

Cloud Layer Overlap and the Influence of Vertical and Temporal Resolution of Radar Data

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- Cloud Layer Overlap
- Influence of Data Resolution
- Radar / Ceilometer Comparison
- Conclusions & Outlook

Cloud Layer Overlap: Introduction

Current Models:

- Random Overlap
- Maximum Overlap

$$C_{rand} = c_a + c_b - c_a c_b$$

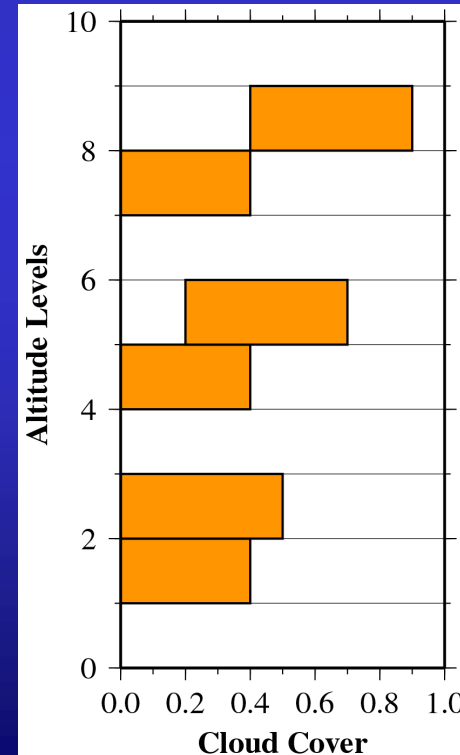
$$C_{max} = \max(c_a, c_b)$$

-> True Overlap?

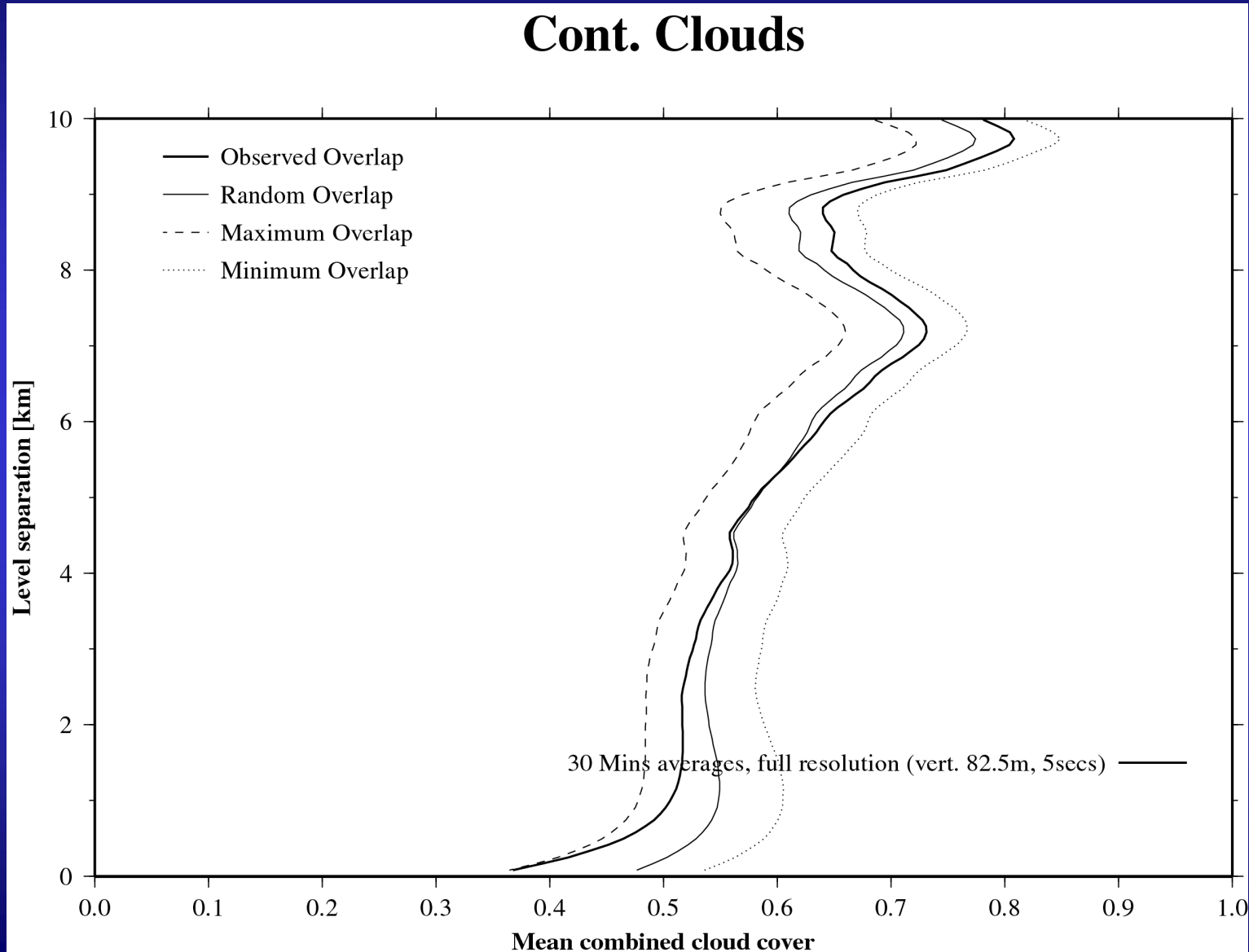
Combined Cloud Cover as function of level separation for all overlap models

(mean values over 30mins / 60mins)

