Final author comments to referee 2 comments on “A high space-time resolution dataset linking meteorological forcing and hydro-sedimentary response in a mesoscale Mediterranean catchment (Auzon) of the Ardèche region, France” by Nord et al.

In the following, the reviewer comments appear in black italic and our answers are provided in blue. When there are quotations from the text of the article, they appear in quotation marks and the new or corrected parts are highlighted in yellow.

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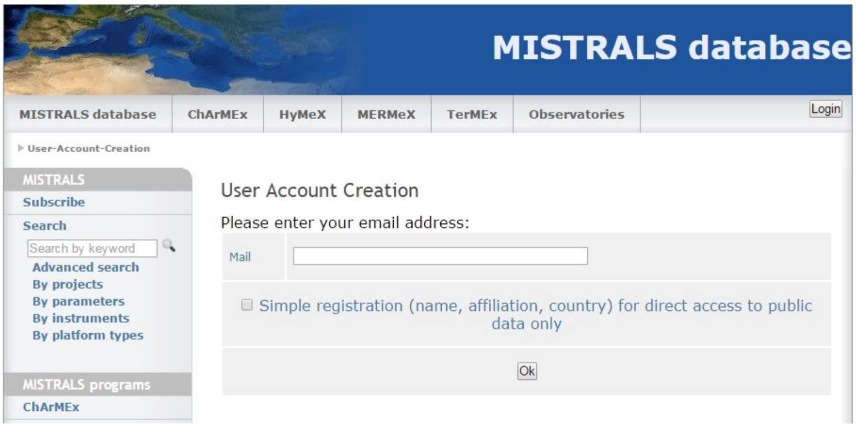
This work describes a comprehensive dataset that includes hydrometeorological, and hydrological data collected from a number of sensors (in situ and remote) over a mesoscale catchment in Mediterranean. The number of observed variables, the various sensors involved and the space/time resolution of this comprehensive dataset makes it a unique contribution to research community. I agree with the authors that such a dataset can serve as an excellent benchmark for evaluating and improving process based models used for understanding triggering rainfall properties, runoff generation mechanisms and erosion processes during Mediterranean floods. My recommendation is to accept the paper for publication in ESSD journal.

Answer: We thank referee 2 for this positive appraisal of the dataset presented in this paper.

Below I list only some minor points/corrections that may help to improve information provided in some specific parts of the text. However, I want to share also the concerns raised by reviewer#1 regarding the conditions that may potentially apply on the use of this dataset. My understanding from reading the manuscript is that the “non public” data require simply a registration to HyMeX before they can be retrieved and used. If there is more into this (see points/concerns of reviewer#1) it needs to be clarified and dataset needs to be subsequently adjusted to include only data that are unconditionally available.

Answer: The HyMeX database requires creating an account even for a user who wants to download only data under public status. We recognize that this step certainly constitutes a complication for a fully open and prompt access to the data. However, it also makes possible to trace the users of the data and contact them in case of an important updating of the datasets. The main problem was that this creation of account required the user to validate the HyMeX data policy whereas the data under public status are not subject to this policy (indeed the HyMeX data policy only applies to data under "associated scientists" or "core users" status). This was an error and was not ethically founded. As a result, with the help of the managers of the HyMeX database, we have modified the step of creation of account by this way (http://mistrals.sedoo.fr/User-Account-Creation/): users wanting to download only datasets under public status no longer need to validate the HyMeX data policy. A simple registration (name, affiliation, e-mail) is necessary to create an account (an e-mail with their login and password is instantaneously sent to their e-mail address) and then access directly to public data.



If users want to use datasets under "associated scientists" status, two situations are possible:

1) Either they have registered previously for access to public data only. In this case, they must go to their account (http://mistrals.sedoo.fr/Your-Account/) and complete the HyMeX registration application.
2) Or they register for the 1st time. They must go to http://mistrals.sedoo.fr/User-Account-Creation/ and do not check the box corresponding to “Simple registration (name, affiliation, country) for direct access to public data only.”

In both cases, they will arrive on a page where they have to describe the planned work in more than 350 characters and they have to validate the HyMeX data policy by accepting various statements. A sentence has been added at the foot of the page to explain the procedure of validation: “Registrations are handled by the MISTRALS Executive Comittee following the criteria established by the HyMeX International Scientific Steering Committee. Registration is reviewed within 7 days and is valid for 3 years.” The database managers have calculated that, since the creation of the HyMeX database, the average period of validation for applications is: 4.43 days.

