The human factor in the severe weather prediction process

Forecaster
warnings and forecasts

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Outline

1. Introduction
2. Recent changes in NWP models at the DWD
3. Using EPS products in severe weather forecasting
4. Tools supporting the forecaster
5. Case studies
6. Conclusions

1. Introduction

- District - based warnings sinde early 2002

Sev warning criteria (well-tried - remain unchanged)

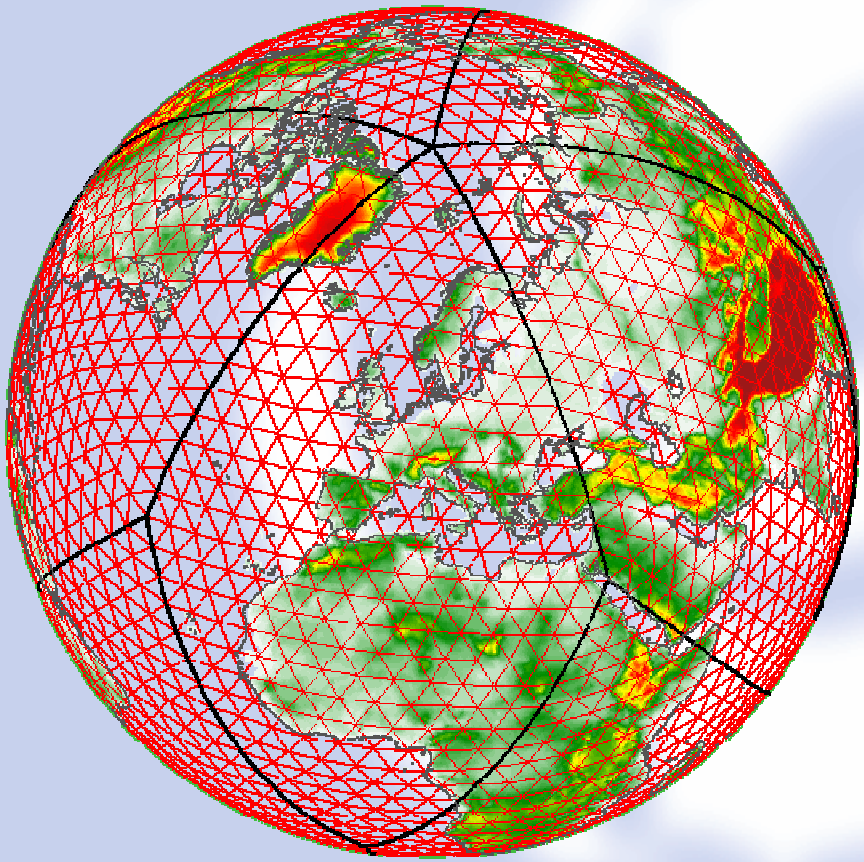
Parameter	threshold	extreme event
wind gusts	> 104 km per hour	> 140 km per hour
heavy rain	> 25mm / 1 hr	
	> 35mm / 6 hrs	
	> 40mm / 12 hrs	> 70mm / 12 hrs
	> 50mm / 24 hrs	> 80mm / 24 hrs
	> 60mm / 48 hrs	> 90mm / 48 hrs
snow	> 10cm / 6 hrs	
	> 15 cm / 12 hrs	> 25cm / 12 hrs
above 800 mtrs:	> 30 cm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

- Time of pre-warnings and the validity of warnings changed
- Use of prewarnigs unified

- **Severe weather pre-warnings - prepared and distributed in the case of large-scale (none-convective) events only - It´s a guideline !**
  - rapid snow melting
  - heavy snow / snow drift
  - heavy rain (none-convective)
  - Gale / gusts exceeding gale force

Parameter	Warning published before the onset of the event	Warning valid from ... to
Rapid snow melting	6 – 1 hours	12 – 24 hours
Heavy snow/ snow drift	6 – 1 hours	6 – 12 hours
Heavy rain (none-conv)	6 – 1 hours	12 – 24 hours
Gale / heavy gusts	6 – 1 hours	6 – 12 hours
Freezing rain	3 – 0 hours	3 – 6 hours
Heavy TS	1 – 0 hours	1 – 3 hours

2. Recent changes in NWP models at the DWD - from a forecasters view



GME

Grid structure:	**triangular**
partition index:	**192**
horizontal resolution:	**40 km**
vertical levels:	**40**
time step:	**133.33 s**

Important Changes:

- **Dec 2003: MODIS used, use of pseudo-profiles, derived from the ECMWF anal**
- **03/2004: significant improvement of the parametrisation of the distribution and development of sea ice**

----> more realistic mslp pattern over polar regions (Greenland ...)

Important Changes of the GME (continued):

- 09/2004: GME: 40 km, L40
  - levels below 800 hPa the same as ECMWF, first level in 10 m
  - introduction of the soil model (7 levels, better parametrisation of surface precesses (snow melting, freezing of water in the soil, ...)

  ----> forecasts of T2m and Td2m has been improved
- 08/2005: modification of the friction length

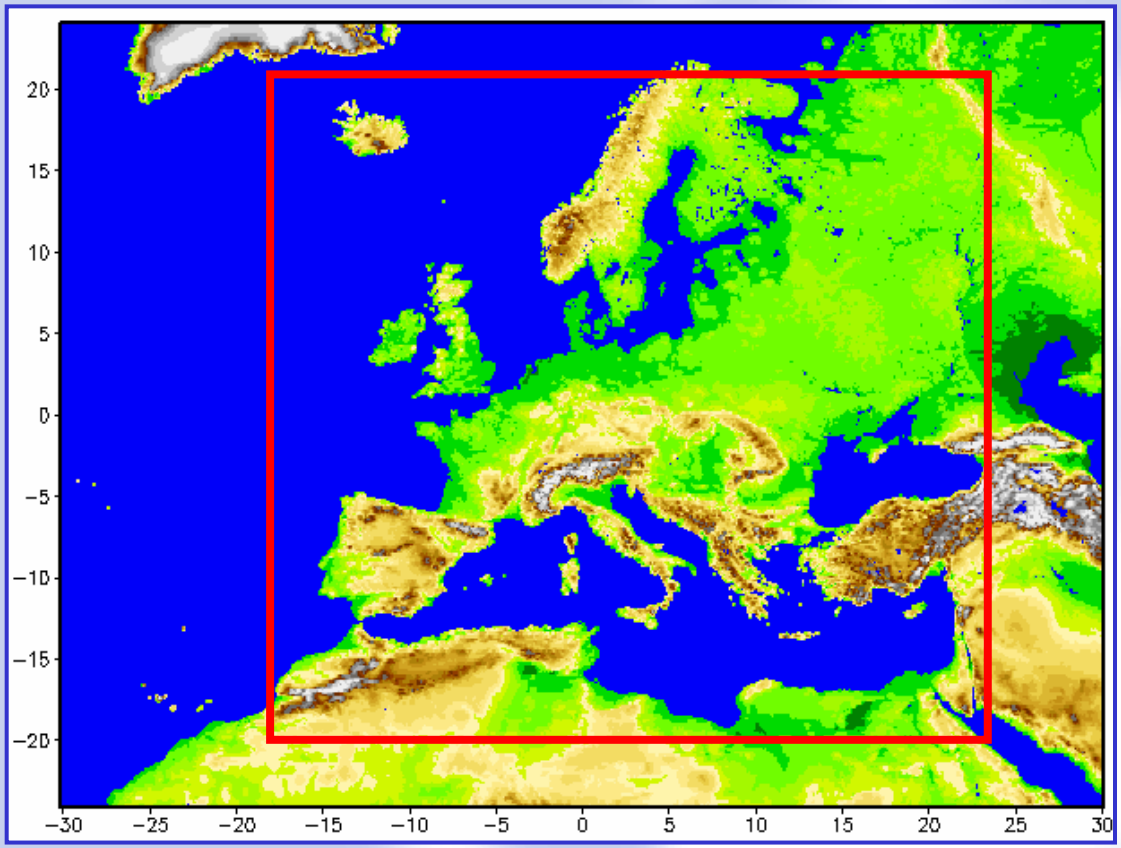
  ----> preventing of unrealistic wind gusts in mountain areas

Important Improvements of the Local Model

- 04/2004: Drift of hydrometeors ----> prevents „dry valleys“ and an unrealistic high values of precip max on the windward side of mountains
- 07/2004: Wind profiler data used
- 10/2004: Introduction of the predicted precip used for initial conditions
- 08/2005: Reduction of the evaporation over water

  ----> more realistic slp pattern and accumulated precip totals

- **09/2005: Introduction of the LME - domain Europe, ... T + 78 h**



LME

grid structure: 665 x 657 x L40
horizontal resolution: 7 km
(0.0625° x 0.0625°)
time step: 40 s

Several model changes initiated by the working group „Evaluation of the NWP system“ in cooperation with the Central Forecasting of the DWD !

3. Using EPS products for severe weather forecasting

„typical“ EPS products from the ECMWF (clusters, EPSgrams, EFI, ...) **But:**

- Severe weather events are mostly rapid-developing and short-living
- scale of these events synoptic or (mostly) smaller
- role of the orography, surface characteristics ... severe weather pattern could be weakened or enhanced ---> poorly represented by the model

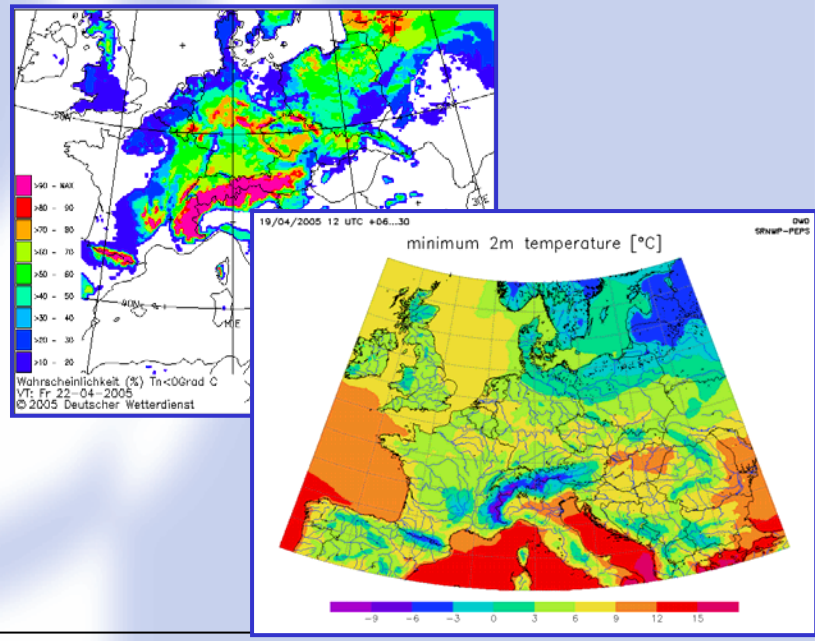
Way out (?): High resolution models (HRM)

- LM, ALADIN, ...
- COSMO-LEPS (see Andrea´s talk)

- PEPS (Short Range Numierical Weather prediction Poor Man EPS - see later)

↓

- creating tailored products predicting severe weather in the meso-scale



PEPS - How does ist work, how it could be used ?

