First analysis of data displayed on the NWP SAF Integrated Satellite Wind Monitoring website: April 2001

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This documentation was developed within the context of the EUMETSAT Satellite Application Facility on Numerical Weather Prediction (NWP SAF), under the Cooperation Agreement dated 25 November 1998, between EUMETSAT and the Met Office, UK, by one or more partners within the NWP SAF. The partners in the NWP SAF are the Met Office, ECMWF, KNMI and Météo France.

Change record			
Version	Date	Author / changed by	Remarks
1.0	20/4/2001	P. Butterworth	Original version.
1.1	23/5/2001	P. Butterworth	Minor amendments.

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1. Introduction

As outlined on the NWP SAF Integrated Satellite Wind Monitoring Report (ISWMR) homepage, at http://www.metoffice.com/research/interproj/nwpsaf/satwind_report/index.html, the data displayed show comparisons between two global NWP models and satellite wind vectors from geostationary satellites, in order to try to separate the error contributions from the two sources. This should enable the improvement both of derived satellite winds and of their treatment within NWP models, as well as highlighting differences in the characteristics of the models.

After more than a year of routine collection of the data, this report is the first thorough analysis of the findings. It has been ordered so that a summary of actions and planned improvements is at the beginning of the report. The lists of comparisons come afterwards, for those with deeper interest. Please note that we do not have answers for all the discrepancies seen; comments and suggestions on these, as well as suggestions for improving the report itself, will be very welcome and should be emailed to nwpsaf@metoffice.com

2. Summary of actions

Please see the referenced items in later tables for more details.

Centre(s)	Action	Priority
ECMWF/Met Office	Liaise to evaluate best option for display of WV satwinds; see item P8	H
ECMWF/EUMETSAT	Characterise biases, investigate height	M/H

	assignment problems; see item SB3	
ECWMF/Met Office/all NWP centres	Ensure QC is effective at low wind speeds; see item SC2	M
ECMWF/Met Office/all NWP centres	Ensure QC rejects high fast winds being assigned to low heights; see item SC3	M
EUMETSAT	Seek ways of further reducing the problem of high fast winds being assigned to low heights; see item SC3	M
Met Office	Display GOES data every 3h, and GOES WV data; see item A2	M
ECMWF/Met Office	Investigate cause of bad O,B agreement for Met-5 VIS in NH and implement QC procedures to counteract; see item SC6	M
ECMWF/Met Office	Look at model-model differences to investigate relative wind speeds; see item DC1	M
ECMWF/Met Office	Derive satwind statistics for GOES winds without bias/height corrections; see item SB1	M
ECMWF	Investigate height assignment within NWP; see item SB2	M
EUMETSAT	Investigate WV wind production; see item SB6	M
ECMWF	Compare satwinds vs other obs in N. Am. to establish bias of satwind or model; see item DB7	M
ECMWF/Met Office	Consider exchange of data, rather than plots, to avoid scalloping in ECMWF contour plots; see item P7	L
ECMWF	Check accuracy of picture-triplet winds; see item ST3	L
Met Office	Check locations of sonde stations off Africa; see item ST5	L

3. Planned improvements to the ISWMR

These relate to improvements to the content or presentation of the ISWMR. They are combined from various sources. (J Gustaffson, M Rattenborg, EUMETSAT; N Bormann, F Lalaurette, ECMWF; R Saunders, Met Office; attendees at the 5th International Winds Workshop.) A number of the suggestions below could easily be fulfilled by incorporating information from the ECMWF SATOB quarterly monitoring report, which is currently a paper report only.

Those suggestions provisionally selected for incorporation into an upgrade of the Monitoring Report are listed in sections 3.1 and 3.2. We are concentrating on those suggestions that fall within the initial remit of the ISMWR. The suggestions in section 3.3 will be considered for later improvements as resources permit.

3.1. Extra information for satwind-model comparisons

- Vector differences could be better than speed differences. Plot MVD or normalised Vector RMS as well as biases. Consider applying to both contours and maps.
- Expand to include GOES VIS and WV winds from participating centres.
- Data shown at the moment are all winds received. Put on extra info to indicate characteristics of assimilated data (eg, %/no/rejection rate).

