

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

André Walser
Mathias Rotach
MeteoSwiss

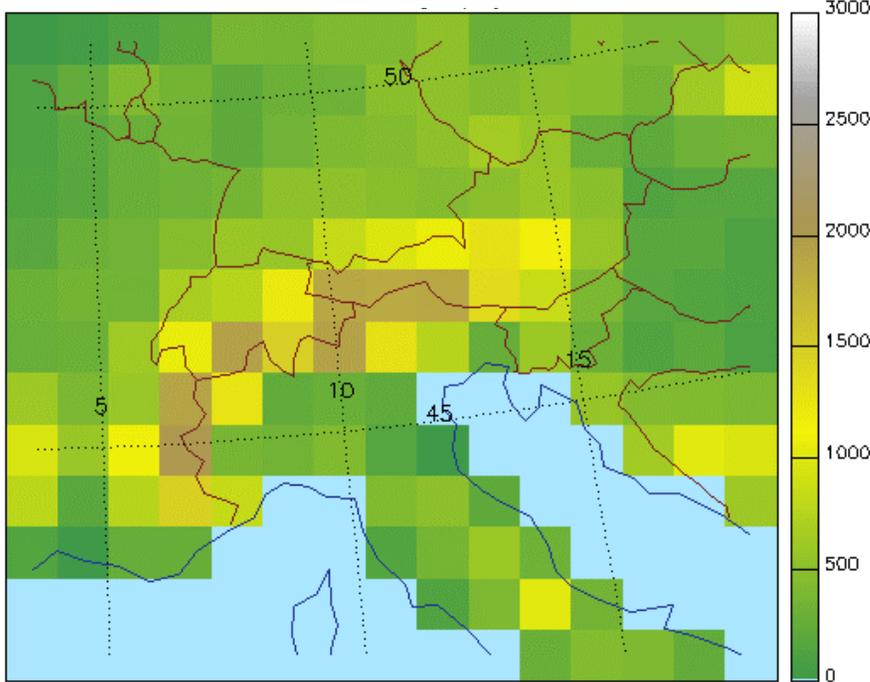


Resolution of EPS for weather forecasts

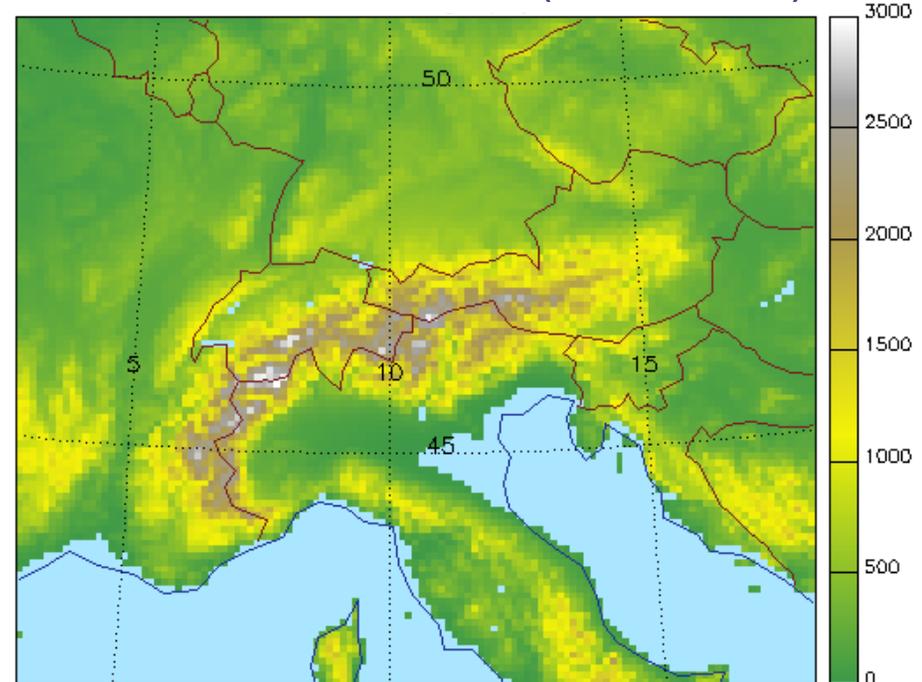


Zoom into Alpine region:

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

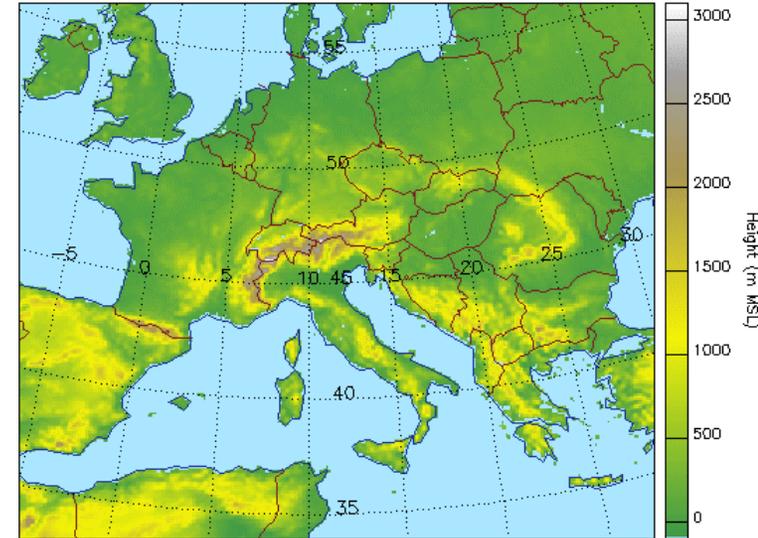


- ◆ Limited-area Ensemble Prediction System of the Consortium for Small-scale Modelling (COSMO).
- ◆ Developed by ARPA-SIM, Bologna, Italy
- ◆ Focus: forecast days 3-5
- ◆ Running since November 2002, fully operational since November 2005

Current COSMO-LEPS setup



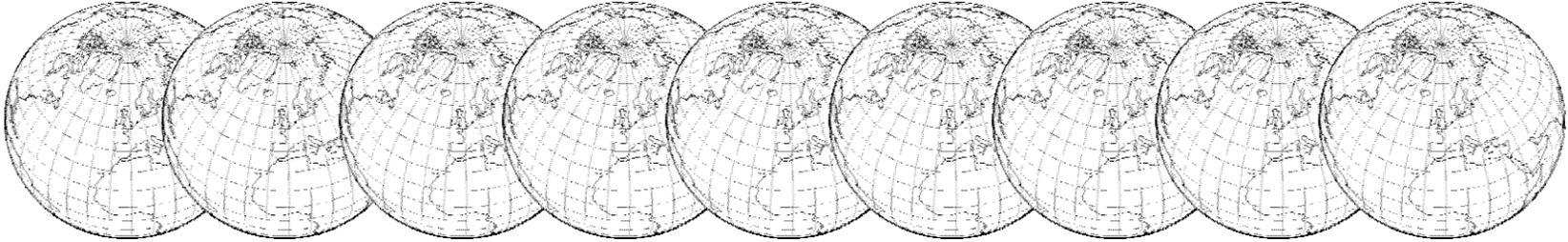
- ◆ Model: LM
- ◆ 16 members (since 7 Feb 06)
- ◆ 132-h forecasts
- ◆ Area: Southern and Central Europe
- ◆ Grid-spacing 10 km, 40 levels
- ◆ Platform: IBM-Cluster at ECMWF
- ◆ Based on ECMWF EPS:



COSMO-LEPS strategy



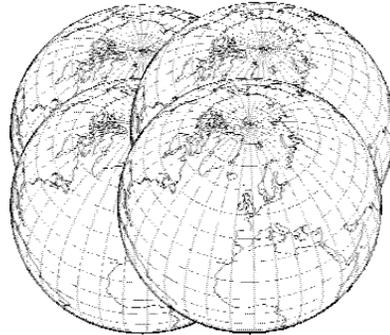
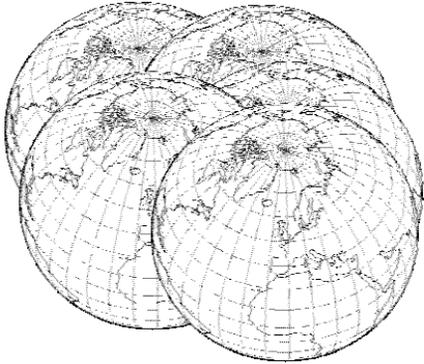
102 ECMWF Ensemble Member („Super-Ensemble“) with $\Delta x \sim 50$ km



COSMO-LEPS strategy



Grouping into 16 groups and ...



