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Quality monitoring of weather radar wind profiles at the Met Office

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Abstract. The Met Office hosts the CWINDE data hub within the EUMETNET WINPROF Programme, and collects data from wind profilers and Doppler weather radars across Europe. Approximately 55 weather radars supply VAD profiles at present. These data come from Sweden, Finland, the Netherlands, Ireland, Austria, Belgium, Germany and Spain.

Quality monitoring of the VAD wind profiles from radars has been carried out at the Met Office since 1999, chiefly by comparison with 6-hour forecasts from the Met Office operational global NWP model, and also with nearby radiosondes. Quarterly reports are produced and circulated to the data providers, who find them useful in their efforts to improve the data quality. The monitoring is also studied on a monthly basis for the purpose of deciding which stations should be assimilated into the Met Office operational NWP models.

Most of the VAD data is of comparable quality to that from other wind profilers and to radiosondes, though a few stations have speed and direction biases, especially at low levels. A small number of stations have persistently larger differences from the model forecast. The monitoring is described, along with examples of the kind of behaviour seen in the statistics.

1 Introduction

The CWINDE (Cost Wind Initiative for a Network Demonstration in Europe) Hub was set up in 1997 as part of COST76. CWINDE began as a development network looking at performance of wind profiler data across Europe. Weather Radar wind profiler (WRWP) data were introduced as part of COST717 and subsequently incorporated into the CWINDE hub. The EUMETNET WINPROF Programme followed on the work started by COST76. The role of the CWINDE hub has now moved on from a demonstration network to focus more on quality control and the expansion of the acronym has changed to Co-ordinated Wind Profiler Network in Europe. The strong liaison between the two EUMETNET programmes WINPROF and OPERA has led to a large increase in WRWP data available to CWINDE during the last year in particular. Most of it is available for exchange over the GTS. Figure 1 shows the current location of each WRWP site contributing to CWINDE. Wind barb plots for the most recent 12-hour period are generated and updated every 30 minutes for each site. An example can be found at Fig. 2. They can be found on the CWINDE web pages at the following URL; http://www.metoffice.com/research/interproj/cwinde/wradar/index.html.

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2 Data monitoring

The Met Office's Numerical Weather Prediction (NWP) section started to process and monitor WRWP in 1999, and began to assimilate them operationally in February 2001, when the majority of reports were from the radar sites in Sweden. From November 2002 reports from 2 Dutch radars and from February 2003 reports from 7 Finnish weather radars have also been assimilated. Recently wind reports from radars in Austria, Germany, Belgium and Spain have been received and are being monitored. Figure 3 shows the upward trend in numbers received.

An "acceptance list" of good stations is maintained, based on monthly statistics, and this list is updated each month. There is a time lag of several months between the increases in the number received and those assimilated, during which time the WRWP quality is monitored. This explains the gap between the number received and the number assimilated at the end of the time series in Fig. 3.

Wind reports are thinned to one profile per hour, prior to assimilation in the Met Office's NWP models. The quality flags within each report are checked and the winds are rejected if a flag has been set. All winds are also quality controlled by an automatic scheme (based on Bayesian probability theory). This consists of a "background check"

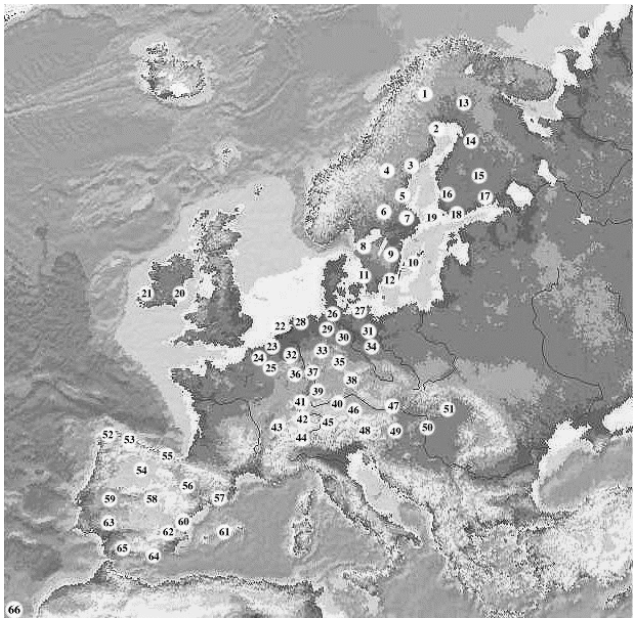

Fig. 1. Locations of weather radars contributing wind profiles to the CWINDE data hub.

