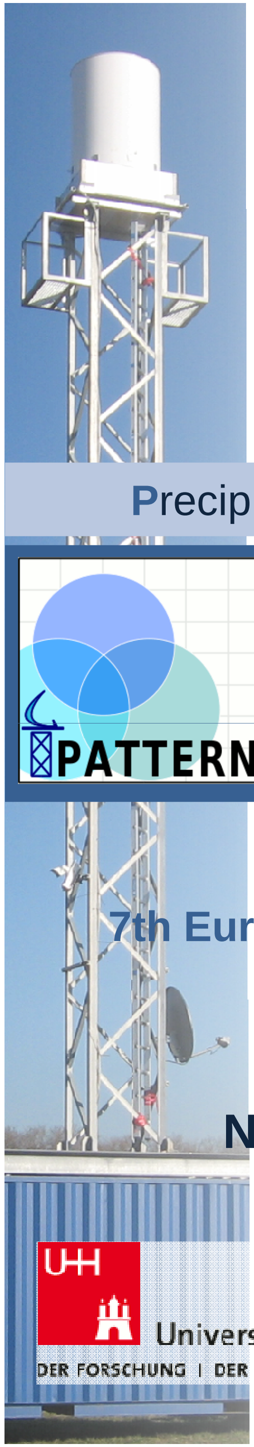

Precipitation and Attenuation Estimates from a High Resolution Weather Radar Network

PATTERN – Development of Retrievals for a Radar Network

7th European Conference on Radar in Meteorology and Hydrology, Toulouse, France

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DER FORSCHUNG | DER LEHRE | DER BILDUNG

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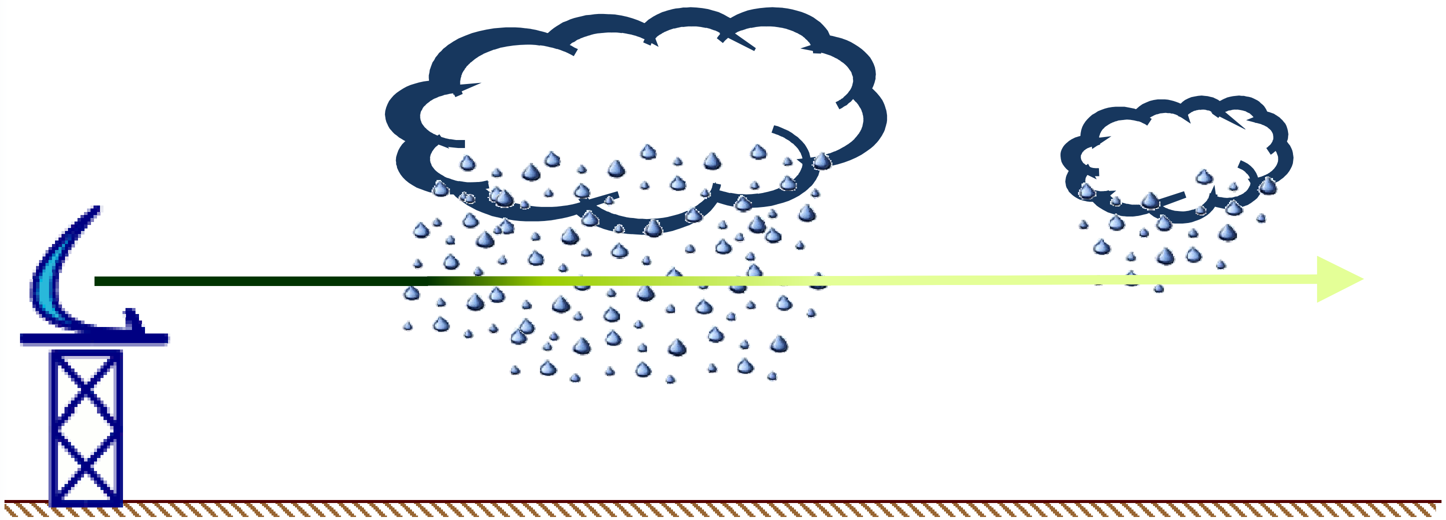
Motivation

X-Band Radar

- Low cost systems compared to e.g. C-Band Radars
- High resolution precipitation estimates
- Frequency: 8.000 – 12.000 MHz | Wavelength: 4 – 2,5 cm

→ **In this frequency range the radar signal is influenced by attenuation**



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WHAT will the project PATTERN demonstrate?

• Network of low cost HRWR systems could overcome the drawback of attenuation and improve the accuracy of rain rate estimates.

HOW will the project PATTERN achieve the aim?

• The radar network covers large overlapping areas which leads to more information about reflectivity, attenuation, clutter … (see Poster No. **DQ 48**)
• Development of a forward operator that simulates radar observations for given spatial distributions of microphysical quantities.

Appendix: Radar Specifications

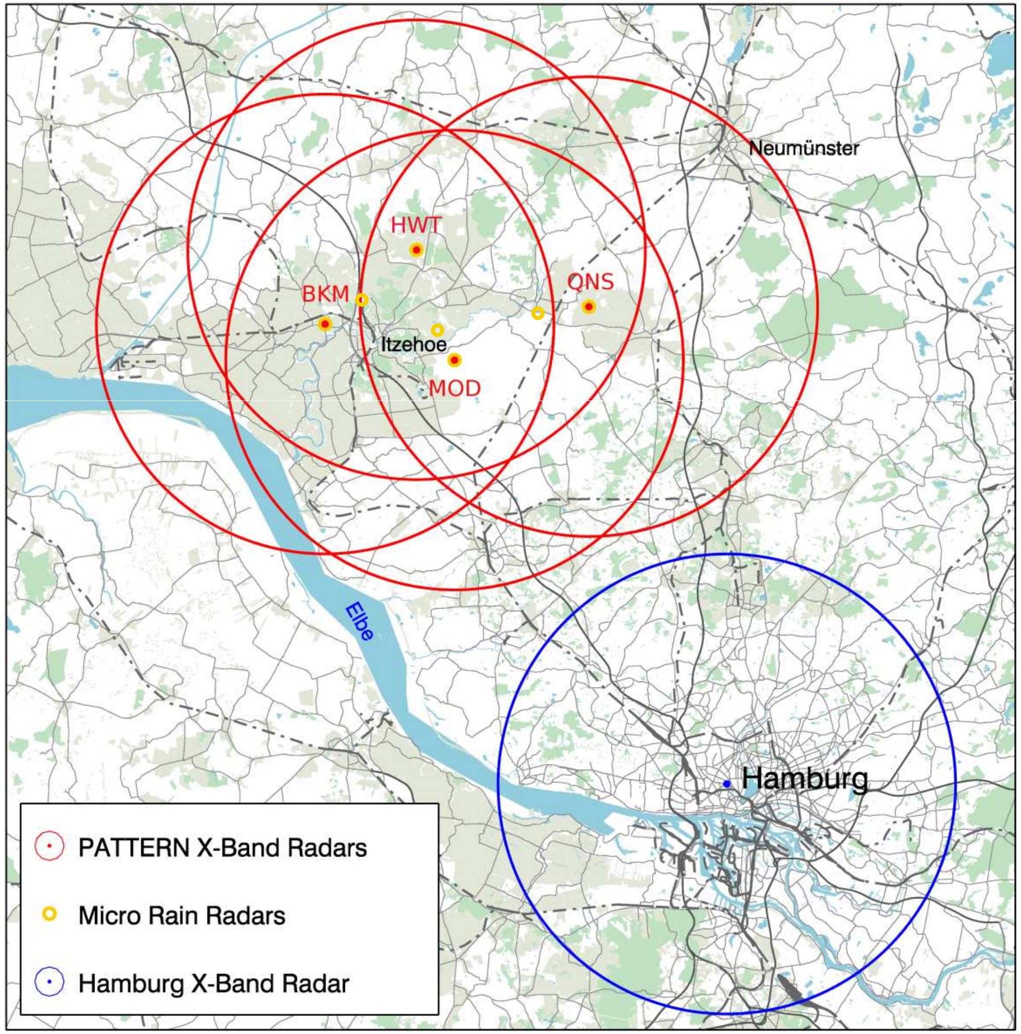
Performance Parameters	Typical	Limit
Range Resolution	60 m	> 15 m
Azimuth Resolution	1°	> 1°
Time Resolution	30 s	> 3 s
Range	20 km	30 km
Calibration Accuracy	±1 dB	

