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# ***On the way to Ensemble Hydrological Forecasts: Lessons Learned from MAP D-PHASE***

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# Outline

- What is D-PHASE?
- Users & End users
  - Their involvement & participation
  - Feedback (questionnaires...)
- Outreach to real applications
  - a business case
  - an operational case





# MAP D-PHASE essentials

Demonstration of Probabilistic Hydrological and Atmospheric Simulation of flood Events in the Alpine region

- Fourth phase of Mesoscale Alpine Programme (MAP)
- 2nd World Weather Research Programme (WWRP) Forecast Demonstration Project (FDP) after Sydney 2000 and before Beijing 2008
- Focuses on heavy precipitation, hydrology, high-resolution numerical modeling and ensembles
- D-PHASE Operations Period (DOP): June to November 2007 (COPS & “MAP season”)
- 9 countries involved
- 30 atmospheric models (7 ensembles) & 7 hydrological models in over 40 catchments





# MAP D-PHASE

## Real-Time Demonstration of Weather Forecast Quality in the Alpine Region

BY MATHIAS W. ROTACH, PAOLO AMBROSETTI, FELIX AMENT, CHRISTOF APPENZELLER, MARCO ARPAGAU, HANS-STEFAN BÄUER, ANDREAS BEHRENDT, FRANÇOIS BOUTTIER, ANDREA BUZZI, MATTEO CORAZZA, SILVIO DAYOLIO, MICHAEL DENHARD, MANFRED DORNINGER, LIONEL FONTANNAZ, JACQUELINE FRICK, FELIX FUNDEL, URS GERMANN, THERESA GORGAS, CHRISTOPH HEGG, ALESSANDRO HERING, CHRISTIAN KEIL, MARK A. LINIGER, CHIARA MARSIGLI, RON McTAGGART-COWAN, ANDREA MONTAINI, KEN MYLNE, ROBERTO RANZI, EVELYNE RICHARD, ANDREA ROSSA, DANIEL SANTOS-MUÑOZ, CHRISTOPH SCHÄR, YANN SEITY, MICHAEL STAUDINGER, MARCO STOLL, HANS VOLKERT, ANDRE WALSER, YONG WANG, JOHANNES WERHAHN, VOLKER WULFMEYER, AND MASSIMILIANO ZAPPA

A six-month project successfully tested real-time, end-to-end multimodel hydrometeorological forecasts for heavy precipitation and related flooding events in many different catchments in the Alps.

As the first research and development project (RDP) of the World Weather Research Programme (WWRP), the Mesoscale Alpine Programme (MAP) made important contributions to our knowledge on atmospheric processes determined by and influencing weather in mountainous terrain between 1994 and 2005 (Bougeault et al. 2001). A wealth of scientific results (Volkert and Gutermann 2007) was produced in research areas ranging from atmospheric dynamics to mountain

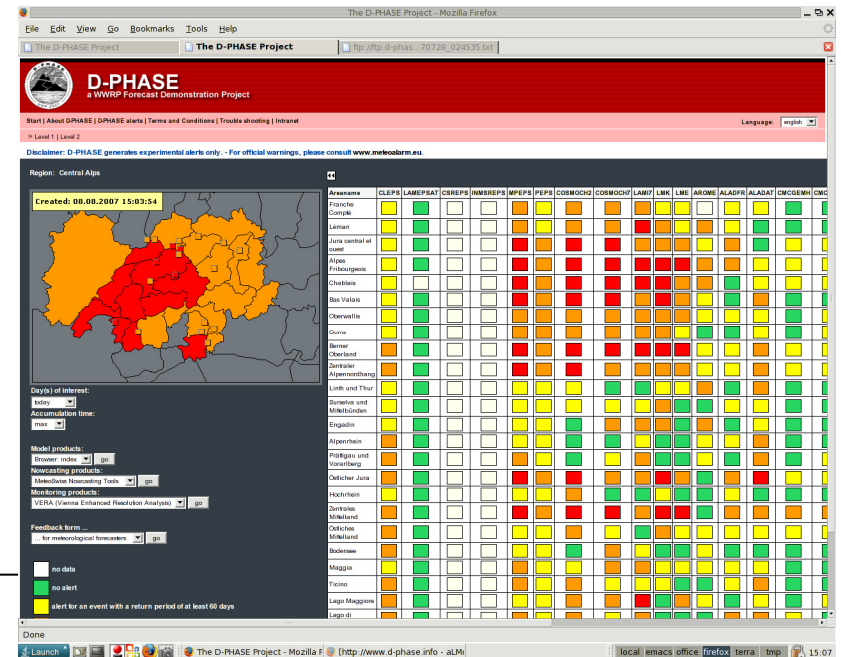
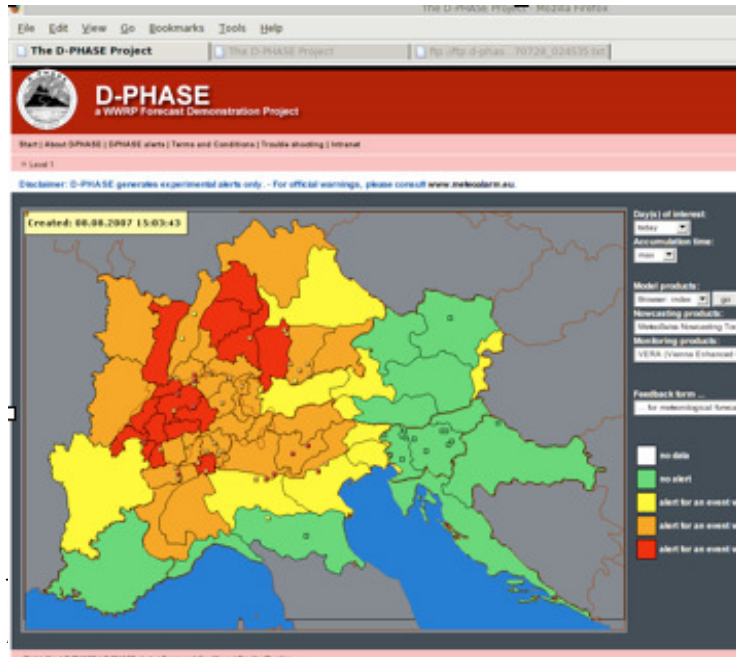
*BAMS Paper, Sept 2009*





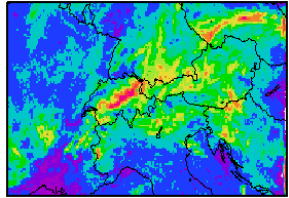
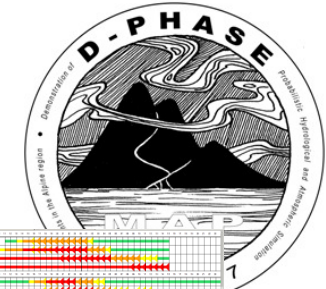
# Key elements of D-PHASE

