

ARM

CLIMATE RESEARCH FACILITY



ICARUS TBS Update

Dari Dexheimer

Sandia National Laboratories

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.



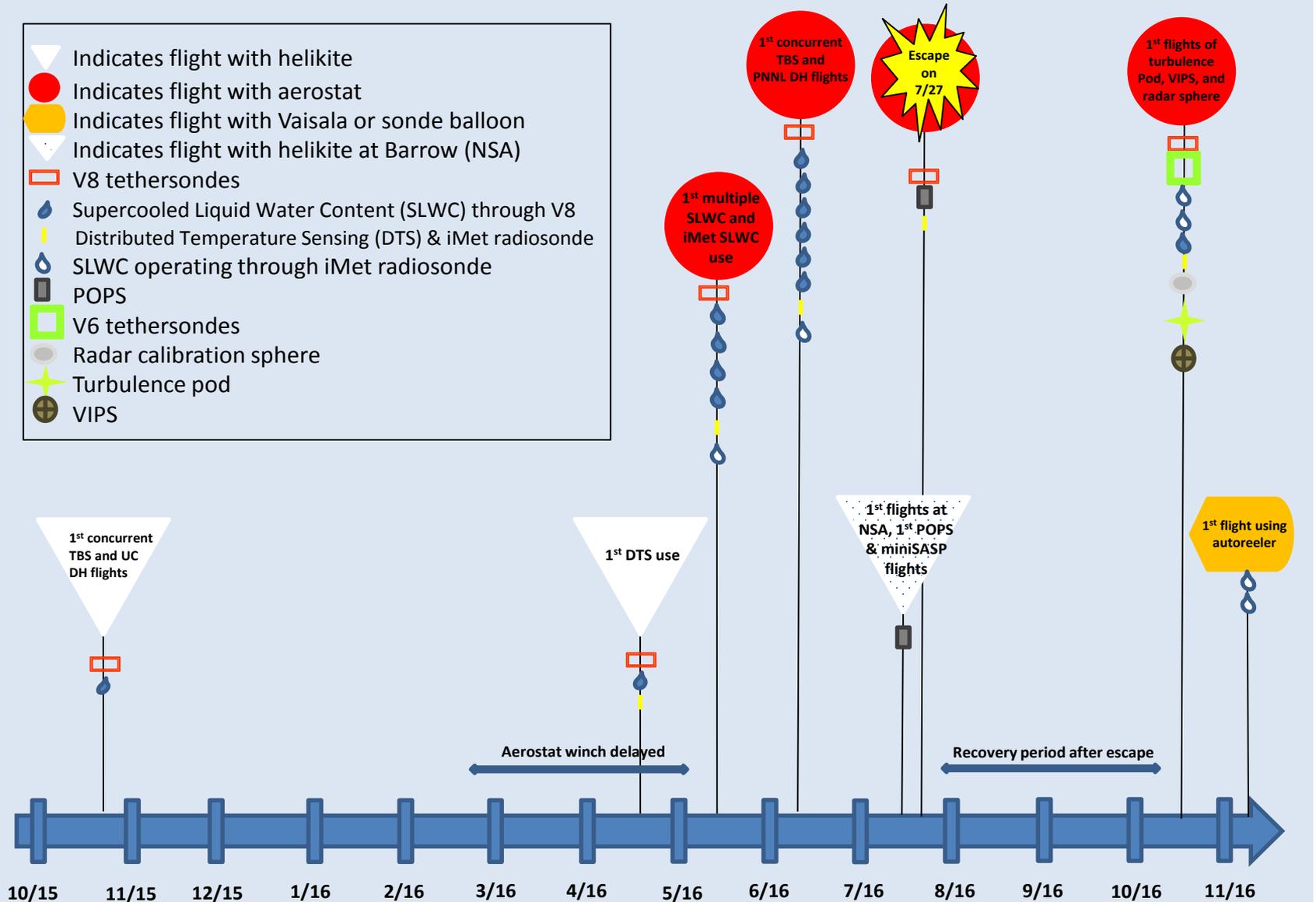
U.S. DEPARTMENT OF
ENERGY



Sandia National Laboratories

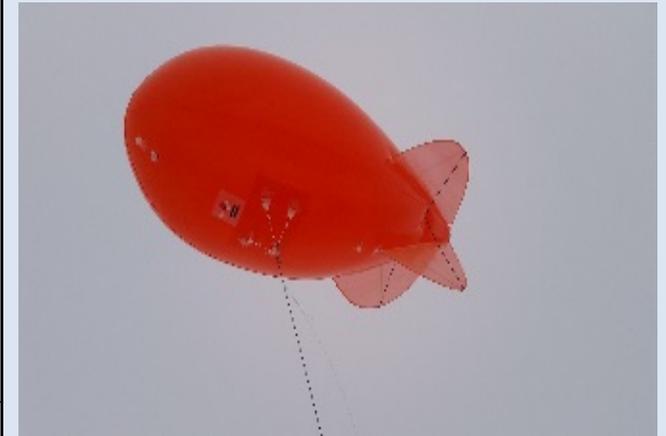
TBS Timeline

- ▽ Indicates flight with helikite
- Indicates flight with aerostat
- Indicates flight with Vaisala or sonde balloon
- ▽ Indicates flight with helikite at Barrow (NSA)
- V8 tethersondes
- Supercooled Liquid Water Content (SLWC) through V8
- Distributed Temperature Sensing (DTS) & iMet radiosonde
- SLWC operating through iMet radiosonde
- POPS
- V6 tethersondes
- Radar calibration sphere
- ★ Turbulence pod
- VIPS



ICARUS TBS Summary

Dates	TBS Flight Hours	Comments
October 22-28, 2015	33.5	Includes CU/B tests of the DataHawk and Pilatus autopilot in the USAF LRRS RF environment by suspending the autopilots from the balloon tether. Flights were conducted on 5 days.
April 3-20, 2016	9.28	Flights were conducted on 2 days due to high winds.
May 13-16, 2016	14.75	Flights were conducted on 2 days.
