Nowcasting of Mediterranean flash-floods

Lovat Alexane, Vincendon Béatrice, Ducrocq Véronique

CNRM UMR 3589, Météo-France/CNRS, GMME/MICADO, Toulouse, France

alexane.lovat@meteo.fr

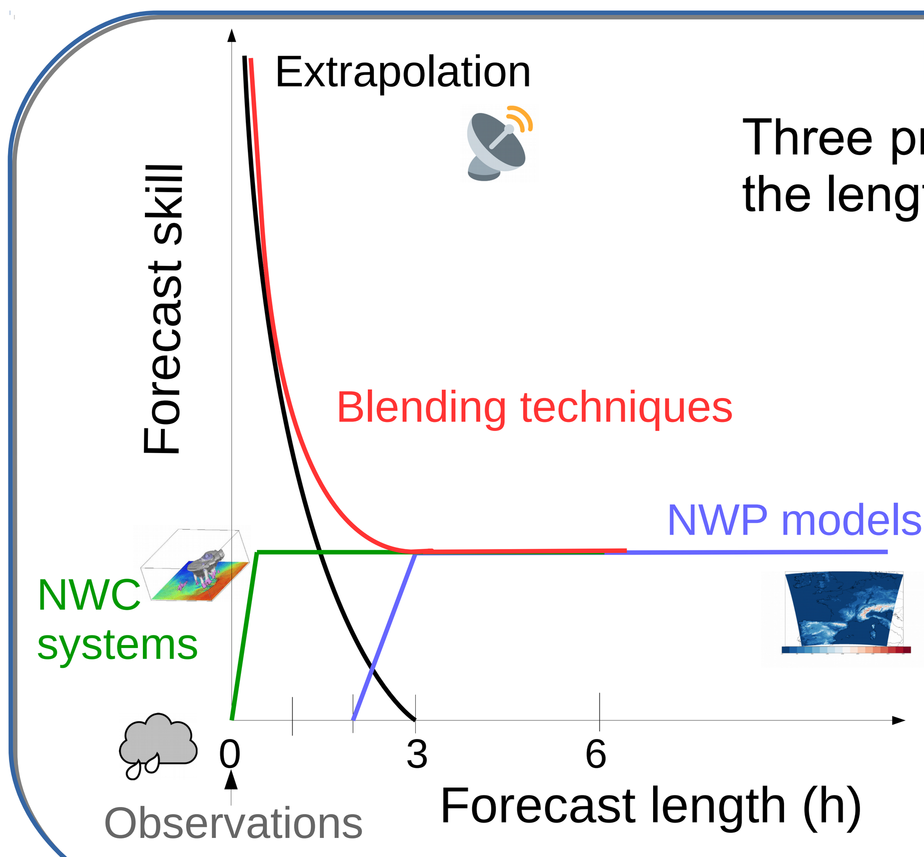
Devastating flash-floods, which are triggered by heavy rainfall events, regularly occur in the Mediterranean coastal regions. These floods represent a significant hazard to human safety and a threat to property, especially in urbanized watersheds. Thus, hydrologic forecasts are needed to generate effective warning guidance and to notify at-risk populations. It would be useful to improve the simulation of the amount of runoff produced during a precipitating event in order to locate exposed areas. Forecasting river discharges needs to be improved especially up to a 6h range, which is a relevant lead time for emergency services in crisis time.

The ultimate objective of the present work is to explore the benefit of rainfall nowcasting products for probabilistic flood forecasting at very short range over Mediterranean watersheds.

Questions which will be addressed :

1. How to better predict the risk of severe runoff over Mediterranean urbanized watersheds ?
2. Do radar quantitative precipitation estimates (QPE) and associated uncertainty information allow to move forward in nowcasting of river flow and runoff events in the Mediterranean region?
3. To which extend numerical weather nowcasting (NWC) rainfall can be relevant for very short term Mediterranean flash floods prediction?
4. How to combine probabilistic QPE and NWC quantitative precipitation forecast to predict the risk of runoff at very short range?

