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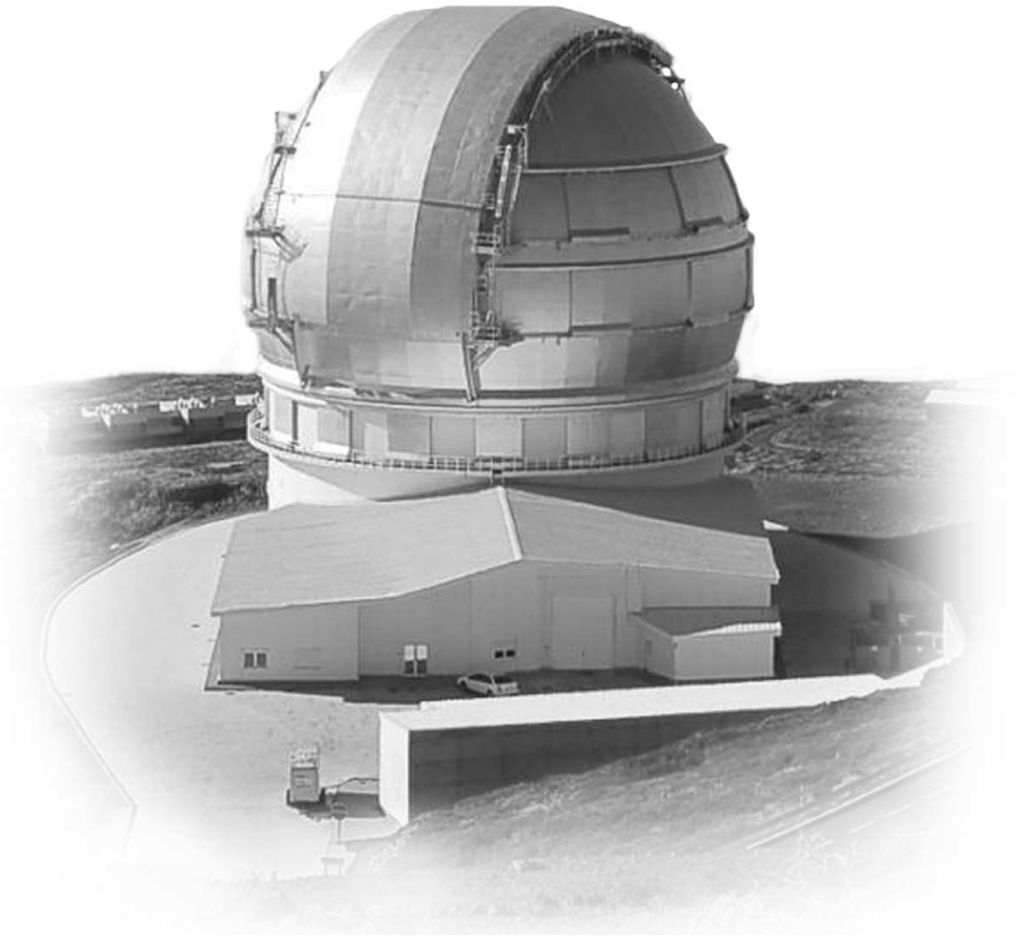

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Large 2011 Draconids outburst observing campaign: ground-based observations of the Paris Observatory team

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To support the 2011 Draconids Airborne Campaign, three teams of observers have been deployed. Our goal was to obtain data from the ground stations during the technical interruptions of the airborne campaign (e.g., landing to refuel the airplane) and also to gather more data to compare.

1 Selections of observation sites

We selected the observing sites according to two criteria: climat data (see Figure 1) and the possibility to observe both predicted activity peaks.The first site selected as observing station was located on Rhodes Island in the Mediterranean Sea, Eastern Greece. The second one was on Pic du Midi de Bigorre, the French astronomical observatory, where the transparancy of the sky is very good with low atmospheric dispersion. There was a big gibbous Moon in the sky during the Draconids display.

