First results of a fireball flux measurement with the AllSky7 Fireball Network

Michael Frühauf [1]
Detlef Koschny [1]
Yannic Heidegger [1]

[1] *Technical University of Munich, Lise-Meitner-Str. 9, 85521 Ottobrunn, Germany*

Planetary Defence

Why care about meteoroids and small asteroids?

- Carancas, 2007: Meter-sized asteroid fully penetrated through the atmosphere and left an impact crater
- Chelyabinsk, 2013: Asteroid of tens of meters caused significant damage on infrastructure and humans
- Potential to distract vehicle drivers, cause fear or occur in politically sensitive regions
- Impact timescales of a human life or even more frequently

→ **Those objects should not be ignored for Planetary Defence.**

The Carancas impact crater. Source: Kenkmann et al. (2009)

Flux Density

Flux density = number / (area × time)

Number

Meteor data from AllSky7 Fireball Network:

- Total about 80 stations (December 2022)
- Mainly in Europe (Germany, Hungary)
- Minimum detectable magnitude of network estimated to about 2 mag by single measurements
- Only events observed by at least 2 stations

For this work:

- 59 stations
- More than 45,000 events

The AllSky7 Fireball Network in December 2022.
Source: www.allsky7.net

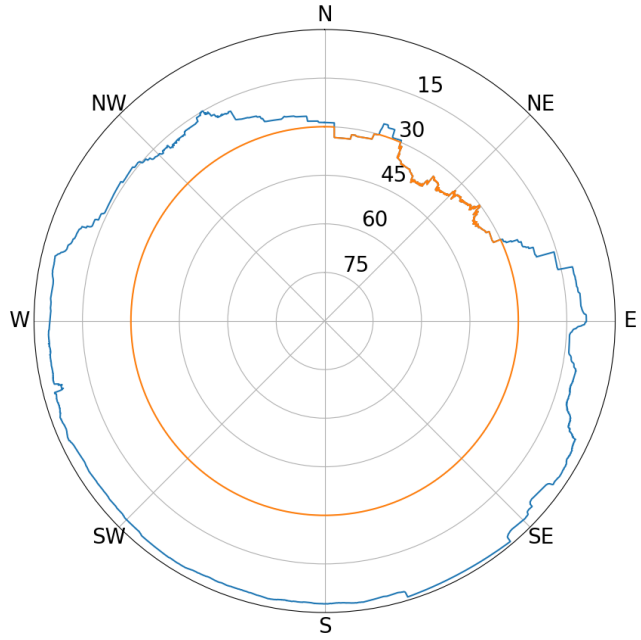
Area

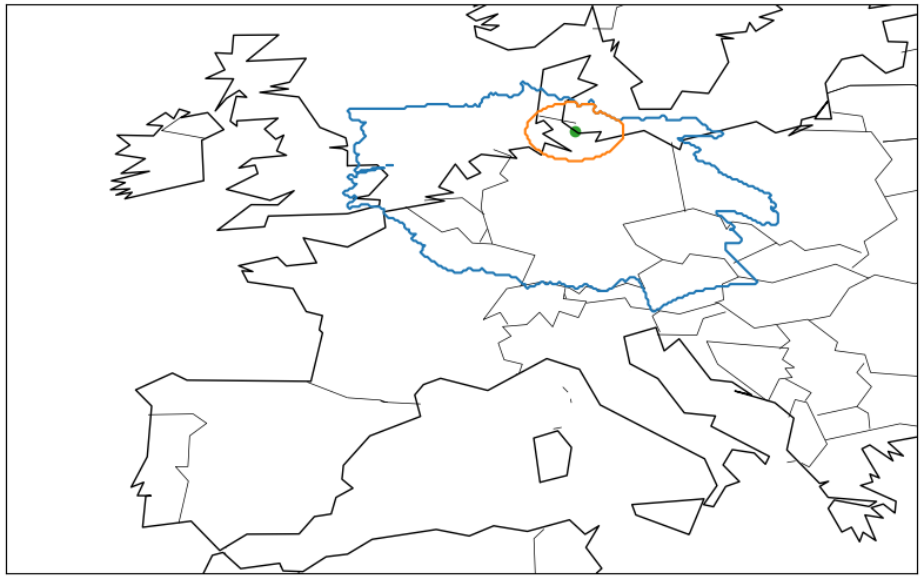
Individual horizons of stations:

- Obstacles (e.g. trees) are taken into account reducing the visible horizon
- Assuming minimum observation elevation of 30°

Combined area

- Assuming meteors appear at 80 km altitude
- Spatial resolution: 0.1° longitude, 0.1° latitude





Sample horizon of an AllSky7 station in an elevation plot and in a map.

