

# ARM

*Atmospheric Radiation Measurement Program*



## Raman Lidar Status

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Need to acknowledge contributions from  
Rich Ferrare and Marian Clayton!

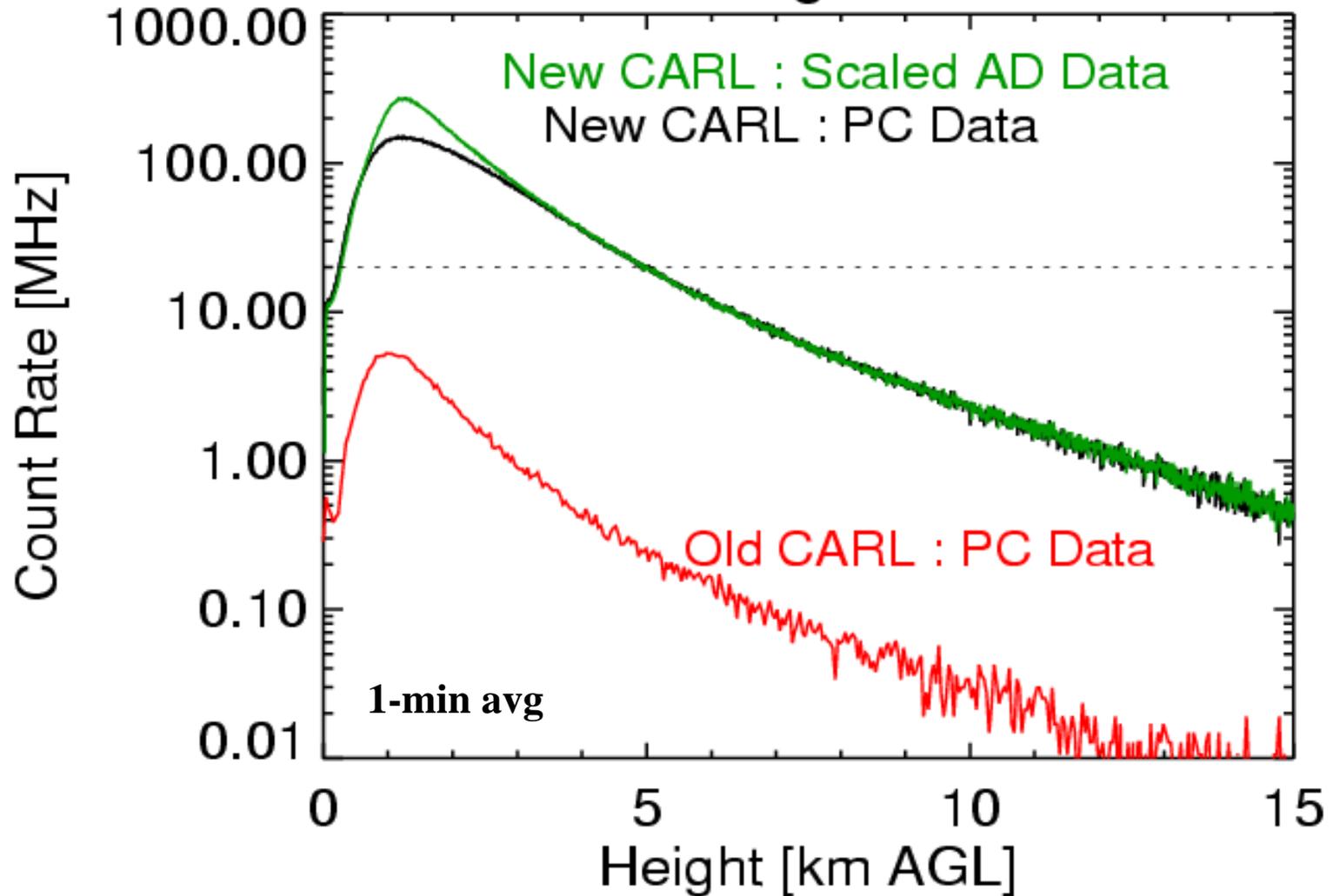


# Big Events in the Last Few Years

- Excellent uptime: average is over 90% for the last 2 years...
- Refurbishment in Sep 2004
  - Replaced interference filters
  - Recoated mirrors on the telescope
- Upgrade #1: Installation of new electronics (Sep 2004)
  - Combined analog-to-digital and photon counting electronics in same package
  - Extended dynamic range of system by  $> 1$  OM in most channels
  - Still working on best way to combine these two signals
- Upgrade #2: Installation of temperature and LW profiling channels (Aug 2005)
  - Three new channels added; original seven had to be rearranged before ALIVE started
  - New photomultiplier tubes installed in system
- ALIVE (Sep 2005)
- Upgrade #3 (planned fall 2006): Installation of boresight alignment module

