Temperature within a mid-latitude NLC - A lidar case study

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LPMR Workshop, Kühlungsborn
18 – 22 Sep 2017

DLR

CORAL lidar

- Compact, autonomous Rayleigh lidar
- Nd:YAG, 12 W, 532 nm
- 61 cm receiving telescope

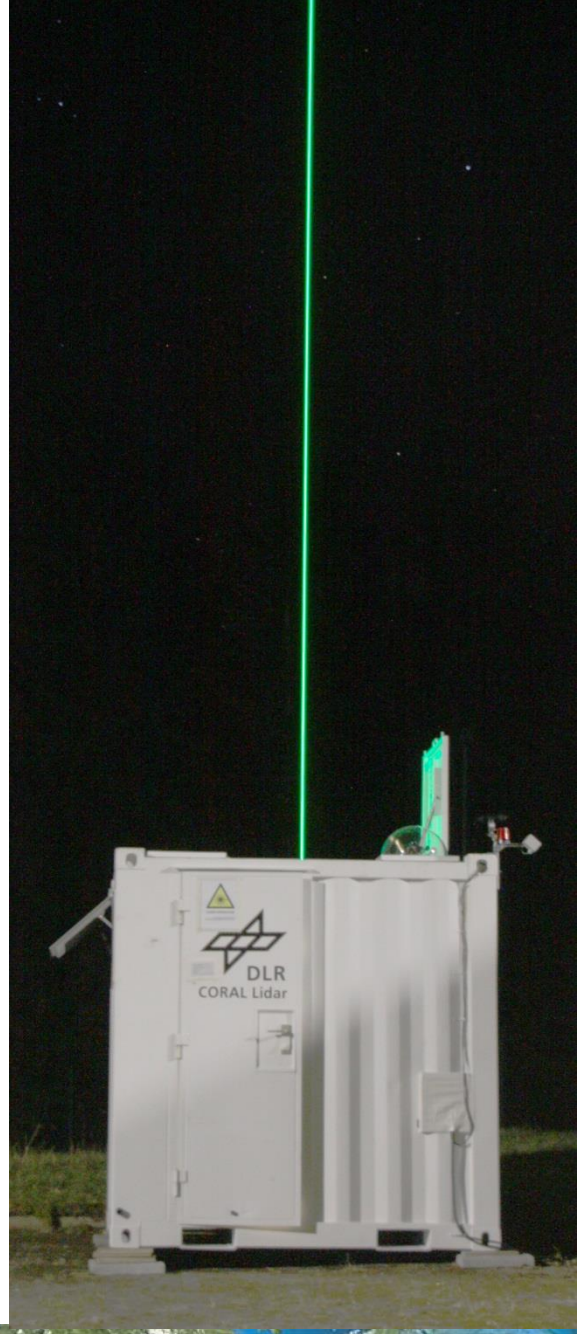
- Rayleigh temperature and NLC backscatter in darkness

History:

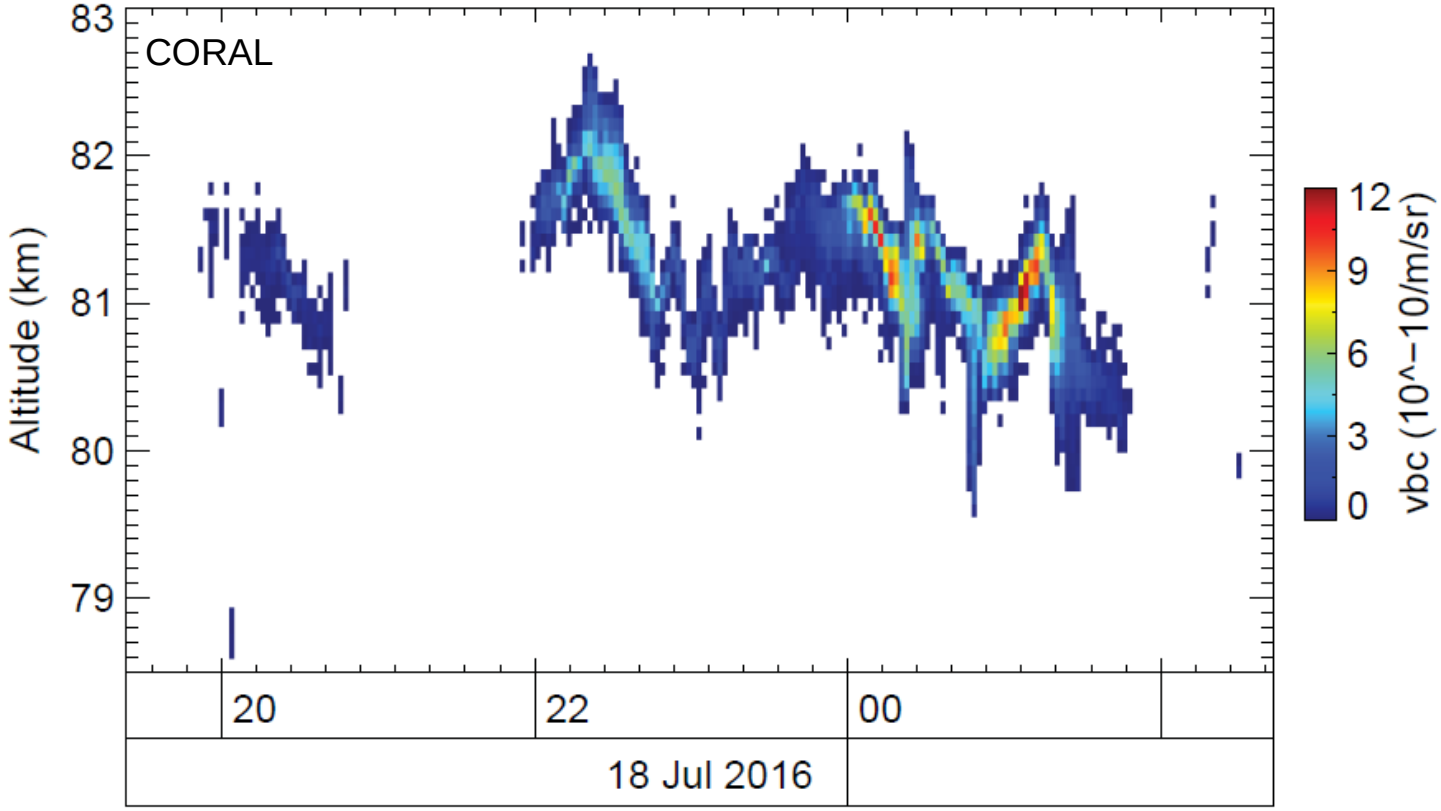
1) Sodankylä, Finland
2) Sulzberg, Germany

48.8°N, 13.7°E
May – Sep 2016
634 h

3) Rio Grande, Argentina



Only NLC observation of 2016 season at 48.8°N



- Bright NLC at low altitudes with thin layers
- Modulations in altitude and brightness

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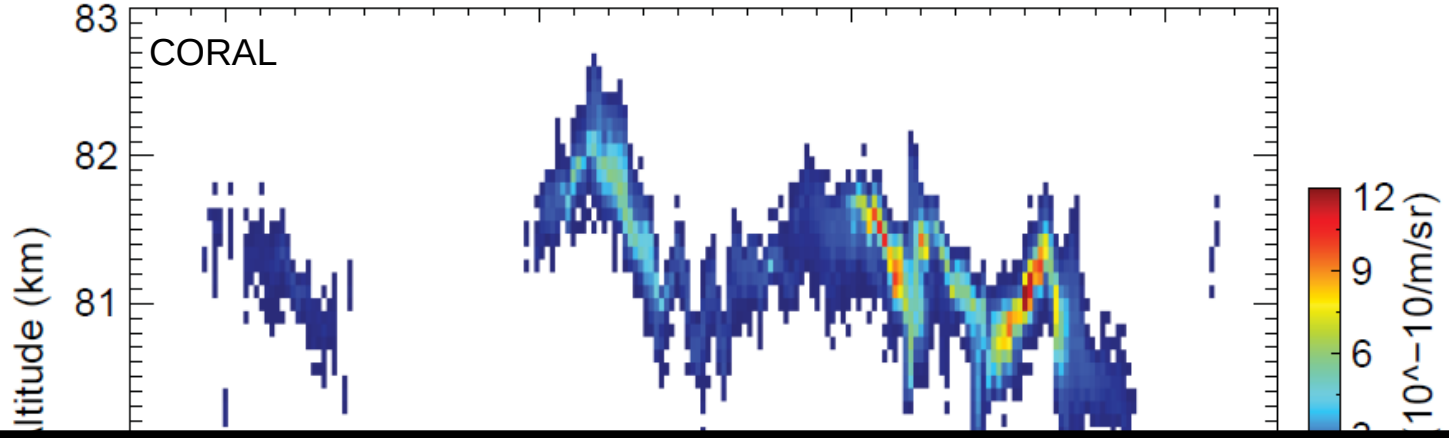


