MUNI

HABILITATION THESIS REVIEWER'S REPORT

Masaryk University	
Applicant	Mgr. Filip Hrbáček, Ph.D.
Habilitation thesis	Active layer thermal regime and thickness in Antarctica
Reviewer	RNDr. Jan Šafanda, CSc.
Reviewer's home unit, institution	Institute of Geophysics, Czech Academy of Sciences

The habilitation thesis "Active layer thermal regime and thickness in Antarctica" submitted by the habilitation candidate summarizes the results of his research conducted at the Czech Antarctic Station of Johann Gregor Mendel on James Ross Island and some other regions of Antarctica. The research done by the applicant over the past decade builds also on the previous observations carried out since the establishment of the station in 2005 and contributes thus to the further exploitation of the collected data.

The scientific results achieved by Dr.Hrbáček are presented in a form of a comprehensive internally consistent thesis documented by 16 papers published in appropriately chosen recognized journals. The candidate is the first author in 12 of them. The thesis's supplement provides a list of the papers with their abstracts and also their full copies. Most of the papers are collaborative ones with several to many authors. The fact that applicant is the first author in 12 of them testifies for his well established and recognized role in the international research community.

The numbering of papers reflects the temporal and spatial development of the research. The papers are formally presented in three groups according to the individual stages of the methodological and temporal progress of the research and its areal extent. The papers belonging to the first group (Papers 1-6) address the factors influencing the active layer properties and dynamics like air temperature, snow cover, physical properties of soil and vegetation cover. These findings were published as a set of case studies and provided the base for interpretation and modelling of long-term observational series of air and ground temperatures, thickness of the active layer, soil moisture and some other parameters. Results of these research activities are described in the second group of papers (Papers 7 – 12). The third group (Papers 13 – 16) demonstrates involvement of the author and his collaborators in the international cooperation with scientists working in other parts of Antarctica and

interpretation of the results from James Ross Island in a context of the whole ice-free Antarctic territory.

The thesis is structured consistently with its outlined objectives and provides answers to three key research questions:

1) How do the thermal regime and thickness of the active layer vary across different sites on James Ross Island, and what are the key factors influencing this variability?

2) What is the reliability and performance of the models used for predicting active layer thickness and temperature on the top of permafrost in Antarctica?

3) What are the spatial variability and temporal trends in the active layer thermal regime and thickness in Antarctica?

In reference to these questions the candidate concludes that (1) The spatial variability of the active layer thickness on James Ross Island amounts to several decimetres. The main sources of variability are differences in the soil lithology; (2) The two models used to predict active layer thickness from the air and/or surface ground temperatures, namely the Stefan model and the Kudryavtsev model, provide satisfactorily accurate results in conditions of the James Ross Island. The same is true for the air temperature-based permafrost temperature reconstructions by the Temperature-at-the-Top-of-Permafrost (TTOP) model; (3) The spatial variability of the active layer thickness ranges between several centimetres to more than 1 m across the ice-free Antarctica. No statistically significant temporal trends were detected.

The concluding chapter of the thesis outlines perspectives for upcoming research of the active layer, including implementation of standardised soil moisture monitoring, valid not only for the James Ross Island, but for the whole Antarctic region where the active layer is present.

The thesis represents a clear picture of the achieved results and a coherent vision for the future research. It is evident that the candidate and his team belong to the international leaders in the permafrost and active layer research in Antarctica.

The technical quality of the thesis is very good. I found minimum of imperfections like 24 °C instead of -24 °C (page 32) or missing references Farzamian et al.(2023) and King and Comiso (2003) or differences between the year of a publication in the text and in the list of references (Gisnas et al., Ugolini & Bockheim, Robinson et al., Westermann et al., Wlostowski et al.).

Reviewer's questions for the habilitation thesis defence (number of questions up to the reviewer)

Contrary to Fig.7 in paper Biskaborn et al. (2019), the mean annual temperature versus depth profile in Fig.2 of the thesis does not show a minimum at the base of the active layer. Is it based on the James Ross Island results?

A potential source of the temperature-on-the-top-of-permafrost history is a temperature-depth profile in the upper several hundred metres. Even about 100 m deep well (going below permafrost base?) would provide a lot of information. How (un)realistic is such a drilling at JGM station?

Might it be that the extent of ice-free areas, 45,000 to 55,000 km^2, represents not 0.2 % (as mentioned on page 9), but 0.3 – 0.4 % of the entire Antarctica (about 14 mil. km^2)?

Conclusion

The habilitation thesis entitled "Active layer thermal regime and thickness in Antarctica" by Mgr. Filip Hrbáček, Ph.D. **fulfils** requirements expected of a habilitation thesis in the field of Physical Geography.

Prague, September 18, 2025 Signature: