

SHF, Lyon, 18-19/11/2008

**Real-time demonstration of hydrological ensemble forecasts in
MAP D-PHASE**

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Outline of the presentation

- MAP D-PHASE presentation
- Impact areas in the Alps
- Criteria for meteorological and hydrological warning thresholds
- Results of hydrological forecast chains
- Hydrology-oriented end users feedback

MAP D-PHASE

- Follow up of **MAP-Mesoscale Alpine Programme** (Bougeault et al., Bull. Am. Meteorol. Soc., 2001)
- **Demonstration of Probabilistic Hydrological and Atmospheric Simulation of flood Events in the Alpine region is the second (after Sydney Olympics) Forecast Demonstration Project of the WWRP-World Weather Research Programme. Real time in June-Nov. 2007**
- Main **objective** was to **test and demonstrate to end-users** the benefits in forecasting heavy precipitation and related flood events in **real-time, and especially in ensemble mode.**
- Meteorological aspects Rotach et al., Bull. Am. Meteorol. Soc., 2008 (submitted)

WG HEU ‘Hydrology and End users’

Chairs: *Christoph Hegg* (WSL, CH), *Roberto Ranzi*

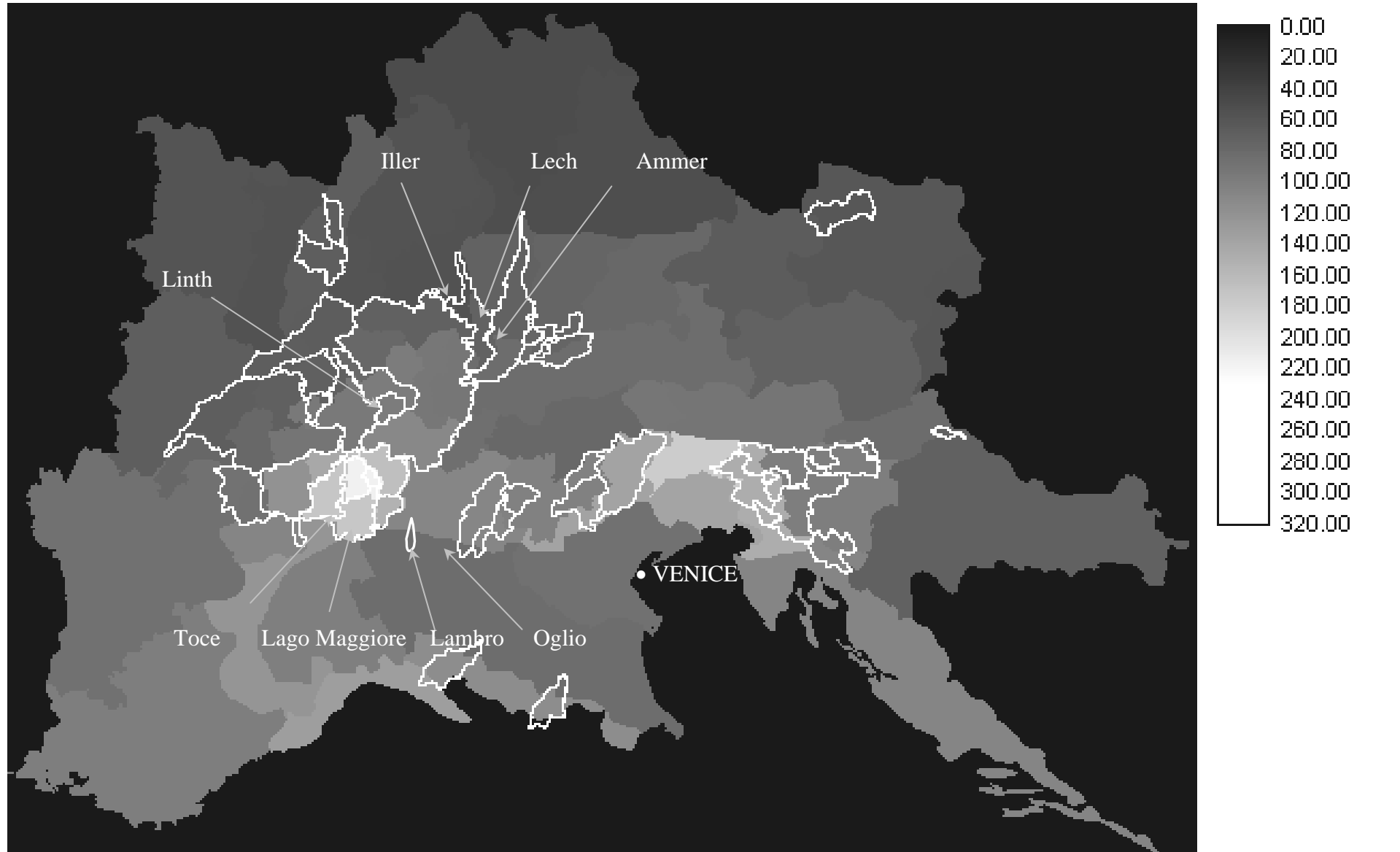
Main tasks:

1. definition of the **hydrological basins** (‘**impact areas**’) and the control sections where average precipitation, and runoff will be computed for verification;
2. definition of common needs of **hydrological modellers** and **end users** with respect to atmospheric model output (e.g., parameters, **meteorological warning thresholds**,...);
3. Collect **feedback from** end users who had access to a **Visualisation Platform**
4. definition of common format of hydrologic model output and **runoff warning levels thresholds**

Impact areas (hydrological basins) in the Alps

Alarm threshold (TR=10 years) for 24 h precipitation

Areal precipitation (mm)



Meteorological thresholds over > 100 of target and impact areas for duration of 3, 6, 12, 24, 48, 72 h

- 1. Attention level (yellow): annual maxima corresponding to mean of annual maxima $m - 2\text{St.dev}$. From theoretical considerations of Poisson occurrence of events with exponential probability distribution function this corresponds to about 7 events/year of the daily precipitation statistics.**
- 2. Alert level (orange): return period of 1.15 years in the tables corresponding to mean of annual maxima $m - \text{St.dev}$ corresponding to about 2 events/year of the daily precipitation statistics.**
- 3. Alarm level (red): return period of 10 years.**

The 'engineering' solution for the threshold task:

From Frei 2006 0.25° gridded daily precipitation,

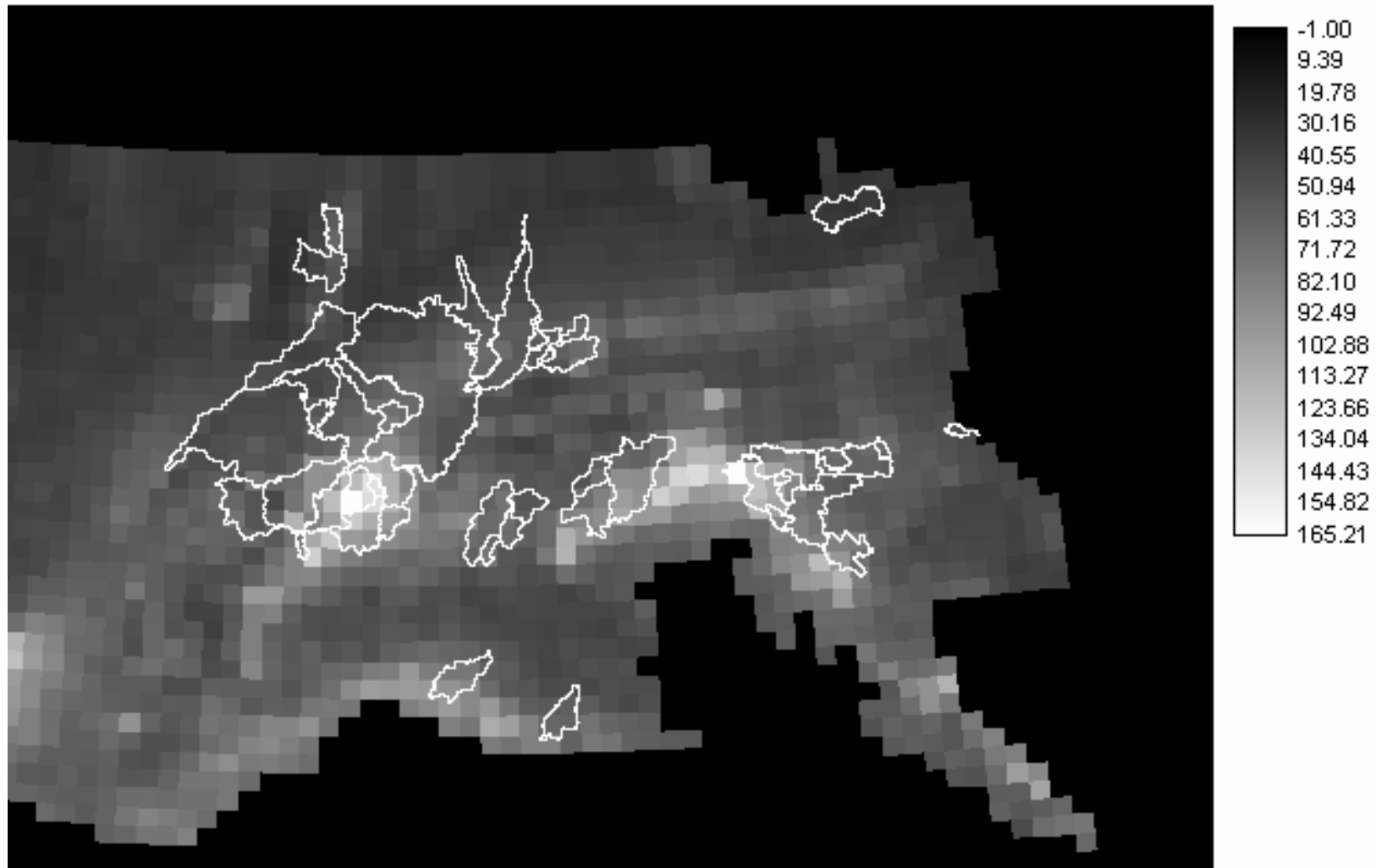
- statistics of gridded annual maxima were computed,
- Extreme Value of the 1st type Cumulative Distribution Function
- and scaling of rainfall depth h with duration d was assumed $h=ad^n$ with exponent n increasing with altitude (after literature)
- Areal Reduction Factor scaling with area and duration

