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EFAS EPS-based forecasts : in-depth case studies analyses & statistical evaluation of summer 2005 and spring 2006 flood forecasts

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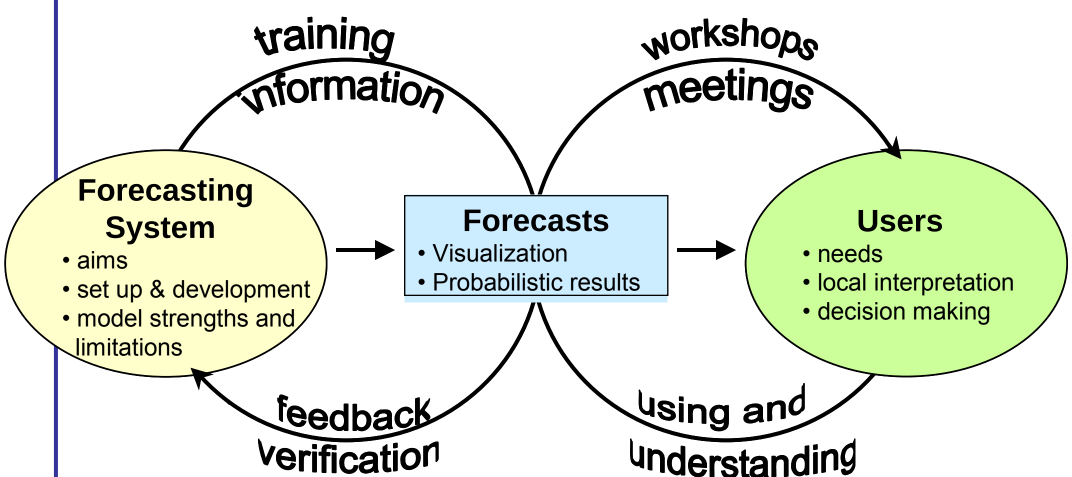
Context

General framework:

- A forecasting system under development : learning on model strengths, limitations and performance
- New probabilistic forecasts : concise visualisation and reliable products for pre-alert, building an archive



- Network of users : getting used to the forecasts in an event-based situation (eg., summer 2005 and spring 2006 flood-prone periods), permanently asking for verification of forecast quality

Challenges and objectives

- **How to extract the relevant and useful probabilistic hydrological information?**

□ development of specific probabilistic forecast products

- **How to implement forecast verification tools? Which ones?**

□ based on the probabilistic products implemented

□ helping to define operational alert rules : making decisions on a potential flooding situation (issuing EFAS warnings)

- How many EPS-based forecasts above an alert threshold should be considered to launch a pre-alert? Which consistency with deterministic (higher resolution) forecasts?

- How can we efficiently communicate probabilistic forecasts?

Challenges and objectives

- **Forecast verification targeted to the object and purposes of the forecasting system?**

(discharges/threshold exceedances, utility/benefit of the forecasts to users)

EFAS: medium-range forecasts complementing national forecasts

⇒ forecasts to be used as a PRE-ALERT : users can play through a number of different scenarii

⇒ high impact of hits (+) and misses (-) and, comparatively, smaller impact of false alarms (BUT: significant role if they happen too often to start generating a systematic “distrust” of the earlier forecasts issued)

- **Can EPS-based forecasts contribute to an earlier detection of floods (increased preparedness)?**

General approach

Development of tools:
- Visualization
- Getting the “right” info

Testing :
case-studies (quality) and
Users (usefulness)

towards a “stable” representation
of EPS-based forecasts

Evaluation of the system’s performance
for individual flood events ✓

Implementation of an objective verification approach to
apply to long-term (statistical) analyses ✓