3.2. Miscellaneous planned improvements

- Make a link to the document on obs/background errors prepared by Dr Tsuyuki (JMA) for CGMS (will be linked on EUMETSAT also), for clarification on errors and background fields etc.
- Post links to NESDIS' satwind monitoring time series.
- Once first analysis (this document) is completed, aim to post further analyses every 6-12 months.
- Make the distinction clear between WV clear and WV cloudy winds.
- Provide links to the winds producers' websites for detailed information about the processing methods used to derive the winds.
- Host a page displaying recent satellite wind impact experiments at various NWP centres, with description, main results and interpretation.

3.3. Later updates

- Post time series of statistics. (ECMWF SATOB report).
- Long-term time series of bias and SD for last N years would be useful, but difficult to assemble for both centres.
- Post Met Office/ECMWF model-model difference plots on website. Already have data available but not corresponding to satwinds layers. (However, this will be difficult to maintain if a third partner arrives.)
- Comparison of winds against other observations. (ECMWF SATOB report). Model comparisons vs other observations. (ECMWF SATOB report).
- Make the satwinds page more than just a monitoring report. Post info (or links) about the use/selection criteria applied at all centres, observation errors etc.
- Use the page as a repository or discussion forum for others' successes/problems with use of satwind data.
- A log of recent changes to satwinds from all producers.

4. Differences in presentation or processing that impede comparison

It was quickly discovered that unless the same data are plotted in the same way, it is very difficult to make comparisons. Harmonising the data and plots was not an easy task, but has now been largely achieved. There remains a fundamental difference in WV plots, which we hope to reconcile soon. Outlined below are the main identified obstacles to comparison. Most have now been removed, but some affect presentation of data from

earlier months. Such differences have to be discounted in order that significant differences relating to data errors can be recognised.

4.1. Presentation differences

Mismatch	Action	Priority	ID no.
The Met Office only displayed EUMETSAT BUFR winds within 60 mins of synoptic time, thereby showing roughly half the data of ECMWF, until mid-February 2001.	resolved		P1
For many months, different QI thresholds on the plotting of EUMETSAT BUFR winds were used. For October 2000, the two centres applied the same threshold (those that ECMWF had been using). From November 2000, both centres use the recommended EUMETSAT QI threshold for a particular satwind type.	resolved		P2
Different graphics packages and colour keys were used for plotting map data until October 2000.	resolved		P3
Different combinations of EUMETSAT BUFR and SATOB winds were plotted by the two centres. From September 2000, both plot EUMETSAT data received in BUFR format only.	resolved		P4
Boundaries for speed bias contour maps have changed over the months, according to the number of winds going into the algorithm, but both centres have changed together.	resolved		P5
Minimum number of winds allowed into contour and map plotting routines differ for the two centres before December 2001. Both centres now show every wind available.	resolved		P6
ECMWF contour plots show scalloping due to the contouring method used; it is not an artefact of the data.	None immediately; unable to edit plotting package. Consider exchange of data to allow plotting by same package. (Met Office,ECMWF)	L	P7
A mismatch in the Meteosat WV and VIS BUFR winds plotted was recently discovered. ECMWF shows low-resolution cloudy and clear-sky WV winds, Met Office displays high-resolution cloudy WV winds only. ECMWF displays low-resolution and high-resolution VIS winds, Met Office displays high-resolution only.	Evaluate best option and both centres to implement (Met Office,ECMWF)	H	P8

