Update on the ARM Raman and Doppler lidar systems

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ARM currently operates 3 Raman Lidar Systems

- SGP C1 – since 1996
- ENA C1
  - Since 2015
  - Previously deployed at TWP C3 from December 2010 to January 2015
- AMF3 (Oliktok)
  - Since 2014
  - To be redeployed to SEUS in FY21/22

All systems were built by Sandia, and all use similar design

Measurements of:

- water vapor mixing ratio
- temperature
- aerosol and cloud properties (extinction, backscatter, depolarization ratio, etc...)
Raman Lidar Issues

• Both the ENA and SGP RLs are showing a gradual degradation in sensitivity
  ▪ Sensitivity = peak-background
    ✓ Pulse energy
    ✓ Receiver characteristics
    ✓ Atmosphere

• The sensitivity loss is larger at SGP
  ▪ Apparent in the last 3+ years of data
  ▪ Seen in all channels

• Time for a tune-up
  ▪ Refurbish telescope?
  ▪ Replace degraded optical components in the receiver
  ▪ Realignment
ARM Doppler Lidars

• Doppler lidars (DL) are operated at all fixed and mobile sites, including a network of five systems at SGP.

• The DLs provide time- and range-resolved measurements of:
  ▪ Radial (line-of-sight) velocity
  ▪ Attenuated aerosol backscatter
  ▪ Wideband signal-to-noise ratio
  ▪ Spectral width new!

• Current mode of operation is pretty simple
  ▪ PPI scans every 10-15 minutes
  ▪ Vertical stare otherwise
ARM Doppler Lidars

• All Systems
  ▪ Manufactured by Halo Photonics
  ▪ 1548 nm
  ▪ Class 1M
  ▪ Nyquist velocity = ±19.4 m s⁻¹

• Four different models: Pro, SL, XR, and XR+

Stream Line Pro
  • Profiler
  • ±20° from zenith
  • 15kHz

Stream Line
  • Full scanning
  • 15kHz

Stream Line XR
  • SL plus...
  • 4x pulse energy
  • Enhanced signal processing
  • 10kHz

Stream Line XR+
  • XR plus...
  • Redesigned optics to improve SNR
Doppler Lidar Instrument Status

- **SGP Network**
  - C1 (XR), E32(SL), E37(SL), E39(SL) and E41(SL)
  - Frequent failures have resulted in significant downtime at some facilities
  - In FY20 an XR+ system was procured for SGP as a spare unit
    ✓ Swapped with the AMF2 DL (Pro) for the SAIL campaign because Dan wants to scan
    ✓ This will enable scanning during SAIL.
    ✓ The AMF2 DL (Pro) is now operating at SGP E39.
  - Providing observational support for AWAKEN
    ✓ DOE/EERE funded wind energy study

- **NSA C1 DL (Pro)** – Very stable and continues to perform well
- **ENA C1 DL (SL)** – Very stable and continues to perform well
- **AMF1 DL (SL)** – Functioning well. Will be deployed in Houston for TRACER

- **Current and Planned Procurements**
  - FY21 (in progress): 2 XR+ systems for SGP and/or SEUS
  - FY22 (planned): 2 XR+ systems for SGP and/or SEUS
Other Tidbits

Development of a new PBL height VAP

- ENG0000893 – Integrate observations from multiple platforms to obtain best estimate zi
- Viasala ceilometers now routinely output zi estimates

• High-temporal resolution wind and vertical velocity measurements during the ECREASTUDY campaign at SGP C1 in the fall of 2020
  - Collocated measurements from the C1 and Spare DLs
  - Enables retrieval of TKE flux profiles, see https://asr.science.energy.gov/meetings/stm/posters/pdf/2021/P002757.pdf

• Examining methods for improving calibration of WVMR and temperature using machine learning techniques

• How can we make better use of the scanning capabilities of the Doppler lidars?