

Combined determination of shower activity and Observability Function

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Reference

- **A numerical method to aid in the combined determination of stream activity and Observability Function**

[Steyaert, Christian; Brower, Jeffrey; Verbelen, Felix](#)

WGN, Journal of the International Meteor Organization,
vol. 34, no. 3, p. 87-93 (2006)

Some maths

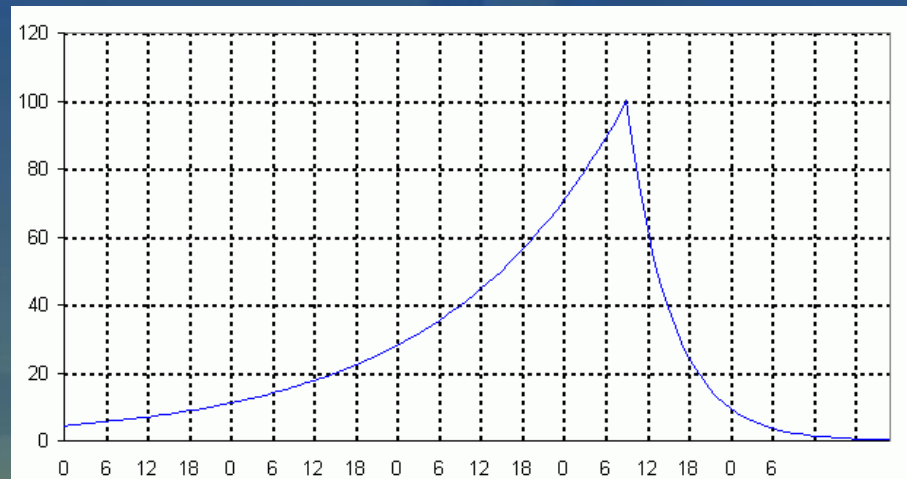
$$O(t) = S(T) + Z(t)OF(T)$$

$$T = \frac{t - t_0}{D}$$

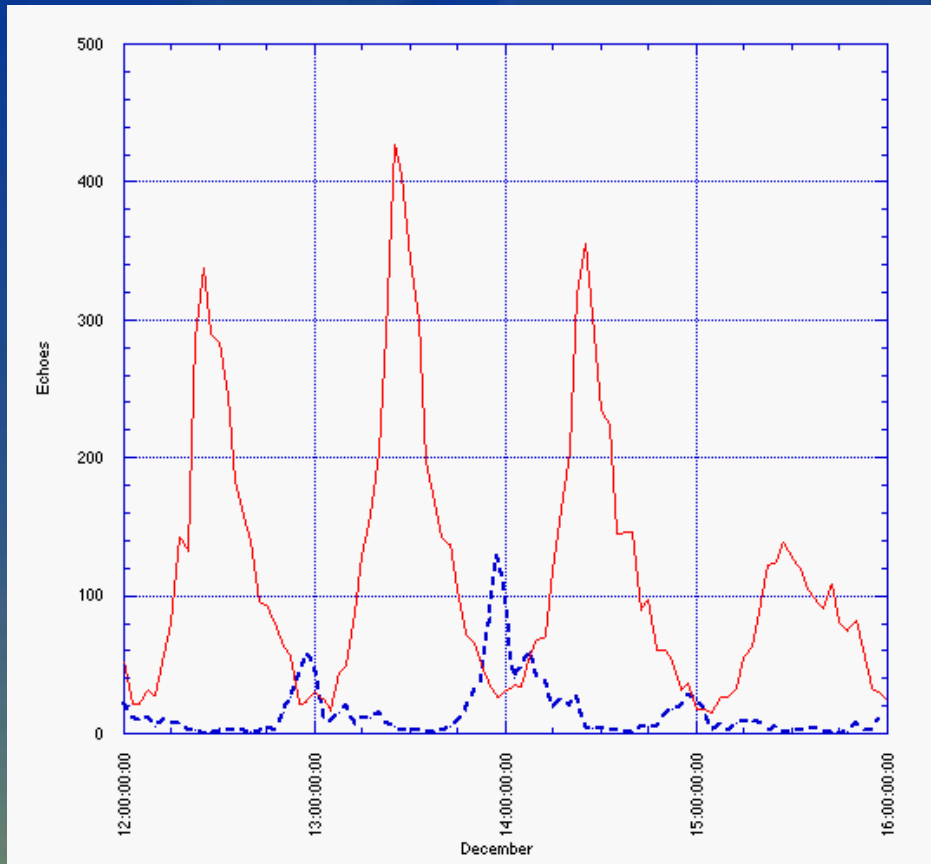
$$Z(t) = e^{-(t-t_M)/a}$$

$$Z(t) = e^{-(t_M-t)/b}$$

O observed 'activity'
S sporadic background
Z shower profile
OF Observability Function
 t_M instance of maximum
a rise time constant
b decay



