WP 2000: Ground-Based Network

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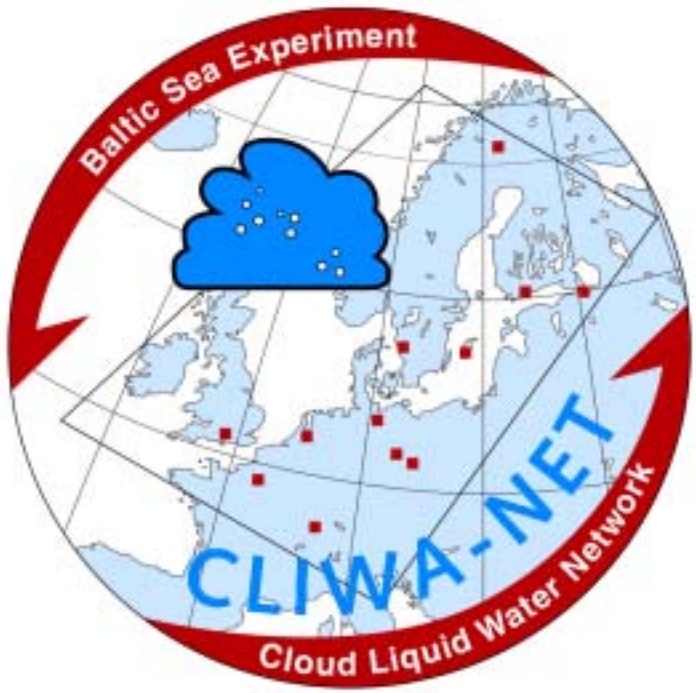
- RAL: Patrick Simpson, Charles Wrench

2001/ 9/11 9:37am

WP 2000: Ground-Based Network

- Instrumentation of CNN I & II
- BBC Campaign
- Products
- Cloud processes
  - diurnal cycle
  - supercooled clouds
- low-cost microwave radiometer



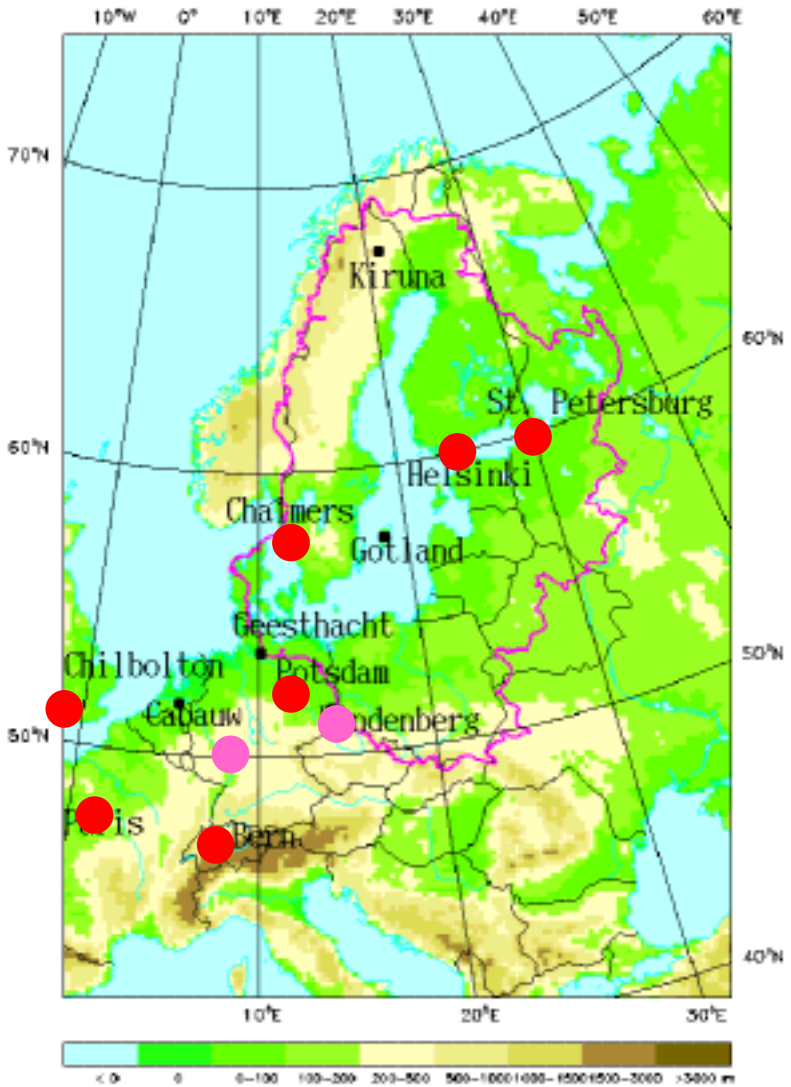
CNN Campaigns

liquid water content of clouds

→ microwave radiometer

2-channel: LWP, IWV

Profiler: temperature,
humidity profiles
LWP



Overview of Measurements CNN I

Station	Microwave	IR-Rad.	Ceilometer	Cloud Radar	BALTRAD
Bern	x				
Cabauw		x	x		
Chilbolton	x	●	x	94 GHz	
Geesthacht	■	■	x	95 GHz	x
Helsinki	x	●	●		x
Kiruna	●	●	●		x
Lindenberg	x	● x	x		x
Onsala	x	●	■		x
Paris	x	●			
Potsdam	x	●	x		x
St. Petersburg	x	●		3, 9.6 GHz	x

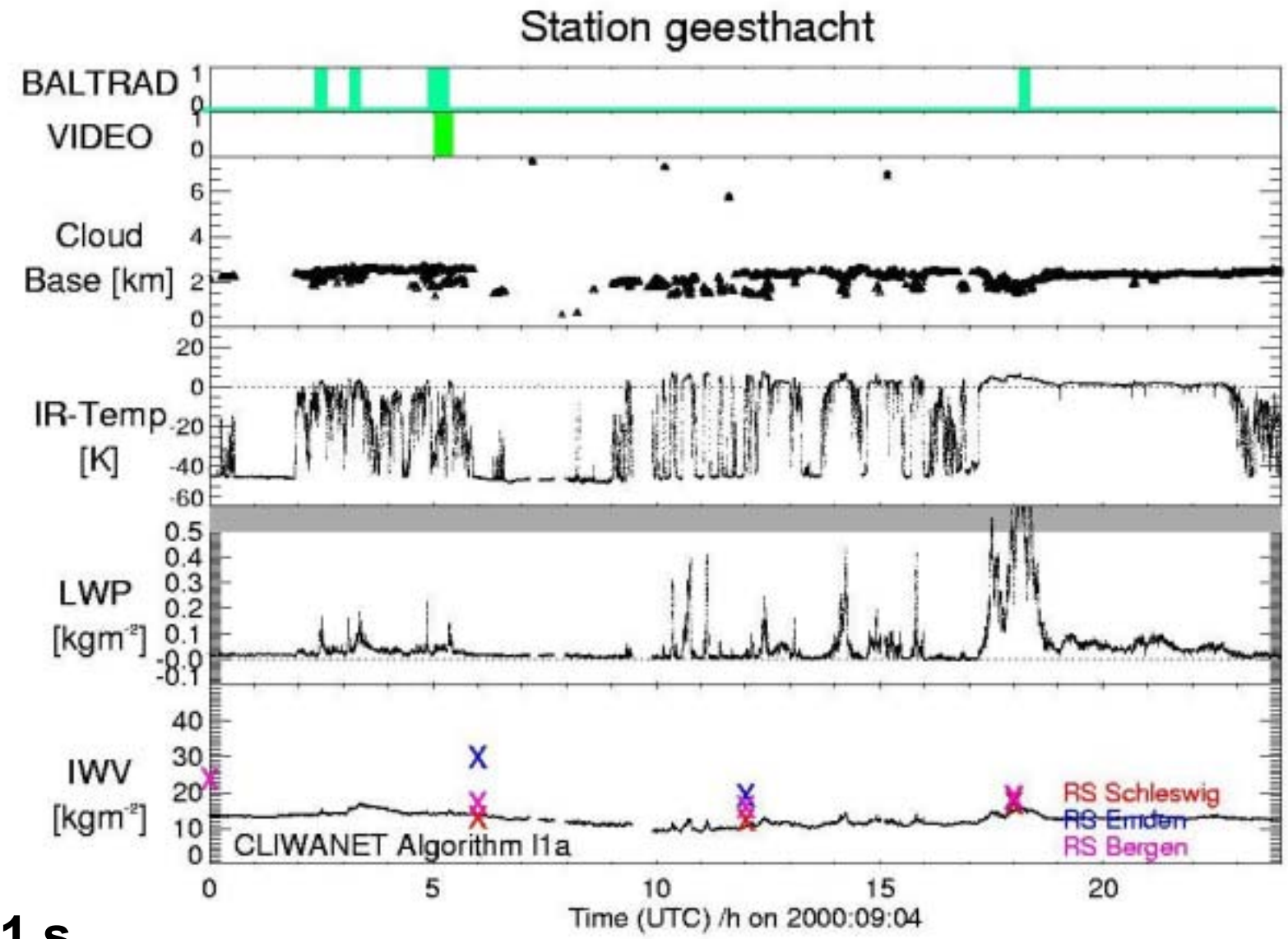
KNMI **MIUB** **Chalmers** **IFM** **Vaisala**

