Engineering Research Center for Collaborative Adaptive Sensing of the Atmosphere

casa

DCAS Radar Modeling

Cloud observation, attenuation case
3 radars data fusion

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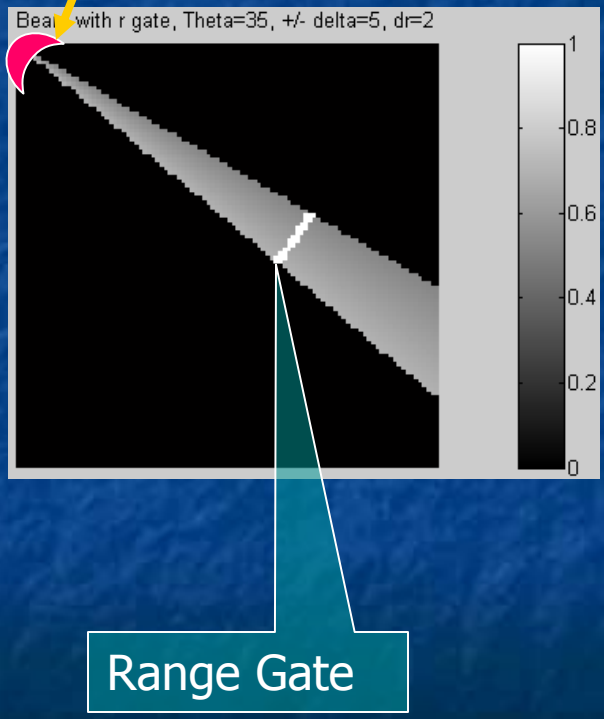
Approach

Modeled area observed by radar with parameters:

- Area: 100x100 pixels
- Beamwidth: 2 deg,
- Range gate width: 2 pixels
- (1 pixel ≈ 1 km)



Cloud and air

- Cloud is modeled as a circle with radius=20 pixels,
- Parameters: reflectivity:

$Z_{air}=0.1$

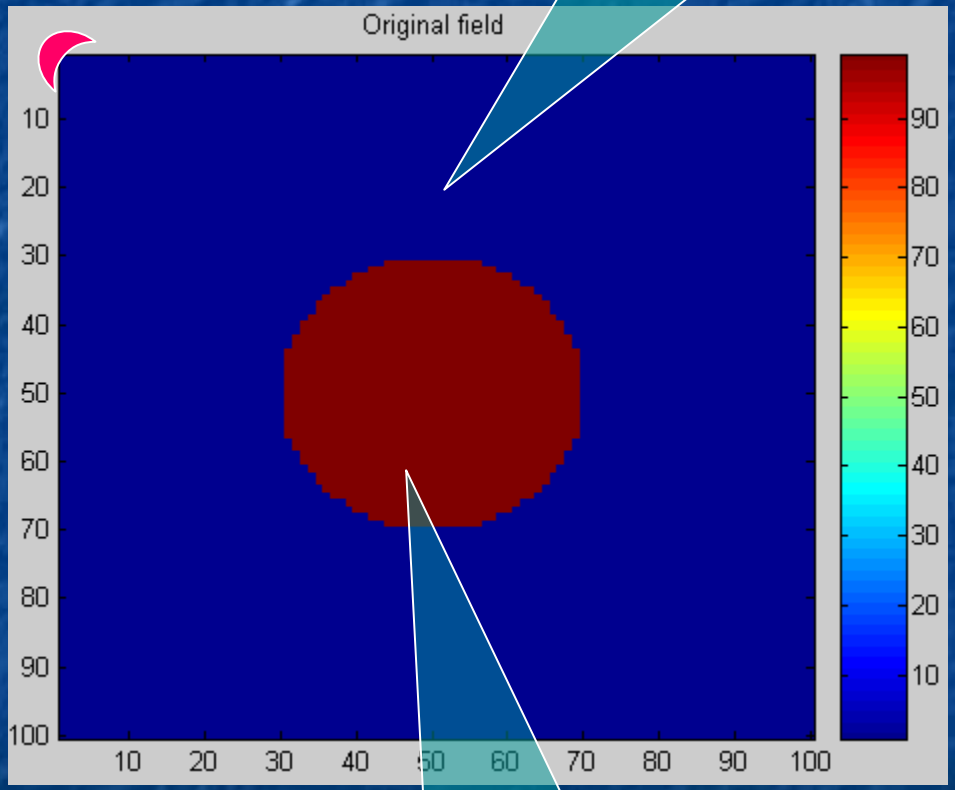
$Z_{cloud}=100$

Attenuation:

$\alpha_{air}=0.01$ Np/pixel

$\alpha_{cloud}=0.3$ Np/pixel

Air area,
$Z_{air}=0.1$ [mm^6 m^{-3}]
$\alpha_{air}=0.01/4.34$ dB/pixel

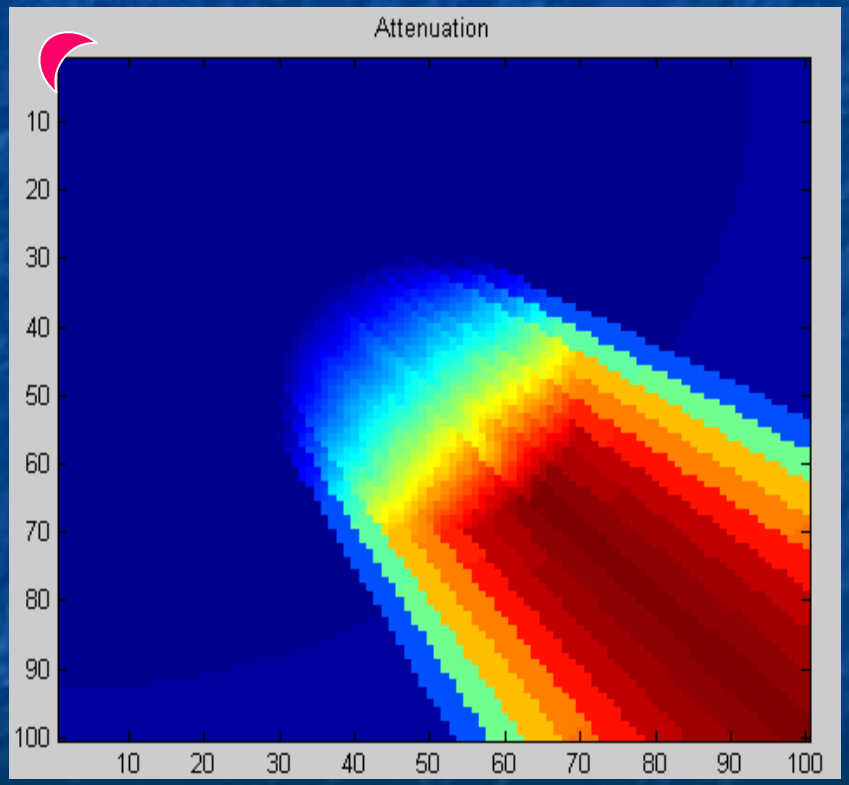


Cloud area,
$Z=100$,
$\alpha_{cloud}=0.3/4.34$ dB/pixel

Attenuation

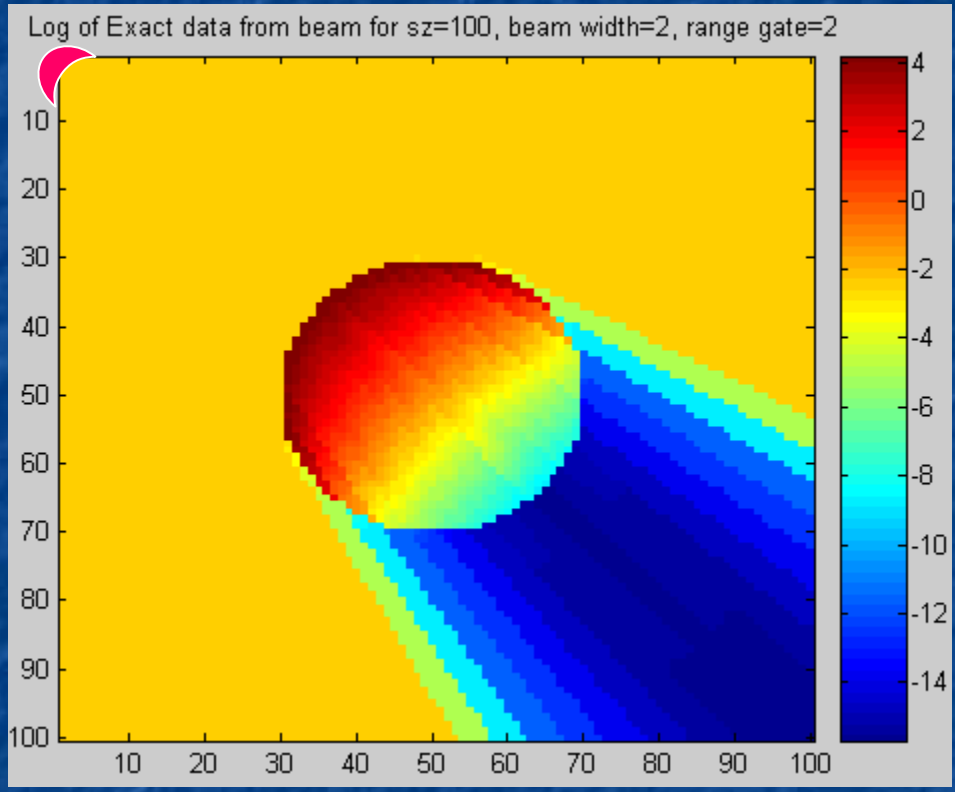
- Total attenuation is calculated as a cumulative sum from the radar position at every point (range, angle)

$$A(r_n)_{total} = e^{-\alpha_1 r_1 - \alpha_2 r_2 - \alpha_3 r_3 - \cdots - \alpha_n r_n}$$

