Aviation Meteorological Forecaster

(AMF)

Practical Course Notes

RTC Pretoria

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Scope

These course notes are used by Aviation Meteorological Forecaster (AMF) training within the Regional Training Centre (RTC) of the South African Weather Service (SAWS). The aviation course is aligned to the World Meteorological Organization (WMO), Aeronautical Meteorological Forecaster (AMF) competencies, which were ratified by the International Civil Aviation Organization (ICAO).

Objectives & Purpose

Objectives

The primary objective of these course notes is to facilitate and guide the learner in applying the AMF competency criteria of WMO within the workplace.

In addition, this document also links the individual competency criteria to the key learning outcomes/products of the practical training sessions.

- Analyze and diagnose the weather situation
- Compile and Issue of Take-off data and TREND forecasts
- Compile and Issue Terminal Aerodrome Forecast (TAF)
- Compile and Issue low and high level significant weather charts
- Compile and Issue warning products (SIGMETs, AIRMETs, Aerodrome Warnings and low level wind shear warnings).
- Communicate en-route weather forecast

The emphasis is on the general understanding of the synoptic circulation, prevailing weather systems and cloud formation and how this poses a hazard to aviation. Creative thinking, innovative skills, communication skills and group discussions are highly encouraged.

Purpose

The purpose of this course notes are to guide the learner through the Aviation Meteorological Forecaster (AMF) practical course in order to successfully complete job competencies required in the forecasting office work environment.

CHAPTER 1 Course Approach

1.1 Instructions

Practical exercises in the form of tasks are given weekly in order to encourage learners to develop the required practical forecasting competency essential in the workplace. Tasks are emailed to the lecturer as soon as they are done so that it can be marked for feedback (see point 1.6).

1.2 Resources and Tools to be used

Synoptic surface and upper air weather charts, MeteoSat Second Generation (MSG) Satellite imagery, Radar imagery, Numerical Weather Prediction (NWP) models (WAFs manipulated with WINGRIDDS and Unified model data), Tephi/SkewTgrams, AMDAR, and all observational data such as METARs/SYNOPs/SPECIs.

1.3 Consultation hours

An appointment must be made by the student to consult with the lecturer. It is highly recommended to work continuously to avoid disappointment.

1.4 Maintaining the Standard

International aviation industry regulations require that aeronautical products and services be provided by the member state. The International Civil Aviation Organization (ICAO) is responsible in setting the international standards for aviation. The South African Weather Service (SAWS) as a MET Service Provider of aeronautical meteorological information, is obliged to comply with the international standards determined by ICAO and the World Meteorological Organization (WMO). The latest edition of ICAO Annex 3 outlines the required standards for meteorological services. Furthermore, WMO developed second level competencies for Aeronautical Meteorological Forecasters (AMF), which was ratified by ICAO. These became an industry standard at the end of November 2013 and all AMF have to comply and be subjected to regular competency assessments on the job. The frequency with which SAWS undertakes these workplace assessments are according to the scope of the Quality Management System (QMS).

1.5 WMO Top Level Competencies for Aeronautical Meteorological Forecasters (AMF)

The following 5 top level competencies have to be adhered to by AMF (CAeM, 2018). Each competency description has competency performance criteria, which are applied by AMF on the job. The numbering of the assessment criteria of the competencies as outlined in this section will be used to refer to the competencies in the rest of the document.

1.5.1. Analyze and Monitor continuously the weather situation

Competence description

Observations and forecasts of weather parameters and significant weather phenomena are monitored to determine the need for issuance, cancellation or amendment/update of forecasts and warnings according to documented thresholds and regulations.

Performance criteria

1.1 Analyse and diagnose[1] the weather situation as required in forecast and warning preparation.

1.2 Monitor weather parameters and evolving significant weather phenomena (as defined in latest version of International Civil Aviation Organization (ICAO) Annex 3) and validate current forecasts and warnings based on these parameters.

1.3 Appraise the need for amendments to forecasts and updates of warnings against documented criteria and thresholds.

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[1] "Analysis" may be defined as answering the question "what is happening?", and "diagnosis" as answering "why is it happening?"

Chapter 2 of this document addresses this competency.

1.5.2. Forecast Aeronautical Meteorological phenomena and parameters

Competence description

Forecasts of meteorological parameters and phenomena are prepared and issued in accordance with documented requirements, priorities and deadlines.

Performance criteria

2.1 Forecast the following weather phenomena and parameters:

2.1.1 temperature and humidity.

2.1.2 wind including temporal and spatial variability (wind-shear, directional variability and gusts)

2.1.3 QNH.

2.1.4 cloud (types, amounts, height of base and vertical extent).

2.1.5 precipitation (intensity, onset and duration, amount and types), and associated visibilities.

2.1.6 fog or mist, including onset and duration, and associated reduced visibilities.

2.1.7 other types of obscuration, including dust, smoke, haze, sand-storms, dust-storms, blowing snow, and associated visibilities.

2.1.8 hazardous weather phenomena listed in Performance criterion 3.1.

2.1.9 wake vortex advection and dissipation, as required.

2.2. Ensure that forecasts are prepared and issued in accordance with ICAO Annex 3, WMO-No.49, regional and national formats, codes and technical regulations on content, accuracy and timeliness.
2.3. Ensure that forecasts of weather parameters and phenomena are consistent (spatially and temporally) across boundaries of the area of responsibility as far as practicable, whilst maintaining meteorological integrity. This will include monitoring forecasts issued for other regions, and liaison with adjacent regions as required.

Chapter 3 of this document addresses this competency.

1.5.3. Warn of hazardous phenomena

Competence description

Warnings are issued in a timely manner when hazardous conditions are expected to occur or when parameters are expected to reach documented threshold values, and updated or cancelled according to documented warning criteria.

Performance criteria

3.1. Forecast the following hazardous weather phenomena, including spatial extent, onset, duration, and intensity:

3.1.1 thunderstorms, particularly organized systems, including associated turbulence, in-flight icing, hail, heavy precipitation with poor visibility, electrical phenomena, down-burst/microburst or gust front, tornadic activity

3.1.2 turbulence (moderate or greater), including onset and duration, intensity, spatial extent, type (orographic, mechanical, convective and clear air turbulence).

3.1.3 moderate and severe low-level wind shear.

3.1.4 aircraft icing (moderate or greater), including onset and duration, intensity, accumulation rate, spatial extent, type (rime or opaque, glaze or clear, freezing rain, hoar frost, mixed ice).

3.1.5 hazardous phenomena affecting aerodromes such as: strong surface winds including cross-winds and squalls, frost, freezing precipitation, snowfall, lightning, wake vortices.

3.1.6 sand- and dust storms.

3.1.7 volcanic ash based on observations and/or advisory products.

3.1.8 tropical cyclones.

3.2. Ensure that warnings are prepared and issued in accordance with thresholds for hazardous weather, and with ICAO Annex 3, WMO-No.49, regional and national formats, codes and technical regulations on content, accuracy and timeliness.

3.3. Ensure that warnings of hazardous weather phenomena are consistent (spatially and temporally) across boundaries of the area of responsibility as far as practicable, whilst maintaining meteorological integrity. This will include monitoring forecasts issued for other regions, and liaison with adjacent regions as required.

Chapter 4 of this document addresses this competency.

1.5.4. Ensure the quality of Meteorological information and services

Competence description

The quality of meteorological forecasts, warnings and related products is ensured at the required level by the application of documented quality management processes.

Performance criteria

4.1. Apply the organization’s quality management system and procedures.

4.2. Assess the impact of known observational error characteristics (e.g. bias, achievable accuracy of observations and sensing methods) on forecasts and warnings.

4.3. Validate aeronautical meteorological data, products, forecasts and warnings (timeliness, completeness, accuracy) using real-time checks.

4.4. Monitor the functioning of operational systems and take remedial actions when necessary.

Chapter 5 of this document addresses this competency.

1.5.5. Communicate Meteorological information to internal and external users.

Competence description

User requirements are fully understood and are addressed by communicating concise and complete forecasts/warnings in a manner that can be clearly understood by the users.

Performance criteria

5.1. Ensure that all forecasts/warnings are disseminated through the authorized communication means and channels to designated user groups.

5.2. Explain2 aeronautical meteorological data and information, deliver weather briefings and provide consultation to meet specific user needs.

Chapter 6 of this document addresses this competency.

CHAPTER 2 AMF Competency 1:

Analyze and Monitor continuously the weather situation

As per section 1.5 of this document, to analyze and monitor the weather situation is the first competency that an AMF must achieve. This competency appears first because it is also the first logical step in the forecast process.

2.1 What is analyze and diagnose the weather?

Competency 1.1 states: **AMF AC 1.1:** *Analyse and diagnose the weather situation as required in forecast and warning preparation* (CAeM, 2018).

Analysis may be defined as answering the question **"What is happening in the weather"**.

In order to do this you have analyse the weather situation (surface chart, upper air chart, satellite imagery and real time observations). This is normally done by analysing a surface and upper air synoptic chart (observational analysis). Satellite imagery is also used in conjunction with the chart to identify the main weather systems driving the current weather. The forecaster can then determine how these weather systems are causing the cloud and other phenomena (dust, haze, air-masses, etc.), visible on the satellite image and the hazard it poses to aviation.

In order to **diagnose** the weather situation the AMF must answer the question **"Why is the weather happening"**.

Reference is made to what weather systems are playing a part to cause cloud and other phenomena observed on the satellite image and link to all other observational data such as Tephigrams or Skew-T grams, AMDAR, METARs and so on in order to show that you understand why the weather is happening and how it relates to the forecasting of aviation weather hazards. If you want to know what is going to happen with the future weather, you need to know what is currently happening otherwise you will not understand why the output of the NWP looks the way it does, nor be able to verify NWP output at the initial time steps.

One way to ensure that you as an AMF address this competency is to write an inference (5-10 lines) explaining what is happening in the weather and why is it happening by also referring to the Aviation Weather Hazards (observed or forecast). Make sure to refer to real time data and NWP model analysis fields in order identify the main weather systems affecting the forecast over the next 2 days. Add any observed AIRMET/SIGMET and imminent Aerodrome Warnings. This competency will be assessed practically in

Question 1 of every task, test and exam.

2.2 Example of an inference for aviation addressing analysis and diagnosis of the weather:

The dominant weather system at the surface is a cold front situated over the south-western Cape as seen by a cloud band on the satellite imagery (Day Natural Colours RGB, Airmass RGB and IR10.8) at 0600Z. This cold front is currently causing rain as reported on the 06Z surface chart. The surface cold front is causing low level clouds resulting in rain as well as middle level clouds. These low level clouds are a hazard to aviation and the issue of an observed visibility (<5000m) AIRMET and cloud base below 1000 feet AIRMET needs to be issued and investigated how long it will persist. Ahead of the cold front is a convective cloud band over the Northern-Cape, Eastern-Cape, North-West and the Free-State (as seen on the convective storms RGB containing a few embedded CB), associated with a surface trough which is situated over the central parts of Namibia and an upper air trough which is located over the western interior of South Africa (also part of the dominant weather system). The convective cloud development will result in an observed embedded CB SIGMET and aerodrome warnings for thunderstorms need to be considered in this band. Ahead of the cold front is a coastal low pressure system in the George area which is associated with the surface trough. Behind the cold front is the Atlantic high pressure system and as the cold front moves eastwards the high pressure system is expected to ridge in from the west.

2.3 Monitoring weather parameters and significant weather phenomena

Competency 1.2 states: **AMF AC 1.2:** ***Monitor*** *weather* ***parameters*** *and evolving* ***significant weather phenomena*** *(as defined in latest version of ICAO Annex 3) and validate current forecasts and warnings based on these parameters* (CAeM, 2018).

In order to do this the AMF has to continually monitor the real time data (observations and remotely sensed data) and validate the currently issued forecasts and warnings. The significant weather criteria will then be used in order to amend these forecasts. This criteria is outlined in section 3.3:

When monitoring forecasts, especially TAFs, the following criteria need to be applied for the issue of amendments to forecasts (WMO, 2016).

1. when the mean surface wind direction is forecast to change by 60° or more, the mean speed before and/or after the change being 5 m/s (10 KT) or more;

2. when the mean surface wind speed is forecast to change by 5 m/s (10 KT) or more;

3. when the variation from the mean surface wind speed (gusts) is forecast to change by 5 m/s (10 KT) or more, the mean speed before and/or after the change being 7.5 m/s (15 KT) or more;

4. when the surface wind is forecast to change through values of operational significance. The threshold values should be established by the meteorological authority in consultation with the appropriate ATS authority and operators concerned, taking into account changes in the wind, which would:

   a. require a change in runway(s) in use; and

   b. indicate that the runway tailwind and crosswind components will change through values representing the main

   c. operating limits for typical aircraft operating at the aerodrome;

6. when the visibility is forecast to improve and change to or pass through one or more of the following values, or when the visibility is forecast to deteriorate and pass through one or more of the following values:

   a. 150, 350, 600, 800, 1500 or 3000 m; or

   b. 5 000 m in cases where significant numbers of flights are operated in accordance with the visual flight rules;

8. when any of the following weather phenomena or combinations thereof are forecast to begin or end:

   a. low drifting dust, sand or snow

   b. blowing dust, sand or snow

   c. squall

   d. funnel cloud (tornado or waterspout);

9. when the height of base of the lowest layer or mass of cloud of BKN or OVC extent is forecast to lift and change to or pass through one or more of the following values, or when the height of the lowest layer or mass of cloud of BKN or OVC extent is forecast to lower and pass through one or more of the following values:

   a. 30, 60, 150 or 300 m (100, 200, 500 or 1 000 ft.); or

   B. 450 m (1500 ft.) in cases where significant numbers of flights are operated in accordance with the visual flight rules;

10. when the amount of a layer or mass of cloud below 450 m (1500 ft.) is forecast to change:

   a. from NSC, FEW or SCT to BKN or OVC; or

b. from BKN or OVC to NSC, FEW or SCT;

11. when the vertical visibility is forecast to improve and change to or pass through one or more of the following values, or when the vertical visibility is forecast to deteriorate and pass through one or more of the following values: 30, 60, 150 or 300 m (100, 200, 500 or 1 000 ft); and

12. any other criteria based on local aerodrome operating minima, as agreed between the meteorological authority and the operators.

This competency will be assessed practically in Question 2 (Take-off data and TREND), 4 (warnings) and 5 (TAFs) of every task, test and exam.

AMF AC 1.3: *Appraise the need for **amendments** to forecasts and updates of warnings against documented criteria and thresholds*

This can be done if you have monitored the weather continuously (AMF AC 1.2) and by applying the amendment criteria for significant weather.

This competency will be assessed practically in Question 2 (Take-off data and TREND), 4 (warnings) and 5 (TAFs) of every task, test and exam.

2.4 Aircraft Observation and Special Air Reports (AIREP)

This is useful in data sparse areas, especially in reporting volcanic ash, wind shear and turbulence.

See http://tqm.saws.local/qms/Documents_View/Aviation_Docs.htm for the template for special air reports (AWC-FRM-SAR-001)

2.4.1 AMDAR

A substantial proportion of upper-air wind and temperature information is obtained through the WMO aircraft meteorological data relay (AMDAR). The website to access the global AMDAR is:
https://amdar.noaa.gov/java/

User name: sAfrica

Password: SAP

Use the non-java option because the java script often does not want to display the login details.

An example of this dataset is shown in Fig.1.

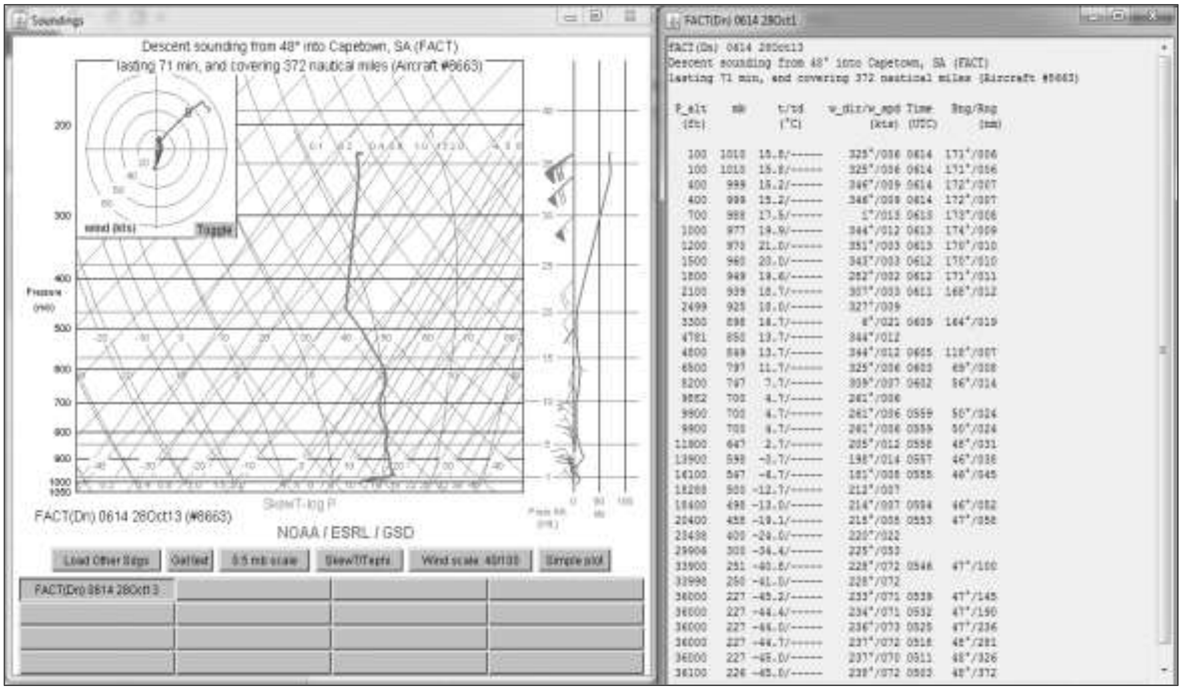


Figure 1: Example of AMDAR data

Low level wind profiles from AMDAR Data (below FL100)

AMDAR data received from domestic airlines (SAA mostly) are processed and a height vs temperature profile with wind at each height level is plotted as graph and made available on the aviation website through a web interface/page at the following address:

http://aviation.weathersa.co.za/Docs/amd/amdlowlevel.html

Low level profiles are useful for identifying inversions, turbulence, low-level wind shear and can be used as validation for issuance of wind shear warnings, SIGMET/AIRMET for turbulence and to evaluate NWP.

CHAPTER 3 AMF Competency 2:

Forecast the following weather phenomena and parameters

The actual forecasting process can only be done once you have completed the first competency and understand what is happening in the weather and why it is happening (observations and NWP analysis field data).

Forecasts of meteorological parameters and phenomena are prepared and issued in accordance with documented requirements, priorities and deadlines. This is done using prognostic (predictive) NWP model output focussing on those weather systems, which are driving the weather noted in competency 1.

Forecasts for aviation are done for an aerodrome or along a flight route. An aerodrome forecast is a concise statement of expected meteorological conditions at an aerodrome. Owing to the variability of meteorological elements in space and time, the limitation of forecasting techniques, and the limitations caused by the definitions of some of the individual meteorological elements (e.g. surface wind, weather), the specific value of any forecast element is to be understood as being the most probable value which the element is likely to assume during the period of the forecast. Similarly, when the time of occurrence or change of an element is given in a forecast, this is to be understood to be the most probable time (ICAO Annex 3, latest addition).

According to AMF competency criteria 2, the following weather phenomena and parameters need to be forecast:

The competency criteria numbering in the rest of the document will follow the numbering outlined in section 1.5 of this document.

AMF AC 2.1.1 - temperature (Done in Take-off data and TAFs) and **humidity** (Forecast in Significant weather charts and TAFs)
AMF AC 2.1.2 - wind including **temporal and spatial variability** (wind-shear, directional variability and gusts) (Forecast in Take-off data, TAFs) (warned for in Wind Shear warning).
AMF AC 2.1.3 - QNH (Forecast in Take-off data).
AMF AC 2.1.4 - cloud (types (Forecast in Significant weather charts and TAFs), **amounts** (forecast in Significant weather charts and TAFs), **height of base** (Forecast in Significant weather charts and TAFs) and **vertical extent** (Forecast in Significant Weather Charts) (warn for AIRMET if below 1000 ft).
AMF AC 2.1.5 - precipitation (intensity (Forecast in TAFs and Significant Weather Charts), **onset and**

duration (Forecast in TAFs and Significant Weather Charts), **amount and types** (Forecast in TAFs, Significant Weather Charts), and **associated visibilities** (Forecast in TAFs, Significant Weather Charts), (warn in AIRMET for reduced visibility).

AMF AC 2.1.6 - fog or mist (Forecast in TAFs and Significant Weather Charts), including **onset and duration** (Forecast in TAFs and Significant Weather Charts), and **associated reduced visibilities** (Forecast in TAFs, Significant Weather Charts) (warn in AIRMET for reduced visibility).

AMF AC 2.1.7 - other types of obscuration, including dust, smoke, haze, sand-storms, dust-storms, blowing snow, and associated visibilities (Forecast in TAFs and Significant Weather Charts) (dust - warn in AIRMET for reduced visibility) (dust - warn in SIGMET if heavy).

AMF AC 2.1.8 - hazardous weather phenomena listed in Performance criterion 3.1 (Forecast in SIGMET, AIRMET, Aerodrome warnings and Low level wind shear warnings)

AMF AC 2.1.9 - wake vortex advection and dissipation, as required (This is not done due to no equipment to forecast this)

AMF AC 2.2: *Were forecasts prepared and issued in accordance with ICAO Annex 3, WMO-No.49, regional and national formats, codes and technical regulations on content, accuracy and timeliness.*

The accuracy of aeronautical forecasts depends upon the accuracy, spacing and frequency of available observations, the period of the forecast and various factors associated with analysis and forecasting techniques. Guidance on the operationally desirable accuracy of aeronautical forecasts is contained in the latest version of ICAO Annex 3.

Table 1: Operationally desirable accuracy of aeronautical forecasts (TAF, TREND, Take-off, area, flight and route forecasts) (WMO, 2016)

TAF		
Forecast parameter	Operationally desirable accuracy of forecasts	Minimum percentage of cases within range
Wind direction	+- 20°	80% of cases
Wind speed	+- 5KT or 10 km/h	80% of cases
Visibility	+- 200 m up to 800 m +- 30% between 800 m and 10 km	80% of cases
Precipitation	Occurrence or non-occurrence	80% of cases
Cloud amount	One category below 450 m (1500 ft)	70% of cases

	Occurrence or non-occurrence of BKN or OVC between 450 m (1500 ft) and 3000 m (10000 ft)	
Cloud height	+-30 m (100 ft) up to 300 m (1000ft) +-30% between 300 m (1000 ft) and 3000 m (10000 ft)	70% of cases
Air Temperature	+- 1°C	70% of cases
TREND		
Forecast parameter	Operationally desirable accuracy of forecasts	Minimum percentage of cases within range
Wind direction	+- 20°	90% of cases
Wind speed	+- 5KT or 10 km/h	90% of cases
Visibility	+- 200 m up to 800 m +- 30% between 800 m and 10 km	90% of cases
Precipitation	Occurrence or non-occurrence	90% of cases
Cloud amount	One category below 450 m (1500 ft) Occurrence or non-occurrence of BKN or OVC between 450 m (1500 ft) and 3000 m (10000 ft)	90% of cases
Cloud height	+-30 m (100 ft) up to 300 m (1000 ft) +-30% between 300 m (1000 ft) and 3000 m (10000 ft)	90% of cases
Forecasts for Take-off		
Forecast parameter	Operationally desirable accuracy of forecasts	Minimum percentage of cases within range
Wind direction	+- 20°	90% of cases
Wind speed	+- 5KT up to 25KT	90% of cases
Air Temperature	+- 1°C	70% of cases
Pressure value	+- 1 hPa	90% of cases
Area, flight and route forecasts		
Forecast parameter	Operationally desirable accuracy of forecasts	Minimum percentage of cases within range

Significant en-route weather phenomena and cloud	Occurrence or non-occurrence Location: +- 100 km Vertical extent: +- 300 m or 1000 ft Flight level of Tropopause: +- 300m or 1000 ft Max wind level: +-300m or 1000 ft	80% of cases 70% of cases 70% of cases 80% of cases 80% of cases

These different types of forecast parameters and phenomena are addressed in the different AMF forecast products. See if you can identify them.

3.1 Type and validity of Aeronautical Meteorological Forecasts, Warnings and Advisories

There are different types of aeronautical forecasts designed to meet requirements for the various stages of flight planning. They differ in respect of area or airspace covered and in respect of the offices preparing and issuing them. Although TAFs give specific forecast information; SIGMET and AIRMET information, aerodrome warnings and wind shear warnings may refer to existing (observed) as well as expected conditions (forecast).

Table 2: Type and validity of Aeronautical Forecasts used by AMF

TYPE: FORECAST/ WARNING/ ADVISORY	**AREA AIRSPACE COVERED**	**STAGE OF FLIGHT PLANNING**	**VALIDITY PERIOD OR FIXED TIME**	**RESPON SIBILITY**	**AMF Competency addressed**
Take Off Forecast	**Runway Complex**	**Pre flight**	**Specified Period, Usually short**	**AMO**	**AMF Competency 2: Wind (AMF AC 2.1.2), Temp (AMF AC 2.1.1) and QNH (AMF AC 2.1.3).**
Landing TREND	Aerodrome	In flight	2 Hours	AMO	AMF Competency 2:
TAF	Aerodrome	Pre and In flight	From 6 to 30 Hours	Aviation Meteorolo	AMF Competency 2: Wind (AMF AC 2.1.2),

			Inclusive	gical Office (AMO)	Visibility (AMF AC 2.1.6), Temp (AMF AC 2.1.1), cloud (humidity) cloud base and cloud type (AMF AC 2.1.4), precipitation onset and duration (AMF AC 2.1.5) and associated visibilities (AMF AC 2.1.6)
SIGMET	FIR OR Control Areas	Pre Flight and in flight	Not more than 4 Hours	MWO (Meteorol ogical Watch Office)	AMF AC 3.1.1, 3.1.2, 3.1.4, 3.1.6
SIGMET for Volcanic Ash and Tropical cyclones	FIR OR Control Area	Pre Flight and in flight	6 Hours	MWO	AMF AC 3.1.7 and 3.1.8
AIRMET	FIR OR Control Area up to FL100 (FL150 In Mountains)	Pre Flight and in flight	Not more than 4 Hours	MWO	AMF AC 3.1.1, 3.1.2, 3.1.4, 3.1.6
Aerodrome warnings	Aerodrome surface conditions	Parked Aircraft and Buildings	Usually not more than 24 Hours	AMO	AMF AC 3.1.5
Wind Shear Warnings	Aerodrome and Approach/T akeoff between runway and 500M(1600 FT)	In Flight	For as long as Wind shear is expected to last	AMO	AMF AC 3.1.3
Volcanic ash	Area	Pre Flight	18 Hours	VAAC	AMF AC 3.1.7

Advisories	affected by Volcanic Ash	and in flight			
Tropical Cyclone Advisories	Area affected by Tropical cyclone	Pre Flight and in flight	24 Hours	TCAC	AMF AC 3.1.8
EN ROUTE Forecast	Routes at Applicable Levels	Pre Flight and in flight	00Z, 06Z, 12Z, 18Z, Valid 3 Hours on either side of this time	AMO	AMF AC 5.2

3.2 Forecast for Take-Off (AMF AC 1.2, 1.3, 2.1.1, 2.1.2, 2.1.3, 4.2, 4.3)

A forecast issued to an airline for take-off contains information on expected conditions over the runway complex in regard to surface wind (AMF AC 2.1.2) and variations there-off, temperature (AMF AC 2.1.1), pressure (QNH) (AMF AC 2.1.3) and other elements. It is supplied on request to operators or flight crew members within the three hours before the expected time of departure (ETD) and the AMF must keep these forecasts under continuous review and issue necessary amendments promptly (latest ICAO Annex 3) (AMF AC 1.2 and 1.3).
The AMF must ensure that forecasts are prepared and issued in accordance with latest version of ICAO Annex 3, WMO-No.49, regional and national formats, codes and technical regulations on content, accuracy and timeliness (AMF AC 2.2) (CAeM, 2018).

The AMF must ensure that forecasts of weather parameters and phenomena are consistent (spatially and temporally) across boundaries of the area of responsibility as far as practicable, whilst maintaining meteorological integrity. This will include monitoring forecasts issued for other regions, and liaison with adjacent regions as required (AMF AC 2.3) (CAeM, 2018).

3.2.1 Take-off Data

Take-off data shall be prepared by the meteorological office designated by the meteorological authority concerned as agreed between the meteorological authority and the operators concerned (WMO, 2016) (latest edition of ICAO Annex 3).

Recommendation - A forecast for take-off should refer to a specified period of time and should contain information on expected conditions over the runway complex in regard to surface wind direction and speed and any variations thereof, temperature, pressure (QNH), and any other elements as agreed locally (latest edition of ICAO Annex 3).

Recommendation - A forecast for take-off should be supplied to operators and flight crew members on request within the 3 hours before the expected time of departure (latest edition of ICAO Annex 3).

Recommendation – Aerodrome meteorological offices preparing forecasts for take-off should keep the forecasts under continuous review and, when necessary, should issue amendments promptly.

<u>Format of forecasts for take-off (AMF AC 2.2):</u>
Recommendation - The format of the forecast should be as agreed between the meteorological authority and the operator concerned. The order of the elements and the terminology, units and scales used in forecasts for take-off should be the same as those used in reports for the same aerodrome (WMO, 2016).

<u>Amendments to forecasts for take-off (AMF AC 1.2 and 1.3):</u>
Recommendation - The criteria for the issuance of amendments for forecasts for take-off for surface wind direction and speed, temperature and pressure (and any other elements agreed locally), should be agreed to between the meteorological authority and the operators concerned. The criteria should be consistent with the corresponding criteria for special reports (SPECI criteria) established for the aerodrome (WMO, 2016) unless otherwise agreed to with operators concerned. In South Africa the 'Operationally desirable accuracy of aeronautical forecasts' for take-off data in Table 1, has been agreed to with operators concerned.

3.2.2 Procedure to issue Take-off data forecast

The forecast process for compiling take-off data for temperature, wind and QNH will be demonstrated using a case study for the fictitious forecast period 08h00Z to 18h00Z (Note: this forecast period differs at forecasting offices and will be specified when you start to work). In the operational environment the AMF will have access to the latest graphs of actual temperature, wind and QNH which makes the monitoring of the forecast easier than in the training environment.

Table 3 indicates the forecast take-off data. This data is used to explain forecast process for compiling take-off data for Temperature (AMF AC 2.1.1), wind speed and direction (AMF AC 2.1.2) and QNH (AMF AC 2.1.3) referred to in each of the columns in Table 3.

Table 3: Forecast Take-off data for OR Tambo International Airport:

TAKE-OFF DATA FOR OR TAMBO INTERNATIONAL AIRPORT ON --/--/----					
TIME	**TEMP in °C forecasted (AMF AC 2.1.1)**	**QAN in KT forecasted (AMF AC 2.1.2)**	**QNH in hPa forecasted (AMF AC 2.1.3 and AMF AC 4.2 and 4.3) Bias correction +9 hPa**	**Monitoring (AMF AC 1.2 and 4.3) State values observed**	**Amend Forecast (AMF AC 1.3) (Yes or No) and state why by referring to specific amendment criteria**
08Z	15	04006	1022	15, 04006KT, 1022	NO, the forecast and observed values are within the THRESHOLD criteria.
09Z	16	04006	1022	17, 02009KT, 1021	NO, the forecasted and observed values are within the THRESHOLD criteria.
10Z	17	33008	1021	18, 36007KT, 1021	NO, the forecasted and observed values are within the SPECI criteria.

11Z	19	33008	1021		
12Z	20	33008	1020		
13Z	21	33008	1020		
14Z	20	33008	1020		
15Z	19	33008	1021		
16Z	18	33008	1021		
17Z	18	33008	1021		
18Z	17	33008	1021		

3.2.2.1 Forecasting Temperature in Take-off data (AMF AC 2.1.1, 1.2, 1.3 and 4.3)

The first step in the forecast process for take-off data is to forecast temperature. Consider the previous three hourly METARs for OR Tambo international Airport (in this example 06h00Z, 07h00Z and 08h00Z). The METARs are as follows:

METAR FAOR 110600Z 11008KT 6000 -RA BKN005 SCT035TCU 14/13 Q1022 RESHRA TEMPO 4000 -SHRA=

METAR FAOR 110700Z 11005KT 060V140 4000 -RA BKN005 SCT040TCU 14/13 Q1022 TEMPO 3000 SHRA=

METAR FAOR 110800Z 04006KT 6000 -RA FEW010 FEW040TCU 15/14 Q1022 TEMPO 3000 SHRA=

Table 3 indicates a forecast temperature of 20°C at 12h00Z for FAOR. Evaluate the F+12 hr WAFs (World Area Forecast) NWP model predicted 2m temperature for 12h00Z initialized at 00h00Z as seen in Fig. 2. The temperature is low for November, but makes meteorological sense since the forecast is for a cloudy day. The 08h00Z satellite image indicates cloudy conditions. These conditions will persist throughout the day according to the forecast. The cloud will block incoming solar radiation and result in a lower maximum temperature than the climatic average for Johannesburg (Check Geography and Climatology subject climatic average for Johannesburg).

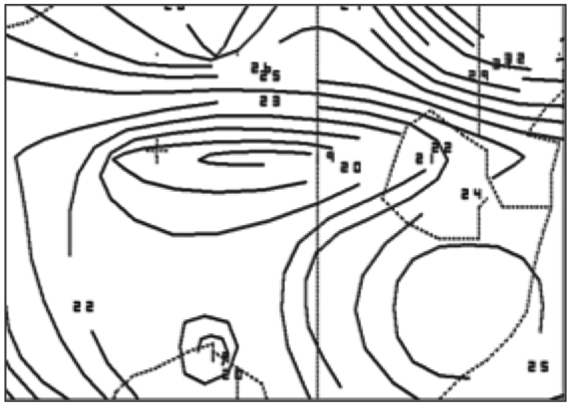


Figure 2: Forecast 2m temperatures (purple lines) for 12h00Z (F12) from the WAFs NWP model initialized at 00h00Z of the same day. The dotted cross indicates the position of OR Tambo International Airport.

The predicted maximum temperature is 21°C at 13h00Z since the solar maximum usually occurs around this time in November. Calculate temperature values between 08h00Z and 12h00Z in Table 3 by using interpolation. Interpolate the temperature increase linearly (1°C per hour) because conditions are cloudy. When the air mass changes or conditions are not uniform (sunny or cloudy), this interpolation will need to be adapted. Apply a similar process to obtain the temperature at 18h00Z using the NWP model at F+18 hr. Interpolate in a similar fashion to obtain temperatures between 13h00Z and 18h00Z. Sometimes it might be necessary to change the predicted NWP model output. Therefore, evaluate the NWP model temperature against current observation before using it.

Continuously monitor your predicted values using real time data and amend when the forecast conditions significantly differ from the observed (AMF AC 1.2, 1.3, 4.3). An alternative NWP source is the Aviation Specific Forecasts from the Unified Model. Both raw and bias corrected values are provided for each model run. The same methodology mentioned above needs to applied and actual model values are rarely used as is, specifically the uncorrected values.

3.2.2.2 Forecasting Wind in Take-off data (AMF AC 2.1.2, 1.2, 1.3 and 4.3)

By following a similar process to the temperature (section 3.2.2.1) the wind can be forecast. Note that the observed wind at OR Tambo is usually slightly stronger than the NWP model forecast (+-5 KT). Evaluate this for yourself. Remember to evaluate the NWP model temperature against the current observation before using it.

Continuously monitor your predicted values using real time data and amend when the forecast conditions significantly differ from the observed (AMF AC 1.2, 1.3, 4.3).

3.2.2.3 Forecasting QNH in Take-off data (AMF AC 2.1.3, 1.2, 1.3, 4.2 and 4.3)

For interior stations over South Africa, a bias correction is applied to the mean sea level predicted QNH value of the NWP model.

Consider the 06h00Z METAR for OR Tambo International Airport (FAOR):

METAR FAOR 110600Z 11008KT 6000 -RA BKN005 SCT035TCU 14/13 Q1022 RESHRA TEMPO 4000 -SHRA=

The 06h00Z METAR QNH is 1022hPa. The WAFs NWP model forecast mean sea level pressure field for 06h00Z (F06) seen in Fig. 3 left indicates a QNH pressure of 1013hPa. The NWP model output has a bias of 9 hPa from that what was observed in the METAR (1022 – 1013 = 9hPa). This bias correction (AMF AC 4.2 and 4.3) is applied to the NWP model output fields for 12h00Z (F12) seen in Fig. 3 right (indicating 1011hPa) and therefore a QNH of 1020hPa for 12h00Z is obtained in Table 3 incorporating the bias correction (1011 + 9hPa = 1020hPa). An interpolation is performed to obtain the QNH between 06h00Z and 12h00Z. A similar forecast process is applied for the forecasting of QNH between 12h00Z and 18h00Z.

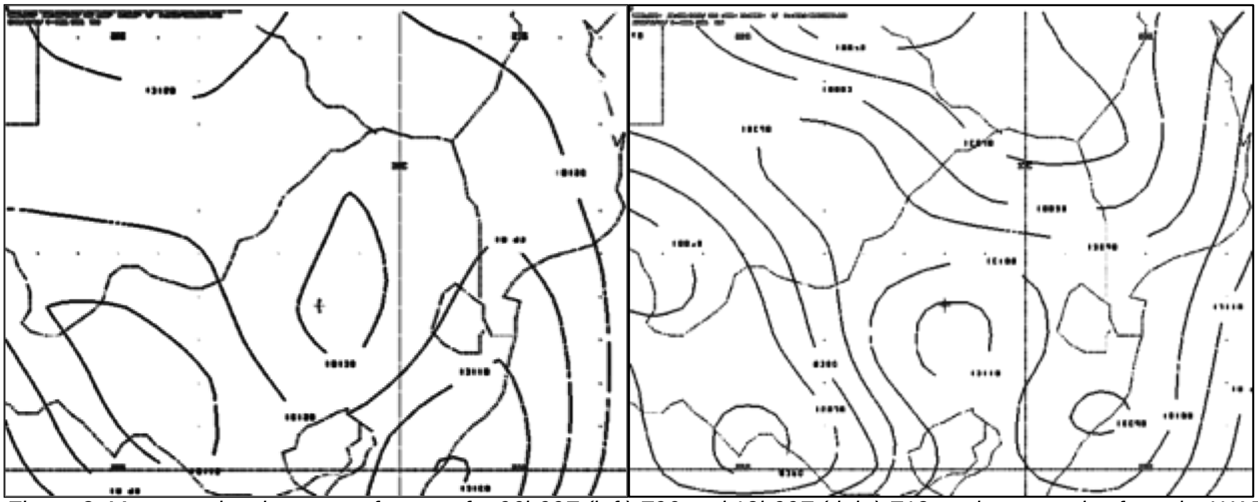


Figure 3: Mean sea level pressure forecast for 06h00Z (left) F06 and 12h00Z (right) F12 on the same day from the WAFs NWP model initialized at 00h00Z. The dotted cross indicates the position of Johannesburg International airport.

Continuously monitor your predicted values using real time data and amend when the forecast conditions significantly differ from the observed (AMF AC 1.2, 1.3, 4.3).Refer to alternative NWP source (Aviation Specific Forecasts) referred to in **3.2.2.1**.

3.3 Forecast for landing (TREND) (AMF AC 2.1.2, 2.1.4, 2.1.5, 2.1.6, 2.1.7 and 2.2)

The latest version of ICAO Annex 3 states that a landing forecast shall be prepared in the form of a TREND forecast by the Aerodrome Meteorological Office (AMO) designated by the Meteorological Authority concerned. This is determined by regional air navigation agreement; such forecasts are intended to meet the requirements of local users and of aircraft within about one hour's flying time from the aerodrome.

Table 4 (A3-1), Table 5 (A3-2) and Table 6 (A3-3) in the latest version of ICAO Annex 3 provides more information regarding the format (AMF AC 2.2) of the TREND forecast.

