International Civil Aviation Organization

TWELFTH MEETING OF THE COMMUNICATIONS/NAVIGATION/SURVEILLANCE AND METEOROLOGY SUB-GROUP OF APANPIRG (CNS/MET SG/12)

Bangkok, Thailand, 21 – 25 July 2008

Agenda Item 8: Implementation of the World Area Forecast System (WAFS)

(3) Review the status of implementation and utilization of the WAFS products

OBSERVATIONS ON WAFS TRIAL GRIDDED FORECASTS

(Presented by Hong Kong, China)

SUMMARY

This paper presents some observations on the WAFS new gridded forecasts on icing, turbulence and cumulonimbus clouds.

This paper relates to

Strategic Objectives:
A. Safety – Enhance global civil aviation safety
D. Efficiency – Enhance the efficiency of aviation operations

Global plan initiatives:
GPI-18 Aeronautical information
GPI-19 Meteorological systems

1. INTRODUCTION

1.1 In October 2006, trial gridded forecasts for convective clouds, icing and turbulence generated by the WAFC London became available on SADIS FTP service for evaluation. Starting from May 2007, WAFC Washington also provides its gridded forecasts on NOAA's FTP site for evaluation (ftpprd.ncep.noaa.gov, in the directory pub/data/nccf/com/gfs/para/gfs.<yyyymmddHH>, where yyyymmdd is the date and HH is model run time: 00, 06, 12 and 18Z).

1.2 WAFSOPG/4 formulated Conclusion 4/17 that the WAFCs Provider States, in coordination with WAFSOPG Members from IATA, IFALPA and WMO, to undertake systematic comparisons of trial gridded forecasts of icing, turbulence and cumulonimbus clouds of the two WAFC models, highlighting characteristics of areas with different values. The results of these systematic comparisons should lead to the alignment of algorithms used by the two WAFCs.

1.3 Since the launch of the trial gridded forecasts, a number of observations, especially differences in the characteristics of the WAFC London and WAFC Washington gridded forecasts, have been made by the Hong Kong Observatory (HKO) and are summarized in this paper.

2. VISUALIZATION SCHEME FOR GRIDDED FORECASTS

2.1 To facilitate comparison of the trial gridded forecasts of the two WAFCs, the gridded forecasts are visualized using the same plotting scheme in which only the gridded values for each grid box are presented, according to a colour scale, without smoothing nor interpolation. Apart from the advantage that the visualization will truly reflect the gridded forecasts provided by the WAFCs, this avoids misinterpreting missing data. Hence, the visualization in this paper would look slightly different from those generated by the two WAFCs. One example is shown in Fig. 1. In the plot of "ICAO height at CB top" forecast of WAFC Washington downloaded from NOAA's website (http://aviationweather.gov/testbed/globalgrids), yellow "boundaries" are observed surrounding areas with true forecast values while the plots generated for this paper will not contain such "boundaries".

2.2 Another example is shown in Fig. 2. In plotting the "maximum icing potential" forecast of WAFC London for the global area, it is found that some of the gridded data within the overlapping boundaries of the eight GRIB data subsets are different from each other, causing difficulties in plotting (highlighted in Fig. 2, with raw data given in Table 1).

3. OBSERVATIONS ON GRIDDED FORECAST

3.1 The gridded forecasts of WAFC London (hereafter denoted as UK) are based on the Unified Model (UM) of the UK Met Office while those of WAFC Washington (hereafter denoted as US) are based on the Global Forecast System (GFS) of NOAA/NCEP. While similar techniques are used in the forecast of turbulence potential, different algorithms are used in generating convective clouds and icing potential [References (1) and (2)].

Comparison between UK and US gridded forecasts

3.2 A case is used to illustrate the difference of the UK and US gridded forecasts. Fig. 3 and 4 show respectively the UK and US 24-h forecasts valid at 00 UTC 23 Jun 2008. Comparison between UK and US forecasts indicates the following differences:

(a) Overall: many apparent differences which may be related to the scaling (range of values), thresholds for depicting SIGWX features and the extent of SIGWX coverage are observed;

(b) "CB horizontal extent" (Fig. 3a & 4a): CB coverage is more extensive with generally larger forecast values in the UK forecast (in the range of 0-5) compared with that of US (in the range of 0-1). Furthermore, small values of CB horizontal extent are given almost everywhere in the UK forecast;