Ticino	m-2s 7/ yr	m-s 2/yrs	T=10 Years
03h	20	29	59
06h	28	41	83
12h	40	58	117
24h	56	82	165
48h	79	115	233
72h	97	141	284

Toce	m-2s 7 / yr	m-s 2/yrs	T=10 Years
03h	16.6	27	62
06h	23	38	87
12h	33	54	123
24h	46	76	173
48h	65	106	243
72h	79	130	297

Hydrological Impact areas

Mean of annual maxima of daily precipitation



Map of the impact areas superimposed to the mean of annual maxima of daily precipitation, computed after the Frei, 2006 climatology. Notice: impact areas are nested into larger basins and are not visible.

Questionnaires feedback

METEO (+hydro + users):

1. ARPA-FVG OSMER Friuli
2. ARPA-Valle d'Aosta
3. Meteotrentino
4. ARPA-ER**
5. CNR.ISAC**
6. ARPA-Liguria**
7. APAT**

**run meteo models

HYDRO-Forecasters in real-time

1. University of Brescia
2. ARPA Lombardia
3. Politecnico di Milano and Arpa Piemonte
4. WSL, IACETH (CH)
5. IMK-IFU Karlsruhe (D)
6. Wasserwirtschaftsamt Kempten (D)

HYDROLOGY- ORIENTED END USERS:

1. ENEL – Mestre (I)
2. Consorzio dell'Oglio Water Authority (I)
3. ARPA Lombardia, (I)
4. SOI-Ufficio Dighe–PAT–Trento (I)
5. Protezione Civile Regionale- FVG (I)
6. ARPA Piemonte (I)
7. Several in Switzerland
8. WWA (D)
9. Env. Agency of Slovenja (SLO)
10. Meteo-Hydro Service (HR)

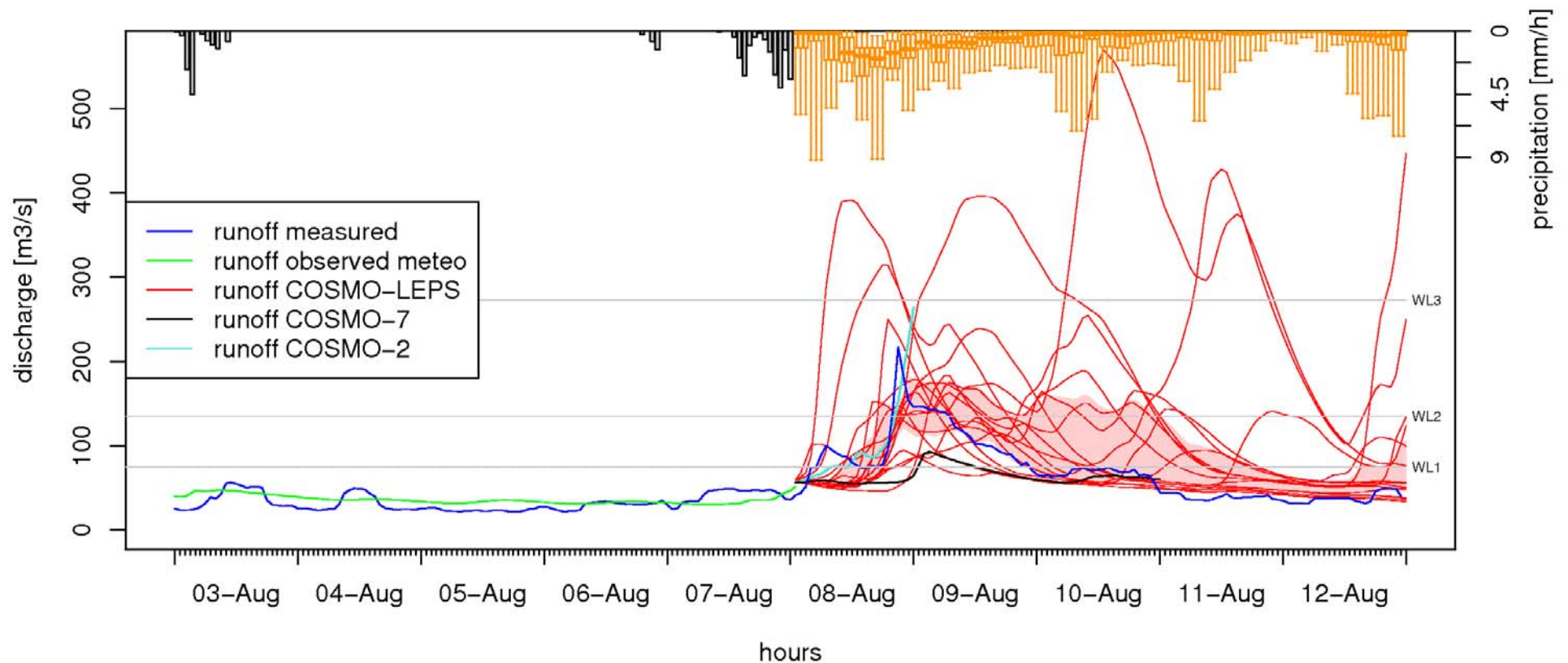
Real-time modelling chains (Italian Alps)

Hydrological models forced by ensemble (E) and deterministic (D) high resolution meteorological models

