Comparison of the RAL 78 GHz, fmcw cloud radar, with the 35 GHz Galileo cloud radar, Chilbolton

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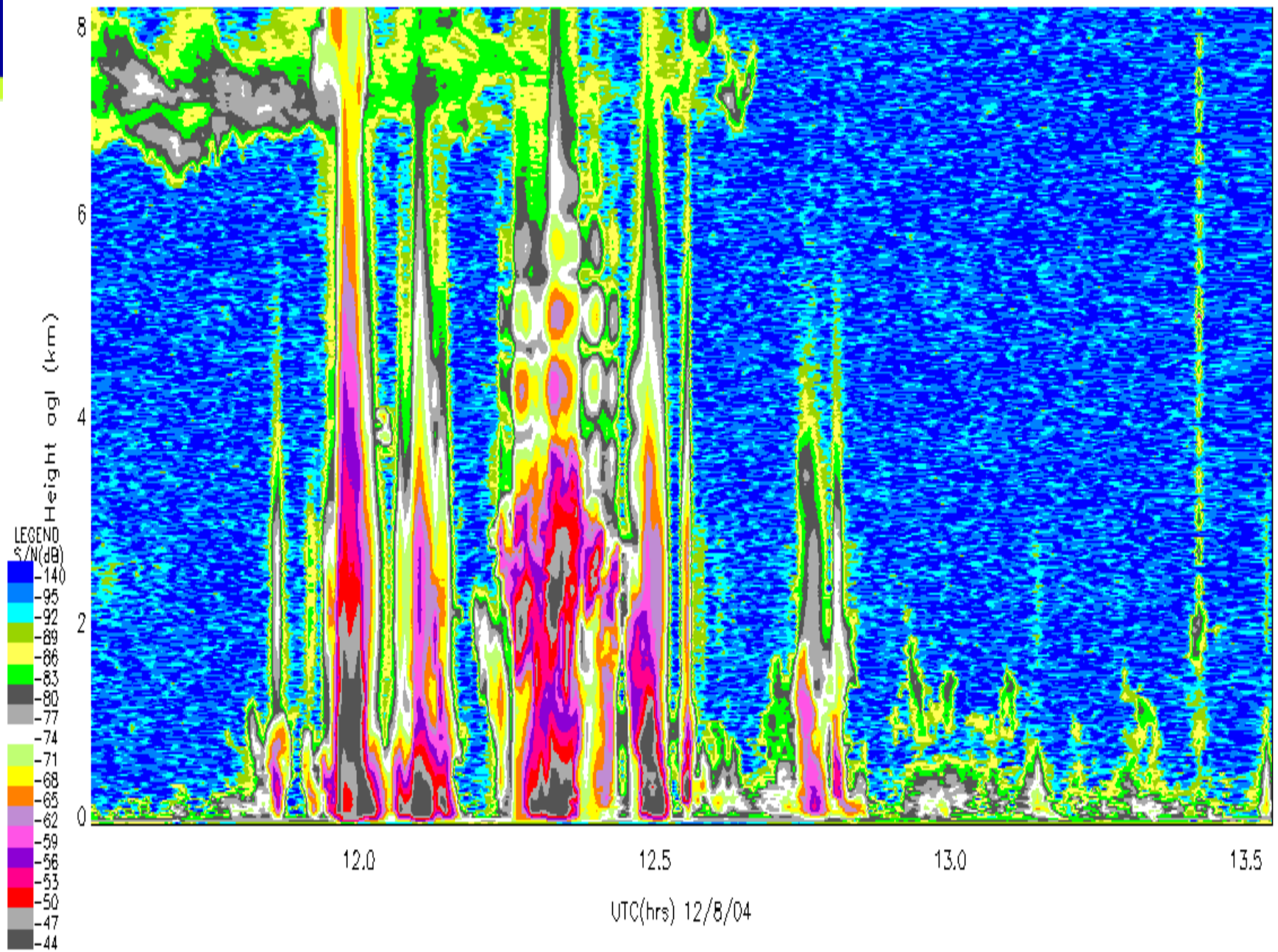
CIMO Expert Team on RS UT&T, Geneva, 14-17 March 2005

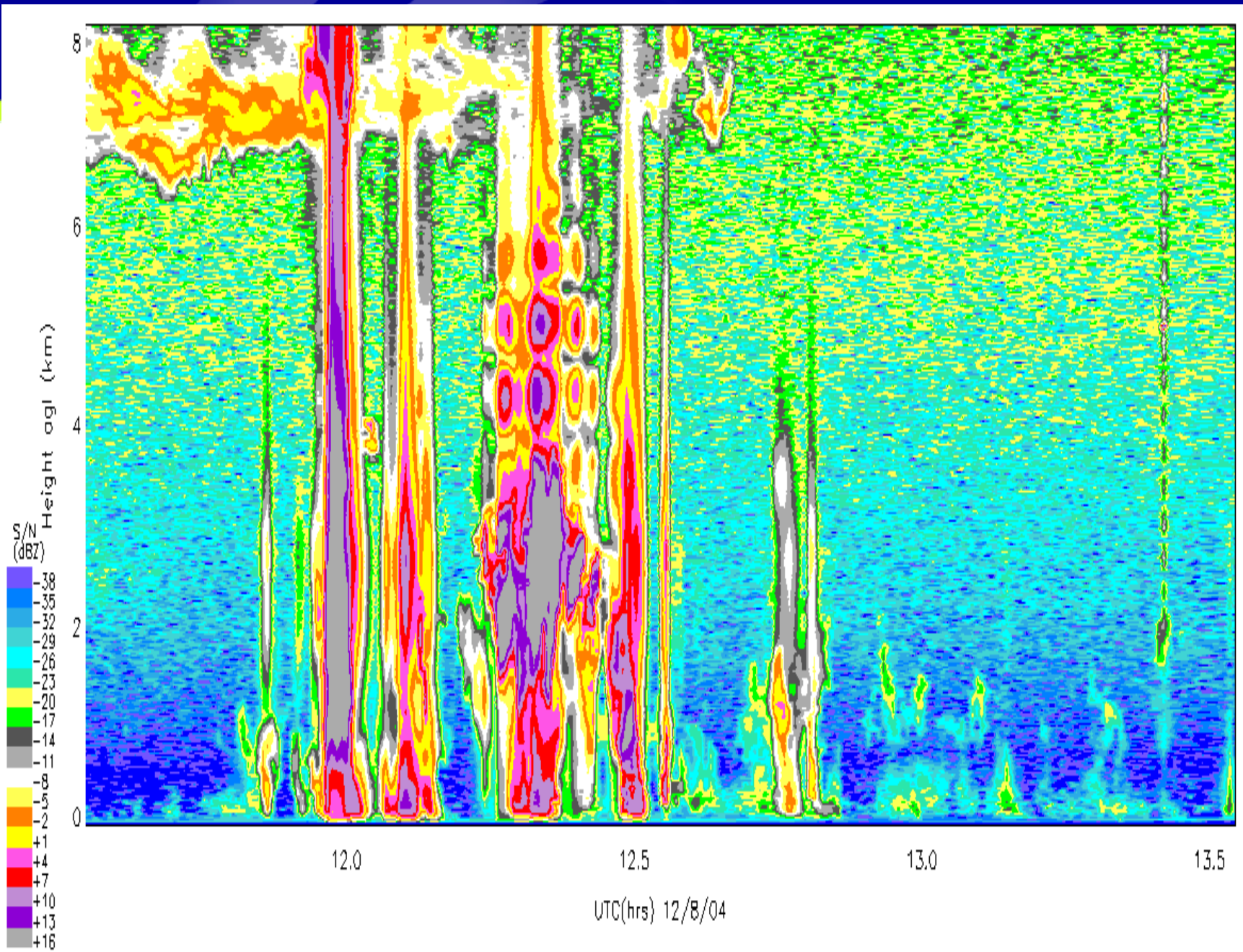
Cloud radar demonstrator, provided by B. Ellison, Rutherford Appleton Laboratory

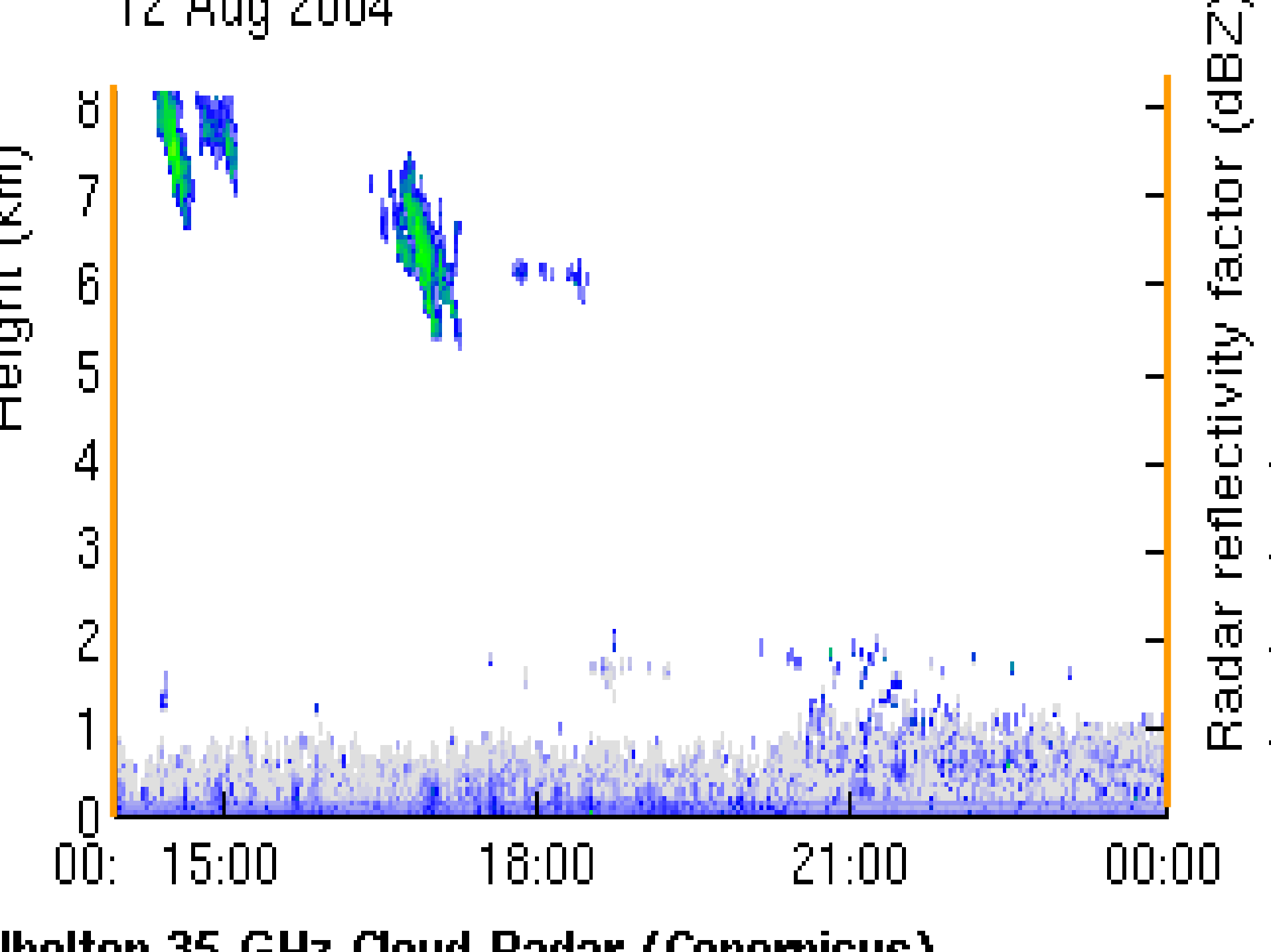
- Deployed in Switzerland by Matthew Oldfield and Darren Lyth, November 2003 to February 2004 , Cloud radar operated with vertical range of 0 to 8 km at vertical resolution of 15 m. Calibration scale is arbitrary. Temporal resolution 30 s.
- Must be used with laser ceilometer to identify properties of cloud, since it is insensitive to scattering from small water drops.
- Met Office needs to make decision with respect to future operational prototypes in liaison with Rutherford Appleton.
- Current system was deployed at Camborne for limited operations during radiosonde testing and then to Chilbolton for testing against 35GHz cloud radar

Comparisons at Chilbolton

- Comparison of the 78GHz FMCW cloud radar with pulsed radars based at Chilbolton, UK was requested at the last COST 720 WG2.
- During this evaluation, the 94GHz radar was not operational, so comparisons were made with the Copernicus 35GHz pulsed radar, and a 905nm CT-75k lidar as supporting evidence.
- We are grateful to C.Wrench, E.Slack, D.Ladd, J.Agnew and D.King of Chilbolton Observatory for their assistance during the Comparison.






12 Aug 2004
Height (km)
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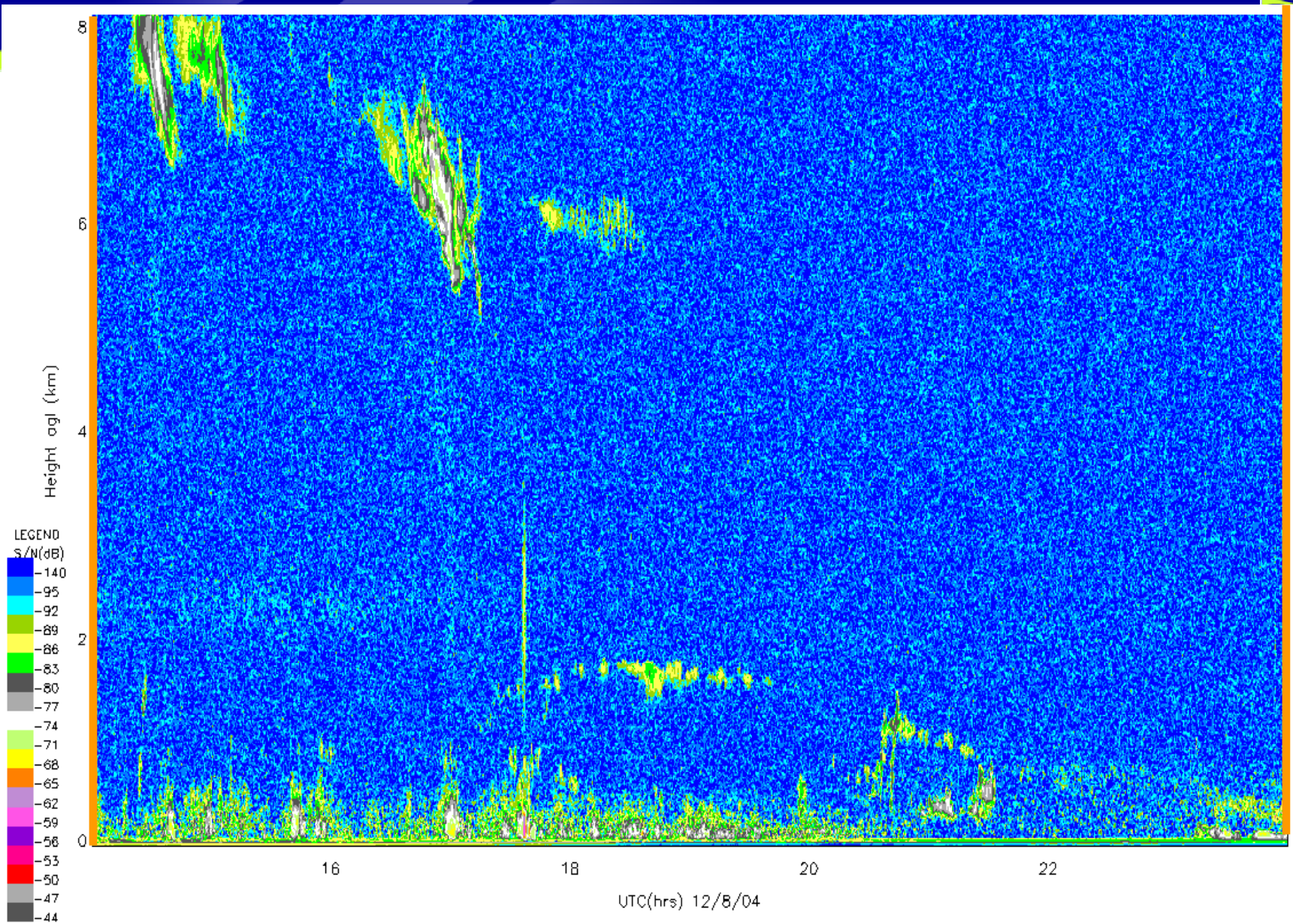
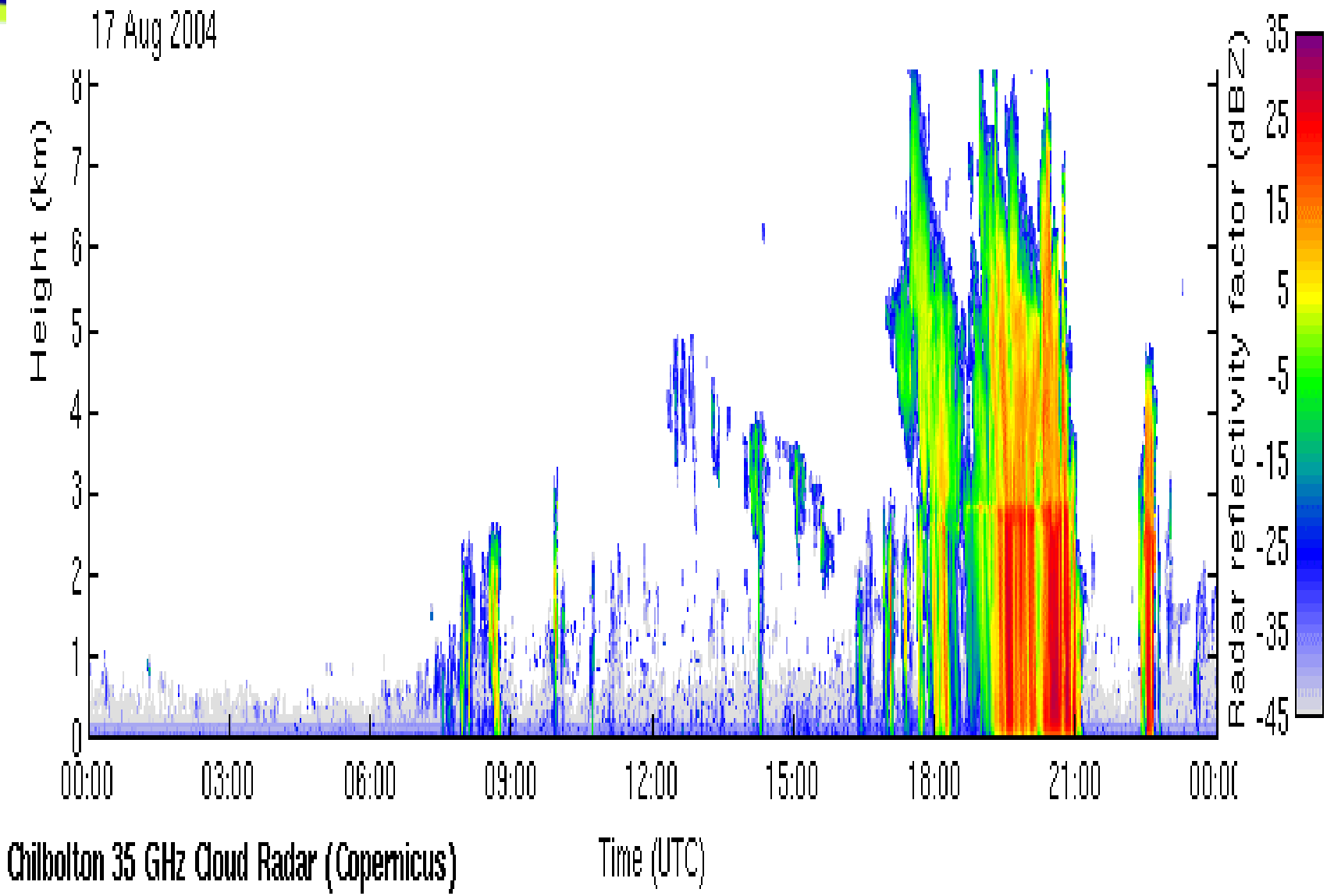
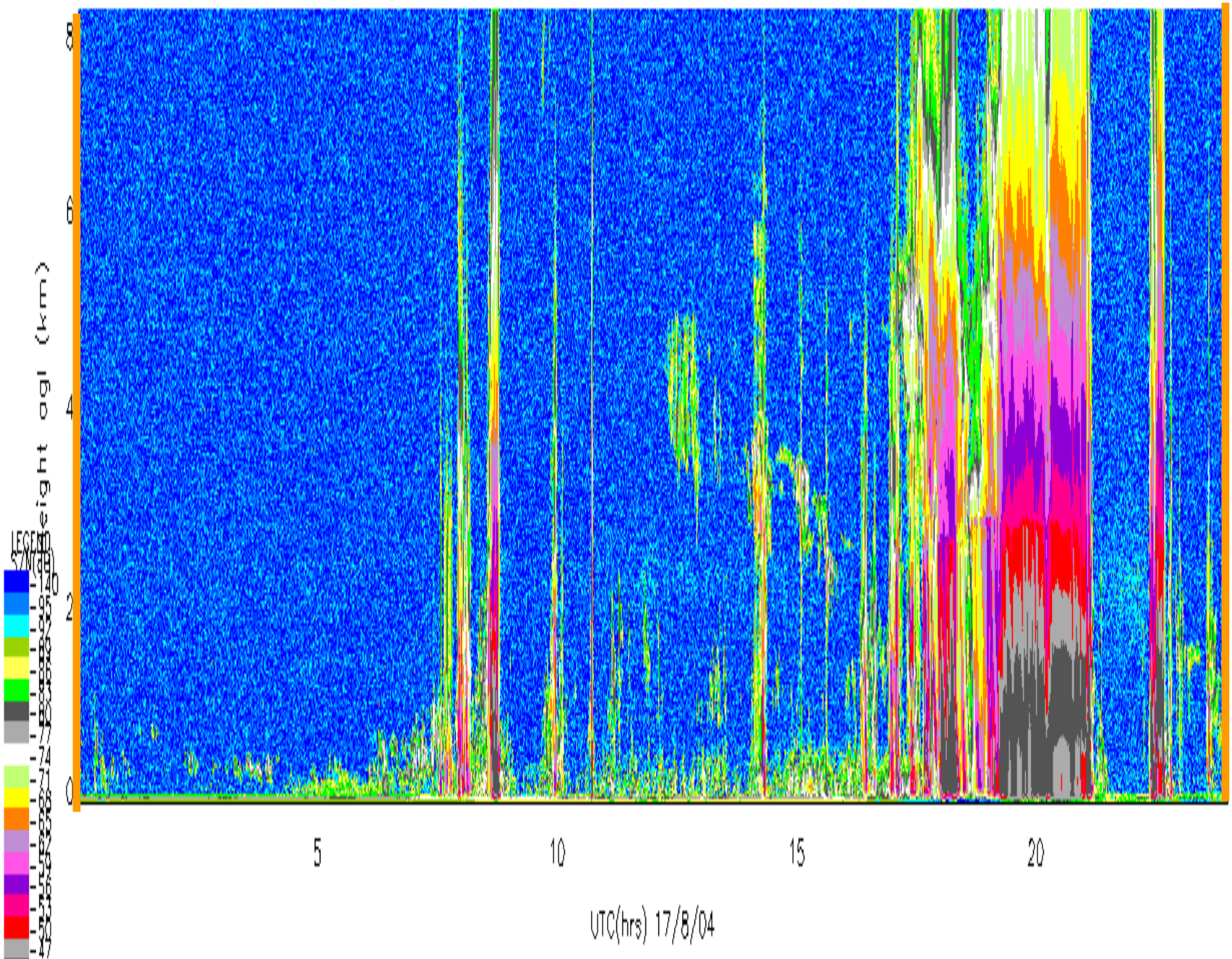
Radar reflectivity factor (dBZ)



