(1) comments from Referees, (2) author's response, ***(3) author's changes in manuscript.***

Reviewer #1 : General comments

We would like to thank Reviewer#1 for his/her encouraging comments and suggestions. We agreed with most of them as detailed below in the point-by-point response.

Despite some comments (most of them minor) on the content and the analyses, my major concern is on the presentation of the manuscript as it results quite difficult to be followed. I recommend several changes in the structure of the manuscript and I also encourage to check carefully the English. I am not English speaker but I have noticed a numerous mistakes and in general it results hard to be read.

The manuscript was edited by the American Journal Experts (AJE) for proper English language before submission (the certificate can be checked online at https://secure.aje.com/certificate/verify using the following code : 7D86-4248-2DE6-554A-A32F). However, we will strive to improve the readability in a new version of the manuscript. If the Editor requires further editing we can ask for another review.

The most important changes in the structure of the manuscript are: - I would drastically reduce the length of the methods section and I would add specific information on the different techniques (glacier mass balance, geodetic techniques, GPR, radar, etc) as supplementary material. Otherwise, it results unbalance the length of the methods section and the one devoted for presenting results.

To reduce the length of the methods section, we propose to move systematically the details on the errors estimation for each metric to the supplementary materials. We will only expose in the text the results of the errors estimations (also summarized in Tab.2 and 3). We believe that this will considerably simplify the methods section. Relevant passages are p.2441 l.4 to l.19., p.2444 l.5 to l.18., and p.2446 l.16 to p.2447 l.24.

- I would move the presentation and discussion of figures 11 and 12 to results sections. Specifically, figure 11 should be moved to section 5.4 (linkage between glaciers evolution and climate) and Figure 12 should be presented in section 4.5.

Thank you for this comment. We will move Fig. 11 and Fig. 12 to the Results section as suggested.

I would rewrite the conclusions section as it contain information that does not summarize the main findings, but are hypothesis that should be presented in discussion.

The conclusion will be rewritten to summarize the main results, namely i) Main phases of the Ossoue glacier evolution since LIA based on the combination of its reconstructed metrics ii) Comparison with other glacier reconstructions in the Pyrenees and the Alps iii) Comparison with meteorological time series iv) estimated date of Ossoue glacier disappearance.

Regarding the methodology, I do not have major comments, except that prior to correlate mass balance and climatic series, both should be previously detrended. As authors correlate series that both exhibit significant trends, the correlation between them may be spuriously enhanced.

We thank the referee for this suggestion. We will indicate the correlations after detrending with a linear fit in a revised version. For information, after detrending we found the following correlation matrix:

Variables	T Gavarnie	T Pic du Midi	T CRU	P Gavarnie	P Tarbes
Period of Record	1992-2012	1882-2013	1858-2013	1992-2012	1882-2012
$B_{glac.a}$ 2002-2013	ND	-0.57	-0.66*	ND	0.74*
B_{summer} 2002-2013	-0.75* (-0.8*)	-0.71*(-0.75*)	-0.72*(-0.8*)	-	-
B_{winter} 2002-2013	ND	-0.38	0.15	0.71*	0.72*

Tab. 1. Correlation matrix (Spearman's s) between the meteorological time series and the Ossoue Glacier mass balances components (calculated in a fixed date system, Cogley et al., 2011). Correlation values given in parenthesis are based on the monthly mean values. Significant correlations (p values<0.05) are marked with asterisks. The Gavarnie time series was not complete enough to perform the correlations between the annual mass balance and the annual mean temperature and precipitation over 2002–2011; we reported a no data value (ND) in these cases.

The correlations remain similar or even higher than previously reported, except for the correlation between the CRU mean annual temperature and the annual glaciological mass balance (-0.66 instead of -0.74).

Minor comments

I think that references of Chueca-Cía et al., 2007; Trueba et al., 2007 and López- Moreno et al., 2006b should be used in more detail to support different parts of the introduction section.

