Review of the 3rd version of the paper : Reconstructing the Salgar 2015 Flash Flood Using Radar Retrievals and a Conceptual Modeling Framework: A Basis for a Better Flood Generating Mechanisms Discrimination. Nicolás Velásquez et al.

General comments about the revision:

I already did the revision of the two first versions of manuscript. I really appreciate the supplementary information added in the manuscript, namely the figure 9, explaining the floodplain iterative assessment; the new discharge data, that comforts the hydrological model results, and the information concerning the stream velocity in Annexe.

However, I'm a bit upset that there are still a lot of annotation issues, and writing mistakes that might exist on the first submission but really not of the third one. Several co-authors comments are also spread within the text. Quick checks of the homogeneity and the consistency of the equations and annotations should be done before submitting and NOT by the reviewer. As example in the hydrological model, you mentioned calibrated parameters that are not in the equations of the model. Also the indexation of the variables/ parameters are still sporadic.

I'm convinced there is a lot of work behind the paper, and that each part of the modeling framework should have been a main topic on its own, making easier the writing, the results analysis and the reading. Nevertheless I respect the choice of the paper to gather the modeling work in one paper. In addition I would have personally chosena slightly different way to highlight the results and to orientate the discussion on several points. But again you're the only ones to choose the direction of your paper.

I divided my comment in three parts. The first one consists in several modifications of the section 3 to make clearer the methodology description, specially the hydrological model and the floodplain submodel description. Those comments and/or suggested modifications are very important and almost unavoidable (from my point of view) to clarify and make the method understandable. In the second part, I made some comments and suggestions on the results and on the discussion that should make the paper insights be highlighted. And finally in the last part, I pointed out the spelling or language mistakes I found.

I. Comments on the methodology's description:

I.1. Description of the hydrological model :

Page 13, line 303-305: I don't understand this sentence "Vertical flows are only time dependent, while lateral flows could also depend on the actual state of the tank (kinematic approximation)." The vertical flows also depend on the actual state of the tank, doesn't it? I would suggest to remove this sentence.

Page 13, lines 306-309: You mentioned 4 modifications of the hydrological model but I don't agree with the fact to classify two of them as modification:

- the first one, "the direct use of radar QPE [...]": it is not a modification, but it is a specific choice of rainfall inputs
- the 4th modification: "the development of two modules [...]": this refers to the "landslide submodel" and the "HydroFlash submodel". For my understanding, it is not a modification of the hydrological model, but additional modelling elements that use the results of the hydrological model. I'm sorry to be picky, but I think for an easy understanding of the paper,

you should strictly follow the subsections's structure and only mention here what is related to the hydrological model.

Page 13, 311-317: I prefer when this part was inserted in the results description. The cell classification is a tool to analyze the spatially heterogeneous response of the catchment. I would even suggest to merge the figure 7 and the figure 14, keeping only the 50 classes categorizations of the figure 7 used in the Figure 14. Moreover I don't understand the first sentence and the expression "soil-rainfall-discharge coupling holistically". Another option would be to introduce this in the same section as the virtual tracers.

Page 14, figure 6: in the Hydrological modelling panel, the storage tanks are called "Ti", but the "Si" parameters are not mentioned as the legend does.

Page 14, title section 3.1.1: the modelling modifications are not only related to runoff but to all the lateral flow; I would suggest to call this section "Lateral flow modelling modifications"

!!! Page 15 – 16: the variable Ai(t), called in the text "sectional area of the storage", has actually no unit [-], according to the equation (6). Reading Velez's thesis, it seems rather to be a coefficient. The actual sectional area is Si(t)*Δx. This error makes the understanding of the equation really complex, and even makes me doubt about the meaning of the equation.

Page 15: definition of vi: I'm not familiar with the dimensionless variable Ai you defined. I used to use relationship between velocity and hydraulic radius or storage water level.

Page 15-16, equations 1- 8: I would suggest to present the general equations that control all the lateral flow first (eq. 7, 6, 1), before indicating the particularity of each tank lateral flow (eq. 2-5).

Page 15, line 334: please call the slope in a different way, it might be confused with the tank levels Si.

