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Interactive comment on "Very high-resolution terrain surveys of the Chã das Caldeiras lava fields (Fogo Island, Cape Verde)" *by* Gonçalo Vieira et al.

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Dear Dr Pablo F. Gonzalez, Thank you very much for your very good comments and suggestions that complement very well the other reviews. Following your comments, we have proceeded with the following modifications: - Although the lava flow extension revision not being our main goal, we agree with your comments and we have expanded section 4.5 in order to clarify the delineation procedures and have included also a figure to illustrate it. - We have checked and corrected the exponentiation. - Kipukas are now defined in the abstract too. - We have rephrased the Introduction and made the objectives clearer, following your suggestion. Thanks! - We have added the reference to James et al (2020). - A new figure 5 includes the landing sites now. - We have im-

proved the description of the data collection and made available the list of coordinates of the GCPs. Figure 4 now includes the location of the base stations. Unfortunately, we don't have the uncertainties of the GCPs. - A new table (Table 1) was made with the flight details. - We have clarified in the text what are the independent checkpoints (not used in the model, but used to evaluate the point cloud accuracy) and also how the survey was made using GNSS RTK mode. We did not find a correlation between the type of the terrain and the accuracy of the checkpoint. If the checkpoint is visible in the images with high quality, and since it is manually inserted by the operator in the model, then the accuracy will depend on the visibility in the image and on the operator precision in the software. - We have tried several filters in CloudCompare during the processing of the model and while some solve issues with outliers in the point cloud in areas of poor quality, they reduce the quality of the point cloud in other areas. Hence, we decided to maintain the point cloud as produced from PIX4D, which guarantees a good quality in the lava flows (that show no gaps in the cloud), while we have decided to manually identify the poorly represented areas (with gaps and affecting the DSM) in figure 7 and develop a qualitative assessment of the DSM. This was a solution we found in order not to provide a DSM with gaps, but also not offer a product only covering the lava flows. It is a compromise solution. - We have added the files with the check points and GCP coordinates, as well as the full survey data set and dense point cloud. - We have rephrased the mentioning to the "unprecedented" survey. You are right. We expect to upload the new version now, but it cannot be sent to you through the platform at this stage. We hope that with the significant changes we have made to the manuscript, following your comments, but also integrating the comments from other three reviewers and from the public discussion, the manuscript is now in good shape to be accepted for publication in ESSD. Our sincere thanks for the time you have put into this review and for very useful comments. Best wishes, Gonçalo Vieira

Interactive comment on Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2020-289, 2020.

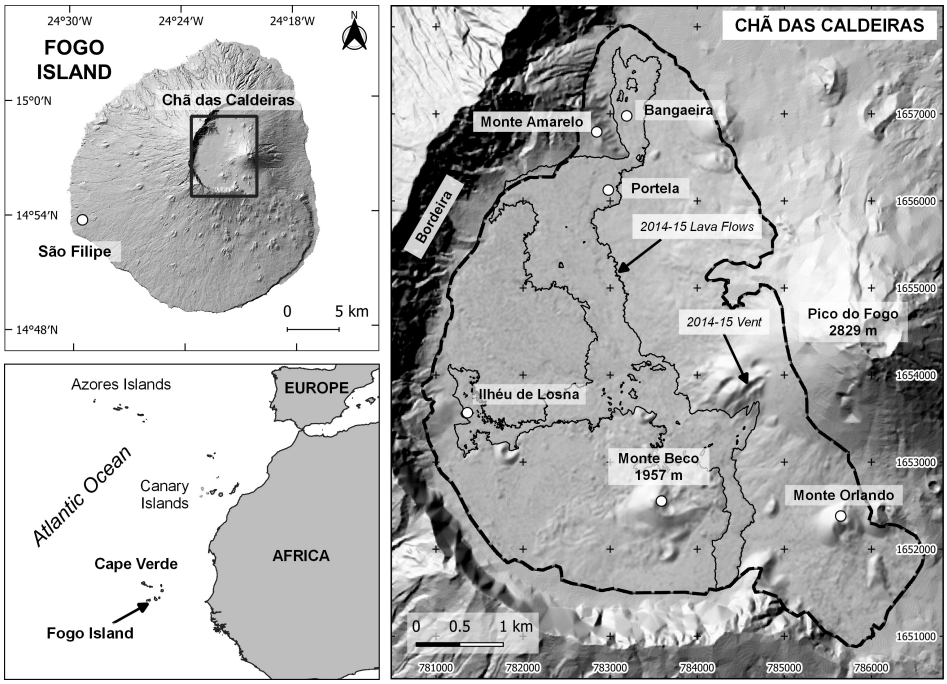

Fig. 1. Figure 1 – Location of the Chã das Caldeiras and of the surveyed area (dashed line) in Fogo Island (Cape Verde). The 2014-15 lava flows are limited by a thin black line. Shaded relief derived from th