Overview of Measurements CNN II

Station	Microwave	IR-Rad.	Ceilometer	Cloud Radar	BALTRAD
Bern	x	x			
Cabauw	■	x	x	x 3 GHz	
Chilbolton	x	●		94 GHz	
Geesthacht	■		x	95 GHz	x
Gotland	●	●			x
Helsinki	x	●	●		x
Kiruna	●	●	●		x
Lindenberg	x	● x	x		x
Onsala	x	●	■		x
Paris	x	●			
Potsdam	x		x		x
St. Petersburg	x	●		3, 9.6 GHz	x

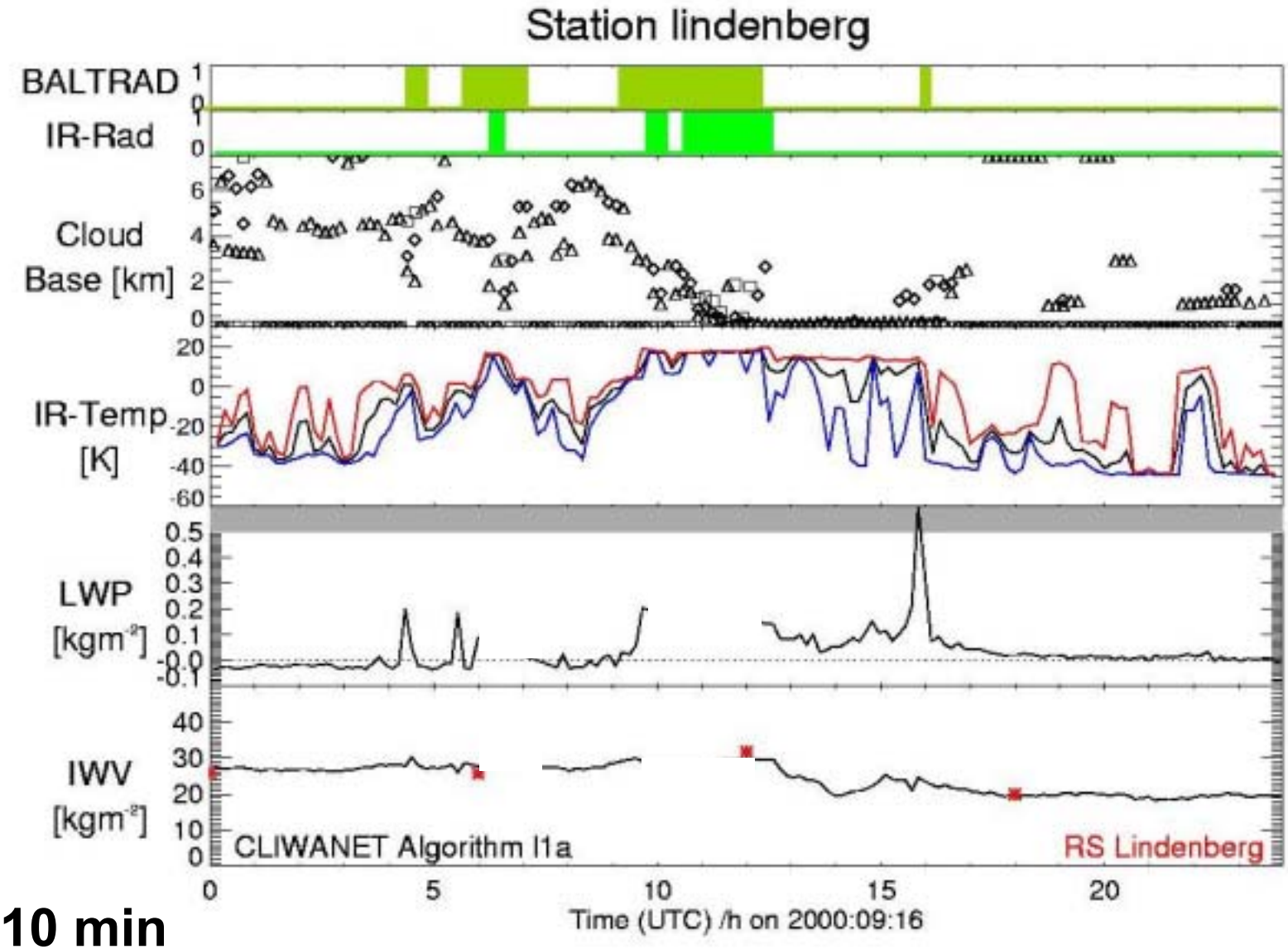
KNMI MIUB Chalmers IFM Vaisala CETP

Example: Time Series Level 1a



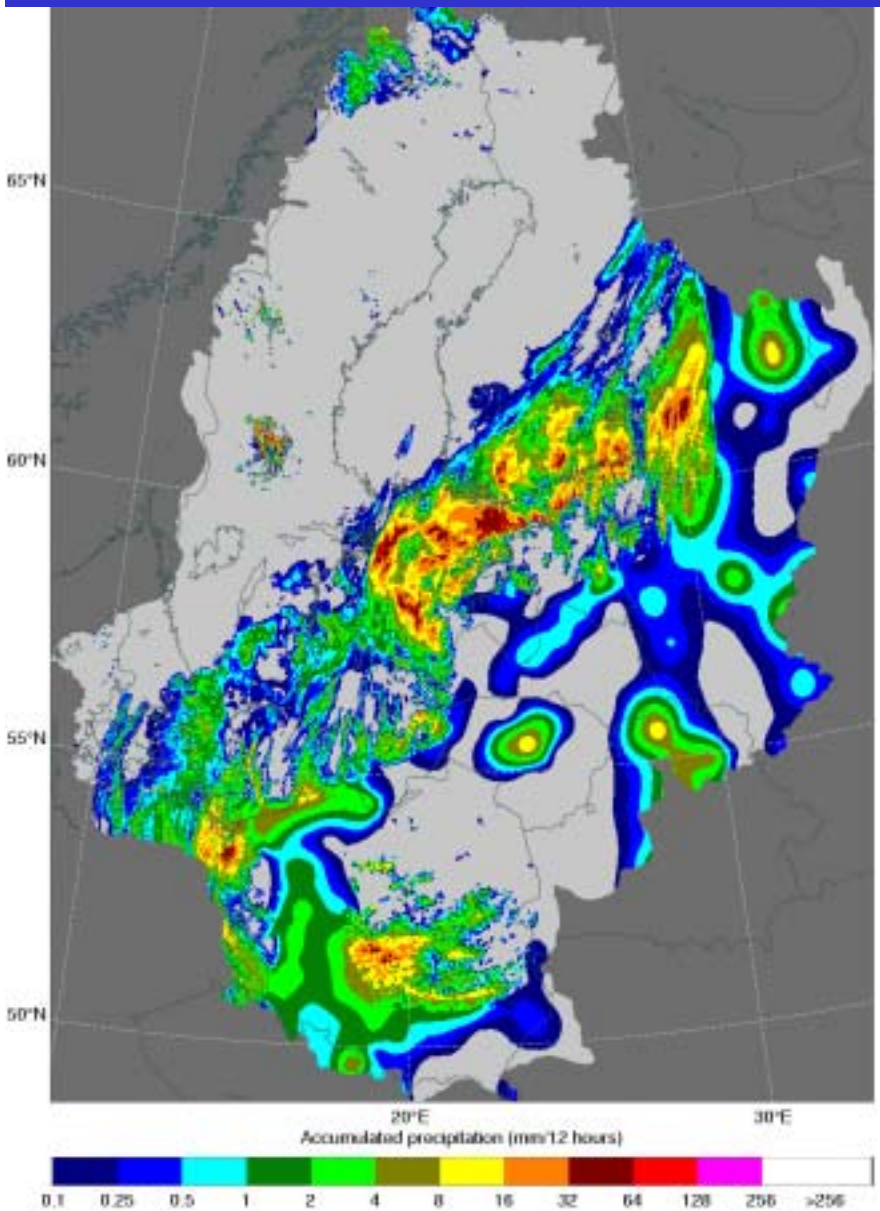
$\Delta t = 1$ s

Example: Time Series Level 1a



$\Delta t \sim 10$ min

BALTRAD: Precipitation Fields



12 h accumulated precipitation

adjusted to rain gauges

3 September 2000 18 UTC

to

4 September 2000 6UTC

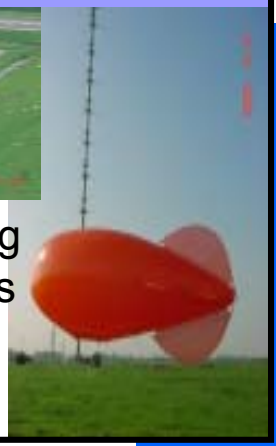
$\Delta x = 2$ km

BBC Campaign

