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Global Radio Draconids 2011

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Radio counts of the Draconids 2011 outburst from all over the globe show remarkable and consistent details in the activity profile. Simple radio observations sufficiently spread around the world can coarsely identify meteor outbursts.

1 "Global" hourly radio counts

"Radio Meteor Observatories On Line" (RMOB)[1], created by Pierre Terrier and operational since 2001, allows observations world-wide to post their hourly radio meteor counts. Participants come mainly from Europe and North-America, not unlike for other observations (Figure 1). Japanese observers coordinate their own observations.[2]

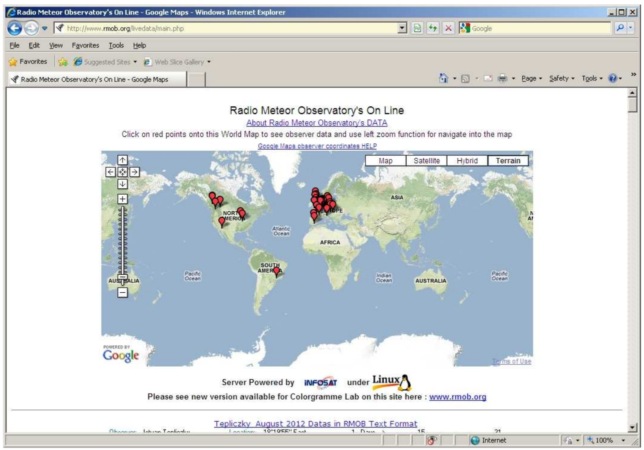
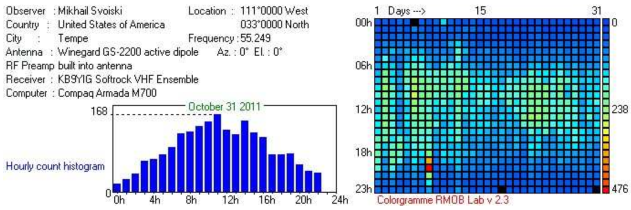


Figure 1 – Participants come mainly from Europe and North-America, not unlike for other observations.

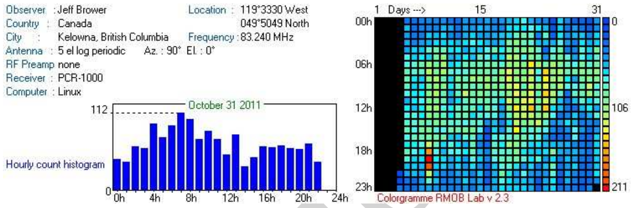
Submissions to RMOB are not verified, but there are some representative long-term observers. Several stations upload automatic counts every hour, other observers count manually, and make a manual upload once a day. High values reported by only one or a couple of observations have a high risk of being due to interference like sporadic-E.

All eyes were turned on to RMOB live data[3] at the occasion of the predicted Draconids outburst of October 8, 2011 (see, e.g., Asher and Steel, 2012). Indeed, both observers in North-America (represented by Svoiski and Brower) and Europe (represented by De Wilde) show significant increases between 18^{h} and 23^{h} UT (Figure 2). In the second half of the month, Orionids activity lasting several days can be seen. The same is seen for Steyaert, observing the same transmitter as De Wilde (Figure 3). A year earlier, no high activity was observed on October 8.

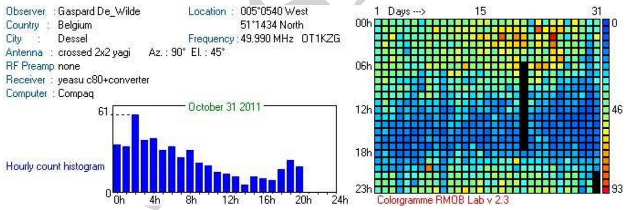
[1] http://www.rmob.org.
[2] http://www5f.biglobe.ne.jp/~hro/Flash-e/index.html.
[3] http://www.rmob.org/livedata/main.php.



