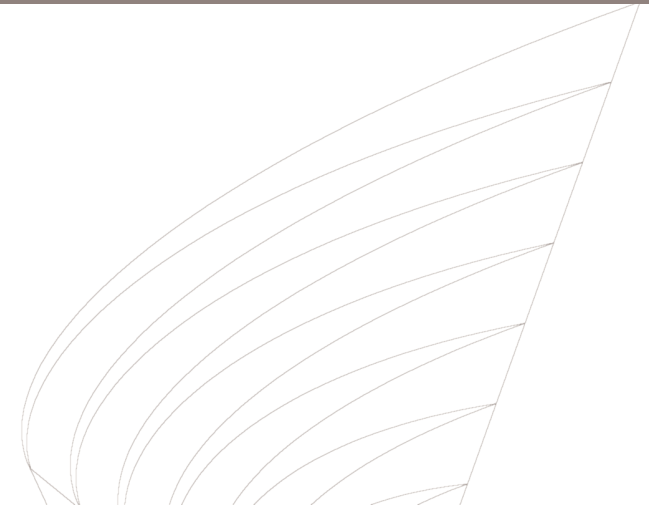




HELSINKI UNIVERSITY OF TECHNOLOGY
Control Engineering Laboratory

Quality of Dense Surface Weather Measurement Networks

Vesa Hasu



Motivation



- More dense measurements are needed for future improved weather forecasting products
 - Dense in both temporal and spatial direction
- Dense measurement networks means:
 - More measurements
 - More devices
- These result in new system requirements:
 - More measurements → more measurement quality control (QC)
 - More devices → more device maintenance

Motivation



- The increased number of devices increases also the complexity and cost of maintenance
 - What to repair?
 - What kind of faults must be repaired?
 - When to repair?
 - When faults are significant enough?
- If all measurements are quality controlled, why not look the network “big picture”?

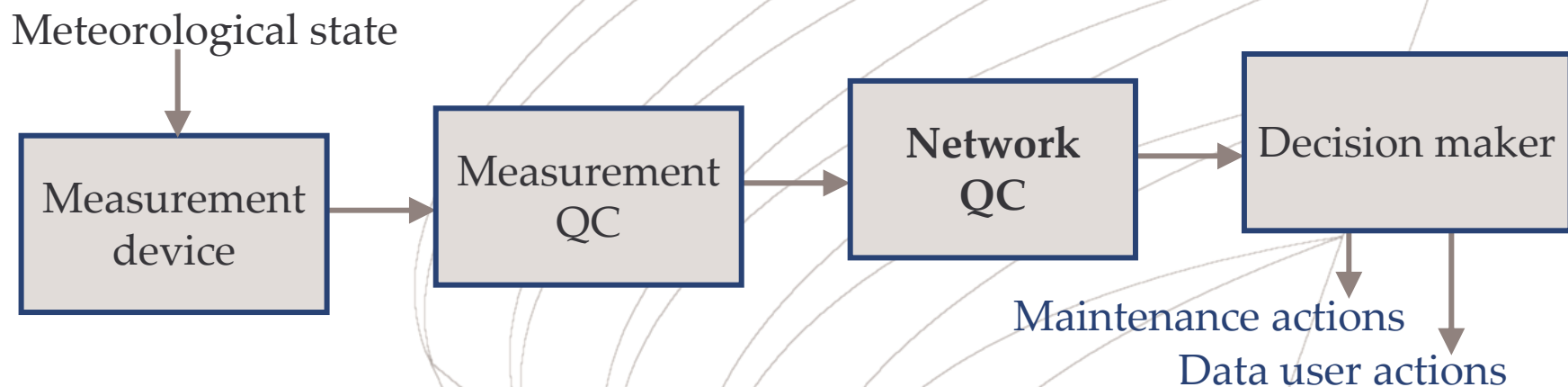
The idea:

in addition to the *Measurement Quality*, let's focus also to the *Network Quality*

Network Quality Control



- In here, network quality control refers to looking the measurement performance in a general level
- The aim is to locate the most problematic devices for maintenance, *i.e.* describe numerically measurement performance levels
- The outlook of the decision chain:



Network Quality Control



- Basically, inputs of network quality control are the outputs of measurement quality control, *e.g.*:
 - Quality control flag (erroneous/ok)
 - Quality control decision information
- Output of the network quality control is a description of the state of the measurement device quality
 - Description through performance indices

Performance Indices



- Performance indices should describe the quality of the measurement device in linguistic terms
- Indices must describe the performance in one station and network levels
- Suggested indices:
 - Availability (Are there missing measurements?)
 - Accuracy (Are there inaccurate measurements?)
 - Reliability (Does the station work reliably?)
 - Estimability (How well the measurement can be estimated based on the neighbor stations?)
 - Influence (How much the station is estimated to affect the network performance?)

