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VALIDATION OF CLOUD AND AMV HEIGHTS WITH CALIPSO (FIRST RESULT FROM STUDY)

In response to CGMS action 34.14

The purpose of this paper is to report the current status of the CGMS recommendation 34.14 at EUMETSAT. EUMETSAT initiated an external study in December 2006 that aims to compare the standart methods for AMV height assignment with CALIOP measurements on board CALIPSO. This study is not finished yet, and should be ended during the autumn 2007. The contractor is a French laboratory located in Paris: the Laboratoire de Meteorologie Dynamique (LMD).
Two periods of coincident CALIOP and AMV data are available, allowing the analysis of the cloud top heigh assignment of about 26000 AMVs. Tools to read, search for coincidence, visualise and analyse the data have been developed during this first phase.
Then a first analyse has been conducted on CLA, AMV and CALIOP cloud pressure distributions. There are on average 15 profiles (30 % of the points) per 23x23 pixels AMV target box.

CALIOP cloud top pressure distribution compared to CLA ones are in fair agreement. Larger discrepancies are observed between CALIOP and the AMV final pressure distributions. The operational AMV HA process tends to overestimate the cloud top pressure detected by the lidar. The AMV alternative height assignment method, based on the use of coldest pixel percentages, set clouds at a higher level. It then tends to decrease the discrepancies with CALIOP pressure retrieval.

Validation of cloud and AMV heights with Calipso (first result from study)

1 INTRODUCTION

The purpose of this paper is to report the current status of the CGMS recommendation 34.14 at EUMETSAT. EUMETSAT initiated an external study in December 2006 that aims to compare the standard methods for AMV height assignment with CALIOP measurements, which is the lidar based on the CALIPSO satellite (Cloud Aerosol Lidar and Infrared Pathfinder Satellite Observations). This study is not finished yet, and should be ended during the autumn 2007. The contractor is a French laboratory located in Paris: the Laboratoire de Meteorologie Dynamique (LMD). The following results reported in this paper are extracted from the progress report written by G. Seze, J. Pelon and S. Marchand in June 2007.

2 DESCRIPTION OF THE STUDY OBJECTIVE

The main objective of this study is to compare the AMV heights derived from these various methods against space based Lidar observations. The Lidar measures cloud top height by analysing the backscatter from the cloud. As it provides an accurate measurement of the cloud top height, Lidar could be used as ’truth’ in satellite validation studies, although such comparisons need to carefully consider what is exactly measured

The study is performed in two different phases. During the first phase all preparatory activities are set up, the data set of Lidar observations is collected together with the collocated Meteosat-8 data, and the methods for the comparison of the two data sets elaborated and documented. An initial comparison is also expected in the first phase, in order to identify any problems or deficiencies in the analysis and/or in the data. The second phase is a more extensive analysis, in which a statistically significant data set should be used.
At the last wind workshop (IWW8), Borde (2006) noted the importance of the pixel selection process, which links the height calculation to the feature that drives the tracking in the tracer box. The most common method sorts the coldest pixels to calculate the height. NOAA/NESDIS uses a fixed threshold of 25% coldest pixels for the GOES instrument, whereas EUMETSAT used the coldest cluster inside the target area for MSG, where the definition of the “coldest cluster” was done with an elaborated clustering scheme that depended on two output parameters within the Cloud Analysis (CLA) step: the cloud phase and the cloud top height (CTH). Unfortunately, the use of these criteria introduced a large error into the calculation of the pressure (Borde, 2006), especially in multilevel cloud situations, or/and when several types of clouds are present in the respective target box. The AMV HA clustering scheme has then been changed at EUMETSAT early 2007, and replaced by a dynamic clustering method which was already used for the first generation of Meteosat satellite.
EUMETSAT took the opportunity of this external study to request a comparison of CALIPSO measurements against the current operational HA pressure based on the dynamic clustering method, but also with an alternative pressure resulting from the use of various percentages (10, 15, 20 and 25 %) of coldest pixels in the target area (Borde, 2006).

In addition, EUMETSAT produces an intermediate product on pixel basis, called Cloud Analysis (CLA), which also contains a first estimate of cloud top height which is the basis for the final CTH computations. It is also the scope of this study to compare these initial cloud top heights in the CLA data.

