Deutscher Wetterdienst
Wetter und Klima aus einer Hand

GRUAN Data Flow and RS92 Data Product v2

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De Bilt, Netherlands
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Outline

- Overview of GRUAN data flow
- RS92 GRUAN data product
- Quantity and quality statistics
- Examples of quality issues
- Conclusion

GRUAN data flow

- ➔ Collecting raw data and meta-data
  - Using RsLaunchClient or automatic batch-routines
- ➔ Pre-processing
- ➔ Archive
  - File archive and GRUAN Meta Data Base (GMDB)
- ➔ Processing
  - RS92-GDP v2 (+ some additional beta versions)
- ➔ Dissemination
  - at NCDC
- ➔ Monitoring
  - Creation of reports for sites

- ✔ Running at **13** sites
- ✔ Running for **all** radiosonde launches
- ✔ File Archive → ~ 160 GiB
- ✔ GMDB → ~ 2,5 GiB
- ✔ Operational running only for **RS92** launches
- ✔ Only for all **approved** data
- ✔ Running **LC intern**

Collected data of sonde types

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Code	Count	Instrument Name	Manufacturer
RS92-FN	162	Vaisala RS92-FN	Vaisala
RS92-K	49	Vaisala RS92-K	Vaisala
RS92-KL	3,060	Vaisala RS92-KL	Vaisala
RS92-SGP	15,308	Vaisala RS92-SGP	Vaisala
RS92-SGPA	1,152	Vaisala RS92-SGPA	Vaisala
RS92-SGPD	1,813	Vaisala RS92-SGPD	Vaisala
RS92-SGPL	1,521	Vaisala RS92-SGPL	Vaisala
RS92-SGPW	603	Vaisala RS92-SGPW	Vaisala
DFM-06	26	Graw DFM-06	GRAW Radiosondes GmbH & Co. KG
DFM-09	63	Graw DFM-09	GRAW Radiosondes GmbH & Co. KG
DFM-97	1	Graw DFM-97	GRAW Radiosondes GmbH & Co. KG
IMET-1	94	iMET-1	InterMet Systems (US)
IMET-1-EE	3	iMET-1 (E+E)	InterMet Systems (US)
IMET-1-H	17	iMET-1 (Humirel)	InterMet Systems (US)
LMS6	11	Sippican LMS6	Lockheed Martin Sippican, Inc.
RS-06G	20	Meisei RS-06G GPS Radiosonde	Meisei Electric Co., Ltd.
RS2-91	115	Meisei RS2-91 Radiosonde	Meisei Electric Co., Ltd.
RS80	34	Vaisala RS80	Vaisala
RS80-15	28	Vaisala RS80-15	Vaisala
RS90-FN	54	Vaisala RS90-FN	Vaisala
SRS-C34	15	MeteoLabor SRS-C34	MeteoLabor
ECC-ENSCI	1	EnSci ECC ozone module	EN-SCI Corporation
ENSCI-Z	210	ECC EnSci-Z	EN-SCI Corporation
SPC-6a	205	Science Pump ECC SPC-6a	Science Pump Corporation
CFH-IMET	89	Cryogenic Frostpoint Hygrometer	
CFH-RS80	26	Cryogenic Frostpoint Hygrometer	
FPH	12	Frost Point Hygrometer	
SW-D	10	SnowWhite Day	MeteoLabor
COBALD	44	Compact Optical Backscatter Aero	ETH Zürich
FLASH-B	7	Flash B	Central Aerological Observatory
MTR-C10	12	Meisei Temperature Reference (ta	Meisei Electric Co., Ltd.
MTR-08S	8	MTR Sensor 08 (none transmitter	Meisei Electric Co., Ltd.
RRD100	10	Vaisala Humidity Reference Sens	Vaisala
RR01-C10	12	Vaisala Reference Radiosonde 1 (	Vaisala
1-UNKNOWN	4	unknown radioactivity sonde	
3THERM-LMS6	11	Three Thermistor Radiosonde (3T	Lockheed Martin Sippican, Inc.