- Centralised **Visualisation Platform** (forecasts & alerts; in real-time)
- Data **archiving** (→ research / analysis)
- **Nowcasting** tools
- Systematic integration of **end users**
- **Evaluation**, objective and subjective





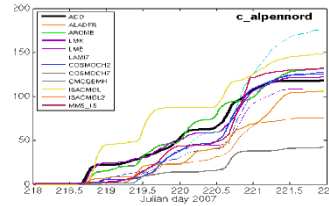
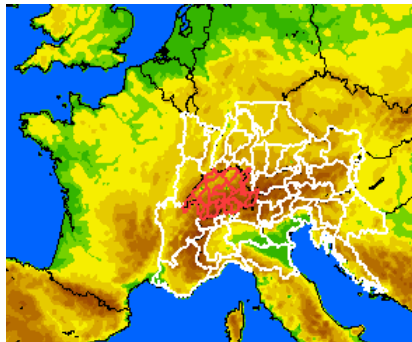
# Visualisation Platform: Alerts



Model output

domain averages

> 40 catchments:



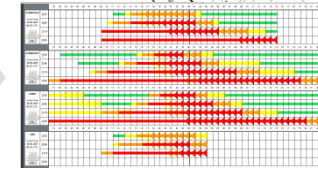
RR time series

apply warnlevels

3 types of alerts:

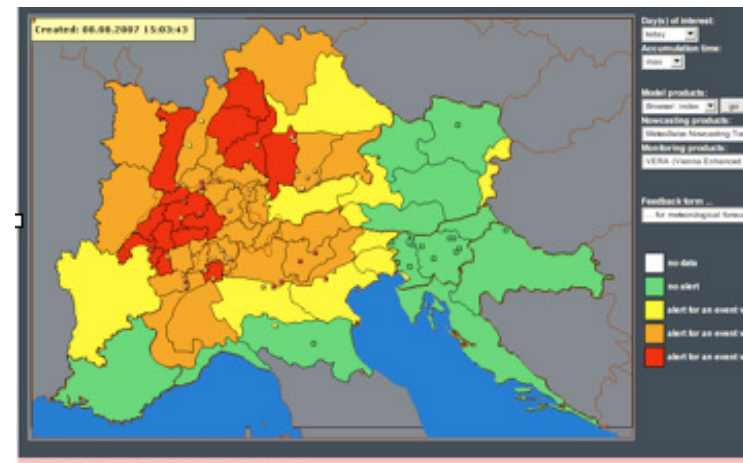


(Accumulation times: 03h, 06h, 12h, 24h, 48h, 72h)



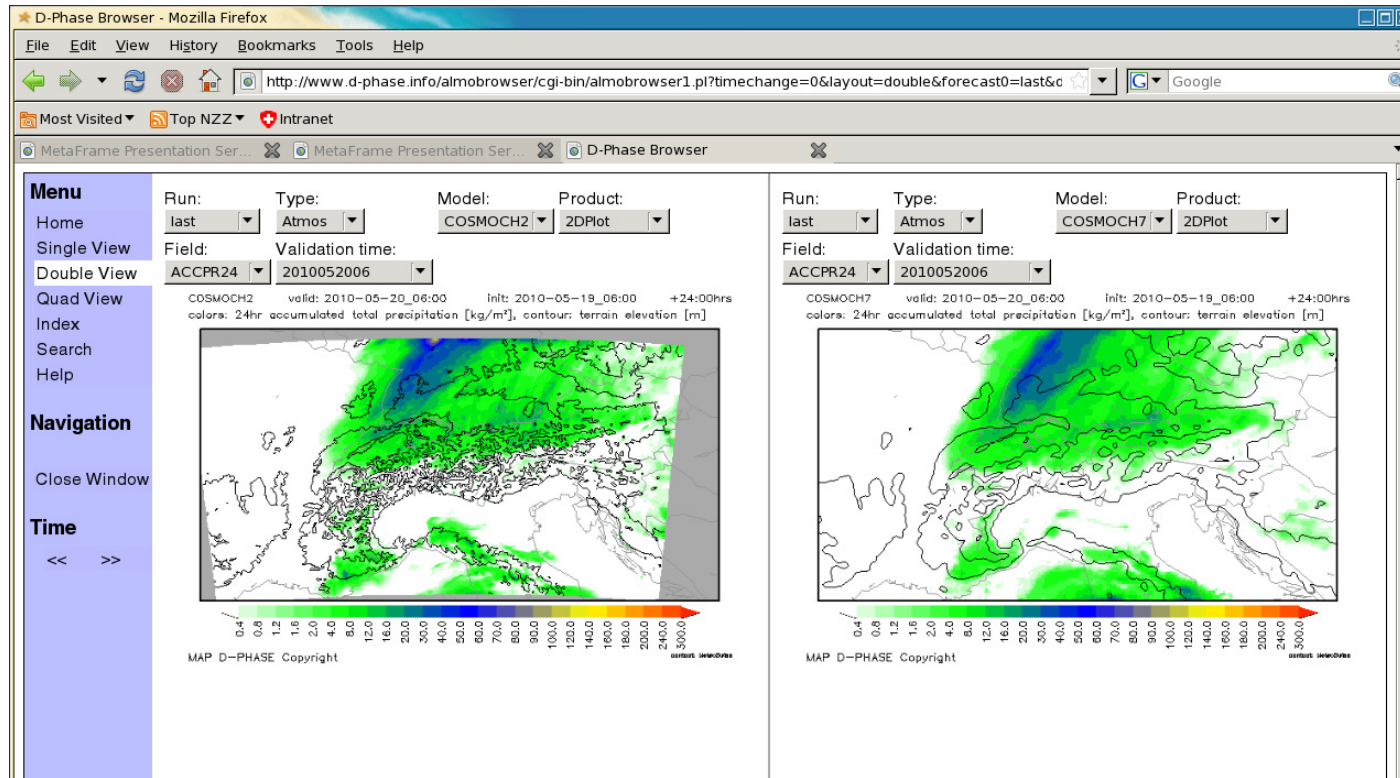
Alert time series

highest level





# Visualisation Platform: Models



Key element of success: **common formats**





# Users

- WWRP Joint Scientific Committee asked for ‘at least 1’
  - over 40 institutions!
  - forecasters (atmospheric & hydrological)
  - COPS (WWRP RDP) mission planning
  - **end** users: civil protection, water management, ...
- Quality
  - feedback
  - transfer to operations







# Forecaster feedback

- **Forecasters (MeteoSwiss):**  
(Fill in feedback forms every day)
- Prefer nowcasting tools in the first forecast hours





