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

**Gonçalo Vieira et al.**

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Dear Dr Moritz Kirsch,

Thank you very much for the detailed review, comments and suggestions of our manuscript on the "Very high-resolution terrain surveys of the Chã das Caldeiras lava fields (Fogo Island, Cape Verde) submitted to ESSD.

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.

In what concerns to your review of the manuscript, our revision of the text includes now more details on the objectives, which are the identification of small-scale geomorphic features below c. 50 cm, as well as improving the existing 1 m pixel DEM. The section 2 was removed following your suggestion. We have reorganized the text on the study area and added a new section on previous studies on the volcanica activity of 2014-15. The section 3 (now 4) on the methods was fully rewritten and provides more details on the procedures. We have also included a figure with the workflow. In section 5, we have clarified the issues raised associated with the evaluation of the point cloud and DSM quality, also following several of your suggestions, and after revisiting James' et al papers. A better description of the lava flow delineation procedure was included in section 4.5. We have also made available the full data set, very high resolution point cloud, 10 and 25 cm DSM and orthomosaic and have included all the aerial photos, as well as the GCP coordinates and lava flow delineation file.

We have also introduced your suggestions and replied accordingly in the attached the RC3-supplement-commentGV.pdf file.

I expect to be able to upload the revised version very soon in the platform.

Our sincere thanks for the time you have put into this review.

Best wishes,

Gonçalo Vieira

Please also note the supplement to this comment:
https://essd.copernicus.org/preprints/essd-2020-289/essd-2020-289-AC3-supplement.pdf
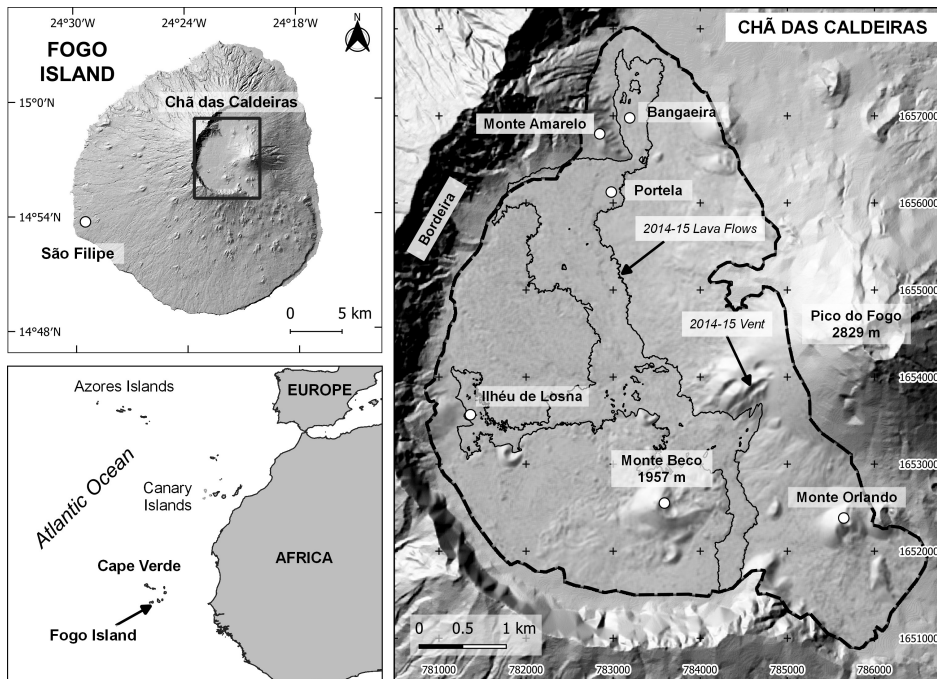
**Fig. 1.** Figure 1 – Location of the Chã das Caldeiras and of the surveyed area (dashed line) in Fogo Island (Cape Verde). The 2014-15 lava flows are limited by a thin black line. Shaded relief derived from th