Vaisala RS92

Various routine radiosondes

Ozone sondes

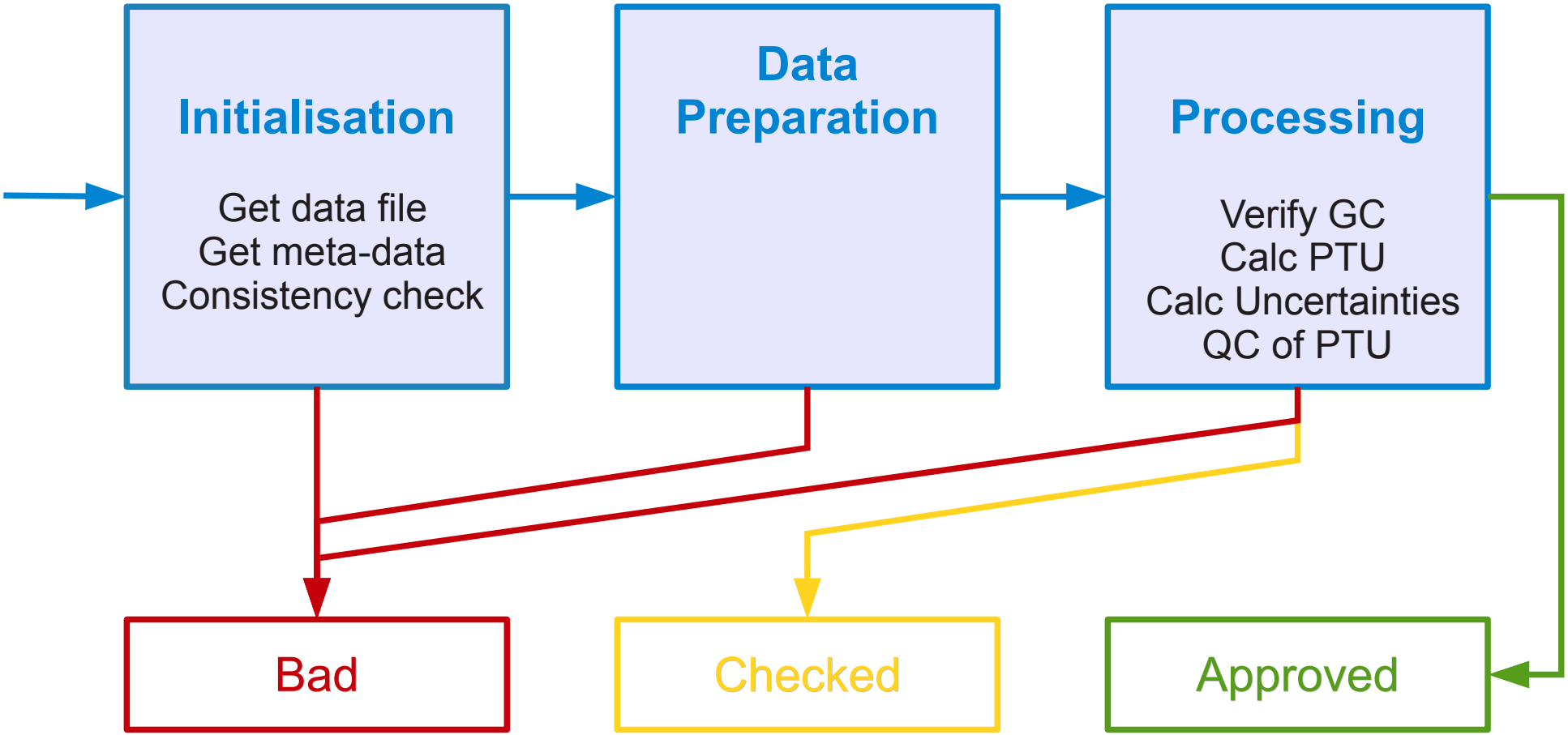
Frostpoint hygrometer

Other special sensors/sondes

RS92 GRUAN Data Product

- RS92-GDP Version 2
  - Second release version of first GRUAN data product
  - Processing started in August 2012
  - All archived RS92 launches are re-processed
- Documentation
  - GRUAN website → www.gruan.org/data
  - GRUAN-TD-4, v1.1 (2011-12-07) – Brief Description of RS92-GDP
  - Peer-reviewed article → writing in progress
- Dissemination at NCDC
  - ftp://ftp.ncdc.noaa.gov/pub/data/gruan/level2/RS92-GDP/version-**002**
- Distribution for GRUAN internal purposes at DWD
  - Please contact the Lead Centre

Processing of RS92 data



Radiosonde launches (with RS92)

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Station	2006	2007	2008	2009	2010	2011	2012	2013	Scheduling	Year's Quota
Barrow				705	710	661	808	80	2 / day	***730***
Boulder						18	39	2	1 / week	***52***
Cabauw						722	717	55	2 / day	***60***
Lamont (SGP)				1409	1398	1463	1426	163	4 / day	***1460***
Lindenberg	2		10	33	1399	1469	1484	184	4 / day	***1460***
Manus						1261	1295	33	2 / day	***730***
Nauru						661	744	87	2 / day	***730***
Ny-Ålesund						1	266	47	1 / day	***365***
Payerne						11	43		1 / week	***52***
Potenza						31	14	4	1 / week	***52***
Sodankylä					8	728	766	7	2 / day	***730***
Tateno				24	91	432	732	93	2 / day	***730***
Summary	***2***		***10***	***2171***	***3606***	***7458***	***8334***	***755***		

Total RS launches: 22,302

Collected launches 2012 (with RS92)
Stored raw data and meta-data

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Month's Quota
Barrow	61	66	62	52	58	57	73	69	85	87	73	65	***60***
Boulder	4	3	4	5	4	3	3	3	2	4	2	2	***4***
Cabauw	62	58	61	59	61	58	59	61	59	62	58	59	***60***
Lamont	121	113	122	113	122	118	123	124	120	119	111	120	***120***
Lindenberg	124	117	125	121	125	122	124	128	123	128	121	126	***120***
Manus	240	227	240	62	62	59	59	76	62	64	65	79	***60***
Nauru	58	60	64	64	63	61	65	66	64	58	59	62	***60***
Ny-Ålesund				22	32	30	29	31	30	29	31	32	***30***
Payerne		6	4	4	4	5	6	4	2	4	2	2	***4***
Potenza	3						1	3			4	3	***4***
Sodankylä	62	60	61	62	67	65	68	68	64	67	65	57	***60***
Tateno	62	58	62	60	62	60	62	62	61	61	60	62	***60***
Summary	***797***	***768***	***805***	***624***	***660***	***638***	***672***	***695***	***672***	***683***	***651***	***669***	

Total RS launches of 2012: 8,334

RS92-GDP v2
Available at NCDC (only approved)

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Available
Barrow	40	16	49	30	42	39	48	43	40	33	43	45	58.6%
Boulder	2	3	2	0	2	2	1	2	0	3	1	1	48.7%
Cabauw	0	0	0	0	0	0	23	33	32	29	41	27	25.8%
Lamont	95	86	91	78	94	83	98	92	69	99	76	71	72.4%
Lindenberg	87	109	81	77	88	75	84	96	88	109	105	116	75.1%
Manus	25	22	7	3	14	10	8	12	5	6	3	7	9.4%
Nauru	6	10	9	7	9	9	7	9	5	3	4	5	11.2%
Ny-Ålesund				19	29	28	26	27	26	26	30	30	90.6%
Payerne		2	2	2	1	0	5	2	1	1	1	1	41.9%
Potenza	2						1	2			2	3	71.4%
Sodankylä	39	32	44	41	48	41	46	31	42	28	30	27	58.6%
Tateno	46	38	40	38	42	26	25	37	42	44	41	43	63.1%
Summary	***342***	***318***	***325***	***295***	***369***	***313***	***372***	***386***	***350***	***381***	***377***	***376***	

Available RS92 launches of 2012: 4,204 → 50.4 %

Result status – 2012

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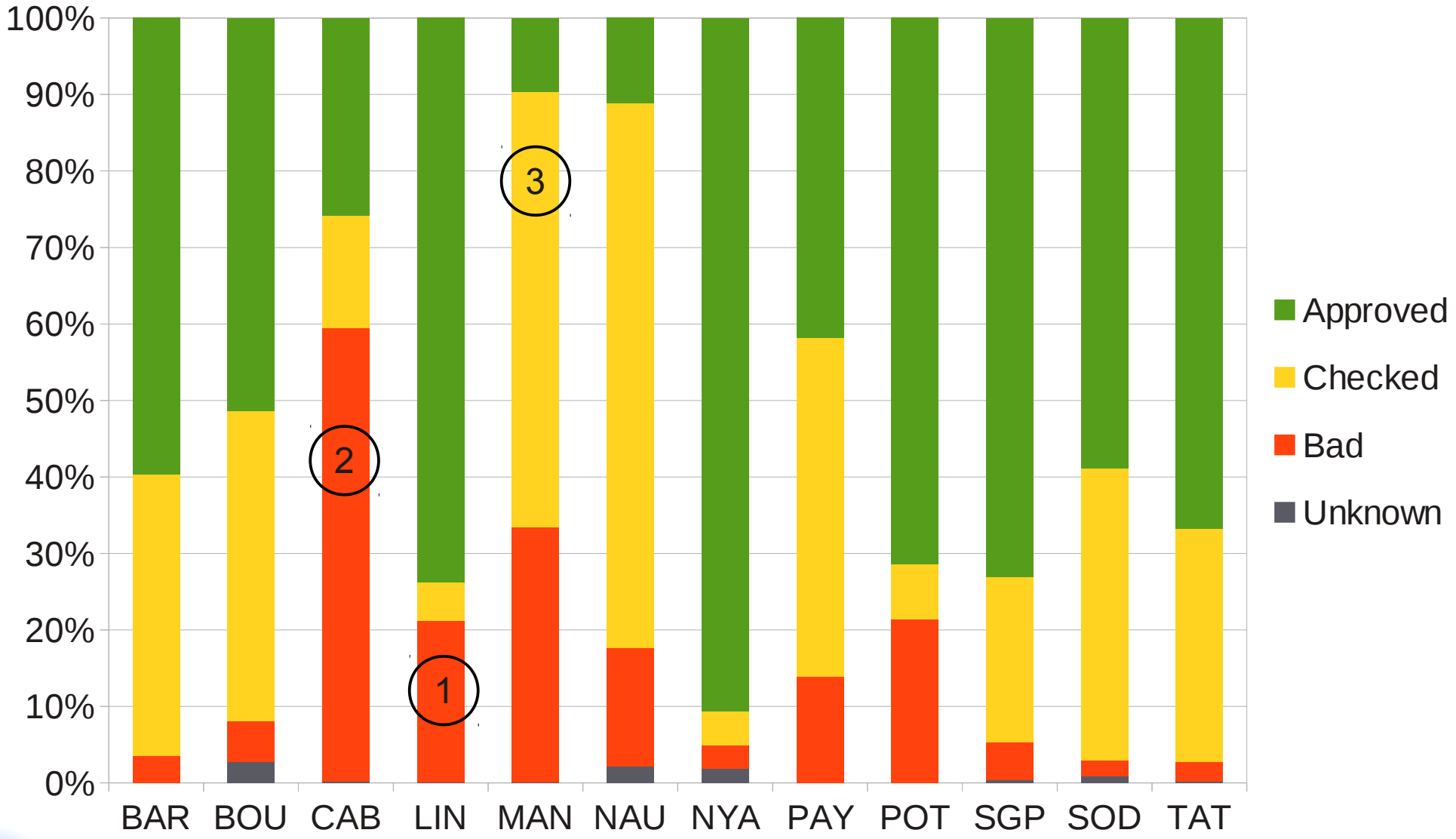

