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Technical Issues with BUFR Migration

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WORLD AREA FORECAST SYSTEM OPERATIONS GROUP (WAFSOPSG)

FIRST MEETING

Lima, Peru, 10 to 14 November 2003

Agenda Item 6: Development of the WAFS

TECHNICAL ISSUES WITH BUFR MIGRATION

(Presented by China)

SUMMARY

This paper highlights the current technical issues to be addressed to ensure smooth migration from the operational use of T4 facsimile WAFS charts to BUFR coded data in SIGWX chart production.

Action by the WAFSOPSG is in paragraph 4.

1. INTRODUCTION

1.1 As proposed in Amendment 73 to Annex 3, which will become applicable in November 2004, the two World Area Forecast Centres (WAFCs) will be required to prepare global SIGWX forecasts in the BUFR code form. The responsibility of the individual Meteorological Offices in respect of the use of WAFS products is stated as "In order to ensure uniformity and standardization of flight documentation, the WAFS GRIB and BUFR data received shall be decoded into standard WAFS charts in accordance with relevant provisions in this Annex, and the content and identification of the originator of the WAFS forecasts shall not be amended" (Appendix 2 to Annex 3, para. 2.1.3). In order to achieve this, the WAFS user States have to acquire/develop the necessary operational BUFR decoding and visualization software and to train the relevant staff to operate the software.

1.2 At present, the individual Meteorological Offices can make use of the WAFS SIGWX charts in T4 facsimile format for the preparation of flight documentation. The process of chart reception, visualization, and inclusion in the flight documentation can be readily automated without the need of significant manual input by operational staff. After 1 July 2005, the WAFS SIGWX charts in T4 facsimile format will no longer be available from the WAFCs, as agreed in the MET Divisional Meeting (2002). The

above-mentioned acquisition/development of the necessary software and training will have to be completed in time for the migration from the operational use of T4 facsimile WAFS charts to BUFR coded data.

1.3 The use of BUFR coded data instead of T4 facsimile charts has the benefits of substantially reducing the data bandwidth requirements on the WAFS satellite broadcast as well as increasing the flexibility for the WAFS user States to tailor the WAFS SIGWX products for meeting specific user requirements. For example, in addition to the charts for the fixed areas of coverage as specified in the regional air navigation plans, route specific charts in a map projection desired by users can be provided as value-added products. Nevertheless, the basic requirement is for States to provide the standard WAFS charts in the flight documentation in accordance with relevant provisions in Annex 3.

1.4 This paper highlights the current technical issues to be addressed to ensure smooth migration from the operational use of T4 facsimile WAFS charts to BUFR coded data in SIGWX chart production and provides suggestions on the way forward.

2. CURRENT TECHNICAL ISSUES

2.1 In the 7th Meeting of the CNS/MET Sub-group of APANPIRG held in July 2003, Hong Kong, China presented results of comparison of SIGWX charts generated from BUFR coded data provided by WAFC London with the corresponding T4 facsimile WAFS charts issued by WAFC London. The SIGWX charts were generated using one of the software packages evaluated by WAFC London. In consultation with WAFC London and the software manufacturer, a number of technical issues are identified and summarized in paragraphs 2.2 to 2.8 below. These issues are believed to be common to a number of the software packages evaluated by WAFC London.

2.2 Obscuration of SIGWX features by cloud/volcano/CAT labels

2.2.1 In the BUFR coded data, the cloud/volcano/CAT labels do not carry information on their placement on the SIGWX chart. As such, depending on the visualization algorithm of the BUFR software, the cloud/volcano/CAT labels are frequently displayed close to the associated SIGWX features (e.g. tropical cyclone symbol, volcano symbol, jetstream information), thus obscuring these features (compare Figure 1(a) with Figure 1(c) for examples of the obscuration problem). With automatic de-cluttering (or auto-placement) algorithms implemented by some of the software packages, this obscuration problem has been largely resolved (see Figure 1(b)) but there are still outstanding issues as described in item 2.3 below.

2.3 Overlapping of SIGWX features

2.3.1 Even with automatic de-cluttering (or auto-placement) algorithms applied (see item 2.2 above), cluttering and overlapping of SIGWX features are still occasionally present in areas with complex weather phenomena, rendering certain important information (e.g. flight level information of jetstream) illegible to users (compare Figure 2(a) with Figure 2(b) for examples of the overlapping problem). Under such situations, it is observed that, in the corresponding T4 charts, some features (e.g. flight level information of jetstream) are displayed on top of the others (e.g. CAT/cloud boundary, fronts), thus improving the clarity of the information presented (compare the features over central Europe in Figure 2(b) with those in Figure 2(a)). Also some information (e.g. tropopause height box) is slightly displaced in the T4 charts to avoid overlapping with other features (e.g. volcano symbol) (compare the features over Sicily in Figure 2(b) with those in Figure 2(a)). It therefore appears that it is possible for some priority schemes or guidelines to be developed, based on the current practices of the WAFCs, to address the overlapping problem with the BUFR

software, thus facilitating further improvement and standardization of the automatic de-cluttering (or auto-placement) algorithms of the software.

2.4 Interpolation of jetstream and CAT/cloud boundary

2.4.1 Instead of a continuous line given in the T4 chart, each jetstream or CAT/cloud boundary is represented, in the BUFR code, by a series of points specified by the WAFC. Common interpolation methods (e.g. cubic spline) are used but the interpolated product may be different from that given in the T4 chart, especially when the number of specified points is small (compare Figure 3(a) with Figure 3(b) for an example of the interpolation problem). There is apparently a need to standardize the coding method (by the WAFCs) and/or the interpolation method (by the BUFR software).

2.5 Folding of jetstreams crossing the dateline

2.5.1 Instead of a continuous line given in the T4 chart, some jetstreams crossing the international dateline are erroneously shown as "folded" or "looping" jets (compare Figure 4(a) with Figure 4(b) for an example of the problem). This problem was first identified over the southern hemisphere and was recently observed over the northern hemisphere as well.

2.6 Odd shaped jetstreams near the North/South Poles

2.6.1 Problems in the depiction of jetstreams were first found near the South Pole (over chart area “K”) and were recently observed near the North Pole as well. The problems result in jetstreams with odd shapes (e.g. with kinks or sharp turns), erroneous loops or discontinuity (compare Figure 5(a) with Figure 5(b) for an example of the problem near the Antarctica).

2.7 Depiction of flight levels, wind barbs and change bars of jetstreams

2.7.1 The flight levels, wind barbs and change bars of jetstreams may be depicted in a manner different from those on the T4 chart (e.g. display of change bars instead of wind barbs and vice versa, absence of flight level information), depending on the visualization algorithm adopted by the software (compare Figure 5(a) with Figure 5(b) for examples of the problem). There is apparently a need to standardize the visualization algorithm (by the BUFR software).

2.8 Edge effects

2.8.1 The wind speed and/or flight level information may not be shown for jetstreams crossing the border of the chart area, especially when the number of specified points is small (see 2.4 above). Compare Figure 6(a) with Figure 6(b) for examples of the problem. There is apparently a need to standardize the coding method (by the WAFCs) and/or the visualization algorithm (by the BUFR software).

2.8.2 High-level SIGWX forecasts in BUFR format are also available from an experimental ftp server of WAFC Washington on an experimental basis. Using the same BUFR software package mentioned above, SIGWX charts were generated from the experimental BUFR data for comparison with the corresponding T4 facsimile WAFS charts provided by WAFC Washington. A comparison is given in Figures 7(a) and 7(b) which illustrates technical problems with the displaying of cloud boundaries and frontal movement vectors. Preliminary investigation conducted by the software manufacturer suggests, subject to advice by the WAFCs, that these problems may be related to the BUFR coding method.

3. THE WAY FORWARD

3.1 Before proceeding to discuss the above-mentioned issues, we would like to express our appreciation for the efforts made by WAFC London in evaluating the various BUFR decoding and visualization software packages that have become available in the past couple of years. The development of these software packages has come a long way to become much more robust than before. Nevertheless, it is apparent from the above comparison results that further improvement and evaluation work is urgently required so that software packages meeting the basic requirement, viz. to decode the WAFS BUFR data received into standard WAFS charts in accordance with relevant provisions in Annex 3, are available to States.

