CGMS-XXIX EUM-WP-23
Prepared by EUMETSAT
Agenda Item: II.6
Discussed in WG II

PERFORMANCE OF METEOSAT-7 BLACK BODY CALIBRATION

This paper presents results on the performance of the Meteosat-7 Black Body Calibration. The paper will address the following topics:

– Black Body Calibration Method

– Results on the performance of the Calibration

CGMS Members are invited to take note.

PERFORMANCE OF METEOSAT-7 BLACK BODY CALIBRATION

1 INTRODUCTION

Since 29 May 2000 Meteosat-7 imagery has been calibrated using the onboard radiometer black body calibration mechanism and a correction model. This model takes account of the different geometry of Earth and black body scanning and the optical transmission through the radiometer front optics. The correction model was updated in January 2001 to remove part of a cold bias of the Meteosat IR channel.

2 BLACK BODY CALIBRATION METHOD

The calibration method uses the black body observations, which are performed at least once a day. Two black bodies on board of Meteosat-7 (with a temperature difference of about 50 K) are used to obtain a response of the detectors, which is then converted into counts and transmitted to Earth. For both the IR and WV channels the observed black body counts (C_{bb}) and the known radiances (R_{bb}) are related to each other through a linear relationship (similar to the one for the present vicarious calibration), the slope of which gives the black body calibration coefficient (a_{bb}):

$$R_{bb} = a_{bb} (C_{bb} – C_{space\ count})$$

The black body is viewed by moving a mirror into the nominal optical path of the radiometer, between the optical block and the front optics. Hence, the front optics of the radiometer is not included in the optical path of the black body calibration mechanism. In addition, the viewing geometry is not the same for the black body and Earth views. Hence, the black body calibration coefficients cannot be used directly for calibration of the infra red channels.

A correction model has been designed to take account of the following corrections:

- A correction for the impact of the transmission of the mirrors of the front optics as they form no part of a black body observation:

- A correction for the different viewing geometry: for a black body observation the viewing geometry is limited by the pupil of the optical block, for a Earth scan the viewing geometry is defined by the geometry of the 1st mirror, which is partly occulted by the 2nd mirror. The correction model for the black body calibration coefficients (a_{bb}) is described by:

  $$a = a_{bb} / ((\cos ?_1 – \cos ?_2) / (t (1 – \cos ?_3)))$$

  In which the following parameters are used:

  a = The absolute calibration coefficient (IR or WV)
  $?_1$ = The maximum angle under which the detector can see the 1st mirror.
  $?_2$ = The maximum angle under which the detector can see the 2nd mirror.
  $?_3$ = The maximum angle under which the detector can see the black body,

which is determined by the pupil of the optical block.

t = A constant factor used to remove the response function of the front mirrors, that are not viewed during a black body scan.

3 BLACK BODY CALIBRATION PERFORMANCE

Meteosat-7 calibration using black body observations became operational on 29th May 2000. The associated correction model was updated in January 2001. The update minimises the bias between the black body and the vicarious calibrations using sea surface temperatures from the NCEP analysis. This could be achieved by slightly varying the angles mentioned in section 2 above. This procedure has proved to be acceptable as there is a certain amount of uncertainty in the derivation of these angles on ground.

Data considered in this document is from 4th January 2001 to 31st July 2001. There were gain changes on 9th January and 15th February and the calibration data has been corrected accordingly. For the IR channel the bias between the black body and vicarious calibrations is about –0.2 % (see Figure 1 attached). The standard deviation of each series with its own mean is less than 1 %. The variability of the black body calibration during eclipse period is larger than the variability of the vicarious calibration. However, it is not clear whether this is a pure sampling problem (the vicarious calibration only updates twice daily, while the black body calibration updates 4 times a day during eclipse). The largest impact of the use of the black body calibration concerns the WV channel. While the bias between the calibration coefficients from both methods is small (about 0.5 %), the variability of the black body calibration is only half of the variability of the vicarious calibration (see Figure 2 attached). For periods outside the eclipse periods the reduction of this variability is even greater.

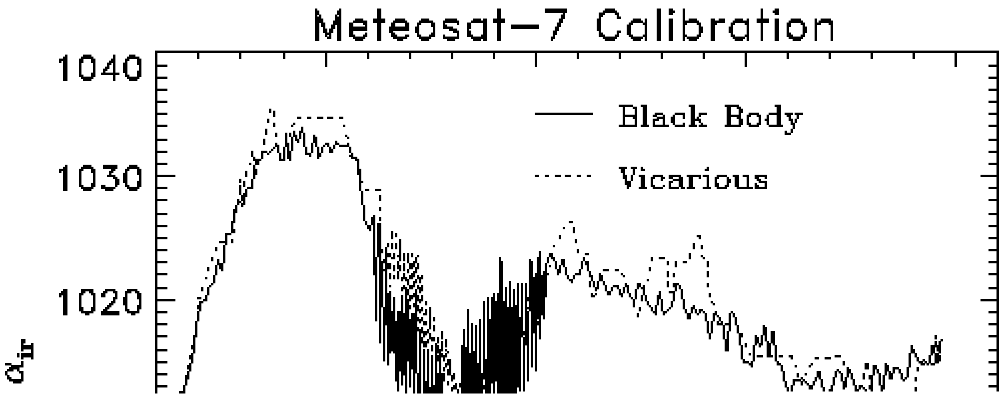
4 SUMMARY

The main aim of the introduction of the black body calibration method was to improve the stability of the infra red calibration, especially of the WV channel. This aim was met beyond expectation for the WV channel. Outstanding issues remain; (i) an understanding of the behaviour of the calibration during eclipse period and (ii) an understanding of the biases with respect to other spacecraft (e.g. HIRS). Here some reports indicate that while the IR calibration of the Meteosat spacecraft is too cold (1-2 K), the WV calibration of the Meteosat spacecraft is too warm (3-4 K).

It is possible to provide a correction factor for the calibration data between 29th May 2000 and 4th January 2001, in order to give unbiased calibration information over the whole period. It should be noted that such a correction factor should not be used when considering meteorological products from Meteosat. This information will be published via the EUMETSAT web pages in due course.

5 CONCLUSION

CGMS is invited to take note of the Meteosat-7 Black Body Calibration Method and Results on the performance of the Calibration


Meteosat-7 Calibration
1040
1030
1020
α_{ir}
Black Body
Vicarious