THE NWP SAF INTEGRATED SATELLITE WIND MONITORING REPORT

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ABSTRACT

The NWP SAF (Satellite Application Facility for Numerical Weather Prediction) is a 5-year EUMETSAT-sponsored project to develop processing methods and software to enable satellite data to be exploited for NWP purposes by the EUMETSAT Member States. One of the first deliverables from the NWP SAF is the Integrated Satellite Wind Monitoring Report, which displays observation-background differences for different NWP models (currently those of ECMWF and The Met. Office). These statistics are being gathered in order to try to separate the contributions from the two sources, observation and background, and thus to improve the derivation of satellite wind observations, their use within NWP models, and the NWP models themselves. After four months of operation, some results are highlighted here, illuminating certain characteristics of the winds and the models. It is hoped that in forthcoming months, both the set of quality statistics displayed and the number of NWP centres contributing to the report will increase. The 5th International Winds Workshop will make a clear recommendation to CGMS for maintenance and enhancement of the satellite wind monitoring report, allowing the satellite producers to give formal permission for the publication of their data. The satellite wind monitoring report is available for viewing at http://www.met-office.gov.uk/sec5/NWP/NWPSAF/satwind_report/

1. Introduction

The NWP SAF (Satellite Application Facility for Numerical Weather Prediction) is one of currently seven EUMETSAT-sponsored SAFs. The purpose of the SAFs is to develop processing methods and software to enable satellite data to be exploited in various meteorological application areas. Each SAF is a 5-year research and development (R+D) collaboration of a few EUMETSAT Member States, with the likelihood of a subsequent operational phase to apply and extend the products of the R+D phase. More information about SAFs is available at the EUMETSAT web-site, http://www.eumetsat.de. The report is available for viewing at http://www.met-office.gov.uk/sec5/NWP/NWPSAF/satwind_report/

The NWP SAF was approved by EUMETSAT Council in November 1998. The Kick-off Meeting was held in February 1999 and the SAF's planned 5-year term will end in February 2004. The SAF is led by The Met. Office, with partners ECMWF, KNMI and Météo-France.

The objectives of the NWP SAF are as follows:

- to improve the benefits derived by European NMSs from NWP, by developing techniques for more effective use of satellite data, and
- to prepare for effective exploitation within NWP of data and/or products from satellites in the EPS and MSG Programmes and related programmes of other agencies.

The main development activities of the SAF are concerned with the processes required to generate the intermediate products of the full data assimilation process, not with the products themselves, and the work of the SAF is structured according to input data (i.e. by instrument: ATOVS, IASI, ASCAT, SEVIRI, etc.) rather than according to geophysical parameter.

The main deliverables from the SAF's activities will be software packages for implementation at NWP centres within their data assimilation schemes, or at EUMETSAT central processing facilities or at other SAFs. The SAF will focus on development activities, but will also provide support to implementation activities.

The emphasis of the SAF's activities is on development, rather than research. However, it is also proposed that there should be some scope for support of associated research activities, through the EUMETSAT SAF Associate/Visiting Scientist programme.

2. The integrated satellite wind monitoring report

One of the first deliverables from the MVIRI/SEVIRI section of the NWP SAF is the Integrated Satellite Wind Monitoring Report, which displays differences between satellite wind observations and NWP models. The comparison is between the transmitted observation of wind and a 6-h forecast of wind from the NWP model, valid at the observation time, that provides the background data for the new model forecast. Both the satellite wind observation and the model forecast contribute to these differences; neither can be assumed to be true, and therefore the differences are model dependent. The report presents, in similar formats, differences found in different NWP models in order to try to separate the contributions from the two sources (observation and model). This should enable the improvement of both derived satellite winds and their treatment within NWP models, as well as highlighting differences in the characteristics of the models. NWP centres contributing to the report are ECMWF and The Met. Office at present.

Currently (February 2000) there are two separate types of statistical quality plot. The first is a wind speed contour map, which plots observation vs background wind speed and gives the density of observations on a logarithmic scale. From these plots can be seen the average wind speed bias, and areas of significant departure from the 1:1 line. The second type is a global map of wind speed bias and standard deviation, plotted for different wind types (infrared, water vapour, visible) and at different pressure levels. From these can be seen the geographical areas where there is significant mismatch between observation and models. The similarities between these maps can highlight where the observations are not matching the real wind, and the dissimilarities can highlight where the NWP centres are modelling features differently.

A set of data has been collected for four months so far (October 1999 - January 2000), and these plots will form the basis of a continual set, at least for the lifetime of the NWP SAF. However, there is still potential for the introduction of new types of quality plot, and the website for the Integrated Satellite Wind Monitoring Report will continue to be developed.