(a) Micha Svoiski.

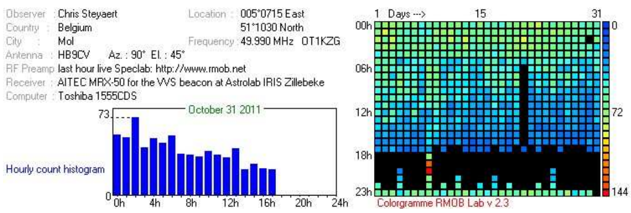


(b) Jeff Brower.

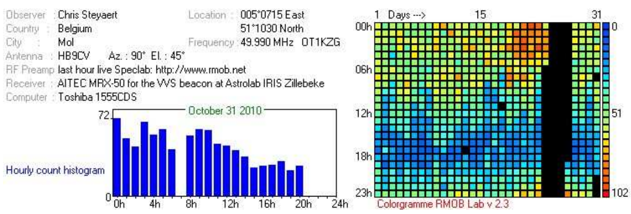


(c) Gaspard De Wilde.

Figure 2 – Observations by (a) Micha Svoiski, (b) Jeff Brower, and (c) Gaspard De Wilde.

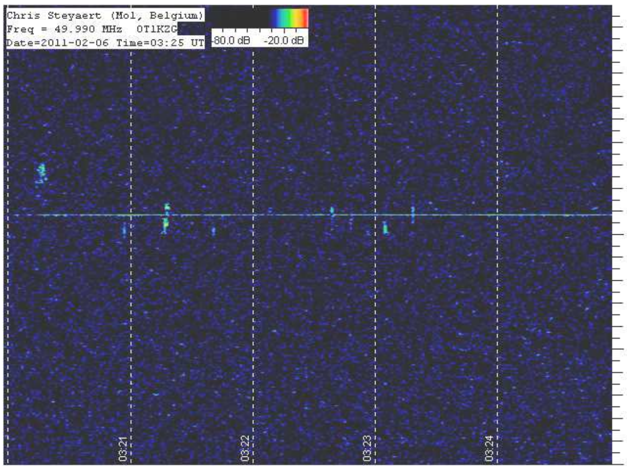


(a) Observations in 2012.

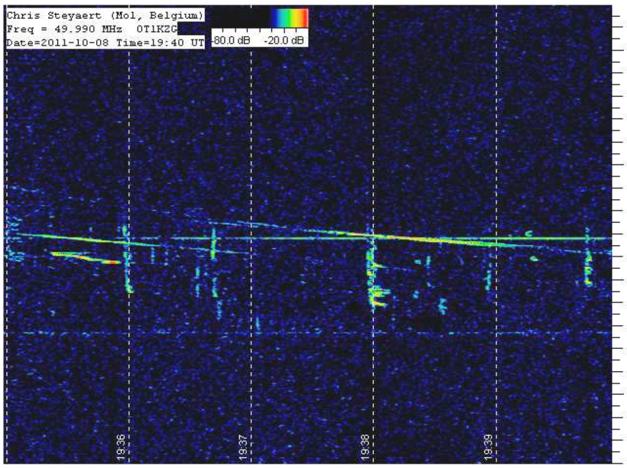


(b) Observations in 2011.

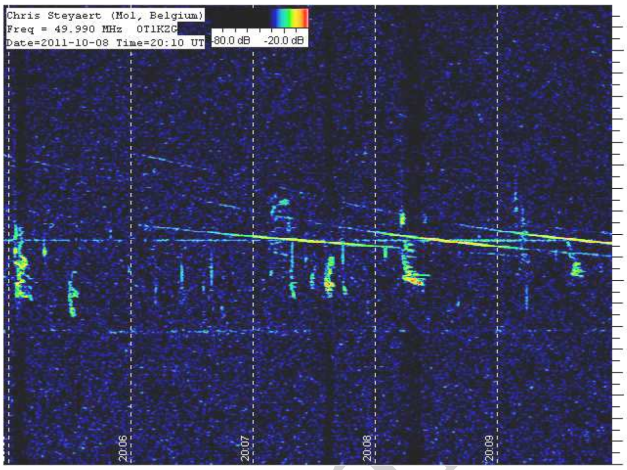
Figure 3 – Observations by Christian Steyaert in (a)2012 and (b) 2011. No high activity was registered around October 8, 2011.