!!! Page16, equation 5: how we are suppose to understand the equation? There is more exponents than parameters.. please also simplify, specially if at the end you will use a regional parameter deduce from any catchment.. Here what is important is the fact that v_5 is depending not only on A_5 but also on the stream bed slope. Only 3 parameters should appear : $v_5 = \beta * Si(t)^{\alpha} * slope^{\gamma}$

Page 16, page 366-367: Δx versus L: Actually according to Velez, 2011 page 89; the Δx variable used his thesis correspond to the cell width; i.e. the resolution if the flow direction is orthogonal or res/sqrt(2) if the flow direction is diagonal...

To summary the remarks I did from page 12, line 290 to page 16, line 372, I would suggest to reword more or less as follow:

"3.1 The Tetis hydrological model

We used a physically-based and distributed model developed and described in Vélez (2001) and Frances et al. (2007). The spatial distribution and the hydrological flow path schema is based on the 12.75 m resolution DEM data. In each cell, five tanks represent the hydrological processes including capillary (tank 1), gravitational (tank 2), runoff (tank 3), baseflow (tank 4) and channel storage (tank 5). The state of each tank varies as a function of vertical and lateral flows as shown in the diagram, where the storage is represented by Si [m] and the vertical input to each tank by Di *[m], which in turns depends on the vertical flow through tanks Ri [m]. Ei represents the downstream connection between cells, except for tank 1, where E1 represents the evaporation rate.*

The original model fully described in Vélez (2001) and Frances et al. (2007) are modified to improve the representation of the flow processes that occur during flash floods (see section 3.1.1). In addition, two analysis tools of the hydrological modelling results are introduced: virtual tracers tracking precipitation origins as well as water paths over or through the soils; and catchment cell grouping (see section 3.1.2). The tools objective is to allow an analysis of the spatially distributed response of the catchment.

3.1.1 The hydrological lateral flow

From water balance applied on a cell, Velez (2001) defined the lateral output of each tank (Ei) as follow:

(1) $$Ei(t) = Ai(t) * vi(t) * \Delta t$$

Where Δt [s] is the calculation time step, vi(t) [m/s] the lateral flow velocity and Ai(t) [-] the dimensionless section area of the tank defined by:

(2) $$Ai(t) = Si(t) / (vi(t) * \Delta t + \Delta w)$$

with Si(t) the tank storage [m] and Δw the cell width [m].

To solve the equation (1) and calculate Ei(t), the unknown vi(t) has to be defined. The lateral flow velocity is usually linked to the water level (Si(t)) of the storage through the general definition

(3) $$vi(t) = \beta * Si(t)^{\alpha}$$ *(or Ai(t) in your case, but I don't know how to introduce it).*

where α and β are parameters depending on the flow environment (flow in porous media, free surfacic flow, geometry of a channel, …). While the original version of the model used linear relationship between vi(t) and Si(t) for all the tanks (not sure); we modified the equations to better represent the non linear increase of the velocity in overland (v2), subsurface (v3) and channel flow (4).

+ description of the choice of (vi,Si) relationship base on lines 328 – 341.

3.1.2 Tools for spatial analysis of the results: virtual tracers and catchment cell grouping"

[...]

Page 17, line 396: hydrological and not hydrologic

pages 17, line 410 – 412: I would suggest to speak about the calibrated parameters rather than the non calibrated parameters

page 18, table 3: the parameters you mentioned in the table are not in the related equations …

page 18, table 3: Assuming the velocity parameters correspond of the velocity of each flow when the related water storage is equal to 1; I would expect the increasing magnitude order: Subterranean speed, subsurface speed, surface speed, channel speed. How can you explain that the subsurface speed is higher than all the other ones?

page 18, line 417: please remove “above the slip surface $Z_{i,w}$”.

I.2. Description of the Hydroflash *model :*

page 19, line 441: I suggest the following title “the floodplain submodel Hydroflash”

page 21, line 477: $A_{i,sed}$ meaning: Is really the flooded area (area along x,y) or the sectional area along the cross profile (area along z,y, x being the stream flow direction)? According to the attributed name, it seems to be the first definition; but according to the figure 9, I would say the second definition. It makes a big difference...

page 19-20 : Hereafter I’ll suggest some rewording, introducing ALL the annotations. The equation references has to be added. It is roughly drafted. Please, feel free to integrate or not.

