# Forecasters' priorities for improving probabilistic flood forecasts
# -or-
# EFAS – Roadmap to future

Fredrik Wetterhall

Thanks to:

Pappenberger, F., H. L. Cloke, J. Thielen-del Pozo, S. Balabanova, J. Daňhelka, A. Vogelbacher, P. Salamon, I. Carrasco, A. J. Cabrera-Tordera, M. Corzo-Toscano, M. Garcia-Padilla, R. J. Garcia-Sanchez, C. Ardilouze, S. Jurela, B. Terek, A. Csik, J. Casey, G. Stankūnavičius, V. Ceres, E. Sprokkereef, J. Stam, E. Anghel, D. Vladikovic, C. Alionte Eklund, N. Hjerdt, F. Holmberg, J. Nilsson, K. Nyström, H. Djerv, M. Sušnik, M. Hazlinger, and M. Holubecka

ECMWF

EPS
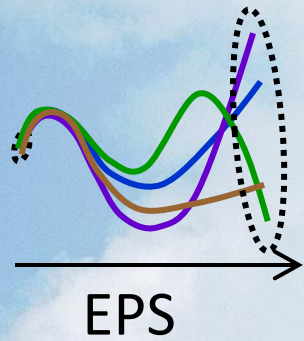
Preprocessing/
calibration

Hydrology
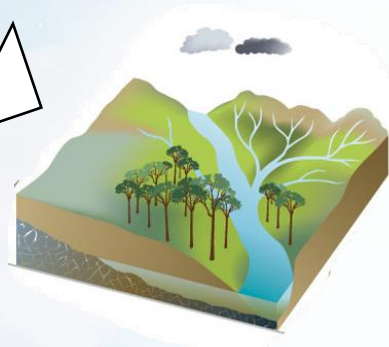
Postprocessing

| Forecast Day | 31 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2013-05-31 00:00 | | | | | | | | | | | | | |
| 2013-05-31 12:00 | | | | | | | | | | | | | |
| 2013-06-01 00:00 | | | | | | | | | | | | | |
| 2013-06-01 12:00 | | | | | | | | | | | | | |
| 2013-06-02 00:00 | | | | | | | | | | | | | |
| 2013-06-02 12:00 | | | | | | | | | | | | | |
| 2013-06-03 00:00 | | | | | | | | | | | | | |
| 2013-06-03 12:00 | | | | | | | | | | | | | |

Warning

**EFAS annual user meeting**

~40 hydrological forecasters and
meet to discuss EFAS in terms of
performance, updates, feedback
and training.

ECMWF

# "Forecasters have an appetite for uncertainty"
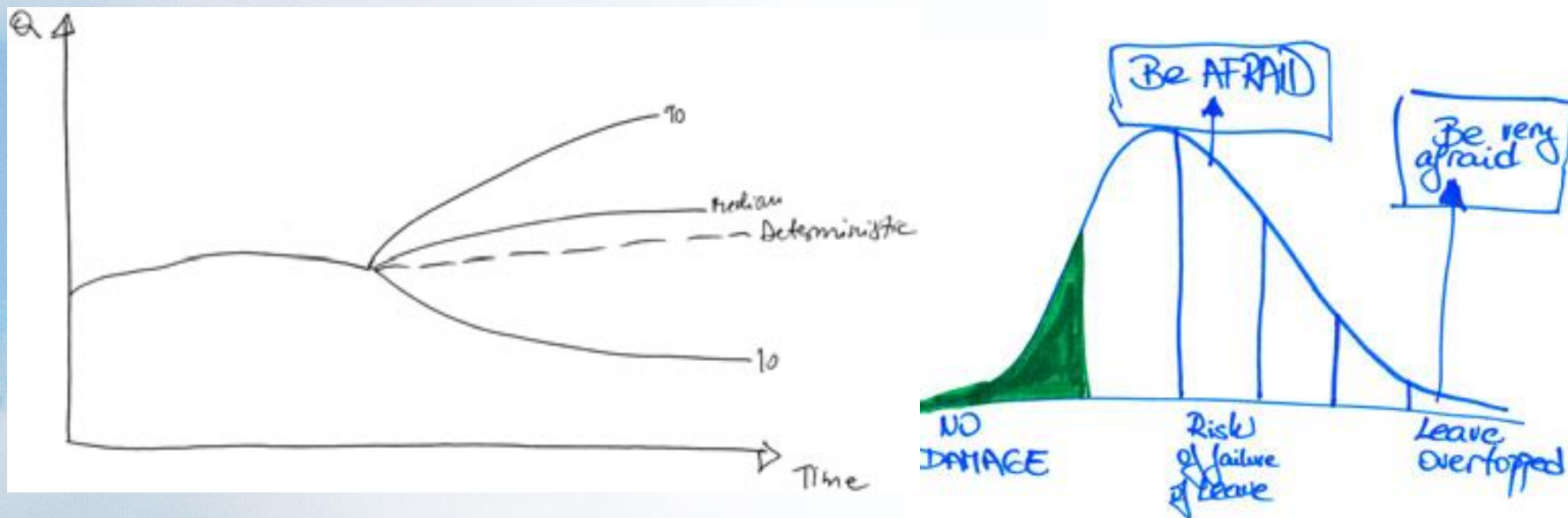


- Probabilistic forecasts are most often used to "anchor" deterministic forecasts
- Uncertainty was requested as a key ingredient to display
- Complexity was not penalized if presented unambiguously
- Preferences on what to display differed substantially
- Displaying uncertainty demands large efforts of training and close communication
  (Pappenberger et al., 2013)

ECMWF

# What do forecasters REALLY want from a HEPS?

**Rationale:** At the the EFAS user meeting in June 2012 there was a total of 30 operational forecasters participating. For the usual exercise we decided to play a game...



**Background:** Operational hydrological forecasting is constantly developing along with better forecasts from NWPs, incorporating ensemble prediction systems and hydrological model development.

But what are the most **important areas of development for the forecasters?**

**Idea:** Pick the brains of the operational forecasters to find out what they think should be prioritised.

**Task 1:**
- Prepare a 5 min presentation on the most important area of development for flood forecasting and pitch on front of a panel of "dragons"
- Allocate "funds" to the best suggestions

**Task 2:**
A questionnaire was sent out where they had to rank 23 suggested improvements (gathered from the previous suggestions and our thoughts).

# What do forecasters REALLY want?

**The pitched priorities (in order of popularity):**

1. Multi-model forecasting system

2. Build a European flood forecasting infrastructure

3. Forecast verification tool

4. Improve physical model representations

5. Improve standardization of hydrological data

**ECMWF**

# Results from the survey

The top ranked priorities were (in order):

1. **Forecast verification for hydrological and meteorological forecast**
2. **Introduce multi-model approach for hydrological modelling**
3. Increase the average skill of the medium range forecast (>3 days)
4. **Education and training of how to use and interpret forecasts**
5. **Improve physical model representations**

The bottom ranked priorities were (in order):

1. Replace/expand web forum by social networks
2. Distinguish between different flood situations
3. Increase the frequency of forecasts
4. Increase the temporal resolution of the forecast
5. Blending of national and EFAS forecasts

**ECMWF**

# What can be improved in EFAS and how?

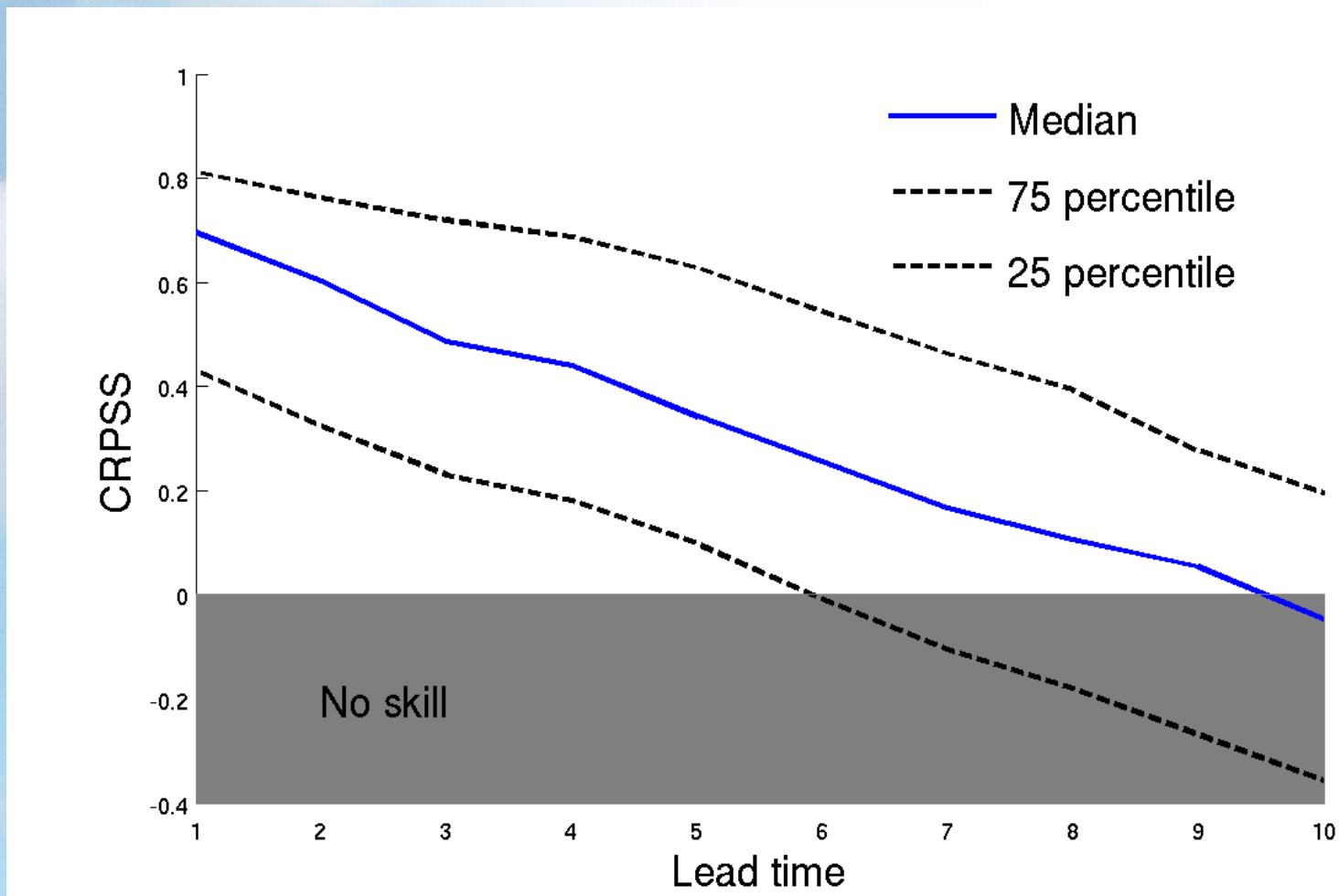# How - A roadmap to future development

**1 Secure funds for the priorities that yields most benefit to a low cost and with low complexity**

- Training and collaboration between forecasters at national and international level

