Siting classification for Surface Observing Stations on Land

Michel Leroy, Météo-France

Content of the presentation

- Quality factors of a measurement

- Site representativeness ➔ Siting classification

- Experience of Météo-France with this classification

- Quality factors : instrumental performance, maintenance and calibration
  - Maintained performance classification

- « Simple » metadata to document a network

- Exemples from Météo-France

- Conclusion

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Quality factors of a measurement

- **The intrinsic characteristics of sensors or measurement methods**

- **The maintenance and calibration needed to maintain the system in nominal conditions.**

- **The site surroundings**

  – Improper siting can jeopardize the quality of the data.

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Site representativeness

- Exposure rules from CIMO recommendations.
- But not always followed and not always possible to follow, depending on the geographical situation.
- Site classification, metadata "easy" to archive and to use.
  - A class 1 site can be considered as a reference site
  - A class 5 site is a site where nearby obstacles create an inappropriate environment for a meteorological measurement that is intended to be representative of a wide area.
  - Class 2, 3 and 4 are intermediate
  - The smaller is the siting class, the higher is the representativeness of the measurement for a wide area.
- Site classification was first designed by Météo-France in 1998. It is now applied or under consideration by several countries (France, USA, Canada, Switzerland, Norway, …). It was discussed and updated within an ad-hoc Working Group on WIGOS Pilot Project in October 2009.
- It is proposed for consideration by CIMO-XV.

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- Each parameter being measured at a site has its own class.
- The rating of each class should be reviewed periodically:
  - A systematic yearly visual check is recommended. If some aspects of the environment have changed, a new classification process is necessary
- A complete update of the site classes should be done at least every 5 years.

- The classification is occasionally completed with an estimated uncertainty due to siting: *additional estimated uncertainty added by siting up to xx*

- Complex terrain or urban area generally leads to high class number. In such cases, an additional flag "S" can be added to class numbers 4 or 5 to indicate Specific environment or application (i.e. 4S)

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What to do with "natural" obstacles?

- The primary objective is to document the presence of obstacles close to the measurement site

- Therefore, natural relief of the landscape may not be taken into account, if far away (i.e. > 1 km)

- Does a move of a station by the 500 m change the class obtained?
  - If no, the relief is a natural characteristic of the area and is not taken into account
  - Applies for the same obstacles, not new ones.

Classification for air temperature and humidity

- Obstacles around the screen influence the irradiative balance of the screen.

- Neighbouring artificial interfaces may heat the air and should be avoided.

- It was decided to not take into account the statistical wind situation at the site.
  - Low wind speed may occur at the time of occurrence of extreme temperatures.
 - The classification should remain as simple as possible to use
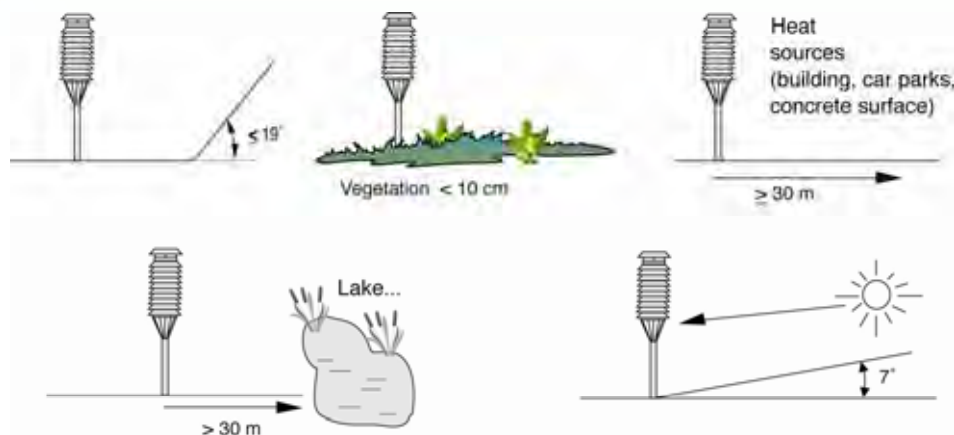
Air temperature and humidity, class 1

- Flat, horizontal land, surrounded by an open space
- Ground covered with natural and low vegetation, representative of the region
- Away from artificial heat sources
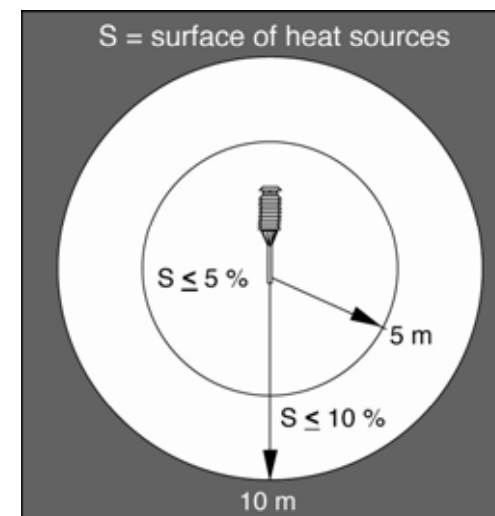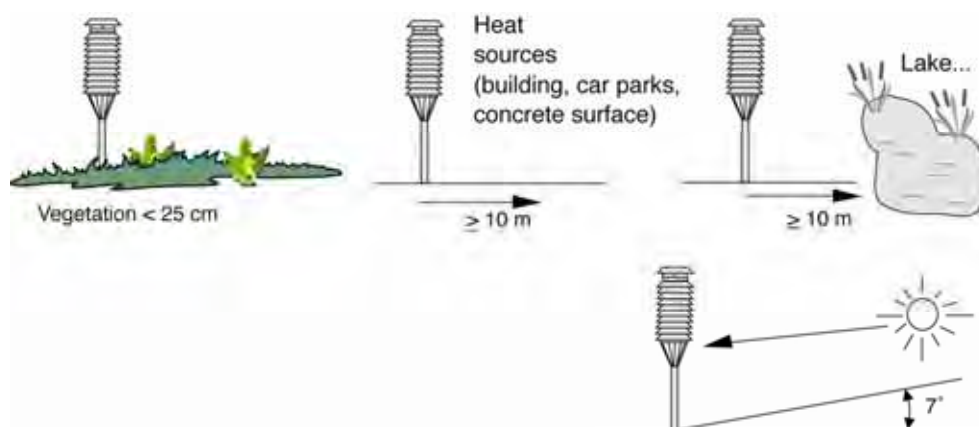- Away from projected shade when the sun is higher than 5°
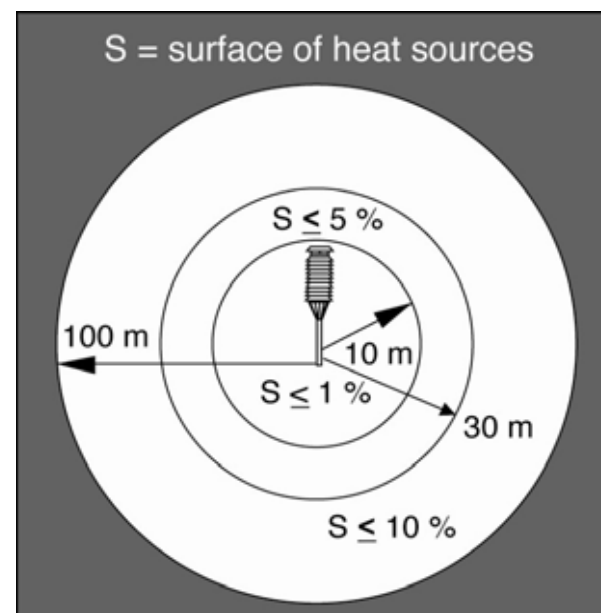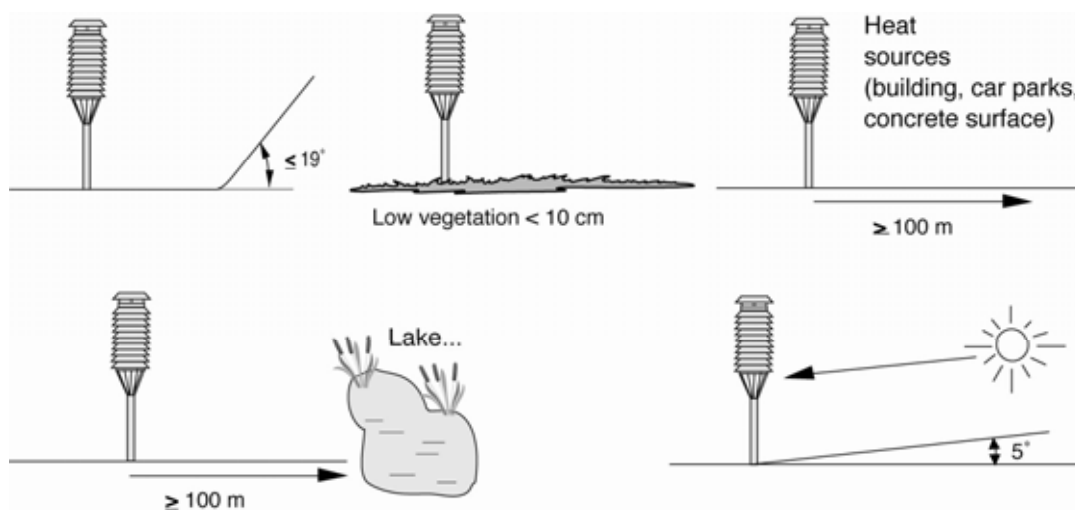
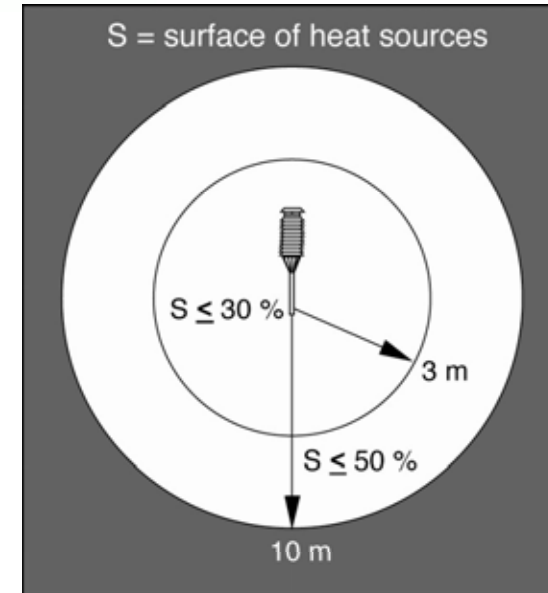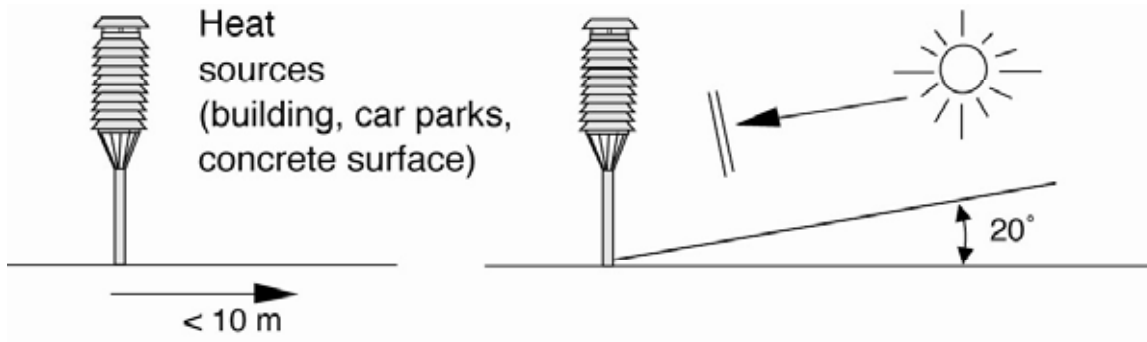# Air temperature and humidity, class 2 and 3

