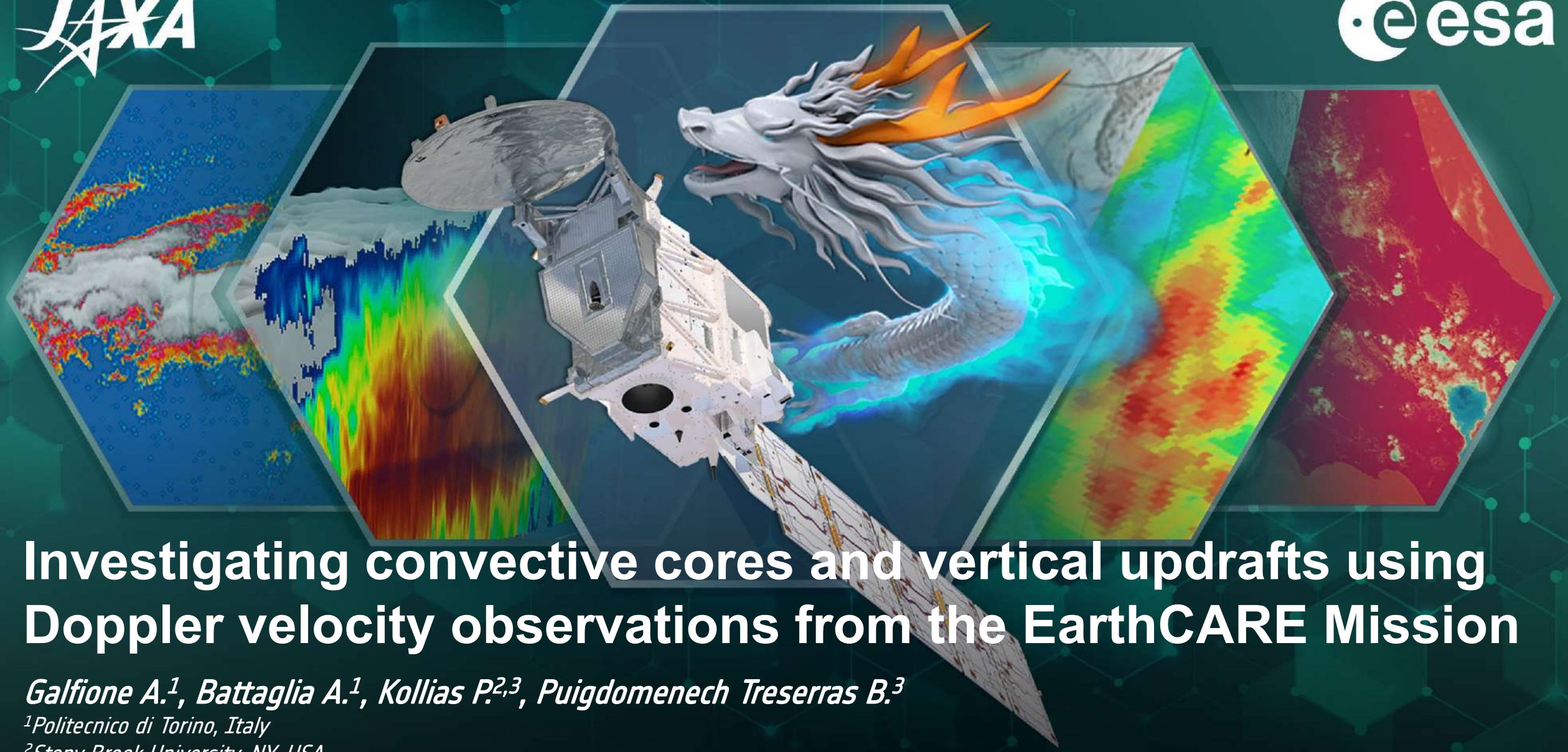

Investigating convective cores and vertical updrafts using Doppler velocity observations from the EarthCARE Mission

Galfione A.[1], Battaglia A.[1], Kollias P.[2,3], Puigdomenech Treserras B.[3]

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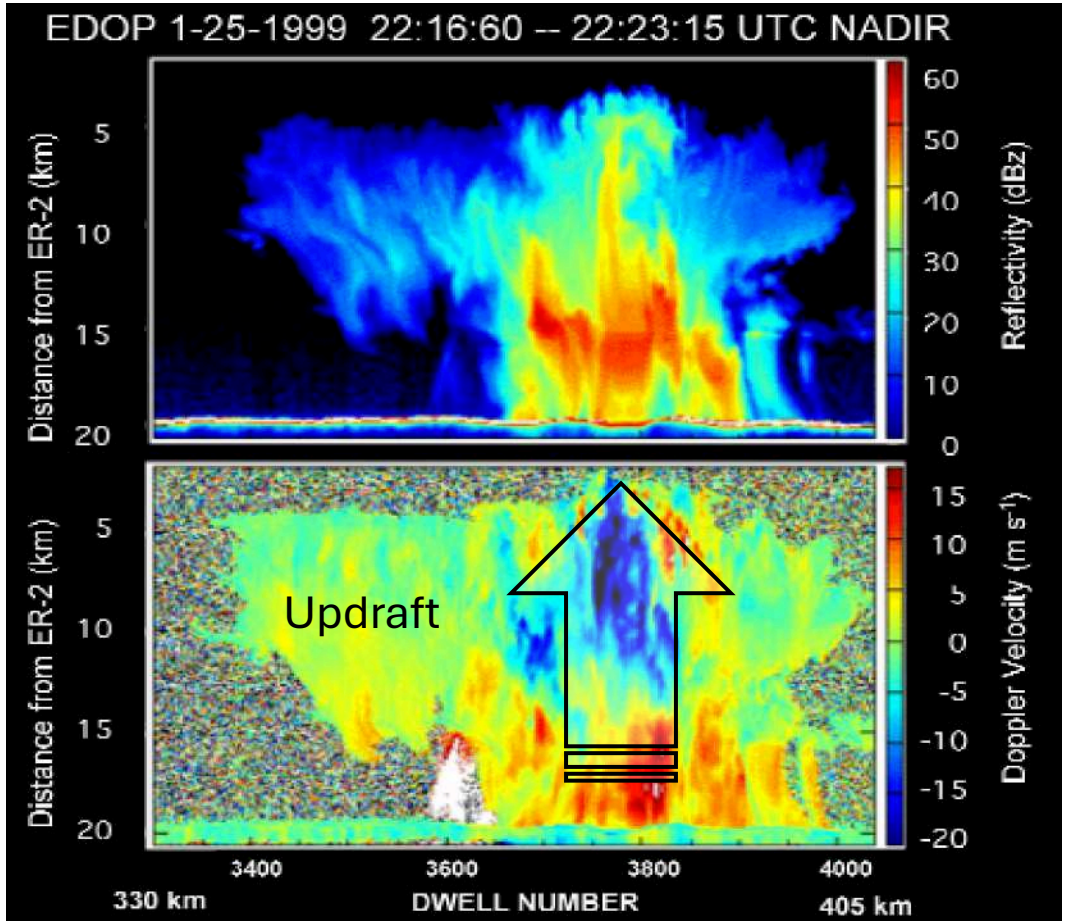
17 – 20 March 2025 | ESA-ESRIN | Frascati (Rome), Italy

