IBL Software Engineering
Galvaniho 17/C, 821 04 Bratislava
Slovakia

Tel:+421-2-32662111
Fax: +421-2-32662110
www.iblsoft.com

Use Cases for Standardised human-readable Representation of OPMET Data

Introduction 1

Situations where TAC is currently used 1
- Flight Planning 1
- Monitoring of METAR/TAF at MWOs 2
- Flight Documentation 2
- VOLMET & D-VOLMET 4
- En-route communication between pilots and ATCs 4

Compactness of TAC METAR/TAF 4
- Colour Coded Tabular Display using TAC 4

METAR & TAF Presentation Examples 5
- Colour Coded Tabular Display of Decoded Values 5
- Meteogram comparison of METAR and TAF 6
- Colour Coded Display of Station Plots on a Chart 8
  - METAR Station Plots 8
  - TAF Station Plots 9

Value of standardising data presentation 10

Graphical presentation of SIGMET/AIRMET being more important than TAC 10

Disaster/Backup Use Case for TAC 12

Introduction

IBL asked several aviation meteorological services questions regarding the real world usage of TAC representation of OPMET data. We also asked if the meteorological offices see importance in ICAO standardising how data should be presented to end-users in graphical, textual or tabular form if TAC was phased out.

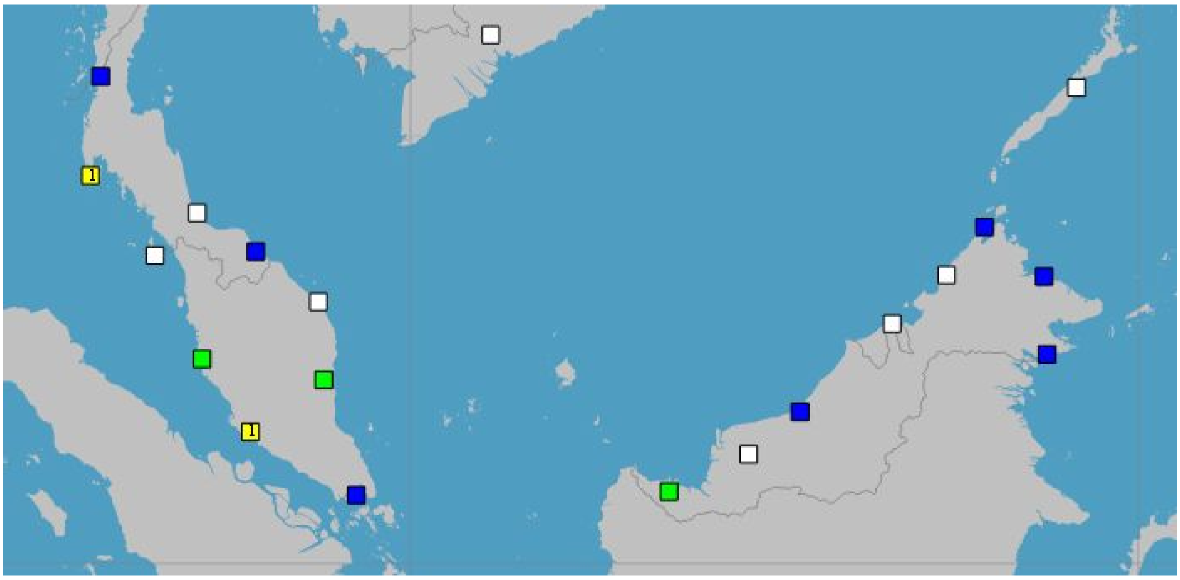
Situations where TAC is currently used

According to the responses we received TAC OPMET data is currently used in the following situations.

Flight Planning

Pilots and airlines use the data for **flight planning**

1. **Large commercial airlines** typically use **software** systems for flight planning. In this case the data exchange format is not an issue, because the flight planning software is interested in the actual values contained in the reports and it does not matter in which particular format these values came in.
2. **General aviation pilots** or smaller private operations might not have access to flight planning software and might be doing flight planning by hand. In this case they need to access the values in a human-readable form.
    - An opinion from MWO Bratislava is that GA pilots prefer simplified representation of weather at the aerodromes using e.g. color coding, rather than reading full TAC. For example colour coding aerodromes according to criteria based on visibility combined with the height of the lowest significant cloud:



Monitoring of METAR/TAF at MWOs

Meteorologists at MWOs will typically have computer monitors displaying METAR and TAF under the responsibility of the MWO. The displays include aerodromes in neighbouring countries or in general flight destinations where airlines from their aerodrome typically fly the most often.

This is typically done by displaying TAC data, sometimes with weather groups colour-coded by weather severity. Please see the following sections **Compactness of TAC METAR/TAF** later in the document for more details on these displays:

1. Compactness of TAC METAR/TAF
2. METAR & TAF Presentation Examples

Flight Documentation

Meteorological watch offices are producing **flight documentation** (in accordance with **ICAO Annex 3 Chapter 9, Section 9.3**). This has to contain METAR, SPECI, TAF, SIGMET, TCA and VAA, and if appropriate also AIRMET as specified in point 9.3.1. Such flight documentation consists of several pages with listings of OPMET data in TAC text format, accompanied with graphical **Wind & Temperature** and **SIGWX** charts. The document is often printed or distributed to users in PDF format using e-mail or published on the website of the MWO.

Some MWOs include in the flight documentation graphical representation of SIGMET or advisories. Graphics is much better at communicating the area affected by hazards than the TAC SIGMET/AIRMET/VAA/TCA.

Croatia Control reported that a significant portion of companies/operators still come into the Zagreb MET office asking for flight documentation. Very large commercial airlines might not be doing this anymore as they often have their own private internal met. departments or software systems that collect the information. But in general the practice of providing flight documentation to pilots/airlines is still common.

The following example is an excerpt from a typical flight document (please note this is an example and does not represent flight documentation issued at Vienna or Dubai international airports. Although Dubai international airport produces flight documentation that consists of lists of TAFs in TAC format for major international airports which is then provided to airlines/pilots).