Evaluation of the system’s
performance for a long run

USERS

1. Post-event analyses

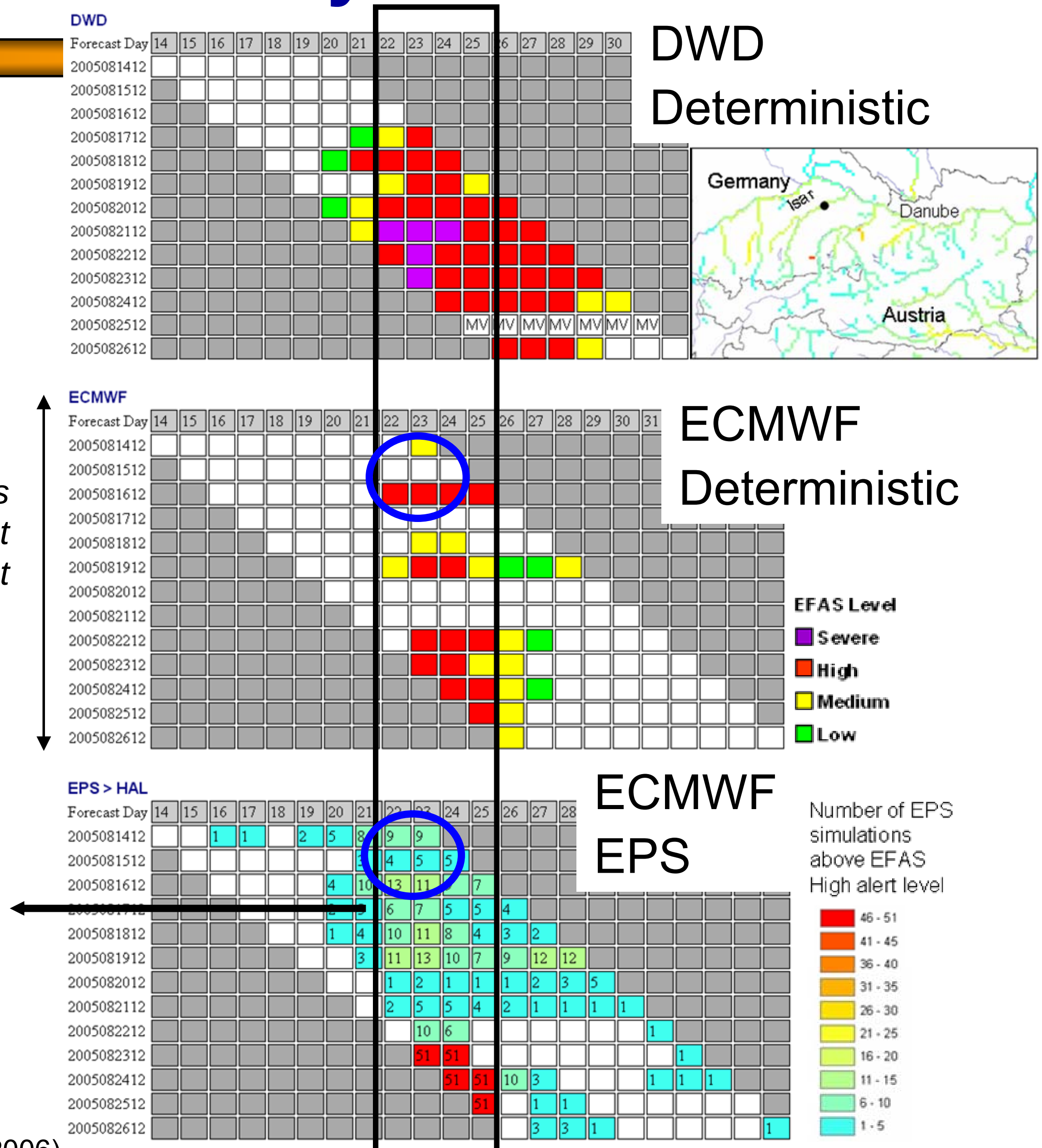
- **August 2005 flood**

Isar River in Germany
Danube River Basin
A ~ 8,000 km2

forecast dates
From: 14th August
To: 26th August

Exceedances of high flood threshold in simulations with observed meteo data (proxy in EFAS for observed discharges)

EPS earlier detection
⇒ GAIN in lead-time



De Roo, A., M-H Ramos, J. Thielen *et al.* (2006)

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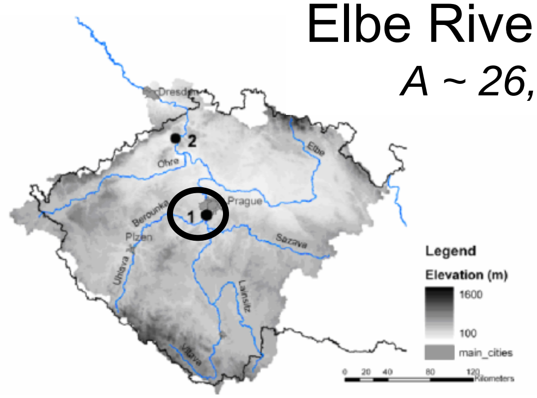
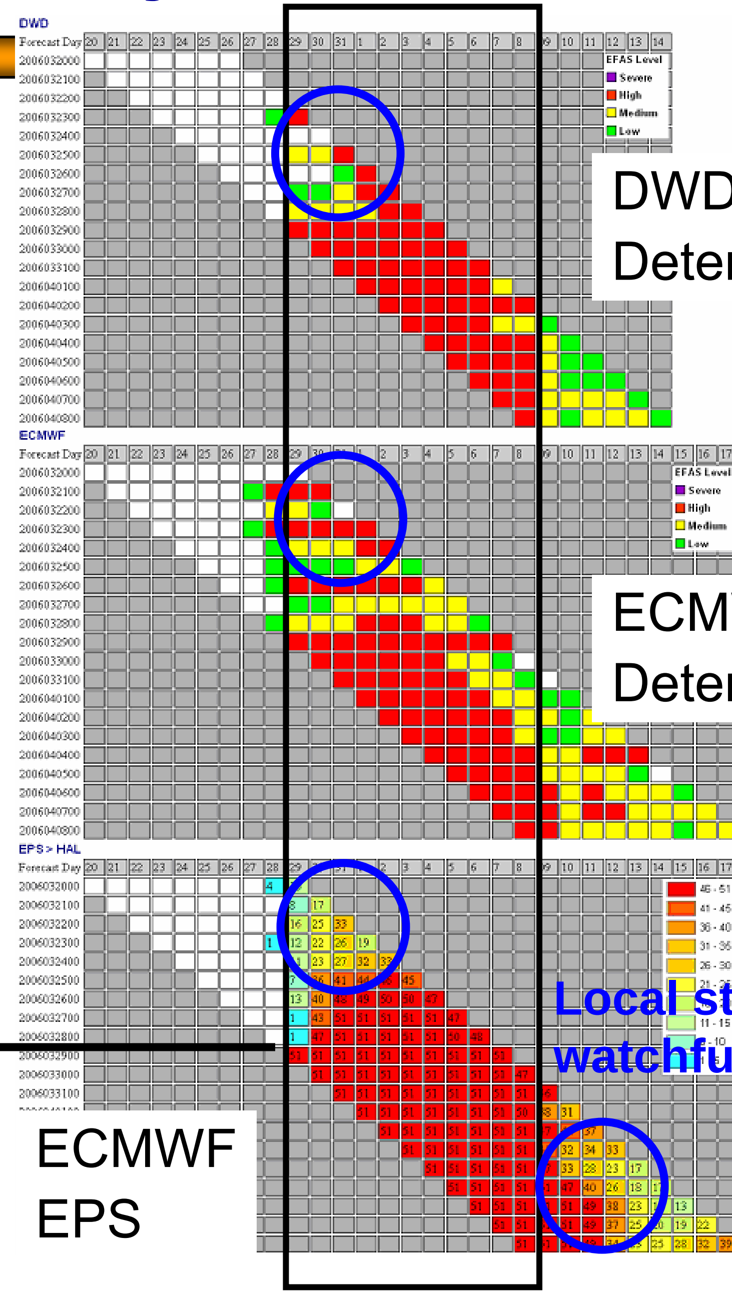
1. Post-event analyses

