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HIGH RESOLUTION WATER VAPOUR WINDS FROM METEOSAT

This paper summarises the status of the high resolution water vapour winds from METEOSAT, that are planned to become an operational product in the 4th quarter of 1999.

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This paper was presented at the AMS/EUMETSAT conference in Paris in spring 1998. It describes the basic algorithms employed in the High Resolution WV winds product HWW. Since then two changes have been made to the HWW product algorithm: Firstly, search area size has been set to 56x56 pixels to reduce aliasing and computational cost. Secondly, tests have shown that with the EUMETSAT standard cross-correlation method 16x16 targets do not produce good tracking in cloud-free areas, and it was decided to eliminate clear-sky areas from the high-resolution product. Clear-sky WV winds are already available operationally using 32x32 targets in the Clear Sky WV Winds product WVW.

The HWW product has been distributed pre-operationally to ECMWF and the UK Met Office since July 1 1999, and it is planned to give the product operational status in autumn 1999.

1 INTRODUCTION

The Meteosat Second Generation prototyping activities for the Atmospheric Motion Vector (AMV) product have suggested that the production of 80km resolution, combined cloud tracked and clear sky water vapour motion winds from Meteosat images would be feasible.

By subdividing the segments into four quadrants, each of 16×16 pixels, and performing the tracking separately for each, it is possible to extract four water vapour winds in each segment. Since every segment must be either cloudy or clear sky, the full processing area can be covered with a high resolution water vapour wind product, consisting of up to approximately 15000 intermixed clear sky and cloud tracked winds.

The enhanced spatial resolution offered by such a product would provide a large volume of data to the user community, and be useful to the variational assimilation schemes used by the forecast models.

A product containing these winds (HWW) has been prototyped for use in the operational MTP MPEF (Meteorological Product Extraction Facility) (Elliott, 1997), and in this paper we present some aspects of the product generation, quality control and distribution mechanisms.

2 TARGET AND SEARCH AREA SELECTION

The present processing segment used for the cloud motion wind product (CMW) is split into 4 quadrants each of 16×16 pixels, and each of these in turn is used as a target area in the extraction of a wind vector. The search area is then an 80×80 pixel region centred on the target area, and extending 32 pixels (one CMW segment) beyond it on each side. This ensures that tracers moving at up to ~111 ms^{-1} (40 pixels per slot) at the sub satellite point can be successfully tracked.

3 HEIGHT ASSIGNMENT

For the early stages of prototyping, a simplified height assignment scheme was used. If any clouds above 700 hPa are detected within a 32 x 32 pixel processing segment, it was assumed that all winds within that segment are cloud tracked, otherwise all the winds were assumed to be from clear sky areas. The height assigned to all winds within a segment was then derived from the water vapour count of the coldest cluster, whether or not the segment was considered cloudy. This scheme resulted in all the winds within a segment being assigned the same height.

An improved height assignment method makes use of the classification of each pixel within a quadrant to determine the coldest cluster of self-similar pixels that fall, to some minimum extent, within the quadrant. The water vapour count of this cluster is then used to derive the height. This method allows height assignment and classification of cloud tracked and/or clear sky winds on a per quadrant basis.

