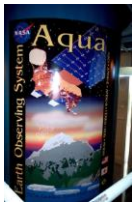
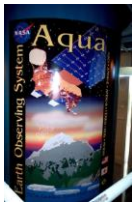


Aqua MODIS Cold FPA Performance and Operation

MODIS Characterization Support Team (MCST)

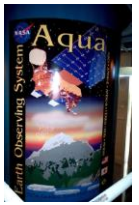
May 4, 2016

Outline



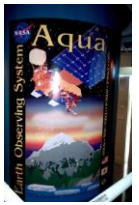
- Introduction
- On-orbit Performance Update
- Observed Impacts
- Mitigation Options
- Summary

Introduction



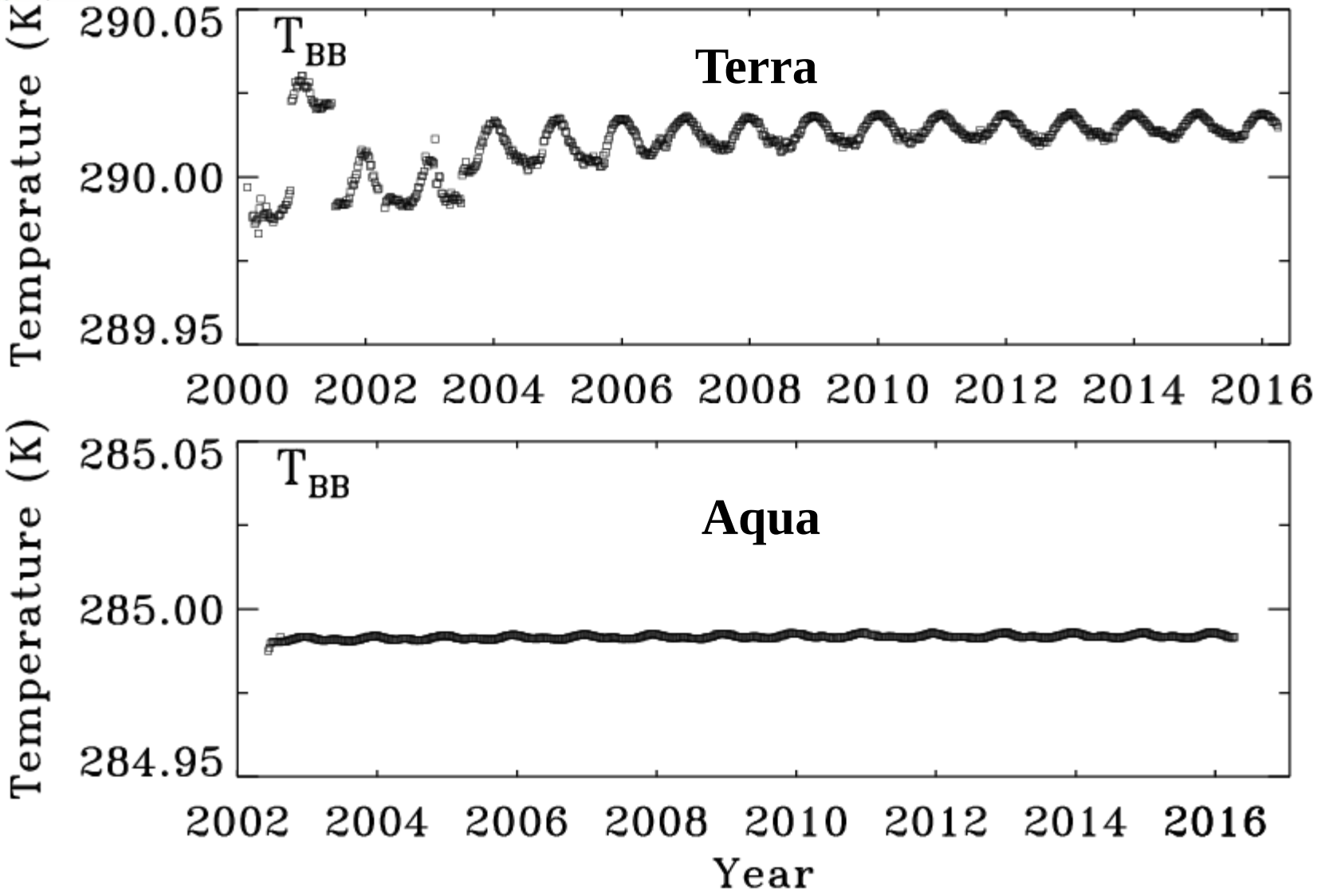
- **Aqua MODIS Cold Focal Plane Temperature Control**
  - Known issue with insufficient radiative cooler margin
- **Prior meetings to brief status, impacts, calibration improvements, and mitigation options**
  - 1st meeting on May 7, 2010
  - 2nd meeting on April 25, 2012
  - 3rd meeting on March 17, 2013
  - 4th meeting on April, 16, 2014
  - 5th meeting on April, 22, 2015
- **Monitor impacts on science products**
  - Orbital variation in TEB detector gain (PC bands more sensitive)
  - Fitting residuals from BB WUCD during a0/a2 derivation
  - EV Saturation in bands 33, 35, and 36 EV data during WUCD
- **Improve calibration algorithms**
  - Improved default b1 algorithm implemented in Collections 5 and 6
  - Temperature correction to a0/a2 analysis implemented in Collection 6

