OBJECTIVE USE OF HIGH RESOLUTION WINDS PRODUCT FROM HRV MSG CHANNEL FOR NOWCASTING PURPOSES

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ABSTRACT

The Satellite Application Facility of EUMETSAT to support Nowcasting and Very short range forecasting activities (SAFNWC) generates products at the MSG update cycle, i.e., every 15min, with less than 15min delivery delay. One important use is in the continuous monitoring of the atmosphere, to get a better understanding of present weather, and detect recent changes or tendencies that could significantly affect in the next few hours. SAFNWC products are just data among others, which should be integrated in its adequate context: it is clear that the best analysis for any parameter is of course the assimilation in a NWP model. Nevertheless, nowcasting could currently be still a too short range for operational NWP models; a time gap remains that could be filled with continuous watch of data such as SAFNWC products, adequately presented.

The SAFNWC wind product is the High Resolution Winds, HRW, computed day-time on HRV-channel images (1km nominal resolution) at two resolutions or scales: basic winds (average optimal resolution around 24 HRV pixels), and detailed winds (12 pixels). Experimental HRW analyses start to be performed at INM, every 15 or 30min, as follows: at synoptic hours, basic HRW winds (at 4 layers) are interpolated at a grid, using a Barnes technique, with a +3h or +6 hours forecast as guess, the result being guess for the analysis of detailed HRW winds. Wind fields at each scale are then used as guess for the analysis of next HRW winds, 15min (or 30min) later, and so on. HRW-appended quality-control information is also included in the wind grid derivation. Time change of wind, divergence, vorticity and vorticity advection fields are also computed, as value-added parameters. Method, results and some considerations for operational use, have been presented and discussed at the Workshop.

INTRODUCTION

High Resolution Winds (HRW) and other SAFNWC products based on Meteosat Second Generation (MSG) data, are routinely generated at INM and meteorological services in other countries, using the product generation elements, included in the software modules provided by that facility.

HRW is, among the SAFNWC products, the most interesting for detailed description of kinematics in the atmosphere: it provides MET-8 HRV-channel AMV (Atmospheric Motion Vectors) winds, that are available at INM with regional coverage every 15min; with average maximal resolutions, in adequate cloudy areas, of around 30km for the Basic product and 15km for the Detailed product.

HRW winds can be very helpful to the diagnostic of cloud systems on MSG images: it is a common practice to animate loops of last images to get a better understanding of these systems considering its recent evolution (displacements, development or dissipation, deformation at small scale), and its dynamic context. On HRV channel images, HRW winds can be even more informative, because the tracers were determined in these same images.

HRW winds are especially interesting for nowcasting purposes: detection of cyclogenetic zones, of areas of convergence or divergence; monitoring of mesoscale rapid changes that could lead to convection, precipitation enhancement or increase in severity of the phenomena; or the wind intensification itself.

MOTIVATION

In applications intended for operational use, the HRW winds are by now just plotted: on HRV images (figure 1); or in the context of application to convection: where different data, including HRW Basic winds, other SAFNWC products and equivalent NWP forecast fields, IR cloudiness and radar Ecotop, can be visualized and compared to each other, for the monitoring of preconvective environment and of already existing convection. Winds are only plotted at a QI (Quality Indicator) of 0.60 or better.

