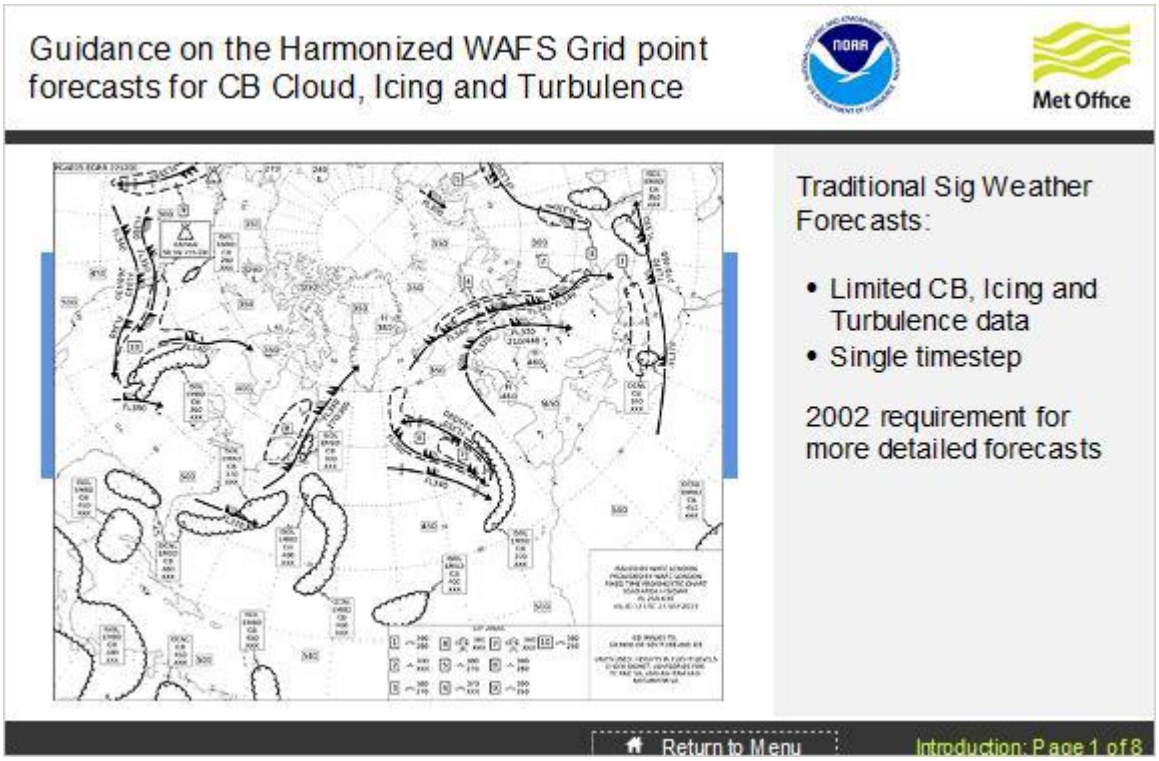
WAFS_Word

2. Menu

2.1 Untitled Slide

1. Introduction

1.1 Introduction



Notes:

As you will probably be aware, the traditional significant weather forecasts, usually seen in chart form, provide only limited information about CB cloud, Icing and Turbulence. They are also only produced for a single timestep every 6 hours, which means that for short-haul flights the latest information is not being used and for very long-haul flights the charts do not go far enough ahead to be useful.

The new grid point forecasts for CB cloud, Icing and Turbulence go some way to addressing these problems.

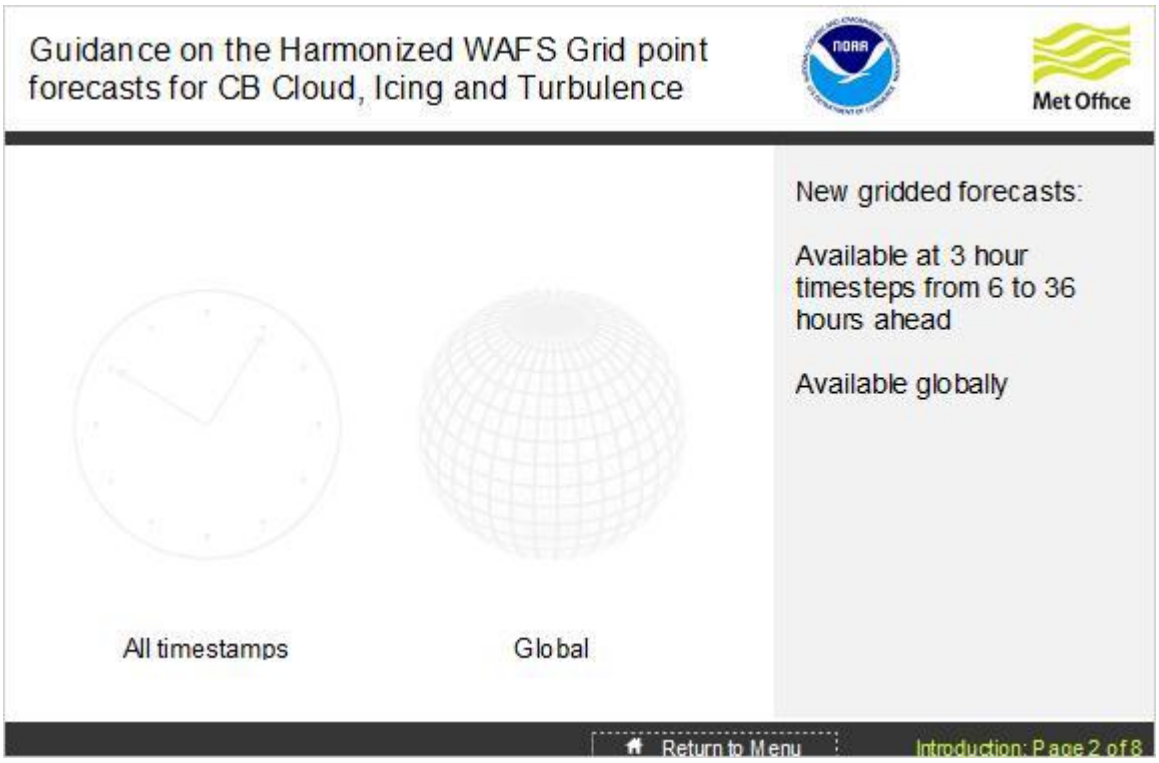
They were first proposed at the ICAO/WMO divisional meeting in 2002 in response to a requirement from the International Air Transportation

Association.

They are primarily designed for use in computerised flight planning systems. The development of the forecasts has been overseen by the World Area Forecasts Systems Operations Group of ICAO (which is usually pronounced I K O).

So what is new about the grid point forecasts for CB cloud, Icing and Turbulence and how can they help you in your role?

1.2 Introduction



Notes:

The traditional sig weather forecasts are only produced for a single timestamp whereas the new gridded forecasts mean that information is available at 3 hour timesteps from 6 to 36 hours ahead, and is updated every 6 hours.

In addition, the gridded forecasts are now available globally at all timesteps whereas on the sig weather forecasts, icing forecasts were only provided for limited geographical areas.

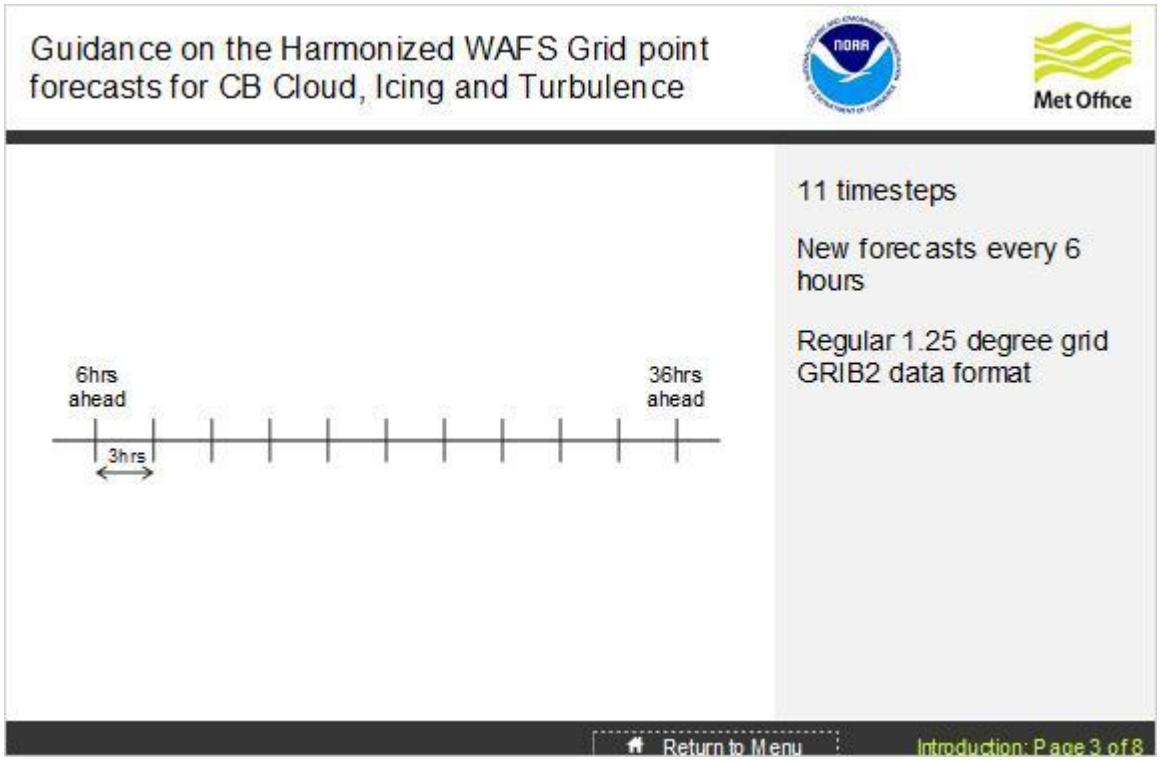
The new gridded forecasts of CB cloud, Icing and Turbulence consist of grid point data at multiple vertical levels that cover the entire globe.

They are produced for the same grid points as the WAFS wind, temperature and humidity forecasts.

This means that users will always have the latest information, relevant to the flight, wherever it is flying.

This is a significant improvement on the traditional forecasts.

1.3 Introduction



Notes:

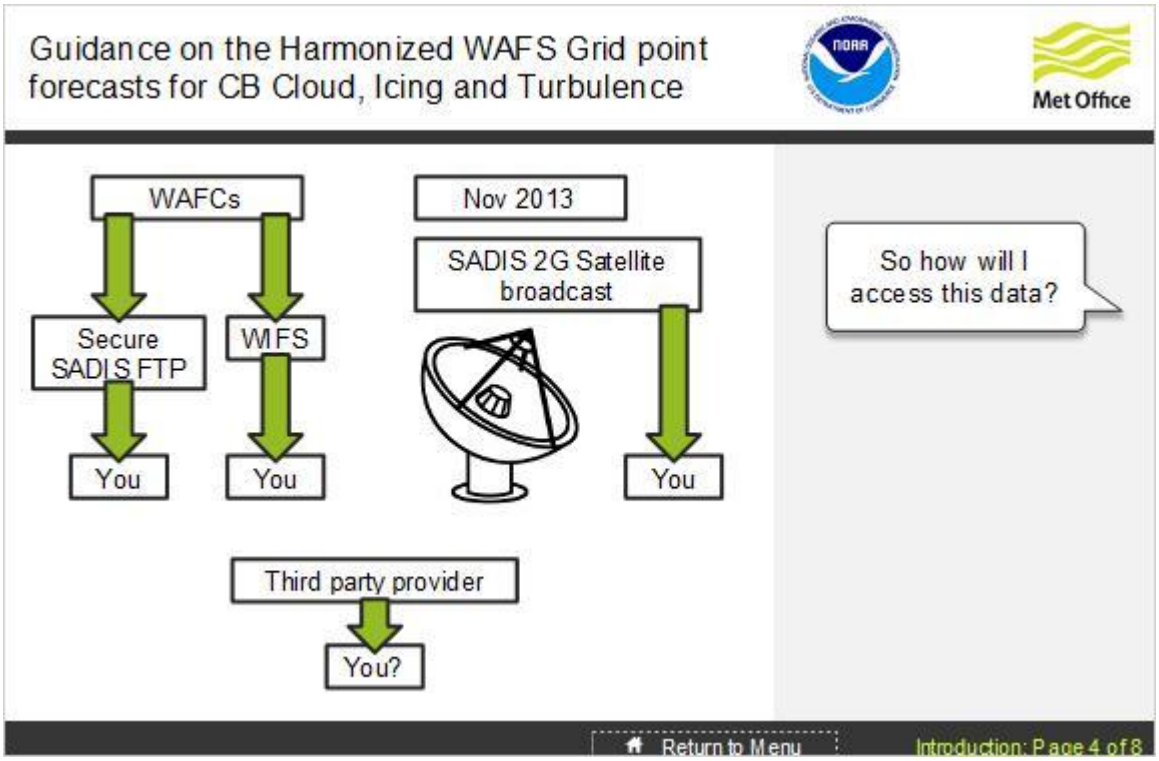
The grid point forecasts are produced for 11 time steps at 3 hourly intervals from 6

hours ahead to 36 hours ahead.

A new forecast is issued every 6 hours.

The forecasts use a regular one and a quarter degree grid and are issued in the GRIB2 data format

1.4 Introduction



Notes:

So how do you get access to this data?

The two WAFCs make this data available over the internet via the Secure SADIS FTP service and WIFS.

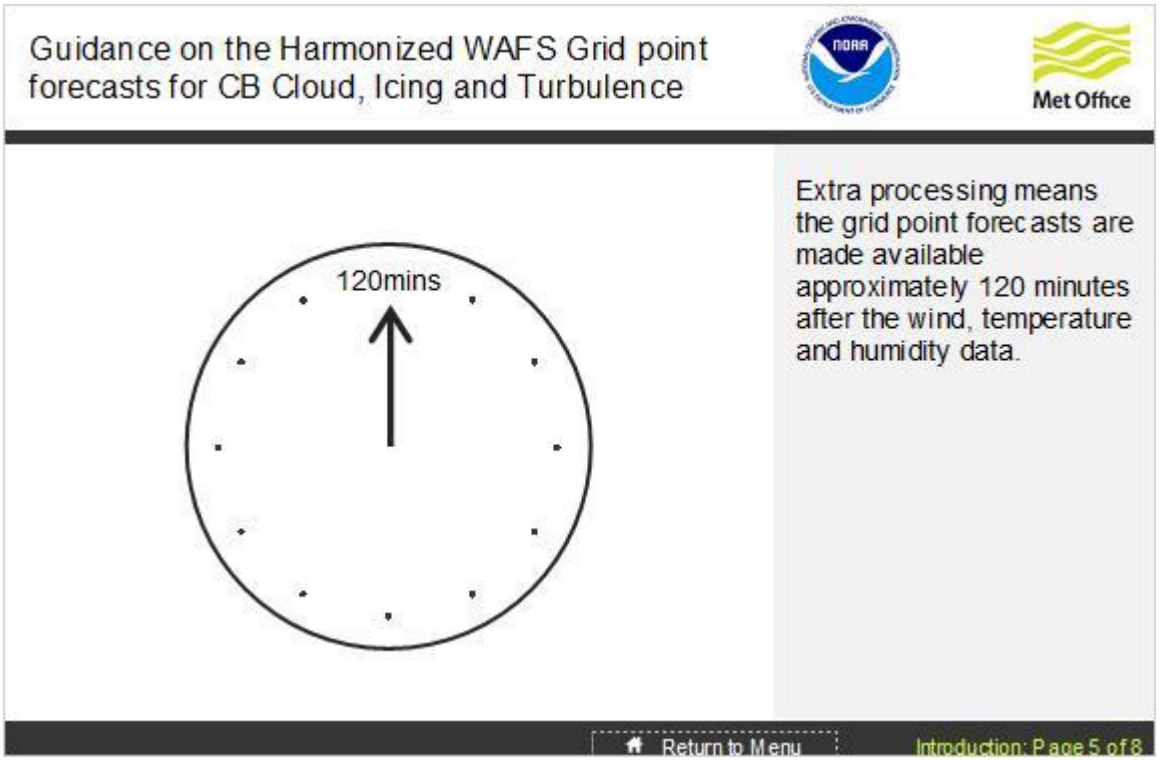
The data will also be added to the SADIS 2G Satellite broadcast from November 2013.

Some users may receive their data via a third party provider.

If you already have a SADIS, WIFS or user developed workstation to access WAFS GRIB data, then your service provider should be able to provide you

with a software upgrade to be able to use the new products.

1.5 Introduction

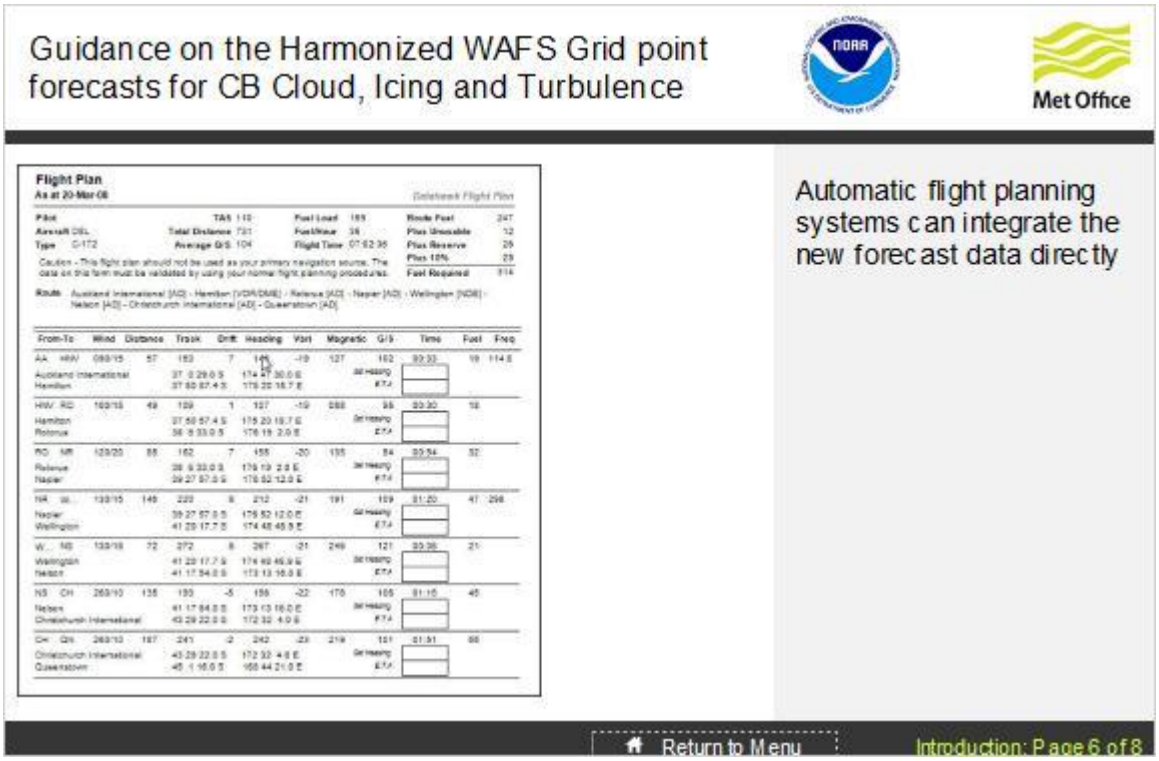


Notes:

In order to harmonise the data from the two WAFCs, the CB, ICING and Turbulence data has some extra processing carried out on it.

It is therefore important to note that, due to this extra processing, the CB, Icing and Turbulence grid point forecasts are made available about 120 minutes after the wind, temperature and humidity data.

1.6 Introduction



Notes:

So how should the new grid point forecasts be used?

The WAFCs produced WAFS upper-air grid point forecasts are primarily intended for use in flight planning.

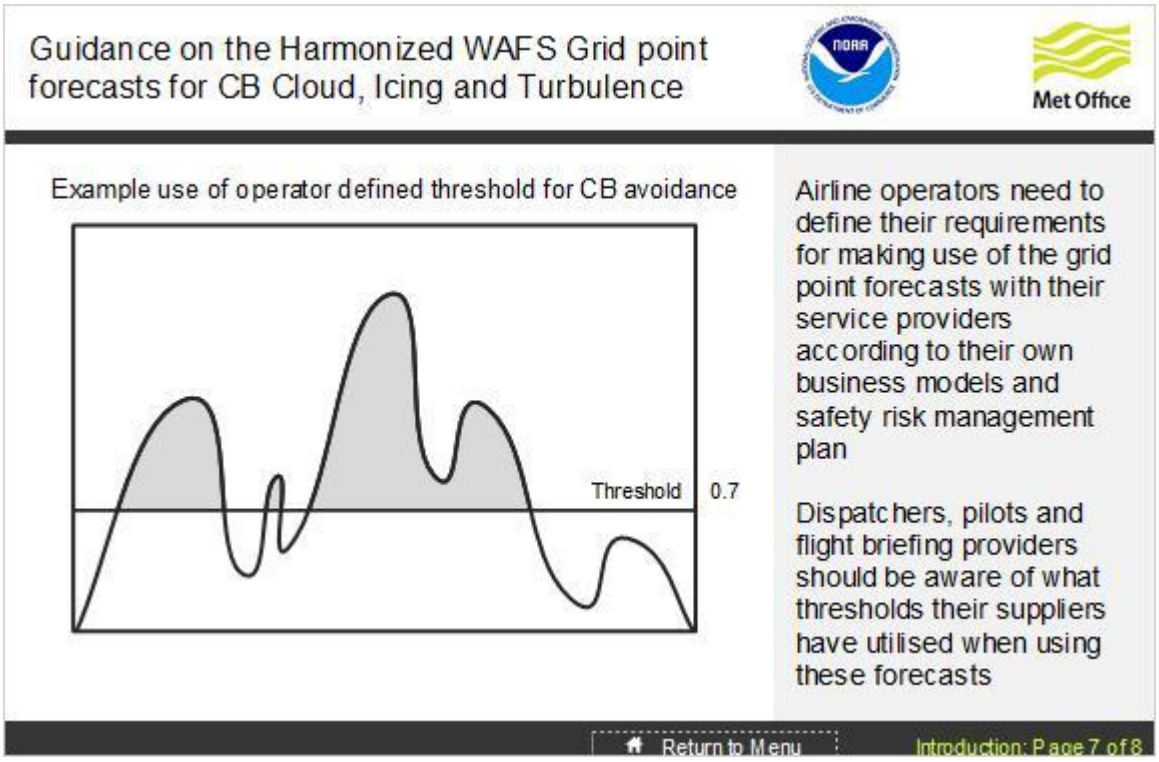
So, for example, wind and temperature forecasts can be used to calculate the most efficient fuel burn for an aircraft, while relative humidity forecasts are traditionally used to indicate areas at risk of icing in extended time diversion operations.