**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
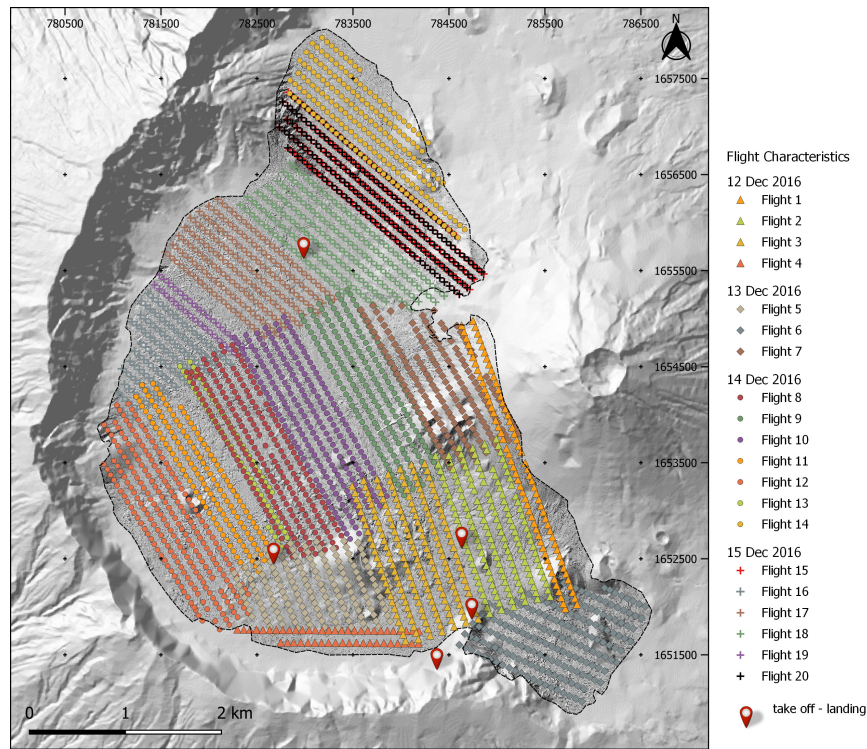
**Fig. 3.** Figure 3 – General characteristics of the aerial survey of the Chã das Caldeiras with the geolocation of the photographs according to the flights and take-off and landing locations. Shaded inside the
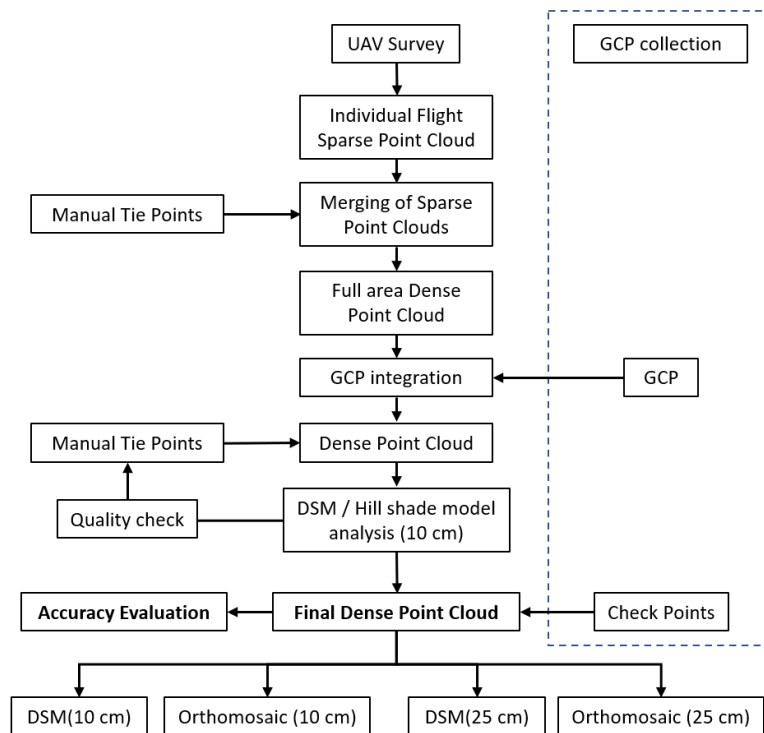
**Fig. 4.** Figure 4 – Work flow from the field survey to the generation of the DSMs and orthomosaics.
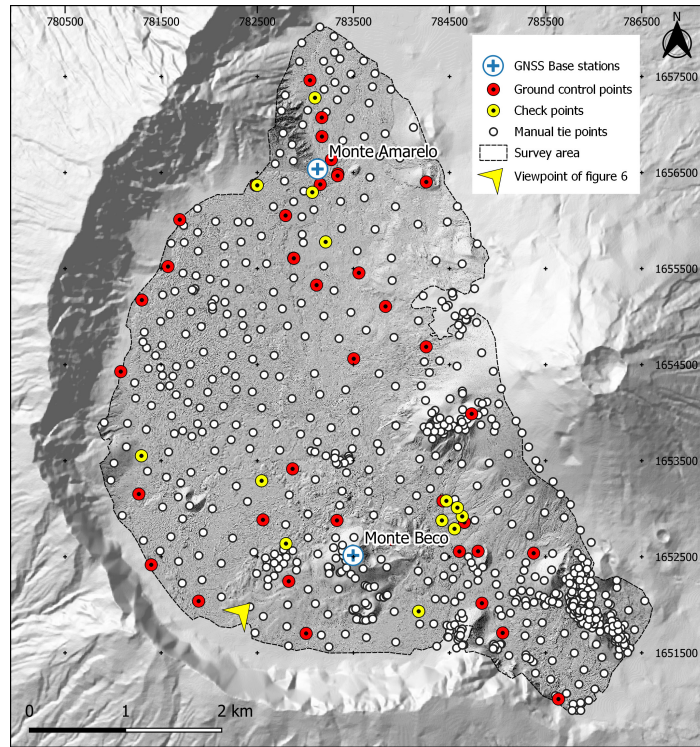
