

**MASSACHUSETTS INSTITUTE OF TECHNOLOGY
HAYSTACK OBSERVATORY
WESTFORD, MASSACHUSETTS 01886**

January 21, 2025

Telephone: 617-715-5533

To: EDGES group

From: Alan E.E. Rogers

Subject: Study of reflections of FM stations from meteor showers and micrometeorites

Table 1 lists the meteors that have produced strong reflections of the carriers of the FM radio stations and the trend of observing a larger number of FM carriers in 2024 and 2025 than in 2023 is consistent with the ablation of the meteors at an elevation over 100 km. The last column is the strength of the strongest carrier over 6 kHz bandwidth.

meteor shower	year_day	range UT hrs	number of FM carriers	strength	peak temp K
Geminids	2024_349	13-21	28	very strong	2e6
"	2024_350	13-21	18	not as strong	4e3
"	2023_350	14-19	6	weak	9e3
"	2022_350	13-17	6	very weak	2e2
"	2020_350	13-21	6	very weak	2e2
"	2018_349	13-21	6	medium	7e2
"	2017_350	13-21	6	strong	5e3
"	2016_347	13-21	5	weak	5e2
"	2015_350	13-21	6	medium	2e3
"	2011_350	13-21	5	medium	1e3
Quadrantids	2025_011	14-21	22	strong	2e4
"	2025_012	14-21	22	strong	7e3
"	2025_013	13-17	13	medium	6e3
"	2024_013	14-17	6	medium	2e3

Table 1. Number of FM carriers observed by EDGES-3 in WA

Micrometeorites which burn up at about 100 km have always produced only reflected the signals from about 6 FM stations because there are about 6 FM transmitters within 3000 km of the site where the EDGES-3 is deployed in Western Australia. These at 94.7 96.5 98.1 98.9 99.7 100.5 101.3 MHz are in Geraldton which is about 300 km from the antenna. This is what makes the site very good for the observations of the global 21-cm absorption signal. Fortunately the meteor events which extend the range of the FM stations being reflected to over 3000 km are infrequent and have only become a more significant source of RFI with the increased solar activity at the peak of the solar cycle 25.

Figures 1 shows the peak of the Geminids meteor shower on the reflections of the FM stations on December 14 2024 from the data taken by EDGES-3 located radio quiet site of the Inyarrimanha Ilgari Bundara, our Murchison Radio-astronomy Observatory in Western Australia and Figure 2 shows peak of the Geminids meteor shower a year earlier in December 16 2023. Papers of observations of occasional meteor ablation above 100 km are listed in the references below but the mechanism of high altitude ablation which is seen to increase with increased solar activity is still under study.

References:

- Brosch, N., Häggström, I. and Pellinen-Wannberg, A., 2013. EISCAT observations of meteors from the sporadic complex. *Monthly Notices of the Royal Astronomical Society*, 434(4), pp.2907-2921.
- Brosch, N., Häggström, I., Pellinen-Wannberg, A. and Westman, A., 2010. Unusual features in high statistics radar meteor studies at EISCAT. *Monthly Notices of the Royal Astronomical Society*, 401(2), pp.1069-1079.
- Schult, C., Kero, J., Stober, G. and Brown, P., 2021. Dual frequency measurements of meteor head echoes simultaneously detected with the MAARSY and EISCAT radar systems. *Icarus*, 355, p.114137.
- Premkumar, B., Reddy, K.C. and Yellaiah, G., 2018. Variation of the meteor count rate and echo height during solar cycle 23 and 24. *Proceedings of the International Astronomical Union*, 13(S340), pp.73-74.
- Kastinen, D. and Kero, J., 2022. High-altitude meteors detected by the interferometric MU radar. *Monthly Notices of the Royal Astronomical Society*, 517(2), pp.3024-3033.