Included Deterministic LAM´s:

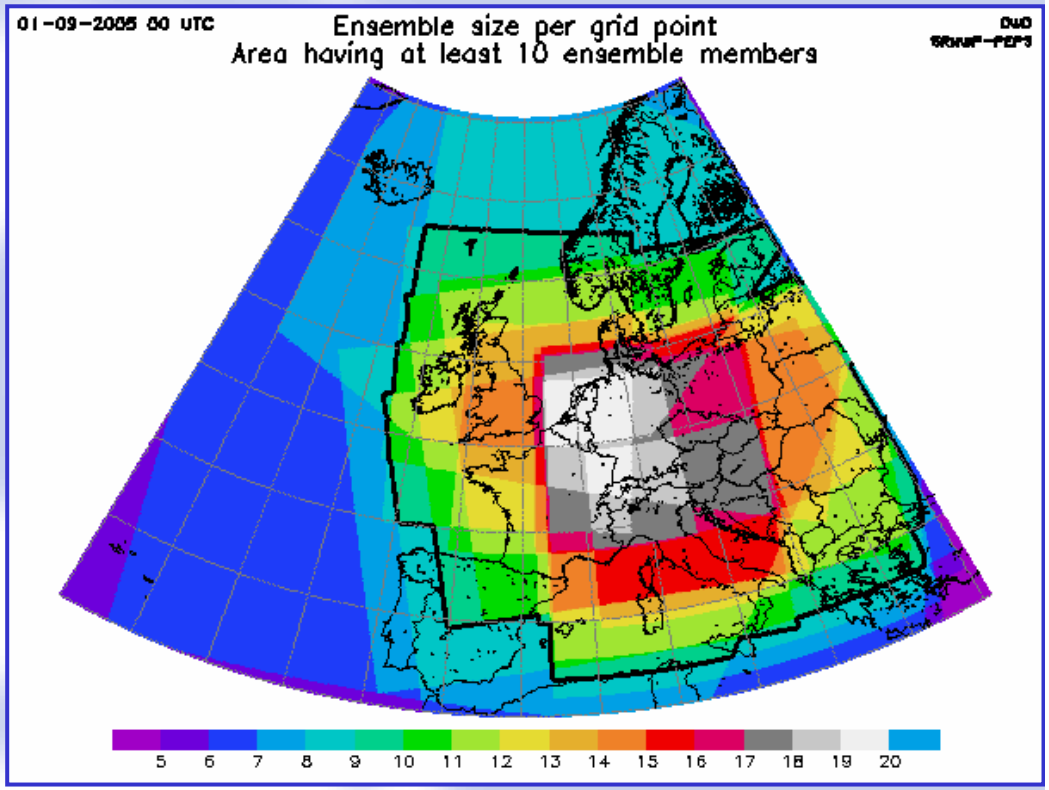
- HIRLAM- und ALADIN-consortia,
- UM-LAM, UM-NorthAtlantic
- aLMo, LME, EuroLM

Size Maximum of the EPS:

00 und 12 UTC:	22 models
06 UTC:	9 models
18 UTC:	10 models

Products interpolated to 7 x 7 km mesh size, available:

- EPS mean
- Probabs for certain thresholds
- EPS size



Several parameters available !
But: Fc´s up to 30 hrs only !

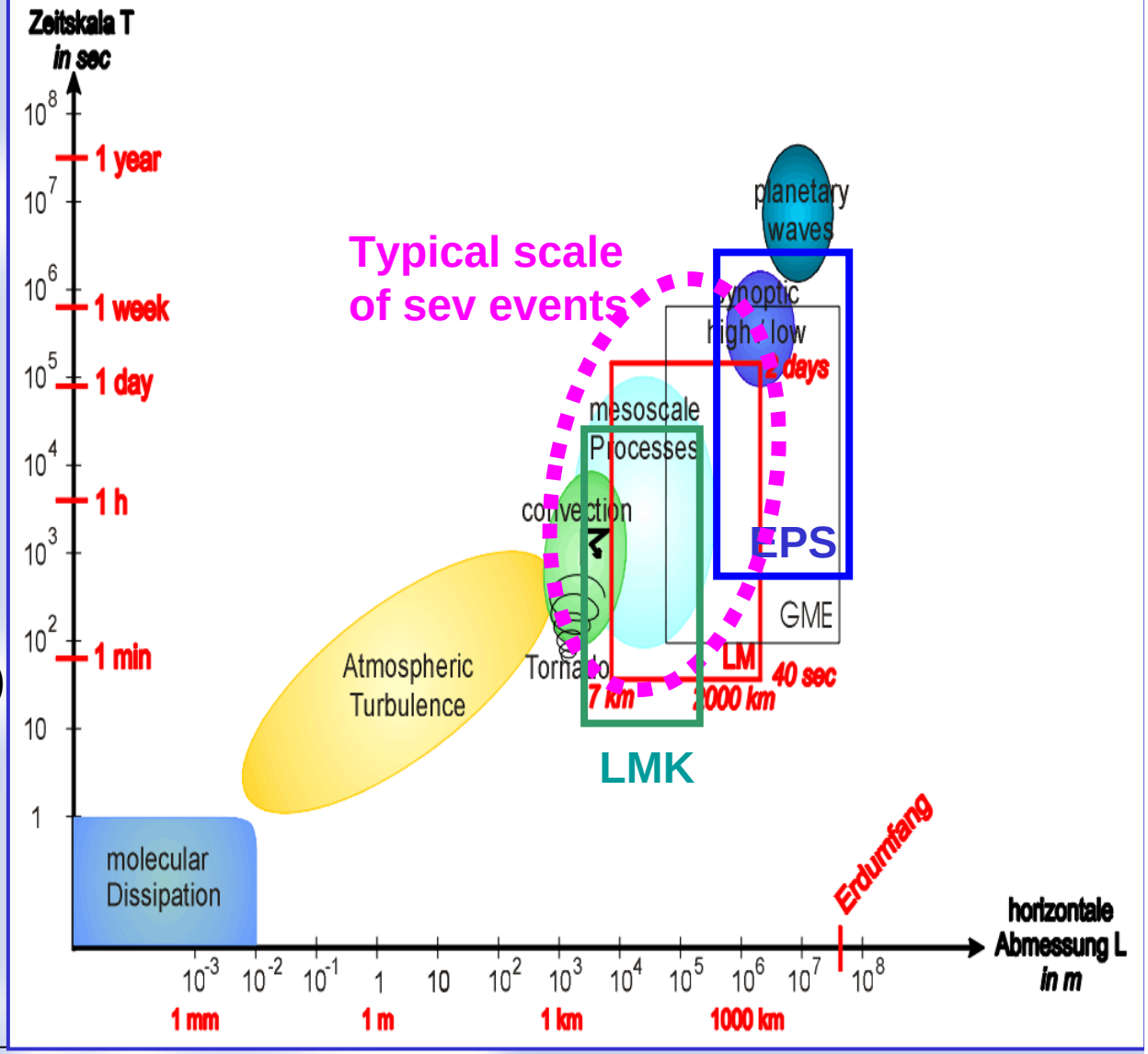
Forecasts will be provided for partner organisations and DWD (Intranet) !

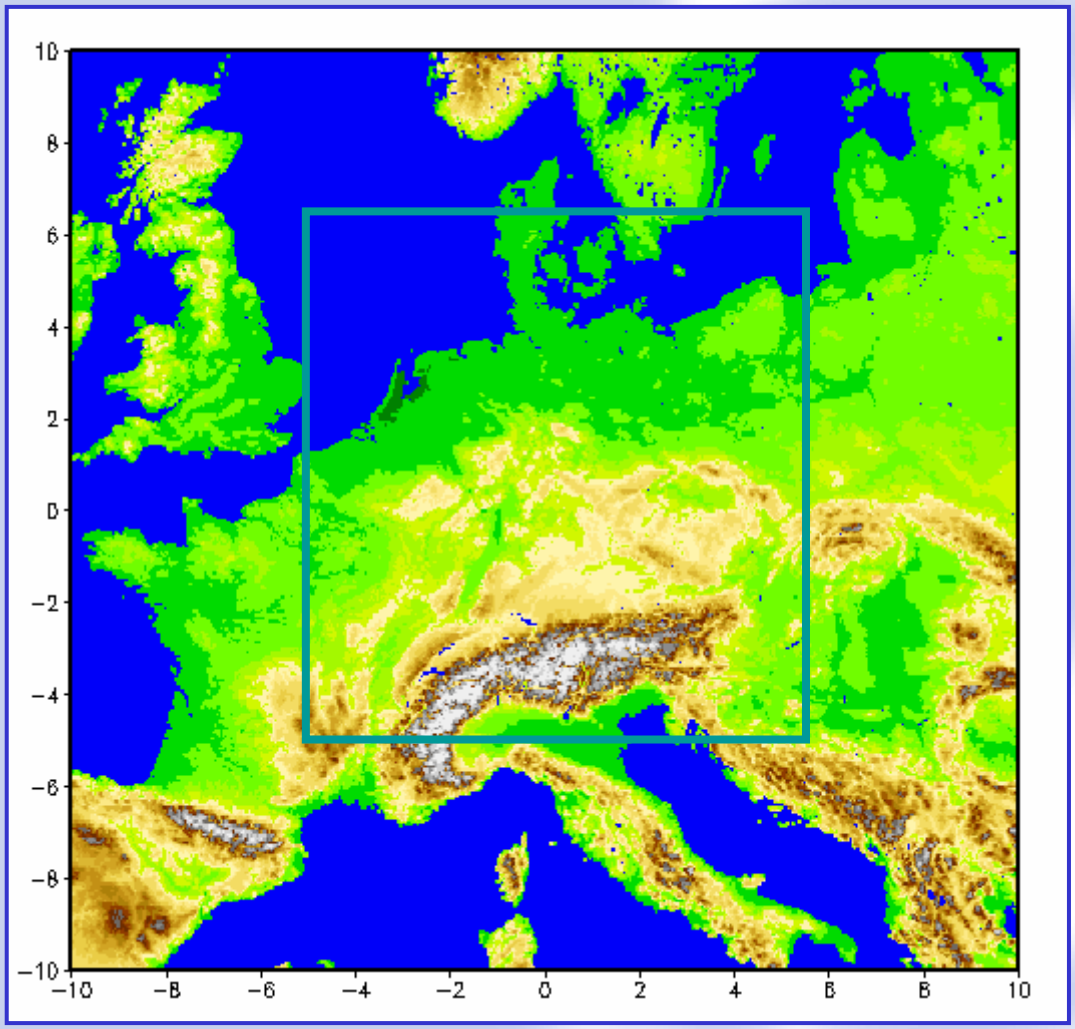
More information (contributing models,...) http://www.dwd.de/en/FundE/Projekte/PEPS/index.htm

Problem: Chaotic behavior of severe weather related pattern

Models (and also HRM´s as well as LEPS and PEPS) not able to deal with

- severe events caused by strong convection
- severe weather related with a high baroclinic instability





LMK

grid structure: 421 x 461 x L 50
horizontal resolution 2.8 km
(0.025° x 0.025°)
time step: 30 s

- **developing convection patterns (convection not has to be parametrisized any longer)**
- **T + 00, ... T + 18 h**
- **Start every 3 hours**
- **creating an ensemble from overlapping LMK-runs**

LMK is under development !