Motivation

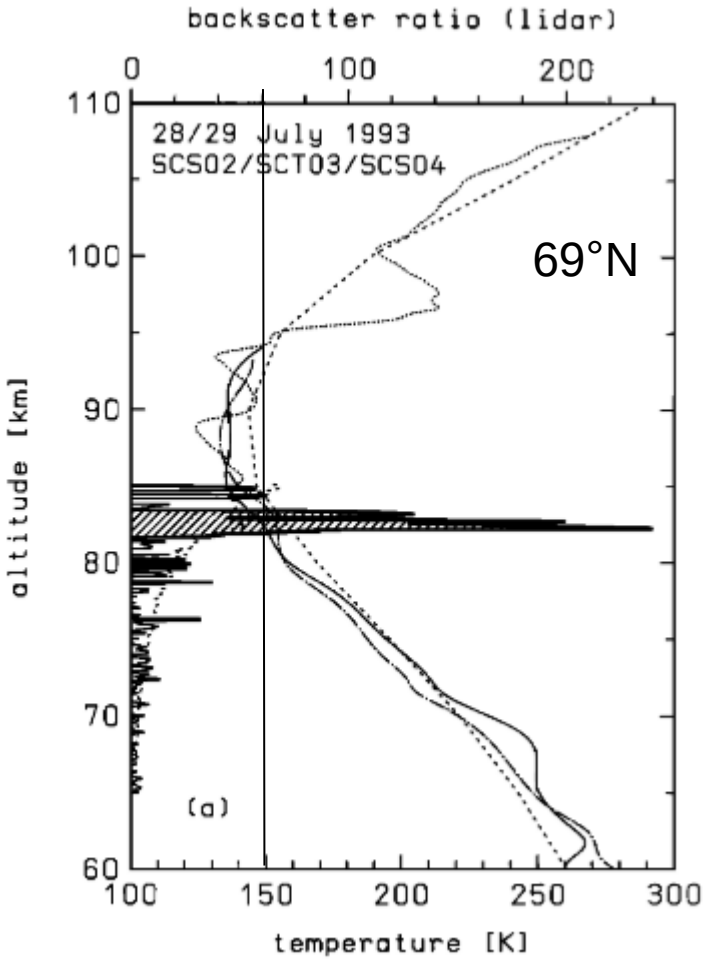
NLC as a tracer for

(1) temperature? → measure temperature

↕

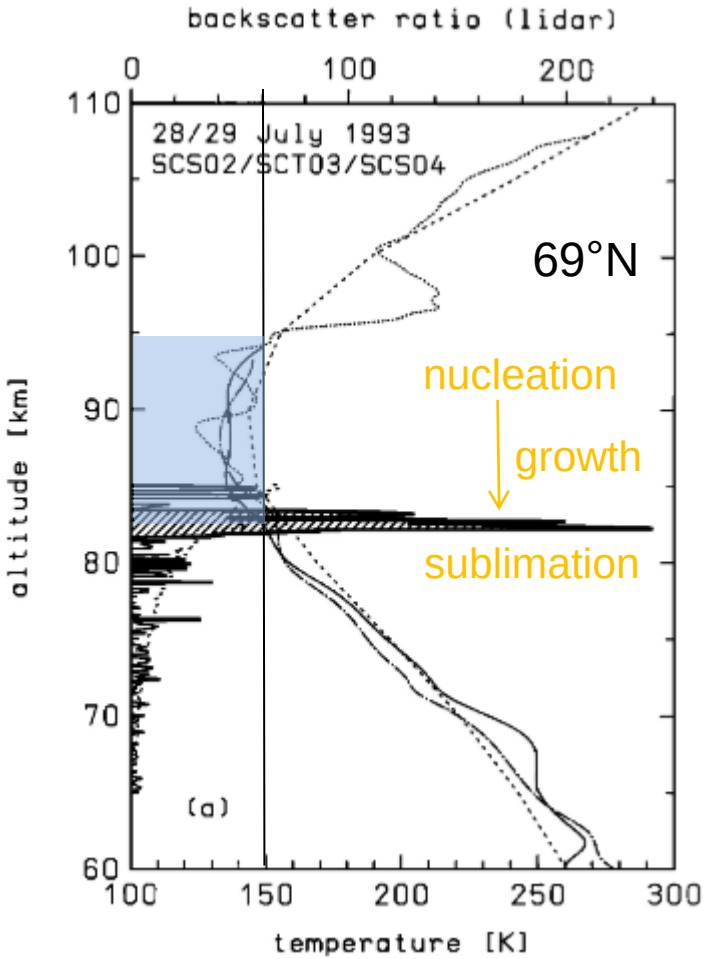
(2) climate change? → where does it come from?

NLC and temperature: polar and mid-latitudes



Lübken et al., JGR, 1996

NLC and temperature: polar and mid-latitudes



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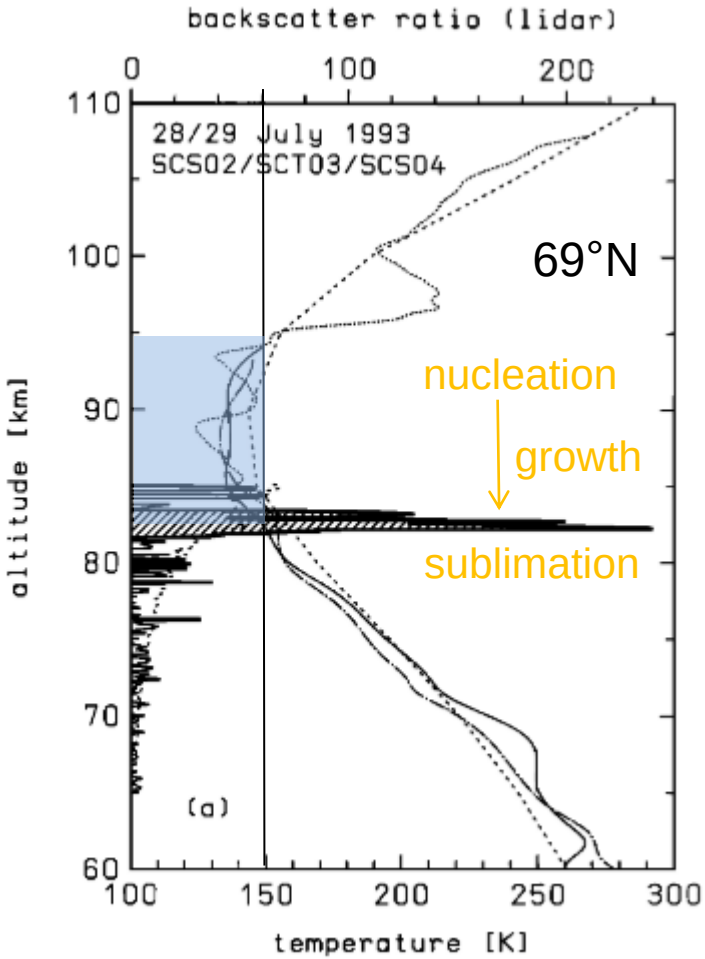

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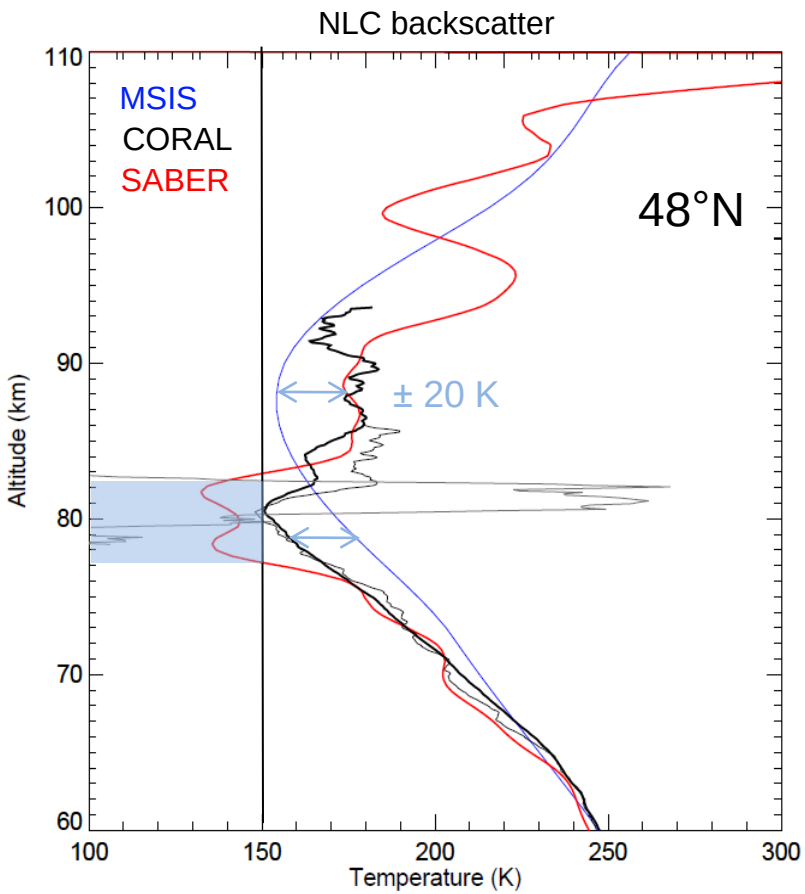
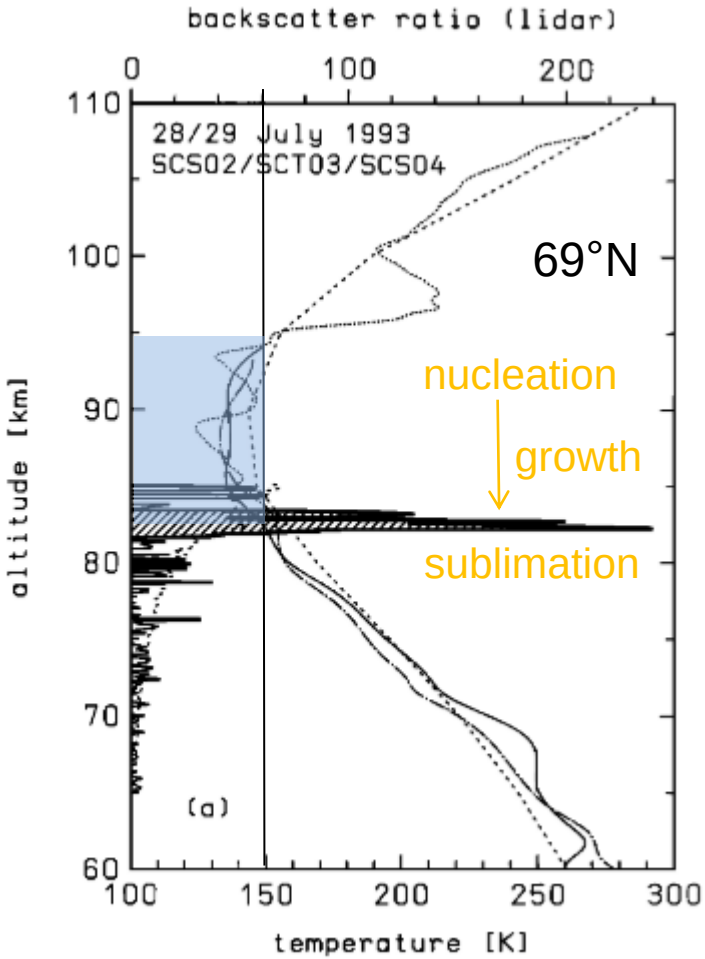


