The Bureau of Meteorology

User Guide

Australian Digital Forecast Database (ADFD)

Version 22 (effective 7 October 2025)

Contents

Introduction

This document outlines the technical details of the data included in the Australian Digital Forecast Database (ADFD). Also included are descriptions of the content, format, and access arrangements for data from the ADFD.

The ADFD is a database of official weather forecast elements produced by the Bureau of Meteorology, such as temperature, rainfall, and weather types, presented in a gridded format. The forecasts use a blend of Australian and international model data with the latest science, technology, and expert meteorologist input to best represent expected weather.

This set of weather element grids at 3-to-6-kilometre resolution will be made available and updated whenever grids are published.

Funding for the database was provided by the Australian Government as part of the Next Generation Forecast and Warning System (NexGenFWS) implementation.

Publication of grids

ADFD formats

The ADFD data are available or viewable in a number of formats:

- grid formats – NetCDF and GRIB2
- image format through MetEye
- web mapping service (for some elements)

The Bureau of Meteorology uses the ADFD to produce text forecasts and warnings and map displays in MetEye. The Bureau's BOM Weather App sources the weather element values from the ADFD.

Quality control of grids

Disclaimers

The ADFD grids represent the official Bureau forecasts which are routinely verified. If the text forecasts and warnings are updated, the ADFD grids may not necessarily be updated at the same time.

The official text formats and grids may not always be directly comparable and may show some inconsistencies, due to the spatial resolution of the grids and a potential offset from the precise location of the text forecast.

Technical information

Availability

The ADFD files are updated routinely four times per day at around 2300, 0500, 1100 and 1700 UTC (Coordinated Universal Time) and updated at other times as required. If the forecasts are updated, the ADFD grids are not necessarily updated at the same time as the changes to the forecasts. Priority is given to updating the forecasts and warnings issued directly to the public through the media or web.

Format of grids

The ADFD grids are available in two formats – NetCDF and GRIB2. Both formats are self-describing and widely used in the meteorological community.

GRIB2 (Gridded Binary)	NetCDF (Network Common Data Form)
GRIB is a concise data format developed by the World Meteorological Organization for efficient international exchange of numerical weather prediction data. GRIB2 is the second edition of GRIB code.	NetCDF is a self-describing, machine-independent open standard data format for scientific data, especially in array form.
A useful link for GRIB2 file format is: http://www.nco.ncep.noaa.gov/pmb/docs/grib2/	A useful link: http://www.unidata.ucar.edu/software/netcdf/docs/faq.html
A site with GRIB2 decoding software is: https://github.com/NOAA-EMC/NCEPLIBS-grib_util	Documentation on decoding and viewing NetCDF: http://www.unidata.ucar.edu/software/netcdf/docs/. The NetCDF files are compressed using GZip (GNU.zip) to assist in download.

Table 1 Format of grids

File naming convention

The files have the naming convention:

- Compressed NetCDF files: ID(X)7nnnn_<domain>_<element>_SFC.nc.gz
- GRIB2 files: ID(X)7nnnn_<element>_SFC.grib2

Where:

- X represents the state of origin – N for NSW, V for Victoria etc., D for Northern Territory and Z for the full Australian domain.
- 7nnnn represents the individual product number
- <domain> - NSW, VIC, TAS, QLD, SA, WA, NT or AUS
- <element> represents the weather element. (Refer to section 3.4.1 for a listing of elements).
- SFC denotes that it is a weather element at the surface (rather than an upper air field).

Element names and individual product numbers are included in the table below.

Details on element names and typical file sizes

Available grids

Individual grid details are listed in Table 2. All grids are available in NetCDF3 format; grids available in GRIB2 are denoted in the table.

The Bureau of Meteorology

Metadata records

Metadata records describing all available grids listed in the table below are available via the Bureau of Meteorology's Data Catalogue

Element type	Element name (<element>)	Frequency of data in file	Available as GRIB2?	Individual product ID (7nnnn)
Daytime maximum temperature (ºC)	MaxT_SFC	Daily	Y	71002
Overnight minimum temperature (ºC)	MinT_SFC	Daily	Y	71003
Temperature (ºC) at specified time	T_SFC	Hourly	Y	71000
Apparent temperature (ºC) for specified time	ApparentT_SFC	Hourly	N	71068
Dewpoint temperature (ºC) at specified time	Td_SFC	Hourly	Y	71001
Relative humidity (%) for specified time	RH_SFC	Hourly	Y	71018
Daily mean precipitation amount*	DailyPrecip_SFC	Daily	Y	71005
Chance of any rain (%) on the day	DailyPoP_SFC	Daily	Y	71090
Rest of day chance of any rain %) on the day	RestOfDayPoP_SFC	Daily	N	71091
25th percentile daily rainfall amount (mm). When not 0mm, a 75% chance of exceeding this value.	DailyPrecip75Pct_SFC	Daily	N	71016
50th percentile daily rainfall amount (mm). When not 0mm, a 50% chance of exceeding this value.	DailyPrecip50Pct_SFC	Daily	N	71015
75th percentile daily rainfall amount (mm). When not 0mm, a 25% chance of exceeding this value	DailyPrecip25Pct_SFC	Daily	N	71014
90th percentile daily rainfall amount (mm). When not 0mm, a 10% chance of exceeding this value.	DailyPrecip10Pct_SFC	Daily	N	71030