MET information for flight VIE to DXB

From:	**Vienna**	*(2019-09-12 17:30)*
To:	**DUBAI INTERNATIONAL AIRPORT**	*(2019-09-12 23:10)*

Flight Plan

Airport: Vienna ICAO: LOWW IATA: VIE
Coordinates: 48°07'N 16°34'E
Departure time: 2019-09-12 17:30:00 UTC

Airport: DUBAI INTERNATIONAL AIRPORT ICAO: OMDB IATA: DXB
Coordinates: 25°15'N 55°20'E
Arrival time: 2019-09-12 23:10:00 UTC

Sunset: 14:49:29 UTC
Sunrise: 01:40:17 UTC

OPMET Information

METARs

```
METAR LOWW 121650Z 28012KT CAVOK 22/10 Q1030 NOSIG=
METAR OMDB 121700Z 33006KT 5000 HZ NSC 34/29 Q1003 NOSIG=
METAR LOAV 121700Z 30009KT 40KM FEW040CU SCT080AC 20/09=
LHBS NIL=
LHBM NIL=
LHTL NIL=
METAR LHBP 121700Z 30011KT CAVOK 22/13 Q1028 NOSIG=
METAR LHKE 121645Z 30008KT CAVOK 22/11 Q1027 NOSIG RMK BLU=
METAR LHSN 121645Z 31004KT CAVOK 23/10 Q1027 NOSIG RMK BLU=
LHBC NIL=
METAR LRSB 121700Z 26007KT CAVOK 17/07 Q1027 NOSIG=
METAR LRTZ 121700Z 06014KT 9999 BKN200 23/13 Q1023 BLU BLU=
LTAL NIL=
LTCR NIL=
OSKL NIL=
METAR OIAW 121700Z 29008KT CAVOK 36/08 Q1003=
METAR OIAM 121700Z 33006KT CAVOK 32/15 Q1003=
METAR OIBK 121700Z 30006KT 4000 BR NSC 33/29 Q1002=
OIBS NIL=
OIBA NIL=
METAR OMSJ 121700Z 35002KT 3000 HZ NSC 33/29 Q1003 NOSIG=
OMDM NIL=
```

TAFs

```
TAF LOWW 121715Z 1218/1324 29010KT CAVOK TX25/1314Z
              TN14/1304Z
              TEMPO 1223/1307 VRB02KT
              TEMPO 1318/1324 27005KT=
TAF OMDB 121700Z 1218/1400 36010KT 6000 NSC
              BECMG 1219/1221 12005KT PROB30 1222/1304 3000
              BR BKN008
              BECMG 1303/1305 19010KT
              BECMG 1307/1309 32010KT
              BECMG 1318/1320 17005KT=
TAF LOAV 121125Z 1212/1221 29010KT 9999 FEW040
              TEMPO 1212/1216 32015KT SCT040=
LHBS NIL=
LHBM NIL=
LHTL NIL=
TAF LHBP 121115Z 1212/1312 31009KT CAVOK
              BECMG 1219/1221 VRB03KT
              BECMG 1309/1311 33007KT=
TAF LHKE 121715Z 1218/1303 30006KT CAVOK=
TAF LHSN 121715Z 1218/1303 31005KT CAVOK=
LHBC NIL=
TAF LRSB 121100Z 1212/1312 VRB04KT CAVOK=
TAF LRTZ 121700Z 1218/1318 10014KT 9999 SCT200
              BECMG 1308/1310 02010KT SKC=
TAF LTAL 121340Z 1215/1224 VRB02KT CAVOK=
TAF LTCR 121340Z 1215/1224 VRB02KT 9999 SCT040
              BECMG 1216/1219 36012KT CAVOK=
OSKL NIL=
TAF OIAW 121100Z 1212/1318 26004KT CAVOK
              TEMPO 1215/1218 30018KT PROB40 1209/1215 4000
              SA=
OIAM NIL=
TAF OIBK 121100Z 1212/1318 12006KT 5000 HZ NSC
              BECMG 1218/1220 3000 HZ/BR
              BECMG 1304/1306 7000
              TEMPO 1306/1310 12016KT
              TEMPO 1314/1318 28018KT=
OIBS NIL=
OIBA NIL=
TAF OMSJ 121700Z 1218/1400 36010KT 6000 NSC
              BECMG 1218/1220 10005KT PROB30 1218/1221 4000
              HZ PROB30 1221/1304 3000 BR BKN008
              BECMG 1303/1305 19010KT
              BECMG 1307/1309 31010KT
              BECMG 1318/1320 17005KT=
OMDM NIL=
```

VOLMET & D-VOLMET

TAC OPMET data is provided to aircraft in flight on **VOLMET** (voice on VHF frequencies) and **D-VOLMET** (data link). For VOLMET the OPMET data is typically expanded into "words" which are read by voice synthesis. On D-VOLMET TAC reports are distributed. This is further elaborated in **Chapter 11 of ICAO Annex 3**. If the VOLMET/D-VOLMET need to continue into the future, probably some kind of standardisation of the content of the broadcasts is still necessary.

https://www.skybrary.aero/index.php/VOLMET has YouTube link with an example of a VOLMET broadcast.

En-route communication between pilots and ATCs

Pilots en-route sometimes ask ATC centre to provide METAR for destination or en-route aerodrome. In this case the air traffic controller will **read the whole METAR report text** to the pilot (use case reported by CroatiaControl).

