CGMS-36 EUM-WP-25
v1, 4 September 2008
Prepared by EUMETSAT
Agenda Item: II/5
Discussed in WGII

REPORT FROM THE 9TH INTERNATIONAL WINDS WORKSHOP

This paper summarises the outcome of the 9th International Winds Workshop (IWW9). The workshop was hosted by NOAA/NESDIS and took place from 14 - 18 April 2008 in Annapolis, Maryland, USA. The IWW9 was attended by 45 scientists from 13 countries. With CMA, JMA, NOAA/NESDIS, KMA and EUMETSAT most of the members of CGMS producing AMVs were represented. Many global numerical weather prediction (NWP) centers participated too, with some sending several contributors reflecting the importance of AMV products for NWP.

This paper:

i) recalls recommendations from CGMS 35 to IWW9,
ii) summarises the highlights of IWW9 with details given as annexes in three working group reports,
iii) introduces the two new co-chairs Dr Mary Forsythe (UK) and Mr Jaime Daniels (USA) who follow Mr Chris Velden and Dr Kenneth Holmlund.

CGMS 36 is invited to discuss the outcome and recommendations from the 9th International Winds Workshop.

Report from the 9th International Winds Workshop

1 INTRODUCTION

This paper summarises the outcome of the 9th International Winds Workshop (IWW9). The workshop was hosted by NOAA/NESDIS and took place from 14 - 18 April 2008 in Annapolis, Maryland, USA. The IWW9 was attended by 45 scientists from 13 countries. With CMA, JMA, NOAA/NESDIS, KMA and EUMETSAT most of the members of CGMS producing AMVs were represented. Many global numerical weather prediction (NWP) centers participated too, with some sending several contributors reflecting the importance of AMV products for NWP.

Members of the Workshop Organising Committee were:
Christopher Velden (CIMSS), Kenneth Holmlund (EUMETSAT), Jaime Daniels (NOAA), Kenneth Carey (Noblis)

and the Scientific Programme Committee members were:
Christopher Velden (CIMSS), Kenneth Holmlund (EUMETSAT), Jaime Daniels (NOAA), Mary Forsythe (Met Office) and Donald Hinsman (WMO)

The structure of the paper is as follows:

- Section 2 recalls the recommendations from CGMS 35 to IWW9.
- Section 3 provides the highlights of IWW9, with more details given in the three reports from working groups at IWW9 on Methods (WG-I), Data Assimilation (WG-II) and Height Assignment (WG-III), respectively
- Section 4 introduces the new Co-Chairs of IWWG.

2 RECALLING RECOMMENDATIONS FROM CGMS 35 TO IWW9

The Rapporteur of IWWG to CGMS, J. Schmetz, introduced recommendations from CGMS 35 in the opening session of IWW9. The recommendations specific to IWW9 were often traceable to IWW8 and subsequent reports to CGMS. Following the format of previous Winds Workshops it was suggested to address the recommendations in the break-out working groups during IWW9.

Recommendation 35.07:
CGMS members to respond to recommendation 34.15 should finalise the first phase of the project (i.e. the processing of the AMVs with their own operational AMV algorithm without any modification) before IWW9 and discuss the results.

Recommendation 35.08:
IWW9 should discuss the results from the height assignment studies based on advanced instruments on the A-train. The co-Chairs of IWWG are invited to provide a summary report to CGMS36.

Recommendation 35.09:
IWW9 should discuss the results of the studies using the images simulated from NWP model output to track AMVs. Co-Chairs of IWWG are invited to provide a summary report to CGMS36 on results of the ongoing studies on deriving AMVs from images simulated from NWP model. The report should address both the imagers as well as the hyper-spectral sounders.

Recommendation 35.10:
Direct retrievals of wind fields from Doppler Wind Lidars need to be continued beyond the ESA ADM mission.

Recommendation 35.11:
IWW9 should discuss the height allocation to atmospheric layers and pursue tests within NWP assimilation and forecast systems.