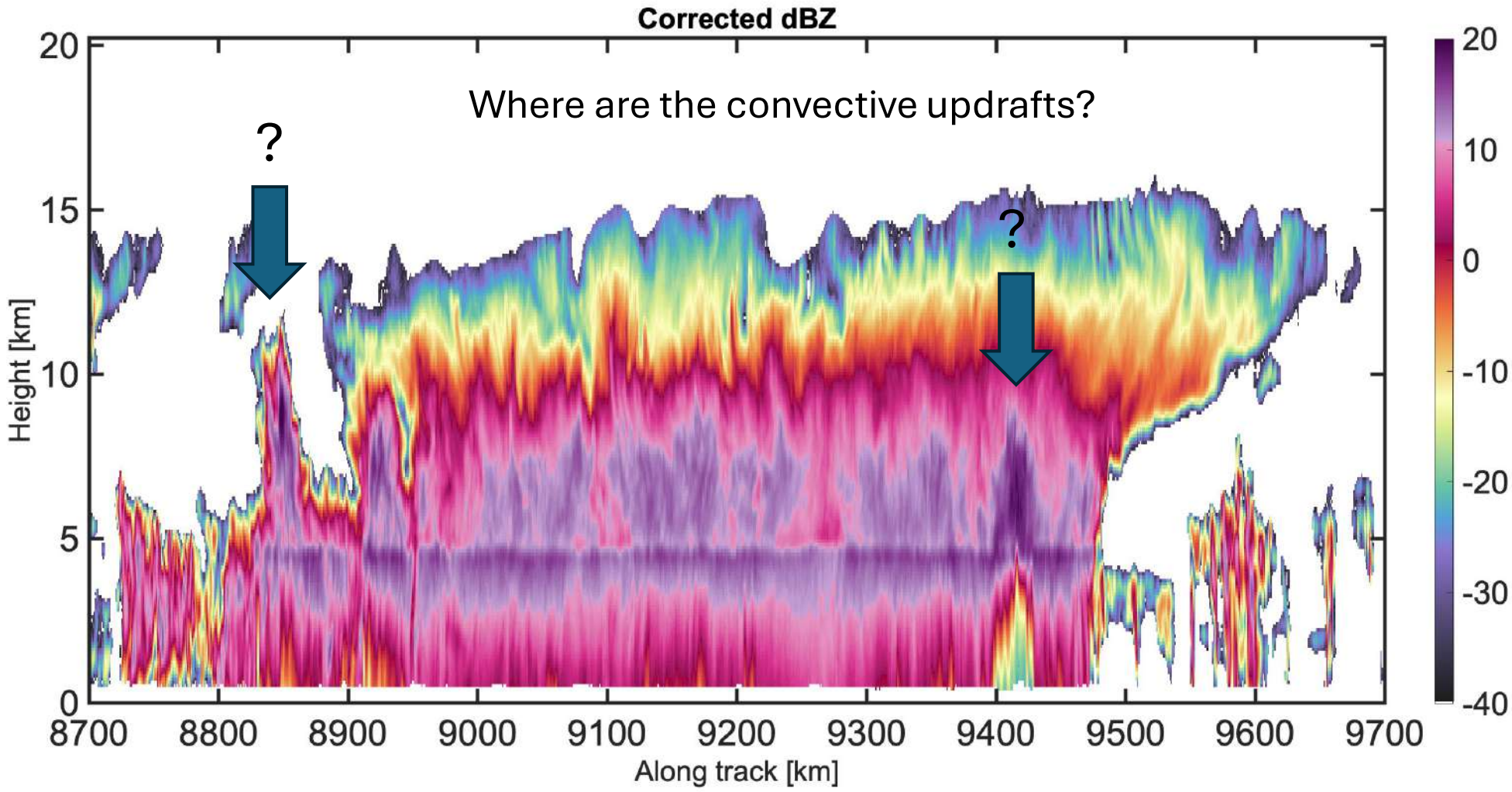
Convective motions affect microphysical processes and control the transport of moisture, momentum, heat, trace gases and aerosols from the boundary layer to the upper troposphere.

- ❑Sparse observational record over land.
- ❑Challenging for ground-based observing systems
- ❑± 5 to 40 ms^{-1} vertical air velocity

