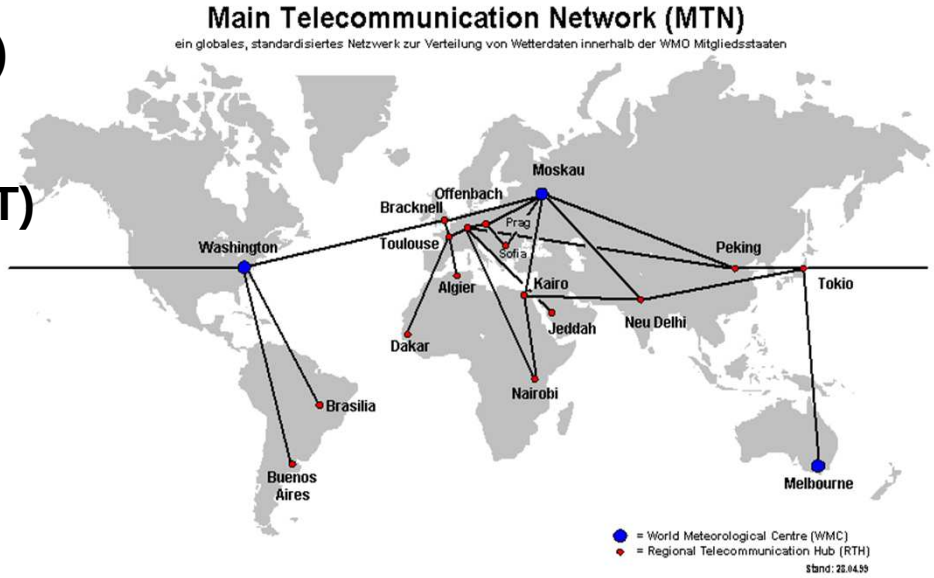
Near real-time regularly exchanged data
via the WMO Global Main Telecommunication Network

- **hourly/daily weather reports (SYNOP)**
  - ➔ **ca. 6,500 stations**
- **monthly climatological totals (CLIMAT)**
  - ➔ **ca. 2,300 stations**

➔ **ca. 8,000 stations**



Non real-time:

Additional data received from ca. 190 countries

plus:
- Historical data collections (CRU, FAO, GHCN, Nicolson)
- International project data (GEWEX and other)

➔ **totally more than 85,000 stations**

GPCC near real-time products

Routinely produced gridded data sets

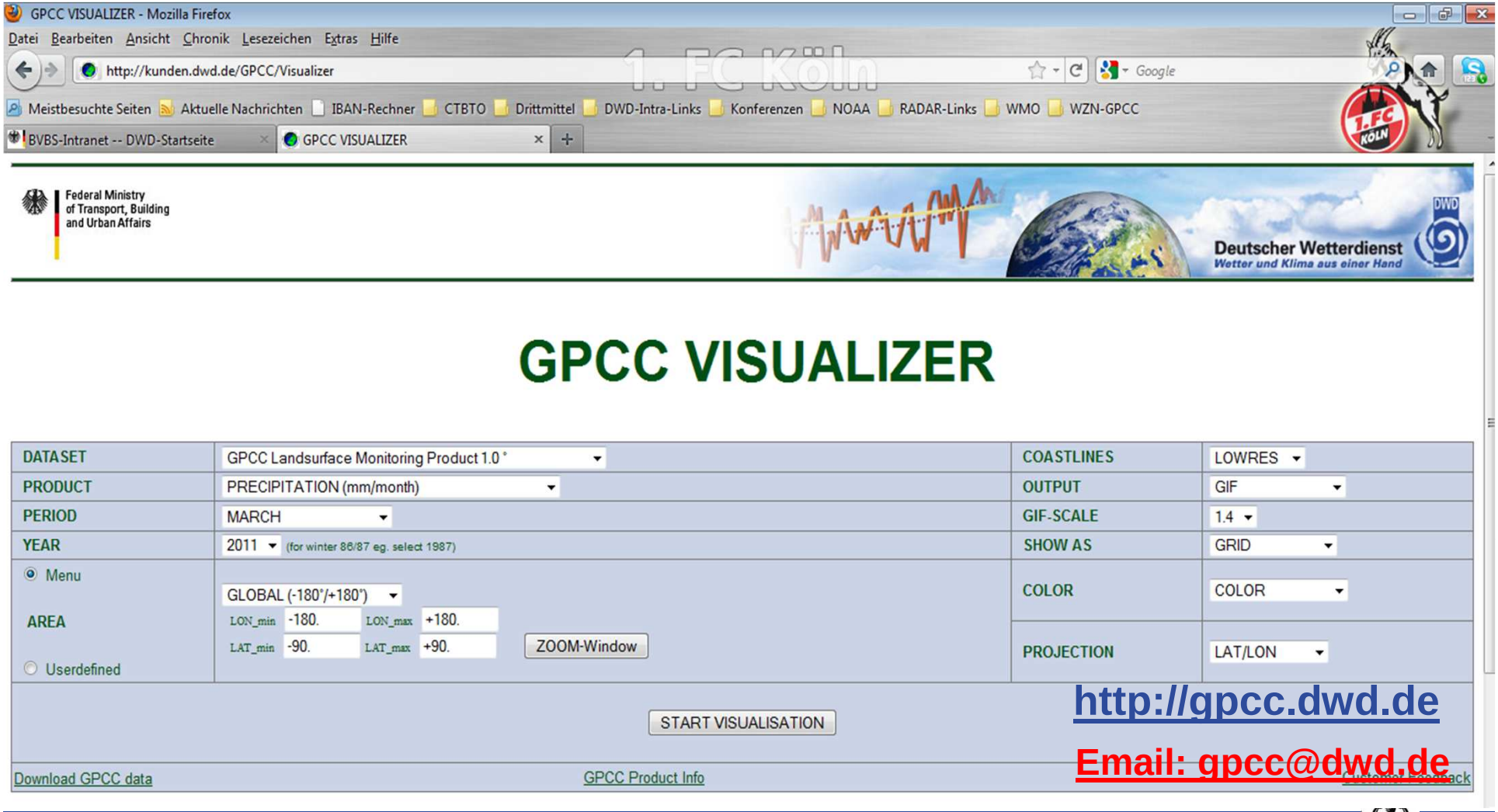
available within:		**application:**	**number of stations:**
5 days	**First Guess Anomalies**	**drought monitoring FAO**	**~ 6,500**
2 months	**Monitoring Product**	**WCRP/GEWEX early reference**	**~ 8,000**

Additional information provided for monitoring product

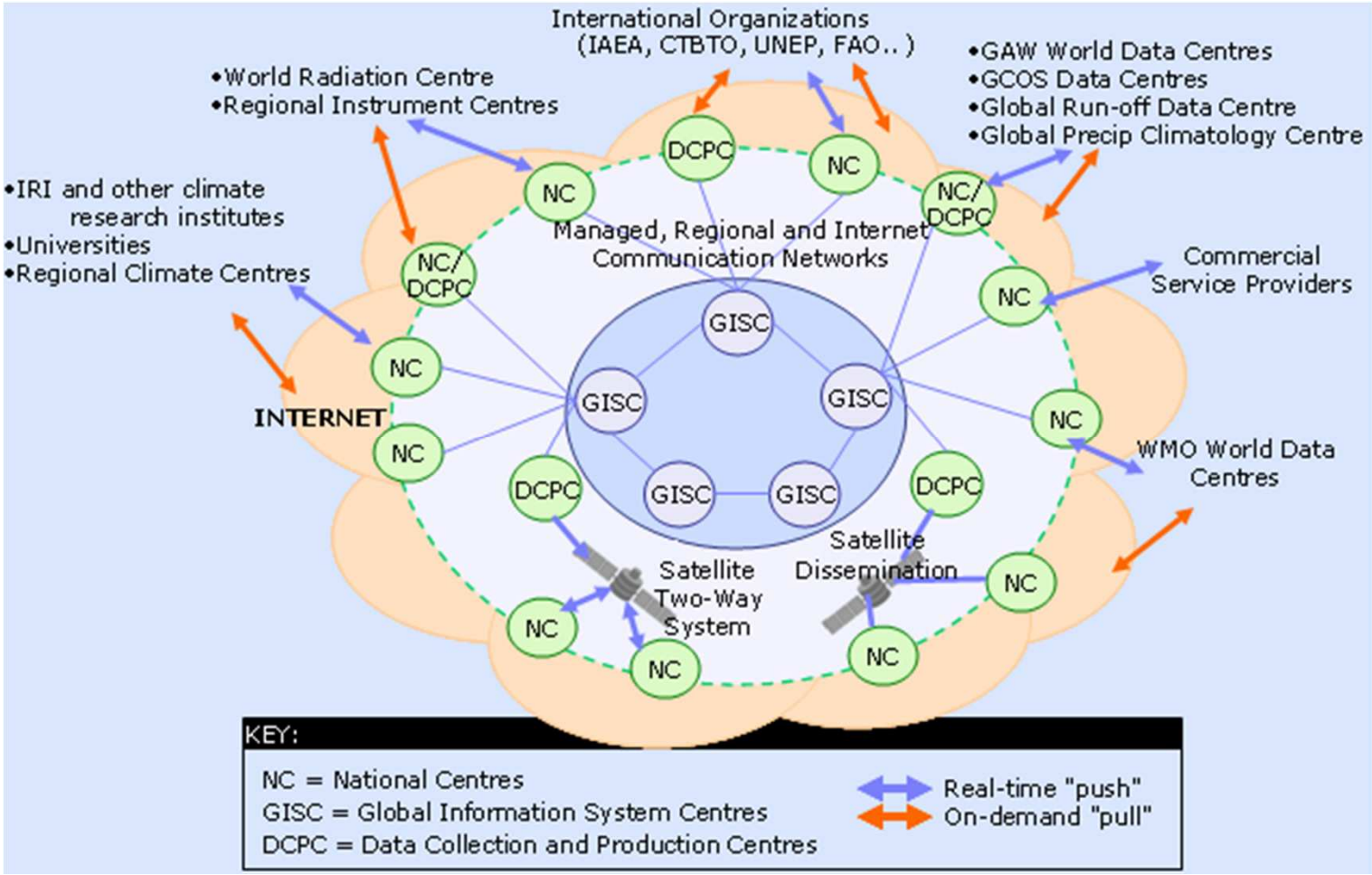
- **Number of stations per grid box**
- **Sampling error**
- **Stochastic error**
- **Systematic error assessment**

This information is updated every month

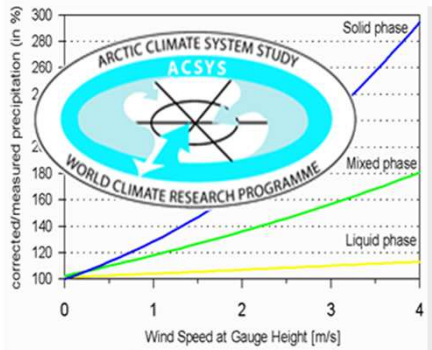
Access to GPCC's Precipitation Products



GPCC serves as a data collcting and producing centre (DCPC) within WIS



Outline



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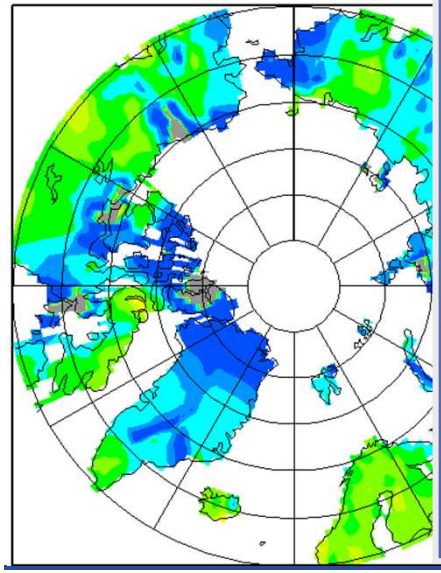

