



SESAR Harmonised Turbulence Polygon Features Guidance

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Introduction

The SESAR Harmonised Turbulence Service provides a blend of turbulence data from participating European Met Services to produce a single harmonised view of turbulence over Europe. The Polygon Features service exports this turbulence data as a series of geometric polygons or 'shapes', marking regions of low, moderate and severe intensity.

The SESAR Harmonised Turbulence Service is one of the outputs from the SESAR Deployment project 2015_068_AF5. The partners contributing to this operational service are DWD, Météo-France and the Met Office.



Polygon data and metadata

The Polygon Features service exports Harmonised Turbulence data as a series of geometric polygons or 'shapes' that consist of several vertices that are connected and closed. Polygons are 2-dimensional features used to represent the areas of different turbulence severity levels, with polygons marking regions of low, moderate and severe intensity.

Polygons are provided for the entire pan-European spatial area (no geographical sub-setting is applied).

Polygons are generated automatically from gridded Harmonised Turbulence data in GRIB2 format, normally every 6 hours.

Only the latest model run to successfully arrive is discoverable and available to be collected by end users via the https: API service. However, polygons are archived for up to 24 months and can be obtained in slow time via a Service Now request sent to the Met Office. (To arrange this, please contact 0370 900 0100 or use this [contact form on the Met Office webpages.](#))

Polygons are provided to end users in GeoJSON format as three datasets:

1. Severity level 1 (LOW)
2. Severity level 2 (MODERATE)
3. Severity level 3 (SEVERE)

These data sets contain the following pressure levels and forecast times:

- **Forecasts:**
 - Hourly forecasts between T+0 and T+24
 - Forecasts for T+27, T+30, T+33 and T+36

- **Pressure levels (hPa):**
 - 15000
 - 17500
 - 20000
 - 22500
 - 25000
 - 27500
 - 30000
 - 35000
 - 40000

Note that the metadata for each polygon describes forecast information such as:

- **Forecast reference time** - the time the forecast was issued
- **Forecast period** - this is the T+ n timestep
- **Forecast validity time** - the time the forecast is valid for, calculated from the forecast reference time + forecast period
- **Severity value (1 = light, 2 = moderate, 3 = severe)**
- **Vertical height** as pressure levels
- **Polygon unique identifier (order in which polygons are generated)**

GeoJSON Polygon Attributes	Example
Polygon ID	
Severity	Level 3 (Severe Turbulence)
Pressure (Pa)	Height Level 400hPa
Forecast Reference Time	05/05/2021 1200 UTC
Forecast Period	T+5h
Forecast Validity Time	05/05/2021 1700 UTC

Always verify polygons against data and check the polygon metadata header information for any warnings by omission of missing timesteps. The metadata header will only expose the timesteps that have been generated successfully, therefore if a timestep/s is missing then it should be concluded that they have failed to be generated for that time/s, NOT that there is no turbulence event at that time/s.

What do polygons represent?

Polygons represent severity levels exclusively

Note that each polygon severity level is exclusive from the others:

Polygons marking regions of severity level 1 and 2 may appear to have gaps where a region of stronger turbulence exists. Visualising all three polygon severity levels together will indicate stronger turbulence embedded within regions of lighter turbulence. Visualising all three polygon severity levels together is not owned by this service, the expectation is that this is owned by the end user and provisioned using their own resources.

For example:

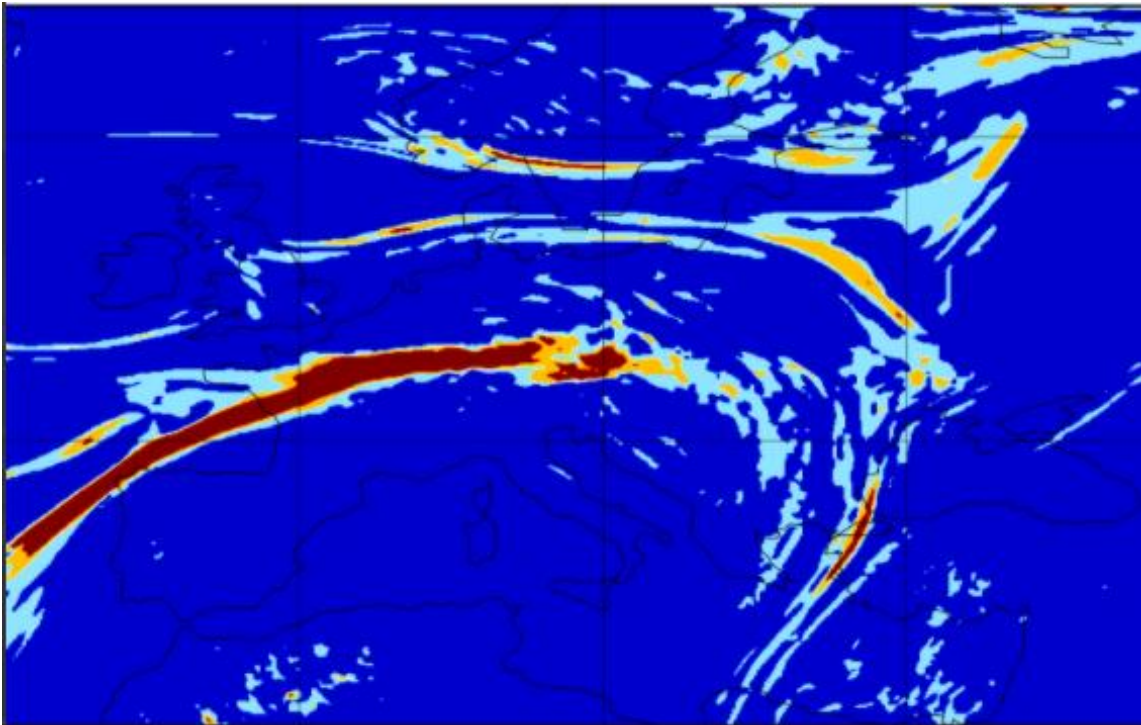


Figure 1. A sample of pan-European Turbulence Data (GRIB2) indicating regions of Severity Level 1 (cyan), 2 (amber), and 3 (red) turbulence.



Figure 2. The corresponding sample of pan-European polygon data marking the region of Severity Level 3 Turbulence



Figure 3. The corresponding sample of pan-European polygon data marking the region of Severity Level 2 Turbulence



Figure 4. The corresponding sample of pan-European polygon data marking the region of Severity Level 1 Turbulence

Smoothing artefacts

You may observe dashes appearing in polygon charts (Figure 5).

This occurs because of the smoothing resolution of the polygon formatting. Dashes indicate very small or narrow areas of turbulence, observable in the GRIB2 data.



Figure 5. GRIB2 turbulence data on the left, polygon data on the right, which displays dashes as a result of the smoothing resolution along a narrow region of Severity 1 Turbulence (thin band of light blue on the left).

Embedded regions of turbulence

Some regions of turbulence at a specific pressure level may contain pockets of airspace with differing levels of turbulence within them:

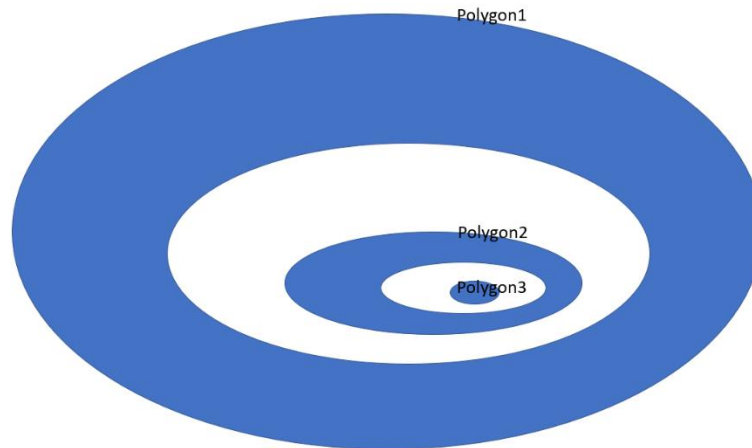


Figure 6. Diagram showing a rough schematic of how the turbulence polygons may theoretically appear when regions with differing levels of turbulence are embedded within each other at a specific pressure level.

