AERI Mentor Report

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ARM Atmospheric Radiation Measurement Program

Background

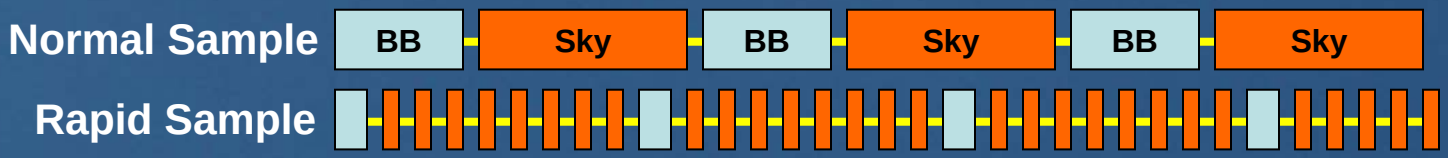
- Spectrally resolved IR radiances were considered key component of ARM's observational strategy
- Stringent requirements placed on absolute radiometric accuracy (1% ambient radiance), spectral accuracy, noise level, and operability
- Instrument development was successful!
- ARM has 8 AERI systems:

SGP-01	TWP-C2
SGP-E14	TWP-C3
AMF-M1	Spare (NR)
NSA-C1 (ER)	Spare (ER)

- Approx *15 Million* calibrated sky spectra have been collected by ARM AERIs (up to Oct 2008)

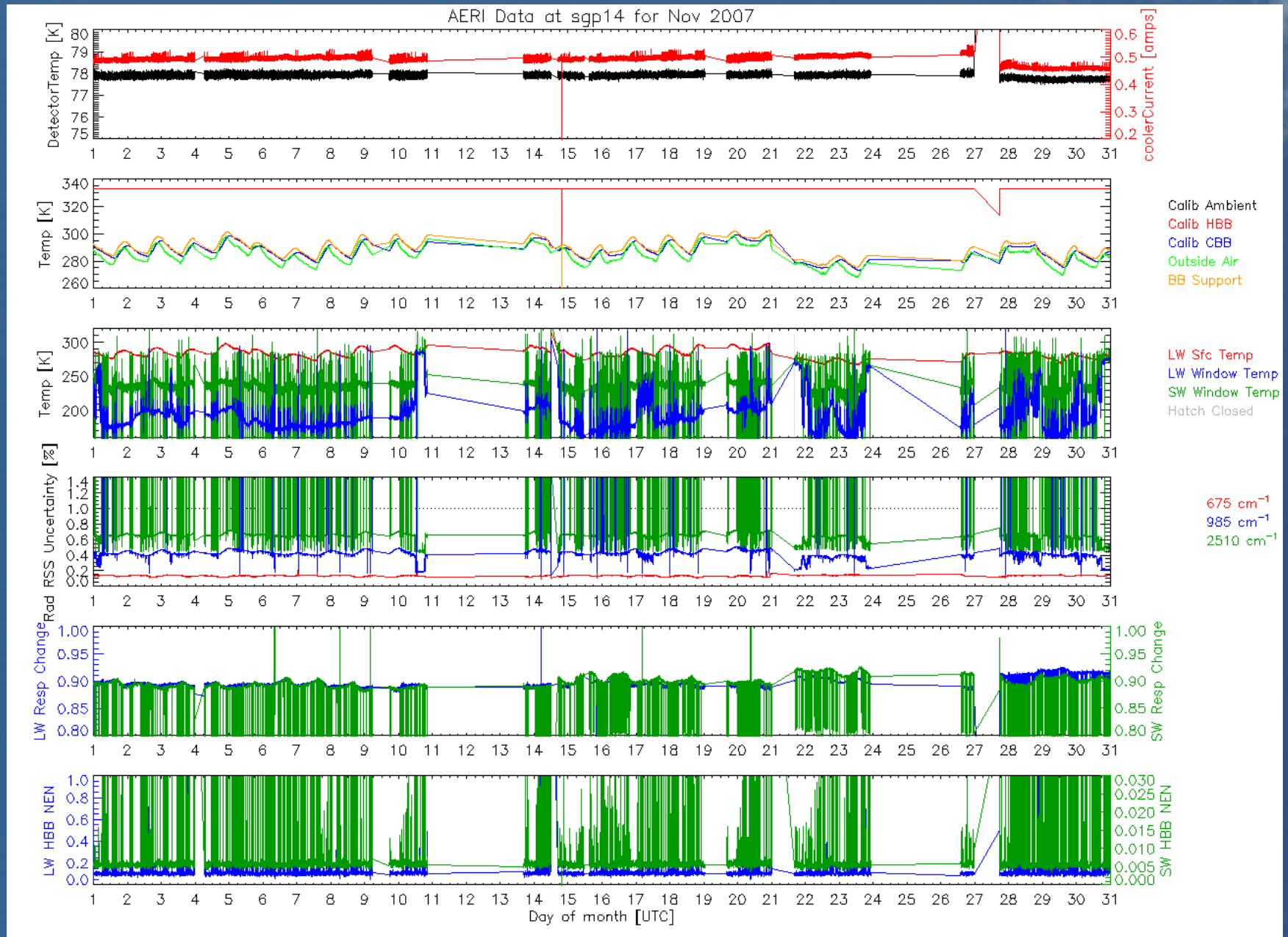
Recent Accomplishments

- Hatch saga (Darwin, NSA, AMF) largely resolved
  - Designed/built by mentors over yrs (⇒3 separate designs)
  - Documentation on hatches thin, difficult troubleshooting
- Trouble shooting Sterling coolers
  - Only one spare on hand, produced in batches
  - One unit at vendor for repair
- Migration of the AMF system to aerosol trailer done
- Improving noise-filtering approach/SW

