Recent developments in severe weather forecasting at the DWD

Thomas Schumann,
Deutscher Wetterdienst, Central Forecasting
D-63067 Offenbach, Germany
E-Mail: Thomas.Schumann@dwd.de

Outline

1. Introduction
2. Recent improvements of the NWP models of the DWD
3. COSMO_DE
4. NinJo – a challenge for developers and users
5. A case study
6. Conclusions

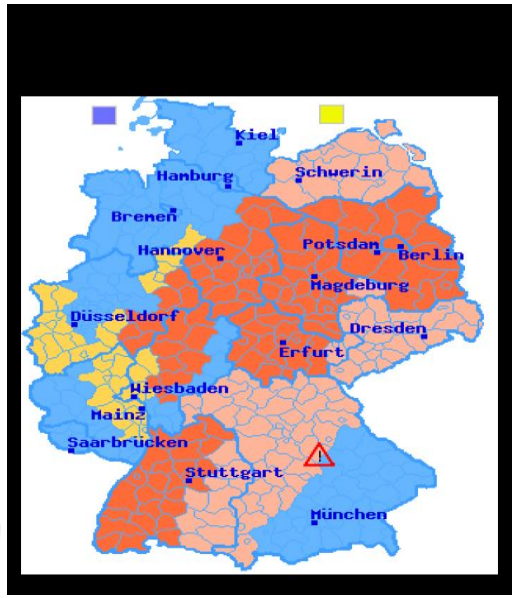
Deutscher Wetterdienst

1. Introduction

Strategy: Warnings related to high impact weather is the key business of the DWD

→ Introduction of district-based warnings in 2003

Coordination by the Central Forecasting to enforce the single voice principle and prevent non -synoptic inconsistencies (synopsis, conference calls → job of the Supervisor)



Transmission of warnings by regional forecast units

21 June, 05:50 UTC

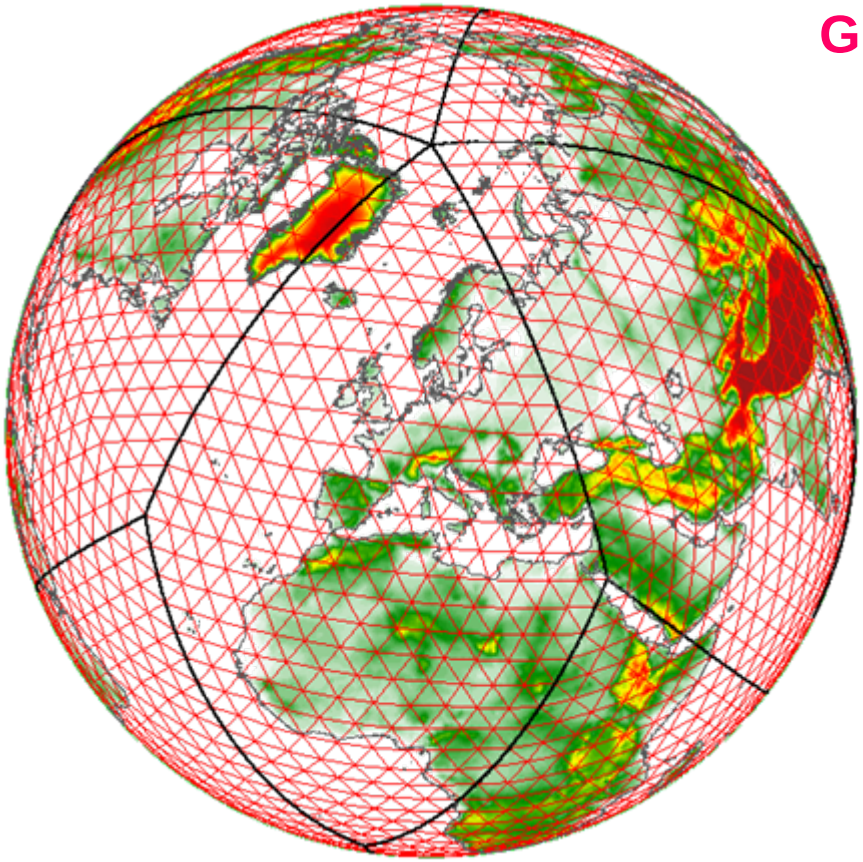
Deutscher Wetterdienst

Severe weather warning criteria (well-tried - remain unchanged)

Parameter	threshold	extreme event
Gusts	> 104 km per hour	> 140 km per hour
heavy rain (convective / large scale)	> 25mm / 1 hr > 35mm / 6 hrs > 40mm / 12 hrs > 50mm / 24 hrs > 60mm / 48 hrs	 > 70mm / 12 hrs > 80mm / 24 hrs > 90mm / 48 hrs
Sev Thunderst	Hail > 1.5 cm or gusts or heavy rain	
snow above 800 mtrs:	> 10cm / 6 hrs > 15 cm / 12 hrs > 30 cm / 12 hrs	 > 25cm / 12 hrs > 50cm / 12 hrs
Icing	wide-spread event rain and temperature < 0 C	

2. Recent improvements of the DWD´s NWP models

See Thomas Hanisch´s talk on Monday



GME

Grid structure:	**triangular**
horizontal resolution:	**40 km**
vertical levels:	**40**

Important Changes (last 2 years):

- **07 Dec 2005: Introduction of a prognostic density of snow cover → Reduction of the cold bias during clear-sky nights in winter**
- **20 Apr 2006: enhanced infiltration in the ground → Reduction of the warm bias during summer (heat waves)**

Important Changes GME (last 2 years, continued):

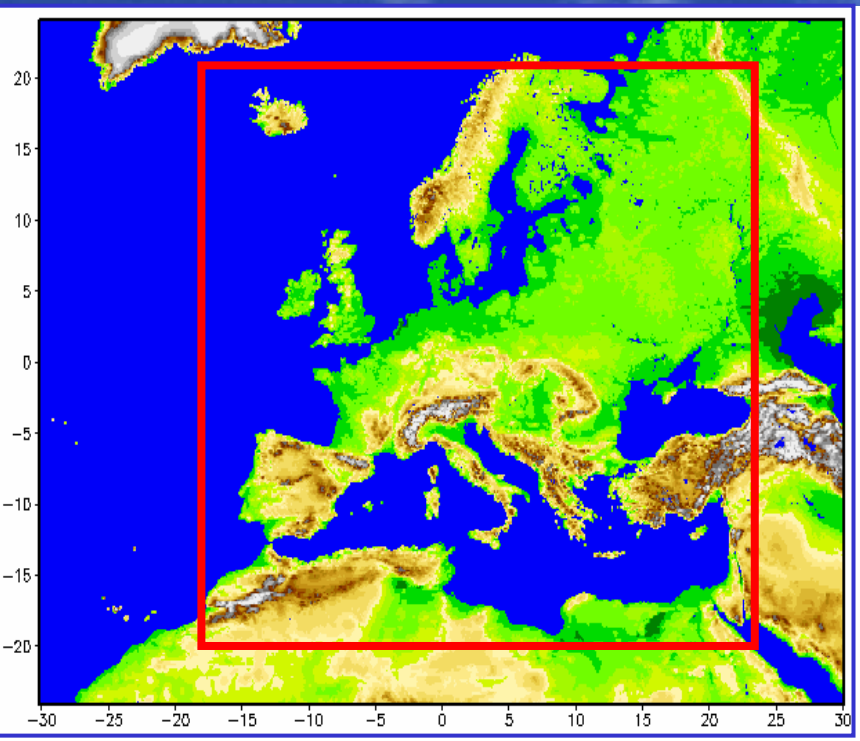
- **24 May 2006: Additional model runs: 48h-forecasts starting from 06 UTC analysis (also COSMO_EU)**

- **31 May / 12 Jun 2006: MET8-derived „Atmospheric Motion Vector“-winds → Improvement of the precip forecasts by a reduction of the positive humidity bias in the lower troposphere**

- **10 Jan 2007: Modification of Snow analysis (also COSMO_EU) → More realistic analysis of snow depth (without alterations between runs)**

- **09 May 2007: MET7 and MET9 Winds, Modis Winds in BUFR Format → Significant improvement of the forecasts in both hemispheres**

Deutscher Wetterdienst



COSMO_EU (former LME)

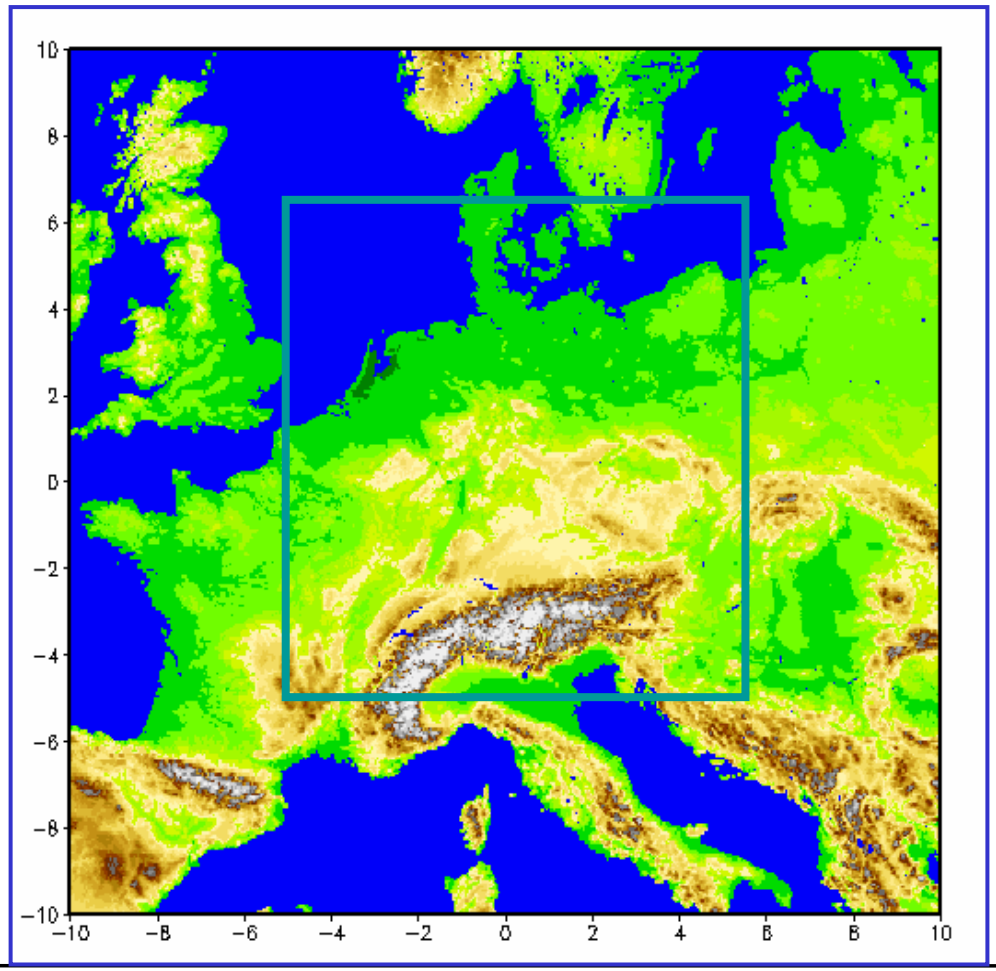
grid structure: 665 x 657 x L40, 7 km (0.0625° x 0.0625°)

Non-hydrostatic !

- **29 Jun 2006: Additional 06 UTC run**
- **31 Jan 2007: Drifting of orographic precip**
  → More realistic precip forecasts in the mountains (Luv-lee-effects)
- **17 Jul 2007: Output extended by CAPE and CIN**

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

3. COSMO_DE (former LMK)



Grid: 421 x 461 x L 50
horizontal resolution 2.8 km
(0.025° x 0.025°)

Simulation of deep moist Convection and its life cycle

T + 00, ... T + 18 h

- **Start every 3 hours**
- **Under development: an EPS from overlapping COSMO-DE-runs**

COSMO-DE became operational since April this year !