4. Tools supporting the forecaster

Problem: Vast amount of information

Analysis

LME - future: LMK

GME

GMOS, MMO

DMO, KALMAN

ECMWF / EPS

COSMO-LEPS

PEPS

External NWP models

Observations

Other staff members, regional weather centers

Plots (as hard copies)

MAP

PC - Internet, Intranet, textual forecasts

Workstation - Satellite

Workstation - IGS for production of weather maps (SWC, sfc fc´s)

Not to be seen:
PC - Radar

Folders (instructions, ...)

- How select the most relevant ones ?
- How access the selected information as quickly as possible?

----> NinJo

NinJo - from a forecasters point of view

Technical details: B. Reicherts talk

Objective: Creation of a system that substitutes several aging components

MAP, IGS, Sat, ... : fulfil users requirements

But: Systems aged, difficult to maintain and expand (for new data, products, ...)

Requirements and expectations from users (forecasters team):

- **If NinJo should replace the currrent systems it has to contain at least the same functionality as MAP, IGS, Sat, ...**
- **The use of NinJo should be similar to current systems**
- **New functions should be easily to learn**
- **Favourite handlings, loadings, savings: the same handling and functionality as the Windows explorer**

The Evaluation process

New version (x.yy)

↓

Implementation of x.yy
in the Central forecast Office

↓

Evaluation of x.yy

↓

Detection of bugs

2 ... 4 weeks

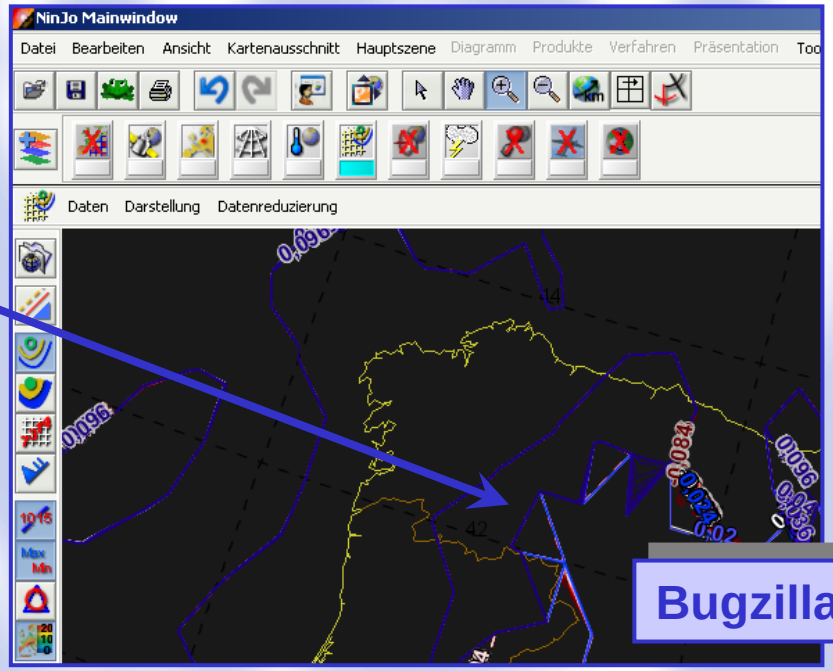
Improvements

Other user
requirements

Evaluation reports
priority list

Evaluation workshop
(DWD, GeoBW, DMI,
MeteoSchweiz, MSC)