3.2 It is also apparent from the above comparison results that the issues will need to be addressed by a number of means:

a) automatic de-cluttering (or auto-placement) as a basic requirement for the BUFR software to meet (item 2.2);

b) development of guidelines for further improvement and standardization of the BUFR software automatic de-cluttering (or auto-placement) algorithms (item 2.3);

c) standardization of the WAFC BUFR coding methods (items 2.4, 2.8 and 2.9);

d) standardization of the BUFR software interpolation/visualization methods (items 2.4, 2.7 and 2.8); and

e) further investigation of the causes of the jetstream problems (items 2.5 and 2.6).

3.3 While most of the above issues (items 2.4-2.9) could only be resolved by the WAFCs and/or the software manufacturers, it has been suggested that items 2.2 and 2.3, viz. the obscuration of SIGWX features by cloud/volcano/CAT labels and the overlapping of SIGWX features, may have to be addressed by the user States. In such event, the individual Meteorological Offices, being tasked with the provision of SIGWX charts as part of the flight documentation, are expected to perform manual editing and/or to provide additional "zoom-in" charts to overcome such obscuration/overlapping problems. To those offices which have already fully automated the flight documentation compilation process based on the T4 facsimile WAFS charts, such manual operations could mean additional staff resources, in addition to the costs for acquisition of the BUFR software and training. It is estimated that, depending on the software package used, the manual operations required could take at least 10 minutes per chart, thus generating more than an hour of work for production of a set of 6 SIGWX charts or more, or at least 4 hours per day. In the long run, if BUFR software capable of automatic de-cluttering (or auto-placement) is available, it would be much more cost-effective than the additional manual operations. This automatic function of BUFR software is also expected to greatly enhance the capability of the user States to provide value-added WAFS products (e.g. route specific charts) from the BUFR coded data in a cost-effective manner.

4. ACTION BY THE WAFSOPSG

4.1 The WAFSOPSG is invited to note the information in this paper.

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APPENDIX

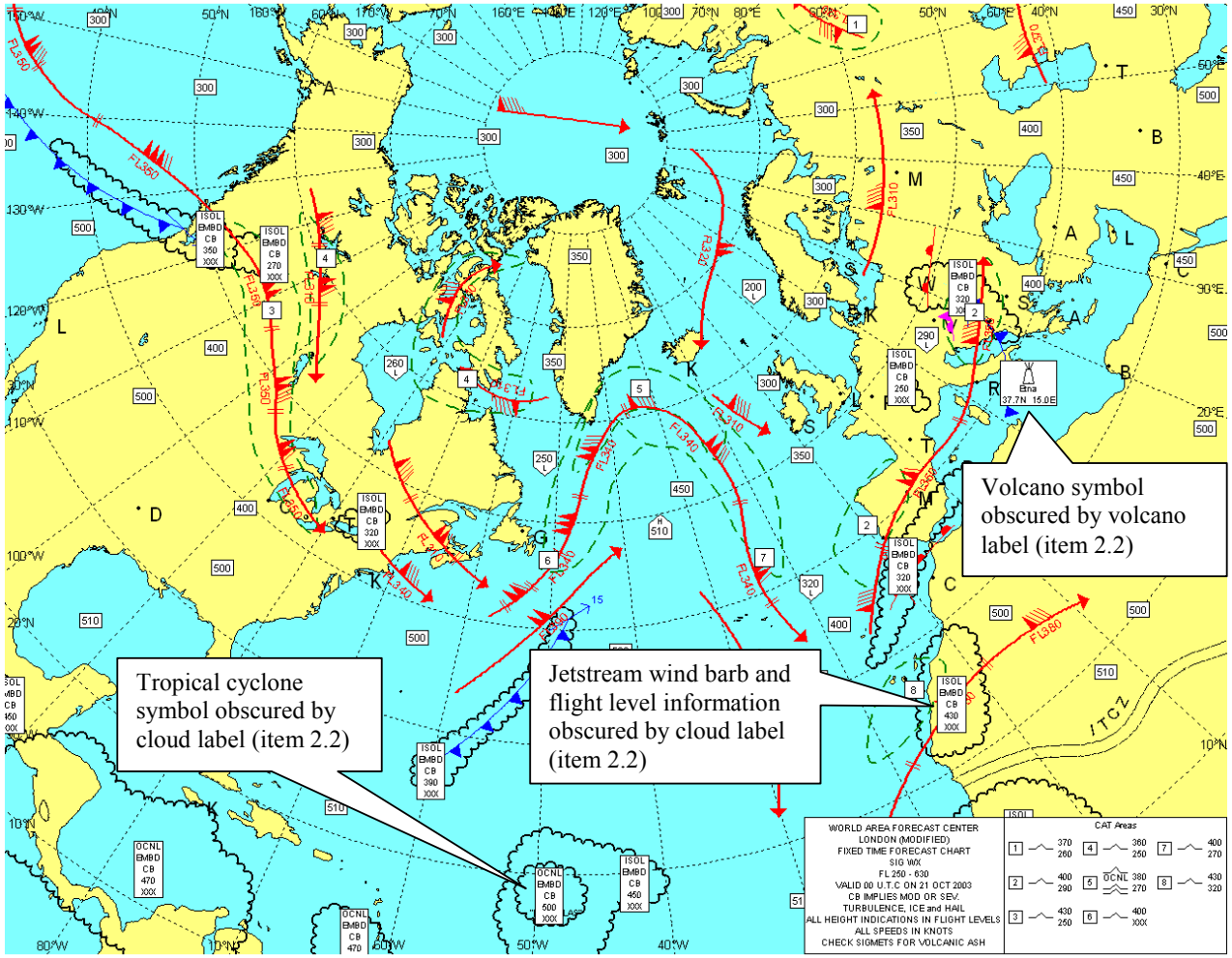

Figure 1(a). SIGWX chart generated from BUFR data issued by WAFC London for 00 UTC 21 October 2003 (without automatic de-cluttering)