Element type	Element name (<element>)	Frequency of data in file	Available as GRIB2?	Individual product ID (7nnnn)
Daily chance of at least 1mm precipitation (%)	DailyPoP1_SFC	Daily	Y	71007
Daily chance of at least 5mm precipitation	DailyPoP5_SFC	Daily	Y	71008
Daily chance of at least 10mm precipitation	DailyPoP10_SFC	Daily	Y	71009
Daily chance of at least 15mm precipitation	DailyPoP15_SFC	Daily	Y	71010
Daily chance of at least 25mm precipitation	DailyPoP25_SFC	Daily	Y	71011
Daily chance of at least 50mm precipitation	DailyPop50_SFC	Daily	Y	71012
3-hourly mean precipitation amount (mm)*	Precip_SFC	3-hourly	Y	71004
3-hourly chance of any rainfall (%)	PoP_SFC	3-hourly	Y	71013
50th percentile 3-hourly rainfall amount (mm). When not 0mm, a 50% chance of exceeding this value.	Precip50Pct_SFC	3-hourly	N	71033
75th percentile 3-hourly precipitation amount (mm). When not 0mm, a 25% chance of exceeding this value.	Precip25Pct_SFC	3-hourly	N	71032
90th percentile 3-hourly precipitation amount (mm). When not 0mm, a 10% chance of exceeding this value.	Precip10Pct_SFC	3-hourly	N	71031
Wind speed for specified time (knots or m/s)**	Wind_Mag_SFC	Hourly	Y	71006
Wind speed (km/h) for specified time	WindMagKmh_SFC	Hourly	N	71071
Wind Speed Max in Hour (knots)***	WindMaxInHour_SFC	Hourly	N	71074
Wind Speed Max in Hour (km/h)***	WindMaxInHourKmh_SFC	Hourly	N	71073
Wind Speed on Hour (knots)***	WindOnHour_SFC	Hourly	N	71076
Wind Speed on Hour (km/h)***	WindOnHourKmh_SFC	Hourly	N	71075
Wind direction (degrees true) for specified time	Wind_Dir_SFC	Hourly	Y	71089
Total wave height (m)	SigWaveHgt_SFC	3-hourly to Day 4	Y	71069

Element type	Element name (<element>)	Frequency of data in file	Available as GRIB2?	Individual product ID (7nnnn)
Wind wave height (m)	WindWaveHgt_SFC	3-hourly to Day 4	Y	71022
Swell (1) magnitude (m)	Swell_Mag_SFC	3-hourly to Day 4	Y	71023
Swell (2) magnitude (m)	Swell2_Mag_SFC	3-hourly to Day 4	N	71024
Swell (1) direction (degrees true)	Swell_Dir_SFC	3-hourly to Day 4	Y	71092
Swell (2) direction (degrees true)	Swell2_Dir_SFC	3-hourly to Day 4	N	71093
Weather-fog	WxFog_SFC	3-hourly	N	71102
Weather-frost	WxFrost_SFC	3-hourly	N	71107
Weather-precipitation	WxPrecipitation_SFC	3-hourly	N	71097
Weather-frozen precipitation	WxPrecipitationFrozen_SFC	3-hourly	N	71096
Weather-thunderstorm	WxThunderstorm_SFC	3-hourly	N	71094
Mixing height (m) at specified time	MixHgt_SFC	Hourly	N	71109
Forest Fuel Dryness Factor	DF_SFC	3-hourly (seasonal)	N	71127
3-hourly weather icon codes	WxIcon_SFC	3-hourly	N	71034
Daily weather icon codes	DailyWxIcon_SFC	Daily	N	71152
Hazardous wind onset	HazWind	Latest, updated hourly	N	71153
Wind Gust (km/h)	windgustkmh	Hourly	N	71072
Wind Gust (knots)	windgust	Hourly	Y	71021
Sky cover (percentage cloud)	Sky_SFC	3-hourly	Y	71017

Table 2 Individual grid details

**These grids display the mean precipitation value for the given forecast time/location and are recommended for use in hydrological applications where summing forecasts in time and space is required to have an expectation of the total volume of water. For point-based applications probabilistic rainfall forecast grids are recommended.*

*** Wind speed in GRIB2 format is m/s; NetCDF format is knots.*

**** These additional grids were made available in July 2021 and new users should use these grids instead of Wind_Mag_SFC (71006) and WindMagKmh_SFC (71071).*

The Bureau of Meteorology

Domains and grid resolution

Grids are available for the Bureau's entire Australian domain.

Area	Aus	Vic	NSW	Tas	SA	WA	Qld	NT
Northern latitude (degrees South)	-8.3	-33.94	-28.0	-39.12	-25.88	-12.63	-8.96	-9.90
Southern latitude (degrees South)	-45.0	-39.76	-37.6	-44.64	-39.38	-36.18	-29.31	-26.15
Latitude spacing (degrees)	0.05	0.02	0.05	0.02	0.05	0.05	0.05	0.05
Number of latitude points	735	292	193	277	271	472	408	326
West longitude (degrees East)	111.98	140.90	140.90	142.75	128.86	112.10	137.86	128.02
East longitude (degrees East)	155.03	151.04	154.68	149.37	141.14	129.10	154.68	141.14
Longitude spacing (degrees)	~0.06	~0.03	~0.06	~0.03	~0.06	~0.06	~0.06	~0.06
Number of longitude points	723	341	232	223	207	286	283	221

Table 3 Domains and grid resolution

Map projection of the grids

- Lat/Long

The datum for these grids is GDA94.

Times within the data files

The times in the ADFD files are in Coordinated Universal Time (UTC).

The time assigned to a grid represents the commencement time as follows:

i. for an hourly grid the forecast is for the start of the hour;
ii. for 3-hourly rainfall and weather grids, the forecast is for the 3-hour period commencing at the start of the hour;
iii. for data issued for a 24 hour period the following rules apply:
    - for rainfall, the period is the 24 hours from 15 UTC;
    - for daily maximum temperature, the period will be 1900 to 1300 UTC
    - for daily minimum temperature, the period will be 0700 to 0100 UTC

Note that, unlike model data, the ADFD data does not have a ‘base time’ field. ADFD grids are generally updated at regular times but may be edited at any time as required. Thus, only ‘valid time’ is reported.

Additional grids

Other elements will be added to the ADFD with further system development, and in response to user needs, and will depend on these fields meeting the Bureau's quality standards. Specialised grids are provided to emergency management agencies.

Information about Bureau spatial boundaries

The Bureau's forecast and warning services use several spatial boundary classifications to meet emergency service and community needs. It may be useful to be aware of these boundaries when designing services using the ADFD and other forecast and warning products issued by the Bureau.

The Spatial Data Guide provides an overview of these datasets.

Support information

Access arrangements

ADFD data is made available through the Bureau's Registered User FTP service.

Some ADFD fire weather grids are available for subscription via separate product bundles: http://reg.bom.gov.au/catalogue/fire_ADFD.pdf.

Sample grids are available via: ftp://ftp.bom.gov.au/anon/sample/catalogue/ADFD/.

Charges and other details on the Registered User service are here: http://reg.bom.gov.au/other/charges.shtml.

Support arrangements

The ADFD is supported by the Bureau's IT Operations group; however certain problems encountered may require the attention of system developers. Return to service will be made as soon as possible but no specific response times can be guaranteed.

Contact us

Connect with us via webreg@bom.gov.au

Attachment 1: Decoding the weather grids

Purpose

This attachment specifies how the weather grids that are stored in the Australian Digital Forecast Database (ADFD) should be decoded.