Quality example 1 – Lindenberg

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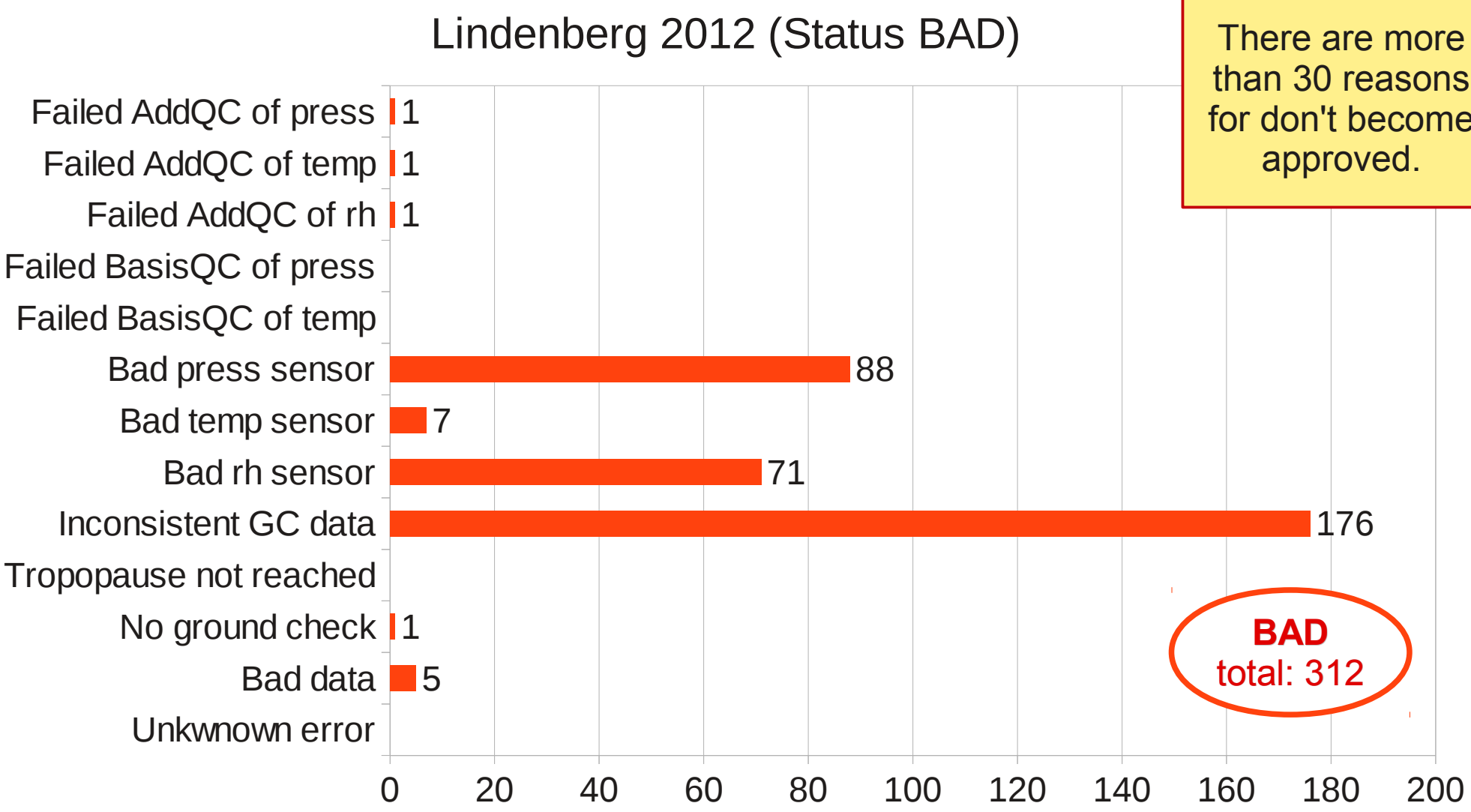

There are more than 30 reasons for don't become approved.

Lindenberg – 2

- **Bad pressure sensor** → Why?
  - Too large correction: $p_{correction}$ > 1.5 hPa
  - Is it a real calibration issue?
- **Bad RH sensor** → Why?
  - Inconsistent meta-data
- Reason
  - Manual fill in of SHC data
  - Swap two values: T + RH
- Solution
  - Improved RsLaunchClient
  - Automatical logging of additional ground check data (SHC)

Quality example 2 – Cabauw (De Bilt)