Current Status



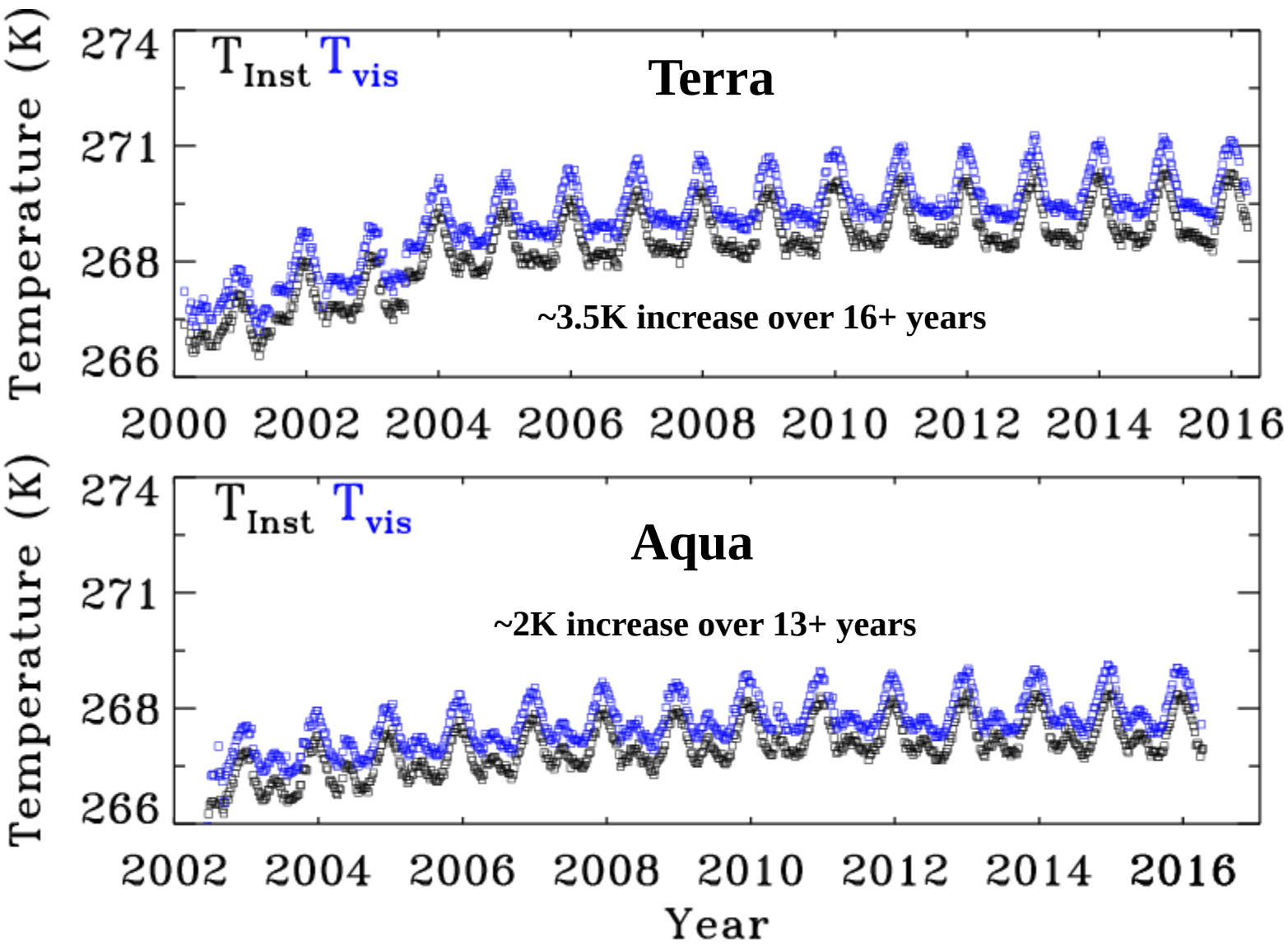
- CFPA temperature peak during summer months with maximum ~83.7 K in mid-2013.
- Peak temperature has decreased since 2013
- CFPA orbital/seasonal oscillation – current max/min difference ~0.3 K
- Radiative cooler margin still not sufficient for CFPA setpoint of 83 K.
- Majority of impacts on L1B products occur during BB Warmup/Cooldown activities