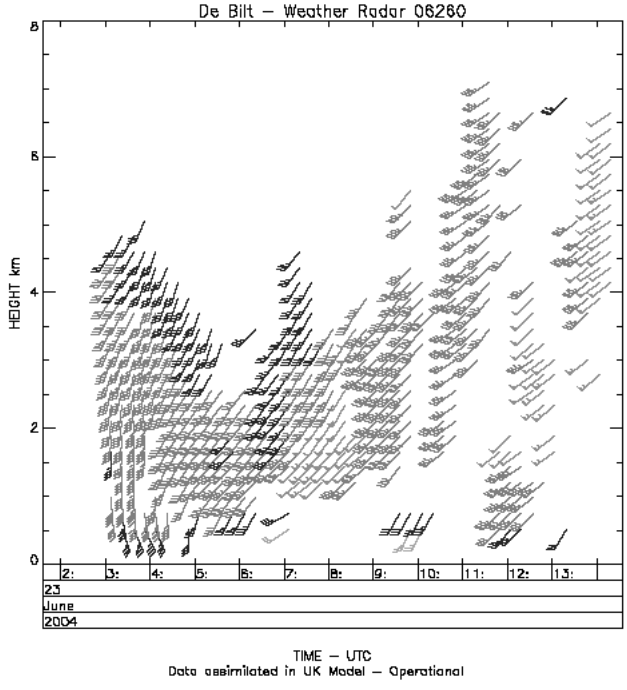

Fig. 2. Example time-height wind barb plot for 12 hours of data from De Bilt (Netherlands).

against a short-period forecast and a "buddy check" against near neighbours. Reported-level winds are averaged over the NWP model layers before being assimilated in the Met Office's 3D-VAR scheme, in which they are treated in the same way as radiosonde winds.

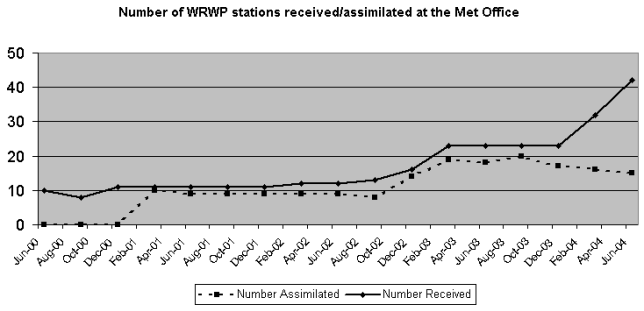

Fig. 3. Time series showing number of WRWP received (dashed line) and assimilated (full line) at the Met Office, for the period June 2000–June2004.

3 Quality of the European weather radar winds

Most of the monitoring of the weather radar winds is done monthly and quarterly, using the statistics on their differences from background winds (o-b values). Background values are interpolated to the observation time from 3-hourly forecast fields valid at T+3, T+6 and T+9. Plots shown in this paper also contain observation-analysis (o-a) differences, though where the model T+0 field has assimilated the observation in question, these are not independent of the observation and so are less useful for monitoring. WRWP are also compared with nearby radiosondes. This comparison is based on a group of nearby stations in the general vicinity of the radar site, as comparison with the single nearest radiosonde might give a misleading impression.

Over the past 4 years the majority of radar wind reports received at the Met Office have been of good quality – e.g. the o-b profiles for De Bilt radar in Fig. 4a compare well with the o-b profiles for the radiosonde station in Fig. 4b. The WRWP winds also compare well with winds from other wind profilers, although their quality is slightly more variable. Several stations have exhibited variable quality from month to month (e.g. see the time-series in Fig. 5) or from night to day (e.g. compare the poor quality winds from Ostersund at 00 UTC in May 2004 in Fig. 6a with the good quality winds at 12 UTC in Fig. 6b).