Fig. 2. Figure 2 – The Chã das Caldeiras and Pico do Fogo during the 2014-15 eruption. View towards the southeast with the 'a'ÄĄ lava flows of 2014-15 in the foreground, evidencing a very irregular and inacces

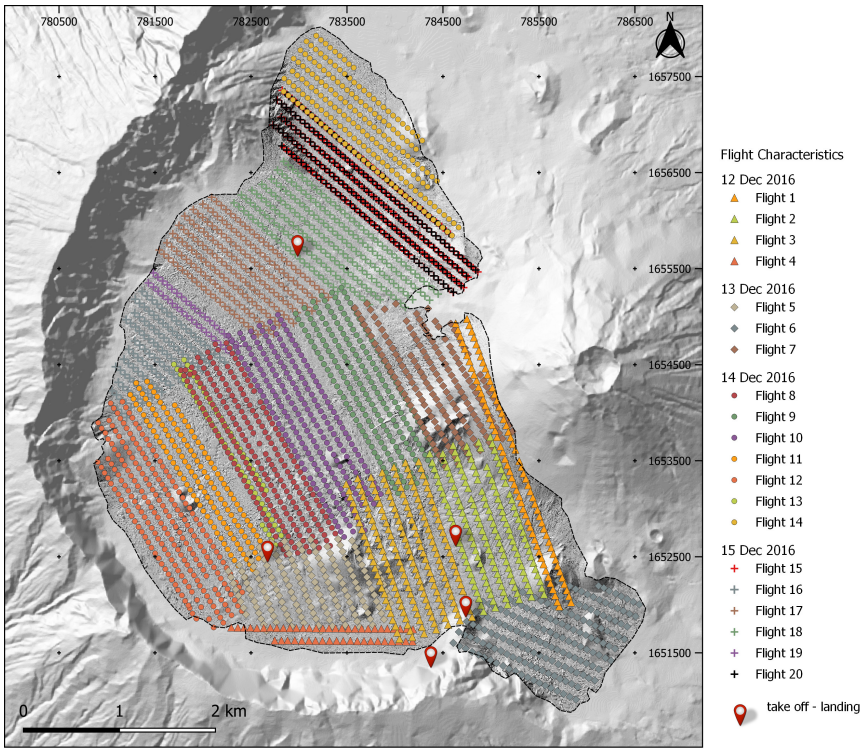

Fig. 3. Figure 3 – General characteristics of the aerial survey of the Chã das Caldeiras with the geolocation of the photographs according to the flights and take-off and landing locations. Shaded inside the