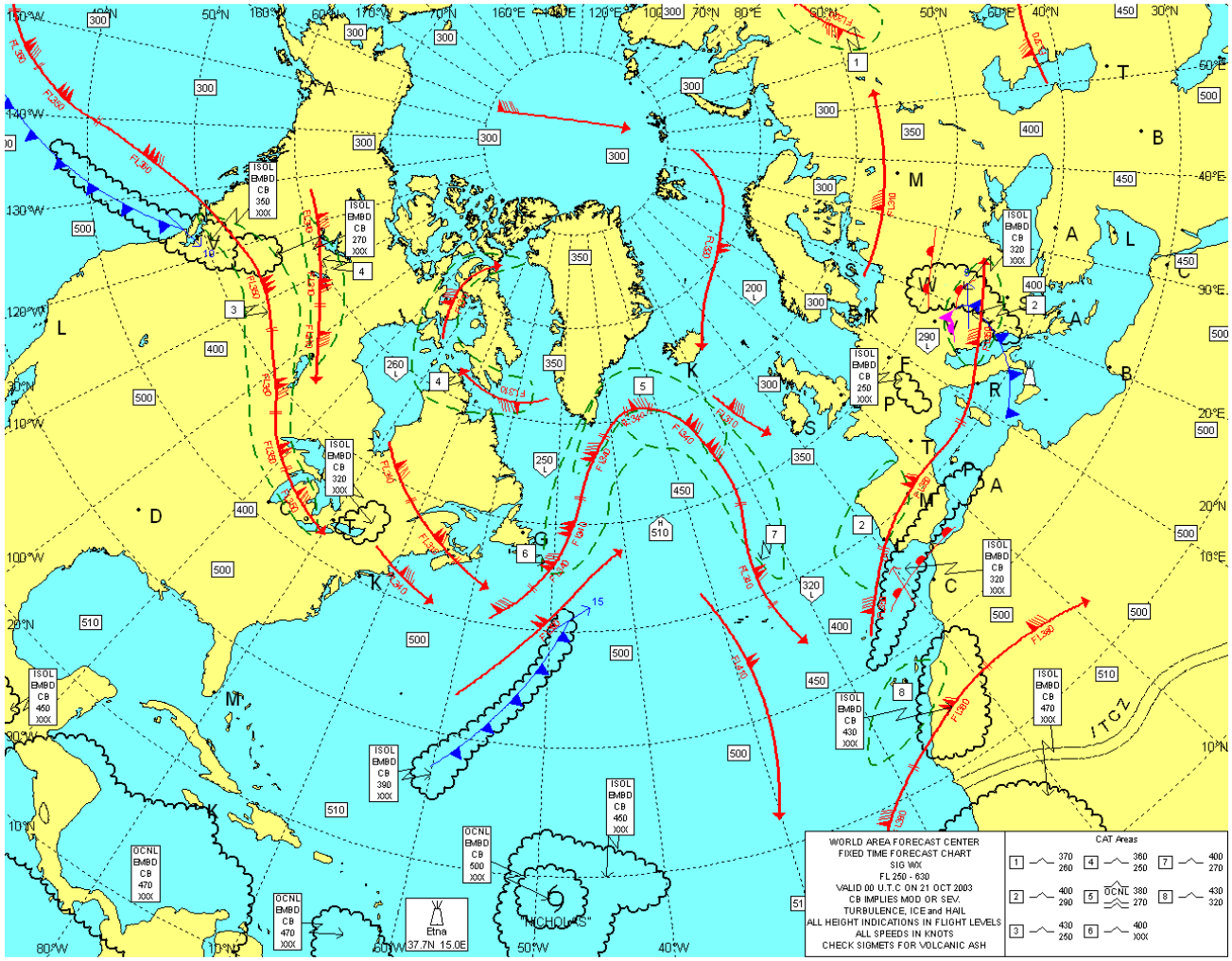

Figure 1(b). SIGWX chart generated from BUFR data issued by WAFC London for 00 UTC 21 October 2003 (with automatic de-cluttering)

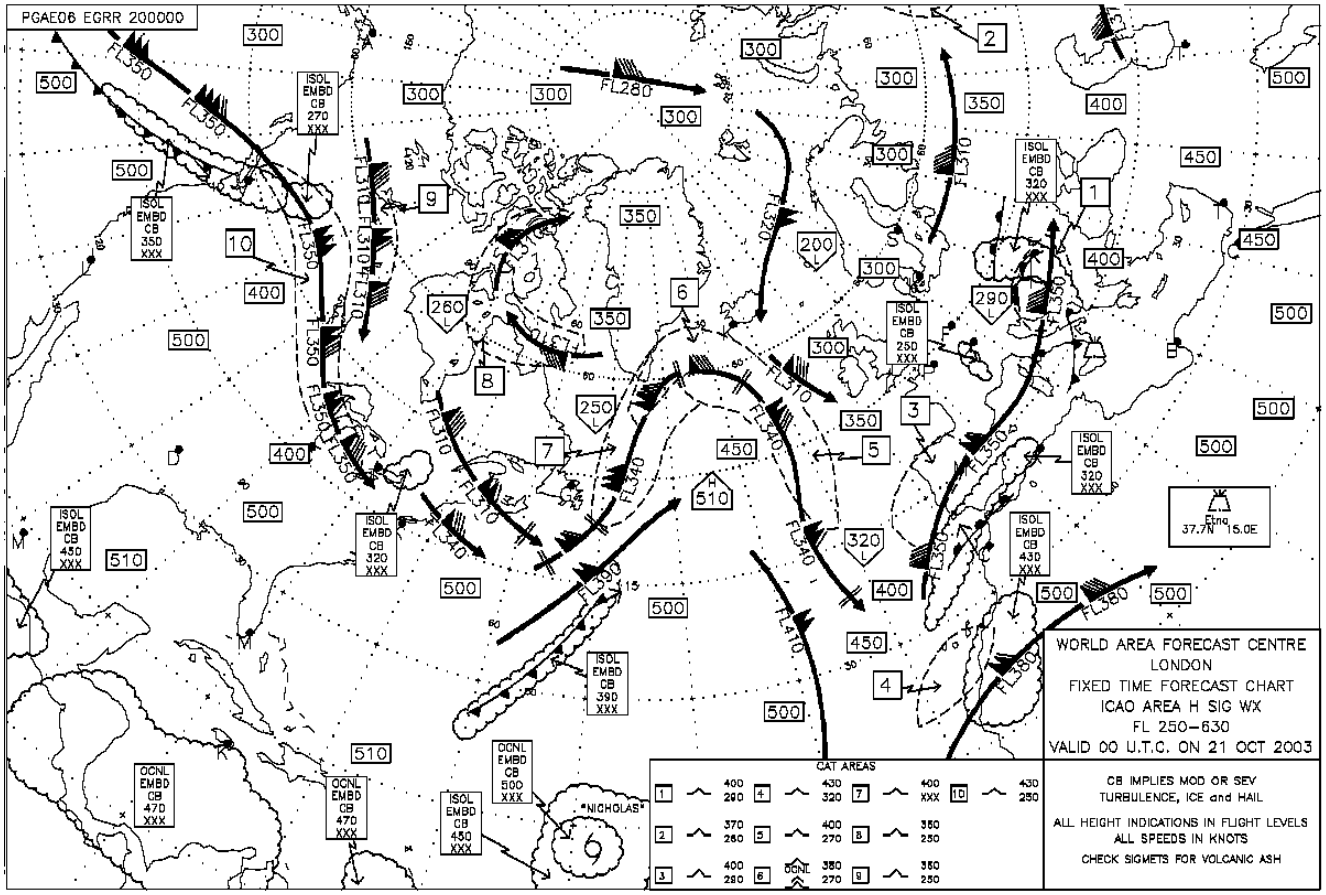

Figure 1(c). T4 facsimile SIGWX chart issued by WAFC London for 00 UTC 21 October 2003

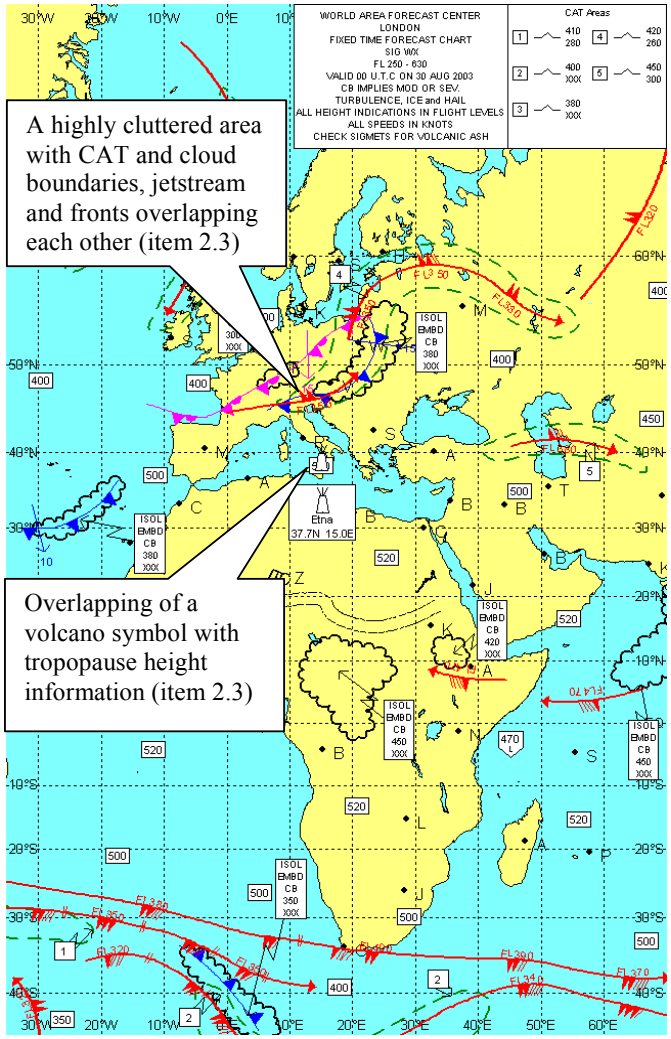

Figure 2(a). SIGWX chart generated from BUFR data issued by WAFC London for 00 UTC 30 August 2003 (with automatic de-cluttering)