18/19 Jul 2016

NLC and temperature: polar and mid-latitudes



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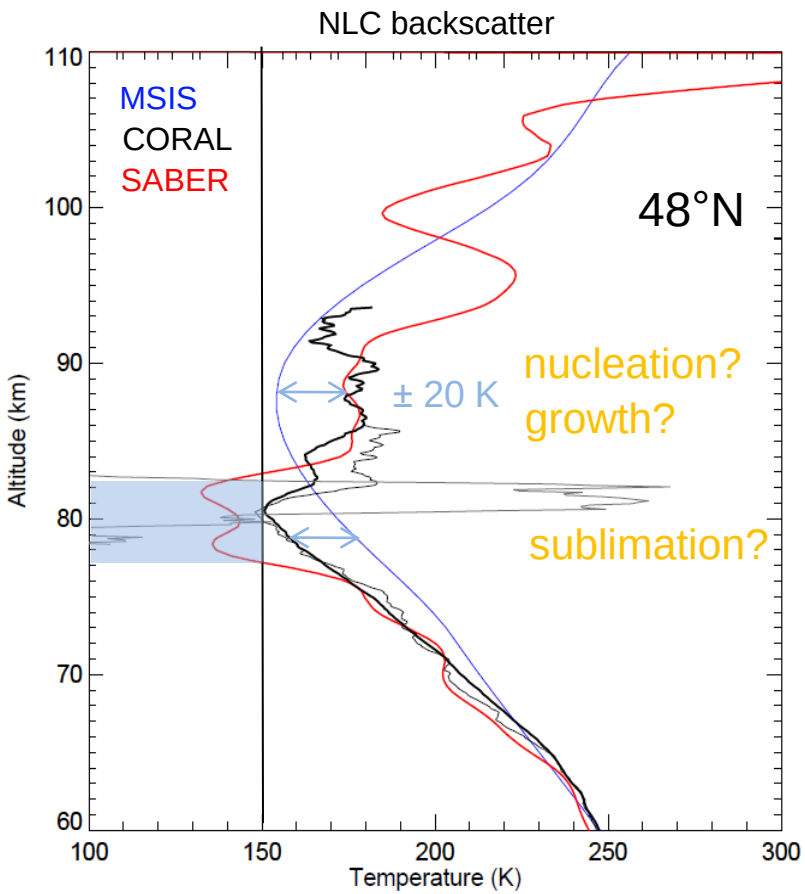

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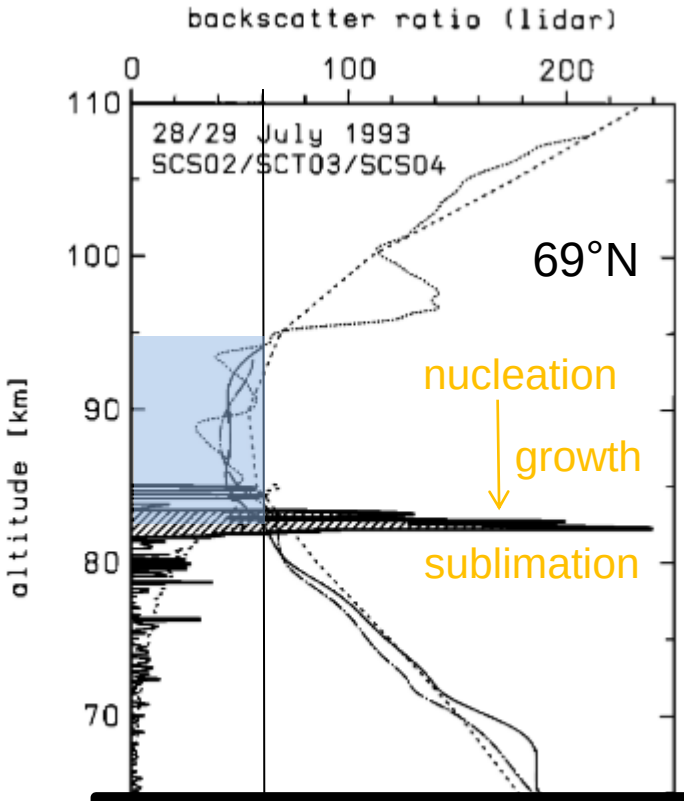
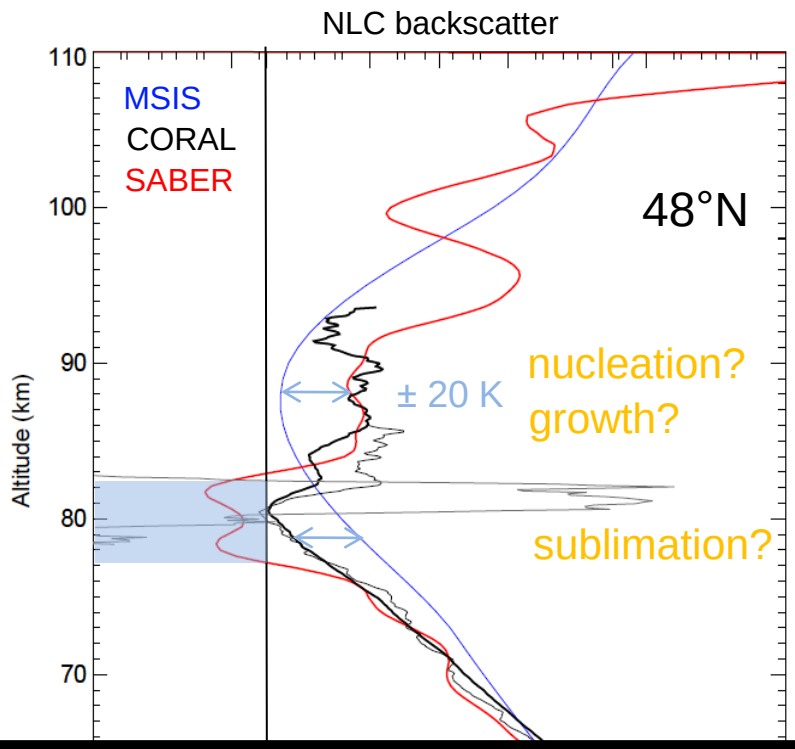
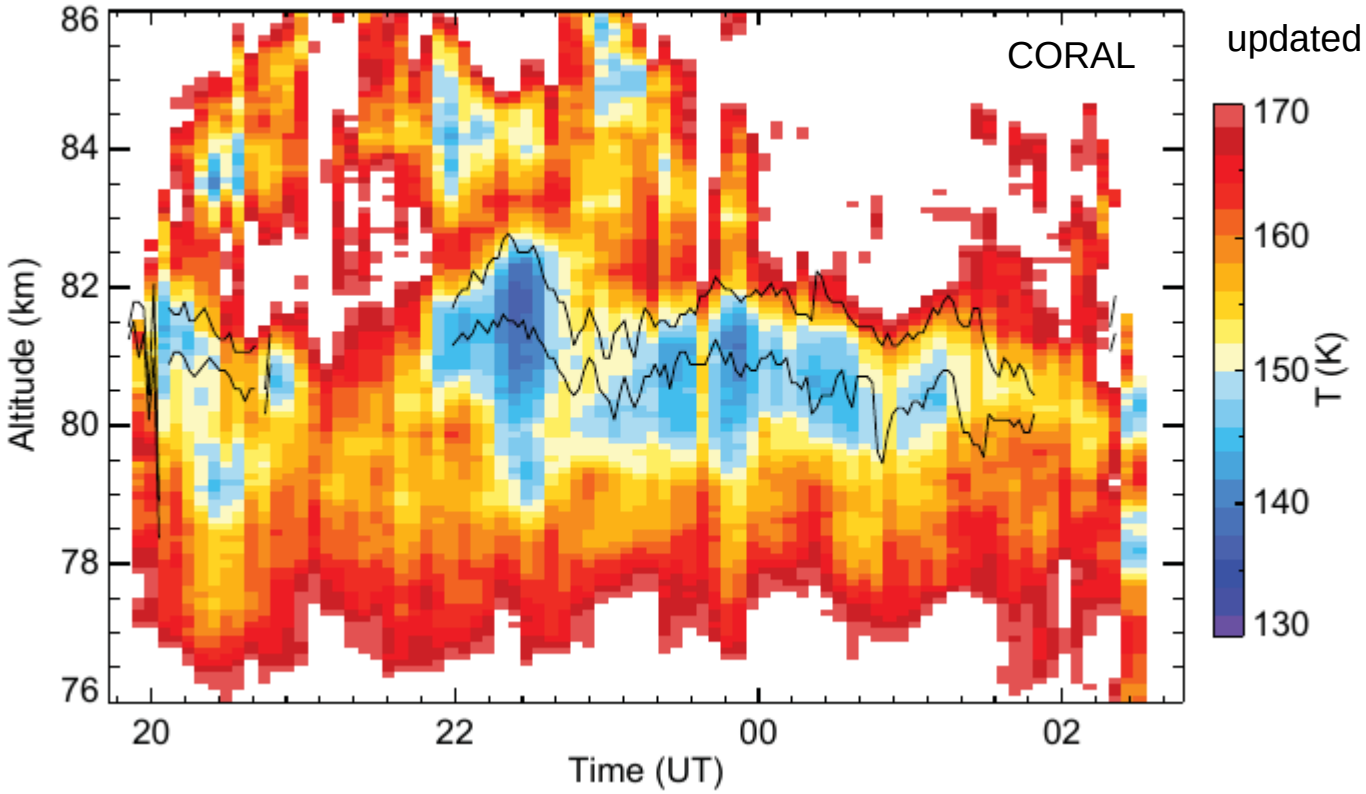