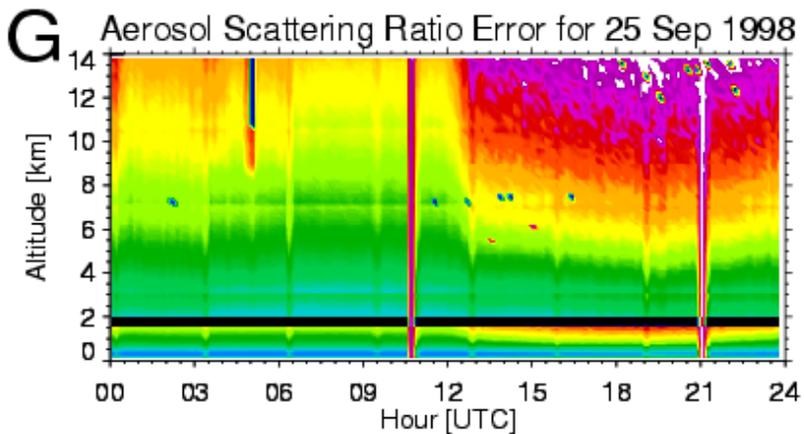
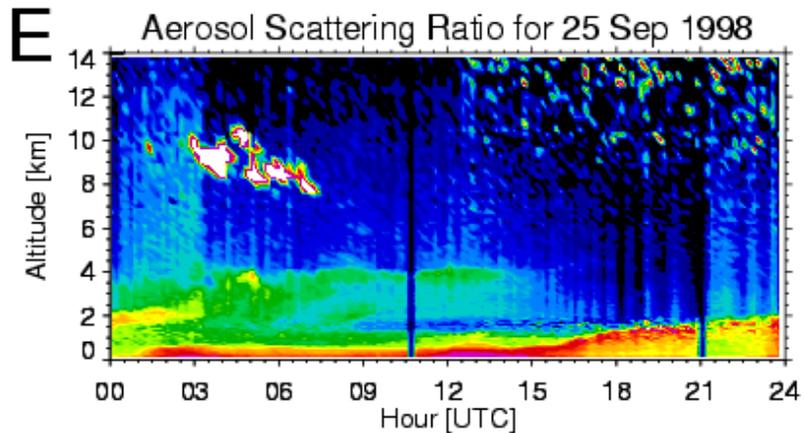
# Signal Strengths: Old vs New CARL

## NFOV Nitrogen Channel

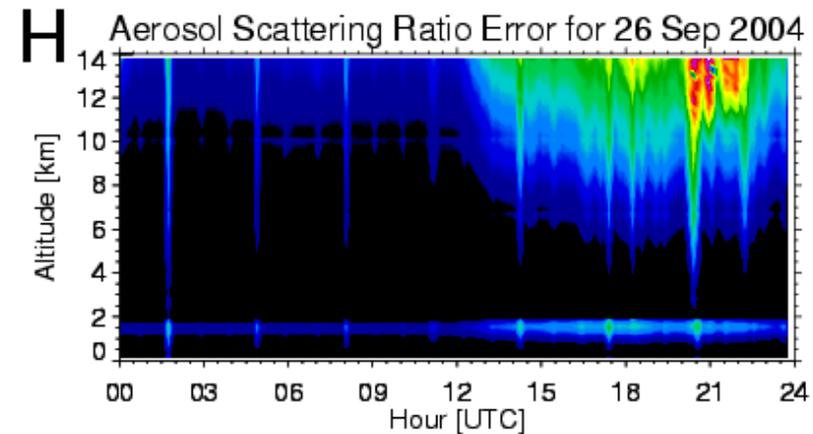
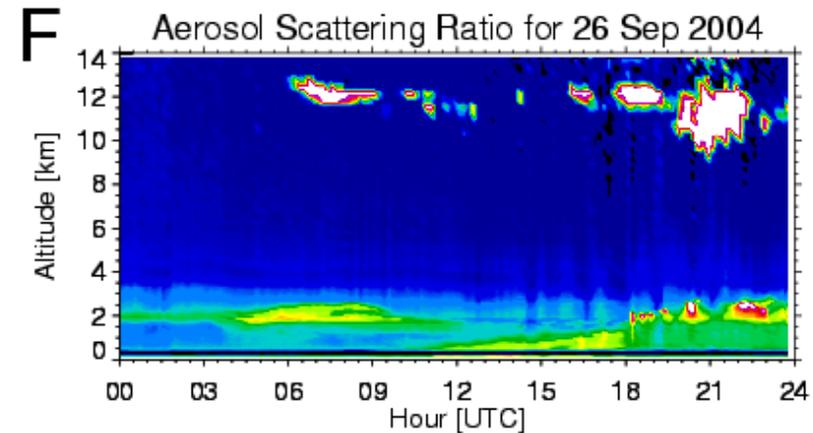