1. GPCC - Basic Facts
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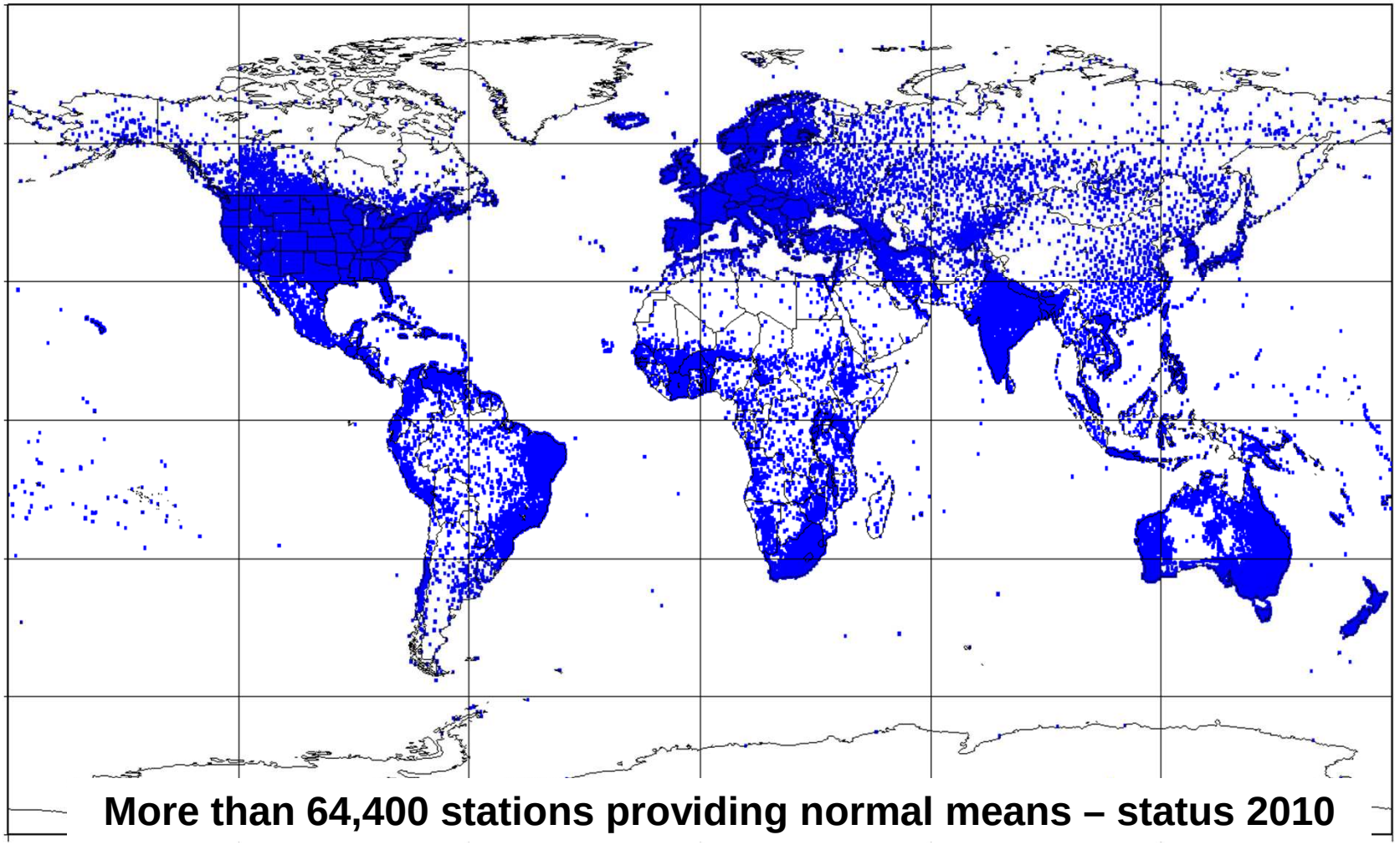
GPCC achievements

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

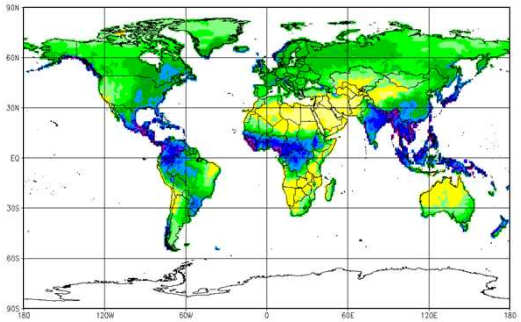


More than 64,400 stations providing normal means – status 2010

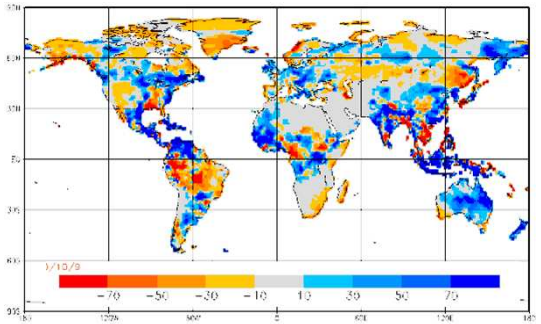
Data used as climatologic background for GPCC gridded data sets

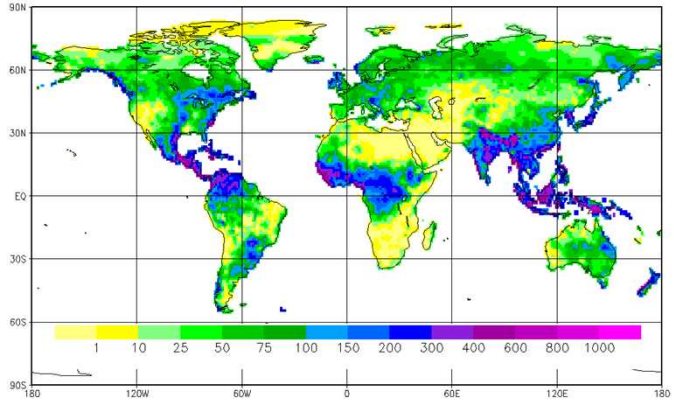
Gridding of the station data for individual months

Long term mean monthly precipitation 'normals'



Monthly precipitation anomaly gridded from station anomalies





Gridded monthly precipitation totals

Products

➔ **Global Precipitation Mean Climatology 2010 / 2011**

- period 1951-2000 — Done, Dec 2010
- based on about 64 / 66 thousand stations — Update, Dec 2011

➔ **Full Data Reanalysis Version 5 / 6**

- period 1901-2009 / 2010 — Done, Dec 2010
- based on all stations with climatology — Update, Dec 2011

➔ **Trend analysis for selected data time-series**

- period 1951-2000 (VasCLIMO) / 2005 (HOMPRA) — Done, 2005
- based long series of 9400 / 16000 stations — Q1 2012

➔ **publication of the methods used and results**

- GEWEX News May 2011 Issue; Web Portal gpcc.dwd.de

two papers in preparation for peer review

GPCC achievements

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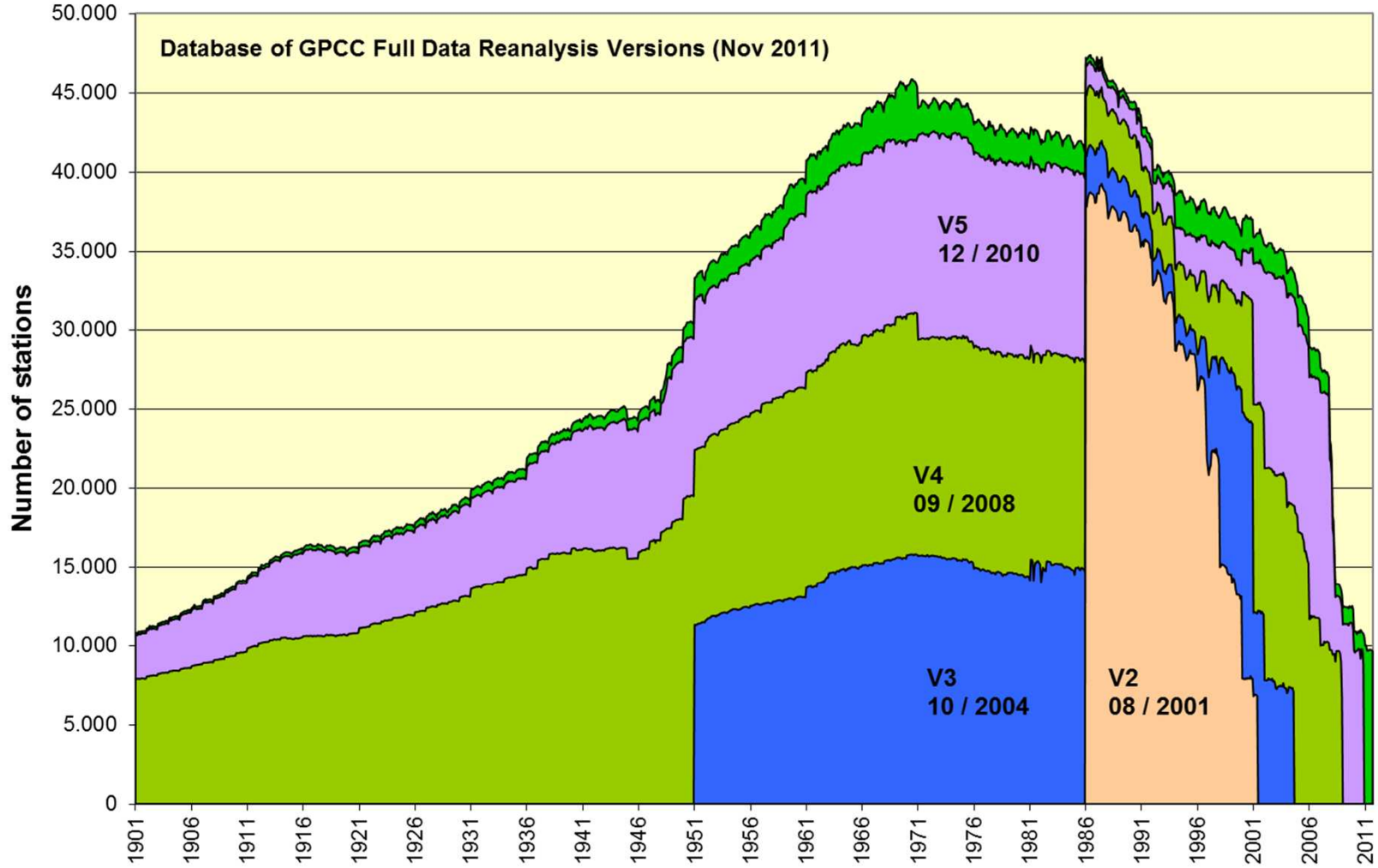
Increased data coverage of Full Data Reanalysis throughout past decade



GPCC data sources

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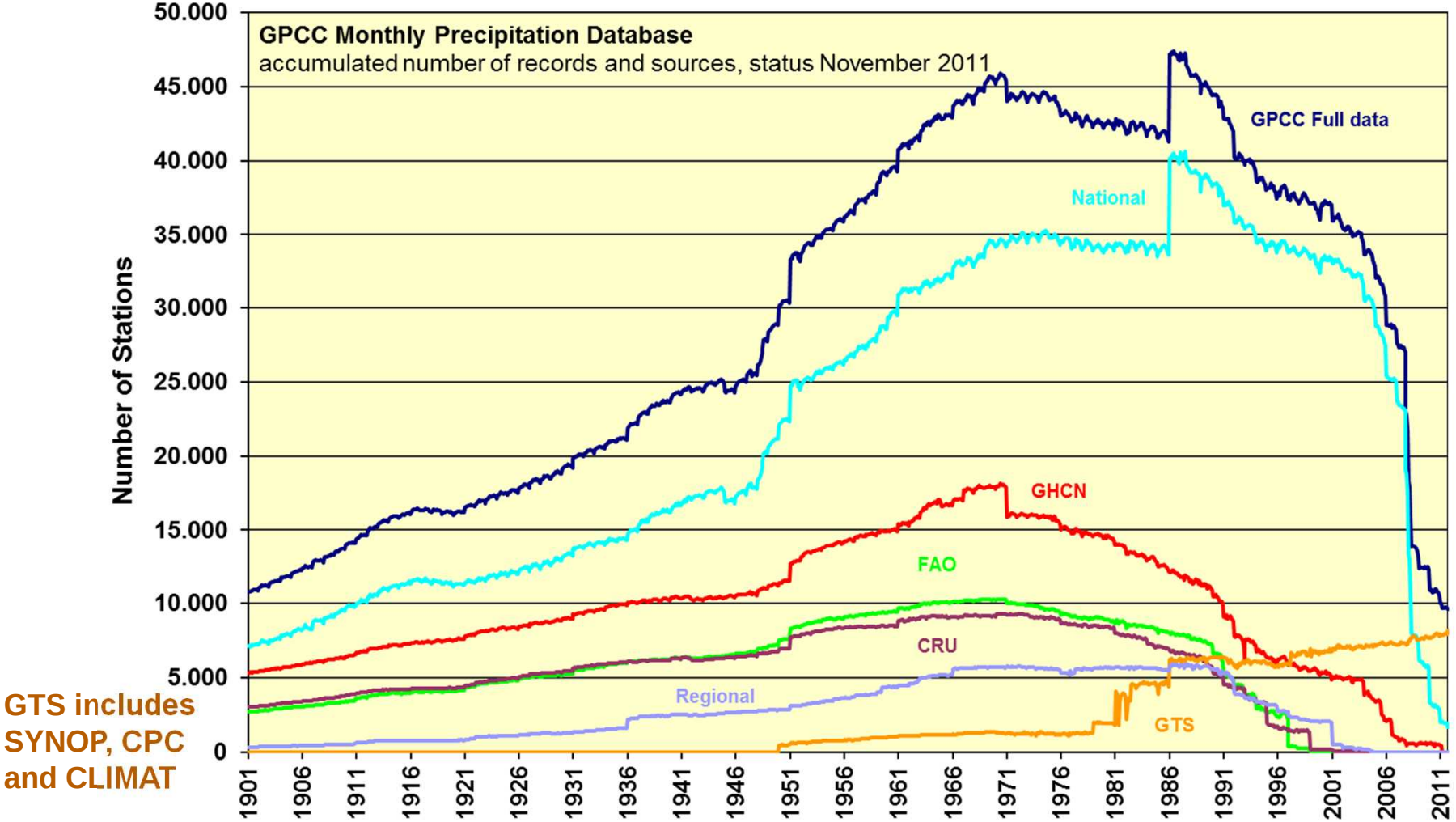
Wetter und Klima aus einer Hand

