Present weather and visibility instruments

– telling users what they want and need to know

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The CS135 is a ceilometer that in addition to derived cloud heights and cloud cover can also provide raw data for an end user to interpret as they wish. Various detection parameters are configurable but the end user can always be clear exactly how 'raw' data has been pre-processed.

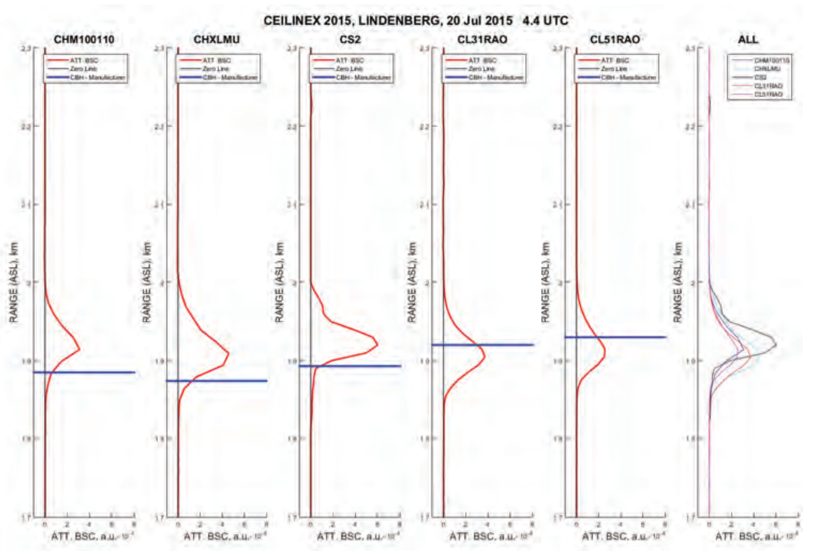
Introduction

Human observers and instruments can disagree dramatically in reporting cloud and present weather via. SYNOP and METAR codes. It may, or may not, be clear which is correct or even if both are in some way 'correct'. Solutions to this problem include designing instruments to provide raw data for the end user, which may be an automatic system on-site or hundreds of miles away to interpret. Alternatively instruments can be made configurable allowing them to interpret the raw data as an individual user might wish.

CLOUD HEIGHT, MAN AND MACHINE

Human observers and ceilometers can disagree dramatically in reporting cloud height. The profile is most likely to be correct but there are problems because different manufacturers will interpret the same profile differently and report different heights. There can be even worse differences between human observers and ceilometers in situations of heavy precipitation where a vertical visibility is reported. One solution might be for the ceilometer to be configurable in some way or produce a raw scatter profile for the user to interpret according to their own rules.

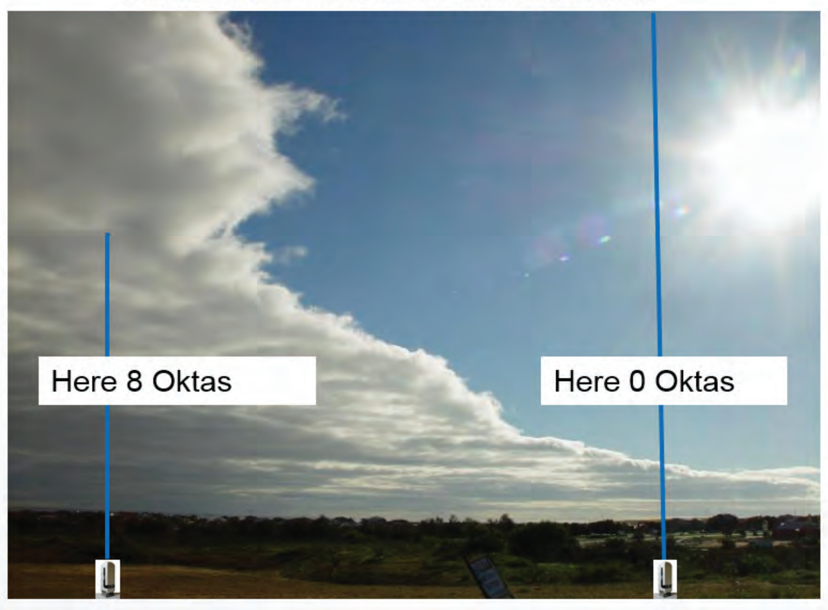
If the latter solution is used it is vital that the user is fully informed about the nature of any pre-processing applied to the `raw' data.



Different ceilometers may agree well in producing a scatter profile but clearly use very different algorithms in calculating the cloud height. The graphs show data from the 2015 'Ceilinex' campaign and are produced courtesy of Frank Wagner, DWD.