Weather grid content

The “weather grid” in the Graphical Forecast Editor (GFE) contains information about the types of weather that can be expected at each grid point. Examples of valid weather types are frost, fog, showers, rain, snow showers, snow, and thunderstorms.

At each grid point the weather grid contains the following information:

1. Weather type: the type of weather expected, e.g. frost, fog, rain, showers.
2. Intensity: the intensity of the weather type, e.g. in the case of rain the intensities could be one of light, moderate, heavy or very heavy.
3. Coverage: the coverage is a measure of the likelihood of the weather type occurring, e.g. “isolated” indicates a low probability of the weather type occurring at that grid point and “widespread” is a high probability.
4. Attributes: attributes are conditions that the weather type can cause. Examples of attributes are tornadoes, flash flooding and gusty winds.

Weather code design

Overview

Weather grids will be produced for precipitation, frozen precipitation, thunderstorms, frost and fog. For each type of weather, there are a large number of combinations of intensities, coverage and attributes, and these have to be grouped to simplify and reduce the number of possible codes in each grid. This simplification is described below.

The resulting code will be a series of numbers indicating if the weather type is present at each grid point, along with its intensity, coverage and attribute.

Weather type

Instead of differentiating between all the types of similar weather possible, the code will only indicate if that weather is present or not. For example, in the case of frozen precipitation, we will not differentiate between the presence of snow and snow showers.

Intensity

There are often up to about four possible intensities for each weather type. Similar intensities will be grouped together to leave essentially two levels; low and high. For example, snow can have intensities of light, moderate, heavy or very heavy. Light and moderate will be grouped together (low intensity), as will heavy and very heavy (high intensity).

Coverage

Coverage will be grouped together in a similar way to intensity to reduce the number of options. They will be grouped into “low probability” and “high probability” coverage.

For example, with fog the available coverage types are chance, patchy, areas and widespread. Low probability coverage types will be chance, patchy and areas. Widespread will be high probability.

Attributes

Attributes are conditions that the weather type can cause such as tornadoes, flash flooding, hail and gusty winds. A complication of attributes is that more than one can be present at a time. To include all the attribute information would result in a large number of variations, so attributes will be prioritized in order of impact, and only the highest impact attribute present mentioned.

Weather grid code specification

The below information specifies how each code maps to the intensity, coverage and attributes possible for each weather type.

Fog

Grouping of fog information

The possible intensities, coverage and attributes are described below, along with how they map to the possible levels available in the code.

Weather presence
Fog not present = no fog
Fog present = fog

Intensities
Normal = low
Thick = high

Coverage
Chance of = low probability
Patchy = low probability
Areas = low probability
Widespread = high probability

Attributes
No attributes are valid for fog weather type.

Code functional requirements

Aus (0.05deg)	Vic (0.025deg)	NSW (0.05deg)	Tas (0.025deg)	SA (0.05deg)	WA (0.05deg)	Qld (0.05deg)	NT (0.05deg)
IDZ71102	IDV71102	IDN71102	IDT71102	IDS71102	IDW71102	IDQ71102	IDD71102

Table 4 Product codes for Weather-fog grids

Code	Presence	Intensity	Coverage	Attribute
0	No fog	-	-	-
1	Fog	Low	Low probability	-
2	Fog	Low	High probability	-
3	Fog	High	Low probability	-
4	Fog	High	High probability	-

Table 5 Code functional requirements for Weather-fog grids

Frost

Grouping of frost information

The possible intensities, coverage and attributes are described below, along with how they map to the possible levels available in the code.

Weather Presence

Frost not present = no frost
Frost present = frost

Intensities

Light = low
Normal = low
Severe = high

Coverage

Chance of = low probability
Patchy = low probability
Areas = low probability
Widespread = high probability

Attributes

No attributes are valid for frost weather type.

Code functional requirements

Aus (0.05deg)	Vic (0.025deg)	NSW (0.05deg)	Tas (0.025deg)	SA (0.05deg)	WA (0.05deg)	Qld (0.05deg)	NT (0.05deg)
IDZ71107	IDV71107	IDN71107	IDT71107	IDS71107	IDW71107	IDQ71107	IDD71107

Table 6 Product codes for Weather-frost grids

Code	Presence	Intensity	Coverage	Attribute
0	No frost	-	-	-
1	Frost	Low	Low probability	-
2	Frost	Low	High probability	-
3	Frost	High	Low probability	-
4	Frost	High	High probability	-

Table 7 Code functional requirements for Weather-frost grids

Thunderstorms

Grouping of thunderstorm information

The possible intensities, coverage and attributes are described below, along with how they map to the possible levels available in the code.

Weather Presence

Thunderstorms not present = no thunderstorms
Thunderstorms present = thunderstorms

Intensities

Normal = low
Severe = high
Very dangerous = high

Coverage
Chance of = low probability
Isolated = low probability
Scattered = low probability
Widespread = high probability

Attributes
The highest impact attribute should be chosen. The order (highest to lowest) is as follows:

Attributes	
1	Tornadoes
2	Destructive winds
3	Flash flooding
4	Damaging winds
5	Large hail
6	Heavy rain
7	Hail
8	Dry
9	Gusty winds
10	None (no attribute present)

Table 8 Attributes for Weather-thunderstorm grids

Code functional requirements

Aus (0.05deg)	Vic (0.025deg)	NSW (0.05deg)	Tas (0.025deg)	SA (0.05deg)	WA (0.05deg)	Qld (0.05deg)	NT (0.05deg)
IDZ71094	IDV71094	IDN71094	IDT71094	IDS71094	IDW71094	IDQ71094	IDD71094

Table 9 Product codes for Weather-thunderstorm grids

Code	Presence	Intensity	Coverage	Attribute
0	No thunderstorms			
1	Thunderstorms	Low	Low probability	Tornadoes
2	Thunderstorms	Low	Low probability	Destructive winds
3	Thunderstorms	Low	Low probability	Flash flooding
4	Thunderstorms	Low	Low probability	Damaging winds
5	Thunderstorms	Low	Low probability	Large hail
6	Thunderstorms	Low	Low probability	Heavy rain
7	Thunderstorms	Low	Low probability	Hail
8	Thunderstorms	Low	Low probability	Dry
9	Thunderstorms	Low	Low probability	Gusty winds
10	Thunderstorms	Low	Low probability	No attribute
11	Thunderstorms	Low	High probability	Tornadoes
12	Thunderstorms	Low	High probability	Destructive winds
13	Thunderstorms	Low	High probability	Flash flooding
14	Thunderstorms	Low	High probability	Damaging winds
15	Thunderstorms	Low	High probability	Large hail
16	Thunderstorms	Low	High probability	Heavy rain
17	Thunderstorms	Low	High probability	Hail
18	Thunderstorms	Low	High probability	Dry
19	Thunderstorms	Low	High probability	Gusty winds
20	Thunderstorms	Low	High probability	No attribute