We agree that these papers are important to present the context of our study. However we are a bit puzzled because we have already cited these references several times. In particular they are the key studies in the Section 2 devoted to "Glaciers study in the Pyrenees"

- Chueca et al., 2007 was cited:
    - in introduction (p2434 line 23: "*Pyrenean glaciers are strongly out of balance with regional climate and are retreating quickly (Chueca et al., 2007)*")

- in Section 2 (p2435 line 19: "*In the middle of the 19th century, after advance and recession phases, the Pyrenean glacier fronts reached positions close to their maximum LIA extent. At that time, the area of Pyrenean glaciers is estimated to be slightly over 20 km2 (Chueca et al., 2007)*", p2437 line 12: "*the reconstruction of the fluctuations of the [...] Maladeta and [...] Glaciers throughout the 20th century (Gellatly et al., 1994;Chueca et al., 2003; Cía et al., 2005; Chueca et al., 2007*)", p2438 l2: "*In the Pyrenees, these local influences are expected to have introduced spatial disparities in ice shrinkage, promoting in particular steep north and northeast glacier cirques, located below the highest summits (Chueca et al., 2007, 2008)*".
- Trueba et al., 2007 was cited:
  - in section 2 (p2435 l16: *"LIA climate cooling in the Pyrenees led to the formation and advance of glaciers in fifteen massifs where there are up to one hundred cirques (Trueba et al., 2008)"*.
  - in section 4 (p.2439 l23: *"the glacier front was actually in contact with its moraine at the middle of the 19th century, i.e., at the estimated end of the LIA in the Pyrenees (Trueba et al., 2008)"*.
- López-Moreno et al., 2006b was cited:

  -"Future work is necessary to better understand the effect of local topography on the spatial variability of glacier mass balance. This influence is expected to augment in the future as the glacier retreats (López-Moreno et al., 2006a, b)."

page 2434- Why does temperature range decreases over time? Which variable (Tmax or Tmin) is exhibiting a sharper trend to cause such effect on diurnal range?

According to Bücher and Dessens, 1991, the temperature range decrease over the 1882-1970 period is due to the sum of a very significant increase in the daily minimum temperature (+2.11 °C) and a decrease in the maximum temperature (-0.45 °C). Over 1882-1984, Dessens and Bücher, 1994, confirmed these trends by observing that the mean night-time temperature has increased by 2.39 °C/100 yr, while the mean daytime temperature has decreased by 0.50 °C/100 yr. As a consequence, the mean annual diurnal temperature range has dropped by 36%/100 yr.

We propose to clarify this by modifying the following sentence:
pp.2434 l7: "*A mean annual temperature increase of 0.83 °C has been observed over 1882–1970 with a significant decrease in the mean annual diurnal temperature range (2.89 °C per century)*, ***mainly due to a significant increase in the daily minimum temperature.***"

Study site: Authors should provide information about mean temperatures over the glacier and the estimation of the elevation of the ELA.

Unfortunately there is no long term air temperature measurement on the glacier so we cannot indicate the mean annual temperature. However, we will indicate the mean annual temperature from the closest meteorological station located in Gavarnie village (operational until 2012, elevation 1380 m asl, 11 km in the north east from Ossoue glacier, elevation difference from the glacier plateau is about 1700 m) in Section 3 (Study site):

p.2438 l.20. "The closest meteorological station (Gavarnie, 11 km, 1380 m a.s.l.) recorded a mean annual temperature of 7.68 °C a^{-1} and a mean precipitation of 1450 mm a^{-1} over 1992–2012."

Regarding the equilibrium line altitude (ELA), we did not refer to this concept for Ossoue glacier since there are only three occurrences of positive mass balance in the stake measurements dataset over the whole period of record (88 measurements). (see p.2447 l.6). However, to respond to this comment we computed the altitude of a zero mass balance using a least-squares linear fit of the stake mass balances as a function of elevation for each year (2002-2013). We found four years for which the regression coefficient R^2 is greater than 0.6. The median value of the ELA for these years is 3190 m asl (glacier maximal elevation is 3210 m asl). We will include this short paragraph in the Result section (new Section 5.1.3).

