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With contributions from
Rich Ferrare and Marian Clayton!

ARM Atmospheric Radiation Measurement Program

Events in the Last Few 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

- **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)**

- **Excellent uptime: average is over 90% for the last 2 years…**

Status of the data and the derived products

- Historical data - before May 2004
- Data from the new electronics - after May 2004
- Data from the new channels

Current VAPs

MERGE ← Supplies input from the new electronics and glues the AD and PC data

ASR
EXT
MR
DEP
BE

← Updated to use the old and the new data as an input

VAP in Development

TEMP ← Will derive atmospheric temperature

Proposed New VAPs

CI
LW
IW

← Will derive cirrus extinction; Liquid or Ice Water content

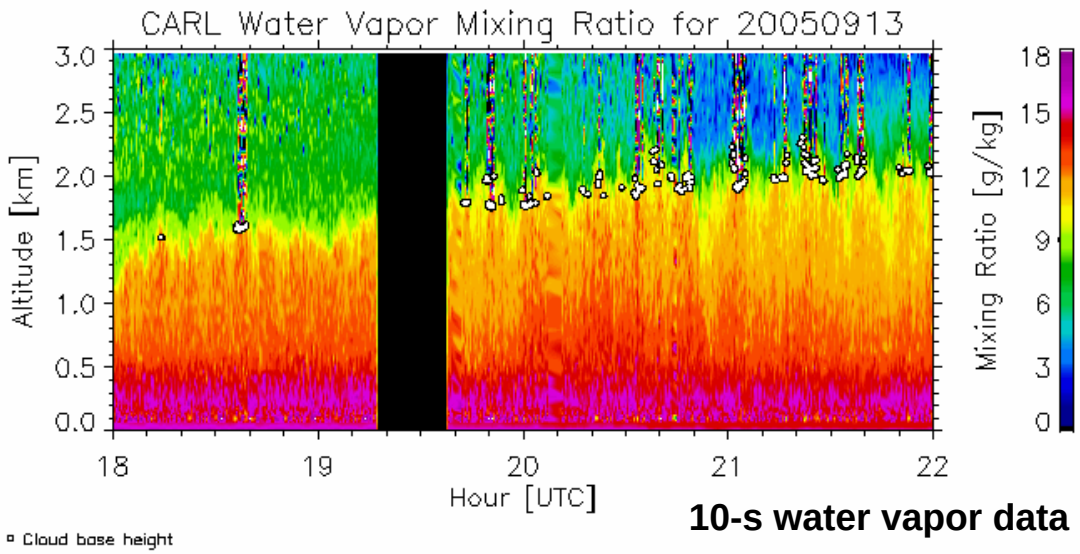
Historical data and derived products

- The historical data 2000-2004 is in need of updated overlap corrections for the Water Vapor Mixing Ratio and Aerosol Scattering Ratio VAPs
- Those corrections have been derived
- Several calibration issues, which came up as a result of detailed analysis of the new data were improved in the VAPs.
- We are currently working on improving the way the temperature and pressure measurements are utilized in the VAPs.
- Hence, ***the historical data is in need of reprocessing.***
- This will be done when the current RLPROF VAPs are released in production.

The data from the new electronics

What do the new electronics give us?

Increased S/N → Increased spatial and temporal resolution



10-s water vapor data

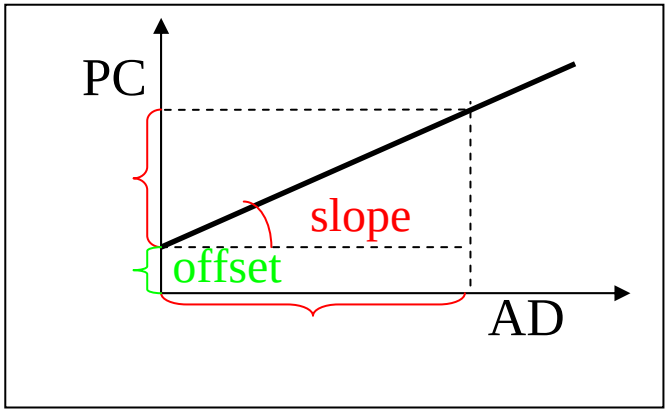
Challenges

- Understand how to merge together (glue) the Analog-to-Digital (AD) and Photon Counting (PC) data to create a single backscatter profile for each channel
- Evaluate how the gluing impacts the derived products

How do we glue the AD and PC data?