Recommendation 35.12:
CGMS 35 recommends to put the CGMS wind statistics on the new IWWG web site and to discuss at IWW9 whether a strict adherence to CGMS collocation criteria should be followed and whether the criteria need to be re-defined.

Recommendation 35.16:
CGMS Members to continue to support activities of the three International Working Groups (ITWG, IWWG and IPWG) particularly upcoming science meetings in 2008:

2.1 Feature Tracking with Hyperspectral Sounders

Following up on previous work in preparation for the use of hyperspectral sounders, the following scientific issues and related questions were recalled:

- Generally speaking: Horizontal feature tracking does not give a 'true' wind vector (due to cloud and moisture development), although in many instances it is a good proxy for the horizontal wind field. Therefore, an important question to be addressed in the future is:
- *Can we use the information from single-band images and hyperspectral data in a better or more adequate way?*
- With new hyper-spectral sounders (e.g. the IRS on Meteosat Third Generation) we would much better observe 3-d changes of moisture fields. The open question is:
- *Which advances have to be made to employ these potential observations of the 3-d evolution of moisture and cloud field? It is supposed that the question of scales in space and time and how they are represented in numerical models is one key.*

In order to substantiate the matter further, some results of a EUMETSAT-led external study (with DLR, Germany) were recalled. In particular, the study found that:

Convective events can lead to strong differences between model winds and derived AMVs.
Convection and related strong signals in the moisture field are an important error source in the derivation of AMVs.
A related question is: to what extent does this compromise the idea to derive wind profiles from hyperspectral sounders? Does emphasis on humidity fields and their changes in space and time deserve a higher priority?

3 HIGHLIGHTS OF IWW9

IWW9 was very successful with an impressive amount of ongoing collaborative projects. Much of the work was in response to CGMS recommendations and a continuation of issues from previous workshops. It was encouraging to see the progress made. A very laudable achievement is the increase in collaboration on common projects; this enhances the basis for discussions and progress.

As highlights from IWW9 the following topics can be listed:

Intercomparison study, using a common MSG data set
A study using image data simulated from NWP fields for the derivation of AMVs
An improved height assignment where the pixel selection for height assignment is based on the feature that is being tracked
A novel study investigating whether an AMV should be assigned to level or layer.
Studies involving the use of CALIPSO to assess AMV height assignments
Work in NWP to better handle correlated errors (notably work at ECMWF)
Research to better understand the impact of AMVs in NWP and the error characterisations of AMVs. This is an ongoing collaboration between most of the NWP centres represented at IWW9
Work to improve understanding of how best to derive and use AMVs for mesoscale applications

With regard to recommendations for work to be performed in the near future and possibly requiring more emphasis and resources CGMS 36 is invited to consider the following topics:

Development of physically-based AMV vector and height error estimates.
Improved understanding of the error characterisation of AMVs
Investigations into use of hyperspectral sounder data in support of future geostationary sounding missions
Use of additional information on cloud characteristics (e.g. microphysics) within the AMV derivation schemes

The complete recommendations are provided in the three working group reports in the annexes.

4 NEW CO-CHAIRS OF THE INTERNATIONAL WINDS WORKING GROUP

The 9th International Winds Workshop was the last workshop under the leadership of the Co-Chairs Chris Velden (CIMSS, Madison, Wisconsin, USA) and Ken Holmlund (EUMETSAT, Darmstadt, Germany). Chris and Ken had chaired this important CGMS Working Group since the 5th workshop in 2000 in Lorne, Australia. The following two workshops, i.e. the 6th in Madison, USA in 2002 and the 7th in Helsinki, Finland in 2004 were held in the hometown and countries of Chris and Ken, respectively. They were followed by the 8th workshop in Beijing in 2006 and finally the 9th workshop in 2008. Chris and Ken have helped foster the progress of the 'winds community' embedded in CGMS. Progress has been substantial and well reflected in the workshop proceedings edited by Ken and Chris. CGMS is kindly invited to acknowledge the outstanding leadership and contributions by Chris Velden and Kenneth Holmlund; their co-chairing of five International Winds Workshops is also a record which presumably will last for a while.