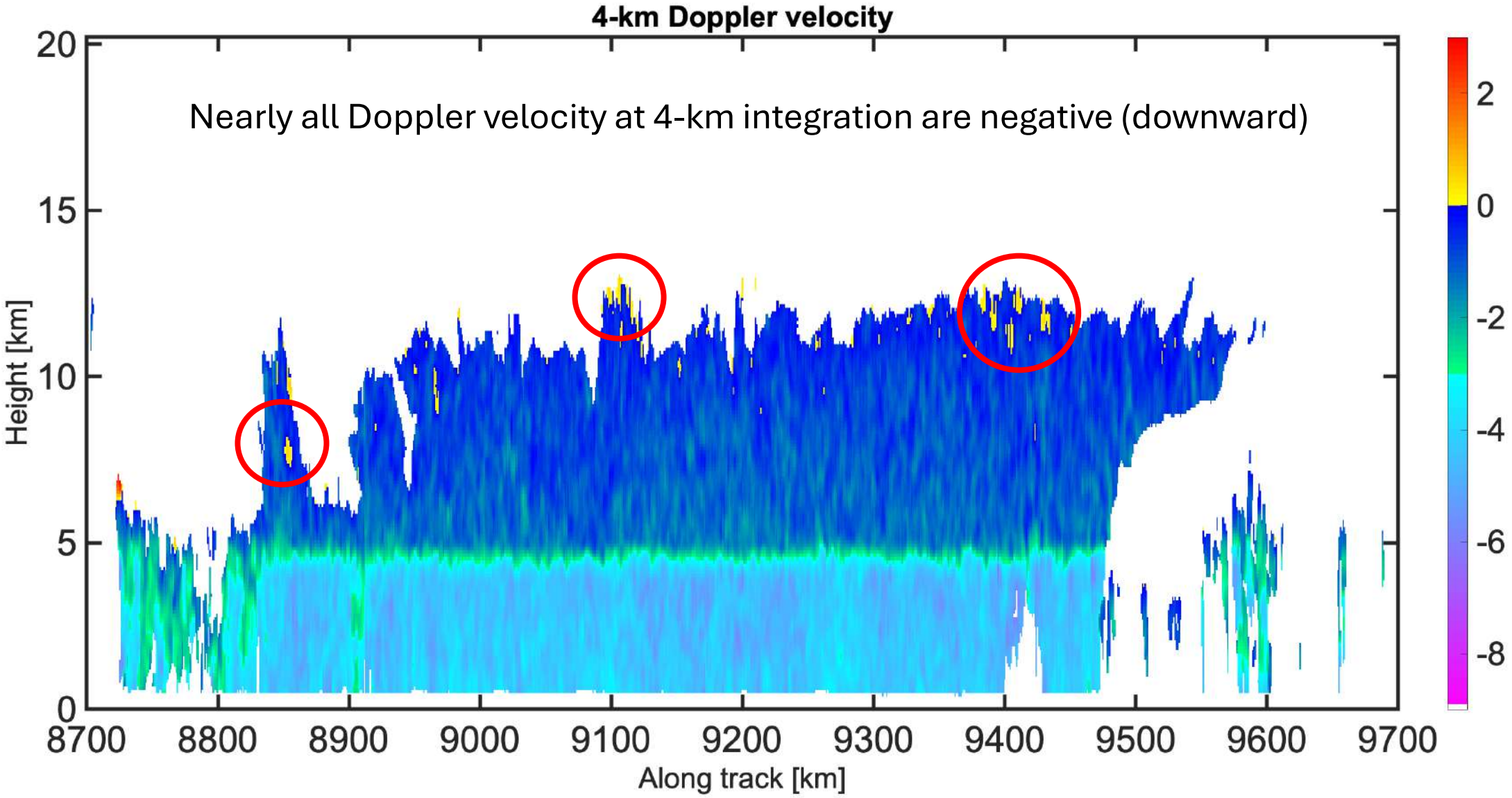


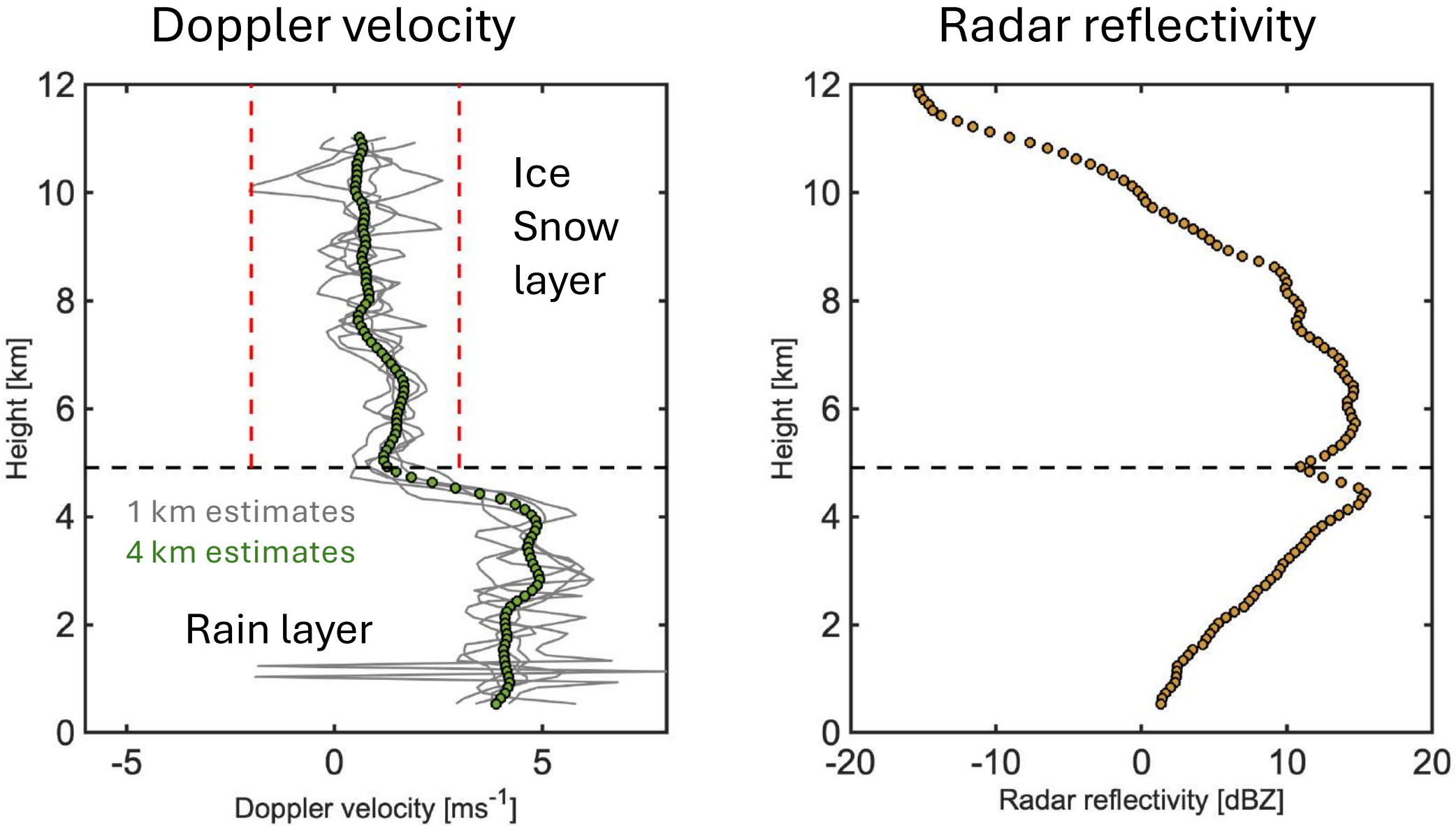
courtesy of G. Heymsfield, NASA GSFC

Example of widespread precipitating system

