

# ***Interactive comment on “Frequency and intensity of palaeofloods at the interface of Atlantic and Mediterranean climate domains” by B. Wilhelm et al.***

## **Anonymous Referee #2**

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### GENERAL COMMENTS

The manuscript ‘Frequency and intensity of palaeofloods at the interface of Atlantic and Mediterranean climate domains’ by B. Wilhelm and co-authors presents a 1100 yr long paleo-flood reconstruction from the French Alps, with the study site influenced by both N-Atlantic and western Mediterranean weather patterns. The study characterizes the sediment record via high-resolution geochemical and geophysical proxy data, and describes well the detection of the flood-induced sedimentary deposits. The manuscript represents important work in order to better differentiate and define the influence of N-Atlantic and Mediterranean weather patterns on different regions of the Alps on the

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historical to geological time scale. I have, however, important concerns regarding the use of the flood-deposit thickness as proxy for flood intensity. The authors describe that the grain size, which is directly depending on the acting hydraulic force of the river, is relatively uniform among the deposits and can therefore not be used as a proxy for flood intensity. Instead, the thickness of the deposits is used as an indicator of the intensity of the reconstructed floods. In my opinion, this approximation does not hold and has to be reconsidered (see major remark #1 below as well as further comments on the text), which means that the manuscript would need to be substantially revised.

#### MAJOR REMARKS:

1) Deposit thickness as proxy for flood intensity: The approximation of flood intensity using the thickness of the deposits does not seem to hold for Lake Foréant. As you indicate on lines 4949-2to7 grain size would be the best proxy for flood intensity. On lines 4953-20to23 and 4959-6to9 you mention that there is no significant grain-size variability that could give an indication on flood intensity, and that you therefore use the deposit thickness as proxy for intensity. As a result, you find that the intensity of the events during the warmer MCA is higher than during the cool LIA (Fig. 8). This is not a legitimate conclusion, as you have no proof (or calibration) showing that deposit thickness is really proportional to flood intensity. During the MCA, floods occur less frequent than during the LIA and a sediment storage effect in the catchment could therefore become highly important. For MCA floods, which occur at longer time intervals, more sediment is thus available for mobilization by the river because the catchment has not been 'emptied' for a longer period of time than during the LIA. In this context, please also see my second-last comment on the discussion part. The study with the fungal spores is helpful for ruling out anthropogenic influences on sediment mobilization, but you still have to take into account natural sedimentary processes acting in the catchment. In my opinion, the thickness of the deposits can therefore not be used as a proxy for flood intensity. As a consequence you would need to adapt the focus of this study ('Frequency and intensity ...') and text passages referring to intensity. An additional

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remark regarding the grain-size results: The results are only shown as a small inset in Figure 2, and you mention it shortly on lines 4953-20to23 and 4959-6to9. However, at these positions in the text you do not show or describe your results but you add many references. The effect is that it looks like the grain-size results were published in the indicated references. Instead, I propose that you show the grain-size results more prominent in this paper.

2) ‘Turbidites’, ‘debrites’ etc: My impression is that the use of the terms ‘turbidites, debrites, event layers, and flood deposits’ may be a bit confusing and is not consistently used throughout the manuscript. Furthermore, for the MMIT (mass-movement induced turbidite) I do not really agree why you have to separate the deposit into a turbidite and a debrite. Sedimentologically I might understand your aim, but still, it is one single event that leads to the deposition of the debrites and the turbidite on top. So why not simply call the complete deposit MMIT and describe in chapter 4.1 how it is composed. This would leave you with 168 flood deposits and 3 MMITs. Instead of 171 turbidites minus the 3 turbidites belonging to the MMITs. In addition, in the methods section you already speak of event layers (4948-20) that were detected by density anomalies, and of flood deposits (4949-13) that were detected by geochemical data. Is there a difference here between event layers and flood deposits? In section 4.1 you then speak of coarse-grained layers or graded beds or turbidites. In total, this is a bit confusing and I propose that you speak of detrital layers or event layers (if necessary with, for instance, the addition ‘coarse-grained’ or ‘homogeneous’) as long as you haven’t interpreted the trigger. Afterwards, you can speak of flood deposits and MMITs. The term turbidite: you mention that the grading is very weak in the detrital layers. I am therefore not convinced that the term ‘turbidite’ is sedimentologically appropriate here. Maybe it would be better to omit the term ‘turbidite’ and speak of detrital layers or event layers, as outlined above.

3) XRF counts as quantitative indication of element concentrations: You use the low XRF core scanning Ca counts in the sediments as direct indication that Ca concentra-

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tions are indeed low compared to the concentration of other elements. XRF core scanning results are qualitative and many factors (e.g. sediment matrix, machine-specific properties) influence the counts. Have you calibrated the results via e.g. ICP-MS? The assumption that the counts are proportional to the element concentrations is speculative, unless you have additional data to show it.

#### DETAILED REMARKS:

TITLE According to my point 1 above you might have to adapt.

