Plumecast Overview

Introduction

Plumecast is a system to provide real time display of possible and actual dispersion of atmospheric pollutants in an accidental release. It shows emergency services, site operators and incident managers the area at risk from any toxic releases into the atmosphere to help them implement appropriate emergency procedures.

Plumecast is a combination of a simple dispersion model and fast response anemometers. A PC monitor displays the area that would be at risk from an accidental release and, in an emergency, it displays the estimated present location of an airborne plume and areas at risk from its further spread. The use of ultrasonic anemometers is critical as they allow turbulence characteristics to be measured directly rather than estimated. This makes real-time dispersion modelling much more accurate. The use of real-time measurements taken at or near the source of the release is the key feature of Plumecast and gives it not just greater accuracy but a unique ability to react to changing circumstances.

The system can be used for both emergency situations and continuous and operational risk assessment.

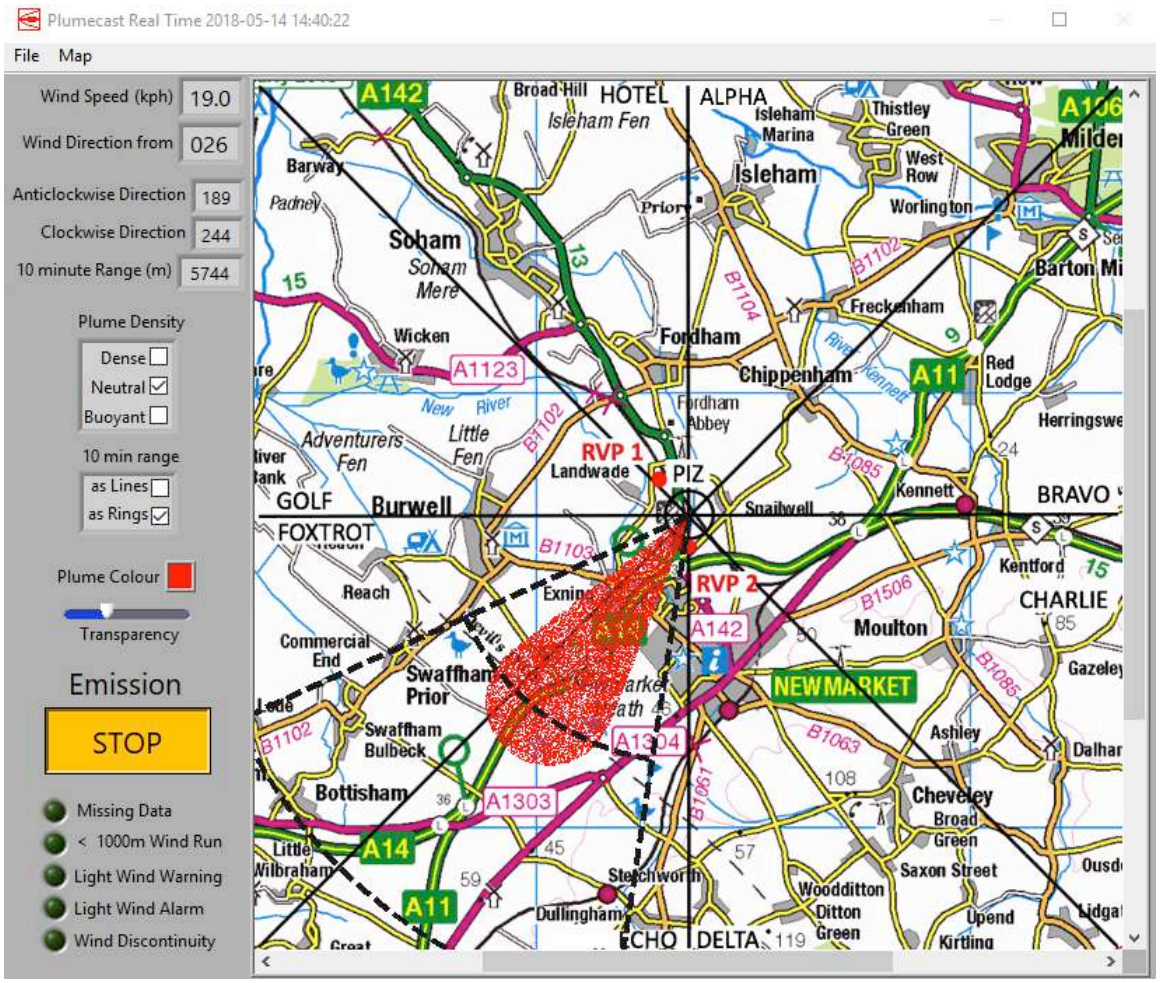
For risk assessment, two lines are drawn from the potential pollution source over a map of the local area. These enclose an 'area at risk', the area over which airborne pollution might pass in the event of a release. These lines are updated continuously even when there is no current release so that in the event of an accident the area at risk is instantly available. There is absolutely no delay in starting dispersion models, and this information can be used in advance of off-site agencies responding.

In the event of an accidental release Plumecast also plots the likely location of the plume. This takes the form of a plot overlaid on the local area map and is based on a 'puff-release' model.

Plumecast does not provide guidance on concentration of material within the plume. This is not relevant to the application Plumecast is designed for. In fact the amount or even type of material released is unlikely to be known until some time into the incident.

Plumecast displays.

Plumecast is intended to give real-time displays of both area at risk and, optionally, the position of a plume if a release does occur. The area at risk is shown by lines; the best estimate of the area the plume has reached is plotted as it happens in real time. To assist incident managers, 'range rings' are drawn to indicate how far the plume is likely to travel in a ten minute period. The picture below shows a plot drawn using Plumecast.



A large icon is used to start plotting of a real plume. It can also be used to stop the emission. In this case Plumecast will continue to plot the movement of the material already released.