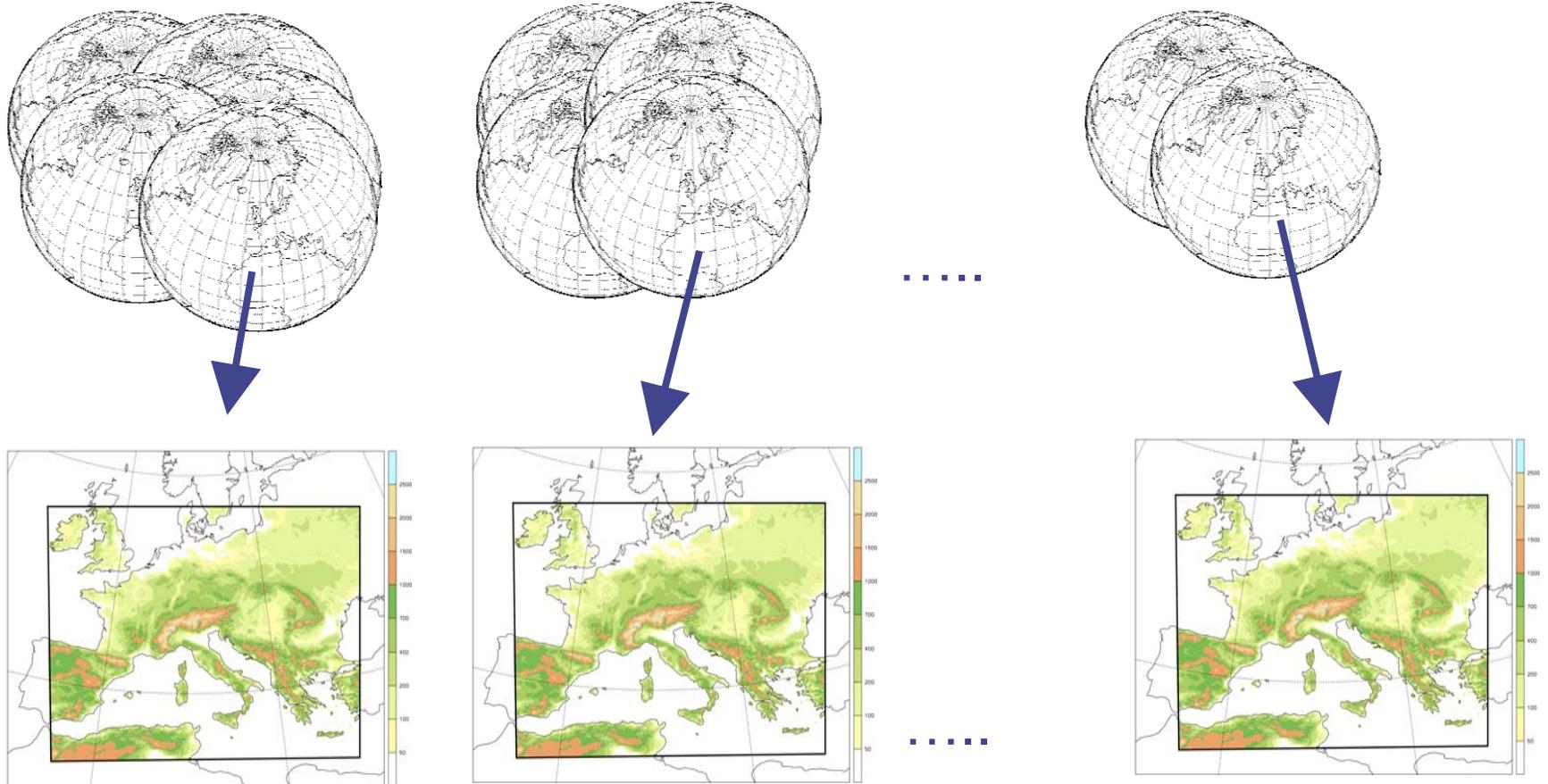
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COSMO-LEPS strategy



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

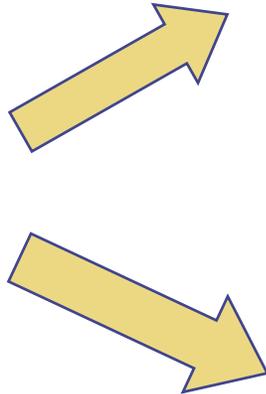
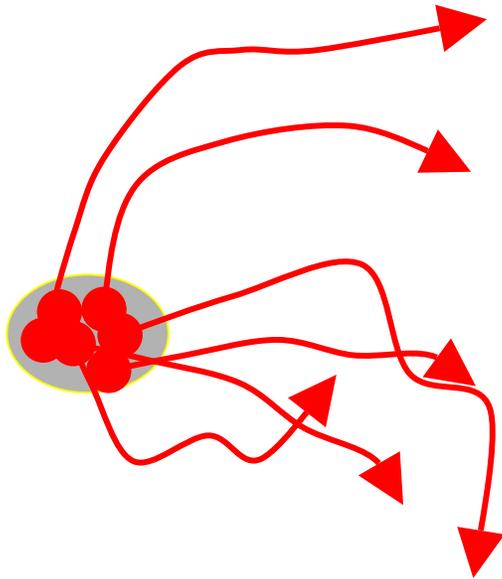


16 LM simulations with different weights according to the group population

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

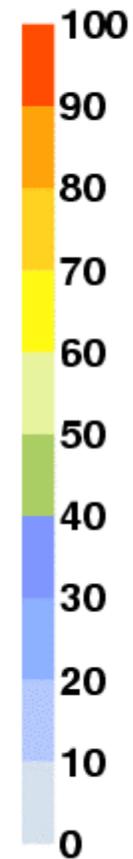
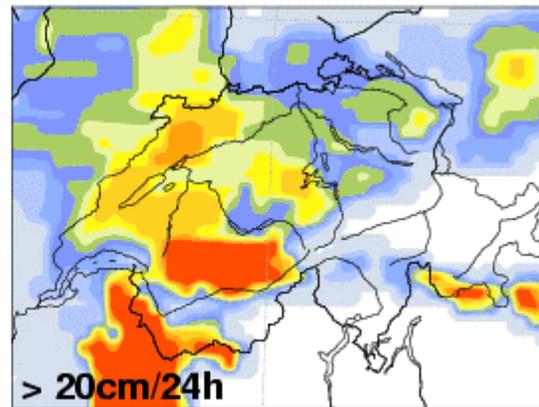
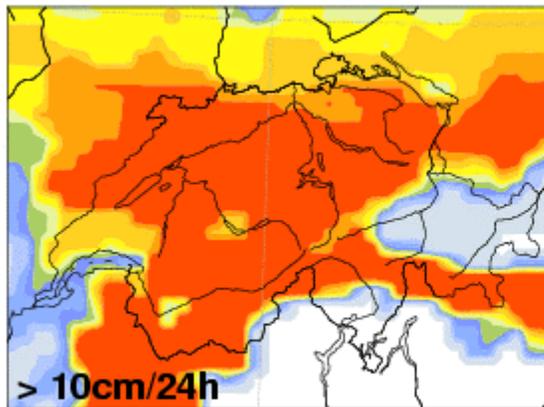
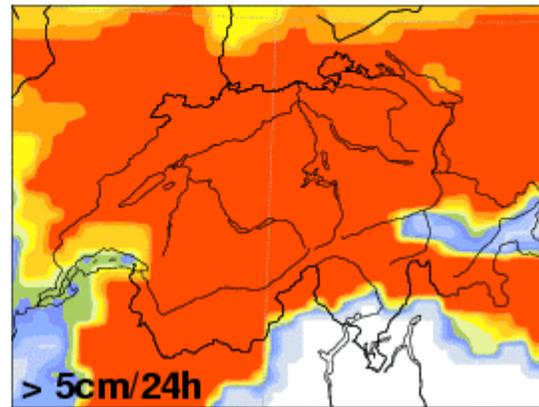
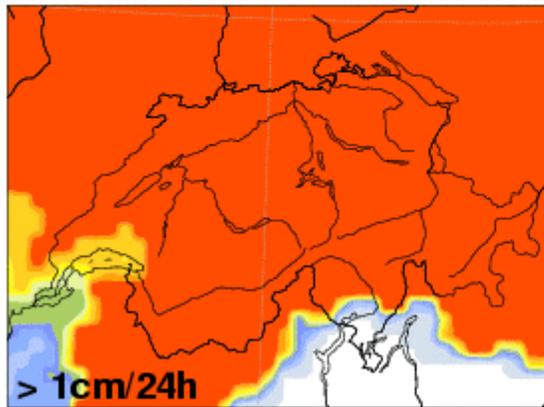


