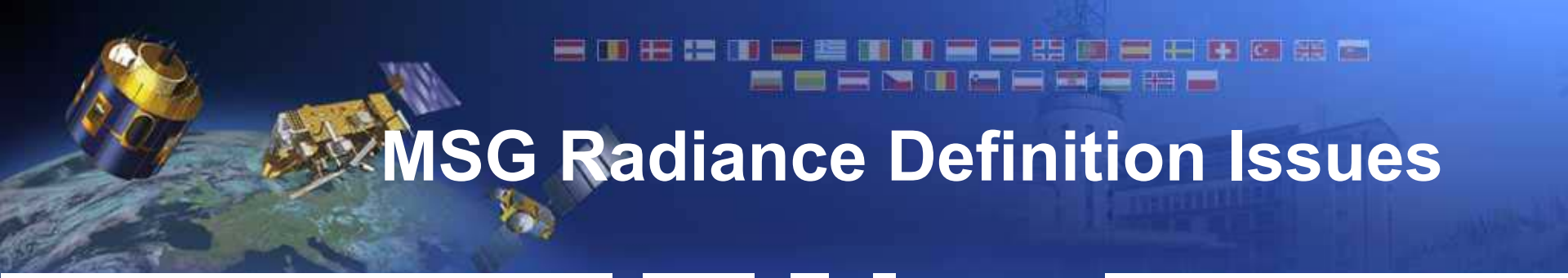

MSG Radiance Definition Issues

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GSICS, 19 – 21 Feb 2008

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Original MSG Radiance Definition

The SEVIRI thermal channels can be seen as a radiance thermometer. The calibrated radiance is provided as a spectral blackbody radiance in units mW m^{-2} sr^{-1} $(cm^{-1})^{-1}$

$$T_B = \frac{c_2 \nu}{\ln\left(1 + \frac{c_1 \nu^3}{L}\right)}$$

Relation between brightness temperature T_B and MSG radiance L is provided by this equation: This is the monochromatic Planck relation with the two Planck constants c_1 and c_2

c_1 = 1.19105 10-5 mW $(cm^{-1})^{-4}$ m^{-2} sr^{-1}

c_2 = 1.43877 K cm

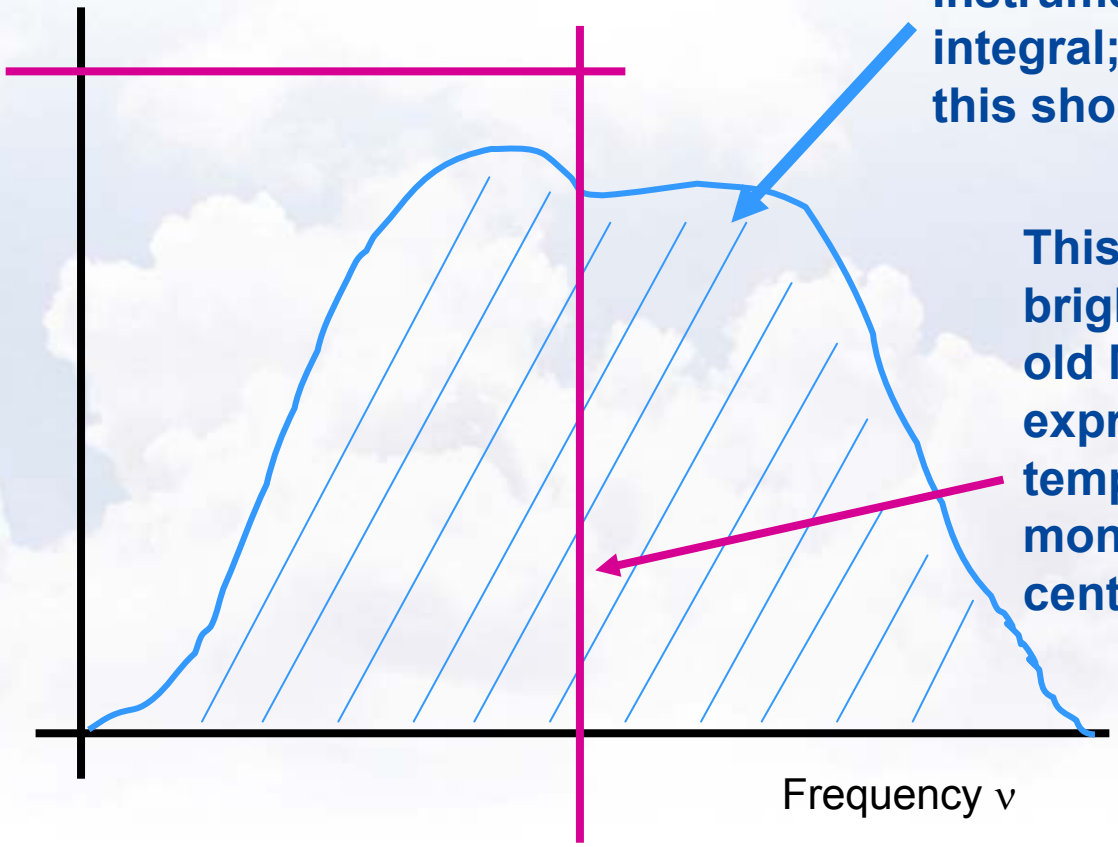
New MSG Radiance Definition

Users, however (and GSICS!) would prefer a radiance definition as a so-called effective radiance – which is also closer to what the instrument actually measures

