A FUTURE PRODUCT ON HRVIS WINDS -HRW-FROM THE METEOSAT SECOND GENERATION -MSG-FOR THE NOWCASTING AND OTHER APPLICATIONS

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ABSTRACT

A product for High resolution visible satellite winds, for the years 2001 onwards, is proposed in the frame of the Satellite application facility of Eumetsat to support Nowcasting generating products derived from data of next generation of European satellite systems. The definition of this product and its development now started are in charge of INM; to be noted that the basic purpose for this products is not assimilation in Numerical weather modelling as for most operational Atmospheric motion winds. It is presented the rationale for the product, its planned characteristics and the developments works and a few initial results.

1. The HrW product in the context of the MSG product extraction under Eumetsat responsibility

1.1. Background: The SAF for Nowcasting

Currently, the Eumetsat Applications Ground Segment -AGS- includes just one centralised Meteosat Product Extraction Facility -MPEF, generating a limited but gradually increased set of Meteosat products, for 'general' purpose, the Atmospheric Motion Winds -AMW - being certainly the most important product, and the global Numerical Weather Prediction -NWP- the main user. For the exploitation of data and the production from next Eumetsat systems Meteosat and polar, it was decided to add to the central facilities several Satellite Applications Facilities -SAF, in a decentralised structure.

The rationale to adopt this SAF strategy in Eumetsat has been: to take advantage of the wide expertise and resources existing at the Eumetsat member states; and to define finality-oriented or theme areas for the SAFs so that each of these can be developed in an environment closer than MPEF to the specific use or have interaction with the users.

The "SAF in support to Nowcasting and very short-range forecasting" (called here-after SAF for Nowcasting) was the first launched in 1997, after signature of agreement Eumetsat-INM and bi-lateral agreements with the other partners, MétéoFrance, SMHI and ZAMG, and has been fully

entering the development phase in 1998. With the MSG-MPEF it will be the main facility dedicated to Meteosat Second Generation -MSG- data and products; because some products could appear similar in the plans of both, it is worth to note the objectives of each:

- MPEF will provide global products, while the SAF for Nowcasting is restricted to the upper quarter of the Meteosat disk (the MSG-N format, for the HrW product here-after introduced it is in fact equivalent to B-format in current Meteosat) where the products will have to be optimised, with a generally higher horizontal and even sometimes temporal resolution than expected from MPEF.
- Because of the finality the products in the SAF of Nowcasting will have to be available very soon after the data routinely received: that is, code optimised for fast processing; and specially the fact that it will be portable code to run locally at Eumetsat member states users' sites, thus not subject to dissemination delays as for MPEF products, but introducing other requirements for the deliverables.
- Despite that differences and because common aspects are still there, good co-ordination is to be achieved for the development between MSG-MPEF and SAF for Nowcasting to avoid duplication of work, redundancies, inconsistencies, in the future Eumetsat AGS.

1.2. The HrW product

The SAF for Nowcasting includes: a basic cloud mask or flag; products for cloud and precipitation, clear air mass humidity and thermodynamic stability, and image analysis; the only purely dynamic product included is the "High resolution winds from the HRVIS" -HrW- (INM development responsibility), as this daylight high-resolution visible channel, offering a horizontal resolution of 1km instead of 3km for the other solar or thermal channels, was deemed to be the only allowing wind computations with a horizontal resolution according to the field of application (a few km, but the 15min cycle is still and always a limitation), and as this was -initially- not in the plans for MPEF winds rather considered at scales around 100km. It is also proposed as a HrW sub-product the HRVIS cloud analysis not planned elsewhere in the Eumetsat AGS.

The HrW is expected to provide detailed wind information, during daylight, in: early convective patterns in unstable air masses; borders of mature convective patters; frontal disturbances or others connected to wind shear; and in low scale circulation in the atmospheric boundary layer. This wind information would be used (probably with other AMW or NWP winds) rather in the form of derived fields as convergence, vorticity, shear, or its evolution, or just displacements; dynamic fields which in the practice influence the use of other products in the SAF for Nowcasting.

As the definition of MSG-MPEF evolves, it seems that HRVIS winds will likely be part of its plans, in this case the SAF developments could be best focused in the most specific aspects as: the best scales and tracers for the higher resolution (around or best than 10km), the more conflictive cases (over land, with low sun or rather slant view), the use of features from the HRVIS analysis, the optimisation of the complete procedure particularly for its specific characteristics.

