Ensemble Prediction and Uncertainties in Flood Forecasting
International Workshop / Expert Consultation
Berne: 30-31 March 2006

Towards (quasi-)operational demonstration of hydrometeorological ensemble prediction systems:

The MAP D-PHASE and COST PROFIT projects

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MAP History

Preparation Phase

Experimental Phase, 1999 SOP 1st WWRP RDP

Analysis Phase

Demonstration Phase

MAP Forecast Demonstration Project

2nd WWRP FDP

MAP - 1. Preparation Phase

Supported by the World Weather Research Program (WWRP)

MAP

-> study of atmospheric and hydrological processes over mountainous regions.

MAP surface hydrology

-> orographically-influenced precipitation

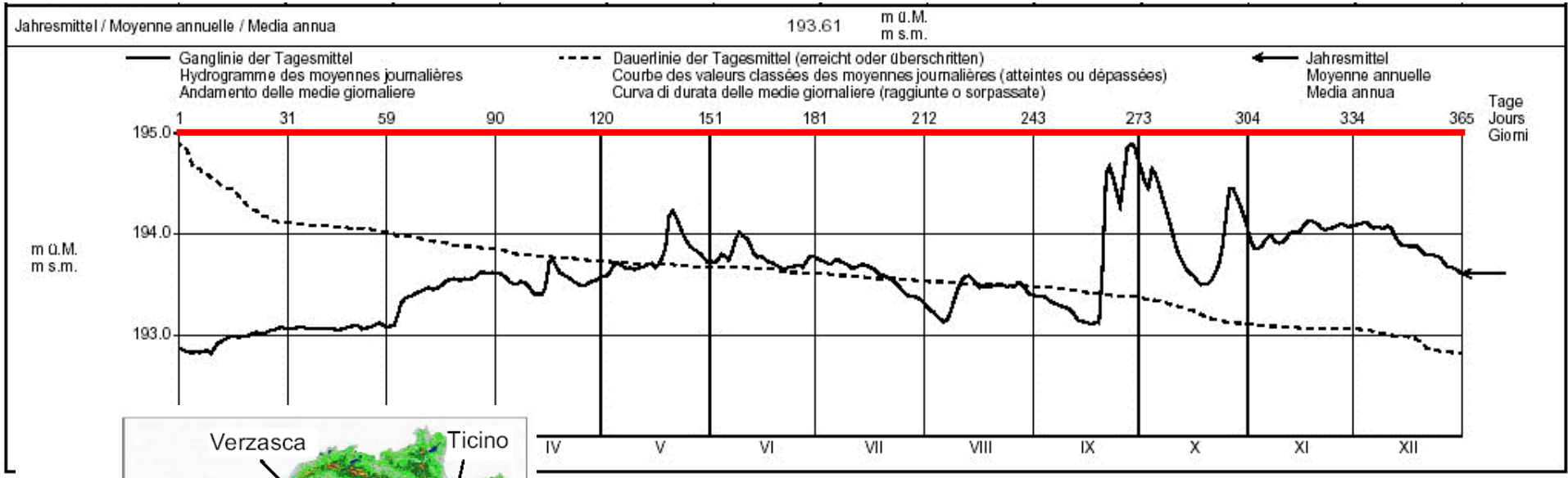
-> related flooding episodes

-> NWP improvement within complex topography

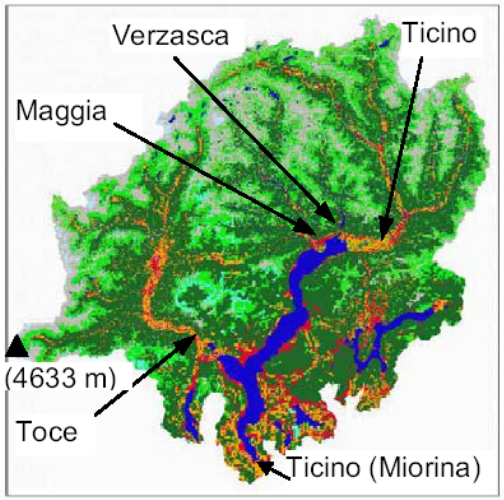
-> interactions with land-surface processes