Scanning Scheme	Typical	Limit
Azimuth	~21 rpm	
Elevation	fixed (adjustable according to site conditions)	0° - 15°

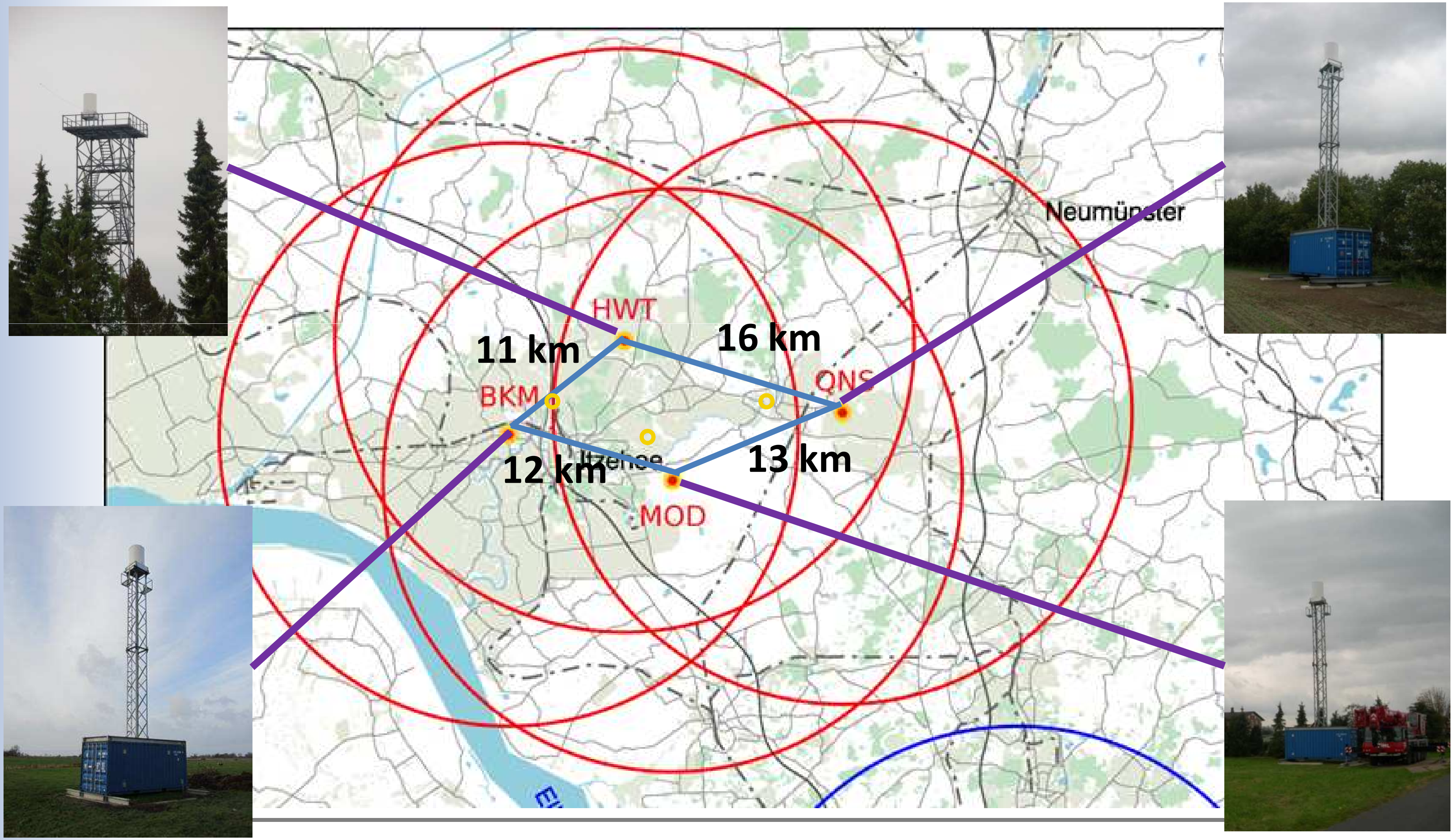
~~Dual-pol~~ ~~Doppler~~

Design of the network

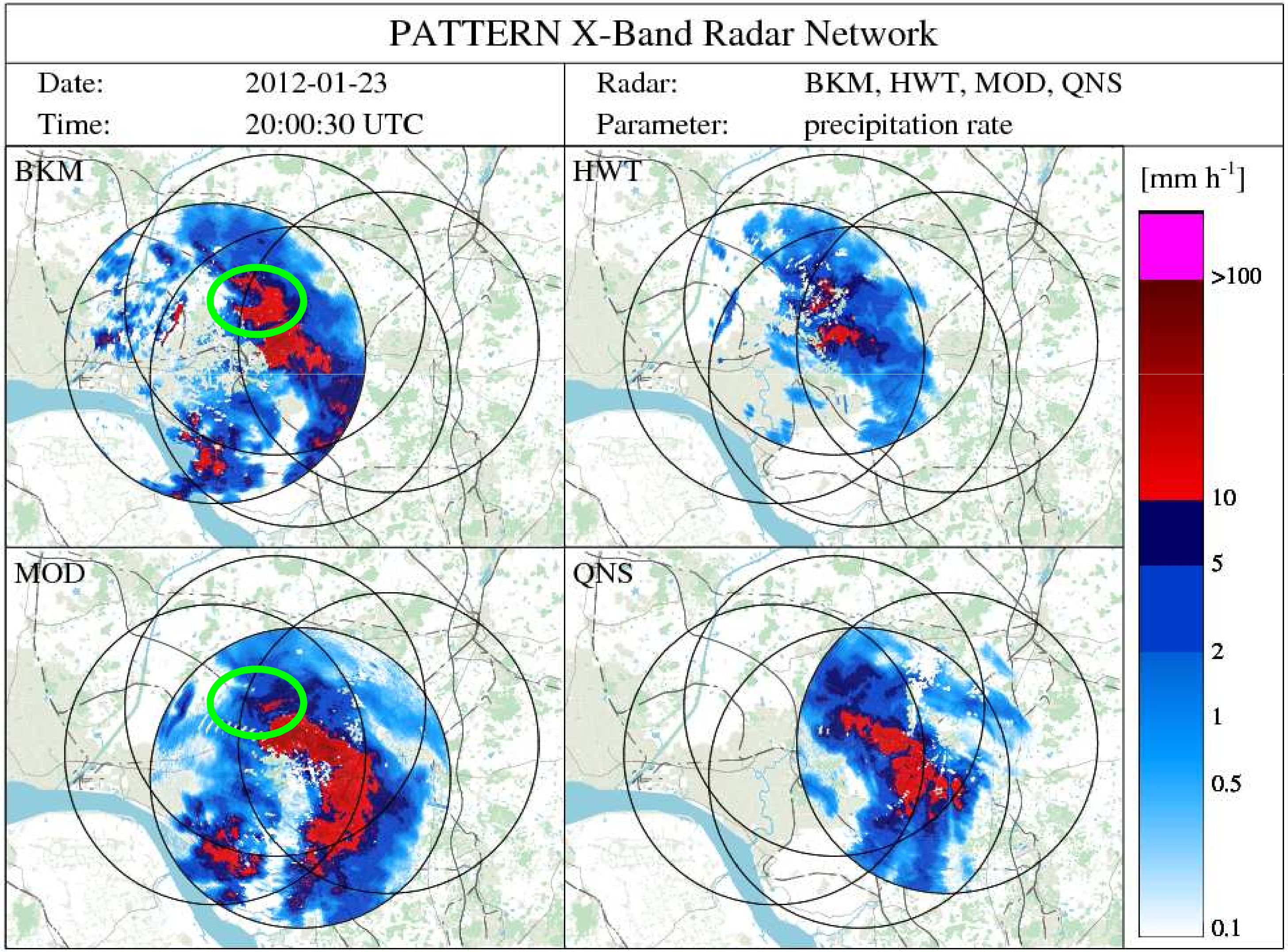
- 4 High Resolution Weather Radars within the PATTERN network
