Composite TOA clear–sky solar fluxes for the GERB processing

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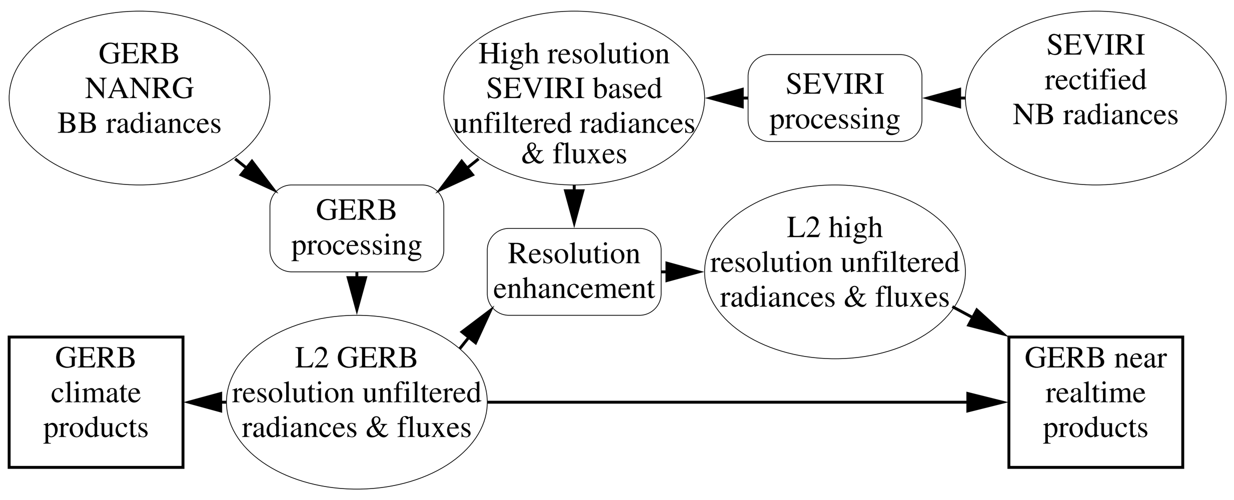
1 Algorithm

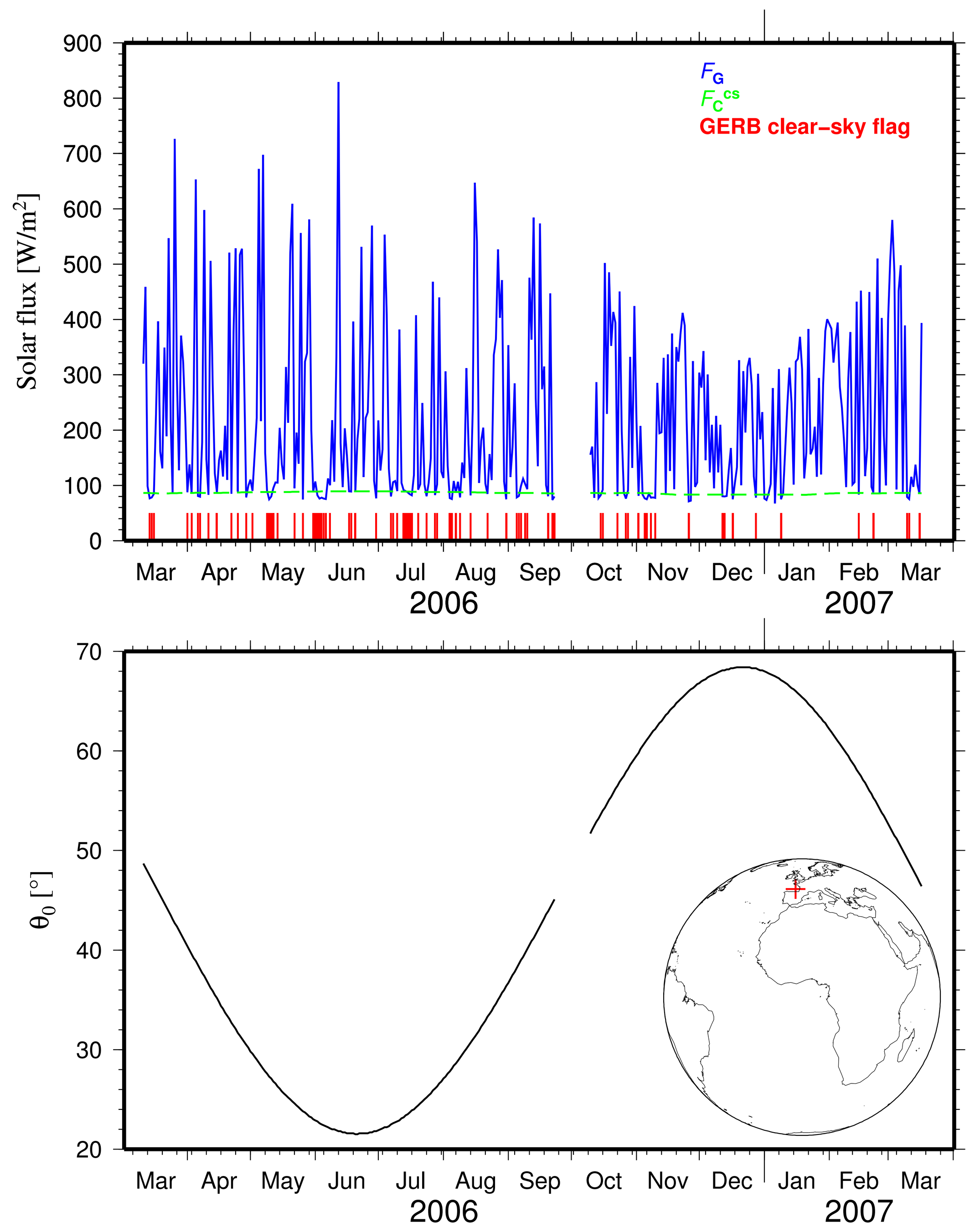
We propose here a method to estimate the instantaneous composite TOA solar clear–sky fluxes from the GERB L20 products. The GERB L20 processing is natively performed over 3 × 3 SEVIRI pixels footprints (about 10 km at nadir). The resulting high–resolution (HR) L20 products are then averaged or convoluted with the GERB point spread function (PSF) to the GERB instrument resolution (50 km at nadir) to generate the averaged rectified geolocated (ARG) and binned ARG (BARG) products [2]. It is therefore obvious that any clear–sky estimation method will have to be based on HR products to reduce any errors resulting from the averaging/convolution process. Moreover, considering HR footprints allows to mitigate the number of partially cloud–filled footprints at the benefit of clear–sky (and overcast) footprints population.