Most of the individual datasets (32 of 41) have “public” access. A few of them (9 of 41) are under the “Associated scientists” status of the HyMeX data policy.

Nevertheless, to facilitate the use of the data and to avoid downloading each individual datasets (41 in total), a bundling service was provided. The bundled data presents the advantage of gathering data in ASCII and cartesian format, in a single coordinate system, and in the same timezone (UTC). The bundled data were selected for the spatial and temporal windows presented in the paper since some individual datasets have different extents. It represented an important task. As explained in section 5 Data availability, the bundled data were organized in two zip files: the "zip1_auzon.zip" and "zip2_auzon.zip" files available from the link to the data repository included in the abstract of the paper (http://mistrals.sedoo.fr/MISTRALS/?editDatsId=1438).

Access to the file "zip1_auzon.zip" is totally public (see the flag “Direct access to public data” in the page http://mistrals.sedoo.fr/MISTRALS/?editDatsId=1438) and does not require any identification. The data can be downloaded directly without any step of identification. In contrast, access to the file "zip2_auzon.zip" is under “associated scientists” status and is subject to the HyMeX data policy. We created a special account to allow editors and reviewers to download this file "zip2_auzon.zip". We had sent a “cover letter” at the time of first submission of the paper to explain the procedure to download all the bundled data (in particular the username and password of the account that enable to download the file "zip2_auzon.zip ").

Minor points

1. P1L29: "…quantity and type of sensors", consider improve wording

Answer: We recognize that the understanding of the text was not straightforward. We have rephrased some of the abstract based on the comments of the two referees to improve the clarity. It now reads as follows:

"A comprehensive hydrometeorological dataset is presented spanning the period 1 January 2011-31 December 2014 to improve the understanding of the hydrological processes leading to flash floods and the relation between rainfall, runoff, erosion and sediment transport in a mesoscale catchment (Auzon, 116 km²) of the Mediterranean region. Badlands are present in the Auzon catchment and well connected to high gradient channels of bedrock rivers which promotes the transfer of suspended solids downstream. The number of observed variables, the various sensors involved (both in situ and remote) and the space-time resolution (~ km², ~ min) of this comprehensive dataset makes it a unique contribution to research communities focused on hydrometeorology, surface hydrology and erosion. Given that rainfall is highly variable in space and time in this region, the observation system enables to assess the hydrological response to rainfall fields. Indeed (i) rainfall data are provided by rain gauges (both a research network of 21 rain gauges with 5 min time step and an operational network of 10 rain gauges with 5 min or 1 h time step), S-band Doppler dual-polarization radars (1 km², 5 min resolution), disdrometers (16 sensors working at 30 s or 1 min time step) and Micro Rain Radars (5 sensors, 100 m height resolution). Additionally, during the special observation period (SOP-1) of the HyMeX (Hydrological Cycle in the Mediterranean Experiment) project, two X-band radars provided precipitation measurements at very fine spatial and temporal scales (1 ha, 5 min). (ii) Other meteorological data are taken from the operational surface weather observation stations of Météo-France (including 2-m air temperature, atmospheric pressure, 2-m relative humidity, 10-m wind speed and direction, global radiation) at the hourly time resolution (6 stations in the region of interest). (iii) The monitoring of surface hydrology and suspended sediment is multi-scale and based on nested catchments. Three hydrometric stations estimate water discharge at a 2 to 10 min time resolution. Two of these stations also measure additional physico-chemical variables (turbidity, temperature, conductivity) and water samples are collected automatically during floods allowing further geochemical characterization of water and suspended solids. Two experimental plots monitor overland flow and erosion at 1 min time resolution on a hillslope with vineyard. A network of 11 sensors installed in the intermittent hydrographic network continuously measures water level and water temperature in headwater subcatchments (from 0.17 km² to 116 km²) at a time resolution of 2-5 min. A network of soil moisture sensors enable the continuous measurement of soil volumetric water content at 20 min time resolution at 9 sites. Additionally, concomitant observations (soil moisture measurements and stream gauging) were performed during floods between 2012 and 2014. Finally, this dataset is considered appropriate for understanding the rainfall variability in time and space at fine scales, improving areal rainfall estimations and progressing in distributed hydrological and erosion modelling."