4.2. Assimilation and/or data differences

Mismatch	Action	Priority	ID no.
ECMWF applies "gross filtering" on all itssatwind data, thereby removing the extremes of O-B. Gross error filtering incorporates filtering of weak winds (< 5 m/s) and those with greater than 50 m/s O-B departures.	None. Not desirable to change this procedure to improve presentation of data		A1
The Met Office is not retrieving, therefore not displaying, any GOES WV data, nor 3-hourly GOES data, only 6-hourly.	Retrieval expected by June 2001 (Met Office)	M	A2
Differences in assimilation at the two centres mean that one model will be drawn towards certain wind types, while the other will not. For example, ECMWF assimilates BUFR winds from EUMETSAT, therefore O-B statistics are likely to be more favourable since these winds are contributing to the model. Since the Met Office is not assimilating EUMETSAT BUFR winds, its model is more "independent" of those data.	None. Not desirable to change this procedure to improve presentation of data		A3

5. Plot comparisons

This section lists similarities and differences between corresponding plots from the two centres. These features are believed to stem from model/assimilation scheme differences or from satwind errors rather than being artefacts of the presentation. In most cases, probable causes and possible actions are suggested.

Similarities between the ECMWF and Met Office plots may point to a deficiency in the observed satwinds, whereas differences in plots are likely to point to model differences. However, it must be borne in mind that different NWP models may have weaknesses that produce similar errors in forecast fields.

Similarities and differences are listed for:

- contour plot comparisons
- map (geographical) comparisons of biases and standard deviations

5.1. Contour plot comparisons

Comparisons are taken mostly from November and December 2000 data, since many difference issues (see above) had been resolved by then.

5.1.1. Similarities in contour plots

Observed feature	Hypothesis	Proposed action	Priority	ID no
Met IR HL: Contours are tight around the O,B line	O ~ B			SC1
Met-5 IR LL: NH showing bulge at low O,B	B>>O. It is difficult to obtain an agreement between O and B in light wind speed areas, and EUMETSAT acknowledge that slow winds can be produced by navigation differences between images.	NWP centres ensure that QC is effective at low speeds (Met Office,ECMWF)	M	SC2
Met-5 IR LL: All latitudes showing drift at higher O,B (implying O>>B), SH to a lesser extent than NH and TR.	High fast wind being assigned to too low a height. This is a known problem at EUMETSAT and is due to semi-transparent cirrus. Some revisions to the wind extraction procedure have already been made to alleviate this problem with some success. The signal remaining is due to few winds as evidenced by the density contour.	NWP centres must ensure that their QC procedures are adequate to reject these winds (Met Office,ECMWF) EUMETSAT is encouraged to seek ways of further reducing the problem (EUMETSAT)	M M	SC3
Met-7 IR LL: Only TR showing a pronounced drift at higher O,B (implying O>>B)	as SC3	as SC3		SC4
Met-5 WV HL: NH showing severe bulging at low B wind speed (B>>O, typically 50 vs 5) for both centres, but ECMWF showing more severe with higher densities exhibiting this trait.	This feature is not seen for Met-7. Perhaps the change in assimilation strategy (ECMWF reject all winds reporting in a box around the Himalayas) is affecting this, as well as the WV plot mismatch.			SC5
Met-5 VIS LL: Generally bad agreement between O and B in the NH	Partly due to low number of winds and light wind speeds, partly possibly to Himalayan effect.	Investigate likely cause; implement procedures to counteract, eg prior rejection, low wind speed cut-off (Met Office,ECMWF)	M	SC6
Met VIS LL: SH very good agreement. O ~ B.				SC7
Met-5 VIS LL: Broad contours at low O,B in TR.	As mentioned above, agreement between O and B in light wind speed areas is difficult to obtain.	as SC3		SC8
GOES IR HL: Contour showing general good				SC9

agreement. O ~ B.				
GMS IR HL: No. of obs approx equal.				SC10
INSAT IR HL: Number of data not sufficient or consistent enough to obtain any general conclusions.		Encourage IMD to produce routinely (Met Office,ECMWF)	L	SC11