This method is directly inspired from a previous technique which was developed to estimate composite TOA reflectances from visible SEVIRI channels [3]. It considers flux time–series at a given location (x, y) in the field–of–view (FOV) and repeat cycle (time of day t) up to Δ previous days from the current day $d^\star$. Basically, it assumes that the signal (flux time–series) can be separated into a clear–sky base curve on top of which a transient contribution is added depending on the atmospheric conditions (cloudiness, dust, aerosols, shadows). To take into account the slow varying dependency of the clear–sky fluxes over time with respect to the Sun position (solar zenith angle θ_0), the ratio α between GERB and the climatological CERES Tropical Rainfall Monitoring Mission (TRMM) clear–sky fluxes built from the associated shortwave broadband ADMs is considered:

$$\alpha(x, y, d, t) = \frac{F_G(x, y, d, t)}{\underbrace{A(\theta_0) \cdot E_0 \cdot \cos\theta_0}_{F_C^{cs}(x,y,d,t)}} \qquad \text{for} \quad d = d^\star - \Delta, \ldots, d^\star,$$

where F_G is the GERB solar flux, F_C^{cs} the CERES TRMM climatological clear–sky flux, A the CERES TRMM climatological clear–sky albedo from the associated ADM and E_0 the solar constant taken equal to 1366 $\mathrm{W \cdot m^{-2}}$. We are implicitly assuming the dependency of θ_0 with (x, y, d, t).



Time–series for an ocean scene (44.97° N, 3.40° E) at 12:00 UTC.

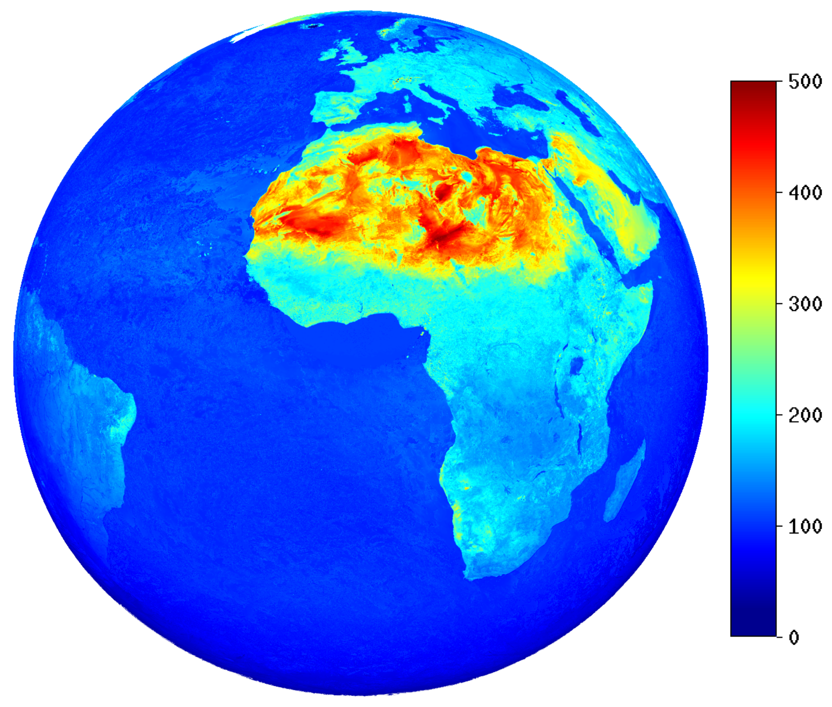
The difference lies in the fact that the solar GERB fluxes are available together with ancillary data from the SEVIRI scene identification (sceneID) such as the associated cloud fraction [4] and ocean dust detection [1] over the HR footprints. We can therefore use such knowledge in our algorithm to filter the α values and to provide a set of ratio $\{\alpha^{cs}(x, y, d_n^{cs}, t)$ where $n = 1, \ldots, N(x, y, d^\star, \Delta)\}$ associated to clear–sky conditions over the Δ previous days. The method then reduces to the selection of the most representative $\alpha^{cs}(x, y, d_k^{cs}, t)$ from the previous set. The composite clear–sky flux F_G^{cs} is finally estimated from:

$$F_G^{cs}(d^\star) = \alpha^{cs}(d_k^{cs}) \cdot F_C^{cs}(d^\star)$$

where the dependency in (x, y, t) has been dropped for clarity. However, it is obvious that any selection strategy has to ensure that the composite clear–sky flux should be equal to the GERB flux for scenes identified as clear–sky by the sceneID. Moreover, due to persistent cloudiness over equatorial regions, Δ should be large enough to avoid the emptiness of the set $\{\alpha^{cs}\}$.

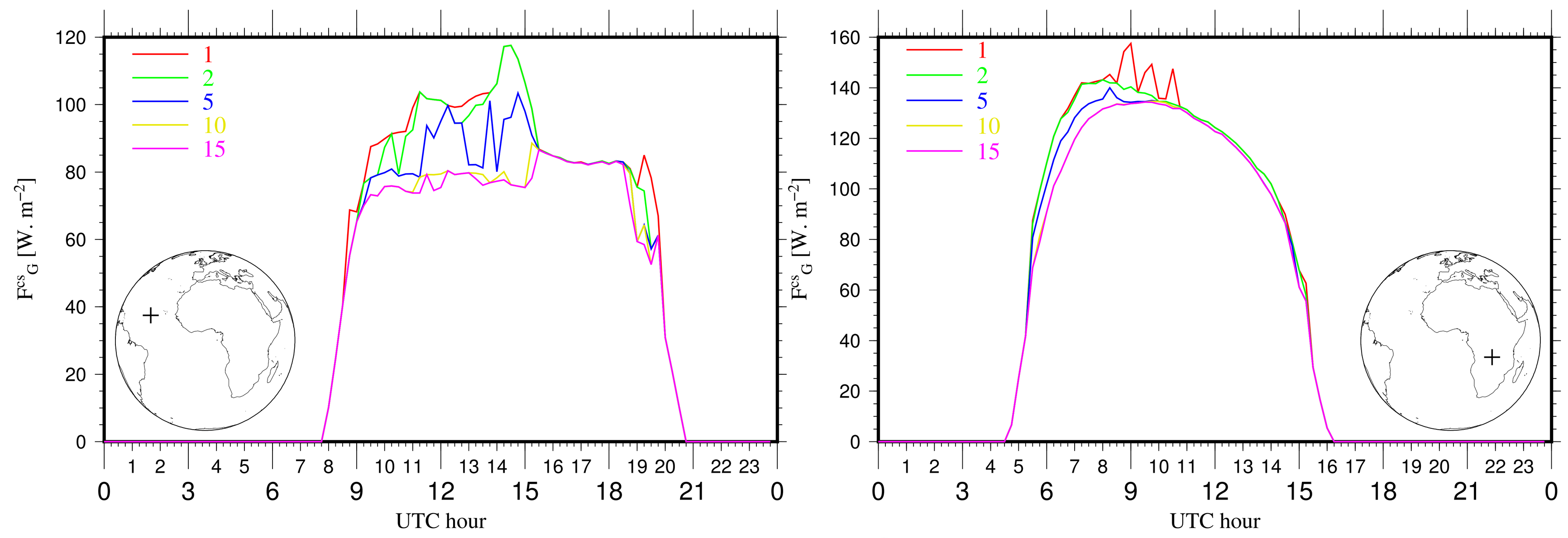
2 Preliminary results

Since the Edition 1 of the GERB HR products are only available after undergoing a strict quality assurance (QA) check, the fluxes of the sun–glint affected area within the FOV which do not satisfy this QA are masked out. Thus, the development and the improvement of our algorithm is carried out on GERB–like HR products. These products are only differing from the GERB HR products in the sense that the fluxes are estimated through a narrowband–to–broadband estimation from SEVIRI data and not corrected by the GERB instrument measurements. Moreover, fluxes in these products are provided over sun–glint regions and during GERB eclipse seasons.