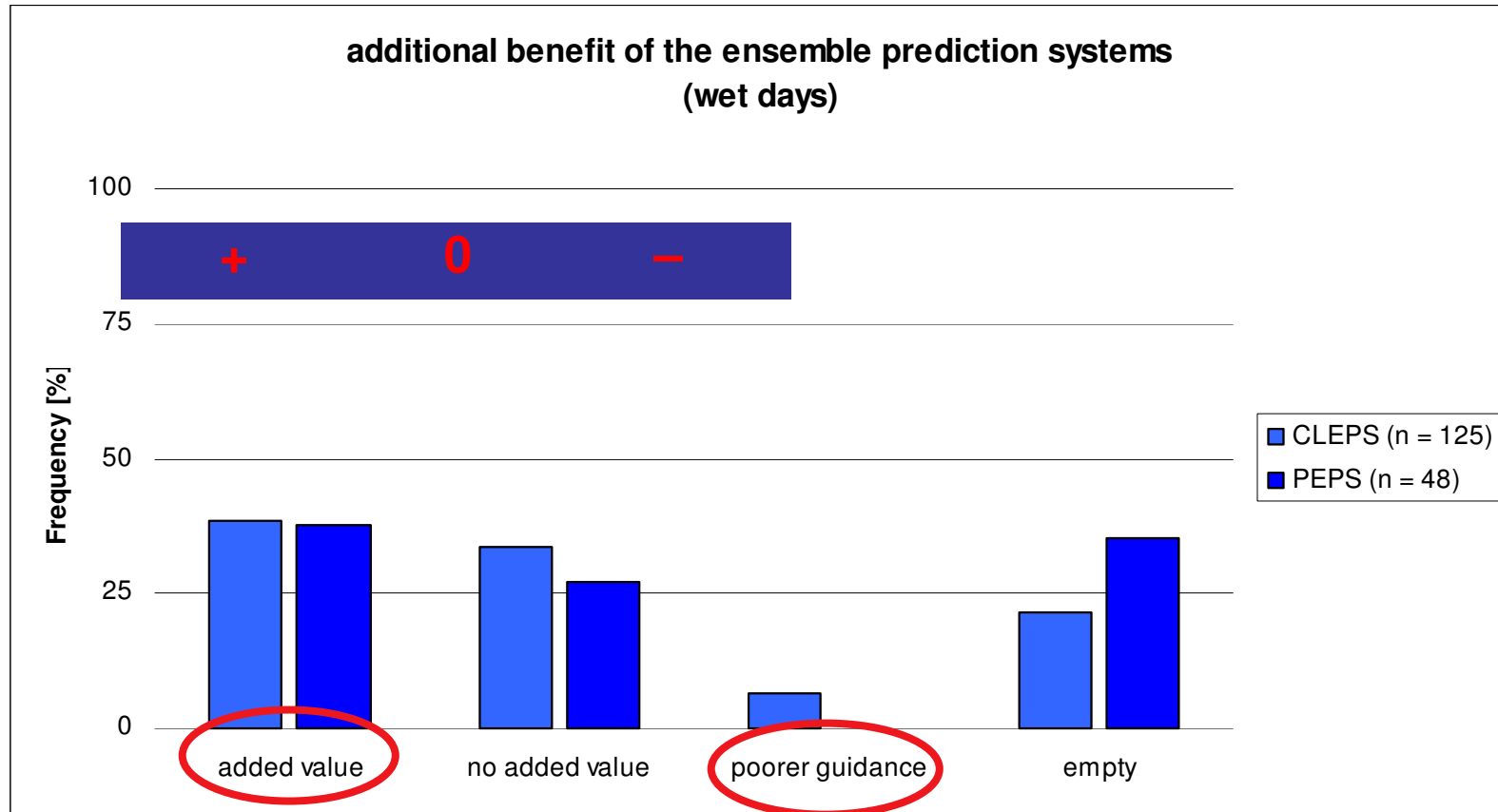
# Forecaster feedback

- **Forecasters (MeteoSwiss):**  
(Fill in feedback forms every day)
- Prefer nowcasting tools in the first forecast hours
- ensemble prediction systems ✓