- **March-April 2006 flood**

Vltava River in CZ
Elbe River Basin
A ~ 26,000 km2



forecast dates
From: 20th March
To: 08th April



Observed exceedances of flood alert thresholds (local state of emergency)
return period of Q between 1-5 years

Younis, J., M.H. Ramos, J. Thielen (2007)

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2. Statistical evaluation of forecasts

- **Data**
  - ECMWF forecasts : deterministic and 51 EPS members
    Leadtimes : 3 to 10 days
  - Locations in the Danube (70) and Elbe (32) River Basins
  - Summer 2005 : June-July-August
    Spring 2006 : March-April-May

- **Contingency tables**: hits, misses and false alerts

f ~ (Nb EPS > EFAS High threshold)

Calculated for exceedances of EFAS High flood alert threshold

		Observed event	
		yes	no
Forecasted	yes	Hit	False Alert
Event	No	Miss	Correct rejection

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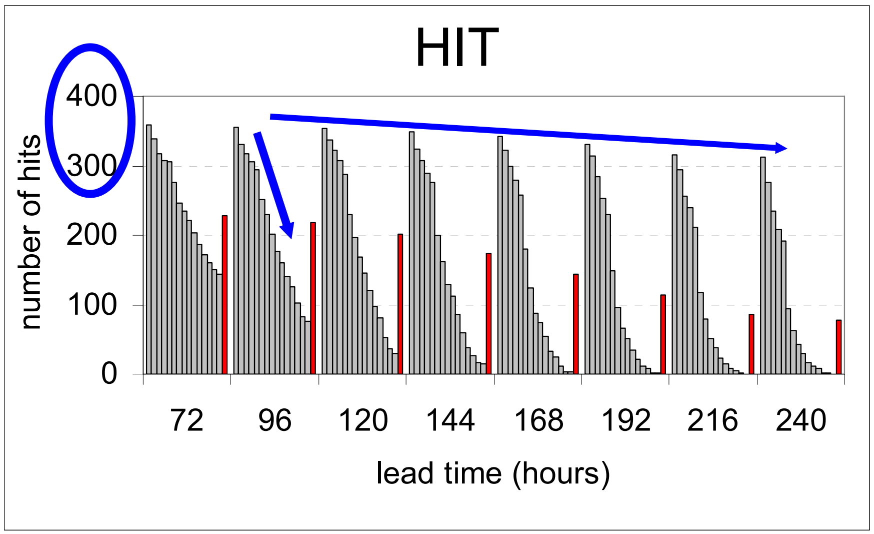
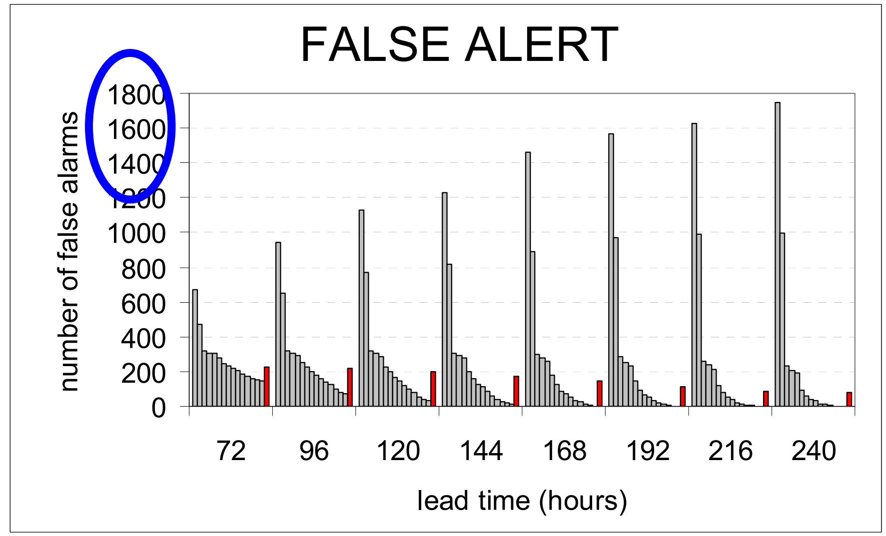
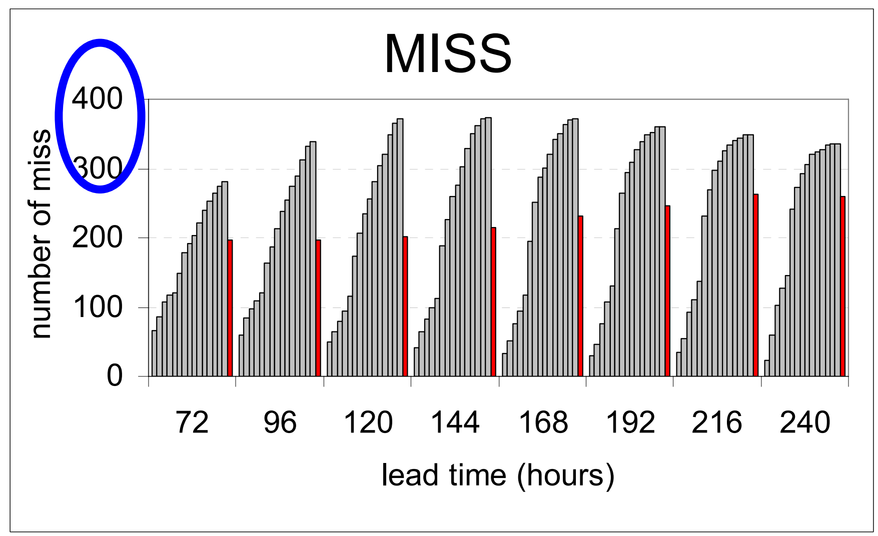
2.1 - Typical scores