#### ABSTRACT

You should mention in the abstract that you reconstruct mid-June to mid-Nov (i.e. summer-fall) events, this seems important.

4944-5: See my comment #2 about the term turbidite.

4944-6: See my comment #1 about thickness as intensity proxy.

4944-9: What do you mean with 'typical of both climatic influences'? You need to explain a bit more here.

4944-13to14: You might want to indicate the age range of the MCA and the LIA in years AD.

4944-15: It is not intuitively clear that you refer to high-intensity events with 'these events'. Please reformulate. Also see my comment #1.

4944-18: What do you want to express here? You need to specify more what you mean with 'uncertainties', 'extremes' and 'forcing factors' that you list.

#### INTRODUCTION

4945-1: Replace 'trigger' with 'lead to'.

4945-18: Delete 'the' in front of 'climate variability'.

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4945-27: '...: Atlantic in the north and Mediterranean in the south.'

4945-27: 'north-western' part of what? Of the Alps, of the Mediterranean?

4946-3: Please specify. It is not clear what you mean with 'changes in atmospheric circulation' and 'pathways and intensity'. As a reader I would like to see here a short explanation and do not want to extract the necessary information from the references.

4946-10: Rather 'in this context' or 'in this framework'.

4946-14: Add the country.

## REGIONAL SETTING

Title 2.1: 'Hydro-climatic setting and historical flood record'

4946-17: 'located between the northern and southern French Alps' -> Why not 'central French Alps'?

4946-26: Rather 'to the Queyras massif' instead of 'until'.

4947-7: 'was' instead of 'have been'.

4947-16: '... , whose hydro-climatic settings are characterized by the south-western and north-western flood pattern, respectively (...).'

4947-22: 'alluvial plain' 4947-22: 'meandering'? This seems rather characteristic for downstream river reaches in settings with a very low slope gradient and not for a mountainous area. Maybe delete the addition about the 'meandering branches' and only use 'alluvial plain'.

4947-25: 'They enter the lake through only small deltas compared to the Bouchouse inflow area, suggesting limited detrital input.'

4947-26: What do you mean here with 'glacial deposits'? I expect that this catchment was glaciated in the past, thus I have difficulties to believe that there are no 'glacial deposits' in the forms of sediments (moraines etc.).

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## METHOD

4948-8: 'was' instead of 'has been'.

4948-9: Looking at the lake map it rather seems to be the axis between the main inflow (Bouhouse stream) and the outlet.

4948-20: 'Bulk density was used as a proxy for identifying event layers, ...' The information about the time ('deposited in a short time') is not necessary in this context, i.e. for detecting the event layers via density, and can be deleted.

4949-1to2: What was the concentration of the hydrogen peroxide? What was the temperature of the bath? Did you control after treatment if all organic matter was dissolved (e.g. microscope, organic carbon analysis)?

4949-3to4: Please specify what you mean with 'transport-deposition dynamics'.

4949-6: 'Grain-size variability' does not reflect the 'maximum discharge volume'. Rather, the grain size is assumed to be proportional to the river discharge. Please reformulate.

4949-12to13: The proposed proportionality of XRF core scanning counts and element concentration is not given for all sediments. Tachikawa et al. (2011) could show this, but it does not necessarily apply to your sediments and the XRF core scanner you used. Without quantitative measurements (e.g. calibration via ICP-MS) I therefore recommend to not interpret element quantities from XRF counts. See also my main comment #3.

4949-23: Rather 'grazing activity' or 'grazing intensity' than 'grazing pressure'.

4949-24: '... from the sedimentary abundance of coprophilous...'

4949-27: What is the depth interval of the samples?

4949-28: Potentially erosive 'event layers' and then on the next line 'turbidites'. This is

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already a lot of interpretation for a method sections. See also main comment #2.

4950-6: What does 'nb' stand for? I assume number but it is not explained.

4950-11: Rather 'For dating the lake sequence...'

4950-13: What do you want to say with 'matching the facies boundaries'? It is the first time that you use these terms here.

4950-27: The information about how you modeled the age-depth model should only be given after the paragraph on the paleomagnetic chronological markers.

4951-3 and following: This is quite a long and detailed explanation on the paleomagnetic chronological markers. Any chance to make this shorter? Or move details into a supplement? What I am missing in this paragraph is actually how you attributed an age to your measurements.

## RESULTS

4952 first three paragraphs: See my main comment #2.

4952-21: '... over the entire lake basin with a consistent deposition pattern.' Delete 'indeed'. The deposition seems not to be 'regular' in terms of thickness.

4952-24: Please specify what you mean with 'over time'.

4953-10: What do you mean with 'well-measured'?

4953-13: Can you provide evidence or ideas where the Fe is incorporated?

4953-20to23: 'However, since grain-size variability is insignificant, the information that can be won from this proxy in regard flood-intensity reconstruction is minor.' Or similar.

4953-24: 'Relative Ca intensities'. Relative to what? See also my main comment #3.

4954-5: You have not yet introduced the abbreviation 'FIT'.