- A "User guide" for hydrological probabilistic forecasting to improve forecast interpretation and decision making

- E-learning tools designed to show the added benefit of using HEPS

# Training and user guide
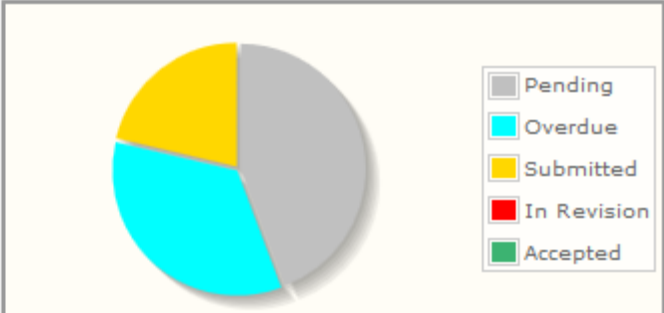


## Handbook of Hydrometeorological Ensemble Forecasting

Reset View | Logout

### List of Articles

○ only show articles assigned to me
● show complete list of articles

Filter Entries: [          ]

☐ Anywhere in title

Legend:
- Pending
- Overdue
- Submitted
- In Revision
- Accepted

### Water management game: instructions

You are the newly appointed **water manager** for Lake Dual

It is a reservoir that serves two primary functions:

1. Water supply for **Swof Town**

2. Flood control for **Safe Town**
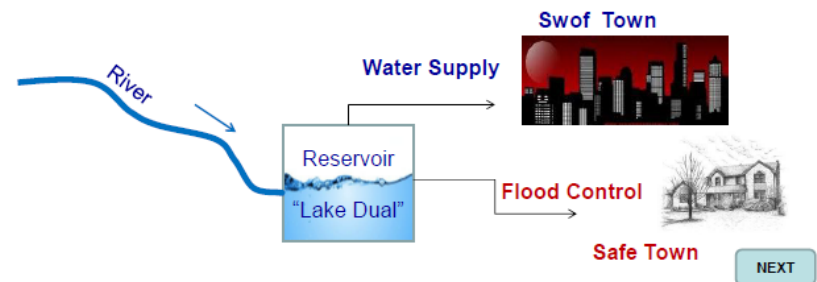
River → Reservoir "Lake Dual" → Water Supply → Swof Town

Flood Control → Safe Town

NEXT

**ECMWF**

# How - A roadmap to future development

**1 Secure funds for the priorities that yields most benefit to a low cost and with low complexity**

- Training and collaboration between forecasters at national and international level

- A "User guide" for hydrological probabilistic forecasting to improve forecast interpretation and decision making

- E-learning tools designed to show the added benefit of using HEPS

**2 Plan and coordinate activities to deal with intermediate cost/complexity priorities**

- Report past performance through forecast verification scores

- Showing calibration and validation results

- Include more NWPs

ECMWF

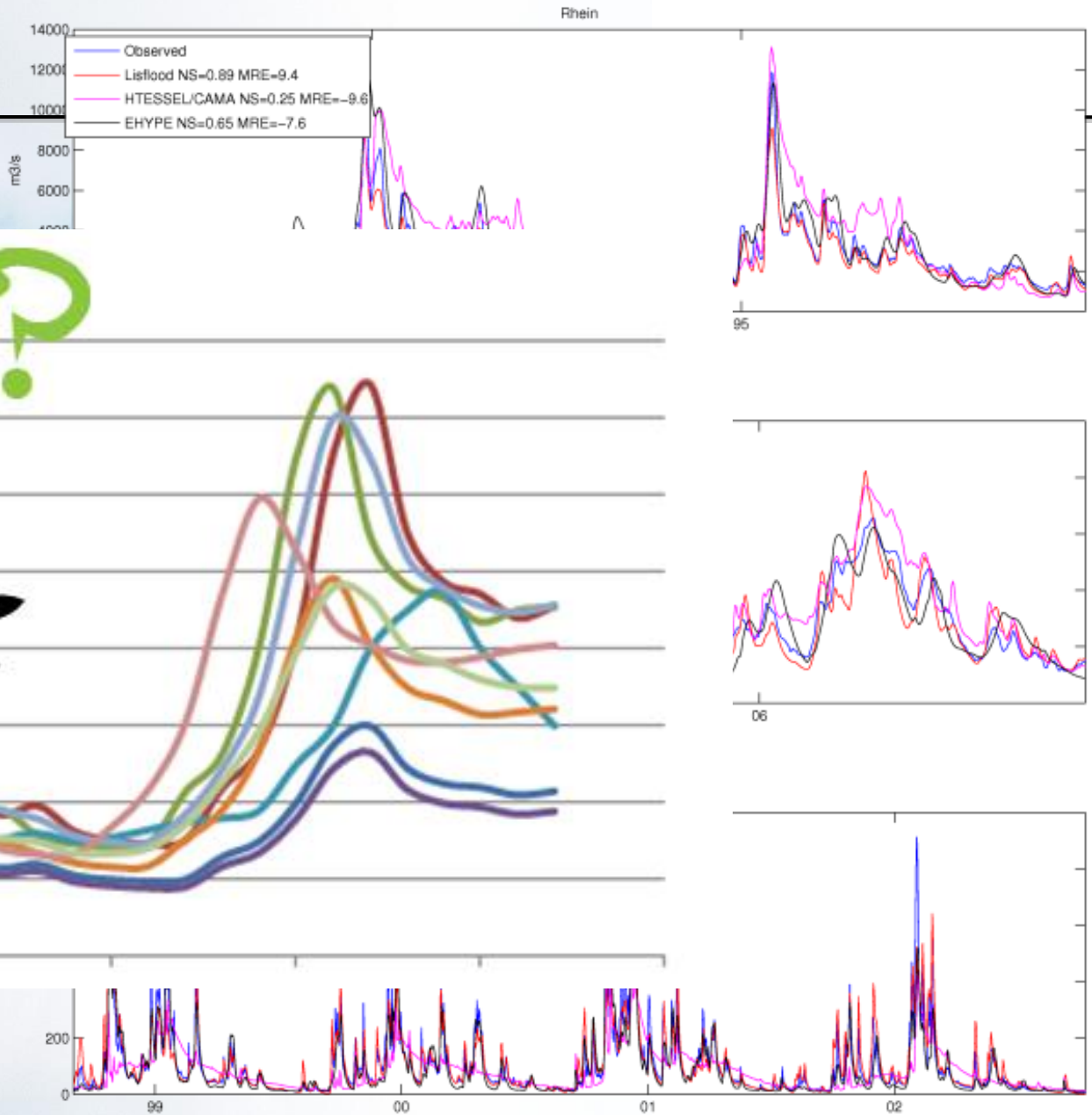# EFAS verification for the first year

# A roadmap to future development

**3. Long-term strategy to coordinate research and development for costly and/or complex priorities**
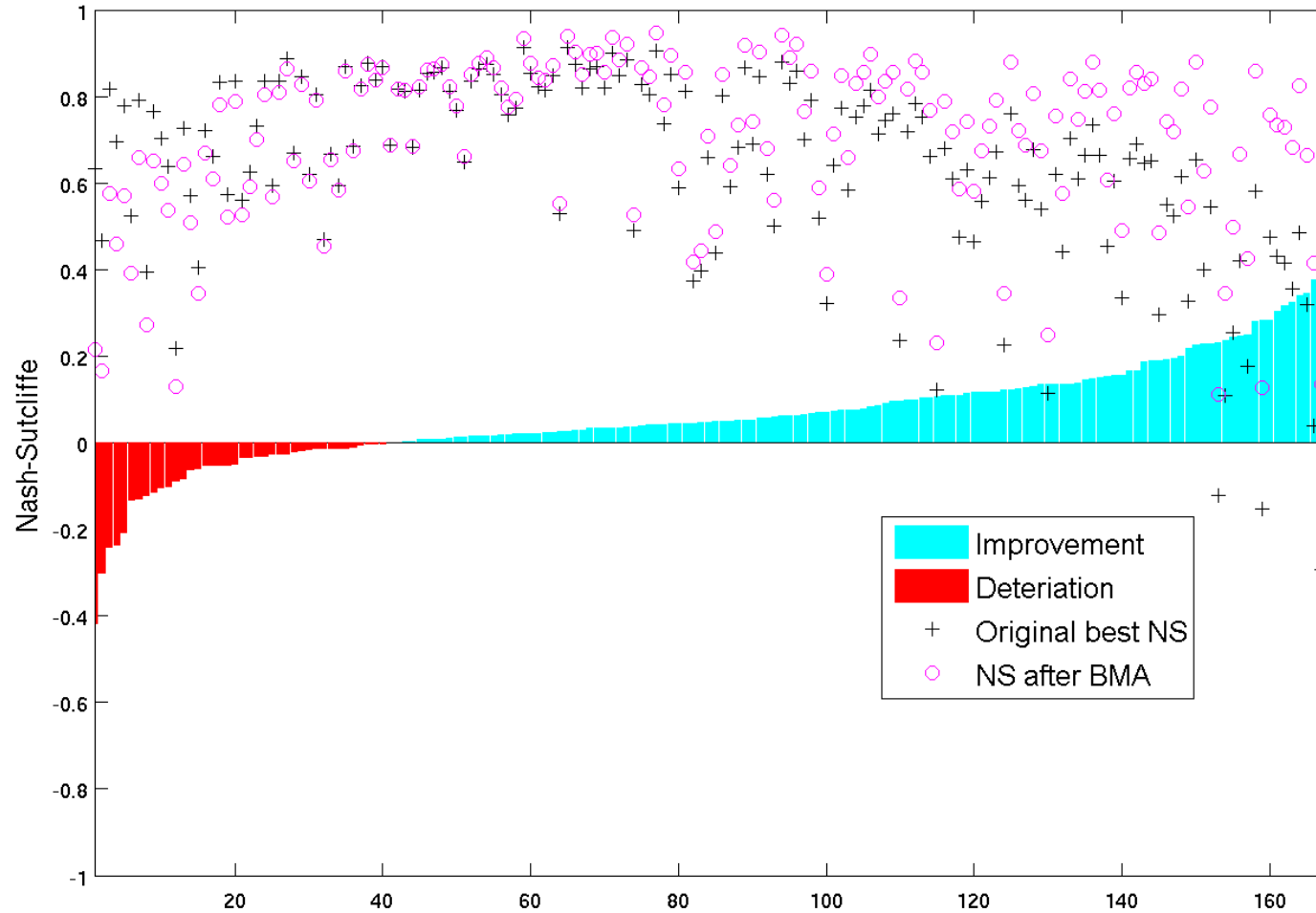
- A multimodel hydrological system