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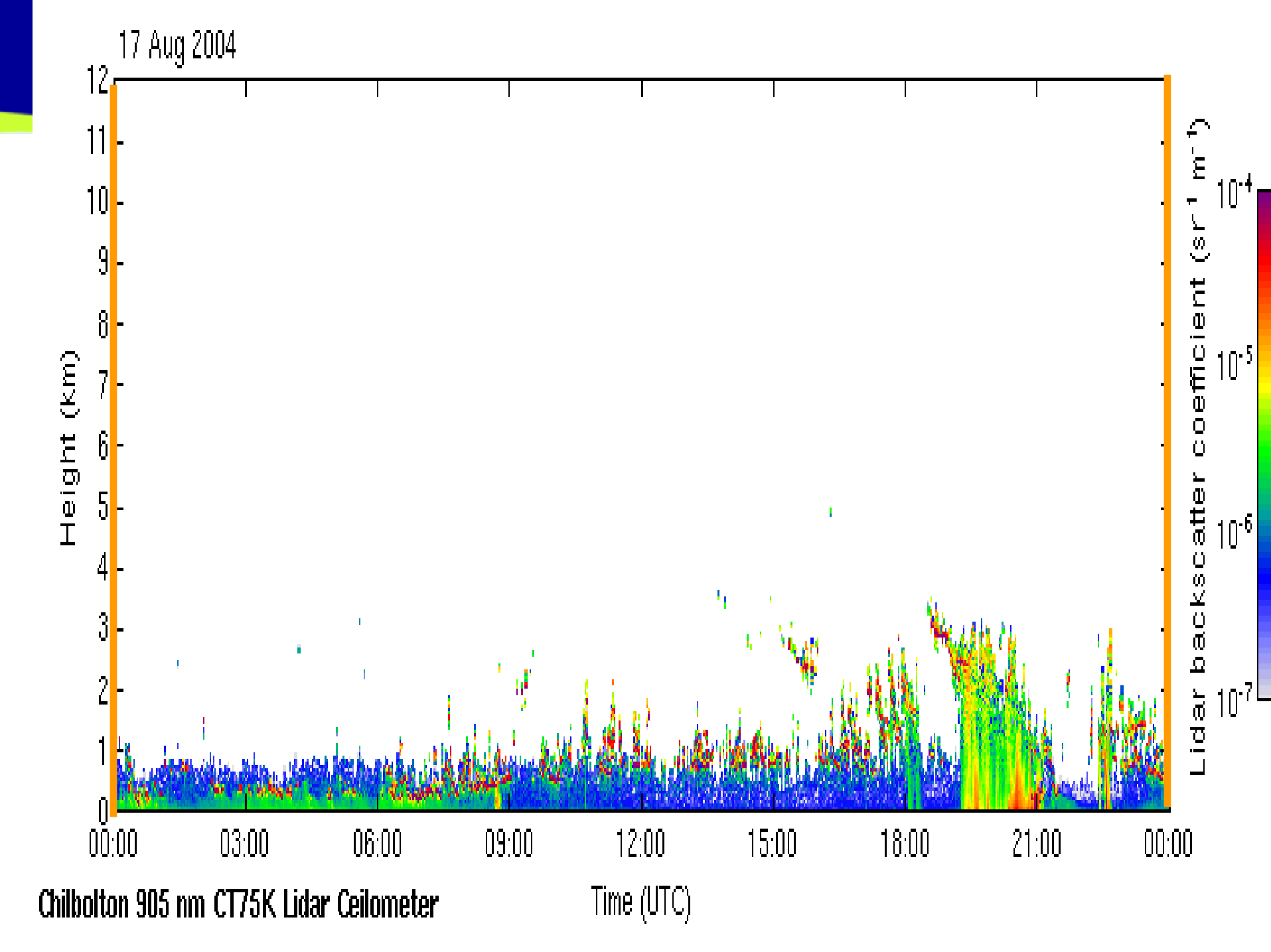
UTC(hrs) 17/8/04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Height (km)
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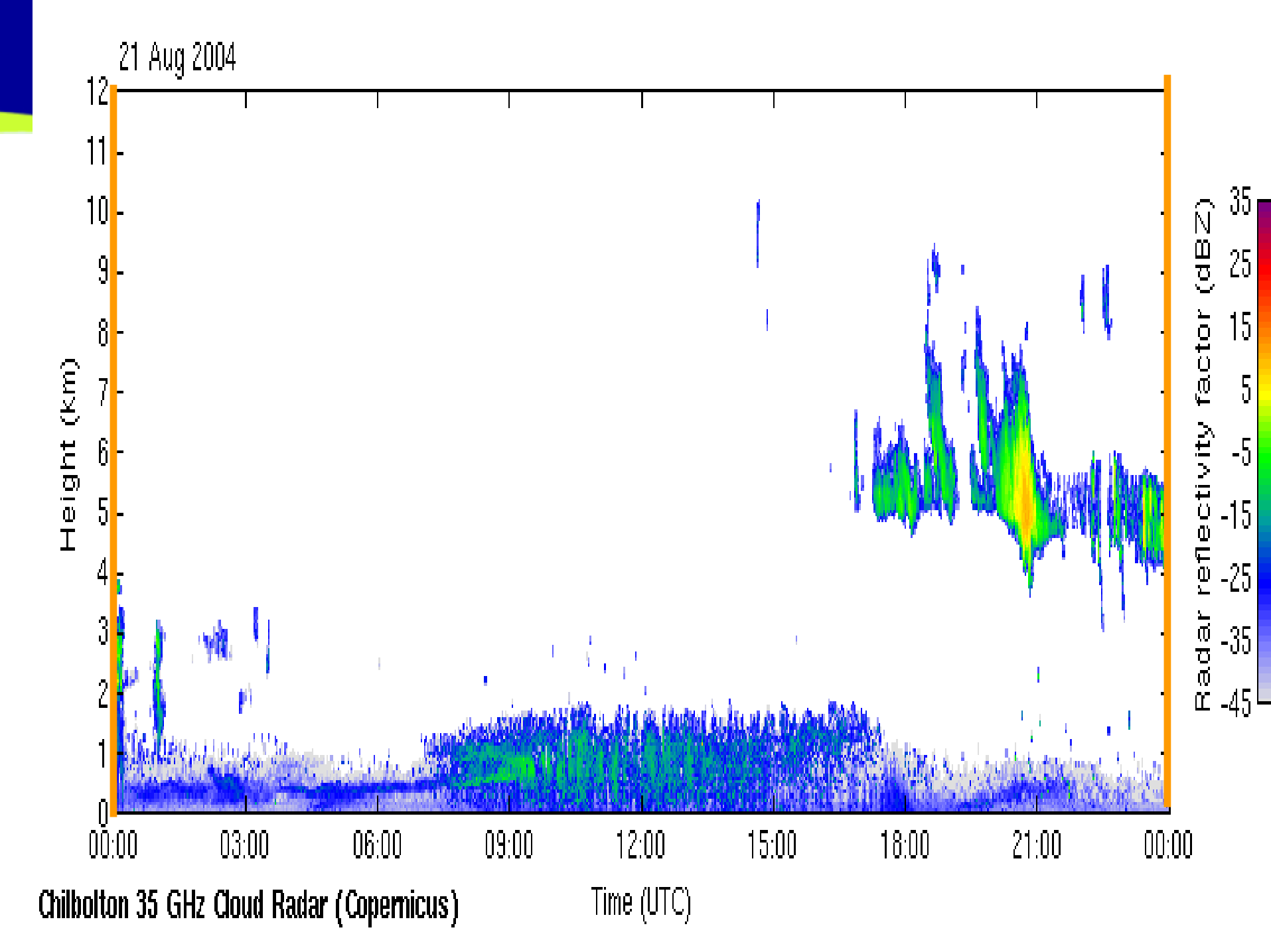
Time (UTC)
Lidar backscatter coefficient (sr⁻¹ m⁻¹)
10⁻⁴
10⁻⁵
10⁻⁶
10⁻⁷
Chilbolton 905 nm CT75K Lidar Ceilometer


21 Aug 2004
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Time (UTC)
Radar reflectivity factor (dBZ)
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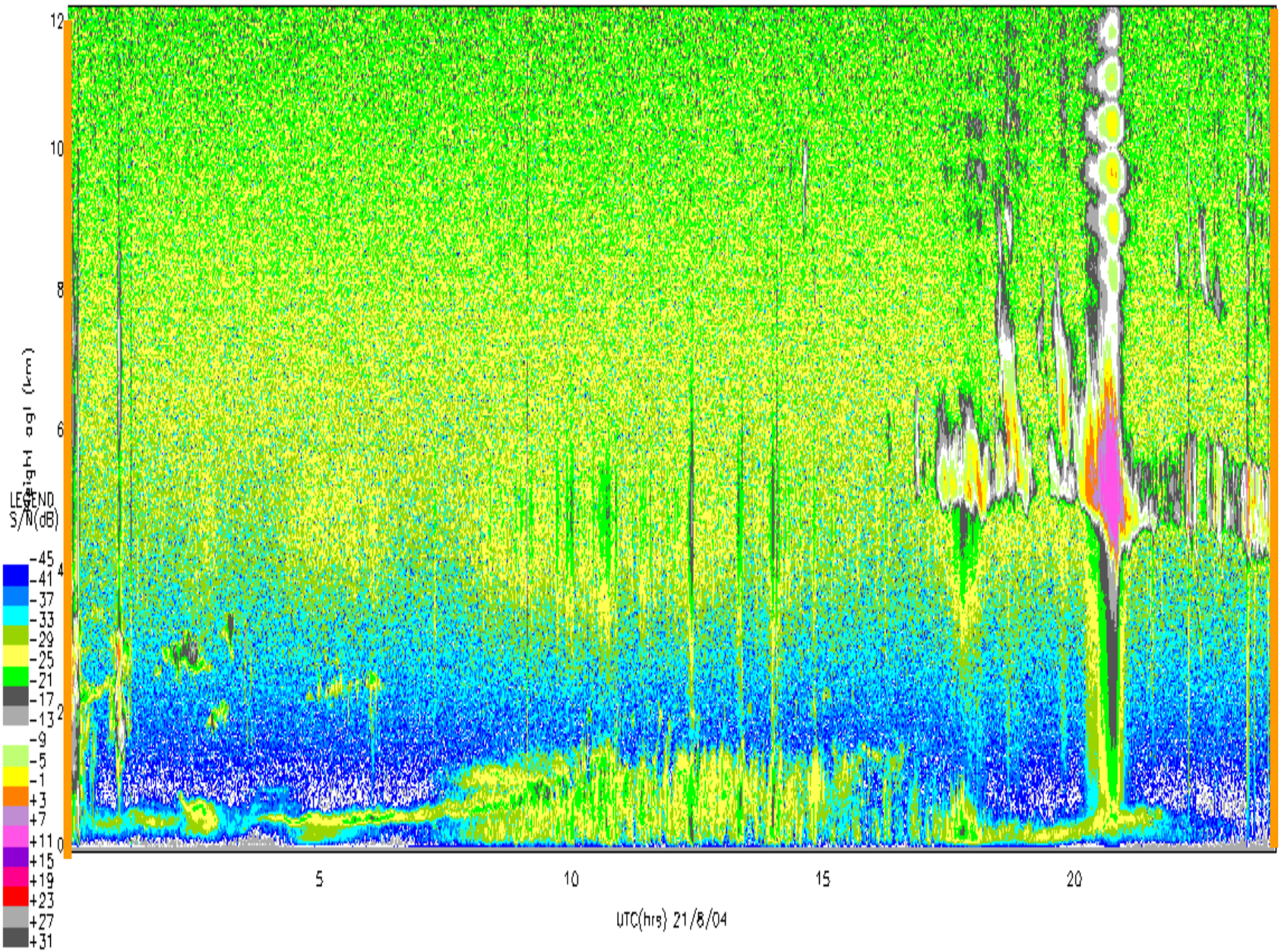
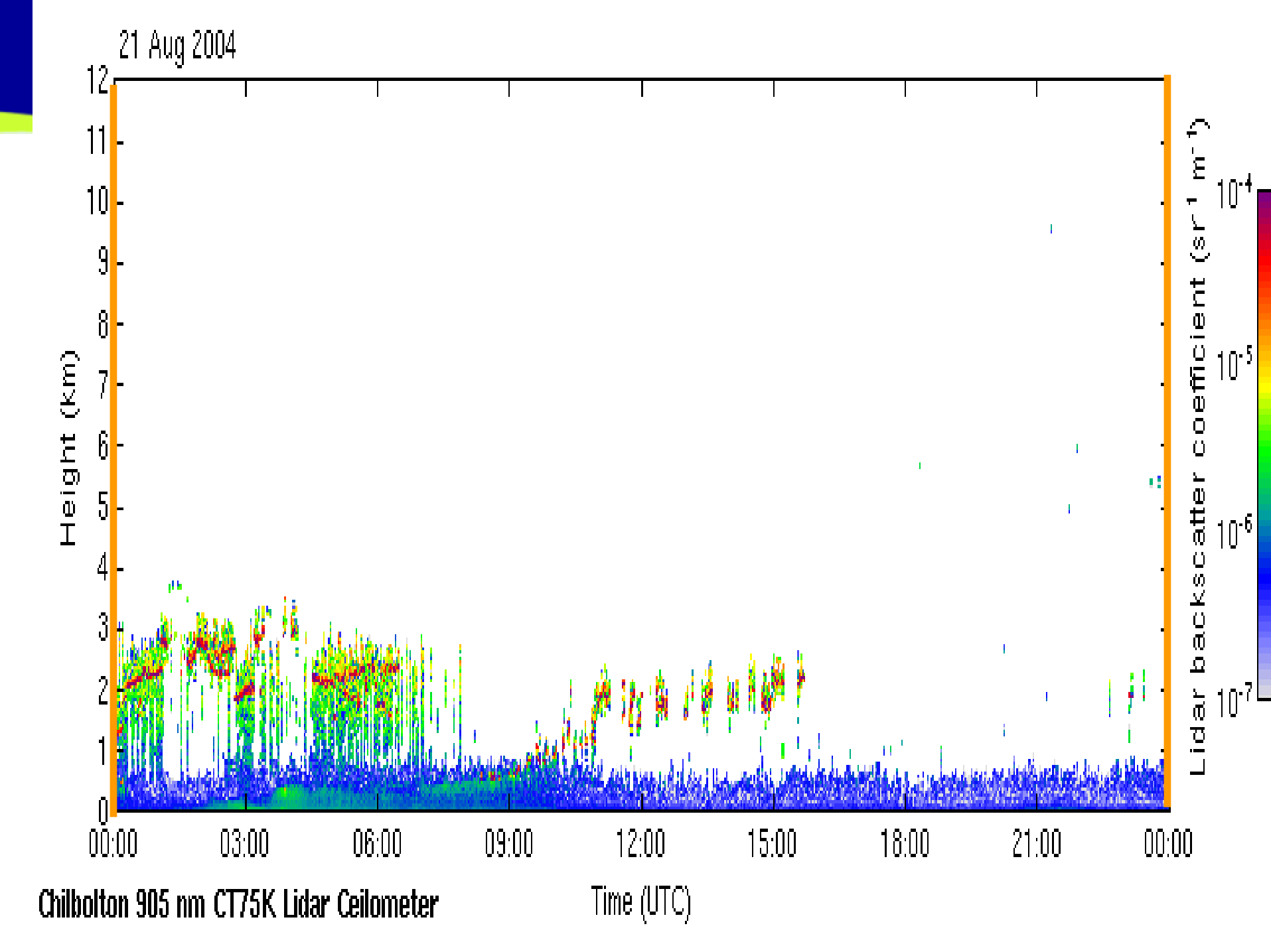
Chilbolton 35 GHz Cloud Radar (Copernicus)




