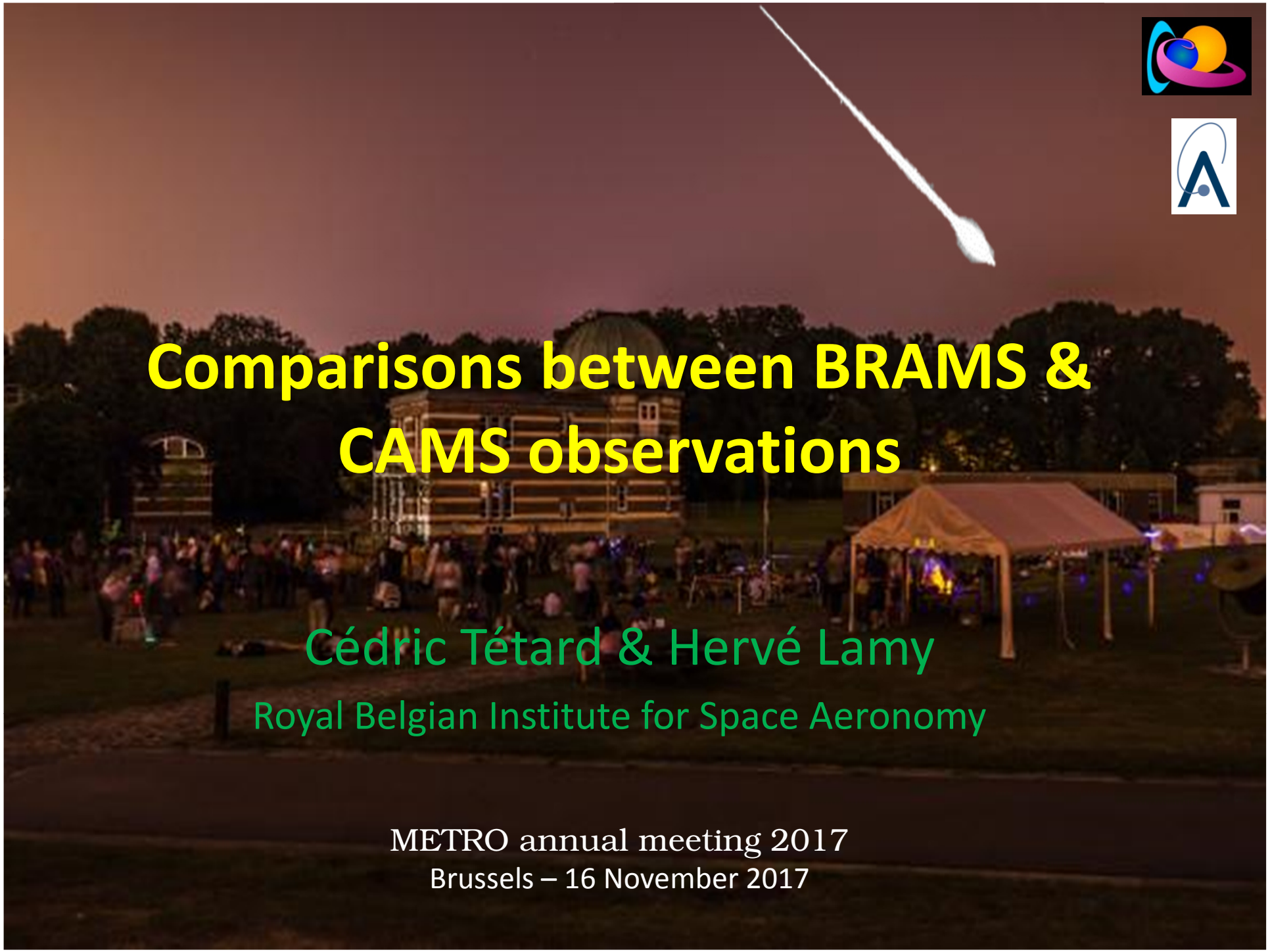

Comparisons between BRAMS & CAMS observations

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Royal Belgian Institute for Space Aeronomy

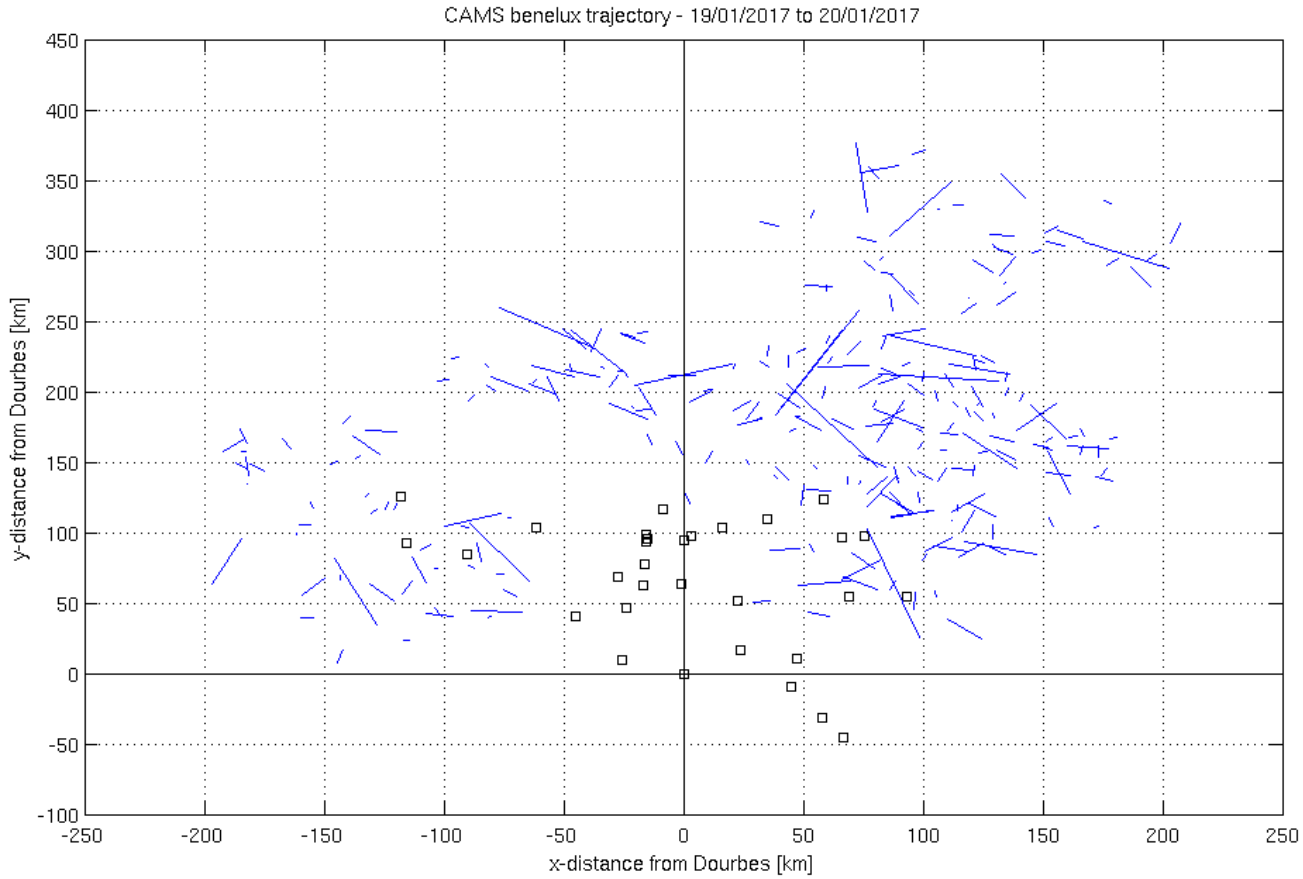
METRO annual meeting 2017

Brussels – 16 November 2017

Motivations

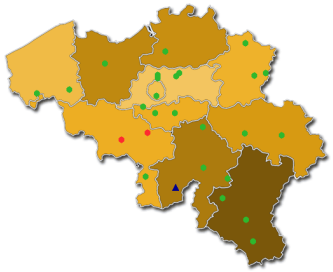
- Simultaneous optical and radio observations of meteors:
  - Better understand our radio measurements
  - Trying to validate the retrieved trajectory using radio measurements
  - Estimate the accuracy of radio measurements
  - Estimate the accuracy of BRAMS interferometric measurements

