1 SATELLITE CROSS CALIBRATION

1.1 Purpose

Quantitative application of satellite observations requires the absolute calibration of the observed raw radiance data. Calibration techniques of the thermal channels of the meteorological satellites rely on onboard calibration employing a blackbody or on vicarious techniques, where calculated radiances are associated with raw measurement units.

A satellite intercalibration is beneficial for two reasons:

- Intercalibration can identify problems and increase the confidence in the operational calibration of individual satellites, i.e. intercalibration can serve as a monitoring tool.
- Intercalibration can provide the basis for a normalised calibration which is a prerequisite for the derivation of global products from different satellites. Normalisation is to be done with respect to a particular satellite where a polar orbiter due to its global coverage is best suited.

1.2 Application to Meteosat

Meteosat measurements are recorded in the engineering unit "count" which is a direct measure of the energy received by the detector. The quantitative use of the observation requires conversion to a physically meaningful radiance unit, which is W/m2/ster for Meteosat. Assuming a linear sensor responsivity, this calibration is obtained through:

$$\text{Radiance} = \alpha\,(C_{count} - C_{space\ count})$$

where α is the calibration coefficients (of units W/m2/ster/count) and the space count is the radiometric offset of the instrument. The space count is obtained from the space view within the image and is usually a constant for the Meteosat IR and WV channel.

1.3 Meteosat-7 and Meteosat-5 Operational Calibration

A satellite cross calibration method for Meteosat-5 became operational on 31st May 2001. The basic principle of the satellite cross calibration is straightforward. First identify the area on the Earth disk that has been imaged by both Meteosat-5 and Meteosat-7. Then identify the region within this area of overlap where the difference in the viewing angles from the two spacecraft is less than 5 degrees. The size and shape of this region depends on the relative spacecraft positions. For each Meteosat-5 image pixel in this region calculate the Meteosat-7 radiance (derived by taking an average of the pixel values in a 3 x 3 region centred on this location) using the Meteosat-7 blackbody calibration ( ):

$$R = \alpha\,(C_{nt} - C_0)$$

where:

R = Meteosat-7 Radiance
α = BB Calibration Coefficient
C_{nt} = Digital Meteosat-7 Count
C_0 = Meteosat-7 Space Count

These Meteosat-7 radiances must then be adjusted to take account of the different spectral response functions for Meteosat-5 and Meteosat-7:

$R'_{M7} = FC_0 + FC_1 * R_{M7}$

where:

R'_{M7} = Corrected M7 Radiance
R_{M7} = M7 Radiance

For the correction of Metosat-5 from Meteosat-7 images, FC_0 and FC_1 are:

FC_0		FC_1	
IR	**WV**	**IR**	**WV**
-0.13842	-0.03069	0.76060	0.84490

The Cross-Calibration Coefficient for each Meteosat-5 pixel is then given by:

$$CrossCal_{M5}(p) = R'_{M7} / (C_{NT-M5} - C_{0-M5})$$

Where C_{NT-M5} is again an average of the pixel values in a 3 x 3 region centred on this location and C_{0-M5} is the Meteosat-5 space count. These pixel Calibration Coefficients are calculated for all pixels in the overlap area, then filtered to remove spurious values, before being combined to give an overall Cross Calibration Coefficient for the whole Meteosat-5 image.

As both the Meteosat-5 and Meteosat-7 images can be subject to image anomalies, especially around eclipse periods, these single image satellite cross calibration coefficients cannot be used directly. Taking advantage of the fact that the calibration of the infra red channels does not change rapidly, the following algorithm to stabilise the satellite cross-calibration has been introduced. Twice daily (at 08 and 20 UTC) the latest 24 image satellite cross calibration coefficients are averaged. Now all individual image calibration coefficients that deviate by more than 10 % from this average are removed from this list of 24 image calibration coefficients. From the remaining image calibration coefficients a new average is determined. If this new average differs by more than 0.1 % from the calibration coefficient that was used operationally, then the new averaged satellite cross-calibration coefficient is made the new operational calibration coefficient.