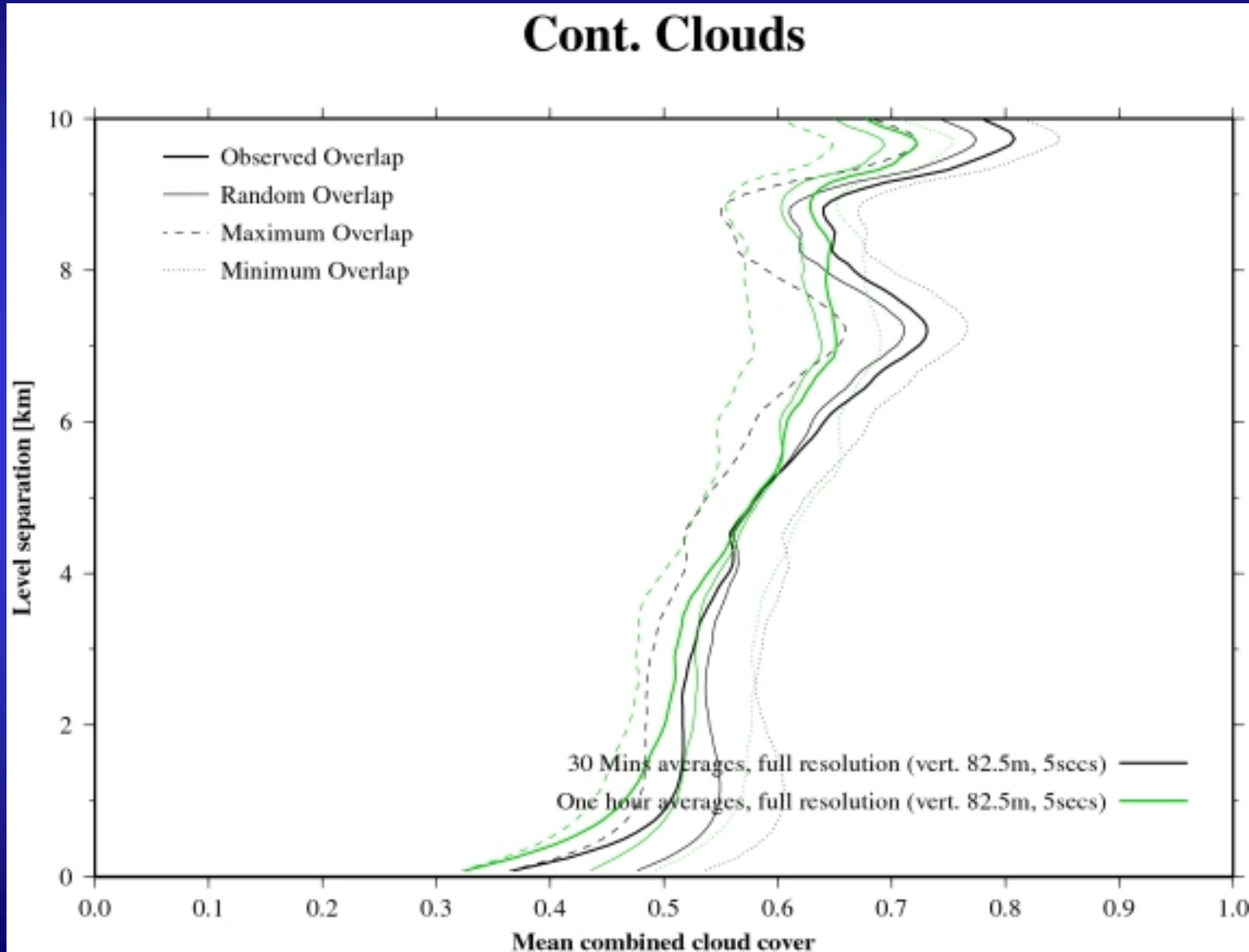
Vert. cont. / non-cont. clouds



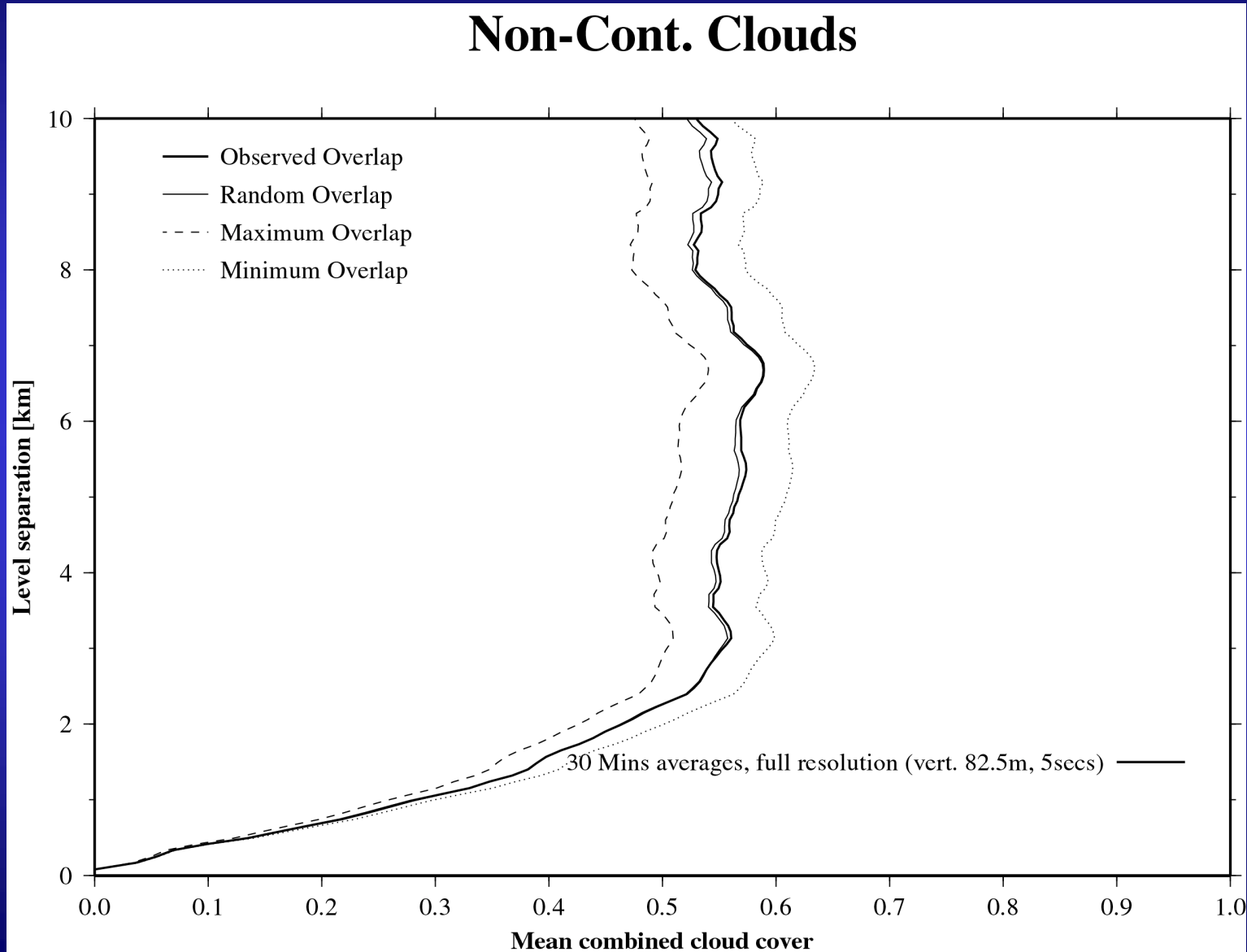
Cont. Clouds



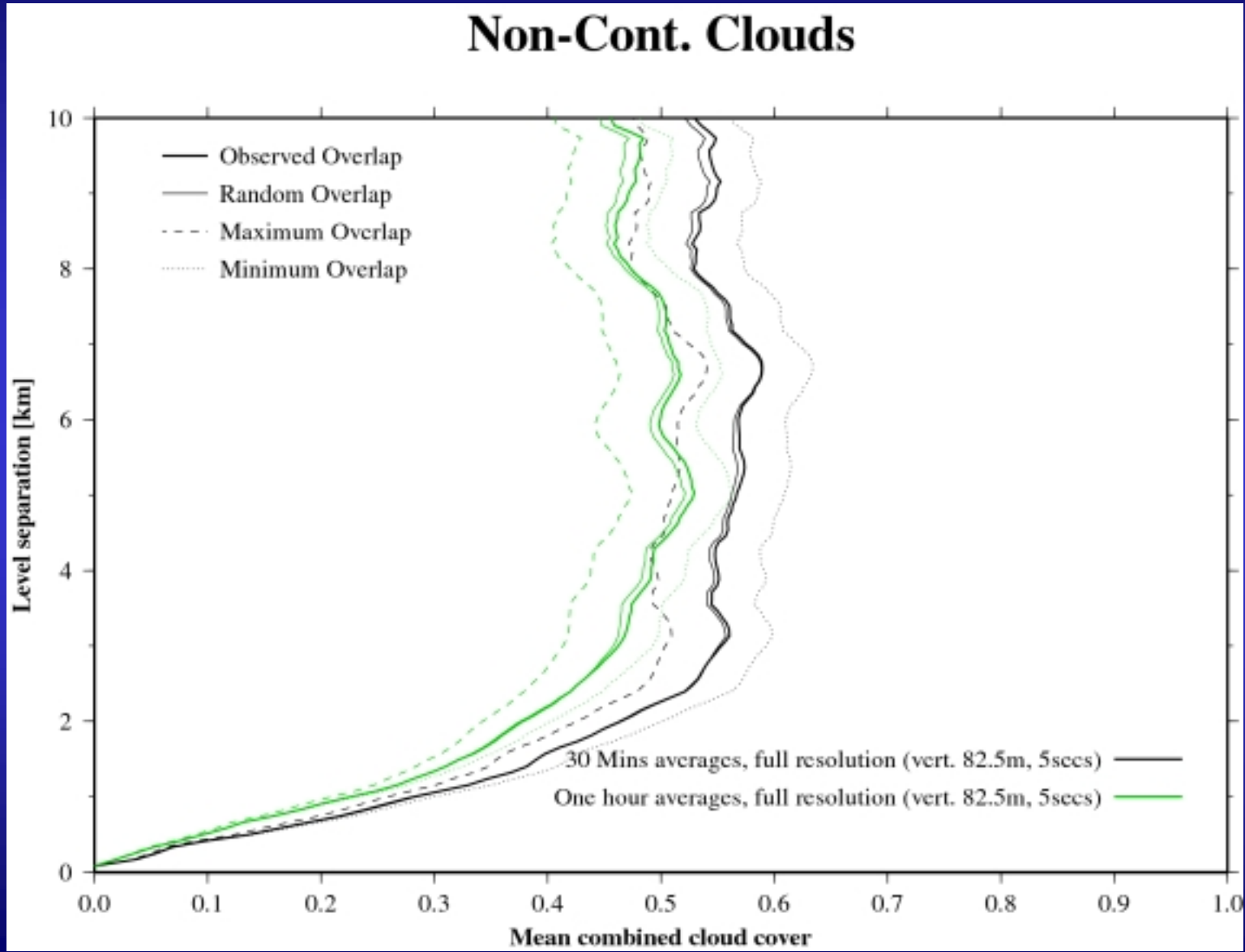
Combined Cloud Cover



Combined Cloud Cover



Combined Cloud Cover



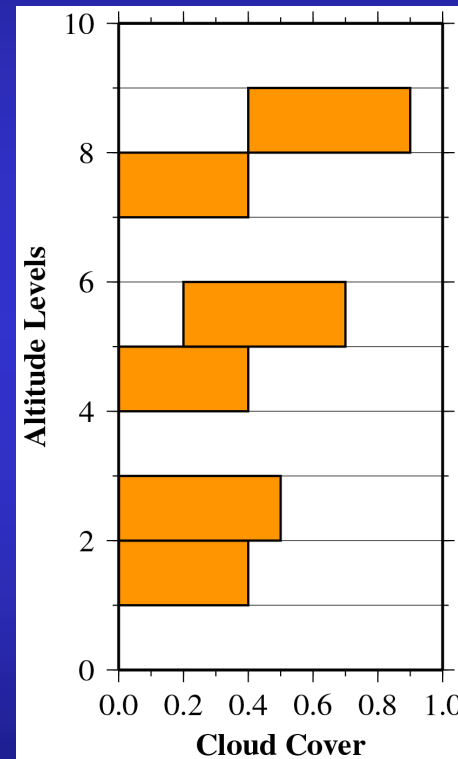
Overlap Parameter α

Combined Cloud Cover not useable to describe cloud overlap