$$L_{eff} = \frac{\int L_\nu \, r_\nu \, d\nu}{\int r_\nu \, d\nu}$$

r_ν is here the spectral response of the instrument.

Visual Explanation



Instrument measures this integral; as a calibrated value this should correspond to L_{eff}

This L^{eff} corresponds to a brightness temperature, and the old MSG radiance definition expresses this brightness temperature as a monochromatic L for a certain centre frequency

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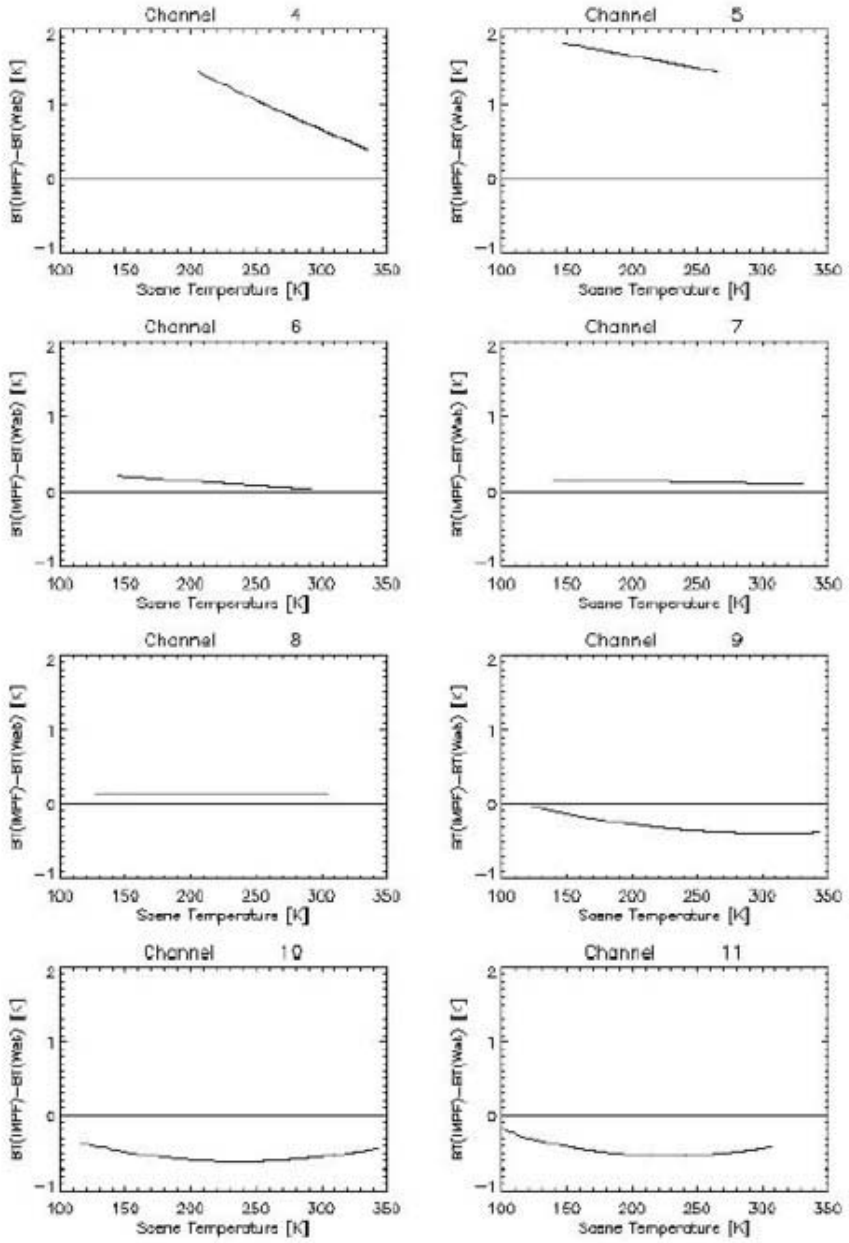
Web Link

Details are explained on

http://www.eumetsat.int/groups/ops/documents/document/pdf_msg_planned_change_level15.pdf



Computed difference between the two radiance definitions, expressed as a temperature difference

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Conversion

Conversion between old and new radiance definition is in principle straightforward via

T_B is a function of L via Planck's Law

$$T_B = \frac{c_2 \nu}{\ln\left(1 + \frac{c_1 \nu^3}{L}\right)}$$

This T_B is inserted into an effective radiance formula of the form

$$L_{eff} \approx \frac{c_1 \nu_c^{\,3}}{\exp\left(c_2 \nu_c / [\alpha T_B + \beta]\right) - 1}$$

α, β are band correction factors, ν_c is a defined centre frequency (equation results from fit of synthetic values)

Conversion

We have used this conversion to produce an effective radiance for the IASI comparison – as we want to compare all the spectral IASI radiance to the MSG radiance and not to the MSG temperature (expressed as monochromatic radiance).