Code	Presence	Intensity	Coverage	Attribute
21	Thunderstorms	High	Low probability	Tornadoes
22	Thunderstorms	High	Low probability	Destructive winds
23	Thunderstorms	High	Low probability	Flash flooding
24	Thunderstorms	High	Low probability	Damaging winds
25	Thunderstorms	High	Low probability	Large hail
26	Thunderstorms	High	Low probability	Heavy rain
27	Thunderstorms	High	Low probability	Hail
28	Thunderstorms	High	Low probability	Dry
29	Thunderstorms	High	Low probability	Gusty winds
30	Thunderstorms	High	Low probability	No attribute
31	Thunderstorms	High	High probability	Tornadoes
32	Thunderstorms	High	High probability	Destructive winds
33	Thunderstorms	High	High probability	Flash flooding
34	Thunderstorms	High	High probability	Damaging winds
35	Thunderstorms	High	High probability	Large hail
36	Thunderstorms	High	High probability	Heavy rain
37	Thunderstorms	High	High probability	Hail
38	Thunderstorms	High	High probability	Dry
39	Thunderstorms	High	High probability	Gusty winds
40	Thunderstorms	High	High probability	No attribute

Table 10 Code functional requirements for Weather-thunderstorm grids

Frozen precipitation

Grouping of frozen precipitation information

The possible intensities, coverage and attributes are described below, along with how they map to the possible levels available in the code.

Weather Presence
Frozen precipitation is present if any of the following weather is in the grid: snow, snow showers, sleet, or sleet showers.

Frozen weather not present = no frozen

Intensities
Light = low
Moderate = low
Heavy = high
Very heavy = high

Coverage
Chance of = low probability
Isolated = low probability
Patchy = low probability
Scattered = low probability
Areas = low probability
Widespread = high probability

Attributes

The highest impact attribute should be chosen. The order (highest to lowest) is as follows:

Attributes	
1	Tornadoes
2	Destructive winds
3	Flash flooding
4	Damaging winds
5	Hail
6	Gusty winds
7	None (no attribute present)

Table 11 Attributes for Weather-frozen precipitation grids

Code functional requirements

Aus (0.05deg)	Vic (0.025deg)	NSW (0.05deg)	Tas (0.025deg)	SA (0.05deg)	WA (0.05deg)	Qld (0.05deg)	NT (0.05deg)
IDZ71096	IDV71096	IDN71096	IDT71096	IDS71096	IDW71096	IDQ71096	IDD71096

Table 12 Product codes for Weather-frozen precipitation grids

Code	Presence	Intensity	Coverage	Attribute
0	No frozen			
1	Frozen	Low	low probability	Tornadoes
2	Frozen	Low	Low probability	Destructive winds
3	Frozen	Low	Low probability	Flash flooding
4	Frozen	Low	Low probability	Damaging winds
5	Frozen	Low	Low probability	Hail
6	Frozen	Low	Low probability	Gusty winds
7	Frozen	Low	Low probability	No attribute
8	Frozen	Low	High probability	Tornadoes
9	Frozen	Low	High probability	Destructive winds
10	Frozen	Low	High probability	Flash flooding
11	Frozen	Low	High probability	Damaging winds
12	Frozen	Low	High probability	Hail
13	Frozen	Low	High probability	Gusty winds
14	Frozen	Low	High probability	No attribute
15	Frozen	High	Low probability	Tornadoes
16	Frozen	High	Low probability	Destructive winds
17	Frozen	High	Low probability	Flash flooding
18	Frozen	High	Low probability	Damaging winds
19	Frozen	High	Low probability	Hail
20	Frozen	High	Low probability	Gusty winds
21	Frozen	High	Low probability	No attribute
22	Frozen	High	High probability	Tornadoes
23	Frozen	High	High probability	Destructive winds
24	Frozen	High	High probability	Flash flooding
25	Frozen	High	High probability	Damaging winds

Code	Presence	Intensity	Coverage	Attribute
26	Frozen	High	High probability	Hail
27	Frozen	High	High probability	Gusty winds
28	Frozen	High	High probability	No attribute

Table 13 Code functional requirements for Weather-frozen precipitation grids

Precipitation

Grouping of precipitation information

The possible intensities, coverage and attributes are described below, along with how they map to the possible levels available in the code.

Weather Presence
Precipitation present if any of the following weather types are in the grid point: sleet, snow, sleet showers, snow showers, thunderstorms, rain, showers, drizzle.

Precipitation not present = no precip

Intensities
Light = low
Moderate = low
Normal = low
Heavy = high
Very heavy = high
Severe = high
Very dangerous = high

Coverage
Chance of = low probability
Isolated = low probability
Patchy = low probability
Scattered = low probability
Areas = low probability
Widespread = high probability

Attributes
The highest impact attribute should be chosen. Some of the below attributes (e.g. dry, large hail, heavy rainfall) only occur with a weather type of thunderstorms.
The order (highest to lowest) is as follows:

Attributes	
1	Tornadoes
2	Destructive winds
3	Flash flooding
4	Damaging winds
5	Large hail
6	Heavy rainfall
7	Hail
8	Dry
9	Gusty winds
10	None (no attribute present)

Table 14 Attributes for Weather-precipitation grids

Code functional requirements

Aus (0.05deg)	Vic (0.025deg)	NSW (0.05deg)	Tas (0.025deg)	SA (0.05deg)	WA (0.05deg)	Qld (0.05deg)	NT (0.05deg)
IDZ71097	IDV71097	IDN71097	IDT71097	IDS71097	IDW71097	IDQ71097	IDD71097

