



CAMS observations

Cédric Tétard & Hervé Lamy

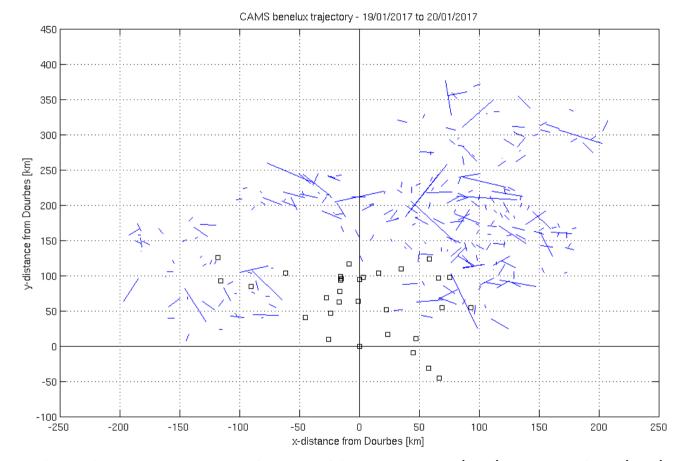
Royal Belgian Institute for Space Aeronomy

METRO annual meeting 2017 Brussels – 16 November 2017

Motivations

- Simultaneous optical and radio observations of meteors:
 - Better understand our radio measurements
 - Trying to validate the retrieved trajectory using radio measurements
 - Estimate the accuracy of radio measurements
 - Estimate the accuracy of BRAMS interferometric measurements

CAMS trajectories



CAMS benelux trajectories observed between 19/01/2017 and 20/01/2017

Are there some CAMS meteors also observed by some BRAMS stations?

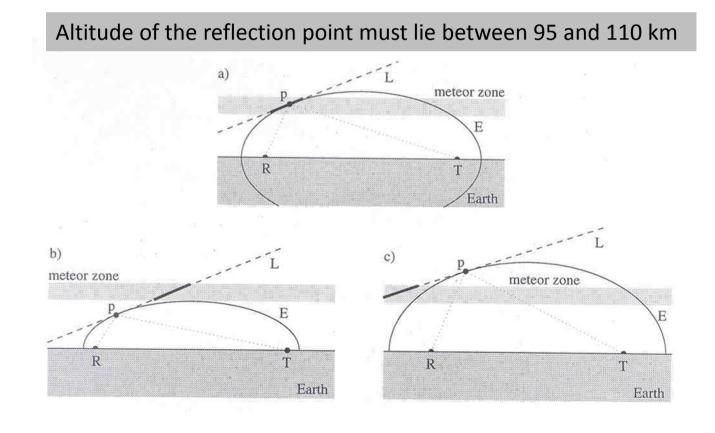


First, some stations are not available at these dates! BRAMS data availability tool:

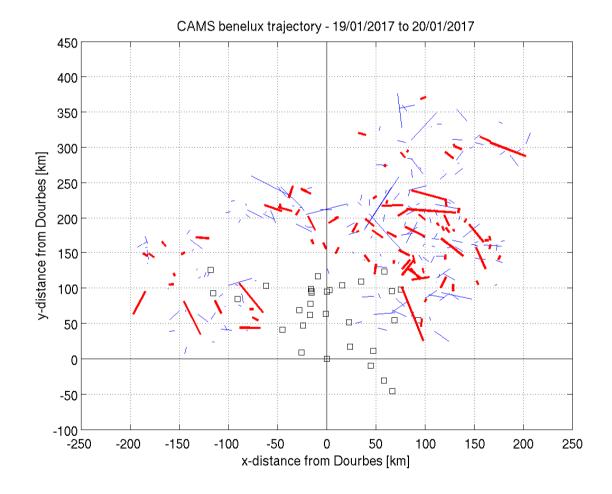
rams.aeronomie.be/availability/					C	Q, Search	☆	ê ↓ ∧	•	
ited 🔒 MAIL 🔒 Misc 🔒 M					o 🔒 forum mac 👗 BIRA-IASB 🛛					
BRAMS TV	DATA ZOO	METRO NEWS DO	WINLOAD BRAMS I	NETWORK THEORY	PARTNERS MY ACC	COUNT				
STATIONS :										
check all	Epinay sur Orge	Genk Genk	Gent	Grimbergen	☑ Haacht	Harelbeke	Hove			
Humain 1	E Epinay sur orge	Humain 3	Humain 4	Grinbergen Humain 5	Humain 6	Humain 7	Humbeek			
🔽 Jalhay	Kampenhout	Kapelle-op-den-Bos		E Lembeek	Euze	🔽 Liège	Maasmechelen			
Mons Nons	Neufchâteau	Oostende	Ophain	Ottignies	Overpelt	💌 Redu	Seneffe			
Sivry-Rance	Tessenderlo	Tintigny	Vcde	🗖 Ucde 4						
DATE :										
From : 2017-01-19	To: 2017-01-21 Prev	ious Request data Next								
							Data ava	ilablo		
irom 2017-01-19 12:0	00:00 AM to 2017-01-21	12:00:00 AM					No data			
Thu 19	DE AM	12 PM	06 PM	Fri 20	06 AM	12 PM	D6 PM	Sat 21		
arimbergen										
love			_							
Capelle-op-den-B										
Compenhout										
Ottignies										
Verpelt										
essenderlo										
Neufchâteau										
ledu										
alhay										
Jcde										
angemark										
angoman.										
.embeek										
embeek										

CAMS trajectories and BRAMS reflection points

 Knowing equation of a meteor trajectory, you can compute position of reflection points of all BRAMS stations using Nedeljkovic (intersection of an ellipsoid and a line)

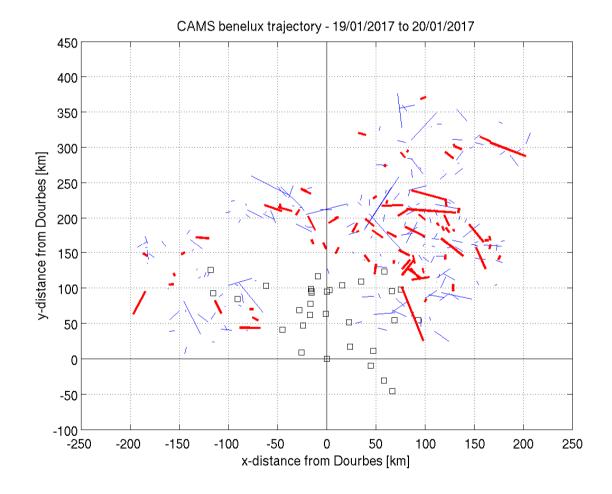


CAMS trajectories possibly detected by at least 1 station (zt>95 km and <110 km)



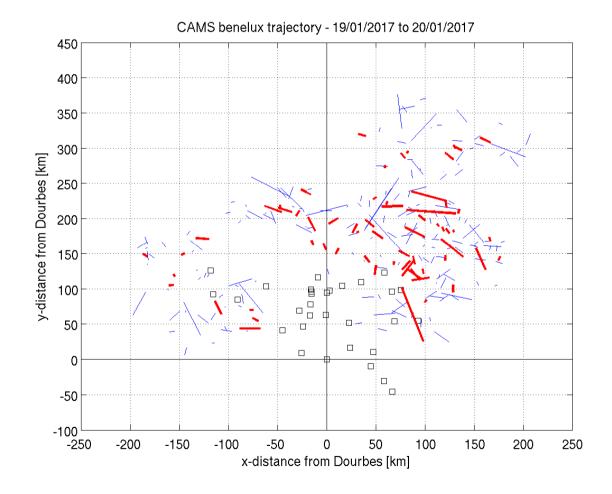
83 trajectories possibly detected by at least 1 stations