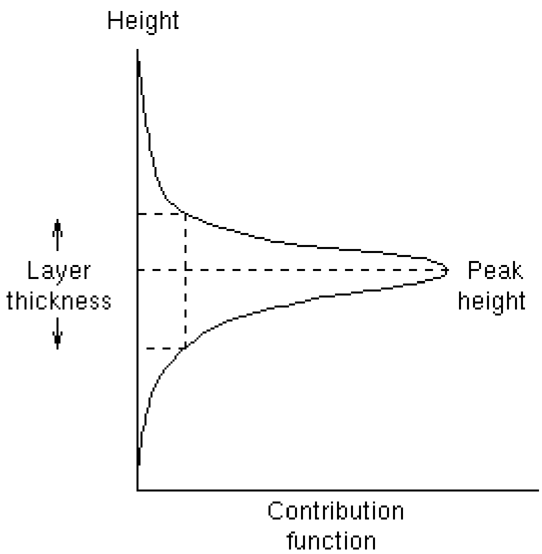


Figure 1

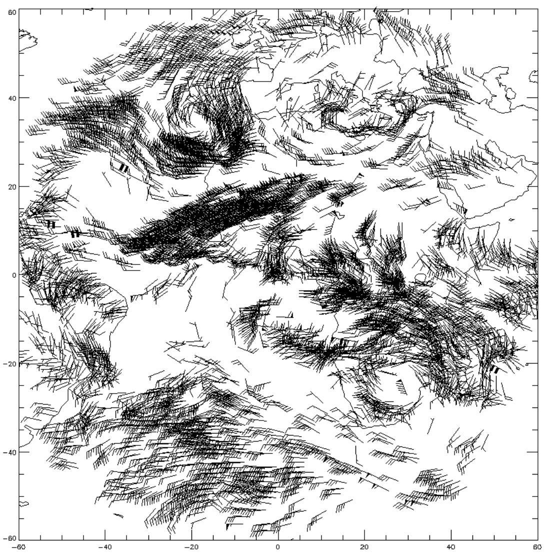
It is also possible to use the contribution function for the water vapour channel to derive some further data about the height assignment of clear sky vectors. This contribution function is calculated as a by-product of the radiative transfer model used in the MPEF to calculate atmospheric absorption and semi-transparency effects, based on forecast data from the European Centre for Medium range Weather Forecasting (ECMWF). The location (*i.e.* height) and width of the peak of the contribution function give an *a priori* indication of the typical height and thickness of the cloud free layer which is being tracked to generate the vector (see illustration in Figure 1). Where this height agrees well with the statistical cluster based height assignment, we can be more confident in the result.

4 AUTOMATIC QUALITY CONTROL

As for the CMW product, the quality control mechanism for HWW consists of a set of normalised consistency tests. These checks can be divided into 3 distinct groups: the two component vectors which are combined to give each resultant vector are checked internally for their symmetric consistency, the vectors are checked for their spatial consistency with respect to any neighbouring vectors from the same height level (+- 50 hPa), and the forecast wind field data from the European Centre for Medium-range Weather Forecasting (ECMWF) are used as an external validation. The results of these tests are linearly combined to give an overall extraction score.

Comparison with radiosonde observations has shown that the overall quality value assigned by the MPEF is a good statistical measure of the actual quality of the operationally derived winds, particularly those from the WV channel (Holmlund, 1996). Since the automatic quality control for HWW is applied in an identical manner, we may use it as an objective measure of the quality of these winds also, although this assumption is only strictly true for cloud tracked HWW winds (Elliott, 1996).

Analysis of the performance of the quality indicators for both the water vapour CMW winds and the 160km clear sky WV winds with respect to the ECMWF analysis data has also shown the reliability of the quality control mechanism. Although there may ultimately need to be some optimisation of the quality control parameters, it is clear that we can be reasonably confident in an initial formulation based on the CMW and WVW settings.



5 INITIAL RESULTS

Figure 2

Figure 2 shows the spatial coverage of vectors for a typical product. The product shown is a composite of cloud tracked, and clear sky winds, after a confidence threshold of 50% has been applied. The total product contained 14785 wind vectors, of which 8311 exceeded 30% confidence, 6217 50% confidence and 4473 70% confidence. It is clear that as the threshold is made higher, more suspect winds are filtered out from the product. The BUFR encoded product will include all the winds whose score exceeds some nominal extraction quality threshold (30%), encoded together with the associated quality control information.

The product illustrated in these figures contained 7708 cloud tracked winds and 7077 clear sky winds. The clear sky winds were distributed over a range of heights centred on 350 hPa. The cloud-tracked winds were distributed over a wider range of heights centred on 250 hPa, and tended to have higher extraction scores.

6 UNIFIED BUFR ENCODING TEMPLATE

The HWW product will be encoded in BUFR according to the unified wind template currently used by the MPEF for the encoding of CMW and WVW. This template was developed multilaterally by ECMWF, NOAA/NESDIS, EUMETSAT and JMA, such that it is flexible enough to contain a wide range of wind related data. By including descriptors for the spatial resolution, channel characteristics, computation methods, *etc*. it is possible to use one template for a variety of wind products from different originators without loss of generality in the data format.

A further important aspect of the wind template is that it allows for data entries to describe more than one type of height assignment for a given wind, and also for the possibility of including the width of the layer being tracked for clear sky winds. Furthermore, there is also room within the template to include information relating to the component vectors used to make the resultant wind vector.

The use of BUFR also means that quality control information, such as percentage confidence and/or a nominal confidence threshold value for valid data, can be included for any of the data elements in the template.

7 CONCLUSIONS

An 80km combined cloud tracked and clear sky water vapour wind product can be generated from Meteosat water vapour images. This product can be generated and quality controlled automatically every 90 minutes. A typical product will contain approximately 11000 winds encoded into BUFR bulletins, together with their associated quality control information. These data will then be distributed via the GTS to the user community, and will provide valuable input to their variational data assimilation schemes.

8 BIBLIOGRAPHY

Elliott, S. S. and K. Holmlund, 1996: Water vapour winds from cloud free areas.
In *Proceedings of 1996 meteorological satellite data users' conference* – Vienna, Austria, September 1996.

Elliott, S. S. and K. Holmlund, 1997: High resolution water vapour winds from cloudy and clear sky areas.
In *Proceedings of 1997 meteorological satellite data users' conference* – Brussels, Belgium, September 1997.

Holmlund, K., 1996: Normalised quality indicators for EUMETSAT cloud motion winds.
In *Proceedings of the third international winds workshop*. EUMETSAT, JMA, NOAA, SMA and WMO.