More references should support the use of Pleiades for estimating changes in glaciers altimetry.

We agree that the use of Pléiades imagery is new in glaciology. We did not emphasize this point because there is a published paper on this specific aspect (Marti et al., 2014, cited p2442, l9). To our knowledge, the first publication which mentioned a DEM generated from Pléiades stereo images in a glaciological context is Wagnon et al., 2013. In 2014, Berthier et al. published an evaluation of the potential of Pléiades stereo images over five evaluation sites, where simultaneous field measurements were collected. The study demonstrated the value of Pléiades DEMs for measuring seasonal, annual and multiannual elevation changes with an accuracy of 1 m, or even better. We propose to refer to this two publications in this added sentence:
p.2247 l8. Pléiades stereo images have been successfully used to measure geodetic mass balances of mountain glaciers with an accuracy of about 1 m (Wagnon et al, 2013, Berthier et al., 2014).

Section 4.6. Which is the resolution of CRUTEM 4 ?

We will include this information p2449 l.20: "We extended the Pic du Midi temperature time series with the CRUTEM 4 **(5°×5° gridded version)** dataset over the period 1858–1890 (Jones et al., 2012)."

Section 5.1 presents mixed the information on changes in the length of the glacier and on the area. I would clearly separate.

We will create a new subsection in order to separate this two metrics assessments (see also the proposed restructuration here below) :
5.1.1 Length variations
5.1.2 Area variations

I would remove the supplied information about the depth of the moulins as it result very uncertain and it is not easy to interpret the progressive increase of their depth.

We propose to simplify this information by replacing this paragraph:
p.2453 l16: “As a verification of these data, we provide here the depth of the main moulins that have been measured regularly since 2004 by glacial speleologists: 30 m in 2004, 38 m in 2005, 36.5 m in 2006 and 41.5 m in 2009. However, these values should be considered minimum estimates of the glacier thickness because they do not necessarily reach the bedrock.”
by:
“Moulins were explored over the 2004-2009 summer in the plateau of Ossoue glacier. The depth of the explored moulins ranged from 30 m to 41.5 m. Given that the bedrock was never reached according to the speleo-glaciologistst, the ice thickness obtained by GPR is consistent with these depth measurements.”

I would recommend to remove section 5.3 it can be used to summarize results in discussion and/or conclusions sections.

Thank you for this suggestion. We agree that the text in Sect. 5.3 can be moved to the Discussion. Also in line with the comments by the Reviewer #2 we propose to restructure the results section in a revised version as follows:

5 Results
5.1 Ossoue glacier metrics variations
- 5.1.1 Length variations
- 5.1.2 Area variations
- 5.1.3 Mass variations

5.2 Comparison with Pyrenean and Alps glaciers variation
5.3 Comparison with meteorological time series
5.4 Ice thickness map

We think that this will clarify the presentation of the results.

Again we sincerely thank the reviewer for this thorough evaluation of our manuscript.

Bibliography cited in this response:

Berthier, E., Vincent, C., Magnússon, E., Gunnlaugsson, Á. Þ., Pitte, P., Le Meur, E., Masiokas, M., Ruiz, L., Pálsson, F., Belart, J. M. C., and Wagnon, P.: Glacier topography and elevation changes derived from Pléiades sub-meter stereo images, The Cryosphere, 8, 2275-2291, doi:10.5194/tc-8-2275-2014, 2014.

Bücher, A. and Dessens, J., 1991. Secular trend of surface temperature at an elevated observatory in the Pyrenees. J. Climate, 4: 859-868.

