Status and History of the IMO Video Meteor Network

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Agenda

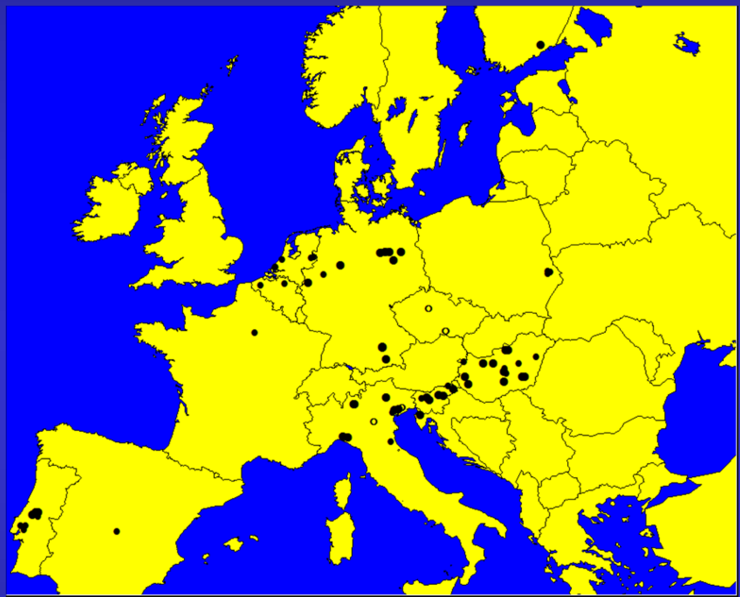
- What is the IMO Network?
- History & Current Status
- Major Achievements
- Conclusions & Acknowledgements

What is the IMO Network?

- International network of amateur astronomers who obtain video meteor observations on a regular basis.
- Participants from many, mainly European countries.
- Observers operate 1..5 video cameras at single/multiple locations.
- Nearly all stations are automated and operate every night.
- Designed as single-station network to allow observers from anywhere in the world to join.
- All stations use identical digitizer hardware and the MetRec software for meteor detection and analysis.
- Observations are reported to the IMO network database, which is centrally maintained and quality-controlled.

History & Current Status

- First camera started automated meteor observation in 03/1999
- Network history can be divided in three main phases.