2. The main features of the proposed procedure and product

A continuous approach, i.e. a new set of winds is generated each 15min day-time from the new and the previous slot, instead of the usual '3 slots' more adequate for N:WP purposes; 'continuity' information is nevertheless used to optimise the procedure in terms of speed and wind quality. The proposed procedure (figure 1) is to perform, once any image available, the following steps:

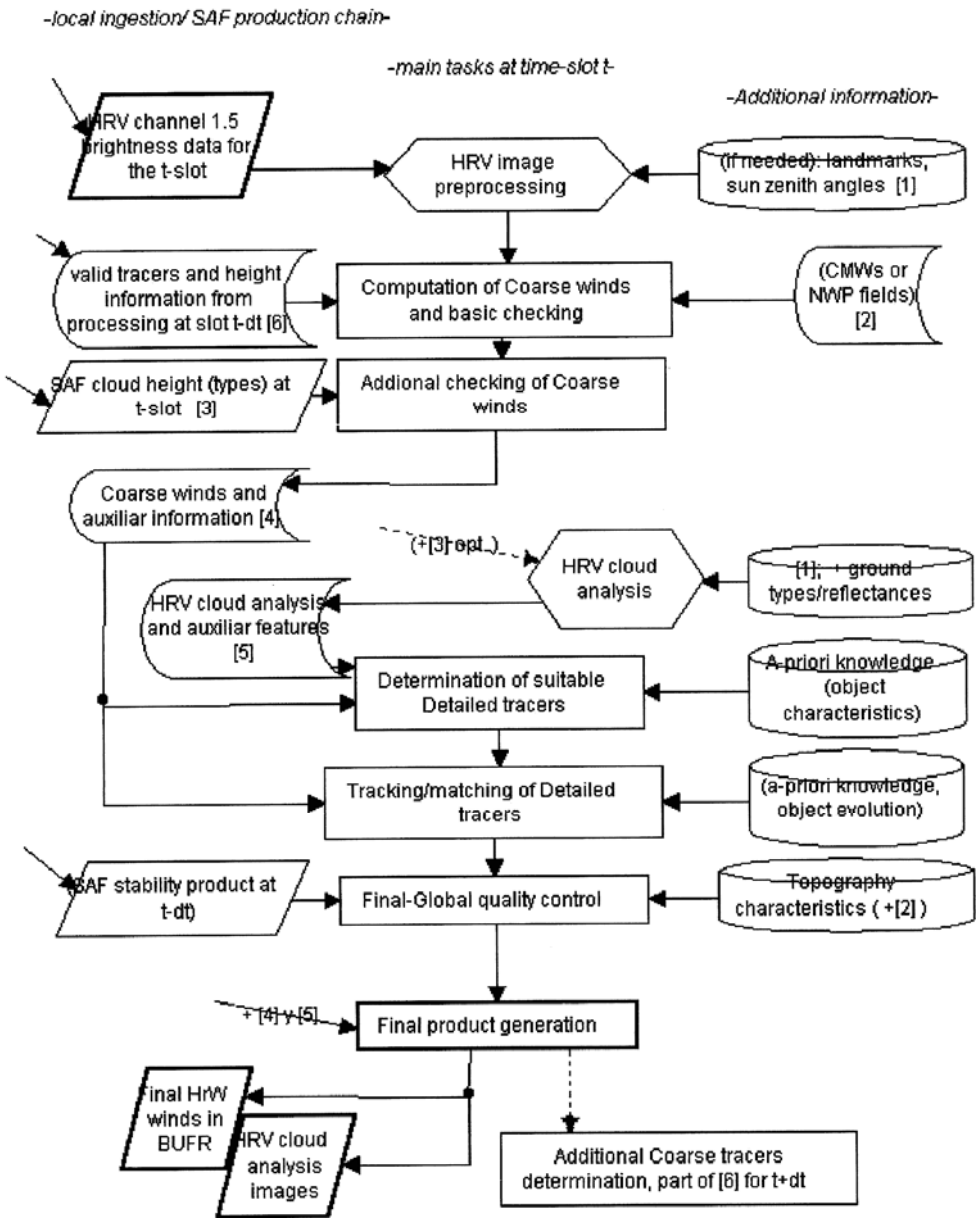

Figure 1. HrW Processing planned scheme (from the Science Plan for the SAF for Nowcasting).