(1) Not a local process

Lübken et al., JGR, 1996

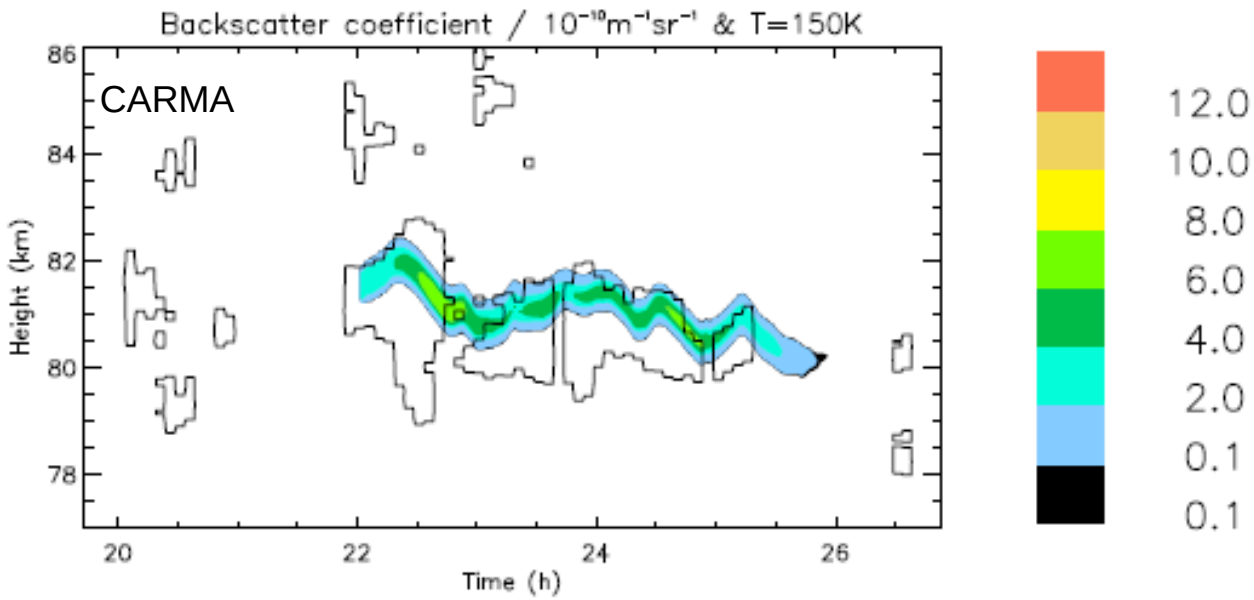
Temperature in vicinity of NLC layer (black contour)



- Density interpolation inside NLC layer
- NLC top boundary follows 155 K isoline

CARMA

- Drive CARMA with lidar T
- Vertical wind from NLC centroid altitude
- Init at 22 UT
- Constant water vapour profile
- No diffusion



DLR

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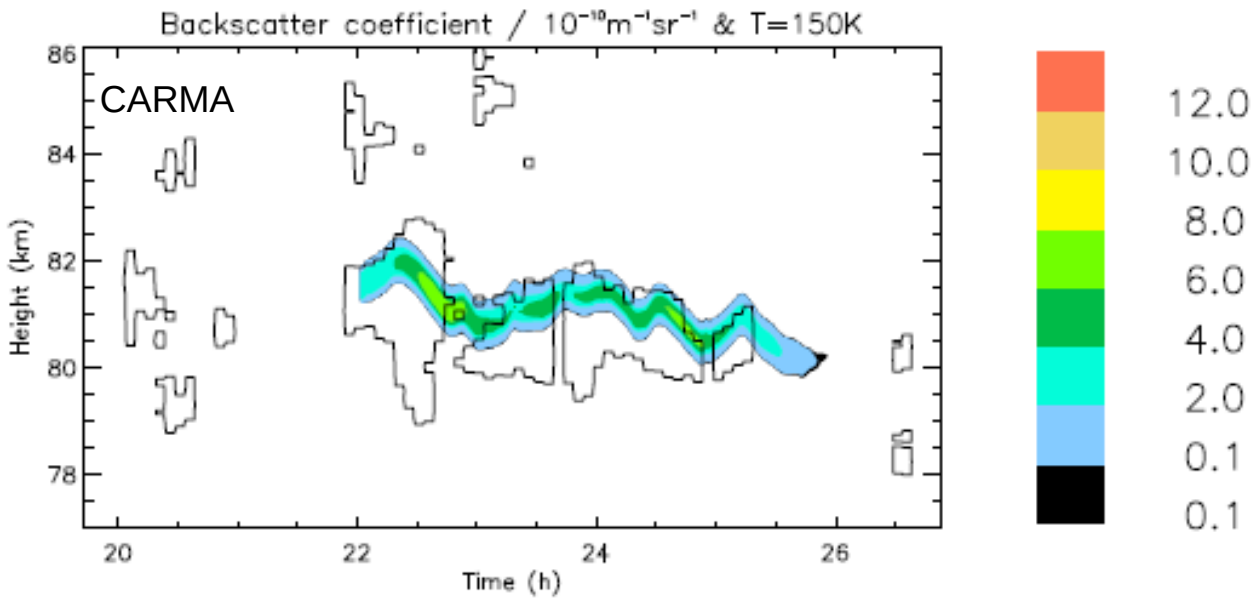
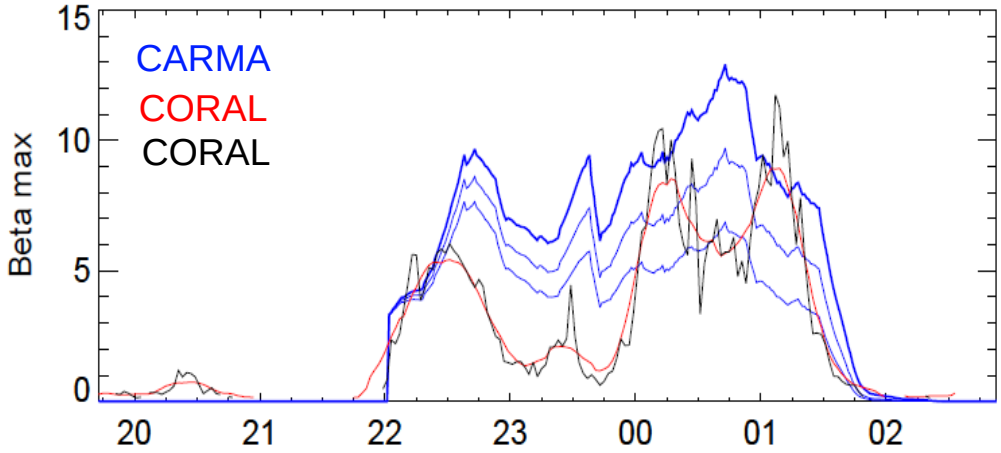
- Evolution of NLC brightness