- 1 additional HRWR in Hamburg at the roof of the Meteorological Institute
- 7 Micro Rain Radars within the PATTERN network
- Rain gauges



Design of the network

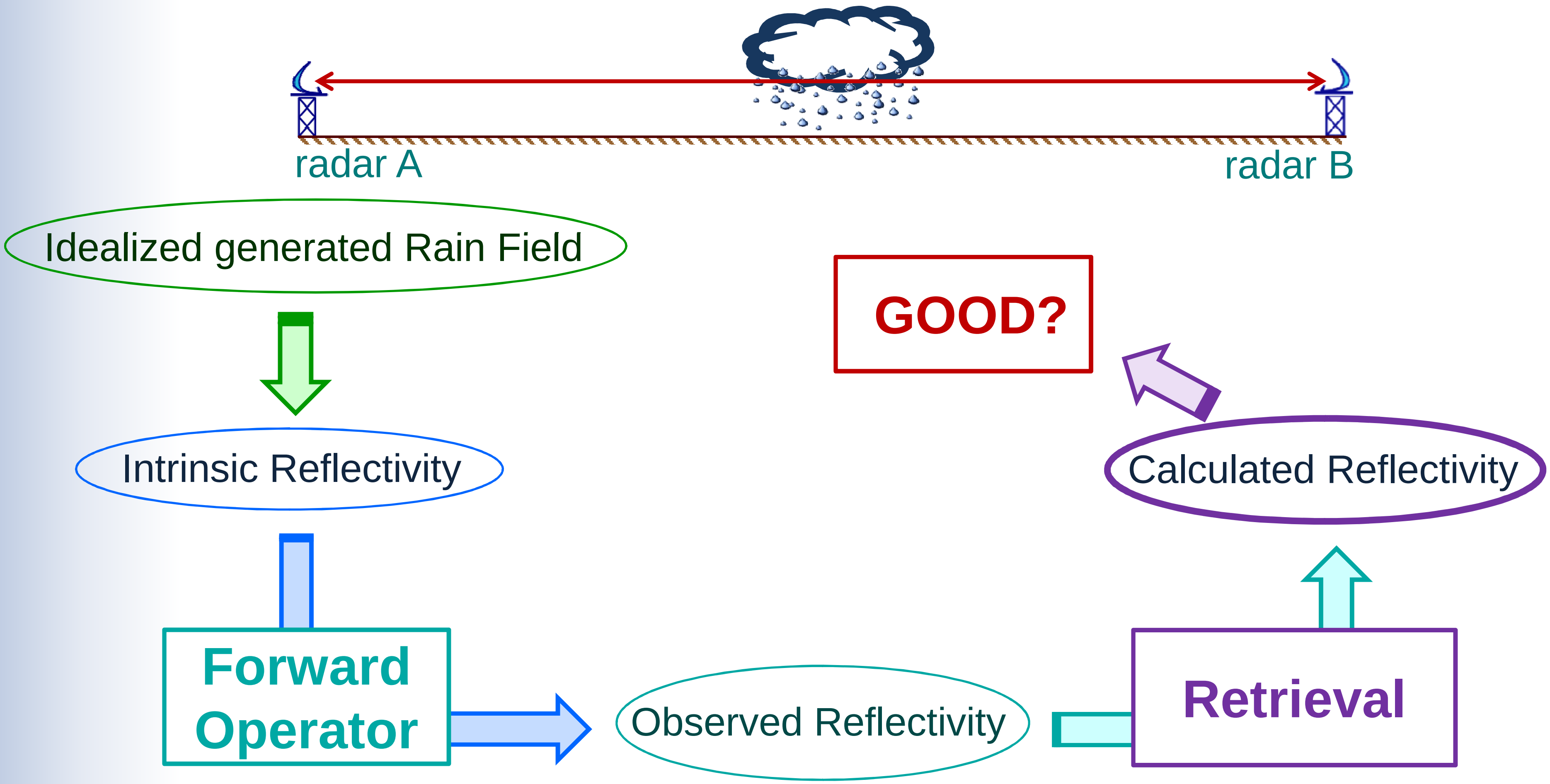


Attenuation Effects



Retrieval

FIRST STEP towards a retrieval of two-dimensional rain fields is to consider an **IDEALIZED ONE-DIMENSIONAL setup along connecting lines.**