2. P2L4: "…measure water discharge…", do you mean water stage or "estimate water discharge"?

Answer: ok, "measure" was replaced by "estimate" (see above)

3. P2L26: "Indeed, the water and sediment discharges simulated by distributed models. . .are generally poorer. . .". It is stated as a universal truth. I suggest to revise statement to mention that "many studies have shown. . .", for example.

Answer: ok, this was corrected. We have also completely re-written and shortened the introduction as suggested by referee 1. It now reads as follows:

"The Mediterranean area is prone to intense rainfall events, sometimes triggering flash floods that may have dramatic consequences (Ruin et al., 2008). Flash floods are the consequence of short, high-intensity rainfalls mainly of spatially confined convective origin and often enhanced by orography (Borga et al., 2014). As such, flash floods usually impact basins less than 1000 km² (Marchi et al., 2010). In medium-scale Mediterranean catchments, the control exerted by the amount of rainfall and its intensity and variability on the generation of runoff and the erosional processes operating at different scales is of major importance (Navratil et al., 2012; Marra et al., 2014; Tuset et al., 2015). Assisting stakeholders in implementing efficient soil conservation and river management measures implies understanding the processes and the factors that control surface runoff, develop modelling approaches able to provide reliable flow separations, localize sediment sources and sinks, and predict the space-time dynamics of sediment and associated contaminant within the catchment. This requires taking into account the space-time variability of rainfall events, using spatially distributed models coupling hydrology and mass transfers.

Although the interest of distributed models is recognized for understanding the inner behaviour of the catchment (i.e. pathways and transit times), many studies have shown that their reliability do not meet the expectations. Indeed, the water and sediment discharges simulated by distributed models at the outlet of the catchment are generally poorer than the results simulated by lumped models (Jetten et al., 2003; Reed et al., 2004; de Vente el al., 2013). To date there are various difficulties that hinder the potential of distributed models (e.g. Cea et al., 2016) such as the large number of parameters, the definition of some parameters which are difficult to measure, the high non-linearity of the equations, the interaction between input parameters, the uncertainty in the experimental measurements and input data, the space-time variability of the physical processes, and the lack of comprehensive field data available for initialization and calibration. Thus the deployment of multi-scale observation systems over a period of several years in medium catchments and the release of the collected datasets as open data with metadata on how the data have been collected, quality assured, and their associated uncertainties (Weiler and Beven, 2015) is of crucial importance to address the current limitations of distributed models.

High space-time resolution (~ km², ~ min) datasets linking meteorological forcing and hydro-sedimentary response are rare in scientific literature because of the high number and diversity of types of sensors required for measuring rainfall and surface hydrology. The already published datasets consist of first order catchments ("Tarrawarra data set" (southeastern Australia): Western and Grayson, 1998), catchments where the observation period is exceptionally long ("Reynolds Creek Experimental Watershed" (northwestern USA): Slaughter et al., 2001; "Walnut Gulch Experimental Watershed" (southwestern USA): Renard et al., 2008; Stone et al., 2008; "Goodwater Creek Experimental Watershed and Salt River Basin" (midwestern USA): Baffaut et al., 2013), or catchments located in snow-dominated mountain ("Reynolds Creek Experimental Watershed" (northwestern USA): Reba et al., 2011; "Dry Creek Experimental Watershed" (northwestern USA): Kormos et al., 2014). In mesoscale catchments, such datasets are scarce ("Walnut Gulch Experimental Watershed" (southwestern USA): Goodrich et al., 1997; "Iowa River Basin" (north central USA): Gupta et al., 2010), especially in the Mediterranean region.

This study is part of the FloodScale project (Braud et al., 2014), which is a contribution to the HyMeX program (Hydrological Cycle in the Mediterranean Experiment, Drobinski et al., 2014), a 10-year multidisciplinary program on the Mediterranean water cycle. A three-level nested experimental strategy was planned for the HyMeX program:

- A long-term observation period (LOP) lasting about 10 years (2010-2020) to gather and provide observations of the whole coupled system that support analysis of the seasonal-to-interannual variability of the water cycle through budget analyses.

- An enhanced observation period (EOP) lasting about 5 years (2011-2015), for both budget and process studies.

