Update on the ARM Raman and Doppler lidar systems

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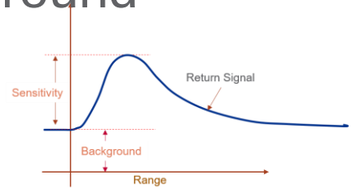
ARM Raman Lidars

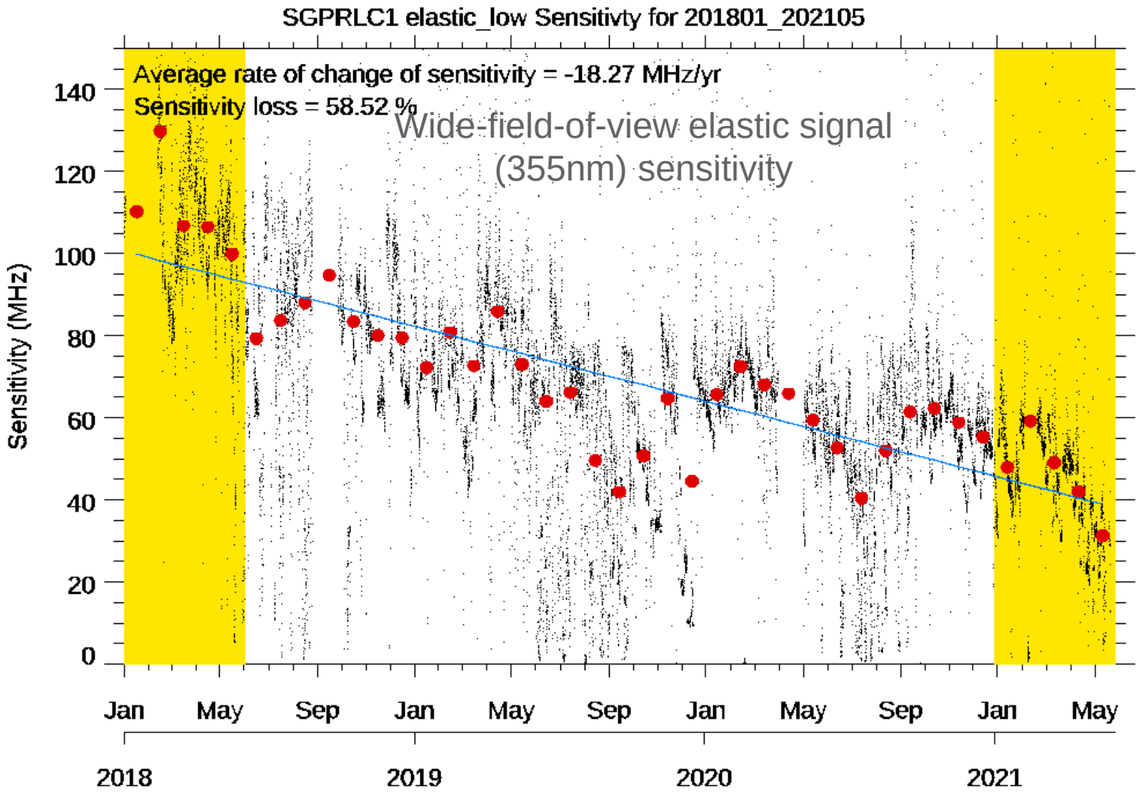
- ARM currently operates 3 Raman Lidar Systems
  - SGP C1 – since 1996
  - ENA C1
    - Since 2015
    - Previously deployed at TWP C3 from December 2010 to January 2015
  - AMF3 (Oliktok)
    - Since 2014
    - To be redeployed to SEUS in FY21/22
- All systems were built by Sandia, and all use similar 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+

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
  - Application of machine learning to estimating zi: “On the estimation of boundary layer heights: A machine learning approach" by R. Krishnamurthy et al., Atmos. Meas. Techniques, June 2021.
  - 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?