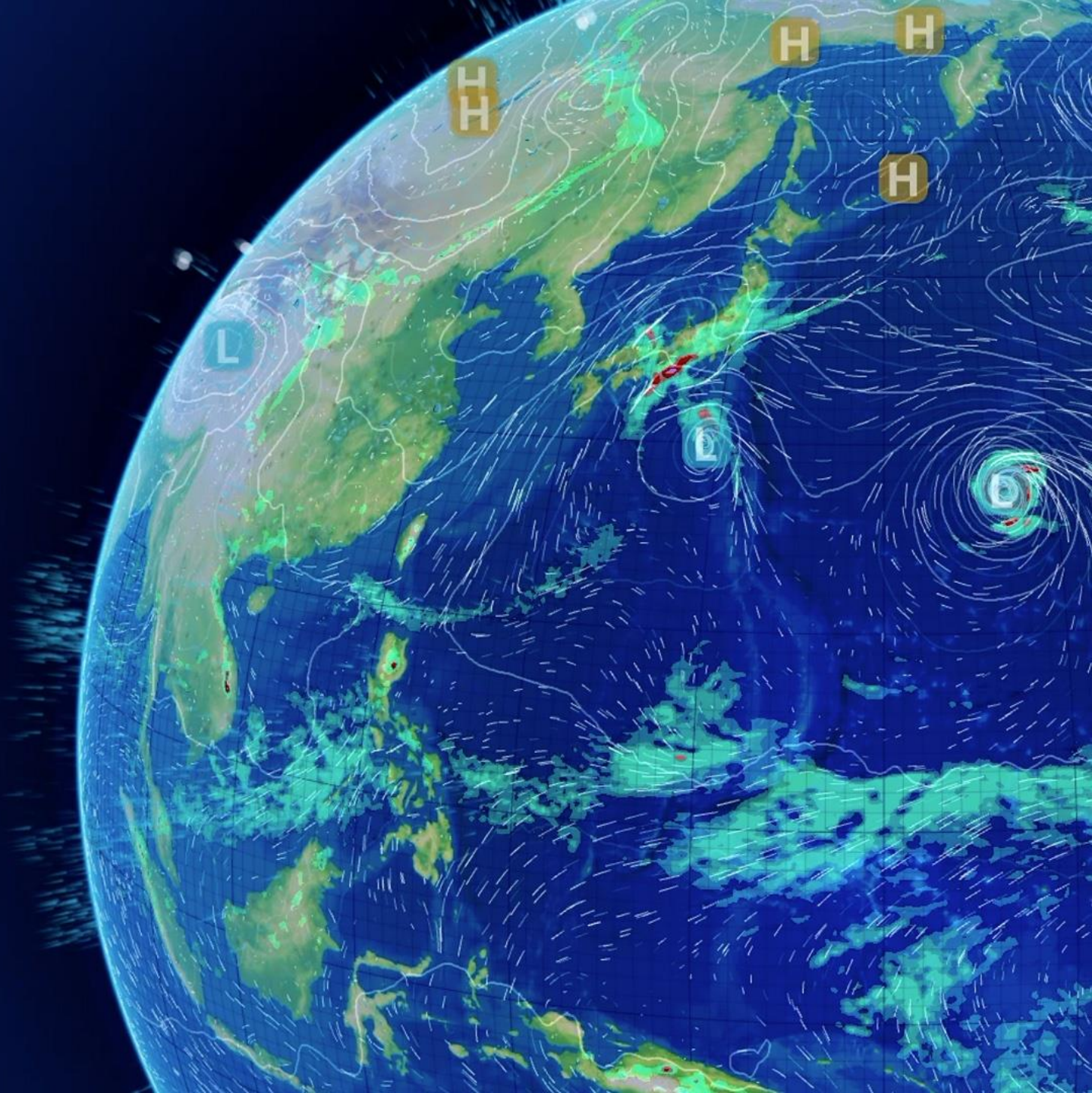# World Area Forecast System Gridded data sets

Met Office

The World Area Forecast System (WAFS) provides global gridded model forecasts of wind, temperature, relative humidity, turbulence, icing and cumulonimbus cloud.

In November 2025 the turbulence, icing and cumulonimbus fields are being upgraded as part of Amendment 82 to ICAO Annex 3 – *Meteorological Service for International Air Navigation.*

The new data is already available via the SADIS API

NEW 0.25-DEGREE WAFS DATA SETS

| Forecast Timesteps: |
| --- |
| **T+06 to T+24 at 1-hourly intervals** |
| **T+27 to T+48 at 3-hourly intervals[1]** |
| **T+54 to T+120 at 6-hourly intervals[2]** |
| [1]*Icing, Turbulence and Cumulonimbus stops at T+48* |
| [2]*WAFC London data past T+66 is only produced for the 00Z and 12Z model runs* |

Wind U/V - 56 vertical levels from FL050 to FL600
Temperature - 56 vertical levels from FL050 to FL600
Geospatial Height - 56 vertical levels from FL050 to FL600
Relative Humidity - 14 vertical levels from FL050 to FL180
Tropopause height and Tropopause temperature
Max wind height, and max wind u/v
Icing Severity - 26 vertical levels from FL050 to FL300
Turbulence Severity - 36 vertical levels from FL100 to FL450
Cumulonimbus Extent, Base and Top

- All data is using exact pressure levels

- For example FL100 is calculated using data for 696.8hPa and not 700hPa.

- Where the flight level is below the ground surface in icing and turbulence data , a "null" value will be given. In the raw data this will be a negative value.

Turbulence Severity FL100 (696.8 hPa)

Eddy Dissipation Rate (EDR)

NULL   0.2   0.6   1.0
0
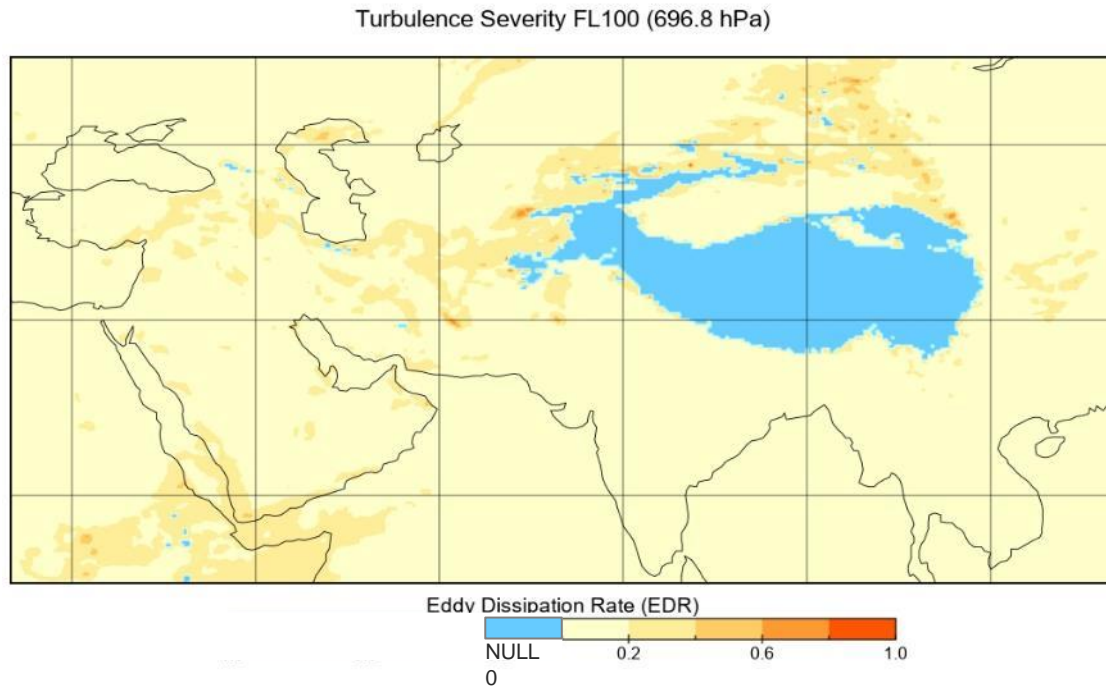
In this example the Himalayas are higher than FL100, and are shown in blue. No turbulence severity value is forecast

