Impact of the change in SEVIRI radiance definition on the GERB products

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Abstract

This short note analyzes the effect on the GERB products of the future change of definition of the SEVIRI radiance from spectral to effective.

It was discovered that for the thermal channels of the MSG-SEVIRI, the IMage Processing Facility (IMPF) at EUMETSAT provides **spectral radiance** (i.e. at defined wavelength) instead of the widely used **effective radiance** (i.e. integral over the spectral band). As most of the users (including the RMIB GERB processing) expect effective radiance, EUMETSAT decided to switch the operational chain from spectral to effective radiance in the beginning of 2008 (April?). After that, the earlier Meteosat–8 and Meteosat–9 data archived at the UMARF will be reprocessed in effective radiance. A flag is added in the SEVIRI prologue file to specify the radiance type. The change of radiance definition only concerns the SEVIRI thermal channels as the solar channel radiances have always been calibrated in effective radiances.

From 21 January to 17 March 2008 EUMETSAT performed parallel dissemination of SEVIRI data in spectral (operational dissemination stream) and effective (parallel dissemination) radiance definitions. These data have been used in this study to assess the impact of the planned change on the GERB Level–2 unfiltered radiances and fluxes. During 3 days (22 to 24 January 2008), the GERB-1 data have been processed in parallel with SEVIRI spectral and effective radiance. This was done without any modification of the GERB processing software and tables.

Figures 1 (solar radiation) and 2 (thermal radiation) show the changes in GERB radiance and flux which are introduced by the SEVIRI radiance definition change. The Figures give the differences in daily means BARG radiance and flux for the 23 January 2008.

Although the change only concerns the thermal channels of SEVIRI, some impacts are observed in the GERB reflected solar radiance and flux. Histogram of solar flux difference (top–right of Figure 1) shows that there is nearly no overall difference but well a standard deviation of about 0.223 Wm^{-2}. These effects on the GERB solar products are explained by the facts that:

- To estimate the unfiltered SW radiance and flux, the thermal contamination in the GERB SW channel (around 4 μm) must be estimated and subtracted. In the GERB processing, this quantity is estimated from the SEVIRI thermal channels and is therefore affected by the planned change.
- The estimation of the thermal contamination can also slightly impact the geolocation of the GERB SW footprint.
- For cloudy scenes the GERB radiance–to–flux conversion is based on the CERES TRMM Angular Dependency Models (ADMs), and these models depend on the cloud thermodynamic phase (ice or water). In the GERB processing the cloud phase is estimated based on the SEVIRI IR 10.8 μm channel, and it is observed that the change in radiance definition slightly increases the frequency of ice clouds.

For the thermal radiance, the histogram of the differences (top–left of Figure 2) shows that the impact is very small. The standard deviation is only 0.027 $\mathrm{Wm^{-2}sr^{-1}}$. The GERB LW channel unfiltering (based on the SEVIRI radiances) is therefore not significantly affected by the change of radiance definition. However, as for the solar radiation, higher impact is observed on the flux (right histogram) with a small overall bias (0.037 $\mathrm{Wm^{-2}}$) but a standard deviation of about 0.121 $\mathrm{Wm^{-2}}$. This is due to the fact that the GERB LW radiance–to–flux conversion is based on the SEVIRI 6.2, 10.8, 12, and 13.4 μm. The image shows that the change in SEVIRI radiance will slightly increase the GERB flux in the center of the disk and decrease it on the border. With SEVIRI in effective radiance, the GERB LW anisotropic factor is a bit more isotropic than in spectral radiance.

Possible correction: it is possible to convert the future effective radiances in spectral radiance to reduce the magnitude of the observed difference (and avoid "jumps" in the GERB–1 dataset). It is however not clear if this "patch" must be implemented in the operational near–real time (NRT) processing as the NRT GERB–1 data are still pre–released. As a minimum, the flag that specifies the type of SEVIRI radiance definition will be propagated into the GERB level 2.0 products (ARG, BARG and HR).

In summary: we can say that the GERB unfiltered solar and thermal radiances are not significantly affected by the future change in SEVIRI radiance definition. Small impacts on the fluxes exist however due to the use of SEVIRI for the GERB angular modellings. For the shortwave radiation the impact is only observed for the cloudy scenes and is explained by the cloud phase determination. For the longwave radiation, the planned change will slightly increase the remaining limb–darkening already present in the GERB thermal flux.

