Ein Team für Mensch und Zukunft



Deutscher Wetterdienst

High variable humidity profiles in troposphere a challenge in observation and validation

Bernd Stiller, Franz H. Berger, DWD, Richard-Aßmann-Observatorium, Am Observatorium 12, OT Lindenberg, 15848 Tauche email: bernd.stiller@dwd.de

History

 \rightarrow Observatory Lindenberg is more than 100 years old long tradition in profiling of atmospheric parameters



Extended Analysis of Lindenberg Campaign Data

stratifying data according to the presence of clouds (AVHRR observations)



- \rightarrow Radiosoundings have been performed for > 60 years
- \rightarrow Recently special research has been done to improve humidity measurements by Vaisala radiosondes especially at upper altitudes
- \rightarrow The Richard Aßmann Observatory is since 2008 lead centre of the GCOS Upper-Air Reference Network (GRUAN) of the WMO.

Validation Campaign 2007

- ✓ A total of 290 radiosondes (Vaisala RS92) have been launched JJA 2007 at times given by the Metop overpasses in addition to 368 routine radiosonde ascents in-situ soundings were supplemented by a variety of ground-based remote sensing ✓ Cloud parameters were
- derived from measurements of a Ka-band radar and ceilometer → 146 profilings during overpass

- generating quality flag of the radiosonde temperature and humidity measurements (analysis of the time rate of change and using independent observations) classifying into stability classes: Stable, Unstable, Potentially Unstable using the instability indices: CAPE, Lifted Index and K-index
- analysing ECMWF meteorological fields over Lindenberg (time rate of change) Iooking for situations evolved into convective cloud system
- -> generating synthetic IASI radiances using LBLRTM for each of the clear sky cases

Clear sky and "Stationarity" (low time rate of change)?

	The right-hand			Cloud fraction within a 50-km radius lower or equal							
	Table shows		Total	0.0%	0.1%	0.5%	1.0%	2.5%	5.0%		100.0%
	a number of	2007	135 (100%)	0	0	8 (5.9%)	2 (1.5%)	4 (3.0%)	6 (4.4%)		48 (24%
Lindenberg	nearly	2008	81 (100%)	0	7 (8.6%)	24 (30%)	8 (9.8%)	8 (9.8%)	8 (9.8%)		3 (3.7%)
RAO	clear sky cases (fraction < 1 percent) 2008: 39 (34.6%)										
MO2_20070614193321Z_2007	AVHRR instrument)	ut 23% ysis a Good Fair Poor	6 (2007 a tre: d 14x , 45x, and 168x.	And 200 Ne (A ^v wit 50	98 toget arly cloudfre VHRR) hin a -km radius 19.8%	her). The N=8	"Station F G 6.1	ts of "St arity" Flag: ood	tationar 227 addi radiosoun d N overpa in 2007+	ty" tional dings uring letop asses 2008	

Campaign 2008

- ✓ focussed on clear sky sounding during overpass ✓ A total of 81 radiosondes
- were launched from Jan to Dec 2008
- ✓ Raman lidar provided profiles of water vapour with high vertical resolution at 19 overpasses → 81 profilings during overpass

P1

- \rightarrow The Integrated **P**rofiling **T**echnique (IPT) combines these measurements in an optimal estimation framework
- → retrieval of the atmospheric state parameters temperature, humidity, and liquid water \rightarrow 2007: IPT implementation at RAO

Fig. 1: A Plot of AVHRR CLOUD_INFORMATION field with a CCM Code (Clear, Cloudy, Mixed) focussed to Lindenberg. Colors: white - cloudy, yellow - mixed, black/blue: clear (Date: 14-06-2007). "Clear" assignment in this analysis requests the pass of not less than 3 tests ("T4-T5 test b" — "T4-T3 test b" — "T3-T5 test b" or "Uniformity test b"). Additional all SCENE_RADIANCES (channels 1-5) were always plotted (here not shown).

Clear sky and Unstable Stratification?



Example 28-07-2008: low change of tropospheric humidity

A quality flag of the radiosonde temperature and humidity measurements were generated from an analysis of the time rate of change of radiosonding profiles and microwave observations.





ok_cs` NO_FUDGE MW G/3 RegO QC: G G G G 10000 8000 6000 MWP 2008-07-28 19:50:00 10000 5 %Temperature [℃] / Rel. humidity Fig. 2: Inter-comparison IPT- IASI - MW - Radiosounding

rcle 50 km: 99.98% ircle 75 km: 99.15%

 \rightarrow 2008: verification of IPT products and studies \rightarrow 2009: improvements (e.g. cloudlayer height), bias-free brightness temperatures are crucial !



2008-07-28 17:03

2008-07-28 19:35

08-07-29 04:58

2008-07-28 23:16

Radiosounding

Stationarity Flag:

'Averaged STDDEV rH : 🔶 4.78 🚀

Good

5000

Temperature and relative humidity profiles show only small variations (overpass time 19:35 Z)

Microwave profiling

The radiometer detects humidity structure satisfactorily (LT: wet, MT: dry) but lacks in vertical resolution



Lidar measurements

Lidar mixing ratio measurements showing pronounced changes of humidity in the lower troposphere and a vertical displacement of a dry layer

other / new instruments

Not operational in 2007



Ceilometer Fourier Transform Infrared CHM 15k (FTIR) spectrometer EISAR (Jenoptik)

Observations and measurements for IASI-validation 2007/08



Microwave profiling **Operational and** additional radiosounding TP 3001 (Radiometrics) (+ reference sounding)

Cloud radar MIRA36 Ka-Band Radar (METEK)

GPS antenna Brewer spectrometer MK2 Ceilometer LD40 (Vaisala) $(\geq IWV)$ (> integrated ozone)

Precision Filter Whole Sky Imager Radiometer (PFR) (≻ Cloud fraction) (> AOD)

Raman LIDAR (Kayser-Threde, Munich)

Validation campaigns, and extended data analysis were funded by Eumetsat under contracts EUM/CO/06/4600000259 and EUM/CO/09/4600000679

Lindenberg Meteorological Observatory – Richard Aßmann Observatory