THE DATA CAN BE USED TO CREATE:
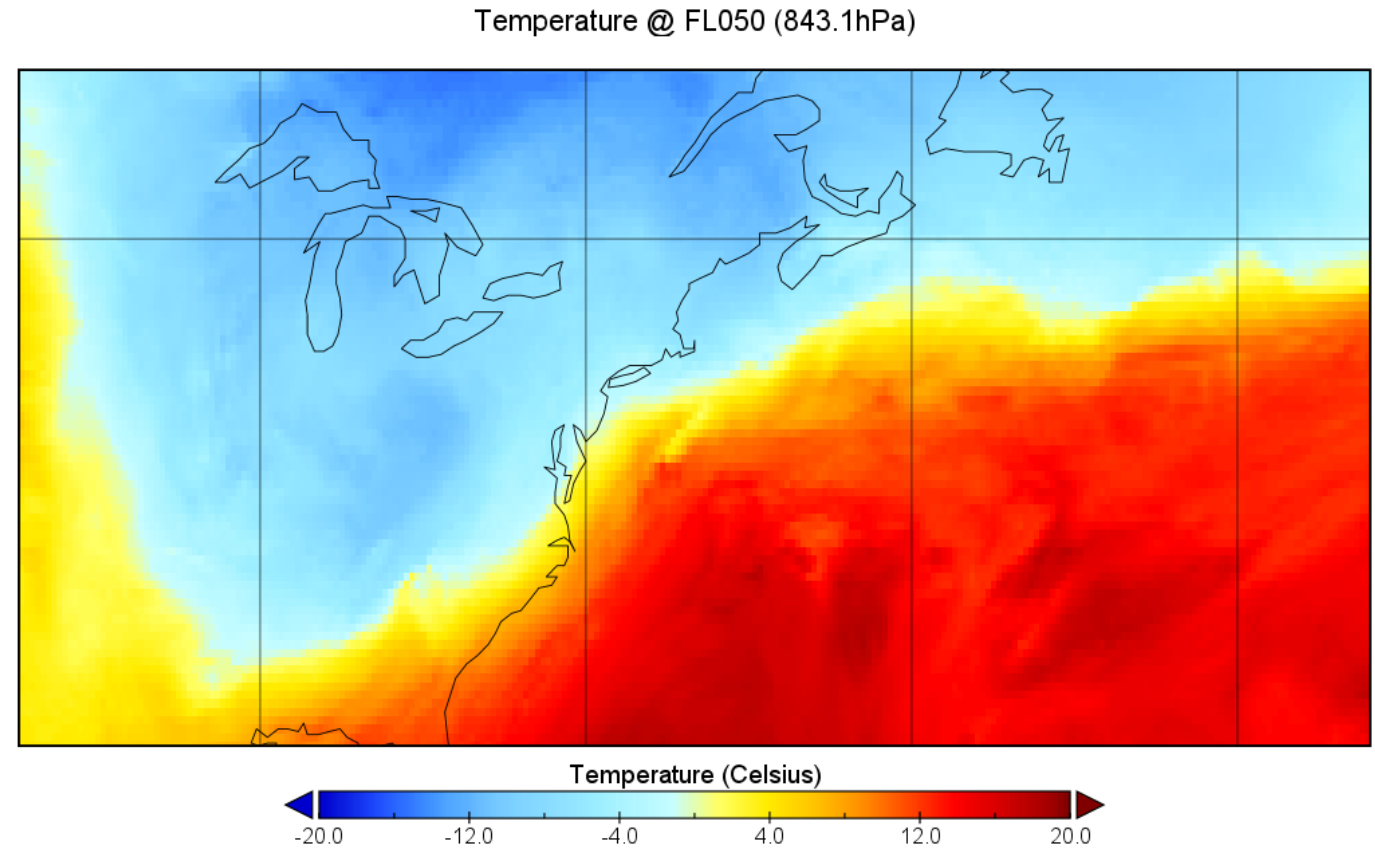
Wind and temperature charts

FL300 Wind and Temperature
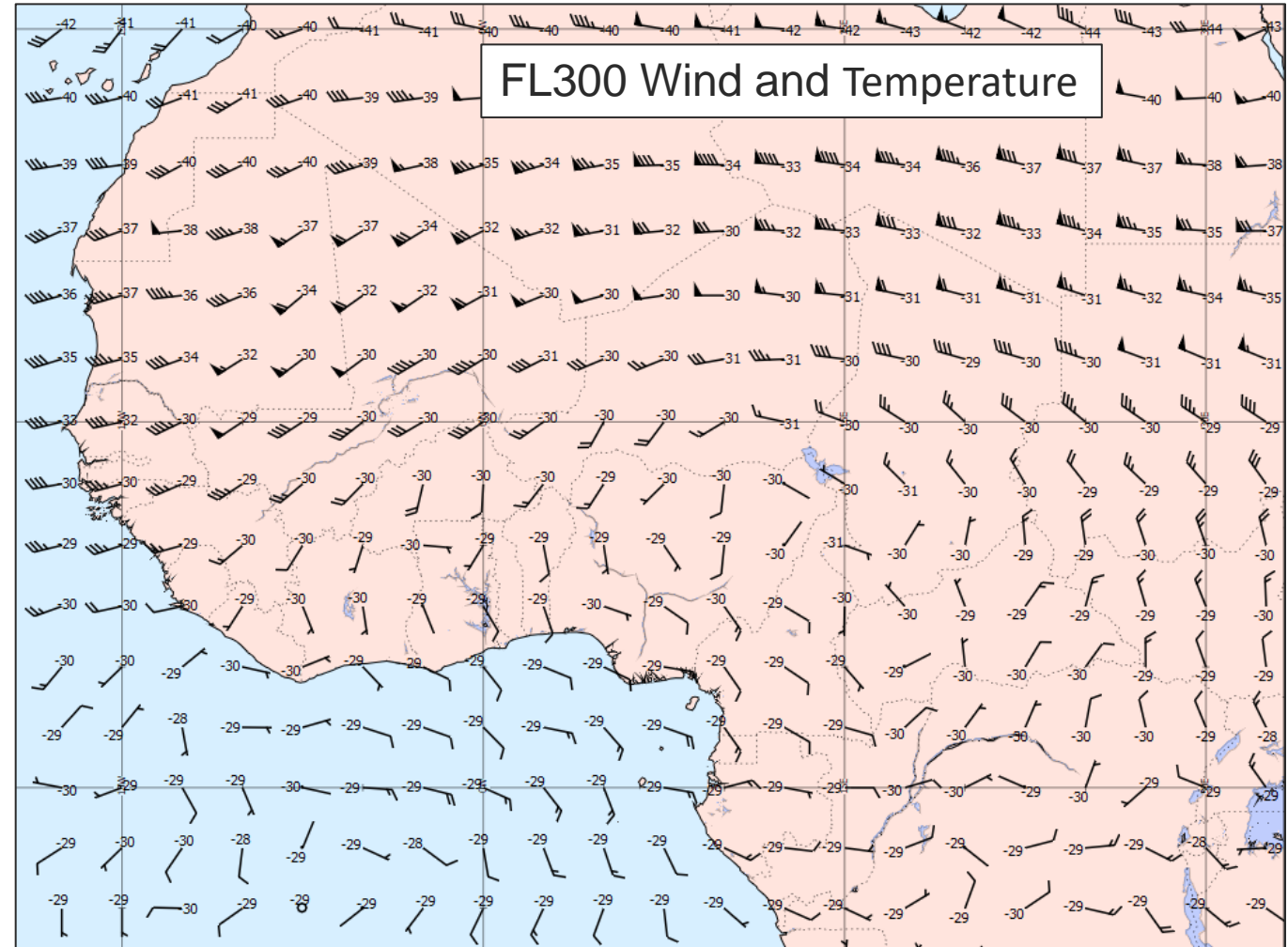
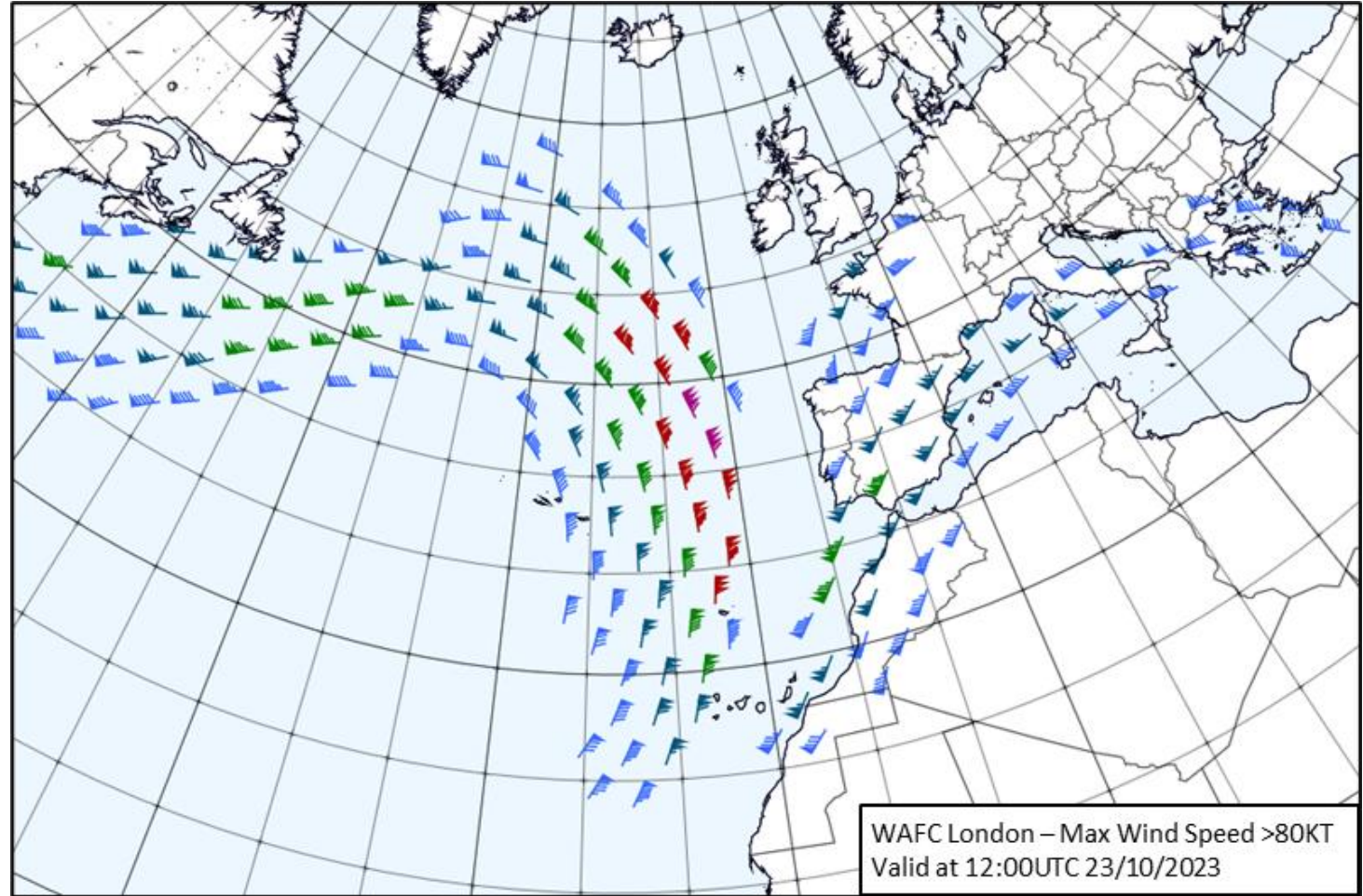# THE DATA CAN BE USED TO CREATE:

Wind and temperature charts

Temperature charts

THE DATA CAN BE USED TO CREATE:

Wind and temperature charts

Temperature charts
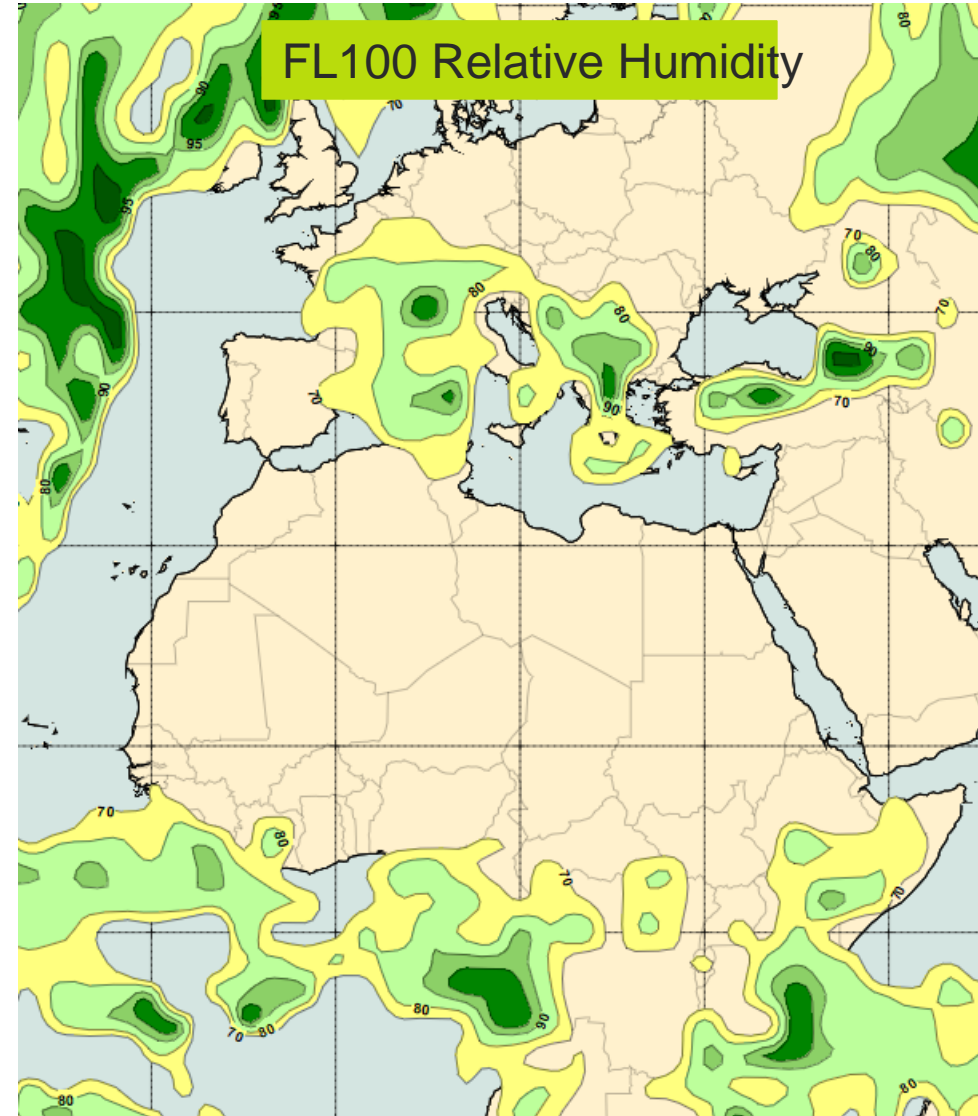
Jet Stream charts

Relative Humidity charts

WAFC London – Max Wind Speed >80KT
Valid at 12:00UTC 23/10/2023

THE DATA CAN BE USED TO CREATE:

Wind and temperature charts

Temperature charts

Jet Stream charts

Relative Humidity charts

FL100 Relative Humidity

THE DATA CAN BE USED TO CREATE:

Wind and temperature charts

Temperature charts

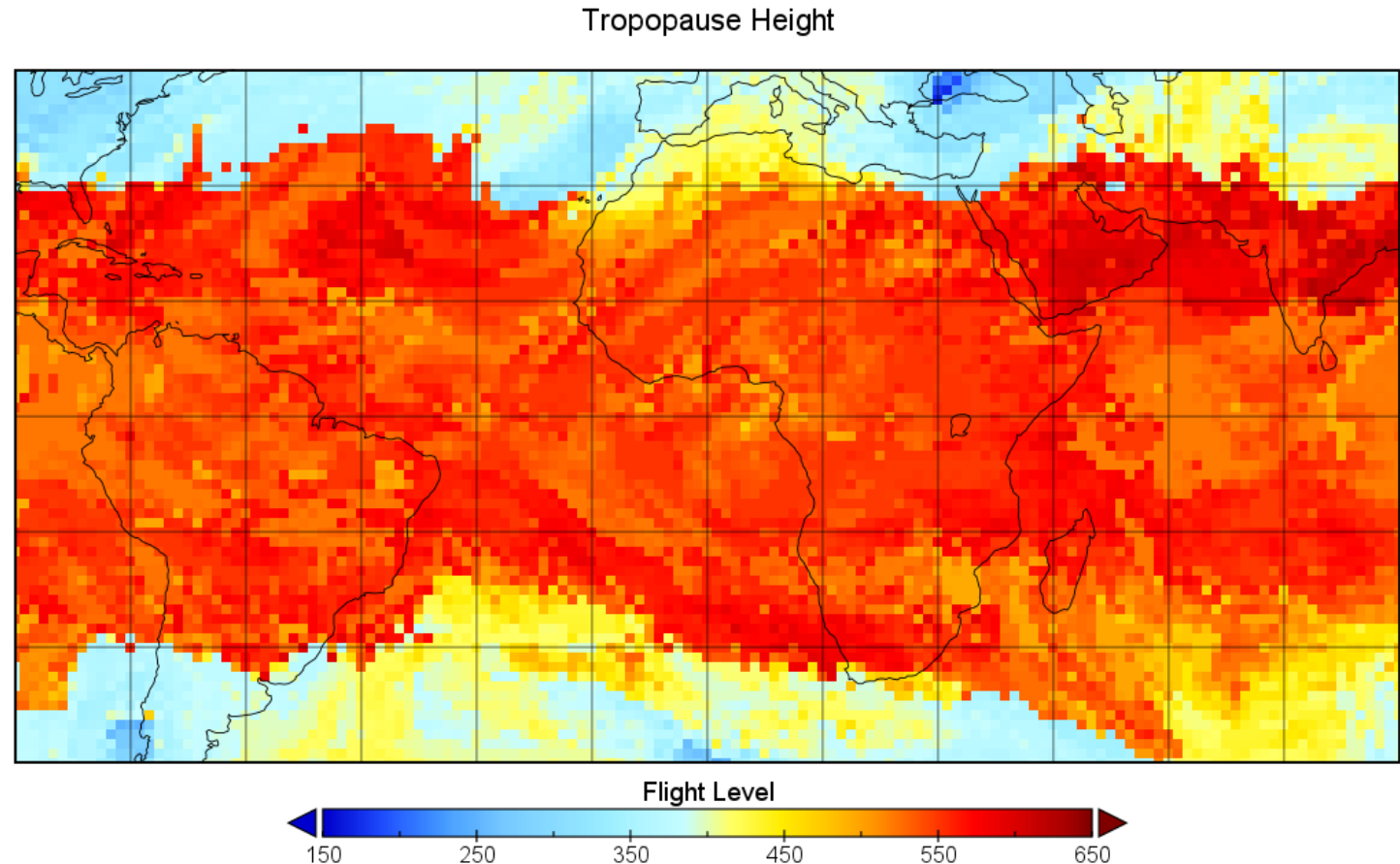Jet Stream charts

Relative Humidity charts

Tropopause charts

Tropopause Height

Flight Level

Met Office

WAFC HAZARD DATA:

- Comprises of turbulence, Icing, CB base, CB top and CB Extent

- Is a blend of WAFC London and WAFC Washington data

- If there is a problem with blending (e.g. WAFC Washington data doesn't reach WAFC London) then an unblended data set is published instead.

Icing Severity

ICING SEVERITY

Specific algorithms are used to calculate the icing severity forecast

Processed satellite imagery was used to "tune" the algorithms, and is used for verification

ICING SEVERITY – VERTICAL LEVELS

SADIS API has Icing Severity data for FL060 to FL300 at 1000ft vertical intervals

SADIS FTP only has Icing Severity data for the following levels:

FL060 (812.0 hPa)
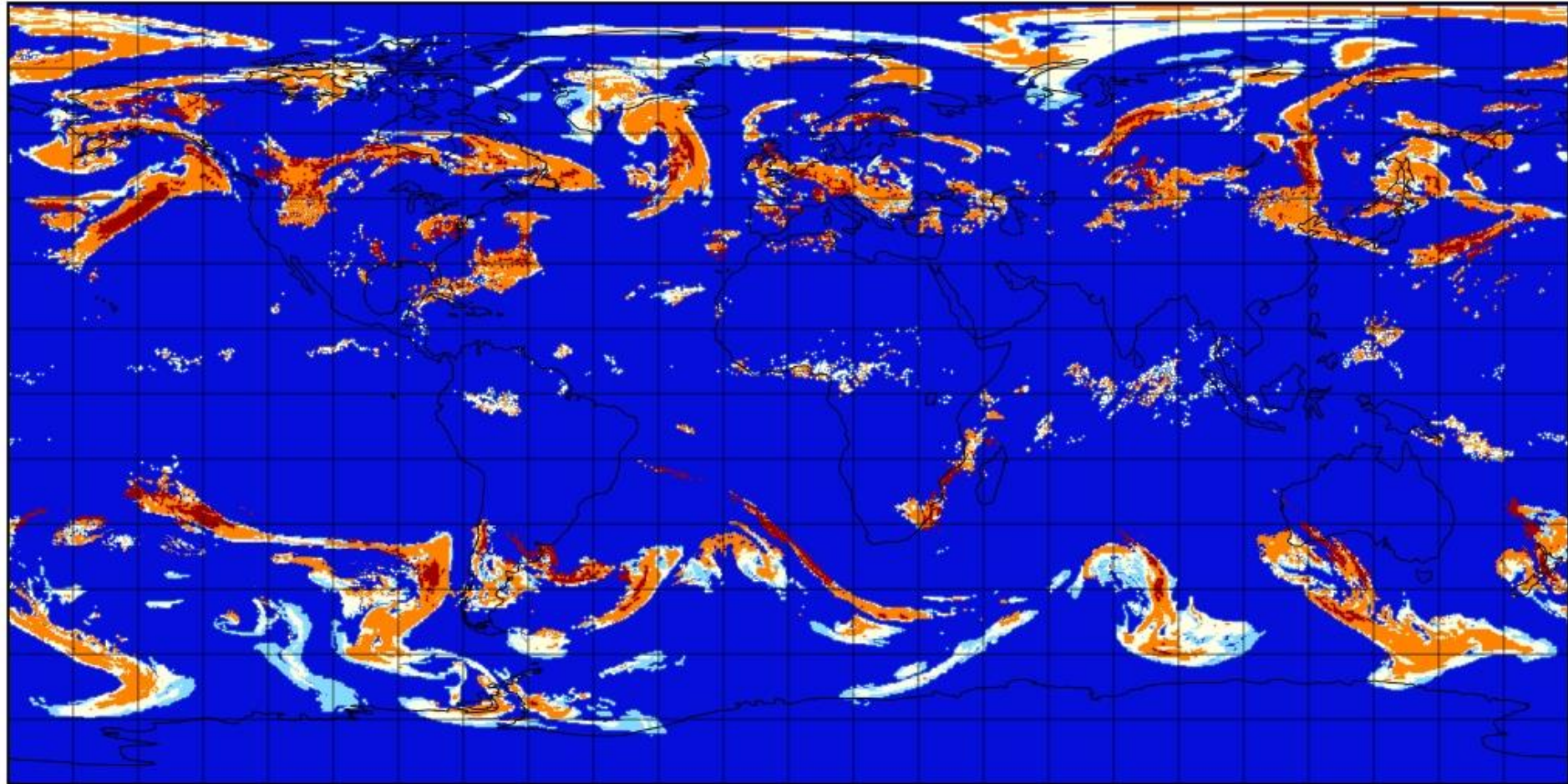
FL100 (696.8 hPa)

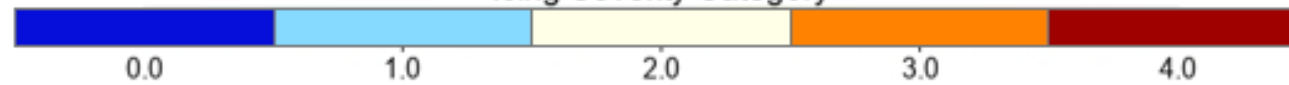FL140 (595.2 hPa)

FL180 (506.0 hPa)

FL240 (392.7 hPa)

FL300 (300.9 hPa)