CAMS trajectories

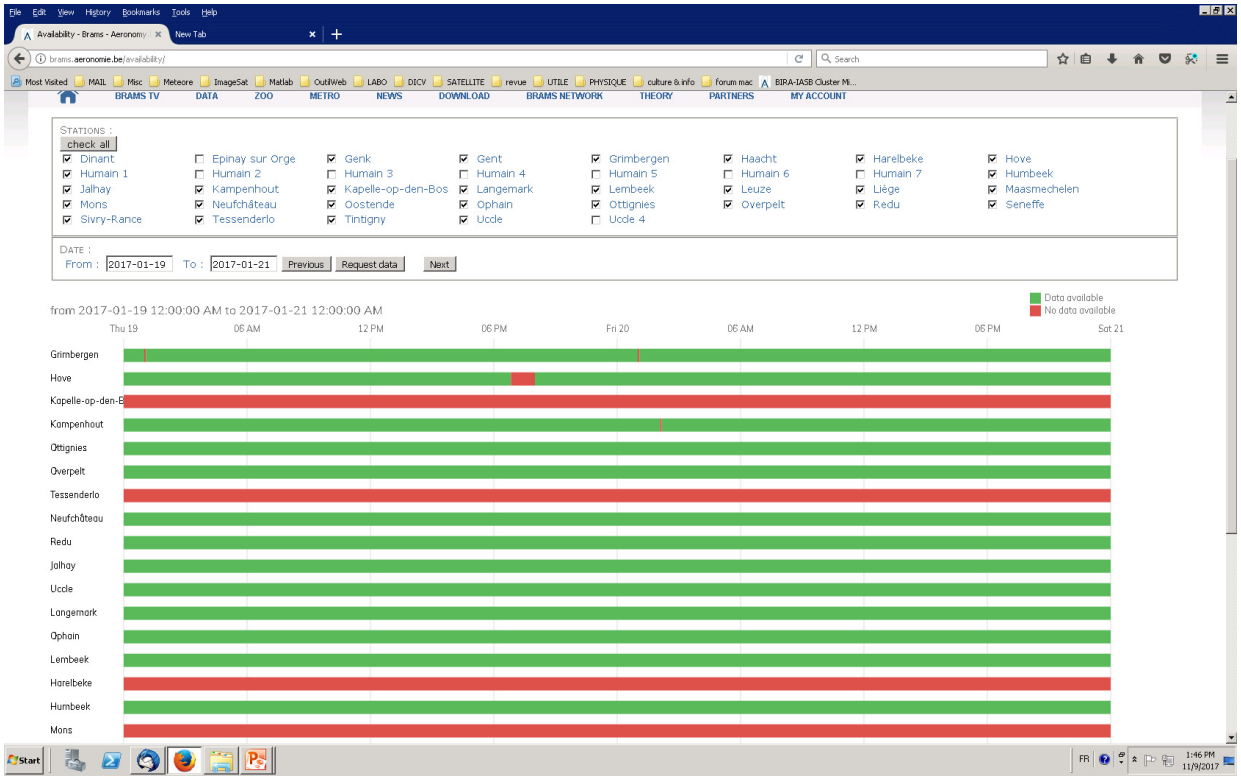


CAMS benelux trajectories observed between 19/01/2017 and 20/01/2017

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



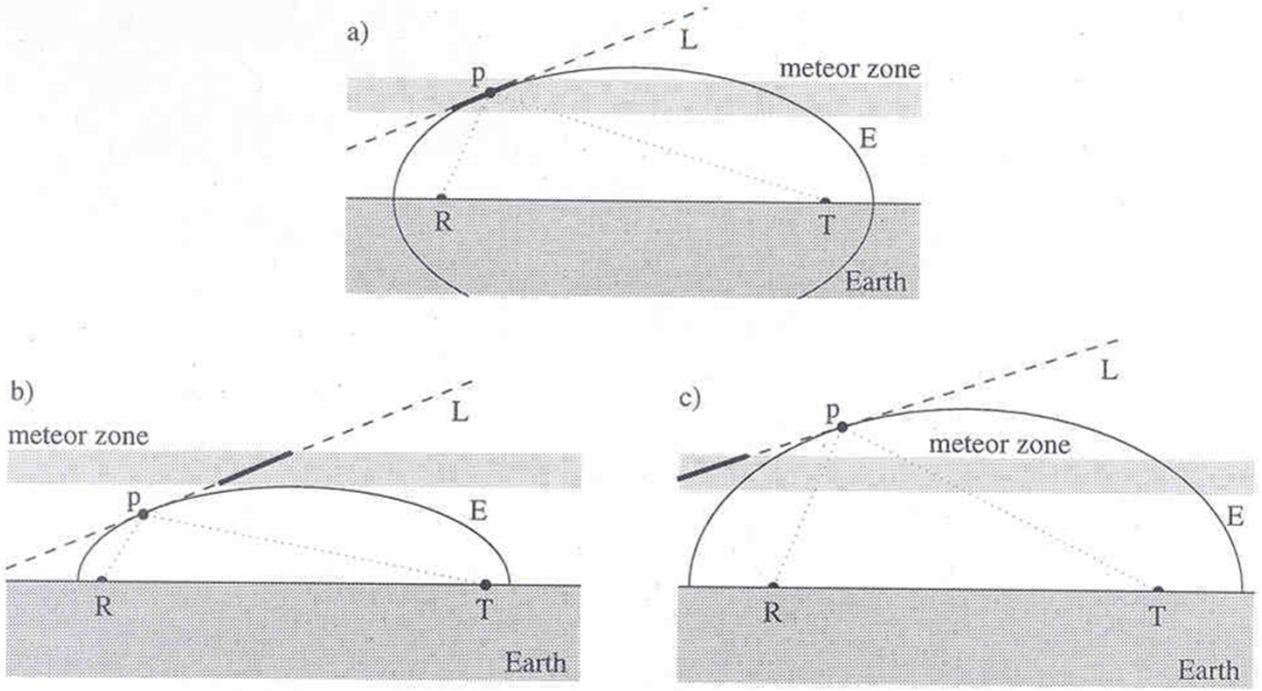
First, some stations are not available at these dates!
BRAMS data availability tool:



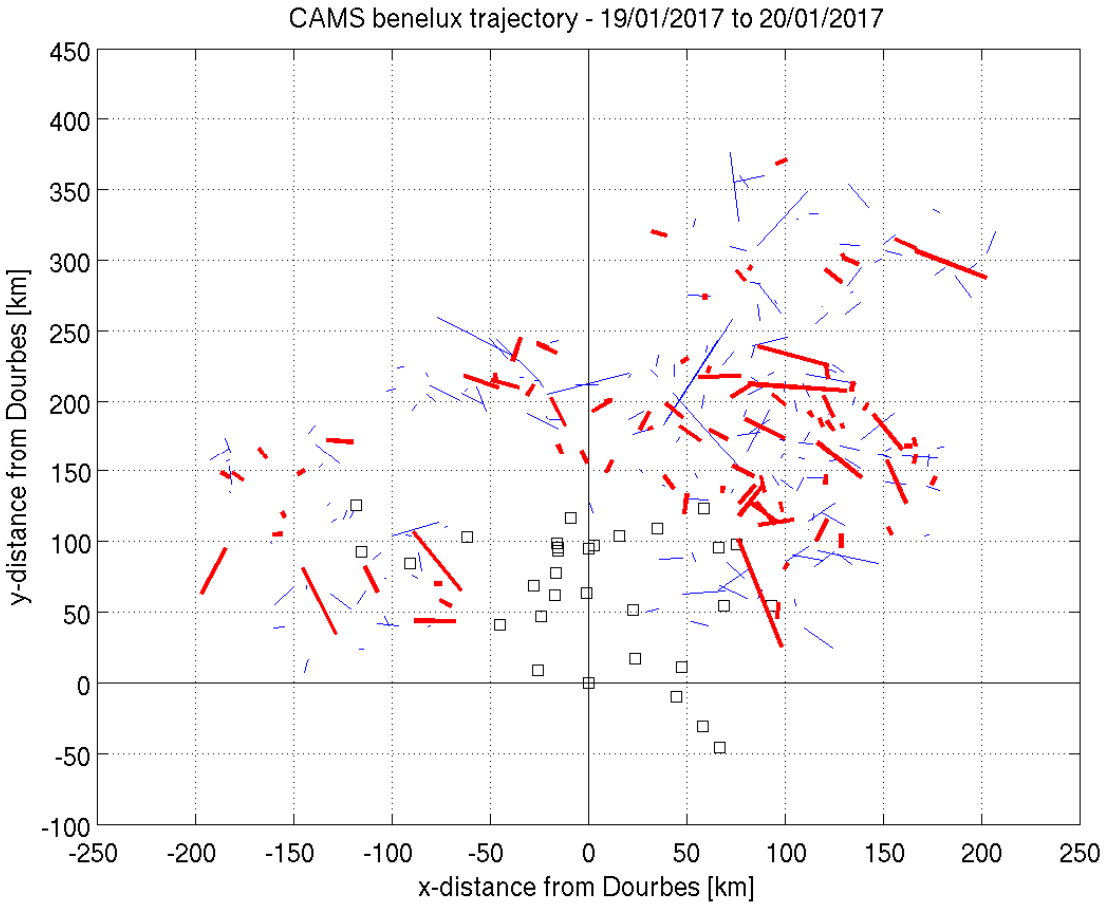
CAMS trajectories and BRAMS reflection points