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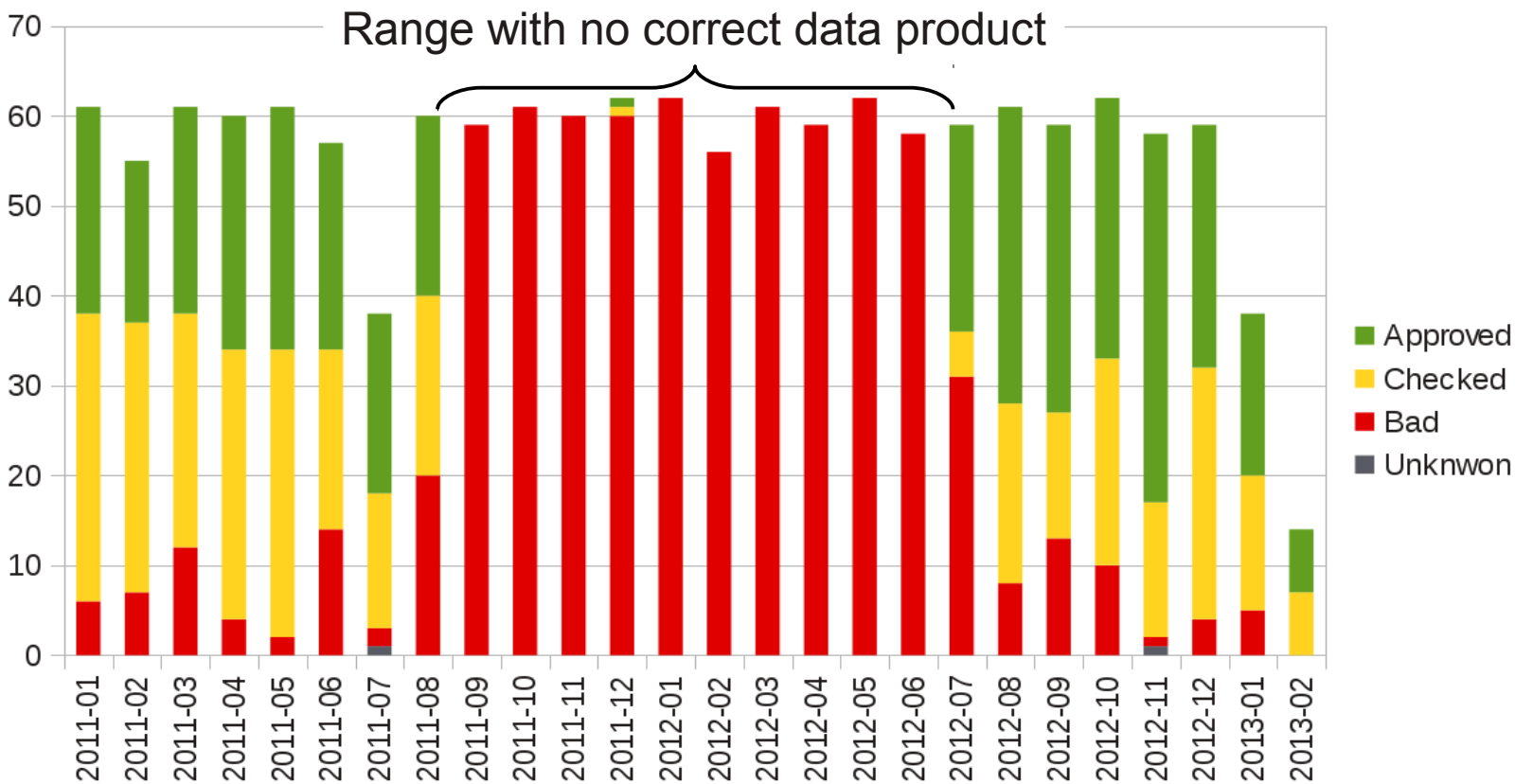

➔ Reason

- Inconsistent meta-data
- Corrupt data file (**DC3DB**)
- Bug in DC3 configuration

➔ Solution

- Repaired at site
- Version 2 can not handle it
- Future version → YES

Quality example 3 – Manus

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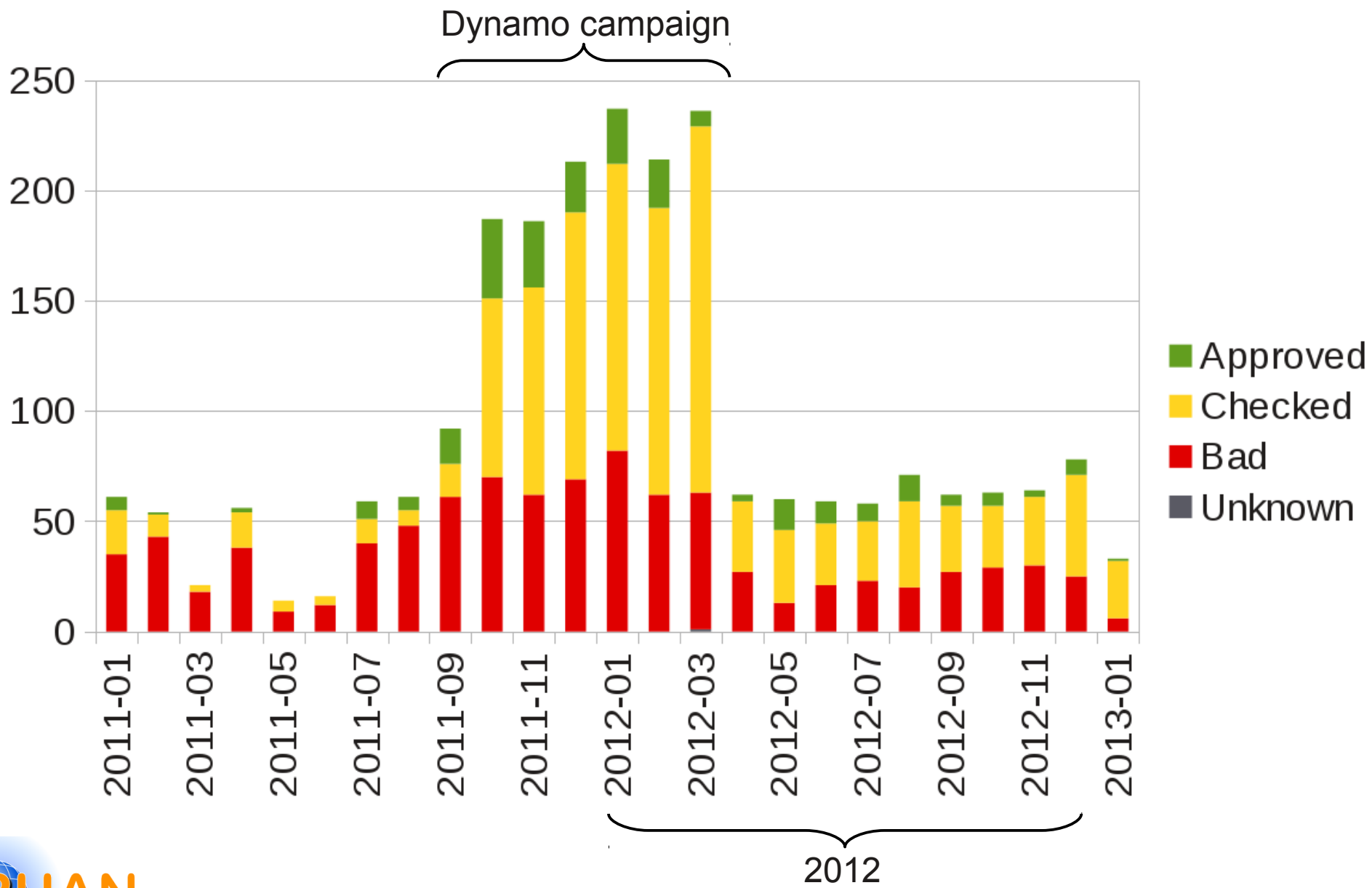