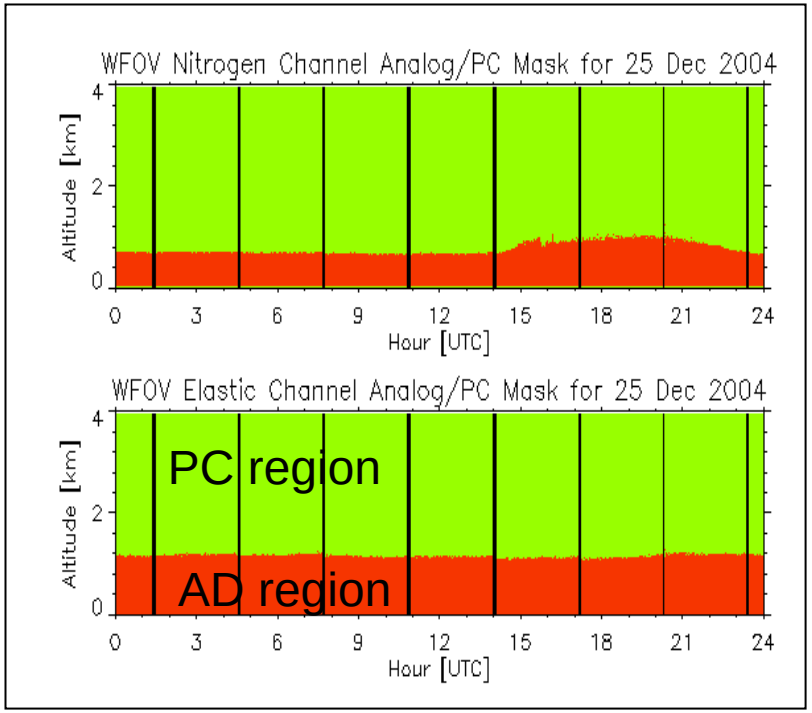
What is our goal: To substitute the PC data in the regions of non-linear response (high signal levels) with AD data

1. Fit the relationship
PC = slope*AD + offset
over a region where both PC and AD electronics respond well



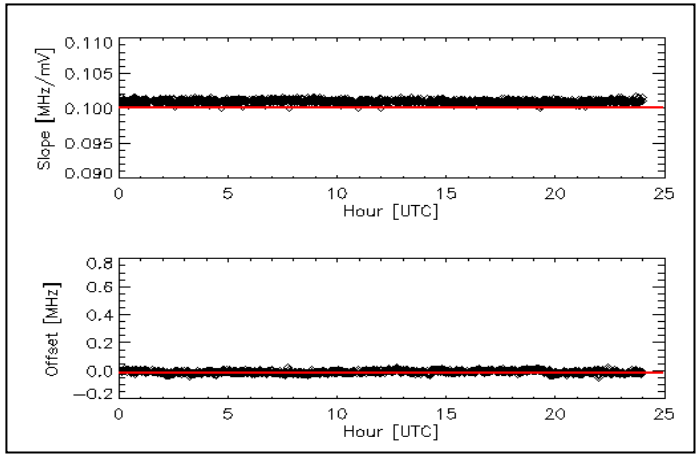
2. Apply the derived glue coefficients (slope and offset) to the entire AD profile to convert it into a virtual count rate $\mathbf{AD_{scaled}=slope*AD + offset}$

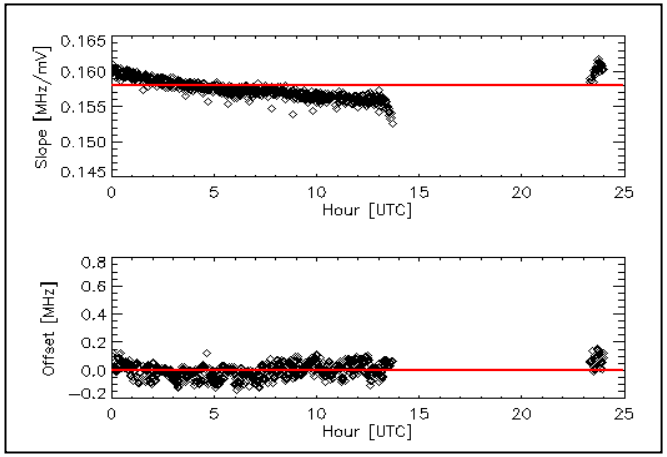
3. The combined backscatter profile uses PC data below some threshold and scaled AD data above.