1 ... 2 x per annum



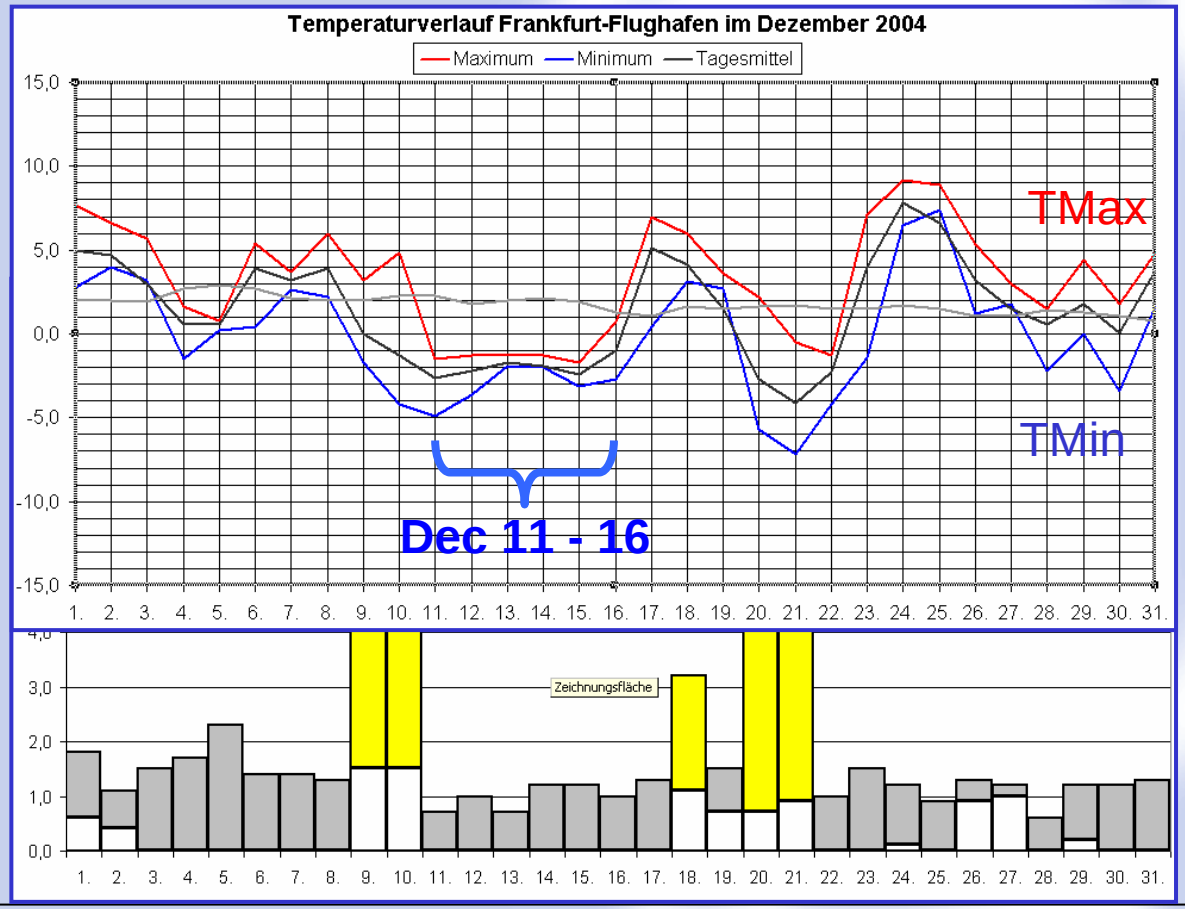
Bugzilla

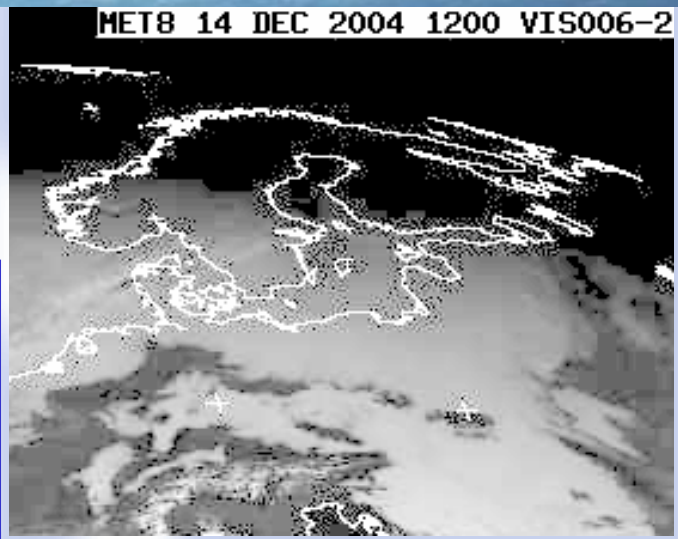
New
version

Report to the
development
team

5. Case studies

1. Blocking situation over C- and SE-Europe



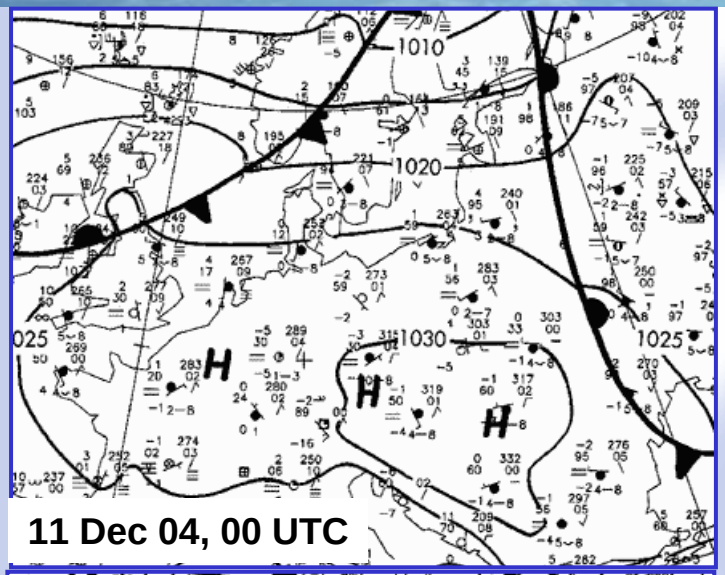


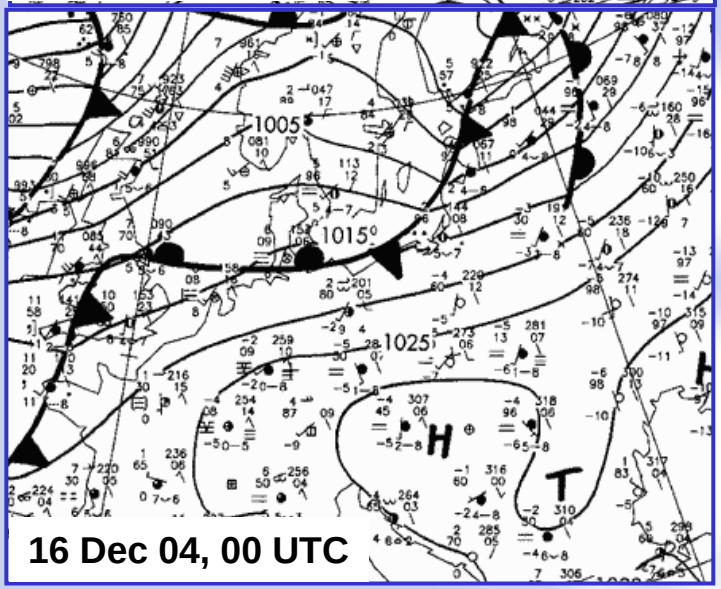
MSG-8, 14 Dec, 12 UTC Vis

Temperature
daily mean

Sunshine duration

Frankfurt, Dec 2004

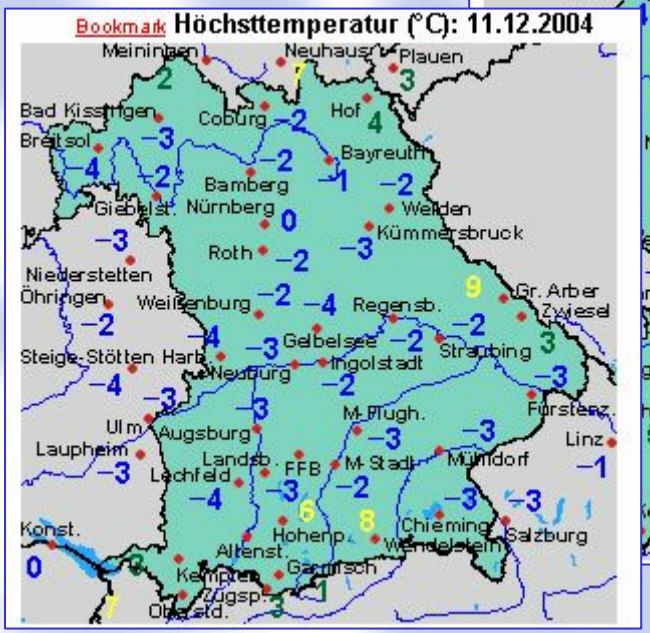


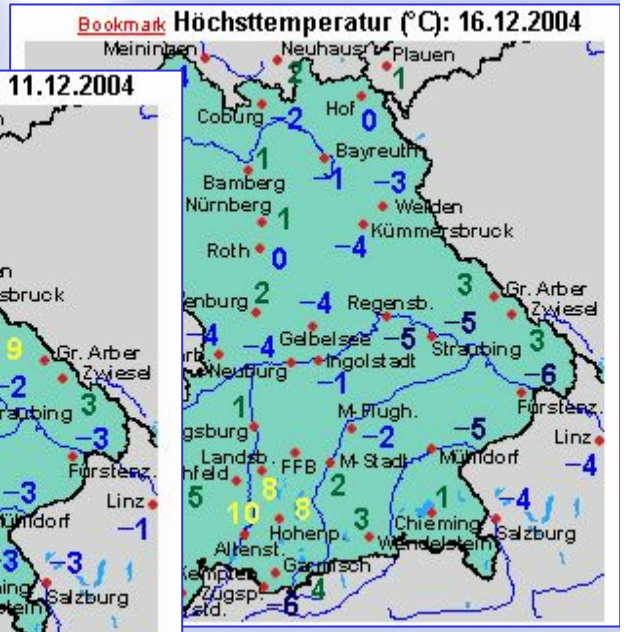


MSL analysis: dominating role of a blocking high over central and SE-Europe

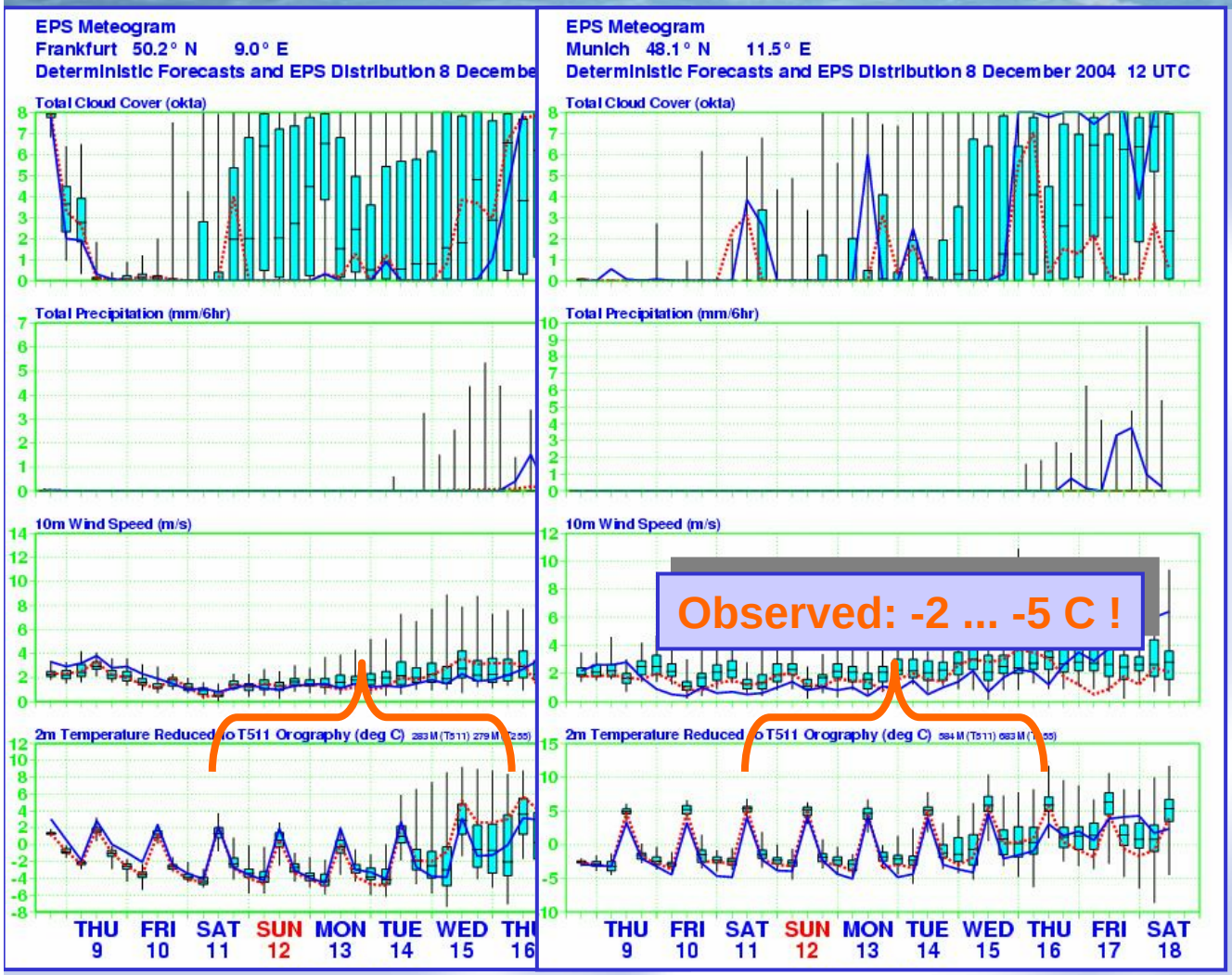
Result: Strong inversion situation, cooling of the PBL, St-clouds, temperature bias up to 10 K !

Synoptic pattern well predicted ---> Correction of automatically generated fc´s (if possible) in the med-range !





www.wetteronline.de



Similar inversion situation this autumn (29 - 31 Oct. 2005)

Low clouds and daily cycle of temperature not predicted very well

Tfc (MOSMIX) - TObs 31 Oct 05, 12 UTC up to 8 K !

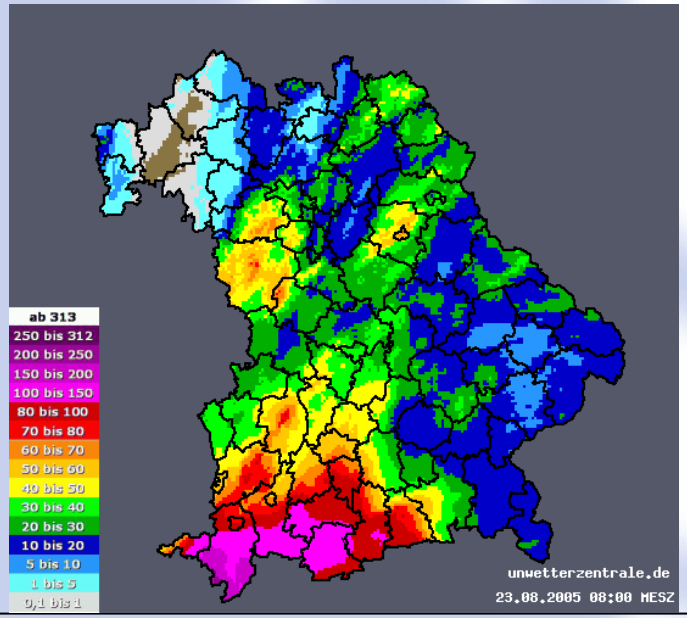
New PBL scheme - parametrisation of low clouds improved (?)

2. Flooding, north side of the Alps, 19 - 25 Aug, 2005

Maximum of the precipitation event: Allgäu Alps, 22 - 23 Aug, 2005

6 hr accumulated:	106 mm	Mindelheimer Hütte
24 hr:	217 mm	(2058 m asl)
48 hr:	252 mm	Nebelhorn
120 hr:	286 mm	Mindelheimer Hütte

---> over wider areas > 200 mm / 72 hr



But: It was´nt a record - breaking event !

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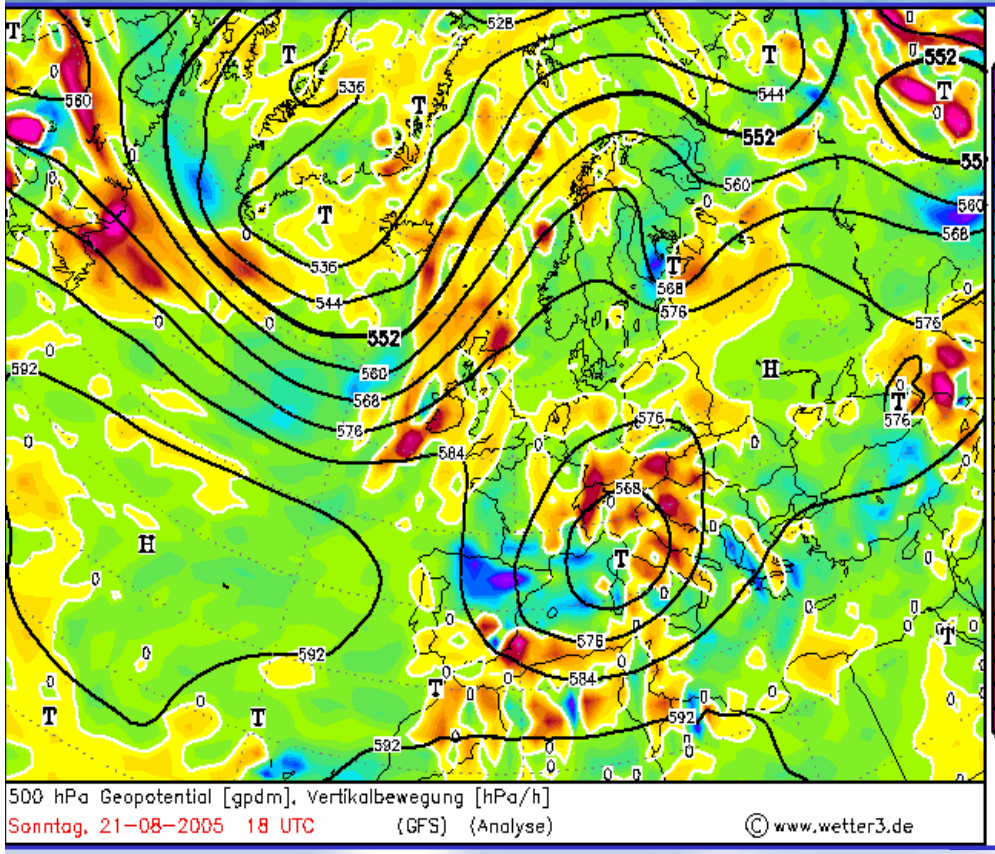

