INTRODUCTION

GOES-17 (G17), the second of the new generation geostationary weather satellites, was launched on March 1, 2018, and became GOES-WEST on February 12, 2019. Advanced Baseline Imager (ABI) onboard G17 has six reflective channels (two Visible and four Near-Infrared bands), which are calibrated using their observations of the space and solar calibration targets. The GOES-R Calibration Working Group (CWG) has developed an Instrument Performance Monitoring (IPM) system to validate the VNIR calibration performance, and has the capability of deriving calibration coefficients for ABI VNIR channels to verify and improve the GS results. This paper reports major results and improvements of G17 ABI VNIR bands calibration and performance since its launch, including: 1) Mitigation of B02 ~8% bias; 2) Discovery of dependence of VNIR gains on Focal Plane Module (FPM) temperature fluctuation; 3) Striping removal with correction of erroneous detector gains due to the lunar intrusion rejection malfunction in solar calibration at Ground Segments (GS).

METHODS

CWG developed an in-house GOES-16/17 solar calibration processing to parallel verify the results of GS and other research purposes. G17 ABI VNIR channel calibration uses observations of the solar calibration target (SCT) and solar calibration space look, following the solar calibration equation to calculate the detector gains $(m)$ of VNIR bands, which depends on the parameters $f_{int}$, $\frac{L_{SCT}}{S_{Solar,Cal,Space}}$, $Q_{0}$, $\left(\frac{L_{int}}{Q_{0}}\right)$ and $\rho_{\text{eff}}$. Where $m$ denotes VNIR band gain, $f_{int}$ as solar calibration integration factor, $L_{SCT}$ as Effective SCT channel average spectral radiance, and $Q_{0}$ is quadratic coefficient for each detector in bands. $x$ is the average of scene count for SCT and space look view, respectively, $p_{\text{eff}}$ is the Integral factor power term (per channel), specified in the algorithm. The computation of $\frac{L_{SCT}}{S_{Solar,Cal,Space}}$ depends on the distance from Earth to sun, Sun-to-SCT diffuser normal angle of incidence, the effective bidirectional reflectance distribution function (BRDF) and mirror reflectivity.

Thus, CWG submitted a new G17 solar diffuser K-LUT (scaled down by 7.43%). The new K-LUT was implemented in OE on 05/05/2019 and the B02 bias was mitigated successfully.

VNR gains vs FPM temperature fluctuation

Different from G16, G17 Loop Heat Pipe (LHP) was found malfunctioned. It brings up to 20K seasonal variation of FPM VNIR temperature superimposed on the diurnal variation of up to 12K in eclipse season. Through the changes of SCT and space look view accordingly, CWG indicates that such a large VNIR FPM temperature fluctuation affects the solar calibration. Especially in G17 B03, its gain is highly anti-correlated to the VNIR FPM temperature fluctuation, while B04 is positively correlated due to the response of their different photodetector characteristics. VNIR FPM temperature change can bring B03 a gain change of 0.27%/1K and 0.1%/1K in B02/B04. A bias will be expected to be introduced into the Earth scene calibration if the gain is not updated timely in eclipse season. To reduce the impacts of FPM temperature fluctuation, several potential mitigation scheme options thus are proposed and compared.

RESULTS

Mitigation of G17 B02 bias

Similarly as G16, G17 ABI B02 was biased ~8.5% high from GEO-LEO monitoring after its launch and the gain difference between post-launch solar calibration vs pre-launch was ~ 7.43%. CWG’s analysis (Xi et al 2019) shows a similar bias can be found in HIMAWARI-8/9 ABI. The gain/0° from sphere calibration should not be used to correct the G17 ABI VNIR bands channel calibration due to striping (irradiance) to derive K-LUT at low signal range because of its dynamical range, which in fact results in the bias in K-LUT. Uncertainty or nonlinearity in the prelaunch FEL test in ABI B02 can directly affect K and then the gain from post-launch solar calibration.

CONCLUSIONS

1) CWG has developed tools to validate G17 ABI reflective channel radiometric calibration and performance and supports to improve the GS after its launch.

2) G17 B02 ~8% bias was mitigated with a new CWG K-LUT implemented in OE since May 2019.

3) CWG identified a dependence of G17 VNIR gains on the FPM temperature fluctuation in seasonal scale and quantified it with the proposal of mitigation schemes to reduce the impacts of FPM temperature fluctuation.

4) G17 VNIR bands L1b images quality was significantly improved with striping removal since May 2019. This is due to correction of the erroneous detector gains with the new lunar intrusion rejection LUT.

REFERENCES

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