Precipitation nowcasting

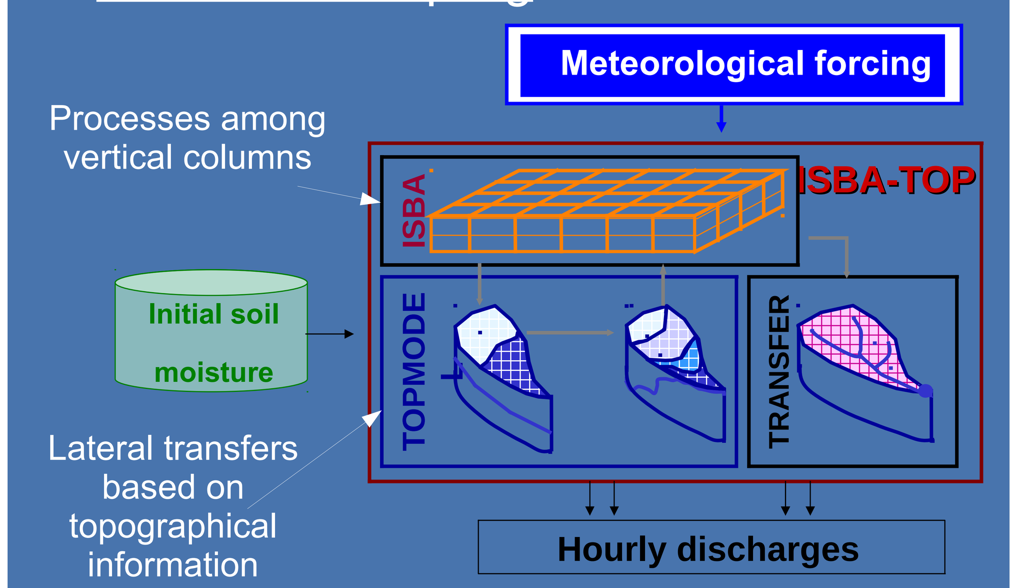


Three primary approaches exist for precipitation nowcasting depending on the length of prediction and the forecast skill. These approaches are :

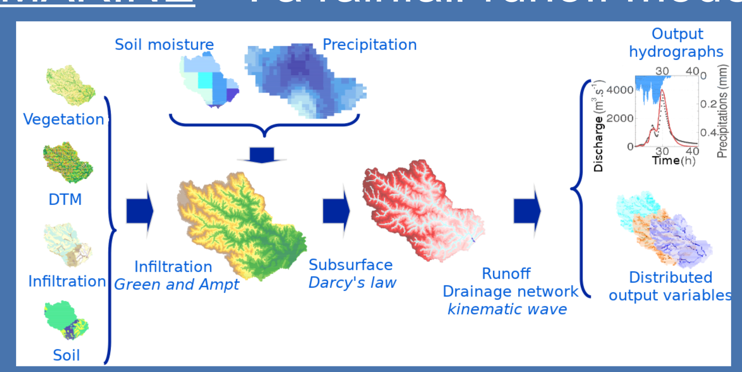
- Based on observational data :
  - extrapolating radar echoes (cross-correlation tracking(1) and centroid tracking(2) techniques)
  - generating an ensemble of precipitation fields to characterise the residual errors in radar precipitation estimates(3)
- Based on numerical weather prediction (NWP) models and rapid update cycle approach used in NWC systems(4)
- Merging of radar-based extrapolation with NWP-based forecast(5)

Two hydrological models are used :

► ISBA-TOP coupling(6)

