

# Supporting Information for ”Observations of elves and radio wave perturbations by lightning”

Maja Tomicic<sup>1</sup>, Olivier Chanrion<sup>1</sup>, Thomas Farges<sup>2</sup>, Janusz Mlynarczyk<sup>3</sup>,

Ivana Kolmašová<sup>4,5</sup>, Serge Soula<sup>6</sup>, Christoph Köhn<sup>1</sup>, Torsten Neubert<sup>1</sup>

<sup>1</sup>DTU Space, Technical University of Denmark, Lyngby, Denmark

<sup>4</sup>Department of Space Physics, Institute of Atmospheric Physics, Czech Academy of Sciences, Prague, Czech Republic

<sup>5</sup>Faculty of Mathematics and Physics, Charles University, Prague, Czech Republic

<sup>2</sup>CEA, DAM, DIF, F-91297, Arpajon, France

<sup>3</sup>Institute of Electronics, AGH University of Science and Technology, Krakow, Poland

<sup>6</sup>Laboratoire d'Aérodynamique, Université de Toulouse, UT3, CNRS, IRD, Toulouse, France

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## Introduction

The Figures S1 to S63 show the background subtracted elve images taken with a Watec 1/2” monochrome CCD camera (WAT-902H) with a 16 mm lens from LSBB in Rustrel. Many of the images have diagonal lines across them. This is an artifact of unknown origin (could be external, such as an radio signal) that we could not remove during post processing of the images because it moved from field to field.



**Figure S1.** Elve occurring at 2020-12-09T20:04:46.607 UTC.



**Figure S2.** Elve occurring at 2020-12-09T20:07:07.313 UTC.



**Figure S3.** Elve occurring at 2020-12-09T20:09:08.216 UTC.



**Figure S4.** Elve occurring at 2020-12-09T20:10:47.929 UTC.



**Figure S5.** Elve occurring at 2020-12-09T20:16:13.883 UTC.



**Figure S6.** Elve occurring at 2020-12-09T20:17:57.214 UTC.



**Figure S7.** Elve occurring at 2020-12-09T20:20:58.790 UTC.



**Figure S8.** Elve occurring at 2020-12-09T20:22:55.682 UTC.



**Figure S9.** Elve occurring at 2020-12-09T20:29:45.575 UTC.





**Figure S10.** Elve occurring at 2020-12-09T20:29:58.690 UTC.



**Figure S11.** Elve occurring at 2020-12-09T20:30:08.119 UTC.



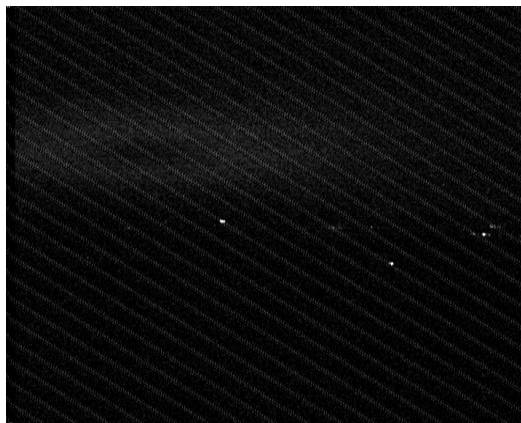
**Figure S12.** Elve occurring at 2020-12-09T20:31:17.727 UTC.