1 MAIN RESULTS OF PHASE 1

The SEVIRI and collocated CALIPSO data have been collected during two periods:
During the first period, 10 days have been selected by EUMETSAT in 2006: 14, 15, 16, 17, 18, 28, 29, 30, 31 August and September 1st. But CALIOP data are not available for the August 29 and 30
The second period is 21 days long in 2007, from February 23 to March 19. The AMV products are not available for the 10 and 11 of March. Only few CALIPSO data are available for the 5 and 6 of March.

Adequate tools have been developed/got by the contractor to

- Read and use the CALIPSO level 1 and level 2b products.
- Read and use the AMV and CLA SEVIRI data, including the alternative height for the second period
- Extract the SEVIRI and collocated CALIPSO data for comparison
- Make statistics about the comparison
- Visualise the results

These tasks are not described in this paper. An example of CLA cloud top pressure and corresponding AMV file for 14 (top images) and 18 (bottom images) August 2007 for the daytime CALIPSO orbits.

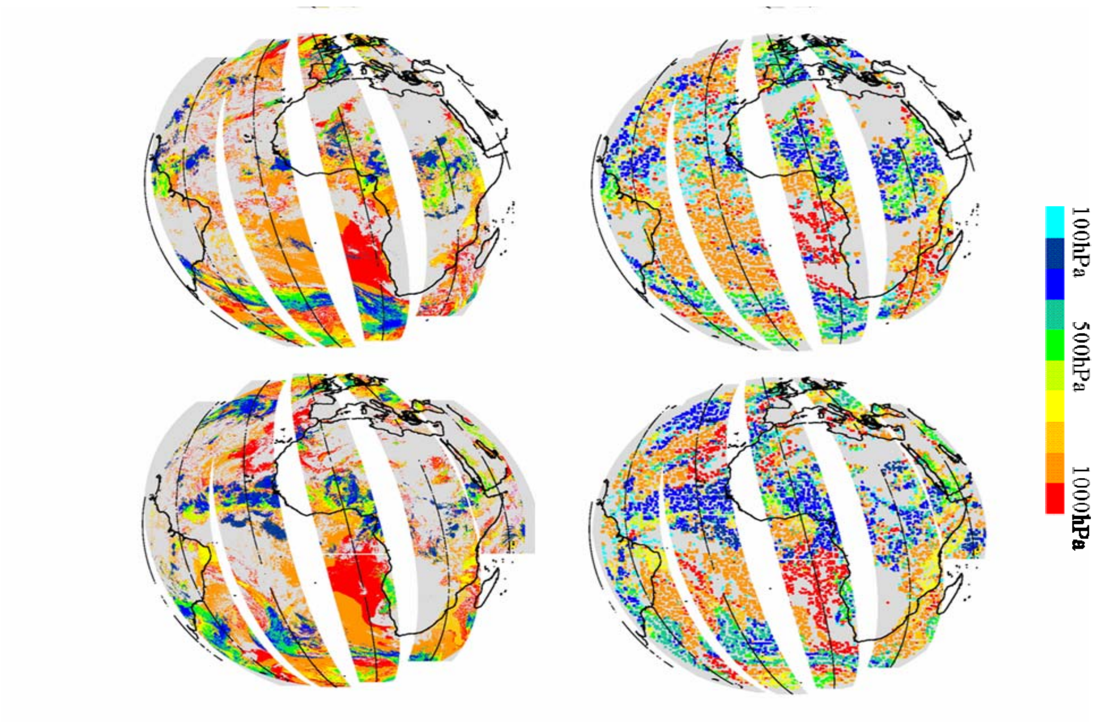

Figure 1: CLA cloud top pressure (left) and corresponding AMV cloud top pressure (right) for 14 (top images) and 18 (bottom images) August 2007 for the daytime CALIPSO orbits

Finally, simultaneous CALIOP, AMV and CLA information are available for 5867 AMVs for the first period and 21000 AMVs for the second period (at least with one CALIOP profile). There is an average value of about 15 CALIOP profiles per AMV, which corresponds to the average size of the AMV box (~ 70 km).