“The HydroFlash submodel is designed/developed to interpret the hydrological model simulations as floodplain inundations (figure 9). For each stream cell and at each time step, the submodel: i) calculates the stream discharge including sediment load (eq. 14 – 18, Rouse, […], Takahashi, 1991); and ii) determine the resulting inundated cells according to the cross-profile of the stream, the sectional area, and the stream velocities when including the sediment load (eq. 17 -21, Takahashi, 1991).

I) To determinate the stream discharge ‘including sediment load/transport’ (Qsed) (→ has to be reformulate), a realistic channel width is firstly calculated according to Leopold (1953) approach:

$Wi = 3.26Qi^{-0.469}$

Then assuming a infinite sediment and ruble supply, the equations 14, 15, 18 are successively applied to deduce from the channel width W_i, the water level Y_i (eq. 14), the friction velocity $v_{fr,i}$ (eq. 15, Keulegan and rouse equation, REF), the sediment concentration c_i (eq. 16) and finally the sediment loaded stream discharge (eq. 18). The above mentioned relationships depend of 2 meaning parameters: the maximum sediment concentration (C_{max} [-]) and the characteristic diameter of the sediments D_{50} [m]. Both are assumed to be constant and respectively equal to 0.75 (O’Brien, 1988) and 0.138 (Golden & Springer, 2006).

ii) To calculate the inundated cells, the flood depth (F_{di}) and the sectional area of the stream ($A_{i,sed}$) are iteratively calculated along the cross profile to reach the relation between the stream discharge with sediment load ($Q_{i,sed}$) and the morphological properties of the cross profile. The latter is defined by the DEM. The relationship between $Q_{i,sed}$ and the morphological properties of the stream (F_{di}, $A_{i,sed}$) is defined in eq. 19:

(19) $$Q_{i,sed}(t) = (1/5)\, ri(t) * (F_{di}^{N})^{3/2} S_o * A_{i,sed}^{N}$$

where ri is the constitutive coefficient of the flow, defined in eq. 7, summarizing the flow dynamics associated with sediments and colliding particles.

And with:

(20) $$F_{di}^{N} = Fdi^{N-1} + \delta y$$

(21) $A_{i,sed}^{N} = \delta x\ sum(from\ j=1,\ to\ = N)[F_{di}^{N} - E_{bedi}^{j}]$ *with* $E_{bedi}^{j} < F_{di}^{N}$

with :

- E_{bedi}^{j} *the DEM elevation of the Nth cross-profile cell closest to the stream cell*
- δx *the cell resolution*
- δy *the flood depth incrementation in the iterative process.*

Page 19-20, about the HydroFlash model: I'm curious to know about the ratio Qsed/Qsim: what is the range of value of c? Is there a significant change to include the sediments when calculating the floodplain?

II. Comments on the results and discussion

- page 21-22, section 4.1: On the one hand, the model simulated a flood peak in the upper range of the discharge peak assessment and the simulated flood peak occurred 20 minutes earlier than the observed one. On the other hand, when doing the sensitivity analysis on the surface speed parameter, decreasing the runoff velocity, the simulated flood peak is diminished and occurs later. Why didn't you calibrate better the surface speed, as the model is sensitive ?

- Page 22, line 506-511: I think those results are insights of the paper. They should be discussed in the discussion part to confront them to the literature (if there is) and to highlight them.

- Page 25, figure 13: the specific flood peaks are interesting. The simulated values are below the envelopp Qpeak = $97*A^{-0.4}$ that make the simulated flood peak consistent with the litterature on flash flood (Gaume et al. 2009). You should mention it on the discussion to strengthen the flood peaks simulation consistency.

- Page 27, line 595-600: I think my previous comment was misunderstood. I think you were right saying: "In event 2, the convective rainfall and the runoff show a similar evolution, denoting a strong influence of the convective portion (figure 12b)". But I think there were one unmentioned condition to observed similar evolution. The similar evolution comes from the fact that the convective portion is totally controlling the runoff processes AND that there is no effect of the stream network to modify or temporize the runoff advent at the outlet. In other words, it's possible to get strong influence of the convective rainfall runoff without having similar evolution, if the stream network buffers the runoff advent.