Danube River Basin
Summer 2005

at least: 1,2,3,4,5,10,15,20,25,30,35,40,45,50,51 EPS>HAL   ECMWF deterministic







OCCURRENCES

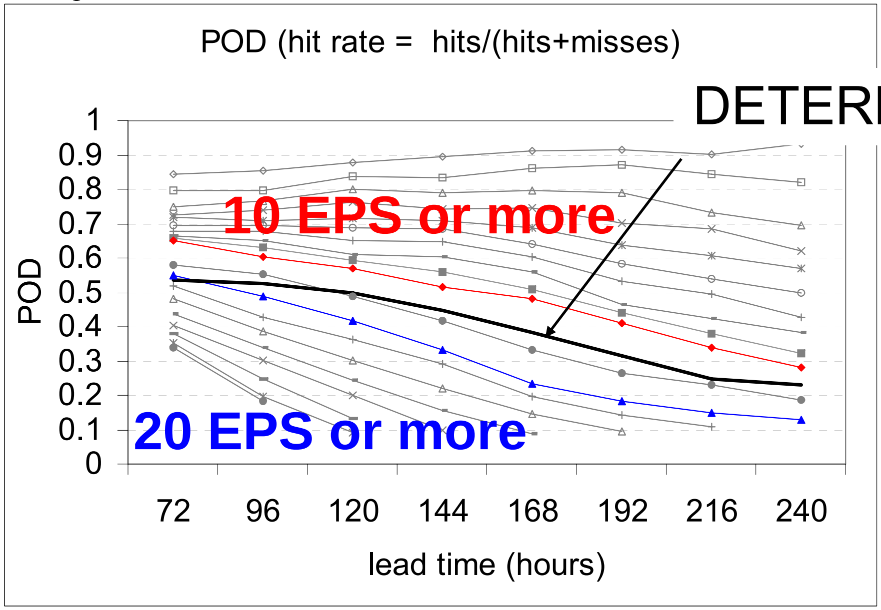
LEADTIME (hours)