Needed: Parametrisation of true overlap as function of overlap models

=> Overlap Parameter α

$$C_{true} = \alpha C_{max} + (1 - \alpha) C_{rand}$$

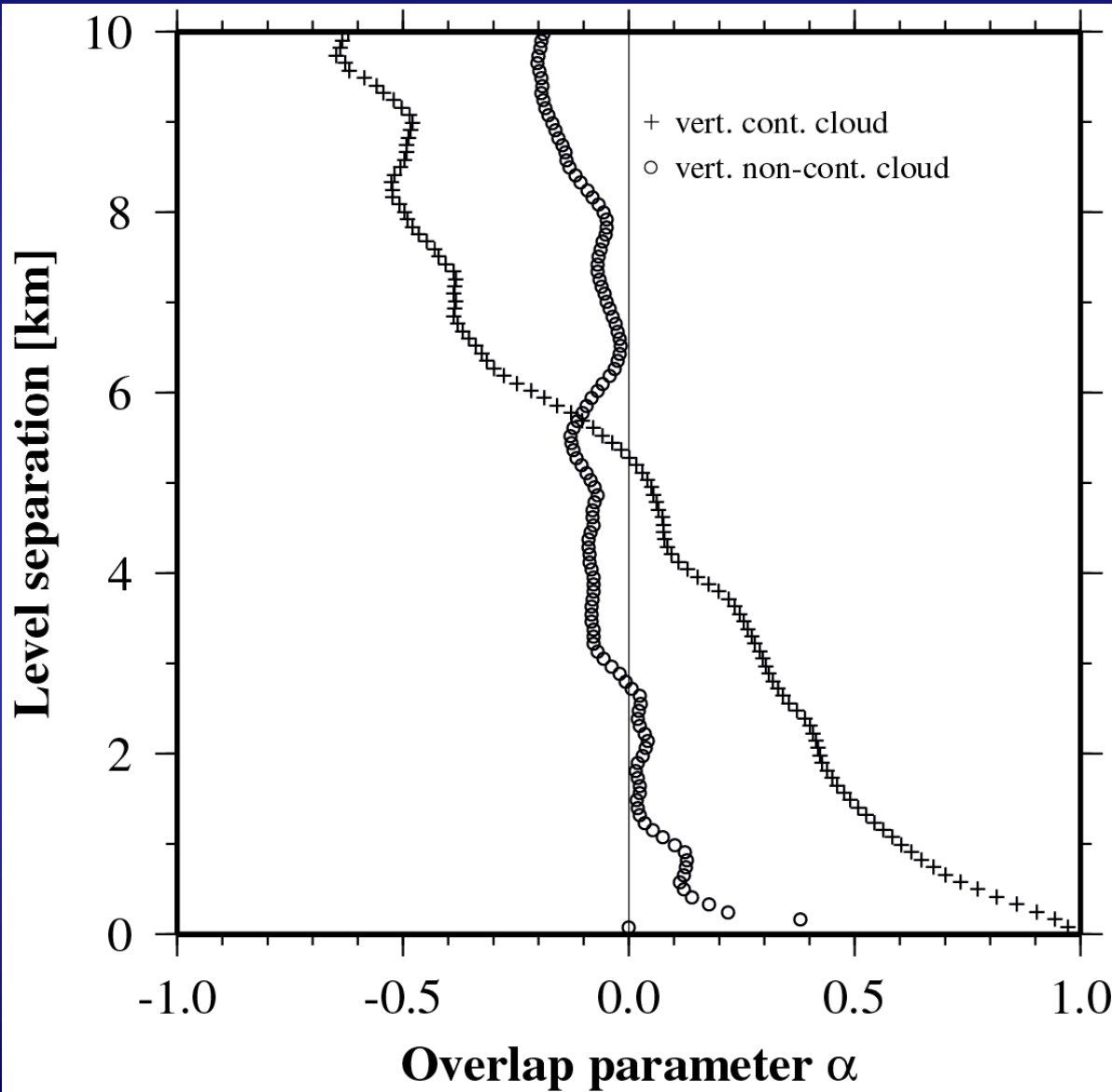


$\alpha = -1$

$\alpha = 0$

$\alpha = +1$

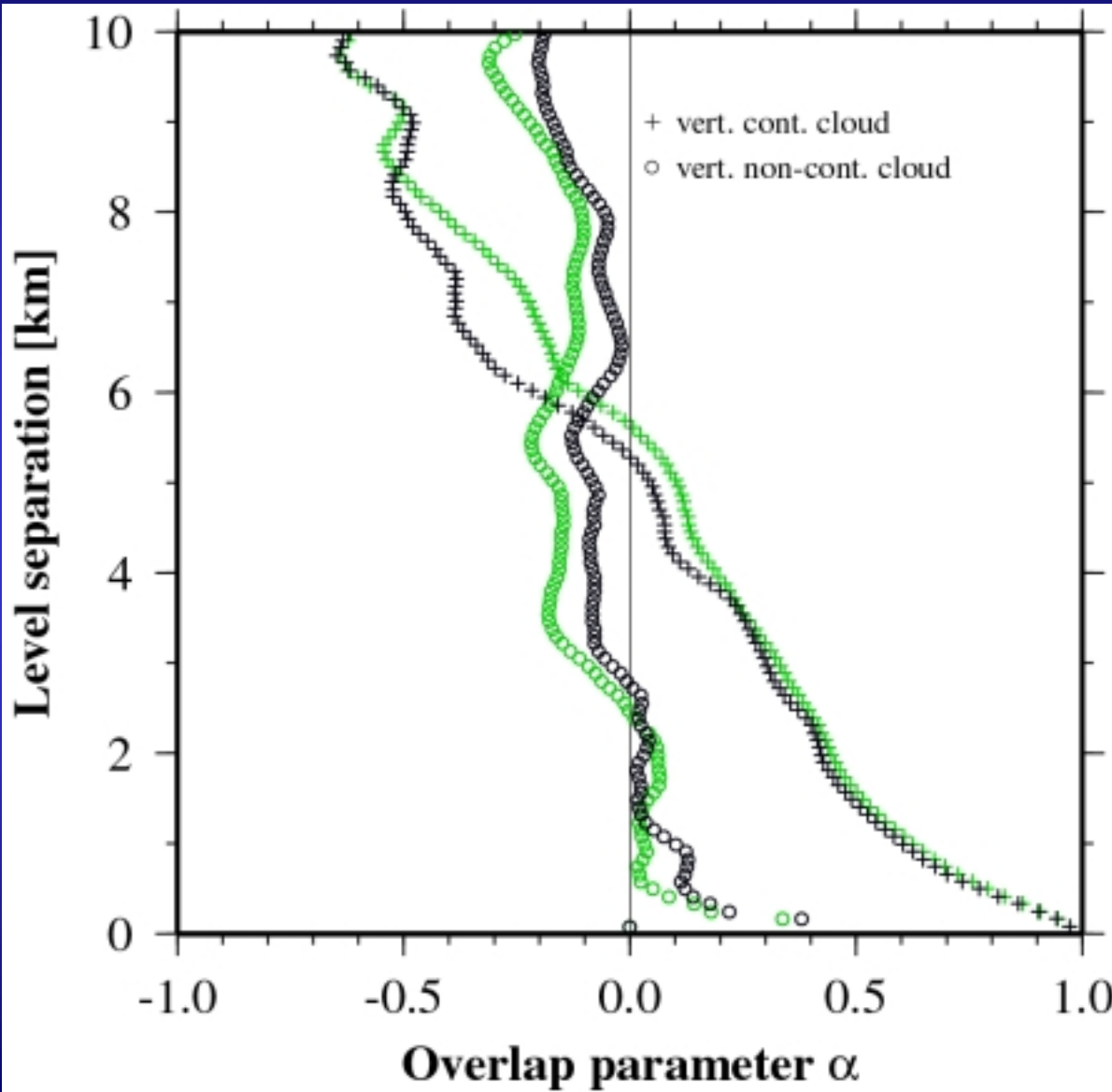
Overlap Parameter α



Full Resolution
(82.5 m / 5secs)