21 Aug 2004
Height (km)
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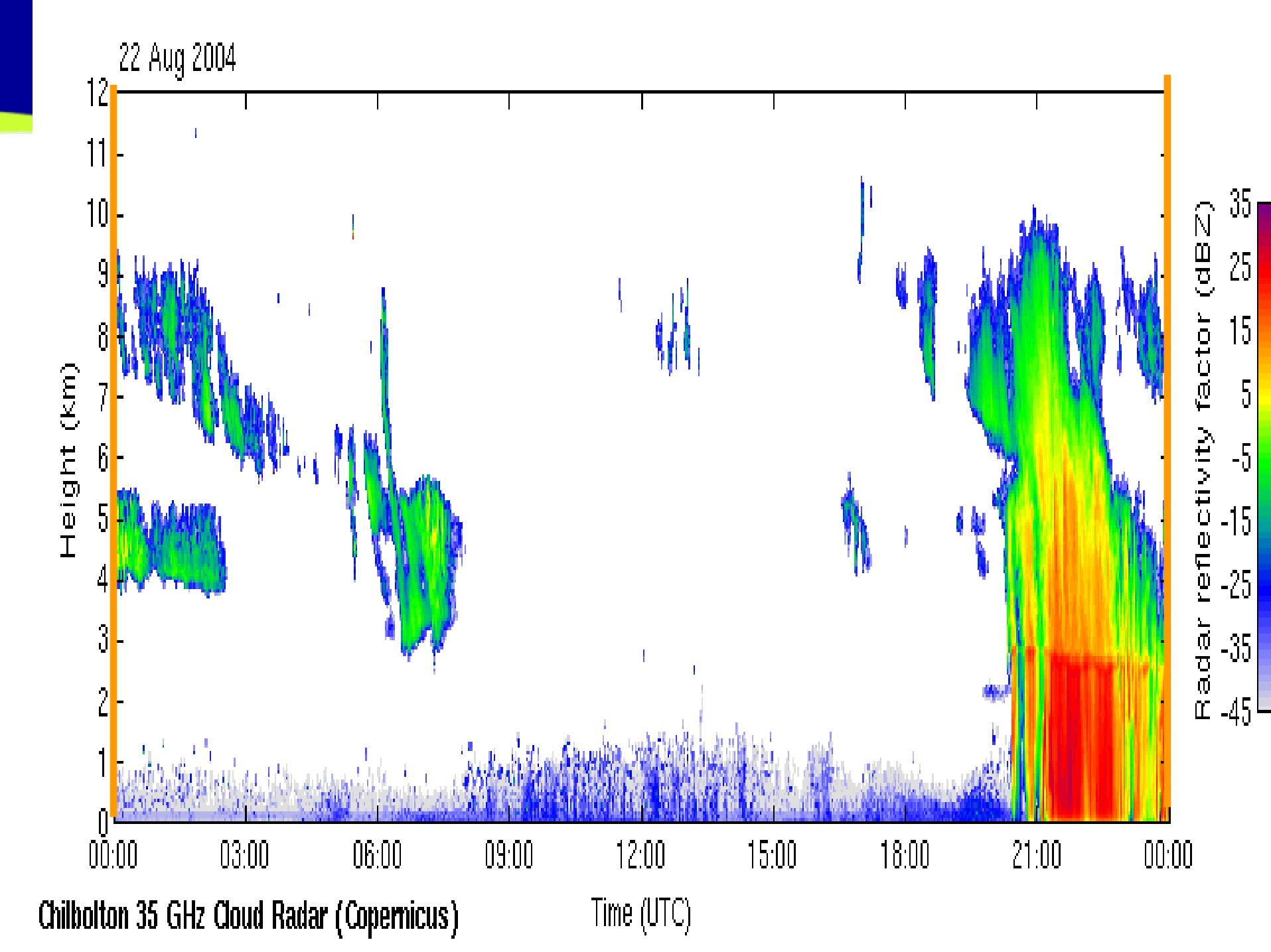
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Time (UTC)
Radar reflectivity factor (dBZ)
35
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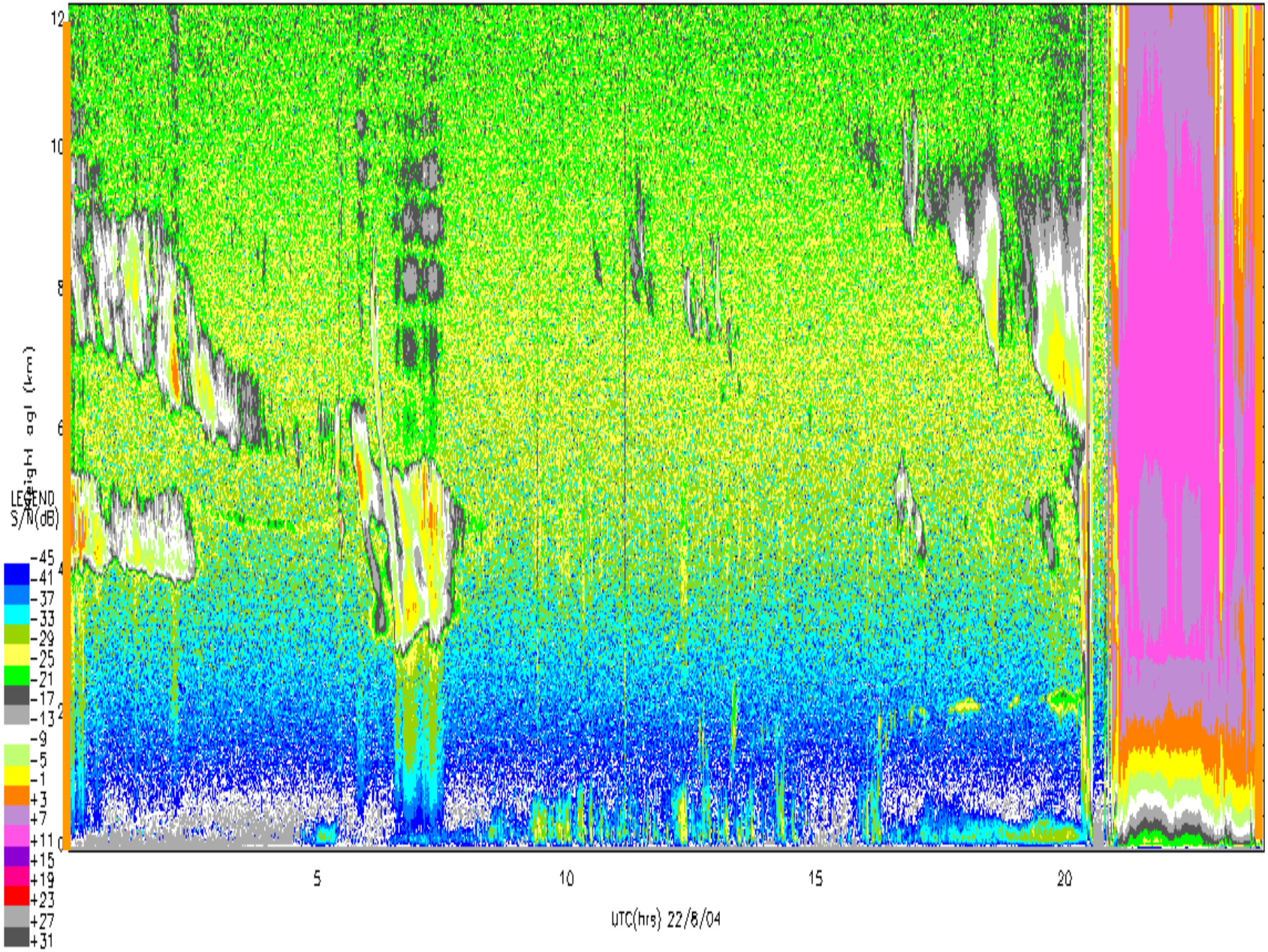

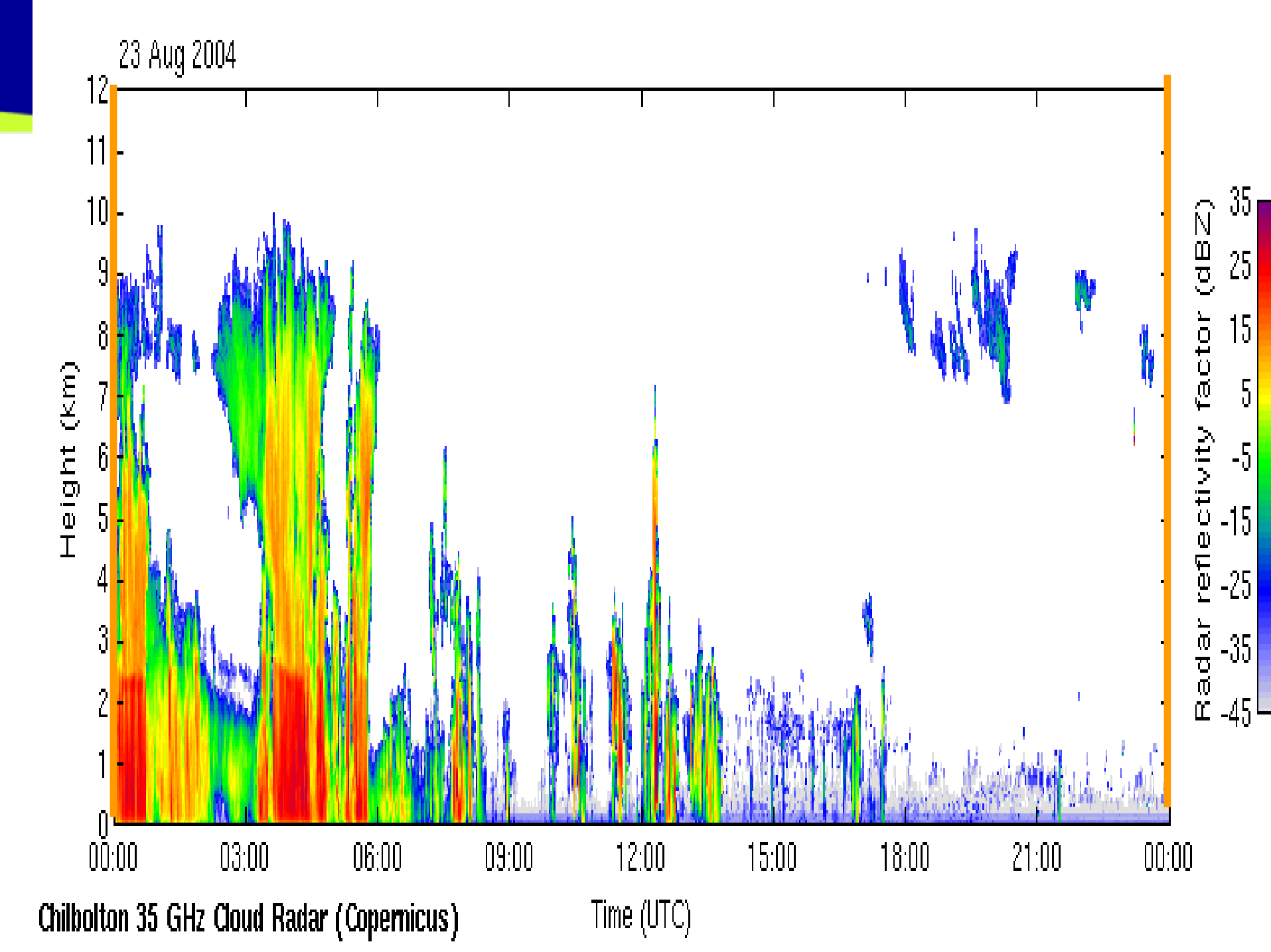
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Height (km)
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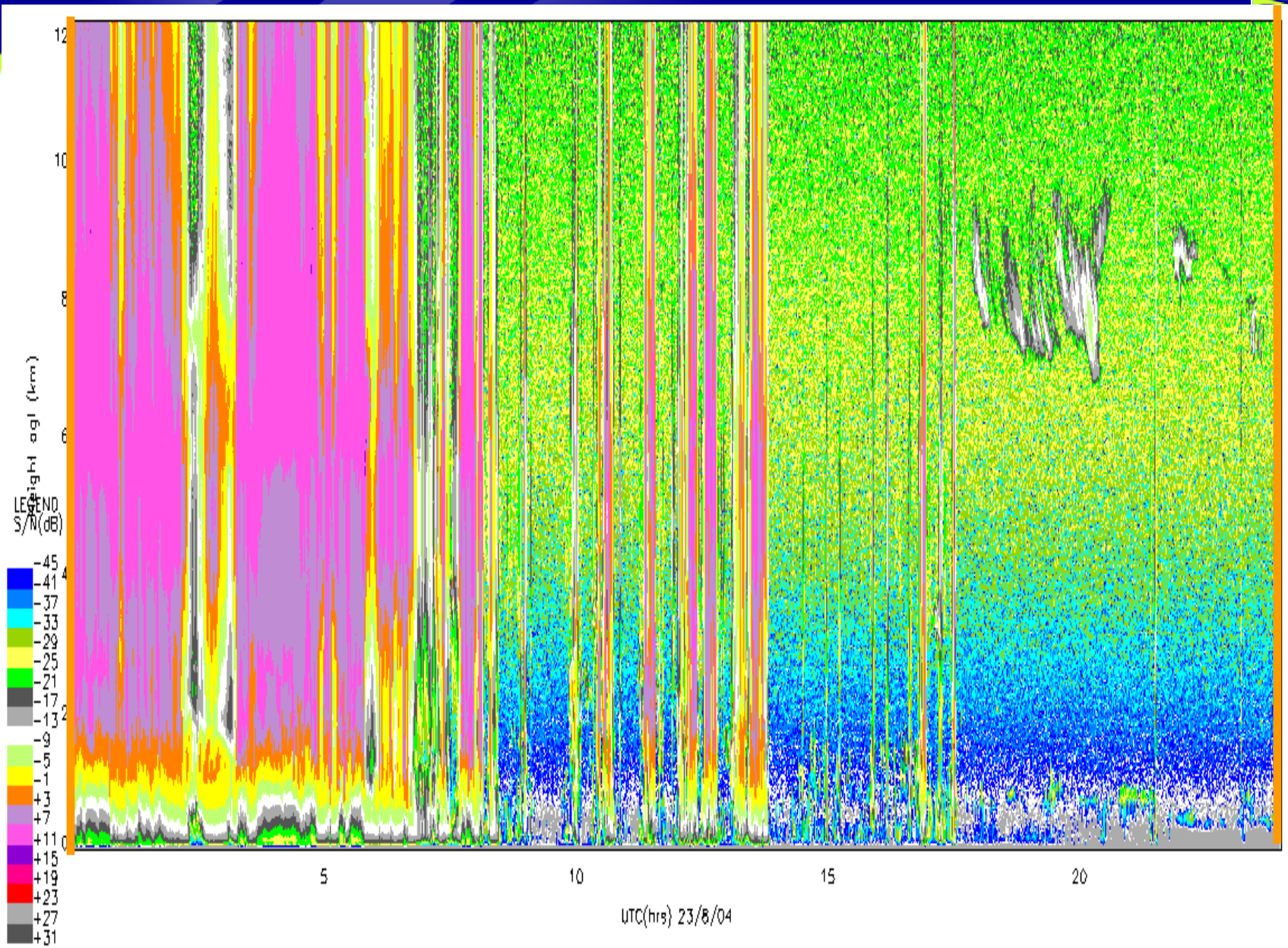