**Figure S13.** Elve occurring at 2020-12-09T20:32:58.789 UTC.



**Figure S14.** Elve occurring at 2020-12-09T20:33:10.516 UTC.



**Figure S15.** Elve occurring at 2020-12-09T20:46:42.528 UTC.



**Figure S16.** Elve occurring at 2020-12-09T20:49:54.100 UTC.



**Figure S17.** Elve occurring at 2020-12-09T21:09:03.613 UTC.



**Figure S18.** Elve occurring at 2020-12-09T21:54:33.415 UTC.



**Figure S19.** Elve occurring at 2020-12-09T22:35:15.984 UTC.



**Figure S20.** Elve occurring at 2020-12-09T22:48:54.352 UTC.



**Figure S21.** Elve occurring at 2020-12-09T23:05:50.075 UTC.



**Figure S22.** Elve occurring at 2020-12-09T23:14:30.984112607Z UTC.



**Figure S23.** Elve occurring at 2020-12-10T01:16:58.560 UTC.



**Figure S24.** Elve occurring at 2020-12-10T01:24:50.840 UTC.



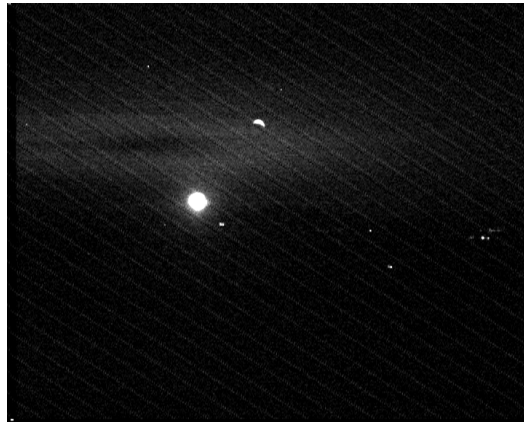
**Figure S25.** Elve occurring at 2020-12-10T01:27:34.330 UTC.



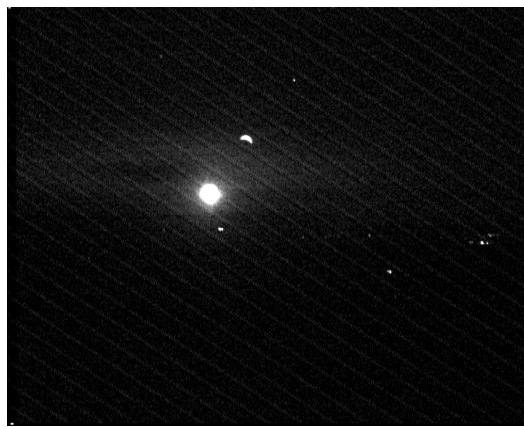
**Figure S26.** Elve occurring at 2020-12-10T01:33:38.668 UTC.



**Figure S27.** Elve occurring at 2020-12-10T01:35:02.158 UTC.



**Figure S28.** Elve occurring at 2020-12-10T01:37:55.356 UTC.



**Figure S29.** Elve occurring at 2020-12-10T01:41:23.277 UTC.



**Figure S30.** Elve occurring at 2020-12-10T01:43:29.316 UTC.



**Figure S31.** Elve occurring at 2020-12-10T01:50:15.490 UTC.



**Figure S32.** Elve occurring at 2020-12-10T01:50:28.950 UTC.



**Figure S33.** Elve occurring at 2020-12-10T02:03:58.538 UTC.





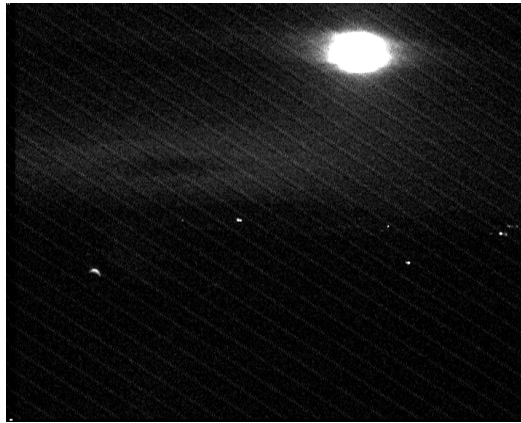
**Figure S34.** Elve occurring at 2020-12-10T02:07:50.666 UTC. No CG was detected by GLD360.



**Figure S35.** Elve occurring at 2020-12-10T02:11:08.862 UTC. No CG was detected by GLD360.



**Figure S36.** Elve occurring at 2020-12-10T02:13:20.216 UTC.



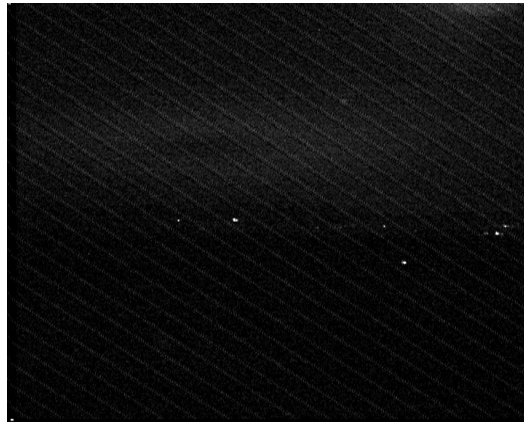
**Figure S37.** Elve occurring at 2020-12-10T02:14:48.433 UTC.