2. Experimental Phase, 1999 SOP

Lago Maggiore - Lake Level 1999



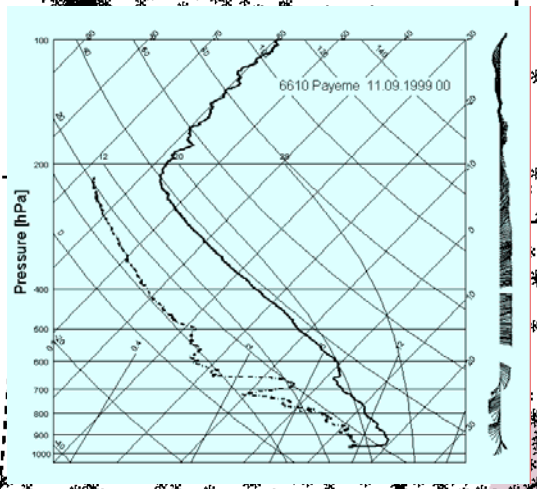
MAP-SOP

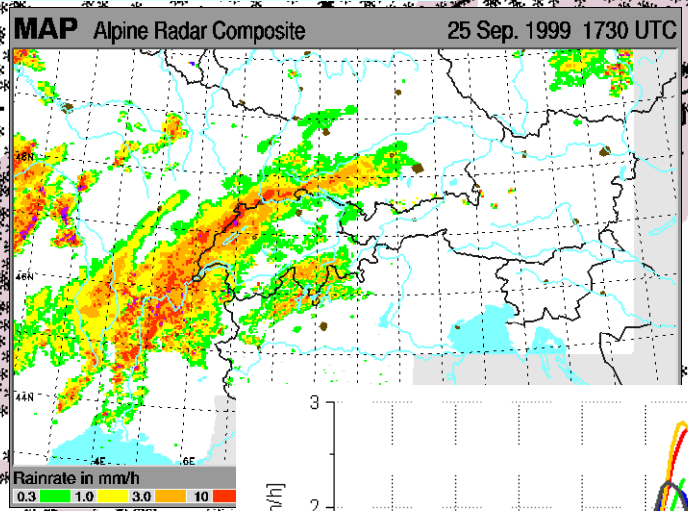


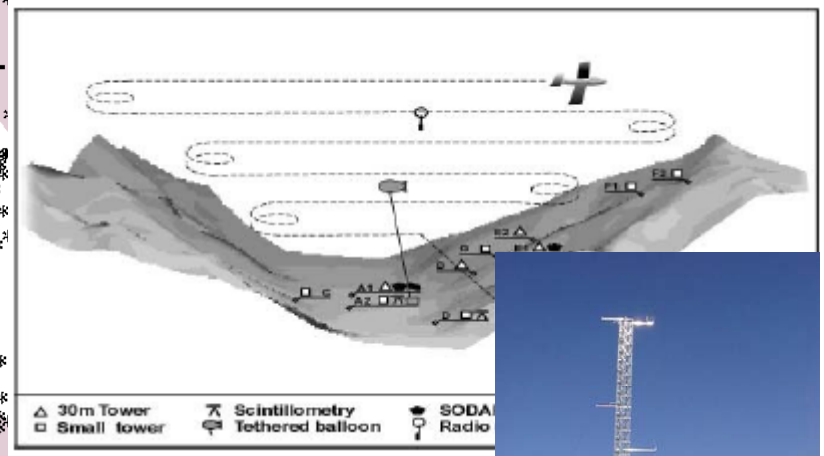
Bacchi & Ranzi, HESS (2003)