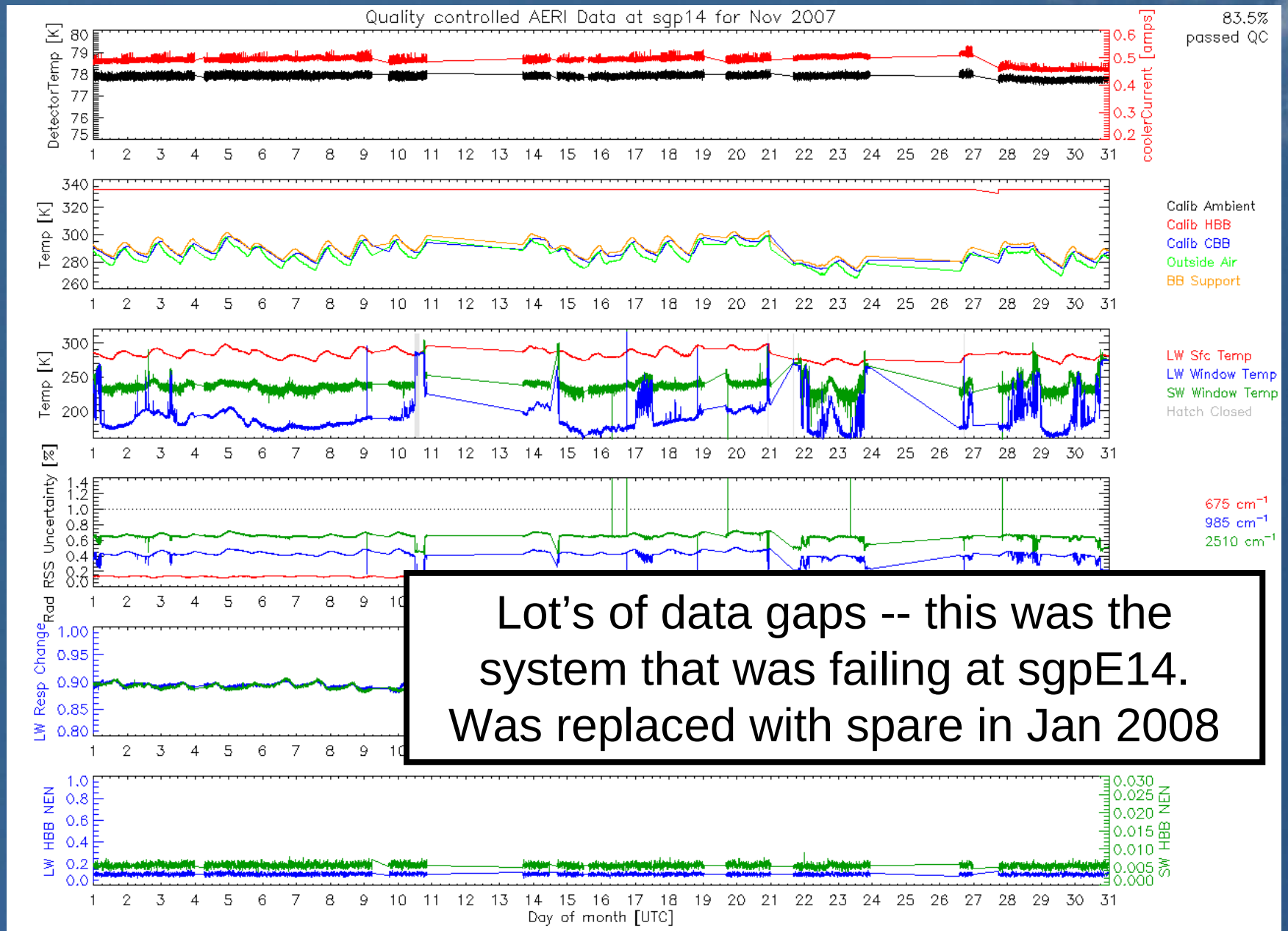


  - NF removes uncorrelated noise
  - Shorter BB avg. periods, together with more sky samples between BB views, creates temporally correlated noise
  - Need to NF BBs, then calibrate sky views, then NF sky views
  - Software mostly complete (“super-filter”, more details later)
- Development of advanced DQ scripts/flagging

QC Plots - Before QC



QC Plot - After QC



Lot's of data gaps -- this was the system that was failing at sgpE14. Was replaced with spare in Jan 2008