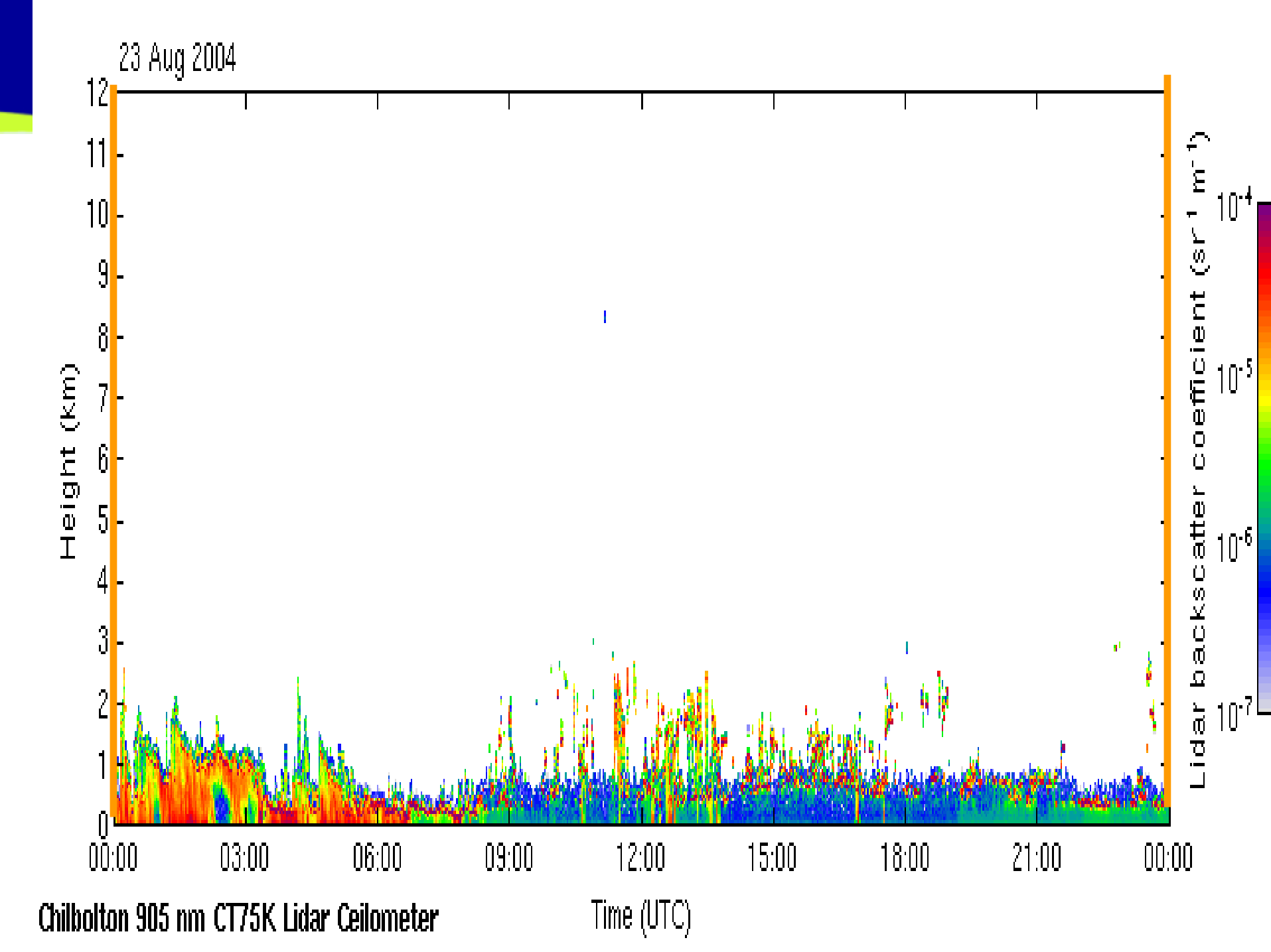
23 Aug 2004
Height (km)
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00:00
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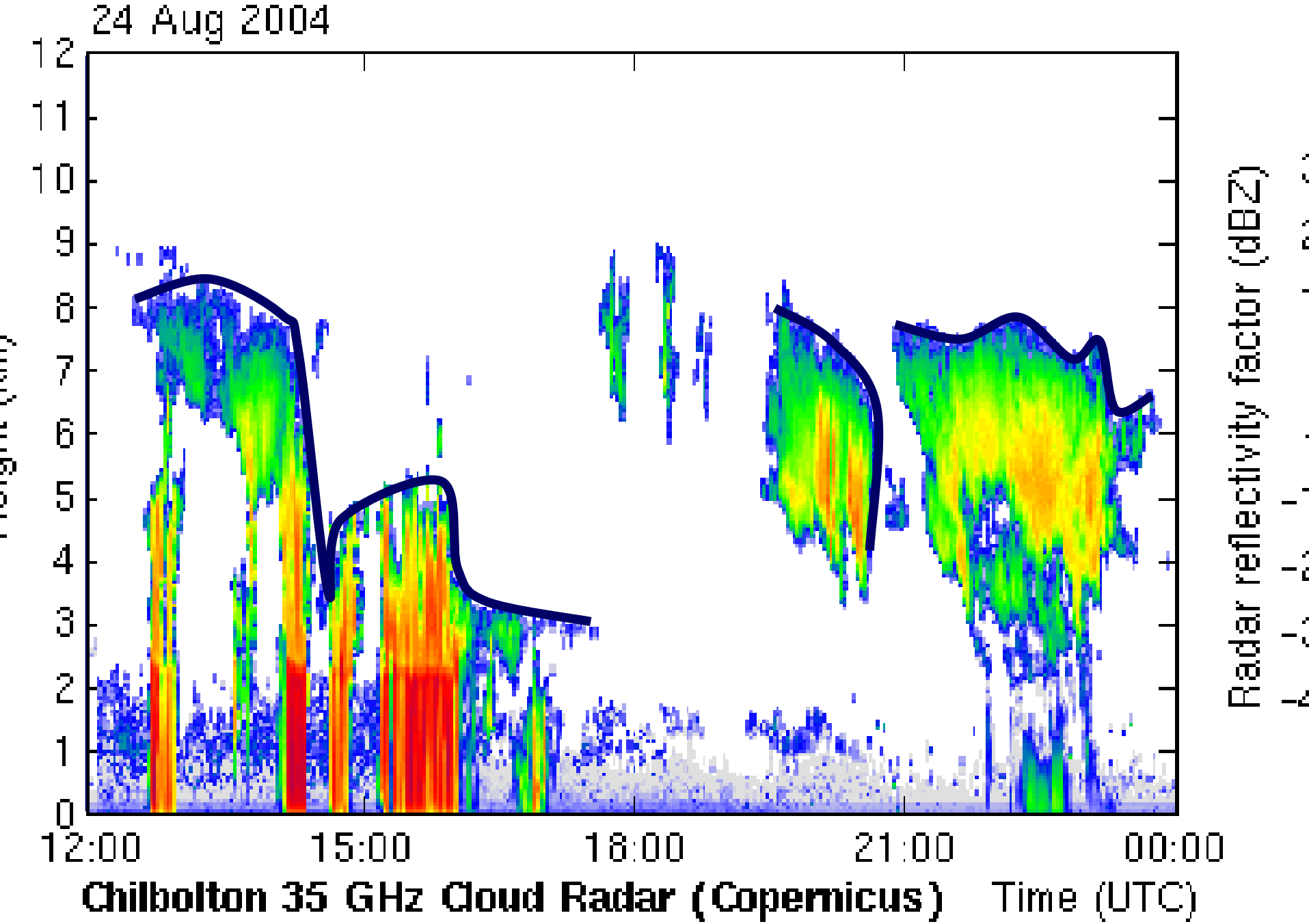
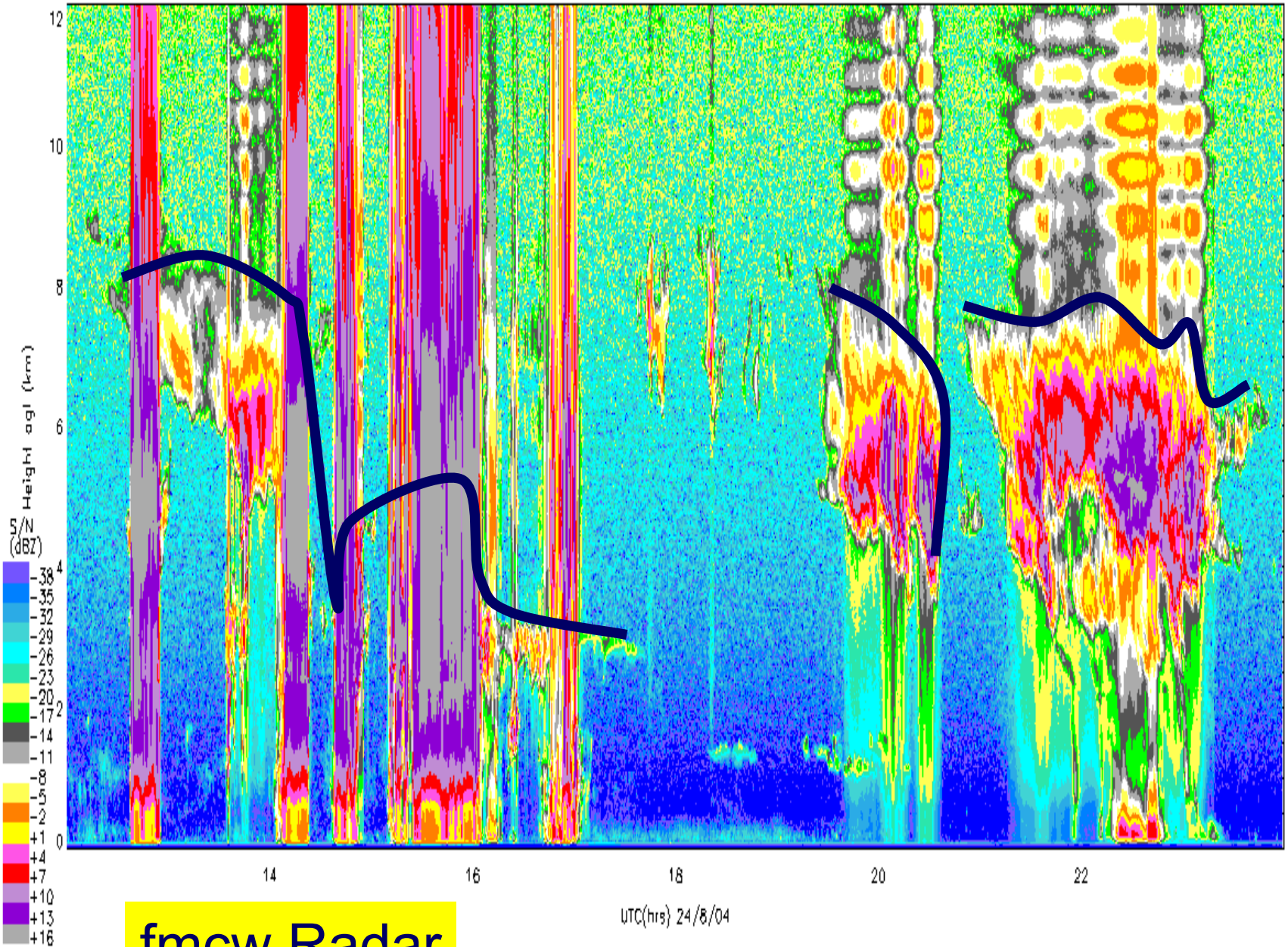
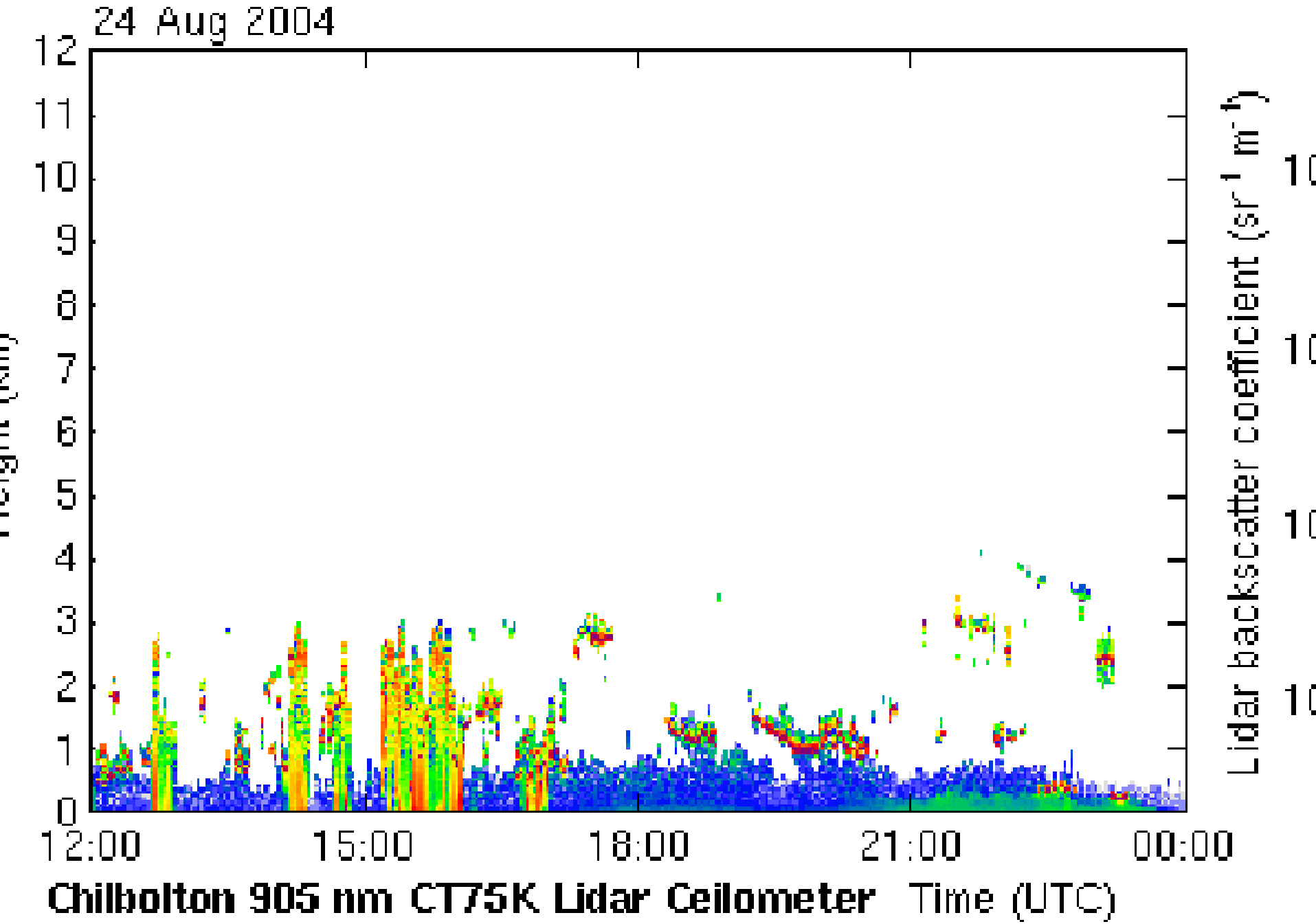
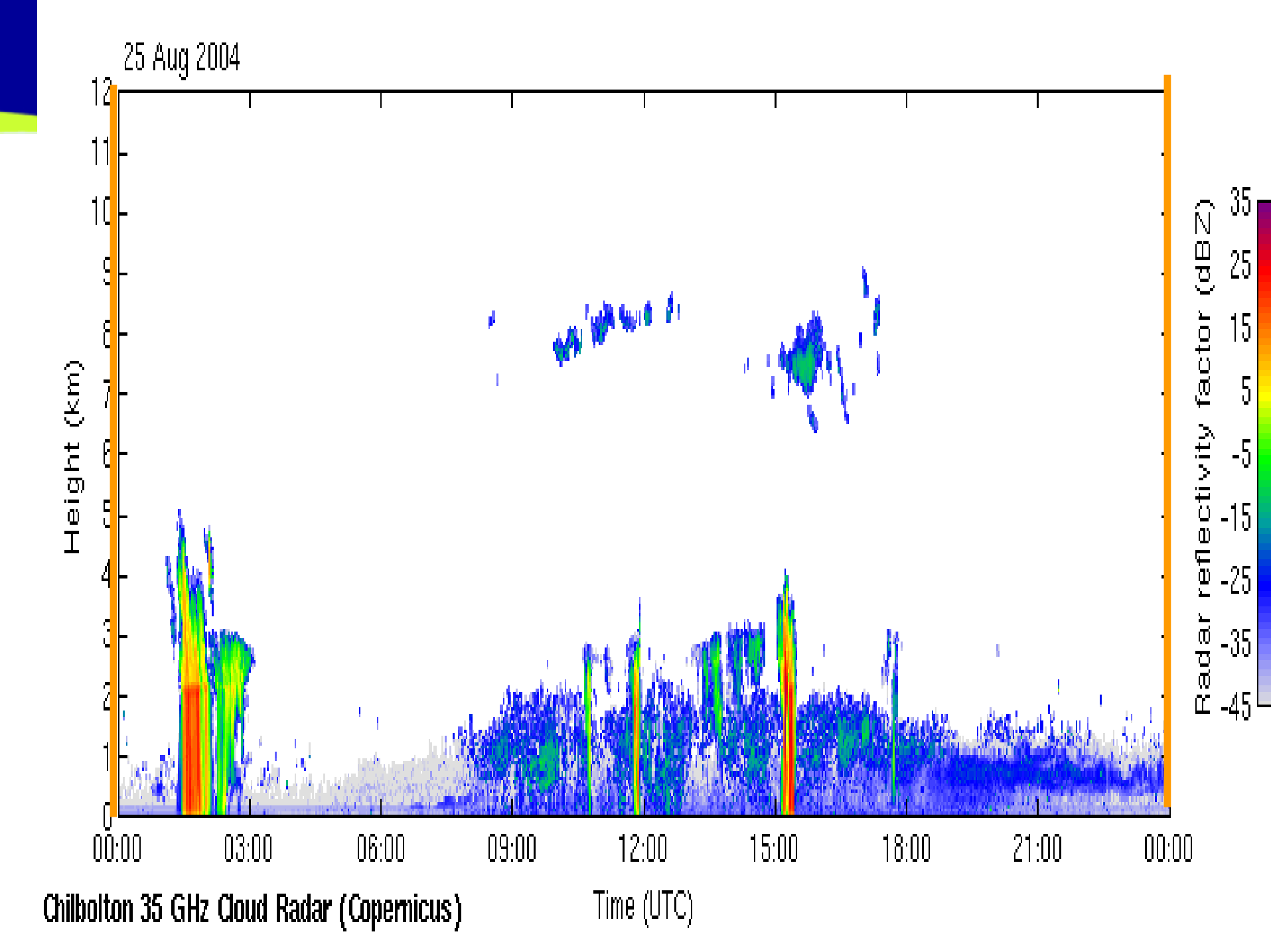