The new Icing forecasts can be ingested directly into automatic flight planning systems and diversion calculations carried out using this data rather than the relative humidity forecast.

The new data will allow forecasters to show customers where Icing, Turbulence or areas of CB cloud are most likely.

These forecasts are provided in digital format, in GRIB2 code form and are designed to be integrated directly into automatic flight planning systems.

1.7 Introduction



Notes:

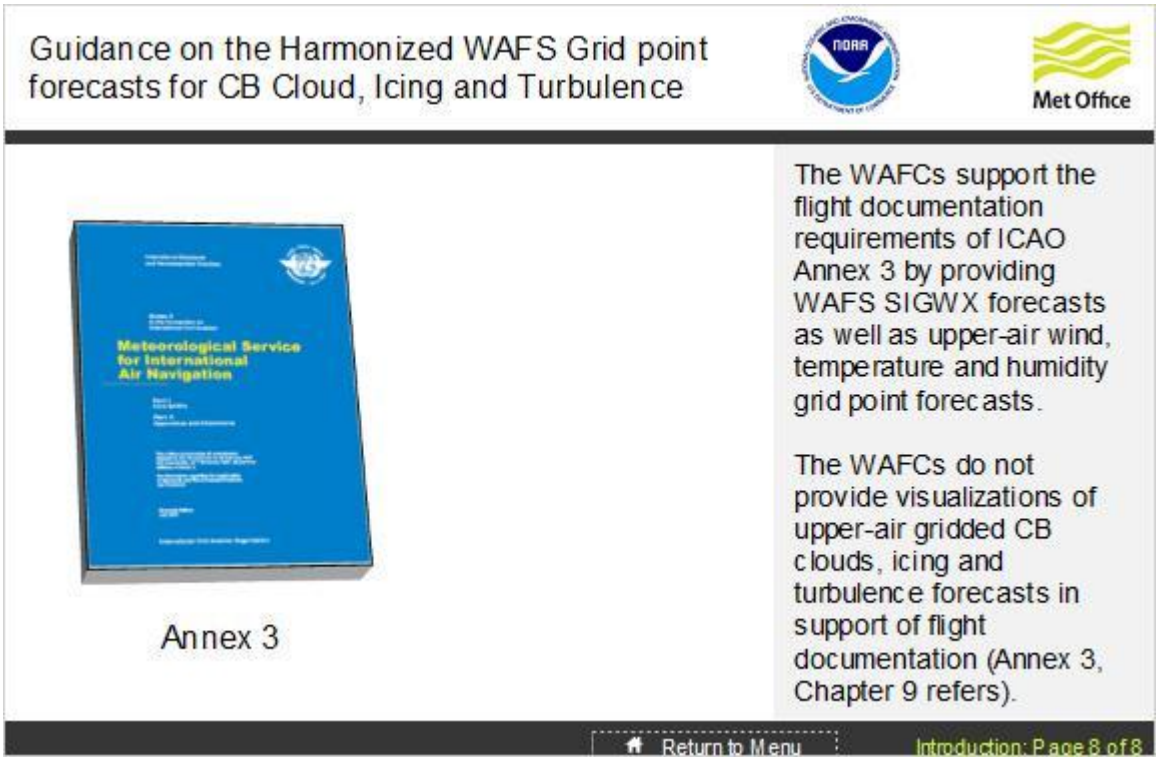
The Operators - usually the airlines - need to define their requirements for making use of the grid point forecasts with their own service providers according to their own business models and safety risk management plan.

For example, if an airline wants to avoid an area of Frequent CB around a tropical storm, then the flight plan provider will know to route the aircraft around the area of frequent CB, so avoiding the hazardous weather.

In this example, the customer has agreed a threshold of 0.7 with the service provider, so that any area with CB coverage of greater than 0.7 could be avoided in the flight plan.

So, Dispatchers, pilots and flight briefing providers need to be aware of what thresholds their suppliers have utilised when using these forecasts.

1.8 Introduction



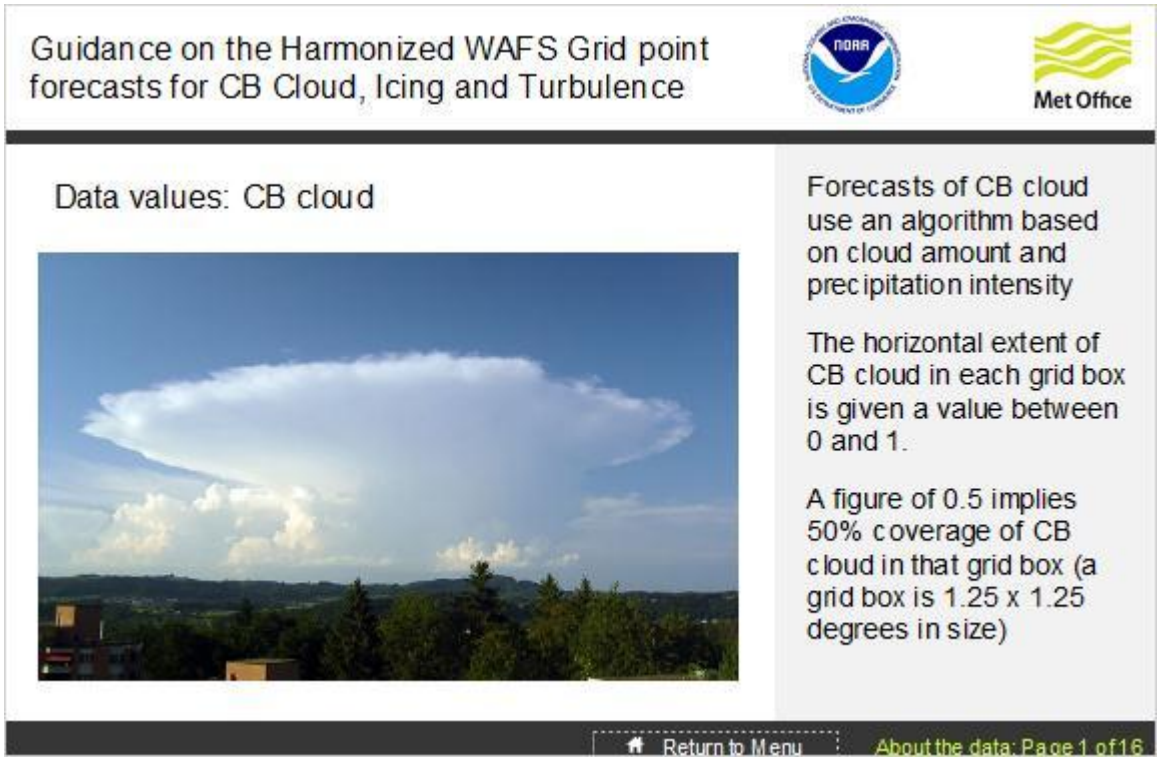
Notes:

Although the WAFCs support the flight documentation requirements of Annex 3 by providing WAFS Significant Weather forecasts as well as upper-air wind, temperature and humidity grid point forecasts, the WAFCs do not provide visualizations of upper-air gridded CB clouds, icing and turbulence forecasts in support of flight documentation.

This is referred to in chapter 9 of Annex 3.

3. About the data

3.1 Data values: CB Cloud



Notes:

So, let's take a look at the data in more depth.

The forecasts of CB cloud use an algorithm that is based on cloud amount and precipitation intensity

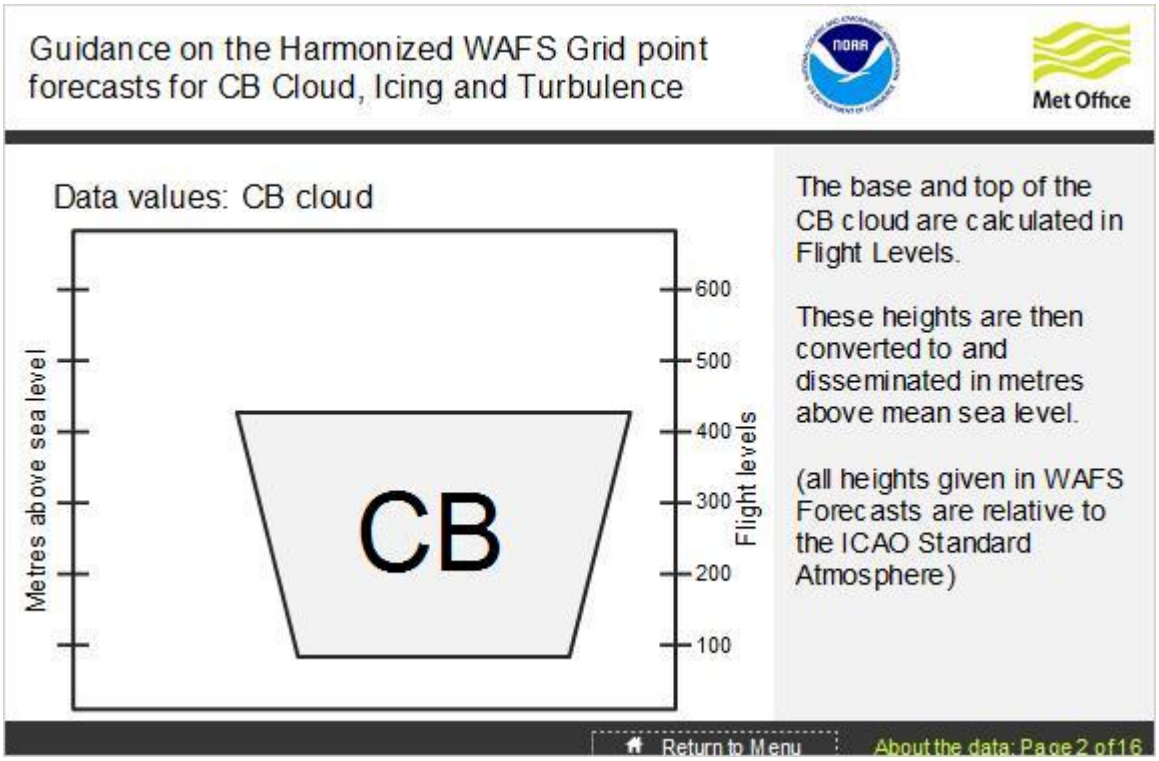
The horizontal extent of CB cloud in each grid box is given a value between zero and 1.

A figure of 0.5 implies 50% coverage of CB cloud in that grid box.

A grid box is 1.25 degrees latitude by 1.25 degrees longitude in size.

Examples of how this data appears when visualised can be seen in section 3.

3.2 Data values: CB Cloud

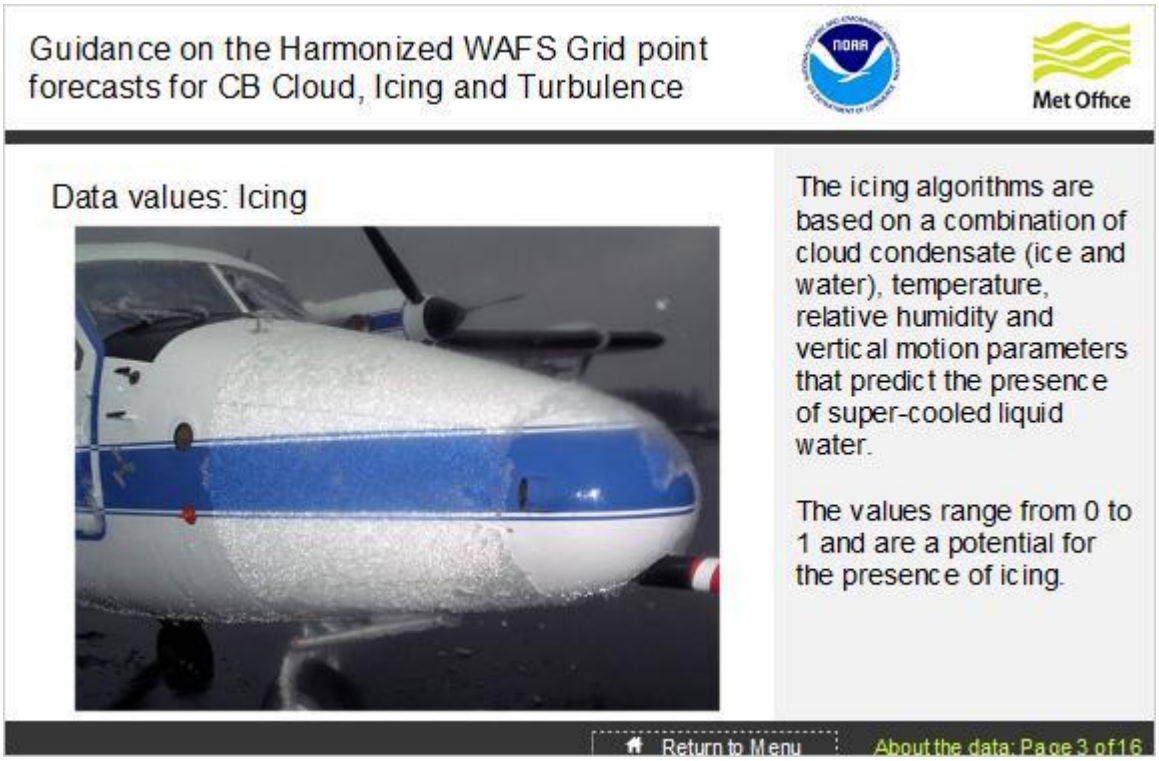


Notes:

The base and top of the CB cloud are calculated in Flight levels and then converted to metres above mean sea level.

Note that all heights given in WAFS Forecasts are relative to the ICAO Standard Atmosphere.

3.3 Data values: Icing



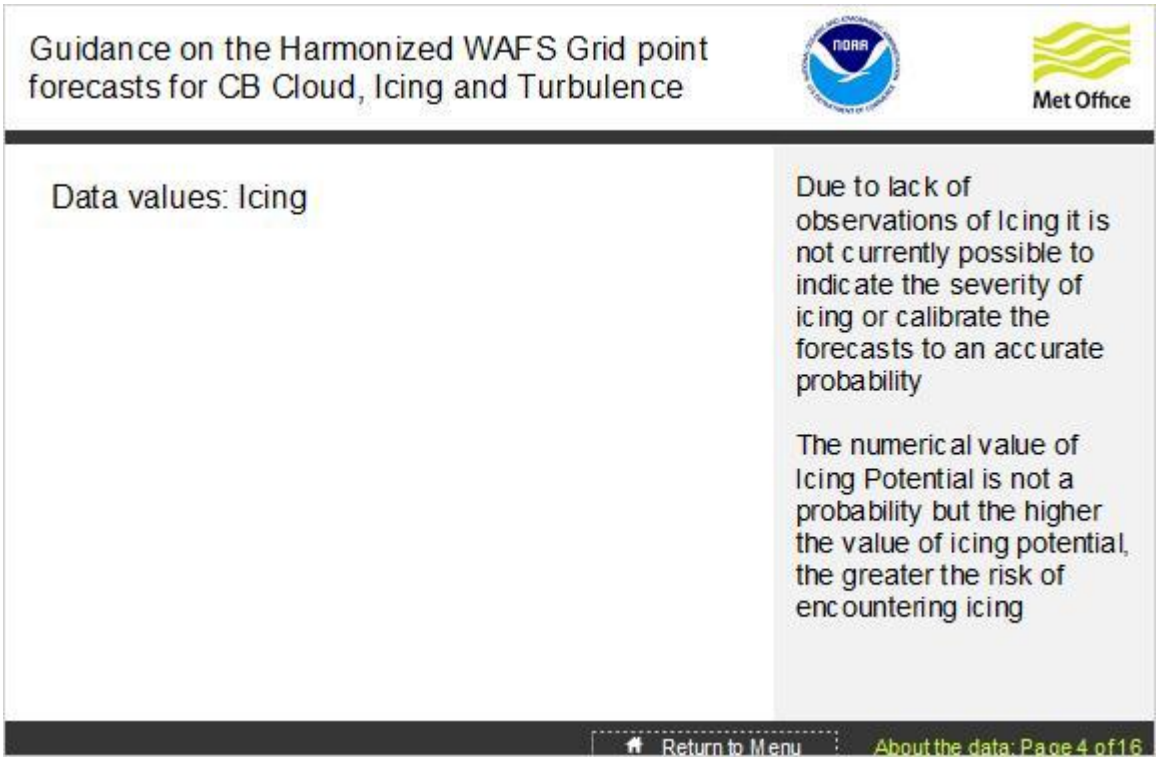
Notes:

This a new method of deriving Forecasts of Icing conditions.

The icing algorithms are based on a combination of cloud condensate (both ice and water), temperature, relative humidity and vertical motion parameters that predict the presence of super-cooled liquid water.

The values range from 0 to 1 and are a potential for the presence of icing.

3.4 Data values: Icing



Notes:

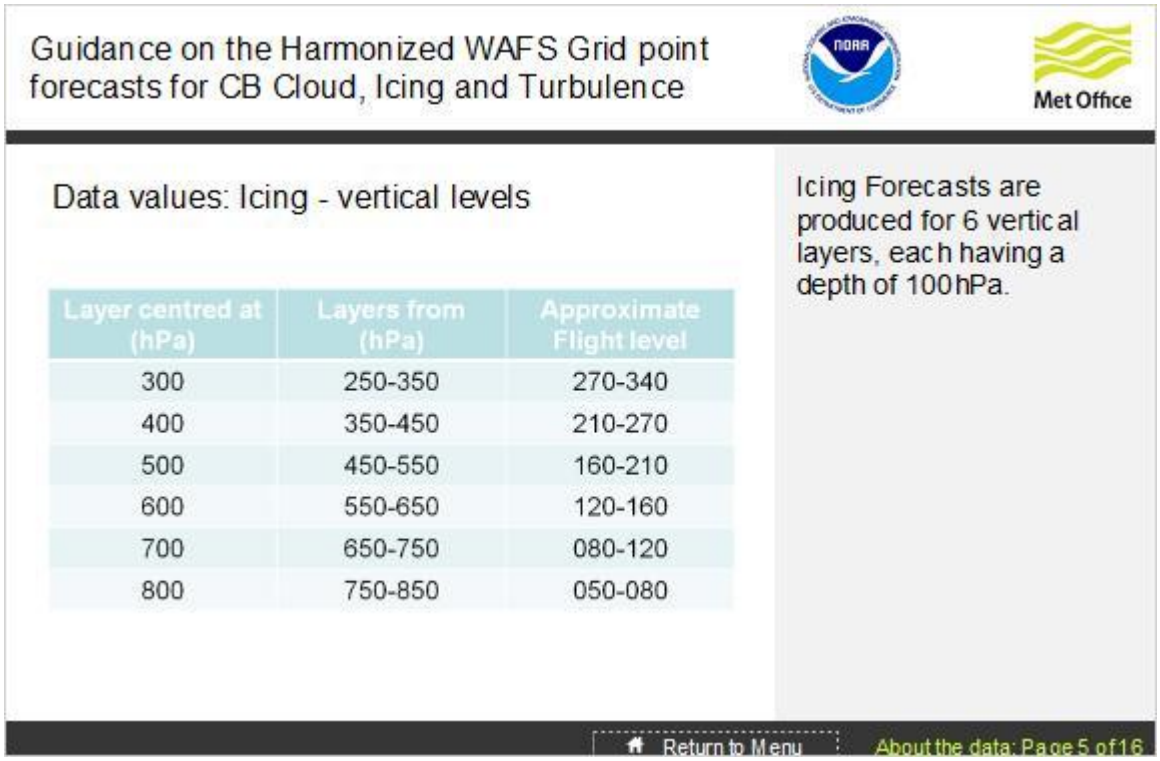
Because there are no routine measurements of Icing by aircraft it is not currently possible to accurately provide a probability of Icing or indicate the severity of Icing within the forecasts.

The WAFCs therefore use the term potential to indicate the likelihood of encountering Icing conditions at a particular location and time.

So,

the higher the value of icing potential, the greater the risk of encountering icing.