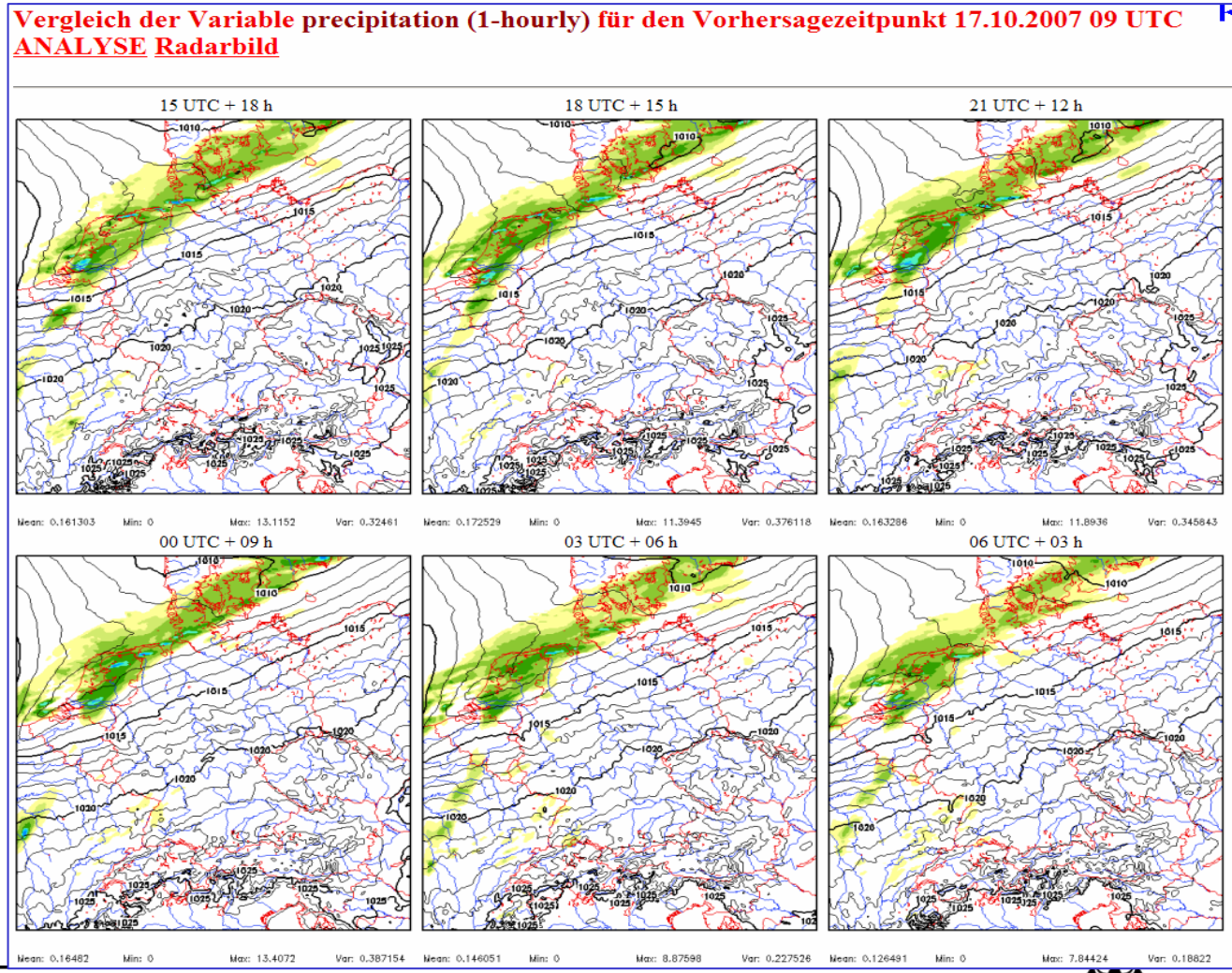
Will it meet forecaster´s expectations ?

Presentation of COSMO-DE

R & D pages (DWD Intranet): COSMO-DE LAF and COSMO-DE against COSMO-EU (animation)

Parameter:

Precip (1-hourly) + type
10m wind + gusts
Mslp, windshear
100/1000, 3000, 5000m
Clouds (low, med, high)
ww-symbols

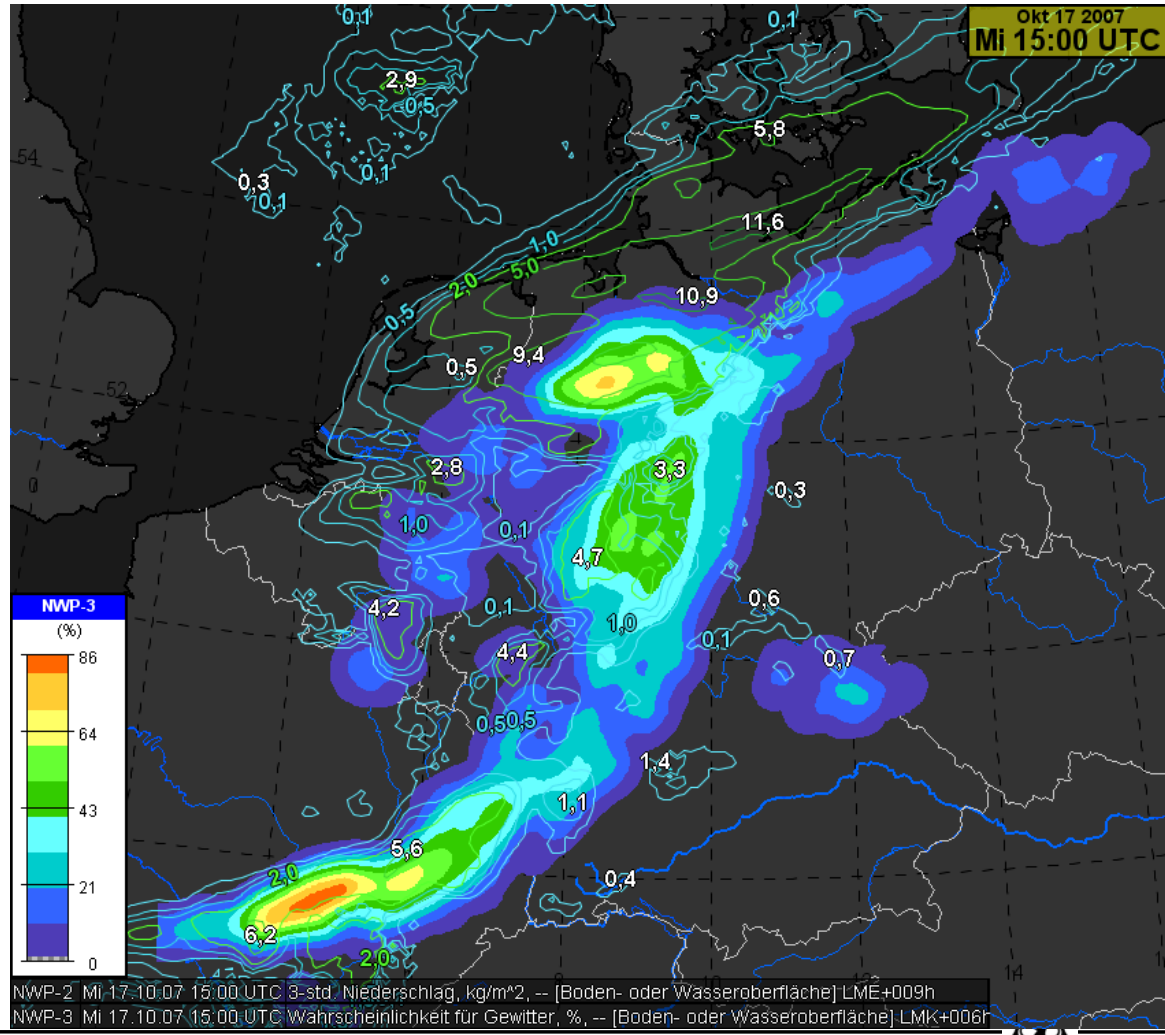


- **Parameter in NinJo:** **additionally** **Much more stuff for R & D available !**

Precip (3, 6, 12 hrly, accum)
T, RelHum, wind, Omega
at standard pressure levels
Snow depth, snow fraction

Probabilistes ww=95, 96, 99
fx > 14, 18, 25, 29, 33, 39 m/s
RR > 10mm / 25 mm /h,
Wide-spread icing
(EPS derived from
nearby grid points)

Fig.: Probability for ww = 95 (isosurfaces) superimposed by 3-hrly precip fc from COSMO-EU



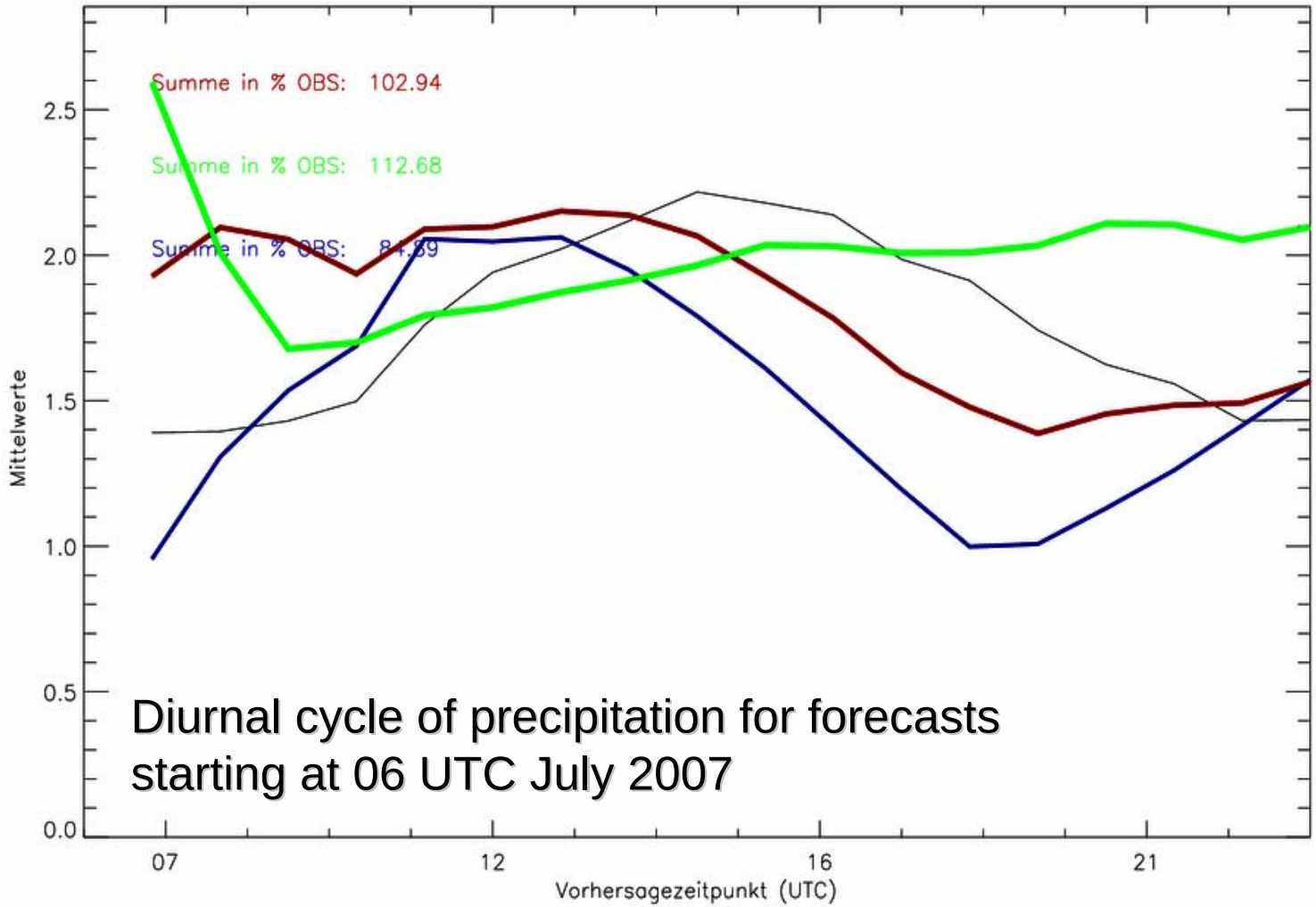
Experience with COSMO-DE (from a forecasters point of view):