30 mins mean CC

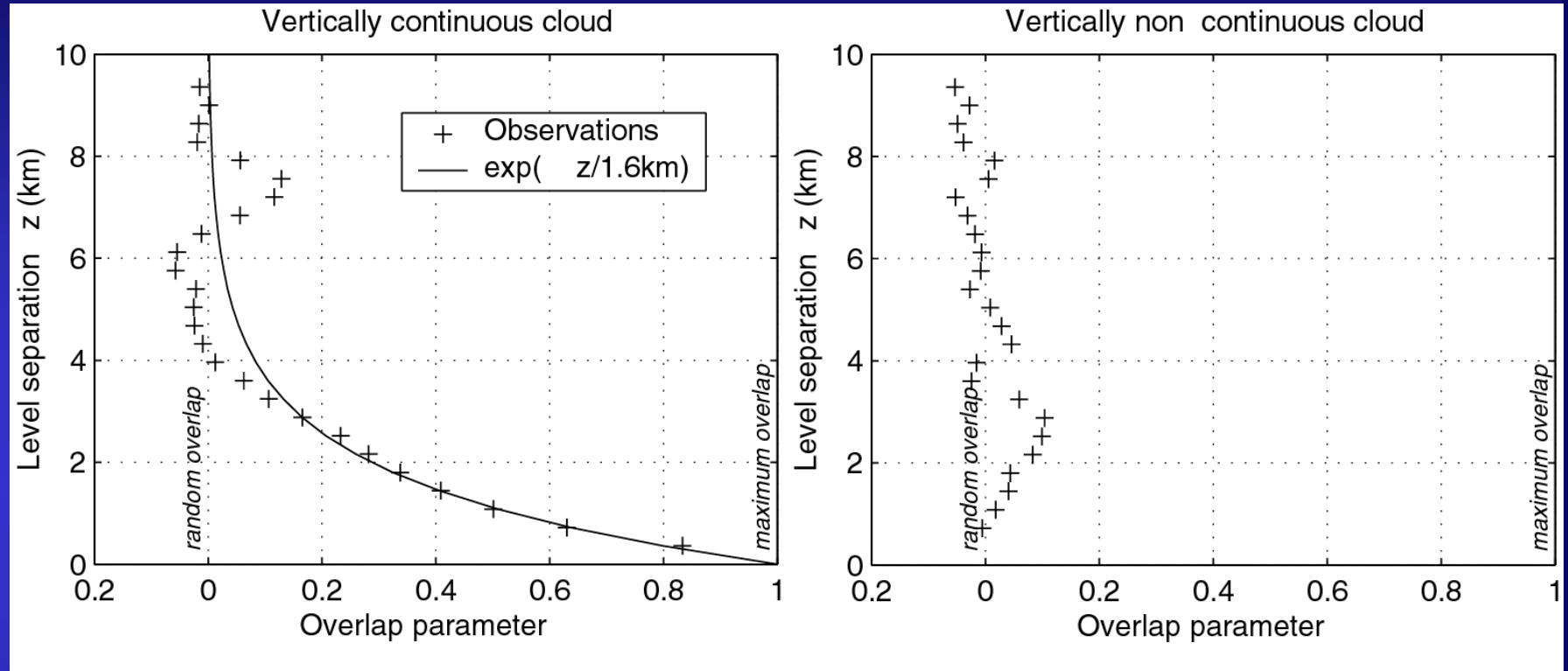
Overlap Parameter α



Full Resolution
(82.5 m / 5secs)

30 mins mean CC
60 mins mean CC

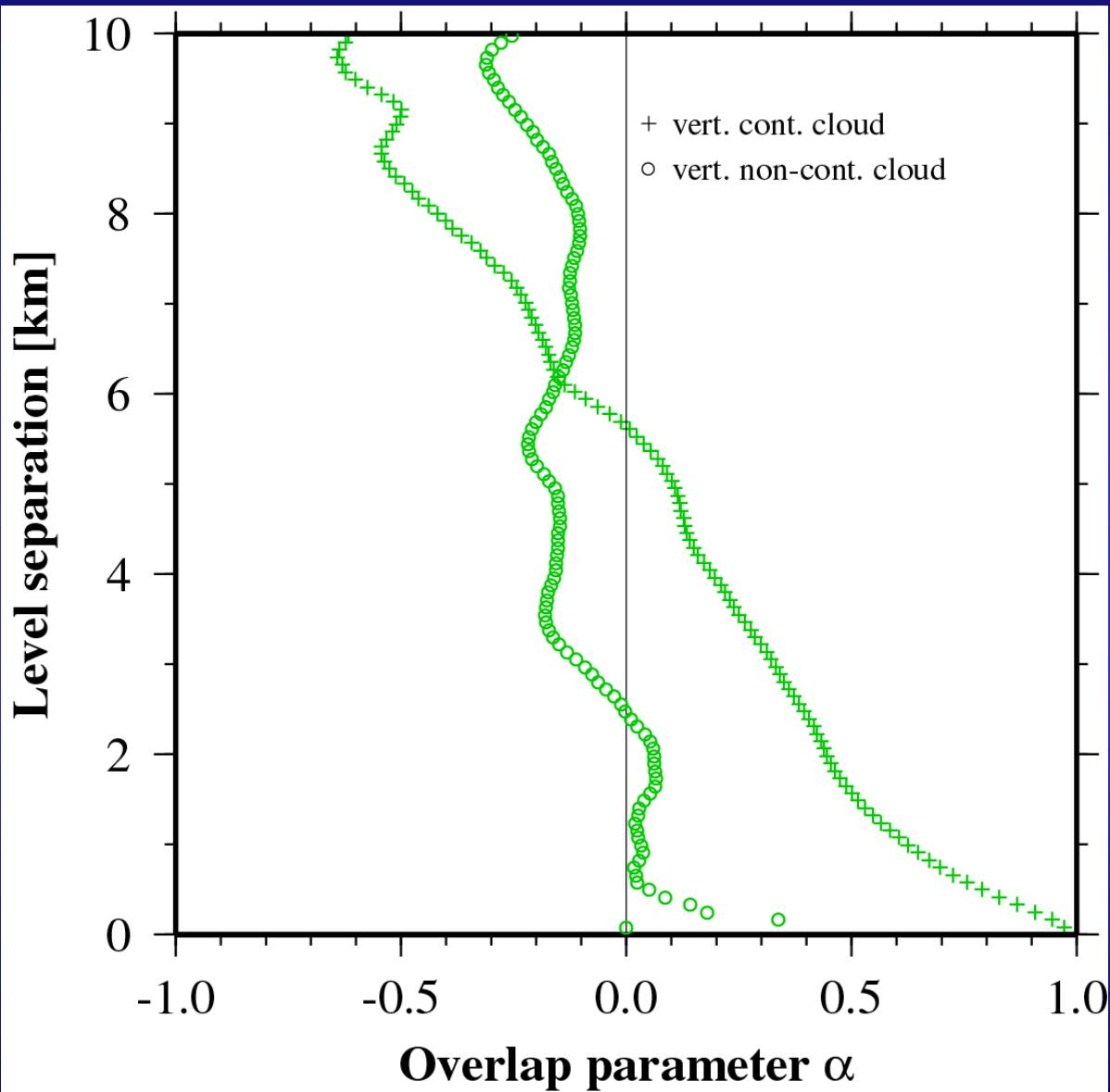
Earlier Publication



From: Hogan and Illingworth, 2000, QJR Meteorol. Soc., 126, 2903-2909
Used resolution: rough cloudmask about 2 mins / 360 m / 60 mins average

BBC: no convergence at random overlap
for large level separation, exponentiell
fitting is „dared“ - but full resolution!