A common problem is a speed bias at low levels, especially in spring and autumn, as shown in Fig. 7 for the Finnish radar at Kuopio (02918) during April 2004. As a result, some stations' winds are only assimilated above or below certain levels. Several stations have been reporting generally poor quality winds for some time, possibly due to lack of quality control at source. An example is Dublin, although the recent upgrade there from VAD to a VVP algorithm seems to have improved the quality somewhat. Over the second quarter of 2004 the quantity and quality of the VAD winds from the Swedish radars seems to have gone down somewhat, with only 5 out of 12 radars reporting significant numbers or levels of winds in May 2004 (another 3 radars reported some very low level winds only). These 5 all had quite high rms vector wind o-b values for the period 21 UTC to 06 UTC, which accounts for the recent slight downward trend in the number of WRWPs assimilated, seen in Fig. 3.

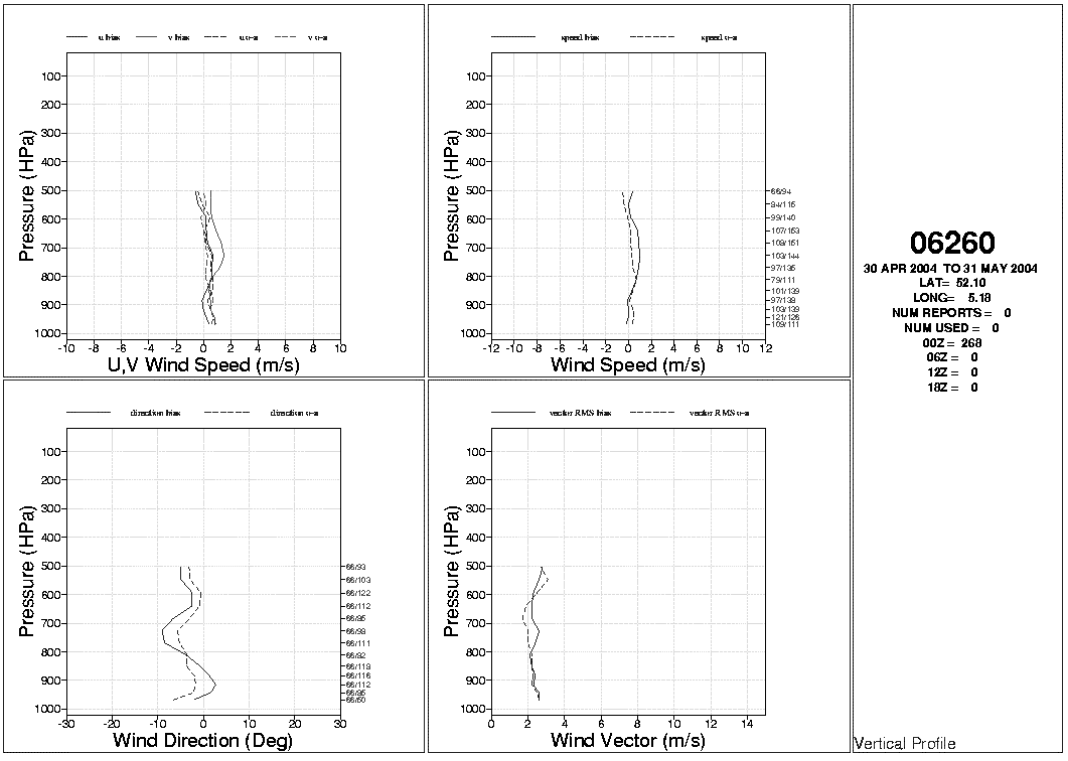

Fig. 4a. Vertical profiles of observation-background differences (solid lines) for the De Bilt (Netherlands) WRWP data in May 2004. Dashed lines are observation-analysis differences.