How the Met Office IP69 Polygonalisation capability manages these pockets of Turbulence:

1. The Polygon generator follows the outline of the gridded Harmonised Turbulence exactly, this includes interior and exterior edges. It does not provide the capability to identify voids and fill them with a Turbulence severity (i.e. make up new forecast events).
2. There are occasions of forecast hazard events where there are regions of 'clean' airspace (i.e. without any turbulence) inside islands of Turbulence Severity 1 which need to be retained, this solution handles these events.

How accurately do the polygonal outlines map to the gridded data and can this be changed?

1. The resolution of the Polygons generated from the gridded data is a hard-coded single value but can be adjusted via a NORMAL release change, any change to this value would affect all users.
2. The resolution is currently set to epsilon 0.1 (50%), this value has been selected after iterative testing as it retains acceptable accuracy whilst keeping file sizes manageable. The finer the resolution the greater the file size and vice versa.
3. Preliminary Quality Assurance has been conducted and passed by laying the output polygons over the underlying gridded data on a mapping visualisation system.

Output

3 separate files based on severity value are generated and compressed by the Met Office IP69 Polygonalisation capability and exposed at unique https: endpoints:

1. Severity 1, T+0 to T+36 @1hr timesteps, all vertical levels, compressed (3MB as zip)
e.g. [sesar-harmonised-turbulence-polygons-severity-1-20210203060000.zip](#)
2. Severity 2, T+0 to T+36 @1hr timesteps, all vertical levels, compressed (0.6MB as zip)
e.g. [sesar-harmonised-turbulence-polygons-severity-2-20210203060000.zip](#)
3. Severity 3, T+0 to T+36 @1hr timesteps, all vertical levels, compressed (0.2MB as zip)
e.g. [sesar-harmonised-turbulence-polygons-severity-3-20210203060000.zip](#)

How to gain access to this service

Polygons are part of the SESAR IP69 Turbulence Hazard service, which also includes the provision of gridded data (GRIB2) and pre-defined sub-sets of gridded data (GRIB2). More information on how to access any or all of these data sets can be found on the [SWIM registry](#), or by contacting the Met Office [SESAR Services Manager](#). Please note, your organisation must be approved and you will need to set up account credentials – we recommend the use of a group business email address for this. More information can be found in the User Guide.

Collaboration with other partners of the SESAR Deployment project (IP069)

There is the possibility that Météo-France and/or DWD will use their own IP069 service capabilities to turn Harmonised Turbulence gridded data (GRIB2) into polygons and that they will expose it via their own services. To learn more about this, please contact the [SESAR Business Manager](#).

Other Frequently Asked Questions (FAQs)

1. How does an end user discover that polygons for a certain timestep in a file are absent because they have failed to be generated?

The meta data header of the polygon file includes all timesteps that are present in the file. If a timestep is missing in the header, it is also missing in the file. It is the user's responsibility to check the metadata of the file they are using and be aware of its completeness.

For example:

A file with all timesteps present:

0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,27,30,33,36

A file with forecast period 12 missing:

0,1,2,3,4,5,6,7,8,9,10,11,13,14,15,16,17,18,19,20,21,22,23,24,27,30,33,36

2. Can I download a single timestep in a file, that includes all turbulence severity levels at all vertical pressure levels?

The data is not available as "files per timestep" because the intention for the service is *to make all data available in a single payload, for users to save and filter for their own use in downstream services*. It is not built around an end user feeding the polygonal data directly into a visualisation system, this is partially because this user case can already be met by ingesting gridded (GRIB2) Turbulence data from SESAR IP69.