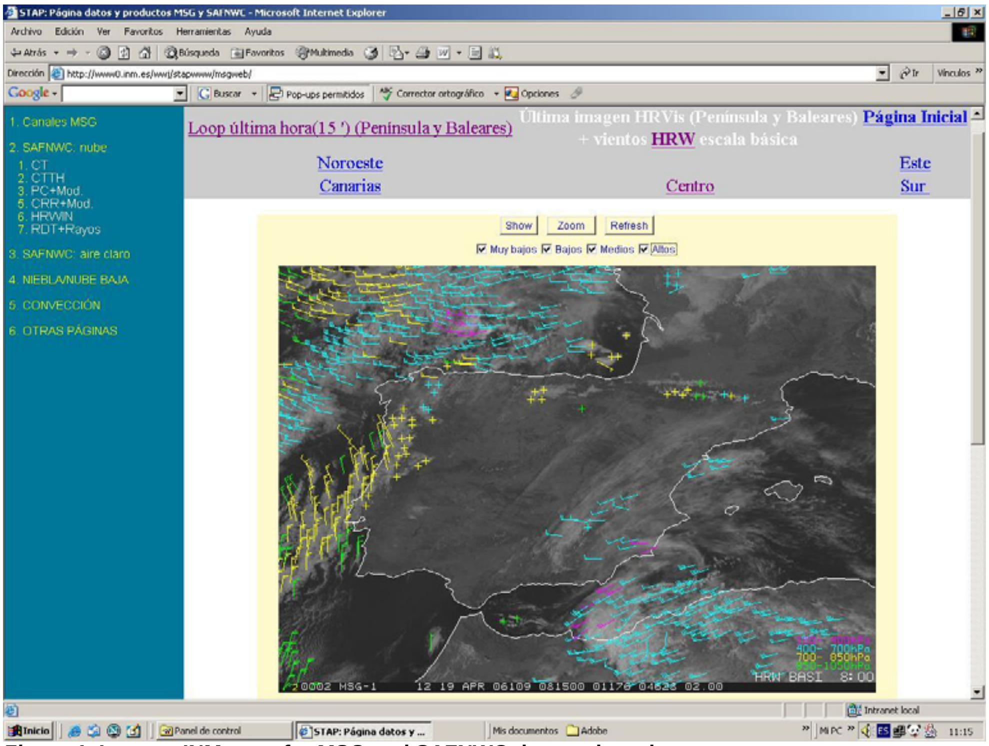

Figure 1: **Intranet INM page for MSG and SAFNWC data and products.**
Example of entry to HRV (at 2km) and HRW (Basic winds, QI > 0.59).
From this page, links exist to a loop over the last hour (4 time slots), and to last data at full HRV resolution plus HRW Detailed winds. Time of data and wind-layer color code is as indicated in the figure.

To be noted, no wind data other than HRW are by now included in these applications. Nevertheless, despite the high resolution of the winds, its coverage is rather irregular, related to the cloudiness, and even more to the ability in the method to extract “good tracers” from it. And by principle these techniques do not allow a 3D picture of the wind distribution. The plotted winds generally include some probably or possibly erroneous ones. In any case, the availability of a “reference wind” is desirable; in the applications, no wind forecast fields are included (as is the case for other SAFNWC products), because of image “visibility” problems.

Rather than adding NWP forecast wind fields in the display, a better way probably, is to actually merge HRW with NWP forecast winds (close in time and level) in an analysis system, producing uniform wind fields. In addition, these grids can also be used as input to easily derive parameters, as divergence or vorticity advection.

A simple and quite efficient analysis method of any parameter is Barnes interpolation to a grid (S.L. Barnes, 1964; improved to include scales separation by R.A. Maddox, 1980). At INM, Barnes methods, for surface or upper level parameters, with NWP fields as background and introducing some quality control of the observations, have been adapted and used for many years: PAMIS (A. García et al., 1993). Recently, they are less and less used given the dramatic improvement in NWP models and its output. 3-hourly mesoscale HIRLAM model is for example run at INM to provide accurate and detailed updates of surface parameters analyses with such a frequency, comparable to synoptic observations; but not yet, or not yet really justified, for upper air parameters.

The HRW wind is nevertheless available at a much higher frequency, and in this rapid update there is certainly information of interest for nowcasting purposes. Thus Barnes interpolation has still a sense for the practical use of HRW winds.

METHODOLOGY AND EXAMPLES

The PAMIS method for interpolation of upper level parameters, has been adapted to run with HRW winds, and a basic procedure has been determined.

As the goal was the operational use, the initial method assumed rather simple choices. Anyway, this study (to be continued) has evaluated different aspects: The best interpolation and overall method, the best use of HRW (resolution, data filtering), the best way to give the results to a forecaster (and guidance to its use). Some considerations are already provided for these aspects from initial results.

The basic procedure analyses every 15min HRW Basic winds with QI > 0.79 (HRW Detailed winds have also been studied).

