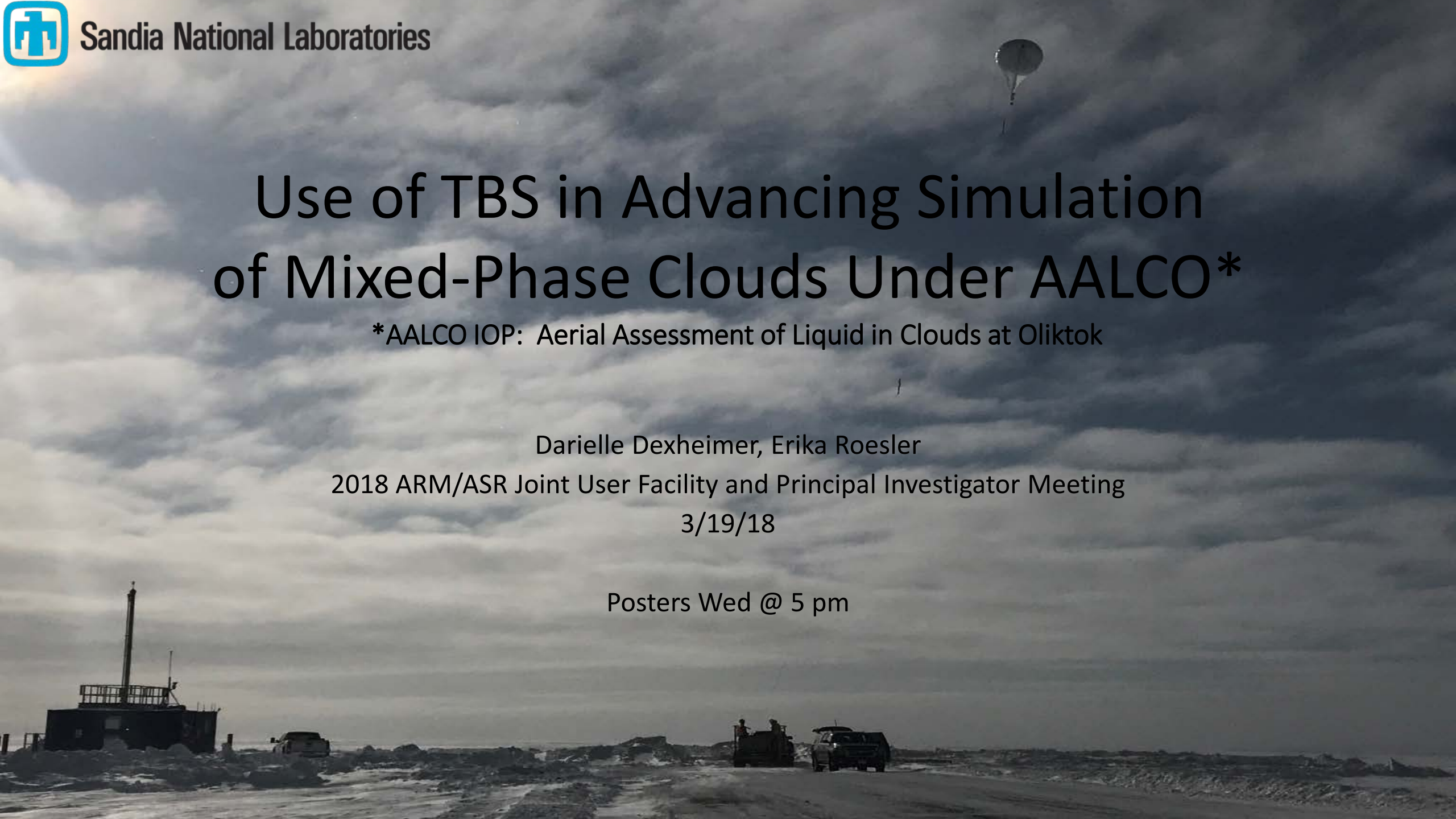

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# Use of TBS in Advancing Simulation of Mixed-Phase Clouds Under AALCO*

