# Site Classification of the Observation Network of the Norwegian Meteorological Institute: Progress and Challenges

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## Abstract

The Norwegian Meteorological Institute performs a stepwise application and continuous evaluation of the site classification scheme recommended by CIMO.
Since 2012, between 60 and 80 precipitation stations are classified yearly. Experiences and problems with the scheme are analyzed regularly in order to improve the clarity of the scheme, concerning the work in the field. In 2013, over 20 stations were classified for temperature with a slightly extended classification scheme, considering the expected challenges of the scheme due to the complex topography and the high latitude of the country.
The high variations of sun elevation and azimuth throughout the year, makes it difficult to represent the exposure of the station due to shadow/no shadow on the sensor with only one number. For example, a station might be affected by shadow on the sensor only one month. Describing the exposure of this station with the correspondent class for this month, does not reflect the exposure during the other 11 months of the year.
This paper will describe the used classification process and present statistics of the classified stations in Norway, covering both temperature and precipitation. Based on concrete examples, it will be shown how the exposure of some stations can change over the course of a year, and how that impacts the quality of the measurements at this location.

## Methods and Status

The Norwegian Meteorological Institute started to work with the classification scheme as recommended from CIMO in 2010. Firstly, the classification manual from the CIMO-guide (WMO-No. 8) was translated to Norwegian. Beside the complete version, a simplified version, containing only class three criteria, was produced, which is mostly used when advising external cooperation partners.

Suitable tools for field measurements were considered and tested. For the present, a laser distance meter with tilt function was chosen (though not perfect), occasionally a fisheye camera is used and tests with smart-phone apps are on-going.

Forms for the field work were deployed and adapted iteratively to ease the work flow. Classification of precipitation stations have started in 2012. At the end of 2013, ca. 140 (40%-50%) precipitation stations were classified. Classification of temperature stations have started in 2013; ca 20 stations (5%) were classified by the end of 2013.
Classification is performed during the routinely inspections of the stations and will continue during summer 2014. Classification of wind and radiation stations will follow eventually. The classification scheme is also used when deciding for the localisation of a new station.

## Classification of precipitation

The following table is used in the field for the classification of precipitation stations:

| | 1 | 2 (±5%) | 3 (±15%) | 4 (±25%) | 5 (±100%) |
|---|---|---|---|---|---|
| Windscreen | Windscreen or natural shield (14°-26°) | - | - | - | - |
| Landscape | Flat horizontal land, surrounded by open area | Flat horizontal land, surrounded by open area | land surrounded by open area, | - | - |
| Slope | <1/3 (<19°) | 1/3 (<19°) | 1/2 (<30°) | >30° | |
| Distance to obstacles | >4 xheight of obstacles, <14° | >2 x height of obstacles, <26.5° | >1x height of obstacles, <45° | >0.5 xheight of obstacles | - |

The average class achieved by the 140 classified stations is 2.6. Possible improvements were noted for 31 stations (22% of the classified), some of them could already be implemented. Figure 1 shows the detailed distribution of the station classes.

Experiences showed that the elevation angle tool (Leica Disto D8) does not work reliable on very bright days. Difficulties were reported to judge if the natural relief is representative or not (rule of thumb: "does a move of the station by 500 m change the class obtained?") due to the complex topography in Norway. The description of the natural shielding ("surrounded by natural obstacles of uniform height, seen under an elevation angle between 14° and 26°)" was differently applied by different people and some of the stations had to be re-classified with pictures and field-notes. It became obvious that if a natural shield by trees or bushes grows and reaches a height of 26°, the class of the precipitation sensor suddenly jumps from one to three. That probably does not represent the change of influence of the surrounding natural shield properly.

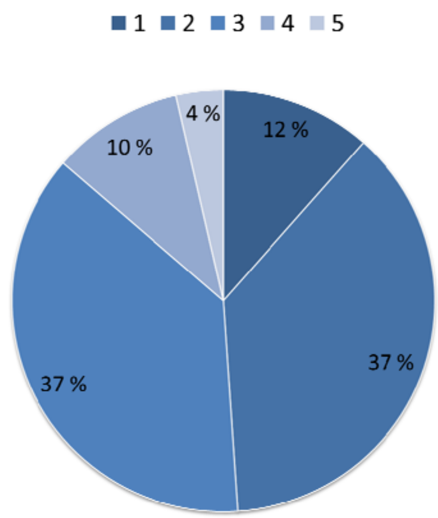


**Figure 1: Distribution of classes (1-5) of the classified preciptation stations in Norway.**

## Temperature

The following table was used for the classification of temperature stations in Norway:

| | 1 | 2 | 3 (±1°C) | 4 (±2°C) | 5 (±5°C) |
|---|---|---|---|---|---|
| Landscape | Flat horizontal land, surrounded by an open space, slope less than 1/3 (19°) | Flat horizontal land, surrounded by an open space, slope inclination less than 1/3 (19°) | - | - | - |
| Ground | Ground covered with natural and low vegetaton (<10cm) representative of the region | Ground covered with natural and low vegetaton (<10cm) repr. of the region | Ground covered with natural and low vegetation (<25 cm), repres. of the region | - | -- |
| Distance (and extension) to heat source/water expanse | More than 100m or<10% (< 3141.6m²) within 100m circle or<5% (<125.6m²) of ring-area 10-30m or<1% (3.1m²) of 10m circle | More than 30 m or<10% (<283m²) of 30 m circle or<5% (<11.8m²) of ring area 5-10m or<1% (<0.78m²) of 5 m circle | More than 10 m or<10% of 10 m circle or<5 of 5m circle | <50% of 10m circle or<30% of 3m circle | -- |
| Not shaded when sunelevation is... | is higher than 5° | is higher than 7° | is higher than 7° | is higher than 20° | -- |