Table 4: Latest ICAO Annex 3 TREND format (from Table A3-1) (AMF AC 2.2)

<table>
<tr><td rowspan="6">Trend forecast (O)[16]</td><td>Name of the element (M)</td><td colspan="5">TREND</td><td rowspan="6">TREND NOSIG TREND BECMG FEW 600M
(TREND BECMG FEW 2000FT)

TREND TEMPO 250/18 MPS MAX25
(TREND TEMPO 250/36KT MAX50)

TREND BECMG AT1800 VIS 10KM NSW
TREND BECMG TL1700 VIS 800M FG
TREND BECMG FM1030 TL1130 CAVOK

TREND TEMPO TL1200 VIS 600M BECMG
AT1230 VIS 8KM NSW CLD NSC</td></tr>
<tr><td>Change indicator (M)[17]</td><td rowspan="5">NOSIG</td><td colspan="4">BECMG or TEMPO</td></tr>
<tr><td>Period of change (C)[9]</td><td colspan="4">FMnnnn and/or TLnnnn or ATnnnn</td></tr>
<tr><td>Wind (C)[9]</td><td colspan="4">nnn/[ABV]n[n][n]MPS [MAX[ABV]nn[n]]
(or nnn/[ABV]n[n]KT [MAX[ABV]nn])</td></tr>
<tr><td>Visibility (C)[9]</td><td colspan="3">VIS n[n][n][n]M or
VIS n[n]KM</td><td rowspan="2">C
A
V
O
K</td></tr>
<tr><td>Weather phenomenon: intensity (C)[9]</td><td>FBL or
MOD or
HVY</td><td>—</td><td>NSW</td></tr>
</table>

Element as specified in Chapter 4	*Detailed content*	*Template(s)*					*Examples*
	Weather phenomenon: characteristics and type (C)[8, 10, 11]		DZ *or* RA *or* SN *or* SG *or* PL *or* DS *or* SS *or* FZDZ *or* FZRA *or* SHGR *or* SHGS *or* SHRA *or* SHSN *or* TSGR *or* TSGS *or* TSRA *or* TSSN	FG *or* BR *or* SA *or* DU *or* HZ *or* FU *or* VA *or* SQ *Or* PO *or* FC *or* TS *or* BCFG *or* BLDU *or* BLSA *or* BLSN *or* DRDU *or* DRSA *or* DRSN *or* FZFG *or* MIFG *or* PRFG			TREND TEMPO FM0300 TL0430 MOD FZRA TREND BECMG FM1900 VIS 500M HVY SNRA TREND BECMG FM1100 MOD SN TEMPO FM1130 BLSN TREND BECMG AT1130 CLD OVC 300M (TREND BECMG AT1130 CLD OVC 1000FT) TREND TEMPO TL1530 HVY SHRA CLD BKN CB 360M (TREND TEMPO TL1530 HVY SHRA CLD BKN CB 1200FT)
	Name of the element (C)[9]		CLD				
	Cloud amount and vertical visibility (C)[9,14]		FEW *or* SCT *or* BKN *or* OVC	OBSC	NSC		
	Cloud type (C)[9,14]		CB *or* TCU	—			
	Height of cloud base *or* the value of vertical visibility (C)[9,14]		n[n][n][n] M (*or* n[n][n][n] FT)	[VER VIS n[n][n]M (*or* VER VIS n[n][n][n] FT)]			

Table 5: Latest ICAO Annex 3 TREND format (from Table A3-2, ICAO Annex 3)

Trend forecast (O)[17]	Change indicator (M)[18]	NOSIG	BECMG *or* TEMPO				NOSIG BECMG FEW020
	Period of change (C)[2]		FMnnnn *and/or* TLnnnn *or* ATnnnn				TEMPO 25018G25MPS (TEMPO 25036G50KT)
	Wind (C)[2]		nnn[P]nn[n][G[P]nn[n]]MPS (*or* nnn[P]nn[G[P]nn]KT)				BECMG FM1030 TL1130 CAVOK
	Prevailing visibility (C)[2]		nnnn			C A V O K	BECMG TL1700 0800 FG
	Weather phenomenon: intensity (C)[10]		– *or* +	—	N S W		BECMG AT1800 9000 NSW BECMG FM1900 0500 +SNRA
	Weather phenomenon: characteristics and type (C)[2, 9, 11]		DZ *or* RA *or* SN *or* SG *or* PL *or* DS *or* SS *or* FZDZ *or* FZRA *or* SHGR *or* SHGS *or* SHRA *or* SHSN *or* TSGR *or* TSGS *or* TSRA *or* TSSN	FG *or* BR *or* SA *or* DU *or* HZ *or* FU *or* VA *or* SQ *or* PO *or* FC *or* TS *or* BCFG *or* BLDU *or* BLSA *or* BLSN *or* DRDU *or* DRSA *or* DRSN *or* FZFG *or* MIFG *or* PRFG			BECMG FM1100 SN TEMPO FM1130 BLSN TEMPO FM0330 TL0430 FZRA TEMPO TL1200 0600 BECMG AT1200 8000 NSW NSC BECMG AT1130 OVC010 TEMPO TL1530 +SHRA BKN012CB
	Cloud amount and height of cloud base or vertical visibility (C)[2, 14]		FEWnnn *or* SCTnnn *or* BKNnnn *or* OVCnnn	VVnnn *or* VV///	N S C		
	Cloud type (C)[2, 14]		CB *or* TCU	—			

Table 6: Latest ICAO Annex 3 TREND format (Use of change indicators from Table A3-3 ICAO Annex 3)

Table A3-3. Use of change indicators in trend forecasts

Change indicator	*Time indicator and period*	*Meaning*	
NOSIG	—	no significant changes are forecast	
BECMG	FM$n_1n_1n_1n_1$ TL$n_2n_2n_2n_2$	the change is forecast to	commence at $n_1n_1n_1n_1$ UTC and be completed by $n_2n_2n_2n_2$ UTC
	TLnnnn		commence at the beginning of the trend forecast period and be completed by nnnn UTC
	FMnnnn		commence at nnnn UTC and be completed by the end of the trend forecast period
	ATnnnn		occur at nnnn UTC (specified time)
	—		a) commence at the beginning of the trend forecast period and be completed by the end of the trend forecast period; or b) the time is uncertain
TEMPO	FM$n_1n_1n_1n_1$ TL$n_2n_2n_2n_2$	temporary fluctuations are forecast to	commence at $n_1n_1n_1n_1$ UTC and cease by $n_2n_2n_2n_2$ UTC
	TLnnnn		commence at the beginning of the trend forecast period and cease by nnnn UTC
	FMnnnn		commence at nnnn UTC and cease by the end of the trend forecast period
	—		commence at the beginning of the trend forecast period and cease by the end of the trend forecast period

A TREND forecast shall consist of a concise statement of the expected significant changes in the meteorological conditions at that aerodrome, and appended to a local routine or local special report, or a METAR or SPECI. The period of validity of a TREND forecast shall be 2 hours from the time of the report which forms part of the landing forecast (latest version ICAO Annex 3).

3.3.1 Use of change groups

When a change is expected to occur, the TREND forecast shall begin with one of the change indicators "BECMG" or "TEMPO".

The change indicator "BECMG" shall be used to describe forecast changes where the meteorological conditions are expected to reach or pass through specified values at a regular or irregular rate. The period during which, or the time at which, the change is forecast to occur shall be indicated, using the abbreviations "FM", "TL" or "AT", as appropriate, each followed by a time group in hours and minutes. When the change is forecast to begin and end wholly within the TREND forecast period, the beginning and end of the change shall be indicated by using the abbreviations "FM" and "TL", respectively, with their associated time groups.

The change indicator "TEMPO" shall be used to describe forecast temporary fluctuations in the meteorological conditions which reach or pass specified values and last for a period of less than one hour in each instance and, in the aggregate, cover less than one half of the period during which the fluctuations are forecast to occur. The period during which the temporary fluctuations are forecast to occur shall be indicated, using the abbreviations "FM" and/or "TL", as appropriate, each followed by a time group in hours and minutes. When the period of temporary fluctuations in the meteorological conditions is forecast to begin and end wholly within the TREND forecast period, the beginning and end of the period of temporary fluctuations shall be indicated by using the abbreviations “FM” and “TL”, respectively, with their associated time groups. When the period of temporary fluctuations is forecast to commence at the beginning of the TREND forecast period but cease before the end of that period, the abbreviation “FM” and its associated time group shall be omitted and only “TL” and its associated time group shall be used. When the period of temporary fluctuations is forecast to begin during the TREND forecast period and cease by the end of that period, the abbreviation “TL” and its associated time group shall be omitted and only “FM” and its associated time group shall be used. When the period of temporary fluctuations is forecast to commence at the beginning of the TREND forecast period and cease by the end of that period, both abbreviations “FM” and “TL” and their associated time groups shall be omitted and the change indicator “TEMPO” shall be used alone.

The indicator “PROB” shall **not** be used in TREND forecasts.

When the change is forecast to commence at the beginning of the TREND forecast period but be completed before the end of that period, the abbreviation “FM” and its associated time group shall be omitted and only “TL” and its associated time group shall be used. When the change is forecast to begin during the TREND forecast period and be completed at the end of that period, the abbreviation “TL” and its associated time group shall be omitted and only “FM” and its associated time group shall be used.

When the change is forecast to occur at a specified time during the TREND forecast period, the abbreviation “AT” followed by its associated time group shall be used. When the change is forecast to commence at the beginning of the TREND forecast period and be completed by the end of that period or when the change is forecast to occur within the TREND forecast period but the time is uncertain, the abbreviations “FM”, “TL” or “AT” and their associated time groups shall be omitted and the change indicator “BECMG” shall be used alone.

According to the latest versions of WMO Technical regulations 49, Volume 2 and ICAO Annex 3, the TREND forecast shall indicate significant changes in respect of one or more of the elements: surface wind, visibility, weather and clouds. Only those elements shall be included for which a significant change is expected. Each of these forecast elements are discussed in more detail in the sections following.

3.3.2 Surface wind in TREND Forecast (AMF AC 2.1.2)

The TREND forecast shall indicate significant changes in the surface wind which involve (Note these are the SPECI criteria) (WMO, 2016).

(a) A change in the mean wind direction of 60°or more, the mean speed before and/or after the change being 5 m/s (10 KT) or more;

(b) A change in mean wind speed of 5 m/s (10 KT) or more; and

(c) Changes in the wind through values of operational significance. The threshold values shall be established by the meteorological authority in consultation with the appropriate ATS authority and operators concerned, taking into account changes in the wind, which would:

(i) Require a change in runway(s) in use; and

(ii) Indicate that the runway tailwind and crosswind components will change through values representing the main operating limits for typical aircraft operating at the aerodrome.

Example:

METAR FAPE 081300Z 10010KT 070V130 9999 FEW033 20/11 Q1024 BECMG 18012KT=

METAR FAPE 081300Z 10010KT 070V130 9999 FEW033 20/11 Q1024 BECMG 10020KT=

METAR FAPE 081300Z 10007KT 070V130 9999 FEW033 20/11 Q1024 NOSIG=

3.3.3 Horizontal visibility in TREND forecast (AMF AC 2.1.5, 2.1.6, 2.1.7)

When the horizontal visibility is expected to improve and change to, or pass through, one or more of the following values, or when the visibility is expected to deteriorate and change to, or pass through one or more of the following values: 150, 350, 600, 800, 1500 or 3000 m ,the TREND forecast shall indicate this expected change. When significant numbers of flights are conducted in accordance with the visual flight rules, the forecast shall additionally indicate changes to or passing through 5 000 m (Note these are the SPECI criteria).

In the case of a significant change in visibility, the phenomenon causing the reduction of visibility shall also be indicated.

Example:

FAOR 131230Z 18014KT 140V230 7000 SHRA SCT020 FEW023CB 11/10 Q1025 TEMPO 3000 TSRA BKN005=

3.3.4 Weather phenomena in TREND forecast (AMF AC 2.1.5, 2.1.6, 2.1.7)

The TREND forecast shall indicate the expected onset, cessation or change in intensity of one or more of the following weather phenomena or combinations thereof: (Note these are the SPECI criteria).

– Freezing precipitation;

– Moderate or heavy precipitation (including showers);
– Thunderstorm (with precipitation);
– Duststorm;
– Sandstorm;
– Other weather phenomena given in Appendix 3, 4.4.2.3 (latest version of ICAO Annex 3) as agreed by the meteorological authority, the appropriate ATS authority and operators concerned.

The TREND forecast shall indicate the expected onset or cessation of one or more of the following weather phenomena or combinations thereof:
– Freezing fog;
– Low drifting dust, sand or snow;
– Blowing dust, sand or snow;
– Thunderstorm (without precipitation);
– Squall;
– Funnel cloud (tornado or waterspout).

The total number of phenomena reported in shall not exceed three.
The expected end of occurrence of the weather phenomena shall be indicated by the abbreviation “NSW”.

Example:
FAOR 131230Z 18014KT 140V230 7000 SHRA SCT020 FEW023CB 11/10 Q1025 TEMPO TS=

3.3.5 Cloud in TREND forecast (AMF AC 2.1.4)

However, in the case of significant changes in respect of cloud, all cloud groups, including layers or masses not expected to change, shall be indicated (Note these are the SPECI criteria too).

When the height of the base of a cloud layer of BKN or OVC extent is expected to lift and change to, or pass through, one or more of the following values, or when the height of the base of a cloud layer of BKN or OVC extent is expected to lower and pass through one or more of the following values: 30, 60, 150, 300 and 450 m (100, 200, 500, 1 000 and 1500 ft), the TREND forecast shall indicate the change.

When the height of the base of a cloud layer is below or is expected to fall below or rise above 450 m (1500 ft), the TREND forecast shall also indicate changes in cloud amount from FEW or SCT increasing to BKN or OVC, or changes from BKN or OVC decreasing to FEW or SCT. When no clouds of operational significance are forecast and "CAVOK" is not appropriate, the abbreviation "NSC" shall be used. Take note of the differentiation between lifting and lowering cloud bases:

- when the height of base … is lifting and changes to or passes through one or more of the values as listed in 3.3.4 above
- when the height of base … is lowering and passes through one or more of the values as listed in 3.3.4 above

Example:

FAOR 130730Z 04014KT 9999 SCT010 15/12 Q1025 BECMG BKN010=

3.3.6 Vertical Visibility (AMF AC 2.1.4)

When the sky is expected to remain or become obscured and vertical visibility observations are available at the aerodrome, and the vertical visibility is forecast to improve and change to, or pass through, one or more of the following values, or when the vertical visibility is forecast to deteriorate and pass through or change to one or more of the following values: 30, 60, 150 or 300 m (100, 200, 500 or 1 000 ft), the TREND forecast shall indicate the change.

If none of the above phenomenon in 3.3.1 to 3.3.5 are expected to change through significant criteria then the term NOSIG should be used?

3.4 Terminal Aerodrome Forecasts (TAFs) (AMF AC 1.2, 1.3, 2.1.1, 2.1.2, 2.1.4, 2.1.5, 2.1.6, 2.1.7)

Terminal Aerodrome Forecasts (TAFs) follow the general form of a METAR and include surface wind, visibility, forecasts of weather phenomena and cloud, and relevant significant changes thereto.

Amendment of the TAF (AMF AC 1.2 and 1.3):

The latest version of ICAO Annex 3 states that "meteorological offices preparing an aerodrome forecast shall keep the forecast under continuous review (AMF AC 1.2), and when necessary shall issue amendments promptly" (Annex 3, par 6.2.4) (AMF AC 1.3). Annex 3 does not explicitly require that a complete METAR should be available to maintain such a review (Although many States do stipulate in their national regulations that METAR are required for this purpose).

Continuous review of the TAF can be done by monitoring weather parameters and significant weather phenomena in order to adjust your weather forecast to current weather conditions. This monitoring can be done by consulting the latest METARs, SPECIs, latest satellite and RADAR imagery in order to issue necessary amendments or corrections promptly.

It is recommended that other sources of meteorological information be used in the absence of full METAR, e.g. weather radar data, observations from automatic weather stations, satellite images, etc.

A TAF that cannot be kept under continuous review shall be cancelled.

The specific values of elements and the time of expected changes indicated in TAF should be understood as being approximate and as representing the most probable mean of a range of values or times.

It is recommended in WMO, Technical regulations, Volume 2 and latest version of ICAO Annex 3 that TAFs valid for less than 12 hours are issued every 3 hours and those valid for 12 to 30 hours are issued at 6-hour intervals. The validity period of TAF is determined for each region on the basis of regional air navigation agreement but must be between 6 and 30 hours inclusive.

When issuing TAF, aerodrome meteorological offices shall ensure that not more than one TAF is valid at an aerodrome at any given time.

3.4.1 TAF Format (AMF AC 2.2)

WMO, Technical regulations 49, Volume states that a TAF shall contain the following;

- Identification of the type of forecast (TAF)
- TAF Locations
- Time of issue
- Date and period of validity
- Temperature forecast
- Forecast (Body of the TAF) (Surface wind, visibility, weather and cloud.
- Expected significant change groups and conditional change groups.

TAF shall be issued in accordance with the template shown in Table A5-1 and disseminated in the TAF code form prescribed by the WMO. Visit the TAF code form at WMO No. 306: Manual on codes, Part A – Alphanumeric Codes

Table 7: After Table A5-1 from ICAO Annex 3 indicates the format to be used in TAFs. Detailed technical specifications

for TAF can be found in latest version of Annex 3, Appendix 5,

Table A5-1. Template for TAF

Key: M = inclusion mandatory, part of every message;
C = inclusion conditional, dependent on meteorological conditions or method of observation;
O = inclusion optional.

Note 1.— The ranges and resolutions for the numerical elements included in TAF are shown in Table A5-4 of this appendix.

Note 2.— The explanations for the abbreviations can be found in the Procedures for Air Navigation Services — ICAO Abbreviations and Codes *(PANS-ABC, Doc 8400).*

Element as specified in Chapter 6	*Detailed content*	*Template(s)*	*Examples*
Identification of the type of forecast (M)	Type of forecast (M)	TAF or TAF AMD or TAF COR	TAF TAF AMD
Location indicator (M)	ICAO location indicator (M)	nnnn	YUDO[1]
Time of issue of forecast (M)	Day and time of issue of the forecast in UTC (M)	nnnnnnZ	160000Z
Identification of a missing forecast (C)	Missing forecast identifier (C)	NIL	NIL
END OF TAF IF THE FORECAST IS MISSING.			
Days and period of validity of forecast (M)	Days and period of the validity of the forecast in UTC (M)	nnnn/nnnn	0812/0918
Identification of a cancelled forecast (C)	Cancelled forecast identifier (C)	CNL	CNL
END OF TAF IF THE FORECAST IS CANCELLED.			
Surface wind (M)	Wind direction (M)	nnn or VRB[2]	24004MPS; VRB01MPS (24008KT); (VRB02KT) 19005MPS (19010KT) 00000MPS (00000KT) 140P49MPS (140P99KT) 12003G09MPS (12006G18KT) 24008G14MPS (24016G28KT)
	Wind speed (M)	[P]nn[n]	
	Significant speed variations (C)[2]	G[P]nn[n]	
	Units of measurement (M)	MPS (or KT)	
Visibility (M)	Prevailing visibility (M)	nnnn — or — CAVOK	0350 CAVOK 7000 9000 9999
Weather (C)[3,4]	Intensity of weather phenomena (C)[5]	– or + / —	RA HZ +TSRA FG –FZDZ PRFG +TSRASN SNRA FG
	Characteristics and type of weather phenomena (C)[5]	DZ or RA or SN or SG or PL or DS or SS or FZDZ or FZRA or SHGR or SHGS or SHRA or SHSN or TSGR or TSGS or TSRA or TSSN / FG or BR or SA or DU or HZ or FU or VA or SQ or PO or FC or TS or BCFG or BLDU or BLSA or BLSN or DRDU or DRSA or DRSN or FZFG or MIFG or PRFG	
Cloud (M)[6]	Cloud amount and height of base or vertical visibility (M)	FEWnnn or SCTnnn or BKNnnn or OVCnnn / VVnnn or VV/// / NSC	FEW010 VV005 OVC020 VV/// NSC SCT005 BKN012 SCT008 BKN025CB
	Cloud type (C)[5]	CB or TCU / —	
Temperature (O)[7]	Name of the element (M)	TX	TX25/1013Z TN09/1005Z TX05/2112Z TNM02/2103Z
	Maximum temperature (M)	[M]nn/	
	Day and time of occurrence of the maximum temperature (M)	nnnnZ	
	Name of the element (M)	TN	
	Minimum temperature (M)	[M]nn/	
	Day and time of occurrence of the minimum temperature (M)	nnnnZ	

Expected significant changes to one or more of the above elements during the period of validity (C)[4, 10]	Change or probability indicator (M)	PROB30 [TEMPO] or PROB40 [TEMPO] or BECMG or TEMPO or FM				TEMPO 0815/0818 25017G25MPS (TEMPO 0815/0818 25034G50KT)
	Period of occurrence or change (M)	nnnn/nnnn or nnnnnn[11]				TEMPO 2212/2214 17006G13MPS 1000 TSRA SCT010CB BKN020 (TEMPO 2212/2214 17012G26KT 1000 TSRA SCT010CB BKN020)
	Wind (C)[4]	nnn[P]nn[n][G[P]nn[n]]MPS or VRBnnMPS (or nnn[P]nn[G[P]nn]KT or VRBnnKT)				
	Prevailing visibility (C)[4]	nnnn			C A V O K	BECMG 3010/3011 00000MPS 2400 OVC010 (BECMG 3010/3011 00000KT 2400 OVC010)
	Weather phenomenon: intensity (C)[4]	– or +	—	NSW		
	Weather phenomenon: characteristics and type (C)[4, 7]	DZ or RA or SN or SG or PL or DS or SS or FZDZ or FZRA or SHGR or SHGS or SHRA or SHSN or TSGR or TSGS or TSRA or TSSN	FG or BR or SA or DU or HZ or FU or VA or SQ or PO or FC or TS or BCFG or BLDU or BLSA or BLSN or DRDU or DRSA or DRSN or FZFG or MIFG or PRFG			PROB30 1412/1414 0800 FG BECMG 1412/1414 RA TEMPO 2503/2504 FZRA TEMPO 0612/0615 BLSN PROB40 TEMPO 2923/3001 0500 FG
	Cloud amount and height of base or vertical visibility (C)[4]	FEWnnn or SCTnnn or BKNnnn or OVCnnn	VVnnn or VV///	NSC		FM051230 15015KMH 9999 BKN020 (FM051230 15008KT 9999 BKN020) BECMG 1618/1620 8000 NSW NSC BECMG 2306/2308 SCT015CB BKN020
	Cloud type (C)[4]	CB or TCU	—			

Notes.—

1. Fictitious location.
2. To be used in accordance with 1.2.1.
3. To be included in accordance with 1.2.1.
4. To be included whenever applicable.
5. One or more, up to a maximum of three, groups in accordance with 1.2.3.
6. To be included whenever applicable in accordance with 1.2.3. No qualifier for moderate intensity.
7. Weather phenomena to be included in accordance with 1.2.3.
8. Up to four cloud layers in accordance with 1.2.4.
9. To be included in accordance with 1.2.5, consisting of up to a maximum of four temperatures (two maximum temperatures and two minimum temperatures).
10. To be included in accordance with 1.3, 1.4 and 1.5.
11. To be used with FM only.

3.4.2 Types of TAF:

- **Routine** forecast issuance (TAF)
- The **amended TAF** (**TAF AMD**)

  A TAF is amended as a result of changes to the forecast or current meteorological conditions leading to the original TAF no longer accurately reflecting the expected meteorological situation.

  Example: TAF AMD FAOR 160900Z…
- **Corrected TAF** (**TAF COR**)

  Indicates that the original TAF contained errors in terms of *syntax* and that the. Correction is merely to correct this rather than any change in the meteorological conditions.
- **Delayed or no observation** (**TAF NIL**) If a TAF is not available for a particular aerodrome, it is identified with the abbreviation NIL within a bulletin that may contain TAF for several aerodromes.
- **Cancelled** (**TAF CNL**)

  A TAF is cancelled using CNL if the TAF cannot be kept under continuous review or is no longer valid owing to the closure of the aerodrome.

3.4.3 TAF Locators:

A list of the four-letter ICAO station indicators used in South Africa can be found on the aviation website. http://aviation.weathersa.co.za/#showAirportList

3.4.4 Time of TAF Issue:

- Consist of six-digit group (ddhhhh)
- First two digits representing the day of the month
- Last four digits represent time of issue in UTC/Z time
- Example: TAF AMD FAOR **190600Z**

3.4.5 Time of TAF Validity

- Consist of eight-digit group (ddhh/ddhh)
- Valid time should be in UTC/Z time
- Long term (FT TAFS, 18, 24 to 36 hour) or Short term (FC TAF, 6 to 11 hours)
- Example: TAF FAOR 190500Z **1906/2012**=

3.4.6 Forecast (Body of the TAF): (AMF AC 2.1.2, 2.1.4, 2.1.5, 2.1.6, 2.1.7)

The body contains the surface wind, surface visibility, weather phenomena and clouds (amount and ceiling). An example: TAF FAOR 190600Z 1907/1918 **02012KT 9999 BKN015**. This is the nowcasting part of the TAF where the METAR and remotely sensed data including actual synoptic weather patterns provide guidance.

3.4.6.1 Surface Wind in a TAF (AMF AC 2.1.2)

As per WMO Technical regulations no 49: Recommendation - In forecasting **surface wind**, the expected prevailing direction should be given. When it is not possible to forecast a prevailing surface wind direction due to its expected variability, for example, during light wind conditions (less than 6 km/h (3 KT)) or thunderstorms, the forecast wind direction should be indicated as variable using “VRB”. When the wind is forecast to be less than 2 km/h (1 KT), the forecast wind speed should be indicated as calm. When the forecast maximum speed (gust) exceeds the forecast mean wind speed by 20 km/h (10 KT) or more, the forecast maximum wind speed should be indicated.

3.4.6.2 Surface visibility in a TAF

As per WMO Technical regulations no 49: Recommendation - When the visibility is forecast to be less than 800 m, it should be expressed in steps of 50 m; when it is forecast to be 800 m or more but less than 5 km, in steps of 100 m; 5 km or more but less than 10 km, in 1 kilometer steps and when it is forecast to be 10 km or more, it should be expressed as 10 km, except when conditions of CAVOK are forecast to apply. The prevailing visibility should be forecast. When visibility is forecast to vary in different directions and the prevailing visibility cannot be forecast, the lowest forecast visibility should be given. Weather phenomena will be any element of weather such as: showers (SH); rain (RA); thundershowers (TSRA); Fog (FG); mist (BR); haze (HZ); smoke (FU); etc.

3.4.6.3 Weather Phenomena in a TAF

As per WMO Technical regulations no 49 Vol 2: Recommendation - One or more, up to a maximum of three, of the following weather phenomena or combinations thereof, together with their characteristics and, where appropriate, intensity, should be forecast if they are expected to occur at the aerodrome:

- freezing precipitation
- freezing fog
- moderate or heavy precipitation (including showers thereof)
- low drifting dust, sand or snow
- blowing dust, sand or snow
- dust storm
- sandstorm
- thunderstorm (with or without precipitation)
- squall
- funnel cloud (tornado or waterspout)
- The expected end of occurrence of those phenomena should be indicated by the abbreviation "NSW".

3.4.6.4 Cloud amount in a TAF

As per WMO Technical regulations No 49 Vol 2: Recommendation— Cloud amount should be forecast using the abbreviations "FEW", "SCT", "BKN" or "OVC" as necessary. When it is expected that the sky will remain or become obscured and clouds cannot be forecast and information on vertical visibility is available at the aerodrome, the vertical visibility should be forecast in the form "VV" followed by the forecast value of the vertical visibility. When several layers or masses of cloud are forecast, their amount and height of base should be included in the following order:

a) the lowest layer or mass regardless of amount, to be forecast as FEW, SCT, BKN or OVC as appropriate;

b) the next layer or mass covering **more than** 2/8, to be forecast as SCT, BKN or OVC as appropriate;

c) the next higher layer or mass covering **more than** 4/8, to be forecast as BKN or OVC as appropriate; and

d) Cumulonimbus clouds, whenever forecast and not already included under a) to c).

Cloud information should be limited to cloud of operational significance; when no cloud of operational significance is forecast, and "CAVOK" is not appropriate, the abbreviation "NSC" should be used.

3.4.7 Temperature Forecast (AMF AC 2.1.1)

As per WMO Technical regulations No 49 Vol 2: Recommendation: When forecast temperatures are included in accordance with regional air navigation agreement, the maximum and minimum temperatures expected to occur during the period of validity of the TAF should be given, together with their corresponding times of occurrence. For example. TX23/1912ZTN18/1918Z.

NB. -Terminal aerodrome forecast should be written as simply and straight forward as possible. Should be clear and unambiguous.
- Heights are given in feet above ground level (A.G.L) and wind strength in knots.

3.4.8 Change Groups (BECMG + FM) in a TAF

The change groups and conditional change groups are the forecast part of the TAF where the numerical weather prediction models provide guidance.

3.4.8.1 Criteria for the Indication of Changes and/or Preparation of Amendments to TAF

WMO Technical Regulation 49 Recommendation - The criteria used for the inclusion of change groups in TAF or for the amendment of TAF should be based on the following:

a) when the mean surface wind direction is forecast to change by 60º or more, the mean speed before and/or after the change being 20 km/h (10 KT) or more;
b) when the mean surface wind speed is forecast to change by 20 km/h (10 KT) or more;
c) when the variation from the mean surface wind speed (gusts) is forecast to increase by 20 km/h (10 KT) or more, the mean speed before and/or after the change being 30 km/h (15 KT) or more;
d) when the surface wind is forecast to change through values of operational significance. The threshold values should be established by the meteorological authority in consultation with the appropriate ATS authority and operators concerned, taking into account changes in the wind which would:
   i) Require a change in runway(s) in use; and
   ii) Indicate that the runway tailwind and crosswind components will change through values representing the main operating limits for typical aircraft operating at the aerodrome;

e) when the visibility is forecast to improve and change to or pass through one or more of the following values, or when the visibility is forecast to deteriorate and pass through one or more of the following values:

   i) 150, 350, 600, 800, 1500 or 3000m; or

   ii) 5 000m in cases where significant numbers of flights are operated in accordance with the visual flight rules;

f) when any of the following weather phenomena or combinations thereof are forecast to begin or end or change in intensity:

   i) freezing fog
   ii) freezing precipitation
   iii) moderate or heavy precipitation (including showers)
   iv) thunderstorm
   v) duststorm
   vi) sandstorm

g) when any of the following weather phenomena or combinations thereof are forecast to begin or end :

   i. low drifting dust, sand or snow
   ii. blowing dust, sand or snow
   iii. squall
   iv. funnel cloud (tornado or waterspout)

h) when the height of base of the lowest layer or mass of cloud of BKN or OVC extent is forecast to lift and change to or pass through one or more of the following values, or when the height of the lowest layer or mass of cloud of BKN or OVC extent is forecast to lower and pass through one or more of the following values:

   i) 30, 60, 150 or 300 m (100, 200, 500 or 1 000 ft); or

   ii) 450 m (1500 ft) in cases where significant numbers of flights are operated in accordance with the visual flight rules;

   i) when the amount of a layer or mass of cloud below 450 m (1500 ft) is forecast to change:

   i) from NSC, FEW or SCT to BKN or OVC; or

   ii) from BKN or OVC to NSC, FEW or SCT;

j) when the vertical visibility is forecast to improve and change to or pass through one or more of the following values, or when the vertical visibility is forecast to deteriorate and pass through one or more of the following values: 30, 60, 150 or 300 m (100, 200, 500 or 1 000 ft)

k) Any other criteria based on local aerodrome operating minima, as agreed between the meteorological authority and the operators. The latest addition of ICAO Annex 3 notes that other criteria based on local aerodrome operating minima are to be considered in parallel with similar criteria for the inclusion of change groups and for the amendment of TAF

As per WMO Technical regulations No 49 Vol 2: Recommendation— The change indicator **"BECMG"** and the associated time group should be used to describe changes where the meteorological conditions are expected to reach or pass through specified threshold values at a regular or irregular rate and at an unspecified time during the time period. The time period should normally not exceed two hours but in any case should not exceed four hours.

Example: TAF FAOR 190600Z 1907/1918 02012KT 9999 BKN015 TX23/1912ZTN18/1918Z **BECMG 1909/1911 BKN030 BECMG 1911/1913 FEW035CB SCT040** TEMPO 1913/1918 4500 TSRA SCT030CB BKN080=

BECMG 1909/1911 BKN030: Condition is expected to change gradually between 09Z and 11Z to broken cloud at 3000ft and this condition will prevail until any further change is expected and this will be indicated by another set of change group: **BECMG 1911/1913.**

As per WMO Technical regulations No 49 Vol 2: Recommendation — The change indicator "TEMPO" and the associated time group should be used to describe expected frequent or infrequent temporary fluctuations in the meteorological conditions which reach or pass specified threshold values and last for a period of less than one hour in each instance and, in the aggregate, cover less than one half of the forecast period during which the fluctuations are expected to occur. If the temporary fluctuation is expected to last one hour or longer, the change group "BECMG" should be used.

Where one set of prevailing weather conditions is expected to change significantly and more or less completely to a different set of conditions, the period of validity should be subdivided into self-contained periods using the abbreviation "FM" followed immediately by a four-figure time group in whole hours and minutes UTC indicating the time the change is expected to occur. The subdivided period following the abbreviation "FM" should be self-contained and all forecast conditions given before the abbreviation should be superseded by those following the abbreviation.

FM is used to indicate rapid change expected, usually within less than one hour. For example, if the condition will rapidly change from overcast (OVC), broken (BKN) to few (FEW)/ clear skies (SKC) or vice versa within a very short space of time. When FM is used the TAF starts all over again and the order of a TAF should be followed.

Example: TAF FAOR 190600Z 1907/1918 02012KT 9999 FEW015 **FM190900 02012KT 9999 BKN015**

Table 8: After Table A5-2 from ICAO Annex 3 – Use of change and time indicators in TAF

Table A5-2. Use of change and time indicators in TAF

Change or time indicator		*Time period*	*Meaning*	
FM		$n_dn_dn_hn_hn_mn_m$	used to indicate a significant change in most weather elements occuring at n_dn_d day, n_hn_h hours and n_mn_m minutes (UTC); all the elements given before "FM" are to be included following "FM" (i.e. they are all superseded by those following the abbreviation)	
BECMG		$n_{d1}n_{d1}n_{h1}n_{h1}n_{d2}n_{d2}n_{h2}n_{h2}$	the change is forecast to commence at $n_{d1}n_{d1}$ day and $n_{h1}n_{h1}$ hours (UTC) and be completed by $n_{d2}n_{d2}$ day and $n_{h2}n_{h2}$ hours (UTC); only those elements for which a change is forecast are to be given following "BECMG"; the time period $n_{d1}n_{d1}n_{h1}n_{h1}n_{d2}n_{d2}n_{h2}n_{h2}$ should normally be less than 2 hours and in any case should not exceed 4 hours	
TEMPO		$n_{d1}n_{d1}n_{h1}n_{h1}n_{d2}n_{d2}n_{h2}n_{h2}$	temporary fluctuations are forecast to commence at $n_{d1}n_{d1}$ day and $n_{h1}n_{h1}$ hours (UTC) and cease by $n_{d2}n_{d2}$ day and $n_{h2}n_{h2}$ hours (UTC); only those elements for which fluctuations are forecast are to be given following "TEMPO"; temporary fluctuations should not last more than one hour in each instance, and in the aggregate, cover less than half of the period $n_{d1}n_{d1}n_{h1}n_{h1}n_{d2}n_{d2}n_{h2}n_{h2}$	
PROBnn	—	$n_{d1}n_{d1}n_{h1}n_{h1}n_{d2}n_{d2}n_{h2}n_{h2}$	probability of occurrence (in %) of an alternative value of a forecast element or elements; nn = 30 or nn = 40 only; to be placed after the element(s) concerned	—
	TEMPO	$n_{d1}n_{d1}n_{h1}n_{h1}n_{d2}n_{d2}n_{h2}n_{h2}$		probability of occurrence of temporary fluctuations

3.4.9 Probability groups (PROB AND TEMPO)

WMO Technical Regulation No 49 Vol 2 Recommendation - The probability of occurrence of an alternative value off a forecast element or elements should be indicated, as necessary, by use of the abbreviation "PROB" followed by the probability in tens of percent and the time period during which the alternative value(s) is (are) expected to apply. The probability information should be placed after the element or elements forecast and be followed by the alternative value of the element or elements. The probability of a forecast of temporary fluctuations in meteorological conditions should be indicated, as necessary, by use of the abbreviation "PROB" followed by the probability in tens of percent, placed before the change indicator "TEMPO" and associated time group. A probability of an alternative value or change of less than 30 per cent should not be considered sufficiently significant to be indicated. A probability of an alternative value or change of 50 per cent or more, for aviation purposes, should not be considered a probability but instead should be indicated, as necessary, by use of the change indicators "BECMG" or "TEMPO" or by subdivision of the validity period using the abbreviation "FM". The probability group should not be used to qualify the change indicator "BECMG" nor the time indicator "FM".

TEMPO indicates that temporary conditions are expected to occur during the forecast period. It also describes any condition with 50 % or more probability of occurrence but expected to last for less than an hour at a time and to cover less than half of the forecast period. It is therefore advisable that all precipitation of a temporary nature such as showers and thundershowers be put under TEMPO group since it is temporary except for rain resulting from Nimbostratus cloud.

Example: TAF FAOR 190600Z 1907/1918 02012KT 9999 BKN015 TX23/1912ZTN18/1918Z BECMG 1909/1911 BKN030 BECMG 1911/1913 FEW035CB SCT040 **TEMPO 1913/1918 5000 TSRA SCT030CB BKN080**=

PROB indicates the probability of occurrence of weather phenomenon such as thunderstorm or any precipitation. PROB30 describes a slight chance of occurrence (30% to less than 40% probability of occurrence. PROB40 describes an equivalent of chance (40% to less than 50% probability of occurrence). A 50% or more probability of occurrence does not require PROB anymore, only TEMPO is used. The probability of less than 30% of the actual values deviating from the forecast shall not be considered to justify the use of PROB. Change groups PROB & TEMPO shall always be used together e.g. PROB40 TEMPO 1913/1918

WMO Technical Regulation No 49 Vol 2 Recommendation - The number of change and probability groups should be kept to a minimum and should not normally exceed five groups.

3.4.10 TAF Decoding Examples

METAR (Indicates the actual weather at an airfield)
METAR FAOR 190600Z 02012KT 9999 BKN010 BKN080 19/16 Q1026 BECMG BKN020=

DECODED

The METAR is for the Johannesburg International Airport, issued on the 19th day of the month at 0600Z time. Wind is from 20 degrees NNE at 12 KT; Visibility is more than 10km; Cloud ceiling is 1000 ft broken with another broken layer at 8000 ft above ground level (A.G.L); temperature at 19 degrees Celsius with a dew point temperature of 16 degrees Celsius, Q1026: QNH (Pressure reduced to mean sea level in hPa) is 1026 hPa BECMG BKN020: Gradual improvement on cloud base to 2000 ft A.G.L expected within 2 hour period.

FC TAF - 6/11 hours (Indicates the expected weather at an airfield)
TAF FAOR 190600Z 1907/1918 02012KT 9999 BKN015 TX23/1912ZTN18/1918Z BECMG 1909/1911 BKN030 BECMG 1911/1913 FEW035CB SCT040 TEMPO 1913/1918 5000 TSRA SCT030CB BKN080 =

<u>DECODED</u>

FAOR	: ICAO Location indicator for Johannesburg International airport
190600	: Issued on the 19th day of the month at 0600Z time
1907/1918	: Valid from 0700Z until 1800Z time period for the 19th day of the month.
02012KT	: Surface wind forecast is 20 degrees (NNE) at wind strength of 12 Knots
9999	: Visibility is more than 10Km
BKN015	: Broken cloud (5-7 eights) at 1500ft above ground level (A.G.L)

TX23/1912Z TN18/1918Z: Forecast maximum temperature of 23 degrees will occur at 1200Z time and the forecast minimum temperature of 18 degrees will occur at 1800Z time.

BECMG 1909/1911 BKN030: Gradual change expected between 0900Z and 1100Z for a cloud to improve the ceiling to 3000ft A.G.L but still broken.

BECMG 1911/1913 FEW035CB SCT040: Another gradual change expected between 1100Z and 1300Z for 1-2 eights of Cumulonimbus cloud to develop at 3500ft A.G.L and 3-4 eights of clouds at 4000ft A.G.L. Please note that only Cumulonimbus clouds and TCU are to be mentioned in a TAF.