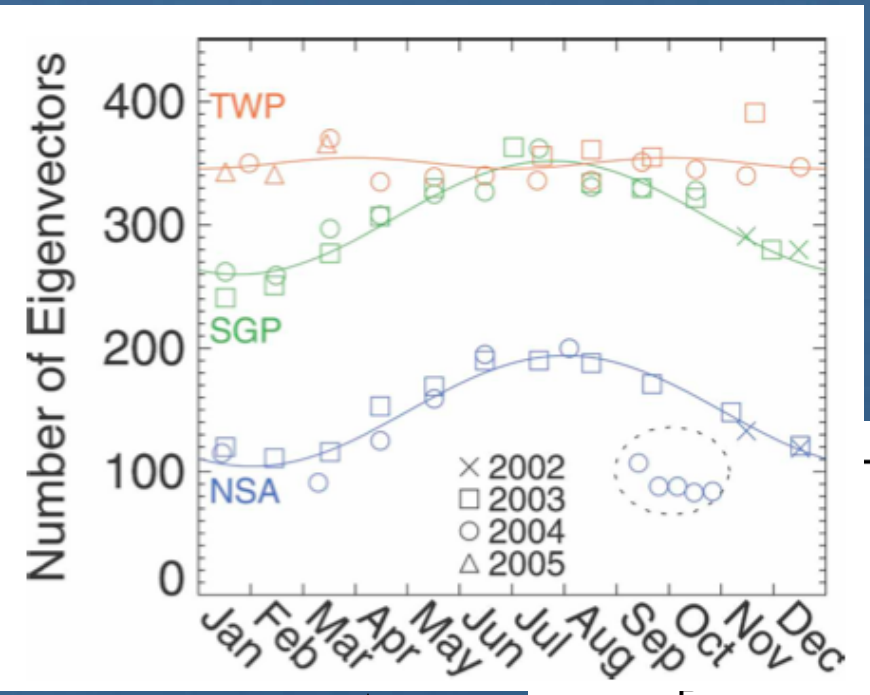
Fraction of Observations that are “Good”

- QC checks look at imaginary component of radiance, instrument stability gauged with BB views, expected responsivity
- Thresholds are manually determined
- Gaining knowledge on stability of thresholds; will transfer QC script to DQO soon
- QC script produces flags (1/0) for each sample to (use/don’t)
- Fraction flagged ranges from 0% to ~5% per month…

	10/08	09/08	08/08	07/08	06/08	05/08	04/08	03/08	02/08	01/08	12/07	11/07
nsaC1	99.8	99.8	99.7	99.6	100.0	99.9	95	99.7	98.7	99.1	99.7	99.3
sgpC1	100.0	100.0	99.9	99.8	100.0	100.0	99.8	100.0	100.0			
sgpE14	100.0	100.0	100.0	99.8	100.0	100.0	99.8	100.0	100.0	94.2	76.6	83.5
twpC2	96.8	94.6	98.8	97.5	96.8	99.2	98.7	95.1	99.3	99.5	98.5	97.6
twpC3	95.1	99.3	98.8	98.4	97.5	97.9	99.0	98.2	95.7	97.2	99.4	97.1

Failing system

Impact of Bad Data on Noise Filter VAP



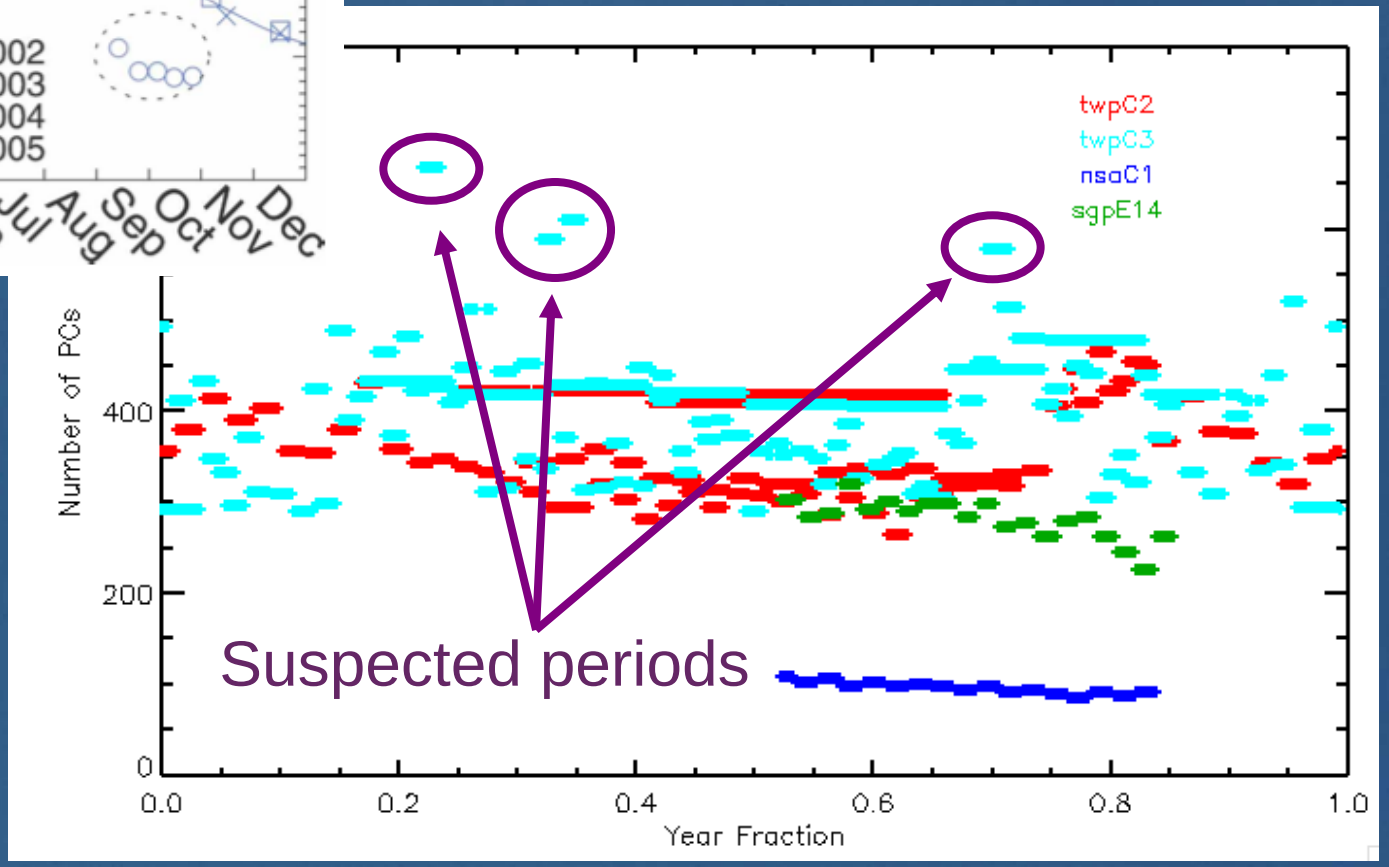
PCA noise filter removes uncorrelated random noise

