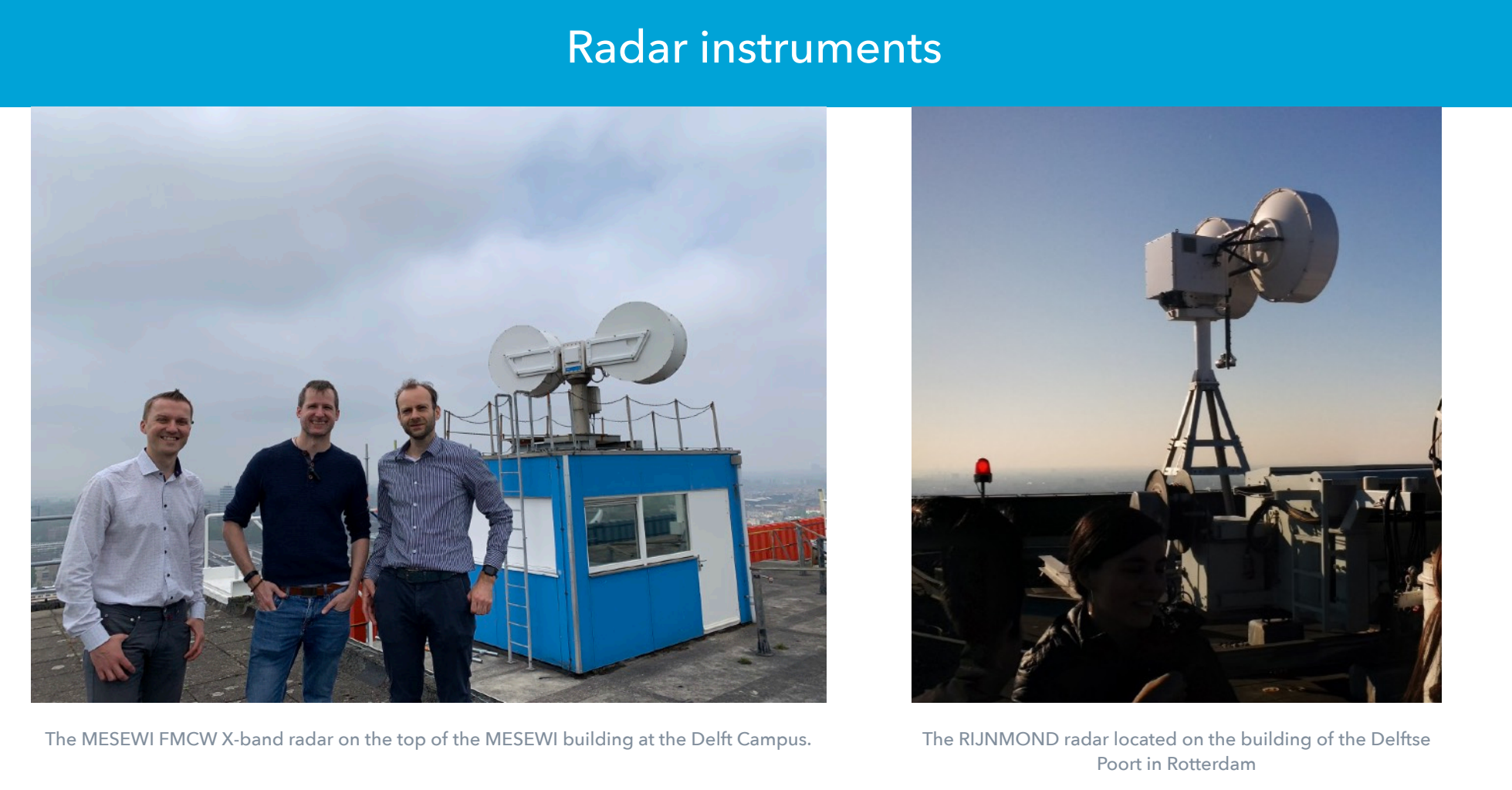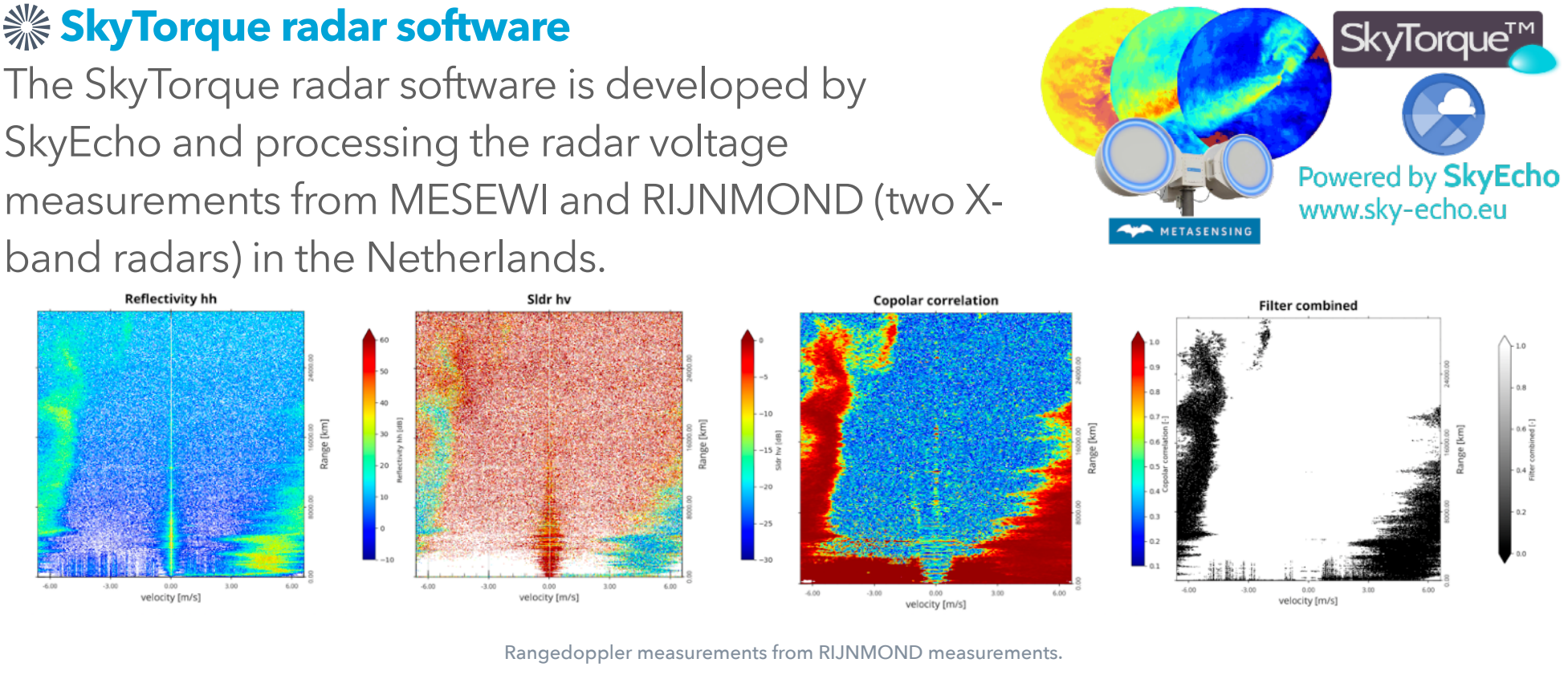# Enhanced composition of X- and C-band radar data