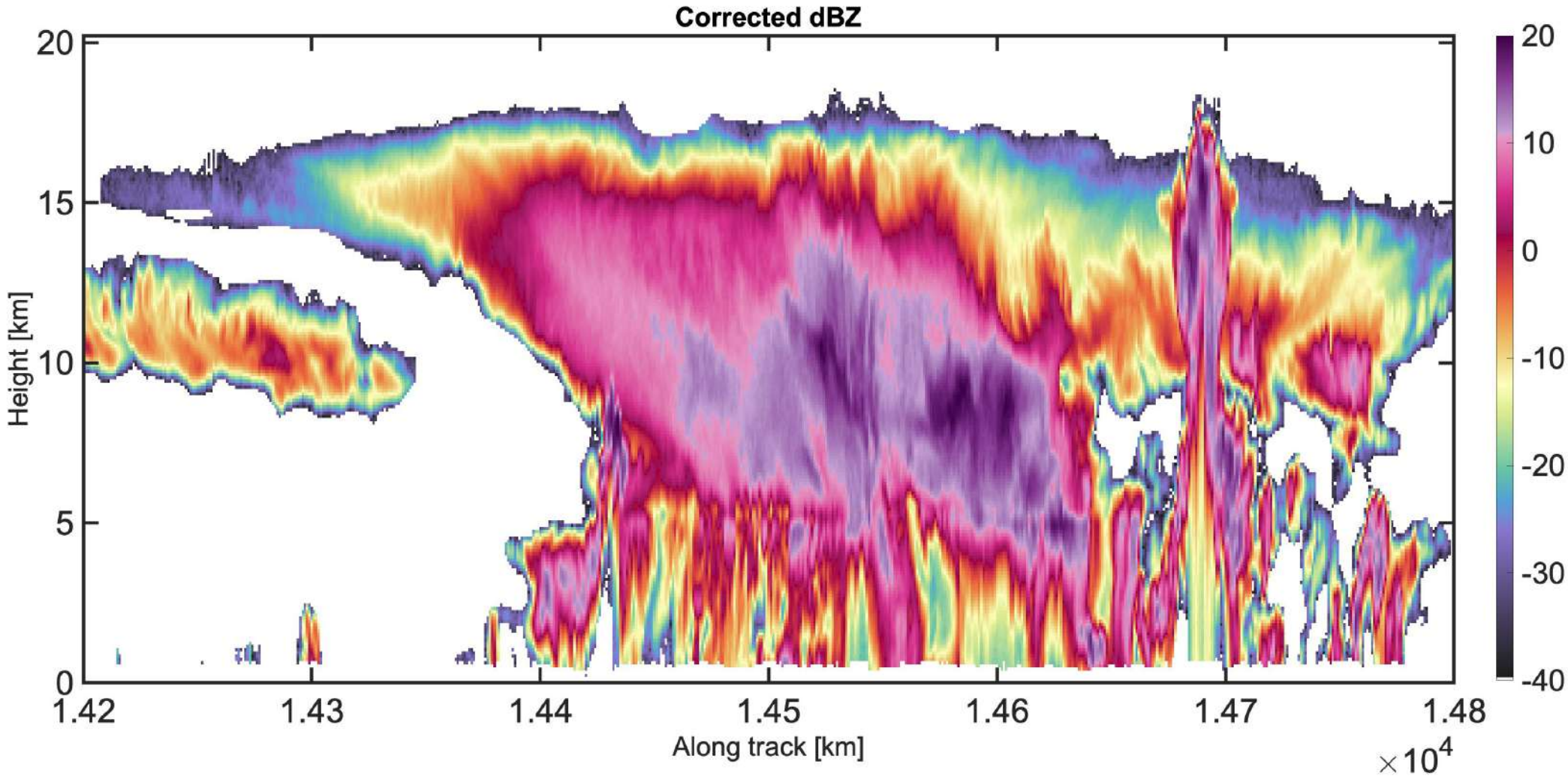


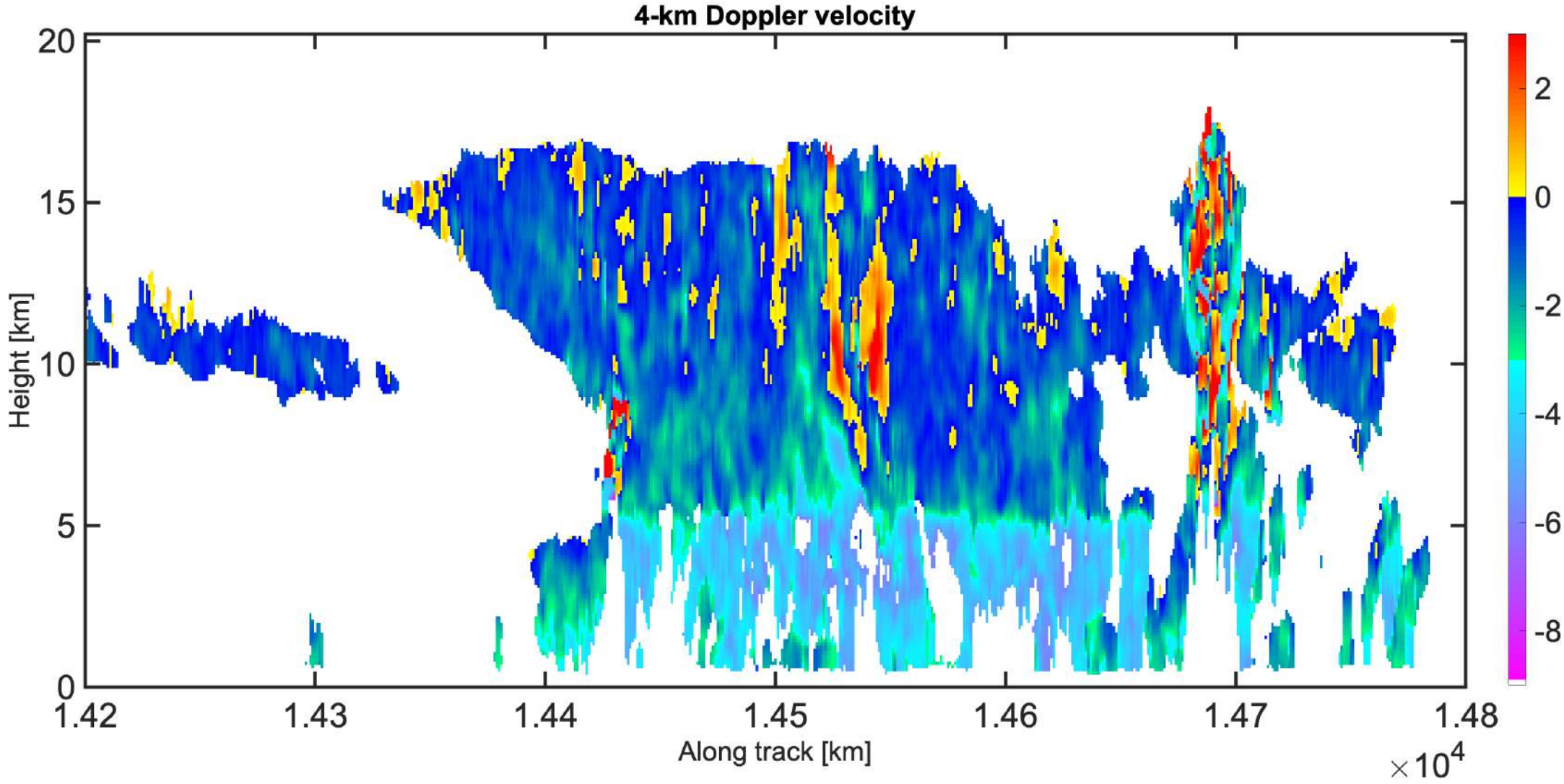
Example of widespread precipitating system

