# Video from the Chilean Navy

*(Antoine Cousyn, François Louange and Geoff Quick - 2015/11/26) **

On November 11th 2014, an AS-532 Cougar helicopter of the Chilean Navy, during a routine daytime mission (16:48 UTC), noticed an unknown flying object through its HD FLIR camera. This object was detected, recorded and seen by the pilot over about ten minutes, before it disappeared behind the clouds. Images were obtained in high definition mode as well as in infrared mode.

The officers asked ground control about this object without success, since it had not been detected by the primary radar. They also tried to establish radio contact with the object, with no result. The object was described as being white and oval, and on two occasions it dumped some unidentified material.

The helicopter was flying at a height of 4500 feet, with a visibility of 30 nautical miles, the cloud base being at 10000 feet.

The key question was to establish whether the object could be an aircraft (possibly a medium-haul or long-haul airliner), in spite of the lack of detection and radio contact, or if it was a UFO.

In the IR sequences of the video, two hot spots appeared over about six minutes, which might correspond to two jet engine hot sections if the object turned to be an aircraft.

** This report was slightly modified on 2017/01/09, thanks to a constructive remark from Tim Printy concerning the possible actual height of the object. The paragraph "Height of the object" was added and the paragraph "Nature of the dumped material" was completed.*

***IMPORTANT NOTE (2017/01/09):***

*This report had been prepared in 2015 on request from CEFAA, on a good will basis, but with no information at all provided about the IR camera model and its characteristics. It was then assumed that this was a EUROFLIR 350-3, since this camera model used to be generally installed by Eurocopter onboard this type of helicopter.*

*However, it was officially announced these days that the actual camera was a WESCAM MX-15.*

*Those two cameras have rather similar characteristics and the conclusions of this report should not differ significantly if it is rewritten using the right camera model.*

*The "IPACO team" chose to leave this report as it is and to wait until the official CEFAA report is available before deciding to make any further effort on this typical IFO case.*

# Available data

Besides the video itself, the following data were initially available for the present analysis:

- Information about the helicopter and its equipment:
  - Helicopter model COUGAR AS-532 (Airbus/Eurocopter)
  - Camera EUROFLIR 350-3
    - Diameter : 14 inches
    - Elevation / Azimuth : +35° to - 120° / 360°
    - TV HD : 1920 x 1080 pixels<br>Zoom 1.3° -> 24°
    - IR (3-5 μ) : 680 x 512 pixels<br>Zoom 1.3° -> 24°
- Information about the flight:
  - Height : 4500 feet
  - Visibility : 30 nautical miles (55 Km)
  - Velocity : 120 knots
- Information about the video:

  The video contains a succession of sequences in various modes, two of which are particularly relevant for this study: "TV HD mode" (noted EOW on top of the screen) and "IR mode" (noted IR on top of the screen).

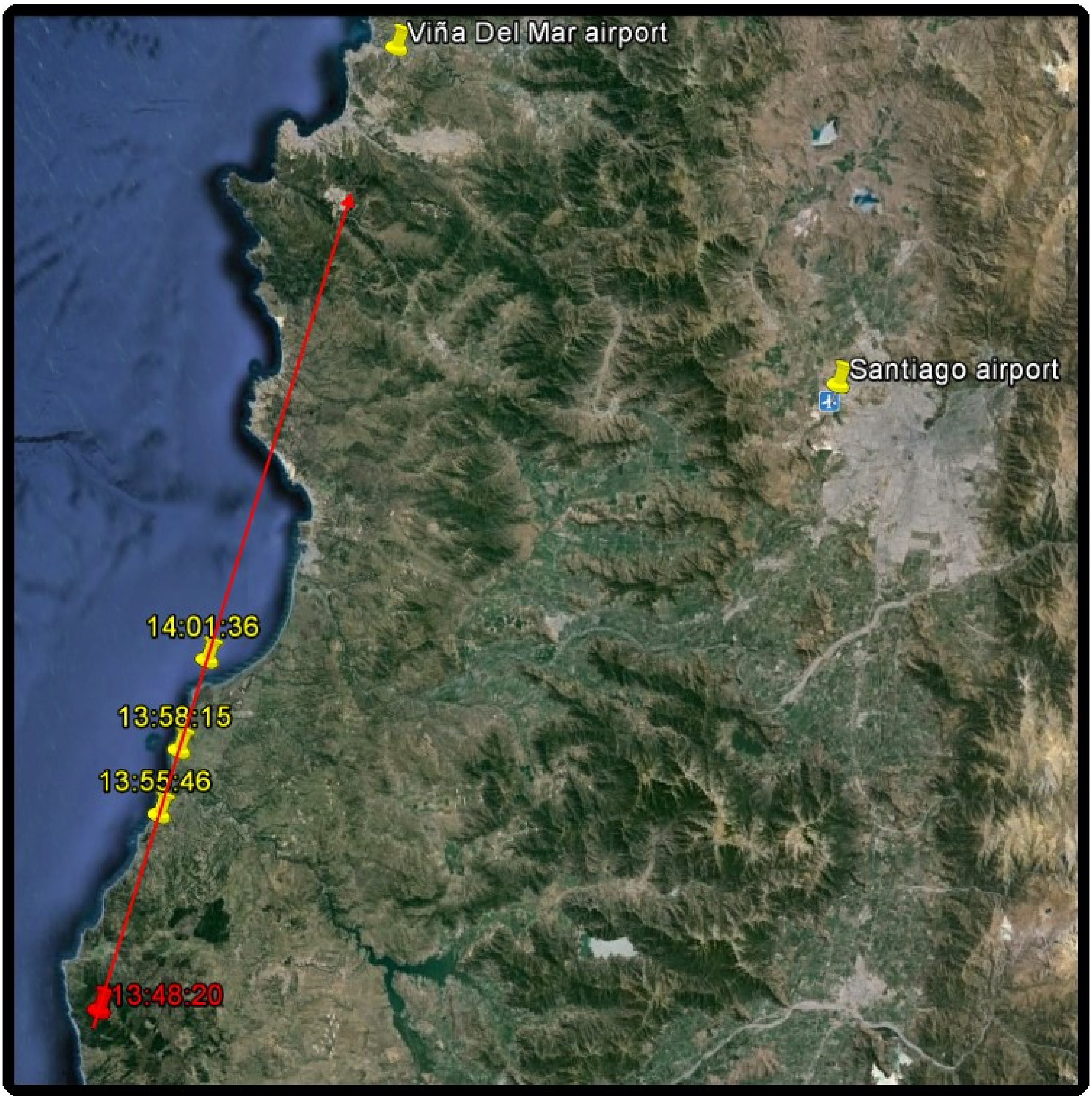
  - Image dimensions : 1920 x 1088 pixels
  - Extracted frames :
    - TV HD : information exists in pixels [0,0] to [1918,1086]<br>*(useful size: 1918 x 1086)*
    - IR : information exists in pixels [319,27] to [1599,1051]<br>*(useful size: 1280 x 1024)*
- Assessments about the UFO *(CEFAA)*:
  - Velocity assessment : *"about the same as the helicopter"*
  - Distance assessment : *"30-35 nautical miles (55-65 Km)"*