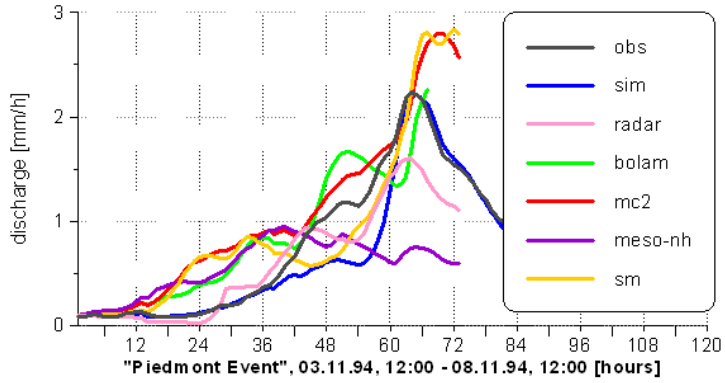
2. Experimental Phase, 1999 SOP

Institute for Atmospheric and Climate Science
IAC ETH



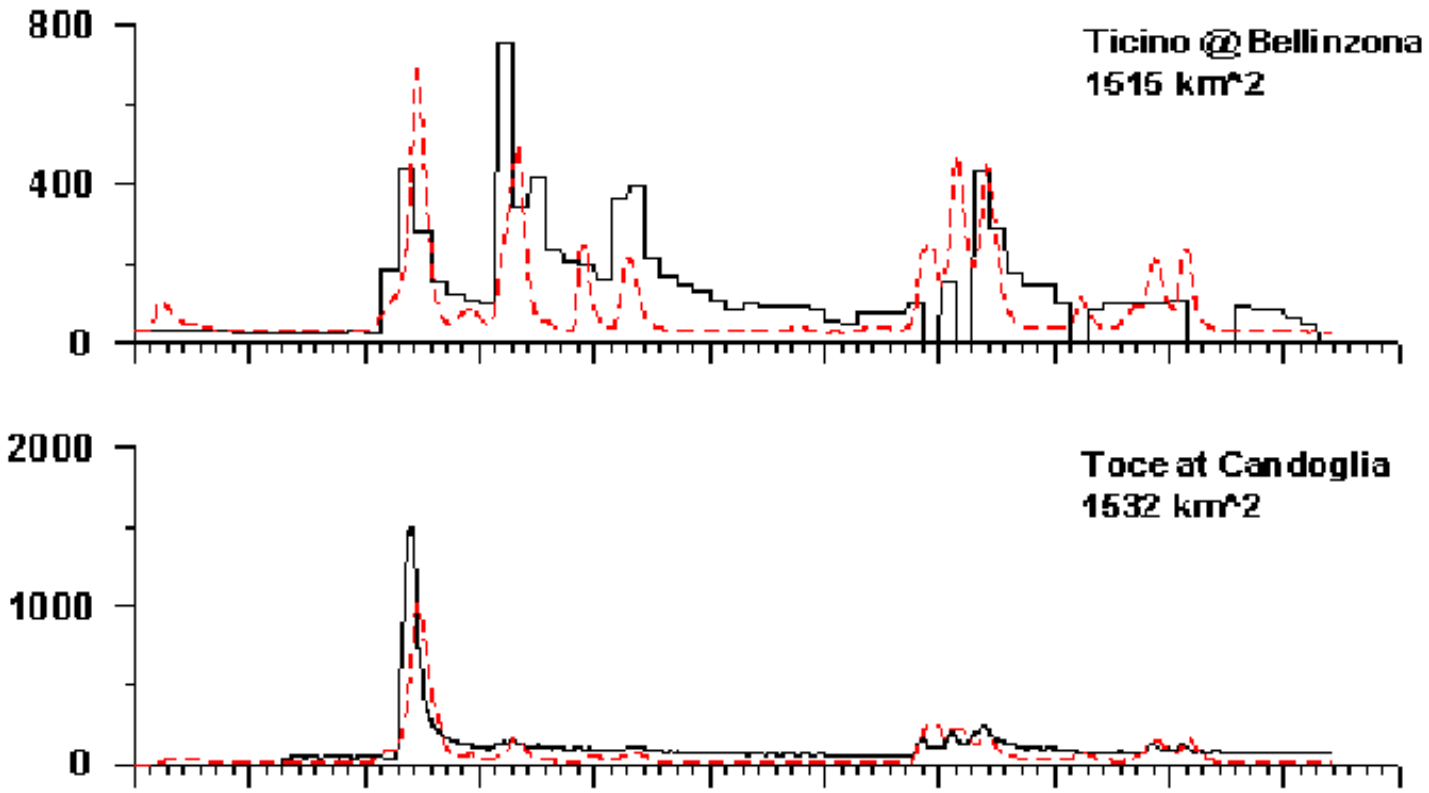






Lago Maggiore - Real-time Forecasting
MC2 <-> WATFLOOD

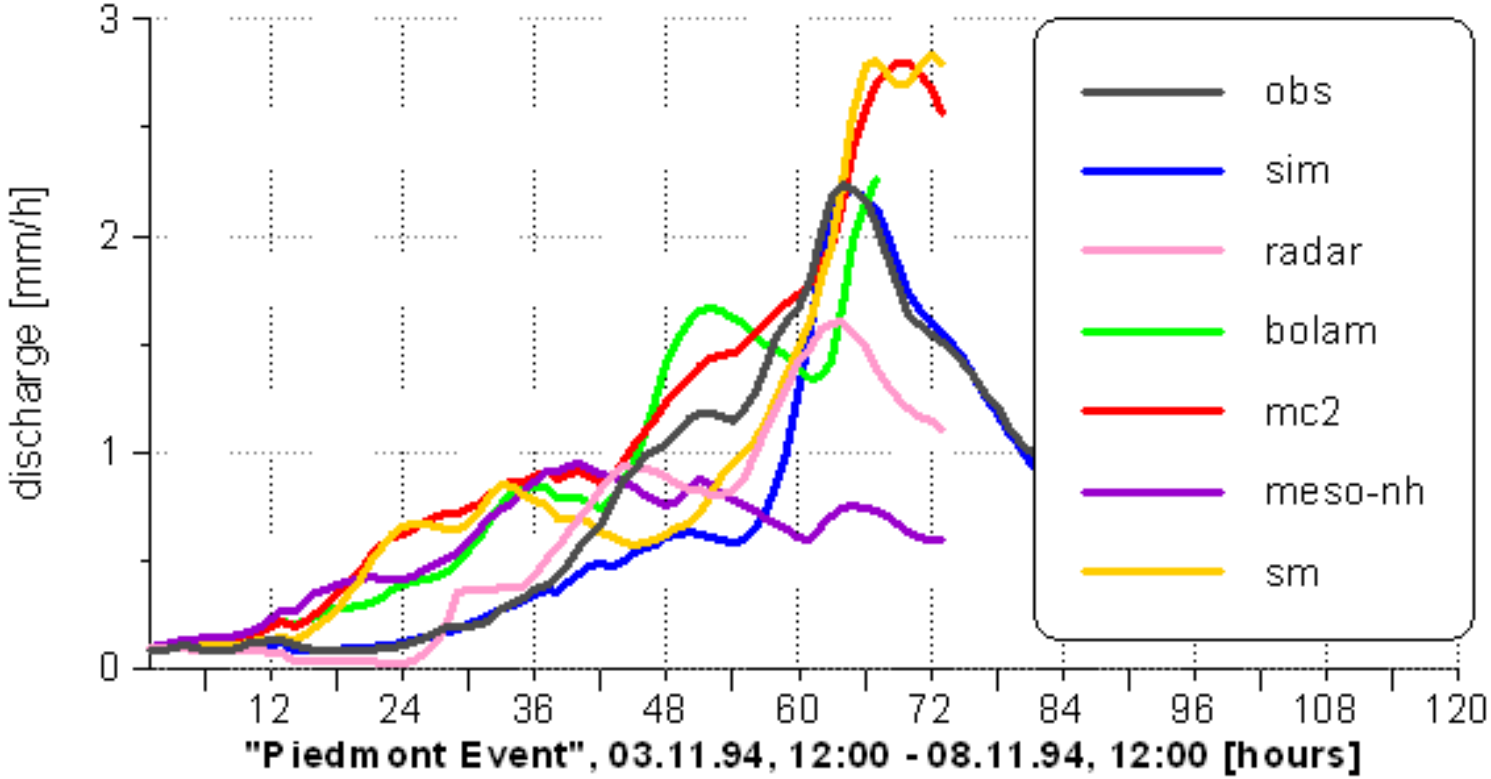
Streamflow (in $m^3 s^{-1}$) for the period of Sep. 4 to Nov. 17, 1999.



Benoit et al., HESS (2003)

Lago Maggiore - Poor man's ensemble
WaSiM ETH <-> NWP's/RADAR

Simulation Results for the Piedmont-Flood 1994
Forecast Mode



Jasper et al., J. Hydrology (2002)

The RAPHAEL* Project

*Runoff and Atmospheric Processes for flood HAzard forEcasting and controL

MAP - 3. Analysis Phase

- operational use of a high-resolution numerical models
- mechanisms of orographic precipitation
- alpine radar composite
- new terrain-following coordinate for steep orography
- progress in hydrological modelling and associated near-surface exchange processes

Publications database http://www.map.meteoswiss.ch/

Annales Geophysicae, Atmospheric Environment, Boundary Layer Meteorology, Bulletin of the American Meteorological Society, Climate Dynamics, Climatic Change, Geophysical Research Letters, Hydrology and Earth System Science, International J Climatology, J Applied Meteorology, J Atmospheric Oceanic Technology, J Atmospheric Science, J Climate, J Geophysical Research, Meteorological Applications, Meteorologische Zeitschrift, Meteorology Atmospheric Physics, Monthly Weather Review, Nature, Physics Chemistry of the Earth (B), Quarterly J Royal Meteorological Society, Remote Sensing of the Environment, Science, Tellus A&B, Theoretical Applied Climatology, Weather

MAP-DPHASE

D*emonstration of* ***P****robabilistic* ***H****ydrological and*
A*tmospheric* ***S****imulation of flood* ***E****vents in the Alps.*

- Demonstrate ability for improved forecast of heavy precipitation in the alps

  → High-resolution atmospheric modelling
  → ensemble forecast technique

  → Radar data (assimilation)

  → Hydrological modeling

- End users involved (end user needs, e.g. probabilistic forecasts): **end-to-end forecast system**