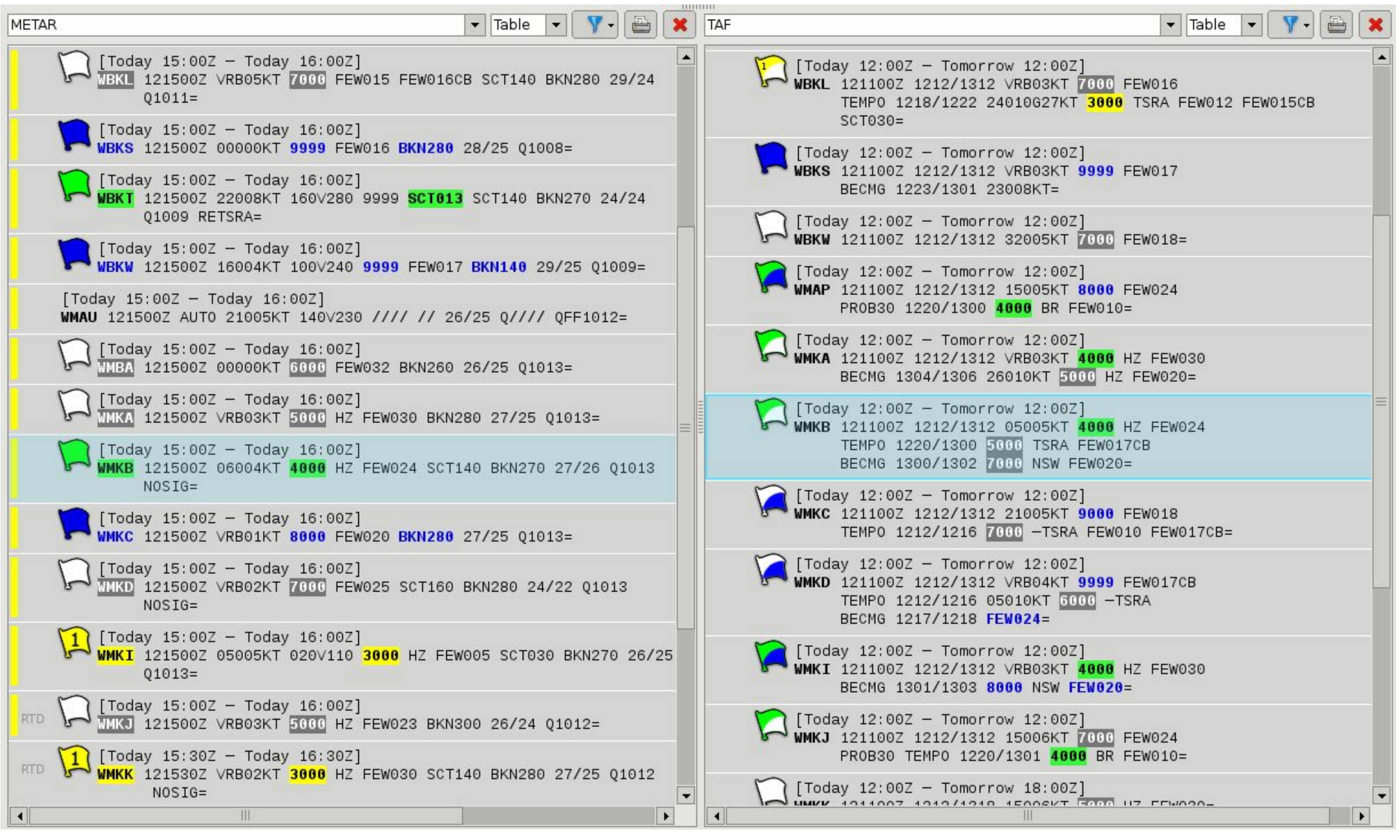
Compactness of TAC METAR/TAF

Meteorologists from MWO at LZIB (Bratislava international airport) see the compactness of TAC METAR and TAC TAF as an advantage. They value the ability to display a relatively large number of observations and forecasts on limited screen area (e.g. for **monitoring** purposes) or paper area (e.g. for **flight documentation**).

Meteorologists are often monitoring METAR and TAF for the aerodromes under their responsibility (in IBL experience this is true for all the MWOs around the world and not specific for MWO Bratislava). Monitoring in the sense of keeping watch for adverse weather, or visually monitoring whether the forecast is consistent with incoming observations (so called TAF monitoring or verification).

Colour Coded Tabular Display using TAC

Below is an example of such a monitoring table where visibility and cloud groups are coloured according to predefined criteria which makes it easy for the forecaster to spot weather that could adversely affect aircraft take-off or landing.



The advantage of this particular presentation over a tabular display with decoded values is that while being reasonably compact it does not hide information contained in TAF change groups (which is not straightforward to express by different means).

METAR & TAF Presentation Examples

Colour Coded Tabular Display of Decoded Values

Arguably for the use case of real-time monitoring of TAF forecast accuracy also decoded values out of METAR and TAC can be used and presented to the meteorologist in a **tabular form** as in the following example.

The table below is used in operation by aviation forecasters at **Australian Bureau of Meteorology** (BoM). It contains an overview of parameters decoded out of METAR observations and TAF forecasts for a list of a subset of aerodromes under responsibility of a forecaster. The individual observation or forecast cells are colour coded if there is any adverse weather displayed (e.g. 350m of horizontal visibility is highlighted).

