Groundclutter

Identifying and correcting

Rainbow (manufacturer software)

Doppler filtering

- multiple pulses in one rangebin
- DFT: space to frequency domain
- power spectrum - distribution of power

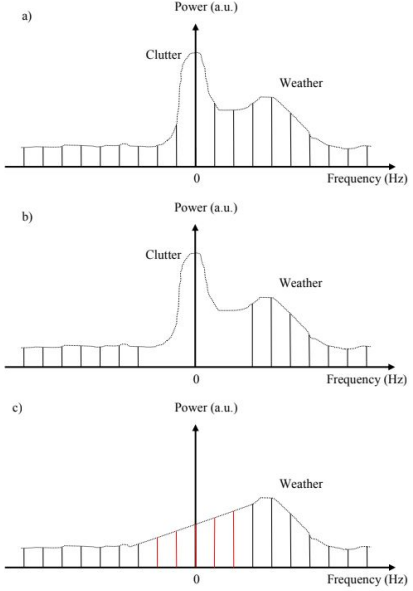


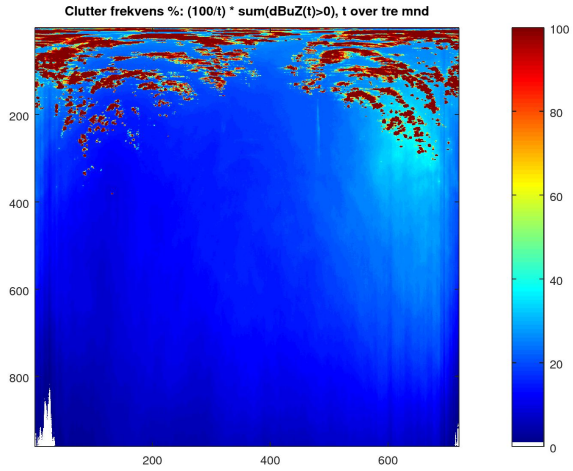
Fig. 4.12 Frequency domain clutter filter, a) power spectrum before filter, b) removal of signal power in filter region, c) interpolation of spectral power in filter region (red lines)

Thresholds

- LOG threshold: reject values below the noise floor (signal to noise ratio)
- CCOR threshold: reject values where unfiltered dBZ is much larger than Doppler filtered dBZ: *dBuZ - dBZ > 30dB*

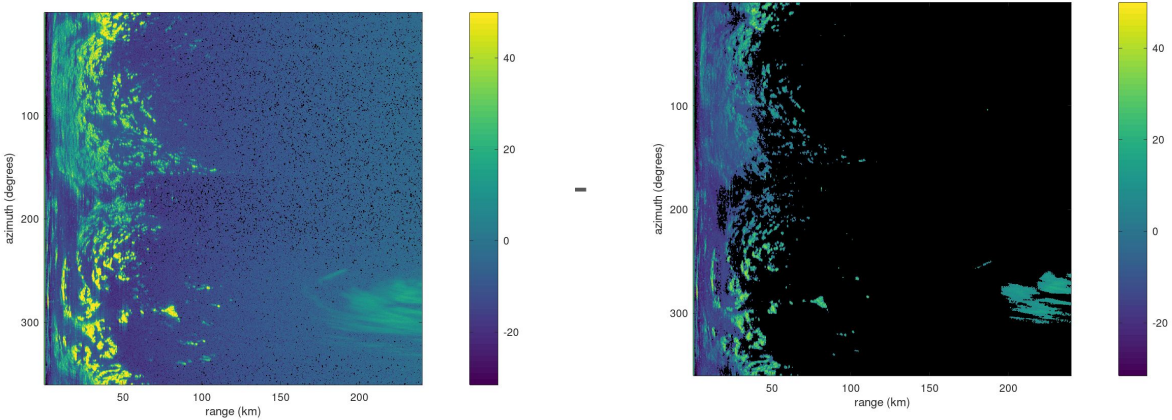
Other strategies to locate groundclutter

- Manual clutter maps
- Count data points where dBZ > 0 over a long period of (~3 months). High frequency indicates clutter
- Use a cloud mask from satellite