- Standardise hydrological data collection
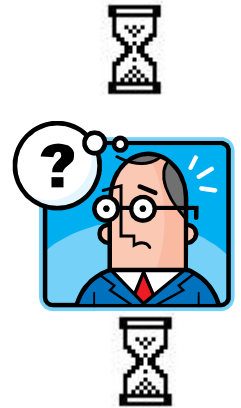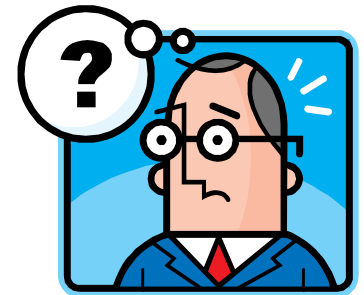
- Improve forecast dissemination
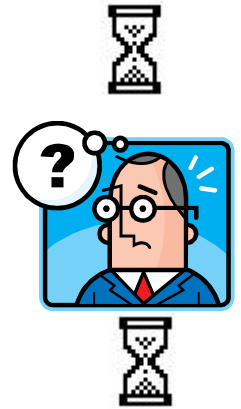
# Multimodel

# Bayesian model averaging

# A roadmap to future development

**3. Long-term strategy to coordinate research and development for costly and/or complex priorities**

- A multimodel hydrological system

- Standardise hydrological data collection
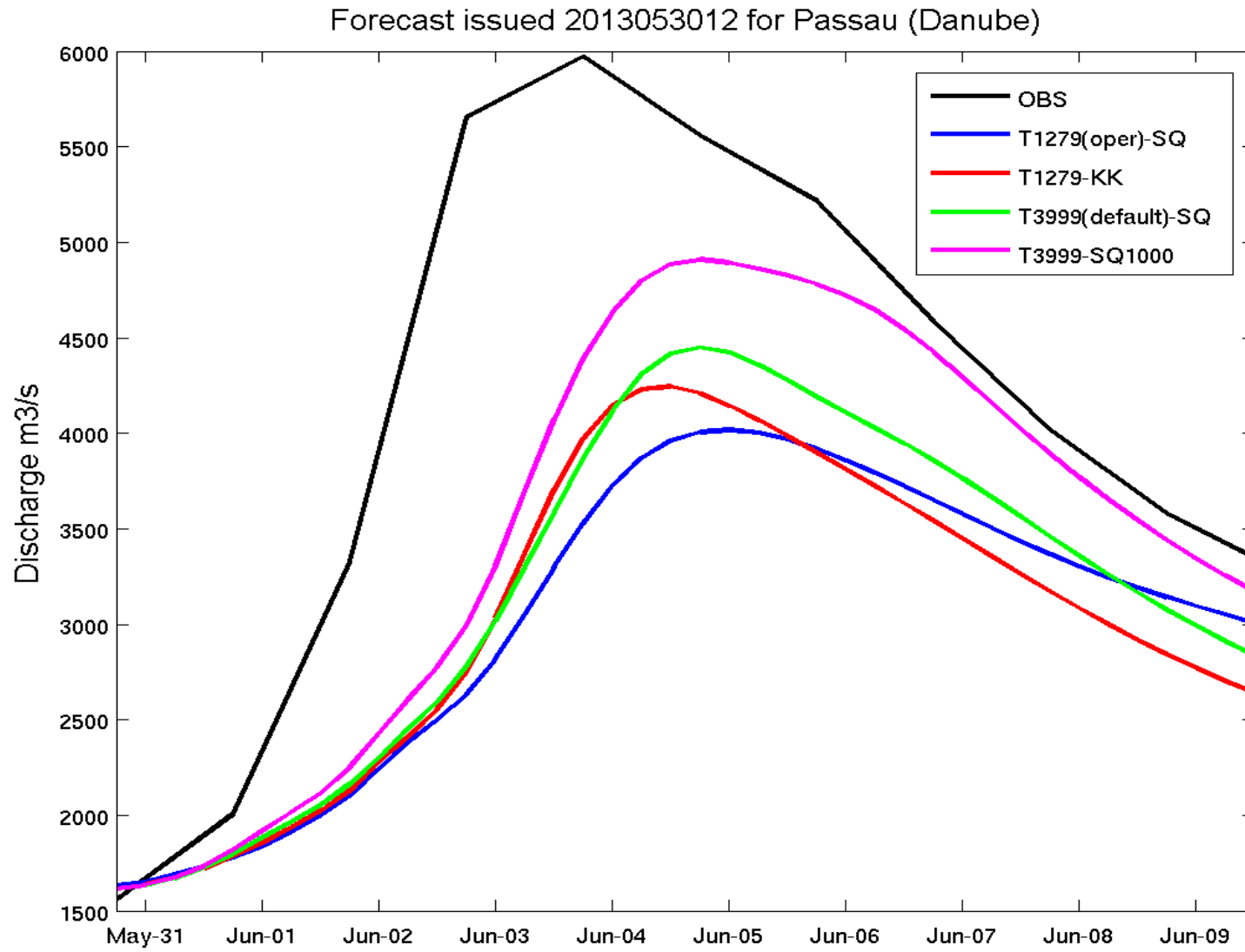
- Improve forecast dissemination

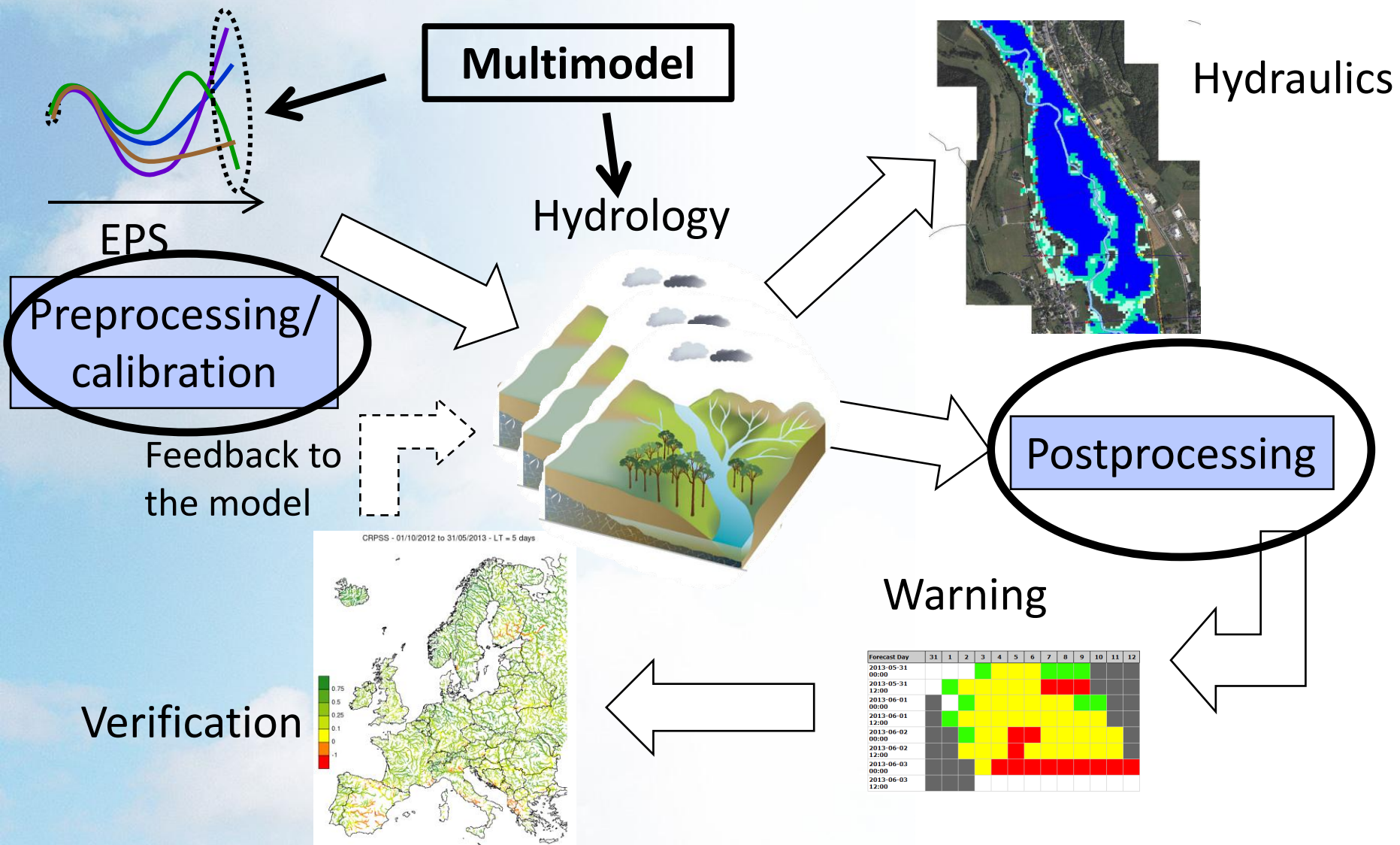**4. Collaboration with the scientific community on long-term improvements of HEPS**

- Improve the physical representations in the used models

- Improve the forecast on lead times > 3 days

# Discharge at Passau - experiments



Forecast issued 2013053012 for Passau (Danube)

# Forecasting chain in near future EFAS



Multimodel

EPS

Hydrology

Hydraulics

Preprocessing/ calibration

Feedback to the model

Postprocessing

Warning

Verification

# Lessons learned from these exercises

1. Forec... ...d clearly

2. Poten... ...ainty if used corre...

3. **Train**... ...ion

4. **Trans**... ...nding and trust in the...