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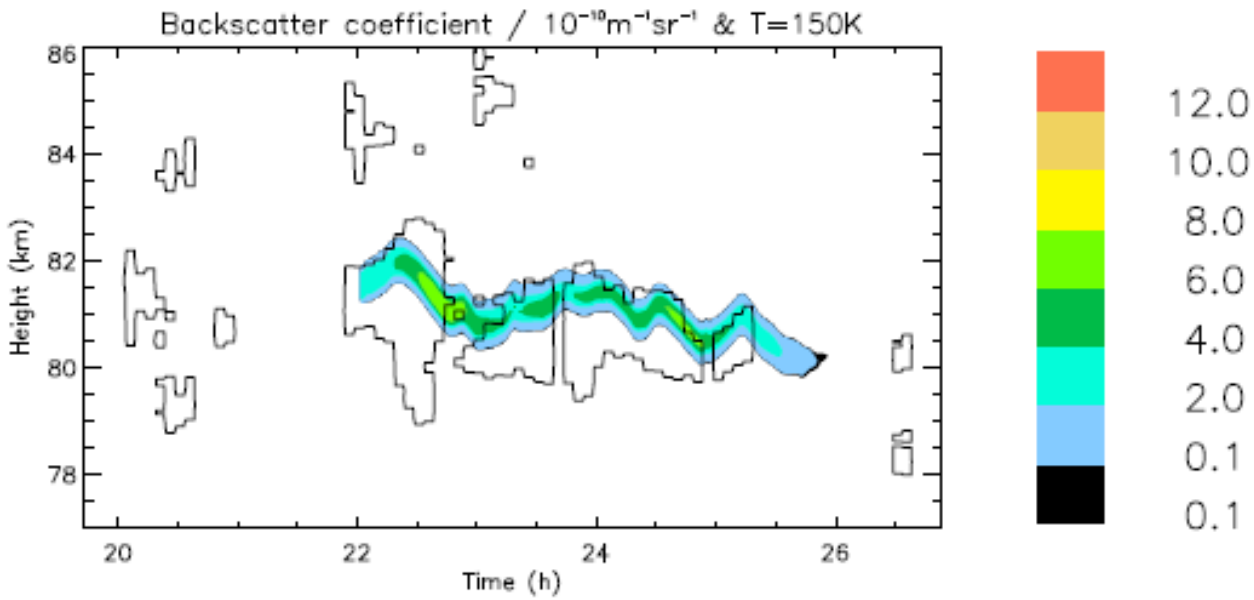
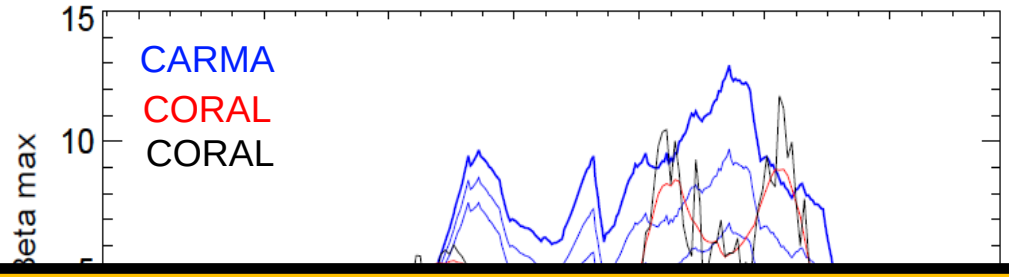
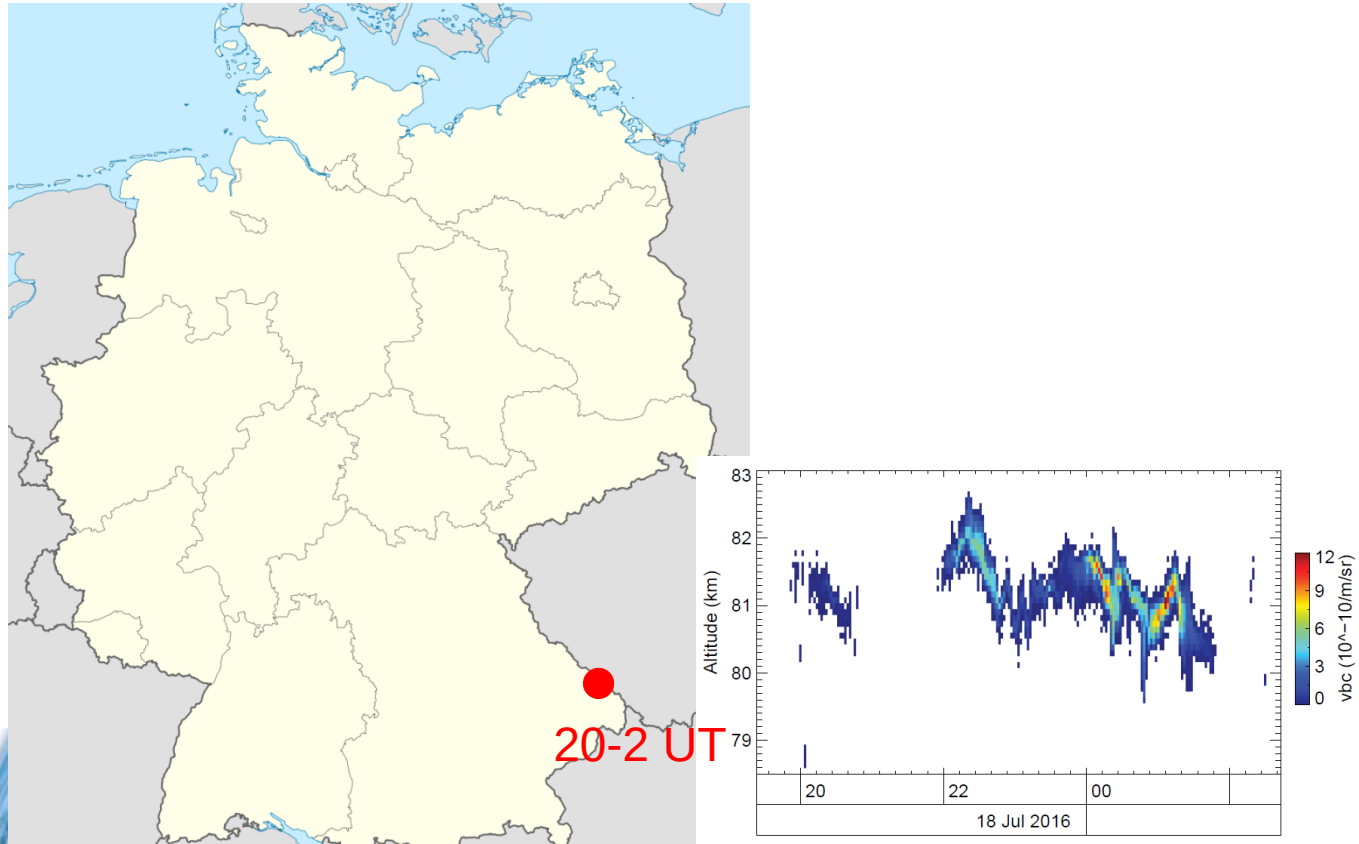




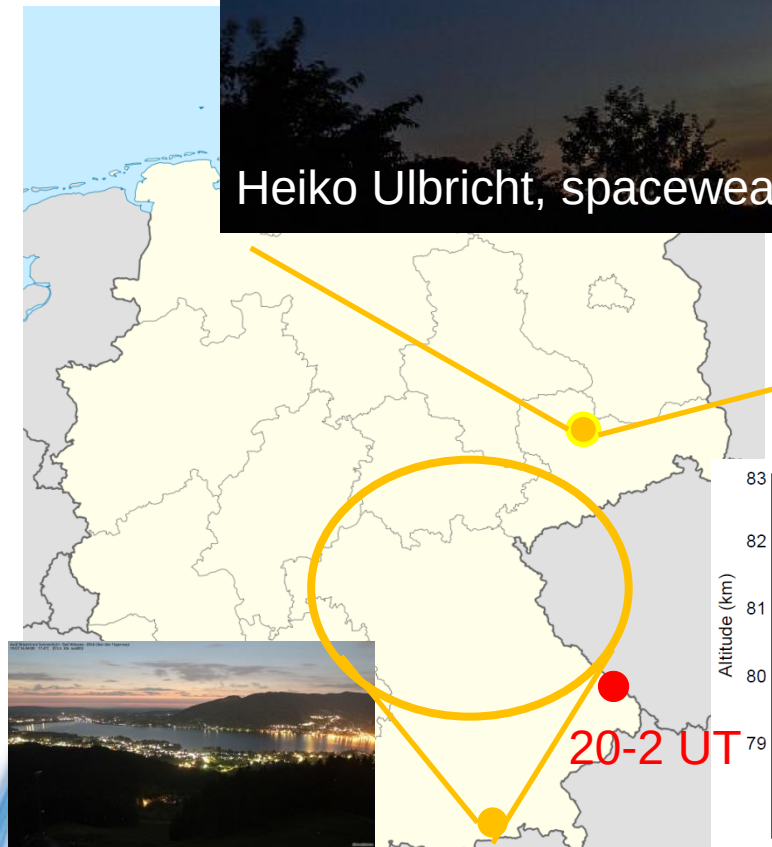
(2) Local conditions determine brightness evolution

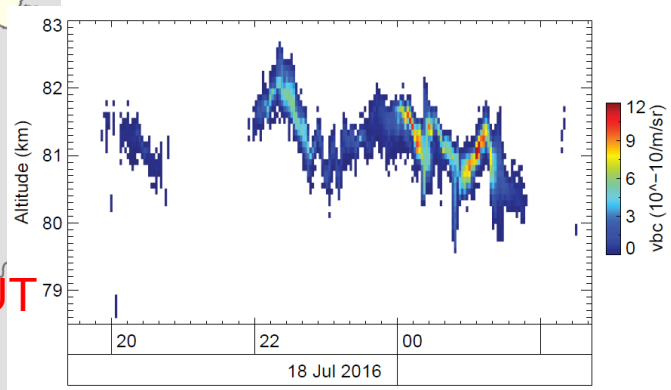
Graphic summary



Visual observations

- Several observations from Germany, Latvia, Estonia and Finland in this night (evening, morning)