BB Temp Trends



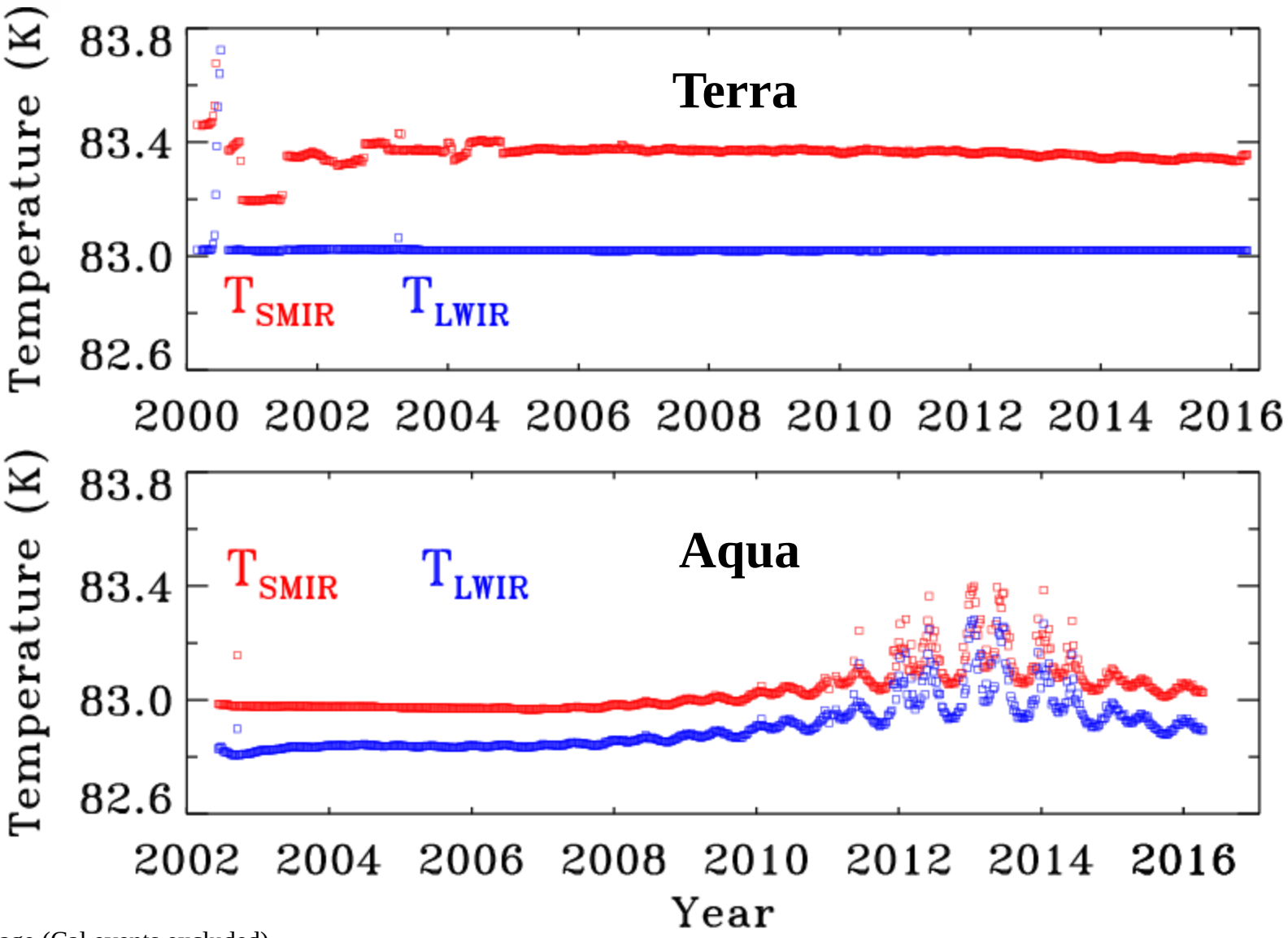
Weekly average (Cal events excluded)

Warm FPA Temperatures



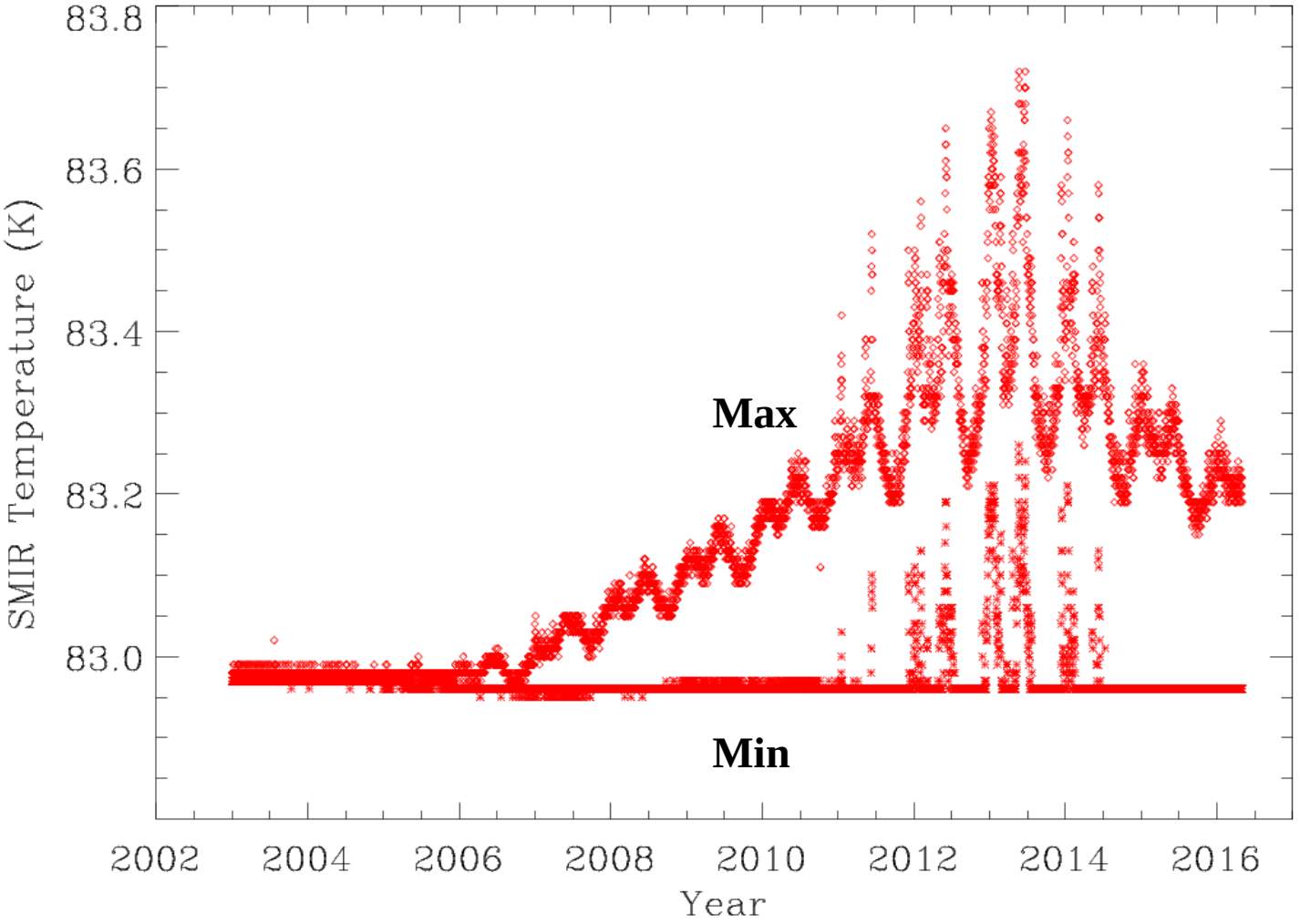
Weekly average (Cal events excluded)