3.5 Data values: Icing - vertical levels



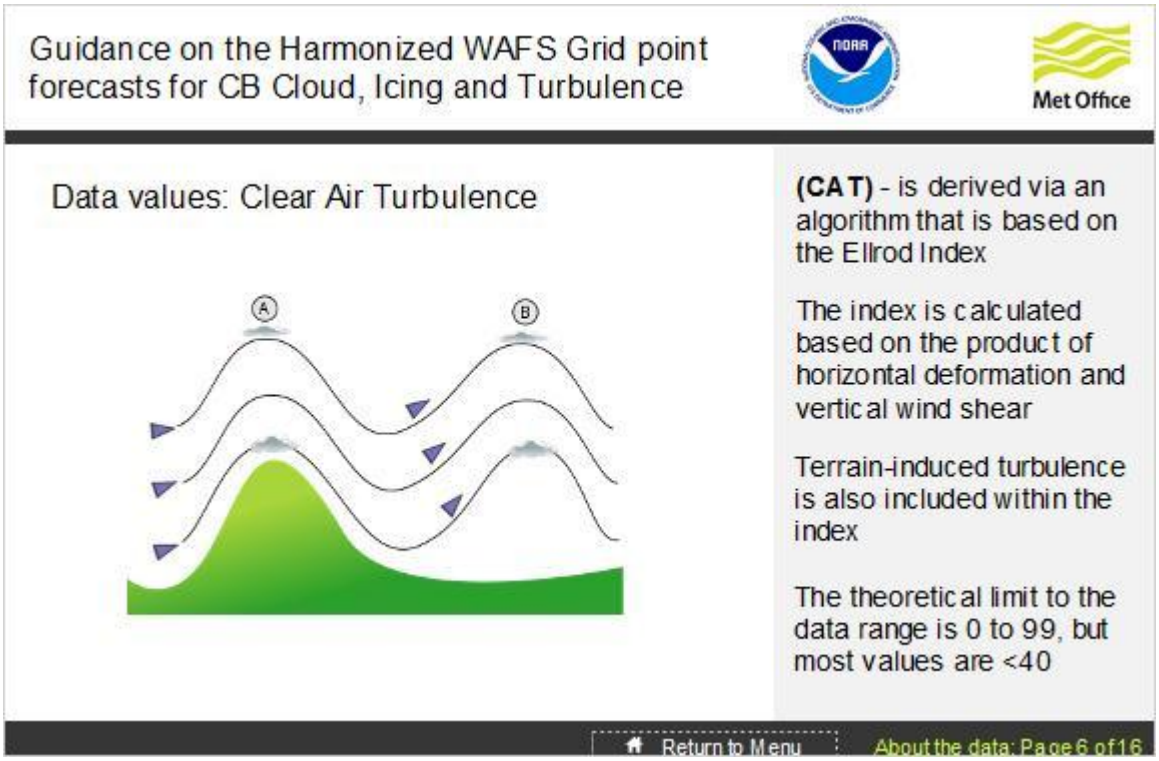
Notes:

Icing Forecasts are produced for 6 vertical layers.

These layers are 100 hectopascals deep and 100 hectopascals apart.

Approximate equivalent flight levels for each of the layers are given in the table.

3.6 Data values: Clear Air Turbulence



Notes:

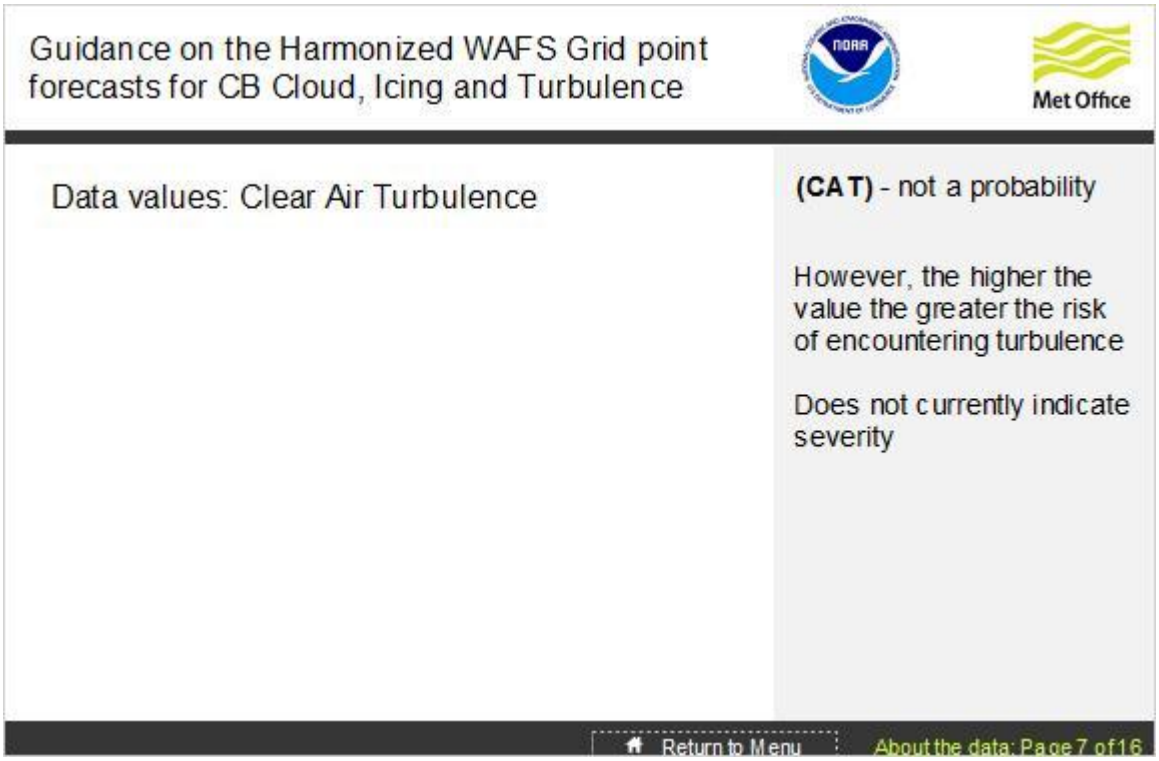
Clear Air Turbulence is derived via an algorithm that is based on the Ellrod Index. The Ellrod Index results from an objective technique for forecasting clear-air-turbulence.

The index is calculated based on the product of horizontal deformation and vertical wind shear derived from numerical model forecast-winds aloft.

Terrain-induced turbulence is also included within the index.

The theoretical limit to the data range is from zero to 99, but most of the values are less than 40.

3.7 Data values: Clear Air Turbulence



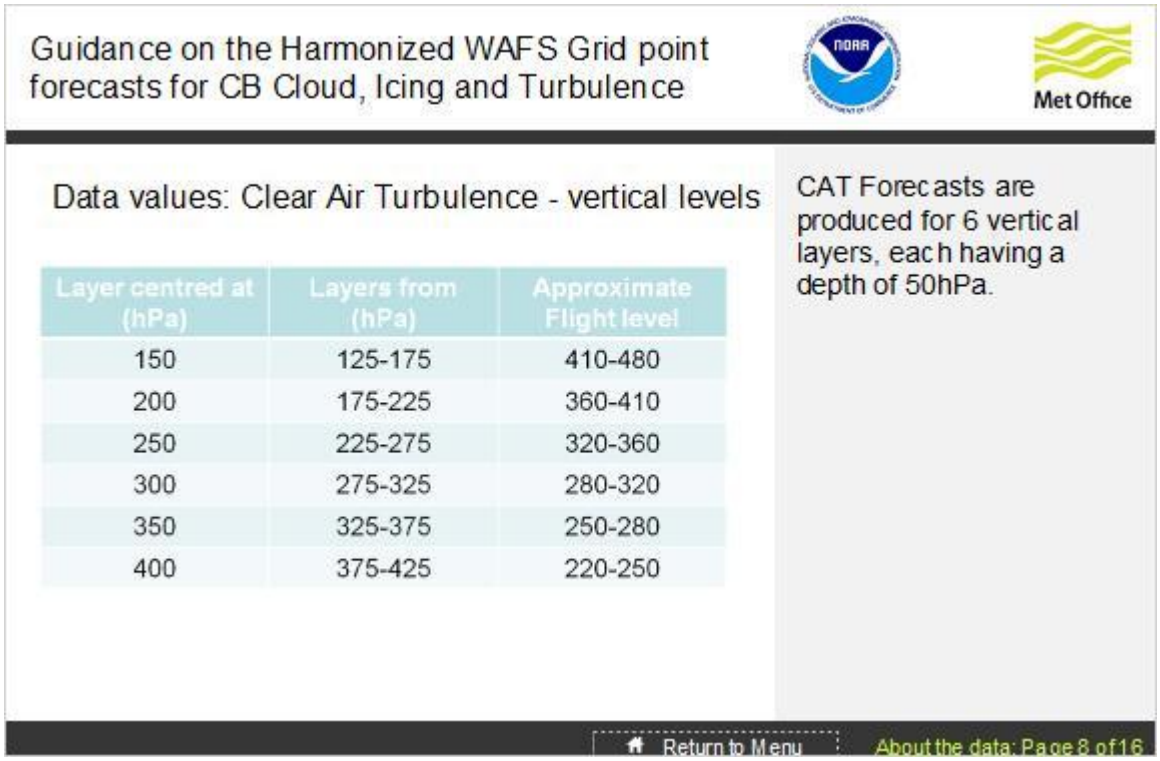
Notes:

The numerical value of CAT Potential is not a probability because there are insufficient observations in order to calibrate the forecasts.

However, the higher the value, the greater the risk of encountering turbulence.

Due to lack of detailed observations it is not currently possible to indicate severity of turbulence.

3.8 Data values: Clear Air Turbulence - vertical levels



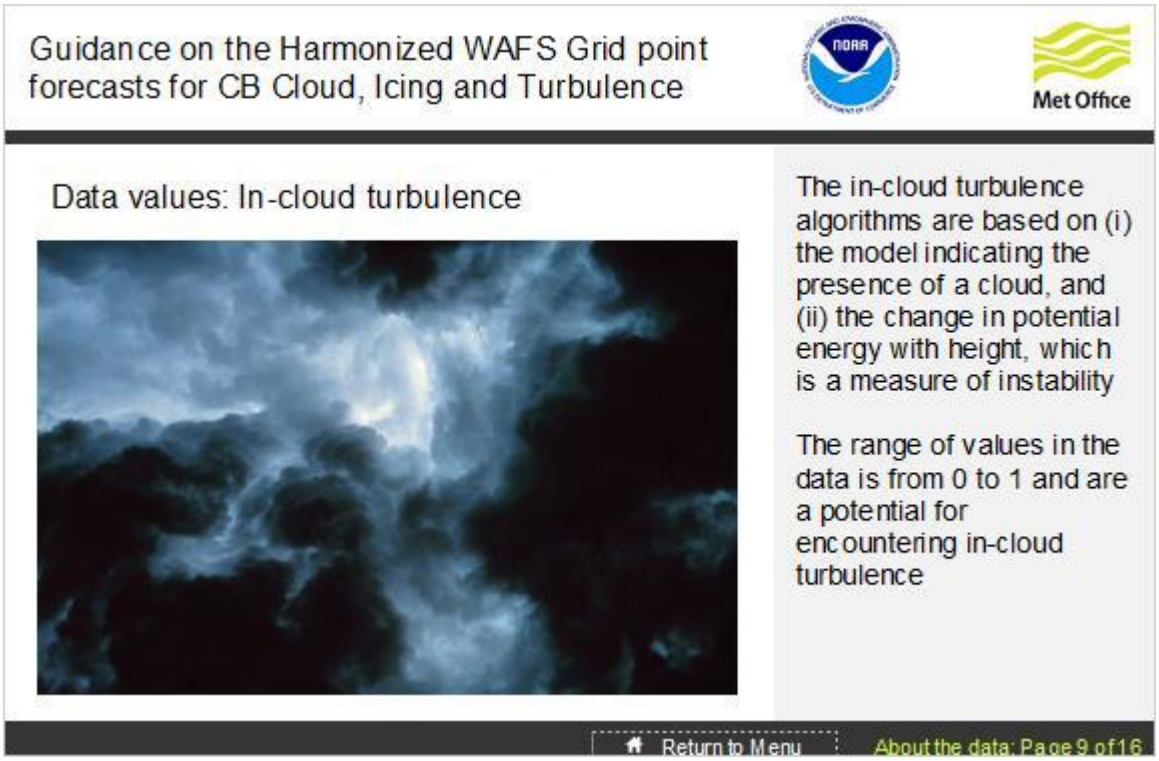
Notes:

CAT Forecasts are produced for 6 vertical layers.

These layers are 50 hectopascals deep and 50 hectopascals apart.

Approximate equivalent flight levels for each of the layers are shown in the right column of the table.

3.9 Data values: In-cloud turbulence



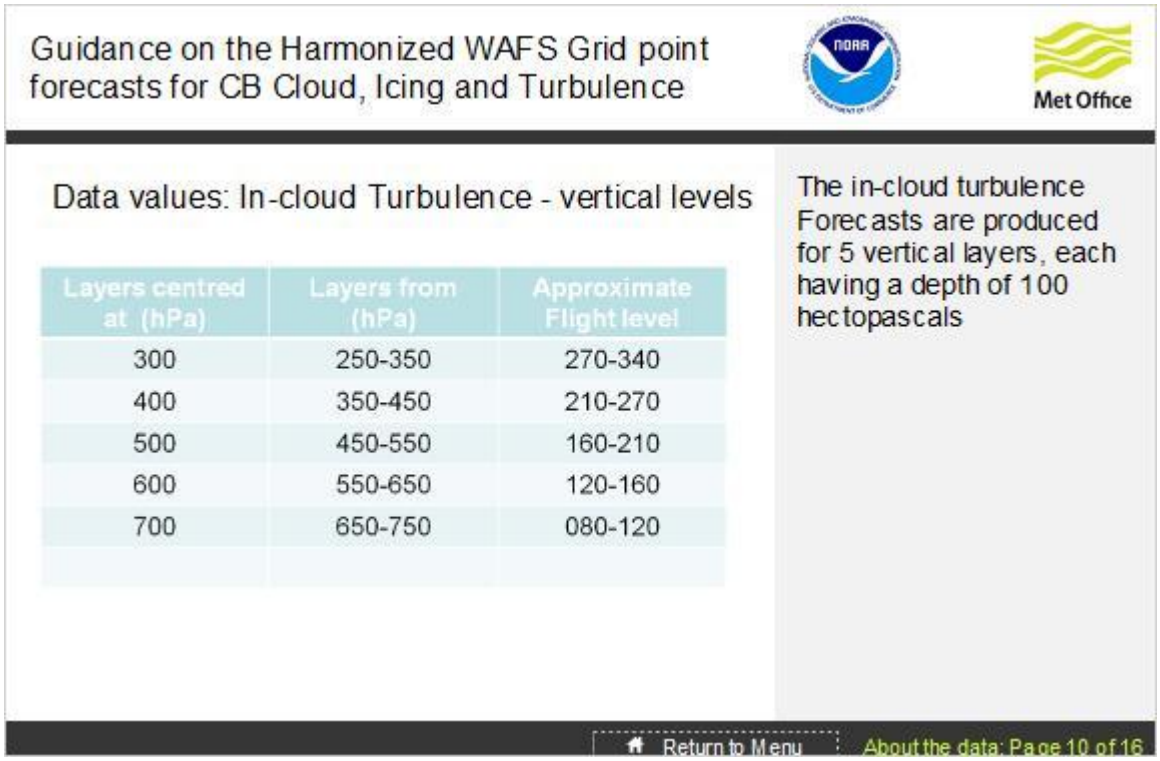
Notes:

There is also forecast data for turbulence in clouds.

The algorithms are based on the model indicating the presence of a cloud, and the change in potential energy with height, which is a measure of instability.

The range of values in the data is from zero to 1 and are a potential for encountering in-cloud turbulence.

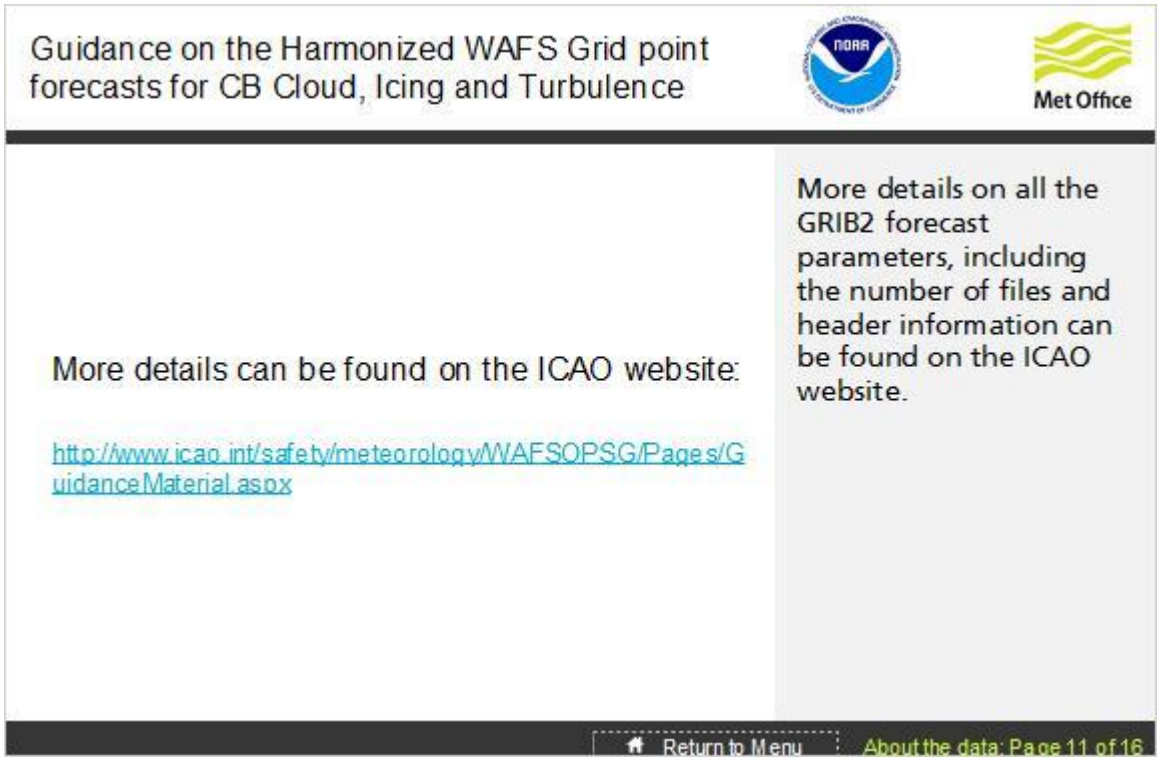
3.10 Data values: In-cloud Turbulence - vertical levels



Notes:

The in-cloud turbulence Forecasts are produced for 5 vertical layers, each having a depth of 100 hectopascals

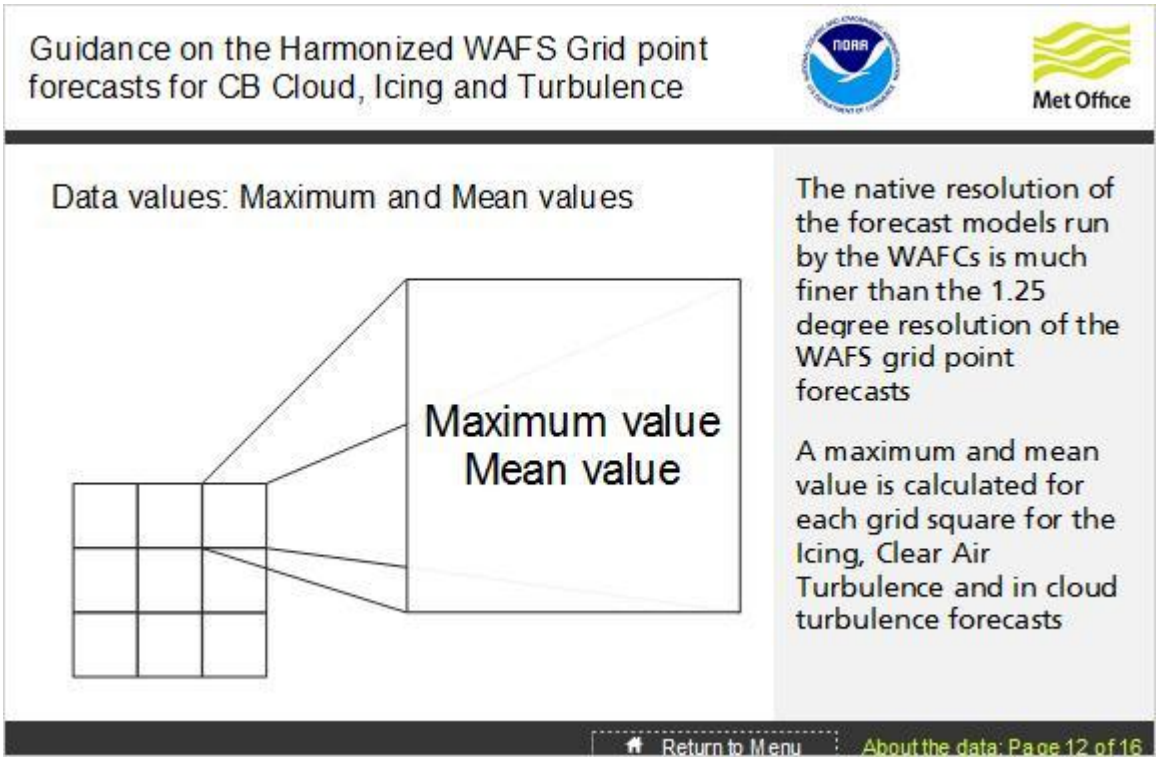
3.11 More details



Notes:

More details on all the GRIB2 forecast parameters, including the number of files and header information can be found on the ICAO website.