August / September 2001

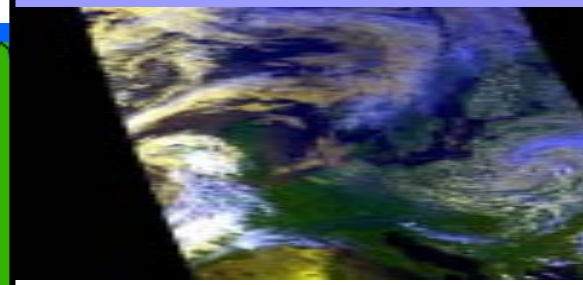
http://www.knmi.nl/samenw/cliwa-net/

Cabauw Site



- remote sensing
- tower, balloons
- surface fluxes

Satellite Measurements



- cloud classification (AVHRR
- LWP (AMSU)

Regional Network

- remote sensing: IR rad., ceilometer, microwave rad.
- radiation

Aircraft Measurements

- cloud microphysics
- radiation

Measurements at Cabauw

MICAM, 1 - 14 August 2001
Microwave Intercomparison Campaign

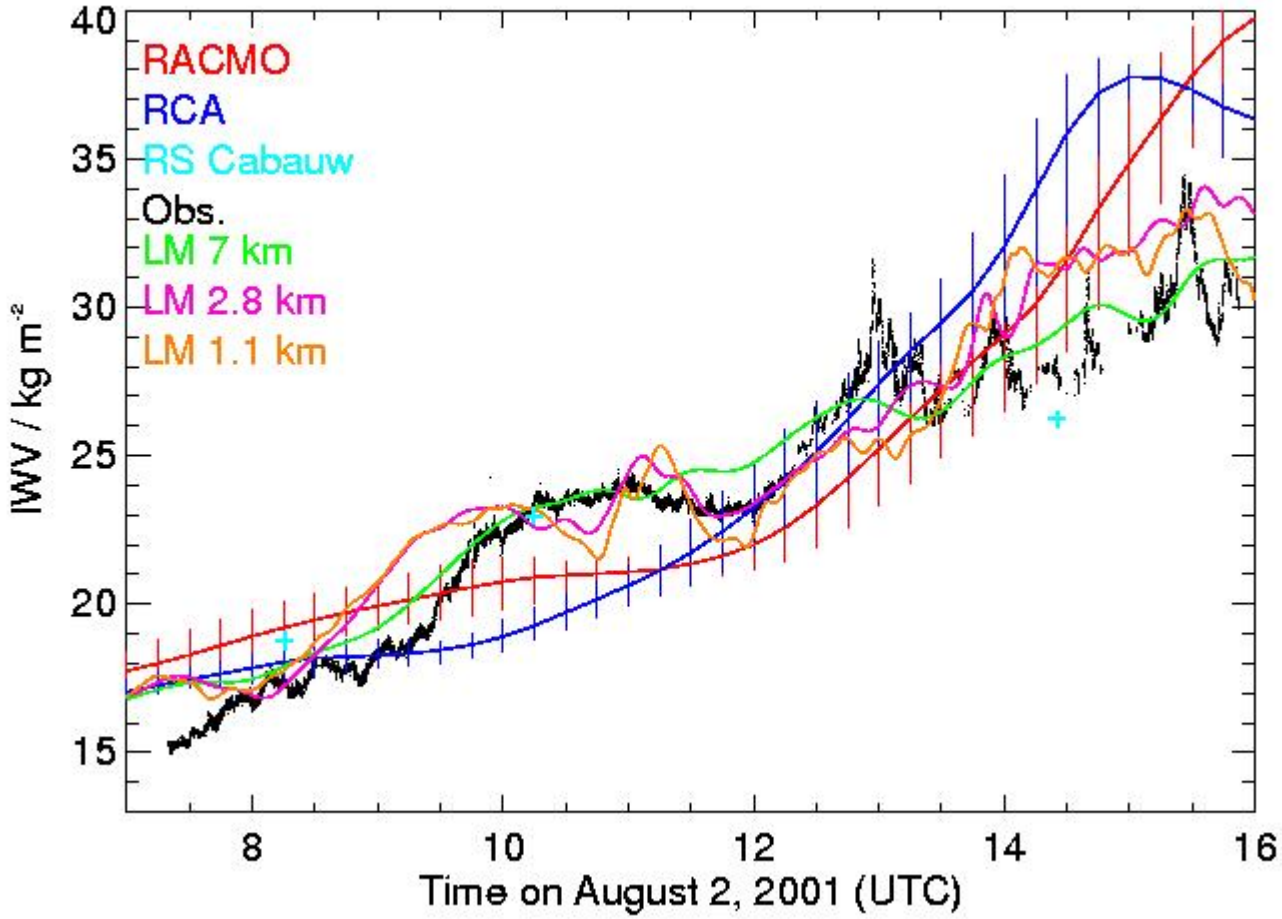
WP 2000: Products

- Time series of raw data — **Level 0**
- Time series of LWP & IWV — **Level 1**
- Time series with consistent time resolution of
  - LWP (cor.)
  - IWV
  - infrared temperature
  - cloud base height
  - precipitation flags