INM/HIRLAM Model +3h or +6h forecast (at resolution 0.48º) is used as guess or background field, just after synoptic hours, otherwise the prior PAMIS analysis (15min earlier) is used as guess.

Analysis is performed in 4 layers, according to HRW level information appended to the winds: High (<400hPa), Mid (400-700hPa), Low (700-850hPa), and Very low (<850hPa). HIRLAM wind fields are at levels 250, 500, 700 and 950hPa respectively.

See figure 2 (Mid layer) and 3 (Very low layer) result examples: there is some tendency to smoothing that will be discussed later.

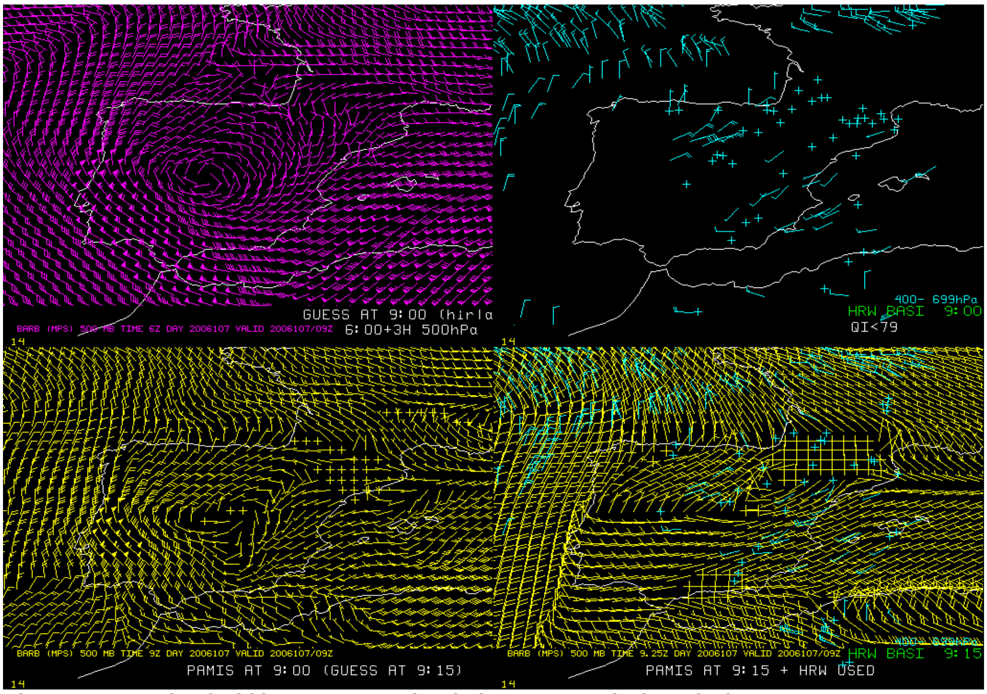

Figure 2: **Example of Mid layer HRW Basic winds PAMIS analysis, 17/04/06 9:00 UTC:
HIRLAM +3h forecast (up, left); HRW Basic winds, QI > 0.79 (up, right);
Analysis with HIRLAM as guess (down, left),
used as guess for the 9:15 UTC HRW analysis (down, right, plus used HRW).**