Temporal data coverage of the eight different data sources and the total



Separate storage of the data from different sources

Data for analysis		Station - Meta Information						Precipitation Data separated for the data sources (Dec. 1995)								Dec.
precip (mm)	selected source	GPCC ID	Name	Continent	lamb decimal	phi decimal	elev m NN	SYNOP (mm)	CLIMAT (mm)	CPC (mm)	Regio (mm)	National (mm)	CRU (mm)	GHCN (mm)	FAO (mm)	normals (mm)
9	National	50000100	Oslo-Blindern	Europe	10,717	59,950	96		9			9	9	9	9	54
28	National	50000092	Turku	Europe	22,267	60,517	59	30	28	29		28	28	28	28	64
60	SYNOP	50002750	Orleans	Europe	1,783	47,983	125	60		62						54
34	National	50000516	Alicante	Europe	5,333	35,333	460	37	34	13		34	34	34	34	34
73	National	50000406	Pescara	Europe	14,200	42,433	11	71		71		73				77
20	National	50000193	Poznan	Europe	16,850	52,417	92	21	20	21		20	20	20	20	38
21	National	50000477	Sivas	Europe	37,017	39,750	1285	23	21	22		21	21	21	21	47
6	SYNOP	50002287	Odense	Europe	10,333	55,467	17	6		8						
25	National	50002508	Sumy	Europe	34,783	50,850	181	26		24	25	25				53
156	National	50000365	Sarajevo	Europe	18,433	43,867	638					156		156		85
51	National	50000492	Cagliari	Europe	9,067	39,250	5	53	49	48		51		49	49	55
72	National	50002788	Kufstein	Europe	12,164	47,575	493	74		71		72				
103	National	50030955	Basel	Europe	7,583	47,533	317	104				103				54
71	National	50														49
73	National	50														46
55	National	50														65
66	National	50														64
69	National	50														
147	National	50														52
95	CLIMAT	50000548	Kalamata	Europe	22,017	37,067	8		95			117	95	95	95	154
64	CLIMAT	50035663	Bet Dagan	Europe	34,817	32,000	35		64				64	64	64	139
156	National	50019414	Kredarica	Europe	13,850	46,383	2515	169	156	155		156				120

The separate storage of the different data sources is an important basis for quality control as well as for understanding and later re-production

GPCC QC

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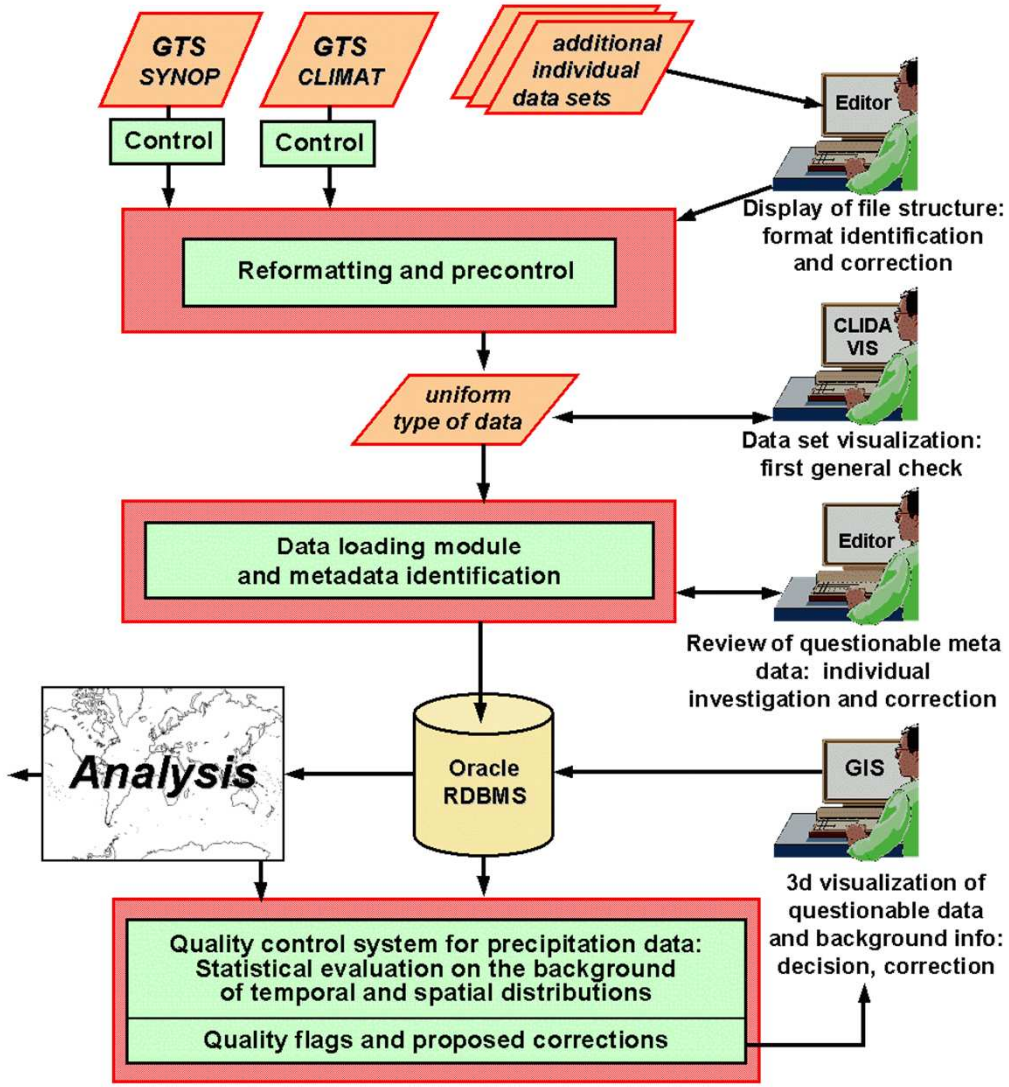
Wetter und Klima aus einer Hand



Quality-control with 4 levels:

1a: Pre-control of SYNOPs
1b: Pre-control of CLIMATs
1c: Format-check of individual data sets

2: Overall visual control of individual data sets

3: Check of station meta data during the loading process

4: Semi-automatic QC of monthly precipitation data: Statistical pre-control and visual check of questionables

Current GPCC Products are useful for

- Drought monitoring
- Verification of climate and NWP models
- Investigation of the interactions between the global energy and water cycle
- Assessment of global water resources
- Validation/Calibration of remotely sensed precipitation estimations
- Analysis of climate variability and trend
- Assessment of wet deposition impacts
- Gobal Cryosphere Watch Purposes !?!

A two page wrap up on GPCC is available from

http://www.gewex.org/ssg-24/GPCC.pdf

GPCC Products

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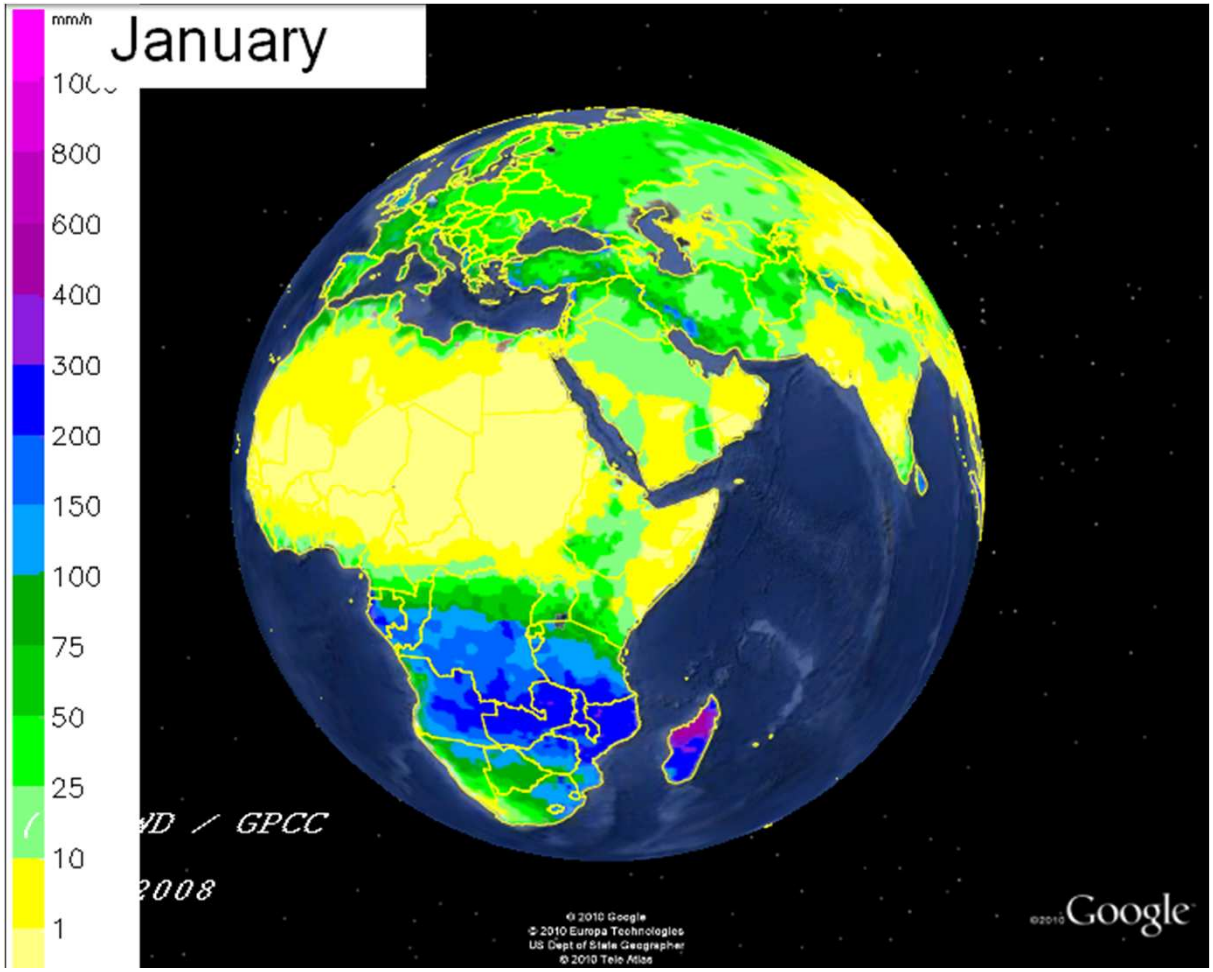
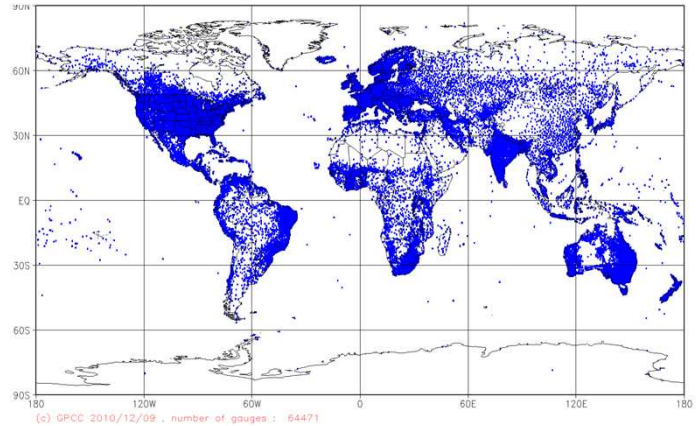
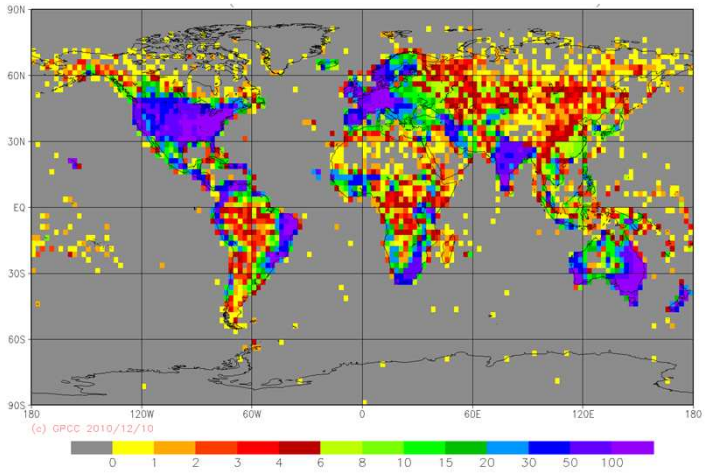
Use Case 1: Provide for a high-quality background precipitation climatology for new re-analyses or educational purposes ➔ **GPCC Climatology 2010**