**Fig. 5.** Figure 5 – Ground control points used for the model and for the accuracy evaluation (check points), manual tie points used to improve the point cloud accuracy and location of the GNSS base stations se
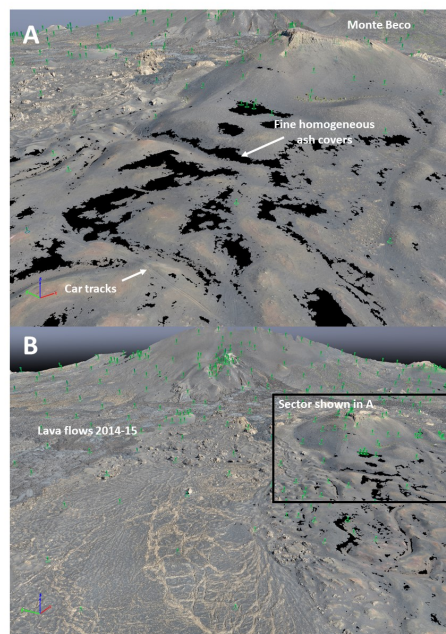
**Fig. 6.** Figure 6 – Examples of the quality of the 3D dense point cloud. A. Low quality areas in ash surfaces close to Monte Beco (car tracks for scale), B. Most of the point cloud shows dense point coverage a
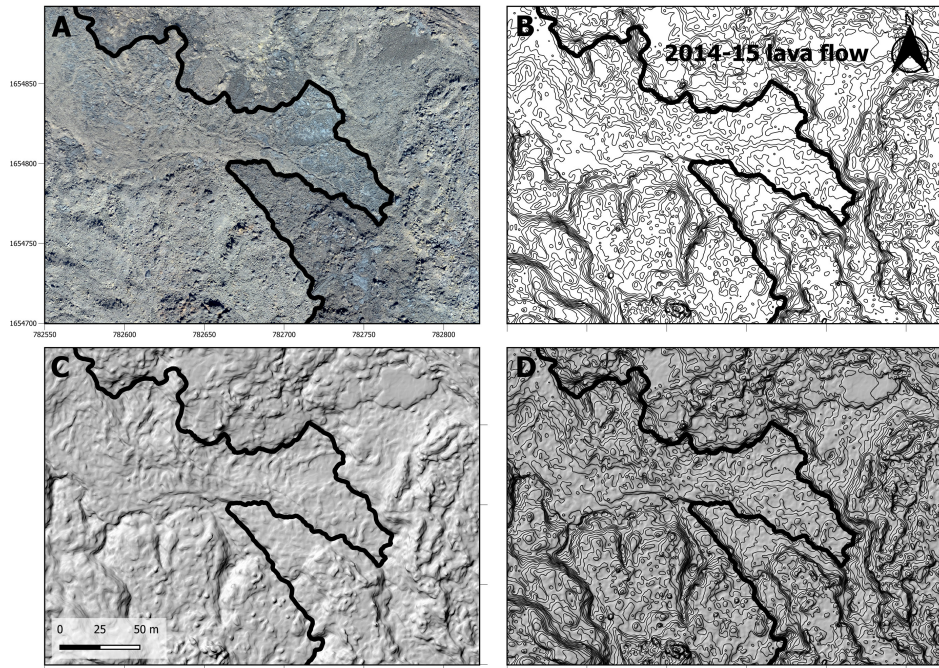
**Fig. 7.** Figure 7 – Example of manual delineation of the lava flow by making use of the: A. Orthomosaic, B. Elevation contours with 50 cm