Severe Weather Warnings at the German Weather Service
Recent Problems, Developments and Progess

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Outline

1. Introduction
2. Modifications in the DWD´s warning procedure
3. Improvements in remote sensing technologies
4. COSMO-LEPS
5. Conclusions, outlook and future plans

1. Introduction

Severe events in 2002 -
forecasts and warnings didn´t always met user´s expectations

- **26 Feb 2002: Storm cyclone „Anna“ - gusts over widespread areas above 30 m/s, loc (North Sea coast) up to 50 m/s**
  - ➢ **DWD´s Model wasn´t able to catch this rapid cyclogenesis**

- **10 July 2002: Thunderstorm squall line, gusts above 30 m/s, loc (Berlin area) above 40 m/s ... several people were killed**
  - ➢ **warnings very early, some customers were not able to use warnings for their decisions**

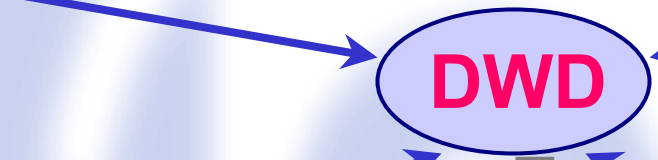
- **12 / 13 August 2002: „Century flood“ over Central Europe - precip in wider areas above 200 mm / 48 h, loc > 300 mm / 24 h - at least 20 people were killed**
  - ➢ **warnings too late because models were not able to detect this event satisfactury well in advance (medium range)**

Private competitors

- unfair attacs
- requiring met informations
- own station network / warnings

Political facts

- Federal Republic Germany
- Reduction of official duties (lower budget)



People „on the street“

- not able to unterstand warnings
- education level
- neglecting severe weather risks

Media

- Weather as a entertainment
- Ignoring DWD´s presence
- not treated to transmit severe weather warnings instantly

DWD is reducing activities for the media

Anyway:

How to provide „people on the street“ with weather forecasts and warnings ? How to sensitize them related to weather risks ?

2. Modifications in the DWD´s warning procedure

➢ **Warnings better understandable by the general public**

- **Use of other units**

wind speed: **km per hour instead of knots or strength in Beaufort**
Background: most of the users are cardrivers

precipitation: **liter per sqare meter in less than 1/6/12/24/48 hours instead of mm. Background: 1 bucket approx 10 liters**

- **Additional information describing possible damages**

Gusts up to gale force: Roofs will be removed, trees breaking. If you have to stay outside: Keep away from trees, forests...

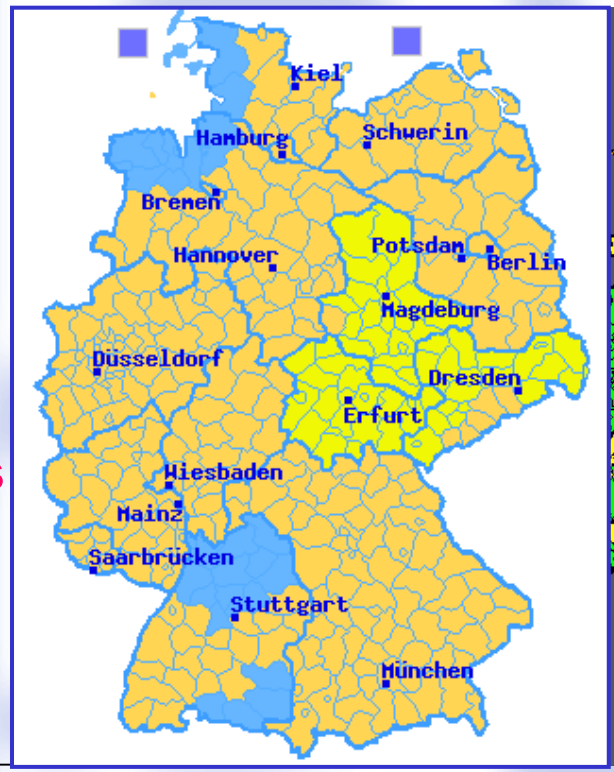
Heavy rain: Local floodings / widespread floodings likely, in the highlands mudflows / flashfloods possible. Streets may be impassable, railway lines out of service...

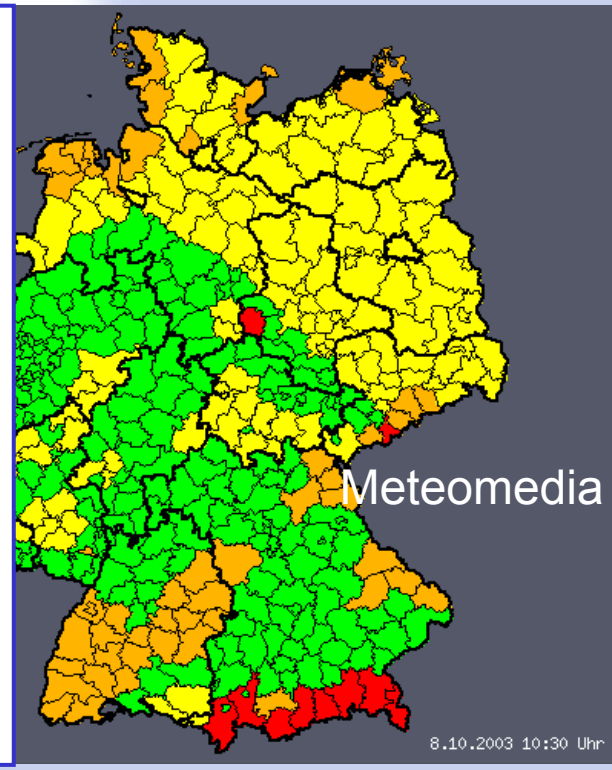
- Warning criteria were modified
- Introduction of a warning level: Extreme severe weather „once in a forecaster´s lifetime“

Criteria	old	new threshold	extreme event
wind gusts	> 104	> 104 km per hour	> 140 km per hour
heavy rain		> 25mm / 1 hr	
		> 35mm / 6 hrs	
		> 40mm / 12 hrs	> 70mm / 12 hrs
	> 15mm	> 50mm / 24 hrs	> 80mm / 24 hrs
	> 40mm	> 60mm / 48 hrs	> 90mm / 48 hrs
snow		> 10cm / 6 hrs	
		> 15 cm / 12 hrs	> 25cm / 12 hrs
above 800 mtrs:	5 ... 15 cm	> 30 cm / 12 hrs	> 50cm / 12 hrs

- severe weather pre-warnings mostly replaced by weather warnings close to thresholds of severe weather warnings
  - users often not able to use pre-warnings in a correct way
  - No uniform procedure how to use pre-warnings

- Introduction of district-based warnings
- confusing: Use of a different procedure and other thresholds by MeteoMedia





Web policy of the DWD has been changed dramatically

- over 50 % of all households could access the web
- most of the authorities, companies and interested users using the web

DWD is distributing forecasts, warnings, weather data etc. by itself

Advantages:

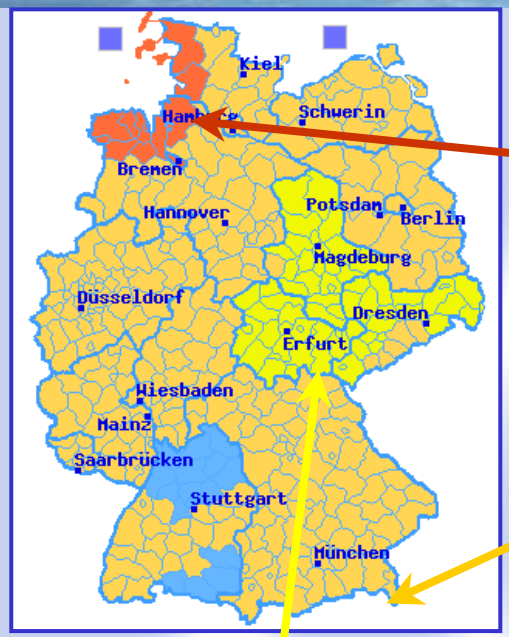
- Informations from the forecaster´s to the users directly
- No „interpretation“ by broadcast or tv moderators anymore
- No loss of information by limited layout windows in papers etc.