# Question III.3: Additional benefit of **ensemble models** as compared to established det. models?





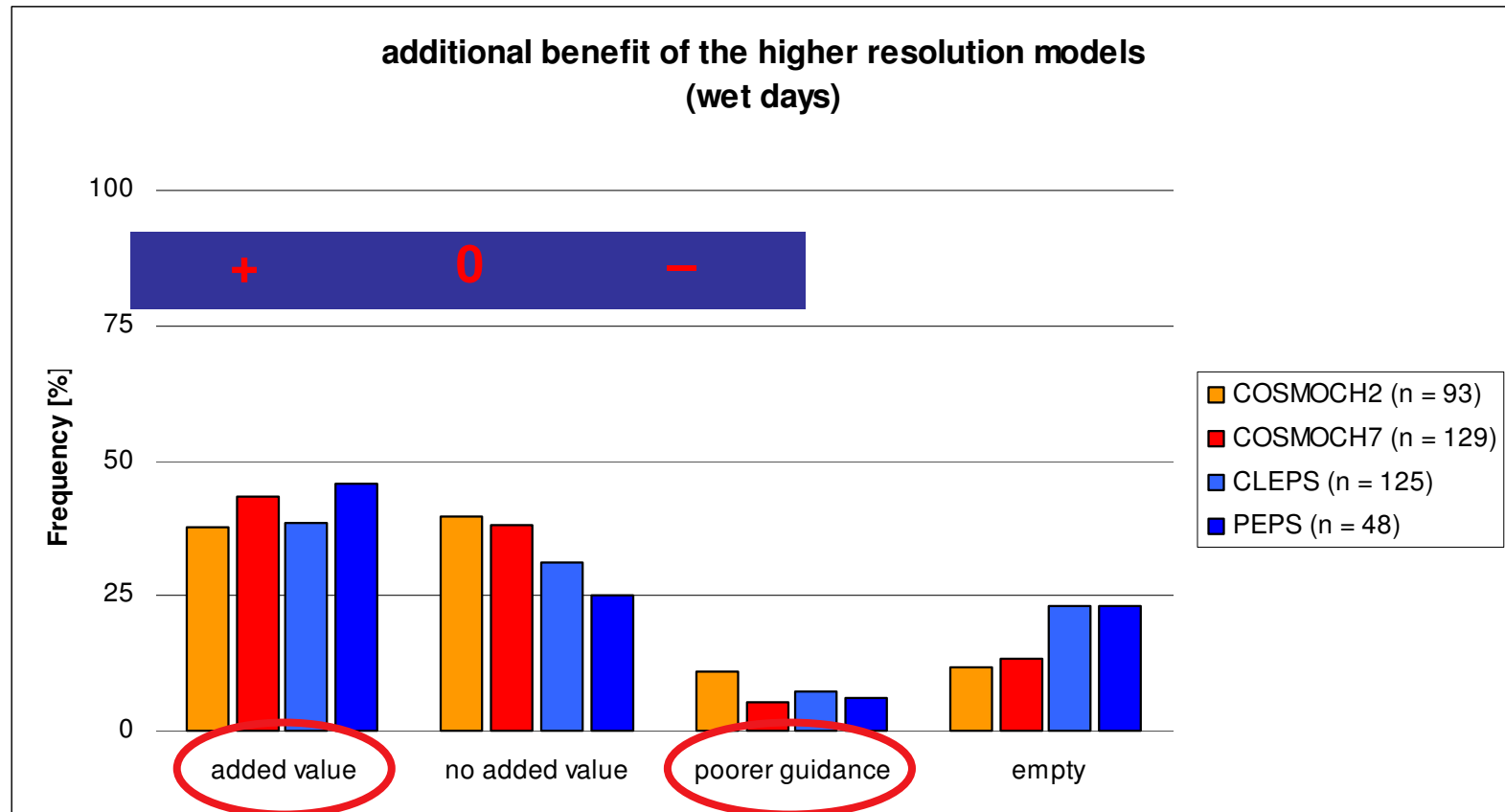
# Forecaster feedback

- **Forecasters (MeteoSwiss):**
  - Prefer nowcasting tools in the first forecast hours
  - Ensemble prediction systems ✓
  - high-resolution models ✓





## Question III.2: Additional benefit of hires models as compared to coarser ones?





# Forecaster feedback

- **Forecasters (MeteoSwiss):**
  - Prefer nowcasting tools in the first forecast hours
  - ensemble prediction systems ✓
  - high-resolution models ✓
  - appreciate large variety of models **But NOT too many!**
  - **Interaction** with hydrological forecasts ✓





# End user feedback

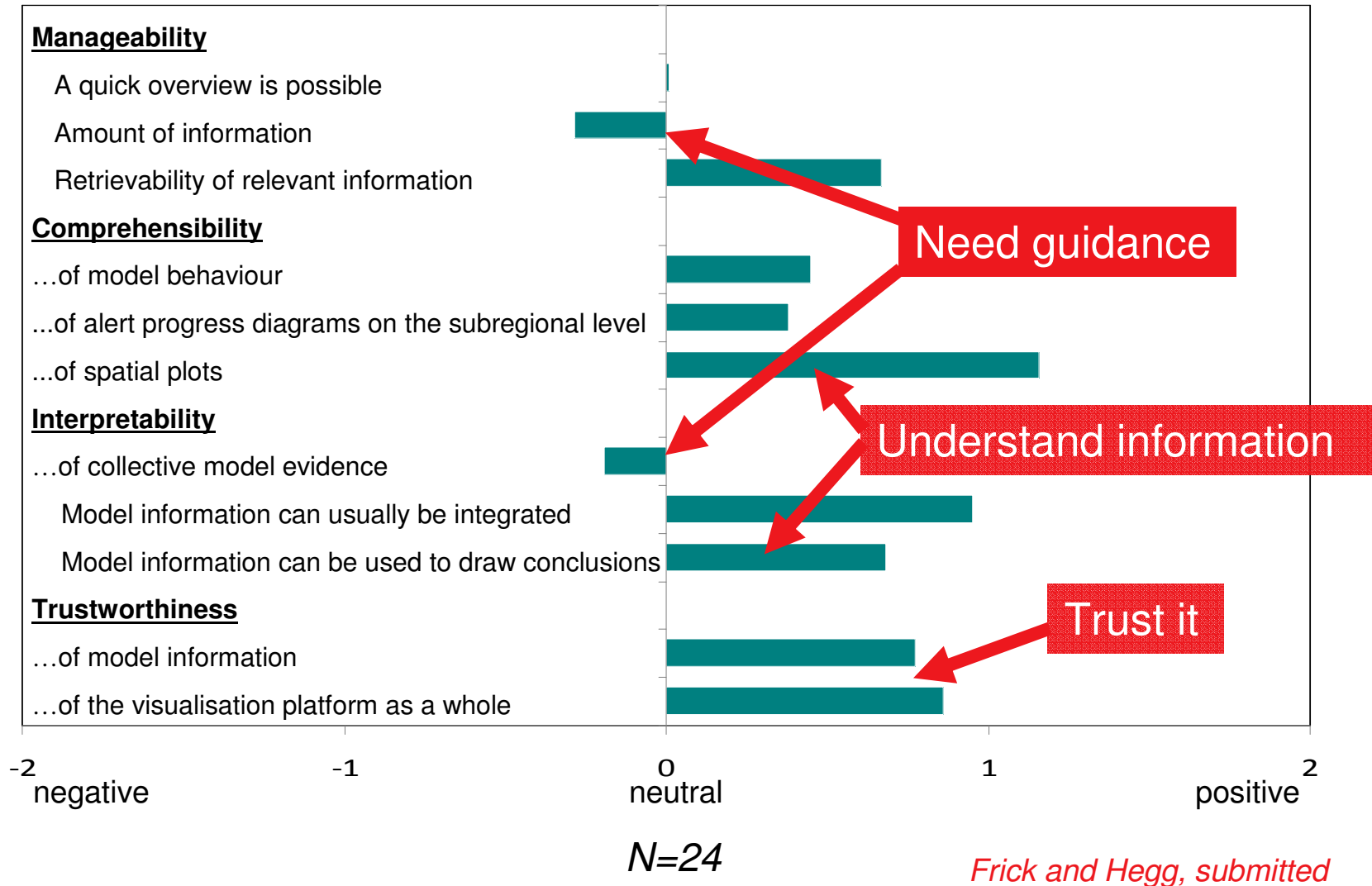
- **End users:**

- workshops before / after DOP
- O(30) participants
- questionnaires before / after DOP
- n rather small, no statistical tests done