MAP - 4. Demonstration Phase

Quasi-operational forecasting system for Alpine flood events

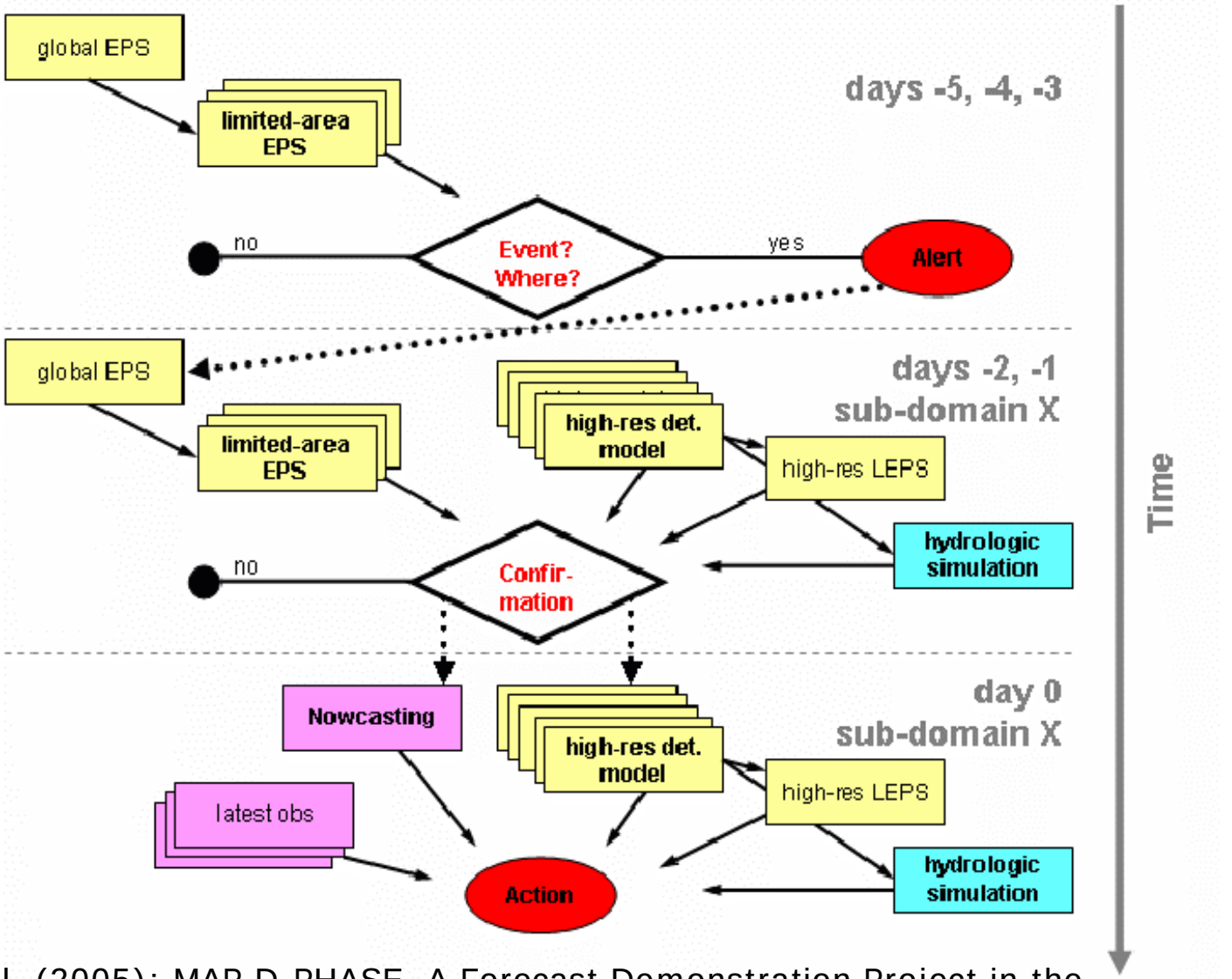
- **EPS** with a lead time of a few days
- short-range forecasts based on **high-resolution atmospheric and hydrologic** models for selected regions or catchments (End-users)
- real-time **nowcasting** and high-resolution observational information (e.g. Radar)

Atmospheric models:
aLMo/2, AROME, MOLOCH, COSMO-LEPS, COAMPS, WRF, ALADIN-Austria, LMK, LAMI, Meso-NH, MM5, GEM-LAM, PEPS, LAMI-CNMCA, MOGREPS, ...

Hydrological models:
DRIFT, PREVAH, TopKapi, DIMOSOP, WATFLOOD ...

End users:
local authorities, lake regulators, institutional agencies... In various countries

MAP - 4. Demonstration Phase



Rotach M. et al. (2005): MAP D-PHASE, A Forecast Demonstration Project in the framework of MAP. - Unpublished project proposal to the WWRP-SSC.

WORKING GROUPS

- *Hydrology and End Users*
  - different levels of (end)users, ‘actors’ or ‘users’
  - interface between the end users and modellers
  - communication on state-of-the-art flood forecasting

- *Verification*

  takes care of the evaluation protocols and is responsible for the validation and verification methodology to be adopted

- *Data Interface* - data collection, storage, and distribution

- *Data Policy* - legal matters related to data exchange

Issues

- *WWRP endorsement: Oct 2005*
- *International Steering Committee*
  - all Alpine countries (and some more)
  - March 13/14: first meeting
- *Project coordinator: Marco Arpagaus @MeteoSwiss*
- *Data Interface*
  - joint data platform: co-financed with *COPS*
  - joint visualisation platform
  - joint warning and alert's platform: jointly with METEORISK
- *Joint evaluation and verification protocols*
- *Demonstration period: June to Nov 2007*

Related initiatives

COST Action 731

Propagation of Uncertainty in Advanced Meteo-Hydrological Forecast Systems

- European Concerted Research Action
- Forecasting (heavy) precipitation events
- Effects on corresponding hydrological processes
- Uncertainty prorogation in model chain
- Communication of uncertainty to the end-users

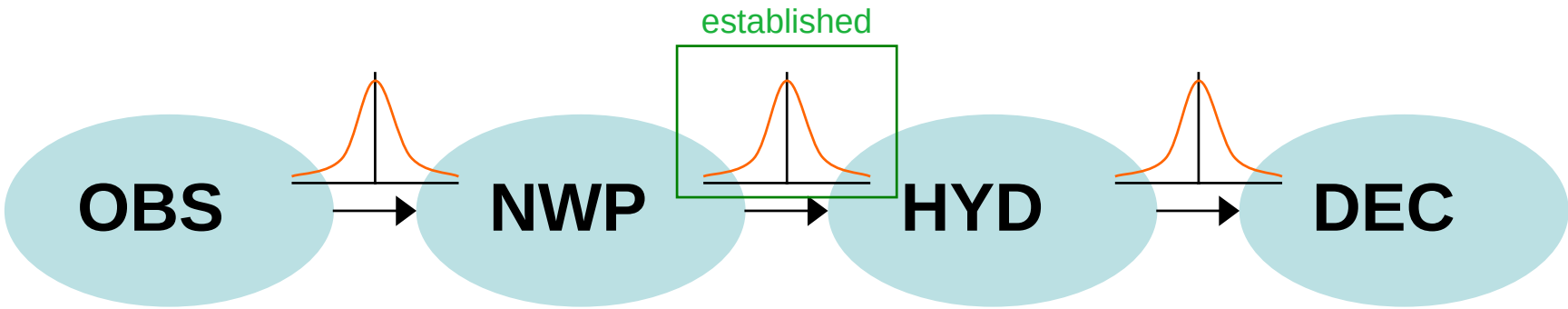
Working groups at the *interfaces*:

- observation and (atmospheric) modeling
- atmospheric and hydrological modeling
- hydrological modeling and end-users.