Bad spectra skew the PC decomposition

Thus, noise filter is less efficient (sometimes significantly so)

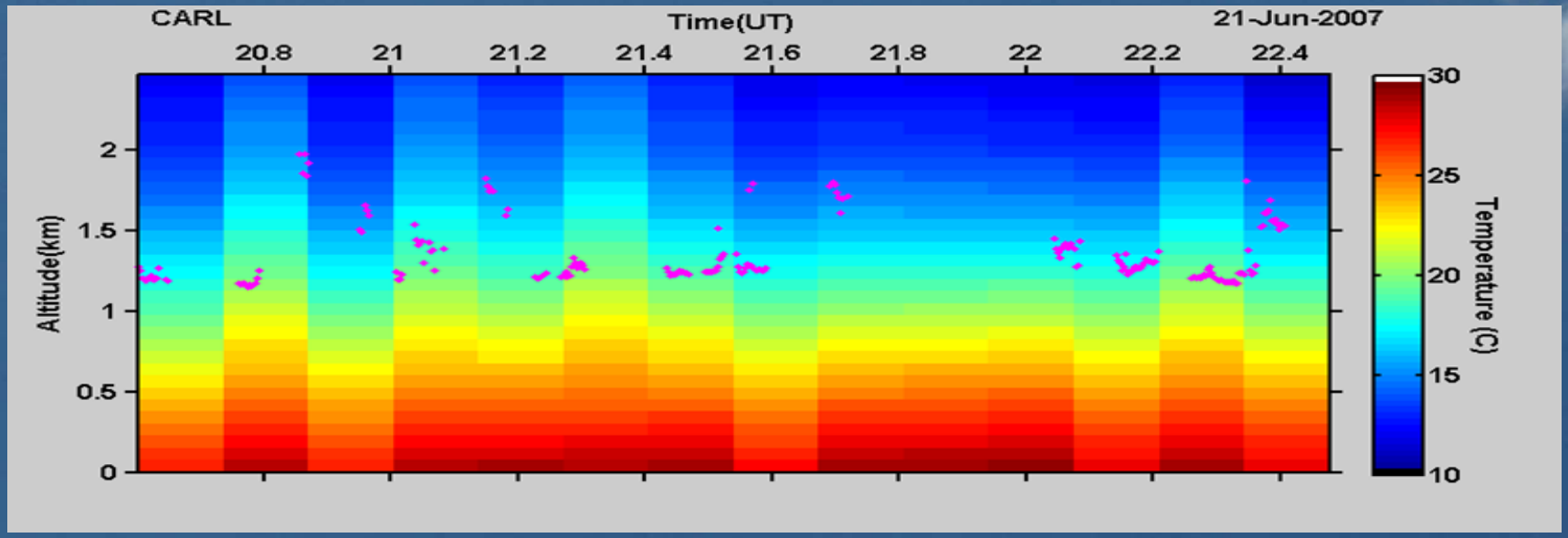
Manual NF

Automated NF

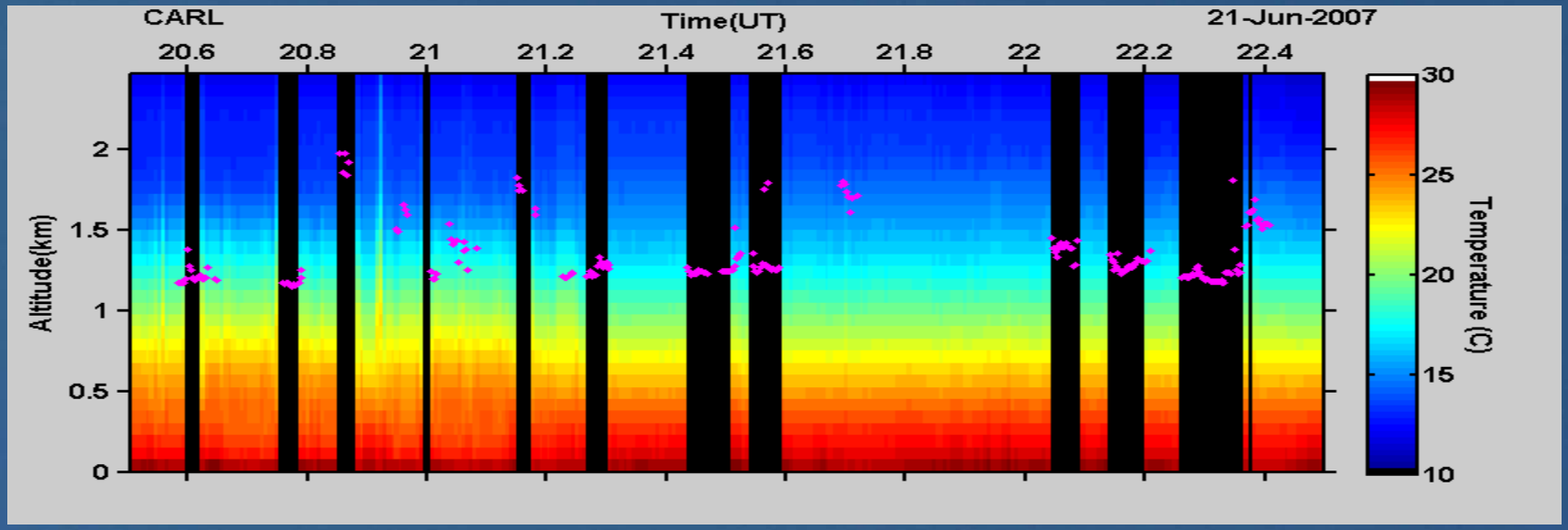


Impact on Retrieved T/Q Profiles

DMF Processed NF and AERIPROF

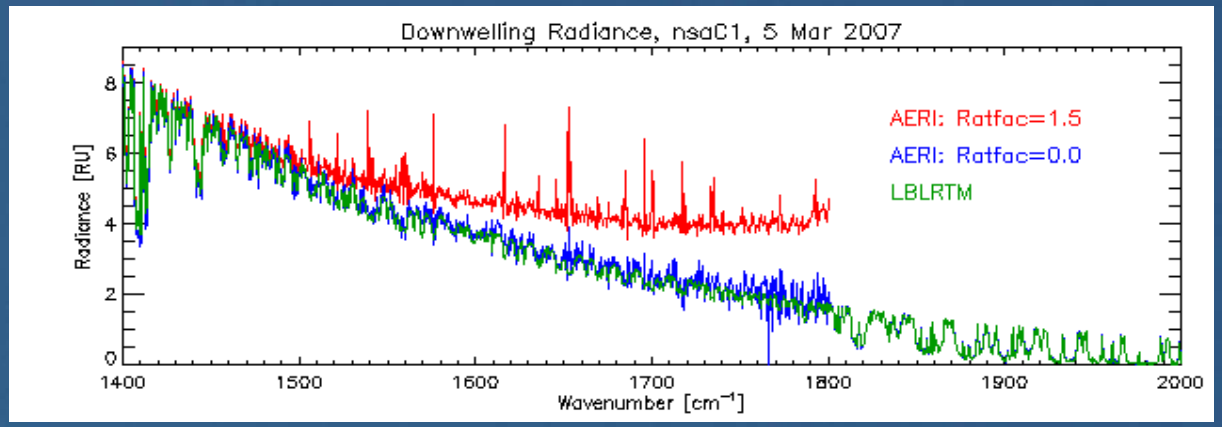


UW Processed NF and AERIPROF



Identification of Logic Error in Operational Processing Code