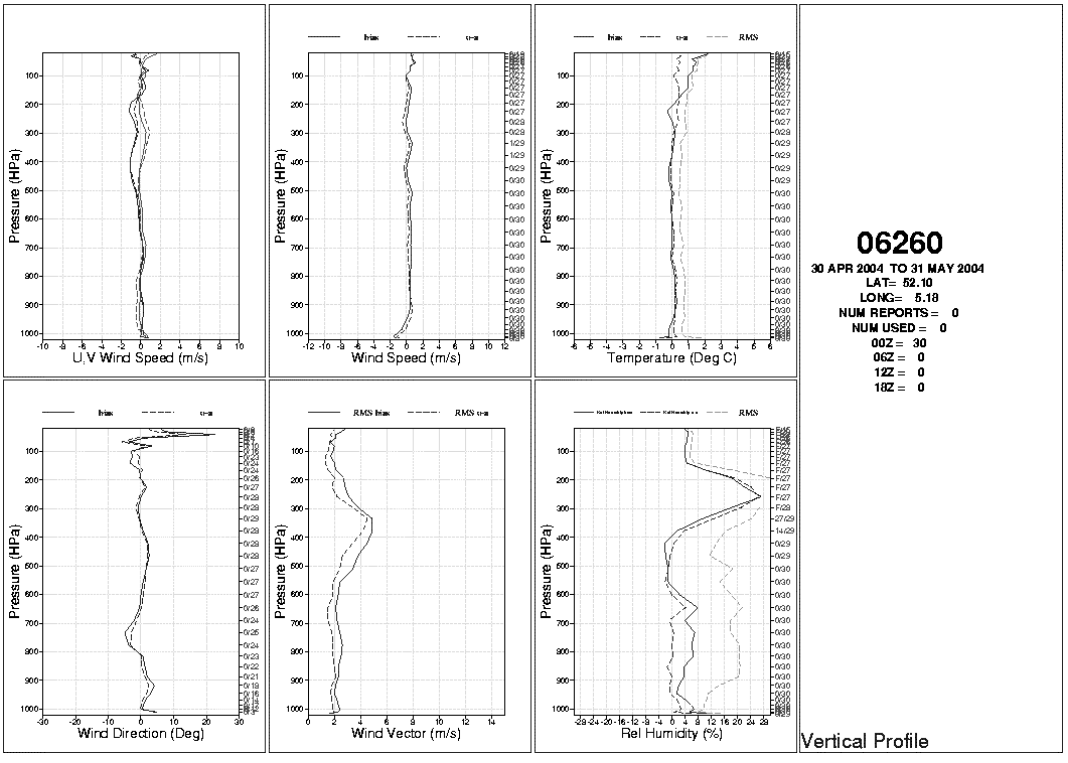

Fig. 4b. Vertical profiles of observation-background differences (solid lines) for the De Bilt (Netherlands) radiosonde data in May 2004. The left and middle pairs of panels compare with Figure 4a. Dashed lines are observation-analysis differences.

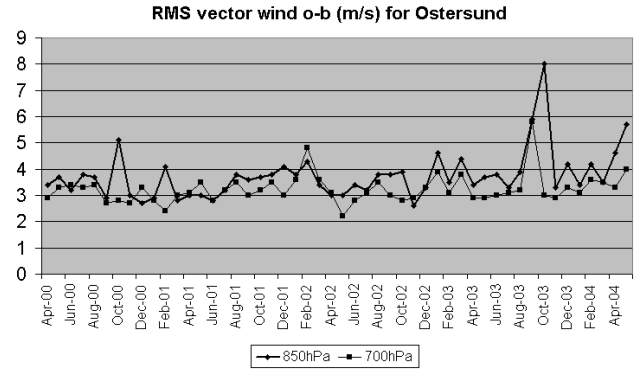

Fig. 5. Time series of rms vector wind difference (observation-background) for Ostersund (Sweden), at 850 hPa (bold line) and 700 hPa (normal line).

4 Feedback to and from the data providers

The monitoring information is sent to the WRWP operators in the form of a monthly email with plots showing the bias and rms errors in wind components, and the biases in speed and direction. A quarterly summary report of the monitoring is also available. One aim of the monitoring is not simply to detect bad data, but also to improve the data over time through feedback to the data providers. Some illustrations of the past and potential effectiveness of this interchange can be quoted. In Sweden, the Hemse radar showed a pointing angle error which was corrected after looking at the monitoring statistics. In the Netherlands, a new WRWP processing system was introduced at KNMI, with a new quality flag to identify poor data. At first the new data stream to CWINDE did not include the quality flag, and as a result no quality control was applied to the Netherlands WRWP data received there. This led to an apparent drop in quality in the CWINDE monitoring statistics which was notified to KNMI, leading to a new data stream for CWINDE taking account of the quality flags.

As more Met Services begin to experiment with assimilating WRWP into their NWP models (see Lindskog et al., 2004), monitoring information from an independent NWP system can be helpful in identifying which problems originate in the data and which come from the assimilating model.

Acknowledgement. The authors thank their many colleagues in WINPROF, OPERA and COST-717 for continuing encouragement in stimulating the exchange and monitoring of WRWP data, particularly Daniel Michelson of SMHI, Asko Huuskonen of FMI and Iwan Holleman of KNMI.