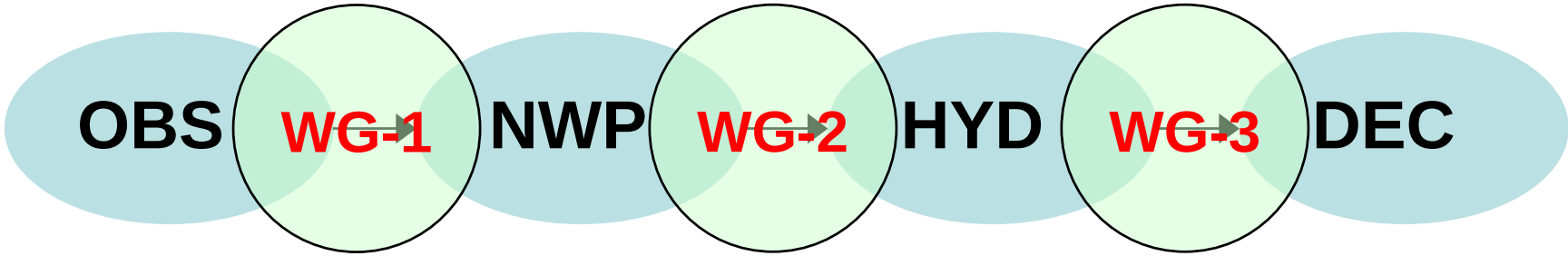
-> investigate the propagation of uncertainty through the various steps of modeling and decision making.

Confidence

Systematic treatment of uncertainty in a prediction chain



WG Structure: community interaction



- WG-1: Propagation of uncertainty from observing systems (radars) into NWP
- WG-2: Propagation of uncertainty from observing systems and NWP into hydrological models
- WG-3: Use of uncertainty in warnings and decision making

The **PROFIT** project

Pro*babilistic* ***F****orecast****i****ng* ***T****ools for Heavy Precipitation Events in the Alpine Region.*

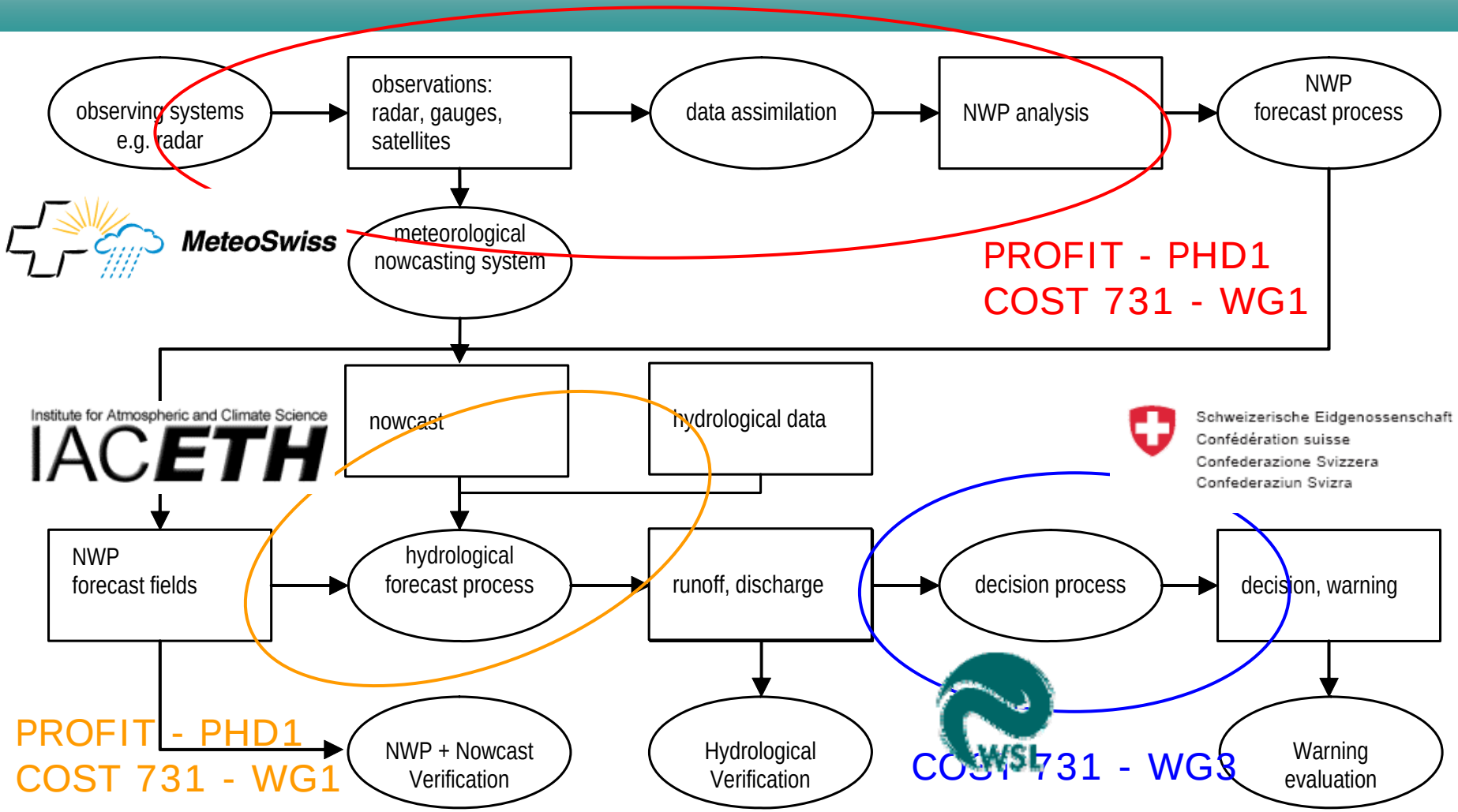
Focus on two specific steps of the forecasting chain:

- In a first PhD project high-quality radar data, NWP forecasts and other observational data will be employed to establish a heuristic probabilistic forecasting tool for the **nowcasting of orographic precipitation**

- A second PhD project concentrates on probabilistic forecasting of potential flood events through the use of a **hydrologic ensemble prediction system** (Talk by Mark Verbunt -> Operationalisation!)

COST 731 + PROFIT

Propagation of Uncertainty in Advanced Meteo-Hydrological Forecast Systems



Schematic to depict the production chain of a flood forecasting, decision making and warning system.