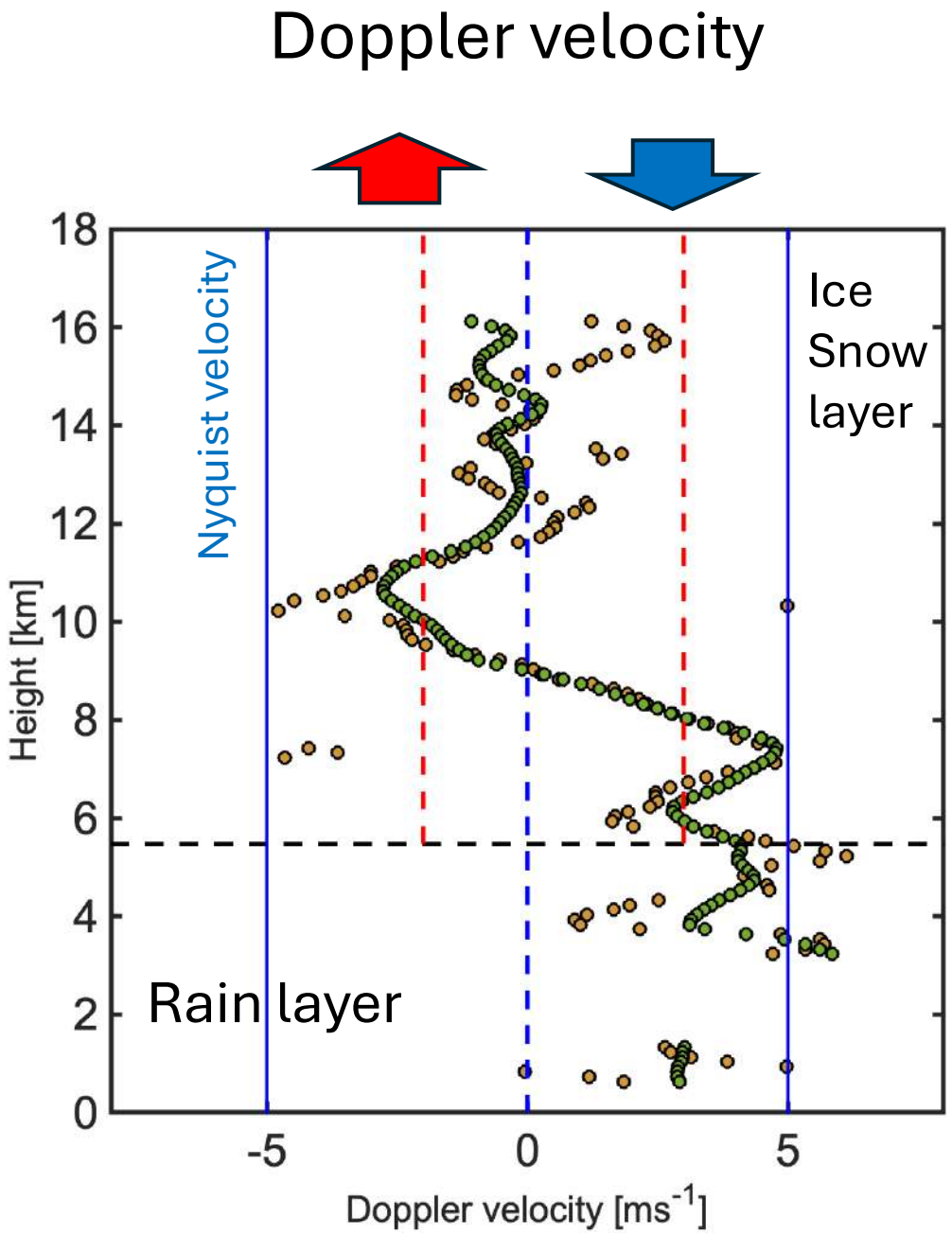


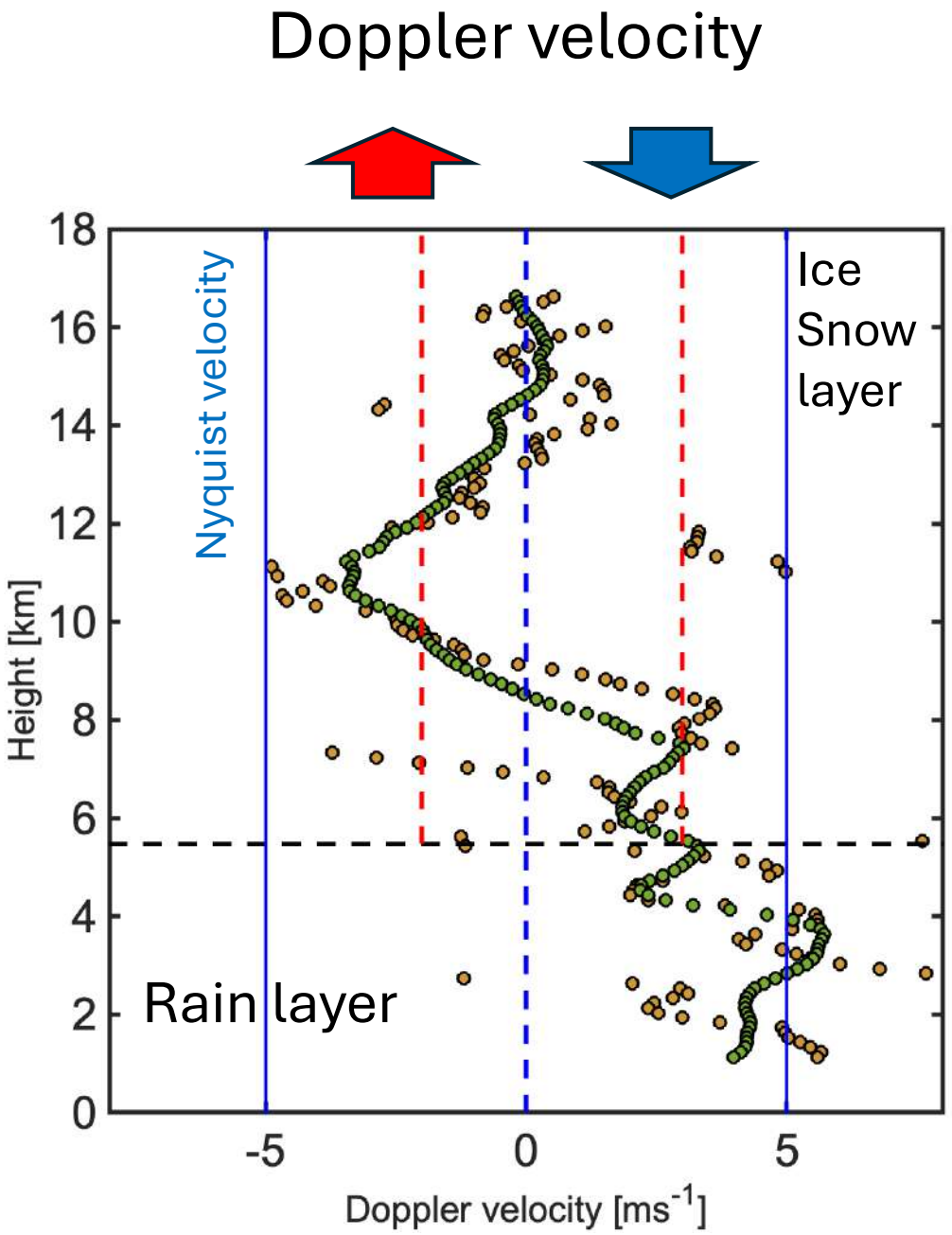


At sub-zero temperatures, we expect that the 1-km (and with more confidence the 4km) EarthCARE CPR Doppler velocities will be between -2 and +3 considering the Doppler velocity uncertainty. In addition, we expect no Doppler velocity unfolding

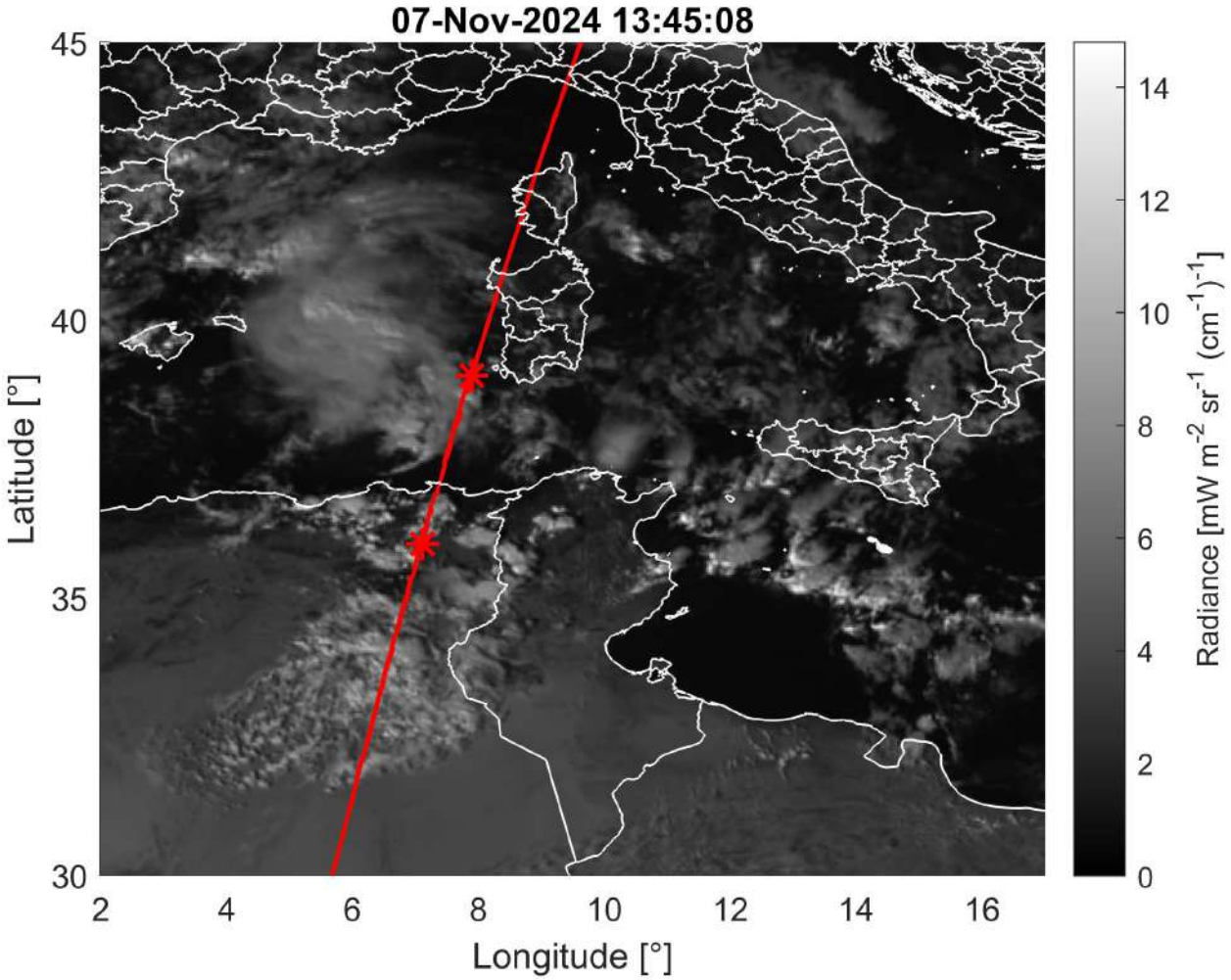

Corrected dBZ
Height [km]
20
15
10
5
0
1.42
1.43
1.44
1.45
1.46
1.47
1.48
Along track [km]
×10^4
20
10
0
-10
-20
-30
-40