Geminids 2005



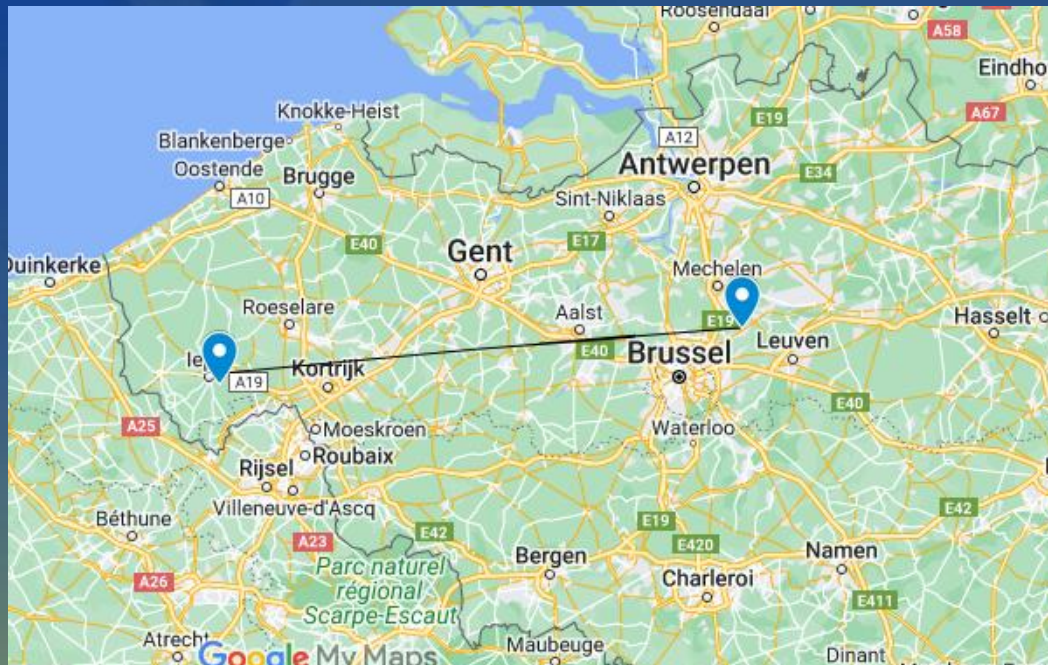
Brower
Verbelen

Geometry Verbelen

Beacon 49.99 MHz, 50 W

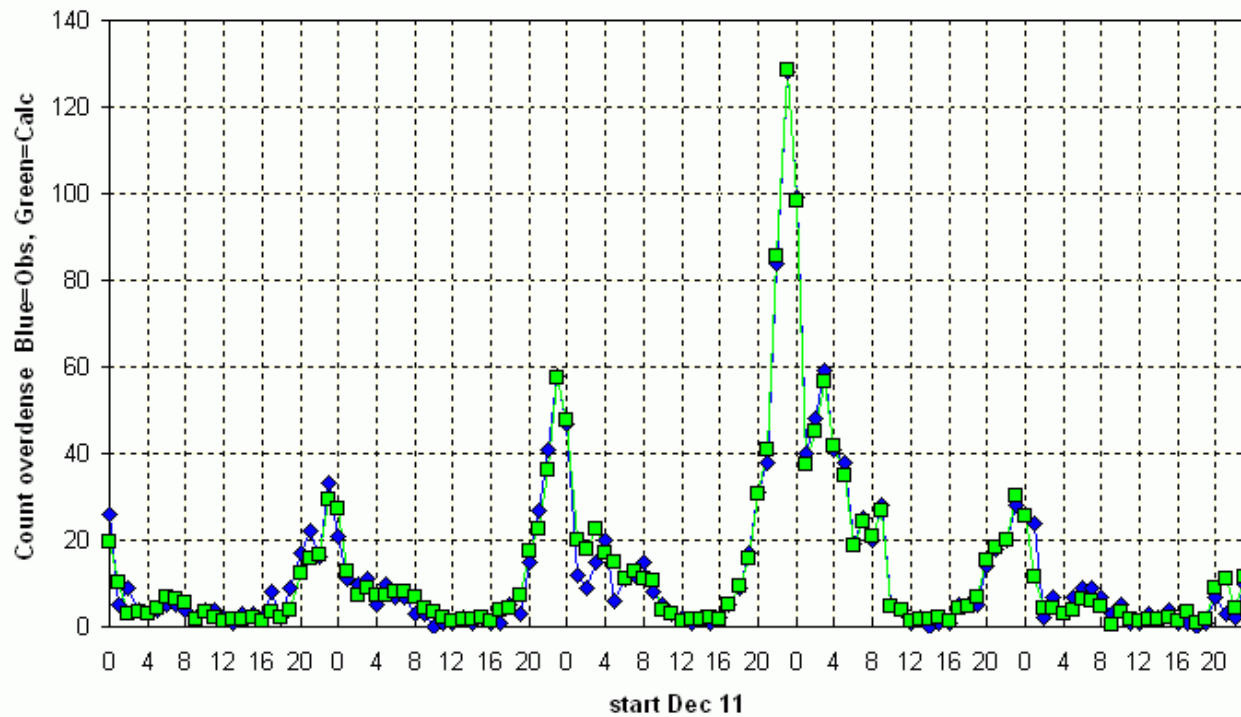
Distance T-R 120 km, direction W

2 element Yagi, elevation 52°



Geminids 2005