- air mass born TS: underestimation / complete missing of convection
  - well developed deep convection pattern „disappearing“
  - Forecaster can get an impression (max precip and wind gust) by checking LAF

- Convection triggered by strong synopic forcing (fronts, …)
  - Pattern will be kept for longer times → better results

- Inversion situations
  - Fog / low st clouds disappears too fast
  - Problem of the parametrisation of the boundary layer

Under development: Site-specific Forecast



(Acknowledgement Ulrich Damrath, DWD)

4. NinJo – a challenge for developers and users

See Michael Rohn´s talk on Wednesday

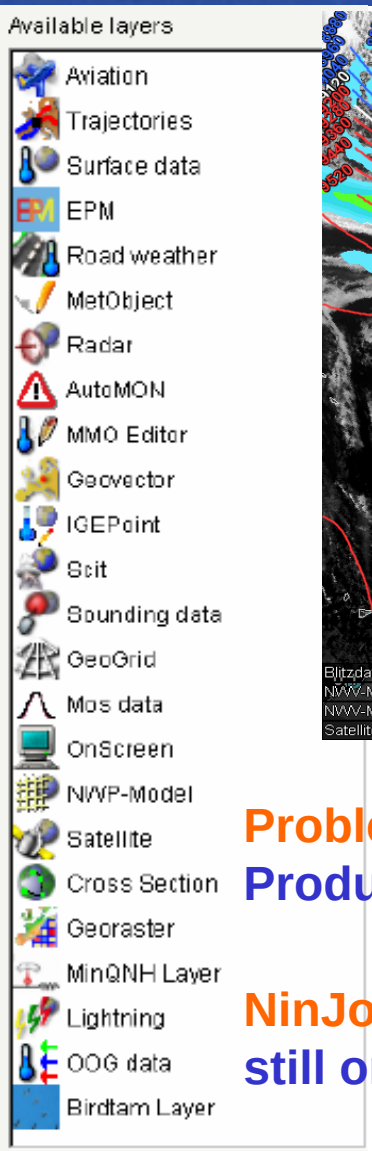
Slides: **European working Group on Operational WorkStations (D. Heizenreder, Dublin 2007)**

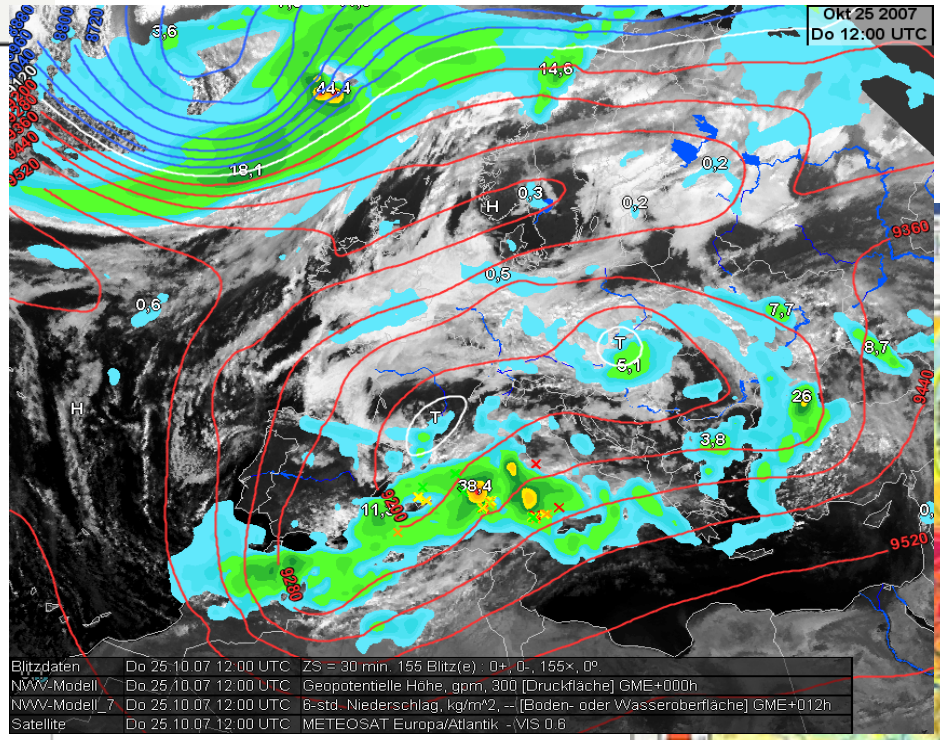
New Integrated Java application

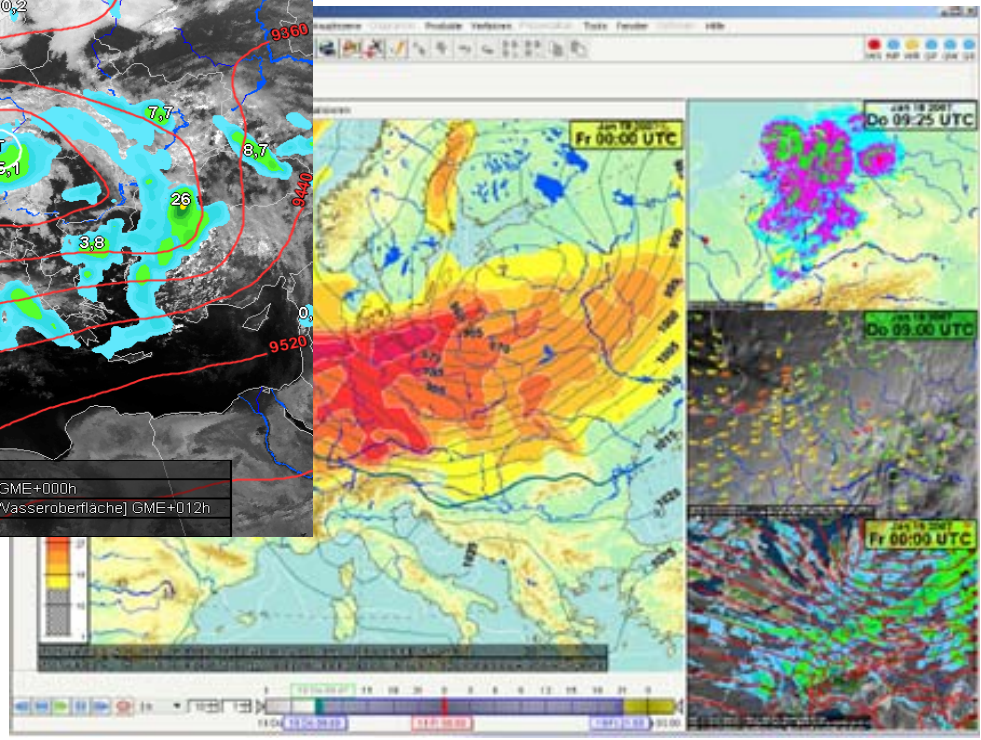
Meteorological Workstation

- International collaboration by 5 Met Services
- Official Agreement signed in 2006
- Further joint Development and Maintenance

Deutscher Wetterdienst







Every user can define his own NinJo environment !

Problem: Only few EPS-based Products and tools available !

NinJo turned into operation since Sept 2007. Parallel usage of IGS still ongoing for some production tasks (Analysis, SWC, SLP fc´s).

Deutscher Wetterdienst

Requirements from users (forecaster team):

(from my talk 2 years ago)

- **If NinJo should replace the currrent systems it has to contain at least the same functionality as MAP, IGS, Sat, ...**

→ **Meanwhile functionality related to MAP has been increased**

- **The use of NinJo should be similar to current systems**

→ **Functions, menues, …, handling conform to previous systems**

- **New functions should be easily to learn**

→ **Documentation close to the release of newer versions**

→ **„Super-user“ teaching the forecaster team**

- **Favourite handling + interaction: Similar related to the Windows explorer**

→ **„Favourites“ for different levels (user, department, admins)**

→ **Handling generally improved**

Project: EPS-Layer for NinJo (brief introduction)

Objective: Provision of EPS products from
- several models and systems
- different resolutions and domains

Current situation (Oct 2007):

Intranet **COSMO-DE**

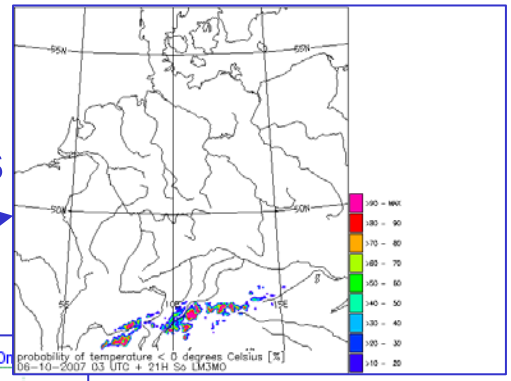
ECMWF

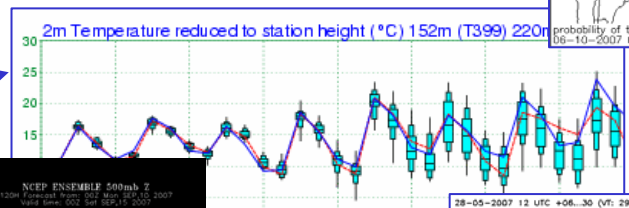
Internet:

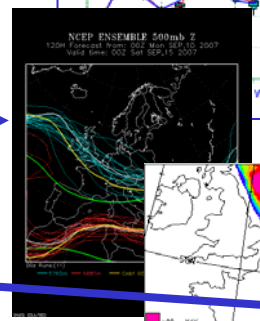
GFS

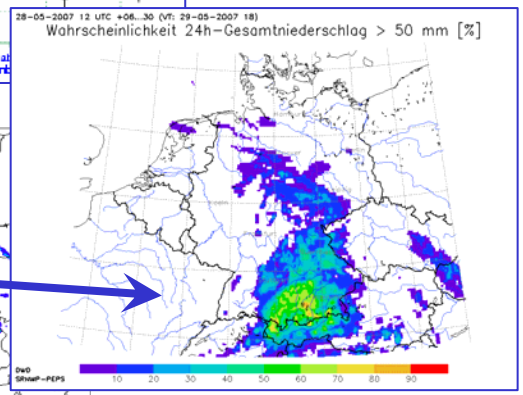
NinJo **SRNWP - PEPS**

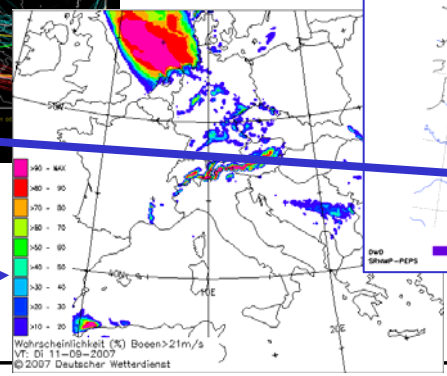
Intranet **COSMO-LEPS**



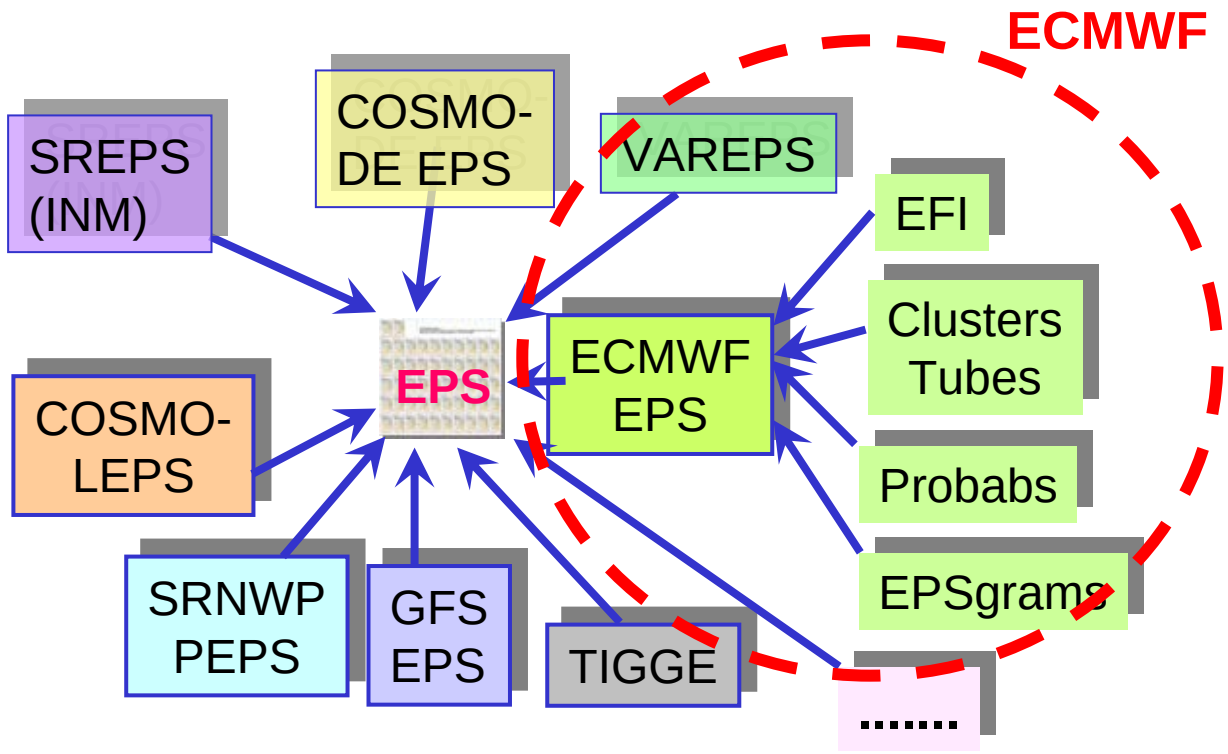








Development of an own layer for EPS-based products



Advantages:

- **One platform (NinJo) only**
- **Different products easier comparable**
- **Set of EPS forecast could be expanded later**

Datei Bearbeiten Ansicht Objekte bearbeiten Kartenausschnitt Hauptszene Diagramm Produkte Verfahren Präsentation Tools Fenster Optionen Hilfe

44% WO WP WR QP Q

EPS

Datenfeldauswahl [Ensemble _3]

Auswahl von Ensemble-Datenfeldern EPS

Ensemble
- ECMWF
- LEPS
- PEPS
- INM-SREPS
- COSMO-SREPS
- COSMO-DE-EPS
- VAREPS
- AFREG

Vorhersagelauf
- 27.09.07 06:00
- 27.09.07 03:00
- 27.09.07 00:00
- 26.09.07 21:00
- 26.09.07 18:00
- 26.09.07 15:00
- 26.09.07 12:00
- 26.09.07 06:00
- 26.09.07 00:00
- 25.09.07 18:00

Vorhersagezeitpunkt
- 26.09.07 21:00
- 26.09.07 22:00
- 26.09.07 23:00
- 27.09.07 00:00
- 27.09.07 01:00
- 27.09.07 02:00
- 27.09.07 03:00
- 27.09.07 04:00
- 27.09.07 05:00
- 27.09.07 06:00

Niveau
- 1000 [Druckfläche]
- 975 [Druckfläche]
- 950 [Druckfläche]
- 925 [Druckfläche]
- 900 [Druckfläche]
- 850 [Druckfläche]
- 800 [Druckfläche]
- 750 [Druckfläche]
- 700 [Druckfläche]

Elemente
- Luftdruck (MSL)
- Geopotential
- Geopotentielle Höhe
- Relative Feuchte
- Temperatur
- Theta Ae
- Windgeschwindigkeit
- max. Windgeschwindigkeit
- max. Windböen 10m

Einstellungen

Aktualisieren

Auswahl aufheben

Mitglied
1 Cosmo-DE
2 Aladin FR
3 UM-EU
4 Hirlam Spain
5 Aladin LACE
6 Euro-LM
7 Aladin Protugal
8 Hirlam NL
9 Hirlam FI

Schwellwerte
- < 10 %
- < 20 %
- < 30 %
- ----------
- > 60 %
- > 70 %
- > 80 %
- > 90 %

Produkte
- Mittel (Mean)
- Varianz (Spread)
- Cluster 1
- Cluster 2
- Cluster 3
- Extrem 1
- Extrem 2

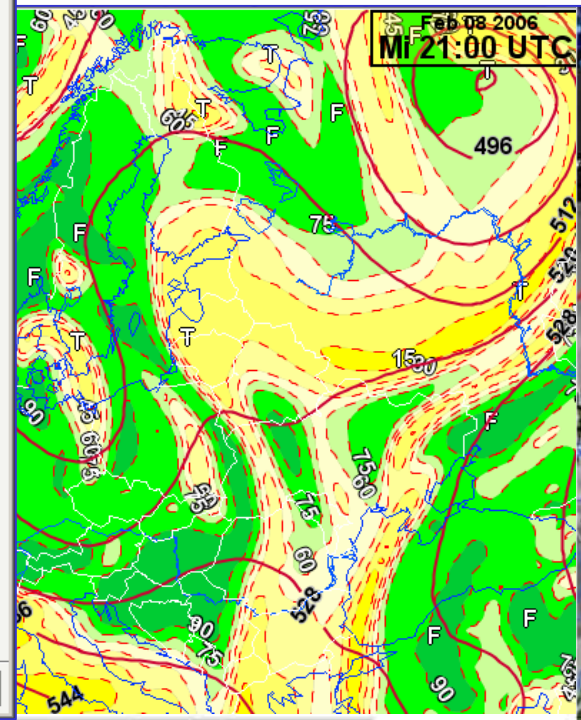
Zeitsteuerung

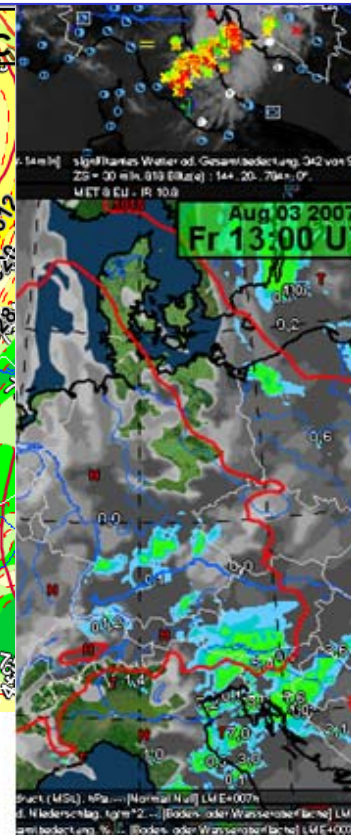
☑ Synchronisiert mit Hauptzeit ☐ Mit Zeitunterschied

Ok Übernehmen Abbrechen Hilfe

fx (m/s) >	ff (m/s) > 925 hPa	ff (m/s) < 850 hPa	RR 1 h	RR 6 h	RR 12 h	RR 24 h	RR 48 h
18	20	20	10	20	25	30	40
25	25	25	**25**	**35**	**40**	**50**	**60**
29	30	30		50	70	80	90
33	**35**	**35**					
39	40	40					

Schnee 6 h	Schnee 12 h	Scherung (m/s) (1000m) >	CAPE (J/kg) >	PPW(mm) >	Tmax (°C) T (°C)	Tmin (°C) T (°C)	Td (°C
5	10	20	500	25	< -10	< -20	< 0
10	**15**	**25**	**1000**	**30**	**< 0**	**< -10**	> 15
	25	30	1500	40	> 25	< 0	**> 20**
			2000		> 30	< +5	
					> 35	> +20	





N 25°12'W 011°31'

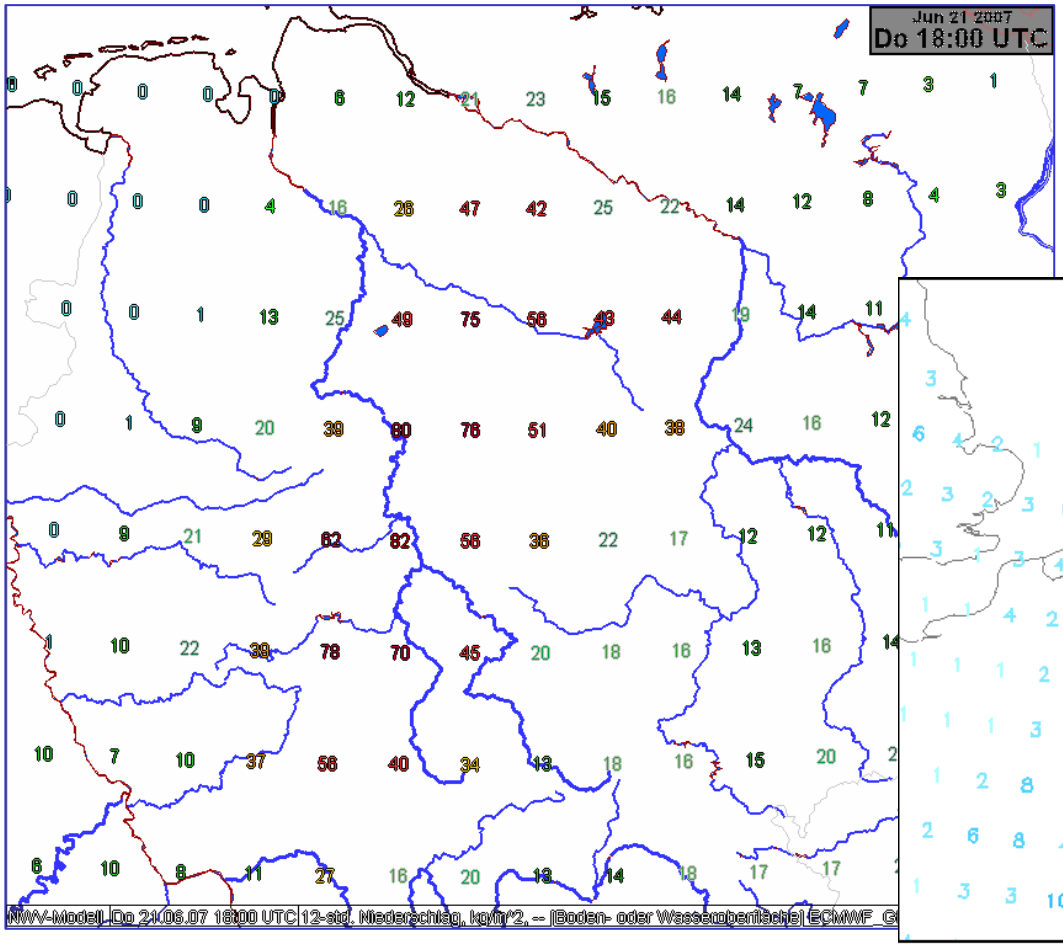
Wert: 5937.3247 gpm | Minimum: 5229.3794 | Maximum: 5978.4707