Appended:

Figures 3 and 4 are similar daily means analysis but realized on the ARG format.

Figures 5 and 6 are similar analysis of the differences but for a single ARG file (ARG time stamp 20080123_115953). In this case large differences are observed for some pixels, up to 60 $\mathrm{Wm^{-2}}$ for the solar flux and 12 $\mathrm{Wm^{-2}}$ for the thermal flux.

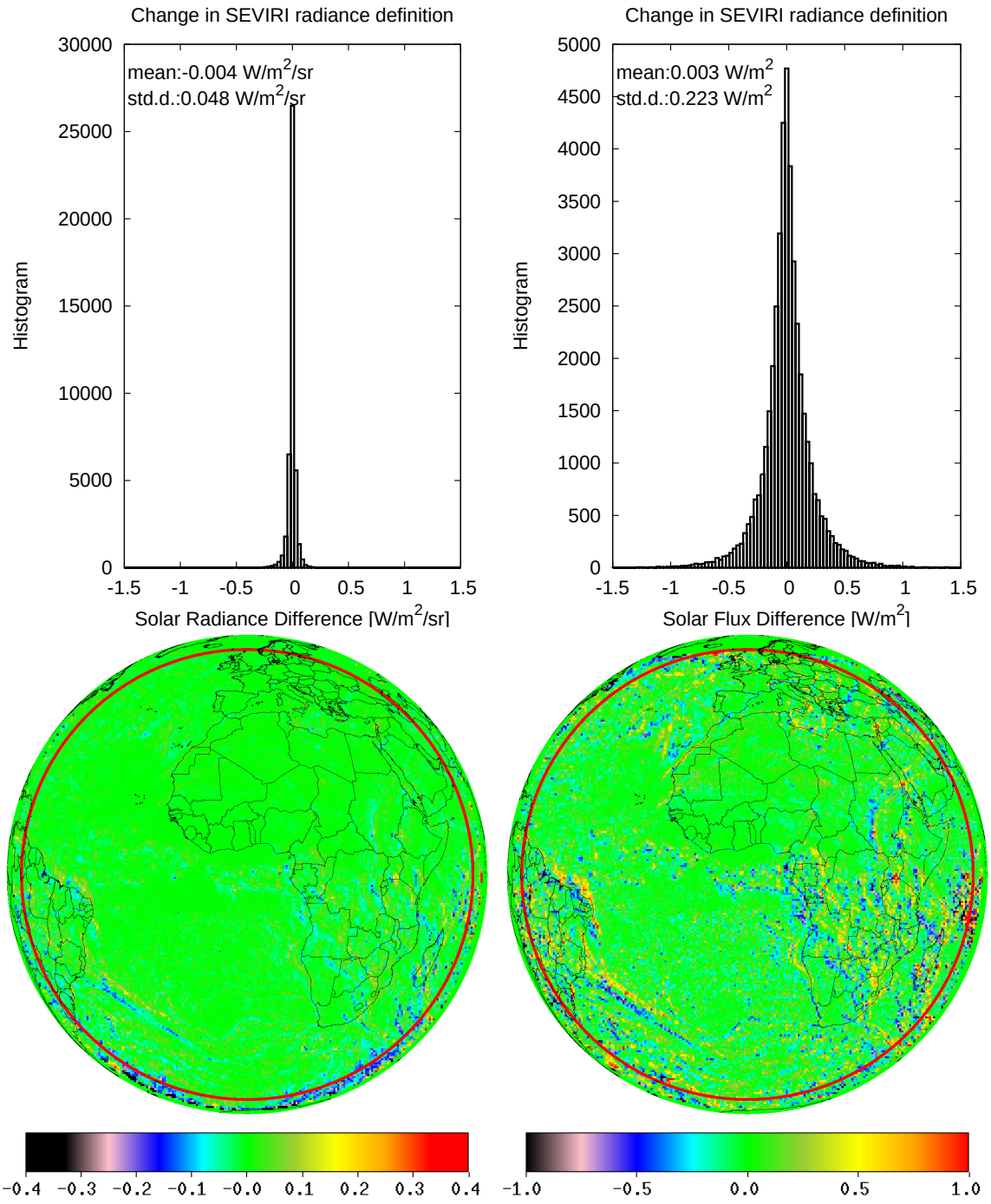

Figure 1: BARG DAILY MEAN SOLAR: Effect of the change in SEVIRI radiance definition on the GERB-1 reflected solar (i.e. shortwave) radiance (left) and flux (right). Images and histograms are averaged BARG pixel values for the 23 January 2008. The red circle indicates the VZA = 70°.