3.12 Data values: Maximum and Mean values

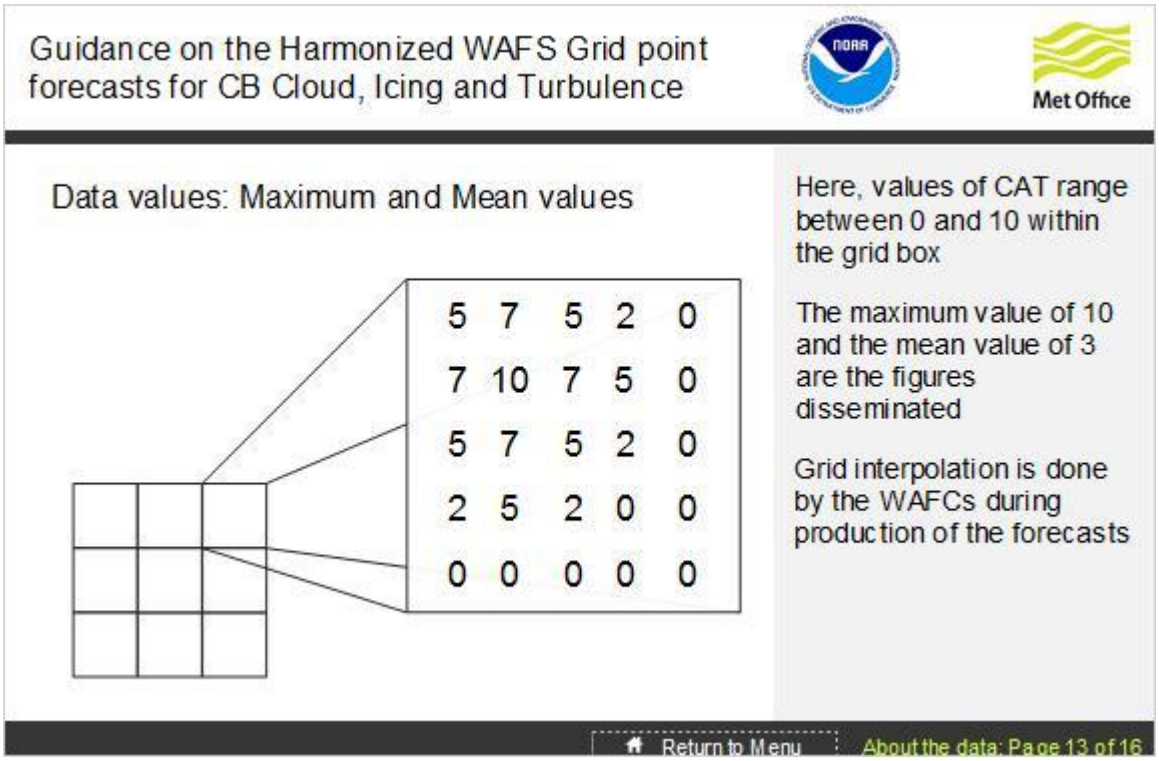


Notes:

The native resolution of the forecast models run by the WAFCs is much finer than the 1.25 degree resolution of the WAFS grid point forecasts.

To provide some information on the variability of the data within each grid box, a maximum and mean value is calculated for each grid square for the Icing, Clear Air Turbulence and in cloud turbulence forecasts.

3.13 Data values: Maximum and Mean values



Notes:

This slide is designed to illustrate the variability of data values that may occur within a single WAFS grid box.

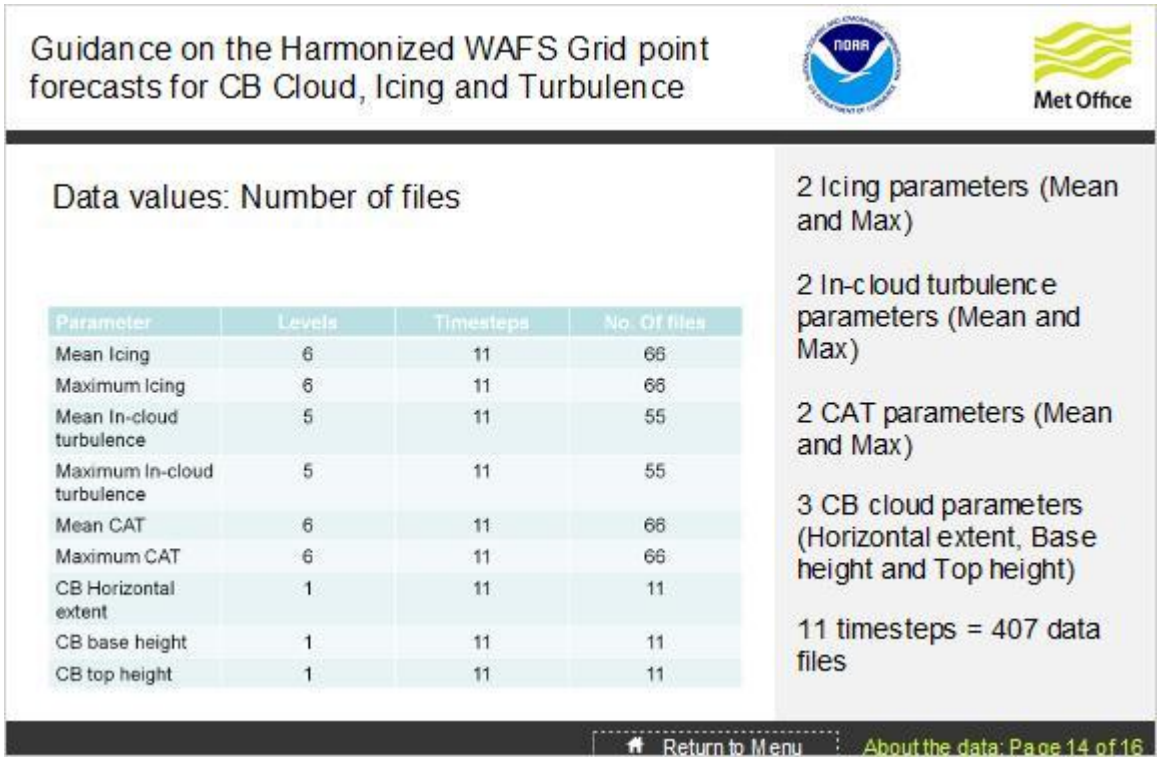
In this example, we show a single grid box, 1.25 by 1.25 degrees in size. Within this one grid box the finer detail from the native model shows that values of CAT potential range between zero and 10.

The maximum value in the grid box is 10 and the mean value in the grid box is 3.

These two figures are disseminated as the forecasts of Maximum CAT and Mean CAT.

This interpolation is done by the WAFCs during production of the forecasts and aims to provide information about the variability of the data within each grid box.

3.14 Data values: Number of files



Notes:

This table shows the number of different files that are produced for each of the forecast parameters.

Note that there are two icing parameters - mean icing and maximum icing

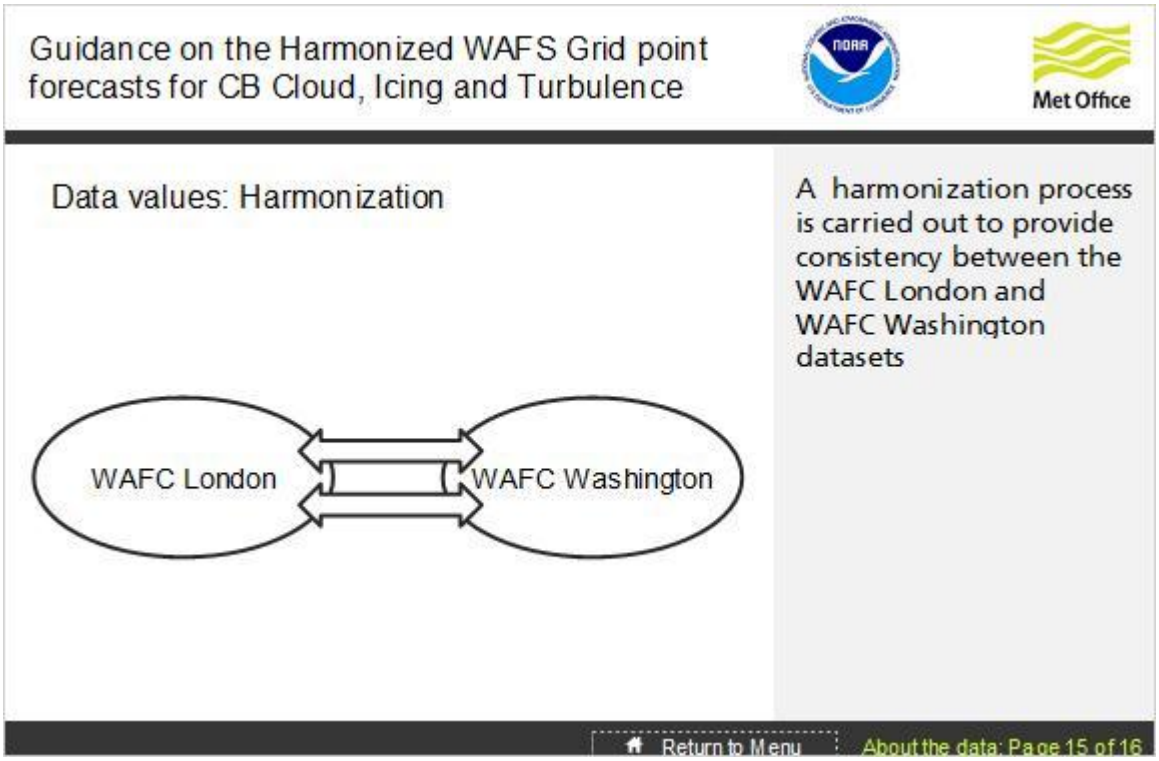
Two "in-cloud" turbulence parameters - a mean and a maximum

Two clear air turbulence parameters - mean and maximum

And three CB cloud parameters - horizontal extent, CB cloud base height, and CB cloud top height.

With 11 timesteps, there are 407 data files in total.

3.15 Data values: Harmonization



Notes:

A harmonization process is carried out to provide consistency between the WAFC London and WAFC Washington datasets.

It is effectively a two-member ensemble of WAFS forecasts.

Before issuance, the WAFC London and WAFC Washington forecasts are harmonized using an identical process.

For each parameter, timestep and pressure level the 'mean' forecast values are calculated from the 'mean of the two means' and the 'maximum' forecasts are calculated from the 'higher of the two maxes'.

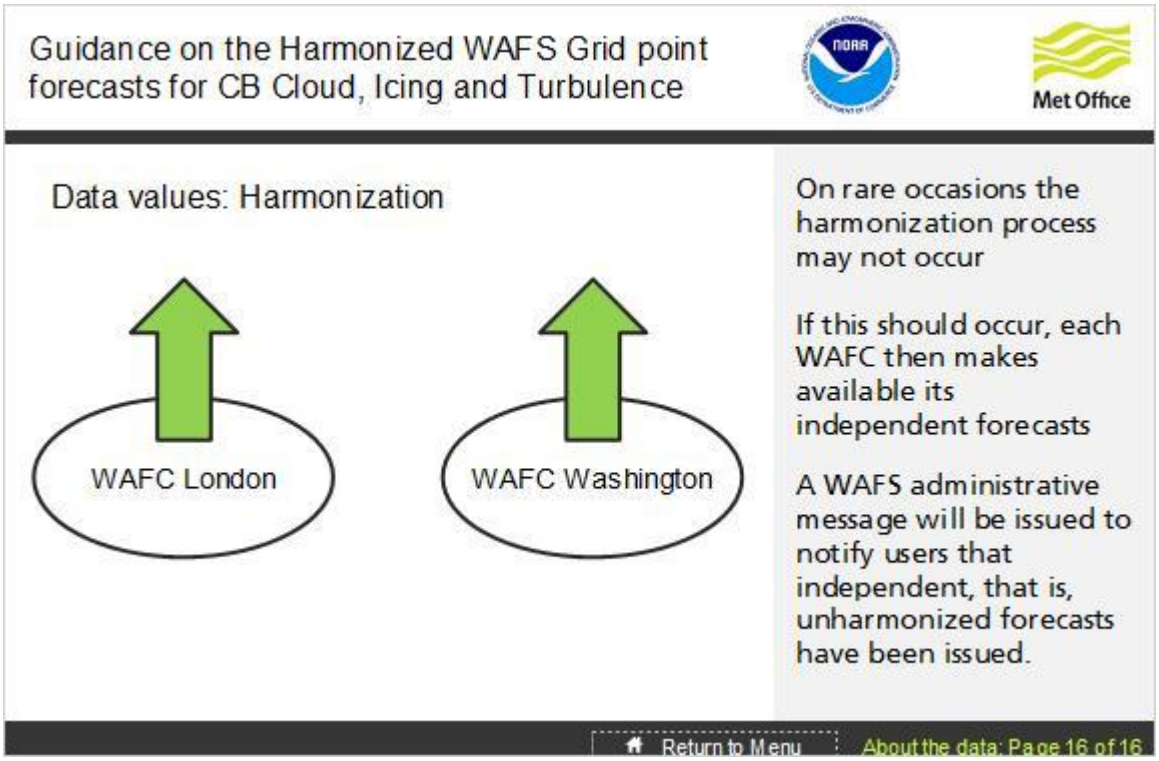
This is done for the CAT, Icing and In cloud turbulence forecasts.

For CB horizontal extent the maximum value from the two forecasts is taken.

For CB top - the higher of the two values is used.

And for CB base - the lower of the two values is used.

3.16 Data values: Harmonization



Notes:

On rare occasions the harmonization process may not occur.

If the harmonization process fails, each WAFC then makes available its independent forecasts.

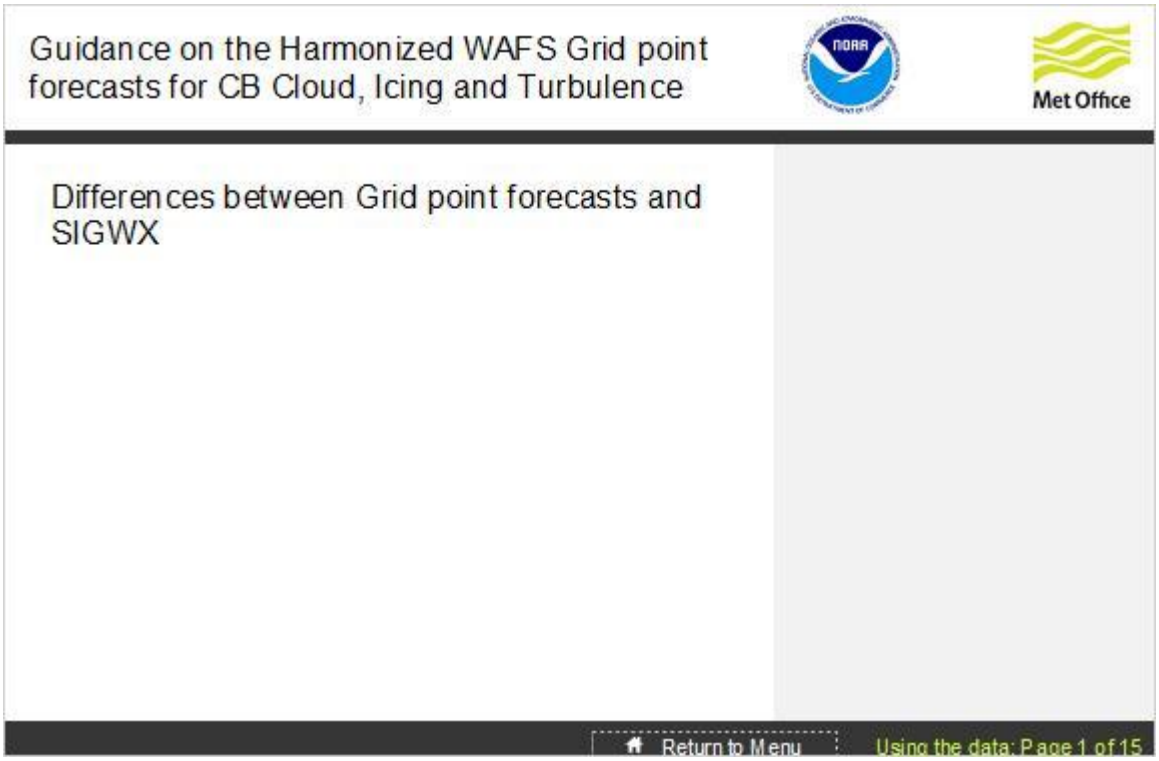
A WAFS administrative message will be issued to notify users that, independent, that is, unharmonized, forecasts have been issued.

You should always ensure you can access the latest Admin Messages on your workstation.

To see examples of an administrative message please click on the resources link in the top right of the screen.

4. Using the data

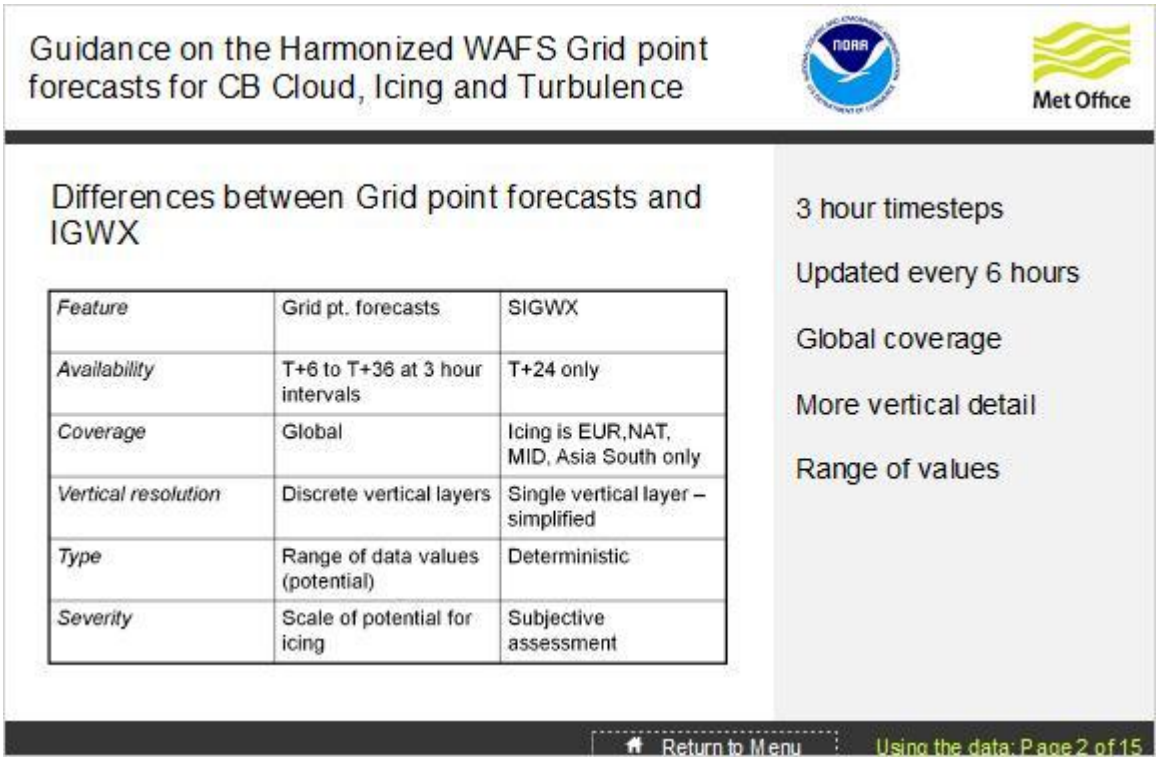
4.1 Introduction (i)



Notes:

The gridded forecasts of CB Cloud, Icing and Turbulence are quite different from the traditional significant weather forecast issued by the WAFCs. The differences are descibed in the next few slides, in particular, the user has much more choice as to how the information can be used and visualised.

4.2 Introduction (i)



Notes:

In this table, we show some of the main differences between the new grid point forecasts and the traditional significant weather forecasts.

First, the new forecasts are available at 3 hour timesteps whereas the sig weather are only available for one timestep at T+24.