*AALCO IOP: Aerial Assessment of Liquid in Clouds at Oliktok

Darielle Dexheimer, Erika Roesler

2018 ARM/ASR Joint User Facility and Principal Investigator Meeting
3/19/18

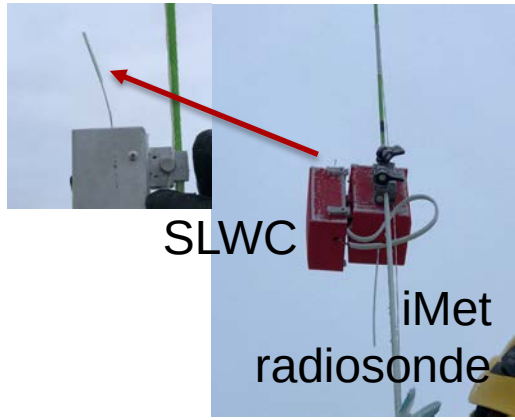
Posters Wed @ 5 pm

# ARM TBS Supercooled Liquid Water Content Sondes (SLWCs)

Sandia National Laboratories

- SLWC sondes were flown on the TBS in supercooled clouds at the AMF3 as part of AALCO from 5/2016 – 10/2017 (43 flights)
  - SLWC in situ measurements in g/m$^3$ – comparisons with other in situ measurements . . .
  - SLWC measurements were integrated across TBS ascents and descents to calculate integrated liquid water (ILW) in mm

$$ILW = \frac{1}{\rho_{H_2O}} \int_{z_0}^{z} LWC \, \partial z$$

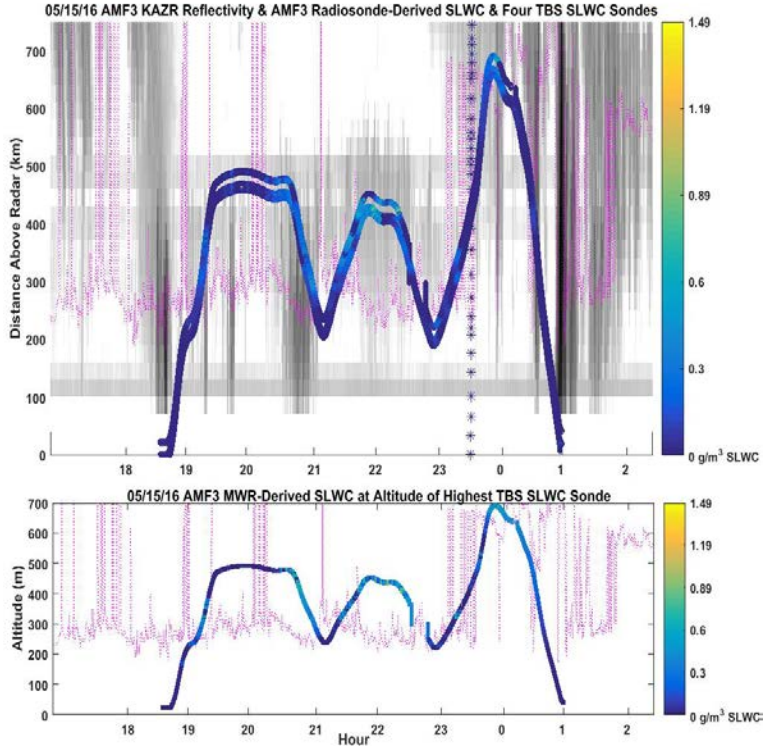



  - SLWC was calculated from AMF3 radiosonde launches at time closest to TBS ascent/descent using adiabatic Enthalpy lapse-rate equation (where $C_p$ = specific heat at constant pressure, L = latent heat of vaporization, $\Gamma_d$ = dry adiabatic lapse rate, $\Gamma_s$ = moist adiabatic lapse rate)

