Development of a Time-Gated Time-Correlated Single-Photon-Counting Lidar to Observe Atmospheric Clouds at Submeter Resolution

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This study is done with the collaboration of
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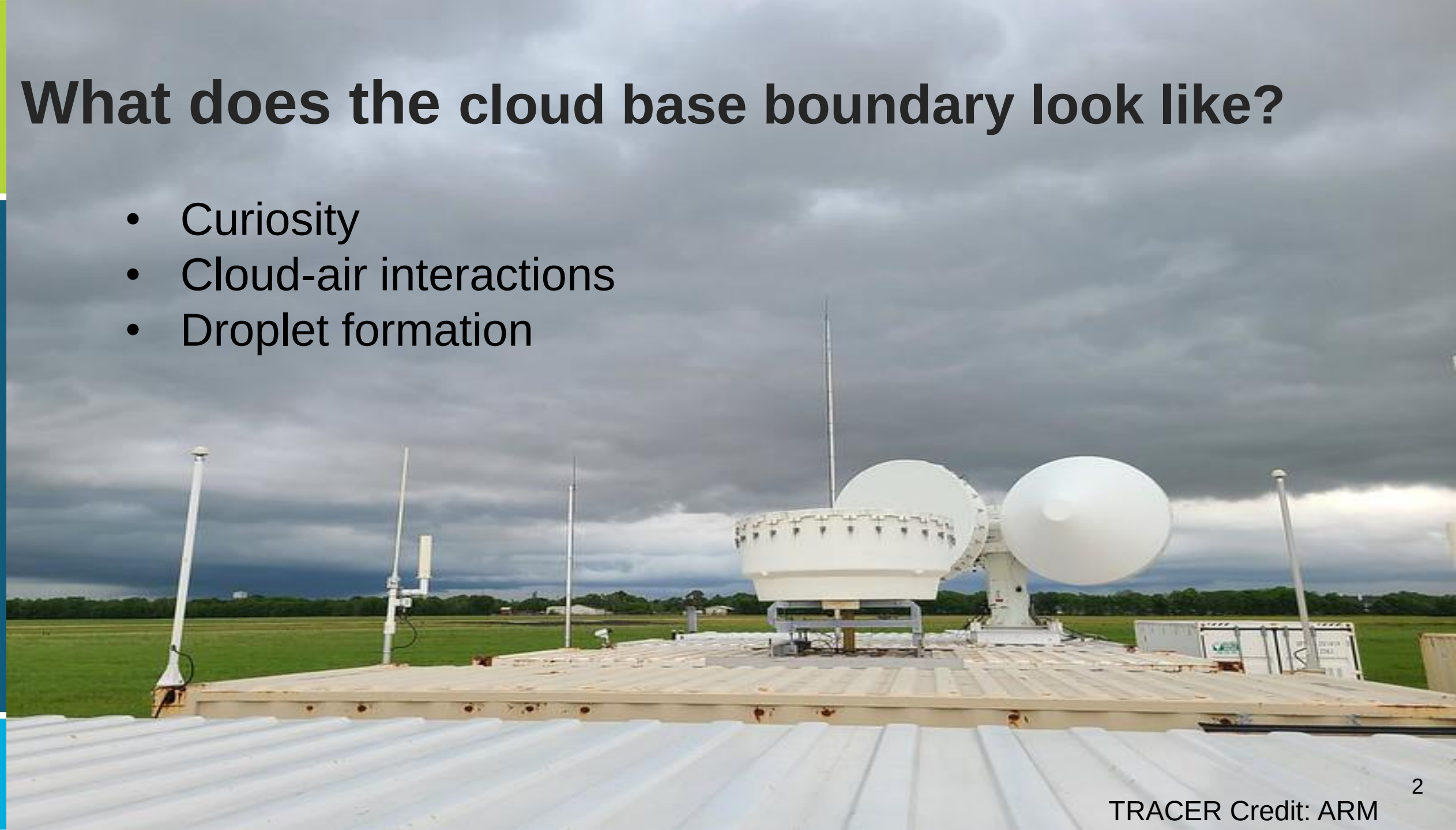
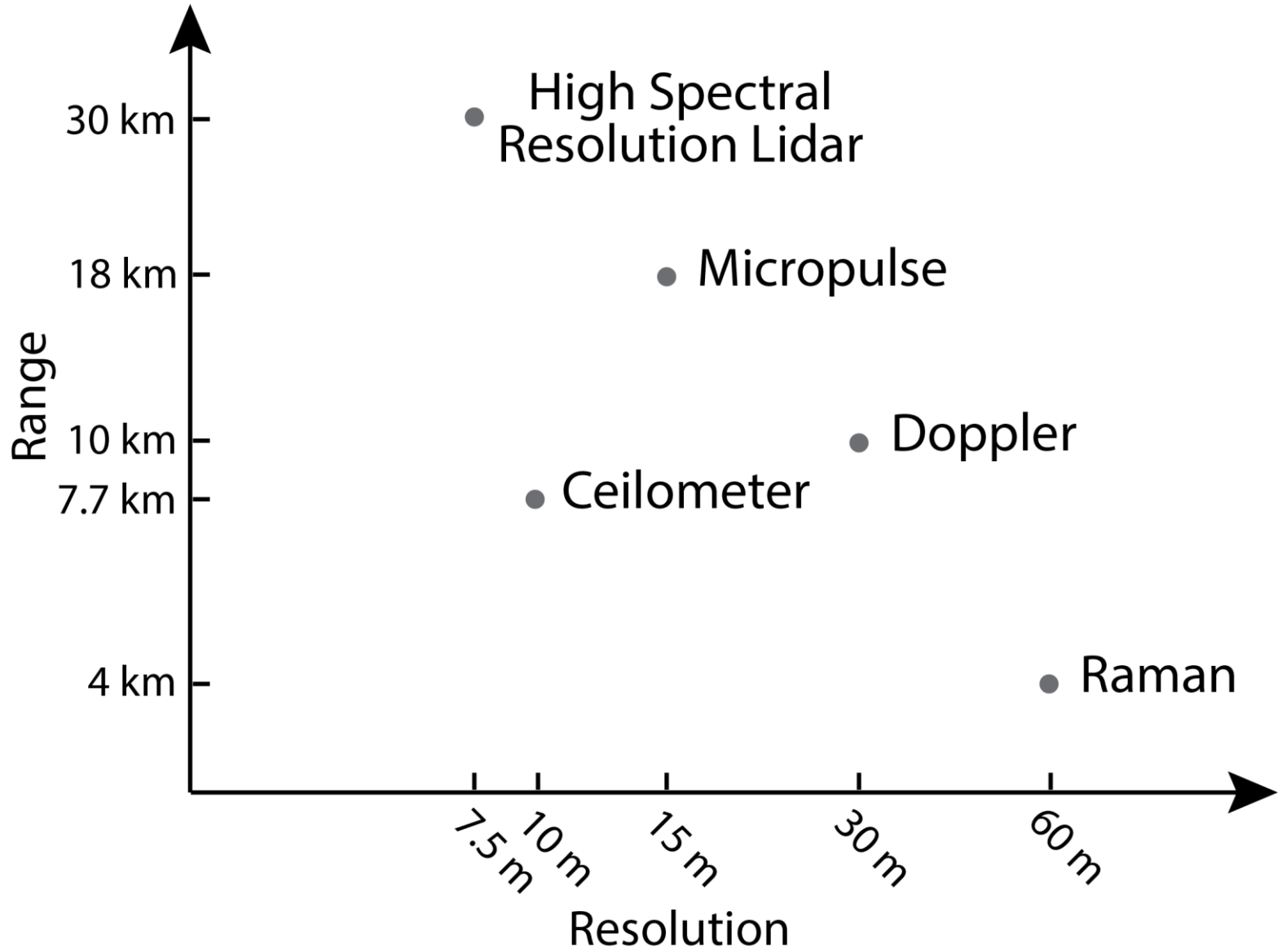
Results are detailed in
Yang et al., *Remote Sensing*, 2023

What does the cloud base boundary look like?

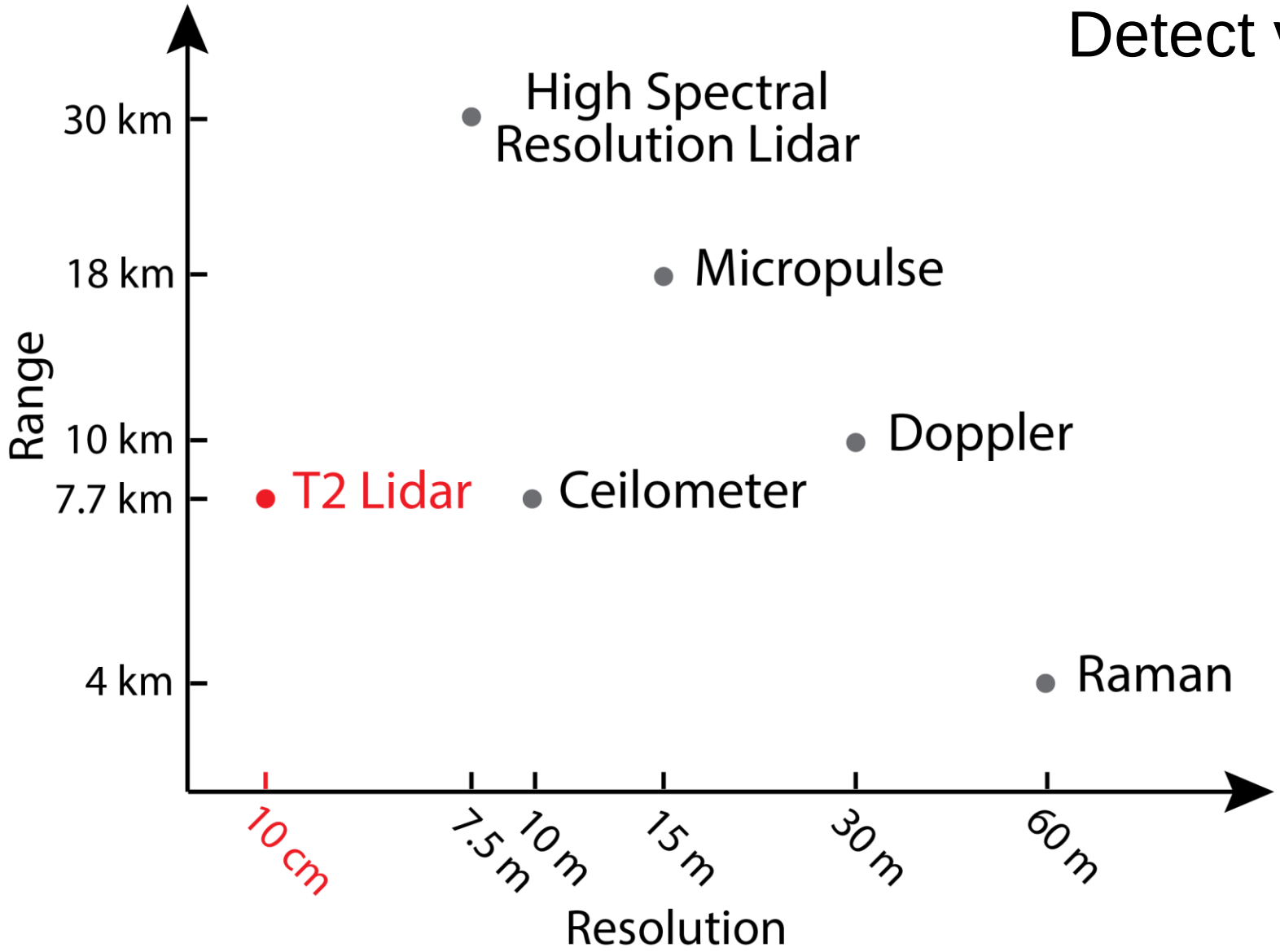
- Curiosity
- Cloud-air interactions
- Droplet formation



TRACER Credit: ARM


High Spectral Resolution Lidar
Micropulse
Doppler
Ceilometer
Raman
Range
30 km
18 km
10 km
7.7 km
4 km
7.5 m
10 m
15 m
30 m
60 m
Resolution