- Extraction of winds at a 'coarse' resolution of around 20-30km; well known existing methods are in principle adequate (except for particular locations or geometry); use of a guess (AMW or NWP; wind from previous slot) is here considered as justified, but other possibilities to fasten tracking (as a 2-step correlation) are foreseen.
- HRVIS analysis: being this a distinct to the others channel, it will rely on spatial analysis of diverse features centred at any pixel with adequate thresholds (calculated taking into account typical ground characteristics and brightness), to at least discriminate: no cloud, bright cloudiness extended/disperse, low brightness cloudiness, dark shadows.

- Extraction of winds at a 'detailed' resolution better than 10km, 2 possibilities (extrapolation of 'coarse' or directly derived methods, or 'objects' matching) are being studied. In both cases, this step will make use of 'coarse' winds as guess, of HRVIS analysis or features, and of knowledge derived during the training of the method, to determine 'conditions' for the tracers (this could also make use of an 'scale analysis'), and (particularly if tracking 'objects') 'constraints' for the matching (also in this case, the possibility to include 'neural' or 'neuro-fuzzy' tools is being considered).
- A final step includes the preparation for the next time-slot, e.g. determination of additional 'coarse' tracers; it is to be determined if 'selection criteria' including meteorological knowledge can be introduced in this step in the procedure itself. Other important element is the quality control, for the most implicit in the mentioned steps but finally enhanced over land to 'avoid' unrealistic winds from non blocked or static cloudiness (using for that topography derived features and other recent products, as stability).

The basic input data are the HRVIS as received at a local station, in an user-defined region in the HRVIS format, and the corresponding SAF products Cloud top temperature-height (for height assignment), and Cloud type (to improve HRVIS analysis and other thresholds). Use of recent SAF Stability product, MPEF's AMW or NWP wind profiles and NWP temperature profiles (for height correction), is to be kept as an option.

The product is to be finally coded in BUFR (binary WMO codes) files, and also as an image for the HRVIS analysis. The baseline is to provide 20-30km winds even over or near land (and at reasonably high latitudes or low sun elevations) where non blocked nor static cloudiness is present, particularly for the phenomena mentioned in 1.2; including height and HRVIS information, plus 'some additional' winds from small tracers in the same locations; the goal being to provide 'homogeneous' wind coverage from which derived fields as commented in 1.2 can be extracted.

3. The development activities and initial tasks

It was started mid-1998 and will be completed until end 2000. It is based on the use of the VIS channels in the GOES-8 and the current Meteosat; the development will be eased with the use of the systems McIDAS (offering interactive possibilities, the access to different data and where is run and utilised the existing INM AMW) and PV-WAVE (very complete tool for image processing), but the software to be prepared will be independent of both and based on wide standards. The validation will combine usual methods (comparison to radio-sonde winds or NWP), with others for highest resolution (e.g. Doppler radar), and also the semi-subjective evaluation of winds from both developer and user point of views. It is considered to involve people outside INM for short missions-specific aspects, using the Eumetsat-SAF frame of "Visiting scientists" (e.g. needs identified for a possible use of neural-neuro-fuzzy methods). Apart from the already introduced product elements, 2 additional items to evaluate in parallel to validation are the impact of the 15min cycle possibly too long for small tracers over land (5min-cycle data-sets are needed to check), and (less relevant) of the fine cloud assignment to small tracers taking into account that a 3km-product is to be used for this.

The work has started with the adaptation of existing methods (INM AMW preparations for GOES, start of preparation for the continuous processing, see figure 2), and the preparations for new or more specific methods and tools (search in documentation references, start to use image processing tools); the -first- objective being to have in the 3rd quarter in 1999: the 'coarse' methods routinely running, being checked and validation cases being selected; a basic HRVIS analysis procedure; and a clear idea of how the 'detailed' procedure will be, to have it implemented and perform final validation in 2000. A detail on these initial works:

- For the 'coarse' procedure the INM AMW is used as basic reference (also because of its user tools not to be in the final modules), but in fact a new one will be prepared which will also include elements from the MPEF AMW (e.g. a similar organisation, part of the tracer selection, additional correlation algorithms, cloud height improvement, and the criteria for quality flagging).