GPCC MP V1 vs V5-RA

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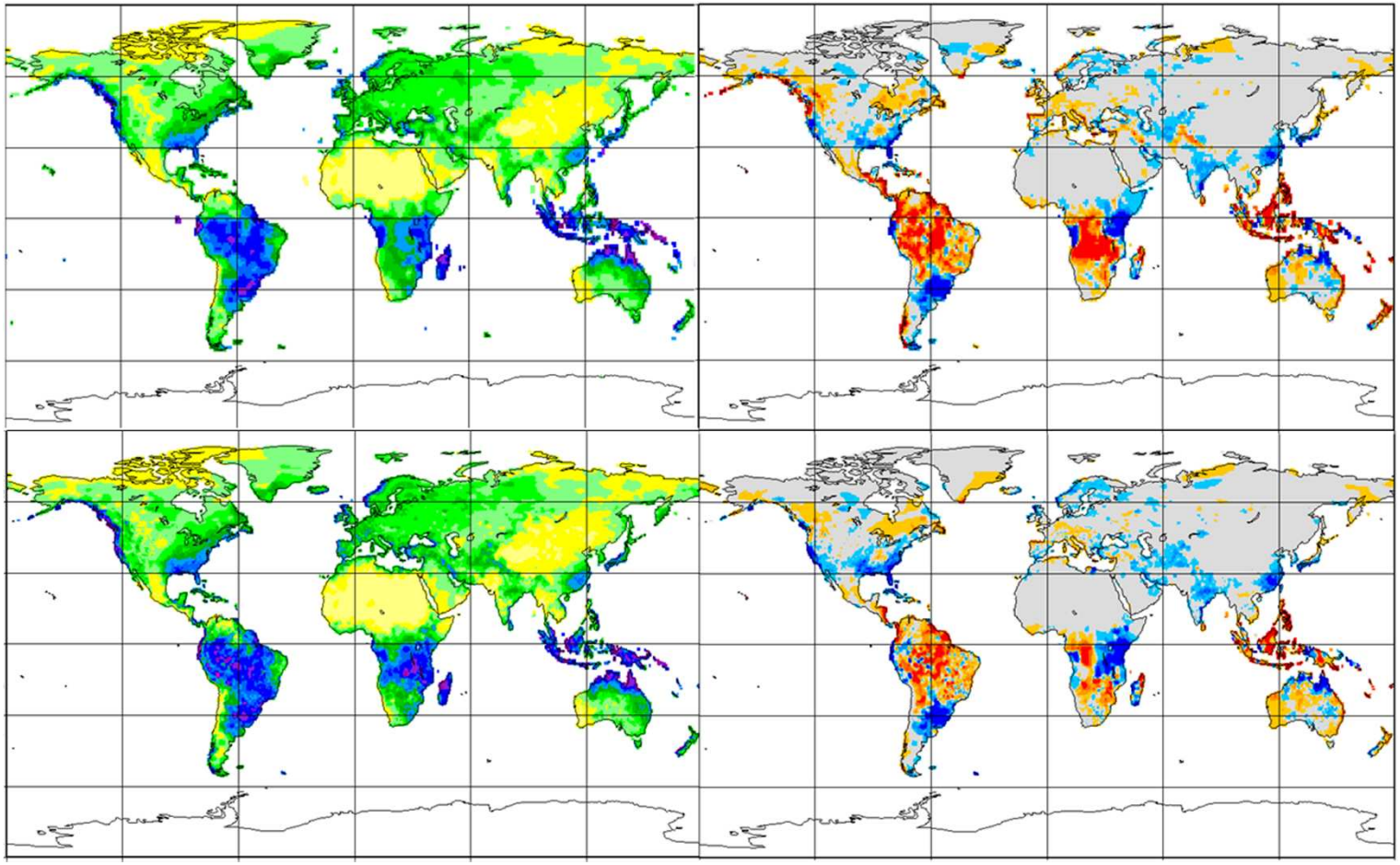
Monitoring (top) and Full Data Reanalysis (bottom) El Nino Winter 1997/98



Please note the excellent overall quality of the monitoring product available 2 months after the fact, but also the improvement in the Full Data Product across central Africa!

Correlation of NAO against regional precipitation anomalies 1901 – March 2011

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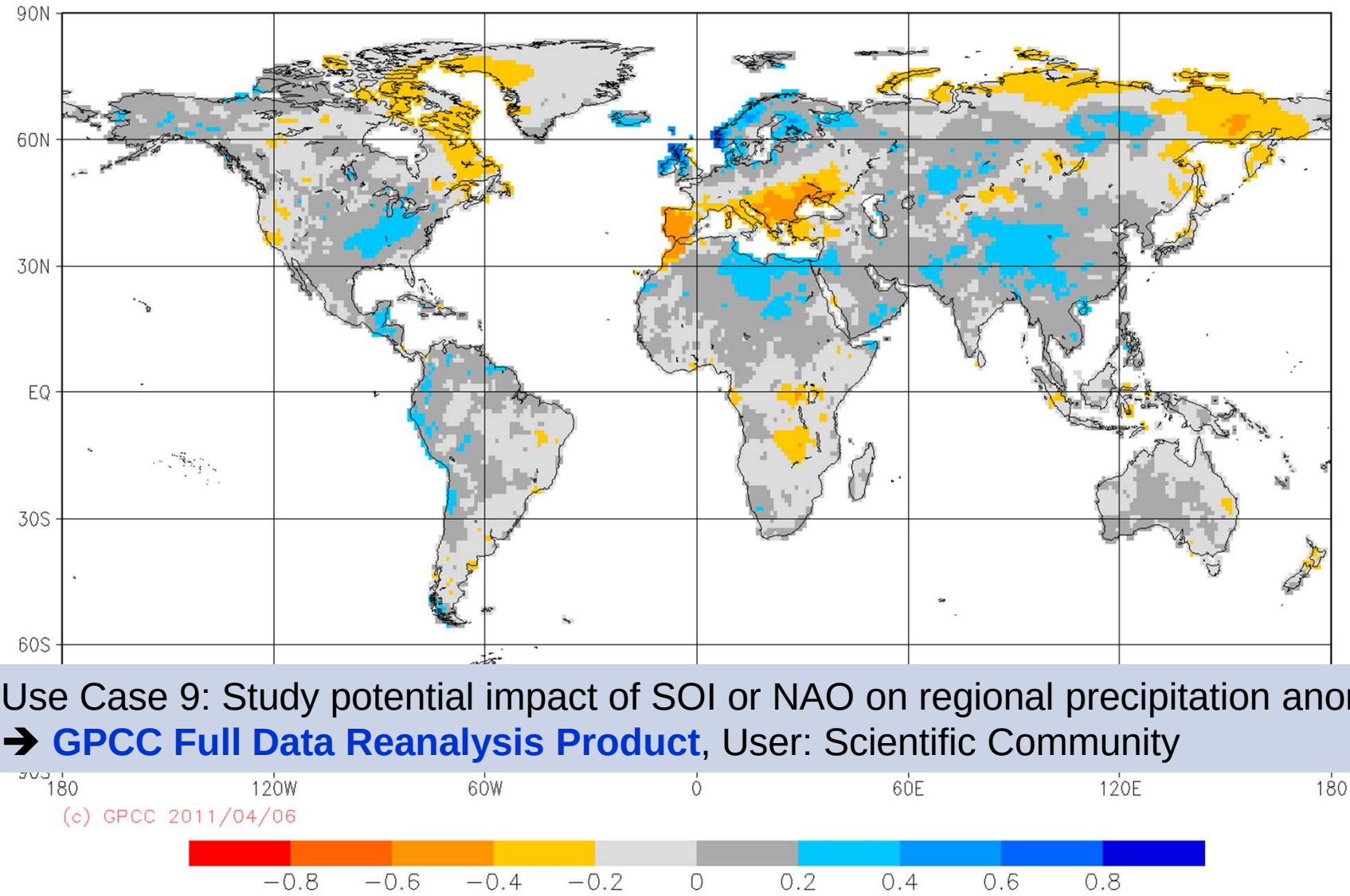
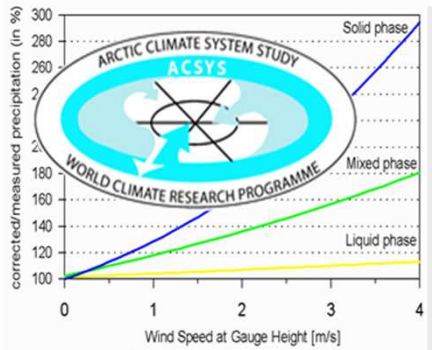
Wetter und Klima aus einer Hand

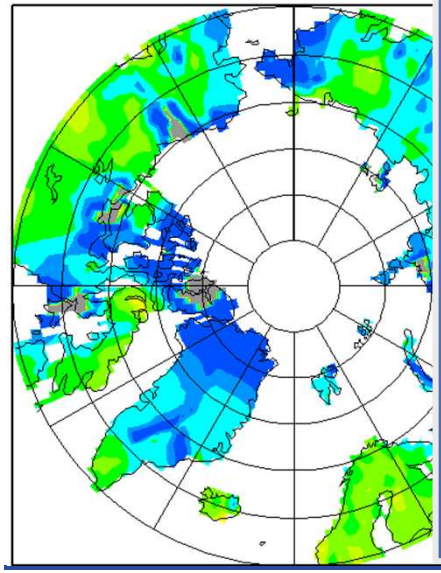


Use Case 9: Study potential impact of SOI or NAO on regional precipitation anomalies
➔ **GPCC Full Data Reanalysis Product**, User: Scientific Community

Outline



GPCC Relative gauge measuring error for January 2007 in % per r



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Motivation for global monitoring: Understanding the Global Water Cycle