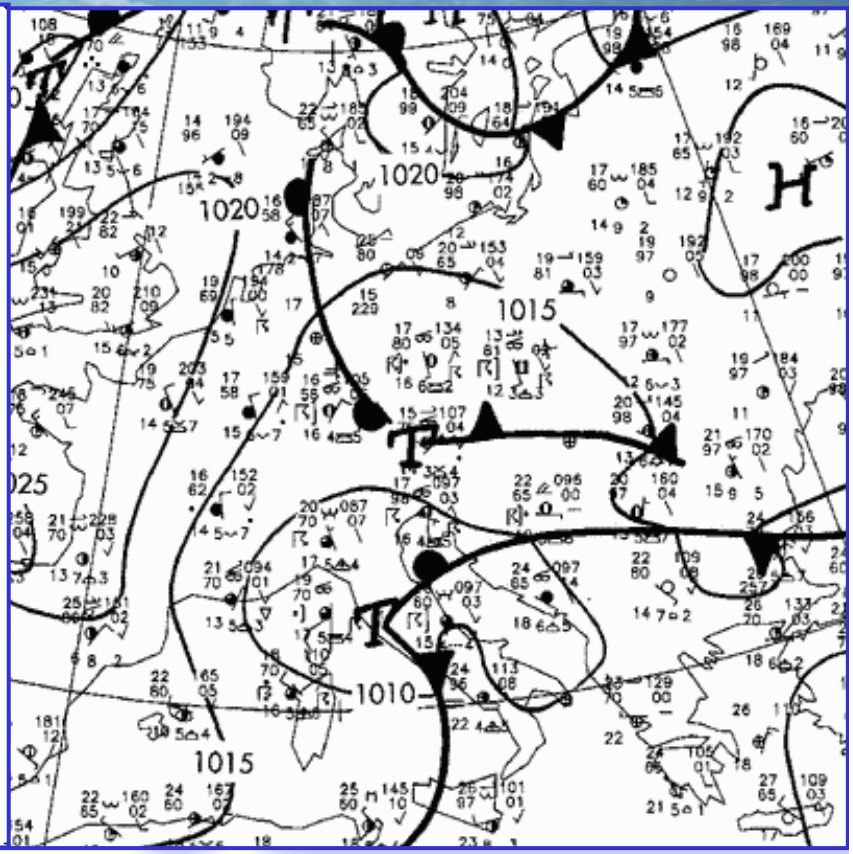

Z500 + vertical velocity, 21 Aug, 18 UTC

Sfc Analysis, 21 Aug, 18 UTC

Vb - like situation: Intrusion of warm and humid air from the Med Sea on the northern side of a cut-off low

Intensification of the precip on the windward side of the Alps !

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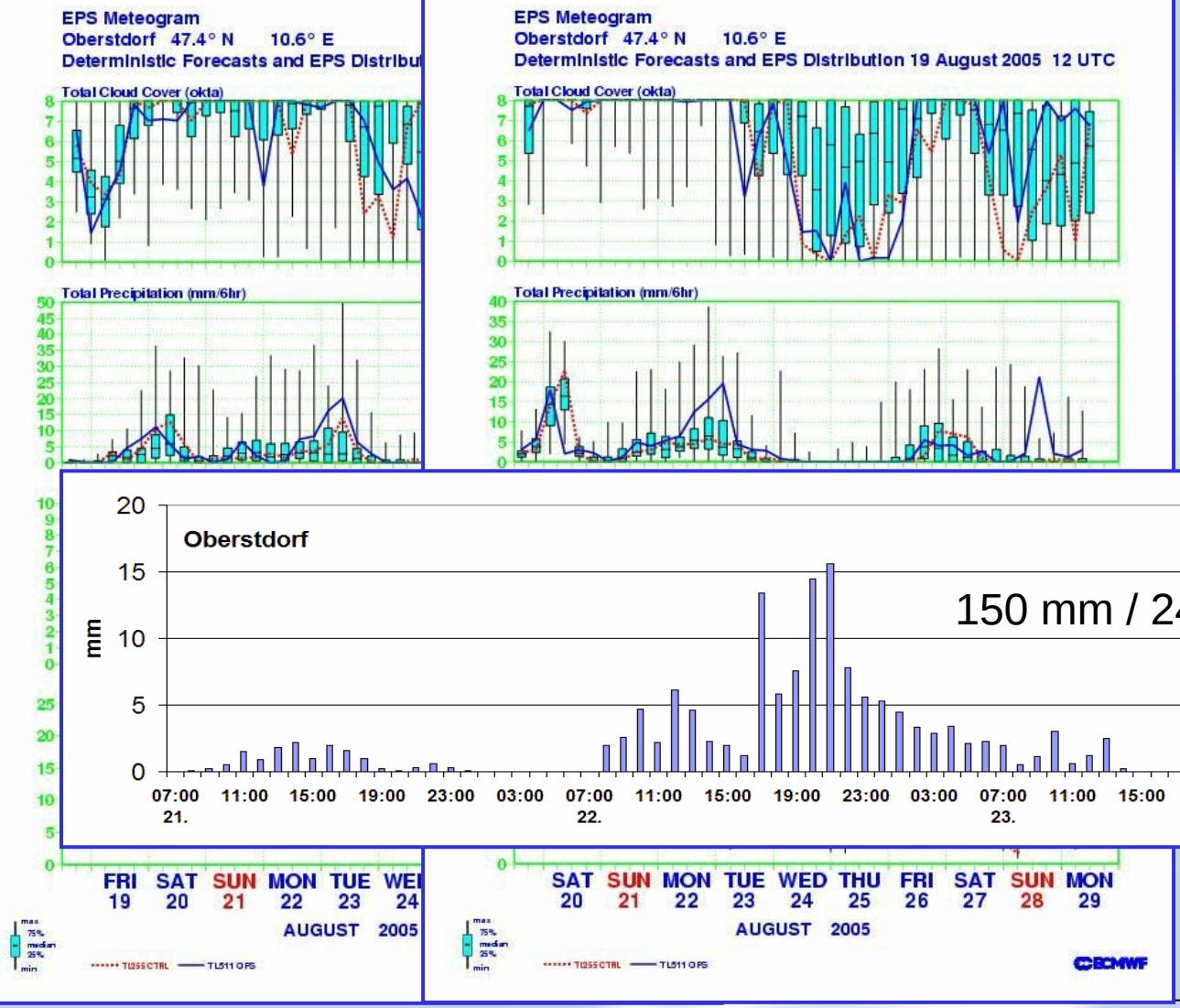
18 Aug 05, 12 UTC

19 Aug 05, 12 UTC **Metgrams: prepared from Cihan Sahin, Metops, ECMWF**

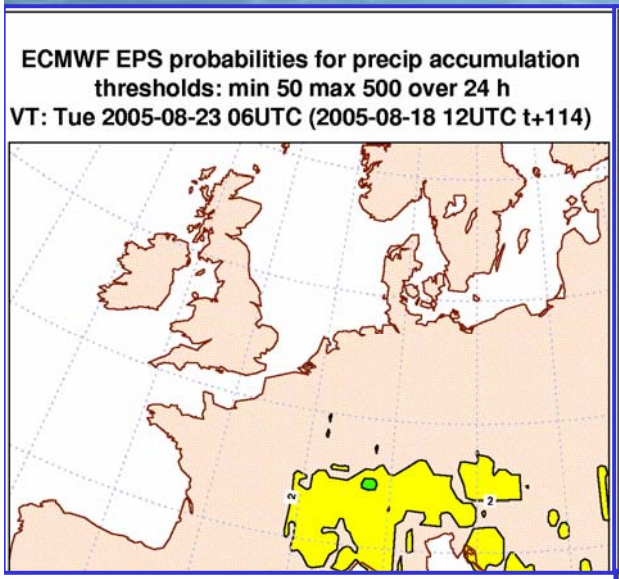


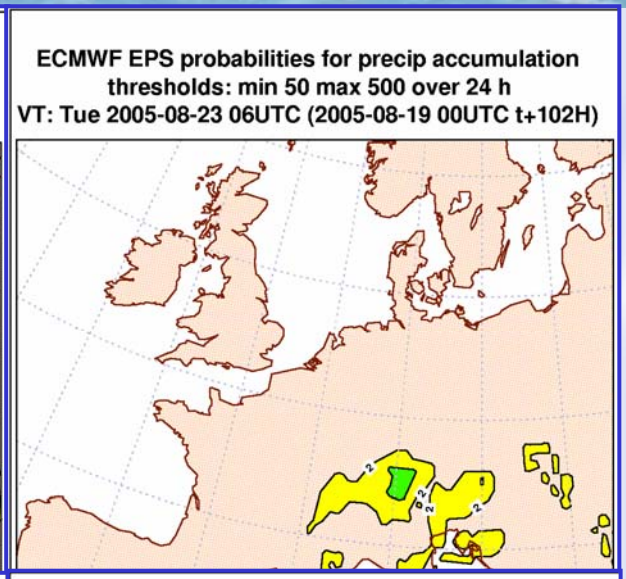
Onset of the event and it´s end well predicted by the EPS already in the early medium range

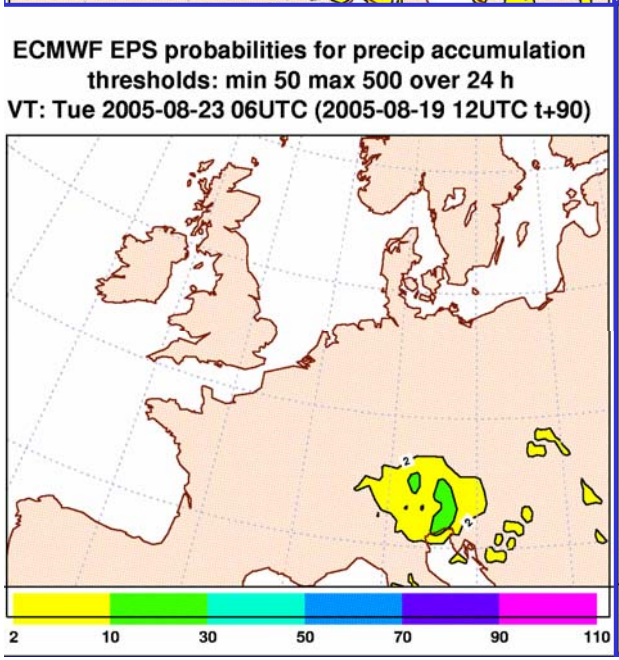
Risk assessments / early warnings issued

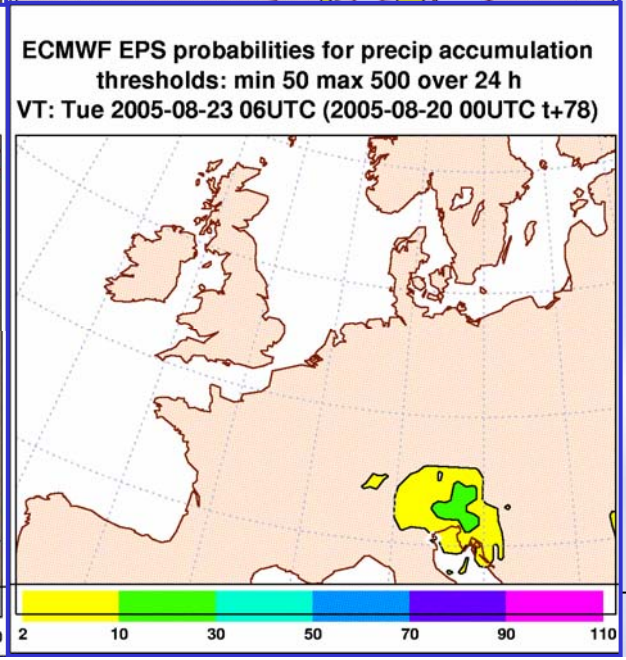
Observed precip (1-hr values !)