interval, C. Hill shade model, D. Hill shade model and elevation contou
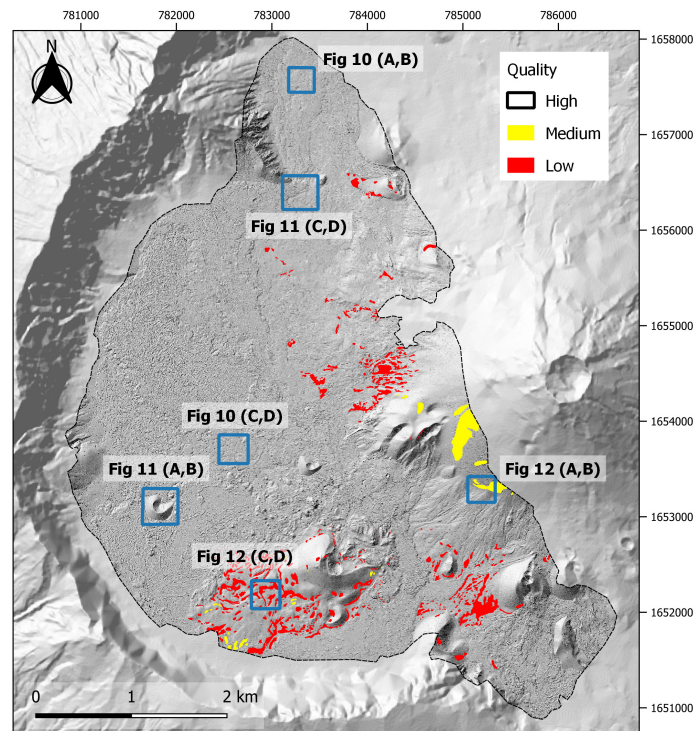
**Fig. 8.** Figure 8 – Assessment of the quality of the dense point cloud and digital surface model in the Chã das Caldeiras and location of the sectors shown in figures 8 to 10. Shaded relief outside the surveye
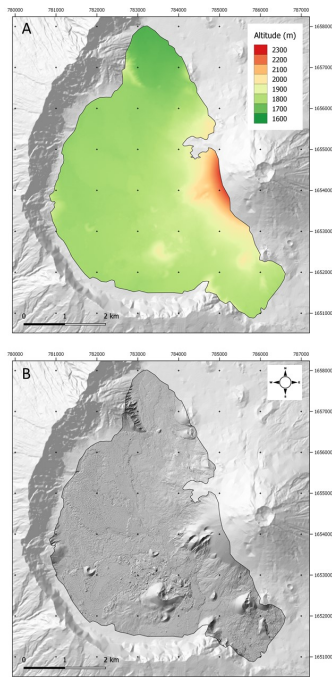
**Fig. 9.** Figure 9 – Digital surface model of the Chã das Caldeiras (A) and DSM shaded relief model (B). The surveyed area is overlaying the DEMFI (2010) 5 m DEM.
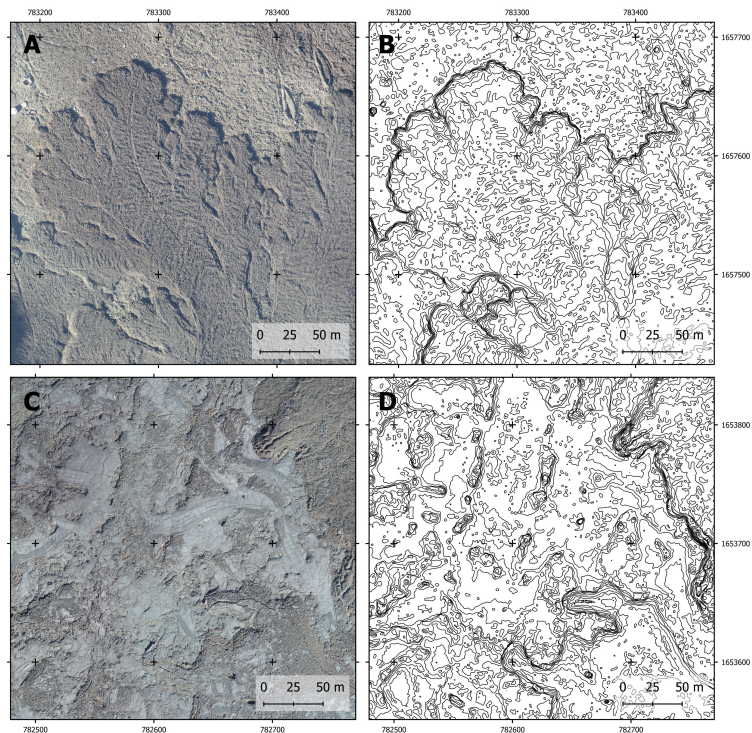