June 5-11, 2016	24	Flights were conducted on 3 days.
July 20-July 24, 2016	8	TBS flights at NSA on 2 days.
July 24-27, 2016	7.35	80+mph microburst on July 27 caused the balloon tether to break at the winch. The balloon and attached tether and instruments were not recovered. No injury or property damage occurred. Notifications were made and the mishap investigated and reported. The tether size has been increased to withstand a 90 mph wind gust or microburst. Flights were conducted on 2 days.
October 10-20, 2016	33	Flights were conducted on 8 days.
November 14-17, 2016	10.5	Flights were conducted on 4 days.
TOTAL	140.4	



TBS Missions



Tethersondes and radiosondes provide pressure, temperature, RH, and wind speeds. Turbulence pod in Oct '16.

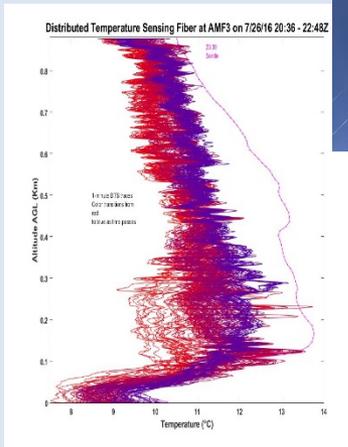


POPS at NSA and AMF3 in July '16. Preparing 2 POPS and Condensation Particle Counter for '17.



Initial radar sphere flights in Oct '16, planned in '17.

Distributed Temperature System using optical fiber deployed in 6 months of '16.



Ice Microphysics



Video Ice Particle Sampler deployed In Oct '16.

Supercooled liquid water sondes deployed in 6 months of '16.