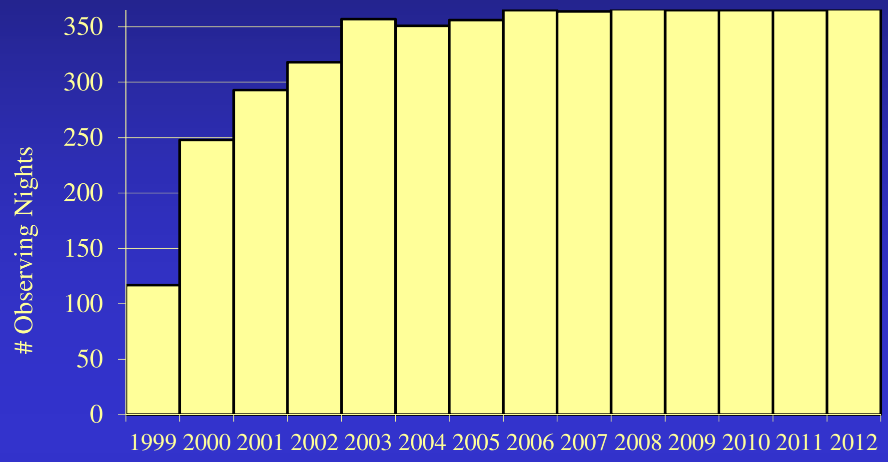


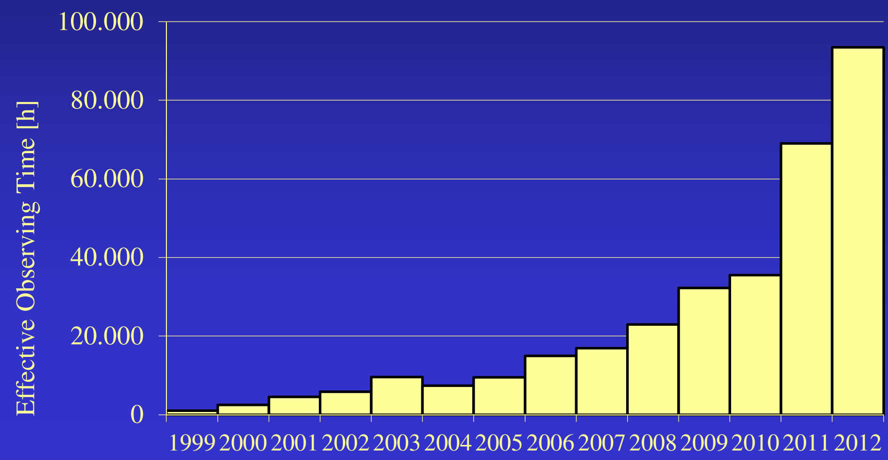
IMO Network Cameras in Central Europe 2012

Year	Cameras	Observers	Countries
1999	8	7	3
2000	11	8	5
2001	19	12	7
2002	19	12	8
2003	23	15	8
2004	21	11	7
2005	23	17	9
2006	28	19	9
2007	30	22	9
2008	37	24	10
2009	43	24	10
2010	57	32	12
2011	80	46	16
2012	81	46	15

Phase	Start Year	Characteristics
1	1999	Network setup, software development, initial data collection
2	2006	Comprehensive meteor shower analyses from single station data
3	2010	Calculation of flux densities, online flux viewer tool

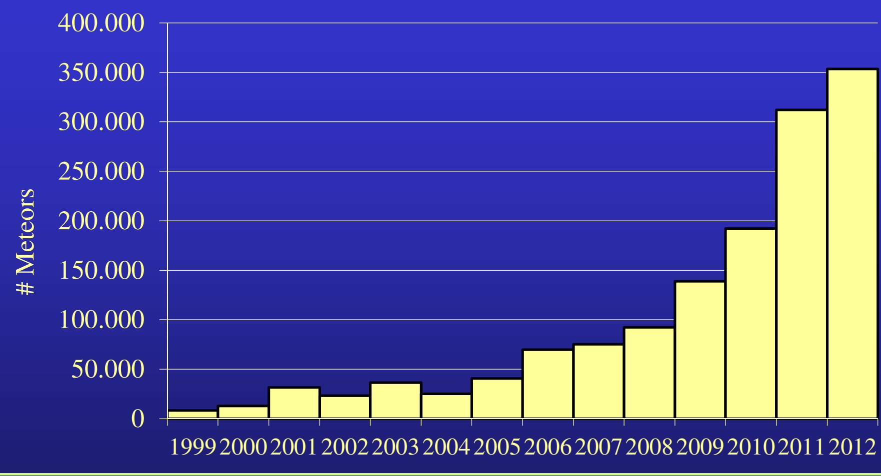
Phase 1: Data Collection





Highlights

- Network outcome and data quality has been increasing continuously.
- Not a single night missed since June 2007.



Phase 2: Meteor Shower Analyses

Automated meteor shower detection

IMC 2006	188,068 meteors (01/1993-07/2006)	• Base procedure based on Bayes' decision rule • Two-step detection (radiant and shower search) • Iterative radiant search
IMC 2008	359,957 meteors (01/1993-07/2008)	• Observability function and activity profiles • Improved detection algorithm (new alitude formula, Laplace distribution)
WGN 37:4 2009	451,282 meteors (01/1993-04/2009)	• Based on MDC meteor shower list • Manual refinement of search results
WGN 38:5 2010	168,830 meteors only SL 250-315° (01/1993-12/2009)	• Specific analysis of PER/AUR region in September/October
IMC 2013	1,063,057 meteors (01/1993-12/2011)	• Bi-directional match between IMO database and MDC meteor shower list

Phase 2: Meteor Shower Analyses

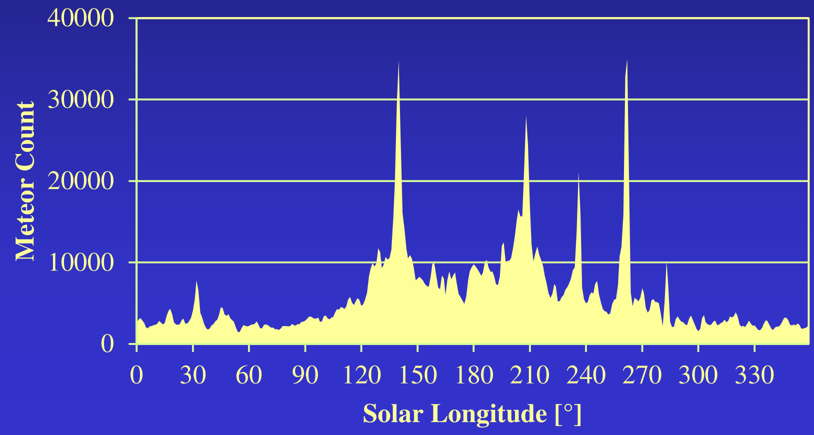
Automated meteor shower detection (single station analysis)