In the frame of this study, it was assumed reasonably that the observed object was unique, whatever it was, and in particular that the two detected hot spots it contained remained at a fixed distance from one another.

# Helicopter’s track

According to the technical data displayed around the image in the video, we could learn that the helicopter was flying towards North (+17°), following the object.

The following map, showing the helicopter’s track, was derived from the displayed geographic coordinates:



# Assessment of focal length

To perform any angular measurements on a photo/video, it is necessary to know either the values of the focal length and of the sensor's dimensions, or the value of the "equivalent focal length 35mm camera".

For the present analysis, none of these parameters were directly available.

## Equivalent focal length 35mm camera in "TV HD mode"

However, the EUROFLIR 350-3 technical sheet (available to the public) provided the maximum and minimum values of the cone angle, from which we could derive respectively the minimum and the maximum values of the "equivalent focal length 35mm camera" in "TV HD" mode:

$F_{35mmTVHD} = [\sqrt{(24^2 + 36^2)}] / [2 \tan(\theta/2)]$ where θ is the cone angle

$F_{35mmTVHD} = 21.6333 / \tan(\theta/2)$

- $\theta = 24°$ => $F_{35mmTVHDmin} = 101.8$ mm ("EOW 17" on top of the screen)
- $\theta = 1.3°$ => $F_{35mmTVHDmax} = 1907$ mm ("EOW 200" on top of the screen)

The whole video image size corresponds nearly exactly to the whole "TV HD mode" image size (1920 x 1088 pixels vs 1920 x 1080 pixels). This image size, in the focal plane, is assumed to be inscribed in the cone angle of the angular aperture.

Therefore, the above-mentioned values of $F_{35mmTVHD}$ could be used for angular computations with IPACO, for the "TV HD mode" sequences of the video.

## Equivalent focal length 35mm camera in "IR mode"

In the video, there is a short transition (over two seconds) from the "TV HD mode", using the minimum zoom factor, to the "IR mode", using the minimum zoom factor, with the same visible landscape.

For this maximum value of θ, it was possible to derive the "equivalent focal length 35mm camera" in "IR mode" from that in "TV HD mode", in the following way (using IPACO):

1. Extract from the video the latest frame in "TV HD mode" just before the transition, and the first frame in "IR mode" just after the transition (here the two frames respectively shot at 13:49:52 and at 13:49:54)

2. Choose a well-defined feature of the scene that is clearly visible in both frames

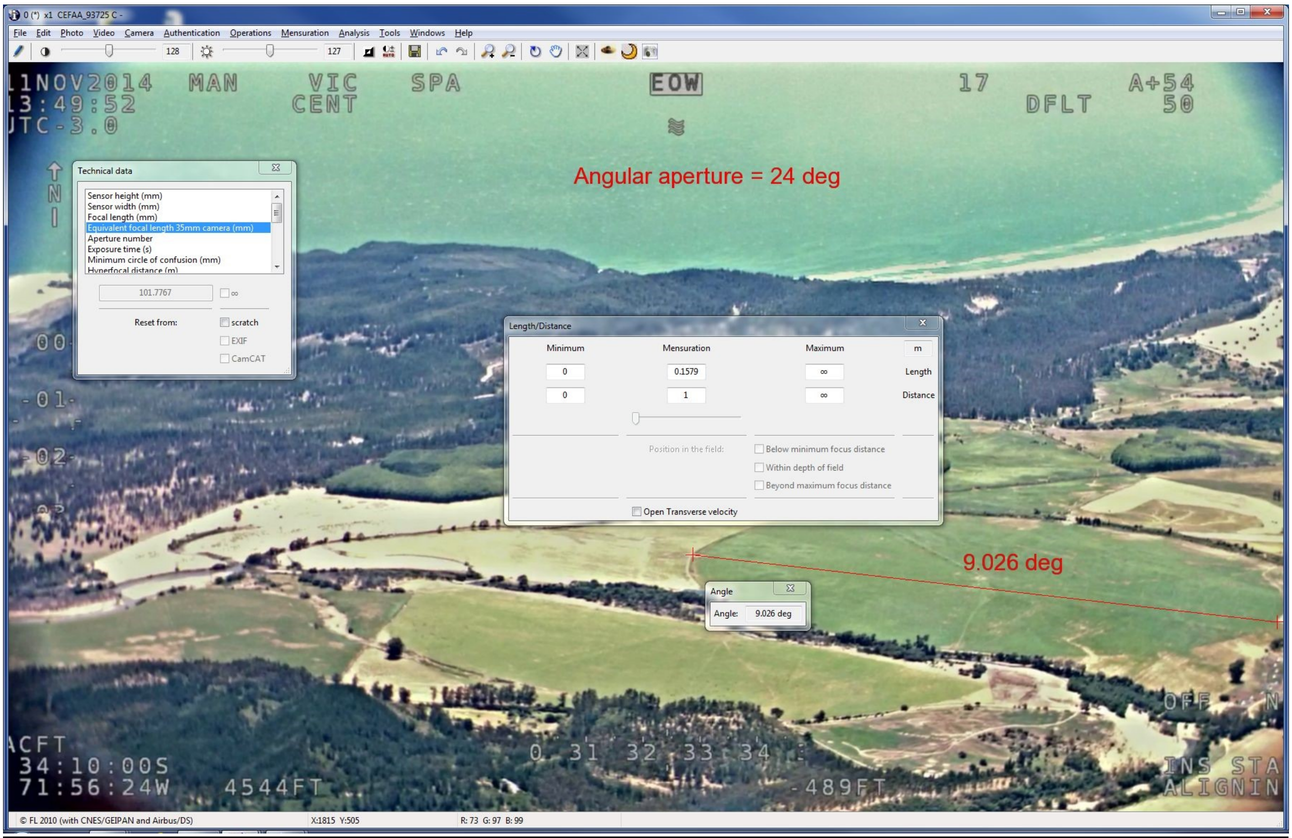
3. Having displayed the "TV HD mode" frame (13:49:52), introduce $F_{35mmTVHDmin} = 101.8$ mm in the *Camera/Technical data/Equivalent focal length 35mm camera* menu of IPACO