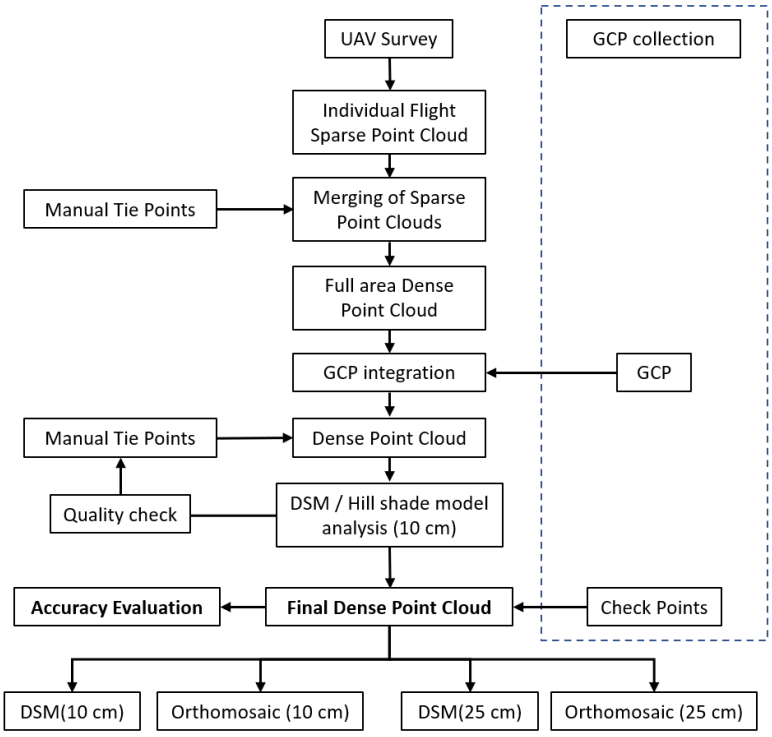

Fig. 4. Figure 4 – Work flow from the field survey to the generation of the DSMs and orthomosaics.

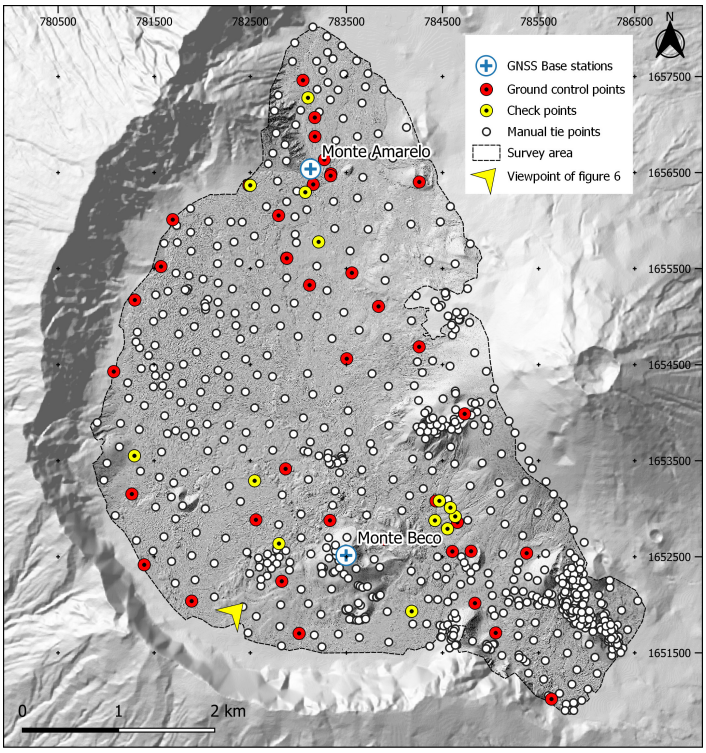

Fig. 5. Figure 5 – Ground control points used for the model and for the accuracy evaluation (check points), manual tie points used to improve the point cloud accuracy and location of the GNSS base stations se

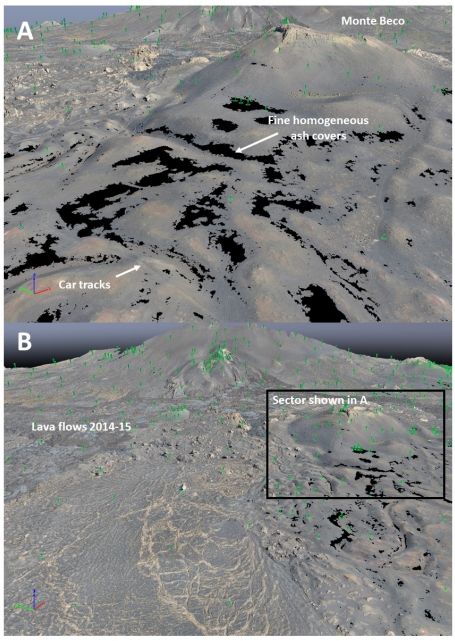

Fig. 6. Figure 6 – Examples of the quality of the 3D dense point cloud. A. Low quality areas in ash surfaces close to Monte Beco (car tracks for scale), B. Most of the point cloud shows dense point coverage a