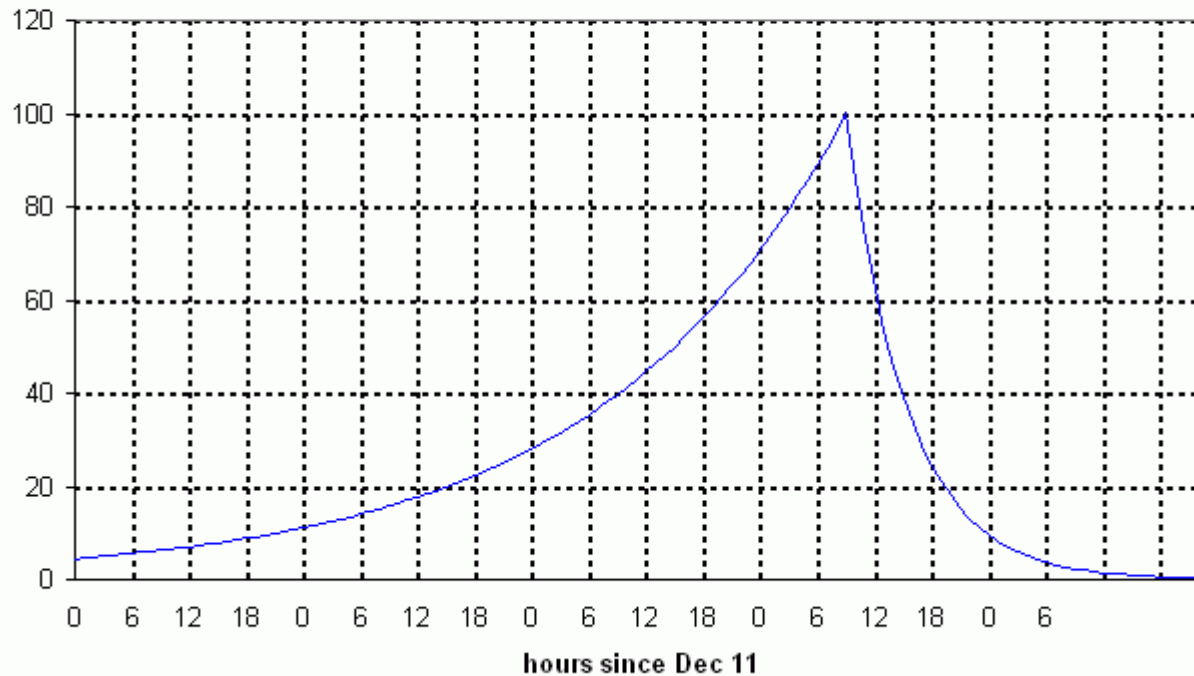
Felix Verbelen Geminids 2005



Observed =
Sporadic + Shower OF

Geminids 2005

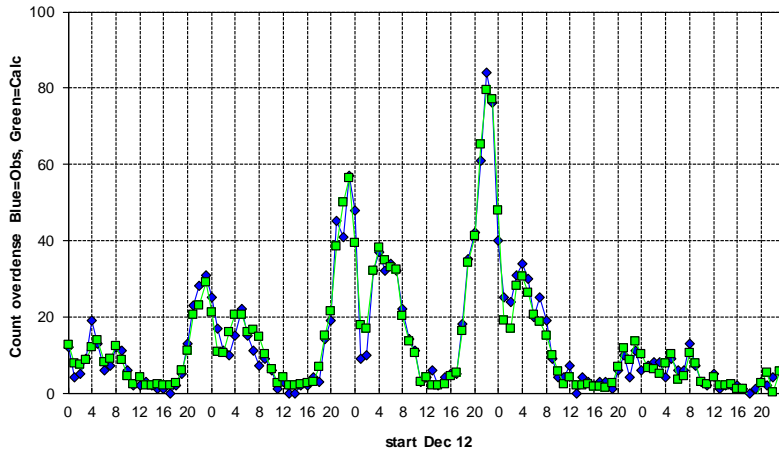
Stream profile Verbelen Geminids 2005
 $a = 26$, $b = 6.4$, $t_{\max} = 14 \text{ Dec } 9\text{h}00 \text{ UT}$



