From the Corporate RapidEye Website – Frequently Asked Questions

Q: How can I translate the radiance values of a RapidEye image product into reflectance values?

A: The digital numbers of the RapidEye image pixels represent

- absolute calibrated radiance values for non atmospheric corrected images
- reflectance values for atmospheric corrected images (currently not offered for delivery)

To convert the Digital Number (DN) of a pixel to radiance it is necessary to multiply the DN value by the radiometric scale factor, as follows: RAD(i) = DN(i) * radiometricScaleFactor(i)

The resulting value is the Top of Atmosphere (TOA) radiance of that pixel in watts per steradian per square meter (W/m2 sr µm). The radiometric scale factor for each band can be found in the image XML metadata file under the band specific metadata. Reflectance is generally the ratio of the reflected radiance divided by the incoming radiance. Note, that this ratio has a directional aspect. To turn radiances into a reflectance it is necessary to relate the radiance values (i.e. the pixel DNs) to the radiance the object is illuminated with. This is often done by applying an atmospheric correction software to the image, because this way the impact of the atmosphere to the radiance values is eliminated at the same time. But it would also be possible to neglect the influence of the atmosphere by calculating the Top Of Atmosphere (TOA) reflectance taking into consideration only the sun distance and the geometry of the incoming solar radiation.

The formula to calculate the TOA reflectance not taking into account any atmospheric influence is as follows:

$$REF(i) = RAD(i) \frac{\pi * SunDist^2}{EAI(i) * \cos(SolarZenith)}$$

with:

- i: Number of the spectral band
- REF: reflectance value
- RAD: Radiance value
- SunDist: Earth-Sun Distance at the day of acquisition in Astronomical Units (Note: This value is not fix, it varies between 0.983 289 8912 AU and 1.016 710 3335 AU and has to be calculated for the image acquisition point in time.
- EAI: Exo-Atmospheric Irradiance
- SolarZenit: Solar Zenith angle in degrees (= 90° – sun elevation)

For RapidEye the EAI values for the 5 bands are:

- Blue: 1997.8 W/m²µm
- Green: 1863.5 W/m²µm
- Red: 1560.4 W/m²µm
- Red Edge: 1395.0 W/m²µm
- Near Infrared: 1124.4 W/m²µm