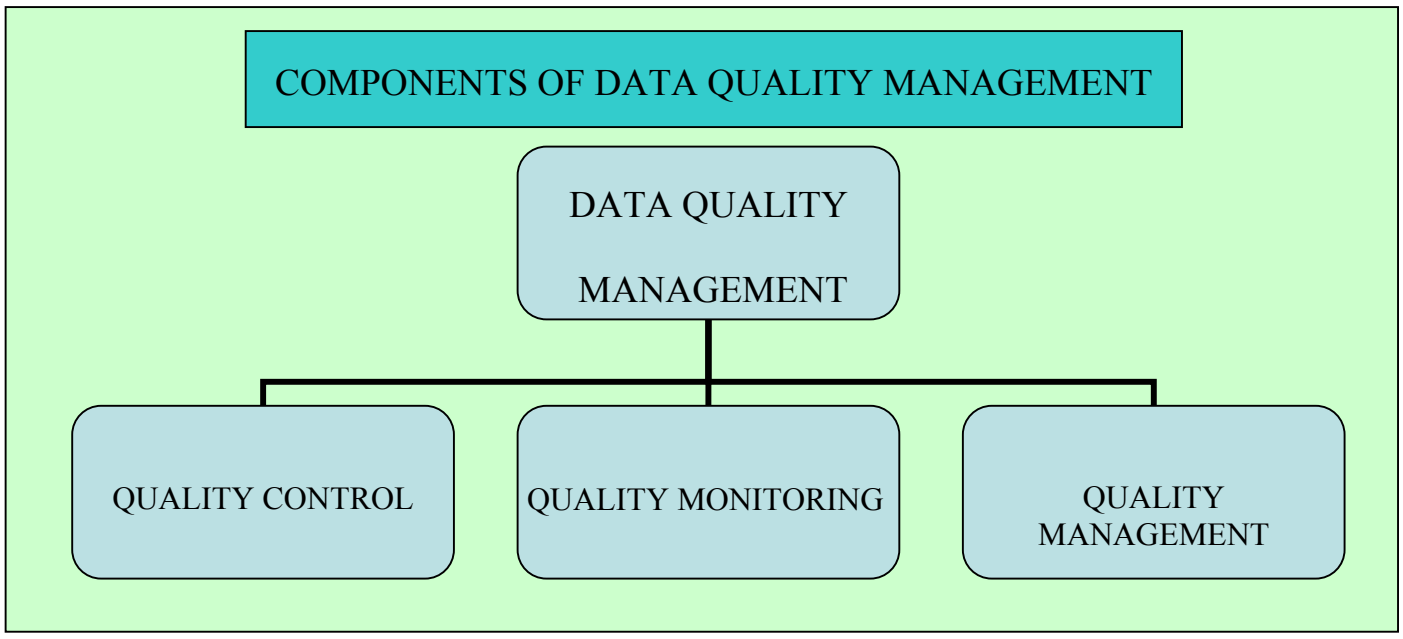
DATA QUALITY MANAGEMENT

Data are of good quality when they satisfy stated and implied needs. The purpose of quality management is to ensure that data meet requirements (for uncertainty, resolution, continuity, homogeneity, representativeness, timeliness, format, etc.) for the intended application, at a minimum practicable cost. Good data are not necessarily excellent, but it is essential that their quality is known and demonstrable.

The best quality systems operate continuously at all points in the whole observation system, from network planning and training, through installation and station operations to data transmission and archiving, and they include feedback and follow-up provisions on time-scales from near-real time to annual reviews.



Quality control is the best known component of quality management systems, and it is the irreducible minimum of any system. It consists of examination of data in stations and in data centres to detect errors so that the data may be either corrected or deleted. Quality control is applied in real time, but it also operates in non-real time, as delayed quality control.

Real time quality control is usually performed at the station and at meteorological analysis centres. Delayed quality control may be performed at analysis centres for compilation of a re-checked database, and at climate centres or data banks for archiving.

Quality monitoring or performance monitoring is a non-real time activity in which the performance of the network or observation system is examined for trends and systematic deficiencies.