Almost everything of user relevant weather informations is available in the web !
Examples: NCEP, UKMO, relaunch of the ECMWF web site, ...

Product	presented as a
early warnings (med-range)	textual forecast (risk assessment)
warning situation (Germany, federal state)	graphical layout, supported by colours displaying the threshold
warning situation report (Germany)	explaining the warning overview (additional maps, sat and radar pic)
warnings	coloured districts / areas, warning text appears after clicking the area

... and current weather data, sfc analysis, temps, forecast charts, sat and radar pictures, additional informations ... for free !

Deutscher Wetterdienst
Zentrale Vorhersage



08 Oct 03
13:00 local time

UNWETTERWARNUNG vor ORKANARTIGEN BÖEN
für den Landkreis Cuxhaven

gültig von: Mittwoch, 08.10.03, 18:00 Uhr
bis: Donnerstag, 09.10.03, 10:00 Uhr

ausgegeben vom Deutschen Wetterdienst
am: Mittwoch, 08.10.03, 13:30 Uhr

Gefahr von West- bis Nordweststurm Stärke 8 bis 9 Bft, dabei verbreitet schwere Sturmböen, örtlich orkanartige Böen bis 110 km/h (Stärke 11 Bft).

DWD / RZ Hamburg=

WARNUNG vor NEBEL

für Landkreis Saalfeld-Rudolstadt

gültig von: Mittwoch, 08.10.03, 09:45 Uhr bis: Mittw
ausgegeben vom Deutschen Wetterdienst am: Mittw

Zeitweise Nebeltreiben mit Sichtweiten unter 150 m

DWD / RZ Leipzig=

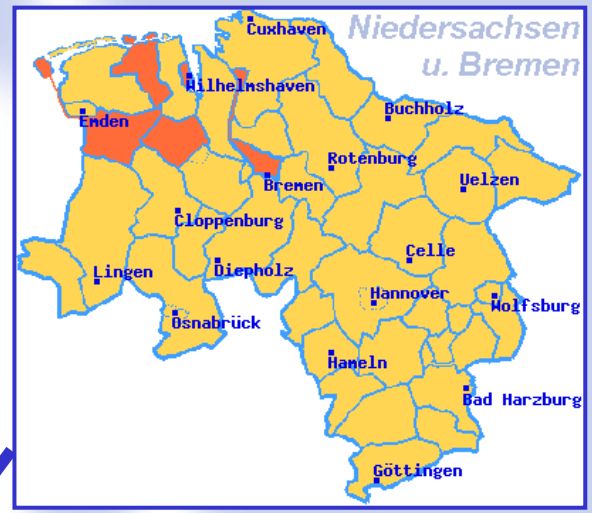
Niederschlagssummen zwischen 40 und 50 Litern pro Quadratmeter in 24 Stunden. Der Schwerpunkt liegt in den Nachtstunden mit 30 bis 40 Liter pro Quadratmeter in 12 Stunden.

DWD / RZ München=

3. Improvements in remote sensing technologies

Political facts

- Reduction of official duties (lower budget)
- influential competitors
- Reduction of the DWD´s staff



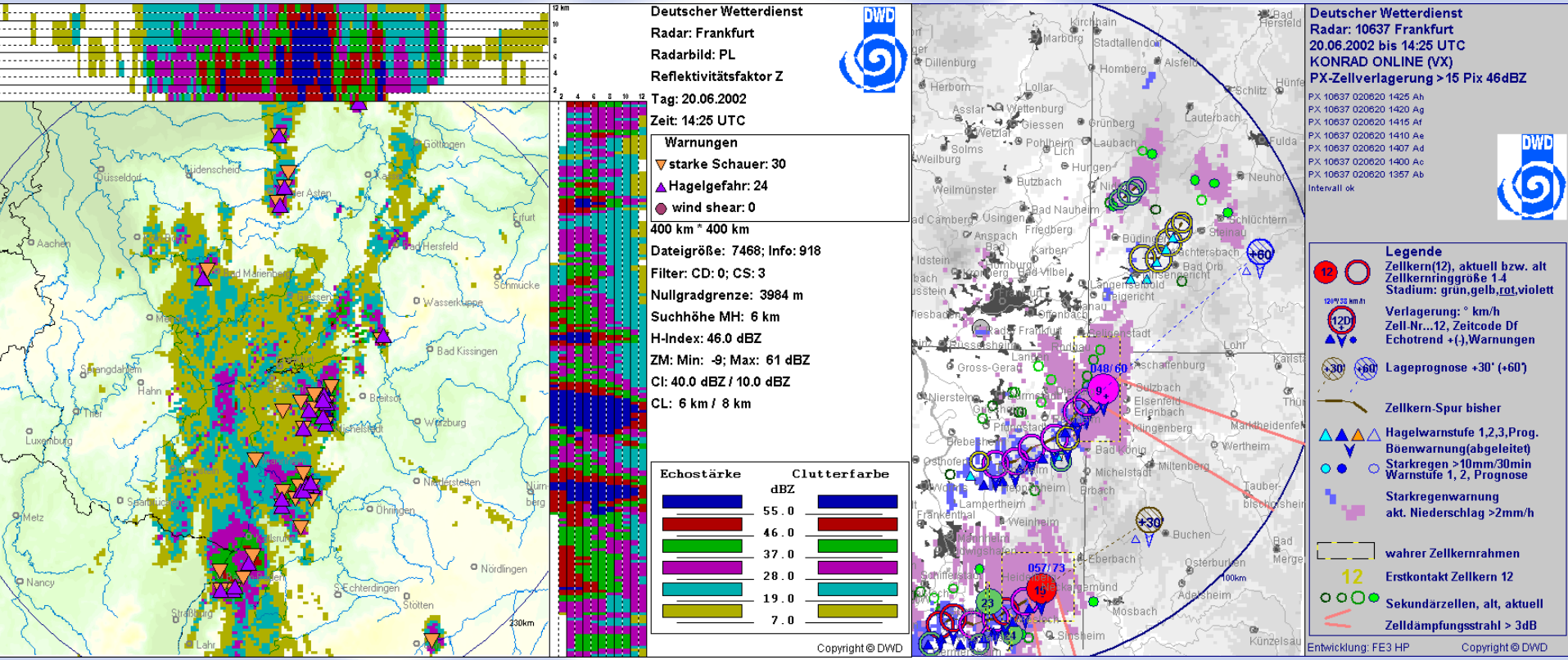
District-based warnings

... needs to improve remote sensing techniques ...

- Radar tools (KONRAD)
- Lightning registration system
- Meteosat Second Generation

Forecast tools suitable for regionalized predictions
COSMO - LEPS ? MMO ?