4955-26: Abbreviated formulation with parenthesis is not intuitively clear. '3 (2) decli-

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nation (inclination)'

4956-6: '(without event layers)'

## DISCUSSION

Title 5.1: 'Different triggers for event layers'

4956-18: 'Ca counts'

4956-19: Please specify here what you mean with 'other turbidites'.

4956-24: What would you like to implicate with these angles of delta and littoral slopes? Do you have numbers for Lake Foréant?

4956-4-6: These first two sentences do not belong here as they discuss event deposits in general and MMITs, but not flood events.

4957-9: 'Ca counts'. See also main comment #3.

4957-17: So what is the effect of oxygen reaching the deeper parts of the basin? I think you should add here the information that Mn-oxides or Mn-hydroxides may precipitate because of this oxygen source.

4957-24 and following: This last sentence of the chapter is not clear. E.g. 'to trigger them', not clear what is triggered?

4958-7to8: A lowering of the lake level still seems to be possible. This would lead to slope destabilization.

4958-23: 'Only a few earthquakes' seems not to be a good expression here, since you wish 'one single strong earthquake' in the database in order to be able to attribute a specific age to the deposit.

4959-7: You should specify what you mean here with 'related proxy' (in parenthesis).

4959-10 and 4959-8to11: As described under comment #1 I am not convinced that this

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intensity approximation via flod-layer thickness holds.

4959-20: 'flood events' 4959-20 and following: I do not understand what you mean with 'almost absence' in regard to documented events of the Bouchouse stream and how that affects your comparison with historical records.

4960-18to19: What exactly should be the difference between a 'catchment-lake system' and a 'river-lake system'? Please specify what you mean and maybe it is clearer when you omit these abbreviations.

4960-22: Rather 'alternating activation'? What 'record' will be disturbed? This does not become clear from the sentence.

4960-28 to 4961-11: Here you address quite well what I mentioned in my comment #1. This alluvial plain is able to store large sediment volumes, which would impact your flood-intensity record. I am particularly concerned because of the very limited grain-size variation in the flood deposits. Hence, no information at all about the hydraulic force of the river can be won (i.e. about the river discharge volume).

4961-21: Here you write 'cells cm<sup>2</sup> yr<sup>-1</sup>', in the method section you wrote 'nb cm<sup>2</sup> yr<sup>-1</sup>'.

4962-8to15: Before you can draw this conclusion you should show that your record relates to the Giguet-Covex record and the former Wilhelm data. Here, it is too early to bring this proposition forward. You should therefore continue here directly with the next paragraph (line 16).

4963-3to4: See my main comment #1.

4963-18to19: Rather '... due to moisture advection from the North Atlantic.'

4963-19 to 4964-19: You will have to reconsider this discussion on flood intensity. See my main comment #1. Most importantly, if you calculate the ratio of the number of events per century during the LIA (17) and the MCA (10) and you compare it to the ratio of the thickness (LIA: 2.4 mm; MCA: 3.8 mm) you would get very similar values:

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1.7 for the number of events and 1.6 for the thickness. Thus, what I want to point out here is that the larger thickness of MCA events could simply be due to the longer storage (thus residence) time of sediment in the catchment. Hence, you would really need the grain size as a flood intensity proxy to make a case here. In addition, you bring forward that the thickness of MCA events (3.8 mm) is 50% larger than the thickness of LIA events (2.4 mm). These '50%' depend on the perspective; one could also argue that LIA events are one third (only) thinner than MCA events.

4964-23to29: This discussion on possible forcing factors such as solar activity and volcanic eruptions, as well as the possibly different situation during the 20th century due to the increase in greenhouse gas concentrations, comes a bit sudden here. If you wish to keep it you have to elaborate more on the potential influence of the different forcings – even if you say that deeper analysis is necessary.

## CONCLUSIONS

4965-3: Delete 'show'.

4965-11to13: Even if there is a consistent depositional pattern in the lake basin, this is unfortunately no proof that the thickness is proportional to flood intensity.

4965-24 to 4966-6: Again, you will have to reconsider your argumentation in regard to flood intensity.

## FIGURES

Figure 2: This figure would profit from a zoom into an interval of about 10 cm length in order to better demonstrate how geochemical and sedimentological proxies fluctuate between normal sediment and event layers. As it is, it is hard to see how in particular the geochemical proxies vary with the occurrence of event deposits. The unit of the sediment depth is wrong: it should be 'cm' and not 'm'. I assume 'thinner' should be 'finer' (Fe/K column).

Figure 3: The caption could profit from a short explanation why you are plotting this

data. (I assume for illustrating the different geochemical characteristics of the different event layers.)

Figure 4: What is 'MP' standing for?

Figure 5: Here you need to indicate what the abbreviations D-1 etc. and I-1 etc. stand for. stands for. This is also necessary because the abbreviation appear in the following figures.

Figure 7: Please indicate in the caption that the question mark refers to a possible gap (am I correct?) in the historical data.

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Interactive comment on Clim. Past Discuss., 11, 4943, 2015.

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