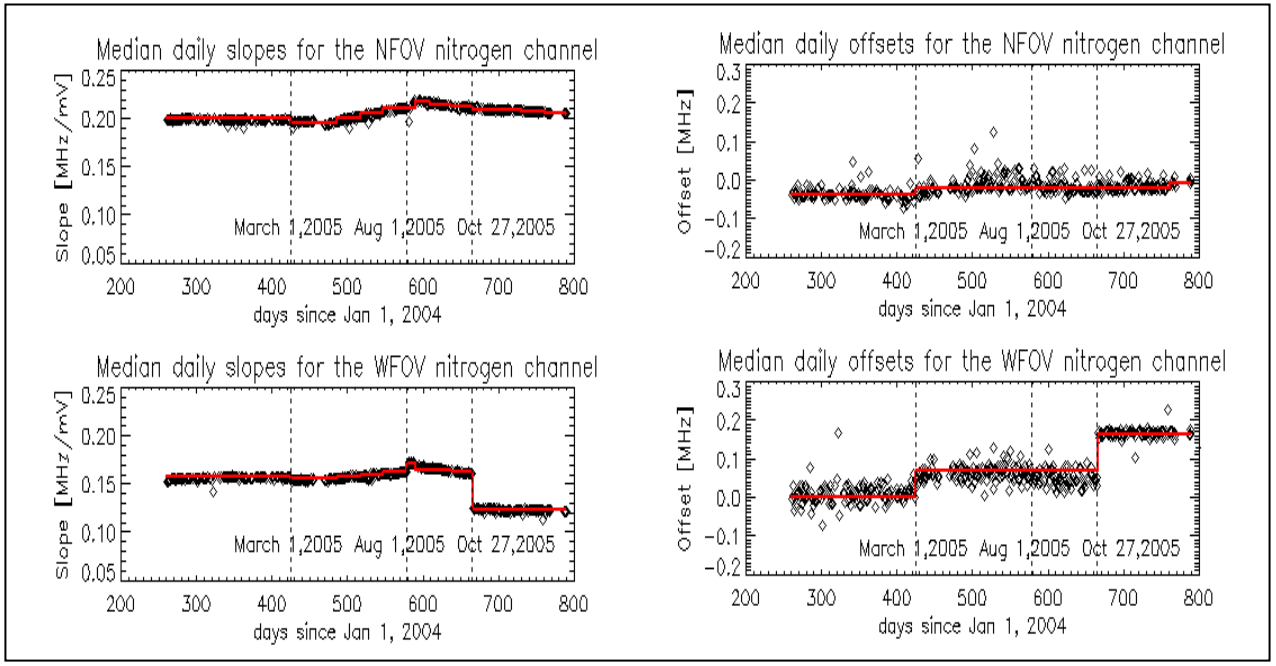


Initial assumption for the gluing

The gain of the PC and AD electronics does not change with time





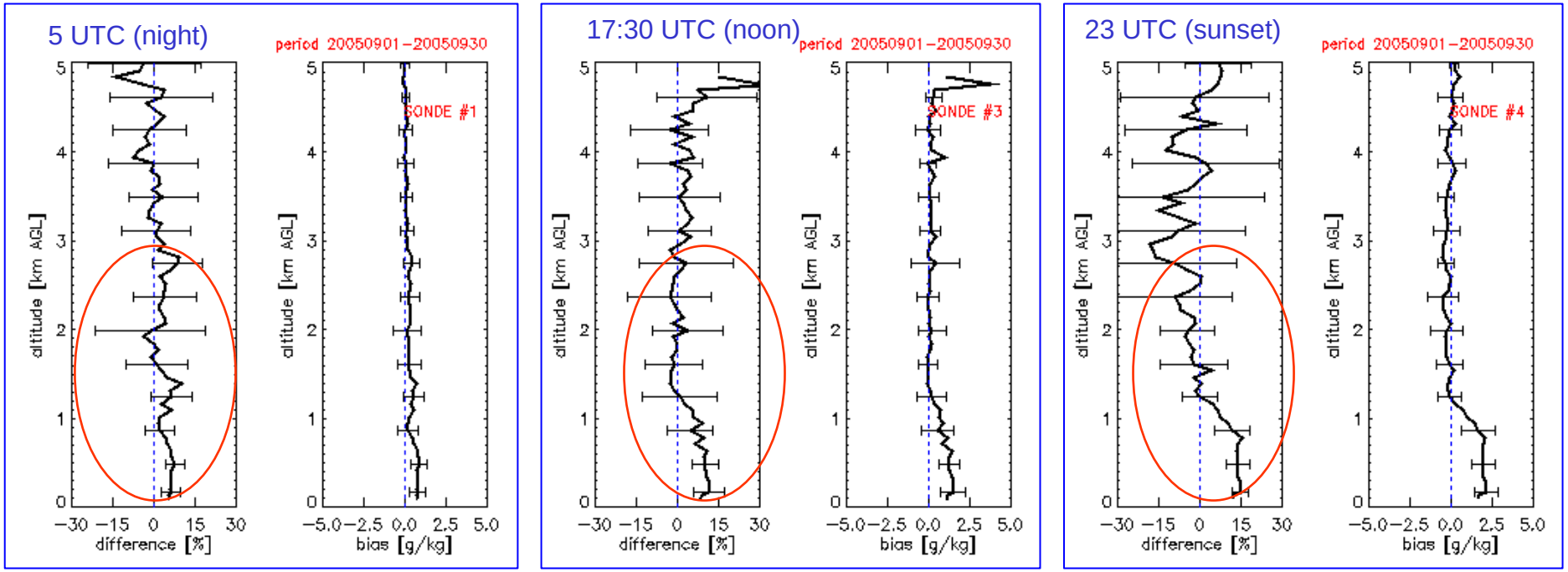


How to evaluate the impact on the derived products

We need independent measurements

Profiles of WV MR can be derived independently from collocated sonde measurements