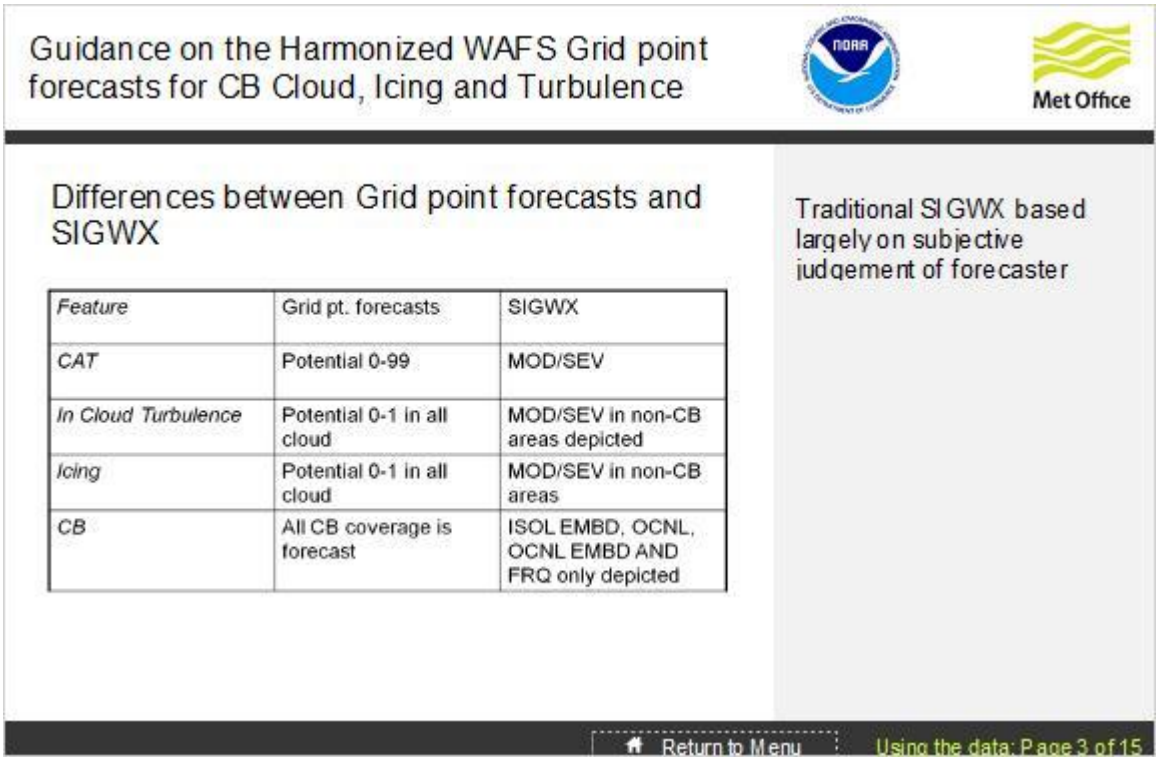
The new forecasts are also updated every 6 hours.

The new forecasts have global coverage whereas Icing was only previously available over limited areas.

The new forecasts give more detail on the vertical distribution of the phenomena.

And a range of values is given for Icing and Turbulence which provides more detail on the risk of encountering these phenomena.

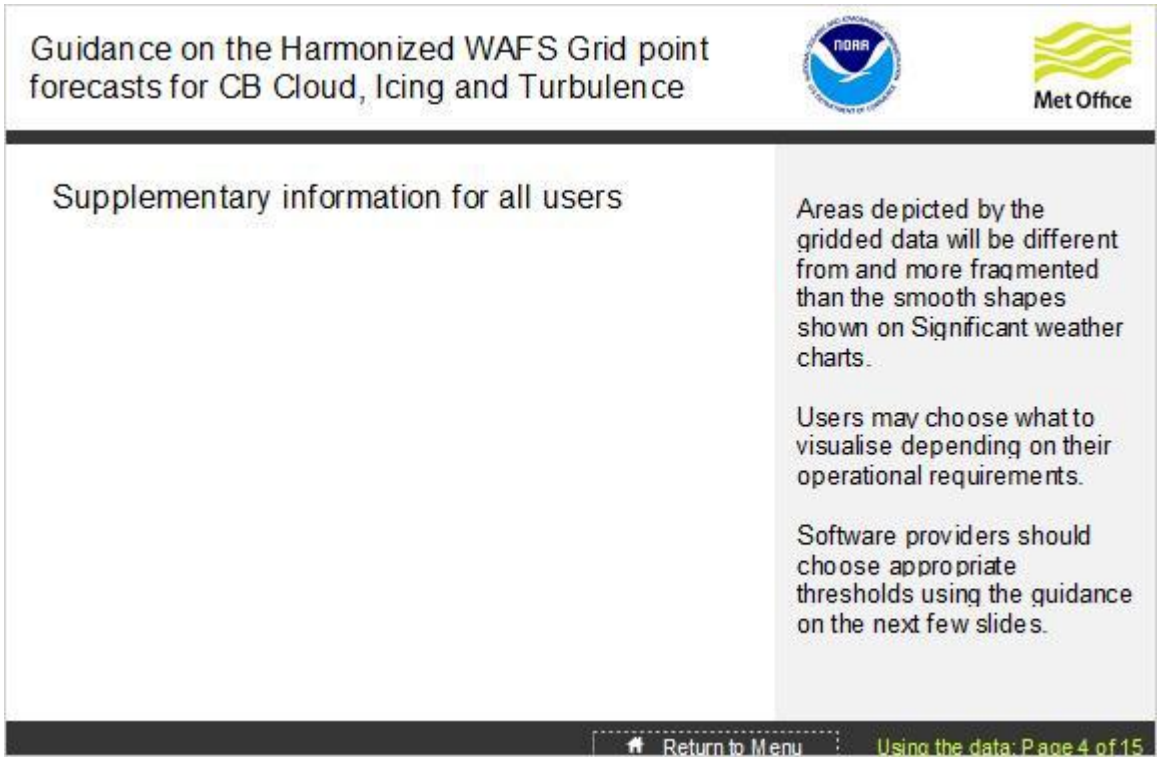
4.3 Introduction (i)



Notes:

It should be borne in mind that while the traditional significant weather forecasts try to indicate moderate or severe categories of Icing and Turbulence this is based largely on a subjective judgement of the forecaster. The icing and turbulence potential values are based on an objective assessment of the risk of encountering these phenomena. At the present time it is not possible for these gridded forecasts to indicate the severity or probability of encountering icing or turbulence.

4.4 Introduction (i)



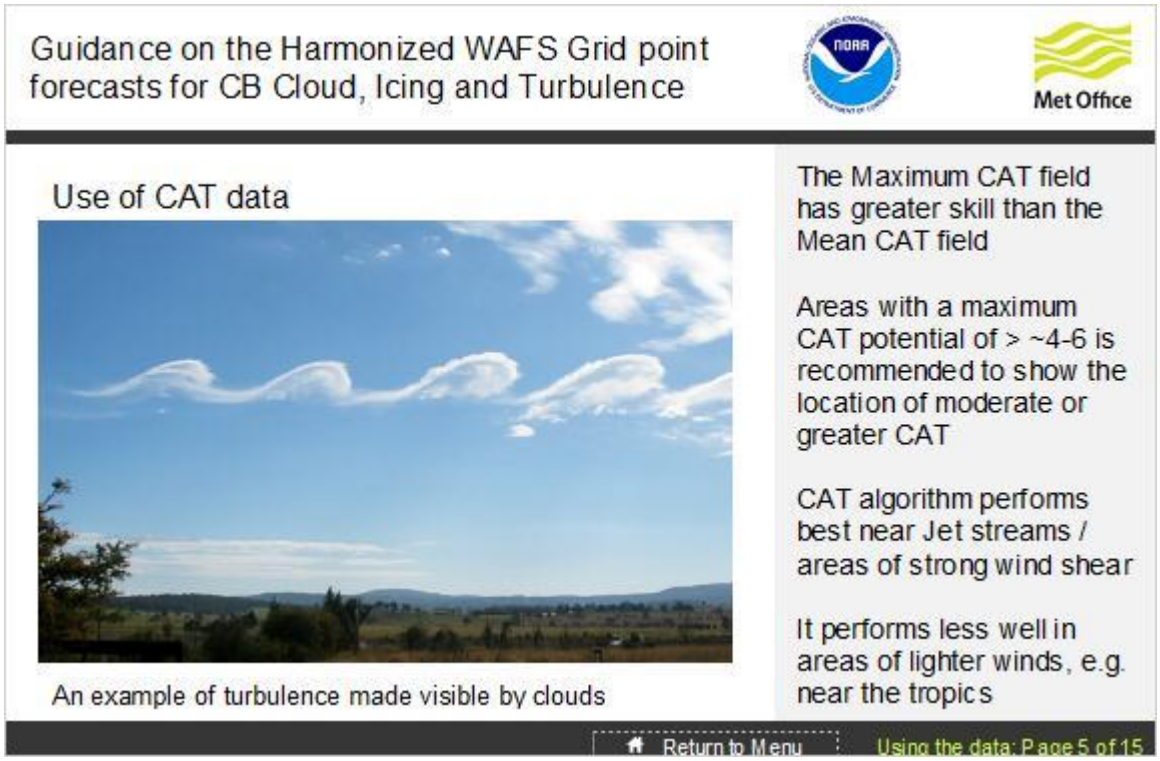
Notes:

Areas depicted by the gridded data will be different from and more fragmented than the smooth shapes shown on Significant weather charts.

Users may choose what to visualise depending on their operational requirements.

Software providers should choose appropriate thresholds using the guidance on the next few slides.

4.5 Introduction (i)



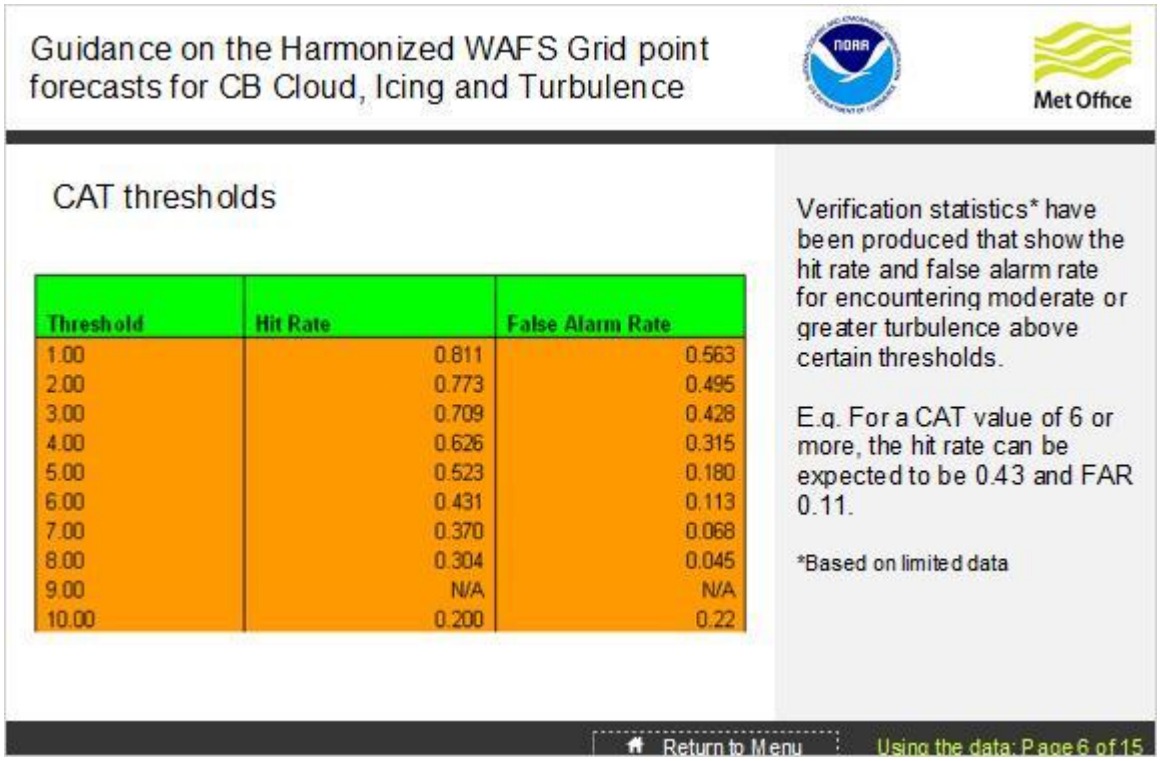
Notes:

The Maximum CAT forecasts are more discerning in identifying areas of higher CAT potential than the Mean forecasts. Verification of the forecasts has shown that the Maximum CAT forecasts have greater skill than the Mean CAT field.

A threshold of around 4 to 6 is recommended for the depiction of moderate or greater CAT. So, for example, a visualisation of areas of CAT with a value of 5 or more can be used to show areas where moderate or greater turbulence is expected.

The CAT algorithm performs best near Jet streams and areas of strong wind shear but not so well in areas of lighter winds, for example, near the tropics.

4.6 Introduction (i)



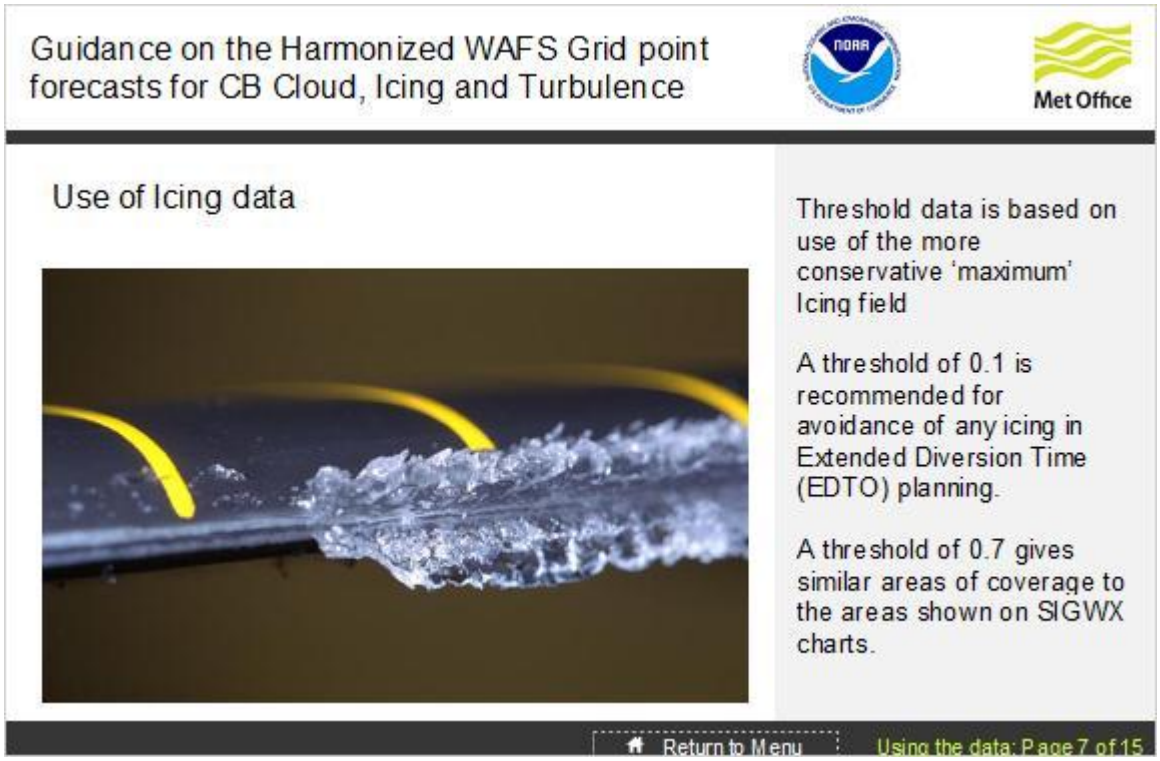
Notes:

Verification statistics, based on limited data have been produced that show the hit rate and false alarm rate for encountering moderate or greater turbulence above certain thresholds.

For example, for a CAT value of 6 or more, the hit rate can be expected to be 0.43 and the false alarm rate 0.11. In other words for a CAT value of 6 or more, you can expect 43 per cent of observed occurrences of CAT to be forecast and for turbulence to be forecast on 11 per cent of occasions when turbulence is not observed.

Users may wish to use their own thresholds to meet their own operating requirements.

4.7 Introduction (i)



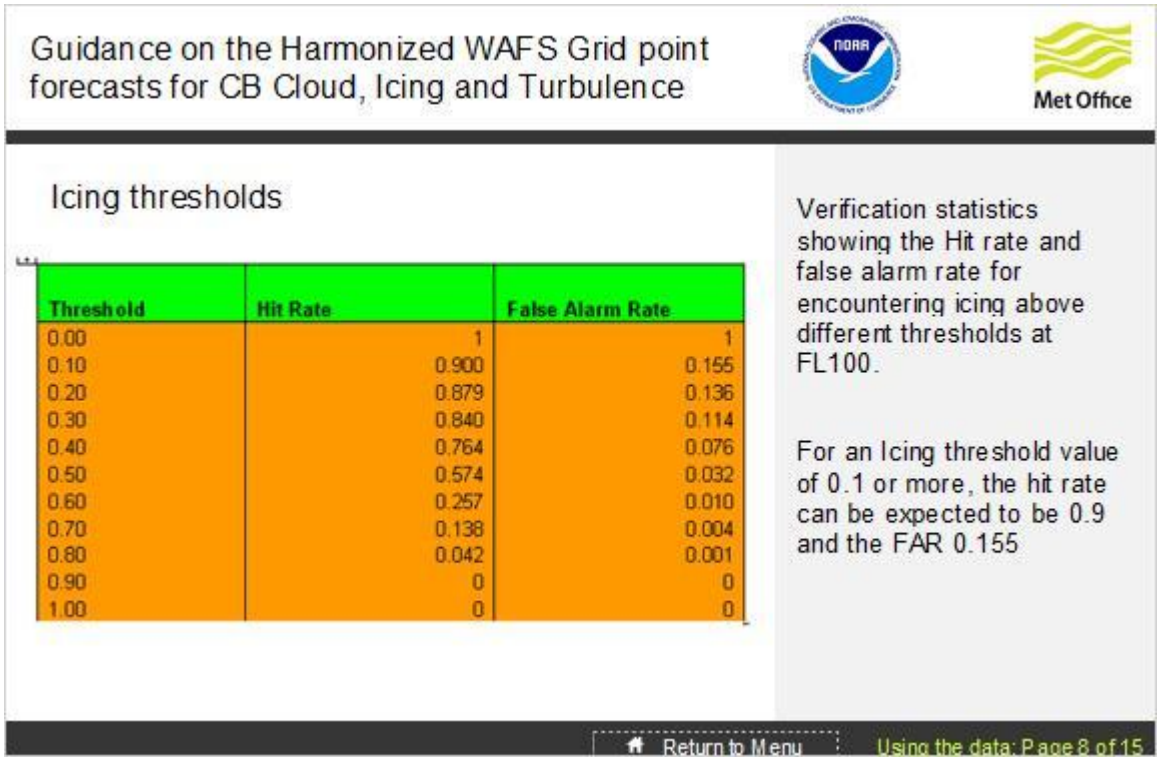
Notes:

For Icing, threshold data is based on use of the more conservative 'maximum' Icing field.

A threshold of 0.1 is recommended for avoidance of any icing in Extended Diversion Time (EDTO) planning.

While a threshold of 0.7 gives similar areas of coverage to the areas of icing shown on significant weather charts.

4.8 Introduction (i)

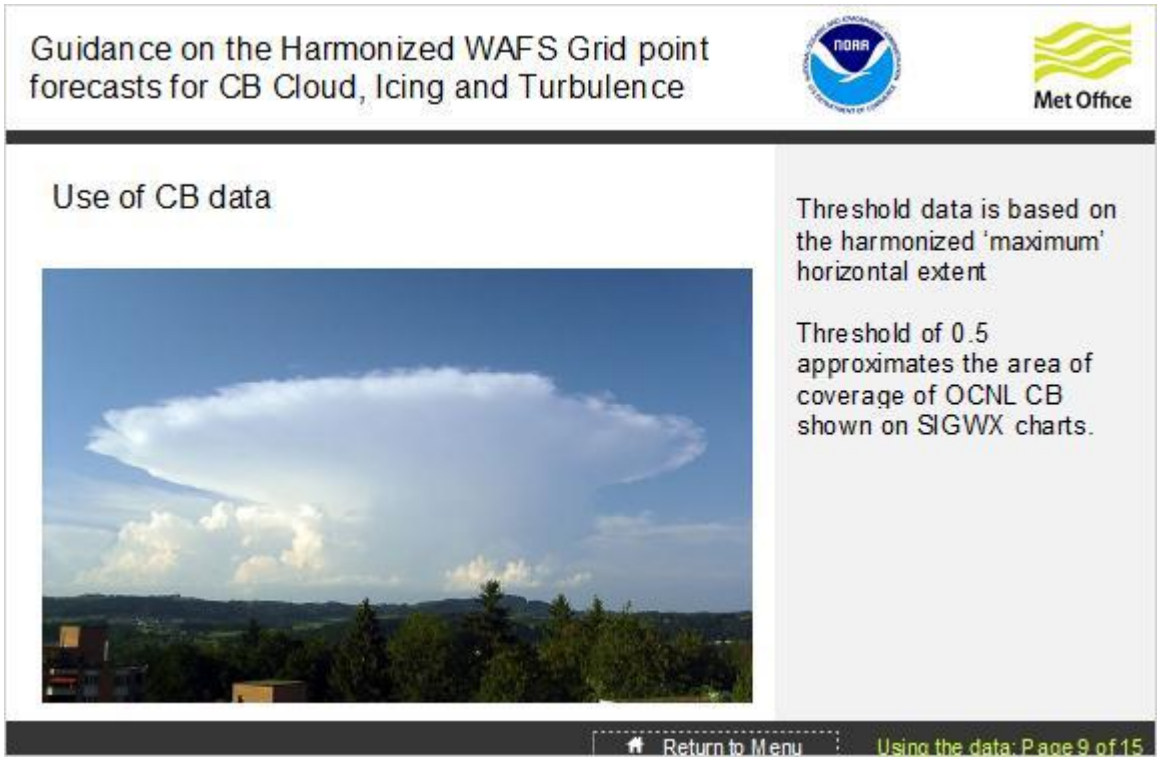


Notes:

Here are some verification statistics that show the Hit rate and false alarm rate for encountering icing above different thresholds at Flight Level 100.

For an Icing threshold value of 0.1 or more, the hit rate can be expected to be 0.9, equating to 90% and the false alarm rate is 0.155 equating to 15.5%.

