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Flash flood warnings for ungauged basins based on high-resolution precipitation forecasts

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Early detection of flash floods, which are typically triggered by severe rainfall events, is still challenging due to large meteorological and hydrologic uncertainties at the spatial and temporal scales of interest. Also the rapid rising of waters necessarily limits the lead time of warnings to alert communities and activate effective emergency procedures. To better anticipate such events and mitigate their impacts, the French national service in charge of flood forecasting (SCHAPI) is implementing a national flash flood warning system for small-to-medium (up to 1000 km^2) ungauged basins based on a discharge-threshold flood warning method called AIGA (Javelle et al. 2014).

The current deterministic AIGA system has been run in real-time in the South of France since 2005 and has been tested in the RHYTMME project (rhytmme.irstea.fr/). It ingests the operational radar-gauge QPE grids from Météo-France to run a simplified hourly distributed hydrologic model at a 1-km^2 resolution every 15 minutes. This produces real-time peak discharge estimates along the river network, which are subsequently compared to regionalized flood frequency estimates to provide warnings according to the AIGA-estimated return period of the ongoing event. The calibration and regionalization of the hydrologic model has been recently enhanced for implementing the national flash flood warning system for the entire French territory by 2016.

To further extend the effective warning lead time, the flash flood warning system is being enhanced to ingest Météo-France's AROME-NWC high-resolution precipitation nowcasts. The AROME-NWC system combines the most recent available observations with forecasts from the nowcasting version of the AROME convection-permitting model (Auger et al. 2015). AROME-NWC pre-operational deterministic precipitation forecasts, produced every hour at a 2.5-km resolution for a 6-hr forecast horizon, were provided for 3 significant rain events in September and November 2014 and ingested as time-lagged ensembles. The time-lagged approach is a practical choice of accounting for the atmospheric forecast uncertainty when no extensive forecast archive is available for statistical modelling. The evaluation on 185 basins in the South of France showed significant improvements in terms of flash flood event detection and effective warning lead-time, compared to warnings from the current AIGA setup (without any future precipitation). Various verification metrics (e.g., Relative Mean Error, Brier Skill Score) show the skill of ensemble precipitation and flow forecasts compared to single-valued persistency benchmarks.

Planned enhancements include integrating additional probabilistic NWP products (e.g., AROME precipitation ensembles on longer forecast horizon), accounting for and reducing hydrologic uncertainties from the model parameters and initial conditions via data assimilation, and developing a comprehensive observational and post-event damage database to determine decision-relevant warning thresholds for flood magnitude and probability.

Javelle, P., Demargne, J., Defrance, D., Arnaud, P., 2014. Evaluating flash flood warnings at ungauged locations using post-event surveys: a case study with the AIGA warning system. Hydrological Sciences Journal, doi: 10.1080/02626667.2014.923970

Auger, L., Dupont, O., Hagelin, S., Brousseau, P., Brovelli, P., 2015. AROME–NWC: a new nowcasting tool based on an operational mesoscale forecasting system. Quarterly Journal of the Royal Meteorological Society, 141: 1603–1611, doi: 10.1002/qj.2463