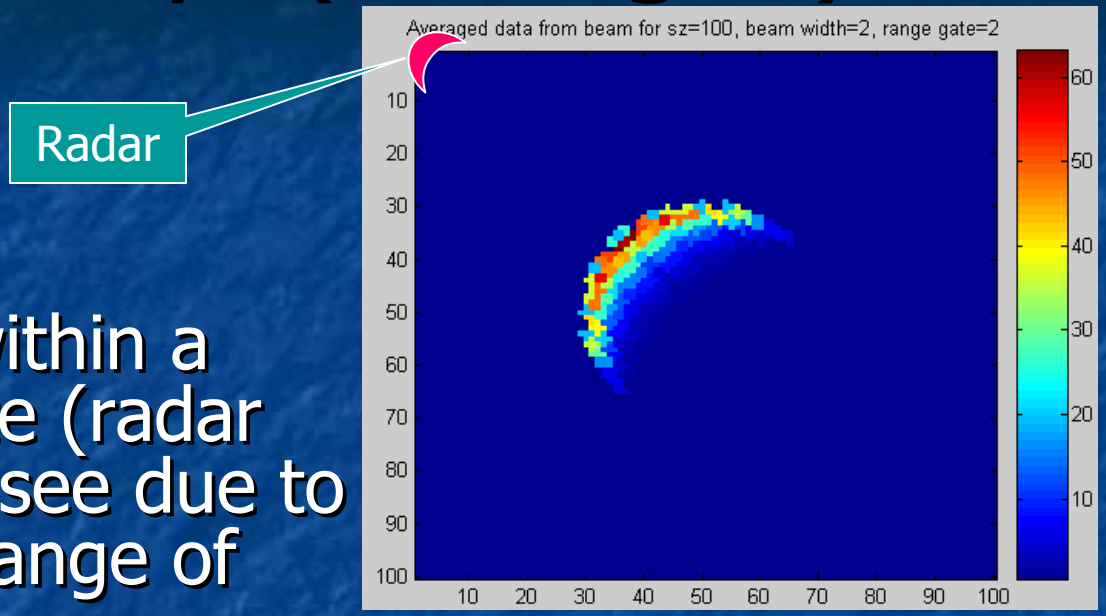


Reflectivity in Log view

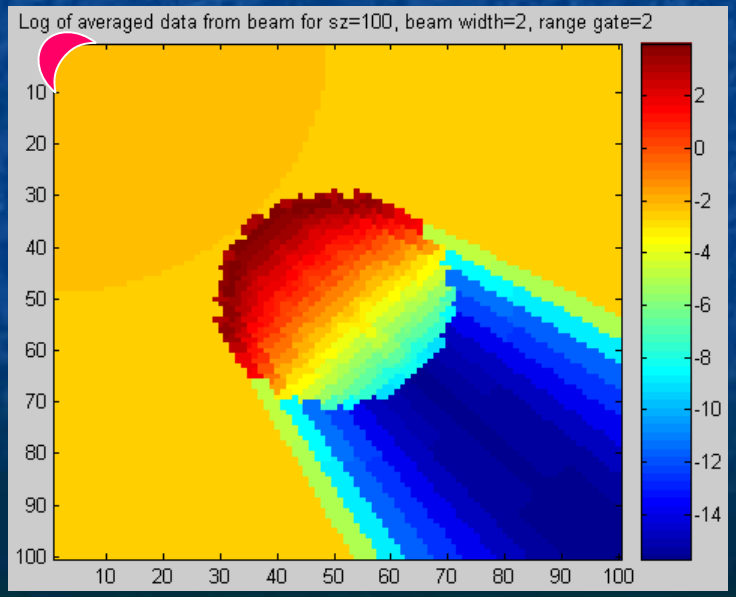
- Log view (dBZ) of exact reflectivity (not averaged by beam)



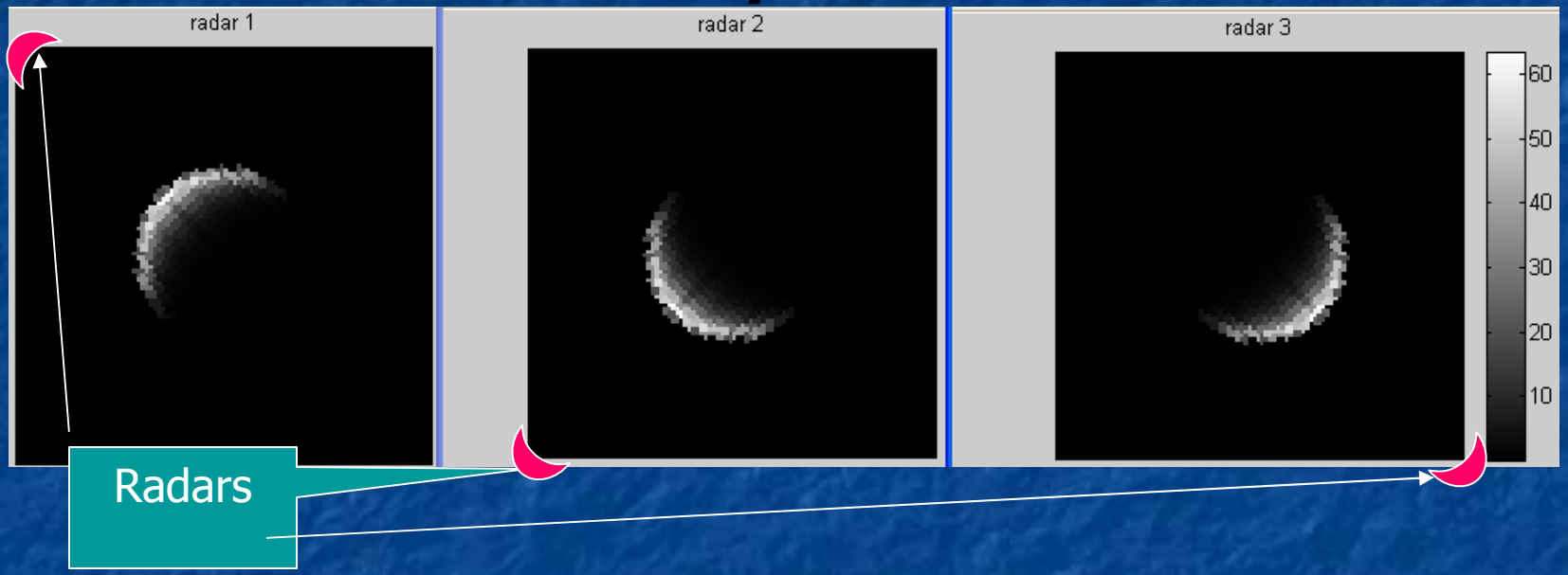
Reflectivity (averaged)



- Averaged linear reflectivity, Z, within a given range-gate (radar view). [Hard to see due to large dynamic range of values]
- Logarithm of averaged data, dBZ



Z seen by 3 radars



- 3 radars on the corners of the square area look to the same "cloud" from different sides.
- Assumes no interaction among them in terms of signal from one unit being detected by other.