- 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)

Altitude of the reflection point must lie between 95 and 110 km

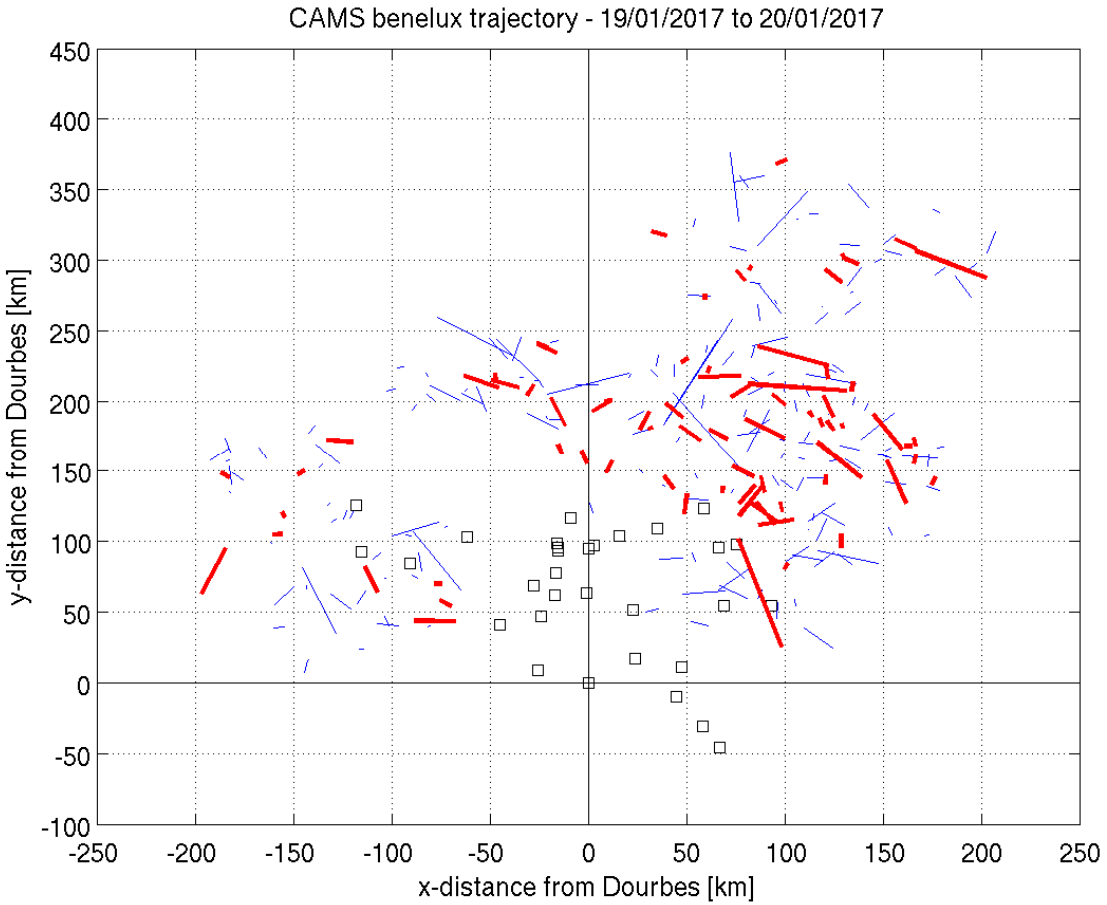


CAMS trajectories possibly detected by at least 1 station (zt>95 km and <110 km)



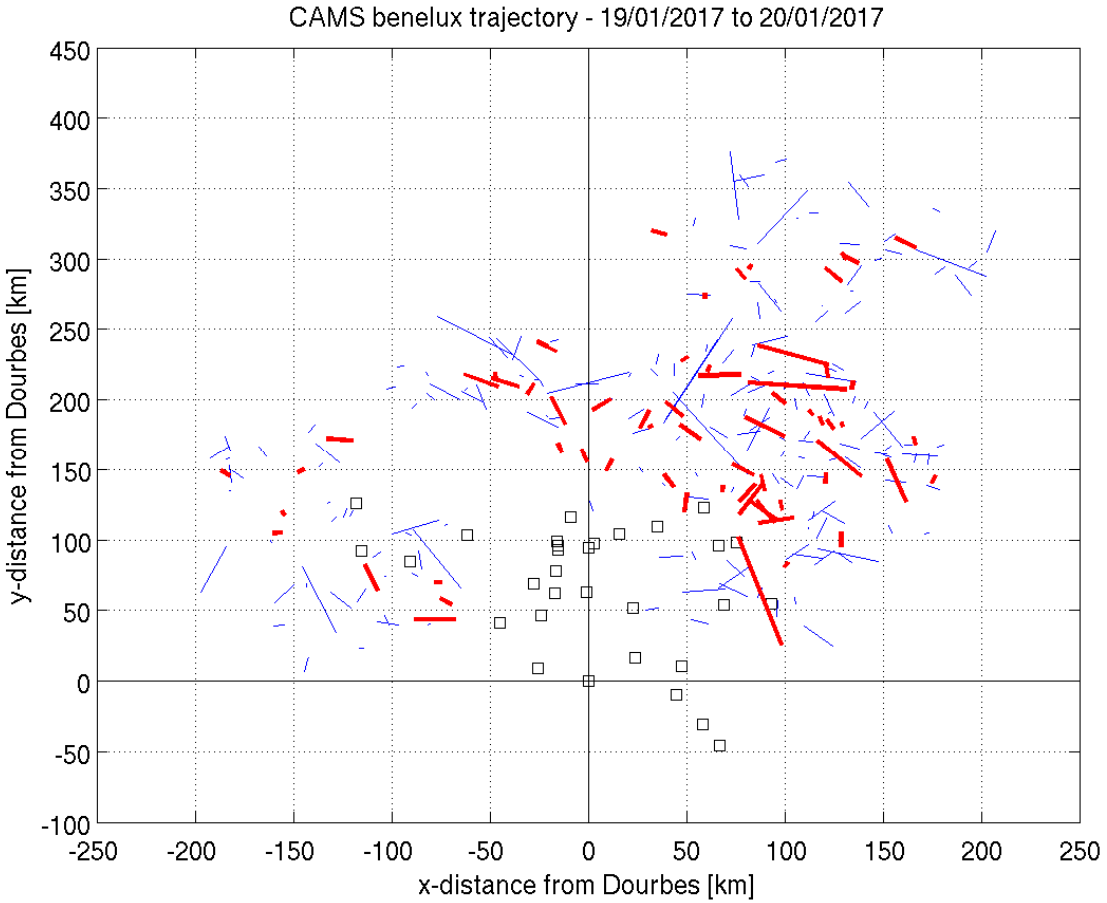
83 trajectories possibly detected by at least 1 stations