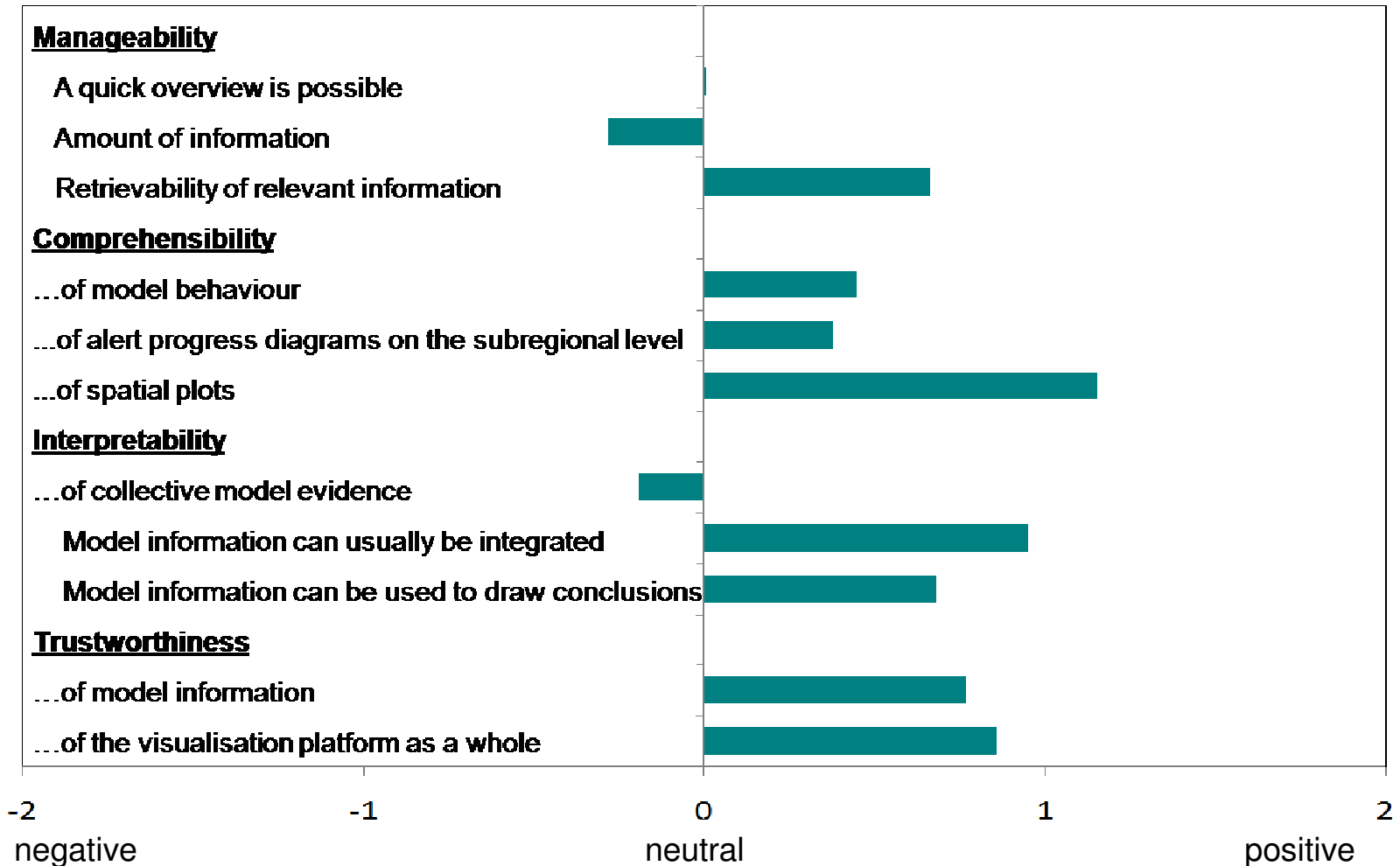
# Judgments about information







# Judgments about information



$N=24$

*Frick and Hegg, submitted*



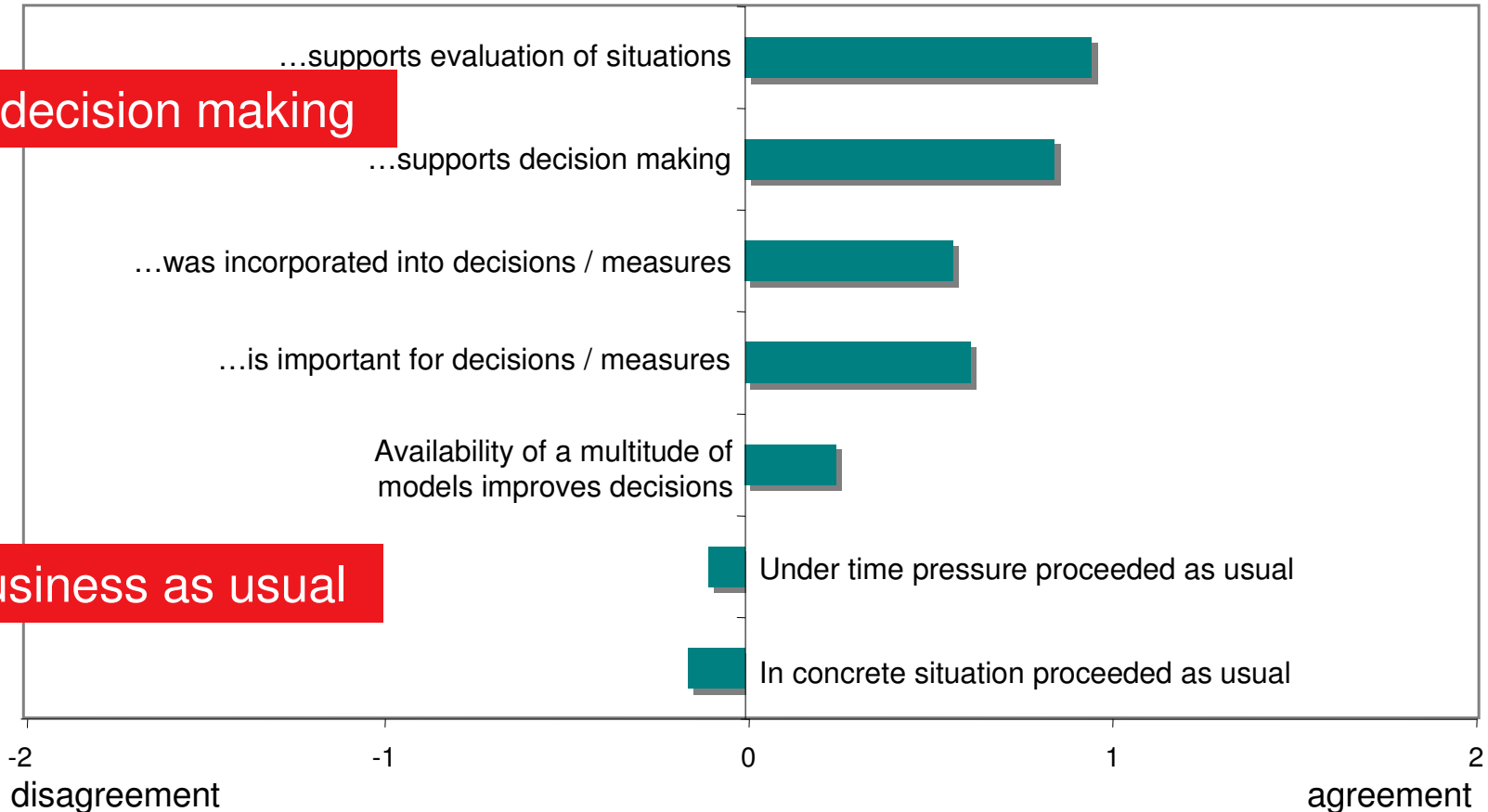


# Appraisal of benefit

*The visualisation platform ....*

Supports decision making

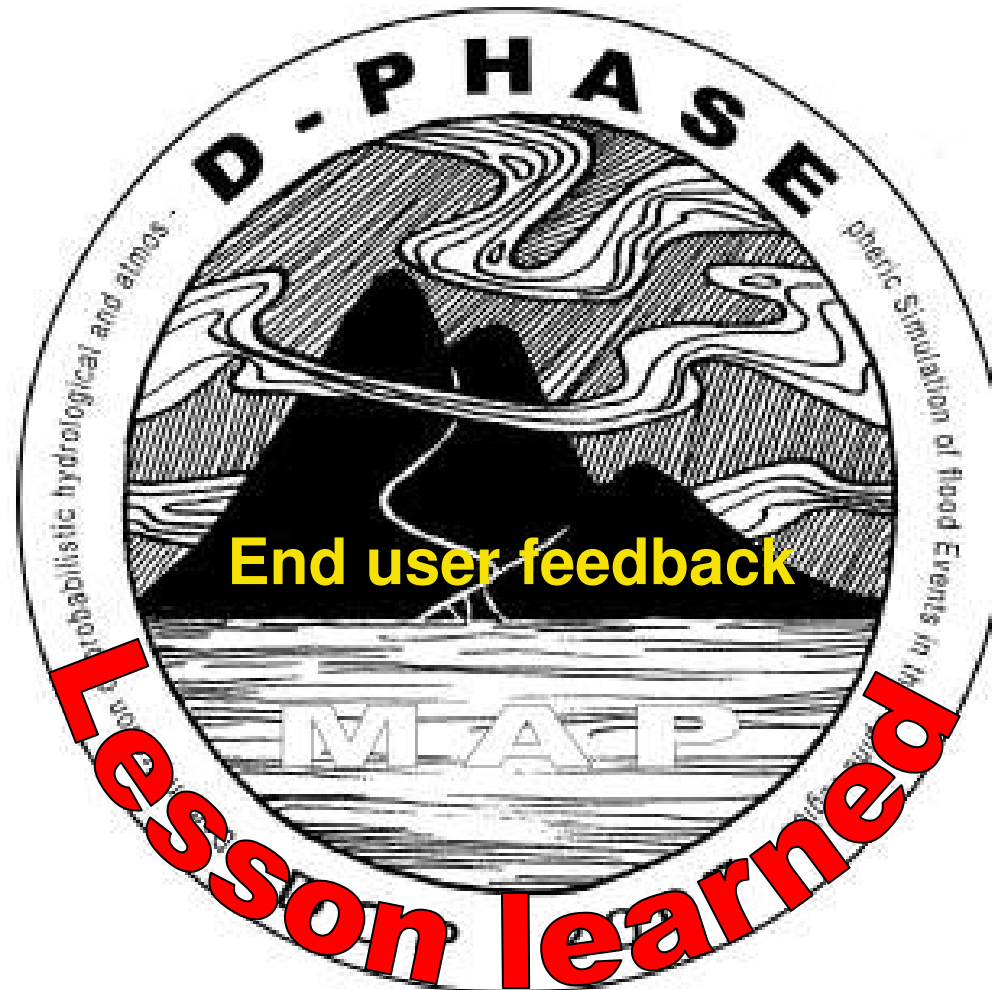
Action: business as usual



*N=24*

*Frick and Hegg, submitted*





- Take end users early on board
- Resolution needs to further increase (and will)