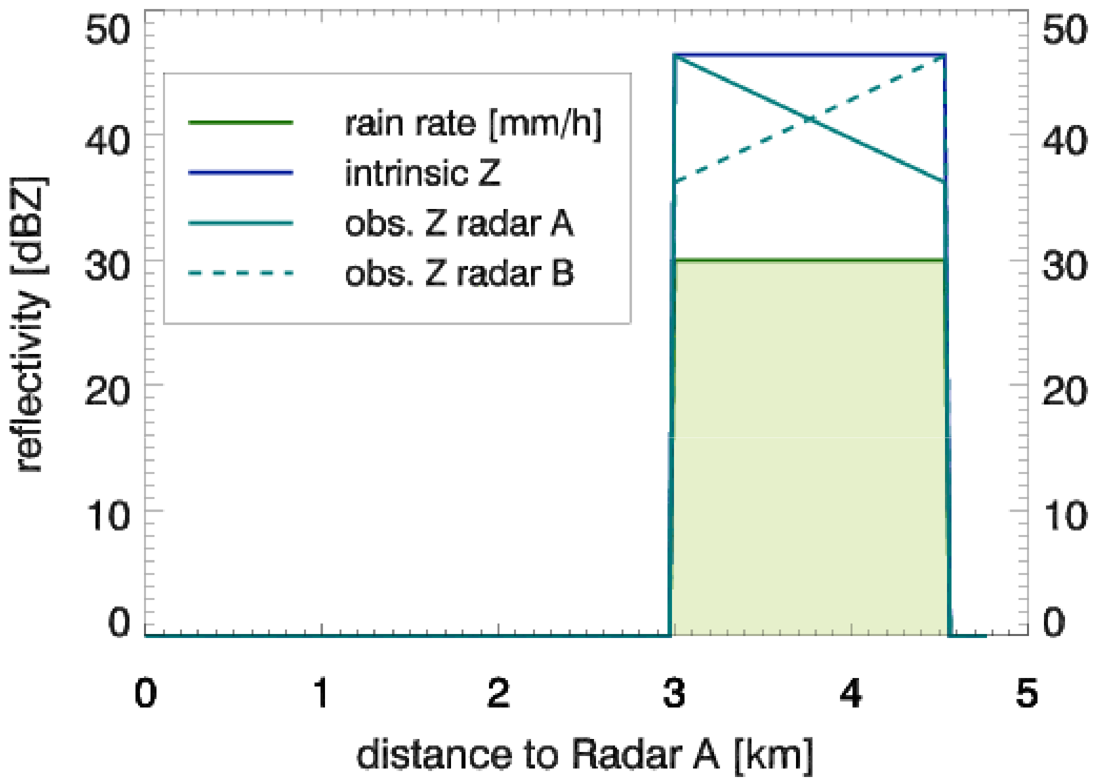


- **Retrieval** estimates intrinsic reflectivity
- Three **different methods** are tested
  - **Method CL08** is related to the retrieval published by *Chandrasekar & Lim (2008)*
  - **Method LES** is based on a linear system of equations
  - **Method ANY** is the analytical solution of the intrinsic reflectivity
- Due to the idealized Forward Operator all settings are exactly known

→ **Detailed studies on the accuracy of each method are possible.**

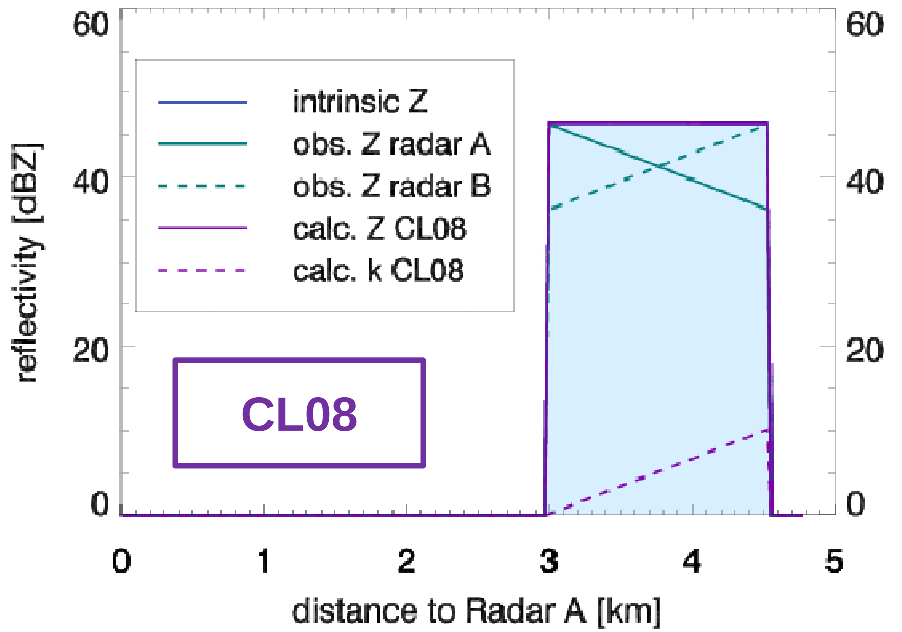
CHANDRASEKAR V., S. LIM, 2008: Retrieval of Reflectivity in a Networked Radar Environment. J. Atmos. Oceanic Tech., ***25****, 1755-1767.*