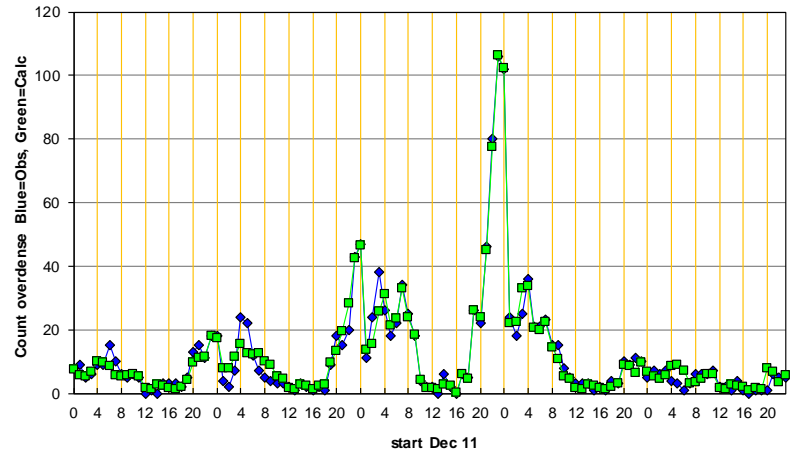
OF
Sporadics

Verbelen Geminids 2015 - 2022

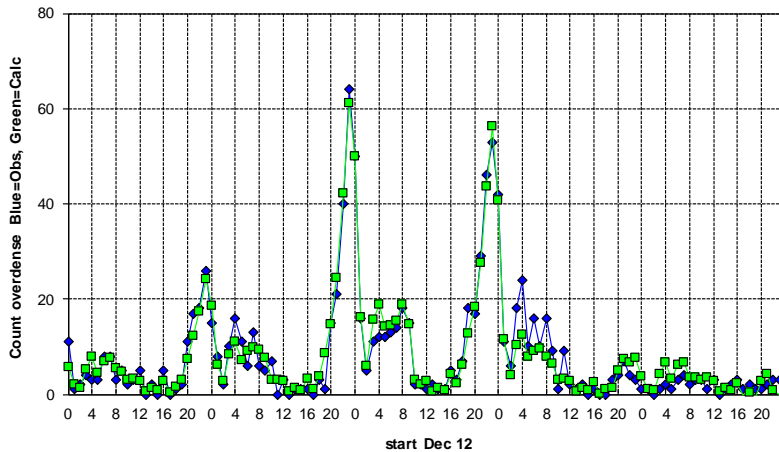
Felix Verbelen Geminids 2015



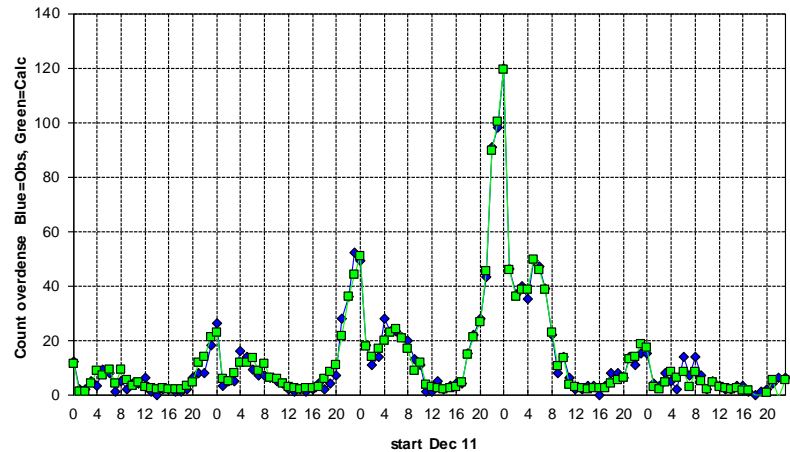
Felix Verbelen Geminids 2016



Felix Verbelen Geminids 2019

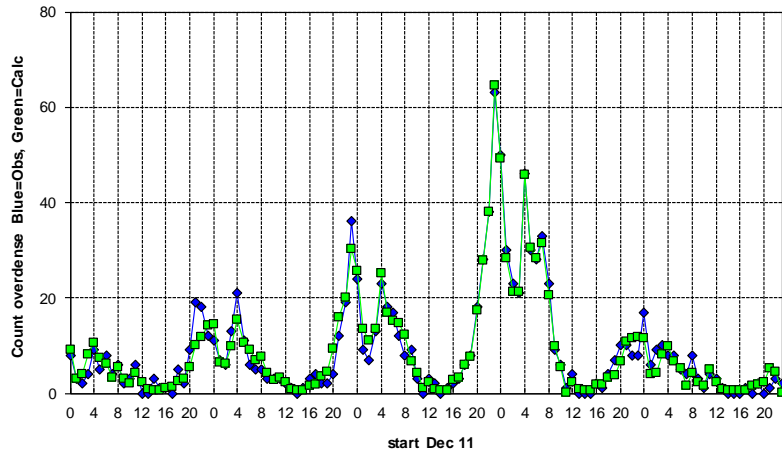


Felix Verbelen Geminids 2020

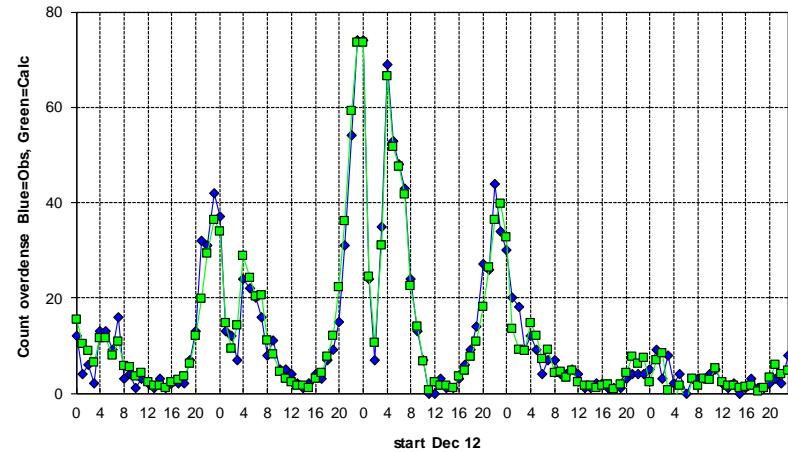


Verbelen Geminids 2015 - 2022

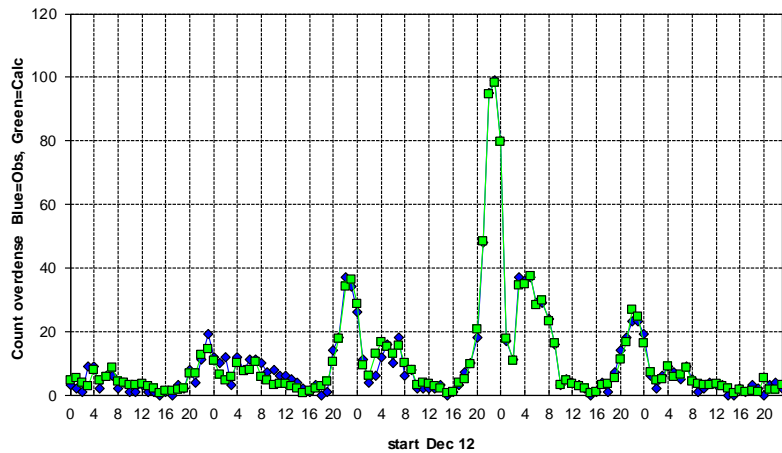
Felix Verbelen Geminids 2017
refl > 2 s



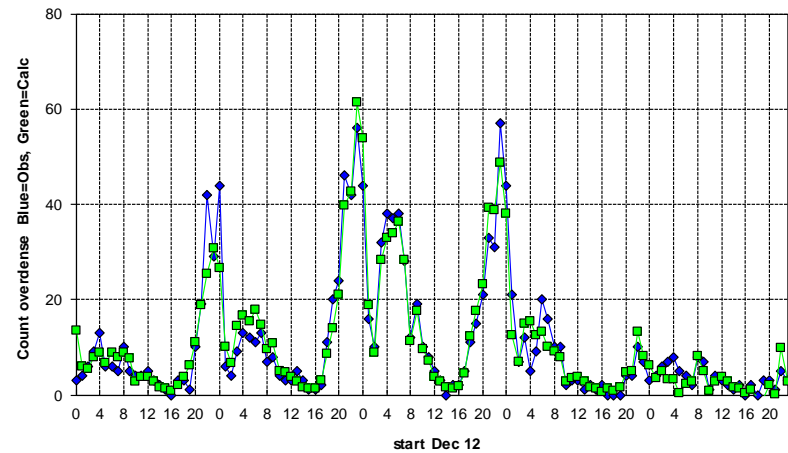