(a) Quiet moment.



(b) Draconid peak.



(c) Busiest 5-minute interval for the author.

Figure 4 – A spectrogram during (a) a quiet moment of the year, (b) the assumed peak hours of the Draconids, and (c) during the busiest 5-minute interval for the author.

2 Detailed observations

Examples of spectrograms are shown in Figure 4. During a quiet moment of the year, a spectrogram can show the following elements (Steyaert, 2012):

1. If the distance from the transmitter to the receiver is rather short, the direct signal of the carrier can be received. It is a good frequency reference.
2. Underdense meteors are short vertical lines. They last up to some tens of a second, and show a Doppler spread due to thermal diffusion.

During the assumed hours of the Draconids, we see also the following:

1. The slow S-shaped lines decreasing in frequency are reflections on mainly high altitude planes that follow predefined corridors.
2. Longer reflections show often sharp "strands" that stop abruptly, called for their apparent shape "epsilons" or "c"s.

My busiest 5-minute interval was 20^h05^m–20^h10^m UT with 20 meteor reflections. There are no or few overlapping reflections.

3 Simultaneous observations

Gaspard De Wilde observes the VVS beacon at Zillebeke, 150 km to the south-east. Since September 2010, a beacon of BIRA/IASB in Dourbes, 130 km south-east of Zillebeke, is also in operation (Figure 5).

Figure 5 – Location of beacons (red) and observers (blue).