4.9 Introduction (i)

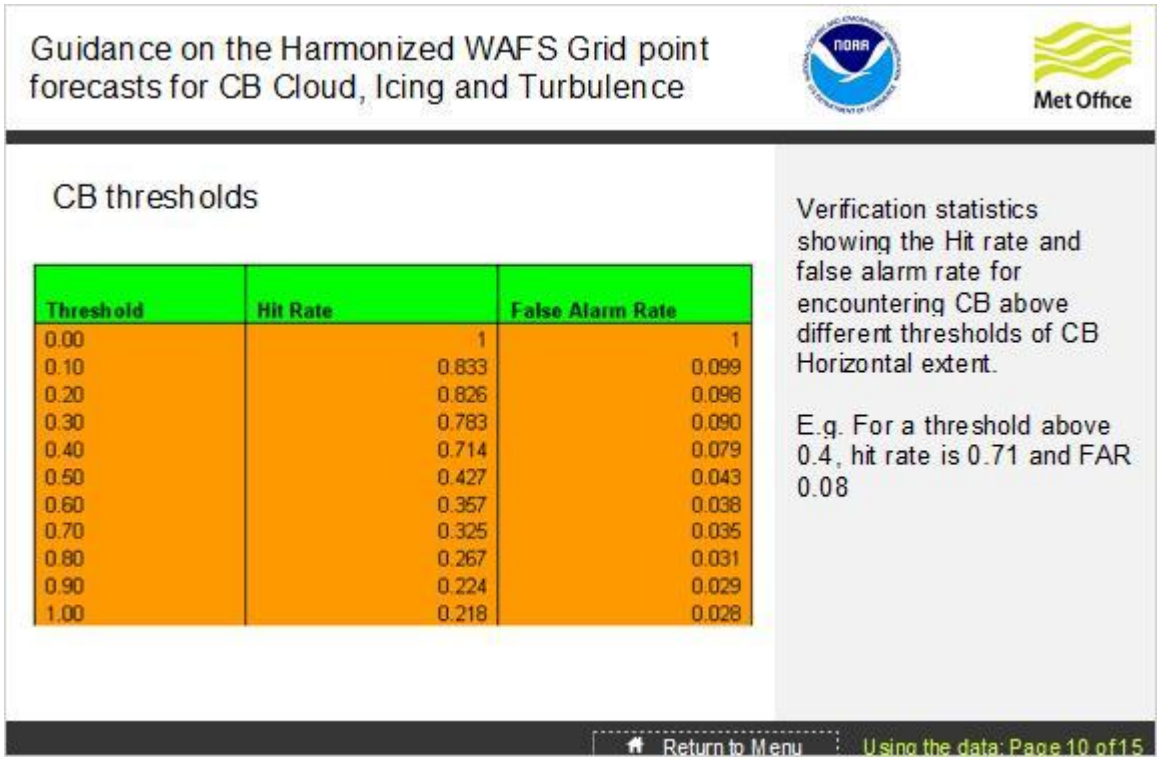


Notes:

For CB clouds, the Threshold data is based on the harmonized 'maximum' horizontal extent.

A Threshold of 0.5 approximates the area of coverage of OCNL CB shown on Significant weather charts.

4.10 Introduction (i)

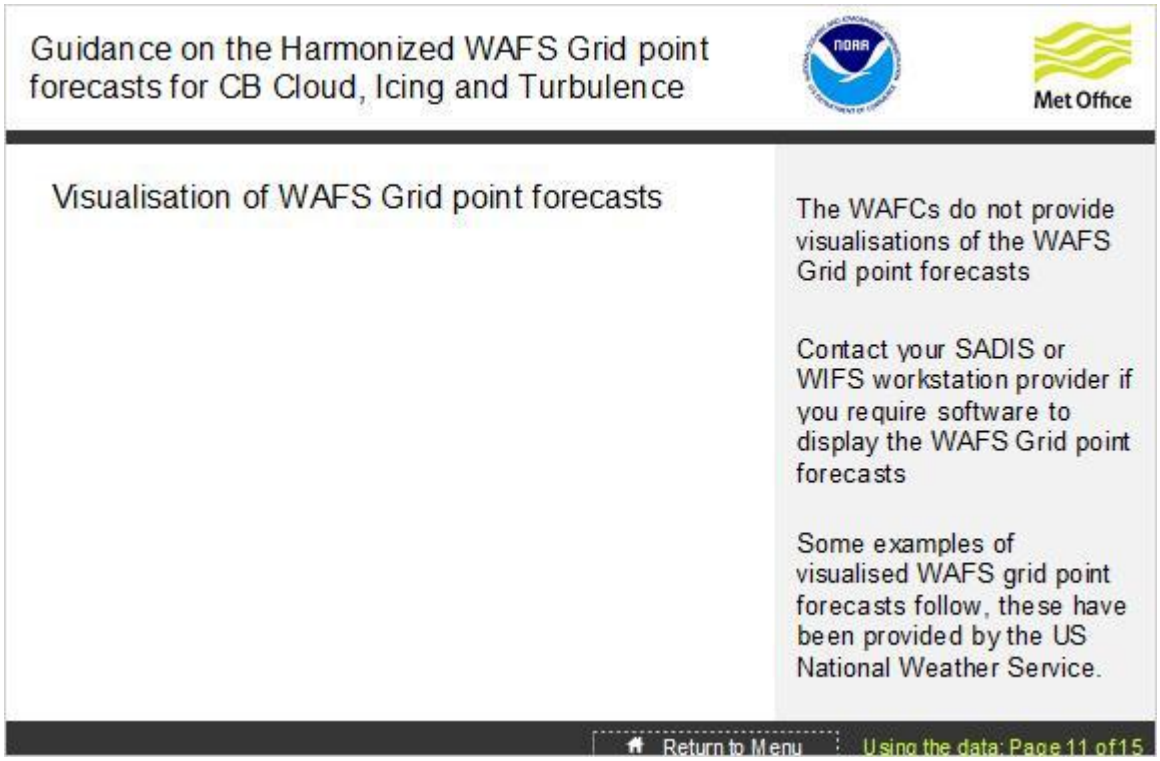


Notes:

Here are some verification statistics that show the Hit rate and false alarm rate for encountering CB clouds above different thresholds 'CB Horizontal Extent'.

For a threshold value of 0.4 or more, the hit rate can be expected to be 0.71, equating to 71% and the false alarm rate 0.08, equating to 8%.

4.11 Introduction (i)



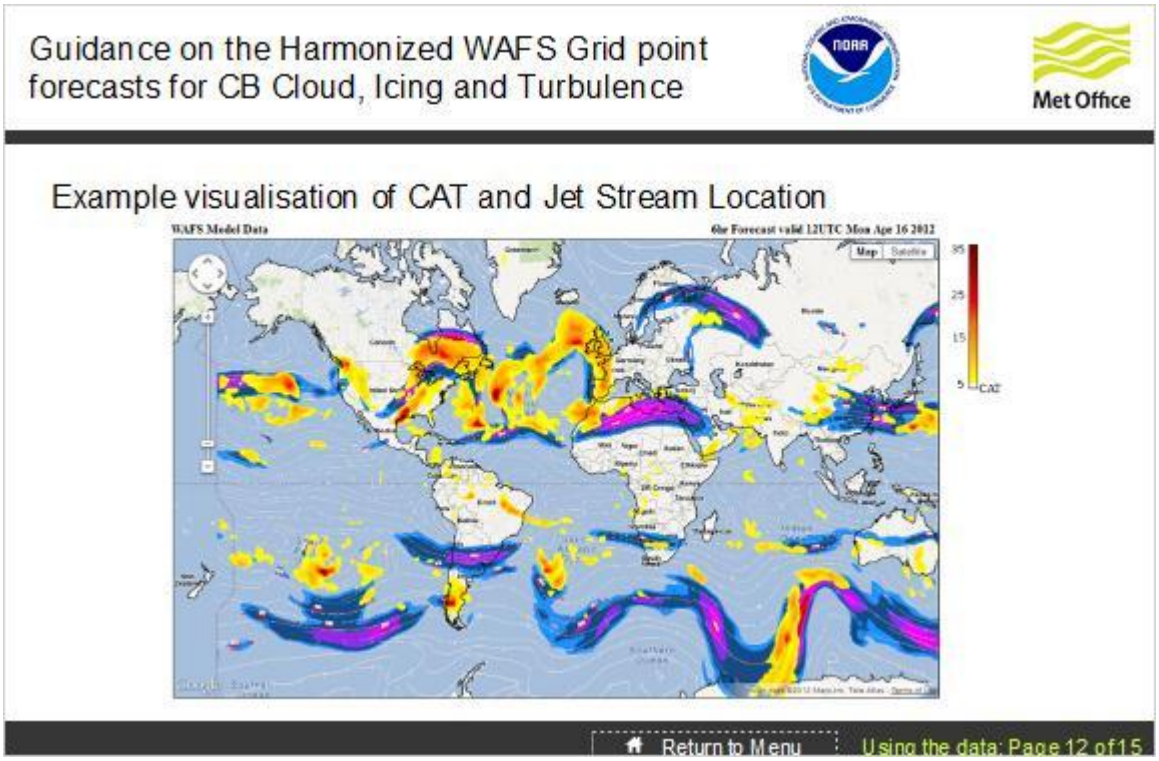
Notes:

The WAFCs do not provide visualisations of the WAFS Grid point forecasts.

Users will need to contact your SADIS or WIFS workstation provider if you require software to display the WAFS Grid point forecasts.

Some examples of visualised WAFS grid point forecasts follow, these have been provided by the US National Weather Service.

4.12 Introduction (i)

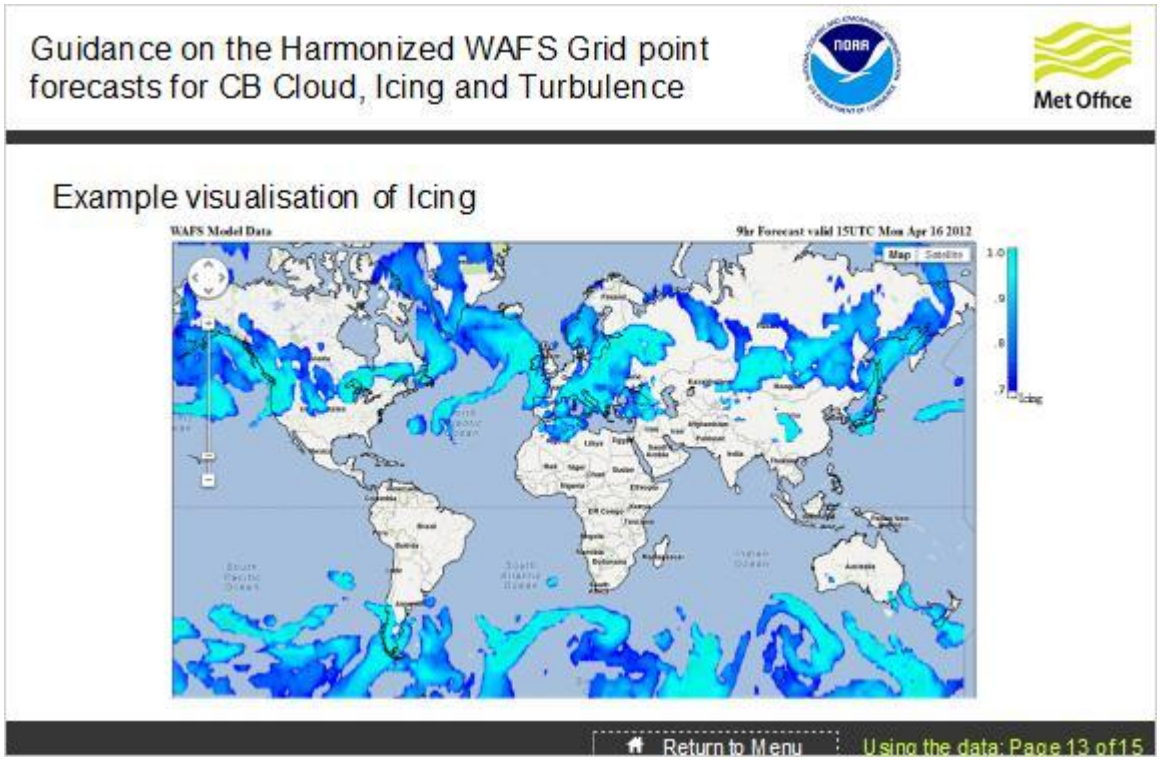


Notes:

This visualisation shows areas of Clear Air turbulence in colours from yellow to red overlaying a depiction of jet streams in blue to purple where wind speeds are greater than 60 knots

The dark red area identified over the North Atlantic has a much higher potential (value more than 20) for moderate or severe CAT than other areas on the chart. An airline that wanted to avoid areas of CAT because of a fragile cargo could be routed to avoid these areas of higher potential CAT.

4.13 Introduction (i)

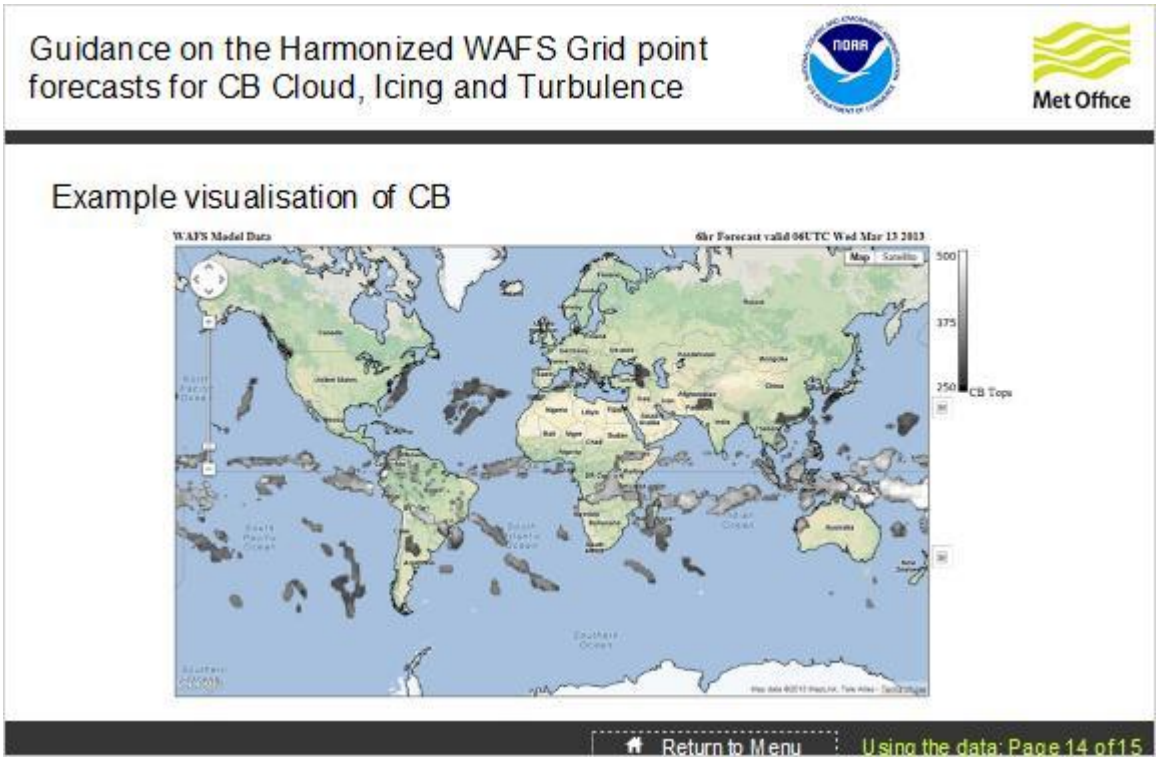


Notes:

This visualisation is of areas of Icing at Flight Level 100 using a threshold of 0.7 or greater.

The WAFCs recommend using a threshold of 0.1 to avoid all areas of potential Icing. This would be useful for Extended Time Diversion Operations.

4.14 Introduction (i)



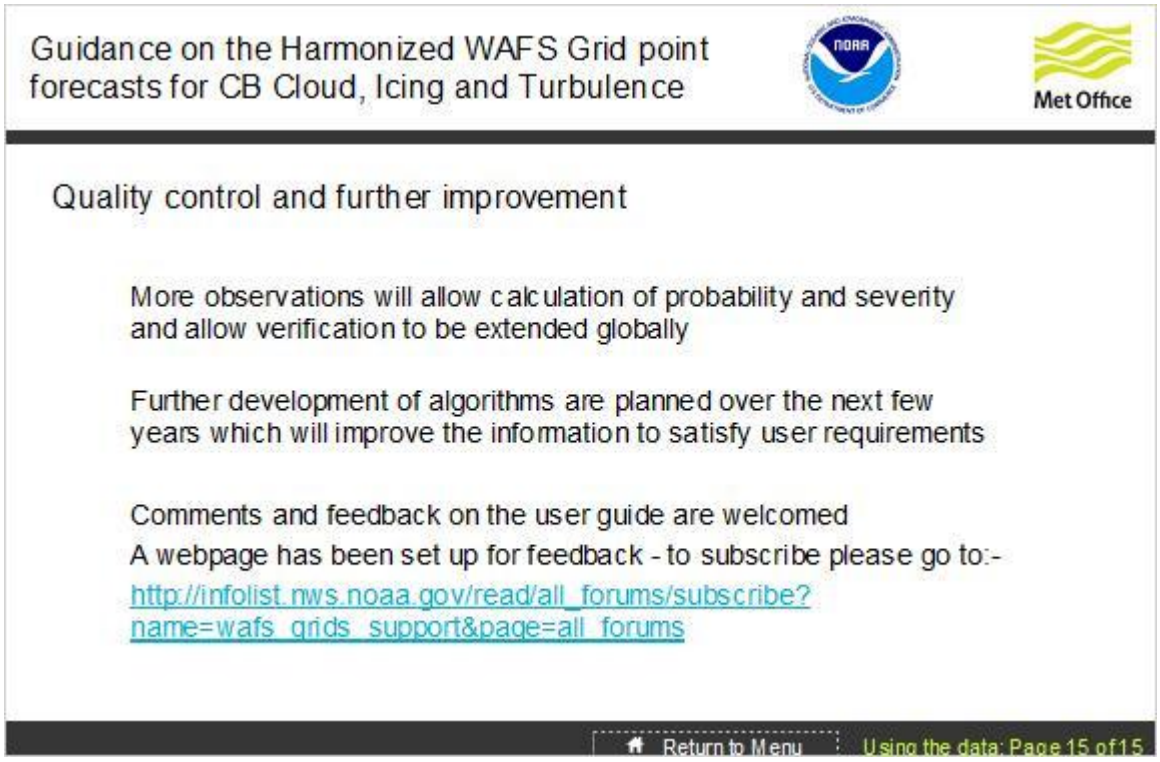
Notes:

This is a visualisation of the location of CB clouds where coverage is more than 0.5 with cloud tops in Flight levels depicted by greyscale.

The light area identified in white has forecast CB tops above FL450.

The dark area identified has Cb tops forecast to be no higher than FL300.

4.15 Introduction (i)



Notes:

The WAFCs are committed to a programme of continuous improvement to the WAFS forecasts.

In particular, the availability of more observations of turbulence and icing will allow the calculation of probability and severity and allow the verification to be extended globally.

Further development of the algorithms are planned over the next few years which will improve the information to satisfy user requirements.

Comments and feedback on this user guide are welcomed.

A webpage has been set up for the receipt of and responses to feedback - to subscribe please go to the address listed.

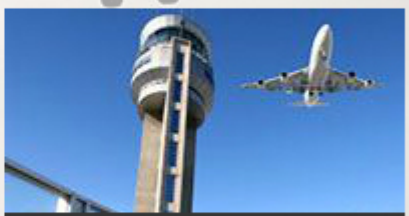
Thank you for making use of this training tool. We hope it has been useful to you.