Z_{dB} Data fusion:

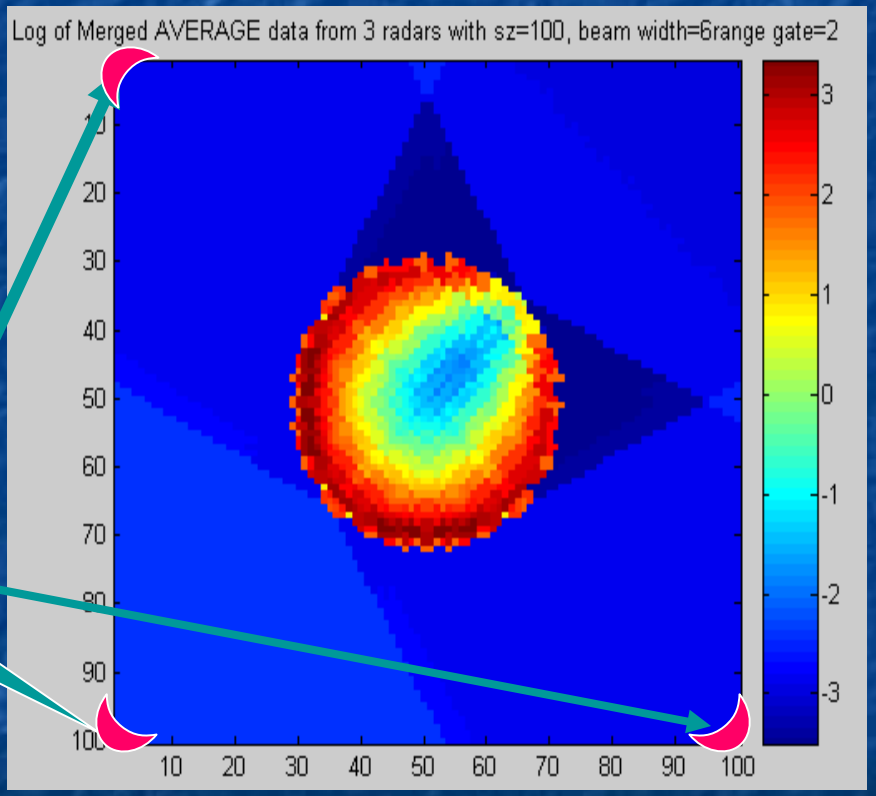
Display Z_{dB} merged from all 3 radars.

- Average
- MAX
- MIN

Z_{dB} Data fusion using Averaged :

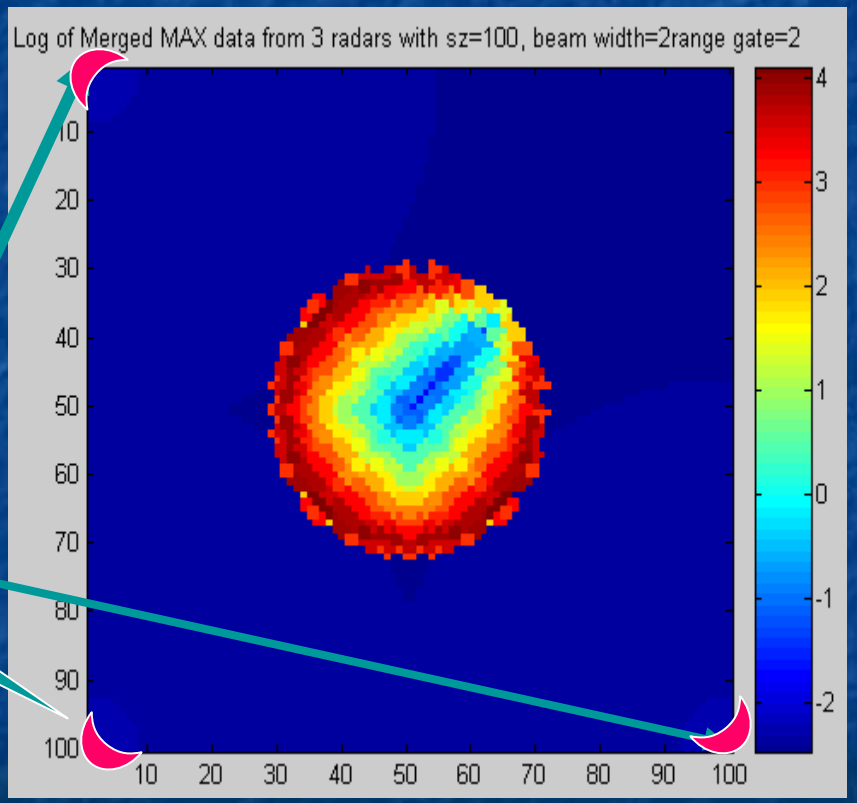
- Average, MAX, MIN
- Log of merged data, Z_{dB}, from all 3 radars.