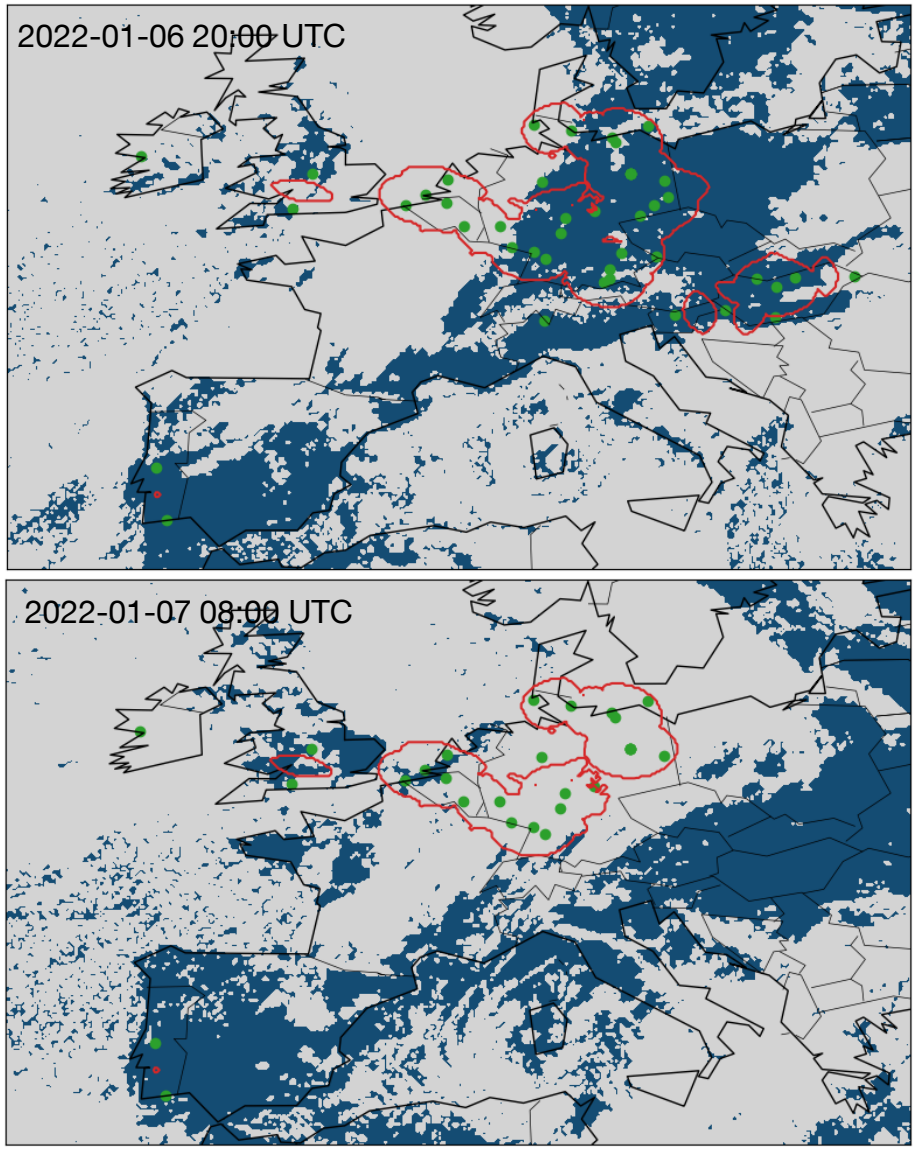
Time

Time dependent observation area:

- Time resolution: 1 h
- Switched-off stations and stations during daytime (sun elevation > -5°) are excluded
- Only area covered by at least 2 stations
- Cloud cover determined from EUMETST Cloud Mask reducing the area
- Average area: appx. 174,000 km^2

Observation hours

- More than 7,400 hours (of 2022)



Maps of used AllSky7 stations, the overlapping area of at lest 2 stations and the data of the EUMETSAT Cloud Mask.