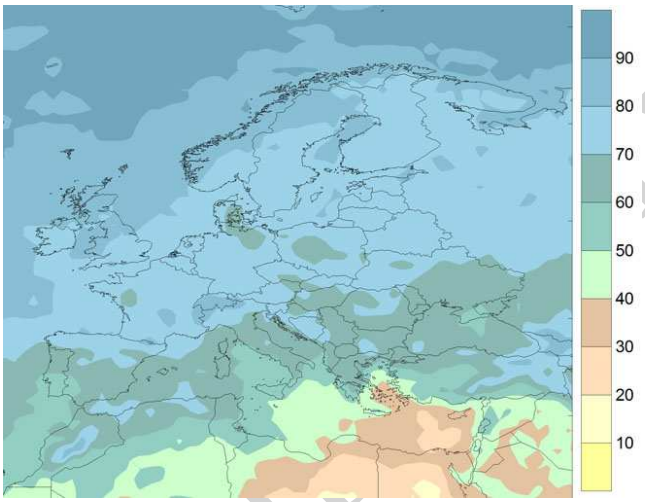

Figure 1 – Percentage of clouds coverage. *Courtesy of J. Anderson, K. Beattly, Sky & Telescope.*[1]

The third station was mobile in order to maximize the chances for double-station observations. The weather was our primary enemy that day, and we were checking the weather forecast all the time. Just a few hours before the maximum, we chose the location of the third station. On Saturday morning, October 8, we decided to move to the South-East of France, in the region of the Alpes de Haute Provence, not so far from the Haute Provence Observatory (see Figure 2).

Figure 2 – Example of a station (South East).

2 Equipment

We used similar equipment in all our ground stations that was comparable as much as possible with the equipment used in the airborne campaign. We have used Watec cameras for meteor detection, and GPS to measure the positions and detection time (with PPS). Table 1 provides an overview of equipment and software[2] used.

3 Results

With three stations, we had a maximum of chance to observe the Draconid outburst. Unfortunatly, François Colas, who was at Pic du Midi, could not make any observations because of a completely cloud-covered sky. The first peak of the activity was observed at Rhodes

[1] http://www.skyandtelescope.com/observing/highlights/104450349.html.

[2] http://sonotaco.com/soft/e_index.html.

Table 1 – Equipment used.

Equipment	Team Rhodes & Team Pic du Midi	Team South-East France
Cameras	Watec 902H2 and 902H	Watec 902H2, 902H, and 120N
Lens	6 mm and 12 mm Pentax	12 mm Pentax with 4 mm grating 300 lines/mm
Grabber/Software	Dazzle DVC100/UFOCapture	Dazzle DVC100 DV camcorder/UFOCapture
Time Inserter	TIM10 with GPS Garmin	TIM10, Black Box, Sprite2 with GPS Garmin

Table 2 – Meteor Counts.

Lens	Rhodes, L. Maquet	Rhodes, S. Bouley	South-East, J. Lecacheux	South-East, A. Leroy
6 mm	5	5		
12 mm	4	2	41	66
4 mm			53	not reduced

Island. However, the weather conditions were not perfect and the clouds just allowed to see some Draconids. In contrast, the conditions were nearly perfect for the South-East France team, i.e., clear sky with low humidity, but wind. A visual observer, Karl Antier, joined the South-East France team. Table 2 gives an overview of the video meteor counts.

We were not able to obtain any data with the grating video camera due to the lack of time.

The visual observations conducted by Karl Antier, registered many meteors: 157 Draconids were observed in nearly five hours. Those results are uploaded in the Visual Meteor Database (VMDB), at the IMO website.[3]

Jean Lecacheux recorded his observational data on a DV camcorder. In order to use his data, we had to convert them first to the same format as UFOCapture data. To do this, we have put the camcorder in the reading mode and the automatic detection of the meteors was done using a computer equipped with a DV input (see Figure 3). After this conversion, we were able to search for double-station observations in the data of the South-East France team.