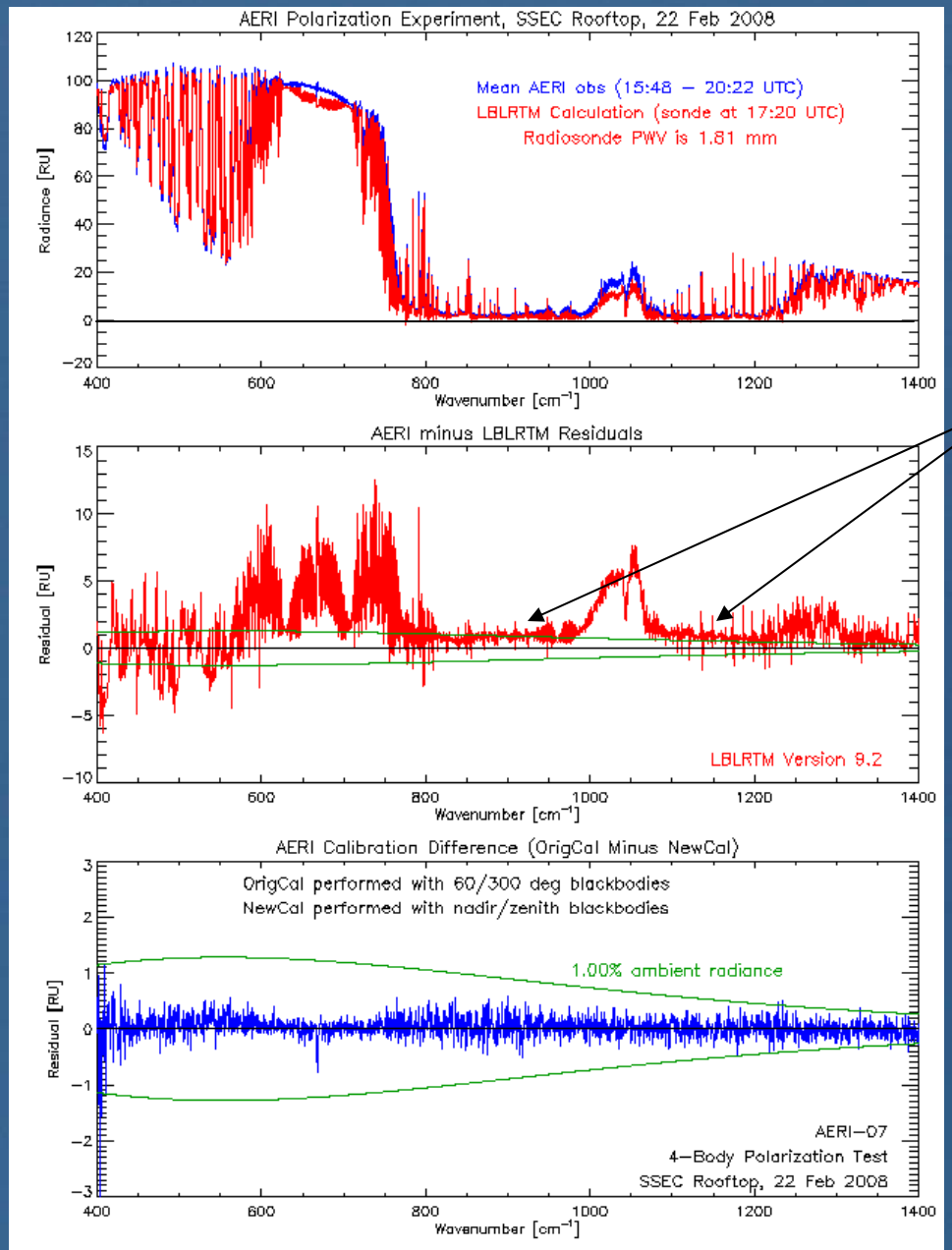
- Manual processing identified “hidden” asymmetric test in operational calibration code
  - Test implemented to prevent divide by zero errors
  - Not an issue with normal-sample data because S/N was much larger; only rapid-sample data affected
- Trap was redesigned, and bias was removed
- Need to reprocess ALL rapid-sample data