Cold FPA Temperatures



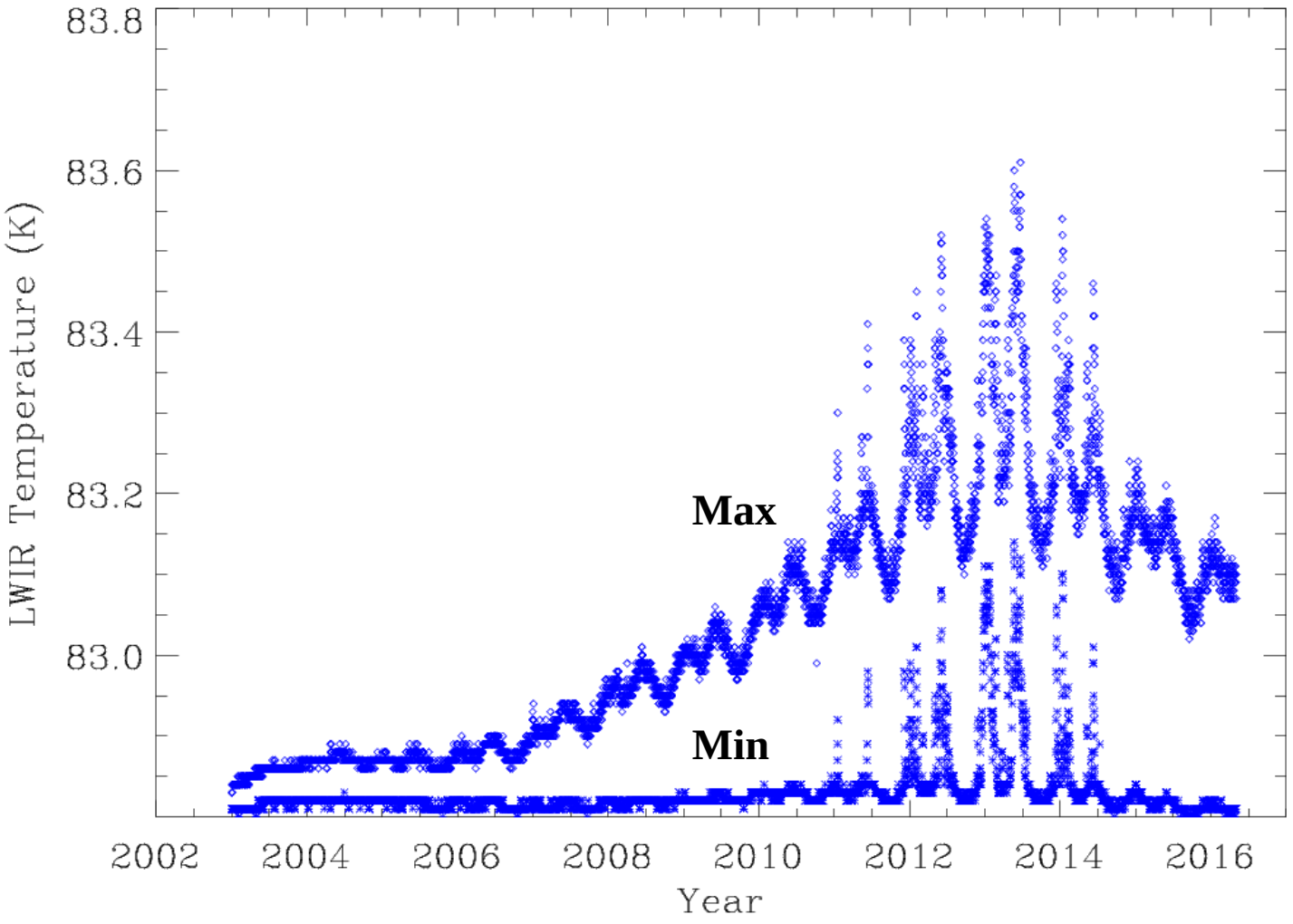
Weekly average (Cal events excluded)