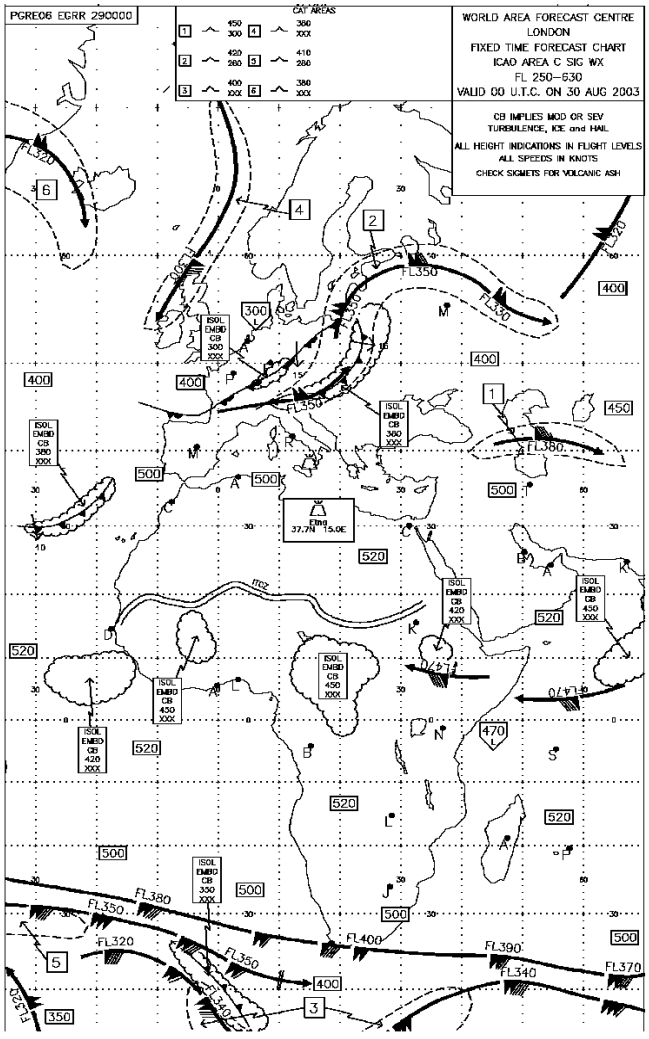

Figure 2(b). T4 facsimile SIGWX chart issued by WAFC London for 00 UTC 30 August 2003

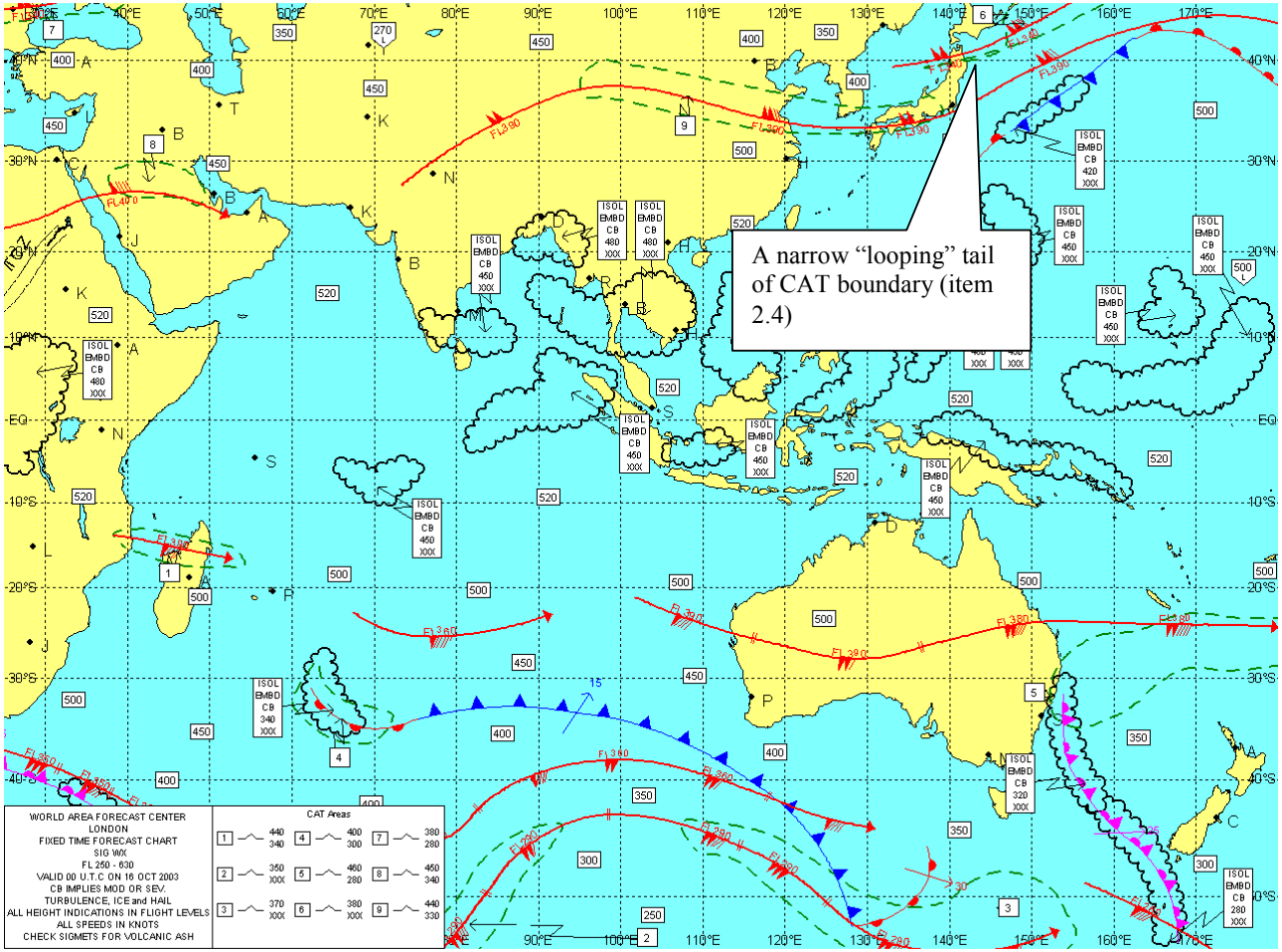

Figure 3(a). SIGWX chart generated from BUFR data issued by WAFC London for 00 UTC 16 October 2003

