The Bureau of Meteorology

Aviation services

# Duststorms and sandstorms

Hazardous phenomena

**Duststorms and sandstorms occur when strong winds lift dust and sand from dry soils into the atmosphere, transporting particles over vast distances.**

## Introduction

**Dust** has a particle size of usually less than 100 microns, is often raised to great heights (3,000 metres) and may be carried great distances from the source.

**Sand** has a coarser particle size (usually above 100 microns) and is not typically raised to as great heights as dust or carried far from its source.

**Blowing dust/sand** (BLDU/BLSA) is raised above the ground by locally strong winds, with a horizontal visibility reduced to not less than 1,000 metres.

**Duststorms/sandstorms** (DS/SS) occur when fine particles of dust/sand are lifted into the atmosphere by strong turbulent winds. The moving dust/sand wall can be many kilometres long and up to 3,000 metres high. Horizontal visibility is reduced to below 1,000 metres but not less than 200 metres. A duststorm/sandstorm is considered severe (+DS/+SS) if the visibility is reduced to below 200 metres.

**Dust devils (PO)** are dust-filled vortices, formed by strong surface heating, which are smaller and less intense than a tornado.

A haboob duststorm at Diamantina National Park, Queensland

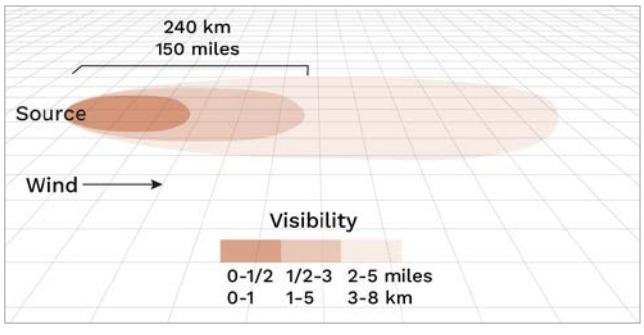
Duststorm at Tullololoboy Station, NSW, 2 Jan 2005. Credit: Geordie Elliott

**Haboob** is a type of intense duststorm generated by the convective outflow from a collapsing or ongoing thunderstorm, or from any collapsing cumuliform cloud of appreciable vertical extent.

## Effects on aviation

### Reduced visibility

Intense duststorms can reduce visibility to near zero in and near source regions, with visibility improving away from the source. For pilots operating under Visual Flight Rules (VFR), encountering reduced visibility due to dust can cause disorientation and reduced spatial awareness, and subsequent loss of control of the aircraft. During duststorms the air-to-ground or slant visible range (SVR) is generally less than the horizontal visibility, which may make it impossible to identify landmarks or aerodrome features. At night, the lack of light can make the reduced visibility even more of a concern.




Typical visibility within a duststorm. Credit: Comet MetEd

### Equipment damage

Suspended dust/sand particles can cause damage to aircraft engines and ground-based equipment by abrasion or cause an overload to electrical equipment due to static energy. This is of particular concern during takeoff as it may cause a reduction in engine output power or engine failure.

### Health hazards

Dust particles pose a health danger, as some particles are so small that our lungs cannot readily expel them. They also have the ability to carry organisms, such as spores, fungus, bacteria, and viruses.

## Conditions

4 conditions are necessary for a duststorm/ sandstorm:

1. a dust/sand source
2. winds capable of disturbing and lifting the dust/ sand
3. instability
4. low atmospheric moisture.

### Source

The source must be a large area of dry, loose, bare soil. The main dust source regions in Australia include the Kati Thanda-Lake Eyre Basin, Murray-Darling Basin, Darling Riverine Plain, central and southern South Australia and north-west Western Australia.

### Wind

Strong and gusty winds with large vertical wind shear must be sufficient to lift soil particles high into the air. This may occur in association with synoptic-scale systems such as vigorous cold fronts, pre-frontal troughs, heat troughs and tropical cyclones, or in smaller mesoscale systems such as thunderstorm gust fronts. As a rule of thumb, the surface wind must be greater than 15 knots, with the 1,000 ft wind around 30 knots.

### Instability

An unstable atmosphere in the boundary layer will enhance lifting and vertical motion and enable dust/ sand particles to remain suspended in the air for longer periods. Strong temperature inversions at night lead to a stable lower atmosphere and tend to inhibit the raising dust/sand. However, if dust is already suspended higher in the atmosphere, the formation of a surface-based inversion will have little effect, and dust will continue to be transported by winds at those higher levels.

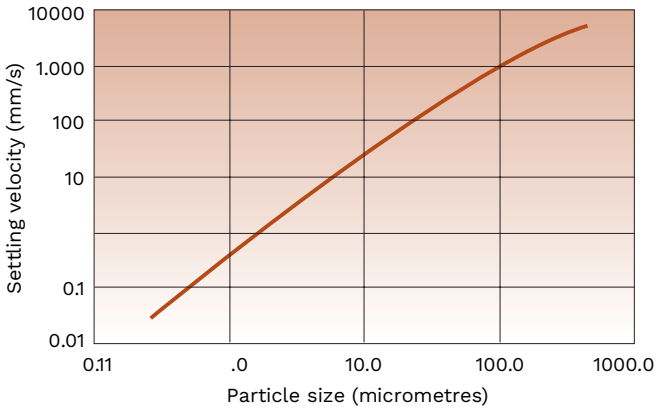
### Low atmospheric moisture

Low atmospheric moisture reduces the likelihood of moisture condensing onto the dust particles to form cloud or precipitation, or to bind dust particles into larger aggregates that cannot be supported by the existing upward motions.