Beyond The Indices



- What are the performance indices good for:
 - the maintenance decision making
 - giving an additional view of possible problems in the measurements for the end user
- The exact reactions of maintenance personnel / data users to indices depend on the minimum required quality level

A Numerical Example: Performance Indices



- Station level indices:
 - Availability
 - Accuracy
 - Reliability (based on the availability and accuracy)
- Network level indices:
 - Estimability (based on reliabilities of the neighbor stations)
 - Influence (based on reliability and estimability)
- The indices are formed based on heuristic mathematical rules and the residual signal of the measurement quality control
- The basic performance index interpretation guide:
0 → bad 1 → good

A Numerical Example



- An example WXT-neighborhood



- Data: July 2006 temperature measurements

A Numerical Example: Index Values



■ Indices:

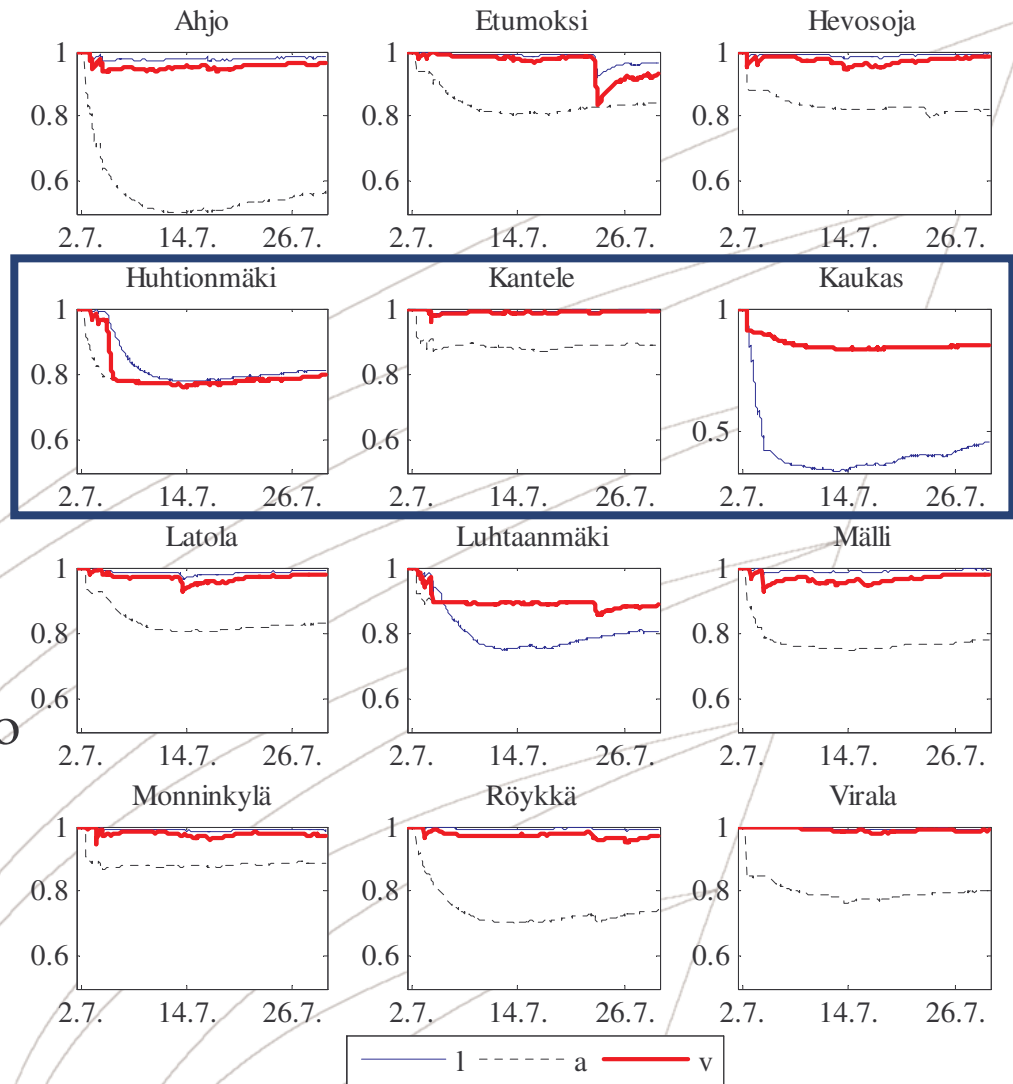
Thin blue = “Reliability”