Aqua CFPA Temperature Oscillations Long-term Trend



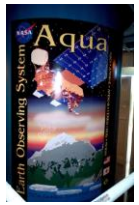
Daily Max/Min

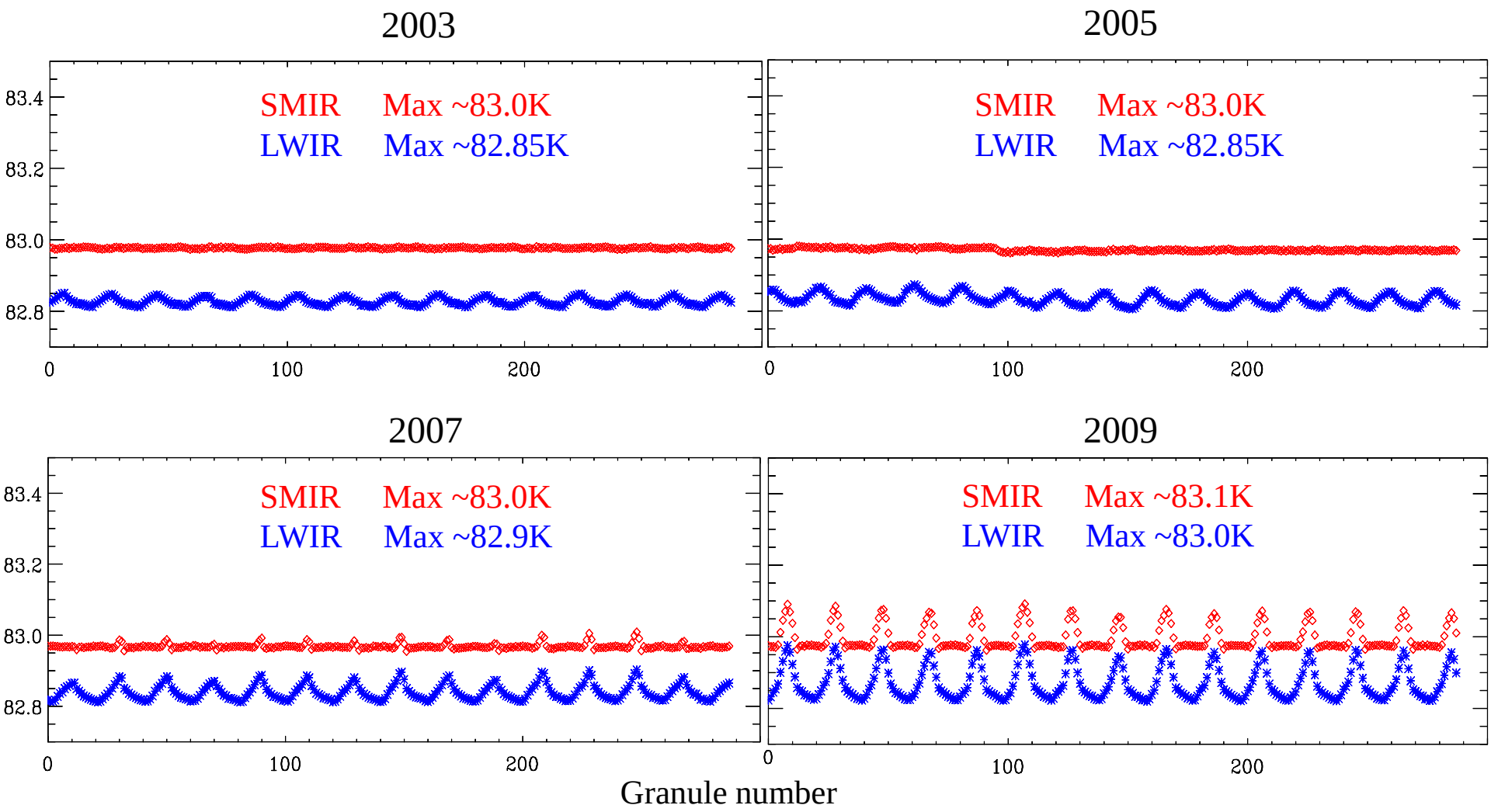
Aqua CFPA Temperature Oscillations Long-term Trend



Daily Max/Min

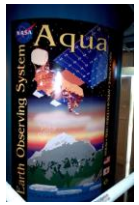
Aqua CFPA Temperature Oscillations Short-term (DOY 100) Trend