- Class 2
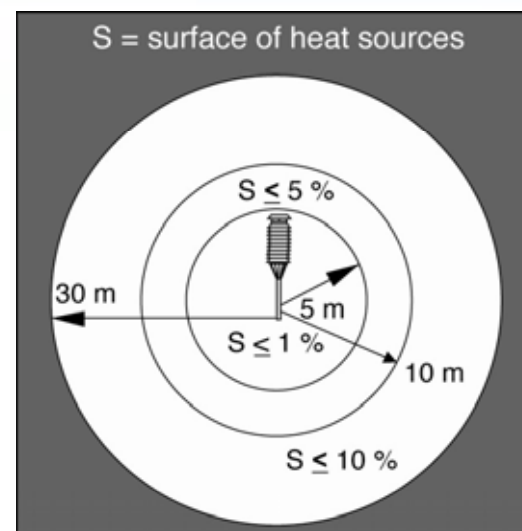
- Class 3 (additional estimated uncertainty added by siting up to 1°C)

JMA/WMO RAII QM-OBS

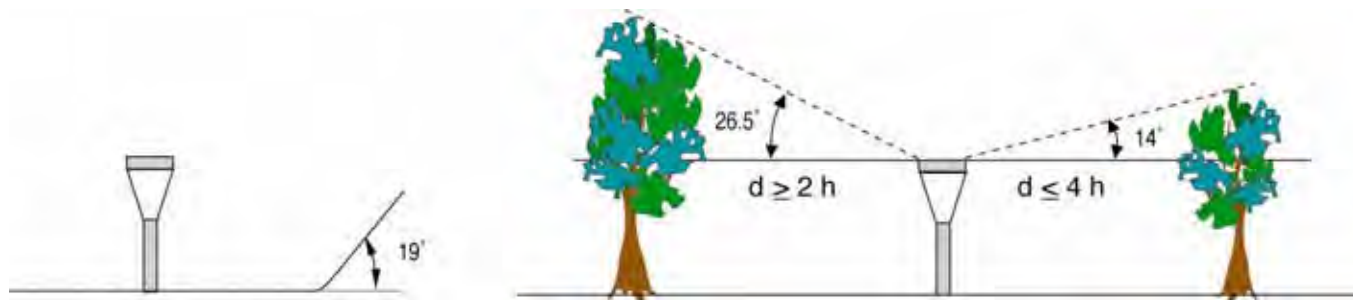# Air temperature and humidity, class 4 and 5

- Class 4 (additional estimated uncertainty added by siting up to 2°C)

- Class 5 (additional estimated uncertainty added by siting up to 5°C)
  - When not class 4

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Classification for precipitation

- Wind is the greatest source of disturbance in precipitation measurements, due to the effect of the instrument on the air flow

- Class 1, preferred

- Or

Precipitation, class 2 and 3

- Class 2 (additional estimated uncertainty added by siting up to 5%)

- Class 3 (additional estimated uncertainty added by siting up to 15%)

Precipitation, class 4 and 5

- Class 4 (additional estimated uncertainty added by siting up to 25%)

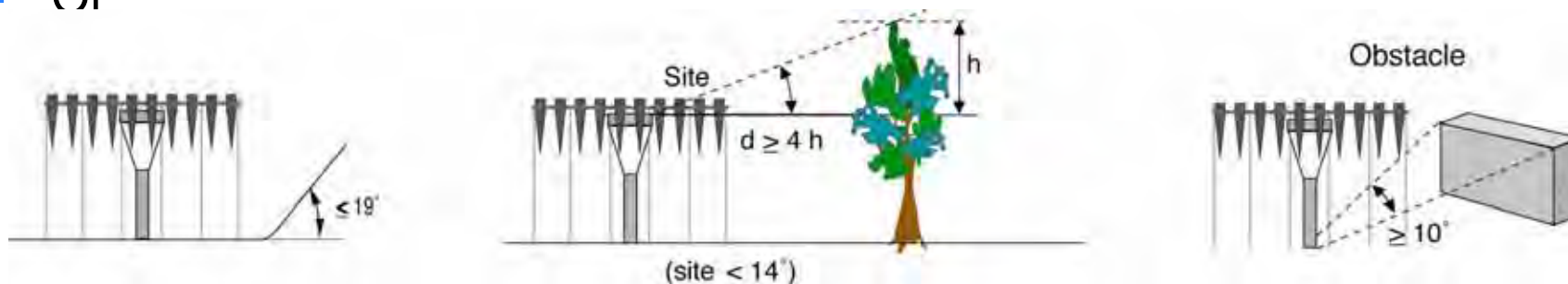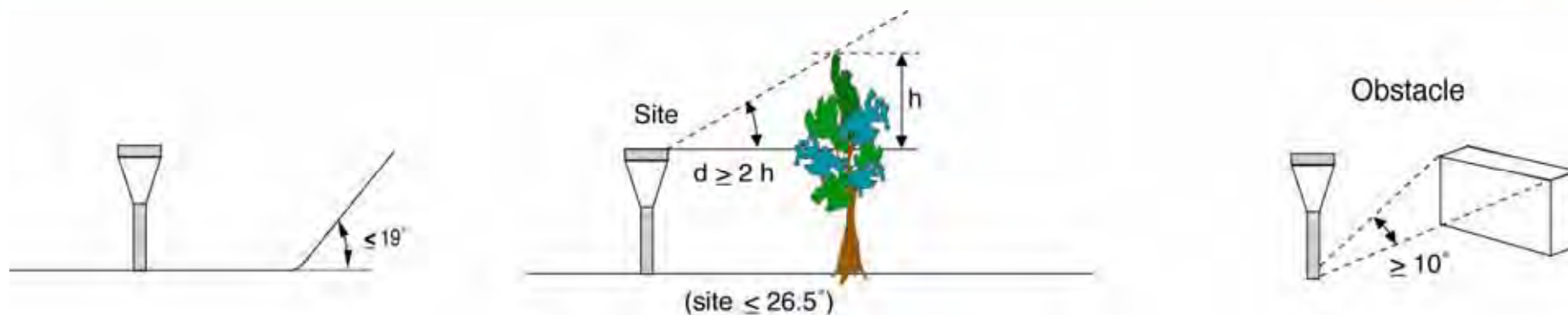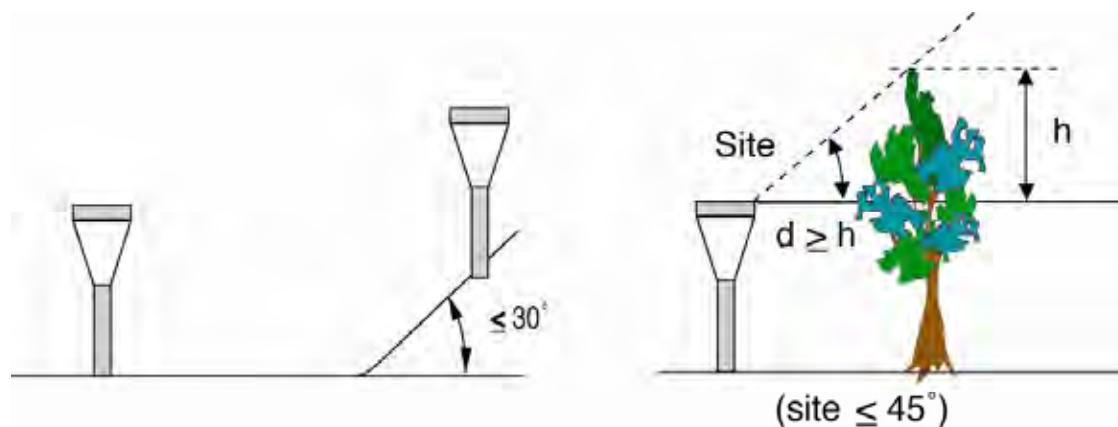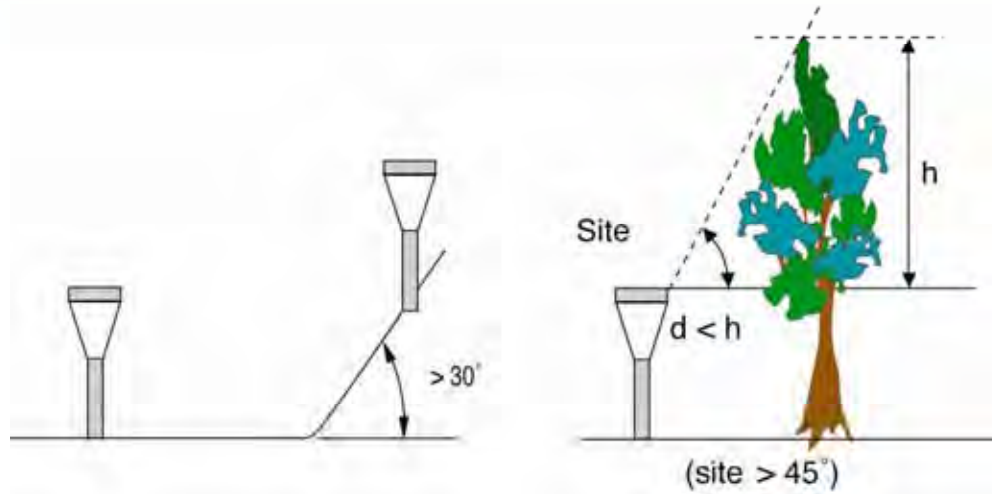- Class 5 (additional estimated uncertainty added by siting up to 100%!)