IBL Software Engineering
Galvaniho 17/C, 821 04 Bratislava
Slovakia

Tel:+421-2-32662111
Fax: +421-2-32662110
www.iblsoft.com

	Time	Obs	WIND	Gust	Fcst	WIND	Gust	Obs VIS	Fcst VIS	Obs	CLD			Fcst	CLD	Fcst BKN	TS-Obs	TS-Fcst	Obs T	Obs Td	T1	T2	T Diff	Obs QNH
YPED	121600	060	5 kt	6 kt	VRB	5 kt		9999 m	9999 m										8.4 °C	7.2 °C	9	8	0.4	1026.1 hPa
YBRM	121600	000	0 kt	0 kt	VRB	3 kt		9999 m	9999 m										14.4 °C	12.9 °C				1018.1 hPa
YBUN	121600	110	1 kt	2 kt	020	3 kt		350 m	300 m	BKN	002	BKN	120	BKN	010	1000 ft			13.8 °C	13.8 °C	14	13	0.2	1023.1 hPa
YPGV	121600	170	4 kt	6 kt	140	8 kt		9999 m	9999 m	SCT	058			SCT	025				20.1 °C	18.1 °C	21	20	0.1	1016.8 hPa
YROM	121600	010	4 kt	4 kt	310	5 kt		9999 m	9999 m										7 °C	-5.3 °C	10	7	0.0	1023.5 hPa
YPPD	121600	190	8 kt	9 kt	150	8 kt		9999 m	9999 m										16 °C	6.4 °C	16	16	0.0	1019.5 hPa
YABA	121600	340	4 kt	5 kt	VRB	4 kt		9999 m	300 m	BKN	013			FEW	010				14.6 °C	14 °C	15	12	0.4	1023.7 hPa
YMAY	121600	000	0 kt	0 kt	VRB	5 kt		9999 m	500 m					BKN	001	100 ft			4.8 °C	3.5 °C	6	5	0.2	1023.2 hPa
YCCY	121600	190	3 kt	5 kt	130	6 kt		9999 m	9999 m										15.6 °C	-1 °C	18	16	0.4	1021.1 hPa
YMBD	121600	300	5 kt	7 kt				9999 m		OVC	008								11.1 °C	9.1 °C				1026.5 hPa
YBCV	121600	000	0 kt	0 kt	170	3 kt		9999 m	9999 m										7.8 °C	-7.8 °C	12	8	0.2	1024 hPa
YOLW	121600	300	5 kt	6 kt															21.1 °C	19.6 °C				1019.6 hPa
YFLI	121600	260	19 kt	23 kt	250	15 kt	25 kt	9999 m	9999 m	SCT	024			BKN	025	2500 ft			10.4 °C	6.5 °C	10	10	0.4	1019.8 hPa
YBAS	121600	290	5 kt	5 kt	290	5 kt		9999 m	9999 m										8 °C	-18.7 °C	10	7	1.0	1025.4 hPa
YTRE	121600	230	4 kt	5 kt	VRB	3 kt		9999 m	9000 m										10.7 °C	7.8 °C	12	11	0.3	1017.9 hPa
YPEA	121600	000	0 kt	0 kt	VRB	3 kt		9999 m	300 m										13.2 °C	11.6 °C	14	13	0.2	1024.4 hPa
YSSY	121600	190	6 kt	8 kt	200	10 kt		9999 m	9999 m	SCT	120			SCT	020				15.4 °C	9.7 °C	14	14	1.4	1018.9 hPa
YCOM	121600	180	4 kt	5 kt	260	5 kt		9999 m	500 m					SCT	010				-2.5 °C	-6.3 °C				1021.4 hPa
YSNW	121600	250	6 kt	7 kt	180	10 kt		9999 m	9999 m					BKN	015	1500 ft			9.8 °C	7.1 °C	12	10	0.2	1020.3 hPa
YBTL	121600	130	5 kt	7 kt	140	7 kt		9999 m	9999 m					FEW	022				17.3 °C	13.9 °C	16	14	1.3	1021.9 hPa
YPLC	121600	250	3 kt	4 kt	VRB	5 kt		9000 m	500 m	OVC	005			BKN	004	400 ft			11.6 °C	11.3 °C	10	10	1.6	1026.4 hPa
YBSU	121600	280	3 kt	4 kt	200	7 kt		9999 m	9999 m										11.1 °C	9.9 °C	12	12	0.9	1022 hPa
YBTH	121600	280	2 kt	4 kt	VRB	4 kt		9999 m	9999 m										7.3 °C	-4.4 °C	8	5	0.7	1021.3 hPa
YBSG	121600	160	3 kt	3 kt	110	8 kt			9999 m					FEW	040				18.3 °C	14 °C	20	19	0.7	1017 hPa
YTWB	121600	290	4 kt	5 kt	280	5 kt		9999 m	9999 m										13 °C	-1.7 °C	11	11	2.0	1023.8 hPa
YLBD	121600	240	1 kt	2 kt	210	5 kt		9999 m	9999 m										19.8 °C	12.6 °C	20	19	0.2	1018 hPa
YPBO	121600	070	8 kt	11 kt	060	8 kt		9999 m	9999 m										24.5 °C	-13.5 °C	24	21	0.5	1021.3 hPa
YNTN	121600	130	6 kt	8 kt	090	7 kt		9999 m	9999 m										20.8 °C	1.6 °C	23	21	0.2	1018.3 hPa
YKSC	121605	250	1 kt	4 kt	VRB	5 kt		5000 m	500 m	OVC	005			BKN	005	500 ft			10.6 °C	9.8 °C	9	9	1.6	1026.1 hPa
YLTV	121600	260	14 kt	18 kt	260	10 kt		9999 m	9999 m	OVC	032			BKN	030	3000 ft			9.7 °C	5.3 °C	10	8	0.3	1023.3 hPa
YGTH	121600	190	7 kt	9 kt	200	10 kt		9999 m	9999 m										10.6 °C	7.1 °C	11	8	0.4	1023.6 hPa
YSHW	121600	170	7 kt	10 kt	200	5 kt		9999 m	9999 m	SCT	110			SCT	020				15.4 °C	1.9 °C	11	11	4.4	1018.9 hPa

There is no need to standardise how such a tabular display should look like, if it is used by meteorologists only. Meteorologists working for a particular MWO will get used to the locally defined presentation. However for pilots or airlines, if TAC was phased out, it would not be very efficient if such end-users were receiving tabular views of METAR/TAF organised differently depending on the MWO that provides such a table.

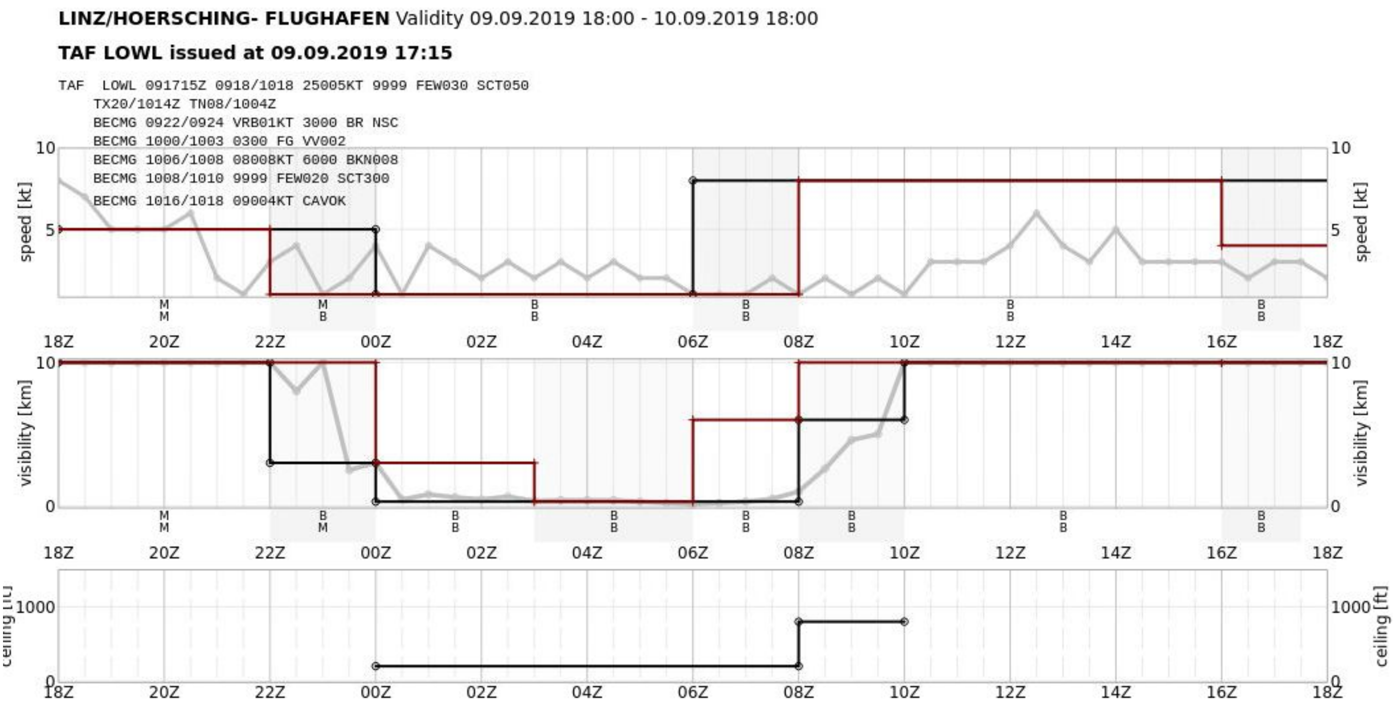
Please note that using a tabular view for TAF like this has also disadvantages. It obscures information about change groups. In TAC TAF the change groups can be read from the report text. Change groups like FM, BECMG or TEMPO are however not something that can easily be represented in a tabular form like the one above, because they add a "3rd dimension" in the data.