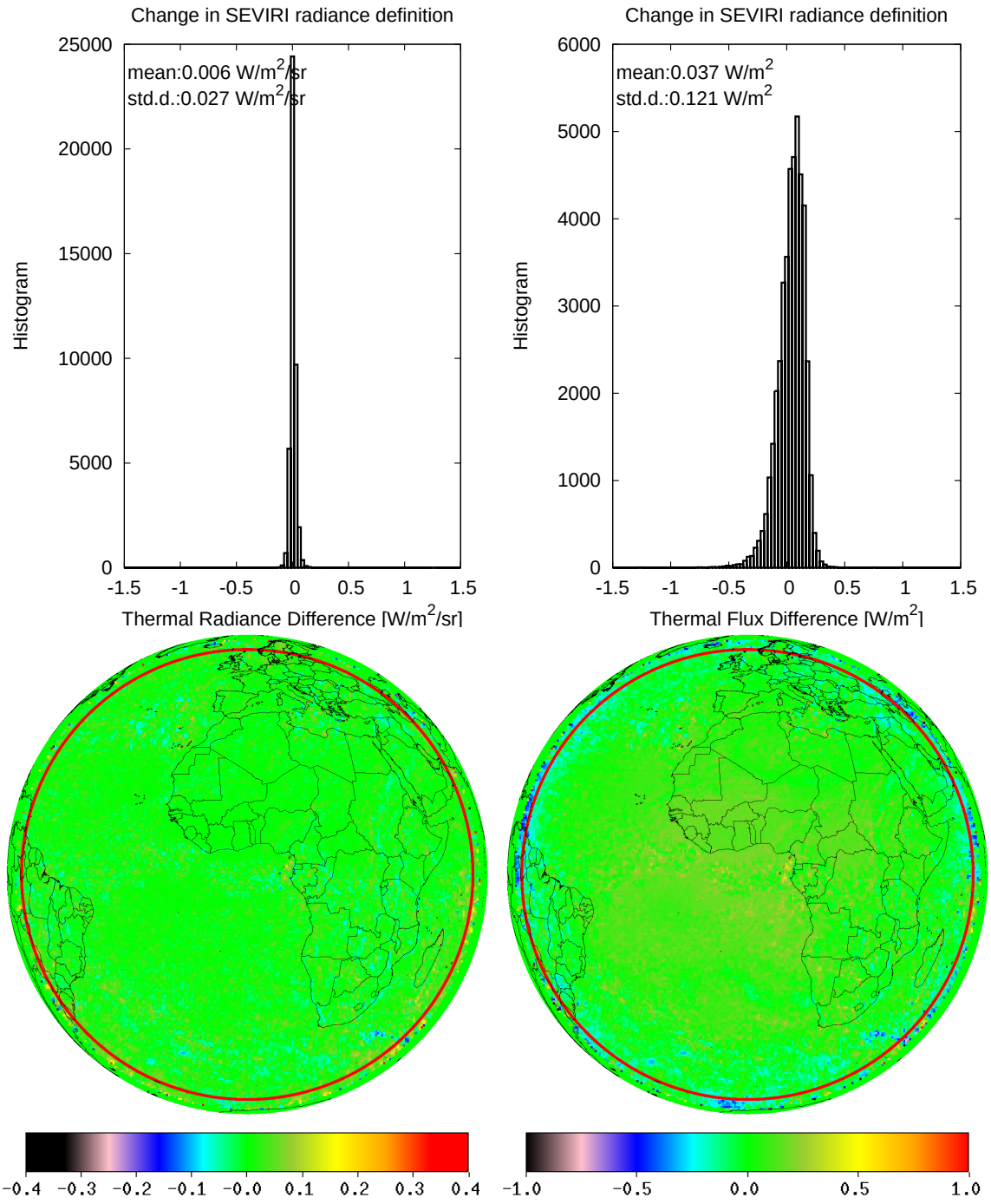

Figure 2: BARG DAILY MEAN THERMAL: Effect of the change in SEVIRI radiance definition on the GERB-1 emitted thermal solar (i.e. longwave) radiance (left) and flux (right). Images and histograms are averaged BARG pixel values for the 23 January 2008. The red circle indicates the VZA = 70°.