Averaged data shown



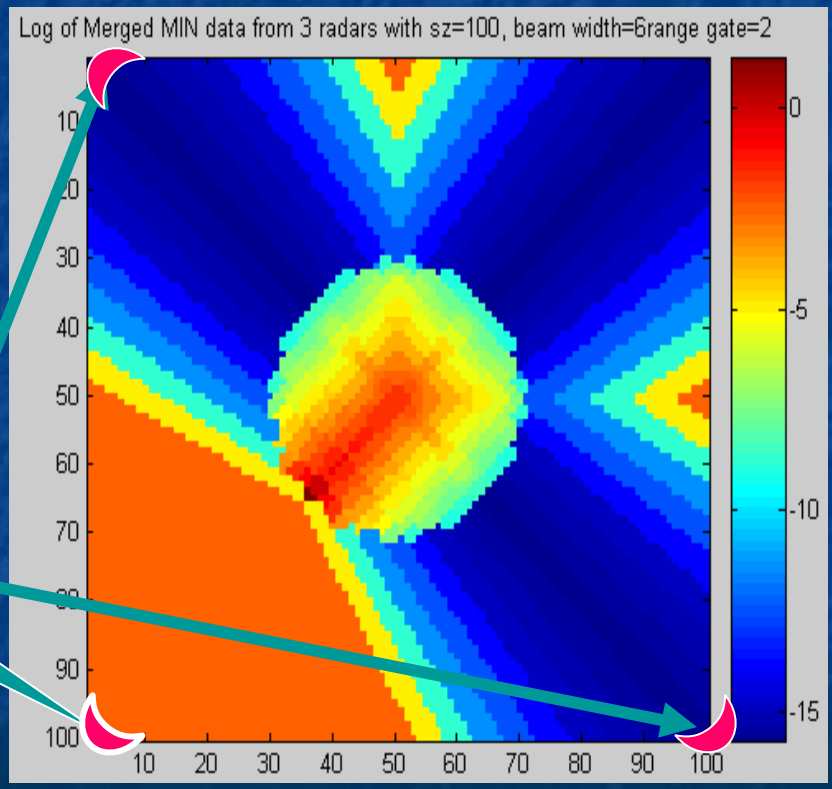
Z_{dB} Data merge using Max

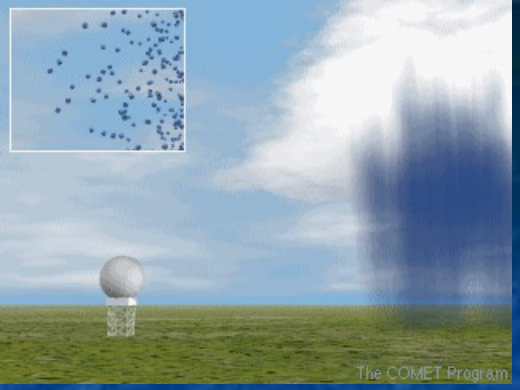
- Log of merged Max data from all 3 radars: at every point we select just max value.



Z_{dB} Data merge using Min

- Log of merged MIN data from all 3 radars:
  at every point we select just min value





Conclusions

- Averaging data from three radars looking at same simulated cloud provides with better estimate than using max or min for data fusion.
- Need to add 3rd dimension (elevation angle)
- Run with different cloud/air parameter to simulate different weather conditions (i.e., heavy rain).