5. Unce... ...ems – new...

## Coincides well with HEPEX science implementation plan!

# Discussion paper in HESS

## Hydrology and Earth System Sciences
An Interactive Open Access Journal of the European Geosciences Union

| EGU.eu |

### HESS Opinions "Forecaster priorities for improving probabilistic flood forecasts"

F. Wetterhall[1], F. Pappenberger[1], L. Alfieri[1], H. L. Cloke[2], J. Thielen-del Pozo[3], S. Balabanova[4], J. Daňhelka[5], A. Vogelbacher[6], P. Salamon[3], I. Carrasco[7], A. J. Cabrera-Tordera[8], M. Corzo-Toscano[8], M. Garcia-Padilla[8], R. J. Garcia-Sanchez[8], C. Ardilouze[9], S. Jurela[10], B. Terek[10], A. Csik[11], J. Casey[12], G. Stankūnavičius[13], V. Ceres[14], E. Sprokkereef[15], J. Stam[15], E. Anghel[16], D. Vladikovic[17], C. Alionte Eklund[18], N. Hjerdt[18], H. Djerv[18], F. Holmberg[18], J. Nilsson[18], K. Nyström[18], M. Sušnik[19], M. Hazlinger[20], and M. Holubecka[20]

[1]European Centre for Medium Range Weather Forecasts, Reading, UK
[2]University of Reading, Reading, UK
[3]European Commission, Joint Research Centre, Ispra, Italy

## Thank you for your attention!

# Case study floods central Europe in 2013

© ECMWF          **ECMWF**

# Floods in Central Europe June 2013

- Persistent rain across Europe has caused major flooding of rivers in Central Europe

- In Germany, around 10,000 were forced to leave their homes in low-lying areas of Saxony and Bavaria as many rivers across the country broke their banks and spilled over the countryside.

- The Bavarian town of Passau, where three rivers meet, saw floods at their highest level in more than five centuries but waters are now receding.

- Hungary has declared a state of emergency.



GRAPHIC NEWS / THE GLOBE AND MAIL

## For full story see:



**ECMWF Newsletter**

The ECMWF Newsletter is published quarterly and contains articles about new developments and systems at ECMWF. Articles about the use of ECMWF forecasts and products are welcome (especially from Member States and Co-operating States).

To submit an article, please refer to the guidance for newsletter authors. Please note that the ECMWF Newsletter is not a peer-reviewed publication.

Editor: Bob Riddaway
Typesetting and Graphics: Rob Hine

Click here for a chronological list of past Newsletter articles.

Alternatively, select computing, meteorology or news for an index of recent Newsletter articles.
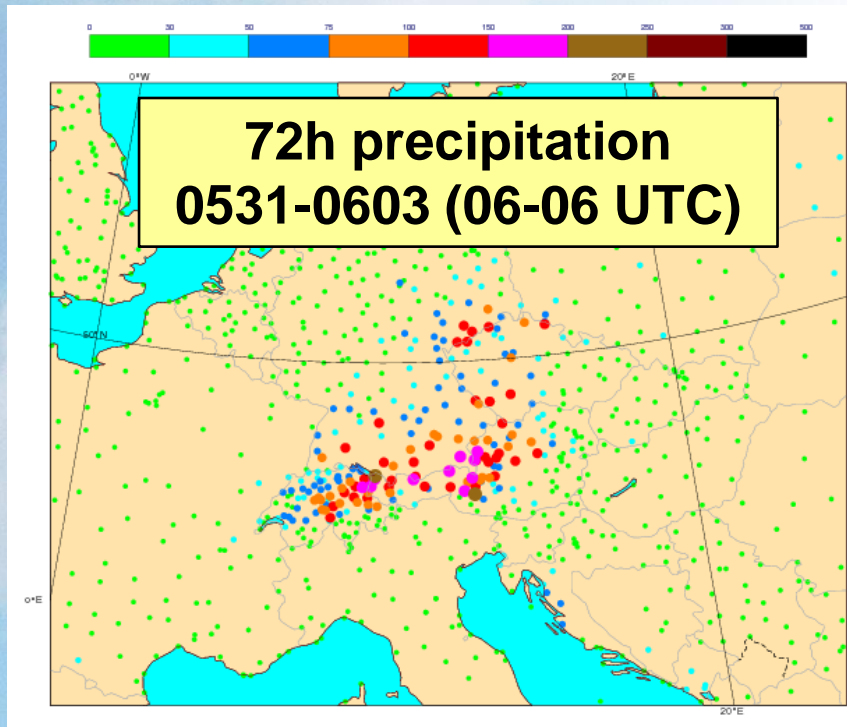
Latest issue:
**No.135 Spring 2013**

# Warnings - Floods in Central Europe June 2013

- Image displays the flood warnings and alerts issued by the EFAS system

- Warnings and alerts have been issued for all major rivers in central Europe (Elbe, Danube, Rhine) up to 8 days in advance
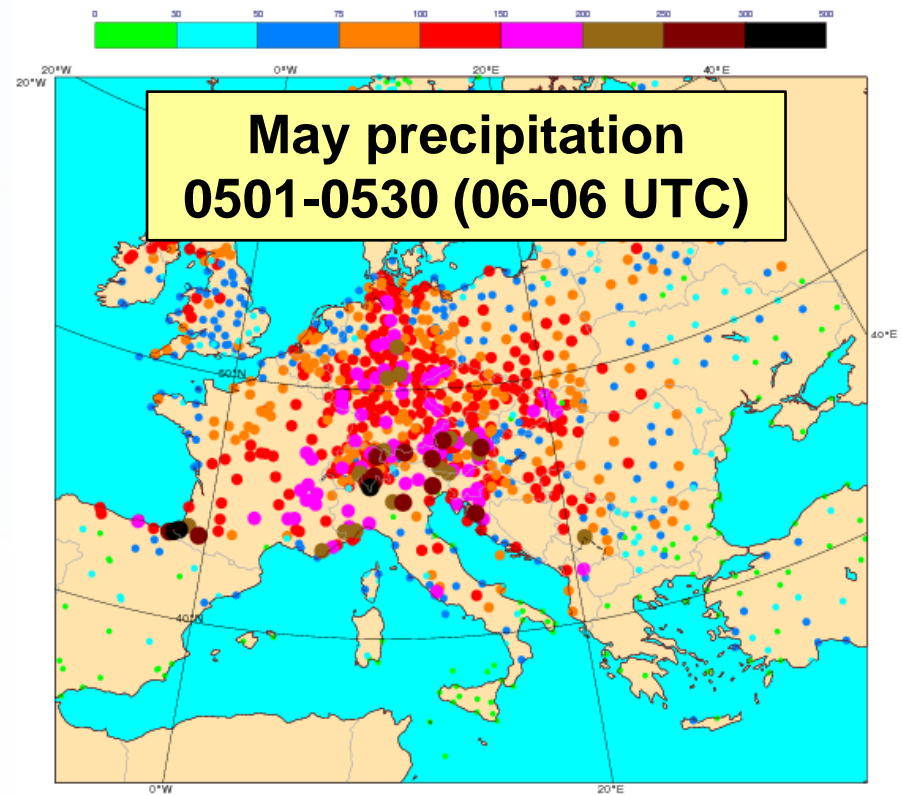
# Meteorology- Floods in Central Europe June 2013



**72h precipitation 0531-0603 (06-06 UTC)**

- In just 3 days large area experienced over 100 mm rain with peaks in the Alps over 200 mm