- EPS's need careful support (for interpretation)
- *Ensemble thinking* for air pollution modelling, heat wave warnings, health impact (e.g., pollen), ...





# Outreach to applications

Business case:

→ Construction of a new train station in Zurich

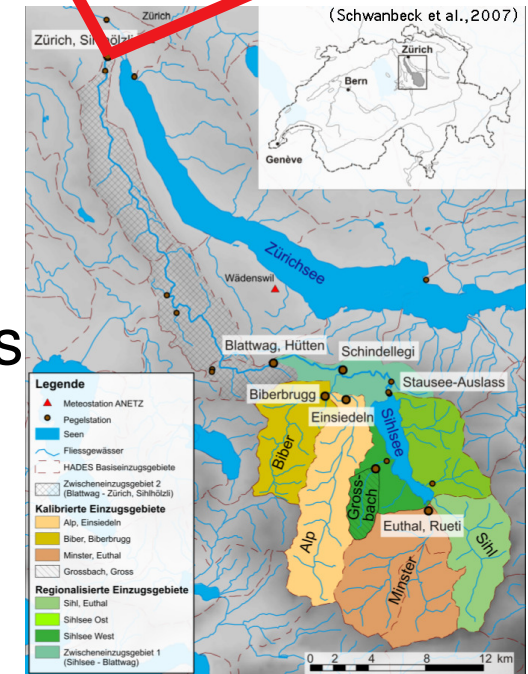
→ requires river duct partially be closed





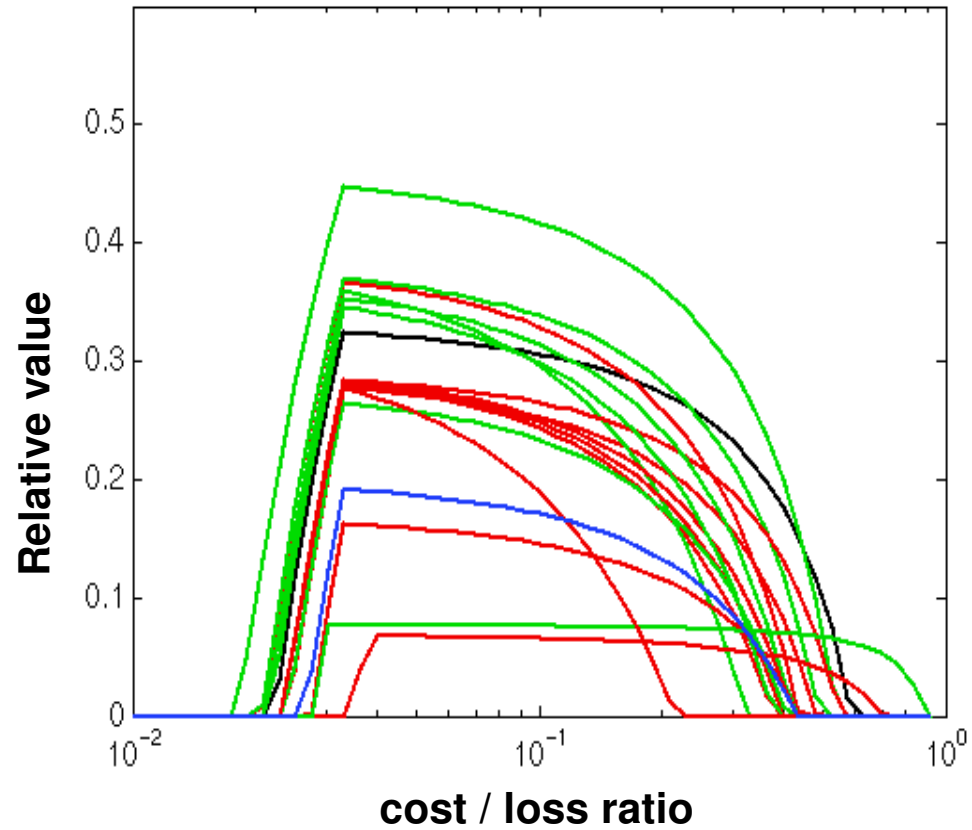
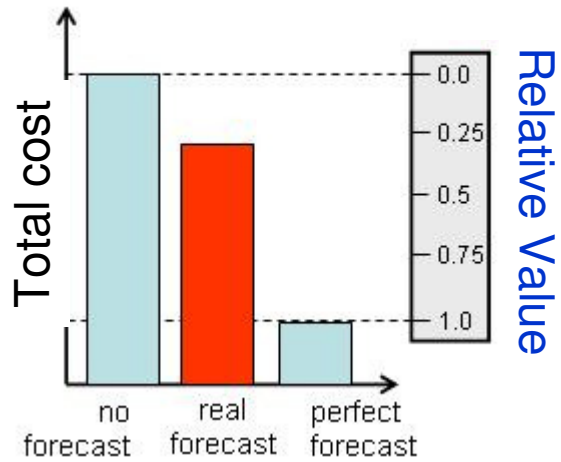
# Outreach to applications