Winds

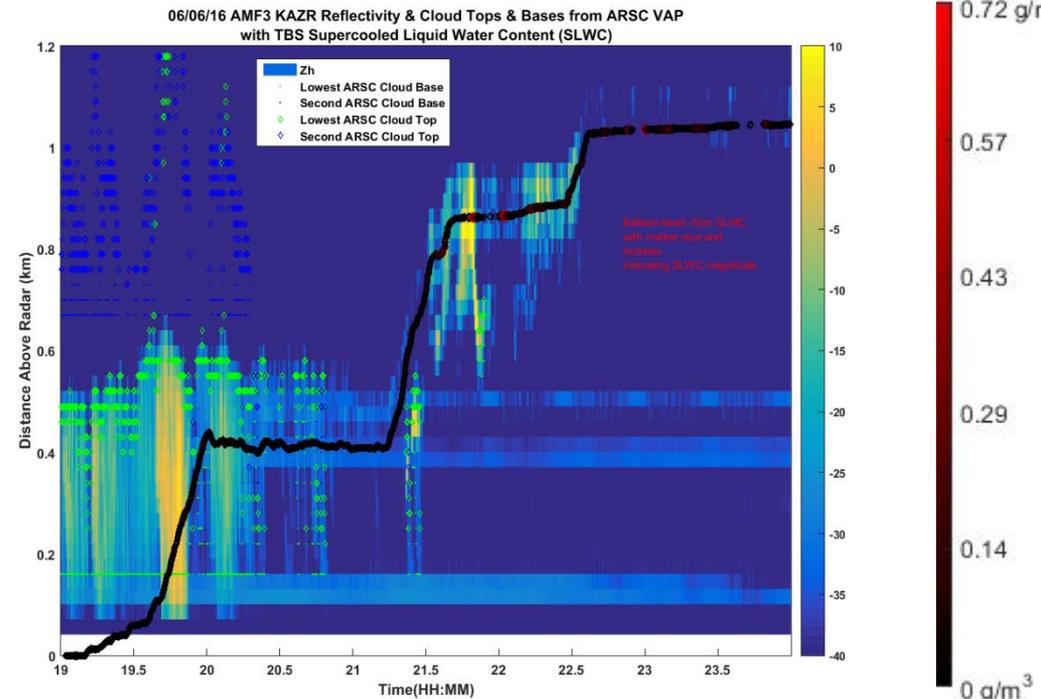
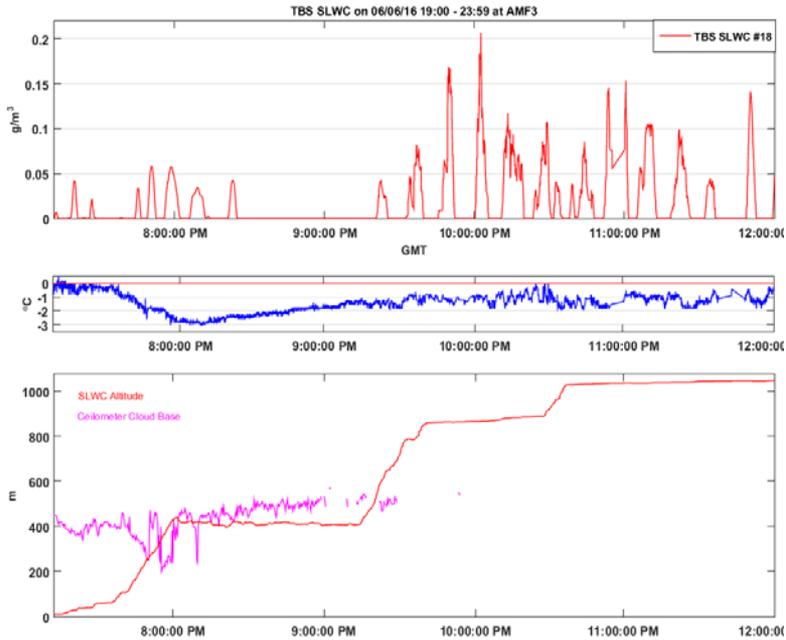
Aerosols