**May precipitation 0501-0530 (06-06 UTC)**
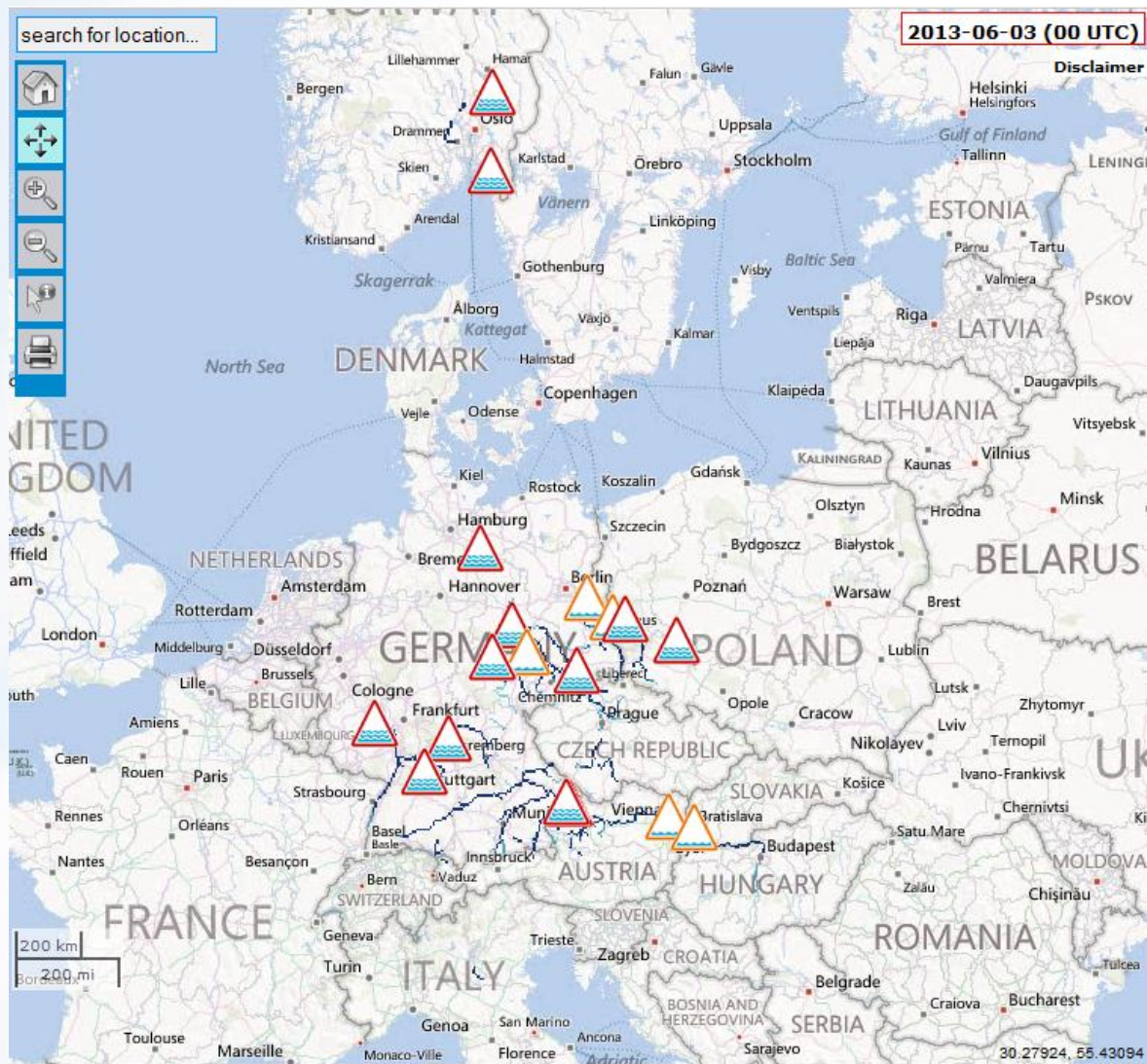
- The weather has been very wet in May before the floods providing a very wet soil and higher than normal waters in the rivers

ECMWF

## High resolution deterministic
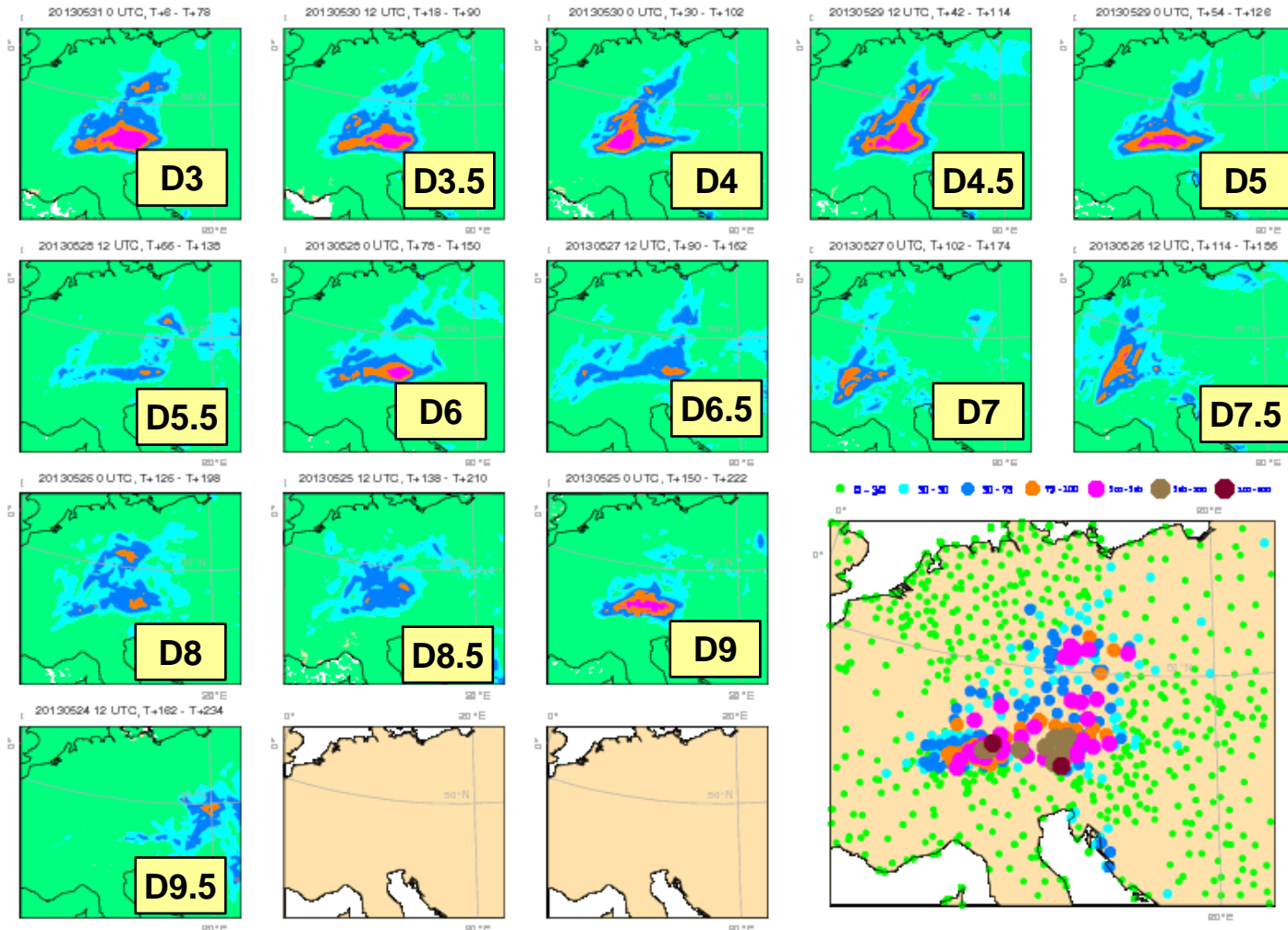


- At short range the area of the maximum precipitation is spot on and the values somewhat underestimated

- At longer ranges the model produces a large precip event near the area in every run even if with less extremity

# Meteorology- Floods in Central Europe June 2013

**Extreme Forecast Index**

- First indication already 8-9 days ahead of potential extreme event in this area

- Signal got gradually stronger closer to the event

- From 4-5 days in advance the area of extreme observed precipitation was highlighted quite well with EFI close to 1



3-day EFI for precipitation T+144-216, valid for Fri-Sat-Sun (06-06 UTC)

**Day 7-9**
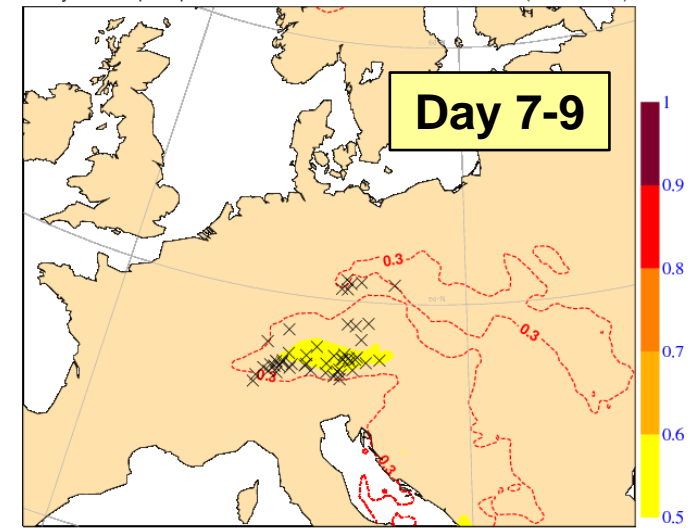
3-day EFI for precipitation T+6-78, valid for Fri-Sat-Sun (06-06

**Day 1-3**
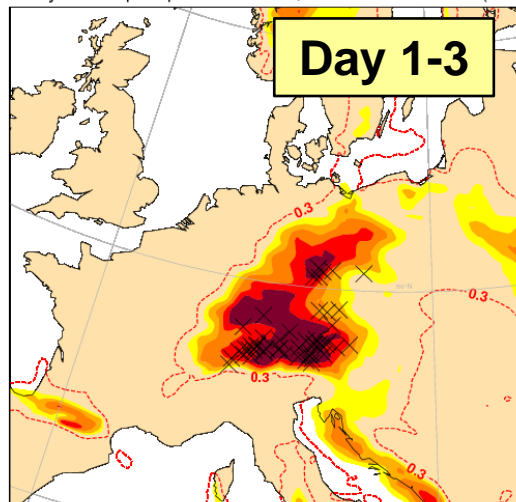
3-day EFI for precipitation T+48-120, valid for Fri-Sat-Sun (06-06 UT

**Day 3-5**
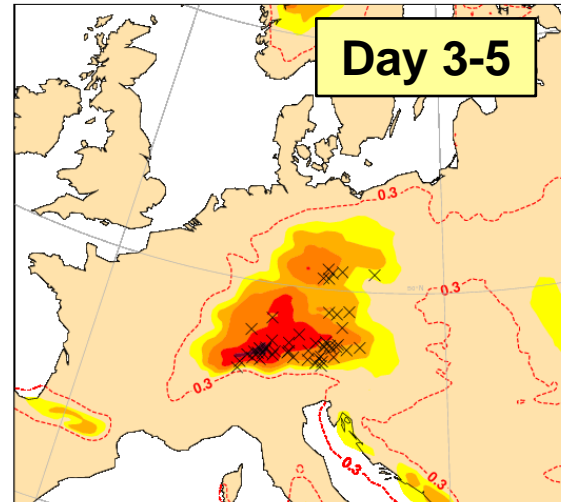
3-day EFI for precipitation T+96-168, valid for Fri-Sat-Sun (06-06 UTC)