Manus – Reasons of quality issues

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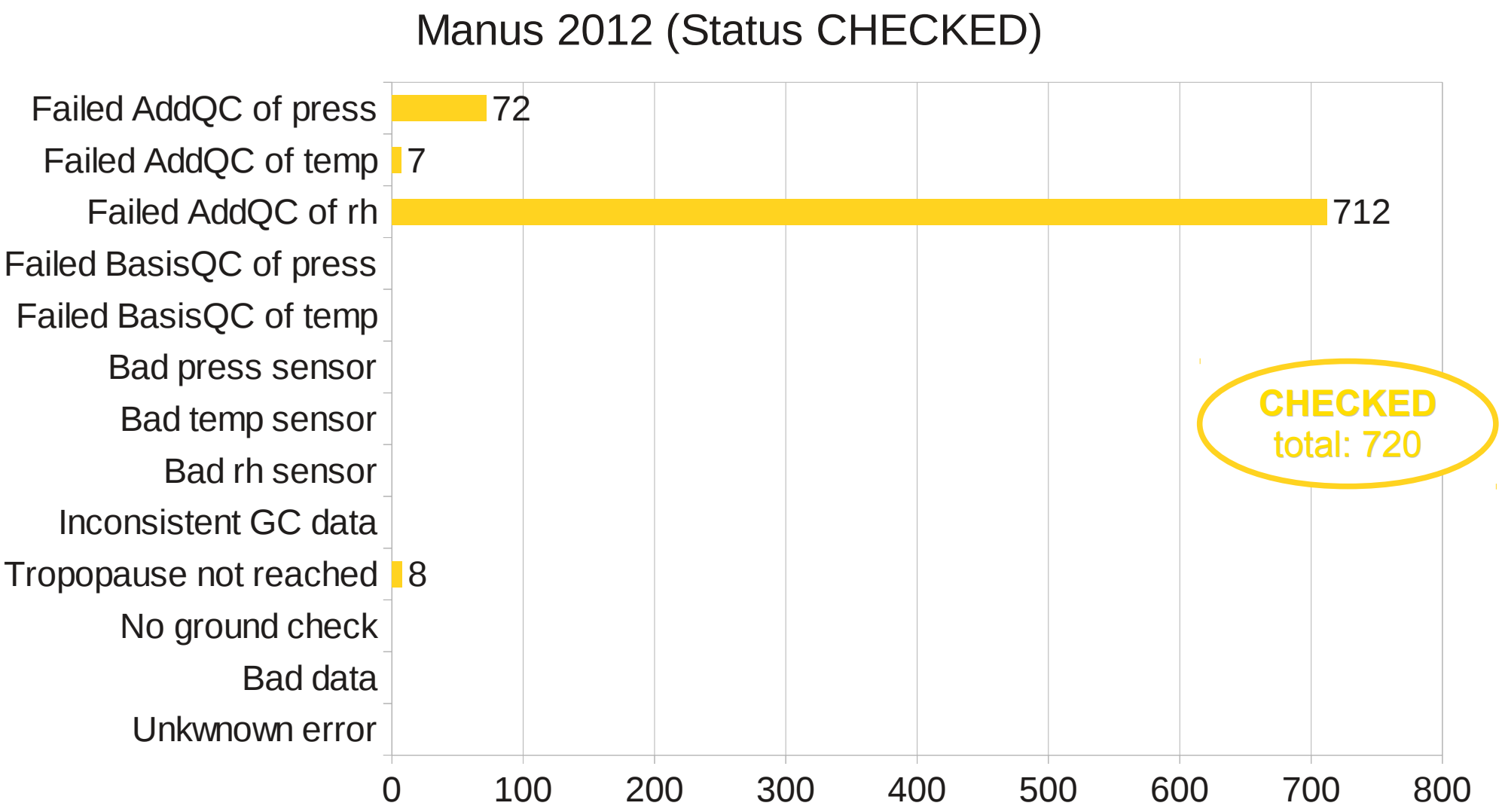
Wetter und Klima aus einer Hand



Manus – Reasons of quality issues

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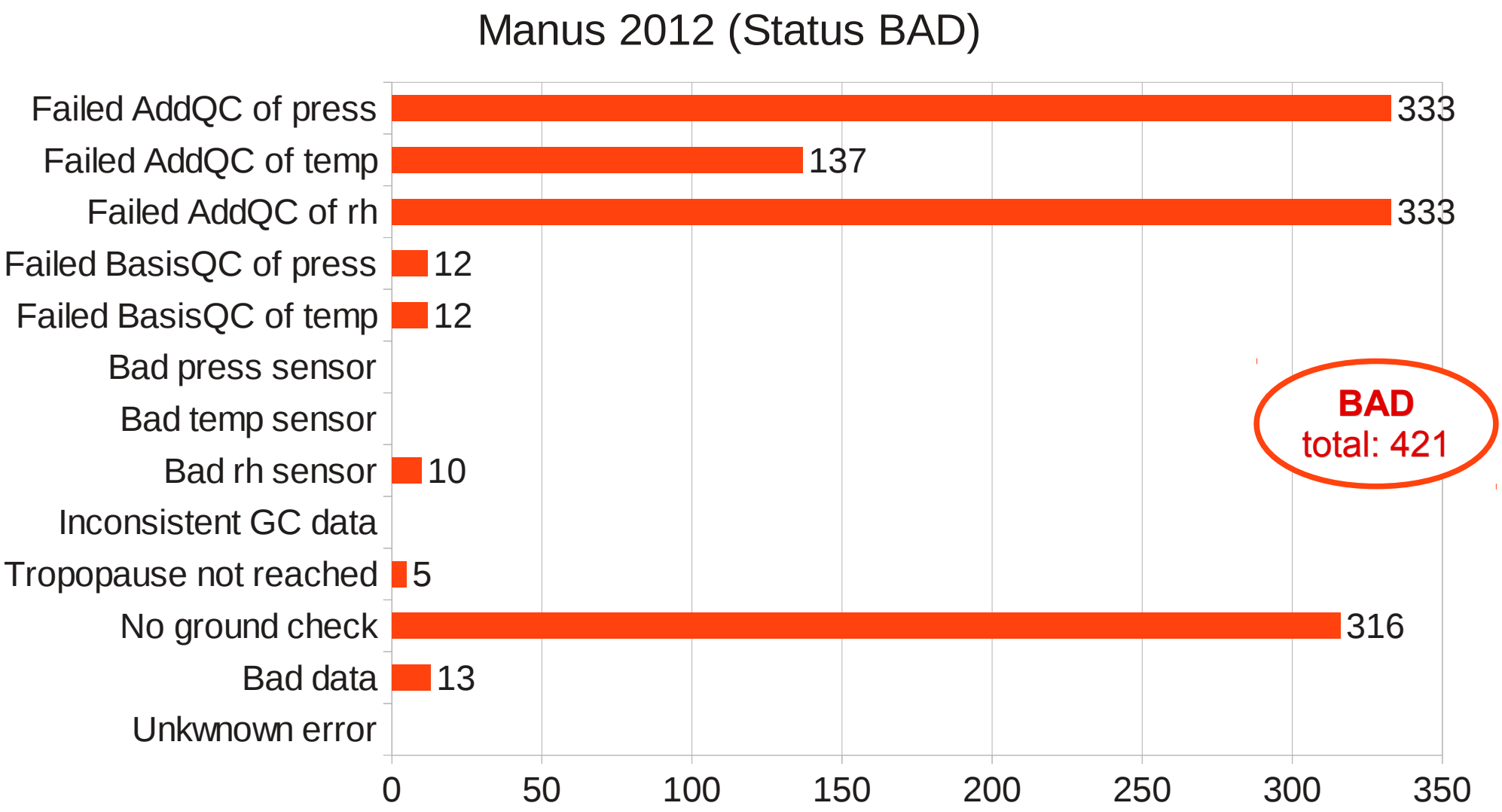
Wetter und Klima aus einer Hand