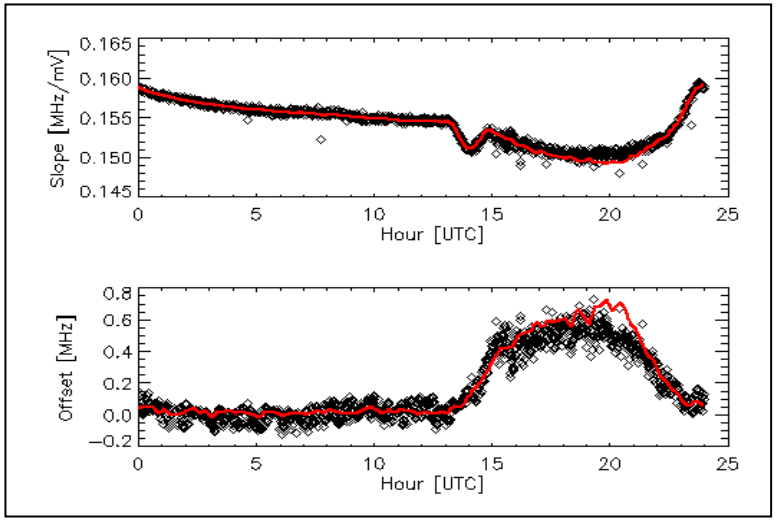
Comparison of CARL and sonde WV MR when using the assumption for constant AD and PC gain

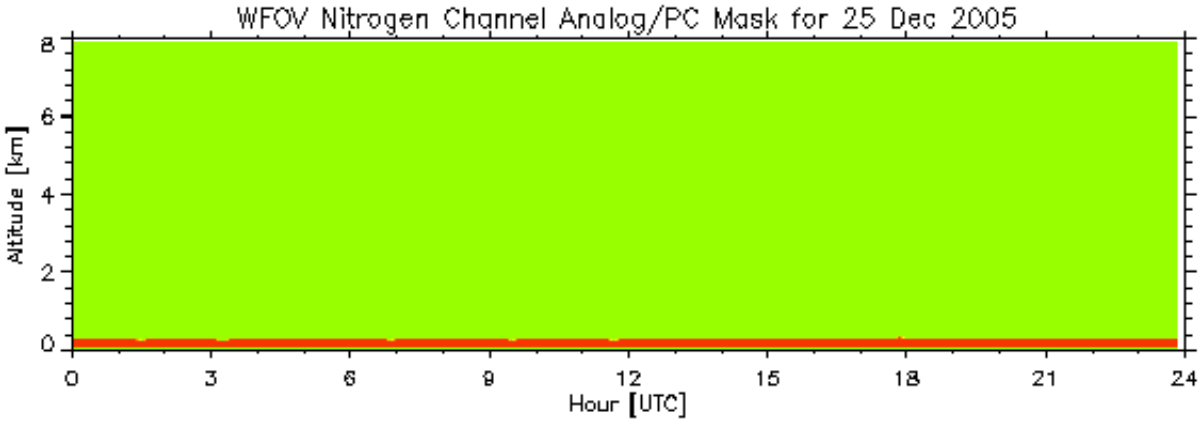


Difference=$(MR_{CARL}-MR_{sonde})MR_{CARL}$

Another assumption

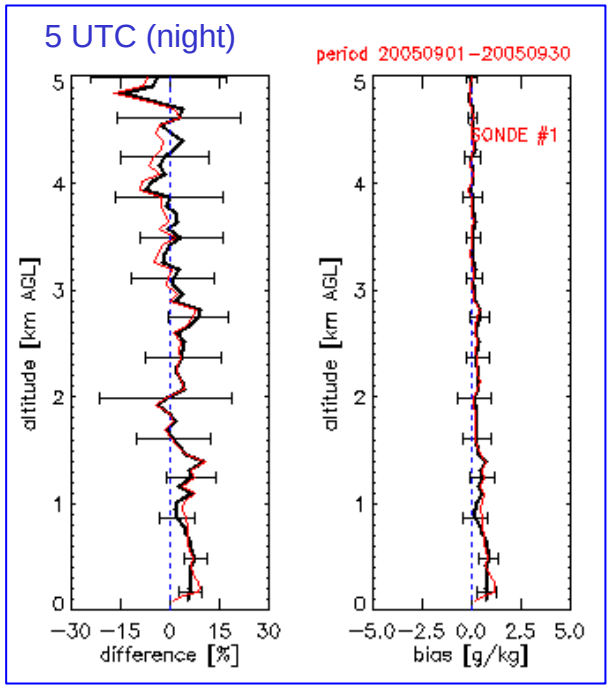
The response from the AD electronics has diurnal trends and we need to account for those trends by using time dependent glue coefficients.