Followup Investigation

- Collect sky view
- Calibrate using normal (60º/300º BBs)
- Calibrate using zenith/nadir BBs
- Differences could be due to:
  - Polarization
  - Misalignment of optical axis
  - “Sidelobe” contribution

Source of Warm Bias Found?



Comparison with LBLRTM shows that the bias IS in this dataset

Evaluation demonstrates that polarization not the issue, nor is mis-alignment or sidelobe.

Source still unknown

Aging ARM AERI Systems

- AERIs are over a decade old
- Recent HW/SW upgrade has extended AERI lifetime significantly
  - Replaced HW components no longer available, upgraded to more modern computer and OS
  - Allowed new science via rapid-sampling
  - Forced change of thermistor A/D card has degraded absolute accuracy
- Experiencing more HW failures recently
  - 4 failures in last 2+ yrs (interferometers)
    - Bomem no longer makes this particular model interferometer
  - Failure modes are unique and hard to diagnose
  - Ultimately may need to replace interferometer subsystem
- Put in request to ARM to stockpile more spare parts and calibration components
  - Not in FY09 budget, but will get some $$ in FY10 for this

4th Generation AERI from Bomem

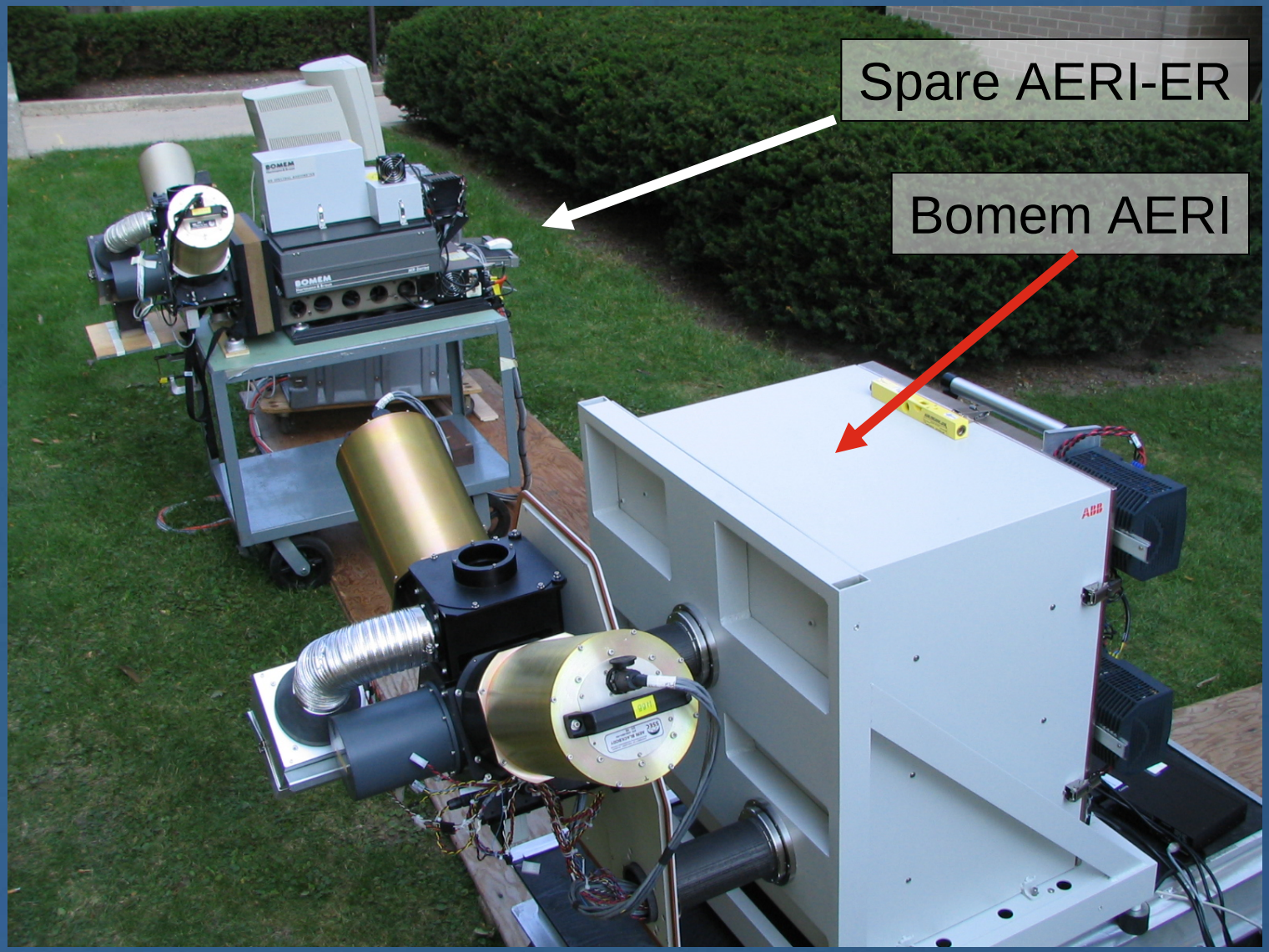
SSEC licensed AERI to ABB Bomem in late 1990's