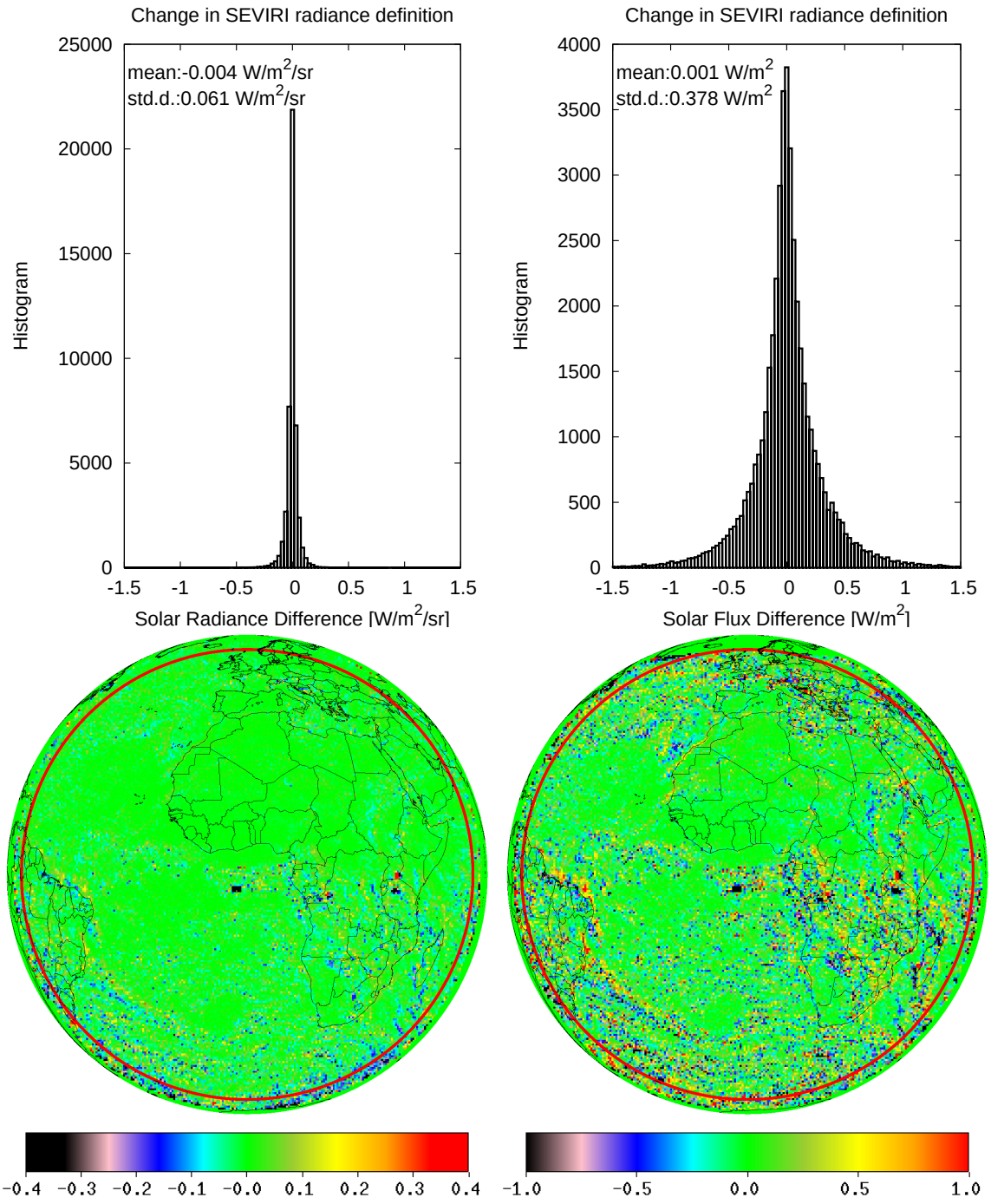

Figure 3: ARG DAILY MEAN SOLAR: Effect of the change in SEVIRI radiance definition on the GERB-1 reflected solar (i.e. shortwave) radiance (left) and flux (right). Images and histograms are averaged ARG pixel values for the 23 January 2008. The red circle indicates the VZA = 70°.

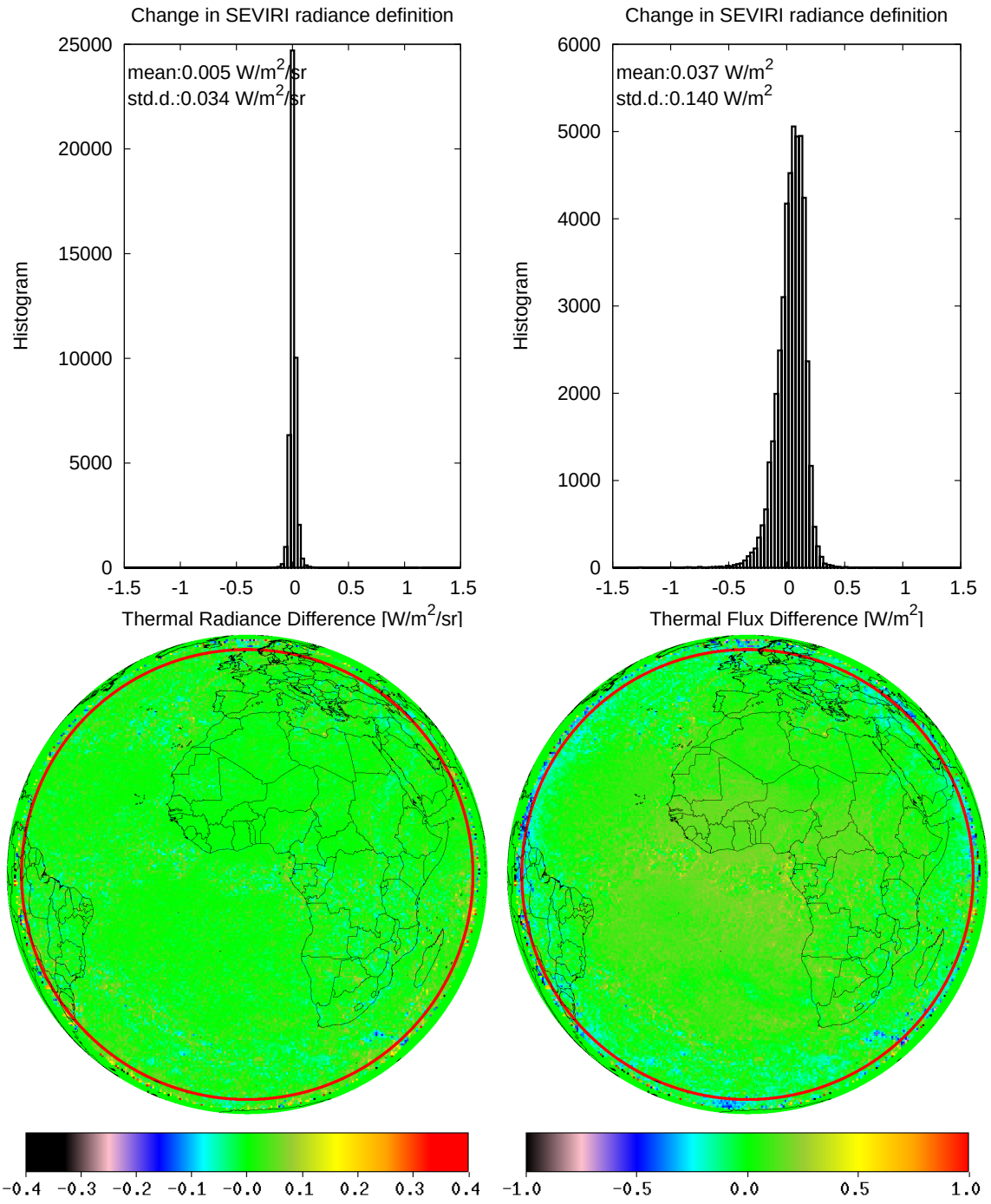

Figure 4: ARG DAILY MEAN THERMAL: Effect of the change in SEVIRI radiance definition on the GERB-1 emitted thermal solar (i.e. longwave) radiance (left) and flux (right). Images and histograms are averaged ARG pixel values for the 23 January 2008. The red circle indicates the VZA = 70°.