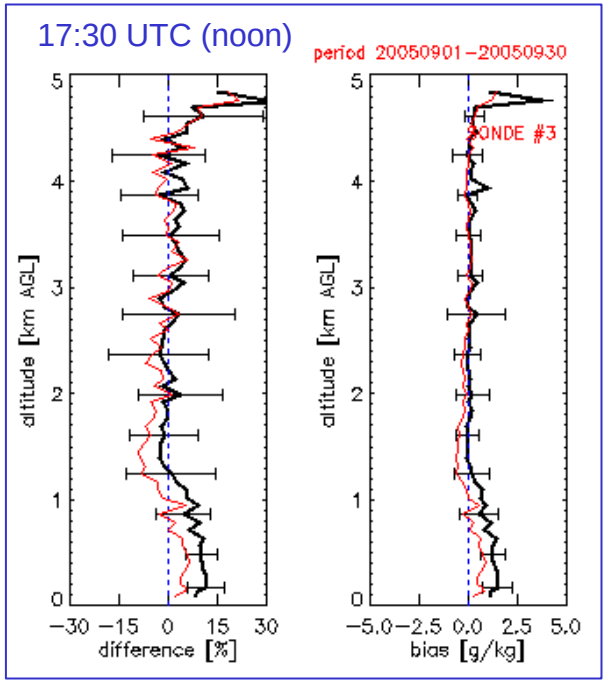


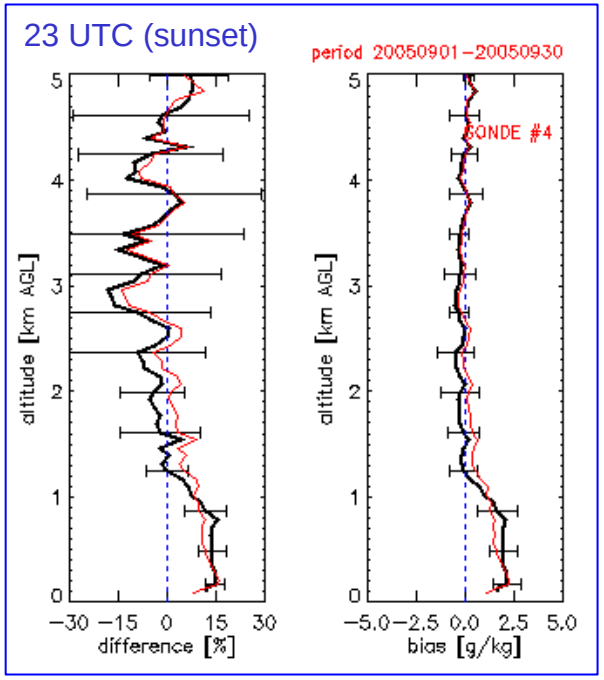


How the two approaches compare

September, 2005





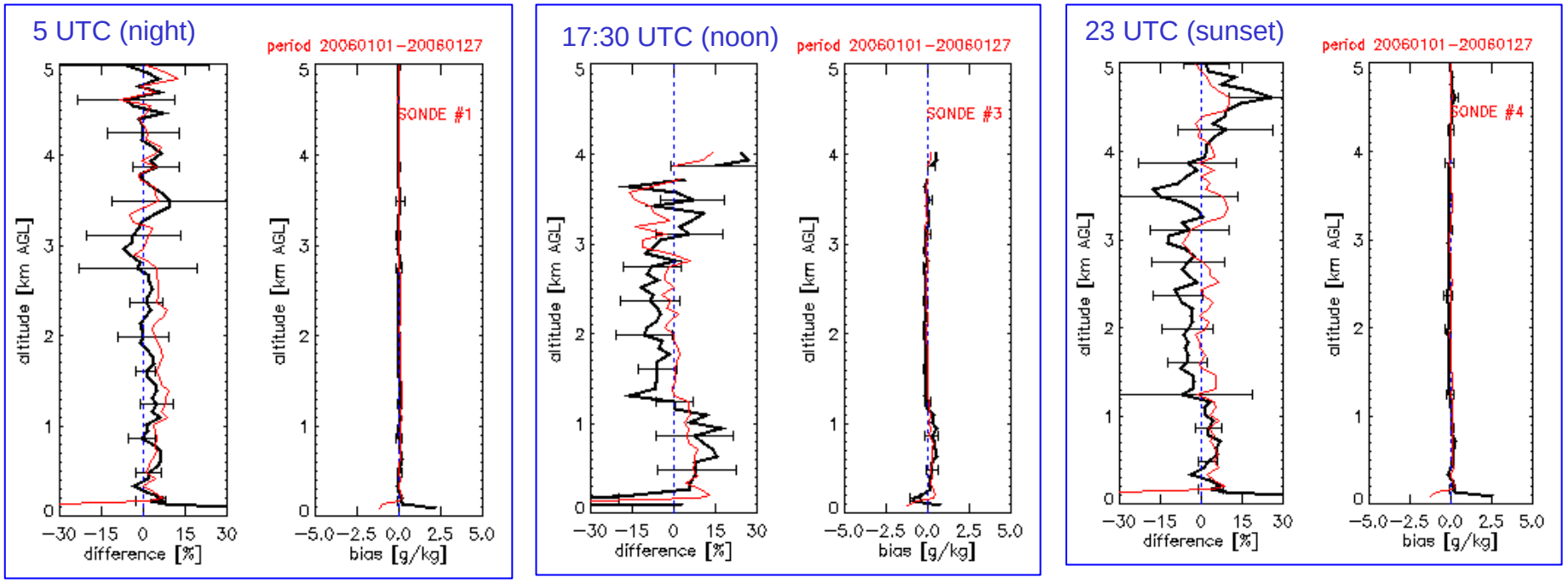


Red- time dependent glue coefficients
Black-time independent glue coefficients

Rich Ferrare and Marian Clayton, who performed major part of the analysis of the different