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Comment on gi-2022-18

Anonymous Referee #1

Referee comment on "Design and Performance of the Hotrod Melt-Tip Ice-Drilling System" by William Colgan et al., Geosci. Instrum. Method. Data Syst. Discuss., https://doi.org/10.5194/gi-2022-18-RC1, 2022

This paper presents a very detailed account of design, together with very limited engineering data from laboratory and field tests, for a 2 m long, 5 cm diameter thermal ice drill intended to emplace thermistor strings vertically in ice sheets and glaciers. Electrical power (typically 1-6 kW) is supplied by a gasoline generator on the ice surface and conveyed to the drill via a tether paid out from the surface. The drill differs in various particulars (e.g., in using custom-made electrical cartridge heaters to try to direct heat preferentially along one axis), but is not fundamentally different in concept from many predecessors of similar size described in the literature.

The laboratory test data comprise 5-6 runs in pure ice at constant powers of 1.1-2.7 kW to depths of ~2 m in a 1 m diameter ice column at approximately -10 C (cf. pg. 12 and Fig. 2). Initial field tests are reported to "< 1 m" depth in lake ice near Thule Air Base in Greenland, ice temperature unspecified, at power levels 1.5-4.5 kW, with corresponding descent rates of 3-5.6 m/hr (Figure 2). A melt-hole diameter of 7 cm in the lake ice is reported (in apparent contrast to the laboratory cases). Two probe runs are also reported in an ice sheet ablation area near Thule at low but unspecified elevation, where ice was perhaps as thick as 44 m. No information on ice temperature, neither near-surface nor versus depth, is given. The first run reached 5 m depth over 3 hours using 3 kW of power, but was arrested by an accumulation of sediment at the bottom of the melt hole. The second run, initiated 2 m laterally distant from the first, reached 21 m depth over ~9 hours using 4.2 kW of power, before encountering a sediment layer which may have been detected independently by radar at that depth. There is no mention of melt-hole diameter in these latter two runs.

In the course of reviewing this paper, I re-read a number of literature accounts of lightweight thermal drilling efforts in the past, including Nizery (1951), LaChapelle (1963), Classen (1967), Gillet (1975), Taylor (1976), Rado et al. (1987), Kelley et al. (1994), and German et al. (2021) (none of which are referenced by the authors), as well as Dachwald et al. (2014), Zagorodnov et al. (2014) and Heinen et al. (2021) (which the authors do reference, albeit incorrectly in the case of Heinen et al.). These accounts all provide more detailed test results for ice penetration, to greater depths or (in the case of German et al.)

with greater scientific return, than is the case in this paper.

I am therefore presently without a clear, compelling answer to the question of what scientific or engineering contribution this paper adds to the existing literature. (A detailed design alone for a probe not shown to offer any new capability does not qualify, in my view.) Neither is this question addressed in the paper so far as I can see. I would be open to an argument for what such a contribution could be, but absent such an argument at present, I am unable to recommend this paper for publication.

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