The display also shows various alarms. These include warnings of missing data, light winds or 'marked discontinuity'. A marked discontinuity alarm means that there has been a major and sustained change in wind direction or speed within the last 10km run of wind. In these conditions Plumecast only takes into account data back to this discontinuity. If winds are very light then the display is 'frozen' and the light wind alarm icon is lit.

The display allows an operator to specify plume density. A site using chlorine, for example, would probably only use the 'dense' option, but a severe fire at a chemical warehouse might need 'dense' 'neutral' and 'buoyant' set.

Current wind data is also displayed. This is based on a representative run of wind rather than an instant snapshot of varying wind speed and direction that could be very misleading.

An operator can change the plot colour and transparency of a plotted plume to optimise the visibility of the plume and underlying map details.

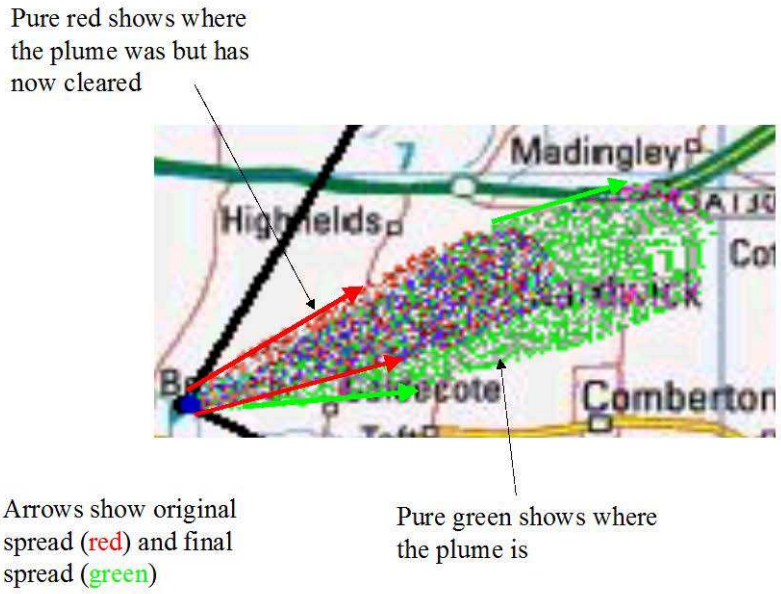
Sensors

Plumecast uses real time data from a fast response anemometer capable of taking wind measurements with a very short averaging time. This allows Plumecast to directly measure key turbulence parameters that other systems have to estimate in order to calculate areas at risk or plume spread.

This data is also combined with knowledge of the source site location, date and time of day, to make assessments of likely variations in wind through the depth of the atmospheric boundary layer.

Software features

The most important feature of Plumecast software is that the use of real-time data from the incident location allows it to react to changes in conditions during an incident. It also means that Plumecast can react to local winds such as sea breezes or katabatic flows, which can be missed if larger scale models, run remotely, are used to provide guidance.
The illustration below is taken from a trial using a development version of Plumecast. The model was run on real wind data, and after the 'plume' had travelled about 3 km the wind had veered clockwise. At this point the plotting colour was also changed to show how Plumecast copes with this situation.



The development of Plumecast takes a 'fail-safe' approach. For example the plume displayed during an incident includes not only the area where the plume is, but also the area where it has been. This is because some pollutants can leave an area hazardous even when the plume has been moved away by a change in wind direction. The area at risk can be limited to some extent if the user can specify whether the released material is denser than air, of neutral density or buoyant.

In addition to local displays Plumecast can be configured to give XML format output representing the area at risk. This allows information to be shared with other emergency response software and GIS systems.

Factors considered by Plumecast

The position of the area at risk lines is determined by a number of factors including the current conditions measured by the sensors, both mean wind and turbulence characteristics. Plumecast uses recent wind data up to the last 10km run of wind.

There are also allowances for likely wind shear through the boundary layer and the change in wind direction that is likely in a given time. These are themselves dependent on the current conditions and are often neglected by other plume modelling systems.

The area at risk is constantly re-calculated as conditions change. For example, statistically the change in mean wind direction that is likely in a given time depends on wind speed; in simple terms stronger winds are less likely to change than light winds. This allows Plumecast, using empirical rules, to constantly adjust the area of risk accordingly. In a similar way allowances for wind shear, both in speed and direction, are assessed using established relationships connecting it to latitude, surface roughness, wind speed and atmospheric stability. Plumecast uses time of day and site location to calculate local sunrise and sunset which are used in these assessments.

Accuracy

Plumecast makes an allowance for the roughness of local terrain. However it should be used with caution if there are major variations in roughness over the area of concern. In particular large buildings, especially if large and tall in relation to the wind sensor height, can cause problems over short ranges. Similarly slopes above about 1 in 10 can, in some circumstances, cause significant flow distortion if they extend over a significant distance, 500 metres or more.

Determining the exact accuracy level of a system like Plumecast is very difficult. However the target figure used during development is 85%. That is, the area at risk is intended to be set such that there is a 15% chance of any of the plume straying outside that area within one hour of a release. This figure is based mainly on the statistical chance of a significant wind direction change in one hour. Plumecast does include a factor allowing for the likelihood of wind direction changes (a function of wind speed), and the area at risk lines can be relied upon for periods up to 30 minutes. Note that the area at risk lines will be adjusted during this time anyway.

There are some unusual meteorological scenarios that are very difficult for any plume prediction system to cope with. In particular, if the surface wind is calm but the wind aloft is significant, and the plume released is buoyant but still hazardous, then Plumecast will not be able to show an accurate location. This will mainly be an issue in the event of a fire releasing smoke, which might condense and release hazardous 'fallout'.

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