4-km Doppler velocity
Height [km]
20
15
10
5
0
1.42
1.43
1.44
1.45
1.46
1.47
1.48
Along track [km]
×10^4
2
0
-2
-4
-6
-8

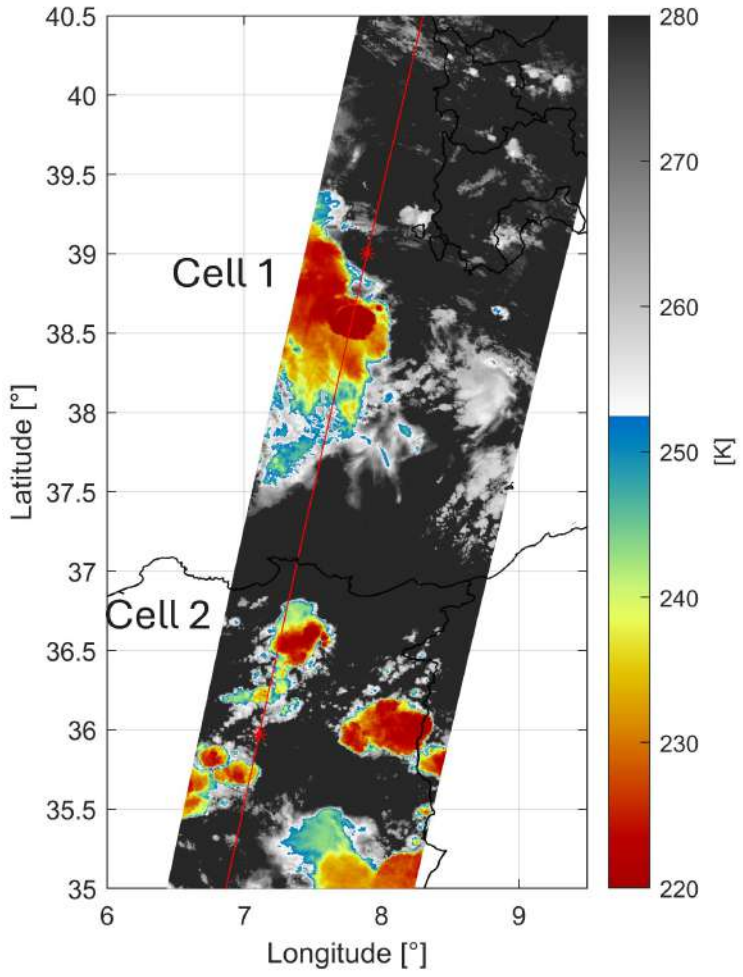

Doppler velocity
Nyquist velocity
Ice
Snow
layer
Rain layer
Height [km]
Doppler velocity [ms^{-1}]
18
16
14
12
10
8
6
4
2
0
-5
0
5


Doppler velocity
Nyquist velocity
Ice
Snow
layer
Rain layer
Height [km]
Doppler velocity [ms^{-1}]
18
16
14
12
10
8
6
4
2
0
-5
0
5

Convective case study over Mediterranean basin

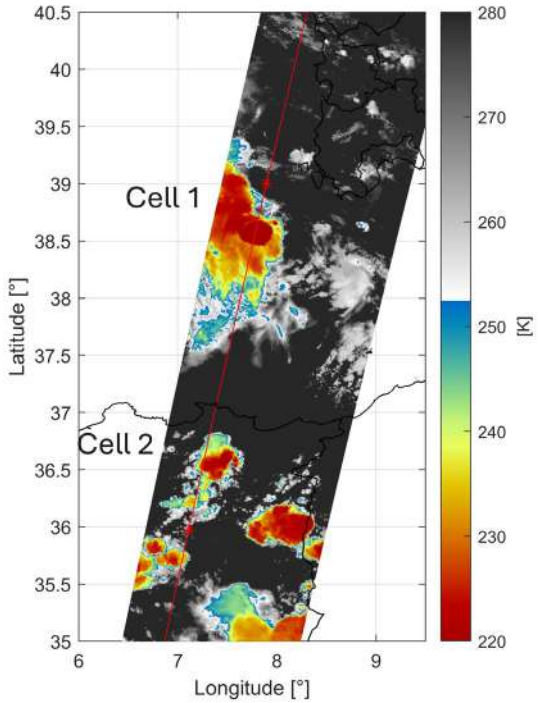


MSG visible, channel 1 (0.6 µm)

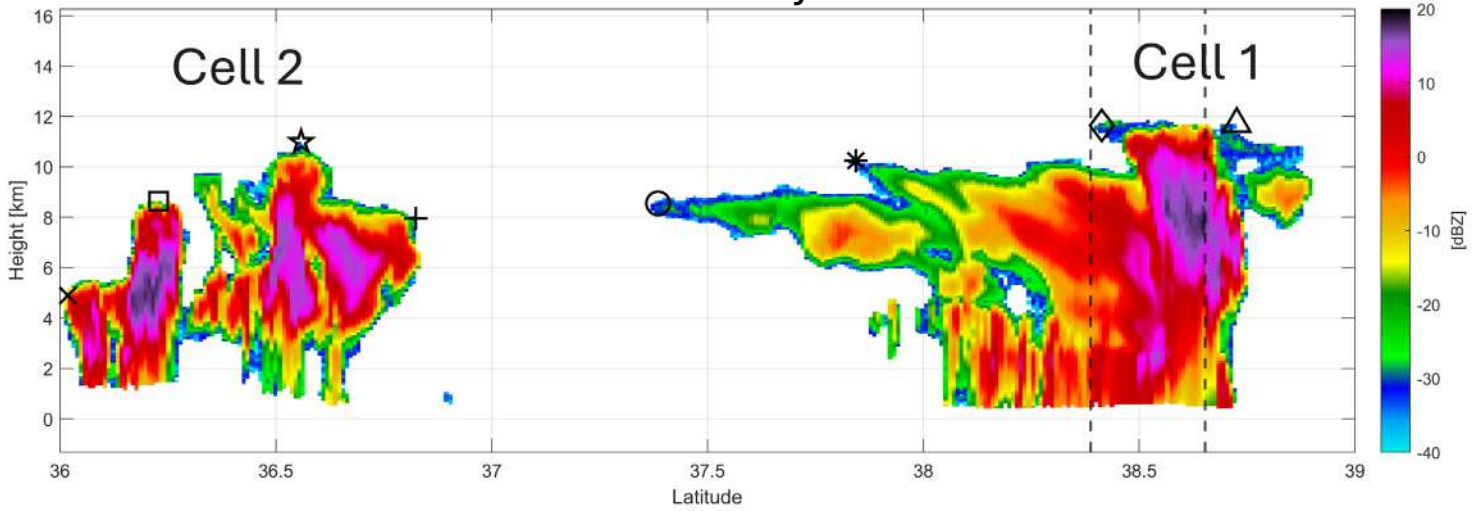


MSI image, channel 6 (10.8 µm)