TEMPO 1913/1918 5000 TSRA SCT030CB BKN080: Temporary fluctuations expected of less than one hour and less than half the period in aggregate between 1300Z and 1800Z time during which the visibility will be reduced to 5000M in thundershowers (TSRA). The clouds will be 3-4 eights of Cumulonimbus at 3000ft and 5-7 eights of clouds at 8000ft.

(=) : Indicates the end of a TAF

3.4.11 Guidance on writing TAFs

NB: Accuracy in a TAF is very important because the forecast will be used for the purpose of flight planning, when to depart, what to expect en-route and also for landing purposes and choosing alternate airports.

1) Check the current weather :- METAR, Satellite, Radar, Synopses/Synoptic chart Check the history of METARs for the TAF station to see what has been happening to the weather and what the current **cloud base heights (AMF AC 2.1.4).** This is where you will find accurate cloud base height information.
2) Evaluate the NWP and choose the best model depending on how the NWP handles the weather situation with regards to the actual data.
3) **Start the TAF with the wind, visibility and weather that will be expected to be most prevalent for the duration of the TAF. For this reason always start with a good visibility as this will be the most dominant over a 24 to 30 hour period**
4) Evaluate the NWP to identify the time at which there will be a significant change in the weather (improvement or deterioration) using the weather stated above as the reference point.
5) Use the significant weather change criteria (SPECI) when considering significant changes in:
   - Wind: When forecasting wind, always relate it to the weather system and pressure field from which it was derived as to understand what is causing the wind. Use VRB for wind direction only if the speed is between 1 and 3KT, or if associated with TS e.g. TEMPO VRB20G30KT 2000 TSRA. If the wind speed is greater than 3KT and not associated with

TS, a wind direction other than VRB must be given.

- Visibility (reduction or improvement): If reduction of visibility is forecast due to showery precipitation from convective cloud this must be included under PROB30, PROB40 or TEMPO because showers or convective precipitation is temporary in nature. If reduction of visibility is forecast due to continuous precipitation from layered stratiform
- Cloud/Nimbostratus: this can be put under BECMG. The only time you put a wind in PROB30, PROB40 or TEMPO is when this wind is caused by the outflow of a thunderstorm or wind gusts greater than 10KT of forecast wind speed in the TAF is expected. Significant cloud type. The only 2 cloud types that are explicitly mentioned in a TAF is TCU and CB. Cloud base height and CAVOK – any cloud base above 5000 ft a.g.l or the minimum sector altitude which is not a TCU or CB is CAVOK.

6) Follow the TAF rules as indicated by WMO.
7) BECMG - only change those weather elements that are expected to change significantly from what was previously stated.
8) In FM, you repeat all the weather elements in the correct order as if you were starting the TAF from scratch. You repeat all the elements as if you were starting a new TAF.
9) Don’t use 040V340 or VC (vicinity) in TAF – use is restricted to observations.

3.4.12 Forecasting stratiform precipitation (intensity, onset, duration, amount, type) and associated visibilities (AMF 2.1.5) in a TAF

Competency 2.1.5 states that a forecaster has to be able to forecast precipitation. An example of forecasting stratiform precipitation along the coast and adjacent interior from stratiform cloud (**red**) is shown in the following TAF.

Note that because that rainfall from this stratiform layered cloud is expected to be continuous (last for more than an hour at a time) BECMG is used instead of PROB40 TEMPO. Compare this to the use of PROB30 TEMPO for convective precipitation from convective cloud:

TAF FADN 180900Z 1812/1912 18010KT 9999 **OVC025**

TX18/1812ZTN17/1903Z

BECMG 1812/1814 4000 RA OVC010

BECMG 1816/1818 **BKN025**

PROB30 TEMPO 1818/1822 4500 TSRA FEW045CB

BECMG 1904/1906 **BKN015**

PROB30 TEMPO 1906/1912 4000 RA **OVC010**=

The TAF was constructed as follows. The latest available observations are inspected. In this case it was the Durban METAR that was provided, valid for 08Z:

METAR FADN 180800Z 21009KT 8000 –RA SCT006 OVC025 19/17 Q1024 TEMPO 4000=

Based on NWP prognosis for the 24 hour period the predomiant weather for the 24 hour period will be good visibility with BKN to OVC stratiform cloud due to persistant southerly onshore flow. For this reason, the TAF is started with the dominant weather for the 24 hour period which is good visibility with OVC stratiform low cloud. Significant improvements or deteriorations from this are then indicated using the change or probability groups.

Rain is forecast along the coast and over the eastern escarpment due to the surface ridging high pressure causing an onshore flow of BKN to OVC cloud (moist low level air at 850 hPa) (See Fig. 4).

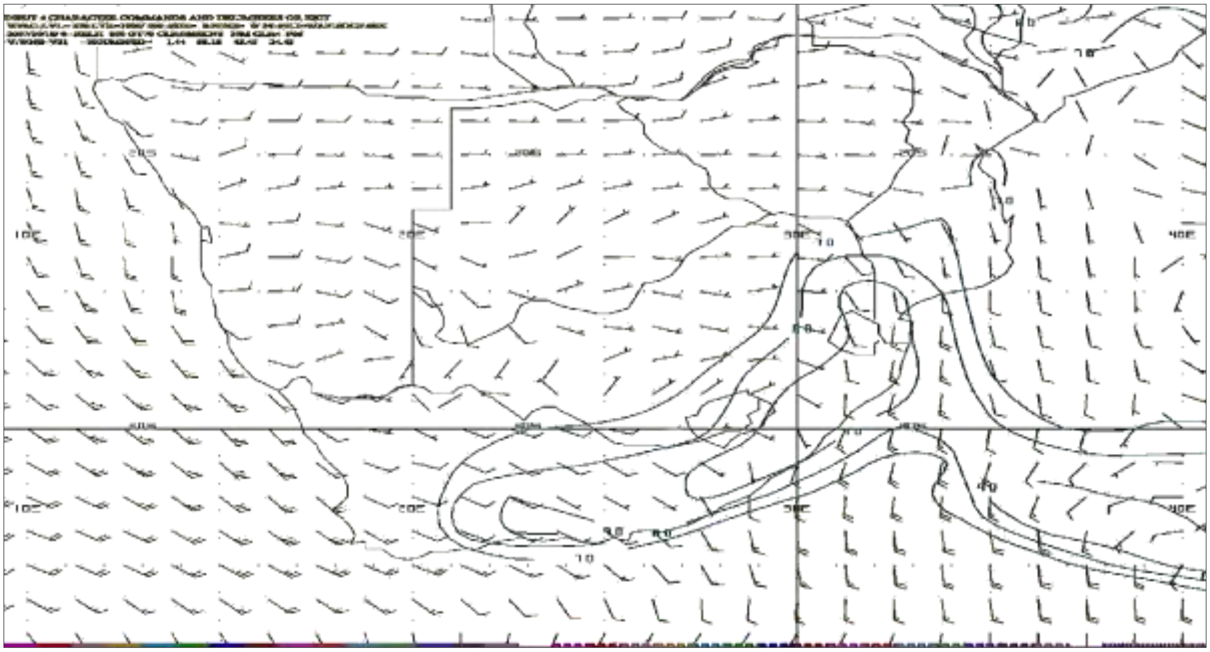


Figure 4: WAFs NWP model output from the 00h00Z model run for relative humidity at 850hPa (%) (cyan) and the winds (barbs) at 10m (yellow) valid for 18 October 2007 at 12h00Z.

This situation is expected to continue for the next 24 hours.

Considering the vertical cross section, there is also low level uplift (cyan), high amounts of low level moisture (green) within the red block (time period of interest when precipitation is expected) (Fig. 5).

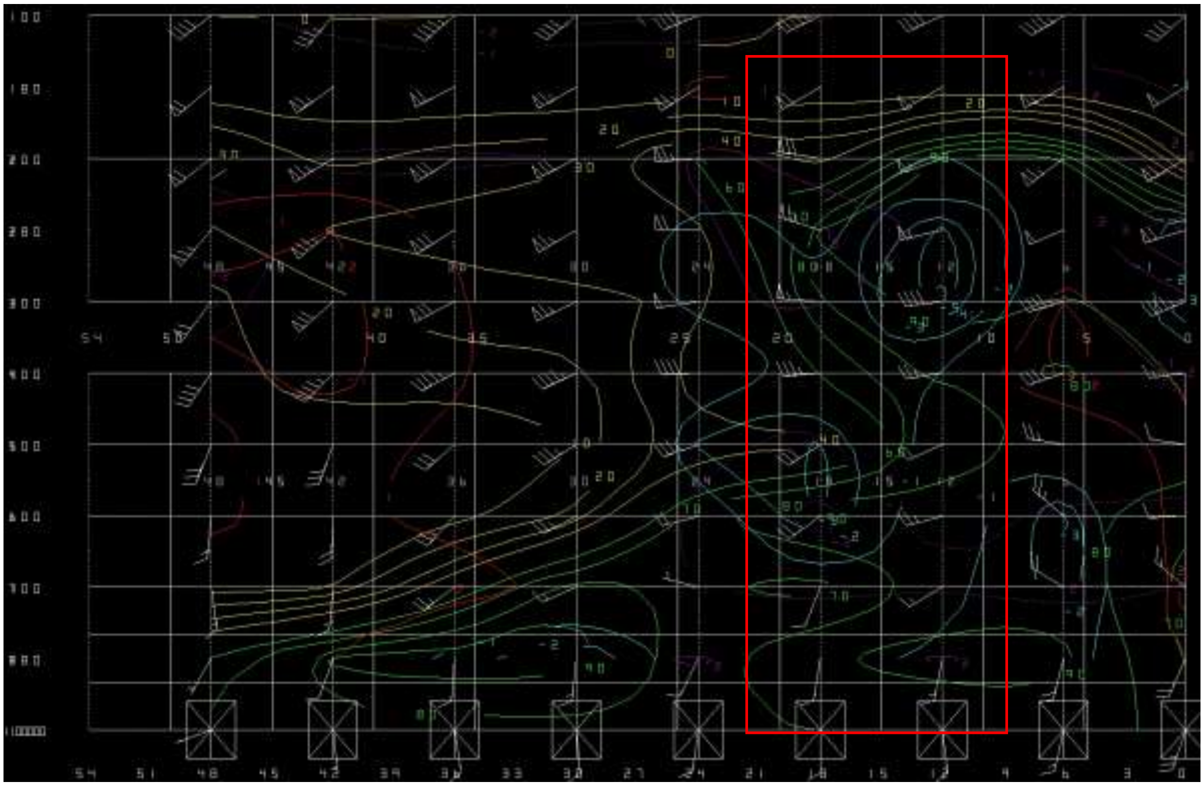


Figure 5: WAFs NWP model output of the vertical atmospheric profile through time (6-hour intervals) at FADN The profile shows vertical uplift (cyan), subsidence (red), moisture (more than 60% in green and less than 30% in yellow), convergence (dashed magenta) and upper level divergence (solid magenta).

Durban is already reporting rain in the 06h00Z METAR (not shown) and the conditions are expected to remain similar and even become more favourable for rainfall after 12h00Z (the starting time of the TAF). For this reason the onset of the rainfall probability in the TAF is chosen to be 12h00Z. The end time is based on the low level moisture that decreases at 21h00Z and the fact that there is no further uplift in the low levels at that time as seen on Fig. 5 above.

On Fig. 6 the orographic uplift (purple) along the escarpment (grey) and the onshore moisture fluxes (yellow), indicate that there is a possibility of rain along the eastern escarpment and coastline due to the strong moisture fluxes and orographic lift.

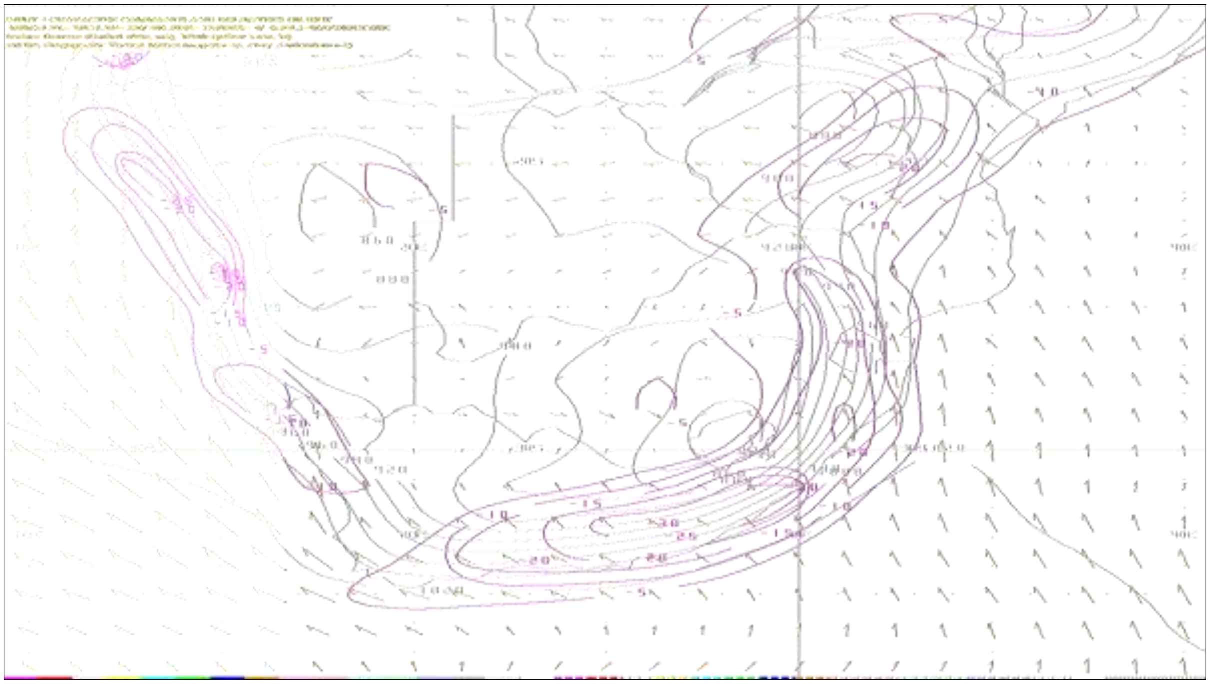


Figure 6: WAFs NWP model output from the 00h00Z model run of orographic uplift over the escarpment valid for 18 October 2007 at 12h00Z. Surface pressure (grey lines), orographic vertical motion (purple lines) and moisture fluxes (yellow vectors).

A horizontal visibility of 4000m is forecast with the moderate rain. Moderate rain usually causes a visibility between 3 and 10km (Table 17). In the Durban 08h00Z METAR light rain was reported with a visibility of 8000m, but in the Trend forecast of the METAR it indicates that there is a 50% chance of a temporary change where the visibility may be reduced to 4000m. An expected reduction in visibility like this will have to be associated with an intensification in the precipitation, therefore the visibility forecast in the Trend, was used in the TAF and the precipitation intensity was also increased due to the moderate rain.

3.4.13 Forecasting Fog or mist (onset and duration) and associated visibilities (AMF 2.1.6) in a TAF

Consider the following TAF: In this particular TAF mist is forecast, although it is caused by stratiform cloud, TEMPO is rather used, as mist and fog normally don't persist for long periods and are temporal in nature over South Africa.

TAF FAOR 180900Z 1812/1918 34012KT 9999 SCT045 FEW045CB

TX26/1812ZTN14/1903Z

TEMPO 1812/1822 2000 TSRA BKN045 SCT045CB

BECMG 1816/1818 15008KT

BECMG 1822/1824 BKN015

PROB40 TEMPO 1902/1906 2000 BR BKN005

BECMG 1906/1908 SCT030

PROB40 TEMPO 1910/1918 4500 TSRA BKN030 FEW030CB

BECMG 1910/1912 29010KT

BECMG 1916/1918 08010KT=

Mist is forecast for the FAOR TAF overnight as there was a light north - easterly wind (white barbs in Fig. 7) due to the ridging high pressure south-east of the country. This high pressure is causing an onshore flow which leads to an increase in the moisture (RH > 80%) in the low levels (850hPa) (cyan lines) and the dew point depression is < 3˚C (yellow lines at yellow cross), but greater than 0˚C as seen in Fig. 7. This is typical for this aerodrome. These are all indications that there is a possibility of mist but most likely very low BKN to OVC low cloud. For fog one would expect RH to be closer to or 100% (dew point depression close to 0 ˚C).

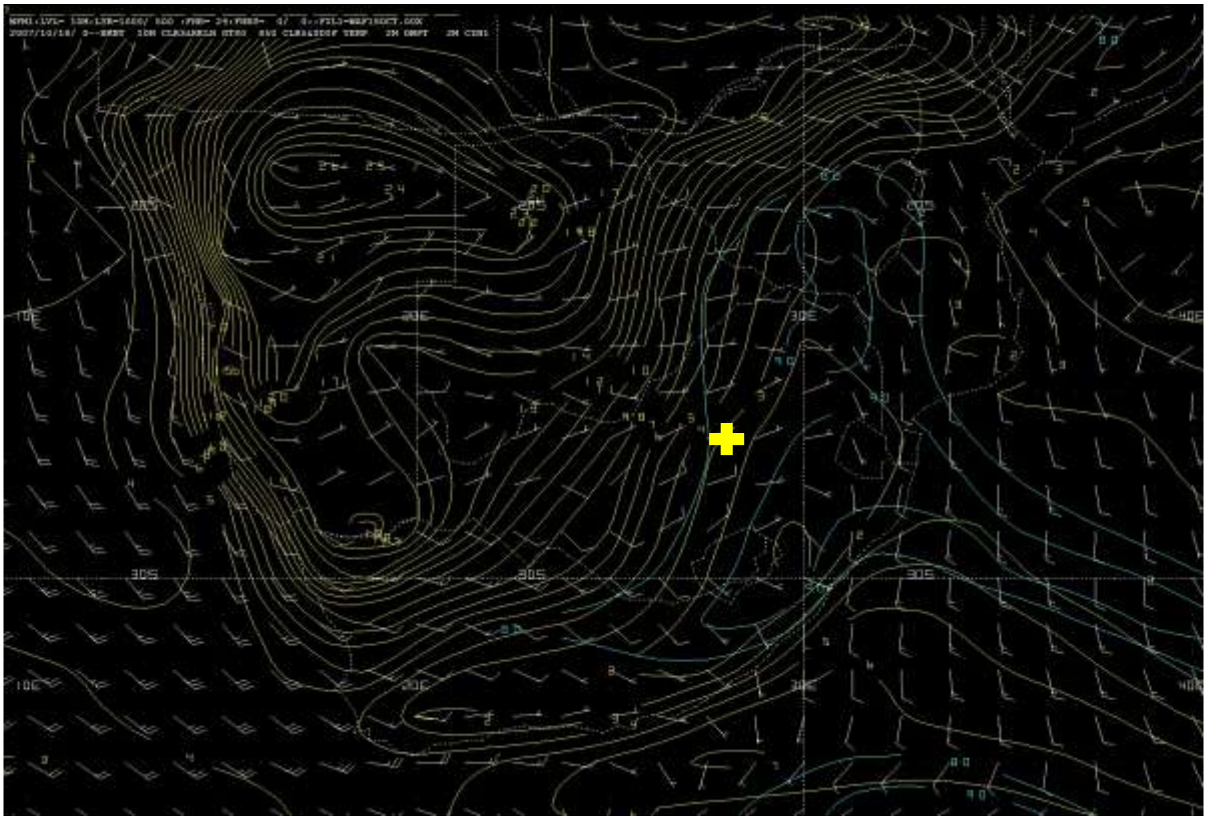


Figure 7: WAFs NWP model output for the 00h00Z model run of relative humidity of greater than 80% at 850hPa (cyan

lines), wind barbs at 850hPa (white) and the dewpoint depression (yellow lines) valid at 00h00Z.

Because mist is forecast visibility has to be between 1000 and 5000m, per definition. The duration time of the mist/fog is chosen based on the climatological history data for the airport which indicates that during summer the fog at the airport occurs mainly between 04h00Z and 07h00Z. The end time is increased with one hour as the NWP is still indicating low level relative humidity's of more than 80% and light north easterly winds at 06h00Z (08h00 SAST).

3.4.14 – Forecasting dust and associated visibilities in a TAF (AMF 2.1.7)

Forecasting dust storms are dependent on the following factors or ingredients:

- Strong winds over a source of dust/sand
- Look for 15-20KT wind at least
- Unidirecitonal wind
- Occurs mostly during the late winter/early spring

There is strong winds over the western interior of the country meeting the first criteria for dust (Fig. 8). These winds are present at 06h00Z, intensified at 09h00Z and was even showing a stronger speed at 12h00Z. The direction stayed the same for NWP time steps between 06h00 and 12h00Zr. The wind speed was also varying between 25 and 30KT. The last important factor was that it was still dry over most of the central interior as the summer season was still starting.

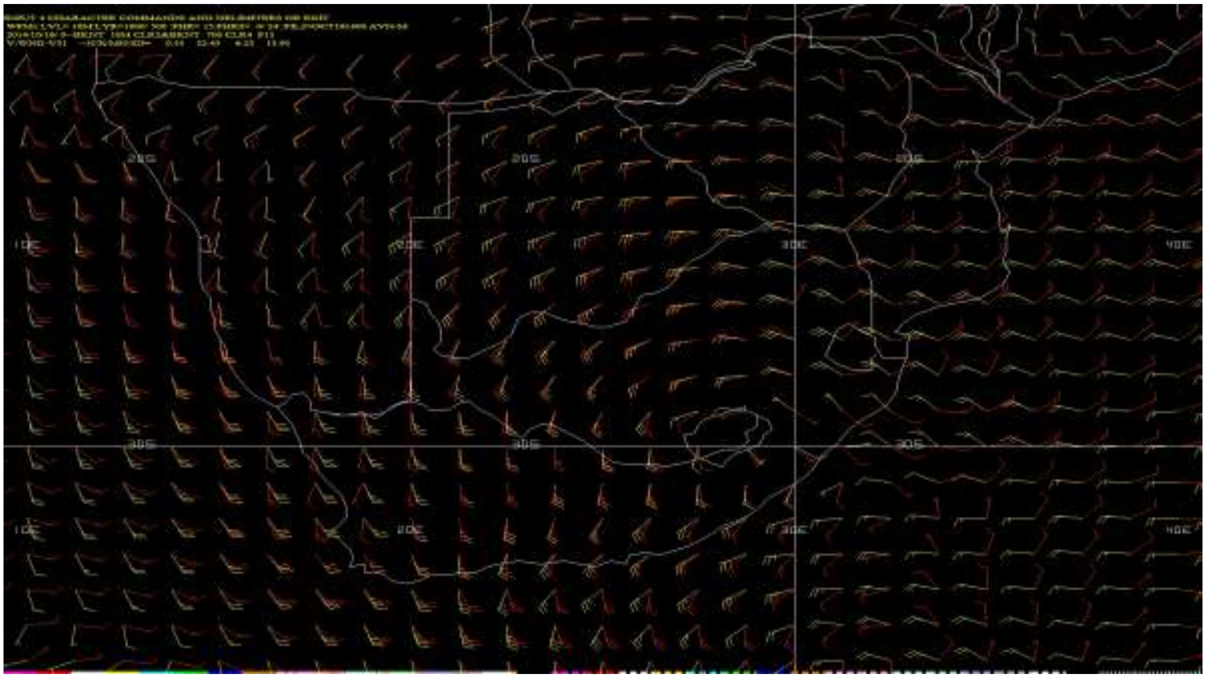


Figure 8: WAFs NWP model output from the 00h00Z model run of the winds at 10m (red) and 700hPa (yellow) valid at 15h00Z.

The western parts of South Africa is also dry throughout the year and the central parts of South Africa is moslty covered by farms, which during winter and spring have many ploughed fields which loose ground/sand. The vertical atmospheric profile over time for the Bloemfontein station (Fig. 9) is used to write the TAF. On the vertical atmospheric profile, the wind changes to 20KT southerly at 15h00Z, and that coincides with the time when there is subsidence throughout most of the troposphere (red lines) , indicating stable conditions, and the wind direction remained unidirectional for the remainder of the TAF period. According to this information, the most probable time for dust according to the NWP would be between 15h00Z and 21h00Z.

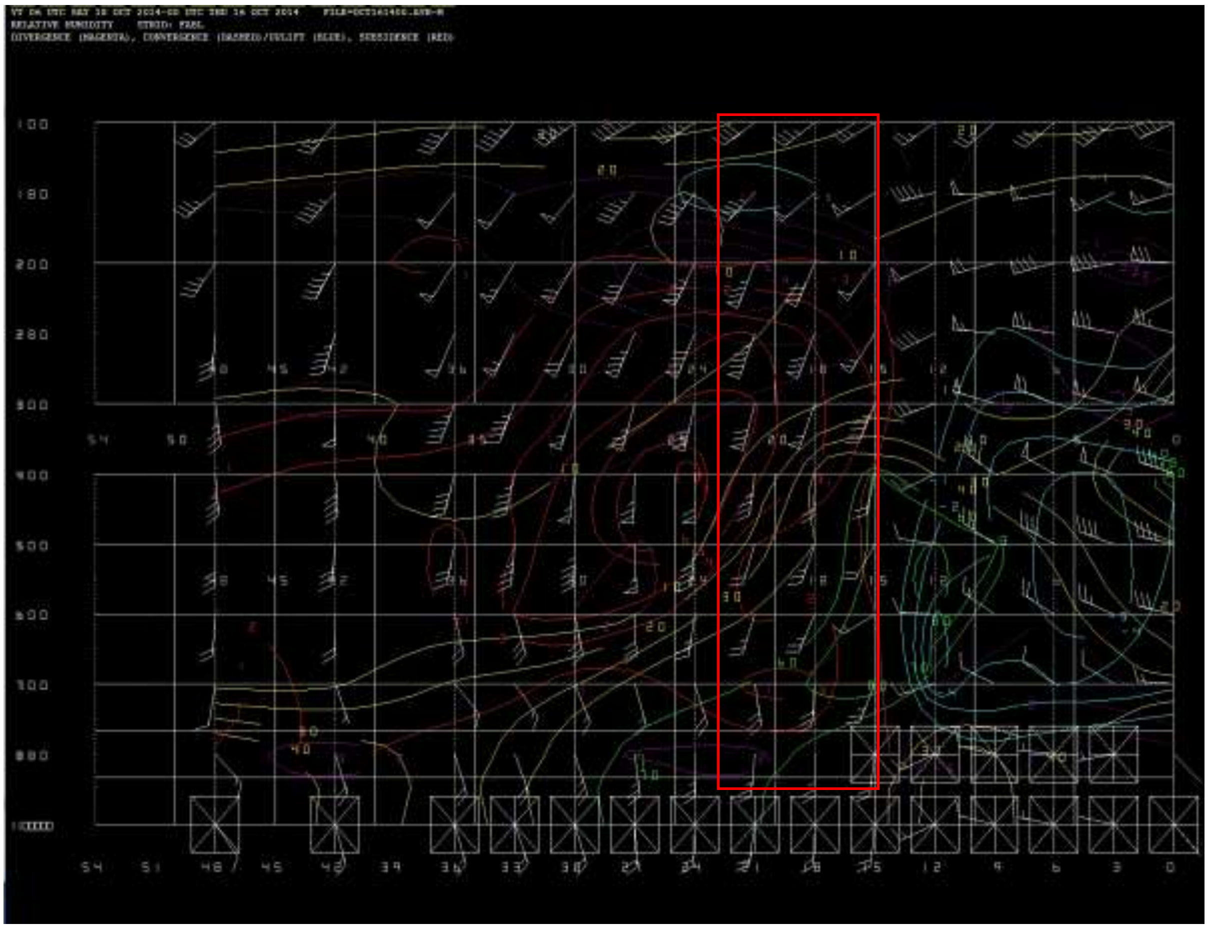


Figure 9: WAFs NWP model output of the vertical profile of the atmosphere through time (3-hour intervals) at FABL. The profile shows vertical uplift (cyan), subsidence (red), moisture (more than 60% in green and less than 30% in yellow), convergence (dashed magenta) and upper level divergence (solid magenta).

The following TAF was written:

TAF FABL 160900Z 1610/1621 27015KT 9999 SCT045

TX21/1612ZTN11/1621Z

PROB30 TEMPO 1611/1614 4000 TSRA FEW045CB

BECMG 1613/1615 18020KT

PROB30 TEMPO 1615/1621 2000 DS=

See section 4.12 on how to warn for dust

3.5 Significant Weather Charts (AMF AC 2.1.1, 2.1.2, 2.1.4, 2.1.5, 2.1.6, 2.1.7, 2.3)

All heights in Significant Weather (SIGWX) charts are given in feet (ft) above mean sea level (a.m.s.l). Visibility is given in meters (m). There are two main SIGWX chart done at the Aviation Weather Centre (AWC) at OR Tambo International Airport:

- Low level chart
- High level chart

Low level significant weather charts contain the following:

- Clouds and weather below flight level 18000 ft.
- Cloud areas delineated by scalloped lines containing information regarding cloud amount, -type, -bases and -tops
- Cloud type, cloud base and top should be well indicated
- Any CB's and only BKN midlevel clouds delineated by scalloped line and containing information regarding cloud amount, -type, -base and –top.
- Significant weather i.e. DZ, RA, TS, SH, SN, FZRA, DU/SA, BLDU/BLSA, BLSN, FG, BR, HZ, FU (Usually widespread).
- Tropical Cyclone (position and center indicated on chart with name in inverted commas alongside while info containing central pressure and expected movement are contained in Additional Information block.
- Cold Front
- Information regarding marked temperature inversions (10°C per 1000ft or more)
- Topography and land features (coast, lowveld, escarpment, highveld, bushveld and mountains) should be considered when giving **cloud bases (AMF AC 2.1.4)** to avoid cloud base below the ground.
- All weather hazards should be clearly indicated using symbols (Icing, Turbulence, Mountain waves, Fog, Mist, etc.). Thunderstorms are indicated by the inclusion of CB.

High-level SIGWX forecasts concentrate on significant en-route weather phenomena of relevance to flights operating at medium and high levels, namely:

a) tropical cyclone;

b) severe squall lines;

c) moderate or severe turbulence (in cloud or clear air);

d) moderate or severe icing;

e) widespread sandstorm/duststorm;

f) Cumulonimbus clouds associated with a) to e) above;

g) flight level of tropopause;

h) jet streams;

i) information on the location of volcanic eruptions which are producing ash clouds of significance to aircraft operations depicted on the chart by the volcanic eruption symbol at the location of the eruption.

j) information on the location of an accidental release of radioactive material into the atmosphere, of significance to aircraft operations, depicted on the chart by the radioactivity symbol at the location of the accident.

The following criteria are used by the WAFCs when including items in the SIGWX forecasts:

a) tropical cyclones, severe squall lines, moderate and severe turbulence, moderate and severe icing, sandstorm/duststorm and cumulonimbus clouds are included if expected to occur between the lower and upper level of the SIGWX forecast;

b) the abbreviation “CB” should be included only where it refers to the occurrence or expected occurrence of cumulonimbus:

1) affecting an area with a maximum spatial coverage of 50 per cent or more of the area concerned;

2) along a line with little or no space between individual clouds; or

3) embedded in cloud layers or concealed by haze.

c) the inclusion of “CB” should be understood to include all weather phenomena normally associated with cumulonimbus clouds, namely, thunderstorm, moderate or severe icing, moderate or severe turbulence, and hail;

d) where a volcanic ash eruption or an accidental release of radioactive material into the atmosphere warrants the inclusion of the volcanic activity symbol or the radioactivity symbol in SIGWX forecasts, the symbols should be included on both high-level and medium-level SIGWX forecasts, regardless of the flight levels to which the volcanic ash column or radioactive material is reported or expected to reach; and

e) in the case of coincident or the partial overlapping of items a), i) and j) in 3.7.2.2, the highest priority shall be given to item i), followed by item j) and a). The item with the highest priority shall be placed at the location of the event, and an arrow shall be used to link the location of the other item(s) to its associated symbol or text box.

Table 9 indicates the time of issue and validity of significant weather charts that are compiled at AWC. The red text highlights the chart that will explained in these course notes.

Table 9: Time of Issue and validity of significant weather charts issued by SAWS

Type of Sig weather Chart issued	Time of Validity	Time of Issue
Low Level and High Level Chart	0000Z	2000Z
Low Level and High Level Chart	0300Z	2300Z
Low Level and High Level Chart	0600Z	0200Z
Low Level and High Level Chart	0900Z	0500Z
Low Level and High Level Chart	1200Z	0800Z
Low Level and High Level Chart	1500Z	1100Z
Low Level and High Level Chart	1800Z	1400Z
Low Level and High Level Chart	2100Z	1700Z

3.5.1 Calculation and placement of freezing level heights (AMF AC 2.1.1) (AMF AC 3.1.4)

Ice accretion is the building up or formation of an ice layer on an aircraft in flight. Icing poses a great danger on aircraft more specially for aircraft without deicing equipment. Icing has been the cause of a number of aircraft accidents. It is therefore very important for the pilot to inquire if there will be any possibility of Icing en-route and how to avoid it during the weather briefing. It is however equally important for the briefing officer or forecaster to accurately forecast any danger of icing and always advice the pilot during briefing and also indicated on the low level Significant weather Chart. The forecasting and warning of icing is dealt with in Chapter 4, section 4.9 of this document.

Consider your observed Tephi/Skew-Tgrams/AMDAR data to obtain the height of the freezing level. Place them on your low-level significant weather chart **rounded down** to the lowest 500 ft (for example 5900 ft becomes 5500 ft and 5400 ft becomes 5000 ft). The rounding down is a safety consideration. If there are no airmass changes in the next 12 hours, these observed values will suffice for the significant weather chart valid for 12h00Z. This is because freezing levels seldom change in response to diurnal heating but rather due to airmass changes caused by weather systems. See Fig. 10 as an example of how and where to place freezing level heights (encircled in red) on a low level significant weather chart.

You need to provide a freezing level height for every Tephi/Skew-T station and AMO (Aviation Meteorological Office) over the country and place it close to that station on the low level significant weather chart **(AMF AC 2.1.1)**. For areas where there are no Tephi/Skew-T grams/AMDAR data, use the NWP model prognostic temperature forecasts to fill the gaps. You shall have freezing level heights placed over the neighboring countries such as Namibia, Botswana, Zimbabwe and Mozambique.

Make sure and check that the freezing levels heights obtained from the NWP model prognostic temperature forecasts (prognostic) fit with those obtained from the Tephi/Skew-T/AMDAR (observed) i.e. there were no airmass changes going to occur in the next 12 hours such as the passage of a cold front, because this will cause a disparity between the observed freezing level heights and the prognostic ones. Remember, the freezing level height, if occurring in cloud will also form the height of the base of your icing layer **(AMF AC 3.1.4)** which will be indicated in your SIGMET/AIRMET warning.

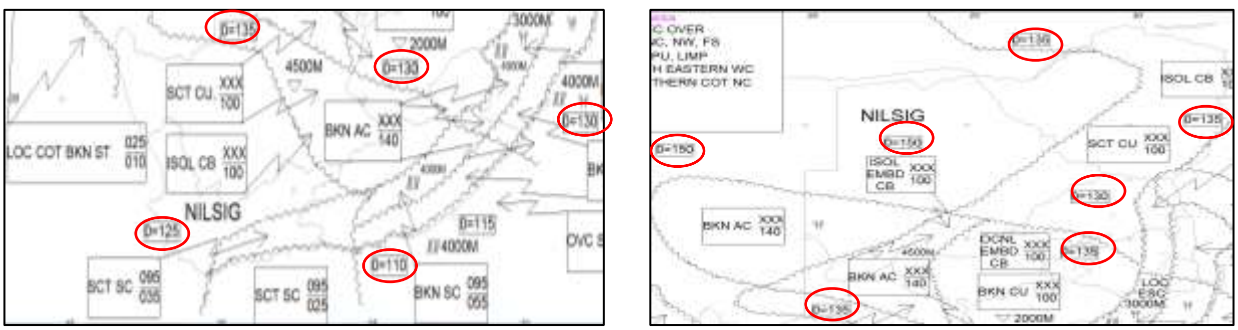


Figure 10: Example of well separated freezing level heights indicated by red circles on a low level significant weather chart.

3.5.2 Calculation and placement of tropopause heights

When adding tropopause height to Sigwx charts it is important to make a distinction between **TROP** and **Tropopause**.

TROP:

- Aviation term and defined as a layer in the atmosphere where, with an increase in height of 2000ft or more, there is no change in temperature.
- Can occur at any level in the atmosphere, below the Tropopause
- When occurring at cruising levels (FL260 to FL450) it can affect aircraft to perform poorly

Figure 11 indicates where one is likely to identify the Trop on a Tephigram.

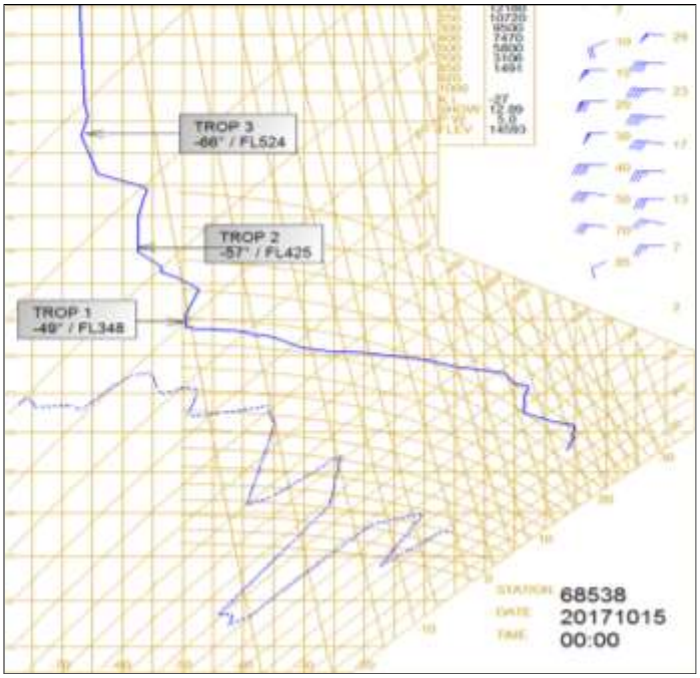


Figure 11: *TROP level identifiable on a Tephigram*

Tropopause is the atmospheric boundary between the Troposphere and the Stratosphere. It is important to monitor the tropopause because day to day changes do occur. There is also an appreciable systematic seasonal changes (greater heights in summer than in winter). The general TREND is that tropopause increases equator-ward and decreases pole-ward. The Tephi/Skew-Tgrams can provide the height of the **Tropopause:**

- An area where the temperature lapse rate drops significantly (temperature becomes semi-constant or increases with height).
- Atmosphere stabilizes abruptly.
- Winds becomes very light.

Consider your Tephigrams/Skew-T and place all tropopause heights on your high level significant weather chart rounded to the nearest 1000 ft (as per Fig. 12). On your Tephi/Skew-T, identify all areas where there is no change in temperature with height, for 2000ft or more. You should provide a TROP and/or tropopause height for every Tephi/Skew-T station and place it close to that station on the chart (note in Fig. 11 Cape Town's value is placed too high).

Use the NWP model to obtain tropopause prognostic heights at 12h00Z for areas without Tephi/SkewTs and compare the NWP to those observed on the Tephi and make sure they make Meteorological sense. The tropopause height increases the further north one moves towards the equator because it is warmer and decreases as one moves towards the south-pole where it is colder. If there is a jet stream in the upper atmosphere, there will be a clear discontinuity in tropopause heights on either side of the jet (lower values to the south of the jet and higher values to the north of the jet). Similarly with the passage of a cold front (lower values behind the cold front and higher values ahead of the cold front).

Airlines have emphasized that the lowest TROP values should be included on the charts. High Tropopause values like FL540, are not of significance to them as commercial aircraft do not operate at these levels.

The highest tropopause values on the chart are drawn as indicated by the red circle in Fig. 11 (56 000ft) while the lowest values are drawn as indicated by the cyan circle in Fig. 11 (40 000ft). If the chart consisted only of high values (56 000ft) then they would all be indicated as the value in the red circle (Fig. 11).

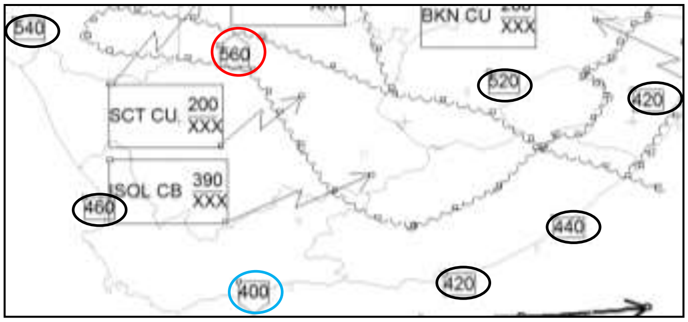


Figure 12: Annotation of how to draw tropopause height on a high level significant weather chart (black circles), tropopause high values (red circle) and tropopause low values (cyan circle).