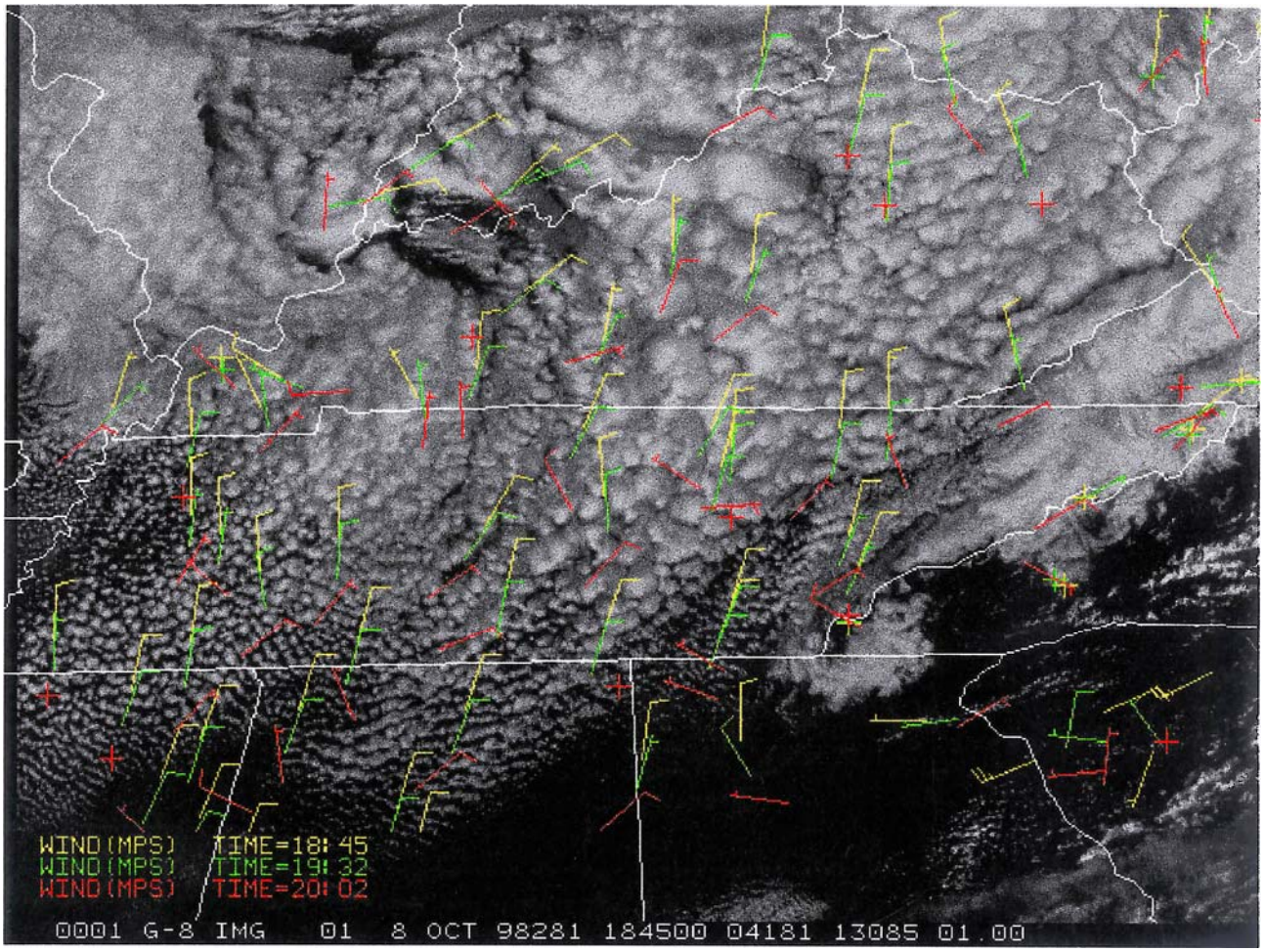

Figure 2 : example of GOES-VIS continuous tracking from a 7-image - 1km - 15min cycle for the same image-1 initial tracers; time slots 1 (yellow flags), 3 (green), and 5 (red, changes or degradation start to be noticeable) are shown.

- The image processing is now used in 3 ways: determination of suitable image- characteristics fields (mean, variance, contrast, entropy, etc.), to be used for the HRVIS analysis (and certainly also in the detailed tracer selection); use of 'wavelets' for the scale analysis (expected to help the tracer selection, could also provide input to a faster 'coarse' tracking, on images at 'adequately degraded' resolution) (figure 3); and topography-derived fields information for the final wind acceptance, over land or orography-influenced (figure 4).