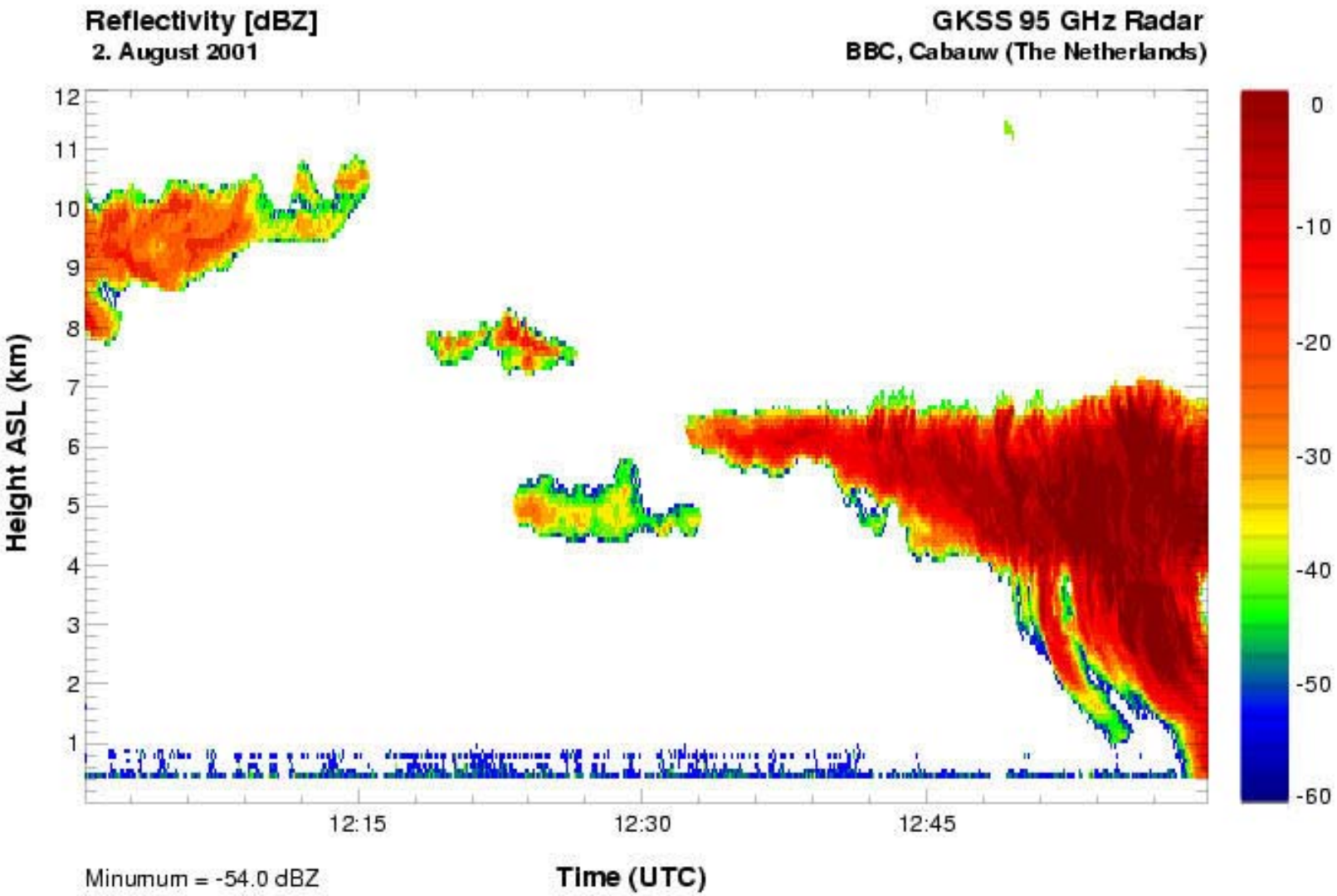
  — **Level 2c**
- Time series of cloud classification
- Time series of LWC, temperature and humidity profiles