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The improvement and quality assessment of radar-derived-rain products remains a tough challenge. In this work, the goal is to ignore "bad quality radar cells", and enhance the final rainfall rate composite product. The focus is on the implementation of radar data quality parameters - specifically signal-to-noise-ratio (SNR), normalised coherent power (NCP) and the percentage of valid doppler bins - to label "bad quality radar cells". Bad quality radar cells can occur because of signal attenuation, radio interference, signal blockage, etc. The work is conducted on a rain composite that merges data coming from a set of Dutch radars (X and C-bands): the MESEWI X-band radar from TU Delft, the RIJNMOND X-band radar in Rotterdam, and the KNMI international realtime radar composite. PhiDp will be used for attenuation corrections, and KDP-algorithms will be applied for rainfall rate estimation. In the merging of X-band and C-band data, there is one noticeable thing: there are places where the C-band composite data contains rain and the X-band composite does not. The most likely reason for this, is that the X-band data is acquired at lower altitudes, whereas the C-band composite is interpolated at some places from higher altitudes (implicating interpolations from clouds or rain that doesn't reach the ground). To overcome this issue, a technique is applied where for a certain region low C-band values are removed.

Radar instruments

The MESEWI FMCW X-band radar on the top of the MESEWI building at the Delft Campus.

The RIJNMOND radar located on the building of the Delfste Poort in Rotterdam.

References

- Chen, C., Unal, C. M. H., & Oude Nijhuis, A. C. P. (2021). Jensen-Shannon Distance-based Filter and Unsupervised Evaluation Metrics for Polarimetric Weather Radar Processing (under review). IEEE Transactions on Geoscience and Remote Sensing.
- Figueras i Ventura, J., Oude Nijhuis, A. C. P., Otto, T., & Dufournet, Y. (2024). Quantitative precipitation estimation in the framework of the prowess project. ERAD2024.
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SkyTorque radar software

The SkyTorque radar software is developed by SkyEcho and processing the radar voltage measurements from MESEWI and RIJNMOND (two X-band radars) in the Netherlands.

Rangedoppler measurements from RIJNMOND measurements.

Preliminary conclusion and outlook

The additional quality parameters has some effect on the filtering. An ongoing challenge is how to use the filtering from different useful quality parameters in a nice and stable manner. Fuzzy logic is a candidate for this (in future work).

Acknowledgement

We acknowledge our appreciation for the usage of the MESEWI X-band radar (TU Delft MS3 group).

MESEWI study case

Composition details

C-band:
- International radar composite (IRC) real-time version from KNMI
- 6 C-band radars.
- Grid: 1x1 km
- A zoomed-in section is shown.

X-band:
- MESEWI radar
- Max range: 108 km
- Range res.: 43 m
- Level3 grid: 100 x 100 m

Combined:
- Grid: 100 x 100 m

C-band rainfall rate clipping

For pixels that have both X-band and C-band data available, an inconsistency mask is defined as:

$$m_t = r_C > 2r_X,$$

where r_* is the rainfall rate for the *-band (X/C). Then, the threshold is determined at the 0.5-point of the cumulative distribution function (CDF).

The application of his threshold on the C-band data, removes the low rainfall rate data that is not consistent with the X-band data.

RIJNMOND study case

Composition details

C-band:
- International radar composite (IRC) real-time version from KNMI
- 4 C-band radars.
- Grid: 1x1 km
- A zoomed-in section is shown.

X-band:
- RIJNMOND radar
- Max range: 30 km
- Range res.: 30 m
- Level3 grid: 100 x 100 m

Combined:
- Grid: 100 x 100 m

Merging process

For the X-band data, an initial mask is created where there is X-band data available (green+blue in the plot). An erosion is applied so that the last 5 km of this initial mask is removed. The resulting mask is the "X-band only mask" (shown in blue). This is where the data of the X-band is considered superior to the C-band data, and only the X-band data is used.

For the remaining region, where there is both X-band and C-band data (green region), the highest value is taken from both sources. For X-band radars, this region is typically behind rain cells, and suffers from attenuation.

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