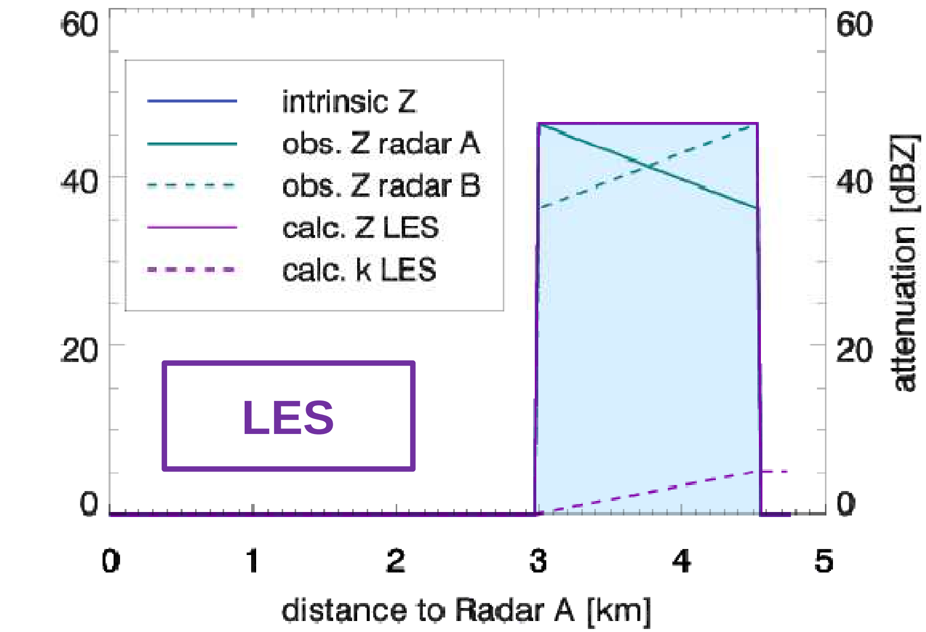
- Creation of idealized rain field

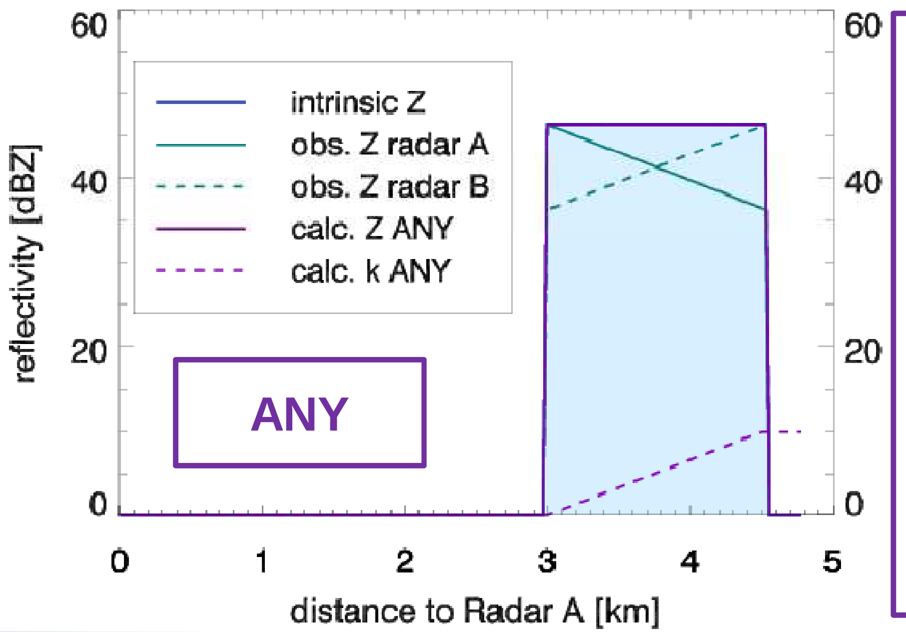


- Intrinsic reflectivity is calculated using relation between reflectivity and rain rate
- Assumption: Marshall-Palmer Distribution
- Simulation of observed reflectivity