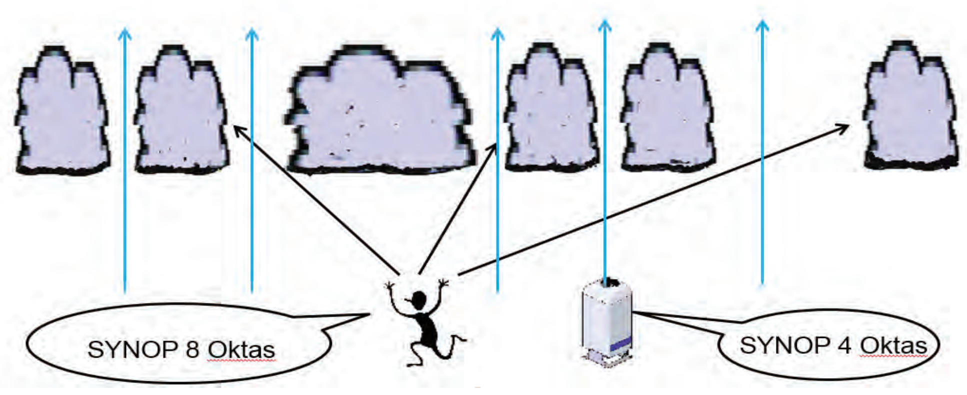
CLOUD COVER (SKY CONDITION) MAN AND MACHINE

Cloud cover measurement is a classic case where human observers and instruments can disagree. Both have serious limitations but it is often not clear which is correct. This can result in varying measurements across an area with a mixture of human and automated observations and makes a valid statistical comparison very difficult.



SOMETIMES THE CEILOMETER FAILS TO REPORT A TRUE VALUE FOR CLOUD COVER (SKY CONDITION)

In some circumstances a ceilometer can give a completely false value, especially in a static situation or uneven distribution in the sky.



SOMETIMES THE HUMAN FAILS - PACKING EFFECT

"The "packing effect" is a condition where the observer tends to overestimate the cloud coverage because clouds near the horizon appear to blend together or overlap." FAA

"A human observer also has a tendency to overestimate cloud cover when the sky is half covered" ICAO9837

The result is that direct comparison between a human and an instrument is far from straightforward. In addition a ceilometer keeps a constant watch and calculates cloud cover based on 30 minutes of data.

PRESENT WEATHER, MAN AND MACHINE

Present weather (PW) is a classic case where the machine sees more than the human observer and differences in interpretation lead to very different results. Ideally both should observe and interpret the type and number of various falling and suspended particles to give the same SYNOP or METAR codes (bearing in mind that there are different code tables for coding human and instrument derived SYNOP codes).

However in practice there are two problems, firstly the instrument will 'see' particles missed by a human and secondly how the particles are interpreted as a PW code is poorly defined and may vary between customers. However some PW sensors allow a level of adjustment on how the measured parameters should be interpreted or can provide detailed information on the size and type of particles allowing the end user to decide for themselves.

ADAPTING SYNOP AND METAR CODING TO CUSTOMER PREFERENCES

The settings below are some of those adjustable in the menu structure of a PWS100 present weather sensor and show how it allows adaptation to local practices. Default values are shown.

Snow water content = 1.00

This is based on local climate and allows the user to adjust according to their local knowledge. Note that in the PWS100 the snow water content varies with snowflake size.

Mixed liquid & liquid precipitation threshold = 0.5
Mixed liquid & solid precipitation threshold = 0.1
Mixed solid & liquid precipitation threshold = 0.9
Mixed solid & solid precipitation threshold = 0.5