Radar tools (KONRAD) KONvection in RADar

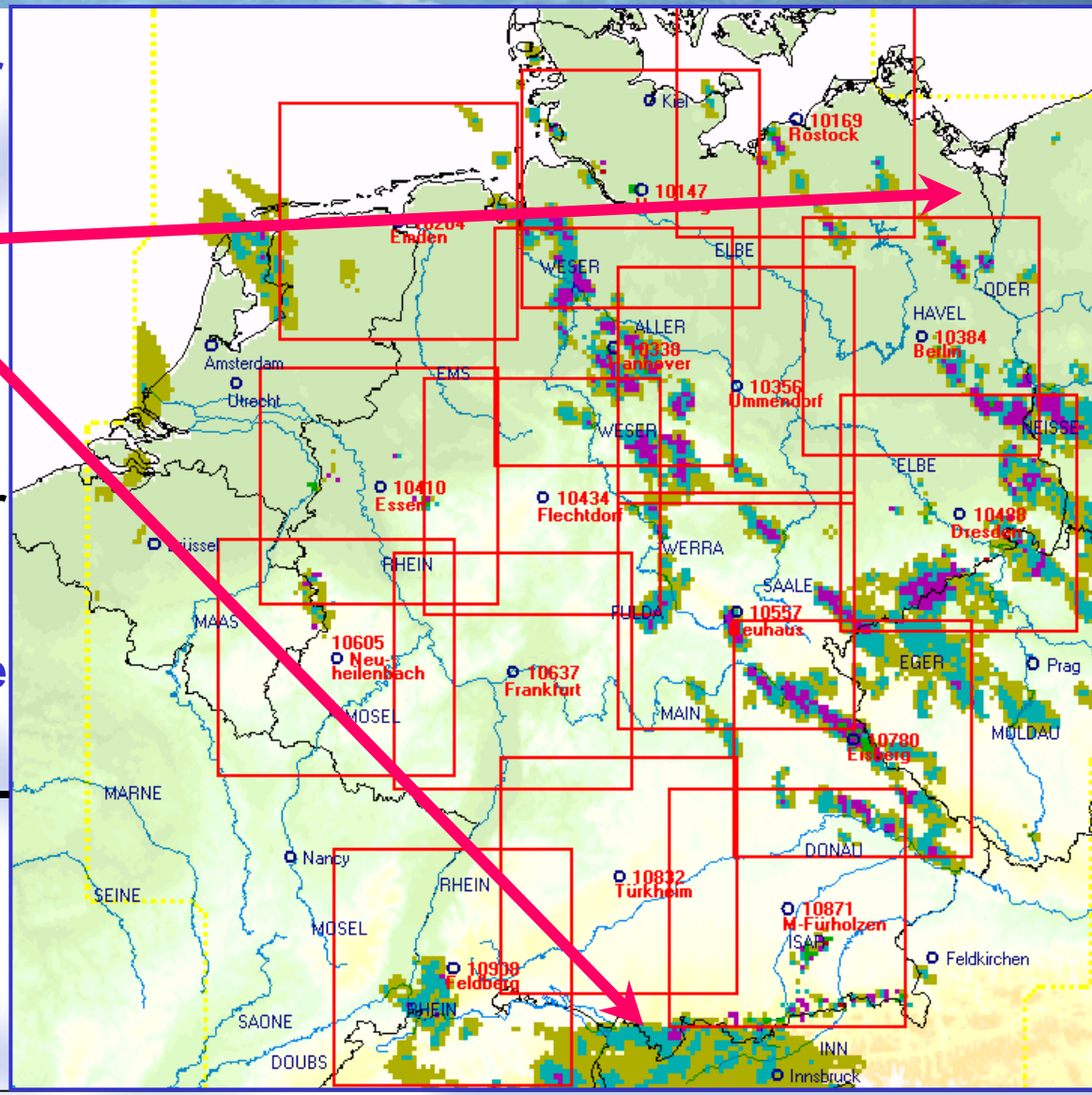


5 min radar scans within a 100 km area ... Tracking of convective cells horizontal resolution 1 km

- part of the German radar network
- Problems : Gaps in „sensitive“ areas
- „rapid scan“ within a 100 km-radius only
- experimental use (server faults, busy lines)

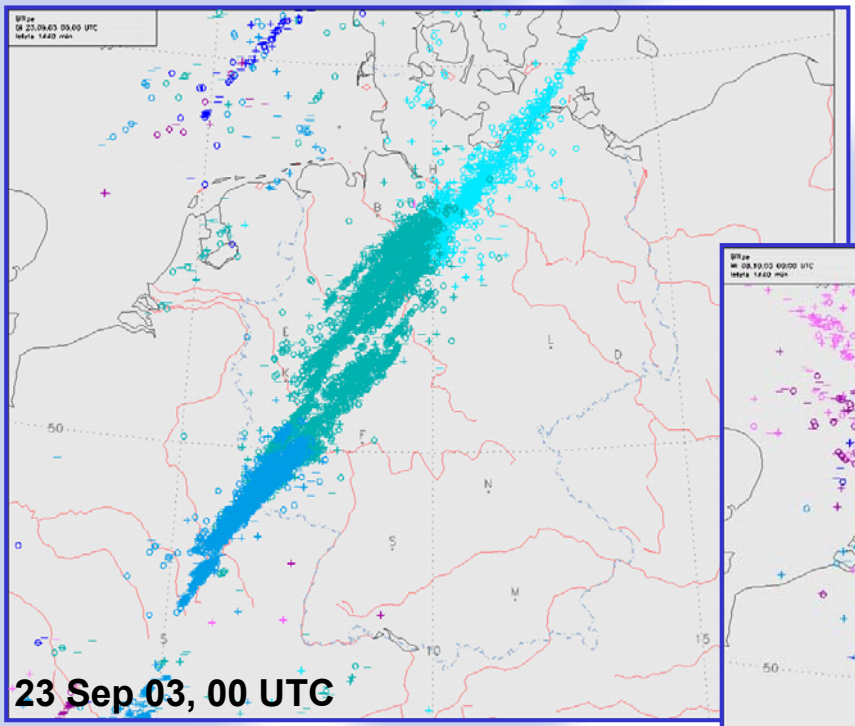
Extrapolation of convective cells for nowcasting:

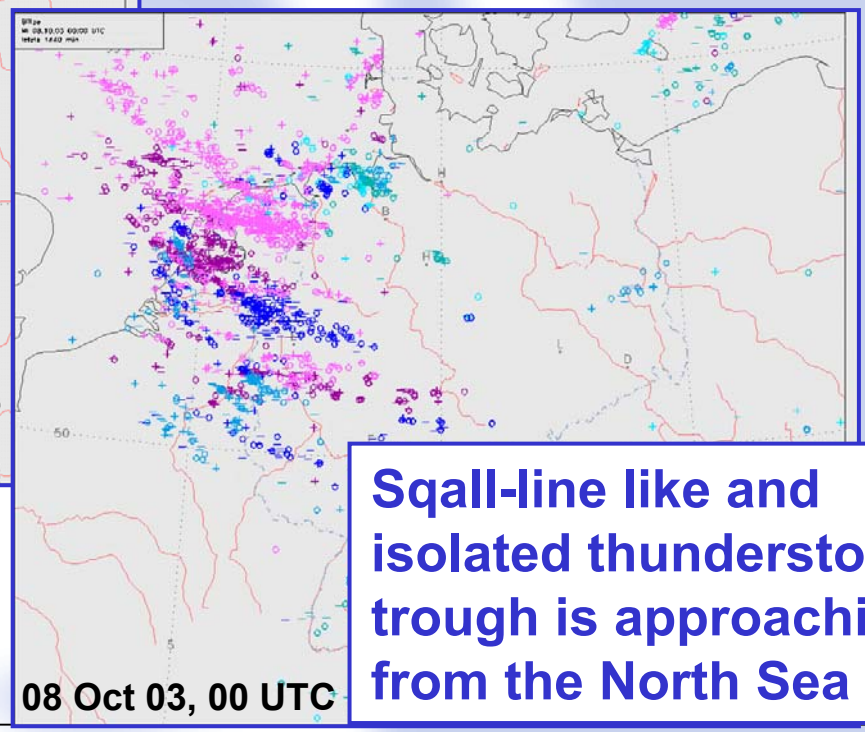
- cells are moving (by mid-tropospheric flow)
- Multi-cells or MCC´s
- best results: Sqall lines over a „flat“ orography



The Lightning registration system

- continuous registration, resolution < 5 km
- displayed by workstations in time steps 0.1 ... 24 hrs
- allows tracking of TS cells