(c) "ICAO height at CB top" (Fig. 3b & 4b): the UK forecast generally gives more extensive but lower heights of CB top (generally below 37kft) compared with that of US (above 43 kft);

(d) "Mean in-cloud turbulence potential" (Fig. 3c & 4c): the UK forecast generally gives wider range and higher turbulence potential values compared with that of US. On the other hand, small values of mean in-cloud turbulence potential are given almost everywhere in the US forecast;

(e) "Maximum icing potential" at FL180 (Fig. 3d & 4d): significant differences are observed in the spatial coverage over the tropical and higher latitude regions with the US forecast giving generally higher icing potential over the tropical region and the UK forecast giving generally higher icing potential over the higher latitude regions;

(f) "Maximum CAT potential" at FL340 (Fig. 3e & 4e): the UK forecast generally gives much less extensive CAT areas compared with that of US.

Comparison between SIGWX forecasts and gridded forecasts

3.3 The SIGWX forecast charts for ICAO Area K generated from the BUFR data of UK and US for the same valid time as in the case presented in para. 3.2 are given in Fig. 3f and 4f respectively for comparison with the corresponding gridded forecasts. Some inconsistencies are noted between the WAFS SIGWX forecasts and the gridded forecasts, e.g. the CAT areas forecast to the southwest of Australia and near the polar region in both SIGWX forecast charts (Fig. 3f & 4f) are not depicted in the UK CAT potential forecasts at all the available levels (FL340 (Fig. 3e) as well as FL450, FL390, FL300, FL240 (not shown)). This inconsistency between the SIGWX forecasts and gridded forecasts may cause confusion to users, especially if both sets of forecasts are made available for operational use.

Comparison between gridded forecasts with actual observations

3.4 Comparison between the CB top forecasts (Fig. 3g & 4g) and the satellite pictures at about the same valid time (Fig. 5a & 5b) indicates that the CB associated with typhoon Fengshen was generally captured by both the UK and US forecasts at T+24 h. However, as already noted in the case study above, the UK forecast generally gives more extensive but lower heights of CB top (generally below 37kft) compared with that of US (above 43 kft).

3.5 It is also noted that the maximum CAT potential forecast of UK occasionally generates unusually high values within a small area. For example, Fig. 6 indicates that the maximum CAT potential was forecast to exceed 100% over Japan. According to Reference (2), this potential should be the percentage probability of encountering turbulence, with typical values ranging from 0 to 25% for shear generated CAT, 0 to 60% for mountain wave turbulence, and values >4% indicating moderate to severe CAT. However, according to actual aircraft observations (thanks to JAL for providing the information), only moderate turbulence pilot reports were received over the region and no mountain wave turbulence was observed during that period.

4. VISUALIZATION OF GRIDDED FORECASTS

4.1 The WAFS trial gridded forecasts contain 15 parameters for icing, turbulence and CB. Except for "CB horizontal extent" and "ICAO height at CB top", forecasts for each parameter are provided for 5 different levels. Therefore a total of 67 forecasts are provided for each valid time at T+6 h, T+9 h, T+12 h, … up to T+36 h. To facilitate "at a glance" assimilation of such a large amount of information by the pilots, development of a standard visualization scheme to present the complete set of forecast information from each model run relevant to the flight/route concerned in a clear and concise format similar to that of the SIGWX chart remains a great challenge.

4.2 Before the operational use of the WAFS trial gridded forecasts, continuous evaluation of the products will be crucial prior to their eventual implementation. In this connection, HKO will make available selected gridded forecasts from the two centers, together with corresponding SIGWX charts and satellite pictures, on its dedicated aviation weather website for evaluation by aviation users. Users' feedback will be collected in due course and the evaluation results are expected to be available at the workshop on the use and visualization of the gridded forecasts scheduled for September 2009.

5. ACTION BY THE MEETING

5.1 The meeting is invited to note the information provided in this paper.

References

(1) *GRIB Aviation Products WAFC Washington Progress Report August 2007*
(2) *SADIS FTP Service V4.1*

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Fig. 1
"ICAO height at CB top" valid at 00 UTC on 14 June 2008
(The plot in the background is generated by WAFC Washington [note the yellow "boundaries"]. The plot in the inset is produced without using any interpolation/smoothing scheme.)