fmcw Radar




25 Aug 2004
Height (km)
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Time (UTC)
Radar reflectivity factor (dBZ)
35
25
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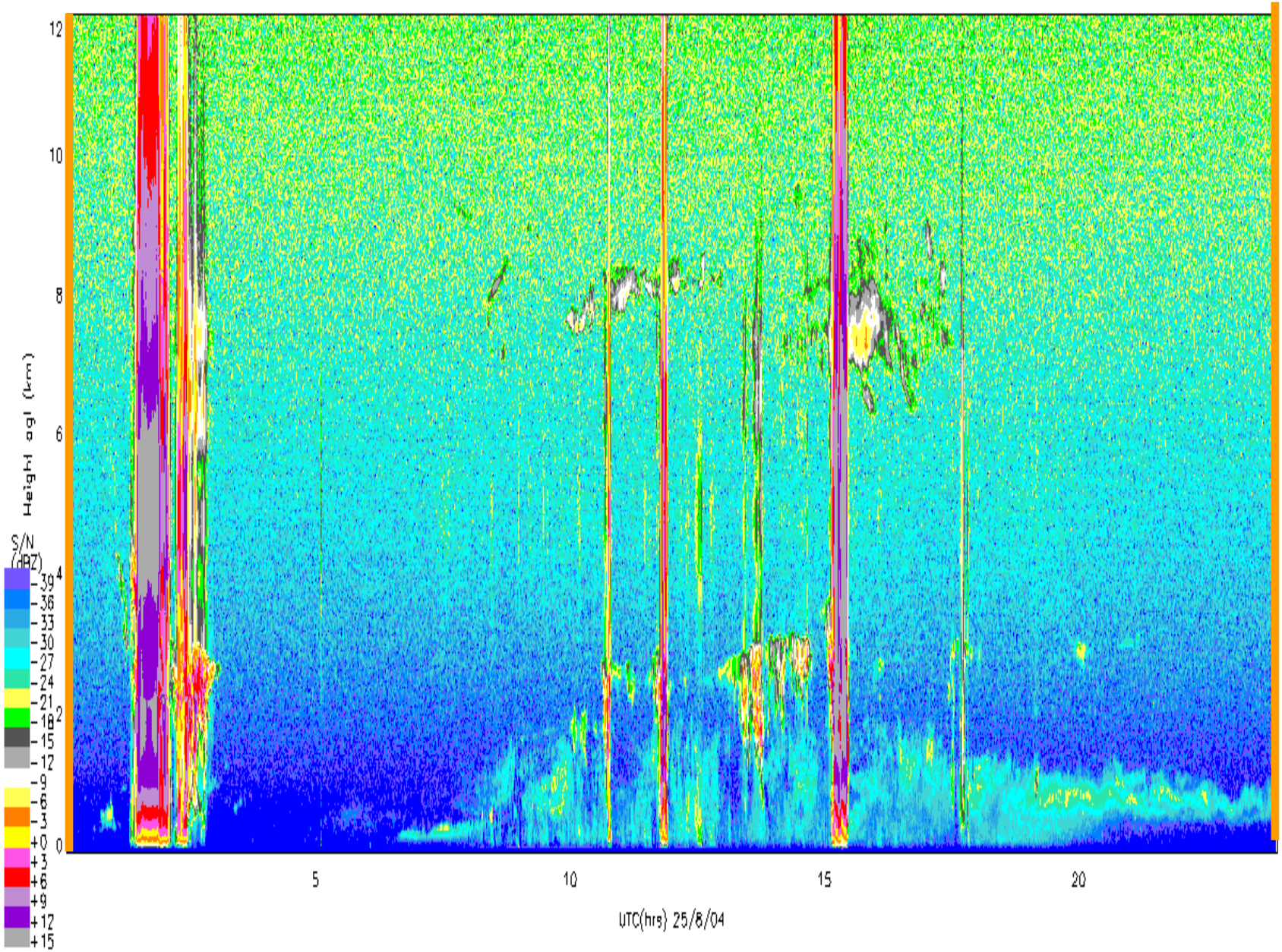
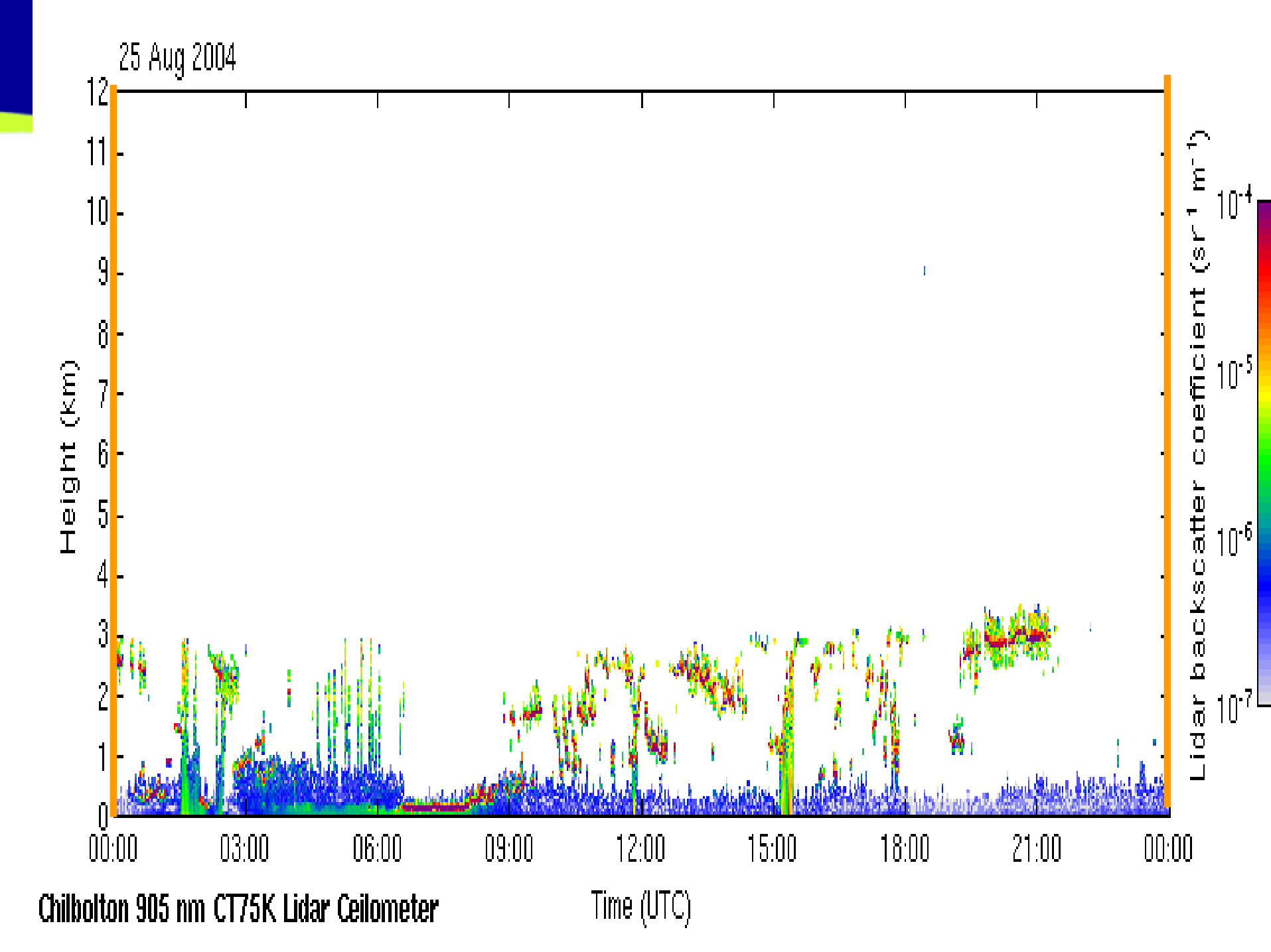
-45
Chilbolton 35 GHz Cloud Radar (Copernicus)




25 Aug 2004
Height (km)
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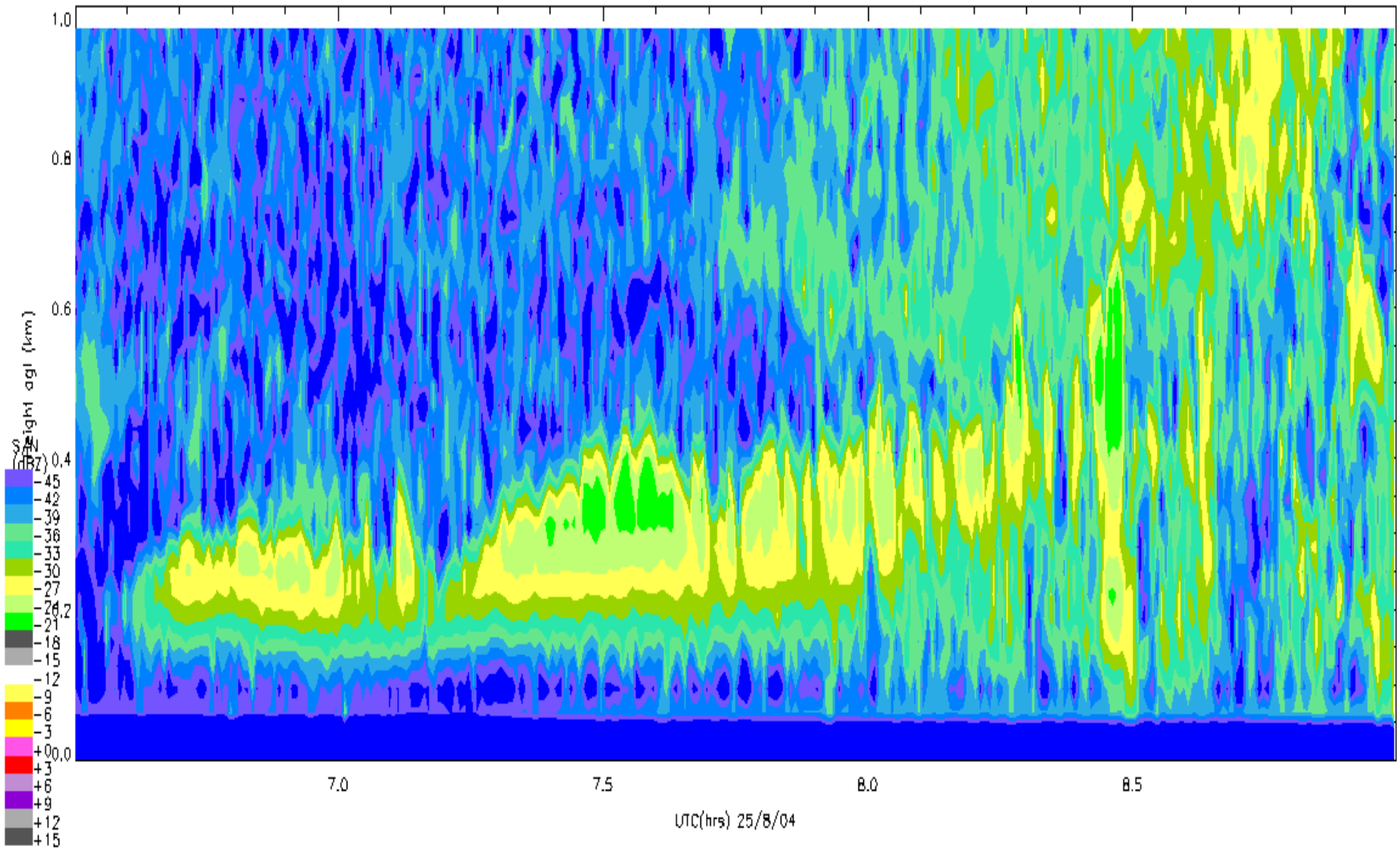

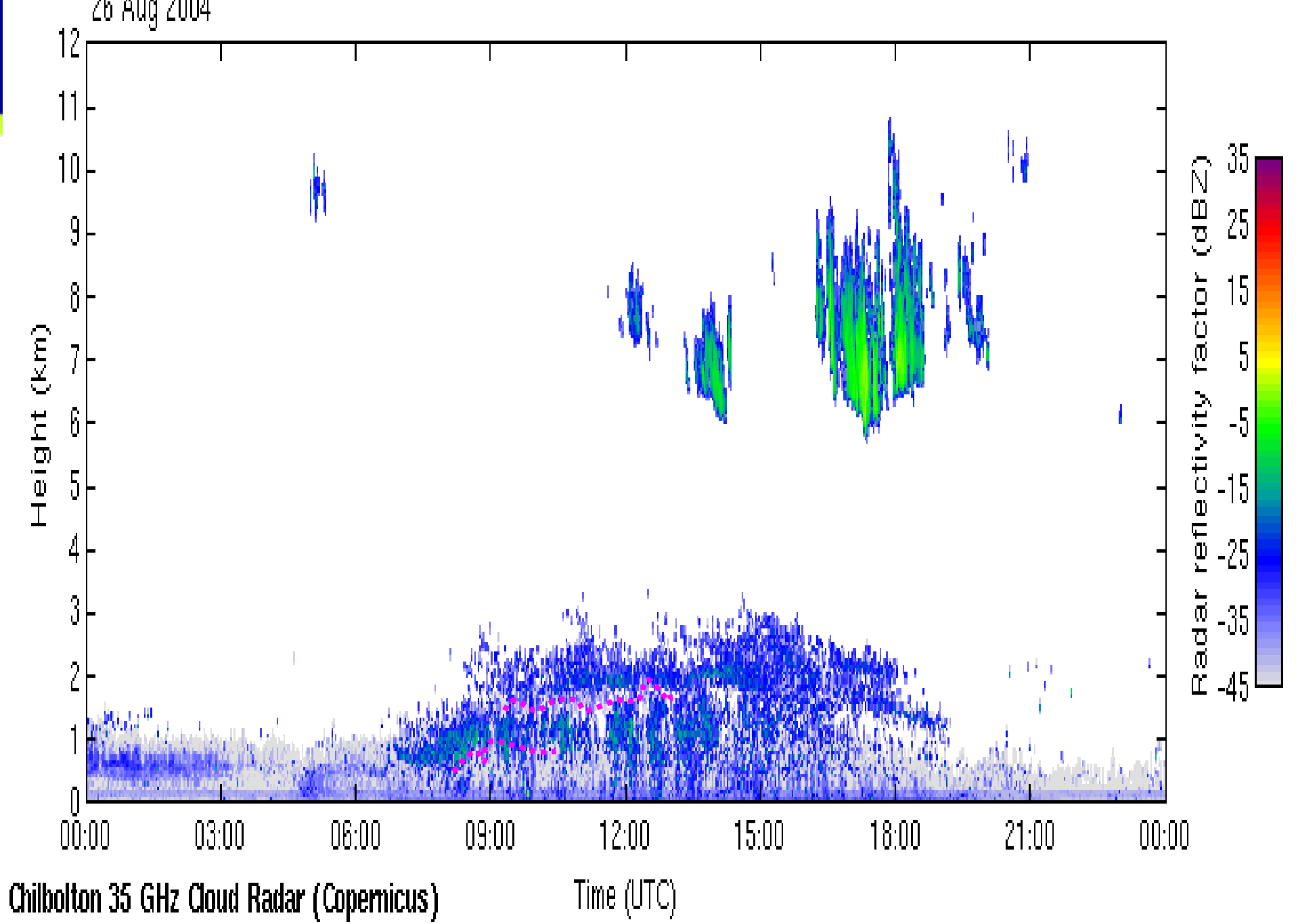

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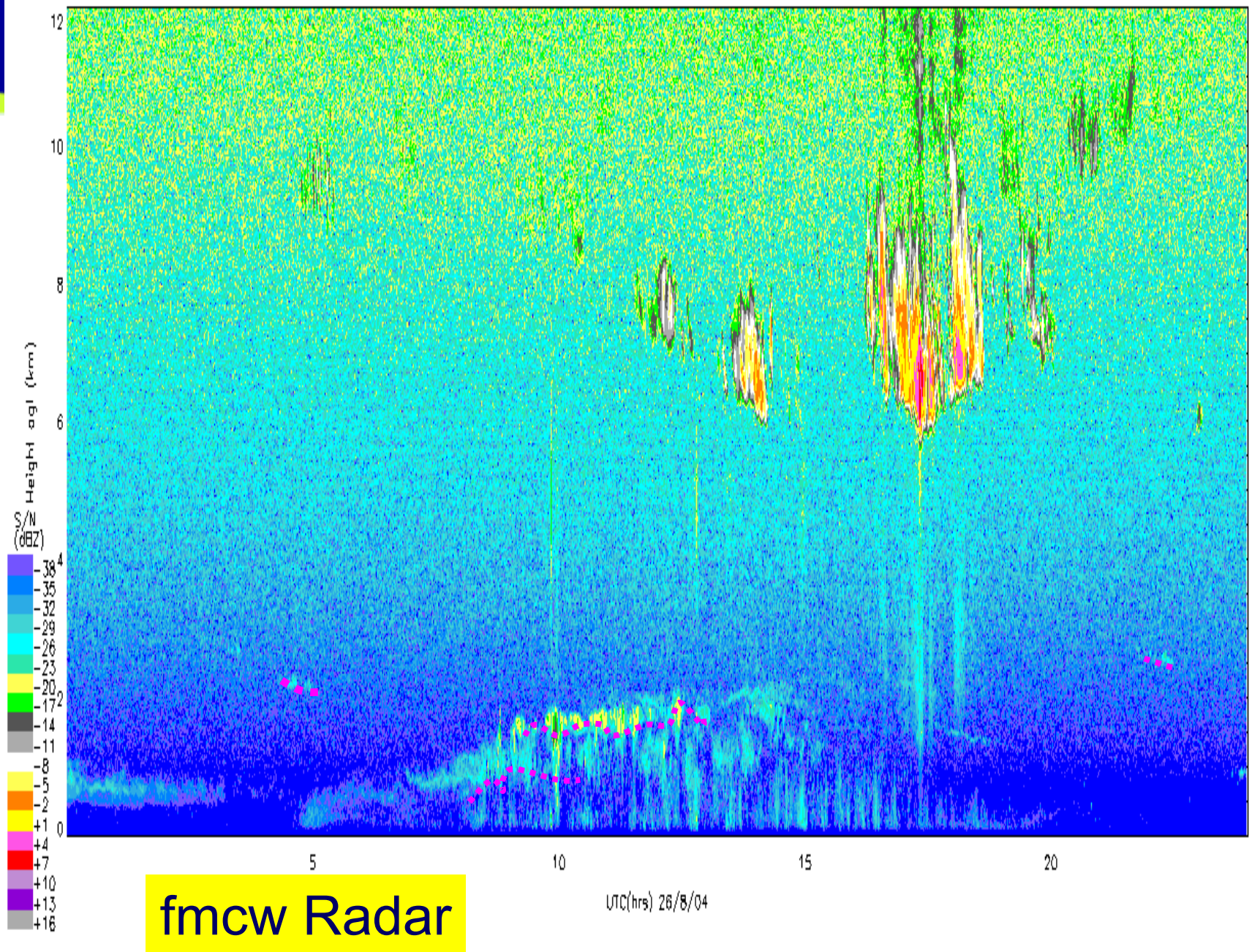
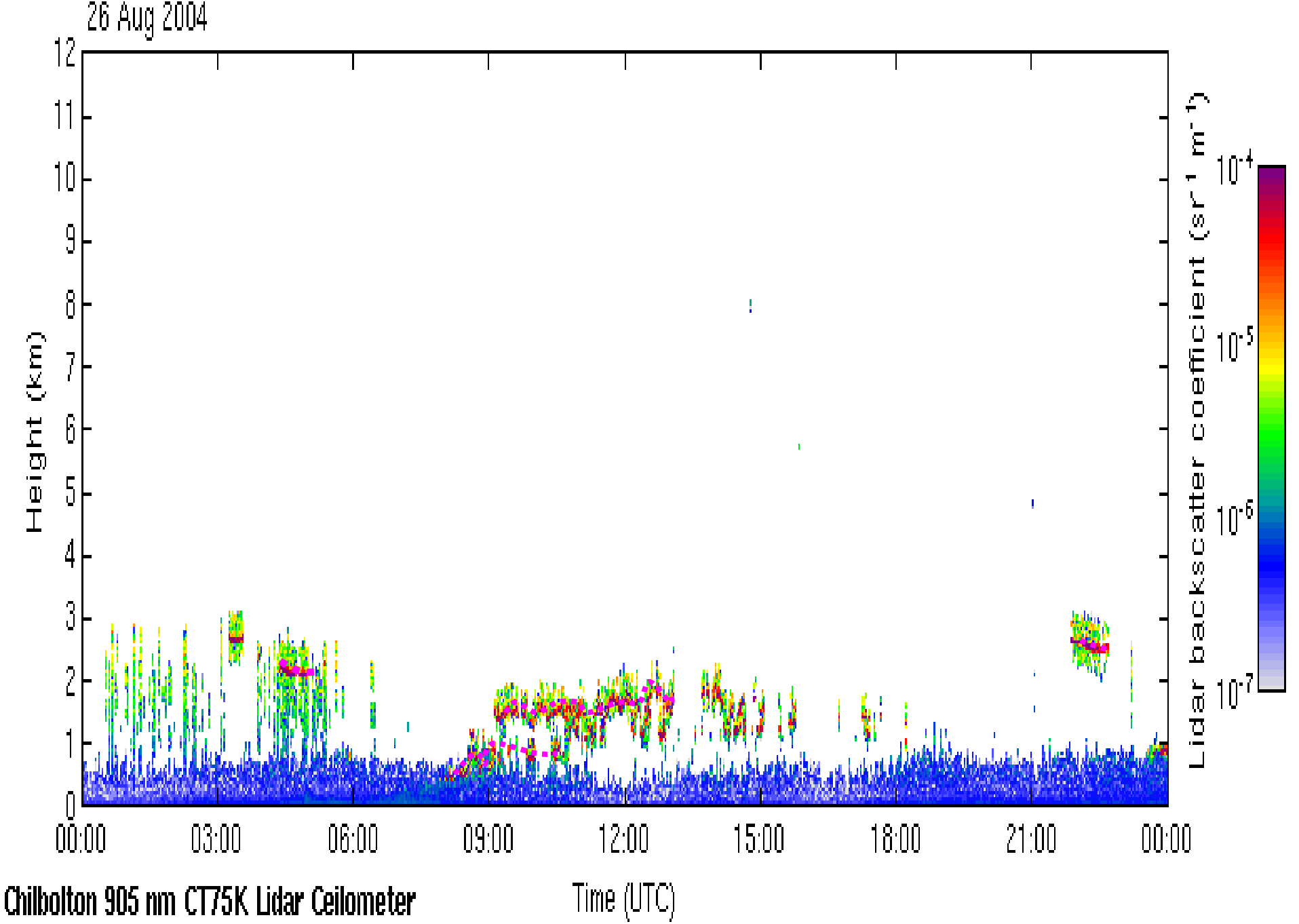
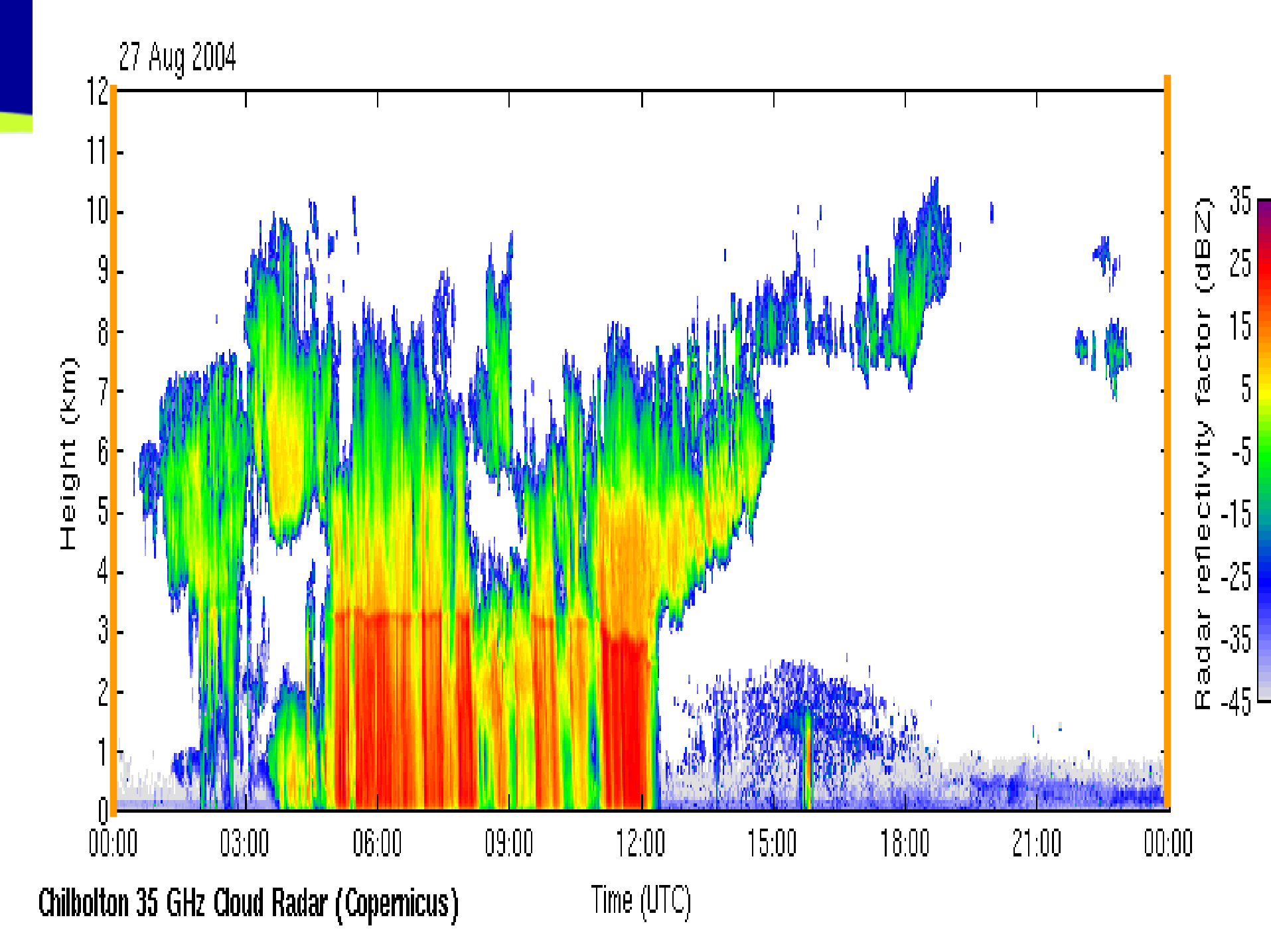