PROFIT areas

Main Target Area

Ticino - Miorina (6600 km²)

Rhine - Rhinefelden (34550 km²)

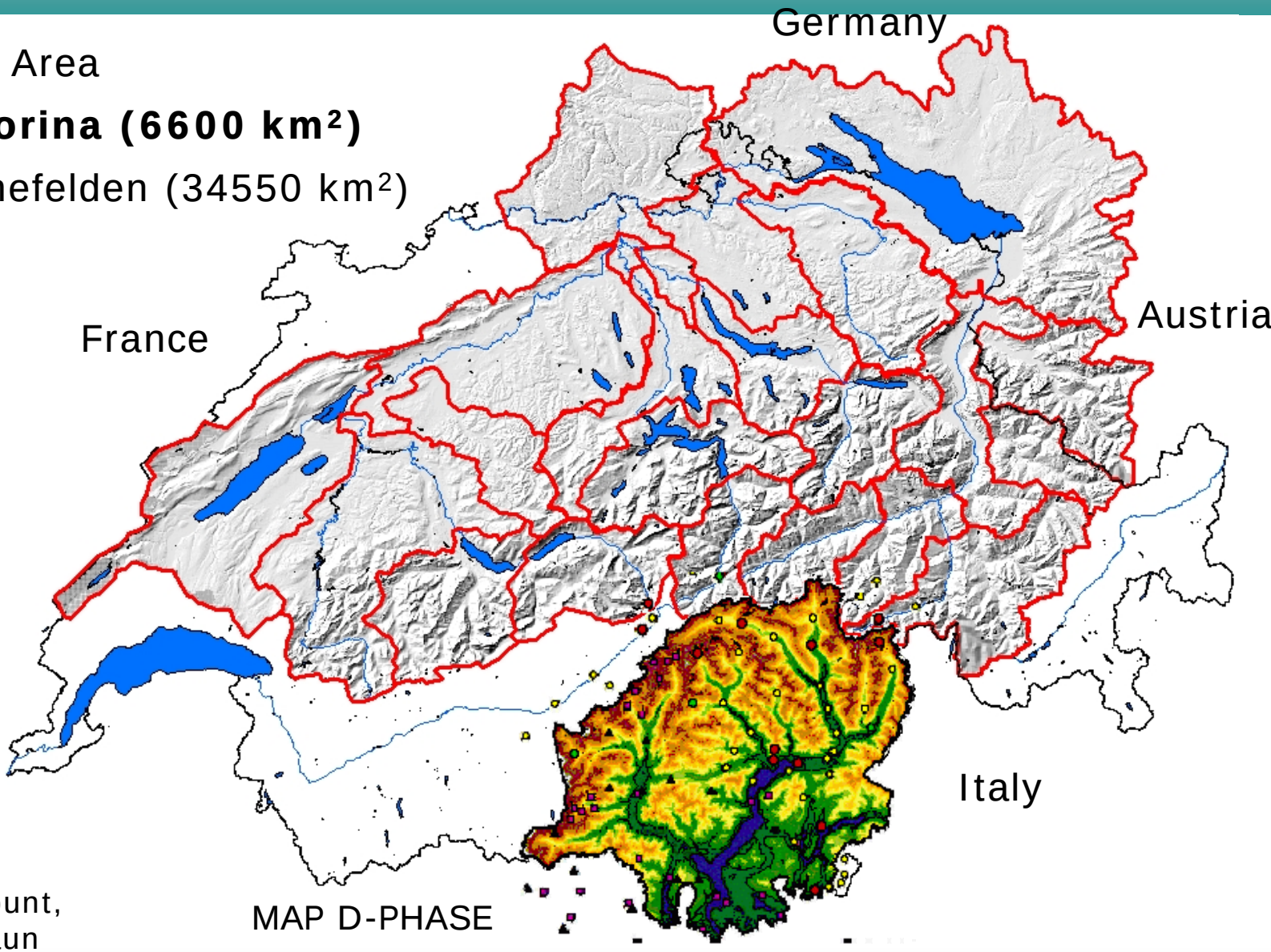
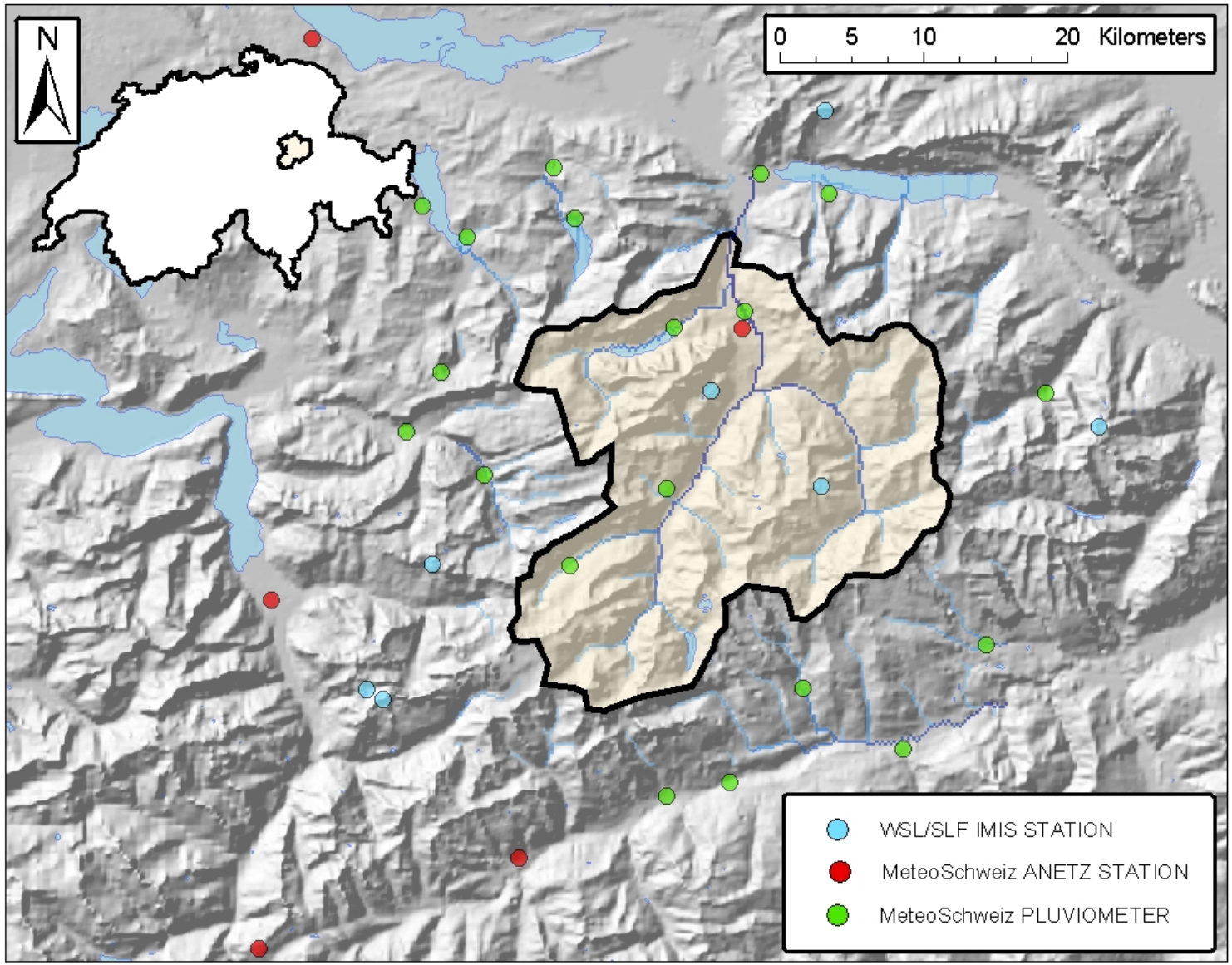