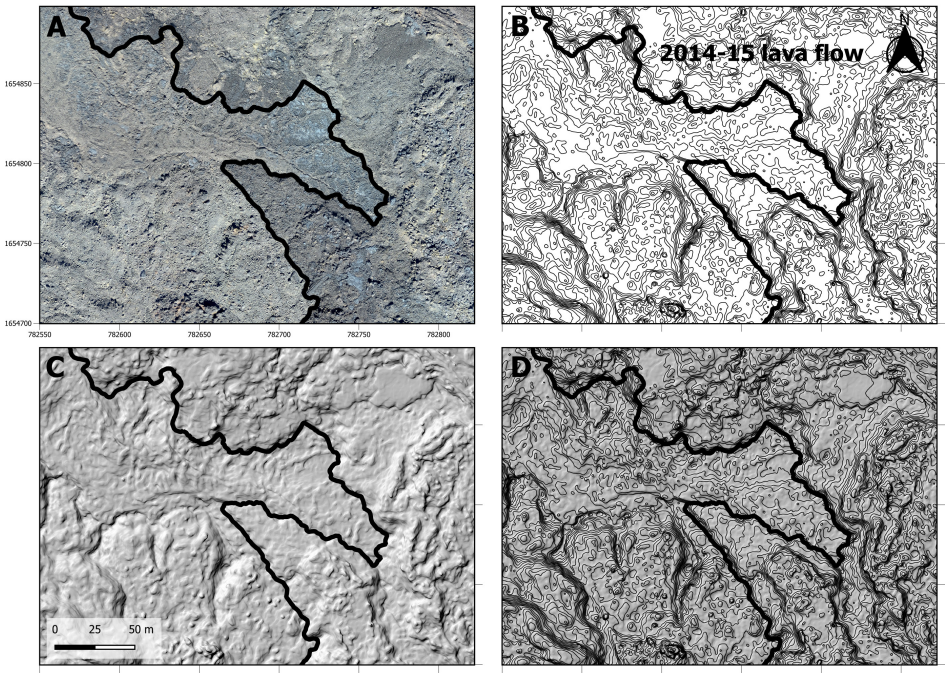

Fig. 7. Figure 7 – Example of manual delineation of the lava flow by making use of the: A. Orthomosaic, B. Elevation contours with 50 cm interval, C. Hill shade model, D. Hill shade model and elevation contou

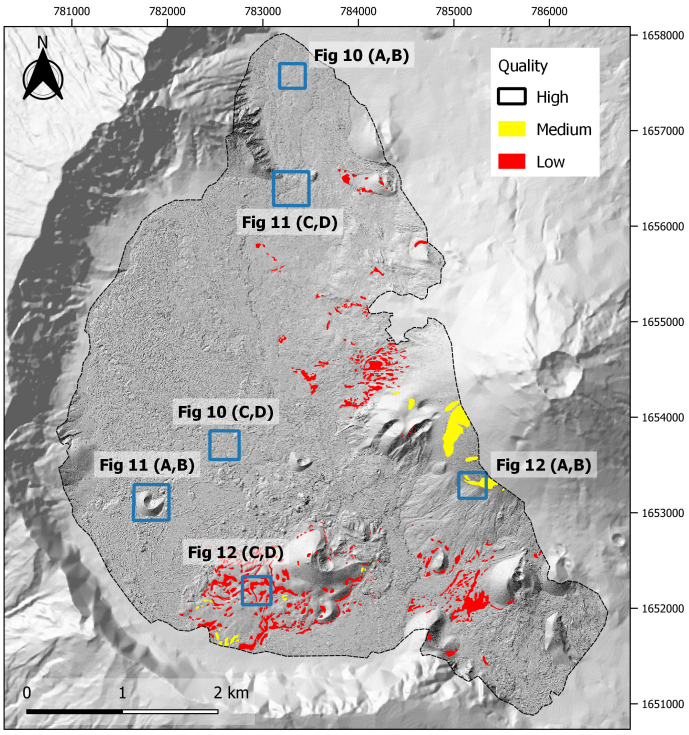

Fig. 8. Figure 8 – Assessment of the quality of the dense point cloud and digital surface model in the Chã das Caldeiras and location of the sectors shown in figures 8 to 10. Shaded relief outside the surveye

