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An oscillating microbalance for meteorological measurements of ice and volcanic ash accumulation from a weather balloon platform

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A new, low cost, instrument has been developed for meteorological measurements of the accumulation of ice and volcanic ash that can be readily deployed using commercial radiosondes and weather balloons. It is based on principles used by [1], an instrument originally developed to measure supercooled liquid water profiles in clouds. This new instrument introduces numerous improvements in terms of reduced complexity and cost. It uses the oscillating microbalance principle, whereby a wire vibrating at its natural frequency is subjected to increased loading of the property to be measured. The increase in mass modifies the wire properties such that its natural frequency of oscillation changes. By measuring this frequency, the increase in mass can be inferred and transmitted to a ground base station through the radiosonde's UHF antenna via the PANDORA interface [2], which has been previously developed to provide power and connection to the radiosonde telemetry.

The device consists of a simple circuit board controlled by an ATMEGA microcontroller. For calibration, the controller is capable of driving the wire at specified frequencies via excitation by a piezo sounder upon which the wire is mounted. The same piezo sounder is also used during active operation to measure the frequency of the wire in its non-driven state in order to infer the mass change on the wire. A phase-locked loop implemented on the board identifies when resonance occurs and the measured frequency is stable, prompting the microcontroller to send the measurement through the data interface.

The device may be used for any application that requires the measurement of incremental mass variation e.g. ice accumulation, frosting, or particle accumulation such as dust and volcanic ash. For the solid particle accumulation, a low temperature, high-tack, adhesive may be applied to the wire prior to deployment to collect the material. In addition, the same instrument may be used for ground-based applications, such as ice accumulation, with direct monitoring via a serial connection or logged to removable storage media in the absence of the radiosonde.

References

[1] Hill, G.E. and Woffinden, D.S. (1980) Journal of Applied Meteorology, 19, 11, 1285-1292
[2] Harrison, R.G., et al. (2012) Rev. Sci. Instrum., 83, 3