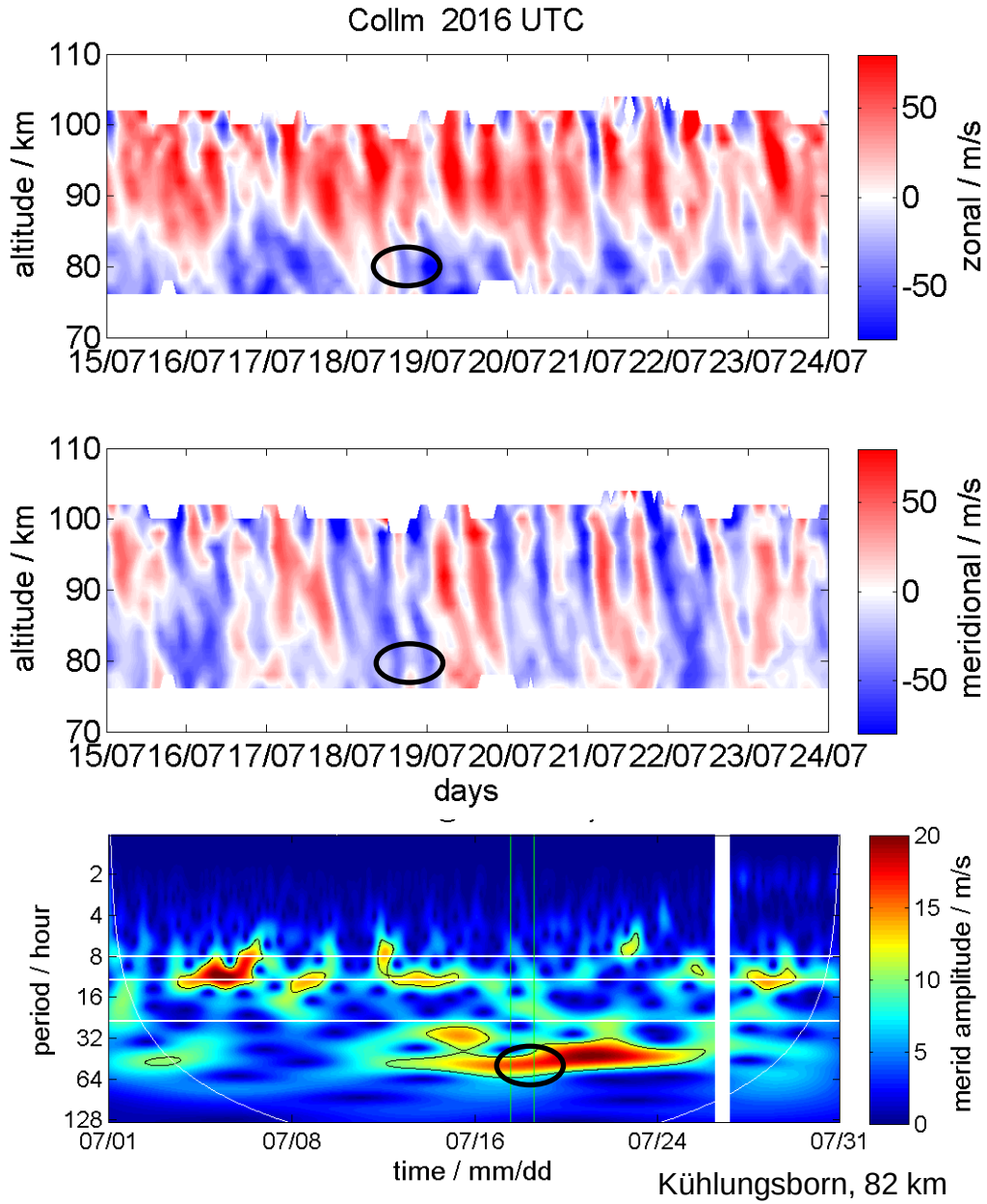


DLR

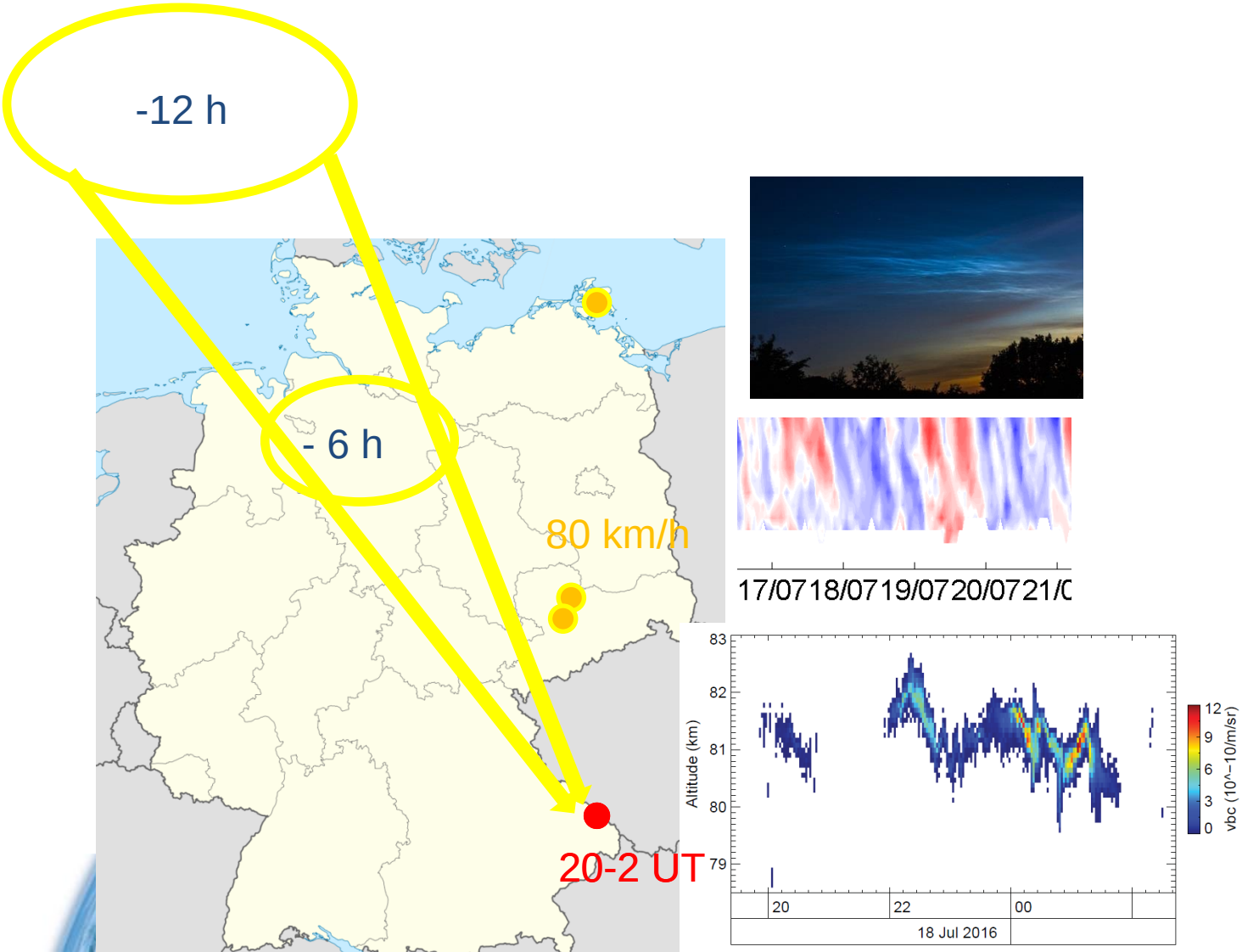
Mesopause winds

- Meteor radar from Collm and Kühlungsborn
- Strong 2-day planetary wave
- Strong southward wind on 18/19 July 2016 at 82 km
- 22 m/s or 80 km/h

→Transport of cold air from polar to mid-latitudes

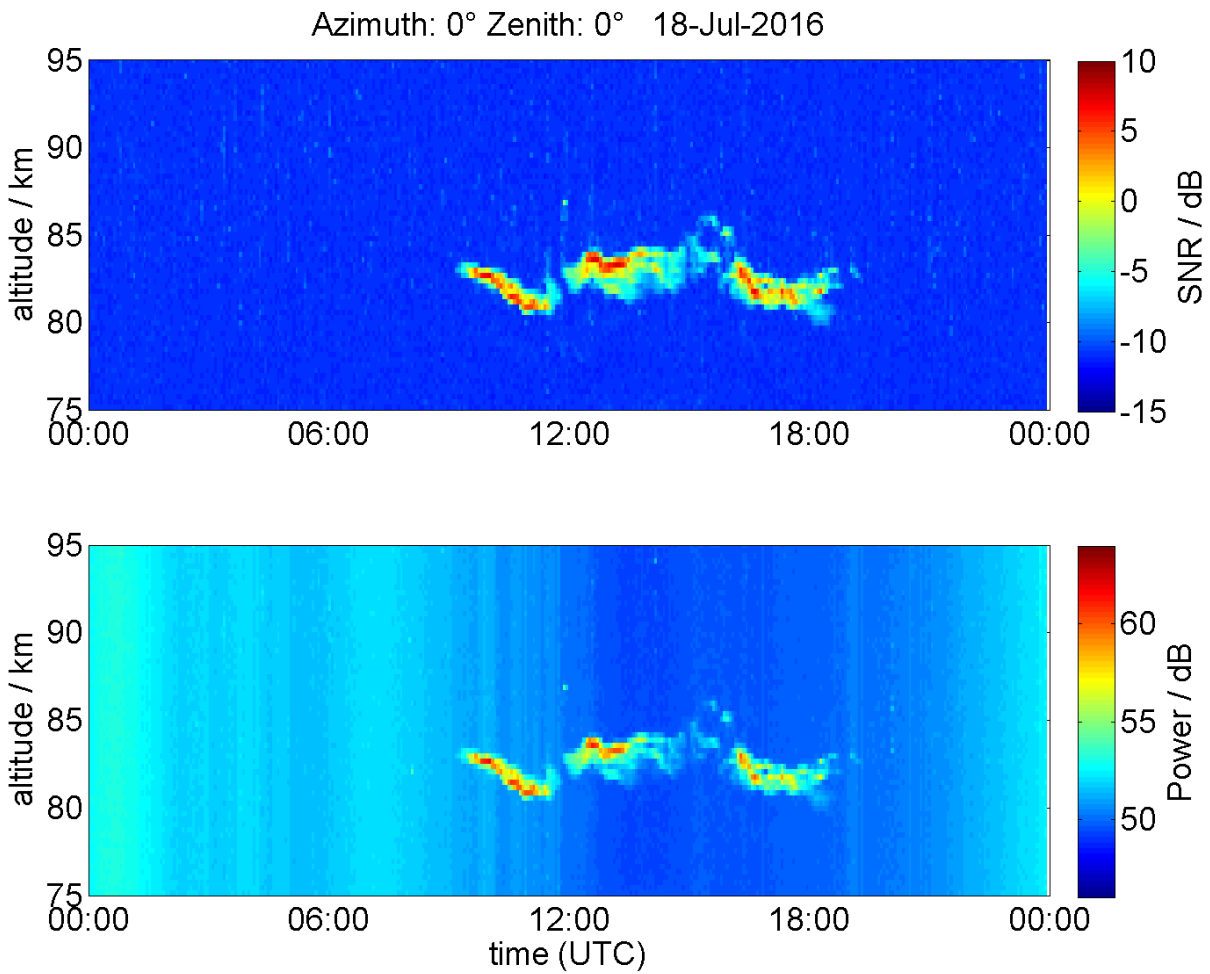


NLC transport



Mesospheric summer echoes

- MSE above Kühlungsborn likely precursor for NLC
- Similar layer morphology
- Higher altitude consistent with sedimentation
- Time lag consistent with transportation