In general, the agreement between the background fields and the observations is good; indeed the satellite winds would not be assimilated routinely into NWP models if it were not. Some examples are given below where significant differences were seen between the background and observed values.

2.1. Comparison of wind speed contour plots

Figures 1a and 1b compare the wind speed contour plots for ECMWF and The Met. Office, respectively, for Meteosat-5 infrared low-level (700 - 1000 hPa) winds in the tropics (20ºN - 20ºS), averaged for January 2000. The difference in the number of winds shown from the two centres is due to the fact that ECMWF monitors (and uses) those winds from EUMETSAT received in BUFR code, whereas The Met. Office monitors (and uses) those winds received in satob code. Notwithstanding the numerical difference, the statistics and features of the plots are very similar. Most notable is the plume of winds reporting an observation speed in excess of background speed. This is due to erroneous height assignment of these winds (high faster winds being assigned to a low height where the wind speeds are actually slower) and is a known problem at EUMETSAT. The problem is often that the wind-tracking algorithm is following semi-transparent cirrus clouds and assigning the motion to a lower height. However there is another cause of incorrect height assignment. An NWP model vertical profile is used to match brightness temperature with height. It was found at EUMETSAT (Gustaffson and Lindberg, 2000) that due to the coarse resolution of the model profile, in regions where maritime temperature inversions exist, an incorrect height can be assigned. Gustafsson and Lindberg (2000) corrected the wind-production method to take account of this and subsequent time-series of quality statistics has confirmed that there has been an improvement in observation-background agreement since this change was made. Thus it can be deduced that the remaining winds that have the wrong height assigned are probably due to the tracking of cirrus clouds. Interestingly, equivalent plots for visible winds show that this problem does not feature in The Met. Office's use of visible winds (at low resolution), yet does show up in ECMWF's use of high-resolution visible winds in BUFR code. (Not featured, see Monitoring Report website.)

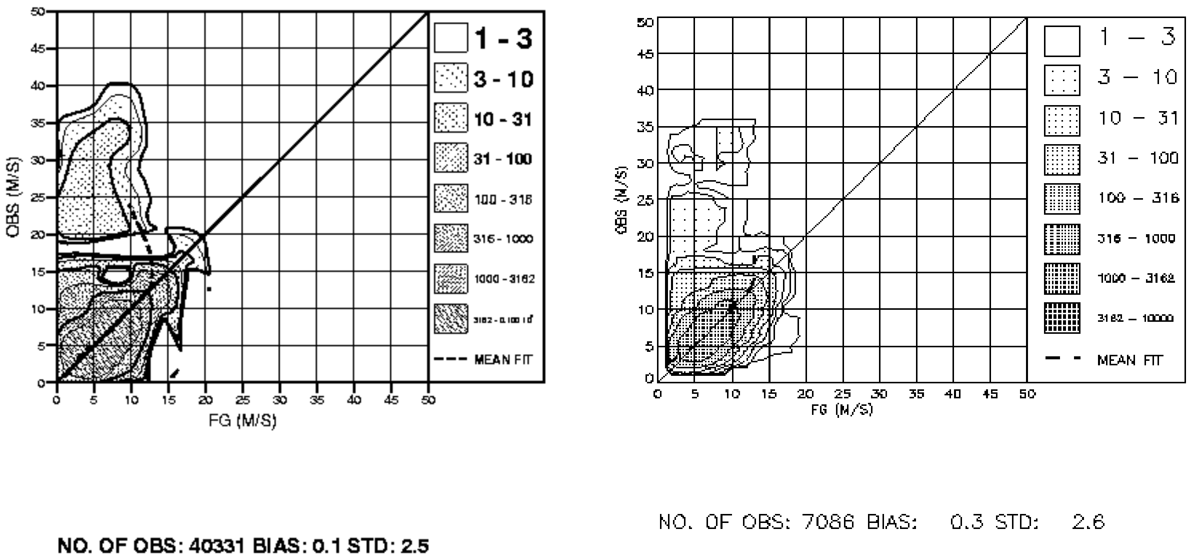

Figure 1. Wind speed contour plot for Meteosat-5 infrared winds in the tropics (20ºN - 20ºS) at low level (700-1000 hPa), averaged for January 2000, compared with the a) ECMWF (left panel) and b) The Met. Office (right panel) background field.