Courtesy of Rudolf, B., H. Frank, J. Grieser, G. Müller-Westermeier, J. Rapp, W. Trampf: Niederschlagsvorhersage, Warnungen und hydrometologisch-klimatologische Bewertung des DWD









Runs 18 Aug 05, 12 UTC
19 Aug 05, 00 UTC

Signal persistent and correct situated

Runs 19 Aug 05, 12 UTC
20 Aug 05, 00 UTC

Signal shifted to NE Italy / Slowenia !

How did COSMO-LEPS and PEPS performed?

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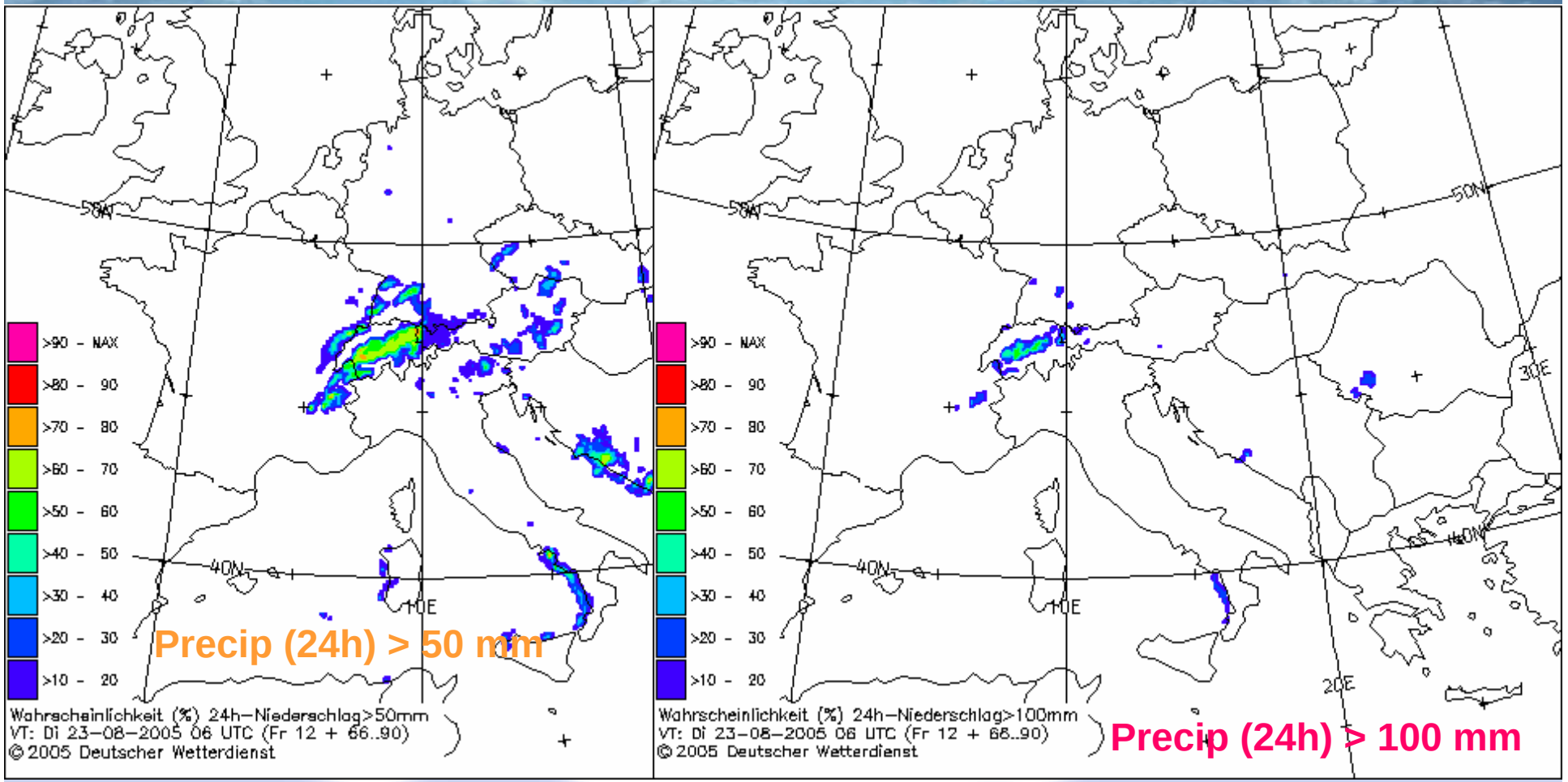

LEPS 19 Aug, 12 UTC - available 20.08.05, 05 UTC

Ealier runs were without of any useful signal

Courtesy of D. Heizenreder: Hochwasserlage in Bayern 22.-24. August 2005

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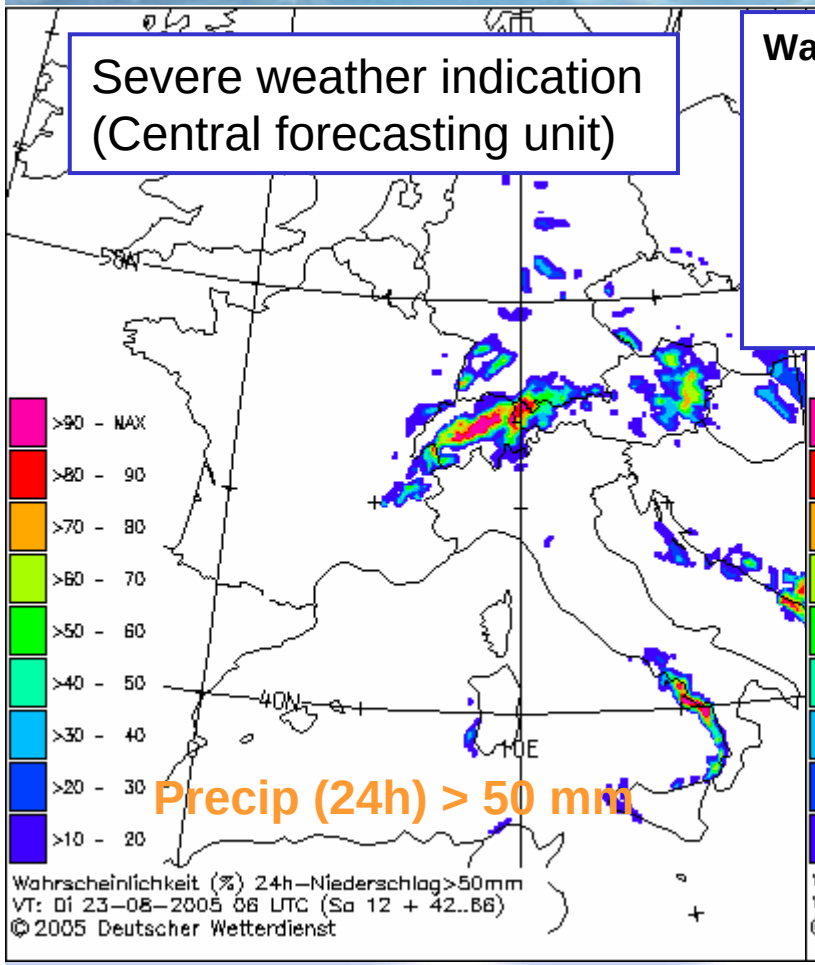
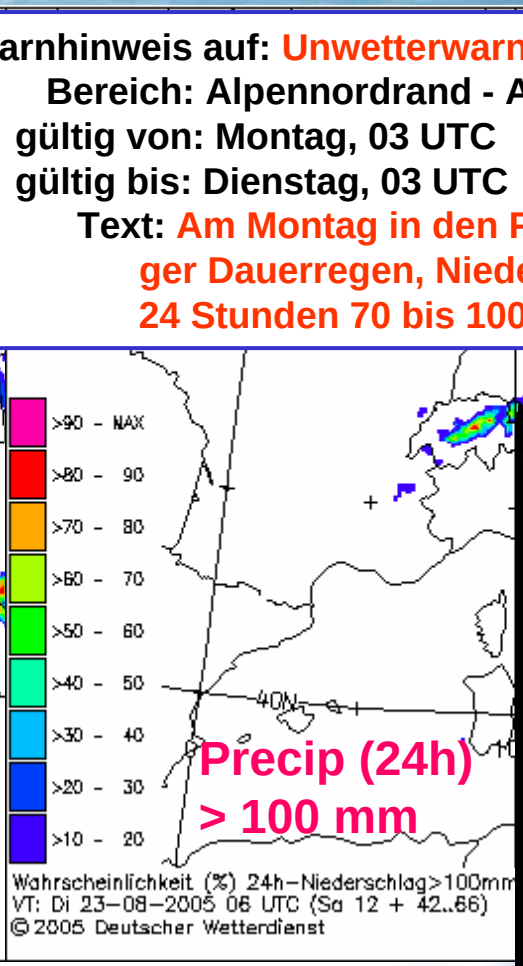
Severe weather indication (Central forecasting unit)

Warnhinweis auf: Unwetterwarnung vor ergiebigem Dauerregen
Bereich: Alpennordrand - Allg. und Bay. Alpen
gültig von: Montag, 03 UTC
gültig bis: Dienstag, 03 UTC
Text: Am Montag in den Frühstunden einsetzend ergiebiger Dauerregen, Niederschlagssummen innerhalb von 24 Stunden 70 bis 100, örtlich bis 120 mm.