4. Draw a segment over the chosen feature and measure its angular size, using the *Mensuration/Geometric Mensuration/Angle* menu of IPACO

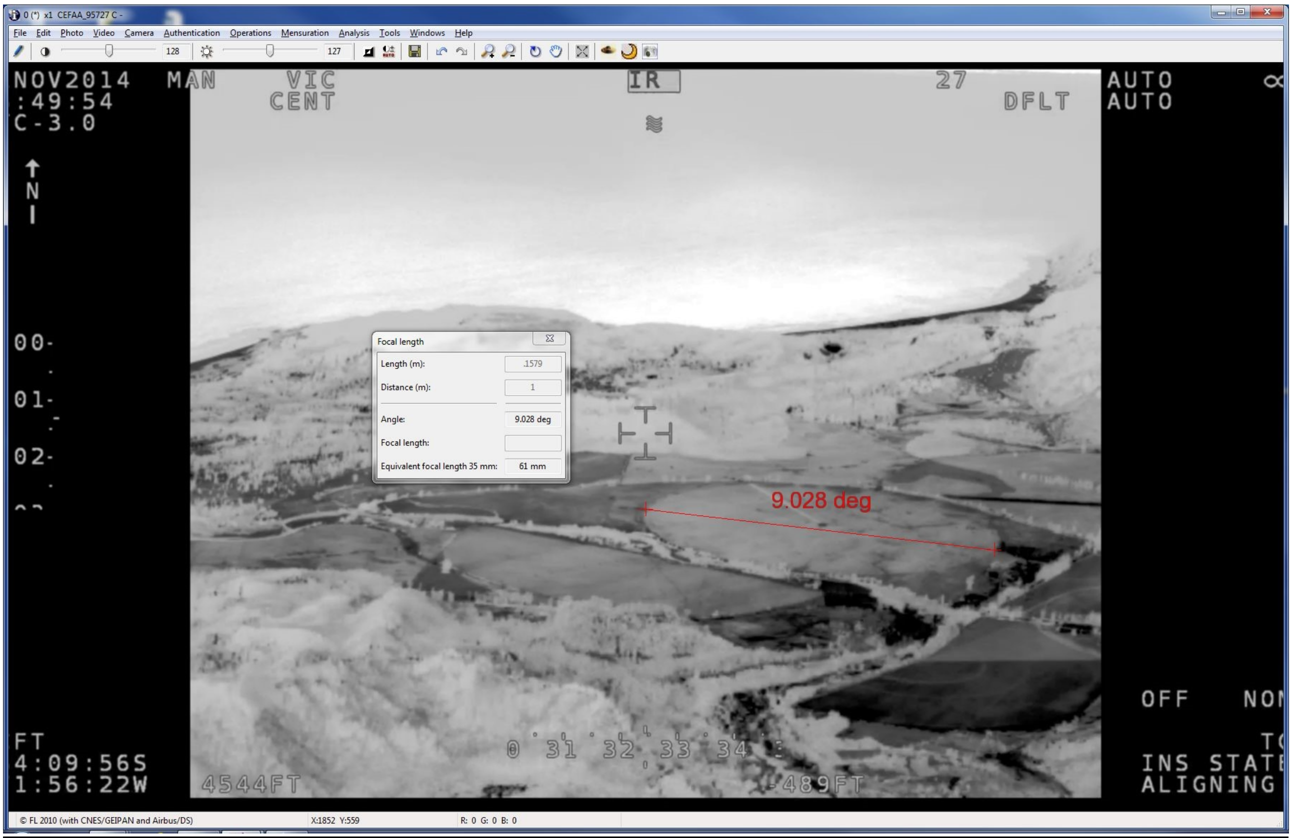
5. Using the *Mensuration/Geometric Mensuration/Length vs Distance* menu of IPACO with the same segment, measure the length/distance ratio: set the distance value to 1 and note down the resulting length value **L**

6. Having displayed the "IR mode" frame (13:49:54), compute the equivalent focal length 35mm camera, using the *Camera/Focal length* menu: draw the same segment over the chosen feature as above and introduce the value of the distance (equal to 1) and that of the length (equal to **L**).

This sequence of operations is illustrated as follows:



TV HD mode




IR mode

*<u>Note</u>: The very small difference (≈0.02%) between both measured angles on the same chosen feature of the scene is due to rounding effects*

The result obtained was:

- θ = 24° => $F_{35mmIRmin}$ = 61 mm ("IR 27" on top of the screen)

<u>Assuming reasonably that the ratio of the respective values of the equivalent focal length 35mm camera in "TV HD mode" and in "IR mode" is constant</u>, we could derive the value in "IR mode" for θ = 1.3° from the value for θ = 24°:

$F_{35mmIRmax} = F_{35mmIRmin} \times (F_{35mmTVHDmax} / F_{35mmTVHDmin})$, thus:

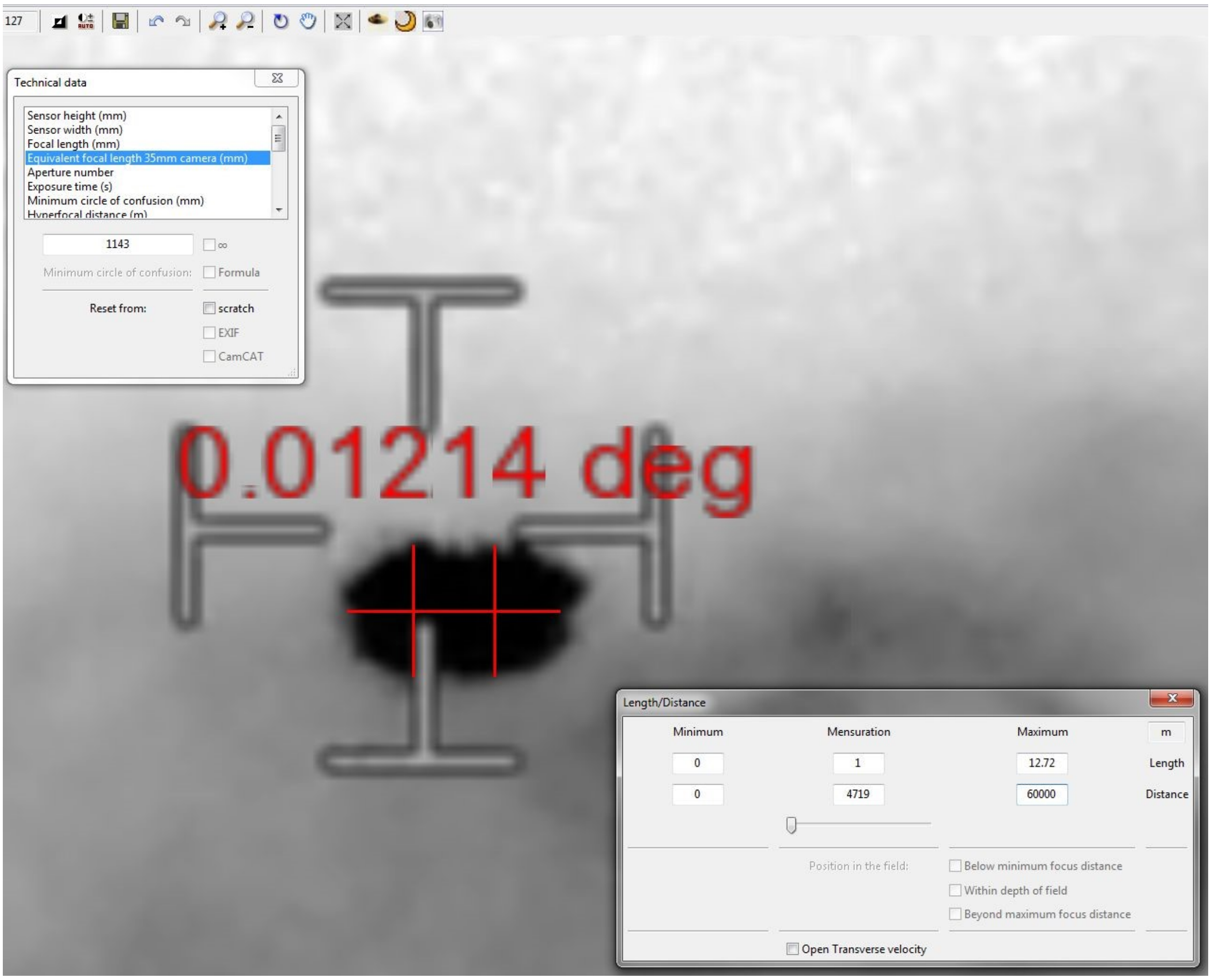
- **θ = 1.3° => $F_{35mmIRmax}$ = 1143 mm ("IR 675" on top of the screen)**

# Angular distance between the two hot spots

Having introduced into IPACO this estimated value of the "equivalent focal length 35mm camera" in "IR mode" (1143 mm), we used the following procedure to measure the angular distance between the two hot spots:

- Display the video with IPACO
- Extract from the IR parts of the video with the "675" setting one given frame where the two hot spots are visible, using the *Video/Extraction* function
- Display the extracted image
- Enter into IPACO the above-computed value of $F_{35mmIRmax}$ = 1143 mm, using the *Camera/Technical data* menu
- Use the *Mensuration/Geometric mensuration/Angle* function to measure the angular distance between both hot spots
- Use the *Mensuration/Geometric mensuration/Length vs distance* function to explore possible solutions for the Distance/Size ratio.

The following example shows results obtained from a frame shot at time [13:58:15]:




- Angle between hot spots = 0.01214°
- Distance/Size ratio = 4719
- If Distance = 60000 m (for instance) => Transverse size = 12.72 m