**Figure S38.** Elve occurring at 2020-12-10T02:19:51.788 UTC.



**Figure S39.** Elve occurring at 2020-12-10T02:23:26.815 UTC.



**Figure S40.** Elve occurring at 2020-12-10T02:40:18.292 UTC.



**Figure S41.** Elve occurring at 2020-12-10T02:54:33.503 UTC.



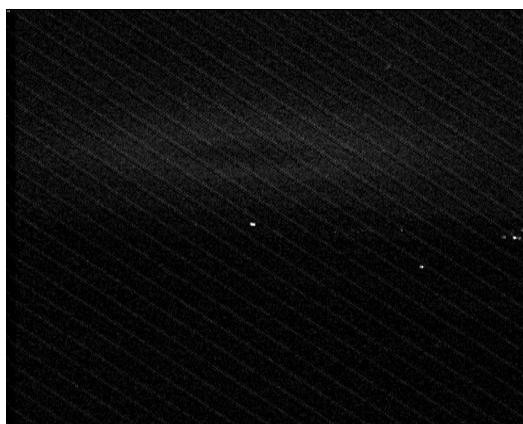
**Figure S42.** Elve occurring at 2020-12-10T02:57:19.244 UTC.



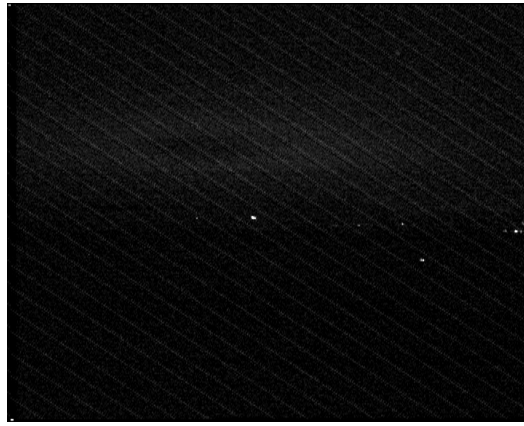
**Figure S43.** Elve occurring at 2020-12-10T02:58:34.754 UTC.



**Figure S44.** Elve occurring at 2020-12-10T03:00:01.679 UTC.



**Figure S45.** Elve occurring at 2020-12-10T03:02:59.548 UTC.



**Figure S46.** Elve occurring at 2020-12-10T03:07:26.771 UTC.



**Figure S47.** Elve occurring at 2020-12-10T03:16:56.367 UTC.



**Figure S48.** Elve occurring at 2020-12-10T03:20:33.680 UTC.



**Figure S49.** Elve occurring at 2020-12-10T03:21:49.979 UTC.



**Figure S50.** Elve occurring at 2020-12-10T03:31:32.347 UTC.



**Figure S51.** Elve occurring at 2020-12-10T03:40:26.663 UTC.



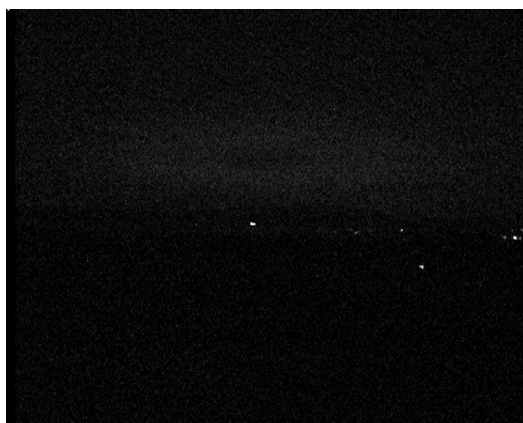
**Figure S52.** Elve occurring at 2020-12-10T03:42:34.366 UTC.