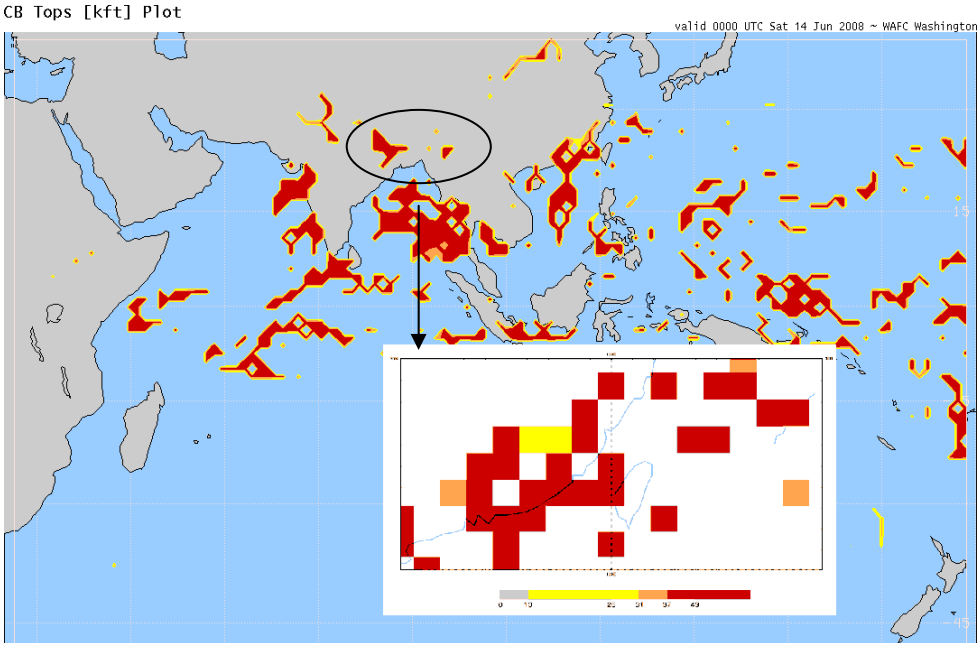


Fig. 2
WAFC London
Maximum Icing potential
Valid 00 UTC 05 Jul 2008
(based on 00 UTC 04 Jul 2008)

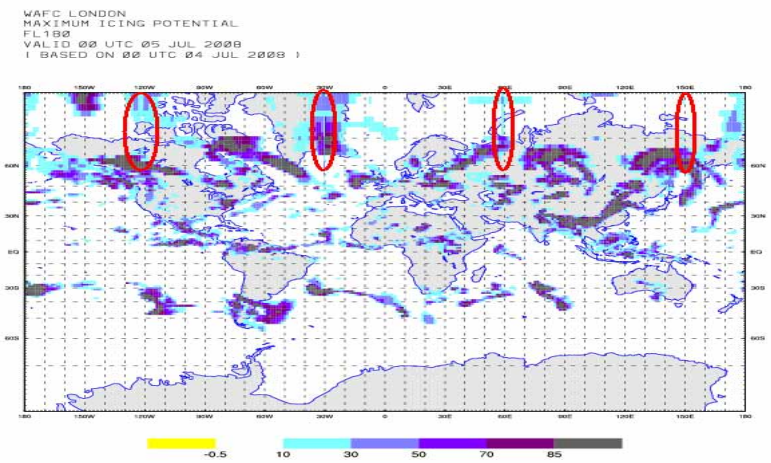


Table 1
Raw data from WAFC London
Maximum Icing potential
Valid 00 UTC 05 Jul 2008
(based on 00 UTC 04 Jul 2008)

latitude - N	longitude - 30W (subset 40)	longitude - 30W (subset 37)
90	0	0
88.75	0.001284247	0.03125
87.5	0.007491438	0.109375
86.25	0	0
85	0	0
83.75	0.1643836	0
82.5	0.2521404	0
81.25	0.3598031	0.203125
80	0.3865582	0.171875
78.75	0.4238014	0.375
77.5	0.3640839	0.328125
76.25	0.2696918	0.28125
75	0.2547089	0.515625
73.75	0.213399	0.671875