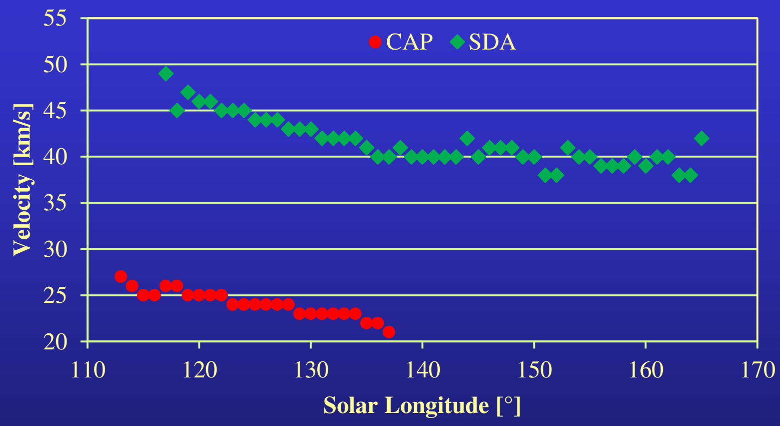
- Cut the data into sol long slices of 2° length, 1° shift.
- Compute for each meteor M in each sol long slice and all possible radiants R (α / δ / v_{inf}) the conditional probability P (M | R).
- Determine the radiants iteratively:
  - → Start: Accumulate P (M | R) over all possible R
    - →Loop: Select the radiant R` with largest probability P (M | R`)
    - →Determine all meteors M` belonging to R`
    - →Accumulate P (M‘ | R) over all possible R and subtract it from the original distribution
  - → End: Reassign the meteors to the radiants and recompute the shower parameters
- Connect similar radiants in consecutive sol long intervals.
- Compute radiant position / drift, shower velocity / activity profile.
- Match the showers with the MDC list.

Phase 2: Meteor Shower Analyses

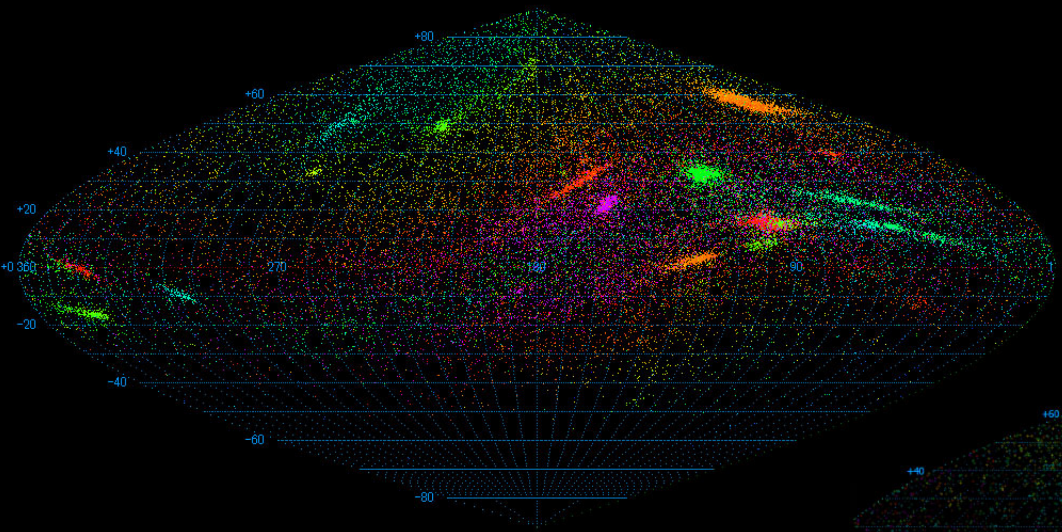
Highlights

- Automated searches for meteor showers in the optical domain covering all solar longitudes.
- Discovery of more than 20 unknown meteor showers.
- Confirmation of >100 showers from the MDC working list.
- Detection of a variability in meteor shower velocity over time.
- Data import to EDMOND DB.