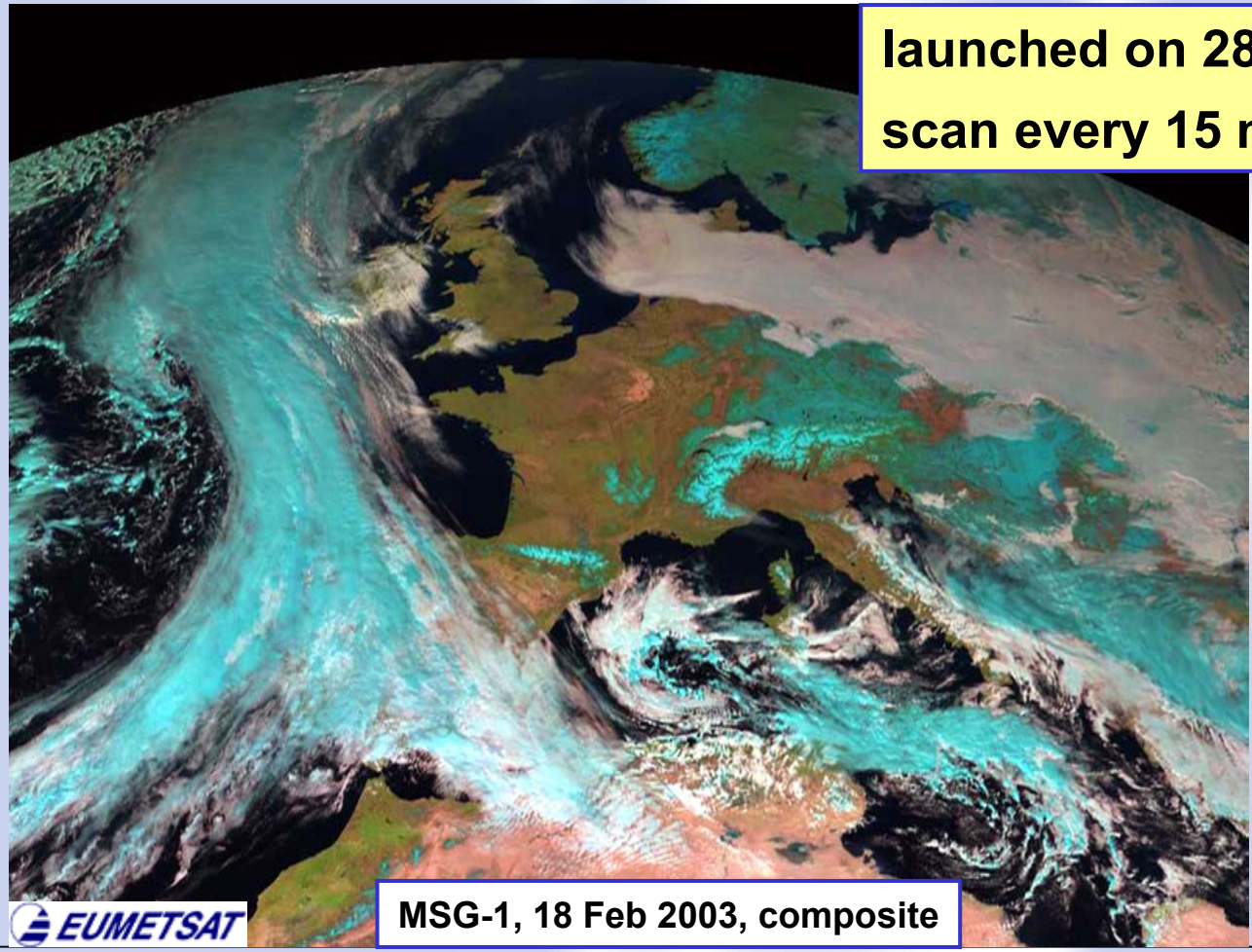




Track of a embedded multicell in a cold front crossing Germany

Sqall-line like and isolated thunderstorms, trough is approaching from the North Sea

Meteosat Second Generation (MSG)



MSG-1, 18 Feb 2003, composite

launched on 28 Aug 2002

scan every 15 min, 12 channels

High-res scans up to 1 km

rapid-developing thunderstorms

classification of clouds

fog detection

Applications at the DWD under development

4. COSMO-LEPS

- **CO**nsortium for **S**mall scale **MO**delling (D, CH, I, Gr, Pl)
- **L**imited-area **E**nsemble **P**rediction **S**ystem
- developed and maintained at the ARPA-SMR (regional Metservice Bologna, Italy)

↓

Producing since Oct 2002 probability forecasts

Experimental use at the DWD since March 2003. Objects:

- combining the ECMWF´s EPS and a local model
- „Downscaling“ of the EPS into the meso-scale
- More realistic predictions of precipitations, gusts and temperature extrema over a complex orography

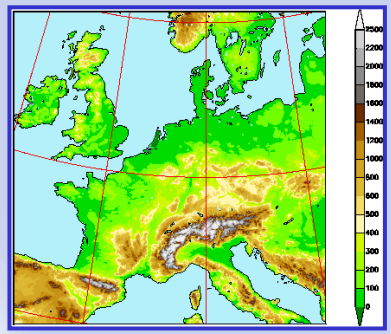
How does COSMO - LEPS working ?

Cluster analysis

10 clusters
independent from
synoptic situation
u,v,q,Z (850,700,500 hPa)

10 representative members

Initial and boundary conditions for LM runs

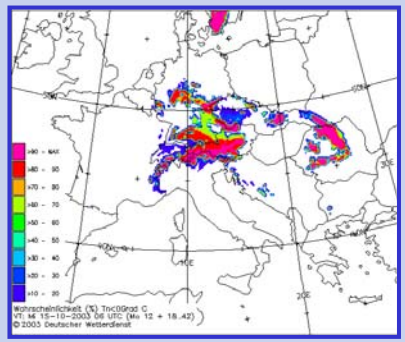


EPS consequtive runs
H-24, H-12, H+00, once per day, oper run 12 UTC
153 single forecasts

Cluster size (weighting)

Calculation of probabilities

Forecasts exceeding a certain threshold of a given parameter



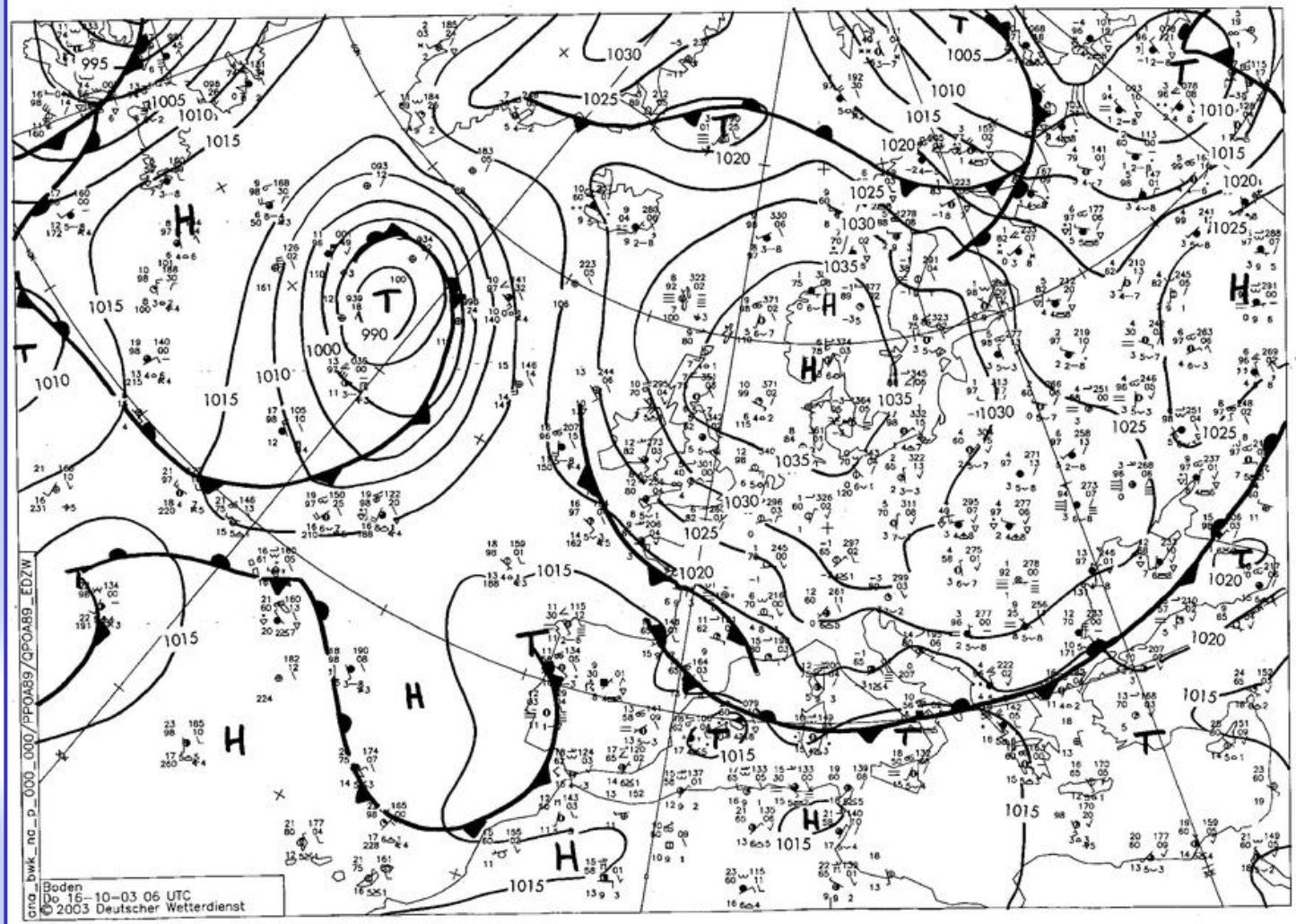
A lot of parameters and thresholds available ... at time steps H+24 . . . 120