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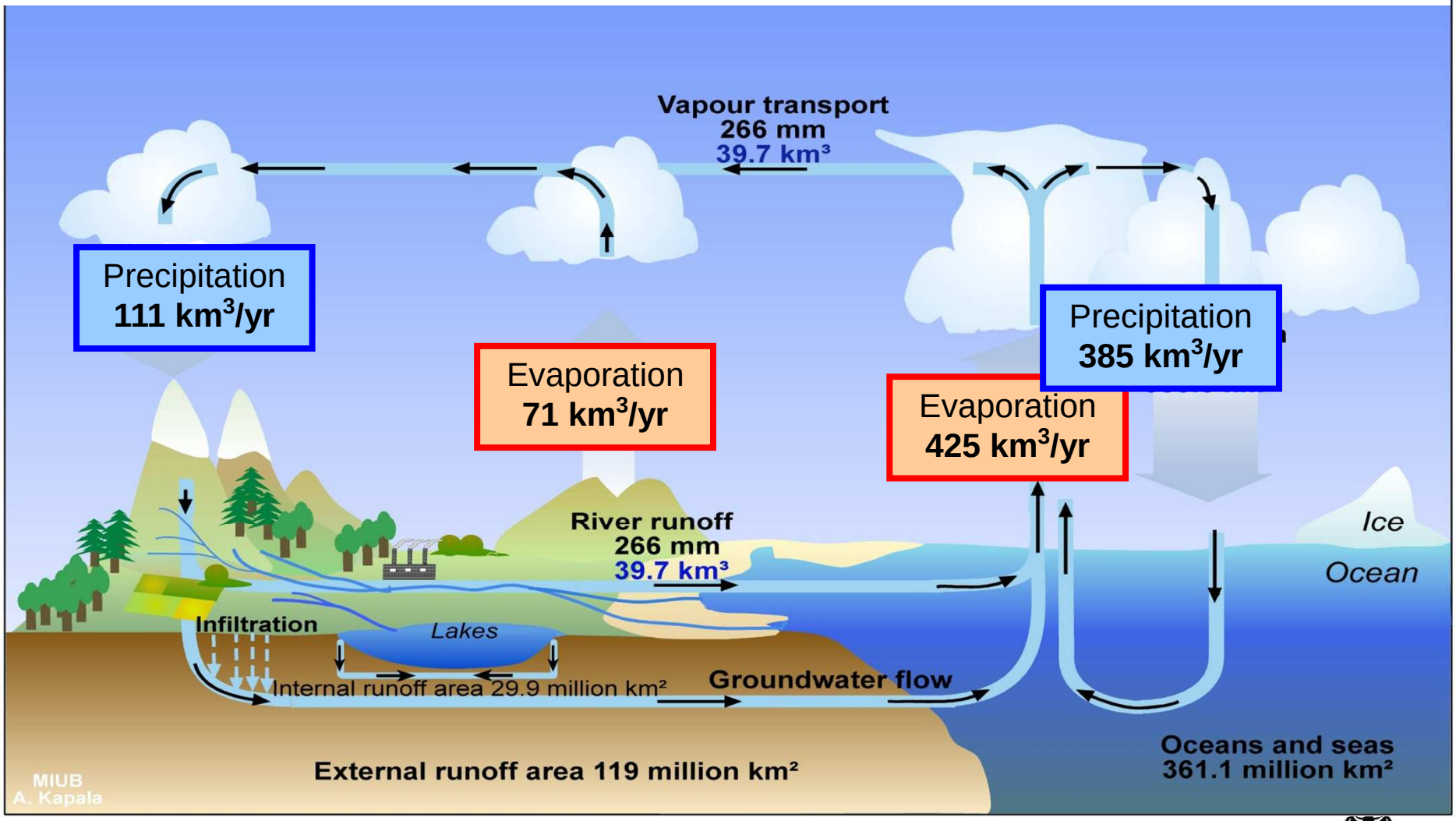
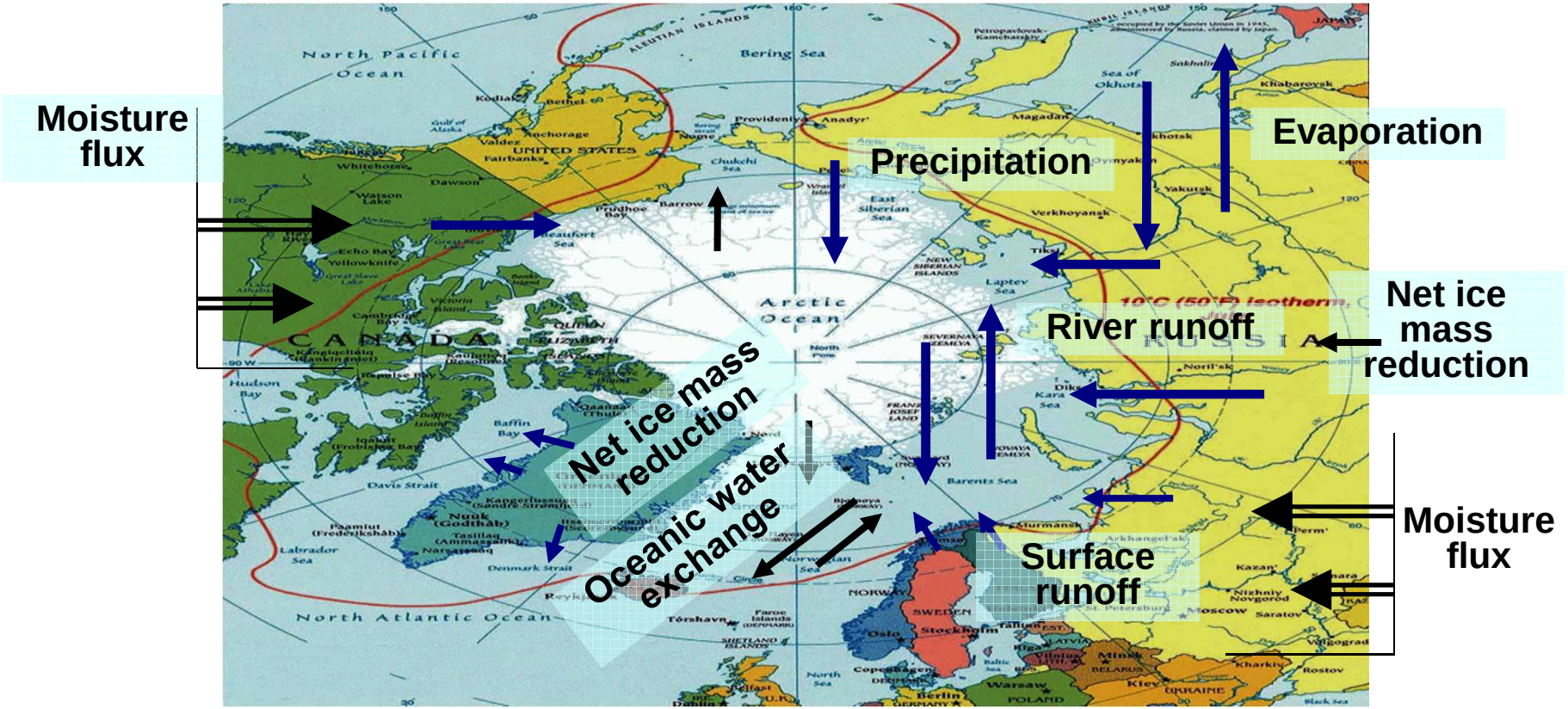
Global: Precipitation = Evaporation = 496 km³/yr = ca. 1.000 mm/yr



The Arctic Hydrological Cycle



is not a closed system because of horizontal atmospheric and oceanic water mass exchange (advection)

To describe the Arctic Hydrological Cycle it needs quantitative information on:

- River runoff (discharge)
- Precipitation (solid, liquid)
- Moisture flux convergence
- Evolution of the ice mass
- Oceanic transports

It needs both, models and observations.

Arctic Precipitation Data Archive (APDA)

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APDA Project yielded in 2003:
Increased number of stations with precipitation data

Region	GPCC status 1994			APDA status 2003		
	resolution	period	stations	stations	resolution	period
FSU/Rus.	monthly	1986-1992	622	2004	daily	1891-1999
Canada	monthly	1986-1992	320	7281	daily	1840-2000
Norway	monthly	1986-1992	77	649	monthly	1950-2000
Alaska	monthly	1986-1992	153	514	daily	1891-2000
---	---	---	---	---	---	---
Arctic			1172	10448		

MoW: a) Acquisition of data -> Extension of GPCC DB

b) Pre-Processing, Reformatting, Redundancy screening and cross- comparison of data from multiple source,

c) Homogeneity Check and QC

d) Estimation of systematic error

e) Interpolation onto 100x100 km Raster

f) Dissemination through the internet

GPCC arctic view

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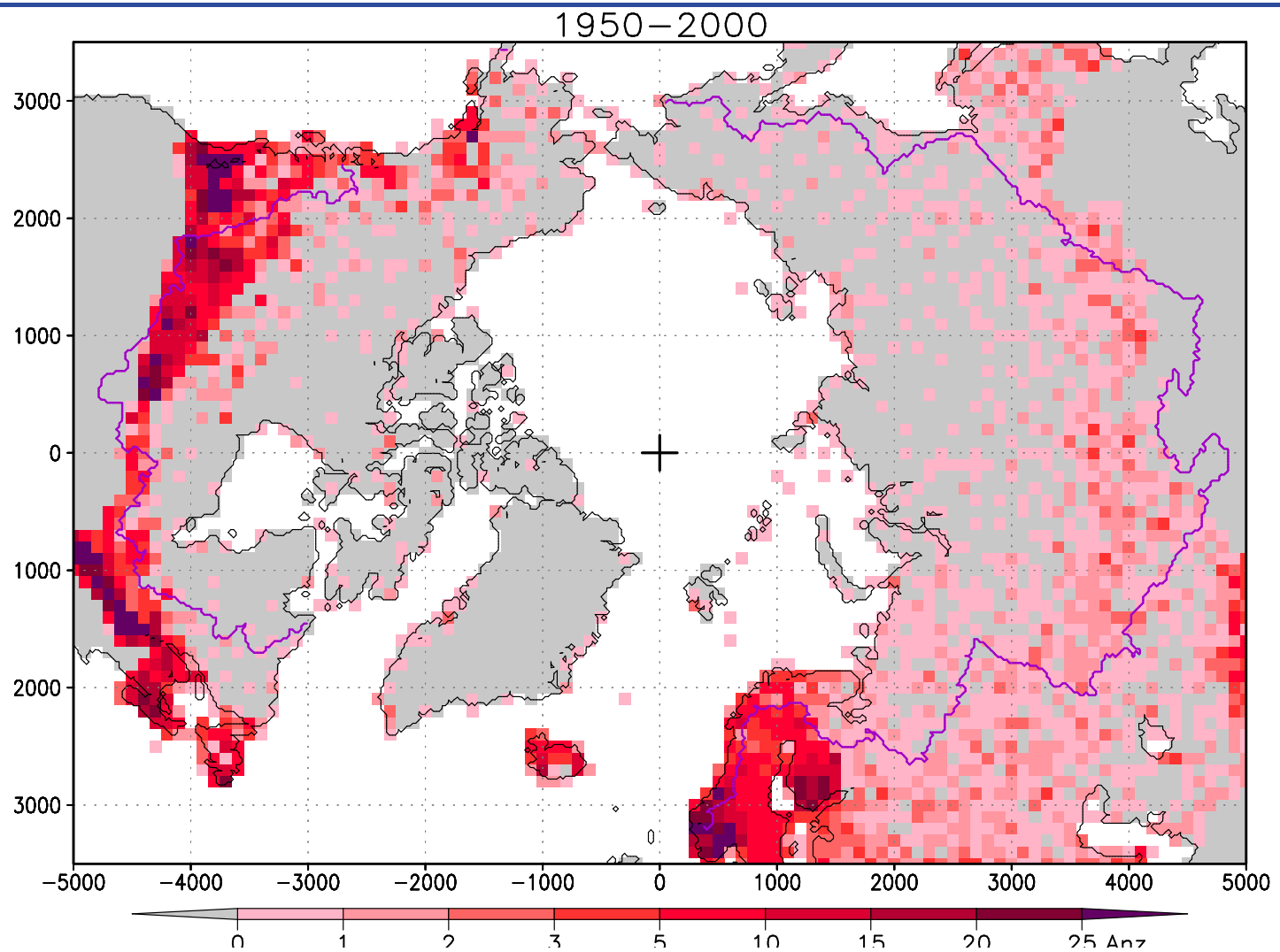
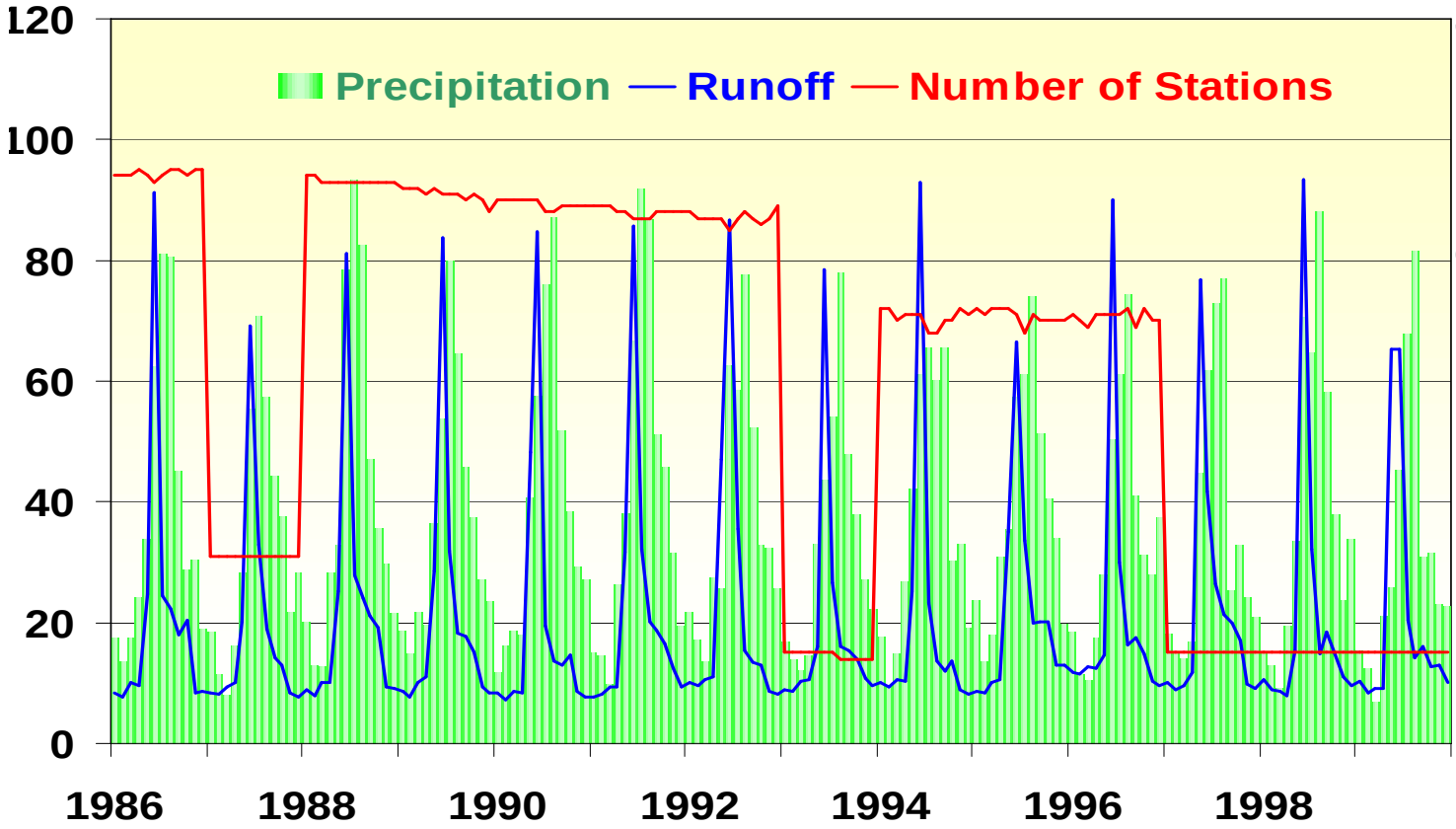