Dashed black = “Estimability”

Bold red = “Influence”

■ An example interpretation of the second row:

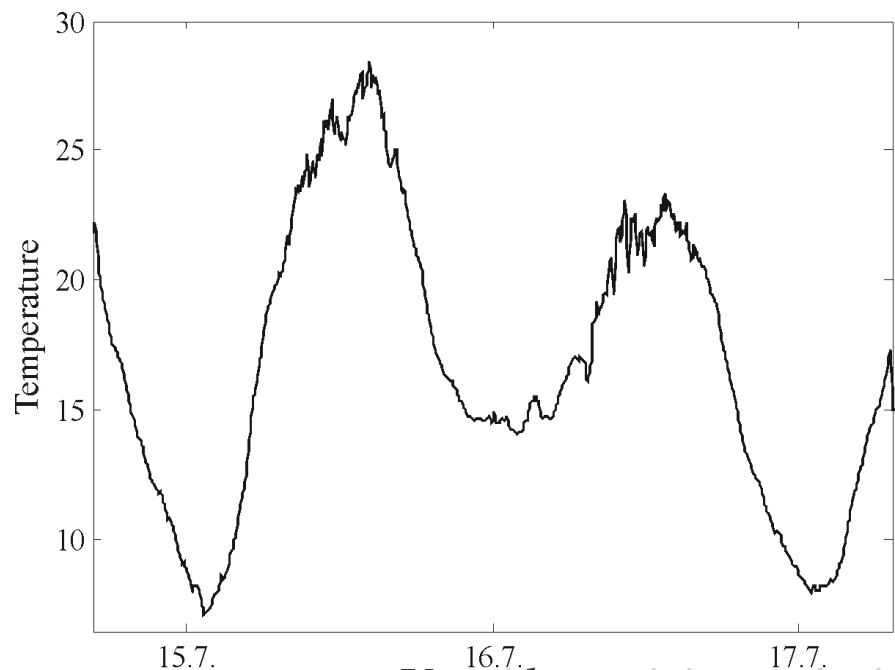
- Huhtionmäki and Kaukas have a low reliability and also compromised estimability
- Kantele has a compromised estimability value, but the measurement is reliable



A Numerical Example: Measurements

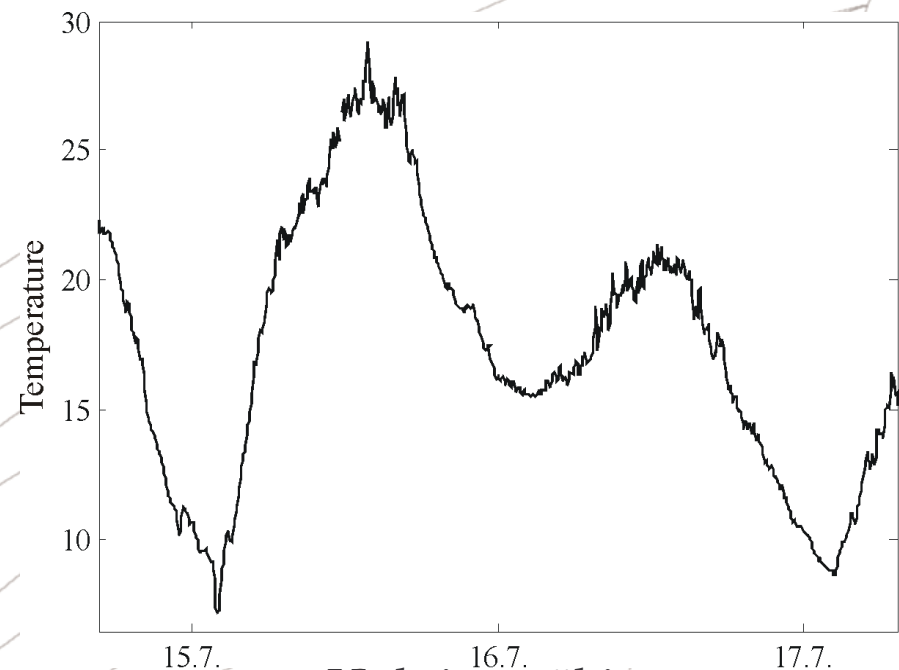


- Exerpts of temperature measurements:



Kantele

OK



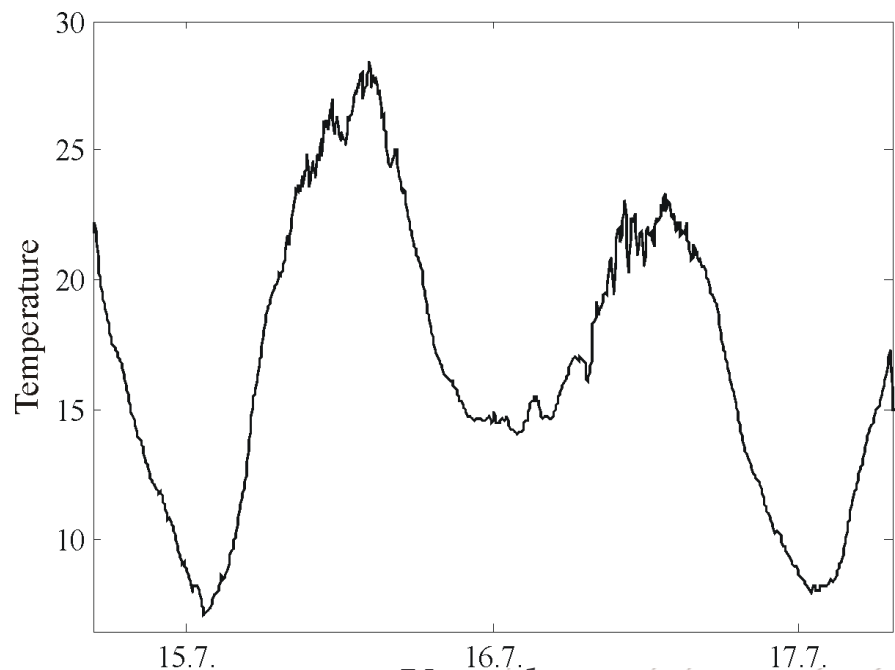
Huhtionmäki

Seems to be OK, but measurement is suffering from larger noise than Kantele

A Numerical Example: Measurements

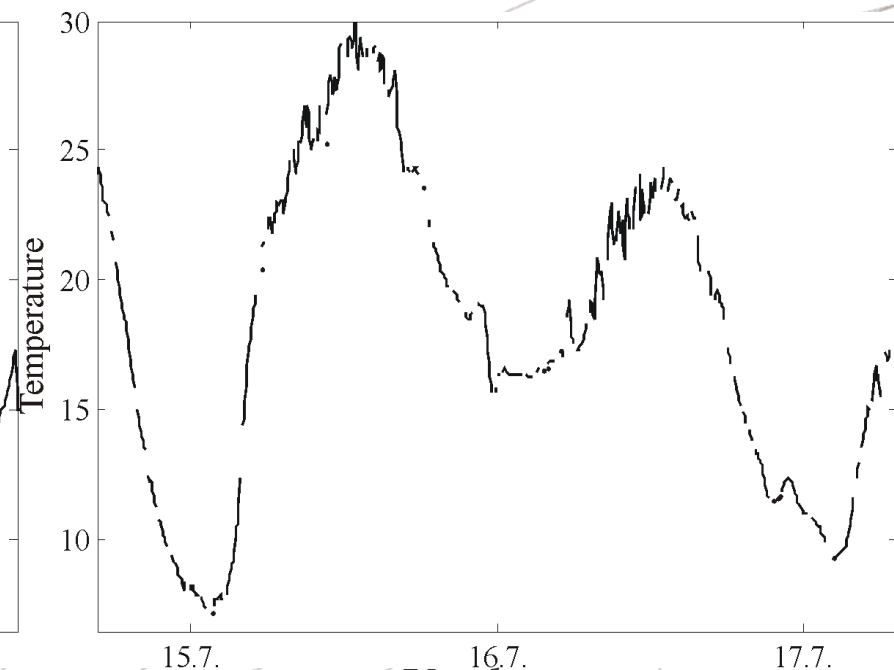


- Exerpts of temperature measurements:



Kantele

OK



Kaukas

A whole lot of measurements is missing

Conclusions



- A flow of incoming data – “desperate times call for desperate measures”?
- Measurement network quality must be monitored
 - in order to get information about the measurement
 - for helping the maintenance decision making
- A key for successful network quality control is the transparency of the concepts for ease of use
 - Simple linguistic terms