- Comparison of the AMV, the CLA and the CALIOP pressure

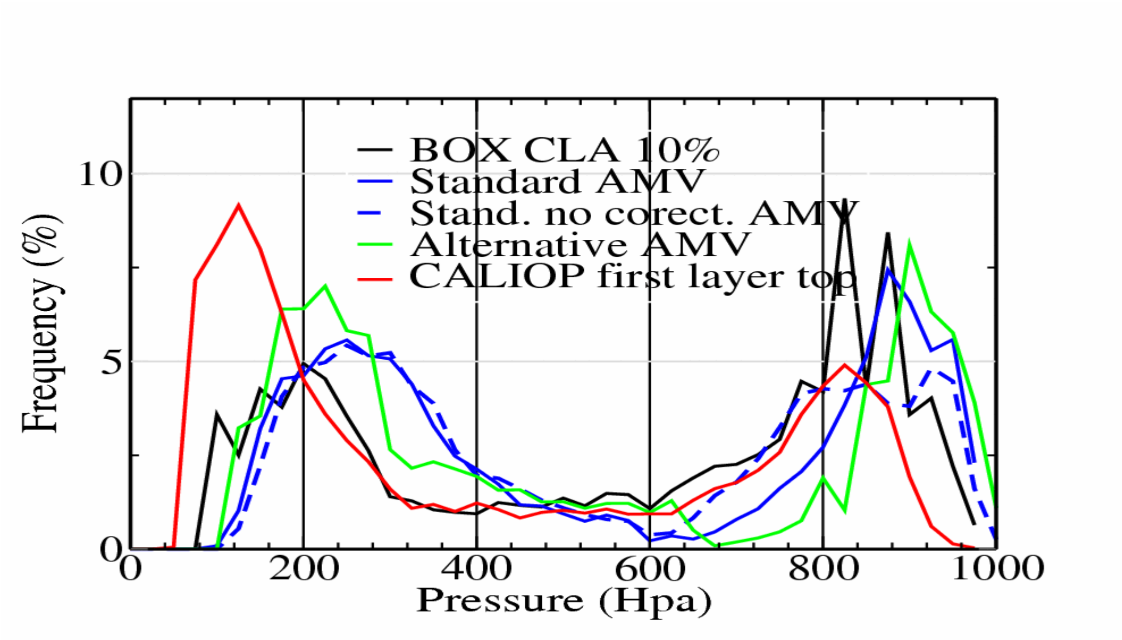

Figure 2: CLA cloud top distribution for the 10 percentile, AMV final height, AMV final height non-corrected, AMV alternative height, CALIOP first cloud layer top.

The figure presents pressure histograms of the 10% coldest CLA CTH in the target box, AMV final height, AMV final height non-corrected, AMV alternative height and CALIOP first cloud layer top, for the second period collocated dataset. The final standard AMV pressure distribution is shifted toward higher pressure comparing to the 10% coldest CLA CTH and the CALIOP highest layer cloud top. These two ones are in a general fair agreement, even if CALIOP detect many more small pressures. The alternative height assignment increases the number of small AMV pressure and decreases the frequency of intermediate AMV pressure. Considering CALIOP as the reference, the new alternative height assignment method seems to improve the estimation of the cloud top height.

- AMV final choice height and CALIOP cloud top pressure: bi-dimensional distributions