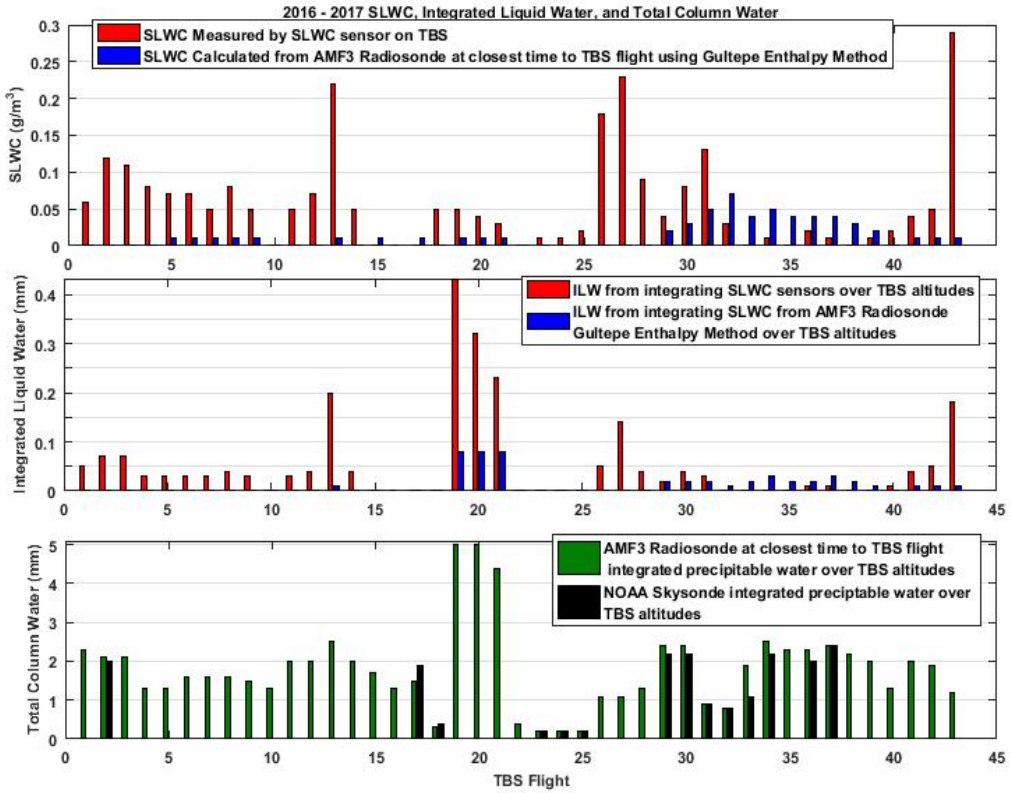
$$LWC_{ad} = \int_{z_0}^{z} \rho(z) \frac{C_p}{L} (\Gamma_d - \Gamma_s) \, dz$$

  - SLWC enthalpy measurements were integrated across TBS ascents and descents to calculate ILW in mm
  - Total column water in mm, representing a vertical integration of mean mixing ratios, was calculated from AMF3 radiosonde launches at the time closest to TBS ascent/descent
  - Total column water in mm was calculated for TBS iMet radiosondes using NOAA Skysonde software methodology