# Impact on the Aerosol Scattering Ratio (and hence aerosol backscatter)

## Original Electronics

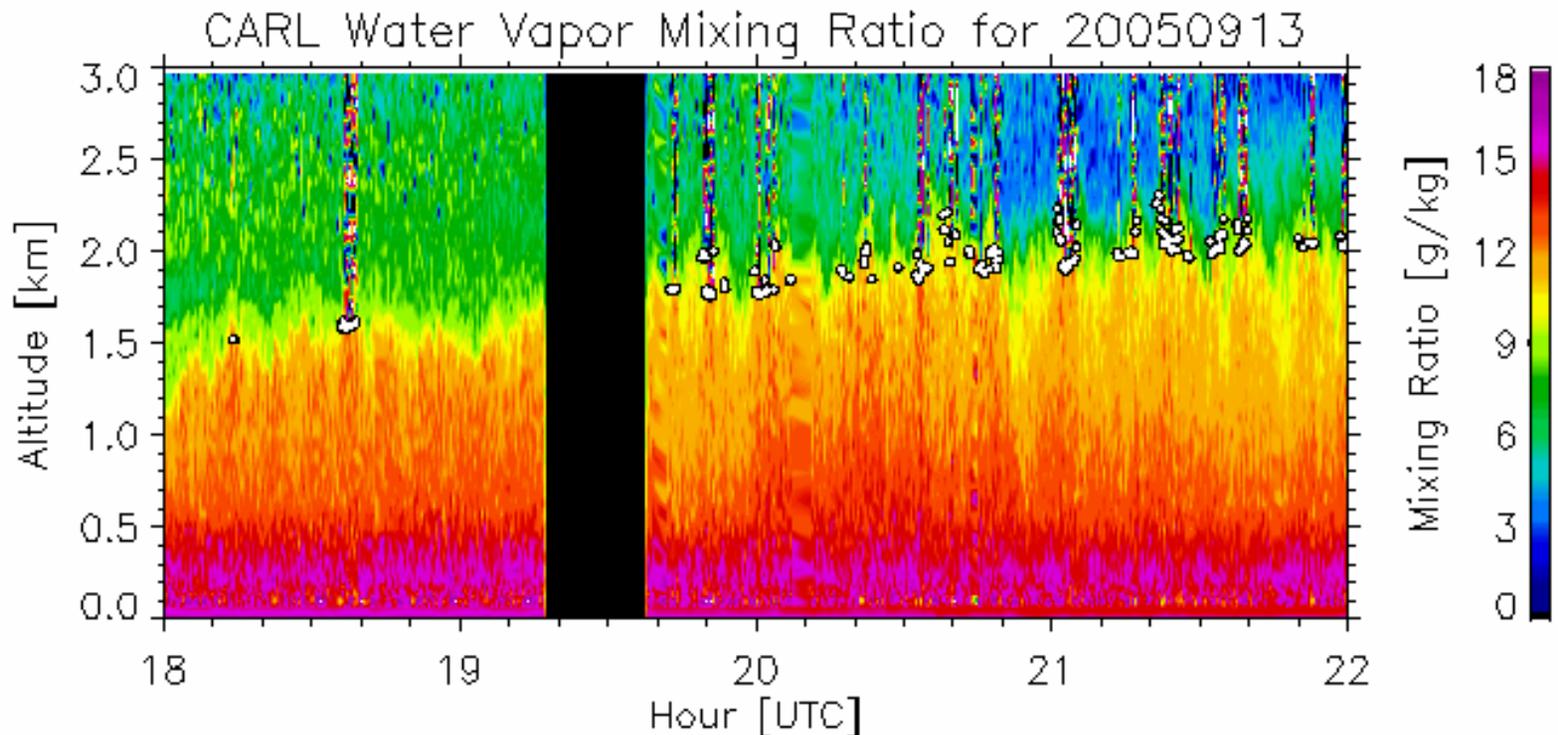


## New Electronics



# Improved Temporal Resolution