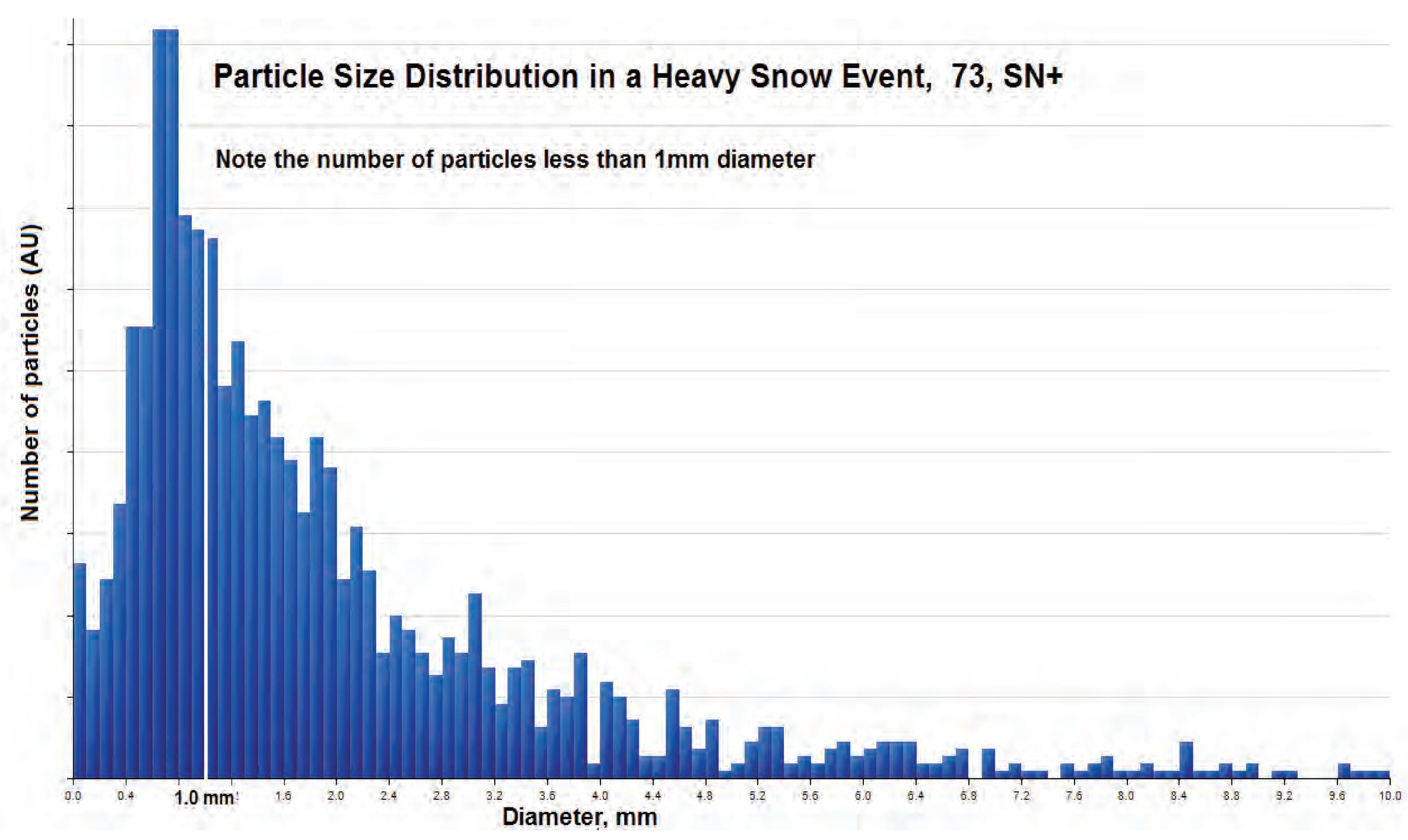
These apply to the reporting of mixed precipitation SYNOP codes such as 57, 'drizzle and rain'. They allow users to set the fraction of the minority particle type at which a mixture is defined. It can be different for two types of liquid or solid precipitation or for solid/liquid mixtures. A value of 0.5 means that a second precipitation type needs to be 50% or more of the most common type to be distinguished as a mixed event. The default values of 0.1/0.9 for solid/liquid mixtures reflect the fact that human observers are typically more sensitive to reporting this as a mixed event than for rain/drizzle as occasional snowflakes are easy to see. Changing these parameters has no effect on reported particle type distribution or calculated accumulations or intensities only on reported SYNOP and METAR codes.

SYNOP snow_flake to snow_grain weighting = 1.00

This is to allow users to avoid over reporting of SYNOP code 77, 'snow grains'. This is a higher code than, for example, 73, 'heavy snow'. However there will ALWAYS be some snow grains (diameter less than 1mm) even if the human does not see them, see below. Question is what fraction should there be for a code 77? This number sets a weighting factor to decide. The range is 0 to 10. If it is 0 then if any snow grains are present SYNOP code 77 will be reported. If it is set to 10 then snow will be reported unless there are an overwhelming number of snow grains. This parameter has no effect on reported particle type distribution only on the reporting of SYNOP code 77.

Visibility SYNOP mist RH% threshold = 95.0
Visibility METAR mist/haze RH% threshold = 80.0
Visibility METAR fog/haze RH% threshold = 95.0

These set the threshold between wet and dry obscuration by aerosols. In some territories not only is there a difference between SYNOP and METAR coding but also different thresholds for fog/haze (MOR < 1,000m) and mist/haze (1,000m < MOR < 10,000m for SYNOP codes and 1,000m < MOR < 10,000m for METAR codes).



CONCLUSIONS

Problems:

The lack of consistent rules for defining 'weather' and cloud height and cloud cover makes it difficult for manufacturers to meet the expectations of customers.
Human observers and instruments can often disagree – without it being clear which is right.

Solutions:

Modern sensors can identify present weather and cloud parameters better than a human and can be configured to code according to individual customer's criteria.
Alternatively detailed raw data can be provided so that customers themselves can make the decision.

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