Real-time hydro-meteorological forecasts: re-analysis of some operational case studies

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Abstract

In the present day, coupling meteorological and hydrological models, it is recognized by scientific community as a necessary way to forecast extended hydrological phenomena, in order to active useful mitigator measures and alert systems in advance, above all in mountain basins where time plays a key role. A real-time flood forecasting system is described in this study with a re-analysis of some operational case studies occurred between 2007 and 2008 in the Piedmont Region, North-West of Italy. We check if hydrological simulations, coupled with weather forecasts are able to provide reliable flood warnings with sufficient lead time, valuing the efficiency of hydro-meteorological chain in case of exceeding warning code. The goal is to evaluate how the uncertainty of meteorological forecasts influences the performance of hydrological predictions in terms of Quantitative Discharge Calculations (QDC) over different basins. In particular we investigate how the meteorological forecasts are efficient into hydrological forecasting system of different days in advance, focusing the attention on key role of air temperature (which is a crucial feature in determining the precipitation in solid phase and liquid phase), which can affect the river discharge predictions in Autumn season (prior flood wathements). Further, we try to understand how the effect of meteorological model spatial resolution and its robustness in different climate conditions can influence discharge forecasts and warning error mountain basins.

The POLIMI hydro-meteorological chain: the forecasting cascade system

Operational real-time hydro-meteorological forecast systems are realized by use of one-way coupling, i.e. the meteorological output variables are driven into hydrological models

Hydro-Meteorological data

2000-2006 available database (A.R.P.A. Piemonte and Molino Swiss)
- Temperature: 463 thermometers
- Relative Humidity: 186 hygrometers
- Precipitation: 496 rain gauge stations
- Solar Radiation: 90 pyrometers
- Wind Speed: 320 anemometers
- Hydroeteor: 132 data @thesis close sections

Meteorological models:

Cosmo-Leps and Moloch
- Spatial Resolution: 10 km x 10 km
- Temporal Resolution: 3 h
- Vertical levels: 40 (no hydrometeorological)
- Ensemble members: 16 + 8
- Emissivity values: [1.00 - 1.05]
- Forecast range: 5-12 days
- Run starting at: 12:00 UTC
- Owner: A.R.P.A. Emilia-Romagna

POLIMI Distributed Hydrological Model: FEST-WB
- Spatial Resolution: 2.5 km x 2.5 km
- Temporal Resolution: 1 h
- Vertical levels: 12 (no hydrometeorological)
- Deterministic model, nested on BOLAC
- Emissivity values: [1.00 - 1.05]
- Forecast range: 48-72 hours
- Run starting at: 00:00 UTC
- Owner: D.A.C. C.N.R.

The May 2008 event: working in real time

The reliability of the hydro-meteorological chain: brief summary

The role of atmospheric forcing: temperature

Effects of temperature on the peak discharge: quantification of errors

Effects of temperature on flood contributing area

Conclusions

The POLIMI hydro-meteorological chain is a very useful tool to predict in real time, generally with 24-48 h lead time, also urban flood events in basins where lees gates are generally lower. The use of simplified precipitation (SPH) is powerful, but due to the coarser resolution of the model, a deterministic model looks with higher grid resolution is suggested above all during flood event, when the standard process-based model, which is not an atmospheric tool alone is used. The quantification of discharge and contributing area is enough to establish an alarm and an alert system for both the decision maker and the public.