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The proposed replacement of Liquid in Glass thermometers by digital technology in Canadian meteorological networks.

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1. Introduction

Earth surface air temperature measurements are critical in meteorological observations. When taken for extended periods of time they provide essential indicator for climate change studies. Liquid in Glass (LiG) thermometers remain, in most parts of the Globe, the prevalent instrument to measure air temperature. The desire to eliminate, due to environmental reasons, the use of mercury, the need to increase automation and the increasing emphasis on maintaining the traceability of temperature measurements to national standards has prompted efforts to investigate alternative methods for replacing the LiG..
Recent advances in measurement and communications technology allow for feasible alternatives to LiG thermometers. Industry provides battery and solar powered wireless sensors that are capable of meeting range and accuracy requirements of meteorological networks. Temperature measurements can be automatically disseminated and archived through the internet interface. The homogeneity of climate observations is one of the critical factors to be considered before a network-wide replacement program.

2. Canadian Status Quo

Although digital technology for temperature measurements is widely used in Canadian meteorological networks it is limited to automatic weather and climate stations. Liquid in Glass thermometers are used in large numbers by:

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1. Daily Climate Volunteer observers to measure twice daily temperature extremes – minimum and maximum. In 2000 the number of volunteers was about 1450. In the process of networks rationalization the number is expected to drop to around 650.

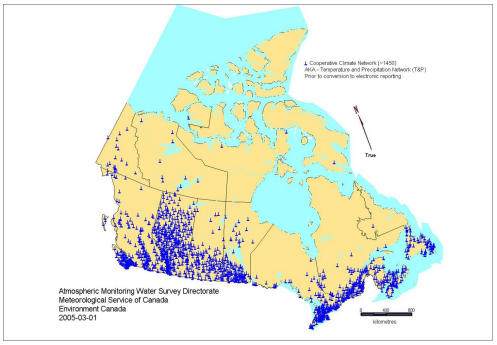

Fig.1 – 1450 Climate Volunteer Network stations reporting precipitation, snow fall and depth, temperature min/max - status as of 2000.

Volunteers report daily by internet or by phone. There are some still reporting monthly on paper forms. After automatic/manual (keypunching) data quality temperature measurements are stored in the electronic archive.

2. Approximately 300 LiG thermometers remain in use in Surface Weather and Aviation hourly observing stations. As well sling psychometers are still standard equipment for Network inspectors.

3. Braking LiG thermometers is frequent occurrence – although MSC does not have supporting statistics the number of replaced units across the country is estimated as reaching few dozens per year

3. Project Objectives

Ultimate goal: replace LiG min/max and ordinary thermometers by electronic "off-the-shelf" digital technology.

Driving force: mercury elimination, improvement of measurement, potential for automation
Milestones:
- technical requirements: collection/"discovery",
- technology market research,
- experience and approaches taken (or not) by other Met services,
- verification tests of technology offered by a market (lab & field) limited in time and space,
- recommendations passed back to the Networks will feed Request For Proposal competitive process.

4. Main Requirements:

- Temperature Range - -60C (-50) +60C (-38C Mercury freezes)
- Accuracy – improve existing (+/- 0.5C); preferable +/- 0.3C in the full temperature range including processing
- Measure real-time ambient temperature
- Measure temperature extremes daily (or between resets)
- No AC power available
- Cost (range of three LiG thermometers)
- Distance from office/home of a maximum 300 m (wireless configuration)

5. Considered Configurations

Configuration 1:

Sensing element with local to Stevenson Screen logger and LCD display

Fig.2 – Configuration 1: local to the temperature screen data logging and display electronics with an external temperature probe

Observer is required, as at present, to go out and take extreme temperature readings from LCD display and reset the device. As direct replacement of present observer standard it is preferred by Volunteer Network configuration.

Configuration 2:

Sensing element with measurement electronics and wireless transmitter in a temperature screen when receiver in the office/house:

- Office/house local display or
- PC running presentation software and/or
- Internet connectivity (potential for automation)

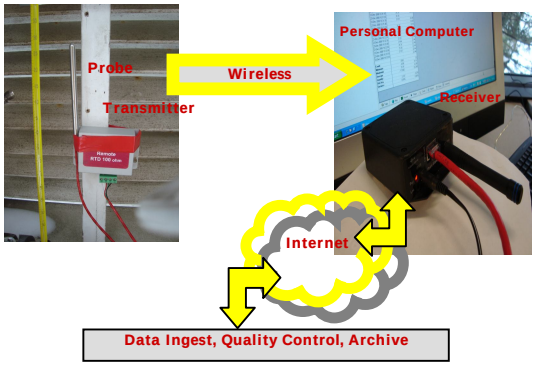

Fig. 3 – Configuration 2: wireless temperature sensor with an autonomous power supply (e.g. batteries) communicating with a receiver in the office/home.

6. Has industry matured?

Available:

- Sensing to -50C with adequate accuracy
- Micro powered electronics to -50C (LCD including)
- Wireless short range (200 m) micro powered temperature sensors with an external probe – no licence required
- Lithium based batteries operating to -50C without extensive charge "degradation" lasting for longer than one year

Not available (not found on a market):

- Single product meeting all requirements and LiG functionality for Configuration 1 (local)
- Single product meeting all requirements with a display other than Personal Computer for Configuration 2 (wireless)

7. Conclusions

- Although technology is available there is a limited number off-the-shelf products meeting MSC measurement and functionality requirements. It may be necessary to influence industry to modify existing products.
- Technical requirements for LiG thermometers digital replacement have to reflect dynamic prosperities of LiG technology.
- In the evaluation of available on a market products laboratory tests in environmental chamber have to proof product adequacy in the whole temperature range before any field tests. Field evaluation does not expose product to the whole required temperature range.

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