Investigating the use of Deep Convective Clouds (DCCT) to monitor on-orbit performance of the Geostationary Lightning Mapper (GLM) using Lightning Imaging Sensor (LIS) measurements

Dennis E. Buechler[1], Hugh J. Christian[1], William J. Koshak[2], and Steven J. Goodman[3]
[1]University of Alabama Huntsville
[2]NASA Marshall Space Flight Center, Huntsville, AL
[3]NOAA, GOES-R System Program

Introduction: There is a need to monitor the on-orbit performance of the Geostationary Lightning Mapper (GLM) on the Geostationary Operational Environmental Satellite R (GOES-R) for changes in instrument calibration that will affect GLM's lightning detection efficiency. GLM has no onboard calibration so GLM background radiance observations (available every 2.5 min) of Deep Convective Clouds (DCCs) are investigated as invariant targets to monitor GLM performance. Observations from the Lightning Imaging Sensor (LIS) and the Visible and Infrared Scanner (VIRS) onboard the Tropical Rainfall Measuring Mission (TRMM) satellite are used as proxy datasets for GLM and ABI 11 µm measurements.

Methodology: Deep Convective Clouds (DCCs) are used as invariant targets to examine the radiance of LIS background (BG) pixels for each July-August period from 1998-2010. LIS background pixels co-located with VIRS 11 µm channel pixels having brightness temperatures (T_B) colder than 205K are identified as DCCs . DCC pixels are constrained to have solar and viewing zenith angle < 40° and relative viewing angle between 10° and 170°. We assume the DCCs are near-Lambertian reflectors, so filters are applied to ensure the DCC pixels are within spatially homogenous clouds. Lightning can contaminate the LIS background, so DCC pixels are constrained to have no lightning observed with 50 km.

Results (July-August 1998-2010):

LIS DCCs occur primarily over the oceans (92.6%), with 7.4% found over land

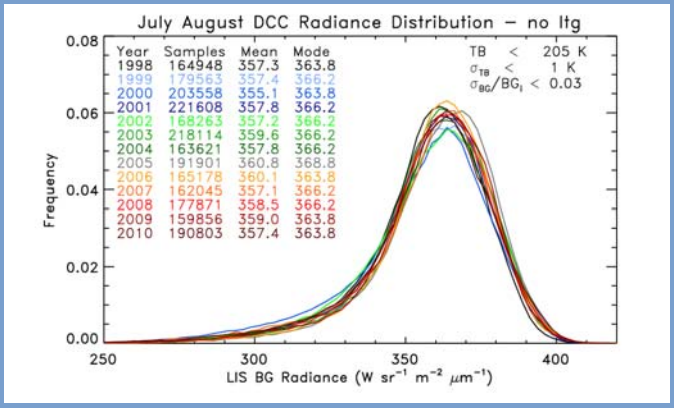
Due to the zenith angle criteria, DCCs can only occur between 0900 and 1500 Local Time.

The greatest concentration of LIS DCCs are found in the Tropical Western Pacific, the East Indian Ocean, and oceanic regions near Central America.

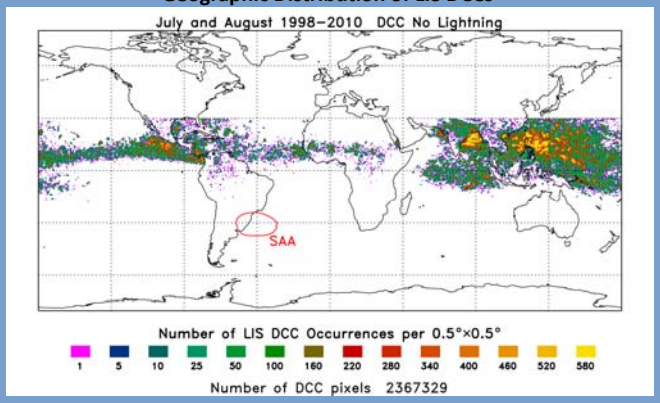
The LIS DCC radiance distributions are very similar over the period indicating stable performance.

The mean LIS DCC radiance for each year shows a maximum deviation from the mean of 0.8%

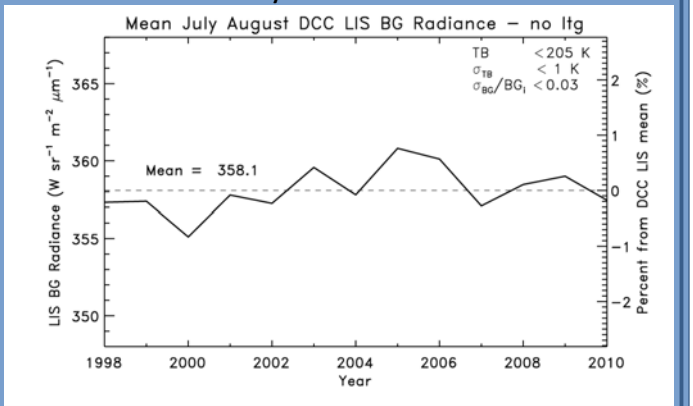
Yearly LIS DCC Radiance Distribution



Geographic Distribution of LIS DCCs



Yearly LIS DCC Mean Radiance



Conclusions:

1) LIS DCCs occur primarily over oceanic regions
2) The DCC analysis of the LIS background images indicates no discernible degradation of instrument performance from 1998-2010.
3) Because of its similar design, the GLM should also experience little performance degradation.
4) The DCC technique can be used to monitor GLM instrument performance once in orbit.

Future Work:

- Run DCC analysis using TRMM VIRS v7
- Apply DCC analysis to other months to examine DCC seasonality
- Examine various angular distribution models
- Examine other targets for possible use as calibration targets (e.g., deserts, glint)
- Examine DCCs in relation to GLM resolution (~8 km vs ~4-8 km for LIS)

Reference: Buechler, D. E., W. J. Koshak; H. J. Christian; and S. J. Goodman, 2012: Assessing the performance of the Lightning Imaging Sensor (LIS) using Deep Convective Clouds, Atmos. Res. http://dx.doi.org/10.1016/j/atmosres.2012.09.008.