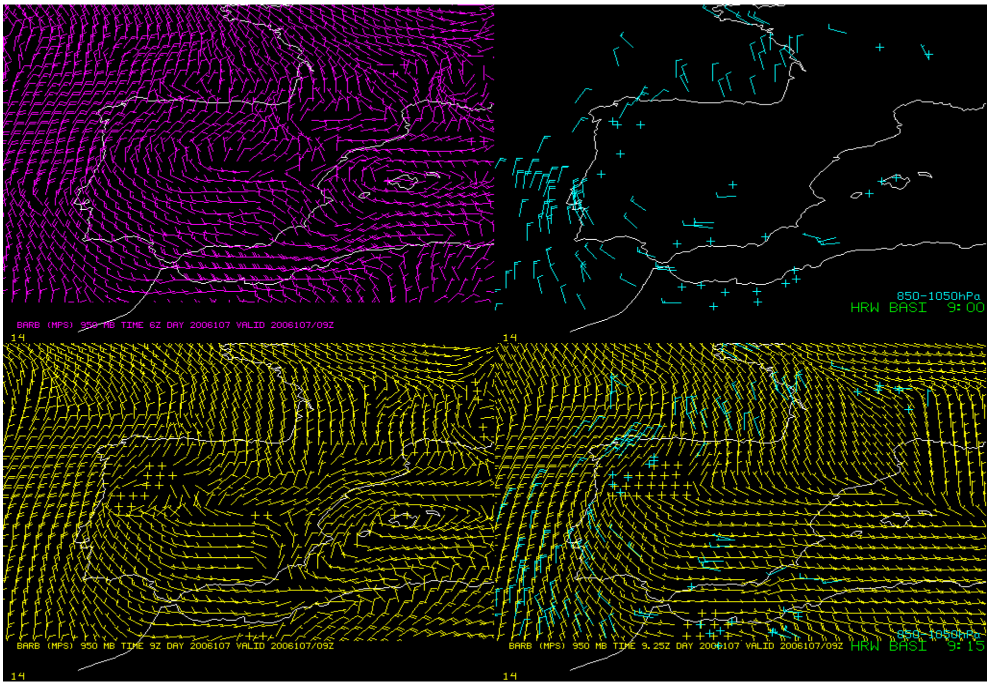

Figure 3: **Same example, for the Very low layer HRW Basic winds PAMIS analysis.**
Day, time, processing and display characteristics as in figure 2.

Divergence, vorticity and its advection (see figure 4) fields are computed: despite some spurious features could appear or be enhanced, the tendency to wave formation along in the cold front east of the Peninsula is well shown in the image.

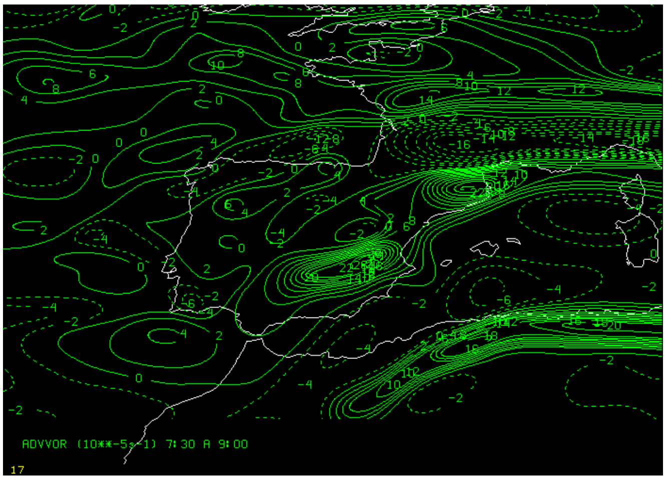

Figure 4: **Example of derived parameter:**
Total vorticity advection in the prior one hour and a half, for the Mid layer at 9:00 UTC (see figure 2).

OTHER PROCESSING OPTIONS

Consideration to quality control information in the product:

Tests have been performed, to process and generate additional PAMIS HRW fields for a relaxed QI threshold (0.60, similar to the one already being used for the wind plotting in the Page, see figure 1), and for the more stringent criteria resulting from HRW validation (J. García et al.): QI>.79, speed>2m/s, mandatory spatial consistency. Some comparative results are shown in figure 6, for the wind after repeated use of PAMIS as guess, i.e. just before the synoptic hour when the information of HIRLAM guess is "oldest": a conclusion could be that a high QI threshold is not improving PAMIS analysis (as compared to HIRLAM analysis), certainly because the number of HRW winds is drastically cut down to take benefit, in our context, of the deletion of some bad quality winds. Results are shown for the Very low layer, but the same conclusion is even more evident for the Mid layer.