**Day 5-7**
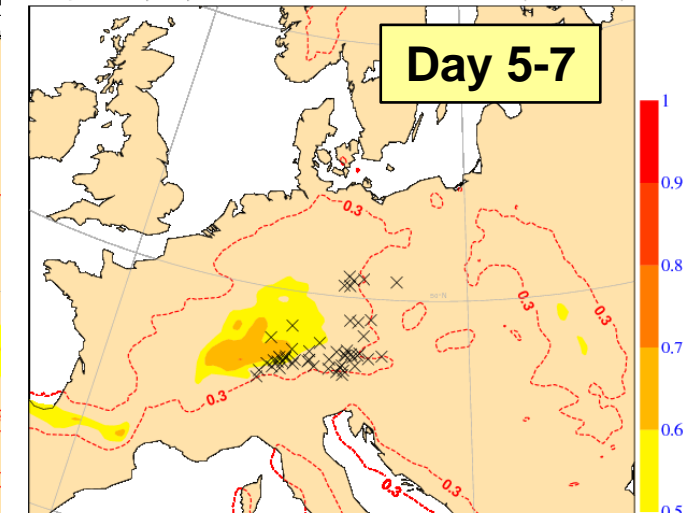
ECMWF

# Hydrology - Floods in Central Europe June 2013

The image shows the EFAS multi-model streamflow prediction for Passau, Germany. Forecast date is 30/05/2013 12 UTC. The colours indicate the different alert levels.
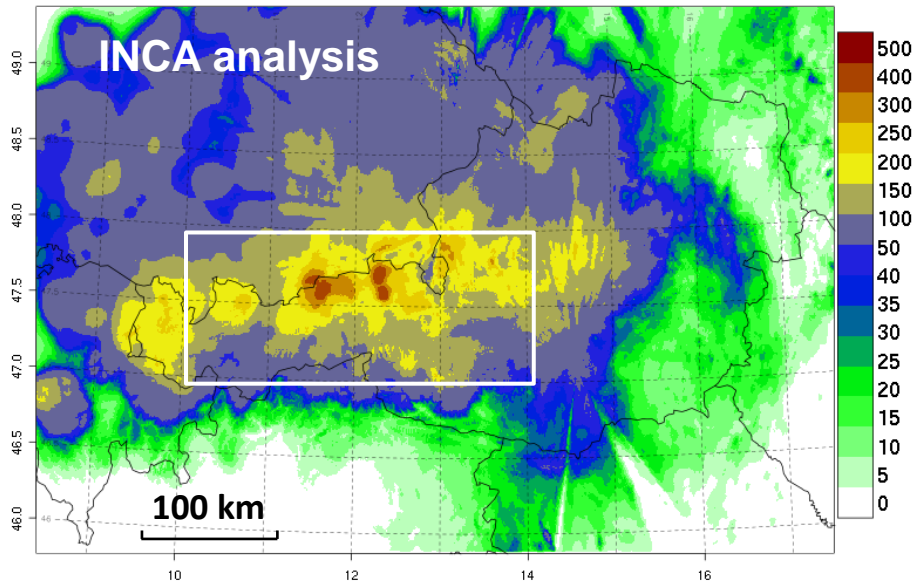
The box plots show the ECMWF EPS, the red line the ECMWF Highres, the black line the DWD COSMO.

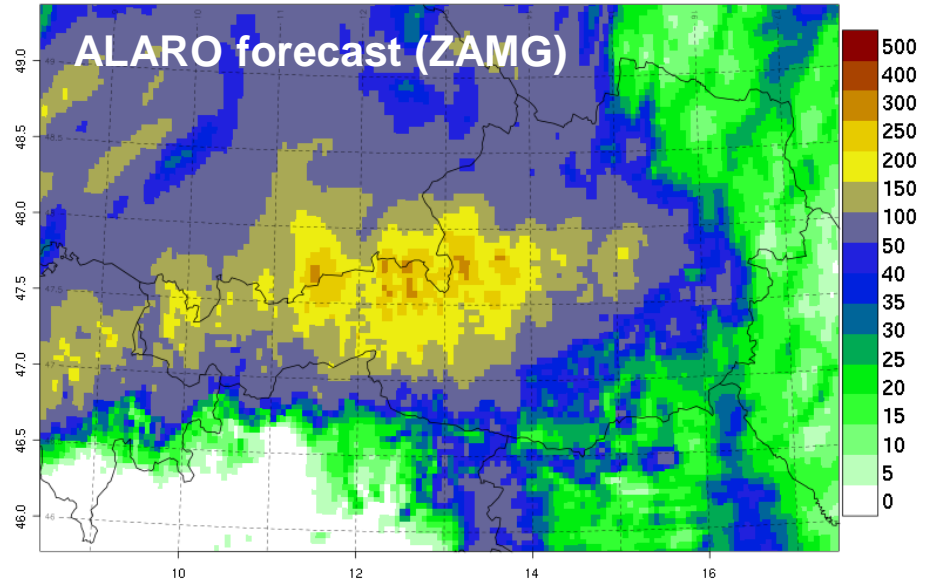The forecasts gives a clear indication of a flooding in 3-4 days
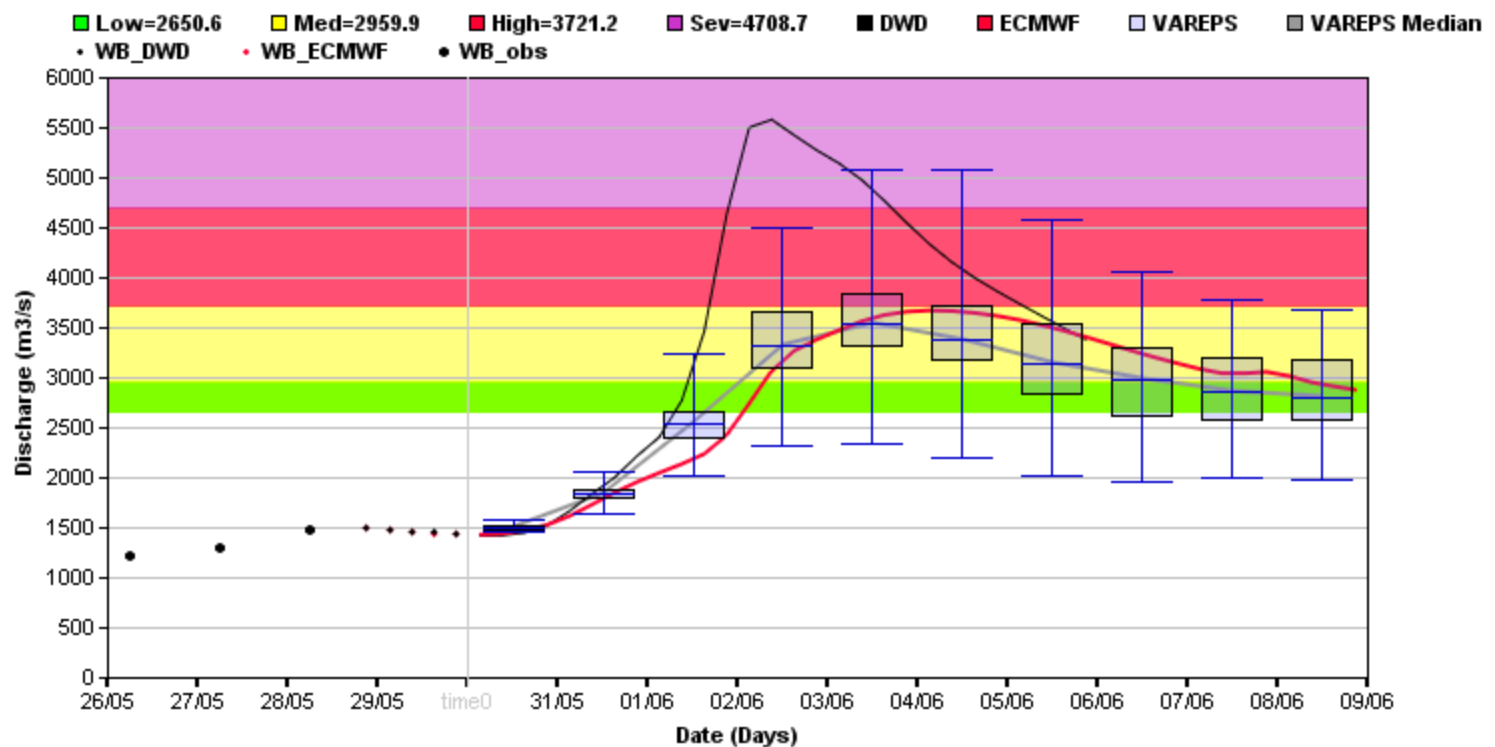
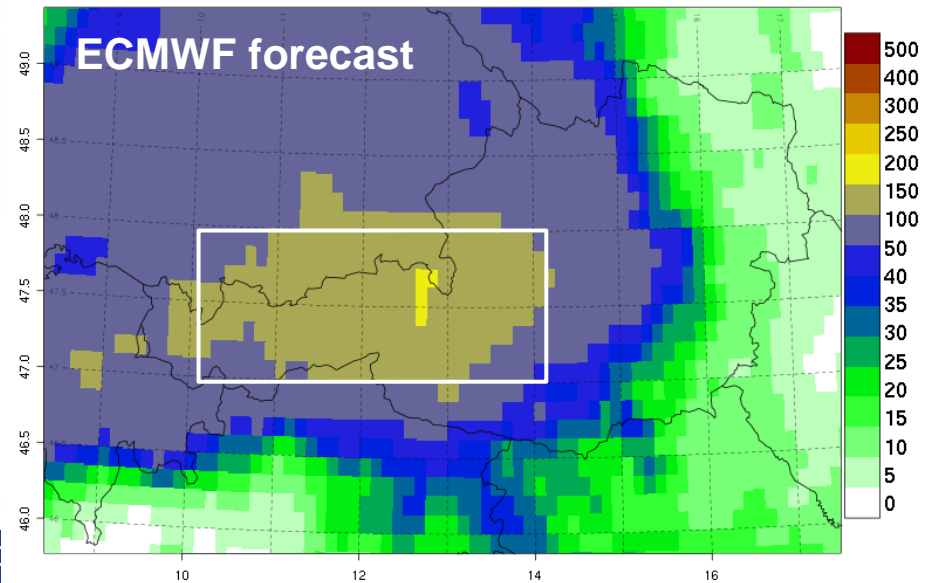# Precipitation from 31/05/2013 00UTC to 03/06/2013 00UTC
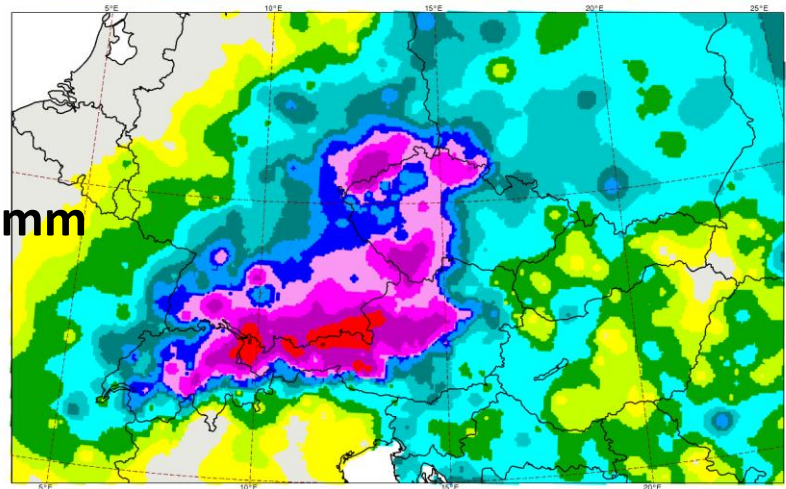