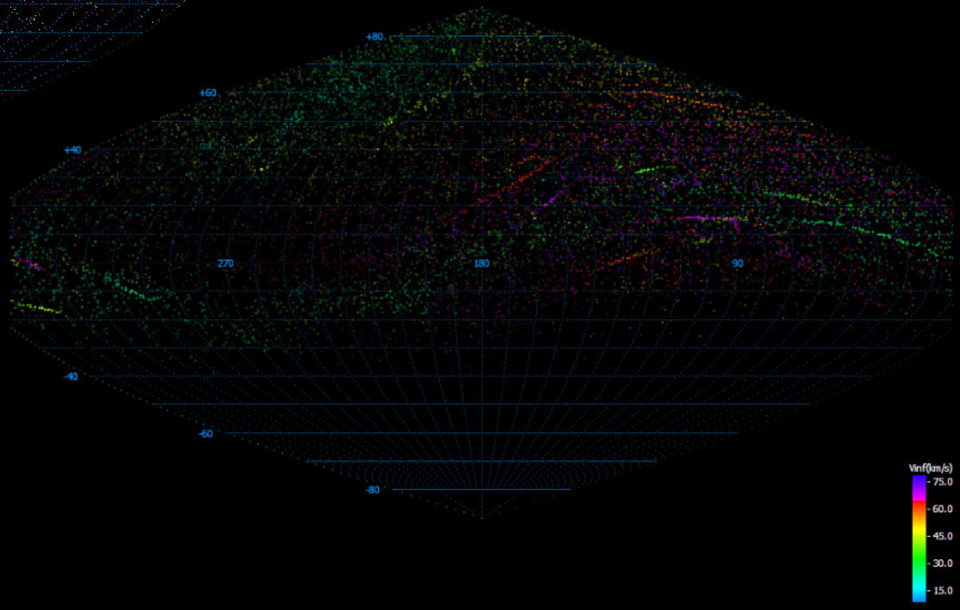


Phase 2: Meteor Shower Analyses



IMO Network 2009

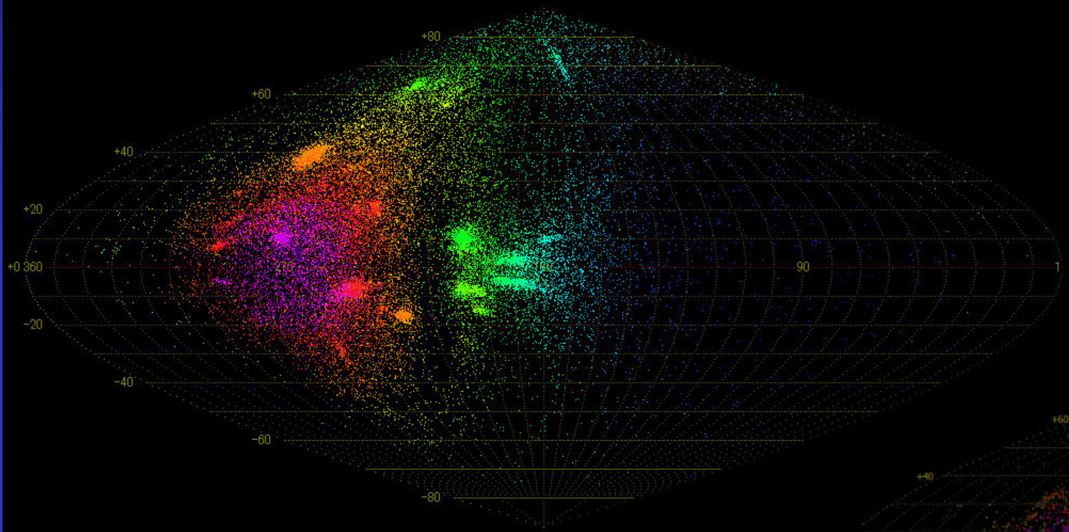
- Each dot one radiant
- 17,000 radiants with 10-10^3 met.
- Radiant velocity color coded
- Radiants strength intensity coded