  — **BBC**

Cloud Classification: 2 August 2001

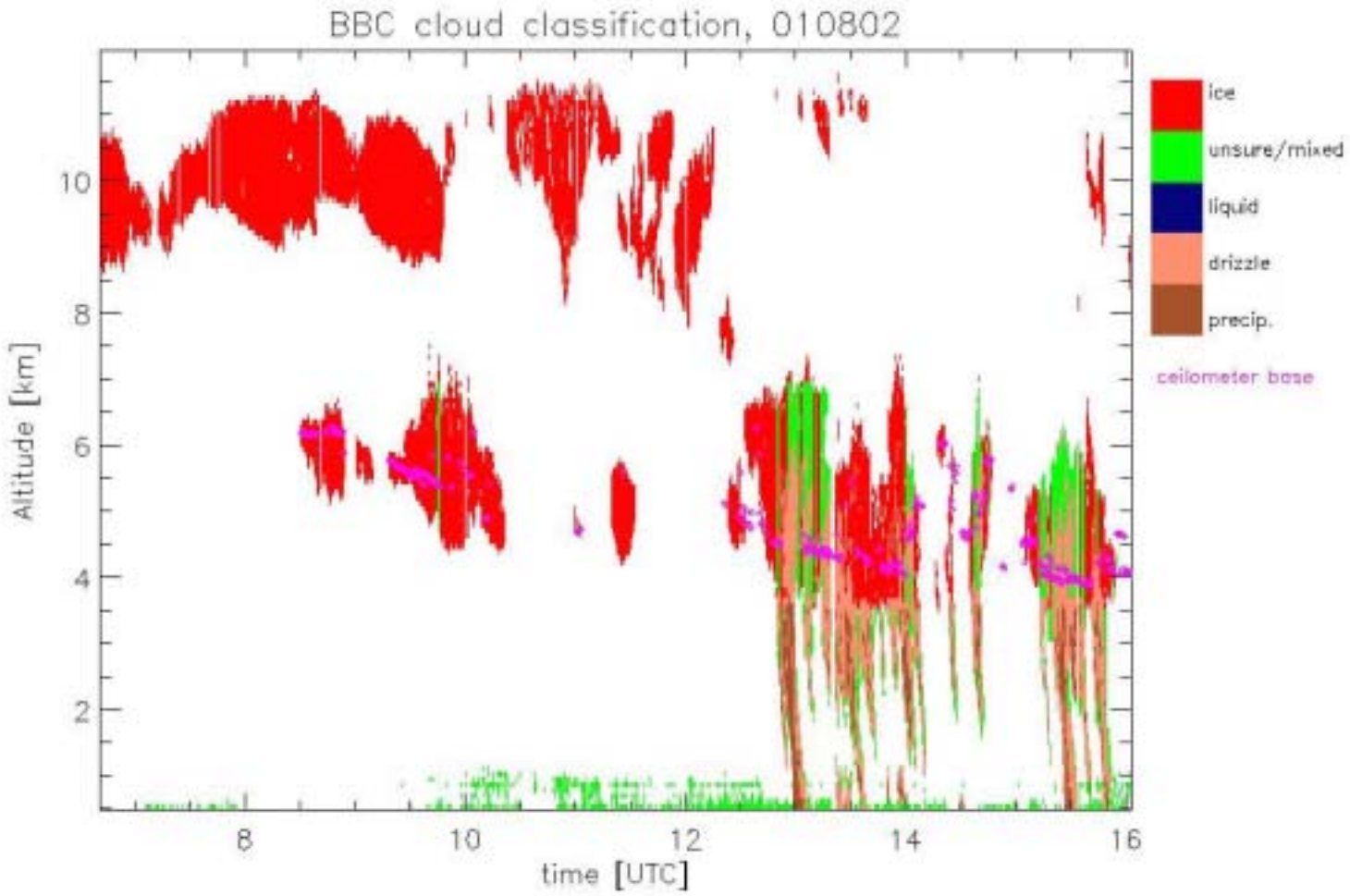


Cloud Classification: 2 August 2001



ɔer 2002

Cloud Classification: 2 August 2001

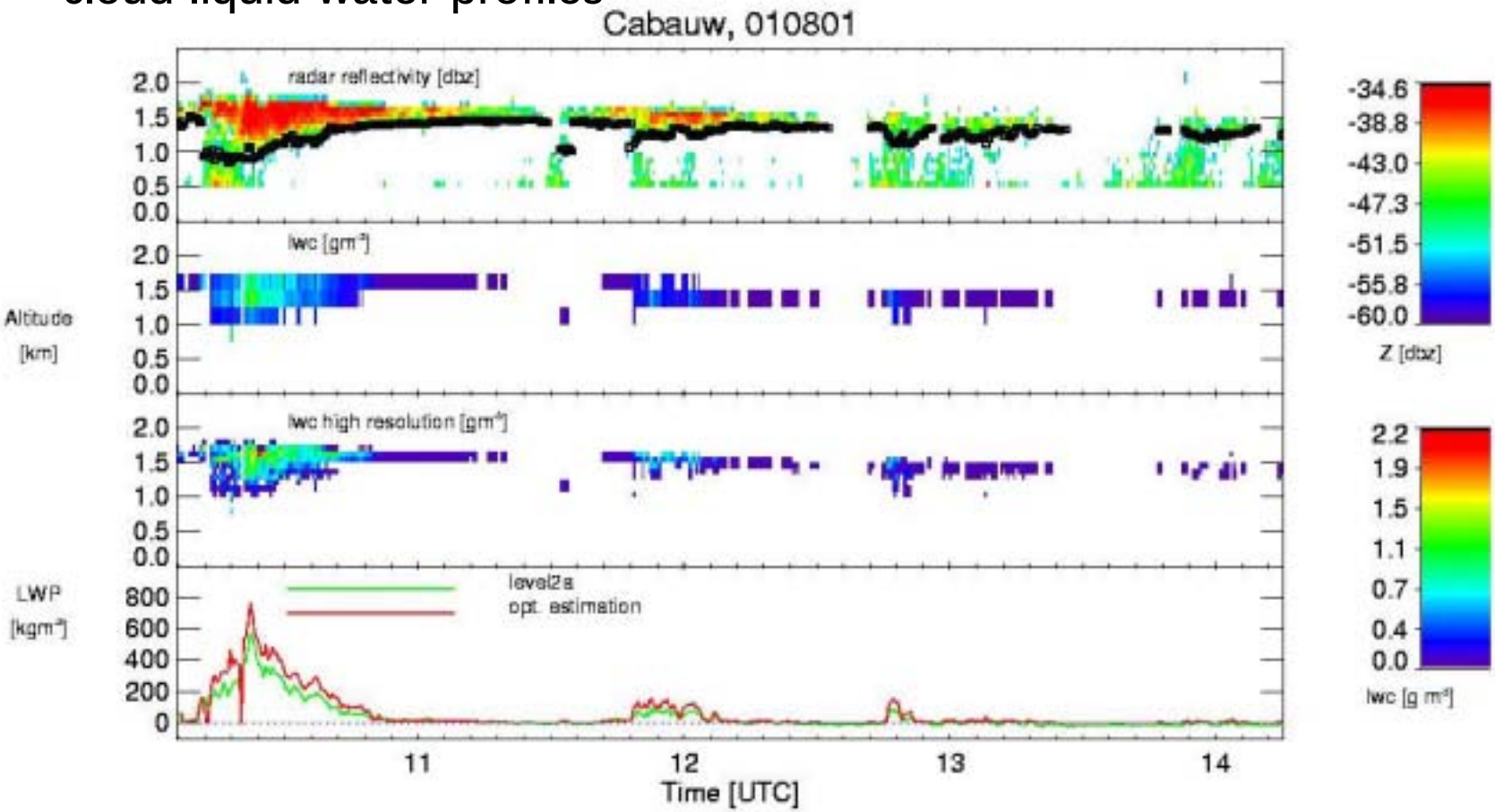


cloud radar, lidar ceilometer, radiosonde, LWP

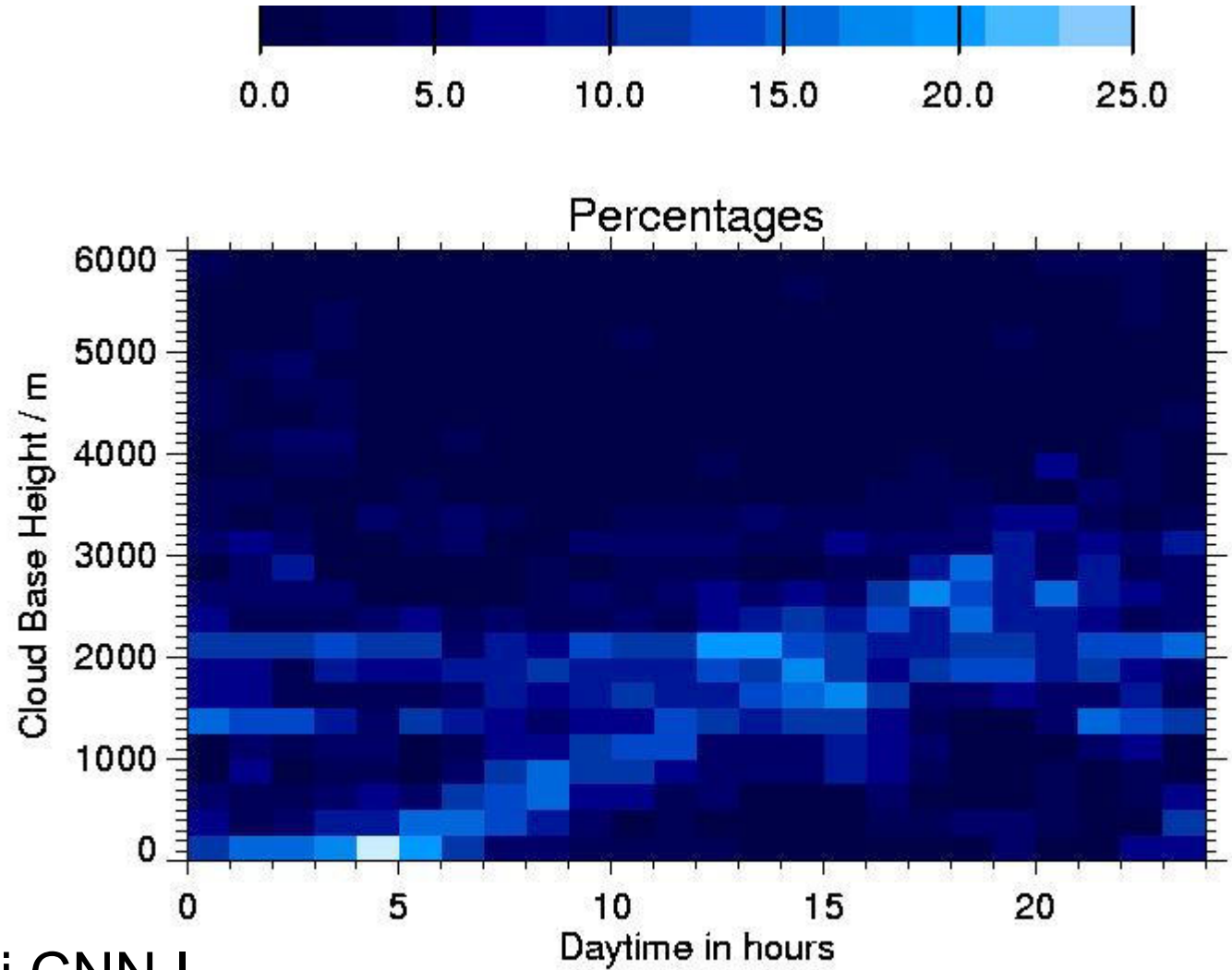
Liquid Water Profiles: Optimal Estimation