**Figure S53.** Elve occurring at 2020-12-10T03:45:38.110 UTC. No CG was detected by GLD360.



**Figure S54.** Elve occurring at 2020-12-10T03:50:04.616 UTC.



**Figure S55.** Elve occurring at 2020-12-10T03:57:37.617 UTC.





**Figure S56.** Elve occurring at 2020-12-10T03:57:56.574 UTC.



**Figure S57.** Elve occurring at 2020-12-10T04:13:43.939Z UTC. No CG stroke was detected by GLD360.



**Figure S58.** Elve occurring at 2020-12-10T04:19:28.843 UTC.



**Figure S59.** Elve occurring at 2020-12-10T04:27:56.658 UTC.



**Figure S60.** Elve occurring at 2020-12-10T04:33:03.529 UTC.



**Figure S61.** Elve occurring at 2020-12-10T04:50:20.225 UTC.

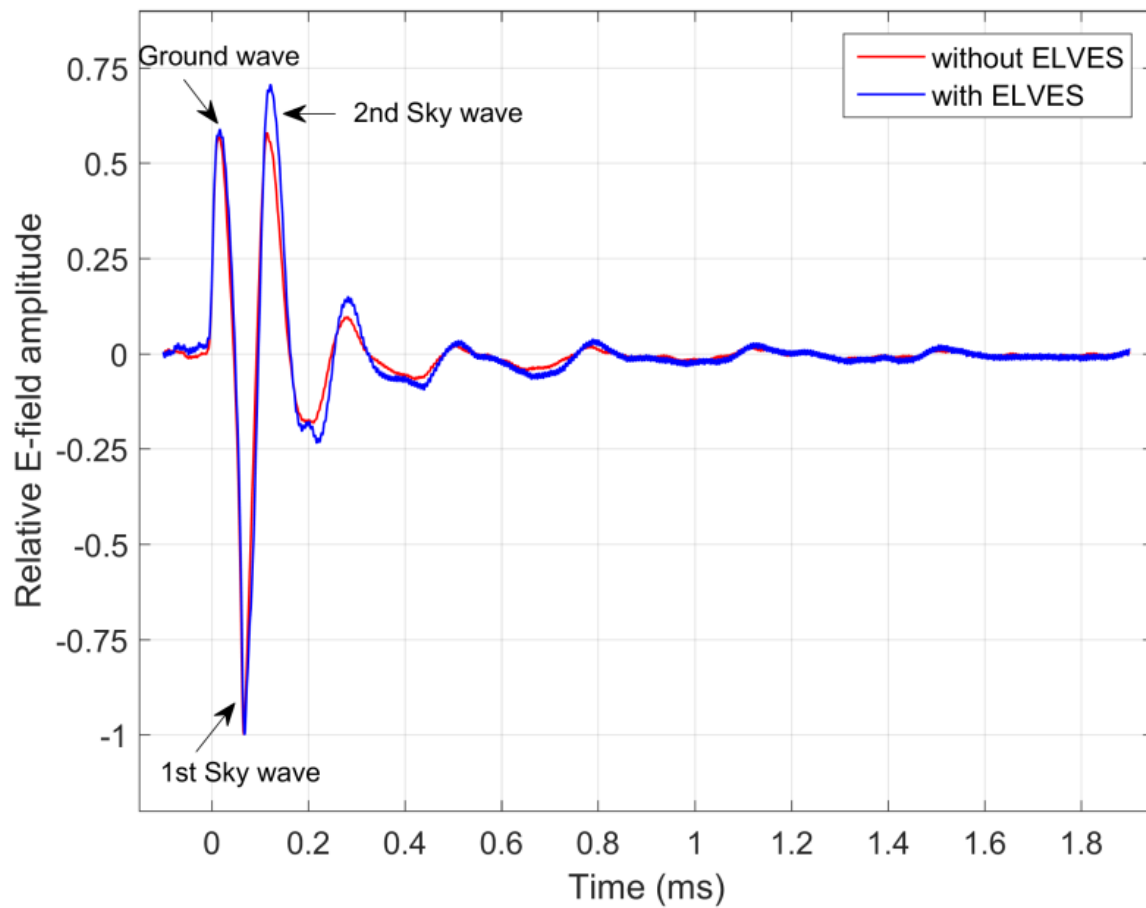


**Figure S62.** Elve occurring at 2020-12-10T05:08:41.960 UTC.



**Figure S63.** Elve occurring at 2020-12-10T05:09:00.625 UTC.

January 21, 2022, 1:40pm



**Figure S64.** Comparison of stack of normalized waveforms for elve parent strokes (blue) and for not producing elves strokes (red). The ground wave and the first and second sky waves are indicated with arrows. The PSD of each flash (Figure 4 in the paper) is computed over this time window.