To determine tropopause height in feet in Wingridds the following command can be used.
HGFT TROP F12
TTTT F12: To determine TROP and Tropopause values from Unified model refer to the following web page: http://cyclone-web.saws.co.za/aero_ximages/trophrho.html indicates UM web page with TROP values.

3.5.3 Placement of the jet stream (AMF AC 2.1.2)

- Is a fast narrow current of air
- Generally form near the tropopause or upper surface of the troposphere
- Can reach up to 200KT or 400km/h
- Characterized by strong vertical and lateral wind shear
- Can be thousands of kilometers long, hundreds of kilometers wide and some kilometers deep but

relatively narrow in cross section.

- Identifying the correct position of a jet stream is very important in weather forecasting because jet Stream influences the weather development.
- It is more crucial for aviation purposes because it triggers turbulence or Clear air Turbulence (CAT) which is dangerous for flying conditions.

Sub -tropical Jet Stream

It is relatively constant in position in a given season.

Polar Jet Stream

It is highly variable in position from day to day over a wide range of temperate latitudes.

A jet stream is normally located ahead of an upper air mid-latitude trough system. It is very often associated with an air mass discontinuity with lower tropopauses to its south and higher tropopauses to its north in the Southern Hemisphere.

Consider if you need to place a jet stream on your high level significant weather chart or not. This is done by studying the NWP model prognostic vector wind valid for 12h00Z (time of validity of significant weather chart) and finding a core of maximum winds greater than or equal to 80KT (remember >= 80KT is the criteria of the Jetstream speed used in aviation) **(AMF AC 2.1.2)**. The line delineating the jet axis begins/ends at the points where a wind speed of 80KT is forecast. Sometimes the jet stream may extend through several layers in the atmosphere. Draw/position the jet according to that flight level where the maximum core speed occurs and place this flight level value directly above the jet stream on your chart for the Southern Hemisphere (P.S. Fig. 13 is for the Northern Hemisphere).

At the start of the jet indicate a core speed of 80 KT. Indicate the maximum core speed of the jet obtained from that flight level where the maximum core speed occurred on the jet. The depth of the Jetstream should be indicated when the wind speed is 120KT or more, and is usually indicated above the flight level value but may be placed elsewhere if the chart is too cluttered.

Provide the vertical limits of the jet stream, only when the core speed is 120KT or more. Consider the upper and lower core bound by considering at which height the vector winds become less than 80KT. This level will form the lower bound of your Jetstream.

The jet stream break is used when the jet stream axis changes by +/- 3000 ft or the speed changes by +-20KT.

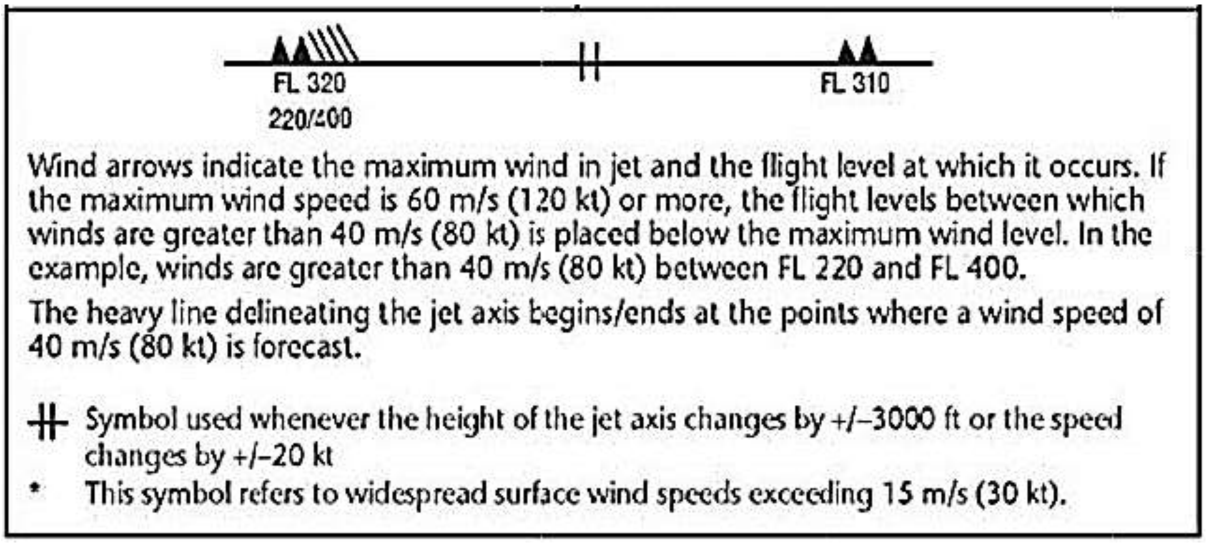


Figure 13: How to annotate the Jetstream on a high level significant weather chart (Latest addition of ICAO Annex 3). Remember wind barbs have to face the opposite direction in the southern hemisphere.

CAT should be annotated by a 'Heavy broken line' (dotted line) in a significant weather chart as indicated in Fig. 14. In some charts both 'solid' and 'broken' lines are used to indicate CAT.

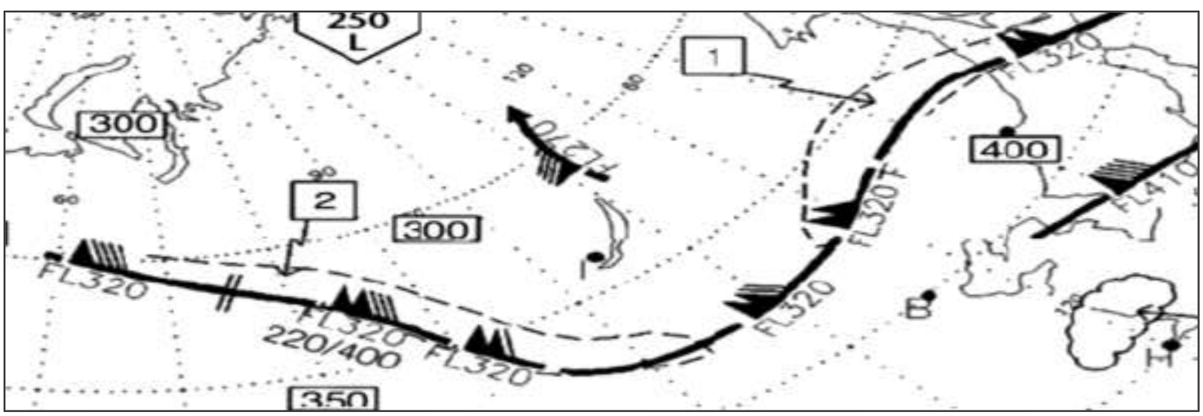


Figure 14: Annotating CAT on a high level significant weather chart in the northern hemisphere

To determine the position of the jet stream in WINGRIDDS the following commands can be used:

WSPK GT80 MAXW F12

JSTR.

WSPK GT80 200 f12

HGFT MAXW F12 (HEIGHT OF THE MAXW LEVEL IN FEET)

3.5.4 Identification of Clear Air Turbulence (CAT) areas (AMF AC 3.1.2)

CAT is a turbulence occurring in a clear atmosphere, not associated with convective clouds or due to rough surface. It might also be associated with thin cirrus clouds if not occurring in clear air. It has been observed in the high troposphere and lower stratosphere, especially in the vicinity of a Jet Stream. Its chief practical significance lies in the acceleration, varying in intensity up to several times gravitational acceleration *g*, which may be imparted to high speed aircraft. CAT is caused by high static stability and large horizontal or vertical wind shear. Orographic effects may also be an important contributory factor.

The forecasting of clear air turbulence (for high level significant weather chart)

Clear air turbulence can be identified by determining if the criteria in Table 11 have been met. Take the NWP model prognostic vector winds and consider the flight level at which you considered the jet stream core to occur.

For <u>horizontal wind speed shear</u>, study the rate of change of wind speed at this flight level in the horizontal (at a fixed level in the vertical), north and south of the jet. Use the answer obtained to draw a dotted line of clear air turbulence around the jet stream (as per Fig. 14). There are lines of latitude in your significant weather chart program as well as the NWP model vector winds, so that you can be guided by that. In your CAT area (small box) on your high level significant weather chart, you will have to identify what are the vertical limits of this CAT layer.

If you use the vector winds, the wind speed difference must be 50KT per 2.5 degree latitude separation for it to cause moderate horizontal wind shear.

If you use the vector winds, the wind speed difference must be 75KT per 2.5 degree latitude separation for it to cause severe horizontal wind shear.

For <u>vertical wind speed shear</u>, study the rate of change of speed in the vertical below and above the Jetstream core. The NWP model vector winds are marked in feet so it is possible to calculate the upper and lower limits i.e. moderate turbulence for 12KT change per 2000 ft (6KT per 1000 ft). CAT normally favours certain weather systems. Know where CAT normally occurs with these weather systems. Note if you have an extreme curved jet such as with a Cut-off low there will always be CAT due to directional shear.

If you use the vector winds, the wind speed difference must be 30KT per 5000 ft separation for it to cause moderate horizontal wind shear.

If you use the vector winds, the wind speed difference must be 45KT per 5000 ft separation for it to cause severe horizontal wind shear.

The following vertical speed shear macros are available for use in NWP:

AMTU. , ASTU. – turbulence for use with WAF and GFS

AMT2. , AST2. – low level turbulence for use with GFS

Table 10: Subjective guide relating moderate and severe CAT to horizontal and vertical wind speed shear

Turbulence	Vertical Speed Shear	Horizontal Speed shear	Directional shear
Moderate	6KT per 1000 ft	20KT per 1˚ of LAT/LON	
Severe	9KT per 1000 ft	20KT per 1˚ of LAT/LON	75˚ and >= 50KT

For **directional wind speed shear** consider when the wind direction changes by >75 degrees and the wind speed is more than 50KT to forecast severe turbulence.

See Chapter 4, section 4.7 for an example on how to forecast and warn for CAT.

3.5.5 Forecasting cloud (AMF AC 2.1.4)

3.5.5.1 Weather systems associated with forecasting Stratiform low cloud (AMF AC 2.1.4)

The major **surface** weather system causing **low,** broken layered cloud is a surface ridging high pressure system which is found behind a cold front. The low-level high pressure system provides the stability necessary to trap the broken low cloud below the low-level inversion. The anticyclonic flow around the Indian high causes an easterly wind, which advects the stable, moist, warm air over the eastern escarpment, causing **orographic broken *Stratus*** cloud to develop. From an aviation point of view it is important to forecast broken/overcast low level cloud as it is hazardous to visual pilots.

If the push is strong enough, broken low cloud can be advected over the highveld of Mpumalanga and Gauteng. Figure 15 indicates such a situation where the high advects moist air over the eastern interior (sold lines).

The RSA, Lesotho, Swaziland and Zimbabwe topography plays a major role in the development of low cloud, mainly over the eastern escarpment mountains and the highveld regions. The low layered stable cloud is associated with light precipitation such as drizzle, ice prisms and snow grains.

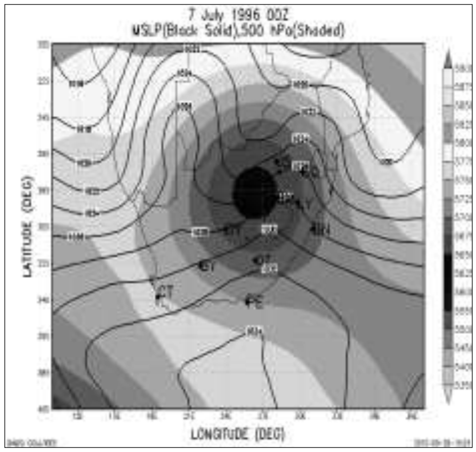


Figure 15: An example of a ridging high pressure system along the east coast of South Africa (Black solid mslp lines) and an upper cut-off low at 500 hPa (Shaded)

Cloud is forecast in TAFs and Significant Weather Charts (low and high level). Consider the following significant weather charts (Fig. 16 and 17) valid for 12h00Z issued at 08h00Z. In the example below, Fig. 16, broken low cloud is forecast along the south and east coast due to a surface ridging high pressure. The process of obtaining the cloud forecast for the Stratiform clouds encircled in blue will now be explained while the next section will deal with the forecasting of mid-level and convective clouds (encircled in red). Broken cloud if low enough can be hazard and needs to be warned for in an AIRMET (See Chapter 4, section 4.15)

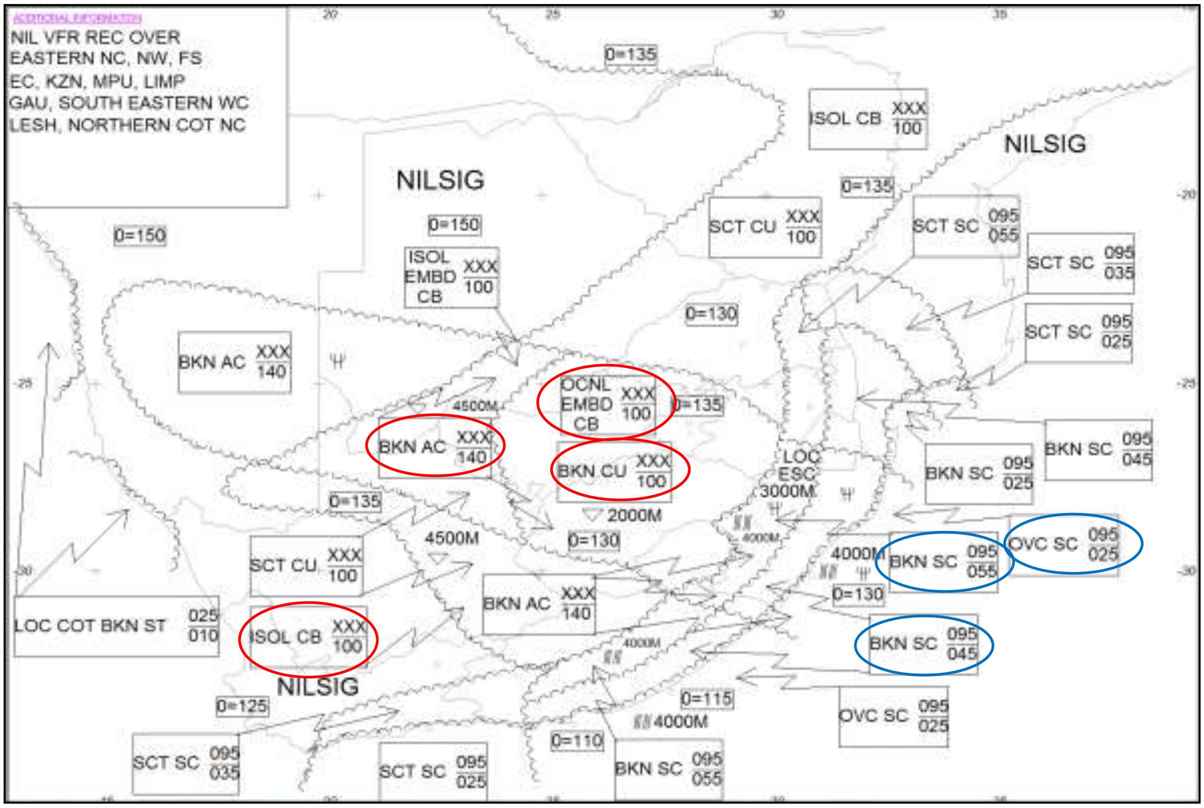


Figure 16: *Low-level significant weather chart valid at 12h00Z and issued at 08h00Z. The blue circles indicate stable stratiform low cloud while the red circles indicate unstable convective low and mid level cloud.*

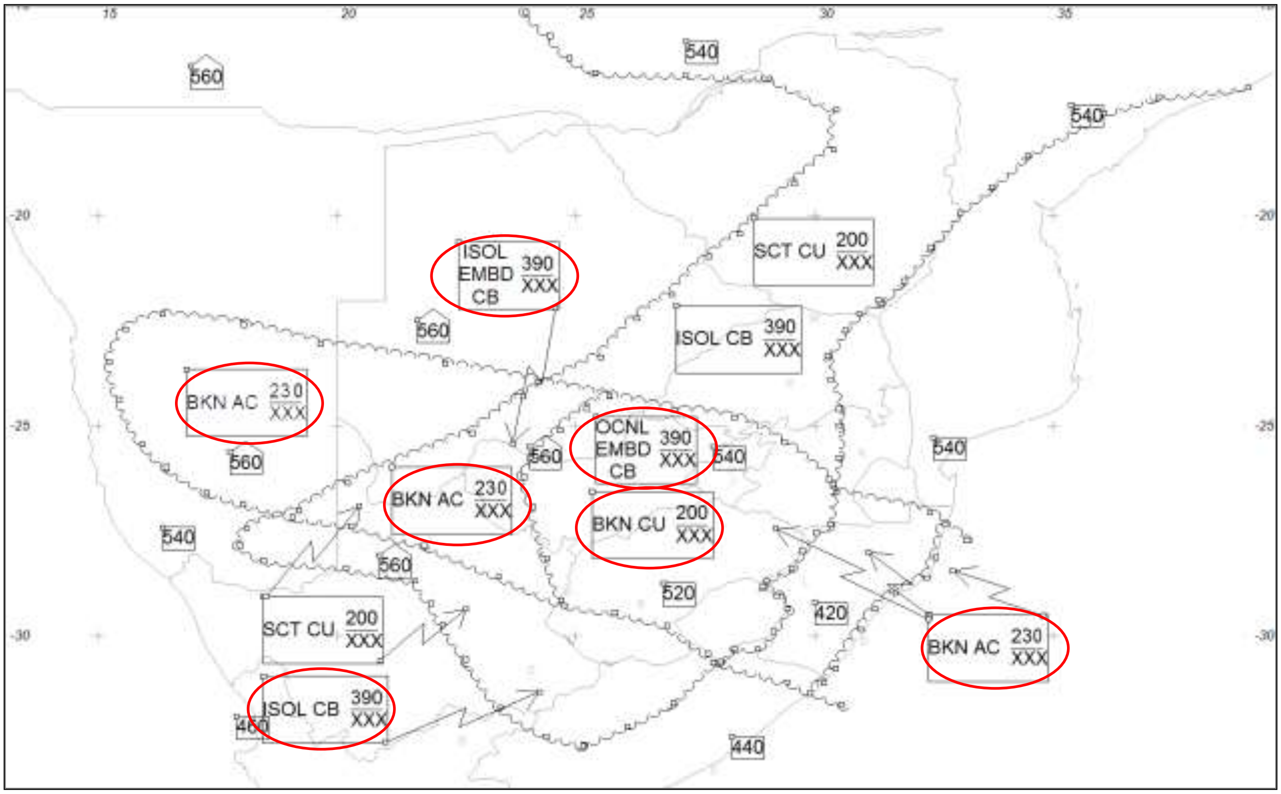


Figure 17: High-level significant weather chart valid at 12h00Z and issued at 08h00Z. The *red* *circles indicate unstable convective cloud.*

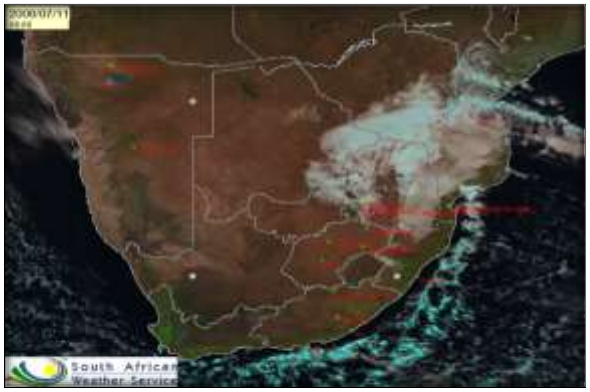
3.5.5.2 Method and example of how to forecast Strati-form low cloud aerial extent and cloud amount (AMF 2.1.1 and 2.1.4).

The Method:

First investigate the low cloud type (AMF AC 2.1.4) (Is it stratiform?). The cloud type is evaluated by looking at the Day Natural Colours RGB satellite image in Fig. 18 (left). The low cloud is Stratocumulus cloud due to the layered cloud appearance with embedded small clumpy cells. The cloud amount is at least **broken**. As previously stated, the focus is on forecasting significant low level cloud which is broken/overcast due to the hazard it poses to visual pilots.

Evaluate the aerial extent of the forecast **broken** low stratiform cloud:

Compare the 06h00Z Day Natural Colors (DNC) RGB satellite image area of broken cloud (Fig. 18 left) with the 850 hPa RH % value corresponding to that area broken cloud at 06h00Z on the DNC image (Fig. 18 right).



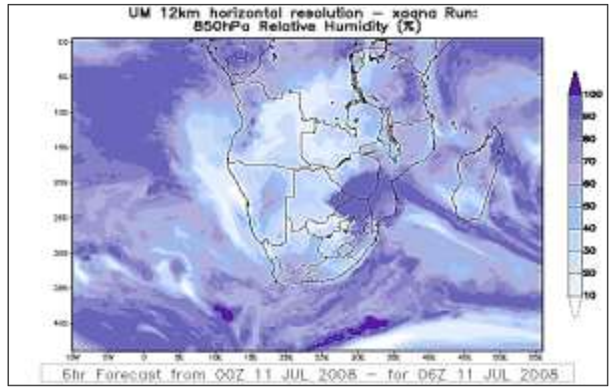


*Figure 18: **06h00Z** Day Natural colours RGB (left) compared with the 850 hPa RH **06h00Z** forecast for the UM 12 km NWP model initialized at 00h00Z.*

From the 850hPa RH field at **06h00Z** (Fig. 18 right), the aerial extent of the RH value of > 80-90% corresponds with the aerial extent of the low level **broken** strati-form cloud observed in the **06h00Z** DNC satellite image (Fig. 18 left) (Note: In another case the RH % value corresponding to the aerial extent of **broken** cloud might be different).

Forecast the aerial extent of broken stratiform cloud:

The RH value of > 80 - 90% at the 850hPa pressure level is used to give a predicted aerial extent (cloud boundary) of **broken** cloud at 12h00Z (NWP 850hPa RH field valid for 12h00Z not shown). Values less than 80% are considered scattered cloud or nil (not significant). The forecasting of this cloud (Relative humidity) provides evidence of AMF AC 2.1.1 (and 2.1.4 which requires the forecasting of humidity and cloud. The emphasis is on forecasting broken cloud (See Chapter 4, section 4.15).

Example of method applied in section 3.5.5.2:

Applying the method explained above to the aerial extent of broken low cloud on the low level significant weather chart in Fig. 16. Low level stratiform cloud can be clearly identified on the DNC satellite image.

The NWP model forecast of the the aerial extent (2.1.4) of relative humidity at the 850 hPa pressure level at 06h00Z (Fig. 19 right) is compared to the corresponding aerial extent of **broken** low cloud on the Day Natural Colours RGB satellite image at 06h00Z (Fig. 19 left).

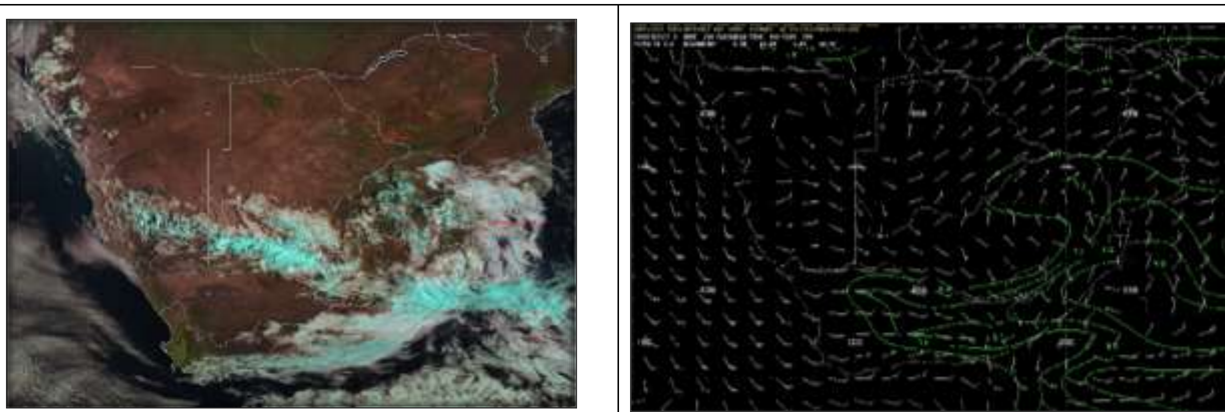


Figure 19: WAFs NWP model output of the relative humidity at 850hPa (%) and the winds (barbs) at 10m (yellow) valid at 06h00Z (right) Copyright EUMETSAT. Day Natural Colours RGB image valid 06h00Z (left).

The aerial extent of RH of 70% at the 850hPa pressure level (Fig. 19 right) corresponds well with the aerial extent of broken low cloud as seen on the DNC satellite image in Fig. 19 left. These low clouds owe their existence due to the onshore flow from the Indian High pressure system as previously discussed.

For the 12h00Z forecast, the 70% RH value in Fig. 20 is now used to forecast the aerial extent of **broken low level** cloud which will then be demarkated in the low level significant weather chart valid for 12h00Z.

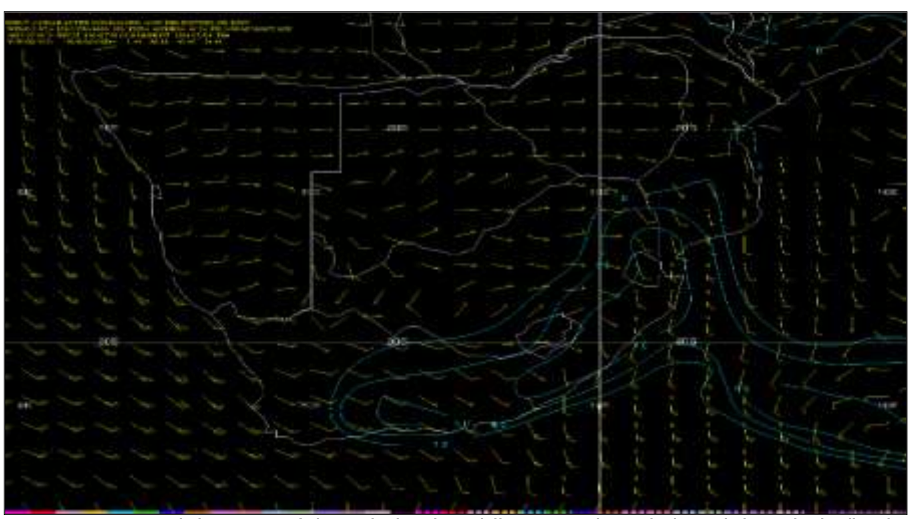


Figure 20: WAFs NWP model output of the relative humidity at 850hPa (%) and the winds (barbs) at 10m (yellow) valid at 12h00Z.

The aerial extent of the broken low level cloud thus forecast to spread up to the escarpment and the cloud base height is lifted over the interior as the height of the cloud bases have to be above the ground level (see low level significant weather chart in Fig. 16) and next section.

3.5.5.3 Method and example of how to forecast Strati-form low cloud base height (AMF AC 2.1.4):

There are 2 methods that can be used here.

1) **Method 1 - Common Sense Method:** is used to identify cloud (amount, base and vertical extent) at the time of the observed ascent or on a prognostic NWP model ascent. A minimum RH value of > 60% is used to discriminate where cloud is likely to occur. On a Tephi/Skew T gram this equates to 6 degrees of separation between the temperature and the dew-point.
2) **Method 2 - Lifting of broken/overcast cloud base height due to minimal surface heating:** Consider the height of the cloud base on the METAR at 08h00Z and lift the cloud base by 500ft to compensate for surface heating in the next few hours.

The topographical map (Fig. 21) needs to be used in order to accurately forecast stratiform cloud base height above mean sea level (AMF 2.1.4) on a low level significant weather chart.

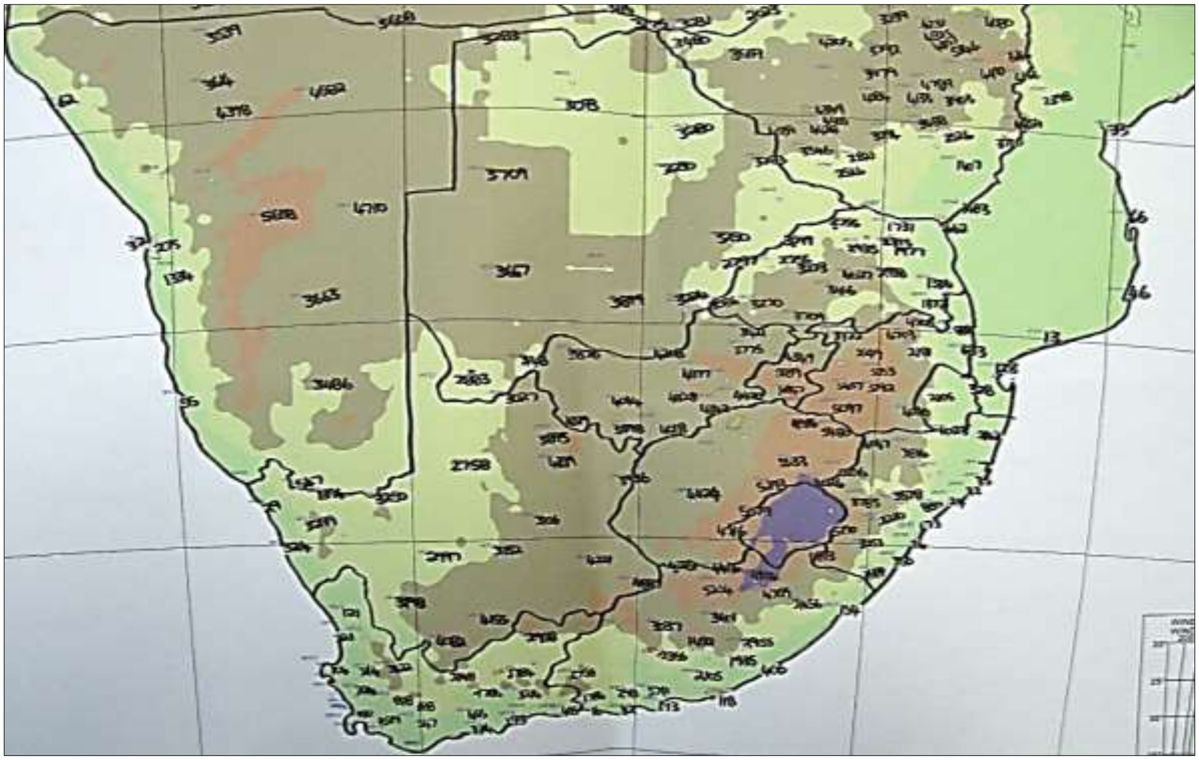


Figure 21: Topographical map of Southern Africa indicating station heights in ft above sea level.

Example of method (2) applied:

Determining the cloud base height (AMF AC 2.1.4) along the coastline for the low level significant weather chart in Fig. 16 is done by considering the latest available observational data (In this particular case it is the 08h00Z METARS).

METAR FADN 180800Z 21009KT 5000 –RA SCT006 **OVC025** 19/17 Q1024 TEMPO 4000 RA=

METAR FAGG 180800Z 070009KT 040v110 9999 SCT008 **BKN025** 17/14 Q1026=

METAR FAEL 180800Z 17009KT 8000 BKN018 **OVC025** 16/13 Q1027=

METAR FAPE 180800Z 14009KT 9999 **SCT025** OVC040 18/12 Q1027 NOSIG=

From the METARs, the average lowest cloud base height which is broken is 2500ft above ground level along the coastline, and since this broken low cloud is expected to persist throughout the day (forecast not shown), the cloud base height at the coast is chosen as 2500ft above mean sea level (no heating). As the cloud is expected to break up due to heating from below, the cloud base height is **lifted by 500 ft**. The low cloud base height is also lifted over the interior to account for the height of the escarpment by using the altitude of the stations (Fig. 21) as well as the following 08h00Z METARS:

METAR FAPM 180800Z 19005KT 9999 **OVC020** 17/12 Q1025=

METAR FAUT 180800Z 11008KT 9999 FEW008 **OVC020** 15/13 Q1026=

Pietermaritzburg (FAPM) and Umthata (FAUT) both fall into the first interior cloud boundary as shown on the low sigweather chart (Fig. 16) and this region has an average altitude of 2500ft a.m.s.l (Fig. 21). Therefore the observed cloud base height in this region is increased by 2500ft to arrive at a height of 4500ft a.m.s.l for the interior just adjacent to the coastline. The third low cloud boundary that is against the escarpment is lifted with another 1000ft (unfortunately no cloud base observation is available in this region to validate the cloud base height with). Areas with broken to overcast cloud base height < 1000 ft must be warned for in an AIRMET. See Chapter 4, section 4.15. Consider whether or not the cloud base height is below the freezing level height in which case this cloud base height will become the base height of your icing layer. See Chapter 4, section 4.9 on the forecast and warning of aircraft icing.

3.5.5.4 Method and example of how to forecast: Strati-form low cloud top height (AMF AC 2.1.4):

The following method can be used to obtain cloud top height or vertical extent of the low stratiform cloud. Determine the cloud top temperature of the layered cloud on the IR 10.8 satellite picture and relate it to a height above mean sea level in the NWP model. This method can also be applied to observational real time data such as AMDAR, instead on NWP.

Firstly, determine the cloud top temperature on the IR 10.8 satellite image at 06h00Z (Fig. 22 left). The IR10.8 image in Fig. 22 (left) shows a cloud top temperature of 5.87°C around the Limpopo river (cross hair). This cloud top temperature of the low cloud is compared to the temperature in the NWP model valid at 06h00Z.

The question now needs to be asked. What NWP model pressure level, temperature value corresponds to the temperature obtained in the IR 10.8 satellite image? In this particular case it is the 700 hPa pressure level, where the temperature value (Fig. 22 right) corresponds with the temperature value in the satellite image (5.87°C) at the same location (Limpopo river).

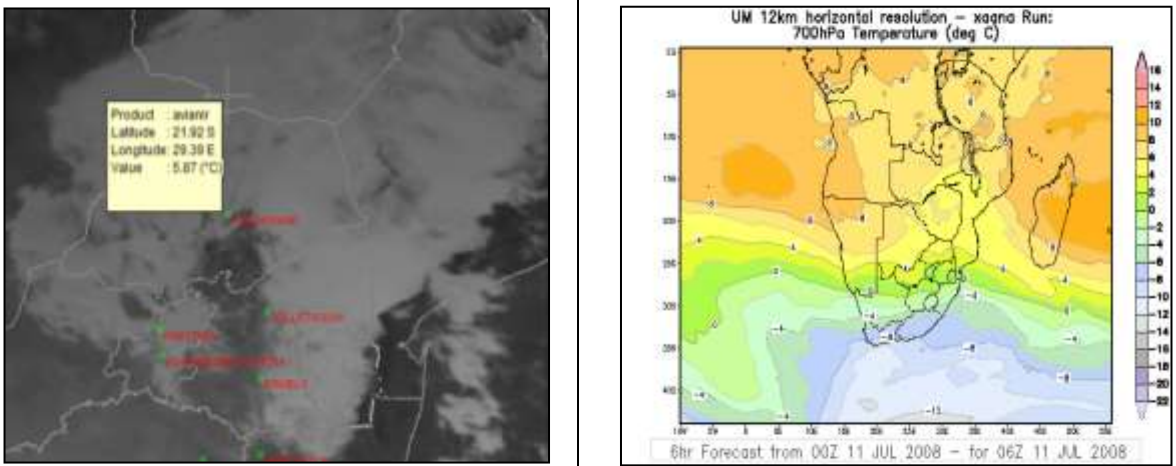


Figure 22: IR 10.8 satellite image valid at 06h00Z indicating the temperature value at the cross hair point (left) and the 700 hPa UM 12km temperature forecast valid at 06h00Z for the model initialized at 00h00Z (right)

The result is the cloud top height is at 10000 ft a.m.s.l at 06h00Z. The 12h00Z NWP 700 hPa pressure level temperature field is now used (Fig. 23) since a forecast of cloud top height needs to be produced for 12h00Z. The temperature at 12h00Z in the same area is still valid, which corresponds with a height of about 10 000ft a.m.s.l.

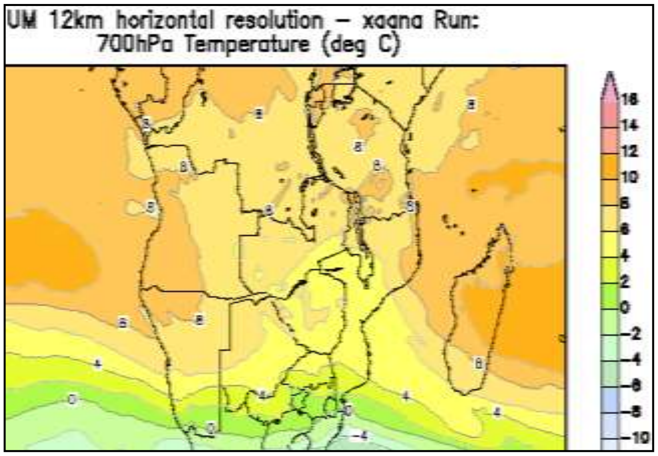


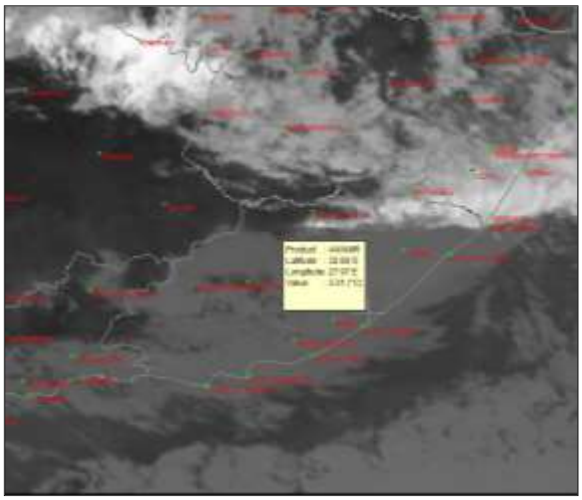
Figure 23: Forecast for 12h00Z for the 700 hPa Temperature for the UM 12km NWP model initialized at 00h00Z

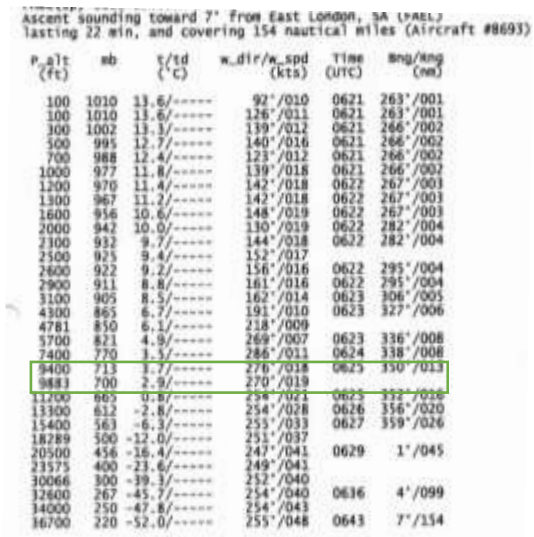
Consider whether or not the cloud top height is below the freezing level height in which case this height will become the icing layer top height. See Chapter 4, section 4.9 on the forecast and warning of aircraft icing.

Example of method applied:

This example is shown using AMDAR or real time data instead of NWP data.

The cloud top height of the broken cloud at 06h00Z is determined by using the IR10.8 cloud top temperature in Fig. 24 and comparing it to the the AMDAR data (or any other data source) at a similar time for that area to find the height of the cloud top. Since Stratocumulus cloud is a layered cloud, the cloud top height will have a similar cloud top temperature everywhere (it has no vertical growth and is flat like a pancake when viewed from above). The IR10.8 satellite image shows a cloud top temperature of 3.31˚C around East London and along the coast (see cross hair in Fig. 24).