2.1 - Typical scores

Danube River Basin
Summer 2005

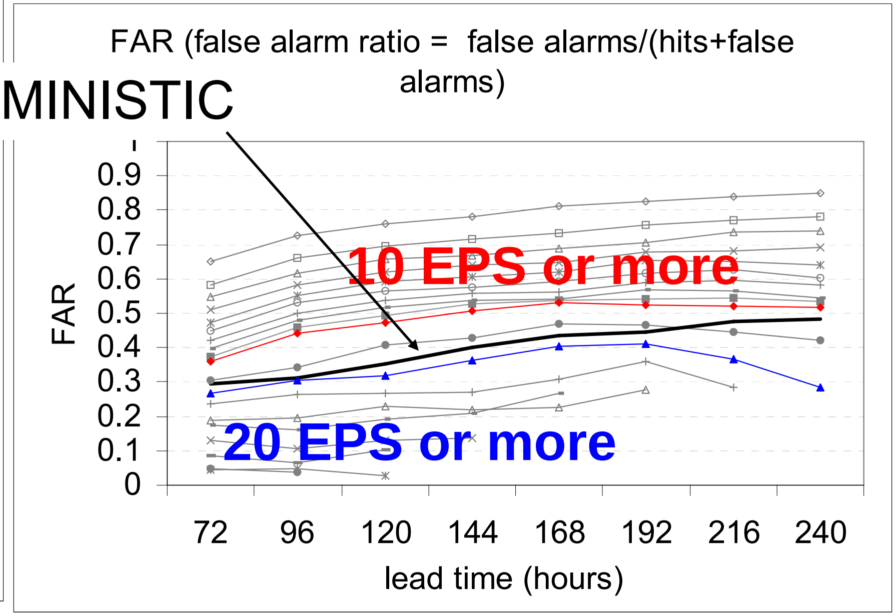
HIT RATE

Range: 0 to 1 ; Perfect score: 1



FALSE ALERT RATIO

Range: 0 to 1 ; Perfect score: 0



S C O R E

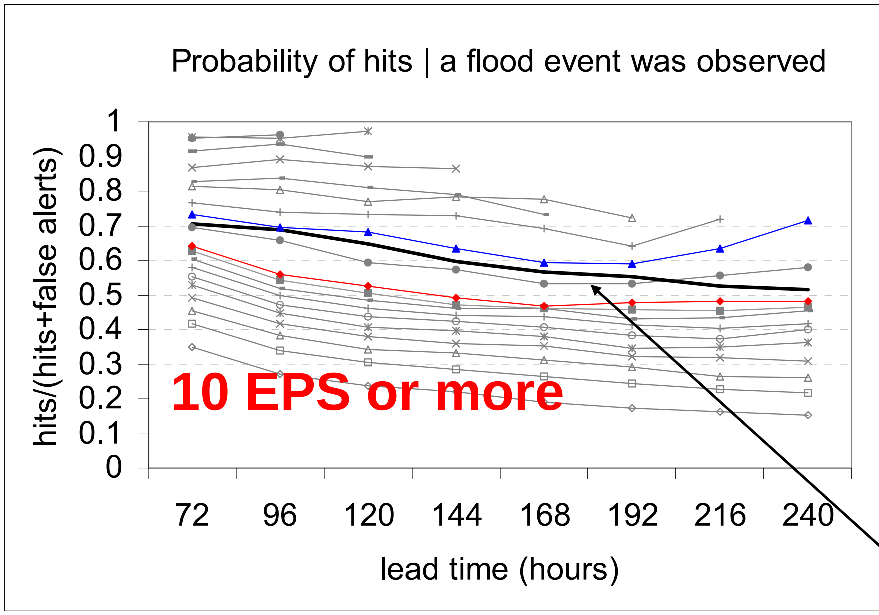
LEADTIME (hours)

2.1 - Typical scores

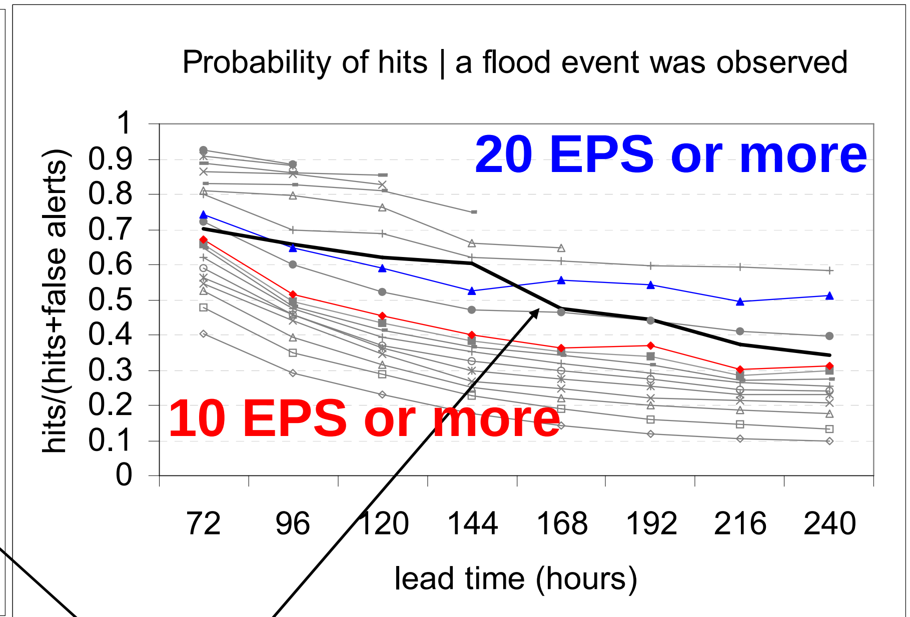
Danube River Basin

- What fraction of the forecasted “yes” events actually did occur (i.e., were hits?) Range: 0 to 1 ; Perfect score: 1