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RAINFALL MEASUREMENTS WITH RAINGAUGES INSTALLED IN VARIOUS LOCATIONS

JAPAN METEOROLOGICAL AGENCY

Location	Ratio(%)
On the roof of a building	57
On the roof of an instrument box	23
On the top of a pole or on the arm attached to a pole	8
On the ground	12

T   1. Ratio of the number of raingauges installed in various locations

F   5. Raingauges in the leeward of trees

F   3. Schematic view of the experiment on the roof of the building
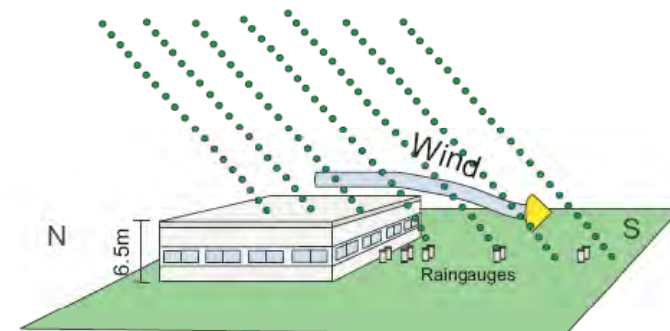
4. Raingauges in the leeward of the building

JMA/WMO Rain QM OBS

JAPAN METEOROLOGICAL AGENCY
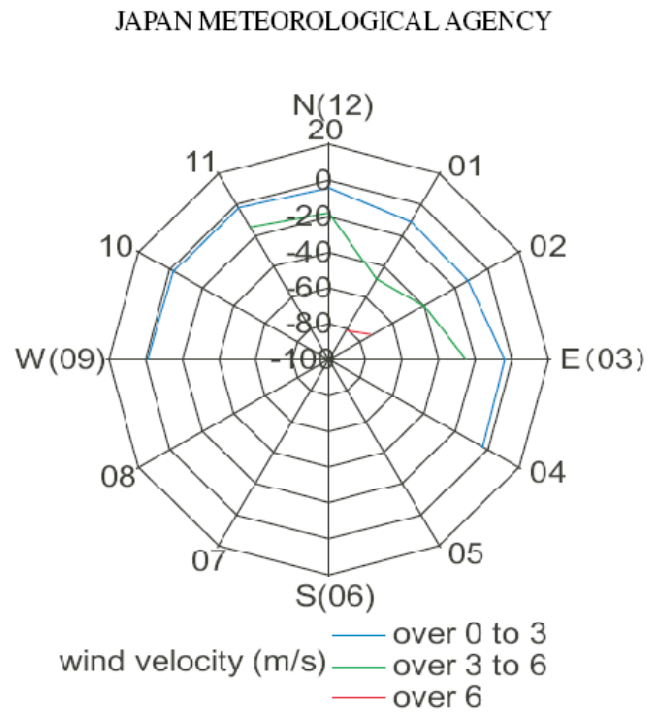
F   11. Same as Fig.10 but at the distance of 1m apart from the building to the leeward
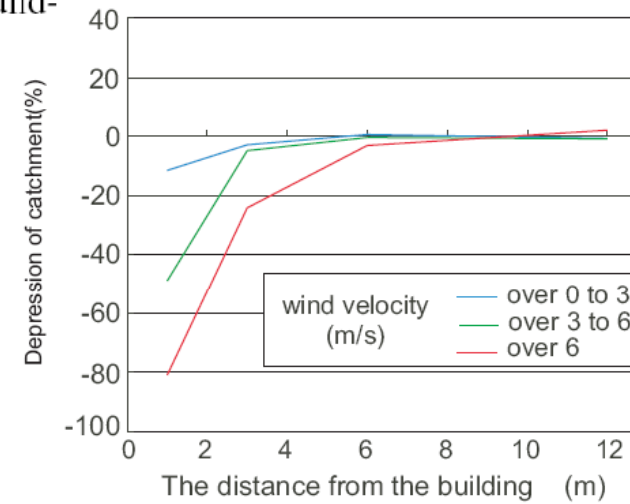
F   12. Variation of the depression of catchment with the distance from the building and wind velocity in wind direction of 01

Classification for wind measurements

- *Roughness classification : Davenport, see CIMO Guide, WMO Doc n° 8*

- *Environment classification*

- The presence of obstacles (almost invariably) means a reduction in average wind readings, but less significantly affects wind gusts.

- The classification assumes measurement at 10 m.

- When measurement are carried out at lower height (such as at 2 m for agro-climatological purposes), a class 4 or 5 is to be used, with flag S (Specific situation)

- When numerous obstacles higher than 2 m are present, it is recommended that sensors should be placed 10 m above the average height of the obstacles.

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Wind, class 1 and 2

- **Class 1**

Site

$d \geq 30\,h$ (site $\leq 1.9°$)

h
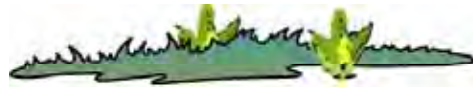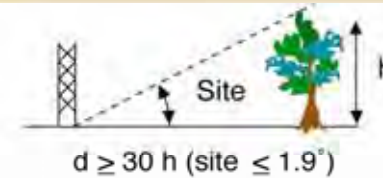
Roughness class ≤ 4

Large obstacle

Thin obstacle > 8 m

Width

$\geq 10°$

≥ 15 Width
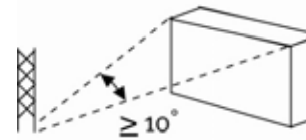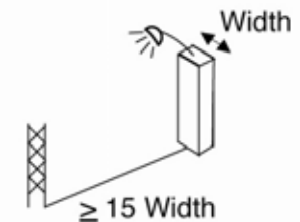
Obstacles lower than 4 m ignored

- **Class 2 (additional estimated uncertainty added by siting up to 30%, possibility to apply correction)**

Roughness class ≤ 5

Site

$d \geq 10\,h$ (site $\leq 5.7°$)

h

Thin obstacle > 8 m

Width

≥ 15 width

$\geq 10°$
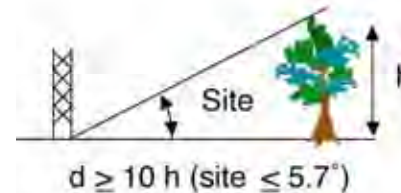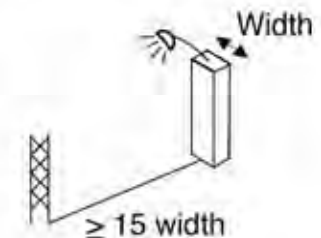
Obstacles lower than 4 m ignored