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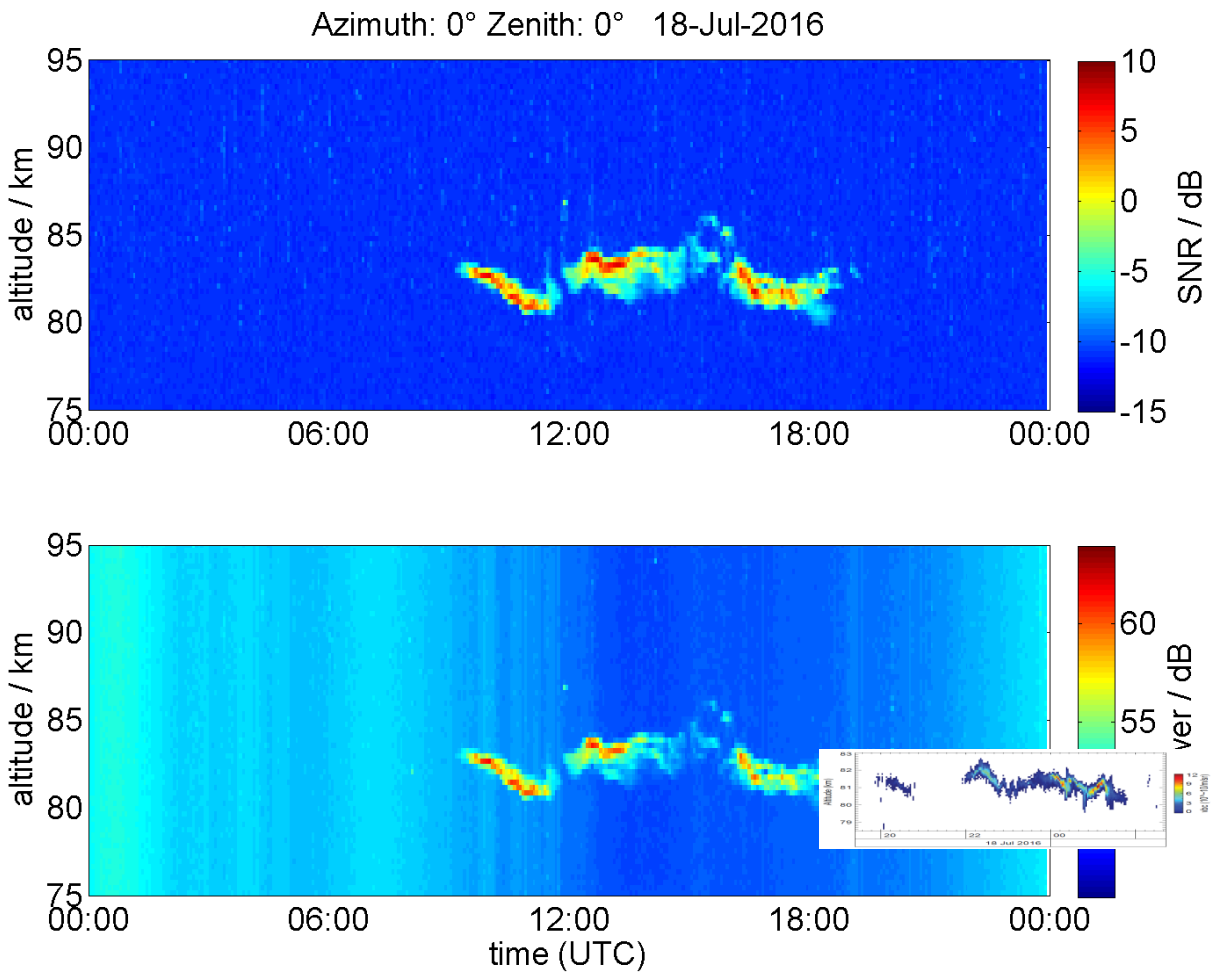
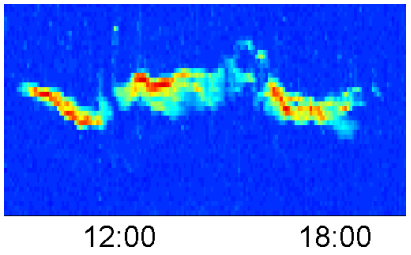
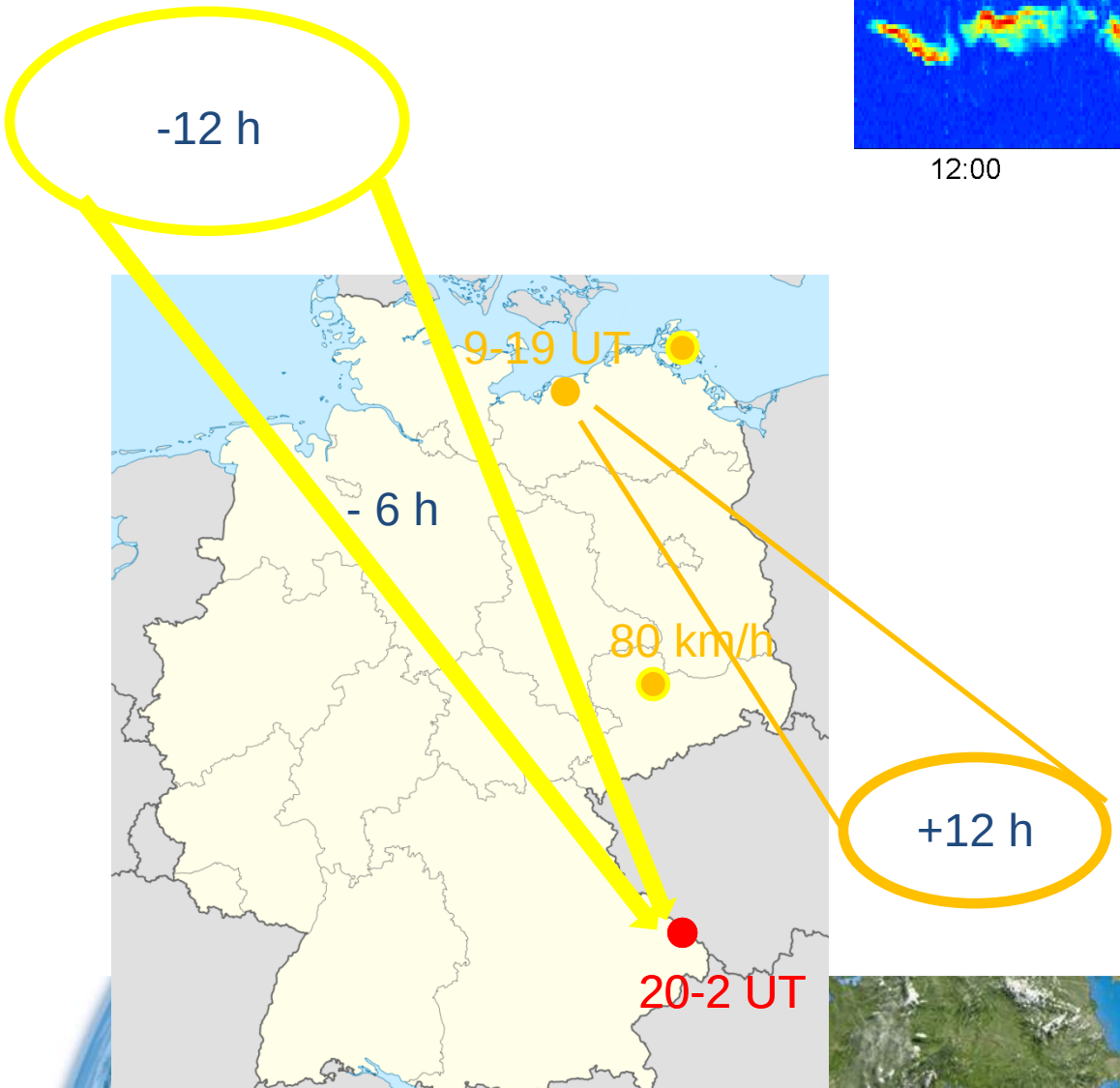