Summer 2005



Spring 2006



DETERMINISTIC

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2.1 - Typical scores

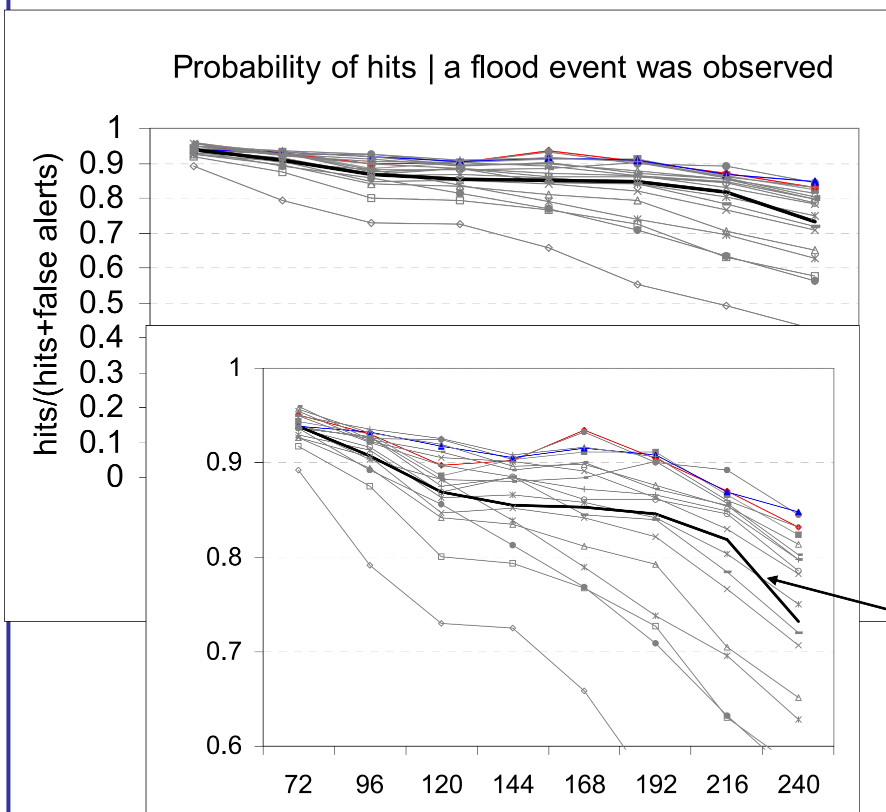
- What fraction of the forecasted “yes” events actually did occur (i.e., were hits?)

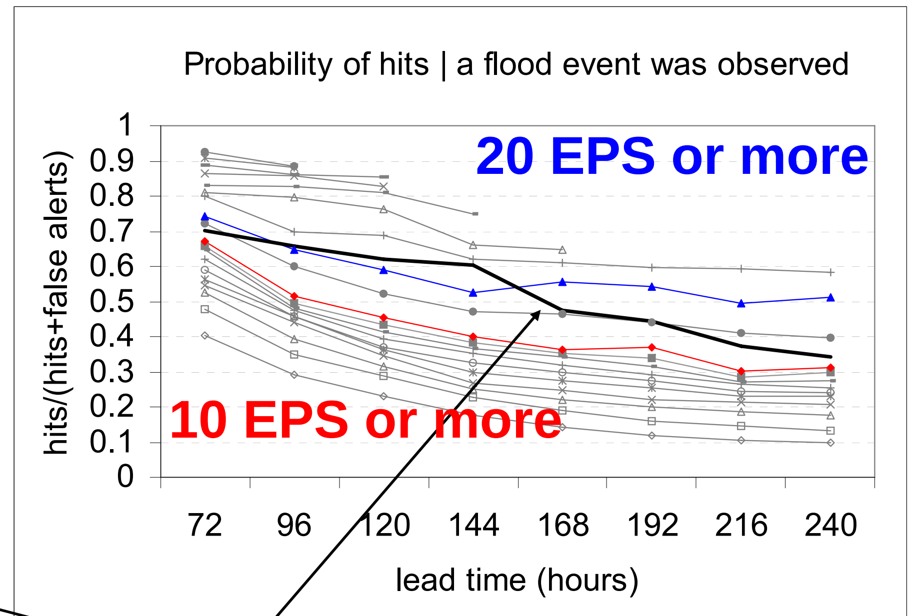
Range: 0 to 1 ; Perfect score: 1

Elbe River Basin ?

Danube River Basin

Spring 2006





DETERMINISTIC

2.2 - Gain in preparedness

- **Gain/loss in preparedness :** **only when observed event=yes**

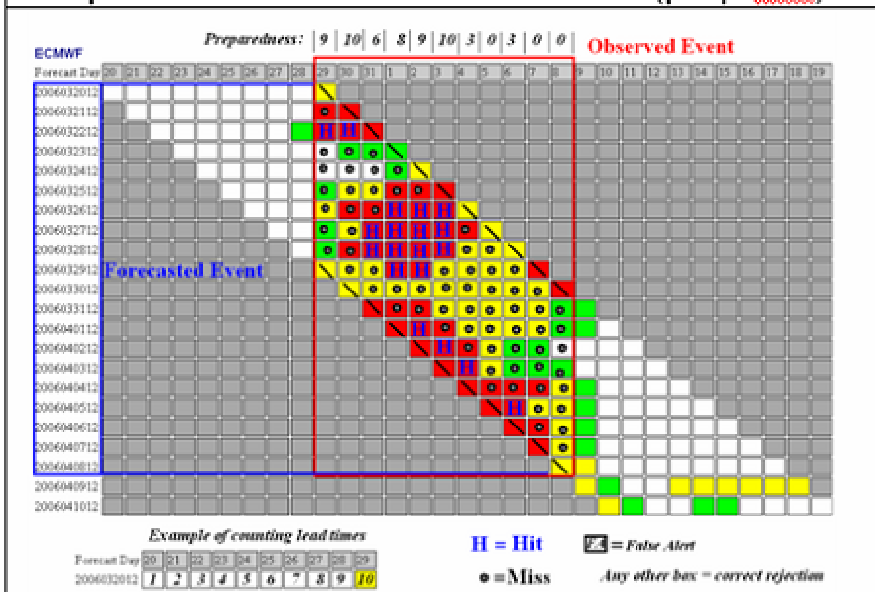
Δ prep = prep eue – prep eud ; -10 ≤ Δ prep ≤ +10

