ANR FLASH (ANR-09-SYSC-004)

Flood forecasting with machine Learning, data Assimilation and Semi-pHysical modeling

## Flood forecasting by machine learning : results with rain gauge data and introduction of weather RADAR measurements

Partners :

- Ecole des Mines d'Alès : Yann Visserot, Guillaume Artigue, Pierre-Alain Ayral, Audrey Bornancin-Plantier, Anne Johannet (coordinator)
- SCHAPI : Bruno Janet, Arthur Marchandise, Caroline Wittwer

ANR FLASH project (2009-2013) intends to capitalize on the advantages of machine learning methods in order to provide tools for real-time flash floods forecasting. In a first step, water level forecasts were provided based on rain estimation of rainfalls, leading to the design of a demonstrating software. In a second step, weather RADAR measurements will be taken in advantage, as for rainfall estimation than for directly inputs reflectivity to the model. Comparison between the 3-type of inputs (rain gauge rainfall, RADAR rainfall, COMEPHORE reanalysis) will be assessed.

Study area

- ✓ Area : 545 km²
- ✓ Response time : 2h < t < 5h
- ✓ Reference flood: September 2002 Discharge~3000m³/s (10m) at *Anduze*) Rainfall : 690mm in 2 days.

Event of Sept. 2002
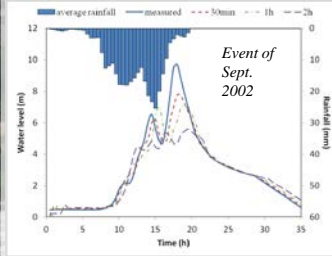
## Results with rain gauge data

- ✓ Without rainfalls forecasts, the neural model provides interesting results for horizons of prediction (*Hp*) 30min, 1h and 2h. (left)
- ✓ Based on the rainfall-height relation, a demonstrating software was implemented. (right)

Systemic modeling

- ✓ As black-box models, artificial neural networks bring forecasting without assumptions about future rainfalls. All relations of the hydrometeorological warning chain can be implemented.
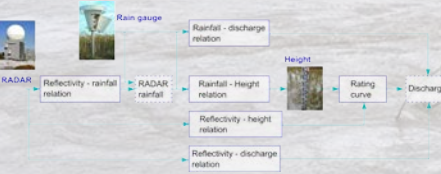

Use of rainfall by RADAR

- ✓ 6 zones, hydrologically consistent, were defined in order to apply RADAR rainfalls to the Neural model (allowing thus the comparison with the model fed by rain gauge rainfalls).

- ✓ The database contains 11 events, between 2000 and 2006 (extent of the COMEPHORE reanalysis).
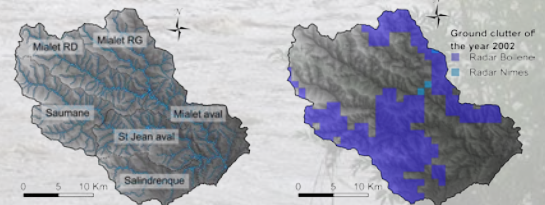
- ✓ Suppression of ground clutters and resampling data from 5 min to 30 min (*Nîmes* RADAR).

- ✓ Currently, the partial beam blocking map is not use. It will be investigated in a second step.

First results with RADAR rainfall

Hp =1h Event of Oct. 2006.

Hp =1h Event of Oct. 2006.
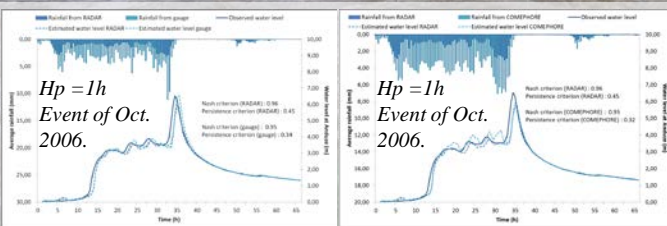
- ✓ First results show that the model takes into account spatialized rainfall and predictions with rainfall from RADAR are interesting.

- ✓ Now, it is necessary to improve the spatial information by testing another cutting (different of sub-watershed). A larger number of zones could better take into account the spatial information.

- ✓ Use of the partial beam blocking map (from metadatas of COMEPHORE) to improve the quality of weather RADAR measurements.

References :

- Artigue G.; Johannet A.; Borrell V. & Pistre S. *Flash Floods Forecasting without Rainfalls Forecasts by Recurrent Neural Networks. Case study on the Mialet basin (Southern France).* In *conférence NABIC 2011 Third World Congress on Nature and Biologically Inspired Computing* (24-26 nov 2011).
- Bornancin Plantier A.; Johannet A.; Roussel-Ragot P. & Dreyfus G. *Flash Flood Forecasting using Neural Networks without Rainfall Forecasts: Model Selection and Generalization capability.* In *European Geosciences Union General Assembly* (Vienne, Austria, april 2011)
- Tabary P.; Dupuy P.; L'Henaff G.; Laurantin O.; Merlier C.; Soubeyroux J.M. *A 10-year (1997-2006) reanalysis of quantitative precipitation estimation over France: methodology and first results.* In *Hydrological Sciences Journal (in press).*
- Toukourou M.; Johannet A.; Dreyfus G. & Ayral P.-A. *Rainfall-runoff modeling of flash floods in the absence of rainfall forecasts: the case of "Cévenol flash floods".* In *Journal of Applied Intelligence* vol. 35, 2 (2011), pp. 1078-189. doi:10.1007/s10489-010-0210-y.

The neural model provides interesting results on the *Gardon of Anduze* catchment , with rainfall from rain gauge and RADAR. As part of the project, this methodology will be extented to others mediterranean watershedS, like the *Ardèche*.

Next stages are a greater spatialization of the rainfall from RADAR and working directly with reflectivities as inputs of the model.

ERAD 2012 Toulouse France 24-29 June 2012