Radar Calibration

Cloud Properties

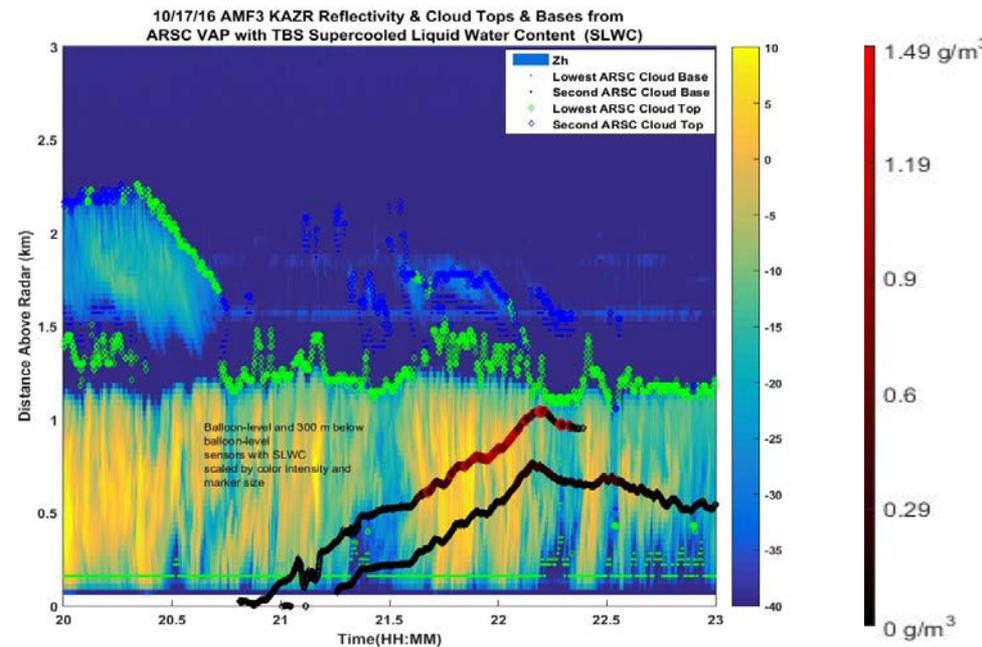
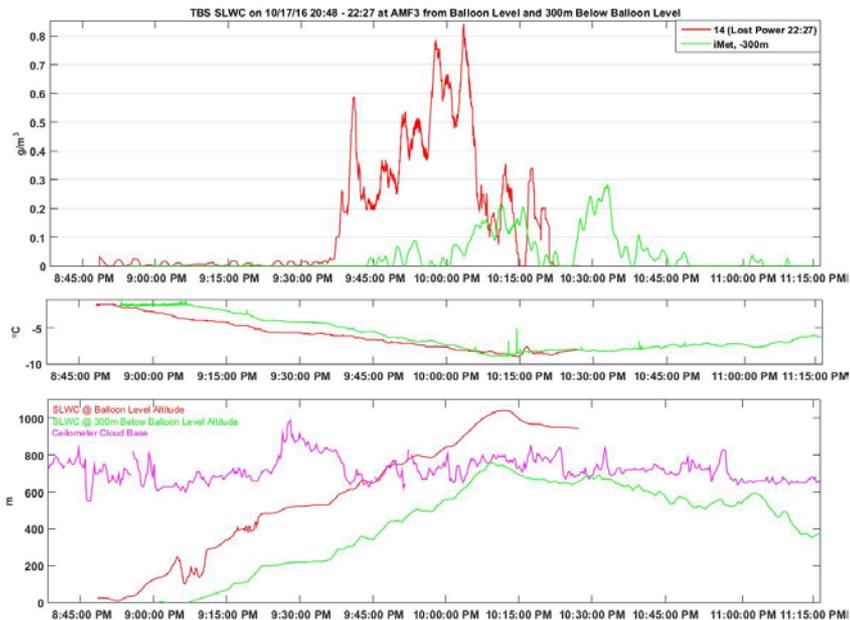