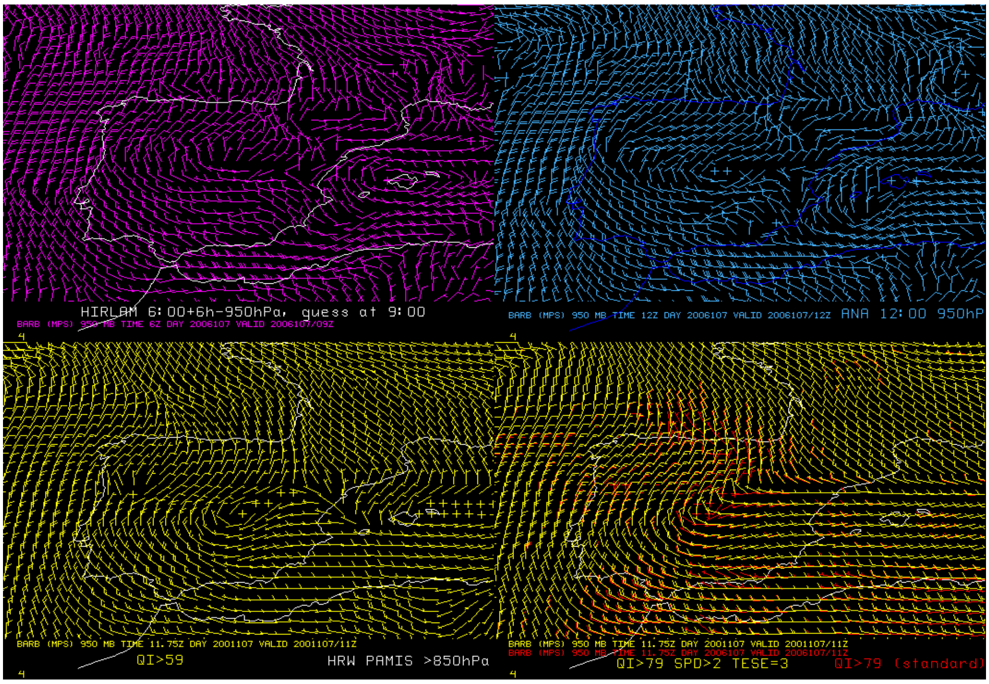

Figure5: **Different selection criteria for the Very low layer HRW Basic winds PAMIS (same day of previous figures).**
HIRLAM +3h forecast used as guess for the 9:00 UTC analysis then guess at 9:15, etc. (up, left).
HIRLAM analysis at 12:00 UTC (up, right).
HRW analysis at 11:45 UTC, QI>0.59 (down, left); QI>0.79 (down, right, in red).
HRW analysis at 11:45 UTC, QI>0.79, speed > 2m/s and spatial consistency test (down, right, in yellow).

In fact, maybe is it the use of a fixed QI threshold that is not satisfactory: QI is actually much dependent of which consistency test passed by each wind, of time and space variability of the flux at the wind location, etc. Possibilities to be considered for the follow-on work: QI threshold adapted to the number of quality tests the HRW wind passed; use of all winds but with an interpolation weight according to its QI (K. Holmlund, 1999) and even more, to the number of consistency test passed, and which ones.

HRW Detailed wind analysis:

To test it, 2 options were considered: either use the HRW Basic PAMIS analysis, or HIRLAM forecast at full resolution (0.16º), as guess at the synoptic hour. Figure 6 shows the comparison of both fields at the synoptic hour + 15min, and the interpolation (second method) at the synoptic hour. It can be concluded that there are no significant differences in both methods. But it is the rather smooth pattern in both cases, at +15min, that surprises. This smoothing was possibly yet there, but by far not so evident, in the HRW Basic winds analysis.