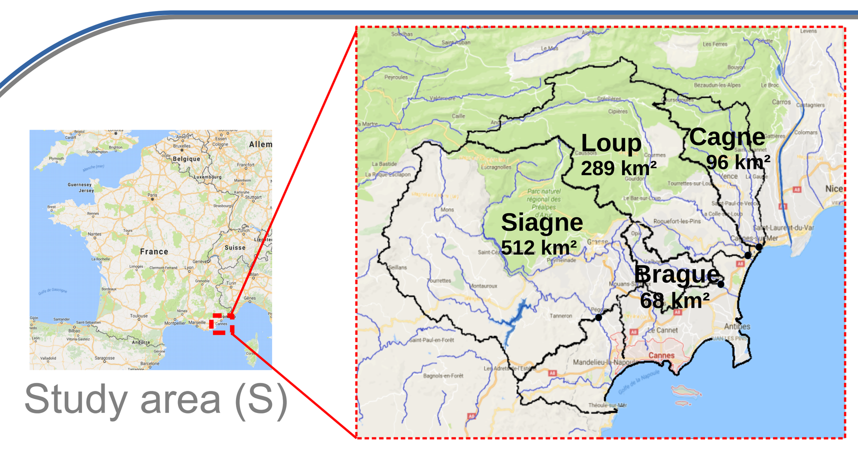


► MARINE(7) : a rainfall-runoff model



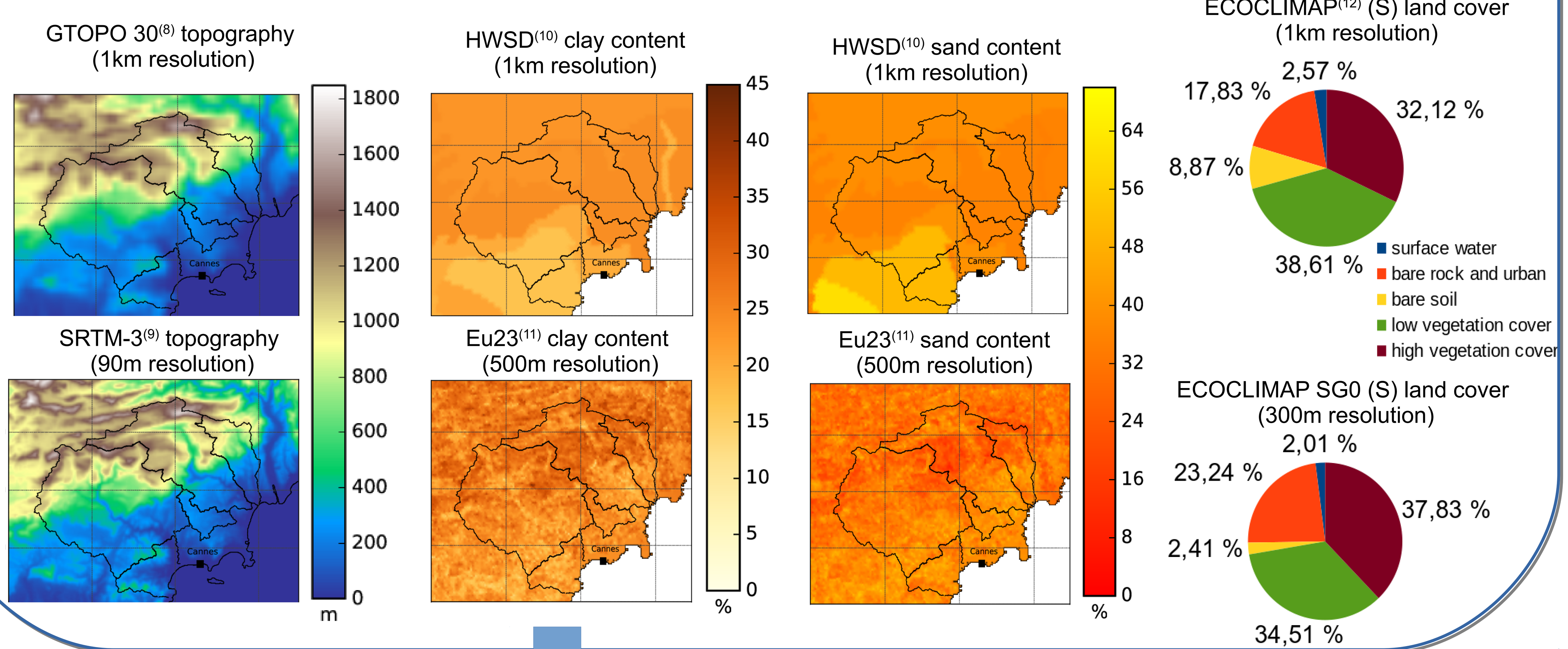
Both are physically-based, distributed, and single-event models.