For new Co-chairs, the IWWG welcomed Dr Mary Forsythe, UK (Met Office) and Mr Jaime Daniels, USA (NOAA/NESDIS). Mary Forsythe has worked on AMV assimilation in NWP at the Met Office for the last 7 years. She also manages the NWP SAF AMV monitoring pages, part of which involves the production of biennial analysis reports and recommendations to coincide with the International Winds Workshops. Jaime Daniels has been at NOAA/NESDIS' Center for Satellite Applications and Research for the past 23 years. During this time he has worked on the development of retrieval algorithms for AMVs, temperature and moisture soundings, and cloud properties from NOAA's operational geostationary and polar orbiting satellites. He has been an active member of the IWWG since 1998. Both Mary and Jaime are already 'old hands' in the winds group and their broad experience will provide a seamless transition from the previous Co-chairs.

5 CONCLUSION

The 9th International Winds Workshop hosted by NOAA/NESDIS in Annapolis, US from 14-18 April 2008 continued the series of successful meetings. All recommendations from CGMS 35 have been considered and were discussed in detail (see Annexes). An outstanding element is the increase in collaborative activities, e.g. work on AMV derivation using a MSG data set, and work on deriving AMVs from image data simulated from NWP model fields. CGMS 36 is invited to comment on this specifically and to encourage the collaboration further. CGMS members are also invited to support the necessary collaboration by enabling specific studies and also by providing funding for travel of scientists.

Concerning recommendations for work in the immediate future CGMS 36 is invited to emphasise the following aspects and possibly request contributed papers on those topics for CGMS 37:

Development of physically-based AMV vector and height error estimates
Improved understanding of the error characterisation of AMVs
Investigations into use of hyperspectral sounder data in support of future geostationary sounding missions
Use of additional information on cloud characteristics (e.g. microphysics) within the AMV derivation schemes

The detailed recommendations from the three Working Group are reported in the annexes of this paper.

Mr. Chis Velden and Dr. Ken Holmlund retired as Co-Chairs of the International Winds Working Group after ten years of service. They provided exceptional leadership and received thanks and appreciation for their sustained work.

Dr. Mary Forsythe and Mr. Jaime Daniels have been selected as new Co-Chairs and their broad experience will provide a seamless continuation of the work of the previous Co-Chairs.

The full proceedings of the 9th International Winds Workshop are available on the EUMETSAT web site under: www.eumetsat.int, then go to Publications and into Conference and Workshop Proceedings.

Annex I - REPORT FROM WORKING GROUP I: AMV EXTRACTION AND QUALITY CONTROL METHODS (WG-1)

CHAIRPERSONS: JOHN LE MARSHALL[1], ARTHUR DE SMET[2]
[1]Centre for Weather and Climate Research (CAWCR), Australia.
[2]EUMETSAT, Darmstadt, Germany.

INTRODUCTION

Several key areas related to wind extraction and quality control were addressed during the Ninth International Winds Workshop. Important results from the AMV inter comparison study were presented and results from the use of simulated imagery in AMV production were provided. Renewed attention was given to relating tracer and height assignment pixels and also to error specification (QI, EE). Considerable progress was noted in the generation of AMVs from MISR data and in the use of the A-train to better understand relevant physics and for verification.

Working Group I discussed several topics related to wind extraction methods and quality control. The items addressed included material arising from the Workshop presentations and as a result of liaison with CGMS. Several of the items addressed arose during the Plenary Discussions chaired by Johannes Schmetz and Ad Stoffelen. Key areas discussed are summarised below.

Intercomparison Study.

The working group members recognised the importance of the AMV inter-comparison study, the results of which were presented at the workshop by Iliana Genkova. They recommended that the study should be continued, with more tightly defined study goals. In relation to the goal to compare algorithms for height assignment and quality control, it was recommended that where possible all participants in the study use exactly the same target locations. It was also agreed that common sizes for target and search areas should be applied (using an even number of pixels, because some AMV derivation systems do not allow an odd number).