The service provisions a single payload that includes polygons for:

- all severity levels (1,2 & 3)
- all vertical pressure levels
- all timesteps

The image below shows Severity Level 3 Turbulence polygons for all timesteps for all vertical pressure levels displayed in geojson.io. The polygons are interrogatable and the metadata can be seen in the table in the image. Users have the flexibility to apply their own filtering methods to isolate data for their own needs.

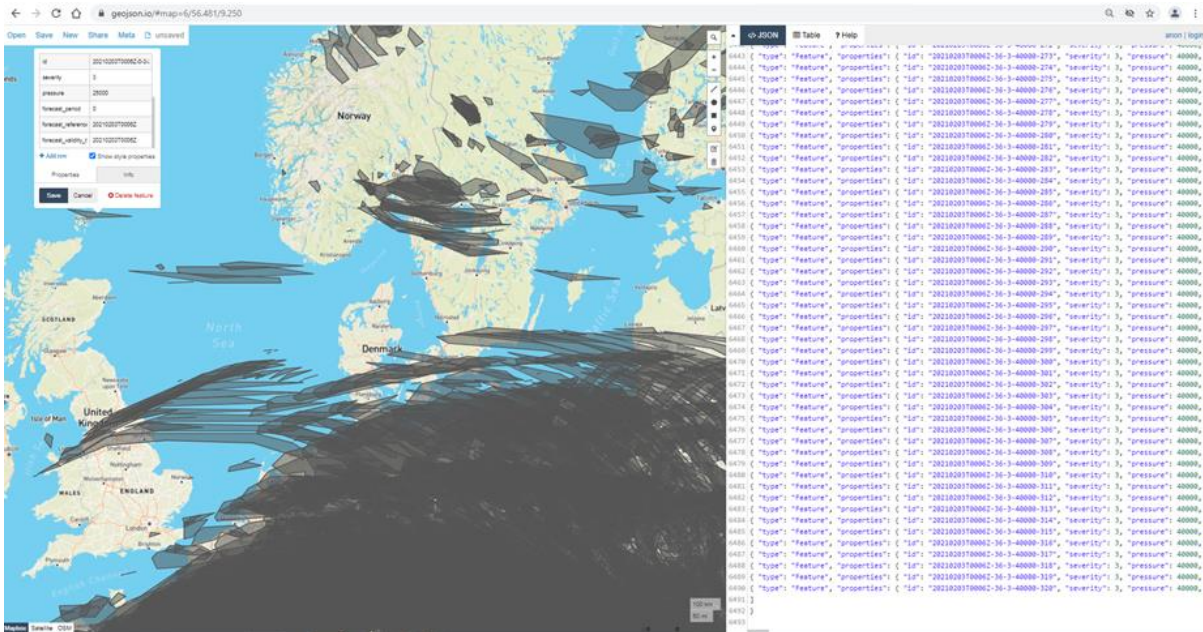


Figure 7. Image demonstrating visualisation of Severity Level 3 Turbulence polygons for all timesteps for all vertical pressure levels displayed in geojson.io.

3. Can I get a sample Polygon GeoJSON file from the Met Office, without having to sign up for the service?

Yes, please contact the [SESAR Services Manager](#) to request a sample of polygon data.

4. I understand that Météo-France and DWD are also contributors to this Service, do they offer a Polygons features service and are the polygons the same as the Met Office’s polygons?

Météo-France and DWD will also offer Polygons in their implementation of the Harmonised Weather Hazards service. These are likely to be for other hazardous weather parameters such as harmonised convective nowcasting and harmonised icing respectively, but it is possible they will also offer a polygon features service for other diagnostic types. However, each of the National Met services uses different polygon generation software, so the output polygons will be different. This can be seen as an advantage in many ways, because getting feedback from users who have access to a more diverse range of polygonal outputs will help the partners inform their knowledge about how polygons are used and ultimately improve the overall service output.