Table 15 Product codes for Weather-precipitation grids

Code	Presence	Intensity	Coverage	Attribute
0	No precip			
1	Precip	Low	Low probability	Tornadoes
2	Precip	Low	Low probability	Destructive winds
3	Precip	Low	Low probability	Flash flooding
4	Precip	Low	Low probability	Damaging winds
5	Precip	Low	Low probability	Large hail
6	Precip	Low	Low probability	Heavy rain
7	Precip	Low	Low probability	Hail
8	Precip	Low	Low probability	Dry
9	Precip	Low	Low probability	Gusty winds
10	Precip	Low	Low probability	No attribute
11	Precip	Low	High probability	Tornadoes
12	Precip	Low	High probability	Destructive winds
13	Precip	Low	High probability	Flash Flooding
14	Precip	Low	High probability	Damaging winds
15	Precip	Low	High probability	Large hail
16	Precip	Low	High probability	Heavy rain
17	Precip	Low	High probability	Hail
18	Precip	Low	High probability	Dry
19	Precip	Low	High probability	Gusty winds
20	Precip	Low	High probability	No attribute
21	Precip	High	Low probability	Tornadoes
22	Precip	High	Low probability	Destructive winds
23	Precip	High	Low probability	Flash flooding
24	Precip	High	Low probability	Damaging winds
25	Precip	High	Low probability	Large hail
26	Precip	High	Low probability	Heavy rain
27	Precip	High	Low probability	Hail
28	Precip	High	Low probability	Dry
29	Precip	High	Low probability	Gusty winds
30	Precip	High	Low probability	No attribute
31	Precip	High	High probability	Tornadoes
32	Precip	High	High probability	Destructive winds
33	Precip	High	High probability	Flash flooding
34	Precip	High	High probability	Damaging winds
35	Precip	High	High probability	Large hail
36	Precip	High	High probability	Heavy rain
37	Precip	High	High probability	Hail
38	Precip	High	High probability	Dry
39	Precip	High	High probability	Gusty winds
40	Precip	High	High probability	No attribute

Table 16 Code functional requirements for Weather-precipitation grids

Attachment 2: Specific grid details

Wind Speed

For many years the Bureau made a single set of gridded wind speed forecasts (at hourly temporal resolution) available through the ADFD. The wind speed grids (Wind_Mag_SFC and WindMagKmh_SFC) were defined as the "wind speed on the hour" (with that time being the start hour of the hourly grid).

This set of wind speed forecasts were used to derive other products, for example, fire danger indices and marine wind warnings, and they were used as inputs into other systems such as fire spread models. It is understood that the uses of the wind forecasts are varied, and in some situations "wind speed on the hour" is important, but in others the "maximum wind speed within the hour" is more appropriate.

To address these different use cases, the Bureau made the following additional wind speed grids available to the ADFD in July 2021:

- WindOnHour: the expected sustained wind speed for the time-stamp (at the start of the hour)
- WindMaxInHour: the expected maximum of the sustained wind speeds within the hour (for a 60 min period centred on the time-stamp)

All wind speeds are sustained wind speeds (i.e. over a 10-minute averaging period) at 10 metres above ground level. These changes have been supported by scientific analysis to ensure that they lead to improved service outcomes. Forecasts and warnings which include wind speed information, and indices which use wind speed as an input (for example, fire danger indices), are adjusted to use the most appropriate wind speed forecast in each case.

Forest Fuel Dryness Factor

Definition

Forest fuel dryness factor (FFDF) is related to an accumulated rainfall deficit and ranges from a value of 0 (relatively moist) to a maximum value of 10 (dry). Winter rainfall usually reduces the drought factor to 0. The FFDF is based on either the Keetch Byram Drought Index (KBDI) in Qld, NSW, VIC and WA or the Mount's Soil Dryness Index (SDI) in SA and TAS. The KBDI and SDI are different measures of accumulated rainfall deficit and can produce different FFDF values.

Forecast periods

The forecast is for the start of the first hour of the (3-hourly) time period selected. This data is produced seasonally (in some states/territories) and is used as the Drought Factor, one of the parameters in determining Fire Behaviour Indices (FBIs) for Forest and Pine fuel types. A typical fire season in forests commences in the late winter months in SE Queensland, extends southwards through NSW during spring and commences in Victoria, the SW of Western Australia, South Australia and Tasmania by late spring or early summer.

Caveats

The values in the ADFD grid outside the fire season are generated automatically from rainfall analyses and are not quality controlled. There are no values available for the NT and some inland areas of WA and SA where the Forest Fuel Dryness Factor (Drought Factor) is not used to

determine Fire Behaviour Indices (FBIs)/Fire Danger Ratings or where there is insufficient rainfall data.

Hazardous wind onset

Definition

The hazardous wind onset map shows if and when hazardous winds will arrive over the next six hours.

The map shows winds that are:

- currently forecast to be hazardous (red, 0)
- expected to be hazardous in the next two hours (orange, 1)
- expected to be hazardous in two to six hours (yellow, 2)
- not expected to be hazardous within the next six hours (transparent, 3).

'Hazardous' wind is defined as average wind speed 26 knots and above or wind gusts 42 knots and above—a threshold chosen for the safety of recreational boaters. The map is available across all areas of Australia, including inland waters, and out to 60 nautical miles from the coast. It is updated every hour and delivered to the server by 50 minutes past the hour.

Attachment 3: Land/sea grid adjustments

Coastal grid cells identified as marine cells (i.e., a greater proportion of water than land within the cell) are adjusted via an algorithm which uses an adjacent land cell for relevant forecast elements such as temperature.

Coastal grids cells identified as land cells are also adjusted to display relevant marine elements such as sea and swell.

The adjusted values overwrite existing values generated by the GFE.

Adjustment of cells by forecast element is as follows:

Element	ADFD definition
Maximum temperature (71002)	Land-biased
Minimum temperature (71003)	Land-biased
Temperature (71000)	Land-biased
Dew point (71001)	Land-biased
Wind (knots) (71006)	Marine-biased
Wind (km/h) (71071)	Land-biased
Total wave height (71069)	Marine-biased
Swell1 height and direction (71023 and 71092)	Marine-biased
Swell2 height and direction (71024 and 71093)	Marine-biased
Wind wave height (71022)	Marine-biased
Apparent temperature (71068)	Land-biased
Relative humidity (71018)	Land-biased
Drought factor (71127)	Land-biased

Table 17 Adjustment of cells by forecast elements

Attachment 4: Icon grid generation

Icon grids are generated according to the following rules.

Three-hourly grids

Weather grid use

The weather grid is a three-hourly grid. The following intensities are defined in the weather grid.