It was also noted that a new date for the Intercomparison should be defined with images using the new radiance definition now used at EUMETSAT. Working group members expressed a preference to select a date for both summer and winter. Moreover, it was noted it would be of considerable benefit to co-ordinate the Intercomparison with the study on simulated images, so that the same dates and times are used.

The comparison should be extended and include all QI components, the RFF, RFI and all components of the Expected Error (EE).

IWW9_WG1 Recommendation 1:

AMV producers should continue the inter-comparison study. The goals of the study should be tightly defined and documented. A new date should be defined, preferably one in Summer 2008 and another one in Winter 2008/2009. It is strongly recommended to co-ordinate this study with the study on simulated images, so that a common date will be used. If feasible, the AMV producers should all derive winds from a pre-defined set of target locations.

Simulated Imagery Study

The working group noted with considerable interest the results of the study using simulated images to generate AMVs. The study was performed by ECMWF and presented at the workshop. Similar studies have also been performed at the University of Wisconsin. The Working Group noted the importance of studies of this type and noted they could be used to investigate in more detail areas such as optimising AMV estimation and error characterization and the determination of error structure functions. The members suggested that further studies be undertaken, some at higher horizontal and vertical resolution if feasible, to improve the modeling of cloud and the wind field.

IWW9_WG1 Recommendation 2:
The study with simulated images should be continued preferably with a model that has a higher horizontal and vertical resolution. It should be co-ordinated with the AMV inter-comparison study.

CGMS Wind Statistics

It is important to have a central storage point for CGMS wind statistics, which is accessible to everyone interested. The IWWG web-site is the obvious candidate for this. The working group members agreed that the web-site should include a description of the methods used by each wind producer in the generation of the statistics, other than the CGMS specified criteria (e.g., methods for handling outliers).

IWW9_WG1Recommendation 3:
The CGMS wind statistics should be accessible on the IWWG web-site. The site should contain a description of the criteria used in the generation of the statistics, not only the criteria specified by CGMS, but also those applied by the individual wind producers.

Rapid Scan Winds And Mesoscale Modeling

There is already some experience with using (rapid scanning) winds in the context of mesoscale modelling and data assimilation. There are also some documented improvements in forecast skill associated with higher temporal resolution wind observations. Work in these areas needs to be continued to assist in the planning of future observation methodologies and the optimization of related assimilation efforts.

IWW9_WG1 Recommendation 4:
More studies are needed on the use of (rapid scanning) winds in the context of mesoscale modelling and data assimilation. These are needed to assist in the planning of future observation methodologies and for the optimization of the related assimilation methods.

Wind Derivation and Height Assignment

Results of a wind derivation method that directly relates the tracking target pixels to the image pixels that are used for the height assignment were presented at the Workshop. This is a promising technique and should be pursued. In recent time the resources devoted to this area of development have been limited, despite the fact that relating tracking and height assignment pixels and the determination of cloud height remain important sources of error in the generation of atmospheric motion vectors.

IWW9_WG1 Recommendation 5:
Wind-derivation methods that identify the pixels that contribute most to the tracking and use these pixels in height assignment, should be further investigated.

(One example of this type of work was presented by Régis Borde and Ryo Oyama at the Winds Workshop.)

Error Characterization

The Working Group discussed the use of the QI at higher spatial resolutions and the use of the Expected Error (EE) components (total wind error (m/s), horizontal error components (m/s), height error (hPa), wind vector determination error (m/s)) for error characterization, quality control and data thinning. It also discussed the feasibility of reporting the expected error (components) in the winds BUFR product.

IWW9_WG1 Recommendation 6:

Wind producers should derive the Expected Error for each wind. The methods of reporting the Expected Error in the BUFR product should be documented.