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

WAFC London and
WAFC Washington
May 2013

Introduction

About the Data



Using the Data

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

ICAO

WMO

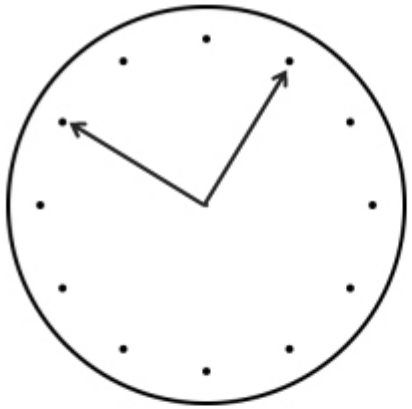
2002

Traditional Sig Weather Forecasts:

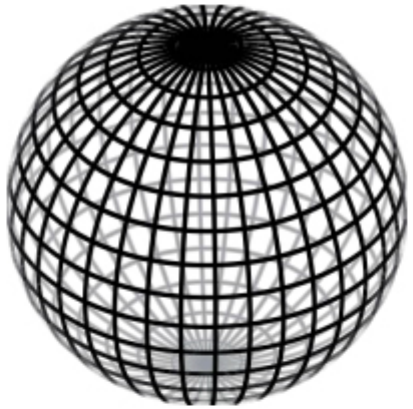
- Limited CB, Icing and Turbulence data
- Single Timestep

2002 requirements for more detailed forecasts

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence



All timestamps



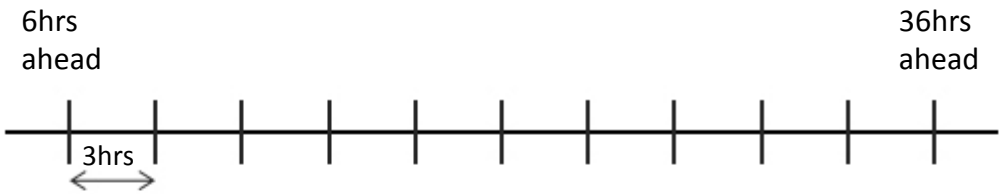
Global

New gridded forecasts:

Available at 3 hour timesteps from 6 to 36 hours ahead

Available globally

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

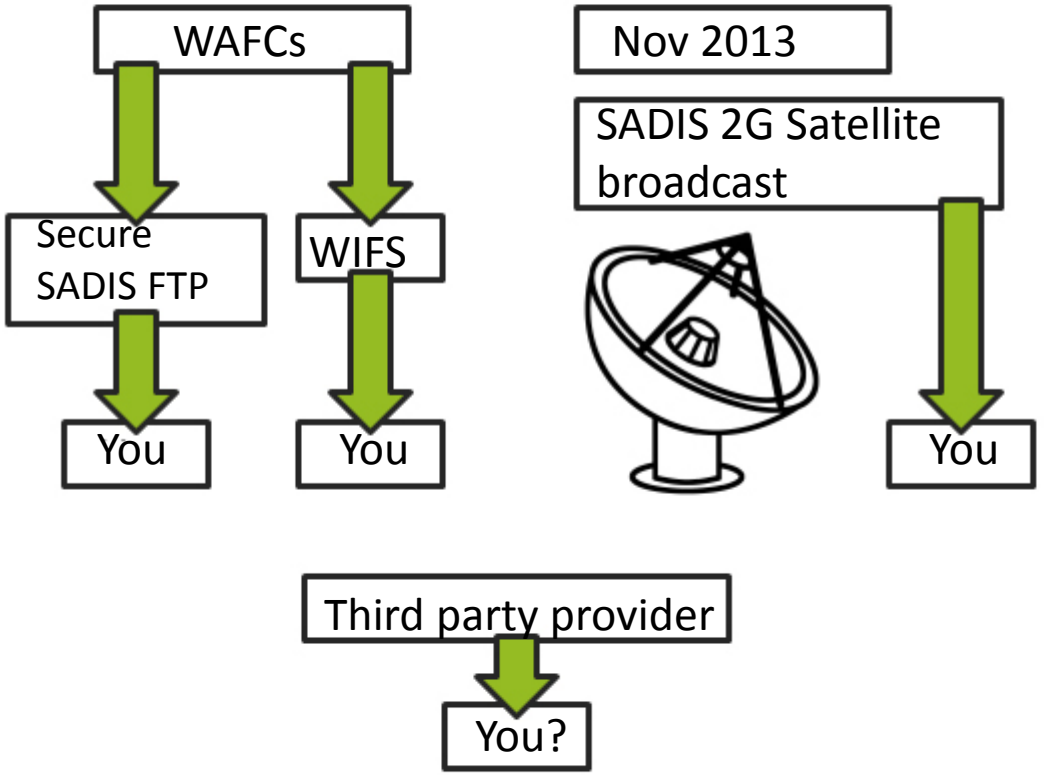


11 timesteps

New forecasts every 6 hours

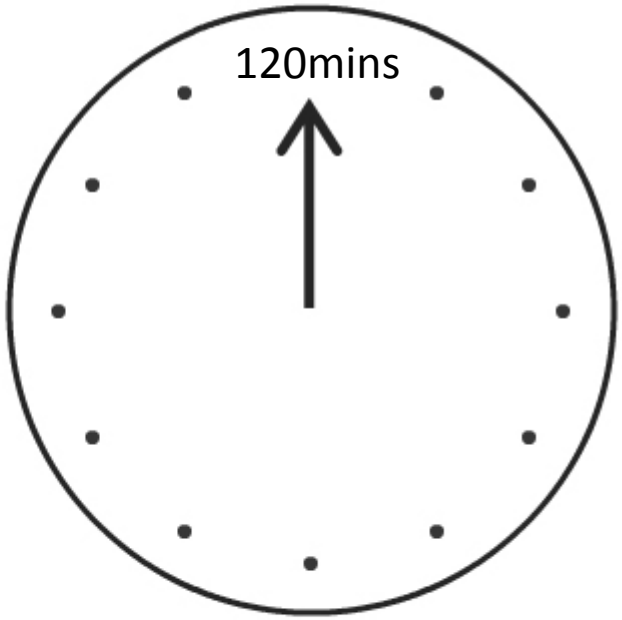
Regular 1.25 degree grid
GRIB2 data format

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence



So how will I access this data?

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence



Extra processing means the grid point forecasts are made available approximately 120 minutes after the wind, temperature and humidity data.

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

Flight Plan
As at 20-Mar-08

Datahawk Flight Plan

Pilot		**TAS**	110	**Fuel Load**	155	**Route Fuel**	247
Aircraft	DSL	**Total Distance**	731	**Fuel/Hour**	35	**Plus Unusable**	12
Type	C-172	**Average G/S**	104	**Flight Time**	07:02:36	**Plus Reserve**	26
						Plus 10%	29
						Fuel Required	314

Caution - This flight plan should not be used as your primary navigation source. The data on this form must be validated by using your normal flight planning procedures.

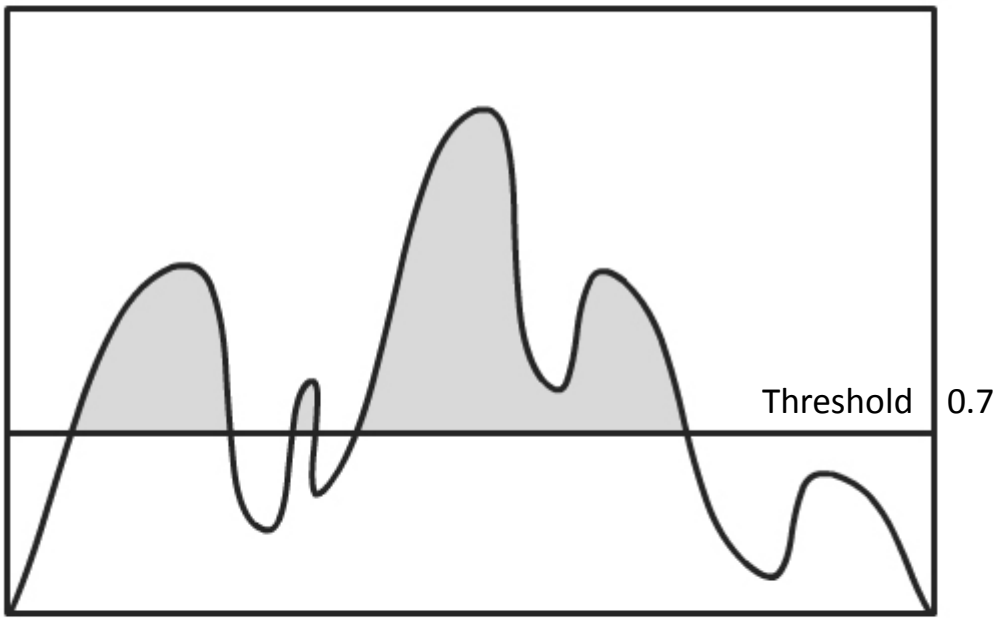
Route Auckland International [AD] - Hamilton [VOR/DME] - Rotorua [AD] - Napier [AD] - Wellington [NDB] - Nelson [AD] - Christchurch International [AD] - Queenstown [AD]

From-To	Wind	Distance	Track	Drift	Heading	Vari	Magnetic	G/S	Time	Fuel	Freq
AA HNV	090/15	57	153	7	146	-19	127	102	00:33	19	114.0
Auckland International			37 0 29.0 S		174 47 30.0 E			Set Heading			
Hamilton			37 50 57.4 S		175 20 18.7 E			ETA			
HNV RO	100/15	49	109	1	107	-19	088	95	00:30	18	
Hamilton			37 50 57.4 S		175 20 18.7 E			Set Heading			
Rotorua			38 6 33.0 S		176 19 2.0 E			ETA			
RO NR	120/20	85	162	7	155	-20	135	94	00:54	32	
Rotorua			38 6 33.0 S		176 19 2.0 E			Set Heading			
Napier			39 27 57.0 S		176 52 12.0 E			ETA			
NR W...	130/15	146	220	8	212	-21	191	109	01:20	47	298
Napier			39 27 57.0 S		176 52 12.0 E			Set Heading			
Wellington			41 20 17.7 S		174 48 48.9 E			ETA			
W... NS	130/15	72	272	5	267	-21	246	121	00:35	21	
Wellington			41 20 17.7 S		174 48 48.9 E			Set Heading			
Nelson			41 17 54.0 S		173 13 16.0 E			ETA			
NS CH	260/10	135	193	-6	198	-22	176	106	01:16	45	
Nelson			41 17 54.0 S		173 13 16.0 E			Set Heading			
Christchurch International			43 29 22.0 S		172 32 4.0 E			ETA			
CH QN	260/10	187	241	-2	242	-23	219	101	01:51	65	
Christchurch International			43 29 22.0 S		172 32 4.0 E			Set Heading			
Queenstown			45 1 16.0 S		168 44 21.0 E			ETA			

Automatic flight planning systems can integrate the new forecast data directly

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

Example use of operator threshold for CB avoidance



Airline operators need to define their requirements for making use of the grid point forecasts with their service providers according to their own business models and safety risk management plan

Dispatchers, pilots and flight briefing providers should be aware of what thresholds their suppliers have utilised when using these forecasts

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

The WAFCs support the flight documentation requirements of ICAO Annex 3 by providing WAFS SIGWX forecasts as well as upper-air wind, temperature and humidity grid point forecasts.

The WAFCs do not provide visualizations of upper-air gridded CB clouds, icing and turbulence forecasts in support of flight documentation (Annex 3, Chapter 9 refers).

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

Data values: CB cloud

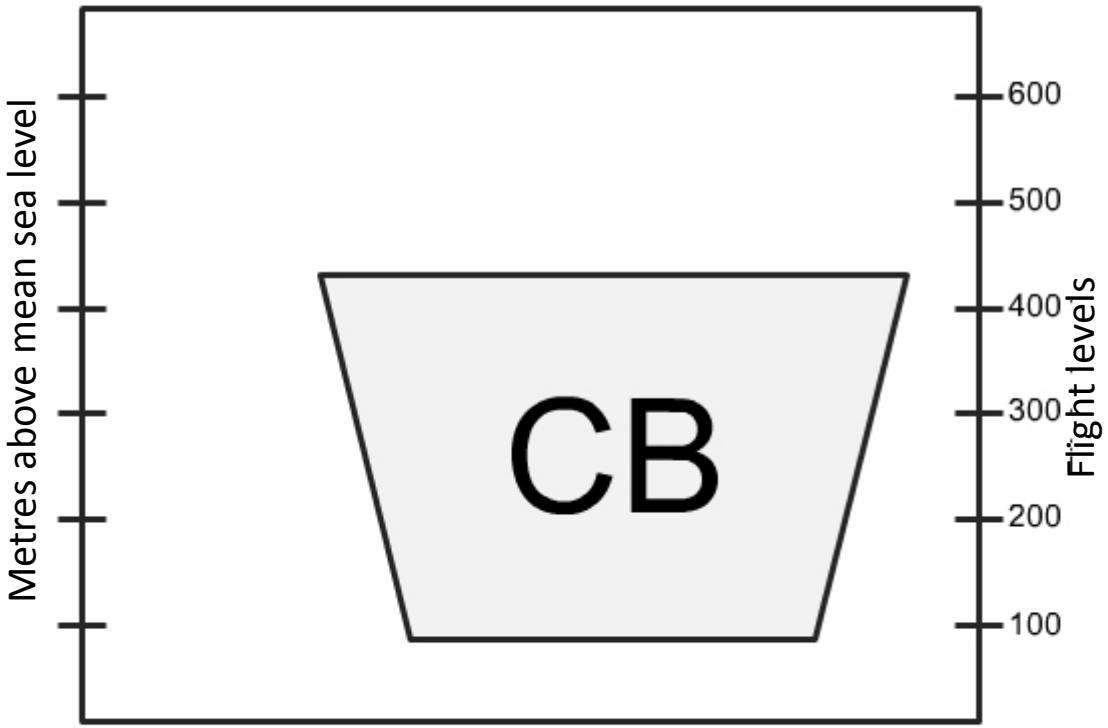
Forecasts of CB cloud use an algorithm based on cloud amount and precipitation intensity

The horizontal extent of CB cloud in each grid box is given a value between 0 and 1.

A figure of 0.5 implies 50% coverage of CB cloud in that grid box (a grid box is 1.25 x 1.25 degrees in size)

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

Data values: CB cloud



The base and top of the CB cloud are calculated in Flight Levels.

These heights are then converted to and disseminated in metres above mean sea level.

(all heights given in WAFS Forecasts are relative to the ICAO Standard Atmosphere)

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

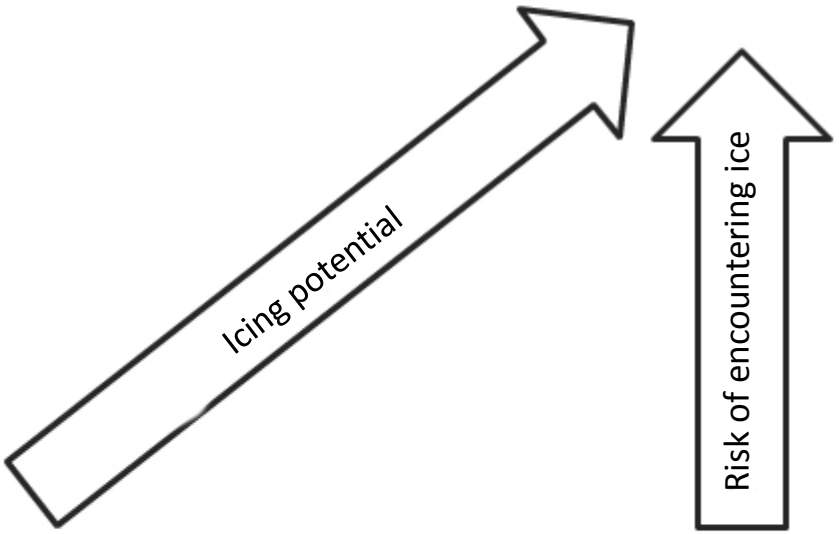
Data values: Icing

The icing algorithms are based on a combination of cloud condensate (ice and water), temperature, relative humidity and vertical motion parameters that predict the presence of super-cooled liquid water.

The values range from 0 to 1 and are a potential for the presence of icing.

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

Data values: Icing



Due to lack of observations of Icing it is not currently possible to indicate the severity of icing or calibrate the forecasts to an accurate probability

The numerical value of Icing Potential is not a probability but the higher the value of icing potential, the greater the risk of encountering icing

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

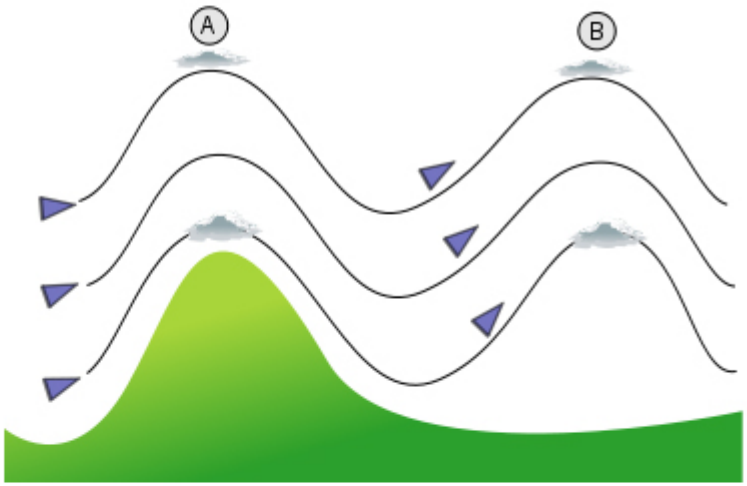
Data values: Icing – vertical levels

Layer centred at (hPa)	Layers from (hPa)	Approximate Flight level
300	250-350	270-340
400	350-450	210-270
500	450-550	160-210
600	550-650	120-160
700	650-750	080-120
800	750-850	050-080

Icing Forecasts are produced for 6 vertical layers, each having a depth of 100hPa.

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

Data values: Clear Air Turbulence



(CAT) - is derived via an algorithm that is based on the Ellrod Index

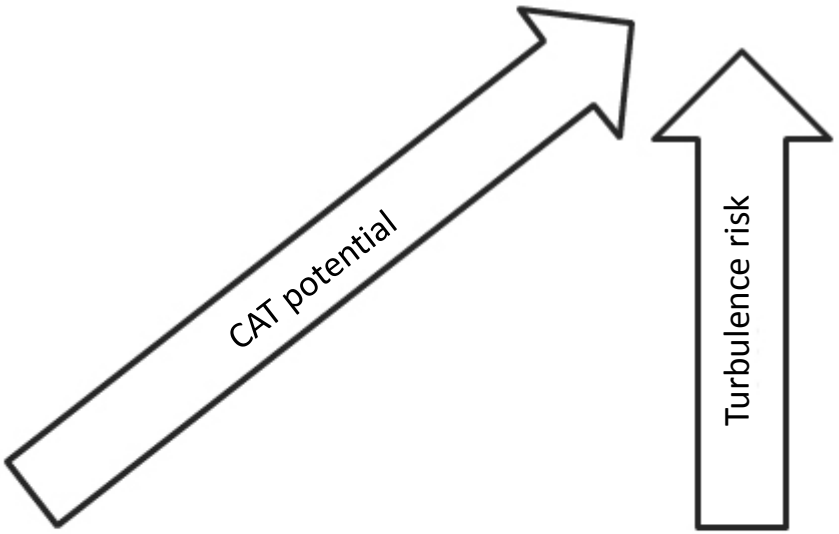
The index is calculated based on the product of horizontal deformation and vertical wind shear

Terrain-induced turbulence is also included within the index

The theoretical limit to the data range is 0 to 99, but most values are <40

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

Data values: Clear Air Turbulence



(CAT) - not a probability

However, the higher the value the greater the risk of encountering turbulence

Does not currently indicate severity

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

Data values: Clear Air Turbulence – vertical levels

Layer centred at (hPa)	Layers from (hPa)	Approximate Flight level
150	125-175	410-480
200	175-225	360-410
250	225-275	320-360
300	275-325	280-320
350	325-375	250-280
400	375-425	220-250

CAT Forecasts are produced for 6 vertical layers, each having a depth of 50hPa.

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

Data values: In-cloud turbulence

The in-cloud turbulence algorithms are based on (i) the model indicating the presence of a cloud, and (ii) the change in potential energy with height, which is a measure of instability

The range of values in the data is from 0 to 1 and are a potential for encountering in-cloud turbulence

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

Data values: In-cloud turbulence – vertical levels

Layers centred at (hPa)	Layers from (hPa)	Approximate Flight level
300	250-350	270-340
400	350-450	210-270
500	450-550	160-210
600	550-650	120-160
700	650-750	080-120

The in-cloud turbulence Forecasts are produced for 5 vertical layers, each having a depth of 100 hectopascals

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

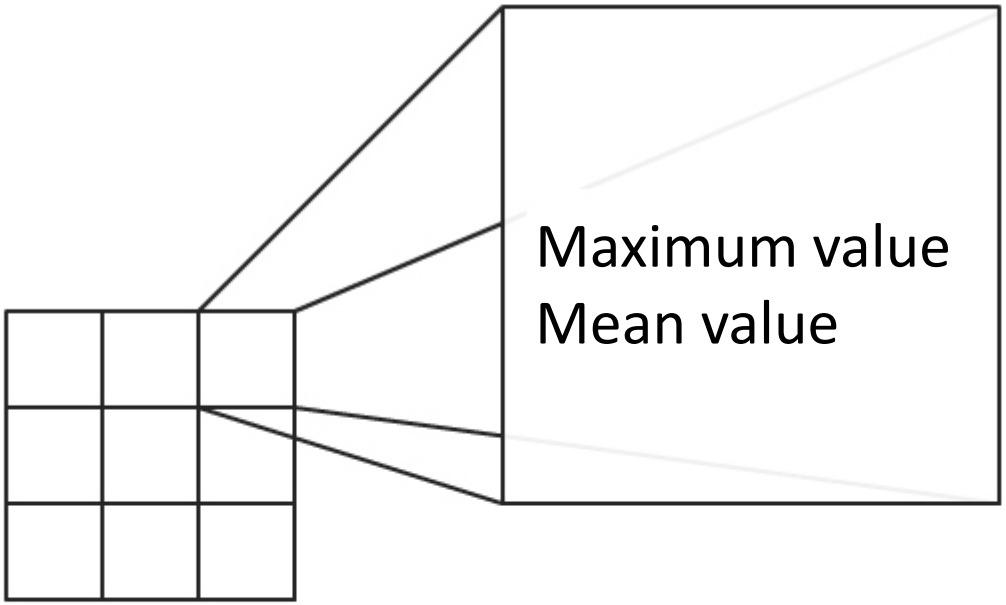
More details can be found on the ICAO website:

http://www.icao.int/safety/meteorology/WAFSOPSG/Pages/GuidanceMaterial.aspx

More details on all the GRIB2 forecast parameters, including the number of files and header information can be found on the ICAO website.