Chueca, J., Julián, A., and López-Moreno, J. I.: Recent evolution (1981–2005) of the Maladeta glaciers, Pyrenees, Spain: extent and volume losses and their relation with climatic and topographic factors, J. Glaciol., 53, 547–557, doi:10.3189/002214307784409342, 2007. 2434, 2435, 2437, 2438

Chueca, J., Julian, A., and Lopez, I.: The Retreat of the Pyrenean Glaciers (Spain) from the Little Ice Age: Data Consistency and Spatial Dierences, Terra Glacialis, 11, 65–77, Special issue, January 2009, Servizio Glaciologico Lombardo, Italy, 2008. 2437, 2438

Cía, J. C., Andrés, A. J., Sánchez, M. S., Novau, J. C., and Moreno, J. L.: Responses to climatic changes since the Little Ice Age on Maladeta Glacier (Central Pyrenees), Geomorphology, 68, 167–182, doi:10.1016/j.geomorph.2004.11.012, 2005. 2437, 2456, 2457

Cogley, J. G., Hock, R., Rasmussen, L. A., Arendt, A. A., Bauder, A., Jansson, P., Braithwaite,
R. J., Kaser, G., Möller, M., Nicholson, L., Zemp, M.: Glossary of Glacier Mass Balance and Related Terms, Paris, UNESCO-IHP (IHP-VII Technical documents in hydrology, 30 86, IACS contribution 2), 2011. 2438, 2444, 2445, 2446, 2450, 2480, 2481

Dessens, J. and Bricher, A., Changes in minimum and maximum temperatures at the Pic du Midi in relation with humidity and cloudiness, 1882-1984. Atmospheric Research 37 (1995) 147-162.

Dessens J et Bucher A, 1997, « A critical examination of the precipitation records at the Pic du Midi Observatory, Pyrénées, France », Kluwers Academic Publishers, Climatic Change 36 : 345-353

Gellatly, A. F., Grove, J. M., Bücher, A., Latham, R., and Whalley, B. W.: Recent historical fluctuations of the Glacier Du Taillon, Pyrénées, Phys. Geogr., 15, 399–413, http://www.tandfonline.com/doi/abs/10.1080/02723646.1994.106425253.VSU7V5MhFSA (last acess: 8 April 2015), 1994. 2436, 2437, 2456

Jones, P. D., Lister, D. H., Osborn, T. J., Harpham, C., Salmon, M., and Morice, C. P.: Hemispheric and large-scale land-surface air temperature variations: an extensive revision and an update to 2010, J. Geophys. Res.-Atmos., 117, D05127, doi:10.1029/2011JD017139, 2012. 2449

López-Moreno, J. I., Nogués-Bravo, D., Chueca-Cía, J., and Julián-Andrés, A.: Glacier development and topographic context, Earth Surf. Proc. Land., 31, 1585–1594, doi:10.1002/esp.1356, 2006a. 2459

López-Moreno, J. I., Nogués-Bravo, D., Chueca-Cía, J., and Julián-Andrés, A.: Change of topographic control on the extent of cirque glaciers since the Little Ice Age, Geophys. Res. Lett., 33, L24505, doi:10.1029/2006GL028204, 2006b. 2459

Marti, R., Gascoin, S., Houet, T., and Lay, D.: Assessment of a glacier digital elevation model generated from Pléiades stereoscopic images: Ossoue Glacier, Pyrenees, France, in: Pléiades Days 2014, Toulouse, France, 1 April 2014, http://espace-ftp.cborg.info/pleiades_days/presentations2014/GO2_Marti.pdf (last access: 8 April 2015), 2014. 2442

Trueba, J. J. G., Moreno, R. M., de Pisón, E. M., and Serrano, E.: “Little Ice Age” glaciation and current glaciers in the Iberian Peninsula, Holocene, 18, 551–568, doi:10.1177/0959683608089209, 2008. 2435, 2439

Wagnon, P., Vincent, C., Arnaud, Y., Berthier, E., Vuillermoz, E., Gruber, S., Ménégoz, M., Gilbert, A., Dumont, M., Shea, J. M., Stumm, D., and Pokhrel, B. K.: Seasonal and annual mass balances of Mera and Pokalde glaciers (Nepal Himalaya) since 2007, The Cryosphere, 7, 1769-1786, doi:10.5194/tc-7-1769-2013, 2013.