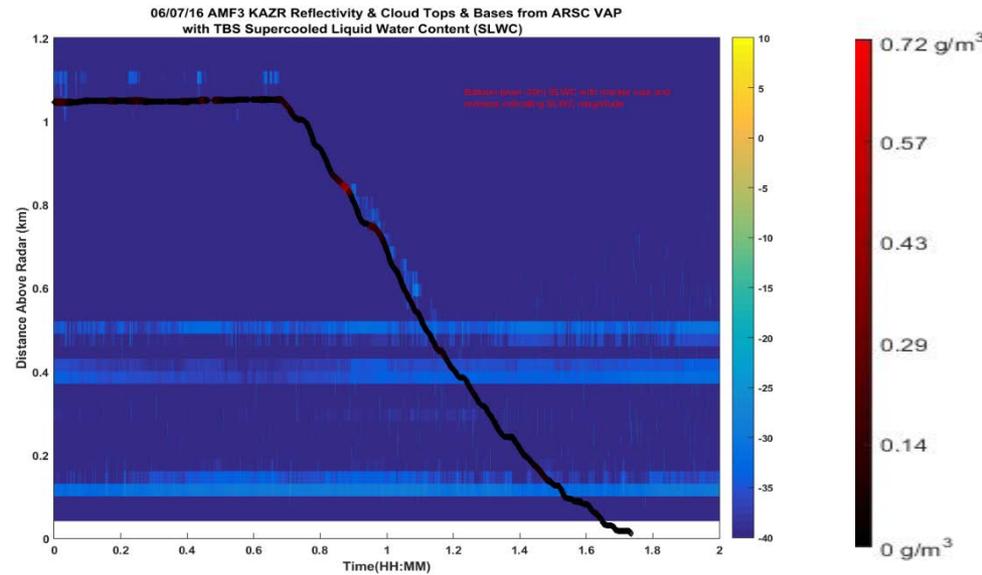
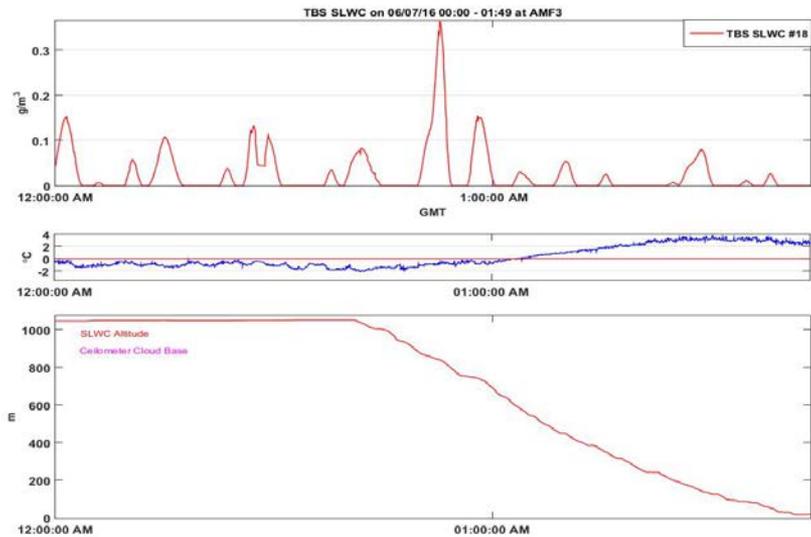
Thermodynamics