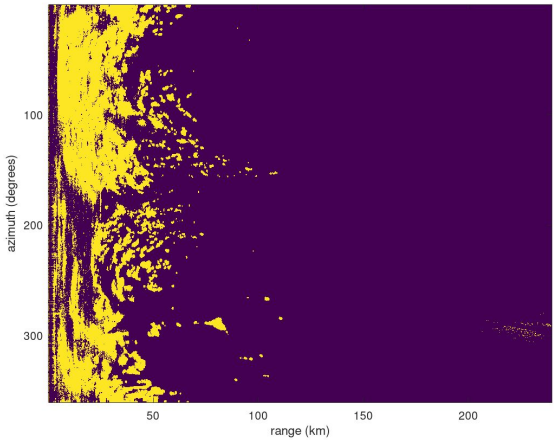
Difference between unfiltered and Doppler filtered reflectivity

dBuZ (unfiltered, rawdata) - dBZ (Doppler-Filtered) = CCOR (Clutter CORrection)

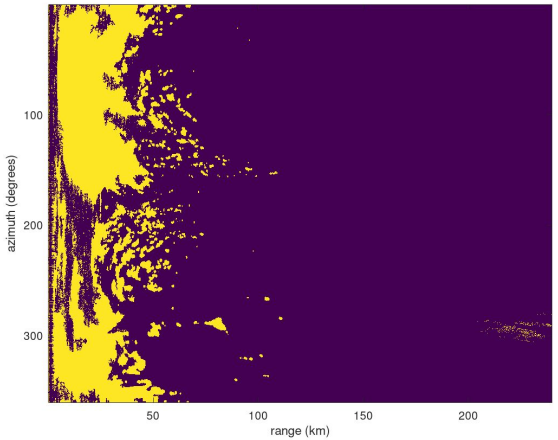


Create a mask that indicate groundclutter

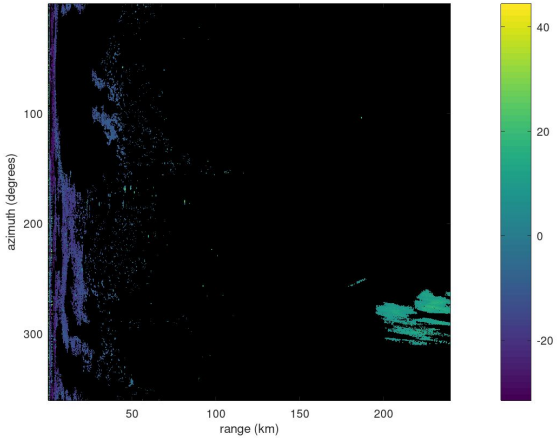
CCOR > 5dB



Fill holes with the aid of “image morphology”



dBZ with the mask



Inpainting. Suppose that a degraded image $g(x, y)$ has defects in a subdomain Ω_0 that is the domain $\Omega_1 = \Omega \backslash \Omega_0$ contains correct image values. In order to replace the defects by image values similar to the neighboring correct values one can use a modification of the ROF model:

$$\min_u \int_\Omega \sqrt{u_x^2 + u_y^2 + \beta^2}\, dxdy + \frac{\lambda}{2} \int_{\Omega_1} (u - g)^2 dxdy. \tag{4}$$

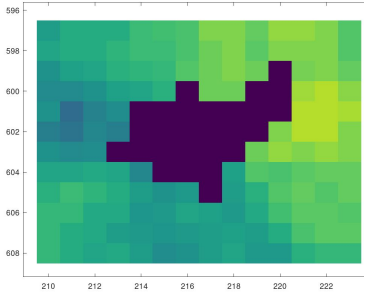
Chambolle, A., Pock, T. A First-Order Primal-Dual Algorithm for Convex Problems with Applications to Imaging. *J Math Imaging Vis* 40, 120–145 (2011)

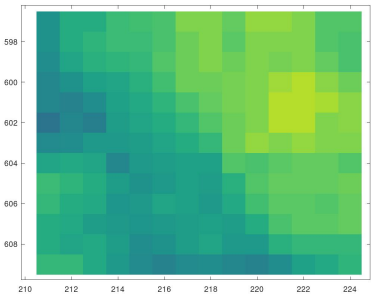
Chambolle, A. An Algorithm for Total Variation Minimization and Applications. Journal of Mathematical Imaging and Vision 20, 89–97 (2004)

L. I. Rudin, S. Osher, and E. Fatemi, "Nonlinear total variation based noise removal algorithms," Physica D 60 (1992) 259–268.