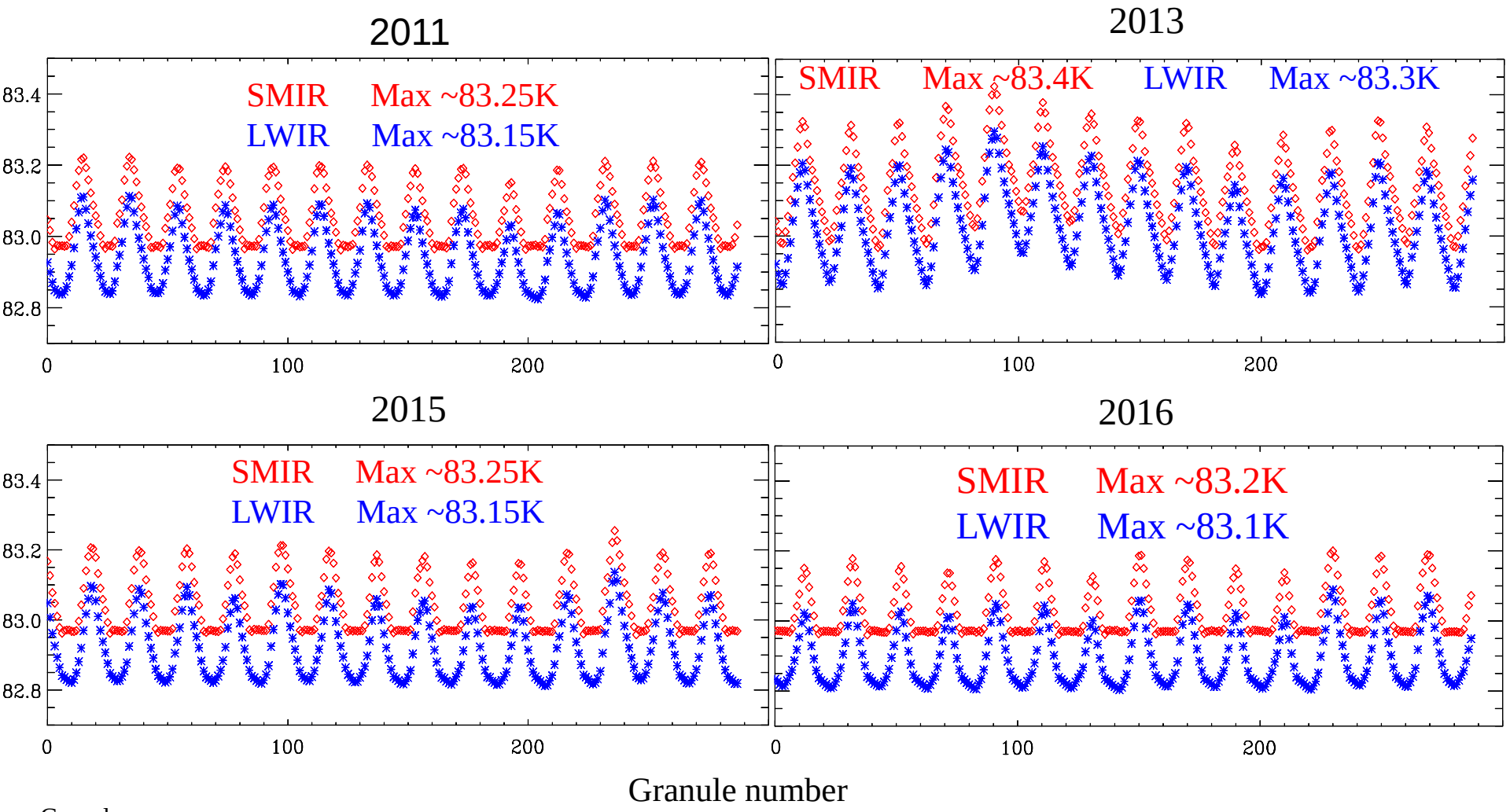




Granule average

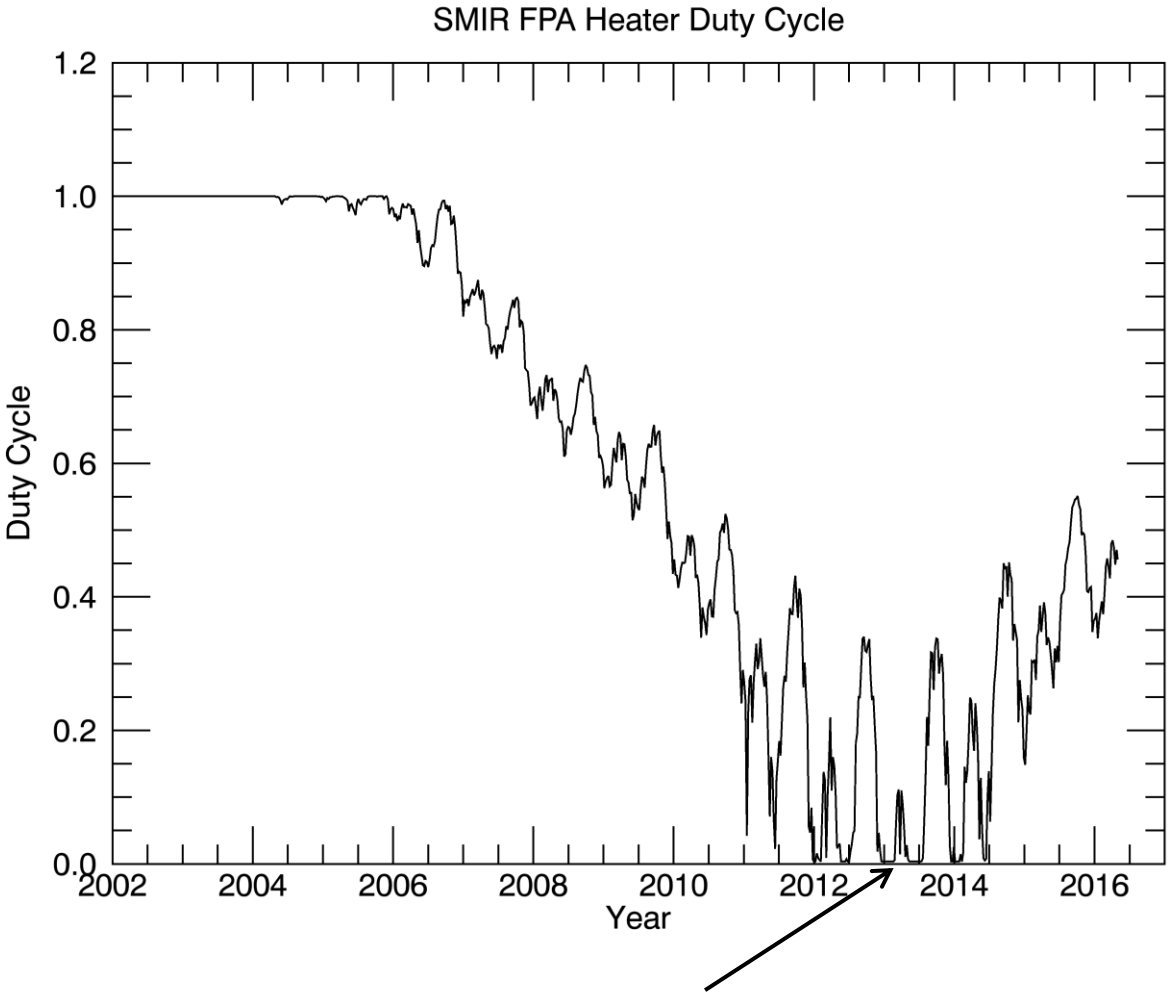
Aqua CFPA Temperature Oscillations Short-term (DOY 100) Trend





Granule average

Heater Voltage Duty Cycle Trend

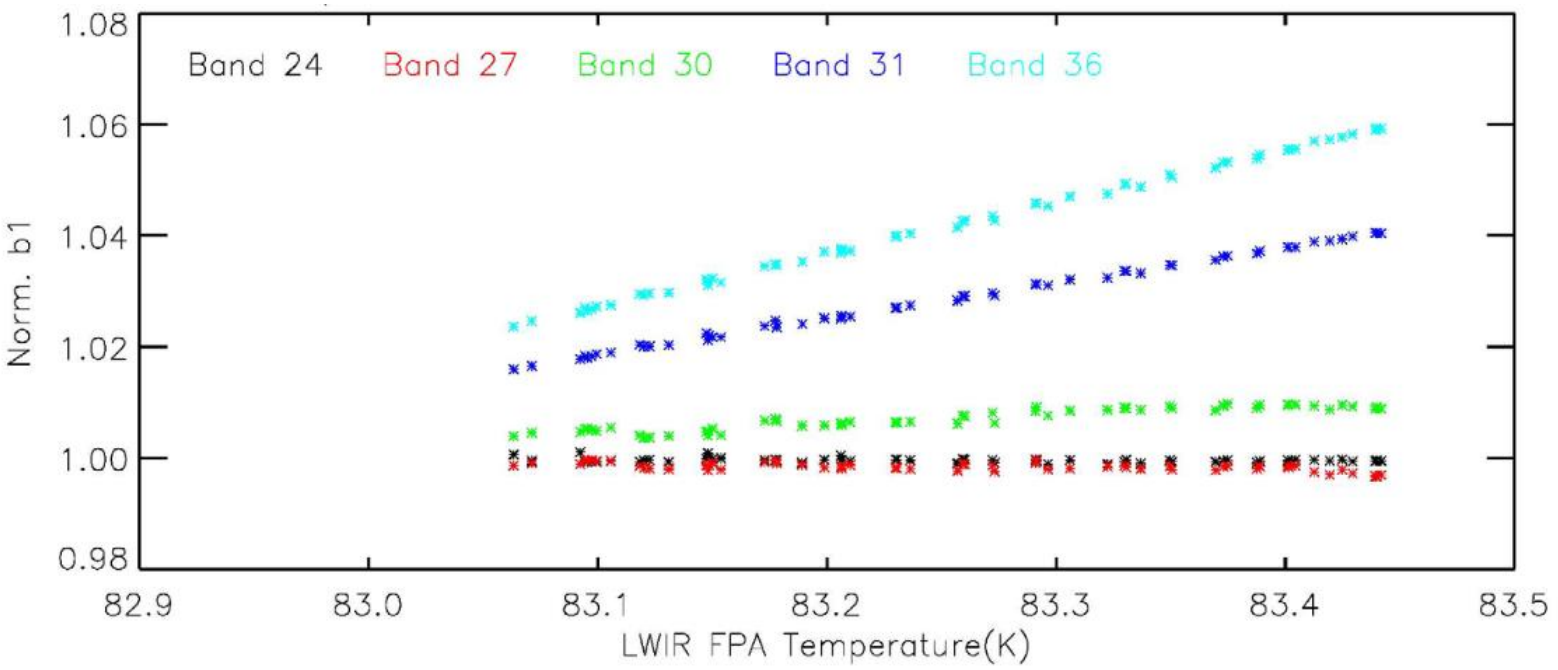


CFPA temperature not controlled for intermittent periods

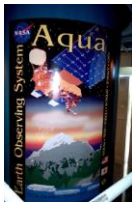
Weekly average

Observed Impacts

- Gain variation with CFPA temperature
  - Linear relationship between gain and CFPA Temp
  - PC bands show largest effect
  - Captured by scan-by-scan calibration