Input for hydrologic EPS
*Talk Verbunt et al.,
Poster Jaun et al.*

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**



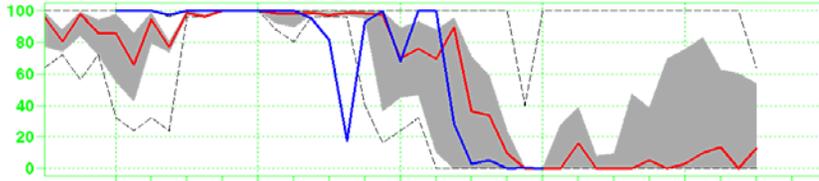
COSMO-LEPS products (2): Meteograms



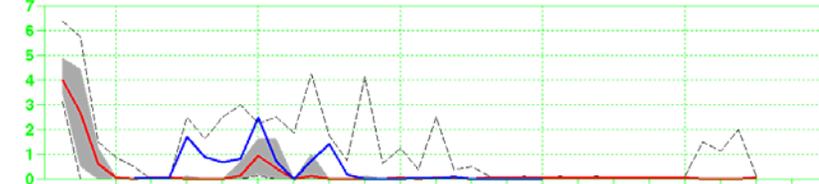
COSMO-LEPS & aLMO Meteogram 2004-06-03 12 UTC
Zurich-MeteoSwiss 47.4N 8.6E 556m (LEPS 461m / aLMO 523m)

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

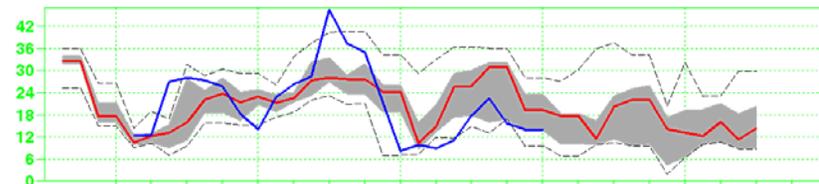
Total Cloud Cover



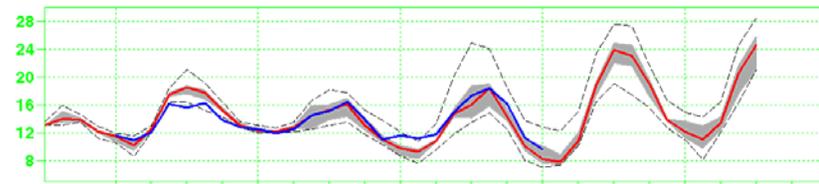
Total Precipitation (mm/3h)



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



2m Temperature (C) Reduced to Station Height



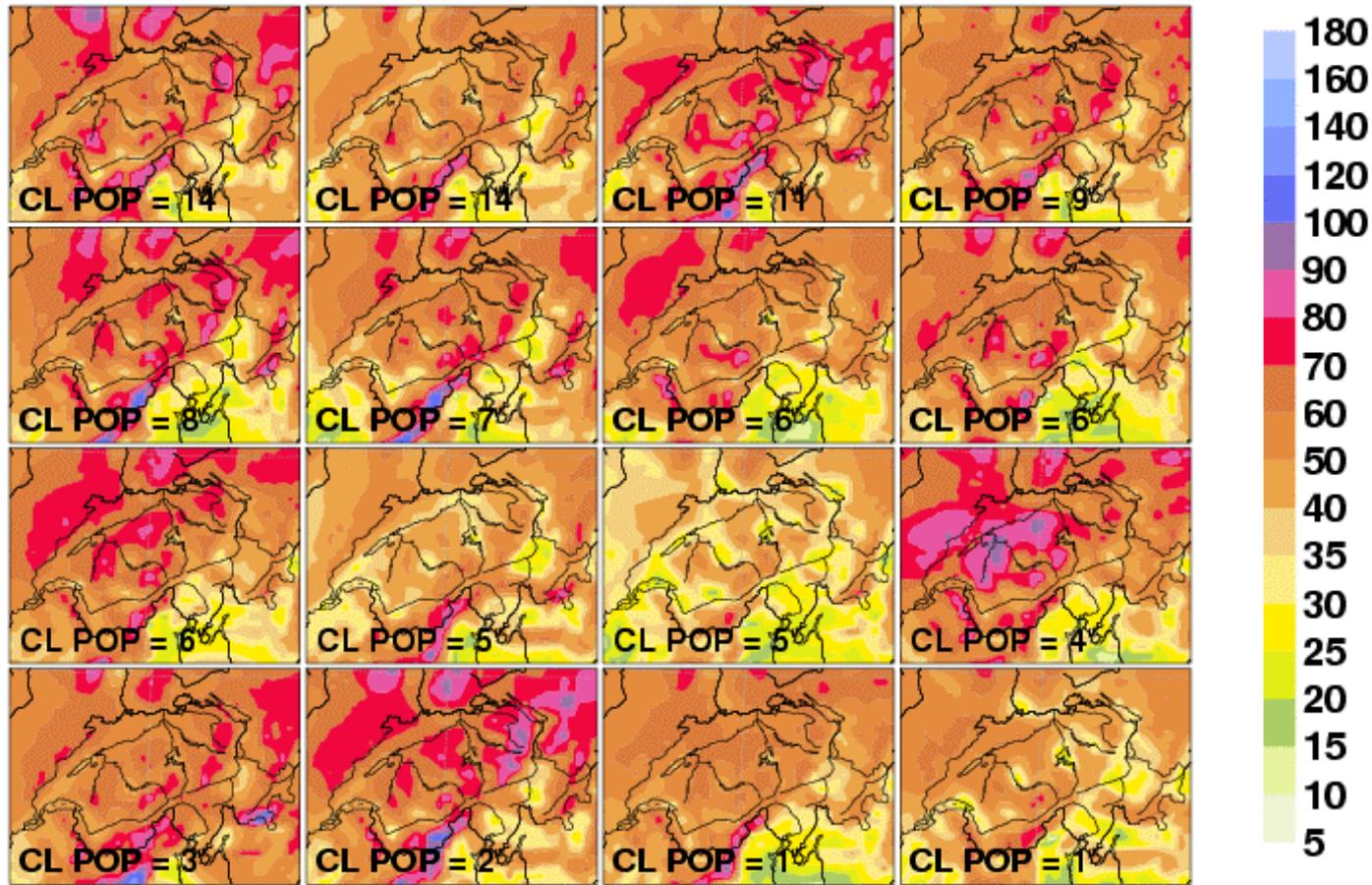
FRI 4 SAT 5 **SUN 6** MON 7 TUE 8
JUNE 2004