Preparedness (prep) = the lead time associated with the first signal of an event in the diagrams of EFAS forecasts

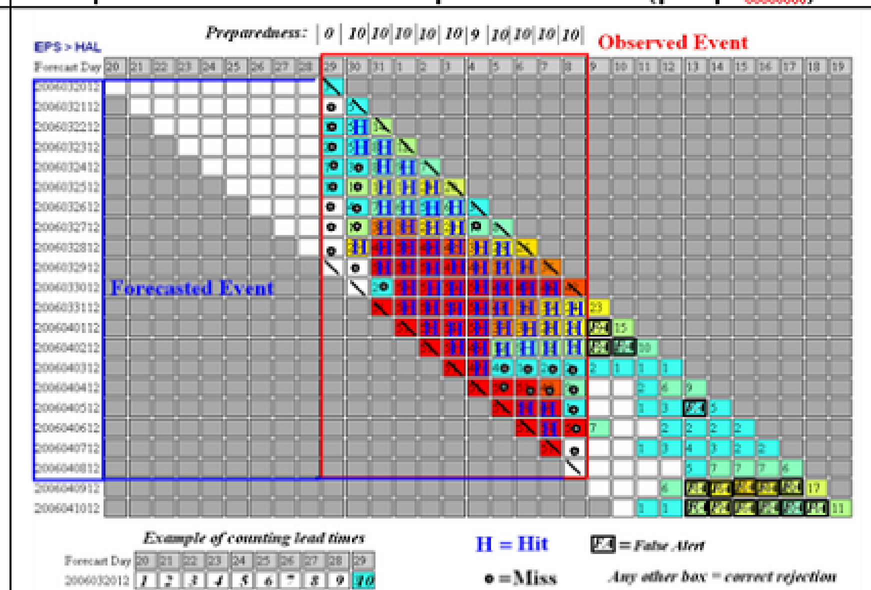
Two consecutive forecasts > High flood threshold

Two consecutive forecasts with at least *N* EPS members > High flood threshold

Preparedness ECMWF deterministic (prep eud)



Preparedness ECMWF probabilistic (prep eue)



Obs.: all LT (>3 days) considered together

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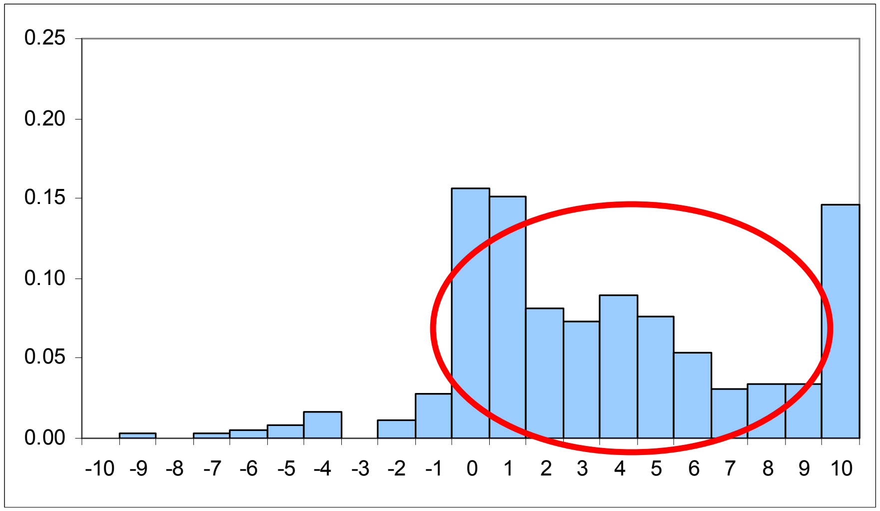
2.2 - Gain in preparedness

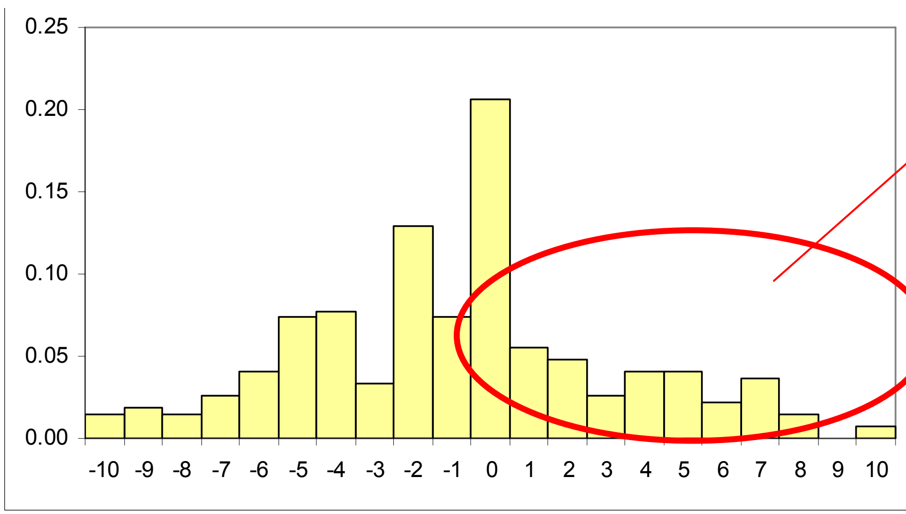
at least **5 EPS** above High thresholds