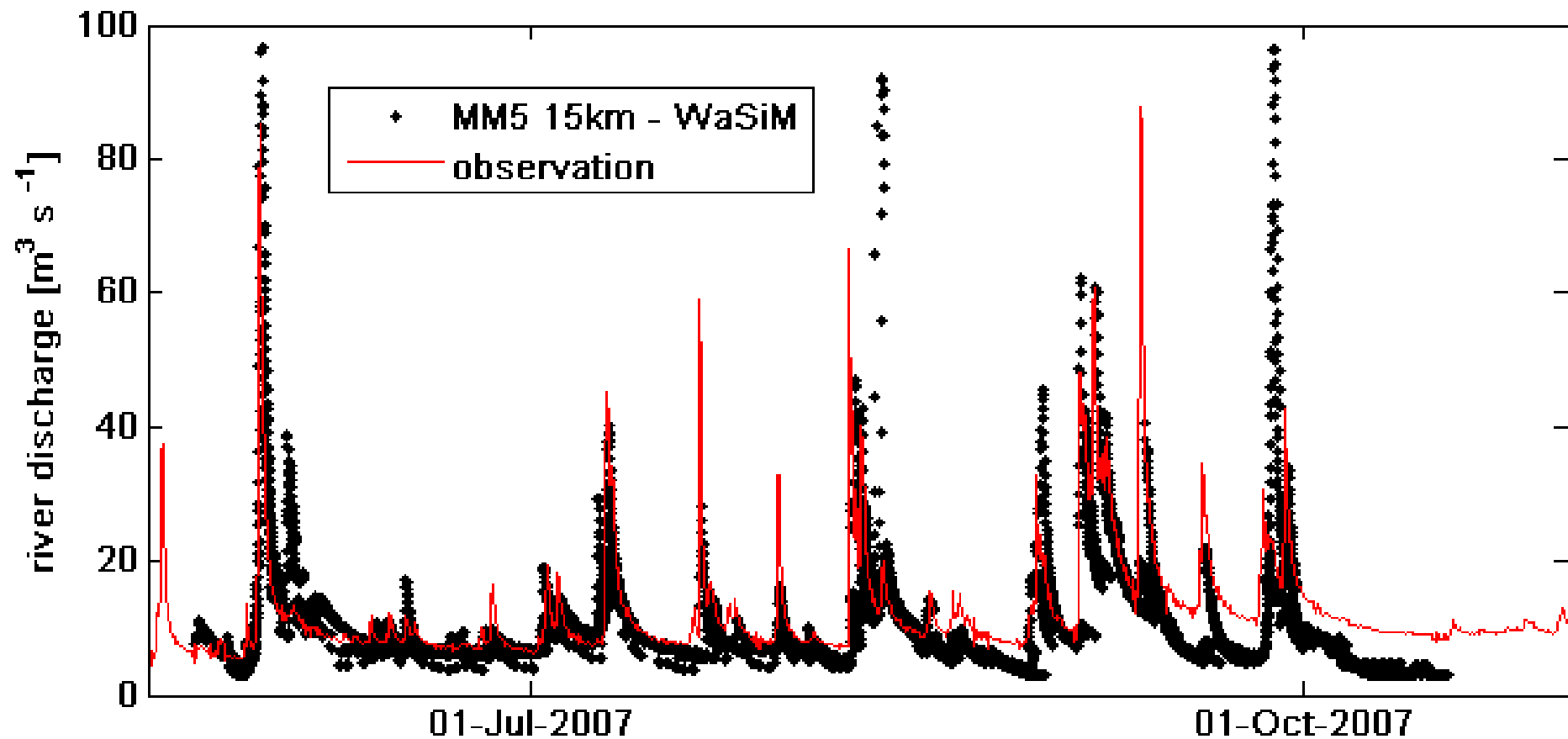
Hydrological Model	Meteorological model						
	CLEPS (E)	ISACMOL (D)	ISACMOL2 (D)	COSMOCH2 (D)	COSMOCH7 (D)	LAMI28 (D)	ARPALMOL (D)
DIMOSOP	●	●	●				
LAMBRO	●	●				●	●
FEST	●	●					
PREVAH	●		●	●	●		

In Switzerland COSMO 2km & LEPS (Meteo) and Radar Ensemble (Germaann et al. 2008) +PREVAH (Hydro)

Linth at Mollis

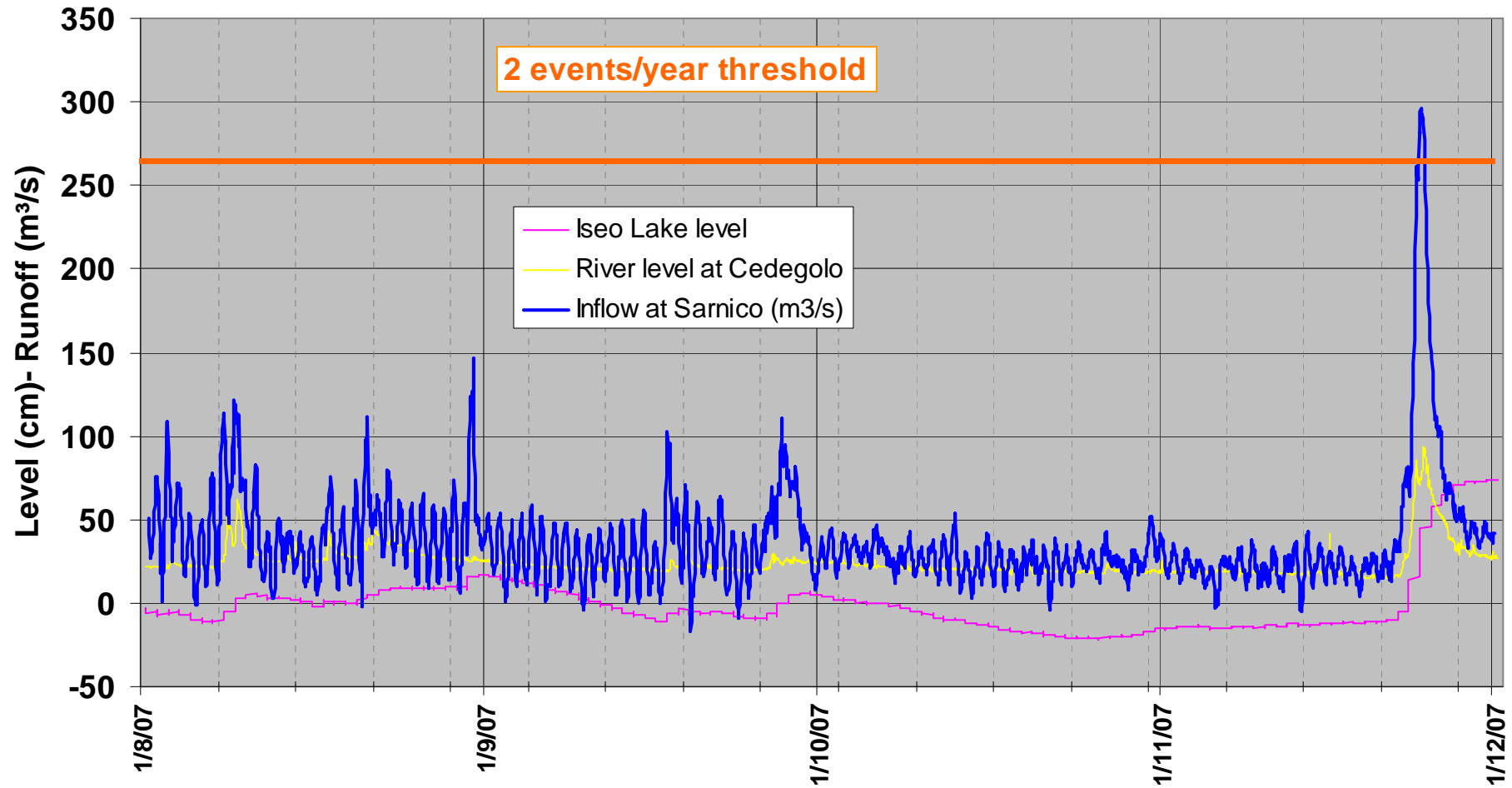


In the Bavarian Alps
MM5 15 km + WaSim
for Ammer watershed (710 km²)



In the Italian Alps

Oglio@Sarnico (1840 km²)