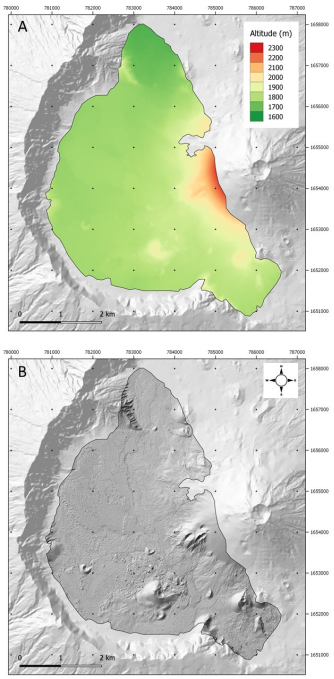

Fig. 9. Figure 9 – Digital surface model of the Chã das Caldeiras (A) and DSM shaded relief model (B). The surveyed area is overlaying the DEMFI (2010) 5 m DEM.

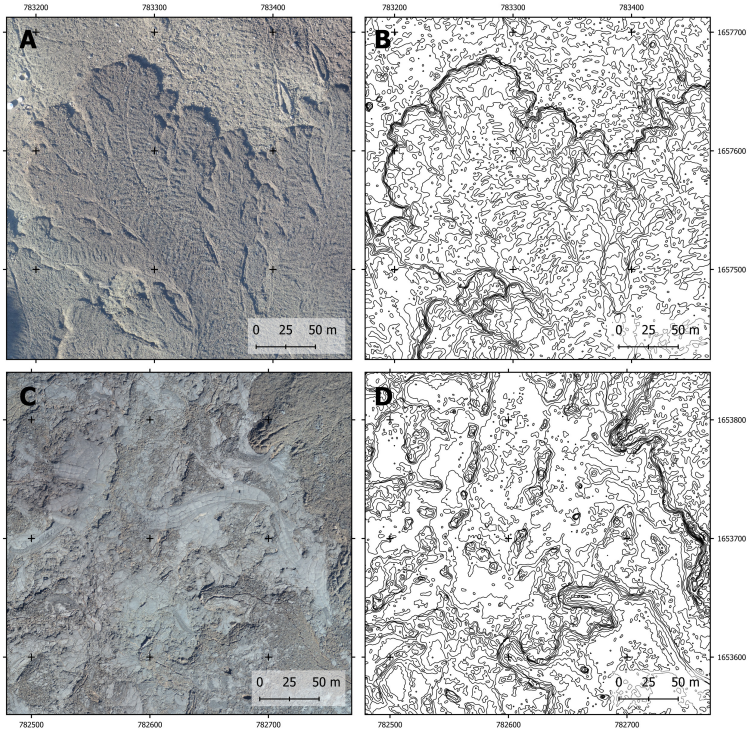

Fig. 10. Figure 10 – Examples of surfaces in the Chã das Caldeiras with high-quality results for the digital surface model, with orthomosaic for visualization (10 cm resolution) and contour lines derived from

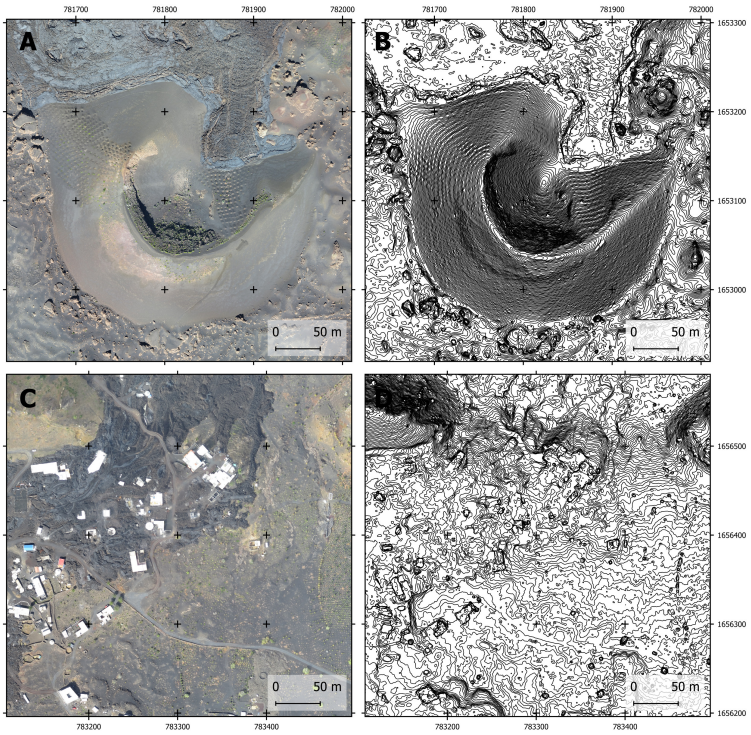

Fig. 11. Figure 11 – Examples of surfaces in the Chã das Caldeiras with high-quality results for the digital surface model, with orthomosaic for visualization (10 cm resolution) and contour lines derived from