Ascent sounding toward 7° from East London, SA (FAEL)
lasting 22 min, and covering 154 nautical miles (Aircraft #8693)

P_alt (ft)	mb	t/td (°C)	w_dir/w_spd (kts)	Time (UTC)	Bng/Rng (nm)
100	1010	13.6/-----	92°/010	0621	263°/001
100	1010	13.6/-----	126°/011	0621	263°/001
300	1002	13.3/-----	139°/012	0621	266°/002
500	995	12.7/-----	140°/016	0621	266°/002
700	988	12.4/-----	123°/012	0621	266°/002
1000	977	11.8/-----	139°/018	0621	266°/002
1200	970	11.4/-----	142°/018	0622	267°/003
1300	967	11.2/-----	142°/018	0622	267°/003
1600	956	10.6/-----	148°/019	0622	267°/003
2000	942	10.0/-----	130°/019	0622	282°/004
2300	932	9.7/-----	144°/018	0622	282°/004
2500	925	9.4/-----	152°/017		
2600	922	9.2/-----	156°/016	0622	295°/004
2900	911	8.8/-----	161°/016	0622	295°/004
3100	905	8.5/-----	162°/014	0623	306°/005
4300	865	6.7/-----	191°/010	0623	327°/006
4781	850	6.1/-----	218°/009		
5700	821	4.9/-----	269°/007	0623	336°/008
7400	770	3.5/-----	286°/011	0624	338°/008
9400	713	3.7/-----	276°/018	0625	350°/013
9883	700	2.9/-----	270°/019		
11200	665	0.8/-----	254°/021	0625	352°/016
13300	612	-2.8/-----	254°/028	0626	356°/020
15400	563	-6.3/-----	255°/033	0627	359°/026
18289	500	-12.0/-----	251°/037		
20500	456	-16.4/-----	247°/041	0629	1°/045
23575	400	-23.6/-----	249°/041		
30066	300	-39.3/-----	252°/040		
32600	267	-45.7/-----	254°/040	0636	4°/099
34000	250	-47.8/-----	254°/043		
36700	220	-52.0/-----	255°/048	0643	7°/154

Figure 24: IR 10.8 satellite image at 06h00Z (left) indicating the cloud top temperature at the cross hair over the Eastern Cape around East London and AMDAR data for East London valid at 06h21Z (right). Red block indicates the area of interest.

This temperature value obtained from the sattelite image corresponds to a height of between 9400ft and 9880ft on the AMDAR data (Fig. 24 left). Therefore a height of 9500ft is chosen as the cloud top height for the Stratocumulus cloud. As the cloud is stable (cloud will not grow vertically), the cloud top height will not change much as the day progresses, and can thus be used for 12h00Z.

3.5.5.5 Method and example of how to forecast: Convective low cloud – amount and horizontal (aerial) extent (AMF 2.1.4)

When compiling convective cloud boundaries on significant weather charts, ensure that the cloud boundaries, which extend from the low-level to the high level chart are exactly the same.

Before one starts to forecast convection, one needs to analyze and diagnose the weather situation. Identify the location of the surface and upper trough axis (the axis occurs where there is maximum cyclonic curvature). In Fig. 25 - thunderstorms will develop to the east of this surface/upper air trough axis.

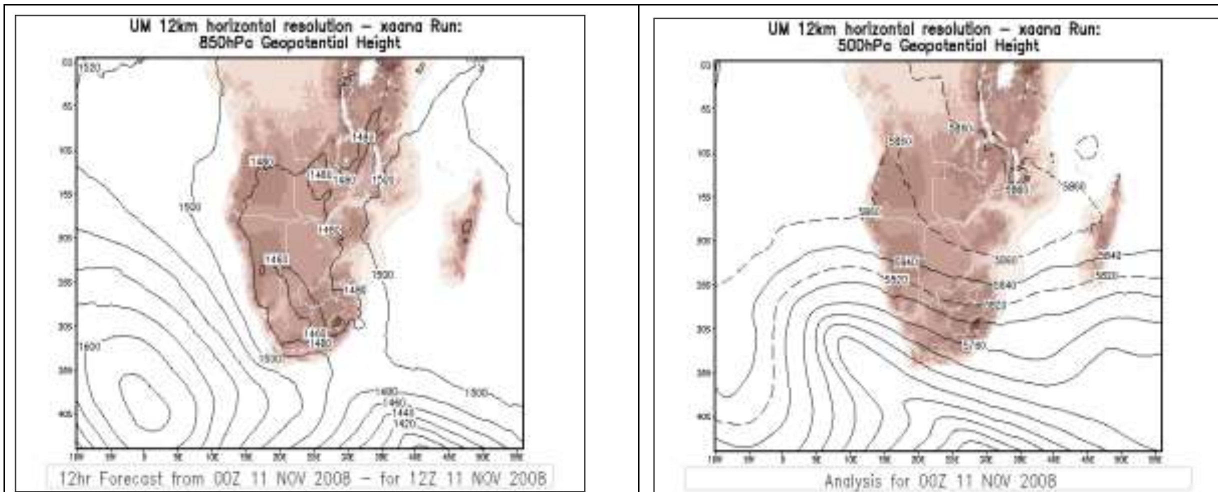


Figure 25: 12h00 hr forecast for 850 hPa Geopotential Height (left) and 00h00 hr analysis field for the 500 hPa Geopotential Height (right)

Thunderstorms require three main ingredients to develop namely instability, moisture (up to at least 700 hPa) and a lifting mechanism (trigger such as dryline).

N.B: <u>If any one of these 3 ingredients are missing, then thunderstorms will not develop.</u>

The process to forecast convective cloud amount and horizontal extent (red circled CB clouds in Fig. 16 and 17), are based upon finding all three necessary ingredients for thunderstorm development, which are moisture, instability and a trigger mechanism.

The **<u>first ingredient</u>** to be considered for convective cloud and therefore thunderstorm development, is moisture in the lower levels (at least up to 700 hPa). For this relative humidity of greater than 40% at 700 hPa is considered as seen by the cyan lines in Fig. 25 (60% is better but for convective cloud not as much RH is needed as compared to layered Stratiform cloud). The red dotted line is a dryline, which seperates dry air in the west from moister air in the east.

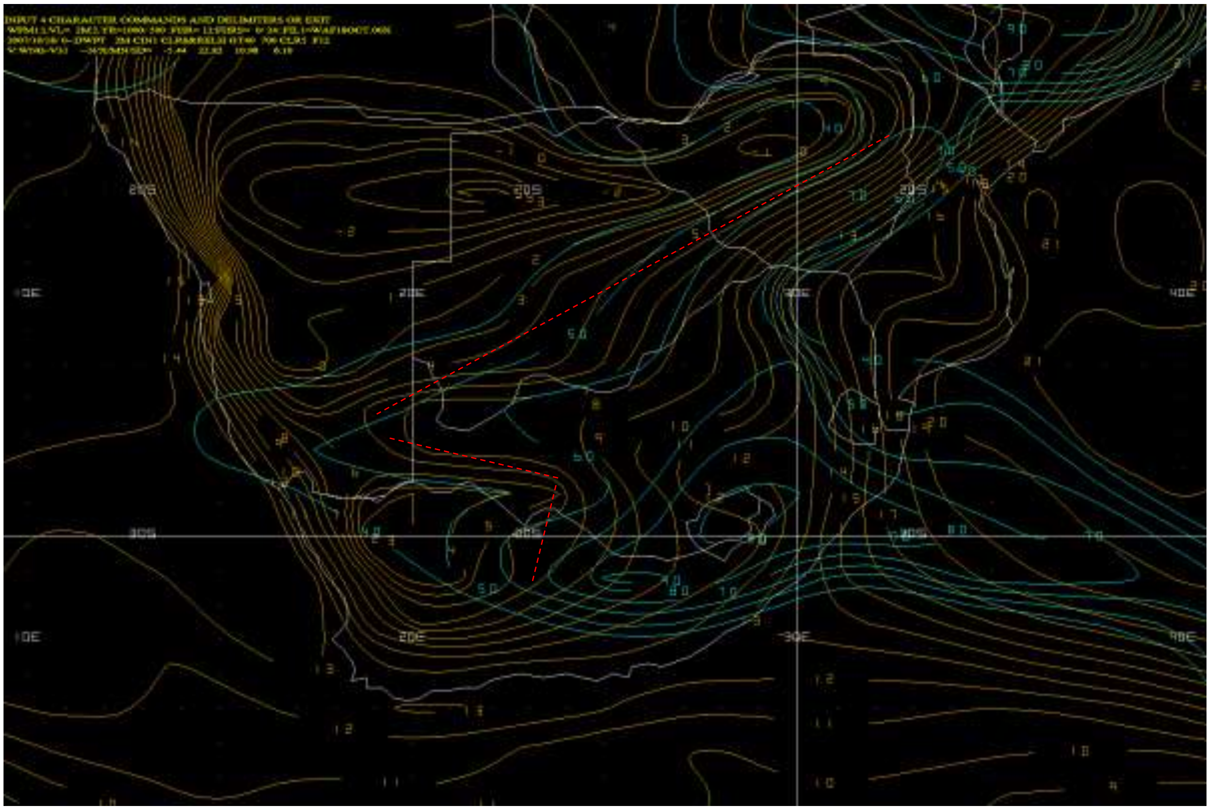


Figure 26: WAFs NWP model output of the relative humidity at 700hPa (%) (cyan) > 40% and the 2m dewpoint temperature (brown) valid for 12h00Z. The red dashed line indicates the position of dryline which acts as a trigger.

The **second ingredient** that is considered is the instability, and for this the K-index, Lifted-index, Showalter-index and Total totals-index are considered, see Fig. 27.

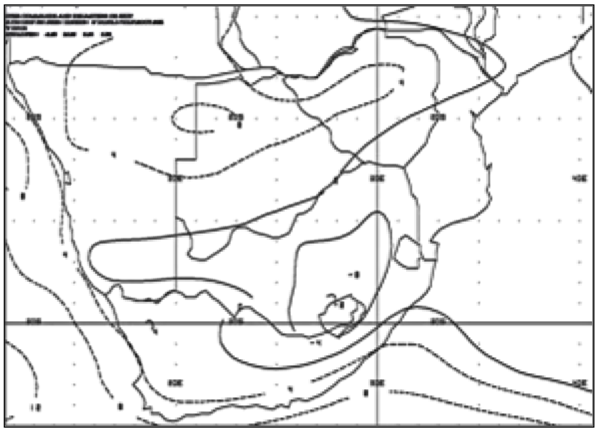
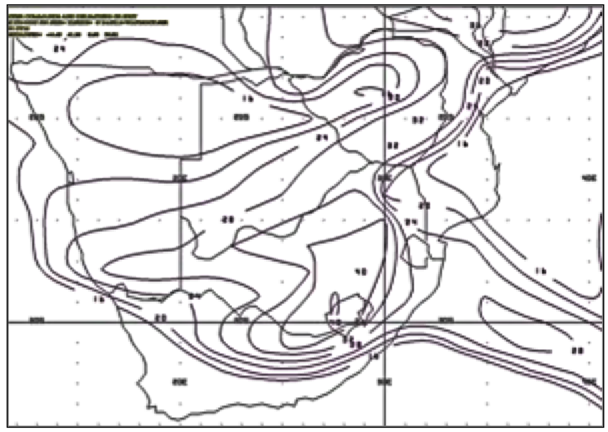
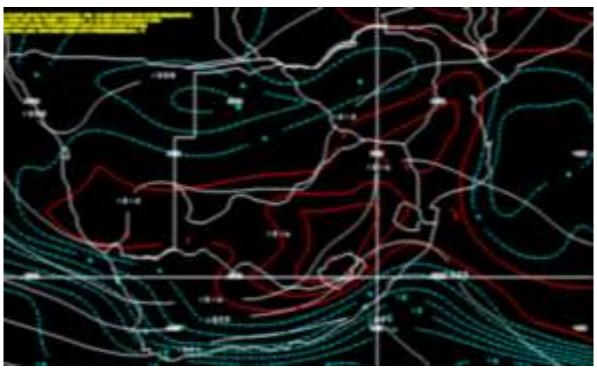
Lifted index	K-Index
	
Showalter index	Total of totals index
	

Figure 27: WAFs NWP model output of the instability indices: Lifted-index (top left) , K-index (top right), Showalter-index (bottom left) and the Total totals-index (bottom right) valid at 12h00Z.

The instabillity indice values that are unstable are indicated in Table 12: Moderate/'low storm likelihood' instabilities are included in the isolated CB and thunderstorm region while the extreme/'Very unstabe' /severe instabilities are included in the occasional CB and thunderstorm region as there is a much greater chance of convective development (see Fig. 16 and 17).

Table 11 SAWS instability criteria for different indicies used in thunderstorm forecasting

LIFTED INDEX	0 to -2 -3 to -5 <-5	Thunderstorms possible, need a good trigger Unstable, Thunderstorms probable Very unstable good thunderstorm potential	$LI = T_{500} - Tp_{500}$
SHOWALTER INDEX	>3 1 to 3 0 to -3 -4 to -6 <-6	Stable Thunderstorm possible, need a good trigger Moderately unstable, probable thunderstorm Very unstable, heavy thunderstorm probability Extremely unstable, strong thunderstorm potential	$SI = T_{500} - Tp_{500}$
K INDEX	<30 30 to 40 >40	Low storm likelihood Better Thunderstorm potential, possible heavy rain Severe thunderstorms most likely	$KI = (T_{850} - T_{500}) + Td_{850} - (T_{700} - Td_{700})$
TOTAL TOTALS INDEX	45 to 50 50 to 55 55 to 60	Thunderstorms possible Strong to severe storms most likely Severe thunderstorms most likely	$TT = T_{850} + Td_{850} - 2T_{500}$

(SAWS, 2013[1])

After analysing the instability indices, the central and north-eastern interior are identified as favourable areas for convective development, with the central interior consisting of Eastern North West, Free State, Lesotho, Gauteng, and western Mpumalanga indicating moderate to strong instabilities – therefore this area is considered as more favourable for Cumulonimbus cloud and thunderstorm development and is therefore included in the occasional CB and thunderstorm area (see Fig. 16 and 17). The areas with lower instabilities are included in the isolated thunderstorm and CB area.

The **third ingredient** that is considered for the convective cloud and thunderstorm area is a trigger mechanism, for this the following fields are considered which are east of the surface and upper air trough as well as east of the dryline: low level convergence (cyan), upper level divergence (red) and vertical uplift (yellow) is considered, see Fig. 28.

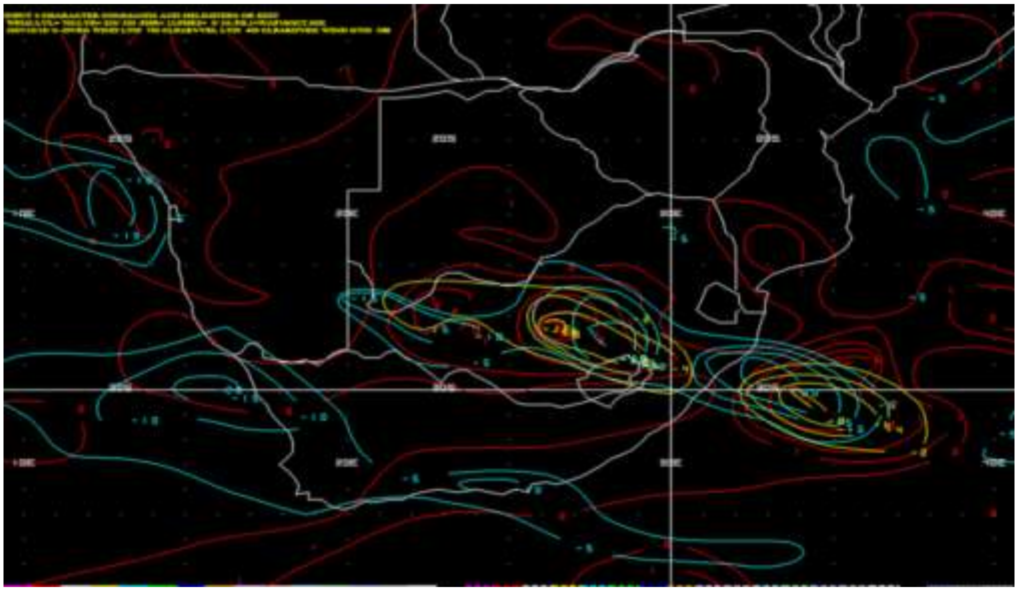


Figure 28: *WAFs NWP model output of low level (850hPa) convergence (cyan), upper level (300hPa) divergence (red) and mid-level (500hPa) vertical uplift (yellow) valid for 12h00Z.*

The position of the dryline is considered, as that acts as a trigger for convective development, notice the tight gradient of dew point temperature (brown) lines in Fig. 26. East of the Dryline is where one would expect convective development to occur (see red dashed line on Fig. 26). The concentration of trigger mechanisms are located over the central regions of South Africa, in a similar area where the instabilities are moderate and strong. The horizontal or aerial extent of the thunderstorm region is based on the areas where the moisture (RH ≥ 40% at 700 hPa) overlaps with instability (weak, marginal and strong) and which has either the dryline as trigger or areas of convergence, divergence and uplift east of the surface and uper air trough (Fig. 28). The convective cloud boundaries can be seen on the significant weather charts in Fig. 16 and Fig. 17.

3.5.5.6 Method and example of how to forecast: Convective low cloud amount (AMF 2.1.4)

The distinction between isolated and occasional CB clouds associated with thunderstorms is based on the amount of instability (only moderate to strong instabilities considered) overlapping with Dines compensation (see Fig. 28 above). To determine the amount of CBs, consider the amount of CBs expected or already present on the sat pic, this will guide you as to giving isolated (ISOL) or occasional (OCNL). In NWP OCNL can be forecasted when favorable convective parameters overlap in an area of instability and moisture.

Frequent CB (more than 70% distribution) (FRQ CBs) normally occur around a Tropical Cyclone or in the ITCZ.

Embedded CB clouds and thunderstorms are forecast in a case where there is broken mid-level cloud, or when occasional or frequent CB clouds are being forecast since there will then be at least broken Cumulus clouds and there will be mid-level Altocumulus clouds forming as a result of the numerous thunderstorms and dissipating Cumulonimbus cloud. The isolated embedded CB cloud are forecast in a region where there is already broken mid-level cloud that is being forecast and therefore the isolated Cumulonimbus clouds will be embedded in this layer of mid-level cloud and that is considered a more hazardous phenomena than an isolated CB cloud (See Chapter 4, section 4.5 on AIRMET/SIGMET).

ISOL/OCNL CB low cloud amount (AMF 2.1.4)

Recommendation — *An area of thunderstorms and cumulonimbus clouds should be considered:*

a) Obscured (OBSC) if it is obscured by haze or smoke or cannot be readily seen due to darkness;

b) Embedded (EMBD) if it is embedded within cloud layers and cannot be readily recognized;

c) isolated (ISOL) if it consists of individual features which affect, or are forecast to affect, an area with a maximum spatial coverage less than 50 per cent of the area concerned (at a fixed time or during the period of validity); and

d) occasional (OCNL) if it consists of well-separated features which affect, or are forecast to affect, an area with a maximum spatial coverage between 50 and 75 per cent of the area concerned (at a fixed time or during the period of validity).

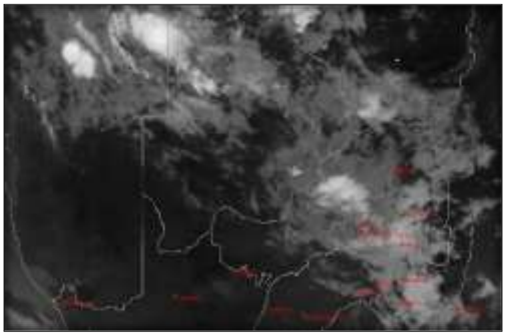
Recommendation.— *An area of thunderstorms should be considered frequent (FRQ) if within that area there is little or no separation between adjacent thunderstorms with a maximum spatial coverage greater than 75 per cent of the area affected, or forecast to be affected, by the phenomenon (at a fixed time or during the period of validity).*

Squall line (SQL) should indicate a thunderstorm along a line with little or no space between individual clouds.

3.5.5.7 Method and example of how to forecast: Convective mid-level cloud type, amount and horizontal extent (AMF 2.1.4)

The specific mid-level cloud type is identified by considering the IR 10.8 satellite image and seeing the clumpy cells in the layered of cloud (see Fig. 29 left). Mid-level cloud horizontal extent is observed at 06h00Z on the IR 10.8 satellite image by the light grey color (Fig. 29 left).

A similar procedure is followed as with forecasting low cloud amount where the 06h00Z satellite image is compared with the NWP RH field at 06h00Z in the mid levels (600 to 500 hPa) to obtain a RH % value that corresponds with the **broken mid level cloud**. The NWP (Fig. 29 right) indicates the band of mid-level cloud (RH > 60%) at 600hPa with a similar horizontal extent to that indicated on the IR 10.8 satellite image.



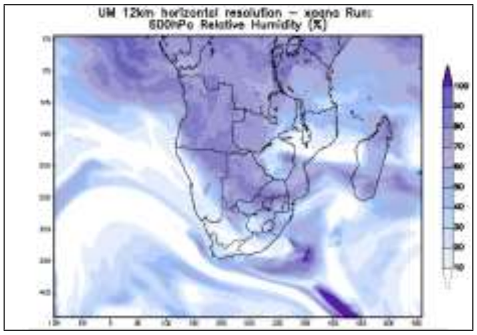


Figure 29: IR 10.8 infrared satellite image at 06h00Z indicating mid-level cloud (light grey color) (left) and 600 hPa RH 06h00Z forecast of the 12km UM model (right)

This value of 60% RH is used to forecast the spatial extent of the Altocumulus cloud for 12h00Z (12h00Z NWP model forecast for 600hPa RH not shown).

Example:

In the low level significant weather chart in Fig. 16 the mid-level Altocumulus cloud is forecast because it is present on the satellite image during the morning and the NWP model output indicates the band of moisture greater than 60% at 500hPa (18000 ft amsl) to persist at 12h00Z as seen in Fig. 30 below.

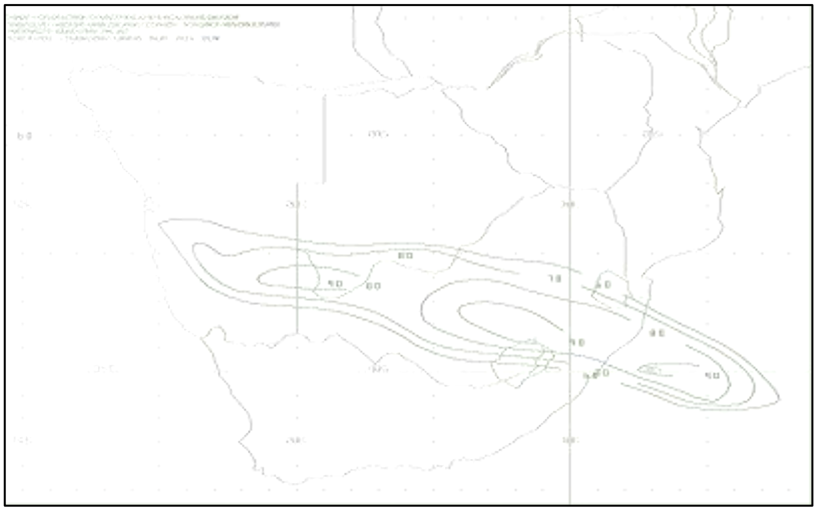


Figure 30: WAFs NWP model output of the mid-level (500hPa) moisture at 12h00Z > 60% for the model initialized at 00h00Z

3.5.5.8 Method and example of how to forecast: Mid-level cloud vertical extent (AMF 2.1.4)

A moisture band is present on the 400 hPa pressure level which corresponds to a height of 23500ft a.msl as indicated by the NWP model, meaning that the cloud would extend at least up to this level (not shown). However, per WMO definition the mid level cloud top can only extend up to 23500ft above mean sea level and therefore the height of the cloud was chosen to be 23500ft (this is subjective, see table 13). The forecast mid-level Altocumulus cloud boundary can be seen on the high level significant weather chart in Fig. 16, and where the Altocumulus cloud area overlapped with the CB cloud area, embedded CBs were forecast.

Table 12: Approximate heights in feet above mean sea level where mid-level cloud can be over the globe.

	Polar Regions	**Mid-latitude regions**	**Tropical regions**
Middle cloud	6500 to 13000 ft	6500 to 23000 ft	6500 to 25000 ft

If there is a pre-existing mid-level cloud band on the satellite image, one can check the IR cloud top temperature and compare to nearest actual data or model data to identify the height a.m.s.l (This method would be similar to that used with Stratiform cloud tops).

If mid-level cloud is to develop later in the day (not currently visible on satellite), check NWP RH at especially 500 hPa to identify its future development. This cloud will normally develop as CBs and start to precipitate or Cumulus cloud spreads out in the evening to become Altocumulus.

3.5.5.9 Method and example of how to forecast: Mid-level cloud base height (AMF 2.1.4)

The cloud base height of mid-level cloud can be obtained from observations (METARs). An example is the following METARs that report mid-level cloud at 08h00Z:

METAR FBSK 110800Z 07010KT 9999 SCT010 FEW030CB **BKN070** 21/18 Q1017 RETS TEMPO TSRA=
METAR FAKN 110800Z 28002KT 5000 HZ FEW020 **SCT100** 25/15 Q1016 NOSIG=

Both Kruger National International Airport (FAKN) and Seretse Khama International Airport (FBSK) are both situated at about 3000ft above mean sea level (See Fig. 21). This means the cloud base height would vary between 10000ft and 13000ft above mean sea level. A middle value of a 12000ft cloud base height would be representative of both of these observations as well as the general mid-level cloud base height.

Table 14 provides guidance on the expected height of mid-level cloud in the mid-latitude to tropical regions.

Table 13: Approximate heights of mid-level cloud a.g.l

Middle Cloud Genera	**Usual Height of mid-level base in feet AGL**
Nimbostratus/Altostratus	Surface to 10000
Altocumulus	6500 to 20000

These mid-level clouds might have their basis around 10000 ft AGL over the interior of South Africa, which will be at the 600 to 500 hPa pressure level (14000 to 18000 ft AMSL) in NWP.

3.5.5.10 Method and example of how to forecast: Convective cloud base height and vertical extent (AMF 2.1.4)

In this example there were already Cumulus clouds visible at Bloemfontein at 08h00Z on the satellite, and it was being reported on the METAR:

METAR FABL 180800Z 03004KT 9999 SCT050 20/12 Q1023=

Therefore the cloud base height for these clouds is 9500ft above mean sea level if the station altitude of 4500ft agl is taken into account (see Fig. 21). This is not the only data that needs to be considered to make a decision of the cloud base height. The 00h00Z tephigram for Bloemfontein can be used with a NWP model forecast maximum temperature (24˚C) and dew point temperature (10˚C), and then **Normand's Theorem** is performed on the ascent as seen on Fig. 31 below. The convective cloud base t 670hPa which is 11 000ft above mean sea level. Since the surface observation at Bloemfontein indicates the cloud top to be 9500ft, a middle value of 10 000ft is taken as the cloud base height. The Cumulonimbus cloud top height is at 200hPa which is 39 000ft above mean sea level.

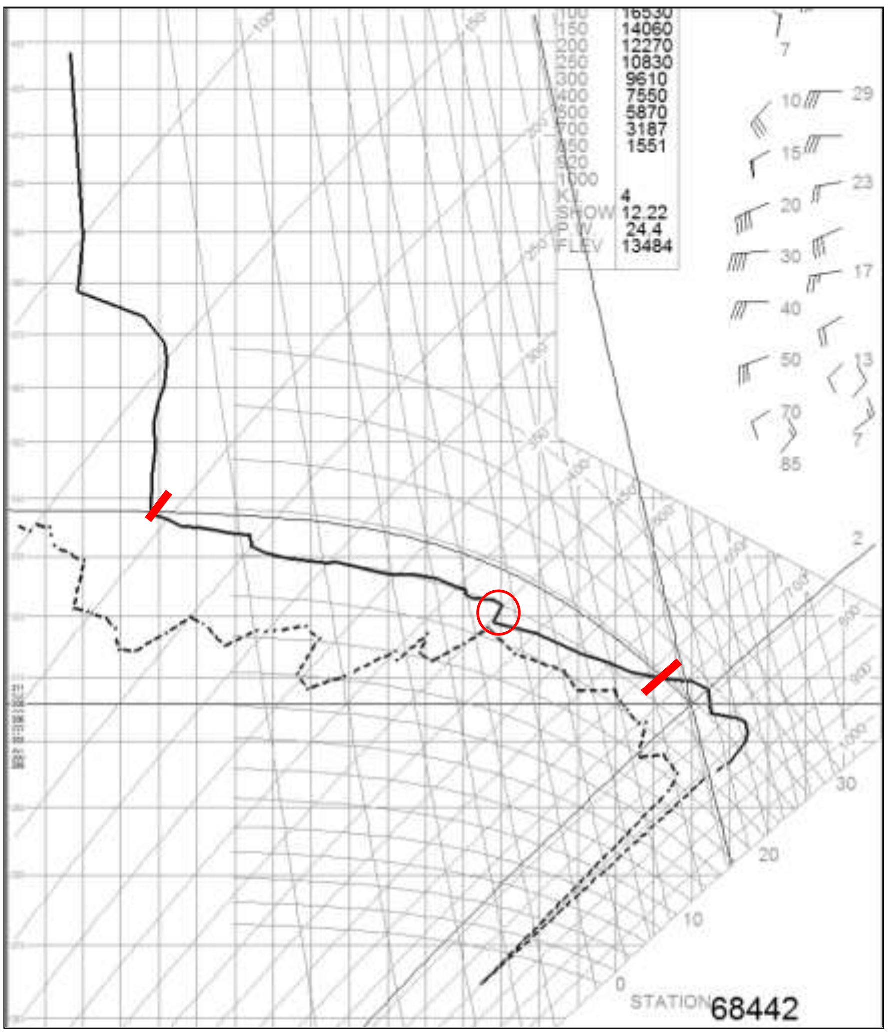


Figure 31: Tephigram for Bloemfontein indicating Normand's theorem calculation for the cloud base (thick red line) and cloud top height (thick red line) for the convective clouds at 00h00Z (SAWS, 2007).

This values for the cloud base height and top as derived on the above tephigram are used for the CB cloud base and height as seen on the significant weather charts in Fig. 16 and Fig. 17. The top of the Cumulus cloud is derived from the Bloemfontein tephigram (Fig. 31) which indicates a mid-level temperature inversion at 460 hPa (red circle). This inversion would prevent some of the Cumulus clouds from growing to Cumulonimbus cloud. Therefore this pressure level can be seen as the predicted cloud top height for the Cumulus cloud. The 460 hPa pressure level corresponds to a cloud top of 20 000ft above mean sea level. This can be seen on the high level significant weather chart in Fig. 17.

3.5.5.11 Cloud base height in significant weather charts

Table 15 indicates the approximate cloud base heights that can be found in significant weather charts.

Table 14: Approximate cloud base height at which different cloud types can be found on a significant weather chart

NWP pressure level in hPa	Height in feet AMSL	Type of cloud in represents in SIGWX Charts
850	5000	Stratus/Stratocumulus or Cumulus
700	10000	Could be Altocumulus on the coast, or Cumulus over the interior
600	14000	Altocumulus or very high based Cumulus
500	18000	Altocumulus
400	23500	Altocumulus

3.5.6 Procedure to be followed in constructing Significant Weather Charts

3.5.6.1 Data sets to be used

You will be given the following data sets to construct these charts: Make sure you understand how to use and interpret them.

1) MSG interpretation – all imagery form 03h00Z to 08h00Z
2) Tephi/Skew-Tgram/AMDAR data interpretation – all 00h00Z Tephi/Skew-Tgrams and available AMDAR.

3) Coding (METARs and SYNOPs) – METARs from 03h00Z to 08h00Z and 06h00Z SYNOPs if available.
4) Block and vector winds valid 12h00Z and 18h00Z
5) Model interpretation – 00h00Z WAFS model run/UM Model.
6) 00Z/06Z analyzed surface chart as well as the 00h00Z upper air chart.
7) Understanding of different weather systems and the hazards they pose to aviation.

3.5.6.2 Analyze and diagnose the current weather situation (AMF AC 1.1)

The steps below (in no particular order) can be seen as a checklist to be followed in compiling your significant weather charts. Each AMF will with time adopt their own way of creating a chart.

You will be preparing the significant weather chart issued at 08h00Z but valid for 12h00Z. Before you can start you first have to analyze and diagnose the weather situation as per AMF competency 1.1.

Analyze the current weather situation before placing any cloud boundaries on your low level significant weather chart. Ask the question: What is currently happening in the weather? To answer this question, the latest analyzed 06h00Z synoptic chart as well as an analyzed upper air chart (00h00Z). Squeeze all possible information from these analyzed charts (look at current weather system, areas reporting rainfall, cloud types, drylines, and moisture boundaries exc.) What weather systems are dominating or influencing the countries weather? Compare this to the latest satellite picture, Tephi/Skew-Tgrams/AMDAR, METARs and any other real time weather data in relation to your surface and upper air chart analysis. Animate the given satellite imagery to confirm if it agrees with what you have seen from the analyzed charts. It is very important at this stage to be able to pinpoint the weather system and the affect it is having on the surface/upper air cloud types i.e. upper air trough system/cut-off low causing convective clouds versus surface ridging high causing low clouds. There could be combinations of more than one weather system at the surface and in the upper air i.e. upper trough with surface ridging high, or cold front with upper trough exc. Consider which aviation weather hazards are at play and what warnings need to be considered. Also look at the date of the chart/case study, it could provide useful information, with regards to what weather/aviation hazards you can expect i.e. summer situation – thunderstorms, winter-cold fronts. **(AMF AC 3)**.

(AMF AC 1.1). You would have done this in Question 1 of the tasks/tests/exam (Also refer to Chapter 2 of this document).

You are now able to diagnose the weather situation. Answer the question: Why is the weather happening? From your surface and upper air chart analysis, you should already know what weather systems are playing a role in producing the clouds found on the satellite picture. Identify the very same weather systems that you saw on the charts and satellite picture at 06h00Z and find them in the NWP in order to see where they are moving to at 12h00Z. Where is cloud deceasing or increasing according to the satellite animation and how does this compare with where the NWP model is showing development or clearance of cloud.

3.5.6.3 Consult the chosen NWP model and further diagnose the weather situation (AMF AC 2)

By consulting the NWP model output, further inferences can be made as to why the weather is happening the way it is. The following are good NWP parameters to look.

To identify the surface weather systems such as a surface ridging high or cold front:

Consult the mean sea level pressure, winds at 10m and relative humidity in the boundary layer or 850 hPa for forecast hour f+00 to f+12. This enables you to see how the surface pressure systems are moving and how onshore or offshore winds are generating relative humidity in the lowest levels of the atmosphere. Using the Wingridds software the following command can be used:

pmsl cin2/bknt 10m/relh gt60 b015 f12

For a cold front, look at equivalent potential temperatures in addition to the command above;

thte 850 cin2 f12

If you are using the Unified model consider the low cloud product or RH at the 850 hPa pressure level. How does this relate to your 06h00Z analyzed surface chart and satellite picture? Remember at the 850 hPa pressure level, moisture (RH) is at the ground over the interior of South-Africa.

Consult the atmospheric pressure levels as you go up in the atmosphere i.e 850, 700, 600, 500, 400 and 300 hPa in order to identify upper air weather systems such as trough, ridges, lows and highs. Remember in NWP these pressure levels are located above mean sea level. At these pressure level consider the geopotential height, wind, relative humidity and vertical motion. At the 850 hPa pressure level consider surface convergence and at the 300 hPa pressure level consider upper air divergence. Using the Wingridds software the following commands can be used:

Hght ci10/bknt/relh gt60/vvel lt00 850/dvrg wind LT00 f00 to f12

Hght ci10/bknt/relh gt60/vvel lt00 700 f00 to f12

Hght ci10/bknt/relh gt60/vvel lt00 600 f00 to f12

Hght ci10/bknt/relh gt60/vvel lt00 500 f00 to f12

Hght ci10/bknt/relh gt60/vvel lt00 400 f00 to f12

Hght ci10/bknt/relh gt60/vvel lt00 300 dvrg wind GT00 f00 to f12

Where geopotential height troughs are not clearly visible it sometimes helps to consider thermal troughs. There are also macros 700l. , 500l. ,50tl.

The 850 hPa pressure level on Win Grids/UM Model is 5000ft above MSL. At the coast this will refer to low cloud while over the interior this moisture will be close to ground level.

The 700 hPa pressure level on Win Grids/UM Model is 10000ft above MSL. When considering relative humidity at the 700 hPa pressure level over the **interior** of South Africa, this will refer to low cloud since most of the interior of South Africa is more or less at the 850 hPa pressure level. At sea level this will refer to mid-level cloud.

The 600 hPa pressure level on Win Grids/UM Model is 14000ft above MSL. When considering relative humidity at the 600 hPa pressure level, this will refer to high based low level cloud or mid-level cloud. At the coast this will refer to mid level cloud.

The 500 hPa pressure level on Win Grids/UM Model is 18000ft above MSL. When considering relative humidity at the 500 hPa pressure level, this will refer to mid-level cloud.

Commands for the general weather conditions – movement of weather systems in WinGridds

Msll.
700l.
500l.
50tl.
Bt12.
Humt.
Stab.
kevr.

3.5.6.4 Draw a picture of your NWP model findings

Draw a picture of what you are seeing in NWP on an empty map of South-Africa so that this information can be used when you start constructing your significant weather chart i.e. areas where there is moisture and vertical lift at different pressure levels and the position of upper troughs exc. Depending on the weather situation you might want to consider instability indices like wxwx. Or kevr. Remember to know what values are relevant.

You are now ready to construct significant cloud boundaries, **cloud (types**, **amounts**, **height of base, vertical extent, precipitation and associated visibilities.**

3.5.6.5 Constructing cloud boundaries, cloud extent, type, height, vertical extent (AMF AC 2.1.4), precipitation (AMF AC 2.1.5) and associated visibilities (AMF AC 2.1.6)

Start with the clouds and weather along the coastal areas (sea level) of your low level significant weather chart and then work your way into the interior (increasing height above mean sea level). If you give any cloud top heights with xxx on you low-level chart (cloud tops above FL180), then these clouds with their associated boundaries need to be copied to the high level significant weather chart. Continue to monitor weather parameters and significant weather phenomena in order to adjust your significant weather chart to current weather conditions **(AMF AC 1.2 and 1.3).**

a) Start on the west coast of Southern Africa

Consider the latest satellite picture and draw the cloud boundaries already present, taking particular care to add what the NWP model is predicting for 12h00Z and the general clearance or development of cloud. Remember, areas that are cloud free on the sat pic, might develop clouds within the next 4 hour forecast period and visa-versa. Consult all latest METARs on the west coast and obtain **cloud base heights and amounts (AMF AC 2.1.4)**. Remember, depending on the situation these clouds base heights will lift in the next 4 hours depending on the amount of diurnal heating (normally at least by 500 feet) (see section 3.5.5.3). In the presence of coastal lows and advection fog on this coast, the cloud base height will normally be of a Stratus/StratoCu type. Know what cloud types you get with different weather systems! Continue to monitor weather parameters and significant weather phenomena in order to adjust your significant weather chart to current weather conditions **(AMF AC 1.2 and 1.3).**

b) Work towards the east coast of Southern Africa

Work your way down to Cape Town and along the coast to PE, Durban, Maputo, Beira and Nampula. When you get to Cape Town, consult the METAR and Tephi/Skew-T gram for FACT. Obtain **cloud base heights (AMF AC 2.1.4)** and if possible cloud tops. Remember all heights on a Tephi/Skew-T are above mean sea level (A.M.S.L) and all cloud base heights on a METAR are above ground level (A.G.L). Remember your significant weather chart cloud bases and top heights are all above mean sea level.

If you are expecting convective cloud over the interior of Western Cape, identify now, using Normand's theorem at 850 hPa, possible **cloud base height, top height and vertical extent (AMF AC 2.1.4)** for the convective cloud. You will have enough temperature and dew point data at 08h00Z to help you.