gluing approaches on the ALIVE data will give more details about those comparisons this afternoon.

How the two approaches compare

January, 2006



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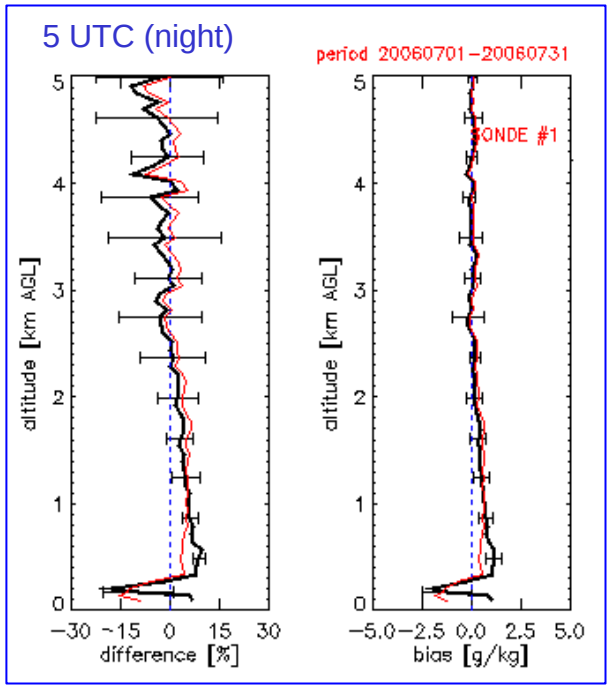
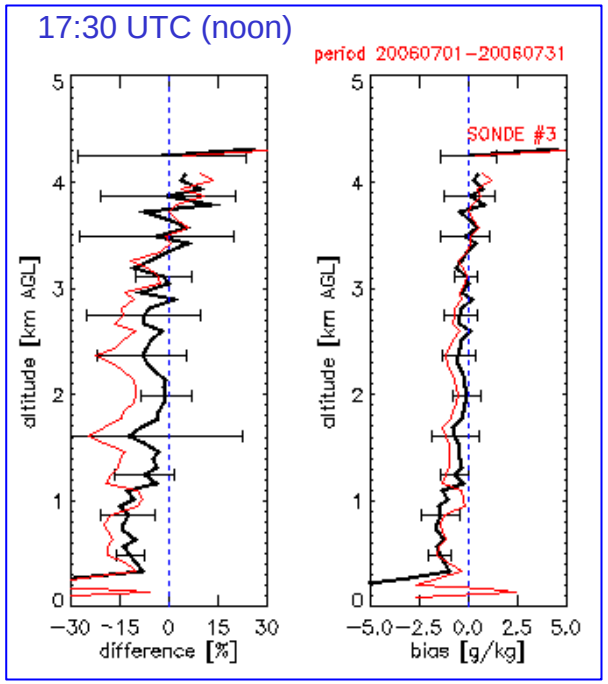
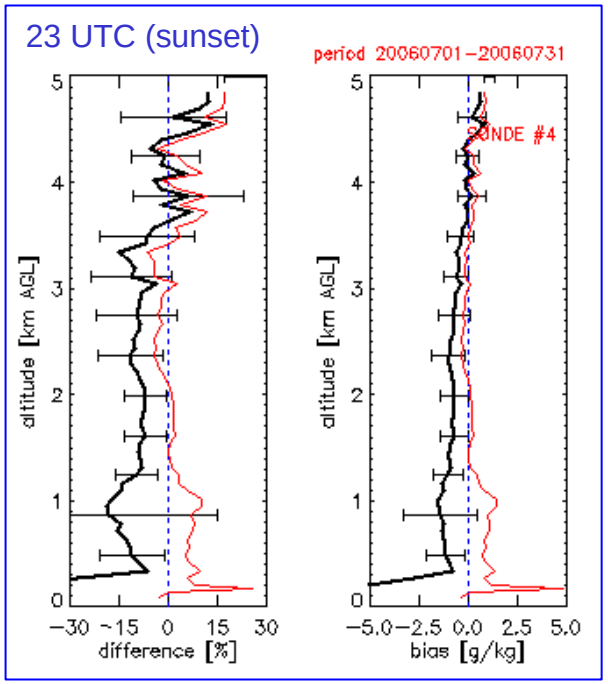
How the two approaches compare