SonotaCo Network 2009

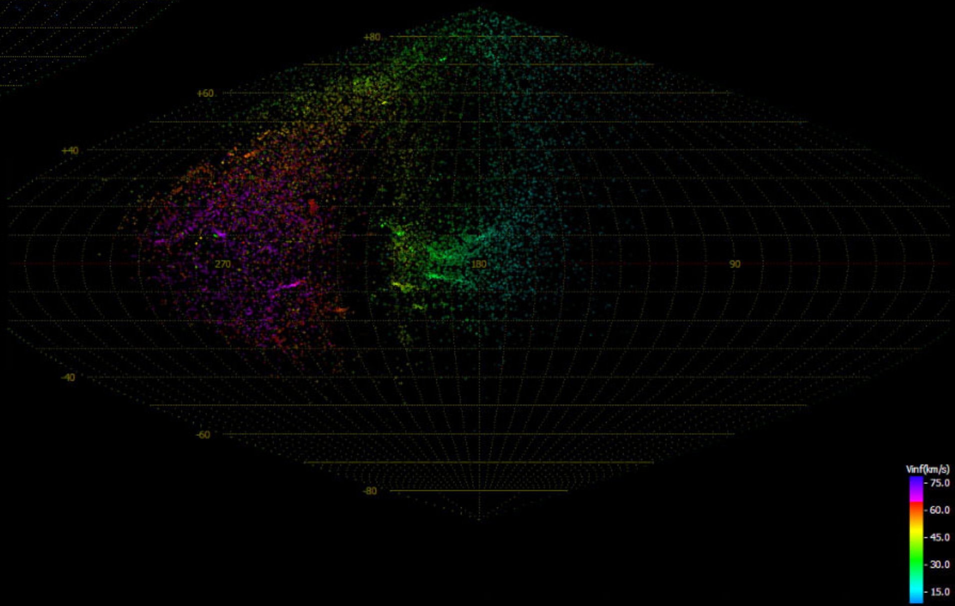
- Each dot one orbit
- 39,000 orbits
- Radiant velocity color coded

Phase 2: Meteor Shower Analyses



IMO Network 2009

- Same dataset
- Antihelion centered graph.