72h precip. INCA 2013060300

INCA analysis

100 km



72h precip. ALARO5 2013053100+72

ALARO forecast (ZAMG)



72h precip. ECMWF 2013053100+72

ECMWF forecast

- ALARO (5 km): very good at 100 km scale but local maxima underestimated

- ECMWF (16 km): correct location but underestimation of magnitude

# Comparison between models: 31 May – 3 June 2013
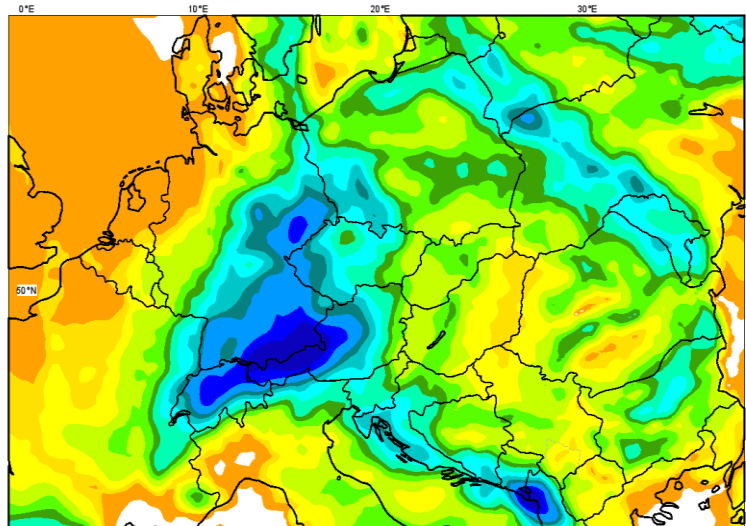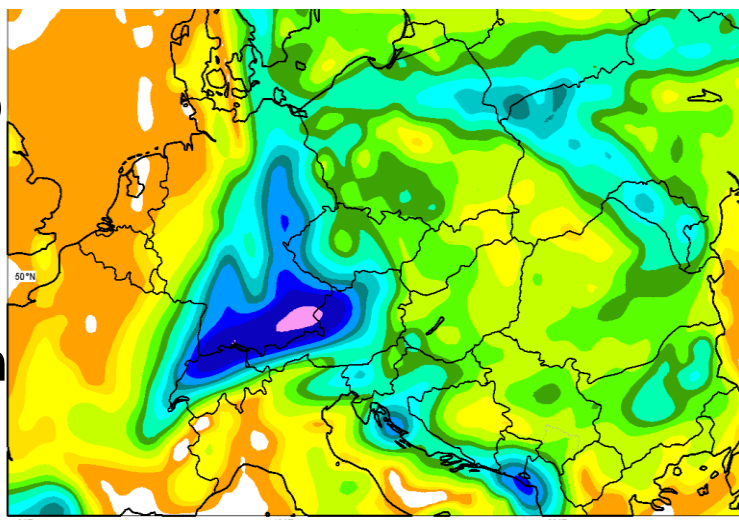