July, 2006





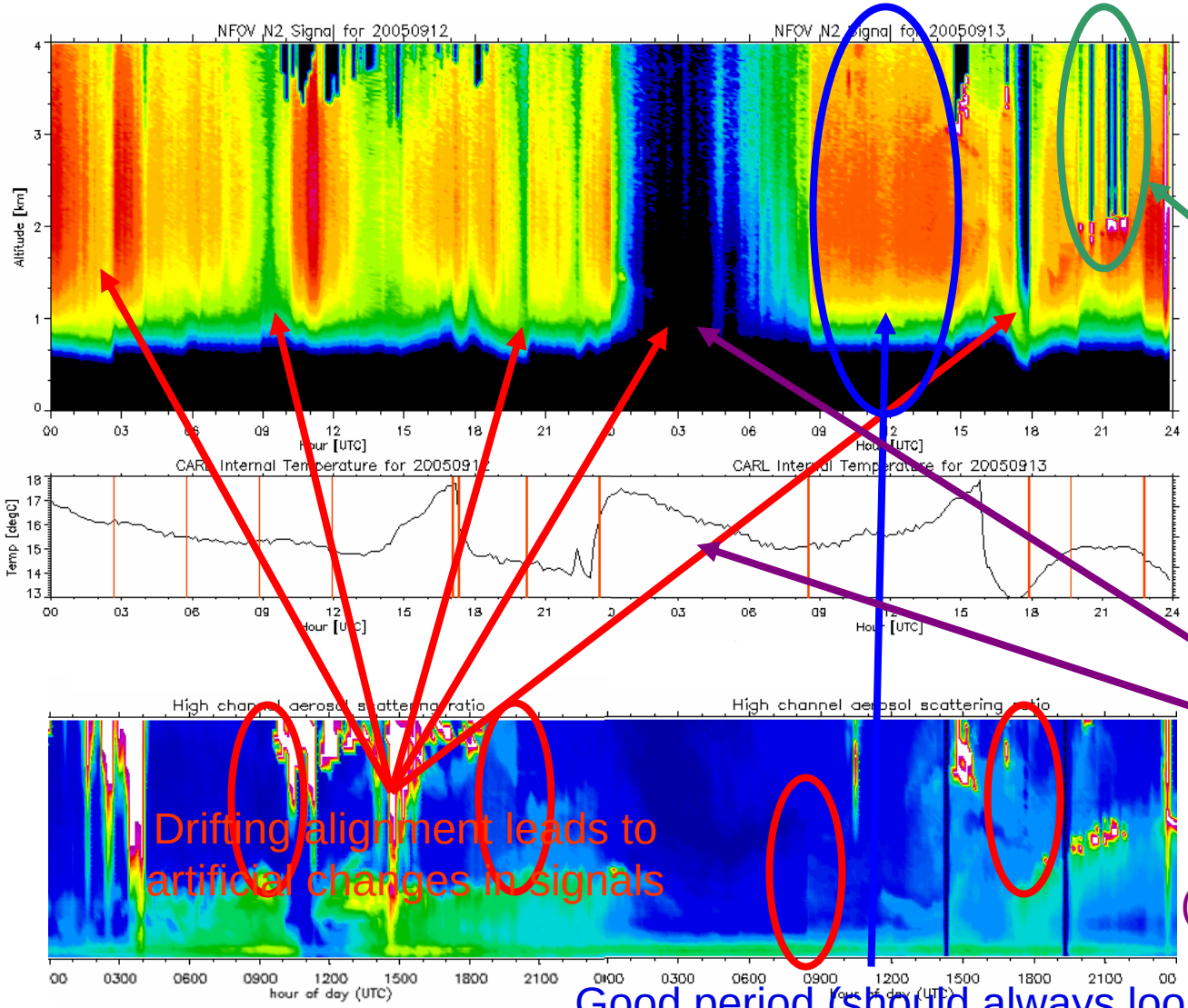


Red- time dependent glue coefficients
Black-time independent glue coefficients

What is next?