WAFC London Gridded Forecasts valid 00 UTC 23 Jun (based on 00 UTC 22 June 2008)	WAFC Washington Gridded Forecasts valid 00 UTC 23 Jun (based on 00 UTC 22 June 2008)

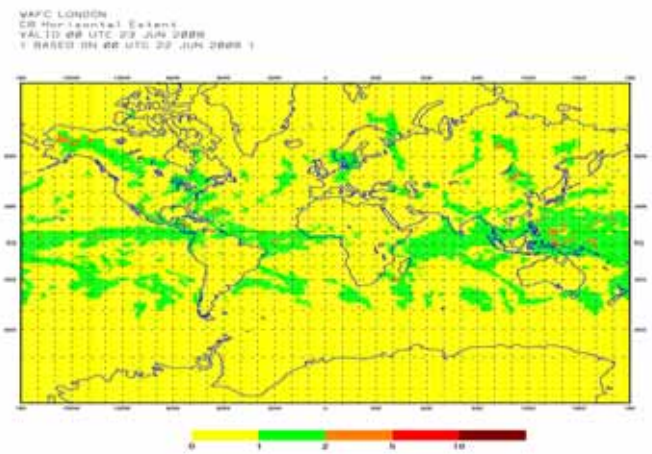
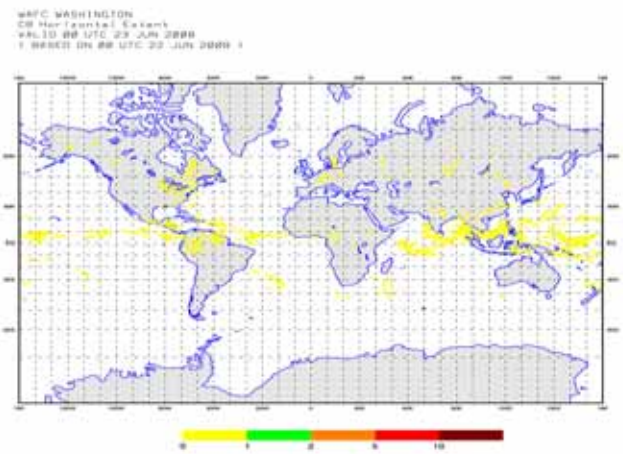

	

Fig. 3a “CB horizontal extent” [UK]	Fig. 4a “CB horizontal extent” [US]

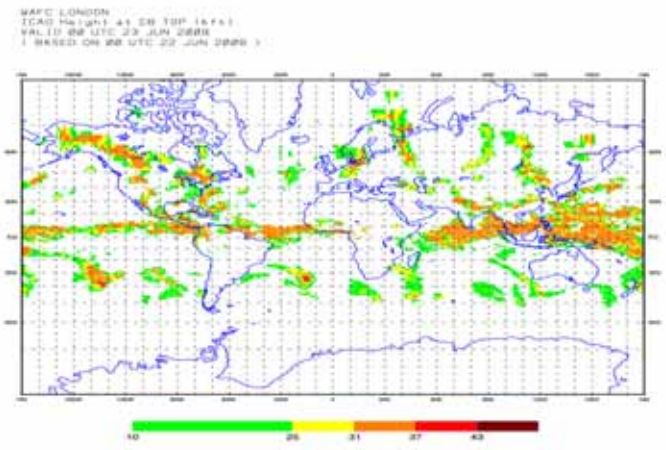
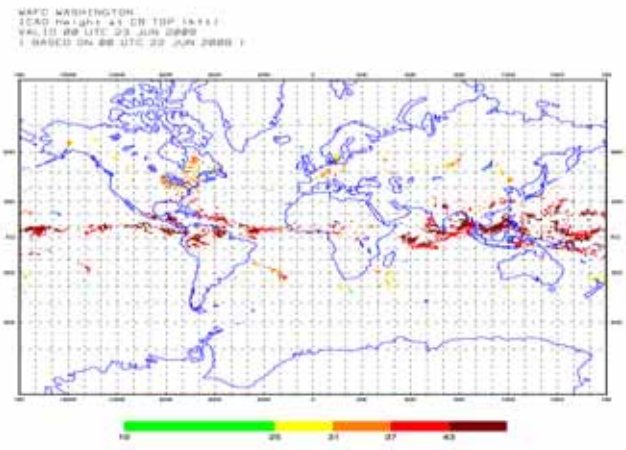