ARPA Lombardia us to perform real time h

CLEPS (ARPA Emr,
LAMI28 (ARPA Emr,
ISACMOL (ISAC CN
ARPALMOL (ARPA

Lambro basin

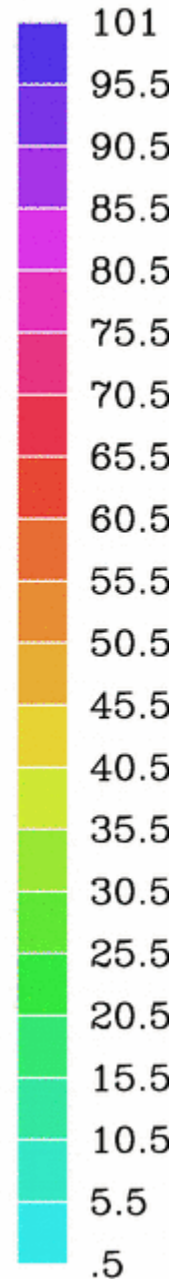
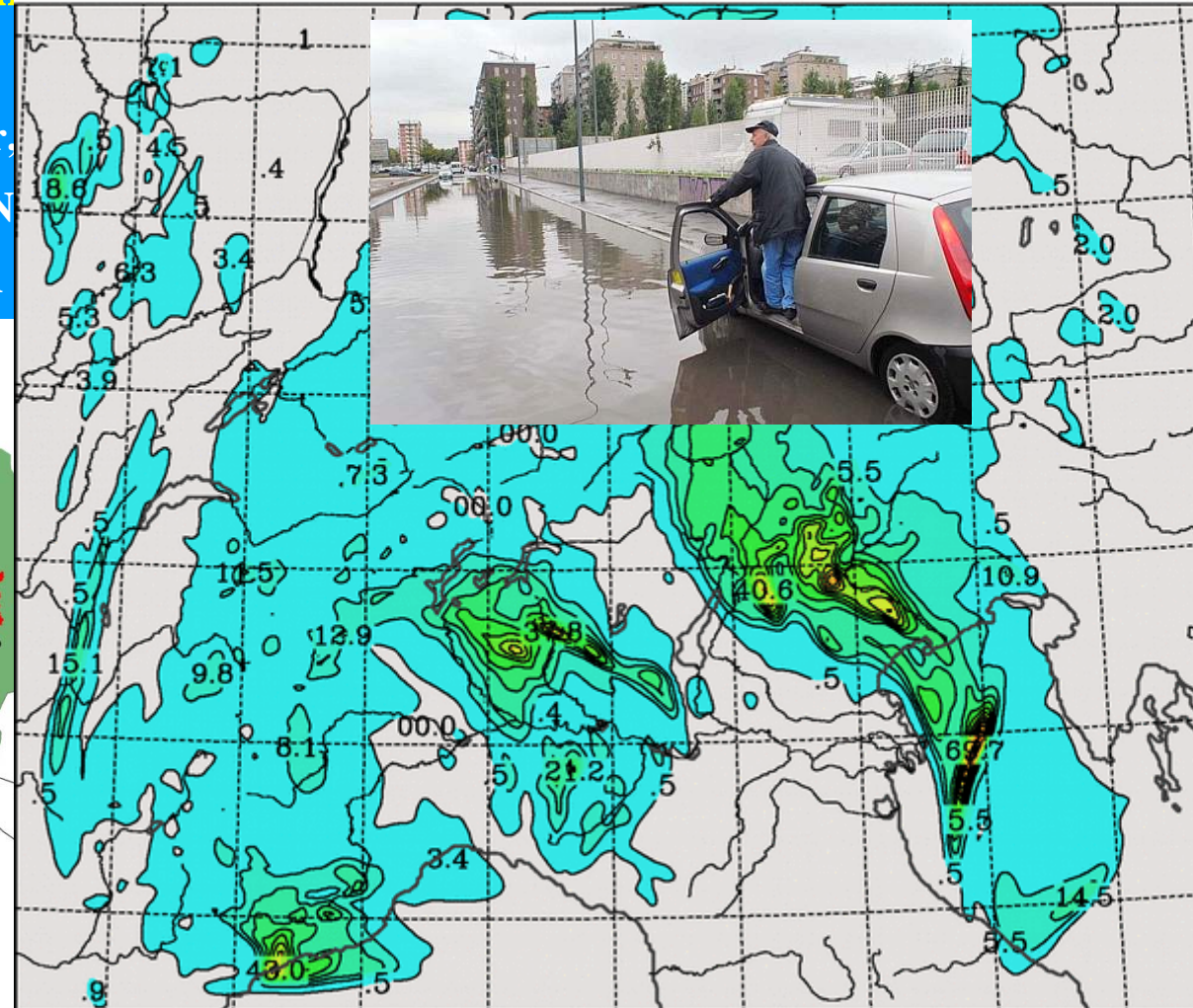


