

The Benefit of a Limited-Area Ensemble Prediction System with Respect to flood forecasting

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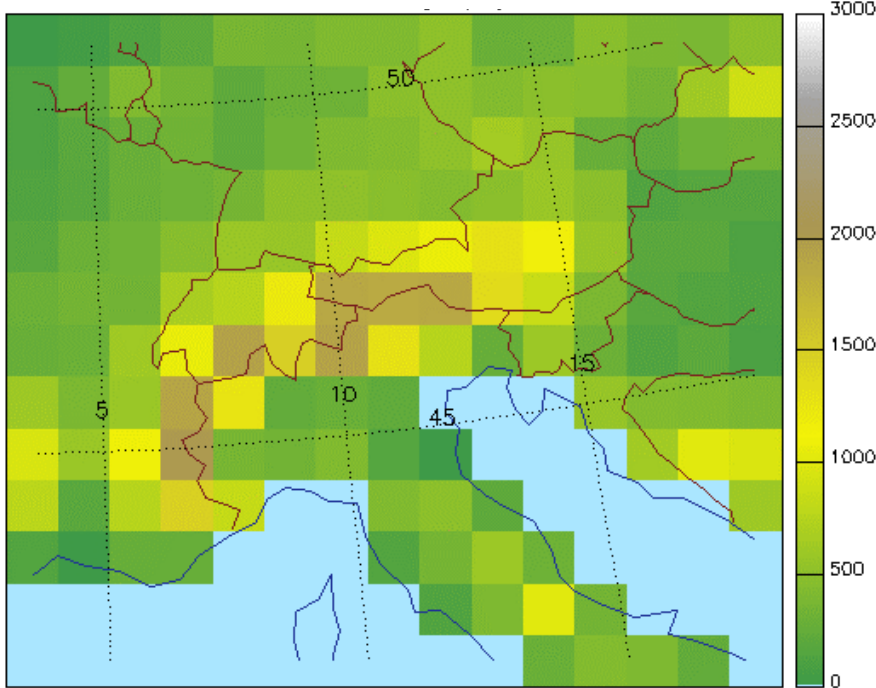


Resolution of EPS for weather forecasts

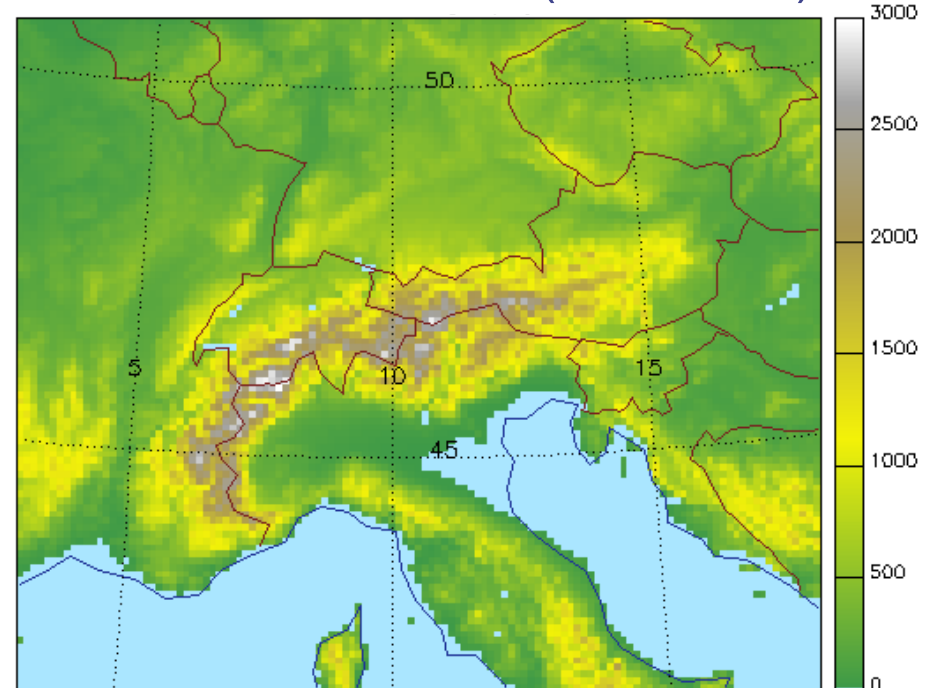


Zoom into Alpine region:

Typical global EPS ($\Delta x \sim 80$ km)



Limited-area EPS ($\Delta x \sim 10$ km)



Outline



- ◆ Current setup of COSMO-LEPS suite
- ◆ Results from “August 2005 event”
- ◆ Objective verification
- ◆ Decision-making based on cost-loss analysis
- ◆ Summary

COSMO-LEPS

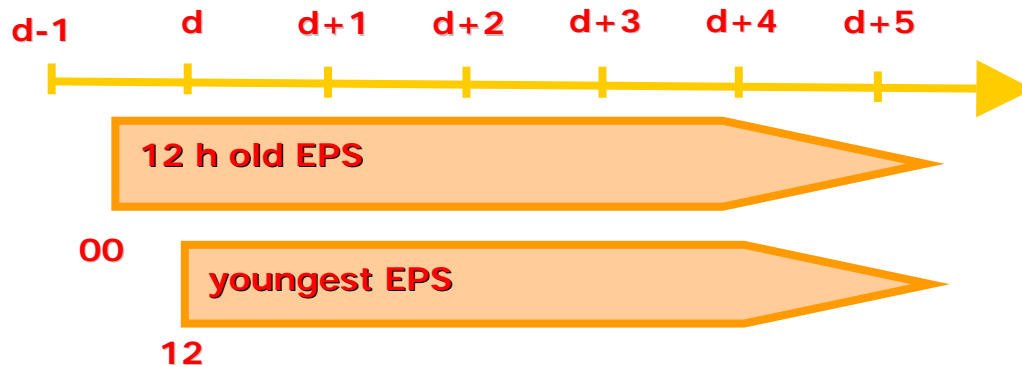
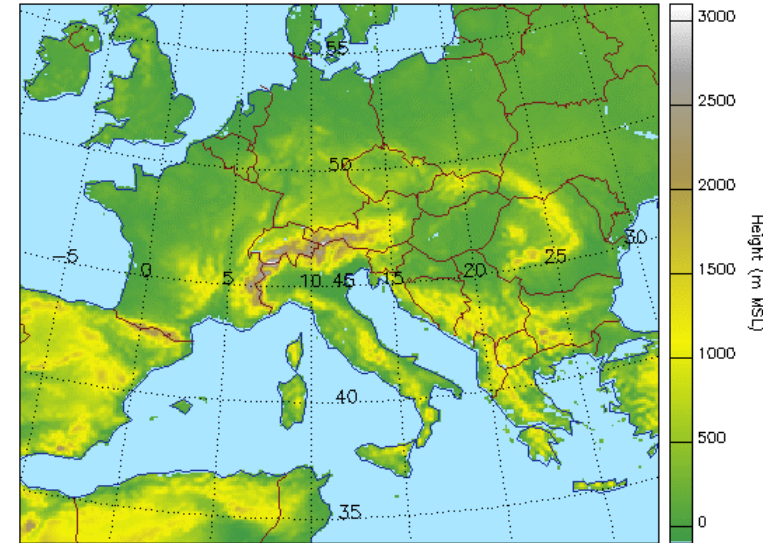


- ◆ Limited-area Ensemble Prediction System of the Consortium for Small-scale Modelling (COSMO).
- ◆ Developed by ARPA-SIM, Bologna, Italy
- ◆ Focus: forecast days 3-5
- ◆ Running since November 2002, fully operational since November 2005

Current COSMO-LEPS setup



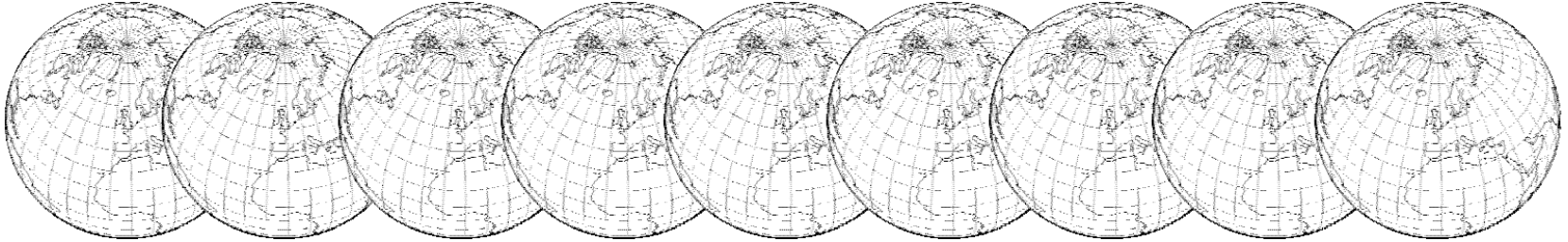
- ◆ Model: LM
- ◆ 16 members (since 7 Feb 06)
- ◆ 132-h forecasts
- ◆ Area: Southern and Central Europe
- ◆ Grid-spacing 10 km, 40 levels
- ◆ Platform: IBM-Cluster at ECMWF
- ◆ Based on ECMWF EPS:



COSMO-LEPS strategy



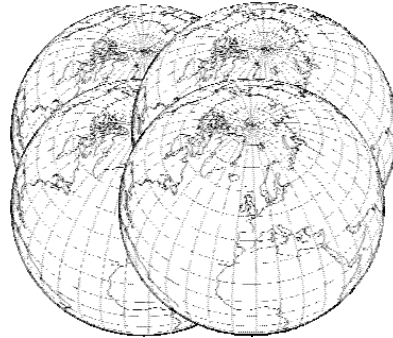
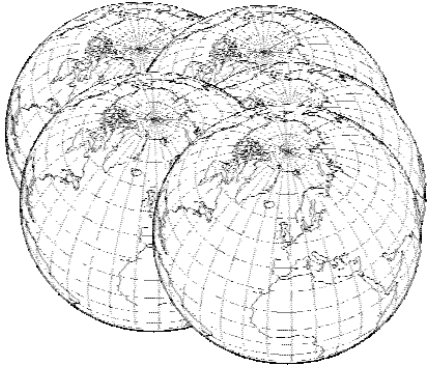
102 ECMWF Ensemble Member („Super-Ensemble“) with $\Delta x \sim 50$ km



COSMO-LEPS strategy



Grouping into 16 groups and ...



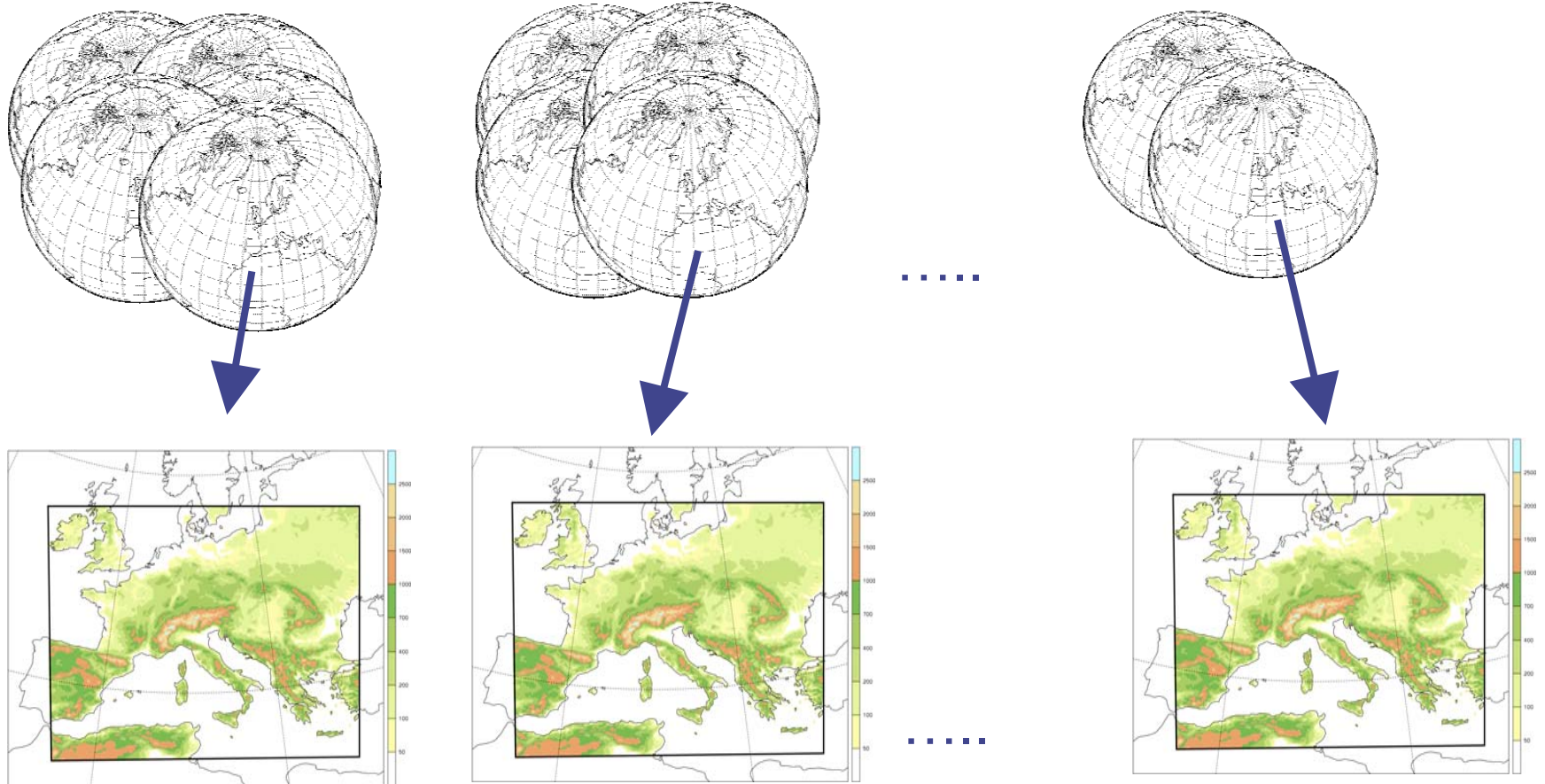
.....



COSMO-LEPS strategy



... identifying a **representative member** for each group

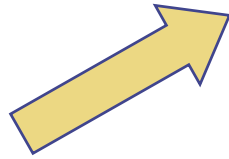
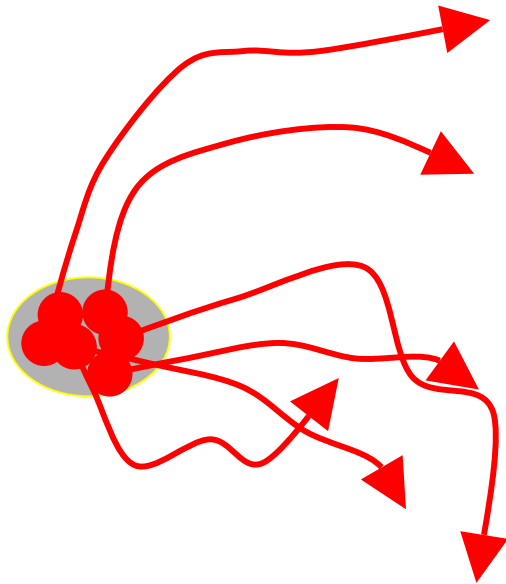