Meteogram comparison of METAR and TAF

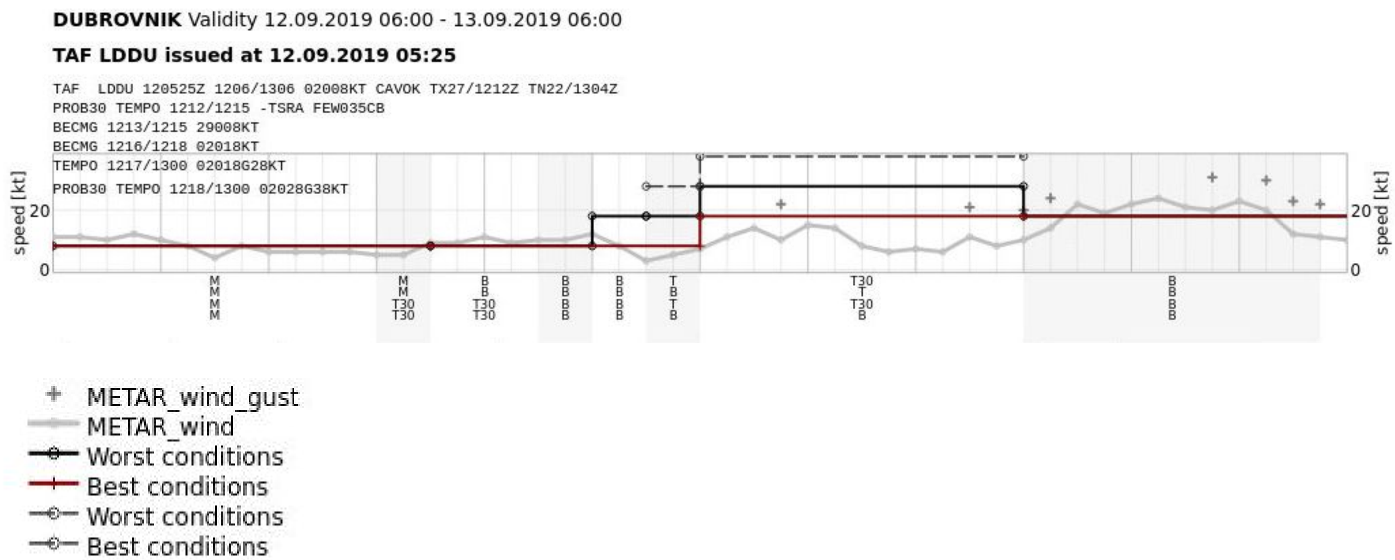
In the following example you can see an alternative graphical visualisation of "best" and "worst" conditions in a TAF forecast for a particular aerodrome. This way of visualisation was created in cooperation between **Croatia Control** and IBL.

- **Black** lines represent the "worst" (most severe) weather forecast from TAF for wind speed, visibility or ceiling.
- **Red** lines are the "best" (least severe) weather forecast. So when for a particular hour of the meteogram there is a gap between the blue and red lines, the height of the gap indicates the range or uncertainty of the forecast for that hour.
- **Grey** lines are METAR observations. The forecaster can easily see from the graphs how much the real observed values deviate from what was forecast.

- On the X-axis of the graph you can see letters like “M” or “B”which indicate what kind of change group is in effect in that interval. M corresponds to “main forecast” and B to “becoming”.



The example below uses a dashed line for temporary fluctuations. In the example TAF there is a PROB30 TEMPO change group indicated with “T30” label on X-axis of the graph and a TEMPO with probability above 50% which is indicated with “T” on the X-axis.