Use the common sense method to identify stratiform cloud type, base height and vertical extent at Cape Town and see if it is still applicable at 12h00Z. Consult the NWP model and compare to the latest satellite image. Do the same for FAPE, FADN and all other locations up the coast where there are METARs and Tephi/Skew-Ts and demarcate the boundary on your coast where you expect cloud. Remember to create boundaries on your coastal area where different cloud amounts, types of cloud base heights are expected. Consider the type of precipitation (Rain stable, Showers unstable) and visibility so that you can include these in your low level significant weather chart. Remember low visibility (< 5000m) **(AMF AC 2.1.5, 2.1.6 and 2.1.7)** is a hazard to aviation. Continue to monitor weather parameters and significant weather phenomena in order to adjust your weather forecast to current weather conditions **(AMF AC 1.2 and 1.3).**

c) Start working over the interior

Now start working your way into the interior of South-Africa. Remember to consult your topographical chart closely and make sure you don't give **cloud base heights (AMF AC 2.1.4**) which are below the ground. If any low cloud (with a base height below 6500 ft a.m.s.l) is being advected over the interior plateau from the ocean (normally surface ridging high weather system), use the topography height in feet a.g.l together with the relevant observed cloud base height in the METAR to obtain accurate **cloud base heights (AMF AC 2.1.4)** a.m.s.l (see Chapter 3, section 3.5.5.2 and 3.5.5.3).

During the advection of low level moisture from the coast your **cloud top height (AMF AC 2.1.4)** should not differ much between the coast and the interior but the cloud base height **will** due to the undulating topography.

Apply the hazard of low cloud and poor visibility to your forecast and warn accordingly (see Chapter 4, section 4.15). Apply your Visual flight rules and specify areas of NIL VFR REC in your additional information box in the low-level significant weather chart wherever you expect the visibility to drop < 5000 m or where you expect BKN cloud with a cloud base lower than 1500 ft a.g.l.
Continue to monitor weather parameters and significant weather phenomena in order to adjust your weather forecast to current weather conditions **(AMF AC 1.2, 1.3).**

d) Consult your METARs, Tephi and SkewT grams

From the different satellite channels and Tephi/Skew-T, it should be clear where low cloud, middle cloud and convective clouds are present at the time of observation. The NWP model will provide you with guidance of where the low and middle cloud are moving and whether the clouds are developing or dissipating. Consult all METARs across the country and the neighboring countries to obtain accurate **cloud base heights (AMF AC 2.1.4)** and remember to add the height of the topography at that particular station in order to obtain cloud base heights a.m.s.l. The diurnal heating and lifting of **cloud base height (AMF AC 2.1.4)** also needs to be taken into account. Consider each Tephi/Skew-T in the interior and obtain convective **cloud base and top height (AMF AC 2.1.4)** if that type of weather system is applicable (Remember you have already identified the weather system and have a mental model of what you are expecting). After having looked at the Tephi/Skew-Ts, upper air chart, sat pic and NWP, it should be clear where CB clouds are to be forecast. Apply your theory knowledge about CB,s and thunderstorms and the hazard that it poses to aviation.

In order to forecast convective cloud refer to Chapter 3, section 3.5.5.5. Remember that the height of the topography will affect the cloud base heights a.m.s.l and that your convective **cloud base heights (AMF AC 2.1.4)** are generally higher over the western interior of South-Africa where it is hotter and drier compared to those the eastern parts where it is cooler and moister. Cater for these differences in **cloud base heights (AMF AC 2.1.4)** by demarcating different boundaries. Remember that CB's can drift to the coastal areas from the interior, so it is now a good time to check the steering winds at 600 hPa to determine if any CB's that develop over the interior will drift down to the coast later in the evening (18h00Z). If that is going to be the case within the next 4 hours, then CB's have to be put into your coastal areas as well (Remember that CB's don't generally develop at the coast due to convection). Remember the typical CU and CB bases over the interior of South Africa are about 3500 to 5000 ft A.G.L under normal diurnal heating conditions. Let the METARs and Tephi/Skew-T guide you as to the value.

e) ISOL CB versus EMBD CB's (AMF AC 2.1.4 and 3.1.1)

See Chapter 3, section 3.5.5.6

There is a big difference between ISOL CB and ISOL EMBD CBs and wrongly identifying or forecasting them can have a profound effect on the warnings you issue. ISOL CB leads to an AIRMET warning while EMBD CB leads to a SIGMET warning **(AMF AC 3.1.1)** so they have to be correctly observed or forecasted. ISOL EMBD CBs refer to CB clouds that have their cloud base embedded in other broken clouds, this could be broken mid-level cloud or broken low-level cloud. Remember that EMBD CBs cannot be seen by pilots and for this reason it is a bigger aviation hazard than that of an ISOL CB, which can still be seen by a pilot and avoided.

f) Cloud top temperatures (AMF AC 2.1.4)

Cloud top temperatures read from the Infrared satellite image can be usefull in determining the **cloud top heights (AMF AC 2.1.4)** of low and mid-level layered cloud (see Chapter 3, section 3.5.5.4 for low cloud and Chapter 3, section 3.5.5.6 for mid-level cloud).

g) BKN and OVC mid level cloud (AMF AC 2,1,4)

Only broken and overcast mid-level cloud amount can be specified on your significant weather chart. If it is less (SCT or FEW) you leave it out as it is not significant (see Chapter 3, section 3.5.5.7)

h) Reduction in visibility (AMF AC 2.1.5, 2.1.6, 2.1.7)

Visibility must be included on the low level significant weather chart where visibility is expected to be significantly reduced (< 5000 m) due to some form of precipitation or obscuration (AMF AC 2.1.5, 2.1.6 and 2.1.7). Poor visibility is an aviation hazard (see Chapter 4, section 4.7).

Table 15: Weather phenomena forecast on low level significant weather charts and their effect on horizontal visibility.

Drizzle	0.5 – 3 km
Light rain	Little effect
Moderate rain	3 – 10 km
Heavy rain	50 – 500 m
Moderate snow	< 1000 m
Heavy snow	50 – 200 m
Sandstorm	< 1000 m
Mist	> 1000 m
Fog	< 1000 m
Fog with drizzle	< 500 m

i) Mountain waves (AMF AC 3.1.2)

Check if the weather situation lends itself to mountain waves or low level turbulence. Apply your theory on these subjects and know how to identify these phenomena on a satellite picture i.e. standing and mountain waves. The satellite is the only visual proof you will have of this phenomena. Remember in dry conditions you may not be able to pick up mountain waves since there may be no cloud development. In winter ahead of an approaching cold front mountain waves occur, where conditions are stable at the height of the mountain top where the winds are strong. Check the Tephi/Skew-T to see if the vertical atmospheric temperature and wind profile support the occurrence of mountain waves.
Consult Chapter 4, section 4.6 which deals with the forecasting and warning of turbulence.

j) Icing (AMF AC 3.1.4)

Consider all areas where the vertical extent of the cloud extends beyond the freezing level height. Moderate and severe icing is a hazard to aviation. Between 0°C and -15°C, moderate to severe icing can occur in the presence of cloud due to the presence of supercooled water droplets. The vertical extent of the icing layer can be determined by considering the cloud top temperature on the Infrared satellite image. This temperature can be compared to Tephi/Skew-T gram/NWP in order to determine the height. Moderate icing is an AIRMET warning while severe icing is a SIGMET warning. Consult Chapter 4, section 4.9 which deals with the forecasting and warning of aircraft icing.

k) Carrying over of xxx tops on the low level chart to the high level chart (AMF AC 2.1.4)

Once you are done with your low level significant weather chart copy all clouds with xxx tops (clouds with tops > 18000 ft) and their associated boundaries to the high level significant weather chart. You should already have obtained cloud top heights of CB,s from the Tephi/Skew-Ts you scrutinized previously. On the high level chart your cloud base height of CB,s will be marked with xxx to indicate that the bases are in the low level chart.

You have already completed all tropopause heights, jet stream and CAT on your high level significant weather chart, so now you are done. Check that you have catered for all aviation hazards and significant weather to aviation. Make sure your charts make meteorological sense and accurately describe the weather systems influencing the country at that time.
NB. The chart should be neat and well presentable.

l) Additional info box on the low level significant weather chart

If there is low cloud which is BKN and **less than or equal to** 1000 ft A.G.L **OR** if the surface visibility is **less than** 5000 m then the following text should appear in the additional information box.

NIL VFR REC OVER: Include the areas where this may occur for example: The Mpumalanga and Limpopo escarpment.

Any other important information such as moderate or severe icing or turbulence occurring in the low levels may also be mentioned here.

3.5.6.6 Abbreviations/Symbols to be used on Significant Weather Charts

Figure 32 indicates the symbols to be sued in significant weather charts.

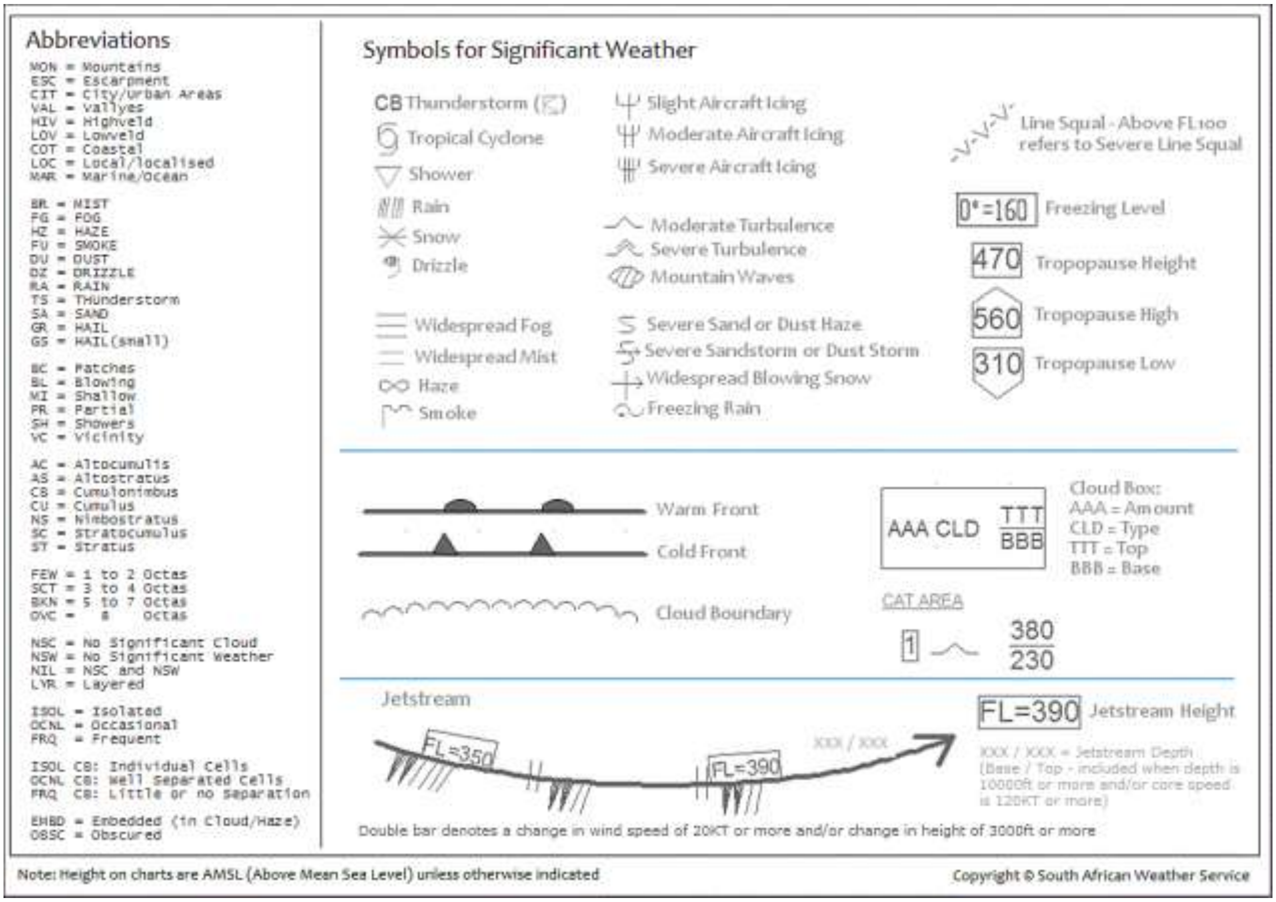


Figure 32: Abbreviations and symbols used on significant weather charts

<u>Other Sigweather chart abbreviations not in figure above</u>

COT-coast

INT-interior

ADJ-adjacent

TURB-turbulence

SEV-severe

SQL-squall line

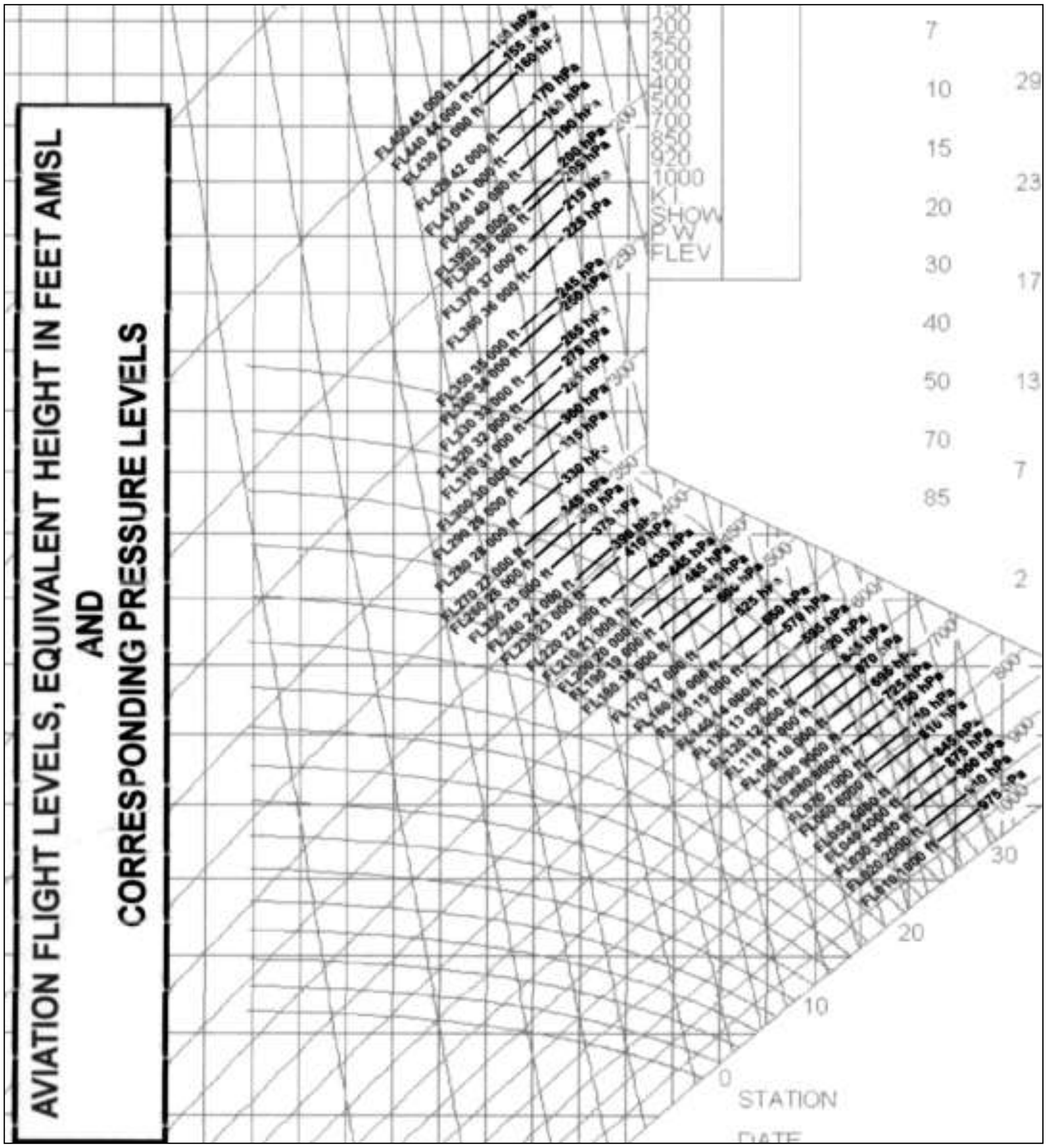
OBSC-Obscured

EXT-extreme

VIS-visibility

3.5.6.7 Table of Flight Levels in Feet and hPa

Table 16: Height in feet and hPa for the different flight levels.



3.5.6.8 Table of precipitation/cloud types and heights (AMF AC 2.1.5)

Table 17: Different precipitation types associated with different cloud types.

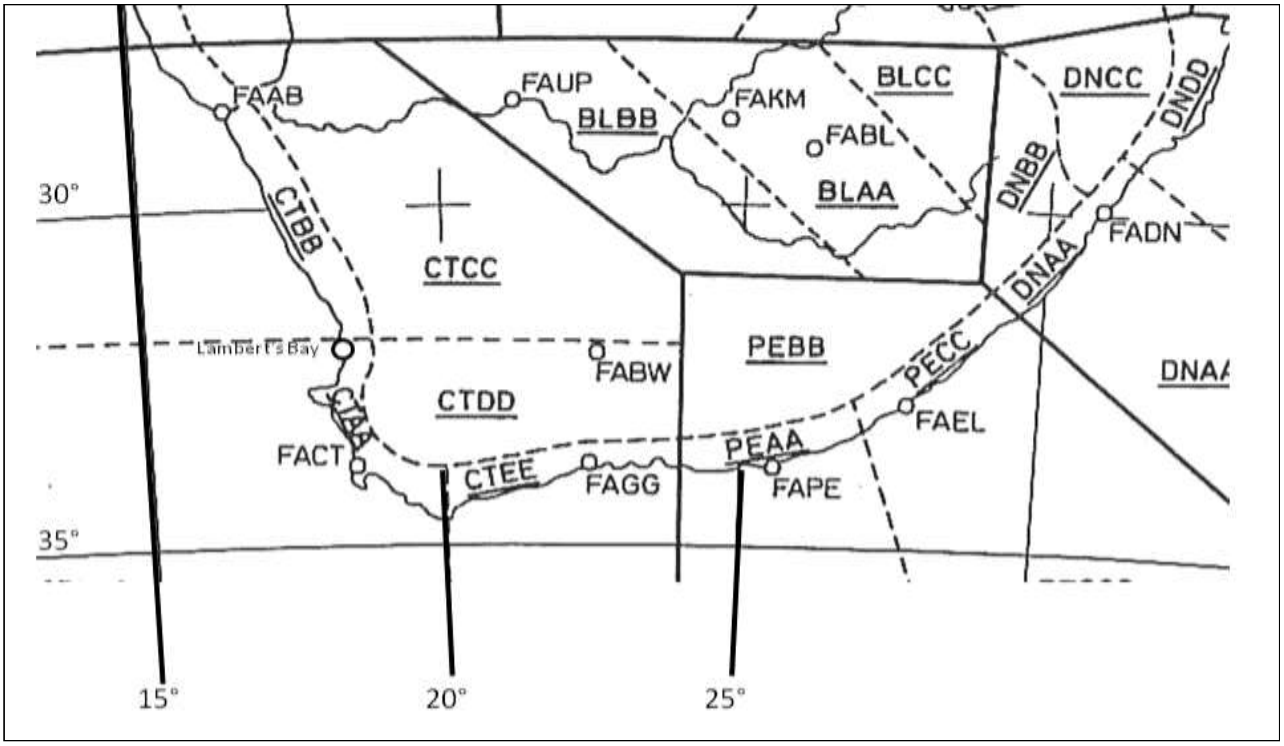
	As	Ns	Sc	St	Cu	Cb
Rain	*	*	*		*	*
Drizzle				*		
Snow	*	*	*		*	*
Snow grains				*		
Snow pellets			*		*	*
Hail						*
Small hail						*
Ice pellets	*	*				

Table 18: Approximate cloud height of low, middle and high cloud in the various regions around the globe (from the WMO International Cloud Atlas; https://cloudatlas.wmo.int/useful-concepts.html)

Level	***Genera***	***Polar region***	***Temperate region***	***Tropical region***
High	Cirrus Cirrocumulus Cirrostratus	3 – 8 km (10 000 – 25 000 ft)	5 – 13 km (16 500 – 45 000 ft)	6 –18 km (20 000 – 60 000 ft)
Middle	Altocumulus Altostratus Nimbostratus	2 – 4km (6 500 – 13 000 ft)	2 – 7 km (6 500 – 23 000 ft)	2 – 8 km (6 500 – 25 000 ft)
Low	Stratus Stratocumulus Cumulus Cumulonimbus	From the Earth's surface to 2 km (0 – 6 500ft)	From the Earth's surface to 2 km (0 – 6 500ft)	From the Earth's surface to 2 km (0 – 6 500ft)

SAFORs are issued by the regional stations (Cape Town, Port Elizabeth, Durban, Bloemfontein and Nelspruit) for their respective areas of responsibility and sent to AWC.

Table 19: Different SAFOR regions across South Africa



CHAPTER 4 AMF Competency 3: Warn of Hazardous Phenomena (AMF AC 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.1.7 3.1.8, 3.2 and 3.3)

Warnings are to be issued in a timely manner when hazardous conditions are expected to occur or when parameters are expected to reach documented threshold values, and updated or cancelled according to documented warning criteria.

OR Tambo International Airport (ORTIA) is a designated Meteorological Watch Office (MWO) which has responsibilities for the Flight Information Region (FIR) it serves. The Aviation Weather Centre (AWC) keeps a continuous watch of weather conditions affecting flight operations in their area of responsibility, issue information on the occurrence of specified hazardous en-route weather conditions (SIGMET and AIRMET) and supply this and other weather information to their associated Air Traffic Services (ATS). They also exchange SIGMET information issued by other MWOs as required by regional air navigation agreement.

In preparing SIGMET and AIRMET information, MWOs normally make use of special air-reports, satellite and radar data. They also supply information on pre-eruption volcanic activity, volcanic eruptions and volcanic ash clouds, for which SIGMET information has not already been issued, to their Volcanic Ash Advisory Centers (VAACs) concerned. In this case Toulouse.

4.1 SIGMET (Significant Meteorological Information) and AIRMET (Airmen's Meteorological Information)

The preparation and issuance of information advising pilots and other aeronautical personnel of weather conditions likely to affect the safety of international civil aviation, are important functions of meteorological offices. In fact, the MWOs such as OR Tambo exist primarily to prepare and issue information on potentially hazardous en-route weather phenomena in their area of responsibility. This information is called "SIGMET and AIRMET information".

SIGMET is warning information for **severe** aviation hazards and hence it is one of the highest priority meteorological information provided to aviation users. It is warning of hazardous conditions combining elements of both reported (observed) and forecast conditions and is used for flight planning.

Tropical cyclone and Volcanic ash advisories are products, which are received from TCACs and VAACs. MWOs use these advisories to prepare SIGMET information for tropical cyclones and volcanic ash clouds. SIGMETs provide timely warning for occurrence or expected occurrence of specified en-route weather phenomena, which may affect the safety of the flight operations in the MWO's area of responsibility. SIGMET provides information concerning the location, extent, intensity and expected evolution of the specified phenomena.

These SIGMETs are issued for individual Flight Information Regions (FIR). In South - Africa there are 3 FIR. These are; FAJA FIR (Johannesburg), FACA FIR (Cape Town) and FAJO (Johannesburg Oceanic). Fig. 33 indicates the flight information regions that are used in South - Africa.

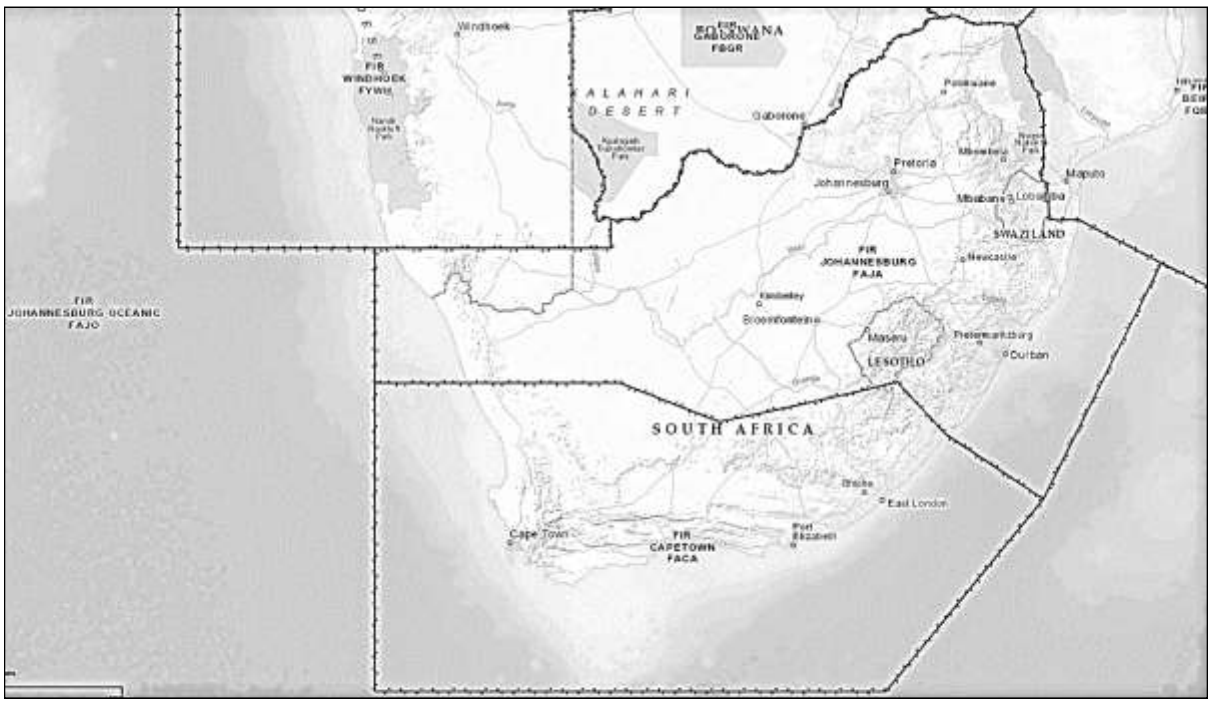


Figure 33: Flight Information Region (FIR) Map. *http://gis.icao.int/FIRMSD/*

SIGMET information is prepared in abbreviated plain language using approved ICAO abbreviations, a limited number of non-abbreviated words, geographical names and numerical values of self-explanatory nature.

SIGMET information is often based on special air-reports; it may also be based on weather satellite data and on ground-based observations, such as weather radar observations, or on forecasts.

It should be noted that although SIGMET information is required to be issued for cruising levels, there is no stated lower limit regarding the height for which a SIGMET should be issued. Since the occurrence of hazardous phenomena are of importance to aircraft during all phases of flight, the MWOs should issue a SIGMET irrespective of the altitude of the phenomenon.

SIGMETs are cancelled by the issuing office when the phenomena are no longer occurring or are no longer expected to occur in the area.

The purpose of AIRMET information is to advise pilots of the occurrence or expected occurrence of specified en-route weather phenomena, which may affect the safety of low-level aircraft operations. MWOs whose area of responsibility encompasses more than one FIR issue separate AIRMET messages for each FIR within their areas of responsibility.

AIRMET information shall be issued to cover the layer between the ground and flight level 100 (or up to flight level 150 in mountainous areas, or higher, where necessary) and shall contain information on en-route weather phenomena hazardous to low-level flights. In other words the base height of the cloud in an AIRMET is given in feet above ground level while the cloud top is given as a flight level above mean sea level.

AIRMET information shall give a concise description in abbreviated plain language concerning the occurrence and/or expected occurrence of specified en-route weather phenomena which may affect the safety of low-level flights, and of the development of those phenomena in time and space.

The period of validity of AIRMET cannot exceed four hours. Area forecasts for low-level flights prepared in support of the issuance of AIRMET information shall be issued every 6 hours and transmitted to meteorological offices concerned not later than one hour prior to the beginning of their validity period. AIRMET information shall be cancelled when the phenomena are no longer occurring or are no longer expected to occur in the area.

AIRMET information is often based on weather satellite data and on ground-based observations such as weather radar observations, or on forecasts.

4.2 Types of SIGMET

4.2.1 Types of SIGMET:

- **WS SIGMET for en-route weather phenomena other than VA (Volcanic ash) and TC (Tropical Cyclone).** This includes (**TS, TURB, ICE, MTW, DS and SS**) **(**denoted as **WS SIGMET)** Information concerning the occurrence or expected occurrence of specific en-route weather and other phenomena in the atmosphere that may affect the safety of aircraft operations. The WS SIGMET provides information on phenomena other than tropical cyclones and volcanic ash. Validity not longer than 4 hours.
- **SIGMET for volcanic ash (denoted as VA SIGMET)** is issued by the MWO responsible for the watch of the FIR, where the volcano is located or where volcanic ash is observed or forecast to be. The period of validity of a SIGMET shall not exceed six hours. Information for the SIGMET will be received from the responsible VAAC. For South Africa the responsible VAAC is Toulouse. Needs to be updated at least every 6 hours.
- **SIGMET for tropical cyclones (denoted as TC SIGMET)** are issued by the MWO responsible for the watch of the FIR in which the center of the tropical cyclone is located. Information for inclusion in the SIGMET will be received from the responsible TCAC. For South Africa this would be La Reunion. The period of validity of a SIGMET shall not exceed six hours. Needs to be updated at least every 6 hours. CB information may be included with the TC SIGMET if provided by the advisory information from the TCAC. (WS SIGMET for FRQ TS should be considered in areas surrounding the center of the cyclone).

The preparation of SIGMET information by the MWO is to be based, where possible, based on advisory information produced by TCAC and VAAC. The detailed content and format of volcanic ash and tropical cyclone advisory information are in Annex 3, Appendix 2, Tables A2-1 and A2-2, respectively.

4.2.2 Renewing a SIGMET

A SIGMET is renewed with a new, next in sequence number when the validity period is due to expire but the phenomena is expected to persist.

4.2.3 Amendment/correction/cancelling of SIGMET

If it is known that an existing SIGMET no longer accurately describes the existing or expected future evolution of the phenomena a new SIGMET, correctly describing the hazard should be issued, followed immediately by a cancellation of the original, erroneous SIGMET.

1) Issue the new SIGMET first before cancelling the old one – this is to ensure there is always a SIGMET in force and that the cancellation is not mistakenly understood to mean that the hazard has completely dissipated.

2) Cancel the SIGMET that no longer accurately describes the state of the

Originally issued SIGMET, later determined to no longer be accurate (bold text identifies points that will be changed):

WSZA21 FAJS 221900
FAJA SIGMET **A01** VALID 222000/222400 FAOR-
FAJA JOHANNESBURG FIR **EMBD TS** FCST WI **S4000 E12000 – S3830 E12200** – S4200 E12100 – S4000 E12000 TOP FL450 MOV SW 05KT INTSF=

Updated SIGMET (bold are coordinates that have been changed)

FAJA SIGMET **A02** VALID 222200/222400 FAOR-
FAJA JOHANNESBURG FIR **EMBD TS** FCST WI **S4100 E12000 – S3850 E12220** – S4200 E12100 – S4000 E12000 TOP FL450 MOV SW 05KT INTSF=

If, during the validity period of a SIGMET, the phenomena is no longer evident or moved out of the FIR, the SIGMET is cancelled as follows:

FAOR SIGMET **A01** **220300/220700** FAOR-
FAJA JOHANNESBURG FIR **EMBD TS** FCST WI S4000 E12000 – S3830 E12200 – S4200 E12100 – S4000 E12000 TOP FL450 MOV SW 05KT INTSF=

FAJA SIGMET **A02** VALID 220555/220700 FAOR-
FAJA JOHANNESBURG FIR **CNL SIGMET A01** **220300/220700**=

4.3 SIGMET Format

All SIGMETs are preceded by an appropriate WMO heading; and first line containing the location indicator of the MWO and period of validity.
WS – for SIGMET
WC – for SIGMET for tropical cyclone
WV – for SIGMET for volcanic ash

- Issued throughout the atmosphere

- The numbering of SIGMETs shall start every day at 0001 UTC.

SIGMET (Significant Meteorological Weather Phenomena) Warnings:

In case of a SIGMET for an observed phenomenon, the filing time (date/time group in the WMO header) should be the same or very close to the time in the date/time group indicating the start of the SIGMET validity period;

When the SIGMET is issued for a forecast phenomenon:
the beginning of validity period should be the time of the expected commencement (occurrence) of the phenomenon in the MWO area of responsibility; the time of issuance of the SIGMET should be not more than 4 hours before the start of validity period (i.e., expected time of occurrence of the phenomenon); for TC and VA SIGMET the lead time should be up to 12 hours. The period of validity is that period during which the SIGMET information is valid for transmission to aircraft in flight.

Important to note is that the end-point coordinate should be a repeat of the start point coordinate. The coordinates must be selected in a clockwise rotation and must not exceed 7:

The WS SIGMET format is as follows:

WSAAii CCCC YYGGgg [BBB]
CCCC SIGMET [n][n]n VALIDYYGGgg/YYGGgg CCCC-
CCCC <FIR/CTA Name> FIR <Phenomenon> OBS/FCST
[AT GGggZ] <Location> <Movement> <Intensity changes>
<Forecast time and forecast position>=

This will be further unpacked below.

WMO Header			
Bulletin identification TTAAii TT is the data type designator (Either WS/VA or VC depending on the type of SIGMET issued AA is the country or territory designator ii is the bulletin	**Disseminating centre** CCCC Four letter ICAO locator of disseminating communication centre	**Transmission time** YYGGgg YY is the day of month GGgg is the time of transmission of SIGMET in hours and minutes UTC	**Correction indicator** [BBB] Included when issuing a correction to a SIGMET which was already submitted CCA – first correction CCB – second correction

First line of SIGMET				
Location Indicator **CCCC** ICAO location indicator of the ATS unit serving FIR or CTA to which the SIGMET refers	**Message Identifyer** **SIGMET**	**Sequence number** **[n][n]n** A01, A02 – restarts every day for SIGMETs issued from 0001 UTC	**Validity Period** **Valid YYGGgg/YYGGgg** YY is the day of the month and GGgg is the time I hours and minutes UTC. WS SIGMET no	**Issuing office** **CCCC –** ICAO locator of the MWO originating the message followed by a hyphen

SIGMET Main Body			
FIR/CTA Name CCCC <name> FIR or CCCC <name> CTA	**Phenomenon (only 1 of the following to be included in message)** **Code** **Description** **OBSC TS** Obscured Thunderstorms Thunderstorms that are obscured by haze or smoke or cannot be readily seen due to darkness. **EMBD TS** Embedded thunderstorms Thunderstorms that are embedded within cloud layers and cannot be readily recognized by the pilot in command **FRQ TS** Frequent thunderstorms Frequent thunderstorms where, within the area of thunderstorms, there is little no separation between adjacent thunderstorms with a maximum spatial coverage greater than 75% **SQL TS** Squall line thunderstorms A squall line indicating that a line of thunderstorms with little or no space between individual cumulonimbus clouds (CB). **OBSC TSGR** Obscured thunderstorms with hail Thunderstorms with hail that are obscured by haze or smoke or cannot be readily seen due to darkness **EMBD TSGR** Embedded thunderstorms with hail Thunderstorms with hail that are embedded within cloud layers and cannot be readily recognized	**Observed/forecast phenomenon** OBS [AT GGggZ] If the exact time of observation is unknown, the time is not included. FCST [AT GGggZ] where GG is hours and gg minutes UTC When the phenomenon is based on a forecast without a reported observation, the time given for **GGggZ** represents the time of commencement of the validity period.	**Location** Geographical coordinates in latitude and longitude in degrees and minutes (not more than 7)

<table>
<tr><th colspan="4"><u>SIGMET Main Body</u></th></tr>
<tr>
<td><u>FIR/CTA</u>

<u>Name</u>

CCCC <name> FIR

or

CCCC <name> CTA</td>
<td><u>FRQ TSGR</u> <u>Frequent thunderstorms with hail</u>

Frequent thunderstorms with hail, within the area of thunderstorms, there is little or no separation between adjacent thunderstorms with a maximum spatial coverage greater than 75%.

<u>SQL TSGR</u> <u>Squall line thunderstorms with hail</u>

A squall line indicating that a line of thunderstorms with hail with little or no space between cumulonimbus clouds (CB).

<u>SEV TURB</u> <u>Severe turbulence</u>

Severe turbulence referring to:

• low-level turbulence associated with strong surface winds;

• rotor streaming; or

• clear air turbulence, whether in cloud or not in cloud. Note. — Turbulence should not be used in connection with convective clouds. Severe turbulence shall be considered whenever the peak value of the cube root of EDR exceeds 0.7.

<u>SEV ICE</u> <u>Severe icing</u>

Severe icing not associated with convective cloud.

<u>SEV ICE FZRA</u> <u>Severe icing due to freezing rain</u>

Severe icing caused by freezing rain and not associated with convective cloud.

<u>SEV MTW</u> <u>Severe mountain wave</u>

Severe mountain wave the accompanying downdraft is 3 m/s (600 ft/min) or more or when severe turbulence is observed or forecast</td>
<td><u>Observed/forecast phenomenon</u>

OBS [AT GGggZ]

If the exact time of observation is unknown, the time is not included.

FCST [AT GGggZ]

where GG is hours and gg minutes UTC

When the phenomenon is based on a forecast without a reported observation, the time given for GGggZ represents the time of commencement of the validity period.</td>
<td><u>Location</u>

Geographical coordinates in latitude and longitude in degrees and minutes (not more than 7)</td>
</tr>
</table>

SIGMET Main Body			
FIR/CTA **Name** CCCC <name> FIR or CCCC <name> CTA	**HVY DS** Heavy duststorm Heavy duststorm where the visibility is below 200 m and the sky is obscured. **HVY SS** Heavy sandstorm Heavy sandstorm where the visibility is below 200 m and the sky is obscured. **RDOACT CLD** Radioactive cloud **VA** (+ Volcano name if known) Volcanic ash **TC** (+TC name)	**Observed/forecast phenomenon** OBS [AT GGggZ] FCST [AT GGggZ] where GG is hours and gg minutes UTC	**Location** Geographical coordinates in latitude and longitude in degrees and minutes (not more than 7)

Level and vertical extent of phenomenon	**Movement or expected movement** (Not included if 'forecast time' and 'forecast position' are given)	**Changes in intensity**	**Forecast time & position (not included if movement given)**
FLnnn (FL320) or nnnM (4500M) or nnnnFT (12000FT) or SFC/FLnnn (SFC/9900FT) or SFC/nnnM (SFC/3000M) or SFC/nnnnFT (SFC/9000FT)	MOV <direction> <speed>KT or KMH STNR (Stationary) Direction can be: E/ENE/ESE/N/NE/NNE/NNW/NW/S/SE/SSE/SSW/SW/W/WNW/WSW	INTSF WKN NC	The forecast position of the hazardous phenomena at the end of the validity period of the SIGMET message in the form FCST AT Z

Level and vertical extent of phenomenon	**Movement or expected movement** (Not included if 'forecast time' and 'forecast position' are given)	**Changes in intensity**	**Forecast time & position (not included if movement given)**
(SFC/9000FT) or FLnnn/nnn (FL250/290) or nnnn/nnnnFT or TOP FLnnn (TOP FL350) (Base is unknown) or ABV FLnnn (ABV FL350) (upper limit unknown) or TOP ABV FLnnn (TOP ABV FL350)	MOV <direction> <speed>KT or KMH STNR (Stationary) Direction can be: E/ENE/ESE/N/NE/NNE/NNW/NW/S/SE/SSE/SSW/SW/W/WNW/WSW	INTSF WKN NC	The forecast position of the hazardous phenomena at the end of the validity period of the SIGMET message in the form FCST AT Z

4.4 AIRMET Criteria

- Surface wind speed (SFC WSPD) above 60 km/h (30 KT) (+ wind speed and units)
- Surface visibility (SFC VIS) less than 5 000 m, including the weather (+ one of the following weather phenomena or combinations of phenomena causing the reduction thereof: BR, DS, DU, DZ, FC, FG, FU, GR, GS, HZ, IC, PL, of visibility PO, RA, SA, SG, SN, SQ, SS or VA)
- Isolated thunderstorms (not embedded) (ISOL TS) without hail
- Occasional thunderstorms (not embedded) (OCNL TS) without hail
- isolated thunderstorms (not embedded) with hail (ISOL TSGR)
- occasional thunderstorms (not embedded) with hail (OCNL TSGR)
- mountain obscuration
- mountains obscured MT OBSC
- widespread areas of broken or overcast cloud with cloud base height < than 300 m (1 000 ft A.G.L)
- broken BKN CLD (+ height of the base and top and units)
- overcast OVC CLD (+ height of the base and top and units)
- Cumulonimbus (CB) clouds which are:

- isolated ISOL CB
- occasional OCNL CB
- frequent FRQ CB
- towering cumulus clouds which are:
- isolated ISOL TCU
- occasional OCNL TCU
- frequent FRQ TCU
- Moderate icing (except when in convective clouds)
- Moderate turbulence (except when in convective clouds)
- Moderate mountain wave turbulence (MOD MTW)

The detailed technical specifications for AIRMET are in Annex 3, Appendix 6, Table A6-1.