16 LM simulations with different weights according to the group population

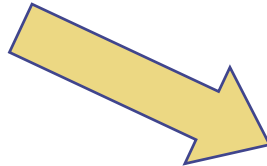
COSMO-LEPS output



16 scenarios



Probabilistic model output (PMO) from the ensemble for defined thresholds



Deterministic model output (DMO) from each of the 16 LM runs

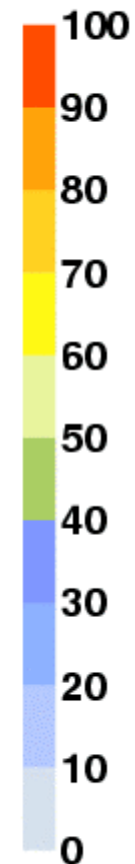
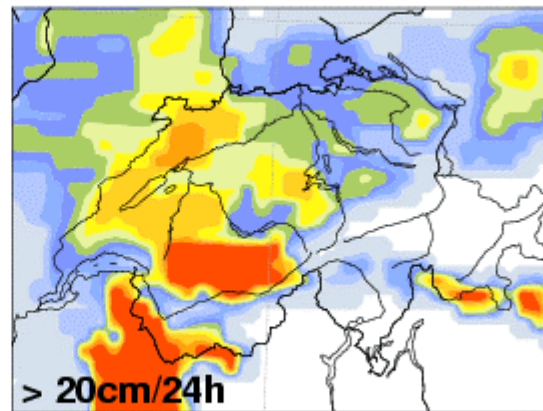
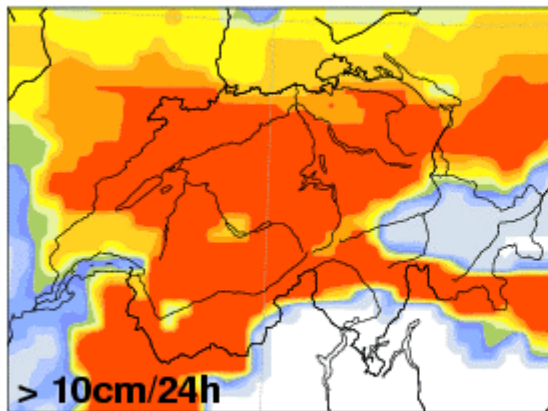
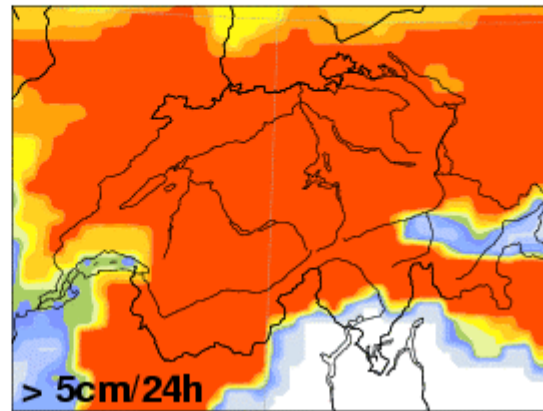
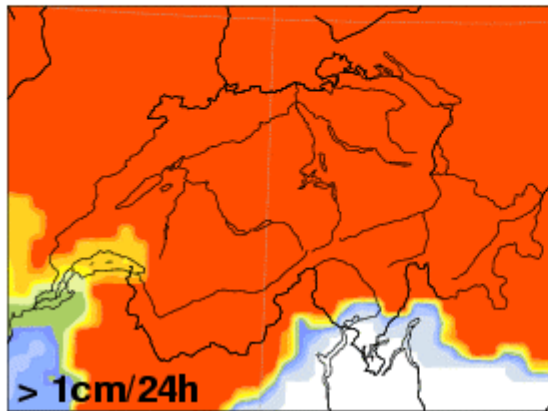


Input for hydrologic EPS
Talk Verbunt et al.,
Poster Jaun et al.

COSMO-LEPS products (1): Prob. Maps



COSMO-LEPS probability forecast: **24h sum of snow**
3 Mar 2006 12UTC, t+(18-42), VT: **Sunday 5 Mar 2006 06UTC**



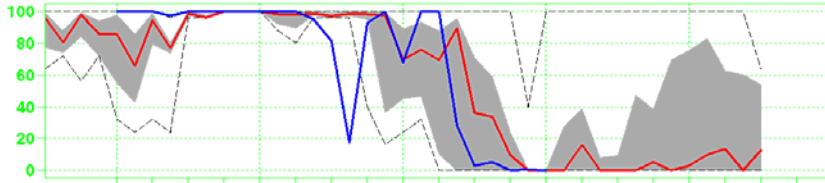
COSMO-LEPS products (2): Meteograms



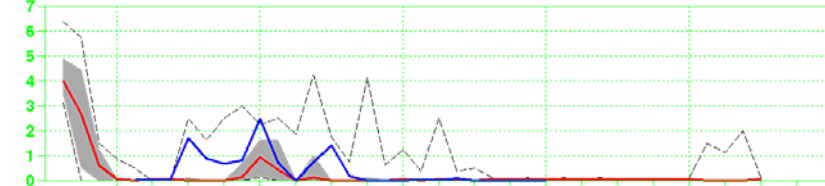
COSMO-LEPS & aLMO Meteogram 2004-06-03 12 UTC
Zurich-MeteoSwiss 47.4N 8.6E 556m (LEPS 461m / aLMO 523m)

— Median ■ 25% - 75% - - - Min / Max — aLMO 00 UTC

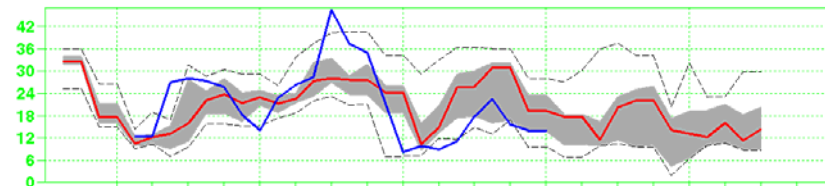
Total Cloud Cover



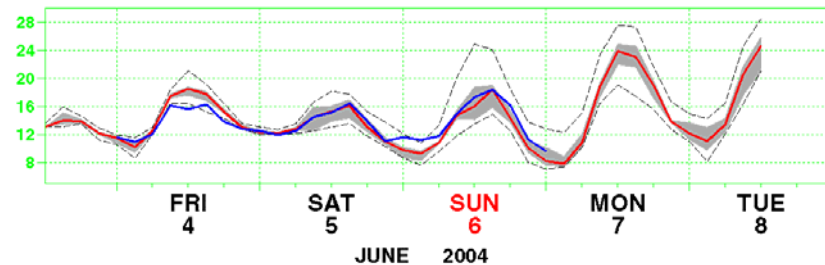
Total Precipitation (mm/3h)



Max Wind Gust at 10 m in Last 3 Hours (km/h)



2m Temperature (C) Reduced to Station Height

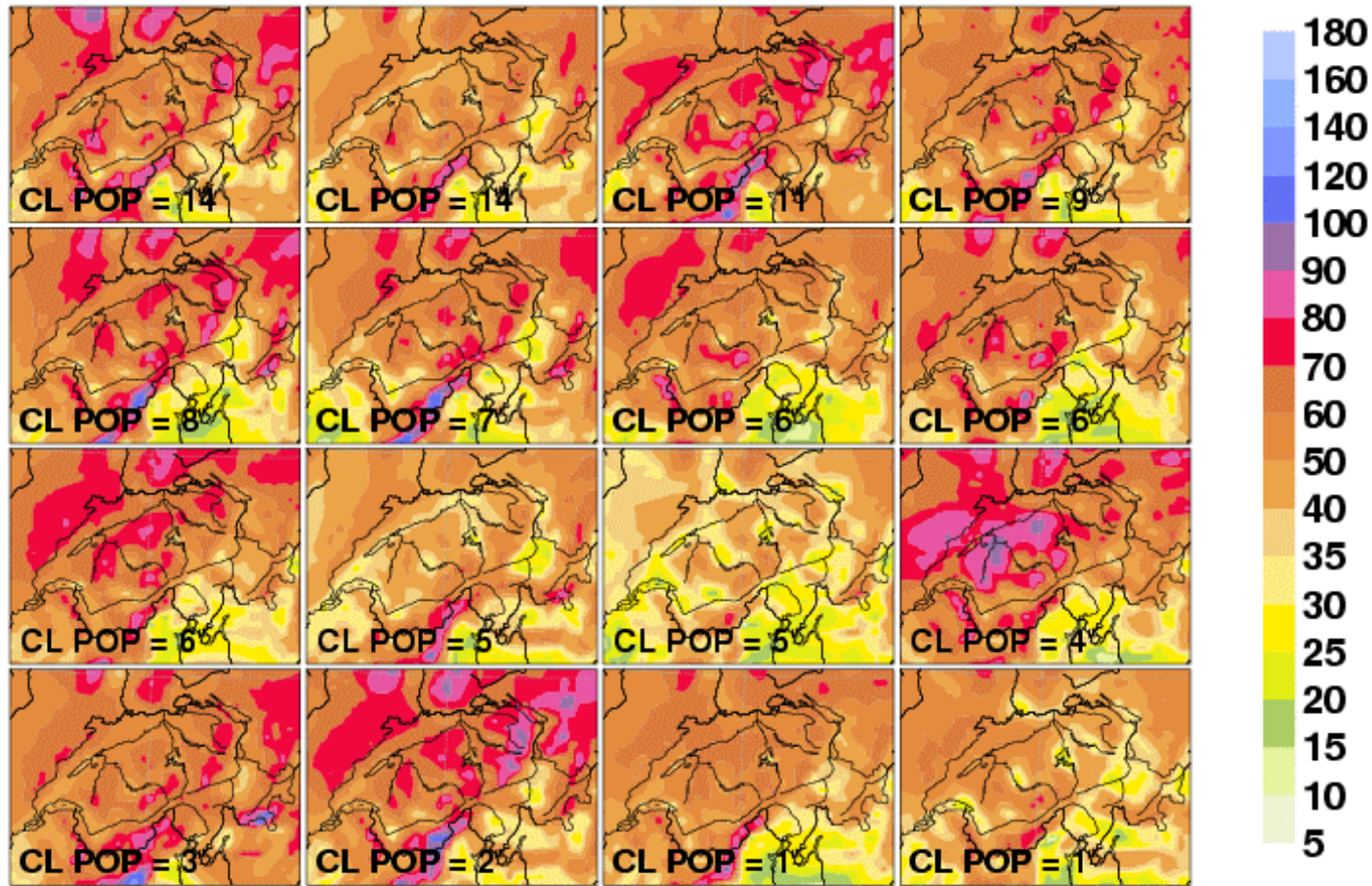


- 5-day weather predictions
- for any location
- 3 hourly resolution
- from COSMO-LEPS and deterministic forecast of MeteoSwiss (aLMO)