Supercooled Liquid Water Content Sondes (SLWC): 6/6/16



- On 6/6/16 low altitude clouds dissipated. No cloud base was detected by ceilometer after 22:00.
- ARSC (Active Remote Sensing of Clouds) VAP uses ceilometer data and the deviation of the KAZR reflectivity from received sky noise to assign bases and tops to up to 10 cloud layers.
- Since the ceilometer beam was not sufficiently extinguished to define a cloud base much past 21:30, ARSC did not define any cloud layers.
- TBS operators visually observed cloud patches intermittently passing across the tether after 21:30, and the TBS SLWC sensor detected SLW at times of Zh spikes.

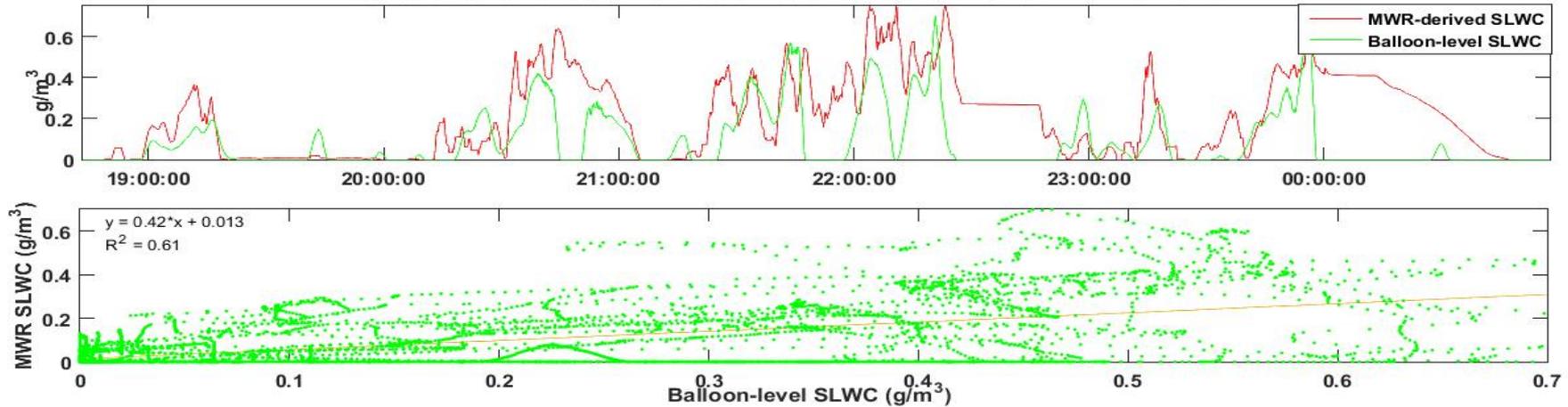
SLWCs: 6/7/17 & 10/17/16



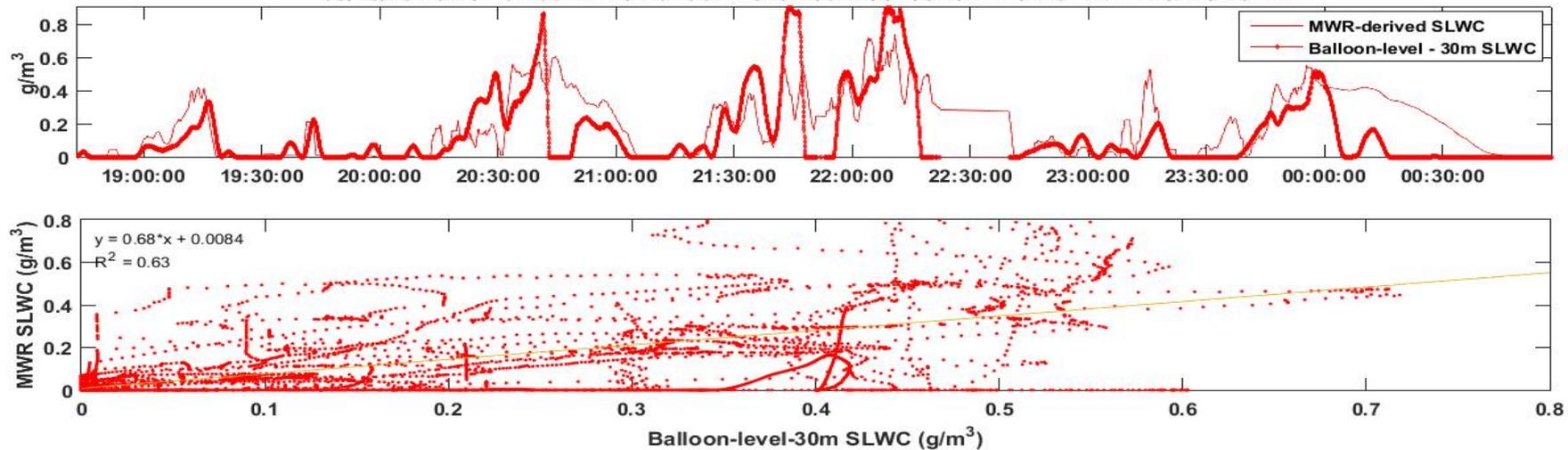
SLWCs and MWR LWP Distributed Through Cloud Layers

- AMF3 MWR LWC is distributed through cloud layers using ARSC VAP in order to provide comparison with SLWC sensor data.

