A meteo-hydrological model intercomparison as tool to quantify forecast uncertainty at medium-sized basin scale

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Purpose

A meteo-hydrological model intercomparison is proposed, in order to estimate the uncertainty associated with discharge forecasting. The hydrological models TOPKAPI and HEC-HMS were used to generate discharge simulations. The non-hydrostatic numerical mesoscale models Lokal Modell (LM) and MM5 provide quantitative streamflow simulations driven by rainfall observations, to be aware of the performance of both hydrological models, as well as by QPFs, in order to evaluate the reliability of the discharge forecast resulting by the one-way coupling. Different configurations of LM and MMS have been adopted, trying to improve the description of the phenomena determining the precipitation amount; in particular, the impact of different initial and boundary conditions and the horizontal resolution increasing are investigated. The accuracy of these forecasts is assessed exploiting the hydrological models as validation tools. The study is performed for an intense precipitation event, which affected northern Italy and caused a flood event on the Reno river, a medium-sized catchment in the Emilia-Romagna Region.

Description of the case study

On November 5, at 00 UTC, an upper level short wave, located over the Balkans, evolved into a cut-off low. Later, this cyclonic system moved slow backward from the northern part of Italy, and in the next 36 hours reached the Alpine regions, causing torrential rains over the central part of the Apennines chain, in particular over the Reno river basin.

The maximum water level at Casalecchio Chiese was 1.72 m (corresponding to a discharge value of about 760 m³/s), at 30 UTC, being 156 m above the mean sea level. The number of hours of flooding events over a total of 12 flooding events (1993 to 2004). The steepness of some of the waves, especially for those caused by debris, observed on the lower reach of the Reno river, is visible in both the photographs taken during the event and in the river discharge data from the HEC-HMS run.

The meteorological models: Lokal Modell (LM) and MM5

The Lokal Modell (LM) and MM5 provided quantitative precipitation forecasts and discharge simulations. The non-hydrostatic numerical mesoscale models Lokal Modell (LM) and MM5 provided quantitative streamflow simulations driven by rainfall observations, to be aware of the performance of both hydrological models, as well as by QPFs, in order to evaluate the reliability of the discharge forecast resulting by the one-way coupling. Different configurations of LM and MMS have been adopted, trying to improve the description of the phenomena determining the precipitation amount; in particular, the impact of different initial and boundary conditions and the horizontal resolution increasing are investigated. The accuracy of these forecasts is assessed exploiting the hydrological models as validation tools.

The very high-resolution (2.8 km) configuration of LM, where an explicit description of the different precipitation convection is added, considerably improves the rainfall forecast, as well as evident by the corresponding discharge predictions. The impact of model resolution increasing is not noticeable for the other LM run. The different runs of MMS provide similar forecasts, not allowing to highlight the impact of the different configuration of the Lokal Modell (LM) for the discharge predictions. The non-hydrostatic numerical mesoscale model Lokal Modell (LM) and MM5 provide quantitative streamflow simulations driven by rainfall observations, to be aware of the performance of both hydrological models, as well as by QPFs, in order to evaluate the reliability of the discharge forecast resulting by the one-way coupling. Different configurations of LM and MMS have been adopted, trying to improve the description of the phenomena determining the precipitation amount; in particular, the impact of different initial and boundary conditions and the horizontal resolution increasing are investigated. The accuracy of these forecasts is assessed exploiting the hydrological models as validation tools.

Conclusions

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The coupling of atmospheric and hydrological models can be regarded as a complementary tool to evaluate QPFs for the verification of meteorological model performance.

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References


Figure 5: 66-hour accumulated precipitation forecast for the different configurations of MM5, run at 2.5 km. 

Figure 4: A to B forecasts for discharge based on the different configurations of MM5, run at 2.5 km.