CAMS trajectories possibly detected by at least 2 stations (zt>95 km and <110 km)



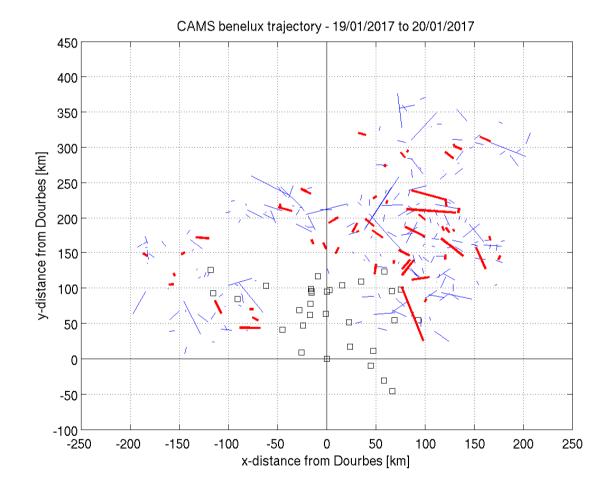
74 trajectories possibly detected by at least 2 stations

CAMS trajectories possibly detected by at least 3 stations (zt>95 km and <110 km)



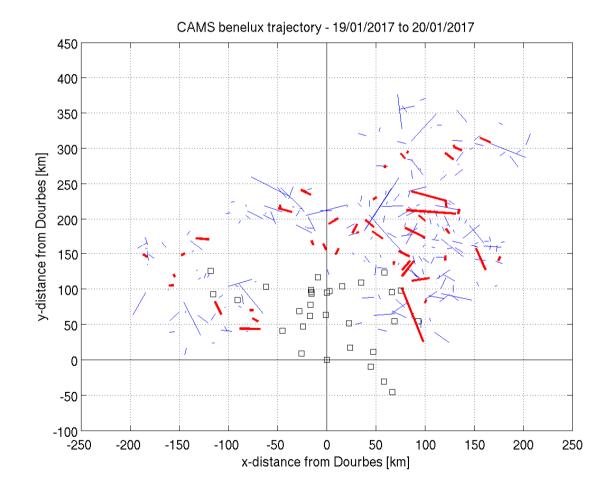
64 trajectories possibly detected by at least 3 stations

CAMS trajectories possibly detected by at least 4 stations (zt>95 km and <110 km)



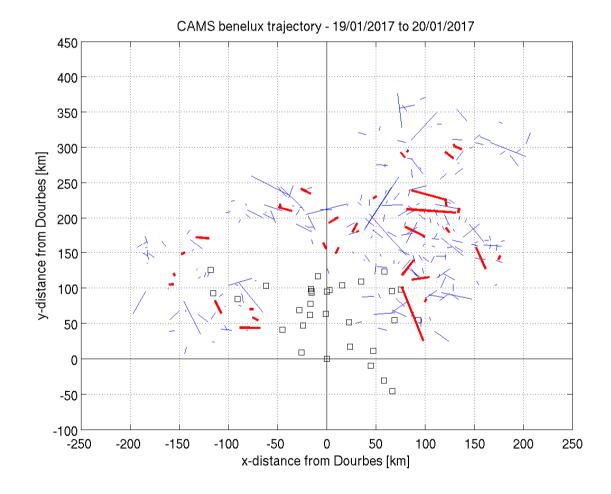
53 trajectories possibly detected by at least 4 stations

CAMS trajectories possibly detected by at least 5 stations (zt>95 km and <110 km)