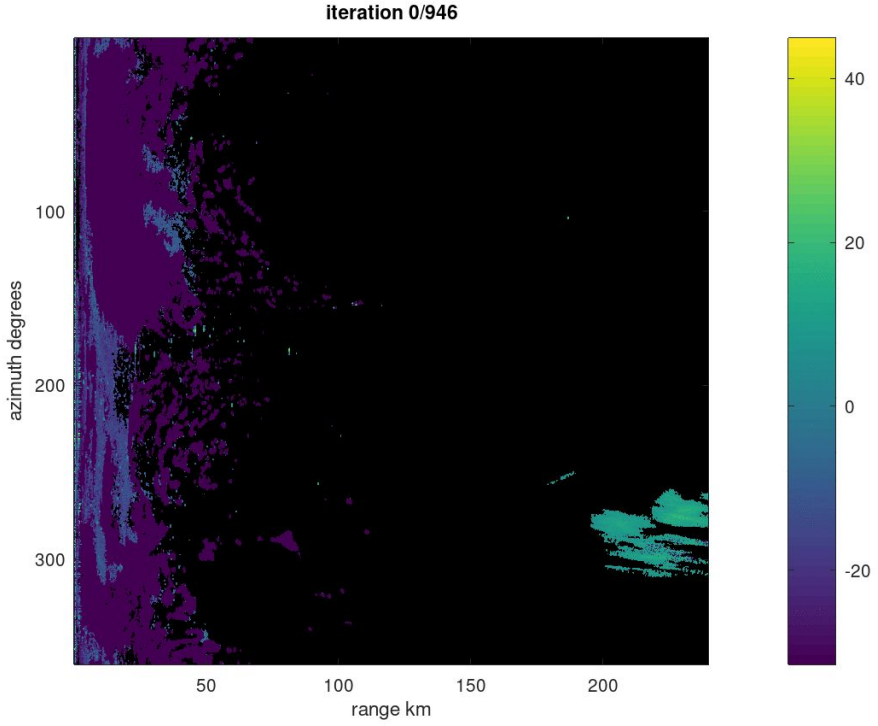
Other strategies

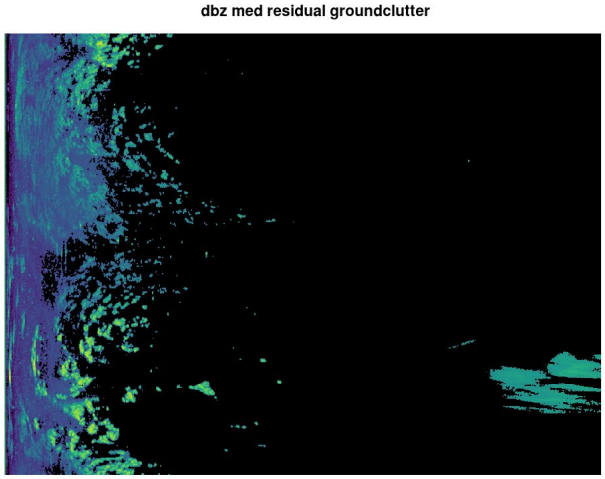
- Extrapolate from higher elevations
- Extrapolate from previous timestep with optical flow
- Interpolation