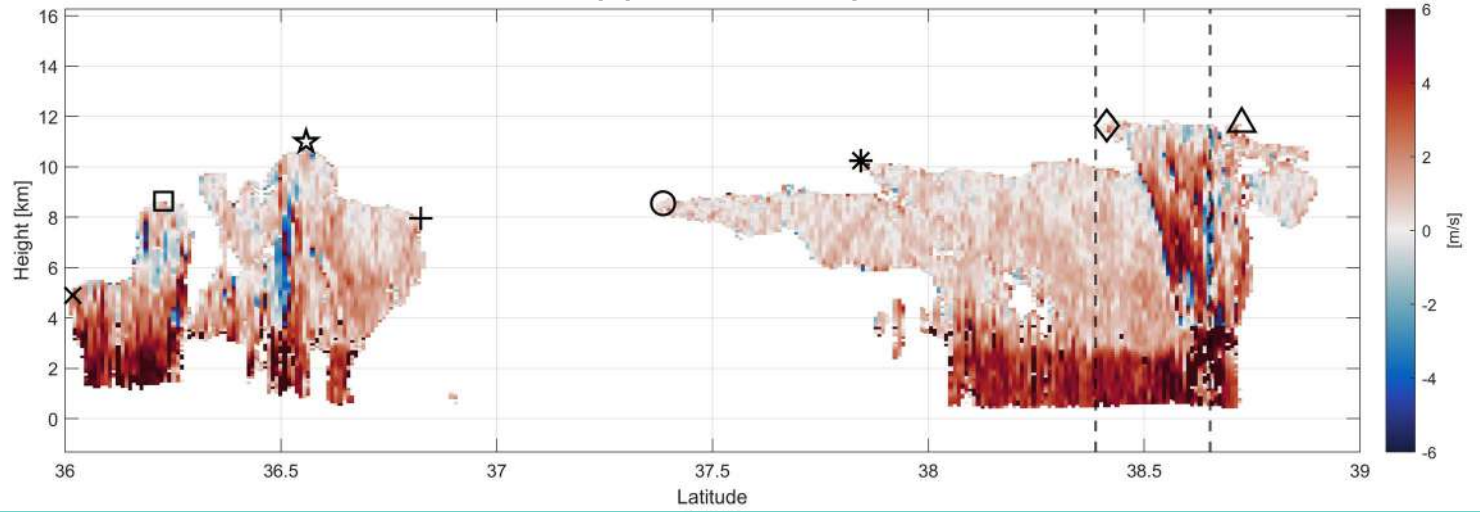
EarthCARE overpass on Nov. 7, 2024 at 13:43 UTC



Reflectivity



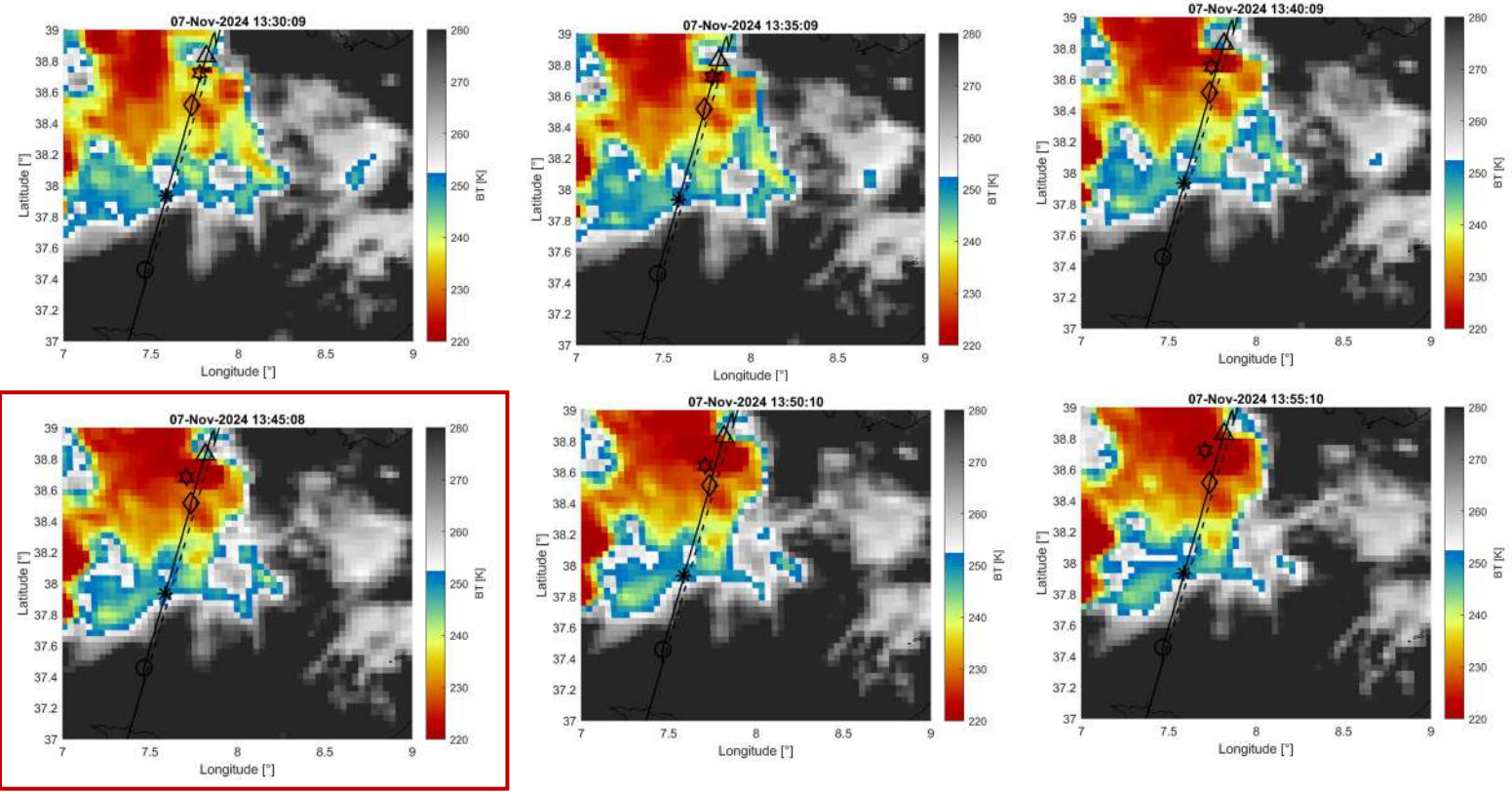
Doppler velocity



- Transition from rain to ice above the melting layer visible in Doppler velocity
- Areas of strong reflectivity attenuation show high variability in Doppler velocity along and across track

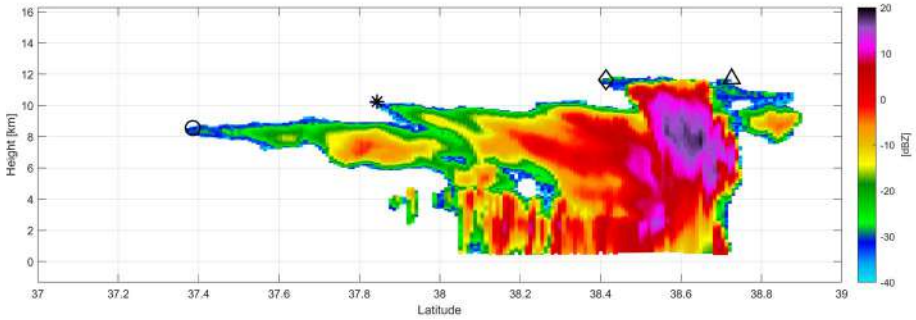
EumetSat MSG SEVIRI observations: Cell 1

MSG clean IR, channel 9 (10.8 μm)