Observed Impacts



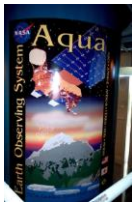
- BB Warmup-Cooldown Activities
  - ➢ Larger fitting residuals for (a0 = 0 for PC bands)
    - ❖ Temperature correction for a0/aa2 derivation 2 analysis implemented in C6
  - ➢ Bands 33, 35 & 36 EV data saturation
    - ❖ Instances of EV saturation

      Cumulative saturation time during WUCD (unit: minute)

Band	33	35	36
WUCD T_{BB}>Tsat time	**365**	**330**	**265**
2004/203	**0**	**0**	**0**
2009/123	**16**	**6**	**10**
2013/174	**209**	**145**	**122**
2015/116	**148**	**117**	**109**
2016/087	**45**	**88**	**102**

    - ❖ FPA temperature dependent default b1 algorithm implemented for C5/C6

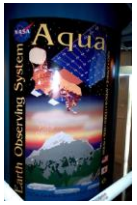
Mitigation Options



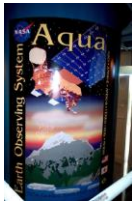
Options under consideration to address Aqua CFPA temperature issue

1. **No change**
   - Continue operations in current configuration
2. **Change CFPA set point to 85K**
   - Detector response, noise performance and dynamic range will change
3. **Perform Outgas**
   - Requires NASA HQ approval
   - If Aqua-MODIS goes into safe-mode for some reasons, MCST/IOT has the authorization to perform an outgas
4. **Reduce frequency of WUCD activities**
   - Reduce instances of EV saturation during WUCD, may affect a2 accuracy
5. **Upload modified DCR table for bands 33, 35 & 36**
   - Eliminate EV saturation during WUCD, may impact dynamic range

Summary

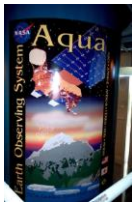


- **Aqua MODIS continues to operate nominally**
  - Decrease in radiative cooler margin since ~2007. CFPA temperature not consistently controlled at set point of 83 K and has orbital and seasonal variations
  - Maximum SMIR temperature reached in mid-2013, temperature control has improved since then
  - Scan-by-scan calibration captures much of the impact of the CFPA variation
  - Improved default b1 algorithm implemented in Collections 5 and 6
  - Temperature correction to the a0/a2 analysis implemented in Collection 6
  - EV saturation for bands 33, 35 & 36 during WUCD.
- **Changes since last workshop April 22, 2015**
  - Increase of radiative cooler margin. Duty cycle increased from approximately 0.35 to 0.45.
  - Improvement of temperature control, maximum SMIR temperature reduces from 83.25K to 83.20K
  - Reduction of EV saturation instance during WUCD.
- **MCST work plan**
  - MCST continues monitoring of CFPA performance and impacts. No reports received of adverse impacts on science products.
  - MCST Recommendation: Option 1 – No change in operation status



Backup Slides

Option 2 – Change CFPA Set Point to 85K



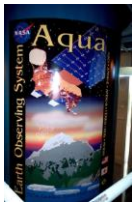
- S/C needs to be in “nominal mode” for this activity
- Ensure that CFPA heater B is in the ON state
- Send the following commands:

  SET_RC_CFPA_TEMP TO 1/2/3

  MOD_SET_PM_RC_CFPA_TEMP(‘T2’)
- Monitor telemetry to ensure that the CFPA temperature adjusts accordingly (real time until it stabilizes)

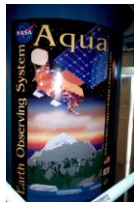
- Advantages:
  - Gain stably controlled
  - EV saturation during WUCD decreased
  - Increase in dynamic range for some TEB
- Concerns:
  - Majority of pre-launch LUT tables based on 83 K set point
  - DCR table for 85 K
  - Decreased radiometric resolution for some TEB
  - Increased detector noise

Option 3 - Outgas



- An outgas without an anomaly requires transitioning MODIS from science mode to standby mode and then to outgas mode
  - Doors are closed, except SV door is moved to outgas position
  - This operation/action may require approval from HQ
- An outgas requires a set of commands and takes 2-3 days to complete (heaters are turned on in specific sequence)
  - CFPA will be back to ambient temperature during outgas operation
- Potential impact on SWIR (band 6 in particular) detector operability
- IOT prepared for and has approval to perform an outgas in the event of spacecraft anomaly resulting in a safe mode transition.

Option 5 – Modify DCR Table



- CFPA setpoint remains at 83 K
- DCR table for bands 33, 35 & 36 modified and uploaded
- Expected to reduce EV saturation during WUCD
- Can be performed by IOT as a regular table upload to MODIS.