6 9 3 Fr 13:20 18 21 0 3 6 9 12 15 18 21 0 3

3 h 10 1

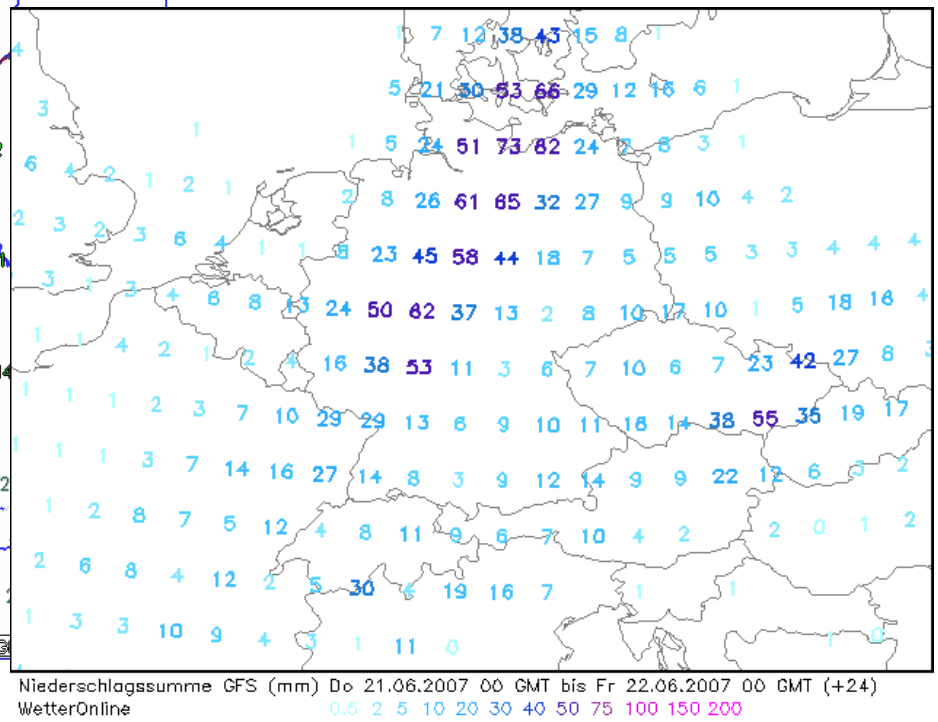
3 Fr 0 3 Fr 12:00 5 So 00:00 06:00

5. A case study (The event that not took place)

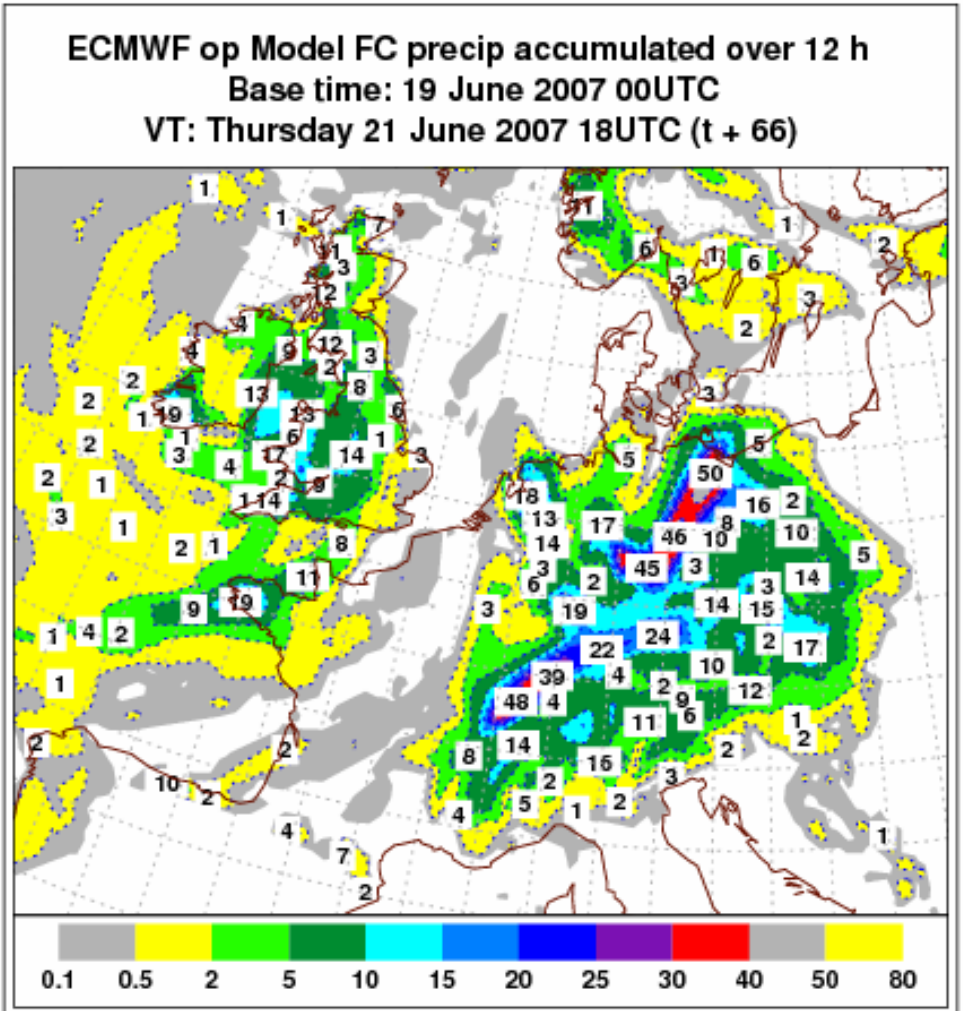


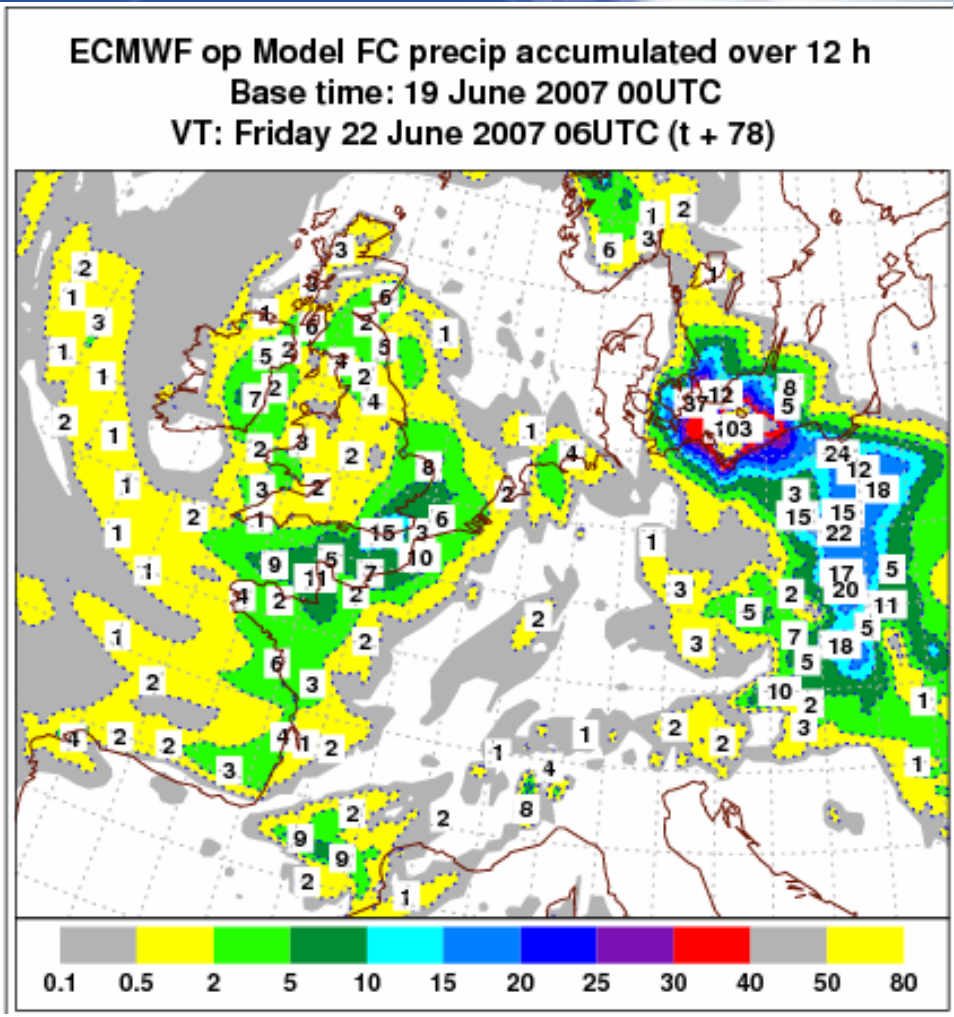
ECMWF: approx 80 mm / 12 hrs (20 June, 12 + 18 … 30 h)

GFS: above 80 mm / 24 hrs (21 June, 00 + 00 … 24 h)