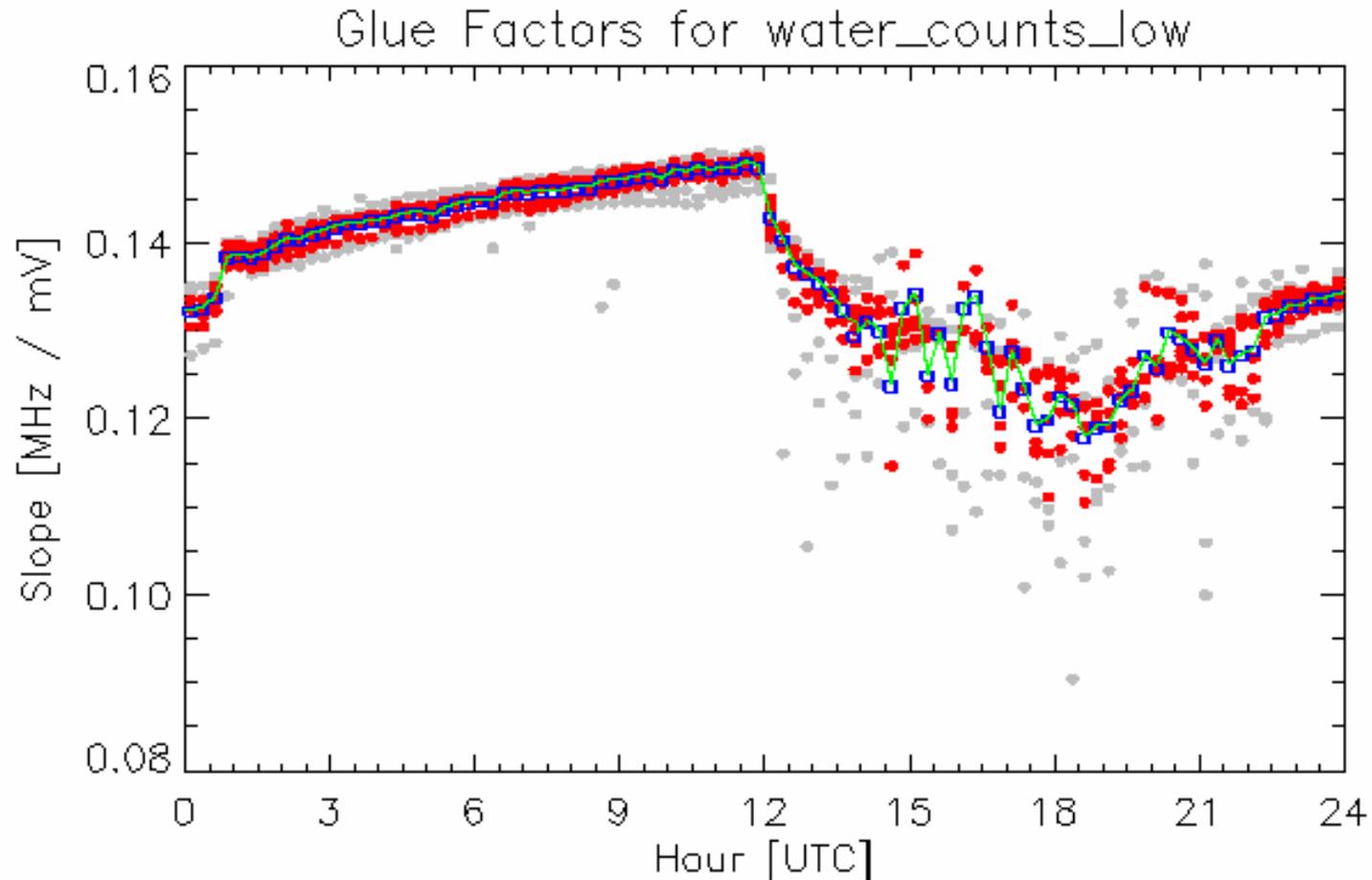
- Greatly improved S/N ratio allowed us to improve the temporal resolution of raw data (1-min to 10-s)
- Greatly expands the use of the CARL data