Without Perturbations





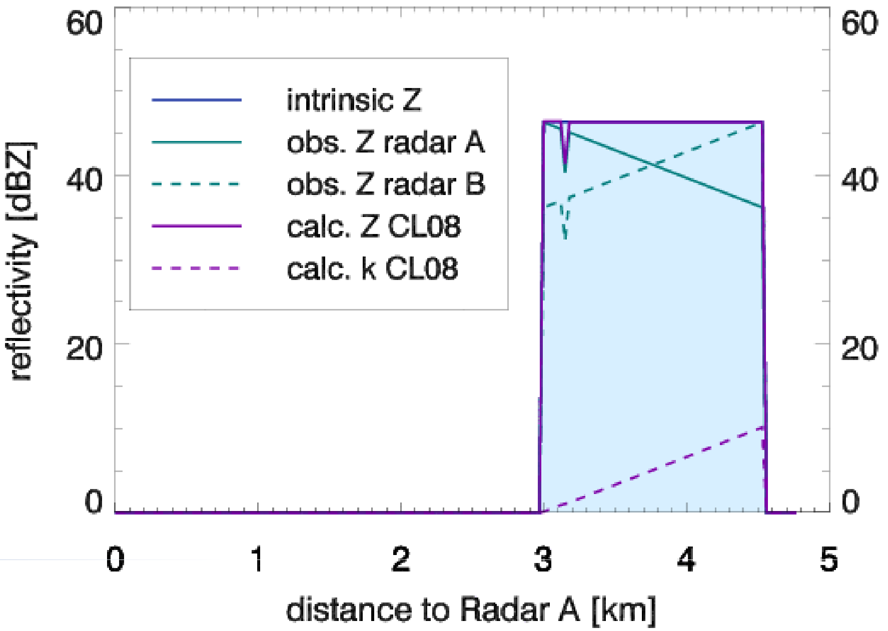


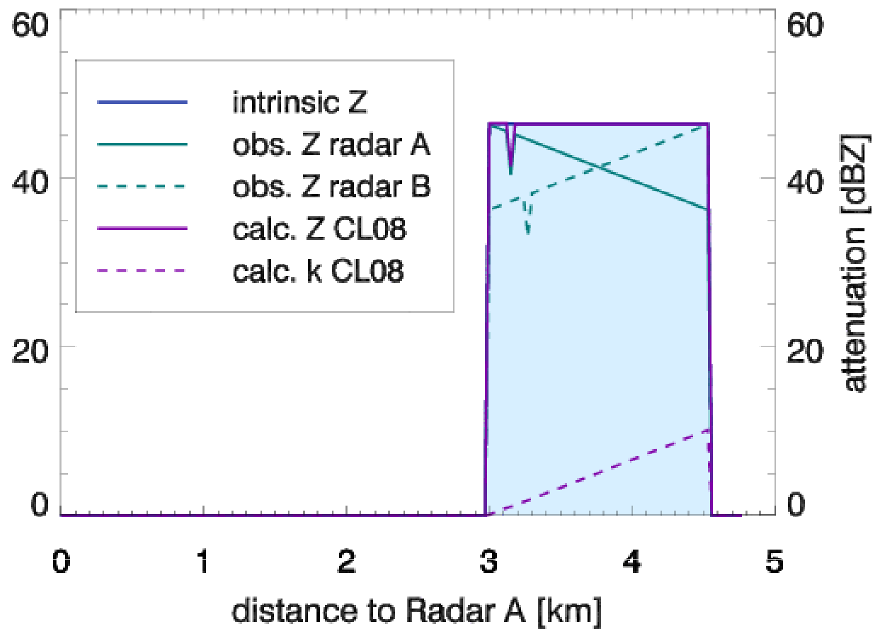
- **almost similar results**

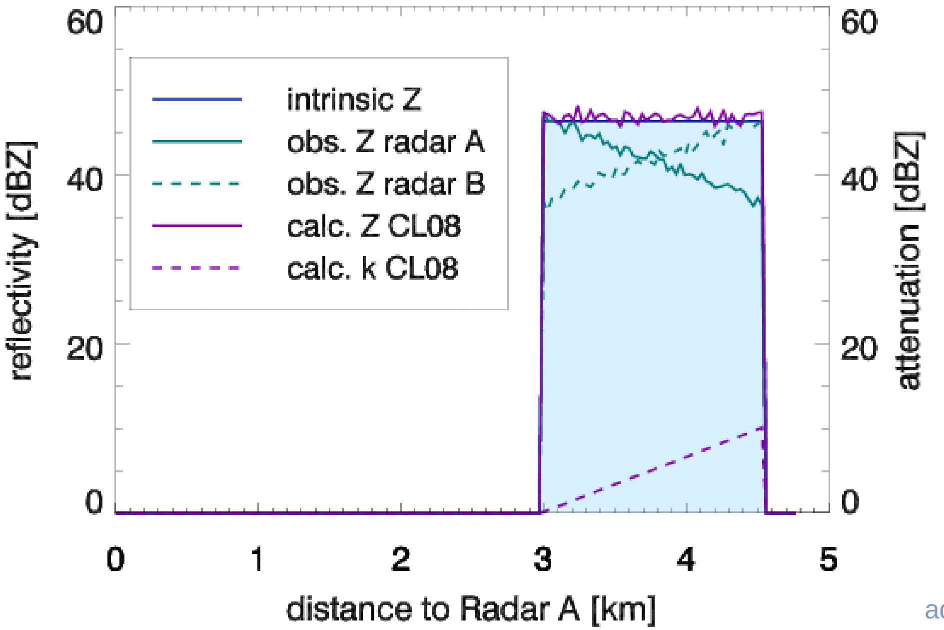
Currently global drawbacks:

- **CL08 →** iterative process costs time
- **LES →** even numbers of grid points needed, otherwise solution is singular
- **ANY →** differences between neighbouring grid points, results in boundary problems