	

Fig. 3b “ICAO height at CB top (kft)” [UK]	Fig. 4b “ICAO height at CB top (kft)” [US]

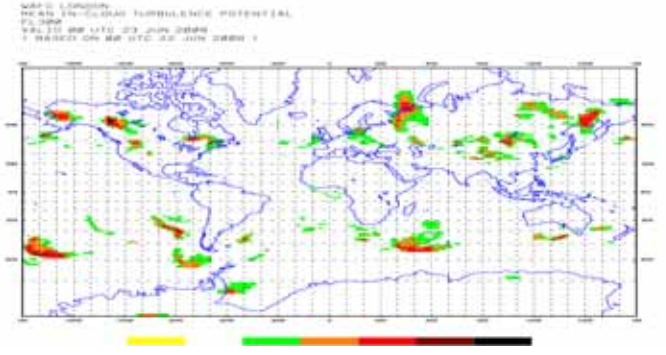
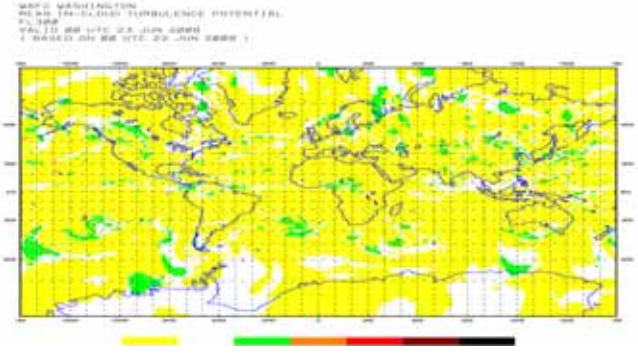
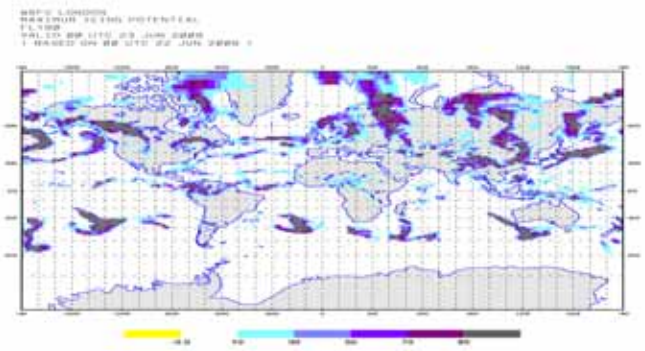
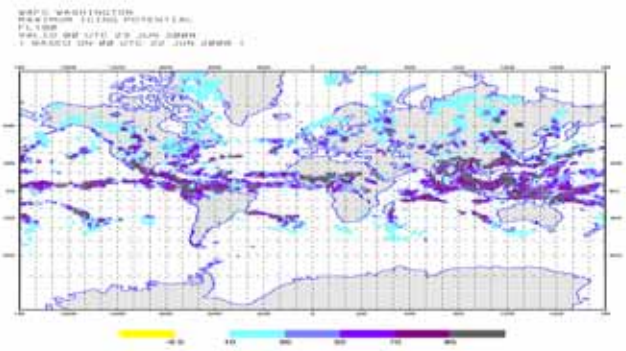
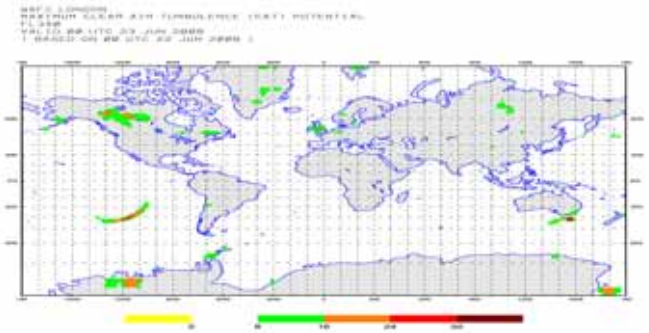
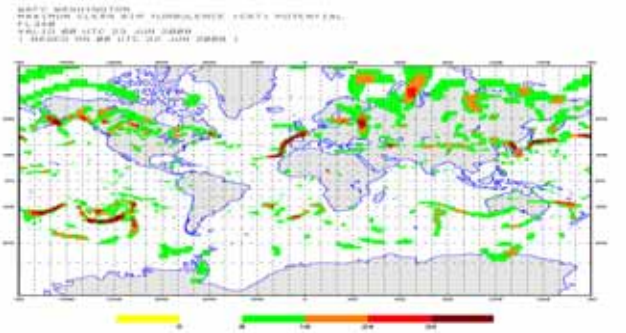