- The efforts to understand how to glue the AD and PC data continue
- The difficulties were discussed with the vendor (Licel) of the electronics
- Sent one of our PMTs to Licel for testing
- Started the collection of a ‘full and reduced’ strength data sets (via the use on Neutral density filters) since Mid October. We are currently analyzing this data to verify that the PC data do not have a diurnal dependence.

Another challenge



Background subtracted, range-squared N_2 signal
12-13 Sep 2005

Strong extinction due to clouds (this is normal)

Alignment Tweaks
Internal temperature

Aerosol Scattering Ratio

Drifting alignment leads to artificial changes in signals

Alignment so bad system thought it was cloudy!
artifacts indicated in red
(Hence no auto-alignment)

Good period (should always look this way in cloud-free conditions)

This was a very bad case due to poor thermal stability in lidar enclosure. However, it illustrates the point well.

How can we improve the alignment?

- 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 within ~10 µrad

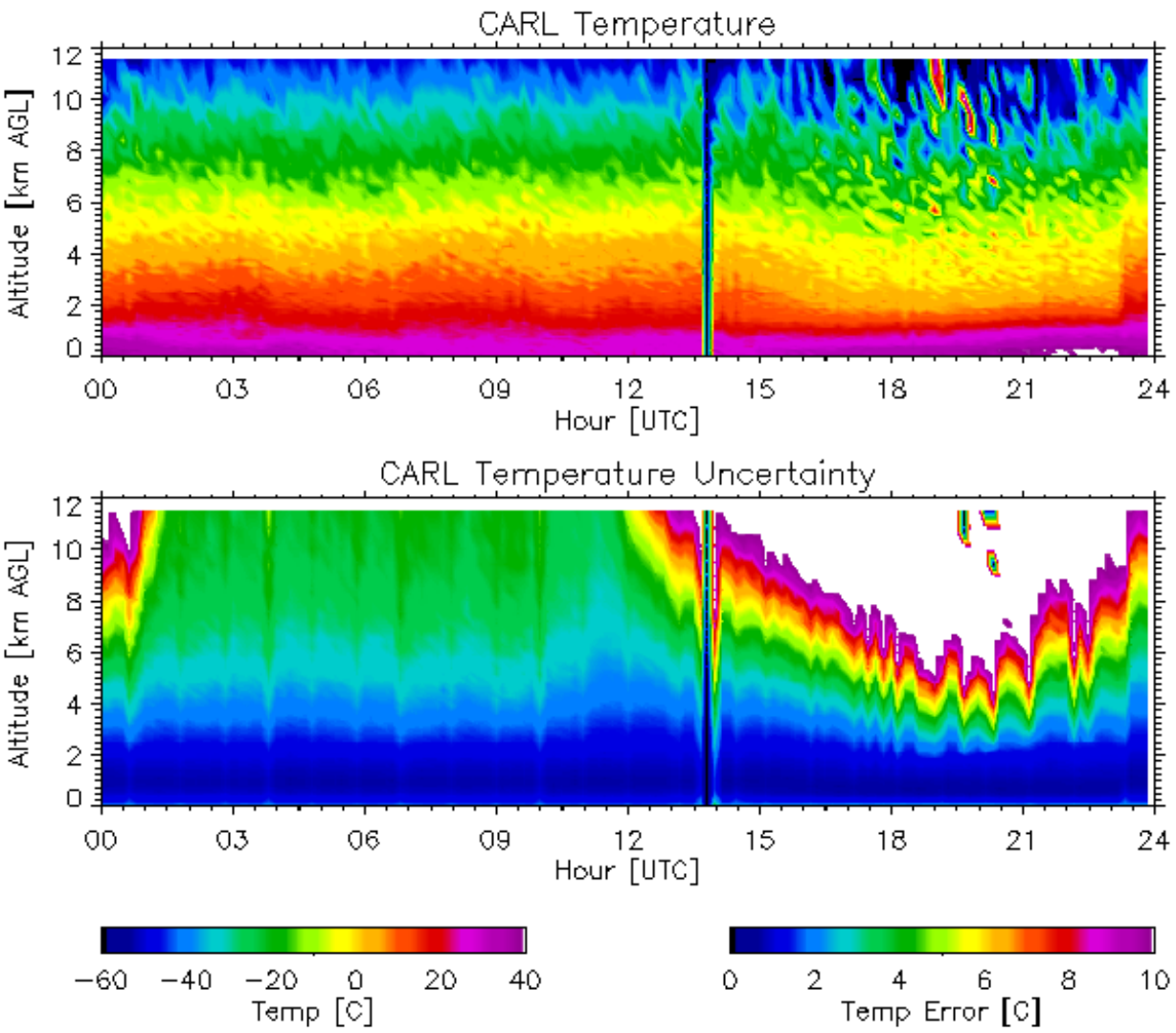
Will install fall 2006

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
- The 2 new rotational Raman channels added to CARL as part of the upgrade would allow us to profile atmospheric temperature
- 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



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

Thank you!