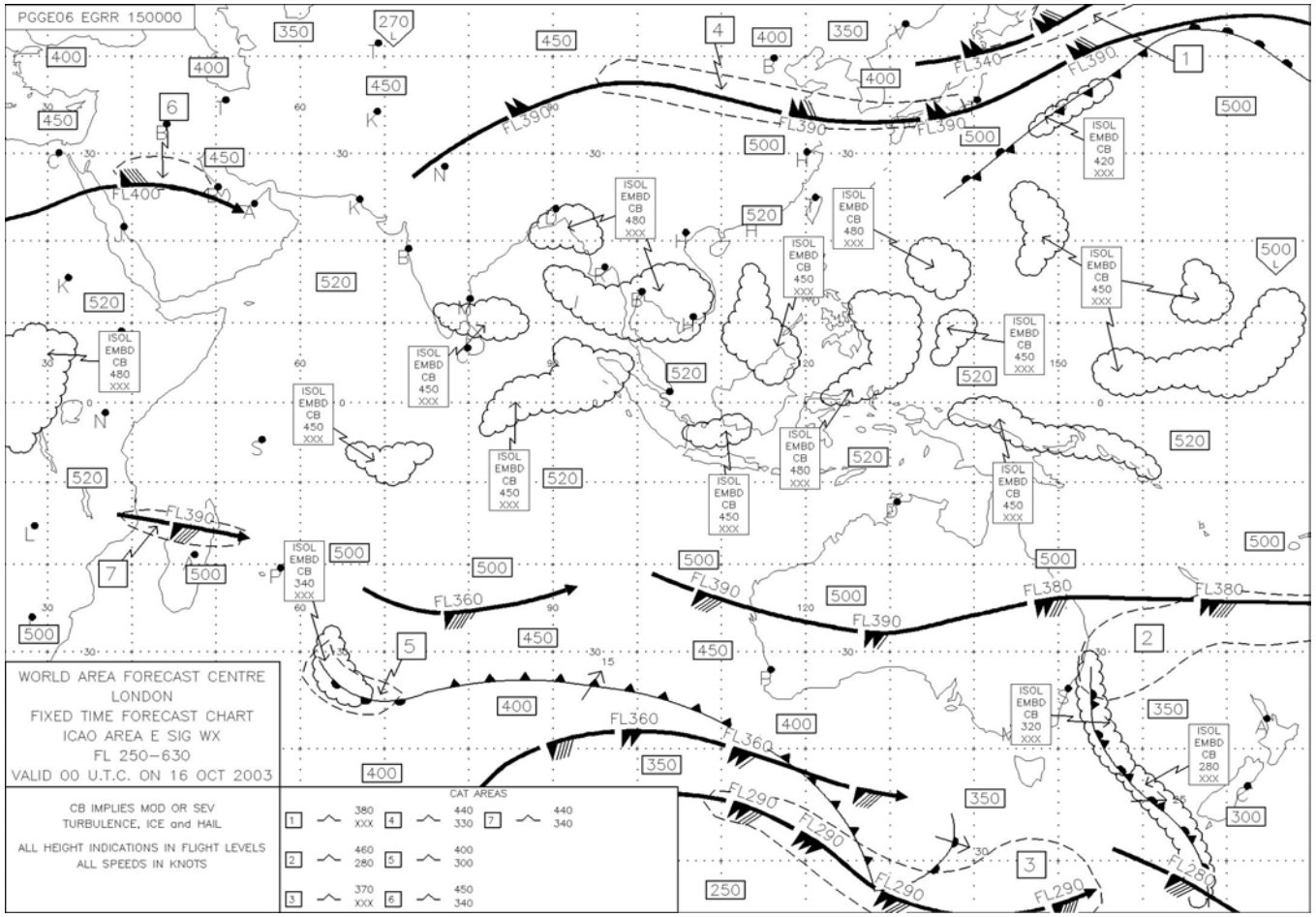

Figure 3(b). T4 facsimile SIGWX chart issued by WAFC London for 00 UTC 16 October 2003

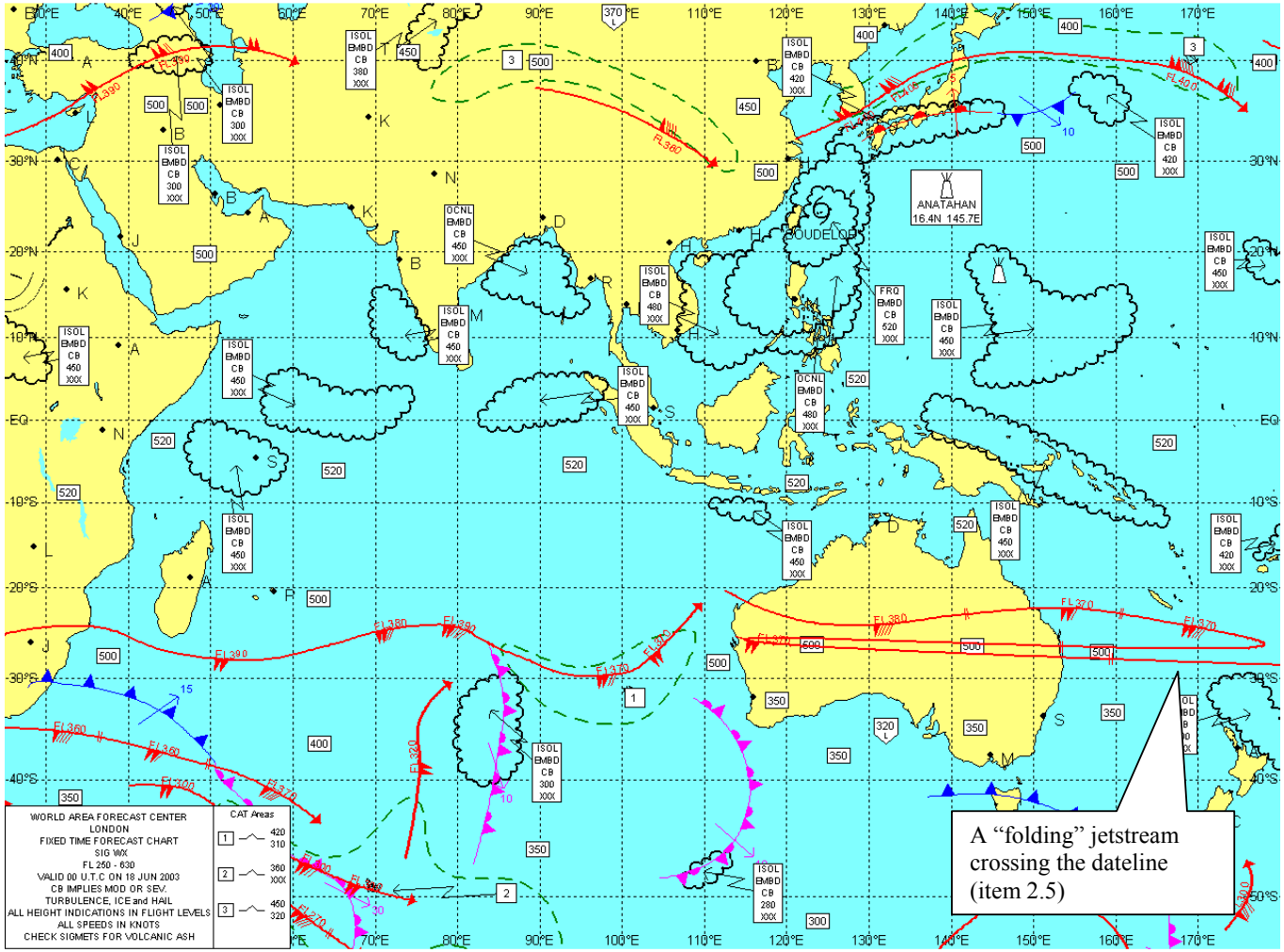

Figure 4(a). SIGWX chart generated from BUFR data issued by WAFC London for 00 UTC 18 June 2003

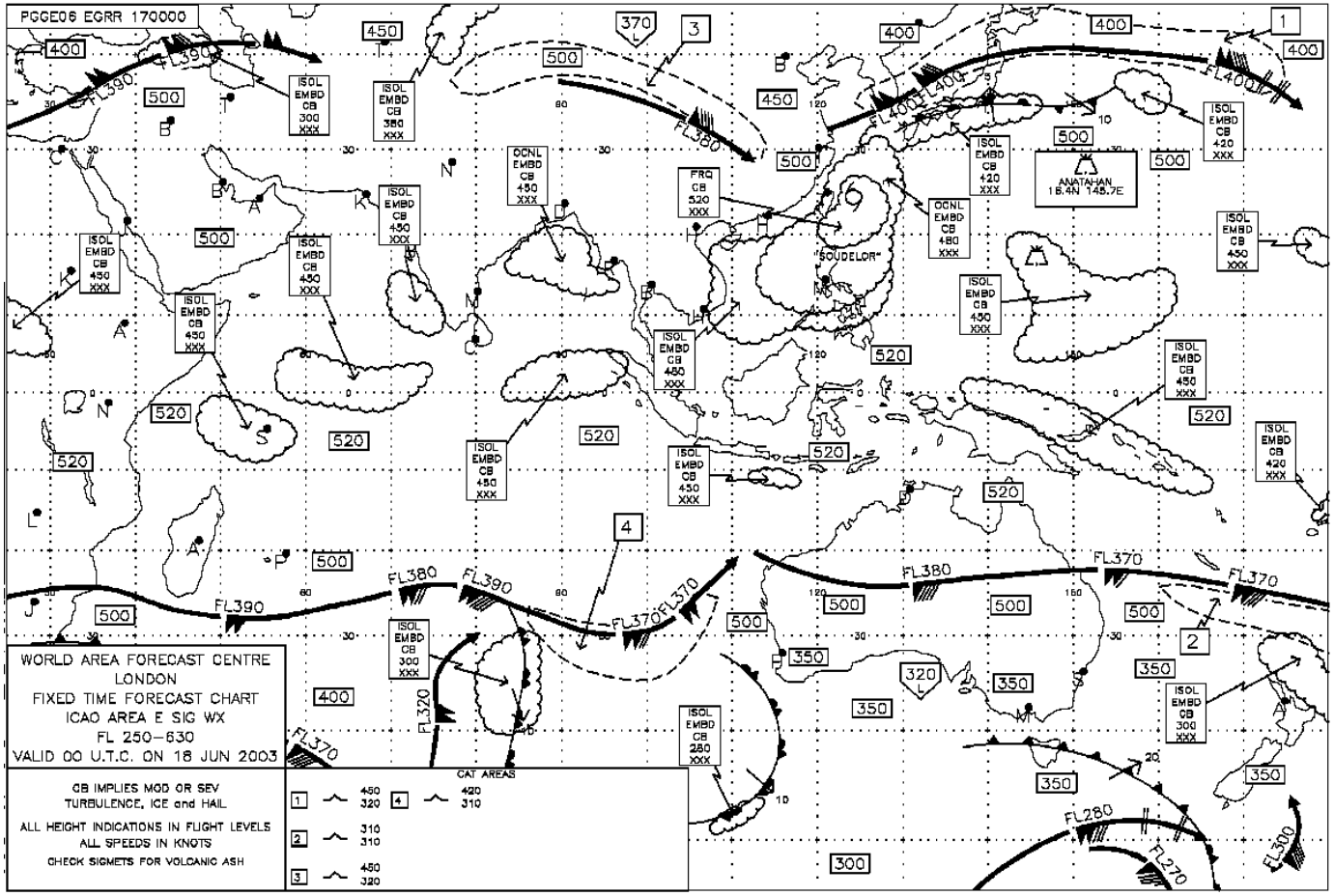

Figure 4(b). T4 facsimile SIGWX chart issued by WAFC London for 00 UTC 18 June 2003