ACC. TOT. PREC. (MM) IN 3 H 0 M

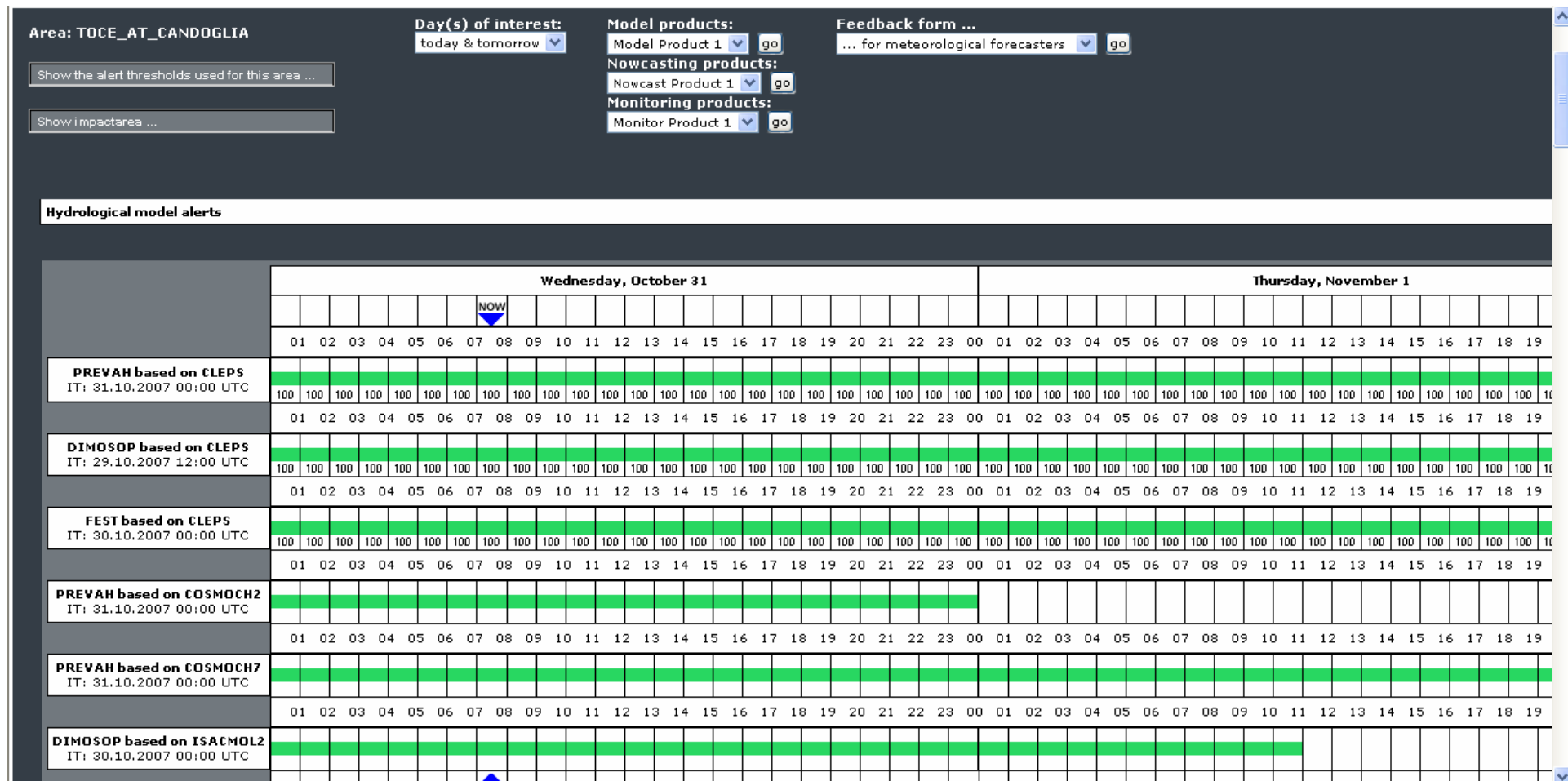
INITIAL DATE 26/09/2007 0900 UTC

FORECAST HH MM +06 00 VALID AT 26/09/2007 1500 UTC

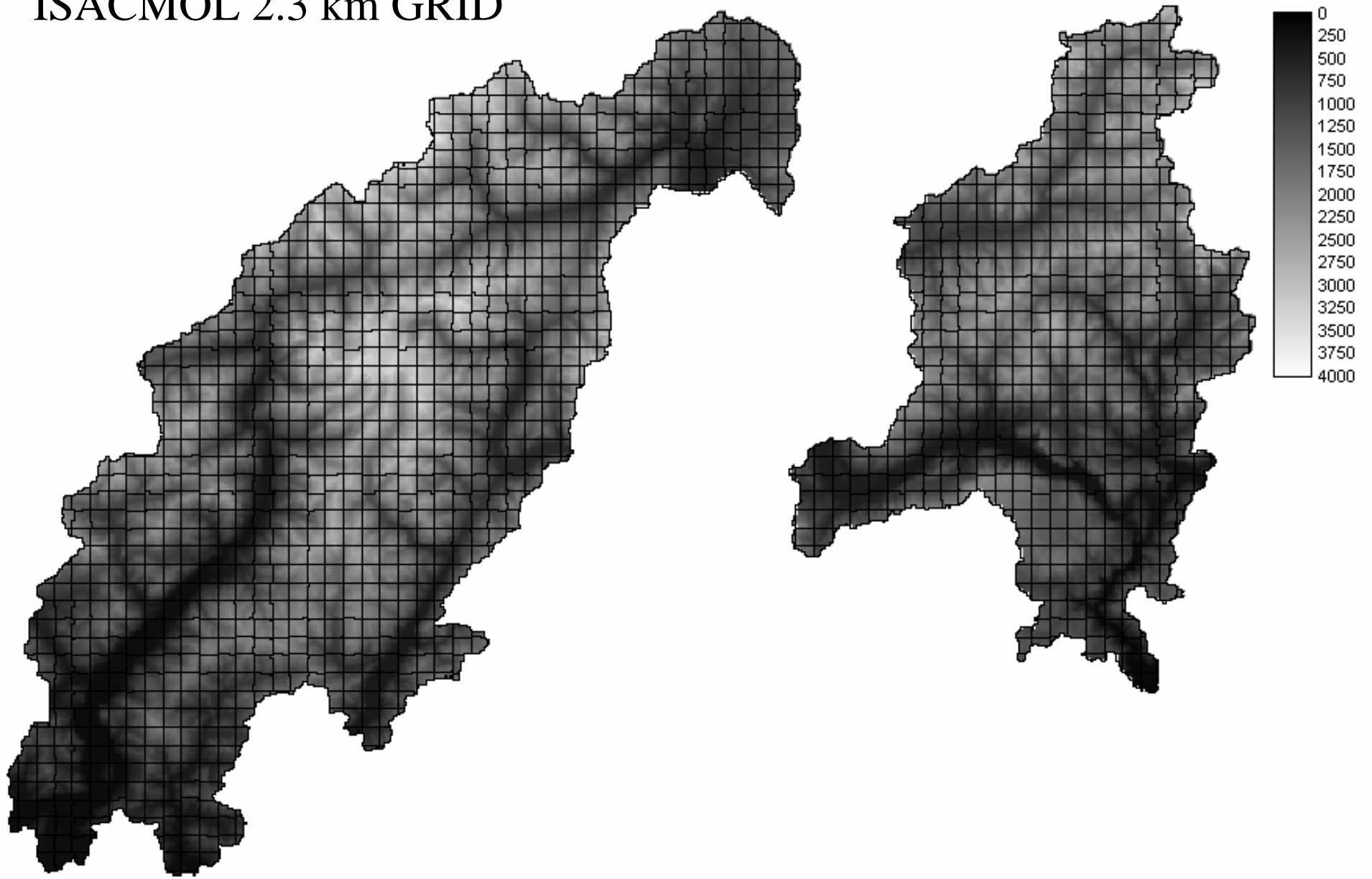
INTERVAL 5.00



Starting with the end of October it was possible to compare in real-time the results of up to 7 meteo-hydrological forecasting chains (3 Ensemble+ 4 Deterministic) for the Toce at Candoglia. (Map case study e.g. Bontron, Djerboua, & Obled, LHB, 2002.