Number of APDA stations per azimuthal equal area grid cell

Comparison of precipitation (GPCC) and river run-off (GRDC) variation at Yenisei river in Siberia



Green area indicates the analysis region

GPCC Arctic activites

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The Arctic Precipitation Data Archive (APDA) of ACSYS/CliC

GPCC Web Page http://gpcc.dwd.de hosts ACSYS portlet with compilation of relevant data sets and station inventories

GPCC station density

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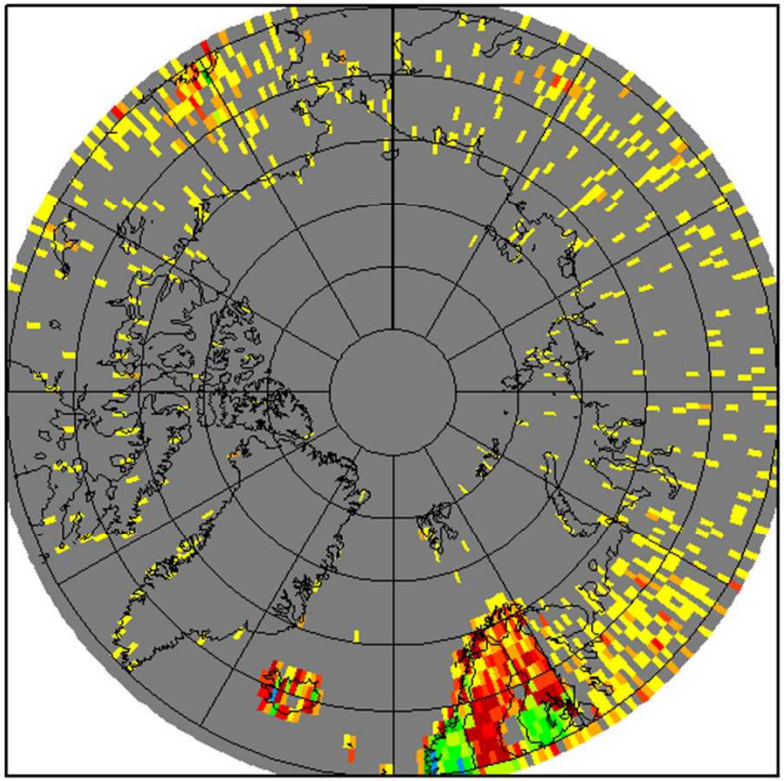
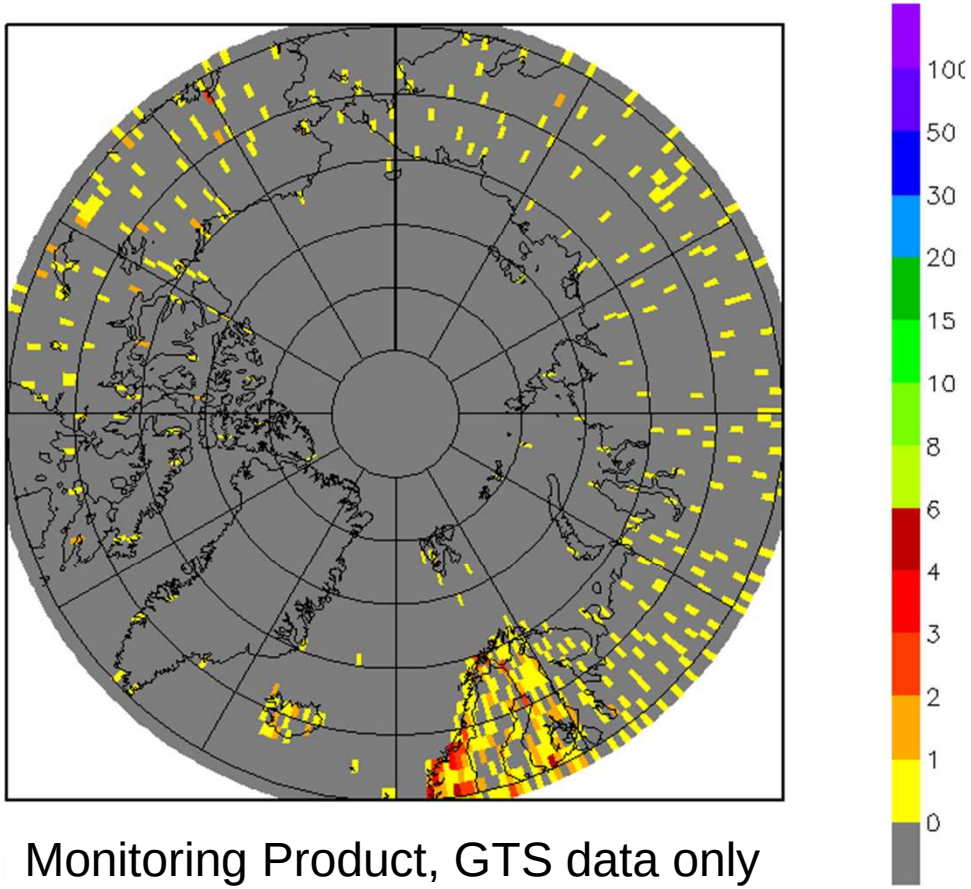
High Latitudes station density is rather desperate!

GPCC Normals Version 2010 1.0 degree
number of stations per grid for year (Jan – Dec)



Climatology with offline data

GPCC Monitoring Product Gauge–Based Analysis 1.0 degree
number of stations per grid for year (Jan – Dec) 2010



Monitoring Product, GTS data only

Systematic gauge measuring error

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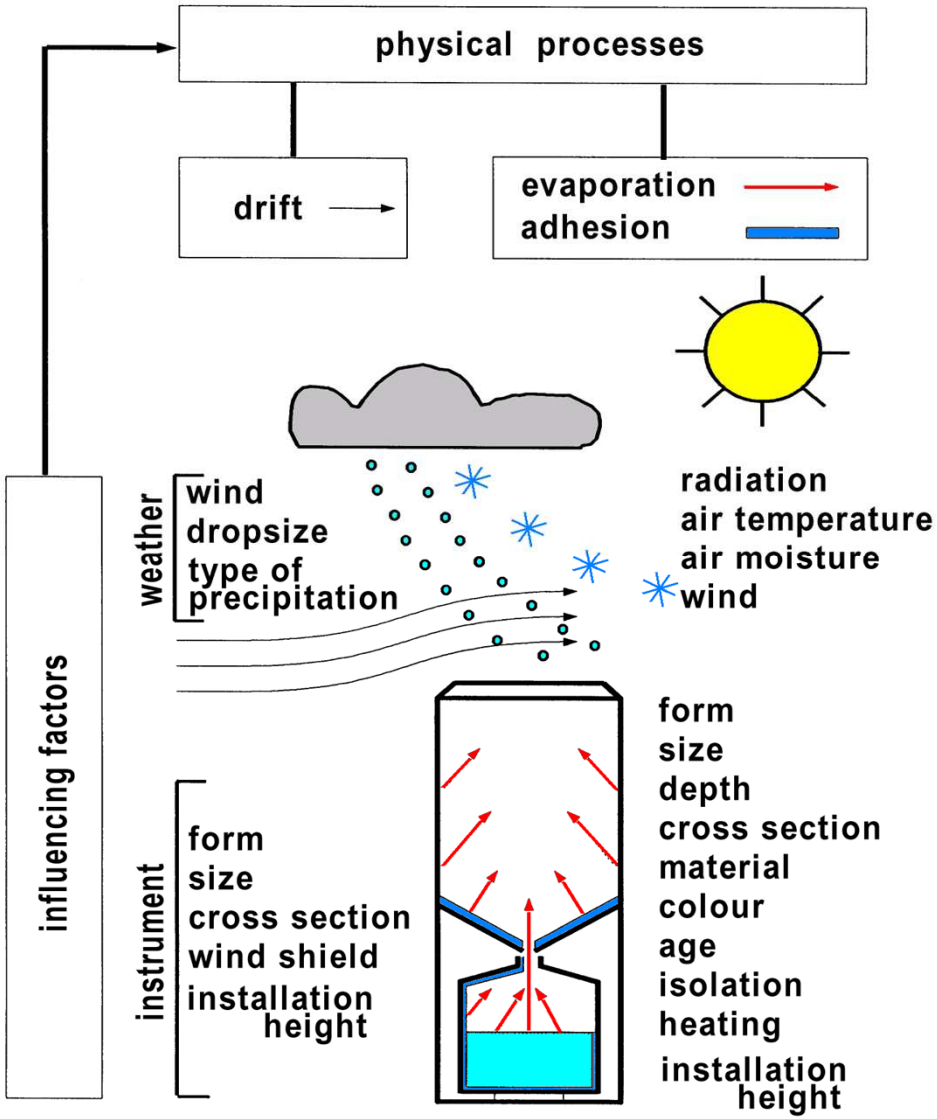
Wetter und Klima aus einer Hand