References

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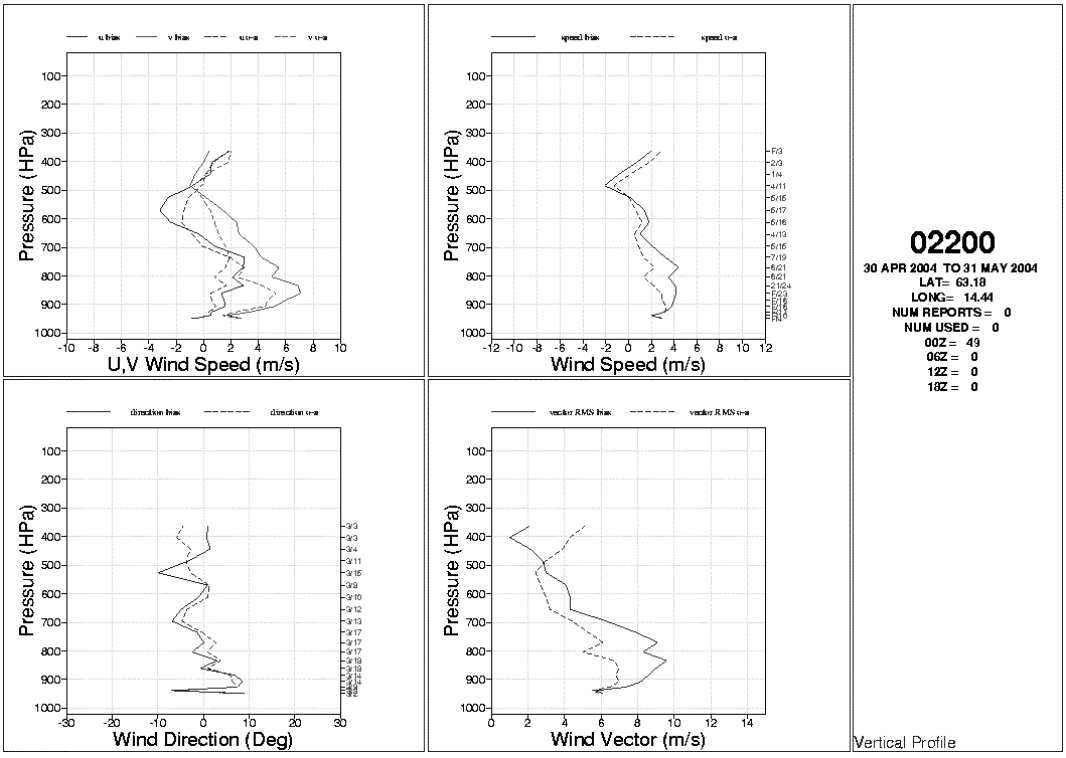

Fig. 6a. Vertical profiles of observation-background differences (solid lines) for Ostersund (Sweden) WRWP data, for May 2004. Data at 00 TC. Dashed lines are observation-analysis differences.