IMPORTANT NOTE: Within the GRIB 2 coding, a new parameter number "37" is used. This is was added to the WMO No. 306 FM-92 GRIB code form in May 2020 into code table 4.2-0-19
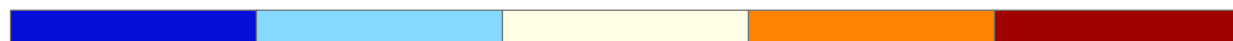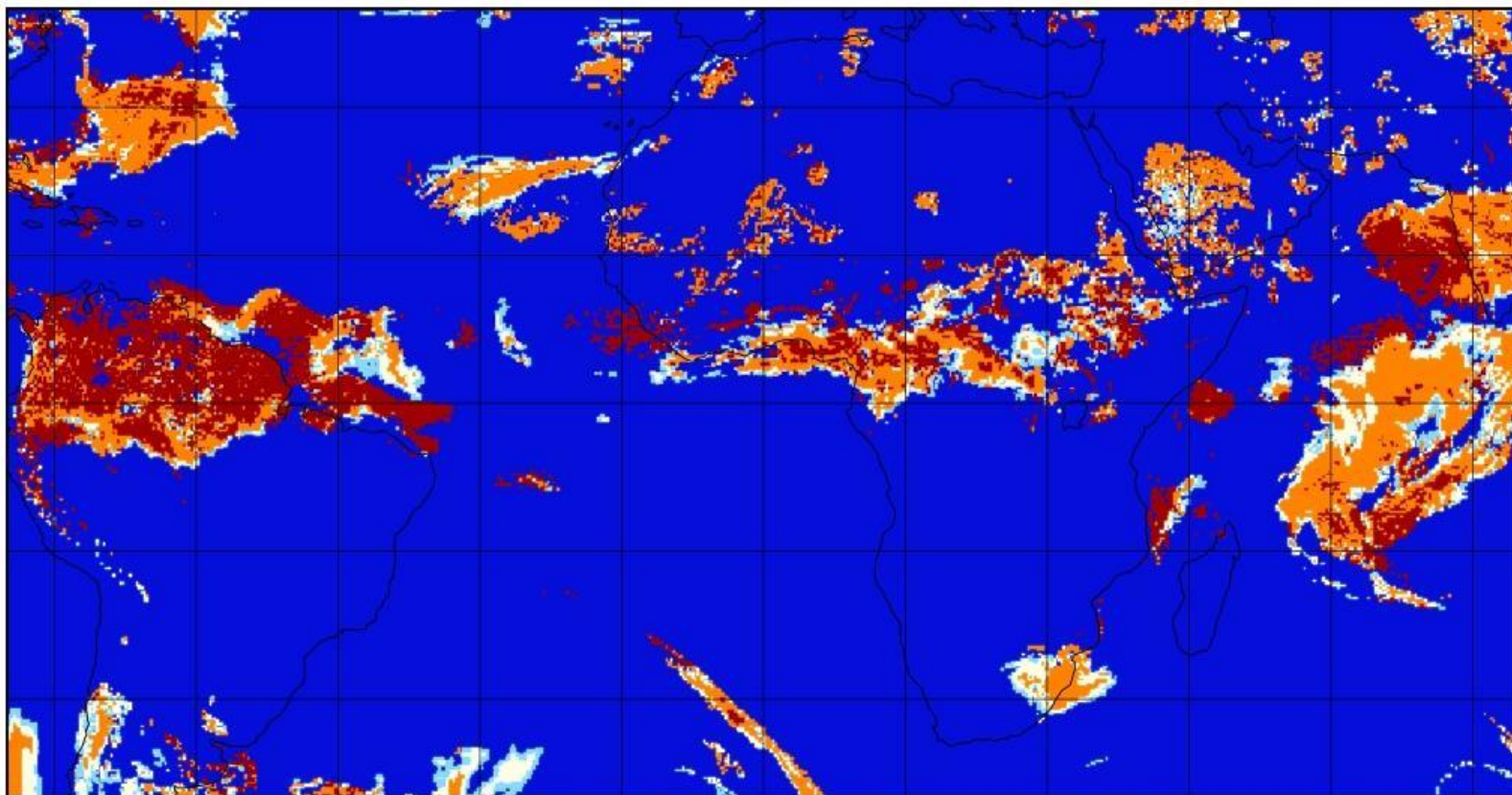
NEW 0.25 Icing Severity FL140 (595.2 hPa)

Icing Severity Category

NEW 0.25 Icing Severity FL180 (506.0 hPa)

NIL   TRACE   LIGHT   MOD   SEV

Closer examination shows the detail that can be seen in the icing field.

Icing occurring in frontal systems and icing from convection are both captured.

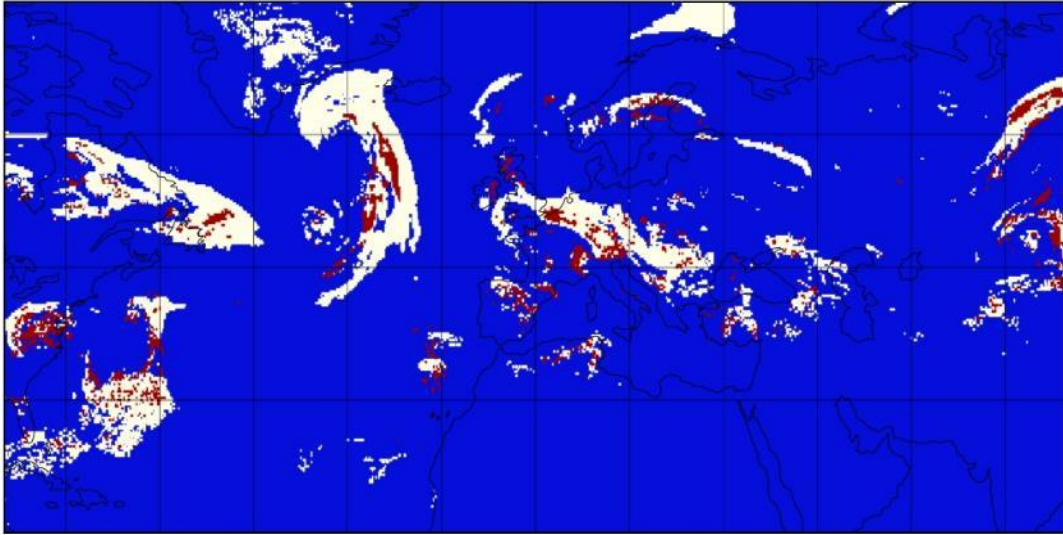The categories relate to an icing intensity

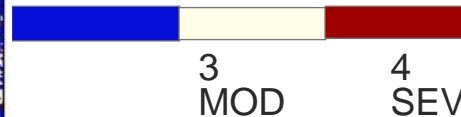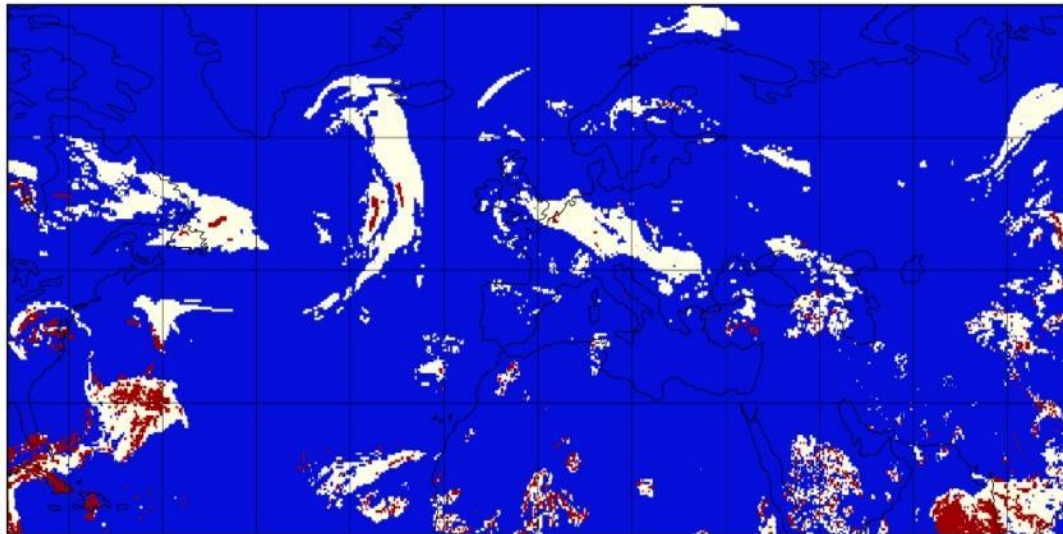0 = NIL

1 = TRACE

2 = LIGHT

3 = MODERATE

4 = SEVERE

NEW 0.25 Icing Severity FL140 (595.2 hPa)

Of course, a threshold could be applied to icing severity data.

In these example only MOD and SEV icing intensities are shown.

NEW 0.25 Icing Severity FL180 (506.0 hPa)

3
MOD

4
SEV

Turbulence Severity

TURBULENCE SEVERITY DATA

- The new Turbulence Severity data uses a multi-diagnostic algorithm, Graphical Turbulence Guidance (GTG) developed by the National Center for Atmospheric Research (NCAR)

- Both WAFC London and WAFC Washington are using the same algorithm in the creation of their data sets, which are then blended together to create the final published WAFS data set.

- GTG forecasts **both clear air and orographic turbulence** and will provide output in terms of Eddy Dissipation Rate (EDR). EDR is the official ICAO and WMO atmospheric turbulence intensity metric.

https://aviationweather.gov/turbulence/help?page=tutorial contains further information on the GTG algorithms used. Note that GTG3 is being used for WAFS.

WHAT IS EDDY DISSIPATION RATE (EDR)

- Eddy Dissipation Rate is an objective, aircraft-independent, universal measure of turbulence based on the rate at which energy dissipates in the atmosphere. EDR is the official ICAO and WMO atmospheric turbulence intensity metric and will have values that range between 0 and 1.