microwave profiler, cloud radar, ceilometer & DeBilt RS

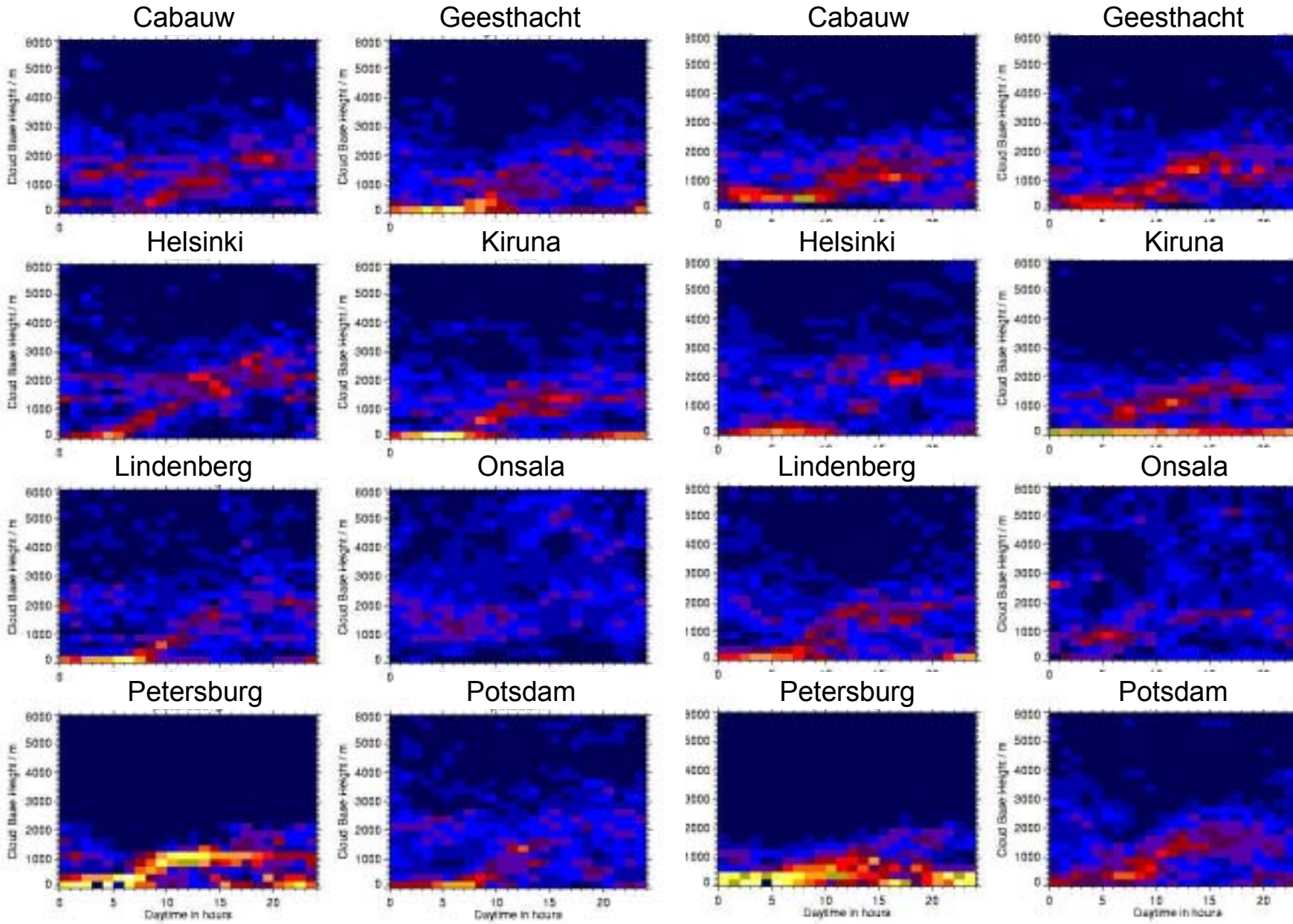
⇒ simultaneous retrieval of water vapor, temperature and cloud liquid water profiles



Diurnal Cycle: Cloud Base Height



Helsinki CNN I


Cabauw
Geesthacht
Cabauw
Geesthacht
Helsinki
Kiruna
Helsinki
Kiruna
Lindenberg
Onsala
Lindenberg
Onsala
Petersburg
Potsdam
Petersburg
Potsdam
Cloud Base Height / m
Daytime in hours
CNN I
CNN II

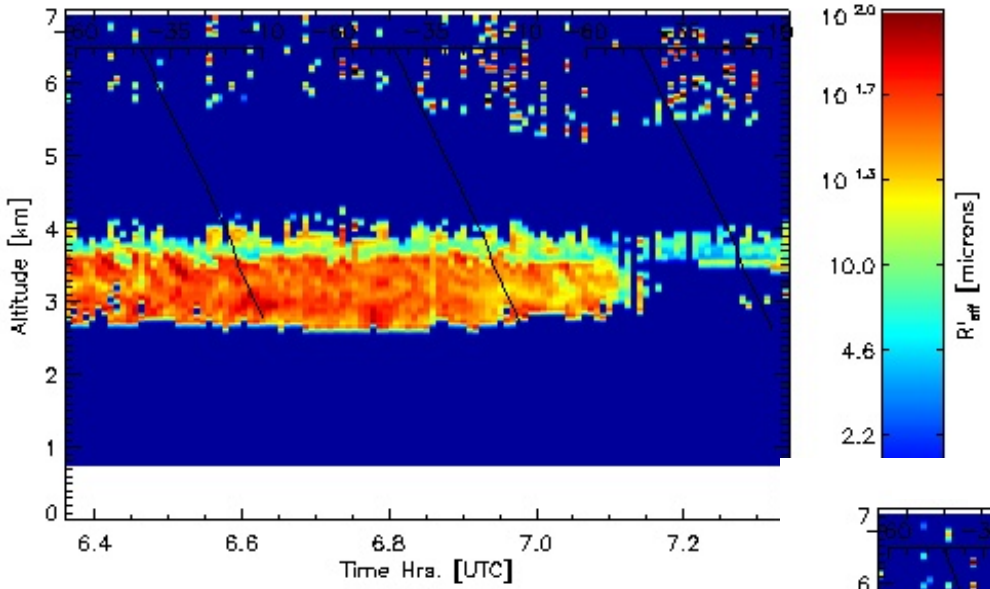
Supercooled clouds at Cabauw

Detection of supercooled cloud layers (SCL) based on ceilometer and radiosode data

Period	Cloud bases detected (%)	Cloud bases <0° C (%)	SCL detected (%)
Aug 2000	43	10	8
Sep 2000	62	11	9
CNN I	**52**	**10**	**9**
April 2001	61	34	30
May 2001	36	13	12
CNN II	**49**	**23**	**21**
Aug 2001	46	13	11
Sep 2001	66	15	13
BBC	**56**	**14**	**12**

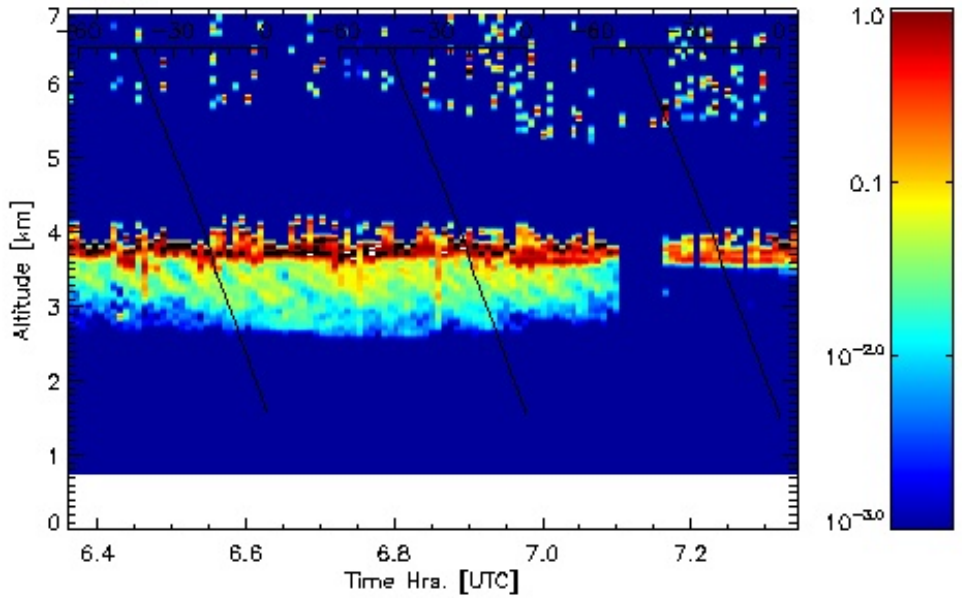
Supercooled Clouds at Cabauw

effective radius



Supercooled layers persist over several hours and more than 100 km

Liquid water content



24 September 2001

combination of radar and lidar profiles
[Donovan et al, 2002]