Figure: M. Verbunt, K. Jasper, S. Jaun

PROFIT small test area
Linth (600 km²) - EU Glarus



Summary

- MAP D-PHASE

--> high resolution probabilistic and deterministic flood forecasting in the Alps

- COST 731

--> uncertainty propagation in meteo-hydrological forecasting

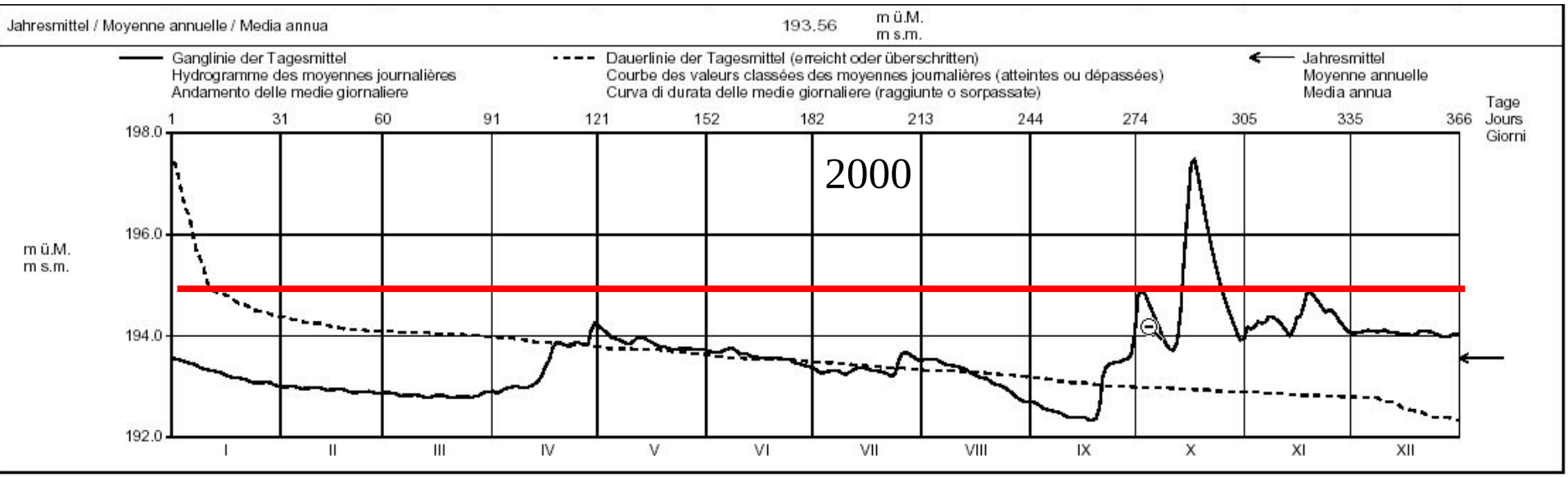
- Both

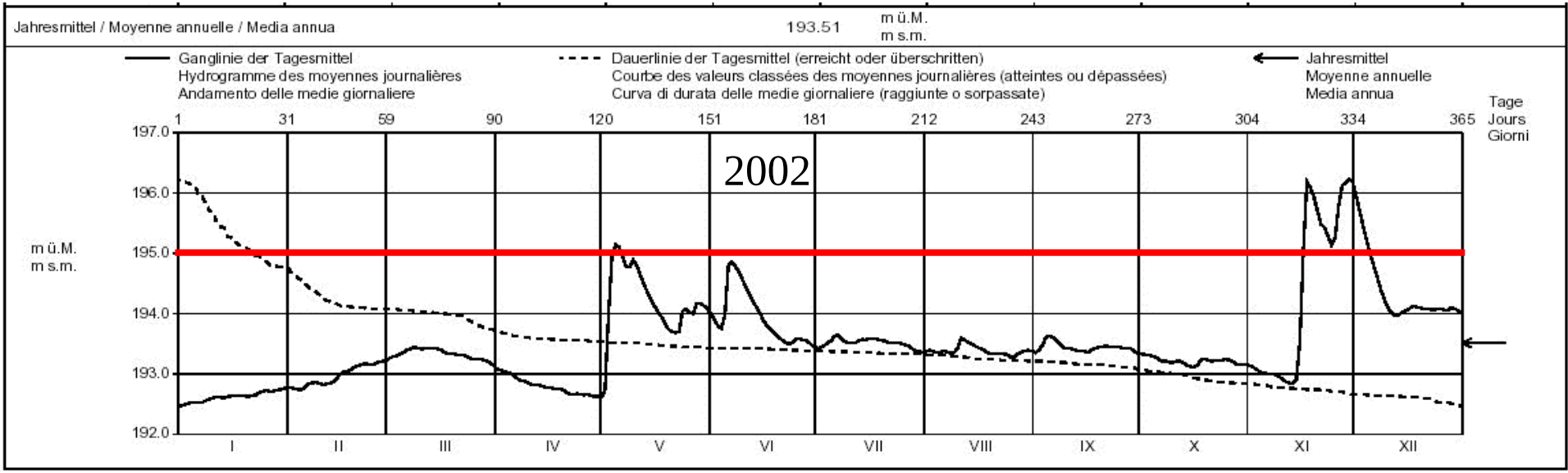
--> ongoing projects

--> one-to-one ‘application’ of today’s workshop theme

Thank you

Lago Maggiore - Lake Level after 1999 SOP





Uncertainty

- Precipitation as most difficult parameter to forecast, observe and interpolate
- operational use of use ensemble prediction systems (EPS) to assess the uncertainty involved in forecasting precipitation in time and space
- Propagation of uncertainty / Atmosphere <-> Hydrosphere
- Hydrological models calibrated for "average" flood
- Uncertainty in case of extreme events
- quantification of uncertainty within hydrological model systems

  -> Previous talk by M. Verbunt + Poster by S. Jaun, both IACETH.