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



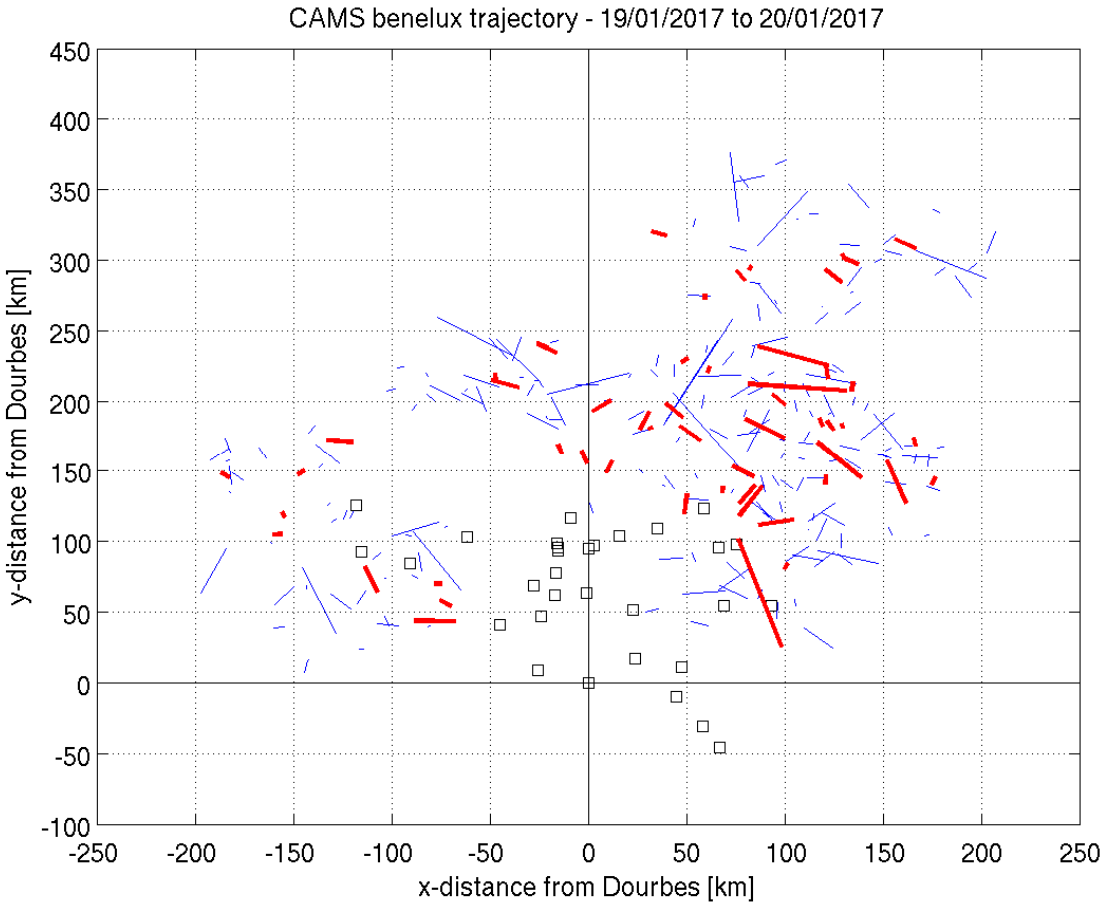
74 trajectories possibly detected by at least 2 stations

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



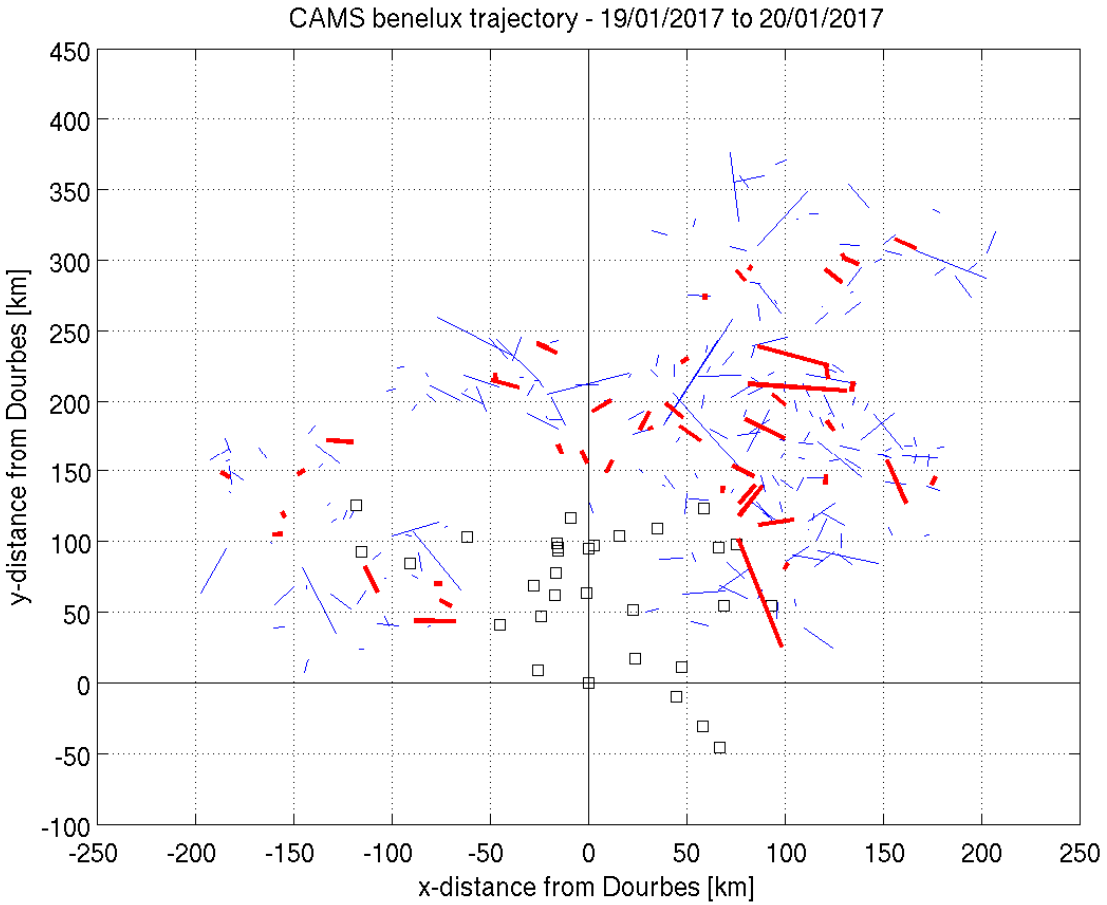
64 trajectories possibly detected by at least 3 stations

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



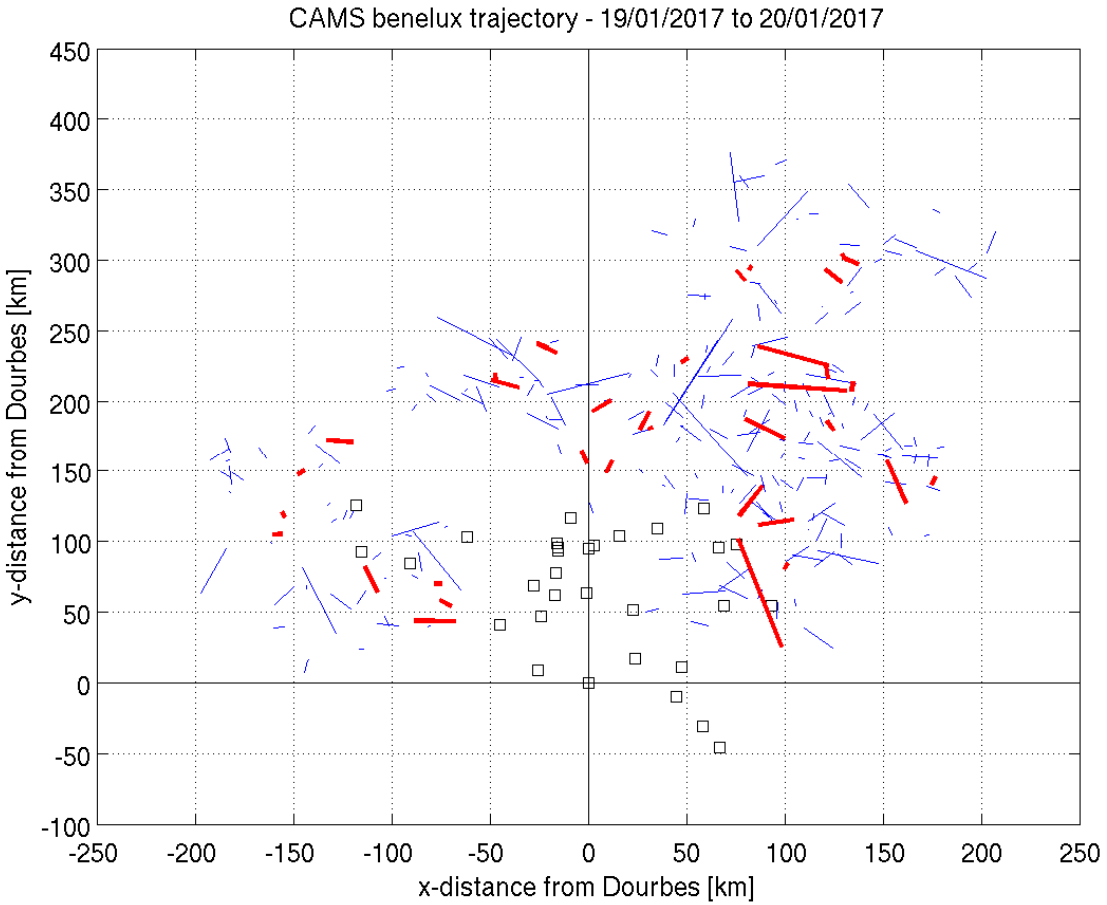
53 trajectories possibly detected by at least 4 stations