Felix Verbelen Geminids 2018



Felix Verbelen Geminids 2021



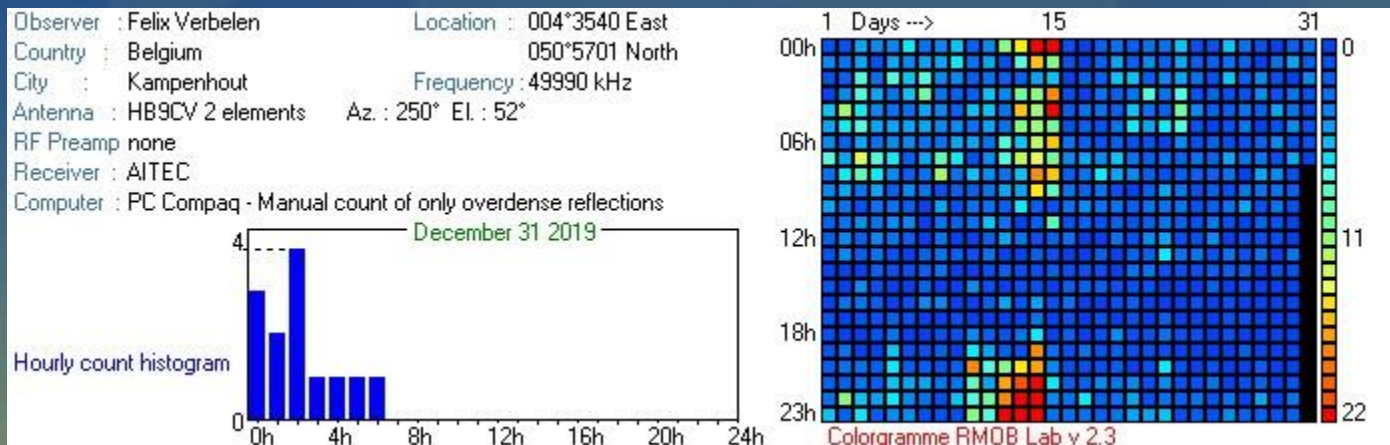
Felix Verbelen Geminids 2022



Verbelen Geminids 2015 - 2022

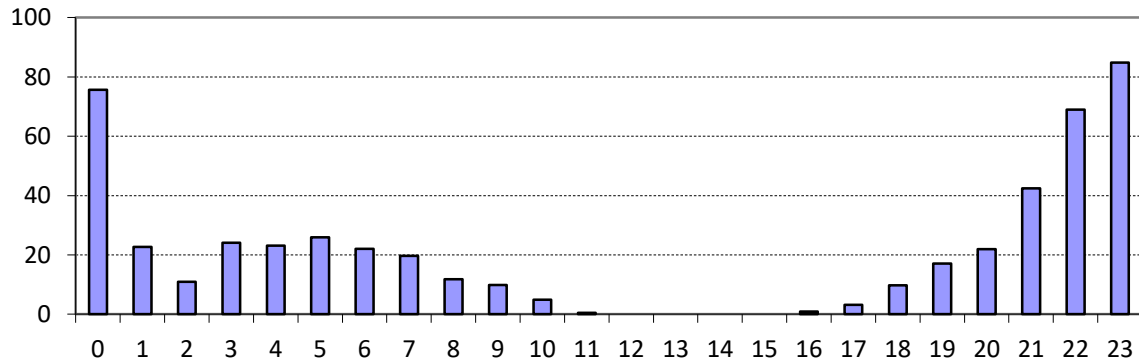
Time of the maximum (constant solar longitude)
+ 6 hours every year, compensated after 4 years by the leap year

Geminids radiant $\delta = 33^\circ$ observer latitude $\varphi = 51^\circ$
culmination height = $90^\circ - \varphi + \delta = 72^\circ$
Dip observed around culmination time = 2h UT
(underdense reflections far away)