- **Newly update with off the shelf components**
  - New MR series spectroradiometer technology
  - New integrated signal conditioning electronics
  - All components integrated into one enclosure
- **SSEC AERI blackbody sources**
- **New environmental protective enclosure**
- **Temperature stabilized FTIR and electronics**
- **Ethernet communication link to the computer**
- **Windows XP compatible software**
- **SSEC operational SW and calibration approach**
- **Systems 'certified' by SSEC before delivery to customers**

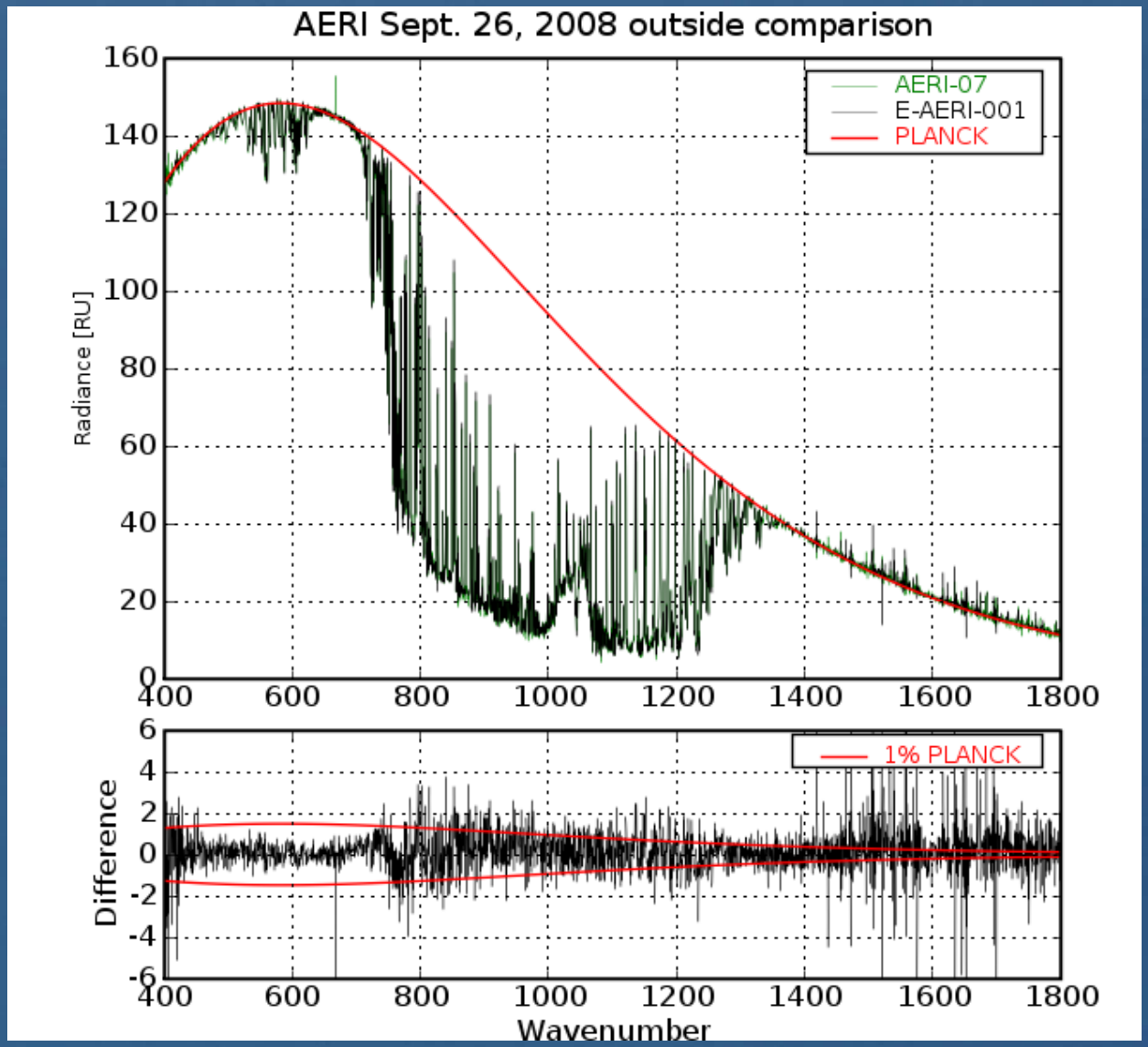
SSEC Certification of Bomem Systems

- Arranged with ABB/Bomem to evaluate each system before delivery to “certify” its calibration
- Bomem delivered their first 4th generation system to SSEC in Oct
  - Used SSEC blackbodies and frontend design
  - Used SSEC calibration / processing software
- Performed standard lab and outdoor calibration and characterization tests
- Short answer: this newest generation system looks very good!