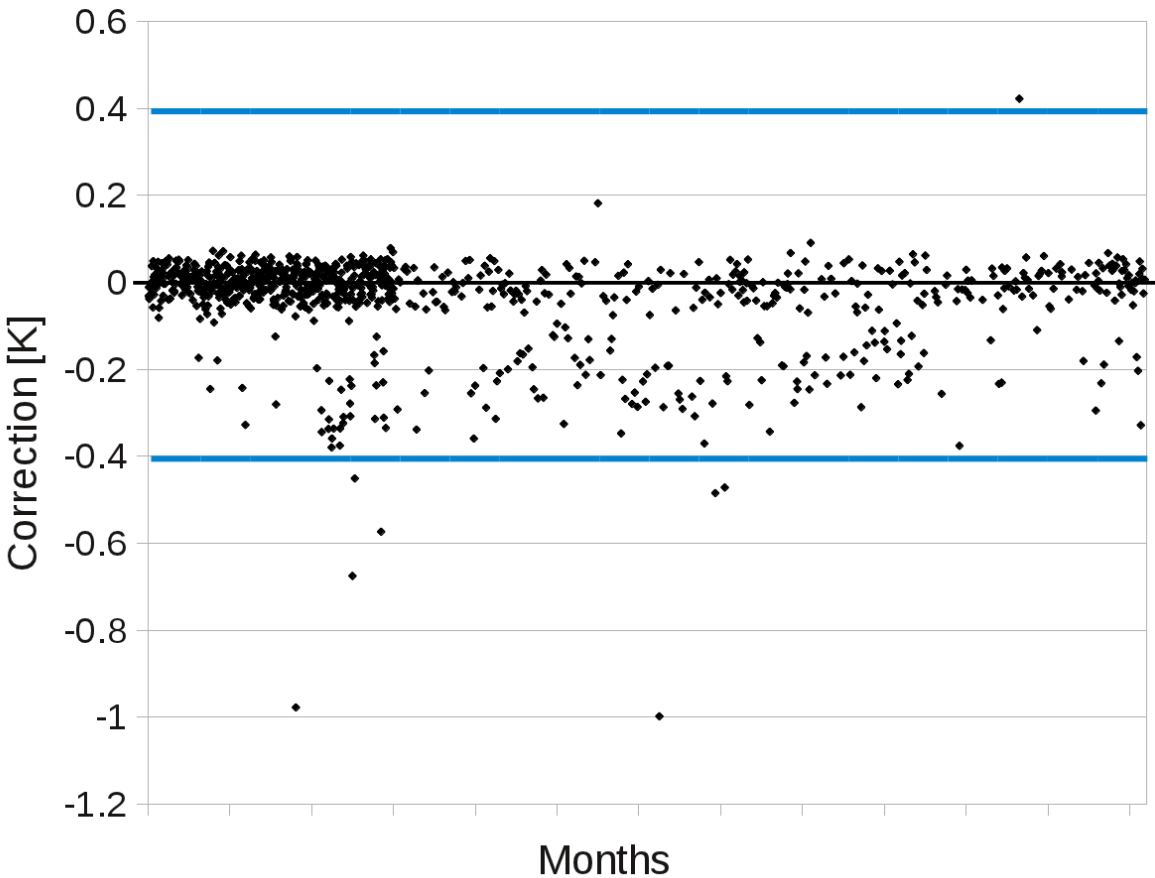
Often detected data quality issues

➔ Missing ground checks	Checked	1
➔ Additional quality checks not passed	Checked	3
➔ Bad sensors (RH, T, p, GPS)	Bad	2
➔ Inconsistent meta-data	Bad	
➔ Corrupt data files	Bad	
➔ 100 hPa is not reached	Bad	

Missing ground check

- GC25 is not a check it is a re-calibration
- No correction → add additional uncertainties

Pressure [hPa]	1.5
Temperature [K]	0.4
Relative Humidity [%]	4.0



Temperature corrections from GC25 (Manus 2012)

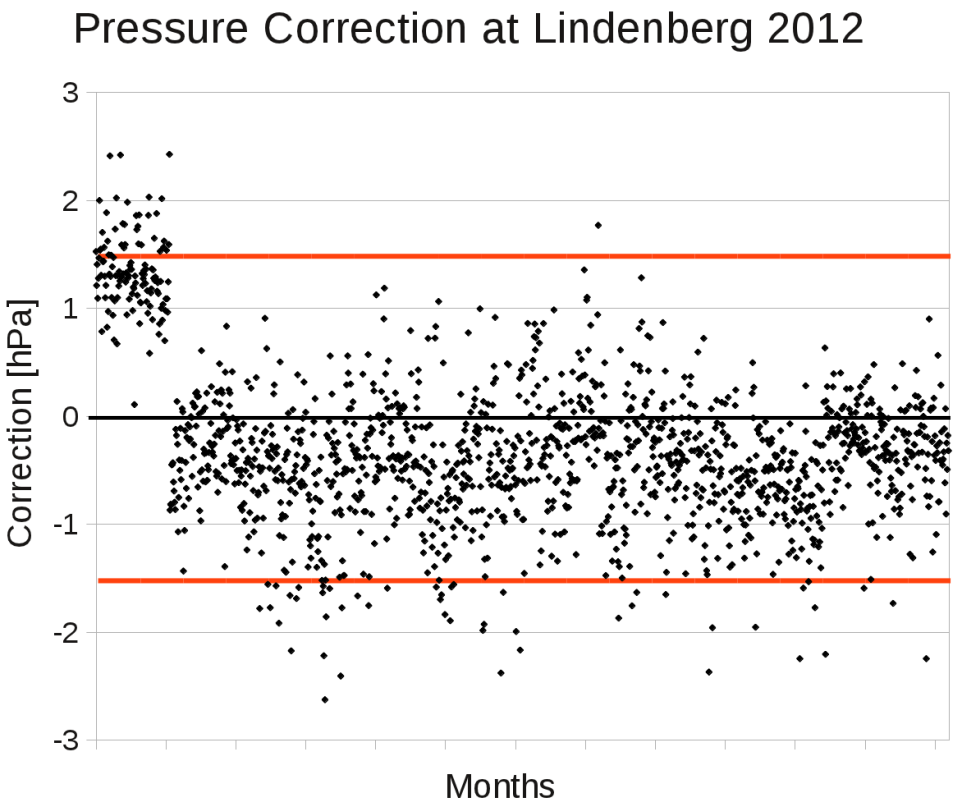
Bad sensors

- Detect bad sensors using ground check corrections

abs(*sonde – reference*) > *limit* = ***bad sensor***

- Limits for GC corrections

Variable	Limit
Pressure [hPa]	1.5
Temperature [K]	1.0
Relative Humidity [%]	2.0
Diff. RH (U1 – U2) [%]	1.5