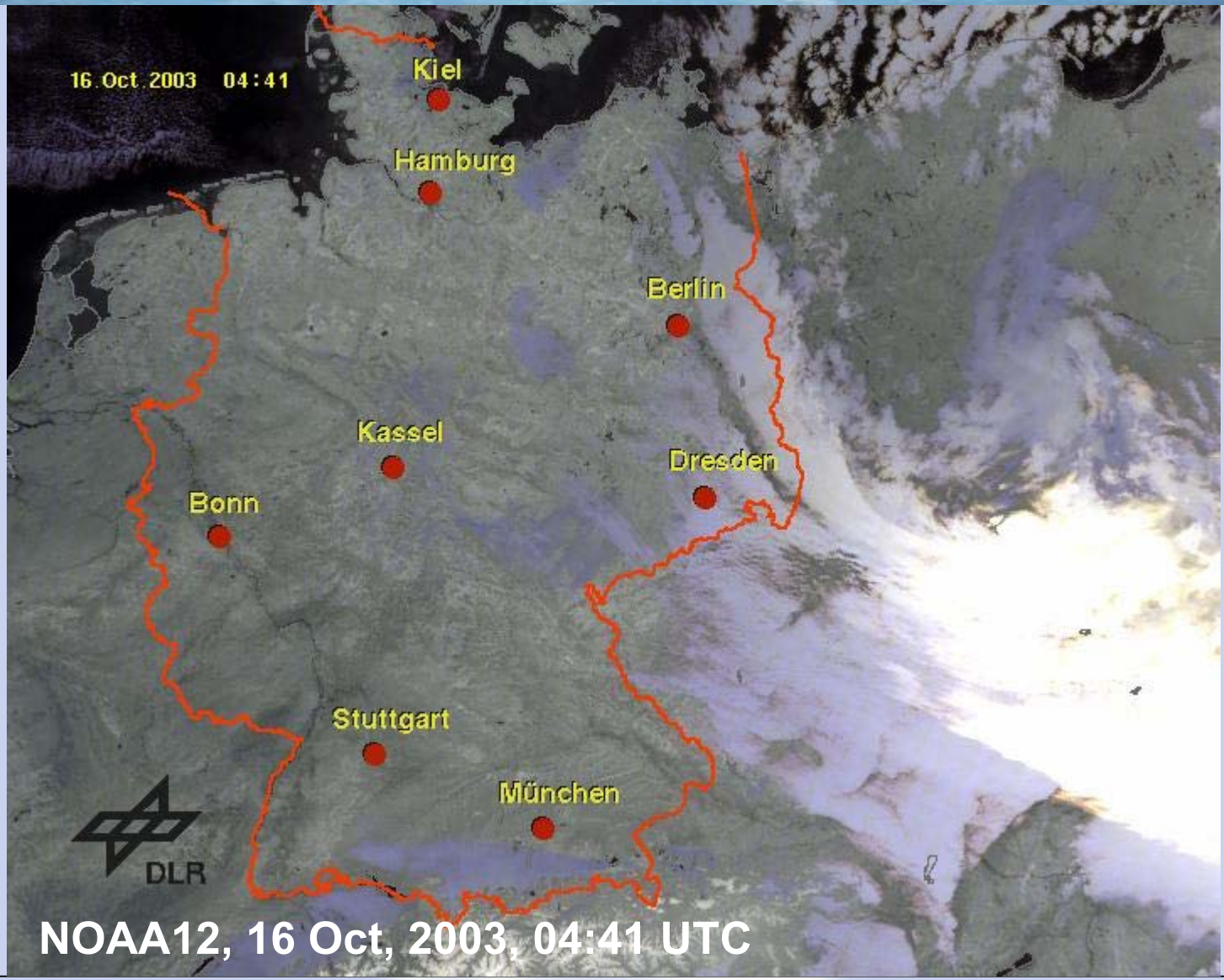
Parameter	Thresholds (> ... , Tn < ...)			
fx	10 m/s	15 m/s	20 m/s	25 m/s
precip 24h (06 to 06 UTC)	20 mm	50 mm	100 mm	150 mm
precip 72h	50 mm	100 mm	150 mm	250 mm
Tx	20°C	30°C	35°C	40°C
Tn	< 5°C	< 0°C	< -5°C	< -10°C
CAPE - convect potential energy	750	1000	1500	2000 J/kg

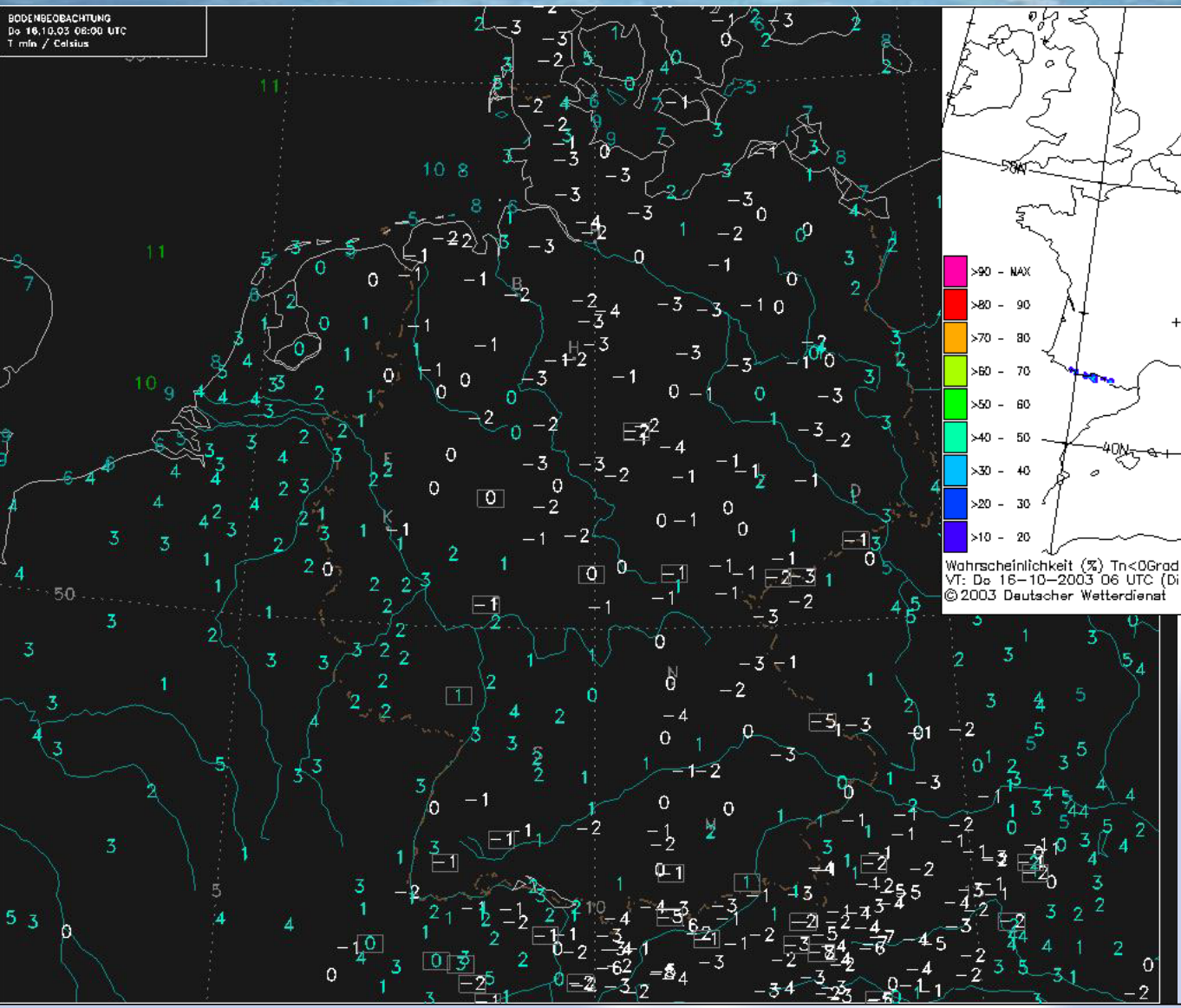
→ Selection for verification !