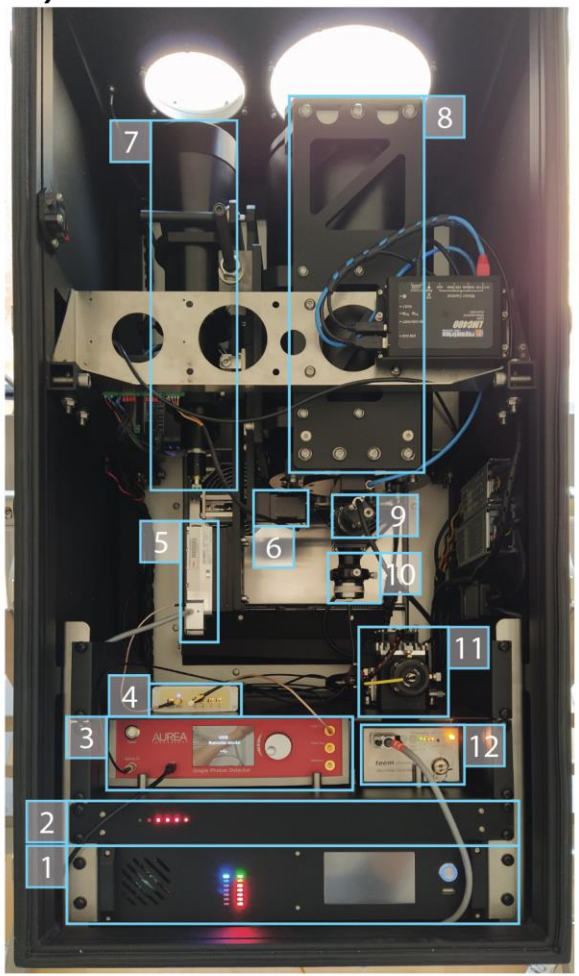
Detect vs. Resolve?



Time-gated Time-correlated Single Photon Counting Lidar (T2 lidar)

a)

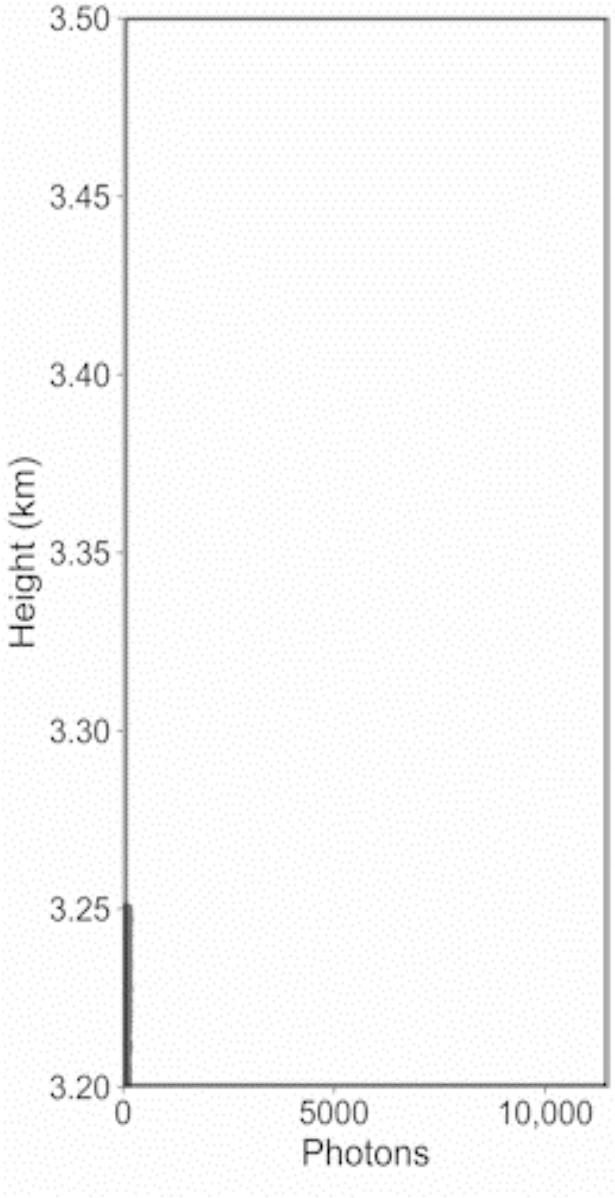
b)