Additional quality checks

- Check, if uncertainty is in the specification from manufacturer

$$\text{count}(U < U_{spec}) / \text{count}(\text{data points}) > 94\%$$

yes → Approved

no → Checked

$$U_{spec,rh} = \text{Limit } U_{abs,rh} + RH_{corrected} * \text{Limit } U_{rel,rh}$$

$$U_{spec,t} = \text{Limit } U_{abs,t}$$

$$U_{spec,p} = \text{Limit } U_{abs,p} + p_{corrected} * \text{Limit } U_{rel,p}$$

- Used limits

	Limit U_{abs}	Limit U_{rel}
RH [1]	0.025 *	0.025
T [K]	0.5 *	–
p [hPa]	0.6 *	0.0004

* Given by manufacturer

Example for relative humidity

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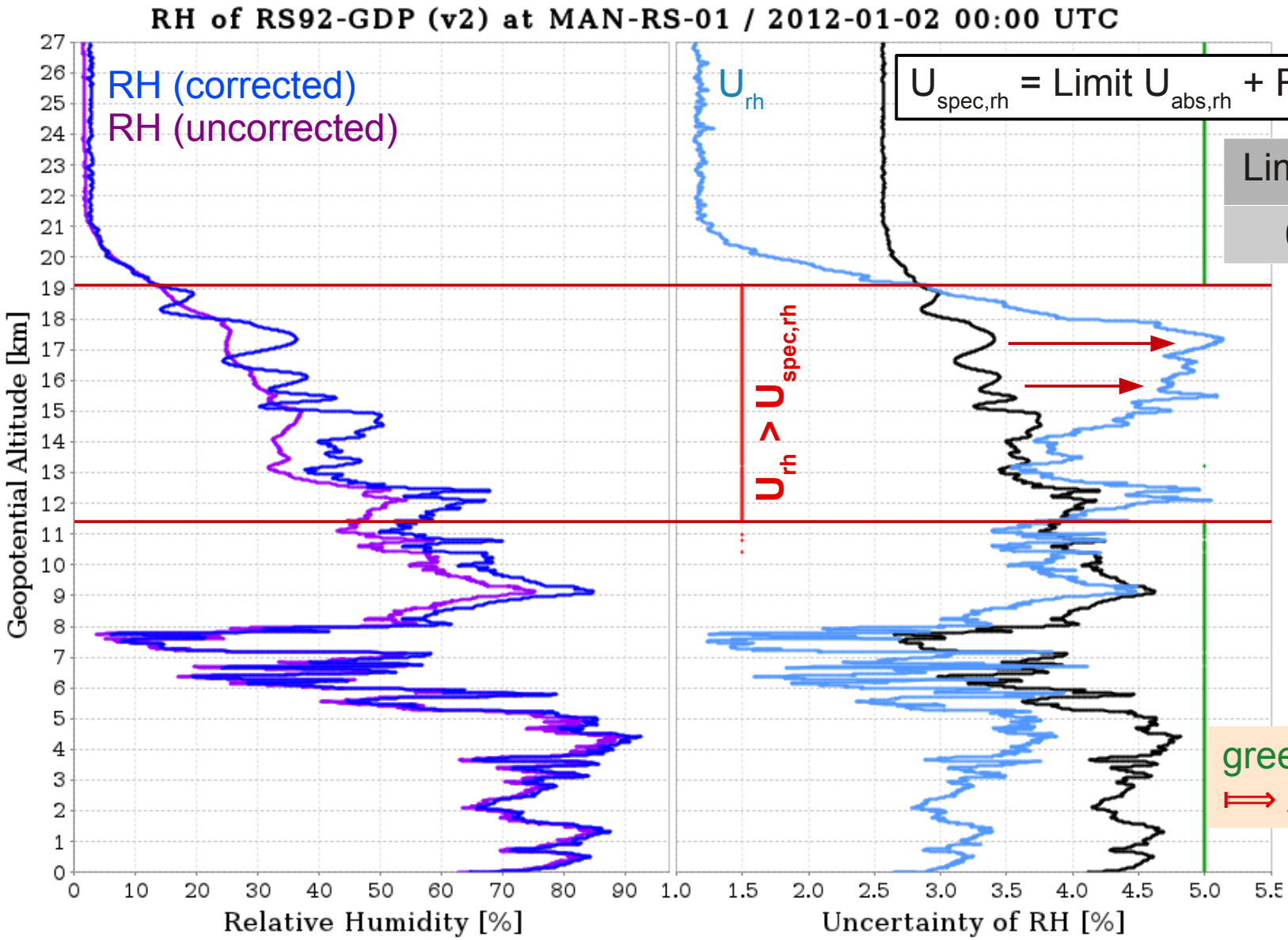

$$U_{spec,rh} = \text{Limit } U_{abs,rh} + RH_{corrected} * \text{Limit } U_{rel,rh}$$