□ Cloud base height

10-s water vapor data

# Time-dependence of glue coefficients



# New Channels for CARL

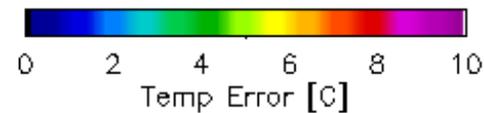
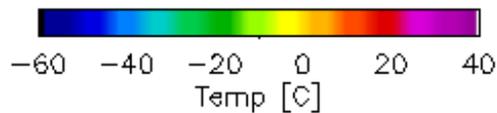
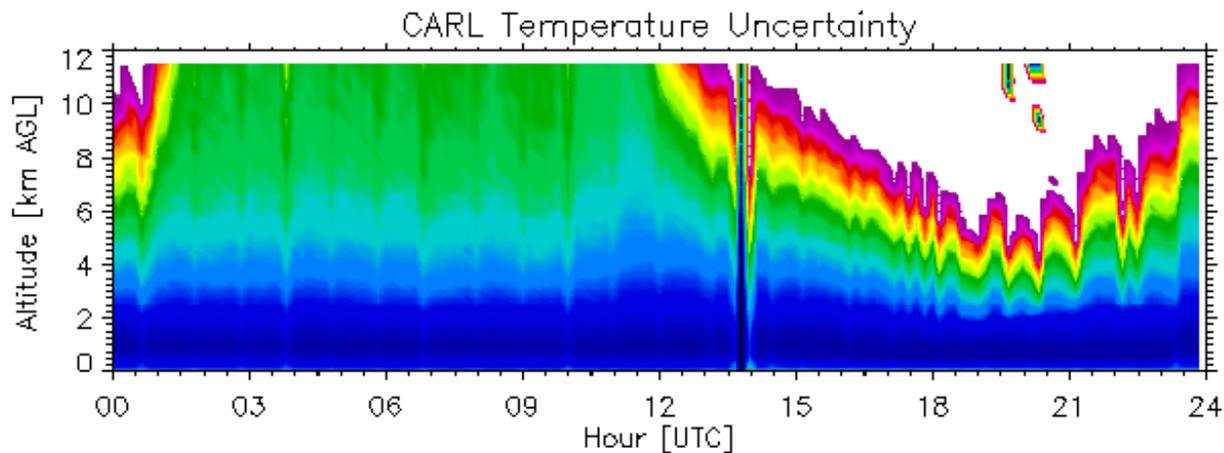
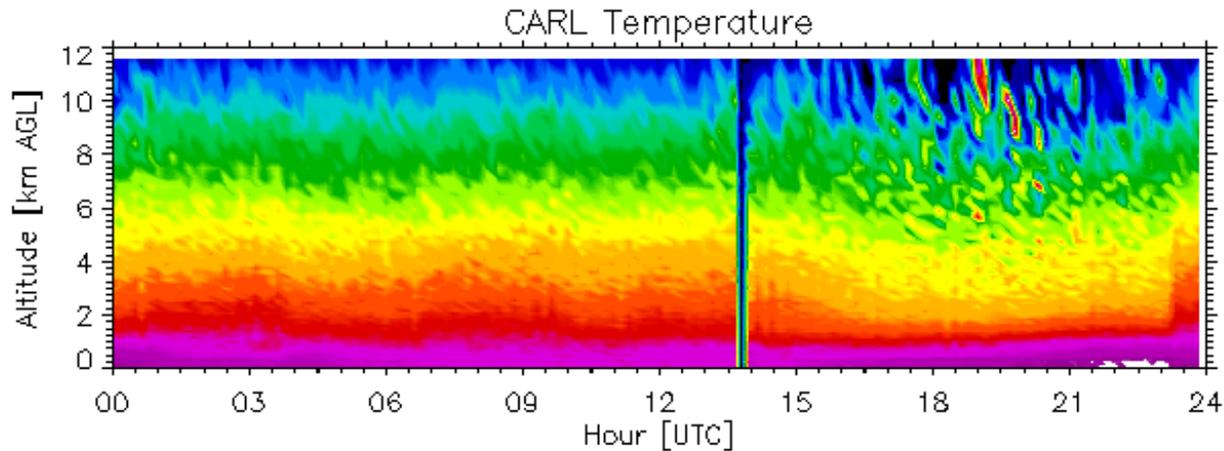
- New channels are the result of “carryover spend down”
- Two channels to measure backscatter from the rotational Raman scattering of nitrogen and oxygen (353 and 354 nm)
  - Derive atmospheric temperature profiles
- One channel to measure Raman backscatter at 403 nm
  - Sensitive to liquid water and ice water Raman scattering
  - Liquid water and ice Raman scattering is much weaker but is spectrally broader
  - Phase can be determined from depolarization ratio measured by the Raman lidar
  - Two interference filters with various bandpasses
    - 0.4 nm FWHM for daytime profiling
    - 6.0 nm FWHM for nighttime profiling
- Data collection from new channels started on 27 Oct 2005
- The 403/0.4 nm measurements appear to not be useful
- The 403/6.0 nm measurements will not be useful in daytime
- Current ARM ST project with Dave Whiteman (NASA/GSFC) to characterize the LW measurements

# Measuring Ambient Temperature Profiles with CARL

- RLPROF VAPs need temperature profiles as input to compute RH, atmospheric density, etc.
- Currently get T profiles from AERIPROF VAP
- Recent advances in interference filter manufacture allow narrow bandpass filters to be manufactured in UV to measure rotational Raman backscatter with good isolation of Rayleigh+Mie backscatter
- “Simple” addition of 2 new detection channels to CARL
- Goal: to measure T profiles to better than 2 K
- Initial version of RLPROF\_TEMP just completed; analyzing some of the first results now