With Perturbations



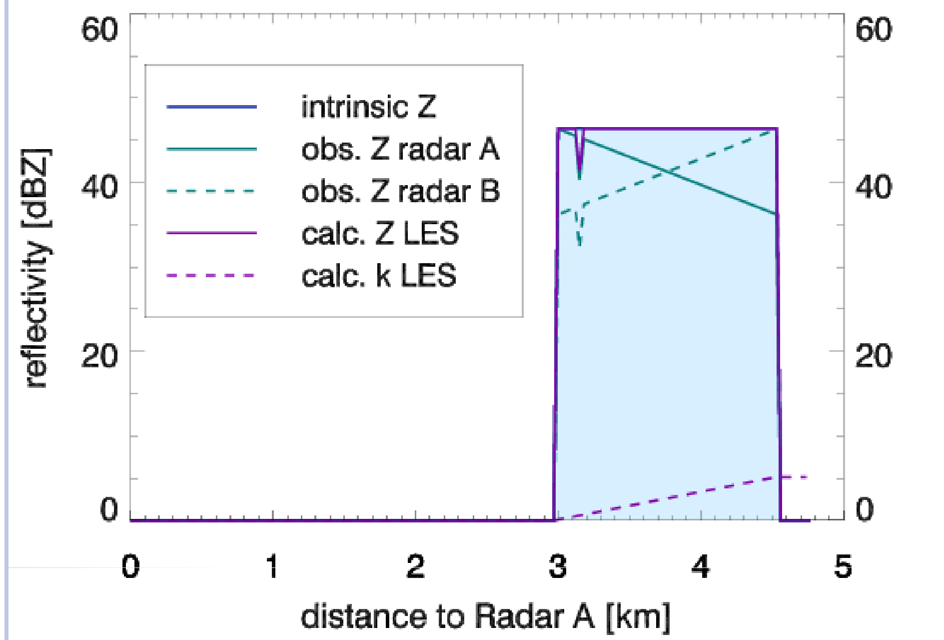


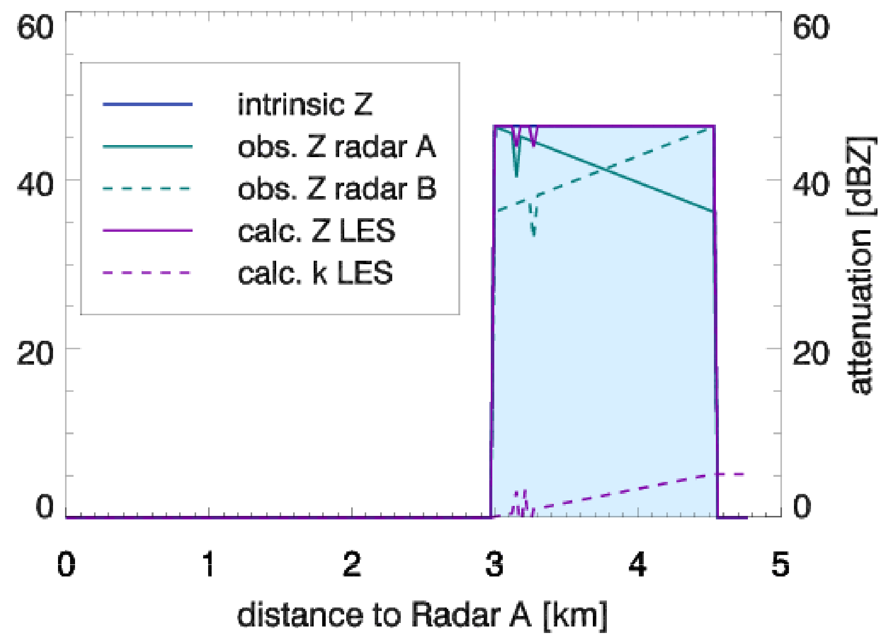


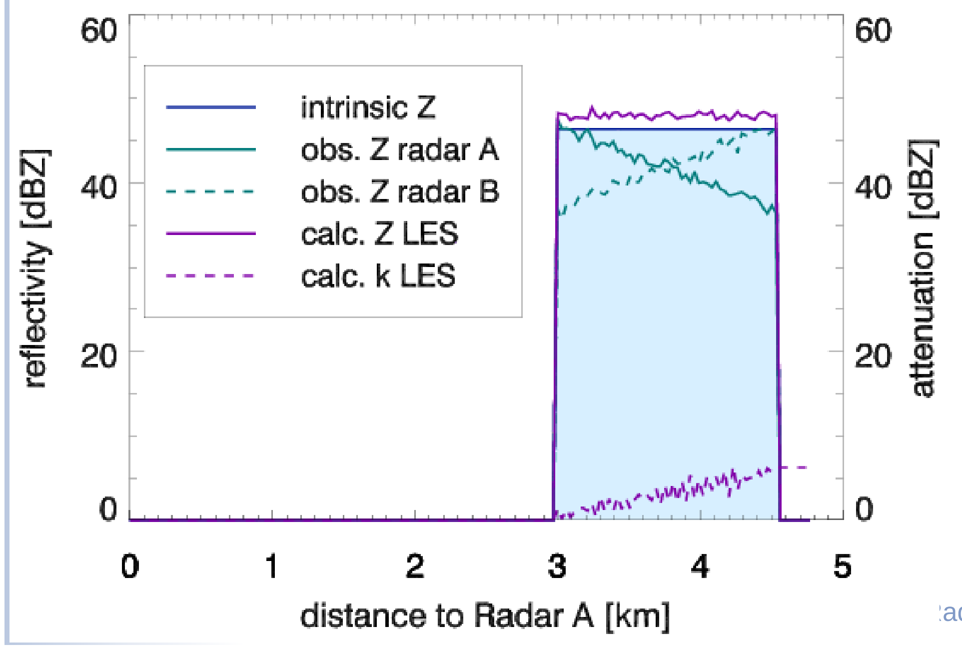
Method CL08

- local events → local effects
- Good results, even with noise
- Robust method

With Perturbations



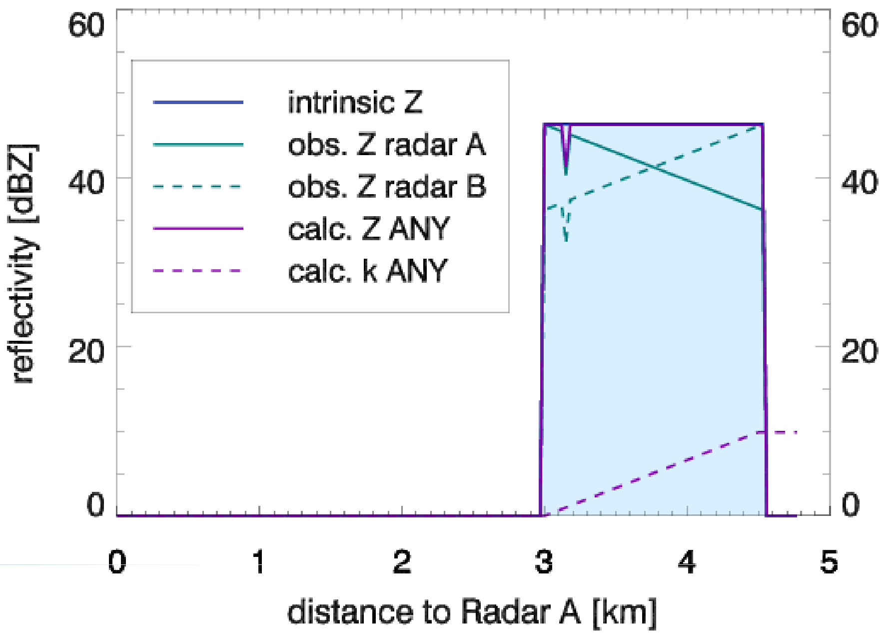


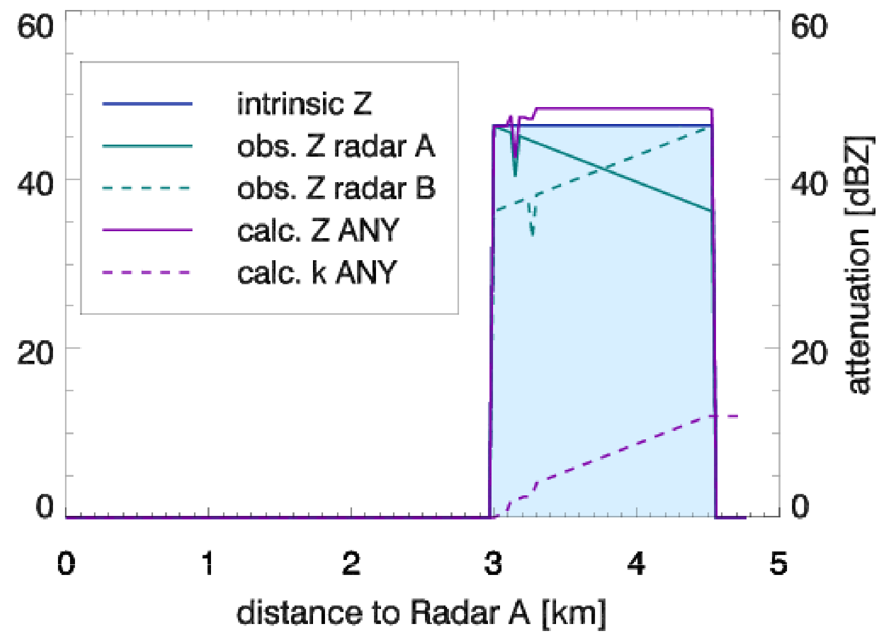


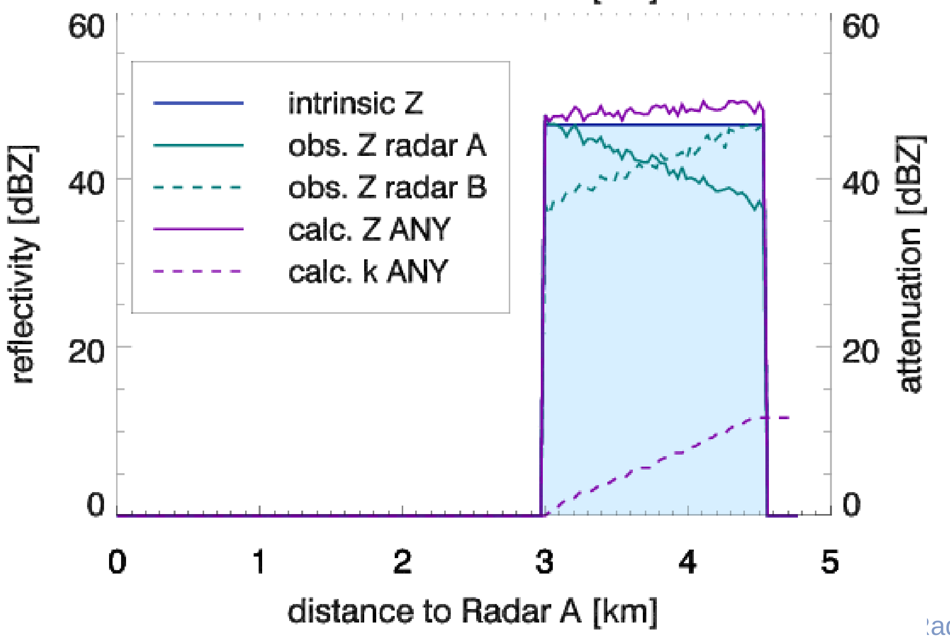
Method LES

- local events → local effects
- Noise results in Bias
- Perturbations can results in negative attenuation

With Perturbations







Method ANY

- local events → global effects
- Noise results in Bias

Method CL08