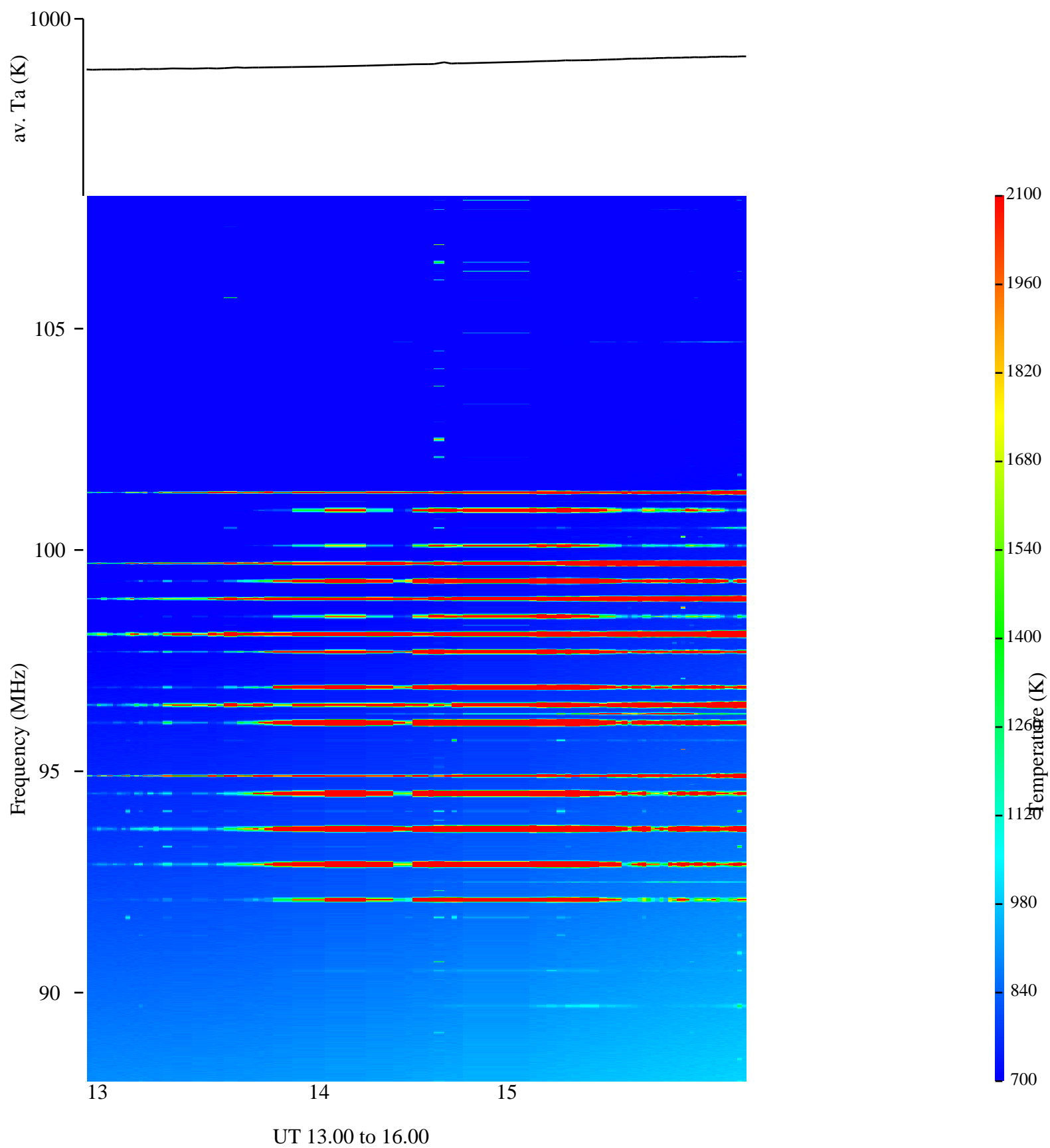
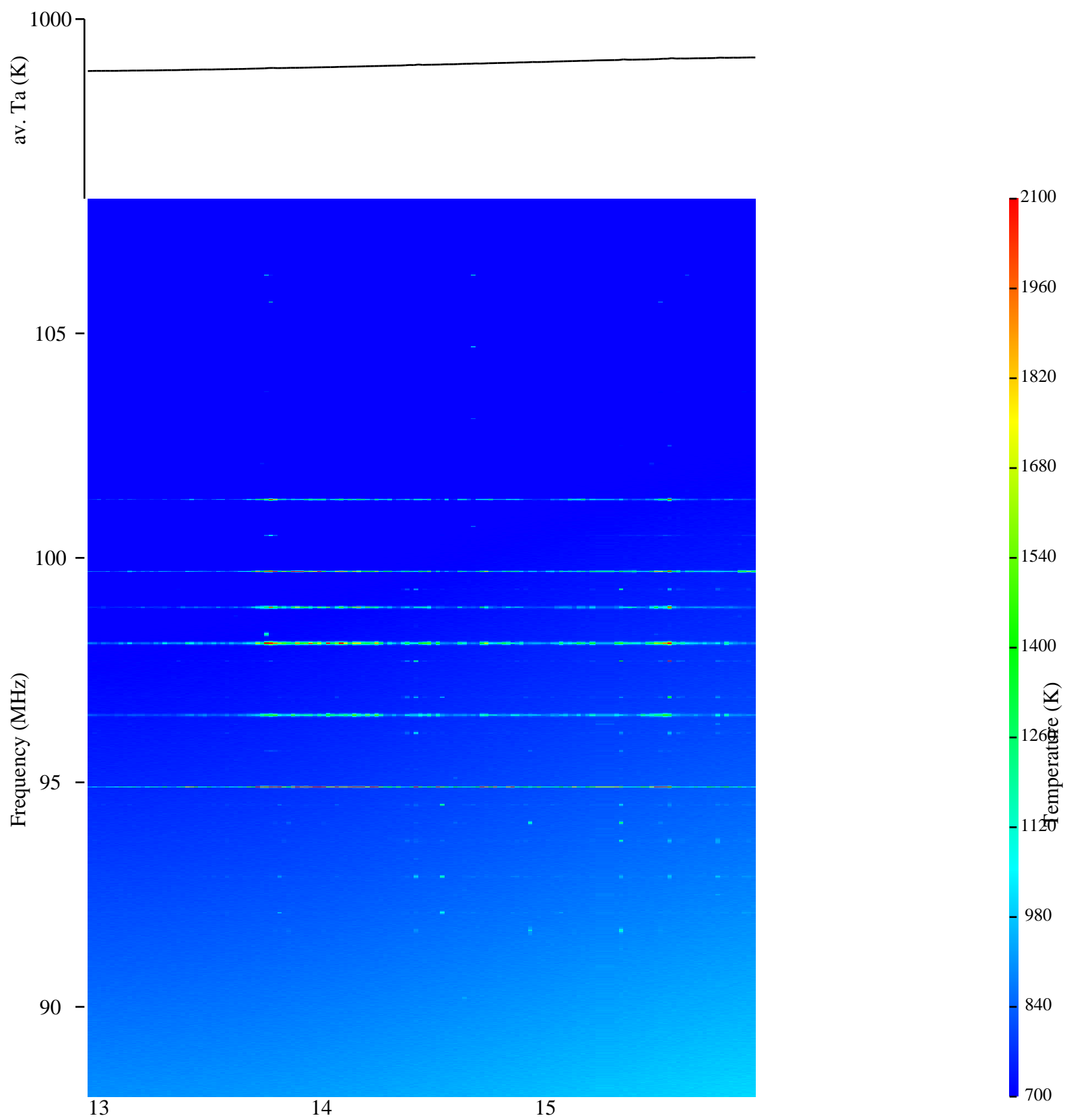


Figure 1. Spectra from EDGES-3 at WA 2024_349 during Geminids meteor shower



UT 13.00 to 16.00
 fstart 88 fstop 108 pfit 37 smooth 0 resol 6 kHz rfi 0.0 nline 240 secint 1534
 Figure 2. Spectra from EDGES-3 at WA 2023_350 during Geminids meteor shower