- Page 27, line 615-617 about the soil depth definition: You justified here the scaling factor by adjusting an underestimated soil depth observation. But then it means that the soil depth definition previously chosen for your hydrological model are also underestimated. I would rather assume that you need to calibrate the model to make the landslide occurring. The scaling factor might explained as to be an artifact of a too simplistic model, and a non calibration of the other parameters.

- Page 29, line 631-632: This comment should appear in the end of the discussion or in the conclusion, not in the result section.

- Page 31, line 669-670. I would refer to Zocatelli et al (2011) as following "Zocatelli et al (2011) found similar results in … (where, and which size of catchement)." As you wrote, it seems that Zocatelli et al (2011) found your own results.

- Discussion: As said before, it would be nice if the results of the landslide model and of the floodplain model are discussed. Here some ideas for the landslide model.
  The facts:
  - your model relates landslides to soil depths, soil water content and topography.
  - the soil depth spatial distribution is roughly done according to the topography.
  - Landslide occurring is therefore only related to soil filling and the combined 'topographical-soil depth properties'.
  - 1) Crossing topographical map and false simulated landslides location, those latter ones seem to appear where there are slope greater than 2. → Is 20 cm soil depth on a 2 slope realistic? Or could it explain the false simulated landslides?
  - 2) The observed landslide is observed where the amount but all the intensities of the rainfall are the highest. → Could the rainfall intensity have an impact on landslide and explain why the model is failing (as not taking into account).

III. ***Technical comments:***

- Page 5, line 120: As said before, keep the same name to call the different submodels of your modelling framework : I would suggest to use 'hydrological model' and even use it name 'Tetis' (Velez et al, 2002), for the first modelling part; 'landslide submodel' for the second modelling part and 'HydroFlash floodplain submodel' for the third modelling part.

- Page 5, line 122: choose to totally insert or remove "assumes infinite sediment suppply and'

- Page 5, line 123: 'hydrological' and not 'hydrologic'

- Page 5, line 122-129: please put the small description in the order it appears in the text: first the hydrological model, second the landslide submodel, third the HydroFlash floodplain submodel.

- Page 6, line 149-153: From my point of view, I would remove those sentences from this section. The aim of the section is to describe the catchment, not to come back on the objectives of the study. If you want to emphasize the challenge to work with scarce physiographical information, you should mention within the introduction for example when speaking to ungauge catchment (end of line 112 for example).

- Page 6, line 166: by brackets, I would say ().

- Page 8, figure 3: please ad the zoom number on the first top window.

- Page 8, line 195 and somewhere else in the manuscript: unity should not be in italic font.

- Page 10, line 241-242: remove the sentence "the results of the radar [...]" as the same information is done in the sentence line 238-239.

- Page 12, title of the section 3.1: I would suggest to choose “the hydrological model Tetis” as there is only the description of the model in this section (and not the 2 linked submodels). Or do you consider the that the framework consists in the the model plus the analysing tools (tracers and catchment cells grouping)?

- Page 22, line 510: please remove “On the other hand”.

- Page 22, line 517: ‘According to the model simulations, the peak flow occurred at **approximately** 2.20am LT’: Why did you say “approximately” ? You have a solely simulation, that should give **exactly** one flood peak time.

- Page 22, line 521, when describing the figure: To make easier the manuscript reading, you should mention the studied parameters in the same order they appear in the figure: parameter of the top panel, parameter of the center panel, parameter of the bottom panel.

- Page 23, line 534: please define the acronym ‘SIATA’

- Page 23, line 545: write ‘skillfully’ and ‘skillfylly’

- Page 24, figure 11: write ‘top’, ‘center’ and ‘bottom’ panels instead of ‘left’, ‘middle’ and ‘right’ panels

- Page 27, line 617 and table 4, page 19: The scaling parameter for the soil depth is not the same within the text and in the table.

- Page 28, line 622-624: I would remove those two sentences.

- Page 31, line 656: “abilities” or “capacities” instead of “capabilities”.

- Page 32, line 691: Event 1 and 2 as you already choose the brackets to distinguish between convective (stratiform) events.