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



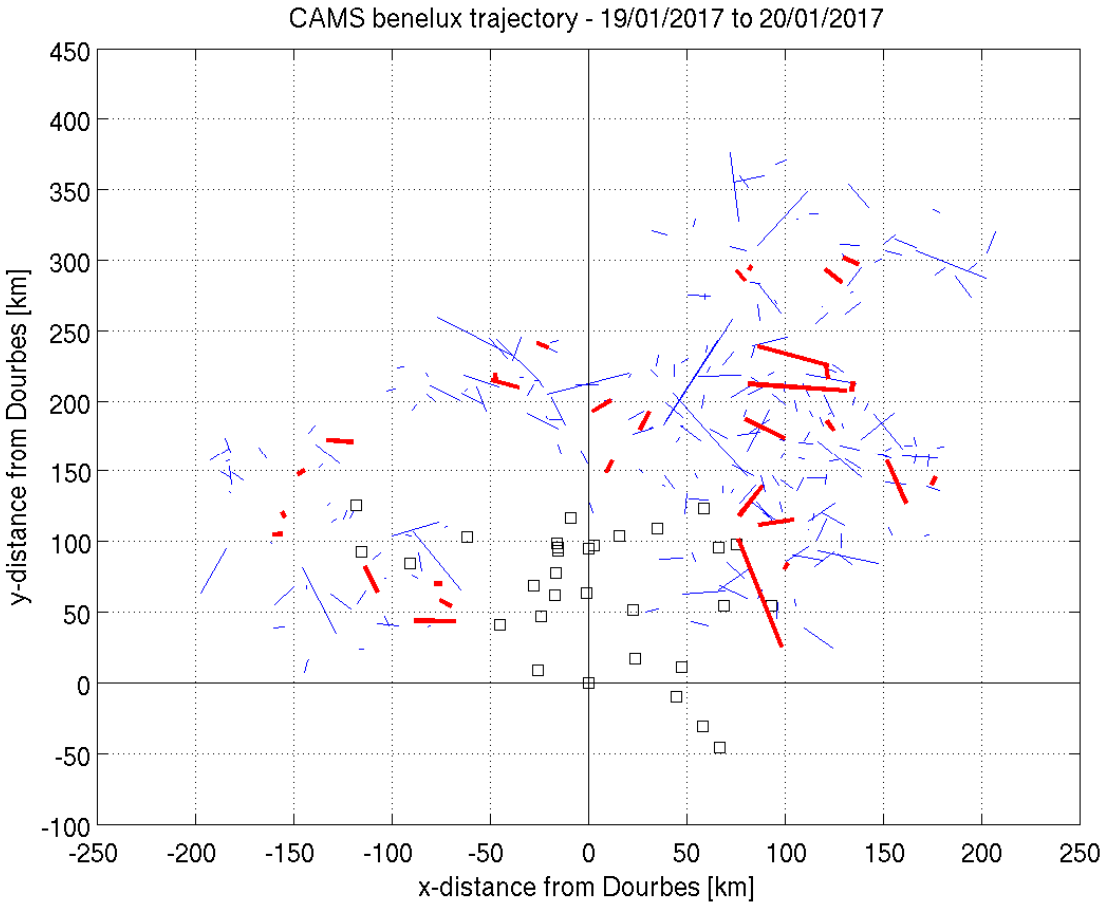
46 trajectories possibly detected by at least 5 stations

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



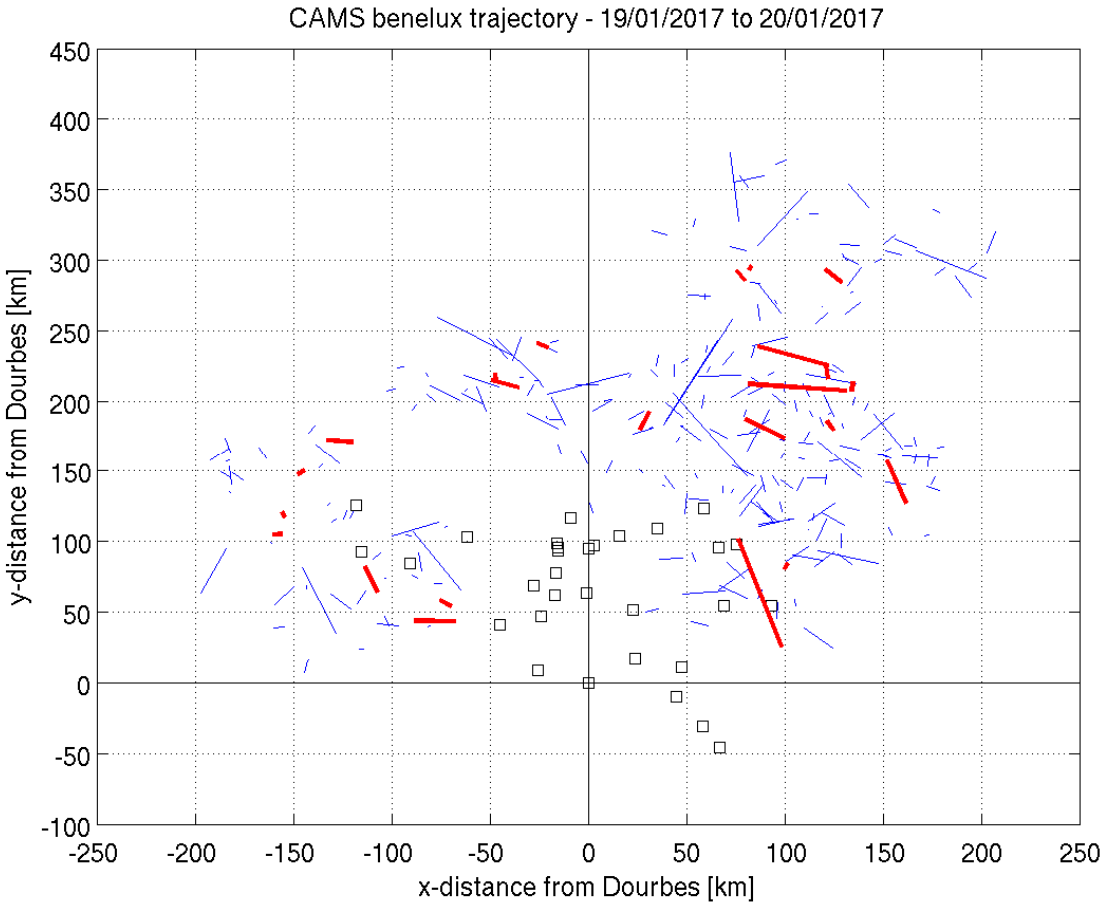
35 trajectories possibly detected by at least 6 stations