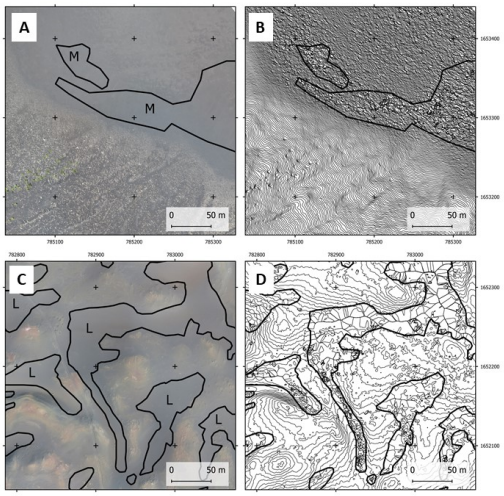

Fig. 12. Figure 12 – Examples of surfaces with medium and low quality. A and B: Steep slope covered with ash with medium-quality results (M) for the digital surface model, with orthomosaic (A, 10 cm resolution

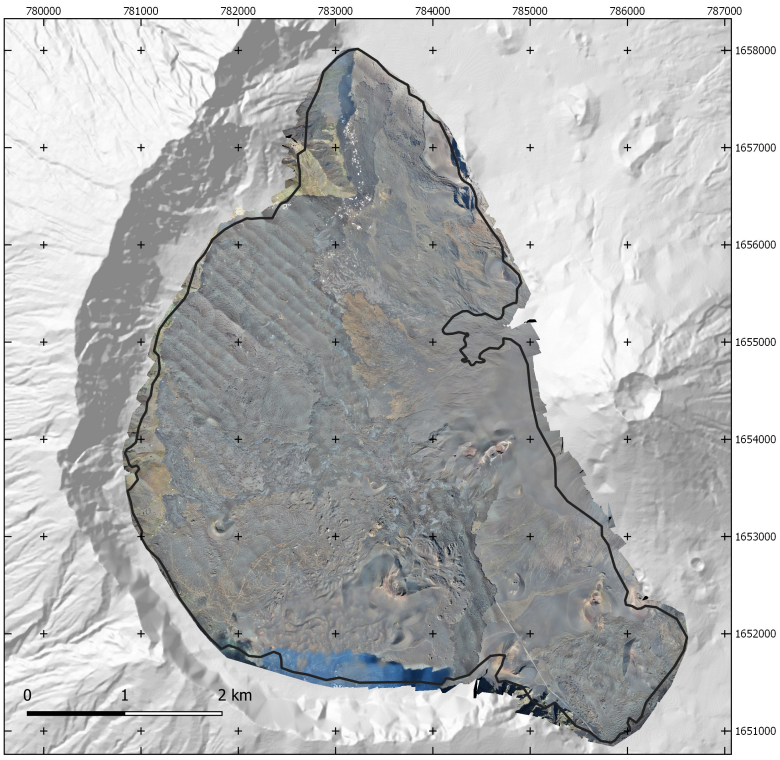

Fig. 13. Figure 13 – Digital orthophoto mosaic with 25 cm resolution of the Chã das Caldeiras. The quality of the point cloud is shown in Fig. 7. Shaded relief outside the surveyed area derived from the DEMFI