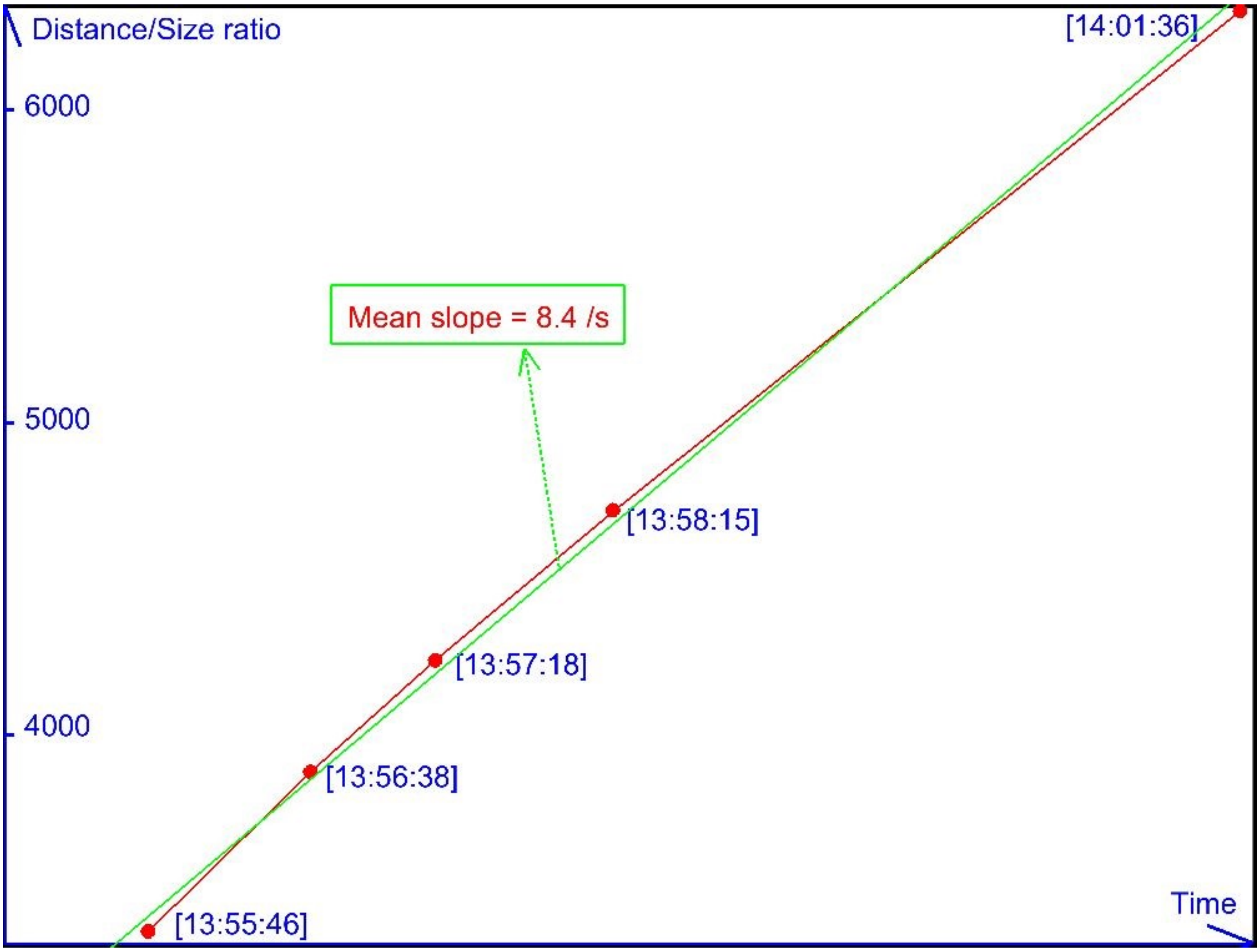
We extracted several frames from the "IR 675" sequences of the video, measured for each of them the angular distance between the two hot spots, and derived the corresponding "distance/transverse size of the segment joining the hot spots" ratio.

The following table displays the results obtained:

| Time | Angle | Distance/Size |
|---|---|---|
| 13:55:46 | 0.0170° | 3368 |
| 13:56:38 | 0.0148° | 3879 |
| 13:57:18 | 0.0135° | 4238 |
| 13:58:15 | 0.0121° | 4719 |
| 14:01:36 | 0.0091° | 6319 |

This table indicates that during the six minutes of interest, the distance between the helicopter and the object had nearly doubled.

It also appeared that the distance/size ratio had increased almost perfectly linearly along time, as illustrated by the following curve, with a mean slope equal to +8.4 units per second:



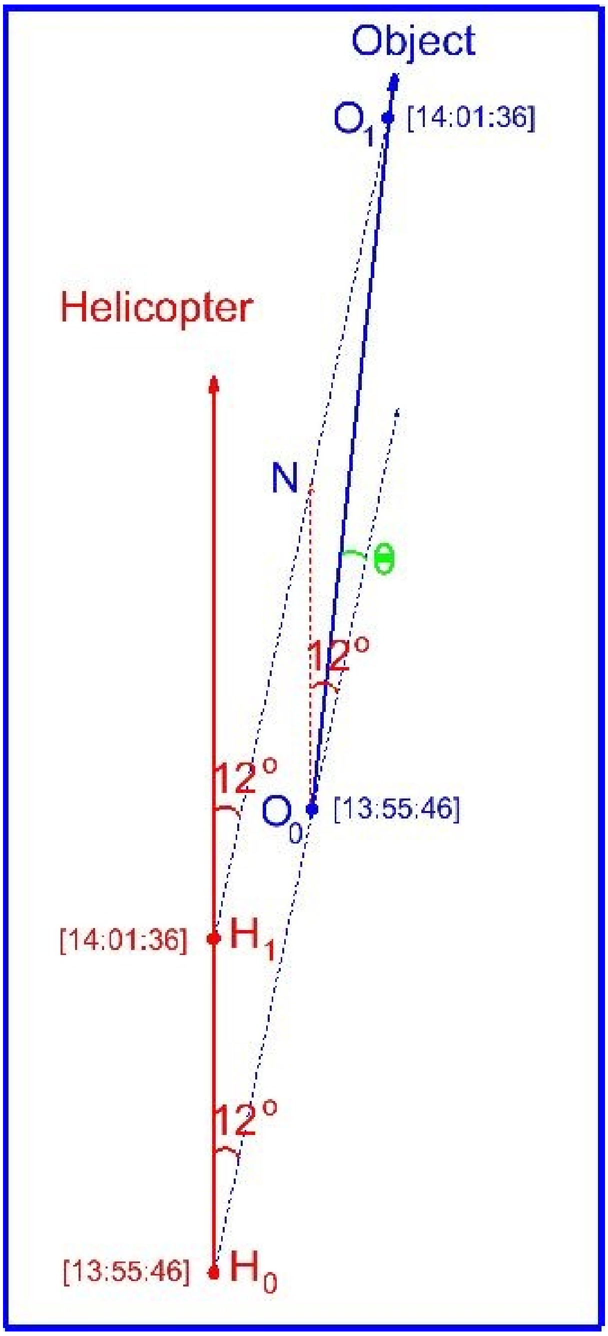

This meant that the object was moving away from the helicopter at a constant velocity.

# Velocity of the object

Analysis of the indications displayed on the sides of the video's image showed that, during the six minutes of interest:

- The helicopter's height remained about constant
- The helicopter's velocity along its linear trajectory was constant (120 kt)
- The object was observed in front of the helicopter, more precisely under a constant azimuthal shift of 12° towards the right
- The object's relative velocity along the camera's line of sight was about constant and was linked to the object's size through the table and the mean slope value above-referenced.

