

HABILITATION THESIS REVIEWER'S REPORT

Masaryk University

Applicant

Mgr. Filip Hrbáček Ph.D.

Habilitation thesis

Active layer regime and thickness in Antarctica

Reviewer

Doc. Mgr. Jan Kropáček Ph.D.

Reviewer's home unit, institution

Department of Physical Geography and Geoecology,
Faculty of Science, Charles University

The present review concerns the habilitation thesis submitted by Mgr. Filip Hrbáček Ph.D. entitled 'Active Thermal Layer Regime and Thickness in Antarctica', in the field of physical geography, for the purpose of obtaining the *venia legendi* (habilitation).

Summary of the Thesis

The evaluated thesis deals with the dynamics of the active layer (AL) of permafrost covering the ice-free surface of Antarctica. The main research objectives and research questions are given in three separate points. They are all elaborating on the central question which can be generalized as follows:

What are the parameters and spatio-temporal variations of AL in ice-free Antarctica and performance of related predictive models with special attention to James Ross Island?

The main study area is the James Ross Island hosting the field research station operated by MUNI and several sites on the South Shetlands, however the spatial focus of the thesis was largely extended by CALM-S (Circumpolar Active Sites in Antarctica) sites on ice-free Antarctica. The included articles are based on the data of this network and importantly on own measurements from James Ross Island. The analysis part of the work involved modelling efforts, laboratory work and geophysical surveying.

The thesis is cumulative publication-based, the introduction part is followed by 16 high-quality research papers. The status of one of the papers is 'accepted'. The papers have been published in the time span from 2016.

The introduction part of the thesis of more than 30 pages provides an overview of the research addressed in the papers and includes an overall summary and conclusions. At the very end, the author suggests several avenues of further research of AL in Antarctica. The quality of the introduction section could be even improved by adding a synthesis chapter contextualizing the presented findings within current cryosphere and climate research in Antarctica.

The text of the thesis is well organized, and it presents the 16 papers embedded in a coherent story. The first several papers are focused on characterisation of AL on single localities, in further papers, the focus moves towards modelling efforts, and it is followed with

studies on spatial variability of permafrost properties in ice-free Antarctica. While the objectives are clearly stated at the beginning, the hypothesis and definitions of research gaps presented in the introduction section which are somewhat scattered, could be perhaps gathered in a dedicated section.

Scientific Context and Relevance

The thesis summarizes the results of the candidate's long-standing research of the AL in Antarctica conducted in the frames of international collaborations. Although based on point measurements the spatial focus of the thesis is the vast extent of the ice-free Antarctica.

The importance of this thesis focused on the cryosphere in Antarctica is given by its context, namely the impact of the ongoing climate change. The thesis largely contributed to our knowledge about the dynamics of the cryosphere on continental scale. The presented studies were conducted by largely international teams which promotes the bridges between Czech polar science and international polar research community.

The author deeply explored the relation of AL parameters to local environmental conditions such as lithology and soil moisture by comparing AL reaction on various localities. An important contribution of the thesis is the integration and analysis of data on AL of the CALM-S project, addressing thus the impact of global warming on the cryosphere in Antarctica, a continent being observed with great attention due to its potential impacts on the global environment.

Until recently, the knowledge about AL in ice-free Antarctica has been relatively sparse and somewhat fragmented, due to remoteness and extreme conditions prevailing on the continent. A major step in this context is represented by Paper 16 which is a thorough review of existing research published in highly prestigious Earth Science Reviews journal in 2023. This paper can be seen as the major highlight of the presented thesis.

Assessment of Scientific Quality

The presented research features novel methodical improvements and approaches. The research has high scientific relevance and potentially significant societal impact.

The second part of the thesis contains 16 research papers, most of them in highly esteemed IF journals. Dr. Hrbáček is the main author in 12 of them. This is clear evidence of the candidate's scientific quality. Initially, the articles were co-authored by fellow colleagues from MUNI, later the co-authors teams were extended with researchers from various other research institutions mainly in abroad. This points out the networking capability of the habilitation candidate and the international acceptance of his work.

The scientific quality of the candidate is underscored by the recent award of prestigious ERC-CZ grant dealing with soil moisture and its future impact on the thermal regime and stability of permafrost in Antarctica, a topic indeed related to the presented theses.

In summary, habilitation thesis presented by Dr. Hrbáček's represents an outstanding contribution to the field of physical geography, specifically within permafrost research and cryosphere studies.

The habilitation thesis demonstrates the candidate's ability to conduct independent, high-level research in the field of physical geography. In my opinion, the thesis fulfils the requirements for habilitation, and I fully recommend its acceptance.

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

1. What is the potential of older active layer measurements in Antarctica initiated in the 1960? Could the data be used for an extension of the time series of more recent measurements that you have used in your studies?
2. What development can be expected in terms of active layer properties and distribution in ice-free Antarctica with advancing climate change? Will active layer in West Antarctica just get gradually thicker with rising temperature or can we expect more complex development, for instance some variations in its distribution due to precipitation, snow cover and freeze/thaw cycle changes? Is active layer in East Antarctica likely going to remain stable over next several decades? What will be the consequences of these developments in both East and West Antarctica and are there going to be any impacts to the society?
3. You have used above, on and below surface measurements on number of point stations. Low resolution passive microwave sensors and scatterometers which have been extensively used in the studies about arctic and Tibetan permafrost provide spatially explicit data about land surface and additionally feature ground penetration capability. Do you see any potential to use them in your research? Similarly, do you see potential of land surface temperature (LST) measured by satellite thermal on Landsat and Sentinel-3 satellites for the investigation of active layer?

Conclusion

The habilitation thesis entitled "Active Thermal Layer Regime and Thickness in Antarctica" by Filip Hrbáček **fulfils** requirements expected of a habilitation thesis in the field of physical geography.

Date: 20 September 2025

Signature: Jan Kropáček