Study area and datasets



Extreme downpours and flash-floods have wreaked havoc in areas around Cannes on October 3, 2015. More than 100mm of rain fell in Cannes in just one hour. Intense flash floods were observed on many rivers. 21 fatalities and high damages notably due to the density of urban areas were reported.

To answer question 1, the impact of physiographic maps on simulated hydrological response (runoff production and discharges) over the study area (S) during this episod, is assessed via 6 datasets at different scales used to describe the soil in the hydrological models :

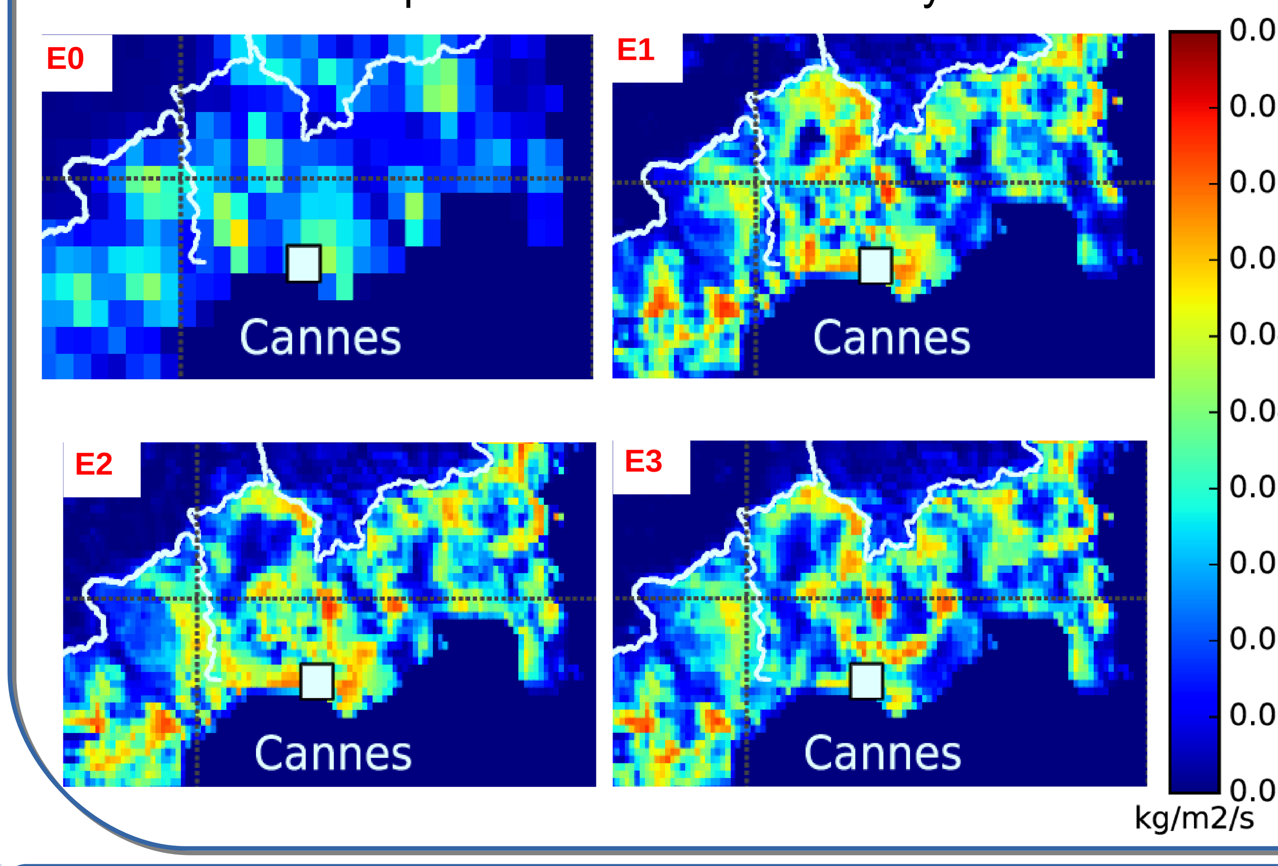


Experiments

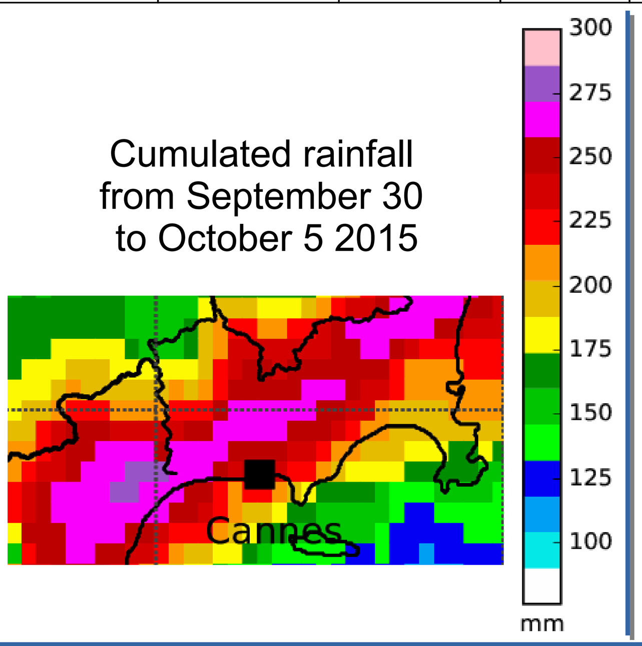
Simulations	ISBA-TOP Resolution	TOPOGRAPHY		TEXTURE		LAND COVER	
NAMES		GTOPO30	SRTM-3	HWSD	EU23	Ecoclimap	Ecoclimap SG0
E0	1 km	X		X		X	
E1	300 m		X	X		X	
E2	300 m		X		X	X	
E3	300 m		X		X		X

Simulated runoff

Cumulated runoff over Cannes from 9/30 to 10/5 according to the different experiments and simulated by ISBA-TOP

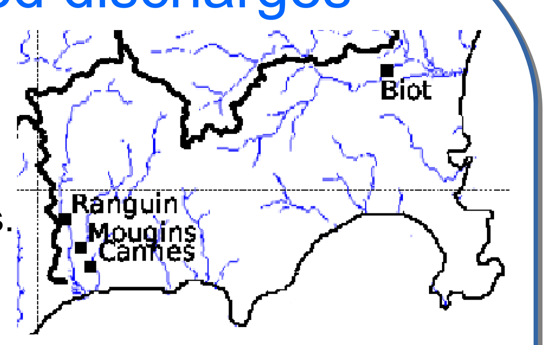


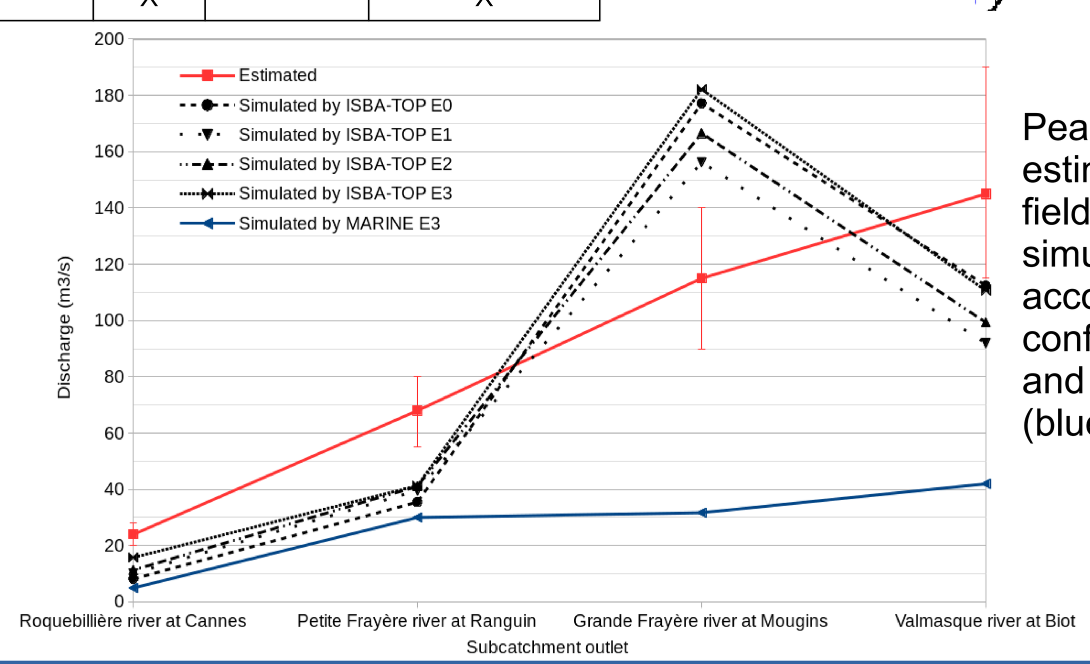
Cumulated rainfall from September 30 to October 5 2015