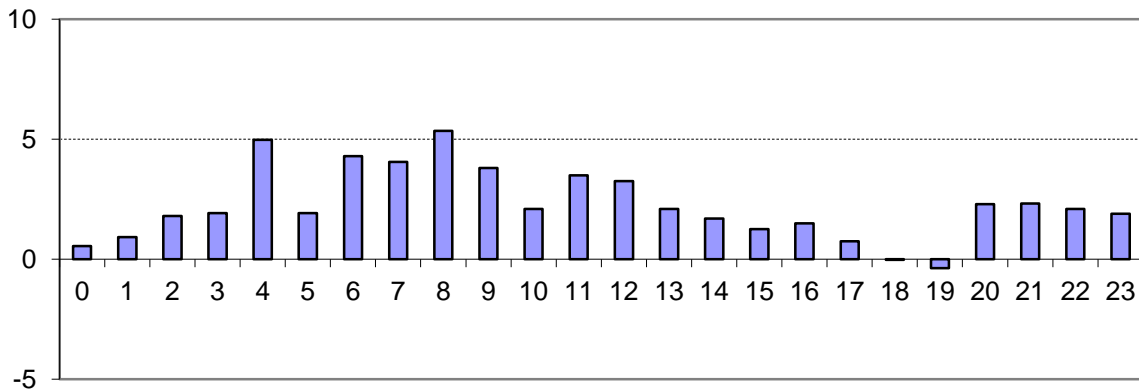


Geminids 2019 - 2022

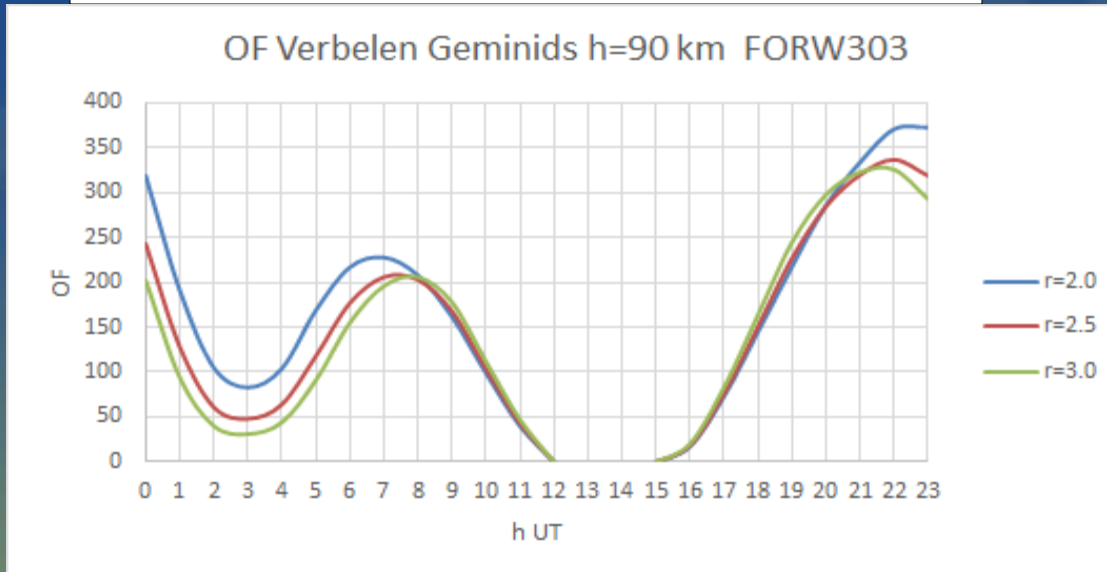
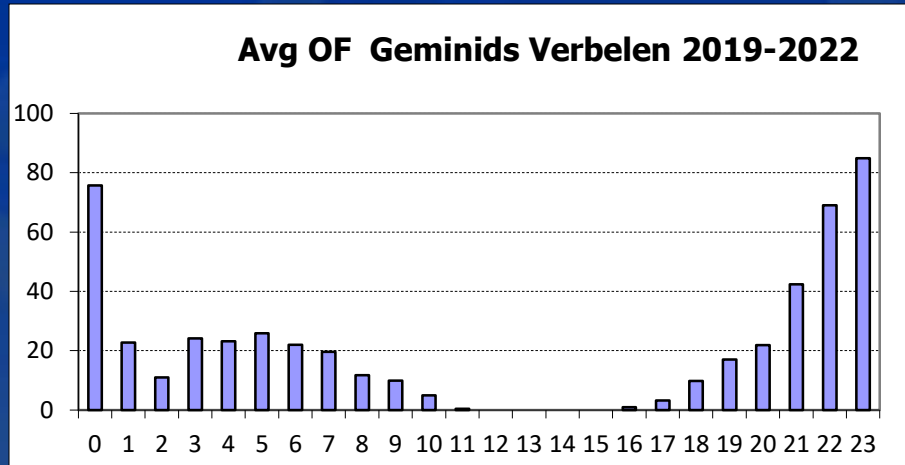
Avg OF Geminids Verbelen 2019-2022



Avg Sporadics during Geminids 2019-2022 Verbelen



Geminids 2019 - 2022

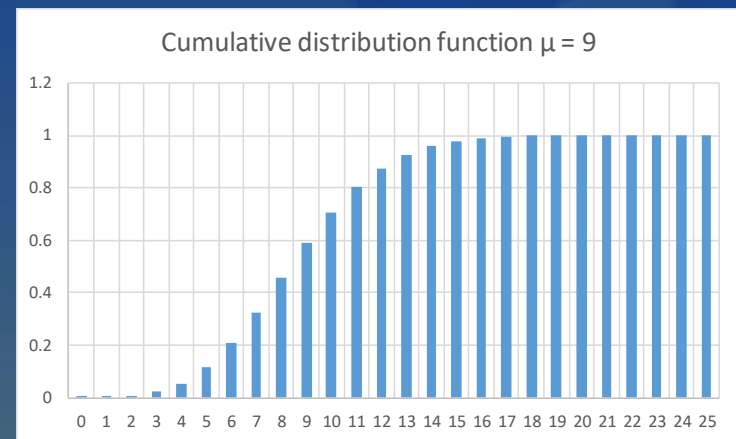
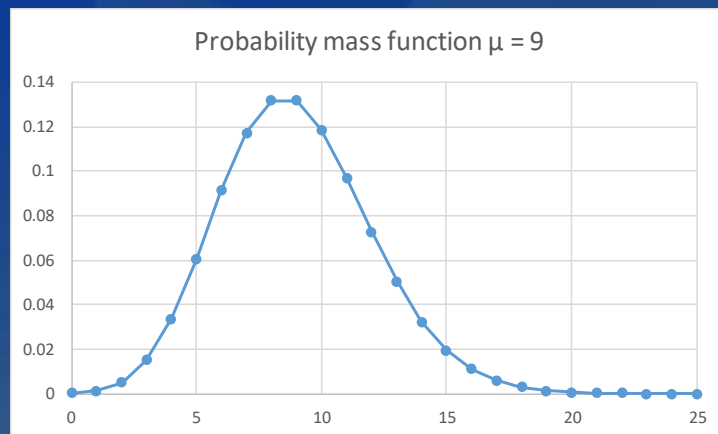