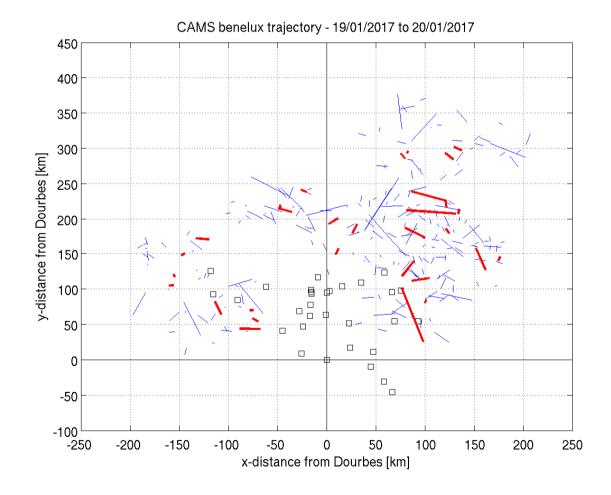
46 trajectories possibly detected by at least 5 stations

CAMS trajectories possibly detected by at least 6 stations (zt>95 km and <110 km)



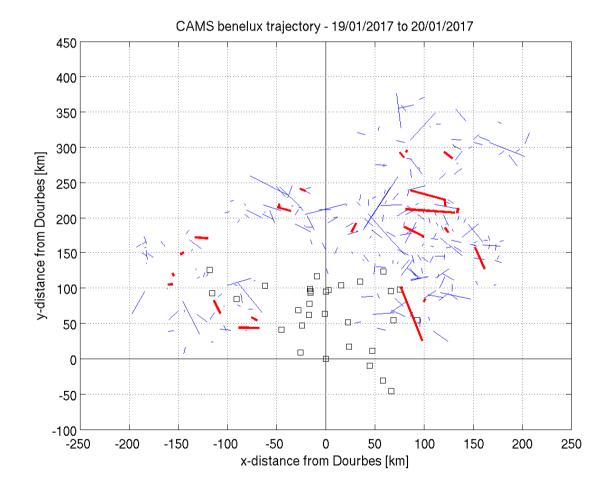
35 trajectories possibly detected by at least 6 stations

CAMS trajectories possibly detected by at least 7 stations (zt>95 km and <110 km)



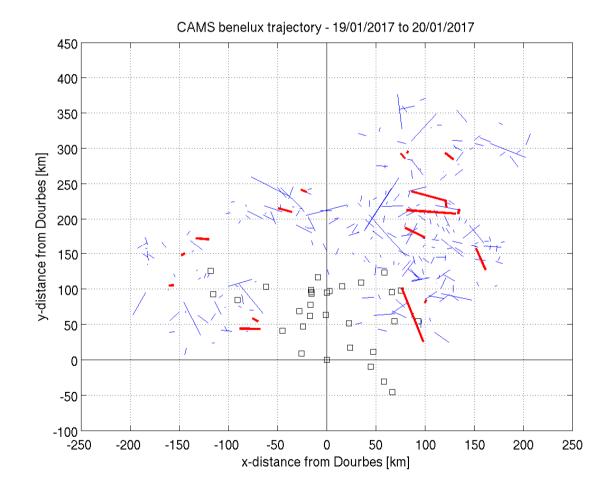
30 trajectories possibly detected by at least 7 stations

CAMS trajectories possibly detected by at least 8 stations (zt>95 km and <110 km)



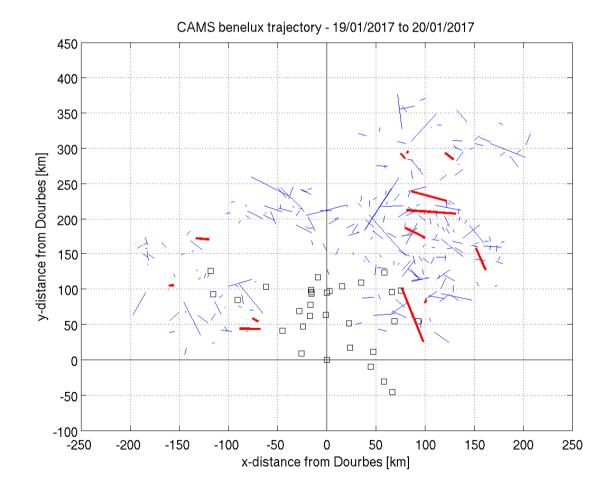
23 trajectories possibly detected by at least 8 stations