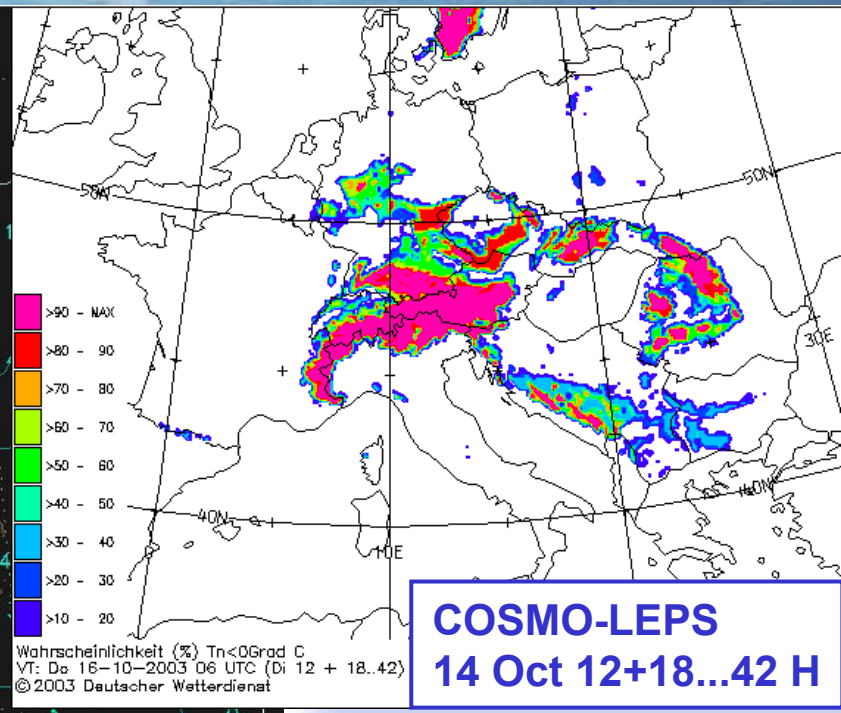
Case studies ...

Analysis
16 Oct 06 UTC




16.Oct.2003 04:41
Kiel
Hamburg
Berlin
Kassel
Dresden
Bonn
Stuttgart
München
DLR
NOAA12, 16 Oct, 2003, 04:41 UTC





COSMO-LEPS
14 Oct 12+18...42 H

16 Oct 06 UTC
Obs TMin

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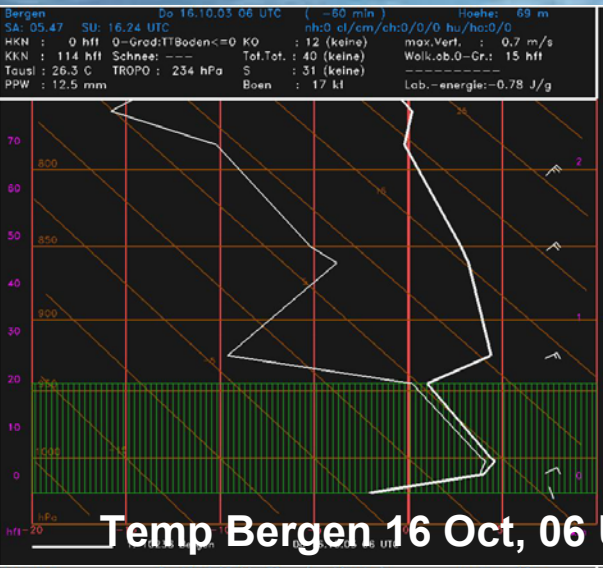
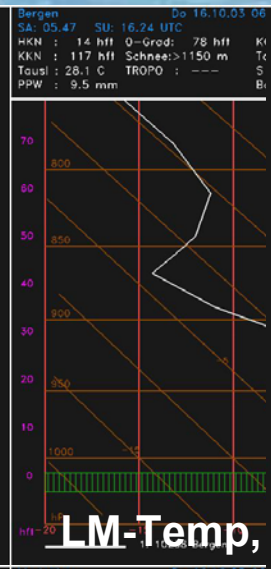
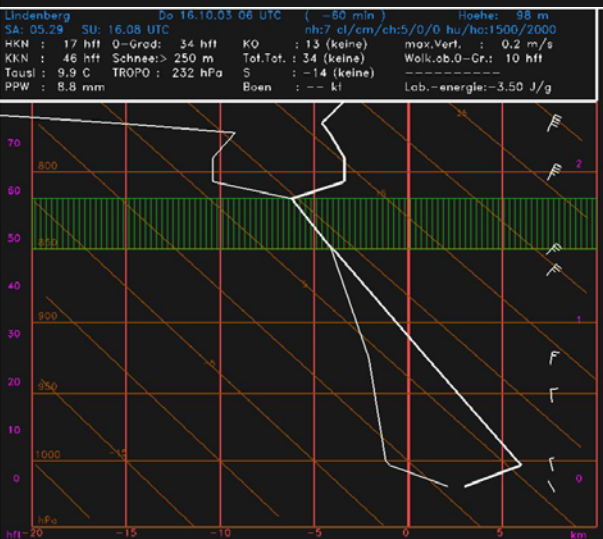