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

Data values: Maximum and Mean values

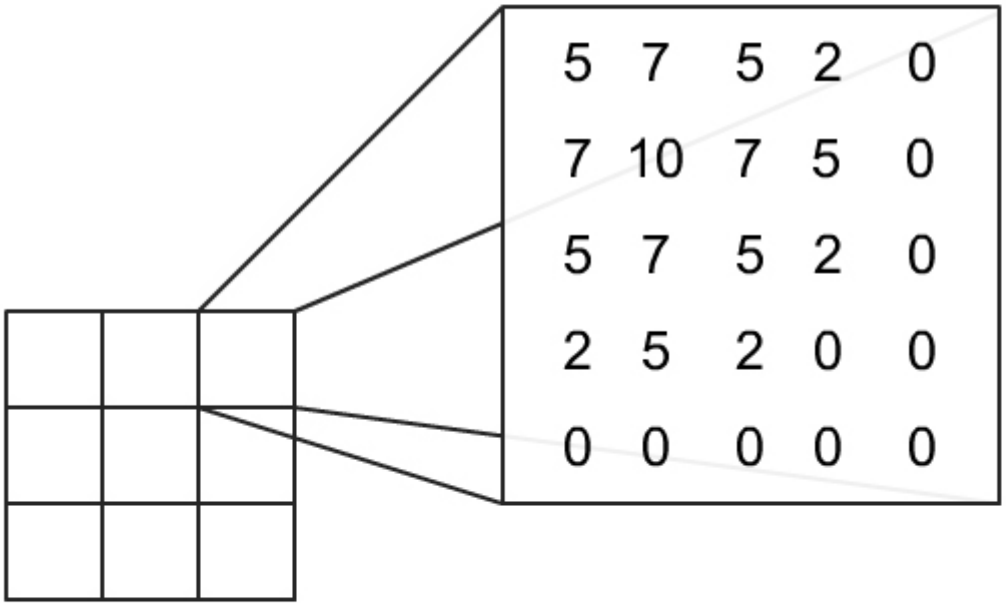


The native resolution of the forecast models run by the WAFCs is much finer than the 1.25 degree resolution of the WAFS grid point forecasts

A maximum and mean value is calculated for each grid square for the Icing, Clear Air Turbulence and in cloud turbulence forecasts

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

Data values: Maximum and Mean values



Here, values of CAT range between 0 and 10 within the grid box

The maximum value of 10 and the mean value of 3 are the figures disseminated

Grid interpolation is done by the WAFCs during production of the forecasts

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

Data values: Number of files

Parameter	Levels	Timesteps	No. Of files
Mean Icing	6	11	66
Maximum Icing	6	11	66
Mean In-cloud turbulence	5	11	55
Maximum In-cloud turbulence	5	11	55
Mean CAT	6	11	66
Maximum CAT	6	11	66
CB Horizontal extent	1	11	11
CB base height	1	11	11
CB top height	1	11	11

2 Icing parameters (Mean and Max)

2 In-cloud turbulence parameters (Mean and Max)

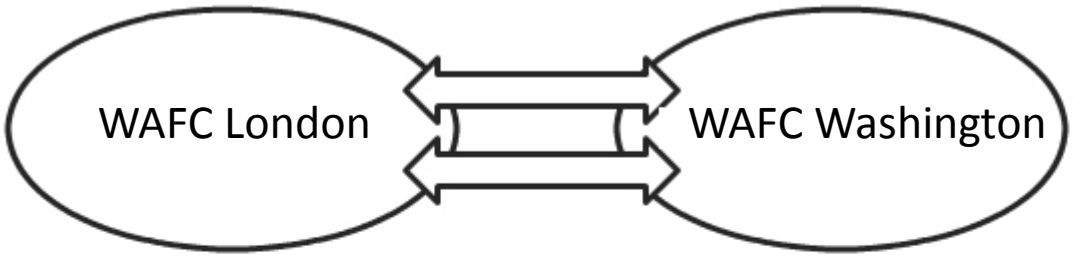
2 CAT parameters (Mean and Max)

3 CB cloud parameters (Horizontal extent, Base height and Top height)

11 timesteps = 407 data files

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

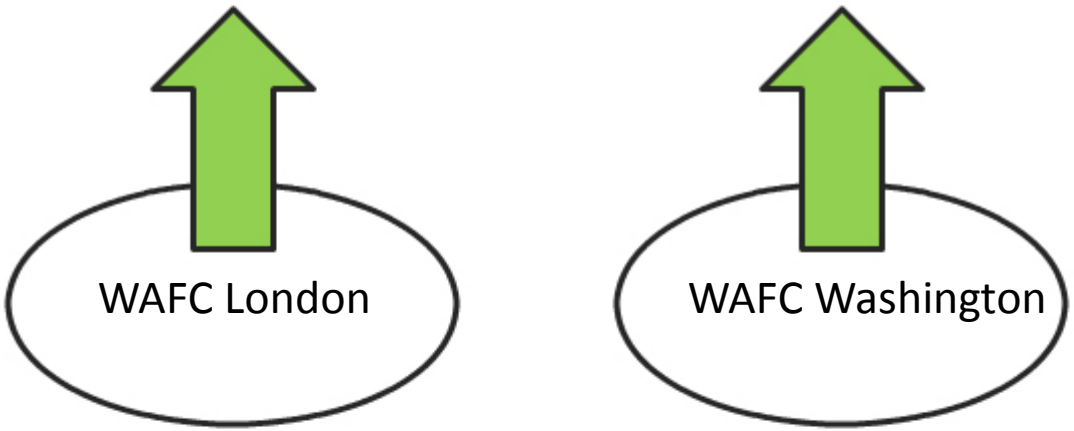
Data values: Harmonization



A harmonization process is carried out to provide consistency between the WAFC London and WAFC Washington datasets

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

Data values: Harmonization



On rare occasions the harmonization process may not occur

If this should occur, each WAFC then makes available its independent forecasts

A WAFS administrative message will be issued to notify users that independent, that is, unharmonized forecasts have been issued.

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

Differences between Grid point forecasts and SIGWX

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

Differences between Grid point forecasts and SIGWX

Feature	Grid pt. forecasts	SIGWX
Availability	T+6 to T+36 at 3 hour intervals	T+24 only
Coverage	Global	Icing is EUR,NAT, MID, Asia South only
Vertical resolution	Discrete vertical layers	Single vertical layer – simplified
Type	Range of data values (potential)	Deterministic
Severity	Scale of potential for icing	Subjective assessment

3 hour timesteps

Updated every 6 hours

Global coverage

More vertical detail

Range of values

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

Differences between Grid point forecasts and SIGWX

Feature	Grid pt. forecasts	SIGWX
CAT	Potential 0-99	MOD/SEV
In Cloud Turbulence	Potential 0-1 in all cloud	MOD/SEV in non-CB areas depicted
Icing	Potential 0-1 in all cloud	MOD/SEV in non-CB areas
CB	All CB coverage is forecast	ISOL EMBD, OCNL, OCNL EMBD AND FRQ only depicted

Traditional SIGWX based largely on subjective judgement of forecaster

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

Supplementary information for all users

Areas depicted by the gridded data will be different from and more fragmented than the smooth shapes shown on Significant weather charts.

Users may choose what to visualise depending on their operational requirements.

Software providers should choose appropriate thresholds using the guidance on the next few slides.

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

Use of CAT data

An example of turbulence made visible by clouds

The Maximum CAT field has greater skill than the Mean CAT field

Areas with a maximum CAT potential of > ~4-6 is recommended to show the location of moderate or greater CAT

CAT algorithm performs best near Jet streams / areas of strong wind shear

It performs less well in areas of lighter winds, e.g. near the tropics

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

CAT thresholds

Threshold	Hit Rate	False Alarm Rate
1.00	0.811	0.563
2.00	0.773	0.495
3.00	0.709	0.428
4.00	0.626	0.315
5.00	0.523	0.180
6.00	0.431	0.113
7.00	0.370	0.068
8.00	0.304	0.045
9.00	N/A	N/A
10.00	0.200	0.22

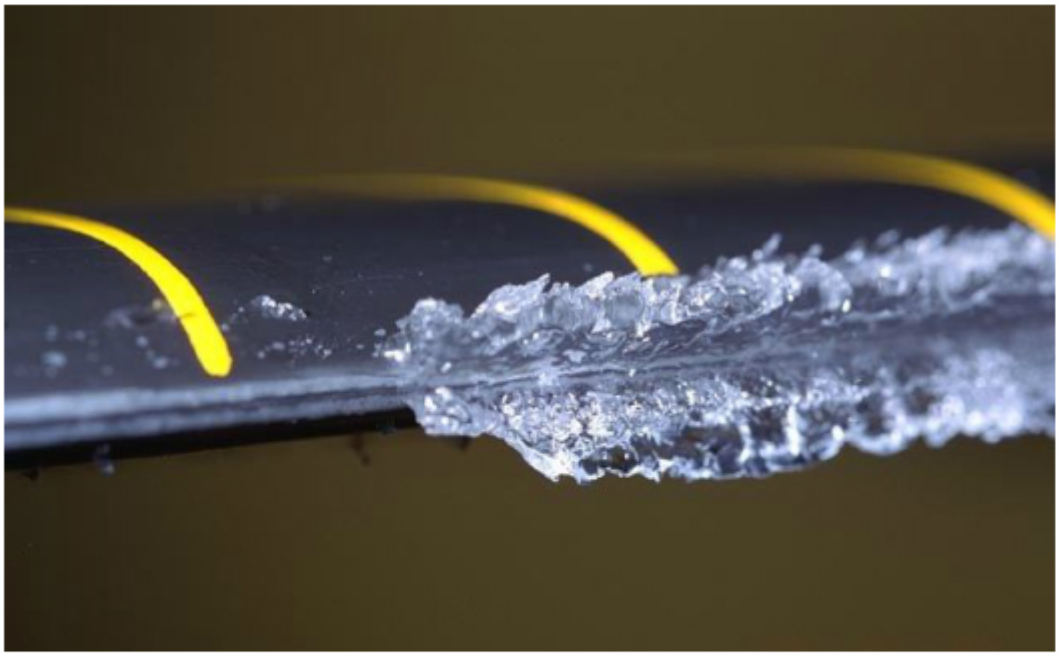
Verification statistics* have been produced that show the hit rate and false alarm rate for encountering moderate or greater turbulence above certain thresholds.

E.g. For a CAT value of 6 or more, the hit rate can be expected to be 0.43 and FAR 0.11.

*Based on limited data

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

Use of Icing data



Threshold data is based on use of the more conservative 'maximum' Icing field

A threshold of 0.1 is recommended for avoidance of any icing in Extended Diversion Time (EDTO) planning.

A threshold of 0.7 gives similar areas of coverage to the areas shown on SIGWX charts.

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

Icing thresholds

Threshold	Hit Rate	False Alarm Rate
0.00	1	1
0.10	0.900	0.155
0.20	0.879	0.136
0.30	0.840	0.114
0.40	0.764	0.076
0.50	0.574	0.032
0.60	0.257	0.010
0.70	0.138	0.004
0.80	0.042	0.001
0.90	0	0
1.00	0	0

Verification statistics showing the Hit rate and false alarm rate for encountering icing above different thresholds at FL100.

For an Icing threshold value of 0.1 or more, the hit rate can be expected to be 0.9 and the FAR 0.155

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

Use of CB data

Threshold data is based on the harmonized 'maximum' horizontal extent

Threshold of 0.5 approximates the area of coverage of OCNL CB shown on SIGWX charts.

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

CB thresholds

Threshold	Hit Rate	False Alarm Rate
0.00	1	1
0.10	0.833	0.099
0.20	0.826	0.098
0.30	0.783	0.090
0.40	0.714	0.079
0.50	0.427	0.043
0.60	0.357	0.038
0.70	0.325	0.035
0.80	0.267	0.031
0.90	0.224	0.029
1.00	0.218	0.028

Verification statistics showing the Hit rate and false alarm rate for encountering CB above different thresholds of CB Horizontal extent.

E.g. For a threshold above 0.4, hit rate is 0.71 and FAR 0.08

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

Visualisation of WAFS Grid point forecasts

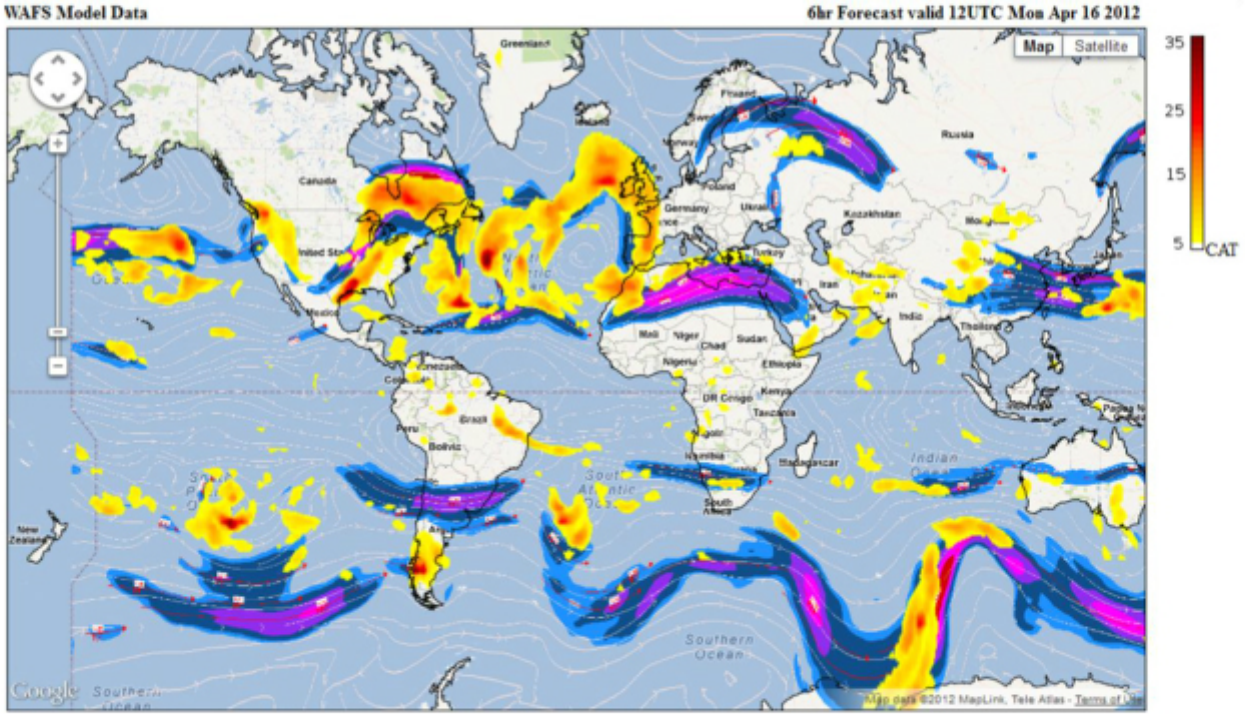
The WAFCs do not provide visualisations of the WAFS Grid point forecasts

Contact your SADIS or WIFS workstation provider if you require software to display the WAFS Grid point forecasts

Some examples of visualised WAFS grid point forecasts follow, these have been provided by the US National Weather Service.

Guidance on the Harmonized WAFS Grid point forecasts for CB Cloud, Icing and Turbulence

Example visualisation of CAT and Jet Stream Location



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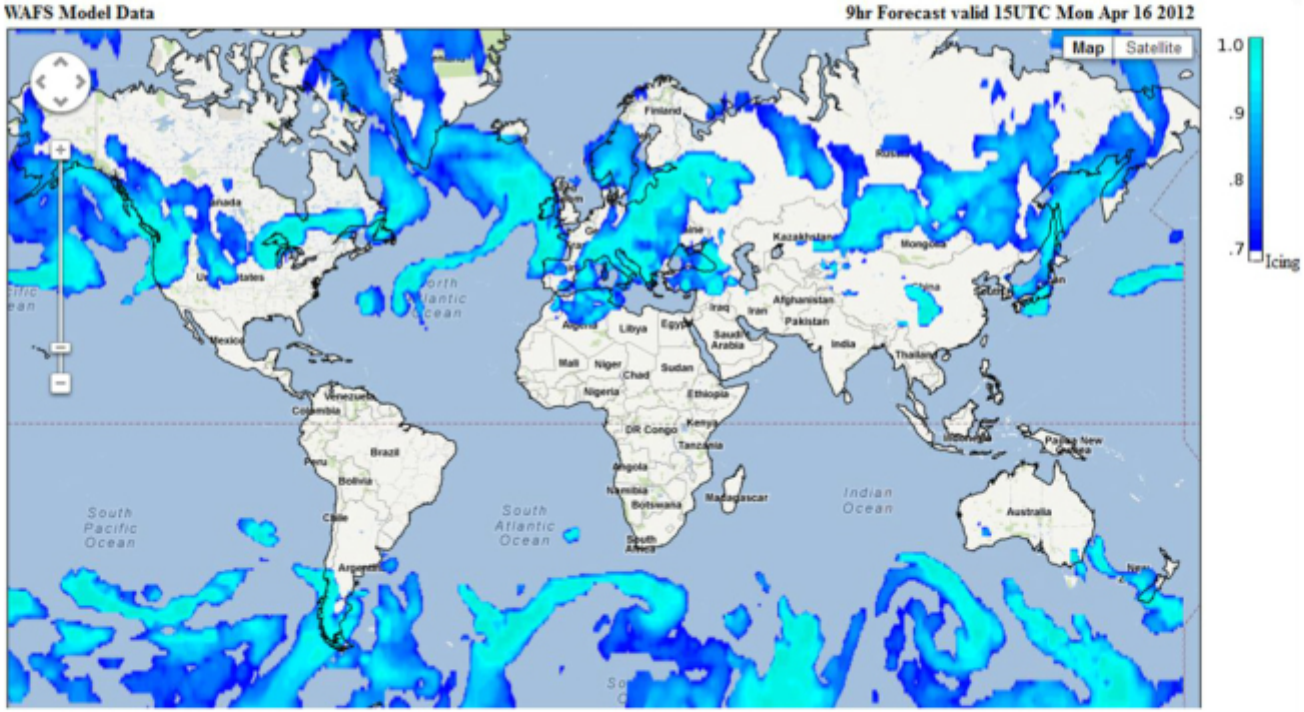
Example visualisation of Icing



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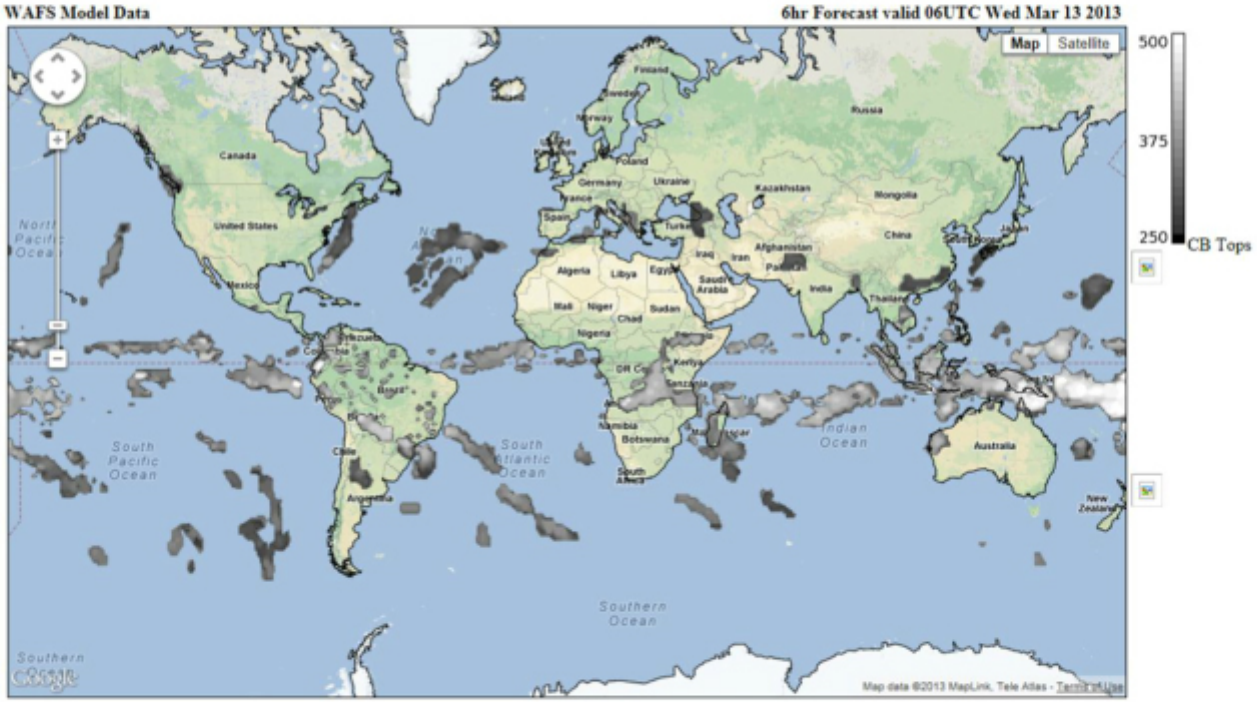
Example visualisation of CB



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Quality control and further improvement

More observations will allow calculation of probability and severity and allow verification to be extended globally

Further development of algorithms are planned over the next few years which will improve the information to satisfy user requirements

Comments and feedback on the user guide are welcomed
A webpage has been set up for feedback - to subscribe please go to:-

http://infolist.nws.noaa.gov/read/all_forums/subscribe?name=wafs_grids_support&page=all_forums