Deutscher Wetterdienst

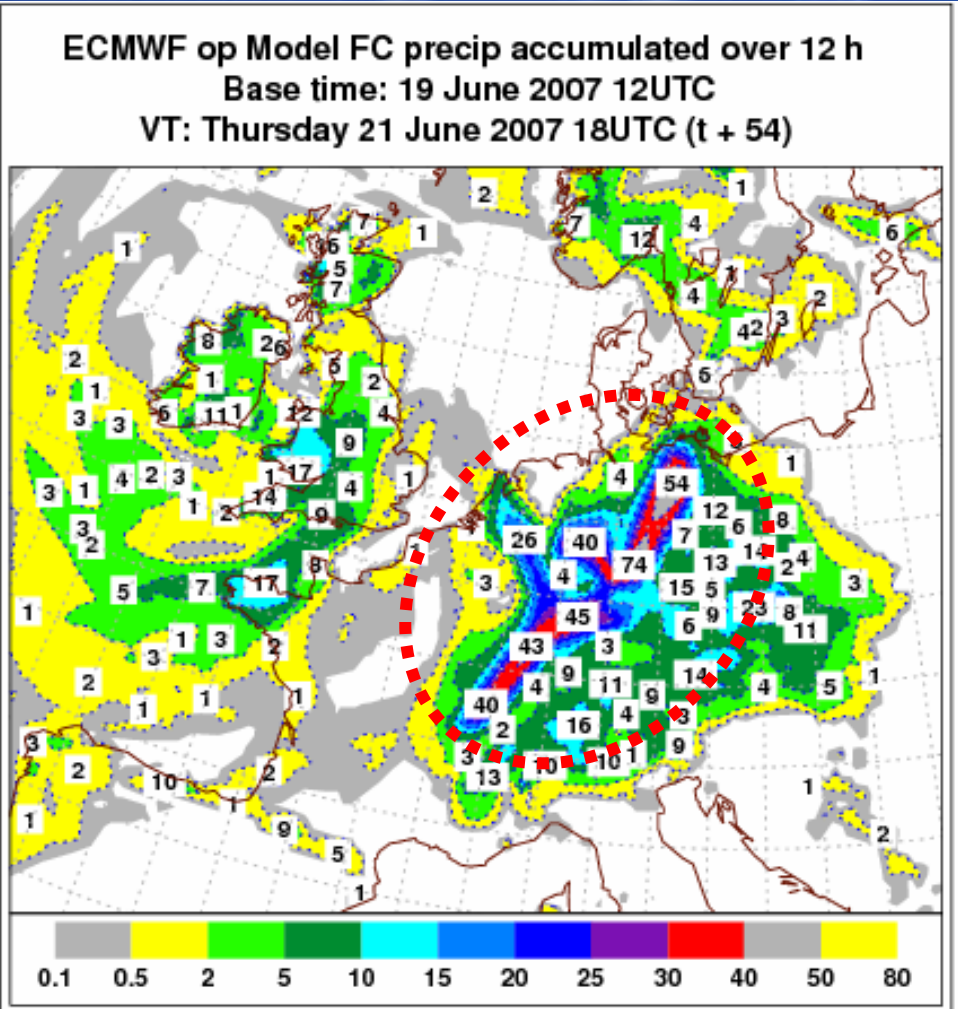


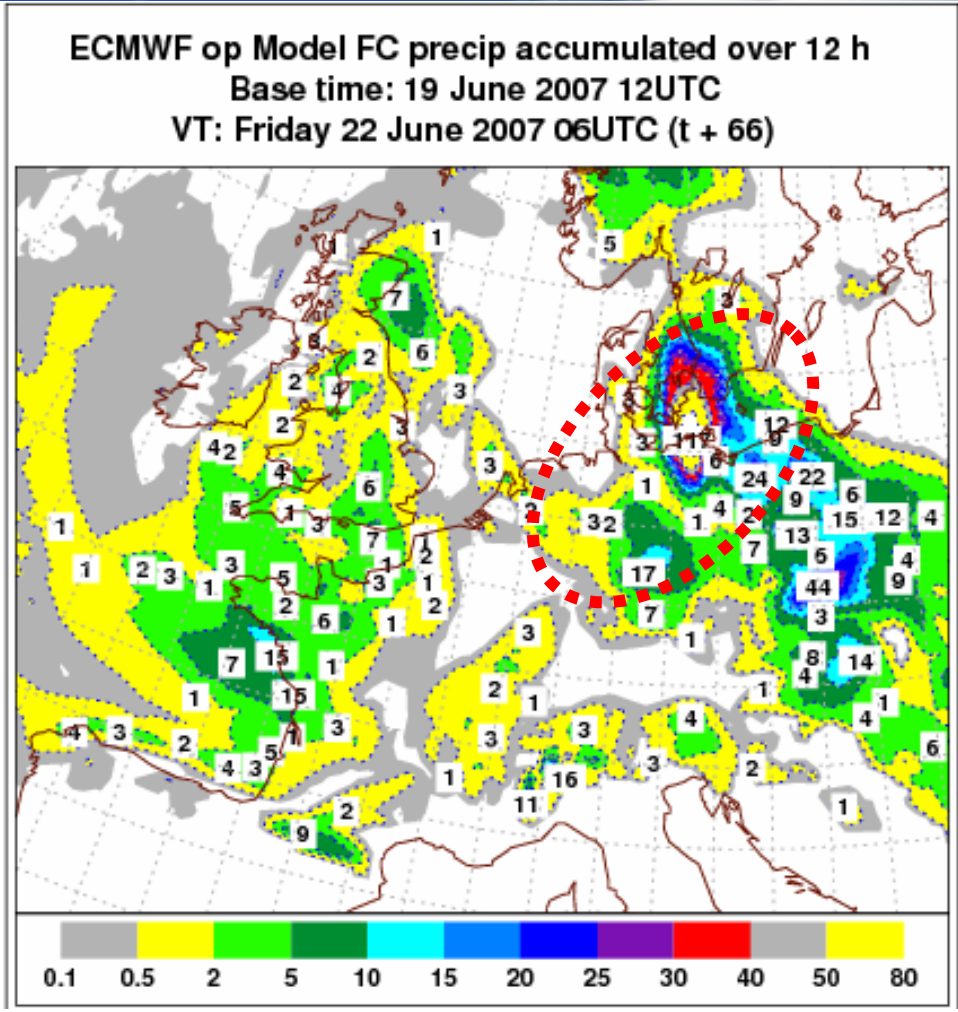


T 799, 19 June, 00 + 54 … 66 h

T 799, 19 June, 00 + 66 … 78 h

Deutscher Wetterdienst





T 799, 19 June, 12 + 42 … 54 h

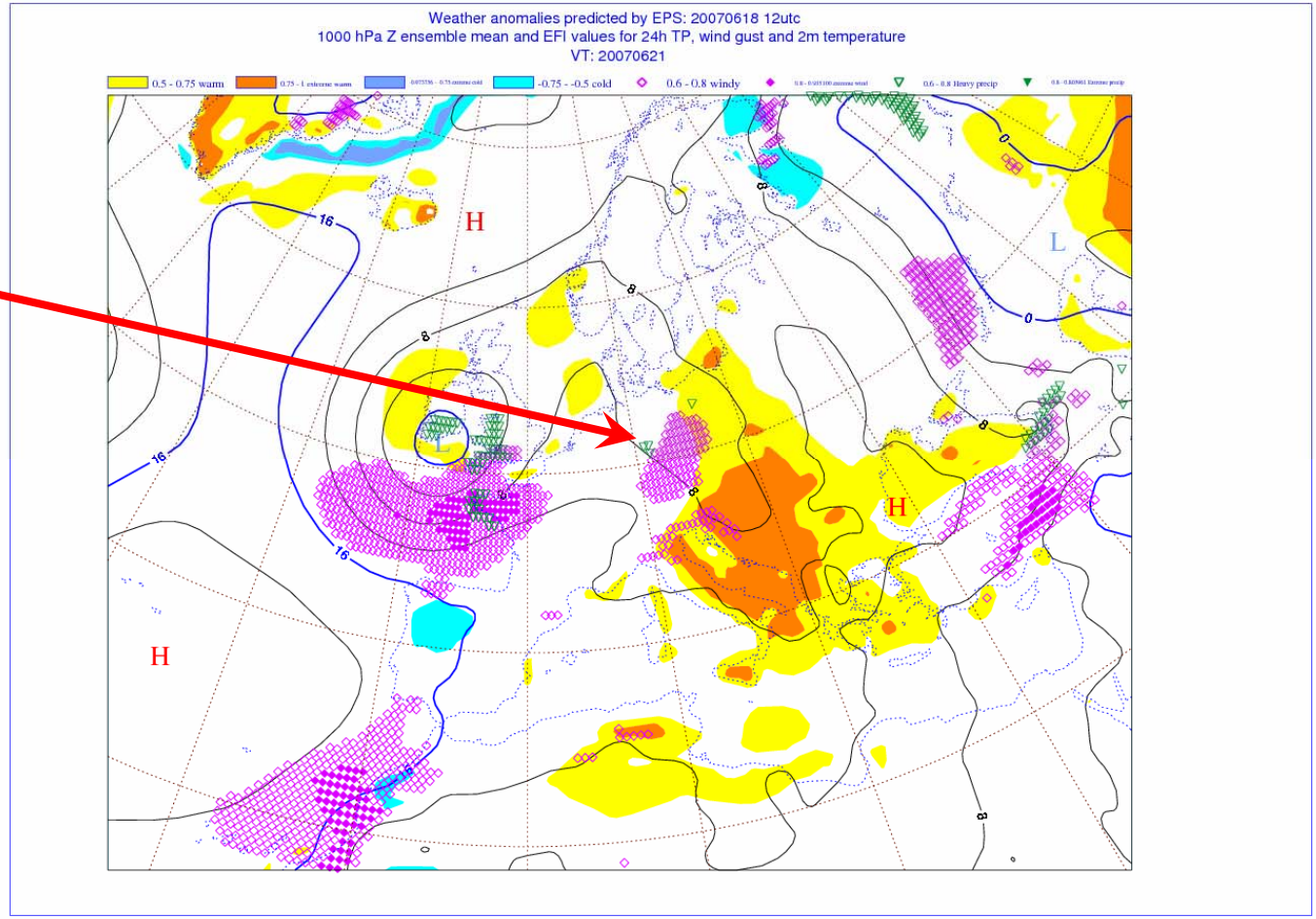
T 799, 19 June, 12 + 54 … 66 h

Pattern of sev precip consistent over several model runs !