2.2. Comparison of wind speed bias global maps

The second type of graphical plot is a global map of observation-background wind speed bias and standard deviation. Figure 2 shows some examples of this type of plot. The top panel shows observation-background wind speed bias for high-level infrared winds vs the ECMWF model and the bottom panel shows the same vs The Met. Office model. The data are averaged for January 2000. It can be seen that there is some consistency in the signals that are seen from the two centres. For example, both ECMWF and The Met. Office show consistent small-scale features of persistent negative speed bias in the northeastern and southeastern Pacific ocean. Similarly, both centres show large positive wind speed biases around the coastlines of northern and western South America. Taken in isolation it is tempting to conclude that in these areas the wind production method for the GOES winds is in error. However, since the production of GOES winds relies heavily on the use of the NESDIS auto-editor (Nieman et al., 1997), there is the possibility that the NCEP model is the source of the problems. Another suggestion is that both the global models at ECMWF and The Met. Office have erroneous wind speeds in these areas. Further investigation is therefore necessary: communications with the satellite wind producers, investigation into radiosonde-reported wind speeds from the regions affected, if any, and a knowledge of the persistent biases inherent in each model. It must again be emphasised that the point of the NWP SAF Integrated Satellite Wind Monitoring Report is to help to improve both the production and the use of satellite winds, and that deficiencies may be revealed in the satellite winds, the NWP models, or both.

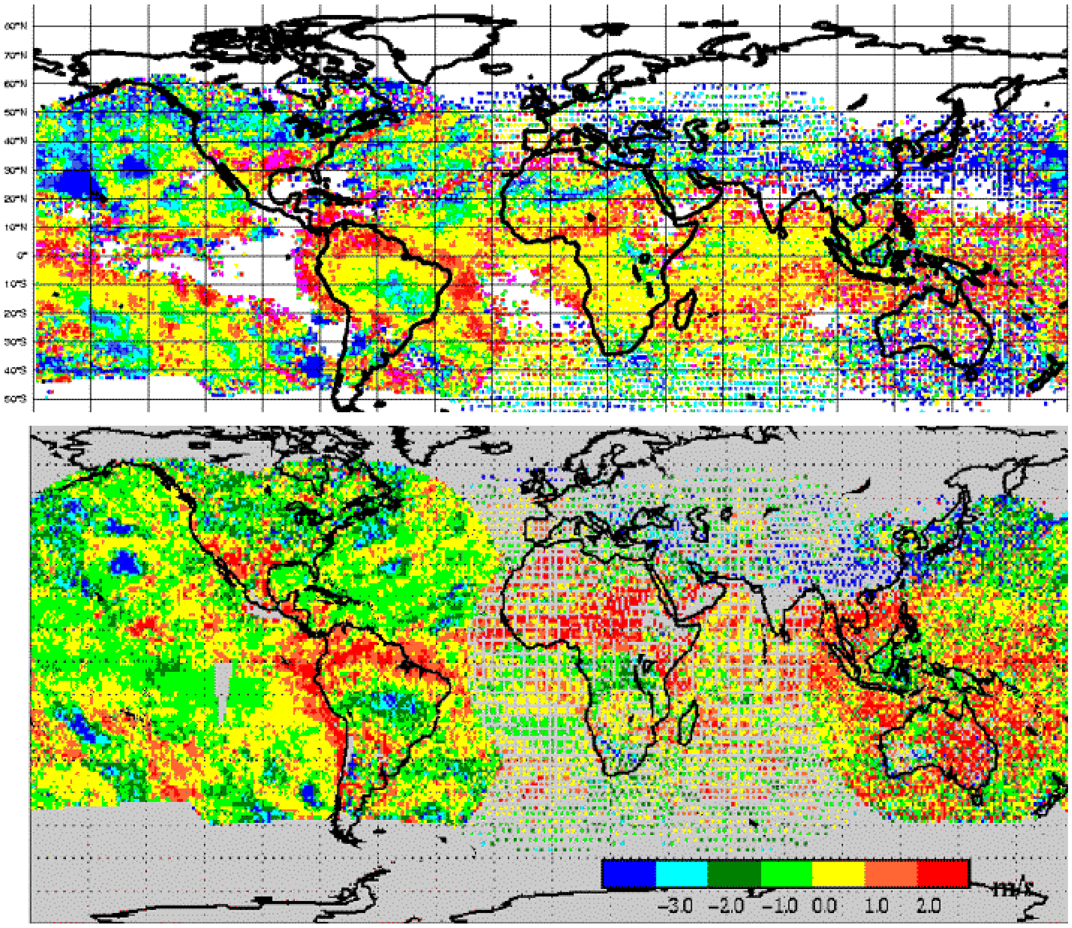

Figure 2. Observation-background wind speed bias. Top: high-level infrared satellite winds vs ECMWF background field, bottom: high-level infrared satellite winds vs The Met. Office background field.