	

Fig.3c “Mean in-cloud turbulence potential at FL 300”	Fig.4c “Mean in-cloud turbulence potential at FL 300”

[UK]	[US]
 Fig. 3d “Maximum icing potential at FL180” [UK]	 Fig. 4d “Maximum icing potential at FL180” [US]
 Fig. 3e “Maximum CAT potential at FL340” [UK]	 Fig. 4e “Maximum CAT potential at FL340” [US]

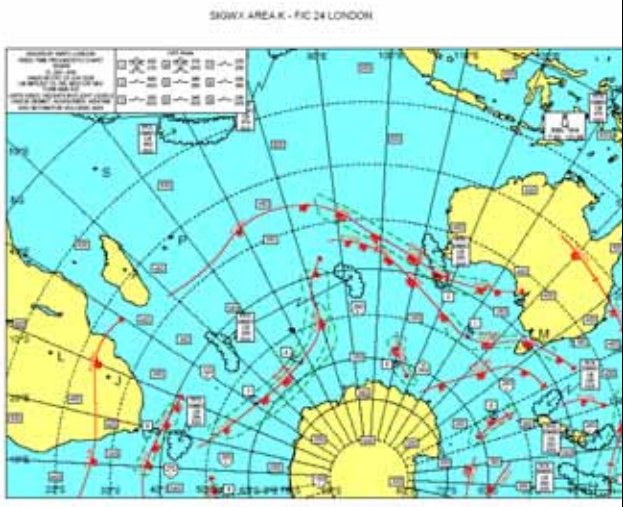


Fig. 3f SIGWX forecast at FL250-630" [UK]

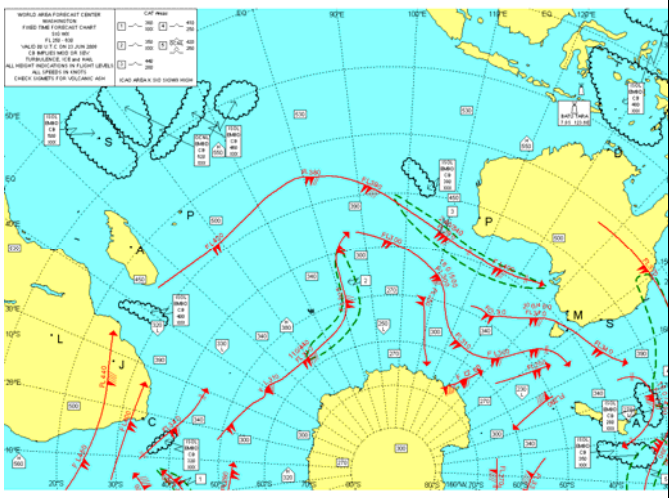


Fig. 4f "SIGWX forecast at FL250-630"" [US]

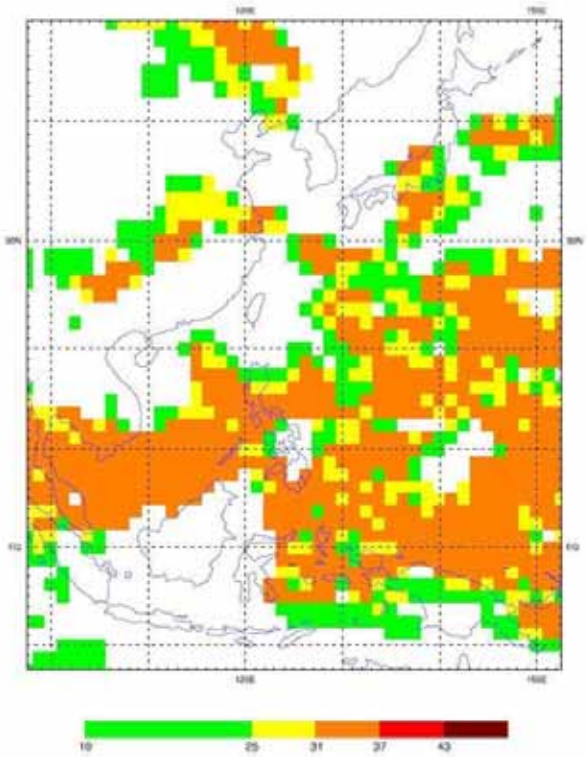


Fig. 3g "ICAO Height at CB Top (kft)" [UK]