CAMS trajectories possibly detected by at least 9 stations (zt>95 km and <110 km)



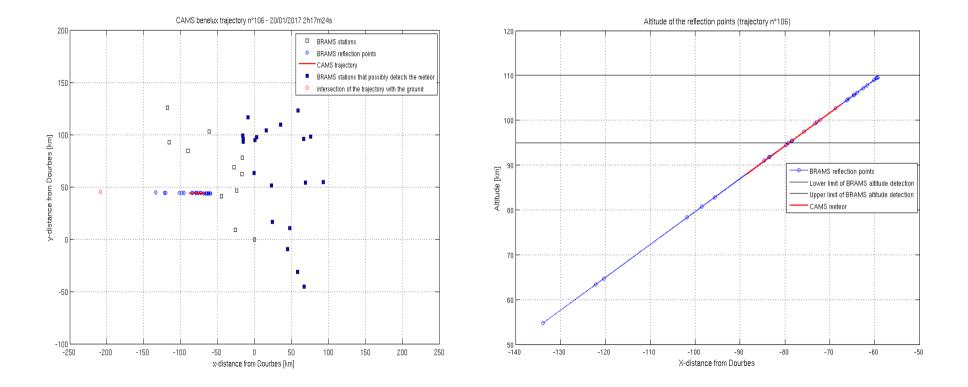
18 trajectories possibly detected by at least 9 stations

CAMS trajectories possibly detected by at least 10 stations (zt>95 km and <110 km)



13 trajectories possibly detected by at least 10 stations

Example: CAMS trajectory 106 also observed by 20 BRAMS stations!



Example: CAMS trajectory 106 also observed by 20 BRAMS stations

	Humain 1 2017-01-20T02:15 (Res: 0-336Hz 2-972s)	
1109		109
1099-	에 가지 않는 것에서 있는 것은 것은 것을 가지 않는 것이 같은 것이 있는 것이 있는 것이 있는 것이 있는 것이다. 가지 않는 것이 있는 것이 있는 것이다. 가지 않는 것은 것이 있는 것이다. 가지 같은 것은 것은 것이 같은 것이 있는 것이 같은 것이 있는 것이 있는 것이 같은 것이 있는 것이 같은 것이 같은 것이 같은 것이 같은 것이 없는 것이 없는 것이 없는 것이 없는 것이 없는 것이 없는 것	099
1089-		089
1079-		079
1069-		+0 069 -1
ана раз алека так так так 1059 -		059 -2 C
1003	날씨는 방송지 않으면 것 같아요. 한 것 같아요. <mark>ㅎ</mark> ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	-3 049
	입사 지원 가슴을 알려왔다. 그는 그는 물소한 것은 바람에서 집에서 가장을 감독하는 것이 가지 않을 수 없다. 것이 많은 것이	-4
1039-	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	039 -5 🍬
1029-	(1.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2	029 -7
	이 것 같은 것 같아요. 아이는 것 같아요. 이 것 같아요. 이 것 같아요. 이 것 같아요. 이 것 같아요. 가지 않는 것 같아요. 것 같아요. 이 것 같아요. 이 것 같아요. 이 것	-8 -8
60 1009	이 것 같은 것 이 같은 것 같은 것 같이 있는 것 같은 것 같	-10
Audus 2011/0 07/021 (No. 6 199) 2 07/0	1. 22:21년 - 21:27년 12:21년 12:21년 13:27년 1 2:22년 1 2:27년 22:21년 12:21년 12:2	99 -10 -11 Mary 17 -5055 No. 100 197
989	"그는 것 같은 것 같이 있는 것 같은 것에서 가지 않는 것 같은 것이 없는 것이 없는 것이 것 같은 것이다.	⁸⁹ –12
979-		79 -13
969		
959-		⁵⁹ -16
949-	이는 것은	49 -17
939-		39 dBFS
929-		29
919		19
	9	09
02:15:10 606	02:15:20 02:15:30 02:15:40 02:15:50 02:15:00 02:15:20 02:15:20 02:15:40 02:15:40 02:15:40 02:17:10 02:17:10 02:17:50 02:17:50 02:18:10 02:18:20 02:18:20 02:18:20 02:18:20 02:19:10 02:19:20 00 00:100 000 00:100 000 000 000 00000000	
6 6 6 F		
	Time (UTC)	