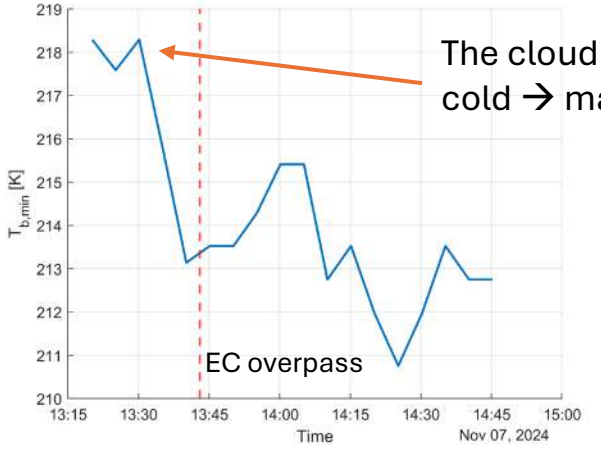


EarthCARE overpass is at 13:43 UTC

Reflectivity



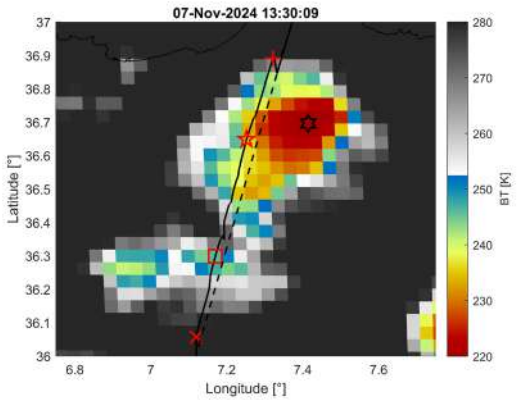
Timeseries of the minimum T_b

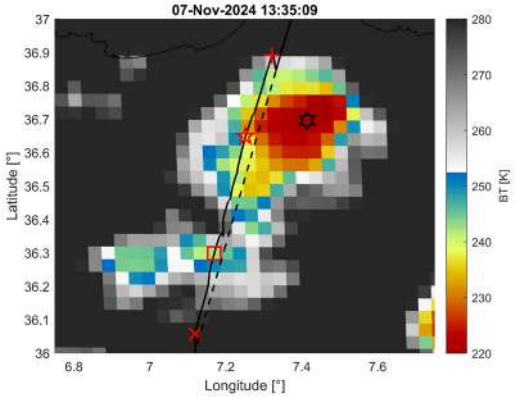


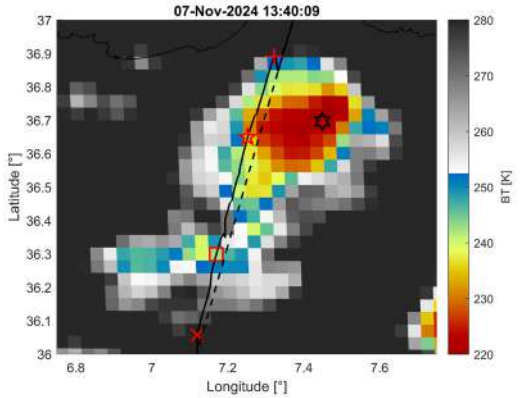
The cell is tracked using tobac algorithm

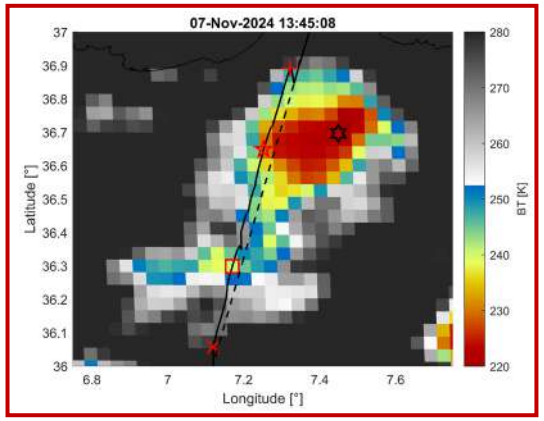
EumetSat MSG SEVIRI observations: Cell 2

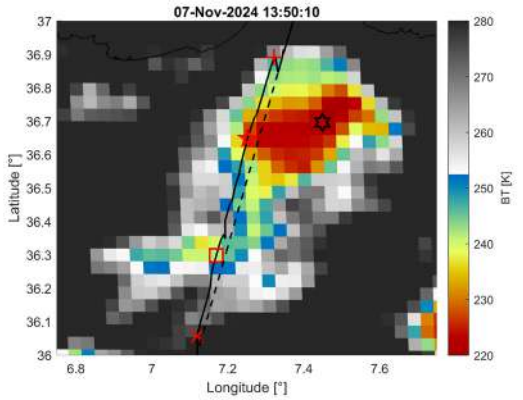
MSG clean IR, channel 9 (10.8 μm)

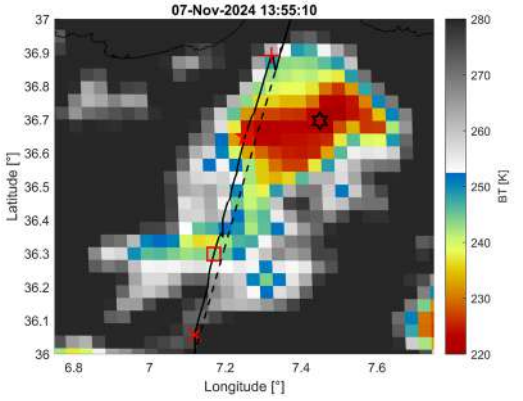






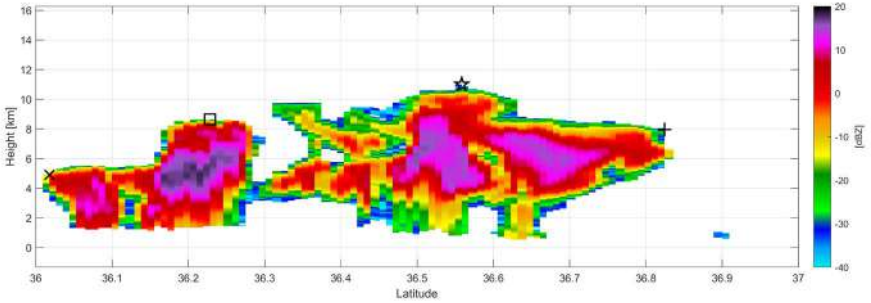




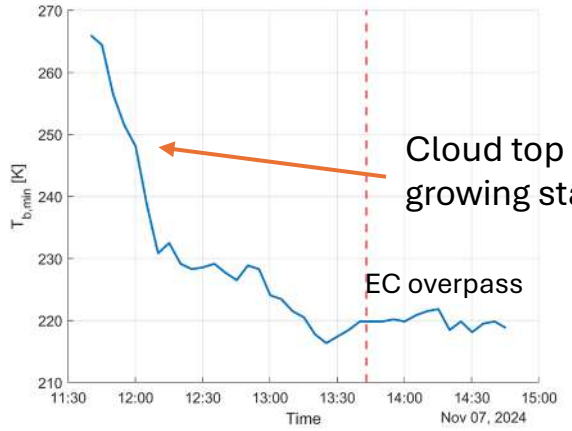


EarthCARE overpass is at 13:43 UTC

Reflectivity



Timeseries of the minimum T_b



The cell is tracked using tobac algorithm

Conclusions and future work

Conclusions

- Areas of strong reflectivity attenuation likely corresponding to convective cores show very high along track and across track variability in Doppler velocities.
- For extended mature convective systems it is very difficult to detect local embedded updrafts below the anvil using only geostationary imagery. The radar plays a crucial role in identifying the convective motions occurring at kilometer scale that the geostationary is failing to detect.
- Sinergy between EC and geostationary imagery has great potential for studying isolated convective cells. Geostationary provides life cycle context.

Future work

- Development of a convection dynamic driven classification method for EC profiles based on Doppler velocities.
- Science studies for global characterisation of convection based on long term statistics collected by EC CPR.

Thank you for your attention!