## Particle size

Dust particle size is measured in microns (where 1 micron, or micrometre, is 1/1000 of a millimetre). Particles capable of travelling great distances usually have diameters less than 20 microns, which is much smaller than the width of a human hair. Dust particles can remain suspended in the air when upward currents are greater than the speed at which the particles fall through air. The smaller the particle the longer it will take to settle. The graphic below shows the fall speed, or settling velocity, as a function of particle size.

**Settling velocity versus particle size**




## Movement

Dust/sand can move in the following ways:

- **Creep**, where particles move along the ground by rolling and sliding, or by bombardment by other moving particles.
- **Saltation**, where small particles move forward through a series of jumps or skips. They are lifted into the air and drift about 4 times farther downwind than the height attained above ground level.
- **Suspension**, where surface sediments are lifted into the air and held aloft by winds. Sufficiently small particles can be carried a distance from the source. Under strong wind conditions, particles may be lifted thousands of metres upward and thousands of kilometres downwind.

Sydney Harbour Bridge, 23 Sep 2009. Credit: John Grainger

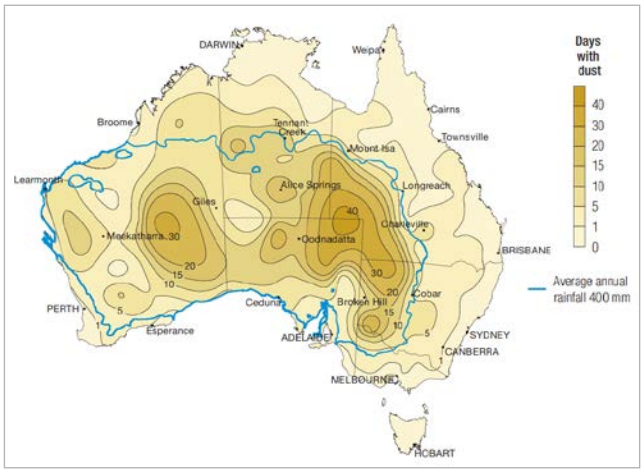
## Removal

Eventually, suspended dust will settle by:

- **Dispersion** – dust tends to fan out as they move downstream from their source regions.
- **Advection** – dust moves away from its source. Winds aloft may carry dust in a direction that is different from the wind direction at the surface.
- **Gravity-driven** – settling of dust. This can be a much slower process depending on the size of the dust particles and the winds aloft that may inhibit the settling.
- **Entrainment** of dust in precipitation.

## Climatology

The majority of duststorms occur in arid and semi-arid regions of inland Australia, where the average annual rainfall is less than 400 mm. The figure below shows the average annual number of days with dust across Australia.

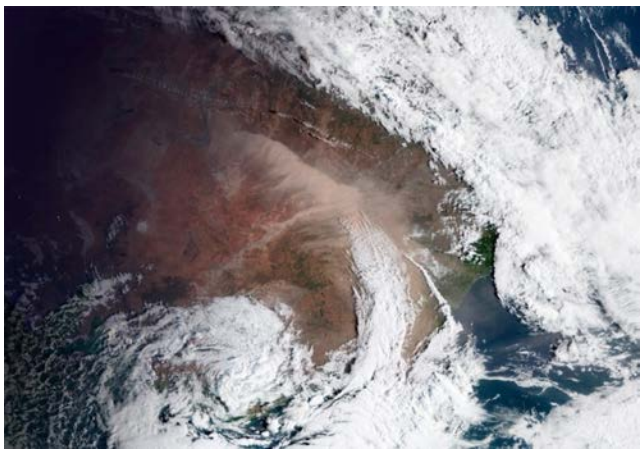



Credit: *Climate of Australia*, Bureau of Meteorology, 2008

Duststorms are most common in spring and summer, due to the greater likelihood of an unstable lower atmosphere, and drier soil conditions. However, duststorm occurrence can vary greatly from year to year. If rains are good, crops and vegetation grow, meaning soils largely stay on the ground. If they're not, such as during a drought, soil is dry and can be easily picked up by strong wind.

## Detection and monitoring

Due to the sparse surface observation network over inland Australia, the primary means of identifying duststorms/sandstorms is from satellite imagery.



Satellite image showing a large duststorm blowing through NSW, 22 Nov 2018. Credit: JMA

Other monitoring and detection methods include:

- manual observations
- data from automated present weather, visibility sensors and ceilometers
- webcams
- aircraft reports (AIREP)
- Doppler radar
- news and/or media reports.

## Forecasts and warnings

Information regarding dust (DU), sand (SA), dust devils (PO), duststorms (DS) and sandstorms (SS) is provided in aerodrome forecasts (TAF and TAF3), graphical area forecasts (GAF) and AIRMET.

If heavy duststorms/sandstorms are observed or forecast, a SIGMET (and associated graphical SIGMET) will be issued. Aerodrome warnings are provided for a limited number of locations and may include rising dust/sand or duststorms/sandstorms.

Further aviation educational resources produced by the Bureau of Meteorology can be found at www.bom.gov.au/aviation/knowledge-centre.



| A vertical line in the margin indicates a change or addition since last update.

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