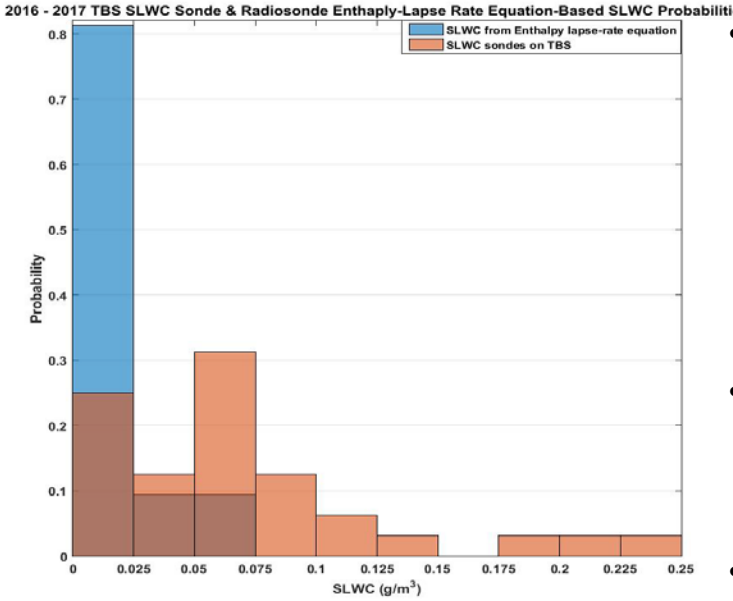
    (converts iMet water vapor mixing ratio to volume of liquid water)



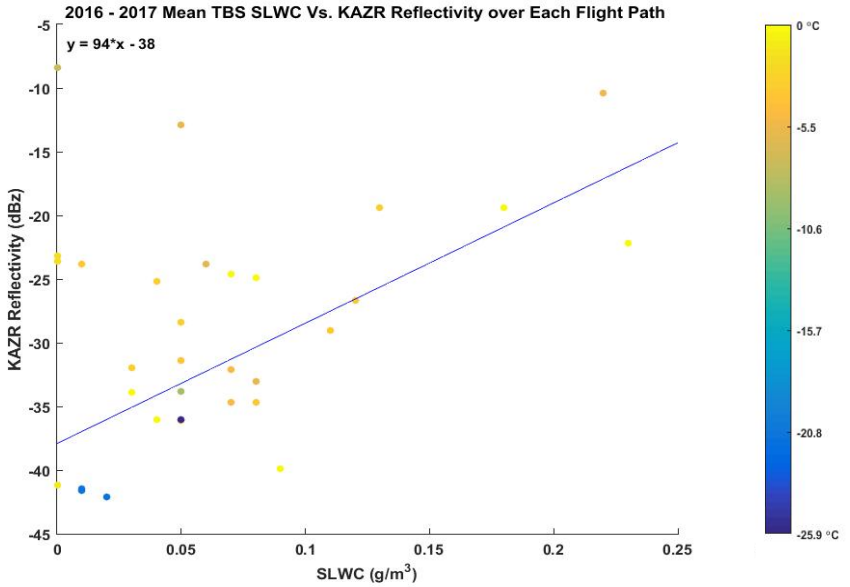
# Calculation of Integrated Liquid Water from SLWCs & Total Water




- SLWC values measured by the TBS SLWC sondes averaged 0.05 g/m$^3$ higher than the SLWC values calculated from the radiosonde launch closest in time to the TBS flight using the enthalpy lapse-rate equation.
- Some difference from spatial/temporal difference between TBS and radiosonde, but SLWC values from the enthalpy lapse-rate equation are quite low.
  - < .05 g/m$^3$ for 93% of the dataset




- Previous aircraft measurements in supercooled stratiform clouds (Sand et al) reported SLWC values < .05 g/m$^3$ occurring with a .35 probability
- This is consistent with the results from the TBS SLWC sonde measurements
- ILW < TCW, next steps