Wind, class 3 and 4

- Class 3 (additional estimated uncertainty added by siting up to 50%, correction cannot be applied)
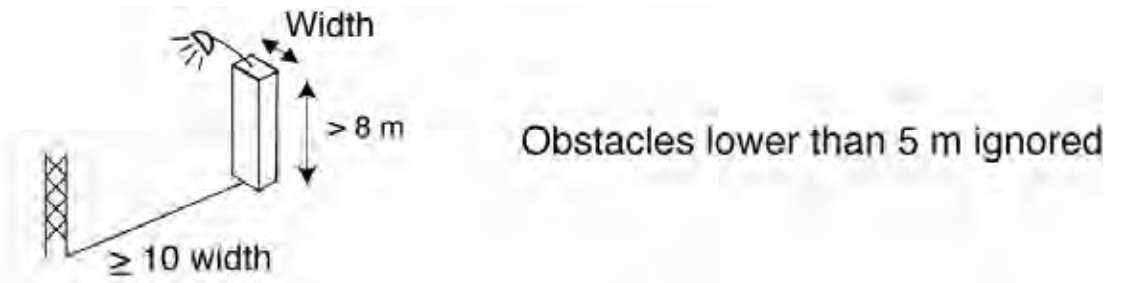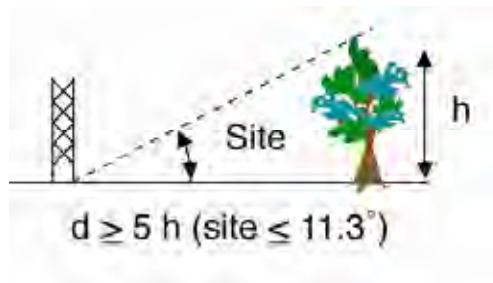
- Class 4 (additional estimated uncertainty added by siting greater than 50%)
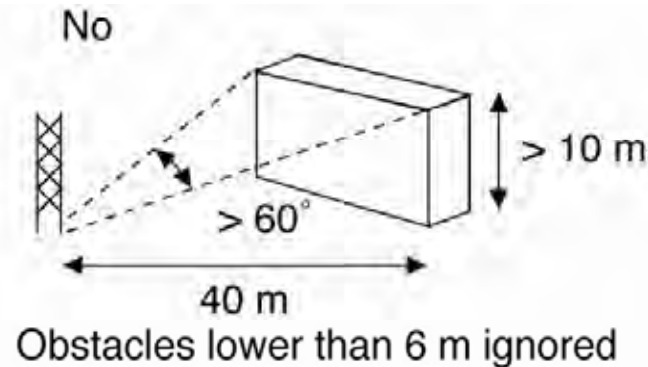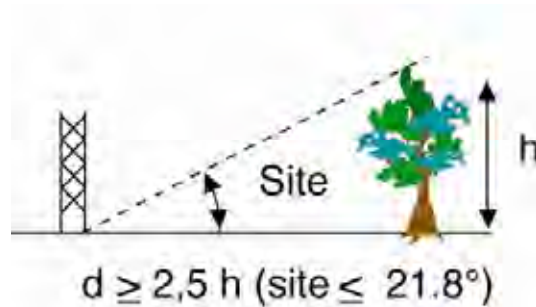
Wind, class 5

- Class 5 (additional estimated uncertainty cannot be defined)

  Site not meeting the requirements of class 4

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St-Sulpice

North   East

St-Sulpice

South   West

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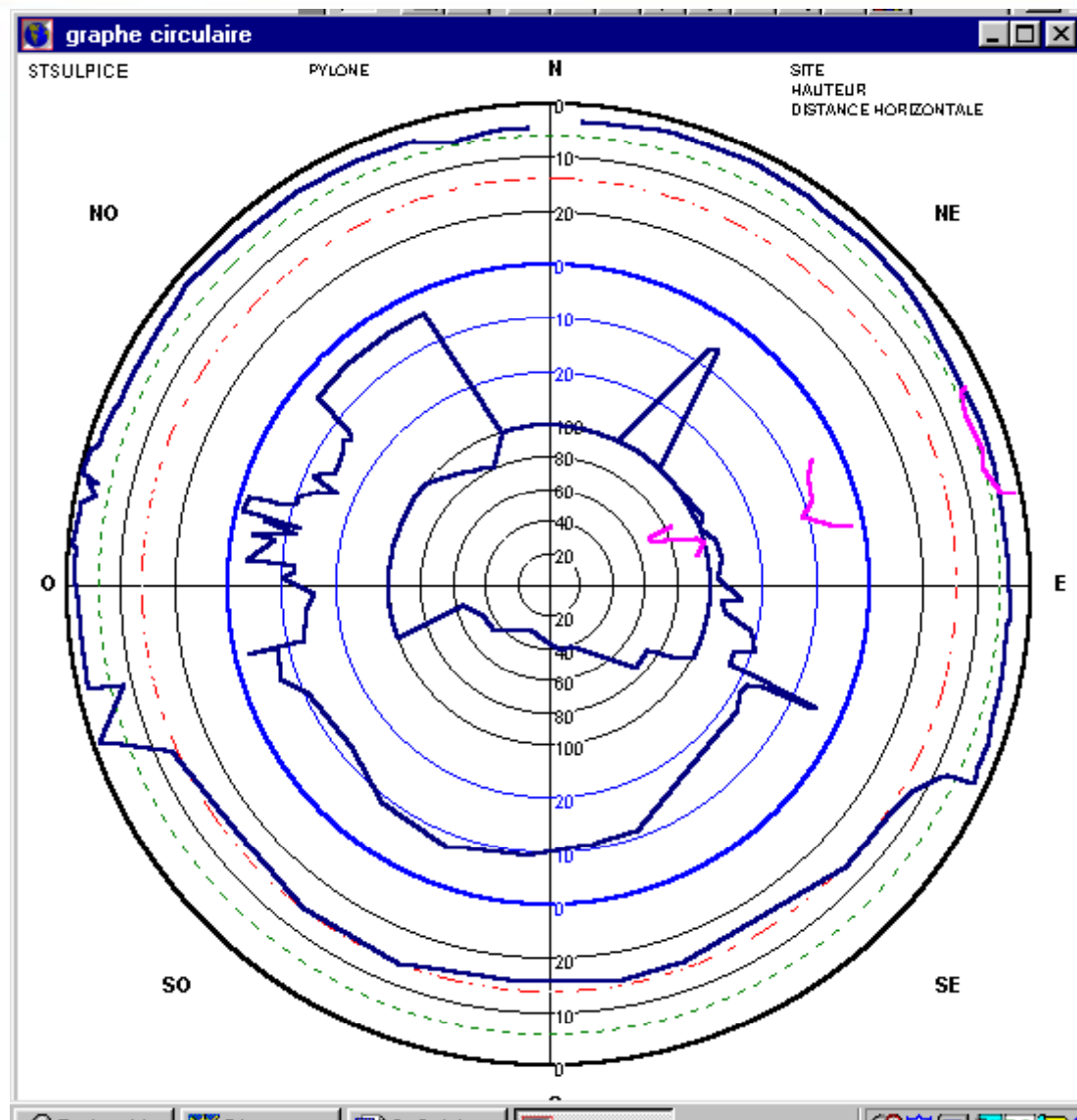
- Class 4 for wind.
- New Radome AWS settled at a distance of 60 m, away from the woods ➔ class 3

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Saint Sulpice, DIRCE
Ratio of mean wind speed (10 min.) between Patac et Xaria

South winds   North winds
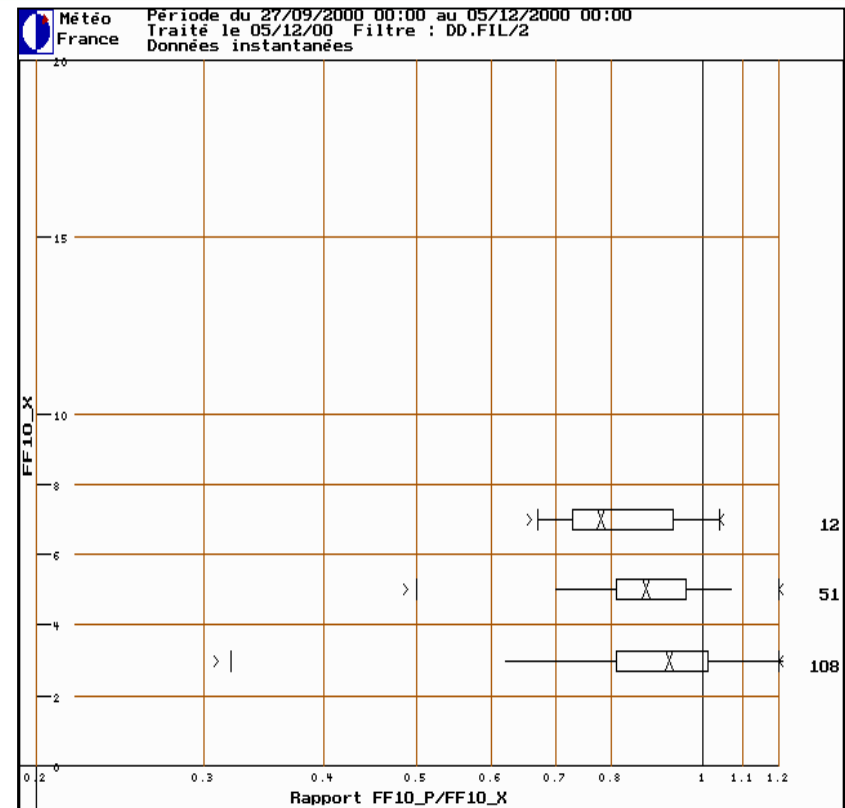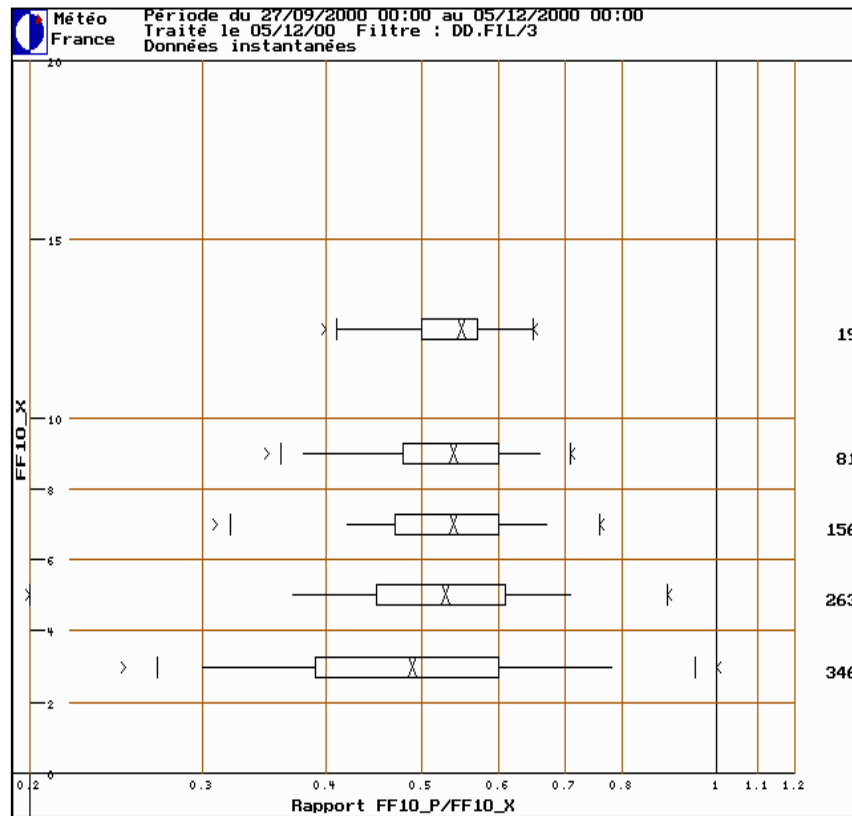
Classification for global and diffuse solar radiation