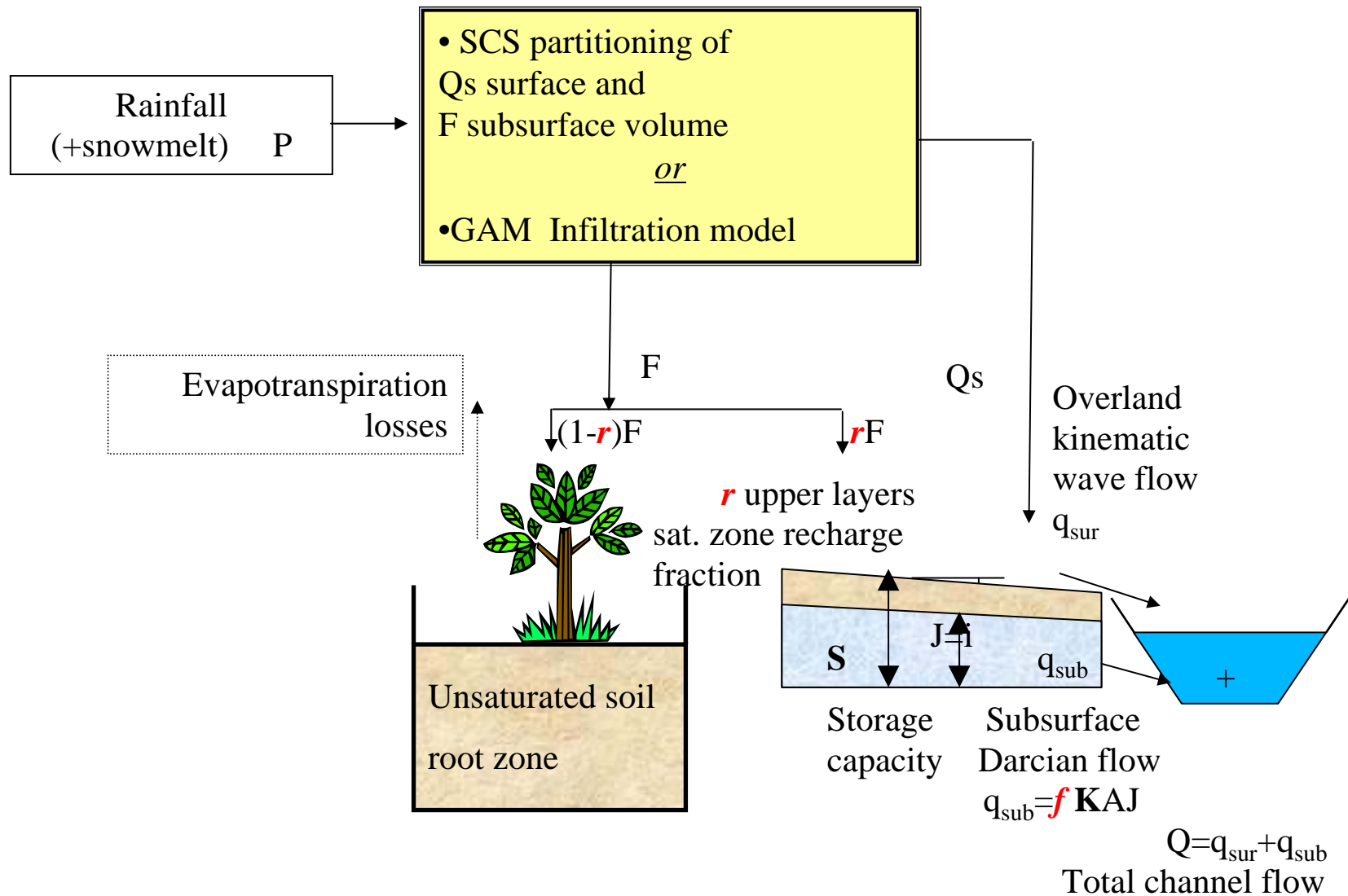
ISACMOL 2.3 km GRID



11: 21.11.2007 00:00 UTC



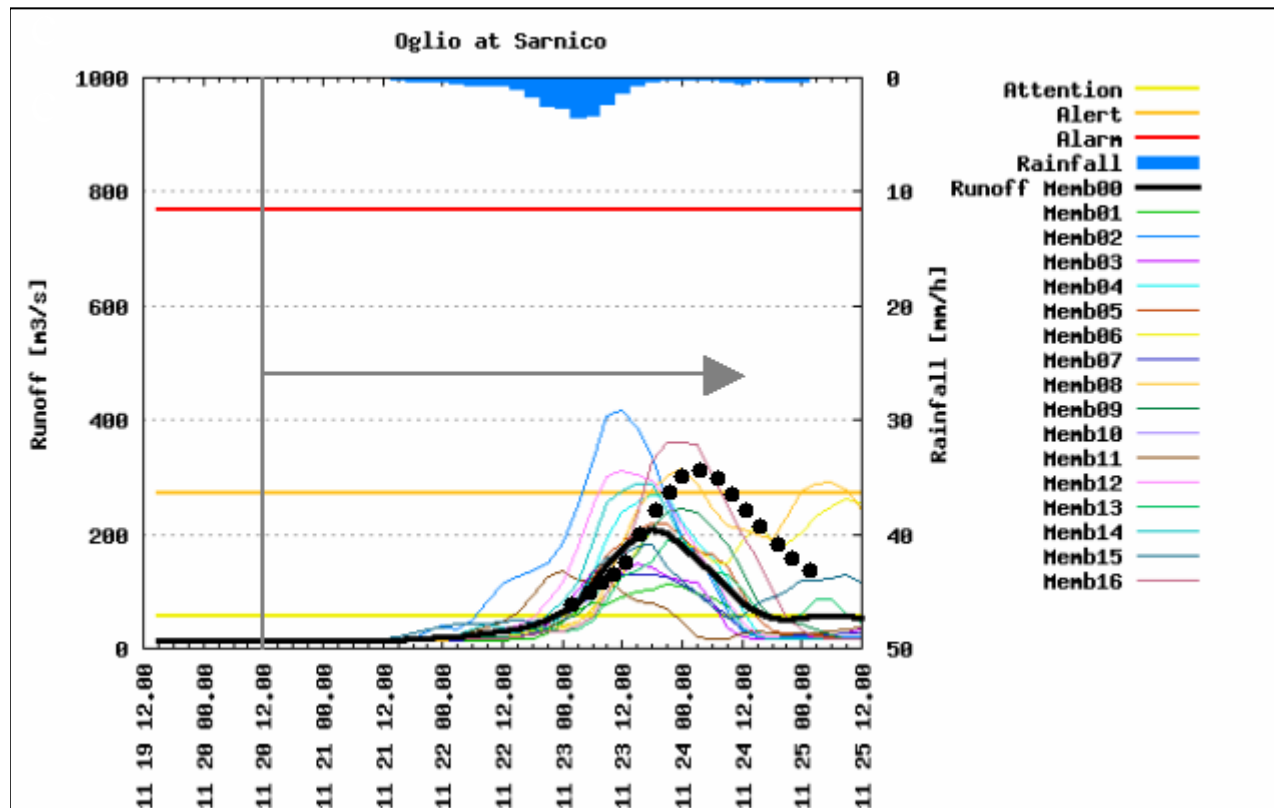
Model scheme



Calibration of r -recharge and f -transmissivity parameters

End user feedback (interview to M.Buizza, Consorzio dell'Oglio dam

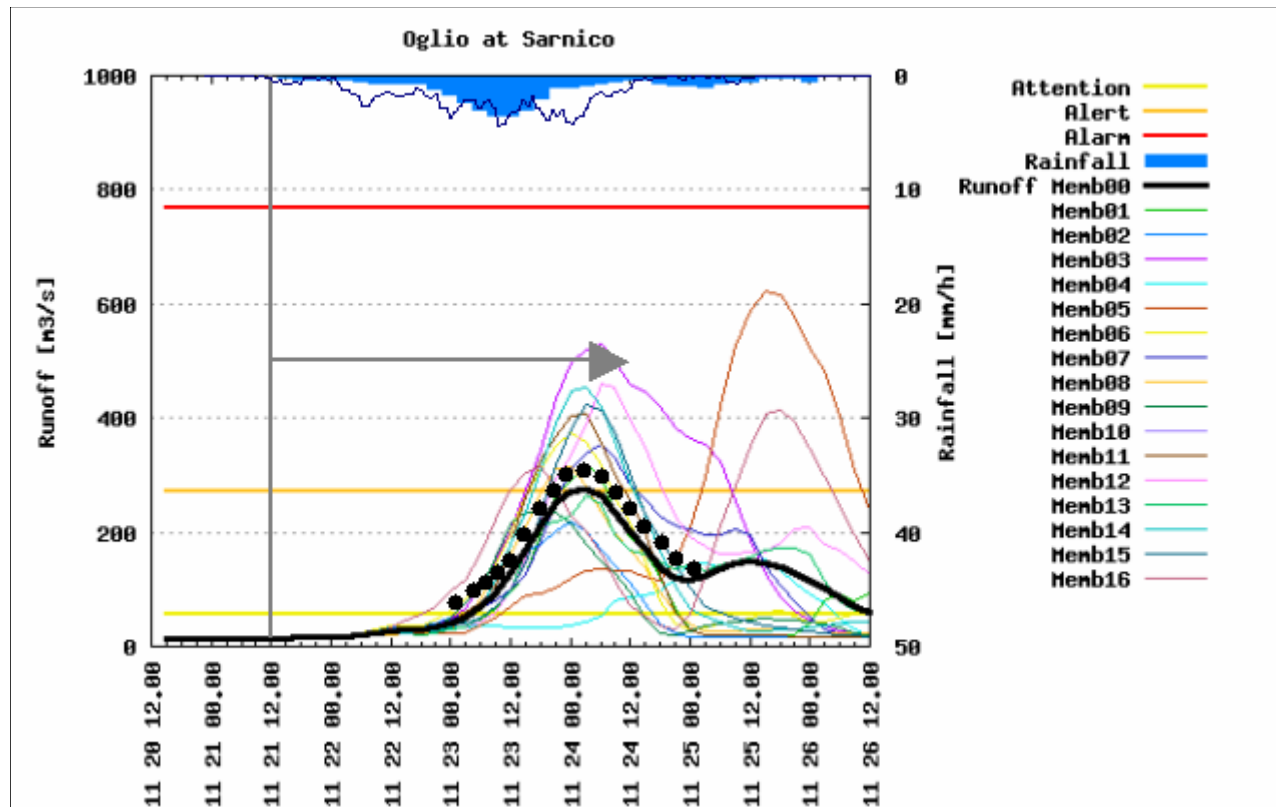
Authority on the basis of the feedback form)



	Marks	Relevance for decisions
CLEPS	4	4
ISACMOL	3	3
DIMOSOP	4	4

1=bad,...,6 excellent

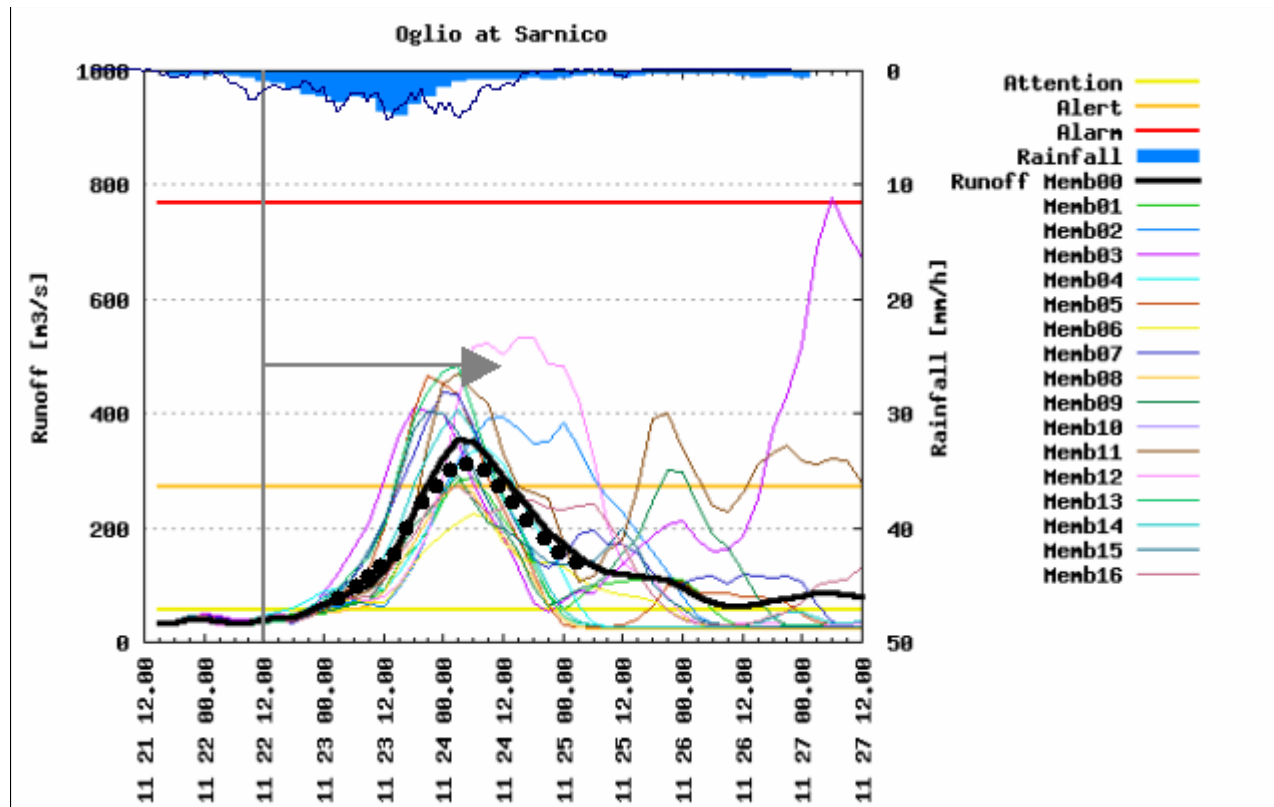
	NWP	HYDROL	NOWCAST	OBSERVATIONS
NO REACTION	X	X	<input type="checkbox"/>	X
CONTACTS WITH HYDROLOGIST	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
INTERNAL EVALUATION	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PERSONNELL ALERTED	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
ALARM	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