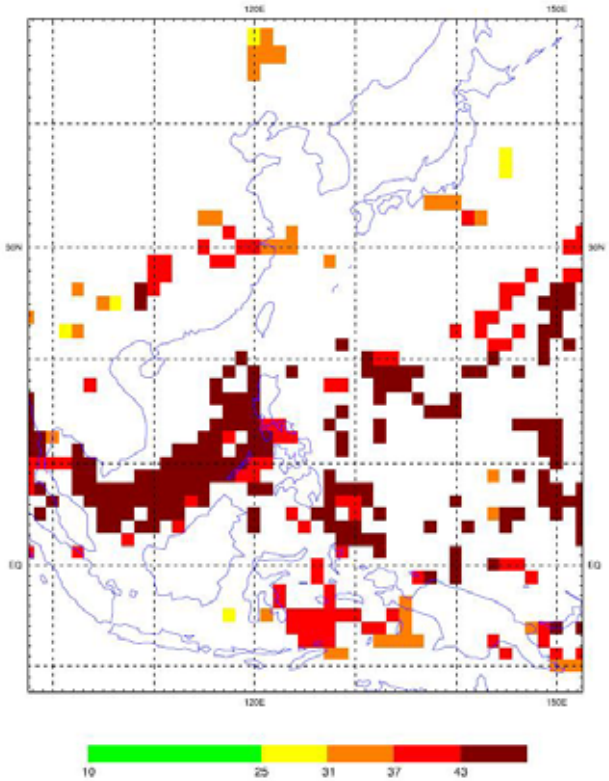


Fig. 4g "ICAO Height at CB Top (kft)" [US]

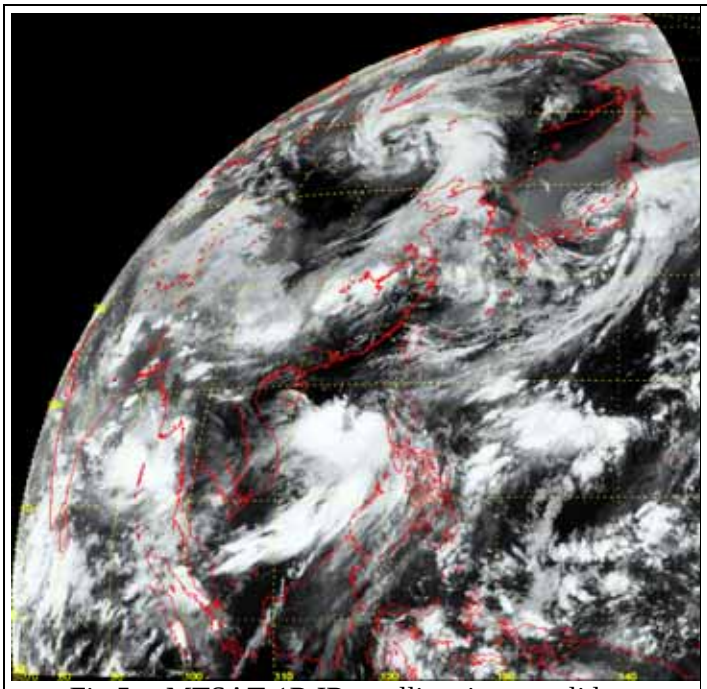


Fig.5a MTSAT-1R IR satellite picture valid at 0030 UTC 23 Jun 2008.