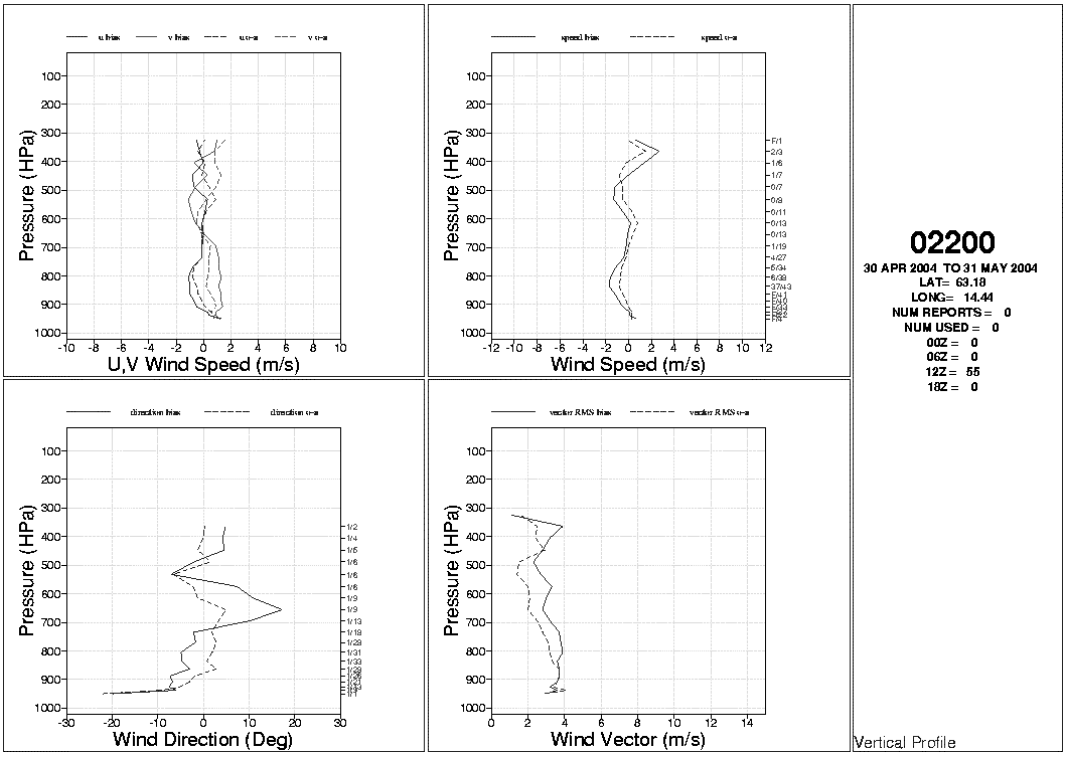

Fig. 6b. As Figure 6a for 12 UTC data.

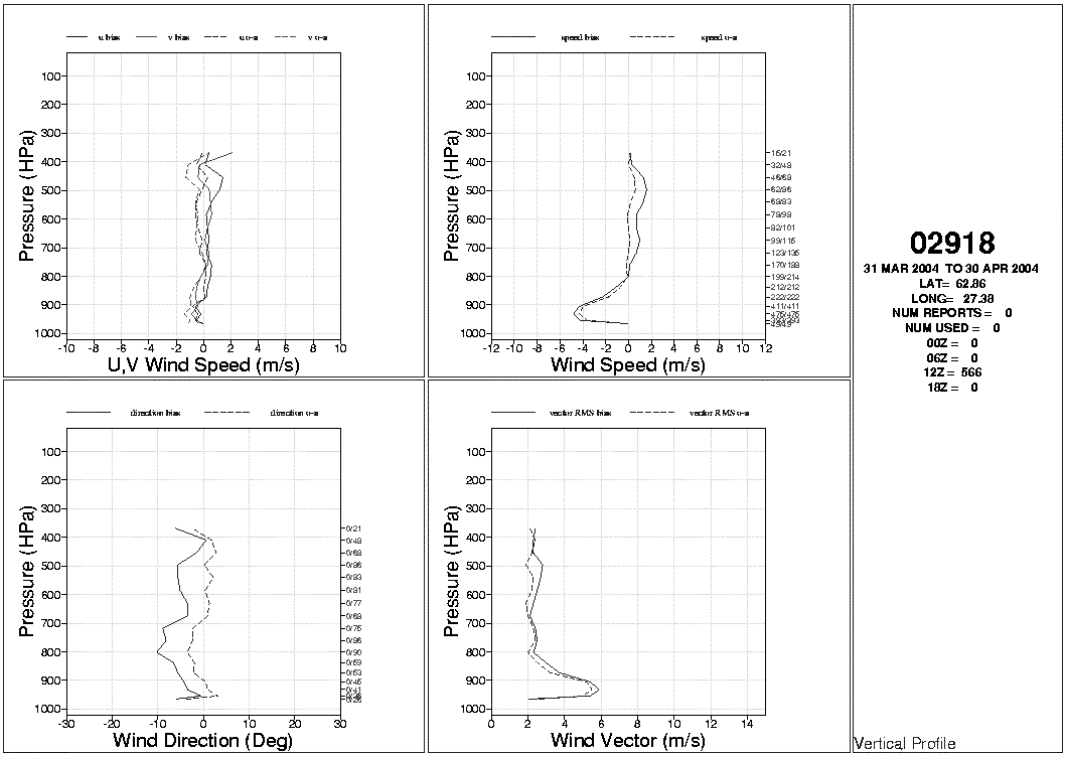

Fig. 7. Vertical profiles of observation-background differences (solid lines) for Kuopio (Finland) WRWP data, for April 2004. Data at 12 UTC. Dashed lines are observation-analysis differences.