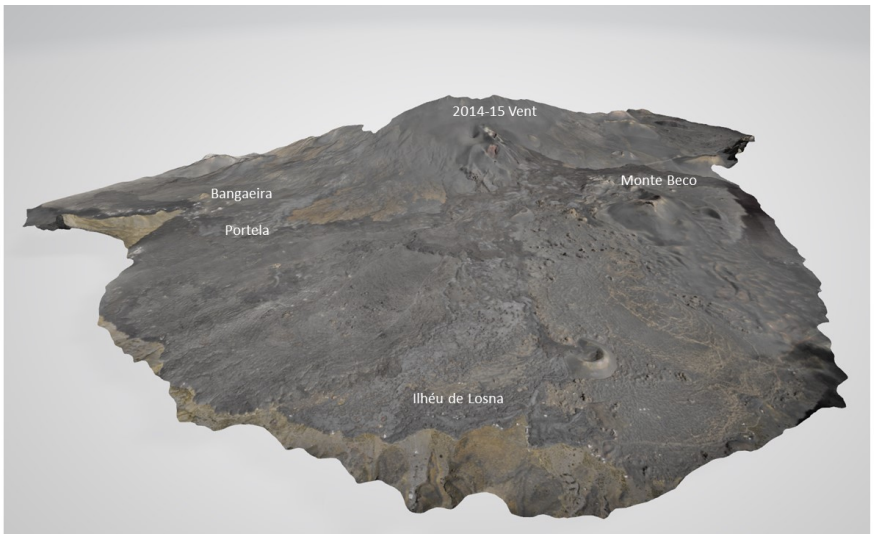

Fig. 14. Figure 14 – 3D visualization of the texture mesh of the Chã das Caldeiras.

Table 1 – Synthesis of flight characteristics and photos excluded from the modelling due to lack of calibration or manually disabled in the pre-processing.

Flight nr	Date (2016)	Start time	Duration (min)	Area (km²)	Weather	Camera	Nr of Photos	First and last photo ID (IMG)	Used	Uncalibrated images IDs (IMG)	Disabled images IDs (IMG)
1	12/12	14:58	20	0.99	Cloudfree	Canon G9X	92	0425 - 0516	Yes	448, 470	425-428, 451-460, 513-516
2	12/12	15:21	29	1.21	Cloudfree	Canon G9X	150	0517 - 0666	Yes		517-519, 542, 564-568, 613-615, 639-642
3	12/12	15:52	28	1.44	Cloudfree	Canon G9X	181	0667 - 0847	Yes		671, 683
4	12/12	16:43	33	0.37	Cloudfree	Canon G9X	50	0849 - 0898	Yes		
5	13/12	11:04	25	1.52	Cloudfree	Canon G9X	161	0900 - 1060	Yes		1053-1060
6	13/12	11:31	35	1.37	Cloudfree	Canon G9X	181	1061 - 1241	Yes	1200, 1241	1113-1116, 1155
7	13/12	12:59	30	1.41	Cloudfree	Canon G9X	166	1243 - 1408	Yes		1244-1260, 1352, 1406-1408
8	14/12	11:00	19	1.40	Cloudfree	Canon IXUS	215	0146 - 365	Yes		
9	14/12	11:55	27	1.19	Cloudfree	Canon IXUS	205	366 - 570	Yes		
10	14/12	12:33	31	1.35	Cloudfree	Canon IXUS	216	0571 - 0786	Yes	786	
11	14/12	13:06	30	0.82	Cloudfree	Canon IXUS	135	0787 - 0921	Yes		
12	14/12	13:41	42	1.43	Cloudfree	Canon IXUS	213	0922 - 1134	Yes		
13	14/12	14:28	15	0.41	Cloudfree	Canon IXUS	65	1135 - 1199	Yes		
14	14/12	17:03	34	1.23	Cloudfree	Canon IXUS	196	1200 - 1395	Yes		
15	15/12	12:45	29	1.31	Scattered/low clouds	Canon IXUS	198	1396 - 1593	No		
16	15/12	14:07	21	0.58	Scattered clouds*	Canon IXUS	119	1594 - 1712	Yes		
17	15/12	14:30	30	1.16	Scattered clouds*	Canon IXUS	196	1713 - 1908	Yes		
18	15/12	15:02	32	1.25	Scattered clouds*	Canon IXUS	209	1909 - 2117	Yes		
19	15/12	15:49	15	0.16	Scattered clouds*	Canon IXUS	37	2118 - 2154	Yes		
20	15/12	16:06	32	1.26	Scattered clouds*	Canon IXUS	197	2155 - 2351	Yes		

* Illumination problems, probably due to light scattering associated to fog entering the caldera from the NE and the dark wall of the bordeira in the S and W, resulting in striping.

Fig. 15. Tables 1 and 2