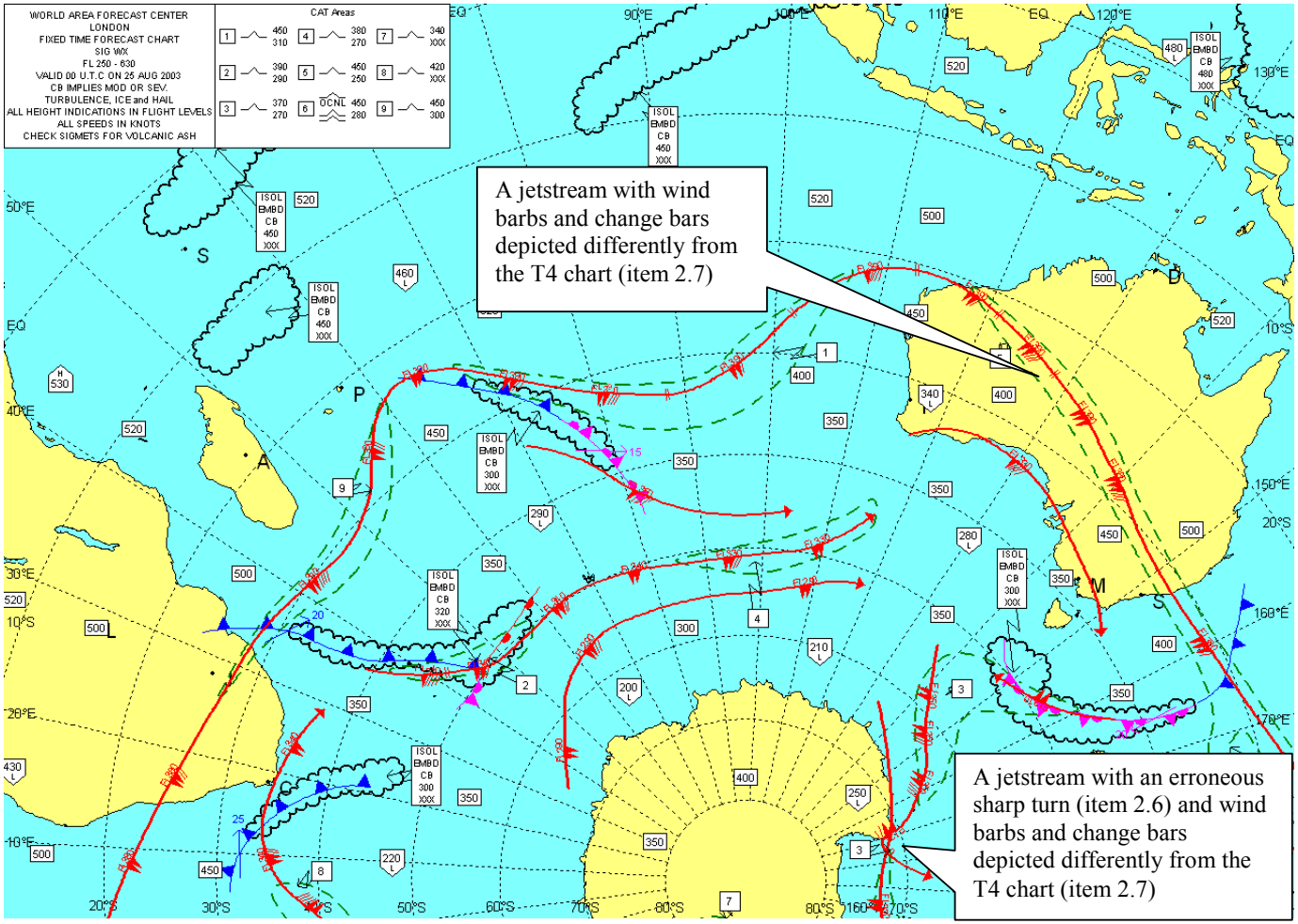

Figure 5(a). SIGWX chart generated from BUFR data issued by WAFC London for 00 UTC 25 August 2003

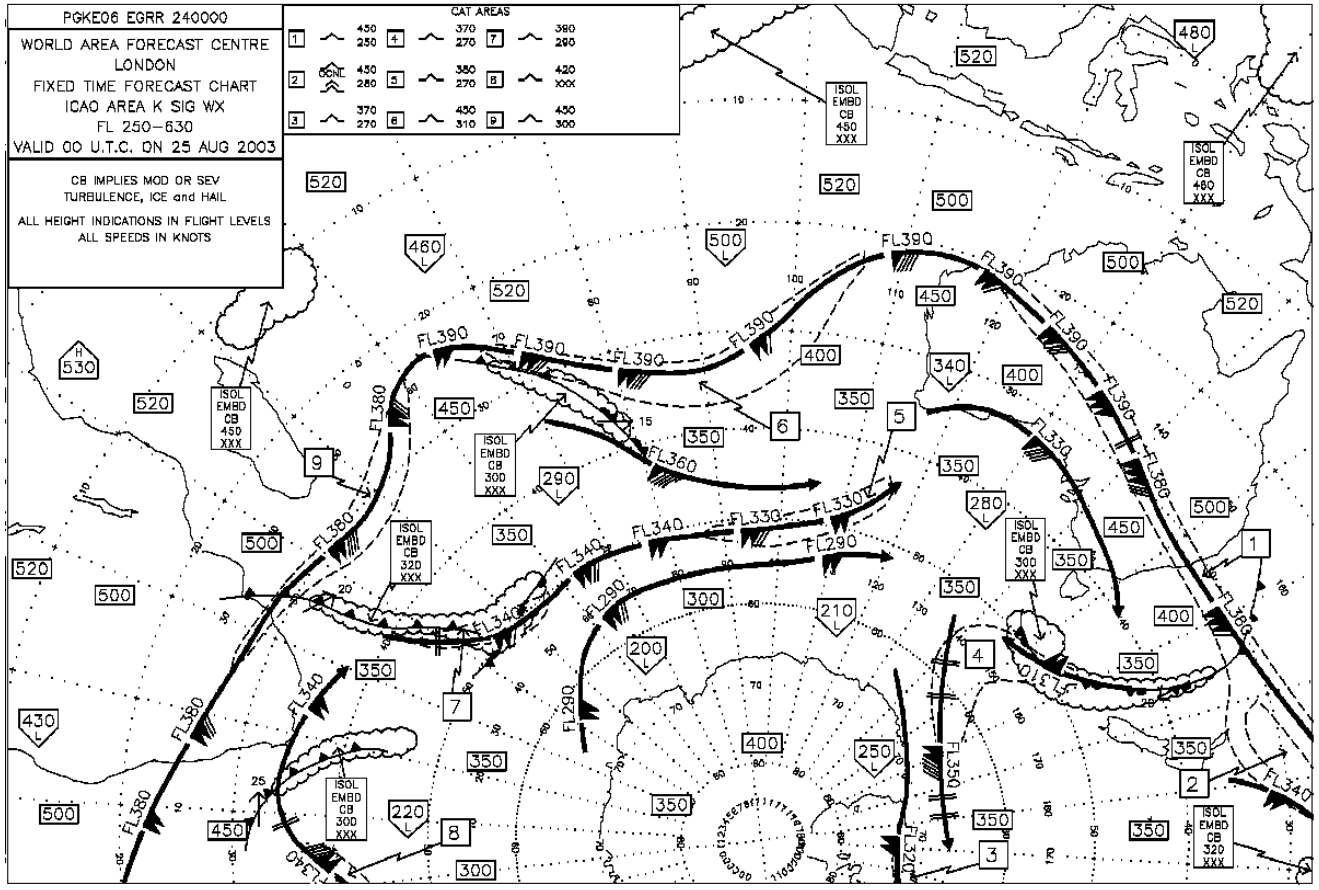

Figure 5(b). T4 facsimile SIGWX chart issued by WAFC London for 00 UTC 25 August 2003