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



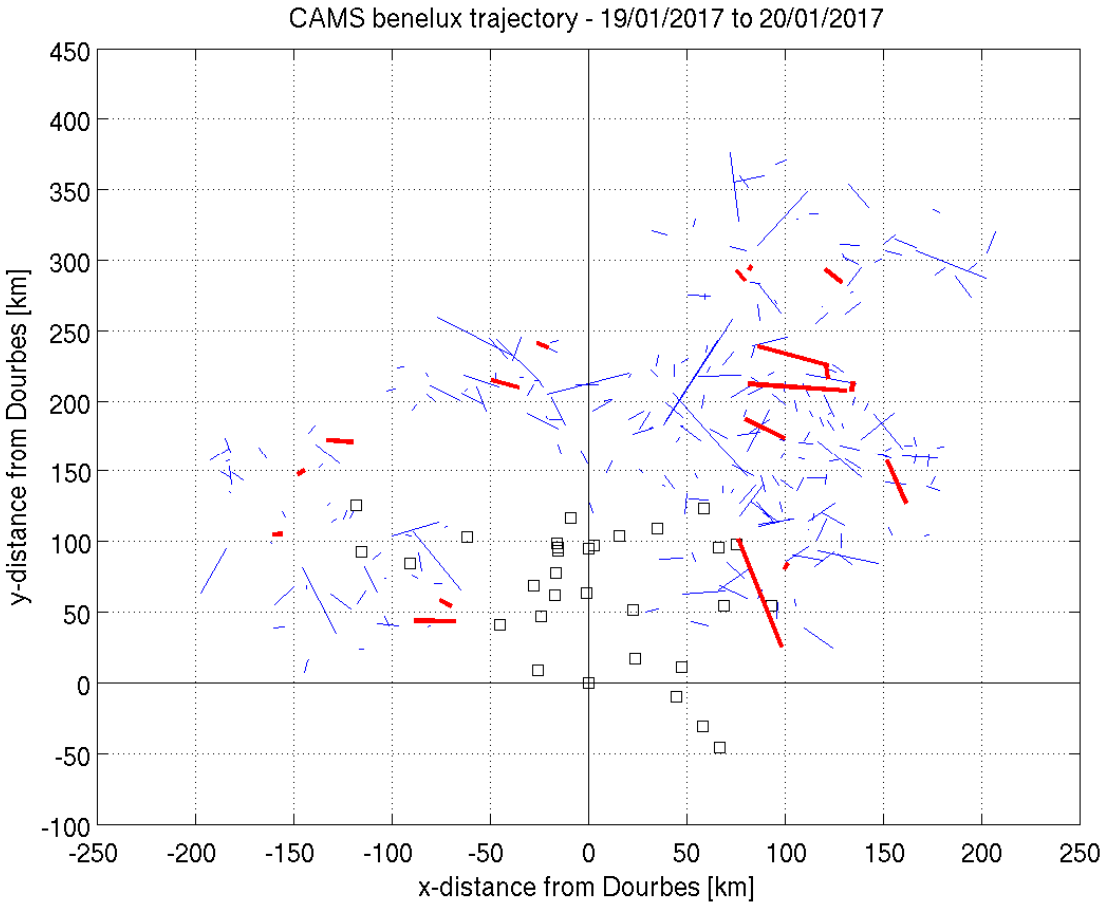
30 trajectories possibly detected by at least 7 stations

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



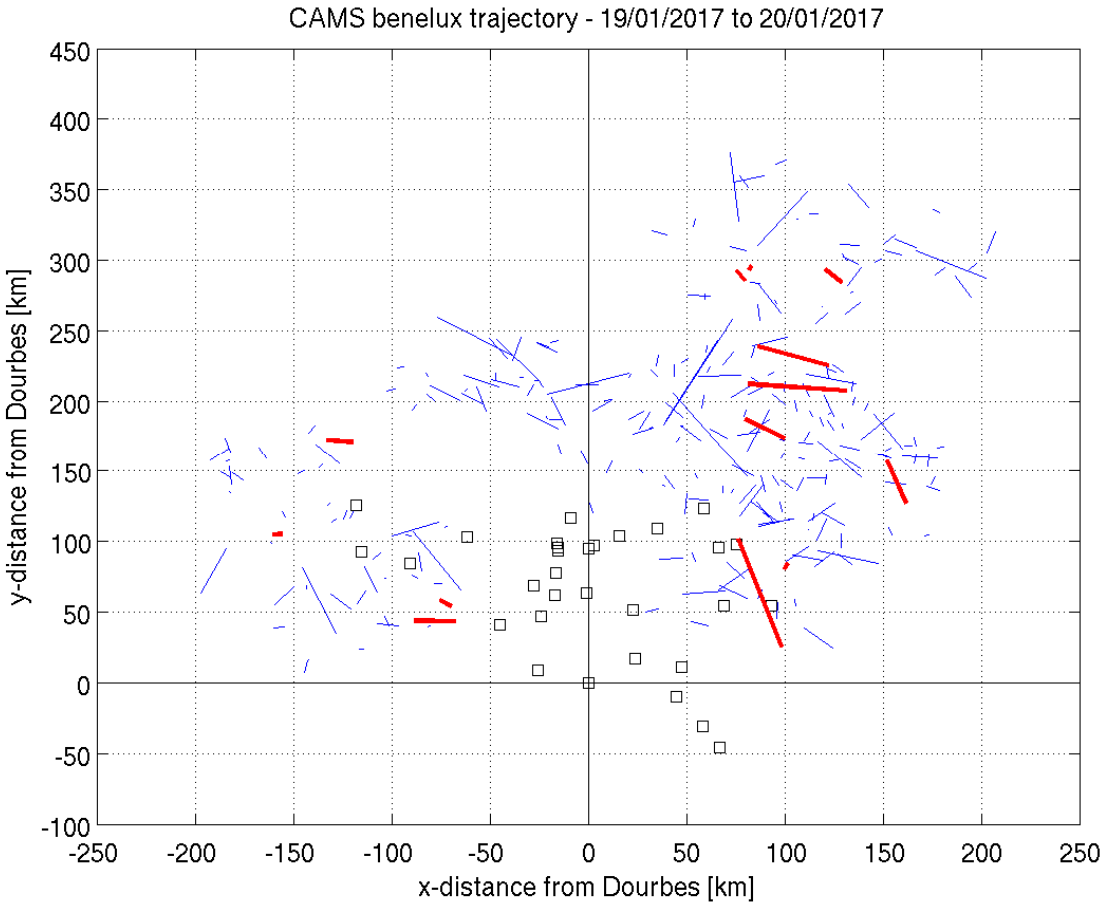
23 trajectories possibly detected by at least 8 stations

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



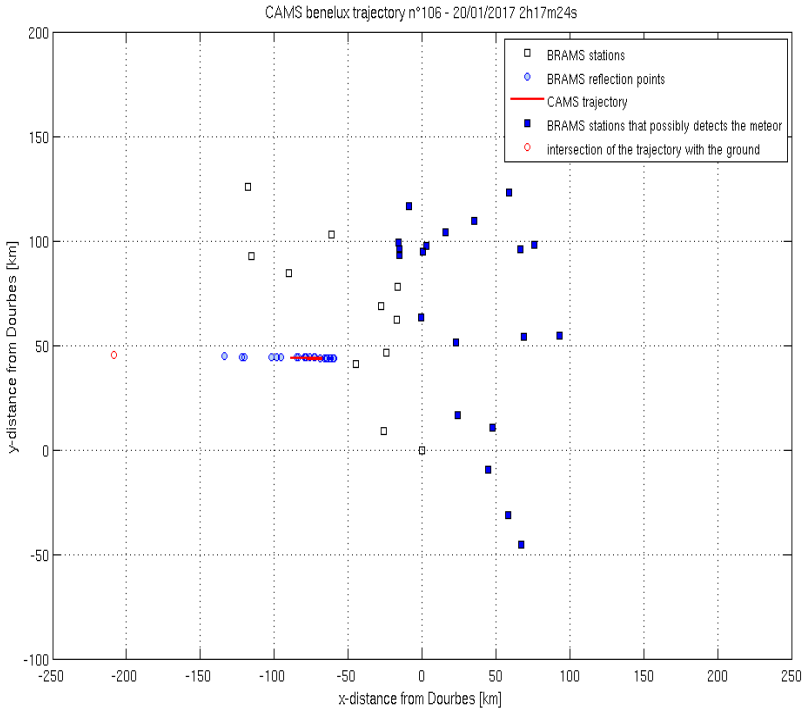
18 trajectories possibly detected by at least 9 stations