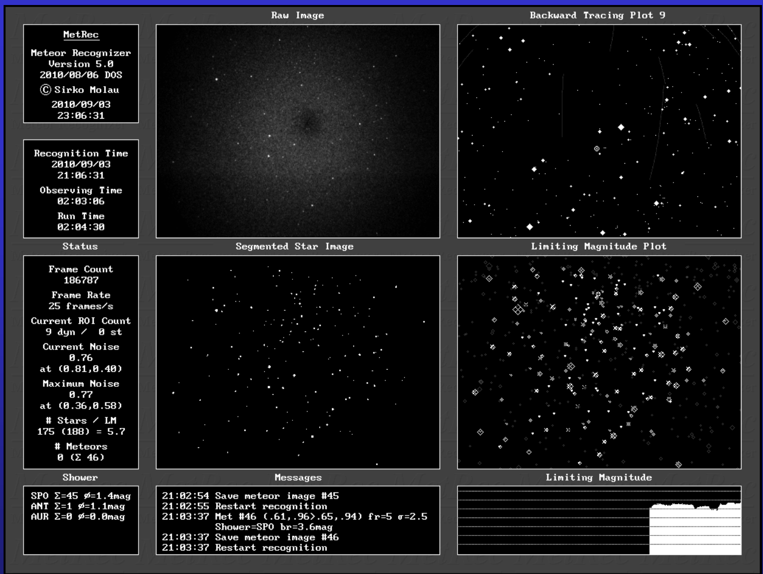


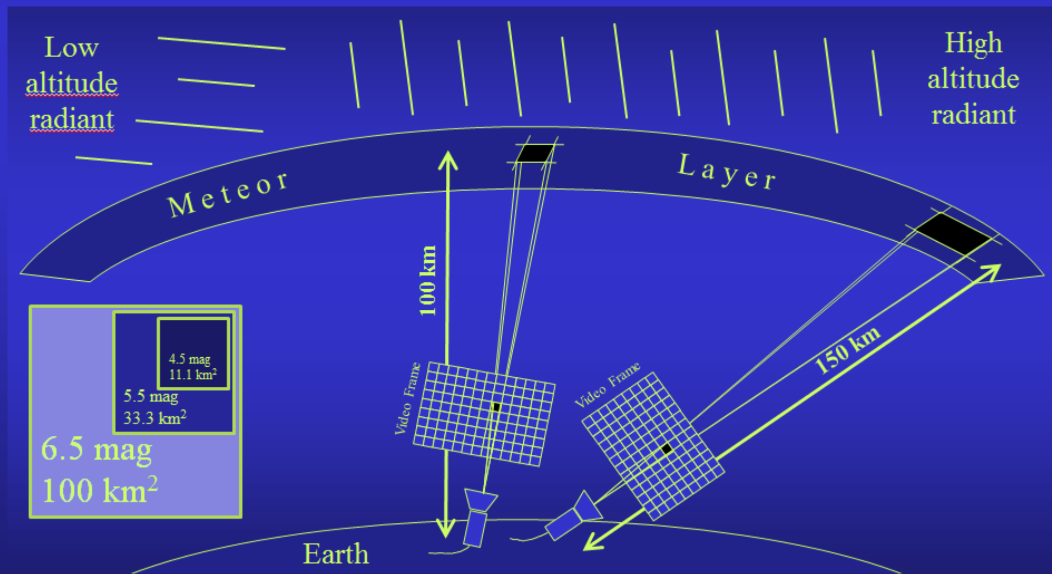
SonotaCo Network 2009

- Same dataset
- Antihelion centered graph.

Phase 3: Flux Density Determination

- Basis: Automated calculation of the limiting magnitude
- Flux density calculation is based on size of fov, eff. observing time, meteor count, stellar lm, lm loss by meteor motion, radiant altitude, meteor layer altitude, population index