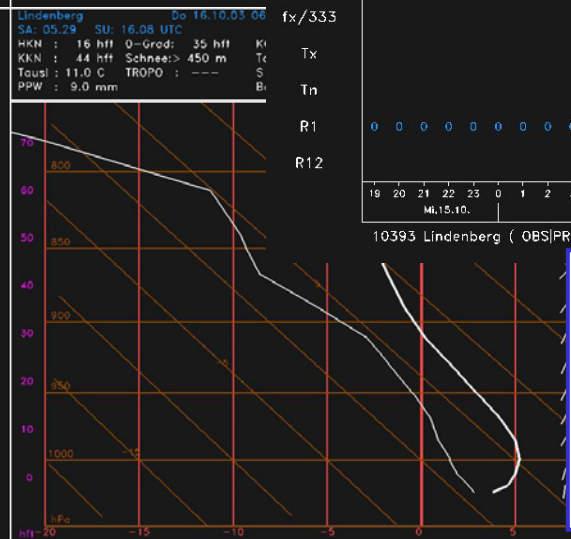
Temp Bergen 16 Oct, 06 UTC



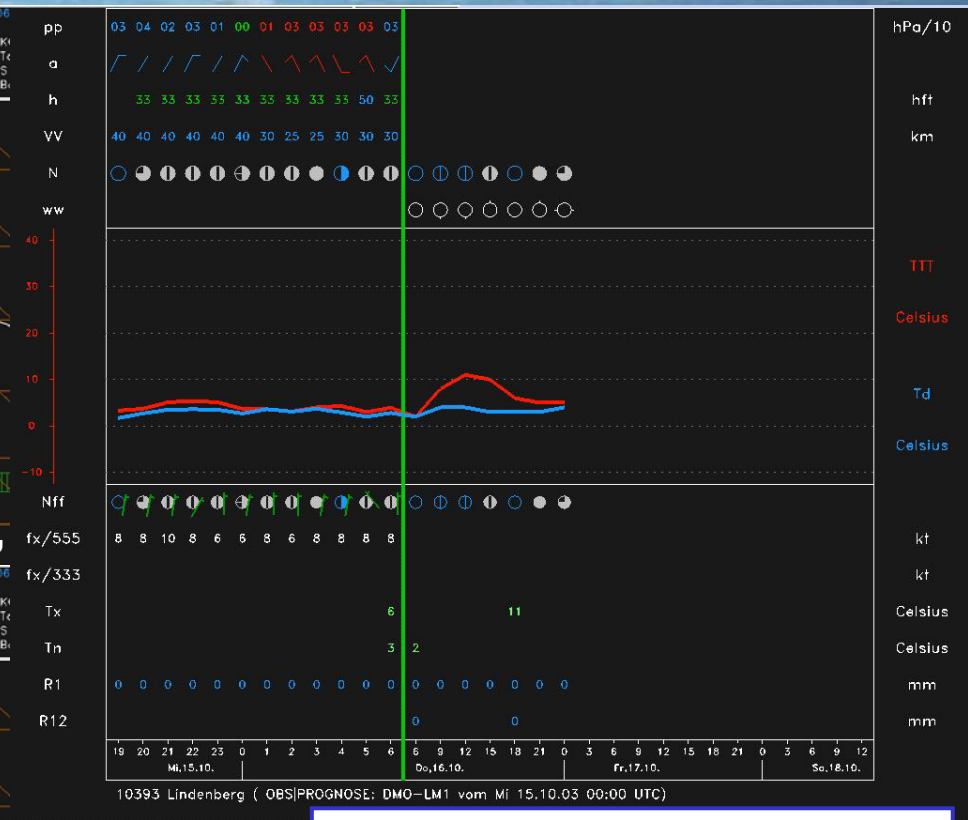
LM-Temp,



Lindenberg 16 Oct , 06 UTC



LM-Temp, 15 Oct, 00+30 H

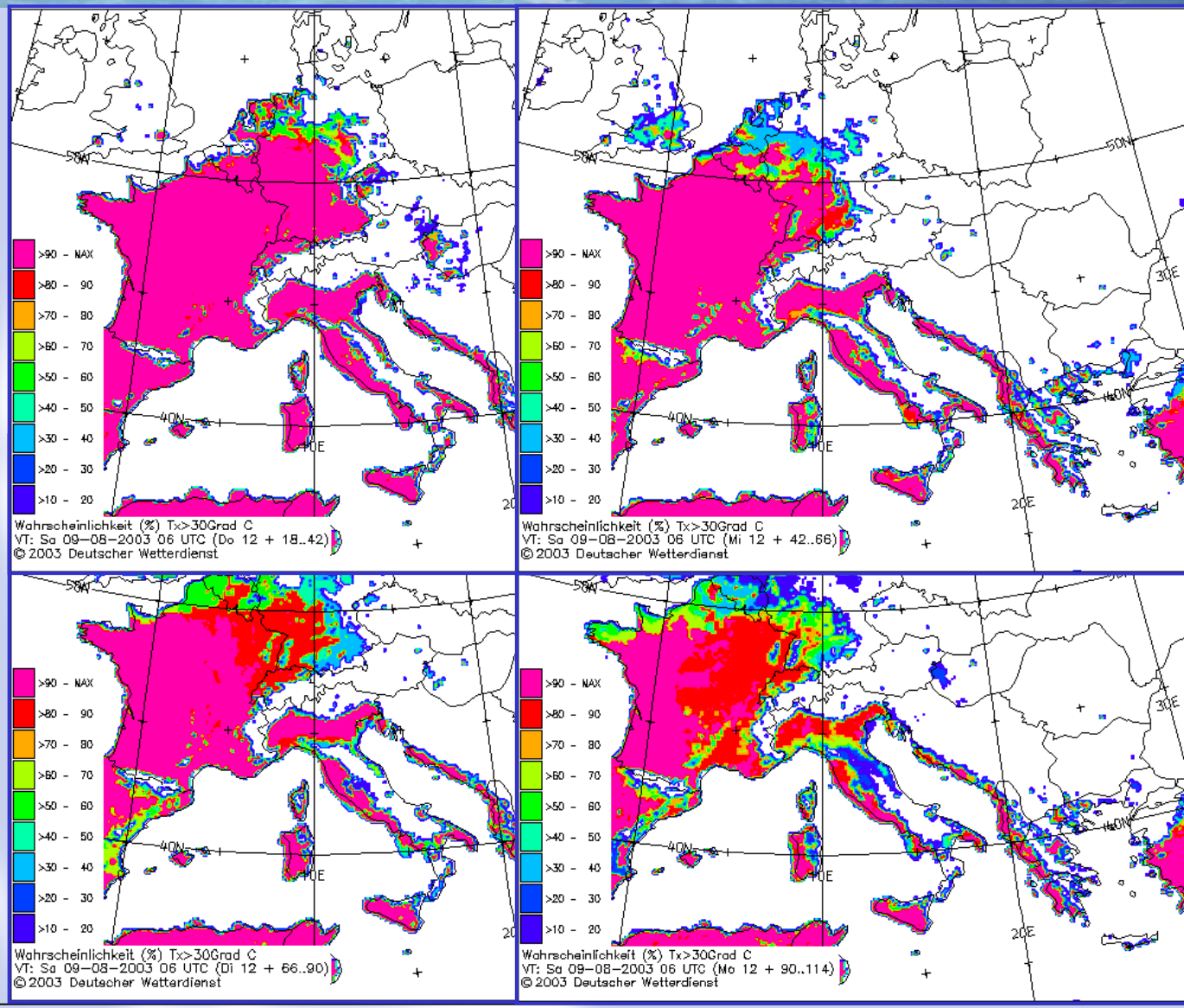


Lindenberg: LM 1/8 Sc
observed: 7/8 St
LM is reducing clouds from 06 UTC onwards !