Wavelength	532 nm
Repetition Rate	20.6 kHz
Pulse Width	650 ps
Pulse Energy	3.4 μJ
Range Resolution	> 10 cm
Time Gating Window	5.5 ~ 85 ns

Yang et al., 2023

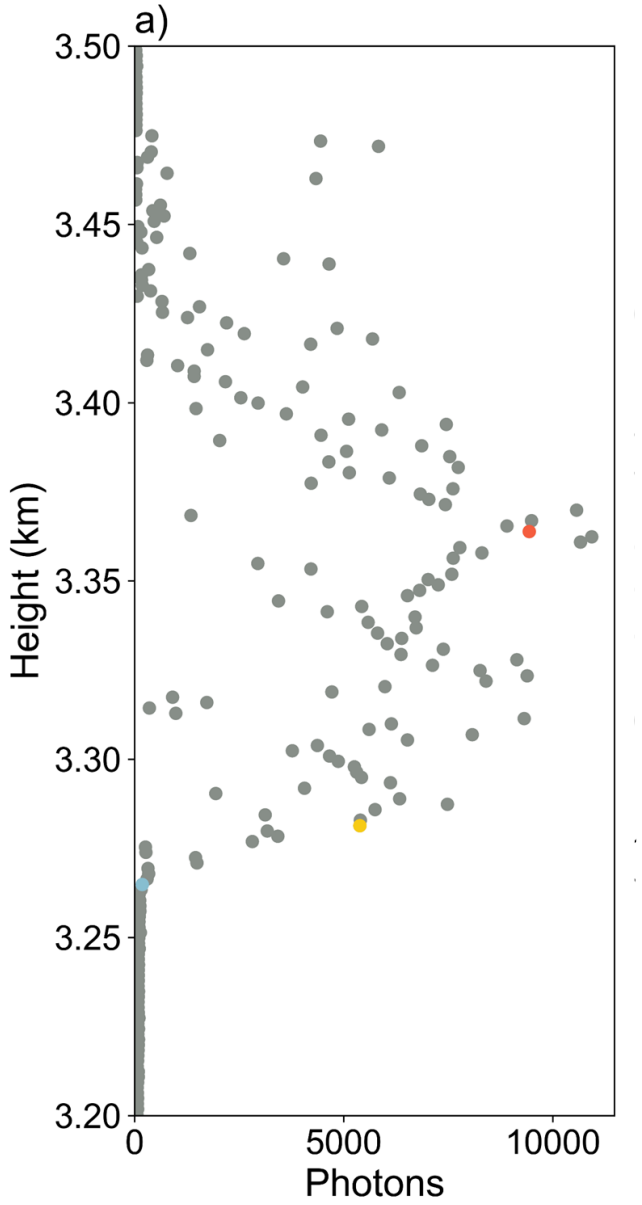
Time-gating technique



When running in the time-gated mode, the T2 lidar only receives backscattered photons in a small time-gated window (up to ~ 12 m).

Yang et al., 2023

Time-correlated single photon counting technique



- In each time-gated window, the arriving time of each photon is recorded at a resolution of ~50 ps.
- The lidar range resolution is limited by the pulse width (~650 ps), corresponding to ~10 cm range resolution.

Yang et al., 2023

Conclusion and future work

- The T2 lidar can resolve cloud base structure at submeter scales.
- We are developing theoretical and modeling approaches to link the T2 lidar observations with cloud microphysical properties and processes.
- More observations are needed.

This project is funded by BNL PD and LDRD.

Reference:
Yang, Fan, Yong Meng Sua, Alexandros Louridas, Katia Lamer, Zeen Zhu, Edward Luke, Yu-Ping Huang, Pavlos Kollias, Andrew M. Vogelmann, and Allison McComiskey. "A Time-Gated, Time-Correlated Single-Photon-Counting Lidar to Observe Atmospheric Clouds at Submeter Resolution." Remote Sensing 15, no. 6 (2023): 1500.