X- and C-band radars: experiences in the Netherlands

Hidde Leijnse
### X- and C-band: important differences

<table>
<thead>
<tr>
<th></th>
<th>X-band</th>
<th>C-band</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Ease of installation</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Clutter</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Attenuation</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Usable range</td>
<td>-</td>
<td>+</td>
</tr>
</tbody>
</table>

**Note that the resolution of X-band radars is not higher by definition!**

- C-band radars are often used for country-wide rainfall information
  - 1500-m pseudoCAPPI composite is the standard product
  - Volume data could also be used
X- and C-band: important differences

\[
Z = 252R^{1.73} \quad r = 0.94
\]

\[
Z = 243R^{1.73} \quad r = 0.94
\]

\[
Z = 195R^{2.05} \quad r = 0.91
\]

\[
Z = 552R^{1.12} \quad r = 0.97
\]

\[
R = 0.0767Z^{0.49}_{HH} \quad r = 0.91
\]

\[
R = 0.612Z^{4.74}_{DR} \quad r = 0.61
\]

\[
R = aZ^{-5.49}_{HH}Z^{-0.73}_{DR} \quad a = 5.49 \times 10^{-3} \quad r = 0.99
\]

\[
R = 13.2k^{0.73}_{DP} \quad r = 0.98
\]
Topic 1: calibration

There are several possibilities for monitoring calibration of radars (this goes for X- and C-band radars alike):

- Measuring solar power
- Analyzing returns from stable clutter targets
- Measuring transmitted power in wave guide
- Comparison of reflectivity in a given volume from different radars (statistics of differences)
- For dual-pol radars: consistency of polarimetric moments
Topic 1: calibration

Example of solar monitoring (C-band)

- Power
- Antenna pointing
- Number of ‘hits’

![Graphs showing received solar power, angular biases, and number of solar interferences.](image-url)
Topic 2: performance

Data from the SOLIDAR X-band radar (predecessor of IDRA) from 1993-1994 (195 events), with a 30-m and 16-s resolution.

van de Beek et al., HESS, 2010
Topic 2: performance

Data from operational C-band radar in De Bilt

- Data very close to the radar
- Used radar elevation scan 3 (0.8 deg., 1.0 km range res.) second range bin.
- Used standard Z-R relation ($Z=200R^{1.6}$).
- Severe underestimation by radar

van de Beek et al., QJRMS, 2012, in prep.
Topic 2: performance

- Corrections applied for:
  - Calibration
  - Clutter
  - Wet radome attenuation
  - Non-standard Z-R relation
- Corrections can be seen to work well

van de Beek et al., QJRMS, 2012, in prep.
Topic 2: performance

Comparison of radar QPE for three radars and two in-situ instruments at the Cabauw Experimental Site for Atmospheric Research (CESAR)

- Operational C-band radar
- X-band radar IDRA
- Vertically-pointing 35-GHz cloud radar
- Rain gauge
- 2-dimensional video disdrometer (2DVD)
Topic 2: performance

Comparison of X- and C-band radars
- Simulated C-band radar signal from X-band radar data
- Compare results using Z-R relation before or after averaging
- Compare results with true C-band radar data
Topic 3: integration of data sources

In the Netherlands: only experience with integration of radar and rain gauge data
• Mean field bias (hourly rain gauge data from 32 gauges)
• Spatial correction field (daily rain gauge data from 325 gauges)

Holleman, MA, 2007
Topic 3: integration of data sources

a) De Bilt pCAPPI
b) Occultation-corrected pCAPPI
c) Rain gauges
d) Raw composite
e) Bias-corrected composite
f) Spatially-corrected composite

Overeem et al., JAMC, 2009
Topic 3: integration of data sources

Other data source: microwave links from commercial cellular communication networks

Overeem et al., BAMS, 2012, in prep.
Topic 4: fine-scale

Consistency of spatial and temporal resolution
Topic 4: fine-scale

- Question: what resolution is really needed?
  - Space
  - Time
- Question: given a certain resolution (in space and time), what is the desired accuracy?