Next-Generation Wind Determination

The working group was aware of the proposed move to infrared hyper-spectral observation from geostationary orbit by several wind producers. A number of studies have been completed (for example in relation to the GIFTS project) documenting the benefits of wind determination using hyper-spectral observations. After a discussion on the future direction of wind derivation from satellite the working group made the following recommendation.

IWW9_WG1 Recommendation 7:
A consolidated study should be presented at the next International Winds Workshop on the use and benefits of hyper-spectral observations for the measurement of atmospheric motion.

Annex II – Report from Working Group II
Data Assimilation Working Group at the
9th International Winds Workshop in Annapolis, April 14-18

Alexander Cress, DWD, and Lars Peter Riishojgaard, JCSDA
Co-Chairs

The Data Assimilation Working Group discussed several of the pertinent CGMS actions as well as a number of separate issues of relevance to the international collaboration on improving the use of satellite winds for data assimilation and numerical weather predictions.

It was noted that the impact of satellite winds is positive in almost all systems, for all regions, all predicted variables and at all time scales. However, it was also noted that considerable room for improvement exists in the areas of height assignment and quality control/data selection, and a number of specific recommendations were put forth. There was general agreement that height assignment is still the main source of error in the AMV data processing chain, especially in regions of high wind shear. In this context, the working group agreed, that separate estimates of height in [hPa], U and V in [m/sec] errors should be provided, along with estimates of the total error. It was also stressed out, that error estimates should be, if possible, physically rather than statistically based.

Another potentially useful item of information is the provision of an estimate of the vertical layer for which the wind vector is representative, so that a suitable layer thickness may be assigned through the NWP observation operator. It was noted that CIMSS might be willing to provide quantitative information about representative vertical layer for each AMV for a test period and that the Met Office then could provide preliminary assessments of innovation statistics for these test data set. It was furthermore recommended that the possibility of using corrected observed temperature rather than assigned pressure to identify the appropriate vertical model level for the AMV wind vector should be tested.

One frequently raised concern about the use of satellite winds for NWP is that the data is affected by spatially and temporally correlated errors that when not accounted for can have a substantial negative impact on forecast quality. Since most data assimilation systems cannot account for horizontal observation error correlations, data thinning is a widely used alternative. The working group discussed this issue intensively and encouraged the data assimilation community to develop methods to explicitly account for observation error correlation in their systems. It was also recognized that observation error covariances are in need of renewed estimation as both the global observing system and typical model resolutions have changed since the original work by Borman et al. substantially.

The use of model-simulated imagery as a tool for studying and improving the perfomance of product generation and data assimilation systems was strongly endorsed, and it was pointed out that these data have potential applications also in the assessment of future candidate observing systems such as hyperspectral infrared sounders in geostationary orbit. The workshop recommended that this work be continued and extended to higher horizontal resolution using limited area non-hydrostatic models together with highly resolved global models for the same date in order to compare the results.

Finally, the Workshop recognized the importance of other (non feature-tracking) types of satellite wind observations. Data assimilation testing of the Lidar wind observations to be obtained from ESA's ADM/Aeolus mission was encouraged and future work toward exploring this measurement technique also for operational use was strongly recommended. The prospects of obtaining real-time access to ISCAT data was greeted with enthusiasm.

Annex III - REPORT FROM WORKING GROUP III: HEIGHT ASSIGNMENT

Chairpersons: Iliana Genkova[1] and **Régis Borde[2]**
[1]CIMSS, Madison, USA
[2]EUMETSAT, Darmstadt, Germany

This working group reviewed the progress made in AMV height assignment research; the results presented in the session III of this workshop, and also examined recommendations from CGMS 34 and 35. Finally, it made some recommendations to CGMS based on recent developments in this field.