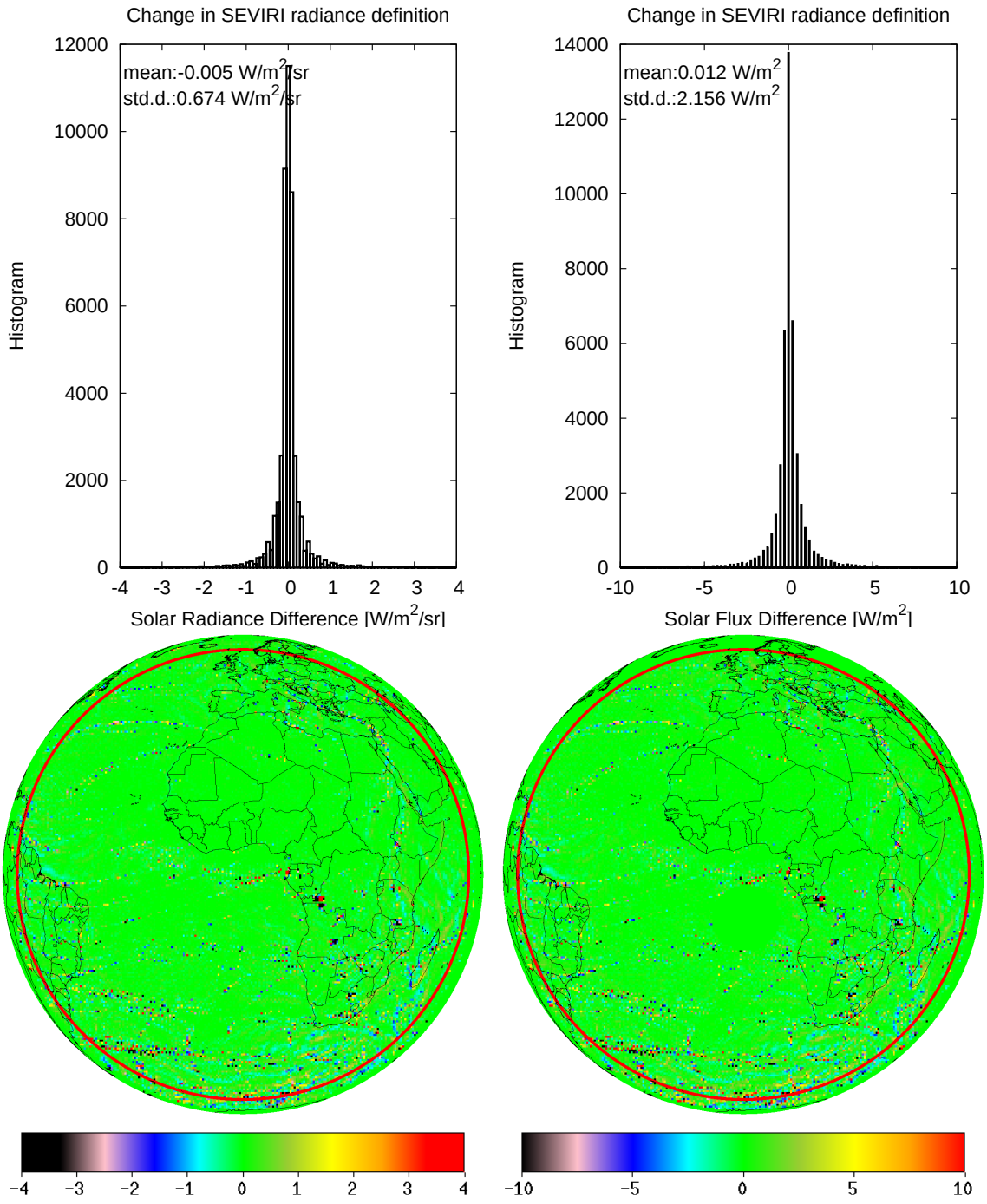

Figure 5: ARG INSTANTANEOUS SOLAR: Effect of the change in SEVIRI radiance definition on the GERB-1 reflected solar (i.e. shortwave) radiance (left) and flux (right). Images and histograms are averaged ARG pixel values for the 23 January 2008. The red circle indicates the VZA = 70°.