The classification scheme does not consider the duration of possible shading, depending on the obstacle's width and location. That aspect is especially important for locations with high variation of sun elevation and azimuth throughout a year usual in high latitude countries. Figure 2 shows an example for a planned station at Ørlandet, Norway. The landscape is very open and flat, just one building is possibly shading for the sun during the summer months. During the months August-April, the station is a clear class 2. From May until July the building shadows the sensor from a few minutes to maximum 2 hours a day, when the sun is higher than 7°, resulting in a class 4 for the station. The authors doubt that the influence of a few minutes to a couple of hours shadow during a short time of the year, would influence the temperature measuring quality as much as a location where up to 50% within 10 m are covered with a heat source such as asphalt. Based on the ongoing analysis of the classified station, a modification of the scheme will be developed for the application in Norway.

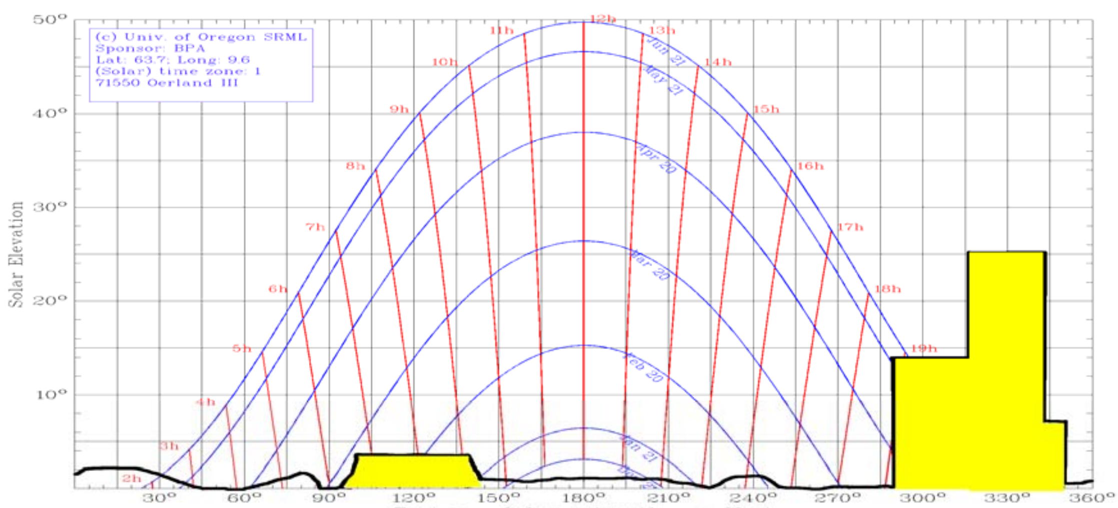


**Figure 1: Sun elevation and azimuth throughout a year at Ørlandet, Norway. Obstacles around the possible station are drawn in yellow.**

## Conclusions

Classification of precipitation and temperature stations in Norway is underway, wind and radiation will follow. The scheme offers an objective method to characterize the exposure of a site and can also be used for establishing new stations. Communication about site exposure is experienced easier and better understandable, both internal and external. Regular classifications of the same station allow to following the development of the site exposure. It is easy to identify possibilities to improve the exposure of the site, which will help to improve the data quality of the network.
The scheme offers a quality measure to evaluate the growing number of stations operated by non-meteorological cooperation partners, which makes it easier to implement these stations in the official network.
Optimizing the actual field work is still going on and exchange of experience about tools, simplification of schemes, evaluation of smart phone apps, etc. is highly appreciated. Not all classification instructions are unambiguous, coursing and continuously discussion between the “field workers” is highly recommended.

The shading duration of a sensor, which is relevant for both temperature and radiation sensors, due to an obstacle depends on its width and its location. That aspect is especially important for high latitude countries as Norway with high variation of sun elevation and azimuth throughout a year. A further discussion of this topic and possible improvements of the scheme would be highly appreciated. In Norway, an adaption of the scheme will be developed based on the analysis of the classified stations.

Generally, the complete classification of an existing network will take a couple of years if no extra “classification resources” are available. Equally important (and labour intensive) is a good and usable archiving of the classification results.

## References

World Meteorological Organization, 2010: *WMO Guide to Meteorological Instruments and Methods of Observation*, WMO-No. 8, Geneva.