**Fig. 10.** Figure 10 – Examples of surfaces in the Chã das Caldeiras with high-quality results for the digital surface model, with orthomosaic for visualization (10 cm resolution) and contour lines derived from
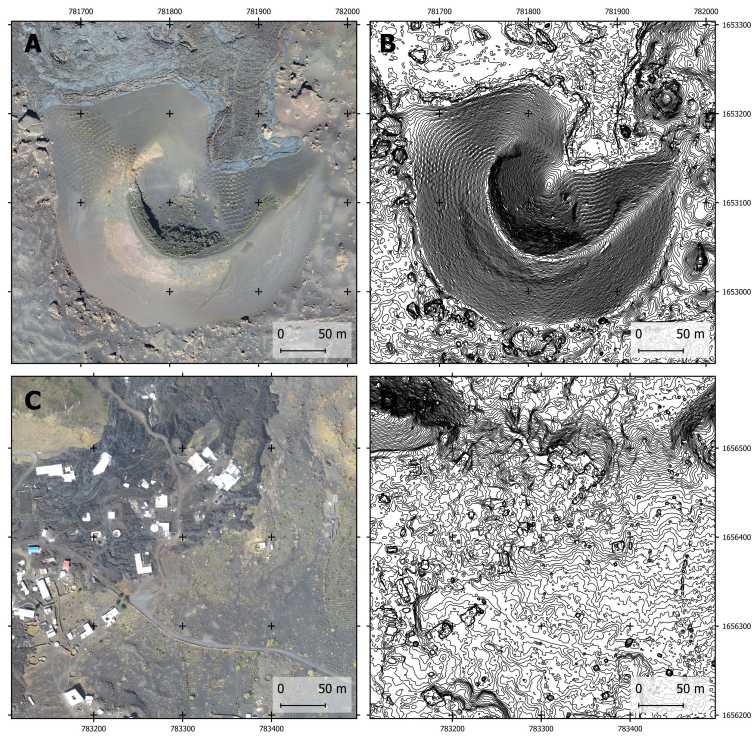
**Fig. 11.** Figure 11 – Examples of surfaces in the Chã das Caldeiras with high-quality results for the digital surface model, with orthomosaic for visualization (10 cm resolution) and contour lines derived from
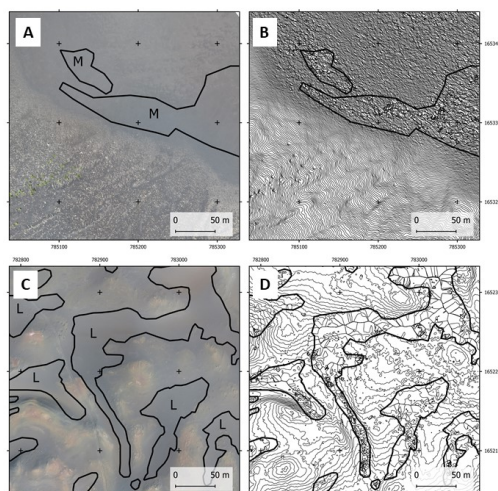