Precip (24h) > 50 mm



Precip (24h) > 100 mm

LEPS 20 Aug 05, 12 UTC - available, 21 Aug, 05 UTC

Severe weather warning, issued from the Regional weather centre Munich

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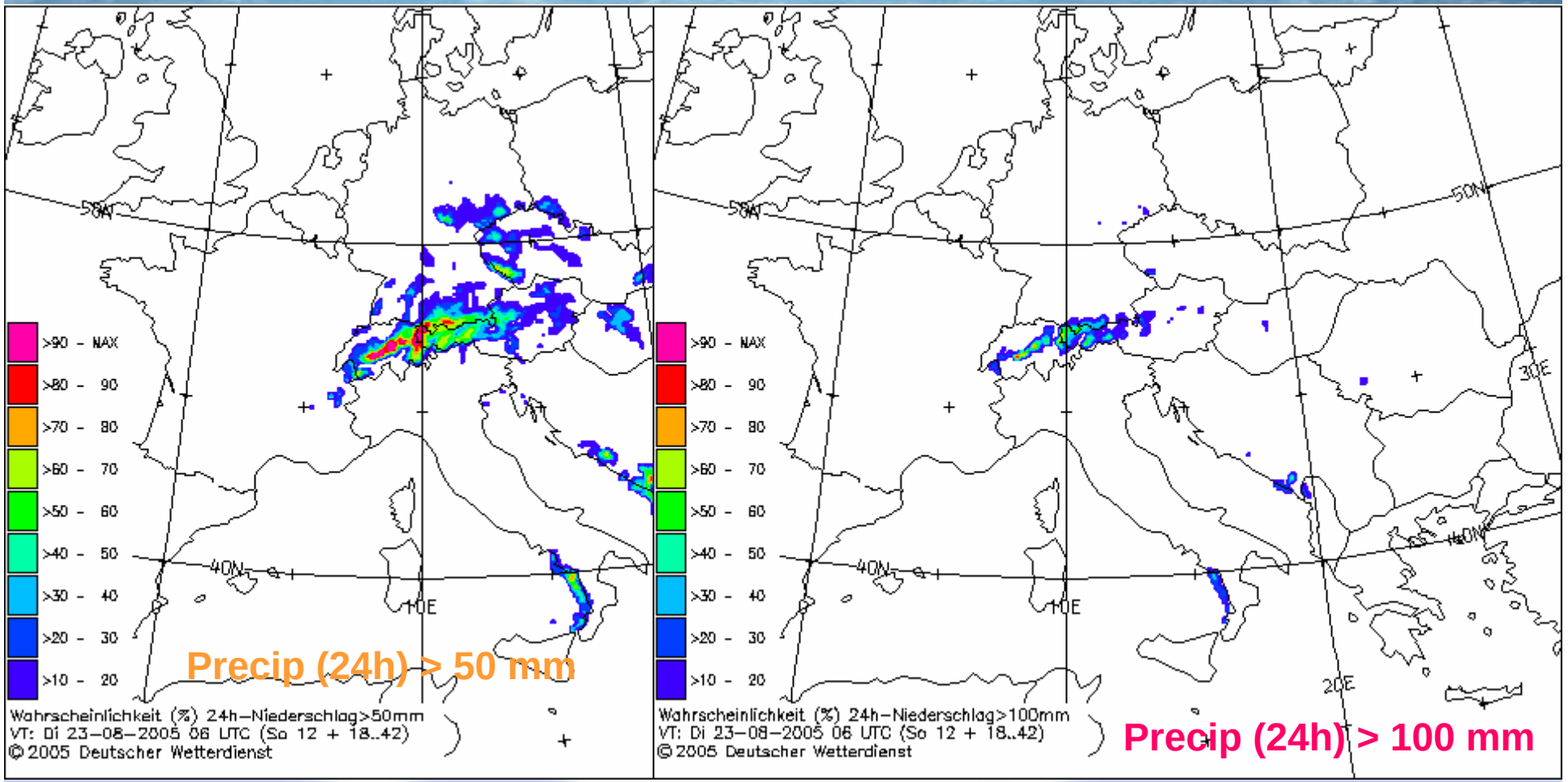
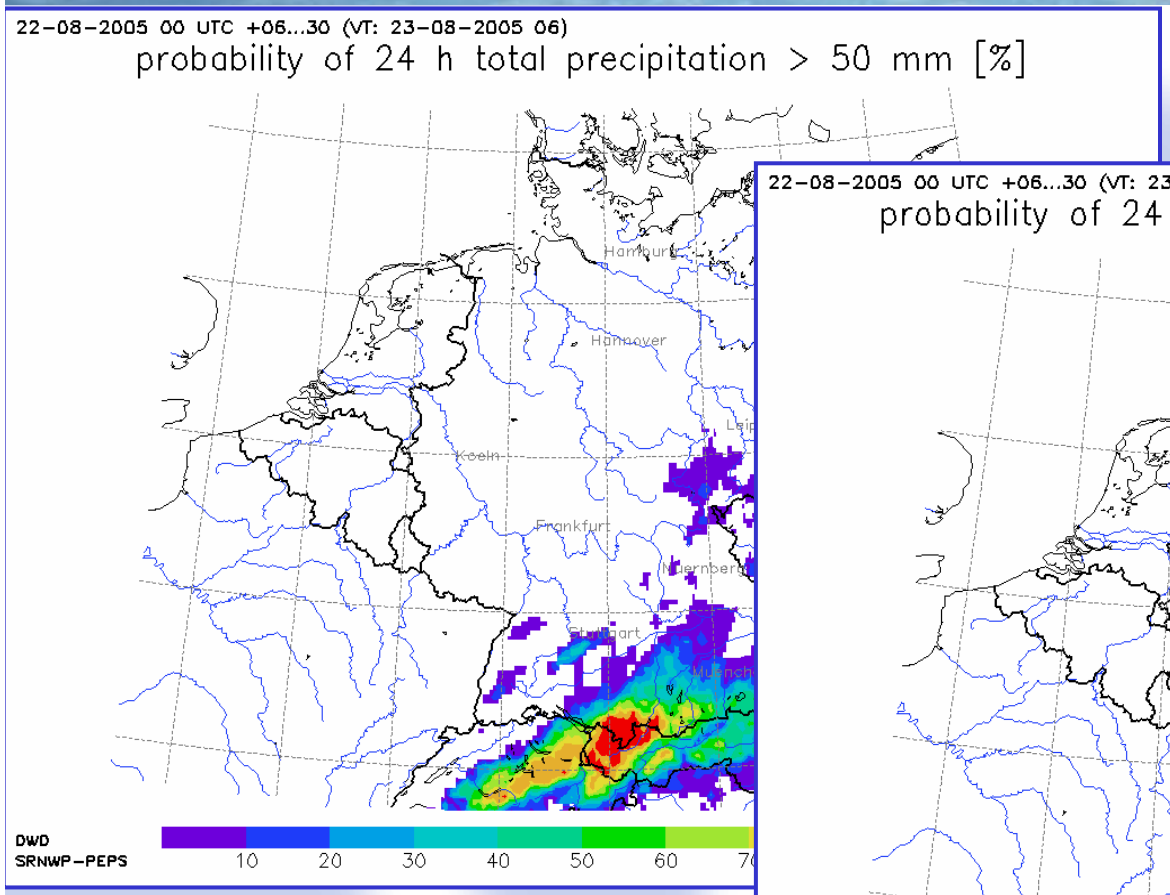
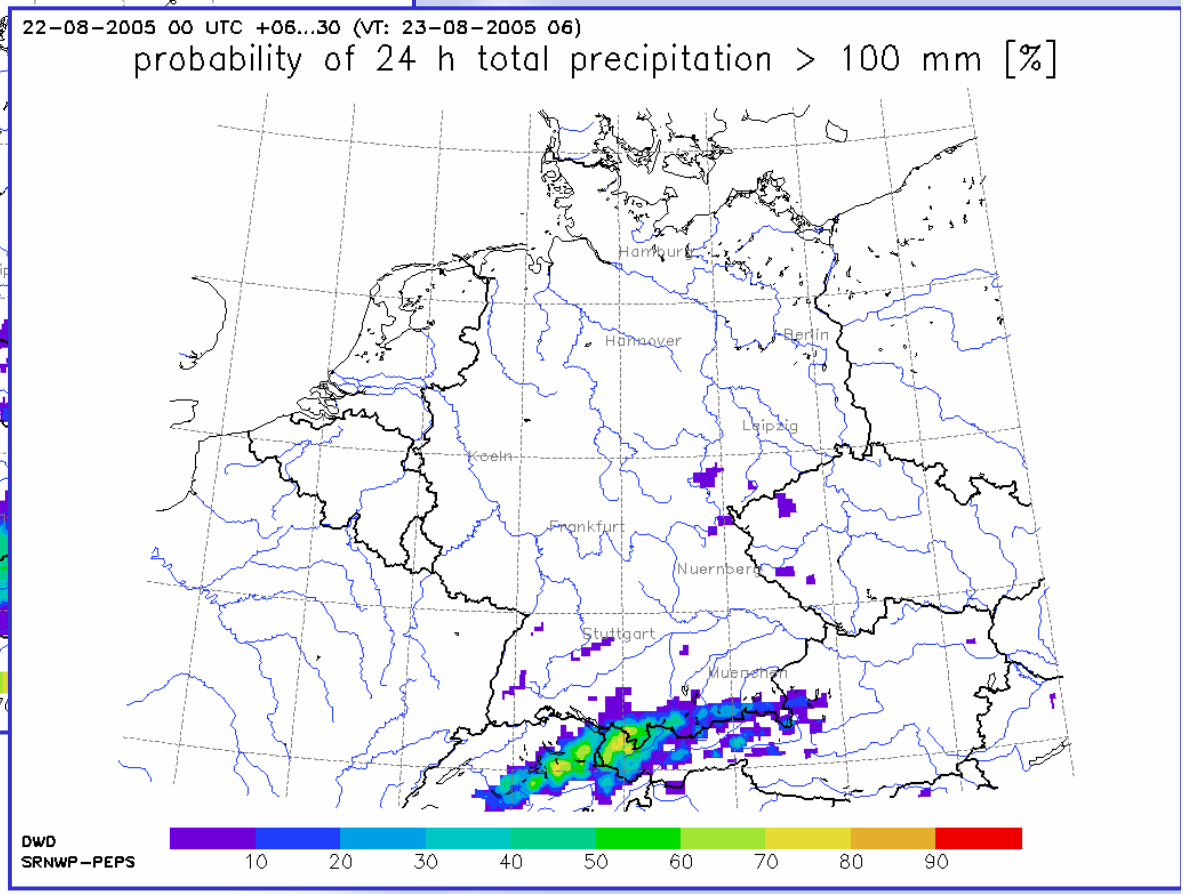


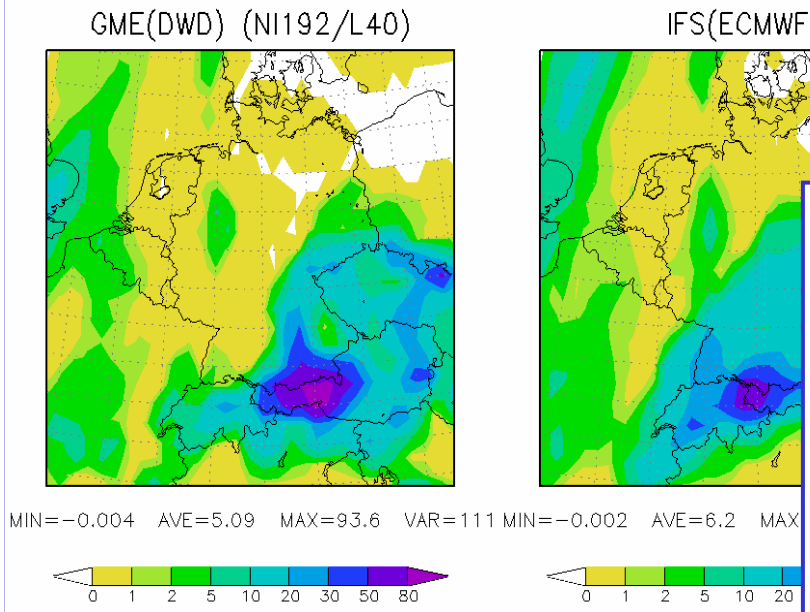
LEPS 21 Aug 05, 12 UTC - available 22 Aug, 05 UTC