Low-cost Microwave Radiometer

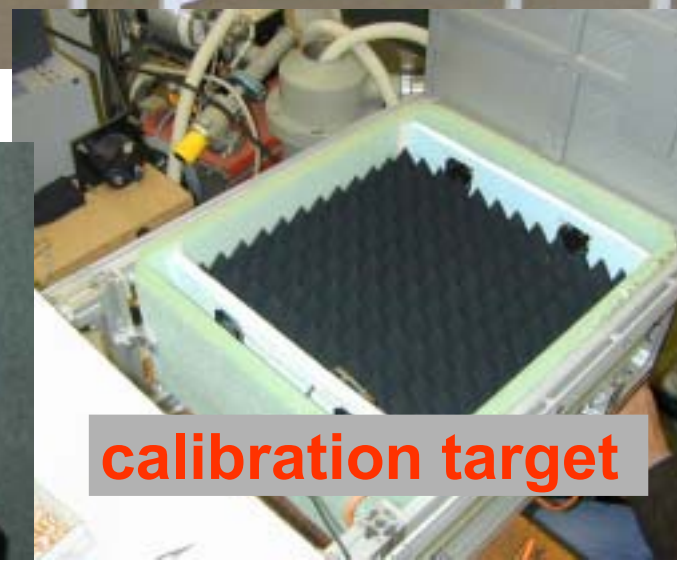
- presently high cost prevents operational use
- low maintainance and uninterrupted measurements (rain!)

Design of Low-cost Radiometer

GPS clock

Rain sensor
& shutter

Environmental
T, rh & p sensors

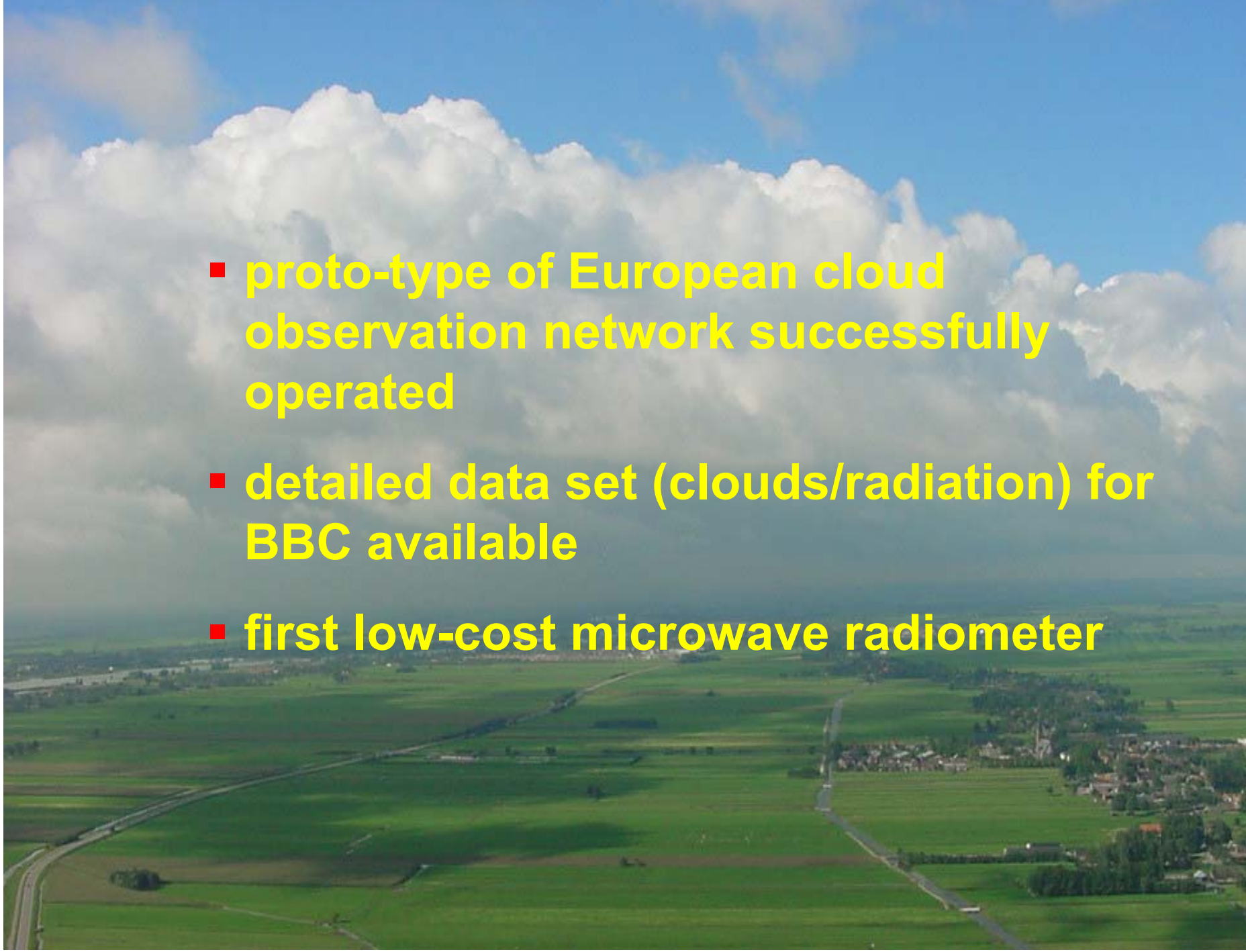


calibration target

Design of Low-cost Radiometer

- new, flexible design for highly accurate measurements
- microwave profiler is only 15 % more than 2-channel
- improved stability and calibration (new load)
- additional rain sensor, GPS clock, inclinometer, temperature, humidity & pressure sensors
- stand-alone, automatic system with embedded PC, interfacing with external PC/laptop (Windows and Linux)
- low maintenance (~ 3 month intervals)

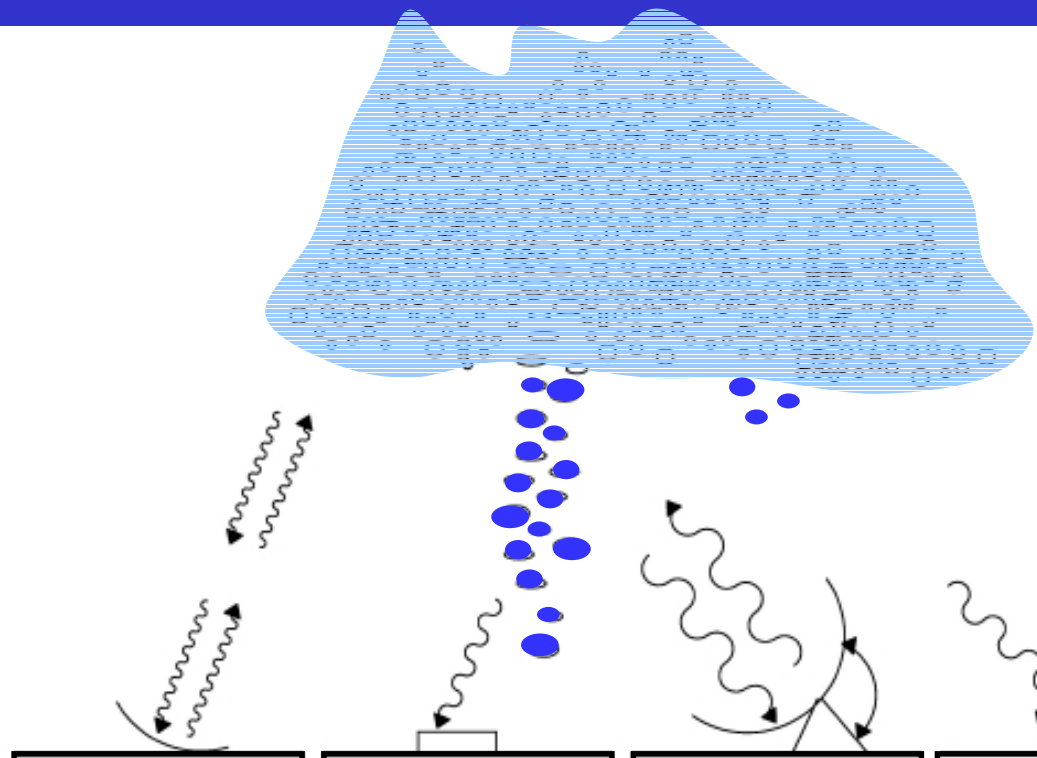
first radiometer will be shipped to Japan by the end of the year