COSMO-LEPS products (3): Stamp maps



COSMO-LEPS Ensemble Forecast: **Max. wind gusts at 10m [km/h] (in last 24h)**
27 Mar 2006 12UTC, t+(84-108), **VT: Saturday 1 Apr 2006 00UTC**



Tue Mar 28 16:00:50 2006 / © MeteoSchweiz

Case study: Swiss Flood event in August 05

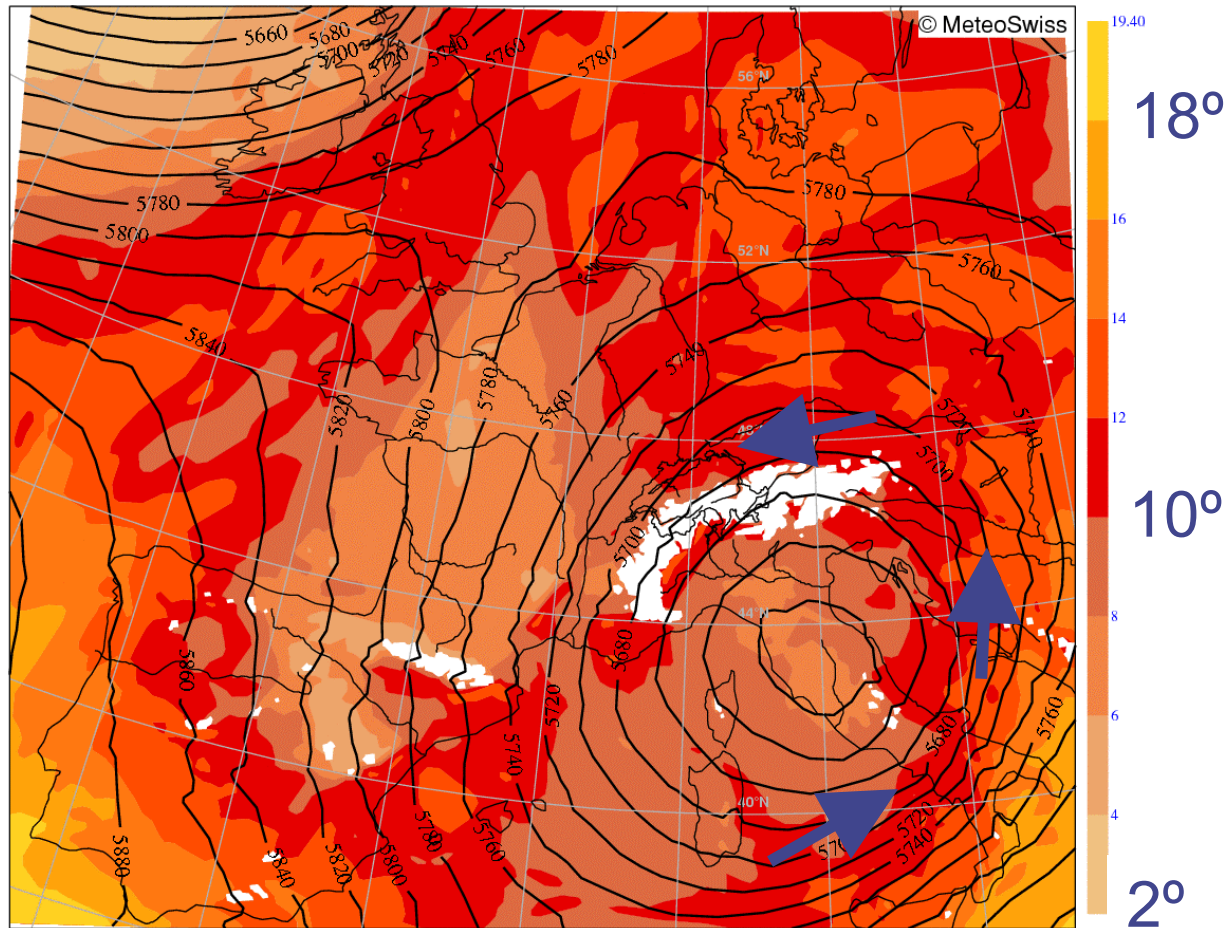


Photos: Tages-Anzeiger

Synoptic overview: 22 August 2005



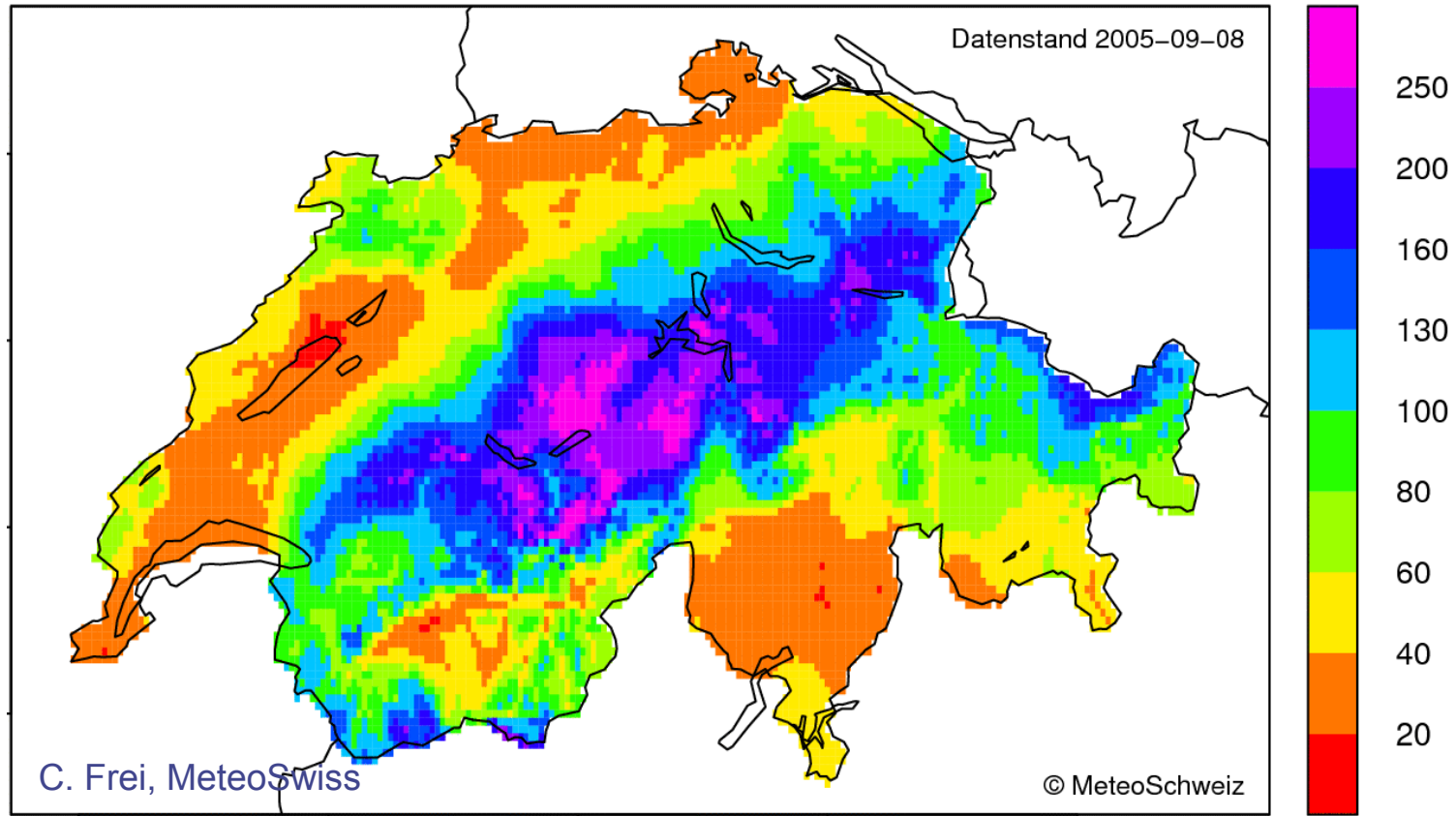
Temperature 850 hPa and geopotential 500 hPa:



Observed total precipitation over 3 days



Niederschlag 72h-Summe (mm) : 20.8. – 23.8.2005 06 - 06 UTC

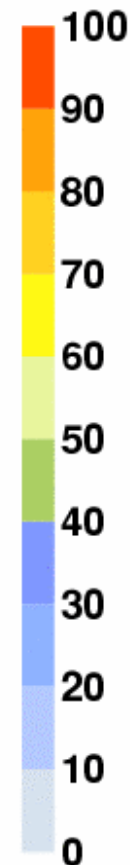
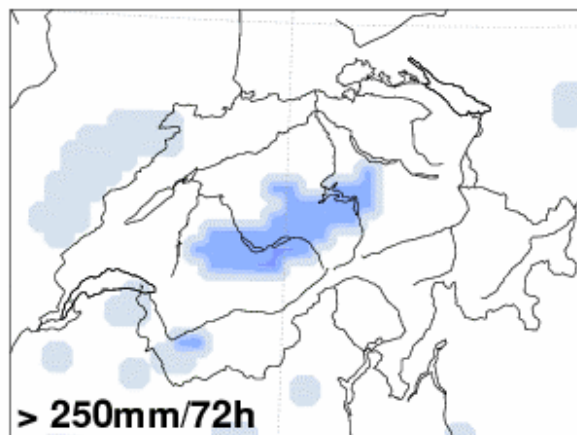
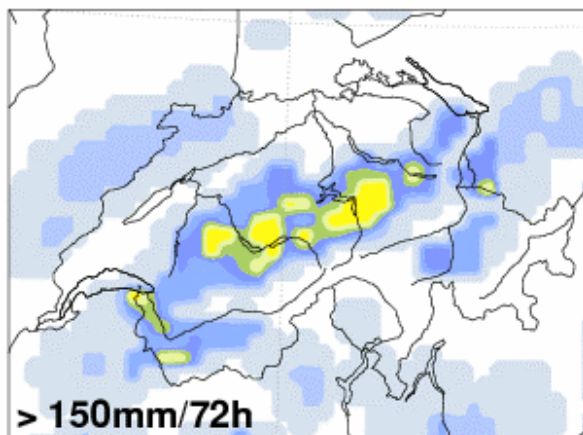
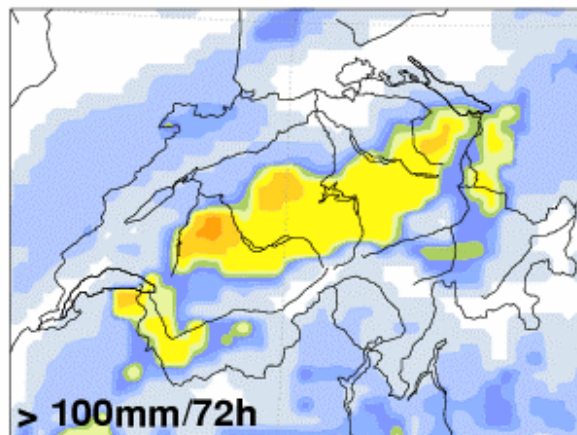
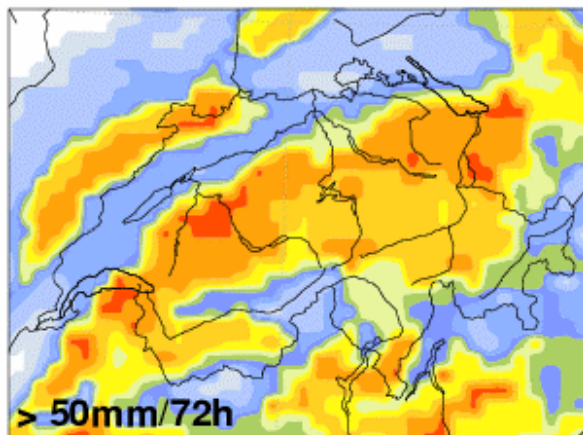


Precipitation sum locally over 300 mm!

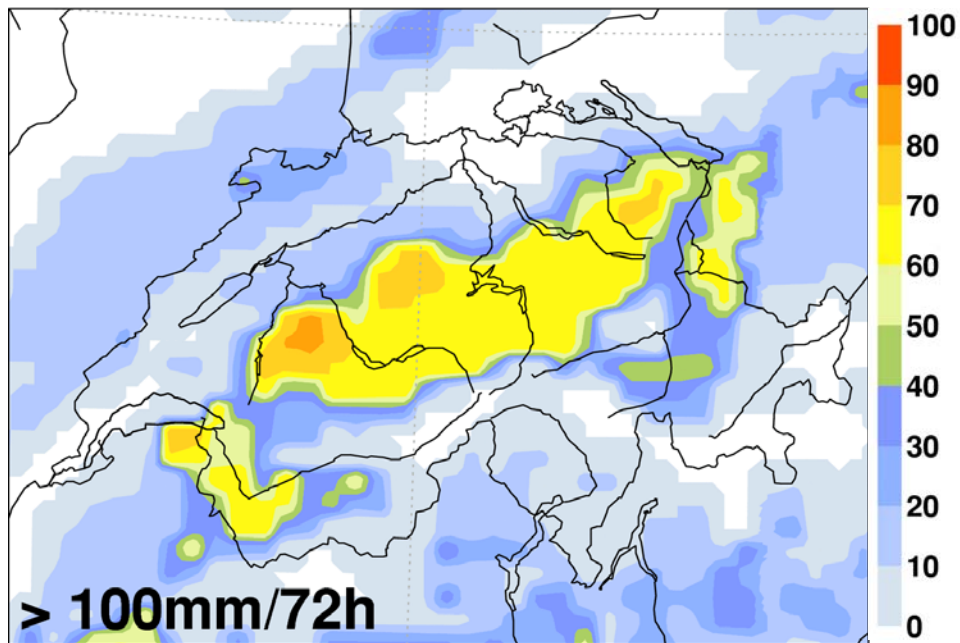
COSMO-LEPS forecast for 72h precipitation



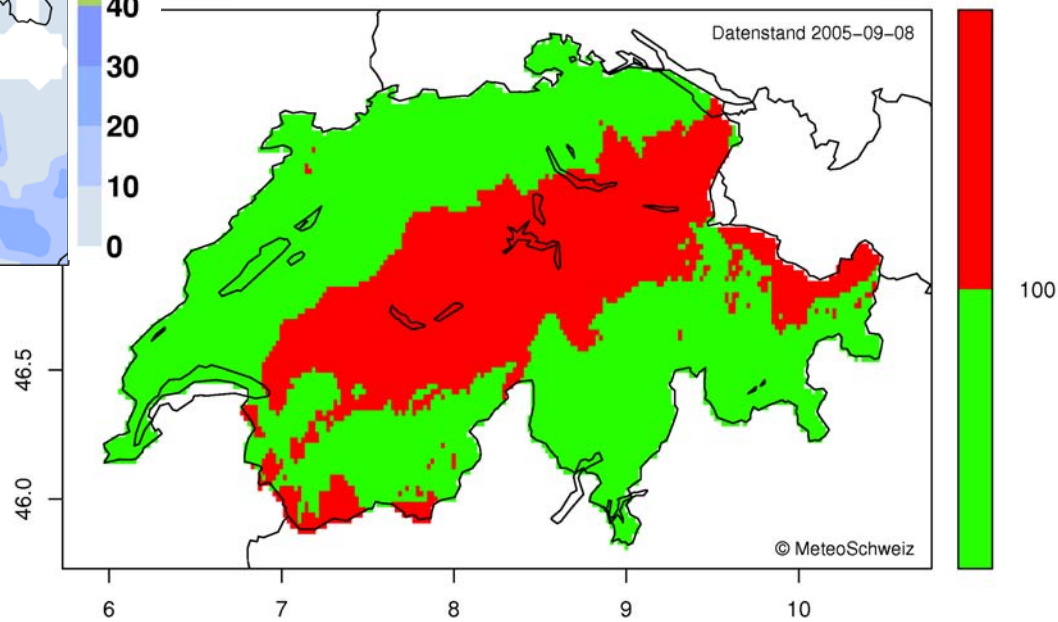
COSMO-LEPS probability forecast: **72h sum of total precipitation**
19 Aug 2005 12UTC, t+(18-90), **VT: Tuesday 23 Aug 2005 06UTC**