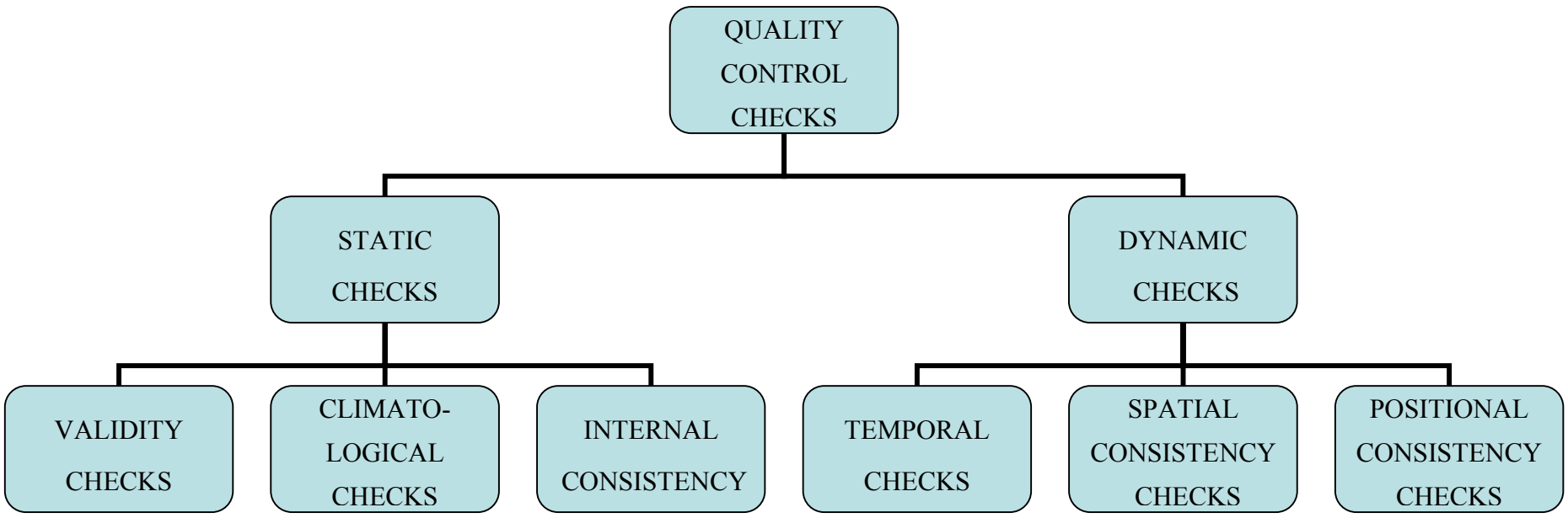
Quality management includes control of the other factors that directly affect data quality, such as equipment, exposure, procedures, maintenance, inspection, data processing and training. These are usually the responsibility of the network manager, in collaboration with other specialists, where appropriate.

FACTORS AFFECTINFG DATA QUALITY

1-	Users' requirements
2-	Functional and technical specifications:
3-	Selection of instruments
4-	Acceptance tests
5-	Compatibility
6-	Siting and exposure
7-	Instrumental errors
8-	Data acquisition
9-	Data processing
10-	Real-time quality control
11-	Performance monitoring
12-	Test and calibration
13-	Maintenance
14-	Training and education
15-	Metadata

QUALITY CONTROL

WMO (1981) prescribes that certain quality control procedures must be applied to all meteorological data for international exchange. WMO (1992) prescribes that quality control must be applied by meteorological data-processing centres to most kinds of weather reports exchanged internationally, to check for coding errors, internal consistency, time and space consistency, and physical and climatological limits, and it specifies the minimum frequency and times for quality control.



Two types of Quality Control checks are considered: **static checks**, which are single-station and single-time checks such as climatological checks and validity checks; and **dynamic checks** which take advantage of other information, such as temporal and spatial consistency checks.

The Static Quality Control checks are single-station, single-time checks which, as such, are unaware of the previous and current meteorological or hydrologic situation described by other observations and grids. Checks falling into this category include: validity, climatological, internal consistency, and vertical consistency checks.

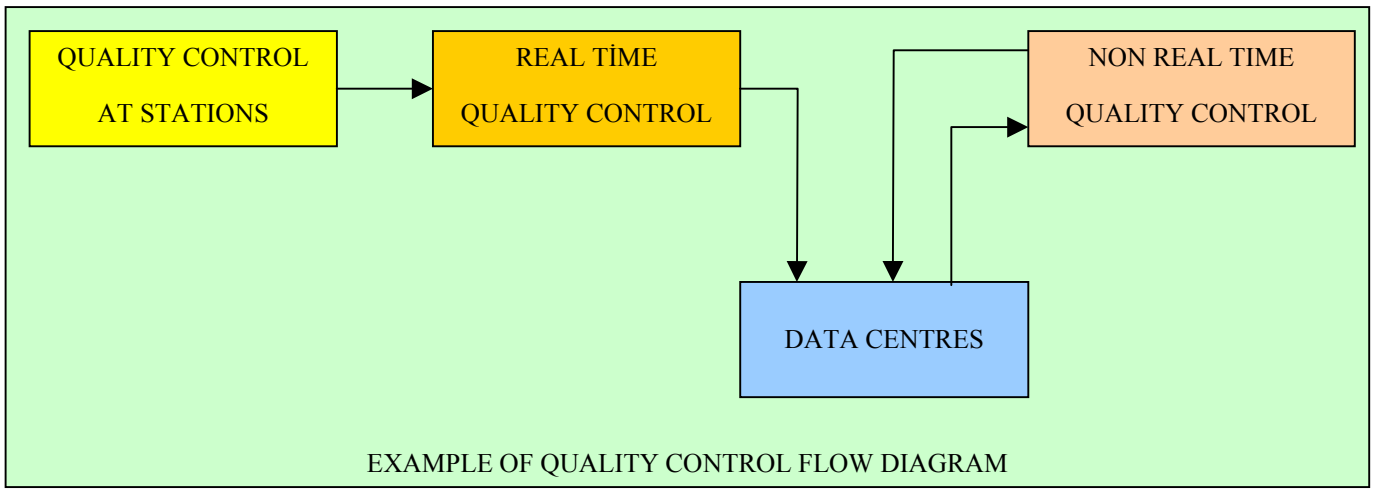
Dynamic checks refine the Quality Control information by taking advantage of other available information. Examples of dynamic Quality Control checks include: positional consistency, temporal consistency, spatial consistency, and model consistency checks.