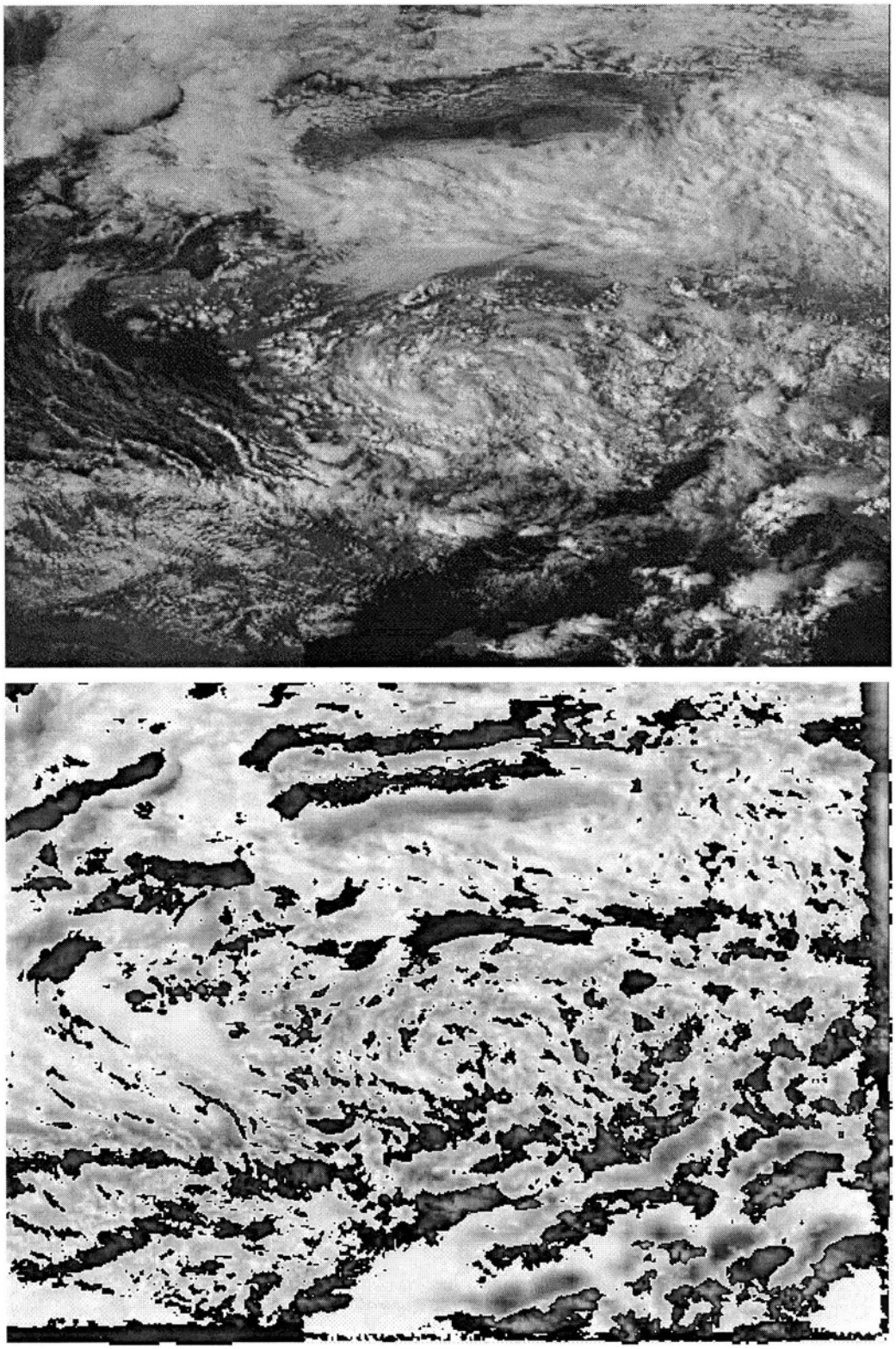

Figure 3. Meteosat-VIS 2.5km image (top), and the same once applied wavelet scale-analysis; the zones including structures between 5 and 20km size appear enhanced in dark.