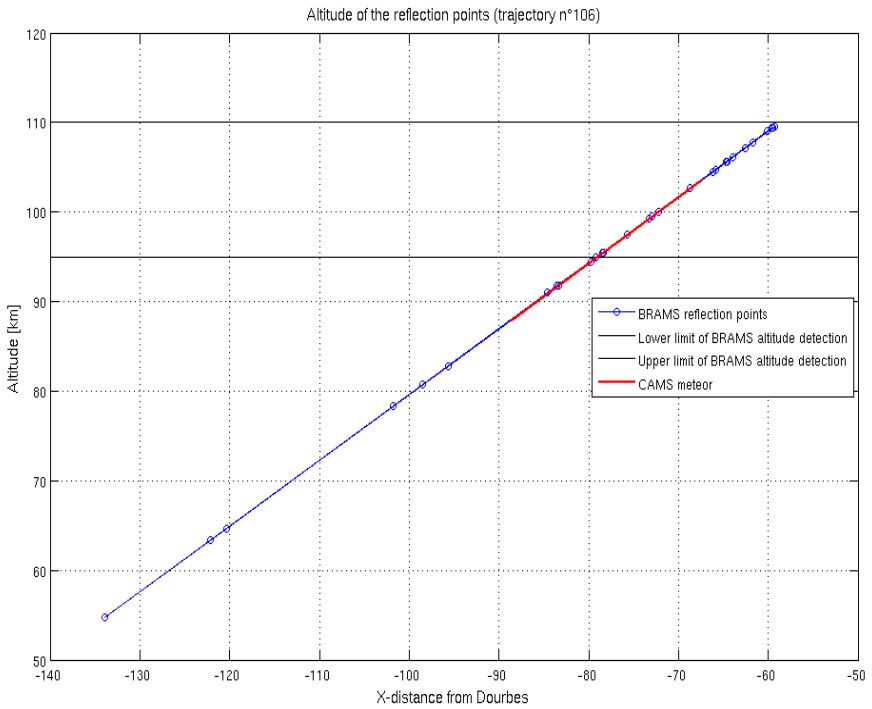
CAMS trajectories possibly detected by at least 10 stations (zt>95 km and <110 km)



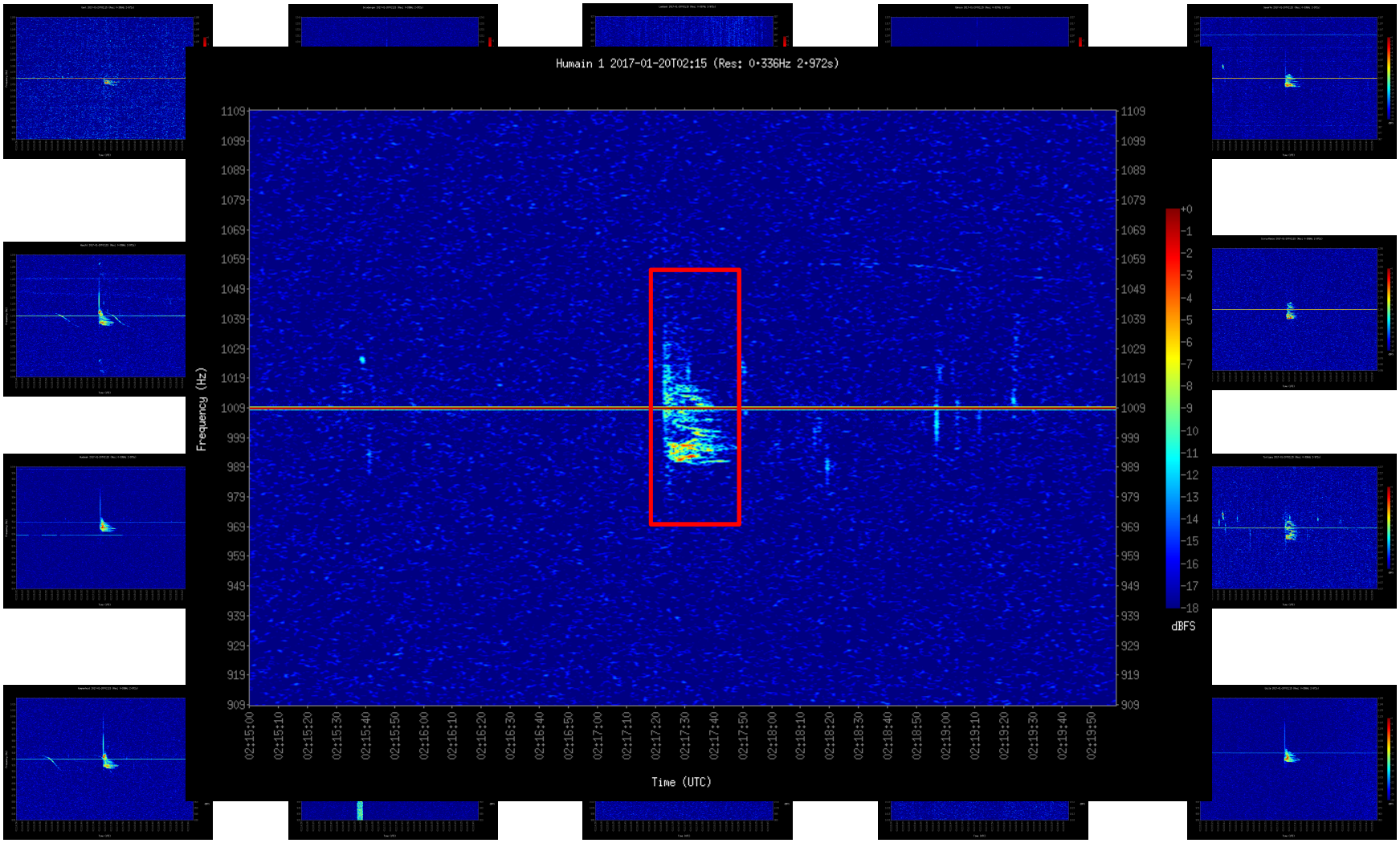
13 trajectories possibly detected by at least 10 stations

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





Example: CAMS trajectory 106 also observed by 20 BRAMS stations



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

- Based on CAMS trajectory equation:

$$x(t) - x_0 = a_1 + v_\infty t - a_1 e^{a_2 t}$$

  - x(t) is position along the meteor trajectory at time t
  - x_0 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						+N deg		+E deg		km		+N deg		+E deg		km	
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

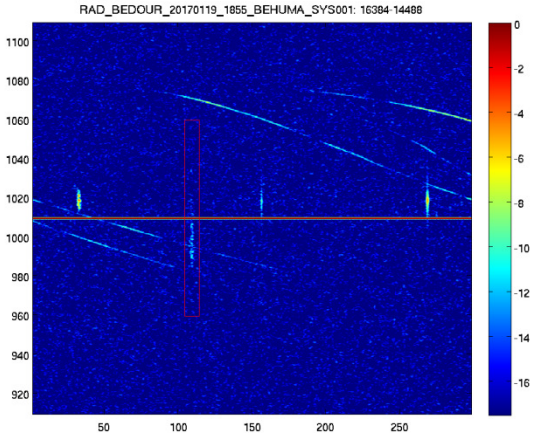
Is this method works well?

- 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!

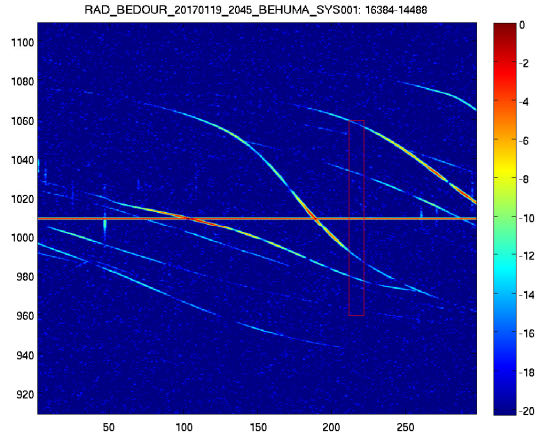
- We apply it to Humain reflection points for some CAMS trajectories.
  - In the next slides, rectangles are centered on the theoretical time of appearance (+ and – 5 seconds) and on the beacon (+ and – 50 Hz)
  - Altitude of the reflection points is given above the plots
  - If a meteor is observed 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?