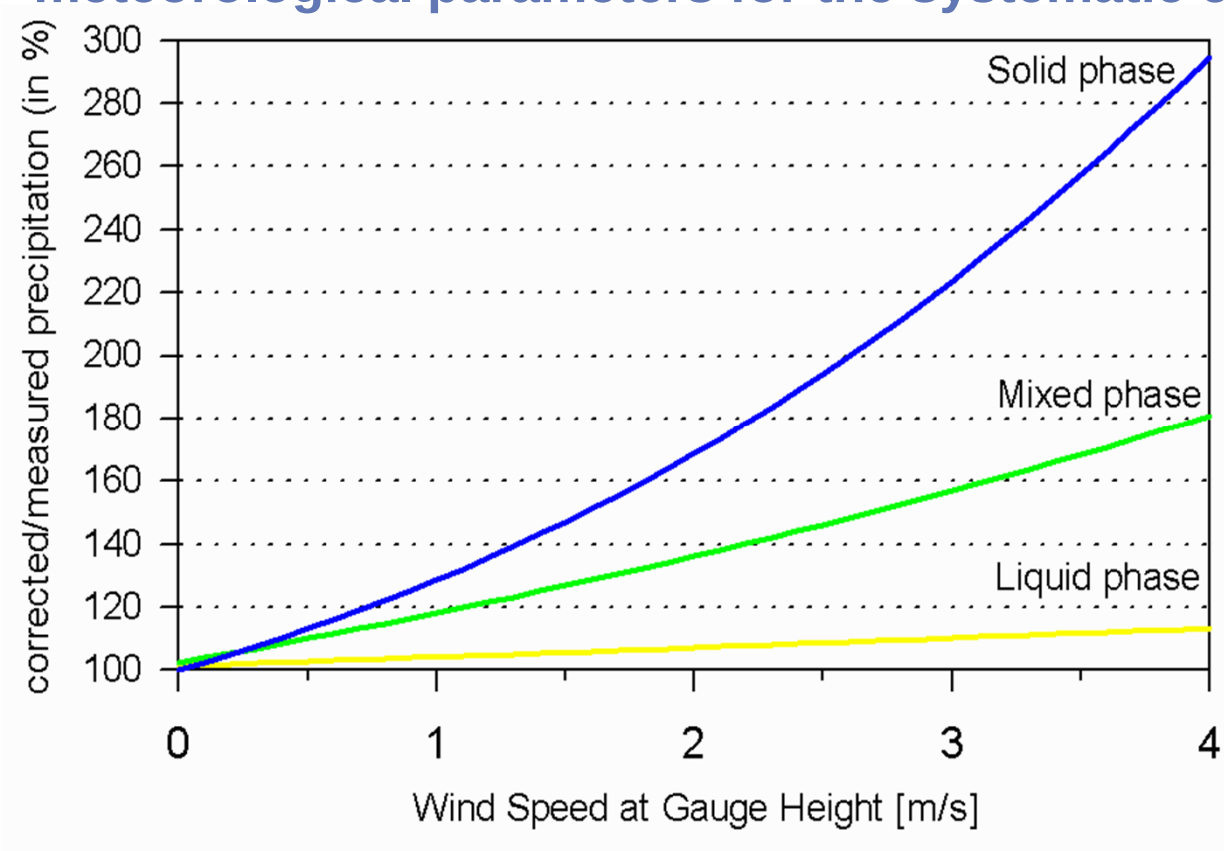
Precipitation measured by gauges is systematically underestimated because of evaporation, wetting losses and drift of snow and drops by wind across the gauge funnel.

In order to get reliable global or regional precipitation amounts, an adequate correction of the data used or of the product is required.

(Fig. after SEVRUK 1989)

WMO Solid Precipitation Measurement Comparison Study

Precipitation phase and wind speed are the most important meteorological parameters for the systematic error

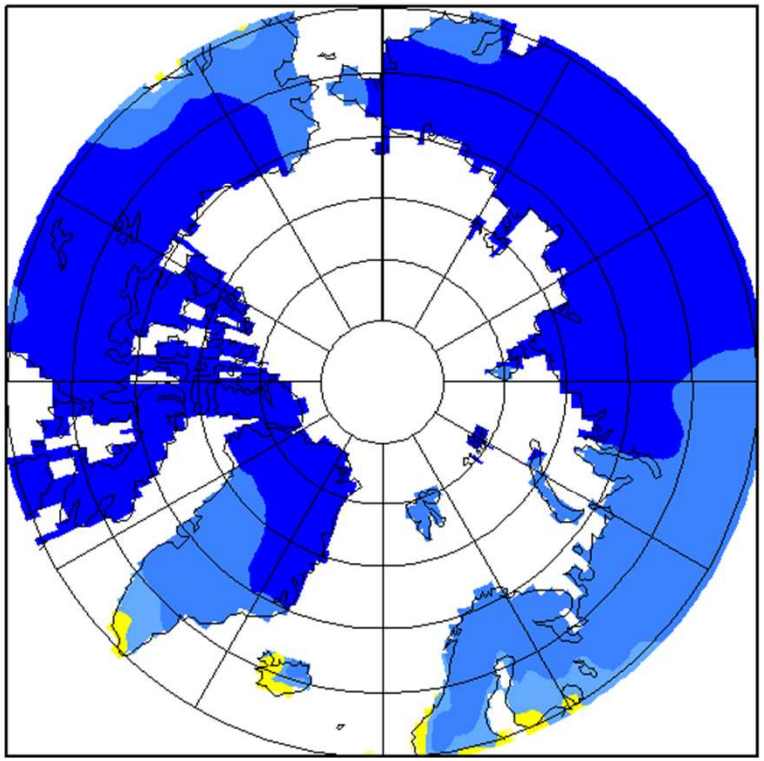


The GPCC has developed a method to estimate wind speed, precipitation phase, air temperature and humidity from synoptic data, which are needed to calculate the bias corrections on a daily "on event" basis.

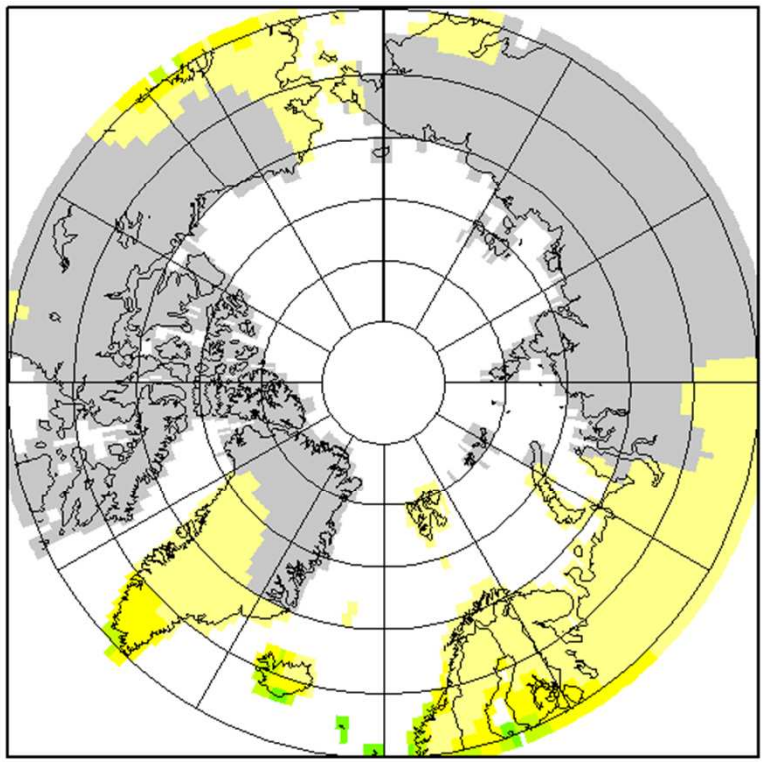
(Figure: T. Günther in Goodison et al, 1998)

Solid / Liquid Precipitation Percentages

GPCC Proportion of solid precipitation 1.0 degree fraction for January 2007 in % per month



GPCC Proportion of liquid precipitation 1.0 degree fraction for January 2007 in % per month



GPCC Monitoring Caps

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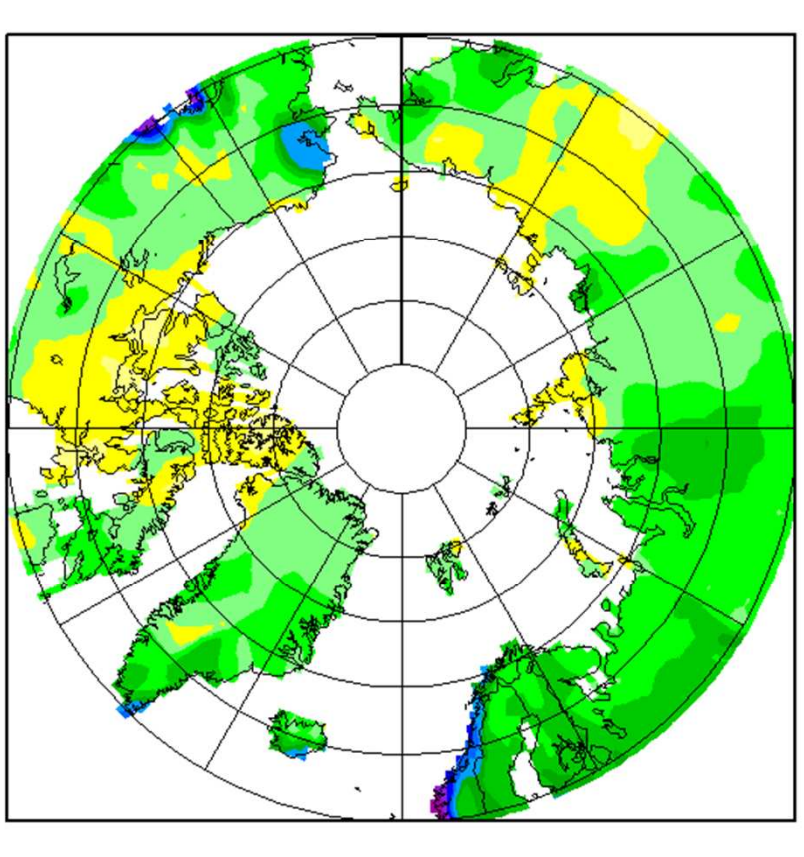
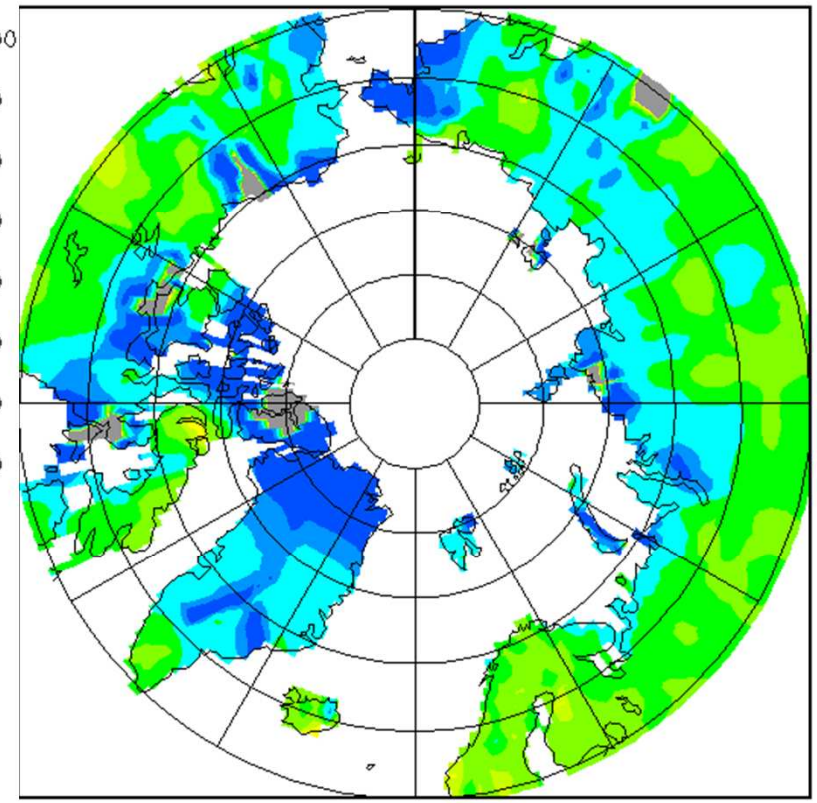
Wetter und Klima aus einer Hand

GPCC Monitoring Product Gauge-Based Analysis 1.0 deg
precipitation for January 2007 in mm/month