COSMO-LEPS consequtive runs verifiing 08 Aug
prob´s Tmax > 30 C

left: H+18 ... 42
right: H+42 ... 66

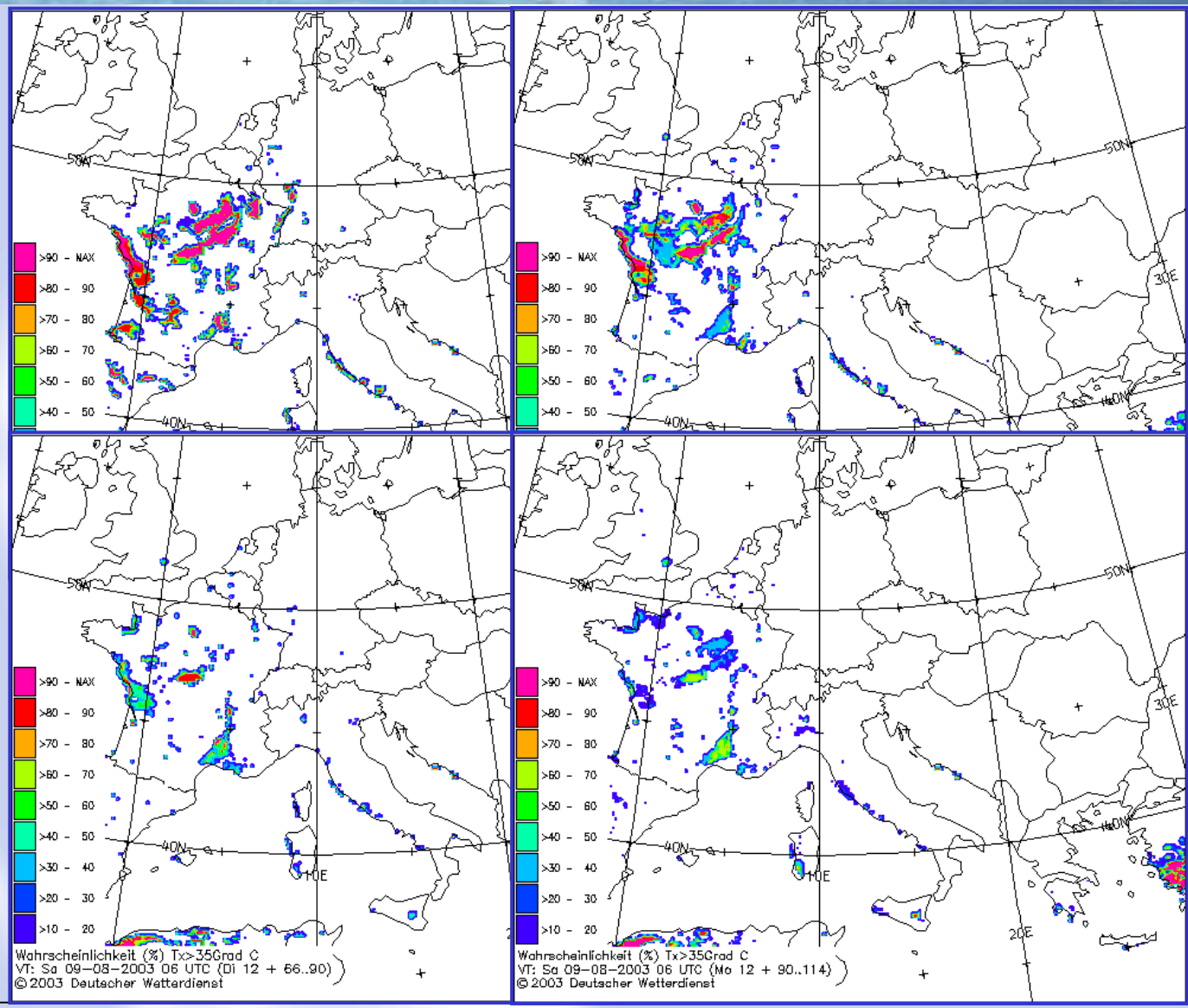
left: H+66 ... 90
right: H+90 ... 114

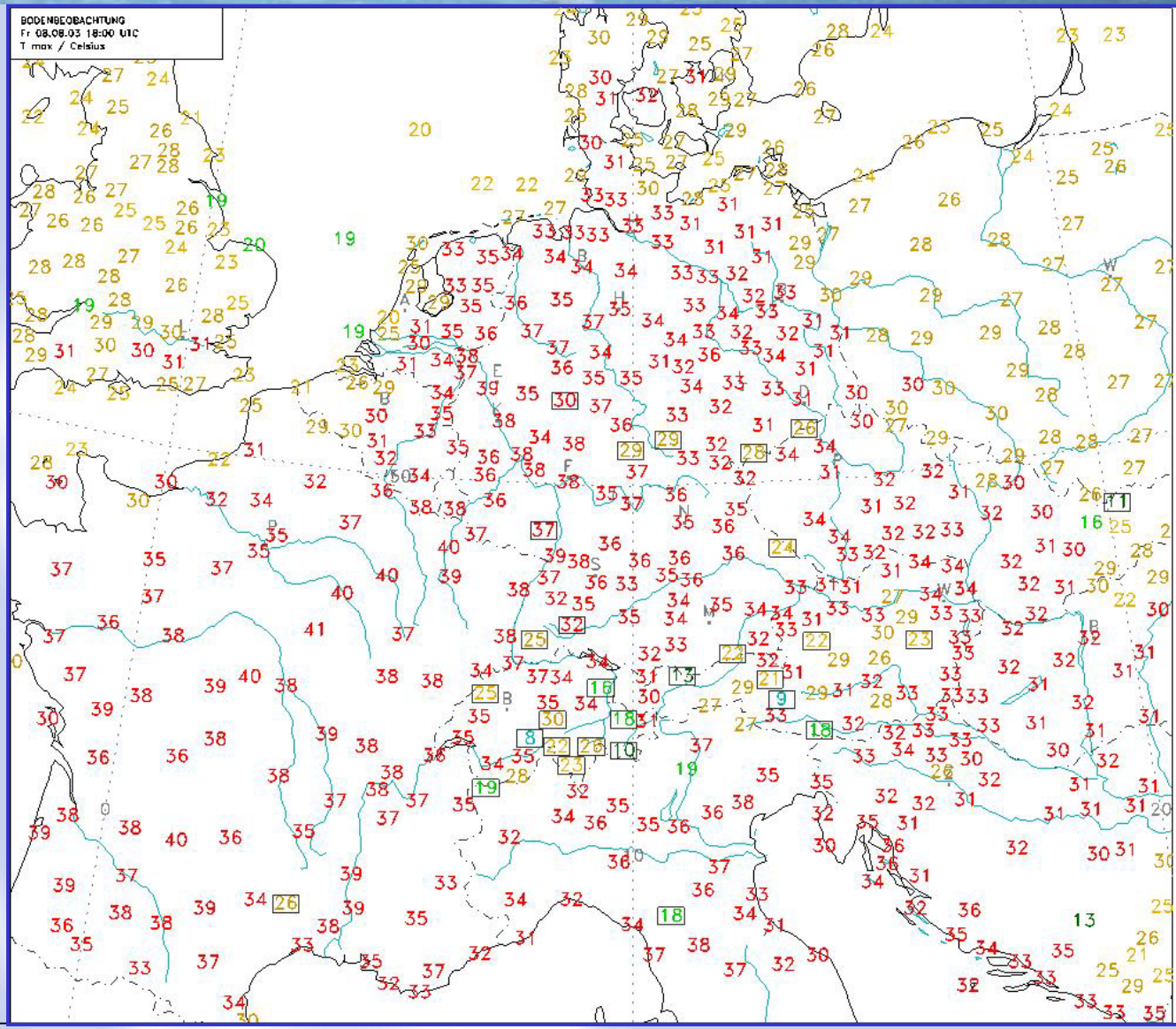


COSMO-LEPS consequtive runs verifiing 08 Aug prob´s Tmax > 35 C

left: H+18 ... 42
right: H+42 ... 66

left: H+66 ... 90
right: H+90 ... 114





8 Aug, 2003, 18 UTC
Tmax Obs

Results of the COSMO - LEPS verification

Parameter	Result	Comments
Minimum temperature / since autumn 2003	**No signal or wrong located**	**Don´t use the LEPS ! Prefer other methods !**
Maximum temperature	sometimes useful	realistic regional assignment of the signals, **poor for extreme events**
Wind gusts (non-convective)	fair, useful	gusts sometimes overestimated realistic presentation of orographic effects, without skill in med-range
Snow	not very well	realistic presentation of orographic effects, one case study only
large scale precipitation	fair, useful	realistic regional assignment of the signals, without skill in med-range
convective precipitation	**mostly no signal**	**The use if LEPS is not recommendable !**

- preliminary status - experiences obtained from several forecasters during semi-operational use
- Case studies ... Problem: lack of severe events
- High expectations to the LEPS - LEPS wasn´t able to meet our expectations (no skill in med-range)
- well-known problems of the LM- and the ECMWF (EPS- and T511) - forecasts (lower troposphere, conv precipitation) - LEPS couldn´t outperform the LM
- Acceptance by forecasters („LEPS not able to add value for severe weather fc´s, addition of errors from the LM and ECMWF model“)
- results of a simulation of „historic“ extreme weather events not known

Enhanced operational use in the future ?

5. Conclusions, outlook and future plans

DWD´s forecasts and warnings did´nt always met user´s requirements (several storm cyclones, flooding, ...)

↓

DWD is under pressure by private competitors, media, policy, people on the street: The DWD has to reduce it´s expenses

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Modification of the warning procedure (warning criteria changed, warnings better understandable, district - based warnings, ...)

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Reduction of the manned observation station network

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Improvements in remote sensing techniques (KONRAD, lighting registrations, MSG - 1)

↓

Changes in web policy

↓

New forecast methods
Introduction of EPS-based foresast tools EFI, COSMO - LEPS, probabilities, ...

Outlook, future plans

- Research and development: needs to improve the horizontal and vertical (!) resolution of the LM and the model physics
- District - based warnings: MOS as a guidance ? Which model ?
- Increasing number of (textual) products automatically generated, based on the LM, MOS, more and more on MMO
- MMO (Man Modified Output) - possibility to modify the model output „interactively“ by the forecaster
  - at certain time steps / time intervals
  - in selected topographical areas / at selected hight levels
  - weather parameter (temperature, clouds, snow or rain, . . .)
- The role of a forecaster is changing

Thank you !

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