- Shows good results even with perturbations
- Is time-consuming

Method LES

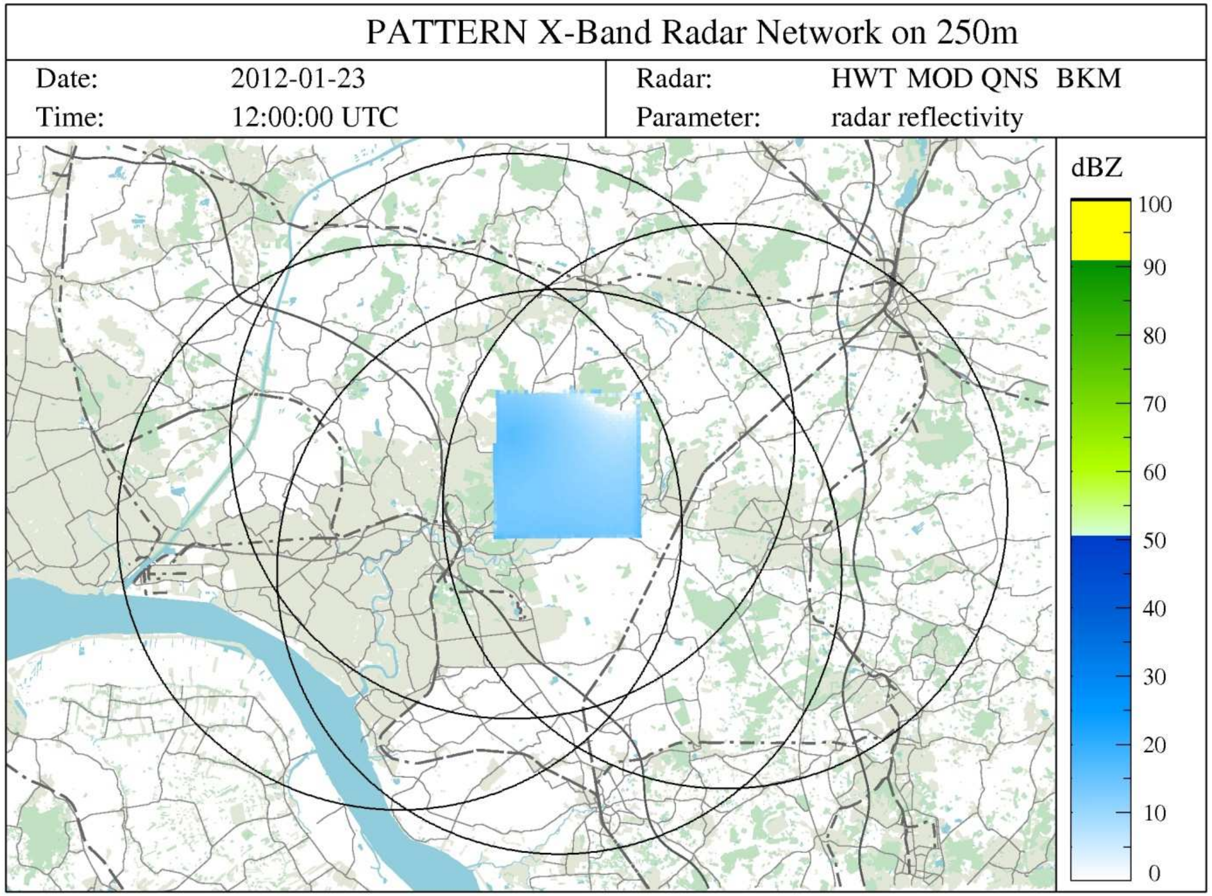
- Time-saving
- Has problems with uneven numbers of rainy grid points
- Perturbations can result in negative attenuation

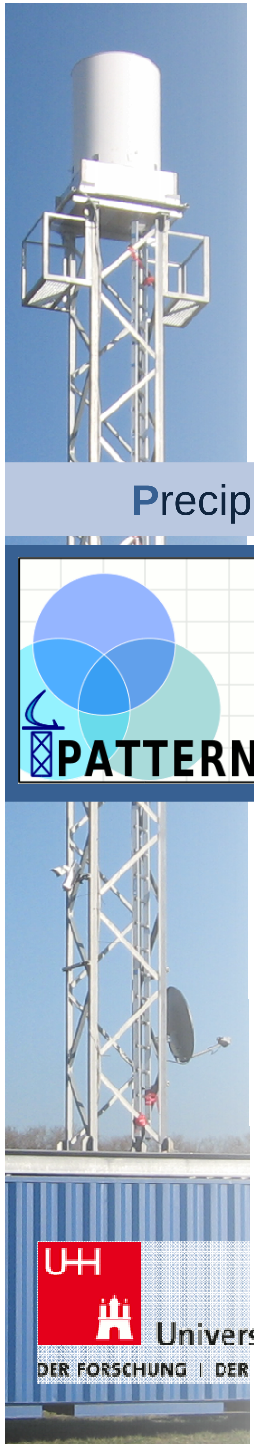
→ **Probably an iterative solution method will be more efficient**

Method ANY

- Time-saving
- Local perturbations results in global effects

Outlook: 2D Set-Up





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Thanks for your attention!

Questions?

http://pattern.zmaw.de

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