IFKIS-HYDRO MountainFloodWatch

Current Operational setup

Real-Time observations

MeteoSwiss

SLF ENA SNV PNL

WSL

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun Svizra

Additional Networks

SLF ENA SNV PNL

WSL

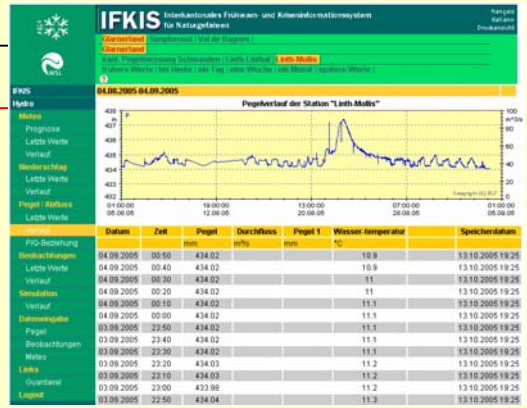
DataBase

Online operational
Hydrological Model
PREVAH-Realtime

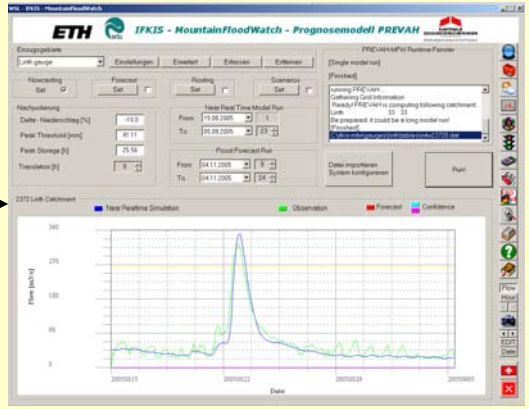
FTP-Server

For each basin:
Incremental interpolation
Nowcasting from
DAY-13 to last hour
Transfer of information
to EU ftp-server

Communication to End-User (EU)



IFKIS-HYDRO MFW
InfoManager



Trained EU
Offline
Hydrological Model
PREVAH-Enduser
(for e.g. scenarios,
event analysis)

Communication of uncertainty

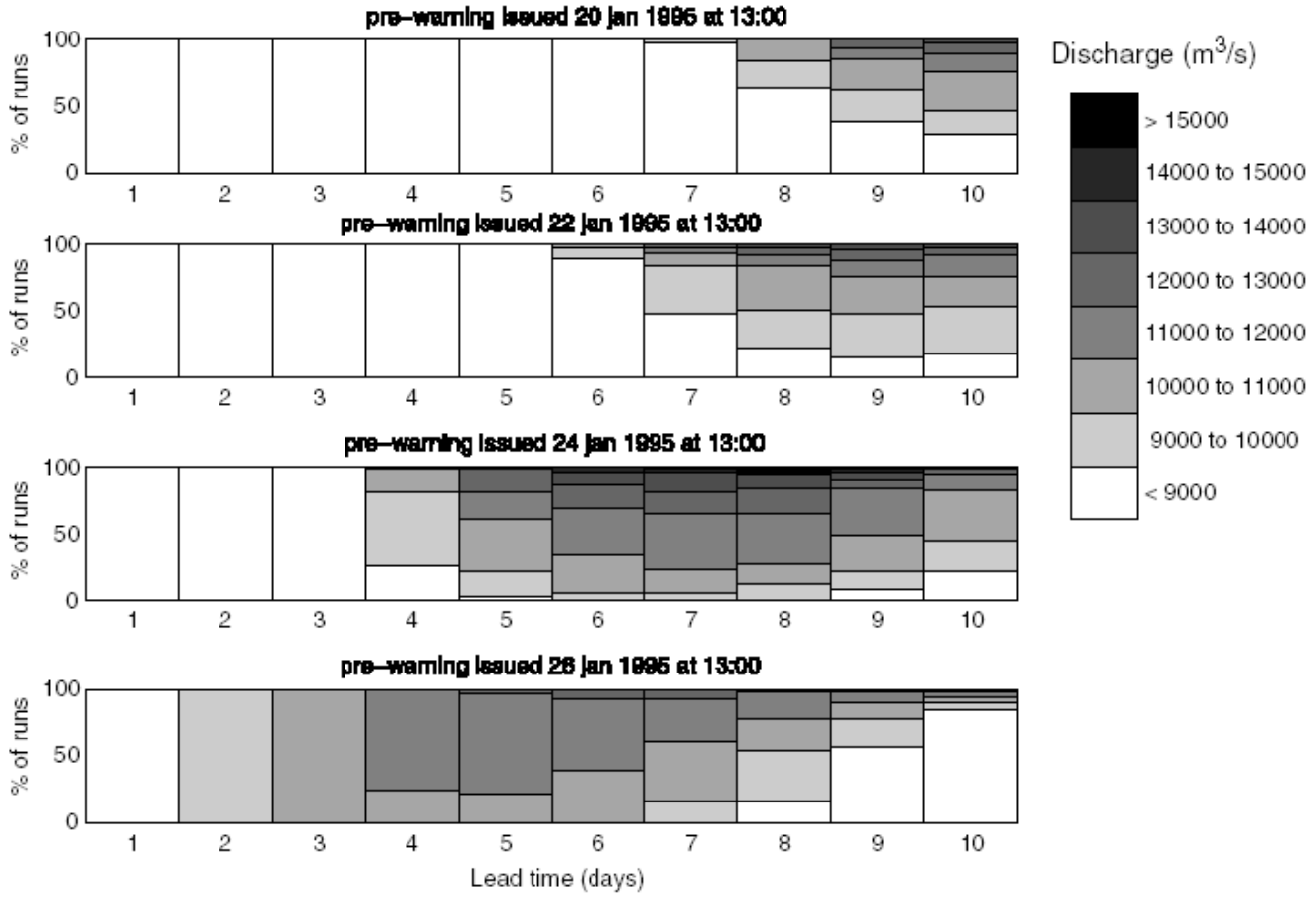


Figure 5. Pre-warning for discharge at Lobith issued at two day intervals starting 20 January 1995 at 13:00.

Werner et al., Natural Hazards (2005)