Definition of limit and step check: In a limit or range check an observation is always compared to previously defined limit values. In a step check temporal changes are compared to step limit values. If the check implies control of one parameter only, it is a pure step check. If the check implies control of two or more parameters, it is a consistency check (of time series or instant values).

Definition of consistency checking: In a consistency check an observation is compared with other parameter values to see if they are physically or climatologically consistent, either instantly or for time series according to adopted observation procedures. The check always includes two or more different parameters from a single station.

Definition of spatial checking: In spatial checking the observation is compared with the expected value at the station which can be estimated by various methods. Spatial checks involve parameter values of neighbouring stations, either by interpolation between observations by checking against numeric prognostic values (on the basis of values from many different stations), or by comparing statistics. The checks can involve more than one parameter at one point in time, or single or multi-parameter analyses of time series.

Definition of homogeneity checking: Homogeneity checks consist of a variety of control methods to unveil if data series are homogeneous or not during a long period of time. Such control methods are based on statistics of different kinds (e.g. internal consistency checks, Nordli, 1997), tests for detecting change points (e.g. Pettitt test, Sneyers, 1995), comparison of statistics from neighbouring stations (e.g. Standard Normal Homogeneity Test, Alexandersson, 1986) and historical metadata checking (e.g. inspection reports from weather station).



EXAMPLE OF QUALITY CONTROL FLOW DIAGRAM

Quality Control For Surface data

MANUAL OBSERVATIONS , STAFFED STATIONS AND AUTOMATIC WEATHER STATIONS

The observer or the officer in charge at a station is expected to ensure that the data leaving the stations have been quality controlled, and should be provided with established procedures for attending to this responsibility. This is a specific function, in addition to other maintenance and record-keeping functions, including:

(a) Internal consistency

(b) Climatological checks

(c) Temporal checks

(d) All arithmetical and table look-up operations should be explicitly checked;

(e) Messages and other records must be checked against the original data.

Quality Control For Upper air data: Checks should be made for internal consistency (such as lapse rates and shears), for climatological and temporal consistency, and for consistency with normal surface observations.

Quality Control For Data centers: The checks that have already been performed on stations are usually repeated at data centers, perhaps in more elaborate form by making use of automation. Data centers, however, usually have access to other network data, making a spatial check possible, against observations from surrounding stations or against analysed or predicted fields. This is a very powerful method, and it is the distinctive contribution of a data center.

PERFORMANCE MONITORING

The management of a network, or of a station, is greatly strengthened by keeping continuous records of performance, typically on a daily and monthly schedule. There are several aspects to performance monitoring:

(a) Advice from data centers should be used to record the numbers and types of errors detected by quality control;

(b) Data from each station should be compiled into synoptic and time-section sets. Such sets should be used to identify systematic differences from neighbouring stations, both in spatial fields and in comparative time-series.

(c) Reports should be obtained from field stations about equipment faults, or other aspects of performance.

DATA HOMOGENEITY AND METADATA

Causes of data inhomogeneities:

Inhomogeneities caused by changes in the observing system appear as abrupt discontinuities, gradual changes, or changes in variability. Abrupt discontinuities mostly occur due to changes in instrumentation, siting and exposure changes, station relocation, changes in calculation of averages, data reduction procedures, and application of new corrections.

Metadata:

Data inhomogeneities should, as far as possible, be prevented by appropriate quality management. Climatologists can run appropriate statistical programs to link the previous data with the new data into homogeneous databases with a high degree of confidence. Information of this kind is commonly available in what is known as metadata — information on data — also called station histories. Metadata can be considered as an extended version of the station administrative record, containing all possible information on the initial setup, and type and times of changes that occurred during the life history of an observing system.

NETWORK MANAGEMENT

All the factors that affect data quality are the subject of network management. In particular, network management must include corrective action in response to the network performance revealed by quality control and performance monitoring.

The manager should keep under review the procedures and outcomes associated with all the factors affecting quality including:

(a) The quality control systems are essential operationally in any meteorological network, and usually receive priority attention by the users of the data and by network management;

(b) Performance monitoring is commonly accepted as a network management function.

(c) Inspection of field stations is a network management function;

(d) Equipment maintenance may be a direct function of the network management unit.

(e) The administrative arrangements should permit the network manager to take, or arrange for, corrective action arising from quality control, performance monitoring, the inspection programme, or any other factor affecting quality.

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Nordic Methods for Quality Control of Climate Data: www.smhi.se/hfa_coord/nordklim/reports_task1.htm

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