Probability precipitation > 100mm/72h



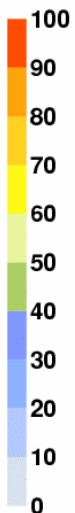
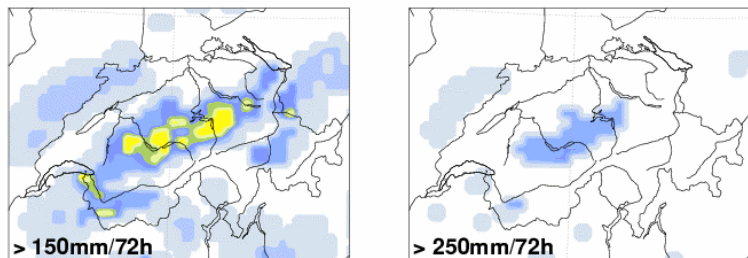
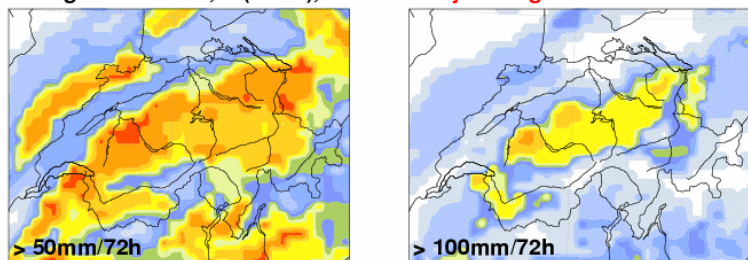
Precipitation observed



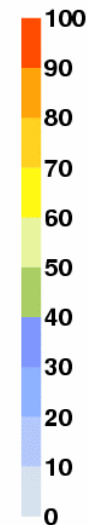
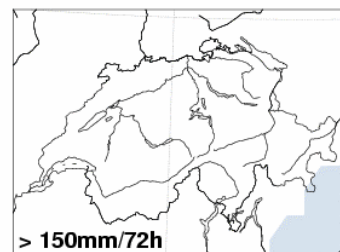
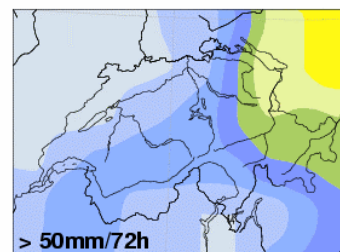
COSMO-LEPS forecast for 72-h precipitation



COSMO-LEPS probability forecast: 72h sum of total precipitation
19 Aug 2005 12UTC, t+(18-90), VT: Tuesday 23 Aug 2005 06UTC



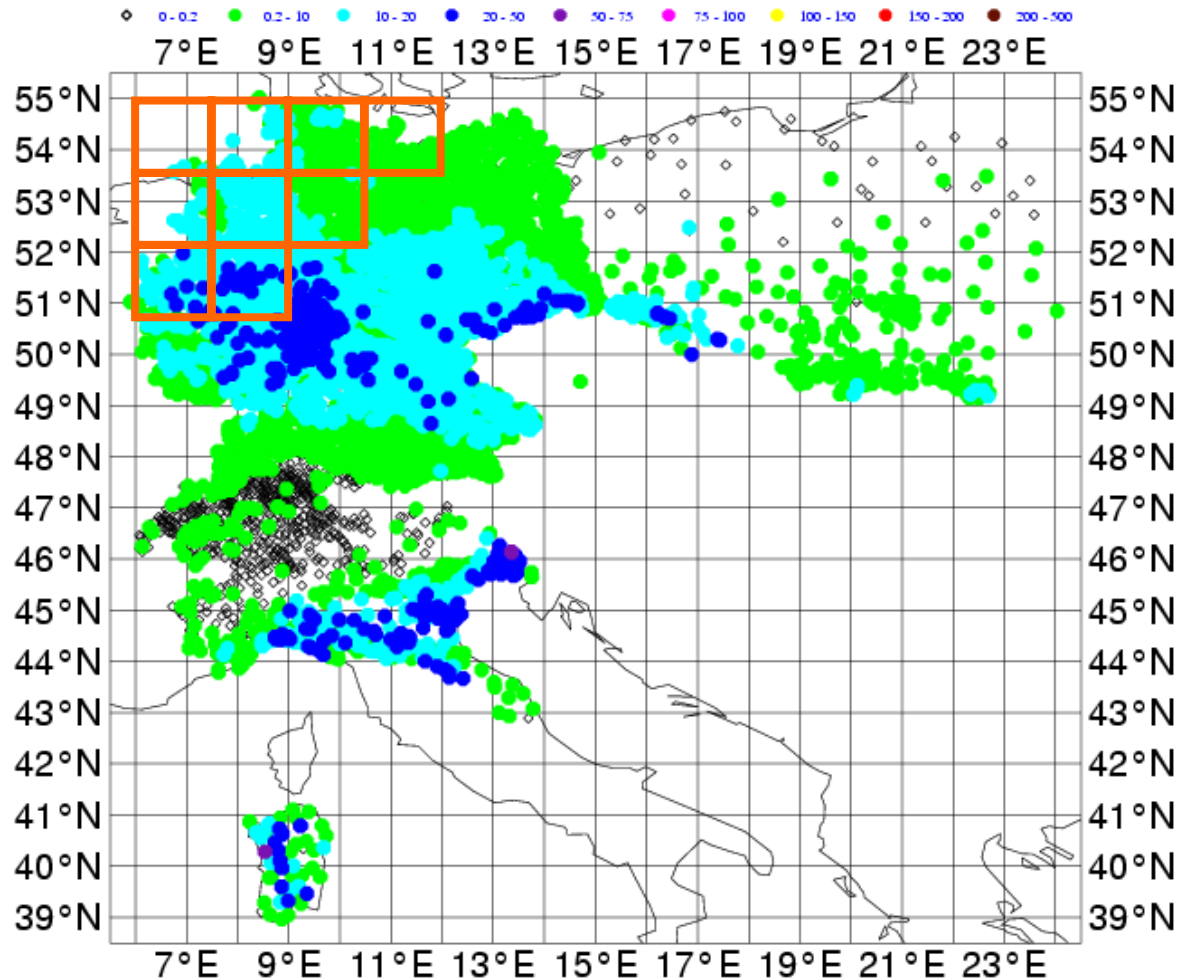
ECMWF EPS probability forecast: 72h sum of total precipitation
19 Aug 2005 12UTC, t+(18-90), VT: Tuesday 23 Aug 2005 06UTC



Probabilistic verification: LEPS vs. ECMWF



COSMO stations and verification grid:

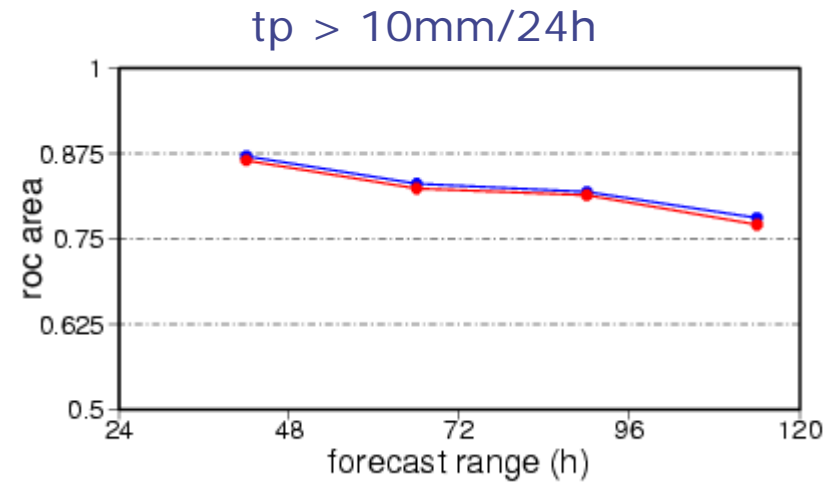
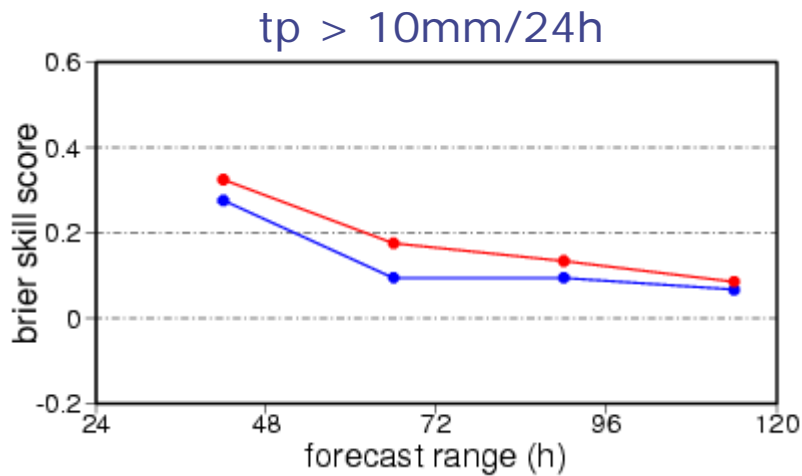
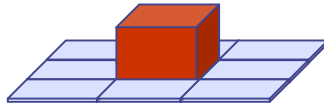


Verification of precipitation SON 2004 (1)