IBL Software Engineering
Galvaniho 17/C, 821 04 Bratislava
Slovakia

Tel:+421-2-32662111
Fax: +421-2-32662110
www.iblsoft.com

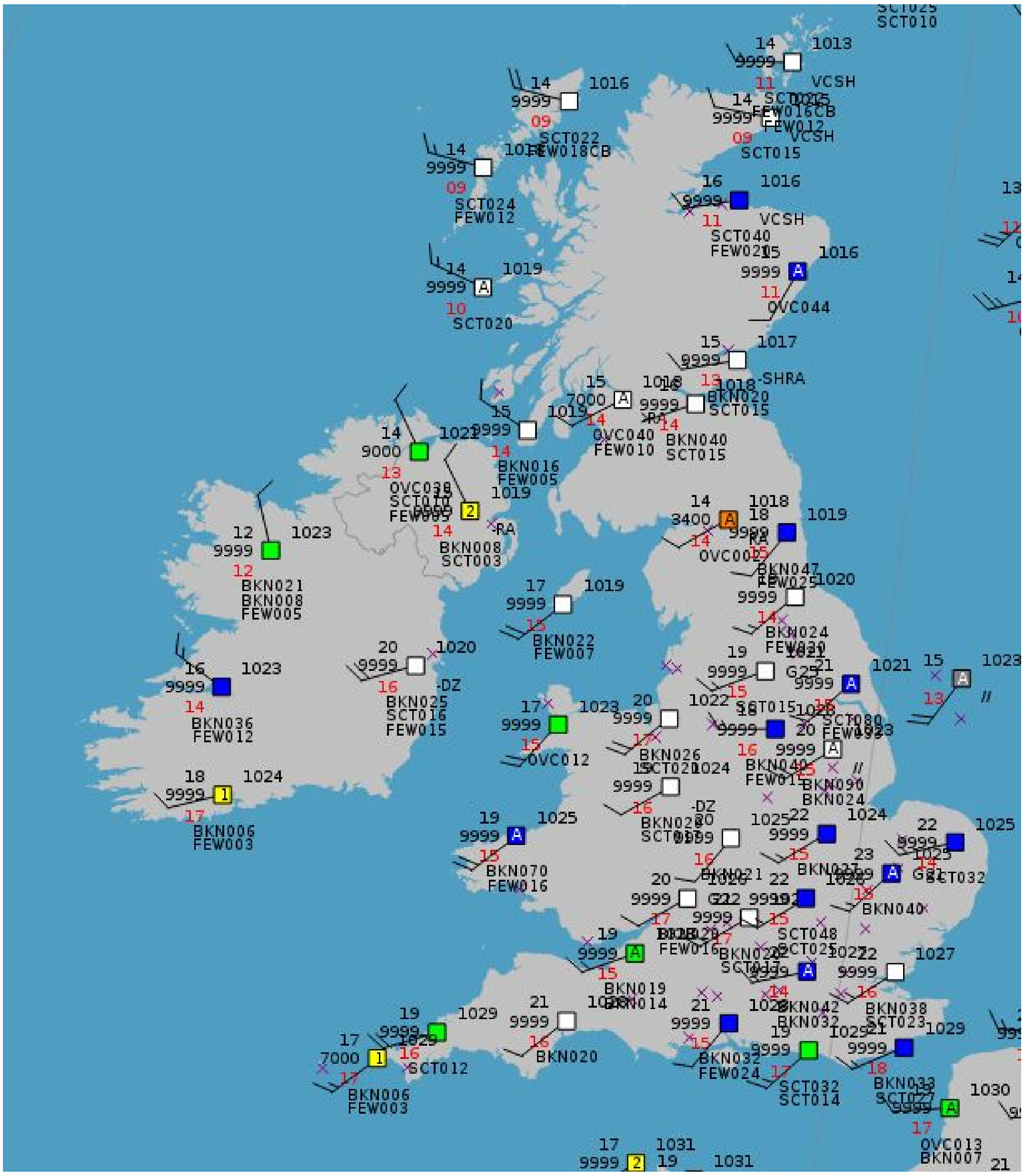
Colour Coded Display of Station Plots on a Chart

METAR data can be presented to users in a graphical way. However as opposed to SYNOP in public meteorology where the station plot is standardised by WMO, there is no such standardisation for a graphical METAR.

For meteorologists and air traffic controllers who are working for one particular organisation this is not a problem at all. They simply get used to the locally preferred way of graphically depicting METAR/SPECI. But if such charts were given to users outside of the MWOs like **airlines or pilots**, these could be **easily confused as they would be getting different visualisation from different providers**.

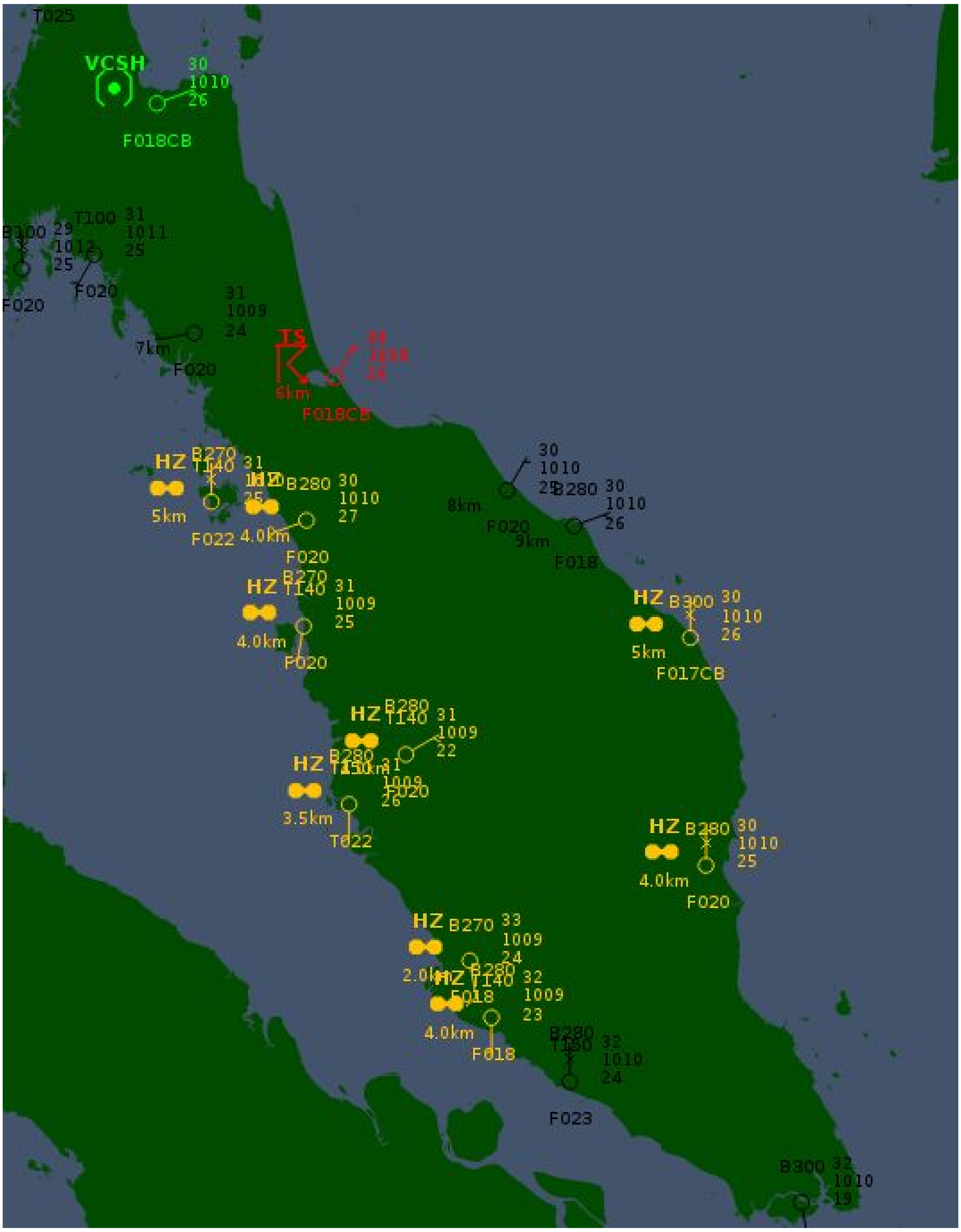
METAR Station Plots

In some parts of the world a colour coded station plot like this is used:



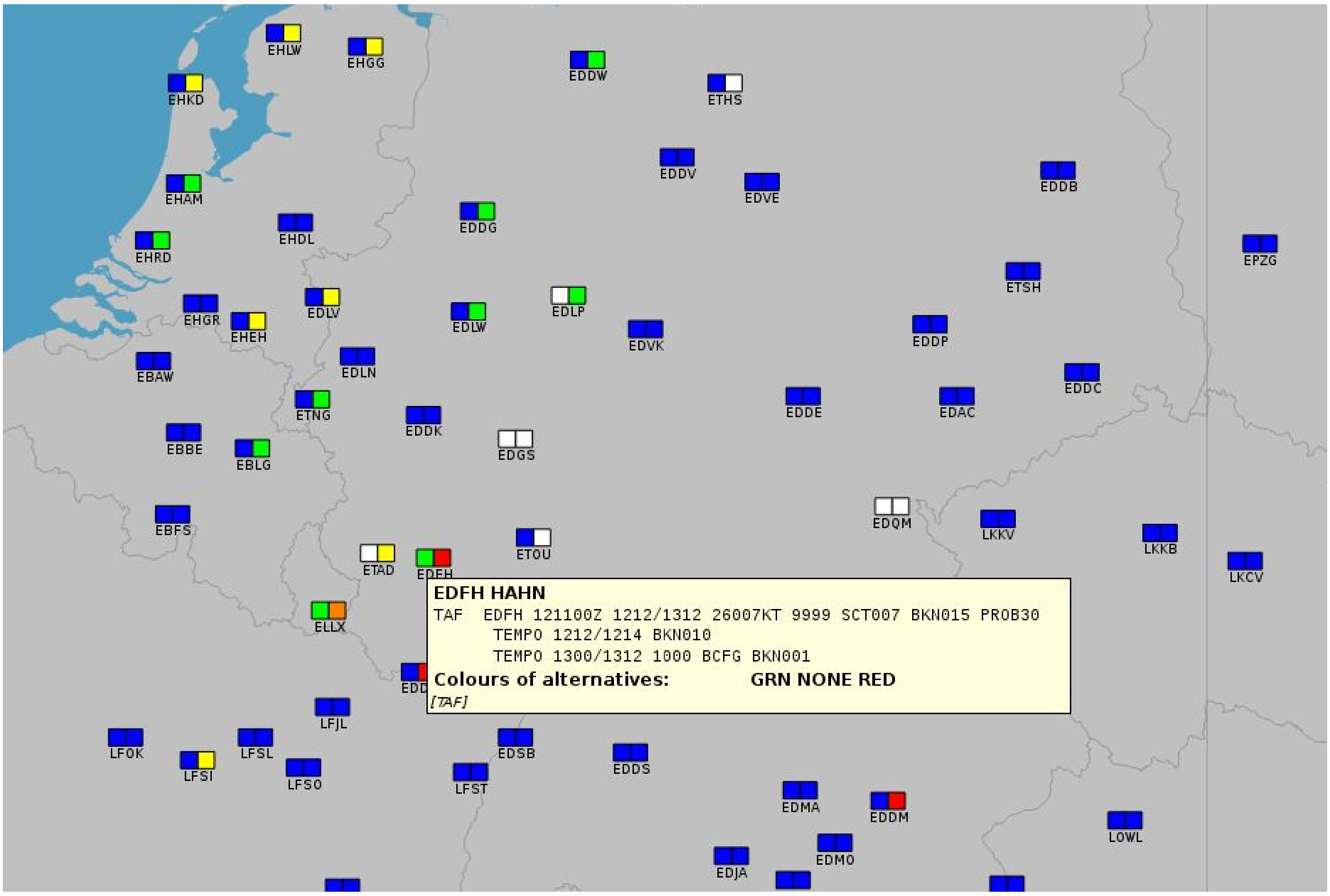
IBL Software Engineering
Galvaniho 17/C, 821 04 Bratislava
Slovakia
Tel:+421-2-32662111
Fax: +421-2-32662110
www.iblsoft.com

Individual states can have their own preferred way of looking at METAR data graphically, like on this example of a METAR chart from Malaysia which combines colour coding with standard meteorological symbols for e.g. thunderstorms.



TAF Station Plots

For **TAF** specifically IBL is not aware of any good station plot representations that would be used in practice. One of the attempts at such a visualization created at IBL can be seen on the following picture. It displays using colour codes the best and worst weather conditions that can be expected at the given aerodrome. But the actual details of the weather responsible for an aerodrome not being suitable for landing are not easily representable on such an oversimplified chart:



Value of standardising data presentation

Opinion coming from CroatiaControl is that ICAO should continue standardising presentation of meteorological aviation data. They view the option of leaving the presentation up to software vendors as a step back compared to current situation with TAC, because:

1. End-users are currently familiar with one common presentation
2. Users should be able to consume meteorological data fast, without "changing of logic" whenever they consume data from a different provider.
3. There is a concern that not standardising any form of data presentation will ultimately cause fragmentation in how data is represented by states or wider regions of the world, making the data harder to consume by end-users.