OBS
Max: ~200mm

ECMWF 0-72h
Max: ~150mm

UKMO 0-72h
Max: ~160mm

NCEP (USA) 0-72h
Max: ~185mm

0.1  1  2  5  10  15  20  30  40  50  60  80  100  150  200  250  300  500  700  1000
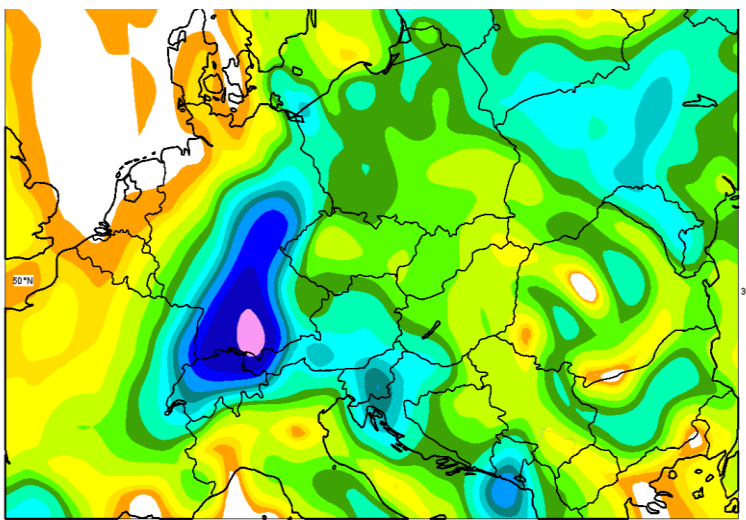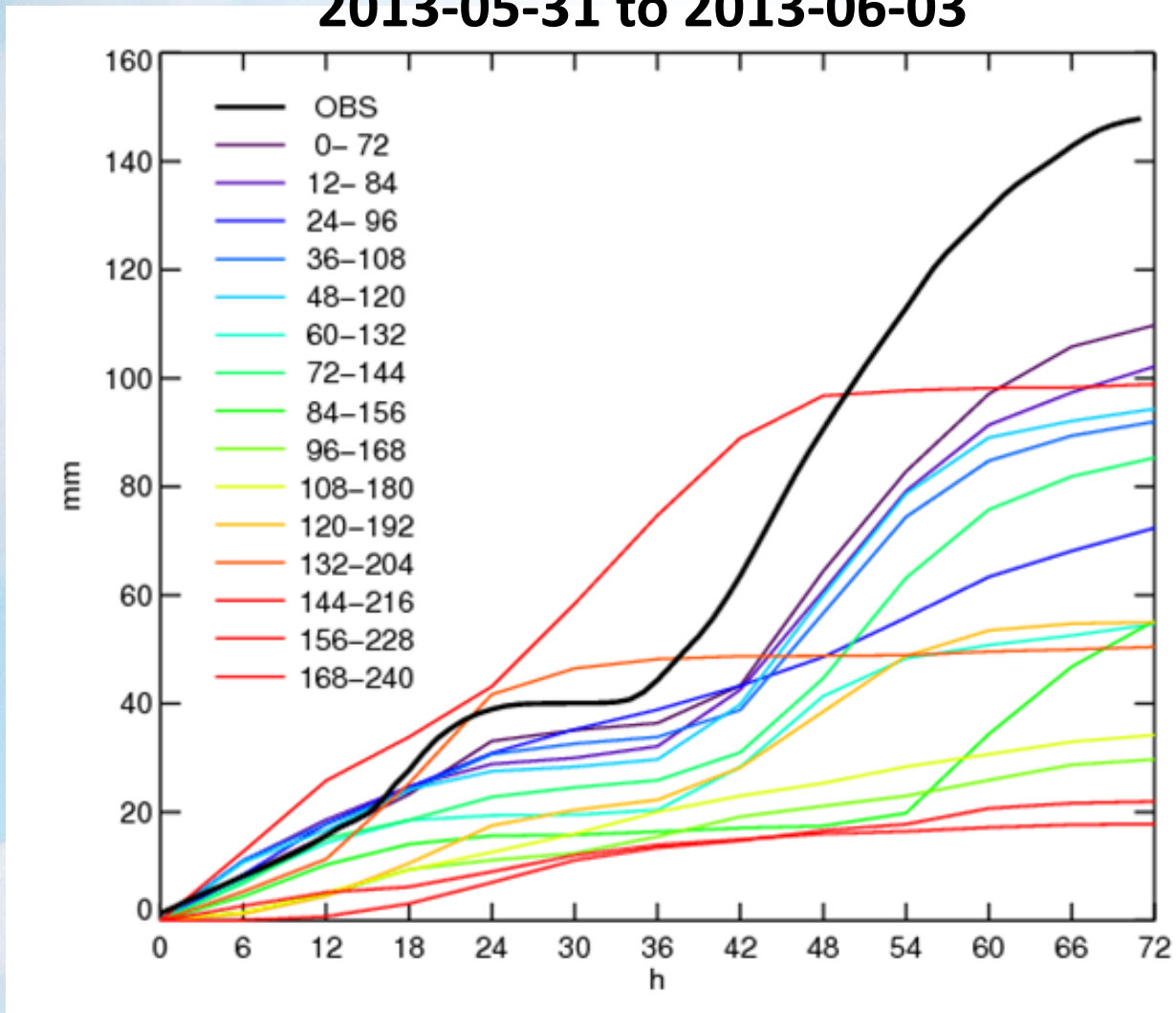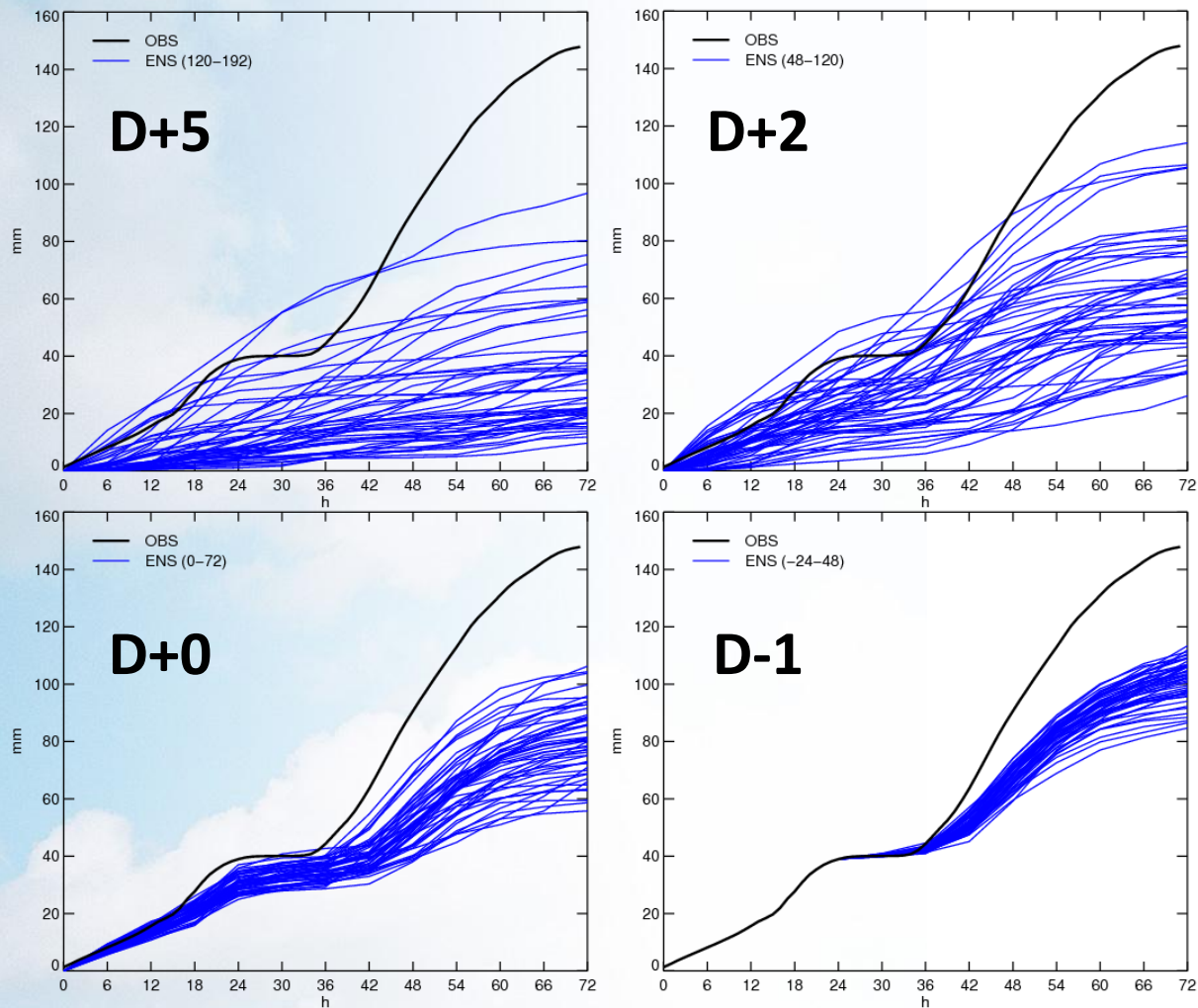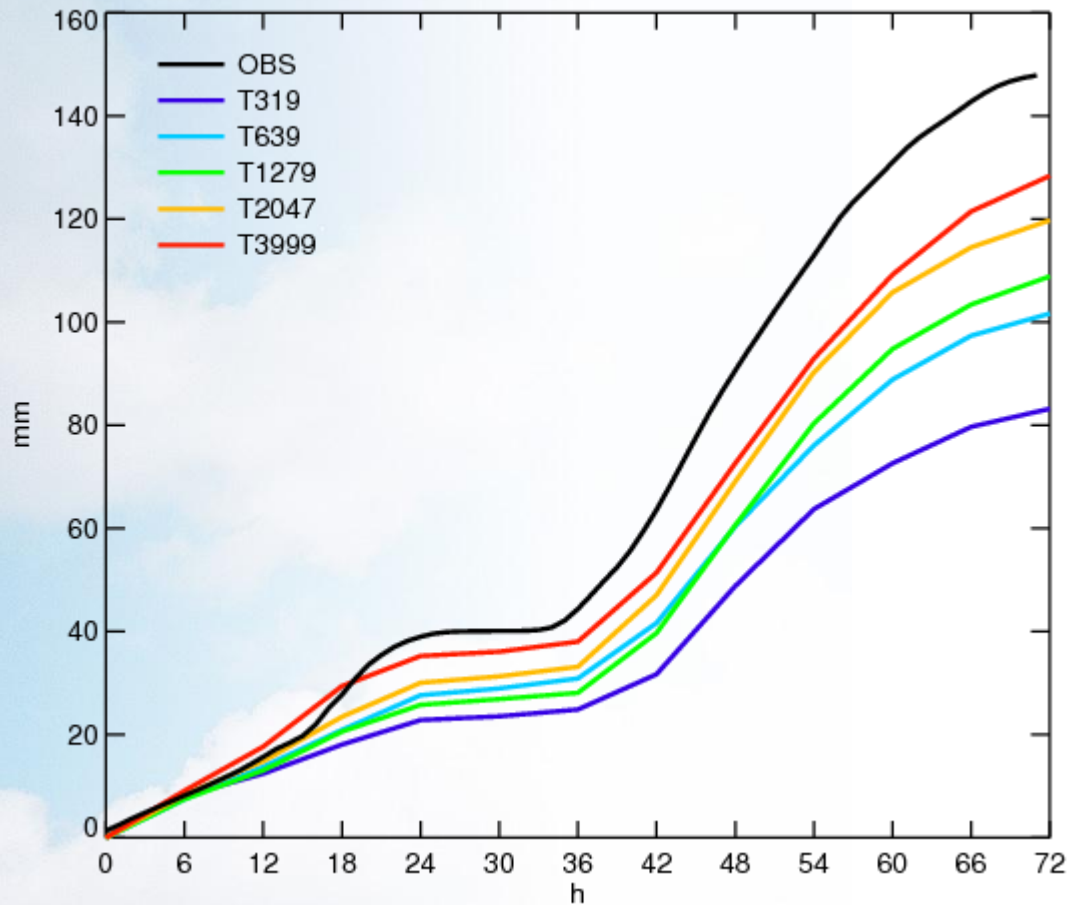
# Cumulative precipitation - HRES

## 2013-05-31 to 2013-06-03

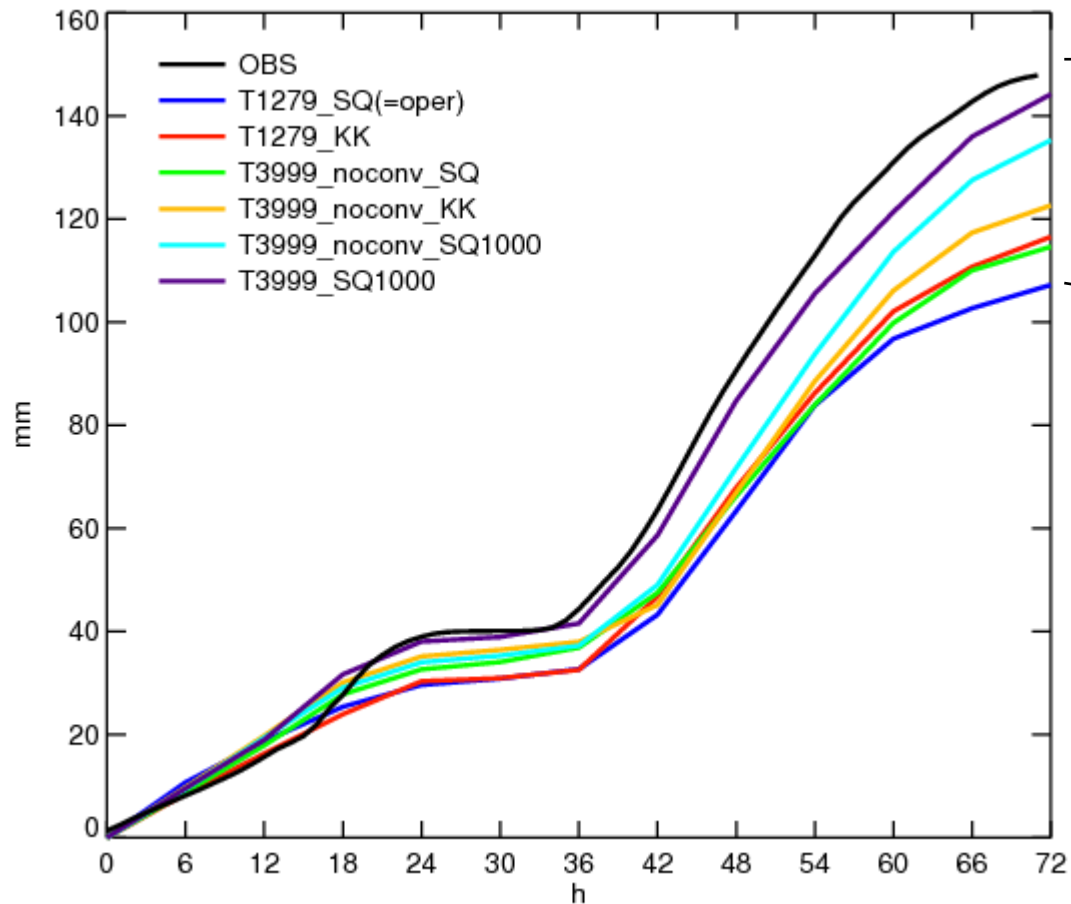# Cumulative precipitation - ENS

## 2013-05-31 to 2013-06-03

# Cumulative precipitation - experiments

## 2013-05-31 to 2013-06-03

**ECMWF**

# Cumulative precipitation - experiments

## 2013-05-31 to 2013-06-03

# Discharge at Passau - experiments



Forecast issued 2013053012 for Passau (Danube)

Legend:
- OBS
- T1279(oper)-SQ
- T1279-KK
- T3999(default)-SQ
- T3999-SQ1000