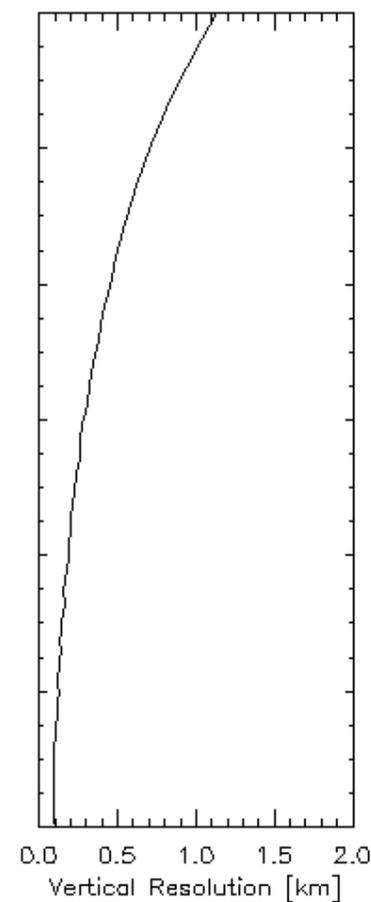
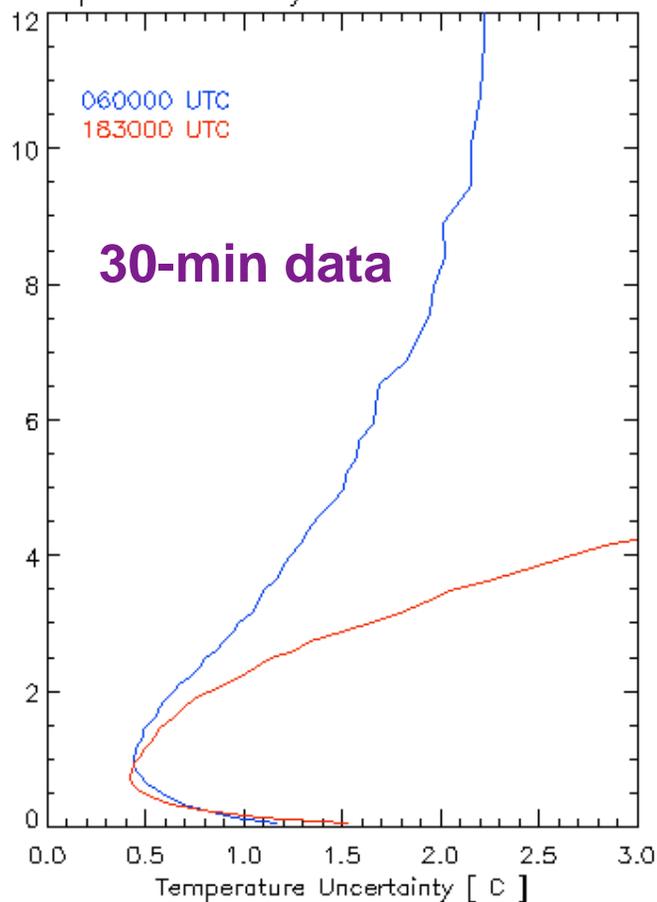
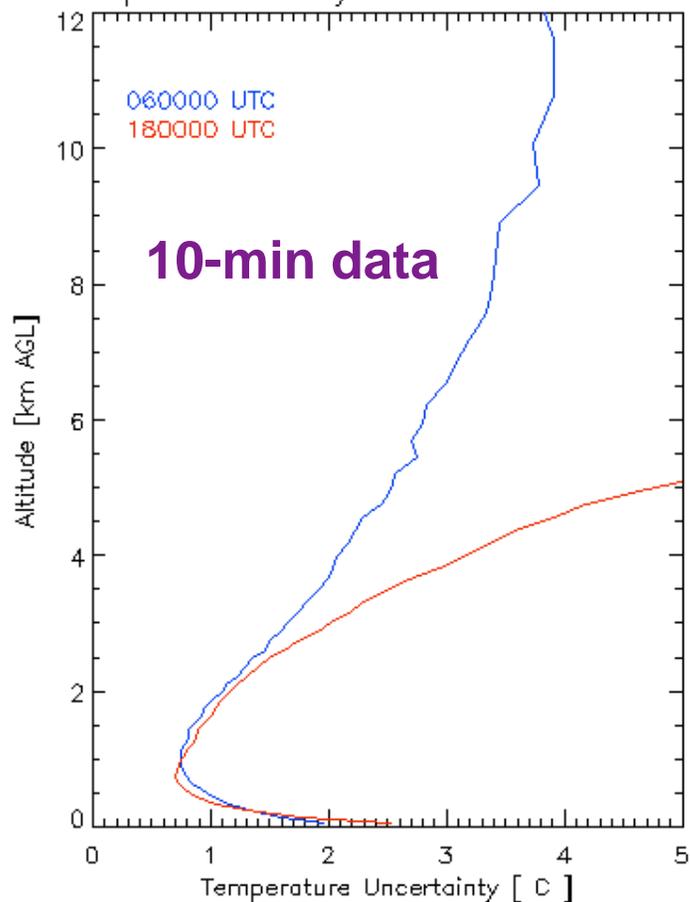
# Temperature Profiles from CARL