- 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

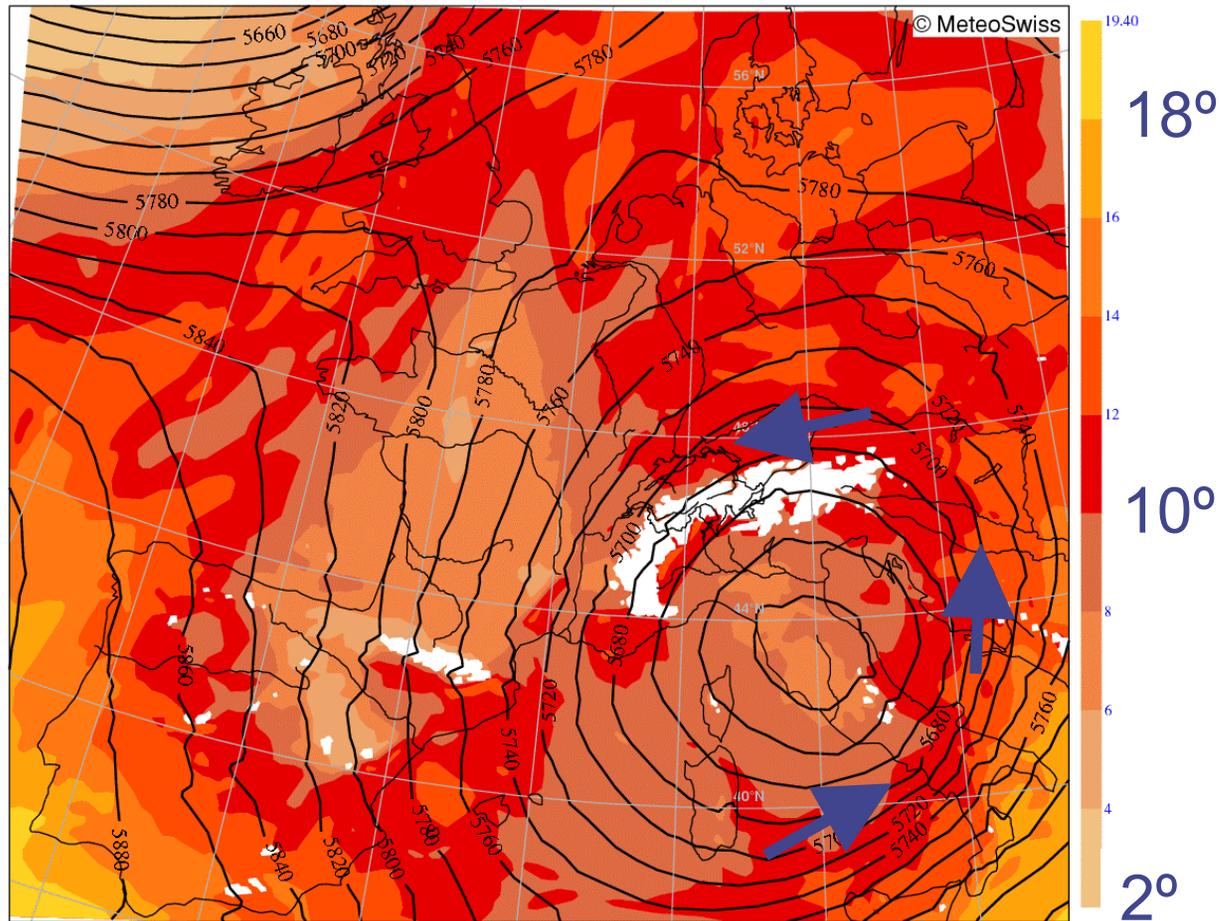


Photos: Tages-Anzeiger

Synoptic overview: 22 August 2005



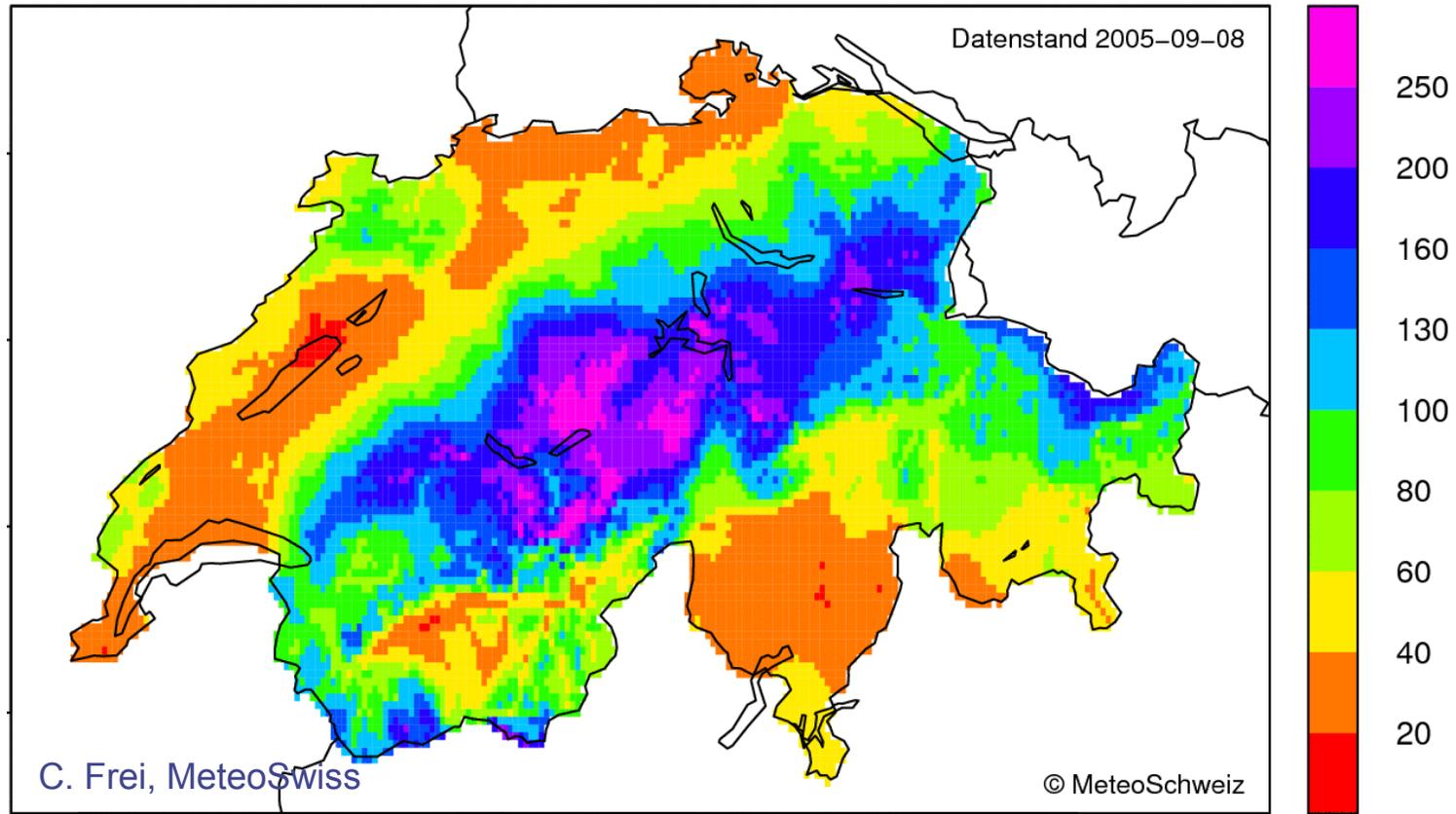
Temperature 850 hPa and geopotential 500 hPa:



Observed total precipitation over 3 days



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

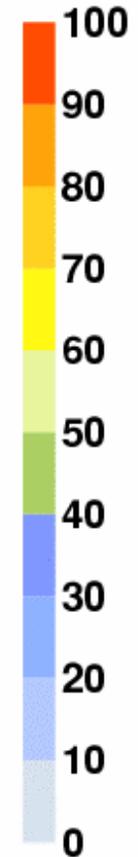
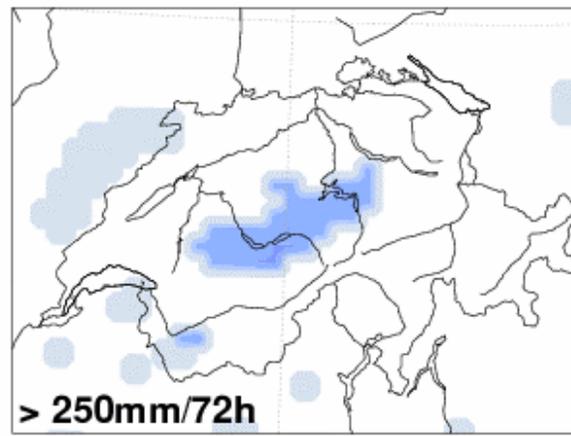
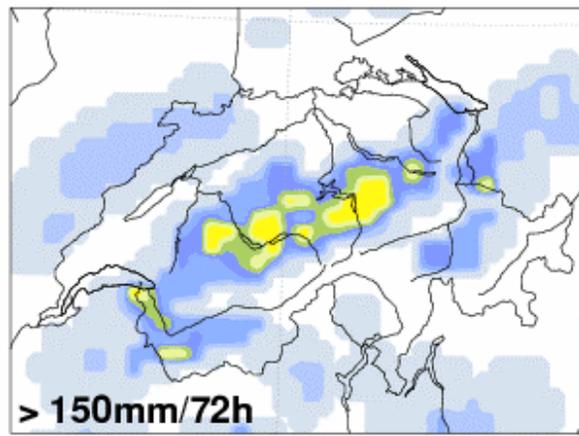
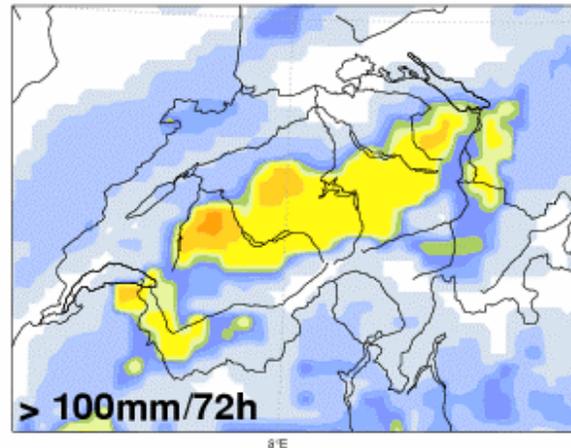
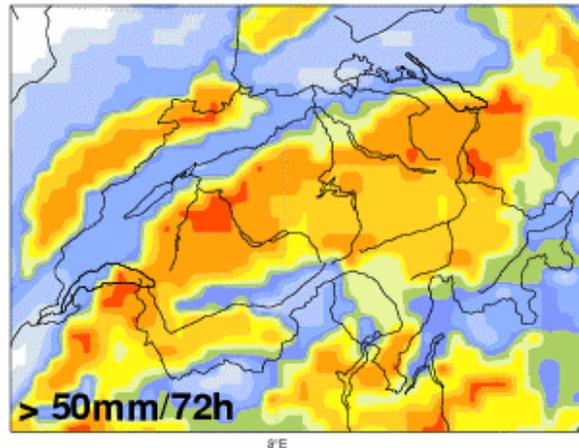


Precipitation sum locally over 300 mm!

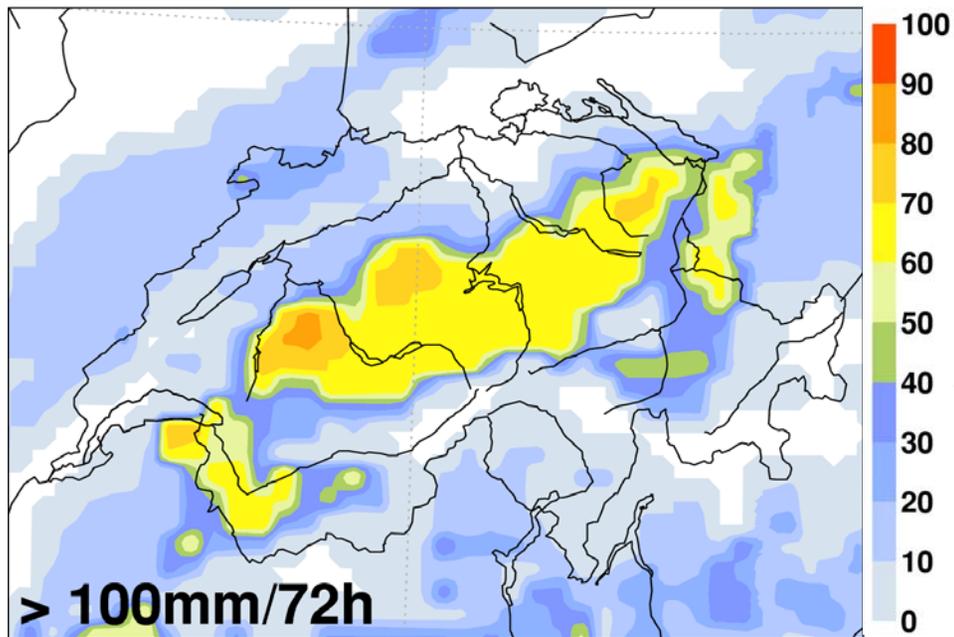
COSMO-LEPS forecast for 72h precipitation



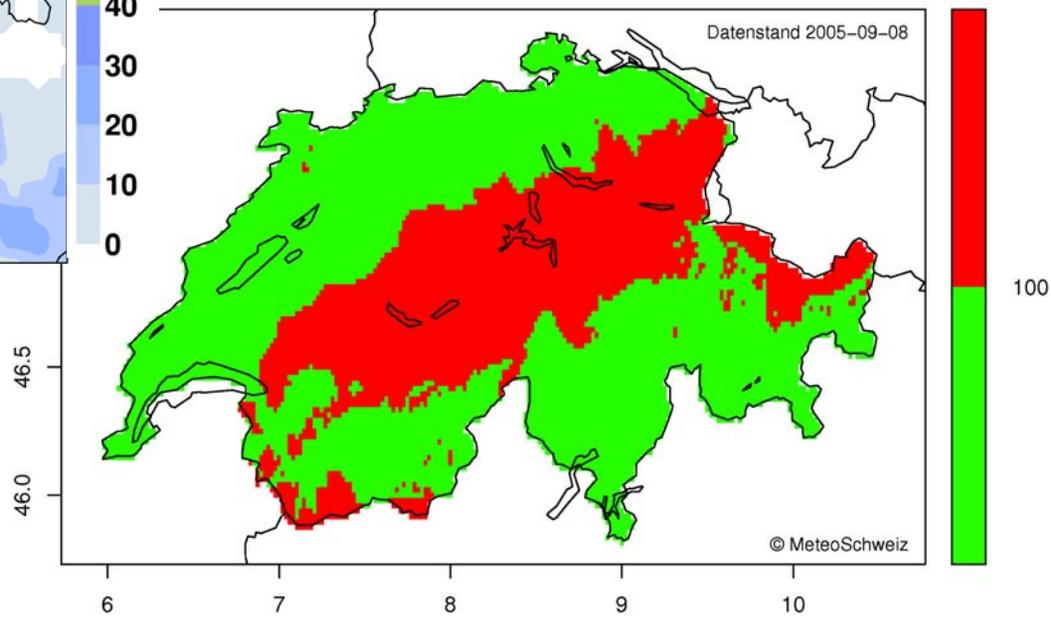
COSMO-LEPS probability forecast: **72h sum of total precipitation**
19 Aug 2005 12UTC, t+(18-90), **VT: Tuesday 23 Aug 2005 06UTC**