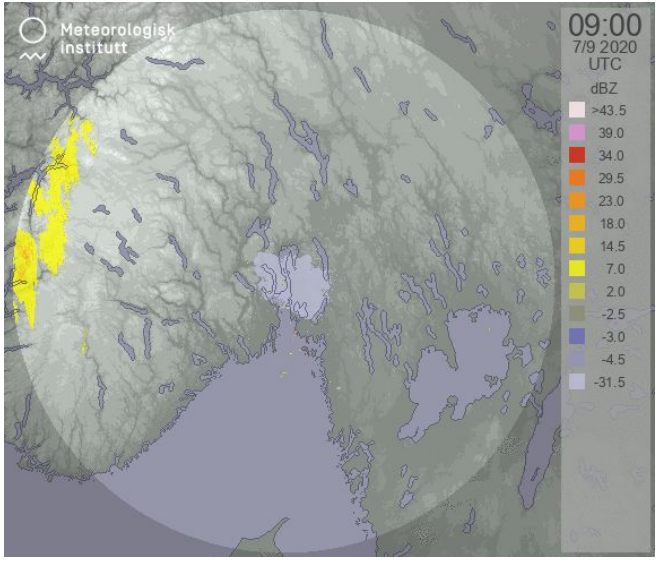




Inpainting without surrounding

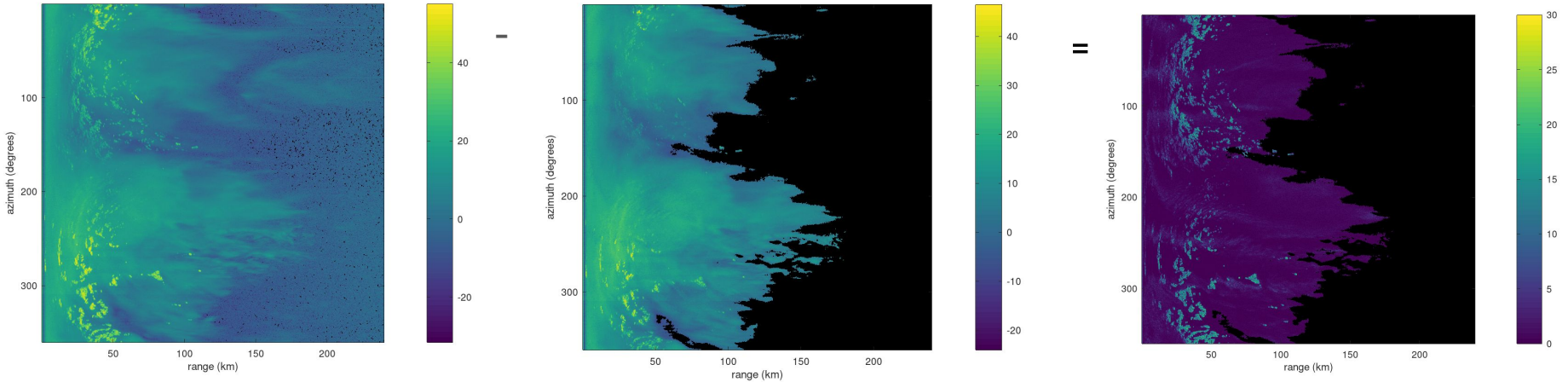




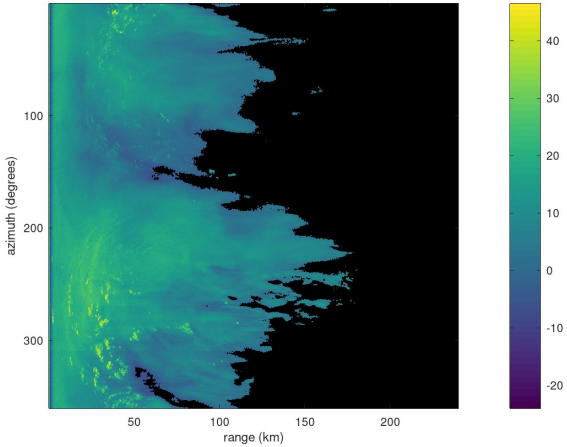


Difference between unfiltered and DP filtered reflectivty

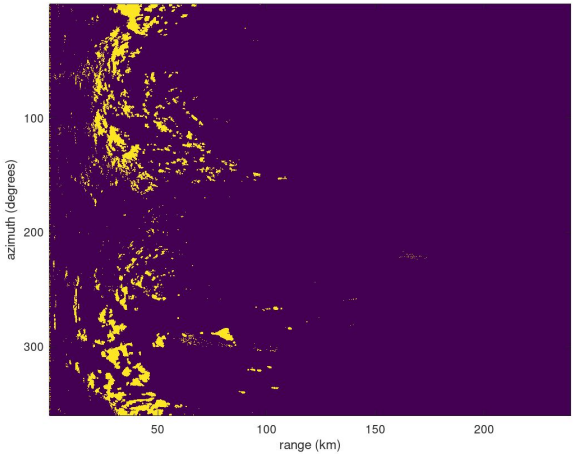
dBuZ (ufiltrert) - dBZ (Doppler-filtrert) = CCOR