	Marks	Relevance for decisions
CLEPS	3	3
ISACMOL	2	2
DIMOSOP	4	4

1=bad,...,6 excellent

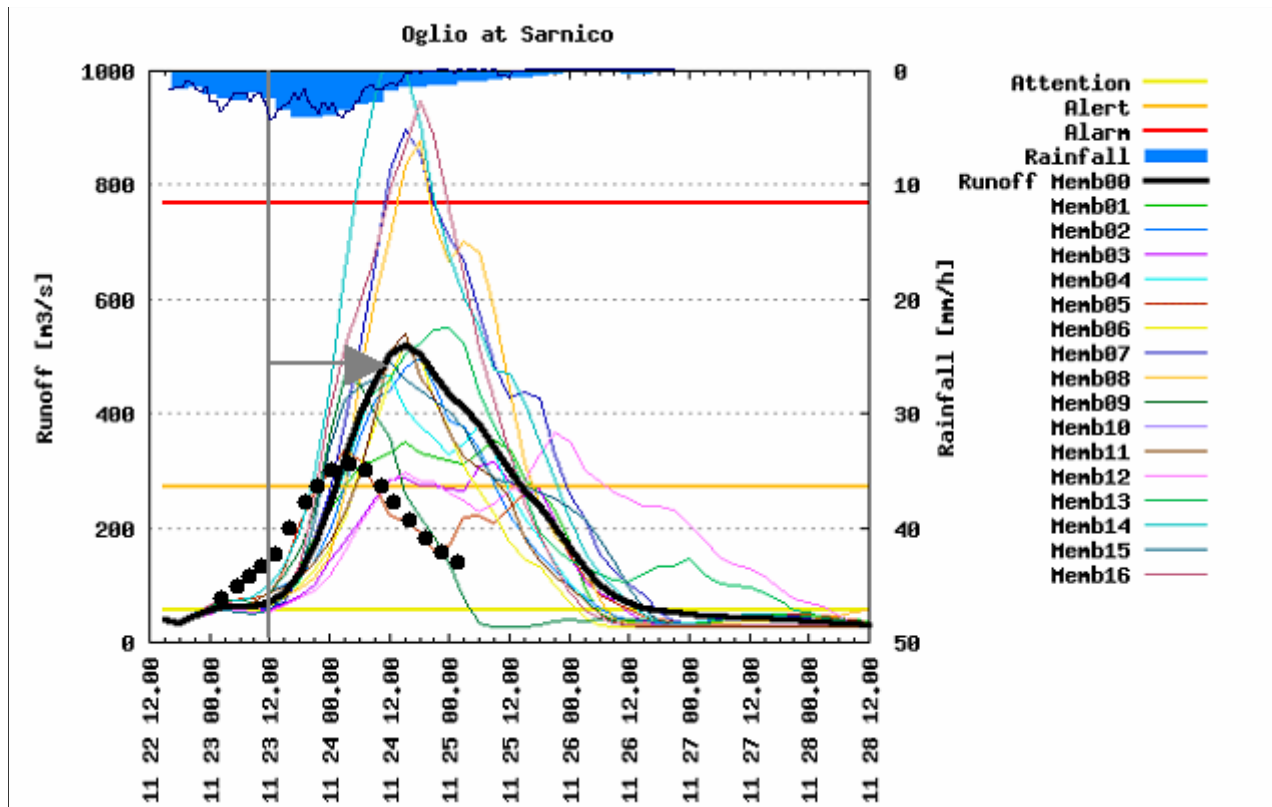
	NWP	HYDROL	NOWCAST	OBSERVATIONS
NO REACTION	X	X	<input type="checkbox"/>	X
CONTACTS WITH HYDROLOGIST	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
INTERNAL EVALUATION	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PERSONNELL ALERTED	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
ALARM	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



	Marks	Relevance for decisions
CLEPS	4	4
ISACMOL	3	3
DIMOSOP	4	4

1=bad,...,6 excellent

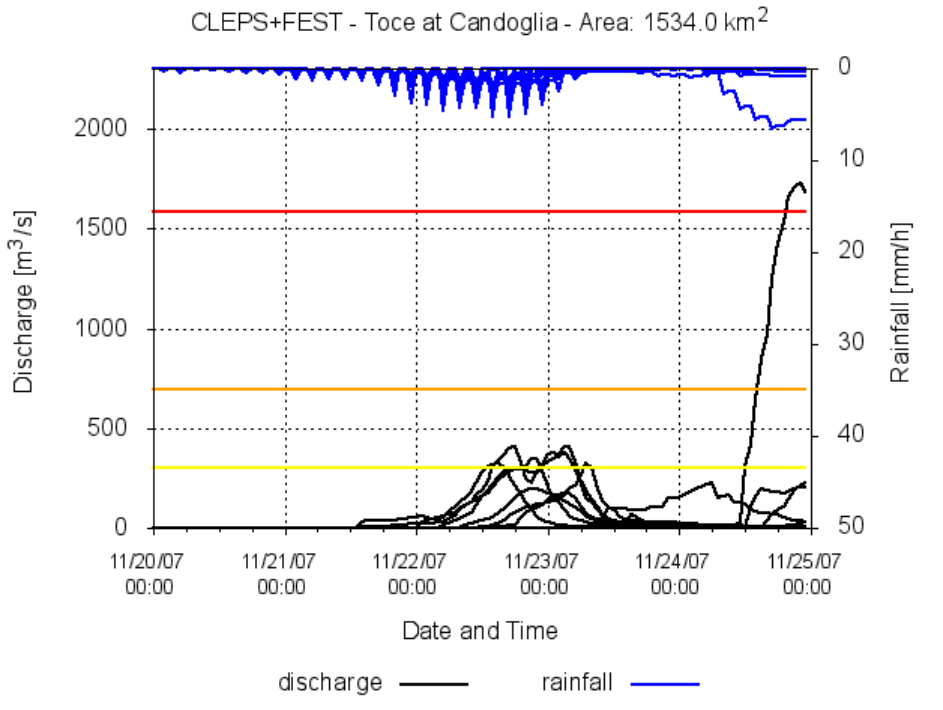
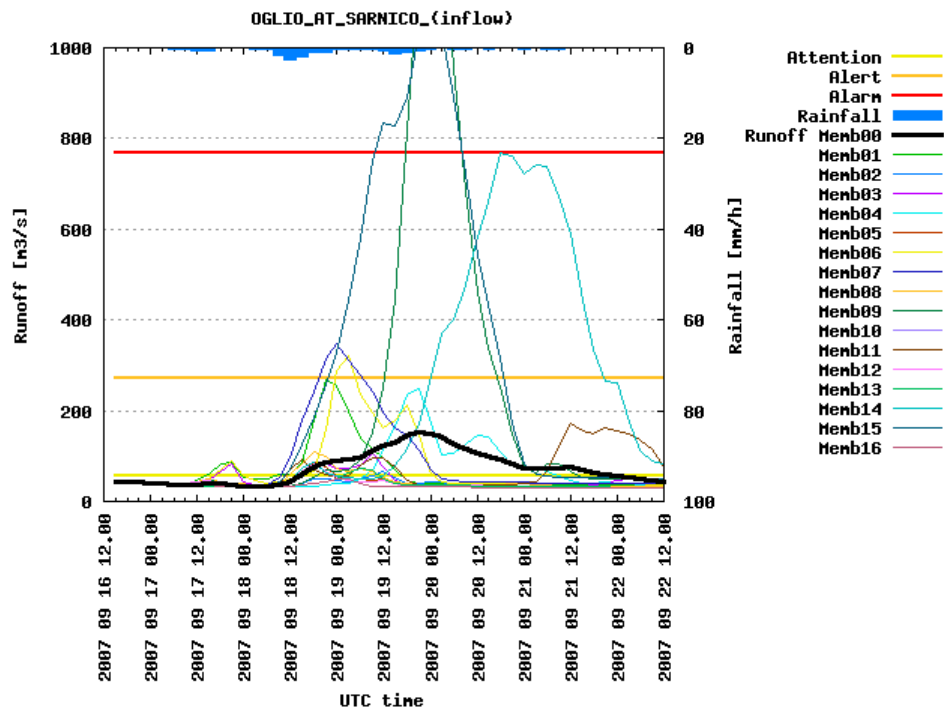
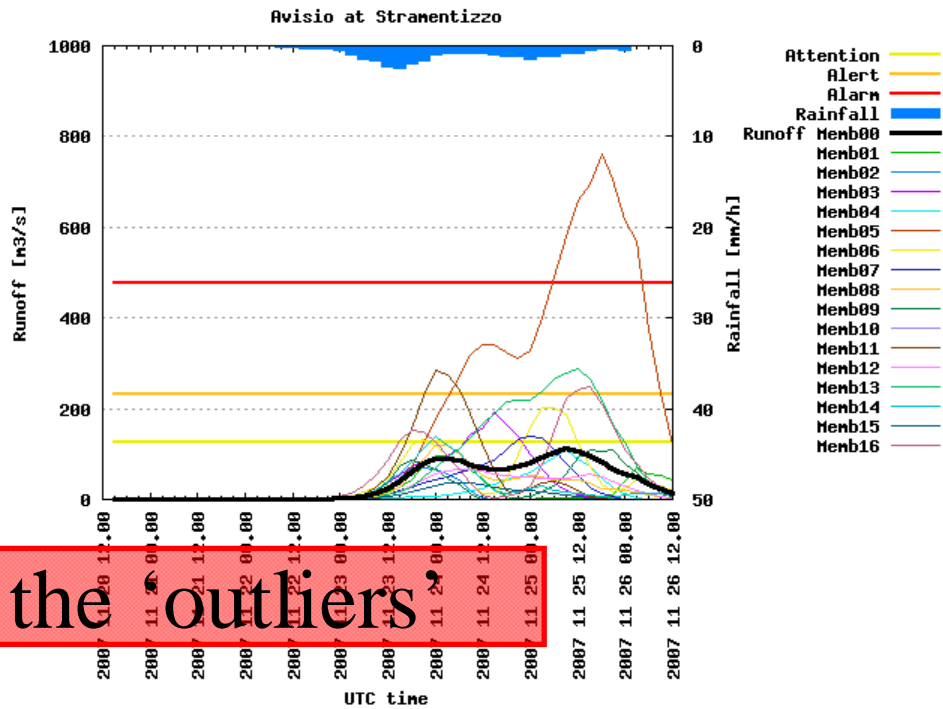
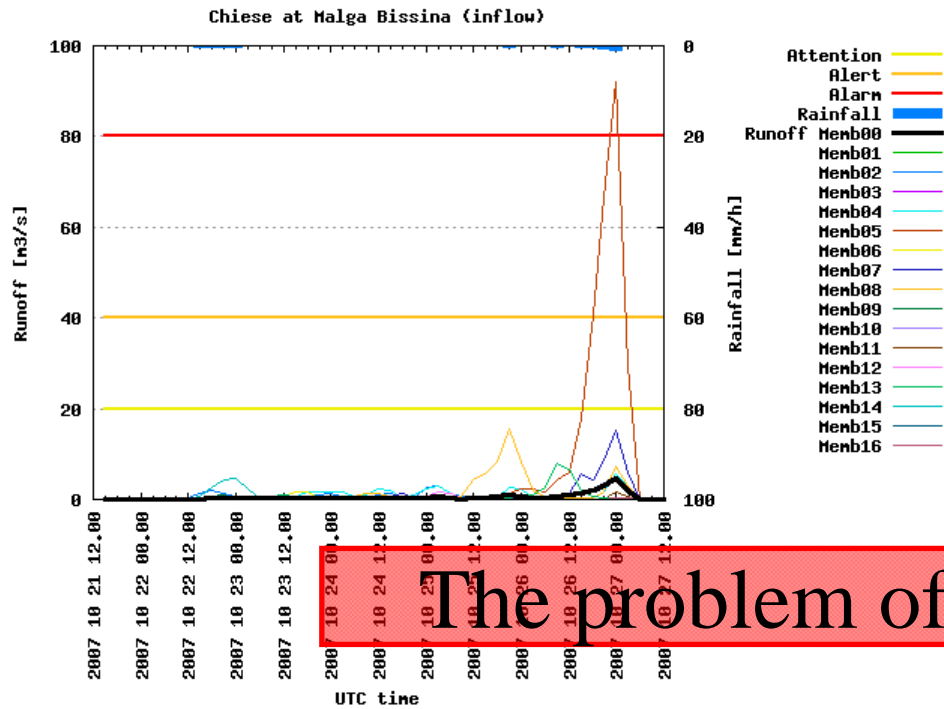
	NWP	HYDROL	NOWCAST	OBSERVATIONS
NO REACTION	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CONTACTS WITH HYDROLOGIST	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
INTERNAL EVALUATION	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
PERSONNELL ALERTED	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
ALARM	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