Average values

boxes 1.5x1.5 deg



COSMO-LEPS



10-MEMBER EPS

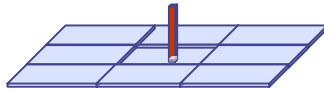


Verification of precipitation SON 2004 (2)

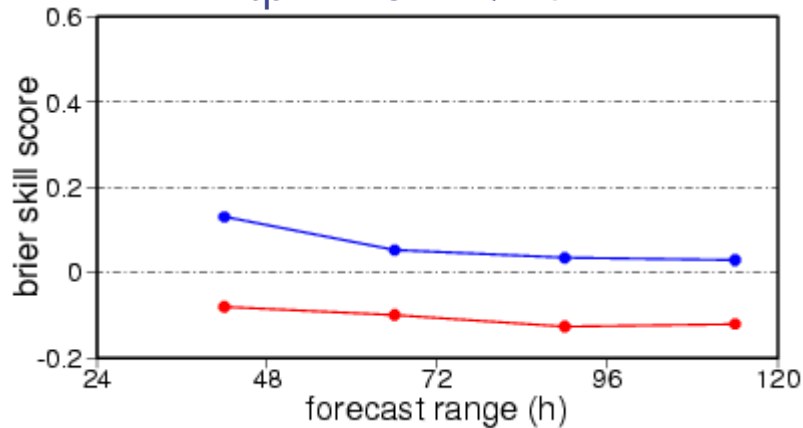


Maximum values

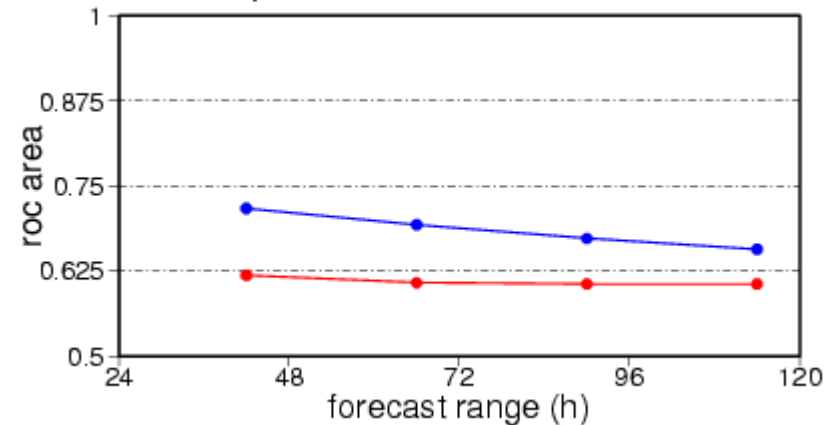
boxes 1.5x1.5 deg



tp > 20mm/24h



tp > 20mm/24h



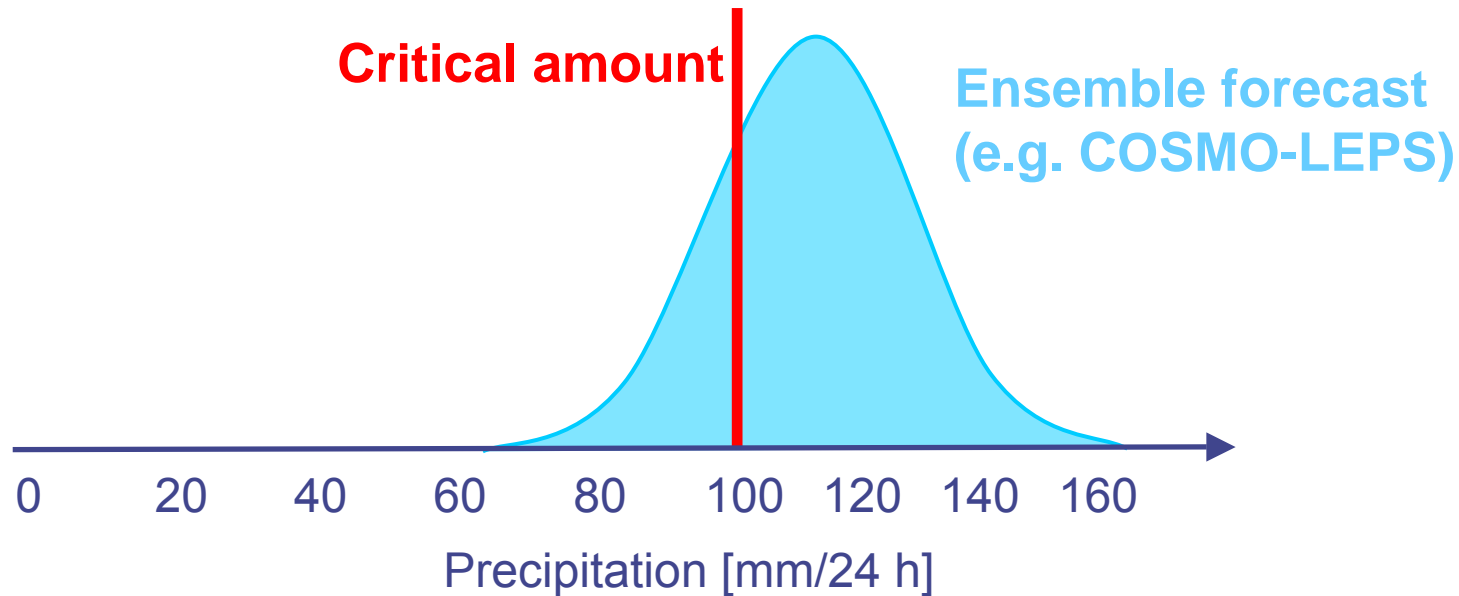
COSMO-LEPS



10-MEMBER EPS



Weather risk management



Ensemble forecasts provide a multitude of decision criteria (probability thresholds).

Should preventive action be taken?

No general answer: Optimum decision is user-dependent !

Decision-making based on cost-loss analysis



		Forecast/action	
		Yes	No
Observation	Yes		
	No		

(Zhu et al. 2002)

- ◆ Typically $C \leq M < L$

Forecast users have to know their C and L_p to optimize the decisions

Economic value



$$V = \frac{E_{climate} - E_{forecast}}{E_{climate} - E_{perfect}}$$

$V = 1$: Perfect system

$V < 0$: Climatology more usefull

$E_{climate}$: expected cost using climatology

$E_{forecast}$: expected cost using forecast system

$E_{perfect}$: expected cost if forecast system is perfect

if $Lu = 0$:

$$E_{climate} = \text{Min}((h + m) * L_p, (h + m + f + c) * C)$$

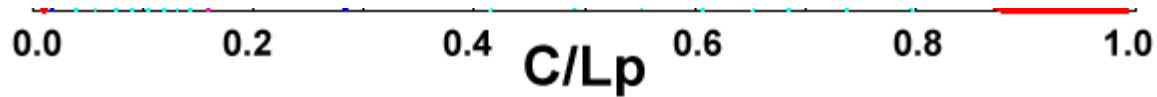
$$E_{forecast} = (h + f) * C + m * L_p$$