- When the atmosphere is dissipating energy quickly (i.e the EDR is large), atmospheric turbulence levels are high."

- The effect of a particular EDR value on an aircraft will depend on the size (weight) of the aircraft.
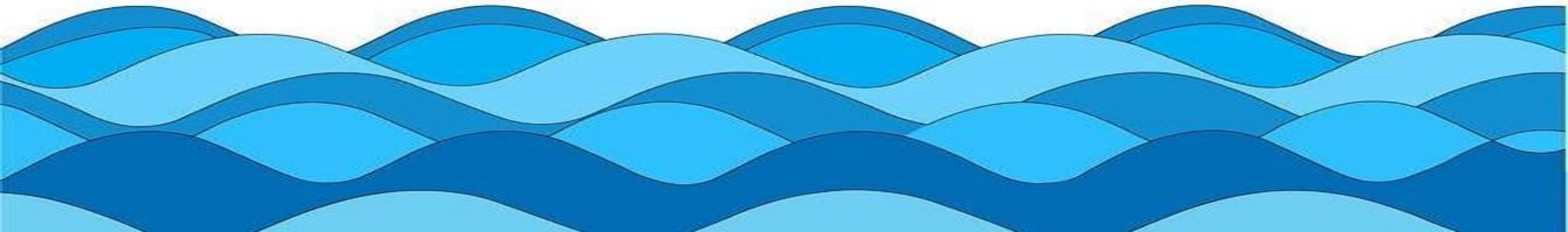
TURBULENCE SEVERITY DATA

- We "tune" the turbulence severity algorithms using turbulence data collected by aircraft

- We also use the aircraft turbulence data to verify our forecasts

TURBULENCE SEVERITY – VERTICAL LEVELS

SADIS API has Turbulence Severity data for provided for FL100 to FL600 at 1000ft vertical intervals

SADIS FTP only has Turbulence Severity data for the following levels:

FL100 (696.8 hPa)

FL140 (595.2 hPa)

FL180 (506.0 hPa)

FL240 (392.7 hPa)
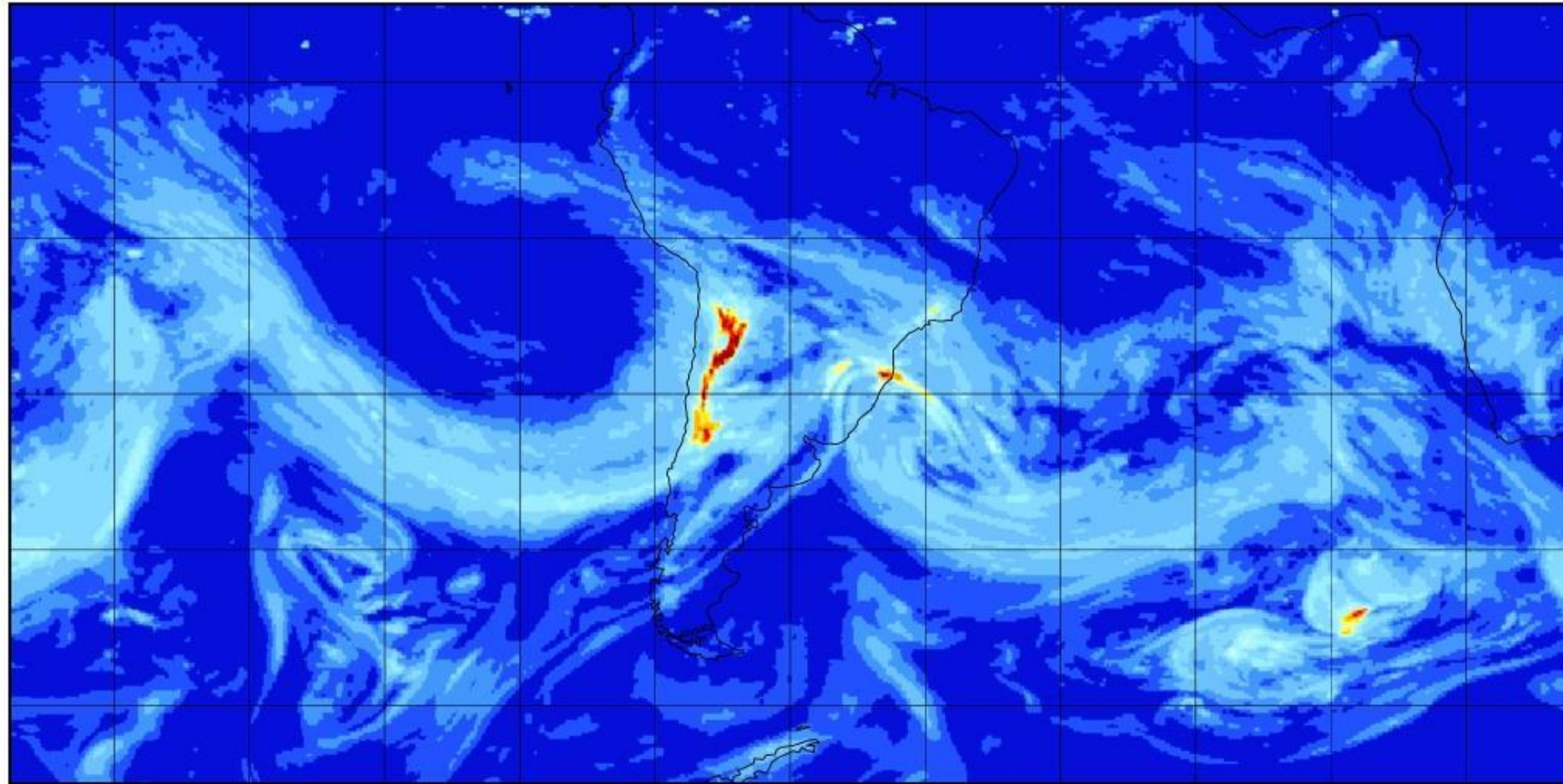
FL270 (344.3 hPa)

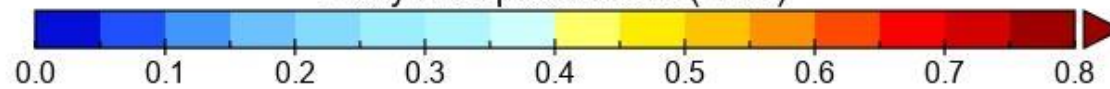FL300 (300.9 hPa)

FL340 (250.0 hPa)

FL390 (196.8 hPa)

FL450 (147.5 hPa)

0.25 degree Turbulence Severity (GTG) at FL240 (392.7hPa)

Eddy Dissipation Rate (EDR)

ICAO Annex 3 - *Meteorological Service for International Air Navigation*, Appendix 4 has the following information:

Turbulence shall be considered:

a) Severe when the peak value of EDR equals or exceeds 0.45;

b) moderate when the peak value is equal to or above 0.20 and below 0.45;

c) Light when the peak value is above 0.10 and below 0.20; and

d) nil when the peak value is below or equal to 0.10.

Note: The EDR values given in Annex 3 describe the severity levels for a medium-sized transport aircraft under typical en-route conditions (i.e. altitude, airspeed and weight).

Whilst EDR forecasts for the other size classes of aircraft have not been defined in the ICAO Annex 3 for a "heavy" classification of aircraft a higher EDR value would be necessary for it to experience severe turbulence, whilst a lower value would be required for an aircraft in the "light" category. The EDR threshold values for a specific aircraft type should be defined in the aircraft technical documentation.