In contrast, some differences between the plots can be seen with respect to high-level infrared winds from GMS. ECMWF biases are strongly negative in the extratropics, whereas those shown by The Met. Office have some strong positive areas. Referring to the contour wind speed plots of high-level GMS infrared winds (Figs 3a and 3b), it is seen that, although overall the wind speed bias is calculated as negative for both centres, it is more strongly negative for ECMWF, implying that average wind speed in this region is greater in the ECMWF model than in The Met. Office model.

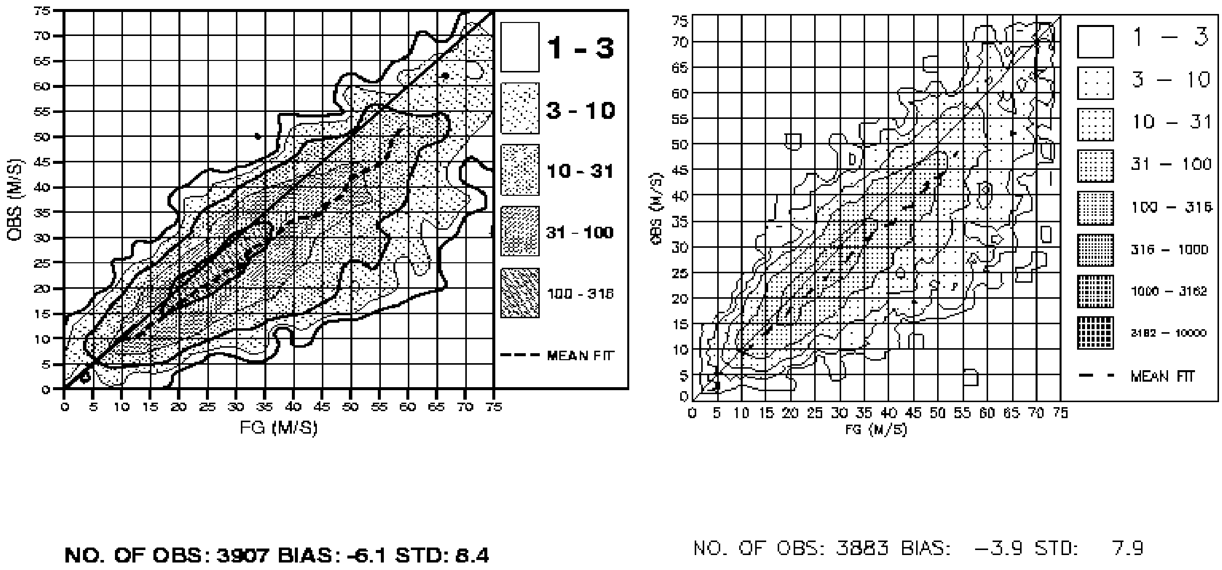

Figure 3. Wind speed contour plot for GMS infrared winds in the northern extratropics at high level, averaged for January 2000, compared with a) the ECMWF(left panel) and b) The Met. Office (right panel) background field

The top panel in Fig. 2 shows that use of new BUFR-coded satellite winds from EUMETSAT is providing much more resolution in the wind field than the use of satob-coded winds (ECMWF uses and monitors high-resolution winds provided by EUMETSAT in BUFR code). Relatively small-scale features can be seen over northern Africa in the data, which are not as obvious when the lower resolution satob-coded product is used (Fig. 3, bottom panel). However, some features are consistent, for example, the small plume of positive wind speed bias emanating from southwestern Africa.

3. Future developments

This paper has featured just a small selection of the plots that are available from the NWP SAF Satellite Wind Integrated Monitoring website. The information is freely available on the internet and it is hoped that it will be of interest to the satellite wind community worldwide; it is not intended solely for the NWP SAF. It is thus intended to stimulate thought and discussion and eventually to lead to improved production and use of satellite winds, as well as improvements in NWP models and assimilation procedures. Other NWP centres are invited to contribute to this report, not just those involved in the NWP SAF, and this invitation is extended to centres outside Europe. Data will continue to be added on a monthly basis, and future plans are for cross-links to access the CGMS satellite wind monitoring site, to encompass comparison of satellite winds vs radiosondes and aircraft. Feedback is invited from viewers of the website (a contact link is provided), and the format is expected to evolve accordingly. A summary of preliminary results will be compiled in spring 2000. It is envisaged that this website will eventually replace the ECMWF quarterly satob monitoring report.

REFERENCES

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