Solar clear–sky GERB–like fluxes F_G^{cs} $[\mathrm{W \cdot m^{-2}}]$ for July 15 2010 at 12:00 UTC.

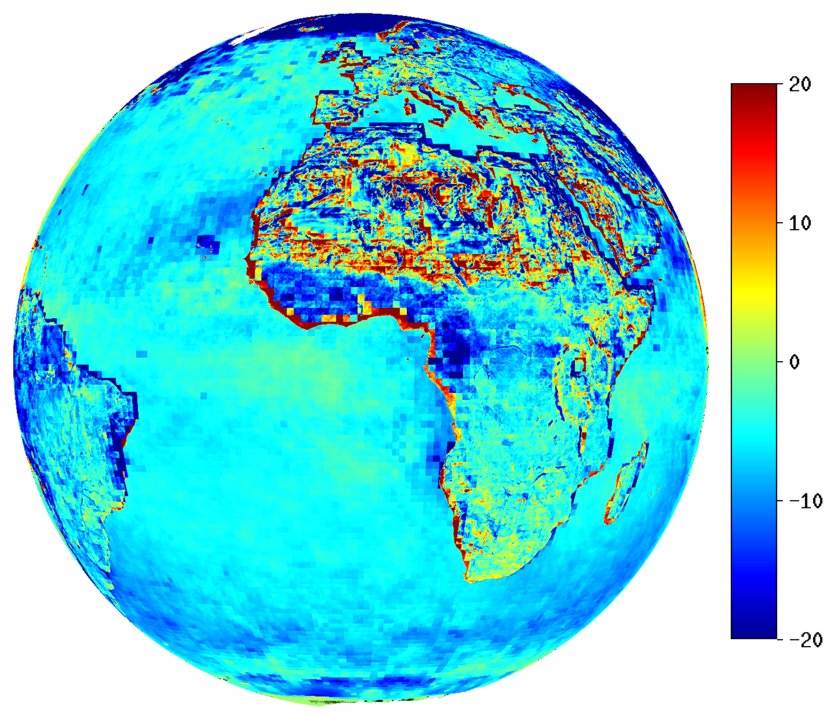
The preliminary results F_G^{cs} showed here are computed by using $\Delta = 120$ days and selecting $\alpha^{cs}(x, y, d_k^{cs}, t)$ as the most recent value relatively to the current day $d^\star$ within the set $\{\alpha^{cs}\}$. One can notice that, despite the fact that we selected α^{cs} associated to clear–sky conditions according the sceneID, thin cloud and aerosols contamination still occurs on fluxes, especially over ocean. This is clearly illustrated in the following diurnal cycles of the flux where $\alpha^{cs}(x, y, d_k^{cs}, t)$ is selected as the minimum value of the n_{cs} most recent values relatively to the current day $d^\star$ within the set $\{\alpha^{cs}\}$.



Solar clear–sky GERB–like fluxes F_G^{cs} $[\mathrm{W \cdot m^{-2}}]$ for July 15 2010 and various n_{cs} for an ocean (14.40° N, 33.84° E) and vegetation (9.32° S, 24.25° W) scene.

3 Preliminary comparisons

We have computed the composite solar clear-sky GERB–like fluxes every 15 minutes for all days of July 2010. From this dataset, we are able to generate a monthly averaged solar clear–sky GERB–like fluxes' L30 product for the considered n_{cs}. We also regridded onto the GERB–like FOV the associated CERES Energy Balanced and Filled (EBAF) TOA monthly clear–sky fluxes [5].



Difference between monthly averaged solar clear–sky GERB–like fluxes F_G^{cs} and CERES EBAF fluxes $[\mathrm{W \cdot m^{-2}}]$ for July 2010 and $n_{cs} = 10$.

4 Future validation

The foreseen validation of the TOA GERB solar clear–sky fluxes once the algorithm will be finalized is twofold:

- Instantaneous solar clear–sky fluxes should exhibit a symmetric diurnal cycle with respect to the local noon. Such property will be used to assess the accuracy of those composite fluxes compared to an "ideal" (fitted) diurnal cycle.
- Monthly averaged fluxes will be compared to the CERES Energy Balanced and Filled (EBAF) TOA monthly fluxes [5]. However, discrepancies are expected to occur to some extent due to different broadband radiometers, sceneIDs and satellite orbits. Moreover, to perform meaningful comparisons, both datasets will first have to be corrected for any systematic offset.

References

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Acknowledgement

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