[1] *https://www.skybrary.aero/index.php/ICAO_Wake_Turbulence_Category#*

0.25 degree Turbulence Severity (GTG) at FL240 (392.7hPa)

Eddy Dissipation Rate (EDR)

0.2   0.3   0.4   0.5   0.6   0.7   0.8
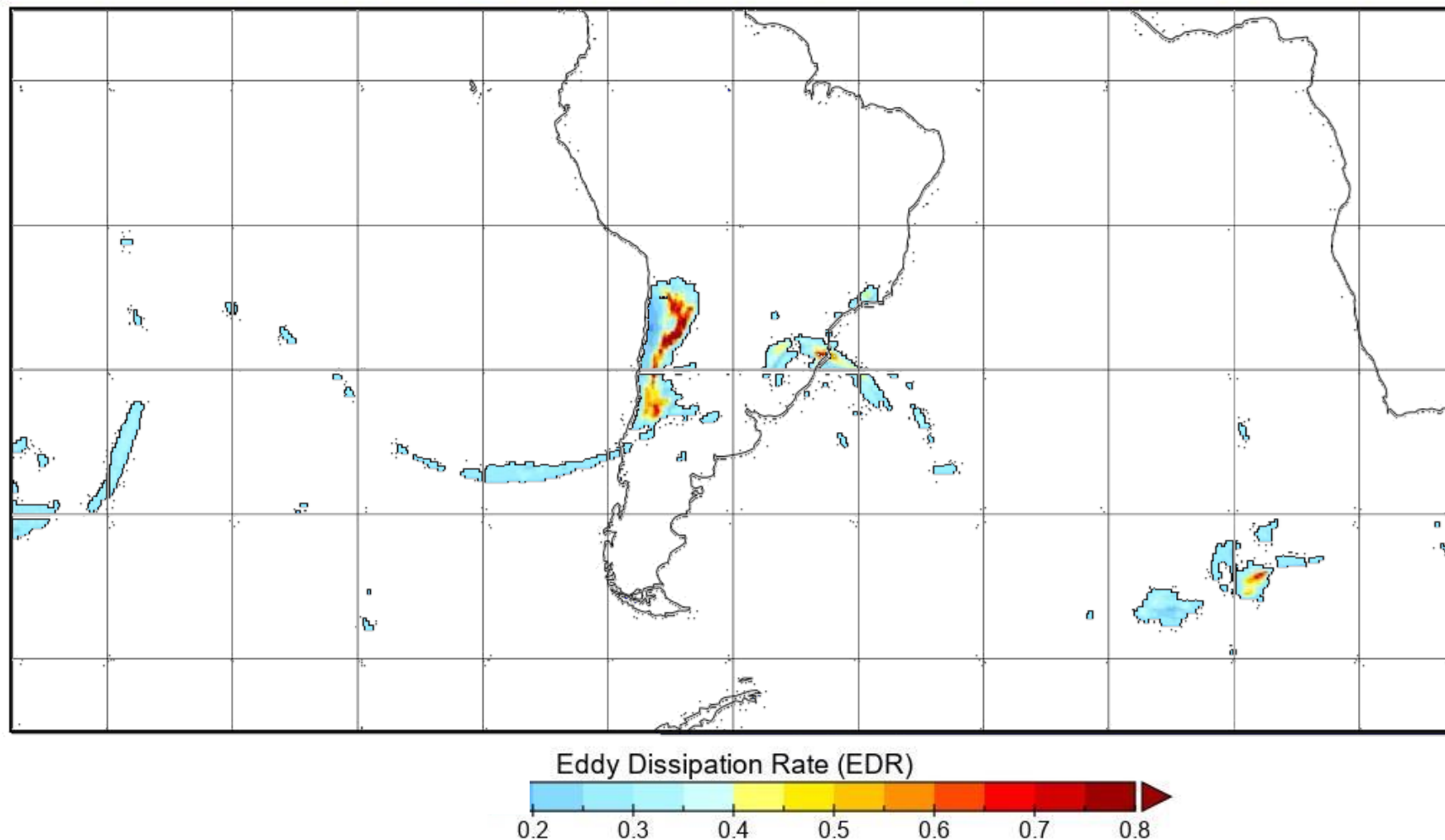
On this example only EDR values greater than 0.20 are shown, which would equate to moderate or greater turbulence for a medium[1] sized aircraft

If the threshold EDR threshold for a particular aircraft is known, then the scale used to visualize EDR data can be set accordingly.

0.25 degree Turbulence Severity (GTG) at FL240 (392.7hPa)

Orographic turbulence

Clear Air Turbulence

Eddy Dissipation Rate (EDR)

0.2   0.3   0.4   0.5   0.6   0.7   0.8
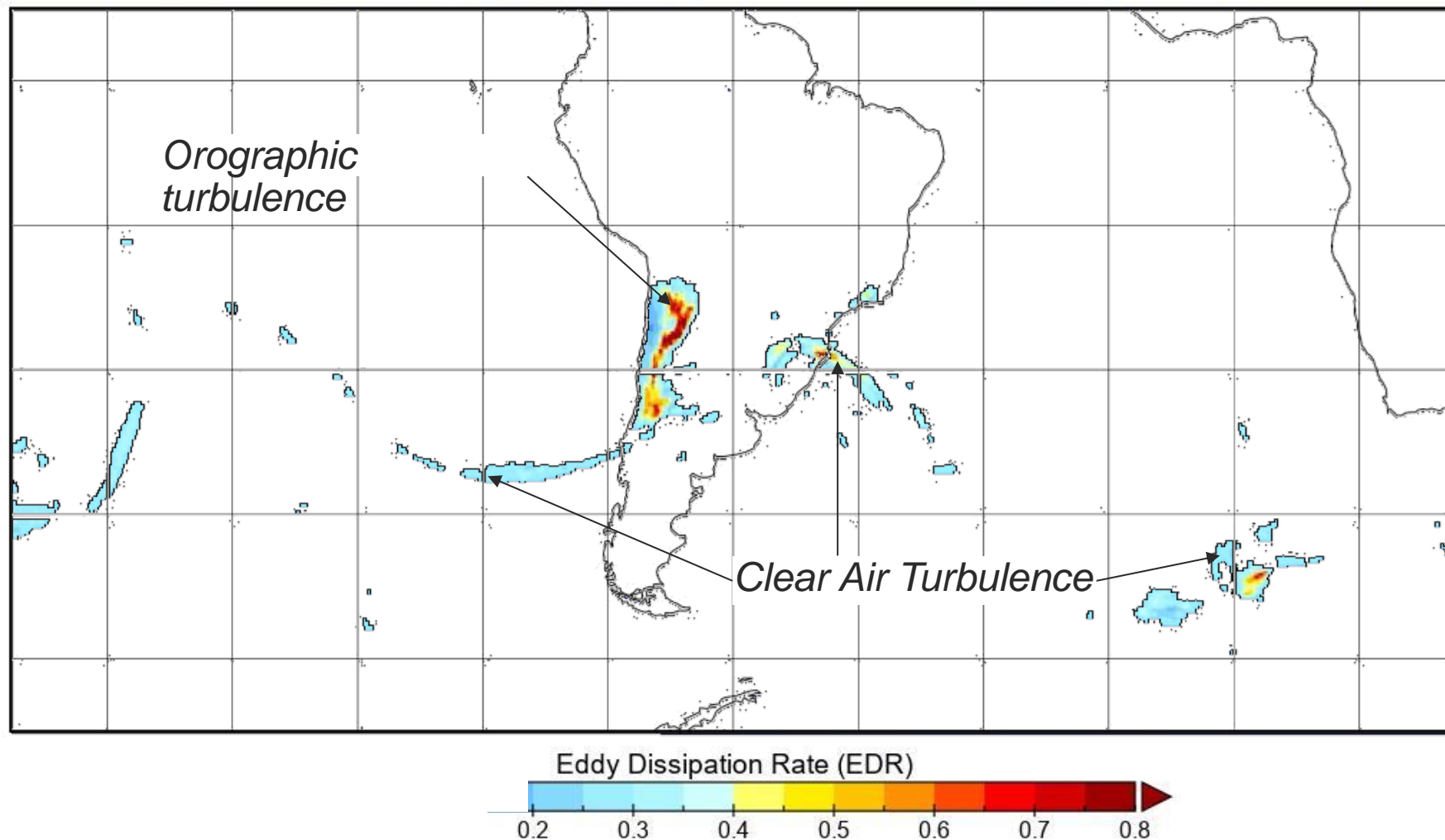
Whilst the Turbulence Severity field forecasts both Clear Air and Orographic turbulence it isn't possible to differentiate them using just one plot.

Examination of data at multiple levels and time steps, as well as applying meteorological principles will assist in the identification of the different types of turbulence.