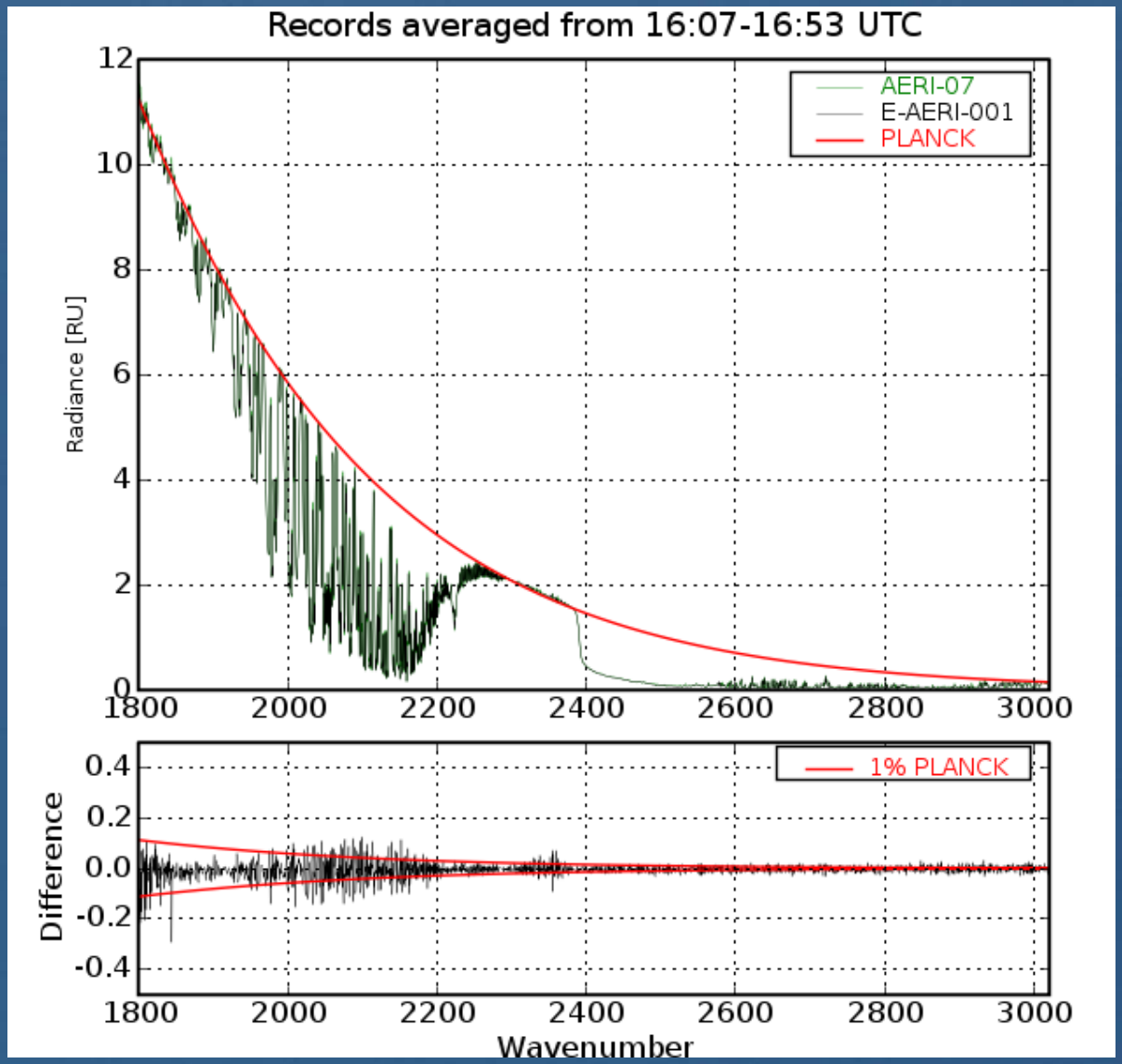
Setup for Atmospheric Test



Clear Sky Comparison (Channel 1)



Clear Sky Comparison (Channel 2)



Summary

- DQ script becoming mature
  - Up to 5% of obs at any site are bad
  - QC flags for each sample are available from mentor
    - Discussion within ARM how to best distribute
- Noise filter VAP needs updating to use these QC flags
- Asymmetric test in calibration code results in bias in rapid-sample data
  - Modified code to redesign test
  - Need to reprocess all rapid-sample data
- Working on “super-filter” code, that would fix asymmetric test, improve blackbody emissivity model, apply NF
  - Run on raw data, significant reprocessing effort, medium priority
  - Ideally run super-filter on all future data also
  - Could retire the Noise Filter VAP if adopt this approach
- There is a path forward for new AERI systems in future