Note: The old radiance definition is not “wrong” – the data should only be used in a consistent way.

With this interchangeability between L and L_{eff} we have no problem …

However!

… but this is not the end of the story:

During the process of defining the processing system for the new radiance definition, a number of inconsistencies and real software bugs were cleared up:

List of Changes

- Instrument ground characteristics was completely redone and is now consistent with the image processing
- Non-linearity of the instrument was newly determined
- Non-linearity dependence on background temperature now incorporated
- Software bug because of filter artefacts during blackbody scan (~0.1% radiance reduction)

Official Radiance to Temperature Conversion

Within this process, consistent and official tables for the L_{eff} – T relations were set up: These are available from

http://www.eumetsat.int/home/Main/Access_to_Data/Meteosat_Meteorological_Products/Calibration/SP_1119512219822

L_{eff} – T fits to these tables are of course possible, but under the user's responsibility!

Table resolution: 0.25 K between 100 K and 250 K, 0.1 K above 250 K

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Table vs. Fitted Formula

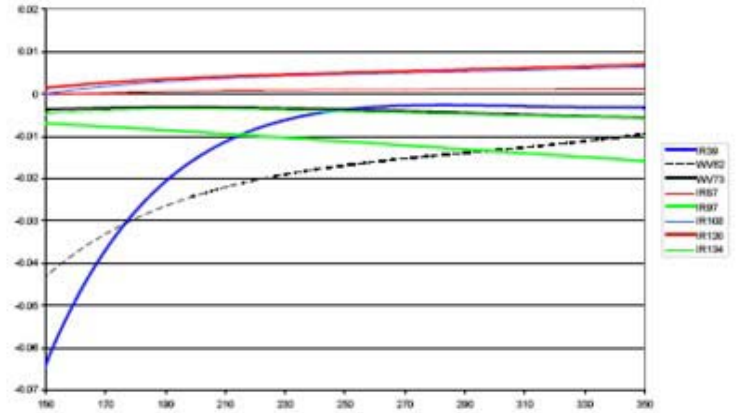

Figure 1 Meteosat 8: Difference of the EBBT determined with the parametric formula and determined with the tables used by IMPF. The difference is plotted in Kelvin vs. the EBBT.

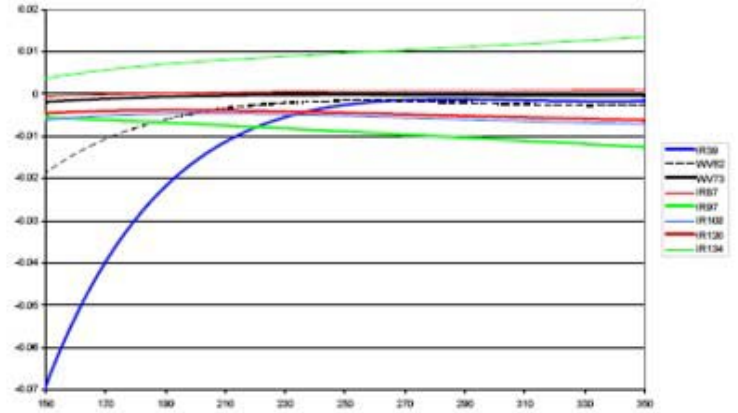

Figure 2 Same as Figure 1, but for Meteosat 9.

Example of the temperature discrepancies using a widely used fit (which is also available on the EUMETSAT web site) of the kind

$$L_{eff} \approx \frac{c_1 \nu_c^{\,3}}{\exp\left(c_2 \nu_c \Big/ \left[\alpha T_B + \beta\right]\right) - 1}$$

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EUMETSAT Operations

- New radiance definition for Meteosat-9 is running on a second operational data stream, which is also disseminated in parallel (since 21. January 2008)
- Full operational service with the new radiance definition will be resumed on 04 April (Met-9) and on 14 April (Met-8)
- What remains to be done: reprocessing of archived MSG data into the new radiance definition

Summary

- The change of the radiance definition did not only put this definition in line with common user expectations, but it was also the opportunity to clear up a few inconsistencies and software bugs in the image processing.
- It should be mentioned that the overall effect is fairly small, so that a simplified derivation of L_{eff} from L for the initial MSG – IASI inter-calibrations seemed justified.