	Marks	Relevance for decisions
CLEPS	3	5
ISACMOL	2	3
DIMOSOP	3	5

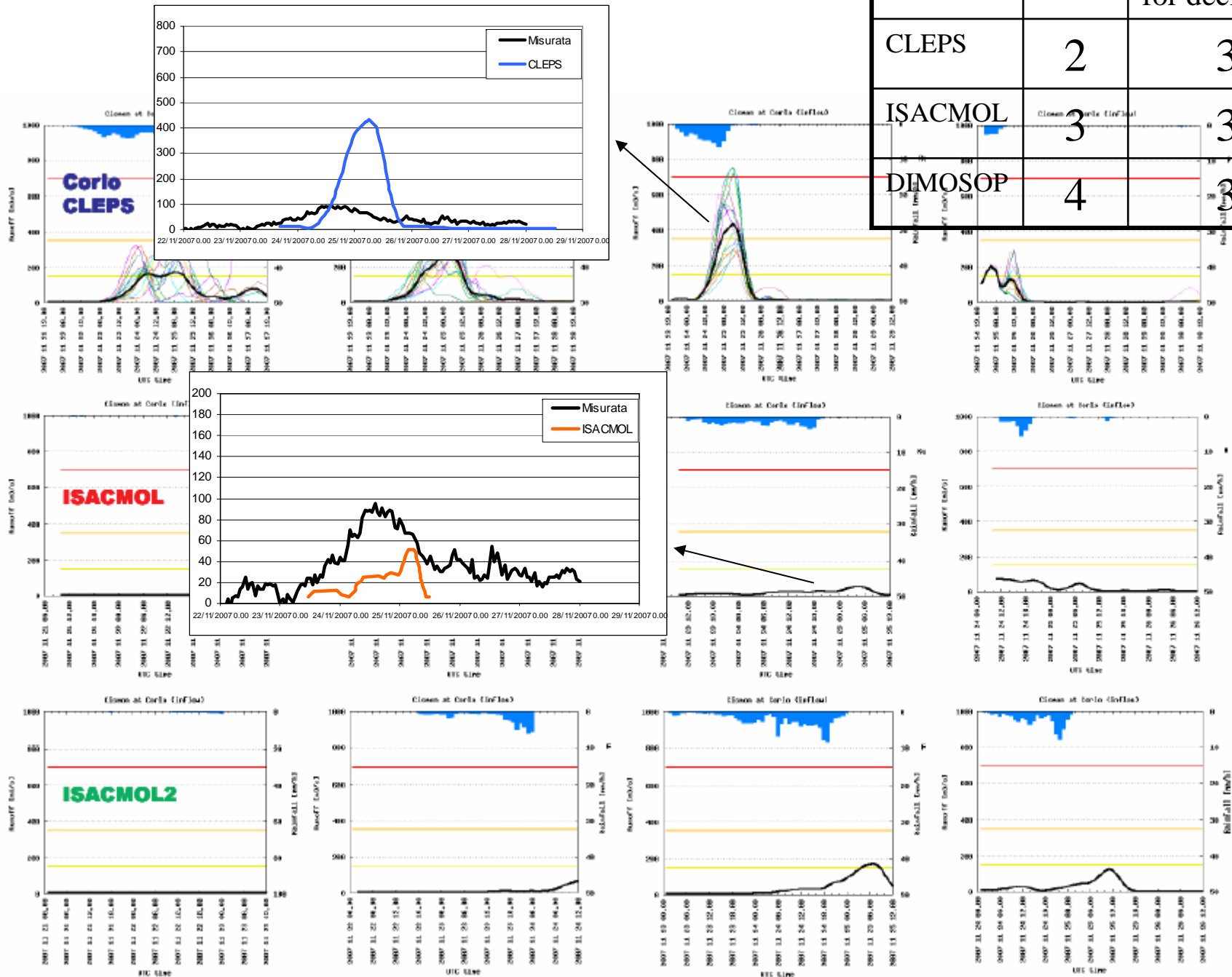
1=bad,...,6 excellent

	NWP	HYDROL	NOWCAST	OBSERVATIONS
NO REACTION	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CONTACTS WITH HYDROLOGIST	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
INTERNAL EVALUATION	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PERSONNELL ALERTED	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
ALARM	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



Feedback from ENEL (Hydropower dams)

	Marks	Relevance for decisions
CLEPS	2	3
ISACMOL	3	3
DIMOSOP	4	3



Conclusions

- 16 modelling chains were in operation in the Alps in D-PHASE and up to 7 in parallel for Toce ☺
- CLEPS **better** than ISACMOL/2 for Chiese and Oglio (good results) but **worse** for small dam-gauged basins ☺
- Some CLEPS-**outliers** (or ‘crazy members’) also for dry events might alert a ‘risk-adverse’ end user. End user training and ‘calibration’ needed. ☺
- Experienced end users weight the importance of **forecasts vs. observations** for their decision. ☺
- Surface **raingauge and hydrometric real time observation** are of key importance for hydrological model updating and initialisation
- One **sure** hydrological **benefit** from D-PHASE: one discharge measurement done by ARPA Lombardia on the basis of the forecasts