**Fig. 12.** Figure 12 – Examples of surfaces with medium and low quality. A and B: Steep slope covered with ash with medium-quality results (M) for the digital surface model, with orthomosaic (A, 10 cm resolution
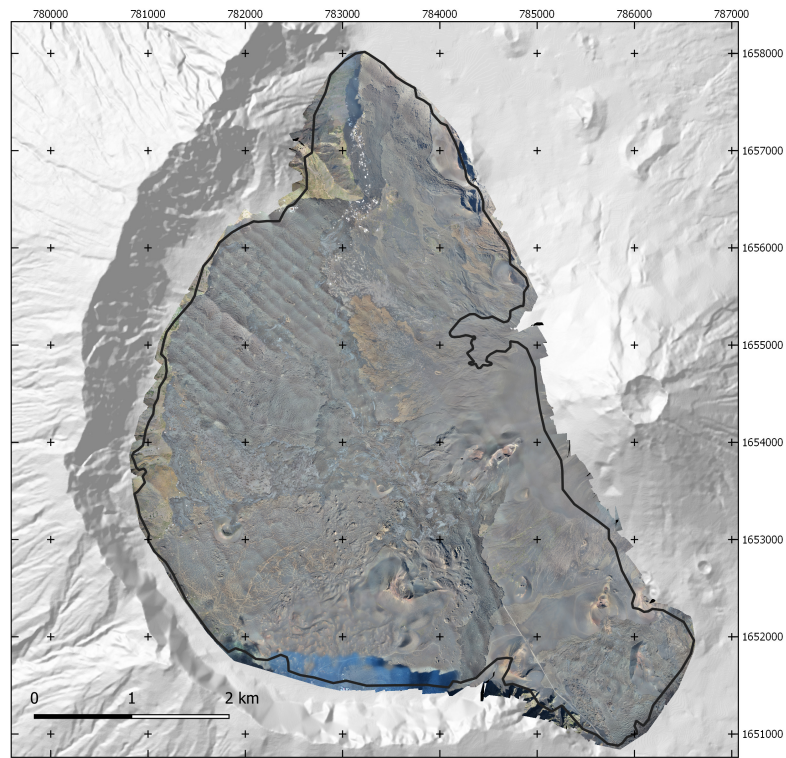
**Fig. 13.** Figure 13 – Digital orthophoto mosaic with 25 cm resolution of the Chã das Caldeiras. The quality of the point cloud is shown in Fig. 7. Shaded relief outside the surveyed area derived from the DEMFI
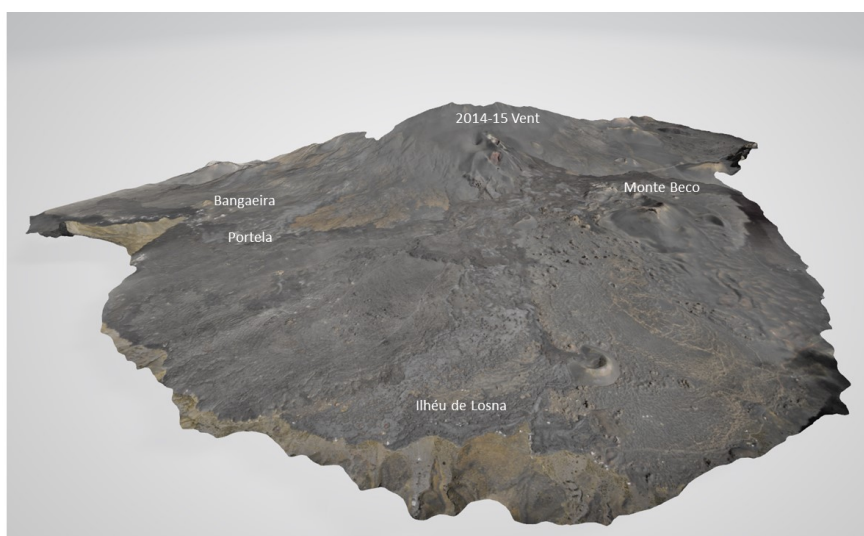
**Fig. 14.** Figure 14 – 3D visualization of the texture mesh of the Chã das Caldeiras.

**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