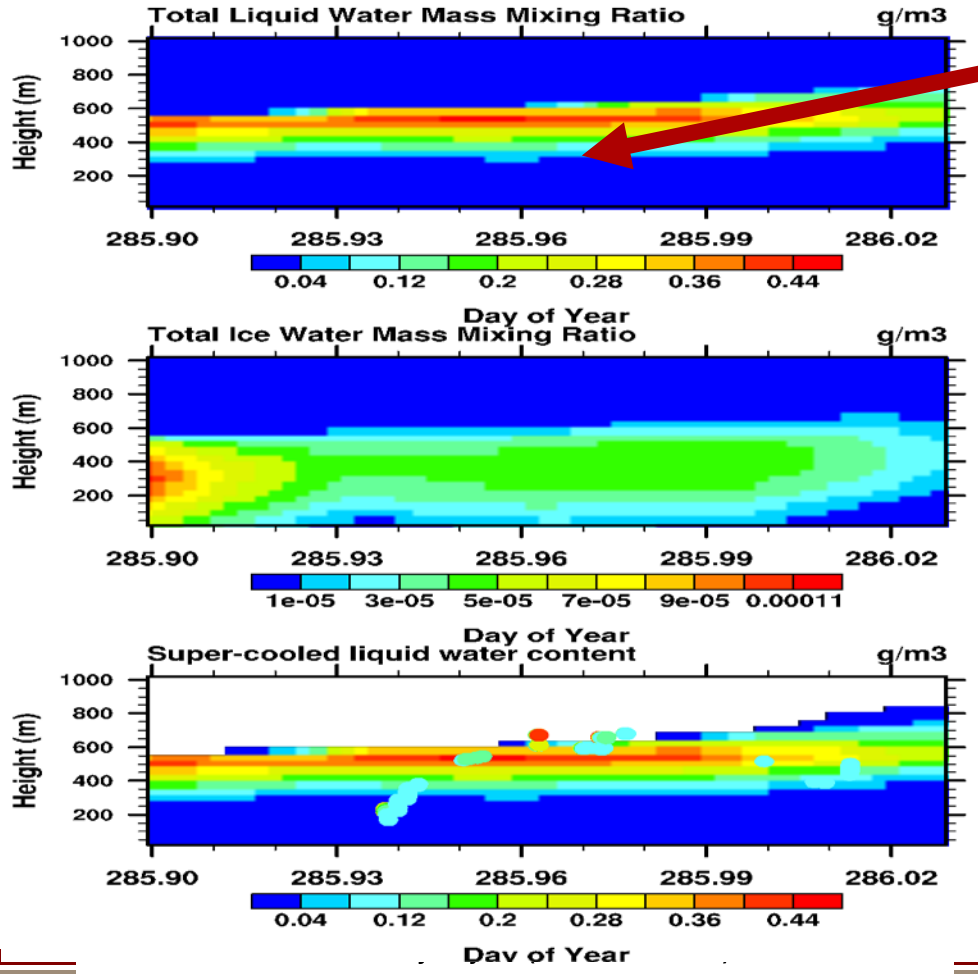



- The mean KAZR reflectivity (Z) over each TBS flight path increases with increasing SLWC, as measured from the TBS SLWC sondes.

# Simulations Over TBS flights

- Purpose of Simulations:
  - Tethered Balloons (**TBS**) run for limited time, are point measurements, can collect ***IN SITU*** cloud data
  - Big Question #1: How ***well*** do LES simulations reproduce the point measurements from the TBS?
  - Big Question #2: If LES simulations reproduce measurements from TBS ***well***, can they ”fill-in the gaps” for when the TBS is not in operation?
- TBS and LES (2016 - 2017)
  - April (2), May (2), June (2), July (1), August (1), October (2), November (1)
- SAM6.11.1 (System for Atmospheric Modeling, Marat Kharatdinov)
  - **OCTOBER 13, 2017 shown here.**
  - dx = dy = 200 m, dz = 40 m
  - Lx = Ly = 25.6 km; Lz = 5.1 km
  - Ice constrained to 0.1 crystals per liter (following Ovchinnikov et al 2011)
  - Initialized and Forced with ARM AMF3 data:
    - Interpolated Sondes
    - Temperature and Fluxes from Met Tower and Ecor
    - Cloud Lifetime and Macrophysical properties from KAZR

# SAM produces a mixed-phase cloud with non-zero supercooled liquid water at the same time as the TBS does




Cold, below freezing.
How compares with DTS?

SAM/ LES reappearing bias: Not simulating any cloudiness below 400m