1000
800
600
400
300
200
150
100
75
50
25
10
1

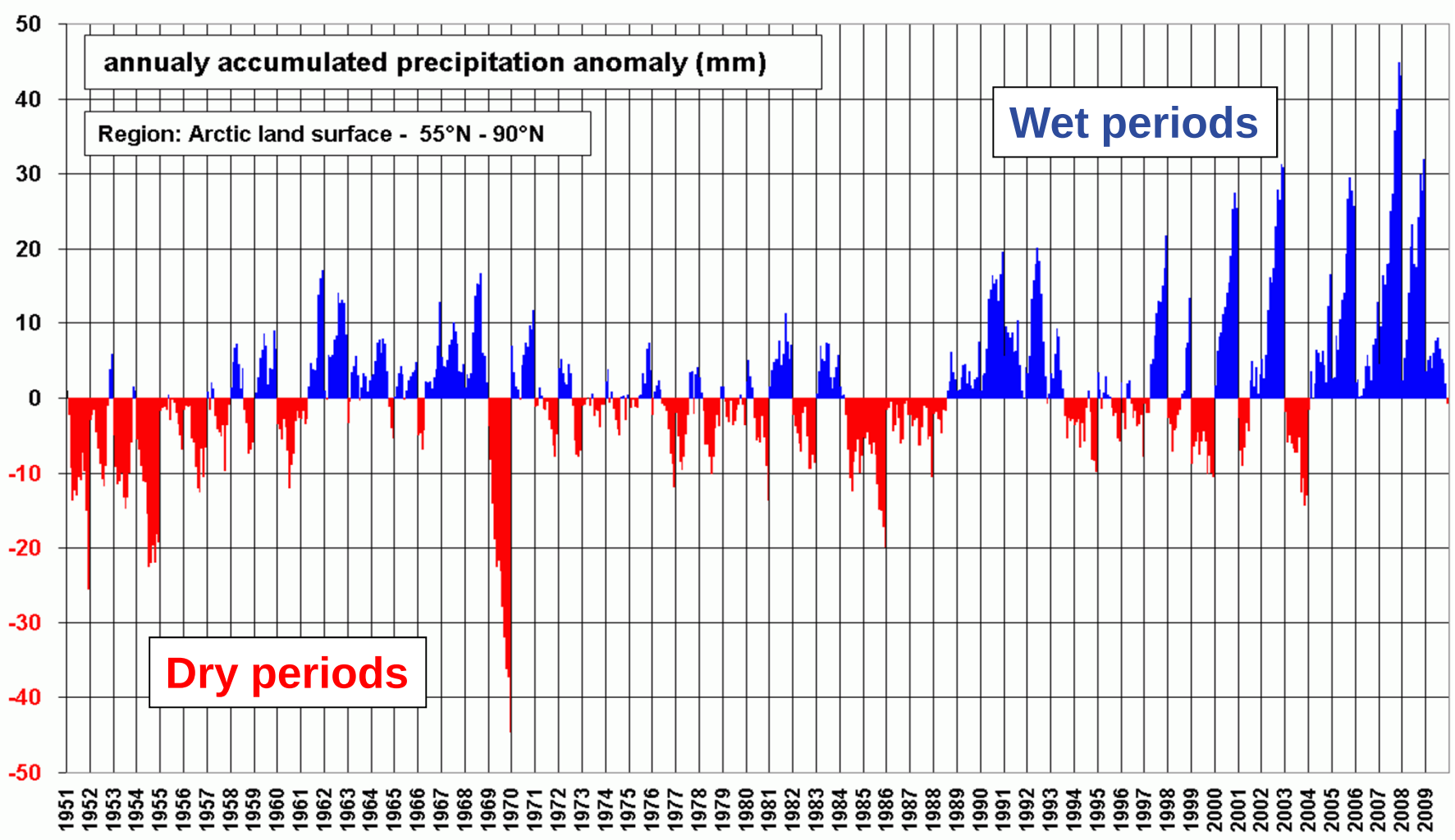
GPCC Relative gauge measuring error 1.0 degree
for January 2007 in % per month



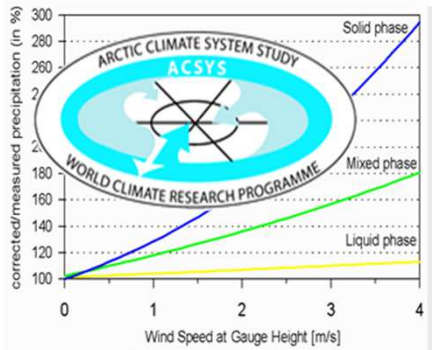
200
150
100
50
25
10
5
0

(c) GPCC 2011/11/20

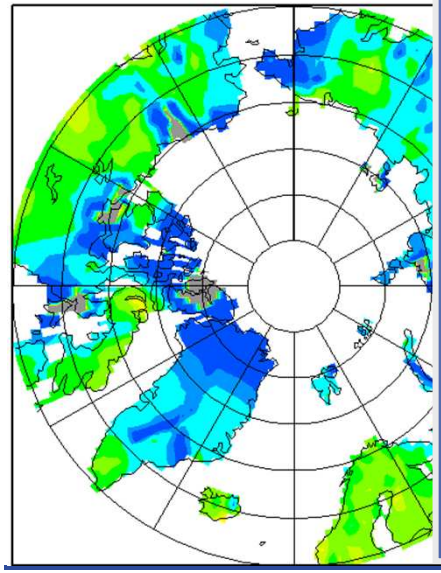
Annualy accumulated precipitation anomaly



Outline



GPCC Relative gauge measuring error for January 2007 in % per r



1 GPCC - Basic Facts

2 GPCC - Latest Achievements and Products

3 GPCC - Arctic View

4 **GPCCs role with GCW**

GPCC/DWDs potential contributions to GCW

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

- **Provision of RA VI RCC Data:** Range 10W, 50E, 70N, 35S via WebWerdis Web Interface http://werdis.dwd.de/werdis/start_js_JSP.do. This functionality will migrate to GISC as part of WIGOS

- **Gridded number of snow days and snow depth on a 0.1x0.1 degree grid** derived from SYNOP data, provided by WMO RA VI Regional Climate Centre (RCC) on Climate Monitoring WMO-RA6-RCC-CM

- GPCC can offer **experiences from the ACSYS-APDA** project and should be available for cross-comparison of arctic precipitation measurements. However, **GPCC has currently no additional DWD in-house resources for further studies**. Efforts of this kind would need to watch out for soft money to fund extra project posts.

- GPCC would like to join in **development and validation of time variable systematic error** correction functions if that is of interest to other partners

- **Sharing GPCCs orignal precipitation data is problematic**, as GPCC cannot claim the copyright on the data from its suppliers. However GPCC is open to solutions that would not require to give away the data, e.g. by hosting experts

- GPCC would join a **re-examination of the quality and reliability of historic solid precipitation measurements**

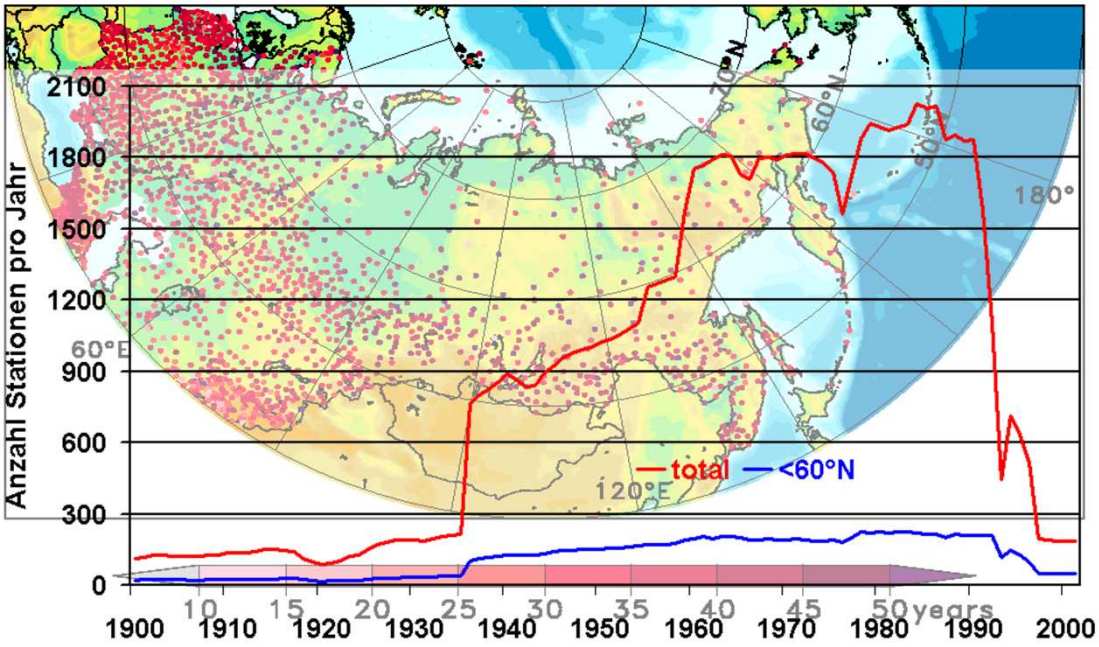
GPCC/DWD wishes from GCW

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

1. To generate **new momentum** for **high altitude data availability**

2. To establish **modern station**

Metadata catalogues. Current Issue: Countries with two little number of station IDs (e.g. Canada) are forced to make too quick re-use of station IDs from suspended stations leading to synchronization issues with WMO documents and GPCCs metadata base.



3. A **reliable watch function** providing **high quality GTS messages on snowfall and snow depth** that allow for early warning on flash floods and calculation of water budgets and river basin specific precipitation to drive or verify runoff models

GPCC/DWD wishes from GCW

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

4. A **reliable watch function on sea ice and icebergs** in order to consult on ship routing, our forecasters would benefit from sea-ice data at a high update frequency and for the parameters

- Concentration
- Thickness
- Type of Ice-Edge
- Drift-Velocity of Icebergs
- Type of Ice

Overall a well updated watch on Iceberg occurrences to assess their potential hazards to navigation and marine safety

5. **GCW to serve a platform** for exchange on recent developments with regard to in-situ and remotely sensed solid precipitation including automated gauges and radar based dual pol. Technologies

Thank you very much!

Also for fresh data!

World Meteorological Organization
Organisation météorologique mondiale

Secrétariat

WMO OMM

TEMPS • CLIMAT • EAU
WEATHER • CLIMATE • WATER

Our ref.: OBS/GCOS/GPCC

GENEVA, 25 July 2011

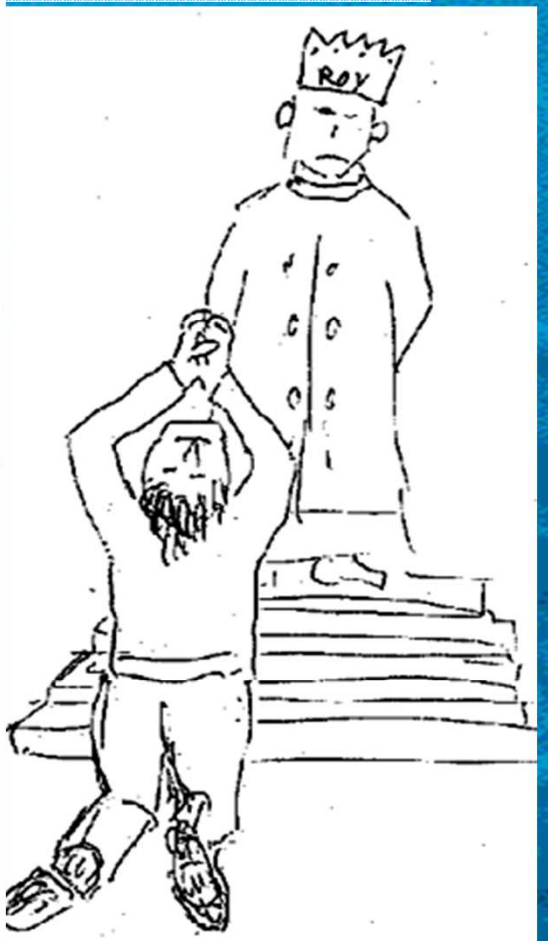
Subject: Supply of daily precipitation data to the Global Precipitation Climatology Centre (GPCC) in support of its extended activities

Dear Sir/Madam,

The regular and timely delivery of precipitation data is a highly important contribution for global climate monitoring and research as reliable assessment, detection and prediction of climate variability and change depend on the availability of good-quality uninterrupted climate data records. Let me therefore express my sincere gratitude to all Members contributing to the Global Precipitation Climatology Centre (GPCC). It is a basic prerequisite, that quality assured essential climate data and products are accessible for users and a concrete step towards the implementation of a Global Framework for Climate Services (GFCS).

Since 1988, the GPCC is operated by the German meteorological service, Deutscher Wetterdienst (DWD), supporting and providing service to the research and operational communities through the provision of high quality observations and analysis of land-surface precipitation based on in-situ rain gauge networks. The GPCC serves international scientific interests related to climate and water cycle monitoring and works under the auspices of WMO in the framework of the Global Climate Observing System (GCOS) and the World Climate Research Programme (WCRP). Its main task is to collect and analyse conventionally observed precipitation, and GPCC products, such as gridded precipitation data on a global and regional [illegible].

I am very pleased to inform you, that so far more than 190 countries worldwide have provided monthly precipitation data to the GPCC. Up to now, precipitation data of more than 80,000 stations have been compiled and analysed and altogether the number of station months in the GPCC database increased by a factor of 5 during the last 10 years.



More Information:

http://gpcc.dwd.de

gpcc@dwd.de