5.1.2. Differences in contour plots

Observed feature	Hypothesis	Proposed action	Priority	ID no.
All sats IR HL: Met Office showing biases closer to 0; ECMWF biases has a stronger slow bias	This implies that the ECMWF model winds are faster than those of the Met Office at high levels. Biases of other obs against the ECMWF model are not as strong as those against satwinds.	Plot model-model differences to investigate further (Met Office, ECMWF)	M	DC1
Met IR LL: ECMWF showing approximately double the number of winds.	Met Office does not retrieve all EUMETSAT BUFR winds at all times, but only those within 60 mins of synoptic time.	as P1		DC2
Met WV HL: NH and SH biases are much better (closer to 0) for Met Office.	Met Office only showing cloudy WV. Indicates that clear-sky winds not as readily comparable to model winds	as P8		DC3
Met-5 WV HL: In TR, ECMWF sees drift to O>>B at higher wind speeds	as above	as P8		DC4
Met-5 VIS LL: ECMWF showing roughly 3 times the no. of winds as Met Office.	ECMWF showing low-res and high-res.	as P8		DC5
GOES IR HL: ECMWF showing roughly 2 times the no. of winds as Met Office.	Due to ECMWF retrieving every 3 h, Met Office every 6 h.	as A2		DC6

5.2. Map comparisons

While comparisons between contour plots display characteristics of the satellite winds at high and low wind speeds, looking at a map display helps to separate the geographical characteristics of the data. Observations below taken mainly from data for Oct - Dec 2000.

5.2.1. Similarities in bias maps

Observed feature	Hypothesis	Proposed action	Priority	ID no.
GOES IR HL: Similar regions of +ve and -ve speed biases are identifiable in ECMWF and Met Office plots.	NCEP's global model is heavily involved in production of GOES satwinds, so it is not clear if we are seeing a real signal or NCEP model climatology.	Derive statistics for winds without bias/height corrrections. Look at model-model differences again. (Met Office,ECMWF)	M	SB1
GOES IR HL: Both centres show strips of +ve bias either side of ~8 N.	ITCZ? Sustained cloudy area? Height assignment wrong?	Investigate height assignment within NWP (ECMWF)	M	SB2
Met IR HL: Negative bias showing mainly in extratropics, where higher wind speeds expected.	Characteristic satwind feature: unable to follow high wind speeds, due to either: (a) height assignment problems/related to using the winds as single level data? (b) Tracer not representative of the actual wind, in terms of spatial averaging or no tracers in jet core. Better temporal averaging may help.	Characterise the biases, investigate height assigment problems, investigate improved observation operator (ECMWF, EUMETSAT)	M/H	SB3
Met IR HL: Positive bias regions showing off SW India, negative biases over Saudi Arabia, Himalayas.	Indicative of cloud climatology and particular cloud that produces poor tracers?			SB4
GMS IR HL: No readily identifiable regions of bias can be seen, although both centres show broad bands of bias for NH, TR and SH.	Wind production method is currently not able to retrieve small-scale features, although it captures broad features.	System upgrade believed due with MTSAT-2 (JMA)	M	SB5
Met WV HL: Overall +ve bias in TR, -ve bias in NH and SH.	WV has difficulty matching light winds in tropics? Height assignment problems?	Investigate WV wind production (EUMETSAT)	M	SB6
GMS WV HL: General +ve bias over oceanic regions, -ve over Australia. Both centres show a low bias region around New Guinea.				SB7
GOES IR ML: Similar bias regions apparent for both centres.				SB8
GOES IR LL: Very clearly defined bias regions, especially +ve	Indicative of cloud climatology and particular cloud that produces poor			SB9

regions off coast of western S.America.	tracers?			
Met IR LL: Positive bias regions off coast of central Africa are very clear.	Associated with oceanic upwelling regions, persistent marine stratocumulus? Height assignment? Recent studies with 5-min imagery show two opposing flows in this region. Normal winds may be unable to resolve these flows	.	As SB2	SB10
GMS IR LL: Both centres show relatively featureless maps.	Due to fixed height assignment at low levels, therefore unable to capture small-scale features of wind field?	none; await MTSAT-2		SB11

