

The SM4 snowpack temperature and snow depth sensor

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Snow depth in starting areas

- Continuous monitoring of snow depth in avalanche starting areas is valuable for avalanche forecasting
- Precipitation during snow storms is not accurately measured by precipitation gauges
- Snowdrift in release areas is a major factor in avalanche cycles

Snow depth poles

- Low cost
- Visibility to starting zones is often poor



Ultrasonic snow depth sensors

- Accurate
- Commercially available and well tested
- Sensitive to snow drift, precipitation, icing
- Needs a stanchion that must extend well above the snow pack

SM4 – The instrument

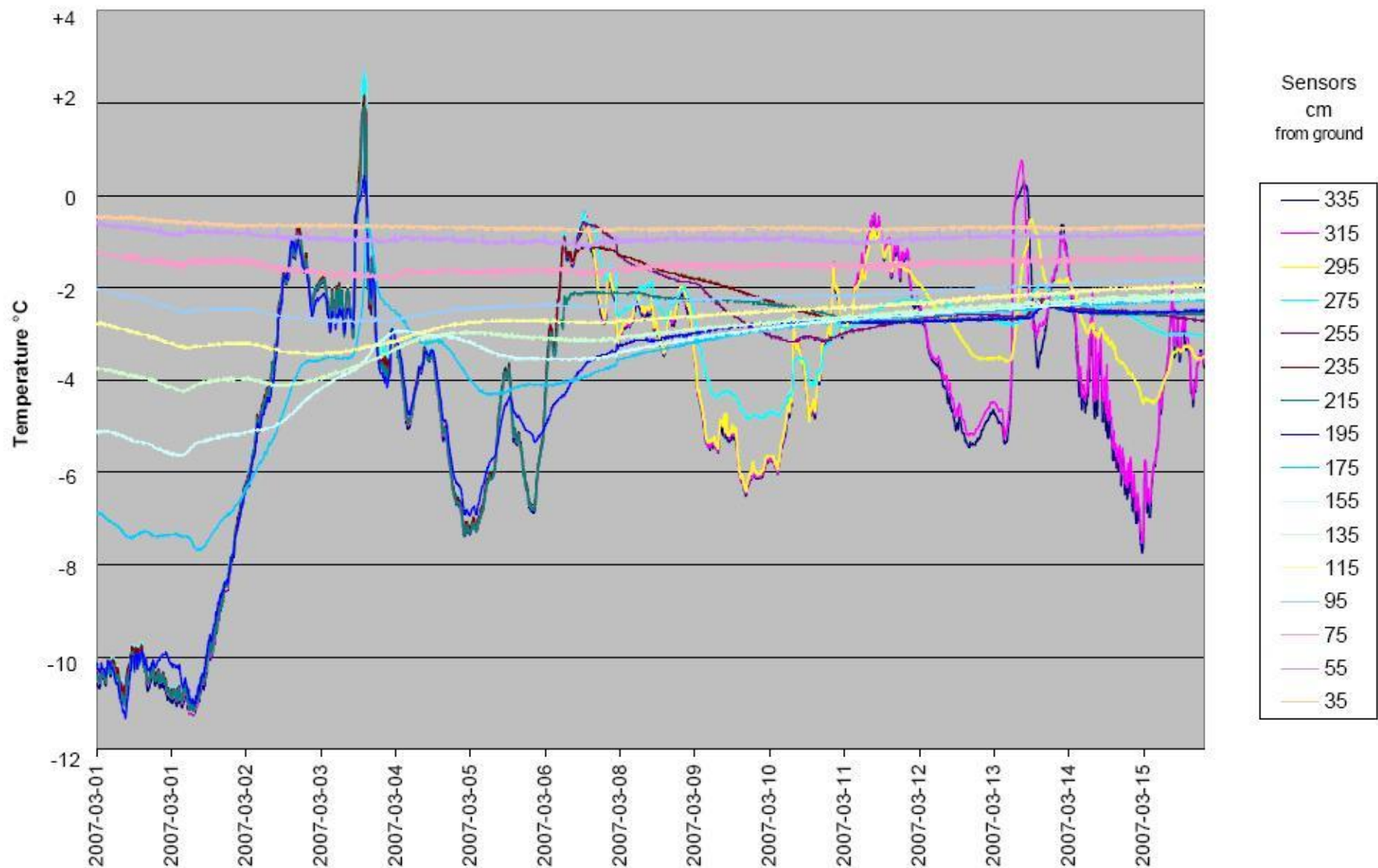
- Consists of a series of digital thermistors mounted with a fixed interval on a pole that extends through the snowpack
- Measurements logged with a few minutes interval to an internal memory card
- Data transferred regularly to a central computer through a wireless GSM telephone connection