$$E_{perfect} = (h + m) * C$$

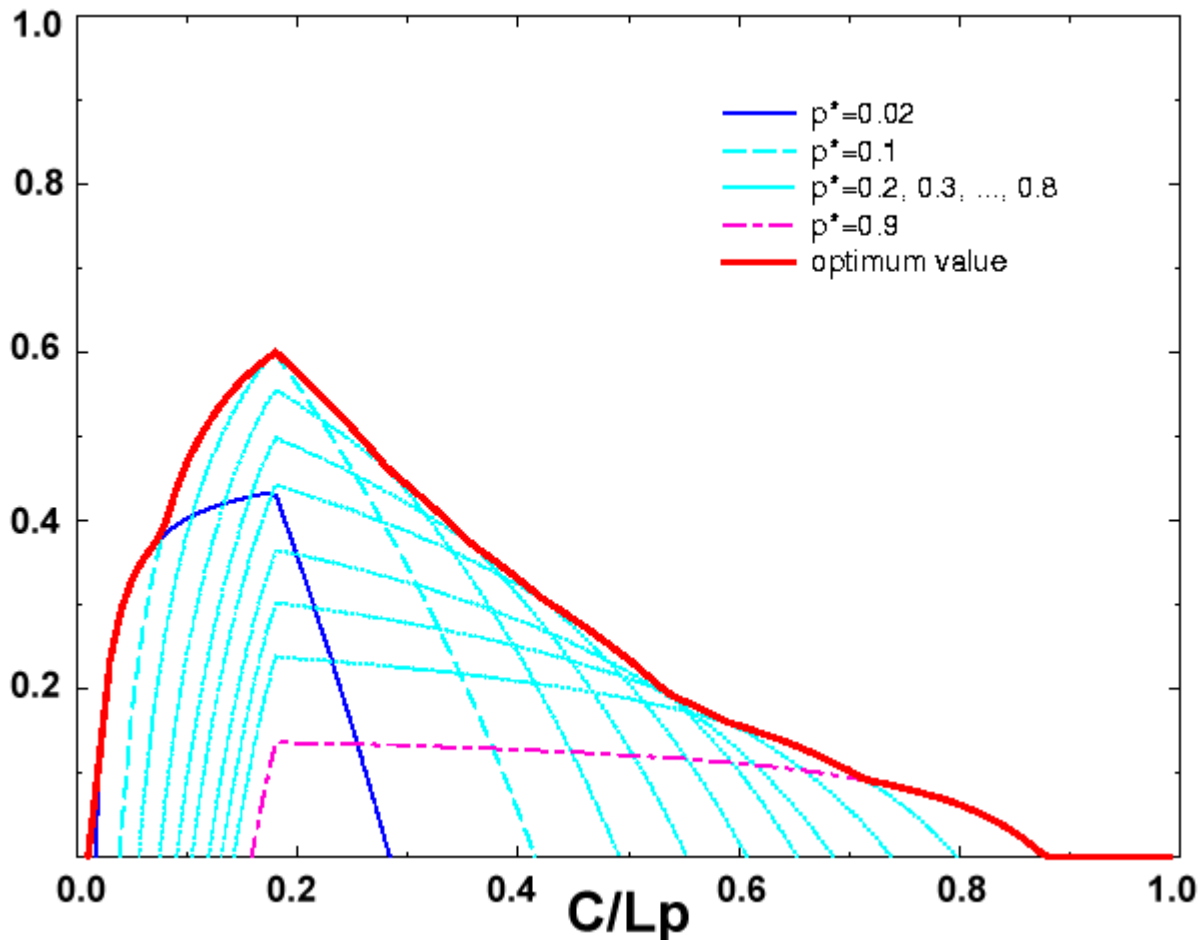
Economic value for different users: example



Every user has its specific C/Lp ratio

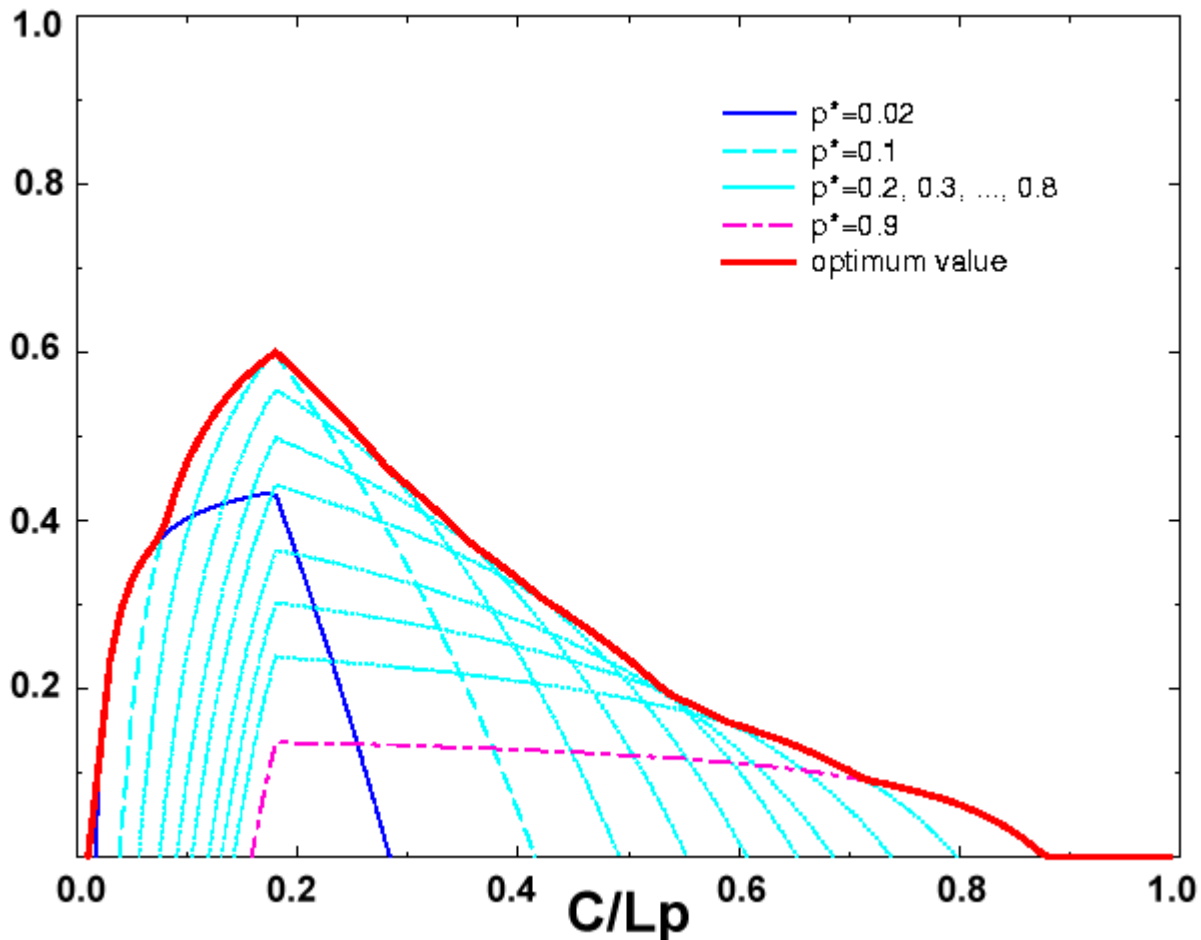


Economic value for different users: example



The optimum value from the system will be achieved if each user acts at the best probability threshold for his particular C/Lp

Economic value for different users: example

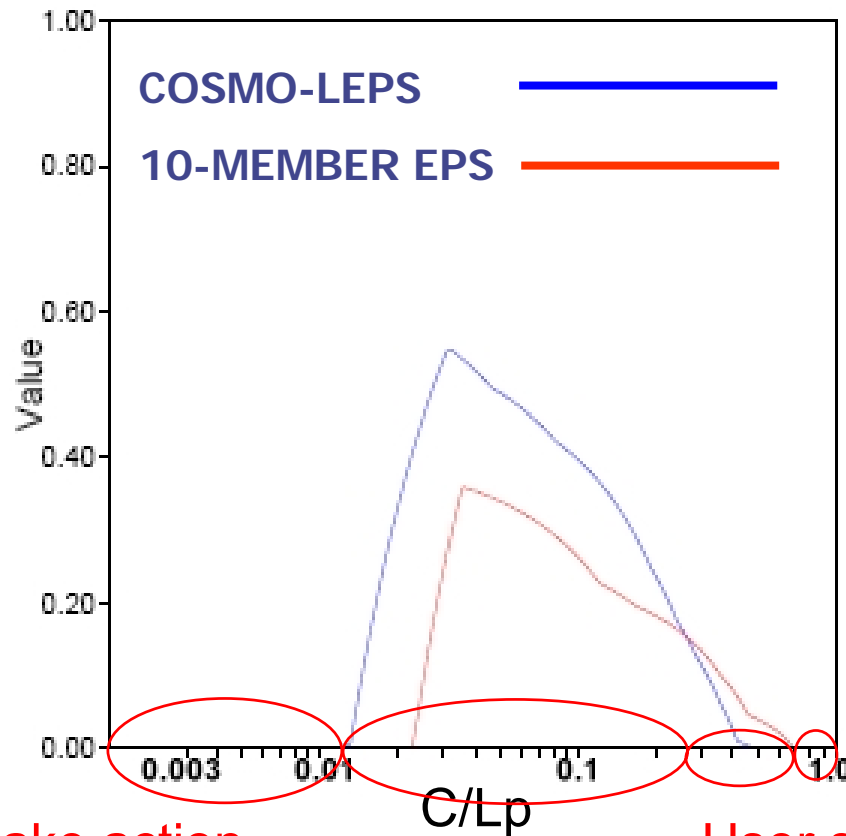


The higher C/Lp , the higher the decision level which gives the maximum economic value.

Economic value of COSMO-LEPS vs. ECMWF EPS



Example for 24-h precip > 30 mm of 90th percentile within 1.5 x 1.5 degree box and for lead-time +66h:



User should never take action

User should always take action

User should use COSMO-LEPS

User should use ECMWF system



C. Marsigli, ARPA Bologna



Summary



- ◆ COSMO-LEPS helps to improve forecasts for extreme events.
- ◆ However, results from objective verifications are in general not very satisfying so far.
- ◆ Improvements in design of LEPSs **and** NWP model important.
- ◆ Use of user-dependent decision levels to optimize benefit of EPSs

The end



Questions?