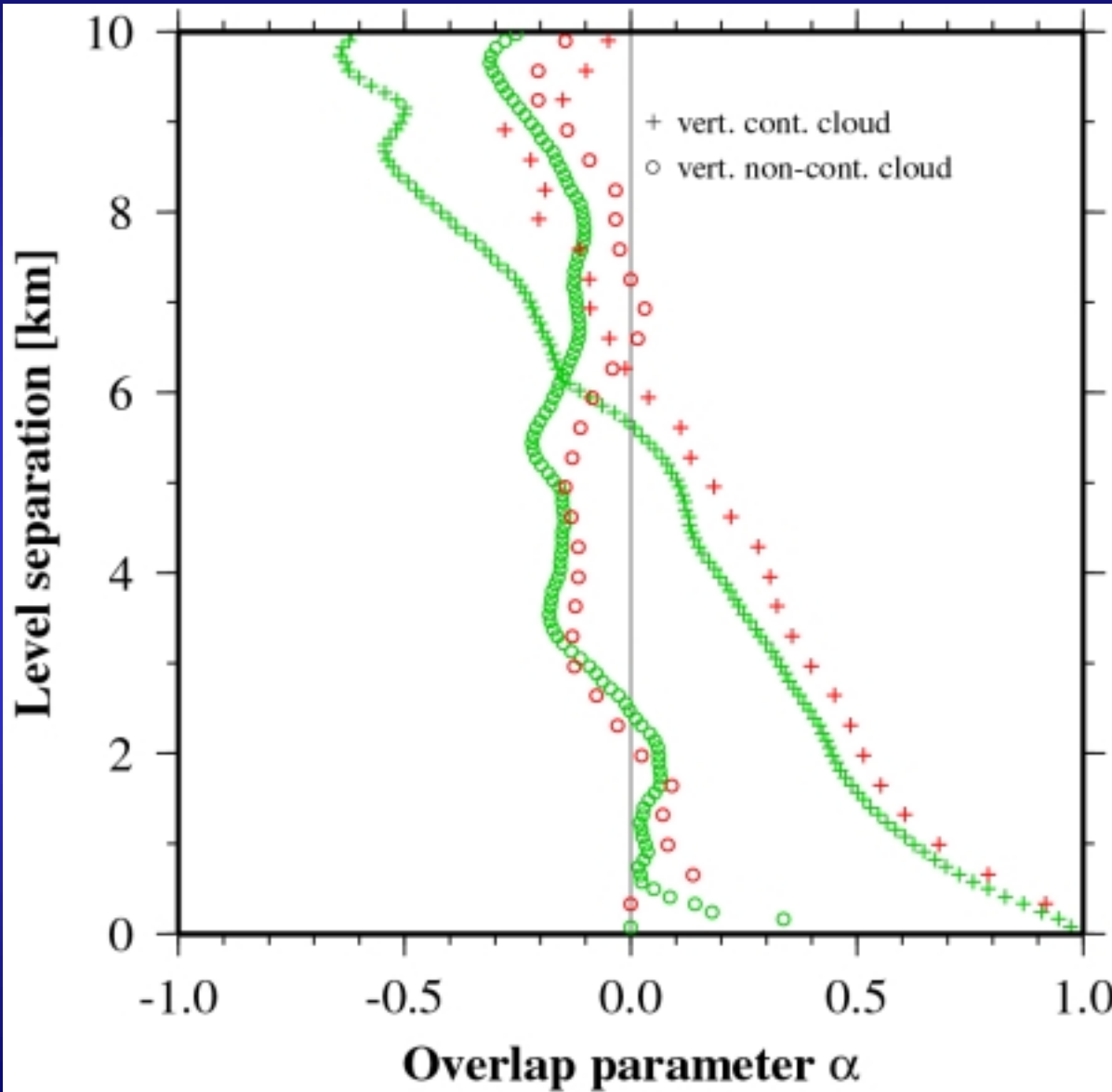
Overlap Parameter α



60 mins mean CC

Res: 82.5 m / 5 sec

Overlap Parameter α

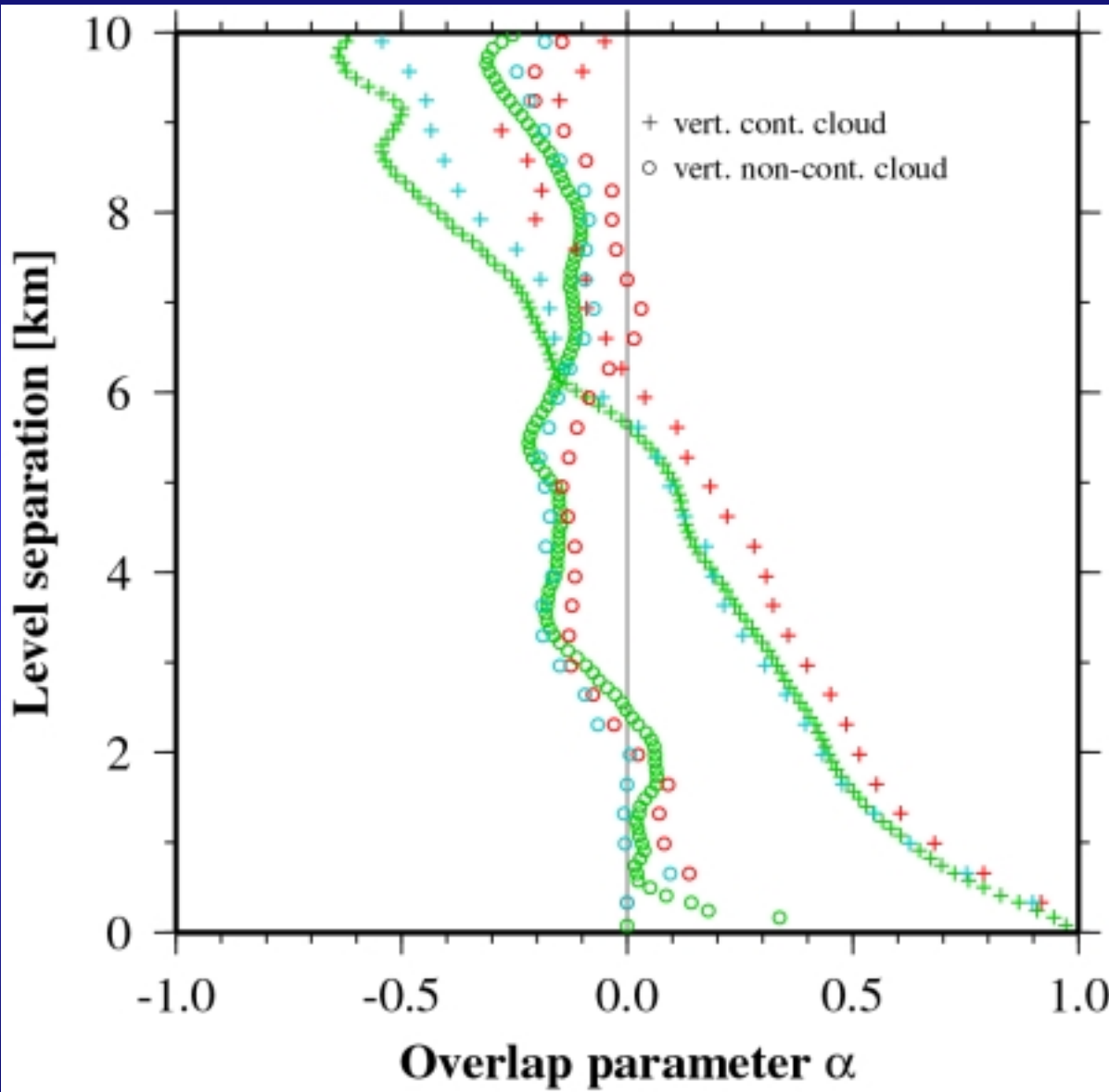


60 mins mean CC

Res: **82.5 m / 5 sec**

Res: **330 m / 2 min**

Overlap Parameter α



60 mins mean CC