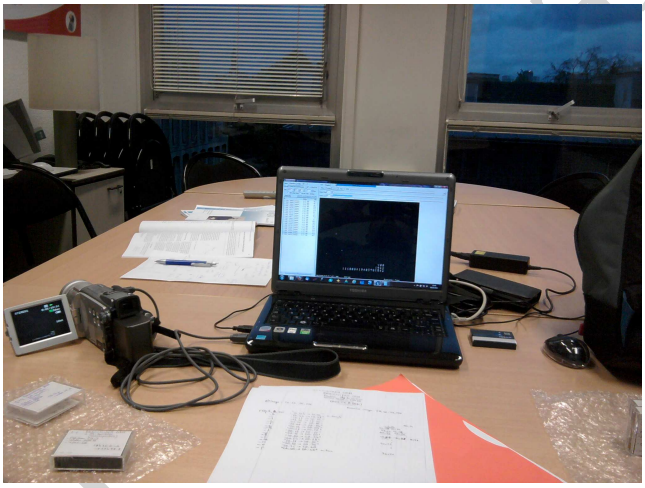

Figure 3 – Grabbing DV camcorder data.

Using UFOAnalyzer and UFOOrbit, we found 29 double-station detections. Assuming some restriction criteria, we computed 9 orbits. Additionally, we compared those orbits to that of the parent body, Comet 21P/Giacobinni-Zinner.

Tables 3, 4, and 5 show the results.

Table 3 – Results of orbit computations with UFOOrbit (Quality 2 parameter).

Element	Median
ω	$172\overset{\circ}{.}2 \pm 4\overset{\circ}{.}2$
Ω	$195\overset{\circ}{.}02 \pm 0\overset{\circ}{.}03$
i	$29\overset{\circ}{.}5 \pm 5\overset{\circ}{.}5$
V_g	19.1 ± 5.1 km/s

Table 4 – Results of orbit computations with UFOOrbit (Quality 3 parameter).

Element	Median
ω	$173\overset{\circ}{.}3 \pm \overset{\circ}{.}8$
Ω	$194\overset{\circ}{.}99 \pm 0\overset{\circ}{.}03$
i	$30\overset{\circ}{.}8 \pm 2\overset{\circ}{.}7$
V_g	20.3 ± 2.3 km/s

Table 5 – Orbital elements of Comet 21P/ Giacobinni-Zinner (December 5, 2011), computed by Jean Lecacheux.

Element	Median
ω	$172\overset{\circ}{.}603$
Ω	$195\overset{\circ}{.}397$
i	$31\overset{\circ}{.}911$
V_g	20.9 km/s

4 Conclusions

The first step in the reduction of Draconids data from the ground campaign is finished.

Now, we hope to compare our results with data recorded by other teams from other countries. Then we may perhaps adjust parameters to reduce the uncertainty in our data.

[3] http://vmo.imo.net/imoshr/obsview/draconids2011.php.

To finish, here are a few comments from Jean Lecacheux.

> *I am a little surprised that the particles emitted 111 years ago still have an average orbit so close to that of their parent comet. Yet those we observed in the Provence on 8 October 2012 took a great advance in their orbit around the Sun, as the Comet was still 2.35 AU from the Earth at this time. The comet will pass closest to Earth's orbit (or near any place we were) on 15 February. This means that these particles were 130 days ahead on the Comet.*
>
> *It seems to me as they passed close to the planet Jupiter in 1969, the same particles should have been two and half month in advance (roughly estimated). Therefore, the particles from the Comet should be placed at a slightly different distance from Jupiter. These would deviate from the other separated orbits.*
>
> *After all, it may be the relatively high orbital inclination of* 31° *which limits the effectiveness of any encounter with Jupiter, keeping the encounters relatively short. But I guess for many to understand what happened at the time that I should redo some calculations of Jeremie—which I shall do indeed!*

For more information, we refer to the IMCCE website.[4]

[4] `http://www.imcce.fr/langues/en/ephemerides/phenomenes/meteor/DATABASE/Draconids/2011/`.