- Close obstacles have to be avoided
- Shading due to the natural relief is not taken into account
- An obstacle is considered as reflecting if its albedo is greater than 0.5

- Class 1
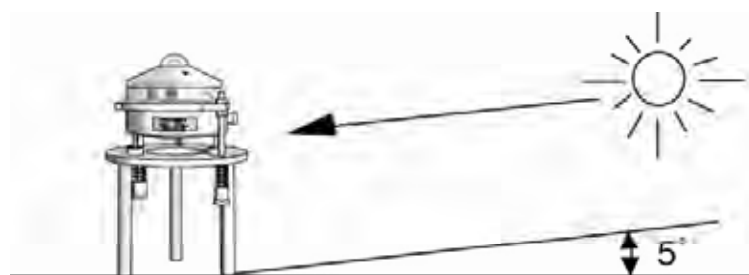
No shade

No non-shading obstacles with total angular width > 10°

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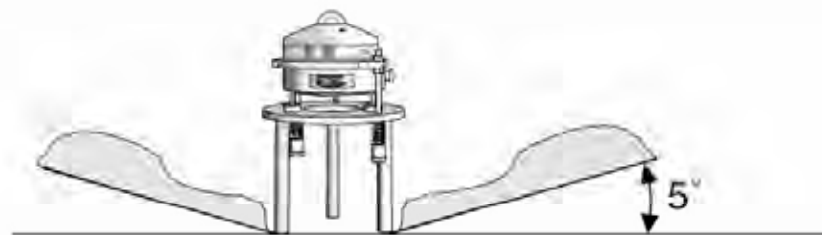
Global and diffuse radiation

- Class 2

7°

7°
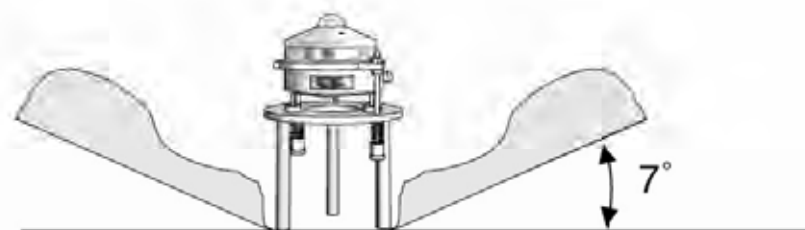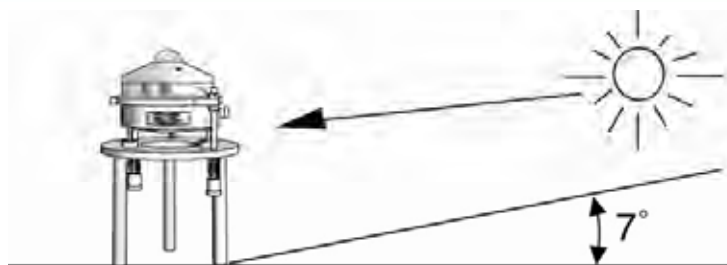
No non-shading obstacles with
total angular width > 20°

- Class 3
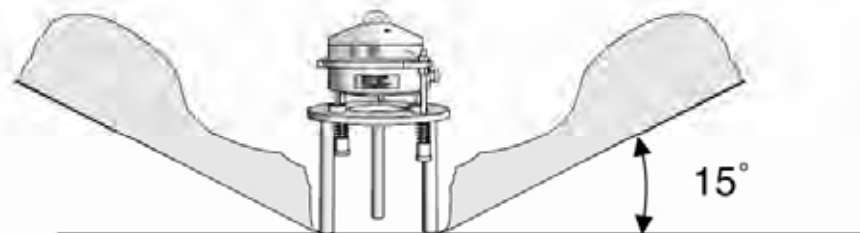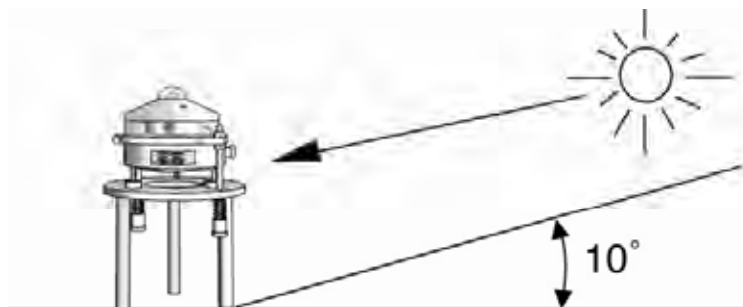
10°

15°

No non-shading obstacles with
total angular width > 45°

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Global and diffuse radiation

- **Class 4**

≤ 30 % of daytime

No shade projected for more than 30 % of daytime
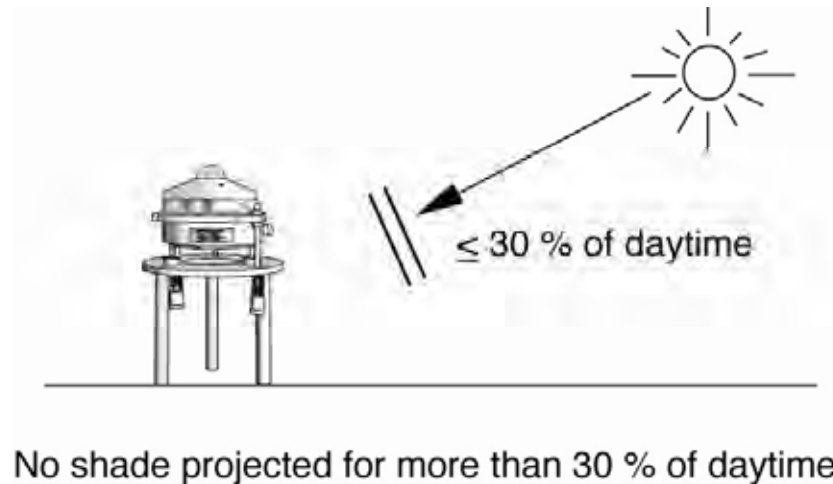
- **Class 5**
  - Shade projected during more than 30% of the daytime, for at least one day of the year

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Classification for direct radiation and sunshine duration

- Class 1

- Class 2

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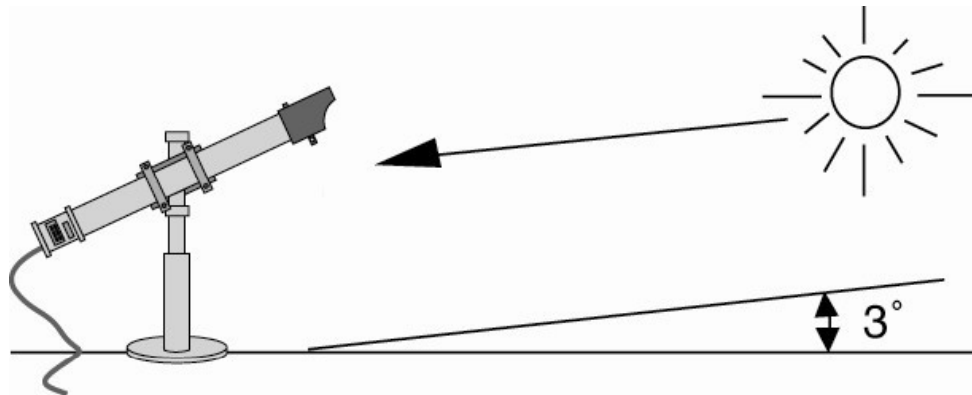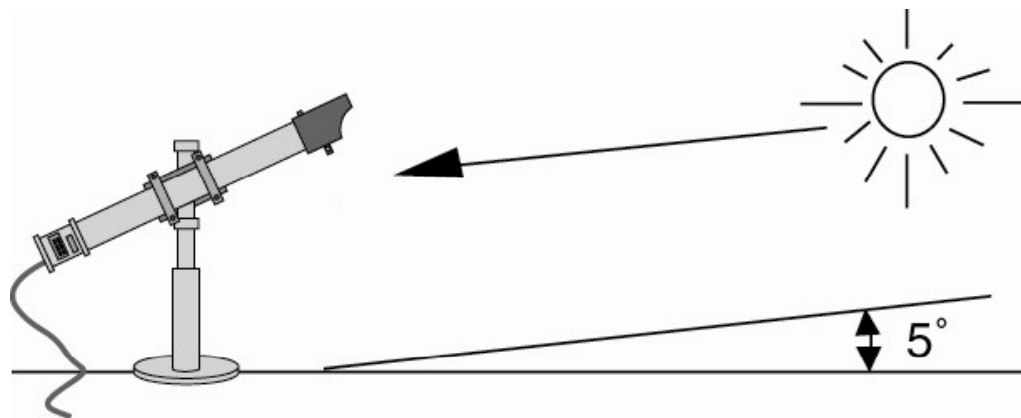
Direct radiation and sunshine duration

- Class 3

- Class 4

Classification for long-wave radiation (tentative)

- Influence of obstacles is taken into account by estimating the portion of the sky hemisphere occupied by these obstacles, as viewed by the sensitive element of the pyrgeometer.