4.5 Abbreviations used in SIGMET:

ABV	Above	E	East or eastern longitude
CNL	Cancel or cancelled	ENE	East-north-east
CTA	Control area	ESE	East-south-east
FCST	Forecast	N	North or northern latitude
FIR	Flight Information Region	NE	North-east
FL	Flight level	NNE	North-north-east
FT	Feet	NNW	North-north-west
INTSF	Intensify or intensifying	NW	North-west
KT	Knots	S	South or southern latitude
KMH	Kilometres per hour	SE	South-east
M	Metres	SSE	South-south-east
MOV	Moving	SSW	South-south-west
NC	No change (in intensity)	SW	South-west
NM	Nautical miles	W	West or western longitude
OBS	Observed	WNW	West-north-west
SFC	Surface	WSW	West-south-west
STNR	Stationary	N	North or northern latitude

TOP	Top (of CB cloud)	NE	North-east
WI	Within (area)	NNE	North-north-east
WKN	Weakening (intensity)	NNW	North-north-west
Z	Coordinated Universal Time	NW	North-west

N.B. SIGMET messages concerning thunderstorms or Cumulonimbus clouds should not include references to associated turbulence or icing. It is assumed that TS and CB clouds are associated with SEV ICING and SEV TURB.

SIGMETs are contained in Annex 3, Appendix 6, Table A6-1 and Aeronautical Meteorological *Services (Doc 9377).* It is the ICAO location indicator of the communication centre disseminating the message (could be the same as the MWO).

4.6 Forecasting and warning for thunderstorms (AMF AC 3.1.1)

An AMF must be able to forecast and warn for the following hazardous weather phenomena, including spatial extent, onset, duration, and intensity:

Each weather phenomena needs to be independently tracked and needs its own reference number so that it can also be cancelled. If a phenomena is observed at the time of issue and forecast for the next 4 hours then the term OBS is used and not the term FCST. FCST is only used if the phenomena is not present at the time of issue but is expected within the next 4 hours of the AIRMET/SIGMET.

The significant chart issued, valid for the next 4 hours will indicate the areas of embedded thunderstorms/isolated/ocassional CB:

4.6.1 Embedded Thunderstorms (SIGMET)

SIGMET FAJA (Johannesburg) FIR

FAJA SIGMET C01 VALID YYGGgg/YYGGgg FAOR-

FAJA JOHANNESBURG FIR **EMBD TS** OBS at YYGGgg WI (MAP)

TOP FL000 (INTSF/WKN/NC) MOV SE 20KT NC FCST AT YYGGgg WI (MAP)=

Embedded Thunderstorms can be:

OBSC TS -	Obscured Thunderstorms
EMBD TS -	Embedded Thunderstorms
FRQ TS -	Frequent Thunderstorms
SQL TS -	Squall Line Thunderstorms
OBSC TSGR-	Obscured thunderstorms with hail
EMBD TSGR -	Embedded Thunderstorms with hail
FRQ TSGR -	Frequent Thunderstorms with hail
SQL TSGR -	Squall Line Thunderstorms with hail

An area of the FIR defined by a polygon. The end point should be a repeat of the start point.

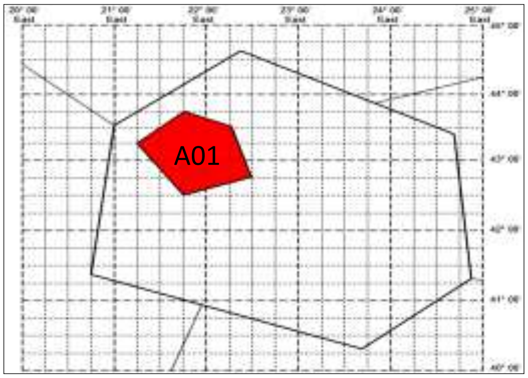
The FIR is a fictitious Johannesburg Oceanic FIR

<table>
<tr><td colspan="2">An example of a Thunderstorm SIGMET when the SIGMET does not include a 'forecast position' section.</td></tr>
<tr><td>FAJO SIGMET A01 090800/091200 FAOR-

FAJO JOHANNESBURG OCEANIC FIR **EMBD TS FCST** WI N4230 E02145 – N4315 E02115 –

N4345 E02145 – N4330 E02215 –

N4245 E02230 - N4230 E02145

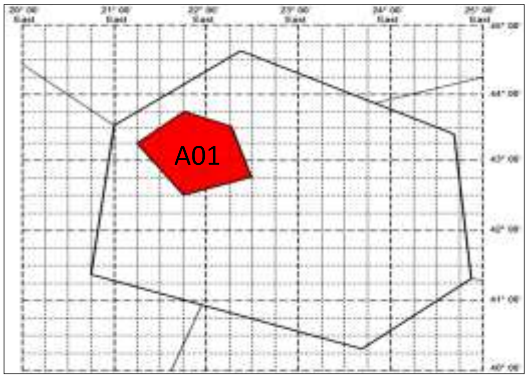
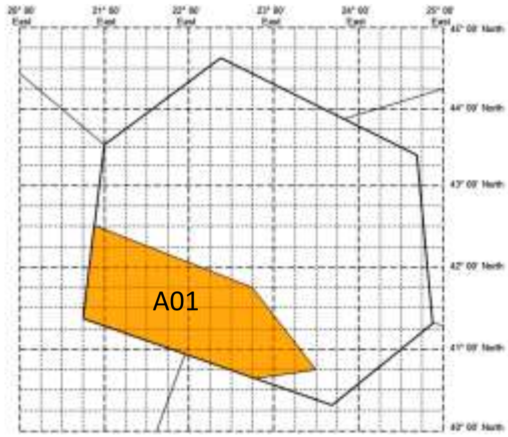
FL250/370 MOV ESE 20KT INTSF=</td><td>
</td></tr>
</table>

Figure………

Two examples of a Thunderstorm SIGMET when the SIGMET includes:

1) explicit ‘forecast position’ section. The FIR is a fictitious Johannesburg FIR

2) Thunderstorms currently observed and are expected to spread in the next 4 hours

1) FAJA SIGMET A01 100800/101200 FAOR- FAJA JOHANNESBURG FIR **EMBD TS FCST** WI N4230 E02052 – N4245 E02145 – N4130 E02200 – N4107 E02130 – N4123 E02045- N4230 E02052 FL250/370 WKN FCST AT 1200Z WI N4230 E02052 – N4145 E02245 – N4045 E02330 – N4040 E02248 – N4123 E02045- N4230 E02052= 2) FAJA SIGMET A01 100800/101200 FAOR- FAJA JOHANNESBURG FIR **EMBD TS OBS AT 0800Z** WI N4230 E02052 – N4245 E02145 – N4130 E02200 – N4107 E02130 – N4123 E02045- N4230 E02052 TOP FL400 INTSF **FCST AT 1200Z** WI N4230 E02052 – N4145 E02245 – N4045 E02330 – N4040 E02248 – N4123 E02045- N4230 E02052=	 

Figure……..

The **EMBD TS** - SIGMET warnings issued for the Johannesburg FIR, associated with the 4 hour forecast areas indicated on the low level (Fig. 16) and high level (Fig. 17) significant weather charts, are (Fig 34):

FAJA SIGMET A01 VALID 180800/181200 FAOR –

FAJA Johannesburg FIR **EMBD TS** OBS at 0800Z WI (MAP) TOP FL390 FCST at 1200Z WI (MAP) TOP FL390=

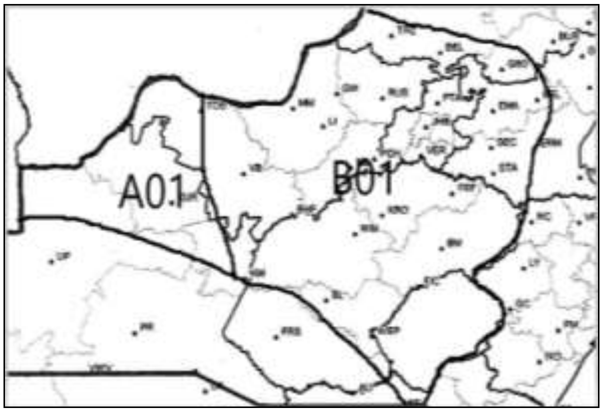


Figure 34: SIGMET map indicating the warning regions for the different alerts as numbered above.

4.6.2 Cumulonimbus Clouds (AIRMET)

AIRMET FAJA (Johannesburg) FIR

FAJA AIRMET B01 VALID 180800/181200 FAOR-

FAJA JOHANNESBURG FIR **ISOL CB** OBS at 0800Z WI (MAP) TOP FL390 NC

FCST AT 1200Z WI (MAP)=

Cumulonimbus Clouds can be:

ISOL CB - Isolated Cumulonimbus Clouds

OCNL CB - Occasional Cumulonimbus Clouds

FRQ CB - Frequent Cumulonimbus Clouds

4.6.3 Thunderstorms (related to 4.6.2-Cumulonimbus Clouds) (AIRMET)

AIRMET FAJA (Johannesburg) FIR

FAJA AIRMET C01 VALID 180800/181200 FAOR-

FAJA JOHANNESBURG FIR **ISOL CB** OBS at 0800Z WI (MAP) TOP FL390 NC

FCST AT 1200Z WI (MAP)=

Thunderstorms can be:

ISOL TS/TSGR - Isolated Thunderstorms with or without hail

OCNL TS/TSGR - Occasional Thunderstorms with or without hail

The AIRMET warnings issued for the Johannesburg FIR, based on the areas indicated on the low level (Fig. 16) and high level (Fig. 17) significant weather charts, are as follows (Fig. 35):

1) FAJA AIRMET A01 VALID 181000/181200 FAOR –
FAJA Johannesburg FIR **SFC VIS** 2000M TSRA FCST WI (MAP)=

2) FAJA AIRMET B01 VALID 181000/181200 FAOR –
FAJA Johannesburg FIR **ISOL CB** FCST WI (MAP) TOP FL390=

3) FAJA AIRMET C01 VALID 181000/181200 FAOR –
FAJA Johannesburg FIR **ISOL TS** FCST WI (MAP)=

4) FAJA AIRMET D01 VALID 180800/181200 FAOR –
FAJA Johannesburg FIR **SFC VIS** 4500M TSRA OBS WI (MAP)=

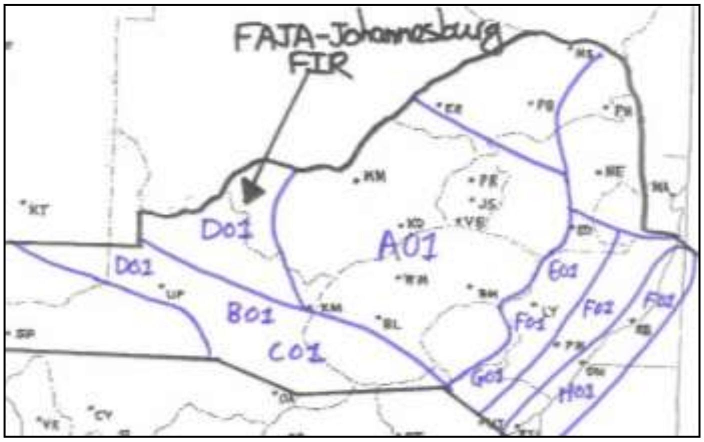


Figure 35: AIRMET map indicating the warning regions A01 to D01

4.6.4 Towering Cumulus Clouds (AIRMET)

AIRMET FAJA (Johannesburg) FIR

FAJA AIRMET D01 VALID YYGGgg/YYGGgg FAOR-

FAJA JOHANNESBURG FIR **ISOL TCU** OBS at YYGGgg WI (MAP)

TOP FL000 (INTSF/WKN/NC) FCST AT YYGGgg WI (MAP)=

TCUs can be:

ISOL TCU - Isolated Towering Cumulus Clouds

OCNL TCU - Occasional Towering Cumulus Clouds

FRQ TCU - Frequent Towering Cumulus Clouds

4.7 Forecasting and warning for Turbulence (AMF AC 3.1.2 and 3.2)

- **turbulence (moderate or greater), including onset and duration, intensity, spatial extent, type (orographic, mechanical, convective and clear air turbulence).**

This case study indicates a surface cold front over the south west of the country, that was coinciding with a sharp upper air trough and cut-off low pressure that was situated to the south west of the country. The upper air trough, Jetstream and cut-off low pressure can be seen on Fig. 36 below.

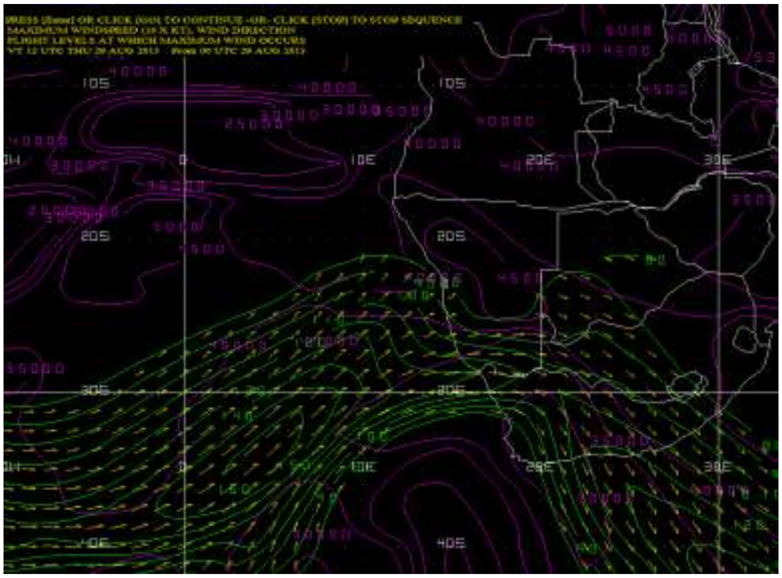


Figure 36: WAFs NWP model output of the jet stream (yellow arrows), wind speed (green) and the flight levels (purple) on 29 August 2013 at 12h00Z.

A sharp upper air trough associated with a upper jet is a good synoptic pattern for Clear Air Turbulence (CAT). A change of at least 6KT/1000ft in the vertical is considered as a threshold for moderate turbulence (AIRMET), while a change of at least 9KT/1000ft or more in the vertical is considered to cause severe turbulence (SIGMET). The NWP wind barb fields per flight level valif for 12h00Z (Fig. 37) are used.

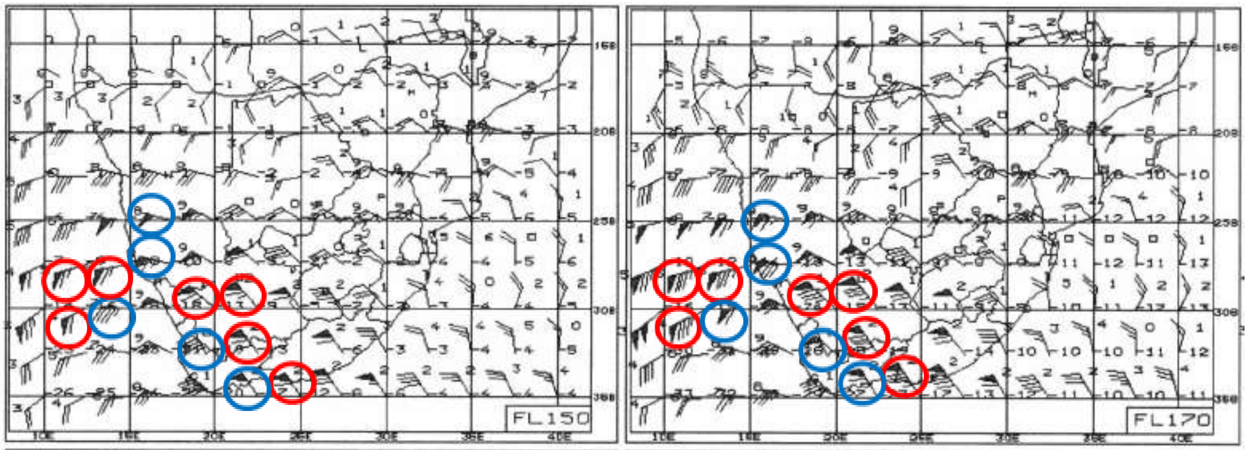


Figure 37: WAFs NWP output of the barb winds (KT) on the different flight levels valid at 12h00Z. The red circles indicate severe turbulence, while the blue circles indicate moderate turbulence.

There is a core of severe turbulence (red circles) surrounded by moderate turbulence (blue circles) and this turbulence crosses both FIRs (Cape Town FIR as well as for the Johannesburg FIR). The top of the turbulence level is at FL170, while the bottom of the turbulence flight level is at FL150. Severe turbulence has to be issued as a SIGMET, no matter what the flight level, but moderate turbulence is only issued as an AIRMET if it is up to FL150.

Severe Turbulence SIGMET format (vertical speed shear (9 KT per 1000 ft) and/or directional shear)

SIGMET FAJA (Johannesburg) FIR

FACA SIGMET C01 VALID 231200/231600 FAOR-

FACA CAPE TOWN FIR **SEV TURB** FCST WI

S2720 E02946 - S2750 E02829 - S3030 E02928 - S2942 E02748 - S2844 E02629 - S2742 E02559 - S2730 E02502 - S2636 E02409 - S2558 E02413 - S2535 E02423 - S2540 E02527 - S2442 E02550 - S2431 E02613 - S2720 E02946

FL150/170 MOV E 25KT INTSF=

The warning maps are not shown in this instance. The warnings were issued as observed warnings from 08Z to 12Z as the sharp trough associated with the COL was already there at 06h00Z.

Competency 3.2 – Ensure that warnings of hazardous weather phenomena are prepared and issued in accordance with thresholds for hazardous weather, and with ICAO Annex 3, WMO-No.49, regional and national formats, codes and technical regulations on content, accuracy and timeliness

The warnings have to be issued according to the correct ICAO format as seen in the table 21 below:

FAJA SIGMET B01 VALID 290800/291200 FAOR –

FAJA Johannesburg FIR **SEV TURB** OBS WI (MAP) FL150/170=

Table 20: Comparison Table indicating the agreement between the ICAO Annex 3 standard SIGMET format, and the format in which I issued a SIGMET

Product	Required Product (as stipulated by latest version of ICAO Annex 3)	Product above in this document
Location indicator of FIR	nnnn	FAJA
Identification (M)	SIGMET [nn]n	SIGMET B01
Validity period (M)	VALID nnnnnn/nnnnnn	VALID 290800/291200
Location indicator of WMO (M)	nnnn-	FAOR-
Name of the FIR	nnnn nnnnnnnnn FIR	FAJA Johannesburg FIR
Phenomenon (M)	OBSC TS[GR] EMBD TS[GR] FRQ TS[GR] SQL TS[GR] TC nnnnnnnnn or NN SEV TURB	SEV TURB

	SEV ICE SEV ICE [FZRA] HVY DS HVY SS [VA ERUPTION] [MT] [nnnnnnnnnn] [PSN Nnn[nn] orSnn[nn] Ennn[nn] or Wnnn[nn]] VA CLD RDOACT CLD	
Observed or forecast phenomenon (M)	OBS [AT nnnnZ] FCST [AT nnnnZ]	OBS
Location (C)	WI Nnn[nn] or Snn[nn] Wnnn[nn] or Ennn[nn]- Nnn[nn] or Snn[nn] Wnnn[nn] or Ennn[nn] – Nnn[nn] or Snn[nn] Wnnn[nn] or Ennn[nn] – [Nnn[nn] or Snn[nn] Wnnn[nn] or Ennn[nn] - Nnn[nn] or Snn[nn] Wnnn[nn] or Ennn[nn]]	*WI (MAP)
Level (C) – Flight level or altitude and extent	FLnnn/nnn	FL150/170
Movement or expected movement (C)	MOV N/NE/E/SE/S/SW/W/NW [nnKT] or MOV NNE/ENE/ESE/SSE/SSW/WSW/WNW/NNW or STNR	NA in this case
Changes in intensity (C)	INTSF or WKN or NC	NA in this case
Forecast posisiton (C)	N/E/S/W OF Nnn[nn]	NA in this case

* For training purposes the 'Location' is only given as WI (MAP) – 'within map', as there is software available at AWC that allows a forecaster to electronically select the area on the map and then the software converts it to coordinates. For that reason, that part of the SIGMET warning does not comply with the ICAO format.

Moderate Mountain Waves (AIRMET)

Format is as follows:

AIRMET FAJA (Johannesburg) FIR

FAJA AIRMET I01 VALID YYGGgg/YYGGgg FAOR-

FAJA JOHANNESBURG FIR **MOD MTW** (FCST/OBS) WI (MAP)

TOP FL000=

Severe Mountain Waves (SIGMET)

An example of a typical SIGMET is

SIGMET FAJA (Johannesburg) FIR

FAJA SIGMET C01 VALID 231200/231600 FAOR-

FAJA JOHANNESBURG FIR **SEV MTW** OBS WI

S2421 E02706 – S2720 E02946 – S2750 E02829 – S2844 E02629 – S2636 E02409 – S2535 E02423 – S2421 E02706 FL100/180 STNR NC=

4.8 Reduced surface visibility (AMF AC 2.1.5, 2.1.6, 2.1.7) (AIRMET)

Visibility reduced to < 5000 m

AIRMET FAJA (Johannesburg) FIR

FAJA AIRMET E01 VALID YYGGgg/YYGGgg FAOR-

FAJA JOHANNESBURG FIR SFC VIS (<5000M) (PHENOMENA) (FCST/OBS) WI (MAP)=

Examples of PHENOMENA Include:

BR - Mist

FG - Fog

DZ - Drizzle

RA - Rain

SH - Showers (Including TS or RA)

TS - Thundershowers

GR - Hail

HZ – Haze

4.9 Forecasting and warning for moderate and severe low-level wind shear (AMF AC 3.1.3 and 3.2)

Wind shear has been cited as a cause or a contributory factor in a number of major aircraft accidents. Guidance is contained in the Manual on low Level Wind Shear (Doc 9817)

As per the latest version of ICAO Annex 3:

When wind shear is encountered and in which opinion of the pilot-in-command, may affect the safety or markedly affect the efficiency of other aircraft operations, the pilot-in-command **shall** advise the appropriate air traffic services unit as soon as practicable.

Note: Icing, turbulence and, to a large extent, wind shear are elements which, for the time being, cannot be satisfactorily observed from the ground and for which in most cases aircraft observations represent the only available evidence.

The objective of wind shear warnings is to give concise information on the observed or expected existence of wind shear which could adversely affect:

a) aircraft on the approach path or take-off path or during circling approach between runway level and 500 m (1 600 ft) above that level and aircraft on the approach or take-off path or during circling approach between runway level and 500m (1600 ft) above that level and aircraft on the runway during the landing roll or take-off run.

b) Where local topography has been shown to produce significant wind shears at heights in excess of 500 m (1600 ft) above runway level, then 500 m (1600ft) shall not be considered restrictive.

The template can be found in the latest version of ICAO Annex 3, Appendix 6.

Table 21: Template for wind shear warnings after Table A6-3 ICAO Annex 3

Table A6-3. Template for wind shear warnings

Key: M = inclusion mandatory, part of every message;
C = inclusion conditional, included whenever applicable.

Note 1.— The ranges and resolutions for the numerical elements included in wind shear warnings are shown in Table A6-4 of this appendix.

Note 2.— The explanations for the abbreviations can be found in the PANS-ABC (Doc 8400).

Element	*Detailed content*	*Template(s)*	*Example*
Location indicator of the aerodrome (M)	Location indicator of the aerodrome	nnnn	YUCC[1]
Identification of the type of message (M)	Type of message and sequence number	WS WRNG [n]n	WS WRNG 1
Time of origin and validity period (M)	Day and time of issue and, where applicable, validity period in UTC	nnnnnn [VALID TL nnnnnn] *or* [VALID nnnnnn/nnnnnn]	211230 VALID TL 211330 221200 VALID 221215/221315
IF THE WIND SHEAR WARNING IS TO BE CANCELLED, SEE DETAILS AT THE END OF THE TEMPLATE.			
Phenomenon (M)	Identification of the phenomenon and its location	[MOD] *or* [SEV] WS IN APCH *or* [MOD] *or* [SEV] WS [APCH] RWYnnn *or* [MOD] *or* [SEV] WS IN CLIMB-OUT *or* [MOD] *or* [SEV] WS CLIMB-OUT RWYnnn *or* MBST IN APCH *or* MBST [APCH] RWYnnn *or* MBST IN CLIMB-OUT *or* MBST CLIMB-OUT RWYnnn	WS APCH RWY12 MOD WS RWY34 WS IN CLIMB-OUT MBST APCH RWY26 MBST IN CLIMB-OUT
Observed, reported or forecast phenomenon (M)	Identification whether the phenomenon is observed *or* reported and expected to continue, *or* forecast	REP AT nnnn nnnnnnnn *or* OBS [AT nnnn] *or* FCST	REP AT 1510 B747 OBS AT 1205 FCST
Details of the phenomenon (C)[2]	Description of phenomenon causing the issuance of the wind shear warning	SFC WIND: nnn/nnMPS (*or* nnn/nnKT) nnnM (nnnFT)-WIND: nnn/nnMPS (*or* nnn/nnKT) *or* nnKMH (*or* nnKT) LOSS nnKM (*or* nnNM) FNA RWYnn *or* nnKMH (*or* nnKT) GAIN nnKM (*or* nnNM) FNA RWYnn	SFC WIND: 320/5MPS 60M-WIND: 360/13MPS (SFC WIND: 320/10KT 200FT-WIND: 360/26KT) 60KMH LOSS 4KM FNA RWY13 (30KT LOSS 2NM FNA RWY13)
OR			
Cancellation of wind shear warning[3]	Cancellation of wind shear warning referring to its identification	CNL WS WRNG [n]n nnnnnn/nnnnnn	CNL WS WRNG 1 211230/211330[3]

Notes.—

1. Fictitious location.
2. Additional provisions in 6.2.3.
3. End of the message (as the wind shear warning is being cancelled).

At aerodromes where wind shear is considered to be a factor, it is therefore necessary to make arrangements, in addition to the inclusion of wind shear in the supplementary information of local routine and special reports and in METAR and SPECI, to provide all concerned with specific wind shear warnings.

Evidence of the existence of wind shear should be derived from:

- ground-based wind shear remote-sensing equipment, e.g. Doppler radar;
- ground-based wind shear detection equipment, e.g. a system of surface wind and/or pressure sensors located in an array, monitoring a specific runway or runways and associated approach and departure paths;
- aircraft observations during the climb-out or approach phases of flight to be made; and
- other meteorological information, e.g. from appropriate sensors located on existing masts or towers in the vicinity of the aerodrome or nearby areas of higher ground.

Wind shear conditions are normally associated with one or more of the following phenomena:

- thunderstorms, microbursts, funnel cloud (tornado or waterspout) and gust fronts;
- frontal surfaces;
- strong surface winds coupled with local topography;
- sea breeze fronts
- mountain waves (including low-level rotors in the terminal area); low-level temperature inversions.

Fig. 39 indicates an example of a special air report based on a report from the air traffic control.

FORM: SPECIAL AIR REPORTS

South African Weather Service

NB: The form is used to log special air reports received from pilots and or via other aeronautical meteorological offices

SECTION A Sender Details: *(Please check/tick the appropriate box)*

AMO		ATC	X	Pilot		Other	
						Specify	

SECTION B

Description of weather phenomena:

wind shear reported at 1500ft (15kt) on runway 24

Observation details *(Please complete appropriate box)*	Date	Time (Z)
	09/03/2013	16:00Z

SECTION C

Received via: *(Please check the appropriate box)*	Phone	X	Fax		E-mail		Other	
							Specify:	
Message type qualifier *(Please check the appropriate box)*	Sigmet		Airmet		None	X		

SECTION D

Details of recipient

Name: Stacy Colborne	Date: 09/03/2013
Designation: FORECASTER	Signature:
Record reference	AWC-SAR-001-YYYY-MM-DD

Figure 38: Example of a special air report where wind shear was reported by the Air Traffic control

<u>Definition:</u> Moderate to severe low level wind shear refers to wind shear that will affect an aircraft approaching the runway for landing or when leaving the runway after take-off, between the runway level (surface) and 1600ft above ground level.

The low level wind speed and direction of adjacent levels needs to be considered when diagnosing low level wind shear. The following wind profiles can be used.

- AMDAR
- TEPHIGRAMs
- SKEW-T Plots from NWP
- SPOT Graphs from NWP

Wind shear criteria:

By definition, the following criteria in Table 23 is considered as moderate and severe turbulence.

Table 22: Thresholds of horizontal and vertical wind shear for the forecasting and warning of moderate and severe turbulence

Type of wind shear	**Moderate**	**Severe**
Horizontal wind shear	20KT per degree of latitude	30KT per degree of latitude
Vertical wind shear	6KT per 1000ft	9KT per 1000ft

Examples of Wind shear warnings:

In this particular case there was moderate low level turbulence at Port Elizabeth (68842) between the surface and 1000ft. The surface wind observation and the 1000ft level wind is indicated in red in Fig. 40. There is a low level inversion between 950 and 850hPa and in that inversion layer there is a wind speed of 35KT at 1000ft and an observed wind speed of 29KT at the surface as seen on the Port Elizabeth (FAPE) METAR for 12Z:

<table>
<tr>
<td>Observation at sea level

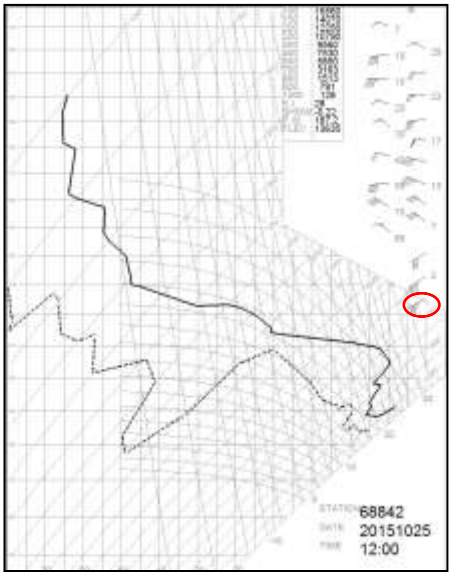
FAPE 251200Z 24029KT CAVOK 22/15 Q1015 NOSIG=

FAPE WS WRNG 1 251200 VALID 251215/251315 MOD WS RWY26 **OBS AT 1200** SFC WIND: 240/29KT 1000FT-WIND: 250/35KT=

OR (Depending on which runway is in use at the time)

FAPE WS WRNG 1 251200 VALID 251215/251315 MOD WS APCH08 **OBS AT 1200** SFC WIND: 240/29KT 1000FT-WIND: 250/35KT=

CNL **WS WRNG 1** 251200 251215/251315</td>
<td>Observation at 1000 FT


</td>
</tr>
<tr>
<td colspan="2">*Figure 39: Surface wind observation (in Metar), Tephigram (wind at 1000 ft – red ellipse) and low level wind shear warning issued for Port Elizabeth on 25 October 2015 at 12h00Z,*</td>
</tr>
</table>

Other Examples:

FAPE **WS WRNG 1** 090530 VALID 090530/090730 SEV WS CLIMB-OUT RWY26 **REP AT 0530 B747** SFC WIND: 043/04KT 281FT WIND: 080/12KT=

FAEL **WS WRNG 1** 120445 VALID 120500/120700 MOD WS **OBS AT 0445** SFC WIND: 145/06KT 1000FT-WIND: 243/11KT=

FLLS WS WRNG 01 090500 VALID TL 090600 MOD WS **FCST** 900FT-WIND: 019/02KT 1600FT-WIND: 059/09KT=

4.10 Forecasting and warning for aircraft icing (AMF AC 3.1.4 and 3.2)

(moderate or greater), including onset and duration, intensity, accumulation rate, spatial extent, type (rime or opaque, glaze or clear, freezing rain, hoar frost, mixed ice)

Consider the following significant weather chart where a band of mid-level Altocumulus cloud is forecast as seen in Fig. 41. Within this band of cloud there is a region of occasional embedded CBs and isolated embedded CBs. Where the mid-level cloud overlaps with the convective cloud, no formal icing warning is issued as it is assumed that convective clouds, such as CBs are associated with severe icing per definition.

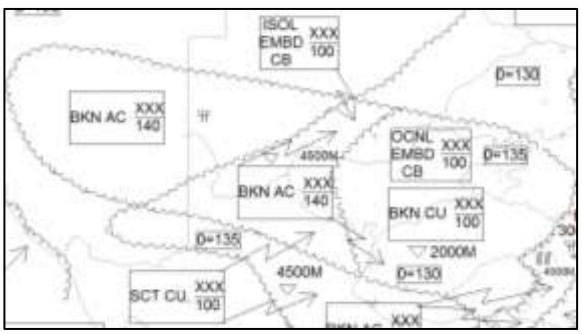


Figure 40: Low level significant weather chart valid at 12h00Z.

However, in the area where the mid level cloud is not overlapping with convective cloud, the warning of aircraft icing has to be evaluated. In this case **moderate icing** will be forecast in the band of Altocumulus cloud. For moderate icing an AIRMET warning is issued, while a SIGMET will be issued for severe icing (latest version of Annex 3).

To assist the forecaster in his/her decision making process, the icing decision tree form the UK Met Office is applied to the tephigram at Durban (Durban fell into the region of Altocumulus clouds in the low level sigweather chart of Fig. 41).

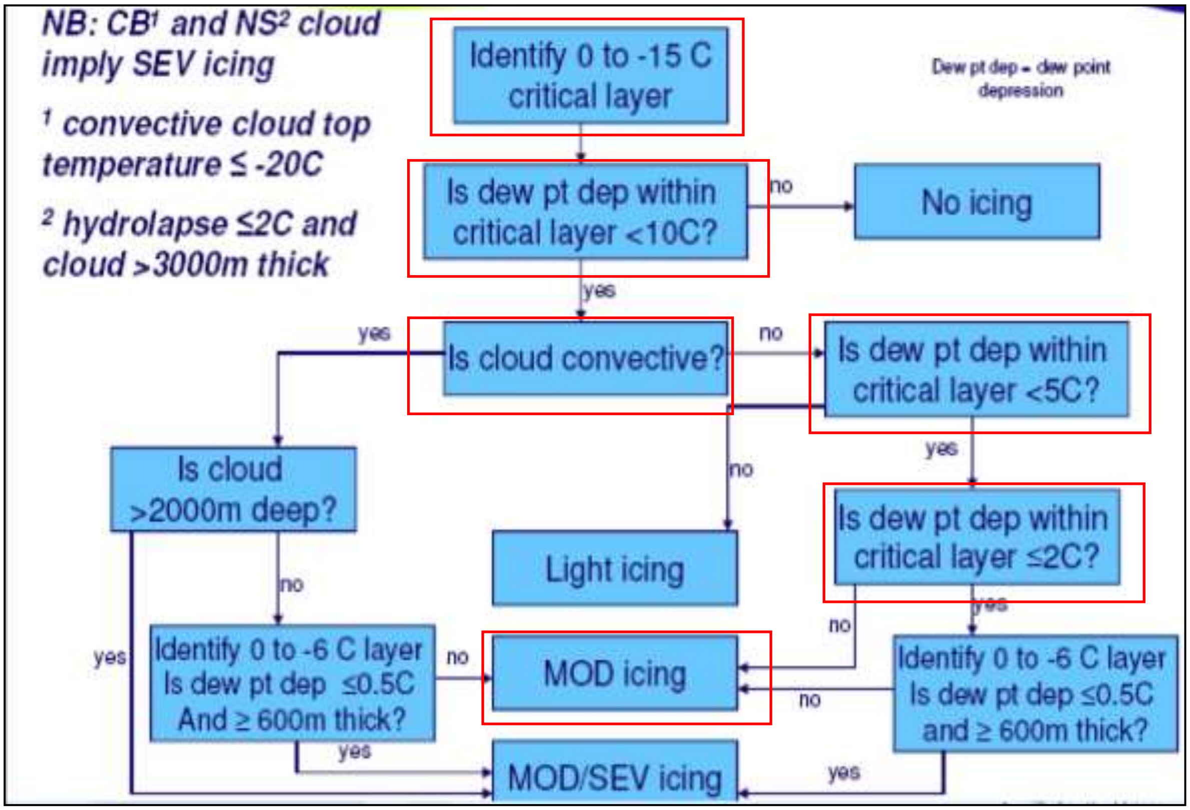


Figure 41: UK Met Office icing decision tree (Lisk, 2005)

The first step in the decision tree is to identify whether the critical icing layer has a dewpoint depression of less than 10˚C, which is indicated on the Durban tephigram in Fig. 43.

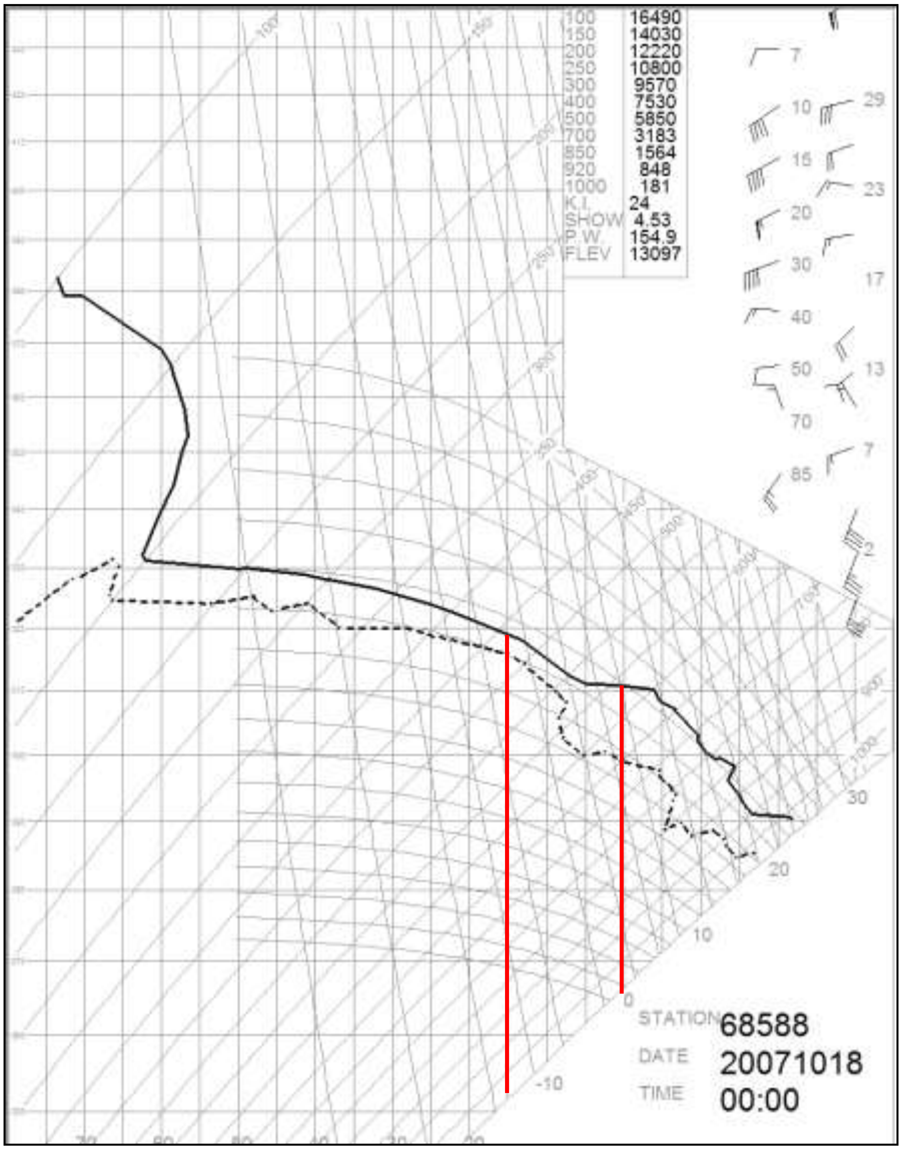


Figure 42: Tephigram for Durban on 18 October 2007 at 00h00Z, indicating the critical icing layer between 0 and -15˚C (red vertical lines).