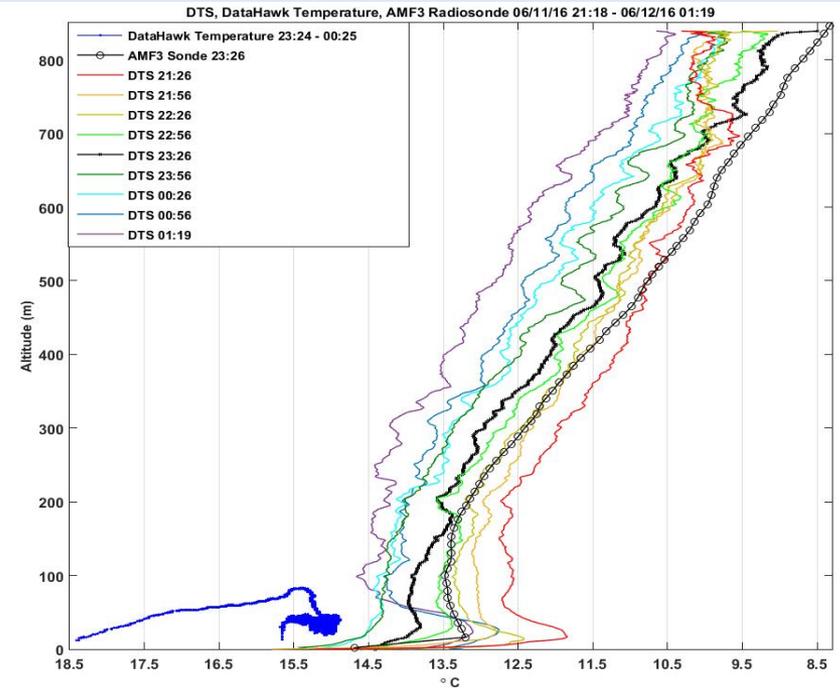
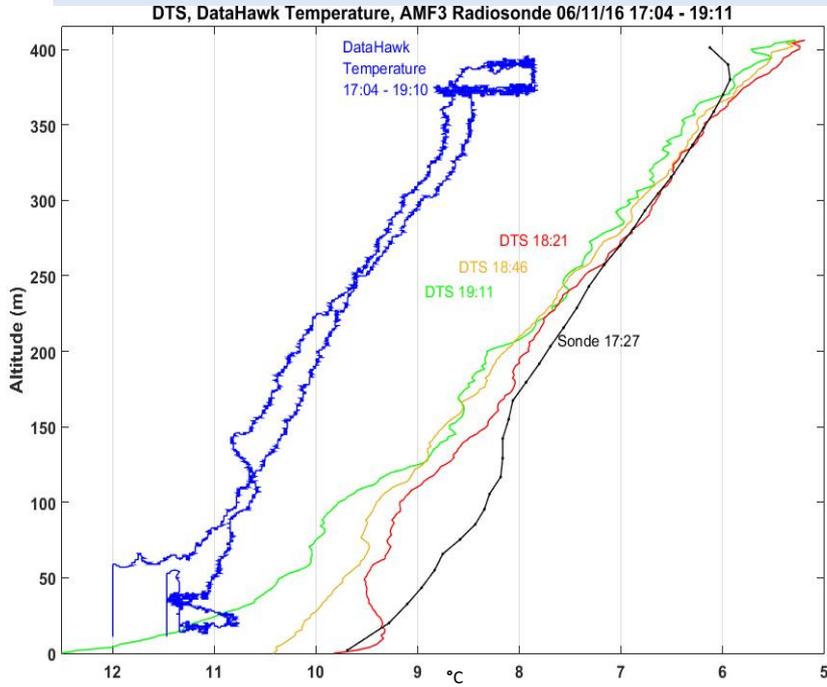
05/15/16 18:45 - 01:00 AMF3 Balloon-Level Sensor & LWC from MWR & ASRC VAP



05/15/16 18:45 - 01:00 AMF3 Balloon-Level -30m Sensor & LWC from MWR & ASRC VAP



Distributed Temperature Sensing (DTS)



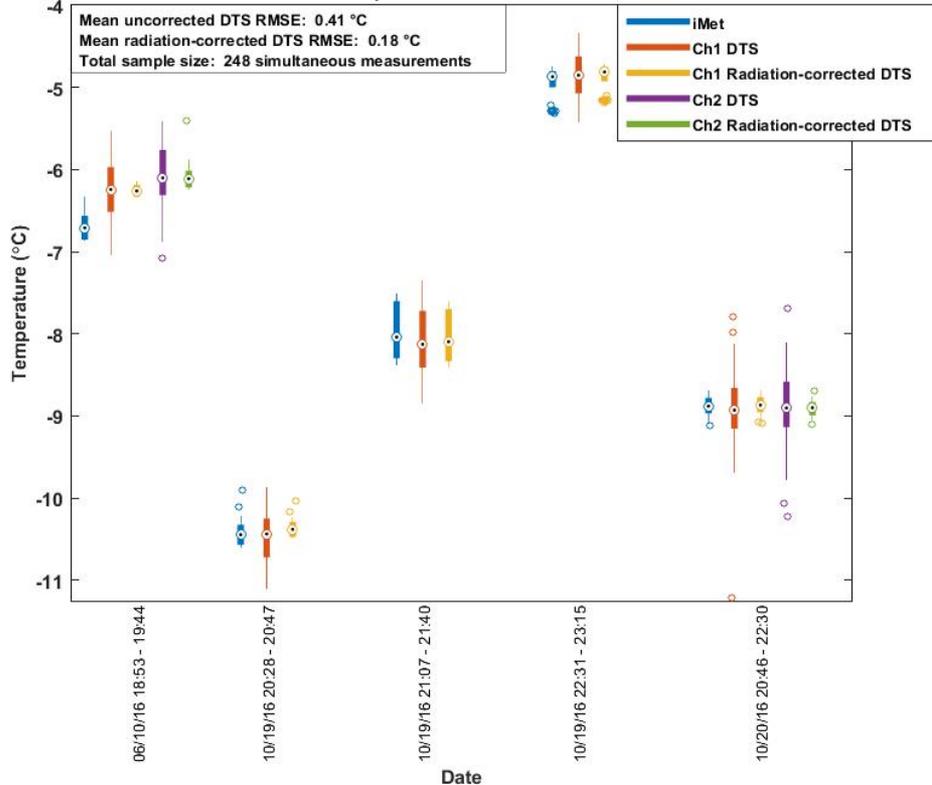
6/11/16 17:40 - 19:11			
	DH Temp	DTS	Sonde
DH Temp		0.96	0.98
DTS	0.96		0.97
Sonde	0.98	0.97	

