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OPERATIONAL CALIBRATION PRACTICES AT EUMETSAT

This paper summarises the operational calibration practices at EUMETSAT.

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1 INTRODUCTION

This paper summarises the current operational calibration practices at EUMETSAT.

2 OPERATIONAL CALIBRATION OF THE WV CHANNEL

The calibration of the Meteosat WV channel is performed using external observation data received routinely via the Global Telecommunication System of the World Meteorological Organisation. Radiosonde observations are received twice daily, and they are used as input to a radiative transfer model, which determines the radiance at the top of the atmosphere. These radiances are then used together with the actual spacecraft observations to calibrate the WV channel. The calibration is performed in two independent steps, first deriving the Instantaneous WV calibration, second determining from the latter the operational calibration coefficient.

2.1 Instantaneous Calibration

After reception of all radiosonde data for a given observation time, they undergo a quality control check, and thereafter they are only used for calibration if the segment (an area consisting out of 32x32 WV pixels) in which they are located is free of clouds above 700 hPa. The latter condition is checked using the results of a multispectral image analysis scheme, which analyse every Meteosat image by interpreting every scene found in a segment. Such scenes can be sea surface, various types of land surfaces, clouds of different height levels.

The above mentioned quality control checks imply that the observation is flagged (and not used) when

- The satellite zenith angle for the station location is larger than 55^0.
- The mean radiosonde relative humidity is less than 4 % (0.1 % in setup !!)
- There must be at least three observations of temperature and dew point depression within the relevant layer between 300 and 600 hPa.

The radiance at the top of the atmosphere is determined using the radiosonde temperature and humidity profile as input to a radiative transfer model, and this radiance is converted in a pseudo count using the presently valid operational calibration coefficient. This pseudo count is used in a quality check, and aims to eliminate rogue radiosonde observations. The check compares the radiosonde pseudo count (C_{pseudo}) and the segment averaged satellite observed count (C_{sat}), and fails for the following conditions:

- For UTH □ 50 %: ABS($C_{pseudo} – C_{sat}$) > 16 counts
- For UTH □ 50 %: ABS($C_{pseudo} – C_{sat}$) > 32 counts

For all radiosonde observations that have passed all quality checks an averaged radiance is determined, and for the collocated segments an averaged satellite WV count is calculated. In a two-dimensional count – radiance diagram the slope of the line though the average and the space count gives the instantaneous calibration coefficient.

2.2 Operational Calibration

As the types of radiosonde observations vary throughout the Meteosat field of view and as the number of radiosonde observations and their originating station will vary because of changing meteorological conditions, the instantaneous calibration has a relatively large fluctuation. Therefore the following smoothing procedure is used for the operational calibration of the WV channel:

- Of the latest six instantaneous calibration coefficients an average and standard deviation is determined.
- A quality check is performed and from these six instantaneous calibration coefficients all are removed that differ more than one standard deviation from the average are flagged.
- Of these six instantaneous calibration coefficients all unflagged values are used to derive a new averaged calibration coefficient.
- The operational calibration coefficient is updated only if it differs by more than 1.0 % from the new averaged calibration coefficient.

3 OPERATIONAL CALIBRATION OF THE IR CHANNEL

The calibration of the Meteosat IR channel is performed using external observation data received routinely via the Global Telecommunication System of the World Meteorological Organisation. The sea surface temperatures from forecasts of the European Centre for Medium Range Weather Forecasts are used. Technically these are the sea surface temperatures produced by the NCEP (National Centres for Environmental Prediction), which in fact are a blend of conventional observations (e.g. buoys), satellite observations (e.g. NOAA polar orbiting spacecraft) and climatology. The calibration is performed in two independent steps, first deriving the Instantaneous IR calibration, second determining from the latter the operational calibration coefficient.

3.1 Instantaneous Calibration

A multispectral image analysis scheme provides for every segment (an area of 32x32 IR pixels) of the Meteosat IR image information on the scenes within the segment. If one of the analysed scenes is sea surface, quality checks on the sea scene are done and the scene is only used for further processing if all the following conditions are fulfilled:

- The cloud coverage is less than 25 %.
- The scene IR standard deviation is less than 3.0
- The scene VIS standard deviation is less than 3.0
- The scene VIS count is less than 250 (???)

Of all segments, considered for further processing, the mean count and the standard deviation of superpixels (3 x 3 pixel areas for every pixel) are determined. For every segment the above found sea surface count is replaced by the superpixel count fulfilling the following conditions

- The warmest superpixel in the segment is taken for the sea surface count.
- If the a superpixel is found with the same mean count, the superpixel with the lowest standard deviation is selected

For all valid sea surface scenes the satellite observed counts are averaged. Additionally for those segments the SST received from NCEP is converted into a radiance at the top of the atmosphere, using the ECMWF forecast temperature and humidity profile to calculate the impact of the atmosphere with a radiative transfer model. A pseudo count is derived from the radiance at the top of the atmosphere and compared with the satellite observed count. If the difference is greater than 50 counts the observation is rejected and the segment is not used anymore in the calibration process.

Those radiances, which are corrected for the atmospheric absorption, are then averaged and the slope of the line though these averages and the space count provides the instantaneous calibration coefficient.

3.2 Operational Calibration

Although the external observations are quite stable in time, and although emphasis is laid on the retrieval scheme to exclude cloud contamination, the latter can not be excluded especially for cloud coverage on sub-pixel level. Additionally meteorological conditions can vary, which in turn can lead to the fact that the geographical areas taken for the instantaneous calibration can vary. Therefore the following smoothing procedure is used for the operational calibration of the IR channel:

- Of the latest 24 instantaneous calibration coefficients, for the same representative time period, an average and standard deviation is determined. So if a calibration is determined at 20 UTC, then the last 24 instantaneous calibration coefficients are used going backwards from the same time on the day before.
- The operational calibration coefficient is updated only if it differs by more than a factor 0.0002 from the new averaged calibration coefficient.

3.3 Calibration during Eclipse

Eclipse periods are characterised by rapid temperature changes within the satellite and the radiometer, especially for night-time images, while the detector temperature is kept constant at 90 K by a passive cooler system. Therefore it is not appropriate to take a 12 hour-average (IR channel) nor a three day-average (WV channel) for the operational calibration. So within the eclipse season, the instantaneous calibration values for the same relevant image for the last six days will be used to determine the operational calibration. The latter is done for both infra red channels. The above-described checks on the instantaneous calibration coefficients remain the same.