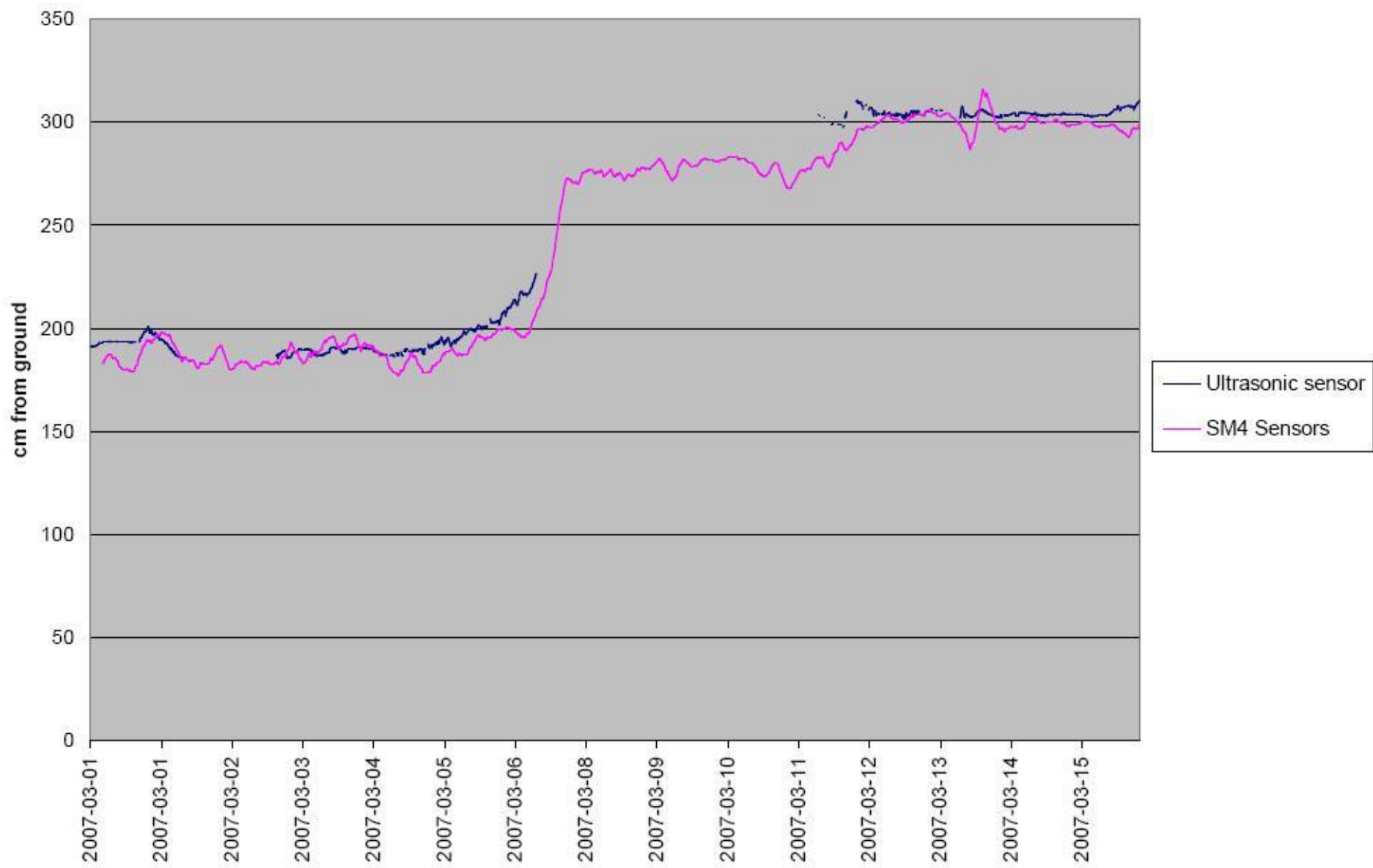


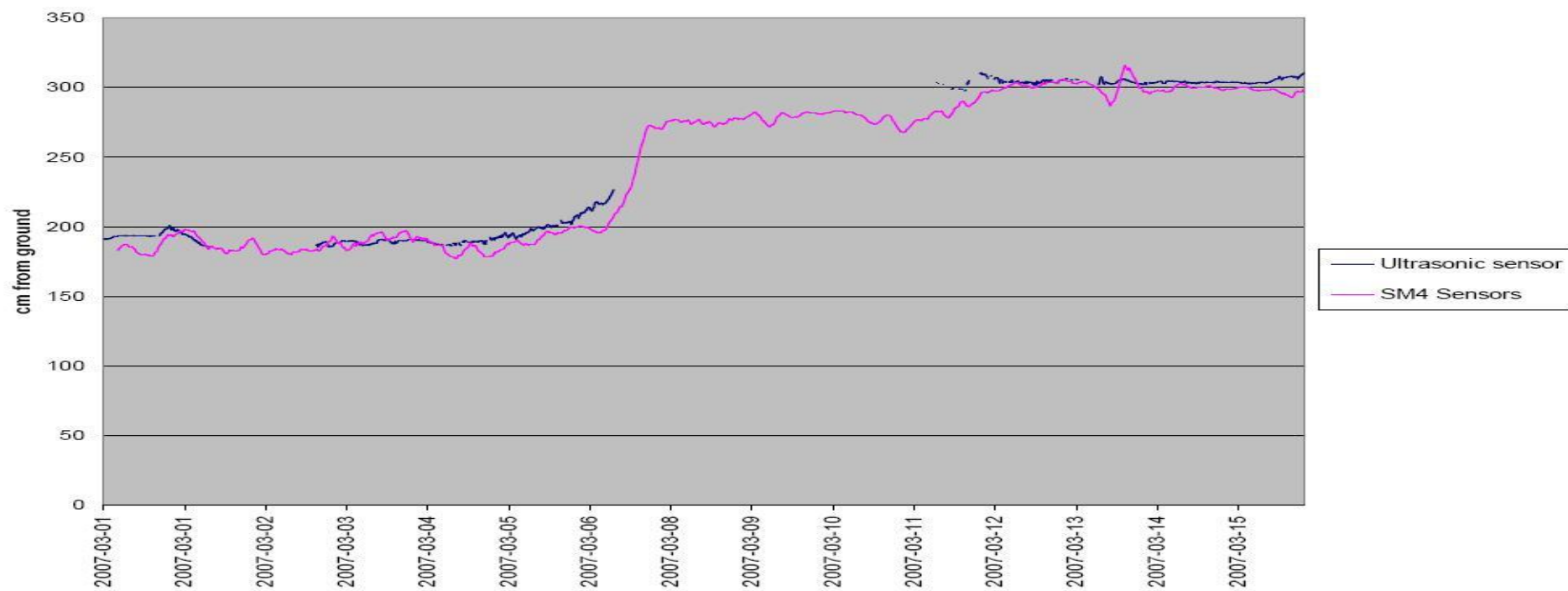
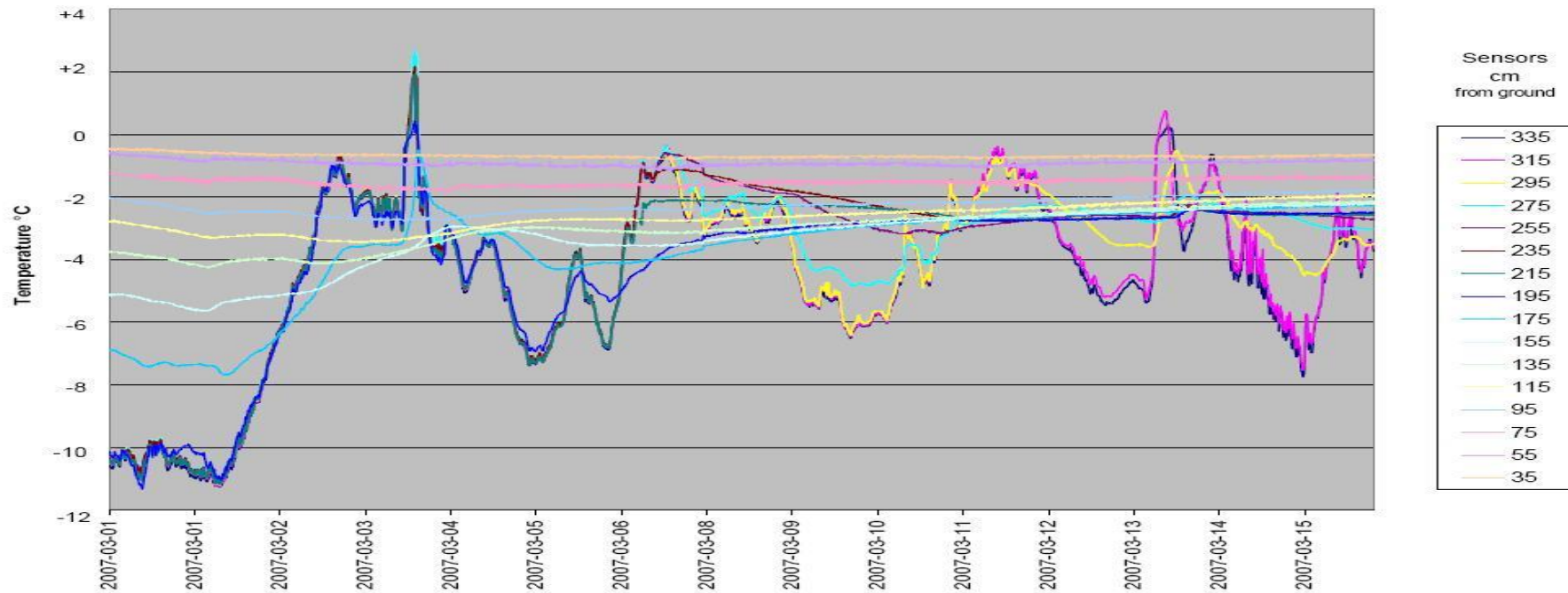
- The SM4 measures snow depth by identifying thermistors buried in the snow based on the damping of temperature fluctuations that is caused by the snowpack compared with temperature fluctuations in air

