AVIATION REFERENCE MATERIAL

# Ceilometers and Visibility Meters



Up until 1996, surface observations of cloud and visibility within the Bureau of Meteorology's surface observations network were made solely by weather observers making visual assessments of these elements. Since that time about one hundred and thirty cloud and visibility sensors (known as ceilometers and visibility meters) have been introduced to the network.

The Bureau has about six hundred and fifty automatic weather stations (AWS) in its observations network. A basic AWS has sensors for air temperature, dew-point temperature, wind, air pressure and rainfall amount. At about one hundred and thirty aviation locations (mostly at aerodromes), these basic AWSs also have ceilometers and visibility meters attached to them; and the Bureau is continuing to install these sensors at aerodromes for which it provides forecasts.

Data from these sensors is included in aerodrome meteorological reports (METAR/SPECI) when there is no human input to the reports. Fully automated reports can be recognised by the inclusion of the abbreviation AUTO after the date/time group.

## What are Ceilometers and Visibility Meters?

**Ceilometers** provide an estimation of cloud height and amount by employing a laser light source to send a light pulse vertically, or near vertically, through the atmosphere. The light pulse is scattered by aerosols including water droplets (clouds), and the component of light scattered back towards the ceilometer is measured at the ceilometer's receiver.

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Cloud sensor (credit, Vaisala 1998–2012)

The AWS uses an algorithm to process the raw sensor data and every minute produce an output in the appropriate format for reporting in METAR/SPECI.

To produce this output, the algorithm processes data collected over the last thirty minutes, with data collected in the last ten minutes being given a double weighting to improve the response time in changing conditions.

The height of the scattering obstruction is proportional to the time taken for the signal to return. A profile of return signal strength versus height is constructed and analysed to determine cloud-base heights.

The algorithm also processes the raw data to produce an estimate of the cloud amount. If the cloud is evenly distributed perpendicular to the wind direction and only slowly developing or dissipating, the algorithm can give a good picture of the cloud downstream from the ceilometer.

Cloud types (cumulus, stratus, etc.) cannot be identified by ceilometers.

Visibility sensor (credit, Vaisala 1998–2012)

**Visibility meters** evaluate the Meteorological Optical Range (the greatest distance at which a black object of suitable dimensions can be seen and recognised when observed against a bright background) by measuring the scatter of infrared light in the air.

Forward-scatter meters are the most commonly used sensor to determine visibility at aerodromes. In such sensors, the transmitter and receiver are located on two arms of a single unit, with the arms positioned to form an angle. The transmitter beams light into the air between the arms. Particles in the air cause the incident light to scatter and the portion of the signal scattered forward towards the receiver is measured by the receiver's photodiode. Scattering due to water, dust, sand or smoke increases with the number of particles and hence with decreasing visibility.

If the visibility meter is appropriately sited and well maintained, it can provide useful guidance in the absence of a human observer, however the information should be used with care as it samples only one litre of air.

## How is the Ceilometer and Visibility Meter Data Different from Human Observations?

Both are estimates of the state of the sky and the visibility at the airfield. Any difference in output will be due to:

- Automated sensors produce an estimate based on the continuous sampling of a single point over a period of time (30 minutes for the ceilometer, and 10 minutes for the visibility meter); whereas
- Human observers produce their estimate based on a view of the whole airfield and the whole sky over a short time prior to the observation.

## What are the Advantages and Limitations of Ceilometer Data?

- **Improved night observations:** Ceilometers may out-perform human observers at night, particularly with the onset of low cloud below another deck or the lowering of existing cloud.
- **Consistent observations:** Unlike humans, ceilometers provide observations that are consistent site-to-site and day-to-night.
- **Time lag:** In rapidly changing cloud conditions, the ceilometer's observations will lag behind the actual cloud development. Human observers can provide an instant update of significant developments.
- **Misreporting stationary cloud amounts:** The ceilometer may under- or over-report the amount of cloud where the cloud is less than overcast and is not moving. This is because in these situations the laser beam will always be below a clear (under-report), or a cloudy (over-report), part of the sky.
- **Spurious cloud base:** A ceilometer may report precipitation, virga, dust particles or atmospheric discontinuities (e.g. moist layers) as if they were cloud bases.
- **Fluctuating cloud base:** Cumuliform cloud in a moderate to strong air-stream can result in fluctuating cloud base heights being reported as a result of the laser beam reflecting from moving bases and the sides and tops of the clouds.
- **Sky obscuration:** When the sky is obscured (by, for example, shallow fog, blowing dust or snow) the ceilometer may not be able to detect a cloud base. In such cases, if the visibility sensor is reporting 1000 metres or less, then 'SKY MAY BE OBSC' will be reported in the METAR AUTO message. In other cases (e.g. fog, precipitation, blowing dust), cloud with a very low cloud base may be inappropriately reported.

## What are the Advantages and Limitations of Visibility Meter Data?

- **Improved night observations:** Visibility meters may out-perform human observers at night in situations of uniform reduced visibility.
- **Misreporting of localised or transitory visibility:** A discrete airmass with reduced visibility moving across the airfield (e.g. a shower or fog bank) will not be identified unless the sensor itself is engulfed. The visibility will also be misreported if the phenomenon is not of uniform density.
- **Misreporting of stationary fog patches:** Stationary localised fog patches will remain undetected if the sensor is clear of the fog. Alternatively, if the visibility meter is within the fog patch, the observation will be more pessimistic than it should be.

## Cloud and Visibility in METAR/SPECI Reports

METAR/SPECI from locations with ceilometers and visibility meters will include data from these sensors when the reports are fully automated. The abbreviation AUTO will be included in METAR/SPECI to indicate an observation without human input:

```
METAR YABC 210714Z AUTO
20018KT 9999 // BKN012 18/13
Q1023 RMK RF00.0/002.0
```

When a METAR/SPECI is produced with human input, AUTO will not be present in the message:

```
SPECI YPAD 210600Z 20013KT
6000 RA BKN010 34/09 Q1023 RMK
RF00.0/000.0
```

If there is no ceilometer or visibility meter present at an aerodrome, the relevant groups will be reported as solidi in a fully automated report:

```
METAR YBWX 210714Z AUTO
12010KT //// // ////// 12/09 Q1020 RMK
RF00.0/000.0
```

When nil cloud is detected by the ceilometer, the letters NCD will be reported in lieu of cloud information in a fully automated report:

```
METAR YAYE 030400Z AUTO
09010KT 9999 // NCD 21/06 Q1021
RMK RF00.0/000.0
```

When the ceilometer does not detect any cloud, and the visibility is equal to or less than 1000 metres, then the words CLD:SKY MAY BE OBSC will be reported after the rainfall group (RF) to indicate a possible obscuration of the sky:

```
METAR YAYE 030400Z AUTO
09002KT 0500 // ////// 07/07 Q1021
RMK RF00.0/004.0 CLD:SKY MAY BE
OBSC
```

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