8 Aug 2006  
10-min resolution

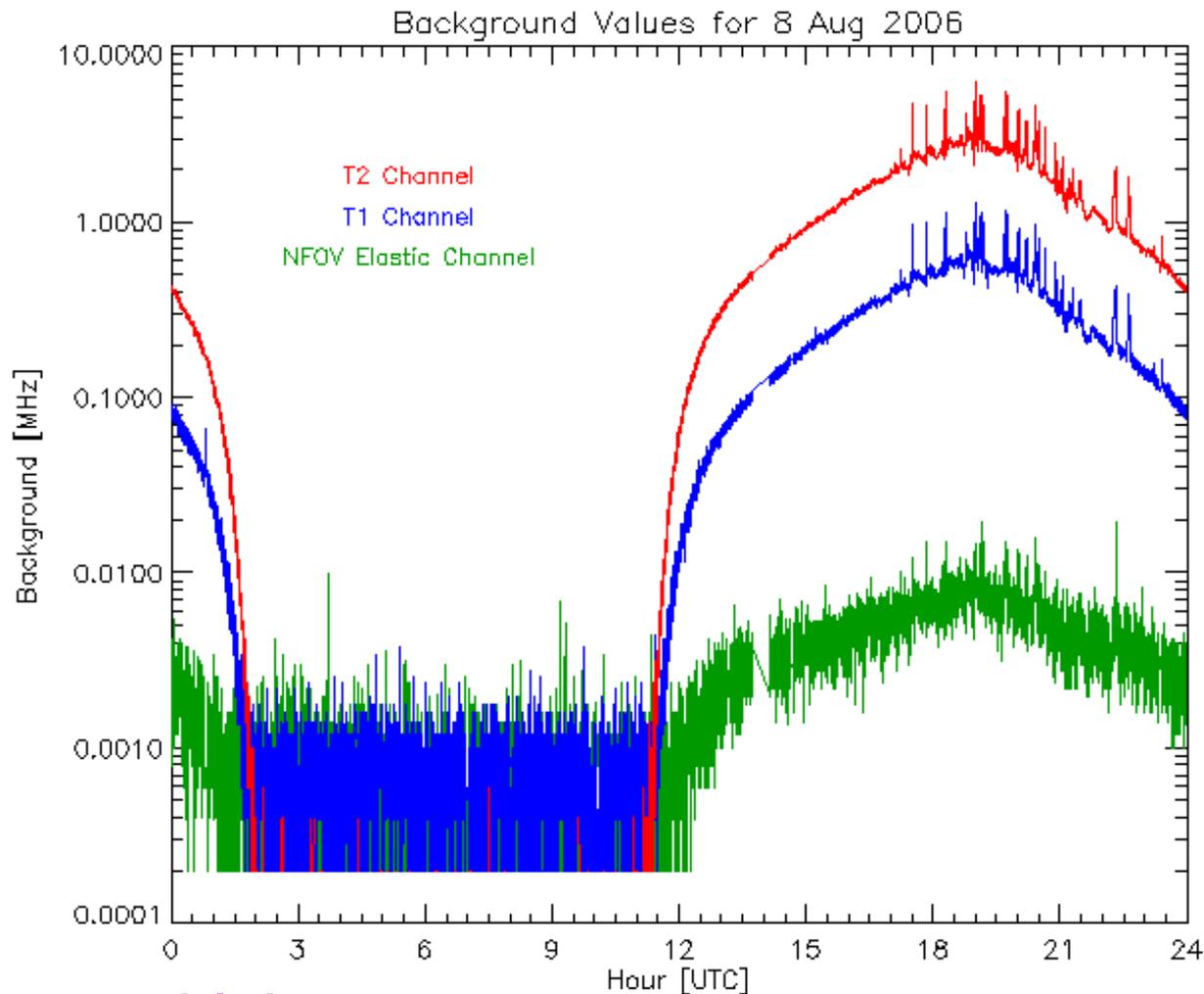


# Nighttime and Daytime Temperature Uncertainty Profiles

Example Uncertainty Profiles from 20060808 Example Uncertainty Profiles from 20060808