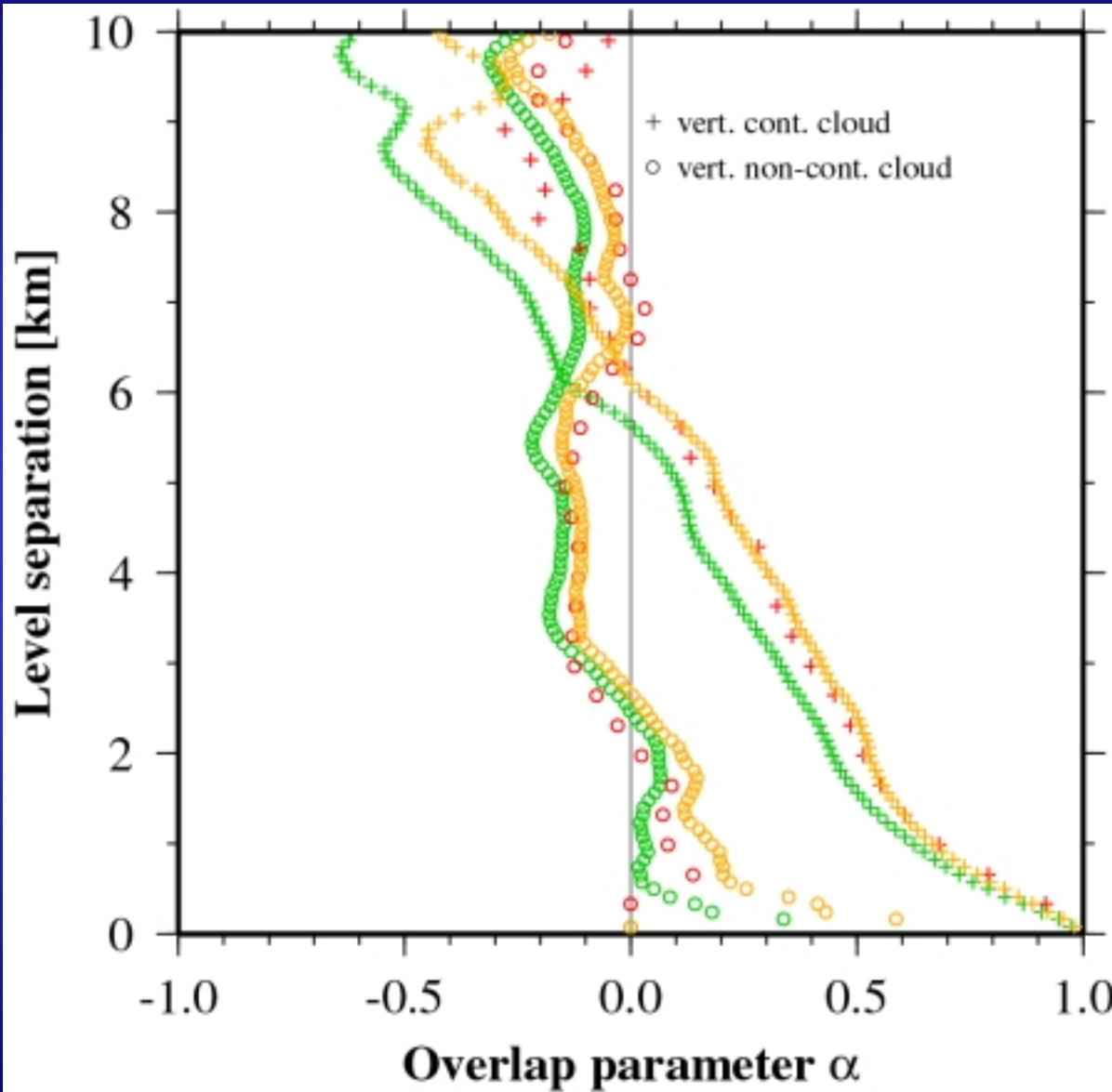
Res: **82.5 m / 5 sec**

Res: **330 m / 2 min**

Res:

Res: **330 m / 5 sec**

Overlap Parameter α



60 mins mean CC

Res: **82.5 m / 5 sec**

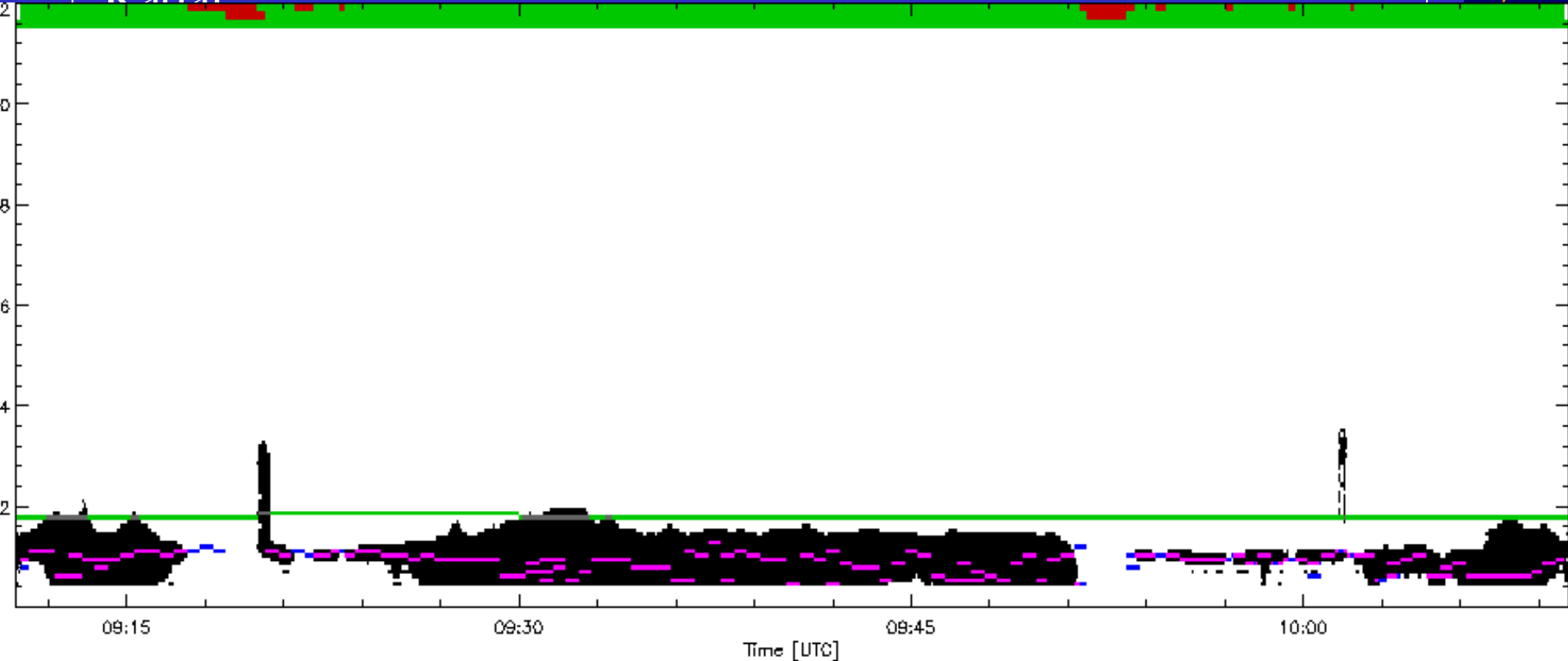
Res: **330 m / 2 min**

Res: **82.5 m / 2 min**

Res:

Radar and Ceilometer Disagreement

		Ceilometer	
	n/a	Cloud-Free	Cloudy
Radar	0.8 %	18.9 %	5.4 %



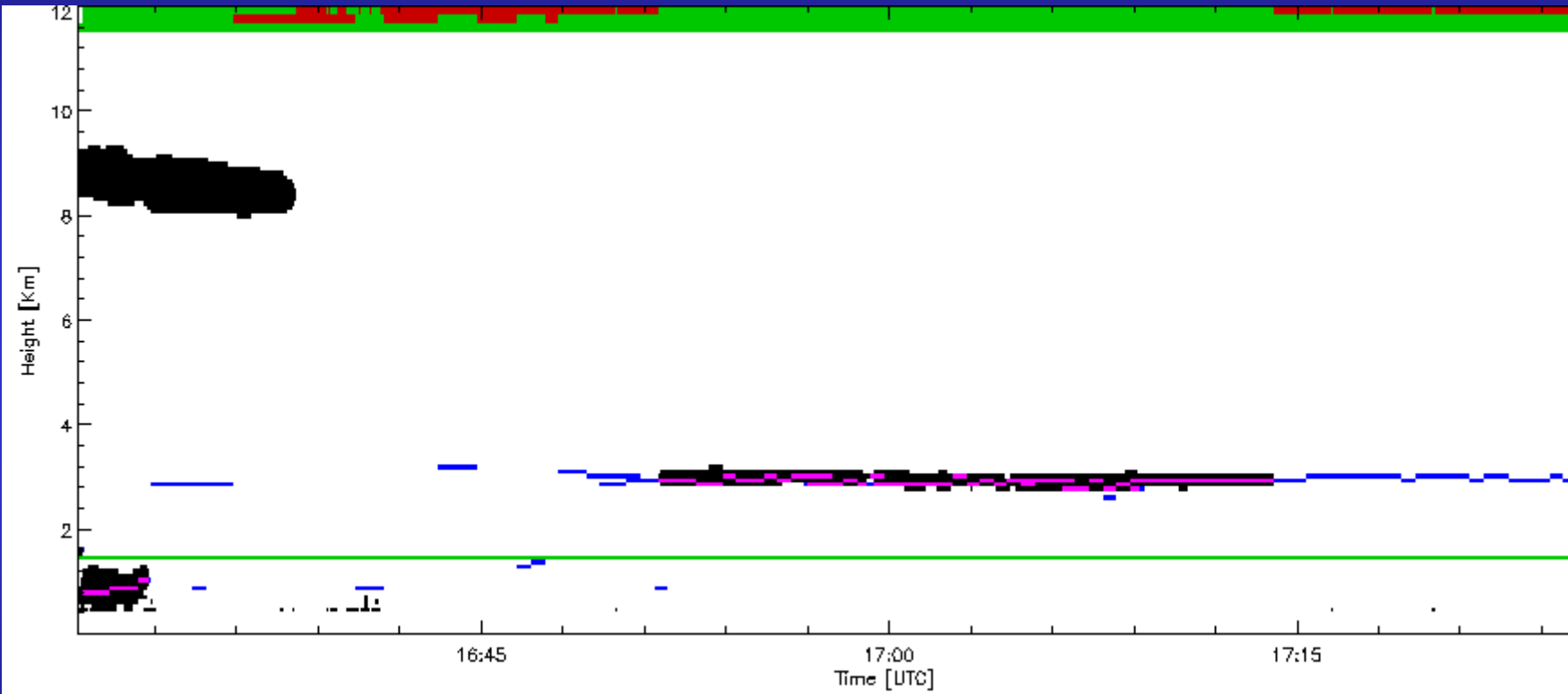
Radar and Ceilometer Disagreement

		n/a	Ceilometer	
			Cloud-Free	Cloudy
Radar	Cloud-Free	0.8 %	18.9 %	5.4 %
	Cloudy	1.3 %	25.2 %	48.4 %

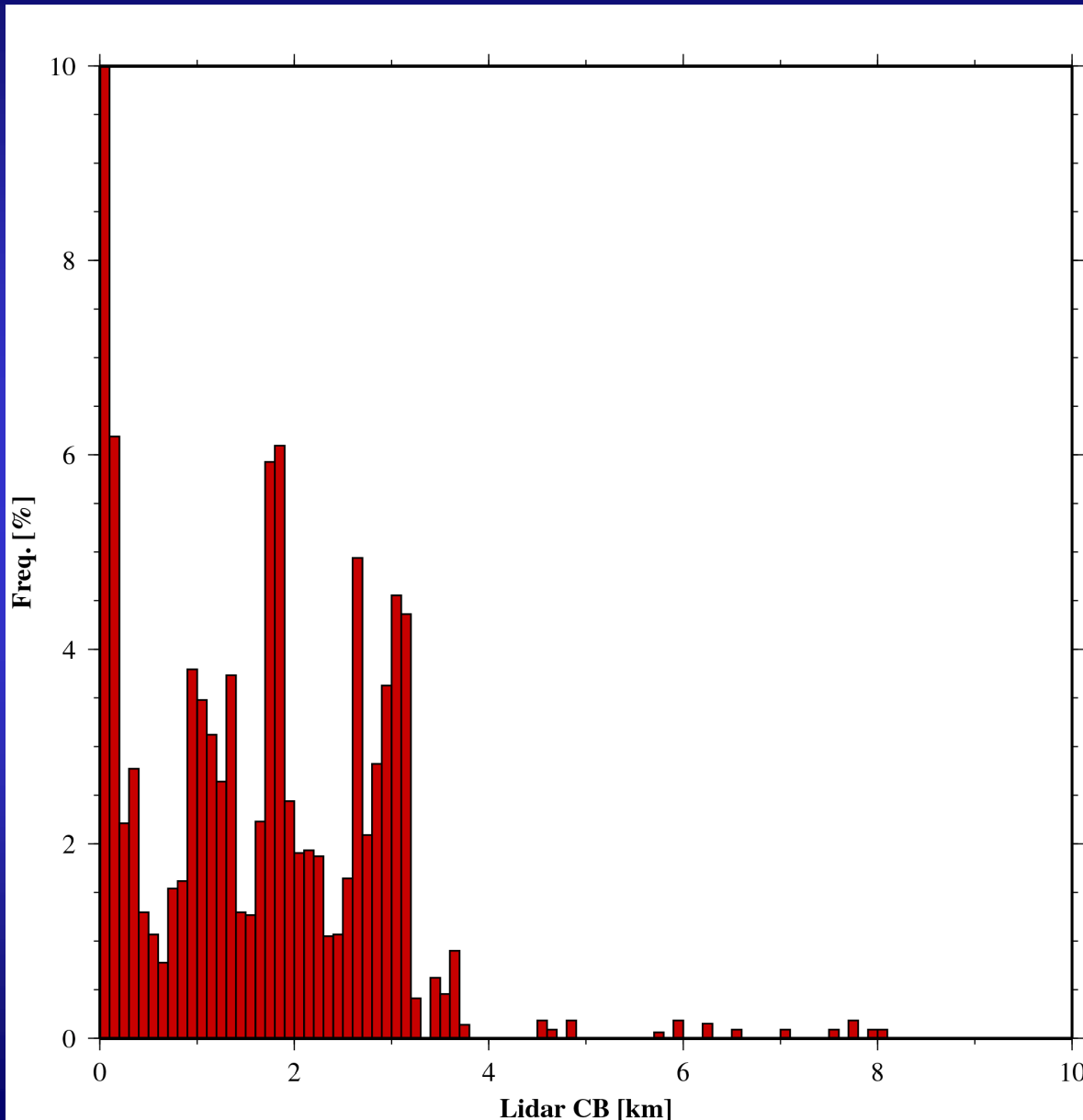
Values relative to Radar profiles (259.370)

- Thin clouds?
- Very low clouds?

Example for thin layer



Ceilometer cloud base distribution w/o radar cloud



Radar and Ceilometer Disagreement

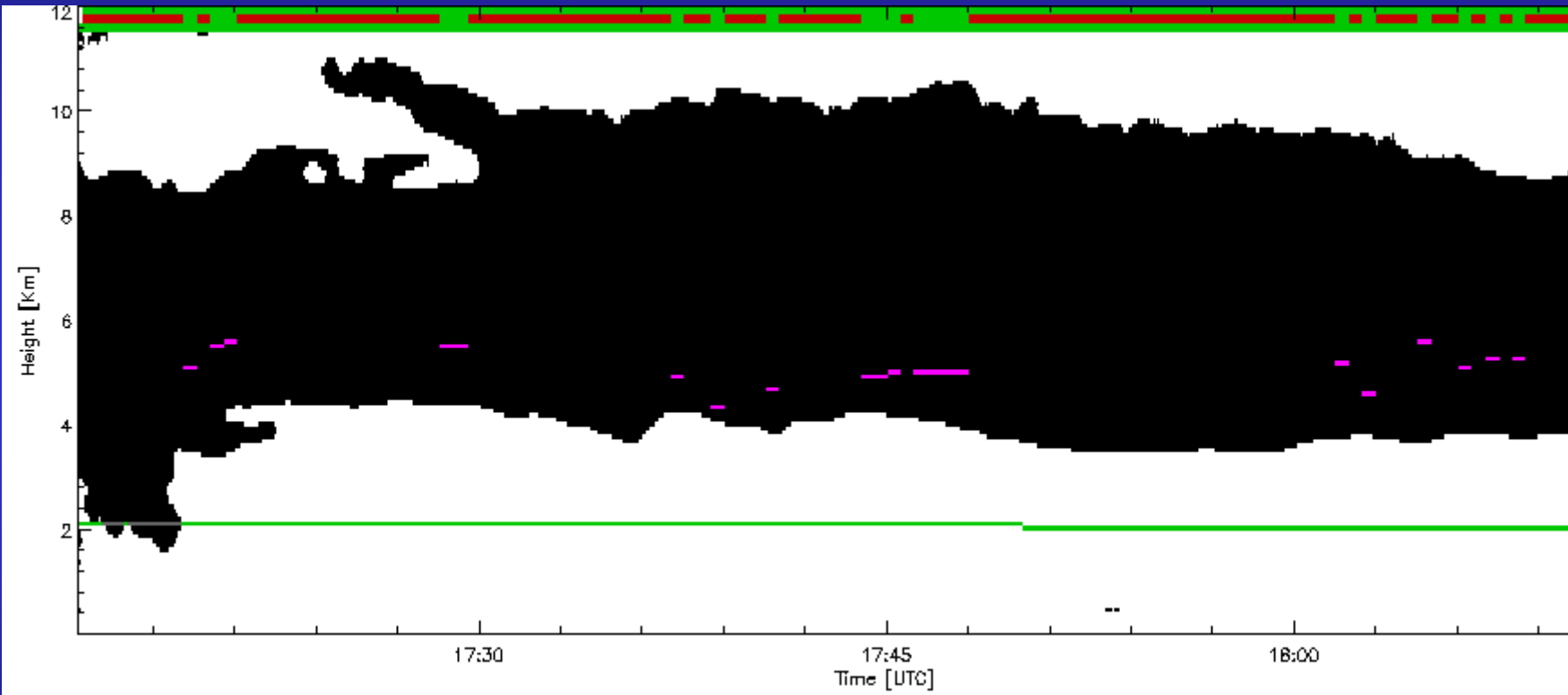
		n/a	Ceilometer Cloud-Free	Ceilometer Cloudy
Radar	Cloud-Free	0.8 %	18.9 %	5.4 %
	Cloudy	1.3 %	25.2 %	48.4 %