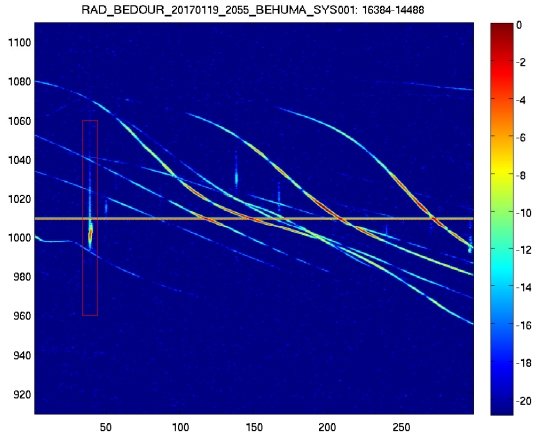
$z_t = 87\ km$ ✓



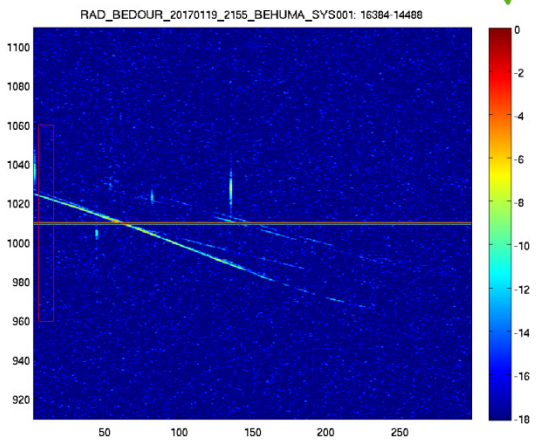
$z_t = 174\ km$ ✓



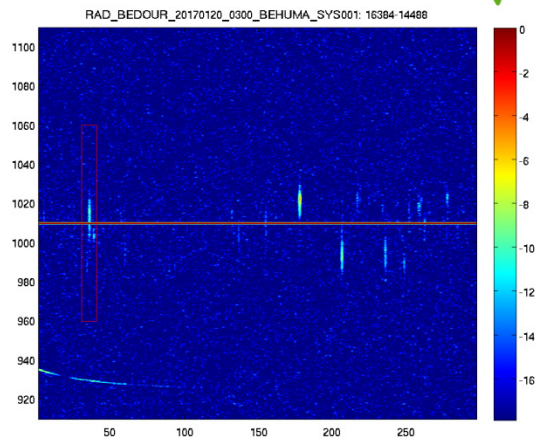
$z_t = 96\ km$ ✓



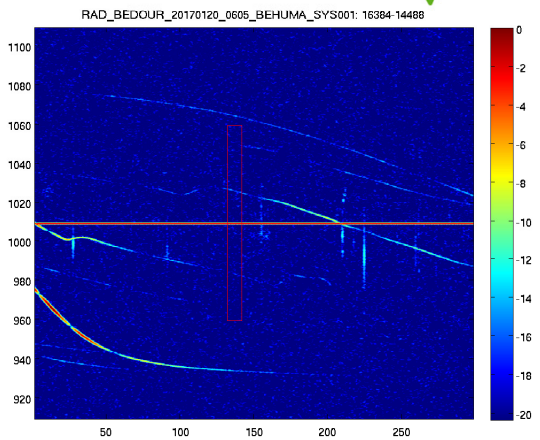
$z_t = 22\ km$ ✓



$z_t = 95\ km$ ✓

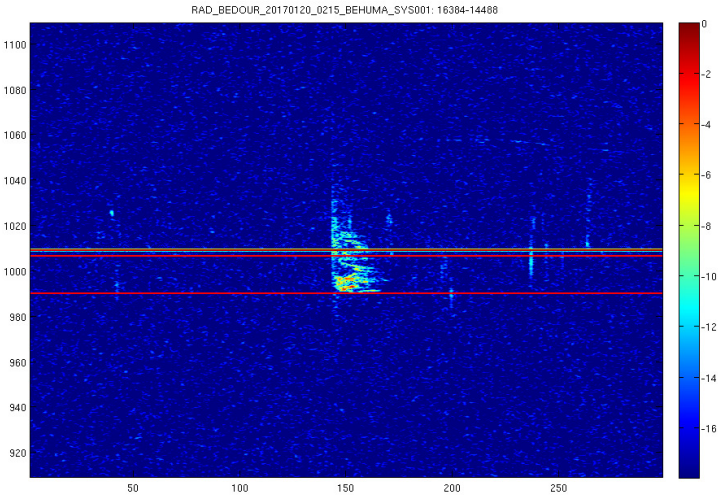


$z_t = 143\ km$ ✓



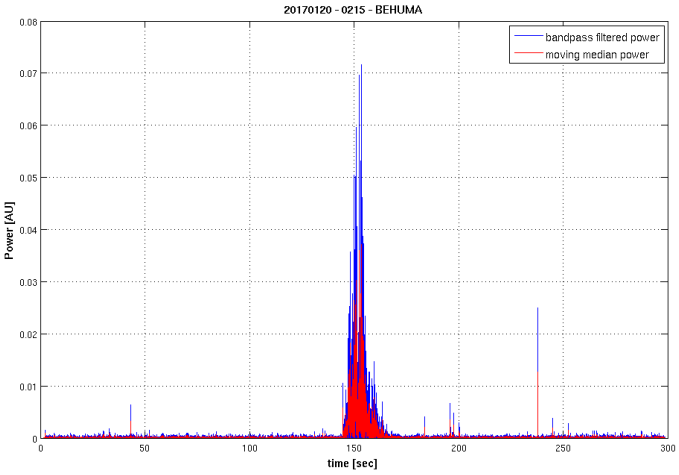
Comparisons between theoretical time of appearance and BRAMS observations

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

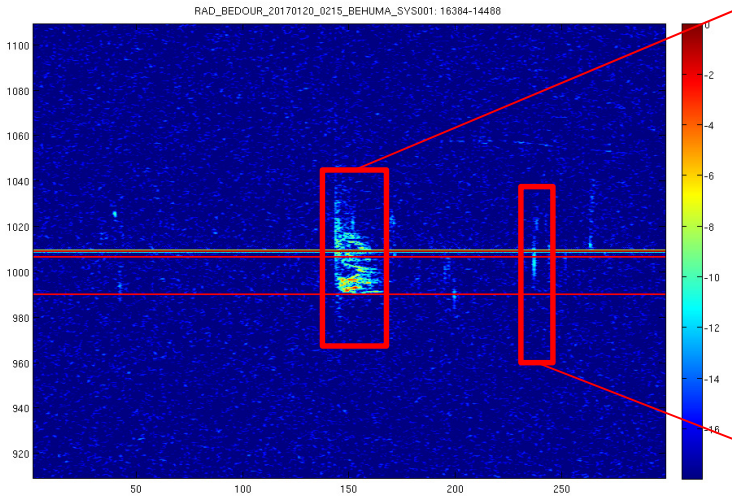


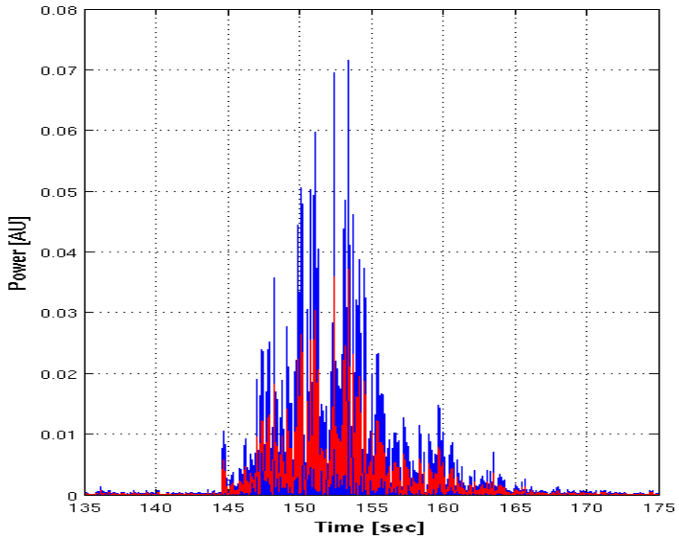
1. Band pass filter (sinc + blackman window)

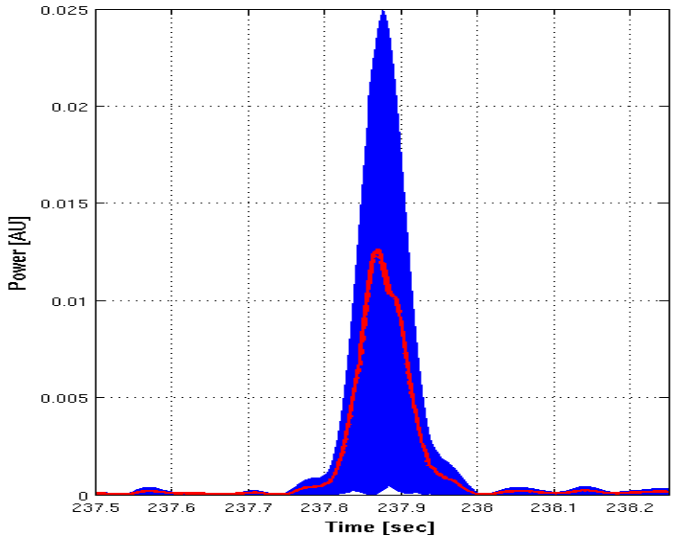
2. Moving median (100 values)



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