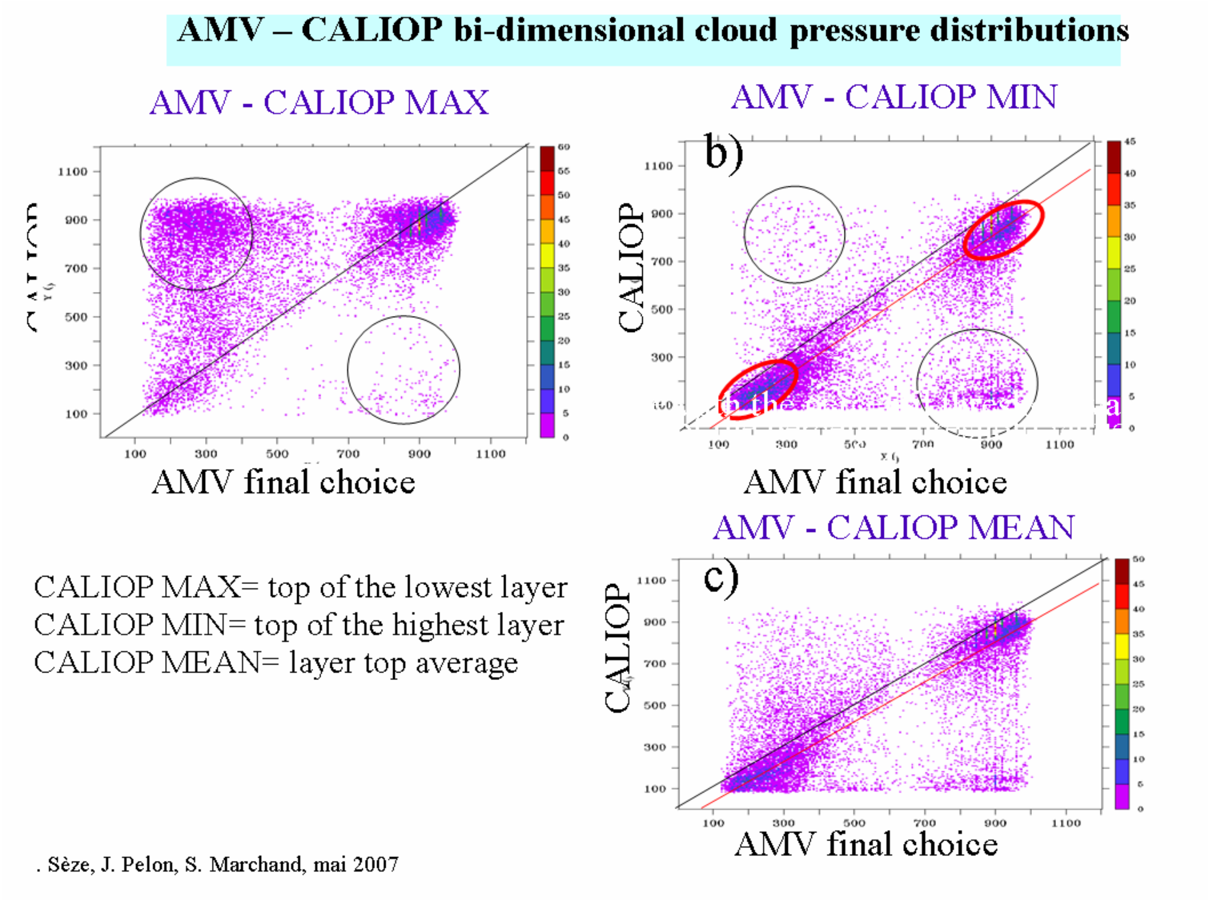

Figure 3: Bi-dimensional distributions of the AMV final choice pressure and the cloud top pressure of a) the lowest layer observed by CALIOP in the target box, b) the highest layer, and c) the average pressure of all the layer tops observed with CALIOP.

The Figure 3 shows scatter plots of several CALIOP pressures (CALIOP max, CALIOP min and CALIOP mean) as function of collocated AMV standard pressure. CALIOP max corresponds to the top of the lowest layer, CALIOP min to the top of the highest layer, and CALIOP mean to average pressure of all the layer tops in the target box.

The AMV height is often but not always in a better agreement with the CALIOP highest layer top than with the CALIOP lowest layer top (Figure 3). There is a fair agreement between AMV pressure at low level and the CALIOP top pressure of the lowest layer (figure 3a). However, it has to be noted that AMV HA process aims to set the low level AMVs to the cloud base, using Cloud Base Height method, or to inversion level when a low level temperature inversion exists.
The CALIOP pressure of the highest layer is smaller than the AMV pressure (red circles in Figure 3.b) for both high and low clouds. That means a general tendency for the operational AMV HA to assign the height of AMVs to levels below the cloud tops detected by CALIOP.

3 CONCLUSIONS OF THE PHASE 1

Two periods of coincident CALIOP and AMV data are available, allowing the analysis of the cloud top height assignment of about 26000 AMVs. Tools to read, search for coincidence, visualise and analyse the data have been developed during this first phase.

Then a first analyse has been conducted on CLA, AMV and CALIOP cloud pressure distributions. There are on average 15 profiles (30 % of the points) per 23x23 pixels AMV target box.

CALIOP cloud top pressure distribution compared to CLA ones are in fair agreement. Larger discrepancies are observed between CALIOP and the AMV final pressure distributions. The operational AMV HA process tends to overestimate the cloud top pressure, setting it too low in the atmosphere. The AMV alternative height assignment method, based on the use of coldest pixel percentages, set clouds at a higher level. It then tends to decrease the discrepancies with CALIOP pressure retrieval.

These preliminary results need to be confirmed and detailed in the second phase of this study. A more detailed presentation will be made at the next workshop of the International Wind Working Group in 2008.