Values relative to Radar profiles (259.370)

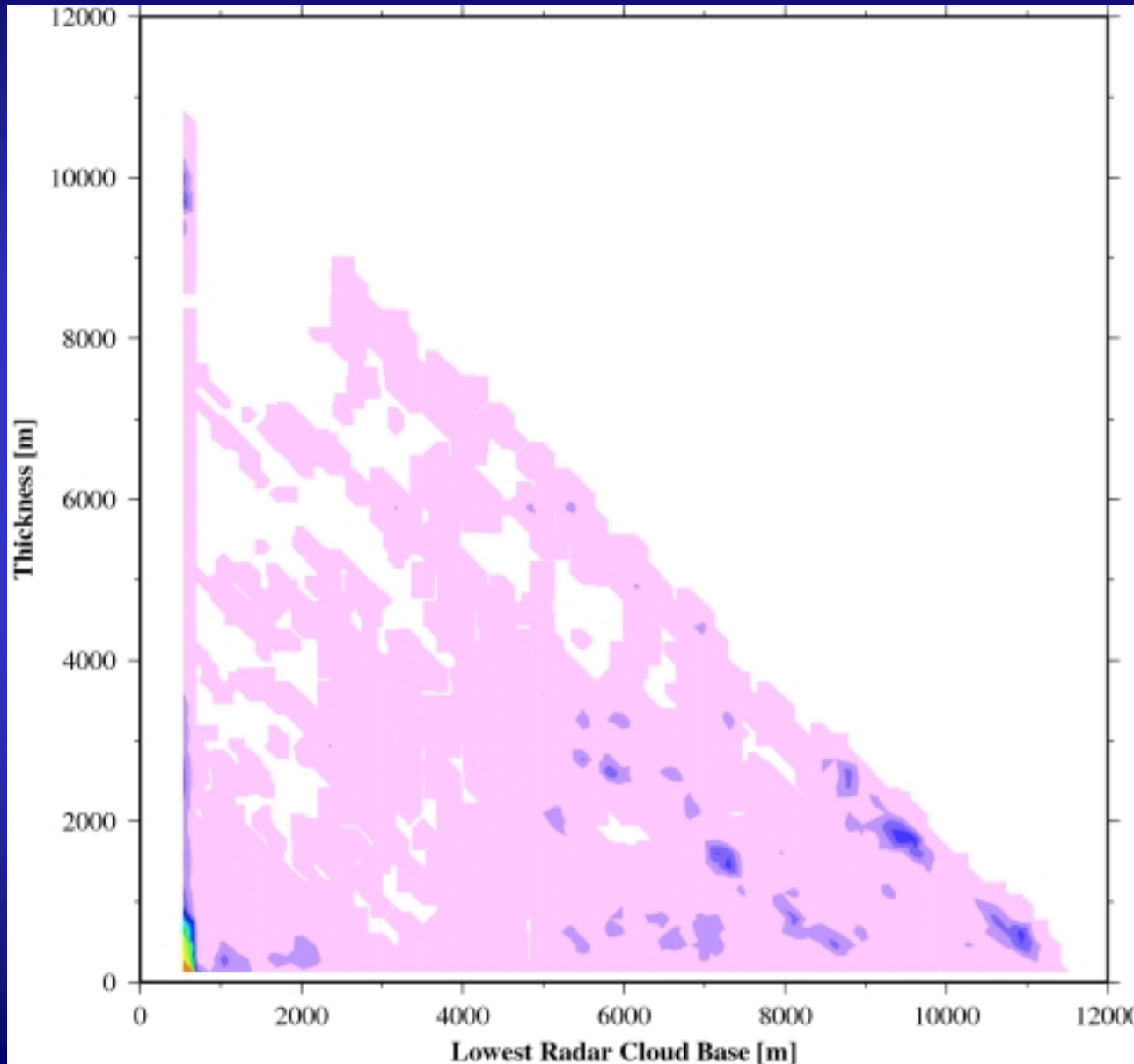
- Very high (=Ice-) clouds?
- Insects?
- ???

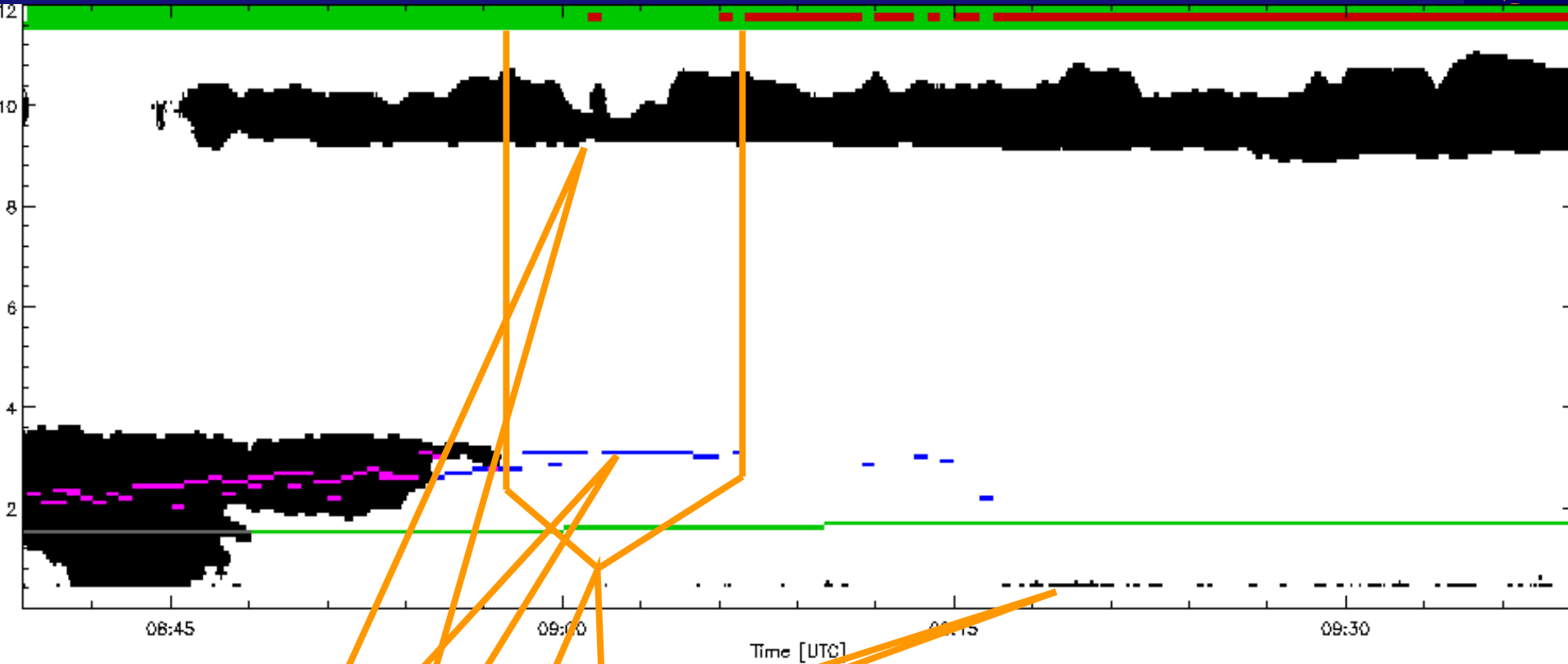
- Thin clouds?
- Very low clouds?
- ???

Difficult cloud for ceilometer



Radar cloud base vs. thickness (w/o ceilometer)





- High clouds
- Thin clouds
- Insects (?)
- Overlapping of layers

Conclusions

- Cloud overlap depends on used resolution
- For vert. cont. clouds:
 - Overlap parameter decreases with level separation
 - Using full resolution, decrease is appr. linear
 - Reducing data to mean 2-minutes-value increases α
 - Reducing vert. res. to 330 m gives a exponentiell decrease for increasing level sparation & converging at random overlap
- Vertical non-cont. clouds are appr. random overlapped

Conclusions (cont.) & Outlook

- Radar fails to see thin clouds
- In boundary layer many radar signals remain (in 20% of all cases w/o ceilometer cloud, isolated pixels in lowest range gate exist)

Outlook:

- Modify Cloudmask
- Check Ceilometer Accuracy vs. Temperature
- Cloud Classification