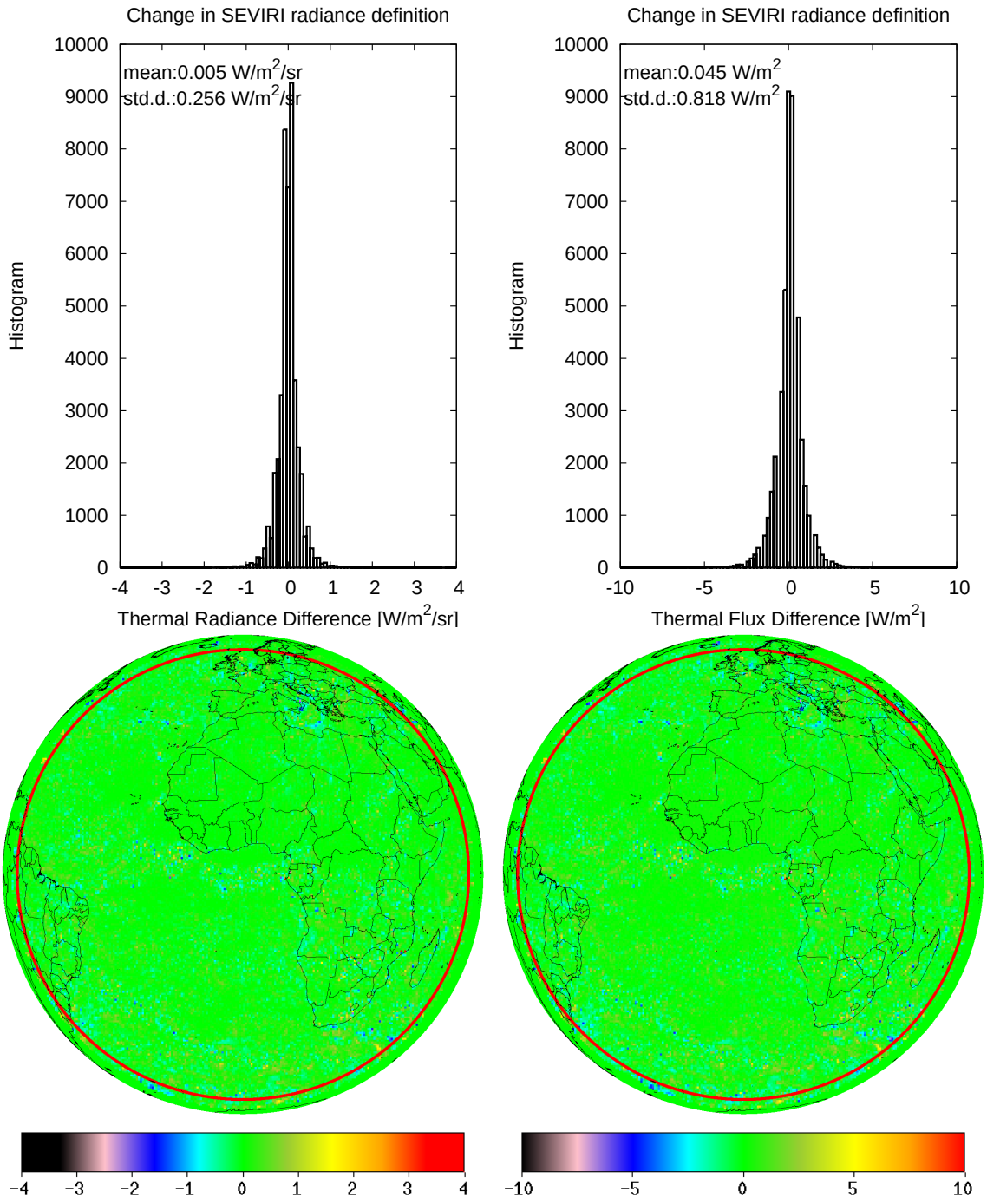

Figure 6: ARG INSTANTANEOUS THERMAL: Effect of the change in SEVIRI radiance definition on the GERB-1 emitted thermal solar (i.e. longwave) radiance (left) and flux (right). Images and histograms are averaged ARG pixel values for the 23 January 2008. The red circle indicates the VZA = 70°.