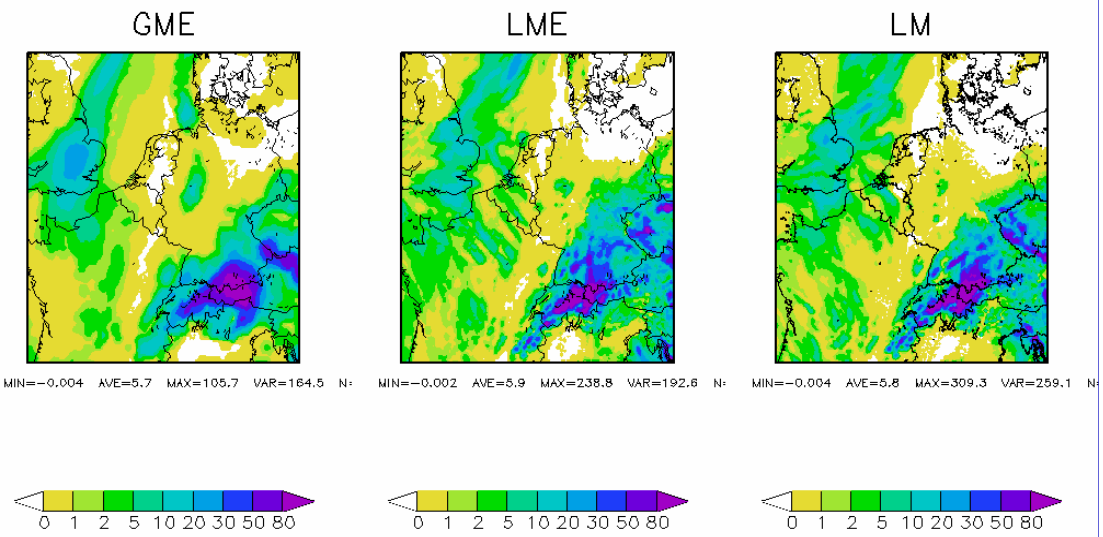
PEPS 22 Aug 05, 00 UTC - available 22 Aug, 08 UTC

Tue 06Z23AUG2005 (Sun 00 +54): 24 h Precip. [mm]



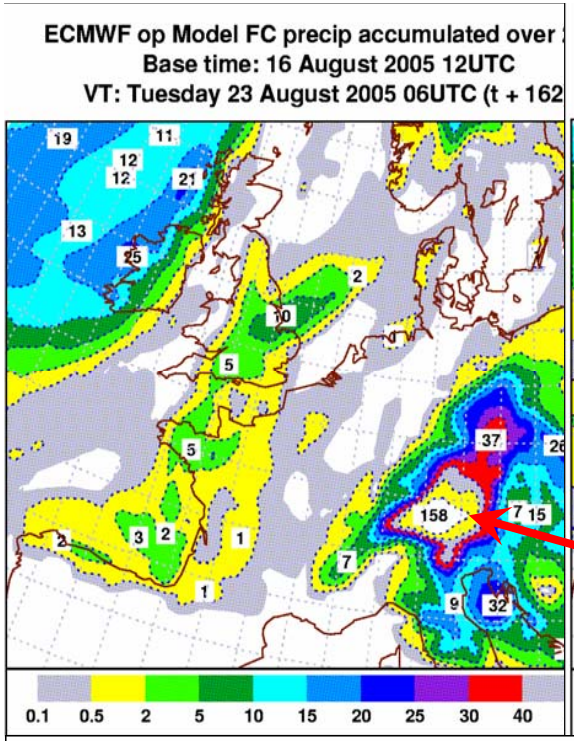
GME / LME / LM: Correct position, intensity well predicted

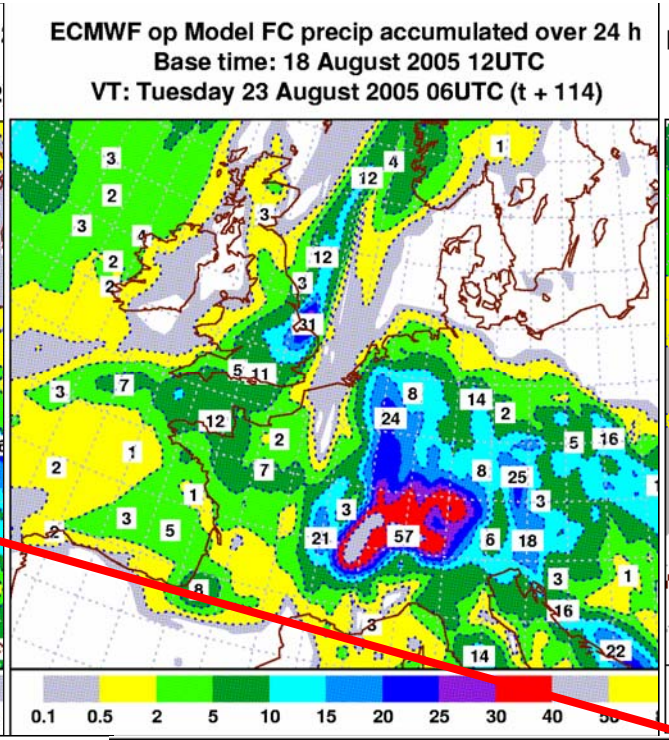
Tue 06Z23AUG2005 (Mon 00 +30): 24 h Precip. [mm]

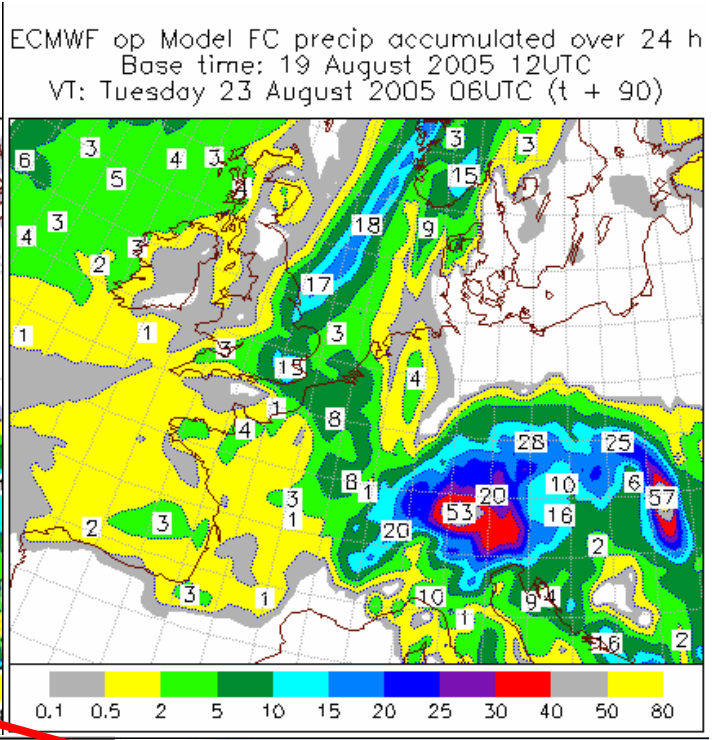


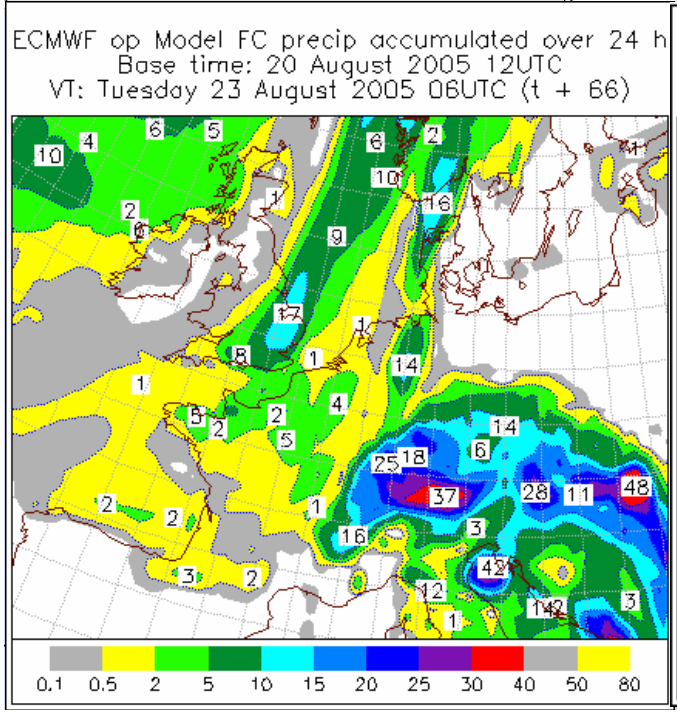
GME: Signal too far east, ECMWF: values too low

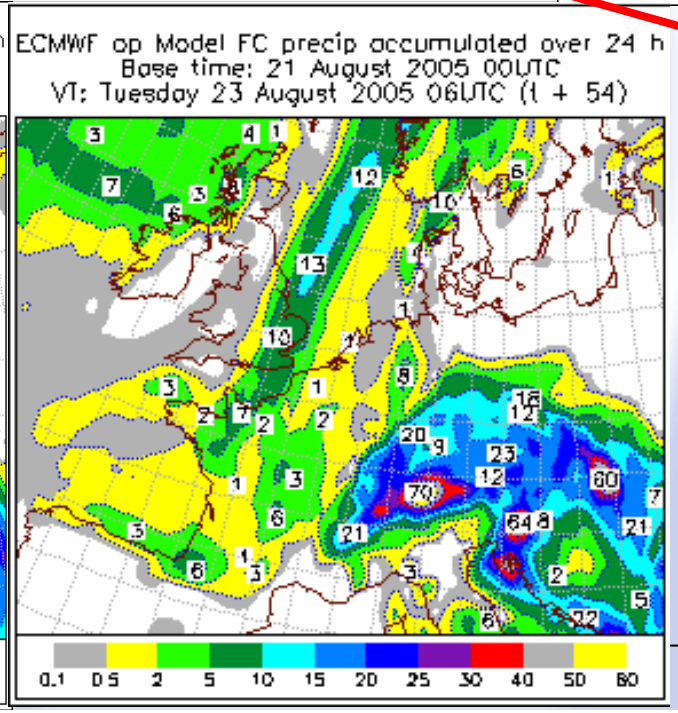
Courtesy of D. Majewski und H. Frank, Hochwasserlage in Bayern 22.-24. August 2005.











Signal of the run from 16 Aug, 12 UTC never confirmed !
Det runs inconsistent !

Realistic values less than 30 hours before the onset of the event !

6. Conclusions

- Warning strategy (district-based warnings) successful
- Use of pre-warnings and pre-warn times unified - it´s a guideline

- Improvements of the GME and LM-Model - , GME 40 km, L 40 + LME
- EPS products as a expression of the chaotic behavior of the atmosphere more and more successful used at the DWD
  - EPS of HRM´s (COSMO - LEPS, PEPS)
  - Problem: Scale of sev weather patterns + sev convection + high baroclinic instability of systems - not solved - LMK - under development

- Information overkill of the forecaster - too many systems and tools NinJo - will replace several aging systems - evaluation by forecasters

- Case studies
  - Model changes: Improvements of the PBL scheme has to be tested
  - Forecaster can outperform model forecasts in certain situations
  - severe weather: EPS products provides indications earlier than det models