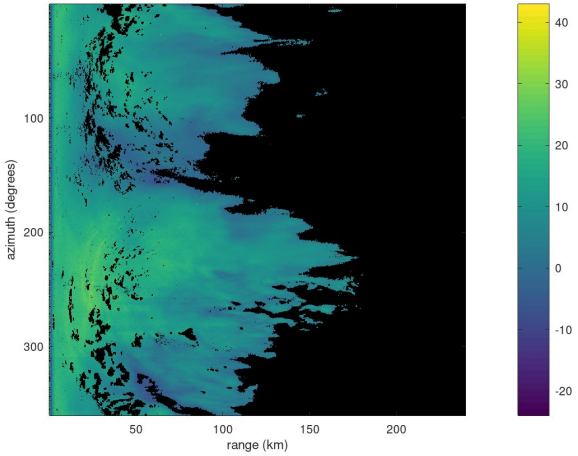
dBZ with residual clutter



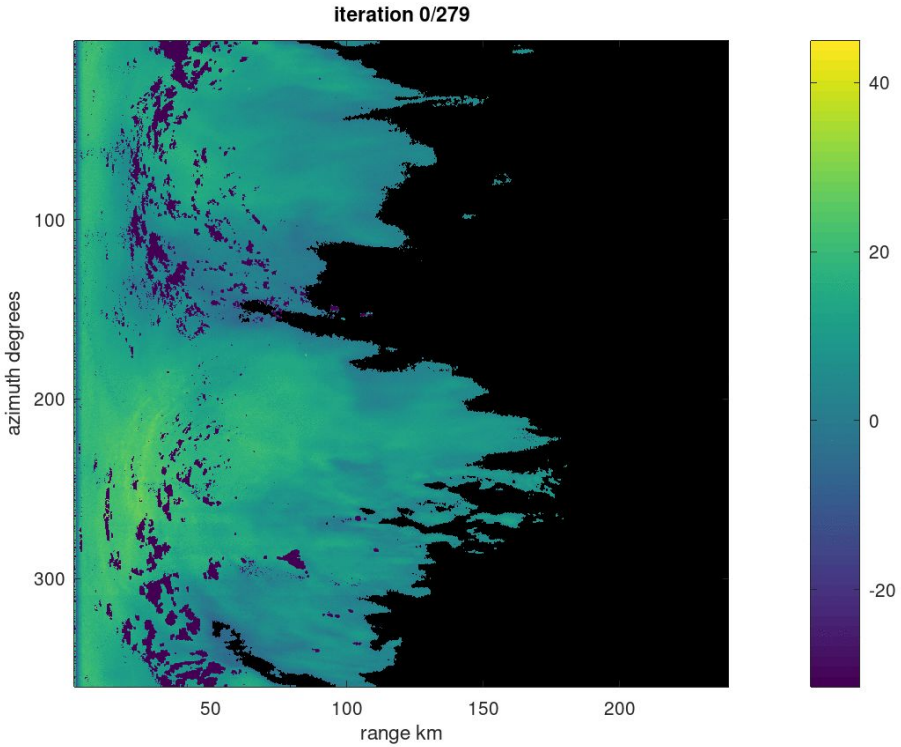
Clutter mask
CCOR > 5dB



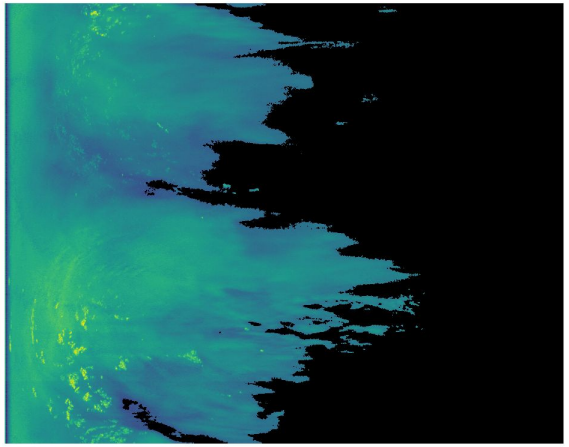
dBZ with mask



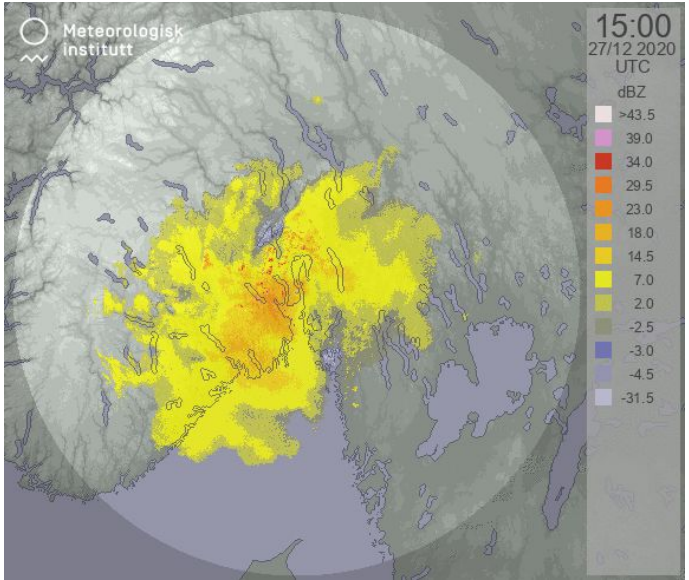
Inpainting with rain

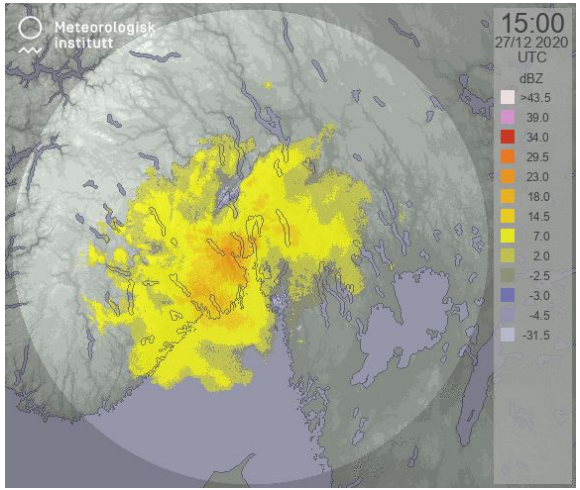


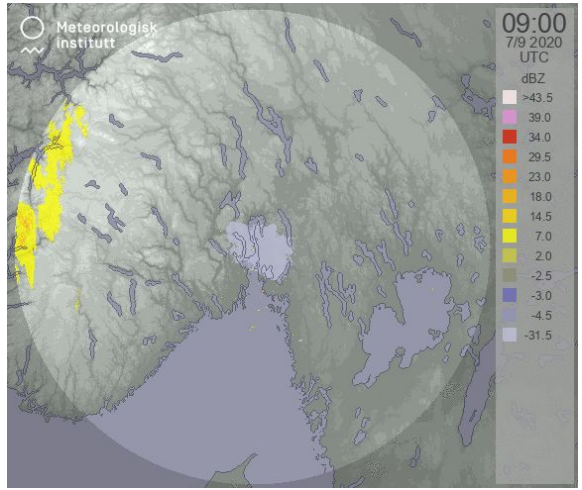
dBZ before inpainting

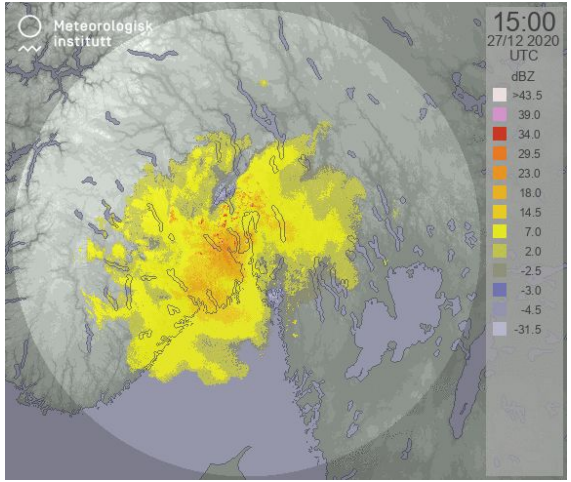


before and after




Meteorologisk institutt
15:00
27/12 2020
UTC
dBZ
>43.5
39.0
34.0
29.5
23.0
18.0
14.5
7.0