fmcw Radar

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Time (UTC)
Radar reflectivity factor (dBZ)
35
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-15
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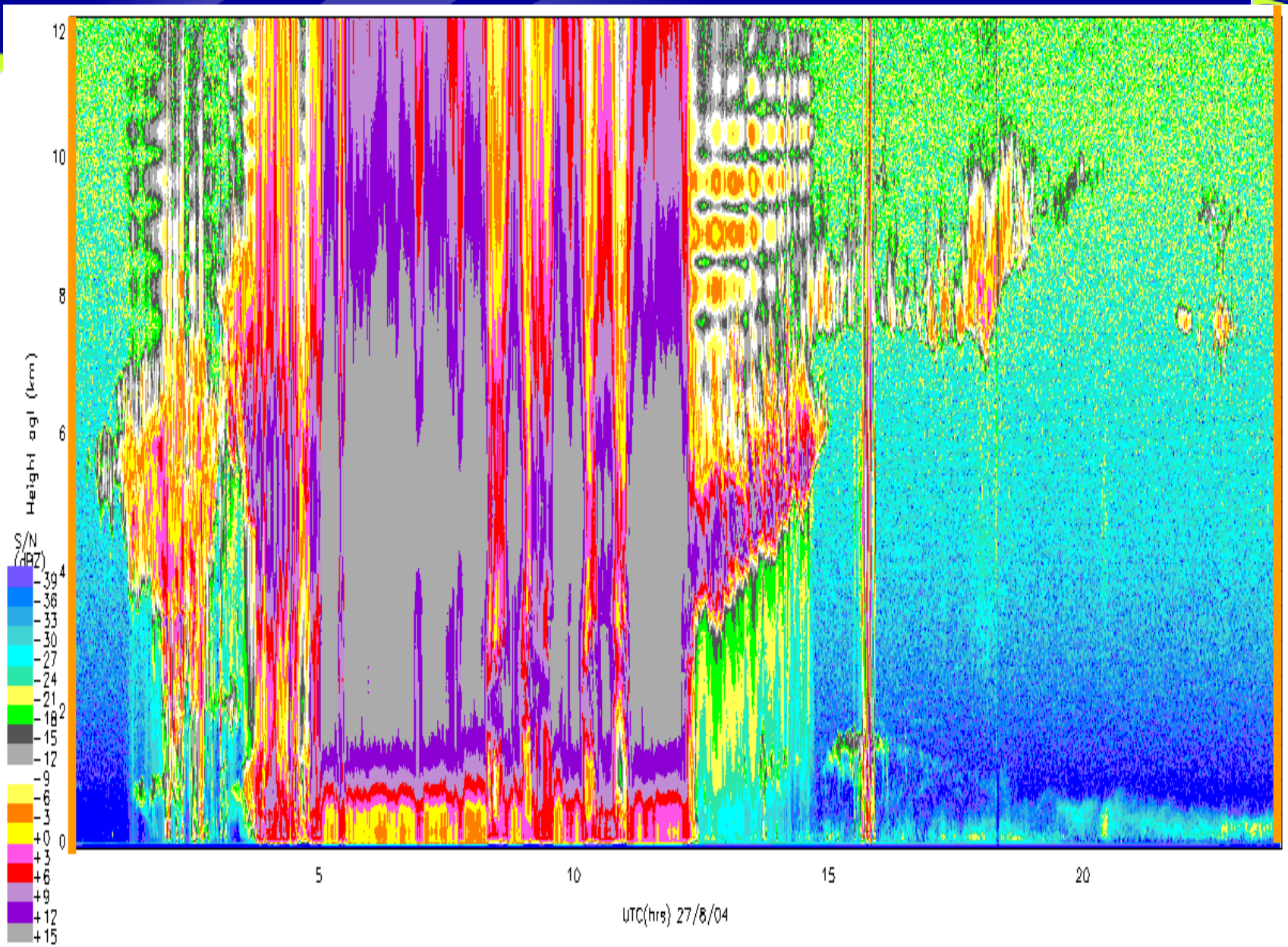

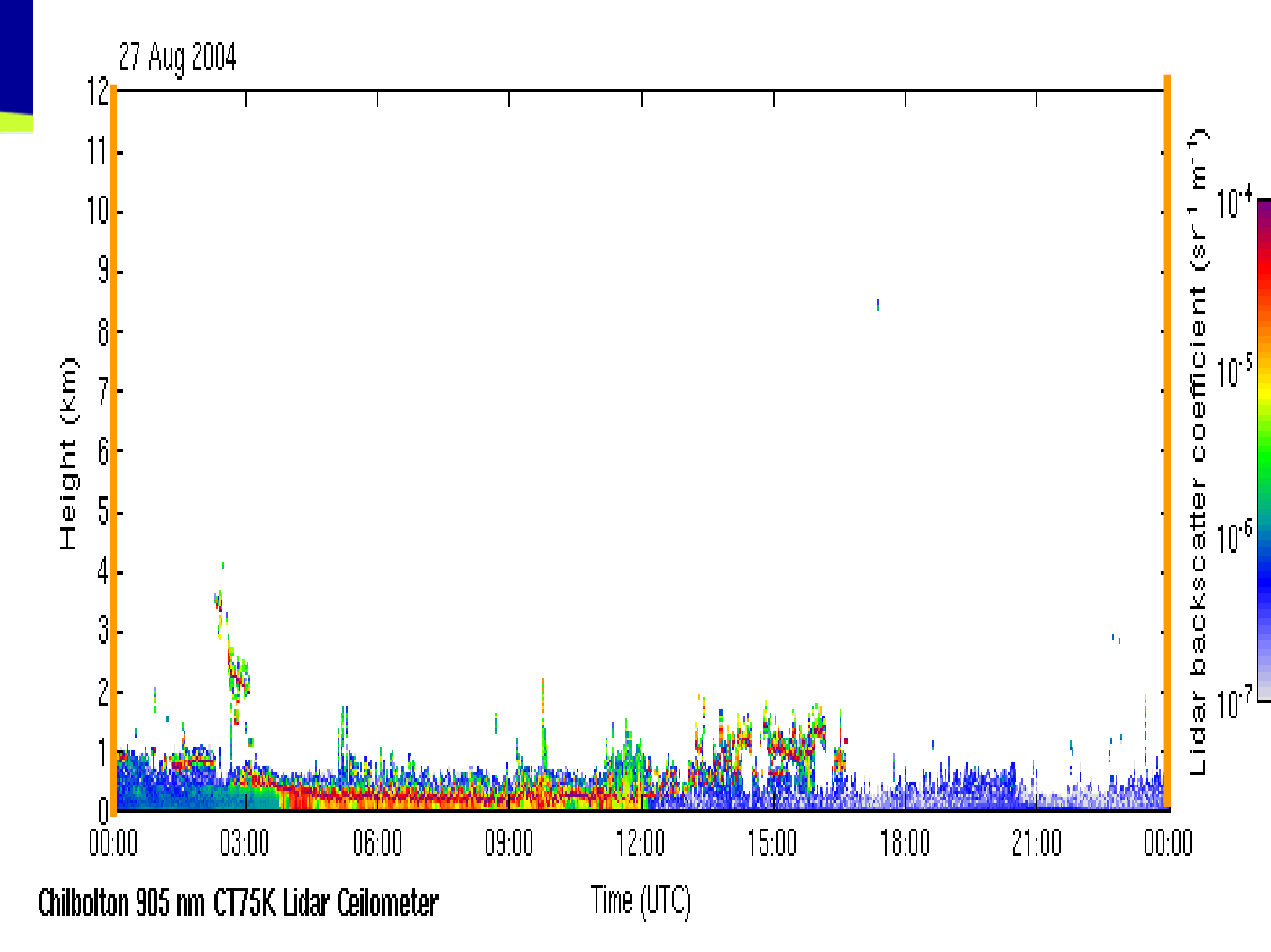
27 Aug 2004
Height (km)
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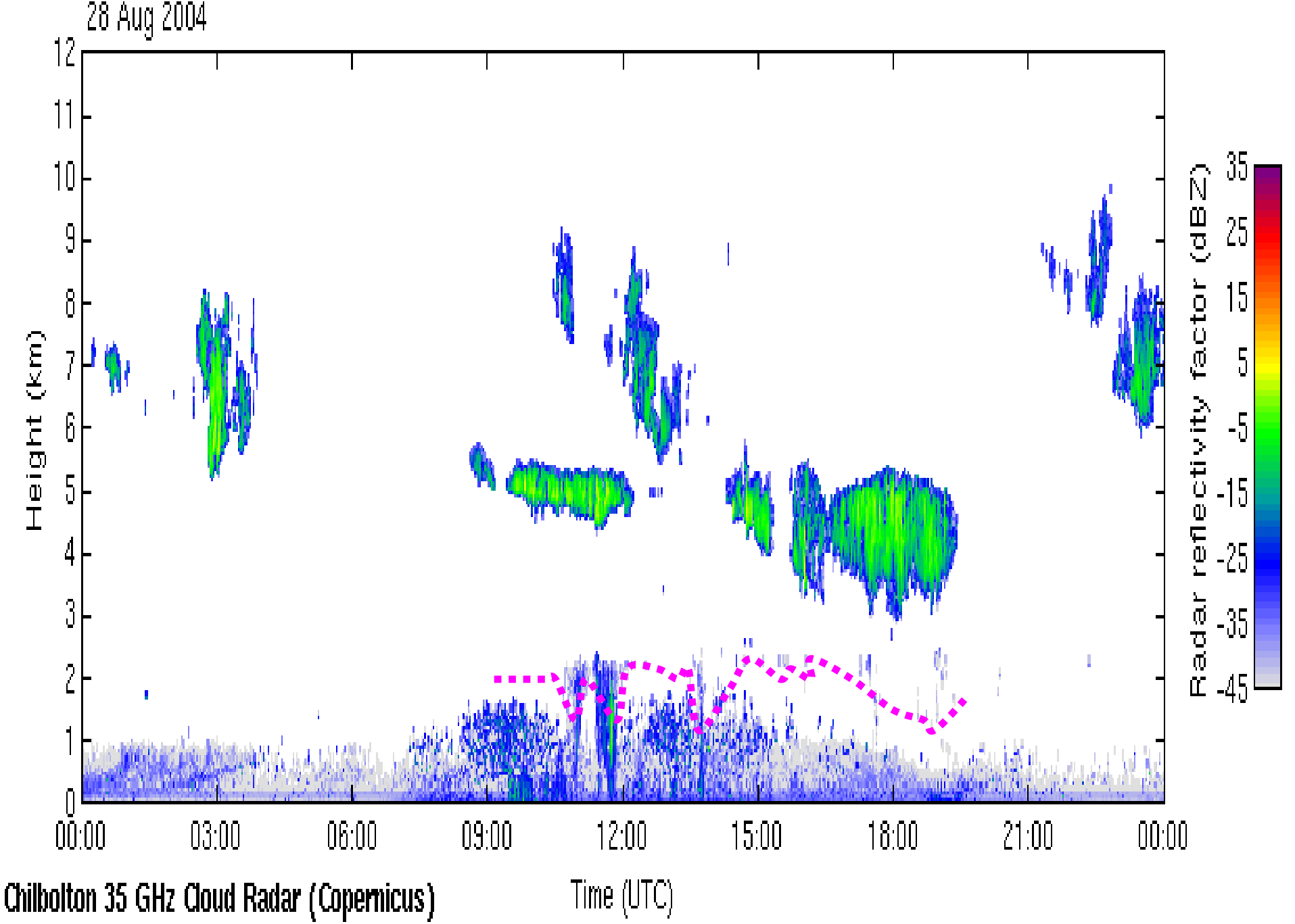
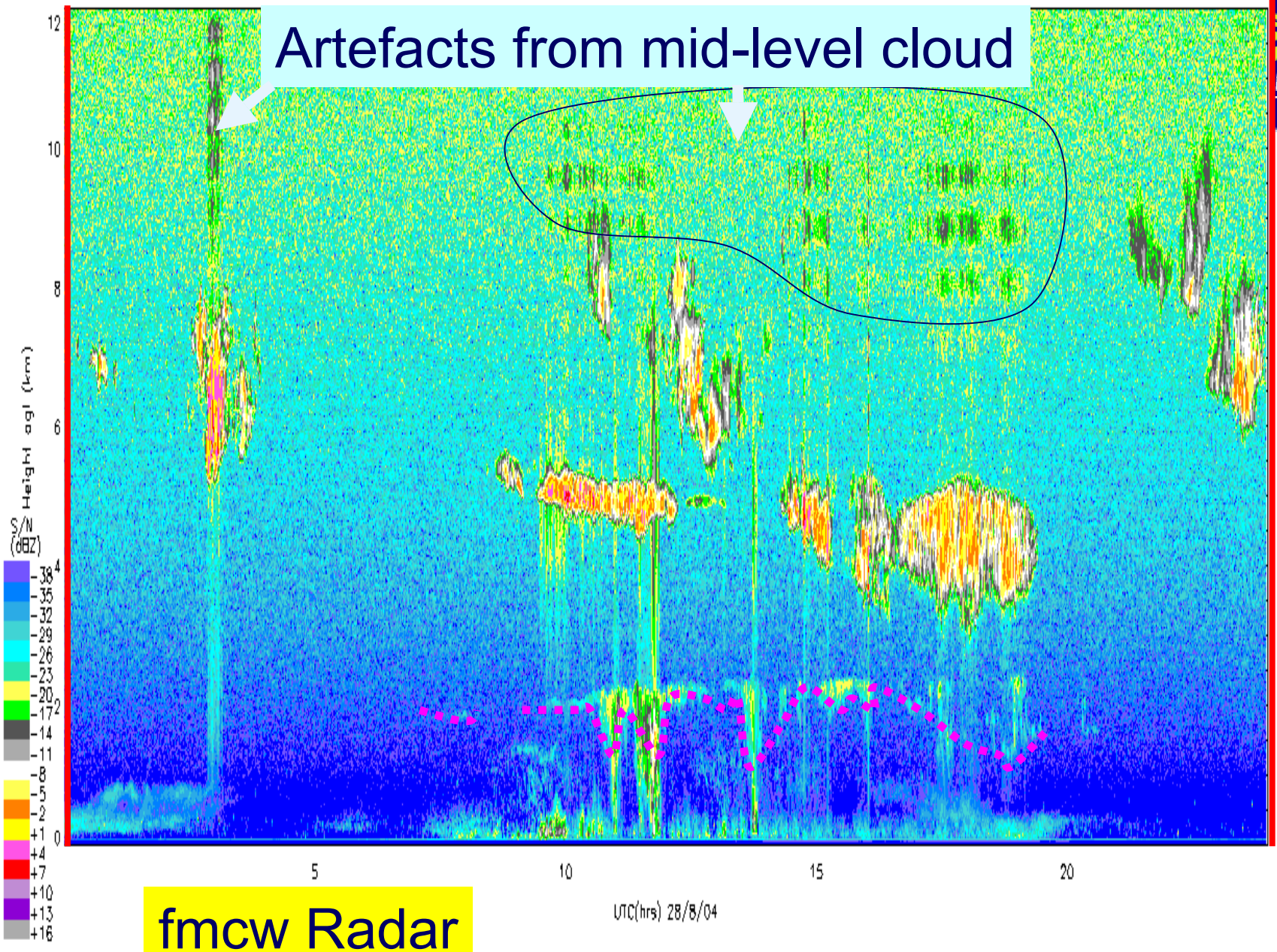
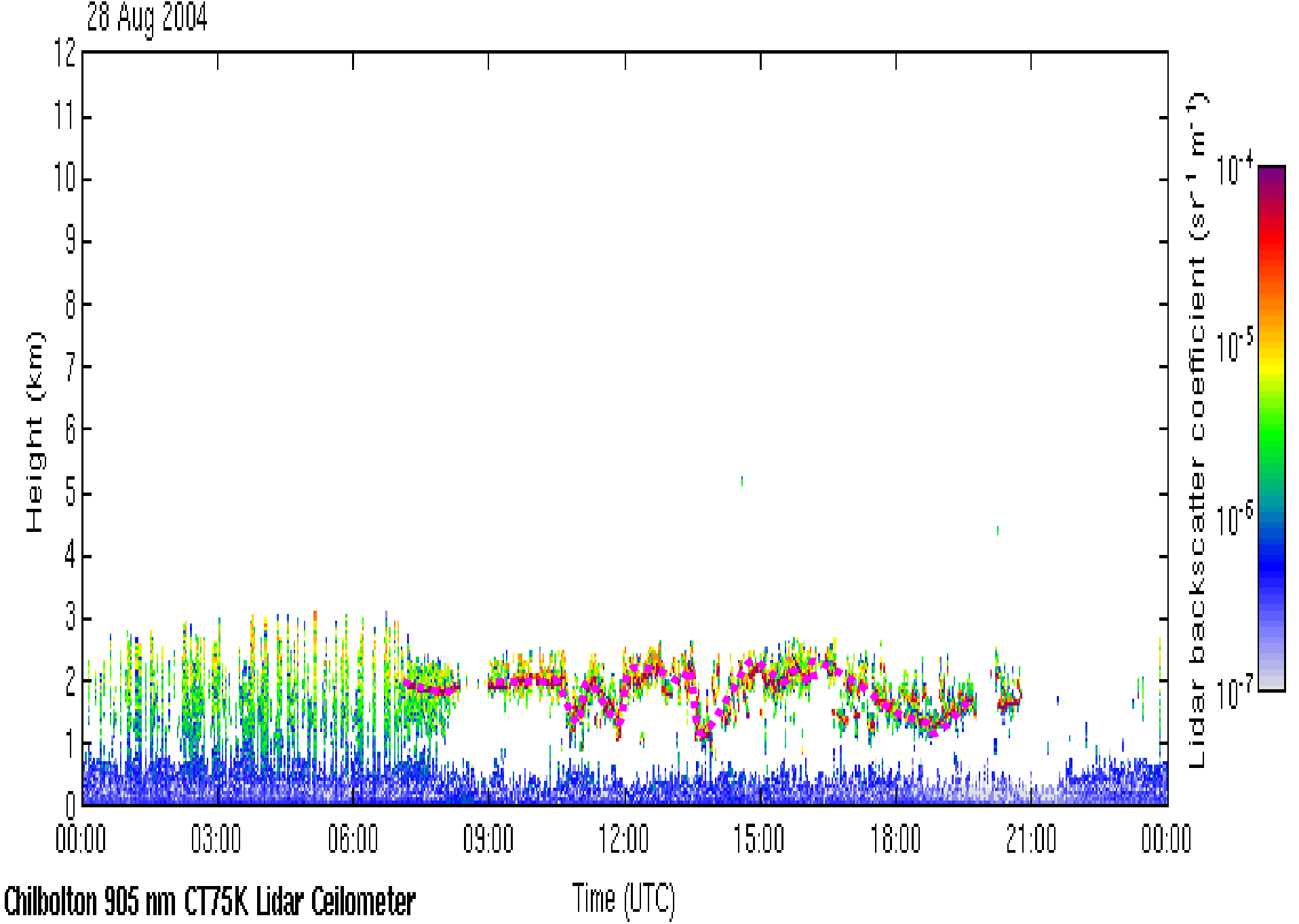
Time (UTC)
Lidar backscatter coefficient (sr⁻¹ m⁻¹)
10⁻⁴
10⁻⁵
10⁻⁶
10⁻⁷
Chilbolton 905 nm CT75K Lidar Ceilometer