Danube River Basin

Summer 2005

at least **20 EPS** above High thresholds



Less gain
if waiting for warning
from too many EPS

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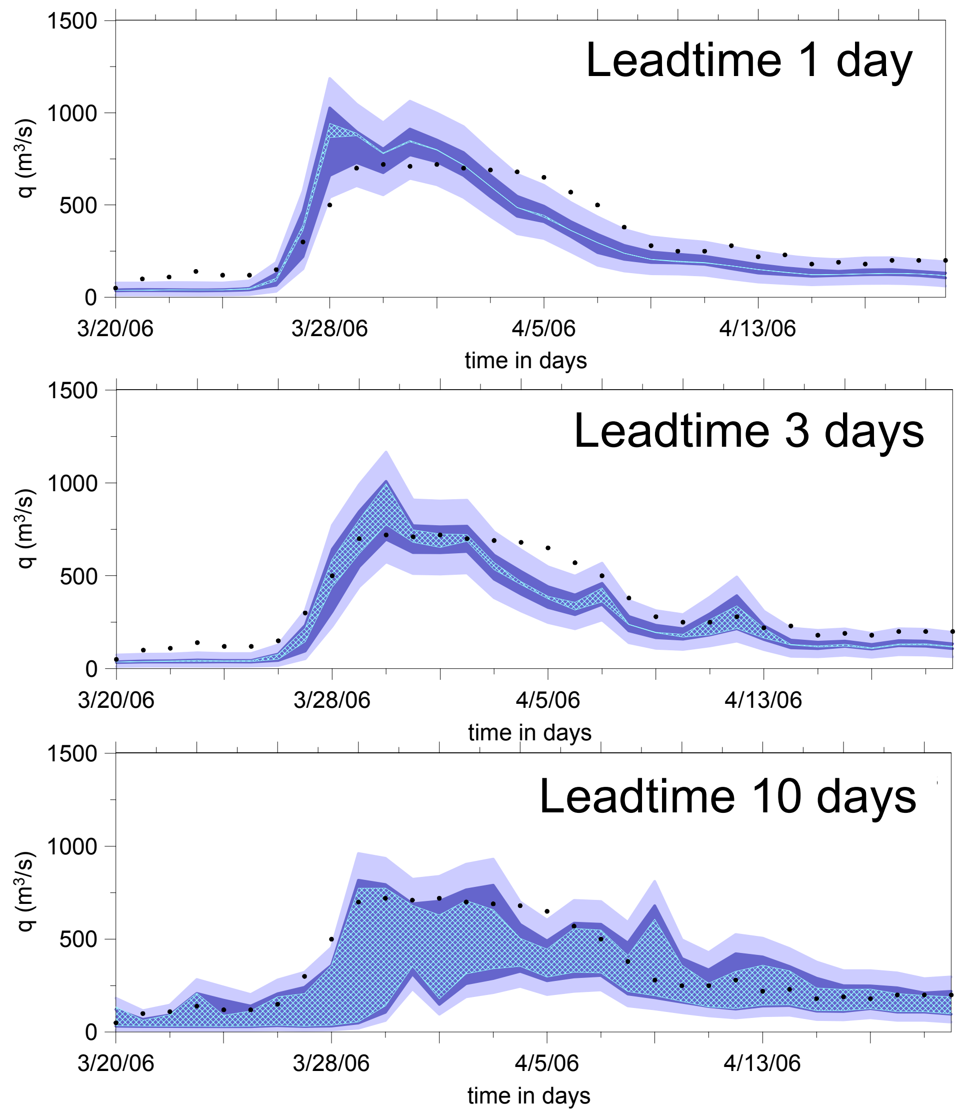
2.3 – Towards probabilistic verification of discharges

- **Cascading uncertainty in flood forecasting**



March-April 2006 flood in Morava river

Source of uncertainty:

weather forecast

wf + parameters

wf + p + “model + Q obs”

Ramos & Feyen, 2007
Feyen et al., (2007) Parameter optimisation and LISFLOOD uncertainty assessment, J. of Hydrology 332, 276-289

Summary

- Post-event analyses (event-based “verification”): additional value of EPS to flood forecasting, useful insights into the behavior of EPS-based forecasts, better understanding on how the system performs

- Long-term evaluation: can general patterns be detected or is verification site-specific, season-specific, etc.?

- EPS-based forecasts can effectively contribute to an earlier detection of the possibility of flooding and to increase preparedness : which rules for decision making? Building knowledge with experience?

- Uncertainty cascading framework for hydrological forecasting: accounting for all sources of uncertainty <=> reducing uncertainty