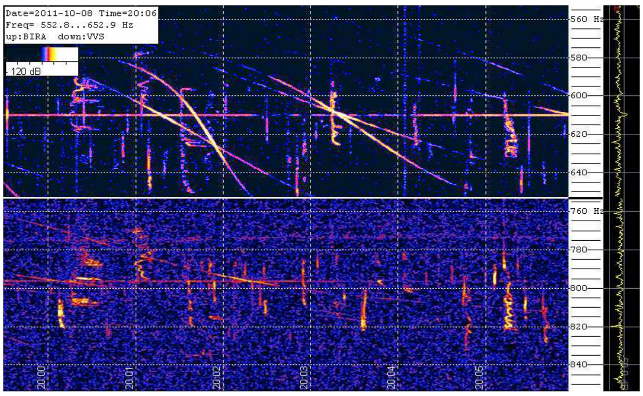
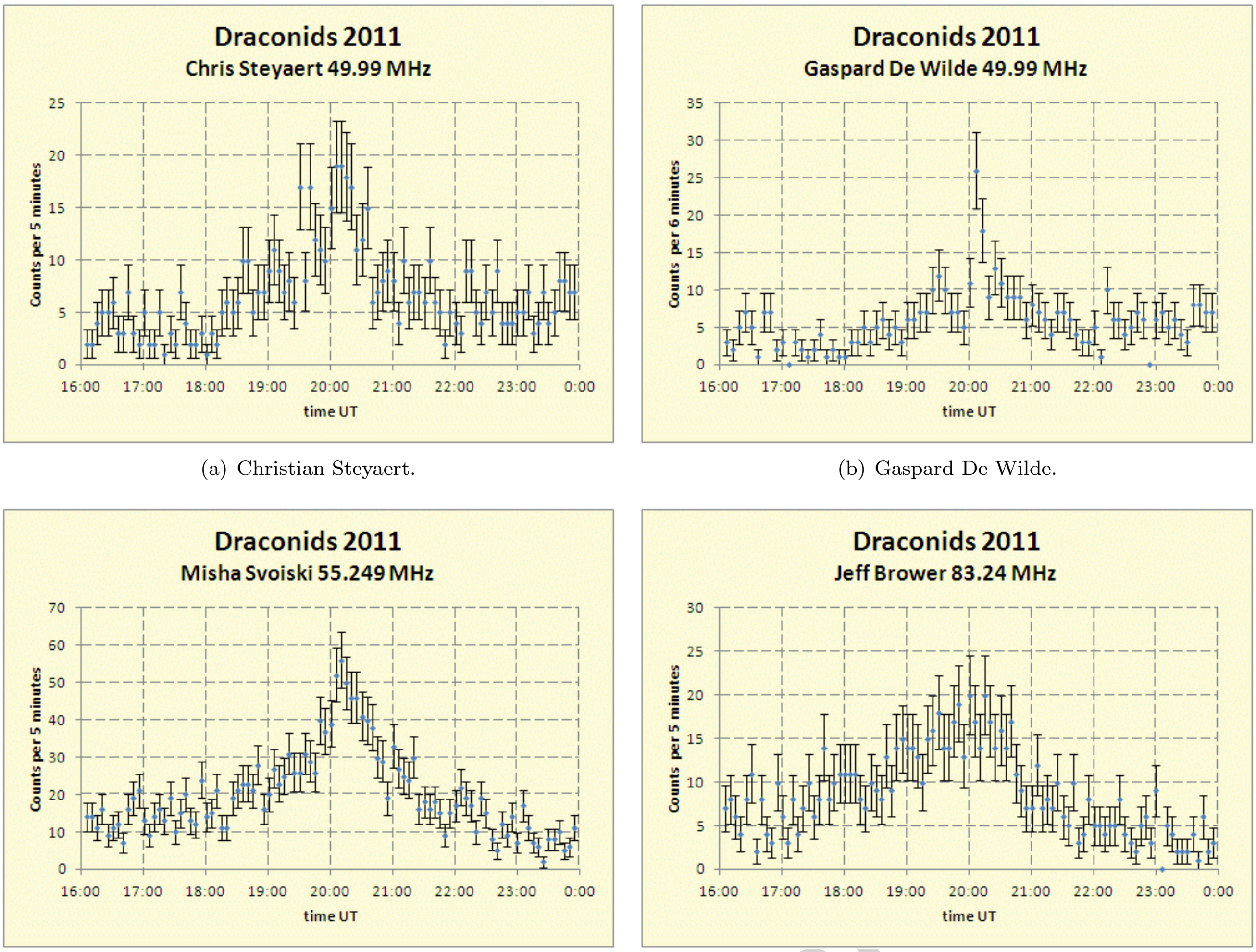


Figure 6 – Draconid maximum activity recorded by Gaspard De Wilde.



(a) Christian Steyaert.

(b) Gaspard De Wilde.

(c) Micha Svoiski.

(d) Jeff Brower.

Figure 7 – Detailed counts of (a) Christian Steyaert, (b) Gaspard De Wilde, (c) Micha Svoiski, and (d) Jeff Brower.

This gives the unique opportunity to observe the same "epsilons" on two transmitters from one receiving site. The Draconid maximum activity recorded by Gaspard De Wilde, Dessel is shown in Figure 6. The two signals are input to two stereo channels, and analyzed by one instance of Speclab[4], giving perfect synchronization. The signal-to-noise-ratio of the Dourbes signal is better, resulting in a clearer image, but otherwise not yielding considerably more reflections. The shapes of the epsilons are very similar, illuminated by two different transmitters (Steyaert, 2012).

The shapes and durations of the long reflections do not seem to be influenced much by the speed (Draconids with the low 21 km/s, Geminids at an average speed of 34 km/s, or Perseids with 60 km/s). The slower meteors penetrate deeper in the upper atmosphere.

4 Detailed counts

As the Draconid activity was sufficiently large, counts in 5- or 6-minute intervals are rather high. As a consequence, we were able to perform a meaningful statistical analysis.[5]

The error bars on counts "n" in Figure 7 represent the unbiased one standard deviation, $\sqrt{n}$. Improved ranges for low counts given by Barentsen et al. (2011) could have been used as well. The four observers use different techniques to identify and count meteors. We are not investigating here which method is "the best". The only assumption is that the technique yields reproducible results during the complete observing period.