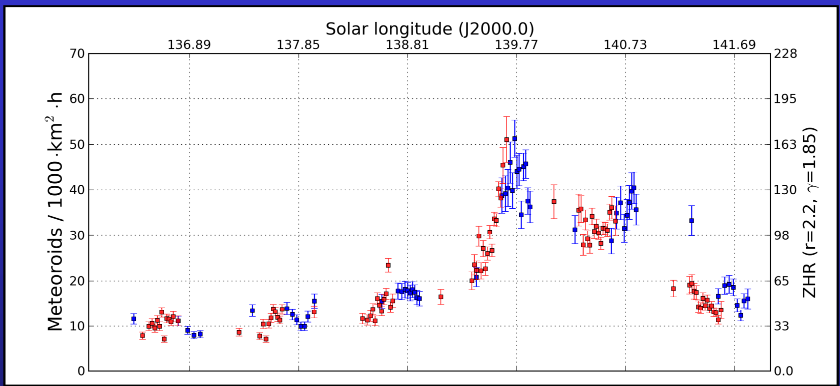




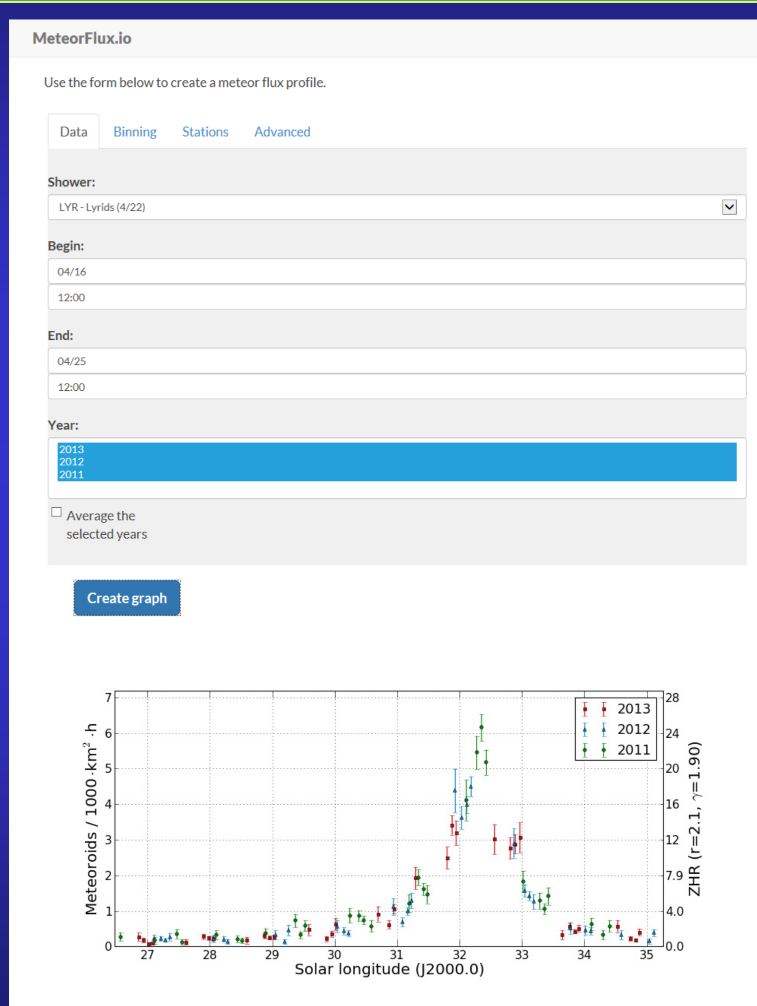
Phase 3: Flux Density Determination

- Observers upload flux data.
- MetRec Flux Viewer* allows to analyse and visualize flux data online.
- Flux density profiles for every shower since 2011.

** See poster by G. Barentsen, S. Molau*



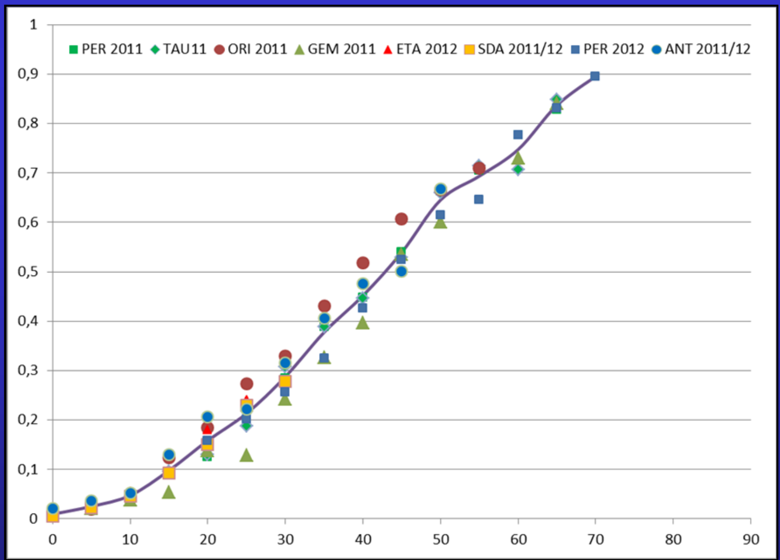
Perseid flux density profile 2011 (blue) and 2012 (red)



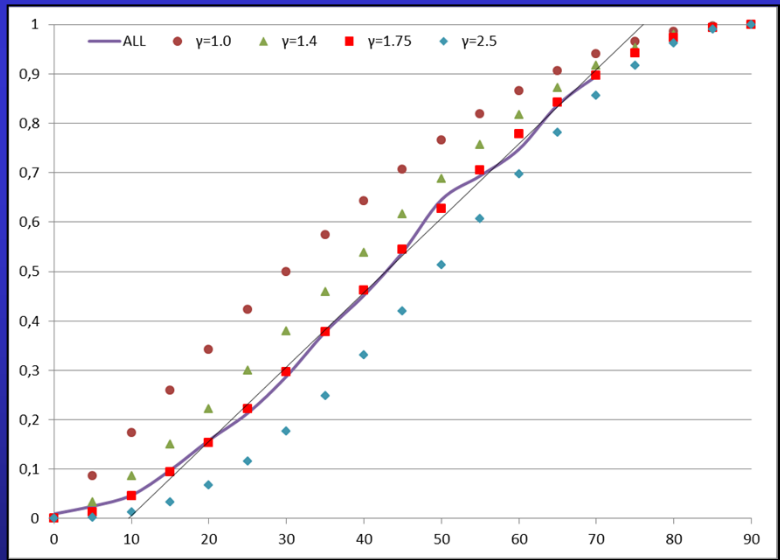
Phase 3: Flux Density Determination

Highlights

- Determination of a zenith exponent γ between 1.5 and 2.0 for different major meteor showers.
- Average value of γ=1.75.