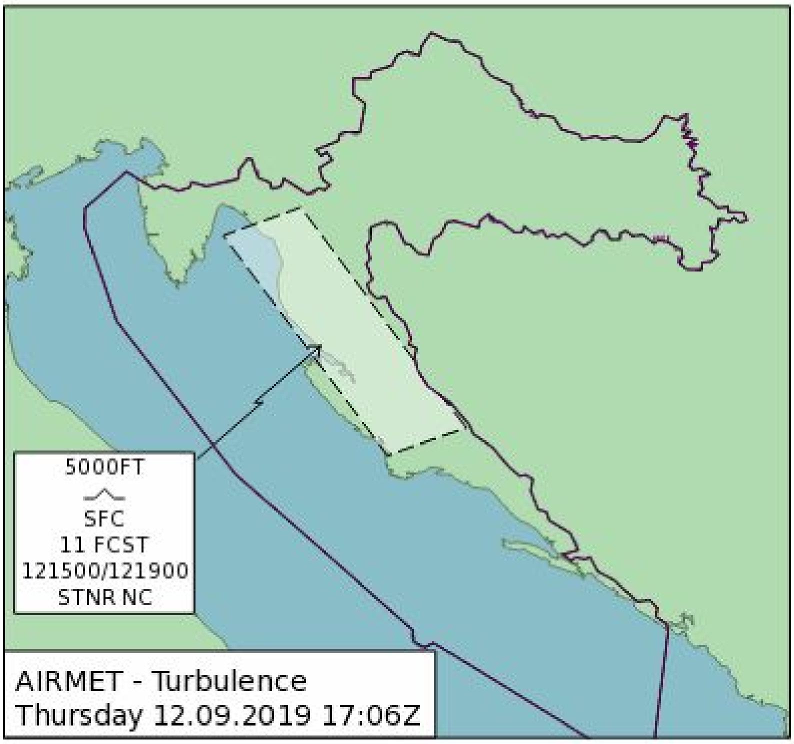
Graphical presentation of SIGMET/AIRMET being more important than TAC

Meteorologists at CroatiaControl are of the opinion that SIGMET and AIRMET in traditional TAC format are almost unusable for end-users. They prefer graphical representation of these warnings - and Croatia

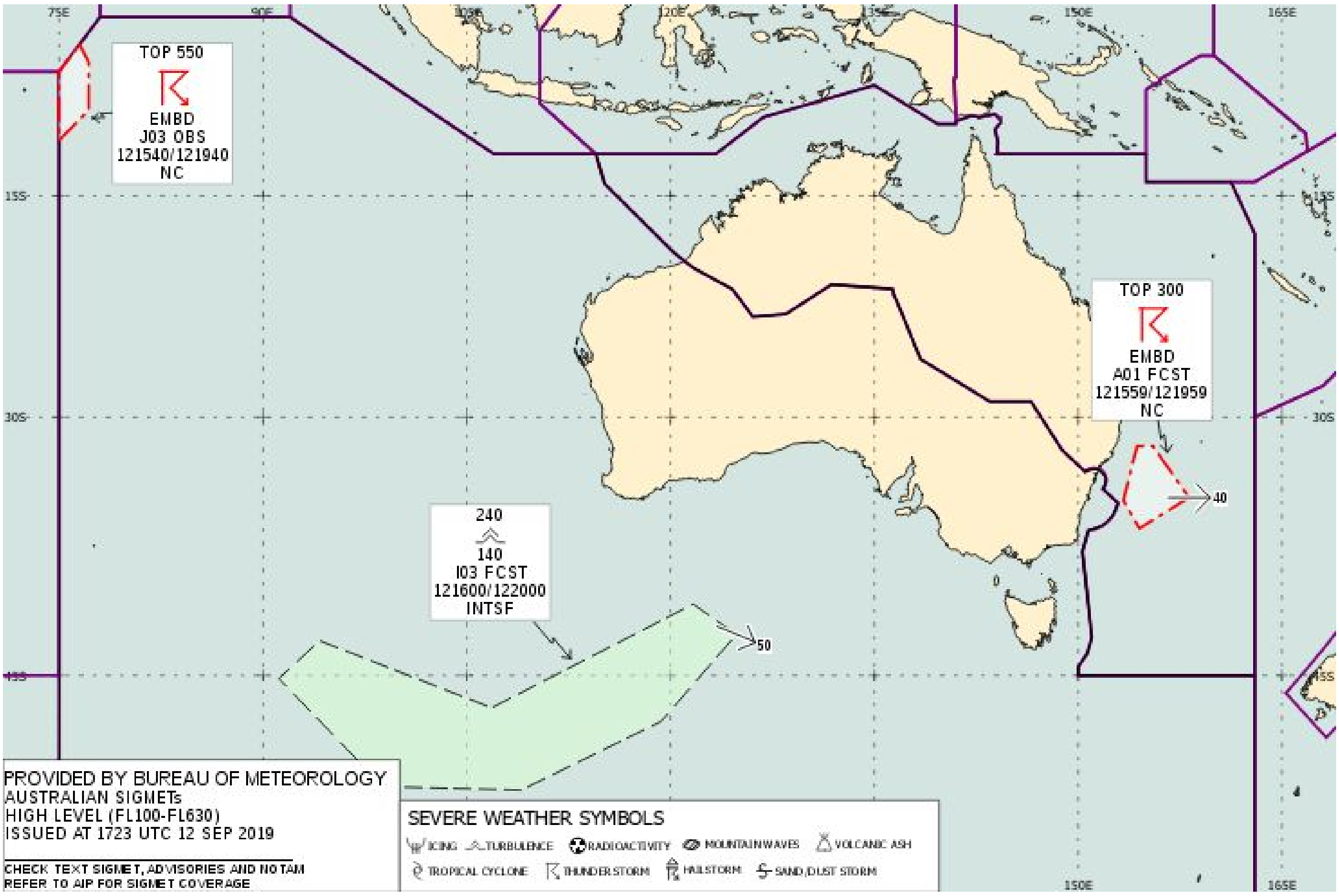
Control CroatiaControl only keeps including the text representation of SIGMET/AIRMET in **flight documentation** due to regulations.

CroatiaControl publishes graphical SIGMET and AIRMET on its public website (at some times of day the images will be empty if there is no SIGMET in effect, but there usually are at least some AIRMETs):

- SIGMET https://met.crocontrol.hr/web/guest/sigmet
- AIRMET https://met.crocontrol.hr/web/guest/airmet



Example of a graphical SIGMET chart from website of Australian Bureau of Meteorology (http://www.bom.gov.au/aviation/warnings/graphical-sigmet/)



Disaster/Backup Use Case for TAC

This is a use case reported by MWO Zagreb (CroatiaControl). One of the useful properties of TAC is that when the software systems used to issue TAF or SIGMET fail, the observer or forecaster has an option to manually type the reports in any text editor and distribute them through AFTN/AMHS networks.

This is a general concern about moving from easy to enter text based formats into “digital” formats that can no longer be authored by human operators. Dependency of aviation meteorology on increasingly complex software systems is on the rise. This creates challenges when planning for disaster recovery.