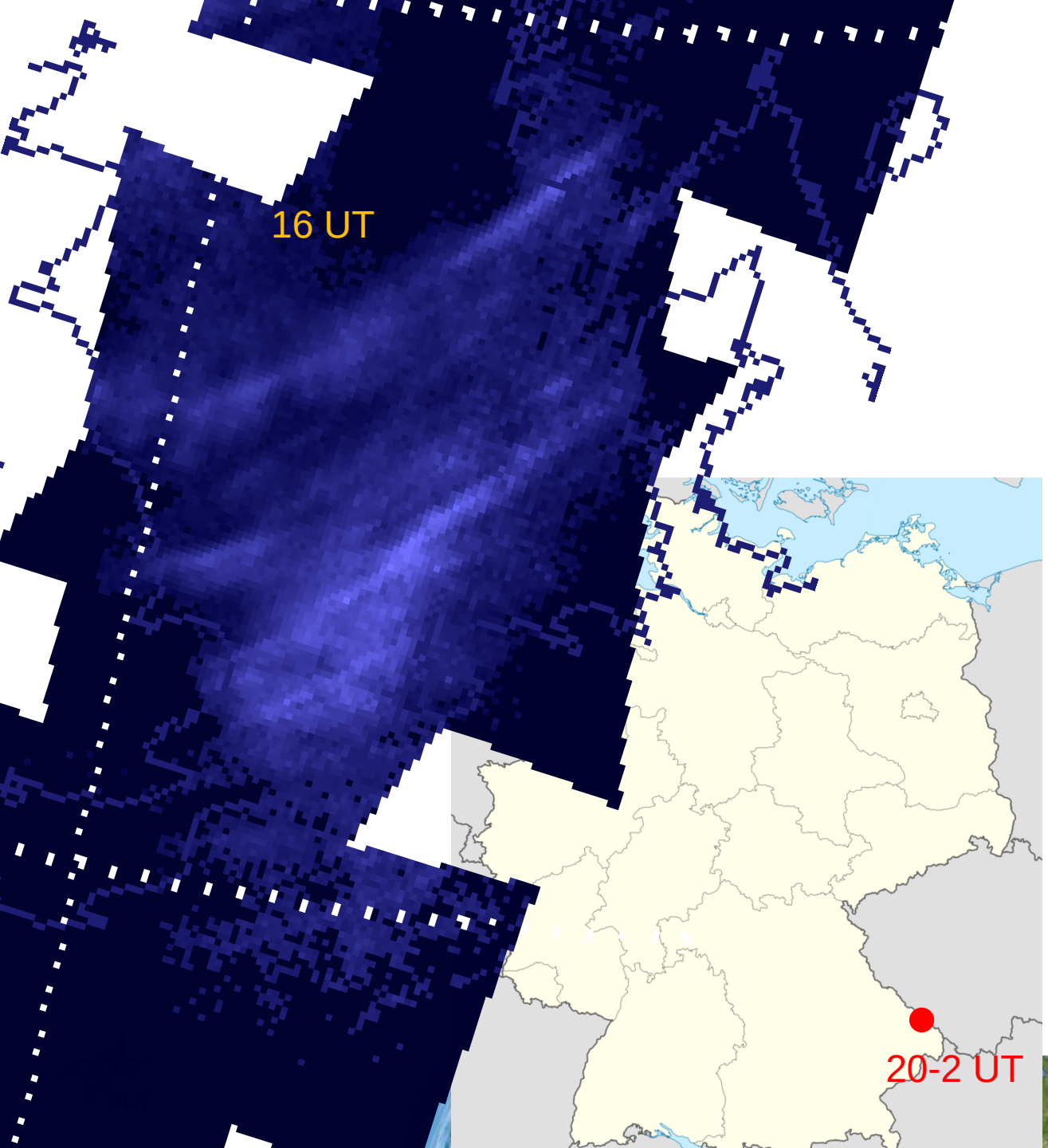
MSE transport



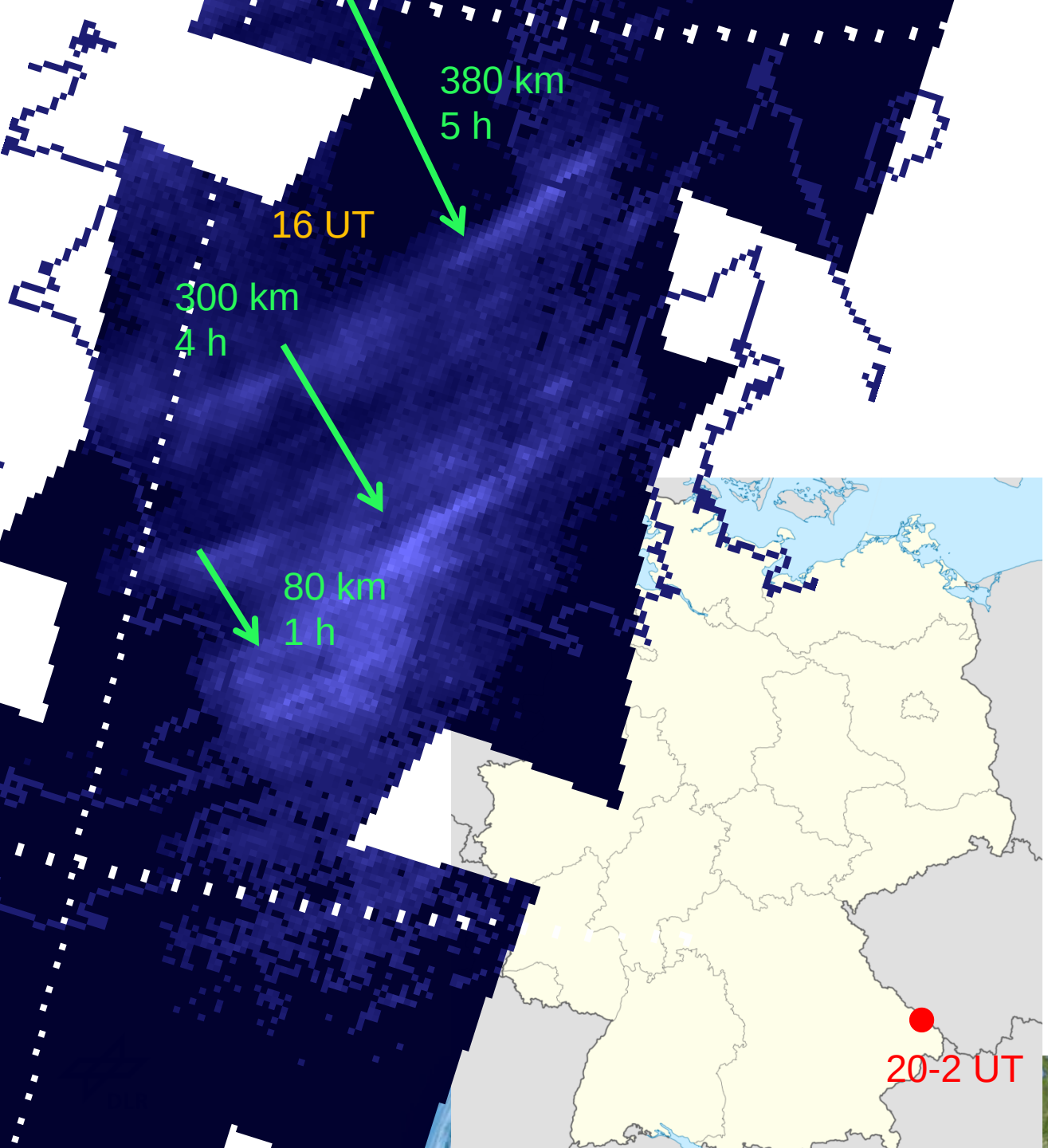


DLR

CIPS/AIM



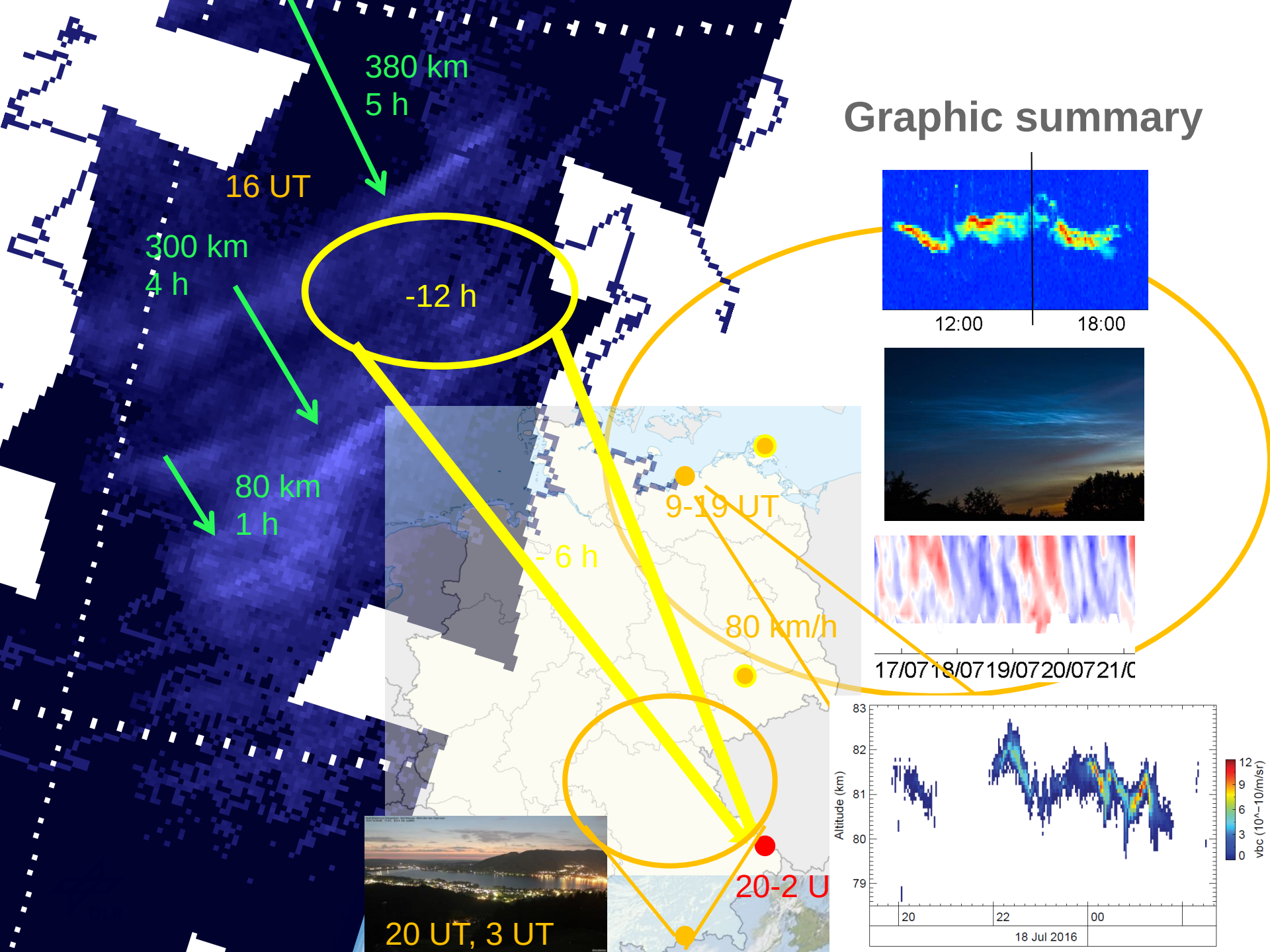
- Extended field of NLC 52 – 62°N above North Sea
- Max 18 · 10^{-10} / sr



CIPS/AIM

- Extended field of NLC 52 – 62°N above North Sea
- Max 18 · 10^{-10} / sr
- Aligned wave crests
- 80, 300 and 380 km

Graphic summary



Conclusions

- Single NLC observation in 2016 at 48.8°N
- Rayleigh temperature measurements above NLC layer
- Large temperature above NLC, T < 150 K inside and below
- CARMA driven with lidar temperatures give realistic brightness evolution
- No local nucleation, but determination of brightness variations locally
- NLC widespread in central Europe
- Consistent with visual, wind, MSE and CIPS observations