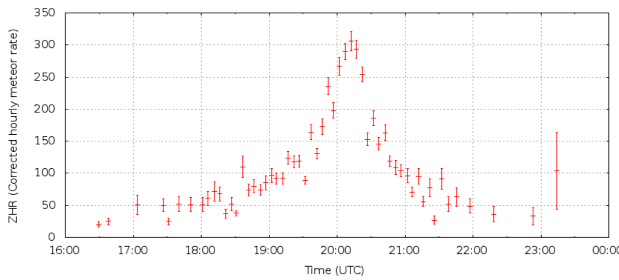
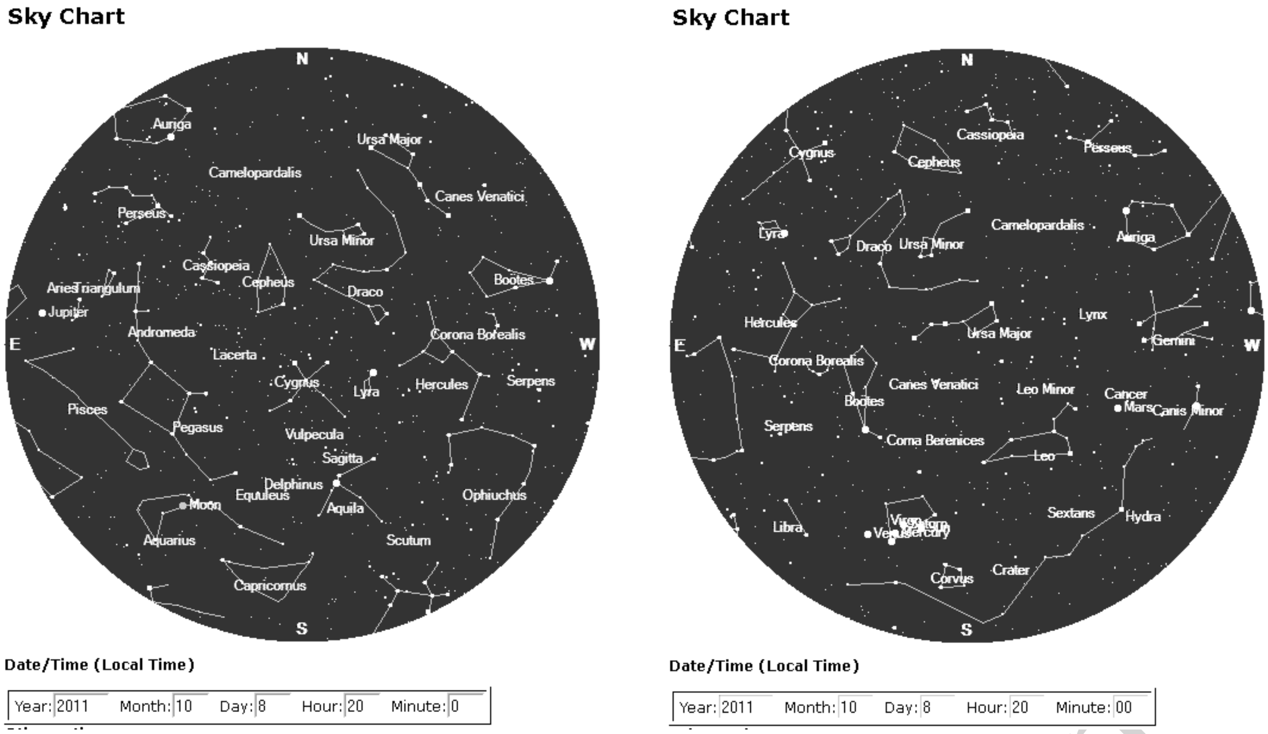


Figure 8 – The visual ZHR curve of the Draconid outburst based on IMO data[6].