- An obstacle seen with an angular height α and an angular width β (in °), has an influence with a weight of $100 * \sin^2(\alpha) * \beta / 360$ in %

- For example, this "shading weight" is only 3% for a full ring of obstacles seen under an elevation of 10°.

- Obstacles below the visible horizon are neglected

- Class 1: no obstacles with shading weight more than 2%

- Class 2: no obstacles with shading weight more than 5%

- Class 3: no obstacles with shading weight more than 10%

- Class 4: no obstacles with shading weight more than 20%

- Class 5: not meeting the requirements of class 4

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Conclusion

- This classification is intended to describe the real world of measuring networks, which is sometimes far from the WMO/CIMO recommendations.

- WMO (CIMO, CBS) has decided to standardize a site classification.

- Additional guidance (documentation, courses) will be necessary

- Such a standard could be further recognized by ISO.

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Experience of Météo-France

- The siting classification is a good mean to "force" network managers and actors to think about the station's environment.

- By checking it, the environment is often improved.

- It gives a picture of the status of a network

- It takes time, but the management of a network takes time.

- The siting classification was well received by the meteorologists who knew that the field situation was quite different from the theoretical status of what should be done.

- It is shared with other network managers: agriculture, roads, nuclear power plants, etc.

- It is now fully included in the climatological data base

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Classe environnement du réseau RADOME_OTARIE
région météorologique : toutes

Informations extraites de la BDCLIM le 26/07/2010

(A noter : la date et la méthode de classement de la classe environnement sont visibles uniquement station par station, en cliquant sur fiche)

Téléchargement au format xls

carte

Ig	Région	Numéro Météo-France	Nom usuel	T	date relevé T	U	date relevé U	RR	date relevé RR	Ray	date relevé Ray	Vent	date relevé Vent	Rug_e	date relevé Rug e	Rug_n	date relevé Rug n	Rug_o	date relevé Rug o	Rug_s	date relevé Rug s	Identité
1	CENTRE-EST	1014002	ARBENT	3	2004	3	2004	1	2004			2	2009	4	2004	4	2004	6	2004	6	2004	Fiche
2	CENTRE-EST	1034004	BELLEY	3	2009	3	2009	3	2009			3	2009	5	2009	5	2009	5	2009	5	2009	Fiche
3	CENTRE-EST	1071001	CESSY	2	2009	2	2009	1	2009			3	2009	5	2009	5	2009	5	2009	5	2009	Fiche
4	CENTRE-EST	1089001	AMBERIEU	3	2009	3	2009	1	2009			2	2009									Fiche
5	CENTRE-EST	1414001	SUTRIEU	3	2009	3	2009	1	2009	2	2009	3	2009	5	2009	4	2009	5	2009	5	2009	Fiche
6	CENTRE-EST	3060001	VICHY-CHARMEIL	3	2006	3	2006	1	2006	3	2006	3	2006									Fiche
7	CENTRE-EST	3155003	LURCY-LEVIS SA	2	1999	2	2010	1	1999	2	1999	1	2010									Fiche
8	CENTRE-EST	3180001	MONTBEUGNY	2	2009	2	2009	1	2009	1	2009	1	2009	3	2009	7	2009	7	2009	7	2009	Fiche
9	CENTRE-EST	3185007	MONTLUCON AERO	2	2009	2	2009	1	2009	1	2009	1	2009	8	2009	7	2009	7	2009	8	2009	Fiche
10	CENTRE-EST	3248001	ST-NICOLAS	4	2010	4	2010	1	2010	1	2010	3	2010									Fiche
11	CENTRE-EST	7025001	BARNAS RAD	4	2010	4	2010	2	2010			5	2010	7	2010	8	2010	8	2010	7	2010	Fiche
12	CENTRE-EST	7032002	BERZEME RAD	3	2010	3	2010	1	2010			3	2010	6	2010	6	2010	6	2010	6	2010	Fiche
13	CENTRE-EST	7068001	COLOMBIER JEUNE RAD	3	2009	3	2009	1	2009	4	2009	4	2009	7	2003	2	2003	4	2003	6	2003	Fiche
14	CENTRE-EST	7096001	GLUIRAS RAD	3	2009	3	2009	1	2009	3	2009	3	2009	7	2009	7	2009	7	2009	7	2009	Fiche
15	CENTRE-EST	7131001	LANAS SYN	2	2010	2	2010	1	2010	3	2010	3	2010	7	2010	6	2010	5	2010	4	2010	Fiche
16	CENTRE-EST	7154005	MAZAN ABBAYE RAD	3	2003	3	2003	1	2003			2	2003	5	2003	4	2003	5	2003	4	2003	Fiche
17	CENTRE-EST	7172002	PEAUGRES RAD	3	2009	3	2009	1	2009			3	2009	2	2009	4	2009	4	2009	4	2009	Fiche
18	CENTRE-EST	7204008	ST-AGREVE RAD																			Fiche
19	CENTRE-EST	15014004	AURILLAC	2	2006	2	2006	1	2006	2	2006	1	2006									Fiche
20	CENTRE-EST	15053001	COLTINES	2	2009	2	2009	1	2009	1	2009	1	2009	4	2009	4	2009	4	2009	4	2009	Fiche
21	CENTRE-EST	15060002	DEUX-VERGES	2	2008	3	2008	1	2002			3	2008	3	2008	6	2008	7	2008	6	2008	Fiche
22	CENTRE-EST	15114002	MARCENAT	3	2009	3	2009	1	2009	3	2009	3	2009	7	2009	6	2009	6	2002	7	2009	Fiche
23	CENTRE-EST	15120005	MAURIAC	3	2008	1	2008	1	2008			2	2008									Fiche
24	CENTRE-EST	15122002	MAURS	3	2009	3	2009	1	2009	3	2009	3	2009									Fiche
25	CENTRE-EST	21065001	BESSEY	1	2009	1	2009	1	2009			1	2009									Fiche
26	CENTRE-EST	21131001	CHAMBLANC SEURR	2	2002	2	2002	1	2008	3	2008	3	2002	5	2008	6	2008	7	2008	4	2008	Fiche
27	CENTRE-EST	21154001	CHATILLON/SEINE	2	2008	2	2008	1	2008	1	2008	1	2008	3	2008	4	2008	4	2008	3	2008	Fiche
28	CENTRE-EST	21473001	DIJON-LONGVIC	1	2008	1	2008	1	2008	1	2008	1	2008									Fiche
29	CENTRE-EST	21560001	ST-MARTIN-MER	2	2009	2	2009	1	2009			1	2009	5	2009	6	2009	7	2009	4	2009	Fiche
30	CENTRE-EST	21561003	ST-MARTIN-DU-M	3	2009	3	2009	1	2009	2	1999	1	2009	4	2009	7	2009	4	2009	6	2009	Fiche
31	CENTRE-EST	26002003	ALBON	2	2009	2	2009	1	2009	2	2009	2	2009	4	2009	4	2009	4	2009	4	2009	Fiche
32	CENTRE-EST	26064001	VALENCE-CHABEUI	2	2009	2	2009	1	2009	2	2009	1	2009	4	2009	3	2009	4	2009	3	2009	Fiche
33	CENTRE-EST	26168001	LUS L CROIX HTE	3	2010	3	2010	1	1999	4	2010	3	2010	7	2010	6	2010	6	2010	5	2010	Fiche
34	CENTRE-EST	26198001	MONTELIMAR	2	2007	2	2007	1	2007	2	2007	3	2007									Fiche
35	CENTRE-EST	26292002	ST-AUBAN	3	2009	3	2009	1	2009	2	2009	1	2009	4	2009	4	2009	4	2009	5	2009	Fiche
36	CENTRE-EST	26327001	ST ROMAN-DIOIS	3	2009	3	2009	3	2009			5	2009	4	2009	5	2009	4	2009	4	2009	Fiche
37	CENTRE-EST	38053003	BOURGOIN	2	2009	2	2009	1	2009			3	2009	4	2009	3	2009	4	2009	3	2009	Fiche
38	CENTRE-EST	38133001	COUBLEVIE	3	2009	3	2009	1	2009			5	2009	6	2009	6	2009	6	2009	6	2009	Fiche
39	CENTRE-EST	38191002	ALPE-D'HUEZ	3	2009	3	2009	2	2009	1	2003	4	2009	4	2009	5	2009	5	2009	5	2009	Fiche
40	CENTRE-EST	38269004	LA MURE- RADOME	2	2004	2	2004	1	2004			3	2004	6	2004	5	2004	4	2004	6	2004	Fiche
41	CENTRE-EST	38336001	REVENTIN	1	2004	1	2004	1	2004			2	2004	3	2004	3	2004	3	2004	2	2004	Fiche
42	CENTRE-EST	38384001	GRENOBLE-ST GEOIRS	3	1999	3	1999	1	1999	2	1999	1	1999									Fiche
43	CENTRE-EST	38442008	ST-PIERRE-LES EGAUX																			