5.2.2. Differences in bias maps

Observed feature	Hypothesis	Proposed action	Priority	ID no.
GOES IR HL: ECMWF showing data in more places than Met Office.	Change of min. obs number in obs plotting for Met Office in Dec 2000 has removed the striking differences in bias map location plotting.			DB1
Met IR HL: Positive bias regions more extensive for ECMWF than Met Office in central Africa.		As DC1		DB2
GOES WV HL: Only ECMWF data available. Clear regions of bias can be seen.	Bias regions comparable to GOES IR HL, so consistent.			DB3
Met WV HL: Met Office data show more extensive +ve bias region in TR, and more extensive -ve bias over Arabia and the Himalayas.		As DC1		DB4
Met WV HL: ECMWF regions of -ve bias in extratropics are broader, implying faster winds over a larger area in ECMWF model.	Partly WV data mismatch.	As P8		DB5
Met VIS LL: ECMWF is	Due to mismatch in VIS	As P8		DB6

seeing data over land and Met Office is not.	plotting. Winds over land produced in low-res product only.			
Note the difference between Meteosat WV and GOES WV data, against one centre: ECMWF.	Most likely a result of the NESDIS bias correction and height adjustments. The NESDIS approach appears to be working in the right direction (though at the expense of greater model dependency), and a better understanding of the speed biases is required for further improvements. Note, however, the remaining strong biases for GOES winds over N. America, a region well-covered by other observations	Compare satellite winds against other observations over N. America to establish whether the remaining bias is a satellite wind bias or model bias. (ECMWF)	M	DB7

Comment: On the whole ECMWF shows more extreme differences in the plots above. The ECMWF first guess check is very tight, and so winds deviating from the first guess significantly will be rejected and not assimilated. This has the result that the model does not draw to extreme winds, and so when differences are plotted, the ECMWF model is further from the extreme winds than that of the Met Office.

5.2.3. Standard deviation maps

Observed feature	Hypothesis	Proposed action	Priority	ID no.
Met WV HL: Generally high SD in high bias regions, but for ECMWF very high SD almost everywhere. Met Office tends to have more small-scale features in SD.	ECMWF include clear-sky WV	As P8		ST1
GOES WV HL: Although biases acceptable at edge of disk, SD are very high.	Indicative of difficulty with retrieval and processing at edge of disk?	Liaise with NESDIS to look at feature	L	ST2
GOES IR LL: Nearly always higher over land, and ECMWF show more data here.	Fewer vectors produced over land? ECMWF probably showing picture triplet winds, which are worse fit to model. (Assigned to fixed height.)	Check accuracy of picture triplet winds (ECMWF)	L	ST3
Met VIS LL: (eg Dec 2000) Note interesting, very localised, high SD	Seem to be located with Canary Islands and Cape Verde, so possibly			ST4

regions over the ocean off the NW coast of Africa, appear for both centres. (Also a fast bias in this region.)	showing influence of sonde data on models. Otherwise a special cloud regime,e.g. thin cirrus being tracked and assumed to be low cloud? ITCZ?			
Met IR LL: Shows some high SD points for both ECMWF and Met Office over Africa.	As ST4- coincides with sonde stations?	Check location of sonde stations (Met Office)	L	ST5

6. Abbreviations

B	background field (equivalent to FG)
BUFR	satellite wind observation in BUFR (Binary Universal Format for data Representation) format
DWD	Deutsche Wetter Dienst
ECMWF	European Centre for Medium-range Weather Forecasts
FG	first guess field (a 6-h forecast valid at the time of the satellite wind)
GOES	both GOES-8 and -10, unless shown otherwise
H	high priority
HL	high-level (above 400 hPa)
IR	infra red channel satellite winds
ISWMR	Integrated Satellite Wind Monitoring Report
L	low priority
LL	low-level (1000-700 hPa)
Met	both Meteosats-5 and -7, unless shown otherwise
M	medium priority
ML	medium-level (700-400 hPa)
NH	northern hemisphere (north of 20 N)
O	observation, i.e. satellite wind vector
QC	quality control
SATOB	satellite wind observation in SATOB format
satwind	satellite wind
SD	standard deviation
SH	southern hemisphere (south of 20S)
TR	tropics (20S - 20N)
VIS	visible channel satellite winds
WV	water vapour channel satellite winds

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