- proto-type of European cloud observation network successfully operated
- detailed data set (clouds/radiation) for BBC available
- first low-cost microwave radiometer


10. 8.00
8:30:01

Remote Sensing Instrumentation



Lidar Ceilometer

λ=905 mm

Cloud base height

Infrared Radiometer

λ=9.6-11.5 μm

Cloud base temperature

Cloud Radar

λ < 1 cm

radar reflectivity

~ diameter^6

Microwave radiometer

λ=3 - 13 mm

liquid water path (**LWP**)
integrated water vapor (**IWV**)

BALTRAD: Time Serie & Fields

Time series Δt=15 min

- radar reflectivty factor at CLIWA-NET stations
  → precipitation rate, rain flag for microwave measurements
- profiles of wind direction, wind speed and radar reflectivity factor at 16 radar locations

Precipitation Fields

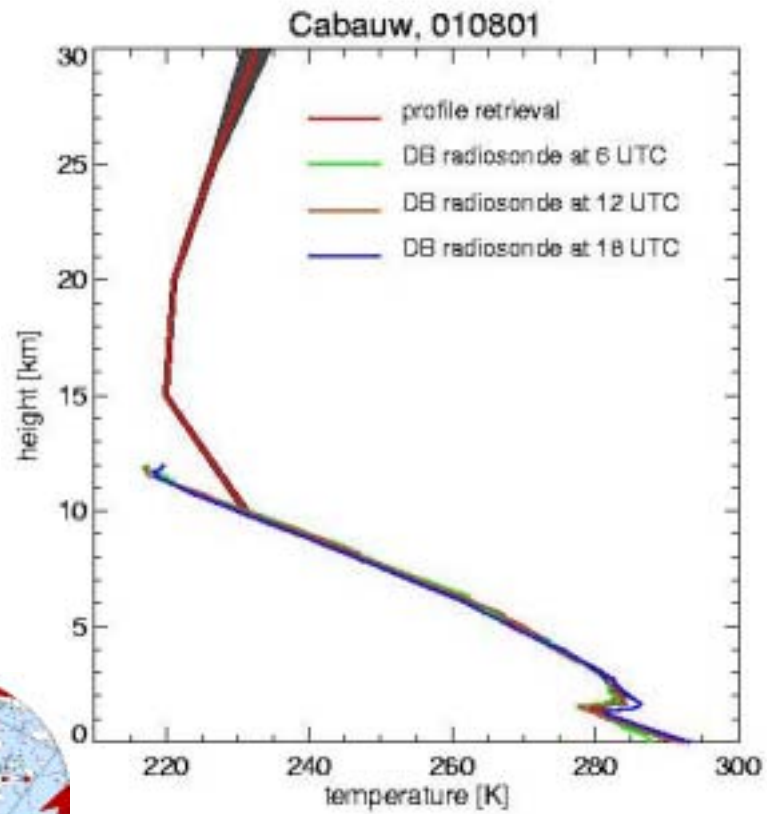
- 12 h precipitation sums with 2 km resolution (radar adjusted with gauges)
- 3 h precipitation sums reflectivty factor at CLIWA-NET stations

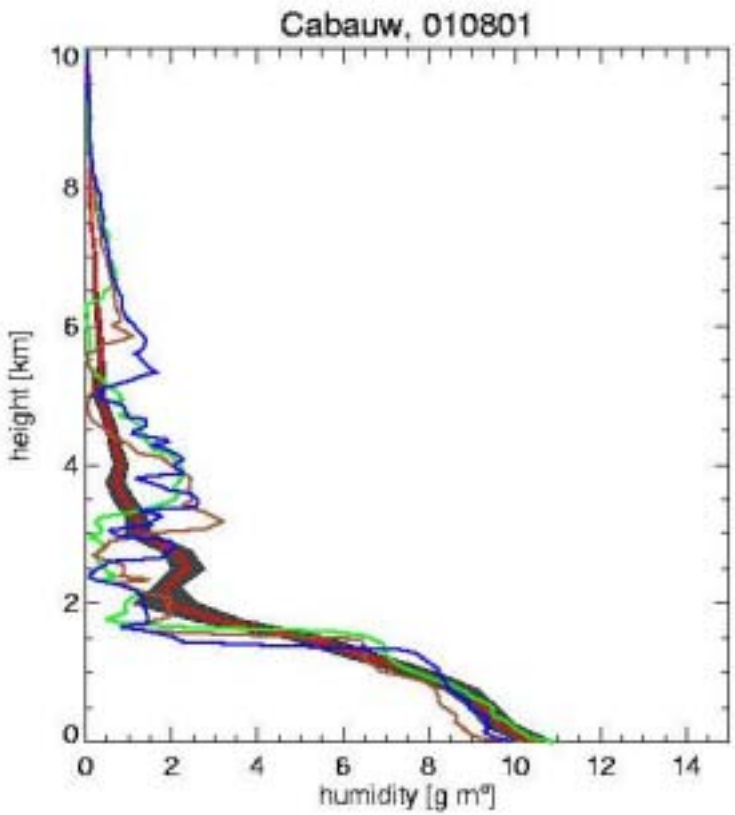
Cloud observations in CNN I

				cloudy				clear		
				z_B < 4 km and T_{IR} > 0 C				no z_B and T_{IR} < -30 C		
Station	Rain (%)	cloudy (%)	clear (%)	z_B (m)	T_{ir} (°C)	LWP (gm^{-2})	IWV (kgm^{-2})	T_{ir} (°C)	LWP (gm^{-2})	IWV (kgm^{-2})
BE	4.6	13.5	43.0	–	5.9	104.8	25.3	–36.8	0.9	18.2
GE	9.9	29.5	42.6	1411	8.8	101.3	22.0	-41.8	5.7	14.5
HE	2.7	15.6	41.9	1880	5.2	132.0	23.9	-42.9	1.5	17.2
KI	4.4	37.7	24.3	1360	6.5	108.8	16.4	-37.3	-0.8	12.1
LI	5.6	22.5	34.4	1637	7.6	107.3	25.0	-45.4	-8.5	17.3
ON	10.2	24.1	47.2	1254	7.7	124.1	22.3	-47.9	-8.7	14.9
PA	3.0	26.4	52.7	–	8.8	80.2	26.7	-42.6	-14.7	20.9
PO	3.9	46.8	45.3	1599	–	69.8	23.5	–	-11.6	18.9
SP	6.2	13.2	40.3	806	8.2	128.6	23.7	-45.9	55.0	16.8

Combination of Radar/Microwave

Optimal Estimation technnique for simultaneous retrieval of water vapor, temperature and cloud liquid water profiles (Ulrich Löhnert)





Diurnal Cycle: Infrared Temperature

Lindenberg CNN II