Response to the reviews

For the Referee #1

The authors would like to thank the Anonymous Referee #1 for his valuable comments and suggestions, they will be seriously taking into consideration and corresponding corrections will be made in the next version of the manuscript. However, we present some clarification and answers (R) to his questions (Q) in the following text :

Q : I do not understand why the authors have not performed statistical analyses other than one PCA. This is clearly lacking and the authors must more thoroughly investigate their claims (see my previous review). To mention the use of XL-STAT is not enough to justify robust conclusions. I agree that the authors should use a PCA of modern samples to test the sources of sediment deposits, but the authors should use further statistical tools to test the value of the data obtained. The authors must use PCA or other statistical analyses on their core deposits to test the reliability of their signal. Secondly, they must compare their present-day dataset (their PCA) with the two cores. The authors must objectively demonstrate their conclusions.

R: Thank you very much again for your comment. We applied the same PCA on all the data from the two cores. Based on these statistical analyses of all geochemical data (surface sediments and cores), three distinct sources of sediments were identified. So we can conclude that the PCA result of cores confirms the results obtained by the PCA of surface sediments. Many techniques have been developed for this purpose, but principal component analysis (PCA) is one of the oldest and most widely used statistical techniques in environmental geochemistry. This multivariate approach is used to reduce a large number of variables that result from XRF analysis. PCA was applied to elements to distinguish the different sediment sources of surface sediments and link them to the geochemical processes or proprieties.

For the Referee #Raphaël Paris

The authors would like to thank Professor Raphaël Paris for his valuable comments and suggestions, they will be seriously taking into consideration and corresponding corrections will be made in the next version of the manuscript. However, we present some clarification and answers (R) to his questions (Q) in the following text:

Q: It is really necessary to revise English (by a native).

R: The english have been revised by a native.

Q: The bibliography is not up-to-date or sometimes not appropriate (e.g. lines 41 or 50).

R: Done

- Section 2.1 could be renamed "Geological and geomorphological setting"

R: Done

Q: In section 3.2 you should clearly distinguish analyses using a XRF handheld device (bulk samples), and XRF core scanner analyses.

R: Done. These analyses were realized by an XRF handheld device

Q: In the results, I would present first the XRF and grain size analyses on cores, and then the possible sediment sources. Please consider inverting sections 4.1 and 4.2.

R: Done.

Q: Lines 144-155 should moved to the beginning of the section, and links should be proposed between the Ti, Si, and Fe trends, and the lithology of the catchment area.

R: Done.

Q: In section 4.2. you should present first the characteristics of the cores, and then the age model (thus inverting 4.2.1 and 4.2.2).

R: Done.

Q: Does the age model takes into account the "event" deposits in terms of thickness and depth correction?

R: Yes, the age model takes into account every event deposits in terms of thickness and depth correction

Q: The statistical analysis (e.g. PCA) must be carried out FIRST on the XRF downcore data, which is of better quality and more reliable than data from mobile XRF.

R: Done. A statistical analysis PCA has been applied on the XRF downcore data and, they confirm the result obtained by the surface sediment with the three poles.

Q: The XRF data should be presented not only as single element curves (in cps rather than ppm?), but also as ratios of elements (e.g. Ca/Ti on normalized values, or ln(Ca/Ti)). PCA analysis should be run using normalized values. Then the sedimentary facies should be compared with the main components in order to identify the sediment end-members (e.g. marine vs continental).

R : The elemental concentrations obtained in this work using the hand-held Nitron XL3t (not by the XRF core scanner analyses) are expressed automatically in ppm or percentage values.

In order to interpret such datasets, methods are required to drastically reduce their dimensionality in an interpretable way, such that most of the information in the data is preserved. Many techniques have been developed for this purpose, but principal component analysis (PCA) is one of the oldest and most widely used statistical technique in environmental geochemistry. This multivariate approach is used to reduce a large number of variables that result from XRF analysis. PCA was applied to elements in order to distinguish the different sediment sources of surface sediments and link them to the geochemical processes or proprieties.

Q: The cores are poorly described. You defined three units, and later proposed 5 phases in the discussion. How are these units defined? We really need a more detailed description of the cores (main units, subunits, sedimentary facies, discontinuities, sorting, vertical grading, etc.).

R: We have considered your comments and, we have formulated this paragraph in the new version as following

The GEM3 and GEM4 sediment cores of 97 and 126 cm long show visual variation in the sediment composition. Lithological description of these two cores highlighted five distinct sedimentary facies (Figure 2):

The first unit (1), situated between 126-67 cm in GEM4 and between 97-85 cm in GEM3, is composed generally of a light grey silt layer and shells. At the base (the last 3 cm for the GEM3 and the last 13 cm for the GEM4) the lithological composition of this unit is characterized by a very thin fine sand. For the GEM3, the transition between unit (1) to unit (2) is defined by a sharp contact (Figure 2).

The second unit (2), situated between 85-63 cm in GEM3 and between 66-60 cm in GEM4, is typically composed of a light grey sand with a combination of shell fragments and siliciclastic grains. It is probably related to marine incursion and washover event during an intense event such as a storm or tsunami.

The third unit (3), situated between 60-36 cm in the GEM3 and between 63-30 cm in the GEM4, is composed mainly of grey silt and shells. In fact, the transition between this unit and the unit subjacent is defined by a discontinuity contact (Figure 2).

The fourth unit (4), is about 10 cm think in GEM3 and 6 cm in the GEM4. This coarse layer is constituted by a mixture of shell debris and siliciclastic sand. This sand layer is usually characterized by coarse sediments with light colours and also dominated by shell fragments. This coarse grain size layer intercalated in the mud sediments indicates an “energetic” event, relative to the background sedimentation. It is probably also linked to washover event and marine incursion during an intense event such as a storm or tsunami.

The fifth unit (5) presenting a thickness of 26 cm (GEM3) and 24 cm (GEM4) and marked by a massive grey to dark clay with trace of oxidized plant roots in the last three centimeters.

Q :Then perhaps you will be able to provide some clues on the distinction between (a) storms, (b) periods of increasing storminess (successive storms), or (c) tsunami.

R: Both tsunamis and storms are considered extreme sea events and can cause short coastal flooding with high overland flow velocities. The sedimentary characteristics of tsunamis or storm deposits are almost similar (Hawkes et al., 2007; Kortekaas and Dawson, 2007; Morton et al., 2007; Mamo et al., 2009). Hence, the distinction between these two coarse deposits is still controversial and several studies have pointed out many hypotheses regarding the diagnostic characteristics of storm or tsunami deposits (Kortekaas and Dawson, 2007; Morton et al., 2007; Tappin, 2007; Engel and Brückner, 2011; Sakuna-Schwartz et al., 2015). For example, Morton et al., 2007, used some sedimentological criteria to distinguish storm from tsunami deposits. According to them, the storm-originated deposits present a moderately thick sand bed composed of several sub-horizontal planar laminations organized into multiple laminates. The stratification associated with bed-load transport and abundant shell fragments organized in laminations also favors a storm origin. In contrast, the presence of internal mud laminae or mud intraclasts is stronger evidence of tsunami deposits. However, in our case, the sand bed that corresponds to the extreme event is characterized by a single homogeneous bed (6–9 cm thick) with no evident sedimentary structures (such as laminations) that correspond neither to storm nor tsunami deposits. To precise the origin of our thin coarse layer, we explored the regional historical storm's records and tsunamis data.