6/11/16 21:18 - 01:19			
	DH Temp	DTS	Sonde
DH Temp		0.30	0.23
DTS	0.30		0.97
Sonde	0.23	0.97	

- DTS data correlate well with sonde
- Currently can only measure when balloon is stationary, testing fiber optic rotary joint in April '17

Distributed Temperature Sensing (DTS)

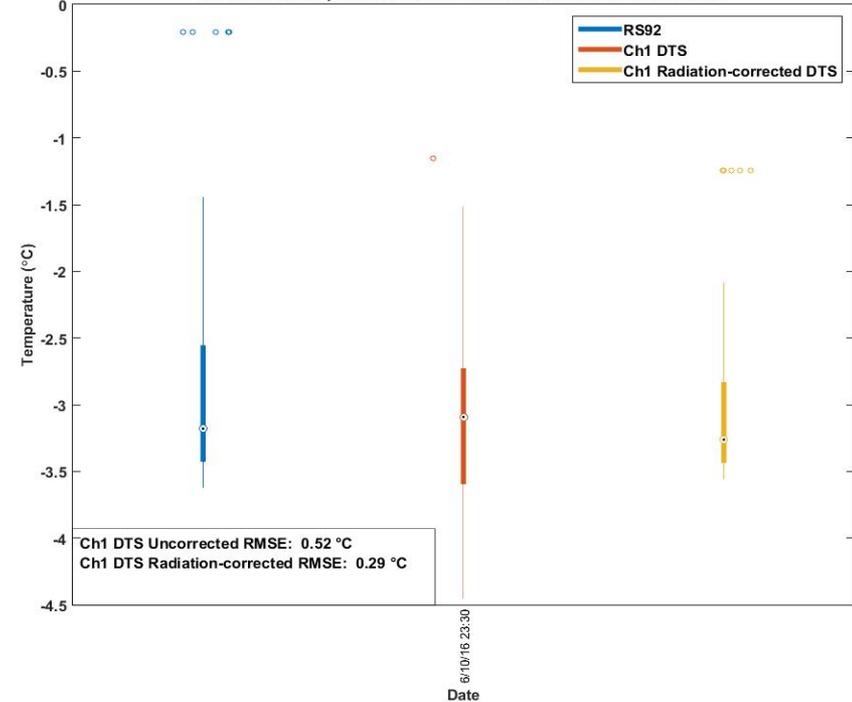
DTS & iMet Temperature from TBS at AMF3 in 2016



- DTS data at same altitude as iMet radiosonde on tether compared

- Working on fitting DTS data against solar radiation-corrected iMet radiosonde temperature data

DTS & RS92 Temperatures from 0 - 400m AGL at AMF3 on 6/10/16 23:30



- DTS 1m vertical data averaged over 10m to match simultaneous AMF3 sonde vertical resolution
- Temperature values compared from 0 - 400m AGL

TBS Flights at AMF3 in 2017

- **3/28 – 4/10 TBS** (AALCO)
 - Radar calibration sphere
 - 2 POPS and Condensation Particle Counter
 - Charged particle sensor & LED-based cloud sensor from UK Reading
 - DTS with rotary joints
- **5/14 – 5/28 TBS & PNNL DH** (AALCO)
- ***5/14 – 5/21 TBS & SNL Octocopter & Fixed Wing** (JUBA)
- **8/1 – 8/15 TBS & PNNL DH** (AALCO)
- ***8/6 – 8/13 TBS & SNL Octocopter & Fixed Wing** (JUBA)
- **10/8 – 10/24 TBS**



*Proposed JUBA (Joint UAS-Balloon Activities) IOP would use R-2204 airspace and be funded by Sandia. Will attempt DTS fiber flights from Sandia octocopter and TBS. Also flying Sandia fixed-wing in SLW to quantify UAS performance degradation in icing conditions.