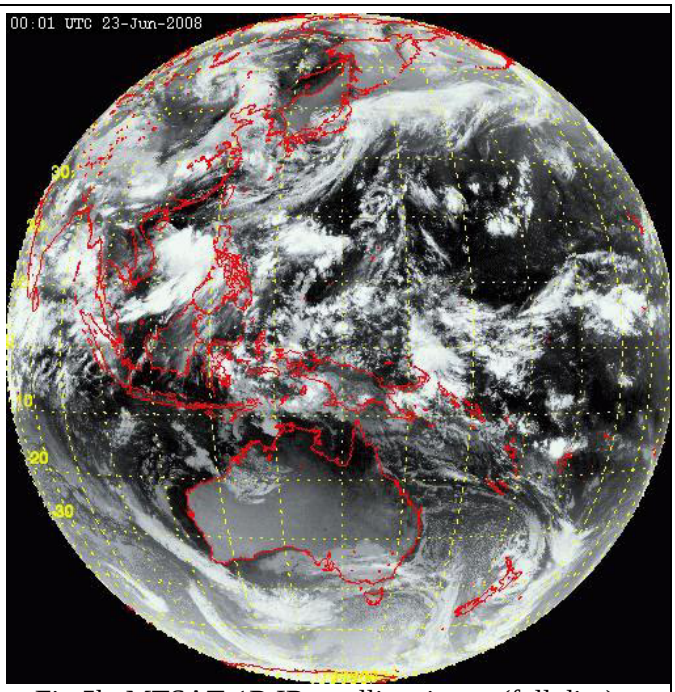


Fig.5b MTSAT-1R IR satellite picture (full disc), valid at 0000 UTC 23 Jun 2008.

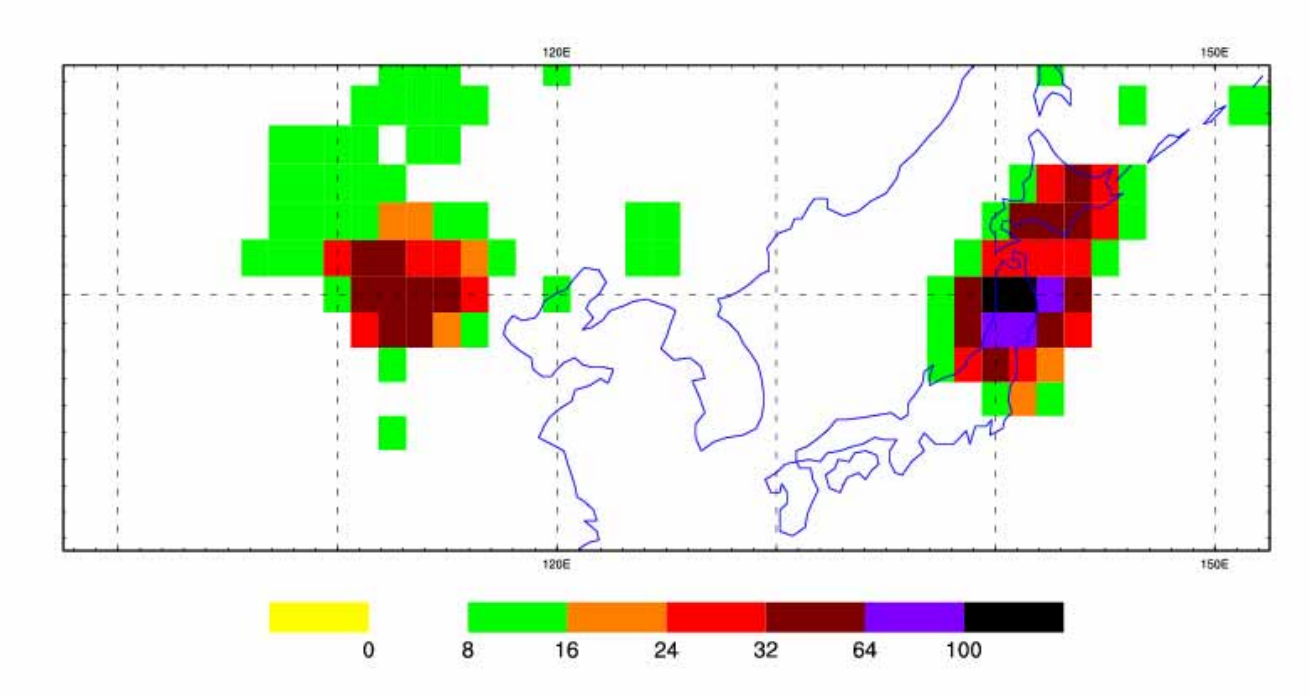


Fig. 6 6-h maximum CAT potential forecast by WAFC London valid at 12 UTC 20 May 2008