The following simplified projection on a horizontal plane of the respective trajectories of the helicopter and of the object could be drawn:



The goal being to compute the object's mean speed during the six minutes of interest (more precisely: 350 s), the useful points were:

$H_0$ : position of the helicopter at time [13:55:46]
$H_1$ : position of the helicopter at time [14:01:36]
$O_0$ : position of the object at time [13:55:46]
$O_1$ : position of the object at time [14:01:36]
N : defined by $H_1N = H_0O_0$

The following computations were done, every length being expressed in kilometers, except the actual distance between the two hot spots (noted D) and the transverse component of this distance (noted T), which were expressed in meters:

$H_0H_1 = O_0N = 120 \times 1.852 \times (350/3600)$
$H_0H_1 =$ **$O_0N = 21.6$ Km**

$H_0O_0 = H_1N = 3.368\ T$
$H_1O_1 = 6.319\ T$

$O_1N = H_1O_1 - H_1N$
**$O_1N = 2.951\ T$**

**$T = D \cos \theta$**

Using twice the generalized Pythagoras' theorem with the triangle $NO_0O_1$:

$O_0O_1^2 = O_0N^2 + O_1N^2 - 2\ O_0N\ O_1N \cos(180° - 12°)$
**$O_0O_1 = \sqrt{(466.56 + 8.708401\ T^2 + 124.697\ T)}$**

and:

$O_1N^2 = O_0N^2 + O_0O_1^2 - 2\ O_0N\ O_0O_1 \cos(12° - \theta)$
**$\theta = 12 - \text{acos}\ [(O_0N^2 + O_0O_1^2 - O_1N^2) / (2\ O_0N \times O_0O_1)]$**

These equations could easily be solved digitally for any given value of **D**.

# Distance between the two hot spots

Since all preceding equations relied on one single unknown D (real distance in the 3D space between the two hots spots observed in the object), calculations were made for several values of D in the range from 1 to 30 meters.

For each considered value of D, the following table indicated the values of the following parameters:

- Angle θ
- Minimum distance between the helicopter and the object (at time [13:55:46])
- Maximum distance between the helicopter and the object (at time [14:01:36])
- Object's mean velocity during the 350 s of interest (in both Km/h and knots)

| **D** (m) | **θ** (°) | **Dist mini** (Km) | **Dist maxi** (Km) | **Velocity** (Km/h) | **Velocity** (knots) |
|---:|---:|---:|---:|---:|---:|
| 1 | 11 | 3 | 6 | 251 | 136 |
| 5 | 7 | 17 | 31 | 371 | 200 |
| 10 | 5 | 34 | 63 | 522 | 282 |
| 15 | 4 | 50 | 95 | 673 | 363 |
| 20 | 3 | 67 | 126 | 825 | 445 |
| 25 | 3 | 84 | 158 | 977 | 527 |
| 30 | 2 | 101 | 189 | 1128 | 609 |

Obviously, values of D below 10 m did not match with available data concerning assessed distance, because for a low distance (up to around 20 Km, the laser range limit in a FLIR turret), the indicators at the right bottom of the image would have delivered a valid range value for the target, which never occurred throughout the video. On the other hand, values of D above 15 m raised a problem of detectability (distance far above the indicated limit of visibility).

Therefore, the range of values of D that seemed consistent with available data was from 10 to 15 meters.

As a matter of fact, this range is consistent with the standard distance between the two jet engines of a **medium-haul aircraft** (type B737, A320, A321), which is around 11 meters:

| **D** (m) | **θ** (°) | **Dist mini** (Km) | **Dist maxi** (Km) | **Velocity** (Km/h) | **Velocity** (knots) |
|---:|---:|---:|---:|---:|---:|
| 11 | 5 | 37 | 69 | 552 | 298 |

It is noticeable that, for this value, the average distance between the helicopter and the object during the six minutes of interest is almost exactly the estimated value reported by the Navy (55 Km).

The hypothesis of a long-haul aircraft is far less acceptable, since the corresponding values of D would then be in a range from 18 to 23 m (type B767, B777, B787, A310, A330, A350) and conditions of visibility would not be fulfilled.

These results are very much in favor of the explanation of the video by a medium-haul aircraft, which was probably in a descending phase, with a low velocity (298 knots), in view of landing, possibly at Santiago airport (Viña del Mar airport is rarely used by civil airliners, and anyway too short for this type of jetliner).

# Height of the object

It was initially assumed that the UFO's height was about the same as the helicopter's, as commented by the CEFAA. This seemed to be confirmed by the indicator on the left side of the screen, indicating a 0° angle, apparently for the elevation of the line of sight in relation with the local horizon.

If in effect the UFO was observed in a direction parallel to the local horizon, its height could be computed as follows:

R = Earth's radius = 6371 Km
h = helicopter's height = 4500 ft
D = camera-UFO distance = 55 Km
H = UFO's height

$$(R + H)^2 = (R + h)^2 + D^2$$

From which we obtain the value of H:

**H ≈ 5400 ft**

However, it was not possible to obtain a clear explanation of what this indicator really means. If we assume that it measures in fact an elevation angle from the helicopter's horizon, and if the helicopter was in a slowly ascending phase, we have to take into account the corresponding angular shift θ.

The corrected equation is then:

$$(R + H)^2 = (R + h)^2 + D^2 + 2D\,(R + h)\sin\theta$$

Leading to the following rounded values of H according to θ:

| θ (°) | H (Ft) |
|---|---|
| 1 | 8 500 |
| 2 | 11 700 |
| 3 | 14 800 |

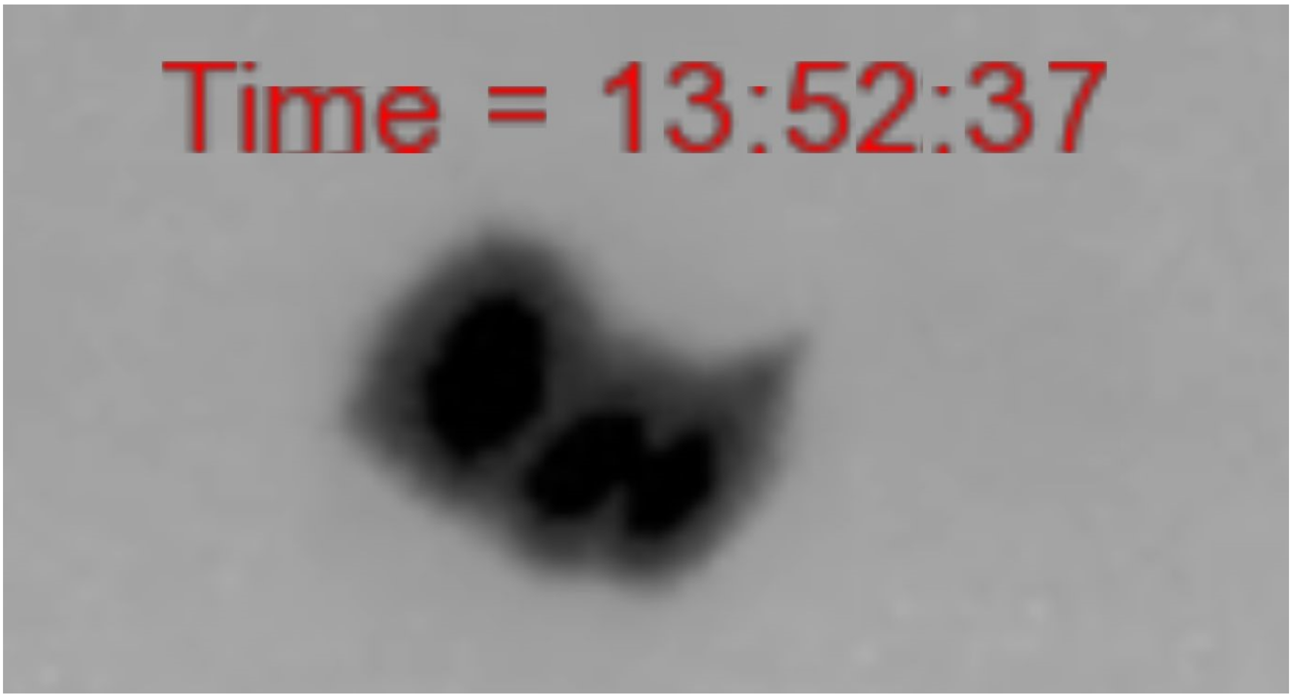
…

# Oddities in the video

Considering the possible explanation by a medium-haul aircraft, there remained two particular odd features in the video that deserved a rational explanation.

## Number of hot spots

Although in most of the IR sequences of the video, 2 hot spots appear clearly, there are a few frames in which there seems to be 3 hot spots, in particular the following one:




In a few other frames, a third hot spot appears more vaguely, often with a lot less saturation that the 2 "main" hot spots.

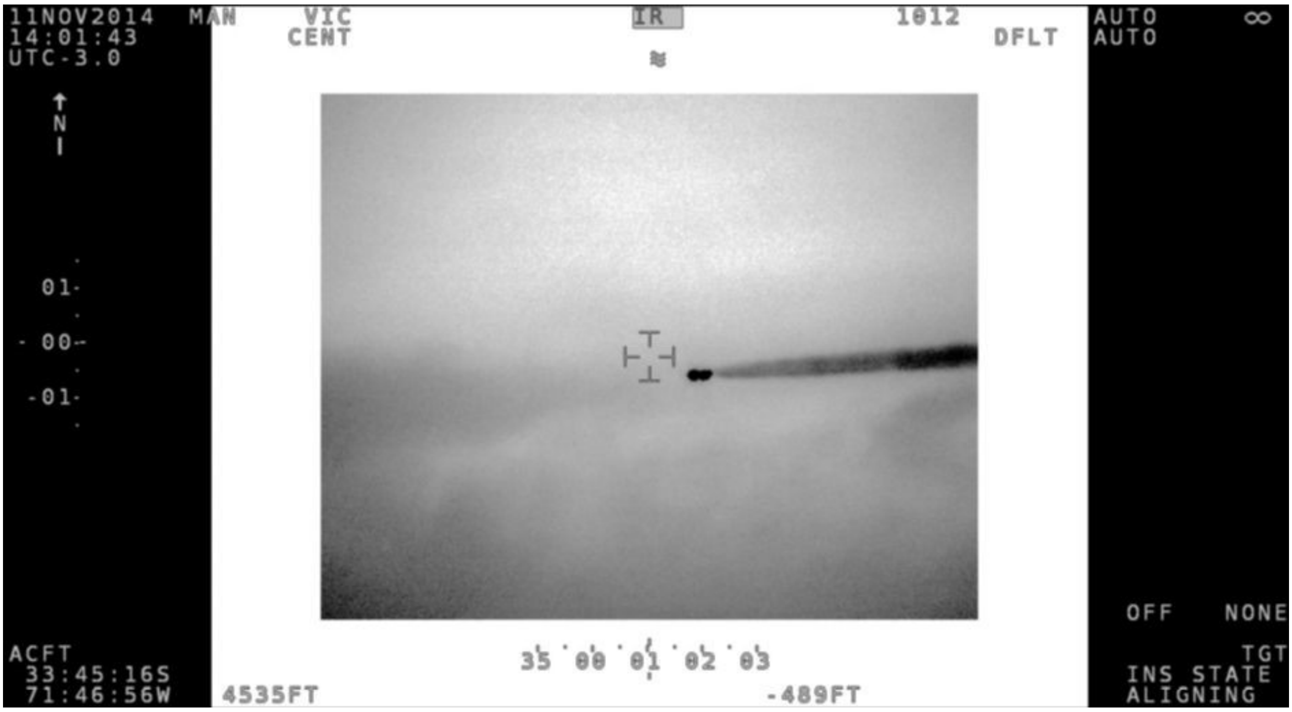
If the object was an aircraft, there would only be two main jet engines. However, the third hot spot could well be explained by a reflection in IR on a part of the plane, in certain particular geometric configurations.

A spurious reflection of this type had already been identified in the past by the IPACO team, in a photo submitted for analysis by MUFON.

Another possible explanation could be the use of the aircraft's APU (Auxiliary Power Unit), which is a small jet engine mounted at the back of the fuselage and which is sometimes run up in flight prior to landing.

# Nature of the dumped material

At two occasions in the course of the video, some material was dumped by the object, as illustrated by this frame:




If the UFO's height was far above the helicopter's height, at an altitude above the 0° isotherm, then the trail was, most probably, a condensation (or vapor) trail.

If, on the contrary, the UFO's height was in the same order of magnitude as the helicopter's height, then such an explanation must be discarded, because the temperature at that time and at that altitude was not cold enough (the 0° isotherm was much higher than the helicopter).