Intensity	Description
!!	Very severe intensity
!	Severe intensity
n	Normal intensity
++	Very heavy intensity
+	Heavy intensity
m	Moderate intensity
-	Light intensity

Table 18 Weather grids intensities

Several weather types can be present at the same grid point at the same time.

Possible weather types and the codes are:

Intensity	Description
TS	Thunderstorm
SN	Snow
SNSH	Snow shower
SL	Sleet
SLSH	Sleet shower
RA	Rain
SH	Shower
FG	Fog
FR	Frost
DU	Dust
VA	Volcanic ash
DZ	Drizzle
SMK	Smoke
HZ	Haze
MI	Mist

Table 19 Possible weather types and codes

The following coverages (and codes) are defined in the weather grid and are used with respect to the inclusion (or exclusion) of thunderstorms. Hence, only coverage of the thunderstorm (TS) weather key is required to be sampled.

Coverage	Description
Chc	Chance of coverage
Isol	Isolated coverage
Sct	Scattered coverage
Wide	Widespread coverage

Table 20 Coverage of thunderstorms

Rule for filtering based on weather grid:

1. Any TS with normal intensity (i.e. TSn) and coverage of Chc should be ignored. All other TS should be included.

Wind grid use

The wind grid is an hourly grid.

For each three-hour period (corresponding to the period of the weather grid), the maximum wind speed at each grid point should be found.

If this wind speed is ≥ 30 knots that point is classified as very windy and depending on the content of the weather grid may result in a windy icon.

If the wind speed is ≥ 22 knots that point is classified as windy and depending on the content of the weather grid may result in a windy icon.

PoP grid use

The probability of precipitation (PoP) grid has a three-hour grid length which corresponds to the same period as the weather grid.

The PoP grid value will be used to determine if precipitation icons should be used.

If the PoP grid has a value < 15%, precipitation icons will not be used. That is, only non-precip icons allowed. Weather types TS, SN, SNSH, SL, RA, SLSH, SH, DZ should be ignored for that 3 hour period if PoP<15%.

Sky grid use

The sky grid has a three-hour grid length which corresponds to the same period as the weather grid.

The sky grid content will be used to determine the icon when there is no weather value and the wind speed is below the windy threshold.

The value of the sky grid and the corresponding icon type is as below:

Sky Grid Value	Icon Name	Icon Number
<= 15 (for grids with a start time of 21, 00, 03 and 06UTC)	Sunny	1
<=15 (for grids with start time of 09, 12, 15 and 18UTC)	Clear	2
> 15 and <= 65	Partly cloudy*	3
> 65	Cloudy	4

Table 21 Sky grid and icon name and number

*See note below icon section.

Daily grid

Icons that represent the weather for the whole day (or the remainder of the day in the case of day0) are produced in a similar fashion to the 3-hour icon grids.

For days 1 through 7, a daily icon is produced for each “day” in the GFE, which is defined as the period between 15UTC and 15UTC.

For day 0, a daily icon grid is produced using the remaining grids, including the one covering the current time, before 15UTC.

DailyPoP grid use

The DailyPoP grid is a 24-hour grid between 15UTC/15UTC which gives the probability of any precipitation during that day.

The value of this grid should be found for days 1 onwards. If this grid has value < 35%, precipitation icons will not be used. If this grid has a value of >= 35%, then sky icons will not be used. This is described in more detail in the following section.

Weather grid use

The following intensities (and codes) are defined in the weather grid.

Intensity	Description
!!	Very severe intensity
!	Severe intensity
n	Normal intensity
++	Very heavy intensity
+	Heavy intensity
m	Moderate intensity
-	Light intensity

Table 22 Weather grid intensity and description

The following coverages (and codes) are defined in the weather grid and are used with respect to the inclusion (or exclusion) of thunderstorms. Hence, **only coverage** of the thunderstorm (TS) weather key is sampled.

Coverage	Description
Chc	Chance of coverage
Isol	Isolated coverage
Sct	Scattered coverage
Wide	Widespread coverage

Table 23 Weather grid coverage and description

Several weather types can be present at the same grid point at the same time.

Possible weather types and the codes are:

Intensity	Description
TS	Thunderstorm
SN	Snow
SNSH	Snow shower
SL	Sleet
SLSH	Sleet shower
RA	Rain
SH	Shower
FG	Fog
FR	Frost
DU	Dust
VA	Volcanic ash
DZ	Drizzle
SMK	Smoke
HZ	Haze
MI	Mist

Table 24 Weather type intensities and descriptions

All weather types, their intensity, and coverage (in the case of TS) that occur during the day are recorded before using a priority table to choose the highest impact weather. However, the following rules filter out some of these weather types from being considered for the final icon code.

1. For day 1 onwards…If DailyPoP < 35%, then only non-precipitation icons are allowed. That is, weather types TS, SN, SNSH, SL, RA, SLSH, SH, DZ should be ignored for that day.
2. Any TS with normal intensity (i.e. TSn) and coverage of CH should be ignored. All other TS should be included.
3. FG should be ignored at day 2 onwards. i.e. the icon should not be 10 at day 2 onwards.
4. FR should be ignored on all days, i.e. icon value 14 is not displayed in daily icon grids.
5. On days 0 and 1, FR occurring after 03UTC should be ignored. So this means that any frost occurring in a weather grid with start time after 04UTC (i.e. 03, 06, 09 and 12UTC) will not be considered for frost. Only frost occurring in grids with start time 15, 18, 21 and 00UTC are used.
6. Of the remaining valid weather types, the highest priority weather type should be chosen as a possible icon. Whether this is chosen as the final icon will depend on its relative priority with other results such as the wind strength.
7. After the above rules have been applied…for day 1 onwards, if DailyPoP >= 35% and no weather types are present, the wind speed value is < 22 knots and no cyclone grid value is present, then a light shower (number 17) icon should be used. That is, if only cloud information remains but DailyPoP >= 35, use icon 17.

Cyclone grid use

The value of the TCAdvice grid should be found.

The TCAdvice grids can be any length because TC Warnings are issued for the next 24 hours, and TC Watches are issued for the following 24 hours.

This grid is populated with one of the following values if a TC watch or warning has been issued for that area.