- Cost of opening the gates: 1 Mio CHF
- Damage if not opened: many billion CHF
- Flood wave to station: 2-6 hours
- Evacuation construction site: 2-4 hours
- Opening one gate: 1-2 hours





# Economic value of forecast



param. conv.

resolved conv.





# Ensemble and/or Calibration

## Simple calibration of COSMO-2

Multiply COSMO-2 precipitation forecasts by a factor of

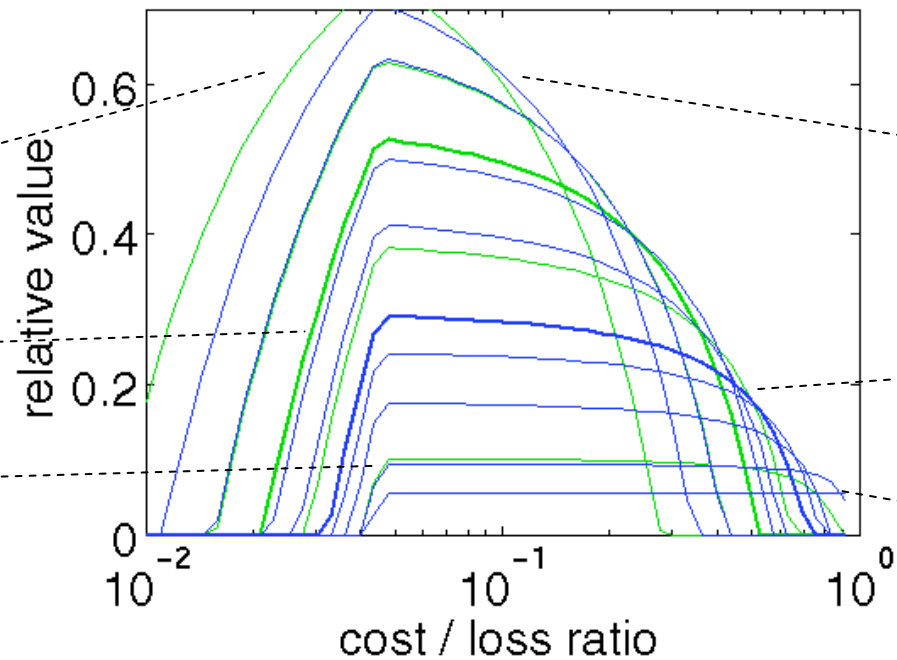
2.0

1.25

1.0

0.8

0.5



## D-PHASE poor-men's ensemble

Issue an alert, if a certain fraction of models gives a warning

10%

20%

30%

40%

50%

60%

70%

80%

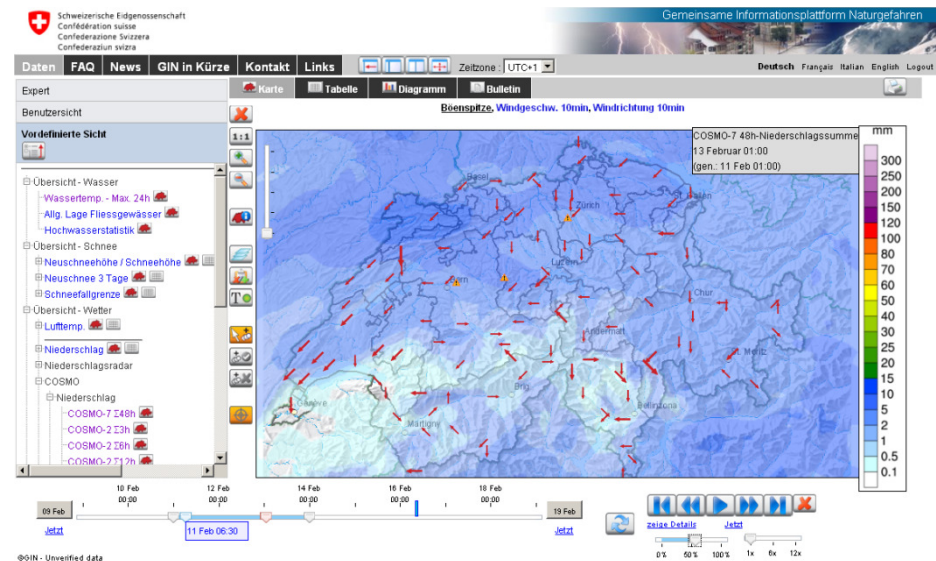
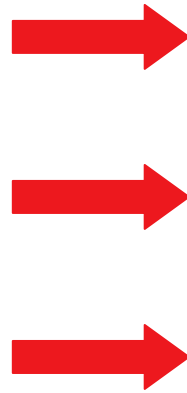
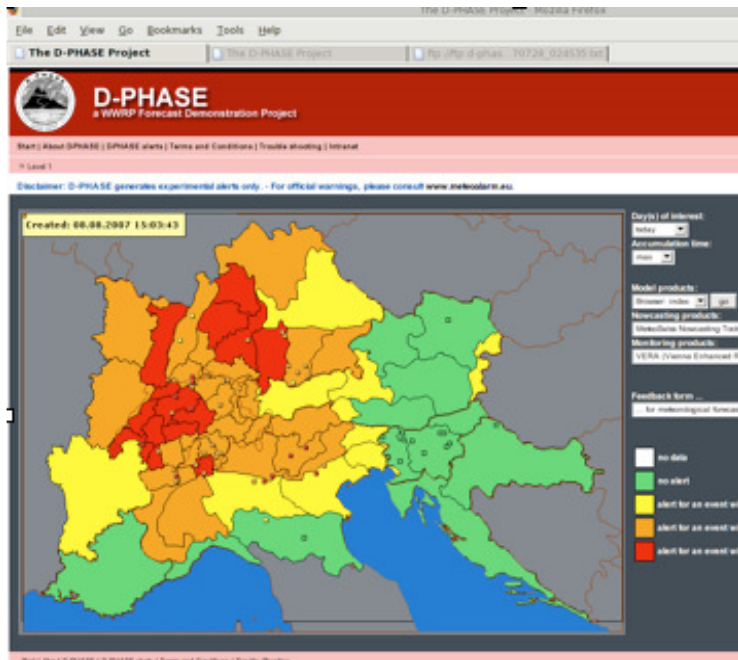
90%