Calculation of the theoretical time of appearance of CAMS meteor at BRAMS tangent points

• Based on CAMS trajectory equation:

 $x(t) - x_0 = a_1 + v_{\infty}t - a_1e^{a_2t}$

- x(t) is position along the meteor trajectory at time t
- x₀ is « zero point » of CAMS trajectory solution
- a_1 , a_2 and v_∞ are parameters calculated by CAMS team for each trajectories

 x_0 is known only if the time from zero point to beginning point (T_{beg}) is 0. In that case, x_0 is the the beginning point (given in CAMS table)

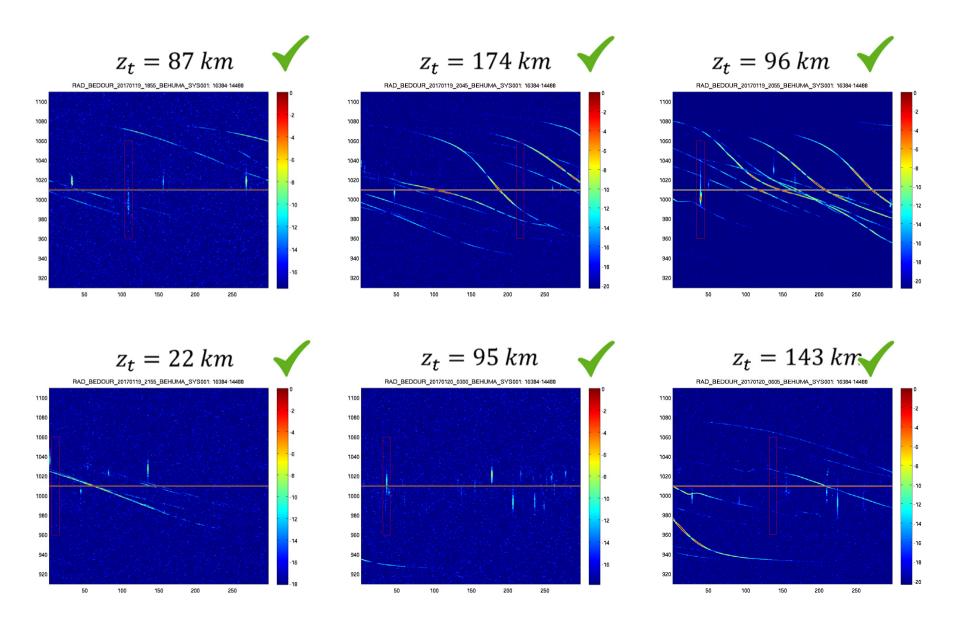
CAMS	Observed	Ref Time	Tbeg	Tend	Vinf	+/-	Acc1	+/-	Acc2	+/-	LatBeg	+/-	LonBeg	+/-	Hbeg	+/-	LatEnd	+/-	LonEnd	+/-	Hend	+/-
Number	Date	UT	sec	_sec_	_km/sec_						_+ <u>N deg</u>		+E deg		<u>km</u>		+N deg		+E deg		<u>_km_</u>	
1	1/19/2017	17:24:00.29	-0.08	1.9	14.66	0.12	0	0	7.436	3.12	51.171	0.05	5.668	0.043	91.2	3.84	51.3597	0.05	5.8317	0.04	77	3.39
9	1/19/2017	18:27:27.52	0	0.88	15.1	0.48	0.223	0.2	1.716	5.06	50.4661	0	3.4594	0.001	75	1.3	50.4622	0	3.4479	0	62.6	1.11

Non linear solver allow to compute the theoretical time of appearance of CAMS meteor at BRAMS reflection points

Is this method works well?