[4]DL4YHF's Amateur Radio Software: Audio Spectrum Analyzer ("Spectrum Lab"). `http://www.qsl.net/dl4yhf/spectra1.html`.

[5]For more detailed observations, we refer to `http://www.rmob.org/rmobtext/rmob1110.txt`.



(a) Steyaert en De Wilde. (b) Brower.

Figure 9 – The theoretical radiant area for (a) Steyaert en De Wilde and (b) Brower.

The influence of the Observability Function is not considered. It does vary during the several hours, but we assume that it varies slowly compared to the rise and fall of outburst activity. Neither did we deduct the sporadic background, which could be obtained from counts a few days before and after the outburst. As can be seen at the beginning and the end of the observing interval, the sporadic rate is very low (local afternoon to evening condition), and by nature varying slowly in time.

5 Peak locations

Visual identification on the individual graphs in Figure 7 yields the maxima and submaxima in Table 1.

Table 1 – Main maximum of the Draconid outburst as recorded by each observer, followed by submaxima.

Observer	Main	Submaxima			
Steyaert	20^h08^m	19^h35^m	16^h45^m	22^h12^m	
De Wilde	20^h06^m	19^h30^m	16^h48^m	22^h12^m	
Svoiski	20^h10^m	(19^h35^m)	16^h52^m	22^h05^m	23^h05^m
Brower	20^h00^m	19^h30^m			

The peaks of the various observers match to within a few minutes, something which was not hoped for.

6 Visual comparison

The visual ZHR curve in Figure 8 obtained by combining many visual observations[6], shows a similar pattern as the radio ones. The radio counts include fainter meteors than the visual counts, so no direct comparison or scaling is attempted. The radio counts use fixed-duration intervals; visual ZHRs cannot always achieve this.