Participants: Roger Davies, Kris Bedka, Richard Dworak, Jamie Daniels, Greg Dew, Claire Delsol, Eun Ha Sohn, Mary Forsythe (part time), Arthur De Smet (part time), Ryo Oyama (part time), Regis Borde (co-chair), Iliana Genkova (co-chair),

Discussion highlights and recognised achievements since the 8th International Winds Workshop

A couple of interesting papers have been published recently that relate to AMV techniques. The WG-3 discussed the most recent of them presented during the 9IWW:

1. Addressing CGMS recommendation 35.11, Chris Velden and Kris Bedka identified the uncertainty in determining satellite-derived HA, and proposed to consider AMVs as a layer in assimilation process

2. Regis Borde and Ryo Oyama proposed a new pixel selection methodology to keep a close link between feature tracking and HA of operational AMVs.

3. Following CGMS recommendations 34.14 and 35.08, Genevieve Seze et al. presented results from a AMV HA comparison against A-train CALIOP instrument. It recognised best agreement with CALIPSO for AMV heights for low level, inversion correction and cloud base HAM. These findings will be written into a paper and possibly used for developing a flag reporting which AMV HAM are most reliable for data assimilation purposes. (See Seze&Borde presentation)

4. Based on results and conclusions from the 8IWW, the clustering process of several HA algorithms have been changed, i.e. EUMETSAT (De Smet) and JMA (Oyama et al.).

5. Following CGMS recommendations 34.14 and 35.07, the results from a global AMV retrieval algorithms inter-comparison between producers have been presented (Genkova et. al.)

6. It was recognized that it is important to separate errors from tracking and HA in assimilation process. Work by Mary Forsythe and Roger Saunders illustrated the idea.

7. HA for polar AMV derived from AVHRR was reported as problematic at times, because the coldest pixels in a target often are not the clouds, but the ice surface instead. Comparisons with MISR (when available) may help assessing the errors in AMV altitudes due to such circumstances.

Major part of the discussion was dedicated on how to add up-to-date cloud type/analysis info into the AMV product development, i.e. EUMETSAT is using cloud analysis (CLA) product, CIMSS/NESDIS could use Geocat cloud product info in the future, Now-casting SAF cloud type could be used by other AMV producers, and so on. Cloud phase and vertical cloud development could be deduced from such products for more stringent test of the quality of the target before derivation of AMV.

RECOMMENDATIONS FROM WORKING GROUP WG-III

The three most significant recommendations were, in no particular order:

1. Work toward derivation of ΔH_error (AMV Producers and collaborating cloud teams); AND ΔH_layer (K.Bedka, C.Velden, J-G. Pereda,); Evaluate/Stratify by cloud properties and AMV characteristics and communicate with NWP for guidance (Met Office, ECMWF).

2. Need for independent height and wind error estimates. Define what input may be used. Report ΔU/V from intermediate (sub-vector/ displacement) AMV as a first step, more elaborate error may be developed at individual AMV centers.

3. Test the use of individual pixel contribution as a pixel selection process for HA (Borde and Oyama; Oyama et al.).

The following recommendations were deemed important, in no particular order:

4. Run new date case, (CGMS study), extract on a grid, estimate height from same target/search box size as well as “as is” in operational algorithm; Report target albedo/BT; only with ECMWF forecast; 10.8microns only; (CIMSS/NESDIS)

5. Recognised AMV heights in best agreement with Calipso; (best - low level, inversion correction and cloud base HA method); write up a paper/report; when possible ‘prescribe’ which AMV HA method are most reliable; (R.Borde, G.Seze)

6. Suggest adding most up-to-date cloud type/analysis info into the AMV product (i.e. new EUMETSAT CLA product, Geocat cloud product info, Now-casting SAF cloud type); (all AMV producers).

7. More stringent tests before derivation of vector: cloud phase, check change of vertical development, to extent possible use channels that all have on their satellites – OK! Re-evaluate thresholds related to possible vertical development ; Optimise use of Cloud phase and Cloud mask for HA purposes

8. Similarity of MISR winds, i.e. bias not due to height assignment: stratify MISR by cloud type for better comparison – It would be good if more MISR data studies are performed – use ECMWF first guess, stratification by cloud type.