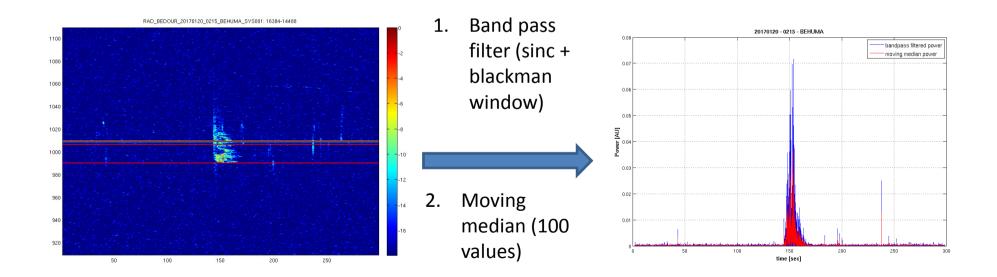
- Apply method between first point of CAMS detection and final point of CAMS detection for all trajectories: results using our solver and data provided by CAMS team are well consistent!
- We apply it to Humain reflection points for some CAMS trajectories.
 - In the next slides, rectangles are centered on the theoretical time of appearance (+ and 5 seconds) and on the beacon (+ and 50 Hz)
 - Altitude of the reflection points is given above the plots
 - If a meteor is observed in the center of a rectangle and if altitude is the right regions: it's good!
 - If no meteor and altitude not in the right region: it's good
 - Otherwise: not good!!

Is this method works well?

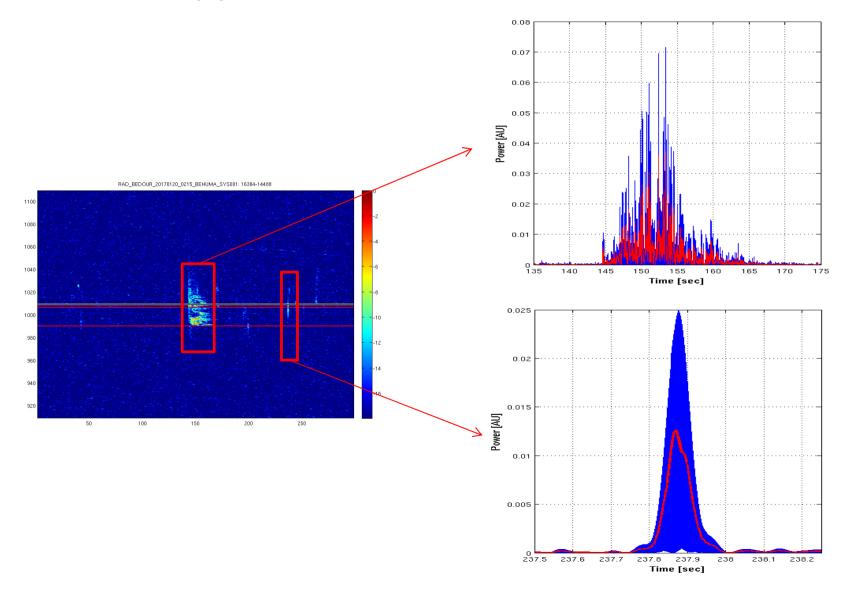


Comparisons between theoretical time of appearance and BRAMS observations

 CAMS trajectory 106 observed by Humain station: not so easy to determine time of appearance of a meteor using BRAMS data:



Comparisons between theoretical time of appearance and BRAMS observations



Conclusions and perspectives

- Simultaneous radio and optical observations of meteors are well observed
- We had to improve the determination of time of appearance of meteors using BRAMS data
- Comparisons between trajectories retrieved using radio and optical observations
- Trying to retrieve CAMS trajectory using Nedljkovic method applied to BRAMS observations
- ... in progress