Results

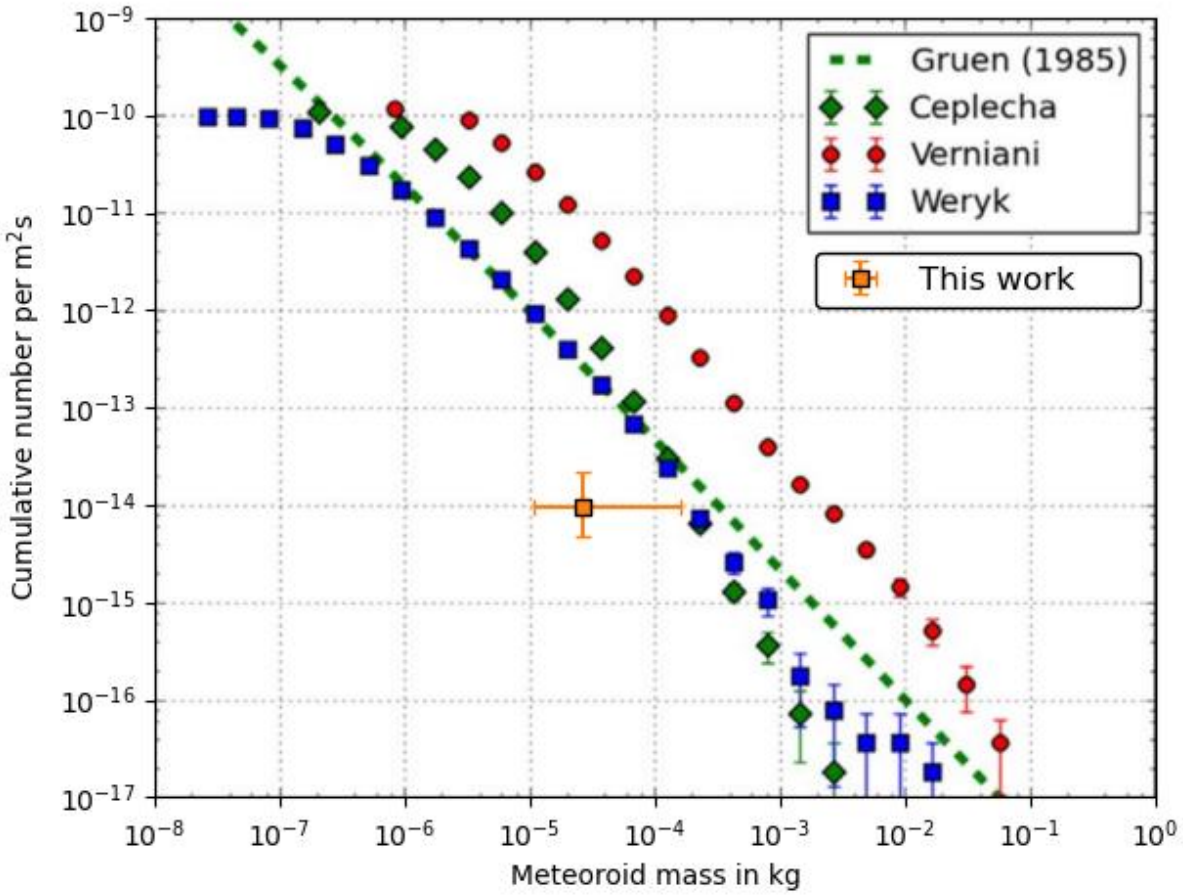
Flux density of 9.7×10^{-15} m^{-2} s^{-1}

Magnitude conversion to Meteoroid mass

- Assuming entry velocity of 17 km s^{-1}
- Assuming a luminous efficiency of appx. 1% (Weryk et al. 2013)

One order of magnitude less than in literature, yet high uncertainties in meteoroid mass.

→ With reasonable estimates of the minimum detectable magnitude, the minimum observation elevation, the meteor altitude and the entry velocity, we obtained a flux density in the region of literature values.



Flux density determined with the Canary Island Long-Baseline Observatory using different magnitude-mass-conversions and the flux density computed in this work. Source of original plot: Koschny et al. (2017)

Future work

- Improving the mass estimates of the observed meteors by using proper magnitude calibration
- Determining the observation area as a function of the meteor magnitude
- Improving the cloud cover estimate
- Increasing the covered observation area by including other fireball networks