Results from the first winter

- SM4 was operated together with an ultrasonic sensor for comparison
- The SM4 was able to measure snowdepth with reasonable accuracy

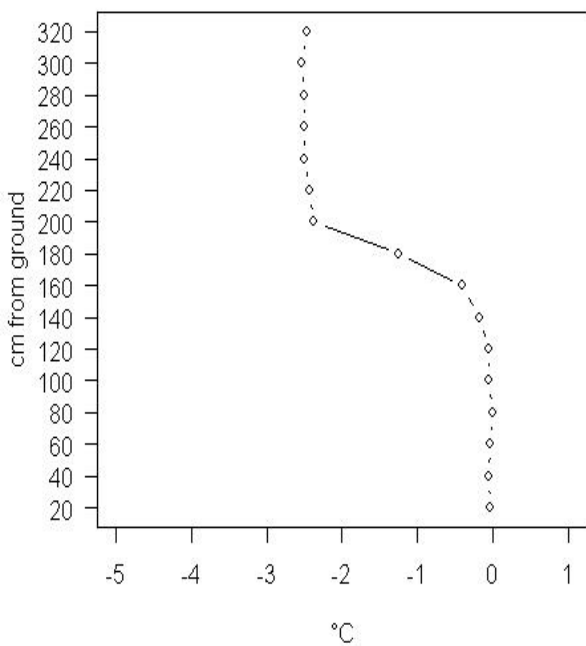






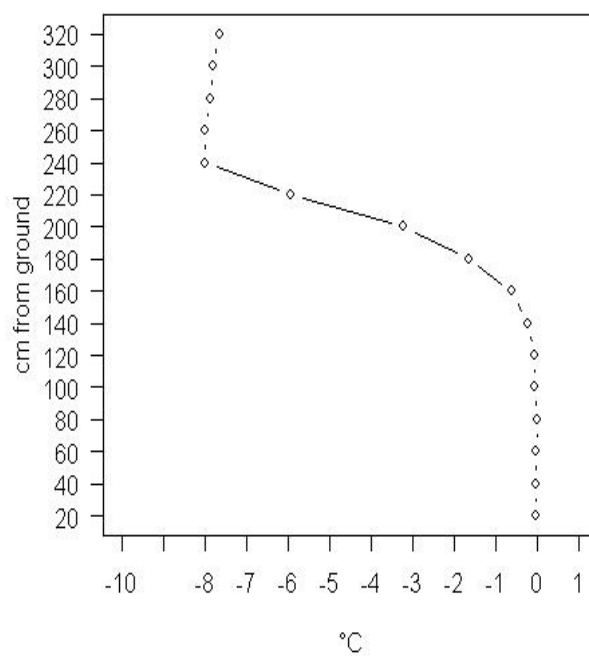
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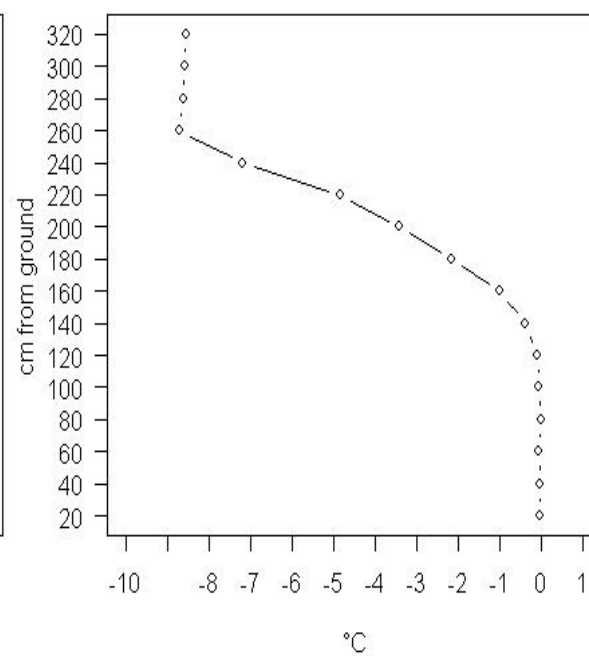
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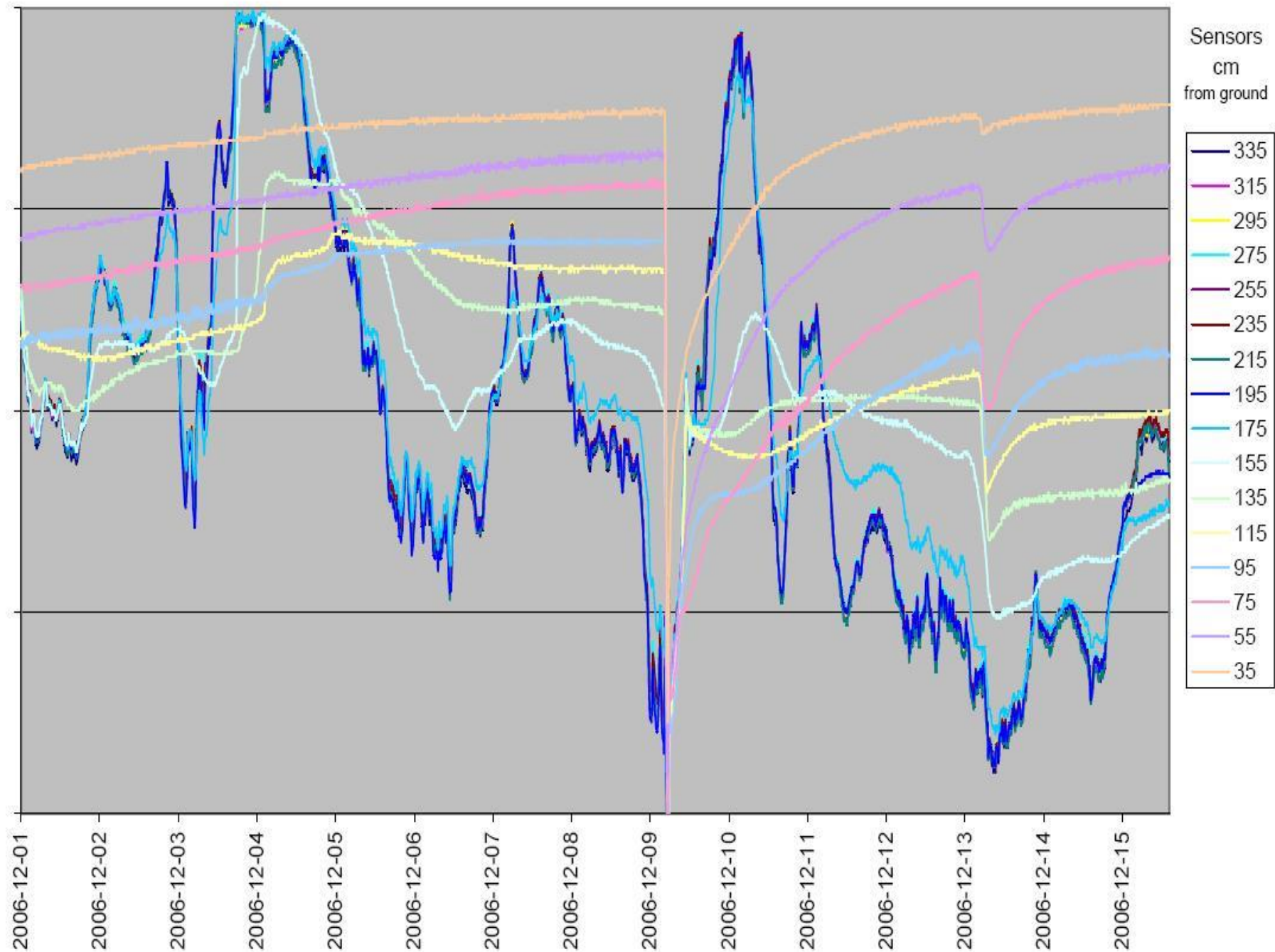


- SM4 was operational during periods of icing when the ultrasonic sensor was unable to operate





Temperature °C



Additional information

- Temperature profile may be useful for avalanche forecasting
 - Processes in the snow pack
 - Effects of thaw periods
 - Effects of sun radiation

Conclusions

- The SM4 is able to measure snowdepth
- Comparison to ultrasonic sensors:
 - The accuracy is not as great
 - The response time is a little longer
 - Easy to install
 - Operational during icing periods as well as periods of precipitation and snow drift

Next steps

- SM4 will be further developed in order to increase it's robustness
- SM4 is now operated by IMO in three starting areas together with ultrasonic sensors
- SM4 is located in a test pit site
 - The identification of weak layers

A photograph of a snowy mountain peak at dusk. The foreground shows two snow-covered poles or cables. In the background, a city with lights is visible next to a lake. The sky is a deep blue.

Thank you!