- Special observation periods (SOP) of several months, which aimed at providing detailed and specific observations to study key processes of the water cycle in specific Mediterranean regions, with emphases put on heavy precipitation systems and intense air-sea fluxes and dense water formation.

The FloodScale project (2012-2015) fits into the EOP and encompasses the SOP1 (Ducrocq et al., 2014) which took place from 5 September to 6 November 2012 and was dedicated to heavy precipitation and flash-floods. This study focuses on nested scales that range from the hillslope to the medium catchment scale all belonging to the Cévennes - Vivarais Mediterranean Hydrometeorological Observatory (OHMCV) (Boudevillain et al., 2011). It is located in Ardèche, in a region with a high gradient in annual rainfall (e.g. Molinié et al., 2012). The observation system has been operated by different teams from various countries during the SOP1 and EOP: LTHE, IRSTEA Lyon, EPFL, Wageningen University, LAMP and Météo-France. The dataset includes precipitation and weather data, soil moisture data, runoff and soil erosion data, hydrologic and suspended sediment response data, surface water quality data, and GIS data.

The duration of the observations presented here (4 years, from 1 January 2011 to 31 December 2014) allows the characterization of the standard catchment behaviour and provides the opportunity to observe less ordinary events with processes that are specific to flash floods and to characterize possible threshold effects that are not observed in small to moderate events. The observation strategy is reinforced by the deployment of conventional and polarimetric radars that provide precipitation measurements at spatial scales not properly resolved by rain gauges networks (Berne and Krajewski, 2013). A special effort was dedicated to soil moisture measurements and stream gauging during floods. These opportunistic observations made possible by a real-time warning system enable to watch transient processes like runoff, to monitor the increase of water content in soil and to gauge high discharges in small to medium catchments, which is challenging due to the very short response times of such systems. This allows documenting the upper ends of stage-discharge rating curves that are generally extrapolated at high values.

The paper presents the acquired datasets to make them accessible to the scientific community and make their use easier and wider. The authors are convinced that the published datasets can serve as a benchmark for hydrological distributed modelling applied to the Mediterranean area. The paper is organized as follows: Section 2 presents the location of the studied catchment and its context (geology, climatology, land use, pedology). Section 3 describes the observation system (instruments and measured variables) and is organized in three subsections: i) hydrometeorological data, ii) spatial characterization data, iii) hydrological and sediment data. Finally, in Section 4, the first studies that provide preliminary answers to the scientific questions selected in the introduction are highlighted."

4. P2L28: "this raises the question of the improvement. . .." Improve wording/syntax.

Answer: This sentence was finally deleted (see in the previous point the new version of the introduction).

5. P3L6: ". . .to exceed the current limitation. . ." consider changing this to "to improve distributed models" or "to address current limitations"

Answer: ok, "exceed" was replaced by "address" (see above the new version of the introduction).

6. P3L16: I am not sure about the "leaser extent on-board satellites. . .". What is the basis for stating that? Especially since you are referring to rainfall all around the world where in many parts satellites are the only source of information.

Answer: This paragraph was removed from the introduction as it was considered too specific to rainfall processes by the authors. Our objective has been to shorten the introduction and gain in clarity. The introduction was refocused on the added value of the coupling between hydrometeorology and hydrology.

7. P3L21: "rainfall is not steady. . ." what do you mean by stead rainfall?

Answer: same answer as to comment 6.

8. P3L22: "..the scales of operational rain gauge. . .". I am not sure what is your reference here but at a global level the typical temporal scale of rain gauge observations is daily.

Answer: same answer as to comment 6.

9. P3L24: "operational radars is essential", for what? The sentence ends rather abruptly.

Answer: same answer as to comment 6.

10. P4L25: Have you previously define what SOP and EOP stands for?

Answer: We thank referee 2 for this note. Indeed, we had not defined precisely SOP and EOP previously in the text. Therefore we have described the 3 phases of the HyMeX program (with their respective periods of application), which makes it possible to better situate this study in relation to the HyMeX program (see above the new version of the introduction).