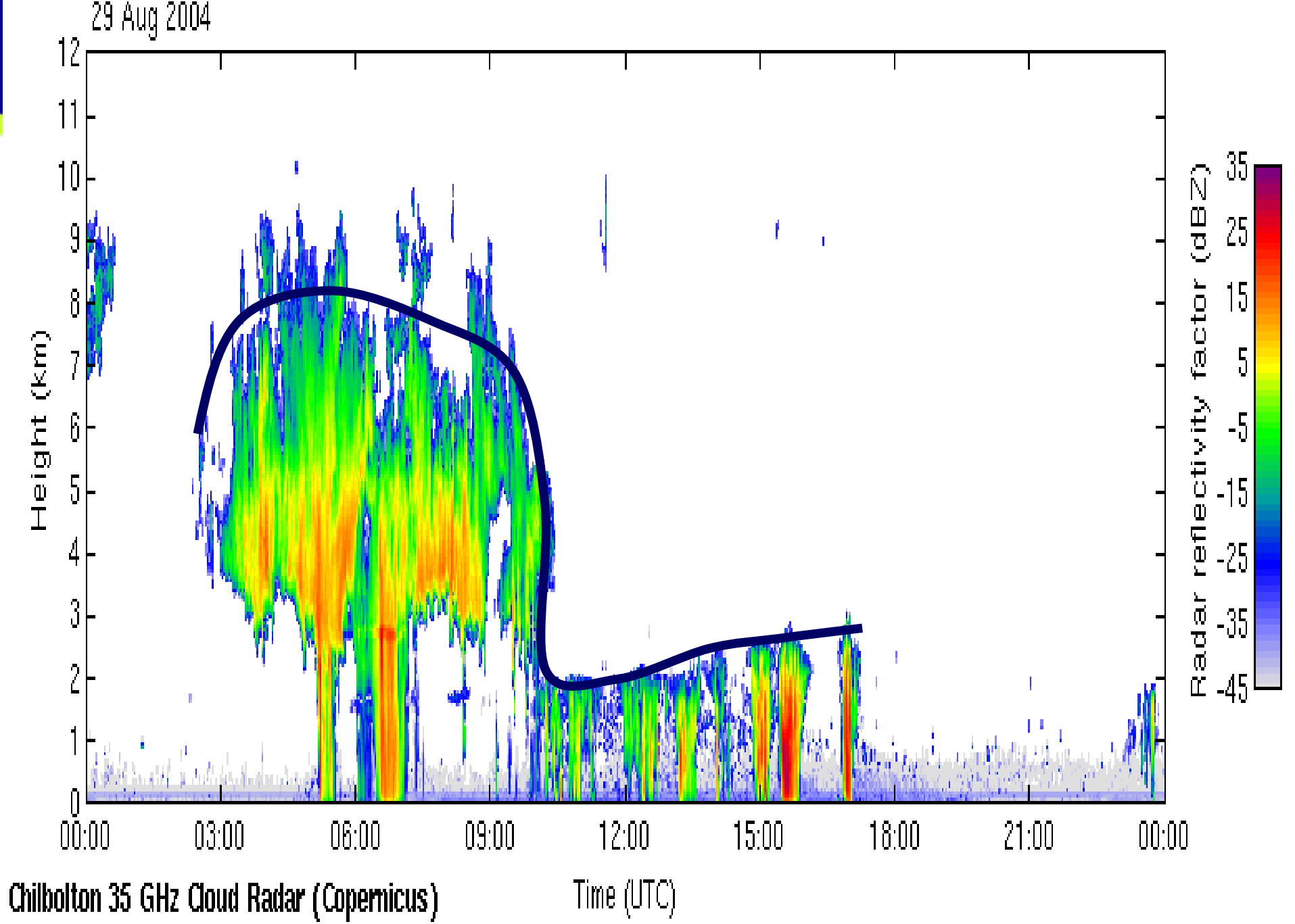


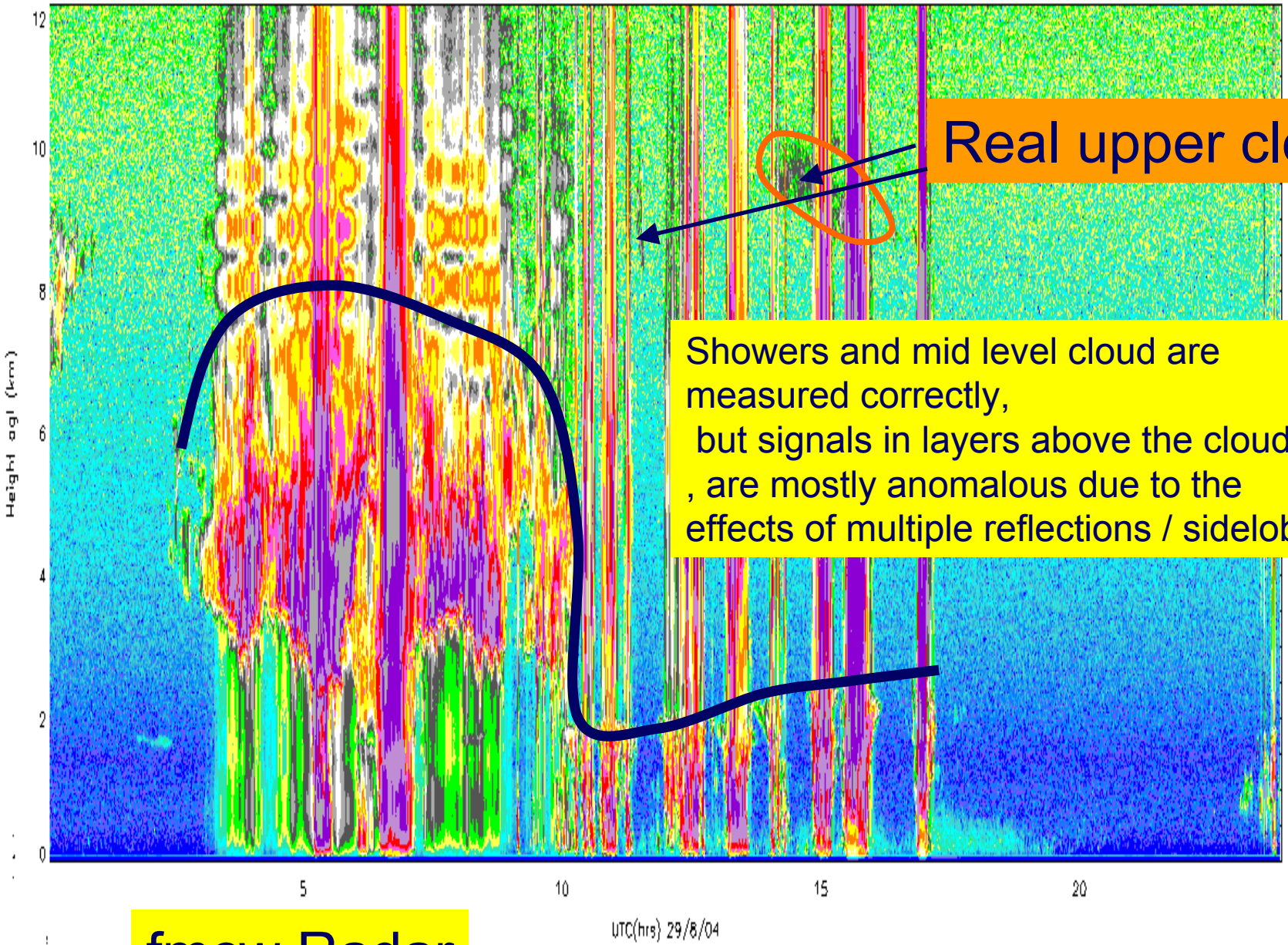
Artefacts from mid-level cloud



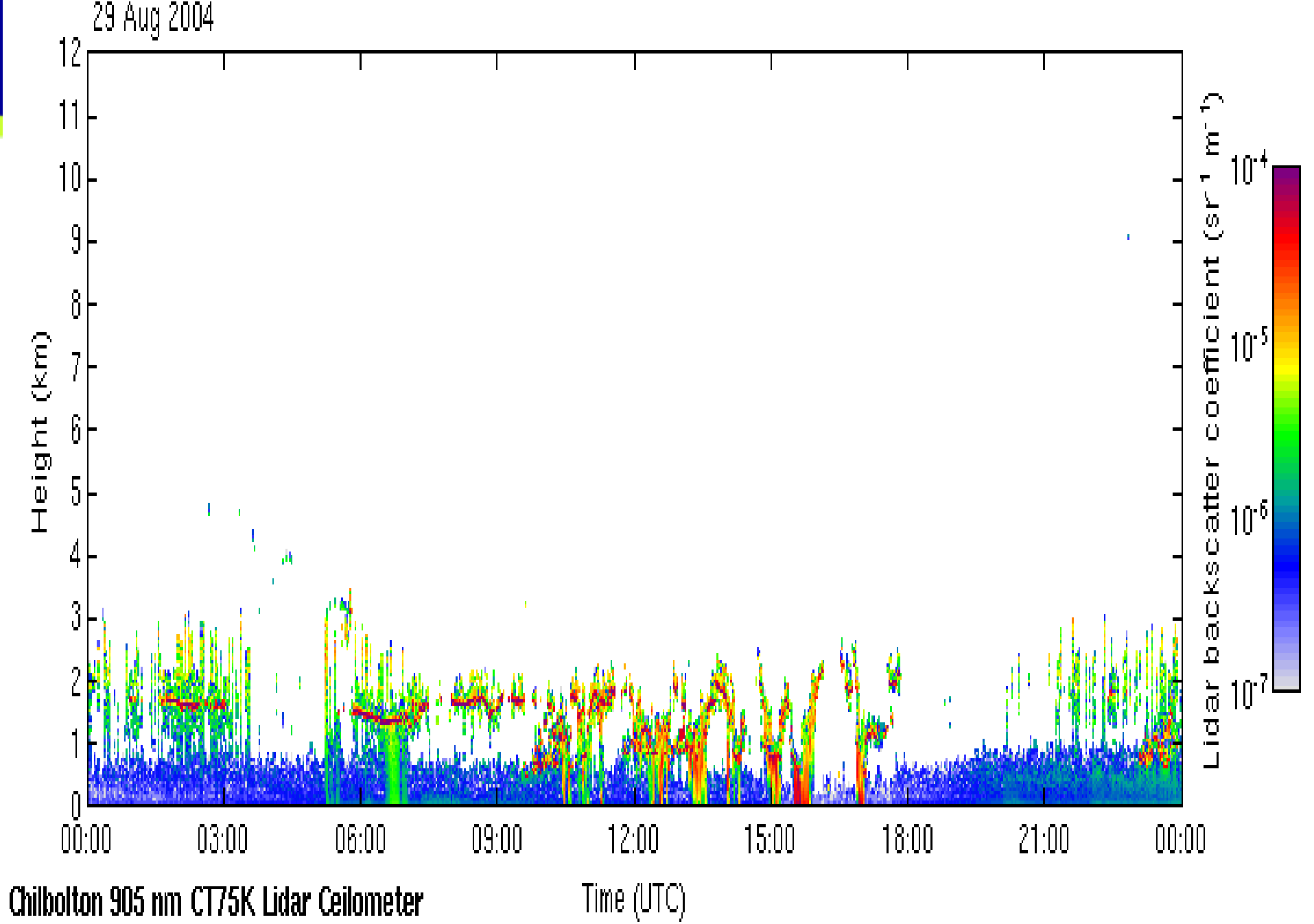
fmcw Radar



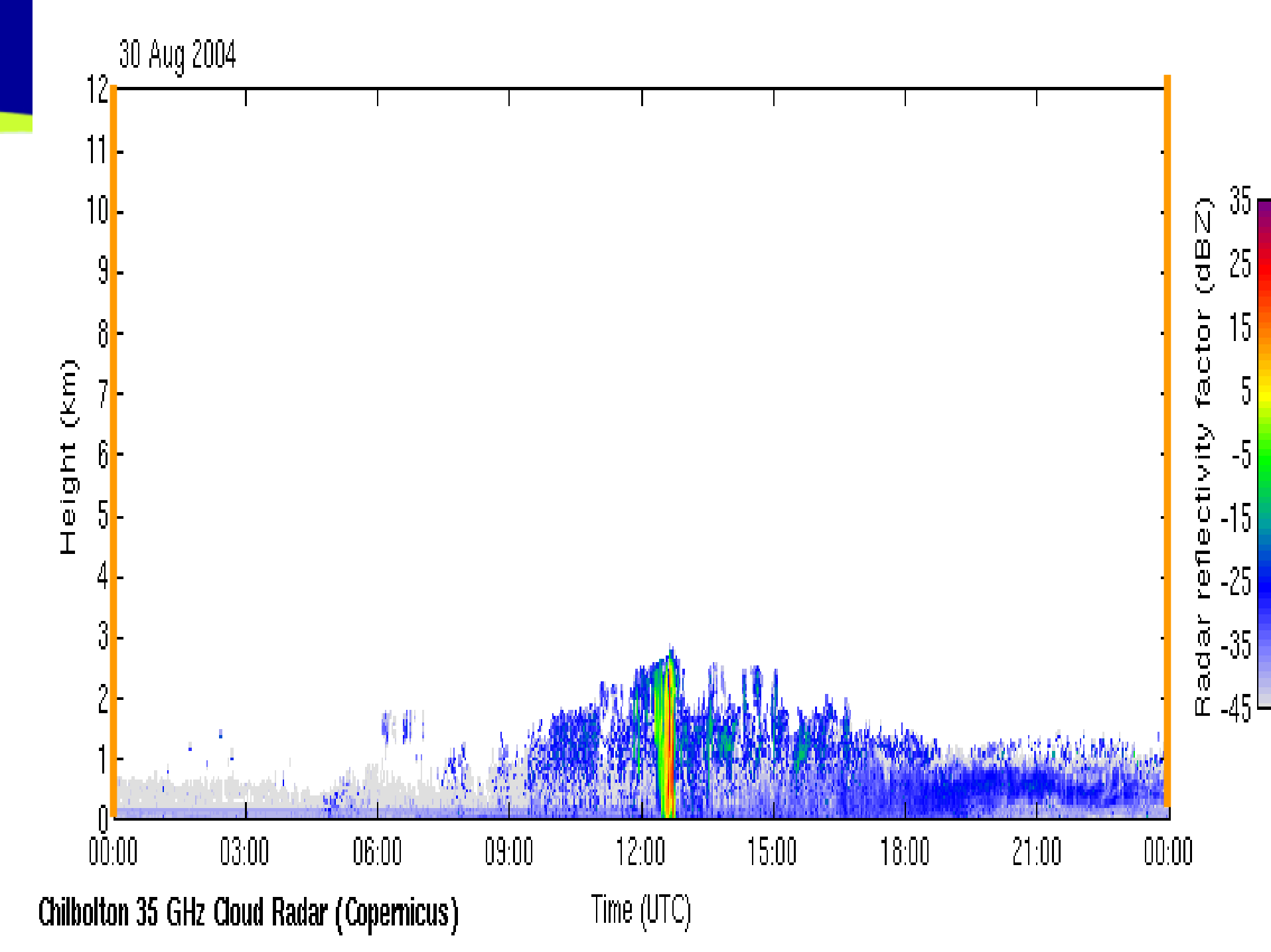




Questions & Answers



Chilbolton 905 nm CT75K Lidar Ceilometer


30 Aug 2004
Height (km)
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18:00
21:00
00:00
Time (UTC)
Radar reflectivity factor (dBZ)
35
25
15
5
-5
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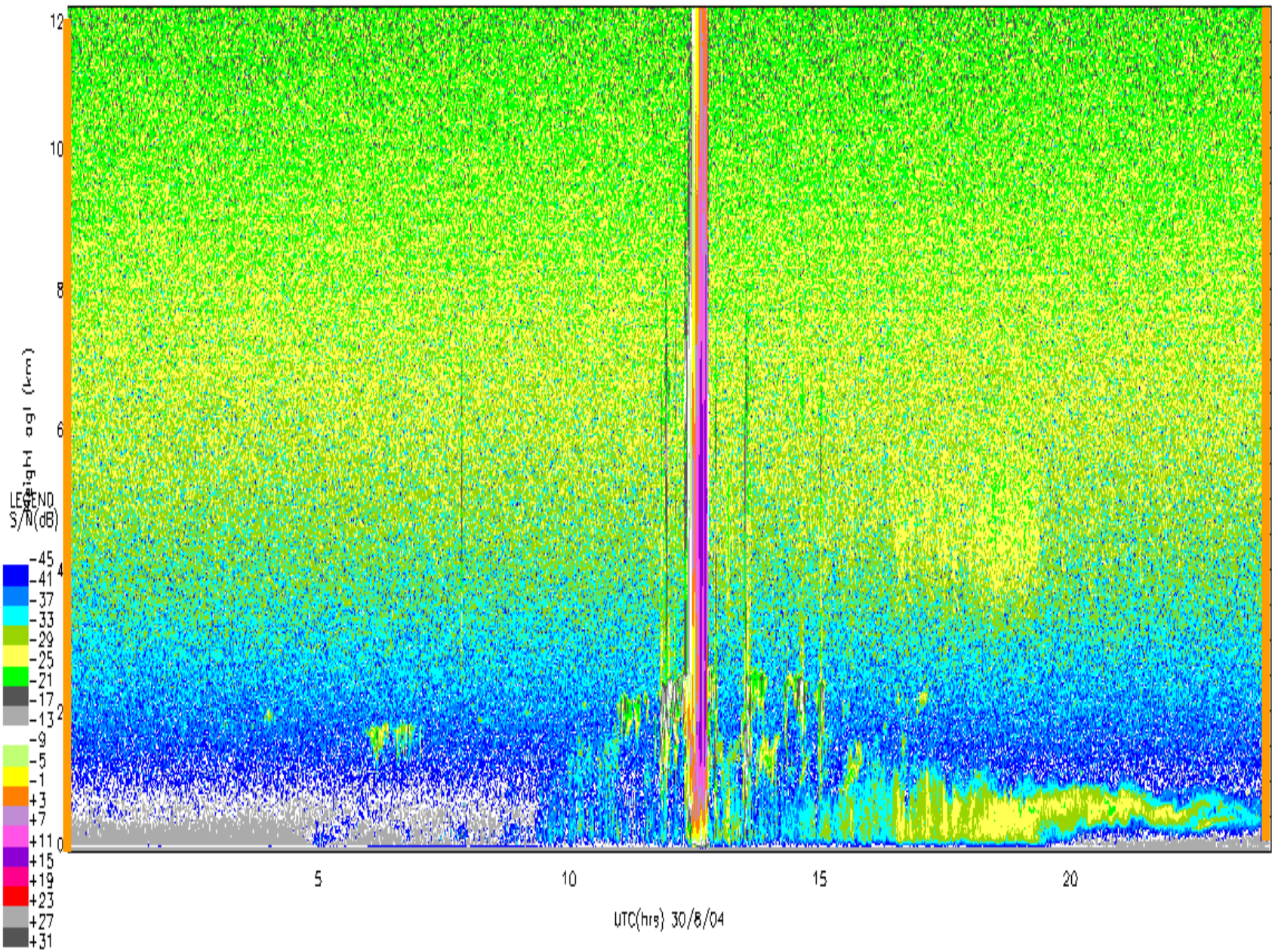

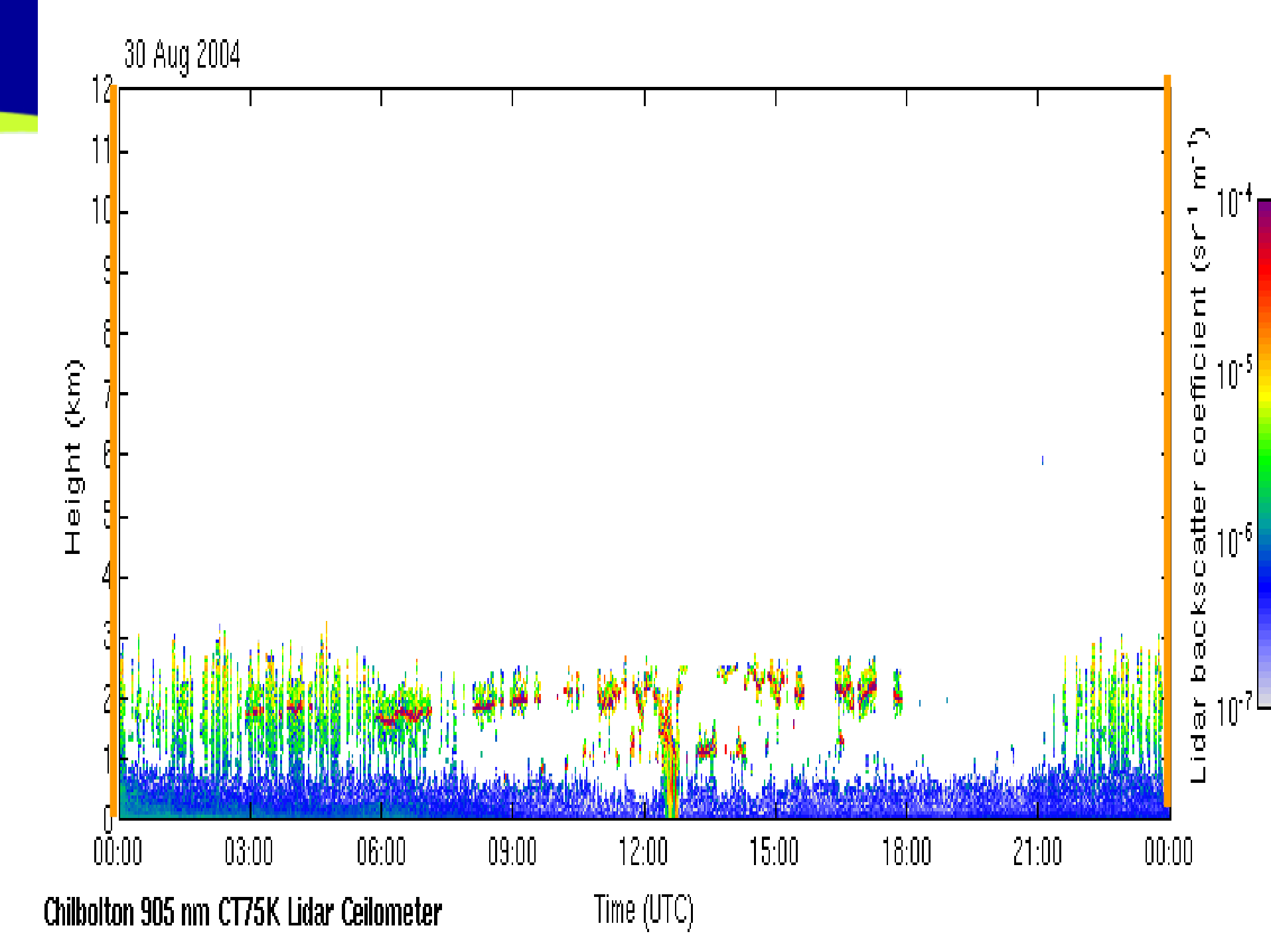
30 Aug 2004
Height (km)
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06:00
09:00
12:00
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21:00
00:00
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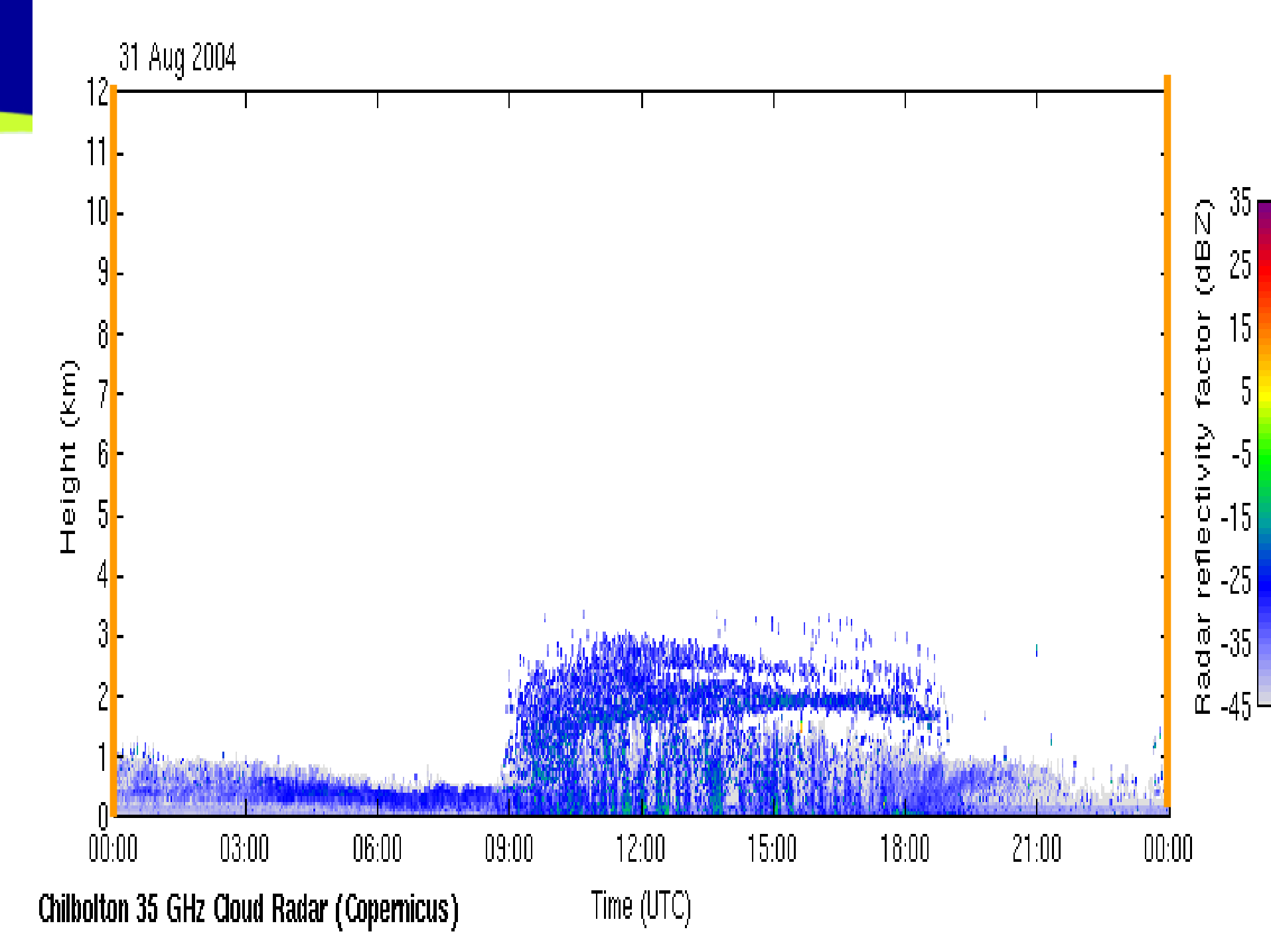
31 Aug 2004
Height (km)
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03:00
06:00
09:00
12:00
15:00
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21:00
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Time (UTC)
Radar reflectivity factor (dBZ)
35
25
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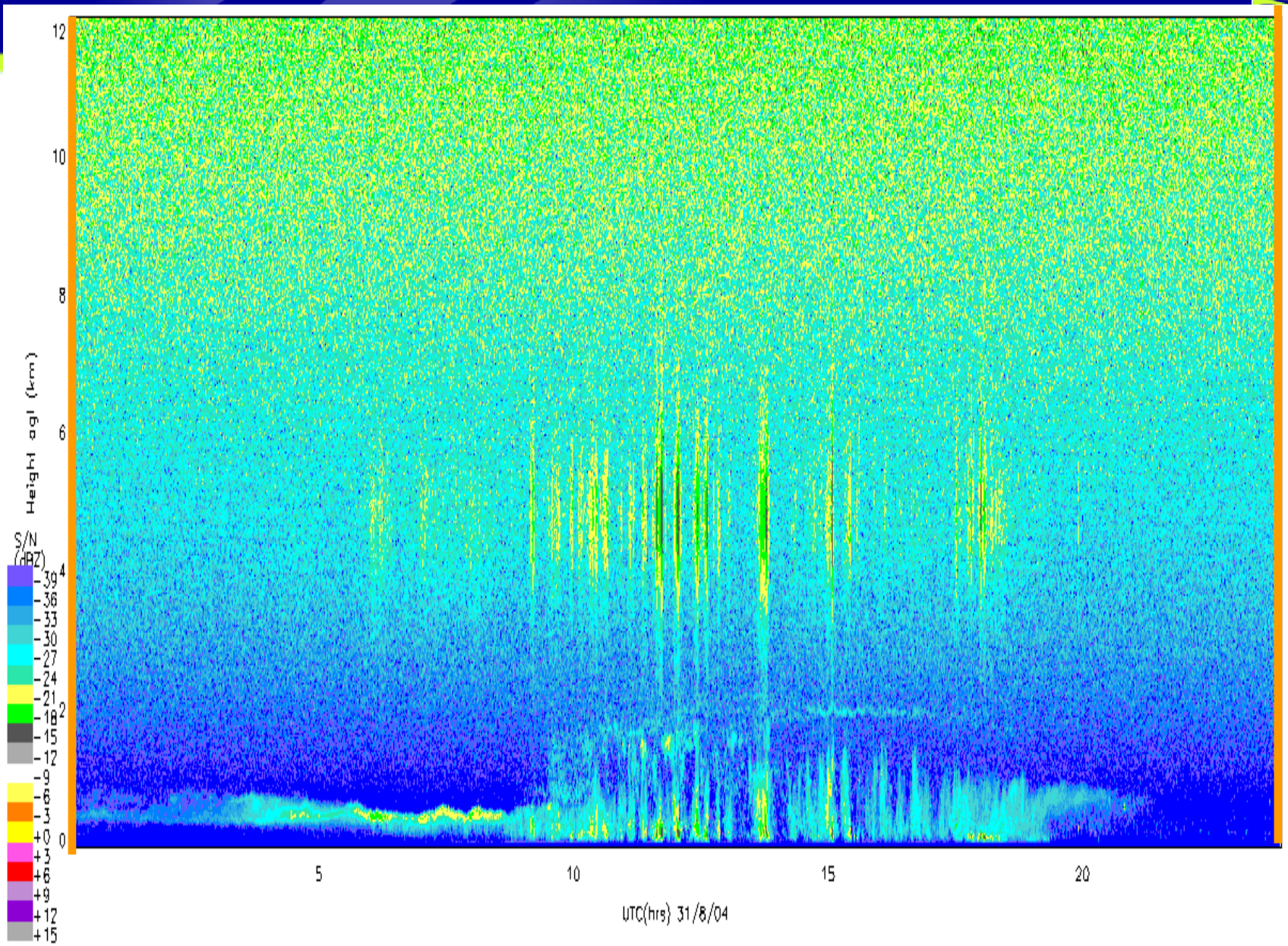