The cloud is not convective as it is a layer of mid-level Altocumulus cloud and the dewpoint depression within the critical layer is less than 5˚C, but not less than 2˚C, and then according to the icing decision tree one has to forecast moderate icing. The base and top of the icing levels is chosen using the following process; the base is 14000ft above mean sea level as that is the cloud base of the mid-level clouds that was being forecast as seen in the low level significant weather chart. Usually the base of the icing layer will be the height of the freezing level (13000ft), but in this case the freezing level was below the cloud base and you need cloud to forecast icing, therefore the height of the icing base was lifted to the cloud base height. The top of the icing level is chosen to be the height of the top of the critical icing layer, which for this case was 20000ft, as 460 hPa corresponds to 20000ft above mean sea level. The icing area is chosen to be the same area in which the mid level cloud is forecast, excluding the area where embedded CBs were as the icing will be covered in that area by the embedded thunderstorm and CB SIGMETs. The AIRMET is chosen to be an observed, rather than a forecast AIRMET as the band of mid-level cloud was already visible at 06Z as seen on satellite image in Fig. 44.

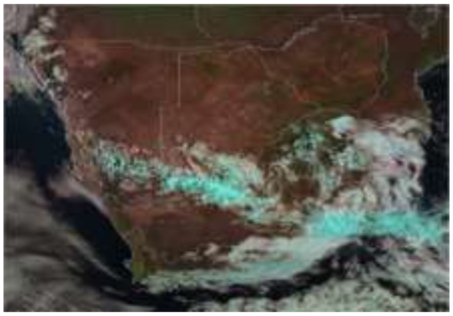


Figure 43: Day Natural Colours RGB image valid for 18 October 2007 at 06h00Z. Copyright (2015) EUMETSAT.

The NWP idicates that the mid-level cloud will still persist to 12h00Z (see sigweather chart).

An example of a **Severe Aircraft Icing** warning:

FAJA SIGMET D01 VALID 231200/231600 FAOR-

FAJA JOHANNESBURG FIR **SEV ICE** FCST WI

S2421 E02706 - S2503 E02904 - S2720 E02946 - S2750 E02829 - S3030 E02928 - S2942 E02748 - S2844 E02629 - S2742 E02559 - S2730 E02502 - S2636 E02409 - S2558 E02413 - S2535 E02423 - S2540 E02527 - S2442 E02550 - S2431 E02613 - S2421 E02706 SFC/FL200

STNR NC=

4.11 Aerodrome warnings (AMF AC 3.1.5)

All AMF are required to warn for hazardous phenomena affecting aerodromes such as: strong surface winds including cross-winds and squalls, frost, freezing precipitation, snowfall, lightning, wake vortices.

The purpose of Aerodrome warnings is to give concise information of meteorological conditions which could adversely affect aircraft on the ground, including parked aircraft, and the aerodrome facilities and services. Aerodrome warnings are cancelled when the conditions prompting the warning are no longer occurring and/or no longer expected to occur at the aerodrome.

Aerodrome warnings are issued in accordance with the template provided in the latest version of ICAO Annex 3, Appendix 6, Table A6-2, when required by aircraft operators and/or aerodrome services.

Table 23: Template for Aerodrome Warnings after Table A6-2, ICAO Annex 3

Table A6-2. Template for aerodrome warnings

Key: M = inclusion mandatory, part of every message;
C = inclusion conditional, included whenever applicable.

Note 1.— The ranges and resolutions for the numerical elements included in aerodrome warnings are shown in Table A6-4 of this appendix.

Note 2.— The explanations for the abbreviations can be found in the Procedures for Air Navigation Services — ICAO Abbreviations and Codes *(PANS-ABC, Doc 8400).*

Element	*Detailed content*	*Templates*	*Examples*
Location indicator of the aerodrome (M)	Location indicator of the aerodrome	nnnn	YUCC[1]
Identification of the type of message (M)	Type of message and sequence number	AD WRNG [n]n	AD WRNG 2
Validity period (M)	Day and time of validity period in UTC	VALID nnnnnn/nnnnnn	VALID 211230/211530
IF THE AERODROME WARNING IS TO BE CANCELLED, SEE DETAILS AT THE END OF THE TEMPLATE.			
Phenomenon (M)[2]	Description of phenomenon causing the issuance of the aerodrome warning	TC[3] nnnnnnnnnn *or* [HVY] TS *or* GR *or* [HVY] SN [nnCM][3] *or* [HVY] FZRA *or* [HVY] FZDZ *or* RIME[4] *or* [HVY] SS *or* [HVY] DS *or* SA *or* DU *or* SFC WSPD nn[n]MPS MAX nn[n] (SFC WSPD nn[n]KT MAX nn[n]) *or* SFC WIND nnn/nn[n]MPS MAX nn[n] (SFC WIND nnn/nn[n]KT MAX nn[n]) *or* SQ *or* FROST *or* TSUNAMI *or* VA[DEPO] *or* TOX CHEM *or* *Free text up to 32 characters*[5]	TC ANDREW HVY SN 25CM SFC WSPD 20MPS MAX 30 VA TSUNAMI
Observed or forecast phenomenon (M)	Indication whether the information is observed and expected to continue, or forecast	OBS [AT nnnnZ] *or* FCST	OBS AT 1200Z OBS
Changes in intensity (C)	Expected changes in intensity	INTSF *or* WKN *or* NC	WKN
OR			
Cancellation of aerodrome warning[6]	Cancellation of aerodrome warning referring to its identification	CNL AD WRNG [n]n nnnnnn/nnnnnn	CNL AD WRNG 2 211230/211530[6]

Notes —

1. Fictitious location.
2. One phenomenon or a combination thereof, in accordance with 5.1.3.
3. In accordance with 5.1.3.
4. Hoar frost or rime in accordance with 5.1.3.
5. In accordance with 5.1.4.
6. End of the message (as the aerodrome warning is being cancelled).

Recommendation: The use of text additional to the abbreviations listed in table 26 should be kept to a minimum. The additional text should be prepared in abbreviated plain language using approved ICAO abbreviations and numerical values. If no ICAO approved abbreviations are available, English plain language text should be used.

They are disseminated in accordance with local arrangements to those concerned, by the meteorological office designated to provide service for that aerodrome.

They **should** relate to the occurrence (observation) or expected occurrence (forecast) of one or more of the following phenomena:

- tropical cyclone (if the 10-minute mean surface wind speed at the aerodrome is expected to be 63 km/h (34 KT) or more)
- thunderstorm
- hail
- snow (including the expected or observed snow accumulation)
- freezing precipitation
- hoar frost or rime
- sand storm
- dust storm
- rising sand or dust
- strong surface wind and gusts
- squall
- frost
- volcanic ash
- tsunami (Note: Not required where a national safety plan for tsunami is integrated with the “at risk” aerodrome)
- volcanic ash deposition
- toxic chemicals
- other phenomena as agreed locally.

Where quantitative criteria are required for the issue of aerodrome warnings, e.g. expected maximum wind or expected total snow fall, these are established by agreement between the aerodrome meteorological office and the users of the warnings.

Examples of Aerodrome warnings:

Wind:

FABL AD WRNG 1 VALID 161100/161300 SFC WSPD 30KT MAX 43 OBS AT 1100Z INTSF=

FABL AD WRNG 2 VALID 161100/161200 SFC WSPD 24030KT MAX 43 FCST=

FABL AD WRNG 02 VALID 161100/161200 SFC WSPD 30KT MAX 43 OBS NC=

Thunderstorm:

FADY AD WRNG 1 VALID 090800/090900 **HVY TS** OBS AT 0800Z INTSF=

FABL AD WRNG 1 VALID 091200/091300 **HVY TSGR** FCST=

Dust:

FABL AD WRNG 1 VALID 161100/161300 **HVY DS** OBS AT 1100Z WKN=
FABL AD WRNG 1 VALID 161100/161230 **HVY DU** FCST=

Volcanic Ash:

FACT AD WRNG 1 VALID 090800/090900 **VA** OBS AT 0800Z INTSF=

Tropical Cyclone:

FQBR AD WRNG 1 VALID 090800/091000 **TC IDAI** OBS AT 0800Z INTSF=

CNL AD WRNG 2 090800/091000Z

4.12 Sand and Dust Storms (AMF AC 2.1.7 and 3.1.6)

A dust storm or a sand storm can be seen on the Dust RGB on satellite imagery as a bright pink feature. Observations can indicate the presence of dust.

Example

At 11:00Z FABL reported dust with a reduced visibility to 2000m:

METAR FABL 161100Z 24030G43KT 2000 DS VV003 16/04 Q1010 TEMPO 5000 TSRA=

If this heavy dust is visible on the satelite and covering a large area then a SIGMET can be issued.

FAJA **SIGMET** A01 VALID 161100/161200 FAOR –

FAJA Johannesburg FIR **HVY DS** OBS AT 1100Z WI (MAP)=

The SIGMET should be accompanied by an AIRMET for reduced visibility with the same validity time:

FAJA **AIRMET** A01 VALID 161100/161200 FAOR –

FAJA Johannesburg FIR **SFC VIS** 2000 SS OBS AT 1100Z WI (MAP)=

Using the observation (METAR) and the validity times in the TAF that corresponded to the dust storm an Aerodrome Warning can be issued. See section on Aerodrome warnings for examples.

4.13 Volcanic Ash (AMF AC 3.1.7) (WV SIGMET)

The Meteorological Watch Office (MWO) is responsible for issuing warnings that will affect their FIRs. The Aviation Weather Centre (AWC), such as OR Tambo, continuously monitor the weather that will affect flights taking place in their area of responsibility. When it comes to Volcanic ash observations/forecasts, the MWO has to consult the Volcanic Ash Advisory Centres (VAACs).

VAACs are meteorological centers designated by regional air navigation agreement on advice from WMO. A VAAC is designated by the WMO to monitor volcanic eruptions in their respective areas of responsibility and also run volcanic ash numerical dispersion models. VAACs provide to MWOs, the lateral and vertical extent and forecast movement of volcanic ash in the atmosphere following volcanic eruptions. The advisory information is to be used by MWOs in support of the issuance of SIGMET information on volcanic ash clouds. http://www.meteo.fr/vaac/

The MWO should then make use of the advisory information provided by the VAAC to issue the relevant SIGMETs for their FIRs by following the procedure as stated in the Standard Operating Procedure (SOP) for Aviation Weather Forecasters (AWC-SOP-FOR-001.5). There are 9 VAACs worldwide as seen on Fig. 45. South Africa falls within the Toulouse VAAC.

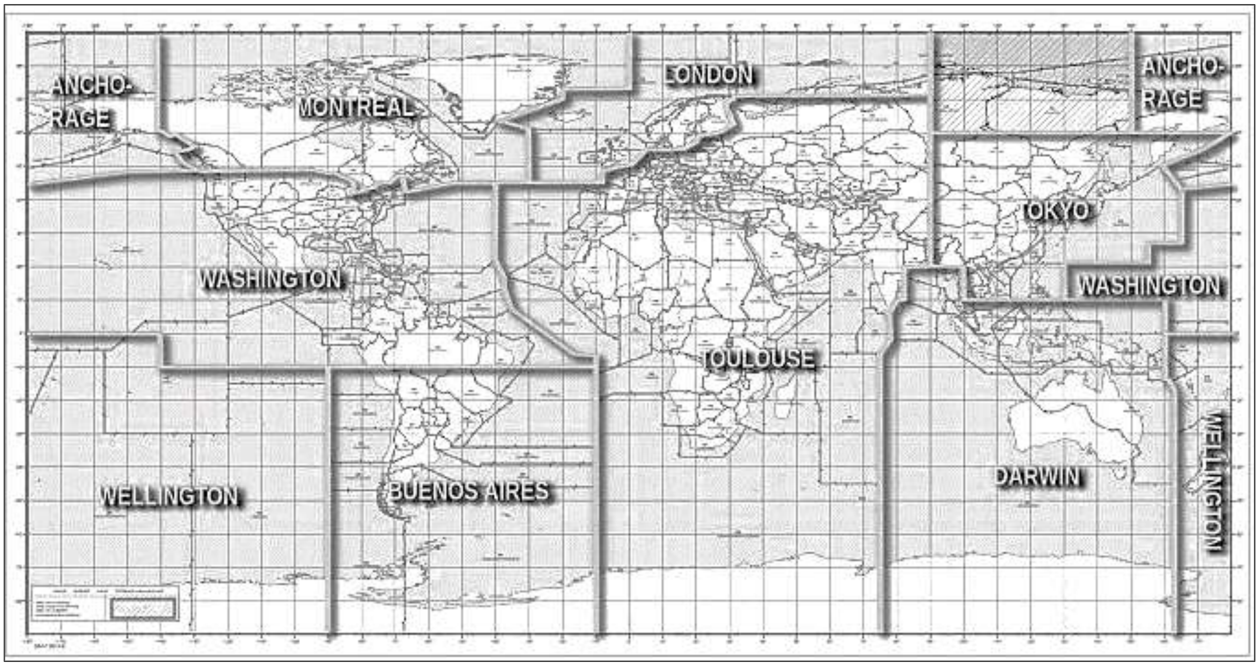


Figure 44: The 9 different VAACs and their respective areas of responsibility. South Africa falls within the Toulouse (Meteo-France) region of responsibility (Source: http://www.meteo.fr/vaac/).

Any volcanic ash activity on or around the African Continent will be monitored by Toulouse and the advisory information regarding volcanic ash can be found at the following address:

http://www.meteo.fr/vaac/evaa.html

A volcanic ash SIGMET based on an advisory will have the following format (this is just an example):

IDD41295
VA ADVISORY
DTG: 20140213/1752Z
VAAC: Darwin
VOLCANO: Kelut 263280
PSN: S0756 E11219
AREA: Indonesia
SUMMIT ELEV: 1731M
ADVISORY NR: 2014/2
INFO SOURCE: MTSAT, MEDIA.
AVIATION COLOUR CODE: RED
ERUPTION DETAILS: VA PLUME OBS TO FL450 EXTEDING 50NM TO W AT 13/1632Z.
OBS VA DTG: 13/1745Z

OBS VA CLD: SFC/FL450 S0715 E11255 - S0720 E11105 - S0825 E11100 - S0830 E11245 - S0715 E11255

FCST VA CLD +6HR: 13/2345Z SFC/FL450 S0720 E11255 - S0715 E11050 - S0830 E11045 - S0835 E11250 - S0720 E11255

FCST VA CLD +12HR: 14/0545Z SFC/FL450 S0720 E11255 - S0710 E11035 - S0830 E11025 - S0835 E11250 - S0720 E11255

FCST VA CLD +18HR: 14/1145Z SFC/FL450 S0715 E11255 - S0705 E11020 - S0830 E11015 - S0835 E11250 - S0715 E11255

RMK: HEIGHT DERIVED FROM 13/1632Z MTSAT IR IMAGE AND JUANDA 13/1200Z SOUNDING.

NXT ADVISORY: NO LATER THAN 20140213/2345Z

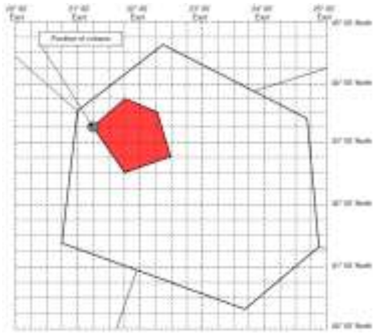
Example of SIGMET based on the volcanic Ash advisory:

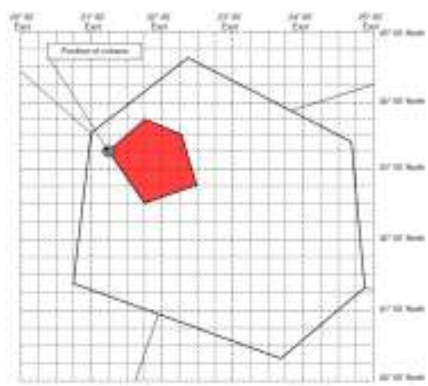
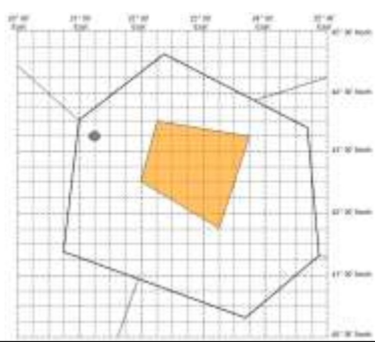
WVID21 WAAA 131805
WAAZ SIGMET A01 VALID 131745/132345 WAAA-
WAAZ UJUNG PANDANG FIR VA ERUPTION MT KELUT
PSN S0756 E11219 VA CLD OBS AT 1745Z WI S0715 E11255
- S0720 E11105 - S0825 E11100 - S0830 E11245 - S0715
E11255 SFC/FL450 NC FCST AT 2345Z WI S0720 E11255 -
S0715 E11050 - S0830 E11045 - S0835 E11250 - S0720 E11255 =

One can also see volcanic ash on the Dust RGB:

The Dust RGB will cause volcanic ash clouds to appear in an orange-y colour however, dependent on the height of material, chemical composition of the material ejected etc., the colours can somewhat vary. In some instances it can have a green color.

NB: All SIGMETs issued for volcanic ash must be disseminated to WAFC and the responsible VAAC and to the internaitonal OPMET data bank. If no warning was issued by the VAAC, but volcanic ash is observed in the FIR, then the observed Volcanic Ash SIGMET will be issued and the VAAC (Toulouse) will be notified accodingly as stated in the SOP for Aviation Weather Forecasters (AWC-SOP-FOR-001.5).

No forecast position	
YUDD SIGMET 2 VALID 101200/101600 YUSO- YUDD SHANLON FIR VA ERUPTION MT ASHVAL PSN N4315 E02115 VA CLD OBS AT 1200Z WI N4315 E02115 - N4345 E02145 - N4330 E02215 - N4245 E02230 - N4230 E02145 - N4315 E02115 FL250/370 MOV ESE 20KT NC=	

With forecast position	
YUDD SIGMET 2 VALID 101200/101800 YUSO- YUDD SHANLON FIR/UIR VA ERUPTION MT ASHVAL PSN N4315 E02115 VA CLD OBS AT 1200Z WI N4315 E02115 - N4345 E02145 - N4330 E02215 - N4245 E02230 - N4230 E02145 - N4315 E02115 FL250/370 NC FCST AT 1800Z WI N4330 E02215 - N4315 E02345 - N4145 E02315 - N4230 E02200 - N4330 E02215=	 

4.14 Tropical Cyclones (AMF AC 3.1.8) (WC SIGMET)

The Meteorological Watch Office (MWO) is responsible for issuing warnings that will affect their FIRs. The Aviation Weather Centre (AWC), such as OR Tambo, continuously monitor the weather that will affect flights taking place in their area of responsibility. When it comes to Tropical cyclone forecasts, the MWO has to consult the Tropical Cyclone Advisory Centre (TCAC).

A TCAC is designated by the WMO to monitor tropical cyclones in their respective areas of responsibility by making use of a variety of data, such as geostationary and polar-orbiting satellite data, NWP models and observations. The TCACs will inform the MWO about the position, movement, forecast position and time, speed, central pressure and maximum surface winds near the centre of the cyclone. The MWO should then use this informaiton to issue the neccesary SIGMET for tropical cyclones.

The TCAC that is responsible for monitoring tropical cyclones and issuing advisories in the area that can affect South African FIRs, is La Reunion-Tropical Cyclone Centre from Meteo-France. They are responsible the area depicted in Fig. 46, known as the South West Indian Ocean.

Figure 45: The South West Indian Ocean area that falls under the responsibility of La Reunion (Meteo-France) for Tropical Cyclone Forecasts and moniotoring (Source: www.meteofrance.re/cyclone/activite-cyclonique-en-cours&prev=search).

Any tropical cyclone activity in the South West Indian Ocean will be monitored by La Reunion and the forecasts and information regarding active tropical cyclones can be found at the following address:

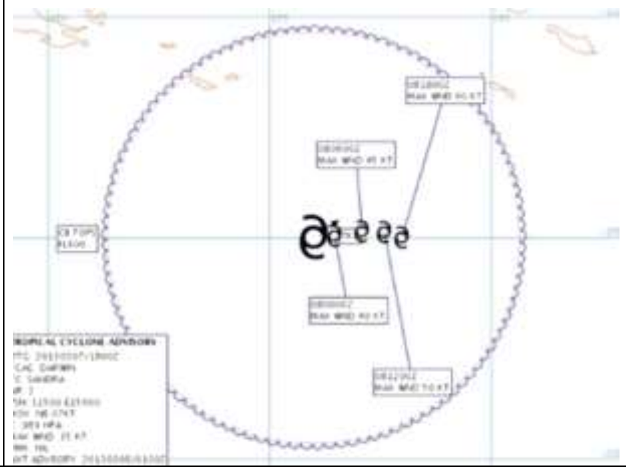
https://translate.google.co.za/translate?hl=en&sl=fr&u=http://www.meteofrance.re/cyclone/activite-cyclonique-en-cours&prev=search

A forecaster on duty should use the advisory received from the TCAC to write the SIGMETs necessary for the FIR in which the centre of the tropical cyclone is located by using the procedure listed in the Standard Operating Procedure (SOP) for Aviation Weather Forecasters (AWC-SOP-FOR-001.5). If some of the

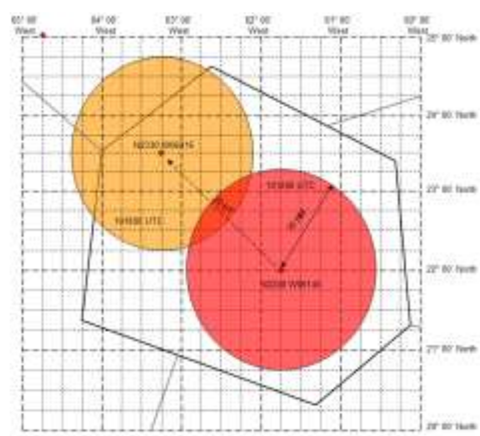
Cumulonimbus clouds and thunderstorms resulting form the tropical cyclone might extend onto on of our FIRs, and in such a case the necessary thunderstorm SIGMETs should also be issued by the MWO.

NB: All SIGMETs issued for Tropical cyclones must be disseminated to WAFC and the responsible TCAC and to the relevant OPMET data bank. If no warning was issued by the TCAC, but a cyclone is observed in the FIR, then the observed Tropical Cyclone SIGMET will be issued and the TCAC (La Reunion) will be notified accodingly as stated in the SOP for Aviation Weather Forecasters (AWC-SOP-FOR-001.5).

Tropical Cyclone SIGMET Format	**Advisory message**
WCAAii CCCC YYGGgg [BBB] CCCC SIGMET [n][n]n VALIDYYGGgg/YYGGgg CCCC- CCCC <FIR/CTA Name> FIR TC <Name> PSN <position> CB OBS/FCST [AT GGggZ] <location> <level> <Movement or expected movement> <changes in intensity> <Forecast time and forecast position> <Repetition of elements>=	FKAU05 ADRM 071830 TC ADVISORY DTG: 20130307/1800Z TCAC: DARWIN TC: SANDRA NR: 02 PSN: S1500 E15600 MOV: NE 07KT C: 989HPA MAX WIND: 35KT FCST PSN +6HR: 08/0000Z S1500 E15630 FCST MAX WIND +6HR: 40KT FCST PSN +12HR: 08/0600Z S1448 E15706 FCST MAX WIND +12HR: 45KT FCST PSN +18HR: 08/1200Z S1454 E15736 FCST MAX WIND +18HR: 50KT FCST PSN +24HR: 08/1800Z S1500 E15800 FCST MAX WIND +24HR: 60KT RMK: NIL NXT MSG: 20130308/0100Z

SIGMET (WC) Example (with movement)	**Graphical SIGMET**
WCAU01 ABRF 071910 YBBB SIGMET D02 VALID 071915/080115 YBRF- YBBB BRISBANE FIR TC SANDRA PSN S1500 E15600 CB OBS AT 1800Z WI 280NM OF TC CENTRE TOP FL500 MOV NE 07KT INTSF =	

If the exact time of the observation is not known the time is not included. When FCST is used, it is assumed that the time of occurrence or commencement of the phenomenon coincides with the beginning of the period of validity included in the first line of the SIGMET.

Use of "WI nnnKM (or nnnNM) OF TC CENTRE " in Tropical Cyclone SIGMET Only	
YUDD SIGMET 2 VALID 101200/101800 YUSO- YUDD SHANLON FIR TC GLORIA PSN N2200 W06145 CB OBS AT 1200Z WI 75NM OF TC CENTRE TOP BLW FL500 MOV NW 20KT WKN= YUDD SIGMET 2 VALID 101200/101800 YUSO- YUDD SHANLON FIR TC GLORIA PSN N2200 W06145 CB OBS AT 1200Z WI 75NM OF TC CENTRE TOP BLW FL500 WKN FCST AT 1800Z TC CENTRE PSN N2330 W06315=	

4.15 Mountain Obscured (AMF AC 2.1.4) (AIRMET)

Below is an example:

AIRMET FAJA (Johannesburg) FIR

FAJA **AIRMET** F01 VALID 010600/011000 FAJA-

FAJA JOHANNESBURG FIR **MT OBSC** FCST WI (MAP)=

4.16 Broken/Overcast Low Cloud < 1000ft (AMF AC 2.1.4) (AIRMET)

Widespread areas of BKN or OVC cloud with base height < 1000 ft (Note - the base height is above ground level). Below is an example:

AIRMET FAJA (Johannesburg) FIR

FAJA **AIRMET** G01 VALID 010600/011000 FAJA-

FAOR JOHANNESBURG FIR **BKN CLD** 100/6000FT OBS at 0600Z WI (MAP)=

4.17 Surface Wind Speed (AMF AC 2.1.2) (AIRMET)

Widespread mean surface wind speed > 30 KT (60km/h) – Note this is different to an Aerodrome warning for wind which is just at a fixed point. Below is an example:

FAJA **AIRMET** J01 VALID 101400/101800 FAJA-

FAOR JOHANNESBURG FIR **SFC WSPD** 320/35KT FCST WI (MAP)=

4.18 Weather systems and their associated warnings

Table 25 indicates the weather systems and their possible associated aviation warnings.

Table 24: Weather systems and their associated aviation warnings

Weather System	Aviation Hazards	Warnings AIRMET	Warnings SIGMET	AD Warnings	Low Level Windshear Warning	NWP Fields	Satellite and RADAR
Cold Front and associated surface and upper air trough	-Low cloud (BKN/OVC SC/ST cloud) in onshore W/NW surface flow ahead of front. -Poor visibility ahead of front (DZ/RA/FG/BR) -Poor Visibility in showers behind front -Mod/Sev Mountain Waves -Mod/Sev Turbulence with upper air jetstream -Mod/Sev Icing -TCU in cold air -Low level wind shear -CB ahead of cold front	-BKN/OVC CLD Cloud base <1000ft a.g.l -Vis < 5000m -MT OBSC -MOD MTW -MOD ICING -MOD TURB -ISOL CB -ISOL TS -ISOL TSGR	-SEV MTW -SEV ICING -SEV TURB	-SFC WSPD 25KT -HVY TS/TSGR OBS AT… MOV… INTF/WKN/NC	Yes	As per above check thunderstorm ingredients with surface and upper air trough. Cold front: -PMSL cin2/BKNT 10m -THTE 1000/850 cin2 -RELH 850-500 -BKNT at all levels (check upper levels for Jetstream) -Check Freezing level height -Instability Indices -Pchg. -2m Temperatures -VVEL 850	IR 10.8 VIS Day Natural Colours RGB Day Microphysical RGB Convective Storms RGB Airmass RGB Consult RADAR to estimate speed of movement/storm track and estimated time of arrival
Upper Trough (500-300 hPa)	-Mod/Sev Turbulence (JSTR.) -Mod/Sev Icing -Poor Visibility in -CB -TS -TCU	-SFC Vis < 5000m -TCU -MOD ICING -MOD TURB -ISOL CB -ISOL TS -ISOL TSGR	-EMBD TS -EMBD TSGR -SEV TURB -SEV ICING	-HVY TS/TSGR OBS AT… MOV… INTF/WKN/NC	Possible if Thunderstorm approaching aerodrome causes gust front	-Instability Indices -DVRG wind 850 lt00 -DVRG wind 300 gt00 -VVEL 850-500 -BKNT at all levels -Freezing levels -HGHT all levels -RELH all levels, especially 600-500 hPa	IR 10.8 VIS Day Natural Colours RGB Day Microphysical RGB Convective Storms RGB WV 6.2 and 7.3

Weather System	**Aviation Hazards**	**Warnings AIRMET**	**Warnings SIGMET**	**AD Warnings**	**Low Level Windshear Warning**	**NWP Fields**	**Satellite and RADAR**
Cut-Off Low	-Mod/Sev Turbulence(JSTR) -Mod/Sev Icing -Poor Visibility -CB -TS -TCU -Low Cloud	-BKN/OVC CLD Cloud base <1000ft a.g.l -Vis < 5000m -MOD ICING -MOD TURB -ISOL/OCNL/FRQ CB -ISOL/OCNL/FRQ TS -ISOL/OCNL/FRQ TCU -ISOL/OCNL TSGR	-EMBD TS -EMBD TSGR -FRQ TS -FRQ TSGR -SEV TURB -SEV ICING	-HVY TS/TSGR OBS AT… MOV… INTF/WKN/NC	Yes	-Instability Indices -DVRG wind 850 lt00 -DVRG wind 300 gt00 -VVEL 850-500 -BKNT at all levels -Freezing levels -HGHT all levels -RELH all levels, especially 600-500 hPa Upper low displaced westward with height in a developing system. Strong upper winds/Strong wind shear in speed and direction and cold temperature core	IR 10.8 VIS Day Natural Colours RGB Day Microphysical RGB Convective Storms RGB WV 6.2 and 7.3 Airmass RGB
Tropical Low	-Low Cloud -Poor Visibility -CB -TCU -TS -Icing	-Vis < 5000m -MOD ICING -ISOL/OCNL/FRQ CB -ISOL/OCNL/FRQ TS -ISOL/OCNL/FRQ TCU	-EMBD TS -FRQ TS -SEV TURB -SEV ICING	-HVY TS/TSGR OBS AT… MOV… INTF/WKN/NC	N/A	-Instability Indices -DVRG wind 850 lt00 -DVRG wind 300 gt00 -VVEL 850-500 -BKNT at all levels -HGHT all levels -RELH all levels, especially 600-500 hPa Upper low superimposed on surface low, light winds, little wind shear and low has relatively warm temperature core	IR 10.8 VIS Day Natural Colours RGB Day Microphysical RGB Convective Storms RGB

CHAPTER 5 - AMF Competency 4: Ensure the quality of meteorological information and services

5.1 Procedures for Forecast products as used within the OR Tambo Aviation Weather Centre (AMF AC 4.1)

5.1.1 (TAFs and SIGWX charts)

Please consult the EQMS as this document may change at any stage:

https://weathersacoza.sharepoint.com/sites/SHEQ/Documentation/Forms/AllItems.aspx

Refer to AWC forecaster's SOP on E-QMS: SER-AWC-SOP-FOR-001.2

5.1.2 The review, amendment, cancellation and correction of TAFs as used within the OR Tambo Aviation Weather Centre.

Please consult the EQMS as the latest version of this document may change at any stage:

http://tqm.saws.local/qms/Documents_View/Aviation_Docs.htm

Refer to the AWC forecaster's SOP on E-QMS: SER-AWC-SOP-FOR-001.2

5.1.3 Procedure used for warning information (SIGMET, AIRMET and Aerodrome warning) at OR Tambo International Airport.

Please consult the EQMS as this document may change at any stage:

http://tqm.saws.local/qms/Documents_View/Aviation_Docs.htm

Refer to the AWC forecaster's SOP on E-QMS: SER-AWC-SOP-FOR-001.2

CHAPTER 6 AMF Competency 5: Communicate Meteorological information to internal and external users

Competence description

User requirements are fully understood and are addressed by communicating concise and complete forecasts/warnings in a manner that can be clearly understood by the users.

Ensure that all forecasts/warnings are disseminated through the authorized communication means and channels to designated user groups.

During the Aeronautical Forecasting Training Course all forecast/warning products need to be emailed to the trainer concerned. In this particular case the trainer can be seen as the customer of the learner concerned. You need to ensure that your products have been received by the trainer (customer) concerned. The best way to do this is to send your final products by email and ask for a read receipt. This is important as it is a standard, namely to **ENSURE** that all forecasts/warnings are disseminated through the authorized communication means and channels to designated user groups.

When you start working in an operational environment, you will have other methods and systems of submitting your forecast products to clients. One way to assess whether a user has received these forecasts in an operational environment is to determine if forecasting products are available on the SAWS website soon after you have submitted them. Email forecasts can be treated in the same way as within the training environment.

6.1 Authorized communication channels of Aeronautical Forecasting Products

6.2 Upper-air wind forecasts

Upper-air forecasts are received from WAFCs in digital form and supplied to users in digital or chart form. On the charts, the wind direction is shown by arrows with a number of feathers or shaded pennants to indicate the wind speed, and temperatures are given in degrees Celsius:

- Negative temperatures are indicated without sign, but positive temperatures are shown with a preceding "+" sign.

- Wind and temperature information is given for points on a grid sufficiently dense to provide meaningful information. On computer-drawn charts, wind arrows normally take precedence over temperatures, and temperatures take precedence over the chart background.

6.3 En route Forecast (AMF AC 5.2)

En-route forecast is the weather briefing conversation between the pilot and the forecaster/briefing officer. It gives a summary of expected weather conditions for the flight route over the next few hours. Only significant weather items that might pose a hazard to aviation are given but general weather conditions are given when required by the pilot. It is therefore imperative that the forecaster and the pilot should understand each other's needs for a conversation to be fruitful and effective.

6.4 Required information for a Quality Briefing

You are advised to interpret all information provided to the client from the valid charts (SIGWX, Block winds, TAFs) exc. Remember, the pilot is entitled to all the information they require.

Before commencing with the briefing first obtain the following information from the pilot. If the pilot does not provide you will all the information you will need to ask for it.

- **Aircraft number or pilot name:**

This will serve as evidence that briefing has been obtained. In some weather centers briefings are recorded, this will help in case of an accident as the briefing can be reviewed. Try to avoid passing information through a third party, make sure you are talking to the pilot.

Table 25: The Aviation Alphabet to be used during oral communication with a pilot.

A	Alpha	**N**	November
B	Bravo	**O**	Oscar
C	Charlie	**P**	Papa
D	Delta	**Q**	Quebec
E	Echo	**R**	Romeo
F	Foxtrot	**S**	Sierra
G	Golf	**T**	Tango
H	Hotel	**U**	Uniform

I	India	**V**	Victor
J	Juliet	**W**	Whiskey
K	Kilo	**X**	X-Ray
L	Lima	**Y**	Yankee
M	Mike	**Z**	Zulu

- **Identify the type of the flight planned.**
  VFR/IFR or able to fly both. This helps the briefer to give relevant information to the pilot for proper planning of the flight. It is normal for a briefer to assume that the flight is VFR unless otherwise stated. It is therefore proper for a pilot to specify his flight and the briefer to ask the type of the flight.
- **Obtain the Flight level.**
  By knowing the flight level it helps the briefer to provide information and hazards at that particular level, e.g. winds, icing, turbulence, wind shear, mountain waves, etc.
- **Provide the Take-off conditions.**
  Start the briefing process of by providing detailed information regarding the take–off conditions of the departure airfield. It might be good to tell the pilot what is currently happening as this instills confidence.
- **Departure and Destination airfields.**
  It is important for a pilot to be specific about the departure place and destination to help the briefer understand the area and give specific weather conditions for that place.
- **Estimated time of departure and arrival.**
  This is essential since weather can affect departure time. It is imperative for a pilot to have his own estimate time, than the briefer will suggest any alternative possible time.
  You are now in a position to provide a quality weather briefing.
- **Provide en-route wind direction and speed at flight level.** Use the WAFC vector winds or Spotgraphs on the aviation website which provide wind direction and wind speeds at different flight levels. A short flight might only require one wind direction and wind speed value, as opposed to a longer route which might require 3 to 4. Use recognized geographical way points on route, such as recognized cities or provinces exc. You can build confidence in the forecast by referring to recent radio-sonde data, AMDAR data or other aircraft reports from the area. You may occasionally be required to provide temperature forecasts en route.
- **Provide En route Weather for the required route.**
  Always mention cloud amount, height of cloud base and top of all clouds in feet above mean sea level en route. Mention significant weather and bad visibility en route. Mention freezing level height en route as well as the potential for icing above those given freezing level heights. Only IFR flights are equipped with de-icing equipment. Also use the animated satellite picture and radar.

- **Provide the destination weather by referring to the landing TAF.**
  Recommend alternate aerodromes in the case of bad weather. Only provide the conditions in the TAF that fit the required time that the pilot is intending on landing. Ensure that you provide the pilot with all the weather elements needed (wind, vis, cloud etc.). Verify the issued TAF with the latest available NWP. You could also mention the latest METAR or TREND forecast that could also instill confidence in the forecast.
- **End your forecast with a recommendation**
  Some examples are: Continue with your planning, the weather should not cause any problems. If possible suggest an alternative route or flight level. Exercise caution crossing the escarpments. Don't recommend Visual Flight Rules, Don't recommend the flight without de-icing equipment. Mention all hazardous weather: Icing, Turbulence (CAT/Mountain waves), Thunderstorms (ISOL EMBD, OCC EMBD), Strong head winds, Microburst/Down burst, Poor Visibility due to fog, mist, low cloud, showers/rain.

6.5 Example of an En Route Weather Briefing

Pilot: Good morning. I would like to fly from Port Elizabeth (FAPE) to OR Tambo International (FAOR) departing PE and arriving in Johannesburg at 15:00 local time (SAST). Please provide me with the weather conditions upon take off, on route and upon landing at Johannesburg.

Confirm the Flight type, either being IFR or VFR, flight time and Flight level if needed.

The flight will be VFR
FL100
Time of Departure: 09:00Z

Take-off Conditions: (Cater for your METAR, include the entire METAR including the TREND)

Wind: 08013KT 050V120
Vis: 9999
Cloud: FEW cloud at 035 A.G.L
Temp: 18/08
QNH: 1031
TREND: NOSIG

Winds en route: (Use your NWP vector winds, use the right time of validity and geographically point out areas where significant changes occur)

FAPE: 330 15KT

Free-State: 330 15KT

Around FAOR: 340 10KT

Weather on route: (Use your sig weather chart to forecast, refer here to cloud types, bases and tops, mention the hazards to aviation, reduced vis, icing, CB,s exc.).
(Progress geographically with the information till close to destination)

Eastern Cape: Clear conditions.
Over the southern Free-State expecting SCT CU to develop base 100, tops 160,
BKN AC base 120, tops 180 A.M.S.L
ISOL EMBD CB base 100 and tops 360.A.M.S.L
In this visibility can be reduced to 4000m in showers and
Expect moderate icing above FL125.
This weather extends up to Gauteng.

Upon arrival at FAOR you are likely to experience the following weather conditions (Read the TAF which is applicable at that time of arrival)
02013KT 9999 SCT040 FEW040CB TEMPO 2512/2521 3000 TSRA SCT035CB BKN080

Warning/Advisory: (Mention CB,s thundershowers,, icing, low cloud, precipitation and reduction to visibility)

Embedded Thundershowers developing over the Frees-state and Gauteng, mod icing and vis reduced to 4000m

CHAPTER 7 Tasks

Every week, for the duration of the AMF practical course, a task has to be completed, which is aligned to the AMF competency criteria. These tasks need to be submitted electronically at the end of every class. The tasks contribute towards your formative assessment mark.

CHAPTER 8 Appendix A

AMF	: Aeronautical Meteorological Forecaster
SAWS	: South African Weather Service
UP	: University of Pretoria
METAR	: Meteorological Aeronautical Report
SPECI	: Selected Special Weather Report
TAF	: Terminal Aerodrome Forecast
ICAO	: International Civil Aviation Organization
AMDAR	: Aircraft Meteorological Data Relay
SIGWX Chart	: Significant weather chart
SIGMET	: Significant Meteorological Weather Forecast
AIRMET	: Area Forecast for Low-Level Flights
RADAR	: Radio Detection and Ranging
MSL	: Mean Sea Level
A.G.L	: Above Ground Level
CAT	: Clear Air Turbulence
VFR	: Visual Flight Rules
VMC	: Visual Meteorological Condition
IFR	: Instrument Flight Rules
IMC	: Instrumental Meteorological Condition
LOV	: Low-veld
HIV	: High-veld
ESC	: Escarpment
BECMG	: Becoming
FM	: From
TEMPO	: Temporary
PROB	: Probability

CHAPTER 9 References

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