Uncorrected flux density vs. radiant altitude

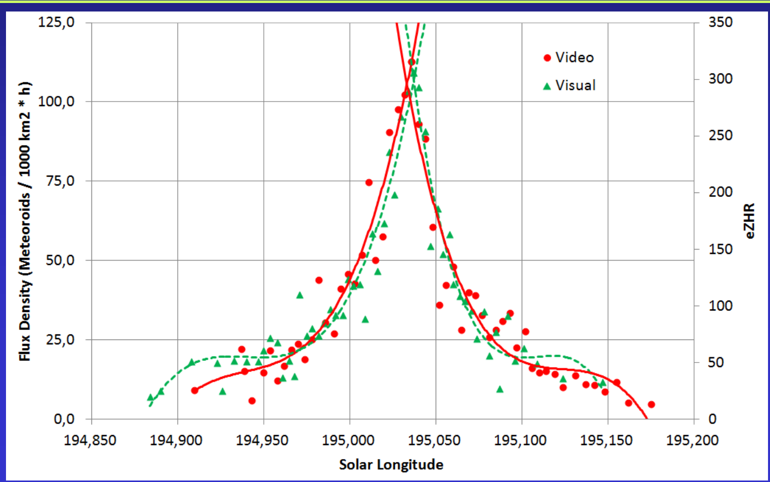


Radiant altitude correction with γ=1.75

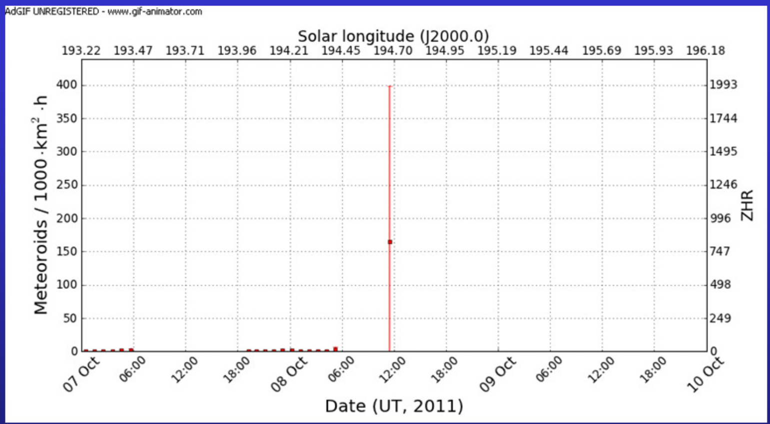
Phase 3: Flux Density Determination

Highlights

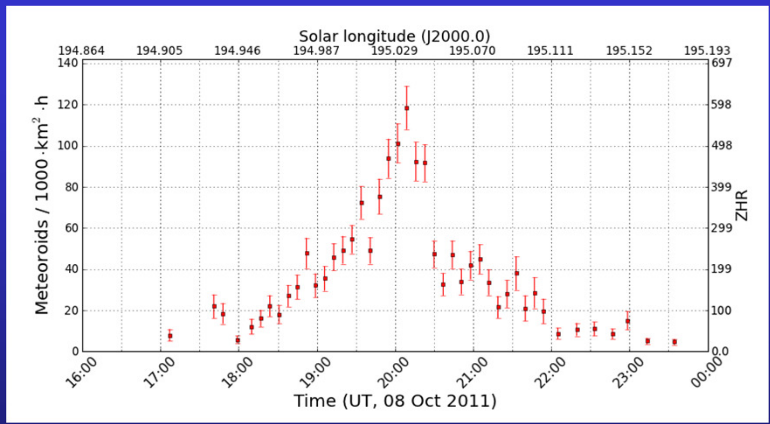
- Automated online real-time flux density display from Draconid outburst 2011.
- Precise determination of peak time, flux density and FHWM.



Comparison between visual and video data



Real-time flux density profile.



High resolution flux density profile.

Conclusions & Acknowledgements

- The IMO Video Meteor Network is a successful international collaboration of amateur video meteor observers.
- After the first data collection phase, plenty of analyses have been carried out touching different aspects of meteor research.
- Further analysis results and discoveries may be expected thanks to a rapidly growing database, improving data quality and refined analysis techniques.

Great thanks to all video meteor observers contributing to the IMO network and providing the data for all of these analyses.

Thanks for your Attention

Questions?