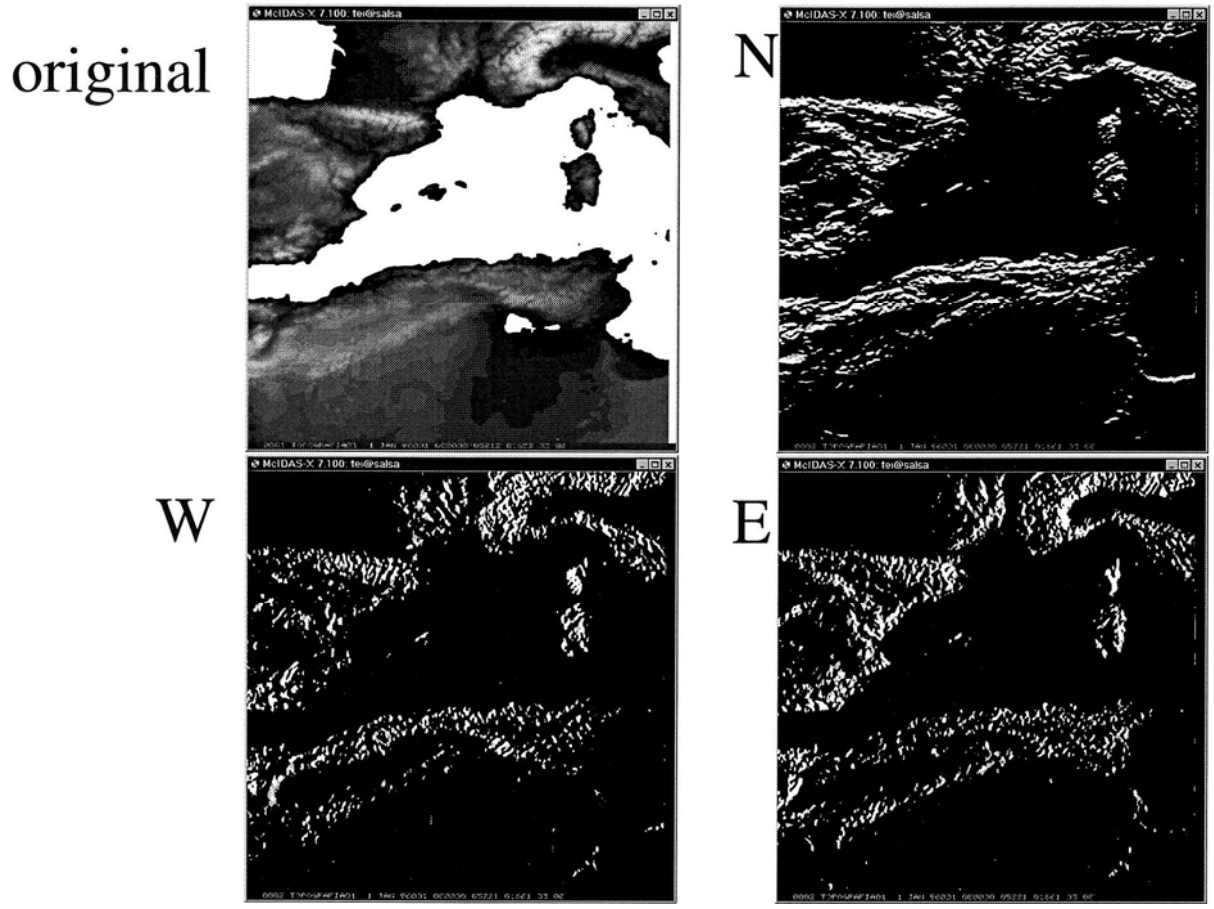

Figure 4. Example of topography (original, top-left) processed using its smoothed gradient: presence and asymmetry of mountains and ridges with respect to different atmospheric flows are shown.

4. Conclusions

A High-resolution winds product from the HRVIS channel has been included in the plans of the Satellite Application Facility in support to Nowcasting and very short range forecasting, to have in this some dynamical information; its development is started.

The HrW product starts from existing techniques; but recognising that this could be limiting for its usefulness for nowcasting, it is proposed to evaluate new ones, or its extension to obtain a resolution of a few km in areas of interest; the possibility of doing this has to be demonstrated during the product development. This presentation (and others) at the Wind Workshop could certainly serve to exchange ideas on the matter, to improve the product definition and subsequent work, or even to think on possible contributions or derived collaboration.

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