Probability precipitation > 100mm/72h



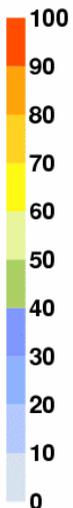
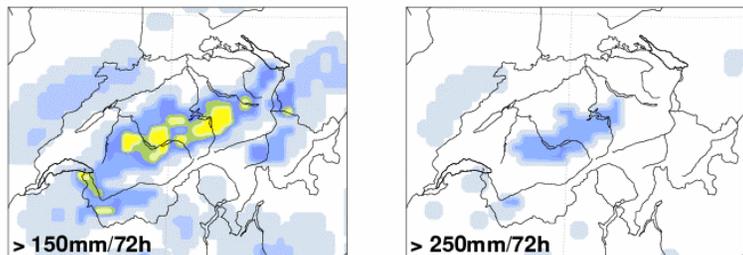
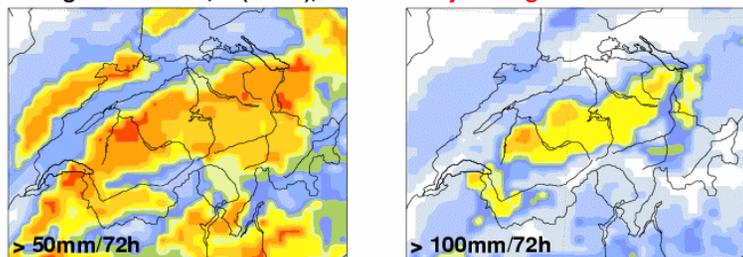
Precipitation observed



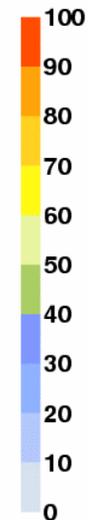
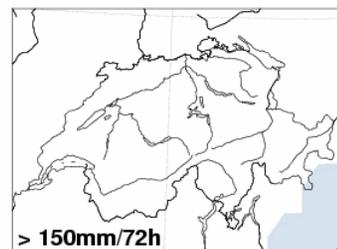
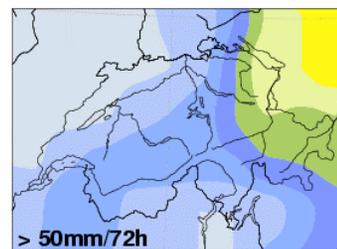
COSMO-LEPS forecast for 72-h precipitation



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



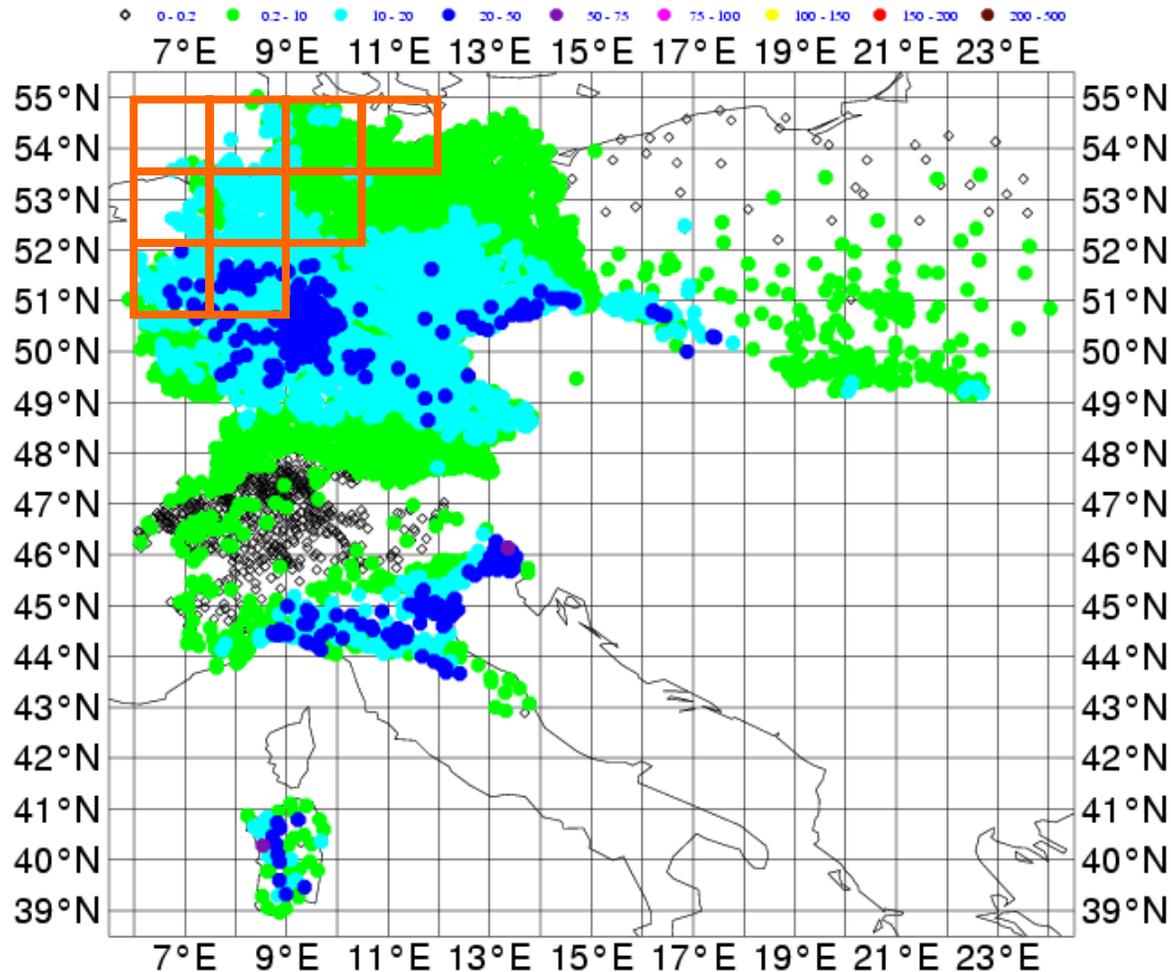
ECMWF EPS probability forecast: 72h sum of total precipitation
19 Aug 2005 12UTC, t+(18-90), VT: Tuesday 23 Aug 2005 06UTC



Probabilistic verification: LEPS vs. ECMWF



COSMO stations and verification grid:

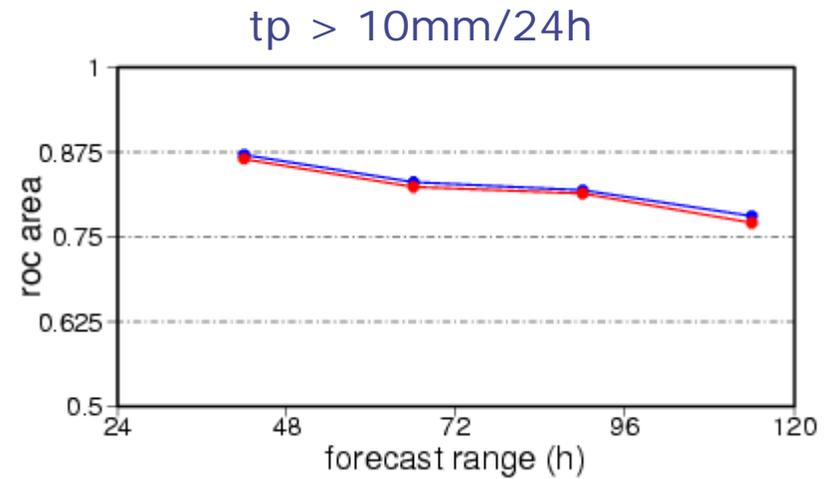
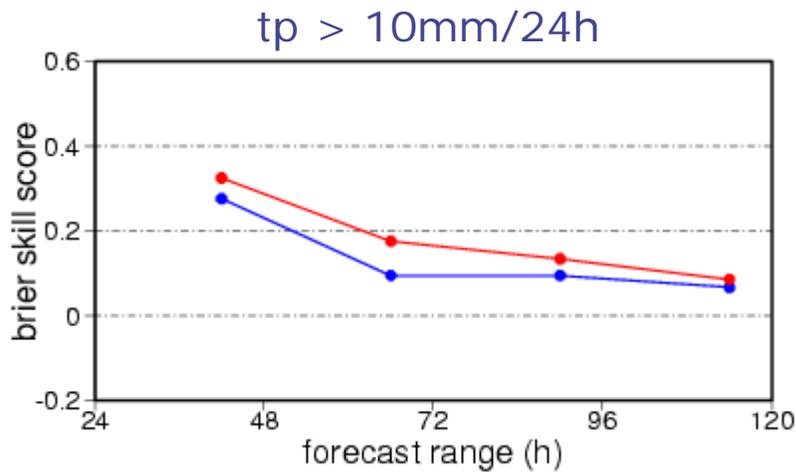
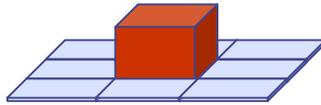