- Watch (TC Watch)
- Warning (TC Warning)
- WatchAdjacent (TC Watch on adjacent coast)
- WarningAdjacent (TC Warning on adjacent coast)
- WatchReport (Report gales due to TC Watch)
- WarningReport (Report gales due to TC Warning)
- WatchAdjacentReport (Report gales due to TC Watch on adjacent coast)
- WarningAdjacentReport (Report gales due to TC Warning on adjacent coast)

If any TCAdvice grid has one of the above values between the hours 15UTC/15 UTC, then the cyclone icon (value 19) will be assigned to that grid point regardless of other priorities. I.e. if there is a cyclone watch/warning current, then the cyclone icon is used.

Wind grid use

The wind grid is an hourly grid.

For each 24-hour time period (or remaining part thereof in the case of day0) the maximum wind speed at each grid point should be found.

If this wind speed is >= 30 knots that point is classified as very windy and depending on the content of the weather grid may result in a windy icon.

If the wind speed is >= 22 knots that point is classified as windy and depending on the content of the weather grid may result in a windy icon.

Sky grid use

The sky grid has a 3-hour grid length which corresponds to the same period as the weather grid.

The sky grid content will be used to determine the icon when there is no weather and the wind speed is below the windy threshold.

For days 1 onwards, only sky grids between 21UTC and 09UTC should be used. That is, grids with a start time of 21, 00, 03 and 06UTC should be considered, with the grids with start time of 15, 18, 09 and 12UTC ignored. The highest value of the sky grid between these times for each grid point should be found.

For day 0, if the current time is before 06UTC, all remaining grids (from current time) before 09UTC should be used. As an example, if the current time was 02UTC, grids with start time of 00, 03 and 06UTC would be used.
If the current time is after 06UTC, all remaining grids before 15UTC should be used. The highest value of the sky grid between these times for each grid point should be found.

The value of the sky grid and the corresponding icon type is as below:

Sky Grid Value	Icon Name	Icon Number
<= 15	Sunny	1
<=15 (only used when time is after 06UTC for day0 icon)	Clear	2
> 15 and <= 65	Partly cloudy*	3
> 65	Cloudy	4

Table 25 Sky grid value, icon name and icon number

*See note below icon section.

Grid priority

The following table is used to determine which icon number to display for both grids. The order is from highest priority to lowest priority.

Weather type: Intensity	Icon Number
TS:!!	16
TS:!	16
TS:n	16
SN:++	15
SNSH:++	15
SN:+	15
SNSH:+	15
SL:++	12
SN:m	15
RA:++	12
SNSH:m	15
SL:+	12
SN:-	15
RA:+	12
SNSH:-	15
SL:m	12
RA:m	12
SLSH:++	18
SH:++	18
SL:-	8
RA:-	8
SLSH:+	18
SH:+	18
Very windy	9
SLSH:m	11
SH:m	11
SLSH:-	17
SH:-	17
FG:+	10
FR:!	14
FG:n	10

Weather type: Intensity	Icon Number
FR:n	14
FR:-	14
Windy	9
DU:+	13
VA:n	13
DZ:++	8
DU:n	13
DZ:+	8
DZ:m	8
DZ:-	8
SMK:+	6
SMK:n	6
HZ:+	6
HZ:n	6
MI:n	10
Cloudy	4
Partly Cloudy	3
Sunny/Clear	1
Clear	2

Table 26 Weather type intensity and icon number

Icons

The Bureau ascribes the following icon images and descriptions to the icon code.

Graphic (day/night)	Icon number	Description
	1	Sunny
	2	Clear
	3	Mostly sunny/partly cloudy*
	4	Cloudy
	6	Hazy
	8	Light rain
	9	Windy
	10	Fog
	11	Shower
	12	Rain
	13	Dusty
	14	Frost
	15	Snow
	16	Storm
	17	Light shower

Graphic (day/night)	Icon number	Description
	18	Heavy shower
	19	Tropical Cyclone

Table 27 Weather icons

*Icon number 3 is rendered as ‘mostly sunny’ where the sky grid is =< 30 and, for day 0, when the time is before 06UTC. Otherwise it is rendered as ‘partly cloudy’.

Attachment 5: Explanation of the precipitation grids

Purpose

This attachment outlines the basic principles and details of each precipitation dataset within the Australian Digital Forecast Database (ADFD) providing examples where possible. Scenarios are presented for possible uses of each grid type.

Grid types

There are several grid types within the Bureau's precipitation suite produced for either daily or three-hourly temporal periods.

Daily grids

Daily grids represent the forecast values over a 24 hour period from 15Z to 1459Z for the Australian domain. The available daily grids are explained below.

DailyPoP (Daily Chance of Precipitation)

DailyPoP values represent the chance of receiving any precipitation above 0.2 mm for that cell. For example, a cell value of "45%" means there is a 45% chance of *at least* 0.2 mm occurring within that cell over 24 hours. Conversely, this represents a 55% chance of receiving no precipitation.

DailyPrecip (Daily Amount of Precipitation)

DailyPrecip returns the average precipitation amount for anywhere in that cell for that day. The forecast is calculated from the average of all precipitation model outcomes including zero. For example, given five outcomes for a particular day (3, 0, 8, 4, and 0) the DailyPrecip grid value would be 3 mm (15 divided by 5).

DailyPrecip$y$Pct for y in {10, 25, 50, 75} (Daily Precipitation for a Specific Chance of Occurrence)

DailyPrecip*y*Pct returns the minimum *amount* of precipitation forecast for that 24-hour period for the defined likelihood of occurrence anywhere within the cell.

The scientific definition for any DailyPrecipYPct element is:

- the value will equal 0 where chance of any rain is less than or equal to Y%, or otherwise;
- the value is the amount of rain you can count on getting or exceeding with Y% confidence.

For example, in Figure 1 if the user set *y* to 50%, the forecast would be for 8 mm (Expressed as "an even chance of receiving greater than 8 mm"). If *y* was set to 25%, the forecast would be for 22 mm (Expressed as "a 25% chance of receiving at least 22 mm"). Conversely, this relates to a 50% chance of receiving less than 8 mm and a 75% chance of receiving less than 22 mm. Put simply, the lower the chance of occurrence, the higher the predicted rainfall.