Simulated discharges

Locations of discharge observation points.





Peaks of discharge estimated by a post-flood field survey (red line), simulated by ISBA-TOP according to the different configurations (black lines) and simulated by MARINE (blue line).

First conclusions and perspectives

The spatial distribution of runoff and values of peak discharge varied substantially depending on the soil datasets and the mesh grid used. These differences still need to be explained. Proxy data will be helpfull to evaluate the relevance of simulated runoff.

(1) Rinehart, R. & Garvey, E. (1978). Three-dimensional storm motion detection by conventional weather radar.
(2) Witt, A. & Johnson, J. (1993). An enhanced storm cell identification and tracking algorithm. In Preprints, 26th Conf. on Radar Meteorology, Norman, OK, Amer. Meteor. Soc (pp. 141143).
(3) Germann, U., M. Berenger, D. Sempere-Torres, and M. Zappa, 2009 : REAL : Ensemble radar precipitation estimation for hydrology in a mountainous region. Quarterly Journal of the Royal Meteorological Society 135, 445–456.
(4) 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(690), 1603-1611.
(5) Mueller, C., Saxen, T., Roberts, R., Wilson, J., Betancourt, T., Dettling, S., Oien, N., & Yee, J. (2003). Ncar auto-nowcast system. Weather and Forecasting , 18(4), 545561.
(6) Vincendon, B., Édouard, S., Dewaele, H., Ducrocq, V., Lespinas, F., Delrieu, G., & Anquetin, S. (2016). Modeling flash floods in southern France for road management purposes. Journal of Hydrology, 541, 190-205.
(7) Roux, H., D. Labat, P.-A. Garambois, M. Maubourguet, J. Chorda, & D. Dartus (2011), A physically-based parsimonious hydrological model for flash floods in Mediterranean catchment, Nat. Hazards Earth Syst. Sci. J1- NHESS, 161,2567–2582.
(8) Data available from the U.S. Geological Survey.
(9) Jarvis A., H.I. Reuter, A. Nelson, E. Guevara, 2008, Hole-filled seamless SRTM data V4, International Centre for Tropical Agriculture (CIAT), available from http://srtm.csi.cgiar.org.
(10) FAO/IIASA/ISRIC/ISSCAS/JRC, 2012. Harmonized World Soil Database (version 1.2). FAO, Rome, Italy and IIASA, Laxenburg, Austria.
(11) Ballabio C., Panagos P., Montanarella L. Mapping topsoil physical properties at European scale using the LUCAS database (2016) Geoderma, 261 , pp. 110-123.
(12) Faroux, S., Kaptué Tchuenté, A. T., Roujean, J.-L., Masson, V., Martin, E. and Le Moigne, P.: ECOCLIMAP-II/Europe: a twofold database of ecosystems and surface parameters at 1 km resolution based on satellite information for use in land surface, meteorological and climate models, Geosci. Model Dev.,6, 563-582, doi:10.5194/gmd-6-563-2013, 2013.