JMA/WMO RAII QM-OBS

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Photos du site SUTRIEU (1414001)

Informations extraites de la BDCLIM le 26/07/2010

dirce/01/001414001_20090519_E.jpg

dirce/01/001414001_20090519_N.jpg

dirce/01/001414001_20090519_O.jpg

dirce/01/001414001_20090519_S.jpg

Classe environnement du réseau CLIM_MANUEL_ROC
région météorologique : Toutes DIR

Informations extraites de la BDCLIM le 26/07/2010

● OK

Classe environnement ou
● date de dernière classification
non conforme

● Classes non renseignées

JMA/WMO RAII QM-OBS
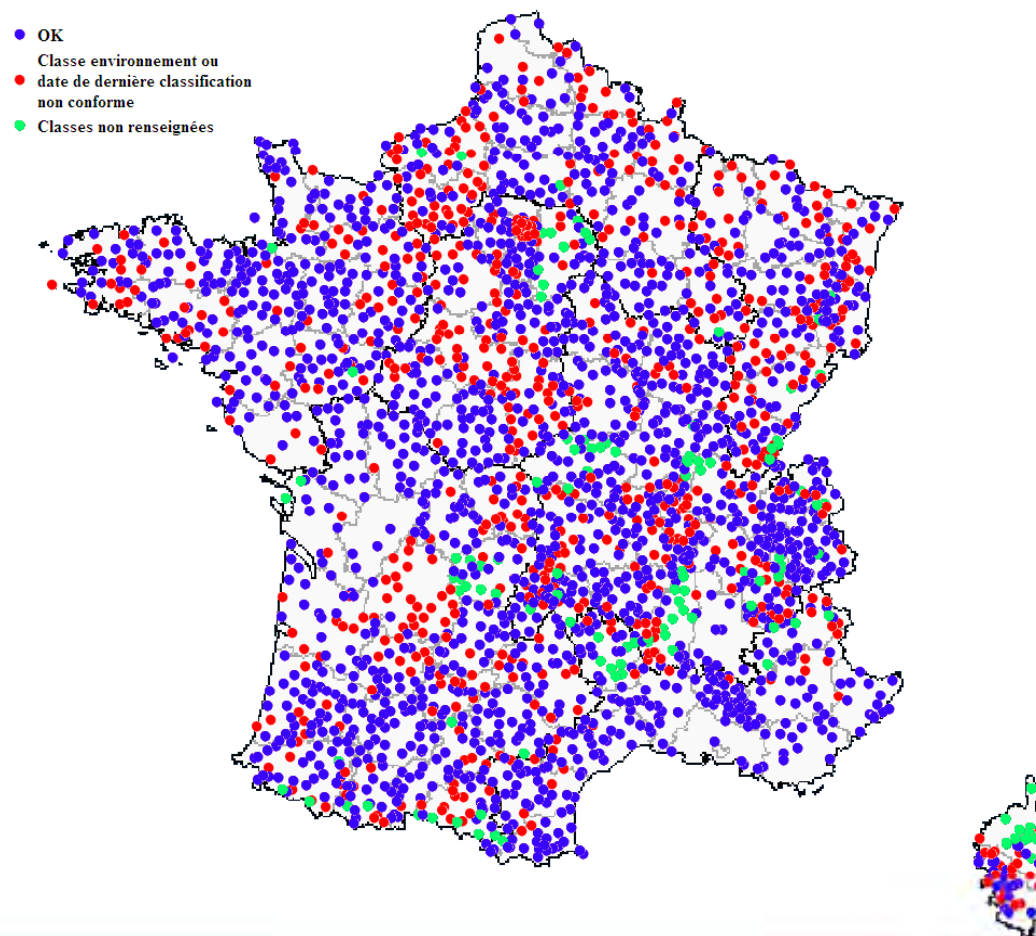
Cooperative climatological network

Cooperative climatological network. Precipitation classification
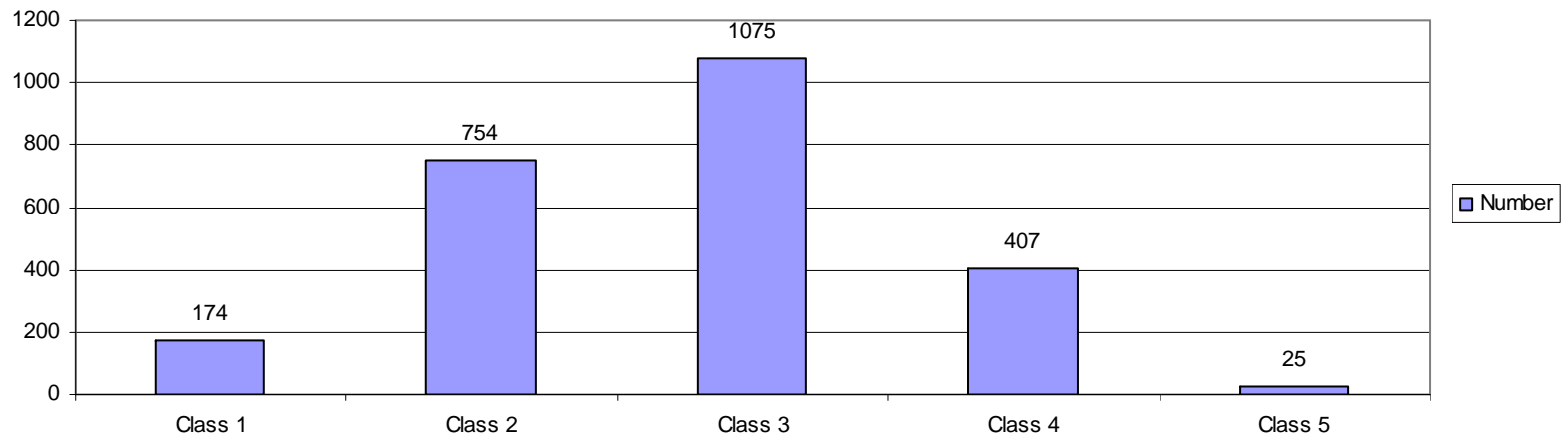
Cooperative climatological network. Temperature classification
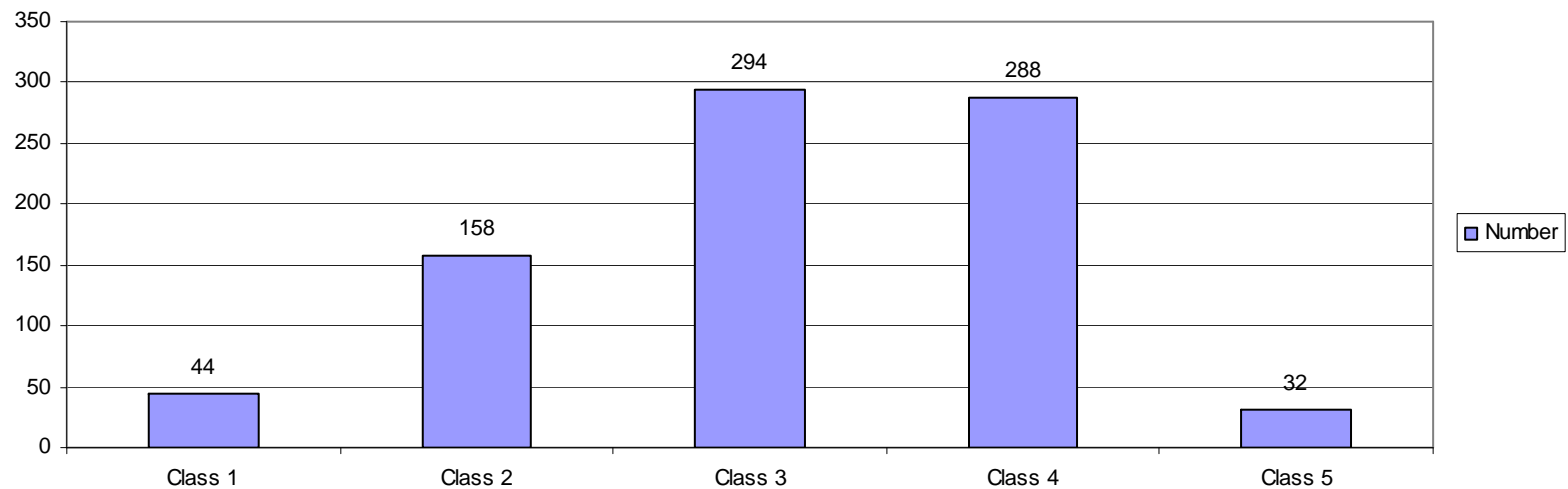
Radome network