# Outreach to applications

- D-PHASE inspired new operational information platform in Switzerland
- D-PHASE platform up and running **on user request** to bridge time to completion







# Common information platform for natural hazards (GIN)

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Confédération suisse  
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Gemeinsame Informationsplattform Naturgefahren

Daten FAQ News GIN in Kürze Kontakt Links Zeitzone: UTC+1 Deutsch Français Italian English Logout

Expert  
Benutzersicht  
Vordefinierte Sicht

- Übersicht - Wasser
  - Wassertemp. - Max. 24h
  - Allg. Lage Fließgewässer
  - Hochwasserstatistik
- Übersicht - Schnee
  - Neuschneehöhe / Schneehöhe
  - Neuschnee 3 Tage
  - Schneefallgrenze
- Übersicht - Wetter
  - Lufttemp.
  - Niederschlag
  - Niederschlagsradar
- COSMO
  - Niederschlag
    - COSMO-7 I48h
    - COSMO-2 I3h
    - COSMO-2 I6h
    - COSMO-2 I12h

**Böenspitze, Windgeschw. 10min, Windrichtung 10min**

COSMO-7 48h-Niederschlagssumme  
13 Februar 01:00  
(gen.: 11 Feb 01:00)

09 Feb 10 Feb 12 Feb 14 Feb 16 Feb 18 Feb 19 Feb

Jetzt 11 Feb 06:30 Jetzt

zeige Details Jetzt

0% 50% 100% 1x 6x 12x

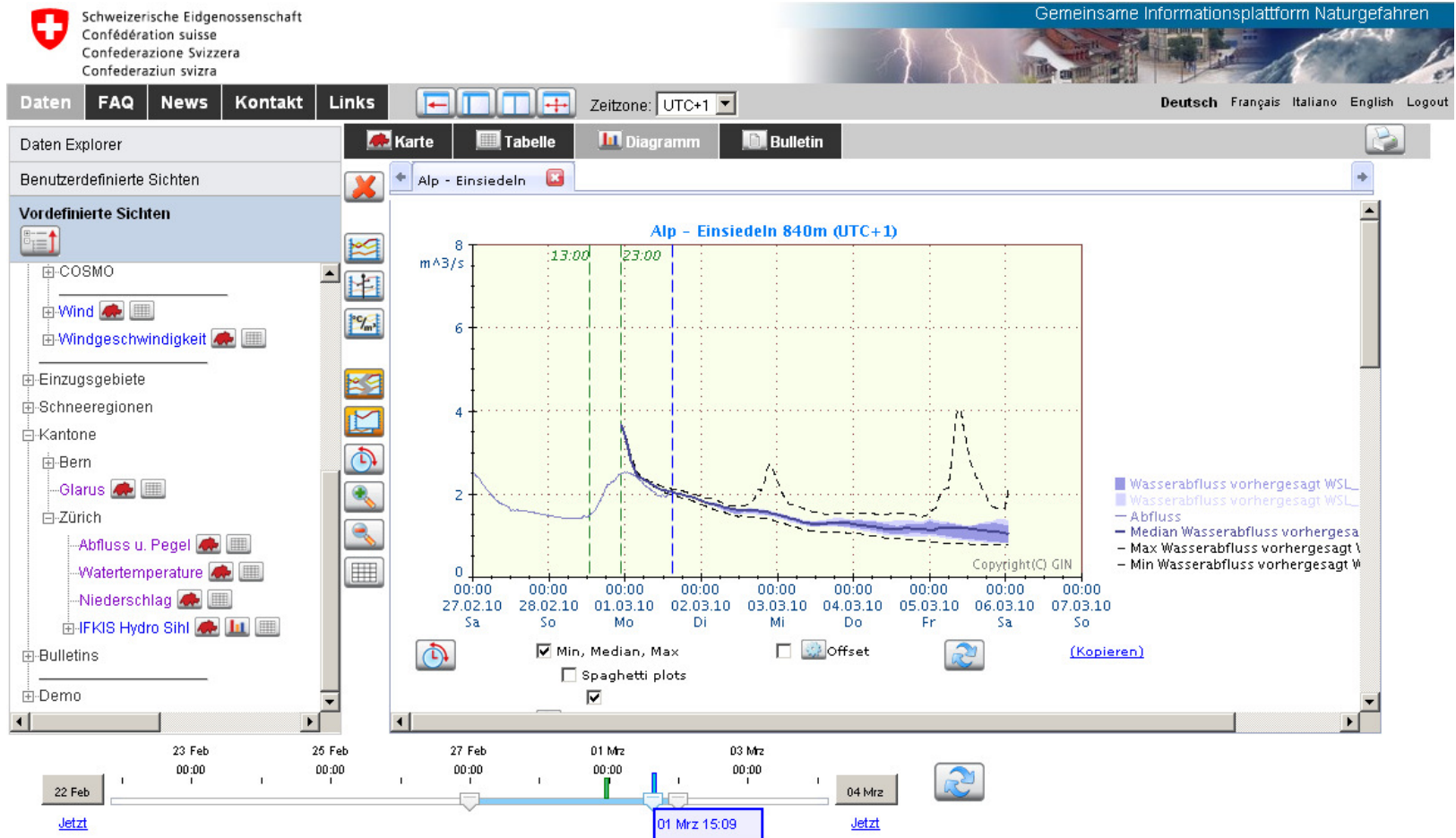
©GIN - Unverified data



D-PHASE lessons learned | CHR Alkmaar, 25-26 May 2010  
André Walser (andre.walser@meteoswiss.ch)



# GIN: Another example



©GIN - Nicht verifizierte Daten



D-PHASE lessons learned | CHR Alkmaar, 25-26 May 2010  
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# Conclusions

For an FDP to be successful....

- Involve users
  - early!
  - feedback
- Commitment 'pays back'
  - most efforts / most rewards
- society profits
  - warning systems
  - business enabling





# Thanks!