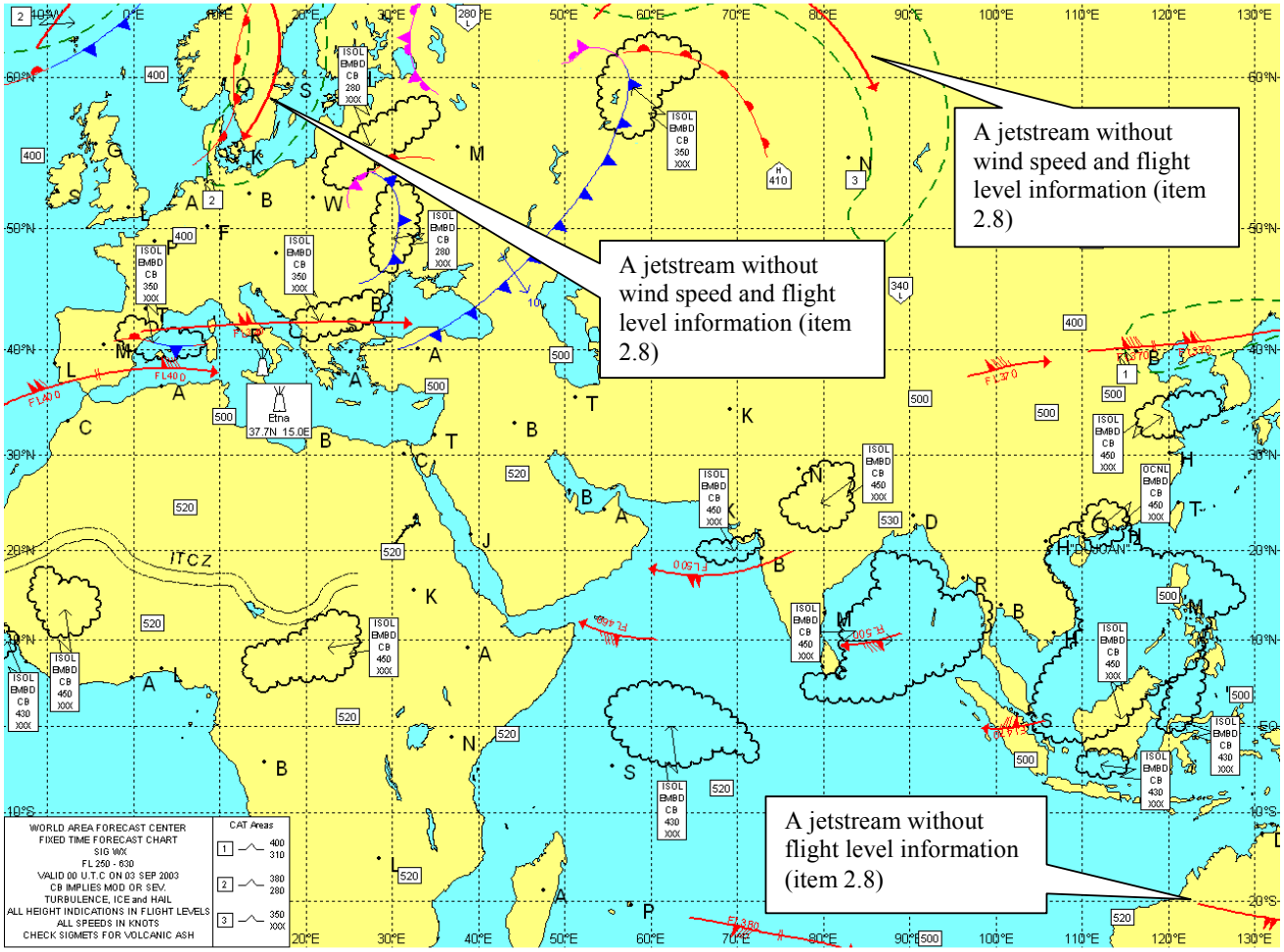

Figure 6(a). SIGWX chart generated from BUFR data issued by WAFC London for 00 UTC 3 September 2003

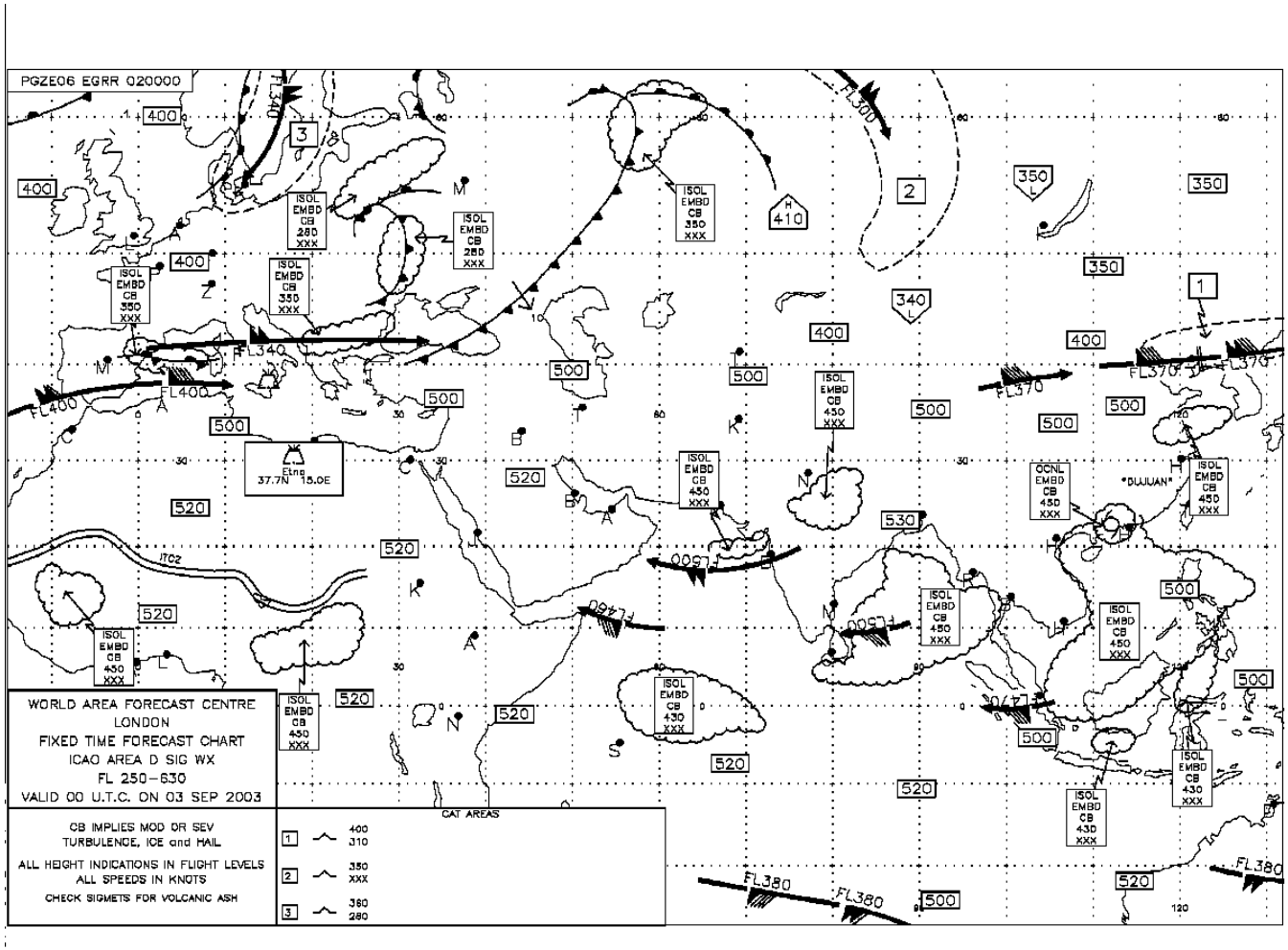

Figure 6(b). T4 facsimile SIGWX chart issued by WAFC London for 00 UTC 3 September 2003