Geminids 2015 - 2022

tMax	a	b	Solar Longitude
2022/12/14 14:00	30.0	11.0	262.23
2021/12/14 10:00	24.0	7.0	262.33
2020/12/14 05:00	28.0	8.0	262.38
2019/12/14 16:48	32.2	11.4	262.12
2018/12/14 11:00	31.0	11.0	262.14
2017/12/14 07:00	30.0	8.5	262.23
2016/12/13 22:00	21.7	7.8	262.11
2015/12/14 19:42	32.7	11.8	262.27
Average	28.7	9.6	262.23
Std Dev	3.7	1.8	0.09

Error margins

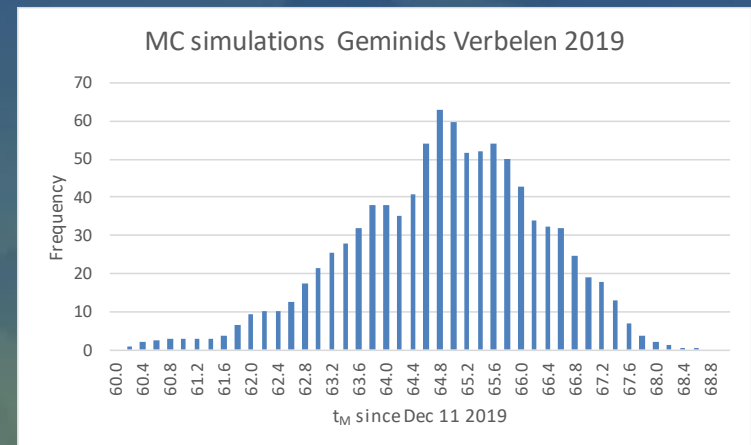
- Counts are Poisson distributed



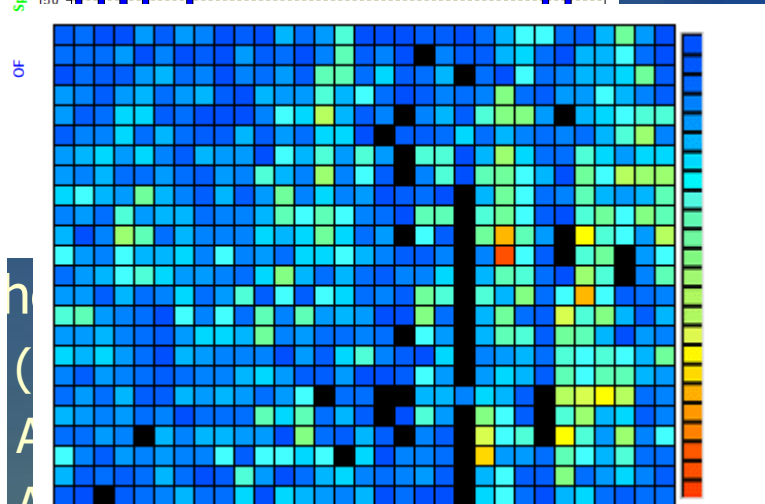
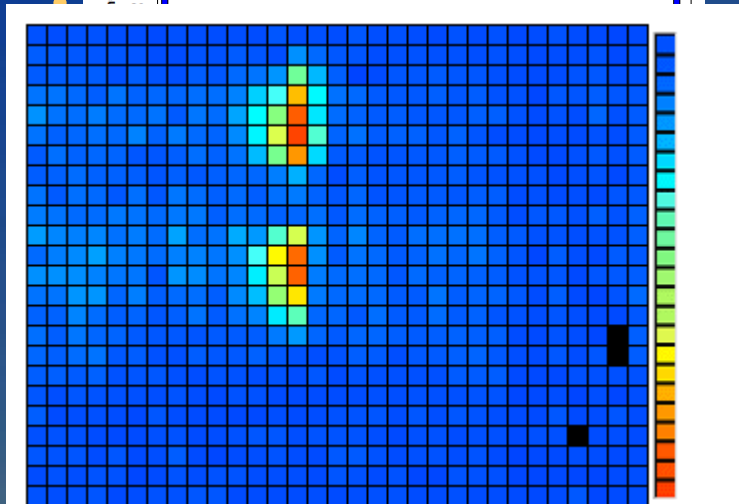
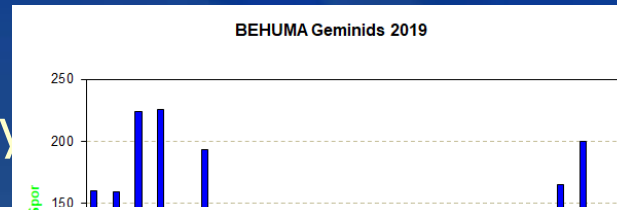
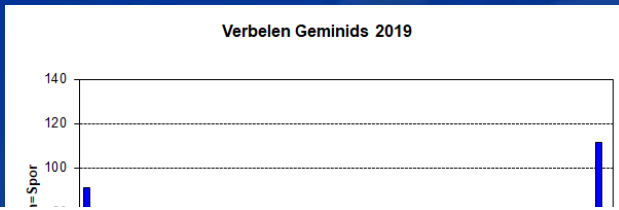
- Monte Carlo simulations
 - Cumulative Poisson
 - Uniform random generator interval $[0,1]$ e.g. 0.821 0.397
 - Lookup generated count: 12 8

Error margins

- Monte Carlo simulations
 - Cumulative Poisson
 - Uniform random generator interval [0,1]
 - Lookup generated count
 - For all counts (e.g. 5 days x 24 hours)
 - Best fit (Nelder-Mead simplex algorithm)
 - Repeat many times (1000)
 - Establish distribution of t_M , a , b
- 68% range ($\pm 1 \sigma$) -1 +1.6 hour
- a -5.5 + 2.5
- b -2.2 + 2