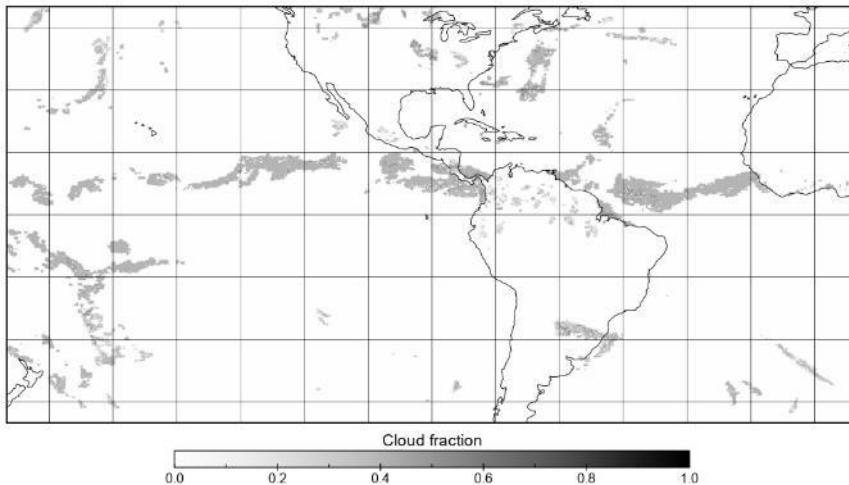# Cumulonimbus

CUMULONIMBUS DATA

Three separate CB data sets:

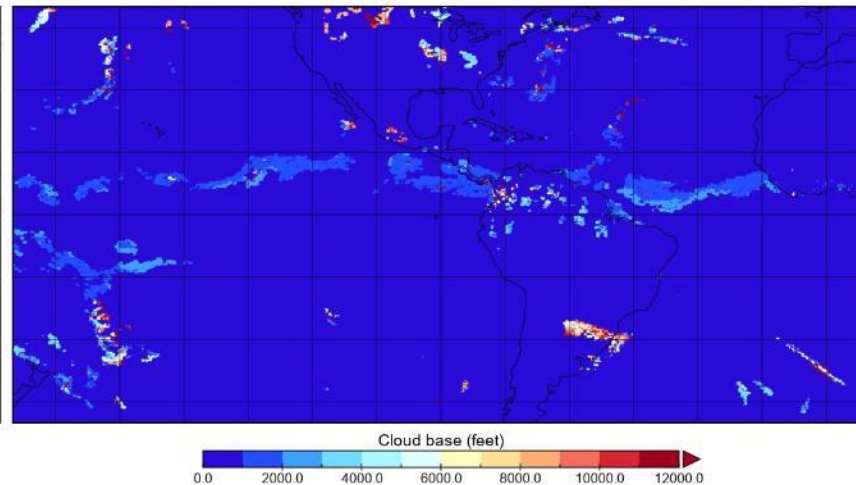Cumulonimbus Extent – which shows where CB are expected to occur

Cumulonimbus Base – which showed the forecast CB base (in feet or metres) using ICAO standard Atmosphere

Cumulonimbus Top – which shows the forecast CB top (in feet or metres) using ICAO standard Atmosphere
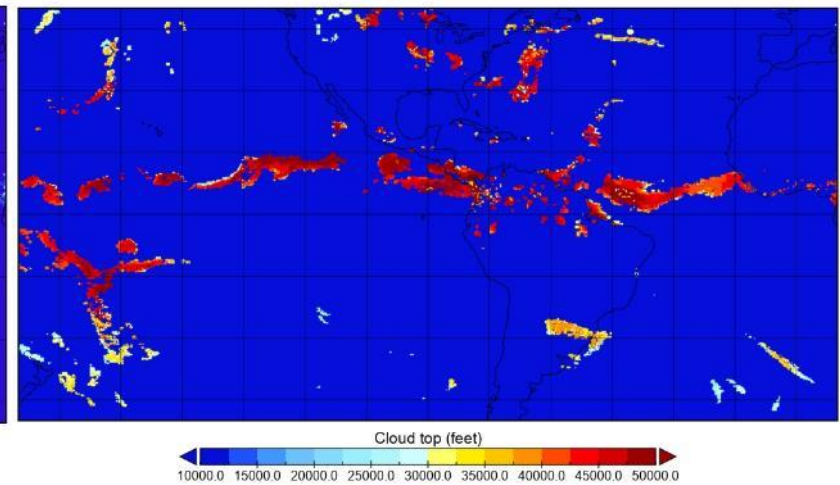

NEW 0.25 Horizontal extent of cumulonimbus

NEW 0.25 Height of Cumulonimbus base
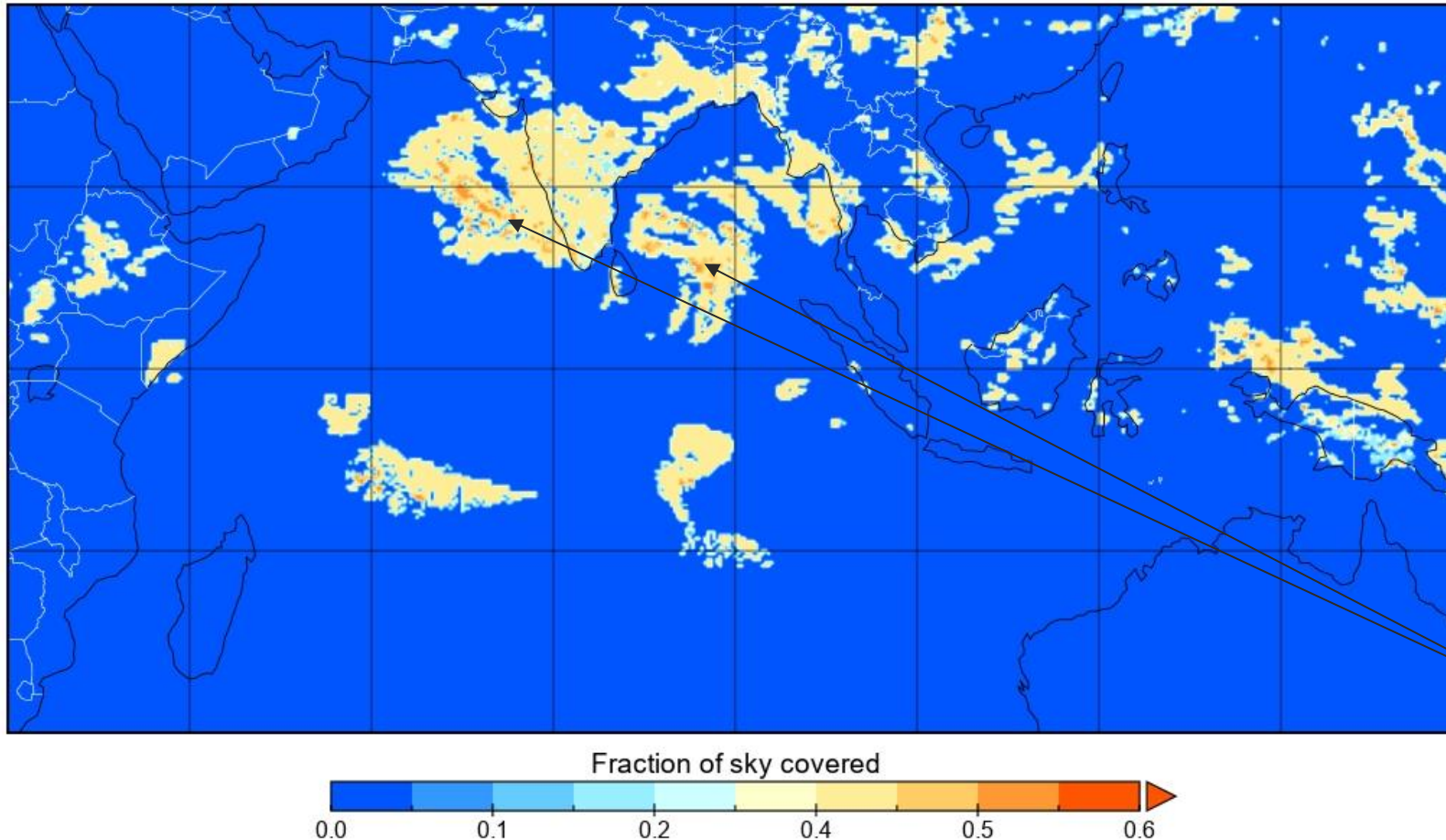
New 0.25 Cumulonimbus top

Cloud fraction
0.0 0.2 0.4 0.6 0.8 1.0

Cloud base (feet)
0.0 2000.0 4000.0 6000.0 8000.0 10000.0 12000.0

Cloud top (feet)
10000.0 15000.0 20000.0 25000.0 30000.0 35000.0 40000.0 45000.0 50000.0

Met Office

Horizontal extent of cumulonimbus

Fraction of sky covered

0.0   0.1   0.2   0.4   0.5   0.6

The cumulonimbus (CB) extent field is provided as the "fraction of sky covered". Values of 0.3 or higher generally indicate where CBs are forecast.

It is rare to see a fraction of sky covered value greater than 0.5, therefore this field cannot be used to determine whether the CB's will be SCT, BKN or OVC in amount.

A large area indicating CB's means that it is likely that there will be multiple CBs in that area

≋ Met Office

SUMMARY

The WAFC data sets should form part of the aviation forecasters toolkit

WAFC data can be ingested into flight planning software and used for fuel loading calculations and hazard anticipation/avoidance

The new WAFS gridded data with its extra timesteps and levels, and data out to 5 days provides the ability to look at the forecast conditions in greater detail.