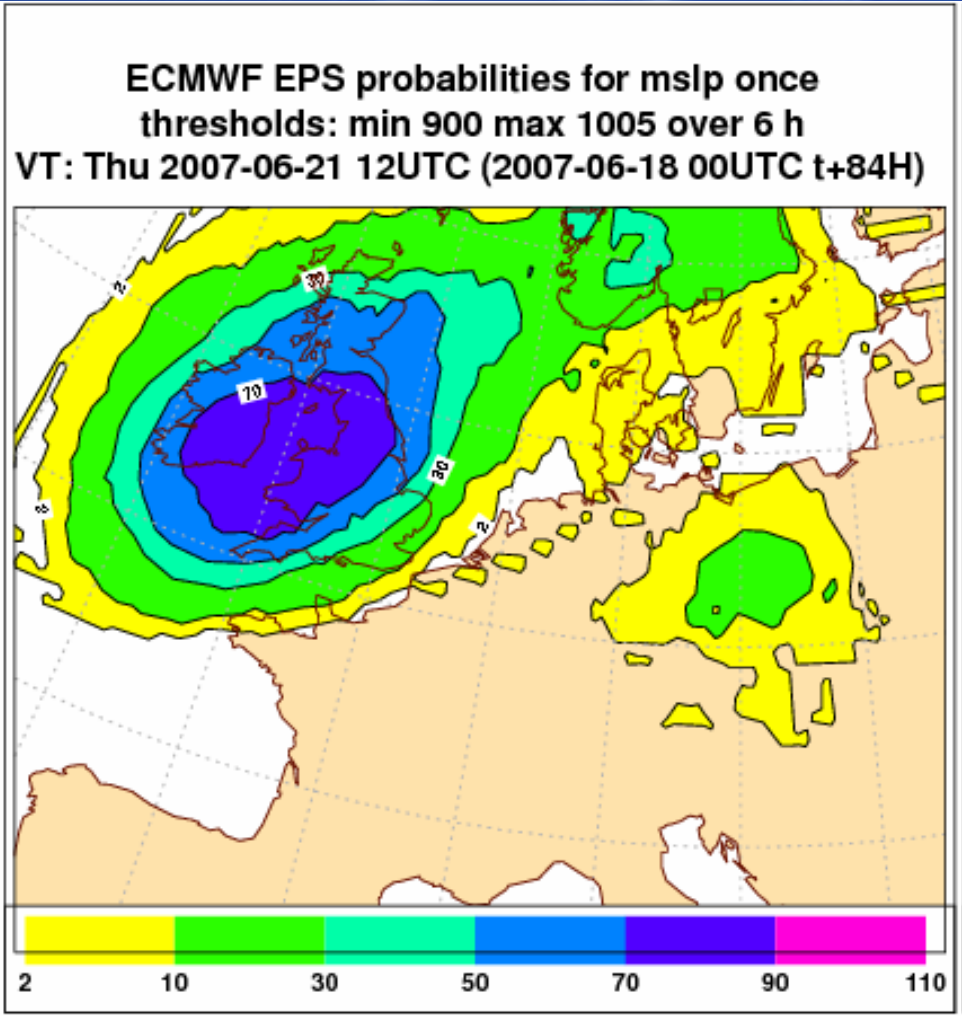
Deutscher Wetterdienst

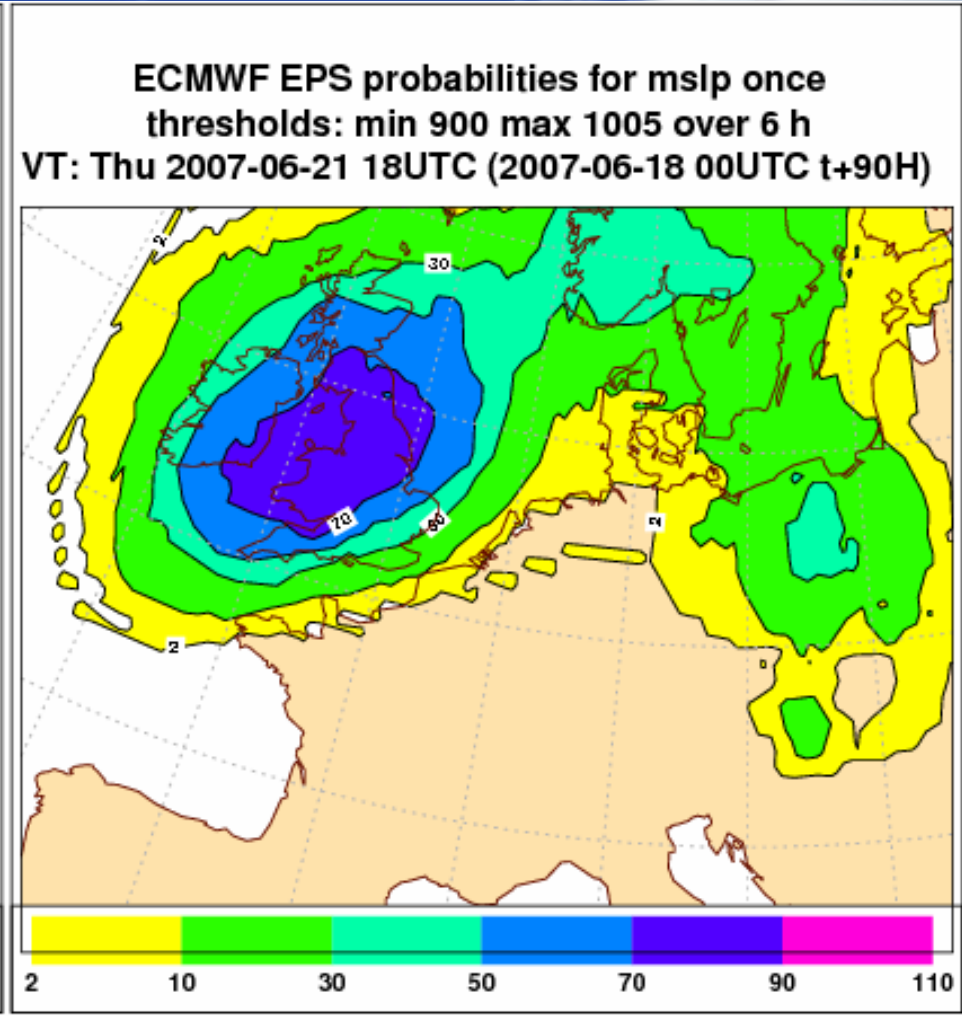
Signals for

Heavy precip
windy conditions



„Combined“ Extreme Forecast index map (F. Grazzini): 18th June, 2006, 12 + 72 H

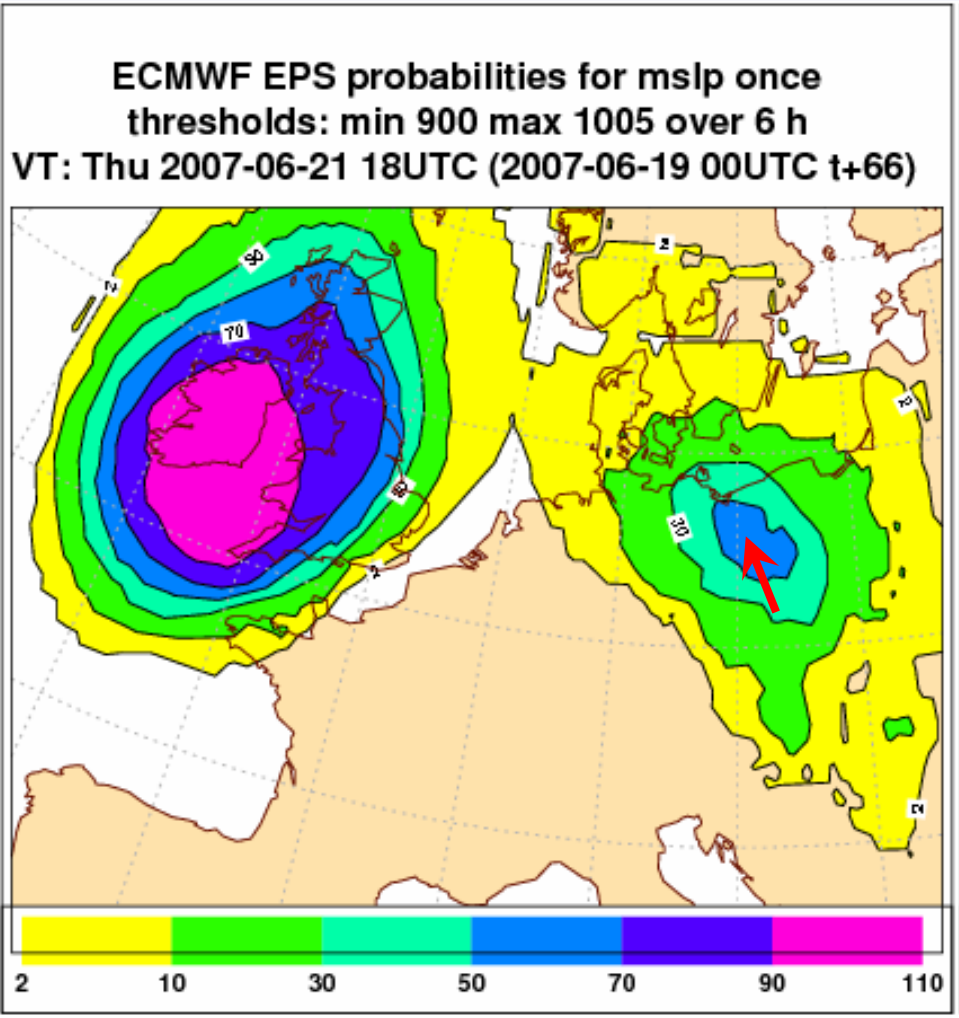


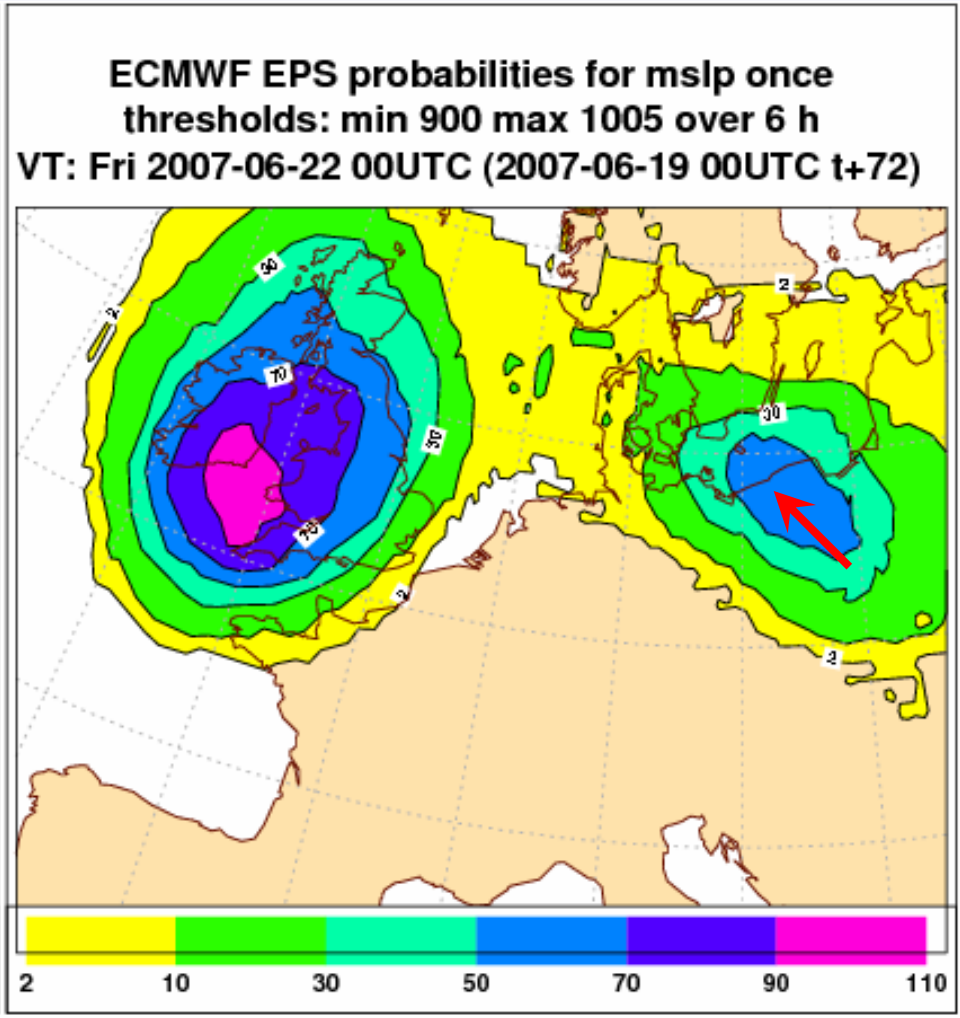


EPS Probability for SLP < 1005 mbar

18 June, 00 + 84 h **18 June. 00 + 90 h**

Deutscher Wetterdienst

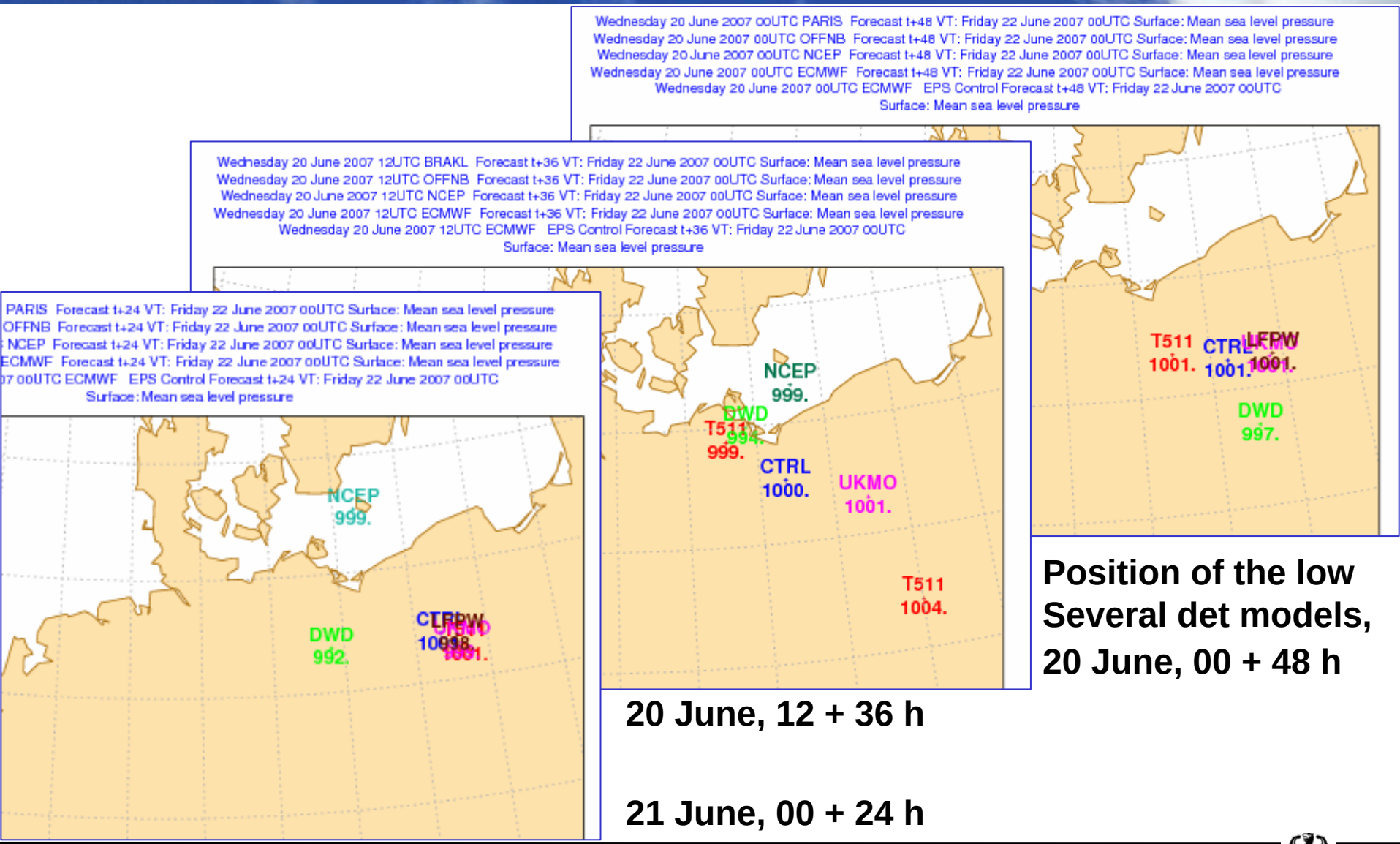




EPS Probability for SLP < 1005 mbar

19 June, 00 + 66 h **19 June. 00 + 72 h**

Deutscher Wetterdienst

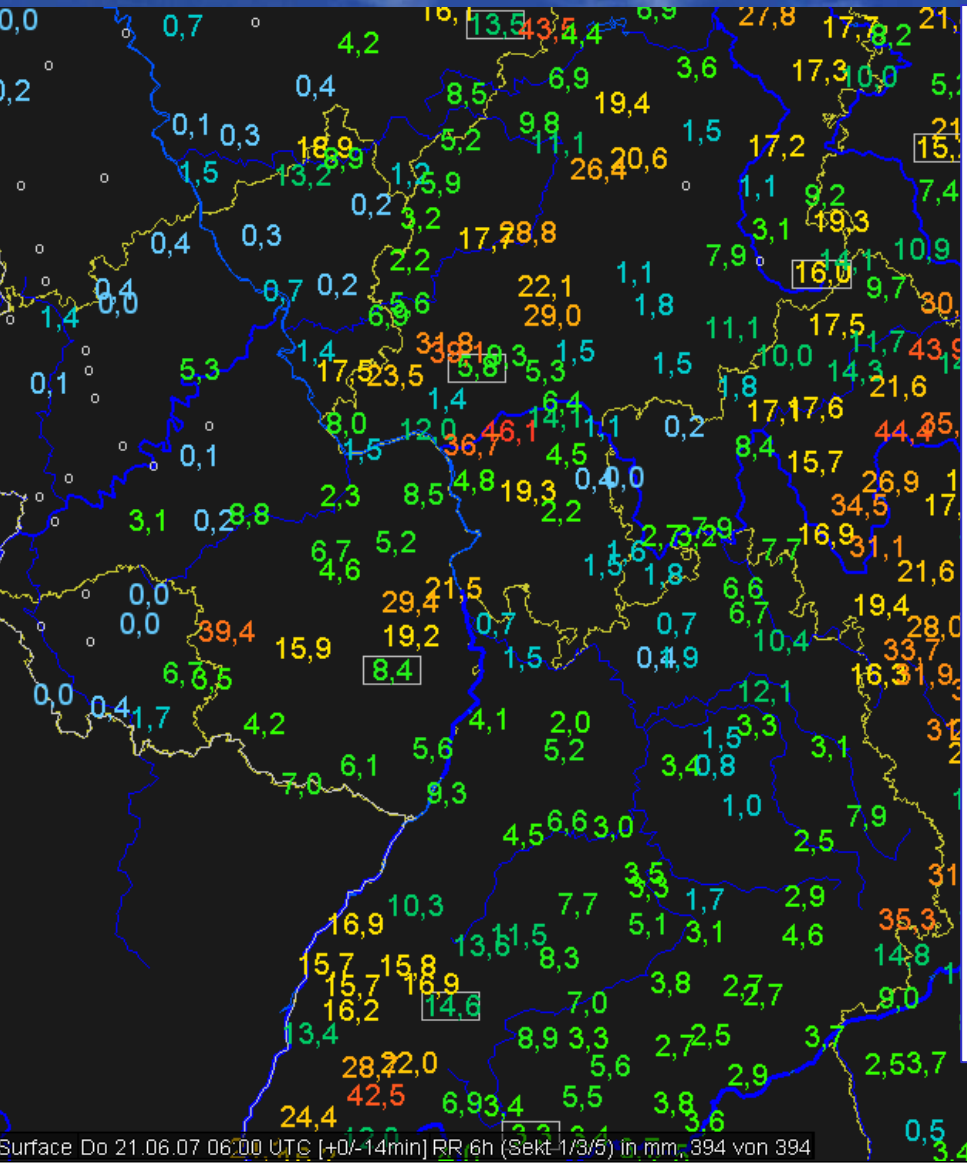


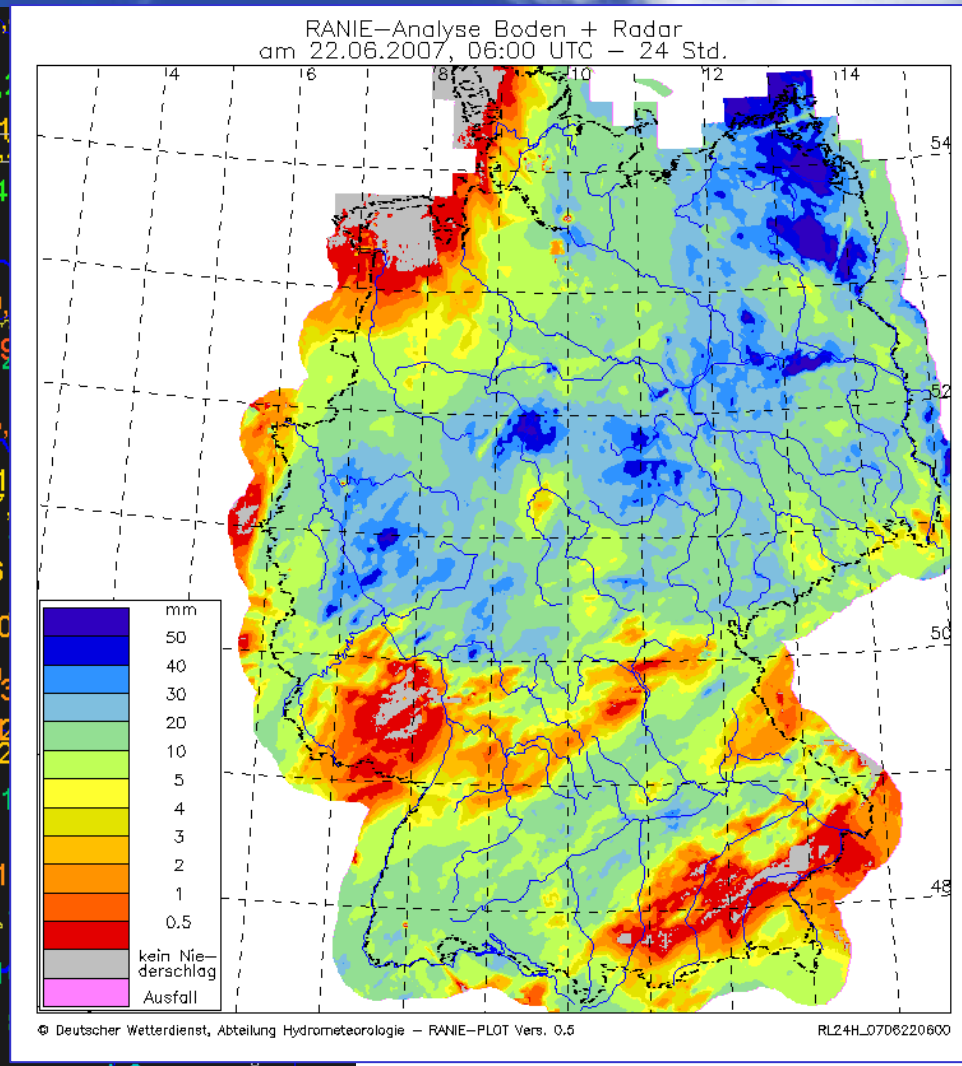
Position of the low
Several det models,
20 June, 00 + 48 h

20 June, 12 + 36 h

21 June, 00 + 24 h

Deutscher Wetterdienst





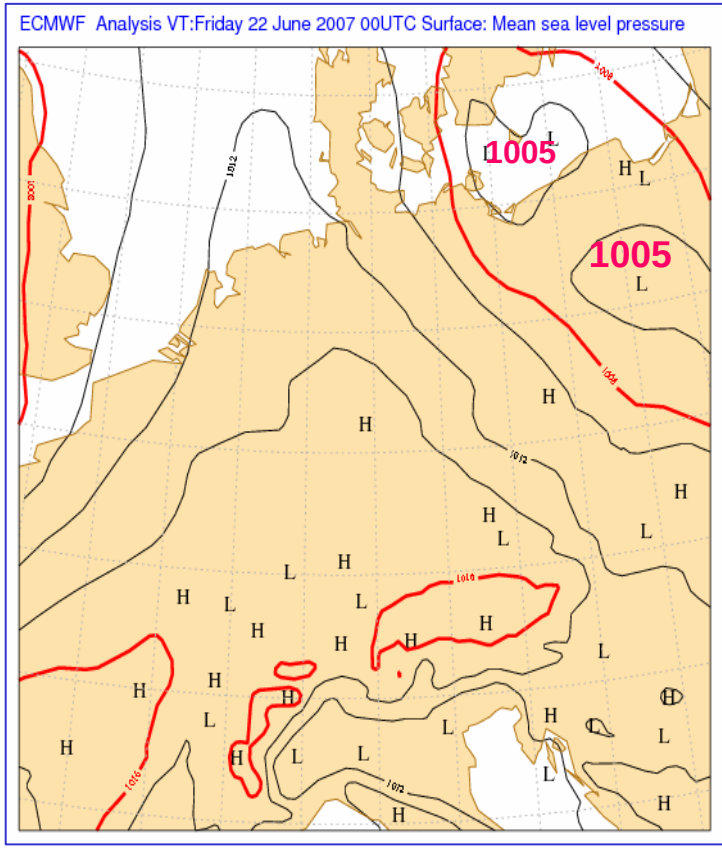
24 hrs, 22 June, 06 UTC

Deutscher Wetterdienst

- **Precip observation: only loc above 40 mm / 12 hrs excerpt NE Germany**
- **Maximum: Rhein-Main-Area loc > 70 mm**
  - **1 person killed**
  - **Severe interuptions in public transport**
  - **FFM Airport: More than 100 flights cancelled / diverted**

For most parts of Germany: False alarm !

Predicted cyclogenesis has not been verified !



Trend of some HRM´s to produce „grid point storms“ ?

Warning situation
21th June,13:35 (loc time)

Verifying analysis,
22nd June, 00 UTC

6. Conclusions

- **Warning strategy and –procedure:** Well tried, minor modifications only → leading function of the Supervisor
- **DWD NWP models:** Several impovements
  - COSMO-DE became operational
  - Not always met forecasters expectatios
- **NinJo:** meanwhile operational
  - Implementation of highly desired tools
  - Handling improved – similar to previous systems (user request)
  - EPS-Layer: Project recently started
- **Severe weather: Prediction of deep convection** → by COSMO-DE not adequate related to district-based warnings → EPS tools under development → Obs network (Radar, Sat, radiosonde … sfc obs) indispensable for monitoring and nowcasting tasks