Verification of precipitation SON 2004 (1)



Average values

boxes 1.5x1.5 deg



COSMO-LEPS



10-MEMBER EPS

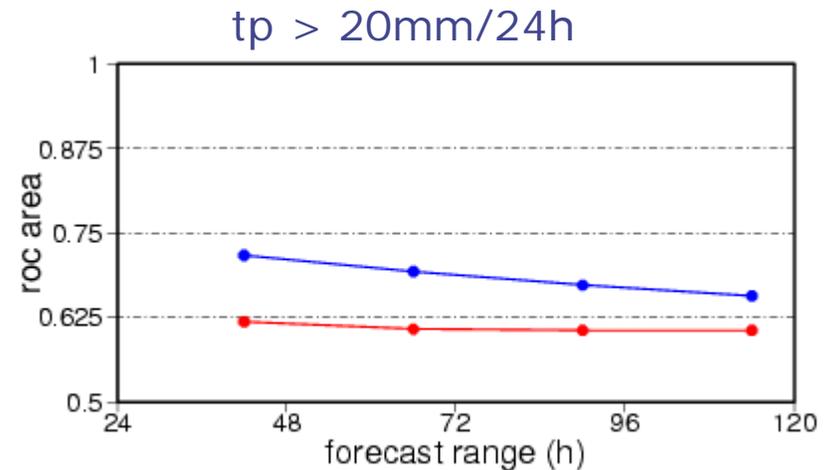
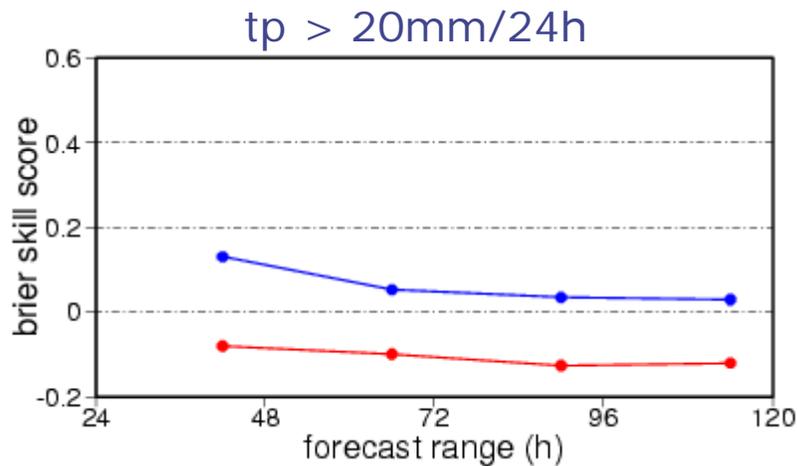
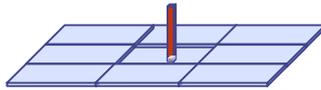


Verification of precipitation SON 2004 (2)



Maximum values

boxes 1.5x1.5 deg



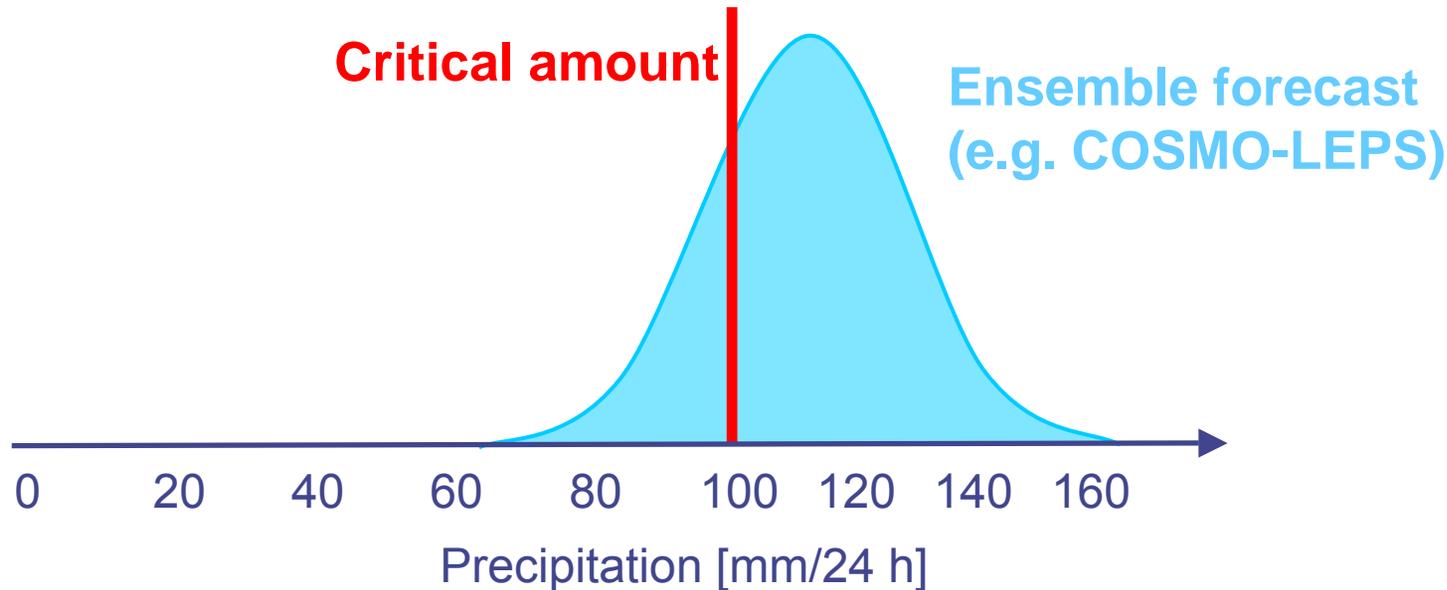
COSMO-LEPS



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 $Lu = 0$:

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

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

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

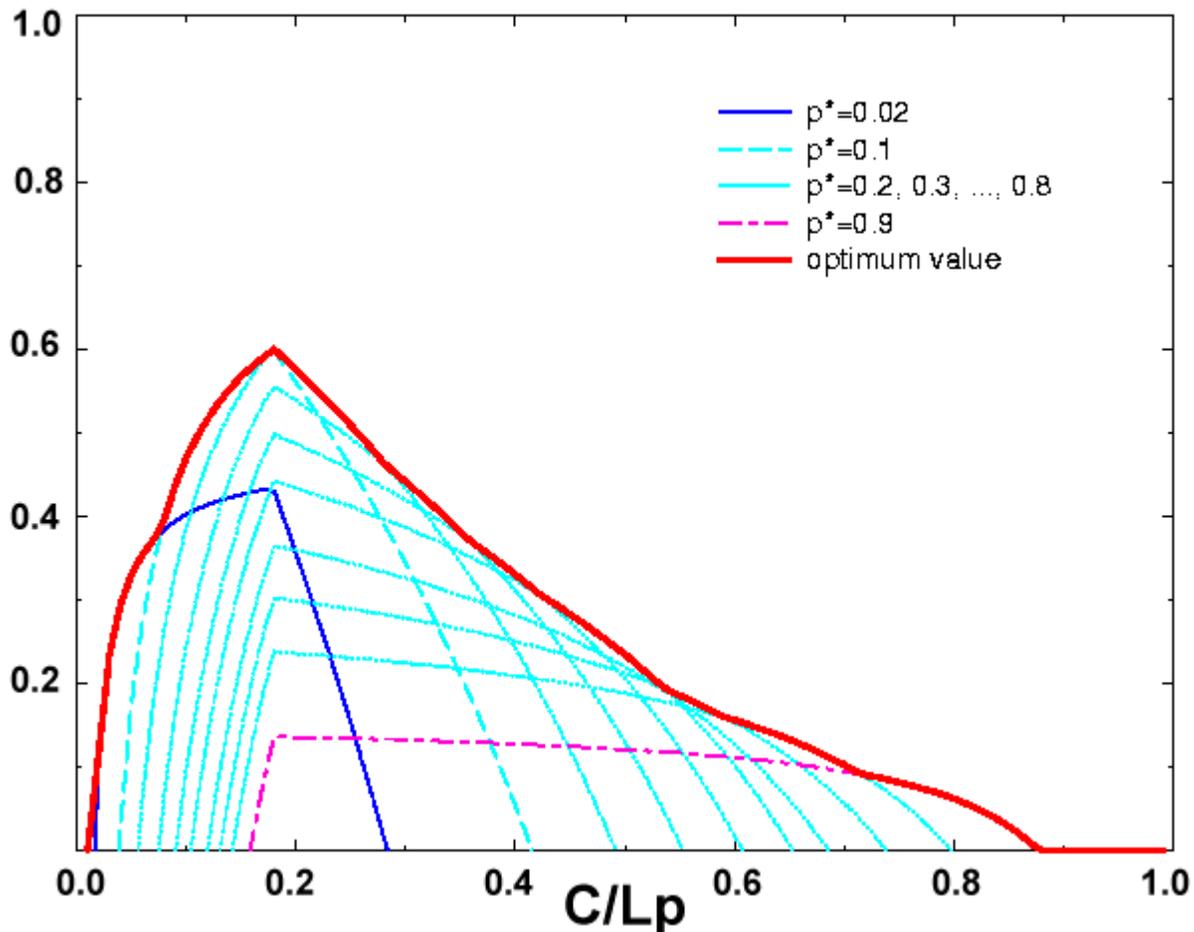
Economic value for different users: example



Every user has its specific C/Lp ratio

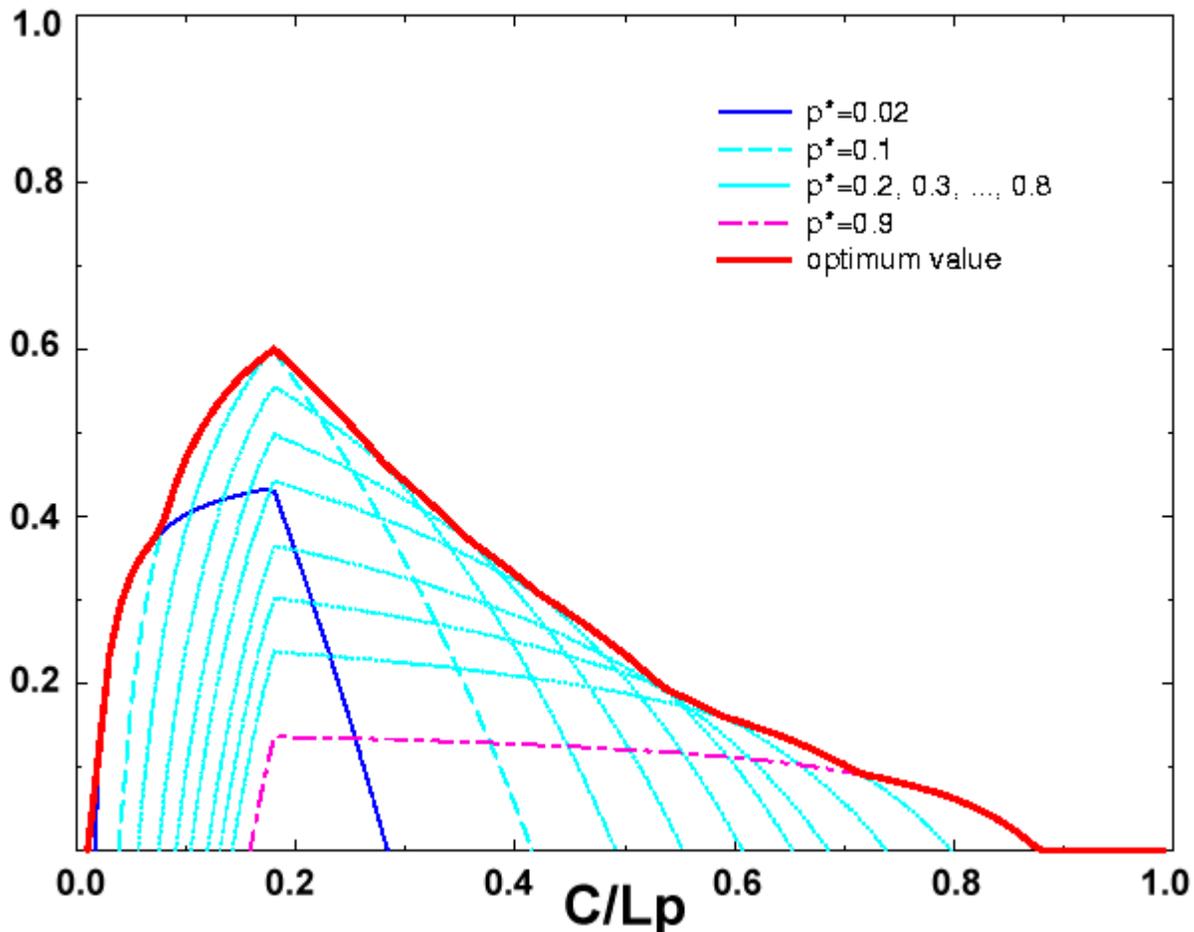


Economic value for different users: example



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

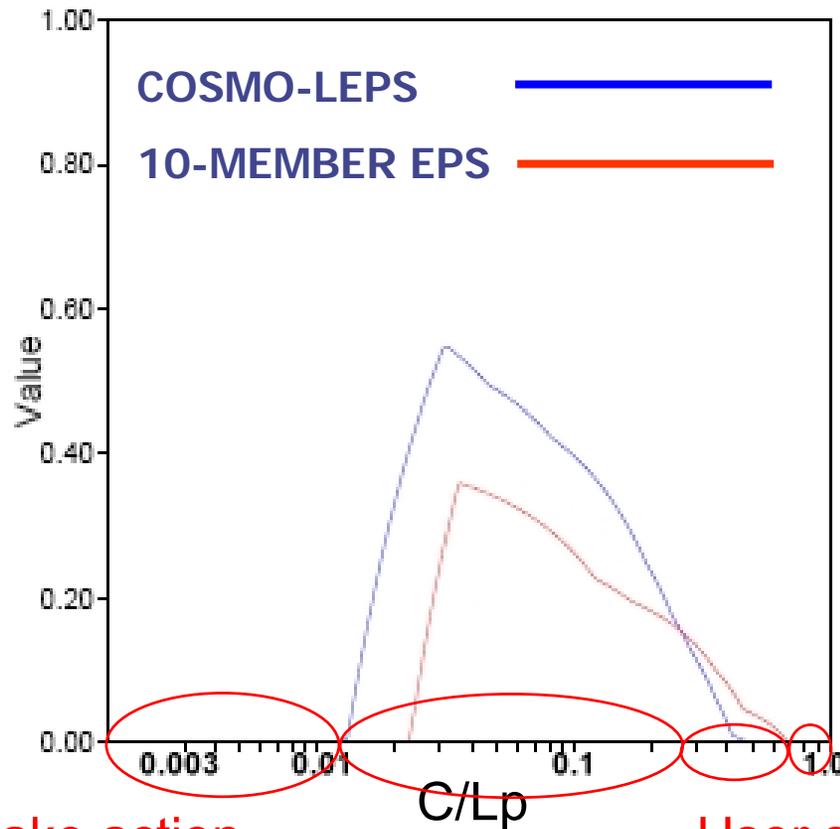


The higher C/Lp , the higher the decision level which gives the maximum economic value.

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



MeteoSchweiz

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?