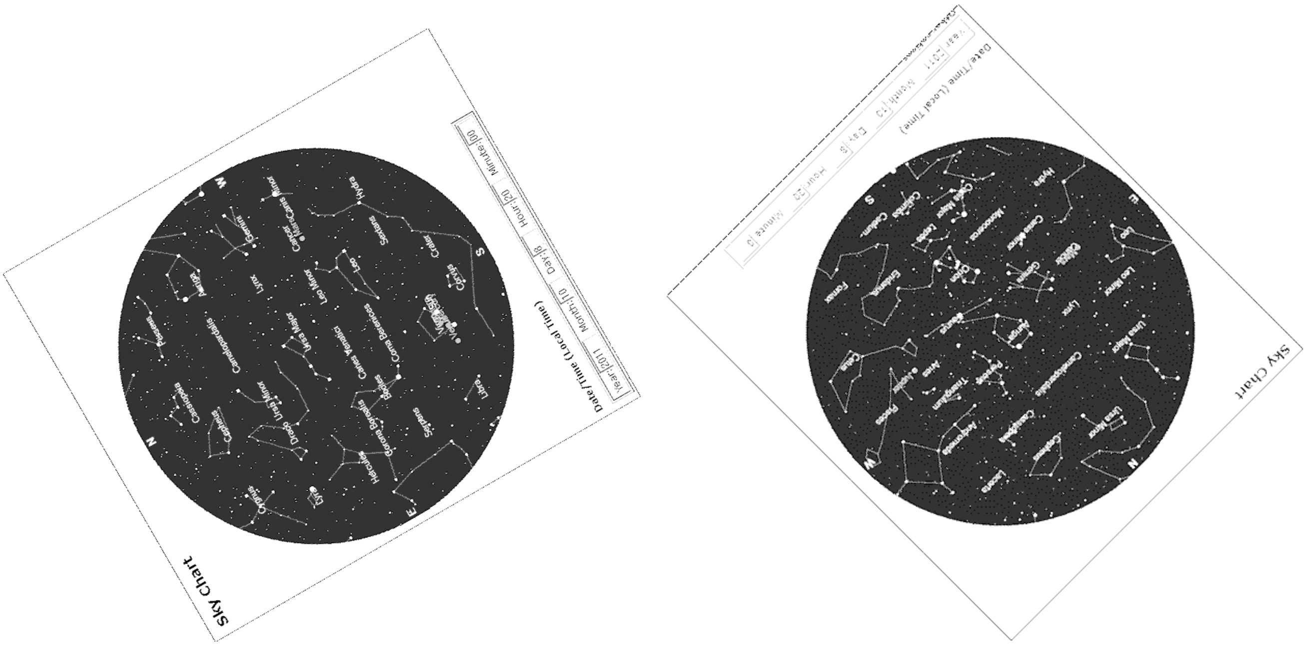
7 Discovery potential of new streams

If stream activity is identified by means of forward radio scatter, one knows in principle only that the radiant was above the horizon for the observing location. This is equivalent to saying that the stream hits half of the Earth. Figure 9 (created with `heavens-above.com`) shows the theoretical radiant area for Steyaert and De Wilde and for Brower. The common radiant area is obtained in these two hemispheric areas. As the latitude for Steyaert/De Wilde and Brower is roughly the same, the map of Brower can be rotated by the difference in longitude to overlay, as shown in Figure 10, (a).

The Japanese observers did observe, but did not record any activity, which means that the radiant was below the horizon for them. Figure 10, (b), is the sky for a location in central Japan, rotated again for the longitude difference. The radiant area for Japan is the area outside the plotted star area.

Finally, Figure 11 shows the common radiant area determined by intersecting great circles rather than overlaying maps, bordered by Lacerta, Serpens, and Canes Venatici. The head of Draco falls indeed within this area. More stations with a better spread across the Earth can still reduce this radiant area further.

[6] `http://www.imo.net/live/draconids2011`.



(a) Brower.

(b) Central Japan.

Figure 10 – (a) The theoretical radiant area for Brower, rotated by the difference in longitude w.r.t. Steyaert/De Wilde; (b) the sky for a location in central Japan, rotated again for the longitude difference.

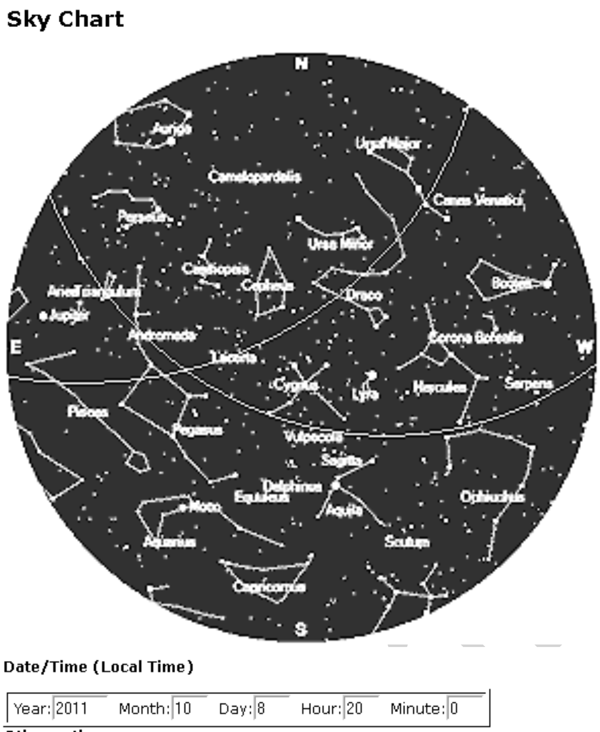


Figure 11 – The common radiant area determined by intersecting great circles rather than overlaying maps, bordered by Lacerta, Serpens, and Canes Venatici.

Proper stream identification requires single-station or simultaneous head echo observations (Steyaert, 2010).

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The author also wishes to thank his fellow observers Jeff Brower, Micha Svoiski, and Gaspard De Wilde for their detailed observations which were very valuable for this study, and for their support.

Finally, thanks go to Pierre Terrier for creating RMOB and maintaining it.

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