Radome network. Precipitation classification
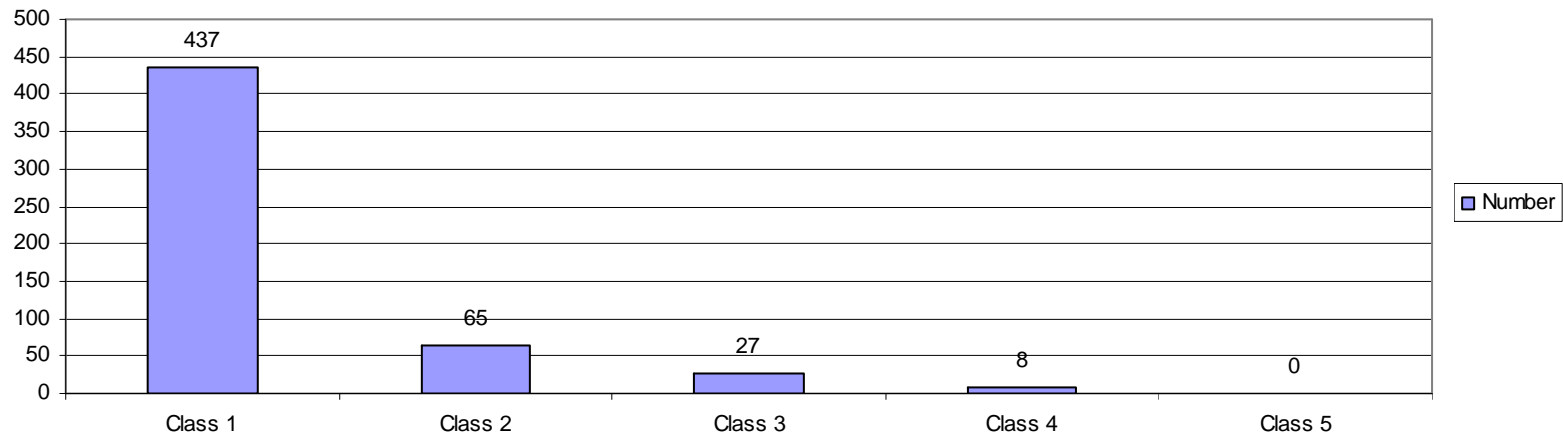
Radome network. Temperature classification

The world is not perfect : some class 5 sites

Photos du site LES ANDELYS (27016001)

Informations extraites de la BDCLIM le 26/07/2010

Photos du site MEAUX (77284003)

Informations extraites de la BDCLIM le 26/07/2010

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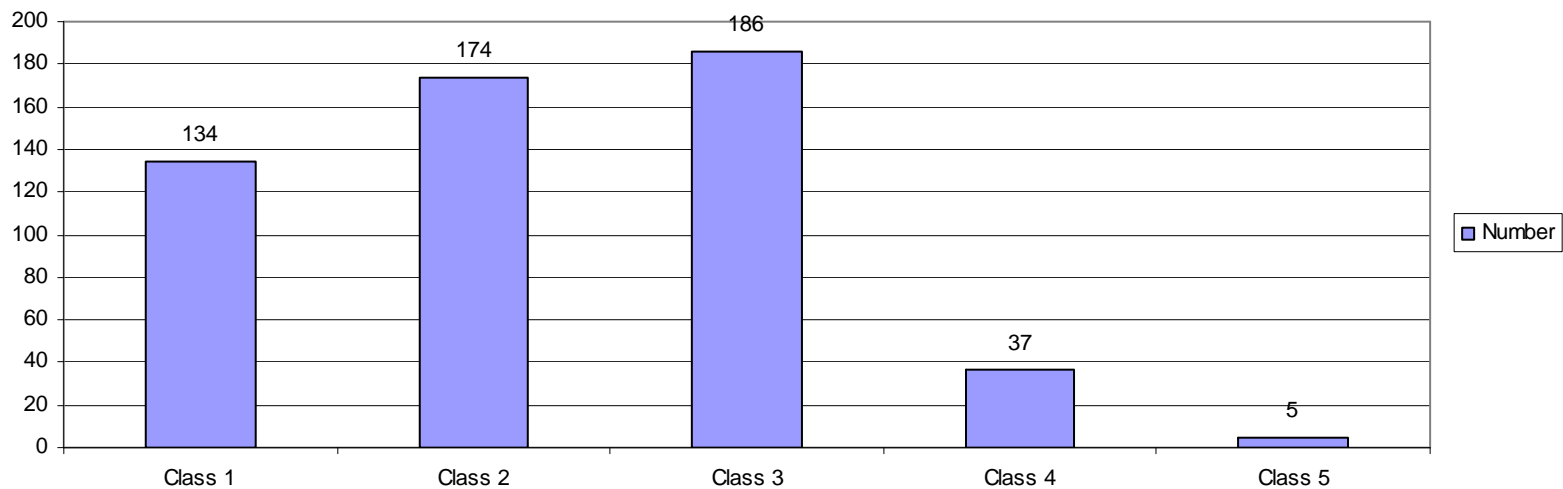# Other quality factors

- Intrinsic performances

- Maintenance and calibration

- Within a homogeneous network, these factors are known and generally the same. But Météo-France is using data from various networks:
  - Radome (554)
  - Non-proprietary AWS (~800)
  - Climatological cooperative network (> 3000)

- The intrinsic performances, maintenance and calibration procedures are not the same.

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Several reasons

- The objectives may be different.

- But some uncertainty objectives are sometimes (often) unknown !

    – To get cheap measurements ?

- The maintenance and/or the calibration are not always organized !

- Within the ISO 9001-2000 certification process, Météo-France was forced to increase his knowledge of the various networks' characteristics.

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Another classification !

- After site classification (1 to 5), definition of an additional classification, to cover the two quality factors :
  - Intrinsic performances
  - Maintenance and calibration
- 5 levels were defined :
  - Class A: ·WMO/CIMO required measurement uncertainty or achievable measurement uncertainty when higher. Maintenance and calibration are organized to keep this uncertainty in the field and over time. When the required measurement uncertainty is smaller than the achievable accuracy, the latter is indicated.
  - Class B: Lower specifications, but still considered as quite "good", often having a good value to money ratio and more affordable in practice. Maintenance and calibration are organized to keep this uncertainty in the field and over time.
  - Class C: Specifications and/or maintenance and calibration procedures lower than class B, but known and applied. Maintenance and calibration are still organized.
  - Class D: Specifications lower than class C or no maintenance and calibration organized.
  - Class E: Unknown performances and/or unknown maintenance procedures.
- This classification is called : Maintained performance classification

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Air temperature

- Class A: **0.2° C** (achievable measurement uncertainty). Temperature probe with uncertainty below or equal 0.05 ° C (in laboratory conditions, over the measuring range). Uncertainty of the acquisition system < 0.02 ° C. High performance artificially ventilated screen. Laboratory calibration of the temperature probe every year.

- **Class B: 0.5 ° C.** Temperature probe with uncertainty below 0.25° C corresponds of class A of IEC 751 standard). Acquisition uncertainty < 0.1° C. Radiation screen with known characteristics and overestimation of Tx (daily max. temperature) < 0.15° C in 95% of cases. Laboratory calibration of the temperature probe every 5 years.

- Class C: **1.0° C.** Temperature probe with uncertainty < 0.4° C. Acquisition uncertainty < 0.2° C. Radiation screen with known characteristics and overestimation of Tx < 0.3° C in 95% of cases.

- Class D: > **1° C.** Temperature probe and/or acquisition system uncertainty lower than for class C. Unknown radiation screen or with "unacceptable" characteristics (for example, overestimation of Tx > 0.7° C in 5% of cases).

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Relative humidity

- Class A: **3%** (achievable measurement uncertainty). Performance verified over the full range of humidity and a temperature range typical for the location of the station. Acquisition uncertainty < 0.2%. Calibration every 6 months, in an accredited laboratory.

- Class B: **6%.** Sensor specified for ± 6%, over a temperature range typical for the location of the station. Acquisition uncertainty < 1%. Calibration every year, in an accredited laboratory.

- Class C: **10%.** Sensor specified for ± 10%, over a temperature range typical for the location of the station. Acquisition uncertainty < 1%. Calibration every two years in an accredited laboratory.

- Class D: **> 10%.** Sensor with performances or specifications worst than ± 10% over the common temperature conditions. Calibration not organized.

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Other parameters

- Solar radiation

- Pressure

- Amount of precipitation

- Wind

- Visibility

- Temperature above ground

- Soil temperature

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Status of the RADOME network

- Air temperature : Class B

- RH : Class B

- Amount of precipitation : Class B or Class C, depending on the rain gauge used.

- Wind : Class A

- Global solar radiation : Class A for manned station, class B for isolated sites.

- Ground temperatures : Class B

- Pressure : Class B

- Visibility (automatic) : Class B

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Status of the cooperative network

- Air temperature (liquid in glass thermometers) : Class C
- Amount of precipitation : Class B

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Status of non-Météo-France additional networks

- Air temperature : Class B to D

- RH : Class B to D

- Amount of precipitation : Class B to C

- Wind : Class B to D

- Global solar radiation : Class B to D

- Ground temperature : Class B to C

- Pressure : Class B to D

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Metadata

- These classification for each site are meta data, part of the climatological database.

- With these two classifications, a measurement on a site can be given a short description.

  - Example : C3 for global solar radiation is for a class 2 pyranometer without ventilation, calibrated every 5 years, installed on a site with direct obstructions, but below 10° .

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An image of a network

	1	2	3	4	5
E	There is still hope				
D	Is it really usable ?				
C	Still useful				
B	Good				
A	Dream ?				

An image of the RADOME network

Wind — Global solar radiation

Conclusion

- These classifications are intended to describe the real world of measuring networks, which is sometimes far form the WMO/CIMO recommendations.

- The two classifications described have the advantage of being simple and therefore, easy to use as metadata.

- WMO (CIMO, CBS) has decided to develop a site classification, on the example of this classification. Such a standard would be further recognized by ISO.

- Another advantage is that it is also a didactic approach, both for network designers, financing authorities and final users. It gives a clear and honest view of a network status.

- The Météo-France experience is that the implementation of these classifications brought and still bring improvements in the networks' design, thus optimizing their value, not necessarily at an extra cost.

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