11. P7L19:which one is the MXPol? Is it the EPFL-LTE? It is a bit confusing.

Answer: We added the name of each radar directly after its first introduction in the text to gain in clarity. We also added the instrument name for the S-band radars. It now reads as follows:

“The region of interest is covered by two operational S-band radars (Fig. 1): a conventional radar (Thomson MTO 2000S) located in Bollène (about 40 km away) and a polarimetric radar (Selex Meteor 600S) located in Nîmes (about 90 km away). Their visibility over the Auzon catchment is however hindered by the topography and the lowest beam is at about 2 km above the ground. These operational radar, managed by Météo-France, provided data (radar reflectivity and rain rate estimates) over the entire period of interest. To complement these radars and monitor the small-scale variability of precipitation, two additional X-band research radars were deployed during HyMeX SOP1 (Fig. 3.a), providing measurements at a resolution of about 100x100 m². A fast-scanning radar (WR-10X+), managed by LaMP, provided rapid Plan Position Indicator (PPI) scans (every 3 minutes) at one elevation. EPFL-LTE managed a Mobile X-band Polarimetric (MXPol) radar, that provided a combination of Range Height Indicator (RHI) and PPI scans of polarimetric variables every 5 min. These two research radars enabled the monitoring of low level precipitation over the Auzon catchment. Their maximum range should vary between 30 and 40 km (the range represented in Fig. 3.a is only qualitative). Finally, 5 Micro Rain Radars (MRR), provided by CNRM, LaMP and OSUG, were deployed in combination during Fall 2012 and Fall 2013 at three locations in the region of interest to document the vertical profile of precipitation. These Doppler FW-CW vertical pointing radars measuring the Doppler spectra enable to study the vertical structure of rainfall as well as the associated microphysical processes in relation with the orography (Zwiebel et al., 2015). More detailed information about the operational and research radar systems involved in HyMeX can be found in Bousquet et al (2015). The operational radar processing algorithms are described in Tabary (2007), while the data from the MXPol radar are processed following the steps described in Schneebeli et al. (2014) and Griazioli et al. (2015). The characteristics of MXPol are given by Schneebeli et al (2013) and Mishra et al. (2016).”

12. P8L12:”..is made thanks to a Hobo. . .” consider revising and avoiding “thanks to”

Answer: ok, we corrected the sentence. It now reads as follows:

“Each rain gauge is connected to a Hobo or a Campbell data logger.”

13. P14L27: Not clear what you mean by “radar-rain gauge” here. Do you refer to a merging technique? OR just a geostatistical-based interpolation to obtain “radar-like” QPE from gauges. Please clarify.

Answer: We refer to a merging method of radar and rain gauge data through Kriging with External Drift. The sentence "Geostatistical techniques (ordinary kriging and kriging with external drift) were used to obtain radar–rain gauge quantitative precipitation estimates (QPE’s)." was modified as follows: "Geostatistical techniques (raingauge ordinary kriging, as well as merging of radar and raingauge data through kriging with external drift) were used to obtain quantitative precipitation estimates (QPE’s)."

14. P15L31: “. . .we saw during the events of the 2014”, how did you see that? Please explain.

Answer: we recognize that the sentence was not clear. It was removed and replaced by the following sentence:”Figure 8 shows the hydrograph and the associated uncertainty for the different rating curves presented in Figure 7 for the 04 November 2014 event, the largest flood recorded during the period 2011-2014."

15. P16L12-13: NSE and PBIAS are not defined previously.

Answer: ok, we completed the text as follows:

"The Nash – Sutcliffe efficiency (NSE), the percent bias (PBIAS)…"

16. P16L22: "5-10 yr return period". This is interesting and I am wondering what is the basis for this estimate? Are there any flood frequency curves available for the area? It would be interesting to have this infor for other flood events in the record.

Answer: Indeed, we have not yet done any statistical analysis to calculate the return periods of the different discharge values because the measurement period is too short. However, we did a work of gathering information among the inhabitants of the region. In particular, the person who lives at 50 m from the Claduègne station took photographs of the most important floods since 1990. The only other flood that produced an overflow in the floodplain occurred in October 1995 (see the photo below). This information was corroborated by interviews with farmers and residents who live by the river. So our estimate is fairly cautious. On the other hand, the measures have continued to date and we have not observed a larger flood since the end of 2014.

Note also that we added the following information to the text (l.16):

"(this return period was estimated from archive photos and interviews with residents and farmers who live and work near the river)"

17. P17L28: ". . .quality (size, fall velocity. . .", please revise because size and velocity of hydrometeors is not a qualitative measure.

Answer: This sentence was finally deleted