Reprocessed Satellite Data Products for Assimilation and Validation

Leo van de Berg and Bertrand Theodore

EUMETSAT
Am Kavalleriesand 31, 64295 Darmstadt, Germany

1. Introduction

On request of the ECMWF's ERA-40 project team EUMETSAT has reprocessed Meteosat-2 image data in order to provide Atmospheric Motion Vector (AMV) Products using state of the art algorithms. The results and lessons learned from this reprocessing project are discussed. A follow on request from ECMWF's ERA team was to provide reprocessed AMV products and Clear Sky Radiance (CSR) products for the ERA-Interim project. The mutually agreed baseline was to reprocess all Meteosat image data between 1989 and 2000. At EUMETSAT side this project has finished and the transfer of the relevant products to ECMWF started. In preparation of a potential new reanalysis (ERA 65/75), the identification of potential improvements to EUMETSAT's reprocessing system will be discussed.

2. ERA-40 Reprocessing

EUMETSAT supported the ERA-40 Re-analysis by reprocessing Meteosat-2 image data for the period 1982 – 1988. This period was selected, because since 1987 the calibration and the AMV algorithms have improved drastically. Therefore the main emphasis of this reprocessing project was to simultaneously recalibrate the image data and to provide AMV Products. In addition EUMETSAT decided to provide CSR products and High Resolution Visible (HRV) wind products.

The recalibration of atmospheric window (IR) channel resulted in a decrease in the calibration with up to 4 % (~ 2 K temperature decrease). For the Meteosat WV channel (atmospheric absorption) the recalibration changed with up to 10 % (in either direction, hence becoming warmer or cooler depending on the reprocessed year). The variability of the reprocessed WV calibration increased drastic. However, this is an artefact as the reprocessed WV calibration is determined against radiosonde observations, while the historical WV calibration was determined from a comparison between the derived Upper Tropospheric Humidity (UTH) fields from the WV channel and an averaged UTH from radiosonde observations. In case the bias between these two UTH data sets became too large, the WV calibration was adapted manually to minimise the bias again. This was done infrequently, and by consequence the historical WV calibration seems quite smooth.

The reprocessed AMV products were verified against radiosonde observations and it was demonstrated that the quality of the reprocessed products improved (e.g. speed bias improvements between 30 – 50 %). In addition these products had a higher temporal resolution (every 1.5 hours versus 2-4 products per day), and had a better geographical coverage (better AMV tracking and inclusion of VIS channel). The reprocessed products had a statistically significant positive impact on the re-analysis (e.g. the 200 hPa anomaly

correlation in the southern and northern hemisphere extra-tropics, with the largest impact over Australia and New-Zealand).

3. ERA-Interim Reprocessing

The lessons learned from the ERA-40 reprocessing run have been implemented in the ERA-Interim reprocessing run. Most importantly the CSR products were only monitored passively as, although the averaged bias between the CSR product and the first guess was small, it showed significant variations over shorter time periods (up to 1 month). It is a known area of concern in the WV calibration method: the selection of radiosonde observations in clear sky areas is impacted by the geographically uneven distribution of stations (with different sensors) and the varying meteorological conditions (i.e. variation in cloud cover). However, the passive monitoring revealed that there might be information in this product, despite the high level of noise in the WV channel for Meteosat-2 and Meteosat-3. As a solution a so-called calibration run was performed for every spacecraft used in the relevant period prior to the ERA-Interim reprocessing. These calibration data were smoothed in order to remove the noise in especially the WV channels on time scales up to a few weeks. In addition, during the ERA-40 reprocessing the retrieval and geo-location of the Meteosat images proved to be a processing bottle neck. As a solution all image data for Meteosat-2 to Meteosat-7 are kept on hard disks. The processing speed increased from 12 days per 24 hr. to 30 days per 24 hr.

The first results from our reprocessing are encouraging, as e.g. for AMV products the RMS difference between Meteosat AMV's and radiosonde observations decreased with about 0.5 m/s in the period between 1990 and 1995. In addition the Meteosat-3 data from the Atlantic Data Coverage (ADC) Mission (Sub satellite point 50^0 W) and the Extended Atlantic Data Coverage (XADC) Mission (Sub satellite point 75^0 W) have also been used to derive AMV and CSR products, allowing a potential re-analysis study on the impact of reprocessed data from two spacecraft (doubling the geographical coverage of these products).

4. Future Reprocessing Activities

In the context of a new Re-analysis project (ERA 65/75) EUMETSAT investigates the potential of reprocessing of the Meteosat Archive (1982 – 2006) with the following aims:

- Recalibration of all spacecraft in a consistent manner
- Inter-calibration of all spacecraft with e.g. HIRS data
- Reprocessing or Generation of geophysical products on request of the re-analysis or other communities (e.g. AMV, CSR, Divergence, Meteosat Surface Albedo, etc)

With respect to the first two points several algorithm improvements are envisaged. First of all the intention is to introduce in the reprocessing environment a pixel based image analysis algorithm (similar to the one used in Meteosat-7 and Meteosat-8 operations). Furthermore, it is planned to use the RTTOV radiative transfer model. In addition the use of the AMV tracking algorithm from Meteosat-8 operations will be investigated.

Besides the reprocessing of meteorological products, it should be noted that EUMETSAT can play an important role with respect to future re-analyses. The Climate Monitoring SAF is in a good position to validate products from the future re-analyses, while EUMETSAT headquarters is responsible for the creation of climate worthy level 1B data (geolocated, calibrated image data).