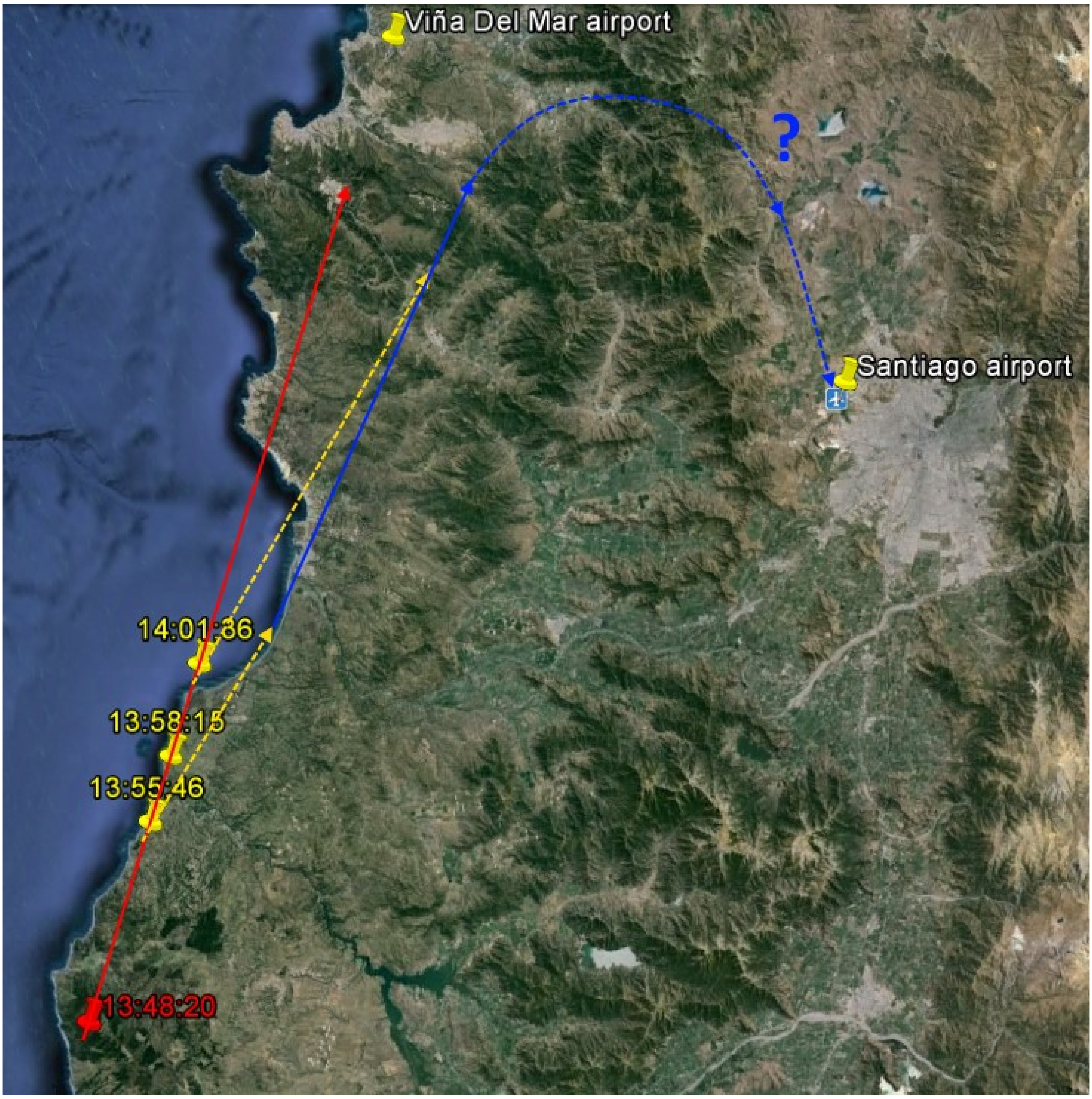
In that case, a credible scenario appeared to be that a twin jet airliner, many kilometers ahead of the helicopter, operating a normal flight profile at low speed, and being at a fairly low level (possibly prior to a landing approach), had been jettisoning an amount of cabin waste water. For example, the cabin crew could have just dumped ice buckets or similar into the galley basins as they cleared away for landing.

The apparent move of the effluent trail to the right resulted from the local wind, which was blowing from the west-north-west according to the following record:

| METAR SCRD 111700Z 30009KT CAVOK 17/11 Q1017 | | | |
|---|---|---|---|
| **METAR** | **METAR Report** | | |
| **SCRD** | station id: | SCRD | |
| **111700Z** | observation time: | on the 11., 17:00 UTC | |
| **30009KT** | Wind: | from the west-north-west (300° (+4°/-5°)) at 16.7 km/h | 9 kt = 10.4 mph = 4.6 m/s |
| **CAVOK** | cloud and visibility OK | | |
| **17/11** | Temperature: | 17 °C | 62.6 °F |
| | Dewpoint: | 11 °C | 51.8 °F |
| | relative humidity*: | 68 % | |
| **Q1017** | altimeter: | 1017 hPa | 30.03 in. Hg = 763 mmHg |

# Conclusion

The object observed in the video was most probably a medium-haul twin jet airliner in a landing phase, flying ahead of the helicopter at a higher velocity, with a low height and a low velocity, in view of landing. One possible sketch of its route is the following:




The “white oval” effect was quite possibly due to halation through the atmosphere, mainly from illumination of a white fuselage roof. The pilot, perhaps not being aware of quite how far away the target was, could be subject to this illusion.

The effluent trail observed on two occasions probably results, depending on the actual height of the airplane, either from a contrail or from dumping some cabin waste water, forming a plume oriented along the local wind blowing from the west.

As concerns the third hot spot observed in a few frames of the video, it may be explained either by an IR reflection on the fuselage, or possibly by the use of an APU before landing.

Therefore, the pending questions are no longer about the nature of the object, but why it could not be detected by the primary radar, and why no radio connection could be established with it.

Concerning detection, could it be that Air traffic ground controllers were looking too close to the helicopter for a radar return, discounting that of the airliner as being too far away to the North?

Concerning radio communication, could it be that the jet was not monitoring the frequencies or did not think it was them being interrogated ("Can't be for us, we are too far North")?

*(Note: this type of incident has already been experienced on many occasions.)*

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