ARM currently operates the following “advanced” lidar systems

<table>
<thead>
<tr>
<th>HSRL</th>
<th>SGP</th>
<th>ENA</th>
<th>NSA</th>
<th>OLI</th>
<th>AMF1</th>
<th>AMF2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C1</td>
<td>E32</td>
<td>E37</td>
<td>E39</td>
<td>E41</td>
<td>C1</td>
</tr>
<tr>
<td>Raman</td>
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<td>Doppler</td>
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</tr>
</tbody>
</table>

ARM also operates MPLs and Ceilometers at most sites
ARM Raman Lidars
All systems developed by John Goldsmith at Sandia – Livermore
All systems operate at 355 nm

- **SGP C1**
  - In operation since 1996
  - Upgraded and moved to radar cluster in Fall 2015

- **ENA C1 (Graciosa)**
  - In operation since 9/2015
  - Previously deployed at TWP C3 from DEC ‘10 to JAN ‘15

- **AMF3 (Oliktok Point)**
  - Deployed in 10/2014
  - Newest of the 3 ARM Raman lidars
  - Non-operational during winter (October-May)
  - There is talk of moving it to Barrow
Raman Lidar Data Products

- **MERGE (rlprofmerge2news.c0)**
  - Photon counting rates from 9 detection channels
  - Resolution: $\Delta z = 7.5\,\text{m}$, $\Delta t = 10\,\text{s}$
  - Cloud base height
- **Water Vapor Mixing Ratio VAP (rlprofmr2news.c0)**
- **Temperature VAP (rlproftemp2news.c0)**
- **FEX VAP (rlproffex1thor.c0)**
  - Aerosol and cloud optical properties
    - Feature mask
    - Extinction coefficient
    - Aerosol Scattering Ratio
    - Volume backscatter coefficient
    - Linear Depolarization Ratio
**Water Vapor Mixing Ratio (VAP)**

- **Datastream:** rlprofmr2news.c0
- **Resolution is configurable**
  - We currently use $\Delta z = 60\,\text{m}$, $\Delta t=10\,\text{min}$
  - The limit is $\Delta z = 7.5\,\text{m}$, $\Delta t=10\,\text{sec}$
- **Calibrated using radiosondes**
- **Generated using a delayed processing schedule, as opposed to near realtime.**
- **Includes estimates of random error.**
- **End users need to apply QC**
  - Recommend filtering based on maximum acceptable relative error
  - Plot to the left uses a threshold of 25%
Raman Lidar Temperature VAP

- **Temperature VAP**
  - Datastream: rlproftemp2news.c0
  - Resolution is configurable
    - We currently use $\Delta z = 60m$, $\Delta t=10$ min
    - The limit is $\Delta z = 7.5m$, $\Delta t=10$ sec
  - Calibrated using radiosondes
  - Generated in near realtime.
  - Includes estimates of random error.
  - End users need to apply QC
    - Recommend filtering based on maximum acceptable relative error
    - Plot to the left uses a threshold of 5%
Feature detection and EXtinction (FEX) VAP

Datastream: rlproffex1thor.c0

Resolution is configurable
- We currently use $\Delta z = 30m$, $\Delta t=2$ min
- The limit is $\Delta z = 7.5m$, $\Delta t=10$ sec

Generated in near realtime.

Includes estimates of random and systematic uncertainty.

End users need to apply QC using the feature mask that is supplied in the output.
ARM Doppler Lidars

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Specs

- Manufacturer: Halo Photonics (UK)
- Wavelength: 1.5 μm
- Pulse width: 150ns (22.5m)
- Pulse repetition Frequency: 15 kHz
- Velocity precision: <10cm s⁻¹
- StreamLine has full upper hemispheric scanning capability
- StreamLineXR - same as StreamLine + 4X pulse energy + enhanced signal processor
- StreamLinePro – same as StreamLine but with reduced field-of-regard (±20° from zenith)

Direct Measurements

- Radial Velocity
- SNR

Derived Measurements

- Attenuated backscatter
- Winds
- Vertical velocity statistics
- Cloud base height and cloud base vertical velocity
Doppler Lidar Network at SGP

- Network of 5 Scanning Doppler lidars
- SGP C1 installed April 2011
- SGP E32, E37, E39, and E41 installed May 2016, (almost) in time for Hiscale
Doppler lidar data products

- **Staring data**
  - Datastream: dlfpt.b1
  - Usually vertical staring but could be slant path. End users should always check the “elevation” variable.
  - Used to derive vertical velocity statistics and cloud base height

- **Conical Scan or plan position indicator (PPI)**
  - Datastream: dlpri.b1
  - 8 beams at elevation=60°
  - Once every 10 to 15 min,
  - Typically takes about 40 s to execute
  - Used to derive winds
Doppler lidar Wind VAP

- Datastream: dlprof4windsnews.c1
- 40 s “snap shot” every 10 to 15 min, with Δz=26 m.
- Vertical coverage is typically <3 km
- Includes MET data for sanity check
- End users should apply QC by rejecting wind estimates corresponding to low SNR
  - Typical SNR threshold = 0.008 to 0.01
Doppler Lidar Vertical Velocity Statistics VAP

- Datastream: dlprof4wstatsnews.c1
- Vertical velocity variance, skewness, kurtosis, cloud base height, cloud base vertical velocity, cloud frequency
- Resolution: $\Delta t=30$ min and $\Delta z=30$ m.
- Vertical coverage is typically <3 km
- Includes ECOR data for sanity check
- End users should apply QC by rejecting wind estimates corresponding to low SNR
  - Typical SNR threshold = 0.008 to 0.01