Applicability

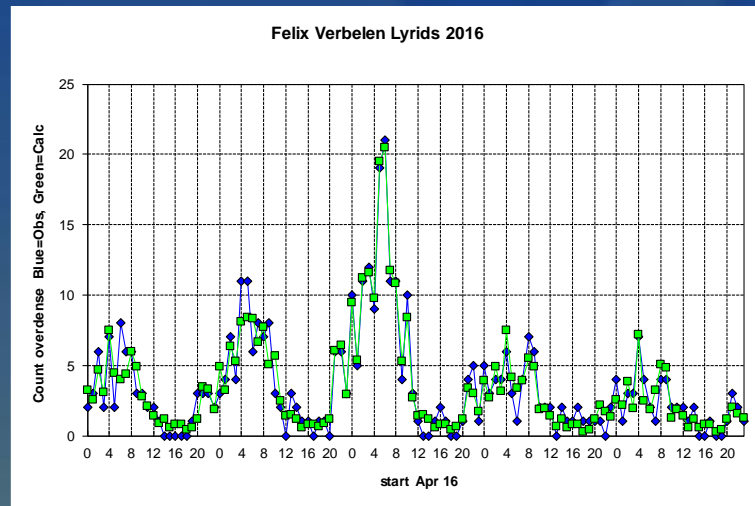
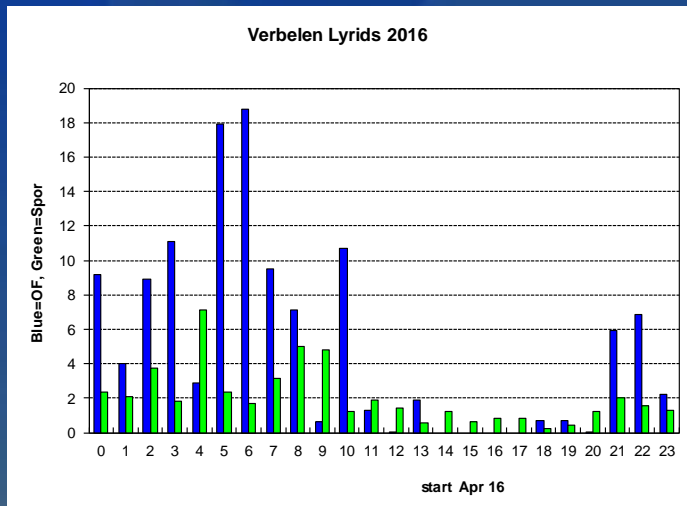


Human 2019

Avg Gemin 110, avg sporadics 70

Applicability

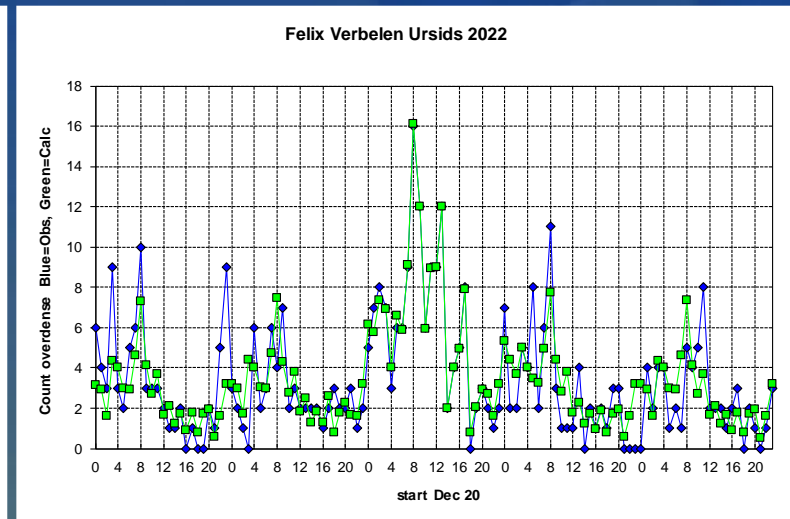
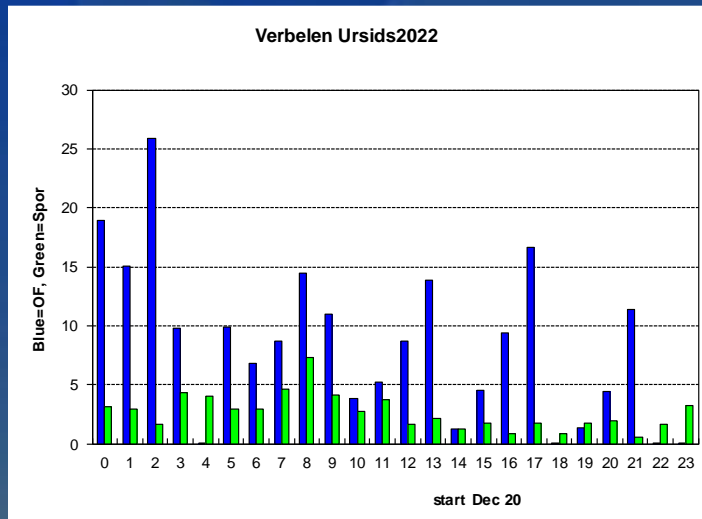
Smaller streams



$$a = 23 \quad b = 10$$

Applicability

High declination radiant: Ursids $\delta = 76^\circ$



OF should vary little

$a = 6$ too short for this method

Future

- Rewrite in Python (scipy.optimize)
- Summaries in WGN

Thanks to

- Felix Verbelen
- Cis Verbeeck
- Pierre Terrier
- BRAMS