2.0
-2.5
-3.0
-4.5
-31.5


Meteorologisk institutt
09:00
7/9 2020
UTC
dBZ
>43.5
39.0
34.0
29.5
23.0
18.0
14.5
7.0
2.0
-2.5
-3.0
-4.5
-31.5


Meteorologisk institutt
15:00
27/12 2020
UTC
dBZ
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39.0
34.0
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23.0
18.0
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-2.5
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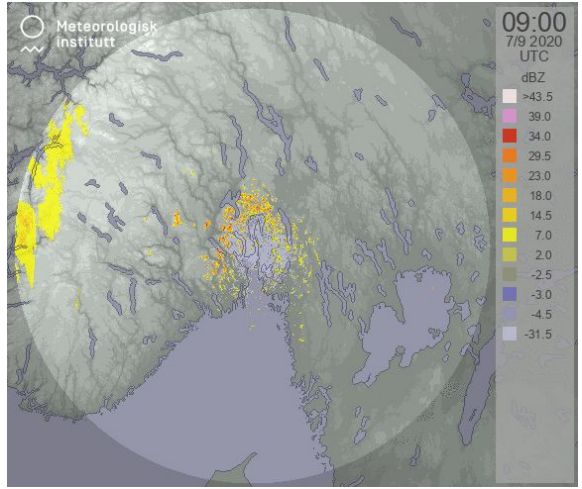
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