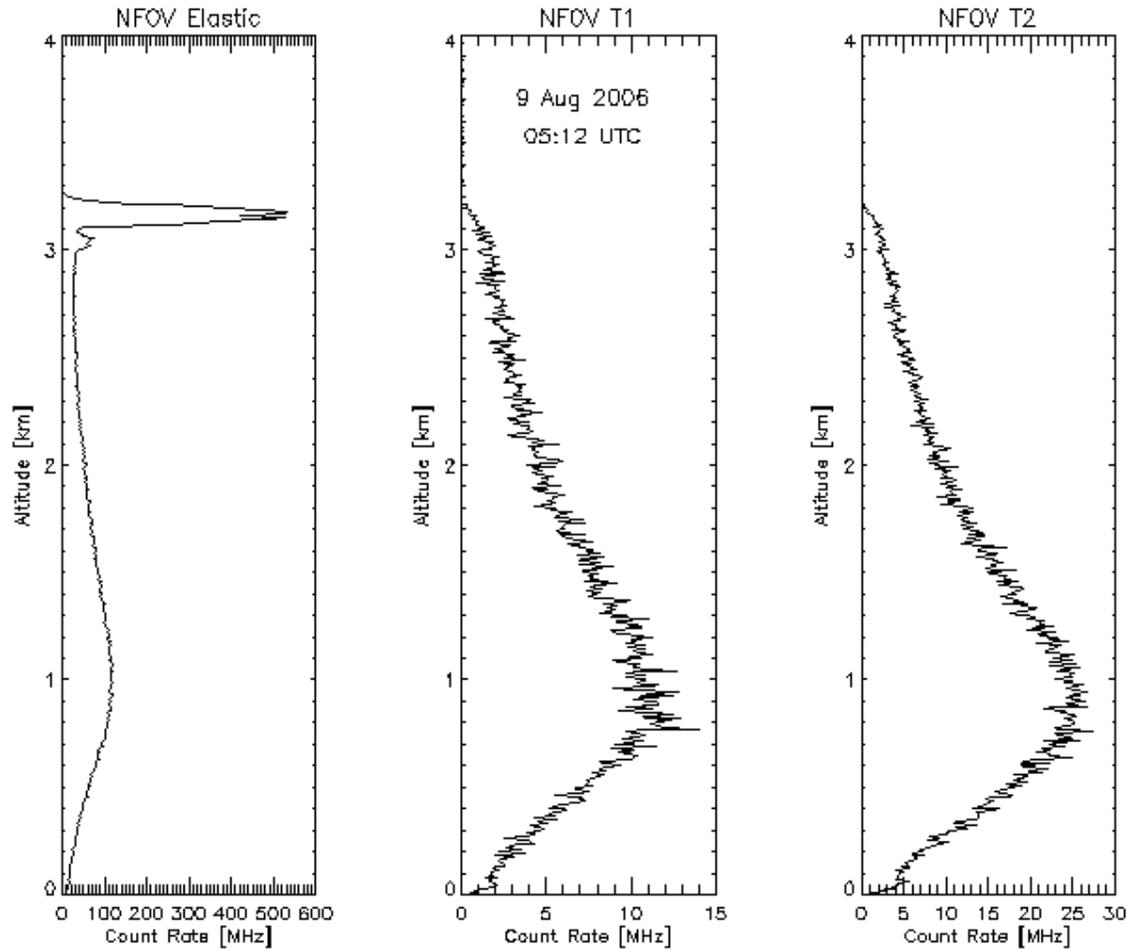


# Solar Noise in Rotational Raman Channels



Unacceptable!

# Blocking of the Laser Wavelength



Excellent!

# Adding a Boresight Module

- CARL uses a narrow field-of-view ( $\sim 300 \mu\text{rad}$ ) approach to minimize the solar background (noise) in the observations
- Important to keep the outgoing laser beam centered in the detectors' field-of-view
- Current approach uses periodic (every 3 hour) alignment tweaks, where laser is “swept” through the detectors' FOV
  - Generally works well
  - Occasionally clouds and other inhomogenities result in occasional misalignments
  - Largest uncertainty in RLPROF VAPs (especially the aerosol codes) are associated with these alignment tweaks
- New product: a 4-photocathode device that can be used to actively maintain the alignment of the system
- Ray tracing results indicate that the device should be able to maintain the alignment  $\sim 10 \mu\text{rad}$
- Will install fall 2006



# Summary: Tons of Work to Do!

- Gluing AD and PC data together
  - Understand trends
  - Understand sensitivities
- Calibration and reprocessing
  - Overlap corrections
  - Crosstalk in the co- and cross-pol channels
  - Temperature dependence
- New products (VAPs)
  - Temperature profiles
  - Cirrus extinction profiles
  - Liquid water content profiles
  - Ice water content profiles
  - Liquid water cloud droplet number density
- New tools to help site operations (and DQ office) monitor instrument health and stability
- ALIVE
- Install boresight module
- Documentation

## Current VAPs

MERGE

ASR

EXT

MR

DEP

BE

## VAP in Development

TEMP

## Proposed New VAPs

CI

LW

IW