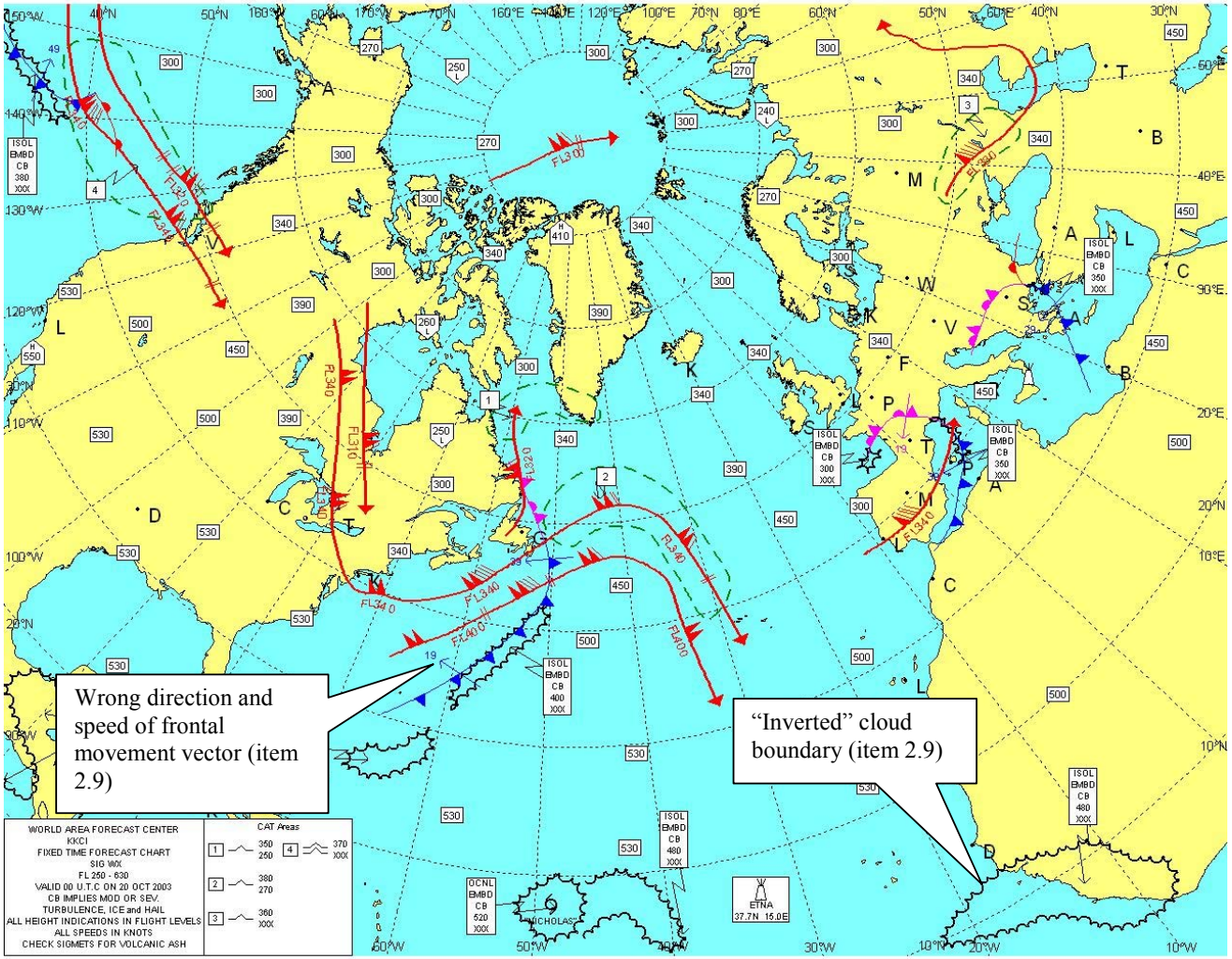

Figure 7(a). SIGWX chart generated from experimental BUFR data issued by WAFC Washington for 00 UTC 20 October 2003

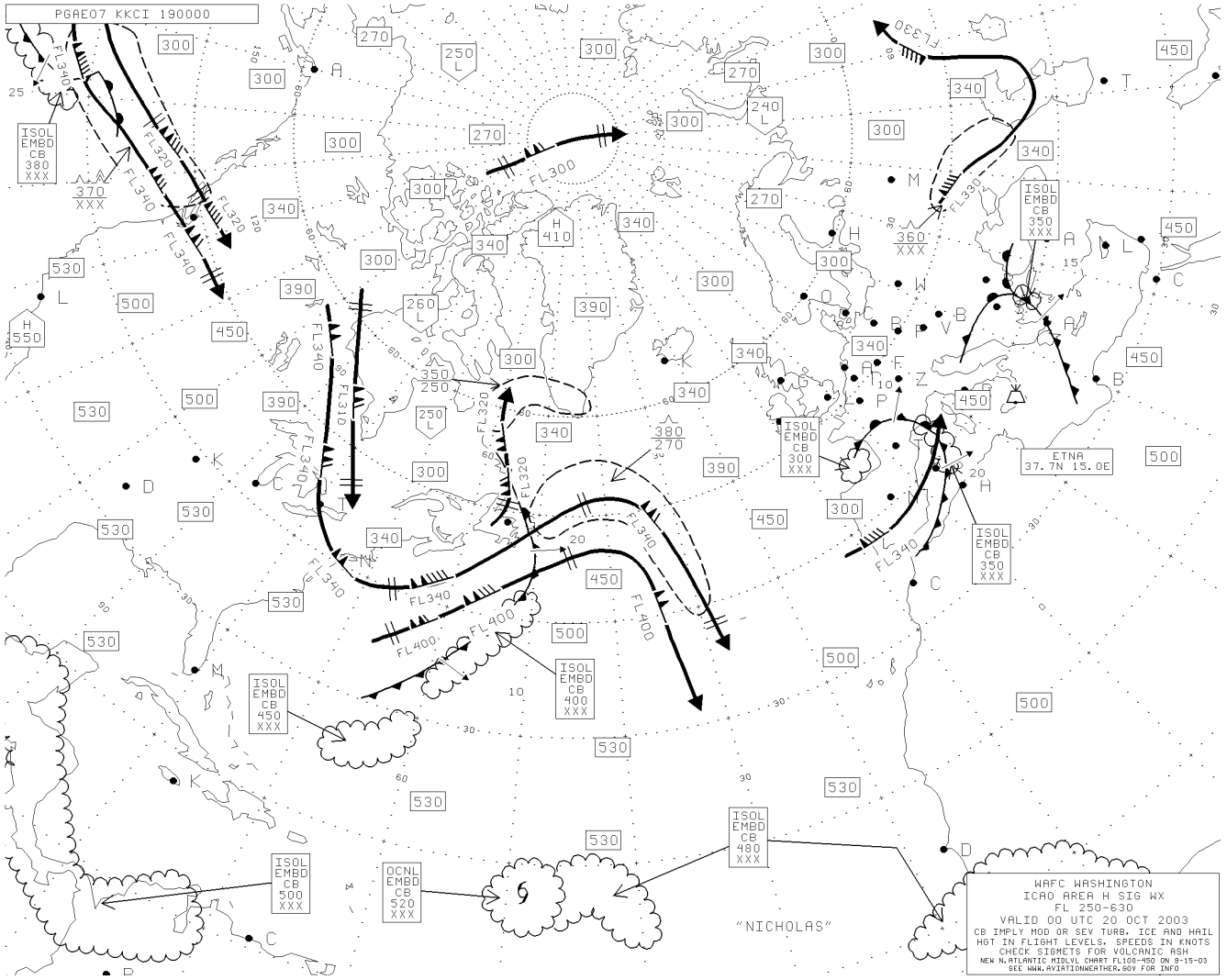

Figure 7(b). T4 facsimile SIGWX chart issued by WAFC Washington for 00 UTC 20 October 2003

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