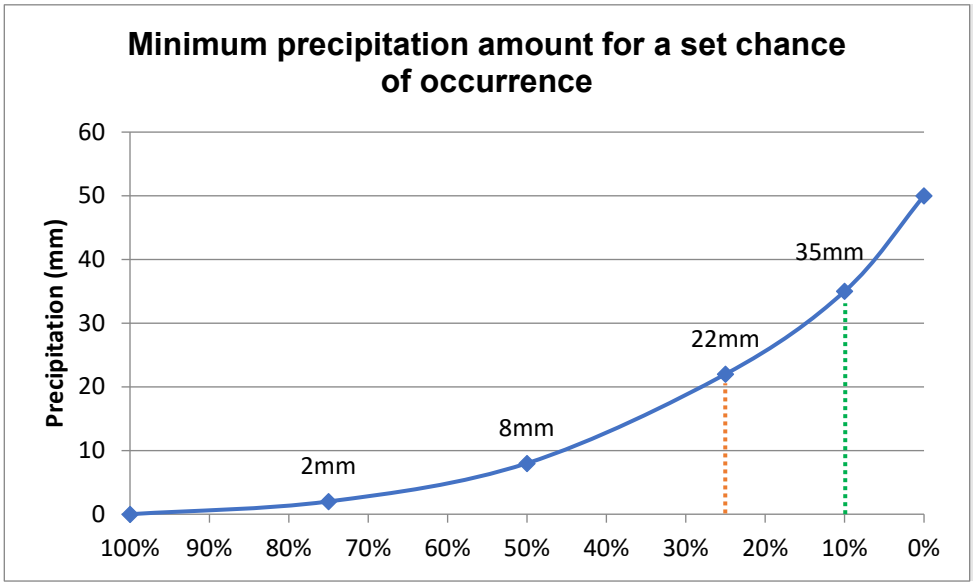

Figure 1 - An example of DailyPrecip*y*Pct showing the variation in minimum precipitation for variations in *y*.

For examples of DailyPrecip*y*Pct currently in use, see the Bureau's MetEye (http://www.bom.gov.au/australia/meteye/). These variables use DailyPrecip50% and DailyPrecip25% respectively.

Three-hourly grids

Three-hourly grids represent the forecast values over a three-hour period for the Australian domain. The available three-hourly grids are explained below.

PoP (Chance of Precipitation)

PoP values provide the chance of receiving any precipitation above 0.2 mm anywhere within the target cell. For example, a cell value of "30%" means there is an 30% chance of *at least* 0.2 mm occurring over the three-hour period. Conversely, this relates to a 70% chance of receiving less than 0.2 mm over the three-hour period.

Precip (Amount of Precipitation)

Precip values provide the mean precipitation amount for anywhere in that cell over a three-hour period. This is calculated in the same way as DailyPrecip but for three-hourly intervals. Precip may be used to calculate DailyPrecip by summing Precip over the course of a 24-hour period (1500Z to 1459Z).

Precip*y*Pct for y in {10, 25, 50} (Precipitation for a Specific Chance of Occurrence)

Precip*y*Pct provides the minimum *amount* of precipitation forecast for a three-hour period for the defined likelihood of occurrence for that cell. It is calculated in the same way as DailyPrecip*y*Pct except for three-hourly intervals only. This allows a range of minimum precipitation amounts to be compared relative to the likelihood of it occurring. See Figure 1 for an example.

Unlike the relationship with Precip and DailyPrecip, Precip*y*Pct cannot be used to reproduce DailyPrecip*y*Pct. Neither can it be used to calculate Precip*y*Pct over an area larger than one cell (e.g., the values of four neighbouring cells cannot be averaged to produce a Precip*y*Pct value for the larger area).

Interpretation of precipitation grid cells

Each 6km x 6km grid cell value represents the forecast across an area of approximately 36km^2. The elevation across each cell is averaged and may cause variability where there is considerable variation in height within the grid square (i.e. valleys or mountains). Local orographic effects which may cause variations include the phenomena of rain shadows, leeside wind acceleration, windward stalling/calming and variations in temperature due to diurnal mountain/valley winds. Figure 2 provides a cross-section of a hypothetical grid cell where point observations are likely to vary from the cell forecast. Conditions at point A should be well represented by the average cell forecast as it is farthest away from any large hills and sits at the average cell height. Point B is likely to experience less rain than forecast due to its leeward position. Point C is likely to experience higher rainfall than forecast due to mechanical convection (wind being forced uphill triggering condensation). Finally, if point D was considered a coastal location, rainfall travelling parallel to the coast would likely affect D much more than A due to channelling along the range.

A topographic reference grid used within the ADFD is available.

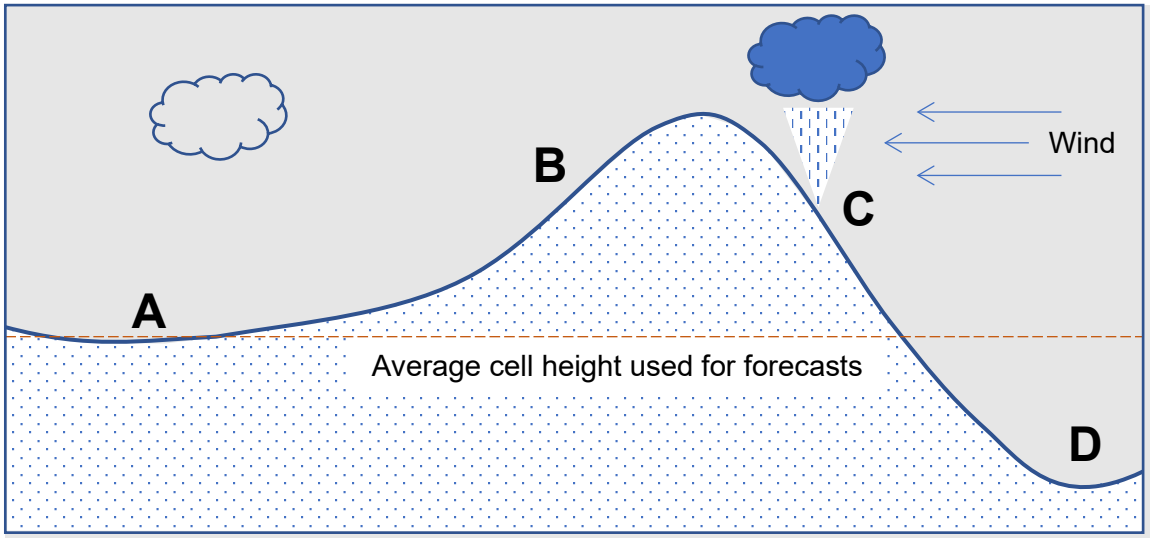

Figure 2 – Cross-section of a ~36km^2 grid cell with varying topography highlighting likely variations from the cell forecast.