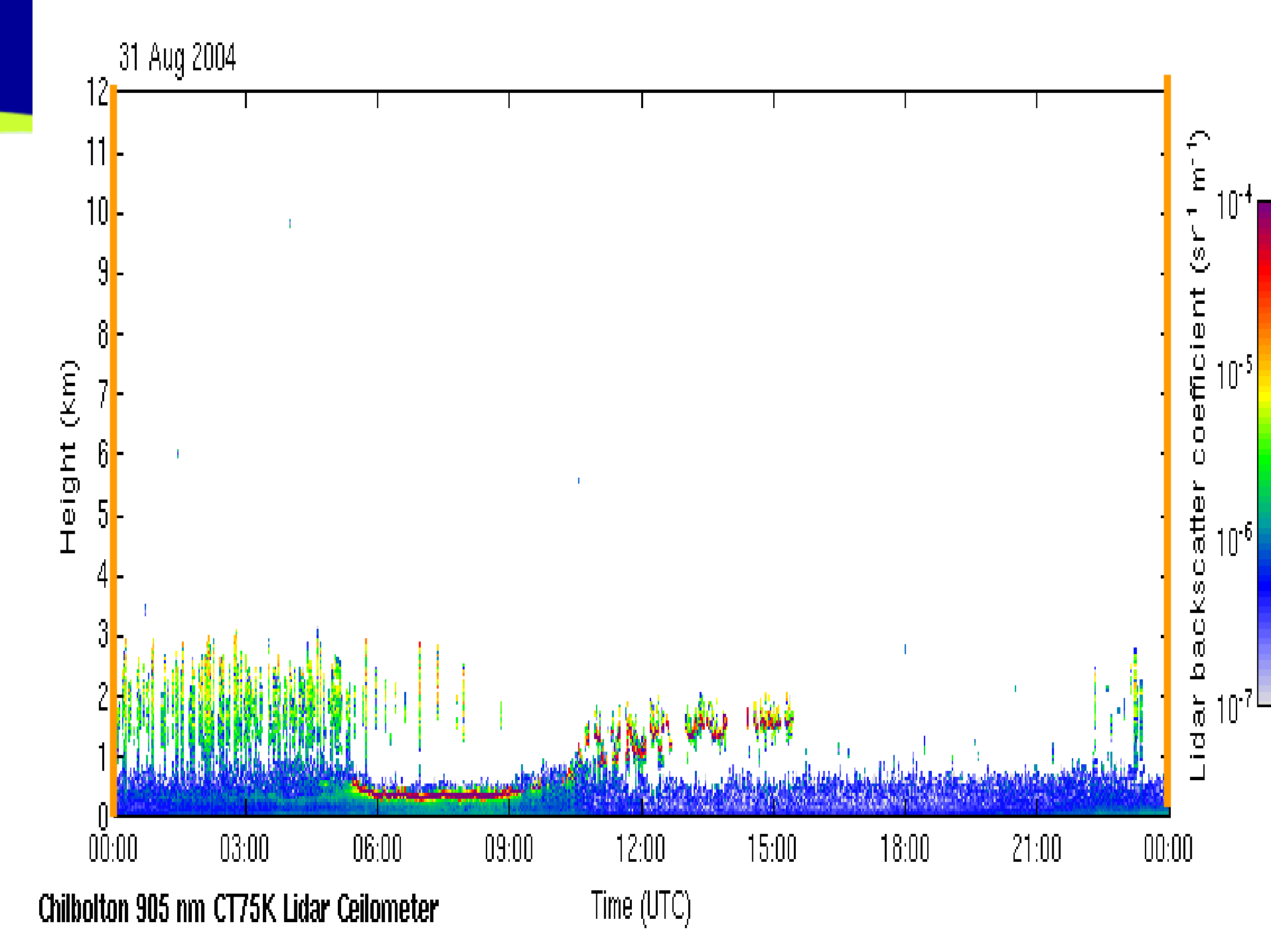
31 Aug 2004
Height (km)
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00:00
03:00
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09:00
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10⁻⁷
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Conclusions from Chilbolton comparison

- The 78GHz radar is of good sensitivity and not inferior to the 35GHz pulsed radar in this respect

- Signals near the ground when no precipitation is falling to the surface are clearly reliable.

- In rain or heavy drizzle anomalous signals may be generated in upper range gates, probably from multiple scattering effects. Thus, the tops of cloud cannot be deduced reliably from the current radar in these conditions. Least reliable in this respect are showers of small vertical extent giving very strong signals near the ground and anomalous signals in nearly all upper range gates.

- Multiple scattering effects can be seen from strong reflections between the surface and cloud in mid-layer cloud. Structure underneath these clouds appears reliable

- Precise estimation of the fmcw calibrations requires further analysis

8km mode range correction

Before & After