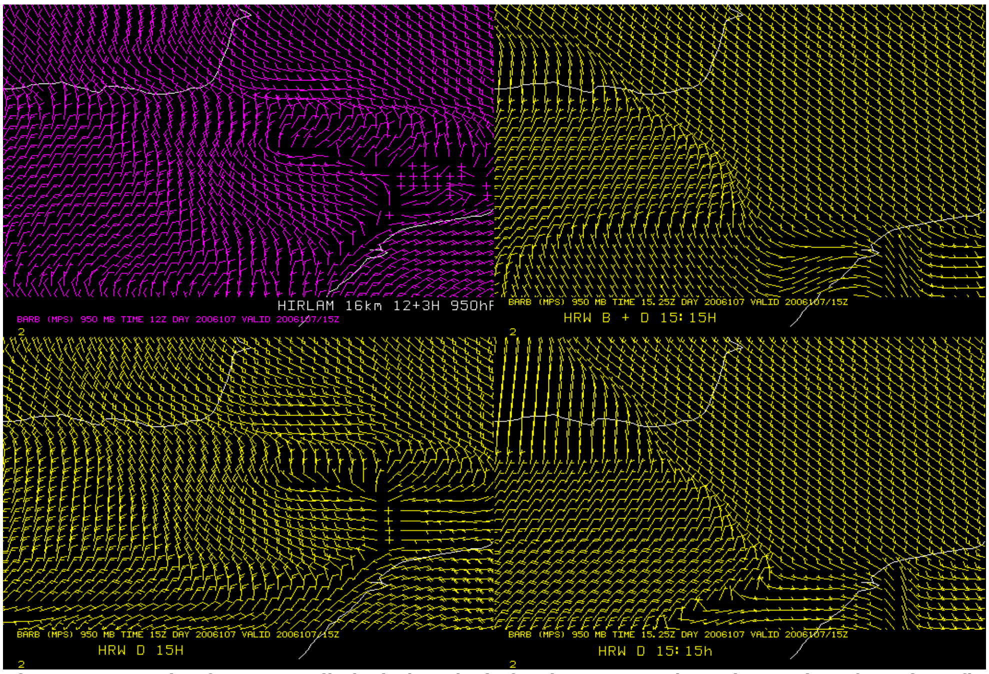

Figure 6: **Example of HRW Detailed wind analysis for theVery Low layer (same day of previous figures, QI > 0.79):**
HIRLAM +3h forecast (up, left);
HRW Detailed analysis at 9:15 UTC, using 9:15 HRW Basic winds analysis as guess (up, left);
HRW Detailed analysis at 9:00 UTC, using HIRLAM at 0.16º resolution as guess (down, left);
HRW Detailed analysis at 9:15 UTC, using PAMIS Detailed analysis at 9:00 as guess (down, right).

In fact, with a QI threshold of 0.80, rather few HRW Detailed winds could be used (in the region displayed). In those conditions, the interpolation should mostly use the guess, but in the test this did not happen. Certainly because the PAMIS method used is the one for upper level parameters, and it is tuned for a mean distance between observations adapted to radio soundings separated hundreds of kilometers: tuning has to be adapted to the HRW and its resolution, or it is the PAMIS method for surface that has to be adapted to interpolate HRW, as distance between surface observations is closer to its resolution.

CONSIDERATIONS FOR FUTURE WORK

HRW winds in the analysis could be over-weighted with respect to the guess (guess information is particularly for the Detailed winds analysis, rapidly lost): there is a need of tuning the Barnes interpolation parameters, or of some changes in the procedure.

It has been discussed that the use of Quality Index and related information, has to be improved: QI reflected in a variable interpolation weight, varying threshold according to which tests were passed, etc. The implications of using more winds (that in turn have shown in the verification activities to give worse results in terms of statistical comparison) must also be evaluated.

Concerning user display tools, there could be too many fields proposed: winds analyzed at 4 layers for 2 different HRW sub-products, plus derived fields. It has also to be taken into account that time discontinuities appear, and could be more relevant at synoptic hours: it is a need to study and work out, how to synthesize, reduce or combine the diverse field parameters to be presented. Besides, the interest and implications of time averaging (e.g. 1hour or 30min products instead of instantaneous) should also be studied.

CONCLUSIONS

The work presented suggests to use the SAFNWC HRW winds (calculated from MSG HRV images) as Barnes interpolations with a guess (NWP forecast at synoptic hours, and then prior HRW interpolations), instead of plotted winds.

A basic method is already experimentally implemented and other possibilities being tested. Anyhow, an important development is still needed: especially with HRW data filtering and interpolation. In order to reach an operational stage, it is also necessary to improve the "user interface".

It is foreseen that in the future, NWP models will assimilate new types of data, including HRW: these studies could provide some hints about how to better exploit HRW possibilities in data assimilation.

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