Geophysical Research Abstracts
Vol. 18, EGU2016-9176-1, 2016
EGU General Assembly 2016

Deriving a relationship between the radiative power and the SWIR radiance for Gas Flares

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Flaring occurs in many regions and is a source of black carbon (BC) globally, among other pollutants. At higher latitudes, flaring is the main source of BC which, upon deposition on snow, lowers its albedo. Therefore, knowing the location and emissions of flares would be a valuable input to climate models.

The main goal of this work is to derive a working relationship between Shortwave Infrared at 1.6 μm (SWIR) radiance and Radiative Power (RP). Such a relationship will be helpful in the processing chain use to determine the emissions from gas flares for upcoming instruments, such as the SLSTR on Sentinel-3.

In order to derive the relationship between RP and SWIR, RP assigned to Gas Flares (GFs) observed by the small German satellite BIRD is related to the SWIR radiance time series as observed by AATSR at that location in a temporal window of $\pm$ 2 months around the BIRD observation.

The SWIR signal was retrieved from the AATSR pixel where the GF was identified by BIRD. For each observation, the signal is considered as being above the detection limit if its value is above three times the background standard deviation. The background is a window of approximately 10×10 km^2 around the GF location pixel. The reported SWIR radiance value is the radiance signal minus the background average.

The SWIR radiance signal thus retrieved shows a large variation throughout the time window considered. Such a variation evidences temporal variation in the flaring intensity, possibly GFs are either inactive or active, with varying levels of intensity, throughout time. In a subsequent step, it is also determined whether the radiance at the GF location pixel is a local maximum (after excluding other possible GF locations within the surroundings). Then, a new average and standard deviation for each GF may be constructed, more representative of when the GF is actually on.

Those figures are then compared to a normalized RP. The normalization is necessary because the BIRD fire processor reports parameters for clusters of cells which may comprehend more than one reported GF within its borders.

The main conclusions are that the relationship between SWIR radiance and RP is temperature dependent and that the relationship is approximately linear within six temperature bins.