Limit $U_{abs,rh}$	Limit $U_{rel,rh}$
0.025	0.025

green < 94%
⟹ Add-QC not passed

Example for temperature

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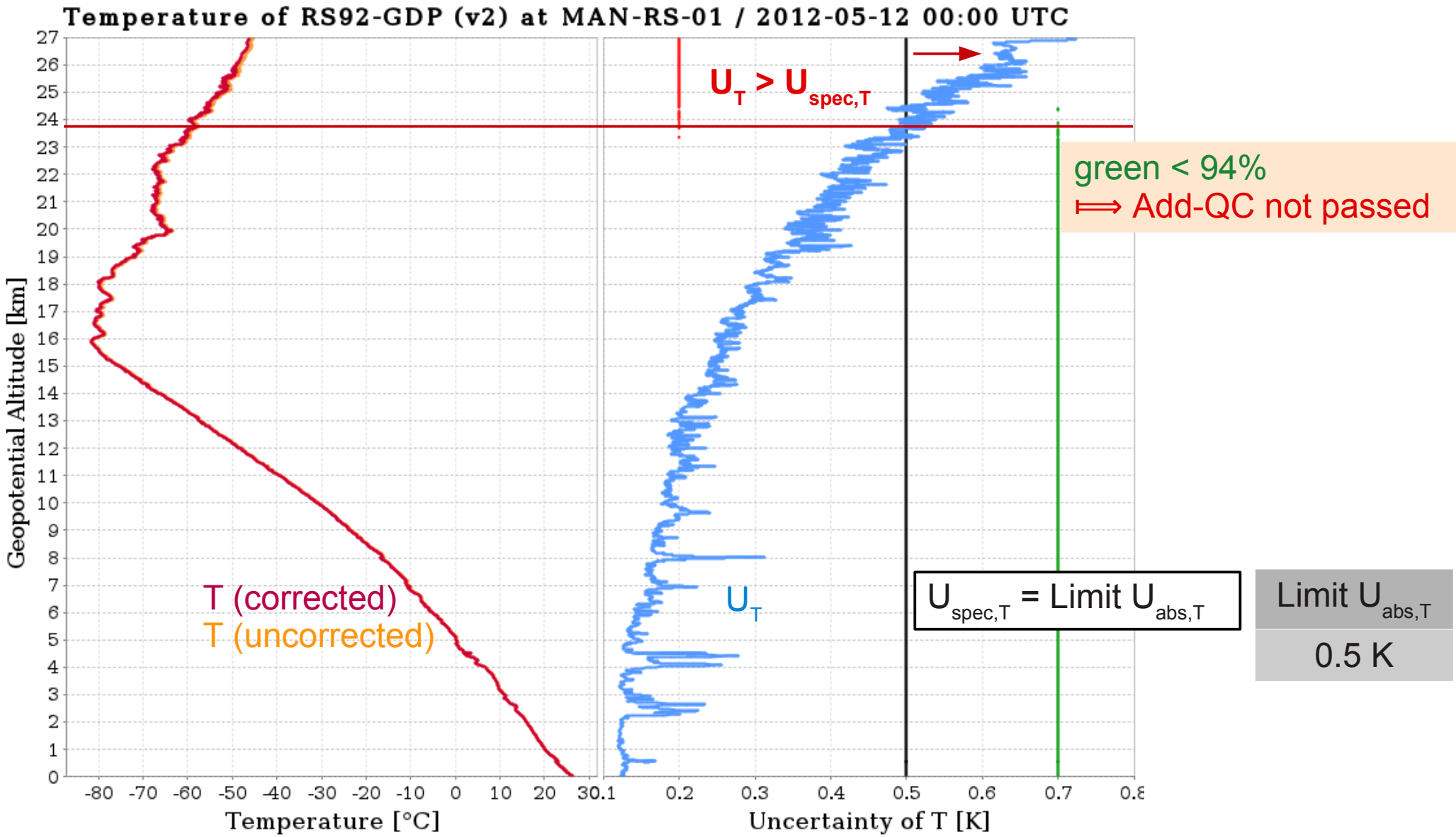
Wetter und Klima aus einer Hand



Example for pressure

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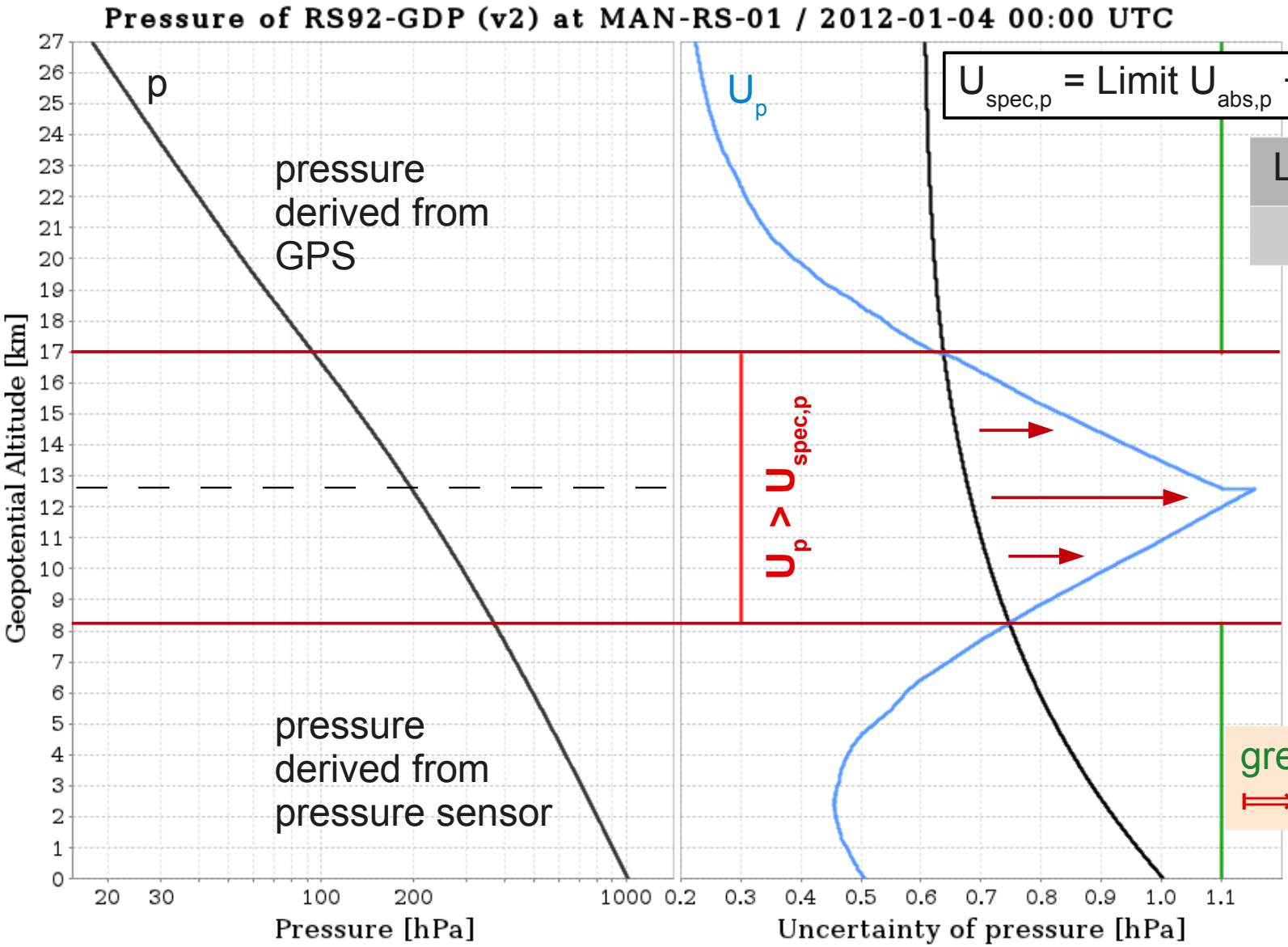

$U_{spec,p}$ = Limit $U_{abs,p}$ + $p_{corrected}$ * Limit $U_{rel,p}$

Limit $U_{abs,p}$	Limit $U_{rel,p}$
0.6 hPa	0.0004

green < 94%
⟹ Add-QC not passed

What have we learnt?

- Sites should have a special attention to meta-data
  - Especially in case of manual fill in
  - Informing LC early enough about changes in instrumentation
- LC should give a (fast) feedback to sites
- Sites should follow the standard procedures → Ground check
- Collecting (and archiving) of RAW data is very important
  - Re-processing is possible and sometimes necessary
- Task for improving the quality checks
- Need more feedback from users of GRUAN data

Conclusion

- Currently data-flow includes **only** radiosounding
  - Large number of launches are stored (raw data + meta-data)
  - Not only RS92
- **Release** version of first GRUAN data product (RS92) is available
  - At moment approx. 50 % of RS92 data is approved → available at NCDC
- Quality monitoring is very important
  - Much to learn for future developments
  - Need feedback from users

Thank you for your attention.